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PEOPLE, BUILDINGS AND ENVIRONMENT 2012

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FACULTY OF CIVIL ENGINEERING
INSTITUTE OF STRUCTURAL ECONOMICS AND MANAGEMENT
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PREFACE

The International Scientific Conference "People, Buildings and Environment 2012" thematically follows previous successful years. The 10th run is a welcome possibility for meeting experts and exchanging research experience from many countries of the world.

Increasing interest of participants not only from the Czech Republic but also from foreign universities shows that sharing and discussing conference research topics seems really necessary.

The conference brings possibility to present new results in four research topics. This year's topics are following the past – Construction Economics and Management, Water Management and Water Structures, Landscape Management and University Teaching and Learning of Civil Engineering.

Our experience from teaching process and necessity of innovation in our teaching programmes confirm the correctness of decision from 2010 year to establish the new section called "University Teaching and Learning of Civil Engineering". What is more we need to share experience and obtain new ideas to support the development of our students' education.

The conference "People, Buildings and Environment" could not take place without the generous help of many people. In particular, I very much appreciate the hard work and dedication of the scientific committee and other reviewers. Without their enthusiasm to do more than 248 reviews of the papers would be impossible. I want to give my cordial thanks to the main coordinator Tomáš Hanák and the entire conference staff. It has been great to work with them, and their effort has made this conference possible. Thanks also to the authors of papers.

I wish all participants a pleasant stay at this year's conference, which takes place in beautiful premises in Lednice. I am convinced that mutual cooperation and communication as well as sharing experience and new knowledge can enrich all of us.

I hope you will enjoy the conference!

Jana Korytárová

KEYNOTE LECTURE

ON THE DESIGN OF A SURVEY TO MEASURE EFFECTIVE COMMUNICATION IN BUILDING

Carles Serrat[1], Sonia Rodriguez[2], Núria Forcada[3]

Abstract

Although effective communication is identified as a key indicator of project performance, communication aspects on contractors' evaluation are not yet included. This paper aims to review the most relevant contributions on the specific literature in order to design a survey to test for the parameters that affect effective communication among Construction Agents (CA), i.e. PM's, builder, designer and other professionals participants, during the construction process of the project. The survey will be based on the experience and perceptions of the corresponding professionals in Spain. The availability of these parameters is crucial and it represents basic information for developing procedures and tools for the evaluation and selection management of CAs.

Key words

Construction management, construction projects, criteria assessment, effective communication.

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1 INTRODUCTION AND GOALS

"The correct choice of construction contractor(s) is a critical function of either the client or the client's consultant/project manager, that usually has a significant impact on the success or otherwise of a project" (Kumaraswamy, 1996 [1]). Within this context, several factors must be considered in the selection process in order to predict the success of a construction project. Communication is the most important skill for an effective project leader (Odusami, 2002 [2]). It can integrate the management of different areas of a construction project; it is a basic tool for continuous improvement through process enhancement and thus the resulting increase in competitiveness. It allows the implementation of tools for innovation, and most importantly, it helps to adapt the changes and improves response times to them in the execution of a construction project. Communication is classified as one of the most important skills for the project manager, attributable to long-term profitability (Gushgar *et al.*, 1997 [3]). Jha and Iyer (2006) [4] found that the critical factors affecting quality performance in construction projects are the 'human element rather than machinery' and 'good communication among people'.

Effective communication has been identified as a key indicator of performance in an evaluation model of a successful construction project (Yeung *et al.*, 2009 [5]), also lack of communication has been identified as one of the critical factors of delays in building projects (Doloi *et al.,* 2012 [6]). Although, there are a number of criteria and methods proposed for an appropriate choice of contractors, communication is rarely considered. The evaluation of the communication process includes an analysis to identify and select suitable factors and objectives and measurable characteristics that can be attributed to the communicative process.

Also, not only is the contractors' evaluation important to achieve project objectives but also the selection of Construction Agents CAs (CAs in this paper are professionals involved in the construction process, such as owner or project manager, builder, designer and other participants defined by the Law in Spain [7]) is essential.

This paper aims on one hand to explore the state of the art on effective communication in building projects and, on the other, to design a survey for the professionals in Spain in order to determine, in a future research, the parameters that affect effective communication among CAs during the construction process of the project.

The structure of the paper is as follows. In Section 2 the state of the art on the parameters of interest will be introduced. The details of the survey will be developed in Section 3 and the paper will finish with a future research section.

2 STATE OF THE ART ON PARAMETERS INVOLVED IN THE COMMUNICATION PROCESS

"Communicating involves the exchange of information. The sender is responsible for making the information clear, unambiguous, and complete so that the receiver can receive it correctly. The receiver is responsible for making sure that the information is received in its entirety and understood correctly" (Project Management Institute PMI, 2000 [8]). Hargie (1986) [9] argues that successful social communication is a skill that involves the effective interaction among people. For Gayeski (1993) [10], the communication is essentially the transfer of information among people and it is determined by the rules and norms of social behaviour as people translate their meaning and use the information. With rules and proper tools the usefulness of information can be improved. Stanton *et al.* (2007) [11] identify

communication as *"the verbal or nonverbal transmission of information between someone who wants to express an idea and who hopes to grasp or is expected to grasp"*.

From these definitions it can be identified that the communication process involves: emission of signals (sound, symbols, gestures, signs, etc.) with the intent to publicize a message, for communication to be successful, the receiver must have the skill to decode the message and interpret it and the process is reversed later when the recipient responds and becomes the issuer. And that the elements of the process are the Code like a system of signs and rules that are combined with the intention of disclosing something, the Medium that is the physical medium through which information is transmitted, the Sender, the Receiver and the Noise (a disturbance which interferes with the normal development of the signal in the process like distortions of sound, the fluency of the speaker, spelling errors, etc.).

The Project Management Institute (2000) [8] defines nine project management knowledge areas: Integration, Scope, Time, Cost, Quality, Human Resource, Communications, Risk and Procurement. Communication Management includes the process required to ensure proper collection and dissemination of project information. It consists of communication planning, information distribution, performance reporting, and administrative closure. Project Communication Management should provide the critical link among people, ideas and information that are necessary for success. Also, communication is an important influence factor on the success of a safety management system for construction sites (Ismail *et al.,* 2012 [12]).

Many researchers have explored the issue in order to determine the characteristics of effective communication. For Dainty *et al.* (2006) [13], effective communication is based on; the efficiency with which the coded information is transmitted through communication systems, channels and networks, the suitability of media and channels used, and how those receiving the communication decodes, interprets and acts accordingly and the ability to minimize noise that might impede the process. On the other hand, a lack of clear objectives, information overload, a channel or inappropriate media, problems of perception and attitude, the physical distance in relation to the means chosen, and the length of the chain of transmission, are factors that cause difficulty in communication (Baguley, 1994 [14]).

In relation to the use of different channels and media, Dainty *et al.* (2006) [13] also mentions that the correct choice depends on four main criteria: a) the amount and importance of information required: in terms of quantity, there are different channels that transmit different amounts of information. b) Instant information required: defined by the moment of transmission required. c) Effective communication: referring to the accuracy of the information transmitted. In this case, bidirectional communication is important. d) Efficient communication: related to the speed of transmission of messages, depending on the distance of transmission.

Tucker *et al.* (2001) [15] determine that the key to project information management, though, consists of the information flows associated with inter-organisational communications. The inter-intra organisational structures such as alliances, establishes communication mechanisms and helps to achieve an efficient and effective communication; which is essential to achieve the objectives of a construction project (Cheng *et al.*, 2001 [16]). It is determinant for effective information management and thus for communication among all professionals linked to the construction process during the whole lifecycle of the project. Short and informal lines of communication as well as regular construction control meetings among project teams further support the achievement of the desired quality level in a construction project (Jha and

Iyer, 2006 [4]). According to Busseri and Palmer (2000) [17] communication between team members and with personnel outside of the team improves work performance, quality and effectiveness and an important tool to achieve this communication are team meetings.

Information plays one of the most important roles for effective communication. Information should not be excessive, should be clear, must be available to personnel who need it, and should be easy to understand and accessed. The construction industry has for many years suffered from difficult-to-access, out-of-date and incomplete information (Shoesmith, 1995 [18]). A core issue is the effective management of information, both in the form of information flows that permit rapid inter-organizational transactions between project participants, and in the form of information accumulated, coded and stored in firm database structures. Therefore, timely and accurate information is important for all project participants because it forms the basis on which decisions are made and how physical progress is achieved (Mohamed and Stewart, 2003 [19]). It is recognized that it is a challenge, establishing effective communication in dynamic conditions and more, given the combination and amplification of the effect of the dynamics of three elements: complexity, uncertainty and speed. Since construction projects today are more technologically complex, the structures are larger, built in crowded urban places, combining the most advanced and complex systems, and resulting in more information to flow from a greater number of personnel at any given time more quickly (Laufer *et al.*, 2008 [20]).

3   SURVEY DESIGN

After studying and analysing the main references on communication process and identifying the factors that can affect it, in this Section we define the parameters of interest, the target population and the survey itself.

3.1   Parameters of interest

Five parameters were selected as they were considered as the most important that may be associated with measurable and/or evaluated characteristics: a) The Organization, b) Communication Management, c) Media and Channels, d) Quality of Information and e) Communication Quality in each Area of the Building Process Management.

a) The Organization or structure established for communications flow. Organizations are structures composed of people, to achieve goals and objectives through the use of resources. To achieve these objectives effective communication is required. Through it organization members get information about their organization and the changes that are generated within it. Planning, organization and control are achieved only through communication and integration of administrative functions. And, this in turn is affected by the characteristics of the organization: size of the organizations (Armstrong, 2001 [21]), information flows (Tucker *et al.*, 2001 [15]), shape of lines of communication (Jha and Iyer, 2006 [4]), etc. An efficient and effective communication is linked to the organization type and its features (Cheng *et al.*, 2001 [16]).

b) Communication Management involves planning, developing strategies, tools and techniques to achieve communication objectives. Communication Management promotes communication between members of the organization, facilitates the integration between corporate goals and the staff objectives, increases the cohesion of team members and reduces sources of conflict, as well as contributing to the creation

of spaces for information, participation, opinion and improves the final product. Being included as one of the nine project management knowledge areas by the Project Management Institute (2000) [8], it is necessary to assess their specific impact on the quality of the communication process.

c) Media and Channels are the shape and physical medium used for transmission of communication. A proper selection of Media and Channels depends on the amount or importance of information to send (Dainty *et al.*, 2006 [13]), the geographic location of the project management team, the number of receivers (Armstrong, 2001 [21]), and the characteristics of the available channels such as transmission speed, capacity, quality, noise reduction, etc.

d) Information is the message itself of all communication. An effective communication should start with Quality of Information. Clearly the position of its relationship to the other parameters chosen is important.

e) The relationship between the degree of communicative quality of the different areas of knowledge or the existence of a communication design in each of them is a factor affecting the integral communication quality of project development.

3.2   Target population

For the selection of the sample and given the geographical framework of the investigation, the CAs should be defined. In Spain, CAs are defined and regulated by the Law 38/1999 of 5 November (*"Ley de Ordenación de la Edificación - LOE"*) [7]. In addition to the owner, designer, builder and product providers, in Spain there are other agents to ensure a good technical, economic and functional building through the allocation of technical responsibilities. These are: the Facultative Manager, which is formed by the Construction Manager and the Execution Manager. The Construction Manager leads the technical aspects of the development of work, e.g. aesthetic, urban and environmental agreement to the project, the license, contracts, etc. His responsibility, moreover is of the final certificate of the work, is to act as a technical consultant and give solutions if required. The Execution Manager leads the implementation of the work and controls the quantity and quality of the construction. The Execution Manager is permanently based on site and his role is more practical in nature than the Construction Manager, but his responsibilities are no less limited than the Construction Manager. However, he is less qualified and experienced than the Construction Manager.

For Facultative Manager, Construction Manager, Execution Manager and Designer agents the law demands that they employ an AC such as an Architect, Technical Architect, Engineer or Technical Engineer, as appropriate, and meet the conditions required by their profession. The AC depends on the form and function of the building to be constructed. In this way, variables like Professional Title or the Experience as CA should not be disqualified in the analysis. Similarly, the perception in terms of Years of Experience could be something that at first glance may not be readily identifiable.

The target population consists of registered professionals in the Professional Associations in Spain, with reference to the construction sector. The distribution of the survey and collection of information was done through an online survey website (Encuesta Fácil, 2010 [22]). The service of an online survey allowed quick and easy access to the survey through a link in addition to a systematic collection of responses. It also allowed the design of the survey to be customized to the requirements of the study.

3.3 Survey specifications and structure

To evaluate the influence of the communication parameters and its features, single-selection test questions organized into a matrix were used. The same type of question was asked throughout the survey, allowing consistency in the overall scheme.

The scale chosen for the survey was a 5-point ordinal scale: Very High, High, Medium, Low and Very Low or, in some cases, Very Good, Good, Regular, Bad or Very Bad.

The survey was schematically divided into three parts and the estimated average time spent in responding was approximately 10 minutes:

- The first part identifies the profile of the respondent: Professional Title, Experience as CA and Years of Experience.
- The second part allows the respondent to assess the importance of the selected communication parameters in the communication process.
- The third part allows the respondent to qualify the characteristics of the factors assessed in the second part of the survey or its importance to communication parameters.

3.4 Collection data

Initially in Catalonia, the management for the distribution was conducted in collaboration with the Institute of Statistics and Applied Mathematics to Building (IEMAE) and of School of Building Construction of Barcelona (EPSEB) from the Polytechnic University of Catalonia (UPC) with the valuable collaboration of the Professional Associations. For the rest of the Spanish territory, the survey was sent directly by e-mail to the associates. A total of 90 surveys were completed in Catalonia and 422 questionnaires were received of 5480 e-mails sent to the associates in the rest of Spain. So, the resulting sample size of the dataset for future analyses was 512.

4 FUTURE RESEARCH

Once data have been collected many analyses are possible in order to test which parameters are actually involved in an effective communication process, as well as to look for tools for the evaluation and selection management of CAs. More details on the survey proposed in this paper and some preliminary findings based on the analysis of the data can be found in Rodriguez *et al.* (2012) [23].

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COLLABORATIVE PLANNING PRACTICE FOR SUSTAINABLE BUILDINGS - A CASE STUDY RESEARCH

Iva Kovacic[1]

Abstract

The current efforts for the realization of nearly zero-energy buildings focus primarily on the calculation methodology and development of technologies for building services and building hull. Little effort has been made to crucially rethink the design and planning processes for such buildings. The complexity of boundary conditions and planning aims for energy-efficient buildings has significantly risen – number of process-stakeholders, as well as the number of the tools and methods that are used. However, "green" buildings are mostly planned with traditional planning methods based on sequential planning model. We argue that energy-efficient and even energy-producing buildings can be realized only through more integrated, collaborative, life-cycle oriented design and planning processes.

This paper will present the results of the study carried out within research project "Co_Be": Cost Benefits of Integrated Planning at Vienna University of Technology. The research was based on practice-oriented case-study of design and planning process of five energy-efficient, sustainable office buildings in Austria and Germany. The applied methods included open-ended interviews with planning process stakeholder (investors, architects, engineers, facility managers), creation of so called project story; and post-occupancy evaluation of the buildings.

In order to propose a collaborative planning strategy the shared problems and bottle necks in planning process of complex projects such as energy-efficient buildings; as well as the crucial criteria for successful design, construction and management of such buildings were identified.

As the final project result a guideline for clients, investors and public policy was developed.

Key words

Building performance evaluation, energy efficiency, integrated planning, post occupancy evaluation.

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1   INRODUCTION

Point of Departure

The realization of energy efficient, even energy producing buildings counts to the major measurement for the achievement of the climate protection aims of the EU [1].

Thereby, the interdisciplinary, integrated planning (IP), due to the complexity of planning and building process for energy efficient building, is considered to be the advised approach. In the practical implementation of the integrated planning is however connected with several problems:

IP as often mentioned as appropriate method by the literature is still seldom practiced. The planning practice of Central European region is largely dominated by the strong, historically founded separation of disciplines, which is also reflected in the fee structures for architects and engineers. There is lack of know-how and experience for integrated planning on the planner and investor side; as well as a lack of support or incentives on the public policy side.

Further on, greater planning effort is necessary for the planning of sustainable buildings, due to the complex coherence of building geometry and innovative technology and materials.
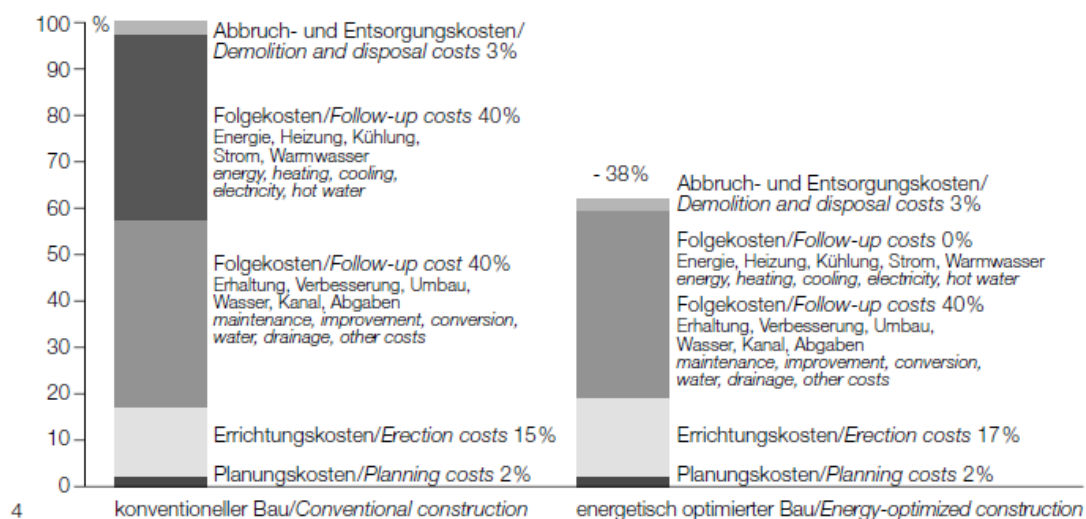
Fig. 1)   Life Cycle costs at standard and energy-optimised building, [2]

The additional planning effort is reflected in measurements such as repeated execution of thermal simulation, implementation of methods as e.g. life cycle assessment including life cycle costing; building certification with numerous air and material- quality measurements – all services that contribute to the building performance but to the planning cost as well. The investors however are seldom ready to recognise this effort in appropriate fees; despite the fact that the planning effort contributes to significant life-cycle benefits. The literature recognises the necessity of construction cost increase of ca. +2% for energy efficient buildings; however with invariable planning cost (Fig.1). Obviously, there is lot of awareness raising necessary amongst investors and public policy in order to increase the appraisal of planning profession and awake the consciousness on complexity of planning but also of benefits of sustainable buildings.

2   RESEARCH FOCUS

The research Project Co_Be (Cost Benefits of the Integrated Planning) carried out at the Vienna University of Technology should for the first time in German speaking region identify the benefits of integrated planning versus the traditional, sequential practice, through qualitative and quantitative research and evaluation.

The project is based on two research foci – empirical research through role-playing experiment for comparison of integrated and sequential planning practice; and practice-oriented case study research of five best practice energy efficient buildings. This paper will present the results of the conducted case study research. The final result of the paper is an Integrate Planning Guideline for Planners/Investiors and Public Policy.

The guidelines introduce the „quantitative" tools for the integrated planning, such as:

Life Cycle Assessment [3], Life Cycle Cost and Benefits Method [4] various building certificates: DGNB/ÖGNI [5], LEED [6], BREEAM [7], and TQB [8], and evaluate their implementation within planning process. Moreover, the guidelines imply on importance of the qualitative aspects such as: design of communication, involvement of a moderator, importance of team building through kick-off meeting. Finally, commitment and trust are identified as key factors for a successful planning process, which should gain on significance over the cost-time-quality project management triangle; in order to enable successful collaboration, instead of ineffective and frustrating against each other as is currently the case.

3   CASE STUDIES

The examined cases are five office buildings in Austria and Germany, build as showcase energy-efficient buildings; featuring either passive-house or even energy-plus standard, aiming for building certificate DGNB [9], silver or gold or being showcase-building for the enterprise.
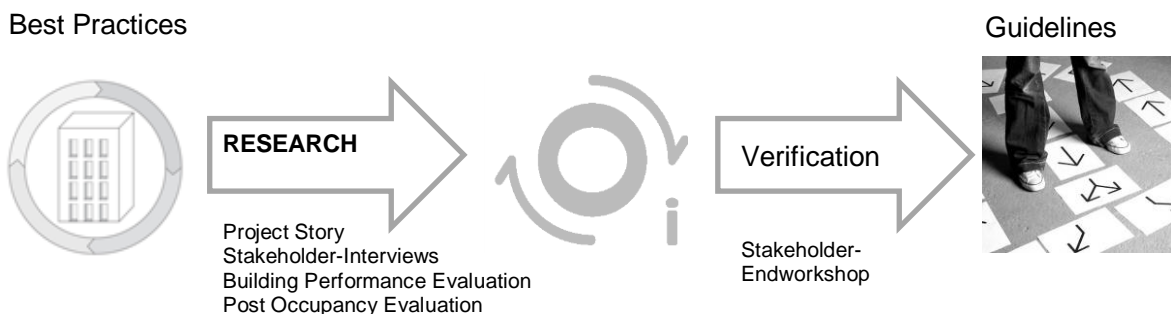
Fig. 2)   Research Method

Based on the analysis, the recommendations for the efficient integrated planning method can be outlined.

The practice-oriented case studies employ descriptive research method [10] involved analysis and examination of the best-practice planning process through interviews, observation and informal communication, to reconstruct the process and identify the potentials and deficits.

Based upon this analysis, project stories were compiled, further on for each case BPE (building performance evaluation) and POE (post occupancy evaluation) were carried out.

Finally a reference model for design of integrated planning process was developed and verified within stakeholder workshop (Fig. 2).

One of the research aims was to identify and analyse the impact of different project organisations on planning process- and building performance quality. The chosen best practices feature high diversity in project organisations and in contracting forms of planners and contractors.

In the case studies, we defined the participating project-oriented organisations in the planning phase as: individual planners, general planner and overall planner; and in construction phase as: single contract awards (individual contractors), general contractor, and total contractor.

Various contracting-constellations were found, such as contracting of individual planners forming a planning-network; overall planer (all disciplines in one company) over to hybrid forms which feature various cooperative models – e.g. architectural competition planning-team consisting of architect and HVAC-planner (Tab. 1).

Tab. 1) Case Studies Overview

Contract Form	Case	Project-organisation	Use	Building Quality	Interviewed Stakeholder
General-Contract Modell	A	Overall planer/ General Contractor	Lease	Energy Plus Building	Investor, Architect, HVAC eng., Structural eng., Energy Consultant
	E	General planer/ General Contractor	Own Use	DGNB Bronze	Project Manager, HVAC eng.
Network	B	Network of Planners+ General Planner/ General Contractor	Lease	Passive-House Standard	Investor, Architect
Hybrid	C	Individual Planners/ Total contractor	Own Use	Flagship Project for Energy Efficiency	Architect, HVAC eng Facility Management
	D	Overall planner/ Single contract award	Own Use	Flagship Project For Energy Efficiency DGNB Silber	Investor, Architect, HVAC eng.

The case study was initiated with compilation of a building catalogues consisting of plan material, general data on building geometry, performance etc, and photo-documentation; in order to represent the cases (Fig. 3).

In the next step, the buildings were made anonymous and a research agenda for mapping of cases was developed. The cases were examined through mapping of planning process, building performance evaluation (BPE), post occupancy evaluation (POE) and open-ended expert interviews (Fig.4).
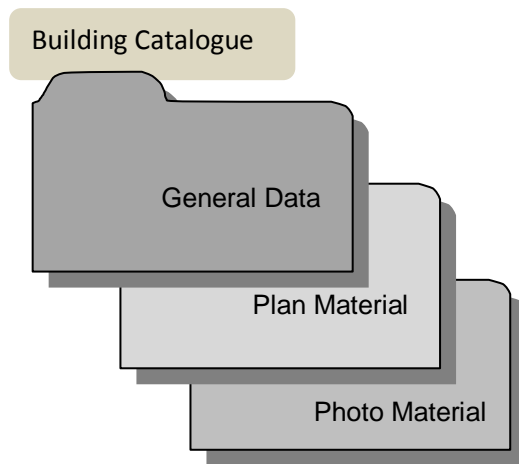
Fig. 3)   Building Catalogue of the Case Studies
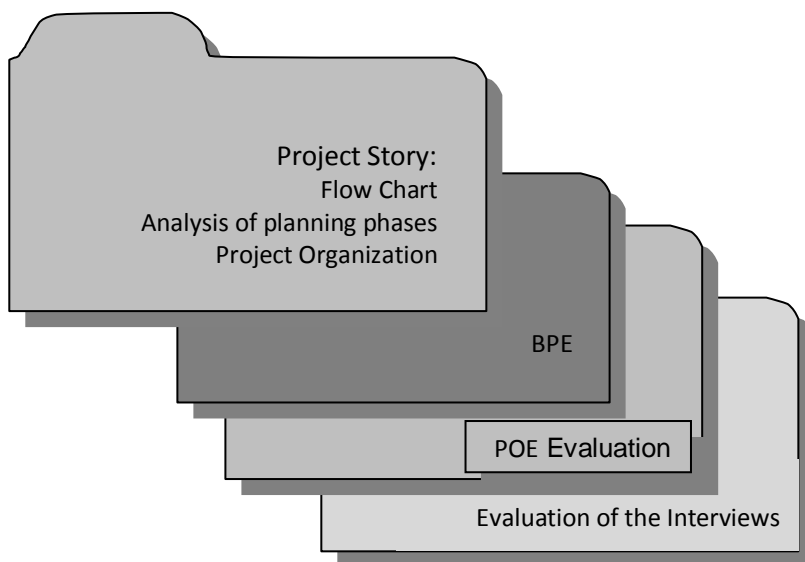
Fig. 4)   Mapping of the Cases

The analysis and mapping of planning process were carried out through so called project-story – graphical representation in number of charts depicting:

- analysis of planning phases (who did what and when) (Fig. 5)
- process flow (flow-chart)
- analysis of project organisation (stakeholder-map).

In order to capture different perspectives of planning process stakeholder, 19 open ended interviews were carried out. The interview partners included investors, architects, structural and HVAC engineers, facility manager and energy consultants.

Planning Process Flow Chart

Phase 0	Phase 1							Phase 2
PH 0 Briefeing	PH 1 u. 2 Competition/Predesign	PH 3 Design	PH 4 Permit Process	PH 5 Construction Drawings	PH 6 Tender	PH 7 Award of Contract	PH 8 Construction	PH 9 Comissioning

Investor

General Planner (GP): Arch, Struct.Eng.,HVAC

PM (Investor & Arch)

Fire Protection Consultant (Sub of GP)

Consultant Geological Survey

Consultant Land Survey

Consultant Land Survey

Energy Consultant (Sub GP)

Thermal Simulation and Optimization

Builidng Supervision

General Contractor: Structural works, HVAC, Electrical

Single Contractors: Finishings

Users

Authorities

Authorities

Neighbours

Fig. 5) Planning phases analysis, Case A

Through the qualitative content analysis method [11] the following issues were evaluated:
- Identification of the most often appearing statements in the interviews
- Comparison of the statements according to the profession
- Comparison of the statements according to the case study (project-related)

As quantitative evaluation of building performance (BPE) and post occupancy evaluation (POE) have been conducted. The data on energy demand and consumption as planned and during operation was gathered, for the building performance evaluation study.

POE is a study and evaluation of operation, existing state and usability of physical setting at given point in time after the project-completion and occupying the building [12].

Mostly the POE is regarded as user satisfaction survey, the Post Construction Evaluation (PCE) is oriented towards monitoring and evaluation of technical systems performance. In this context PCE would correspond to a building performance survey.

The POE was carried out as user-satisfaction web-based survey, addressing the issues of satisfaction with interior comfort, air quality, air movement, and lightning situation.

5   RESULTS

Because of the complete responsibility in one entity, the general or even overall planner model is often advocated as most suitable project organisation model for integrated planning. The process analysis of the case studies has shown that this is not necessarily always the case.

Each building, energy-efficient one even more so, is a prototype, one of the kind; therefore customised project organisation and contract model is required for each project.

The examined cases have demonstrated similar problems; despite the different character of project organisation models.

For example, in the case A (overall planner – general contractor), even though the planning process was carried out of "one hand" – architecture, structural and HVAC engineering belonging to one organisation; due to the innovative building character – energy plus standard – employment of a number of external consultants and researchers contributing with the diverse simulations was necessary, which was causing the delay of the planning process of very efficient "overall planner".

The case B (general planer+ planner network /general contractor) faced the problem of over dimensioned slabs, due to the fact that the structural engineer was contracted in latter planning phase (was not part of the tam from the beginning).

The case D (overall planner/ single contract awards) featured insufficient programming before architectural competition – therefore the actual space and area program was developed after the competition as cooperation of the winning architect and the client. The submitted winning design had to be completely redesigned as the consequence; which resulted in delay of four months.

At the case C (network of individual planners/overall contractor) by contracting the overall contractor the actual disturbance was caused. The original planning team consisted of architect and HVAC engineer, which resulted in very detailed and innovative building services and energy-concept. The lack of knowledge and competence of the overall contractor in the field of energy-efficient building caused numerous difficulties in execution of the building; finally a completely new HVAC design had to be compiled, in order to enable the overall contractor to actually realise the building as ordered.

In the case E (general planner/general contractor) the well organised programming phase was lacking – the investor called for additional area need immediately before of the beginning of permit process. This resulted in complete new design of the building.

The interview evaluation pointed out following (Table 2):

- The client plays crucial role for the success of a project; it is important that she actually knows the planning aims and follows them.
- The early involvement of planning stakeholders (disciplines), especially of HVAC engineering and facility management.
- The importance of early planning phases and programming phase in order to determine the client's need (what will be build, what is necessary) and planning aims in form of e.g. benchmarks.

Generally, it can be concluded that project success depends much more on commitment and competences of individuals, than on the prescribed "ideal" project organisation.

All of the cases had very ambitioned planning aims in terms of energy efficiency. However, only two cases (C and D) feature an aimed monitoring and evaluation of the measured data. It is noticeable that the planned heating energy demand (HED) is almost doubled by the measured consumption in the operation (Tab.3).

Tab. 2) Interview evaluation: Placement after most often occurring statements, according to category

Success Factors	Optimisation Potentials	Deficits
Early Collaboration	Changes of planning priorities	Low competencies in building sector
Interdisciplinarity	Tools for decision support	Sole interest in profit-maximisation, especially with large project-oriented organisations (overall contratot)
Transparent Communication	more interdisciplinarity	Low flexibility/openess of planners
Collective Aimsetting	Transparency of communication	Innovation loss
Know-How transfer	Aim setting at earlier point	Wrong priorities
Commited Investor	Leadership of communication	Conservative role-allocation
Flat Hyerarchie	Earlier involvemt of consultants	Wrong criteria at formation of planning team
Professional communication leadership	Better education of planners	Tendering Law!

Tab. 3) Heating energy demand as planned and as measured

Building	HED (planned)	HED (in operation)
C	17,4 kWh/m²	36,72 kWh/m²
D	33,4 kWh/m²	51,7 kWh/m²

Due to the organized monitoring in the case D, the deficit was recognised, and through an additional building measurement (windscreen) implementation and the energy-consumption could be reduced.

The POE shows that the energy efficient buildings do not only contribute to the ecologic component of sustainability through minimisation of CO_2 emissions; but to the social sustainability as well. The increased quality of interior climate contributes to the well-being and comfort of the employees.

The user satisfaction with the interior climate in winter as in summer is over the median value in examined cases (Fig.6).

POE can therefore be recommended as a cost- and time-effective method to determine the optimisation potentials after initiation of operation, and should be conducted in regular intervals in order to adjust the HVAC-technology.

6   CONCLUSION

The integrated planning requires not only cooperative, but collaborative attitude of all stakeholders involved into the planning process.

The influence of the specific project organisation or advantage of large project-oriented organisations over smaller structures in conduction the planning of energy-efficient buildings could not be demonstrated.

The process- analysis implies much more on the importance of interdisciplinary collaboration in the early planning phases and on necessity the programming (project briefing) as one of the crucial assignments and responsibilities on investor-side in order to determine needs and aims.
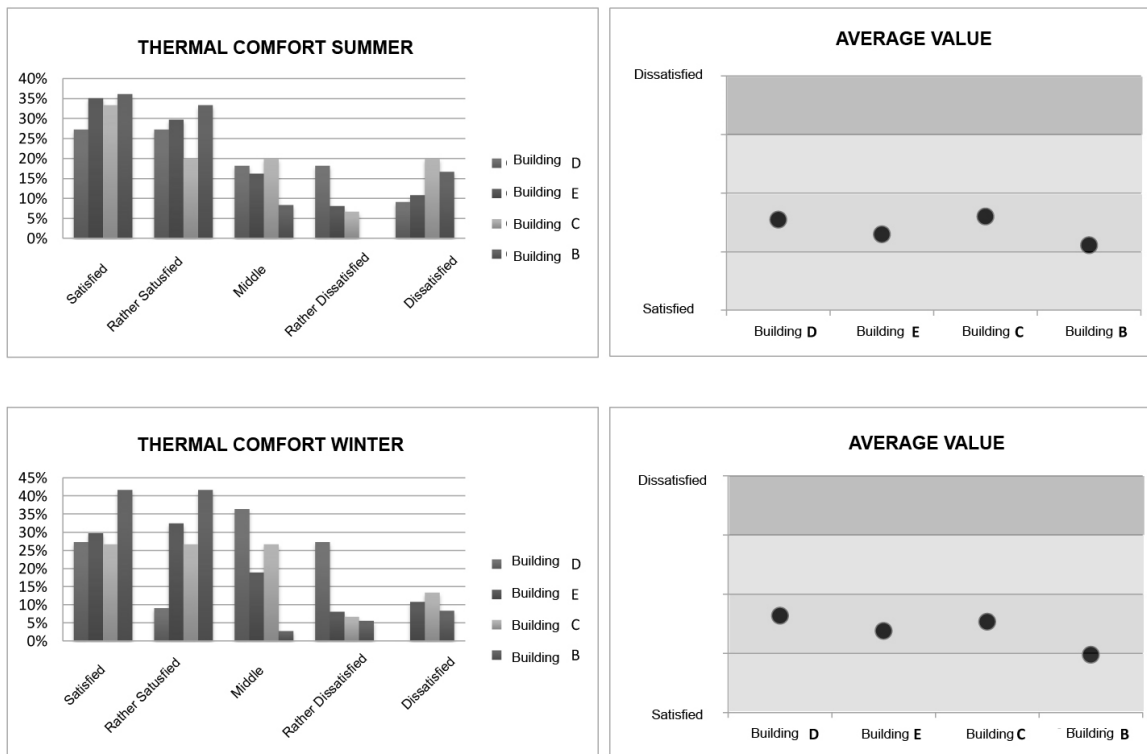
Fig. 6)   POE (User Satisfaction Survey) on Thermal Comfort in Summer/Winter

Both of these issues are still not sufficiently regarded in the planning practice. The result are numerous changes in the latter phases; due to which the achievement of optimal building performance, cost- and time-efficiency is often hardly possible.

The buildings which were built for own use, were monitored and evaluated in after operation-initiation with much more élan; the achievement of energy-efficiency flagship-project was uttermost concern of the investors. The cases show that energy-efficient buildings still often have experimental character due to the new technologies and materials used, and planners often lack experience or references. Therefore, the optimisation of operation must become a standard service to be conceptualised and planned already in the design phases (strategy, implementation, know-how transfer).

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SECTION I

CONSTRUCTION ECONOMICS AND MANAGEMENT

INVESTMENT ATTRACTION OF THE CZECH REPUBLIC

Zarina Bakirova[1], Anzhela Khamzina[2], Alena Ticha[3]

Abstract

The Czech Republic is actively carrying out a policy to attract foreign direct investment in its own economy, which in turn is the basis for development of the main Czech sectors of production and a generally stable economy. The purpose of this paper is to analyse the investment attractiveness of the Czech Republic, with a focus on the Czech construction sector. The main data source for analysis is the official statistical information published by the Czech Statistical Office, Eurostat and research by CzechInvest.

Key words

Construction, Czech Republic, foreign direct investment, investment attraction, investor.

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1   INTRODUCTION

Traditionally, the notion of investment attractiveness refers to the presence of such investment conditions that affect the preferences of an investor in choosing an object of investment. This object of investment can be a separate project, an enterprise as a whole, a corporation, a city, state or country.

The United Nations Conference on Trade and Development (UNCTAD, 2008a) notes that while Foreign Direct Investment (FDI) flows have been rising steadily in recent decades, declines occurred in the early 1980s, 1990s, and 2000s. This trend was partly driven by increasing corporate profits worldwide and the resulting higher stock prices, which raised the value of cross-border mergers and acquisitions. The Organization for Economic Co-operation and Development (OECD) claims that FDI is a key element in the quickly evolving phenomenon of international economic integration. In 2007, global FDI reached a record high, with inflows of $1833 billion. According to UNCTAD (2008b), this surpasses the previous record by some $400 billion. OECD (2008) emphasizes that the growth in FDI flows reflects both an increase in the size and the number of individual FDI transactions, which are typically a result of cross-border mergers and acquisitions or green field investment. Although the flow to emerging countries has increased, developed countries still comprise about 75% of the world's inward FDI stocks (UNCTAD, 2008b). FDI plays a significant role in the development of international trade, and it helps to establish direct, stable, and long-lasting links between economies. OECD (2008) discusses that FDI can serve as an important vehicle for local enterprise development, strengthening the competitiveness of both the recipient and the investor. [1]

The opening of the Central and Eastern European Countries (CEECs) offered many valuable investment opportunities for enterprises in the West. Between 1993 and 2002, FDI inflows to the Czech Republic increased approximately by a factor of 14 (Czech National Bank). In 2001, foreign-controlled firms accounted for about 18% of Czech GDP. This development may have been aided by investment incentives, which were introduced by the Czech government in 1998, aiming at large investment projects in technology intensive sectors. The strong increase in FDI inflows is an indicator of progress made in integrating the Czech market with the European and global economy. [2]

The Czech Republic is among the countries most often chosen by foreign investors. This article discusses what the main benefits of the Czech Republic are. What measures are necessary to increase the attractiveness of the Czech economy to FDI? It then describes the main economic sectors which are interesting for investors; the construction sector is analyzed in the article in detail.

2   THE MAIN BENEFITS OF THE CZECH REPUBLIC FOR FOREIGN INVESTMENT

The Czech Republic is one of the most successful CEE countries in terms of attracting foreign direct investment (fig. 1). Over 173 000 Czech firms across all sectors are now supported by foreign capital. According to the Czech National Bank, a total amount of EUR 74.4 billion worth of FDI has been recorded since 1993 (Source: Czech National Bank, 2011).

The main investors are from the Netherlands, Germany, Austria, Luxembourg and France. In recent years, investors from the United States and the Republic of Korea have shown high activity in the field of direct investment in the Czech economy.
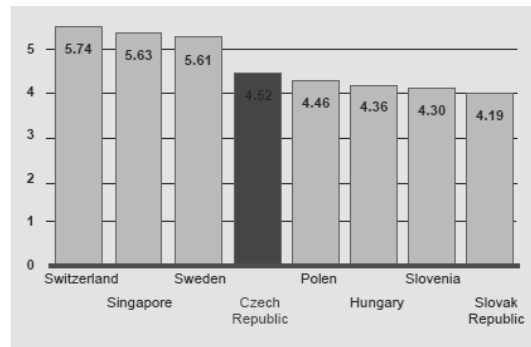
Source: World Economic Forum, Global Competitiveness Report 2011-2012

Fig. 1)   The Czech Republic tops CEE countries in the competitiveness ranking of world economies

About a quarter of Czech firms are wholly owned by foreign investors at present, and nearly half of Czech companies are common. [3] German firm gives the Czech Republic a positive assessment as an investment location. According to the research, the benefits of the Czech Republic are mainly "EU membership, a high-quality workforce and available local suppliers. The Czech Republic is characterized as a mature host country for FDI with low inflation, modest interest rates, a relatively stable currency and a good rate of economic growth providing favourable conditions for investors". [4]

The introduction of investment incentives in 1998 stimulated a massive inflow of FDI into greenfield projects. The Czech Republic's accession to the European Union in 2004 and amendments to investment incentives legislation have further boosted investment.

According to an Economist Intelligence Unit database, the Czech Republic has consistently attracted a high rate of foreign direct investment per capita since 2000, which confirms the country's strong attractiveness for foreign investors.

The Czech Republic is fortunate to be located very close to the Europe's industrial backbone. This area is considered the best choice for investments in transport and logistics because of its ideal location with regard to consumption and production zones. The Czech Republic has one of the most advanced transportation networks in Central and Eastern Europe. Its geographical position makes it a natural crossroads for major transit corridors. The Czech Republic is ranked among the world's most advanced countries in terms of transport-network density. The significance of the Czech Republic as a transit hub has grown since the country became a member of the EU Single Market covering an area of 27 countries in Europe with 502 million consumers in total (Source: Eurostat, January 1, 2011). [5]The Czech government is going with subsidies of the European Union the current length of freeways and highways to double by 2015. [6]

The next competitive advantage of the Czech Republic is its skilled workforce. The Czech Republic combines an outstanding level of general education with strong science and engineering disciplines. Technical education in the Czech Republic has a long tradition and enjoys a strong reputation around the world. The availability of technically educated graduates at a fraction of the cost of western labour creates a perfect environment for both manufacturing and R&D-oriented companies.

The Czech Republic spends more resources on research and development than many of its competitor countries. Over the past ten years, the Czech Republic's spending on R&D has increased from 0.95% of GDP to 1.61%. Many multinationals are running Czech R&D or design centres, including Panasonic, Honeywell, Mercedes-Benz, Motorola, Rockwell Automation and Visteon. [5]

It has been some time since the Czech Republic could be called a country with very cheap labour. Unlike some other CEE countries, labour costs have greatly increased in the Czech Republic in recent years.

Between 2004 and 2008, the average annual wage grew around 6%, but it was starting at a much lower base compared to Western Europe. Thereafter, a slowdown was registered in average nominal wage growth to about 2–3% in the years 2009 and 2010, a development mainly due to the financial crisis. Differences in remuneration among the regions reach approx. 20%. Traditionally, employees in Prague are paid more than in other regions (currently 25% above the Czech average). [5]

Therefore, German firms are focusing on investments in new, innovative technologies for using the highly skilled workforce in the country.

However, ensuring the country's economic performance by means of qualified personnel, especially in the technical sector, has been a problem in recent years. Technical education at all levels (primary, secondary and higher education) unfortunately lacks a systematic approach and a clear strategy. The Czech Republic is gradually losing competitiveness in this sector which it dominated for decades and in which it significantly differed from other CEE countries. [4]

The Czech Republic is a member of the Multilateral Investment Guarantee Agency (MIGA), an international organization for protection of investments, which is part of the World Bank-IMF group. The country has signed a number of bilateral treaties which support and protect foreign investments, for example with the United States, Germany, the UK, France, Austria, Switzerland, Italy, Belgium, Luxembourg, the Netherlands, Finland, Norway, Denmark and China. The Czech Republic has also concluded agreements for the avoidance of double taxation.

EU legislation was adopted in preparation for EU accession. Commercial, accounting and bankruptcy laws are compatible with western standards. The Czech crown is a fully convertible currency. All international transfers (e.g. profits and royalties) related to an investment can be carried out freely and without delay. Foreign legal entities from the EU and other nations may acquire real estate in the Czech Republic without any restrictions and under the same conditions as Czech legal entities. The original legal requirements on the location of a company or an establishment of a branch in the Czech Republic and entitlement to conduct business in the Czech Republic have been lifted. [5]

The ranking "European Cities and Regions of the Future 2012/2013" by the British investment magazine fDi assessed 253 European cities and 110 European regions in the following seven categories: economic potential, human resources, cost effectiveness, quality of life, infrastructure, business friendliness and strategy to support foreign direct investment. According to the comparison, Czech cities and regions are doing very well in supporting foreign direct investment. Brno, Ostrava and Cheb entered the Top 10 Eastern European cities with the best support for investment. A position in the Top 10 East European regions in this category was also granted to three of the Czech regions – Central Bohemia (Středočeský), Plzen (Plzeňský) and Pardubice (Pardubický). Prague ranked in the Top 10 business-friendly European capitals. [7]

Investors – both foreign and Czech – have the possibility to obtain investment incentives whose purpose is to support the introduction or expansion of production in the manufacturing industry.

There is some view that national strategic marketing management is necessary for creating or increasing economic development (Kotler, Jatusripitak & Maesincee, 1997). In other words, a government can market a country in the same way that a company can market its products and services in order to attract foreign direct investment (FDI). Most governments have increasingly adopted measures such as liberalizing the legal and regulatory framework for FDI and establishing mechanisms for settling investment disputes to attract FDI, as a means of achieving their economic development goals. [8]

A system of investment incentives is incorporated into the Czech legal system (Act No. 19/2004 On investment incentives). By fulfilling the minimum conditions specified by the Act on Investment Incentives, projects are supported in the form of corporate tax relief for a period of five years. Furthermore, projects located in regions that are affected by the worst unemployment rates can obtain job creation grants and training and retraining grants. Businesses set up in the Czech Republic can also obtain financial support from EU structural funds. Currently, the Ministry of Industry and Trade of the Czech Republic is developing a new version of the "Export Strategy of the Czech Republic for the period 2011–2016". The government of the Czech Republic attaches great importance to the support of Czech exports and attracting investment in the economy. Activities to attract foreign investment to the Czech Republic are coordinated by the state agency for support of entrepreneurship and investment CzechInvest. This agency is implementing a government program designed to support the development of municipal industrial properties and zones. In addition, CzechInvest operates an extensive database of business properties and assists with the regeneration of brownfields.

In addition, appropriate support is provided through the State Agency for Trade Promotion, CzechTrade, which is tasked with assisting the development of international trade and mutual cooperation between Czech and foreign entities and the provision of assistance to firms entering the Czech market in search of business partners. [9]

Foreign investors usually face difficulties in acquiring reliable and accurate information for evaluating a host country's FDI attractiveness, as well as in defraying the cost of searching for information when they enter a local market (Mariotti & Piscitello, 1995). The provision of high-cost information (e.g., consumer behaviour patterns, institutional frameworks and so on) by IPAs especially reduces the uncertainties related to the quality of the investment destination or the market. IPAs can play the role of a coordinator in influencing FDI decisions by compensating for market failure resulting from asymmetric information on investment opportunities or the investment climate of the host country. IPAs can also function as a bridge between the FDI environment and FDI-attraction performance of the host country. In summary, an IPA can play the role of a mediator between a host country's FDI climate and FDI inflows. In other words, the FDI climate influences FDI inflows through the IPA's activities. [8]

2.1   The strategy of improving the competitiveness of the Czech economy to attract FDI

In Central and Eastern Europe, the Czech Republic is currently a highly competitive investment location. However, as shown by the yearly survey of the Czech-German Trade and Industrial Chamber, there is still room for improvement. Large state contracts must be more transparent and fight more efficiently against corruption. At the same time, local firms want a

faster and more reliable legal system. Often it is not easy to plan for the long term, because the Czech political scene is very unstable and because the Czech Republic has not adopted the euro yet. 80% of exports go to the eurozone, while the continuing costs of the areas must be calculated in crowns. The exchange rate is associated with a high risk mainly due to the crown's tendency to gain strength in recent years. Another decisive aspect of competitiveness is the above-mentioned professional workforce. The provision of sufficient qualified graduates depends on an education system focused on practice and a willingness to educate young people in fields that promise a good chance in the labour market. [4]

3　FDI INFLOW BY SECTOR ECONOMY

Mostly, foreign investors are investing in the financial sector of the Czech Republic and in the automobile and oil refining industries (fig. 2).

*Q1-Q3 2011
Source: Czech National Bank, 2012
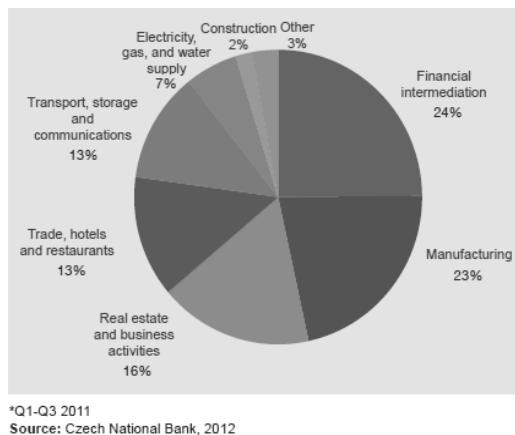
Fig. 2)　　Cumulative FDI Inflow by sector 1993–2011 (total 77.1 billion EUR)

The structure of FDI inflow into the Czech Republic has undergone substantial change and this trend is expected to strengthen in the coming years (fig. 3). The Czech Republic is experiencing the introduction of a new, very valuable type of economy, which is based not on the traditional processing of resources, but on the knowledge of the country's people. In previous years, investments in research and development (28%) and business support services (48%) in the Czech Republic outweighed those in manufacturing projects (24%). [5]

Source: CzechInvest, 2012
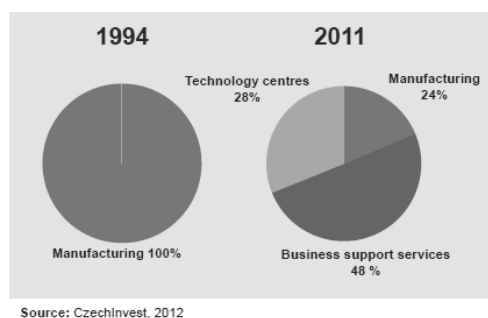
Fig. 3)　　More value added investment projects

The Czech Republic hosts over 73 000 foreign companies of all sizes. Well-known multinational companies such as ABB, Continental, DANONE, Ford, Panasonic, Nestlé, IBM, DHL, Astra Zeneca, Rockwell, Procter & Gamble, Renault, Siemens, Tyco, Honeywell and Volkswagen have significant subsidiaries in the Czech Republic.

Foreign-owned companies are transforming the Czech economy:

- 58.7% of the workforce in industry (Q1 2011)
- 76.9% of sales in industry (Q1 2011) [5]

The foreign trade influence of Russia on the Czech Republic is not very large because Russia is only 8th in the list of the Czech Republic's leading international partners, while Russia's share in the total foreign trade of the Czech Republic is 4.0%. However, more than 5% of the total number of firms in the Czech Republic (approximately 17 000) belong to Russians. For this indicator, Russian investors outperform Germans (3.2%) and Ukrainians (3%), who occupy the second and third place in the ranking of the most active foreign investors in the Czech Republic.

In particular, Russian investors own the following large Czech firms: Vemex (leading supplier of Russian natural gas to the Czech Republic), the Lukoil chain of petrol stations, the Metallurgical Plant EVRAZ VÍTKOVICE STEEL a.s., the bank Volksbank (bought in the summer of 2011 by Sberbank), the company Škoda JS (owned by the OMZ group), Valve Plant Arako, the manufacturer of cooling towers Chladíci Věže Praha, Valve Plant MSA, the producer and distributor of workwear and personal protective equipment Červa, the European-Russian Bank (a subsidiary of the First Czech-Russian Bank), SITRONICS Telecom Solutions, etc. [3] "Small" investors, including Russians who do not have bullions in their pockets, are investing in construction and real estate in the Czech Republic.

4 INVESTMENT IN CONSTRUCTION AND REAL ESTATE IN THE CR

The construction market in the Czech Republic has experienced rises and falls. The first recession of construction was observed in the 1990s, while the second has been ongoing since 2008. 2005 saw the rise of the construction industry, namely building office spaces, warehouses, private residential houses and industrial buildings. The economic situation in the country contributed to a massive buying of land, registration of mortgages and real estate construction. However, the global crisis has brought corrections in the pace of construction, its profitability and availability.

Construction in the Czech Republic is, like other sectors of industry, suffering from the economic recession. The decline of demand in the construction market probably has not yet reached bottom. Despite this negative trend, construction remains one of the important sectors of the economy, which contributes to employment in the economy at a level of 9%, and the GDP at about 6.5%. In 2011, the decline in construction production in the CR over the previous year was 3.1%. In engineering the decline was near 8.3% and in building construction 0.3%. [10]

One of the most important indicators of housing construction is the number of dwellings completed. Very often this is used as a decisive criterion in evaluating the success of housing policies. Figure 4 shows the dynamics of the construction of residential buildings, that is, the number of completed apartments in the period 2000–2010. From 2000 to 2006 a fluctuating development with a slightly increasing tendency can be observed, and the number of completed apartments ranged from 25 000 to 32 000. 2007 saw a peak in construction; in comparison with the previous year, the number of completed apartments increased by 46%. 41 649 completed dwellings represented the highest number since 1991. For such expansion primarily has been due to the adoption of the law on VAT increase since 2008, what greatly accelerated the finishing work on the construction sites. [11] However, the pace of

construction significantly decreased due to the global crisis. In 2011, the number of completed apartments reached only the level of 2003–2010.
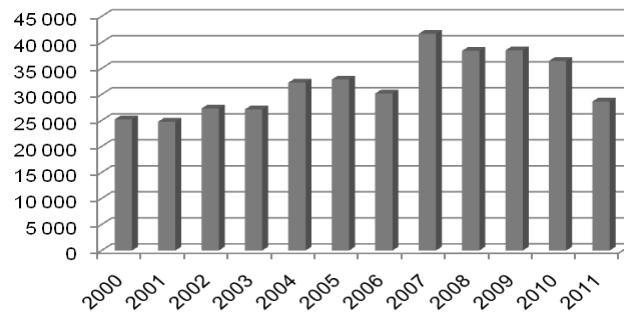
Fig. 4) Residential building of the CR, dwellings completed in period 2000–2010
Czech Statistical Office. Own construction

a) In the construction of nonresidential buildings the same trend can be observed (fig. 5). In 2009, a total of 1 308 nonresidential buildings were completed, 53 less than in 2008. In 2010, 1 416 were completed. Most nonresidential buildings, about 70%, are found in the commercial building sector (hotels and similar buildings, for trade).
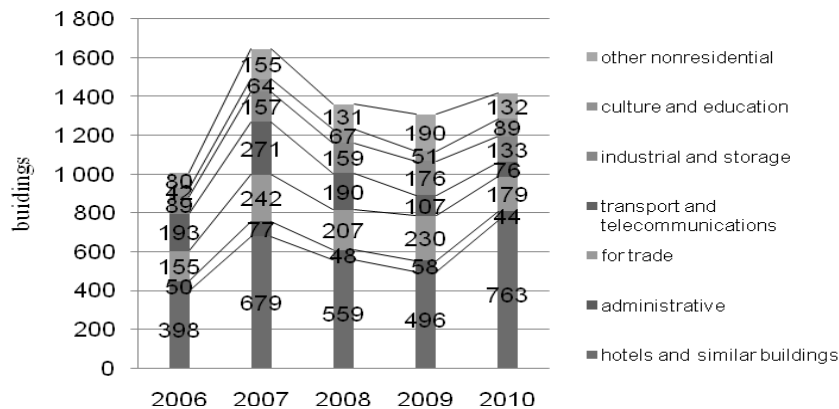
Fig. 5) Non-residential buildings CR, completed in period 2006–2010

Czech Statistical Office. Own construction

Figure 6 shows the average monthly wage of construction workers in the years 2000–2010. During this period, the wages of workers grew by 1.8 times and to date has reached an average of 22 114 crowns.
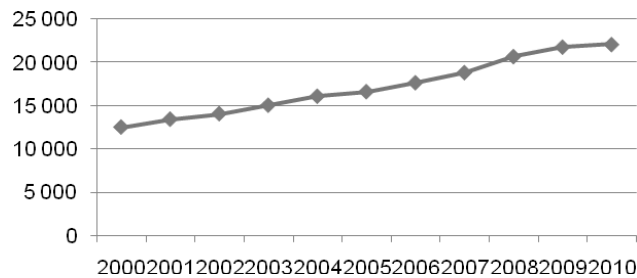
Fig. 6) Average gross monthly wage per person in building, CZC 2000–2010

Czech Statistical Office. Own construction

The average cost of construction of residential buildings is constantly growing (fig. 7). The total acquisition value of all completed housing construction (single-family houses and apartment buildings including extensions and superstructures) in 2009 was 92.3 billion CZK, some 3.3 billion CZK (3.7%) higher than in 2008. In the last year, the trend of increasing costs of building new family houses more or less continued (with the exception of a temporary stagnation in 2008). In 2009, the average acquisition value of 1 m2 of apartment floor space in a new family house was 22 844 CZK, about 640 CZK more than in 2008, and in comparison with 2000 about 7 520 CZK (49%) higher.

For new apartment houses after the year 2000, over the following years this indicator saw fluctuating development with a slightly increasing tendency, but in the last two years there was a further pronounced increase of the indicator. 1 m2 of apartment floor space completed in 2009 was acquired for 29 504 CZK, about 10 520 CZK (55.4%) more expensive than in 2000, and 2 986 CZK (11.2%) more than in 2008. Acquisition prices of apartment houses have seen the greatest progress of the four types of buildings in the last two years.

In the average for period from the perspective of the acquisition value of floor space, new residential houses were built more expensive than in family houses. The dwellings completed in extensions and superstructures to residential houses are also built expensively. Construction is currently running in the Czech Republic, but on the whole the industry has become less profitable compared to pre-crisis period by 5–15% and now stands at about 15%. Building is mainly done by large construction companies (Skanska, Metrostav, Eurovia CS, Strabag, OHL ŽS, Hochtief CZ, Eiffage Construction Česká republika, PSG-International and Geosan Group), that are trusted not only by people but also by banks. The main areas of building in the Czech Republic are construction of cottages and villas, high-rise buildings, commercial and industrial construction. Old panel buildings have seen renovation and modernization. [12]
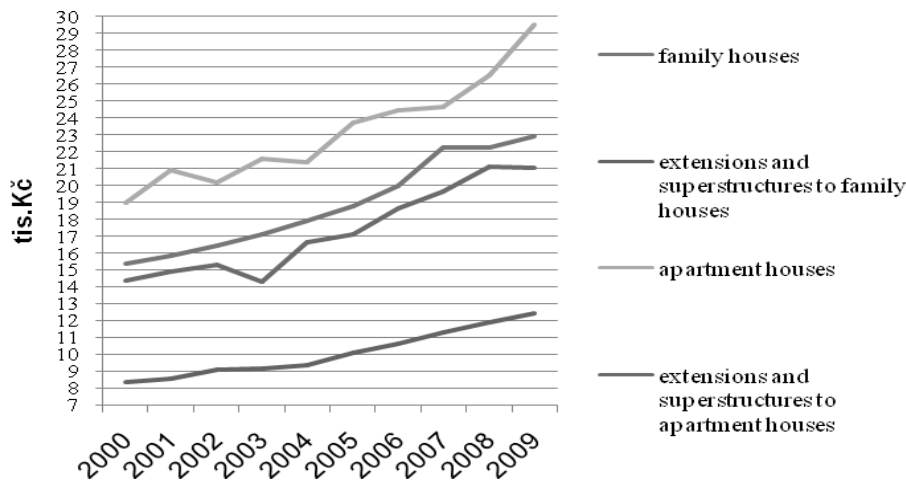
Fig. 7)　　　The average acquisition cost of 1 m^2 of useful space in residential buildings

Czech Statistical Office. Own construction

A definite trend can be seen in purchases by foreigners, including Russians, of small plots (500–700 meters) and construction of individual houses for the purpose of resale and renting. Another trend is the construction of apartment buildings with the subsequent sale of apartments. The Czech real estate market represents serious interest for investments which provides such things as availability of the market to investors, guarantees of a favourable investment climate from the state, firmness of the institution of private property, a steady tendency of growth in the cost of real estate and an excess of demand for the qualitative new

real estate above its offer. Investing in real estate was seen as a relatively conservative and safe form of investment. [6, 9]

5   CONCLUSION

The Czech Republic is actively carrying out a policy of attracting foreign direct investment to its own economy, by increasing the investment attractiveness of the country. FDI is the basis for the development of its main sectors of production and a generally stable economic situation. The benefits of the Czech Republic are mainly EU membership, a high-quality workforce and available local suppliers. The Czech Republic is characterized as a mature host country for FDI with low inflation, modest interest rates, a relatively stable currency and a good rate of economic growth providing favourable conditions for investors. Investment promotion by governments today is an important tool for improving an investment environment and for attracting FDI to the respective countries.

The conditions that will enable the Czech Republic to continue to perform competitively are a more effective fight against corruption, more efficient governance, better law enforcement, political stability and ultimately an educational system focused on practice.

Like any other complicated economic phenomenon, the arrival of foreign capital may have a positive as well as a negative effect on the economy of host countries. For the economy of the Czech Republic, it is possible to identify positive consequences of attracting foreign capital: an increase of volume of actual capital investments, acceleration of the pace of economic progress, delivery of advanced foreign technology and know-how, expansion of exports, increase in the occupation level, progress in infrastructure and the service sector, etc. On the other hand, it is possible to identify obviously negative consequences: suppression of local manufacturers, as well as a strengthening of the dependence of the national economy that threatens its economic and political security.

One cannot deny a decline in the Czech economy in the last two years. Dependence on foreign markets, and especially the state of EU markets, has led to significant deterioration in the basic economic performance of the Czech Republic during the crisis period 2008–2009 and to a falling of the country's GDP in 2009 by 4.2%. However the rapid post-crisis recovery of the Czech Republic (in 2010 the GDP of the Czech republic grew by 2.3%, while exports to dollar expressions have remained practically on the pre-crisis level of 2007), the active progress of business (the general number of businessmen in the Czech Republic in the last year has grown by 59 767 and exceeds 2.29 million, and the annual pace since 2008 has been identical) and a quick return to the Czech market of investors (according to data of the Czech National Bank, already in the first two quarters of 2010 inflow of direct foreign investments began to occur at a rate of 4.2 billion US dollars), lead us to assume that the prospects of the Czech economy are not settled yet, and signs of its "overheating" while are expressed slightly. [3] However, the almost complete dependence of the Czech economy on the economic conditions of the leading EU countries suggests that the prospects of the Czech Republic and its currency over the next years will be defined completely by the EU's ability to make it through current intra-European and global crises.

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List of abbreviations

FDI - Foreign direct investment
CEE - Central and Eastern Europe
CR – Czech Republic
CZK - The Czech Crown
GDP - Gross domestic product

COMPARATIVE ANALYSIS OF GOVERNANCE FRAMEWORKS FOR LARGE-SCALE INFRASTRUCTURE PROJECTS

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Abstract

This article, after a brief overview of role of the state in promoting development, focused on comparative analysis of governance frameworks for large-scale infrastructure projects. This article showed that different political systems and political cultures need different governance frameworks for large-scale projects; therefore it is necessary to determine what the main elements of design framework are. Based on main characteristics of comparative analysis future research area are identified in order to develop framework for design of governance regimes. It was concluded that main elements for design of governance framework are gate models and authorisation processes, review methods, development and construction processes with document content, organisation and political culture and finally, approach to risk management.

Key words

Gate model, governance, infrastructure, large-scale projects.

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1   INTRODUCTION

There is no doubt that an active role of the state is one of the most important factors that promotes development. Peter Evans' book Embedded Autonomy [1] shows that activist, positive role of government could be a decisive factor in rapid economic growth. The author showed that the economic success of Japan, Taiwan and Korea have been the result of a very active role of state in promoting economic and social development. In Japan, the Ministry of International Trade and Industry (MITI) was "the greatest concentration of brainpower." As a result, "Japan's developmental state was a central element in explaining the country's post-World War Two economic miracle" [1]. Similarly, in South Korea, the state bureaucracy recruited the most talented students from the best universities. This bureaucracy conducted various activities: financing of public education[4] and public health, investing in infrastructure, constructing comparative advantages to compete in the world market, financing irrigation systems and fertilizers, protecting infant industries, financing science and technological development, etc.

However, economic history also shows that state investments can also cause economic catastrophes. If the state apparatus is corrupted and incompetent, state intervention may produce more harm than good. For example, Bates [2] found that public institutions in Africa were used for private advantages. Only those who were supportive of government received public funds. Any addition of the World Development Report, by the World Bank, provides copious examples of government failures. Therefore, there is no wonder that Srinivasan [3] concluded that developmental state is an illusion:

> *"Dominant view of the early development literature that a benevolent state, acting solely in the societal interest, and equipped with needed information, knowledge and policy instruments, can intervene in an optimal way to correct any market failure and launch a society along the road to self-sustained and rapid development turned out to be much too optimistic, if not completely out of touch with realities. Instead, the state is seen to be pushed and pulled by lobbies and interest groups that are mostly interested in redistribution rather than growth and development."*

However, experience shows that building an efficient and uncorrupted bureaucracy is a difficult but possible endeavour. Max Weber stipulated, at the beginning of 20th century, the main principles of modern bureaucracy. It is interesting to note that Asia is the place of origin of these principles. According to Ezra Vogel [4], "the development of a meritocratically selected bureaucracy [is] one of the greatest contribution of East Asia to world civilization." The experience of these countries shows that bureaucracy could be not only interested in promotion of growth and development but even the main actor of this promotion. To be capable of formulating and implementing development plans, bureaucracy must be, according to Waldner [5] "endowed with certain organizational resources, including meritocratic norms of recruitment and promotion to ensure that agency is staffed with the requisite talent… and insulation from pressure groups to ensure depoliticized decision making."

From the analysis above it is obvious that the main question is not whether state should be involved in promotion of economic growth but rather which kind of state interventionism spurs economic growth. In order to answer this question this article analyzes how different countries regulate and control capital investments in infrastructure. More specifically, it

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[4] For example, at the end of 1980s, there were twice as many engineering students in South Korea as in the United Kingdom [1].

investigates so called "governance framework models" in three countries: United Kingdom, Australia and New Zealand, Norway and Quebec-Canada.

2 IMPORTANCE OF GOVERNANCE FOR LARGE PROJECTS

Due to large amount of money involved and great impact of project results on its environment, large infrastructure projects attract great attention of media and public. It is hard to hide when expected results are not met. And yet, in spite of their poor results in terms of costs, time and benefits, more and more large and mega projects are planned and fulfilled [6]. Even properly managed projects failed, either from social, investors or other stakeholders' aspect. Therefore, research community shifted focus from execution to front-end phase [6–11]. Failure of many large major projects is result of shortage of an appropriate governance on project level and their management [12].

Klakegg et all [7] identified that project management is in general dominated by best practices in project execution and issues such as organisational culture, competence standards and certification of project managers as current hot topics in the PM community are seen as essential for managing large, complex projects. However, it became evident that best practices through phases should be abandoned, directing towards governance. Understanding governance framework of project is vital for choosing methods and tools for managing project [7].

When undertaking a very large project without an adequate governance regime, most organizations are exposed to high probability of failure and the resulting significant negative impacts. Megaprojects are qualitatively more complex and riskier, and therefore require governance regimes that are different from those of more routine and less risky endeavours.[10] Therefore, a specific governance regime must adapt to the particular project and its context.

While Miller and Hobbs [10] question the whole concept of a common governance framework, and tend to identify design criteria that should be brought to bear when developing a governance regime rather than to design a governance regime, Klakegg et all [7].believe that there is a need to have general governance framework defining how resources and risks are distributed among stakeholders. Laws and regulatory mechanisms make up the structure while information, auditing and other control measures are actively used to secure the intended results [7]. Anyway, governance framework designed for one government is not applicable to other government without any adjustment and, therefore, it must be considered in socio-economic context.

3 METHODOLOGY AND THE ANALYSIS OF FRAMEWORKS

Three governance frameworks for large infrastructure projects are available for analysis OGC Gateway Review (UK), Quality-at-entry (Norway) and Framework Policy for the Governance of Major Public Infrastructure Projects (Quebec-Canada). Comparative analysis of these frameworks was made based on twelve criteria represented in Table 1. Implementation of governance frameworks in all of these three governments had common goals − to improve government performance in delivering public projects. British goal was greater value for money, Norwegians wanted better projects and project performance and Quebec framework is focused to optimize the management of government resources in large-scale infrastructure projects.

All frameworks have political background, originated by responsible minister but all of them had different design process. In Norway and Quebec framework was initiated with bottom-up implementation of improvement and learning process, while in UK, it was set-up with implementation of management system ant tools related to UK management policy. Norway and Quebec broke up with tradition and introduced a new mandatory system while UK built a system based on tradition which improved the existing system.

Tab. 1) Comparative analysis of government frameworks for large infrastructure projects

	Gateway Review	Quality-at-Entry	Quebec Framework policy
Purpose	best value for money	better projects and project performance	to optimize the management of government resources in large-scale infrastructure projects
Induced by	Political will/decision	Political will/decision	Political will/decision
Mandatory/ advisable	Mandatory only for critical projects, for other is advantage	Mandatory for major projects, for other is not applicable	Mandatory for large infrastructure projects, for other is not applicable
Implementation	Independent reviews (authorised reviewers certified)	Independent reviews (consultants)	Independent reviews (government body)
Basis documents	Business case	Studies with compulsory content	Studies with compulsory content as part of business case
Levels of authority	4 – Parliament, HM Treasury, Ministry, Agency	4 – Parliament, Government, Ministry, Agency	4 – Infrastructure Quebec, Ministry, Cabinet, Conseil du Tresor
Phase approach	Developmental approach	Encompasses whole project at once	Developmental approach
Character	Builds on tradition and improves existing	breaks up with tradition and introduces new mandatory system	Introduces new mandatory system
Front-end phases	0: Strategy assessment 1: Business justification 2: Delivery strategy 3: Investment decision	QA1: The early choice of concept, the decision to initiate project pre-planning QA2: The GO decision, the decision to finance the project	1. Developing the strategic presentation document 2. Developing the initial business case 3. Developing the final business case
Construction phase	N/A	N/A	N/A
Post construction phases	4: Readiness for service 5: Benefits realisation	N/A	Revision if cost overruns are greater than 5% Control of Maintenance plan
Type	Whole-life cycle gate model	Front-end gate model	Whole-life cycle gate model

In the 1980s, reforms in public administration which were focusing on how public investment should be performed (to give greater 'Value for Money' in UK) developed into a strong governance regime for public investment projects. It also created several important frameworks and PM systems such as the Gateway Process TM and Prince2TM (Office of

Governance Commerce, or OGC). Today, the UK framework is perhaps the 'state-of-the-art' governance framework for major public investment projects, and it is to a large extent copied by other countries [7]. Every review determinates areas which should be checked, and within each area questions that must be answered are assigned.

Simplicity is a major characteristic of the second framework with two front-end points of project review, as opposed to totally six Gateway Reviews though whole project life-cycle (four front-end and two post-execution). Quality-at-Entry started with one review (QA2) focusing on control of cost-estimates, progress plans, risk analysis, contract strategy and organisation, reviewing only one document - The Project Management Plan. Later, another review (QA1) was established focusing on strategic issues (a needs analysis, an overall objective and strategy document, an overall requirements specification, and an analysis of alternatives).

Quebec framework is based on research results which should avoid cost overruns and significant delays in the construction of major public infrastructure projects. The framework is based on the comparative study of the main governance frameworks used in countries around the world and on twelve major public infrastructure projects carried out in Québec in recent years, from a perspective of the challenges and success factors. It is focused on procedure to ensure clearly defined decision process, comprehensive business case and process to evaluate the business case [13]. It regulates the content of project studies controlled in three front-end steps and strict margin for cost overrun after construction phase. Major differences between approaches are in post-construction phase. Quebec policy is the only framework which includes control of maintenance plan [13]. Neither maintenance nor benefit realisation are the subjects of Norwegian framework and the UK controls benefit realisation after 5 years.

All reviews are conducted by independent reviewers organized differently: by special government body (OGC in UK), responsible government body (Infrastructure Quebec) or consultant firms selected by government (Norway).

4 DISCUSSION AND CONCLUSION

For better understanding of existing governance frameworks, based on beforehand analysis, common and different characteristics are set up. (Table 2)

This analysis displays that existing governance frameworks have more differences than common characteristics. Differences derive from different large project execution tradition and ways of issue consideration. In development of governance framework political and value systems have major influence. This is a reason why Australia and New Zealand have successfully implemented OGC Gateway Review Process. Obviously, similarities of political systems influence the way how large-scale infrastructure projects are managed. This is the main reason why Australia and New Zeeland, former UK colonies, accepted British model. The UK was not only a role model for political systems but also a role model for policy implementation. Rightfully, Quebec and Norway have not copied governance framework of countries that have different political culture but developed their own framework. Separated position of Quebec inside Canada resulted in a different approach toward infrastructural projects.

Tab. 2)   Common characteristics and differences of governance frameworks

Common characteristics	Differences
Political will and purpose	Review and authorisation process
Mandatory for large-scale projects	Number of reviews
Compulsory content of documentation	Different content of documentation
Levels of authorisation encompassed	Compliance with tradition
Risk management	Type of gate model
No review during construction	Character of revision
Gate model is used	Approach to phases
	Development of scope
	Control after construction
	Risk assessment approach
	Reviews involving risks

These characteristics reveal guidelines for future research of governance frameworks needed for its design:

- gate models and authorisation processes,
- review methods,
- development and construction processes with document content,
- organisation and political culture
- approach to risk management.

Therefore, we can conclude that the main elements of governance framework have been identified. These elements are not strictly technical nature. Therefore, to create governance framework for one government, it is needed multidisciplinary approach which will include experts from political, economic, management and technical aspect.

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RISK ANALYSIS AND MANAGEMENT ON PUBLIC PRIVATE PARTNERSHIP PROJECTS (PPP) IN SERBIA

Goran Cirovic[1], Simo Sudic[2], Snezana Mitrovic[3]

Abstract

Infrastructure projects are going through a lot of difficulties connected with the financing in South Eastern Europe countries. During and after transition period, lack of all infrastructure in Serbia became a problem. Infrastructure network is necessity for the development of different sectors (energetic, agriculture, industry, commerce etc.). Domestic regulation allow project financing through Public Private Partnership (PPP) model, which is great opportunity for opening new projects and finishing many projects with on hold status. The main problem in decision making and starting financing projects in that model is too many risks on the market. The analysis of potential risk elements, throughout the processes from bidding to operational infrastructure projects, is one of the most important elements to maximising profit and functionality, and properly develop country infrastructure, while minimalising potential difficulties that may arise. Much of the risk of a PPP project comes from the complexity of financing, taxation, law regulatory, aquired technical documentation and construction process involved in a major infrastructure venture. Main risks, their analyse and management on infrastructure projects are explained in this paper. After risk analyse, risk management tools are presented, together with method of managing risks on PPP projects in Serbia.

Key words

Infrastructure projects, project financing, public private partnership (PPP) projects, risk analyse and management.

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1   INTRODUCTION – BACKGROUND OF PUBLIC/PRIVATE PARTNERSHIP PROJECTS

In its widest sense a public/private partnership (PPP) may be defined as "a long term relationship between public and private sectors that has the purpose of producing public services and infrastructure" [1]. Public/private partnerships bring public and private sectors together in long term contracts. PPPs (public/private partnership) encompass voluntary agreements and understandings, service-level agreements, outsourcing and private finance initiative. A PPP projects therefore usually involves the delivery of a traditional public sector service and can encompass a wide range of options. General idea of that concept is to mobilise to use private sector capital to generate economic development, and to deliver value for money to the public sector, and the higher costs of private sector financing and the level of returns demanded by the private sector investors must be outweighed by lower whole-life costs and increased risk transfer. One of the main goals is to develop infrastructure projects including roads, hospitals and schools, without the response to the limited capital of the public sector and utilising superior cash and project management capacity of the private sector.

As the infrastructure has great impact on the development of whole economic of the country, the main reason for the delayed development of Serbian economy is many unfinished infrastructure projects. Also, it is observed that maintanace of the infrastructure has very high costs as low quality of construction and as whole live cost was not calculated during realisation of investments.

In april 2004, in its Green Paper *On-Public-Private Partnership and Comunity Law on Public Contracts and Concessions*, the European Commision used the term 'phenomenon' to describe the spread of public/private partnership (PPPs) across Europe. That's the main reason why these type of procurement of civil engeneering and infrastructure projects start to be reviewed in a countries which are in the process of joining the Europian Union like Serbia, Bosnia and Hercegowina etc. Traditional procurement process is less complicated and cheaper than procurment of public/private partnership projects, as the procedure is demanding and potential project members are not experienced in these procedures.

The main weaknesses in government procurement systems in Serbia are:

- organisation;
- process;
- people and skills;
- measurement;
- contribution of the central government.

Accordingly, PPP can be defined as agreements where public sectors bodies enter into long-term contractural agreements with private sector entities for the construction or management of public sector infrastructure facilities by the private sector entity, or the provision of services (using infrastructure facilities) by the private sector entity to the community on behalf of a public sector entity. They can make many forms and may incorporate some or all of the following features [2]:

- The public sector entity transfers facilities controlled by it to private sector entity (with or without payment in return) usually for the term of the arrangement;
- The private sector entity builds, extends or renovates a facility;
- The public sector entity specifies the operating features of the facility;

- Services are provided by the private sector entity using the facility for the defined period of time (usually with restrictions on operations and pricing; and
- The private sector entity agrees to transfer the facility to the public sector (with or without payment) at the end of the arrangement.

As Serbia government have been motivated into entering into PPP arrangements to improve lack of infrastructure and by the desire to reduce debt, the other benefit is to share financial risk between public and private sector bodies, and in the next chapter will be examined these risks.

2   MAIN RISKS ON PUBLIC/PRIVATE PARTNERSHIP PROJECTS

The main risks of the PPP projects comes from the complexity of the arrangements between public and private sector bodies [3]. As the organisational structures of Serbian public sector bodies are very complex (due to very poor privatisation process, insufficient modernisation, involment and implementation of international standards etc.), it is very important to approve organisational structure of the project before operational phase. Issues such a political lidership, bureaucratic resistance to change and corruption often create disinterest and disillusion in the private sector. In Serbia during the previous period many land disputes have arrised due to unfinished process of restitution. Political agitation and disruptions create unfavourable climate for the private sector to commit significant resources in order to participate with government in respect of long-term projects.

The other risks are the complexity of the arrangements itself in terms of documentation, financing, taxation, technical details, subcontrating, project delivery, etc. Infrastructure projects are long term projects, and the nature of the risks alters over the duration of the projects.

PPP tenders might fail due to inexperience and lack of technical knowledge on the part of the bureaucrats to design an appropriate PPP process, political interference, a poored design tender documentation and tender evaluation methodology or failure to nagotiate a commercial rigorous contracting structure. Serbian goverment have opened many agencies which have not enough qualified and experienced specialists to proceed PPP procedures. The balance between the commercial realities and the bureaucrats' desire to impose regulatory and institutional framework that might otherwise destroy an deal. Also civil protest could be risky for that type of contracts. Civil protest may be result of lack of stakeholder consultation before designing the project structure, and lack of appreciation of the political situation by bureuacrats when structurion the environmental/commercial/cost recovery aspects of the project.

Construction phase mostly open many different risks from those during the preparation and operational phase. The most important risks in that part of the project are insufficient results from geotechnical surveys, bad contractors, claims, increased budget, bad quality of works etc.

From the viewpoint of public procurer, the main goal is to ensure that the money has been spent economically, eficiently and effectively, and to find optimal solution to deliver project on time. Government seeks to optimise private sector financing in the provision of public sector infrastructure and service and to achieve value for money. For the public funds it is very important to comprehend value for money concept, and the most important is to transfer risks to the private partners who have responsibility for the design, construction and

operational phases. In some cases, the emphasis on risk transfer can be misleading as value-for-money requires equitable allocation of risk between the public and private sector partners, and they may be an inherent conflict between the public sector's need to demonstrate the valie-for-money versus the private sector's need for robust revenue streams to support the financing arrangements [4] [5].

The contractural provisions in PPP contracts are complex, and should include among other requirements (technical, financial, etc.) following:

- Requirements for performance bonds;
- Insurance requirements;
- Delay provisions;
- Force majeure;
- Government action;
- Private sector warranties;
- Change in the law;
- Variations;
- Termination;
- Indemnification;
- Intellectual property;
- Claims;
- Financial security;
- Dispute resolution;
- Partnership management;
- Compliance with all laws;
- Personal and conditions precedent.

What are the main risks of civil engineering and infrastructure projects? At least nine risks face any infrastructure project [6]:

- Technical risk, due to engineering and design failures;
- Construction risk, because of faulty construction techniques and cost escalation and delays in construction;
- Operating risks, due to higher operating costs and maintenance costs;
- Revenue risk; e.g. due to traffic shortfall or failure to extract resources, the volatilary of prices and demand for products and services sold (e.g. minerals, office space etc.) leading to revenue deficiency;
- Financial risks arising from inadequacy hedging of revenue streams and financing costs;
- Force majeure risk, involving warnand other calamities and act of God;
- Regulatory/Political risks, due to legal changes and unsupportive government policies;
- Environmental risks, because of adverse environmental impacts and hazards;
- Project default, due to failure of the project from a combination of any of the above.

From the experience of the authors top five risks facing the PPP projects in Serbia are:

- Goverment bureaucratsy and complex procedures, due to high financial expectation of public sector;

- Many problems and disputes from the ownership, especially of land, due to bad provatisation process and unfinished restitution;
- Often changes in local authorities as well as goverment;
- Financial problem in constraction sector, and unpredictable performance of construction companies;
- Operational and maintanance risk, due to unpredictable revenue as different social programs of goverment.

3   PROPOSED METHOD FOR RISKA MANAGEMENT ON PPP PROJECTS

General idea of risk management process frame is to identify all main risks and to calculate time and cost contingency of the project, based in these risks, as it is shown in Figure 1. This data will help the decision makers to define strategy of the project in the planning phase.

Risk Identification					
Risk Number	Title	Risk Description	Effect	Category	Status

Fig. 1)   Methods of responses to an appropriate risk

Monitoring the risk level of certain project activities by evaluating the probability and risk categories is necessary in order to create the strategy of responses to risks. Generally, there are four types of responses to risks:

- acceptance and control;
- reduction;
- transferring; and
- avoidance.

Acceptance and control are usually carried out if the risk is within tolerable limits, because it does not require additional resources. This category of responses to risk should also be considered as the main action of risk management. Risk reduction often requires engagement of resources (and additional costs in a project). Transferring risks means to shift risks from some participants in the project to other participants, assuming that they will manage that risk easier, and that the risk level will be lower in this case. Avoidance of risks means the implementation of managerial action which does not bring the project into the zone of a specific risk.

Risk management involves eliminating or reducing the risk level implementing managerial actions [7]. Planned managerial actions in the preparatory stage of project completion may not be the final solution, because during the project changes occur very often, so that planned actions are not an appropriate response to the risk. Therefore, managerial actions should be implemented in response to a specific risk at a time (which may be the same as actions planned in advance). At this stage risks and action holders should be designated (this is why it is important to predict delegating in the project), as well as the time determination for the conducted action. Risk management procedure is shown in Figure 2.

Fig. 2)   Risk Management Procedure

After the implemented managerial action the risk is not usually eliminated, but it remains to exist in the project with altered probability and cost and time effects. After evaluating these parameters, as shown in Figure 3, the level (ROAG) is obtained, i.e. the level of risk at a time. This risk level should be less than the initial risk level, which is presented at the beginning of this table. Moreover, it is important to enter the time elapsed from the last change, i.e. observation. In addition, there should be a strategy of reserves in this plan along with the anticipated actions to be implemented if a risk occurs.

Fig. 3)   Procedure of remaining risks assessment and strategy of reserves

The aim further analysis is to evaluate their cost and time effects and probability that they will occur based on identified risks, which tells us how large the factored cost and timing risk is, i.e. the potential reserve with which to start the project [8]. An example of risk analysis on a large construction project is shown in Figure 4.

RISK ANALYSIS AND EXPOSURE

CLIENT:
PROJECT:
CONSTRUCTION / PROJECT MANAGER:

PACKAGE / STAGE / PHASE:

Risk Ref	Risk Title	Description of Risk	Management Action
5.1	Water Supply	The water supply is currently inadequate for the whole coastal area of Montenegro	A new water supply contract is now underway and is scheduled for completion at the end of 2010, this is likely to effect the occupany of the phase one buildings. Interim solutions to be considered (Herceg Novi)
6.4	Down-turn in local / regional economy	There is no guarantee that the local / regional economy will continue, which may effect later phases of the development	AM to monitor market indicators and make allowance for any down-turn in the economy

Fig. 4)   An example of risk analysis on a large construction project

Only two risks have been processed in the table, and the descriptions of the given risk and managerial action that would eliminate or reduce risk are given in the first part of the table along with the risk itself. Both risks are classified as working (WBS) categories to make them clearer and easier to follow, and not to overlap risks.

The evaluation of cost and time consequences is graded from 1 to 5 where the gradation of monetary and time values is defined in advance (Shown in Figure 5 and 6). It is important to present the highest consequence level as the maximum value of cost and time consequences, because this value has a major impact on risk level. Calculation of cost and time risk is based on average values.

Cost Rating	Duration Rating	Highest Rating	Cost Risk			Duration Risk		
0 - 5	0 - 5		Min €	Max €	Ave. Cost	Min days	Max days	Ave. Duration
4	3	4	1,000,001	3,000,000	2,000,001	15	30	22.5
1	1	1	0	100,000	50,000	0	7	3.5

Fig. 5) An example of risk analysis in a large construction project

This calculation is based on the probability of occurrence, i.e. the principle of expected monetary value is represented in this calculation [9]. The risk level is obtained by multiplying probability of occurrence and the highest level of consequences, and the factored cost and time risks are obtained by multiplying probability of occurrence and mean values of cost and time risks [10].

Probability Rating	Probability %	Risk Rating Number	Factored Risk Cost	Factored Risk Duration
0 - 5				
2	40%	8	800,000.20	9.00
3	60%	3	30,000.00	2.10

Fig. 6) An example of risk analysis in a large construction project

4 CONCLUSION

As the PPP projects are risky from the different viewpoint of both public and private partner, due to different key success factors, risk analysis and management should be the main activity for managing these projects.

As the Serbia is country with poor developed infrastructure it is very important to analyse all possible risks and to propose to the management good data for the decission making and to speed up inplementation of these type of project.

Private sector participation in infrastructure building should be encouraged, particularly in basic infrastructure like roads, power, water supply, housing; industrial infrastructure such as development of industrial areas and parks, cluster development; logistics infrastructure like air-cargo complex, inland container depot, warehousing, logistics hub; and social infrastructure like

health, education, tourism etc. Especially, an efficient road network is necessary both for national integration as well as for socio-economic development.

Acknowledgements

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HOTEL LONE IN TOWN ROVINJ, CROATIA

Milan Crnogorac[1], Ivan Kalafatić[2], Vedran Kobašlić[3]

Abstract

Hotel LONE (5 stars) is located in town Rovinj. It has 240 rooms, 9 luxurious apartments, one presidential apartment and congress hall for 600 persons. Hotel total gross floor area is about 30.000 m2. Architectural design and location caused formation of heterogeneous and irregular structure. Star shaped building has central atrium. Complicated structural system, design and FEM modelling procedure are presented. Large number of simple and complicated FEM models have been made for structural design using SOFiSTiK and TOWER software. The largest D1 building was designed using 3D numerical model consisting of 271 area macro elements, 80.000 nodes and 130.000 finite elements. Design made following construction phases gave 4 times larger longitudinal reinforcement in entrance lobby main beams than design without construction phases (self weight applied on whole structure). Architects and structural engineers received Croatian annular awards: Architectural award "Viktor Kovačić", year 2011., and award "KOLOS" for structural design of building, year 2012.

Key words

Hotel Lone, heterogeneous and irregular structure, structural design following construction phases, structural modelling.

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1   INTRODUCTION

Five stars luxurious hotel Lone is located in town Rovinj on northwest shore of Istrian peninsula. Architectural design and location caused formation of heterogeneous and irregular structure. Hotel was designed by 3LHD architecture and urban planning studio, Zagreb, Croatia [1]. Architects and structural engineers received Croatian annular awards: Architectural award "Viktor Kovačić", year 2011., and award "KOLOS" for structural design of building, year 2012. The objective of this paper is to give a brief introduction of complicated structural system, design and finite element modelling procedure and other design challenges for this project [2].

2   PROJECT DESCRIPTION

Hotel is located in Park Forest Zlatni Rt in town Rovinj (Fig. 1). Six storey building has 240 rooms, 9 luxurious apartments, one presidential apartment and congress hall for 600 persons. Hotel total gross floor area is about 30.000 m^2. Construction work started in June 2010 and finished in June 2011. Total construction cost was about 40 million euro.

Fig. 1)   Hotel Lone

Maximal width of hotel is 150 m. Regarding creep and shrinkage of concrete, temperature actions and irregular structural system, building was divided in four separate structures (Fig.2, Fig.3): central part of hotel containing atrium and congress hall (D1), rectangular-shaped building (D2), one storey underground garage (D3) with 56 parking places and two storey building (D4). D1 building has 90 m maximal width because complex geometry of central atrium disallowed formation of smaller buildings by seismic joints. Three storeys at the top of the two main D1 and D2 buildings have almost identical floor plan containing only apartments. Restaurant, kitchen, swimming pools, wellness and entrance lobby are located at first three storeys causing irregularities of structural system.
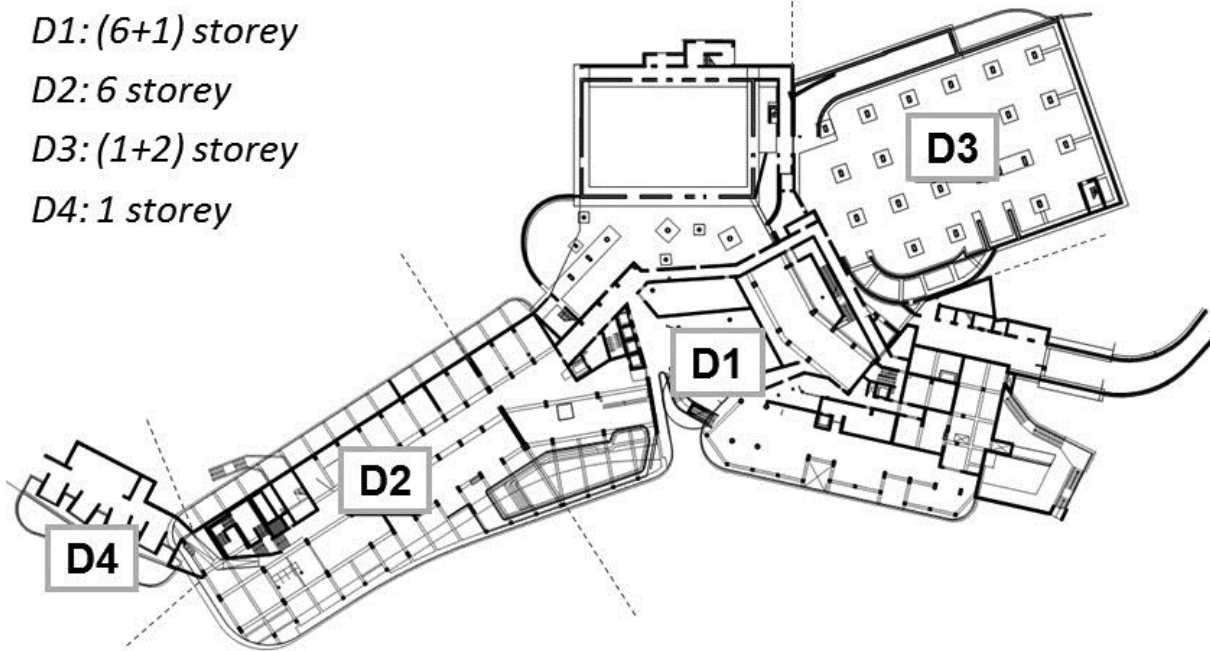
Fig. 2)   Seismic joint position between four buildings D1, D2, D3 and D4
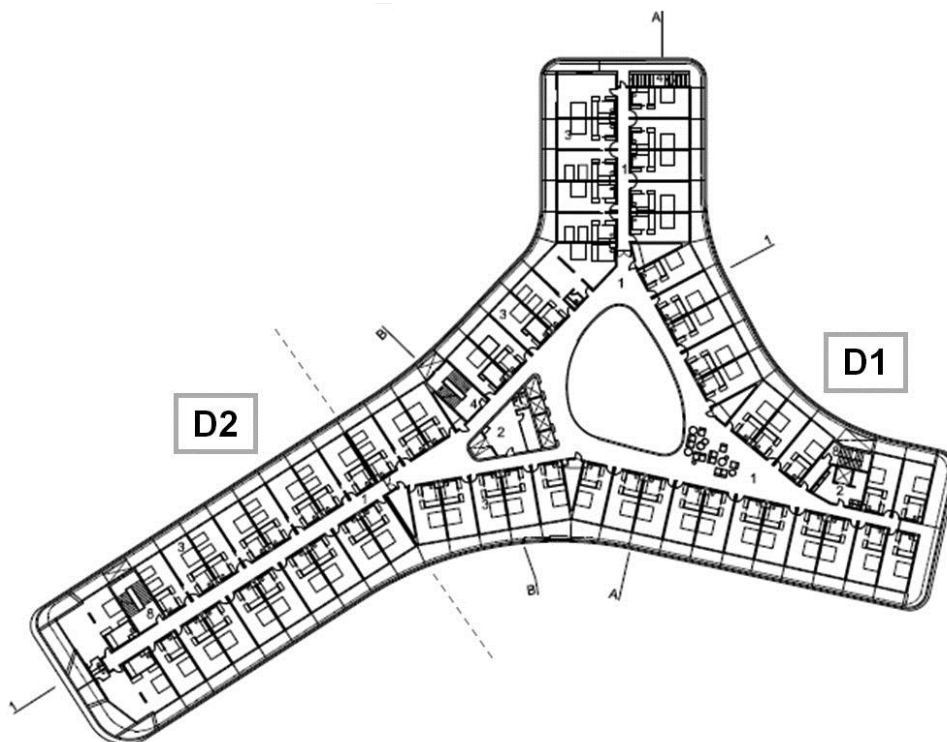
Fig. 3)   Characteristic storey-plan of main buildings D1 and D2

Star shaped building D1 has six-storey central atrium. Glass roof covers elliptical opening 16,50 × 26,00 m in reinforced concrete roof slab over atrium (Fig.4, Fig.5). Steel grillage formed using IPE profiles grade S 235 J0 is supporting glass roof. Grillage transmits reaction forces on edges of roof slab opening. Marine environment and durability requirements defined concrete class C30/37 and reinforcement B500B for all reinforced concrete elements. Building foundations are laying on solid rock reducing possibility of differential settlements.

Fig. 4) Central atrium during construction

Fig. 5) Central atrium after construction

Congress hall covering area 19,80 × 30,00 m is part of D1 building. One of the biggest structural problem was construction of three apartment storeys over hall spanning 19,80 m. For that reason so-called installation storey 2,95 m high was formed for storages rooms, air conditioning equipment and other installations over congress hall. Installation storey is divided by 6 reinforced concrete walls 19,80 m long, 2,95 m high and 0,50 m thick acting as simply supported reinforced concrete girders transmitting weight of three upper storeys on 0,40 m thick reinforced concrete walls. Reinforced concrete walls between neighbouring apartments (Fig.6 - axis 51 to 55) are laying over concrete walls formed in installation storey.
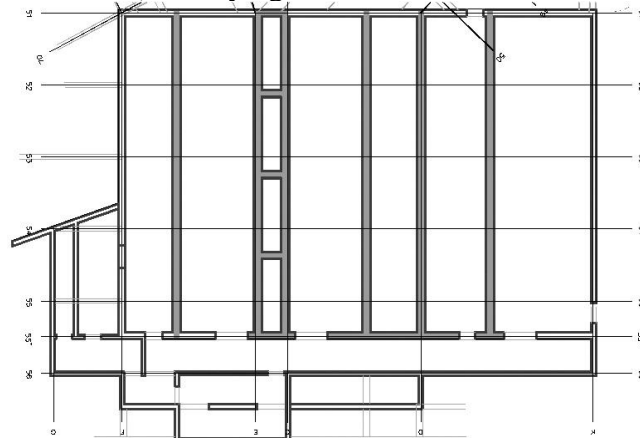
Fig. 6) Installation storey plan - position of 6 walls over congress hall

Large entrance lobby represented another structural problem (Fig.7). Three upper apartment storeys are supported by three reinforced concrete beams spanning 16 m, 1,0 wide and 1,2 m high (Fig.8). Concrete slab console span from beam edge to hotel atrium is 3,90 m. Large span caused slab thickening to 0,40 m in vicinity of beam.

Fig. 7) Longitudinal vertical cross section through hotel
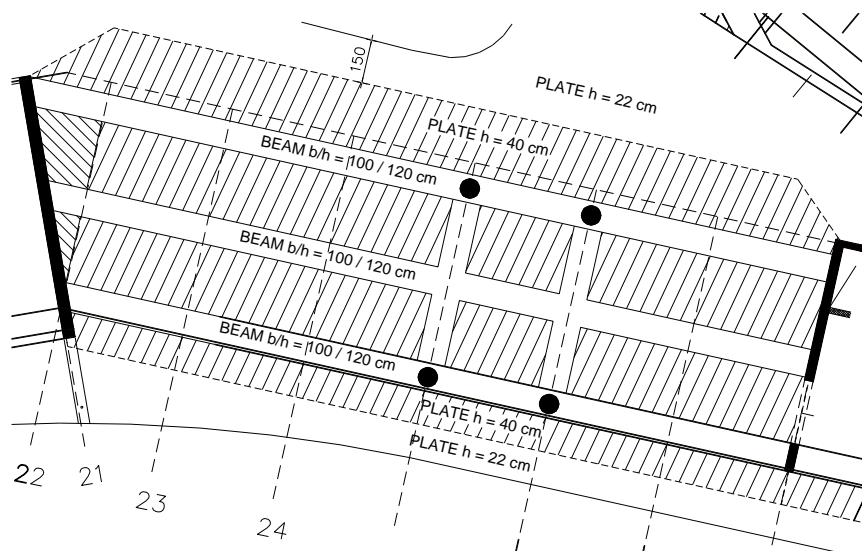
Fig. 8)   Storey plan of entrance lobby
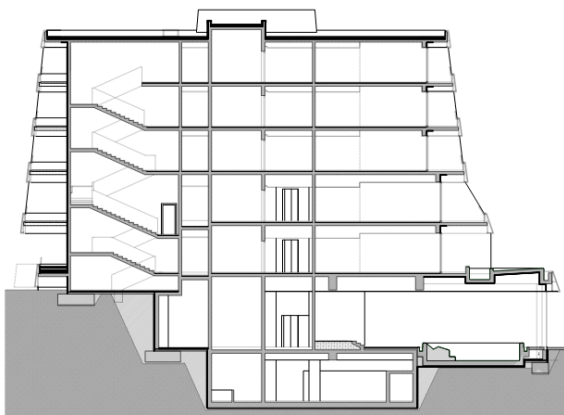
Fig. 9)   Transversal vertical cross section through hotel

Fig. 10)   Indoor swimming pool construction

3   STRUCTURAL DESIGN

Structural analysis was made according to Eurocodes [3], [4], [5]. Hotel is located in low seismicity zone. Small design ground acceleration ag = 0,1·g [5] allowed formation of irregular structure (Fig.9, Fig.10). Period of first mode of vibration for D1 building is 0,24 sec, and 0,42 sec for D2. Multimodal response spectrum analysis according [5] was used for seismic design. Base shear is only 5,6 % of vertical force acting in seismic analysis (self weight + percentage of live load).

SOFiSTiK and TOWER software were used for FEM structural modelling (Fig. 11). The largest D1 building was designed using 3D numerical model consisting of 271 area macro elements, 80.000 nodes and 130.000 finite elements. Design made following 16 construction phases gave about 4 times larger longitudinal reinforcement (71 cm^2) in entrance lobby main beams (Fig. 8) then design without construction phases (20 cm^2) (self weight applied on whole structure). Without construction stage modelling, front wall separating apartments and atrium forms deep beam significantly lowering forces in entrance lobby beams.

Several FEM models were made to evaluate behaviour of concrete girder over congress hall (Fig.12, Fig.13). Global 3D model gave lower amount of reinforcement than expected.
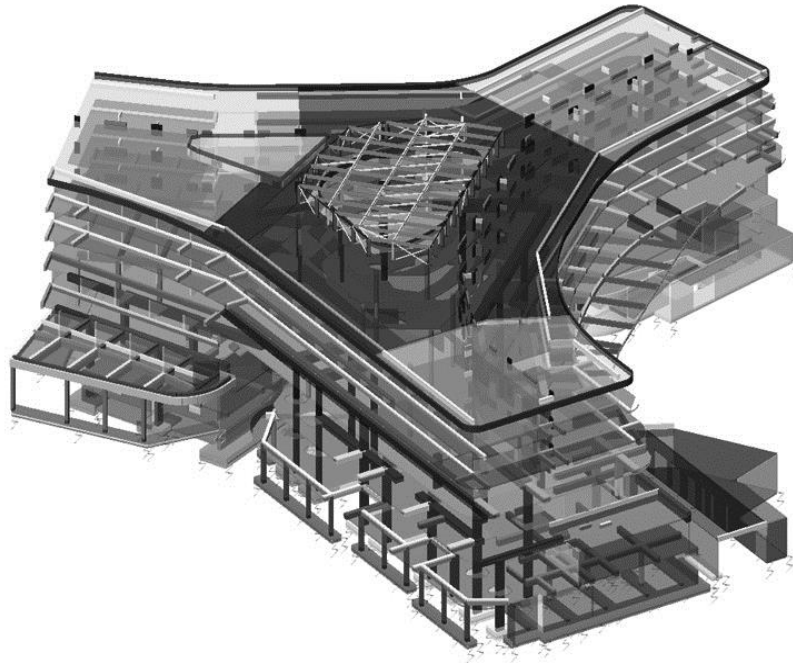
Fig. 11)   Global 3D FEM model

Congress hall ceiling slab acted as tensile element and received large amount of reinforcement in connection area with 0,50 m thick wall girders. Finally simple girder model was made. Total load acting on each girder was established and applied on simply supported beam. Distribution of longitudinal and shear reinforcement was as expected. Additional vertical reinforcement was added to hang congress slab ceiling plate on RC girders.

Global 3D model without construction phases gave only 25 cm2 in high beams formed in installation storey and large reinforcement in ceiling slab. Longitudinal walls forming corridor in upper storeys acted as deep beams. Simply supported beam model gave 120 cm2. Fifty percent of total reinforcement was placed in lower zone one high beam and 50 % in part of ceiling plate near beam.
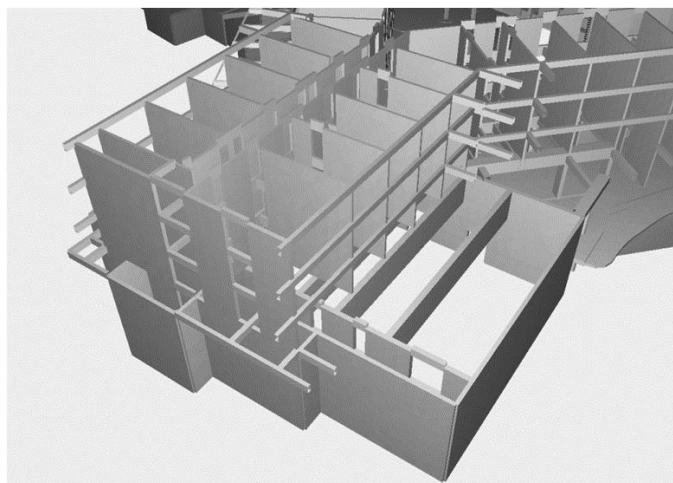
Fig. 12)   Part of global 3D FEM model - congress hall
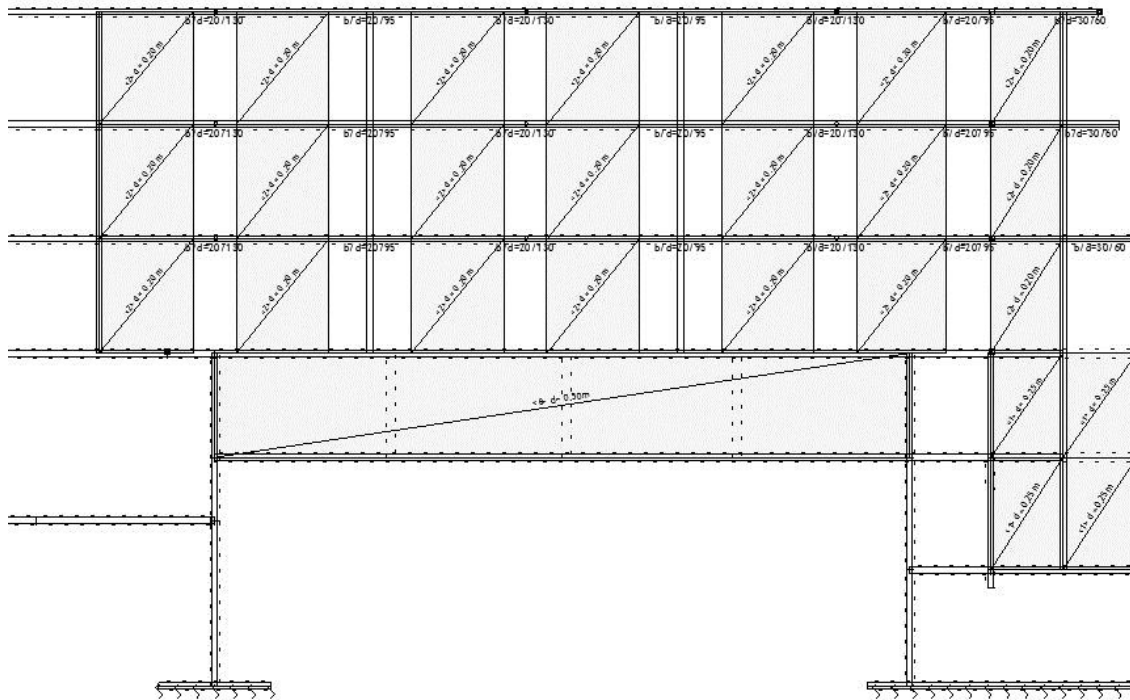
Fig. 13) Global 3D FEM model - deep beam over congress hall and walls above deep beam forming corridor in tree upper apartment storeys

Plane FEM models were made for additional analysis of concrete storey slabs (Fig. 14). Rigid connection in global 3D model caused significant compression forces in upper storeys slabs reducing required amount of reinforcement. Bigger amount of reinforcement from 3D and plane model was adopted.
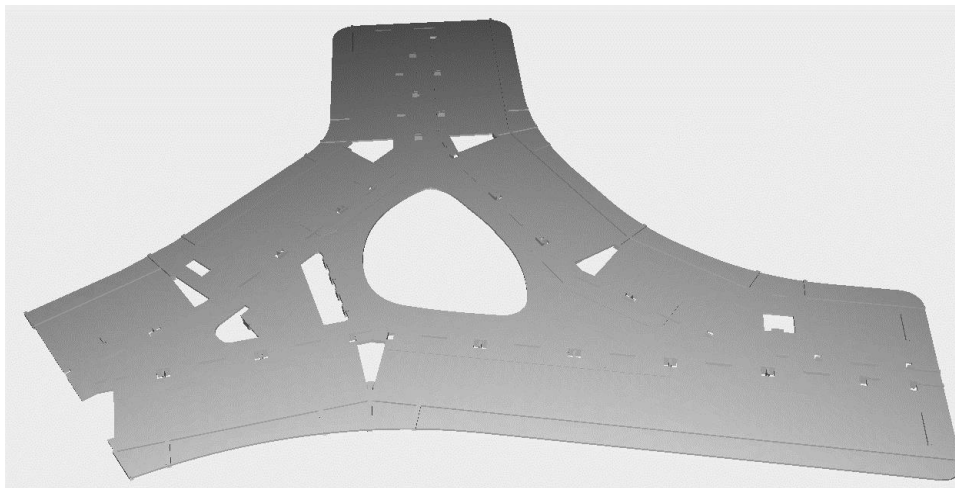
Fig. 14) Plane FEM model for slab analysis

Foundations were analyzed on separate 3D FEM model containing only foundations and lowest storey walls connected with foundations. Global 3D model made in SOFiSTiK didn't contain foundations. Walls an columns had fixed points at the ground level causing maximal possible seismic and base shear force. Reaction forces stored in SOFiSTiK database were transferred on foundation FEM model (Fig. 15). Winkler coefficient was used for soil modelling.
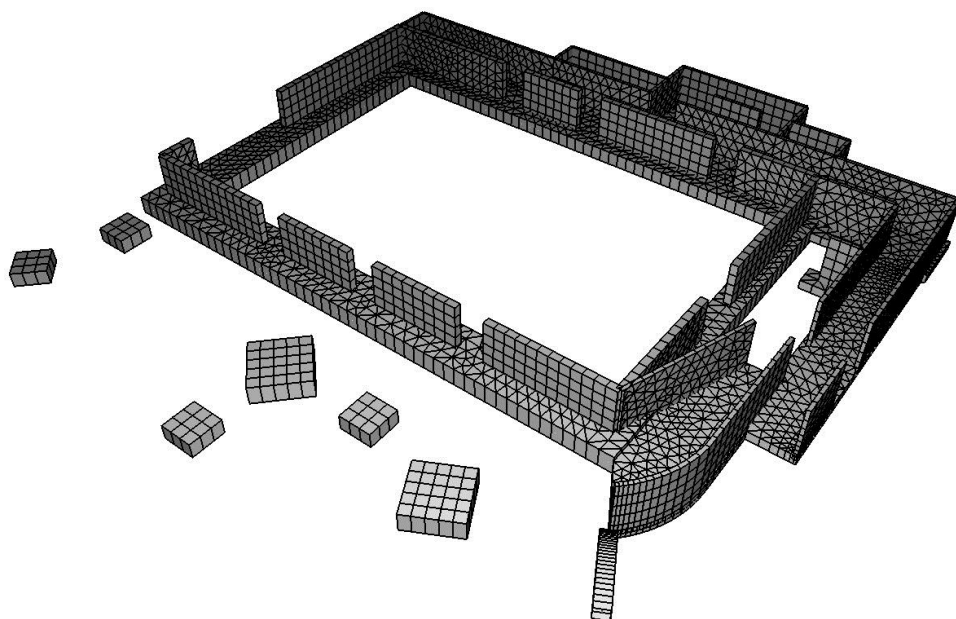
Fig. 15)   FEM model of foundations under congress hall

4   CONCLUSION

Design and construction of hotel Lone was complex engineering task that needed good cooperation among architects and civil engineers. Structural Analysis confirmed that complex irregular structural system like hotel Lone are allowed only in low seismicity zones. First simple FEM models must be analyzed to determine global forces and structural behaviour. Plane FEM model of storey slabs gives better results for dead weight and live load analysis then global 3D models. Construction stages must be taken into account resulting in higher amounts of reinforcement in deep beams and beams carrying hotel lobby ceiling.

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DEFICIENCIES OF THE SOUTH AFRICAN FIRE PROTECTION STANDARDS AND THE PROBLEMS WITH INTERNATIONAL REINSURANCE COMPANIES

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Abstract

South African industrial companies such as Anglo American or Sappi, which are to large to be insured on the local insurance market face several difficulties while trying to find reinsurance coverage at the international insurance market. While the South African Standard (ASIB 11th Edition Rules) are mainly used for the fire protection requirements across the industrial sector, they are not recognized by the majority of international insurance companies, especially by reinsurers. Contrary to The Automatic Sprinkler Inspection Bureau (ASIB) 11th Edition Rules, NFPA standards (National Fire Protection Association) are internationally recognized by insurers. A number of fires in the South African industry sector in the last 10 Years has shown that the present fire protections systems, compliant with ASIB, have mainly been ineffective. This paper shall focus on the deficiencies of the ASIB 11th Edition Rules while defining minimum requirements for fire protection systems in different occupancies compared to the NFPA standards. Especially the differences of ASIB 11th Edition Rules and NFPA 13 "Standard for the installation of Sprinkler Systems" shall be described in detail. Although the implementation of NFPA standards in the South African industry sector is combined with significant cost, this paper shall provide examples where the upgrades from ASIB 11th Edition Rules to NFPA requirements can be achieved with minimum costs. In order to have an insight on the reinsurers view on the ASIB 11th Edition Rules, the senior risk management experts from Zurich RE have been interviewed. The proposed upgrades of ASIB 10th Edition Rules in specific areas have been discussed with Zurich RE. The example provided in this paper will demonstrate that upgrades can be achieved with low cost while meeting the requirements of reinsurers.

Key words

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1   INTRODUCTION

Fire protection, especially in the industrial sector, has gained more importance within the last decade. Often, after fatalities occur during a fire in the industrial sector, the companies and community become aware of the dangerous potential a fire can have. In [1] the author emphasises the importance of fire protection inside the industrial sector.

Within the industrial sector, fires often caused enormous property damage. One of the best examples of the damage scale a fire can cause is the Buncefield fire of oil storage in 2005, where 43 people have been injured and the property damage has been estimated at 700 Mio. Euros. The second important factor for industrial companies is the business interruption caused by a major fire event. Around 50% of the industrial companies could not recover from the loss of costumers and have gone into bankruptcy after a major fire event.

The situation in South Africa is even more complex, as the majority of the industrial companies could not survive a major fire event. Taking into account that the majority of the municipal fire brigades are facing financial problems, industrial companies have to rely on the response of their personnel and the fire protection systems in place. In [2] the authors have presented the losses caused by fire inside the South African industry. These figures have been summarized in the following Table 1 and present the financial losses caused by fires within the industrial sector in South Africa during 2008 and 2009.

Tab. 1)   Financial losses in the South African industrial sector caused by fire.

Description	Sum of damage (Euros)		
	2008	2009	2009 incidents
Furniture	427,090	2,180,619	15
Plastics and rubber	13,576,430	6,446,873	96
Textile	1,258,500	912,231	38
Printing	574,000	2,615,125	13
Milling	15,262,210	583,858	22
Petroleum	15,219,300	8,827,800	20
Food and drink	16,700,000	34,000,280	59
Paper and packaging	194,150	691,991	24
Chemical	32,168,475	1,171,805	53
Metal	2,847,100	2,743,420	74
Electronics	434,350	2,229,717	170
Mines (surface)	50,000	600,000	5
Utilities	14,198,950	271,191	114
Total	112,910,555	63,274,910	703

Insuring industrial properties with local insurers becomes even more difficult, as some insurance capacity has to be bought at the international insurance market, which often comes at a higher price. The reason for this can be found in the deficiencies of the Fire Protection Standards used in South Africa (ASIB 11th Edition Rules) compared to the NFPA Standards (National Fire Protection Association).

In order to increase the level of safety and minimize the risks of major fire events, industrial companies should not maximize the level of fire protection as this is often combined with higher building and maintenance costs. Especially in South Africa, where companies are facing financial difficulties, it is not economically rational to install fire protection systems that are complying with international standards (i.e. NFPA).

1.1   ASIB 11th Edition Rules and NFPA

The Automatic Sprinkler Inspection Bureau (ASIB), was founded in 1970 in South Africa by the thirty-five short term insurance companies that were operating at that time. While the insurance companies would differentiate themself with the premiums and ratings, they would not request different requirements for fixed fire protection systems and a unifor inspection standard was of high importance for them.

ASIB was tasked with regulating the industry by, amongst other things;

-    Updating the Rules which were hopelessly outdated
-    Listing and grading sprinkler installing companies
-    Control the standard of design and installation
-    Inspect new and existing premises
-    Issue Clearance Certification for premises that complied with the required minimum standard

The ASIB standard, which is currently known as the 11th Edition Rules, has been based on international standards such as BS EN 12845, BS 5306 Part 2 and Loss Prevention Council fire test technical bulletins. Nevertheless, the majority of the European based insurers and international reinsurers hesitate to insure South African industrial companies that have implemented their fire protection systems in accordance with ASIB standards.

According to [3], the ASIB 11th Edition Rules covers the minimum standard for the installation of automatic sprinkler systems in buildings that are housing one or more of the following hazard classes of occupancy:

a) Ordinary Hazard: presents light non-commercial, commercial and industrial occupancies that are involving the handling, processing and storage of mainly ordinary combustible materials unlikely to develop intensely burning fires in the initial stages.

b) High Hazard: presents commercial and industrial occupancies with abnormal fire loads

- where the materials handled or processed are mainly of combustible nature likely to develop rapid and intensely burning fires, (High Hazard- Process risks);
- involving high piling of combustible goods, (High Hazard - High piled storage risks).

The deficiencies of this standard will be explained in detail in Section 3 of this scientific paper.

Even thought, the ASIB standard deviates from the British Standards, the only standard which is accepted by all European insurers and international reinsurers is the NFPA standard.

The National Fire Protection Association (NFPA) is an international non-profit organization that was established in 1896. The company's mission is to reduce the worldwide burden of

fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education.

According to [4], the NFPA is responsible for 300 codes and standards that are designed to minimize the risk and effects of fire by establishing criteria for building, processing, design, service, and installation in the United States, as well as many other countries.

The NFPA has listed all codes and standards, while the following codes are most widely used across the industrial sector:

- NFPA 1, Fire Code - Provides requirements to establish a reasonable level of fire safety and property protection in new and existing buildings.
- NFPA 13, Standard for the Installation of Sprinkler Systems - Provides the minimum requirements for the design and installation of automatic fire sprinkler systems and exposure protection sprinkler systems.
- NFPA 72, National Fire Alarm and Signaling Code - Covers the application, installation, location, performance, inspection, testing, and maintenance of fire alarm systems, supervising station alarm systems, public emergency alarm reporting systems, fire warning equipment and emergency communications systems (ECS), and their components,
- NFPA 70, National Electric Code - The world's most widely used and accepted code for electrical installations.
- NFPA 101, Life Safety Code - Establishes minimum requirements for new and existing buildings to protect building occupants from fire, smoke, and toxic fumes.

As the comparison of the complete standard would be to extensive, the deficiencies of the ASIB 11th Edition Rules will be presented on examples and compared to the requirements for the fire protection systems – sprinklers defined in NFPA 13.

1.2   Problem Definition

Despite the insurers requirements on the level of fire protection systems in industrial occupancies, it is often not feasible to comply with these requirements as the installation of these systems is combined with significant cost. In order to optimize the business and maintain current customers and constant growth, industrial companies are not keen to invest in fire protection systems, as the return on capital employed (ROCE) for these systems is not within the cycles defined by the companies. It is therefore necessary to find a balance between the insurers requirements and the companies possibilities to spent capital on these systems.

Especially in South Africa, the installation of fire protection systems in accordance to NFPA 13 is combined with enormous costs, and local industrial companies choose to install the systems in accordance to ASIB standard. The problems occur when industrial companies are facing problems to insure their assets on the international insurance market.

In [5] the author explains the problems of over proportional investments in fire protection. On the other hand reducing the fire risk onto the lowest level possible by exaggerated fire protection measures is senseless, because the costs for the effort can be much higher than the costs that can result from fire damage. In order to prevent financial imbalance between the effort and the damage costs that can be expected, the fire protection measures have to be optimized. The following Figure 1 explains the relation between investment into fire protection systems and damages caused by fire.
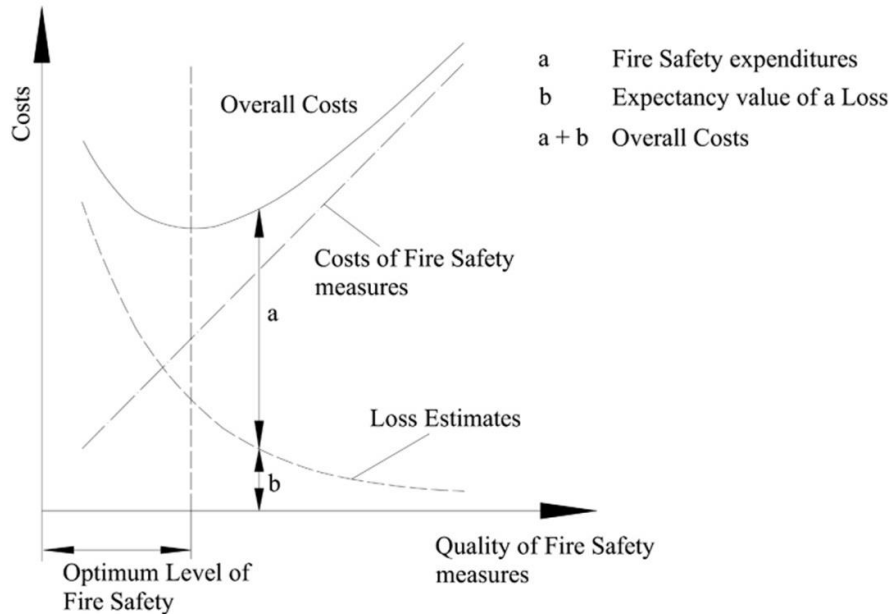
Fig. 1) Optimal financial fire protection level considering the costs for fire protection measures and fire damages

In order to understand the reluctance of the international reinsurers towards the ASIB standards, a detailed analysis of the 11th Edition Rules and comparison to NFPA 13 "Standard for Installation of Sprinkler Systems" has been conducted.

The authors are identifying the deficiencies of the ASIB 11th Edition Rules in comparison to NFPA 13, presented on several examples of design criteria for fire protection systems, while also presenting solutions how to improve the existing systems with minor upgrades in order to meet the requirements set by international insurance companies.

2 DEFICIENCIES OF THE SOUTH AFRICAN FIRE PROTECTION STANDARD – ASIB 11TH EDITION RULES IN COMPARATION TO NFPA 13

When defining minimum standards required for the installation of automatic sprinkler systems in buildings, the ASIB Standard differs between two hazard classes of occupancy, and defines the appropriate density of discharge over an assumed maximum area of operation for these hazard classes as stet in the following Table 2:

Tab. 2) Design density of discharge for hazard classes

Hazard Class	Design Density of discharge	Assumed max. area of operation
Ordinary Hazard System	5 mm/min	216 m²
Extra High Hazard Systems – Process Risks	7,5 – 12,5 mm/min	260 m²
Extra High Hazard Systems – High Piled Storage Risks	7,5 – 30,0 mm/min	260 – 300 m²

Compared to NFPA 13 Chapter 5 "Classification of Occupancies and Commodities" the ASIB definition delivers a less detailed description and classification. For example, the NFPA 13 definition for Occupancies compromises two Groups (Group 1 and Group 2) for Ordinary Hazards and Extra High Hazards and Mixed Commodities, while in the ASIB 11th Edition Rules do not describe how the protection requirements for these types of commodities should be conducted. As a detailed comparison of the complete ASIB 11th Edition Rules and NFPA

13 would be to extensive, the writer will concentrate on several examples and present the deficiencies of these compared to NFPA 13.

The protection of paper rolls, which present an enormous fire load, is crucial for any paper making and converting operation. If inadequately protected, a fire starting in this storage area could develop enormous temperatures and spread throughout the plant, causing total property damage. The deficiencies of the ASIB 11th Edition Rules compared to NFPA 13 will be presented on the design criteria for sprinkler protection in these storage areas. According to the ASIB 11th Edition Rules, paper rolls that are stored vertically present Category III of stored goods. In Chapter 1014 "Free standing storage or block stacking" in Table 1.2 the appropriate density of discharge and assumed maximum area of operation according to the category and stack height are defined for roof or ceiling protection only. As stated in [3], the following design criteria, presented in Table 3 are defined for this type of stored goods:

Tab. 3)   Design density of discharge for Category III stored goods

Storage height (m)	Design density of discharge	Assumed max. area of operation
2,9	7,5 mm/min	260 m²
3,5	10,0 mm/min	260 m²
4,1	12,5 mm/min	260 m²
4,7	15,0 mm/min	260 m²
5,2	17,5 mm/min	260 m²
5,7	20,0 mm/min	300 m²
6,3	22,5 mm/min	300 m²
6,7	25,0 mm/min	300 m²
7,2	27,5 mm/min	300 m²

ASIB makes a general approach regarding categorization of paper rolls. This approach is insufficient as there are three types of papers (lightweight, medium weight and heavyweight) which differentiate themselves based on their characteristics and fire load. Contrary to the ASIB 11th Edition Rules, the NFPA 13, as stated in [6], has design requirements for the protection of medium weight stored paper rolls as stated in the following Table 4:

Tab. 4)   Sprinkler protection criteria for the protection of roll paper storage (roof or ceiling up to 9,1 m).

Storage height (m)	Clearance (m)	Closed array banded or unbanded (mm/min over m²)	Standard array banded (mm/min over m²)	Standard array unbanded (mm/min over m²)	Open array banded or unbanded (mm/min over m²)
3,1	≤ 1,5	12,2/185,8	12,2/185,8	12,2/185,8	12,2/185,8
3,1	> 1,5	12,2/185,8	12,2/185,8	12,2/185,8	12,2/185,8
4,6	≤ 1,5	12,2/185,8	12,2/185,8	18,3/232,3	18,3/232,3
4,6	> 1,5	12,2/185,8	12,2/232,3	18,3/278,7	18,3/278,7
6,1	≤ 1,5	12,2/185,8	18,3/232,3	24,5/232,3	24,5/232,3
6,1	> 1,5	12,2/232,3	18,3/278,7	24,5/278,7	24,5/278,7
7,6	≤ 1,5	18,3/278,7	24,5/278,7	30,6/232,3	30,6/232,3

The comparison clearly shows the differences between the two standards. Paper rolls in converting operations are often stored up to 3,0 m in height, while the stacking at paper production operations goes up to 8,0 m. The ASIB 11th Edition Rules define lower densities than NFPA 13 for vertically stored paper reels up to 3,0 m height (10 mm/min over 260 m² and 12,2 mm/min over 185,8 m²). The operation area is according to ASIB is 74,2 m² higher than defined by NFPA 13. Furthermore, according to NFPA 13 it is permitted to interpolate

densities or areas, or both between any 1,5 m storage height increment, while the ASIB 11th Edition Rules do not allow the interpolation of these.

Similar deficiencies are found when comparing the design criteria for sprinkler protection of Rubber Tires and Plastic Commodities according to ASIB 11th Edition Rules Chapter 1055 and the requirements of NFPA 13 Chapter 15.

The maximum design density of discharge for these type of storage materials according to the ASIB 11th Edition Rules is 30 mm/min over an operating area of 300 m². The detailed densities for this type of Storage, according to [6], are stated in the Table 5 and Table 6.

Tab. 5) Design densities for palletized, solid piled, bin box or shelf storage of plastic and rubber commodities.

Storage height (m)	Roof/Ceiling height (m)	Density (mm/min)				
		A	B	C	D	E
> 1,5 to ≤ 3,6	Up to 4,6	8,2	EH2	12,2	11,4 – 12,2	11,4 – 12,2
	> 4,6 to 6,1	12,2	24,5	20,4	15,5 – 16,3	15,5 – 16,3
	> 6,1 to 9,8	16,3	32,6	24,5	18,4	28,6
4,6	Up to 6,1	12,2	24,5	20,4	16,3	18,4
	> 6,1 to 7,6	16,3	32,6	24,5	18,4	28,6
	> 7,6 to 10,7	18,4	36,7	28,6	22,4	34,7

Tab. 6) Design densities for palletized, solid piled, bin box or shelf storage of plastic and rubber commodities.

Storage height (m)	Roof/Ceiling height (m)	Density (mm/min)				
		A	B	C	D	E
6,1	Up to 7,6	16,3	32,6	24,5	18,4	28,6
	> 7,6 to 9,1	18,4	36,7	28,6	22,4	34,7
	> 9,1 to 10,7	24,5	49,0	34,7	28,6	44,9
7,6	Up to 9,1	18,4	36,7	28,6	22,4	34,7
	> 9,1 to 10,7	24,5	49,0	34,7	28,6	44,9

Notes: Column designations correspond to the configuration of plastics storage as follows: A (1. Nonexpanded, unstable; 2. Nonexpanded, stable, solid unit load); B (Expanded, exposed, stable); C (1. Expanded, cartoned, stable; 2. Nonexpanded, stable, cartoned); D (Expanded, cartoned, stable); E (1. Expanded, cartoned, stable; 2. Nonexpanded, stable, exposed)

The deviation regarding the required densities for certain plastic commodities is up to 19 mm/min. The densities defined in NFPA 13 are based on tests and experiments. This is only one of the examples which confirms that the sprinkler systems designed according to ASIB requirements would be insufficient in a fire event.

2.1 Case presentation – Improvement of the sprinkler systems in coal conveyors

The coal conveyor of a South African paper production mill has been protected in accordance with the ASIB 11th Edition Rules. Coal conveyors have been defined as Ordinary Hazard process risks. The conveyor has been protected with a wet type sprinkler system with the defined density of discharge of 5 mm/min. Compared to NFPA 13 and FM Global (Factory Mutual Insurance Group) requirements, this density is insufficient. As the replacement of the piping system and reinforcement of a new sprinkler system in accordance to NFPA 13 (deluge sprinkler system) would be too expensive the following upgrade has been proposed and implemented:

As the water supply is sufficient (10 sprinkler heads at 1 bar, 1000 l/min) and the incline of the conveyor does not approach 30°, according to [7] the required density of the sprinkler system is 10 mm/min over an operating area of 186 m² using sprinkler heads with a K Factor of 115.

With this solution only the existing sprinkler heads had to be changed. The implemented proposal resulted in saving of approx. 650 000 €. International reinsurers also accept this type of system, as FM Global Data Sheets present standards that are recognized across the insurance industry.

This improvement shows that upgrades of the sprinkler systems, which have been implemented according to ASIB, can be achieved with minimal costs in order to be accepted by international reinsurers.

3   CONCLUSION

The analysis of the ASIB 11th Edition Rules has shown significant deviations from the requirements defined in NFPA 13. In specific cases (plastic and rubber tier storage) the deviations are enormous, and an effective suppression of the fire would not be possible. Improvements can be made within the existing systems to a certain degree. The example of the sprinkler protection at the coal conveyor is one example of this, where significant cost have been saved.

In general, the ASIB 11th Edition Rules present a standard that provides general and insufficient information on protection systems for different occupancies and compared to internationally recognized standards (i.e. NFPA 13) has significant deficiencies. This standard may be sufficient and acceptable to the South African insurers, and most of the local industrial companies will implement their fire protection system in accordance with ASIB due to the lower cost. The problems start when the capacity of the local insurers is not sufficient to cover the insured value of an industrial company.

Depending on the size of the company and the need for insurance coverage on the international insurance markets, the decision on further improvements and investments in these areas is up to the senior management. With the growing economy in Africa and expenditure of companies from South Africa, the local insurance market will not be able to assure sufficient coverage. The risk management strategy of these companies should consider these facts, as later upgrades of the existing systems should be combined with significant costs. The decision on whether to implement the local ASIB standard or the internationally recognized NFPA standards should be evaluated in detail, but looking on the long term and growth of an company, the implementation of the NFPA standards will pay off with lower insurance premiums.

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EFFECT OF FUELS FROM A PETROL STATION UPON ENVIRONMENT

Biserka Dimiskovska[1]

Abstract

The petrol station owned by the Association for Trade and Services Import-Export Triterol DOOEL Strumitsa, which is in the economic zone of the v. Gradoshortsi along the main Strumitsa – Radovish road, R. Macedonia, has been considered. This paper deals with air emissions in accordance with the Law on Protection of Air Against Pollution Caused by the Petrol Station categorized as: emissions from boilers, point emissions from stationary and mobile sources and potential and fugitive emissions. Presented in the paper is the effect of the exhaust gases from the vehicles which contain 180 organic components as harmful matter, whose concentration is the biggest at places with increased number of vehicles and operation of motors in stationary position when the emission of toxic matter in respect to the speed of motion of 70 km,/h is 2,5 times greater. According to some investigations, it has been defined that 98 kg carbon monoxide, 6-8 kg nitric oxides, 4-5 kg sulfur compounds and 0.5 kg lead are emitted in the atmosphere per 1000 litres of combusted petrol in a motor vehicle. The emission factors related to polluting matter from internal combustion engines are presented. It is concluded that, in conditions of long term exposure, toxic gases may adversely affect human health. For example, smoke affects the respiratory organs and the skin, lead affects the respiratory, the nervous and the cardiovascular system, the nitric oxides cause asthma, allergies and malignant diseases. Hard particles from the combustion are also cancerous.

Key words

Air pollution, emissions of dust, emission of gases, nitric oxides, sulfuric compounds.

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1   INTRODUCTION

The petrol station is in the economic zone of v. Gradoshortsi, next to the Strumitsa – Radovish main road. The planned petrol station is located north of Strumitsa, to the left of the Strumitsa-Radovish main road and its exit is toward service street U-2 where access of vehicles by circular motion around the petrol station is anticipated. It is separated from the service street by a protection traffic island. According to its characteristics, the street represents a service road section with allowed speed of 40 km/h. Located at the petrol station will be a diesel fuel reservoir with a capacity of 60 m3, a reservoir for motor petrol of 40 m and a reservoir for liquid oil gas of 10 m3. The three reservoirs will be placed underground and behind the zone of motion of vehicles. The petrol station consists of a facility for the employees with sanitary knots, an operation area under a canopy as well as access roads and a parking lot for light and heavy vehicles in [1].

2   DESCRIPTION OF THE ACTIVITY

The petrol station consists from a facility for accommodation of the employees; a canopy over the petrol automats; a protective traffic island; a location island for the petrol automats; the part with the reservoirs; connecting lanes; operational area; parking lot.

The ground floor structure for the employees with a sanitary knot is anticipated for keeping 200 l flammable liquids of 1,2,3 class (liquids that are flammable at a temperature of up to 1000C) and 1000 l liquids that are flammable at a temperature of over 1000C. The liquids and the devices like lubricants, antifreeze and autocosmetics are anticipated to be kept in hermetically closed vessels with a volume of up to 5l. The underground mechanical installations for transfer and pouring of petrol from the embedded reservoirs into the reservoirs of the motor vehicles will be placed in the area (the plateau below the canopy) where pouring of fuels will be done. The access and the exit from the petrol station will be elaborated in accordance with the standards and the norms for this type of structures. The connecting traffic lanes and the operational area will be done as a standard asphalted area according to the norms referring to a secondary asphalt road. The apparata for pouring of fuel are planned to be placed on separate islands, i.e., on a concrete pedestal uplifted for at least 14 cm in respect to the traffic lanes. The apparata for providing fuel of "multiplex" type , for four types of fuel and with eight guns for two-sided service, will be placed at a minimal distance of 500 mm from the edge of the pavement, at inter distance of not less than 2000 mm. The apparata for pouring of fuel must have a valve for automatic closure in all positions.

The protective island physically separates the facility from the service street and prevents direct access to the petrol apparata. Behind the facility, a parking lot will be constructed of behaton plates over well compacted gravel and sand for parking of light and heavy load vehicies.The grassing of the courtyard area as a natural filter will contribute to reduction of pollution of air and soil particularly when trees are also present. Due to the fact that the petrol station is classified as a facility with high risk pertaining to occurrence of fire, fire fighting apparata with dry powder (manual – type S-9 and portable - type S-50), sand boxes and a fire protection wall are anticipated. These will be periodically inspected according to the instructions given by the producer. For the purpose of reduction of emission of gases and noise during the pouring of the fuel into the reservoirs of the vehicles, the vehicle motors will be turned off. While decanting the fuels in the separate part for access of the cisterns, special danger signs will be placed according to international standards and norms. Used as a driving energy for all the apparata within the facility as well as for lighting will be electric power to

be supplied from the public electric network. The entire system (the reservoirs, the pipe network, the automats and the remaining equipment will be appropriately grounded and protected against electric shocks. A classical lightning rod is also anticipated to be installed.

The facility will be supplied with water from the existing local water pipeline network. Waste water from this facility will be only due to the sanitary needs since there is no need of use of technological water in any process of operation of the facility in [2]. The outlet of waste waters of fecal character is anticipated to be solved by a classical double-chamber septic tank and a blotting tank. For catching the atmospheric water and the water from the washing of the pavement platforms (asphalted and behaton areas), i.e., floors where there is a possibility of presence of poured fuel (places where the fuel is poured into the reservoirs of the vehicles, parking places and places of pouring of fuel from cisterns), two linear gulleys are anticipated to be constructed. The water will flow into these gullies from the surface under an inclination and will be led to the separator catching the oil. The purified water will then enter a separate blotting pit. When conditions for connection to the local atmospheric sewerage are created, the water from the separators will flow, through the anticipated special shafts, into the stated sewerage and the atmospheric waters from the roof and the eaves will be led to the stated sewerage system through gutters and shafts.

3   RAW MATERIALS AND ACCESSORY MATERIALS

It is considered that the annual distribution and consumption will amount to:

Euro diesel fuel	1.000.000 l/per annum
Euro super 95	500.000 l/per annum
Euro super 98	300.000 l/per annum
Liquid oil gas (natural gas)	100.000 l/per annum
Water	100 м^3 /per annum
El. power	10 000 KW/per annum

Fuels are the main raw material distributed from the petrol station, namely petrol that indirectly participates in the process of combustion and diesel fuel belonging to the III class of flammable matter.

According to the level of defined danger ranked from 1 – 4 referring to health, the danger arising from the presence of these matters is very low. According to flammability 4 of 4, these are flammable gases or easily evaporable liquids which can create explosive mixtures in the air within a short period of time. For the extinguishing of the flames, dry powder, foam, carbon dioxide and halogen hydrocarbon are used. As to the reaction of the motor petrols, these are normally stable and do not react with water under temperature effects.

Natural gas – oil gas (TNG) represents a mixture of oil hydrocarbons (propane, propene, butane, butane and its isomers) in a gas state.

4   DESCRIPTION OF ENVIRONMENT AROUND THE PETROL STATION

The petrol station is located to the left of the main Strumitsa – Radovish main road and faces service street U-2 from where the access of the vehicles is anticipated. The petrol station itself is separated from the service street by a protective island. Its capacity of reservoirs for liquid fuel amounts to a total of 100 м3 and 10м3 for gas, the reservoirs being placed underground.

The existing traffic lines satisfy the needs for undisturbed traffic and traffic of fire fighting vehicles. The Strumitsa fire station is at a distance of 7 km from the facility.

In the immediate vicinity of the facility, there are no locations of the type of hospitals, schools, kindergartens and alike.

As to the infrastructure, the location has: a water supply installation for supply of sanitary and hygienically proper potable water and an electric power network for satisfying the needs of the facility.

Anticipated is construction of a separate sewerage for waste fecal and atmospheric water in the near future. Until the construction of the stated local infrastructure, the following is anticipated: the waste sanitary fecal water to be led sanitarily and to be purified in a double chamber septic and blotting tank, and, the atmospheric water from the pavement platforms to be led through channels to be treated in a separator, i.e., to be freed from oil and to be deposited. Then the purified water will flow into a separate blotting tank.

4.1 Natural – Geographic Characteristics of the Wider Surrounding and the Location

According to its position at regional level, the location of the facility belongs to the Vardar zone geotectonic unit with a belt of shells of the Paleozoic and Mesozoic complex where old formations are slipped under the more recent ones. As to the Jurassic complex, metamorphosed rhyolites are present. The most important for the considered area are the Pliocene sediments that are present in the Radovish and Strumitsa valley and the surrounding of Kosturino and are represented by clay, sand and gravel. With the recent geological processes in the Quaternary and Holocene, through highly expressed erosion processes and activities of river water flows, the geomorphologic structure of the terrain has been formed. It is characterized by alluvial and proluvial sediments as well as proluvium and detritus. From hydrogeological aspect, the location belongs to regions with relatively scarce hydrographic network.

4.2 Climatic Characteristics of the Area

Considered within the Strumitsa valley can also be the Radovish field, which in fact, represents the northwest part of this morphological structure, which is under great thermal effect of the Aegean Sea so that the climate is of a Sub-Mediterranean type, but there are disturbances of temperature stratification of the sea climatic effect due to openness of the valley toward northwest. Therefore, Mediterranean climatic conditions are manifested along the Struma river valley. The average annual temperature amounts to 14,2 ^{o}C. In the winter months, the Mediterranean effects are disturbed by quite low temperatures that are manifested by values below -8 ^{o}C each year. The precipitation regime is also under Mediterranean climatic influence, with small quantities in the course of the summer months and maximum quantities in late autumn. The maximum height of the snow cover is less than 40 cm although a snow cover of 80 cm was observed during one winter. On the average, this region is characterized by a small quantity of snow precipitations and short lasting of the snow cover whereby its participation in the overall precipitation is small. Dry periods occur with a somewhat greater frequency in autumn and summer. Out of the total dry periods, 28% occur in summer and autumn and 22% occur in winter and spring. The longest dry period lasted 88 days as recorded in 1956, while the average summer-autumn dry periods start on the 14th July and end on the 9th October. The Strumitsa valley is an area with the longest sun radiation

in the country. The longest sun radiation takes place in July with 11 hours daily, while the shortest is in December, with only 4 hours. The cloudiness in the area has the least values in the entire country, with an average value of 4,2 tenths. Months with the least cloudiness are July and August, with a mean value of 2,2 tenths, while the greatest cloudiness takes place in November, January and March, with an average value of 5,7 tenths. The relative air humidity has a well expressed annual trend. It is gradually reduced from January until July and starts to increase in December. The average annual value amounts to 71%. It is the least in July and August amounting to 56% and the greatest in the winter months, amounting to 80%. The occurrence of hail in unstable convective clouds is very much present, particularly in April and May, but also in the summer months inflicting damages to agricultural raisings. The fog as a phenomenon is not present in this area, with ten days of fog on the average, mainly during the winter months.

4.3 Wind Regime

In the Strumitsa valley, the most pronounced are the air circulations along the Strumitsa river valley which coincide with the Vardar circulations through the so called Vardarets wind blowing from north and south in southeast direction.

4.4 Seismic Characteristics of the Area

From regional-seismotectonic aspects, the area of the location belongs to the Vardar seismogene zone in which the Strumitsa epicentral area is one of the most distinguished according to the level of destructiveness of earthquake effects. The seismicity of the location has been estimated to amount to 8 degrees according to the Richter's scale.

5 EFFECT OF THE PROJECT UPON THE ENVIRONMENT

5.1 Emissions in the Air

In accordance with the Law on Protection of Air Against Pollution, emissions in the air are categorized as emissions from boilers, point emissions from stationary and mobile sources as well as potential and fugitive emissions. During the construction of the facility, emission of dust and emissions from exhaust gases from point sources will occur. The fugitive dust will be emitted during the construction works and the operation of the machines. Exhaust gases in the air will be emitted from the construction mechanization containing carbonmonoxide, carbon dioxite, nitric oxides, sulfur dioxide in [3]. Considering the temporary character of the construction works and taking into consideration that the construction mechanization will be equipped with filters for purification of exhaust gases, it is considered that there will be no significant air pollution that will impose taking of measures. Since pouring of concrete is done automatically within a closed system and the air pollution of the microatmosphere, i.e., the zone of effect of the petrol station is in function in [4] of the emission of toxic gases from the operation of the vehicles for supply and pouring of fuels, there is only a negligible short emission from mobile sources (vehicles).

Therefore, Table 1 of the Rulebook on Form and Contents of Reports on Protection of Environment (Official Gazette of RM no. 50/2009) can be filled out as follows:

Tab.1)   Data on pollution of environment

Source of emission	Details on emission				Deviation from МДК (mg/Nm3)
Description	Height of chimney (when applicable) Number of mobile sources (when applicable)	Substance /material	Emission (mg/Nm3)	MDK(mg/ Nm3)	Exceedence/ within the frames of MDK
Chimney	Non-applicable				
Temporary, mobile sources (vehicles):	During temporary parking of 5-6 vehicles for washing	to CO CO2 NOx SO2 Smoke no. lead	/ Negligible Negligible Negligible Negligible Negligible Negligible	/ * * * * * *	/ / / / / / /

It is considered that the exhaust gases from vehicles contain even 180 organic components as harmful matter, whose concentration is the greatest at places with increased number of vehicles and in situ operation of motors.According to some investigations, it has been defined that during the combustion of 1000 l petrol in a motor vehicle, 98 kg carbon monoxide, 6-8 kg nitric oxides, 4-5 kg sulfur compounds and 0.5 kg lead are released in the air in [5]. The emission factors of polluting matter are presented in table 2.

Tab. 2)   Polluting matters from internal combustion motors

Compound	Petrol driven morors g/l	Disel motors g/l
Sulfur dioxide	0.4	4.5
Nitric oxides	20	90
Organic volatiles	40	110
Total suspended particles	3	15
Carbonmonoxide	220	90
Lead	0.45	0
Bensopyrene	20 mkg/m3	10 mkg/m3

During long term exposure, the above stated toxic gases may adversely affect human health. So for example, the smoke acts upon respiratory organs and the skin, the lead acts on the respiratory, the nervous and the blood system, the nitric oxides cause asthma, allergies and malignant diseases and the hard particles from the combustion process are also cancerous.

Tab. 3)   MDK for harmful matter

Components	Released amount MDK g/h	Released concentrations MDK mg/m3
Lead	25.0	5.0
Nitric oxides	5000.0	500.0-800.0
Hydrocarbons		500.0
Formaldehyde	100.0	20.0
Hard particles		130.0
Carbon monoxide		650.0
Carbon dioxide (%)		2.5

Since the activity of the facility does not produce evaporable organic components and no boilers are used, Tables 2 and 3 of this Rulebook are not applicable. The use of ecological fuels that are currently being introduced in retail sale of oil derivatives will drastically contribute to reduction of negative effects upon the environment in [6]. The distribution of the surrounding structures enables good natural ventilation. The grassing of the courtyard area as a natural filter will also contribute do reduction of the stated pollution of air and soil, particularly if trees are present.

5.2   Emissions in Waters and Sewerage

The facilities are supplied with water from the public water supply network. Water is used for sanitary needs, washing of floors and watering of the green area. The waste water from the sanitary knots is led for treatment, through the fecal sewerage network, in a classical double-chamber septic tank and blotting pit. After mineralization by way of anaerobic boiling in the septic tank, the mineral matter falls on the bottom and is deposited. After a longer time period (35-40 years), these deposits are removed mechanically. The partially purified water in the other part of the septic tank, after additional mineralization up to stabilization of the waste matter, flows into a blotting well and is blotted into the soil, at depth of less than 10 m. For catchment of atmospheric water and water from the washing of the pavement platforms (asphalted and behaton areas), i.e., floors where there is a possibility of presence of poured fuel, it is planned to construct two linear drains in which the water will be poured from the surface under an inclination and will be led to the separator where it will be released from oil. The purified water will then flow into a special blotting tank. When conditions for connection to the anticipated local (public) sewerage system are created, the water from the separators will flow toward the stated sewerage through the anticipated special shafts. Considering that the waste water load due to the operation of the petrol station is small and there is a channeled separate outflow and treatment of the waste waters, it can be concluded that the functioning of the petrol station will not cause pollution of the surface waters. The measures undertaken for corresponding isolation of the floors and the reservoirs will prevent the possibility for pollution of the underground waters, as well.

5.3   Creation of Waste

During the performance of the construction works, municipal waste and waste from excavation of earth will be created. The contractor performing the construction works will enable timely removal and depositing of the municipal and construction waste that cannot be re-used to appropriate landfills in [7]. Table 4 also shows other waste materials that are produced in minor quantities. In accordance with the legal regulations for minimization of quantity of waste and appropriate treatment in [8], the waste should be selected for re-use by recycling in Table. 4.

5.4   Emissions in Soil

There is no pollution of soil due to the construction works and the operation of the considered facility because: the waste will be selected and removed in a safe way whereby pollution of soil is avoided; the floors of the facility are with corresponding isolation (concrete, ceramic tiles); technological waste water is not produced; the atmospheric water will be led and made oil free through channels in [9]. Until connection with the local sewerage network for atmospheric water, the oil free atmospheric water will be led into a special blotting tank; the fecal water will be sanitarily led to a double-chamber septic tank and then in a blotting pit.

From the above stated, it can be concluded that there is no danger of degradation of the soil and the surrounding soil vegetation.

Tab. 4)   Types of waste

No.	Type of waste	No. from the list of types of waste1	Quantity of waste at annual level (t/per annum	Mode of treatment of waste	Method and location for depositing
1	Construction waste	17 05 05 and 17 01 01	Variable quantity	Is selected	It is deposited on a landfill for construction waste
2	Municipal solid waste	20 03 01	0.6 t/per annum	Is selected	Public Works company collects it and deposits it on a landfill
3	Silt from the septic tank	20 03 04	Insignificant quantity	Is deposited-fermented for approx. 35/40 years	Public Works company collects it and deposits it on a landfill
4	Sediment from water purification	19 08 02	Insignificant quantity	Is separated by removal of oils and is deposited	Public Works company collects it and deposits it on a landfill
5	Waste paper	03 03 09	Variable quantity	Selection	Sale for recycling

[1] List of Waste Types (Official Gazette of RM no. 100/2005)

5.5   Noise, Vibrations and Non-ionizing Radiation

Noise will be produced during the construction works. The construction machines and the trucks emit noise of up to 85 dB. Since a small scope of construction works of temporary nature is at stake, these will be carried out only in the course of the day and measures will be taken for amortization of the noise. We therefore consider that the emitted noise will not have any harmful effect upon the environment. Considering that the installation is beyond an inhabited place, in an industrial zone or area of the fourth degree pursuant to the Rulebook on Locations of Measuring Stations and Measuring Points (Official Gazette no. 120/08) and the Rulebook on Ultimate Values of Level of Noise in Environment (Official Gazette no. 147/08), and taking into account that the ultimate level of noise in the environment for this area amounts to 70dB, it is considered that this level will not be exceeded due to the construction and the operation of the petrol station. Given that the sources of noise represent point sources and that the intensity of noise is reduced with distance from the source (as presented in figure 1):
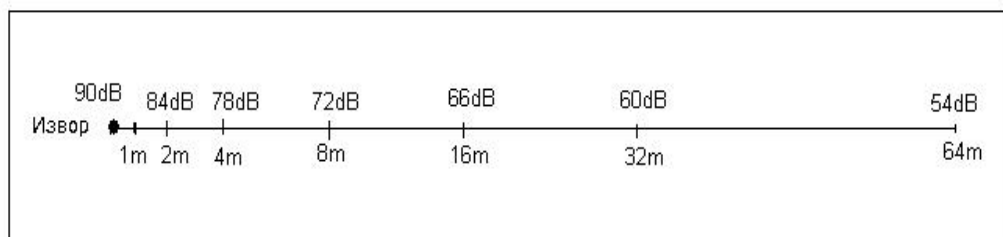
Fig.1)   Presentation of reduction of intensity of noise with distance from the source

It can be concluded that the produced noise due to the facility will not be harmful for the environment.

6   PROGRAME FOR PROTECTION OF THE ENVIRONMENT

All legal and physical entities are obligated to take care for the environment in accordance with the Law on Environment (Official Gazette of RM 53/05) as well as take measures and activities to reduce to minimum the effects upon it. From the stated above, it can be concluded that the effect of the considered facility upon the environment is negligible because the petrol station will function by carrying out and taking measures of prevention of fire and uncontrolled pouring of oil derivatives. With the combustion of the fuels (oil derivatives), toxic gases are released. When the oil derivatives are at a ground floor, these toxic gases are present for quite a long time and cause long term pollution wherefore protection against corrosion, i.e., the double coating of the reservoirs placed underground, timely and permanent automatic control according to the legal regulations are of essential importance for preventing penetration of the poured out fuel into the soil. From the previously stated, it can be concluded that the effect of the servicing – distribution complex for oil derivatives upon the environment is negligible. The evaluation of the effects is presented in the subsequent Table 5.

Tab. 5)   Final evaluation of the effects

Component	Significance of the effect	Significance of the effect after taken measures	Global significance of the effect upon components
Climate	Negligible	Negligible	Negligible
Surface waters	Low	Low to negligible	Low to negligible
Underground waters	Low	Low to negligible	Low to negligible
Landscape	Low	Low	Low
Vegetation	Low	Low	Low
Quality of air	Low	Negligible	Negligible
Land	Low	Negligible	Negligible
Noise	Low	Negligible	Negligible
Economic effects	Moderate	Moderate	Moderate

Since management of environment requires permanent upgrading and keeping up with modern technological preliminary solutions, trends, the following measures and activities are proposed for protection of the environment against the effects arising from the operation of the complex:

- For this type of facilities, permanent abiding, effectuating and controlling of measures for prevention of fire, namely timely placement, control and maintenance of fire fighting apparata is necessary;
- On time prevention of leakage of fuels from reservoirs by timely control of prevention systems. The underground reservoirs are uncovered completely at least

once in five years for examination of external areas and providing of maximum protection against corrosion, i.e., damage;

- Although the noise generated from such business facilities does not exceed the prescribed ultimate values, it is proposed that recording of noise be done once the structure becomes operational in order to take additional measures for amortization of noise if necessary;
- Permanent upgrading of vegetation in the grassed area is an essential biotechnical measure. The vegetation acts as a natural purifier of air and soil protecting them against harmful gases and heavy metals. Therefore, permanent planting of corresponding trees should be planned to increase their scope.

6.1 Review of Legal Regulations

Monitoring of conditions and level of pollution of environment in each country is in accordance with the legal acts in which are defined the main directions toward preservation of the quality of media and areas within the environment in [10]. In our Republic, there are many legal acts are applied for protection and upgrading of the environment, among which are the following:

- Law on Environment ("Official Gazette of RM" no.53/05);
- Law on Protection of Nature ("Official Gazette of RM" no.67/04);
- Law on Protection Against Noise in the Environment ("Official Gazette of RM" no. 79/07);
- Law on Waters ("Official Gazette of RM" no. 87/08)
- Law on Waste Management ("Official Gazette of RM" no. 68/04);
- Law on Quality of Ambient Air ("Official Gazette of RM" 67/04);
- Law on Protection and Rescue ("Official Gazette of RM" no.36/04);
- Law on Storage and Protection Against Flammable Liquids and Gases (Official Gazette of SRM 15/76, 51/88,19/90 and Official Gazette of RM 12/93);
- Rulebook on Ultimate Values of Noise in the Environment ("Official Gazette of RM" no. 147/08);, etc.

7 CONCLUSION

Based on the inspection of the site and the facilities within the petrol station owned by the Association for Trade and Services Import-Export TRITEROL DOOEL Strumitsa and insight into the technical documentation, analysis of the natural characteristics of the terrain of the wider area as well as the ecological factors and resources in the zone of effect of the facilities, the following is concluded:

- With its operation, this servicing distributive compound that has been presented with its technical modern and functional contents will improve the offer of ecologically friendly liquid fuels and liquid oil gas. It will finally give a quality contribution to the social-economic sphere in the surrounding area by supply of fuels and opening of new jobs.
- The incorporated measures for protection of the environment will eliminate all the expected risks regarding degradation of some of the resources of life importance in the surrounding of the location and in the area beyond. With this, the anticipated petrol pump fulfills, from ecological aspects, the necessary conditions for rational and safe functioning.

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TYPOLOGICAL METHODS OF MARKET SEGMENTATION AS A KEY PRESUMPTION FOR THE SUCCESSFUL MANAGEMENT OF CONSTRUCTION PROJECTS

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Abstract

The article deals with methods of typology and market distribution from a marketing-oriented point of view for construction investment projects. Building a solid foundation for a company to successfully operate requires the identifying typical investors for whom the service offered is literally created. To address an investor through one's offers is even more important in the case of project activities, to which construction belongs. Emphasis should be placed on market segmentation from different points of view (space, social or economic). Methods of targeting and positioning expand the view of the construction market and the interaction within it. These interactions can fundamentally affect the performance of a construction company. Individual methods are adapted and applied for use in the real-world environment of the Czech construction market. Companies are forced to deal with cost efficiency under the actual pressure of price competition. This includes costs spent on mapping business opportunities and contracts in preparation. We use targeted marketing techniques in the construction industry to focus the budget and information flows in a specific direction, which increases the probability of success only in the defined market, not in the market in its entire breadth. A well-defined market is more important now than ever before. No one can afford to target all segments. Small construction companies can compete effectively against large ones by targeting a market "niche". This is a less expensive, more powerful and therefore more efficient means to secure a supply of work and develop a business.

Key words

Construction, market segmentation, marketing, marketing specifics in construction, marketing systems, motivation factors for construction, stakeholders, typology, value.

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1   INTRODUCTION

Market segmentation is the traditional method, first discussed in the 1950s, i.e. by [1], at a time when product differentiation was the key marketing strategy. The current state of marketing science and the practical use of segmentation in marketing strategies has brought us a better understanding of customers' needs and wants, makes it possible to take greater responsibility over an environment and the appropriate segments to target and obtain a competitive advantage. The segmentation approach can add clarity to the process of marketing planning, by highlighting the marketing program requirements of particular customer groups. Appropriate market segmentation, its identification and use, requires ongoing thought and analysis and binds resources, therefore it must bring value to a providing organization. [2] Because according to [3] the purpose of a business is to create a customer, the core business of the organization is only marketing and innovation, as these produce results, and all the rest are costs.

2   THE CONSTRUCTION MARKET TODAY

The best time to make change is not when the market situation is good, but rather periods of recession and crisis. From this perspective, we are at break time, both in terms of global and national economies, companies and their business partners. The crisis has hit the construction industry later due to its nature of investment and long production cycle. The construction industry as a whole began to sink decline in 2010 (building construction in 2009). This decline is continuing and it is not realistic to assume that the construction industry will get over it in the next three years, and return to its performance of 2008. [4]

The construction market mainly suffers from declining demand, which is caused by a lack of financing, increasing distrust in markets and prevailing government restrictive precautions rather than pro-growth initiatives. [5]

In order to cope with market conditions and survive, companies use restructuring actions with the aim of performance optimization and effective distribution and use of own resources. Quantitative evidence of this situation is the reduction of the number of employees in construction by 8.4% since 2008. [4]

3   THE IMPORTANCE OF MARKETING IN CONSTRUCTION

Marketing should be one of the key activities in construction companies. It is vital for companies to win and satisfy customers by means of offers tailored to their needs and at the same time the offers must ensure fulfillment of company's objectives in an efficient way. Success in tendering procedures refers to the efficiency of resource use and marketing operation. Behind bids there lie significant costs, which consist – apart from administrative expenses – of preparation, financial bonds, travel expenses and representation and promotion of a company.

Marketing as a management process is defined by various experts' views on the philosophy of customer approach. This diversity may reflect a variety of companies, individuals and their needs or is only a sign that this science is at an immature stage of development.

From the perspective of the internal company environment, the master of management **Peter Drucker** [6] writes of its organization and philosophy, "Marketing is not only much broader

than selling, it is not a specialized activity at all. It encompasses the entire business. It is the whole business seen from the point of view of the final result, that is, from the customer's point of view. Concern and responsibility for marketing must therefore permeate all areas of the enterprise."

A whole range of institutions is engaged in marketing. In 2008, the **American Marketing Association (AMA)** revealed a binding definition for literature and teaching throughout the United States, which presents marketing as "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large."

Marketing is here presented as a complex activity, the process of learning and growth, emphasizing its broad-spectrum effect. [7]

4 MARKETING SPECIFICS IN CONSTRUCTION

The center of marketing activities in construction is the realization of construction contracts based on pre-identified customer needs, that is, based on a demand. From the perspective of a construction company one must distinguish:

- **The primary construction market**, where a construction company is in a bilateral relationship with the investor who financed the contract.
- **The secondary construction market**, where a construction company is a subcontractor on the construction contract. Financing is dependent on the overall status of work on the construction contract and the bargaining power of the general contractor.

Key factors for sustainable development of construction companies are:

- generating new customers,
- retaining existing customers and building long-term relationships with them.

These above-mentioned factors require maintaining and enhancing the project know-how of building orientation, high-quality references from already realized construction projects and knowledge of the customer and its needs in relation to the construction project as a prerequisite for realization of an objective.

Construction investments outputs are often a necessary premise for investor's intention and therefore they must be projected according to investor's needs, i.e. they represent a secondary project resource and its operation has long-term direct and indirect effects. The current trend in investment construction can be summarized as **getting the best value for money**. Value can be defined as the information obtained from assessment based on subjective and objective points of view and expressed in measurable and immeasurable units. An economic perspective talks about the exchange value, utility value, customer value, investment value, stakeholder value, opportunity costs and cost price. Increasing attention is being paid to the efficiency, suitability, sustainability and added value of construction. [8], [9], [10]

Considering the above mentioned complexity of construction should lead construction companies to a highly individual approach to investors. The realization of construction shall fulfill investor's goal, which may be defined in accordance with a global experts' opinion as: "To use restricted resources for an achievement of maximum benefits (satisfaction of maximum possible stakeholders) with respect to sustainable development." The functional-

technical, financial, social, aesthetic-environmental attributes are defined by research as the basic attributes for the management of building quality (see Fig. 1). For cost-analytical purposes, building construction can be defined by the following requirements:

- Functional-technical view. The purpose of the construction is subordinated to efficient operation. Construction durability is subordinated to the technical characteristics in relation to the level of process intensity and environmental conditions.
- Financial view. Achievement, assurance and maintenance of planned investment benefits.
- Social view. Construction harmonization meets the needs of the regional economy and surroundings, work convenience and occupational health and safety.
- Aesthetic-environmental. Attractiveness, building aesthetics, its membership and consideration the environment. [11]
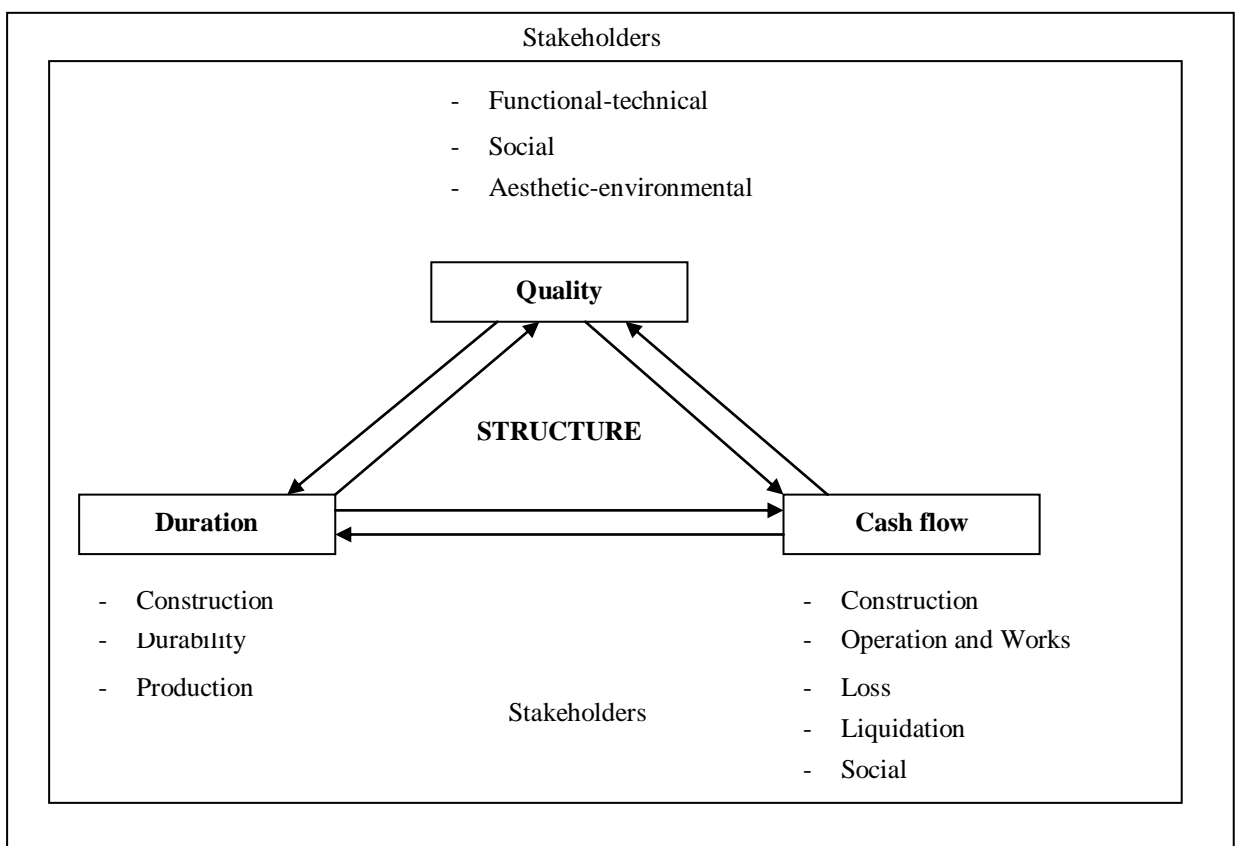
Fig. 1)   Basic attributes of construction management [11], [12]

5   PRINCIPLES OF MARKETING

Principles of marketing can be described as a series of steps that, according to [13], can be summarized in Fig. 2. The authors consider organization, leadership and communication as an integral part of abilities of a construction firm in which corporate culture is focused on understanding, anticipating and satisfying customer needs, i.e. the broader needs of the construction contract.

```
Marketing orientation
    |
    v
Realization of marketing concept
    |
    v
Marketing systems                    Opportunity survey
    |                                 Planning, Organising
    |                                 Management and Leadership
    |                                 Control and Communication
    v
Marketing in praxis                  Management of marketing mix
```
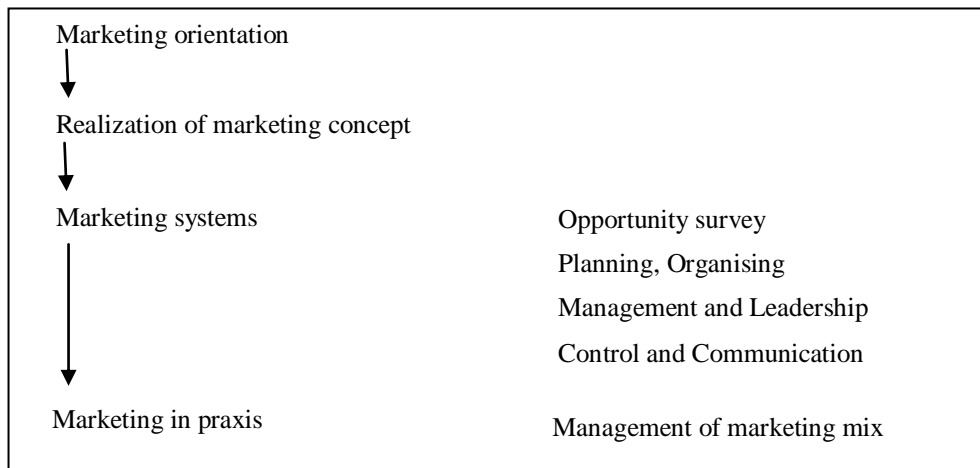
Fig. 2)   Basic attributes of construction management [13]

6   TYPOLOGY AND MARKET SEGMENTATION

The primary prerequisite for the implementation of a marketing approach in the management of construction contracts is knowledge and definition of the market where the firm operates or intends to operate. With the economy in its current state, a well-defined target-market and marketing aimed at the specific building industry characteristics is more important than ever before. No one can afford to target all groups. Small construction companies can compete effectively with large companies by targeting a market "niche".

Market segmentation is a tool for identifying the relevant target group. The main task of segmentation is to identify the market structure and key customers and to create a unique system of offers. This segmentation can be done from different perspectives and according to the needs of a company. For construction, three of the following **segmentations** are particularly appropriate:

- Geographic segmentation.
- Demographic segmentation.
- Psychographic segmentation.
- Behavior segmentation.
- Multivariate segmentation. [13], [14]

According to [15], segmentation can be presented as a conceptual model of the way a manager wishes to view a market, the method of describing the situation for a particular construction service to provide input to managerial decisions. There are alternatives to segmentation, with one-to-one marketing at one extreme and mass marketing at the other. This means the ability to compare marketing opportunities, effective allocation of the marketing budget and the ability to make adjustments. [2]

Geographic segmentation

This segmentation is based on a division into smaller geographical areas – regions, districts, cities. Companies can take into account:

- the character of environmental conditions, especially the climate, depending on the technology used in construction,
- the location of key customers (e.g. residential structure of organizational units of ŘSD),
- the official statistics of the territory. [13], [16]

Demographic segmentation

The principle of demographic segmentation is connecting wishes, preferences and needs with demographic variables that can be used for better refinement based on demographic data, such as defining areas with regard to education, social class, age of children, etc. Demographic data includes income, gender, nationality, social class, education, age, stage of life (e.g. divorce, buying a house), generation, family size, etc. These can be applied to planning in road construction, and in the case of construction companies this segmentation is useful for focusing marketing activities with regards to asset management. Appropriate demographic data for road construction, intensive use of road transport or selection of roads can be:

- age,
- income,
- sex,
- marital status. [13]

Psychographic segmentation

This type of segmentation is based on the use of psychology and demography. Different environments generate different needs. To better understand the consumer, this segmentation divides customers into groups based on personality traits, values and lifestyle. It is used mainly in property development companies, and for road construction planning the following reasons for using roads can be used:

- for everyday purposes, such as work, shopping, hobbies, transportation, etc.
- recreation and vacations,
- parking,

Behavior segmentation

This method of segmentation contains the following views on the market: reasons for the construction investment (housing, saving money, business, etc.), expected benefits, attitudes toward the product and the status of the investor (classification according to the terms of use of the building). The most common reasons for the purchase of a home, according to a bank survey [17], are the following:

- Entering a marriage or serious relationship.
- Becoming independent.
- Favorable market situation.
- Birth of a child.
- Special rate in the mortgage market.
- Migration of labor.

Investors' reasons for undertaking construction in the road market are specified in Tab. 1. Subsequent to this, reasons for choosing the road type are important for an investor, e.g. users select according to:

- time,
- habits,
- availability,
- health,
- security,
- price,
- ecology,
- entertainment.
- comfort,
- transportation needs,
- marital status. [10]

Tab. 1) Motivation factors and determinants of road construction [12]

Builder	Subject of construction	Construction needs
State and state organizations	Highways Speedways Main roads	International contracts and obligations
		Maintenance and repair
		Reconstruction and modernization
		Growth-promoting meassures
		Ecological and safety precautions
		Expansion
Municipalities	Secondary roads Tertiary roads Other routes	Maintenance and repair
		Reconstruction and modernization
		Needs of local residents
		Legislative and obligations
		Recreation and leisure
Physical person, artificial person	Roads to investment units	Maintenance and repair
		Reconstruction and modernization
		Legislative needs
		Marketing precautions

Multivariate segmentation

Praxis, with regard to the specificity, durability, cost and diversity of construction, cannot make do with only one of the methods described above. To form an accurate view of customer groups, one must properly combine two or more of these methods.

Targeting is the process by which the company selects the segments that it plans to focus on.

7 TARGETED MARKETING TACTICS AND STRATEGIES, THE CONCEPT OF TOTAL MARKETING MIX

The concept of total marketing (see Fig. 3) extends the traditional 4P marketing mix by incorporating marketing into all departments and personal policy. The total marketing mix has two main parts. The first is internal, which is important for the "correct" operation of the company. In this section there are two basic elements of the total marketing mix:

- **Planning.** The output is the marketing plan, business plan and company marketing policy.

- **Processes.** Determination of company processes should reflect marketing access, develop relationships and provide interactive experiences and added value.

The second part focuses on the external environment (stakeholders) and consists of the following elements:

- **Product/Service.** The product must provide value to a customer.
- **Programming.** Determination of company processes should reflect marketing access.
- **Packaging.**
- **Price.** Pricing must be competitive and must entail profit. The pricing strategy can comprise discounts, offers and the like.
- **Promotion** (communication). Promotion includes the various ways of communicating with the investor to present the company and its offer.
- **Place** (distribution). This includes different channels for reaching the investor (internet, EIA database, system of public competitions, design offices, development plans, public budgets, etc.).
- **People.** Traditional marketing divides people into two groups, a company and investors. The new concept of marketing in the company must involve directors, employees, shareholders, partners, the press, analysts and the public.
- **Physical evidence.** Physical evidence concerns the policy of technical background development, where construction is performed.
- **Partnership.** This includes a company's access to cooperation and making alliances and partnerships that lead to a synergetic effect for all parties.
- **Political power** (lobbying and political influence). This is important for construction companies because the long-term share of public contracts is about 50%.
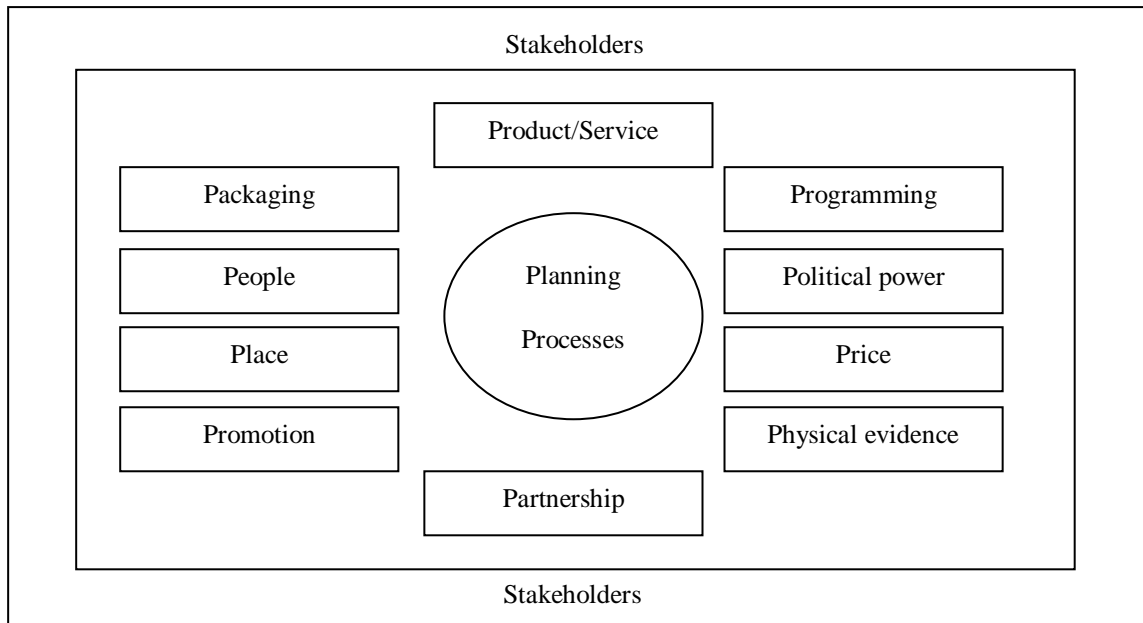
Fig. 3)   Concept of a total marketing mix [8], [18]

8   CONCLUSION

This article has dealt with the use of marketing segmentation methods applied to the construction industry. The aim was to demonstrate the suitability of these methods for medium and large construction companies for production planning, in particular taking into account the economic crisis and stagnation of the construction market. Most construction companies operating in the construction market already monitor many market indicators, have introduced databases and provide marketing analysis, but in the case of an integrated perception of marketing there is still room for interpretation and use of outputs in all internal structures so that they could strengthen their individual approach to an investor and ensure maximum satisfaction on all sides.

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OPTIMIZATION IN THE CHOICE OF BUILDING MECHANIZATION

Jasmina Dražić[1], Milan Trivunić[2], Vladimir Mučenski[3], Igor Peško [4], Aleksandar Nikolić [5]

Abstract

Contemporary building production involves complexity of engineering and technology, a large number of operations, high level of process mechanization and complex organization of a construction process. High rate of mechanization engagement in construction works raises the problem of the choice of an optimal machine, where the planning and realization of construction works require rapid decision-making. The paper suggests the model of evaluation, the choice of an optimal construction machine type, based on the practical performance, work costs, its working hours and energy usage. By applying computer application, and choice automatization, high-quality information is provided, with the aim of achieving favourable construction effects and reduction of negative impacts of the construction process on the environment.

Key words

Effect, costs, mechanization, multi-criteria optimization, working hours.

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1   INTRODUCTION

Construction of buildings nowadays can hardly be imagined without applying adequate mechanization. The reasons for employing machines are the following: advancement of industrial production, growth in the amount of works, requirements for equal quality etc. Primarily, building mechanization is employed in order to:

- shorten the time of production – realization of construction
- reduce the effort of workers.

Building mechanization is present in all segments of building production and is applied in realization of various types of works. Processes in building construction involve connection between certain technological operations, where a larger number of different machines which perform them require coordination and maintenance of mechanized work continuity (providing an uninterrupted working process).

Apart from numerous differences, construction works also vary in the amount of employed mechanization. Works which are dominant in the construction process (earthworks, making of base course, asphalt works and concrete works) involve high level of mechanization and raise the problem of choosing the adequate mechanization [1]. In such cases, it is significant to make an optimal choice of machines for a specific task they perform. A condition for a proper choice of building mechanization is the knowledge about works technology, features of machines as well as working conditions. Only well-chosen and coordinated machines can provide continuous and efficient work and economical construction (competitive price).

2   CHOOSING BUILDING MECHANIZATION

Choosing building mechanization presents a complex procedure based on the analysis of [2]:

- Possibility of applying certain machines for realization of specific work – conditions for usage at a certain construction site (chosen technology of construction, space, communications, working conditions at a construction site...),
- Features of specific machines (given by a technical specification or the manufacturer's brochure - dimensions, theoretical workload, speed, surface requirements, etc.).

Choosing of building mechanization for a specific building (project) is carried out in two phases:

A.   wider choice of mechanization;
- In making a wider choice of mechanization it is necessary to define the task of building mechanization by analyzing technological process, divide the technological process into separate working operations, consider available machines for realization of certain operations, study the conditions a machine needs to meet in order to perform certain operations, make a choice of machines which are suitable for the adopted technology, choose a machine which is capable of completing the specified task.

B.   narrowed-down choice of mechanization;
- Based on a wider choice of machines, by analyzing the technological process it is necessary to choose machines which offer greatest possibilities, with lowest costs as well (requirements of deadlines and costs of realization of particular works.)

Basic principles for a successful choice of building machines are [3]:

- Avoiding to choose neither too large nor too small machines,
- Planning of the highest possible number of machines of the same kind in order to reduce maintenance costs,
- Trying to choose as many different machines as possible which use the same type of fuel.
- Using standard machines to a high extent, since they are cheaper than the specially -designed ones,
- When choosing a machine for special works, check the economic justifiability of purchasing a new machine.

3   OPTIMIZATION – CHOOSING A BUILDING MACHINE

Optimal planning and management of construction requires the awareness of all factors important for decision-making. Making decisions based on timely and high-quality information reduces the insecurity of decision-making and favorable consequences on the progress, costs and quality of a construction process [4]. For economical employment of mechanization, it is necessary to properly organize and plan their use in advance, which requires the knowledge of hourly workload in specific, real working conditions for a specific machine, taking into consideration the length of their work as well.

3.1   Practical workload of machines

The choice of construction mechanization, apart from defining a machine for completing a particular task (possibility of application), determines practical workload, real workload of a construction machine on a specific construction site in specific exploitation conditions. Practical workload (U_p) is conditioned by technical features of each machine individually, by its theoretical workload (U_t), but also by specific features of each construction site, i.e. working conditions for specific operations, which means that all objective and subjective circumstances which lead to reduction in theoretical workload are taken into consideration. It is common to express all the influences which result in reduction of theoretical workload by correction coefficients, by which he theoretical workload is multiplied.

$$U_p = U_t \cdot k_p \cdot k_v \cdot k_r \cdot ..... \cdot k_n \qquad (1)$$

The most frequently used correction coefficients are the following:
- k_v – coefficient of working hours usage
- k_p – coefficient of working body filling
- k_r – coefficient of soil looseness
- k_o – coefficient of rotation
- k_i – coefficient of unloading manner
- k_z – coefficient of material grabbing
- k_{ut} – coefficient of transport coordination
- k_u – coefficient of working conditions optimality.

3.2   The cost of an effective working hour of a machine

The working hour cost of building mechanization is one of the key criteria in choosing machines for realization of particular works. This indicator is significant in calculating the cost of works realization in particular positions.

The structure of machine's working hour cost (K_h) is defined by the expression:

$$K_h = \frac{J_t}{h_{gr}} + (E_e + E_{os}) \times (1 + \varphi) \qquad (2)$$

Where the following are:

- J_t – one-time costs
- h_{gr} – planned fund of machine's working hours on a construction site
- Ee – exploitation costs
- Eos – costs of fixed assets
- φ – factor of calculating overheads and unproductive work (0, 25 - 0, 50).

One-time costs

One-time costs present all the costs of mechanization transport to a construction site, assembling, trial work, starting the operation, disassembling, as well as transport from the construction site. These costs are defined according to the purchase value of a machine:

$$J_t = p \times NV \qquad (3)$$

Where the following are:

- p – percent amount determined according to a machine type
- NV – purchase value of a machine.

Exploitation costs

Exploitation costs present a group of costs which comprise:

$$E_e = E_{rs} + E_{en} + E_{maz} + E_{to} + E_{hab} \qquad (4)$$

Where the following are:

- Ers – costs of working force – gross income of a machine operator
- Een – costs of used energy
- Emaz – costs of grease
- Eto – costs of ongoing repairs
- Ehab- costs of wearing-out parts

Tab. 1)   Costs of used energy

$E_{en} = q_{en} \times C_{en} = N_o \times g_s \times K_o \times C_{en}$	
qen	Quantity of used energy
Cen	Unit price of energy-generating products
No	Nominal engine power (KW)
gs	Specific use of fuel within one working hour per each KW of nominal engine power
Ko	Engine load coefficient

Tab. 2)   Costs of grease

$E_{maz} = q_{maz} \times C_{maz} = N_o \times g_{maz} \times K_o \times C_{maz}$	
qmaz	Quantity of used grease
Cmaz	Unit price of grease
gmaz	Specific use of grease within one working hour per each KW of nominal engine power
No	Nominal engine power (KW)
Ko	Engine load coefficient

Tab. 3)   Costs of ongoing maintenance

$E_{to} = p \times NV/15000$	
p	Percent amount determined according to a machine type
NV	Purchase value of a machine

Tab. 4)   Costs of wearing-out parts

$E_{hab} = 1.10 \times NV_{hab}/Hek_{hab}$	
NVhab	Purchasing value of a wearing-out part
Hekhab	Economic life of a wearing-out part

Costs of fixed assets

Costs of fixed assets comprise the following costs:

$$E_{os} = E_{am} + E_{inv} + E_{kios} \tag{5}$$

Where the following are:

- Eam – costs of depreciation
- Einv – costs of investment maintenance
- Ekios – costs of interest and insurance

Tab. 5)   Costs of depreciation

$E_{am} = NV/hek$	
NV	Purchase price of a machine
hek	Economic life of a machine

Tab. 6)   Costs of investment maintenance

Einv = 0.15 x NV/hgod	
NV	Purchase value of a machine
hgod	Annual number of machine's working hours

Tab. 7)   Expenses of interest and insurance

Ekios = 0.10 x NV/hgod	
NV	Purchase value of a machine
hgod	Annual number of machine's working hours

3.3   Optimization model

The task of the optimization process is to make the best choice out of several possible and convenient options, based on the defined criteria. The best option in these cases is the optimal solution of the optimization task. The optimal solution makes a compromise between the wishes (criteria) and possibilities (limitations). The criteria are expressed by the criteria function, which is supposed to reach global extremum for the best option, considering the limitations, which condition the possibility of achieving the optimization goal [5]. This paper considers the problem of choosing building mechanization as the problem of multi-criteria optimization, and is reduced to determining the extremum of a vector criterion function.

The optimization model is suggested in the form:

$$\min F(x) = \min (f_1, f_2, f_3, \dots f_n) \tag{6}$$

The choice of optimization method depends on the nature of a problem, number of criteria, possibility of involvement of a decision-maker, required detailedness etc. The problem of optimal choice of building mechanization is solved by methods of multi-criteria optimization, method of compromise programming and compromise ranking. In the method of compromise programming, the solution to a problem of multi-criteria optimization is determined by minimizing deviation from ideal point, according to the adopted distance measure, including all the criteria. Ranking is applied when it is necessary to determine the ordering of planned alternative solutions based on the given criteria f1, f2, f3,..., fn. An alternative solution can be any solution of a system which is included in a set of solutions for which a ranking list is required. The only condition which has to be met is for each of the alternatives to be valued according to all the criteria from the given set [5].

4   AUTOMATIZATION OF BUILDING MECHANIZATION CHOICE

In order to provide a quick and simple choice of the optimal machine by applying the method of multi-criteria optimization, a specialized application (software) "Baumaschinen-AN" [6] was created, in C++ computer language, with the aid of QT development environment. The process of choosing optimal building mechanization – machine by using this application is illustrated in several steps.

Figure 1 shows what the input application screen looks like. On the left side, there are four groups of works: earthworks, making of base course, asphalt works and concrete works, and below them, there is a list of types of machines necessary for realization of those works. By choosing a group of works and pointing to a type of machines, a table layout of possible options (machines) and their features is opened on the right side of the screen. For each of the machines included in the base, necessary data for calculating its practical workload Up in [m3/h] as well as the price of an effective working hour in [euro/h] are inserted.

By activating EDIT command, access to the machines base is opened, with the possibility of its correction (add machine / remove machine) or changing of features (parameters) of particular machines.
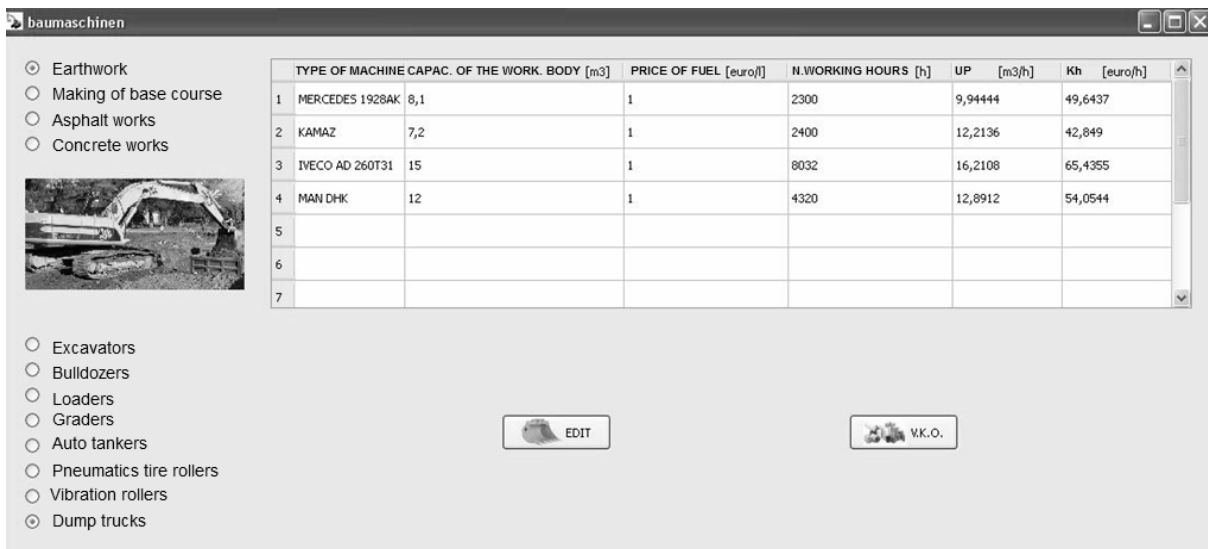
Fig. 1)   Appearance of input screen - STEP 1

Optimization model based on three criteria functions f_1, f_2 and f_3 is defined as

$$\min F(x) = \min (f_1, f_2, f_3) \qquad (7)$$

Where the following are:
- $f1 = 1/Up$
- $f2 =$ the price of an effective working hour of a machine
- $f3 =$ number of working hours.

The choice of the optimal type of machine involves:
- choice of variant solutions (selecting a group of machines),
- application of optimization methods (activating VKO command) (Figure 2)

Output, the result of multi-criteria optimization is a rank list, ordering of machines which were observed as variants. For the most favorable one, the optimal solution, its features, practical workload, price of an effective working hour and the number of working hours also appear on the screen (Figure 3). The advantage of the shown application does not only reflect in obtaining the output results of the optimal type of machine in a fast and simple way, but as well in its openness which provides the possibility of adding new optimization criteria.

Fig. 2) Variant solutions - STEP 2

It is estimated that construction industry and its products account for approximately 40% of total energy usage and gases emission which cause the greenhouse effect [7],[8]. Traditional approach to planning and evaluation of building constructions was long based on the three major factors: quality, costs and time. Agenda 21 and Agenda on sustainable construction [8],[9] stress out that the three basic aspects of sustainability concept, i.e. environment protection, economic limitations and socio-cultural aspect should be included into planning, construction, usage and other phases within a life – cycle of any product. While the traditional approach was based on maximum economic cost effectiveness, the new approach of sustainable construction emphasizes the significance of reducing influences of buildings and of construction processes on the environment [8]. Machine selection for building processes from an aspect of energy use is given in paper [10]. In the context of sustainable construction, the problem of multi-criteria optimization of building mechanization considered in this paper, was expanded by introducing another criteria function.

As an adopted method of multi-criteria optimization provides an opportunity to include qualitative criteria along with the quantitative ones in the optimization process, a criteria function f4 was defined, showing the proportion of used energy. Analytical form of criteria function is:

$$f_4 = \frac{q_{eni}}{q_{enmax}} \tag{8}$$

Where the following are:

- q_{eni} – quantity of used energy of i-variant (of a machine)
- q_{enmax} – maximum quantity of used energy within the frame of observed variants (of machines).

Criteria function f4 favors the machine (variant) which in the working process features lowers energy usage and smaller negative effect on the environment (pollution).

The rank list obtained by applying the method of multicriteria optimization is shown as a following table

MERCEDES 1928AK	4
KAMAZ	3
IVECO AD 260T31	2
MAN DHK	1

It can be seen from the tale that solution 1 presents the most suitable one

MAN DHK

Up =	12.8912
Kh =	54.0544
Number of working hours =	4320

Fig. 3)   Output results - STEP 3

In the case of expanding the optimization procedure onto a larger number of criteria functions than three, it is necessary to insert the number of additional criteria as well as their values for each machine (variant) included in the optimization process (Figure 4).

The process of choosing the optimal machine is repeated. After inserting the values of the additional criteria, by activating the VKO command, output results in the same form as the ones on the screen in step three, figure 3, are obtained.

- A rank list obtained by applying the method of multi-criteria optimization (ordering of variant solutions) and
- The most favorable variant (features for the optimal variant - machine).

5   CONCLUSION

This paper considers the problem of choosing building mechanization. The choice of mechanization is conditioned by having the knowledge of works technology, features of machines as well as working conditions. Since processes in building construction require the connection between technological operations and a larger number of different machines which perform them, it is necessary to coordinate and maintain continuity of mechanized work. Only machines chosen in an optimal way can provide efficient work and competitive price. The problem of choosing building mechanization was observed as a problem of multi-criteria optimization and an adequate optimization model was suggested.
Individual criteria were defined and analytically expressed, and methods of multi-criteria optimization were chosen (compromise programming method as well as method of compromise ranking of alternative solutions). An application was created, for choosing the optimal type of machine for the group of works which are dominant regarding the workload and require a high level of mechanization employment (earthworks, making of base course, asphalt works and concrete works). In the initial phase of using the application, the optimal solution was calculated based on three quantitative criteria functions (practical workload, price of an effective working hour of a machine and length of work).

110
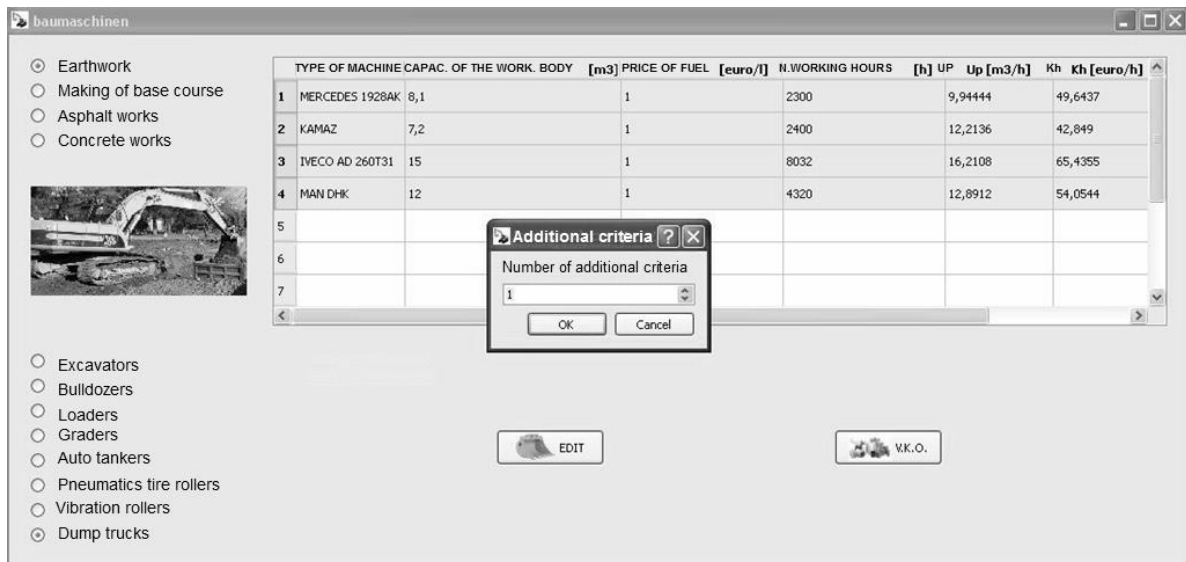
Fig. 4) Adding a new criteria function - STEP 4

The advantage of the software was confirmed, regarding the rapidness and simplicity of obtaining a larger number of output results, as relevant grounds for making a decision, with the aim of optimal planning and managing of construction, which provides a favorable course of actions, economic effectiveness and quality of construction. "Openness" of the application is not only reflected in working with data bases and possibility of its correction (adding new machines, removing the existing ones, changing the features of certain machines), but also in the ability to add new criteria. In the second phase of the optimization procedure the possibility of the adopted multi-criteria method to introduce new qualitative criteria was used. The optimization field was expanded by the fourth criteria function. This function favors the machine (variant) which consumes less energy and features a smaller negative effect on the environment (pollution) throughout the working process. In this manner, the traditional approach to choosing the optimal solution based only on maximal economic effectiveness is abandoned, supporting the new approach (sustainable building construction) which stresses out the importance of reducing the negative impact of construction processes on the environment.

Acknowledgements

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CONTRIBUTIONS TO THE DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR ORGANIZATION'S RISK MANAGEMENT AS A STRATEGIC MANAGEMENT

Cosmin Filip[1], Mirela Popa[2]

Abstract

Like any other activity that involves high consumption of resources, the formulation and the implementation of construction projects must be firmly grounded in economic terms. In these circumstances, it is necessary to increase the share of monitoring and evaluation activities of all factors that are competing in the project. Thus, the development and the implementation of construction projects includes for any involved organization, among other processes, the Risk Assessment Stage in order to analyse the factors that might induce the state of uncertainty about the proposed outcome. To be effective within an organizational context, risk management should be developed by taking into account the organization's overall governance, management, reporting processes, policies, philosophy and culture in order to strengthen these areas. The general framework of Risk management is included in the International Standard ISO 31000:2009, which presents some general principles and guidelines that can be applied to a wide range of activities, decisions and operations, but it is too generic and not specific to any industry or sector. Starting from the idea that Risk Management should be a central part of any organisation's strategic management in order to achieve its objectives and its lack of a functional methodology with a direct application in construction investment field, in this paper we propose a Conceptual Framework of Risk Management as an integral part of organizational processes. The aim of this framework is to assist organizations to manage its risks effectively through the application of the risk management process at different levels and within specific contexts of self-organization in Construction Projects.

Key words

ISO 31000, process of managing risk, risk assessment, risk in project management, risk management, risk treatment process.

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1 INTRODUCTION

Civil engineering projects involve identifying and taking multiple risks related to the specificity of this domain. Performing work under the direct action of the elements of nature, mobility production process, long execution period, the large number of activities that have to be conducted and coordinated, the complexity of the production process, contractual relationships between the many parties involved - often with competing interests - are all arguments offered in support for the previous statements [1].

Risk management activity has been developed conceptually, theoretically and practically becoming a powerful industry. Any performant organizational structure has a risk department, risk strategy and an obligation to report the risk operations that they encounter.

Risk usually refers to conditions or circumstances that are beyond the control of the current project team and will have a detrimental impact on the project, in case they would appear. In other words, if a difficult situation is a problem that must be resolved, a risk is a potential problem that has not appeared yet [2].

By risk management we mean all of the operations that limit the losses and can affect an organization, a group or a person. In other words, risk management aims to maximize positive outcomes and minimize adverse consequences.

Risk management is a process that in a systematic and cyclic form, identifies, analyzes and evaluates all risk assessment situations, so there can be established effective risk control measures. This process must be integrated with the other management system elements.

In civil engineering, risk management is addressed in the management of civil engineering projects.

The management of civil engineering projects proposes to identify, define, plan, organize, coordinate and control the project from beginning to its end, in order to fulfill the requirements and expectations of the client regarding the production of a viable target functionally and financially that respects the quality standards, costs and deadlines agreed. These tasks are especially difficult to achieve as the completion of the civil engineering project involves several different organizations: the beneficiary, the investor, funding bodies, public authority, builder, designers, consultants, suppliers of materials and equipment, etc thus, contributing to a significant level of risk as opposed to other fields.

2 PROBLEM FORMULATION

Investments in civil engineering projects, both in the design stage but especially in the execution stage, have some defining features that include [3]:

- useful and definitory activity for human society;
- using all the existing materials from earth, water, atmosphere to synthetic materials and components;
- social involvement in large-scale production processes from manual to industrial and robotics;
- strong transformation factor of the natural and social environment;
- unique character;
- the products are fixed and have very large weights;

- complex processes of production;
- major economic implication and horizontal development of industries;
- keeper and developer of the cultural environment;
- realizes finished products whose exploitation resists over centuries;
- development of early innovation, of technical and technological research and its implementation in a short period of time;

These features lead to the particular risk management approaches in project management, given the specific activities and processes developed.

Risk management methodologies in the civil engineering industry are not standardized, although over time many attempts have been made in this regard. Nearest standard that can be taken into account is ISO 31000:2009 [4] with the Romanian equivalent SR ISO 31000:2010 [5]. The purpose of [4] is to be applicable and adaptable for any public, private or community enterprise, association, group or individual. Accordingly, the general scope of [4] - as a family of risk management standards, together with [6] and [7] and, as equivalent in Romania, with [8] and [9] - is not developed for a particular industry group, management system or subject matter field in mind, rather to provide best practice structure and guidance to all operations concerned with risk management.

But the need to develop a methodology to address risk management in investment projects of civil engineering is urgent.

In our research, we found that there are also other attempts of structuring Risk management methodologies for organizations in order to clarify some general aspects from the standards (for example [10] and [11], which provide information on risk management procedures). In general, all these procedures are not referring precisely to a particular application of the risk management process within a specific domain or in a particular context of self-organization of an enterprise.

As a partial result of our research work, we present a conceptual framework for risk management assessment, as a part of organization's strategic management which can be applied quite functional in construction investment field and in Construction Projects. Thus, starting from mainstream indications of [4], based on experiences taken in the risk management of civil engineering, it has been proposed in this paper "A Conceptual Framework for Risk Management" as an integral part of organizational processes. The aim of this framework is to assist organizations in order to better manage its risks as an internal culture and self-organization point of view towards risk.

3   METHODOLOGY

Structuring this methodology starts from the recommendations of [4] in which organizations should develop, implement and continuously improve a framework whose purpose is to integrate the process for managing risk into the organization's overall governance, strategy and planning, management, reporting processes, policies, values and culture.

Regarding the implementation of an integrated risk management approach in an organization or company is recommended:

- to be a continuous process integrated in the organization's strategy;
- to consider all risks affecting the organization's activities;

- to be integrated in the organizations culture;
- to translate strategy into tactical and operational objectives, designating to each manager and employee responsibilities involved in risk management as part of the job description.

Approach to risk management by an organization involves two levels of hierarchy. One refers to the structure and training of the organization as framework for the development and actions for developing enterprise for risk management activities. The second level refers to activities undertaken for evaluating risk assessments on a project level. These two levels of hierarchy are based on the application of sound principles envisioned in the organization risk management of an organization. In fig. 1 are presented the relations between the risk management principles, the organizational framework and the process of managing risk. In this paper we approach the issue for the first hierarchical level, composed of risk management principles and the organizational framework.
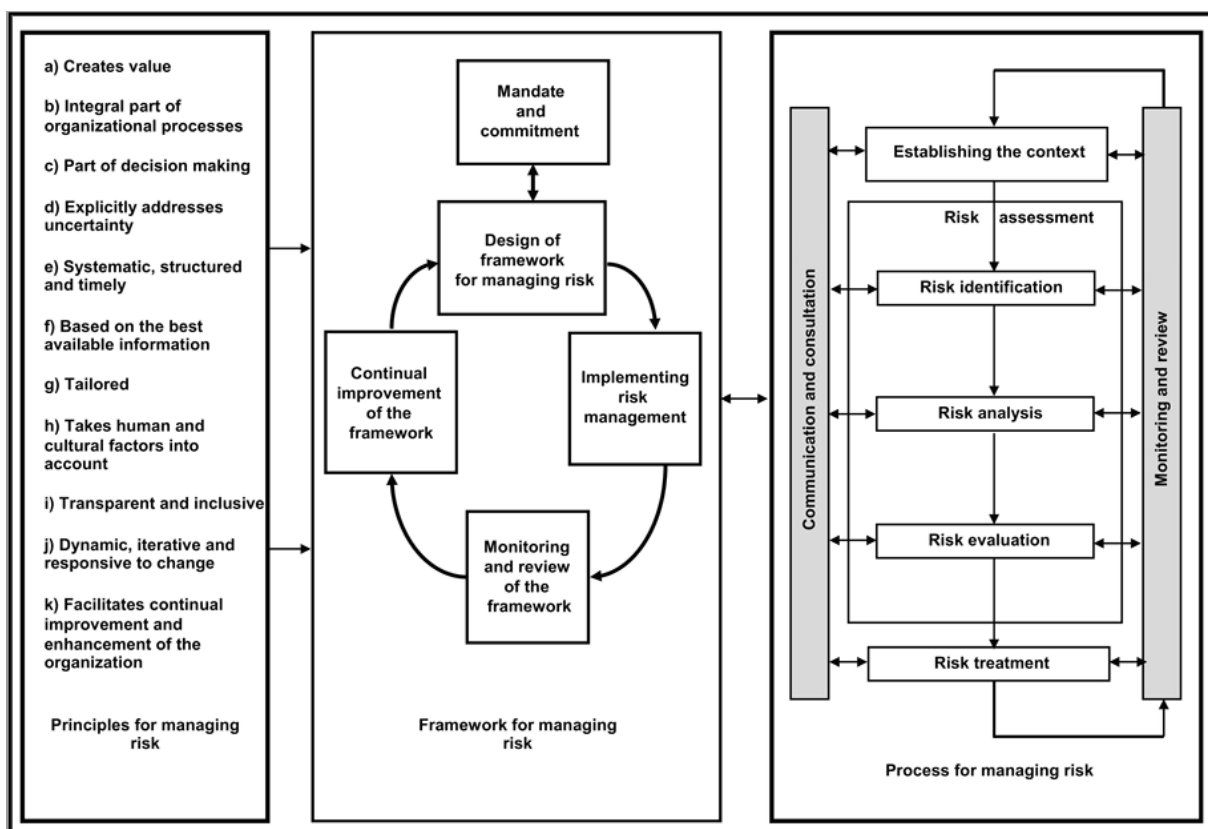
Fig. 1) Relations between the risk management principles, organizational framework and process [4]

Respecting and applying these principles in structuring the managing risk process, all these are creating the preconditions and the prerequisites for formulation the organizational framework and so leading to the conceptual framework for risk management as a part of organization's strategic management.

Organizational framework ensures that information on risk from the risk management process are properly reported and used for decision making and for responsibility in all relevant levels of organization.

4 PROBLEM SOLUTION

The guidelines for structuring the Conceptual Framework for Risk Management as a part of Organization's Strategic Management which is proposed in this paper can be found in the recommendations formulated in [4] and presented in an iterative manner through Fig.2. This framework assists in managing risks effectively through the application of the risk management process at different levels and into specific contexts of the organization. The framework ensures that information about risk derived from these processes is adequately reported and used as a basis for decision making and accountability at all relevant organizational levels [4].
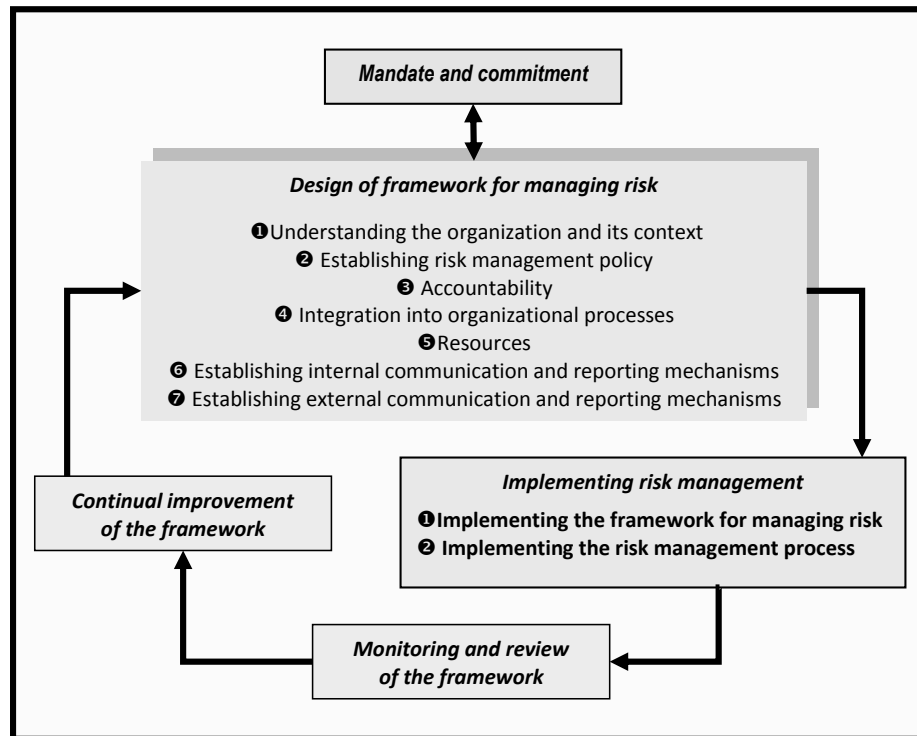
Fig. 2) Relationship between the components of the organizational framework for managing risk [4]

As recommended in [4], this framework is not intended to prescribe a management system, but rather to assist the organization to integrate risk management into its overall management system. Therefore, organizations should adapt the components of the framework to their specific needs, in their field of activity.

Starting from the idea that a Risk Management Plan is a document developed by a project manager in order to prepare the organization to foresee and assess risks, estimate impacts and define responses to issues, this proposed Risk Management Plan presented in Fig. 3 synthesized the extended information contained in the Conceptual Framework for Risk Management as a part of Organization's Strategic Management.

In the following lines we will present some brief details on the information that should be contained in this plan.

4.1 Introduction in Risk Management Plan

In chapter I, the purpose of the Risk Management Plan should present information regarding the goal pursued in correlation with its possibility of achievement. Also, it must be very clear the object in view, in order to create, maintain, operate and report on risk register.

The recipients of the plan must be identified together with all stakeholders involved in project risk management.

Conceptual Framework for Risk Management as a part of Organization's Strategic Management - Risk Management Plan -	
CHAPTER	**SUBCHAPTER**
I. Introduction	I.1 Purpose of the plan I.2 The recipient of the plan
II. Risk Management Policy	II.1 References II.2 Understanding the organization and its context II.3 Risk management objectives II.4 Establishment risk management policy II.5 Risk criteria
III. Risk management structure	III.1 Roles and responsibilities involved III.2 Resources involved III.3 The structure. Communication and reporting
IV. Implementing risk management	IV.1 Framework for managing risk IV.2 Risk management process
V. Coordination	V.1 Risk register V.2 Risk monitoring V.3 Risk review V.4 Reporting on risks V.5 Coordination with other projects
VI. Improvement on the organizational framework	VI.1 Regarding organizational structure VI.2 Regarding risk management procedures VI.3 Regarding risk management culture

Fig. 3) The proposed structure of the Conceptual Framework for Risk Management as a part of Organization's Strategic Management - Risk Management Plan

4.2 Risk Management Policy

This chapter contains the references that are considering in developing of this plan. References should include, besides the norms related to risk management, also the internal norms, policies and procedures for risk management. All these internal documents actually render for the organization the appetite and the level of expertise for evaluating risk.

Before starting the design and implementation of the framework for managing risk, it is important to evaluate and understand the organization's culture towards risk and also both the

external and internal context of the organization, since these can significantly influence the design of the framework.

Risk management objectives must be clearly presented in order to properly identify and treat the risks that could affect project objectives. The risk management policy and the risk criteria should clearly state the organization's objectives and commitment to risk management and typically addresses the following, as also recommended in [4]:

- the organization's rationale for managing risk;
- links between the organization's objectives and policies and the risk management policy;
- accountabilities and responsibilities for managing risk;
- the way in which conflicting interests are dealt with;
- commitment to make the necessary resources available to assist those accountable and responsible for managing risk;
- the way in which risk management performance will be measured and reported;
- commitment to review and improve the risk management policy and framework periodically and in response to an event or change in circumstances.

4.3 Risk management structure

Related to the roles and the responsibilities involved, the organization should ensure that there is accountability, authority and appropriate competence for risk management. Also, it should be considered that the implementation of risk management process have to ensure the adequacy, effectiveness and efficiency of any controls. Risk management procedures developed by an organization are recommended to be incorporated in all the organization's structures, practices and processes in order to be relevant, effective and efficient.

About resources involved, any organization should allocate appropriate resources in order to develop in good terms the risk management processes. From this point of view the recommendation [5] would be to consider the following:

- people, skills, experience and competence;
- resources needed for each step of the risk management process;
- the organization's risk processes, methods and tools to be used for managing risk;
- documented processes and procedures;
- information and knowledge management systems; and
- training programs.

Risk management structure has to include also internal and external communications and reporting mechanisms, in order to ensure the responsibility towards risk. There are different processes of consultations with internal and external stakeholders, providing feedback and thereby improving the procedures and the results.

4.4 Implementing risk management

By implementing the organization's framework for managing risk, the organization can establish if the management framework is appropriate to ensure that the processes of decision making are aligned with the expected outcomes of risk management processes. Risk management is recommended to ensure that the risk management process is applied through a risk management plan at all relevant levels and functions of the organization as part of its practices and processes.

4.5   Coordination

In order to obtain useful results, risk management policies have to include a Risk register in which it should be script all the important information about the risk events that can occur. This Register has to be completed after the risk assessment stage.

The monitoring and the review of the organizational framework have to be done continuously, measuring the risk management performance and periodically measuring the progress and the deviation from the plan. Given the organization's internal and external context at a specific time and the possible situation of changing internal or external factors, it is necessary periodically to review whether the risk management framework, policy and plan are still appropriate.

Each time it is necessary and also periodically it is important to report on risk, on progress or on any other particular situation in order to be able to follow the schedules, the interim results or any other deviation from the plan.

The coordination with other projects is important to be followed with all good or bad aspects, ensuring this way that any project results and any particular cases will be taken into account in similar situations.

4.6   Improvement on the organizational framework

Based on results of monitoring and reviews, decisions should be made on how the risk management framework, policy and plan can be improved. These decisions should lead to improvements in the organization's management of risk and its risk management culture [4].

5   CONCLUSION

This proposed Risk Management Plan which refers to a Conceptual Framework for Risk Management as a part of Organization's Strategic Management can be subject to improvements. In this structure, its role is to be a more useful tool in Risk management approach for different organizations and especially for construction projects, than the actual form of the ISO 31000 standard. This structure of Risk Management Plan has been already been used for about 15 Construction investment projects, proving this way its utility.

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CONTRIBUTIONS TO THE DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR PROCESS OF MANAGING RISK

Cosmin Filip[1], Mirela Popa[2]

Abstract

The development and the implementation of construction projects includes for any involved organization among other processes, the Risk Management Stage in order to manage the factors that might induce the state of uncertainty about the proposed outcome. Risk assessment is the determination of quantitative or qualitative value of risk related to a concrete situation and a recognized threat. If the organizational context of Risk Management is based on clear and effective principles, in order to be a complete and effective Risk Management Methodology, The Process for Managing Risk should be developed by taking into account properly all the necessary process for risk assessment and risk response. The general framework of Risk Management is included in the ISO 31000:2009, which presents general principles and guidelines that can be applied to a wide range of activities, decisions and operations, but is too generic and not specific to any industry/sector. Starting from the idea that Risk Assessment Procedure should be a central part of any organisation's operational activities and that it's a lack of a functional methodology with a direct application in construction investment field, in this paper we propose a Conceptual Framework of Process for Managing Risk in order to develop a General Risk Assessment Methodology in Construction Project Management, together with Conceptual Framework of Risk Management as a Part of Organization's Strategic Management. The paper presents also examples of procedures for Risk Assessment approach as an overall process of risk identification, analysis and evaluation.

Key words

ISO 31000, process of managing risk, risk assessment, risk in project management, risk management, risk treatment process.

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1   INTRODUCTION - RISK AND RISK ASSESSMENT

We call risk any uncertainty associated with the result. Uncertainty may refer to the likelihood of an event appearing or influence, the effect of an event if it occurs.

Risk apears when [1]:

- an event produces itself, but the result is uncertain;
- the effect of an event is know, but its occurrence is uncertain;
- both the event and its efect are uncertain.

We call an element of risk in a project anything that has a measurable probability of deviating from the plan. This of course assumes the existence of a plan. In civil engineering it is used as programming tools for graphics production network.

Any element of such a structure can be used as a potential risk factor. The more this structure is significant, close to reality, the more significant the elements of risk will be considered.

The existence of risks led to the development of structures dealing with risk management. Risk management and the risk manager are absolutely mandatory for any business that wants to be successful.

An inadequate risk management activity leads to significant financial, political and even human losses. Risk management is not an easy or cheap activity, these two parameters actually being at their peak.

Risk assessment is not a stand-alone activity and should be fully integrated into the other components in the risk management process.

Risks can be assessed at an organizational level, at a departmental level, for projects, individual activities or specific risks. Different tools and techniques may be appropriate in different contexts.

Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. The manner in which this process is applied is dependent not only on the context of the risk management process but also on the methods and techniques used to carry out the risk assessment.

Risk assessment provides an understanding of risks, their causes, consequences and their probabilities. This provides input to decisions about [2]:

- whether an activity should be undertaken;
- how to maximize opportunities;
- whether risks need to be treated;
- choosing between options with different risks;
- prioritizing risk treatment options;
- the most appropriate selection of risk treatment strategies that will bring adverse risks to a tolerable level.

2   PROBLEM FORMULATION

Risk management methodologies in the civil engineering industry are not standardized, although over time many attempts have been made in this regard. Nearest standard that can be

taken into account is ISO/IEC 31010:2009 [3] with the Romanian equivalent SR EN 31010:2010 [4]. These standards are supporting standards for ISO 31000 [5] and respectively for Romanian version SR ISO 31000 [6] and provide guidance on selection and application of systematic techniques for risk assessment. This standard does not provide specific criteria for identifying the need for risk analysis, nor does it specify the type of risk analysis method that is required for a particular application, being general in nature.

But the need to develop a methodology to address risk management in investment projects of civil engineering is urgent.

In our research, we found that there are also other attempts of structuring Managing Risk Process in order to clarify some general aspects from the standards (for example [7] and [8], which provide information on risk management procedures). In general, all these procedures are not referring precisely to a particular application of the risk management process within a specific domain or in a particular context of self-organization of an enterprise.

As a partial result of our research work, we present a conceptual framework for risk management assessment, as a managing risk process procedure, which can be applied quite functional in construction investment field and in Construction Projects. Thus, starting from mainstream indications of [5], based on experiences taken in the risk management of civil engineering, it has been proposed in this paper "Conceptual Framework for Risk Assessment" applied to risk management basic processes. The aim of this framework is to assist organizations in order to manage better the implementation of risk assessment procedures in construction projects.

3   METHODOLOGY

Structuring this methodology starts from the recommendations of [3] highlighting the idea that the design and implementation of risk management plans and frameworks will need to take into account the varying needs of a specific organization, its particular objectives, context, structure, operations, processes, functions, projects, products, services, or assets and specific practices employed.

Approach to risk management by an organization involves two levels of hierarchy. One refers to the structure and training of the organization as framework for the development and actions for developing enterprise for risk management activities. The second level refers to activities undertaken for evaluating risk assessments on a project level. These two levels of hierarchy are based on the application of sound principles envisioned in the organization risk management of an organization. In fig. 1 are presented the relations between the risk management principles, the organizational framework for managing risk and the process of managing risk. In this paper we approach the issue for the second hierarchical level – Process for Managing Risk.

The core of a Process for Managing Risk is the Risk Assessment. Some of the principal benefits of performing risk assessment activities include [3]:

- understanding the risk and its potential impact upon objectives;
- providing information for decision makers;
- contributing to the understanding of risks, in order to assist in selection of treatment options;

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- identifying the important contributors to risks and weak links in systems and organizations;
- comparing of risks in alternative systems, technologies or approaches;
- communicating risks and uncertainties;
- assisting with establishing priorities;
- contributing towards incident prevention based upon post-incident investigation;
- selecting different forms of risk treatment;
- meeting regulatory requirements;
- providing information that will help evaluate whether the risk should be accepted when compared with pre-defined criteria;
- assessing risks for end-of-life disposal.
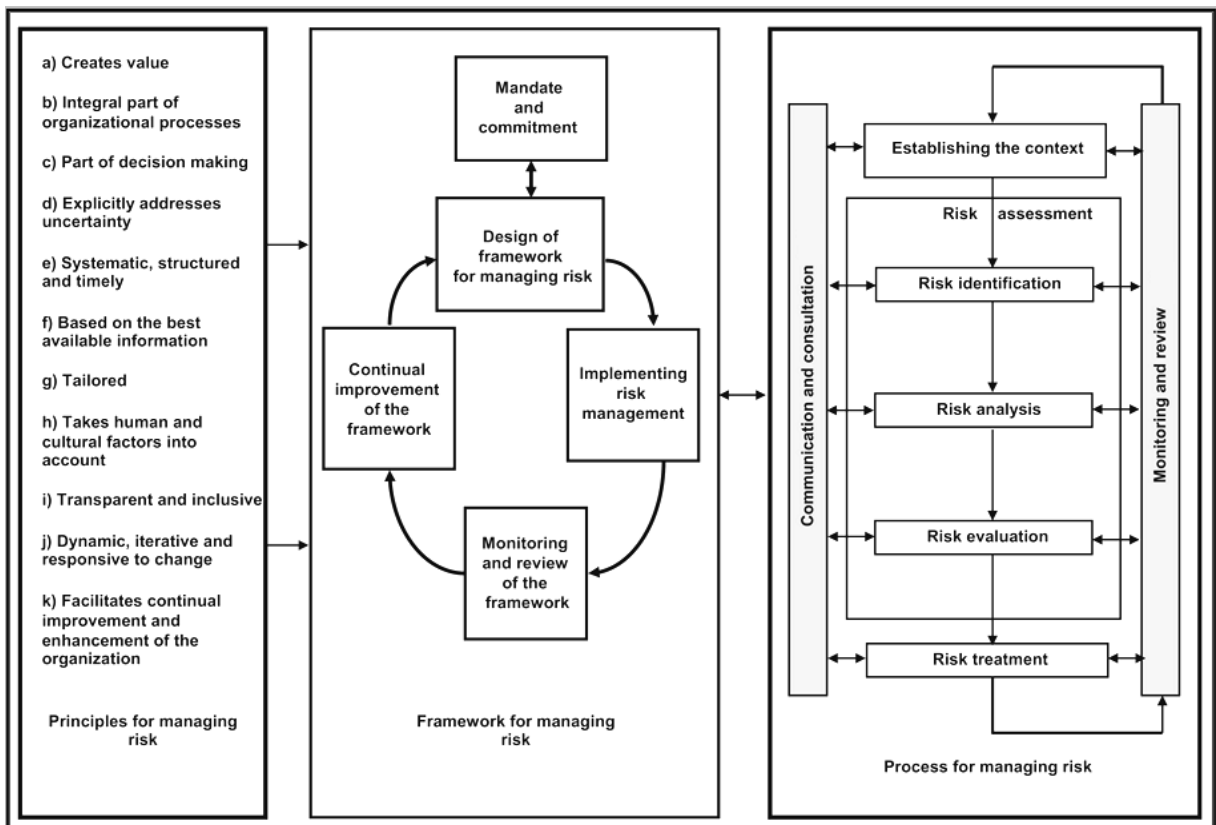
Fig. 1) Relations between the risk management principles, organizational framework and process for managing risk [5]

4 PROBLEM SOLUTION

The guidelines for structuring the Conceptual Framework of Process for Managing Risk which is proposed in this paper can be found in the recommendations formulated in [3] and presented in an iterative manner through Fig.2.

The risk management process has to be developed in order to be:
- as an integral part of organization's management,
- incorporated in the culture and practices of organization,
- adapted to the business processes of the organization.

The Risk Management Procedure should provide a systematic, effective and efficient way by which risks can be managed at different levels throughout the organization. It should be a continuous undertaking by the organization and its units as an integral part of their decision making, be and operated in accordance with the parameters that are set out by the risk management framework [9].
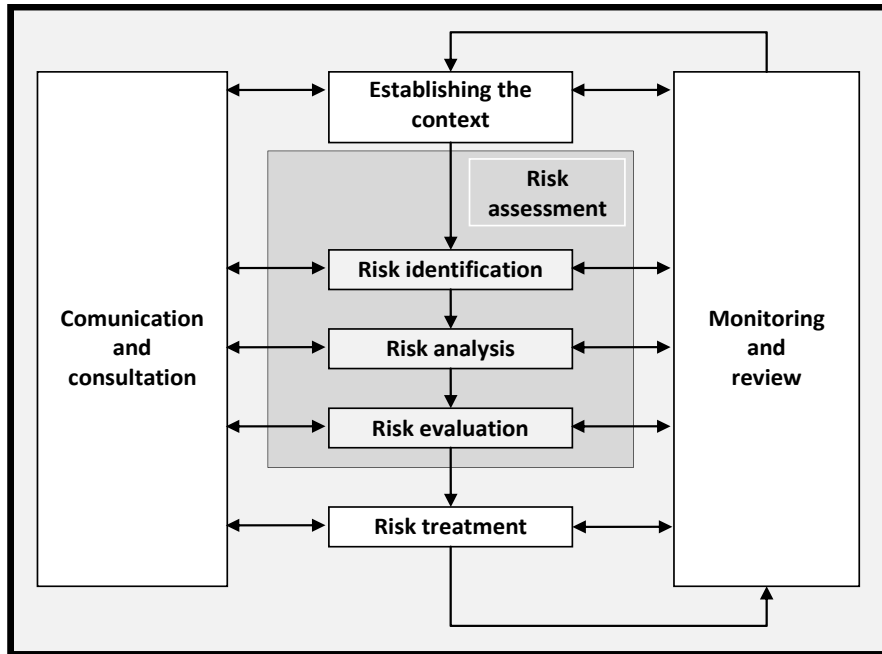
Fig. 2)   Risk Management Process [3]

Starting from the idea that a Process for Managing Risk should provide evidence-based information and analysis to make informed decisions on how to treat particular risks and how to select between options, this proposed structure of Process for Managing Risk presented in Fig. 3 synthesized the extended information contained in the Conceptual Framework for Risk Assessment applied to risk management basic processes.

In the following lines we will present some general reviews on the information that should be contained in this plan.

4.1   Establish the context

The strategic context defines the relationship between the organization and its environment, identifying the organization's strengths, weaknesses, opportunities and threats (SWOT Analysis). The context includes the financial, operational, competitive, political, social, client, cultural and legal aspects of the organization's functions. There should be a close relationship between strategic objectives and organization's management of all the risks to which it is exposed.

The establishment of the organizational context is necessary in order to understand the organization and its capabilities, as well as its objectives and the strategies that are in place to achieve them. Also, according to the organizational policy and goals it will be decide whether a risk is acceptable or not and the form of risk treatment as well.
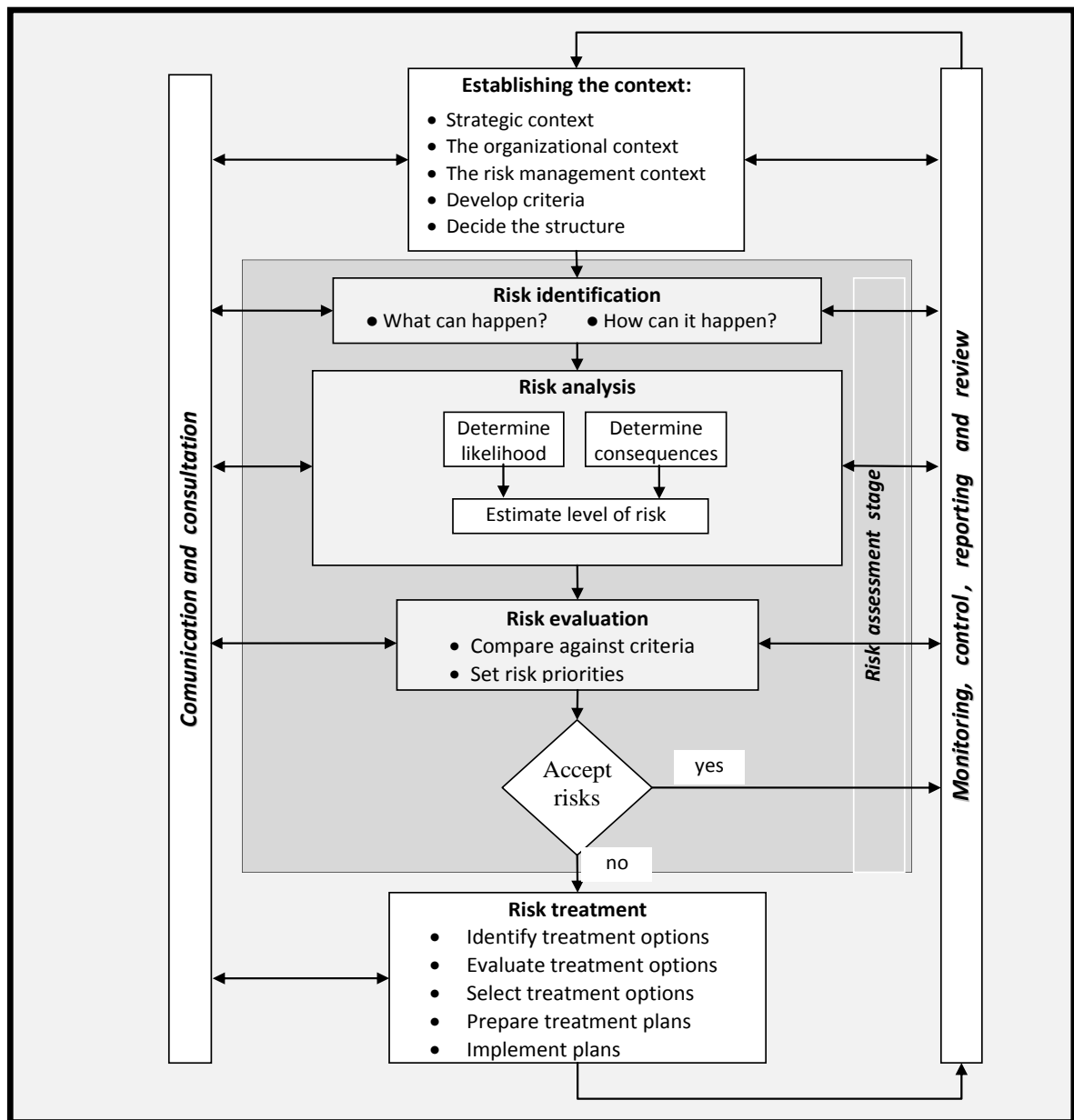
Fig. 3)   Risk Management Process Plan, adapted and updated from [10]

The risk management context represents the organizational point of view about the risk management that is applicable in the managing risk process. In this point it has to be done a connection with the structure of management that is applied in the organization. Information about the balance costs, benefits and opportunities should be considered, and as well about resources required.

In order to develop risk evaluation criteria, an analysis and decisions concerning risk acceptability and risk treatment based on operational, technical, financial, legal and social should be undertaking.

In establishing the context, it has to be done a defining of the structure, separating the activity or the project into a set of elements, providing this way a logical framework for risk identification and assessment, depending on the nature of the risks and the scope of the project.

4.2   Risk identification

This step seeks to identify the risks to be managed. Comprehensive identification using a well-structured systematic process is critical, because a potential risk not identified at this stage is excluded from further analysis. Identification should include all risks whether they are or not under the control of the organization.

The idea is to generate a comprehensive list of events which might affect the common state. After that these can be considered in more detail to identify what can happen.

Identifying this list of events, it is necessary to consider possible causes and scenarios, because there are many ways that an event can be initiated and it is important that no significant causes to be omitted.

4.3   Risk analysis

The objectives of analysis are to separate the minor acceptable risks from the major unacceptable risks, and also to provide data to assist in the assessment and treatment of risks. Risk analysis involves consideration of the sources of risk, their consequences and the likelihood that those consequences may occur. Risk should be analysed by combining estimates of consequences and likelihood in the context of existing control measures. Factors which affect consequences and likelihood have to be also identified.

Risk analysis may be undertaken to various degrees of refinement depending upon the risk information and data available. Analysis may be qualitative, semi-quantitative or quantitative or a combination of these, depending on the circumstances. The order of complexity and costs of these analyses (in ascending order) is qualitative, semi-quantitative and quantitative. In practice, qualitative analysis is often used first to obtain a general indication of the level of risk. Later it may be necessary to undertake more specific quantitative analysis.

4.4   Risk evaluation

Risk evaluation involves comparing the level of risk found during the analysis process with previously established risk criteria. Risk analysis and the criteria against which risks are compared in risk evaluation should be considered on the same basis. The output of a risk evaluation is a prioritized list of risks for further action.

If the resulting risks can be fitted into a low or into an acceptable risk category, they might be accepted with a minimal further treatment. These risks should be monitored and periodically reviewed to ensure that they are remaining acceptable.

If some risks do not fall into the low or acceptable risk category, they should be treated using one or more of the options from risk treatment stage.

4.5   Risk response and risk treatment

Risk treatment as a response involves identifying the range of options for treating risk, assessing those options, preparing risk treatment plans and implementing them. In fig. 4 is synthesizing this stage.
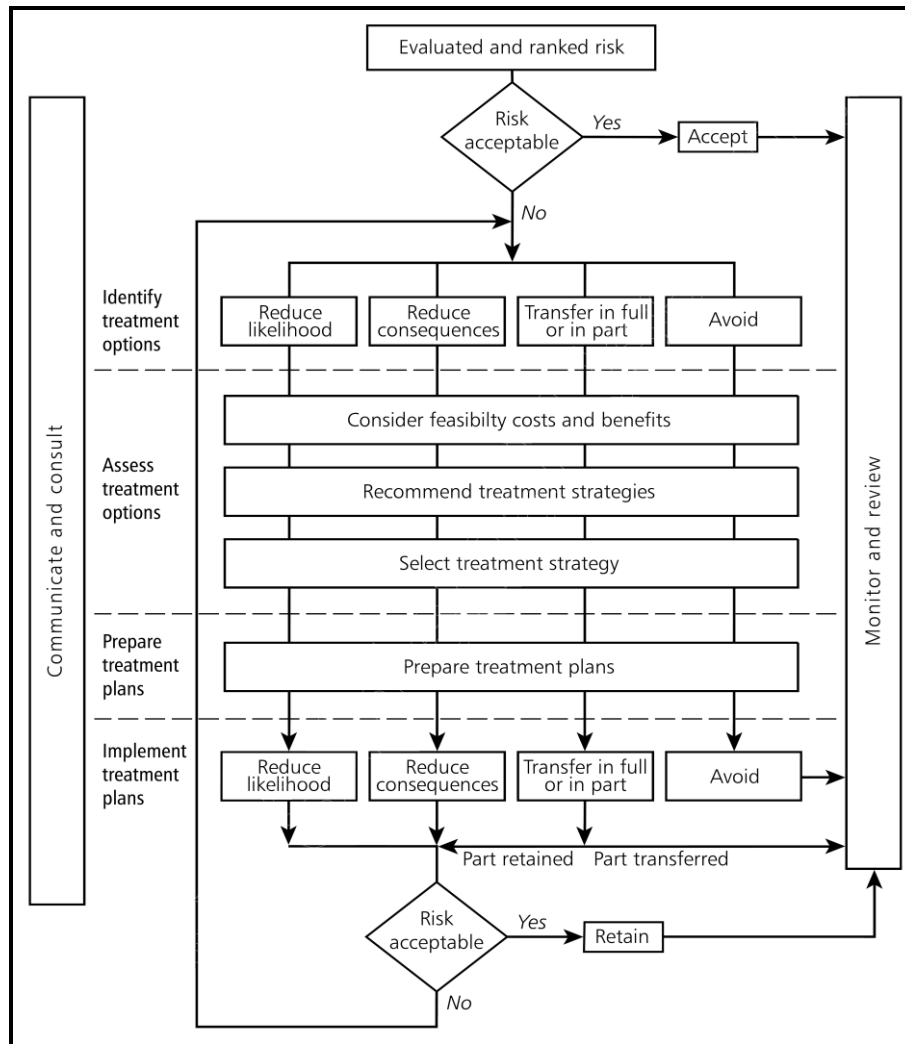
Fig. 4)   Risk treatment process [10]

4.6   Risk monitoring and control

Risk monitoring and control keeps track of the identified risks, residual risks, and new risks. It also ensures the execution of risk response plans, and evaluates their effectiveness.

Risk monitoring and control continues for the life of the project. The list of project risks changes as the project matures, new risks develop, or anticipated risks disappear.

Risk control involves:

- choosing alternative response strategies;
- implementing a contingency plan;
- taking corrective actions;
- re-planning the project.

4.7   Risk reporting

The key outputs from the risk management process should be communicated to the relevant stakeholders. Individual risk management process level reporting should provide an appropriate level of detail and be specific, relevant, timely and reliable.

4.8   Risk review

Periodic project risk reviews repeat the tasks of identification, analysis, and response planning. The project manager regularly schedules project risk reviews, and ensures that project risk is an agenda item at all meetings. Risk ratings and prioritization commonly change during the project lifecycle.

If an unanticipated risk emerges, or a risk's impact is greater than expected, the planned response may not be adequate. Additional response planning must be performed to control the risk.

5   CONCLUSION

This proposed Risk Management Plan that refers to a Conceptual Framework of Process for Managing Risk should be subjected to improvements. In this structure, its role is to be a useful tool in Risk management approach for different organizations and especially for construction projects, complementary to the actual form of the ISO 31000 standard. This structure of Risk Management Plan has been already been used for about 15 Construction investment projects, proving this way its utility.

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AN INNOVATIVE APPROACH TO URBAN ENVIRONMENT AND URBAN ECONOMY: SMART CITIES AND THE CIRCULAR ECONOMY

Július Golej[1]

Abstract

The primary dependence of urban development is gradually changed from initial focus on hard infrastructure and it incorporated into its concept the availability and quality of knowledge communication and social infrastructure. This concept is called Smart City and reflects the innovative approach to urbanism that was created in response to the current development of knowledge-based society. It is closely linked to traditional economic and regional theories of urban development. It consists of six priority axes: people, living, environment, mobility, economy and governance. Through these axes the concept pursues sustainability, social equity and liability by using the latest technological innovation, through judicious management of natural resources (land management) and through participatory governance.

In this paper the author tries to describe not only the concept of Smart City but as well as the complexity of its initiatives involving a large number of stakeholders, which causes a very complicated financial model of the "new city". In particular, the financial schemes are often a key issue and one of possible alternatives could be a concept based on the principles of circular economy.

Key words

Circular economy, infrastructure, smart cities, stakeholders, sustainability, urban development.

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1   SMART CITIES – INTRODUCTION

Cities are increasingly assuming a critical role as drivers of innovation in areas such as education, health, environment and business. According to the United Nations [1] in 2011 the urban population in European cities was 72.9% of all residents. European cities in recent years are facing the large competitiveness and the trend of sustainable urban development. "This challenge is likely to have an impact on issues of Urban Quality such as housing, economy, culture, social and environmental conditions changing a city's profile and urban quality in its composition of factors and characteristics" [2].

The concept of Smart cities is a relatively new term, which we can consider as a next stage in the process of urbanisation that is not used in holistic approaches to describing cities as entities with certain characteristics and attributes [3]. This concept is a framework for a particular vision of modern urban development that recognizes the growing importance of information and communication technologies (ICT) - broadly characterized here as 'networks' - in driving the economic competitiveness, environmental sustainability, and general liveability of cities. [4]. But Smart cities are associated except the usage of innovative ICT technologies also with implementation of effective energy management, modern education, smart people, smart buildings, infrastructure, environment, modern transportation, smart industry, smart government (administration), urban planning and urban development. Smart city covers different areas that forming from the city a comprehensive organic entity. The idea of Smart cities can generally be summarized into three parts, "which form an integrated whole: an Eco cities (ecologically sustainable cities), Social cities (socially intelligent) and Digital cities (digitally smart)" [5].

The basic characteristics of Smart cities are summarized into the six priority axes (Figure 1) which have been developed within the international project *Smart cities - Ranking of European medium-sized cities*.
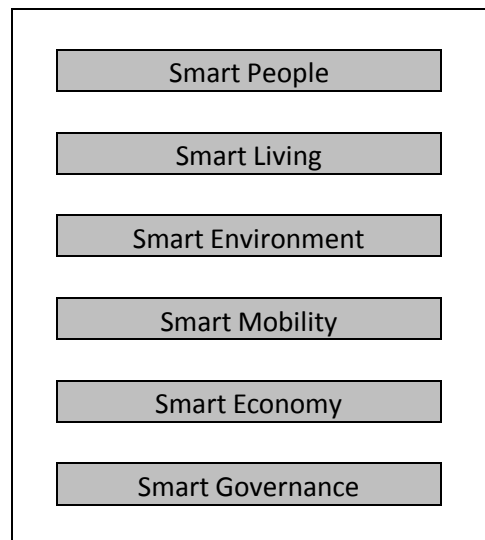
Fig. 1)   The six priority axes of Smart cities

Source: GIFFINGER, R., et al. Smart cities, Ranking of European medium-sized cities. Final report. Centre of Regional Science, Vienna UT, October 2007. [online] http://www.anci.it/Contenuti/Allegati/Ranking%20EU%20citt%C3%96%20smarts.pdf

These axes are based on theories of regional competitiveness, transport and information and communication technologies in economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities.

Smart Economy includes factors all around economic competitiveness as innovation, entrepreneurship, trademarks, productivity and flexibility of the labour market as well as the integration in the international / national market. Smart People are not only described by the level of qualification or education of the citizens but also by the quality of social interactions regarding integration and public life and the openness towards the "outer" world. Smart Governance comprises aspects of political participation, services for citizens as well as the functioning of the administration. Local and international accessibility are important aspects of Smart Mobility as well as the availability of information and communication technologies and modern and sustainable transport systems. Smart Environment is described by attractive natural conditions (climate, green space etc.), pollution, and resource management and also by efforts towards environmental protection. Finally, Smart Living comprises various aspects of quality of life as culture, health, safety, housing, tourism etc. [2].

In order to Smart Cities projects could be successful; it is necessary a cooperation between a large number of stakeholders as "governments, municipalities, property developers, infrastructure providers, utilities, IT companies, engineering companies, architectural firms, telecommunications companies, grid providers, building systems suppliers, and even automakers" [5].

Especially it's necessary to involve to the cooperation process inhabitants, businesses and governments. The undoubted importance has innovative technologies in all areas (construction, energetics, industry, transport, etc.), and stimulating change in the behaviour of inhabitants. Project implementation of such a scale should be realized through the public-private partnerships. The most effective initiatives can be implemented and realized also at national level.

2   CIRCULAR ECONOMY – THE BASIC CONCEPT

The usage of natural resources, particularly in recent decades goes hand in hand with the rapid consumer lifestyle. This lifestyle leads to massive consumption of goods in which production there is no emphasis on their utility value and there is often purposely limited their operating life. This ensures to artificial continuing demand for goods, resulting in increasing consumption of materials, energies and related natural resources. It leads to continued formation of unwanted by-products, such as domestic and industrial waste and different harmful emissions.

This economic model of use of natural resources leading to the consumption of goods has been described as linear with simple scheme: take - make - dispose [6]. In this model, there is no emphasis on the issues of limited resource capacities or on the reuse of consumer goods (Figure 2).

At the end of the 70th years, several researchers have begun to address issues of sustainability.
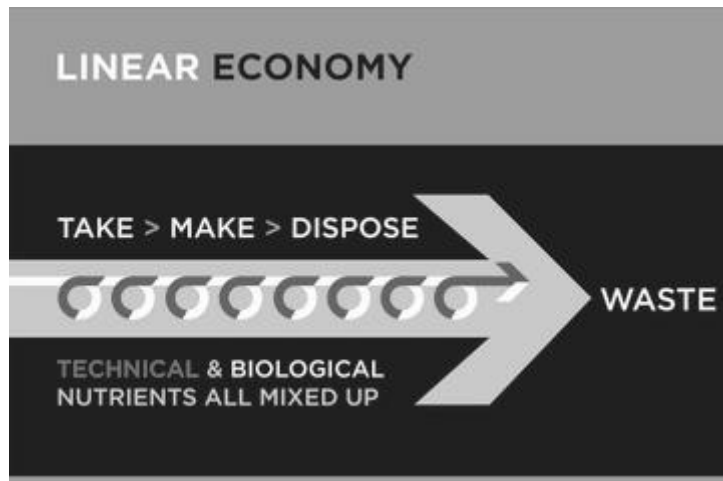
Fig. 2)   The Linear economy model

The main objectives included the extending the operating life of goods, the complete depletion; reuse (regeneration) and minimization of production of waste. During this period were laid the foundations for innovative economy model - the Circular economy. It works on the principle of a living entity where consumed resources, after reaching its operating life are returning to the life cycle (Figure 3).
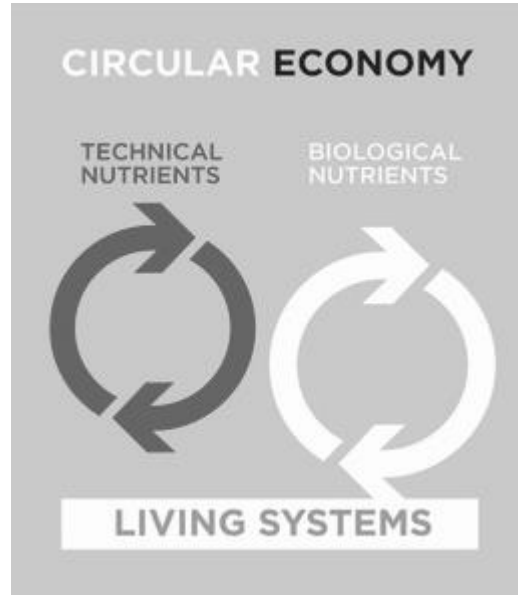
Fig. 3)   The Circular economy model

The basic idea of Circular economy model is the usage of "healthy" sources. From these sources - nutrients are produced goods which by the end of its operating life will return back

to the life cycle. They are either of biological origin, which are returned to circulation - into the soil through decomposition and without specific treatment or procedures. These nutrients become food for the ecosystem. Nutrients can be also a technical origin, consisting of materials that do not have a negative impact on the environment and they are permanently re-usable in industry, with a minimum consumption of energies for their regeneration [7].

3   THE FINANCIAL ISSUES OF SMART CITIES

One of the important issues that cause the complexity of the Smart cities is how to provide their funding. Due to the large number of stakeholders involved to this issue is quite difficult to find a suitable financial model for Smart cities, under which the investment and profits will be equitably distributed among the different actors. Traditionally ownership-based models appear to be insufficient and ineffective in so many actors involved. Here arises the question of applying the new economy based models - e.g. above-mentioned Circular economy.

This approach is unlike traditional ones, does not prefer relations based on the property but rather it is based on relation, in which producers remain the owners of their products, instead of the users. They offer their products to customers along with other services.

As an example of applying this approach in practice, could be case studies from the Netherlands. In the first case, a company with offices ordered from the electronics company the lighting the building according to the standards required per workplace. They signed a contract. This electronics company was responsible for lighting. They provided to its client the lamps together with energy, while remained the owner of its products.

The second example is about the municipality in the Netherlands, which built the town hall based on performance of 20 years. The costs of the building are connected only with its use. After this time, the municipality can decide how to handle with this object - to keep it or dismantle it without further impact on the environment [8].

Although these examples show that the ownership may not always be the only possible solution, on the contrary, it is often the limiting barrier. In this approach the producers have a much greater responsibility for their products and services. This approach also encourages the producers to much more intensive links to innovations and efficiency of their use. Finally and most importantly, all producers remain responsible for the efficiency of its operations and production costs. "In fact, it is all about reconsidering responsibilities and interdependencies in a value chain" [8].

Currently, this approach requires different kind of contracts and finance models from banks. It is important in this type of financing to spread all risks, including financial risks, between different involved actors with the right skills.

At present, most banks do not provide such financing models; therefore we think this is one of the area that deserves considerable attention at this moment.

4   CONCLUSION

In conclusion are provided some recommendations to be taken to ensure the effective functioning of the concept of Smart City:
- Understand the real value of resources in the city.

- Ensure the necessary technologies, processes and systems to support innovation at the city level.
- Redefine the responsibilities - in the foreground the local initiatives stand out more and more.
- Support the creativity, greener and competitive economy, social and territorial cohesion, a synergetic integration and interaction of all urban dimensions, as integrated physical, virtual, natural, social, and institutional spaces.
- A Smart city strategy must be a key strategy for a city.

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SPECIFICITIES OF CROATIAN CONSTRUCTION CONTRACT MANAGEMENT PRACTICE IN PROGRESS BILLINGS AND PAYMENTS SUB-PROCESS

Ivona Gudac[1], Ivan Marović[2], Dražen Bošković[3]

Abstract

International contract management practice has a great influence on domestic, Croatian construction contract management practice (CCCMP). The influence manifests in terms of globalization and integration processes, implementation of new financing models, ascending market demands, as well as the increase of projects' complexity. Shortage of national assets and constant need for government's borrowing from international financial institutions, resulted with presence of international contract management and legal systems in the Republic of Croatia, which are inconsistent with domestic ones. Such influences urge for remodeling and reshaping of the national contract practice. For instance, public projects financed by international finance funds, due to lack of quality and eligible domestic contract practice, often result in direct application of FIDIC forms of contract. This paper will show the reasons for stagnation and non-development of national autonomous regulations. Main idea is to present construction contract management as a form of complex organizational process composed of several generic sub-processes, with the emphasis on progress billings and payments sub-process, and its specificities in CCCMP.

Key words

Billings and payments, construction contract management, contract practice, Croatia, FIDIC.

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1   INTRODUCTION

For the last couple of years, under the influence of globalization and integration processes, Croatian construction industry undergoes intense changes. Implementation of new financing models, ascending market demands and the increase of projects' complexity are only a part of many influential elements. Shortage of national assets and constant need for government's borrowing from international financial institutions in executing large public projects, resulted with presence of international contract management and legal systems in the Republic of Croatia. Emergence of such "new" contract management practice and legal systems based on Common law, strongly affected domestic Civil law based contract management practice.

With public projects financed by international funds, existence of quality and eligible contracting practice is one of key conditions for credit arrangements approval. In lack of adequate contracting practice investors often turn to direct application of forms of contract inscribed by International association of construction engineers (Fédération Internationale Des Ingénieurs-Conseils – FIDIC). FIDIC form of contract [1] was first issued in 1957, and is based on Common law.

Introduction of other legal system's forms of contract, such as the ones from Common law, causes great deal of conflict between the provisions of two different legal systems. Causes of conflict between national construction contracting practice and FIDIC form of contract can be linguistic, or they can arise due to different conceptual interpretations originating from the diversity of these legal systems. Conflicts can also arise as a consequence of underdevelopment or, more often, lack of national contractual provisions conforming to those of the FIDIC. In any case, one of the major problems is the existence of same legal provisions within legal systems with a different legal effect. For public projects it is necessary to fully understand and be familiar with legacy of contractual provisions and to proactively work on construction contract documentation and actively manage it.

The presence of FIDIC form of contract affects the national contracting practice forcing its remodelling. Conflicts that occur for differences in legal systems result in a number of circumstances in the construction contract management, which are in practice usually determined by the consultants and contractors [2]. With the termination of each project, the experience and knowledge that could be transferred on and formulate a "Best Practice" disappears, and contract documentation management system stagnates [3].

In public projects, taxpayers of public procurement are the main factor in the formation of market prices and relations. Achievements of public works are not evaluated, resulting in lack of interest of taxpayers for modelling desirable contracting practice and the development of autonomic regulation.

Under the development of autonomous regulations authors are reviewing the making of general contract conditions for conducting construction works which will be supported by general and specific technical requirements. Underdeveloped technical legislation and the late emergence of professional organizations that have significantly contributed to the development of national legislation can be linked with the socialist practice in pre-1990's period [2, 3]. Croatian Chamber of Architects and Engineers is a young organization that has to actively provide answers to a numerous market demands. It was established in 1998 [4] and separated, in 2009, into the Croatian Chamber of Architects and the Croatian Chamber of Civil Engineers.

This paper will show the reasons for stagnation and non-development of national autonomous regulation through presentation of complex organizational process of construction contract management composed of its generic and extensive sub-processes, with the emphasis on progress billings and payments sub-process.

2   CONSTRUCTION CONTRACT MANAGEMENT - PROCESS STRUCTURE

Construction contract is strictly formal, negotiated, bilaterally obligated, financially binding contract acceptable in written form only. The most important parts of the Contract are considered to be subject of the contract, construction period and total price. The subject is strictly defined, while the cost and completion date may be determined on the basis of legal provisions or the contract itself.

Due to a number of complex legal issues that arise during construction, the construction contract is a complex agreement that gains important economic significance with high amounts of investment. The purpose is to make construction contract management a factor in protecting the public interest and a benefit to the national economy.

The overall construction character includes a very broad legal representation. The provisions of the Spatial Planning and Construction Regulation [5] relate to the protection of public interest, while the Civil Obligations Act (COA) [6] regulates the relations between the parties of the contract. COA also applies to foreign persons (physical and legal) when it comes to the rules of private international law that obligation relations suggest to.

Sources of law in Croatian construction contracting practices are based on Roman-Germanic legal system which is represented by contracts (if in compliance with mandatory regulations), customs, regulations and COA judicial and arbitral practice, or indirectly legal science. The legal source of the construction contract is Civil Obligations Act. General provisions (relating to compensation, unilateral termination of the will of the Employer, the Contractor's liability, breach of contract due to the deviation from the provisions of the contract) and the provisions of the service are applicable. Sources of Anglo-Saxon system of jurisprudence are precedents, equity, legislation, international conventions, treaties and customs.

The term Contract management can be explained in detail from the literature provided by the Project Management Institute - PMI and the National Contract Management Association - NCMA. PMI in their "Guide to the Project Management Body of Knowledge" divides the overall project management knowledge areas and related processes [7]. In line with this idea NCMA issued "Guide to the Contract Management Body of Knowledge" [8] which takes the above structure of PMI processes, and further develops the concept of Contract documentation management. Project Management presents a broader framework for generally accepted knowledge and professional practice, where Contract Management presents one of many Project Management areas [9].

PMI describes Project Procurement Management through six processes from the aspect of the Client as a signatory: Procurement Planning, Solicitation Planning, Solicitation, Source Selection, Contract Administration and Contract Closeout; and six processes from the aspect of the Contractor: Presales Activity, Bid/No bid Decision Making, Bid or Proposal Preparation, Contract Negotiation and Formation, Contract Administration and Contract Closeout [3]. Figure 1 shows the PMI knowledge areas, according to which the Contract Administration lies in the field of Project Procurement Management.
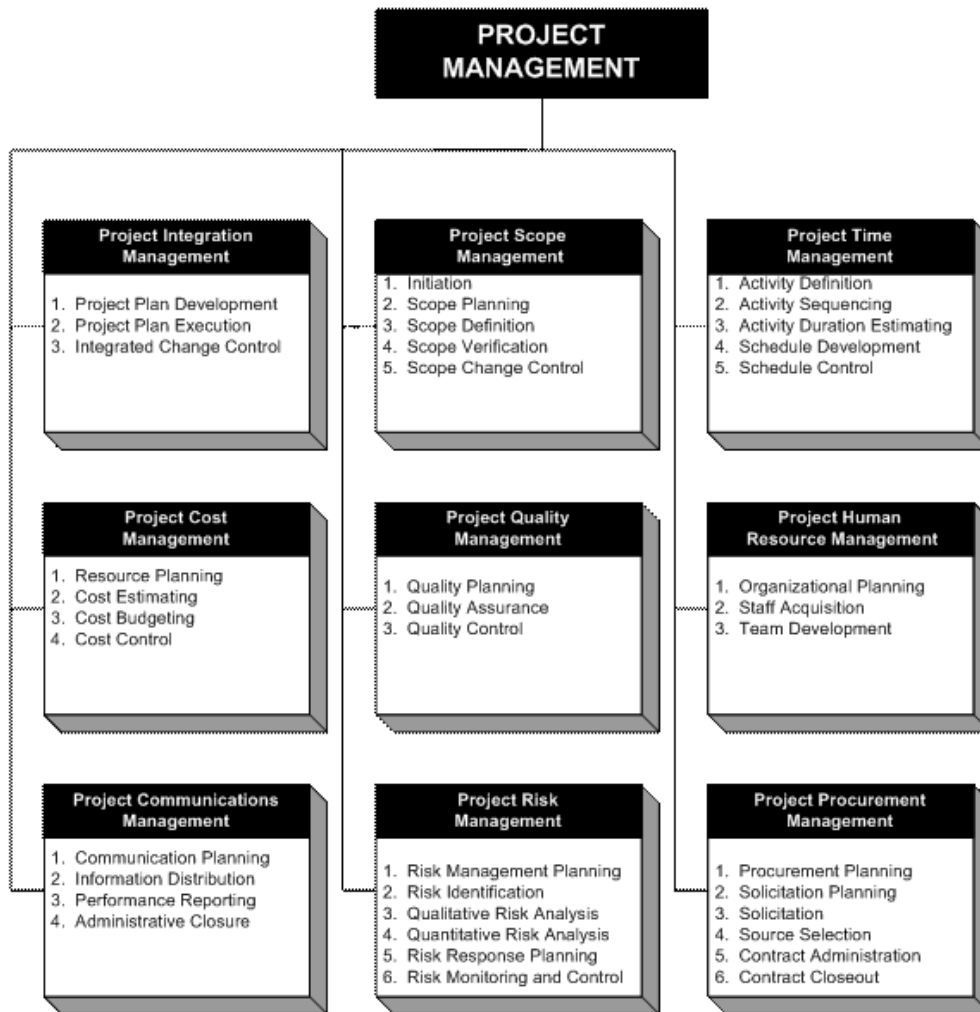
Fig. 1)   Project management knowledge areas [7]

Authors Garrett and Rendon [10, 11] describe Contract Management area as "a comprehensive contract management process", while the Contract Administration is defined as "the process of securing the execution of contractual obligations of each party in accordance with the requirements of the contract". Gilbreath [12] recognizes the area of Contract Administration as a key element of the process of Contract Management, and defines it as "direct contract documentation management from the time the contract was awarded to the moment when it is formally concluded". He states that the Construction Contract Management is systematic collection of plans, activities and approaches necessary for the fulfilment of commercial side of the contracts.

Generally it can be concluded that the stages of Contract Management life cycle, regardless of the legal system in question, output two types of documentation - bidding and contracting. Bidding documents consists of calls for tenders and bids, whilst the contract documents constitute of the Contract and documents resulting from implementation of the contract. The typical contract structure used in public works consists of a contractual agreement, the special and general conditions of the contract, bid, attachments, contract bill and plans.

By definition [1, 2, 7, 8] which states that the process is "a set of related activities, with the consumption of certain resources, convert the input parameters to output", we can define

construction contract management as a process. Processes are rarely found in its purified form in practice, more often they are within the complex hierarchical systems.

The general concept of construction contract management process (Figure 2) as an input entries processes arising from the formation stage of the Contract, while the output represents the realization of the provisions of the Contract. The process is actively affected by contracting parties (Client and Contractor), as well as control processes that are encouraged part by environment, part by Client and Contractor. All sub-processes of Contract documentation management represent a complex organizational process.
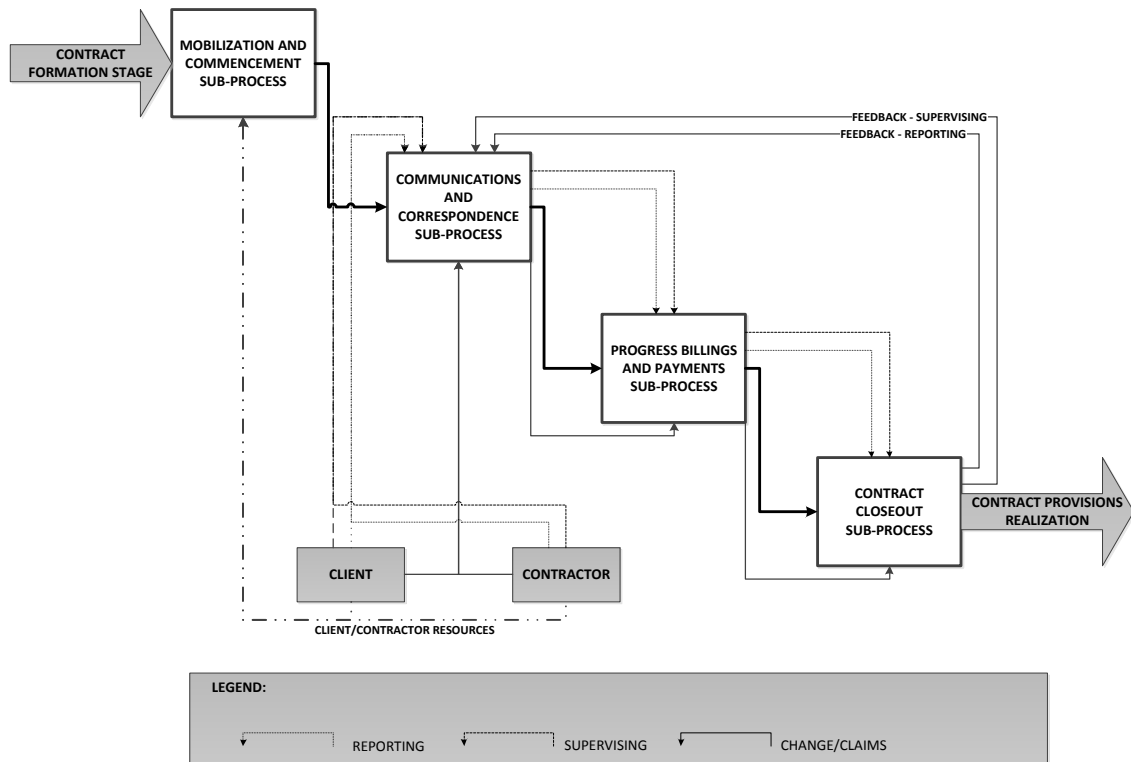
Fig. 2)   The process of construction contract management

Construction contract management consists of a series of sub-processes that are not organized in a linear sequence. We distinguish two types of sub-processes, generic and extensive.

Sub-processes which are permanent and appear in any construction contract management process (shown in Figure 2) are called generic sub-processes, and can be divided into: Mobilization and Commencement, Communications and Correspondence, Progress Billings and Payments and Contract Closeout.

In addition to constant generic sub-processes, within construction contract management process extensive sub-processes are also present. They are likely to appear, but unpredictable in terms of volume and frequency of appearance and therefore have extensive character. These sub-processes are induced by conscious action of the contracting parties which affect them and/or represent the reaction to changes that occur during the process by producing direct and indirect feedback. Extensive sub-processes are: Change Management, Claims Management, Contract Reporting and Contract Auditing.

3   CROATIAN CONSTRUCTION CONTRACT MANAGEMENT SPECIFICITIES IN SUB-PROCESS PROGRESS BILLINGS AND PAYMENT

Progress billings and payment sub-process is the part of the Contract Management with the most attention given. There are three basic concepts of pricing methods:

- Payment based on actual costs,
- Payment based on time spent, and
- Payment based on performed work.

In general, they are functionally associated with the intention of monitoring the dynamics and trends of the works done by the Employer. This further indicates on the calculation method of construction works and the technique of calculation [2].

The manner in which the price is contracted often depends on who bears the risk of changes in quantity and variety of unforeseen circumstances that may arise during the performance of works, and on which the final cost of works depends.

The main problem in determining the price of construction is the fact that it is usually difficult to accurately pre-determine exactly how much will be the amount of work to be done. Pricing methods are formed depending on who bears the risk for these unknown quantities. This means that the way the price was contracted, determines the division of responsibilities between the contract parties.

There are three basic ways of pricing:

1. Unit prices - quantities are measured, and they have the effect on final price. The contractor takes responsibility for the continuity of unit prices, but not for the total amount of quantities.
2. Lump-sum - one price for all the construction work. The contractor assumes the risk that entails' exclusive price for all works.
3. Cost reimbursable - The contractor is compensated for all costs and is given a percentage of his makings.

Variations on the above pricing methods, as well as the level of the obligation are as follows:

- Non-binding calculations,
- Calculations without the express warranty,
- Calculations with the express warranty,
- Unit prices,
- Lump-sum prices,
- Prices according to the actual cost together with fee,
- Prices according to price lists,
- Joint contract prices,
- Prices for the "turnkey" contract,
- Prices for "project management",
- Target price

3.1   Unit prices

The system of unit price contracting incorporates the distribution of risk between the client and the contractor, and through it presents a very balanced way of price contracting. The risk division lies in the fact that the contractor takes the risk for the price of individual units, while

the client takes the risk for the total number of derived units, therefore the quantities. Precisely because of this balance, contracting of unit prices is the most common way of price fixing in construction industry. Such method of contracting is especially suitable for larger investment projects - larger amount and longer duration of the works in which the extent of work is measured.

Unit prices are usually contracted when the final amount of work required for the construction of a building cannot be predicted with certainty, which is the most common case of construction works. For each such type it is required by the bidder (contractor) to determine his unit price. Unit price is given individually for all those works that can be specified individually, which should be performed in a facility. These works and supplies are presented and sorted by each unit which can be calculated separately (e.g. excavation per cubic meter, foundations on the width and depth, individual price for each type of door, window, installation of all types of doors, windows etc).

A document that contains the display of certain types of works and deliveries, and is broadcasted in the format, in which prices are included, is called Bill of Quantities (BOQ). In BOQ detailed evidence describes all kinds of work to be done, and the bidder is expected to set their price for each reported kind. Bills also contain the final sum of the estimated total amount of work to be done. These amounts, however, are yet unknown at the time of bidding and are only estimates. Unit prices are, therefore, agreed to when they cannot predict the final amount of work required for the construction of an object with certainty, or when the contractor is not required to take the risk for the accuracy of that amount. These contracts are known as "measured contracts", since the real amounts derived are measured as work progresses, and are calculated periodically. Periodical calculations of performed work are calculated by multiplying the quantity of performed works and deliveries to the agreed unit prices, and the final cost of the entire structure is known only after the works are carried out in entirety.

The difference between the estimated quantities and actual quantities of delivery and works executed may occur as a result of various circumstances that are not yet known at the time of contracting. Unit pricing allows the client at the time of contracting to have rough estimate of works and prices of these works per unit of measurement, and that he can compare those prices with the prices of other tenderers. The prices offered by the contractor cannot be changed and the contractor bears the risk for the appropriateness of the specified unit prices. There are no obstacles, however, that such contracts provides the audit of the prices, depending on various factors that influence their possible revision. The danger for clients with this pricing method is that bidders can provide lower prices for those works which are expected to be fewer, and higher prices for those are expected to be more. Similarly, the initial work can be charged more expensive to ensure a greater amount of money in the beginning of construction works. COA prescribes the application of contractual instruments such as a sliding scale, index clauses, and currency clause which is very popular in Croatian contracting practices.

3.2 Lump-sum

The term lump-sum is widely used in commercial terminology as a label for pre-agreed fixed fee. Croatian regulation of COA avoids the use of this term. Instead the terms "total contract price" or "price determined in the total amount" are used. Lump-sum is the price at which the contractor has determined the total cost for all the work to be done in advance and in which quantities do not measure. If the price is fixed like that then the contractor cannot ask for price

increases due to higher amount of quantities, because the increase or decrease of the amount has no effect on the agreed cost.

When contracting lump-sum prices it is essential that the parties agree on what works are immutable. Generally speaking, the lump-sum refers only on the price in a way that the contracted quantities are not measured for payment. This means that the work not covered by lump-sum must be paid separately. All the additional work must also be paid separately. It is possible; however, that lump-sum refers not only on price but on the scope of work, which depends on the formulation of the contract.

Special difficulties in lump-sum prices may occur in premature termination of the contract. The Contractor is entitled to compensation for all work performed, and if no specification of individual sections and their prices is given, the value of the work can be disputed. The situation is simpler if the lump-sum price has been contracted after determining unit prices for certain type of work, and if these prices served as the basis for determining the lump-sum price.

If there was any doubt whether some of the work is included in lump-sum price or not, the provisions of the agreement and intention of the parties will be taken into account. In some cases the principles of honesty and integrity can be applied with which it is evaluated whether a work is so beyond the agreed scope and nature that the contractor could not have had to reckon with them as a possible, if none of the above stated indicators would provide the basis for the decision. Given the potential ambiguity in the contract of lump-sum price and job description parties should define and specify those works and the scope of work that is implied with the utmost care.

3.3   Cost reimbursable

Cost reimbursable is a way of contracting the price where the contractor will reimburse all his costs, and a certain percentage of his makings will be added to the amount. This pricing method usually applies when contractors at the time of contracting do not know the exact price, or in the case of emergency or experimental works. It is appropriate when the scope of work and circumstances under which the work will be done are not known at the time of biding. The final price is known at the end of the project. The result is derived by multiplying the total amount of quantities with the agreed unit prices.

In such calculation method the contractor shall be entitled to reimbursement of all actual costs incurred by the job performance, and even a certain fee which will cover his profit and overhead costs. With this pricing method it is not necessary to agree on price revision clauses, since the client will pay the actual costs that will reflect the possible price increases. Such method of cost contracting shifts the entrepreneurial risk from the contractor to the client.

These contracts are frequently exposed to disagreements between the contractor and the client, both in terms of the construction works scope, and in terms of labour and machinery use. It is therefore necessary to agree in advance on the documentation that will prove the basis for calculation and payment. At the time of contracting clients do not have any advance review of the amount or the price of the project. All this leads to much more complex process of cost control and administration of the entire construction process, which greatly increases the price of the entire project. From the client's standpoint this pricing method is very risky and control measures should be provided to prevent and reduce the possibility of contract abuse.

3.4 Payment methods

COA provides two pricing models for construction based on payment for the performed work: unit price from which follows payment based on the Unit price method; and Lump-sum method. Third model also appears in practice - payment based on actual costs, which can be identified with the Cost reimbursable pricing method. This does not exclude other pricing models, so it can be said that in Croatian contracting practice they are determined by agreement between the Client and the Contractor. If the unit prices are contracted, for each calculation work will be evaluated depending on the measured quantity amount for each unit. If the agreed price is lump-sum, the amount of payment will be lump-sum price that remains constant, unless it is subject to changes in accordance with the contract.

Method of payment compliance and method of the advance payment is defined by the contract. Procedures of monthly progress billings and payment sub-process are carried out through the end of the project. Central role in the progress billings and payment sub-process in Croatian construction contract management practice has Supervising engineer. In practice, the measurement of actual net quantity of each work section is made in accordance with the bill or with the provisions from technical specifications, standards and etc. It is interesting that in FIDIC form of contract documentation, on which the measurement is based, is made by Supervising Engineer. The Contractor's obligation then is to review and conciliate with the documentation. In Croatian construction contract management practice the Contractor documents the work in document called Bills of Measurements, and the Supervising Engineer reviews it and approves/disapproves the work performance.

The Supervising engineer generally solves the calculation issue through monthly situations, with its minimal amounts limited by contract (usually not less than 1% of contractual amount). He controls the documentation and approves the work performed, the amounts to be added or deducted based on variations of price due to changes in the cost or quantity, or other circumstances (correction due to changes in legislation). The Supervising engineer calculates the advanced and retention amounts, approves additional and unexpected works, and additions and deductions that are due under the claims resolutions. The amount calculated in all previous situations will eventually be deducted. The progress billings and payment sub-process is sensitive and suffers from inadequate project preparation and imprecise contractual strategy definitions in the Contract planning, part of Contract formation phases [2, 3].

4 CONCLUSION

The introduction of new funding models, the growing market demands and market documentation as well as increasing complexity and scope of the projects are just some of the elements that affect the construction contracting practice in the Republic of Croatia. The construction of large public projects financed by international financial institutions leads to presence of the international contracting practices and legal systems. In such projects it is essential that a quality contracting practice exists as one of the main conditions for the granting of credit arrangements. The organizational complexity of the process is presented within this paper, with special attention on the Progress billings and payment sub-process.

In the absence of adequate national contracting practice FIDIC form of contract is widely used. The presence of contract forms, based on the legal system (Common Law) that does not correspond to the national (Civil Law), causes many problems and conflicts. Perhaps one of the most outstanding problems is that with the cessation of every public project, the project team breaks and the experience and knowledge, which could pass on to formulate a "Best

Practice", disappears. Such an attitude towards the projects and acquired knowledge directly affects the stagnation of contract management practice.

Although the paper did not discuss the advancement of the process, it is evident that by the very action on the dissipation of this knowledge may lead to the development of autonomic regulation. Because of increased international investment activities, general trend offset of contracting practices from the national legislation will be even more visible.

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ENVIRONMENTAL EVALUATION OF ENERGY-SAVING MEASURES – A CASE STUDY

Tomáš Hanák[1], Pavla Dosedělová[2]

Abstract

Rising energy prices, increasing energy intensity, more demanding technical norms and global climate change promote carrying out energy-saving measures on existing buildings and even realization of zero emission construction projects. These energy-saving measures have a positive economic impact, but for their overall evaluation, the emissions and the energy consumption needed to carry out the particular measures must be considered.

This paper analyses the energy lifetime of energy-saving measures in terms of embodied energy. The objective of this paper is to evaluate the environmental impact of the performance of energy-saving measures on an existing house with multiple dwellings. This evaluation is performed in terms of the energy payback period. At the end of the paper we discuss general principles of an environmentally friendly approach to construction related to embodied energy issues and the performance of energy-saving measures on existing buildings.

Key words

Carbon dioxide, embodied energy, energy-saving measures, environment, evaluation, payback period.

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1   INTRODUCTION

Rising energy prices, increasing energy intensity, more demanding technical norms and global climate change promote carrying out energy-saving measures on existing buildings and even realization of zero emission construction projects. *Eurostat* estimates that approximately 40% of final energy in the European Union is consumed just in buildings [1, 2]. The above-mentioned energy-saving measures have a positive economic impact, but for their overall evaluation, the emissions and energy consumption needed to carry out the particular measures must be considered.

Treloar et al. emphasise the need for energy conservation measures to be evaluated in a life-cycle perspective, only then can it be ensured that the energy for carrying out such measures was used efficiently [3]. If the total energy used during a life-cycle is to be determined, both the energy needed for operation and embodied energy must be considered in order to ensure that the total costs will be paid back within a reasonable period. Therefore, it is necessary to prepare plans for the design of new houses and for performance of energy-saving measures on already existing buildings.

Fay et al street the fact that *it is necessary to take into account that embodied energy is significant relative to operational energy and as operational energy becomes lower (through efficiency improvements), embodied energy becomes even more significant* [4]. The objective of this study is to evaluate the environmental impact of carrying out energy-saving measures on an existing house with multiple dwellings. This evaluation is performed in terms of the energy payback period.

2   BACKGROUND

According to the concept of sustainability, energy systems have to be evaluated within the frame of 3E (Energy, Economy, Environment), write *Sasnauskaité et al.* [1]. The embodied energy of a building is defined as *the energy required by all the activities associated with its construction and the share of energy used in making equipment and in the provision of other supporting functions* [5]. The embodied energy comprises a direct component (the fuel used in its assembly) and an indirect component (the energy embodied in building materials). *Treolar et al.* find embodied energy a significant concept because in this way energy efficiency and operational energy may be considered together and within the life-cycle of the measures carried out [3].

2.1   Methods of embodied energy analysis

The energy directly consumed can be defined easily and uniquely. However, the indirectly consumed energy used for carrying out the necessary measures outside of the building site (e.g. for production of material at the manufacturer) is more difficult to determine and measure [4].

Embodied energy should be analysed by [4, 5]:
- *Process analysis* – focused on the energy required for a particular process, but unfortunately this analysis does not take into account e.g. the energy associated with extraction of raw materials;
- *Input-output analysis* – focused on economic flows between sectors that are transferred into energy flows using average energy tariffs;

- and *Hybrid analysis* – which combines process analysis and input-output analysis by taking advantage of their strengths and suppressing their weaknesses.

2.2 Life-cycle Energy Analysis

The economic aspect usually takes into account life-cycle costs, i.e. both the investment costs and the operating costs of the options considered are evaluated. The same approach should be applied to the environmental aspect, since the life-cycle of any product includes a manufacturing phase and an operational phase.

Life-cycle energy can be calculated within the frame of lifecycle energy analysis and by using the following equation (modified from *Fay*) [4]:

$$LCE = EE_i + (EE_{rec} + OE) \text{ x building lifetime} + EE_r + EE_d \qquad (1)$$

where:

LCE = the lifecycle energy;

EE_i = the initial embodied energy of a building;

EE_{rec} = the annual recurrent embodied energy;

OE = the annual operational energy;

EE_r = the reconstruction/modernization energy of a building;

EE_d = demolition embodied energy.

Bekker argues that EE_d does not have to be considered, as the energy required for the demolition of a building is negligible compared to the rest of LCE [6]. Moreover, it is possible to obtain additional embodied energy savings if the demolished materials are reused or recycled.

Many authors stress the fact that the energy embodied in energy-saving measures should be paid back within a reasonable period of time [3]. Payback period is an economic term referring to the time necessary for restoring the whole sum of the original investment. Thus, for the purposes of this paper the **energy payback period** of the performance of energy-saving measures may be understood as *the period of time required for the return of embodied energy savings to repay in energy terms the initial amount of embodied energy*.

The study performed in this paper is focused on carbon dioxide (CO_2) produced as a constituent of emissions e.g. from coal-fired power plants and which contributes to global climate change. The embodied energy units used are given in MJ/kg (i.e. megajoules of energy needed to make one kilogram of a product) and tCO_2 (i.e. tonnes of carbon dioxide created by the energy needed for production of one kilogram of a product). Other emissions (e.g. sulphur dioxide or nitrous oxide) degrading water, air and soil are outside the scope of this paper.

3   CASE STUDY

The analysed object is a multiple dwelling house constructed by utilizing a standardized structural wall system from prefabricated panels in Olomouc, system T06-OL with a total facade area of 2,590.6 m^2. The building was constructed in 1972, it has nine floors and the height of one floor is 2.8 m. In 2007, installation of new thermal insulation on outside walls (system Stomix Therm Alfa), roof thermal insulation (Rockwool Rockminhave) and thermal insulation of the floor construction between the underground floor and the ground floor (Nobasil) was carried out in order to reduce energy consumption. The description of the particular energy-saving measures is introduced in Table 1.

Tab. 1)   Description of applied energy-saving measures on the analysed building

Measure	System / Material	Thickness	R [m^{2}K/W] of whole structure	U [W/m^{2}K] of whole structure	U required [ČSN 73 0540/2002] [7]
Insulation of outside walls	Stomix Therm Alfa	90 mm	2,819	0,355	0,380
Insulation of floor	Nobasil	60 mm	1,722	0,581	0,750
Insulation of roof	Rockwaal Rockmin	200 mm	5,198	0,192	0,300

(Source: Bohuslav, J. [8])

3.1   Calculation of initial embodied energy of energy-saving measures

When energy-saving measures are introduced, it is possible to calculate the value of the initial embodied energy in terms of the CO_2 weight embodied in energy-saving measures. This analysis takes into account the energy consumed on the manufacturing of components of energy-saving measures. The energy spent on transport and assembly of components is not taken into account.

The total amount of the CO_2 embodied energy for energy-saving measures on particular structures was calculated according to the equation:

$$m_{CO2} = \sum_{i=0}^{n} GWP_i \ x \ m_i$$

(2)

where:

m_{co2} = the amount of CO_2 embodied energy;

GWP_i = amount of CO_2 equivalent to 1 kg of a particular material [kg CO_2 equiv. / kg];

m_i = weight of the particular material.

Table 2 shows the total weight of CO_2 in kilograms distributed among particular energy-saving measures. The most CO_2-demanding energy-saving measure is the additional thermal insulation on outside walls.

Tab. 2) Amount of CO_2 related to embodied energy of particular measures, calculated according to [8,9,10,11] using equation (2).

Measure	Value m_{CO2} [kg]
Insulation of outside walls	27,209.7
Insulation of floor	7,159.6
Insulation of roof	10,909.8

Consequently, the value of unit embodied energy related to 1 m^2 of facade is calculated according to the equation

$$m_{CO_2,u} = \frac{m_{CO_2,wall} + m_{CO_2,floor} + m_{CO_2,roof}}{A} = 17,48 \; kg \; CO_2, equiv./m^2 \tag{3}$$

where:

$m_{CO2,u}$ = unit CO_2 embodied energy related to 1 m^2 of facade;

A = facade area.

3.2 Calculation of operational embodied energy savings

Since energy-saving measures enhance the technical parameters of a building, considerable energy savings should be recorded in operation. The annual operational energy consumption before and after the implementation of energy-saving measures was compared by using the data provided by the housing association and the heat distributor. It is important to note that the distributed energy is produced from brown coal with emission 111 g CO_2, equiv./MJ [12]. Achieved results were transferred in $m_{CO2,u}$ units.

Tab. 3) Amount of CO_2 related to annual operational embodied energy on 1 m^2 of facade

Period	Annual operational unit CO_2 embodied energy [kg CO_2 equiv./year/m^2]
Before the implementation of energy-saving measures	69.76
After the implementation of energy-saving measures	43.63
Difference (if positive then savings are achieved)	+26.13

(Source: *Dosedělová, 2012*)

The implementation of energy-saving measures has resulted in considerable energy savings (37.5%) and thus 26.13 kg CO_2 equiv./year/m^2 are saved annually.

3.3 Evaluation of Energy Payback Period

When all necessary input data has been collected and calculated (unit initial embodied energy and unit annual operational embodied energy) it is possible to evaluate the energy payback period (EPP). EPP is evaluated according to the following equation [11]:

$$EPP = \frac{m_{CO_2,u}}{m_{CO_2,u,b} - m_{CO_2,u,a}} \tag{4}$$

where:

EPP = energy payback period;

$m_{CO2,u,b}$ = unit annual operational embodied energy before the implementation of energy-saving measures;

$m_{CO2,u,a}$ = unit annual operational embodied energy after the implementation of energy-saving measures.

The energy payback period has been calculated for 0.67 years. Such a result passes the above-mentioned requirement that energy-saving measures should be paid back within a reasonable period of time [3]. This very favourable EPP result lies principally in the fact that the primary source of energy is brown coal. It can be anticipated that the more environmentally friendly the energy source is, the longer the EPP is. Calculation of EPP for different types of energy sources is given in Table 4.

Tab. 4)   Comparison of EPP for different types of energy sources

Type of energy source	Emissions CO_2 [g/MJ] [13]	EPP [years]
Brown coal	111	0.67
Coke	92	0.81
Fuel oil	75	0.99
Natural gas	56	1.32

The results illustrated in Table 4 show the significance of the energy source factor on EPP. For natural gas, the EPP is almost twice as long as that reached with brown coal. Nevertheless, the EPP for natural gas will still be shorter than the economic payback period of the analysed energy-saving measures.

4   CONCLUSION

Obviously, the type of energy source specific to the particular energy distributor supplying power and heat for the building influences significantly the energy payback period. The more emission-demanding the energy source is, the shorter the payback period. The energy-saving measures are environmentally friendly if the energy payback period is shorter than the lifetime of the applied measures and especially if it is shorter than the economic payback period. For the purposes of illustration, the economic payback period valid for the analysed case study is 14 years.

Nowadays, it is vital to consider both economical issues and environmental and energy actions together. The concept of sustainability stresses the evaluation of energy systems by taking into account energy, economy and environment aspects.

The energy payback period is dependent especially on the type of energy source, materials used and energy savings achieved. From an environmental perspective it is necessary to use ecologically friendly materials, provide highly efficient energy-saving measures and replace environmentally unsuitable energy sources with ecological and renewable energy systems such as wind or solar power.

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EVALUATION OF FRICTION COEFFICIENT EFFICIENCY BETWEEN ELASTOMERIC BEARING PAD AND CONCRETE IN PRE-STRESSED CONCRETE BOX BRIDGES

Ehsan Hassani Nezhad Gashti [1], Javad Razzaghi Langroudi [2], Kauko Kujala [3]

Abstract

For pre-stressed concrete box girder bridges, anchor bolts are used to restrain elastomeric bearing pad displacements due to horizontal movements of superstructure resulted from earthquake or horizontal forces caused by breaking vehicles. According to AASHTO code [1], there is no need to use the anchor bolts when friction coefficient between the elastomeric bearing pad and concrete is more than 0.2. Based on balanced cantilever method seismic loads amounts in construction phase is more than in service phase. This paper evaluates the friction coefficient efficiency by considering ratio of shear forces resulted from the seismic loads to weight of deck during the construction phase for a practical case in Iran. The ratio after installing last segment in construction phase was equal to 0.190 and 0.203 for horizontal and longitudinal earthquakes, respectively. Factor of safety (FoS) analysis indicated the bridges during construction phase are safe against the horizontal earthquake (FoS =1.050), but vulnerable to the longitudinal earthquake (FoS = 0.985). It can be concluded that the friction coefficient recommended by the AASHTO code for pre-stressed concrete box girder bridges was not sufficient during the construction phase, and using the anchor bolts seems to be necessary to make the bridges safe in this phase.

Key words

Box girder bridges, construction phase, elastomeric bearing pad, free cantilever method, friction coefficient.

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1   INTRODUCTION

Long-span bridges could be considered as very important structures in industrial societies and economic expansion on the basis of their performance at development of these communities [2]. Based on the researches carried out by Stanton [3], Hamzeh [4] and Yoon [5], elastomeric bearing pads are used as bridge-support widely because of their proven appropriate specifications (Fig. 1). For pre-stressed concrete box girder bridges, anchor bolts are used to restrain elastomeric bearing pad displacements due to horizontal movements of superstructure resulted from earthquake or horizontal forces caused by breaking vehicles. Based on AASHTO LRFD [1] and articles [6], [7], [8], [9] friction coefficient between the contact surface of sole plate and elastomer is around 0.1 and according to Stanton [10] 0.4 will be applied between sole plate and bottom flange of deck. It could be noted that almost no study has been done to evaluate these factors efficiency between elastomeric bearing pad and both concrete and sole plate during construction phase. Considering the AASHTO code [1] there is no need to use the anchor bolts when friction coefficient between the elastomeric bearing pad and concrete is more than 0.2. This conclusion results from that in most applications, forces induced from regarded loads in service phase are less than 0.2 times bridges deck weight and consequently, using anchor bolts will not be necessary to prevent from bridges deck movement under service phase loads.
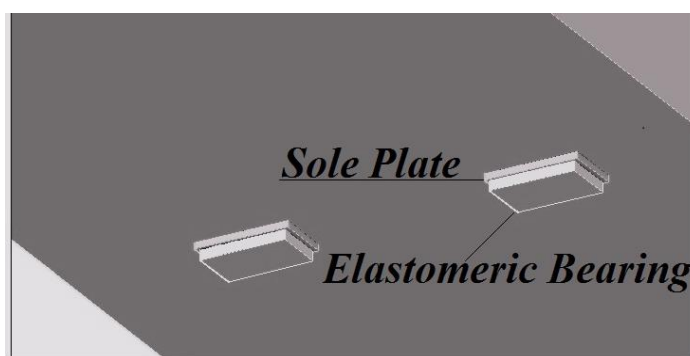
Fig. 1)   Schematic of Elastomeric bearing pads underneath box girder bridges deck

Recently, pre-stressed concrete box girder bridges constructed with free cantilever method have been used in many places [11]. Two methods could be utilized for construction in cantilever method: a single cantilever method and a double cantilever method which is also called balanced cantilever method [11]. In the balanced cantilever method the deck advances from top of a pier symmetrically to the mid spans or an abutment. Cantilever decks are incorporated by implementation of a key segment and post-tensioning tendons at the middle of span [11]. Duration of construction phase for the deck of this type of bridges regarding segmental implementation may last a relatively long time (Fig. 2). Earthquake occurrence at implementation of these bridges deck could be considered substantially in high risk seismic zones. Cantilever position of decks located at right and left sides of a midst pile could induce decks to be more vulnerable against seismic loads. As mentioned before the decks will be integrated by installation of key segment at the middle of each span. Amounts and distribution of seismic loads in incomplete structures are different before the installation of key segment in comparison to operational structures in service phase. Consequently, evaluation of seismic loads in this bridges deck during construction phase (by considering their vulnerable position in cantilever state) seems to be important and necessary. In this study it has been tried to examine these loads in a practical case in northern Iran (Fig. 3). Factors of Safety (FoS) in horizontal and longitudinal seismic states have been computed and at the end based on results

obtained from FoS has emphasized the necessity of more attention to friction coefficient efficiency between elastomeric bearing pad and both concrete and sole plates.

Fig. 2)   Box bridge implemented by balanced cantilever method (Photo by J. Razzaghi)

2   INTRODUCTION OF BRIDGE STRUCTURE

The pre-stressed concrete box girder bridge studied in this research has been made by balanced cantilever method and cast-in-place segments (Fig. 4). The bridge has four spans as shown in Fig. 3.
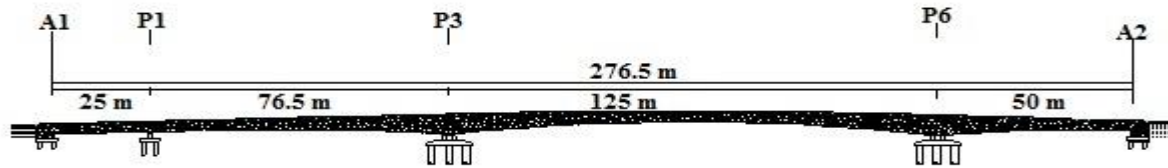
Fig. 3)   Longitudinal diagram of the bridge

In Fig. 4 the deck located over mid-support P3 before installation of closure segments has been shown. The number of box segments in each right and left sides of pile before assembling key segments in the middle of spans is equal to 14.
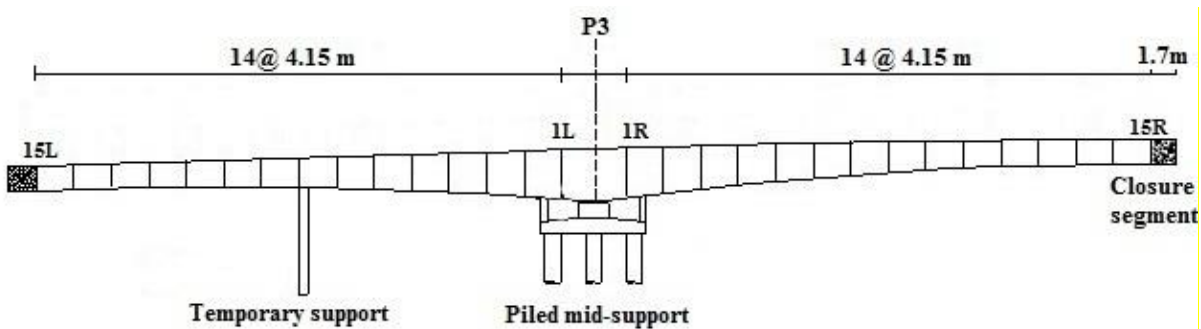
Fig. 4)   Pile P3 with 14 box segments in each left and right sides of pile (in meter unit)

General cross-section and geometric specifications of the bridge segments have been shown in Fig. 5 and Table 1, respectively.
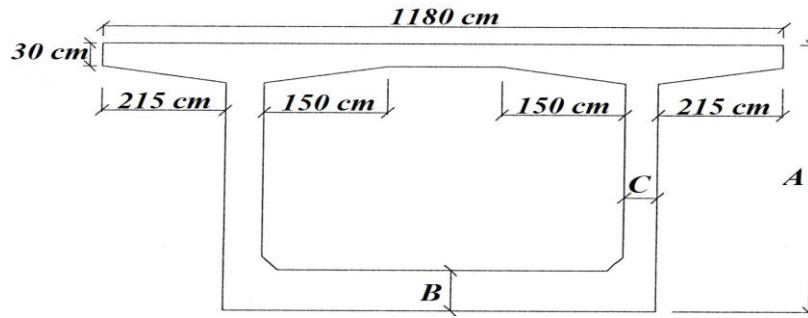
Fig. 5)   General cross section of the bridge segments

Tab. 1)   Geometric specifications of bridge segments

Section position	A(m)	B(m)	C(m)
1R,1L	6.18	0.8	0.65
2R,2L	5.88	0.7	0.5
3R,3L	5.57	0.5	0.5
4R,4L	5.24	0.45	0.5
5R,5L	4.94	0.35	0.5
6R,6L	4.67	0.3	0.5
7R,7L	4.42	0.3	0.5
8R,8L	4.21	0.3	0.5
9R,9L	4.02	0.3	0.5
10R,10L	3.86	0.3	0.5
11R,11L	3.73	0.3	0.5
12R,12L	3.63	0.3	0.5
13R,13L	3.5	0.3	0.5
14R,14L	3.5	0.3	0.5
15R,15L	3.5	0.3	0.5

3   MATERIAL SPECIFICATIONS AND SOFTWARE USED FOR MODELLING AND ANALYSIS

Ultimate resistance for each one of strings in pre-stress cables used in the bridge is equal to 260 kN. Consequently, ultimate resistance of each twelve strings cable will be equal to 3120 kN. Pre-stress force for each cable by considering implementation plans is assumed to 75% of ultimate resistance. f_{cu} (28-days compressive strength of concrete used in deck) is equal to 40 N/mm^2. Structural modelling of the bridge was carried out using SAP 2000 program. [12,13]

4   STABILITY EXAMINATION OF THE DECK OVER THE ELASTOMERIC BEARING PAD UNDER HORIZONTAL EARTHQUAKE

4.1   Fundamental period of vibration of the bridge structure

For analysis of internal horizontal seismic forces induced in a cantilever deck before installation of key segment, fundamental period of vibration for cantilever deck will be computed at first. If X_1, X_2, ... , X_n refer to displacements induced from the weight of segments concentrated masses and the displacements remain in an elastic range, the

fundamental period of vibration for the deck will be computed by considering Eq. (1). [14, 15]

$$T = 2\pi\sqrt{\frac{\sum p_i x_i^2}{g \sum p_i x_i}}$$

(1)

Where Pi is the weight of each segment based on ton unit, Xi displacement induced from segments weight based on m unit, and g is gravity based on m/s^2 unit.

In Fig. 6 displacements induced from segments weight in cantilever deck have been shown.
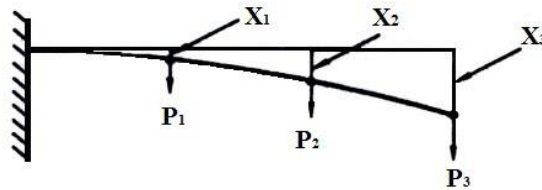
Fig. 6)   Displacements induced from segments weight in a cantilever deck
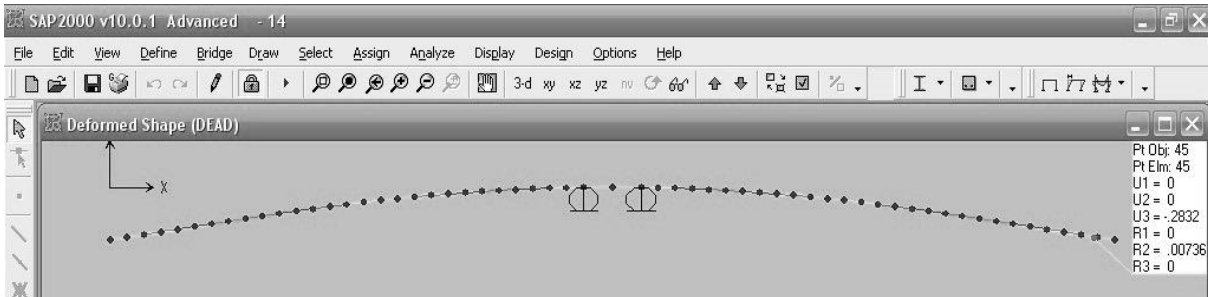
Fig. 7)   Displacements induced from Dead loads (segments weight) before installation of closure segment

Finally, based on displacements concluded from Sap modelling as shown in Fig. 7 and by considering equation (1) T the fundamental period of vibration for the bridge cantilever deck will be equal to 0.85 s.

4.2   Computation of static forces for modifying dynamic forces in horizontal seismic loads

Seismic coefficient method modified by structural response is one of the methods which could be utilized for computation of static elastic seismic forces. [16]

Spectral constant B regarding the soil coefficient and seismic zone is computed by considering Eq. (2) and Eq. (3). [17, 18]

$$If\ 0 \leq T \leq 0.15 \Rightarrow B = 1 + \frac{1.75 \times T}{0.15}$$

(2)

$$If\ 0.15 \leq T \leq 1 \Rightarrow B = 1.75 + 1$$

(3)

Consequently, based on $T = 0.85$ s and considering Eq. (3), B coefficient will be equal to 2.75. Eventually, seismic coefficient C will be calculated based on Eq. (4).

$$C = \frac{ABI}{R} \qquad (4)$$

Where *A* peak ground acceleration by considering the zone with high risk is equal to 0.3, *B* Spectral constant as computed is equal to 2.75, *I* importance coefficient regarding the medium importance of structure is equal to 1 and *R* response modification factor regarding the cantilever coefficient of deck is equal to 4. [15]

Finally by considering Eq. (5) and C computed from Eq. (4), base static shear force at conjunction point of deck and superstructure located on the pile will be computed with the aim of assimilation of dynamic and static shear forces.

$$V = C \times W \qquad (5)$$

Where *V* is base static shear force and *C* is seismic coefficient and *W* is the weight of deck segments located in each side.

4.3   Computation of dynamic seismic forces under horizontal seismic loads

For applying dynamic analysis by Sap2000 software, modal spectral analysis method has been selected [12],[19]. Spectral constant *B* considering the soil coefficient and seismic zone (Saturated cohesive soils and high risk seismic zone) which has been computed in chapter 4.2 will be introduced to the program firstly. After the first dynamic analysis of the program, the coefficient *AI/R* introduced to the program will be modified with the ratio of base static shear force to the dynamic one with the aim of assimilation of base shear forces in both static and dynamic analyses (usually base shear force in static analysis is more than dynamic one). In Fig. 8 internal dynamic forces under horizontal seismic loads after assimilation with static shear force have been shown.
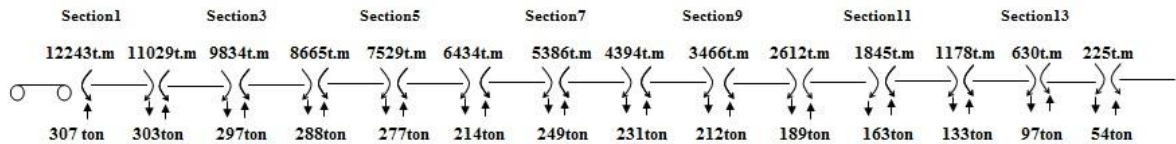
Fig. 8)   Internal dynamic forces under horizontal seismic loads

Based on shear force 3070 kN resulted from horizontal seismic loads at section 1 in Fig. 8 and on the basis of structural symmetry of decks located in both right and left sides of the superstructure, the force applied on superstructure located over elastomeric bearing pad in horizontal direction could be considered as 6140 kN.

Consequently, the ratio of shear force between superstructure and elastomeric bearing pad to the all segments weight could be computed by considering Eq. (6).

$$\frac{6140kN}{32310kN} = 0.190 \cong 0.2 \qquad (6)$$

It could be concluded that due to high proximity of this ratio to the friction coefficient 0.2 between concrete and elastomeric bearing pad recommended by AASHTO code, slipping of

superstructure could be considered and addressed for more attention to this issue with the aim of prevention from the destruction of these structures under horizontal seismic loads.

5 STABILITY EXAMINATION OF BRIDGE DECK OVER ELASTOMERIC BEARING PAD UNDER LONGITUDINAL SEISMIC LOADS

It is obvious that there is no difference between incomplete decks in construction phase and complete decks in service phase in this type of bridges when compared under longitudinal earthquake effects. As a result, it is possible to utilize response modification factors *R* in complete structures of bridges, for computation of longitudinal seismic loads in construction phase which bridge deck is still incomplete (before installation key segment). Response modification factor R for conjunction area of superstructure and piles could be considered as amount 3. [18]

In Fig. 9 details of anchor bolts and some various methods to restrain beam displacements have been shown.
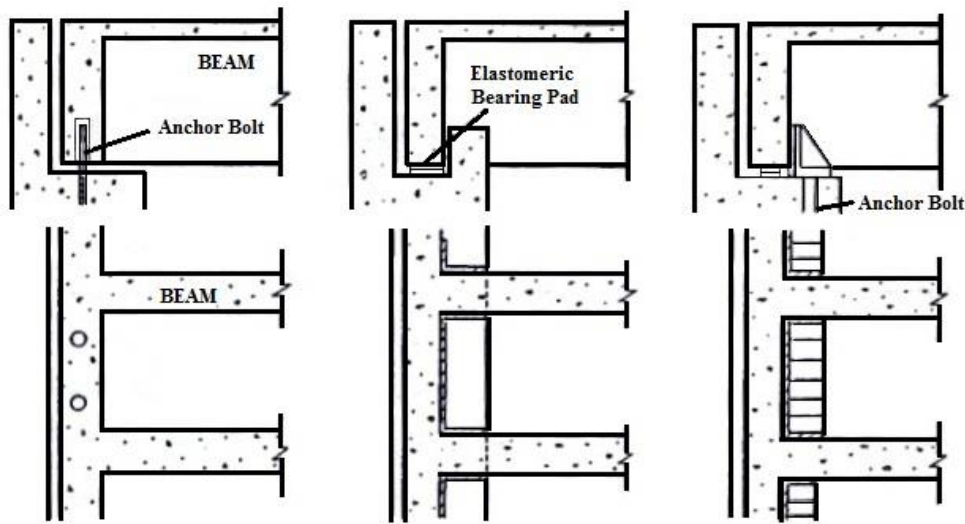
Fig. 9) Various methods for prevention from beams displacement

5.1 Computation of longitudinal seismic loads

Considering number and diameter of piles in piled mid-support P3 which are 9 and 180 cm respectively, following equations are used to compute longitudinal seismic loads.

Eq. (7) is used to compute *K* bending stiffness of piled mid-support P3.

$$K = \sum_{1}^{9} \frac{3EI_c}{h^3} \tag{7}$$

Where I_c is moment of inertia for each circle pile and *E* is modulus of elasticity for concrete used in piles which could be computed corresponding to Eq. (8) and Eq. (9) respectively.

$$I_c = \frac{\pi r^4}{4} \tag{8}$$

$$E = 5000 \sqrt{f'_c (N/mm^2)} = 316220 (kg/cm^2) \tag{9}$$

Consequently, by using Eq. (8) and Eq. (9) and 28-days compressive strength of concrete mentioned in chapter 3, bending stiffness of piled mid-support P3 could be calculated as $162.8 \times 10^5 (kg/cm)$.

Based on K computed and the weight of all segments in cantilever state, fundamental period of piles vibration will be calculated according to Eq. (10).

$$T = 2\pi \sqrt{\frac{m(kg)}{k(N/m)}} = 0.089 (s) \tag{10}$$

Where m the mass of both cantilever decks is equal to 32310 kN.

Using Eq. (2) and Eq. (4) spectral constant B and seismic coefficient C will be calculated as follows:

$$0 \leq T \leq 0.15 \Rightarrow B = 1 + 1.75(\frac{T}{0.15}) = 1 + 1.75(\frac{0.089}{0.15}) = 2.03 \tag{11}$$

$$C = \frac{ABI}{R} = \frac{0.3 \times 2.03 \times 1}{3} = 0.203 \tag{12}$$

Where A peak ground acceleration by considering the zone with high risk is equal to 0.3, I importance coefficient regarding the medium importance of structure is equal to 1 and R response modification factors regarding the chapter 5 is equal to 3.

By considering Eq. (5), F_{SH} shear force between elastomeric bearing pad and concrete caused by longitudinal seismic loads is equal to $0.203W$, where W is the weight of cantilever decks.

Static friction force between elastomer and concrete can be calculated as Eq. (13).

$$F_{SF} = F_N \times \Upsilon \tag{13}$$

Where F_{SF} is static friction force, F_N is normal force applied on surface of elastomer which is equal to the both decks weight in cantilever state and Υ is static friction coefficient between elastomeric bearing pad and concrete which will be considered as 0.2 according to AASHTO code´s recommendation.

Consequently, FoS (Factor of Safety) will be calculated corresponding to Eq. (14).

$$FoS = \frac{F_{SF}}{F_{SH}} = \frac{0.2W}{0.203W} = 0.985 \leq 1.0 \tag{14}$$

Based on results extracted (factor of safety less than 1), necessity of more attentions to this issue seems to be significant. Consequently, an increase in friction coefficient between elastomeric bearing pad and concrete can be concluded and be addressed for more researches and studies to prevent from the destruction of box girder bridges during construction phase under probable longitudinal earthquakes.

6   RESULTS

Results show that the ratios of static friction forces to the shear forces caused by horizontal and longitudinal earthquakes (FoS) at the contact surface of elastomeric bearing pad and concrete in construction phase are very close and even less than 1 amount. Consequently, by considering the probability of earthquake occurrence in this phase and factors of safety computed, the destruction of bridge structure under mentioned earthquakes will not be impossible and should be addressed for more researches and studies in the future to prevent from probable financial and physical costs induced by earthquakes.

7   CONCLUSION

ASSHTO code could be regarded as one of the most reliable regulations in design and construction for bridges. Consequently, attention to AASHTO´s instructions in construction phase could be considered as a crucial issue in order to prevent from bridge destruction and extra costs in this phase. Based on AASHTO code [1], there is no need to use of anchor bolts when friction coefficient between elastomeric bearing pad and concrete is more than 0.2. This study tried to analyse the friction coefficient efficiency recommended by AASHTO code with consideration of the static friction   forces-to-shear forces ratio at the contact surface of elastomric bearing pad and concrte during the construction phase in a balanced cantilever method. Analyses corresponding to the FoS computed showed that the friction coefficient recommended by the AASHTO code was not sufficient during the construction phase for balanced cantilever box girder bridges in particular for longitudinal seismic loads, and using the anchor bolts seems to be necessary for this kind of bridges to make them safer against various eathquakes.

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KNOWLEDGE MAP SUPPORTING MANAGEMENT IN CONSTRUCTION COMPANIES

Bożena Hoła[1], Andrzej Polak[2], Wiktor Gronowicz[3]

Abstract

The focus of the paper is to present the model of knowledge management for construction companies based on process approach. The authors observed, that in a number of construction companies in Poland, the knowledge obtained in the course of running the processes fades away with time. The main reason for this phenomenon is the turnover of the company personnel, including key experts of various aspects of the company business, and lack of regular recording and archiving of significant experiences acquired and events observed during the execution of company projects. The recording of such knowledge and experience will enable its analysis and the arrival at useful conclusions for the future.

The activity of each company consists of execution of processes. The application of the process approach to the management of a construction company significantly affects the improvement of its efficiency and competitiveness in the construction market. The knowledge map has been chosen as a method to develop a tool for knowledge acquisition in regard to the most important processes occurring in a construction firm during the execution of a construction project.

The following fields of knowledge, pertaining to a construction company, were taken into account: system and environment, assets and resources, processes, documents, completed and ongoing projects, analysis and corrections and lessons learned. A knowledge map can become a tool for recording experiences and potential innovations.

Key words

Construction company, knowledge management, knowledge map, process approach, quality management.

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1   INTRODUCTION

Each construction company, must possess essential knowledge needed to run its business. This knowledge is contained in documents, databases (explicit knowledge), but also in employees' minds (tacit knowledge) [1]. The level of knowledge and its range are constantly changing in the course of running the business. On one hand, knowledge is developed and enriched with new experiences. On the other hand, some elements of knowledge naturally disappear because they are not recorded anywhere.

The subject of this paper is knowledge management in a construction company. In many construction firms the knowledge, acquired during the course of a project, fades away with time. The main reason for this phenomenon is the turnover of the company personnel including key experts of various aspects of the company business, and lack of regular recording and archiving of significant experiences acquired and events observed during the execution of company projects. The recording of such knowledge and experience will enable its analysis and the arrival at useful conclusions for the future. A knowledge map can become a tool for recording of experiences and potential innovations.

The remainder of this paper presents a Knowledge Map based on the process approach. In order to identify the processes that occur in construction companies and the structure of Knowledge Map a comprehensive survey of over 200 Polish construction firms was completed. The survey was sent by e-mail and the part of them were carried out direct by visiting the company. The authors describe a prototypical computer program under development, its application supporting the company's executive management staff allowing for the accumulation of knowledge, and its implementation in the firm for which they are responsible.

2   PROCESS APPROACH IN CONSTRUCTION COMPANY MANAGEMENT

The process approach is one of the most popular trends in construction project and business management [2,3]. The numerous studies show, that the application of the process approach to the management of a construction company significantly affects the improvement of its efficiency and competitiveness in the construction market [4, 5, 6, 7, 8].

The process approach is defined for the industry by PN-EN ISO 9001:2008 "Quality Management Systems – Requirements" standard [9]. According to this standard "the desired result is achieved more efficiently when activities and their related resources are managed as a process." The essence of the process approach is a presentation of all duties performed by laborers on a construction site and corporate office employees as processes, and constant focus on and improvement of the processes.

A mathematical model of the processes assessment was developed. This model is used in the Knowledge Map to assess the processes, which can occur in the company.

2.1   Mathematical model of process approach

According to the PN-ISO 10006:2005 "Quality management systems; Guidelines for quality in the management in projects" standard [10], the "process" is defined as a set of mutually connected resources and activities which transform an input state to an output state". The activity of each company is to accomplish a specific set of processes

$$ZP = \{P_i; i = 1,...,n\}, \tag{1}$$

where:

    ZP - set of completed processes,

    P_i - single process i.

In this set one can distinguish the following processes: the main processes related to the main actiivity of a company and the supporting processes serving the subordinate part to the main processes.

Operations are elementary parts of a process. They cover the whole of all actions performed (without a pause) in a specific workplace by a particular employee or a group of employees. Among the operations there are relationships of technological sequence.

$$P_i = \{O_j : j = 1,....,k\}, \tag{2}$$

$$O_1 \prec O_2 \prec ..... \prec O_j \prec .... \prec O_k \tag{3}$$

where:

O_j - operation j done in process P_i

Each operation O_j can be described by a vector of attributes:

$$O_j = \begin{bmatrix} a_{1,j} & a_{2,j} & . & .. & a_{l,j} & .. & .. & a_{m,j} \end{bmatrix}, \quad l = 1,.....,m, \tag{4}$$

where:

$a_{l,j}$ - attribute l in operaton j.

If in the process is completed k different operations and each of them describes m different attributes so to each process P_i corresponds the set of information associated with this process, which can be written in the form of two-dimensional data matrix, $P_i = [a_{l,j}]$ $i = 1,...,n$

$$P_i = \begin{bmatrix} a_{1,1} & ... & a_{l,1} & ... & a_{m,1} \\ a_{1,2} & ... & a_{l,2} & ... & a_{m,2} \\ ... & ... & ... & ... & ... \\ a_{1,j} & ... & a_{l,j} & ... & a_{m,j} \\ ... & ... & ... & ... & ... \\ a_{1,k} & ... & a_{l,k} & ... & a_{m,k} \end{bmatrix}. \tag{5}$$

The implementation of the process approach makes sense only when a manager of a process or the entire system can estimate the processes and next can draw some conclusions for the future. Although the estimation is conducted in the retrospective context, but its results (and especially the drawn conclusions) are a guide to improve the future processes [11].

The proposed matrix notation enables the easy filtering of the descriptive and the numerical data relating to: the operations, the individual processes, the subsets and the set of processes. The attributes of operations are used to elaborate the various indicators of qualitative and

quantitative estimation of the processes and a company activity. They enable to take a decision of improvement of processes and whole company activity.

2.2 Classification of processes

In this paper processes are divided into three groups: the main processes, the supporting processes and the management processes [12].

- The main processes are related to the main activity of a company. They might arise from the character of company activity (e.g. production processes or service processes) or legislation (e.g. government department). It is assumed that they create value for a customer.
- The supporting processes are for the support for the main processes in their proper functioning. The supporting processes might concern: maintenance (e.g. machine repair, conservation, etc.), storage, transport and control.
- The management processes are related to the management/administration of a company and they are to monitor the operation of an entire company as well as to take appropriate actions to improve work organization. The management processes involve inventorying, financial settlements, business plan development, training, work safety management, improvement of management, and others.

$$ZP_i = MP \cup SP \cup MNP , \tag{7}$$

where:

MP - The main/primary processes, including the processes of project planning (PP), project design (PD), and project execution (PE).

SP - The supporting processes, including the processes focused on materials delivery area (DA) and project inspection and testing area (PIT).

MNP - The management processes, including the processes of personnel management (P), financial management (F), risk management (R), general administration (GA), and tactical supervision of company operations (TS).

3   RANGE OF KNOWLED COVERD BY KNOWLEDGE MAP

A company can be regarded as a system operating in a given environment. The production, supporting, and management processes are the results of the functioning of such a system. In order to accomplish the processes, tangible resources are needed including people, materials and equipment, as well as intangible resources such as intellectual property in the form of technical know-how/ trade secrets, patents, trademarks or copyrights. The knowledge required for the realization of company processes has to be documented. The records of the completed processes (which are the evidence of the management decisions taken by the company) are created during the execution of each process. The undertaking of construction work is associated with various hazards and risks. The assessment of completed processes, personnel employed, design service providers, subcontractors and suppliers, as well as the entire projects is essential for the proper functioning and growth of a construction company. The results of these assessments have an impact on the company growth decisions concerning innovation and possible organizational changes. Change and innovation are the most important factors for the company growth. These observations form the basis for the classification of knowledge related to a company [13, 14, 15].

4 STRUCTURE OF KNOWLEDGE MAP

Based on the surveys and literature [16, 17, 12], the structure of the Knowledge Map was developed. The proposed Knowledge Map consists of seven domains of knowledge which are significant for the proper management of a construction company. These domains are shown in Figure 1.

1 System and environment	2 Assets and resources	3 Processes	4 Documents	5 Completed and Ongoing Projects	6 Analysis and correction	7 Lessons Learned
1.1 Scope of activity	2.1 Human resources	3.1 Main processes	4.1 Internal documents	5.1 Defined tasks	6.1 Assessments	7.1 Development activities
1.2 Aim of activity	2.2 Buildings and installations	3.2 Supporting processes	4.2 External documents	5.2 Planned tasks	6.2 Complaints	7.2 Innovations
1.3 Organizational structure	2.3 Technical means of production	3.3 Management processes	4.3 Control of documents	5.3 Tasks in progress	6.3. Corrective activities	7.3 Changes

Fig. 1) Knowledge Map structure with knowledge domain classification

4.1 System and environment

The first domain of knowledge, defined as System and Environment, is used to identify a construction company and its business environment. This domain contains knowledge about the field of business activity, the organizational structure of the company, government departments and organizations with whom cooperation is either required by applicable laws and regulations or by the nature of business or technology employed.

4.2 Assets and resources

The second domain of knowledge contains information about assets and resources at the disposal of a construction company. This domain is used to identify the tangible and intangible resources of the company. The tangible resources include personnel, owned equipment and tools, as well as real estate. The intangible resources include intellectual property such as trade secrets, patents, trademarks and copyrights.

4.3 Processes

The next two domains of knowledge contain business knowledge and experience related either to the execution of construction projects or related to applicable legislation, including design codes and technical standards, which are enforced, as well as the construction know-how. The domain processes consist of the applicable processes identified from the completed surveys of the construction firms. This set of processes was divided into three subsets, i.e. the main processes, the supporting processes and the management processes. The elaboration of individual process procedures follows the requirements of the PN-EN ISO 9001:2008 "Quality Management Systems – Requirements" standard.

4.4 Documents

The explicit knowledge about a construction company should be contained in the existing documentation. The "Documents" domain of knowledge was divided into three subsets. The

first is formed by the internal documents created within a construction company and includes work orders and instructions, daily reports, meeting minutes, and other supporting documentation. The second subset contains external documents required by laws and regulations such as: legal acts and decrees, design codes and applicable standards. The third subset, "Control of documents," specifies the people responsible for creating, supervision, approvals and storage of the documents. In this domain of knowledge, a user of the Knowledge Map will also find the forms and formats of the typical documents found in a construction company, as well as hyperlinks to the websites from where one can download the currently applicable laws and forms. Figure 2 shows an example of an integrated database of documents.
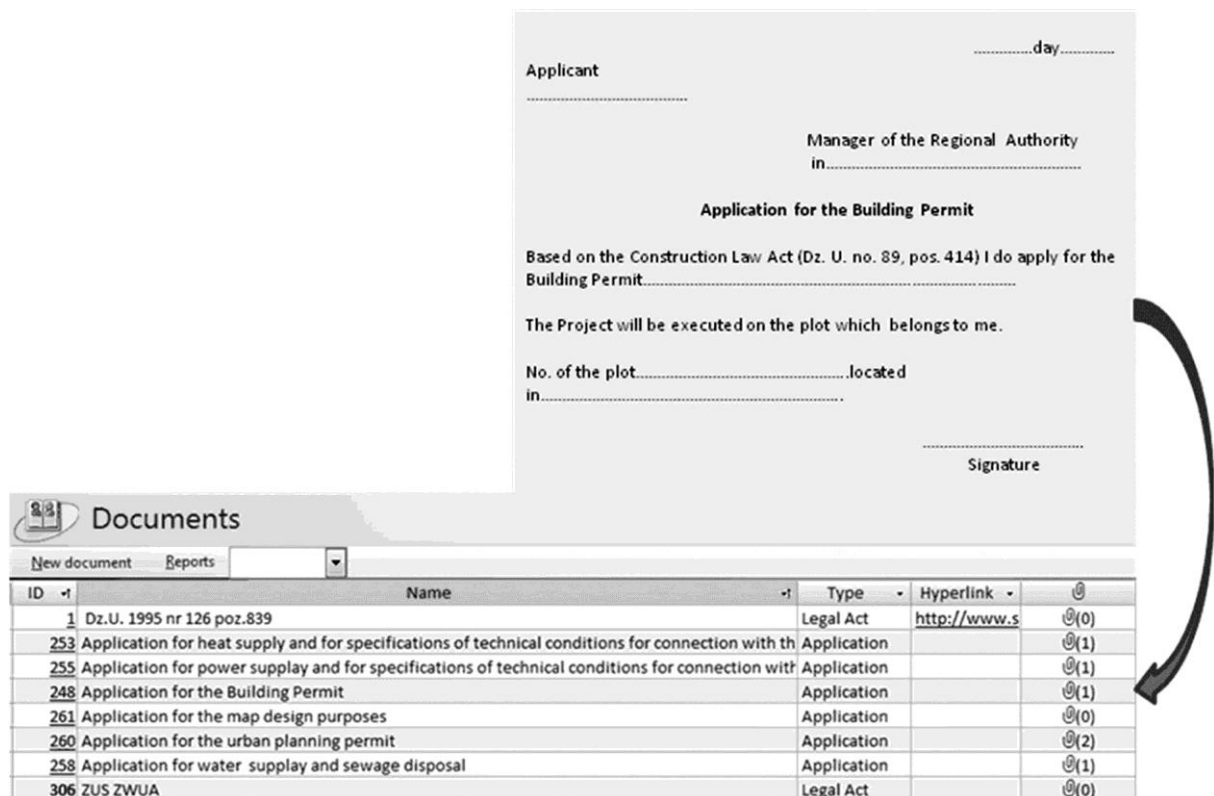
Fig. 2)   Example of intergrated database of documents

4.5   Completed and Ongoing Projects

The "Completed and Ongoing Projects" domain of knowledge features a dynamic character of the Knowledge Map. In this domain the user will find information about the completed projects or ongoing site work, or about projects still in the planning or design phases. Using the questions contained in the "Defined Tasks" subset, the user can group the processes for each construction project of interest. A set of processes related to a specific contract can be derived from the process grouping. The required documents and the range of personnel responsibilities involved in a project are automatically generated together with the process.

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4.6   Analyses and Corrections

Monitoring and assessment of risks associated with business activities are required in quality management systems. The following components are included in the "Analyses and Corrections" domain of knowledge: assessment of risk, assessments of processes, staff and suppliers as well as complaints from internal and external customers together with corrective actions taken. The element labeled "Risk" contains the assessment of risk associated with the production quality, work conditions, environmental protection and financing. The element labeled "Assessments" includes the methodology of assessments of the completed processes, as well as of the project personnel and suppliers. A 5-stage scoring scale has been proposed. Information concerning the lodged complaints, which forms the basis for revisions in service quality and business management, is very important for proper functioning of a construction company in a competitive market. Figure 3 shows an example of process assessment.

4.7   Lessons Learned

The last but equally important domain of knowledge, detailed in knowledge map, concerns the "lessons learned." The Lessons Learned domain records business process improvements resulting from the completion of a construction project, individual and collective experience, implementation of employees' ideas, applications of product or process improvements, other innovations and changes resulting from them. The contents of Lessons Learned, identified and recorded on the knowledge map, decide whether the user deals with a knowledge management system, or merely an information management system. This distinction comes from one of the definitions of knowledge specifying it as the combination of information with experience, interpretation and inference [18]. For this purpose information is defined as organized data and presented in text form, in graphic figures or with numbers. On the basis of information available it is possible to formulate conclusions and predictions. As far as information has a descriptive and historical character, knowledge concerns future events. It can be concluded that identification and recording of the Lessons Learned contents (innovations and changes) is a condition for the existence of a knowledge management system. This condition can be satisfied by the proposed Knowledge Map.

5   CONCLUSION

The proposed Knowledge Map is a computer-based implementation supporting a wide array of management processes in a construction company. All activities performed by company employees were presented in the form of processes. In order to identify the processes that occur in construction companies, a comprehensive survey of over 200 Polish construction firms was completed. Based on the survey, the most important company management processes were compiled. Subsequently, audits were conducted in the selected construction companies with the aim to identify the domains of knowledge which are significant in the management of a construction company and which should be included in the Knowledge Map.

The following domains of knowledge for a construction company were identified: system and environment, assets and resources, processes, construction projects, documents, analyses and conclusions, and lessons learned.
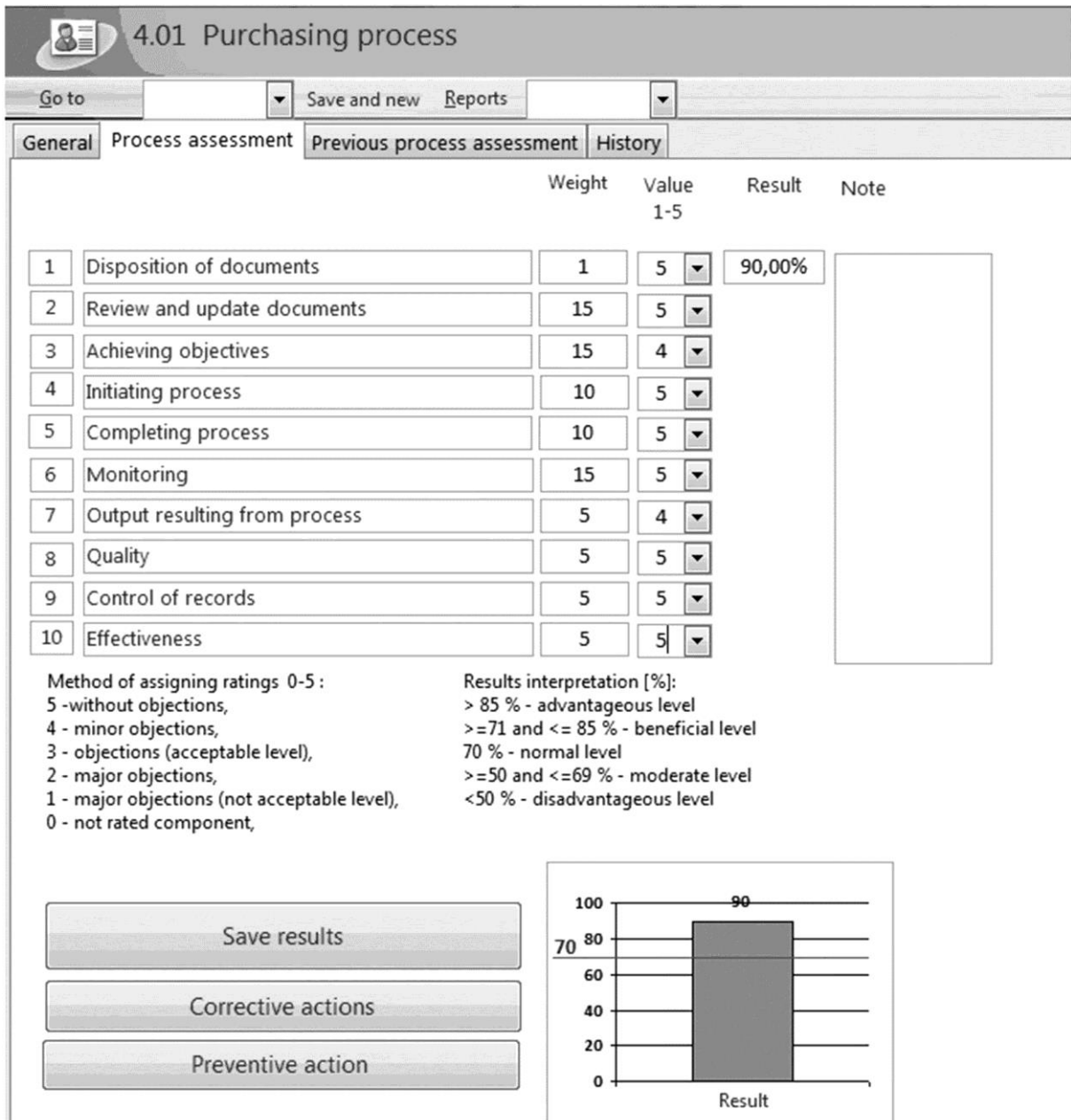
Fig. 3)　　Example of process assessment

Acknowledgement

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COMPUTER SIMULATION AND NOISE MITIGATION ON CONSTRUCTION SITES AND IN THEIR SURROUNDINGS

Václav Hrazdil[1]

Abstract

Construction sites depending on machinery and vehicles are important sources of noise. Corrective measures consist in an appropriate deployment of site equipment including the use of noise barriers. Commonly used calculations of sound pressure levels at different distances from the sources of noise are usually difficult. For this reason the submitted article showes the possibility of using a computer program for noise modelling. Important role of the software modelling is documented by the acoustic study of a constrcution site at the stage of earthworks.

Key words

Noise pollution, noise reflection of facades, protected outdoor space, public health authorities, sound pressure level.

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1   INTRODUCTION

Estimation of acoustic levels caused by noise sources on a construction site is important for determining the noise in the workplace and its surrounding. Hygienic limits for workplaces, protected interior spaces of buildings and protected outdoor spaces are laid down by the new Government Regulation of the Czech Republic no. 272/2011 Coll. [1] and standard [2]. Noise adversely affects not only the health of employees on building site, but also people living in its surrounding. As to the occupational safety at work, Suter in [3] evaluates effects of noise exposure on construction sites and the suitability of different personal protective equipment.

Propagation of construction noise in the surrounding urbanized area is significantly influenced by the surface properties of objects and areas (reflective or absorptive). See [4] and [5]. The effect of noise attenuation may decrease with deployment of buildings along a street. There is a concentration of acoustic waves due to reflections on the façades of objects. The features of buildings have significant influence, especially the properties of reflective surfaces near the noise source.

Acoustic situation on building sites needs to be evaluated by complicated procedures in accordance to the phases of construction progress and thus in various conditions for noise spreading: decrease of noise in ideal conditions for the calculation - flat terrain; decrease of noise in a hilly terrain (taking over configuration of terrain into the calculation); dislocation of temporary buildings, equipment and noise barriers on construction; emitted noise of machines in solved building stages. See [6].

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2   MEASURES TAKEN TO REDUCE CONSTRUCTION NOISE

Reducing noise from a technical standpoint, we are dealing with:

- Measures in the noise sources, i.e. active measures
- Measures on the way of noise propagation, i.e. passive measures (for instance Fig. 1, see [8])
- On construction sites - with personal protective equipment, this solution can be realized only in the workplaces
- In neighbouring buildings - increasing sound reduction indexes of windows and balcony doors in order to meet exposure limits in protected interior spaces of buildings

In protecting the environment from the construction site noise, active and passive noise abatement measures should be applied. If a construction project is examined in the EIA study (Environmental Impact Analysis according to the Act no. 100/2001 Coll., "on the assessment of environmental impact" as amended), the noise assessment for construction and operation phases can be an important part of this documentation (Fig. 2).

Noise reducing in course of construction phases requires an appropriate strategy and measures of contractors including quantification of such costs. Thalheimer in [9] discusses the construction noise control and mitigation strategy on a large transportation construction.

Fig. 1)   Noise barrier as a specific part of the fence of a construction site

In order to assess the spread of noise from construction sites into interior of surrounding buildings, it is necessary to determine the noise level close to the façades. Knowing the acoustic properties of building envelopes, especially glazed surfaces, we can assess whether hygienic acoustic limits in different protected interior spaces are met.

For this reason, noise study requires the calculations of sound spreading in a chosen zone, which includes the construction site and surrounding terrain, buildings, vegetation, and other obstacles to sound propagation. Our institute is engaged in elaborating construction noise studies. The solutions consist in the use of software "HLUK+" [10].

The numerical method ensures the accuracy of calculation with the fineness of the triangular gird in the examined area.

The zone of calculation: point sources of noise on the site – earthmoving machines, drilling rigs, - compact construction site fence (location of the site in the lower half of the image), and adjacent service road. To the north of the site is a residential building.

In addition, the software enables the calculation of sound intensity levels at specified points (Tab. 1). The calculation points are located in the vertical at the distance of 2 m from the façade of assessed building to the southwest. The heights of points above ground correspond to the heights of windows on chosen floors.

Main parameters of calculation of the sources of noise: drilling rig for deep foundation – emitted noise: 90 dB (3 sources); excavator – emitted noise: 75 dB (3 sources). The height of compact site fence is 2.5 m. Traffic intensity on local road past the construction site per day (all cars / trucks): 150/40.
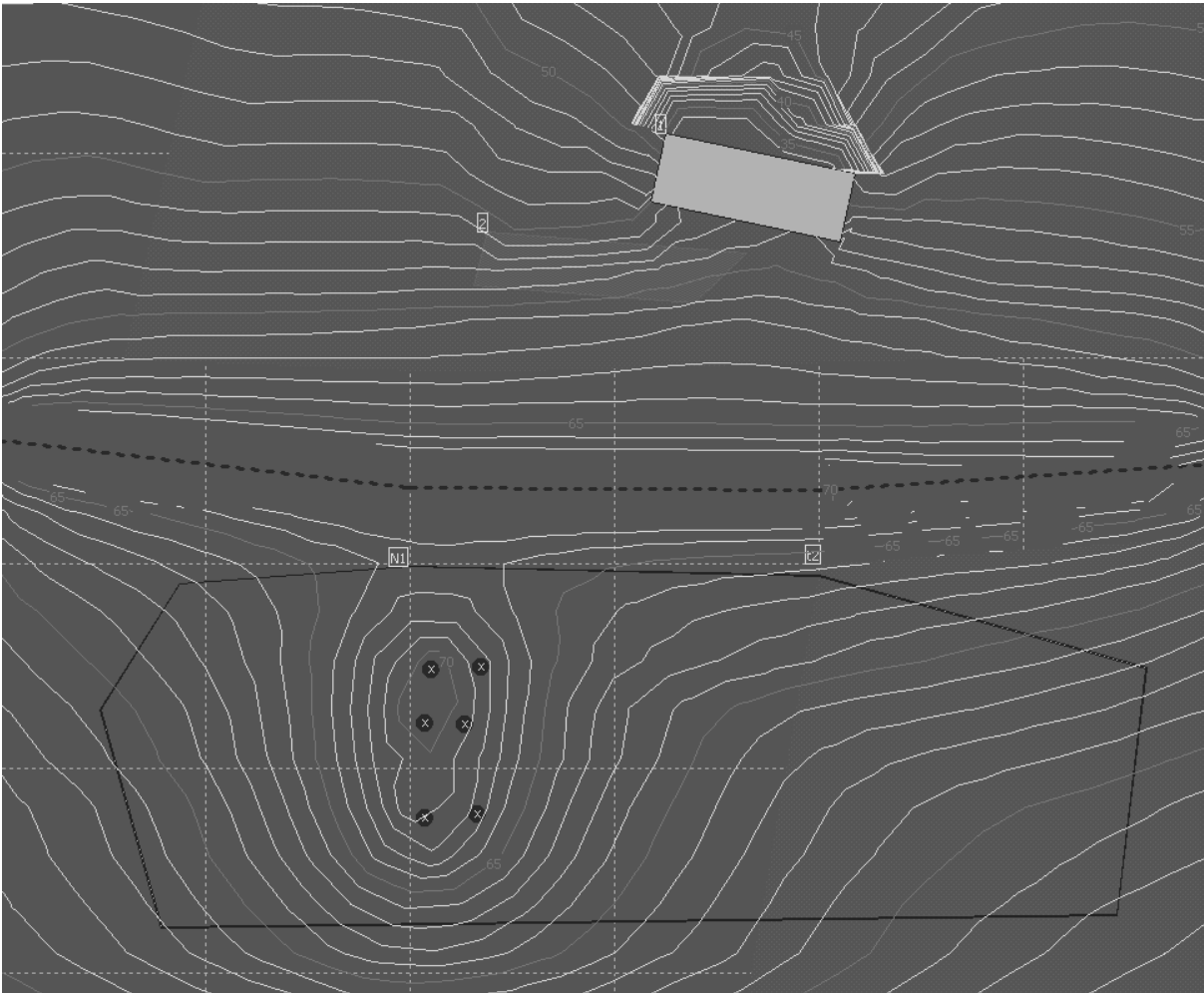
Fig. 2) Noise isophones - comprehensive solution of the construction noise study in the zone occupying the construction site and the surrounding area in the process of excavation

Tab. 1) Calculation points – equivalent sound pressure level A from traffic $L_{Aeq,16}$ and machines on construction site $L_{Aeq,S}$

Location of point – floor	Traffic dB	Excavation, foundations dB	Total dB
Ground floor	59.8	42.3	59.8
First floor	59.4	49.9	59.8
Second floor	60.7	52.0	61.2

The presented noise isophones were determined on the level of the second floor of the existing building.

2.1 Active measures to reduce noise on construction sites

Active organizational and technical precautions include in particular:

- efficient design of temporary roads of construction site and supply routs
- in innovation of machinery purchasing construction equipment and machines with low noise, high reliability and operating live

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- according to the conditions of a site the selection of machinery with optimum performance, right planning of construction phases
- on construction sites in exposed areas of city centres to work only with selected mechanisms in the first half of their life

The formula (1) enables the right deployment and the use of greater number of construction machines in certain phases of a building progress. The condition for application of the formula is the work of machines concentrated at one place of construction site and approximately the same character of noise emissions of these machines, as to the frequency.

$$L_r = 10 \log_{10} \left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + ... + 10^{\frac{L_n}{10}} \right), \tag{1}$$

where

L_r ...resulting noise level at the place of sources in dB (A),

$L_1, L_2, ... L_n$ ...noise sources in dB (A).

2.2 Passive measures to reduce noise on construction site

The method is based on the use of effect of barrier placed between source of noise and the area in which it is necessary to reduce noise. Acoustically effective barrier can be created:

- by using natural or artificially created mounds that block out the noise source from protected area
- the implementation of noise barriers – soundproof curtains or suitable types of fence of construction site
- the dislocation of noise source in a suitable space such as acoustic enclosure or shelter

3 CALCULATION OF NOISE LEVELS ON CONSTRUCTION SITES IN EXPOSED AREAS OF CITY CENTRES

The need for modelling noise levels by means of software, which provides sufficient accuracy (uncertainty in the calculation of the maximum level of 3 dB), illustrates the construction site in the area of St. Anne's University Hospital in Brno (Fig. 3). Recently, the number of renovation work is carried out within hospital premises in the Czech Republic as well as construction of new hospital pavilions.

The implementation of the large investment project of the International Clinical Research Centre (ICRC) in the University Hospital in Brno required special attention because of noise, which was mainly emitted during the construction of new pavilions basements.

In terms of noise, construction technology stages of earthwork and deep foundation of implemented buildings were considered as the most difficult. Carrying out of such works requires the presence of heavy machinery on construction sites.

The more detailed description of the solution of site preparation and construction phasing from the point of view of work organizing and occupational safety and health at work provides publication [11].

Fig. 3)   Special foundation – underground walls of ICRC basement

4   CONCLUSION

This paper offers information on measures taken for the mitigation of dangerous impacts of construction noise on human health. There are defined active and passive measures taken by the production of construction to eliminate its adverse effects.

Variants of corrective measures for certain constructions must be supported by calculation of noise levels.

Given the extent and complexity of the input data, the accuracy of calculation can be only ensured by means of computer with appropriate software.

In the paper presented software allows to assess the effectiveness of the proposed measures for the implementation phases of construction.

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SUPPORT OF "GREEN" ENERGY IN THE CZECH REPUBLIC

Vít Hromádka[1], Jana Korytárová[2], Eva Vítková[3]

Abstract

Production of "green" energy in the Czech Republic is at this time very discussed issue. In last years it has been supported number of kinds of "green" energy, e.g. small hydroelectric power stations, biomass, biogas, landfill gas, wind energy plants and geothermal energy plants. This paper deals with support of solar energy plants in the Czech Republic. Authors describe possibilities of financial support of solar energy and they focus on the financial efficiency of the realization of solar energy plants on family houses respecting used financial support, way of financing and time of realization. Solved themes are demonstrated on practical examples taking into account the way of financial support (green bonuses, guarantied prices), utilization of external financial resources and year of the realization of the project. There is described the development of the economic efficiency of realized projects in time arising because of changes in unit support represented by "green bonuses" and "guaranteed prices" of produced "green" energy.

Key words

Economic efficiency, financial support, green bonuses, "green" energy, price.

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1 SUPPORT OF „GREEN" ENERGY IN THE CZECH REPUBLIC

Important recent phenomenon in the European Union and in the Czech Republic as well is the production and use of electricity from renewable sources. It is called "green" energy because of the low impact of its production on environment. It is possible to use several possibilities. It concerns mainly about:

- small hydroelectric power stations,
- biomass,
- biogas,
- landfill gas,
- wind energy plants,
- solar energy plants,
- geothermal energy plants.

The production of "green" energy is in the Czech Republic supported with system of specific tools, which can make some investment projects in this area very efficient. For all above mentioned resources can be currently used system of guaranteed purchase prices of electricity or green bonuses.

This paper is focused on valuation of the general efficiency of projects of solar power plants respecting the development of conditions during the last years. Development of the support of the solar energy production is shown on the case study. [1]

2 ECONOMY OF SOLAR ENERGY IN THE CZECH REPUBLIC

For the governmental financial support of the production of solar energy it is generally possible to use the principle of:

- guaranteed purchase prices of electricity,
- green bonuses.

Guaranteed purchase prices of electricity are defined in the act no. 180/05 Coll., which implies an obligation for the transmission (or distribution) system to connect photovoltaic system to the transmission system and all the electricity to ransom. Purchase price is defined for year of installation by the Energy Regulatory Office and the price will be paid as a minimum for the next 15 years.

The second possibility is utilization of green bonuses. Green bonuses can be defined as amount of money increasing the market price of electricity, which takes into account the reduced damage to the environment by using renewable resources. It is applied to electricity supplied and metered at the delivery point and supplied by the manufacturer to the customer. It can be also applied for other manufacturer's own consumption of electricity with the exception off own use for technology to operate solar power plants. [2], [3]

Big changes in revenues from the sale of solar energy are caused by taxes. First, incomes from the sale of solar energy, considered as the renewable source of energy, were freed from the income tax. This exemption was cancelled in 2010, so from the year 2011 it is necessary to pay the income tax from all incomes from the sale of the solar energy. [4]

Moreover it was defined by government the special "solar" tax 26 % intended for big solar power plants on fields with the installed output bigger than 30 kW. It is connected only with power plants put into operation in 2009 and 2010.

3   CASE STUDY

The case study is focused on the comparison of possible ways of the financial assurance of the production of the solar energy. The output of the case study is the comparison of net present values of particular variants of the financial assurance, which are by the authors considered as criterions of the economic efficiency. [5], [6], [7]

The subject of the case study is following situation. The owner of the house (physical person, income tax payer) is considering the implementation of the installation of solar power photovoltaic panels on the roof of a house in two alternatives of support:

- guaranteed purchase prices of electricity,
- green bonuses.

Fig. 1)   Solar power photovoltaic panels on the roof of a house [8]

The example of the family house with solar photovoltaic panels on the roof is shown on fig. 1. Input data used in the case study are defined in the table 1.

Tab. 1)   Input data for the case study

Installed output	5 kW
Energy production	5 000 kWh
Investment cost (IC)	360 000 CZK
Valuated time period	20 years
Discount rate	5 %
Operation costs (OC)	1,5 CZK/kWh
Selling price of electricity from grid	4,54 CZK/kWh
Guaranteed purchase price	6,16 CZK/kWh
Green bonus	5,08 CZK/kWh
Annual consumption of electric energy of investor	2 500 kWh

3.1   Variant I

Variant I is defined with following characteristics:

- the solar power plant was put into the operation in 2012,

- sale of all energy produced by solar power plant to the distribution network at the guaranteed price,
- calculation simply assumes that the purchase price will not be for the reporting period (20 years) changed.

Discounted cash flows and the final net present value of variant I is calculated in tab. 2. In the table there are defined investment costs (IC), unit purchase price (guaranteed purchase price) in CZK/kWh, revenues from the sale of energy, operation costs (OC), income tax 15 %, net cash flows (NCF), discount factor (DF), discounted net cash flows (DNCF) and cumulated discounted net cash flows (CDNCF). Financial values are in CZK.

Tab. 2)   Calculation of NPN – Variant I

Year	IC	Pur. price	Revenue	OC	Income tax	NCF	DF	DNCF	CDNCF
2012	360000	6,16	30800	7500	2772	-339472	1	-339472	-339472
2013		6,16	30800	7500	2772	20528	0,952	19550	-319922
2014		6,16	30800	7500	2772	20528	0,907	18620	-301302
2015		6,16	30800	7500	2772	20528	0,863	17733	-283569
2016		6,16	30800	7500	2772	20528	0,822	16888	-266681
2017		6,16	30800	7500	2772	20528	0,783	16084	-250597
2018		6,16	30800	7500	2772	20528	0,746	15318	-235278
2019		6,16	30800	7500	2772	20528	0,710	14589	-220689
2020		6,16	30800	7500	2772	20528	0,676	13894	-206795
2021		6,16	30800	7500	2772	20528	0,644	13233	-193563
2022		6,16	30800	7500	2772	20528	0,613	12602	-180960
2023		6,16	30800	7500	2772	20528	0,584	12002	-168958
2024		6,16	30800	7500	2772	20528	0,556	11431	-157527
2025		6,16	30800	7500	2772	20528	0,530	10886	-146641
2026		6,16	30800	7500	2772	20528	0,505	10368	-136273
2027		6,16	30800	7500	2772	20528	0,481	9874	-126398
2028		6,16	30800	7500	2772	20528	0,458	9404	-116994
2029		6,16	30800	7500	2772	20528	0,436	8956	-108038
2030		6,16	30800	7500	2772	20528	0,415	8530	-99508
2031		6,16	30800	7500	2772	20528	0,395	8124	-91385

3.2   Variant II

Variant II is defined with following characteristics:

- the solar power plant was put into the operation in 2012,
- assumes the use of electricity produced by solar power plant for own consumption of investor and the cashing of green bonuses for the electricity,
- variant does not simply supposes the sale of unused energy to the public network for the market price because of a complicated estimate the selling price,
- investor saves own consumption of energy, so the savings are considered a positive cash flow and included in the evaluation,
- simply it is assumed that the amount of green bonuses for the duration of the reporting period and even the selling price of electricity from the public network for this period will be constant.

Discounted cash flows and the final net present value of variant II is calculated in tab. 3. In the table there are defined investment costs (IC), the green bonus in CZK/kWh, revenues from

green bonuses, operation costs (OC), income tax 15 %, energy savings of investor, net cash flows (NCF), discount factor (DF), discounted net cash flows (DNCF) and cumulated discounted net cash flows (CDNCF). Financial values are in CZK.

Tab. 3)   Calculation of NPN – Variant II

Year	IC	Green bonus	Revenue	OC	Income tax	En. saving	NCF	DF	DNCF	CDNCF
2012	360000	5,08	25400	7500	2286	11350	-333036	1	-333 036	-333 036
2013		5,08	25400	7500	2286	11350	26964	0,9524	25 680	-307 356
2014		5,08	25400	7500	2286	11350	26964	0,9070	24 457	-282 899
2015		5,08	25400	7500	2286	11350	26964	0,8638	23 293	-259 606
2016		5,08	25400	7500	2286	11350	26964	0,8227	22 183	-237 423
2017		5,08	25400	7500	2286	11350	26964	0,7835	21 127	-216 296
2018		5,08	25400	7500	2286	11350	26964	0,7462	20 121	-196 175
2019		5,08	25400	7500	2286	11350	26964	0,7107	19 163	-177 012
2020		5,08	25400	7500	2286	11350	26964	0,6768	18 250	-158 762
2021		5,08	25400	7500	2286	11350	26964	0,6446	17 381	-141 381
2022		5,08	25400	7500	2286	11350	26964	0,6139	16 554	-124 827
2023		5,08	25400	7500	2286	11350	26964	0,5847	15 765	-109 062
2024		5,08	25400	7500	2286	11350	26964	0,5568	15 015	-94 047
2025		5,08	25400	7500	2286	11350	26964	0,5303	14 300	-79 748
2026		5,08	25400	7500	2286	11350	26964	0,5051	13 619	-66 129
2027		5,08	25400	7500	2286	11350	26964	0,4810	12 970	-53 159
2028		5,08	25400	7500	2286	11350	26964	0,4581	12 353	-40 806
2029		5,08	25400	7500	2286	11350	26964	0,4363	11 764	-29 042
2030		5,08	25400	7500	2286	11350	26964	0,4155	11 204	-17 838
2031		5,08	25400	7500	2286	11350	26964	0,3957	10 671	-7 167

3.3   Variant III

Variant III is defined with following characteristics:

- the solar power plant was put into the operation in 2012,
- use of green bonuses at bank loan financing,
- in substance corresponds with Variant II, the difference is that half of the investment costs will be financed by a bank loan, which has the following parameters:
  - bank loan   180 000 CZK,
  - maturity of loan   10 years,
  - interest rate   4 %,
  - way of repayments   constant annuity.

Discounted cash flows and the final net present value of variant III is calculated in tab. 4. In the table there are defined investment costs (IC), revenues from green bonuses, operation costs (OC), income tax 15 %, energy savings of investor, annual payment of the loan including interest, net cash flows (NCF), discount factor (DF), discounted net cash flows (DNCF) and cumulated discounted net cash flows (CDNCF). Financial values are in CZK.

Tab. 4)   Calculation of NPN – Variant III

Year	IC	Revenue	OC	Tax	Saving	Annuity	NCF	DF	DNCF	CDNCF
2012	180000	25400	7500	2286	11350	22192	-175228	1	-175 228	-175 228
2013		25400	7500	2286	11350	22192	4772	0,9524	4 544	-170 684
2014		25400	7500	2286	11350	22192	4772	0,9070	4 328	-166 356
2015		25400	7500	2286	11350	22192	4772	0,8638	4 122	-162 234
2016		25400	7500	2286	11350	22192	4772	0,8227	3 926	-158 308
2017		25400	7500	2286	11350	22192	4772	0,7835	3 739	-154 570
2018		25400	7500	2286	11350	22192	4772	0,7462	3 561	-151 009
2019		25400	7500	2286	11350	22192	4772	0,7107	3 391	-147 618
2020		25400	7500	2286	11350	22192	4772	0,6768	3 230	-144 388
2021		25400	7500	2286	11350	22192	4772	0,6446	3 076	-141 312
2022		25400	7500	2286	11350		26964	0,6139	16 554	-124 759
2023		25400	7500	2286	11350		26964	0,5847	15 765	-108 994
2024		25400	7500	2286	11350		26964	0,5568	15 015	-93 979
2025		25400	7500	2286	11350		26964	0,5303	14 300	-79 679
2026		25400	7500	2286	11350		26964	0,5051	13 619	-66 061
2027		25400	7500	2286	11350		26964	0,4810	12 970	-53 091
2028		25400	7500	2286	11350		26964	0,4581	12 353	-40 738
2029		25400	7500	2286	11350		26964	0,4363	11 764	-28 974
2030		25400	7500	2286	11350		26964	0,4155	11 204	-17 770
2031		25400	7500	2286	11350		26964	0,3957	10 671	-7 099

3.4   Variant IV

Variant IV is defined with following characteristics:

- the solar power plant was put into the operation in 2010,
- corresponds with Variant II (green bonuses),
- in the year 2010 revenues from production of solar energy were freed from the income tax.

Discounted cash flows and the final net present value of variant IV is calculated in tab. 5. In the table there are defined investment costs (IC), the green bonus in CZK/kWh, revenues from green bonuses, operation costs (OC), energy savings of investor, net cash flows (NCF), discount factor (DF), discounted net cash flows (DNCF) and cumulated discounted net cash flows (CDNCF). Financial values are in CZK.

4   CONCLUSION

In previous tables it is possible to see the development of cash-flows from the investment project in solar power plant realization in dependence on the variant of the financial support (guaranteed prices and green bonuses), way of financing and the data of putting of the solar plant into operation. The efficiency of the investment project is valuated with the index of net present value (NPV), which summarizes discounted future cash-flows of the project.

Tab. 5)   Calculation of NPN – Variant IV

Year	IC	Green bonus	Revenue	OC	En. saving	NCF	DF	DNCF	CDNCF
2012	360000	12,75	63750	7500	11350	-292400	1	-292 400	-292 400
2013		12,75	63750	7500	11350	67600	0,9524	64 381	-228 019
2014		12,75	63750	7500	11350	67600	0,9070	61 315	-166 704
2015		12,75	63750	7500	11350	67600	0,8638	58 395	-108 308
2016		12,75	63750	7500	11350	67600	0,8227	55 615	-52 694
2017		12,75	63750	7500	11350	67600	0,7835	52 966	273
2018		12,75	63750	7500	11350	67600	0,7462	50 444	50 717
2019		12,75	63750	7500	11350	67600	0,7107	48 042	98 759
2020		12,75	63750	7500	11350	67600	0,6768	45 754	144 513
2021		12,75	63750	7500	11350	67600	0,6446	43 576	188 089
2022		12,75	63750	7500	11350	67600	0,6139	41 501	229 589
2023		12,75	63750	7500	11350	67600	0,5847	39 524	269 114
2024		12,75	63750	7500	11350	67600	0,5568	37 642	306 756
2025		12,75	63750	7500	11350	67600	0,5303	35 850	342 606
2026		12,75	63750	7500	11350	67600	0,5051	34 143	376 748
2027		12,75	63750	7500	11350	67600	0,4810	32 517	409 265
2028		12,75	63750	7500	11350	67600	0,4581	30 968	440 233
2029		12,75	63750	7500	11350	67600	0,4363	29 494	469 727
2030		12,75	63750	7500	11350	67600	0,4155	28 089	497 816
2031		12,75	63750	7500	11350	67600	0,3957	26 752	524 568

From tables 2 – 5 is created following comparison of particular variants:

- Variant I   NPV = -91 385 CZK (cca -3 655 EUR),
- Variant II   NPV = -7 167 CZK (cca -287 EUR),
- Variant III   NPV = -7 099 CZK (cca -284 EUR),
- Variant IV   NPV = 524 568 CZK (cca 20 983 EUR).

From results it is evident that the most efficient variant is the Variant IV. It is caused with the policy of the development in governmental financial support of solar energy. This policy brought two main factors:

- decreasing of green bonuses and guaranteed purchase prices after 2010,
- cancelling of exemption from income tax relating with revenues from solar power plant.

The next factor influencing the efficiency of new projects is the additional solar tax defined by government for years 2011 and 2012. However this tax is intended only for power plant with the nominal output bigger than 30 kW.

On figure 2 it is possible to see the development of discounted cash-flows in Variant IV. The result is very good and the project seems to be very efficient. But due to changes in the governmental financial support after 2010 it is impossible to achieve the same results also in the future.
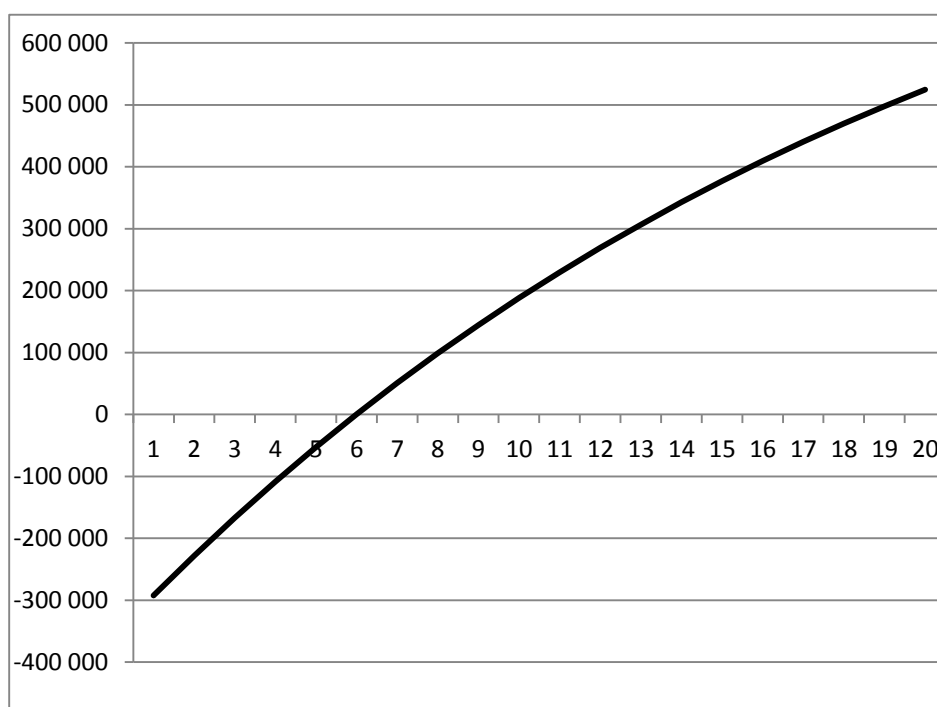
Fig. 2)   Development of cash-flows in Variant IV

Acknowledgement

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THE 3-PARAMETER PACKING DENSITY MODEL WITH THE WEDGING EFFECT INCORPORATED

Ka Wai Chan[1], Albert K.H. Kwan[2], Vivian Wong[3]

Abstract

A concrete mixture can be regarded as a pack of aggregate particles in a matrix of cement paste. Since the matrix of cement paste is more expensive and less strong and durable than the natural aggregate, maximizing the packing density of aggregate is generally considered a good strategy both to reduce costs and to get an optimized concrete mix in terms of performance. For the sake of concrete mix optimization, it is important to have a particle packing model that can accurately predict the packing density of multi-component particulate systems. For this purpose, the 3-parameter packing density model (3PPM) has been developed. It is a new particle packing model for packing density estimation of multi-component particulate systems, which is modified from the linear packing density model by incorporating the wedging effect. The wedging effect is a particle interaction effect other than the loosening and wall effects, which occurs, for example, when the fine particles are locked at the narrow gaps between the coarse particles. An experimental program of measuring the packing density of binary and ternary mixes of mono-sized spherical glass beads was launched. The model was calibrated from the experimental packing densities of binary mixes. Then, the theoretical packing densities predicted by 3PPM for ternary mixes were compared with the experimental packing densities. With the wedging effect incorporated, the authors believe that 3PPM gives an excellent alternative tool for concrete mix optimization.

Key words

Packing density, particle packing models, powder technology.

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1 INTRODUCTION

The packing of solid particles is a major factor affecting the behaviour and performance of many materials made-up of solid particles. As concrete mixture can be regarded as a pack of aggregates in a matrix of cement paste, packing density of aggregate should be a key factor governing the performance of concrete. With the advancement of concrete technology and the demand of concrete for different applications, particle packing of concrete constituents has become a key issue for mix optimization design of high-performance concrete. These calls for the development of particle packing models that can accurately predict the packing density of concrete constituents so that suitable proportioning strategy can be performed for the production of high-performance concrete. Many particle packing models have been developed over the past 80 years. The linear packing density model (LPDM) developed by Stovall et al. [1] is one of the well-known models for multi-component particulate system, which takes into account the various known particle interaction effects including the filling effect, the occupying effect, the loosening effect and the wall effect [2].

For binary mix, LPDM generally generates packing density curves similar to that shown in Fig. 1, giving a sharp peak at the volumetric fraction which yields the maximum packing density, r_1*. In reality, however, the experimental packing densities such as those plotted as data points in Fig. 1 generally lie on a smooth curve with a flat peak where the experimental packing densities are always lower than that predicted by LPDM. To reduce the discrepancies, the compressible packing model (CPM) was modified from LPDM by de Larrard by incorporating a compaction index to take account of the effect of compaction in different packing processes [3]. Although CPM was found to provide good packing density estimation for both binary and ternary mixes, the accuracy of the model highly depends on the value of the compaction index, which is not easy to be determined.
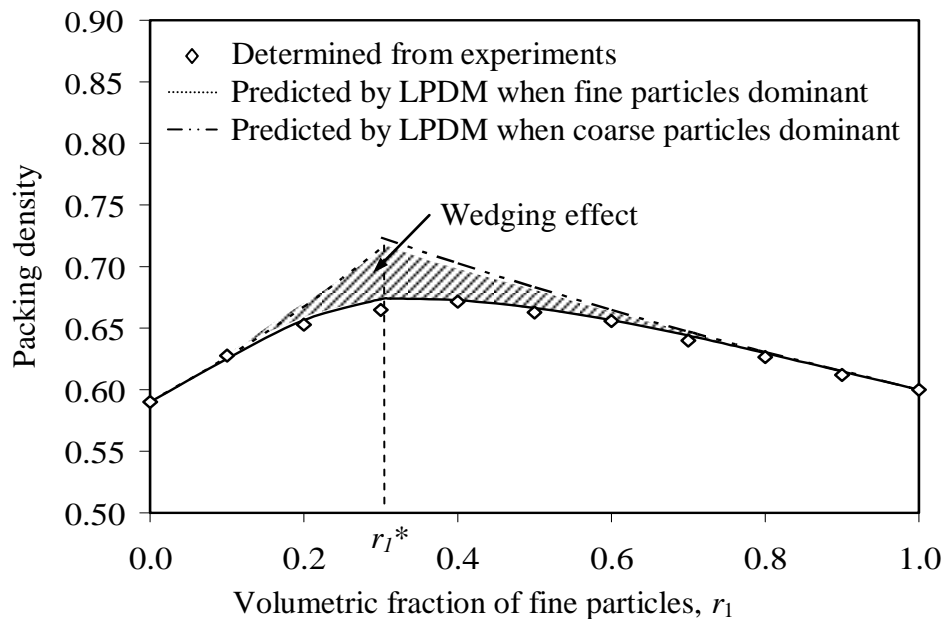
Fig. 1)   Packing density against volumetric fraction of fine particles

It is postulated that the discrepancies between the experimental packing densities and the theoretical packing densities predicted by LPDM is mainly due to the wedging effect, which is a new particle interaction effect other than the filling, occupying, loosening and wall effects. The wedging effect is shaded as shown in Fig. 1, which can be explained in two scenarios for binary mix, i.e. when the coarse particles are dominant and when the fine particles are dominant. When the coarse particles are dominant, some of the fine particles may be trapped in the narrow gaps between the coarse particles instead of filling the voids between them, thereby wedging the coarse particles apart and causing the solid concentration near the surface of the coarse particles to be lower as illustrated in Fig. 2. On the other hand, when the fine particles are dominant, some of the coarse particles may place themselves into the sea of fine particles by almost touching each other instead of discretely and evenly. The space between the coarse particles can no longer accommodate a single layer of fine particles, thereby wedging the fine particles sideway, forming gaps between the coarse particles that are unoccupied by fine particles and causing the solid concentration near the surface of the coarse particles to be lower as illustrated in Fig. 3.
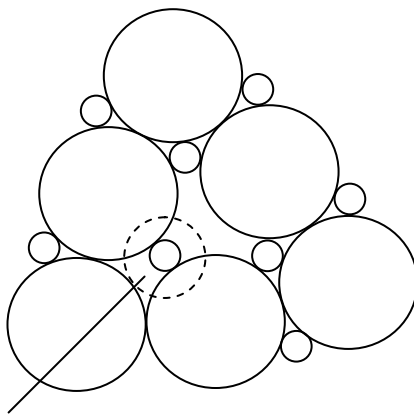
Wedging effect

Fig. 2)   The wedging effect when the coarse particles are dominant
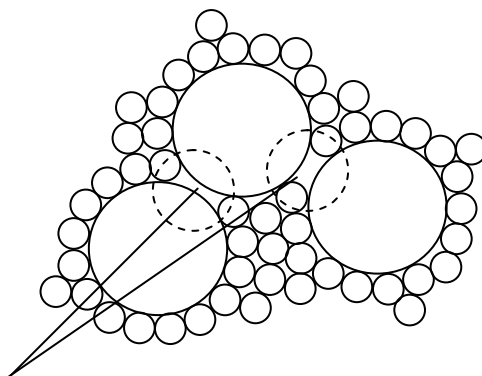
Wedging effect

Fig. 3)   The wedging effect when the fine particles are dominant

A new particle packing model, namely the 3-parameter packing density model, has been developed by the authors by introducing the wedging effect to LPDM. The 3-parameter packing density model (3PPM) for both binary mix and multi-component particulate system will be reviewed in this article. Following that, the new model will be calibrated from the experimental packing densities of binary mixes of mono-sized spherical glass beads. Then, the accuracy of the model will be tested against the experimental packing densities of ternary mixes of mono-sized spherical glass beads.

2   THE 3PPM FOR BINARY MIX

Consider a binary mix of particles that size class 1 represents the fine particles and size class 2 represents the coarse particles. By equating the packing density equations of LPDM, the optimum volumetric fraction of fine particles, r_1*, yielding the maximum packing density can be determined as:

$$r_1* = \frac{(1-b)\cdot\left(\frac{1}{\phi_2}-1\right)}{(1-a)\cdot\frac{1}{\phi_1}+(1-b)\cdot\left(\frac{1}{\phi_2}-1\right)}$$

(1)

where ϕ_1 and ϕ_2 are the packing density of the fine and coarse particles respectively, a is the loosening effect parameter accounting for the loosening effect between the fine and coarse particles and b is the wall effect parameter accounting for the wall effect between the fine and coarse particles. The coarse particles are dominant when the volumetric fraction of fine particles (solid volume of fine particles), r_1, is smaller than its optimum i.e. $r_1 < r_1*$.

The optimum volumetric fraction of coarse particles, r_2*, yielding the maximum packing density can then be calculated by $1 - r_1*$, which is denoted as:

$$r_2* = \frac{(1-a)\cdot\left(\frac{1}{\phi_1}\right)}{(1-a)\cdot\frac{1}{\phi_1}+(1-b)\cdot\left(\frac{1}{\phi_2}-1\right)}$$

(2)

The fine particles are dominant when the volumetric fraction of coarse particles (solid volume of coarse particles), r_2, is smaller than its optimum i.e. $r_2 < r_2*$.

From Fig. 1, the wedging effect is about maximum when the volumetric fraction is close to its optimum. By assuming the wedging effect is maximum when $r_1 = r_1*$ and taking the wedging effect to be proportional to $(r_1/r_1*)^2$, the packing density of the binary mix when the coarse particles are dominant can be denoted as:

$$\phi_2* = \frac{1}{\frac{r_1}{\phi_1}+\frac{r_2}{\phi_2}-(1-a)\cdot\frac{r_1}{\phi_1}\cdot\left[1-c\cdot\left(\frac{r_1}{r_1*}\right)^2\right]}$$

(3)

where c is the wedging effect parameter. The packing density of the binary mix can be interpreted as the solid volume of particles divided by the bulk volume of the binary mix, where the solid volume of particles is $r_1 + r_2$, which equals 1. When the coarse particles are dominant, the coarse particles would interact with the fine particles by the filling, loosening and wedging effects. In Eq. (3), the contribution to the bulk volume of the binary mix by the filling effect is r_2 / ϕ_2, which is the bulk volume of coarse particles; the contributions to the bulk volume of the binary mix by the loosening effect and the wedging effect are $a \cdot r_1 / \phi_1$ and $c \cdot (1-a) \cdot (r_1 / r_1 *)^2 \cdot r_1 / \phi_1$ respectively, where a takes account of the loosening effect, $c \cdot (1-a) \cdot (r_1 / r_1 *)^2$ takes account of the wedging effect and r_1 / ϕ_1 is the bulk volume of fine particles.

On the other hand, by assuming the wedging effect is maximum when $r_2 = r_2 *$ and taking the wedging effect to be proportional to $(r_2 / r_2 *)^2$, the packing density of the binary mix when the fine particles are dominant can be denoted as:

$$\phi_1 * = \frac{1}{\dfrac{r_1}{\phi_1} + \dfrac{r_2}{\phi_2} - (1-b) \cdot \dfrac{r_2}{\phi_2} \cdot (1-\phi_2) \cdot \left[1 - c \cdot \left(\dfrac{r_2}{r_2 *}\right)^2\right]}$$

(4)

When the fine particles are dominant, the fine particles would interact with the coarse particles by the occupying, wall and wedging effects. In Eq. (4), the contribution to the bulk volume of the binary mix by the occupying effect is $r_1 / \phi_1 + r_2$, which is the sum of the bulk volume of fine particles and the solid volume of coarse particles; the contributions to the bulk volume of the binary mix by the wall effect and the wedging effect are $b \cdot (1-\phi_2) \cdot r_2 / \phi_2$ and $c \cdot (1-b) \cdot (r_2 / r_2 *)^2 \cdot (1-\phi_2) \cdot r_2 / \phi_2$ respectively, where b takes account of the wall effect, $c \cdot (1-b) \cdot (r_2 / r_2 *)^2$ takes account of the wedging effect and $(1-\phi_2) \cdot r_2 / \phi_2$ is the void volume within the bulk volume of coarse particles.

It is noted that the loosening effect parameter, a, the wall effect parameter, b, and the wedging effect parameter, c, are empirical functions of size ratio r (a ratio of the characteristic diameter of fine particles to the characteristic diameter of coarse particles), which have to be calibrated by fitting the experimental packing densities of binary mixes by regression analysis.

3   THE 3PPM FOR MULTI-COMPONENT PARTICULATE SYSTEM

Now, consider a particulate system of n size classes (size class 1 is the smallest size class and $n \geq 2$) that there exists only one dominant size class. If size class i is dominant, it is assumed that particles of the other size classes would not have interactions with each other but would interact with the dominant particles of size class i only. The dominant particles would interact with particles of smaller size classes by the filling, loosening and wedging effects and interact with particles of larger size classes by the occupying, wall and wedging effects. By considering that the particulate system is composed of n-1 local binary mixes where particle interactions take place between particles of the dominant size class and one of the other size classes, the portion of the dominant particles that interact with particles of size class j in a local binary mix, R_j, may be calculated as:

$$R_j = \frac{r_j}{\sum\limits_{k=2}^{n} r_k} \qquad\qquad \text{for } i = 1 \qquad\qquad (5a)$$

$$R_j = \frac{r_j}{\sum\limits_{k=1}^{i-1} r_k + \sum\limits_{k=i+1}^{n} r_k} \qquad\qquad \text{for } i = 2,3,...,n-1 \qquad\qquad (5b)$$

$$R_j = \frac{r_j}{\sum\limits_{k=1}^{n-1} r_k} \qquad\qquad \text{for } i = n \qquad\qquad (5c)$$

where r_j and r_k are the volumetric fractions of particles of size class j and size class k in the particulate system respectively. Then, the volumetric fraction of particles of size class j in the local binary mix, z_{ij}, can be derived as:

$$z_{ij} = \frac{r_j}{r_i \cdot R_j + r_j} \qquad\qquad (6)$$

where r_i is the volumetric fraction of the dominant particles of size class i in the particulate system.

Consider a local binary mix of particles of the dominant size class i and one of the smaller size classes j (when $j < i$), the optimum volumetric fraction of particles of the smaller size class j yielding the maximum packing density for the local binary mix, $z_{ij}{}^*$, can be denoted by:

$$z_{ij}{}^* = \frac{(1-b_{ij}) \cdot \left(\dfrac{1}{\phi_i} - 1 \right)}{(1-a_{ij}) \cdot \dfrac{1}{\phi_j} + (1-b_{ij}) \cdot \left(\dfrac{1}{\phi_i} - 1 \right)} \qquad\qquad (7)$$

where ϕ_i and ϕ_j are the packing density of particles of size class i and size class j respectively, a_{ij} is the loosening effect parameter accounting for the loosening effect between particles of size classes i and j and b_{ij} is the wall effect parameter accounting for the wall effect between particles of size classes i and j. On the other hand, consider a local binary mix of particles of the dominant size class i and one of the larger size classes j (when $j > i$), the optimum volumetric fraction of particles of the larger size class j yielding the maximum packing density for the local binary mix, $z_{ij}{}^*$, can be denoted by:

$$z_{ij}{}^* = \frac{(1-a_{ij}) \cdot \dfrac{1}{\phi_i}}{(1-a_{ij}) \cdot \dfrac{1}{\phi_i} + (1-b_{ij}) \cdot \left(\dfrac{1}{\phi_j} - 1 \right)} \qquad\qquad (8)$$

By assuming the wedging effect in a local binary mix to be proportional to $\left(z_{ij}/z_{ij}*\right)^2$, the packing density of the particulate system with size class i being dominant, ϕ_i*, can be denoted as:

$$\phi_i* = \cfrac{1}{\displaystyle\sum_{j=1}^{n}\frac{r_j}{\phi_j} - \sum_{j=1}^{i-1}\left(1-a_{ij}\right)\cdot\frac{r_j}{\phi_j}\cdot\left(1-c_{ij}\cdot\left(\frac{z_{ij}}{z_{ij}*}\right)^2\right) - \sum_{j=i+1}^{n}\left(1-b_{ij}\right)\cdot\frac{r_j}{\phi_j}\cdot\left(1-\phi_j\right)\cdot\left(1-c_{ij}\cdot\left(\frac{z_{ij}}{z_{ij}*}\right)^2\right)}$$
(9)

where c_{ij} is the wedging effect parameter and size class i is considered dominant when $z_{ij} < z_{ij}*$ for all values of j (1 to n excluded i).

In Eq. (9), a_{ij} and b_{ij} take acount of the loosening effect and the wall effect contributed from the local binary mixes respectively; $c_{ij}\cdot\left(1-a_{ij}\right)\cdot\left(z_{ij}/z_{ij}*\right)^2$ takes account of the wedging effect contributed from the local binary mixes where the dominant particles are larger, while $c_{ij}\cdot\left(1-b_{ij}\right)\cdot\left(z_{ij}/z_{ij}*\right)^2$ takes account of the wedging effect contributed from the local binary mixes where the dominant particles are smaller.

It is noted that the loosening effect parameter, a_{ij}, the wall effect parameter, b_{ij}, and the wedging effect parameter, c_{ij}, are empirical functions of size ratio r_{ij} (a ratio of the characteristic diameter of the smaller particles to the characteristic diameter of the larger particles in a local binary mix), which have to be calibrated by fitting the experimental packing densities of binary mixes by regression analysis.

4   EXPERIMENTAL DETAILS

An experimental program of measuring the packing density of binary and ternary mixes of mono-sized particles was launched for the calibration and verification of 3PPM. The particles used in the experiments were spherical glass beads of six mono-sized classes. The six size classes of glass beads were named according to their size in ascending order, namely B1, B2, B3, B4, B5, and B6. Their ball diameter and specific gravity were measured and are tabulated in the first and second row of Tab. 1 respectively.

Tab. 1)   Properties of mono-sized spherical glass beads

Property	B1	B2	B3	B4	B5	B6
Diameter (mm)	1.43	3.29	5.26	8.03	11.71	15.73
Specific gravity	2.48	2.46	2.45	2.48	2.45	2.48

By blending the glass beads at various volumetric fractions with 10% increment, a total of 264 mixes were prepared for experimental packing density tests. Dry packing method with no compaction applied was adopted conforming to BS 812: Part 2:1995 [4] for measuring the packing density of aggregate. The prepared volume of glass beads were mixed thoroughly and delivered to a steel cylindrical container as stipulated in [4]. It is noted that the diameter of the cylindrical container has to be more than ten times the diameter of the largest particle so as to avoid a significant wall effect as suggested by Fedor and Landel [5]. The excess glass beads were leveled off and the container fully-filled with glass beads was weighed. The packing

density of the prepared mix was then calculated from the mass of the glass beads inside the container.

5   CALIBRATION OF THE 3PPM

The particle interaction functions of the loosening effect parameter a_{ij}, the wall effect parameter b_{ij} and the wedging effect parameter c_{ij} were calibrated from the experimental packing densities of binary mixes of mono-sized spherical glass beads by regression analysis based on Eq. (3) and Eq. (4), as presented in the following equations:

$$a_{ij} = 1 - \left(1 - r_{ij}\right)^{3.3} - 2.6 \cdot r \cdot \left(1 - r_{ij}\right)^{3.6} \tag{10}$$

$$b_{ij} = 1 - \left(1 - r_{ij}\right)^{1.9} - 2 \cdot r \cdot \left(1 - r_{ij}\right)^{6} \tag{11}$$

$$c_{ij} = 0.322 \cdot \tanh\left(11.9 \cdot r_{ij}\right) \tag{12}$$

The calibrated particle interaction functions were used for packing density estimation of ternary mix of mono-sized spherical glass beads. The theoretical packing densities predicted by 3PPM were compared with the experimental packing densities, as discussed in the next section.

6   RESULTS AND DISCUSSIONS

The theoretical packing densities for ternary mix series B1-B2-B6, B1-B3-B6, B1-B4-B6 and B1-B5-B6 were predicted by 3PPM using the above calibrated particle interaction functions. The experimental and theoretical packing densities predicted for the four ternary mix series are plotted in the form of ternary contour diagrams in Fig. 4 and Fig. 5 respectively. It can be seen that 3PPM can provide very good packing density estimation as the contours in Fig. 4 and Fig. 5 are good fit with each other. However, there is a drawback of 3PPM that the model developed at this stage is not able to predict the packing density for all combinations of particles as the model is applicable only to particulate systems with dominant size class. For ternary mix of mono-sized spherical glass beads, there would be no dominant size class when the volumetric fraction of the smallest size class is between 10% and 20% and neither the medium size class nor the largest size class is dominant. Nevertheless, the packing density of those mixes with no dominant size class can be directly obtained from the ternary contour diagrams, which are plotted by linear interpolation using the theoretical packing densities of mixes with dominant size class. Disregarding those ternary mixes with no dominant size class, the R2 computed are 0.97, 0.97, 0.95 and 0.99 for ternary mix series B1-B2-B6, B1-B3-B6, B1-B4-B6 and B1-B5-B6, respectively, with a mean of 0.97 and a standard deviation of 0.02.

By incorporating the wedging effect into LPDM, 3PPM successfully predicts the packing density for ternary mix using the three particle interaction functions calibrated from binary mix as indicated by the high value of R^2. There is no doubt that the wedging effect can explain the discrepancies between the experimental packing densities and the theoretical packing densities predicted by LPDM.
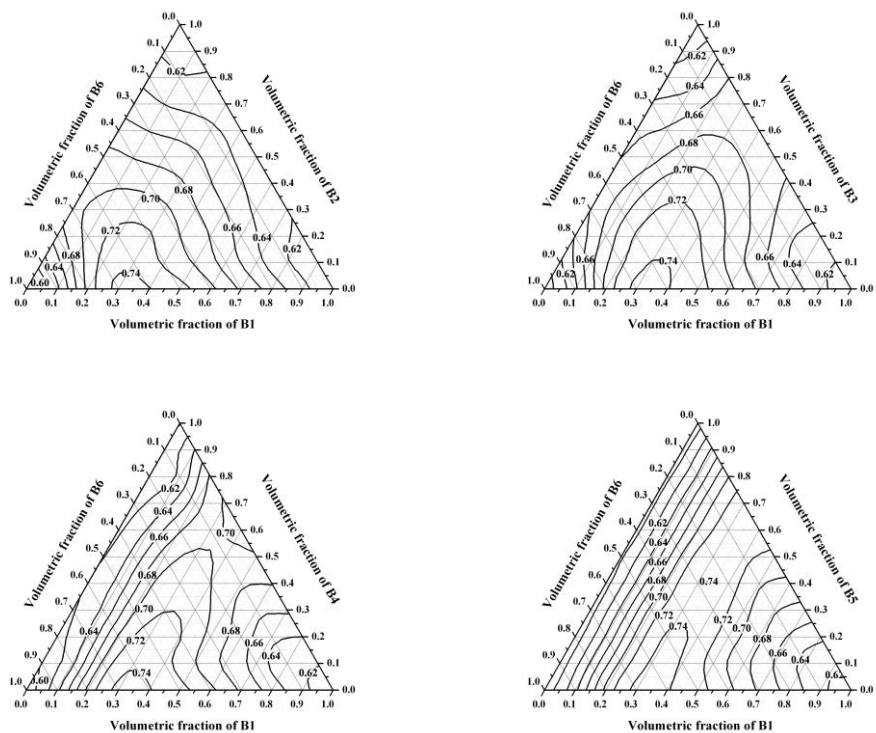
Fig. 4) Experimental ternary contour diagrams of ternary mix series B1-B2-B6, B1-B3-B6, B1-B4-B6 and B1-B5-B6
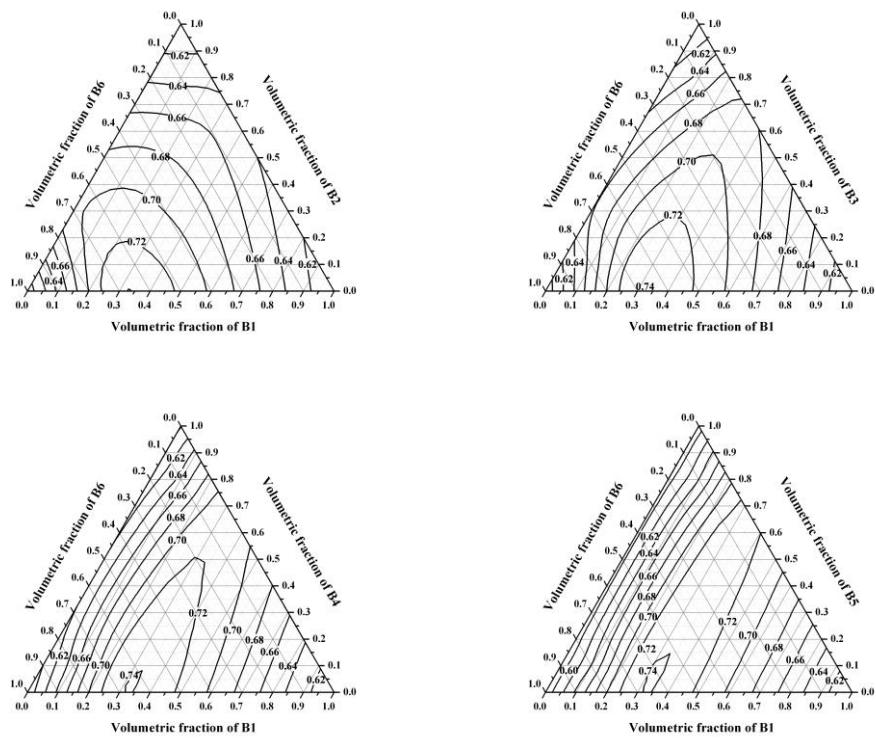
Fig. 5) Theoretical ternary contour diagrams of ternary mix series B1-B2-B6, B1-B3-B6, B1-B4-B6 and B1-B5-B6

The wedging effect provides physical interpretation of how the particles interact with each other as it is easy to realize, for example, how the fine particles are locked at the narrow gaps between the coarse particles causing the solid concentration near the surface of the coarse particles of the particulate system to be lower.

7   CONCLUSION

With the incorporation of the wedging effect, it is found that the 3-parameter packing density model can predict the packing density of ternary mix of mono-sized spherical glass beads accurately using the particle interaction functions calibrated from binary mix as shown by the high value of R^2 and the good match between the experimental and theoretical contours of packing density. Although the applicability of 3PPM to particulate system composed of particles with particle shape and size distribution has not yet been tested, it is already very inspiring as 3PPM potentially gives an excellent alternative tool for packing density estimation.

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SUSTAINABILITY ASPECTS OF THE CONTRACTUAL SAVINGS SCHEME

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Abstract

Contractual savings scheme is an important source of financing for development and maintenance of housing stock in the Slovak Republic. It supports targeted saving of the population, which is later largely used to meet housing needs and it is also an important source of residential lending for the Slovak population. The housing sector belongs to one of the largest consumers of the energy in the national economy. Construction, operation and liquidation of the housing units generate the large energy cost. The energy costs may be reduced only when the large investment are allocated to the housing sector. Former Slovak Government contemplated the abolition of state bonuses for construction savings, which was rationalized and justified by the particular burden on the state budget. Authors of the present paper believe that such a move would lead to significant losses in the Slovak economy, particularly in the areas of tax collection, contributions to insurance companies, job losses and increased costs due to unemployment. Under the conditions of high unemployment and the government deficit in Slovakia it represents in our opinion, the high political risk. In addition, the shortfall caused by the investment would bring negative consequences of thermal insulation and renovation of housing stock, and therefore may also affect the amount of greenhouse gas emissions in the energy balance of the state, and thus negatively influence the direction of economic growth based on sustainable development. Although these effects are not easy to quantify, the authors have succeeded to deliver tangible results in this area.

Key words

Contractual savings scheme, energy costs, housing sector, multiplier effect.

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1   CONTRACTUAL SAVINGS SCHEME – INTRODUCTION

In its simplest form, a Contractual savings for housing involves an agreement between a household and a financial institution regarding the granting of a loan at a future date dependent on successful fulfillment of a savings contract. The household agrees to save either a prespecified total or a certain minimum amount each year. AT the end of the savings period, the household becomes eligible for a loan the amount of which is dependent on the amount saved [1].

Contractual savings scheme is an important source of financing for development and maintenance of housing stock in the Slovak Republic. It has the positive impact on housing demand and supply thanks to the provision of accessible housing credits, indirectly supported by the state premium [2]. It supports targeted saving of the population while the vast majority of investment goes to housing and it is also a major source of residential lending for the Slovak population. Investments from construction savings encourage the employment growth and production in the housing sector, development of human settlements, employment, consumer expenditures in other economic sectors and grants and revenues to the state budget as well.

Accumulation of funds by construction savings scheme influences the expenditure structure of the population. Citizens spend more money on construction works which are mostly carried out by using domestic materials and home workers. Less money will then remain for some commodities, such as luxury goods imported from abroad or foreign holidays, which are indeed a source of job creation outside of Slovakia, but for Slovakia it means increase of unemployment and foreign trade deficit. It also means less money spent on alcohol and cigarettes and on excise tax, which some economists welcome as a source of state budget income but they forget to calculate with the impact of these expenditures on working disablement, medical expenses and loss of productivity. In this sense, investment in housing sector is acting anti-inflationary.

2   STATE EXPENDITURES ASSOCIATED WITH THE CONTRACTUAL SAVINGS SCHEME

The government supports construction savings through a state support in the form of bonuses. State bonuses represent a percentage of the annual contractual saving deposit of saver and the calculation of this percentage is established in Contractual Savings Scheme Act. The Ministry of Finance by its actions annually announces the amount of state bonus for the following calendar year. State bonuses may be granted only for one personal entity - saver or for legal entity – saver (an owners' association). The maximum amount of a state bonus is provided by law.

Tab. 1)   The number of savers and the volume of state premium of CSH provided by state budget to savers during the period 2008 - 2011

Year	2008	2009	2010	2011
Number of savers	929,696	973,264	973,318	962,730
The amount of state premium (in € million)	38,578	43,620	41,610	43,100

Source: Contractual savings banks / The Ministry of Finance of the Slovak Republic [3].

Average volume of annual state premium for Contractual Savings Scheme for Housing (CSH) reimbursed by State budget during the period from 2008 to 2011 represented € 41 million, from which benefitted 963,000 savers on average (see the table. 1).

3   MULTIPLIER AND ITS CALCULATION

The construction industry as a sector affects the production in almost all other sectors of national economy. It has a significant impact on employment in primary (building) industry but also it affects employment throughout the whole economy. The intensity of this impact is measured by the multiplier effect. This effect determines size of investments or new job opportunities caused by activities in primary sector, for example in construction industry or in other sectors of national economy.

The coefficient of multiplier effect of various construction activities in the world ranges from 1.8 to 3.5, while in the sector of housing construction it is generally higher. For example in the years 1977 – 1993 the multiplier effect of housing construction in Poland ranged from 2.4 to 2.7. This means that the increase of employment in the construction sector has led to a 1.4 to 1.7 multiple increase of employment in other sectors of national economy [4]. In the Czech Republic in 2000 this coefficient reached a value 2.6. IS EMERGING Markets [5] argued that the employment multiplier in the construction sector usually stands from 3.2 to 3.5.

In our analysis we used the following calculations of multiplier coefficient:

To calculate the multiplier was used knowledge from input-output analysis [6]. The starting point of input-output model is input-output table, respectively commodity-sectorial table that shows the relationships between sectors of the national economy and quantitative flows of production in the productive and non-productive sphere [7]. Analysis focuses also on technologies, with emphasis on the relative role of manufacturing and services inputs. Lastly, standard measures of linkages are used to determine the main sources of induced output that are created by the push and pull effects of the construction sector on the rest of the economy [8].

Input-output table consists of four quadrants that show cross-sectorial flows; components of final consumption; total production and added value in individual sectors of the economy.

To calculate the multiplier, it was necessary analysis of the first quadrant of input-output table, which shows the relationship between economic sectors – cross-sectorial flows, so-called intermediate consumption. The matrix of intermediate consumption indicates how many units of production of one economic sector were used within the productive consumption in other sectors of the national economy.

The matrix of intermediate consumption X is square shape with dimensions n x n, while lines from "1", "2" to "i" until to "n" indicates the supplier sector and columns "1", "2" to "i" until to "n" indicates the consumer sector. Element " x_{ij} " indicates the volume of consumption of production of the "i" sector in the "j" sector.

Relations between the different sectors are very strong, because the changes in the volume of certain sector affect the flows of production in all of its supply sectors. This is reflected in the production of these sectors.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & & \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nj} & \cdots & x_{nn} \end{bmatrix} \qquad i, j = 1, 2, \ldots n \qquad (1)$$

Consumption of production of the "i" sector in the production of the "j" sector (x_{ij}) is a function of the total production of this sector (x_j), which can be expressed by the following equation [7]:

$$x_{ij} = f_{ij}(x_j) \qquad i, j = 1, 2, \ldots n \qquad (2)$$

Provided that:

- the character of functions "f_{ij}" is the same for all sectors of production,
- in the production of outputs are used the same technological process,
- consumption of individual products in the output production is directly proportional to the scale of produced production,
- production factors are consumed in fixed ratio.

Consumption of production of the "i" sector in the production of the "j" sector x_{ij} can be expressed as a linear function x_j, by using the Leontief production function [9]:

$$x_{ij} = a_{ij}.x_j \qquad i, j = 1, 2, \ldots n \qquad (3)$$

After the treatment we receive technological coefficients or direct consumption coefficients expressing the financial volume of production of the "i" sector supplied to total production per unit of the "j" sector [7].

$$a_{ij} = \frac{x_{ij}}{x_j} \qquad i, j = 1, 2, \ldots n \qquad (4)$$

Coefficients of direct consumption for all sectors can be written by the matrix "A":

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots & & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & & \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix} \qquad i, j = 1, 2, \ldots n \qquad (5)$$

The total output of sectors expresses a column vector "X":

$$X = \begin{bmatrix} x_1 \\ \vdots \\ x_i \\ \vdots \\ x_n \end{bmatrix} \qquad (6)$$

Husár [7] show the relationship how to calculate complex coefficients of consumption, which reflect necessary extent of production in the "i" sector, needed to produce one unit of output in the "j" sector for final consumption:

$$L = (I - A)^{-1} \tag{7}$$

Where "I" is the unitary matrix of size n x n:

$$I = \begin{bmatrix} 1 & \cdots & 0 & \cdots & 0 \\ \vdots & \ddots & \vdots & & \vdots \\ 0 & \cdots & 1 & \cdots & 0 \\ \vdots & & \vdots & \ddots & \vdots \\ 0 & \cdots & 0 & \cdots & 1 \end{bmatrix} \qquad i, j = 1, 2, \ldots n \tag{8}$$

The "L" is the inverse matrix $(I - A)^{-1}$ with elements "l_{ij}":

$$L = \begin{bmatrix} l_{11} & \cdots & l_{1j} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots & & \vdots \\ l_{i1} & \cdots & l_{ij} & \cdots & l_{in} \\ \vdots & & \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nj} & \cdots & l_{nn} \end{bmatrix} \qquad i, j = 1, 2, \ldots n \tag{9}$$

The matrix "L" is called the matrix multiplier, which transforms changes in final consumption to changes in production [7].

By summing of multipliers per individual sector (sum of line), is obtained multiplier of particular sector. If final production of the sector increases by one unit, the total production in all other sectors will increase exactly by the value of the multiplier [10].

Matrix of cross-sectorial flows in 2008 (with revision in 2011) has size 85 x 85 sectors. According to methodology of NACE - in 41st up to 43st line there is the Construction industry with the following structure:

- 41. Buildings and construction of buildings,
- 42. Structures and construction of engineering structures,
- 43. Specialized construction works.

Within the context of input-output analysis, we calculated that the value of the multiplier for sector 41. Buildings and construction of buildings is L = 2.85. This means that increasing in production in this sector - "Buildings and construction of buildings" by one unit causes increasing of the total production in all sectors by 2.85 units.

4   THE BENEFITS OF CONTRACTUAL SAVINGS SCHEME TO THE NATIONAL ECONOMY OF THE SLOVAK REPUBLIC

The benefits of Contractual Savings Scheme can be generally divided into three areas:

- benefits for employment,
- savings of public funds as a result of higher employment,
- impact on public finances.

4.1   Benefits for employment

In 2010 the sum of housing investments from all three building societies was € 392.6 million. The amount of investment flowing into the housing from three building societies that year represented 64% of all funds provided by savings banks. These investments were used for various purposes as follows:

- Reconstruction - € 255 million,
- Purchase - € 112 million,
- The new construction - € 26 million.

Since the total construction output - subsectors "Buildings and construction of buildings" was in 2010, € 1302 million [11] and labor productivity amounted to € 26,856 per employee; it provided approximately 50,000 new job opportunities for employees. Contractual Savings Scheme participated on these investments by € 392.6 million. With labor productivity per employee (€ 26,856), Contractual Savings Scheme have participated in the creation almost 14,760 new jobs in the subsector "Buildings and construction of buildings". By offsetting of the multiplier effect (L = 2.85) this leads to the creation of approximately 42,060 jobs throughout the whole economy. These jobs already involves 14,760 jobs in the construction subsector "Buildings and construction of buildings" and 27,300 jobs in all other sectors of national economy (including other construction subsectors or subclasses). This impact on job creation in the economy is definitely not negligible.

4.2   Savings of public funds as a result of higher employment

Unemployed citizens don't pay income taxes; moreover, they generate state budget expenditures in the form of levies and contributions to social and health insurance. The growth of unemployment is creating a very strong pressure on public finances. In this section are calculated costs for unemployed person, which arise to the state in the case of non-creating jobs through the Contractual Savings Scheme.

Estimation of social benefits provided to one unemployed person in Slovak national economy

The state expenditures in the form of various social benefits for a one unemployed person in 2010 over 6 months consisted of:

- Average biannual support of € 1,544.16 (average monthly unemployment compensation in 2010 represented € 257.36) [12],
- Health insurance (4%), i.e. € 184.56 (calculated from the average gross wage in Slovak economy in 2010 = € 769) [12].

The state benefits provided to one unemployed person over the six months represented approximately € 1,730 in 2010.

If a one unemployed person has worked instead of receiving the unemployment compensation (during 6 months), so it would bring to the state budget an average of € 809 per year. This amount consists of contributions to Social Insurance Company of € 432 and from a wage tax of € 377. Therefore the total expenditure for a state per one unemployed person in 2010 represented approximately € 2,540.

In our considerations we haven't taken into account other possible state expenditures in 2010 and active employment policy which is difficult to quantify (contribution for establishment

the small business, commuting contribution for the distant job places, state contribution for supporting the job mobility, retraining, etc.).

If Contractual Savings Scheme were not a source of significant investment in housing, then the state would lose totally 97.4 million € throughout the national economy as a result of growing unemployment in 2010.

4.3 Impact on public finances

Taxes are the most important revenue item of the state budget, which serve to cover the state budget expenditure. The tax system is the sum of taxes levied in the country in a given period. Its mission is to provide revenues to cover all necessary expenses of the state. Tax system in Slovakia consists of direct taxes (paid by operators for each of their income or assets and transfer them directly) and indirect taxes (paid by actors in the price of goods or services, but diverting them through another person, i.e. indirectly) [13].

The most important benefits of contractual savings scheme for public funding are:
- Income to the state budget from value added tax (VAT),
- Income to the state budget from income tax,
- Contributions to health and social insurance.

VAT

If we use the fact that investments from construction savings in 2010 was € 392.6 million and the rate of VAT was 19%, then the total amount of income to the state budget from VAT was € 74.6 million.

Income tax and contributions to health and social insurance

Income tax is one of the direct taxes. In 2010, income tax burden was 19%. The employee pays from wages in addition to income tax also levies which are other important contributions to the economy of the state. Contributions can be divided into two groups: social contributions and contributions to health insurance.

The employer is also obliged to contribute to social and health insurance of his employees. Monthly contributions in 2010 for health insurance were 4% of gross wage; 1.4% of gross wage for health insurance; 4% of insurance for retirement pension; 3% for the disability pension insurance; and 1% for unemployment insurance of gross wage. Employees do not pay charges for accident insurance; guarantee insurance and reserve fund. Total employee contributions to health and social insurance thus represent 13.4% of monthly gross income [14].

The employer pays the employee's monthly health insurance of 10% of super-gross wage; 1.4% for Health insurance; retirement pension to 14%; the disability pension of 3%; 0.8% of accident insurance; unemployment insurance 1%, guarantee insurance of 0.25%; and for the reserve fund of solidarity of 4.75% of super-gross wage. The employer and the employee pay his monthly 35.2%. Total employer contributions to health and social insurance of employee are 35.2% of monthly super-gross wage.

In 2010, investments from Contractual Savings Scheme generated 14,700 jobs in the subsector "Buildings and construction of buildings". We estimate according the Yearbook of

the Slovak construction industry of 2011 that 2,900 jobs were created in large companies, 2,400 jobs in small businesses and about 9,400 jobs were accounted for tradesmen [15]. Knowledge of this structure is important because the average amount of taxes and contributions from wages varies within this business division. According to calculations, we came to the result that the total amount of taxes and contributions from wages of employees in small and large businesses and from wages of tradesmen in the construction sector in subsector "Buildings and construction of buildings " in 2010 was € 38.1 million.

Considering the multiplier effect that generates in the economy about 27,300 jobs and the average wage in the economy at level € 769 in 2010, the tax revenue after taxing the employees reached € 10.3 million and contributions collected reached € 122.4 million. Total revenue from taxes and contributions from workers throughout the whole economy was € 132.7 million.

The total addition from the investment from Contractual Savings Scheme for the national economy of Slovak Republic in the form of tax and contribution revenues to insurance in 2010 represented € 245.4 million.

5   CONCLUSION

Tab. 2)   Effects of Contractual Savings Scheme on Slovak national economy in 2010.

The effect of construction savings for the national economy of Slovakia	
Multiplier effect (MP) in entire economy	2,85
- MP in construction	1,0
- MP in other sectors	1,85
Job creation	
- overall	**42,060**
- construction	14,760
- other sectors	27,300
Benefits for national economy	
- total	**€ 245,400,000**
- from taxes	€ 88,050,000
- from contributions to insurance	€ 157,350,000
State budget savings	
- overall for unemployed	**€ 97,400,000**
Benefits of construction savings for national economy and state budget	
Overall benefit in 2010	**€ 342,800,000**
Costs for the state bonus in 2010	€ 41,610,000
1 € of state premium to the Contractual Savings Scheme brings to the state budget	**€ 8,2**

Support of Contractual Savings Scheme by a state premium has significant impact on the development of housing sector and for the Slovak economy as a whole. State expenditures on these savings are repayable and in form of multiplier effect they also influence the development of other industries.

The overall efficiency of the unit of state bonus (€ 1) can be expressed from the above results through its share to the total contribution of investment for the national economy caused by Contractual Savings Scheme. The total benefit is the sum of revenues from taxes; contributions from individuals and legal entities; government resource savings for supporting unemployment; and contributions to insurance companies; according to model scenario of not creating job opportunities through investments from Contractual Savings Scheme. Based on the obtained results we can conclude that every € 1 of state bonus going to Contractual Savings Scheme generated more than 8 times higher amount in the national economy in 2010 (table 2).

Contractual Savings Scheme is also a supportive method of funding housing for poor regions of Slovakia since in these regions the citizens often do not fulfill the conditions for getting other loans to obtain adequate housing. Contractual Savings Scheme is a support tool for mitigation of regional disparities. Investments into thermal insulation have positive impact on energy savings, which are very important at a time when energy prices are growing rapidly.

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SUSTAINABILITY IN BUILDING CONSTRUCTION

Róbert Janiss[1], Daniela Špirková[2]

Abstract

Environmental issues have recently receiving the first place in many areas of life for every individual. Careless actions of humanity greatly contribute to the gradual disappearance of our "green" planet. In recent decades, consumption of energy, oil and other non-renewable resources have grown rapidly. Carbon dioxide CO_2 is a normal part of Earth's atmosphere, but mainly due to industrial emissions, the concentration of CO_2 in the air is still growing. Growth of carbon dioxide in the atmosphere is considered as a major cause of global warming and health-related catastrophic phenomena on Earth (soil erosion, eutrophication, frequent floods and droughts). The contribution explains the concept of sustainability in building construction. It also highlights the current situation and impact of construction and housing fund on the environment. Expert analysis confirms that the housing sector in Slovakia has the second highest final energy consumption. Significant pressure on the overall recovery of the housing fund and commercial real estates makes the "energetic law", which entered into force in January 2006. In this contribution, attention is paid to the certification of buildings as one of the tools for demonstration the possibilities to increase energy efficiency in buildings and its positive impact on the environment. At the end of this contribution is given a practical calculation of the impact of thermal insulation of residential house that was built in the traditional panel technology, 70 and 80-ies of last century, the overall economy of the building.

Key words

Housing sector, panel blocks of flats, sustainability in building construction.

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1   INTRODUCTION

Principle of permanent sustainability is now becoming one of the generally accepted principles for development of human society. "Sustainable development is a development that will maintain option for current and future generations to satisfy their basic needs and still reduce the diversity of nature and conserve the natural functions of ecosystems" (§ 6 law no. 17/1992 coll. about the environment). In the development of sustainability, construction sector plays an important role for several reasons:

- is a key sector in the economy of each country, the infrastructure and living conditions are essential in determining the quality of life,
- providing employment opportunities in construction, operations and maintenance activities have a significant impact on poverty reduction.

Long-term energy policy concept is based on continuously reducing of the energy intensity of its economy. Its aim is primarily to ensure the implementation of energy available to all end users in real time and on cost-effective basis [1]. The professional analysis show that the total energy consumption in Europe the construction sector accounts for at least 40%, total electricity consumption 11% and 50% of the consumption of raw materials [2]. Construction and demolition activities in this sector produce 40 to 50% of total waste, though in a large extend recyclable. In the sustainable construction, participants should keep in mind environmental, socio-economic and cultural aspects such as: design and management of buildings, materials selection, buildings operations, interaction with city and economic development [3]. Comparing the requirements for the construction of the current laws and requirements for sustainable building, we could see a value-added, respectively higher standard of the sustainable buildings. The lower energy demand not only in use (usually a low energy or passive houses), but also during their construction (materials with lower primary energy consumption are used) flows from more strict requirements for sustainable building compared with conformal buildings. Sustainable buildings are more environmentally friendly, there are made from recycled and recyclable materials, in course of production of these materials lower production of CO_2 is achieved. [4]

Standard of housing is conditioned not only by new constructions but it is significantly influenced by the state of existing housing stock. The biggest flat construction in panel houses was mainly in years 1960 up to 1980 in compliance with technical standards valid since year 1963. 46% of present housing stock in Slovakia was built in accordance with these standards. Substantial part of apartment blocks show drawbacks which are caused by life span exceeding and wear and tear of building construction and installation distributions which lowers their utility value, increases energetic intensity and so also facility management costs. It leads to breakdowns which can negatively influence the health of inhabitants and safety of building usage. Distinct is mainly insufficient thermal protection of buildings. According to Vagač [5] it is also outcome of in the long term undercapitalized housing economy, neglecting of investments into renovation of the existing housing stock.

As an illustration it is possible to show the comparison of energy intensity of older housing stock with values round 200 kWh/m^2/year with present new buildings (upon fulfilling our legislative provisions) with values 70 - 100 kWh/m^2/year. If we compare values of a low energetic multi-flat house, its heating energy consumption is less than 50kWh/m^2/year.

All stated reasons lead to increased need of complex renovation, within which it is necessary to introduce a system which is supporting principles of energetic effectiveness. From

professional analyses results that housing sector has the second highest energy consumption which in year 2006 represented 26 % share from total final energy consumption of the Slovak Republic. The third highest energy consumption in the amount of 73 566 TJ with the share of 17.9 % on the total final consumption in the Slovak republic has tertiary sector (services). On the energy consumption in service sector there participates predominantly heat consumption in non-residential buildings and consumption of electricity for lighting and operation of electric appliances (approximately 3-4%). So in the year 2006 residential and non-residential buildings represented 43.9 % share in total energy consumption in the Slovak Republic. The consumption in housing sector built mainly before the year 1989 is not in correlation with the idea of constantly sustainable development. Its energy intensity highly exceeds energy consumption in comparison with developed western EU countries.

In early 2008 the EU introduced a climate-energy package (KEB), which till 2020 guarantees:

- reduction of greenhouse gases by at least 20%,
- achieve a 20% share of renewable sources of energy (RSE) within the energy consumption of the European Union,
- achieve 10% share of biofuels within the energy consumption of the European Union.

In 2010, the assessment report and draft of measures for the implementation of KEB in the Slovak Republic was approved which was submitted by the Ministry of Environment. In this context, the measure has been established for residential and not residential buildings, where the implementation of reconstruction ensures the energy efficiency, saving energy by 40%. That report also states that it will promote solutions to achieve the criteria of low energy buildings in the major renovation of buildings, if it is functionally, technically and economically feasible [6].

2   CERTIFICATION OF BUILDINGS

Energy consumption in buildings represents a significant share of total energy consumption and therefore the effort of reduction is also reflected in the administration of buildings. Acquiescence of legislation on energy efficiency of buildings, Slovakia has made the first step to reducing the energetic difficulty of residential and not residential fund and reduction in greenhouse gases CO_2. An important tool for improving and achieving greater transparency in the real estate market becomes the energy certification of buildings. Since 2008, the certification is required for newly constructed buildings or significantly updated, but the certificate is also required for buildings sold or leased after this date. Up to this day, the second step lacks - motivation of building owners to save energy (introduction of a combination of funding mechanisms, market-based instruments of support, soft loans and real estate taxes, grants, fines, ecological taxes, etc.). Under this act, a precise methodology for calculating energy efficiency was set, minimal power requirements which must be achieved in new construction or major renovation of existing buildings. Decree of the Ministry of Construction and Regional Development of the Slovak Republic in July 2009 [7], the details on calculating the energy economics of buildings and the content of the energetic certificate was set. Three main evaluations were used to calculate the actual energy efficiency of buildings:

- project evaluation,
- standardized assessment
- operational evaluation.

Project evaluation is carried out in the project and design phase of new buildings or major renovation of the building. Energy needs in building are determined by the building project documentation and project indicators.

Standardized evaluation consists of calculation based on information about outdoor and indoor environment and the actual realization of building construction, technical and energetic equipment of the building.

Operational evaluation is done by measuring the actual energy consumption. The result of evaluation is an energy efficiency of a building, which is the basis for the classification of buildings in the energy class (A - G) [7].

3 THE LIFE CYCLE OF BUILDING

Life cycle of building is the time period from the beginning of its implementation through its handover to its use after the expiry time of its life, or to its demolition. The term life means the period during which construction properties remain at a level compatible with the fulfillment of essential requirements. In other words, it is time period since commission until the condition when the desired properties fall below acceptable minimum [8].

Service life of buildings is generally determined during its design. This is known as design life, which should be achieved by adequate and regular maintenance (see table 1). There are other types of service life. For example, economically justified working service life, which reflects the level of costs for maintenance and reconstruction with expected benefit and profit from the construction. Another type of service life is a moral service life. It expresses the ability of construction to meet changing demands for its use especially in changing standards of use and demands of comfort. Life cycle is in no matter which figure a key parameter for achieving sustainable development.

Tab. 1) Lifetime of selected construction materials of building

Material, structure, technical equipment	Lifetime (years)
the hydro insulating roofing	20
windows	40
water distributions	30-40
heat distributions	40
ceramic and wood floors	30-40
lifts	25-40
wiring	30-50

Source: STERNOVÁ, Z. et al. Renewal of residential houses I. Mass housing construction after 1970 [9].

4 LIFETIME PROLONGATION OF PANEL HOUSE BY THERMAL ISOLATION

From the findings of the Statistical Office of the Slovak Republic on 31.12.2008 The Slovak Republic had about 1,988,000 panel houses. Approximately half of the apartments are located in apartment buildings, a majority of which are in a unsuitable technical and thermal condition [10]. In the flats built in the last regime we notice a number of systemic disorders, poor technical condition of roof, window and exterior structures, which are caused by excessing of lifetime, which increases their energy consumption and operating costs. Since 1955 in Slovakia, panel houses were built according to 23 prefabricated system types. Construction systems differed in the outer wall material, number of storeys, the application of the balconies or loggias. Some were built in a support system and the other in longitudinal splitting, with construction height of 2700 mm to 3000 mm. As an example, the panel block of flats was built in the structural system T06B, located in the town Malacky (about 38 km north from Bratislava). It was built in 1977 and we can find in it number of 120 housing units (see figure 1 and table 2).

Fig. 1) South façade of a block of flats T06B

Source: Janiss Robert

Converted volume Vb = 25 547.4 cubic metres
Total floor area Ab = 8 888.0 square metres
Construction height of h = 2.8 m

Thermo-technical assessment of structures was performed by STN 73 0540, the Act no. 555/2005 Z. z of. Energy Performance of Buildings [11] and to reach the thermal comfort of the thermal resistance, it should be higher than the norm STN 73 0540-3 [12]. Thermo-technical assessment of packaging structures can be seen in table 3.

From the above table we can see that the packaging structure of the apartment building do not reach the technical requirements of thermo-technical standard STN 730540. To determine the energy need for heating and energy efficiency class of an existing residential house proceed in accordance with the decree of the Ministry of Construction and Regional Development of the Slovak Republic of 13 July 2009 lays down the details of calculating the energy economics of buildings [7]. On the basis of decree which is establishing the details of calculating the energy efficiency of buildings and STN 730540 – 4 [13]   we can see the data in the table 4, which describes partial results of the findings of the final energy need for heating.

Tab. 2)   Composition of packaging structures of the block of flats T06B

The composition of packaging structures block of flats:		
The façade of the house - front:	Inner plaster	0,0100 m
	Expanded concrete	0,0280 m
	Outer plaster	0,0300 m
The façade of the house - side:	Inner plaster	0,0100 m
	Reinforced concrete	0,1400 m
	Air gap	0,0050 m
	Expanded concrete	0,2400 m
	Outer plaster	0,0300 m
Dilatation -Reinforced concrete wall:	Inner plaster	0,0100 m
	Reinforced concrete	0,1500 m
The ceiling of the elevator machine room:	Inner plaster	0,0100 m
	Reinforced concrete	0,1500 m
Flat roof:	Inner plaster	0,0100 m
	Reinforced concrete	0,1200 m
	Basalt wool - mat	0,0600 m
	Fibreboard - Hobra	0,0150 m
Ceiling 1.floorof the exterior:	Linoleum	0,0010 m
	Glue	0,0010 m
	Cement screed	0,0400 m
	Board A 397	0,0007 m
	Expanded polystyrene	0,0250 m
	Reinforced concrete	0,1200 m
The ceiling 1.floor of the unheated ground floor:	Linoleum	0,0010 m
	Glue	0,0010 m
	Cement screed	0,0400 m
	Board A 397	0,0007 m
	Expanded polystyrene	0,0250 m
	Reinforced concrete	0,1200 m
	Inner plaster	0,0100 m

Source: own elaboration

On the basis of result value of specific energy need for heating the surface of the apartment building we can say that the building is extremely uneconomic (see table 5). There is a big heat loss through packaging design, which do not conform to STN 73 0540. For the classification of the building in energy class we use a range of energy classes for different categories of buildings listed in the decree - coll. of laws 311/2009 of energy efficiency of buildings.

Tab. 3) Thermal-technical assessment of the current condition of packaging structures according to STN 730540-2 , valid for residential house T06B B

Thermodynamic assessment of packaging structures for residential area STN 730540 - 2			
Description of structures	**Heat transfer coefficient Uv.** W/m²K	**Heat transfer coefficient Unorm.** W/m²K	**Assessment**
The façade of the house - front	1,31	0,46	Fail
The façade of the house - side	1,15	0,46	Fail
Dilatation - Reinforced concrete wall	3,50	0,46	Fail
Flat roof	0,78	0,30	Fail
Ceiling 1.floor of the exterior	1,12	0,30	Fail
The ceiling of the elevator machine room	3,91	0,35	Fail
The ceiling 1.floor of the unheated ground floor	1,07	1,91	Meets
Plastic windows and doors - orig.	2,64	1,10 (the proposed)	Fail
Plastic windows and doors (replaced)	1,57	1,10 (the proposed)	Fail
Original glazing windows and doors in the stairwell	5,55	1,10 (the proposed)	Fail
Steel front door	5,55	1,10 (the proposed)	Fail

Source: own elaboration

Tab. 4) Partial results necessary to determine the heat energy need valid for apartment building T06B

1. The total specific heat loss Ht + Hv (W/k)	**15 624,81**
The specific heat loss Ht (W/k)	**11 214,37**
The specific heat loss of heat transfer (W/k)	10 412,95
Effect of thermal bridges (W/k)	801,42
The specific heat loss of heat transfer Hv (W/K)	**4 410,44**
2. Total intrinsic gains Qi + Qs (kWh)	**347 807,89**
Solar gains Qs (kWh)	125 607,89
Intrinsic gains Qi (kWh)	222 200,00
3. The heat energy demand (kWh/year)	**952 379,41**
4. The Specific heat energy demand (kWh/m³)	**37,28**
5. The Specific heat energy demand (kWh/m²)	**107,15**

Source: own elaboration

According to this table, apartment house built in 1977 in the town Malacky belongs to the category E. This is very energy inefficient building. To improve the thermal performance of residential house, it must be completely thermal insulated. As the insulating material is mainly used an expanded polystyrene EPS 70. Based on our suggestion, in the table 6 we show different residential building constructions, along with the kind of thermal insulation and changes of the thermal insulation properties in packaging structures [14].

Tab. 5) Classes range of energy for heating

Place of consumption	Categories of buildings	Classes EPBD (kWh/m^2.a)						
		A	B	C	D	E	F	G
Heating	family houses	≤ 42	43-86	87-129	130-172	173-215	216-258	> 258
	residential houses	≤ 27	28-53	54-80	81-106	**107-133**	134-159	> 159
	office buildings	≤ 28	29-56	57-84	85-112	113-140	141-168	> 168
	school buildings and school facilities	≤ 28	29-56	57-84	85-112	113-140	141-168	> 168
	hospitals buildings	≤ 35	36-70	71-105	106-140	141-175	176-210	> 210
	buildings of hotels and restaurants	≤ 36	37-71	72-107	108-142	143-178	179-213	> 213
	sport halls and other buildings for sport	≤ 33	34-66	67-99	100-132	133-165	166-198	> 198
	buildings for wholesale and retail services	≤ 33	34-65	66-98	99-130	131-163	164-195	> 195

Source: The decree of the Ministry of Construction and Regional Development of the Slovak Republic lays down the details of calculating the energy economics of buildings [6]

Tab. 6) Thermodynamic assessment of the insulated packaging structures STN 730540-2, valid for insulated apartment building T06B

Thermodynamic assessment of packaging structures for residential area STN 730540 - 2			
Description of structures	Heat transfer coefficient Uv. W/m^{2}K	Heat transfer coefficient Unorm. W/m^{2}K	Assessment
The façade of the house - front+EPS hr. 80 mm	0,39	0,46	Meets
The façade of the house - side+ EPS hr. 80 mm	0,37	0,46	Meets
Dilatation - Reinforced concrete wall	3,5	0,46	Fail
Flat roof + EPS hr. 120 mm	0,21	0,30	Meets
Ceiling 1.floor of the exterior + EPS hr. 120 mm	0,28	0,30	Meets
Ceiling 1.floor of the exterior + Nobasil hr. 120 mm	0,30	0,30	Meets
The ceiling of the elevator machine room	3,91	0,35	Fail
The ceiling 1.floor of the unheated ground floor	1,07	1,91	Meets
The ceiling 1.floor of the unheated ground floor + Ytong 80 mm	0,37	1,91	Meets
The ceiling 1.floor of the unheated ground floor + Ytong 50 mm + spatula	0,49	1,91	Meets
The ceiling 1.floor of the unheated ground floor + Ytong 50 mm + paint	0,50	1,91	Meets
Plastic windows and doors - orig.	2,64	1,10 (the proposed)	Fail
Plastic windows and doors (replaced)	1,57	1,10 (the proposed)	Fail
Original glazing windows and doors in the stairwell	1,33	1,10 (the proposed)	Fail
Steel front door	1,33	1,10 (the proposed)	Fail

Source: own elaboration

The individual parts of an apartment building are insulated with polystyrene foam, which greatly improved the insulation of peripheral constructions. These structures conform to the revitalization of the STN 730540. Partial results and the final heat need which we got by calculations which are presented in table 7.

Tab. 7) Partial results necessary for determining the energy need for heating valid for insulated apartment building T06B

1. The total specific heat loss Ht + Hv (W/k)	**9 398,68**
The specific heat loss Ht (W/k)	**5 567,12**
The specific heat loss of heat transfer (W/k)	5 166,41
Effect of thermal bridges (W/k)	400,71
The specific heat loss of heat transfer Hv (W/K)	**3 831,56**
2. Total intrinsic gains Qi + Qs (kWh)	**345 936,28**
Solar gains Qs (kWh)	123 736,28
Intrinsic gains Qi (kWh)	222 200,00
3. The heat energy demand (kWh/year)	**442 992,16**
4. The Specific heat energy demand (kWh/m^3)	**17,34**
5. The Specific heat energy demand (kWh/m^2)	**49,84**

Source: own elaboration

Significant reduction of heat loss of peripheral structures has helped to significant reduction of energy need for heating. Warmth required to heat the original apartment building is 952 379.41 kWh per year. After the insulation of peripheral construction, replacement of entrance doors and glazing of floor is need of heat 442 992.16 kWh per year. What is up to 53.5% reduction of energy for heating the apartment building. According to the energy range of classes for different categories of buildings, we can say that panel house in Malacky belongs to category B (see table 8).

Tab. 8) The new inclusion of an apartment building after reconstruction

Place of consumption	Categories of buildings	Classes EPBD (kWh/m^2.a)						
		A	**B**	**C**	**D**	**E**	**F**	**G**
Heating	**family houses**	≤ 42	43-86	87-129	130-172	173-215	216-258	> 258
	residential houses	≤ 27	**28-53**	54-80	81-106	107-133	134-159	> 159
	office buildings	≤ 28	29-56	57-84	85-112	113-140	141-168	> 168
	school buildings and school facilities	≤ 28	29-56	57-84	85-112	113-140	141-168	> 168
	hospitals buildings	≤ 35	36-70	71-105	106-140	141-175	176-210	> 210
	buildings of hotels and restaurants	≤ 36	37-71	72-107	108-142	143-178	179-213	> 213
	sport halls and other buildings for sport	≤ 33	34-66	67-99	100-132	133-165	166-198	> 198
	buildings for wholesale and retail services	≤ 33	34-65	66-98	99-130	131-163	164-195	> 195

Source: The decree of the Ministry of Construction and Regional Development of the Slovak Republic lays down the details of calculating the energy economics of buildings [7]

An important benefit of reconstruction of residential building in Malacky can be:

- saving the funds necessary for heating the apartment building,
- extend the service life of the individual parts of the building,

- improve thermal comfort in flats - insulation also allows the elimination of structural defects and thermal bridges,
- evaluation of property and relieve the appearance of building.

5 CONCLUSION

Recent years mean distinctive advance in the field of realization of complex renovation of existing housing stock with focus on the principle of its energetic efficiency. Energetic effectiveness is not possible to be understood just as problematic of energetic sector. It is cross-sectional problematic distinctly influencing all fields of national economics.

It is necessary to emphasize that energetic low-budget measures is not possible to implement without necessary financial supportive mechanisms as well as the use of particular operative programmes of structural funds. Another possibility is international programmes and funds and solving of project financing of energetic effectiveness via public-private partnerships PPP (Public Private Partnership).

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THE EFFECT OF DIAMETER AND LENGTH-TO-DIAMETER RATIO ON THE COMPRESSIVE STRENGTH OF CONCRETE CORES

Kilinc Kadir[1], Ahmet Ozan Celik[2], Mustafa Tuncan[3], Ahmet Tuncan[4]

Abstract

Compressive strength tests were performed on 2352 specimens and the effect of core diameter and core length-to-diameter ratio on concrete core strength was examined. The strength correction factors were determined to convert the strength of a core with a diameter of 94, 69, 46 or 28 mm to that of a core having a diameter of 94 mm. In the present experimental investigation, the effects of the l/d ratio of cores drilled from 180-day-old concrete beams on the core strength were studied. Additionally, test results revealed that the length-to-diameter ratio of the specimen is more significant for small diameter cores and microcores.

Key words

Compressive strength, core diameter, core length-to-diameter ratio, core strength, microcores.

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1 INTRODUCTION

Compressive strength of concrete is probably the most important single property of concrete. Knowledge of the compressive strength is important as an indication of other properties of concrete [1, 2]. The simplest compressive strength test uses the standard test specimens such as cubes and cylinders [1]. Potential strength relates to the quality of the concrete used and is an estimate of the standard test specimens [3]. However, In-situ strength is the strength of the concrete as it exists in the construction and is the end result of the quality of concrete in the construction [4]. The estimate of in situ concrete strength is one of the problems most frequently encountered whenever it is necessary to assess the bearing capacity of a structure; as a result, research in this field has been very active and has led to the development of a wide variety of destructive and non-destructive methods [5]. It is well established that the properties of In-situ concrete will vary within a member, due to differences of compaction and curing as well as non-uniform supply of material [1, 6]. Core compressive strength test is one of the most reliable tests used for the assessment of in-situ strength of concrete [7, 8]. Generally, cores are drilled and then tested when the strength of concrete in structures is doubted [7, 9]. If the cores are tested to shape the actual concrete strength, the test results should be carefully evaluated since there are a number of factors affecting the core strength [7, 10]. The diameter of the core affects the compressive strength test results of cores [11]. Both ASTM and British Standards allow a minimum core diameter of 102 mm provided that the diameter of the core is at least three times greater than the maximum aggregate size in concrete mixture [12, 13]. The Concrete Society published an addendum to its report on core testing in 1987 that allows the use of 51 mm and 76 mm diameter cores [14]. Standards of some countries including Turkey permit using small diameter cores but, the minimum diameter is 51 mm when the core is intended to be used for investigation of in-situ strength of concrete [15]. Recently published Turkish Standard, TS EN 12504-1, does not restricts the core diameter but stresses strongly to take into consideration the diameter of the core [16]. However, relevant standards don't include the correction factors for the strengths of different diameter cores.

2 LITERATURE REVIEW

The diameter affects the strength of the core in accordance with general size effect [11]. As the diameter of the core decreases, the volume of the specimen also decreases significantly for a given length-to-diameter (l/d) ratio. It is generally accepted that the likelihood of occurring elements of a given extreme (low) strength arises in a larger volume according to Griffith's hypothesis. Thus, the strength of a specimen lowers with an increase in its size [7]. Smaller diameter cores with l/d ratios should give higher average strengths than larger diameter cores due to the size effect. However, the situation is different for concrete cores since they are susceptible micro-cracking caused by drilling operation [17]. Some of the energy and effort used to cut and remove the specimen invariably causes damage to the core. This could be in the form of microcracking, weakening, or breaking of the bond of the cement matrix to the surface of the aggregate particles, or by causing major cracks or damage to the core [18]. Moreover, the homogeneity of the material in test specimen diminishes with a decrease in diameter and this may also affect the internal failure characteristics of the specimen [19]. Finally, the effects of drilling are much more important for small diameter cores since the damaged part of the core has a constant thickness independent of the core diameter. Assuming 102 mm diameter and 204 mm height cores as standard specimens, Bartlett found average correction factors of 0.98 and 1.06 for 152 mm and 51 mm diameter cores having same l/d ratio, respectively [20]. The most common criticism on the strengths of small diameter cores

is that they are unreliable. The small diameter cores have a higher variability than standard size cores [7, 19]. For cores with larger diameter, the coefficient of variation of the core strength depends mostly on the variability of the undamaged interior region. Additionally, the large variability of small diameter specimens may be caused by the large variability of the in-situ concrete strength within the element being cored [11]. Consequently, most of the investigators indicate that the variability of the strength of small diameter cores is greater than that of larger diameter cores even when the strengths are very close to each other [7, 21]. Since it is not always possible to drill cores of this size, experimenters are often forced to utilize smaller diameters. However, as the diameter decreases, it is hard to assess the results correctly and to convert core strength into the corresponding strength values as would be obtained on standard specimens, such as the cubes specified by many existing standards [5]. Small cores are often used as substitutes for large cores to test the strength of concrete. They have many advantages of being easily drilled and cut, and are of small damage to structures compared to larger cores [22]. Although standards normally indicate cores to have a minimum diameter of 100 mm for compressive strength testing, microcores offer many considerable advantages in terms of reduced cutting effort, time and damage. Microcores as small as this can be drilled in situ with very light and easy to wield equipment, resulting in greatly reduced costs; what is more, by using this technique, damage to the structure becomes virtually negligible and core testing can be classified as a non-destructive method [5, 23]. The aim of microcore testing is to bring together the advantages of classical core tests and those afforded by non-destructive methods.

A practically non-destructive method of testing focused on the strength of microcores (28 mm diameter) obtained from existing structures was developed by Indelicato for the determination of cube strength of concrete types commonly used in the building industry. It is stated that the standard l/d ratio of 2 is suitable, not only because the end effect is largely eliminated and a zone of uniaxial compression exists within the specimen, but also because a slight departure from this ratio does not significantly affect the measured value of strength [7]. The former Turkish Standard, TS 10465, recommends the use of cores having equal length to diameter [15]. The recently published Turkish Standard, TS EN 12504-1, states that the length-to-diameter ratios of 2 and 1 should be selected if the core strength will be converted into the cylinder or cube strength [16].

However, no correction factors are given for the strength of cores with the l/d ratio between 2 and 1 in the previous and current Turkish standards. ASTM and former British Standards give correction factors for shorter cores as shown in **Table 1** [24, 25]. The effects of moisture content of the core specimen, diameter, and strength level of concrete from which the cores are removed, are not taken into consideration in these correction factors. Bartlett and MacGregor found that the l/d ratio is more important for small diameter cores [26]. Moreover, there is some indication that as the concrete strength increases, correction factors become closer to 1.0 [7, 26, 27].

3   RESEARCH SIGNIFICANCE

The diameter of the core and core length-to-diameter ratio plays an important role on the evaluation of the core test results. The main objective of the present study is to determine the effect of core diameter and core length-to-diameter ratio on concrete core strength.

Tab. 1)   Strength correction factors for core specimens of different l/d ratios

Length-to-diameter Ratio	Correction Factor	
	ASTM	BS
2,00	1,00	1,00
1,75	0,98	0,97
1,50	0,96	0,92
1,25	0,93	0,87
1,00	0,87	0,80

4   EXPERIMENTAL STUDY

In this investigation, six concrete mixtures were produced using one type of aggregate with maximum size of 22 mm. The core specimens were drilled from 250x300x650 mm beam specimens produced from these mixtures and the effect of core diameter and core length-to-diameter ratio on concrete core strength was examined. An ordinary Portland cement and a crushed limestone were used in concrete production. Particle of maximum size of 22 mm was utilized. A plasticizer was also used in some of the mixtures to increase the workability. Mix proportions and properties of concrete mixtures are given in **Table 2** and **Table 3**, respectively.

Tab. 2)   Proportions of concrete mixtures

Mixture	Mix Proportions, kg/m³				
	Coarse Aggregate	Fine Aggregate	Cement	Water	Admixture
CON-A	1130	924	100	172	–
CON-B	1039	850	238	190	–
CON-C	993	813	320	195	–
CON-D	973	796	420	177	5,46
CON-E	820	671	580	231	7,54
CON-F	795	650	700	210	14

   – = not added.

Tab. 3)   Properties of concrete mixtures

Mixture	w/c ratio	Aggregate type	Maximum aggregate size, mm	28-day cylinder compressive strength, MPa*	180-day cylinder compressive strength, MPa*	28-day cube compressive strength, MPa*	180-day cube compressive strength, MPa*
CON-A	1,72	Crushed limestone	22	5,5	5,7	9,3	10,0
CON-B	0,80			11,4	15,4	13,1	17,2
CON-C	0,61			18,9	24,0	26,6	32,5
CON-D	0,42			38,8	41,3	42,7	46,0
CON-E	0,40			44,1	47,7	48,5	56,4
CON-F	0,30			45,4	53,1	56,8	58,6

* The values quoted are a mean of six specimens

Beam specimens were cast and moist cured in the laboratory until testing. The cores with diameters of 94, 69, 46, and 28 mm were removed from the beams by drilling in the direction perpendicular to the direction of concrete placement. Then, the cores were trimmed to proper lengths so that to have the l/d ratios of 2.0 and 0.25. The compressive strengths of cores were determined at the age of 180 days. The compressive strength was obtained from the average of at least six specimens. A total number of 2352 cores were tested in this study.

5   EXPERIMENTAL RESULTS AND DISCUSSION

In this investigation, the cores of 94 mm diameter were considered as standard core specimen. The compressive strength values of 94 mm diameter cores with l/d ratios of 2 and 1 are given in **Table 4**.

Tab. 4)   Compressive strength values of 94 mm diameter cores *

Mixture	Compressive Strength, MPa	
	Length-to-diameter Ratio=2	Length-to-diameter Ratio=1
	180 days	180 days
CON-A	4,18	5,73
CON-B	13,44	15,72
CON-C	21,82	25,51
CON-D	34,30	35,97
CON-E	38,26	43,35
CON-F	42,02	42,97

  * The values quoted are a mean of at least six specimens
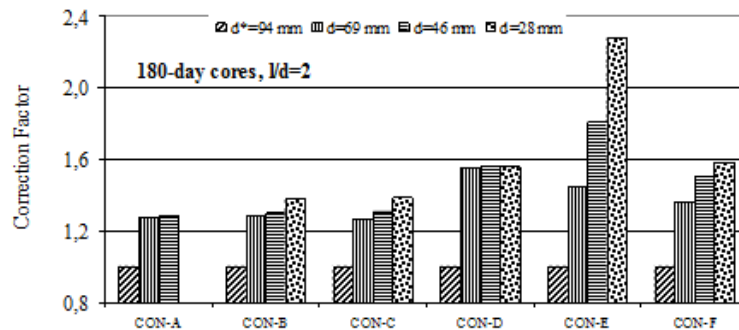
Fig. 1)   Strength correction factors for different diameter cores (l/d=2)
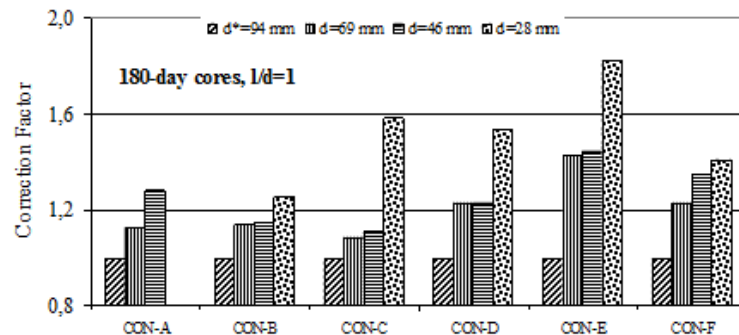
Fig. 2)   Strength correction factors for different diameter cores (l/d=1)

The strength correction factors for cores with different diameters were calculated by dividing the strength of 94 mm diameter core to that of different diameter core. **Fig. 1** and **Fig. 2** illustrate these correction factors calculated for cores having l/d ratio of 2 and 1, respectively.

5.1   Influence of Length-to-Diameter Ratio on Core Diameter Effect

Fig. 3 illustrates the trend-lines of the average correction factors obtained from 180-day results. It was observed that the correction factors gradually increased when the diameter of the core decreased. This was found to be valid for both l/d ratios of 2 and 1. However, the factors for 94, 69, and 46 mm were slightly lower for l/d ratios of 1 than those for l/d ratios of 2. The effect of l/d ratio was more significant for 28 mm diameter microcores. Moreover, the average correction factors for cores having l/d ratio of 2 varied in a wider range than those having l/d ratio of 1. The effect was more significant in 28 mm diameter cores. Similarly, Bartlett et al. found that the effect of length-to-diameter ratio on the core compressive strength is more significant for 51 mm diameter cores than for 102 mm diameter cores [11].
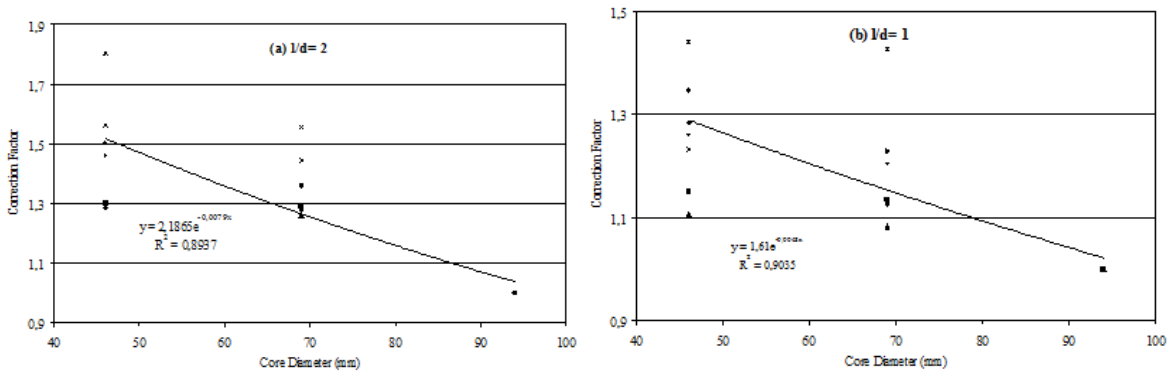
Fig. 3)   Trend-lines of average correction factors

5.2   Proposed equations for core diameter effect

Eq. (1) and **Eq. (2)** are the relationships for cores having l/d ratios of 2 and 1, respectively. In these equations, CF_d is the strength correction factor for different diameter cores other than 94 mm and d is the core diameter in mm.

$$CF_d = 2.1865e^{-0.0079(d)} \qquad (l/d=2) \qquad\qquad (1)$$
$$CF_d = 1.61e^{-0.0048(d)} \qquad (l/d=1) \qquad\qquad (2)$$

5.3   Influence of length-to-diameter ratio on core strength

The effect of length-to-diameter ratios of core specimen on concrete core strength was investigated. The core with the l/d ratio of 2 was considered as the standard specimen and the strength correction factors were calculated for other l/d ratios. The compressive strength values of 180-day age cores with the l/d ratio of 2 are shown in **Fig. 4**.
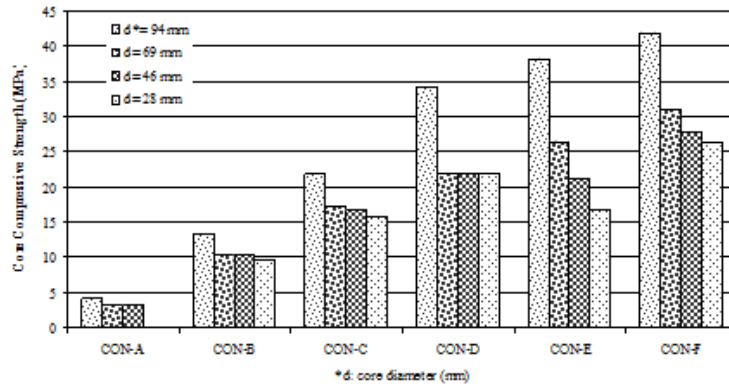
Fig. 4)   Compressive strengths of different diameter cores with the l/d ratio of 2

The test results showed that the compressive strength of cores gradually decreased when the diameter of the specimen decreased. The average compressive strengths of cores removed from CON-A were 4.18 MPa for 94-mm and 3.25 MPa for 46-mm diameter cores, respectively. It should be noted that it was not possible to drill microcores from the beams of CON A due to very low strength. The homogeneity of the material in a small test specimen is considerably reduced in comparison with a larger specimen and this may also affect the internal failure characteristics of the specimen. This is strongly stressed in the current Turkish standard [16]. The strength correction factors for different l/d ratios of 94, 69, 46, and 28-mm diameter cores are shown in **Figs. 5–8**, respectively.
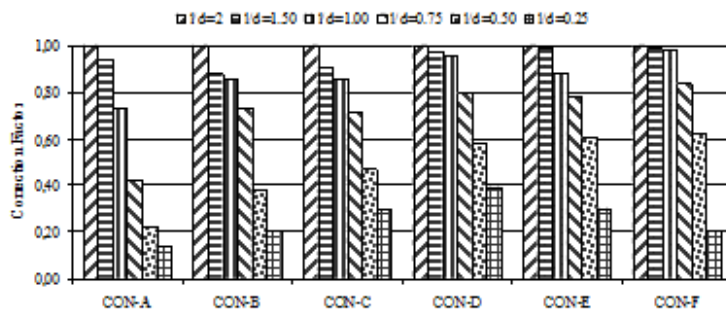
Fig. 5)   Strength correction factors for l/d ratios of 94-mm diameter cores
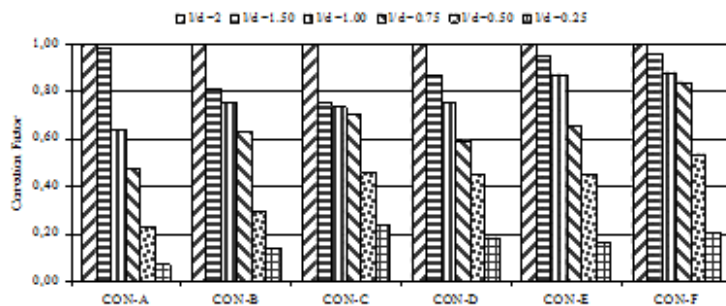
Fig. 6)   Strength correction factors for l/d ratios of 69-mm diameter cores
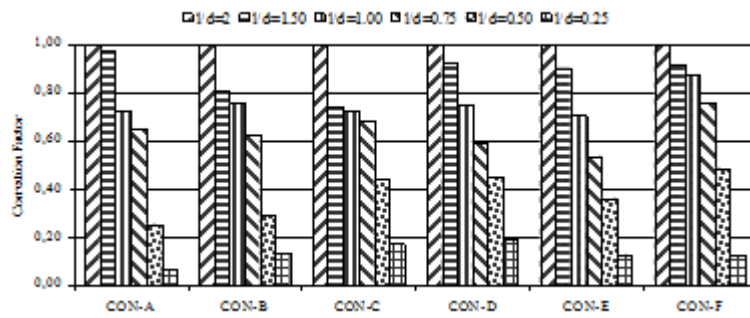
Fig. 7)   Strength correction factors for l/d ratios of 46-mm diameter cores
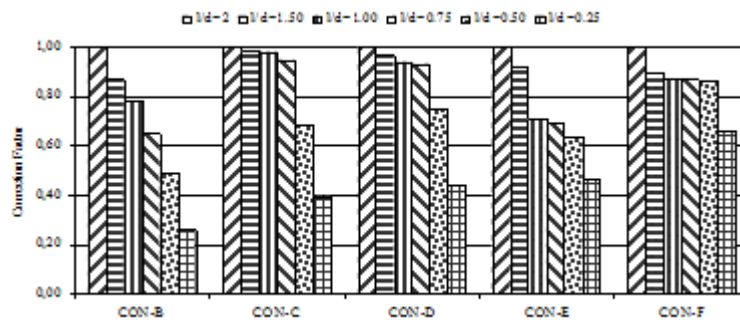
Fig. 8)   Strength correction factors for l/d ratios of 28-mm diameter cores

As was expected, the compressive strength of cores increased as the l/d ratio of the specimen decreased. Therefore, the strength correction factors decreased with the decrease in the l/d ratio. Similar to the findings of Bartlett et al. it was observed that the effect of the l/d ratio became more significant as the diameter of the core specimen became smaller [11]. Moreover, as the strength of concrete increased, the correction factors became closer to 1 as stated by Kesler [27]. Although the cores having a l/d ratio of 0.75 gave higher strength values, the results of the present investigation revealed that there were no pronounced differences between the strengths of cores with l/d ratios of 1 and 0.75, especially for 28-mm diameter microcores. However, the difference between the correction factors having l/d ratio of 0.50 and 0.25 was significant. The differences between the strength correction factors calculated for cores with an l/d ratio of 1 and those calculated for cores with an l/d ratio of 0.75 were found to be more significant for 46-mm and 28-mm diameter cores. As the strength of concrete increased, the correction factors also increased for 28-mm diameter cores with l/d ratio of 0.50 and 0.25. It has been found that the correction factors were observed such as 0.86 and 0.66 for 28-mm diameter cores with l/d ratio of 0.50 and 0.25 for CON-F. It seems that the cores having a l/d ratio of 0.50 and 0.25 can be used in the evaluation of core strength results especially for microcores.

The correction factors were calculated and shown in **Fig. 9**. In the same figure (**Fig. 9**), the correction factors proposed by other investigators or recommended by ASTM (ASTM C 42/C 42M-04) and BS (BS 1881) standards are plotted.
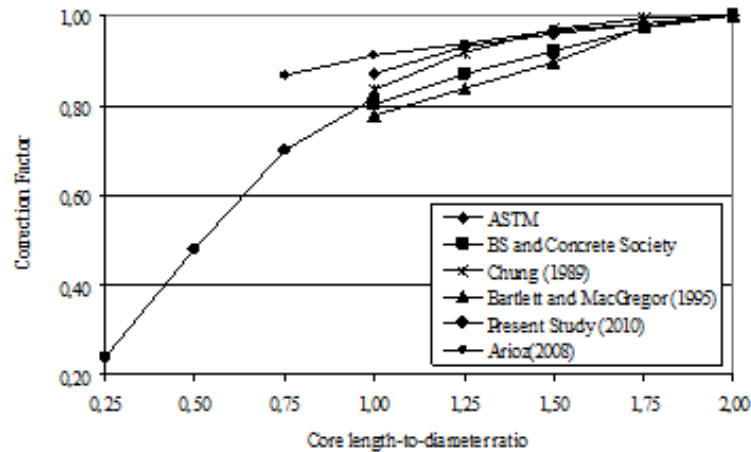
Fig. 9)   Strength correction factors for different l/d ratios

It is obvious that the correction factors obtained in the present study are very close to BS and Concrete Society correction factors. The following logarithmic relationships with R^2 value of 0.9684, 0.989, 0.9892, and 0.9728 for 94, 69, 46, and 28-mm diameter cores were established to fit the correction factors well, respectively.

$CF_{l/d} = 0.3806 \; \text{Ln} \, (l/d) + 0.7915$	94 mm diameter core	(3)
$CF_{l/d} = 0.4103 \; \text{Ln} \, (l/d) + 0.7341$	69 mm diameter core	(4)
$CF_{l/d} = 0.4237 \; \text{Ln} \, (l/d) + 0.7229$	46 mm diameter core	(5)
$CF_{l/d} = 0.2591 \; \text{Ln} \, (l/d) + 0.8419$	28 mm diameter core	(6)

where $CF_{l/d}$ is the correction factor and *l/d* is the length-to-diameter ratio of the core.

6   CONCLUSION

It was observed that the correction factors gradually increased when the diameter of the core decreased. This was found to be valid for both l/d ratios of 2 and 1. The effect of l/d ratio was more significant for 28 mm diameter microcores. The test results showed that the compressive strength of cores gradually decreased when the diameter of the specimen decreased. The compressive strength of cores increased as the l/d ratio of the specimen decreased. Therefore, the strength correction factors decreased with the decrease in the l/d ratio. As the strength of concrete increased, the correction factors became closer to 1. The differences between the strength correction factors calculated for cores with a l/d ratio of 1 and those calculated for cores with a l/d ratio of 0.75 were found to be more significant for 46-mm and 28-mm diameter cores. It seems that the cores having a l/d ratio of 0.50 and 0.25 can be used in the evaluation of core strength results especially for microcores. It is obvious that the correction factors obtained in the present study are very close to BS and Concrete Society correction factors.

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SHEAR WALL BUILDINGS, CONFLICTS BETWEEN ARCHITECTURAL DESIGN AND EUROPEAN STANDARD FOR DESIGN OF STRUCTURES IN SEISMIC ZONES

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Abstract

European standard for design of structures in seismic zones EN 1998-1 prescribes basic principles of conceptual design: structural simplicity, uniformity and symmetry. Structural simplicity is characterised by existence of clear and direct paths for transmission of the seismic forces. Uniformity of structure along the height of the building eliminates occurrence of sensitivity zones of stress and large ductility demands. Regularity in elevation significantly limits conceptual architectural design and functionality. Most buildings have different purposes on different floors: Lower storeys - garage, middle storeys - business offices, upper storeys - housing. Structural form is often changes between floors and regularity in elevation can't be achieved. Structural irregularity problem is solved through seismic detailing. Article presents three irregular buildings designed in Croatia, structural design problems and seismic detailing.

Key words

Architectural conceptual design, design of structures in seismic zones, EN 1998-1, shear wall buildings, structural simplicity, symmetry, uniformity.

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1   INTRODUCTION

Conceptual design of buildings for human occupancy is determined by architects. Structural engineer must also be involved in early stages of conceptual design because it largely determines type and effectiveness of the earthquake-resisting system that can be used [1], [2]. According to our experience, in most cases structural engineers are involved in architectural conceptual design only for large buildings in Croatia. Largely building plans are made and location permit issued by Croatian authorities for small and medium size buildings is obtained by architect before structural engineer involvement in design process. In case of poor seismic conception of building, structural engineer can only improve poor solution.

European standard for design of structures in seismic zones EN 1998-1 [3], [4] prescribes basic principles of conceptual design: structural simplicity, uniformity and symmetry. Structural simplicity is characterised by existence of clear and direct paths for transmission of the seismic forces. Uniformity of structure along the height of the building eliminates occurrence of sensitivity zones of stress and large ductility demands. Regularity in elevation significantly limits architectural design and functionality. Most buildings have different purposes on different floors: Lower storeys - garage, middle storeys - business offices, upper storeys - housing. Structural form is often changes between floors and regularity in elevation can't be achieved. Article presents three irregular buildings designed in Croatia, structural design problems and seismic detailing.

2   CASE 1: APARTMENT BUILDING IN MOKOSICA NEAR DUBROVNIK

Apartment building is located in Mokosica near town Dubrovnik in high seismicity zone with design ground acceleration ag = 0,3·g. Architect designed structure with complex L shaped floor plan above garage (Fig.1).
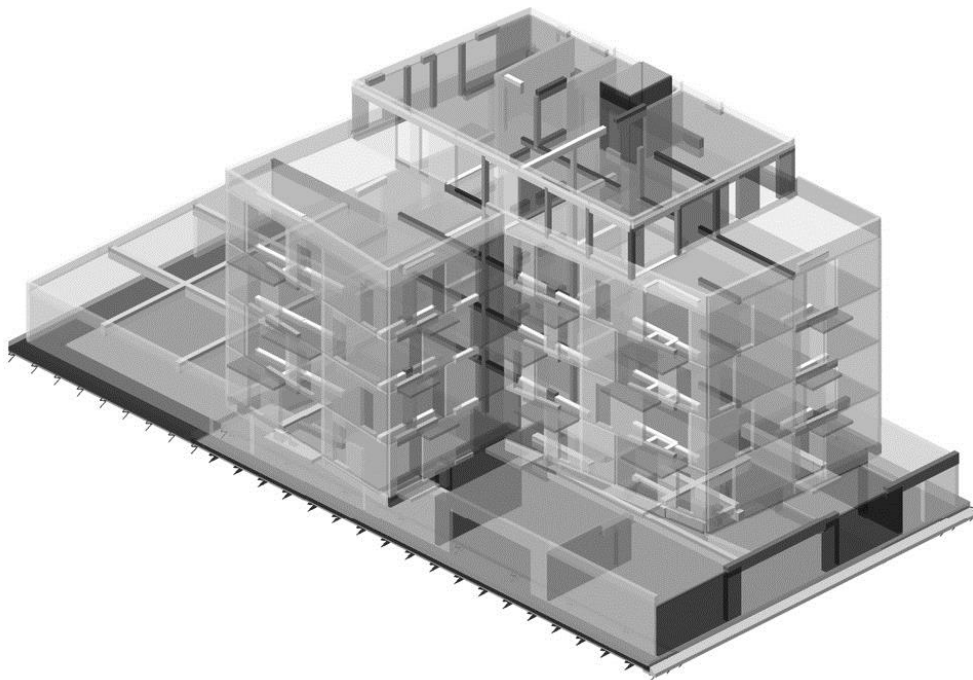
Fig. 1)   FEM model of apartment building in Mokosica near Dubrovnik

Four apartment storeys and penthouse are laying over garage. Vertical communication is established by elevator and staircases. Regularity in elevation is disrupted by parking places in garage. Some shear walls in apartment storeys are forming deep beams and other are only laying on beams b/h = 40 / 220 cm. Some deep beams are indirectly supported by reinforced concrete cross beams (Fig.2, Fig.3) forming grillage structure in garage ceiling slab. Cross beams are supported by reinforced concrete walls inside garage.
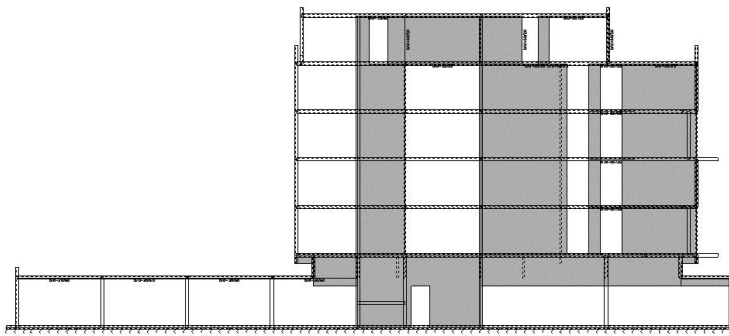
Fig. 2)   Wall panel in longitudinal direction of the building
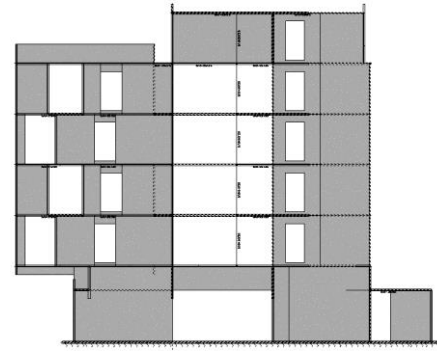
Fig. 3)   Wall panel - transversal direction

Structural engineers informed architect and investor about seismic design criteria described in [3], [4], [5], [6] but they insisted on their architectural design. According to EN 1998-1 [3] structural system was classified as irregular with medium ductility class (DCM). Structural irregularity demands design by modal analysis on spatial FEM models. Behaviour factor for linear earthquake analysis was multiplied by 0,80 according to [3], [4] for non-regular in elevation buildings. Long shear walls in apartment storeys in two orthogonal directions gave large torsional stiffness about a vertical axis. Vibration of first mode (T1 = 0,275 s) is in longitudinal direction and second mode (T2 = 0,213 s) in transversal direction. Third mode is torsional (T3 = 0,109 s). Interstory drift is very small due to large stiffness. Only five storeys above garage and large stiffness caused by long shear reinforced concrete walls allowed formation of described irregular structure.

3   CASE 2: BUILDING IN NEHAJSKA STREET, ZAGREB

Nehajska street building in Zagreb has three underground garage storeys, ground floor for business offices and upper seven apartment storeys (Fig.4). Underground part of the building (foundation slab, two garage ceiling slabs 20 cm thick, reinforced concrete walls in garage, ground floor slab 70 cm thick) forms "foundation structure" for the aboveground part of the building. Floor plan is rectangular 24,30 × 13,20 m. Car elevator enables vertical transportation of cars in underground garage. Aboveground storeys have shear reinforced concrete wall structural system. Regularity in elevation is disrupted in first business offices floor and in garage due to parking places (Fig.5, Fig.6, Fig.7). About 40 % of walls continue uninterrupted from foundation slab to roof slab. Rest of the walls are laying on 70 cm thick reinforced concrete slab (garage level -1 ceiling) or they are indirectly supported by walls going in orthogonal direction. Unfortunately building is located in high seismicity zone with design ground acceleration ag = 0,3·g. Detailed 3D FEM seismic analysis for non-regular medium ductility class building showed that building can resist earthquake according to [3]. First two modes of vibration (T1 = 0,30 s, T2=0,24 s) are orthogonal translations, and third mode is torsional (T3= 0,20 s). Additional shear reinforcement to is placed in 70 cm thick slab under shear walls going only through aboveground storeys to prevent punching [7], [8] and to

enable formation of "hidden" reinforced concrete beam inside the slab. Structural design had to be made following construction stages.

Fig. 4)   FEM model of the building in Nehajska street, Zagreb
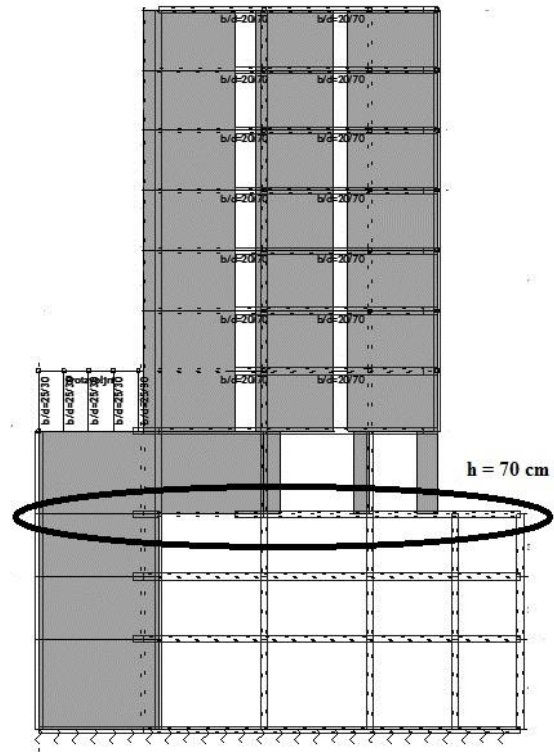
Fig. 5)   Shear wall panel H3 - orthogonal walls in garage under wall panel
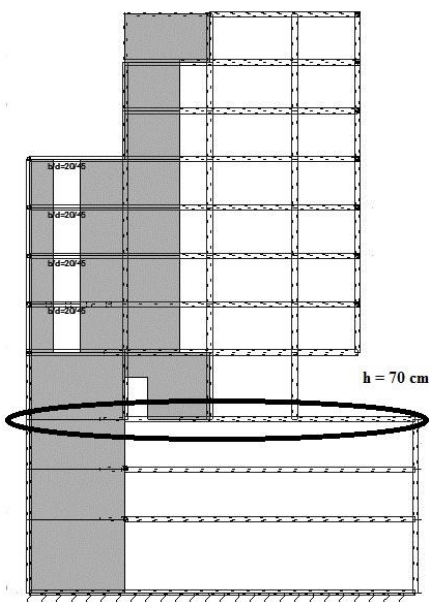
Fig. 6)   Shear wall panel H5
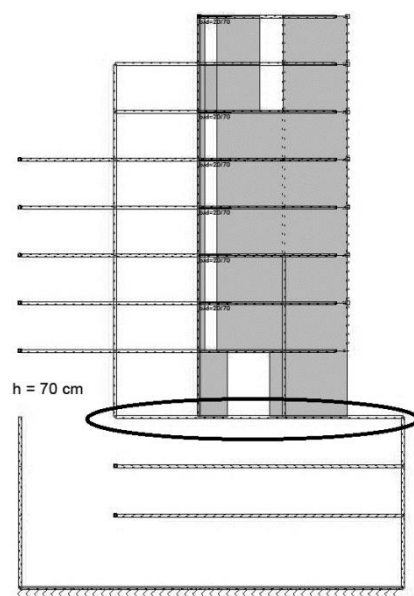
Fig. 7)   Shear wall panel H6

4   CASE 3: HYPO CITY BUILDINGS IN ZAVRTNICA QUARTER OF ZAGREB
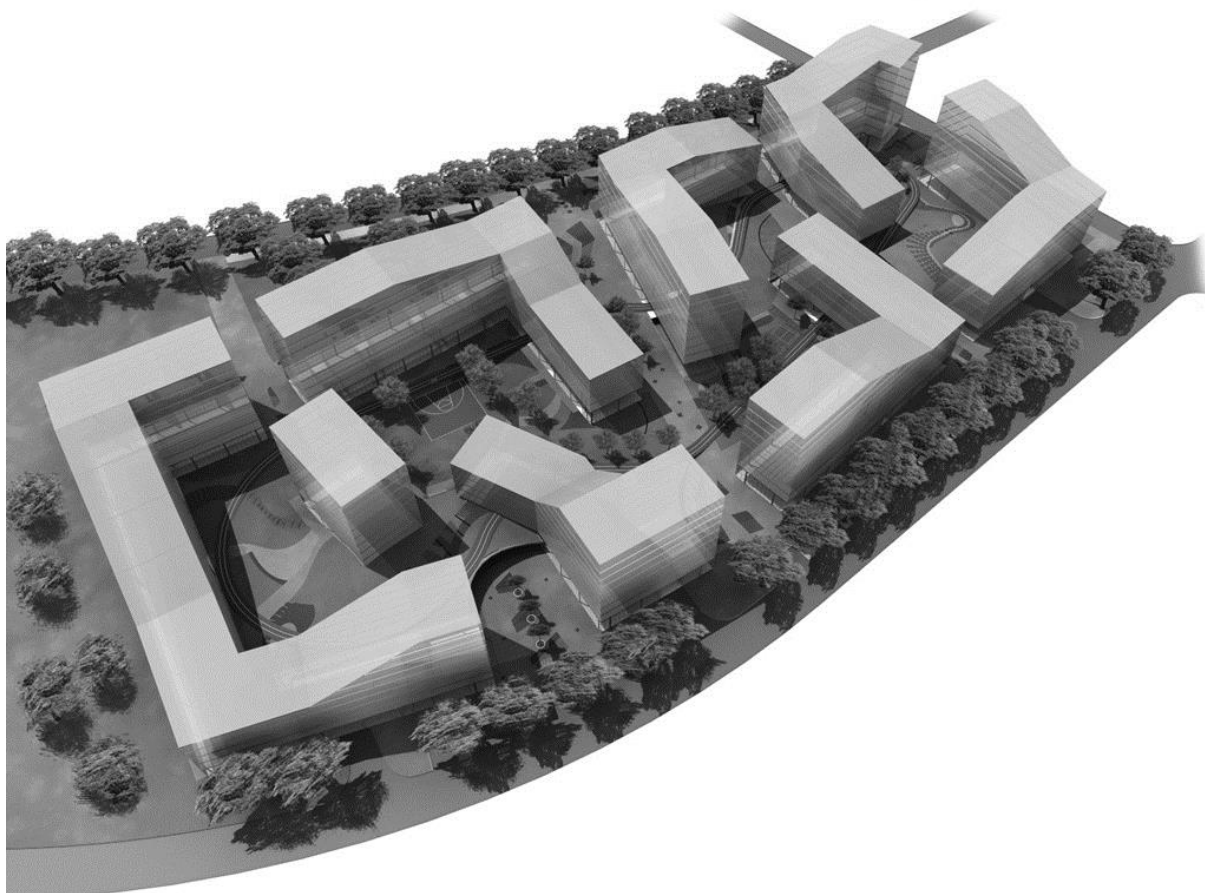
Fig. 8)   Architectural design of "Hypo city" buildings in Zavrtnica quarter of Zagreb

Architectural design of Hypo city buildings in Zavrtnica quarter of Zagreb was made by 3LHD architecture and urban planning studio, Zagreb, Croatia (Fig.8). Building complex is divided in four building segments, each consisting of two buildings. Main purpose of complex is housing. Buildings have two underground garage storeys, ground floor for business offices and four to eight apartment storeys above. Underground garage is positioned under whole complex. Green roof is placed on garage reinforced concrete ceiling slab between buildings. Also roadway for fire-fighting vehicles and delivery trucks is designed between buildings over garage roof slab. Regarding complexity of floor plan, buildings were divided in four categories: one rectangular, one C shaped, five mainly L shaped, and one like deformed "Z" shaped building. C and L shaped buildings are long and are divided by seismic joints in rectangular floor plan structures as it is preferred in [1], [2], [3] for buildings in seismic areas. Division of floor slabs by seismic joints also reduced forces caused by temperature actions and shrinkage of concrete. The most challenging structure was "Z" shaped building. Complexity and relatively small floor plan dimensions enabled division of building in rectangular floor plan structures. Structural 3D FEM model has been made using ETABS and Tower (Fig.9) structural engineering software. Both programs gave similar results. First mode of vibration ($T_1 = 0,34$ s) is torsion, second mode ($T_2 = 0,28$ s) translation along longer floor plan diagonal axis of the building together with small torsion rotation. Avoidance of torsion along vertical axis of the structure in two first modes of vibration is preferred according to [1], [2], [3].
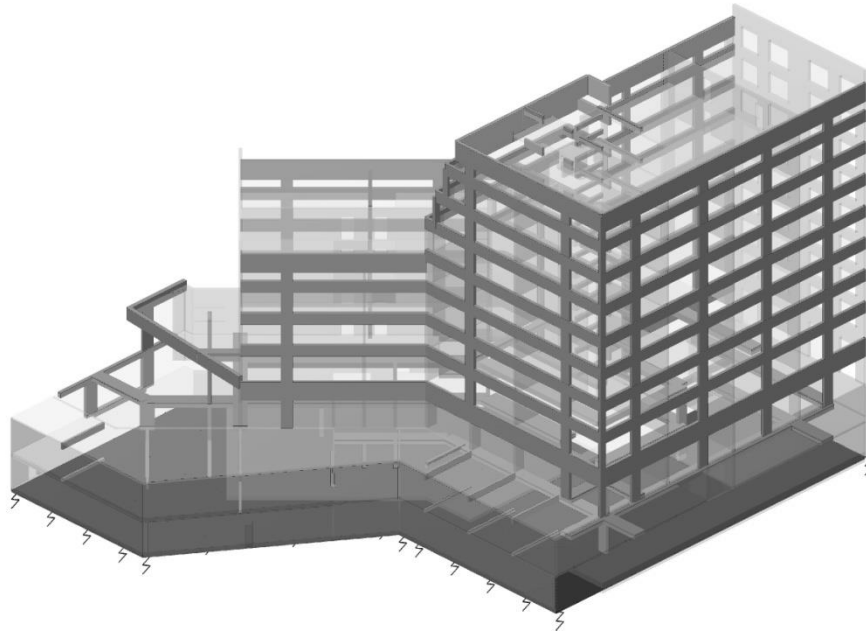
Fig. 9)   FEM model of Hypo city "Z" shaped building in Zavrtnica quarter

Redefinition of floor plan was not allowed by investor. Fortunately aboveground storeys have long reinforced concrete walls in orthogonal directions that can easily resist longitudinal shear forces along their axes. Regularity in elevation is disrupted in ground floor and in garage due to parking places, similarly as presented in cases of Mokosica and Nehajska street buildings (Fig. 10, Fig. 11).
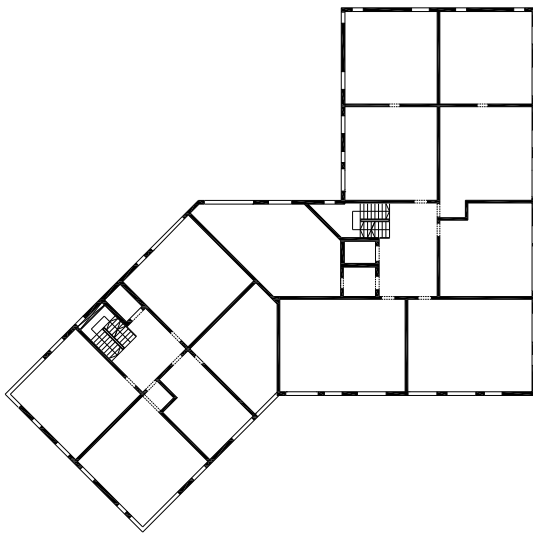
Fig. 10)   Second storey floor plan   **Fig. 11)**   Garage -1 underground storey floor plan
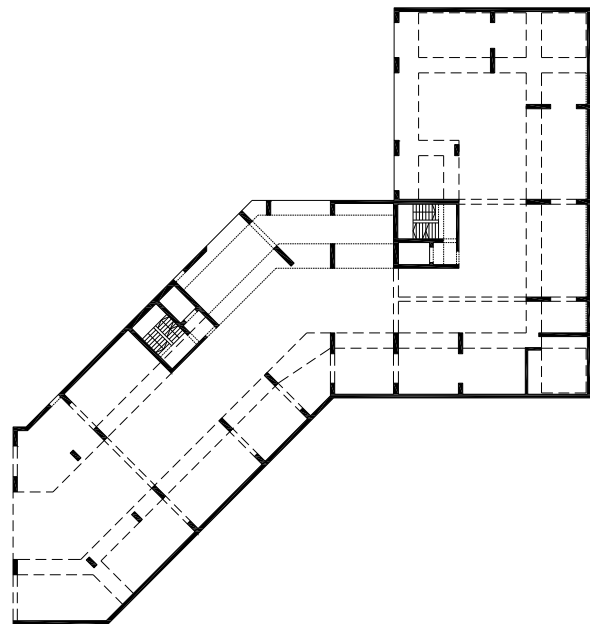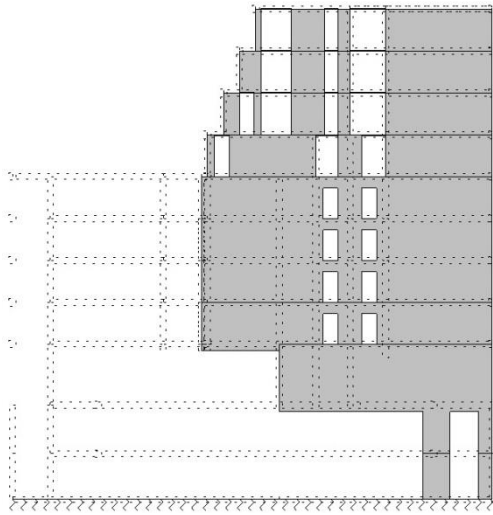
Fig. 12)   Shear wall panel H9
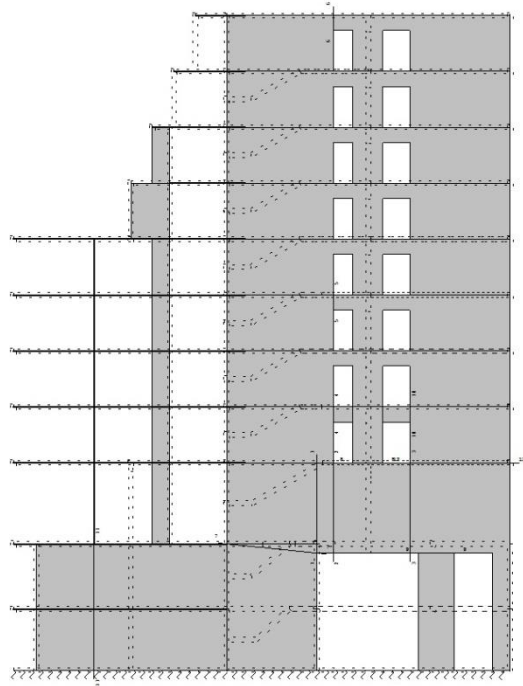
Fig. 13)   Shear wall panel H13
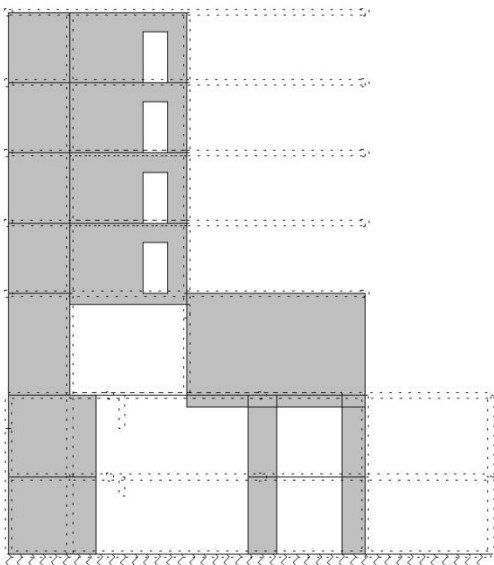
Fig. 14)   Shear wall panel K26
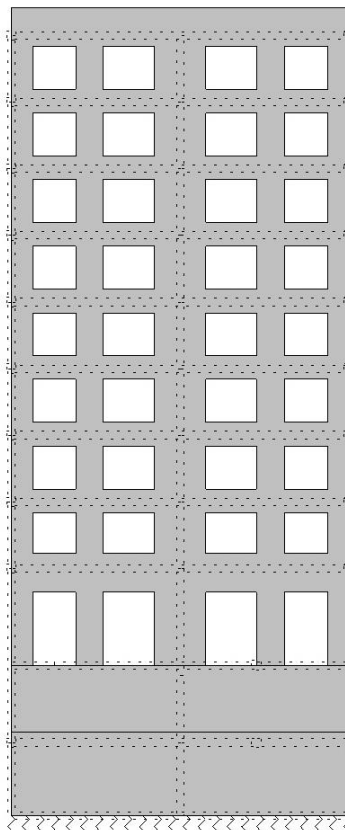
Fig. 15)   Shear wall panel H17

Complex structural system was designed consisting of continuous shear wall going from foundation slab to roof (Fig.13, Fig.15) and indirectly supported deep beams by shear walls going from orthogonal direction (Fig.12, Fig.14). Structure is very stiff. Exterior reinforced concrete walls are designed to resist seismic forces multiplied by factor 1,50.

5   CONCLUSION

Architects and investors intend to design and build extraordinary and irregular structural forms especially in last fifteen years in Croatia. The article briefly presents seismic design problems caused by structural irregularity in elevation on shear wall apartment buildings with underground garages. Problems and possible solutions are explained on three different buildings designed in high seismicity zones in Croatia. Ground floor are often used for business purposes causing structural system weakening. Greater structural change is introduced between ground floor and underground garage highest storey. Formation of parking places and driving lanes in garage enables continuation of some reinforced shear walls from apartment storeys to foundation slab. Structural regularity in elevation preferred by seismic design codes [1], [2] can't be achieved. Seismic resistance is solved by careful local ductility detailing of reinforced concrete elements [1], [3], [9].

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USE OF SPECIAL STEEL BRACING SYSTEMS IN REINFORCED CONCRETE STRUCTURES

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Abstract

It is quite a long time known that steel bracing has important contribution to the lateral strength and ductility of both RC and steel frames. In addition to concentric bracings placed in between the beam and column connections there are several other bracing configurations found in literature. In Japanese practice another closed frame braced by diagonals are placed in a RC frame by shear studs and connected to peripheral elements in continuous way. Some of the others knee bracing type configurations can be found in the literature as well. Most of the ordinary RC buildings have the common deficiency which is the lack of proper detailing in the zones of beam-column connections. This future should be kept in mind if cost effective retrofitting technique is going to be proposed for ordinary RC buildings. Therefore knee bracing which are activating the sections where the strength has not be exploited yet either by vertical and horizontal loads becomes very interesting. In this article the results of five different type of bracing configurations have been presented together with for reference frames in laboratory to see the effectiveness of the bracing systems proposed. The experimental results were theoretically achieved through non-linear analysis and the findings were used to retrofit a five storey RC structure which is strengthened by means of other retrofitting techniques. Energy dissipating capacities, damping ratios drift ratios and fundamental periods are all compared. One of the important aspects of retrofitting by light steel bracing configurations is to minimize the changes on the structural characteristics of the existing systems. In other words no drasting changes should be expected in the vibrational characteristics of the original structure and hence on the amount of earthquake forces to be imparted to the structure.

Key words

Ductility, energy dissipation, knee-braced, load carrying capacity, non-linear analysis.

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1   INTRODUCTION

It is an important issue to rehabilitate the vulnerable low-cost, low-rise structures of the big metropolitan cities located on earthquake prom areas such as Istanbul by means of cost effective retrofitting techniques. After having experienced different techniques such as converting the structural portioning walls to structural walls integrating them to the peripheral RC elements and keeping them in their own position during the whole course of earthquake excitation is a good way to resist earthquake loads.

The basic philosophy behind the RC specimens strengthened by different configurations of steel diagonals is to create more sections with reserved capacity either on existing rc elements or in steel elements to dissipate more energy imparted to the structure by seismic excitation, [1]. The steel diagonals are not blocking totally the flexural behavior of individual RC elements in the inelastic excursions and they can be mounted or renewed very easily if they experience excessive plastic deformations during severe displacement reversals.

Use of steel bracing in concrete-framed structures to determine the degree of effectiveness of different diagonal bracing arrangements to increase the in-plane shear strength of the concrete frame and to observe the relative behavior of tension and compression braces, [2]. Special form of diagonal brace connected to a knee element instead of beam-column joint, is investigated, [3]. The transformation of a complex problem into a new, practical set of design charts and graphs is demonstrated. For diagonal-knee bracing using the elastic behaviour of the system, a suitable shape and angle is proposed. Pushover experiments conducted on scaled models of ductile RC frames, directly braced by steel X and knee braces are tested, [4]. In this paper, knee type of bracing increase the yield capacity and the strength capacity of a ductile RC frame. It is concluded that both X-bracing and knee-bracing systems may be used to design or retrofit for a damage-level earthquake. A new structural lateral bracing system called 'Chevron Knee Bracing' (CKB) is investigated, [5]. As a result, based on the presented optimal shape of the CKB in this paper, two step-by-step algorithms accompanied by appropriate main graphs and charts are suitably demonstrated and nonlinear behavior of the new model for flexural and shear yielding modes is well determined. Different geometric shapes of knee-braced types in retrofitting of RC frames and concluded that the number of the knee braces increases the ductility and energy dissipation of the system increase, [6].

From the mentioned literature review in this study, main objectives are energy dissipating capacities, damping ratios, drift ratios and increasing the lateral load capacity without changing of the initial stiffness.

2   EXPERIMENTAL STUDY

Model unit frames constructed for experimental investigations were 1:3 scaled models of a typical 4.0 m x 3.0 m unit ductile frame, Fig 1. The full size unit frame was selected from a typical RC building. In this study, Lateral reversed cycling loading tests are conducted on scaled models of ductile unit frames, directly braced by X and knee steel braces. They have been designed to consume energy in flexural deformations. Buckingham's pi- theorem was referred to scale down the specimens from prototype.
Specimen's dimensions are 1.40 m height, 1.33 m width. The column and beam have 20x10 cm cross sectional dimensions. The same quality of materials has been used for all the specimens. Average concrete compressive strength is 18.5 MPa. In column and beam 4□8 in

beam longitudinal reinforcement and 4⬜6 transverse reinforcement are used and the average yield strengths are 475,72 MPa and 465,8 MPa.

The experimental study was conducted at Structural and Earthquake Engineering Laboratory of Istanbul Technical University. A constant axial load which is about 10% of the axial load capacity of columns was used. Lateral reversed cycling loading imposed as displacement increments was applied to the specimens by means of one DARTEC actuator which was placed at the middle level of beam, **Fig 2-3**.
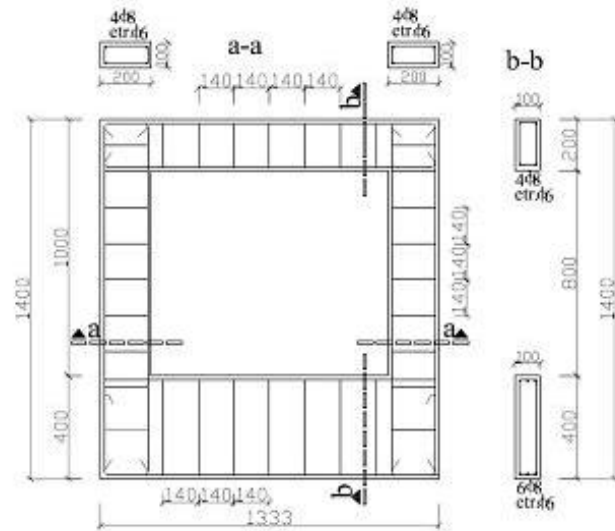
Fig. 1)   Test specimen schematic figure
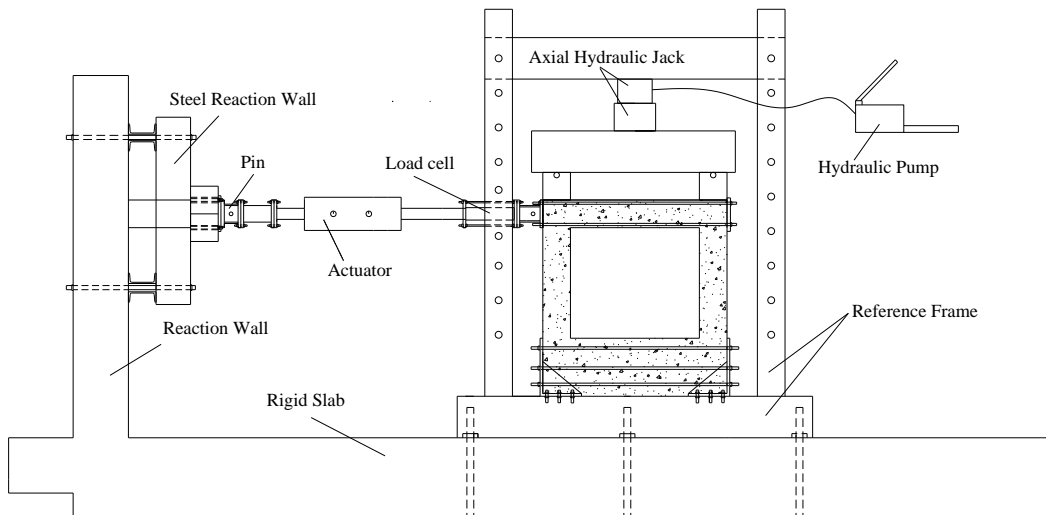
Fig. 2)   Test set-up
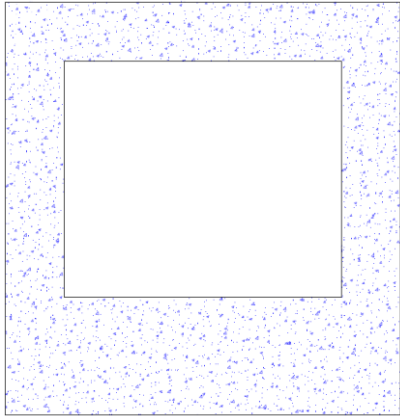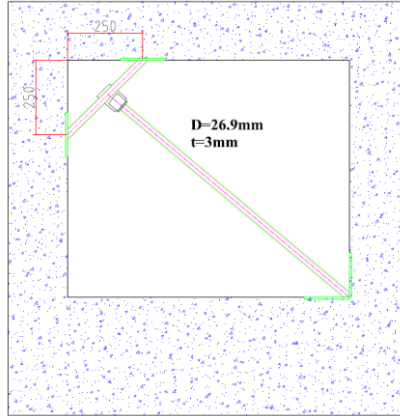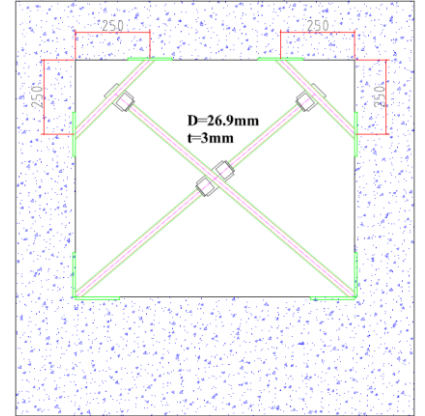
Bare Frame
SKNEE
DKNEE
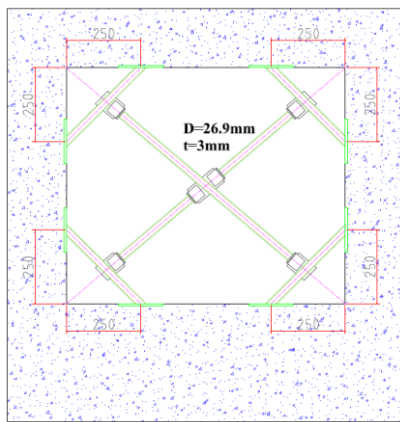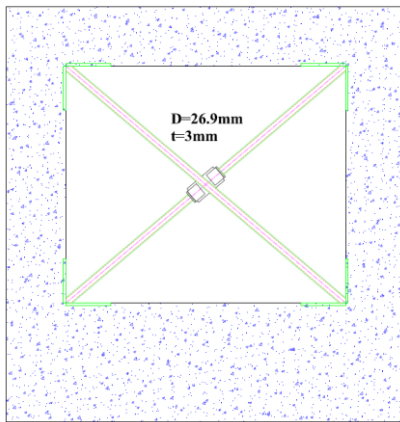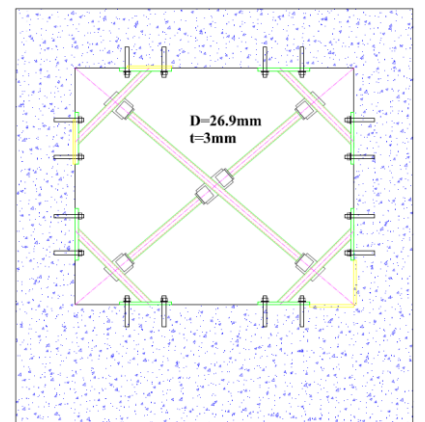
FKNEE
CONBRACE
FKNEE_REV
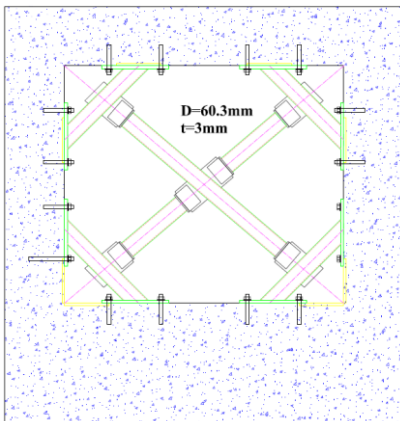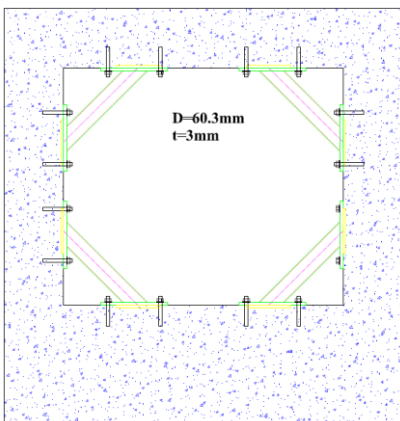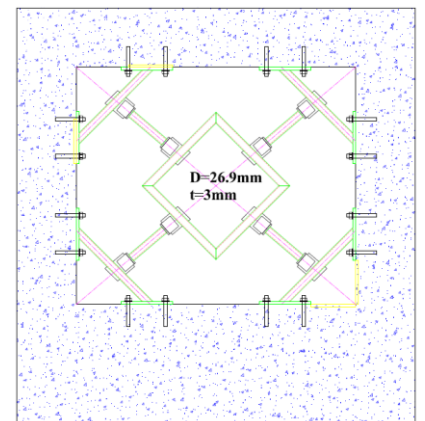
FKNEE_H
KNEE_60.3
FKNEE_RING

Fig. 3)   Retrofitted RC specimens by simple steel bracing system

3 EXPERIMENTAL RESULTS

3.1 Load capacity

Test results show that the load capacity of an existing ductile frame can be increased to the desired level by directly adding a bracing system to the frame, without the need for prior strengthening of the existing frame, see **Fig 4-5**. The maximum load capacity is in CONBRACED specimen. On the other hand adding or increasing the number of energy dissipating elements gives more ductility to the system. Also load degradation of the maximum lateral load is minimized to the bare frame in **Fig 6**.
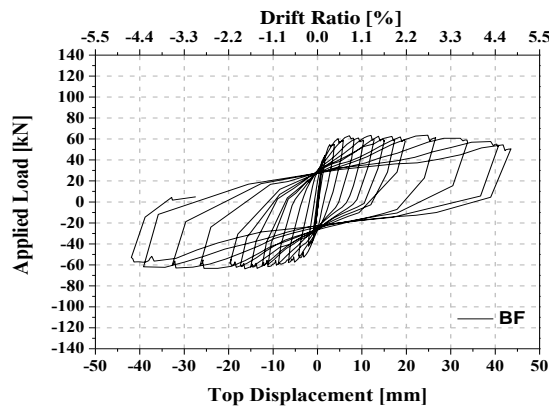
Fig. 4) Load-Top displacement cycle of bare frame (BF)
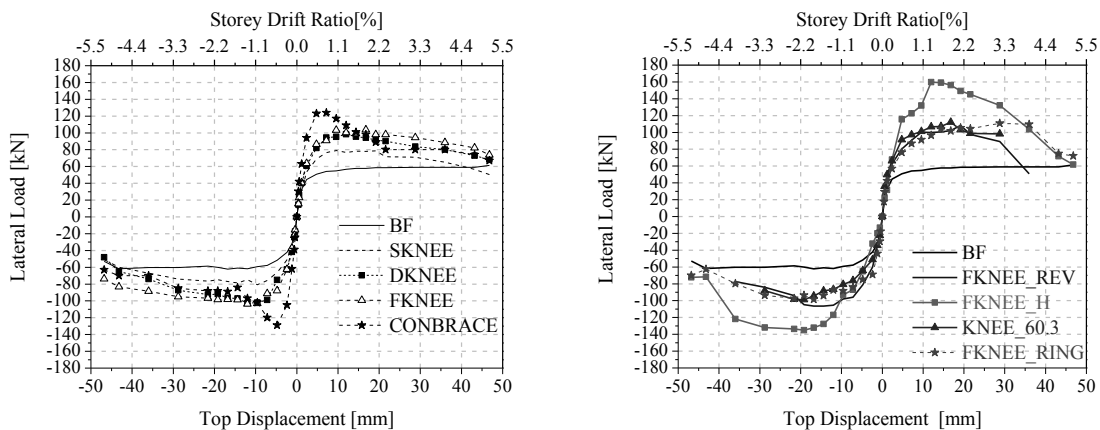
Fig. 5) Envelopes of load-displacement curves of specimens

3.2 Stiffness

For comparison, the stiffness degradation by drift ratio is similar all of the steel braced elements except concentric braced specimen **Fig 7**.

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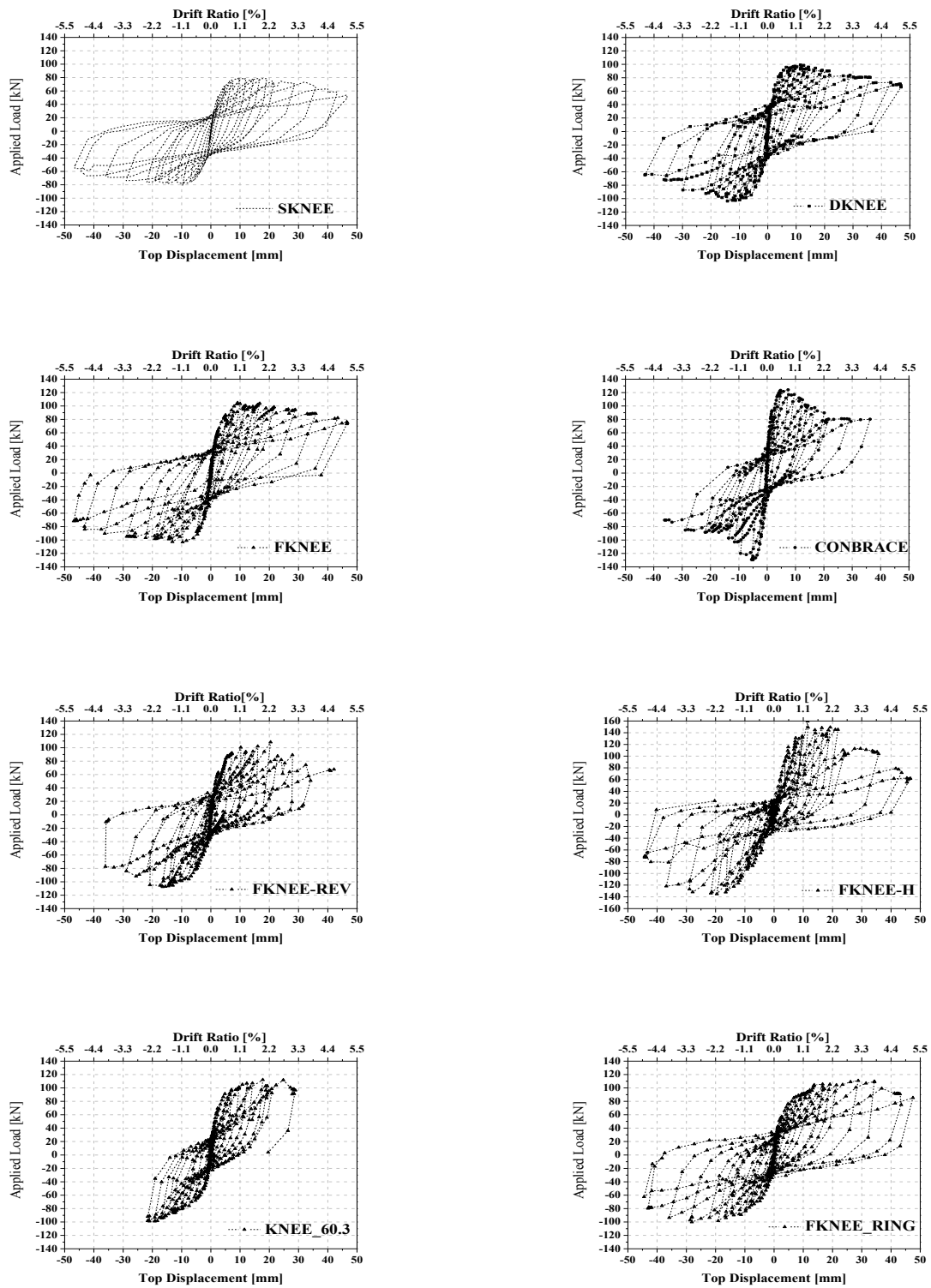
Fig. 6) Load- Displacement cycles of energy dissipating simple bracing systems
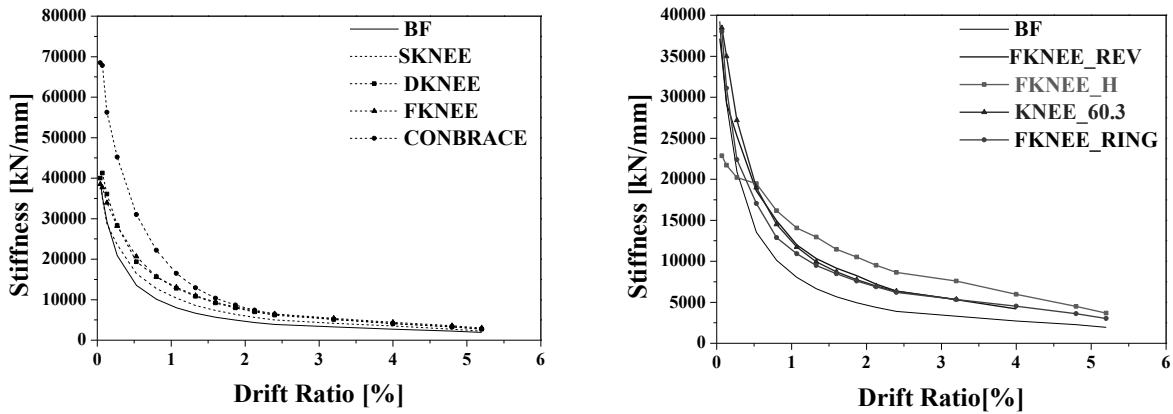
Fig. 7) Stiffness degradation of test specimens

3.3 Energy dissipation

Hysteretic cumulative energy dissipation calculated for each cycles of load-displacement curves are presented for different steel bracing configurations in **Fig 8**. It should be noted that to put a new dissipating element to the RC system increases the energy capacity. Most efficient strengthening form by using knee brace is FKNEE-RING specimen.
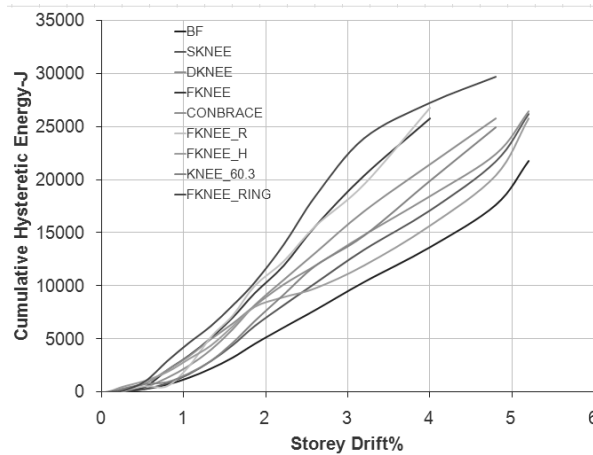
Fig. 8) Cumulative hysteretic energy graphs

4 ANALYTICAL STUDY

A 5-storey medium-rise RC building is considered for this study, [7, 8]. This building located in a high-seismicity region of Turkey with no shear walls. Since the majority of building was constructed according to the earthquake code, [9]. It is designed according to this code, considering both gravity and seismic loads. Material properties are assumed to be 10MPa for the concrete compressive strength and 220 MPa for the yield strength of both longitudinal and transverse reinforcements. RC building is 10.5 m by 10.5 m in plan and typical floor-to-floor height is 3.00 m, **Fig 9-10**. The column and beam dimensions used in this study are typical frame element proportions in the existing building stock. Column dimensions and the amount and arrangement of longitudinal reinforcement are provided in **Table 1**. All beams are 20 cm × 50 cm and the amounts of top and bottom reinforcement are 3Ø14 and 2Ø12 respectively.

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The dead and participating live loads (30% of live load) on the frame are 578.3 tons and 33 tons, respectively. The first mode period is 0.925 s.

Tab. 5)   Column dimensions and reinforcement

Column Orientation	Size (cm x cm)	Longitudinal Reinforcement
Middle	40 x 40	8Ø16
	35 x 35	8Ø14
	30 x 30	6Ø14
Side	25 x 35	6Ø14
	25 x 30	6Ø12
	25 x 25	6Ø12
Corner	25 x 25	6Ø12
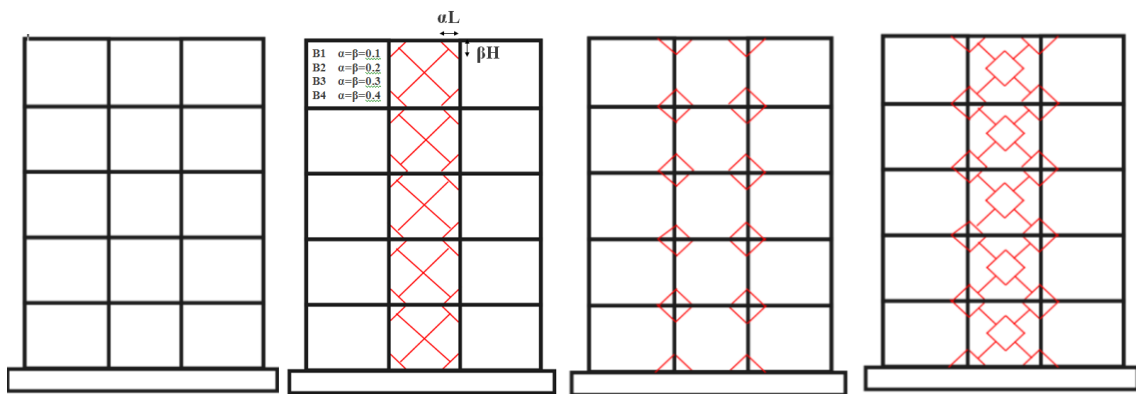
Fig. 9)   Bare frame and three different steel brace configuration

The pushover curves of the alternative systems generated from **Fig 9.** are given **Fig 11.** consists of the pushover curves calculated for the bare and the three alternative retrofitted systems defined in **Fig 10**. The points where the bracings are connected to the RC elements and the sizes of the bracing elements are too important factor on the overall behavior of the structure. If the sizes of the bracings are increased three times and used in hypothetical structure the pushover curves are changed as in **Fig 10** and if the sizes of bracing is doubled to increase the control of lateral displacements the results in Figure 11 is achieved.
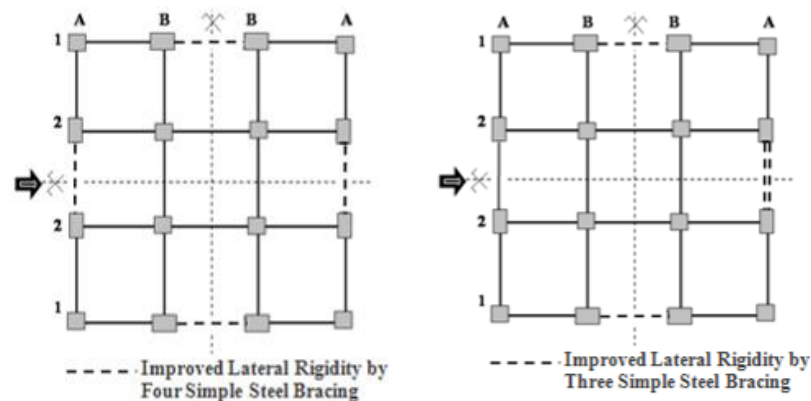
Fig. 10)   The locations of lateral load resisting elements

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It should be noted that the knee elements used in the adjacent spans are very effective on changing the failure mode of RC elements. Two configurations of steel braces named D1 and D2, are evaluated from **Fig 9** and **Fig 10** and the results of pushover analysis in **Fig 11**.
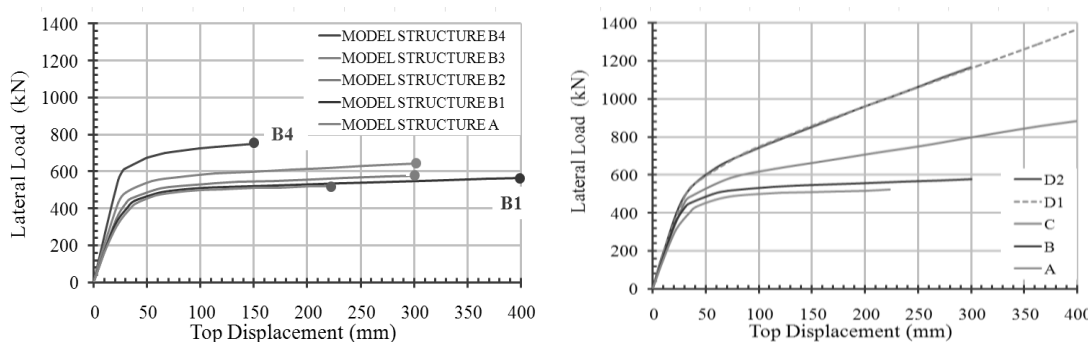
Fig. 11) Lateral load-top displacement relations of the systems.

5   CONCLUSION

The following conclusions can be extracted both for experimental and theoretical works carried out:

- All kind of light steel bracing configurations are increasing the lateral load capacity and are decreasing the storey drift.
- Concentric bracing which are placed in between the most vulnerable zones of the structures is not good as much as the other knee braced configurations proposed.
- The thicker bracing system the more lateral load capacity has been reached and the more redundancy and more deformable elements the more energy consumption and more hysteretic damping ratios are reached.
- Pushover analysis indicates that if the knee braces are not used only in the strengthened span of the structure but in the adjacent spans also protecting the early failure of the columns higher lateral load capacities and overall the specimen ductilities are reached and the similar results has been obtained for three sided bracing in the plan instead of having four sided bracing as shown in Figure..
- Damping ratios selected for rehabilitation design stage should be above 5% of critical damping. The suggested value of the effective damping ratio can be selected between 8–15% of critical damping depending on the retrofitting techniques submitted in this paper

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CROSS-CULTURAL TRAINING FOR INTERNATIONAL CONSTRUCTION PROJECTS

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Abstract

The research reported in this paper is a part of a wider study aimed at investigating the effects of cultural differences on construction projects. One of the specific objectives of this study was to discover construction professionals' perspectives on cross-cultural training for international construction projects. The research was carried out in three international construction projects located in Qatar, Libya and Bulgaria. The researcher stayed in each of these projects for 1 month for the purpose of data collection. Semi-structured interviews were carried out with 76 construction professionals. Based on the findings, cross-cultural training plays an important role in preventing culture shock. However, despite the importance of cross-cultural training, it was found that all participants had never received formal cross-cultural training. All of the interviewees highlighted the importance of a formal approach for gaining necessary cross-cultural skills. The interviewees focused mainly on specific trainings that provide training on one specific culture.

Keywords

Expatriates, international construction cross-cultural training, culture.

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1   INTRODUCTION

The importance of national cultural differences has become more critical for companies operating in international markets or having employees from different cultural backgrounds. Understanding and successfully managing cultural differences can provide several advantages for project as well as company success [1].

An expatriate is a person temporarily or permanently residing in a country and culture other than that of the person's upbringing or legal residence. Expatriates face challenges when working and living in a foreign country. These challenges are substantially greater than what they come across in the domestic arena [2]. Expatriate failure is usually defined as a posting that either ends prematurely or is considered ineffective by senior management. Many researches showed that there is a high rate of expatriate failure [3,4]. One of the main reasons for the failure is lack of cross-cultural skills to adapt to their new environment [3].

Cross-cultural adaptation includes issues related to differences in culture and language, living conditions, and working harmoniously with co-workers with different cultural backgrounds [5,6]. Besides costs, expatriate failures can also have negative effects on the image and reputation of the expatriates and companies [3]. Thus, many companies operating in international markets have been looking for methods to improve the adjustment of expatriates to their new environments. To improve expatriate adjustment, researches have focused on two methods. The first is expatriate selection methods and the second is cross-cultural training (CCT).

CCT can help expatriates adapt to living and working in new environments [7,8]. CCT can help expatriates to create realistic expectations with respect to living and working in the host country [9]. Like in other industries, the increase in strategic alliances in construction also increases the significance of cultural differences due to the interaction of people from different cultures [10]. Previous studies and experiences in the construction industry showed that cultural differences have an impact on daily businesses, either negative or positive, of construction enterprises working nationally or internationally [11,12]. It is also widely recognized that prior knowledge of a culture and its people is essential if successful interaction is to occur. In this respect, CCT can also significantly contribute to the success of international construction projects.

Tung defined CCT as "any intervention aimed at increasing an individual's capability to cope with and work in foreign environment" [13]. The objectives of CCT are to teach members of one culture to interact effectively with members of another culture, improve functional skills and to minimize "culture shock" for the expatriates during international assignments [14]. Culture shock can significantly affect the performance of the expatriates and consequently the performance of the company [15]. The term culture shock was introduced by Oberg and defined as the period of anxiety before an individual feels comfortable in a new culture that is different from their own [16]. Oberg described four stages of adjustment: the honeymoon stage; the culture shock stage; the adaptation stage; and the mastery stage [16]. Many studies have found positive correlations between CCT and a reduction in participants' experience of culture shock, adjustment in the host country, and improvement in their performance on the job [8,9,17]. Despite the importance of CCT, previous studies have shown that CCT provided by most international organizations is neglected, insufficient or incomplete [18,19,20].

CCT can involve many techniques and methods. Tung identified five different training programs as didactic training, culture assimilator, language training, sensitivity training, and field experience [13]. Gertsen proposed a typology of training methods and identified two kinds of training as conventional training and experimental training [21]. In conventional training, information is transmitted through a unidirectional communication whereas in experimental training the trainer gets the trainees to participate by simulating real life situations [22]. Then, according to Gertsen, the training can focus either on the notion of culture in general or on one specific culture (Fig. 1) [21]. Similarly, Gudykunst et al. stated that the type of CCT method should be selected as either a learning approach (didactic vs. experiential) or an approach that focuses on the content (culture-general vs. culture-specific) [23]. There is no one type of training program that is determined as the most effective method. Pre-departure training is the traditional form for CCT [24]. Post-arrival training is another type of CCT that can be carried out in the host country after the arrival of the expatriate. Selmer et al. stated that CCT should be sequential, starting at pre-departure and continuing to the post-arrival phases. They recommended sequential training that can enhance the efficiency of CCT [25].

Experimental Training

General Experimental Training	Specific Experimental Training

General Culture ————————————— Specific Culture

General Conventional Training	Specific Conventional Training

Conventional Training
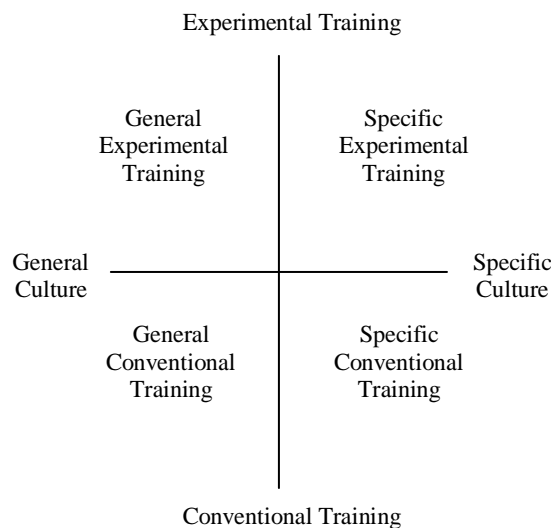
Fig. 1)   Gertsen's typology of cross-cultural training methods

2   METHODS

The research reported in this paper is a part of a wider study aimed at investigating the effects of cultural differences on construction projects. One of the specific objectives of this study was to examine construction professionals' perspectives on CCT for international construction projects. The study was conducted using a qualitative approach to provide enhanced understanding and generate rich descriptions of the concept of cultural training. The research was carried out in three international construction projects located in Qatar (Turkish-Japanese Joint Venture), Libya (Turkish-Libyan Joint Venture), and in Bulgaria (Turkish-Turkish Joint Venture). The researcher stayed in each of these projects for 1 month for the purpose of data collection. Semi-structured interviews were carried out with 76 construction professionals working in these projects. The interviews were carried out in Qatar between April and May 2009, in Libya between January and February 2010, and in Bulgaria between August and September 2010. Each interview lasted approximately 1 hour. More than half of

the participants were Turkish professionals whereas the remaining participants were from 14 different nationalities including British, American, Japanese, German, Egyptian and Greek.

The questions were strongly shaped by the probing questions to seek further details. The interviews were audio-recorded and transcribed. The data collected were coded and analyzed using content analysis, based on guidelines provided by Gillham and Strauss and Corbin [26,27]. Content analysis was completed with computer assistance using the software program NVivo 2.0. This program was selected for its powerful data codification and data searching capabilities. Finally, emerged themes from the data were identified and they are reinforced with actual instances from the transcripts.

Little attention has been given in the literature for analyzing the CCT provided to Turkish expatriates. Thus, this study has potentials to contribute to the CCT literature, particularly in the Turkish context.

3 STUDY FINDINGS

During the interviews, each participant was asked to provide some personal information such as educational background and professional experience. Based on the analysis, 37% of the participants have more than 10 years' of experience in international construction. Half of the interviewees have more than 15 years' of experience in the construction sector. Almost half of the participants (49%) consist of civil engineers.

3.1 Culture Shock

Approximately half of the participants indicated that they experienced a culture shock before. Seven categories emerged from the analysis of the data: lack of experience, language differences, lack of motivation, personality/mentality, lack of cultural training, lack of company support, and different value systems.

The majority of the participants mentioned that having previous overseas experience can help expatriates to prevent culture shock. They stated that the possibility of getting a culture shock will be less if the expatriates have adequate experience in overseas projects and working with people from different cultural backgrounds. Participants having previous overseas experience stated that these experiences to a certain extent have facilitated their adjustments in their new environment. This finding is in accordance with the literature. Anderson found that previous overseas experience of expatriates had helped them to adjust to their new environments [28]. Similarly, Waxin and Panaccio showed that international experience facilitates cross-cultural adjustment [22].

One significant theme that emerged from the analysis of the data was language differences that can affect the adjustment of the expatriate. The interviewees expressed the importance of using the common language between the project team members. Ineffective use of common language was stated as one of the main reasons for conflict and thus, can lead to problems for the expatriates. On the other hand, host country language skills were also considered as a crucial factor in rapid adjustment. This finding is consistent with the literature. Some authors suggest that language skills are more important than ever in reducing uncertainty in the new environment [29], and send out positive signals of interest and willingness to the host nation employees and business partners [7,18].

Some participants mentioned lack of motivation as a critical issue for culture shock. They indicated that expatriates should have the necessary motivation to reduce the possibility of culture shock. According to some of the interviewees, lack of motivation in performing necessary job-related activities is a more critical issue than international experience or language differences for experiencing culture shock. Motivation is also linked with personality/mentality that is presented in the following category. As one manager commented: ''It depends on how focused you are and what you want to achieve. If you come here seriously and want perform to be a good professional person then you will not allow you to be distracted. But if you don't know why you are here then of course. I don't think there is a lot of culture shock for those who are serious. For those who are experts who are coming from abroad. For them it is nothing''.

Almost one-third of the participants reported that expatriates' personality and mentality are significant factors for culture shock. According to these interviewees, flexibility, optimism and enthusiasm can help expatriates to adjust in their new environment. At this point, participants recommended that companies should select expatriates carefully, based on their personalities and their ability to adapt to foreign cultures, in addition to their technical problem-solving skills and knowledge. This finding is also in accordance with the literature [6].

Almost all of the interviewees mentioned that CCT can prevent culture shock. The participants, who experienced culture shock, reported that if they had CCT before, the culture shock that they experienced could have been reduced. Thus, lack of CCT seems to be a major issue that causes culture shock. This finding is consistent with many previous studies [8,17].

According to most of the interviewees, company support plays an important role in preventing culture shock. The support includes pre-departure trainings, post-arrival trainings, providing necessary skills training to adjust in the new environment, and providing social activities. Previous studies showed that social support is one of the contributing factors on the expatriates' success [7].

People can live together in harmony with different value systems. However, these differences can cause serious conflicts. Most of the participants highlighted this issue during the interviews. Differences in life styles, social life, foods, and traditions were all considered as important factors to get culture shock.

3.2 Cross-cultural Training

The participants overwhelmingly expressed the need for cross-cultural training. However, despite the importance of CCT, it was found that all participants had never received formal CCT. Four categories emerged from the analysis of the data: training, language training, pre-departure training, and post-arrival training.

Based on the analysis of the data, all of the interviewees had never received a structured CCT. However, some of the participants reported that their firms provided them some kind of technical trainings rather than culture-oriented. The interviewees reported that these trainings were focused mainly on information about the project and company, health and safety training, and job responsibilities. The majority of the interviewees stated that they had gained cross-cultural skills through informal learning. The informal ways of learning were reported as learning from internet, learning-by-doing approach, learning from books and learning from colleagues [9]. However, all of the interviewees highlighted the importance of a formal

approach for gaining necessary cross-cultural skills. Thus, it is crucial for the companies to provide a formal CCT for their expatriates.

Language training is generally rarely provided by most of the international companies. During the interviews, almost all of the participants expressed the need for language training. Like CCT, none of the interviewees received language training from their firms before. The participants reported that miscommunication is one of the main problems during their day-to-day business in the project. Certain terms can have different meaning in different languages. Therefore, they highly recommended language training before the departure or after arriving. They also indicated that such training should include non-verbal communication. This finding is consistent with previous studies in which language training was highlighted as an important step for better communication with people from different cultural backgrounds [3,7]. Although some authors argue that CCT is more important than language skills, language training should not be neglected since language skills become more important in today's global business environment [30].

All of the participants agreed on the necessity of a formal pre-departure training. The participants reported the importance of this kind of training mainly due to the interaction with project team members having different cultural backgrounds. They stated that CCT is required especially when the respective cultures are more diverse from each other. For example, Turkish expatriates indicated that there was a need to have some knowledge of Japanese culture prior to arrival to accelerate the adaptation period. Moreover, they also stated that the need for having prior information about the host country culture. As one manager noted: ''It is necessary before the start of the project. I have to know what they are dealing with or expect from the other side. Particularly if it is a JV, you have to understand the mentality. There are some human factors which have to be considered''.

Many of the participants recommended pre-departure training a few weeks before departing. The interviewees focused mainly on specific trainings that provide training on one specific culture. Most of the participants stated that information about different cultures in real-life situations can be a good method to gain information about these cultures. Therefore, when considering Gertsen's typology of cross-cultural training methods, illustrated in Fig. 1, it can be stated that most of the interviewees recommend 'specific experimental training' as the effective training method [21]. This finding is consistent with many previous studies in which specific and experimental trainings were highlighted as a better training method [22]. Moreover, the majority of the interviewees recommend not only pre-departure training but also post-arrival training so that pre-departure training would be more effective.

Post-arrival training has potential impacts on the performance of expatriates [25]. The majority of the participants highlighted the need for training after the arrival and during the international assignment. Most of them focused on continuous training about cultural issues. They reported that cross-cultural skills can be facilitated by training not only at the preparatory stage but also during international assignment. Thus, it can be said that sequential training, proposed by Selmer et al., was considered as a vital method for CCT by most of the participants [25]. Like in pre-departure training, for post-arrival training the interviewees focused again mainly on specific and experimental training. These findings are in parallel with many previous studies [23,24]. As a result, most of the participants prefer sequential and specific experimental training.

4   CONCLUSIONS

This study is based on interviews with construction professionals. In this study, construction professionals' perspectives on CCT for international construction projects were examined. This research supports findings in existing literature. The analysis of the interviews showed that despite the importance of CCT, there is a need for a structured CCT program. Based on the findings, cross-cultural training plays an important role in preventing culture shock. However, it was found that all participants had never received formal cross-cultural training. All of the interviewees highlighted the importance of a formal approach for gaining necessary cross-cultural skills. The interviewees focused mainly on specific trainings that provide training on one specific culture.

The companies operating in the international market should not perceive CCT as a useless expense. CCT can reduce the time to adjust in the new culture and reduce culture shock which can affect the productivity of the expatriates. According to the analysis, besides pre-departure training, post-arrival training should also be provided to the expatriates. As a consequence, CCT can be sequential to ensure successful completion of the expatriate assignment.
On the other hand, technical competence should not be the only selection criterion of the expatriates. Besides technical competence, the companies should also focus on personality traits in expatriate selection to increase the possibility for better cross-cultural adjustment. Moreover, based on the analysis, specific experimental training can be more beneficial for the expatriates. Language training should also be provided to improve communication.

Acknowledgement

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THE ISSUE OF INNOVATION IN THE INITIATION OF CURRENT CONSTRUCTION PRACTICE IN THE CZECH REPUBLIC

Gabriela Kocourková[1]

Abstract

This work discusses the issue of innovation and innovative entrepreneurship both in the Czech Republic and within the European Union. The EU's efforts to launch innovative processes in various countries are described here. This new basic instrument of the European Union is the recently created Innovation Union, which has resolved to improve conditions and access to finance.

As there is not enough outside support, owners and management companies must take the initiative in innovation. Due to an increasingly competitive environment, globalization of production and markets and the emergence of new technologies, business success is dependent on the efficiency and intensity of innovation activities. Therefore, companies' senior management must take maximum advantage of their company's innovation potential, since in this competitive environment only those who innovate survive.

This work focuses on the currently most used innovative methods which help to find solutions for initiating innovation processes and find solutions for them. Most of these methods are focused on product innovation and distribution of goods. Apparently no method claims a possibility of use in construction, which is striking. This leads to the impression that the building industry is stable and unaffected by innovations.

The aim of this article is to identify and analyze the actual state of innovation in current construction practice on the basis of information obtained in the investigation of companies working in the construction industry in the Czech Republic.

Key words

Construction company, innovation, research, science.

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1   INTRODUCTION

This work presents the problems of innovation and innovative business in the Czech Republic. This country and the European Union as well have recently realized that without continuous support of innovation and research and development companies, they will not be able to compete with developments globally.

However, support from the outside is not enough; it is mainly owners and management companies who must take the initiative in the innovation process. The current, more competitive environment, globalization of production and markets and the emergence of new technologies make business success dependent on the efficiency and intensity of innovation activities. Therefore, companies' senior management must take maximum advantage of their company's innovation potential; only those companies who innovate survive.

The aim of this work is to identify and analyze the actual state of innovation in current construction practice. The basis of the information for analysis has been obtained through an investigation of companies from the construction industry in the Czech Republic.

2   INNOVATION

Innovation and creativity are much discussed issues in recent years, not only in business circles but also at the governmental level and in the European Union. This is only natural, because a business without innovation has little chance for success. The government recognizes this and is seeking to promote innovation in business.

What is an innovation, really? This term has had a long historical development. It was first used by J. A. Schumpeter, who developed the theory of innovation [1]. His ideas were later taken up by other authors, such as P. F. Drucker, F. Valenta and M. Švejda. According to experts, innovation should be defined as the following:

- a series of scientific, technical, organizational, financial, business and other activities aimed at creating a new or significantly improved product (product, technology or services) effectively placed on the market. Research and development is one of these activities. [2]
- the renewal and extension of a range of products and services and related markets, creating new methods of production, supply and distribution, introduction of changes in management, work organization, working conditions and labour qualifications. [3]
- expressing a change in events, such as the introduction of scientific and technological advances and new kinds of products. As a result of an innovation, labour and natural resources are saved. Innovations are divided into product innovations (product) which count for about 70% of all innovation, technological innovations whose share is about 28% and finally material innovations which count for about 2%. [4]
- any change in the inner structure of the production organism. [5]

Drucker presents innovation and entrepreneurship as a purposeful and systematic discipline that explains and analyzes the challenges and opportunities of America's new entrepreneurial economy. Superbly practical, *Innovation and Entrepreneurship* explains what established businesses, public service institutions, and new ventures need to know and do in order to succeed in today's economy. [6] The follower of Schumpeter's ideas in the Czech Republic is

Valenta, who elaborates on the definition of innovation. He ranks consequently works with this definition: he names orders of innovation from the easiest ones, which keep the company (system) in its present state, to the most complicated, which abandon the basic principles hitherto in place. [5, 7] Further challenging topics, such as variations of innovating effects, primary elements of production organisms and their relations, or chaining of innovations, were transparently elaborated by Prof. Vlček. [8]

3   TYPES OF INNOVATIONS

If we continue to pursue the analysis of the current state of innovation in specific companies, it is necessary to take into account what types of innovation may arise in the company. On this issue there are several views. J. A. Schumpeter has proposed a list of different types of innovations [1]:

- Launching of a new product or a qualitative change in an existing product.
- Process innovation that is new in a particular sector.
- Opening of a new market.
- Development of new sources of raw materials or other inputs.
- Changes in the management and organization of production.

However, at present the classification of innovations into four broad categories prevails. This is the so-called 4P innovation [9]:

- Product innovation – change in the product or service that an organization offers.
- Process innovation – change in the method of production and delivery of the products or services.
- Innovation of the position – change in the context in which certain products or services are launched on the market.

4   INNOVATION OF THE PARADIGM – CHANGE IN THE UNDERLYING MENTAL MODEL WHICH IS THE FRAMEWORK FOR THE ORGANIZATION'S ACTIVITIES.PRODUCT AND PROCESS INNOVATION IN A CONSTRUCTION COMPANY

In the promotional materials of many companies, one often reads that a company is "innovating". However, if we examine the details of the specific steps of this innovation and we want to know what profit these changes have brought and what they consumed in financial or other resources, we find that not everything is idyllic.

What is the reality in most companies? According to Ján Košturiak: [10]

- Innovations are often not the most important.
- Innovations are often focused on security and risk avoidance.
- A marketing information system is not set up correctly or is missing completely.
- Realizing innovation depends too often on the owners or senior management.

Based on a survey I have conducted at companies this year, I have found that most small and medium-sized enterprises carried out innovation occasionally and irregularly – they react especially to customer requirements.

I contacted about 50 companies in the construction business in the Czech Republic, both companies focusing on building construction and those concentrating on material manufacturing, services and commercial activities. The criterion for their selection was

primarily their active participation in applying for a grant in the Grant Agency CR and Technology Agency. Then I addressed other large and well-known contractors in the construction industry in the Czech Republic.

4.1 Research outputs

The response rate was surprising, about 30% of companies answered in a very short time. The production focus of companies is shown in Figure 1.
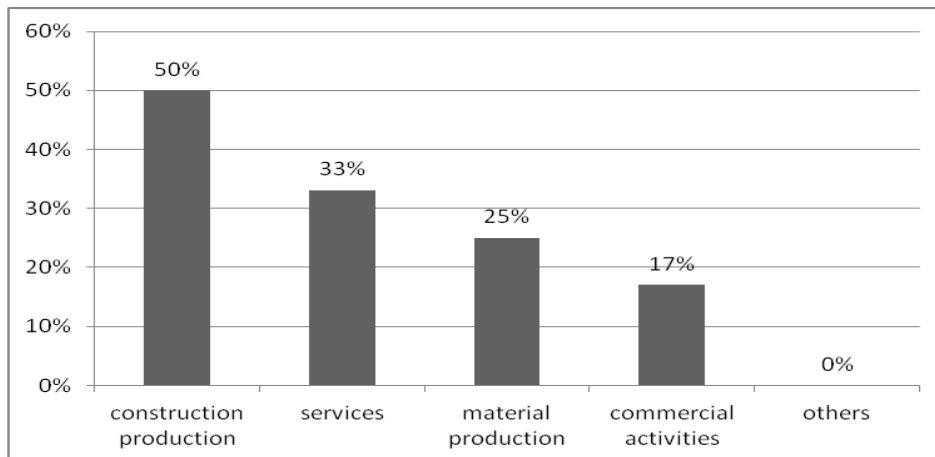
Fig. 1)   Production focus of companies

The process of business innovation is definitely seen as an important part of business activities. Most companies have active experience with the process of innovation (91% of managers said they made at least occasional innovation in their company). But only about half of the companies have departments (or a responsible person) engaged in development, research and innovation.

This result is not surprising. Innovation management is not a simple process, and a systematic approach is used mainly by medium-sized companies, manufacturing companies and export-oriented companies in highly competitive industries. Other companies understand the importance of innovation, but here innovation is carried out more intuitively – based on customer requirements.

It is interesting to note in what areas companies introduce innovations. Innovations in management and production prevail. The results are clearly shown in Figure 2.

I have surprisingly found that almost no companies care about the effectiveness of resources invested in innovation! (Figure 3)   A closer examination – interviews with the relevant workers in specific companies – shows that they consider as successful innovation only business success of a particular innovative product. Companies do not evaluate the efficiency of the applied innovations, there are no surveys on if and when the capital invested into the innovations is paid back. I think that there is still room for improvement in this area for many companies.
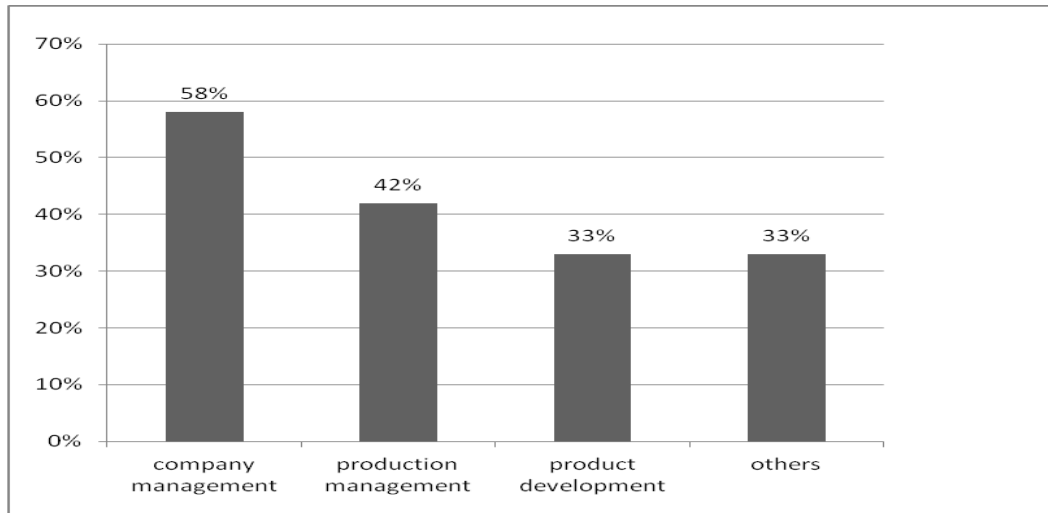
Fig. 2)   Areas in which companies introduce innovations
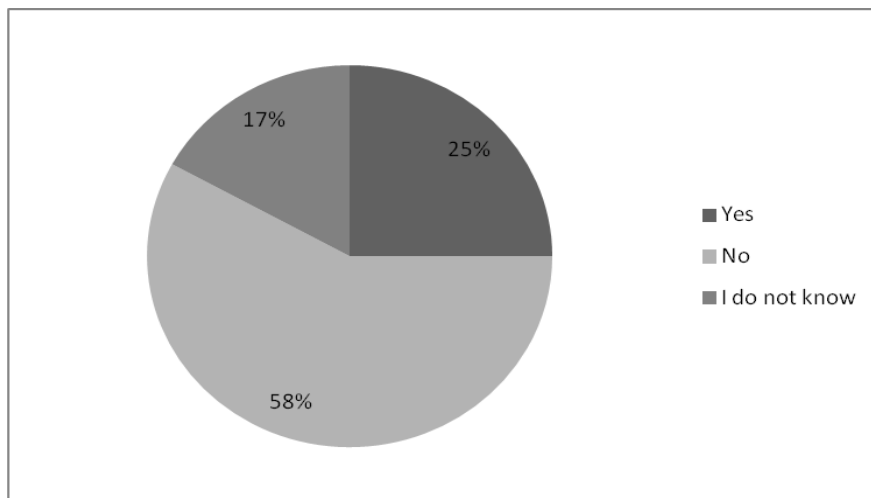
Fig. 3)   Do you measure financial efficiency of capital invested in development or innovations?

5   CONCLUSION

Most companies working in the building industry know about the potential problems of innovation. Some innovations are carried out. Companies have a similar overview of opportunities for using grants and subsidies to promote innovation, research and development in the Czech Republic and the European Union just as companies active in other industries do.

The link between scientific discovery and the assurance of practical results, i.e. technologies, is key for creating wealth for individuals, companies and nations. It is reported that technology creates half of the economic growth of developed countries. [11] Nevertheless, the link between scientific discovery and development of new technologies shows to be poorly understood.

In fact, after the analysis of the results of my work I arrived at the same conclusion as the company Aspectio, which carried out a study on the attitude of Czech entrepreneurs to innovation and funding innovation in all business sectors of the Czech Republic. *The result of*

the survey confirms that even though companies do not systematically plan innovation to a large degree, they account innovation as an integral part of their business in response to clients' needs and continuing development of their activities. The frequency of innovation is thus ultimately surprisingly high. [12]

Researchers and managers have found that the use of external knowledge in the process of innovation helps to sustain a company's competitiveness by strengthening its innovative performance. However, little is known about why some companies use external knowledge sources in an extensive manner while others hardly ever use them. In addition, there is disagreement about which external partners significantly contribute to the innovative performance of a company as valuable sources of knowledge. [13]

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METALLIC L SHAPED DAMPER USING ON BEAM TO COLUMN CONNECTIONS OF STEEL FRAMES

Mehmet Alpaslan Köroğlu[1], Ali Köken[2]

Abstract

The crucial point of this study is to prevent the damage formation of columns and beams by dissipating lateral loads at the beam to column connections of steel frame structures by means of dampers. Therefore, the columns and beams of steel frame structures will not be damaged after a heavy earthquake, and the structures might be put into the service again simply by replacing the dampers at the connection sites.

In this study, the use of seismic L shaped dampers at beam to column connections was investigated not only for new steel frame structures to be constructed, but also to strengthen existing steel structures. To investigate the performance of the proposed system, 4 full scale cyclic tests were investigated. The results were evaluated in terms of the load-bearing capacity and other features in terms of the general behavior.

Key words

Beam to column connection, L shaped damper, metallic damper, steel frame.

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1   INTRODUCTION

In steel structures Moment Frames (MFs) are widely used as Lateral force resisting systems because of their superior ductility and energy dissipation capacity. Through the flexural yielding of the beam and shear yielding of the panel zone, MFs behave in a ductile manner. A large amount of plastic deformation is expected at each member and joint of a MF during an earthquake ground motion. MFs were believed to be one of the most effective lateral force resisting systems through many experimental tests of the 1960–1970s [1,2].

The typical welded steel moment frame connection used in seismically active zones in the United States failed to provide the expected ductile behavior in the 1994 Northridge earthquake in Los Angeles, California. And also During the Kobe (1995) earthquake, a large number of steel buildings suffered severe damage, which occurred at the beam-to-column joints and included fractures of full penetration welds, cracks in beam flanges ,and cracks through the column sections[3,4].

After the Northridge and Kobe earthquakes, many experimental programs on beam-to-column connections were developed to investigate the causes of the brittle failures. The research and development of structural control against earthquake excitation have achieved significant progress over the last three decades [5]. Structural control can generally be classified in to three categories as; Passive control systems, Active control systems and Semi-active control systems [6].

Energy dissipation can be achieved by a number of mechanisms like; friction, sliding, yielding of metals, phases transformation of metals and deformation of visco elastic solid or fluid [6]. Exclusively, one of the most popular mechanisms for dissipation of energy in put to a structure is through the yielding of metallic materials which are popular nowadays. Numerous metallic dampers which make use of flexural deformation of metals have been proposed such as: the patented added damping and stiffness damper (ADAS) [7], triangular added stiffness and damping damper (TADAS) [8], the honeycomb damper [9], the buckling-restrained brace (BRB)[10-11],and the slit damper [4,6,12,13]. On the other hand, some Researchers have made use of alternative materials devices to be installed between beams and columns in a frame structure [4]

This present study aims to develop a new steel structure that achieves structural performance and is easily repairable after a heavy earthquake. The principal feature of this system is to limit plastic deformation on the metallic dampers at the bottom flange of the beam-ends. In this innovate structural system, the mechanical joint is adopted that is equipped with a metallic damper as the beam-to-column connection. The goal of this study is not only to limit the earthquake energy but also to repair the structure easily and quickly.

During an earthquake, a large amount of energy is imparted to the structure. It is important to reduce such permanent damage to the structure. Therefore, the studies on passive energy dissipation in earthquake risk mitigation of civil structures have greatly increased in the last three decades [1-5]. The concept of passive energy dissipation is to limit such permanent damage to the structure. A portion of the input seismic energy could be diverted into these devices when designated energy dissipative devices installed within the structure. So, damage of the structure can be effectively reduced. In addition, repair and/or replacement of the devices after earthquakes can be carried out with minimal interruption to occupancy, a crucial benefit to building owners and occupants if these devices which are called dampers are located at convenient positions [14]. Many kinds of dampers, including friction dampers,

viscoelastic dampers, viscous fluid dampers, lead dampers and metallic dampers have been developed.

Metallic dampers dissipate energy input to a structure from an earthquake through inelastic deformation of metals and dissipate energy through the nonlinear property of steel plate after yielding out of plane. Generally, a good metallic device for seismic applications must exhibit:

(1) adequate elastic stiffness to withstand in-service lateral load (e.g. wind)
(2) a yield strength of the damper exceeding the expected in–service lateral loads
(3) large energy dissipative capability
(4) a stable hysteretic force–displacement response which can be modeled numerically.

Lots of metallic dampers have been proposed and installed which the popular are; added damping and stiffness damper (ADAS) [7], triangular added stiffness and damping damper (TADAS) [8], the honeycomb damper [9], the buckling-restrained brace (BRB)[10-11],and the slit damper [4,6,12,13]. On the other hand, some researchers have made alternative materials such as; lead and shape-memory alloys, Low Yield Steel Shear Panel (LYSSP) [15], Bell-shaped Steel Dampers, Lead Joint Dampers, Lead Extrusion Dampers and pi damper [16].

2   EXPERIMENTAL VERIFICATION

The objective of the experiments is to verify the structural characteristics as well as the cyclic performance of the proposed devices. Therefore, large-scale structural testing will be performed to investigate a comparison of the cyclic performance between the proposed steel structures that have dampers and that of a conventional welded moment resisting frame.

In the test beam to column connection will be idealized as in Fig. 1.

Before the seismic load damages the superstructure, the damper must be able to yield and absorb the seismic energy. So, the design yield points of these test specimens will be determined to be allowable strength and allowable deformation angle of the beam and column in the study.
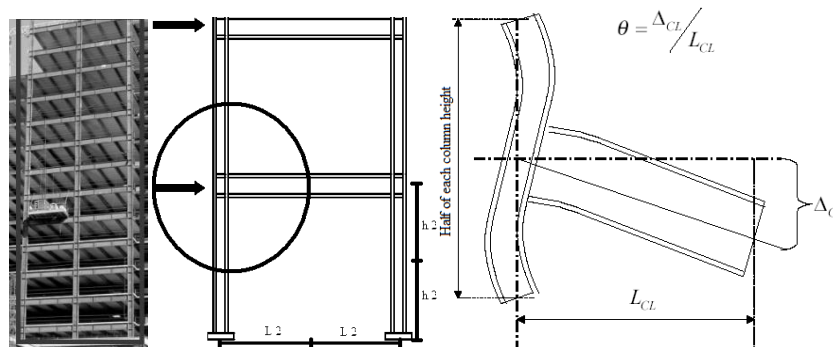
Fig. 1)   Idealization of beam to column connection

The test set up will be designed to simulate the boundary conditions of a beam-to-column connection subassembly in a moment resisting frame under typical lateral loading. Thus, it will be created by using pin connections to support both ends of the vertical column, and by connecting the actuator to the loading point of the beam, as shown in Fig. 2. The cycling load will be applied by hydraulic jack. During loading, lateral supports will be installed on the beam to prevent an out-of-plane deformation of the beam.
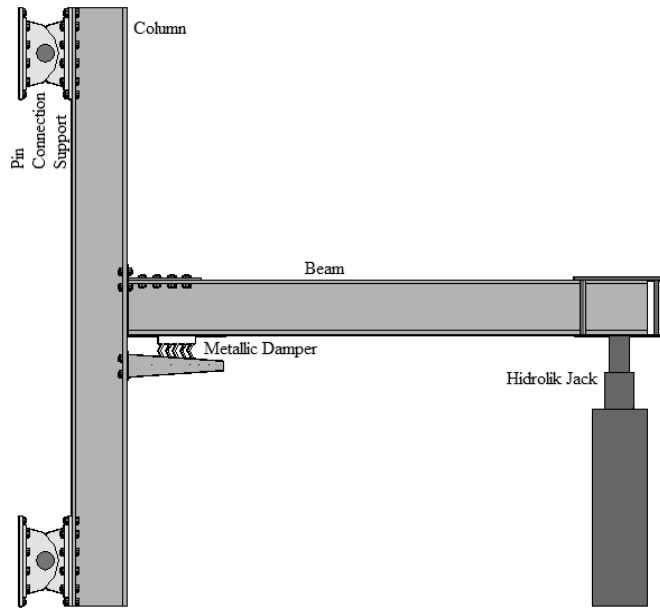
Fig. 2)   Test setup
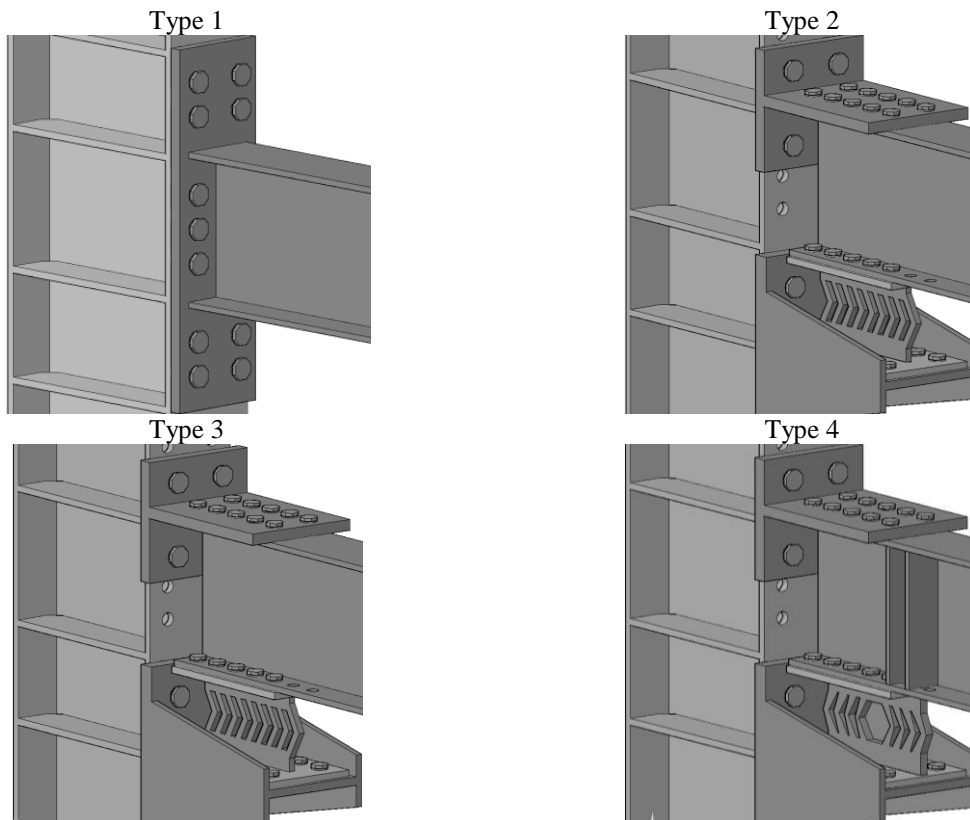
Fig. 3)   Beam-to-column connection of four full-scale specimens

In the connection between the beam and column, a split-T connection element will be used on the top of the beam, and the energy absorption elements constructed by welding the steel damper to the split-T will be used at the bottom of the beam. To facilitate installation and removal high strength bolts will be used. The frictional connection and the tensile connection

of the test specimens constructed with high-strength bolts will have sufficient connection strength so that the connection would not separate or slip until the slit plate of each test specimen demonstrated maximum strength. Four full-scale specimens that 3 one had metallic dampers and the other one is conventional extended end-plate beam to column connection are shown in Fig. 3.

Type 1 is a conventional extended beam to column connection with the beam IPE 270. All specimens have the same type and size of beam and columns. The difference between Type 2 and Type 3 is only the thickness of the damper. 12 mm damper was used for Type 2 and 22 mm damper was used for Type 3. For Type 3 20mm damper with symmetric L shapes was produced.

Fig. 4 shows the moment versus rotation relationship of each specimen. The dashed line in Fig. 4 represents the fully plastic moment of the beam (121 kN m) calculated by using the material properties of IPE 270 beam.
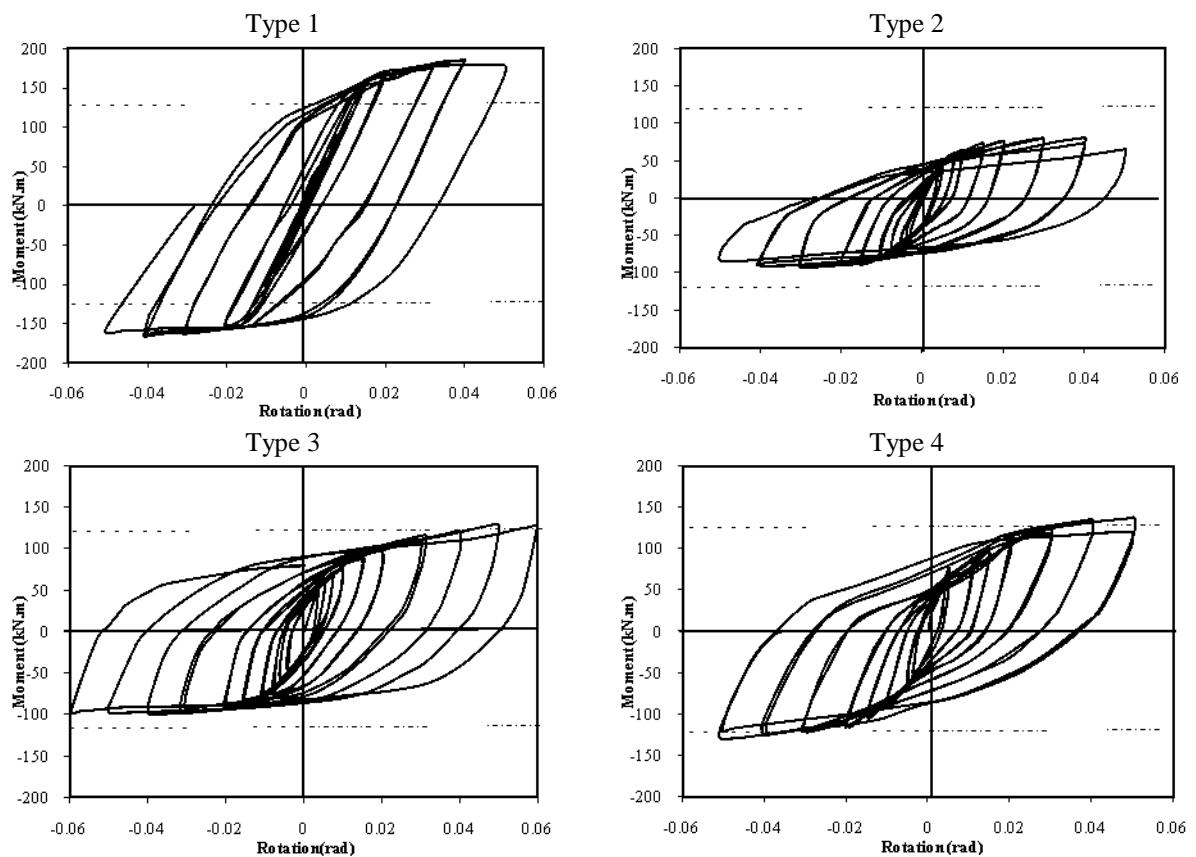
Fig. 4) Moment versus rotation relationship

3   CONCLUSION

In this study, seismic performance of metallic dampers which could not only provide good seismic performance but could also be easily repaired after a heavy earthquake was studied. The metallic dampers which is a low-cost steel energy dissipative device can easly be fabricated in practice. Metallic damper is proposed that features superior deformation capacity and ease of repair after an earthquake. this connection is a beam-to-column connection system where the metalic damper is connected to the bottom flange of the beam using high strength

bolts. cyclic tests were conducted on four full-scale specimens that three had metallic dampers and on one specimen that had a conventional extended end plate connection to verify the performance of the proposed system.

The conventional extended end plate specimen Type 1 also showed stable hysterectic loop and good plastic deformation capacity. However, the entire plastic deformation originated from the local buckling of the beam. Therefore, it is ineffective to repair these conventional extended end plate connections after an earthquake. It is believed that the energy absorption is concentrated only at the slit dampers rather than at the beams. Thus, the slit dampers can be replaced after an earthquake more easily than can beams and columns. Test results showed that the plastic deformation capacities of specimens Type 3 and Type 4 were nearly equal, while the negative rotation capacity of Type 4 significantly higher than that of Type 3. This was because, for Type 4 L shapes were manufactured for both right and left sides. And also further research is necessary to investigate the behavior of a structural system equipped with slit damper so that a more generalized evaluation of seismic capacity of the proposed system can be achieved.

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EU REGIONAL POLICY INFLUENCE ON REGIONAL DEVELOPMENT IN THE CZECH REPUBLIC FROM 2014 TO 2020

Lucie Kozumplíková[1], Jana Korytárová[2]

Abstract

The article deals with the basic directions of regional policy in the programming period 2014 - 2020 and its impact on the performance of regions. In this period, the EU regional policy should try to maintain its primary goal, therefore, be an instrument for reducing disparities in levels of development of regions and member states. Just the fact that the Czech Republic in this period will not promote any change in the rules of the EU Cohesion policy; it may receive the maximum possible amount of the financing needed to fulfill their goals. The aim of this paper is to outline the context and the connections of regional policy of the Czech Republic with the performance of individual regions and regional policy of EU.

Key words

Gross domestic product, region, regional performance, regional politics, unemployment.

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1   INTRODUCTION

Especially in this period of crisis, the European Union needs the Cohesion Policy. Through this Policy, investments should be realized that help the entire European Union as well as the individual regions overcome the crisis, reduce regional disparities, and promote the fulfilment of the targets of the Europe 2020 Strategy. In prior periods, the Cohesion Policy has helped to improve economic, social and environmental conditions, however, in the coming periods, it would be better to concentrate only on several key priorities, especially in the more developed regions. As a result, it is desirable that the Cohesion Policy is more selective. Therefore, future programmes should focus only on a few priorities that are closely connected to the Europe 2020 Strategy - thus each priority would get the necessary finance and real influence. These priorities should be established through the cooperation of the European Commission, Member States, but also the individual regions. [1]

The Regional and Structural Policy designed for the period after 2013 will enable the Member States and regions to strive for smart, sustainable and inclusive growth.

2   CURRENT SITUATION

The European Union expresses solidarity with less developed countries and regions, and therefore it channels financial resources to the areas and sectors where they have the greatest effect. The Regional Policy aims to reduce the great economic, social and territorial disparities that still exist among the different European regions. If there were no attempts to reduce these inter-regional disparities, some of the foundations of the EU would likely be endangered.

In the programming period 2007 – 2013, a total of € 347 billion is invested in the European regions. These resources are primarily invested in the improvement of transport and Internet connection in remote regions, support of small and medium enterprises in disadvantaged areas, environmental protection and education. EU resources are also invested in innovation, the development of new products and production methods, energy efficiency, and in combating climate change. [2]

3   PROGRAMMING PERIOD 2014 – 2020

In recent years, the European Union has adopted a new strategy for long-term recovery, called Europe 2020, the main objective of which is smart, sustainable and inclusive growth. To achieve this objective, the need for innovation, employment and social inclusion, and strong responses to environmental challenges and climate change must be even more emphasized. The main objectives of the Europe 2020 Strategy cannot be achieved through policies formulated at the EU or national levels; the regions must also participate in their formulation. [3]

The main sources of investment at the EU level are the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF). In accordance with the targets of the Europe 2020 Strategy, these funds should help the Member States restore and enhance growth and secure enough employment, while simultaneously ensuring sustainable development. The objectives of the European Union are better fulfilled if greater coordination of these funds is achieved, so that they do not overlap

and maximum synergistic effect is ensured. Closer coordination of funds should help achieve the following results:

- Concentration of resources on the targets of the Europe 2020 Strategy through a common set of thematic targets, which the funds shall help fulfil,
- greater simplicity, which shall be achieved through more compact measures in planning and implementation,
- greater emphasis on results, which shall be achieved through the performance framework and reserve,
- harmonization of eligibility rules and extending the simplified cost options in order to reduce the administrative burden on beneficiaries and managing authorities. [4]

Also, partnership agreements should be adopted, which shall provide for the obligations of the partners at both national and regional level. These agreements shall be connected to the objectives of the Europe 2020 Strategy as well as the National Reform Programmes, and shall set out an integrated approach to territorial development, which shall be supported by all the above-mentioned funds.

3.1   European Regional Development Fund (ERDF)

The ERDF shall participate in all thematic targets and shall focus on investment areas that are connected with business operation environment (infrastructure, services and support to business entities, innovation, ICT and research). It shall also participate in the provision of services to citizens (energy, on-line services, education, health care, social research infrastructure, accessibility, environmental quality). [5]

3.2   Cohesion Fund (CF)

The Cohesion Fund shall focus on improving the state of the environment, sustainable development and the development programme of the Trans-European Transport Networks (TEN-T). [5]

3.3   European Social Fund (ESF)

The ESF shall continue to provide specific support to people who need help with finding a job or with making progress in their current work. The objectives of the ESF are to improve employment opportunities, promote education and lifelong learning, improve social inclusion, contribute to the fight against poverty and develop the capacity of the public administration.

The individual programs within the ESF shall be based on four thematic objectives:

- Employment and labour mobility,
- education, skills and lifelong learning,
- improving social inclusion,
- fighting poverty and administrative capacity building.

The ESF activities shall not be focused only on these programmes but shall also contribute to the fulfilment of other thematic objectives. [5]

3.4   European Agricultural Fund for Rural Development (EAFRD)

The EAFRD focuses on six priorities in the agriculture, food and forestry sectors as well as development of rural areas themselves. These priorities cover the areas of knowledge transfer

and innovation, competitiveness of agriculture, natural resource management, climate change and inclusive rural development. [5]

3.5 European Maritime and Fisheries Fund (EMFF)

In accordance with the reform of the Common Fisheries Policy, the EMFF priorities shall focus on the viability and competitiveness of the fisheries and aquaculture sectors, and the support of their sustainability in terms of environmental protection. The EMFF also supports social cohesion and job creation in areas dependent on fisheries, especially through their integration in other maritime sectors and through measures in the area of the Integrated Maritime Policy. [5]

4 INNOVATION IN THE COHESION POLICY FUNDING FOR THE PERIOD 2014 - 2020

All EU regions shall continue to receive financial support, according to their classification into the defined categories:

- Less developed regions - GDP per capita is below 75 % of the EU average; these regions shall remain a priority of the policy.
- Transition regions - GDP per capita is between 75 % and 90 % of the EU 27 average.
- More developed regions - GDP per capita is above 90 % of the EU 27 average.

The transition regions include 51 regions with more than 72 million people. This group facilitates transition of the regions which have recently gained greater competitiveness but still need targeted support. By 2014, about 20 regions should transfer from the group of less developed regions to the group of transition regions, which proves the success of the Cohesion Policy.

The following figures show the classification of the individual European regions into the above groups. The first figure shows regions according to the average GDP per capita between 2006 and 2008 (Fig.1), while the next figure simulates the situation in the next programming period (Fig.2). The last figure is a follow-up to the second figure, and describes funding in the individual categories of regions (Fig.3).

5 EUROPE 2020 STRATEGY

The Europe 2020 Strategy was adopted in June 2010 and its main objective is to stimulate energetic, sustainable and inclusive growth. The strategy defines the main targets of the European Union for the period up to 2020 in the areas of research and innovation, climate change and energy, employment, education and reduction of the poverty rate, which should be translated into the targets of the individual states. [7]
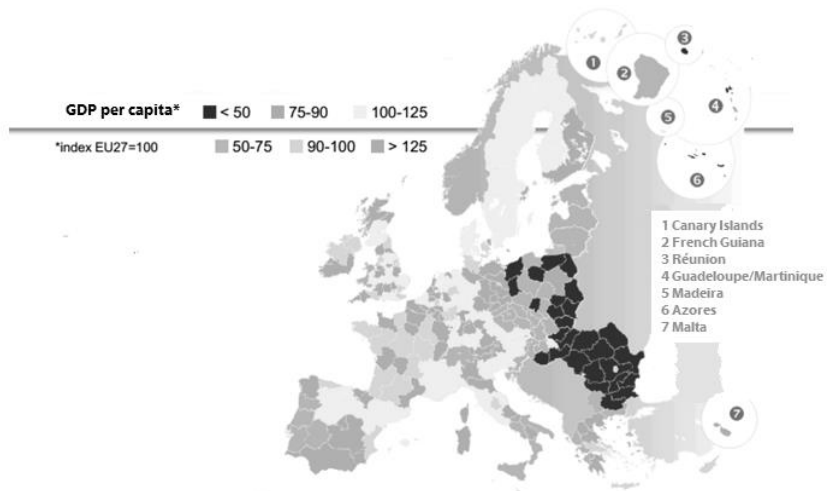
Fig. 1)   Disparities among regions (2006 to 2008 average) [6]
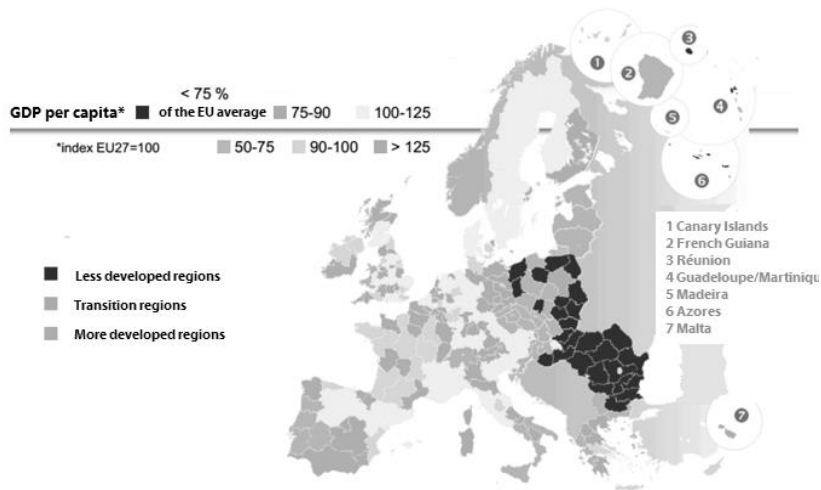
Fig. 2)   System suitable for all EU regions (simulation of eligibility) [6]

Less developed regions / Member State	
Cohesion Fund	68.7
Less developed regions	162.6
Transition regions	38.9
More developed regions	53.1
European Territorial Cooperation	11.7
Remote regions and sparsely populated areas	0.9
In total	336.0

Budget allocation (%)
- 15,8 %
- 11,6 %
- 68,7 %

Population included (millions)
- 307.1
- 72,4
- 119,2
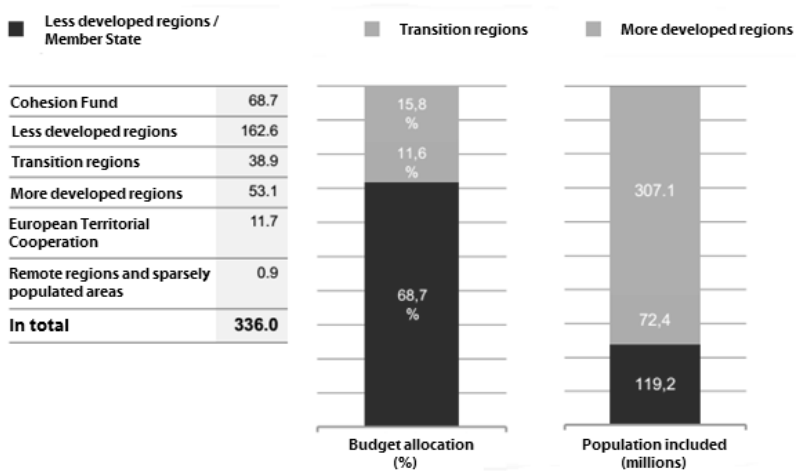
Fig. 3)   Allocation of resources to individual regions [6]

The European Union has set five main targets which should enable progress towards the fulfilment of the Europe 2020 Strategy. The European Union has set the following five targets to be achieved by 2020:

1. *Employment* – increasing the employment rate of the population aged 20 - 64 to 75 %

2. *Research, development and innovation* – investing 3 % of the EU GDP in research, development and innovation; through a combination of private and public sources

3. *Climate change and energy* - reducing greenhouse gas emissions by 20 % or by 30 % compared to 1990 levels; increasing the share of renewable energies to 20 %, and increasing energy efficiency by 20 %

4. *Education* – reducing the school drop-out rate to less than 10 % and increasing the proportion of tertiary degrees to 40 % in the population aged 30 to 34 years

5. *Poverty and social exclusion* – reducing the number of people living in or threatened by poverty and social exclusion by at least 20% [8]

These targets are interrelated and primary achievement overall success. The European Commission proposes conversion into national targets and the directions. The each Member State should adapt the Europe 2020 Strategy to its particular situation.

The targets represent the overall picture of what the EU should, in the main measures, fulfil by 2020. Each of these targets is translated into a national target, so that each state can monitor whether the targets are successfully fulfilled. It is not necessary to allocate the costs necessary to achieve the targets, because they are common targets which can be achieved through the optimum combination of measures by Member States and the European Union. The targets are interrelated and support each other. Achieving better results in education brings increased employment and reduced poverty. A larger proportion of research, development and innovation in the economy, along with optimal use of resources, lead to increased competitiveness and creation of new jobs. Investment in green technologies helps mitigate climate change and create new business opportunities and jobs.

The Europe 2020 Strategy includes seven flagship initiatives, which make it possible for the EU institutions and the national authorities of the Member States to join their efforts in the areas that help achieve the priorities of the Strategy. The Strategy will only be successful if all the interested parties work towards its realization, whether at the national or the EU level. At the EU level, decisions are made regarding the completion of the Single Market in services, energy and digital products, but also regarding investments in important cross-border networks. At the national level, barriers to competition and the creation of new job opportunities need to be removed. The desired impact on economic growth and employment will only be achieved if these two levels work together.

The seven flagship initiatives that should start the progress in each of the priority themes include:

- The *Innovation Union*, to support the production of innovative products and services, in particular concerning climate change, energy efficiency, health and the ageing population.

- The *Youth on the Move* initiative, to primarily enhance the performance of education systems, support informal learning, student and researcher mobility, and facilitate the entry of young people into the labour market.
- The *Digital Agenda for Europe* initiative, to promote the creation of a Digital Single Market, characterized by a high level of security and a stable legal framework. Furthermore, fast and subsequently ultra-fast internet should be accessible to the population as a whole.
- The *Resource-efficient Europe* initiative, to support the sustainable management of resources and the reduction of carbon emissions, while maintaining the competitiveness of the European economy and its energy security.
- The *Industrial Policy for the Globalisation Era* initiative, to help industrial enterprises to overcome the economic crisis, integrate into world trade and adopt more environmentally-friendly production methods;
- The *Agenda for New Skills and Jobs*, to improve employment and the sustainability of social models. The primary aim is to encourage worker and student training, but also gender equality and the employment of older workers;
- The *European Platform against Poverty*, to increase cooperation between EU countries, and to follow the Open Method of Coordination in the areas of social exclusion and social protection. The objective of the Platform is the economic, social and territorial cohesion of the EU, and the social inclusion of people experiencing poverty.

5.1 The Europe 2020 Strategy and the national targets of the Czech Republic

The Country-specific Recommendations are documents prepared by the European Commission for each country, analysing its economic situation and providing recommendations on measures it should adopt over the coming 12 months. They are tailored to the particular issues the Member State is facing and cover a broad range of topics: the state of public finances, reforms of pension systems, measures to create jobs and to fight unemployment, education and innovation challenges, etc. The final adoption of Country-specific Recommendations prepared by the Commission is done at the highest level by national leaders in the European Council. [9]

Upon the recommendation of the European Council, the individual Member States were required, in cooperation with the European Commission, to set national targets with respect to their economic and social characteristics. With regard to the consultations with the Commission, existing obligations, and taking into account the national economic, social and political situation, the following national targets of the Czech Republic were identified within the framework of the Europe 2020 Strategy:

1. Employment
- The Czech government shall submit to the EC the national target of the overall employment rate of 75 %
- National sub-target of the female employment rate: 65 %
- National sub-target of the employment rate of older workers: 55 %
- National sub-target "reduction of the unemployment rate of young persons" (15 - 24): reduction by one third compared to 2010
- National sub-target "reduction of the unemployment rate of low-skilled persons": reduction by a quarter compared to 2010

- National sub-target of reducing the administrative burden on businesses compared to 2005: 30 %
- National sub-target of increasing labour productivity compared to 2010: 20 %

2. Investment in research and development
- The Czech government shall submit to the EC the national target for investment in research and development of 2.7 % of GDP

3. Increasing energy efficiency
- For the present, the Czech government shall not submit to the EC the national target of reducing the consumption of primary energy sources

4. Education
- The Czech government shall submit to the EC the national target of the proportion of tertiary degrees in the population aged 30 to 34 of 32 %
- The Czech government shall submit to the EC the national target of the school drop-out rate of 5.5%

5. Social inclusion and poverty reduction

- The Czech government shall submit to the EC the target to keep the 2008 number of people at risk of poverty, material deprivation or in jobless households by 2020. However, at the same time, the Czech Republic shall make efforts to reduce the number of people at risk of poverty, material deprivation or in jobless households by 30,000. This number corresponds to the reduction in the number of these people to a level below 15% compared to the current state (15.3%). [10]

Unlike the programming period 2007 – 2013, during which support was allocated to a large number of programme priorities, in the new period 2014 – 2020, it is expected that resources will be concentrated only to a limited number of priorities. From the expected innovations, promotion of the use of new financial instruments in a wider range of areas and increasing the prominence of towns as competitiveness accelerators can be highlighted. The urban aspect of the Cohesion Policy shall be represented mainly through the so-called third dimension - territorial cohesion. It is likely that towns will be more active both in proposing as well as in implementing urban development strategies. In the new programming period, the so-called performance bonus may be used, i.e. a bonus in the form of additional allocation to the Member States and regions that have contributed most to the targets of the Europe 2020 Strategy. [11]

On the basis of the Partnership agreement for the programming period 2014 to 2020 – Definition of operational programmes – the following operational programmes for the efficient use of European funds are likely to be established in the Czech Republic:

- Operational Programme "Entrepreneurship and Innovation for Competitiveness" managed by the Ministry of Industry and Trade.
- Operational Programme "Backbone Infrastructure" managed by the Ministry of Transport.
- Operational Programme "Employment and Training" managed by the Ministry of Labour and Social Affairs.

- "Integrated Regional Operational Programme" managed by the Ministry of Regional Development.
- Operational Programme "Prague – the pole of growth of the Czech Republic" managed by the Municipal Authority of Prague.
- Operational Programme "Technical Assistance" managed by the Ministry of Regional Development. [12]

Within the target of the European Territorial Cooperation, there are expected to be seven cross-border operational programmes, and the Rural Development Programme and the Fisheries Operational Programme should continue to exist.

6   CONCLUSION

This article introduced the new strategy for the period up to 2020, called Europe 2020. The three main targets of the Strategy cut across traditional sectoral perceptions and so require, in addition to the necessary structural reforms, an integrated investment framework coordinating individual investment and non-investment activities. This approach, combining investments in various areas (innovation, human resources, business environment, infrastructure, etc.) into a single framework in the national, regional and local context, corresponds to the role of the Cohesion Policy. It is therefore clear that future priorities of the Cohesion Policy must be in accordance with the thematic priorities identified in the Europe 2020 Strategy.

The EU 2020 Strategy builds on the Lisbon Strategy which has failed in many respects to meet expectations. One of the failings of the Lisbon Strategy was, among others, the lack of togetherness and understanding of the targets on the part of the EU citizens. In accordance with the subsidiarity principle, there is a related need to involve in the implementation of the targets of the EU 2020 Strategy, to the greatest extent possible, the representatives of the regional and local authorities, broad civil society (non-governmental non-profit organizations), representatives of economic and social partners, etc., through the concept of so-called multilevel governance.

Closer coordination of economic policies of the Member States, especially within the Eurozone, and reinforced supervision over the individual Member States should primarily become important features of the new period.

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EXPERIENCES IN DESIGNING OF REHABILITATION WORKS FOR NORTH-SOUTH RAILWAY LINE IN MONTENEGRO

Zoran Krakutovski[1], Miloš Knežević[2], Zlatko Zafirovski[3], Meri Cvetkovska[4]

Abstract

The subject of this paper includes redesign of alignment and superstructure calculation for every subsection of the railway line. The subsections are defined for each station along the railway line and also for the open line between two neighboring stations. The paper also includes drawing solutions for renewal (rehabilitation) of railway track using topographic surveys or the geodesic data from the existing track layout and neighboring sites and also the superstructure calculation based on the traffic forecast scenarios, cost efficiency, traffic safety and the geotechnical investigation results.

Key words

Infrastructure, main design, railway track, rehabilitation, superstructure.

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1   INTRODUCTION

The electrified railway single line Bar – Vrbnica was opened to traffic in 1976 and links Montenegro to the European rail network via Belgrade. The superstructure of railway track is 35 years old and it was necessary to repair and to change the existing track components.

The objective of work was to prepare civil engineering infrastructure design for major repair (rehabilitation) of this railway line. Two separate civil engineering infrastructure design dossiers were prepared for the following sections:

- Section 1: Kolašin – Podgorica from km 340+991 to km 404+418 (length of 63,4 km)
- Section 2: Podgorica – Bar from km 404+418 to km 455+500 (length of 51,1 km)

Fig. 1)   Railway line Kolašin – Podgorica - Bar

The designed maximum speed is 80km/h and maximum allowed axle weight is 22,5t and 8t per m' (UIC track class D4) [1]. During the operating of railway line, the railway infrastructure loss of substance and the technical speed for trains in 2008 was between 35 and 50km/h [2]. The layout of the existing track is made of S49 continuous welded rail installed on wooden sleepers.

The drawings include the geometrical horizontal and vertical alignment of railway track, including the cross sections. The alignments have to use as much as possible the existing railway tracks to reduce the need for land use changes and excessive costs. The improvement of track geometry of the railway line for higher speeds is made for each section where this is possible without having big impact on additional construction works and costs [3], [4].

2 GENERAL CURRENT STATE ANALYSIS

The studied railway line is divided on two sections between Station Kolašin and Station Podgorica and between Station Podgorica and Station Bar. The total length of the railway line is 114, 5 km, including the both sections. The railway line is electrified with 25 kV, 50 Hz single-phased system with single-track and standard gauge. The maximum allowed speed according to original design is 80 km/h.

The permanent track is composed of rails type S49 attached on 260/26/16 wooden sleepers with rigid K fastenings and laid in standard ballasted bed outside of the steel bridges. The ballasted bed is not used on the portion of the track through the steel bridges.

The rails are welded in the Continuous Welded Rail (CWR) and on the particular portions there are standard rail joints. The maximum temperature amplitude differences in the rails is 95°C (-35°C in the winter and +60°C in the summer).

The existing ballast is produced from carst stone (broken limestone) which is particularly wide-spread in the Montenegro area. Minimum thickness of ballast bed is 30 cm under at the bottom of the wooden sleepers.

Several portions of the track have a ballast thickness more than 30 cm because of the maintenance works during the period of 35 years.

2.1 Section 1. Kolašin – Podgorica

The Section 1 Kolašin – Podgorica, from km 340+991 to km 404+418 contents 11 subsections for design preparation. Among these 11 subsections there are 5 sections in the following stations: Kos, Trebešica, Lutovo, Bratonožići and Bioče.

The total length of the section is 63, 4 km and the part of curves in the total length is about 52%. Along this section there are 47 bridges, 78 tunnels and 137 culverts. The existing minimum radius of horizontal curve is 300 m. The transition curve is cubic parabola and the maximum cant elevation of exterior rail is 150 mm. The originally design allows a maximum speed of 80 km/h. The existing track alignment was carried out according to Instruction 314 JŽS valid for each railway line constructed in Yugoslav Railways Network.

2.2 Section 2. Podgorica – Bar

The Section 2 from station Podgorica to station Bar (from km 404+418 to km 455+500) contents 11 subsections for design preparation. Among these 11 subsections there are 6 stations: Podgorica, Golubovci, Zeta, Virpazar, Sutomore and Bar.

The total length of the section is 51, 1 km and the part of curves in the total length is about 30%. Along this section there are 11 bridges, 4 tunnels and 77 culverts. The existing minimum radius of horizontal curve is 300 m. The transition curve is cubic parabola and the maximum cant elevation of exterior rail is 150 mm. The originally design allows a maximum speed of 80 km/h. The existing track alignment was carried out according to Instruction 314 JŽS valid for each railway line constructed in Yugoslav Railways Network.

3 SUBGRADE AND SUPERSTRUCTURE STATE

The geotechnical investigation results are presented in the "Report on geotechnical investigations for repair and reconstruction of several sections of railway line".

The mentioned Report contents some details concerning each investigated location and appropriated proposals to improve, or to repair the bad subgrade sites. The detailed presentation of these results is done for every subsection in the part of superstructure calculation. The superstructure is very old about 35 years. During this period some maintenance works are made and several portions of the railway track are changed their first components. The lateral wear of rails type S49 are particularly current in the curves with the small radius between 300 m and 600 m.

The important number of wooden sleepers is damaged and it must be changed. The ballast needs cleaning and replacement with the new ballast for about 1m3 for 1m' of the track length shall be sufficient.

4 GENERAL INTERPRETATION FOR REDESIGN OF ALIGNMENT

– *Planimetric study*

The starting point for preparation of main design of track geometry is the digital topographic data and the geotechnical data resulting from the site investigations. The plan is produced with a scale of 1/1000 for the railway line and 1/500 for the stations.

The drawings illustrate following items: the length of the tracks, the widths of the tracks axis, the number of the tracks, the type of the turnouts and their numbers, the changes of gradients, the main points in the curves, the location of the cross sections, the location of the stations, the location of the structures, type span of structures, the location of the hydraulic structures, the representation of the longitudinal drainage. Each horizontal intersection point (vertex) is enumerated in progression and it has one table with following data: the curve number, the radius, the angle, the length of tangent, the length of circular curve, the length of transition curve, the cant, the speed.

The coordinates of centre line of each important point of the alignment are shown on the drawings.

– *Altimetric study*

The longitudinal profile is produced at a scale of 1/1000/100 for the railway line and 1/500/50 for the stations. The longitudinal profile drawing contents the followings issues: the dimensions of existing and running surfaces of track, the dimensions of the earth level, the gradient of the tracks, the straight parts of the tracks and the curves, the cant, the mileage, the crossing with roads, subways, over bridges, the location and numbers of the cross sections, the location of the structures, the length of every section with same gradient. Each vertical intersection is enumerated in progression and it has one table with following data: the radius of the vertical curve, the length of tangent, the length of circular curve, and the gradients.

– *Cross sections*

The cross sections of the track alignment are drawn at a scale of 1/100. The cross sections are illustrated the subgrade formation, the inclinations of the embankments and of cuttings, the

ditches, the culverts and structures, the tracks components, the elevation of the rails. According to the Terms of Reference, the cross sections are established at distances from 100m to 300m according to the complexity of the site for the straight sections and every 10m in curves including the transition parabolic curves.

4.1   Limit values of plan and profile

All limiting parameters are in function of design speed including minimum and maximum values for plan, longitudinal profile and cross section. The design parameters are calculated according the new standards everywhere the track alignment not changes widely to increase considerably cost of works.

The segments where the changes of alignment require considerable additional civil works, the design follows the basic technical criteria and parameters according to Instruction 314 JŽS which are used during preparation of the original design. The normal and limit values of route alignment parameters are determined. The value of parameter extends from the limit allowed value, through the normal value to the limit of feasibility.

The limit allowed value is generally determined by the safety in railway traffic and the minimum requirements concern the comfort. Feasibility limits are determined on the basis of requirements for accurate application of the default value and the possibilities for its maintenance. The normal values are recommended to use.

1.1. Vertical curves

The vertical curves are purely circle, necessary for connecting two consecutive gradients in longitudinal section. Their minimum value is depending on the maximum speed, in order to limit the vertical acceleration. The circle must be inserted in case where the difference of gradients is $\Delta i \geq 2‰$. The minimum length of circle shall be $l \geq 20$ m.

The vertical curves should be not considered along the transition curves, on expansion device installation, onto turnout of main track and also on the steel bridges with open slab.

The maximum value of radius of vertical curve (feasibility limit) is $R_V = 30000$ m, the usual value is $R_V \geq V2$ and the minimum value (limit value) is $R_V \geq 0, 25 \cdot V_2 \geq 2\ 000$ m.

Where: V - maximum allowed speed (km/h)

1.2. Track and turnouts in stations

The designs take into consideration only the main track in stations. The turnouts considered in the design are located on the main track passing through station area. The turnouts should be constructed on some sections with gradient $i \leq 10‰$. The minimum distance between the end of the first and the start of the second turnout shall be $m \geq 7,0m$.
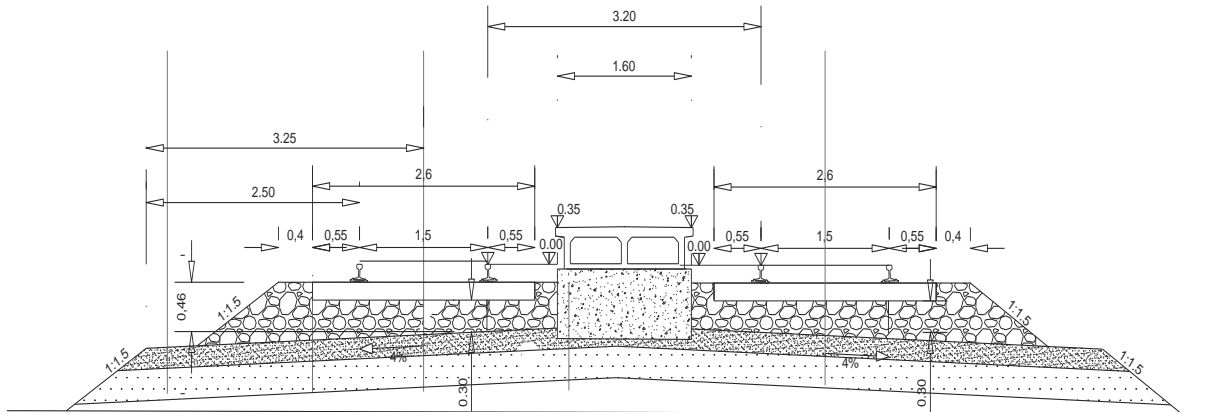
Fig. 2)   Cross-section for railway station with middle platform

4.2   Typical cross-sections

The cross sections on the studied sections are designed and accompanied with all relevant data stating about the applied solutions. These are marked and described in detail, and each cross section is accompanied with relevant quantities.

- *Distance between track axes*

The minimum distance between axes of the main tracks in stations is 4,75 m and for the parallel tracks is 4,00 m.

- *Components used in superstructure*

The level of the track is measured below the top of rail head for each rail in straights and for interior rail in curve:

- Height of track with ballast is 0,624 m (0,149 m rail 49E1, ribbed base plate 0,015 m, wooden sleeper 0,160 m and ballast 0,300 m).

- Height of track without ballast is 0,50 – 0,70 m (it depends on type of structure).

- Length of wooden sleeper 2,60 m.

- Width on the top of ballast bed in front of the sleeper min. 0,40 m.

- Declivity of ballast bed 1:1,5.

The thickness of the ballast bed on the concrete bridges and tunnels shall be minimum 35 cm.

- *Cross section characteristics*

The cross section characteristics depend on the position of the track in layout, topography, structure and location of the track on station or on open track. The existing width of the top line of formation layer is 2 x 2,85 m = 5,70 m. The cross section of simple track railway line should be considered with 6, 0 m wide track formation outside of bridges and tunnels. The

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cross section in difficult topography and sections on bridges or in tunnels should generally remain unchanged to avoid cost increases.
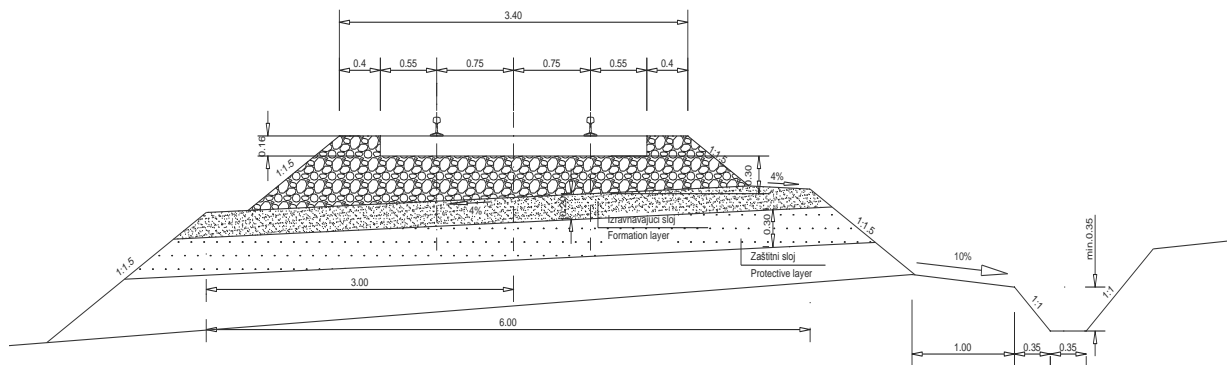
Fig. 3)   Cross-section for single railway structure

The work for sections with poor quality material in subgrade considers following items:

After removing of existing ballast bed and performing excavation of the present track embankment up to the design levels and construction of the missing embankment segment, the protective and formation layer of track embankment shall be completed. The final layer of fill generally is formed by formation layer with 10 cm or 20 cm thickness. The formation layer with 10 cm thickness shall be laid on all sections where the foundation protective layer is not envisaged under formation layer, while the formation layer with 20 cm thickness shall be introduced on each section where a foundation protective layer with 30 cm thickness is embedded, according to the requirements in the geotechnical investigation report.

The subgrade cross fall of open track shall be 4%.

The slope formation in station is consistent with the existing slopes and drainage system of station, everything to the required profiles and details of the project.

The both newly constructed track embankment and the existing track embankment shall be connected by gradually cutting into the slopes of the existing embankment. The embankment slopes shall be designed with gradient of 1:1,5. Typical cross sections shown in the design shall be accompanied with all required details.

4.3   Caracteristics of new rehabilitation designs

– *Layout plan*

The major part of the new design of railway sections is considered for a maximum allowed speed of 80km/h. The new alignments try to follow existing track geometry to avoid supplementary excessive costs. The existing structures as tunnels and bridges are the fixed points where the new and existing track alignments have to be identical. The new alignment improves track geometry to increase the speed of trains wherever this is possible without considerable additional costs. Three sections are redesigned with increasing of allowed speed from 80 km/h to 90 km/h, 100 km/h and 120 km/h. The increasing of the speed is allowed just by the changing of the length of transition curve and the intensity of the cant.

- *Longitudinal profile*

The new longitudinal profile follows designed track geometry and attempts to avoid supplementary excessive costs. The existing structures as tunnels, bridges, culverts are the fixed points where the new longitudinal profile must be identical with the existing level of structures.

- *Cross sections*

The cross sections on the studied section are designed for this level especially and accompanied with all relevant data stating about the applied solutions. Every cross section is accompanied with relevant quantities.

5 SUPERSTRUCTURE COMPONENTS AND CALCULATION

a) Choice of track components

The existing track is equipped with rails type S49. The choice of rail profile mainly depends of the traffic load as well as on the expected lifetime [5], [6]. The rail type S49, UIC 54 is usually used for low traffic load, and UIC 60 rail for medium and heavy traffic loads for a standard gauge track [1], [6], [7]. The forecast of the traffic considers that this line will have low and medium traffic loads. The rail profile 49E1 (EN 13674) is compatible with existing rail profile and appropriate for the renewal (rehabilitation) works of the track 8], [9], [10].

The existing sleepers are wooden sleepers with dimensions 260/26/16 cm. The similar wooden sleeper will be used for rehabilitation works. The existing rigid K fastening system will be replaced with elastic fastening which should be finally chosen in the process of tendering.

b) Calculation of superstructure

The calculation of superstructure starts with the calculation of bending stress in the rails loaded by the static loads according to the standard loading schemes after UIC with maximum axel load of P_{max}=22,5t or 8t/m' (UIC class D4) [1], [7]. The effects from dynamic loads of the trains are considered by increasing the static stress with dynamic coefficients which are function of train velocity. The rail is treating as a beam on elastic supports to calculate stresses in the rails from static and dynamic loads (Zimmermann's theory) [2].

The axial stresses from temperature changes are also calculated and added to the dynamic stresses to obtain the total stresses in the rails which were compared with the maximum allowable stresses [6]. The effects from negative temperature changes in winter period and the possibility of rail break are calculated and the maximum clearance due to rail break is considered. The stability of the continuous welded rail (CWR) from the buckling in vertical and lateral direction is also verified.

The thickness of the ballast bed is determined as a function of maximum axel load, daily traffic load, quality of materials in the subgrade, thickness and quality of the protective layer, dimension of sleepers and quality of the track maintenance, in accordance with the proposed UIC method [1], [4], [6], [7]. According to the "Technical and Financial Study for the rehabilitation of Belgrade – Bar railway line", Second report, March 2010 – Italferr, the forecasting of traffic considers that this railway line shall be in UIC group 5, a daily traffic

ranging until 20 thousand tons (UIC-Leaflet 719 R). The calculation of superstructure is based on the theory usually used in the railway engineering. To obtain evenly intensify of the locomotive engines and a harmonic motion, additional running resistance from the route are equalize through the procedure for alleviate the route in curvature sections and in the tunnels areas where additional tunnel resistance is acting.

6   CONCLUSION

Designing a railway line involves satisfying many objectives that often conflict. Throughout the process, the designer must prioritize project objectives and decide to what extent one objective may be sacrificed to satisfy another. It is the proper balance of these compromises, specifically matched to each situation that produces a good railway line design.

Rehabilitation involves restoring facilities to a "like new" condition and/or upgrading existing facilities to current design standards or installation requirements. During the planning process, current and future installation requirements should first be clearly established. If subsequent investigations and analyses show that existing facilities could meet installation requirements through improving their condition and/or minor modifications, then rehabilitation is an appropriate option. The railway line in Montenegro is an example of how the complete design procedure has to be done and during the design stages it was proved that rehabilitation is an appropriate option.

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POST DISASTER MANAGEMENT OF BUILDING REFURBISHMENT ON URBAN AND BUILDING SCALE: EARTHQUAKE DAMAGE MITIGATION

Matej Kušar[5], Mojca Jarc Simonič[6], Jana Šelih[7]

Abstract

The paper describes the key elements of the postdisaster management system recently used is Slovenia in the case of earthquakes. The system is employed both in the early stage, when the primary concern is securing the safety of the inhabitants, and more in detail the elements of the disaster management model implemented in the secondary stage, when the actions are focussed towards achieving the required performance of the damaged buildings by selecting appropriate refurbishment actions. The procedures required to execute the upgrading of damaged buildings are presented and discussed. The current system in the response/early recovery stage has proved to be efficient enough and ensures that buildings that have been upgraded exhibit adequate performance and earthquake resistance, while the allocated governmental funds are efficiently used.

Key words

Building, earthquake damage mitigation, recovery phase, refurbishment.

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1   INTRODUCTION

Natural disasters, e.g. floods, draughts, earthquakes, typhoons, landslides, heavy snows, forest fires etc are accompanying the human race and civilization since its onset. They induce serious losses, both in losses of human lives as well as property and economic losses. Sometimes, they also have an adverse effect upon environment. Many countries have therefore recognized the need to establish and implement an institutional framework for disaster management system [1].

Disasters have a lifecycle of occurrence which must be matched by a series of management phases. The phases include strategies to mitigate hazards, prepare for, respond to, and recover from the effects of the emergencies. Realising that disasters exist throughout time leads to organising emergency management in parallel with the disaster life cycle: foreseeing a series of phases that include strategies to mitigate the hazards, prepare for and respond to emergencies and finally to recover from their effects. These phases are interconnected, while the emergency management cycle is an open ended process (Figure 1). The four phases comprising the cycle begin and end with mitigation, the on-going attempt to limit or prohibit the effects of a disaster. [2]
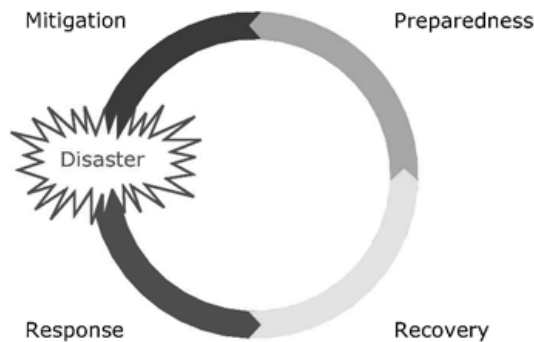
Fig. 1)   The emergency cycle [2]

Mitigation refers to activities which actually eliminate or reduce the chance of occurrence or the effects of a disaster, either natural or man made. Various instruments are used in this phase, e.g. implementation of improved building and safety codes, risk mapping, monitoring of the built environment, public education and research.

Preparedness deals with planning the response in case of an emergency or disaster occurrence. In this stage, the resources necessary to ensure efffective response effect are increased. Activities like developing emergency policies, plans and procedures; conducting and evaluating drills and exercises; and providing training and public education are carried out in this stage. Response activities occur during and immediately following a disaster. Their goal is to save lives, minimise property damage and facilitate the beginning of recovery from the incident. Police, fire and rescue services are the primary responders during the response phase. Recovery is the final phase of the emergency management cycle, which continues until all systems return to normal, or near normal. Short-term recovery returns vital life support systems to minimum operating standards. Long-term recovery from a disaster may go on for longer periods, until the entire disaster area is completely redeveloped. Short term recovery activities related to the built environment include damage assessment and debris removal. Long term recovery comprises rebuilding and upgrading and is generally an activity carried out by local authorities under the local Building Department. [2]

Recent comprehensive studies, e.g. [3] show that the majority of research in the area has been devoted to the response phase. Unfortunately, damage assessment, which often initiates disaster response operations and facilitates recovery, as well as recovery stage, has received less attention from researchers.

Slovenia, as an earthquake prone country, has experienced a large number of strong earthquakes over the past 50 years. During this period, the country has gradually developed an earthquake disaster management system, focused primarily to the response phase, and secondary, to the recovery phase that enables full social and economic recovery of the affected area. Damage assessment of the built environment (buildings and infrastructure) plays a crucial role that enables planning and execution of further actions.

The paper describes the key elements and procedures of the late response and recovery phase of the disaster management system related to the built environment in the case of the earthquakes, and gives a critical view of the procedures being employed in the recent past.

2 SURVEY OF RECENT EARTHQUAKE DAMAGE ON BUILT ENVIRONMENT IN SLOVENIA

The region with highest earthquake occurrence within last 40 years in Slovenia is the Upper Soča Valley (Gornje Posočje), that borders Italy and was first damaged by the Friuli earthquake in 1976. This earthquake had devastating consequences both on Italian (where, according to [4], 43000 buildings were unusable and 190000 inhabitants were homeless) and Slovenian side (where 12000 buildings were damaged, out of which 4200 to the extent that required demolition [5]). The magnitude on the Slovenian side was 6,4. The second earthquake occurred in 1998 (earthquake magnitude 5,6). 4055 buildings were damaged, out of which approximately 500 were unusable. The estimated loss was 37,1 million EUR. The last earthquake (2004) had globally lower intensity as the previous in 1998. However, due to specific unfavorable geological ground composition, there were locations (e.g. village Čezsoča, part of the town Bovec) with higher local impact; the measured ground acceleration reached in these locations 0,47 g *(maximum project ground acceleration prescribed by the Eurocode 8 is 0,25 g, where g is gravity acceleration) [5]. Approximately 20 buildings out of 1764 damaged buildings (that were inspected after the earthquake) were unusable after the 2004 earthquake. The total estimated damage on the inspected buildings was 8,5 million EUR.

The affected region has already been identified as vulnerable both in socio-economic as well as demographic aspects, therefore special attention has been devoted to its recovery after the earthquakes.

3 ESTABLISHMENT OF DISASTER MANAGEMENT SYSTEM IN RESPONSE AND RECOVERY PHASE

Immediately after the 2004 earthquake, the Civil Protection Department (a part of the Ministry of Defence of Republic of Slovenia) carried out initial priority actions targeted at ensuring the safety of inhabitants and their assets (e.g. ensuring temporary housing and supply for the residents, establishing emergency communication routes etc). Building usability / damage inspection was carried out as the next stage of the response phase. Immediately after, the Department started to execute recovery phase actions ensuring permanent structural

upgrading and refurbishment of the damaged buildings and thus provide adequate physical living environment for the inhabitants.

After the 1998 earthquake, the Government of the Republic of Slovenia initiated, for the affected area, a program of technical support for the residents whose real estate property was damaged during the earthquake as the initial part of the recovery phase. State Technical Office (STO) was established as the instrument providing the support. In 2004, when the third earthquake occurred, the refurbishment of the buildings damaged in 1998 has not yet been completed. Consequently, the decisions regarding the procedures and methods used in the refurbishment and upgrading processes of affected buildings were to a large extent linked to the Posočje refurbishment program established back in 1998. Therefore, State Technical Office took over the supervision of the refurbishment of buildings damaged in 2004 as well.

From the governmental point of view, the two consequent earthquakes were treated as 2 waves of a single earthquake. By using this attitude, the already refurbished buildings that have been damaged again in 2004 have been treated as buildings in the process of refurbishment. Such point of view enabled complete financial support for the mitigation of the 2004 earthquake damages. In addition, the buildings that have not yet been refurbished after the 1998 earthquake and suffered additional damages in 2004, have been evaluated by the same criteria as the buildings that were damaged in 1998 and upgraded between 1998 and 2004.

Legal background for the execution of the refurbishment programme was provided by two legislative documents:

- Removal of Consequences of Natural Disasters Act (2003) and
- Post-earthquake Reconstruction of Structures and Development Promotion in Posočje Act (2005).

In addition to providing financial aid for the refurbishment of the built environment and accelerating socio-economic development in municipalities Bovec, Kobarid and Tolmin, the main principles underlying these two acts were:

- residential and public-use (e.g. schools, health centres, senior citizen homes) buildings have priority when financial aid is allocated;
- the allocated sum for the refurbishment is proportional to the damage;
- in case of residential buildings, the financial means can be either non-refundable (as direct governmental support) or refundable (as a loan from the Residential Fund of Slovenia);
- continuous monitoring of the executed works ensures the appropriate use of the allocated funds.

Only buildings where permanent residents were registered were entitled to receive governmental financial aid for the refurbishment and upgrading. Both Acts enabled successful realization of the early recovery stage, and ensured optimal proportions between public and private goals, interests and benefits.

Response phase

Legally, the response phase management is the responsibility of the Civil Protection Office that operates within Minstry of Defence. This office has carried out the initial usability and safety assessment of the buildings, and determined whether they are safe enough to be used or not. In 1998, the buildings were placed into three categories (dangerous and unsuitable,

damaged and requires upgrading, not damaged). Residents of the first category buildings were not allowed to use the building and were relocated. In 2004, the assessment system was upgraded and 5 categories of damage levels were used.

Early recovery phase

Governmental support was allocated to buildings where the damage was assessed to be higher that 1250 EUR. Damage assessment was carried out systematically by the personnel of the State Technical Office (STO) that was established within the Ministry of Environment and Space. All regular procedures (e.g. obtaining the building permit for the upgrading works) had to be used in the early recovery stage.

One of the challenges encountered during the STO work was the modification of the general space planning and building legislature in 2002. After 1998 earthquake, the upgrading could be carried out after issuing the decree allowing the planned works that was relatively easy to obtain Municipal Building Office. The legislature changes in 2002 require, however, that any action affecting the mechanical resistance and stability (1st Essential Requirement of the Construction Product Directive), can be carried out only after the Building Permit is issued. As a consequence, every structural upgrading of the damaged building had to comply to relevant part(s) of the Eurocodes, and Building Permit had to be issued before the start of the upgrading. This fact prolonged the administrative procedure required to approve the financial aid to the property owner, as only works that duly satisfying the legal requirements could be subsidized.

The flowchart of the procedures used in the upgrading of buildings is presented in Figure 2. Based on experience from previous natural disasters, one of the most important tasks (in the recovery stage) that ensured subsequent adequate upgrading was the preparation of the project brief. This document was based on the building damage assessment, carried out by a group of surveyors (usually a structural engineer and an architect). In order to ensure equivalent assessments, the surveyors received special courses and training. In the next step, the owner authorized the STO to carry out the procedures required to obtain the Building Permit. To maintain quality level of the design documentation for upgrading works, the STO issued a list of authorized (pre-qualified) design offices. The owner could select the design office from this list.

Project documentation was prepared on the base of a 3-party contract (the owner, STO and the Design Office). After being completed, it underwent revision that ensured its compliance with the project brief and instructions issued by the STO, as well as adequacy of the proposed upgrading procedures, bill of quantities and cost estimate. Governmental financial support could be obtained only for the upgrading of buildings that received the Building Permit.

```
┌─────────────────────────────┐
│   STRUCTURAL ASSESSMENT     │
│     OF THE BUILDING         │
├─────────────────────────────┤
│     Evaluation report       │
└─────────────────────────────┘
```

Proof of ownership	Cataster map copy	Project brief

```
┌─────────────────────────────┐
│   Authorisation of the owners │
└─────────────────────────────┘
┌─────────────────────────────┐
│  Selection of the design engineer │
└─────────────────────────────┘
┌─────────────────────────────┐
│    Project documentation    │
└─────────────────────────────┘
```

Conceptual design	Building permit documentation	Detailed design documentation

Review records		3rd party review report

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┌─────────────────────────────┐
│   Building permit application │
└─────────────────────────────┘
┌─────────────────────────────┐
│     Building permit issue    │
└─────────────────────────────┘
┌─────────────────────────────┐
│ Application for governmental funding │
└─────────────────────────────┘
┌─────────────────────────────┐
│ Temporary approval of governmental funding, │
│      temporary mortgage entry │
└─────────────────────────────┘
┌─────────────────────────────┐
│      Execution of works      │
└─────────────────────────────┘
┌─────────────────────────────┐
│       Use permit issue       │
└─────────────────────────────┘
┌─────────────────────────────┐
│  Final calculation and approval of │
│      governmental funding    │
└─────────────────────────────┘
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Fig. 2)   Flowchart of the procedure employed in the upgrading of buildings and
governmental funding

4   CONCLUSION

The earthquakes occring in 1998 and 2004 inflicted a substantial damage to the area already vulnerable in economic and demographic terms. The governmental support was therefore crucial to revitalize the Posočje area. 49 million EUR were allocated in total to the upgrading and refurbishment of the buildings in this area between 2004 and 2012. The procedures employed in the distribution of funds for refurbishment projects were prescribed by the legislature.

The main element ensuring efficient resource distribution and quality refurbishment works was the establishment of the State Technical Office. Its organisational structure did not change significantly during its operation, except for the changes linked to the changing scope of the work to be performed and the changes in legislature (that modified the procedures in the refurbishment process), therefore the number of employees in the office ranged from the maximum number 89 (in 1998) to 24 in 2011. STO ensured unified procedures in damage assessment and, during execution of works, adherence of these works, to the project documentation. In addition, it also supervised the allocation of refundable and non-refundable financial support provided by the Government of Slovenia

The executed construction works resulted in approximately 360 refurbished buildings between 2004 and 2012, which means that the majority of the residential building stock has been upgraded. Special attention has been also devoted to buildings protected as cultural heritage, as these are a part of the unique identity of the Posočje region. Despite the devastating effect of the earthquake, the region has been revitalised, especially in the area of tourism.

It can be concluded that the current system in the early recovery stage has proved to be efficient. It ensures that all buildings that have been upgraded exhibit adequate performance and earthquake resistance, necessary for their future use.

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SURVEY ON LEARNING CURVE IN ROOF INSULATION

Levente Mályusz[1], Attila Pém[2]

Abstract

Mathematical learning curve models can be used in construction for the prediction of the time cost required to perform a future repetitive activity. The time required to perform a given activity is fall in a repetitive construction work. In this paper we evaluate three mathematical models and four data presentation methods – average methods - of different learning curves for flat roof insulation reconstruction work of a building. Our evaluation is based on a survey done in 2009 spring in Budapest. The surveyed project was a reconstruction work of flat roofing. Several mathematical models are identified and each of these are used to estimate the real performance. The models are compared and evaluated to each other and to the measured data. Based on this study we can declare that if there is noise in the working conditions or a delay in working hours, most probably the best accuracy of estimating work performance using one of the average methods is better than using the unit data.

Key words

Construction time estimation, empirical equations, learning curve, mathematical models.

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1   INTRODUCTION

The basic principles of learning curves are well understood. Learning curves imply that when performing numerous similar or nearly identical tasks the effort is reduced with each successive task. Learning curve theory can be applied to measure the cost and time, generally in units of time, to complete repetitive activities. The cumulative average time is the average time required to perform a given number of units. Method of cumulative average time was used in the original formulation of the learning curve method in Wright [1], the famous paper which was referred to as Wright's Model. In practice a few construction companies utilize learning curve computations on in-place construction costs on ongoing construction jobs to make projections on the costs and time of future work to be performed. There are little information in the literature about these uses, although it seems that learning curve principle can apply to repetitive construction operations as Hinze et. al in [2] writes. In this study we evaluate mathematical models of learning curves based on Farghal et. al in [3], and investigate data presentation models based on Farghal et. al in [4], Mályusz et. al in [5] and Mályusz et. al in [6].

2   MATHEMATICAL MODELS AND METHODS

2.1   Mathematical models

Learning curve theory is applicable to predict the cost/time of future work based on the assumptions: there are repetitive work cycles with same or similar working conditions in terms of technology, weather, workers as persons without delay between two consecuted items. The direct labour hour required to produce the $(x + 1)$st unit will always be less than the direct labour required for the xth unit. The reduction in time will follow a monoton decreasing function in Wright paper it is an exponential curve.

In this present paper we calculate the labour hour/square meter for each repeated activity.

Wright's linear model was

$$\ln y = \ln a + b \ln x; \quad \text{or} \quad y = ax^b \tag{1a}$$

where x is the cycle number, y is labour hours/square meter the time required to complete cycle x, a is the time required to complete the first cycle, and b is a constant that reflects the rate of learning. Wright discovered that labour cost declines at a constant rate, the learning rate, as production/cycles doubles.

The mathematical models evaluated in this survey are in equation (1a), (1b) and (1c).

Linear x, log y model:

$$\ln y = \ln a + x \ln b; \quad \text{or} \quad y = ab^x \tag{1b}$$

linear log x, y model:

$$y = \ln a + b \ln x; \quad \text{or} \quad \exp(y) = ax^b \tag{1c}$$

where x is the cycle number, y is the time required to complete cycle x and a and b are parameters.

In model In this paper we investigate on application of learning curves for flat roof insulation reconstruction work. The objective of the paper is to apply different methods of representing learning curve data and investigate which method can be used to give the most accurate approximation. Unit, cumulative average, moving average and exponentially weighted average with α=0.3 and exponentially weighted average with α=0.5, are presented to predict the time of an insulation work. Linear log x, y model is applicable only for small number of repetitive items because y is a decreasing function only if b<0 but in this case y→-- ∞.

2.2 Data presentation

Unit is the original data that presents the time to perform one cycle of the insulation work.

Cumulative average is in the work of Wright (1936). He discovered that cumulative average (CA) time decreased by a fix percent when output doubles. CA represents the average time or cost of different quantities (X) of units.

$$CA_t = (Y_1 + Y_2 + ...Y_{t-1} + ... + Y_t)/t. \qquad (2)$$

Where: t is the number of cycles. CAt is the cumulative average in cycle t. Yt is the unit data for cycle t.

Moving average (MA) – in present paper is the average time of the last 3 cycles. Although MA is an average like CA but in MA the most recent data are presented. Analyst can decide how far back in time the data are still relevant. More points will help smooth the curve. In extreme cases moving average are unit data or cumulative average.

$$MA_t = (Y_t + Y_{t-1} + Y_{t-2})/3. \qquad (3)$$

Weighted Moving Average (WMA) is a weighted average where weights decrease in arithmetical progression. In an n day WMA, latest day has weight n previous one hase weight (n-1) and so an.

$$WMA_t = \frac{tY_t + (t-1)Y_{t-1} + (t-2)Y_{t-2} + ... + Y_1}{t + t - 1 + t - 2 + ... + 1} \qquad (4)$$

Exponential average (EA) is a weighted average of the most recent data and the previous one.

$$EA_t = \alpha Y_t + (1-\alpha)EA_{t-1}. \qquad (5)$$

$$EA_{t-1} = \alpha Y_{t-1} + (1-\alpha)EA_{t-2}. \qquad (6)$$

$$EA_{t-2} = \alpha Y_{t-2} + (1-\alpha)EA_{t-3}. \qquad (7)$$

That is

$$EA_t = \alpha Y_t + \alpha(1-\alpha)Y_{t-1} + \alpha(1-\alpha)^2 Y_{t-2} + (1-\alpha)^3 EA_{t-3}. \qquad (8)$$

Where EAt is the exponential average time for cycle t, EAt-1 is the exponential average time for cycle t-1. Yt is the unit data (time to perform activity) in cycle t and α is a number, in this present paper it is 0.5.

Our assumption is that between Yt and x – between the time required to complete the activity for a given cycle and cycle number -there is an exponential relationship, that is equation (1a) holds.

So this is a straight line on log-log paper between logYt and logx and all the regression formulae can apply to this equation just as they do to the equation. Mathematically this latter is solvable for parameters a and b by least squares method. In the case of equation (1b) there is also a linear relationship between x and logYt so parameters a and b are calculated based on least squares method. In equation (1c) there is a linear connection between log x and Yt so parameters a and b are calculated as in previous case. LibreOffice 3.5 was used to find these parameters.

3 ANALYSING THE METHODS BY A REAL CONSTRUCTION PROJECT

3.1 Description of the project

The surveyed project was a reconstruction work of flat roofing. The building and the construction work was divided to two separated part in time and space. One part of the reconstruction was the tower (office) building that contained five pieces of flat roofs on five different floors and the other part was the roofing of the hall building (Figure 1.). During the reconstruction process the circumstances and the weather was ideal for roofing (sunny, 26-33°C, no wind), the same amount of workers and the same persons did the entire erection. The technology was repetitive within one part. The workers knew that they are monitored but they were not informed what was measured and they were not disturbed.
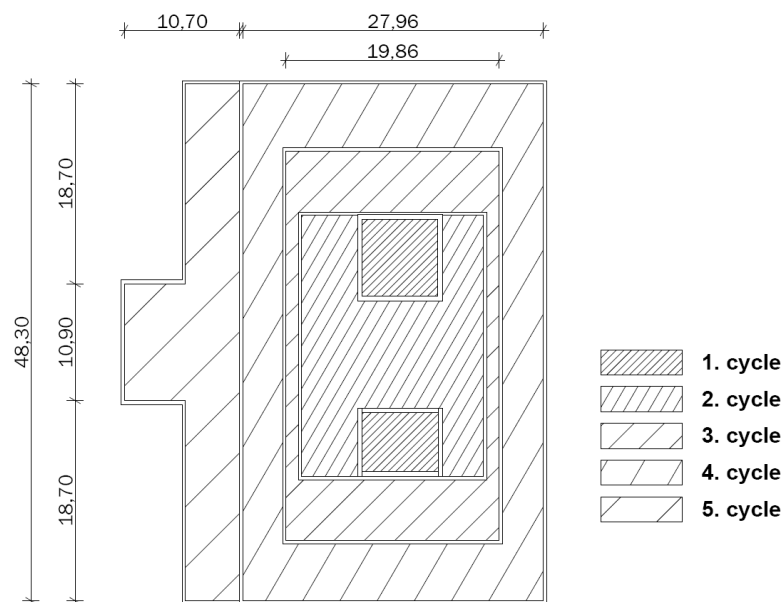
Fig. 1) Hall building roof

The tower building part of the reconstruction process the technology changed because the fixing of the heating insulation and the fixing of the EPDM rubber has changed from mechanical fixing to gravel loading. The activities that were surveyed are the followings: slicing up the old water proofing, laying down 10 cm thick heating insulation, installation of the tin-plates, spreading one layer of EPDM rubber water proofing onto the horizontal planes and gluing the rubber onto the vertical planes. All the time when the workers did any kind of other activities the timer was stopped.

The tower building consists of 5 pieces of flat roofs above 5 different floors. Every flat roof was a section that was taken under consideration. The areas of the sections were not equal so during the evaluation we calculate by labour hours/square meter.

3.2 Evaluation by the different methods for the roof insulation of the hall building

Input raw data of the tower building are in column "Unit". Dimension of the elements in columns Unit, CA, MA,WMA, EA(0,5) is labour hours/square meter.

Tab. 1) Raw input data of learning curve for tower building

cycles	Unit	Cumulative av.	Moving Av.	WMA	Exp. Av. 0,5
1	3,837	3,837	3,837	3,837	3,837
2	2,975	3,406	3,406	3,578	3,406
3	2,755	3,189	3,189	3,331	3,081
4	2,644	3,053	2,791	3,125	2,863
5	2,544	2,951	2,648	2,951	2,704

Linear relationships between ln(cycle) and ln(Unit), ln (cycle) and ln (CA), ln(cycle) and ln (MA), ln (cycle) and ln (WMA), ln (cycle) and ln (EA5) are calculated based on principle of least squares using Libreoffice 3.5 built in function "linest".Table 1. raw input data of learning curve

In linear log x log y model, linear relationships between ln(cycle) and ln(Unit), ln (cycle) and ln (CA), ln(cycle) and ln (MA), ln (cycle) and ln (WMA), ln (cycle) and ln (EA5) are calculated based on principle of least squares using Libreoffice 3.5 built in function "linest". In the case of equation (1b) and (1c) linear regression was calculated between x and log y and between log x and y.

Results of least squares method − b is the slope and a' is the constant - presented in tables below based on the first 5 cycles of table above.Results of least squares method − b is the slope and a' is the constant - presented in tables below based on the 5 cycles of Table 1.

Tab. 2) Results of least squares methods for tower building

methods		b	a'	ln(b)	learning rate
Unit	ln(y)=a'+b*ln(x)	-0,2521991473	1,3122554636	-0,175	83,95%
CA	ln(y)=a'+b*ln(x)	-0,1636387753	1,3424677635	-0,113	89,32%
MA	ln(y)=a'+b*ln(x)	-0,2311042267	1,3674591866	-0,16	85,21%
EA3;0,3	ln(y)=a'+b*ln(x)	-0,1617865946	1,3636944857	-0,112	89,40%
EA3;0,5	ln(y)=a'+b*ln(x)	-0,2187989596	1,3580781239	-0,152	85,90%

In Table 2, "b" is the so called learning coefficient where b = ln of learning rate / ln of 2 (assuming that learning coefficient is constant when cycles are doubles) and a'=ln(a), see equation (1a). In the case of mathematical models presented in Tables 3 and 4 parameter b has no such a meaning.

Tab. 3) Results of least squares methods for linear x, log y model

methods		a'	b	ln(b)
Unit	ln(y)=a'+x*ln(b)	1,352	0,910	-0,094
CA	ln(y)=a'+x*ln(b)	1,376	0,938	-0,064
MA	ln(y)=a'+x*ln(b)	1,428	0,910	-0,094
EA3;0,3	ln(y)=a'+x*ln(b)	1,407	0,935	-0,066
EA3;0,5	ln(y)=a'+x*ln(b)	1,410	0,916	-0,087

Tab. 4) Results of least squares methods for linear log x, y model

methods		b	a'
Unit	y=a'+b*ln(x)	3,709	2,364
CA	y=a'+b*ln(x)	3,160	2,070
MA	y=a'+b*ln(x)	2,838	1,825
EA3;0,3	y=a'+b*ln(x)	2,611	1,639
EA3;0,5	y=a'+b*ln(x)	2,434	1,500

3.3 Results for the roof insulations of hall building

In Tables 5, 6 and 7 y values are presented based on the calculation of linear regression between log x and log y.

Tab. 5) Results of the different methods in man-hours/square meters for linear log x, log y model. (tower building)

	Original	UNIT	CA	MA	WMA	EA; 0,5
1	3,837	3,715	3,828	3,925	3,911	3,889
2	2,975	3,119	3,418	3,344	3,496	3,341
3	2,755	2,816	3,199	3,045	3,274	3,058
4	2,644	2,619	3,051	2,849	3,125	2,871
5	2,544	2,475	2,942	2,706	3,014	2,734

In Table 6, y values are presented based on the calculation of linear regression between log x and y.

Tab. 6) Results of the different methods in man-hours/square meters for linear x, log y model le of the table

	Original	UNIT	CA	MA	WMA	EA; 0,5
1	3,837	3,521	3,717	3,798	3,824	3,756
2	2,975	3,205	3,488	3,457	3,579	3,442
3	2,755	2,918	3,273	3,147	3,349	3,154
4	2,644	2,656	3,072	2,864	3,135	2,89
5	2,544	2,418	2,882	2,607	2,934	2,648

In Table 7, y values are presented based on the calculation of linear regression between x and log y.

Tab. 7) Results of the different methods in man-hours/square meters for linear log x, y model

	Original	UNIT	CA	MA	WMA	EA; 0,5
1	3,837	3,709	3,816	3,886	3,889	3,859
2	2,975	3,160	3,433	3,209	3,509	3,366
3	2,755	2,839	3,209	3,051	3,287	3,077
4	2,644	2,612	3,051	2,855	3,129	2,873
5	2,544	2,435	2,928	2,690	3,007	2,715

In order to compare the different type of methods we calculate accuracy as a difference between input data and result. It means calculation of absolute value between the corresponding elements of Table 1. and Tables 5, 6, 7. For example in column of MA the first element in Table 8 is calculated:

$$Abs(3,925 - 3,837) = 0,088.$$

In row "Accuracy 1-5" we add all the differences from cycle 1 to cycle 5, although in the case of averages the first two or three values are not real average values.

Tab. 8) Accuracy of the different methods linear log x, log y model

cycles	UNIT	CA	MA	WMA	EA; 0,5
1	0,122	0,009	0,088	0,074	0,052
2	0,144	0,012	0,062	0,082	0,065
3	0,061	0,01	0,144	0,057	0,023
4	0,025	0,002	0,058	0	0,008
5	0,069	0,009	0,058	0,063	0,03
Accuracy 1-5	0,421	0,042	0,41	0,276	0,178

Tab. 9) Accuracy of the different methods for linear x, log y model

cycles	UNIT	CA	MA	WMA	EA; 0,5
1	0,316	0,12	0,039	0,013	0,081
2	0,23	0,082	0,051	0,001	0,036
3	0,163	0,084	0,042	0,018	0,073
4	0,012	0,019	0,073	0,01	0,027
5	0,126	0,069	0,041	0,017	0,056
Accuracy 1-5	0,847	0,374	0,246	0,059	0,273

Tab. 10) Accuracy of the different methods for linear log x, y model

cycles	UNIT	CA	MA	WMA	EA; 0,5
1	0,128	0,021	0,049	0,052	0,022
2	0,185	0,027	0,035	0,069	0,04
3	0,084	0,02	0,12	0,044	0,004
4	0,032	0,002	0,064	0,004	0,01
5	0,109	0,023	0,042	0,056	0,011
Accuracy 1-5	0,538	0,093	0,31	0,225	0,087

Comparing Tables 8, 9 and 10 it can be seen there are slight differences between the mathematical models. The original Wright method - Cumulative Average method – is one of the best in each mathematic model.

Sum of these values from cycle 1 to cycle 5 are in row of "Accuracy 1-5" . Less values in last row show more accurate result of learning curve methods. The best method result comes from the original log x, log y model with CA method (see Table 8) second best is model linear x, log y model with WMA method (Table 9).

In order to compare the best CA and unit data methods, estimate unit data Yt for 5th cycles from the best CA. From Table 8, original data= 2,544, Unit data estimation= 2,475 and CA=2,942. Using equation (2):

$$2,942 = \frac{\left(4 * CA_4 + Y_5\right)}{5},$$

where from

$$Y_5 = 2,506 \ .$$

It is closer to the original 2,544 than Unit data estimation: 2,475.

4   CONCLUSION

In this paper different mathematical models and data presentation methods of the learning curve have been investigated to assess which one is the best – the most accurate - at predicting the time required to perform cycles in roof insulation repetitive work. Three mathematical models and five data presentation methods were evaluated. This study was based on data of an insulation work performed in 2009 in Budapest. Results of this study show that in the case of equation (1a) - linear log x log y, method CA gave the most accurate estimation of the real data. In the case of (1b) – linear x, log y – weighted moving average method gives the most precise prediction and referring to equation (1c) – linear log x, y – exponential average with α =0.5 gives the most accurate result. It seems that data presentation has a bigger effect on the prediction than mathematical models have. In this paper the learning curve theory was applied to a small number of repeated items. It is because an average type method helps smooth out some of the noise in data.

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MEASURING THE EFFECTIVENESS OF WEBSITE AS ELECTRONIC BUSINESS COMMUNICATION TOOL FOR CONSULTING FIRMS

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Abstract

Websites play a vital role in marketing and promotion of service industry like construction as an electronic business communication tool. Information technology still not a salient part of construction business but its worth is considerable in development of technology and interest of client. Effective design of dynamic website must provide authentic information. Combine study of construction business and information technology is used to build effective website for consulting firms. Review of nineteen relevant aspects summarizes the features into seven important parameters: expectations, easy to use, upgradation, integration, media support, visitor traffic and multi lingual. Efficiency of one hundred and forty websites were observed and graded accordingly. General design schemes were founded insufficient and ineffective for business purpose. Information available on websites is mirror image of interests and efforts of consulting firms. Convincing features of a website are history, contact, content understanding, depth level of pages, quarry/help option and page navigation whereas unconvincing features are strategic management, projects, scope of operation/services, resources, HSE policy, website map, searching option, updated on, status of information in events, social networking, RSS, media support, visitor traffic. Gradation of one hundred and forty websites regarding efficiency is provided. This research will help consulting firms in upgrading and development of their website information by considering the resolved parameters.

Key words

Consultants, e-commerce, e-marketing, Pakistan, website.

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1   INTRODUCTION

Projects are mainly complex, expensive and hazardous sometimes in construction business. To safe conduct the demands; clients confine professional services of consultants [1]. Verily a consultant must induce durable and literal values to the firm. Consultant management is fundamental key to the success of project. Construction project may face some problem in schemes, planning, cost, control and supervision which can alter the time cost quality and risk levels of project by hiring inefficient consultants. Obviously, fully qualified consultants should be employed for projects. Consulting projects are hired for any kind of contract to solve technical, legal, commercial, financial, and management consultancy problems [2].

Usually project delay and low level work happen because of inefficient communication between clients and consultants. Conflicting communication between consultants and contractors may devastate their cooperation which cause low quality, claims and arguments. Good consultants sustain a fair relationship with sub consultants to supervise the project effectively [3]. Delay may also occur due to lack of consultancy bureaus i.e. incorrect process, incomplete information and miscommunication [4].

Consultant must have potency of quick response to all demands of clients right away, also they should recognize and predict the faults to avoid the problem intensification [5]. Vivid procedures should be provided by consultant by monitoring engineers and following good management and certification system [6] [7].

[8] Concludes consultants should have the skill of leadership and encouragement, good contacts with contractor and solution for clients. In addition [9] describes the consultant work is procedure based while contractor work is more outcome based. Use of information technology is for operational command and to supervise engineering procedures. Nonetheless, use of information technology is for globalization and technical basis for many industry step (e.g. high use of knowledge and communication technologies and development in 'virtual building factory') [10]. Consulting firms modify information technology which do not make out with recent demand such as online project monitoring. So firms go out for business when they do not fulfill the advance technology demands of stakeholders.

Virtual building surroundings are provided by website for project partners to access and control of information [11]. Basic requirement is updating the information technology. Procurance and construction of project must be effective for Business to Business (B2B) communication with consultants or clients. Any construction business preferably should be the part of strategic cyber market plan [12]. Website shows the virtual presence of consulting firms in e-commerce. Avoiding of conflict and dispute helps to speed up project construction can be achieved by dynamic information exchange between clients and consumers.

"Consumer first" philosophy is achieved by "consumer is god" in business world. Websites for customers and stakeholders must be designed to facilitate users. Services or information must satisfy users and provide level of experience to buy the company project so that customers become loyal to "brand" [13]. Concentration must be on website designs and evolution because customer is in search of existence of firms by true means. Promptly available information needs to be updated to pull up the customer's interest. In website visit, customers are free to click any link so website company should organize the information in an adequate way to attain the promotion and marketing of projects.

From Pakistan engineering council licensed firm, only 10% have their virtual building through website. To come up with local and foreign companies internet and intranet communication is significant. So the owner of company should make sure that the website is properly developed to cope the needs of both customer and top ranking [14].

This research is the fundamental effort to measure the efficiency of websites for consulting firms. They can detect the week areas by following the obtained parameters for betterment. In addition grading of website according to efficiency has also been evaluated. Consulting firms can modify their website by considering derived parameters for their development.

2   PARAMETERS FOR EFFECTIVE WEBSITE DESIGN

Content, format and access are important aspects for website design [15]. [12] identify four key issues when designing a site; (1) First impression must immediately add value and ensure positive perceptions of the brand and service quality, (2) Responsiveness to on-line requests is an indication of service. It must be faster than traditional communication tools as the Internet is perceived to be an immediate medium. Customers will be reassured if a business responds quickly and that if they have any problems with the service or product the business will act speedily in finding solutions, (3) Technological quality of the site is essential, out-of-date links or screens that don't work sends out a very negative message, (4) Understanding of the user/customer and the way they buy is imperative. Site must be simple to use and allow the customer maximum freedom. The business will have to recognize that some customers will still want to use traditional forms of communication at some point. [13] established criterion comprised of five (5) Sections accessibility, design, content-incorporating online information, interaction and approach. Around seven possible parameters for effective website have been defined with nineteen relevant aspects after detailed literature review and visiting online sources. Parameter are indicated with numbers in ascending within parenthesis ( ) brackets.

2.1   Intutive/Expectation

In this parameter there are seven questions related to following aspects; History (1): Customers' feedback shows that mostly they are interested in knowing about the history, the previous projects and work the company has accomplished. What are the success rates and what sort of (how many) registrations and affiliations it has. Working for how many years and how do people remember about this company [14]. Strategic Management(2): It is recommended that the constructors must espouse a more strategic advancement to the Internet as it helps in setting up foundation to target a better and direct contact with the clients. Adopting internet to achieve better business objectives entails certain limitations. Information should be presented in a way that it is beneficial for the company, not leaking companies' significant strategic information [16]. According to website [14] Mission and Vision statements play a very crucial role in clarifying objectives. However its text should be kept to a minimum well written length in order to catch people interest, long and lengthy text can loss customer's attention. Short term objectives also played vital role to allure the interest of customer. Projects (3): Details of projects (completed and running) like information as name, cost, name of stakeholders, duration, purpose and progress should be displayed. Scope of operations/services and projects' information (4): In spite of the necessity and significance of the designing related information websites, literature studies hardly present the importance of internet solutions to the problems associated with the usefulness of construction operations in construction industry. Existing web sites indicating about provide some basic information about the previous and ongoing projects, and services but lack their achievement in line with

objectives [17]. Firms' resources(5): The value of professional services should not be merely measured in monetary terms, but also consider consultants' experiences and resources that best suit a project [18]. Display of information and photographs on websites gives customer in understanding about technical capability. Quality. Health, Safety and Environment (QHS&E)(6): [19] derived from case studies, development of integrated management systems is an organization-specific decision and different circumstances will lead to different decisions as to the degree of integration that is desirable or achievable. Nevertheless, the contractor organizations are open and willing to embrace the integrated management systems application in order to make the management systems uality, health and safety and environment (QHS&E) more efficient, effective, user-friendly, streamlined and more acceptable on sites. Display policies regarding QHS&E provides the customer an overview that company is following international standards. Contact information (7): Customers need to contact the company for exchange of information and decision making. Email has become the most reliable and readily available source to contact the companies. Authentication of email address lies under the ownership of email (e.g. xxx@companyname.com). Even indication of location by physical address and map (e.g. googlemap) provides more reliability of existence of the firm.

2.2   Ease to Use

To design your paper and style the text, template is used. Please don't make the changes in prescribed at margins, column width, line spaces and text fonts. For example, proportionately measure is done by this template more than customary measure. This or other measurements are considered by using the characteristics which privies your paper as a part of whole procedure instead of self sufficient document. Please do not alter the current identification and assignments. There are four questions in this parameters related to the following aspects. Site map (8): An over view of complete website is provided by site map which helps the visitor in understanding the vision of website. Depth level of pages (9): the information divided into pages within pages create confusions and depth level of pages more than by two can misguide the users. Search within website (10): website usability increase with the help of search box, its role is very crucial in website designing. It improves the usage and save the time. It is important for company to guarantee that clients are resourceful to find the information easily. Thus search box option is simplify and make unproblematic for clients to locate the information [20]. They can be relegate to the popular search engine to be added for enhancement in access of website [21]. Quarry form (11): Clarification and amplification is provided by quarry facility as per demand, with a general FAQ's section facilitating with answers to common questions. Page navigation (12): Website pages are interlinked and there is no incomplete link.

2.3   Up-gradation

There are two questions in this parameter related to following aspects; Modified/updated on (13): Dynamicity of website is achieved by quick update in information along with query or related information. Events status (13): Previously past events should be deleted from website; only upcoming events should be mentioned.

2.4   Integration

There are two questions in this parameters related to the following aspects; social networking (15): For any business quality, the role of websites cannot be denied in the world of internet. In future, information technology social networking will be spontaneous tool to spread the

business information in all over the world by creating a mesh of connectivity. Thus a company may achieve a power for business not only within a community but all over the world. The social networking toll like facebook, twitter and social blogs etc. are very important for the promotion and popularity of wherewithal [21]. RSS (Really Simple Syndication)(16): RSS makes the information data public able and shareable.

2.5 Media Support (17)

Adequate use of multimedia content e.g. images, audios, flash, videos is smartly used to increase in getting idea and to improve the vision of website information.

2.6 Visitor Traffic (18)

The number of traffic that comes to the site from different location is generally observed by a counter.

2.7 Linguistic (19)

International investors or governments are highly attracted by multi-lingual websites to understand the business of competitive companies for intelligent projects. Generally websites are in English languages but other languages like French, Russian, Latin, Arabic and Urdu not only attract the local stakeholders but international as well.

3 METHODOLOGY

Following are the steps adopted for this research study:

1. Parameters (P) derived from literature review are set for survey questionnaire on likert scale (Not at All = 1, Not Really = 2, Undecided = 3, Somewhat = 4, Very Much = 5) or possible options relevant to that specific parameter.
2. A survey was conducted to visit all available websites of consulting firms in Pakistan.
3. Average score (1 ~ 5 from poor to best website) upon 19 parameters for each firm's website was calculated and ranking of whole sample was defined.
   $$\text{Average Score} = \frac{P_1 + P_2 + \ldots, + P_{19}}{5}$$
4. Strength and weak areas for these firms are evaluated and discussed.

4 RESULTS

Evaluation of consulting firms of Pakistan is shown in Table 1. All these firms are evaluated on the basis of cumulative score gained in 19 aspects of 7 parameters required for effective website design. Strength and weak areas are differentiated by average score under each aspect. Firms which are evaluated and ranked in table 1 are leading consulting firms and have major share in construction industry but still there average score is 2.535 which indicates flaw in marketing strategies and promotion of services and this is needed to be improved on priority basis. Standard deviation of sample is 0.758 and variance is 0.575 which indicate websites are far from standard requirement of website effectives but more close in website performance to each other. Companies having websites is an indication that they have some level of competition in and are in race to set high standards in market. According to table 1 there are only 7 aspects which show strength of websites of consulting firms (mean score of aspect) i.e. history (3.57), contact (3.26), content understanding (3.86), depth level of pages (3.52), quarry/help option (3.03), Page navigation (3.57).

Tab. 1)   Ranking of websites of Consulting firms

Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
1	4.263	31	3.158	61	2.579	91	2.263	121	1.737
2	4.105	32	3.158	62	2.526	92	2.263	122	1.737
3	4.105	33	3.158	63	2.526	93	2.263	123	1.474
4	4.000	34	3.158	64	2.526	94	2.263	124	1.474
5	4.000	35	3.158	65	2.526	95	2.263	125	1.421
6	3.947	36	3.105	66	2.526	96	2.211	126	1.368
7	3.789	37	3.105	67	2.526	97	2.211	127	1.316
8	3.789	38	3.105	68	2.474	98	2.211	128	1.316
9	3.684	39	3.105	69	2.474	99	2.211	129	1.263
10	3.632	40	3.053	70	2.474	100	2.211	130	1.263
11	3.579	41	3.053	71	2.474	101	2.211	131	1.211
12	3.579	42	2.947	72	2.474	102	2.158	132	1.211
13	3.579	43	2.947	73	2.474	103	2.158	133	1.158
14	3.526	44	2.947	74	2.474	104	2.158	134	1.158
15	3.526	45	2.895	75	2.474	105	2.105	135	1.158
16	3.526	46	2.895	76	2.474	106	2.105	136	1.105
17	3.474	47	2.895	77	2.368	107	2.105	137	1.105
18	3.474	48	2.842	78	2.368	108	2.105	138	1.053
19	3.421	49	2.789	79	2.368	109	2.105	139	1.000
20	3.421	50	2.789	80	2.368	110	2.105	140	1.000
21	3.421	51	2.789	81	2.368	111	2.105	-	-
22	3.368	52	2.789	82	2.368	112	2.053	-	-
23	3.368	53	2.789	83	2.316	113	2.053	-	-
24	3.368	54	2.737	84	2.316	114	2.053	-	-
25	3.368	55	2.737	85	2.316	115	2.053	-	-
26	3.316	56	2.684	86	2.263	116	2.053	-	-
27	3.263	57	2.632	87	2.263	117	2.000	-	-
28	3.263	58	2.632	88	2.263	118	1.947	-	-
29	3.263	59	2.632	89	2.263	119	1.947	-	-
30	3.211	60	2.579	90	2.263	120	1.842	-	-

Remaining 13 aspects are those which requires attention if firms want to sustain in global market i.e. strategic management (2.92), projects (2.90), scope of operation /services (2.33), resources (1.36), HSE policy (2.01), website map (2.27) searching option (2.22), updated on (1.58), status of information in events (2.29), social networking (1.54), RSS (1.89), media support (2.83) visitor traffic (1.20)

5   DISCUSSION AND CONCLUSION

Management system is essential for development in industry but consulting firms show their lack of interest in website by not mentioning about their vision, mission and purpose statement. Acquirement of projects and to attract the client's interest, the history of projects matter a lot to strengthened their case. But the negative aspect of the firm is to not describing the history on their website. Specialist, capability and individuality of companies is indicated by the profile shown on website which distinguish it from competitors. But companies did not pay attention towards it which gives it low rank. Highly qualified workers and key personals are considered as the backbone of consulting firms. But most companies did not provide such information for clients. Many companies don't have the policies regarding environment, health and safety, even this aspect plays a crucial rule in their long term survival and global marketing. So these companies are losing the market trust. Site map portraits the whole sketch of website to help the visitor in finding the information in which he/she is interested. In

addition, site map searching option is the quicker way to get required information about firm or company but average score of this aspect clarify that companies did not take it seriously. Updated information is not provided on website which creates confusion about the events are ongoing or happened previously. Companies are not interested in providing the information about the aspect of sharing information socially, although it is getting importance day by day. Tracing the archive is the goal of many competitive clients to know about contractors but companies are not giving importance to RSS. Companies can improve their image in front of customer by making the website user friendly and providing the media links i.e. video and images but companies are reluctant in this aspect too. Most of the firms deny the importance of counter on website. It can make the website popular on national and international level.

6   RECOMMENDATION

Consulting firms should pay a sufficient attention to the design of their websites by having the view of the parameters required to make website more efficient to achieve more company marketing and promotion of services. This study will help them to acknowledge the latest requirements and conditions and even in designing new website by considering derived parameters.

7   ACKNOWLEDGEMENT

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MEASURING CONTENT OF VISION STATEMENT FOR IMAGING FUTURE

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Abstract

Strategic Management in Construction Contracting firms of Pakistan is partially ineffective. Most of the firms are lacking Vision statement which is essential to proceed the long term planning. The evaluation revealed that the unpredictable conditions of economy and politics has substantial influence over strategic management prevailing approaches. Twelve content items named as Short length, Clarity, Abstractness, Vivid, Inspiring, Brevity, Express confidence, Risky, Future-oriented, Practical, Stability and Flexible were used to analyze the vision statements of twenty construction firms. Results showed four items including short length, brevity, inspiring and express confidence were high scored and addressed by more than seventy percent of firms. Future image seems to achieve highest level in market (growth and share) with confidence on resources and not addresses uncertainty prevailing in country.

Key words

Construction firms, Pakistan, strategic management, vision statement.

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1   INTRODUCTION

The construction industry has been criticized for lacking in visions, innovations and change [1]. [2] define strategic planning as the devising and formulation of organisational level plans which set broad and flexible objectives, strategies and policies of a business driving the organization towards its vision of the future. [3] Strategic management is the procedure by which an organization: builds, controls and evaluates its future direction. It focuses on the organizational commitment to maximize current business opportunities while maintaining long term market growth. It is a dynamic process that needs to respond to changing market demands.

[4] Strategic management in Pakistani construction contracting firms is done by board of directors of the firms for acquisition, diversification and innovation with strengths of technology and competency for growth and dominance of the firm by considering external issues as market and competition. It is evident from the study that concept is integrating from conceptualization to implementation phase. Vision of industry is not clear because of the influence of dynamic issues and leads to biased strategic planning. They are clear about present customer so they drive the mission and short term goals/objectives accordingly. They have showed positive attitude towards areas such as market analysis, competition and technology induction. They paid less attention to core competencies, lifelong learning and financial risk analysis areas.

The strategic management literature identifies the activity of constructing and delivering vision statements as an important function of the organizational manager or business strategist [5]. Researchers have, with a few exceptions, largely ignored the actual content of vision statements [6] [7] [8].

According to [9], "The concept of vision has never been more important than in today's world of flattened, delayer, decentralized organizations." This need for a clear vision, as a starting-point and anchor for what we do, is equally important for our organizations, the individuals in those organizations and all of the levels in between [10]. "Strong" visions have been described as inspiring, and such visions have been associated with higher organizational performance [11]. [12] Long-term business vision is to develop sustainable communities. Despite the commerciality of the business, researchers emphasized the need for maintaining the balance of social, economic, and environmental requirements of the local community, through stakeholder engagement activities.

Vision statement makes it easier to define the actions and goals that will help you achieve your vision. It acts as a yardstick against which you can measure your current reality and your progress. It allows you to evaluate your values. [13] describes vision as "the ability to see the potential in or necessity of opportunities right in front of you." In other words, vision is creating the future by taking action in the present. Having a vision is important, as it influences the goals, and consequently, the mission. [14] suggests that most successful executives have a clearly-defined vision of the future, generate excitement at work and heighten others' expectations, arouse interest in new ideas and approaches, build effective teams, and coach, advise and provide hands-on help for others to improve their performance. [15] For success, business systems engineering requires vision, drive and determination and, most importantly, alignment of targets with business strategy. There must be a clear vision as to how business process re-engineering improvements will lead to, and sustain, a competitive edge.

[16] Vision is neither rhetoric nor platitude. It provides organizational direction, aligns people so that they move in roughly the same line, and it forces senior management to come to grips with their strategic obligation. Vision must give guidance. Thus wordy documents without a painting of what the company will be like when we arrive at our destination isn't very helpful. This painting must be understood and communicated throughout the organization. The visioning process requires that senior management get in touch with their leadership responsibilities. Visions are crafted and they need thought to develop, nurture, and practice to deliver effectively. Vision is not perfect at all. Paintings are by nature imperfect. The colors may not be true to life, the brush strokes are not uniform, and the closer to the painting one gets, the more flaws one sees. Vision must have fortitude. Courage can be brought out in people who have it and may not know it. Finally, the ability to develop a vision is not the sacred territory for senior management alone. Unit managers can create visions for their units. Divisional heads can do the same. It helps if there is a corporate vision to connect to, but in its absence, people in the middle have to make their best guess.

According to [17], translating the vision helps managers build a consensus around the organization's vision and strategy. Despite the best intentions of those at the top, lofty statements about becoming "best in class", "the number one supplier", or an "empowered organization" don't translate easily into operational terms that provide useful guides to action at the local level. For people to act on the words in vision and strategy statements, those statements must be expressed as an integrated set of objectives and measures, agreed upon by all senior executives, that describe the long-term drivers of success. There are four interrelated perspectives for translating vision as Financial ("To succeed financially, how should we appear to our shareholders"), Internal Business Process ("To satisfy our shareholders and customers, what business processes must we excel at"), Learning and Growth ("To achieve our vision, how will we sustain our ability to change and improve") and Customer ("To achieve our vision, how should we appear to our customer").

The definition of a project vision and mission as an abstract statement of a project's purpose is now widespread. [18] [19] these define the overriding purpose in line with the values or expectation of the stakeholders and capture these in a clear, short and inspiring way. However the generality of these abstract statements often means they are difficult to translate into practice and they often represents a top down corporate view, rather than representing the hearts and minds of the broader employees and stakeholders. Current study emphasize on contractor organizational vision as how they intend to survive in the market.

The present study aims to measure contractors' vision statements through evaluating vision content or the elements to get clear picture of prevailing vision.

2   LITERATURE REVIEW

2.1   Vision Statement

A Vision is defined as 'An Image of the future we seek to create'. A vision statement is sometimes called a picture of your firm in the future but it's so much more than that. Your vision statement is your inspiration, the framework for all your strategic planning [20]. A vision is a picture of the future we seek to create, described in the present tense, as if it were happening now. It shows where we want to go, and what we will he like when we get there. According to [9], when you create a vision, "you're writing a constitution, a frame of reference for everyone". A vision is a commitment to establish rethinking, and reviewing who we are and what we are here to do.

[21] The future is the domain of the vision statement; whatever confusion there may be around vision, the term consistently has a future-orientated flavour. In boiling the vision down to this one idea--the desired future position of a company within its arena of competition- the hope is to remain consistent with actual usage (insofar as that is ever possible) yet carve away the baggage which the term has picked up along the way. [22] Vision statement is as an inspirational message to followers that expresses optimism about the future, confidence in achieving positive future challenges and opportunities, while highlighting the intrinsic needs that can be met and connecting this all to the core values of the organization. Collectively, many leadership authors have included in the content definition of visions the image of the future, in that it provides direction to be pursued. Visions also clarify a set of ideals, articulate a sense of purpose and highlight the uniqueness of an organization.

2.2   Content or elements of vision statement

Researchers have defined many contents or elements of vision statements in different studies. These contents have been taken into account for the current study.

[23] 26 items (vision descriptors) were used to evaluate the content of the vision statement of firms defined by executives of financial service industry. These are Action-oriented, Responsive to competition, Long-term, Purposeful, Bottom-line-oriented, Product of leadership, Focused, Strategic, Flexible, Planned, Changing, Directs effort, Describes what is taking place, Innovative, Integrated with visions of others, Widely accepted, Inspirational, Well-communicated, Understood, Tactical, Detailed, Formalized, General , Risky, Conservative and Difficult to describe.

[24] Three components of the business vision can be portrayed as Core Values (must be independent of the current industry environment and management fads e.g. excellent customer service, pioneering technology, creativity, integrity, social responsibility etc.), Core Purpose (answer why the firm exists e.g. 3M: to solve unsolved problems innovatively, Cargill: to improve the standard of living around the world etc) and Visionary Goals (define core ideology and milestones of the firm in terms of lofty objectives which should be Big, Hairy and Audacious, which are categorized as target, common enemy, role model, and internal transformation).

[25] Criteria to consider in writing a vision statement includes: strategic focus and market place competitive advantage, adding value, building on current strengths, and embracing the organizational values. Vision should provide the driving force. It should be clear, specific and simple. Everyone in the organization should be able to speak it, feel it, act on it and integrate it.

[10] Allen (1995) stated what a vision can do, but to be really effective a vision must:

- be coherent enough to create a recognizable picture of the future;
- be powerful enough to generate commitment to performance;
- emphasize what realistically can be;
- clarify what should be

Most vision statements include some aspects of three important elements: a core ideology, an envisioned future, and recognition of service to stakeholders. The core ideology of the vision statement contains a statement about the firm's values and "reason for being." The envisioned future is a statement that describes what the firm will be like if it achieves its most important goals. The final part of the vision statement is the recognition of how the firm business serves

its stakeholders, including owners or stakeholders, employees, customers, community and the society as well.

Content of vision statement is based on premises for inspirational vision themes (Presents an optimistic picture of the future; Expresses confidence that the vision is achievable; Links the vision to specific values; States the importance of followers' participation; Compares vision to other efforts; Links the vision to intrinsic benefits; States the importance of the mission; Highlights tomorrow's opportunities) and instrumental vision themes (States a specific mission/vision; Ties goals or examples to the mission/vision; States a specific time frame for the vision; Links the vision to extrinsic benefits). [22] [26]

2.3   Measuring vision statement

Vision Statements are difficult to write - they should be short, clear, vivid, inspiring and concise without using jargon, complicated words or concepts. Abraham *et al.* (1998) Vision is the perceived clarity of goals, means and values for change.

[27] Disagreement with existing way of measures of vision statements have several drawbacks. First, they lack grounding in a theoretical perspective. Second, a variety of different measures have been applied. No single measure has gained acceptance as an adequate measure of vision statement content. Third, the use of different measures across studies makes it difficult to compare results and draw meaningful inferences about the characteristics of effective vision statements. Measuring motive imagery contained in the vision statement is advance methodology based on variables as Achievement, Affiliation, Power and Venture growth. Methodology used for this study may indeed be relevant for studying the relationship between vision statements and individual-and organizational-outcomes.

[26] A model presented, in which charismatic leadership was positively related to inspirational vision themes and negatively related to instrumental vision themes. Contingent reward leadership was positively related to instrumental vision themes, but unrelated to inspirational vision themes. Laissez faire leadership was unrelated to both inspirational and instrumental vision themes.

Another study [11] identified the following characteristics that are said to differentiate effective from ineffective vision statements: brevity, clarity, abstractness, challenge, future orientation, stability and ability to inspire. Inspirationally "strong" vision statements should be optimistic, express confidence, highlight the intrinsic needs that can be met, connect to the core values of the organization, and place emphasis on positive future challenges and opportunities. In simple means, we define "vision strength" in terms of the extent to which the vision contains the above mentioned inspirational contents [22]. Coding vision is attributed to measure effectiveness of vision statement of organizations as content attributes (Ideological goal, Value-based core, Frame of reference, Growth themes, Change-oriented) and articulation attributes (Use of inspirational imagery, Inclusive language, Clarity, Challenge, Task and goal specification) [28].

3   METHODOLOGY

Detail review of literature has been done to find the appropriate measures for content of vision statement of construction firms. Measure to effectiveness of vision statement is based on twelve items as variables (attributes/characteristics/qualities); *Short length* (less than 50

words), *Clarity* (effective communication of idea and easily understood), *Abstractness* (refer to specific objectives or purpose; focused), *Vivid* (appealing and fresh and innovative), *Inspiring* (ability to inspire and product of leadership), *Brevity* (concise), *Express confidence*, *Risky* (identify opportunities), *Future-oriented* (responsive to competition and challenges), *Practical* (action-oriented), *Stability* (Long-term) and *Flexible* (non-conservation).

Each item has been assigned score of '1' and cumulative score of '12' for all items to measure overall effectiveness of vision statement. If the item is considered in vision statement then it is given score '1' otherwise '0' (i.e. Yes/No scale). Current study is focused only on content of vision statement and not addresses the relevant measures for leadership and organization performance. Around twenty vision statements (Appendix – I) have been solicited from website of construction firms (belong to category A of Pakistan Engineering Council having high points in terms of technical and financial capability). Finally only eighteen vision statements were considered for analysis as rest does not addresses construction business (which is among portfolio of the specific firms).

Co-authors were invited to analyze the vision statement individually and develop consensus upon final content item addressing each statement. Co-authors belong to academics and practice of construction management discipline.

High score items of all vision statements were analyzed to image future of construction firms based on their vision.

4   RESULTS

Mean score against all items for whole sample was 7.39 (out of 12 i.e. number of items), which was slightly above the average (i.e. 6). This means average about eight selected items were considered by each vision statement. Highest score of items was based on the consideration of specific item in more than 70% of vision statements. These were short length, inspiring, brevity and confidence. Short length and brevity was related to structure of vision statement but other was more related to vision to envisage future image for construction firms.

5   DISCUSSION AND CONCLUSIONS

Vision statement of the construction firms (of given sample) is partially effective and mainly focuses on inspiring and giving confidence to all stake holders but these are readable as short in length and very concise to deliver main vision thoughts of the firm.

Most firms want to achieve the highest level in market in terms of growth and share. These firms have set standards like leading, premier, state-of-the-art, the best, first choice position etc to be achieved in future. Few firms seem to be patriotic who draws more attention on country development. Firms are lean towards better future as compare to present in terms of profit, growth and market share. The fascinating content items are really attracting but the reality is opposite as there is significant decrease found in terms of contribution to Gross domestic product (GDP), contribution to Gross national product (GNP) and Credit to private sector [29]. Uncertainty in country urges to align the vision with real situation and avoid very fascinating terms in vision statements. These statements are also giving extra confidence to stakeholders without clear direction. Vision statement is not the final version and needs

continuous improvement. It is recommended that prior SWOT (strength, weak, opportunity, and threat) analysis should be done.

It can be concluded in context of vision statement that image of future for construction firms seems to be very bright with inspiration of achieving high standard with strong confidence on resources.

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Appendix - I (Selected Vision statements)

1. *To be a Premier Civil Engineering Construction Company.*
2. *To be a state-of-the-art organization in the Construction industry.*
3. *To make concerted efforts to help mold the future of Pakistan and to open up new business areas, with the frontier spirit living in the hearts of us all, and with unbreakable determination to make the best of business environments even better.*
4. *To be recognized for leadership, commitment, and innovation among our clients, principals and competitors*
5. *To be a world class dealer of fertilizer products, with a focus on safety, quality and positive contribution to national economic growth and development. We will care for the communities we work in while continuing to create investors value*
6. *To make the ideas a part of reality.*
7. *To set new standards in road construction*
8. *To become a company of first choice for our clients*
9. *We visualize ourselves in the forefront of four industry by delivering the best to our clients by harnessing quality manpower and employing the best technologies.*
10. *Our vision as a construction giant imparts every individual in the organization a very clear direction and goals to aim for:*
    - *To be the company of first choice for all stake holders, customers, employees, suppliers, trade contractors and the society we live in.*
    - *To challenge and change the image of construction industry in Pakistan.*
    - *To continuously strive to approach each project with utmost care, concern and responsibility of accountability*
    - *To assist in helping to alleviate the poverty level in Pakistan*
11. *To reshape the world*
12. *To offer clients, partners, shareholders and society in general full trust and reliability. To Corporate and public prosperity depend on honesty and transparency, as well as efficiency and excellence in all operations.*
13. *To be the leading oil and gas exploration and production Company of Pakistan with the highest proven hydrocarbon reserves and production, and which provides optimum value to all stakeholders*
14. *To be a market driven construction company renowned for excellence, quality, performance and reliability in the construction industry.*
15. *To be the most trusted and choice human resource agency in the region*

16. To be the authentic source for customer's present and future demands within the scope of our core activities. Constantly endeavouring to be the preeminent service provider, improving the quality of work/deliveries; to add value for clients through innovation, foresight, integrity, and aggressive performance as a superior Service Provider to make our customer prosper, our staff excel and to create the Value for our Partners
17. To become a total solution provider in the civil engineering works from concept to completion under one roof.
18. To achieve customers focus
19. To develop the knowledgeable and motivated work force with a positive commitment to professional excellence.
20. To give you a better tomorrow

TESTS OF MOISTURE CONTENT IN BRICK WALLS OF SEVENTEENTH CENTURY BAROQUE BUILDING

Zygmunt Matkowski[1], Adelajda Pala[2]

Abstract

The paper presents the results of moisture content tests carried out before and after the renovation of a baroque building. Moist brick walls of the cellars and moisture in the ceramic dome are caused by flood waters and rainwater. The dielectric technique and a Uni moisture meter with the B50 probe were used for the nondestructive tests. The dielectric technique is a popular and highly precise method of measuring dampness. The first measurements of moisture content in the brick walls were taken in 1999, directly after a flood event. In 2004, four years after damp proofing, moisture content measurements were taken again. The moisture content in the brick walls was low enough to do the remaining renovation work. Ultimately, the damp proofing work proved to be successful.

Key words

Brick walls, historic building structure, moisture content, nondestructive tests.

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1   INTRODUCTION

Historic building structures are a feature of the European landscape. Unfortunately, most of them, particularly in Poland, are in poor condition and need immediate repair. A major destructive factor is water, affecting basement and top storey walls, plasters and furnishings. This means that the ability to determine the moisture content in the brick walls in such building structures is of critical importance. This paper presents the results of tests of mass moisture content in the structural brickwork components, such as the basement walls and the vault, in a 17th century baroque building.

Water, occurring in all its physical states in the environment, is the worst enemy of building structures, particularly the historic ones. The main source of moisture in buildings in their lower parts is the capillary rise of water from the ground and in their upper parts, water leaking through leaky roofs. Before deciding on any damp proofing one must precisely determine the causes of the accumulation of moisture and familiarize themselves with the specifications of the building and its structure, foundations and subsurface conditions. Any hasty action, even at the design stage, may cause irreversible changes in the building.

Selected problems encountered in the course of damp proofing the 17th century building (erected in the years 1675-1715) of considerable architectonic and historic value are described below.

In the past the building was used as a grammar-school and today it houses the Library of the National Institute of the Ossoliński Family. In the elevation view the building has the shape of an irregular quadrilateral resembling a trapezoid (fig. 1).
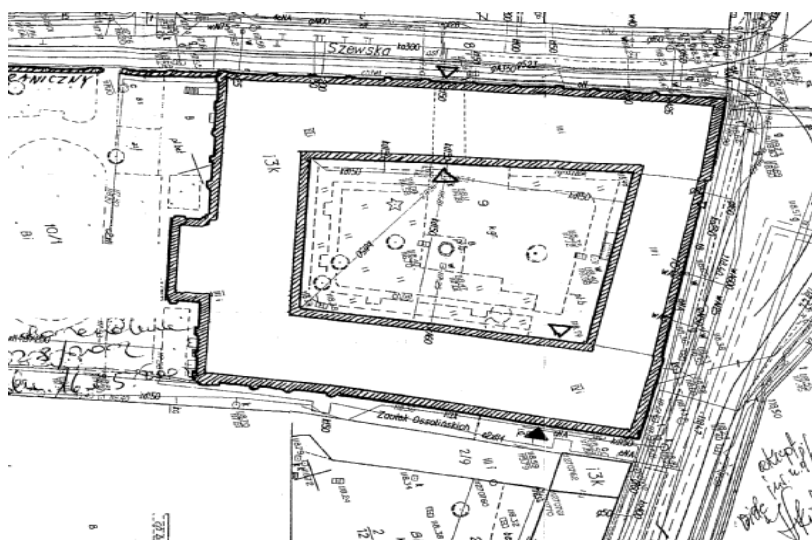
Fig. 1)   Location of main building belonging to National Institute of Ossoliński Family in Wrocław.

The quadrilateral is formed by four wings surrounding a courtyard. The east and west wings are slightly longer. In the south wing there is an asymmetrically located short break, being a remnant of the former wing connecting a monastery with the St. Matthew's Church. The entrance to the courtyard is afforded via a wide drive-through gate situated in the west wing on the Szewska Street side.

The south and west wings are three-storey high. The north wing has two storeys and the east wing has four storeys. The south and north wings are intact, whereas the east and west wings have a partial basement. Some of the cellars in the east and wings are buried.

The building was erected in the traditional way. Drill cores showed the building's walls to made of solid brick. The wall thickness varies, amounting to about:

- 130-175 cm for the exterior walls of the cellars in the southern part,
- 80 cm for the ground floor walls in the window zones,
- 145 cm for the square piers on the ground floor.

All the building's facades are richly decorated (fig. 2).

Fig. 2)   View of building from south-western side before renovation (in 1999).

1.1   Description of damage to walls and vaults before renovation

The main damage to the walls was due to their excessive dampness and salinity. The damage affected mainly the basement and ground floor walls (fig. 3). In the basement walls the damage extended practically to the ceiling, whereas in the ground floor walls the extent of the damage varied (from 1 m to about 6 m, i.e. to the cornice above the ground floor). The damage had the form of:

- dark stains on the interior and exterior surfaces of the walls,
- flaking off and corrosion of the interior and exterior plasters,
- flaking off of the interior and exterior plasters,
- severe salt efflorescence on the interior and exterior surfaces of the walls,
- peeling and flaking off of paint coats,
- corrosion of the steel structural and nonstructural components,
- dark stains on the cementitious floorings.

Fig. 3) Damage caused by excessive accumulation of moisture in building's west wall.

The damage caused by excessive moisture and salt accumulation, which is typical [1, 2], occurred in all the basement walls and in some ground floor walls, i.e.

- in the exterior basement walls whose outer surface was in contact with the ground,
- in the interior basement walls separating the basement from the rooms buried in the past or from the building's part without basement,
- on atypical interior walls in the basement,
- on the interior ground floor walls,
- on the exterior ground floor walls.

Other excessively damp (as a result of leakage of rainwater through a leaky terrace) were the brick vaults over a room on the second floor (photo 4).

Fig. 4) Damage to part of vault situated over graphics storeroom.

1.2 Brick wall rising damp test methods currently used in Poland

A theoretical description of water absorption in clay bricks has been presented in [3]. So far measurement of dampness is difficult in practice [4,5,6,7]. Currently in Poland wall rising damp is tested by the conventional drying-weighing method and by nondestructive methods [tab. 1]. The former method is regarded as the primary one, but it is destructive since wall specimens must be taken. While taking a specimen one should take care not to dry it with the heat generated during drilling. For this reason slow-speed hammer drills are used for this purpose. The taken specimens are locked in hermetic containers and delivered to a laboratory where the mass of the damp specimens and that of the dried (at a temperature of 105°C to a constant weight) specimens are determined. The weight moisture content (denoted by U_m) is calculated from this formula:

$$U_m = \frac{m_w - m_s}{m_s} \times 100\%$$

(1)

where: m_w – the damp specimen's weight [g],

m_s – the dry specimen's weight [g].

Tab. 1) Methods of measuring moisture content [4,5]

1	2
CHEMICAL METHODS	
Chemical reagent method (Fischer method)	amount of Fischer reagent (iodine, sulphur dioxide, pyridine, methanol) used up for titration
Indicator paper method	change in indicator paper colour
Carbide method (CM)	Pressure of C_2H_2 formed as result of reaction of CaO_2 with water contained in tested materials
PHYSICAL METHODS	
Electrical methods	
Electric resistance method	electric resistance of tested medium or moisture absorbent
Dielectric method	dielectric constant of tested medium or moisture absorbent
Frequency permittivity dispersion method	change in permittivity at different current frequencies
Microwave method	attenuation of microwave
Computer impedance tomography	electrical impedance measured between particular electrodes (spatial distribution of impedance)
Optical methods Videography method	analysis of images taken in visible light, in near infrared, in near ultraviolet, in excited luminescence
METHODS BASED ON MEASUREMENT OF THERMAL QUANTITIES	
λ probe method	change in material thermal conductivity as result of change in moisture content
Thermovision method	change in temperature on surface of element as result of change in moisture content
Nuclear methods	
Examination with γ radiation	change in γ radiation
Neutron method	number of neutrons slowed down after passing through examined material
Nuclear magnetic resonance method	width or amplitude of curve of variable electromagnetic field energy absorption by hydrogen nuclei

The most popular methods are: CM, the electric resistance method and the dielectric method. Sometimes the microwave method and the neutron method are used for in situ investigations.

Considering that gauge reading-weight moisture content correlations depend on the material's other properties such as its chemical composition, porosity, porosity structure and the kind and concentration of the salts, the commonly used gauges require calibration.

2   RESULTS OF WALL MASS MOISTURE CONTENT TESTS

Measurements of the moisture content in the walls by nondestructive methods and the conventional drying-weighing method showed that in 1999 [8,9]:

- the mass moisture content in the basement walls varied in a range of 3.1-21.1%,
- in most of the measuring places, mass moisture content exceeded 12%, amounting on average to 14 %,
- the distribution of moisture content along wall thickness varied; in most of the measuring places moisture content deep inside the wall was a few percent higher than the near-surface moisture content, but in some places (especially with severe salt efflorescence on the wall surface) the wall near-surface moisture content was higher than that deep inside the wall,
- no clear difference between the moisture content in the samples taken at the height of 20 and 50 cm above the basement floor level was observed; a lower moisture content characterized the samples taken from places situated at a greater height of 80-100 cm,
- the wall near-surface moisture content would decrease with height.

The primary cause of the high moisture content in the basement walls was the lack of any horizontal or vertical damp proof courses.

The designed and implemented damp proofing protection of the exterior walls being in contact with the ground is shown in fig. 5 and that of the interior walls is shown in fig. 6.
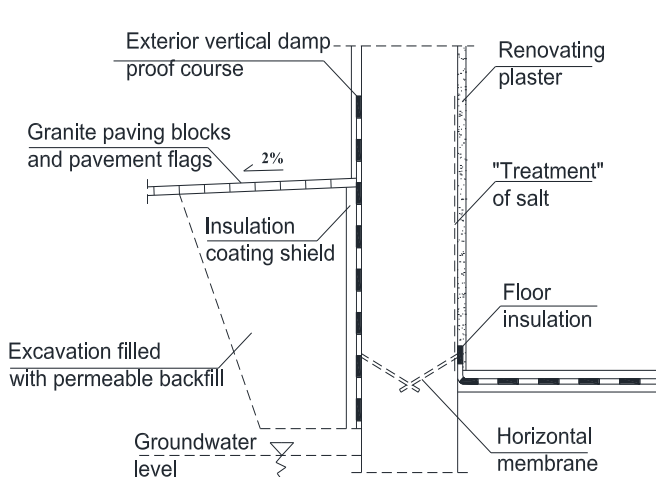
Fig. 5)   Schematic of damp proofing protection of exterior   walls excavatable from outside.
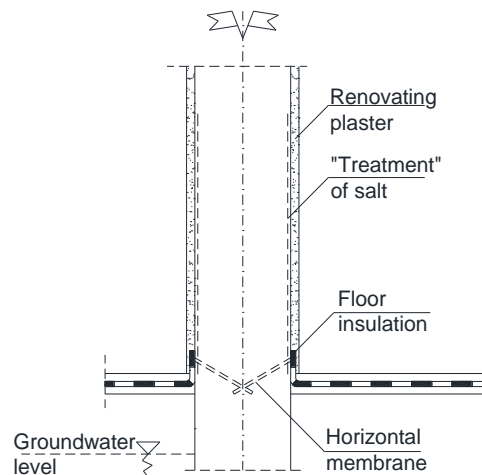
Fig. 6)   Schematic of damp proofing of interior walls.

The results of the moisture content measurements taken in 1997 (before damp proofing) and in 2004 (after about 7 years from the renovation) are presented in figs 7-9.
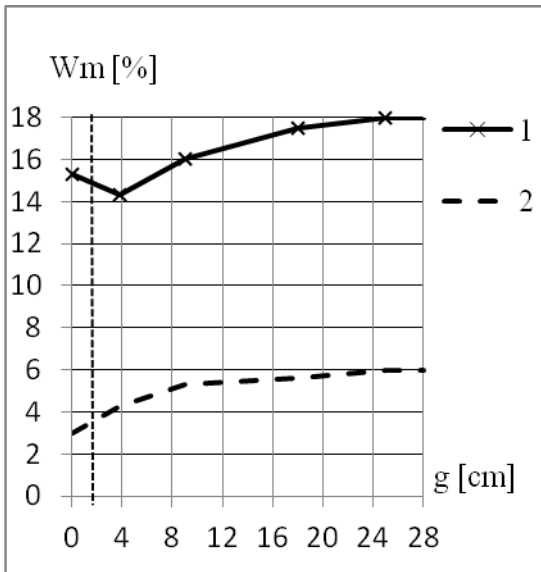
Fig. 7)   Exemplary mass moisture content Um (Wm) distribution along thickness of interior basement wall: 1, 2.

1 – October 1997, 2 – April 2004.
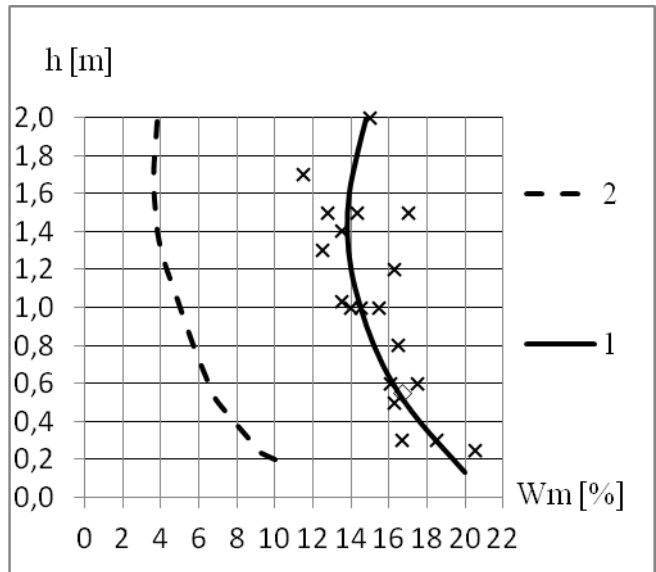
Fig. 8)   Exemplary mass moisture content Um (Wm) distribution along height of exterior basement walls: 1, 2.

1 – October 1997, 2 – April 2004.
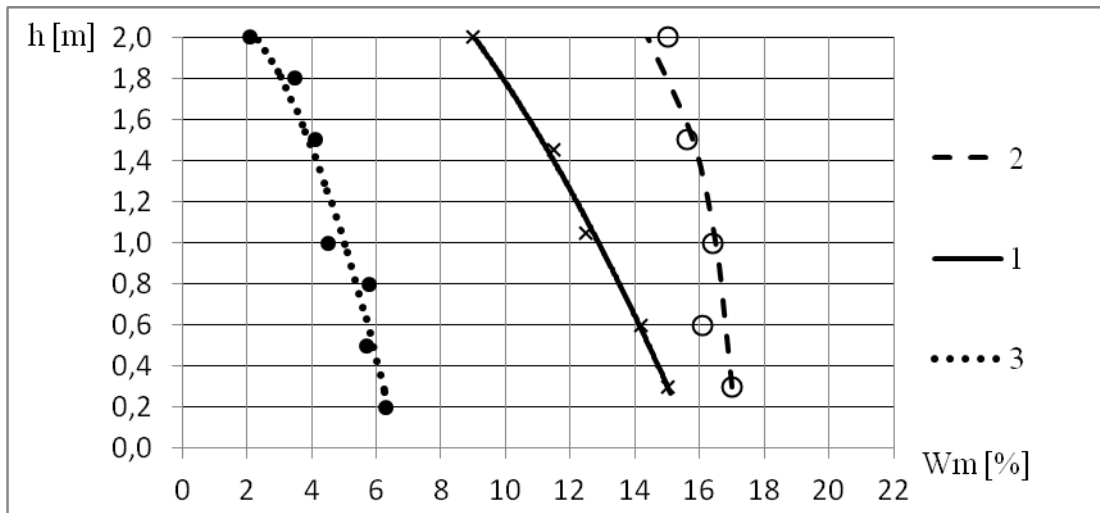
Fig. 9)   Exemplary mass moisture content Um (Wm) distribution along height of external basement walls:

1 – in west wing in 1997, 2 – in east wing in 1997. 3 – in east wing in April 2004.

The measurements showed that:

- the mass moisture content in the basement walls was lower, ranging from 1.5 to 8.1%;
- in most of the measuring places the mass moisture content did not exceed 5%, amounting on average to about 4.8%;
- the mass moisture content in the walls after a few years from the damp proofing was lower, on average, by 8-10%, which is evidence of the effectiveness of the damp proof protection.

Moisture content diagrams for the particular stages in the drying of the vault shown in fig. 4 are presented in figs 10-12.

The wall moisture content tests carried out in three stages in the years 2011-2012 were performed using the nondestructive dielectric method based on measurements of material dielectric properties. The results of the destructive tests carried out in April 2004 were used to graduate the nondestructive meter.

The moisture content in the walls and in the vault was measured in 17 measuring points at the height of over 300 cm from the floor level.

The moisture content in the exterior walls, tested on their interior surface, locally exceeded 4.0%. The walls showed an elevated moisture content. There was visible efflorescence and damage to the paint coat. After 8 months of the natural drying of the walls, the moisture content in the walls and in the vaults of the graphics storeroom in the building of the National Institute of the Ossoliński Family in Wrocław decreased to about 2% and the mass moisture content near the interior surface of the walls did not exceed the values allowable for renovation work to be done on them.
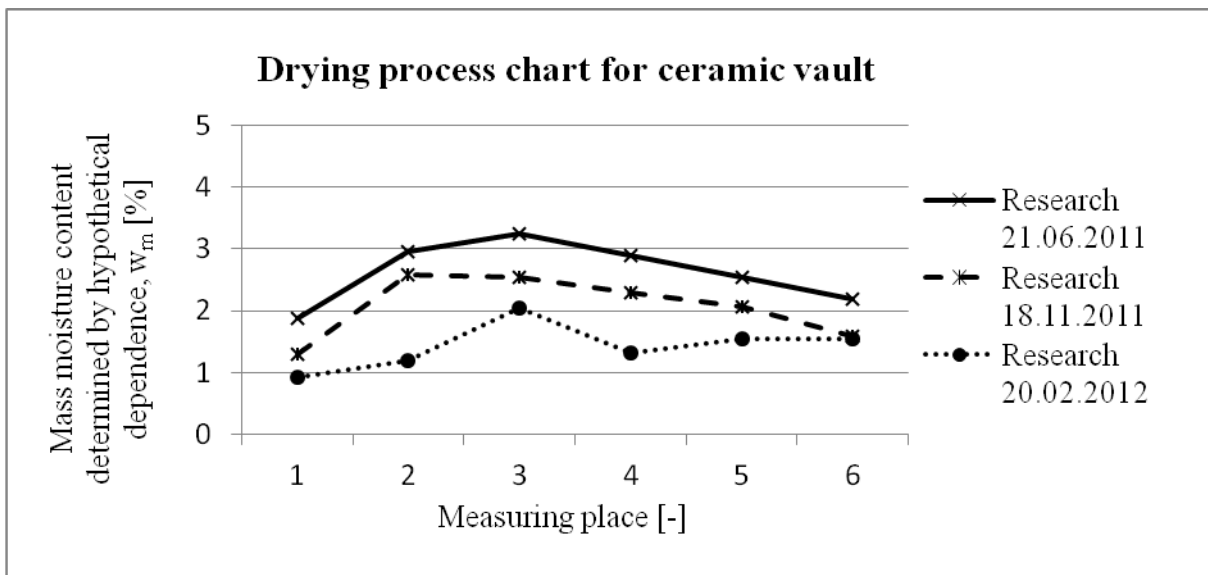
Fig. 10)   Diagram of moisture content in brick vault.
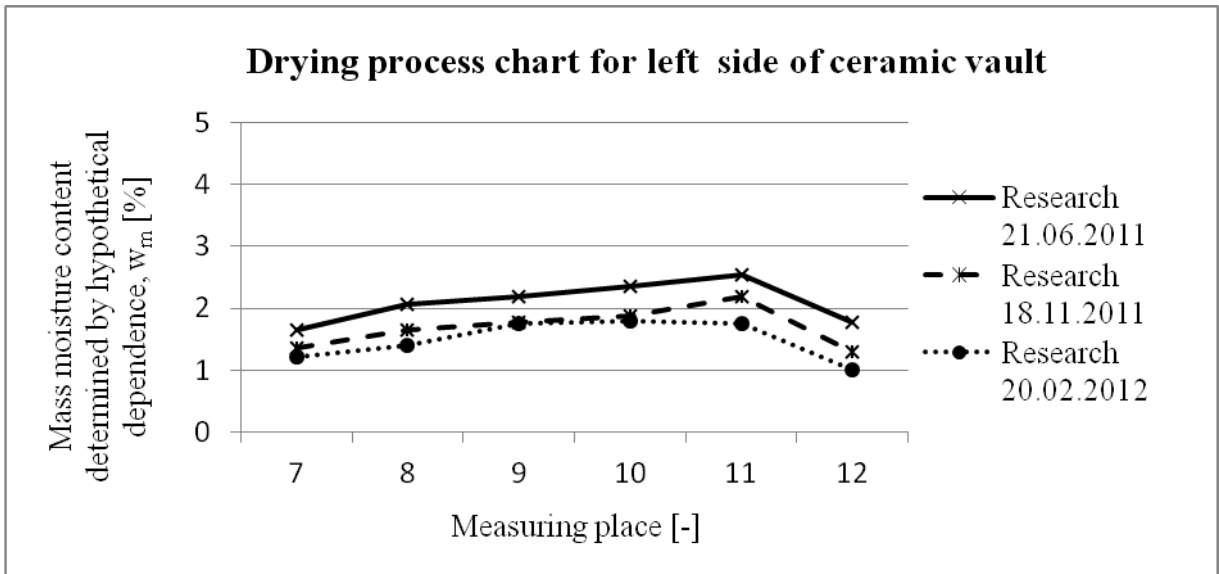
Fig. 11)   Diagram of moisture content in vault on its left side.
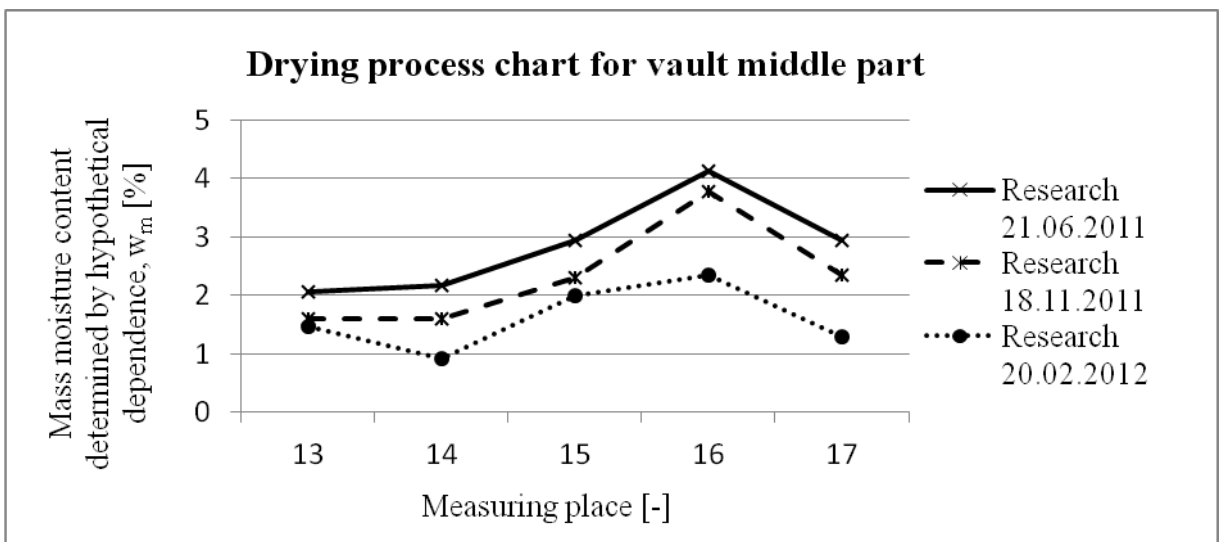
Fig. 12)   Diagram of moisture content in vault in its middle part.

3   CONCLUSION

The problems described here only hint at the wide range of problems connected with the excessive moisture accumulation in the walls of historic building structures. The humidistat condition of building should be taken into account when designing and making damp proofing protections. Before the design and execution of such protections one should carry out very detailed hydrogeological surveys, moisture content tests and salinity type and concentration tests in order to precisely determine the causes of the excessive moisture and salt accumulation in the walls. Moisture accumulation and salt accumulation usually occur together and interact with each other.

It is absolutely necessary to carry out mass moisture content tests in order to design and make proper and effective damp and water proofing protections. In this particular case, this work was done properly, as evidenced by the appearance of the building, shown in figs 13 and 14, after about 15 years since the renovation.

Fig. 13)   View of building from north-western side after renovation.

Fig. 14)   View of building's west facade in 2012.

One should also bear in mind that all the damp proofing work should be carried out extremely carefully by a firm with long experience in such work, under the supervision of a properly qualified supervising officer. It is recommended that the contractor be given a training course in the works to be carried out as part of the project.

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RISKS IN INFRASTRUCTURE CONSTRUCTION PROJECTS AND BIM AS A RISK AVOIDING TECHNIQUE - SERBIAN MARKET SURVEY

Miljan Mikić[1], Dragan Arizanović[2], Nenad Ivanišević[3]

Abstract

Project Risk Management (PRM) in construction is a very important and unavoidable area of construction project management. It helps to analyze, mitigate and control risks associated with project cost, schedule, quality, performance, health and safety aspects, environmental aspects but, as well, with other, non-tangible factors. PRM generally consists of: Risk Management Planning, Identification, Analyses, Response Planning and finally Monitoring and Control of Risks. Although risk in construction projects may occur in any of project life cycle phase, it is most important for risks to be analyzed and assessed in project development process, where Building Information Modelling (BIM) could improve PRM. Infrastructure projects are usually followed by numerous standard, but also specific risks. They, if not timely identified, treated and controlled cause that project actual performance significantly varies from planned values. This paper presents results of an still ongoing infrastructure construction project risks survey for projects settled in Serbia. The survey includes: Analysis of usage, necessity and problems with construction PRM practice and BIM practice in Serbia, as well as the evaluation of major risks in relation to infrastructure project cost, schedule and quality performance.

Key words

BIM, construction project risk management, infrastructure, risk.

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1 INTRODUCTION AND BACKGROUND

The realization of an investment project, especially large one, is an extremely complex undertaking both from technical and technological, as well as the organizational, legal and financial standpoint [1]. Success in a project can be regarded as provision on time, on budget, of a required performance or achievement [2]. In order to achieve the success on a project, it is neccessary to manage the project troughout the all project areas.

Project Risk Management (PRM) in construction, as one of construction project management areas, is extended well beyond the confines of insurance and helps to analyze, mitigate and control risks associated with project cost, schedule, quality, performance, health and safety aspects, environmental aspects but, as well, with other, non-tangible factors, such as corporate image, employee satisfaction, increased customer service [2-4]. Project risk is an uncertain event or condition that, if occurs, has a positive or a negative impact on at least one project objective [5]. Risk is described with a probability of event occurrence and a possible impact that it might have on project goals [6]. On figure 1, the PRM procedure is shown as defined by *Project Management Institute* (PMI) [5].
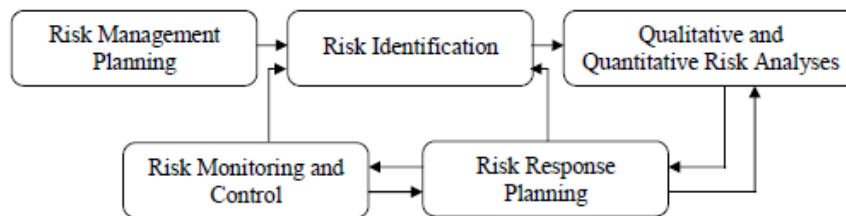
Fig. 1)　　(adapted from [7]): Project Risk Management (PRM) Processes

Risk Management Planning is the process of defining how to conduct risk management activities for a project. In Risk Identification, it is determined which risks may affect the project. Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact. Quantitative Risk Analysis is numerical analysis of the effect of identified risks on overall project objectives. Risk Response Planning develops options and actions to enhance opportunities and to reduce threats to project objectives. Finally, Risk Monitoring and Control is the process of implementing risk response plans, tracking residual and new risks and evaluating risk process effectiveness throughout the project.

Large infrastructure projects, due to their nature, specific construction sites, project surrounding, numerous stakeholders, multidisciplinary character, being often complex and international are followed by many uncertainties. When considering project costs, a research investigation looking at 258 infrastructure projects (i.e., roadways, rail, fixed links) worldwide reported that 90% of the projects experienced cost overrun with an average cost escalation of 27.6%. The average escalation for roadway projects was 20.4% [8]. In Serbia, as a developing country, heading towards EU, there is a need and a plan for upgrading infrastructure capacity and availability. Although Serbia is in the process of a constant infrastructure upgrading and development, significant infrastructure works are still to come. If example of highway network is considered, Serbia at the moment possess a highway network of 650 km, of which 188 km is constructed in period from 2009. until 2012. Additional 700 km is still to be constructed, of which 165 km is designed and is in the construction phase at the moment, for 290 km there are designs, but construction has not yet started and the rest of 240 km is planned in the Spatial Plan of Republic of Serbia [9].

In feasibility, design and construction phases of an infrastructure project, it is very important for all stakeholders to be aware of possible threats to the project goals and overall project success. This is especially important for advance planning stage (Figure 2), in which up to 98% of all savings on the project could be made [1]. Much more attention in project management research and practice has been paid to construction, while much less has been focused on advance planning and design phases [10]. Starting from these phases, and particularly from preliminary design, Building Information Modelling (BIM) technologies could be applied. BIM is in literature defined as an evolution of traditional design process, where, dislike from existing practice, design procedure starts and continuous with process of forming a unique 3D model of object that contains all elements of object with information about types, quantities, characteristics of all building materials and equipment, but also, among other, information about planned values of construction costs and schedule [11]. While forming, such a model can be manipulated by more than one designer at the same time, while, after formed, it could be used and upgraded in construction and exploitation phase from different stakeholders. Basic benefits of BIM technologies application in relation to project management would be: standardization of design process, timely discovering and reduction of design collisions, more accurate and efficient project cost and time planning, easier project performance control [11]. These benefits might be reasons for owner and/or project management team to choose BIM as one of risk avoiding techniques.

2   METHODS

In order to provide the opinion of construction professionals on potential risks sources regarding infrastructure project cost, time and quality performance, a survey of Serbian market is conducted. Within this research, infrastructure projects were defined as: road, railroad network projects, water supply and sewage system, gas infrastrucutre, electricity and telecommunication projects. Although, as we have seen, PMI [5] defines that risk could have either a positive or a negative impact on at least one project objective, for the purpose of the survey, risk was defined only as a threat, i.e. only as an event with possible negative impacts. In the survey, which is still ongoing, existence of risk management practice, as well as the possibility of application of BIM as a risk avoiding technique in Serbia were examined. The most significant goal was to identify major risks to infrastructure project performance.

Some of the previous surveys on construction projects risk perceptions, based on questionnaires with predefined risk list were those conducted by: Adams (2008) [12], comparing perceptions of risks between UK and Ghana contractors; Andi (2006) [13], exploring the importance and allocation of risks on projects in Indonesia; De Camprieu (2007) [14], examing the perceptions of risk among Chinese and Canadian large-scale projects practitioners; and Zou et al. (2007) [15], identifying the key construction projects risks in China and Australia. Thomas et al. (2003) [16] and Bryde and Volm (2009) [17] explored, respectively, the most critical risks of an Indian BOT road projects in an unstructured interview and perception of risks of owners in German construction projects in a semi-structured interview based surveys. The results of the survey for Serbian market, regarding sources and priority of risks, are in the section 3 of this paper compared to the results of some of the previous studies. The questionnaire in this research consisted of four parts:

- The PART 1 contained 7 general questions.
- In the PART 2, there were 11 questions which examined the practice of construction project management in Serbia, as well as the usage, necessity and problems related to construction project risk management practice. Risk was here

defined as an event that could potentially impact the basic project performance goals (costs, time and quality).

- 5 (five) questions in the PART 3 aimed to point out the main sources of risks on infrastructure construction projects in Serbia.
- The PART 4 consisted of 6 questions which analyzed the problems and potential application of BIM (Building Information Technology) technology as a risk avoiding technique. A basic definition of BIM was given in the first question in this part of the survey.

After initial structured questionnaire forming, to get feedback on the questions, the questionnaire was taken by three construction professionals with both practical and scientific experience in construction project management of more than twenty years. Based on this feedback, slight modifications to the wording of some questions were made.

In order to conduct the third and crucial part of the survey, identification of potential risks was performed prior to the survey, trough a literature review and an iterative process of predefined risk list generation. In a literature review, similar previous surveys [12-17] were studied, but also the researches which employed construction risk modelling using Analytical Hierarchy Process (AHP) [18], Analytical Network Process (ANP) [19] and Alien Eyes-Risk Model [20]. Existing risk lists, developed in considered literature, were the basis for a risk list for the survey, which was made to fit infrastructure construction project surrounding and specific conditions of Serbian market, similar to the conditions in other developing countries, especially in South East European region. After initial risk list forming and construction professionals feedback, definite predefined risk list was offered for a qualitative risk analysis in the third part of the survey.

Risk list consisted of risks grouped into three risk areas: General market risks, Risks in Feasibility and Design phase and Risks in Construction phase (Figure 2). Apart form stated literature, this type of risk division was partly also based on chronological risk classification, suggested by Bunni (2003) [6], supporting the plan to examine risk sources in pre-construction phases more carefully.
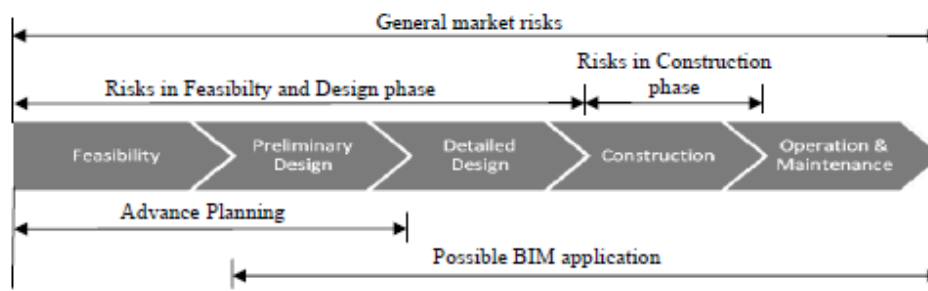
Fig. 2)   (adapted from [10]): Infrastructure construction project phases and Risk areas

As general market risks, the following were in the list:

- Political risks in Serbia (instability of political conditions, political pressure and impact)
- Domestic market financial risk (instability of economic conditions)
- Legal risk in Serbia (change of regulations, delay of approvals)
- Corruption

As risks in Feasibility and Design phase, there were:

- Inadequate initial surveys conducted (location, geology, geotechnics, hydrology)
- Inadequate Terms of Reference
- Design contract issues (deadline, price)
- Design company organizational issues (weak design project management, lack of qualified desgin engineers, lack of business standards and organization)
- Design technology issues (lack of standards and technical guidelines, lack of knowledge and applience of advanced methods, technologies and softwares)
- Inadequate control from customer in design phase

As risks in Construction phase, in the list there were:

- Unforeseen ground conditions
- Design defects (incl. BoQ) which lead to numerous changes and variations
- Contractual issues (inadequate contract model, strict conditions towards contractor, tight deadline, low prices, inadadvance payment structure, bad wording, incompleteness, potential claims and disputes)
- Contractor company organizational issues (weak project management performed by contractor, lack in management and engineers skills and know-how, lack of business standards and organization)
- Construction technology issues (lack of knowledge and application of advanced methods, technologies, equipment, materials and softwares)
- Resource issues (problems with borrow pits, specific materials and equipment procurement, change of material prices, lack of engineers, lack of qualified labor force)
- Bad quality of materials
- Lack of control and support from the Engineer, Engineer's incompetence
- Exproipriation problems
- Unforseen extremely adverse climatic conditions
- Accidents on construction site (health and safety issues, environmental issues)
- Force Majeure

The survey was distributed to 65 construction professionals with experience on infrastructure construction projects in Serbia. It was also available for the Linkedin PMI Local Chapter Serbia and Assocciation of Consultant Engineers of Serbia (ACES) group members to take part in. In the survey 36 respondents took part, 31 of which responses were complete. Only complete responses were analyzed.

3   RESULTS

3.1   Part 1: Results of General Questions

In this part, respondents were asked about their profession, professional experience, types and values of infrastructure construction projects they have taken part in. Among all respondents, almost all (97%) were construction or civil engineers. 55% of all respondents confirmed that in their career they have worked as a project manager, 42% that they have worked as a designer, 42% confirmed they have worked as a contractor, 39% as a consultant, 29% in company management team, 26% as a supervising engineer, 19% as an investor, 16% have worked the other as well.

In preparation of studies and design, 29% of respondents have more then 15 years of experience, 13% of respondents have 10-15 years, 13% have 5-10 years, 29% have less then 5 years, while 16% have no experience in preparation of studies and design at all.

On construction sites and related activities, 29% of respondents have more then 15 years of experience, 10% have 10-15, 23% have 5-10, 32% of respondents have less then 5 and 6% have no such experience at all.

The most of respondents have participated in road infrastructure projects (72%), in water supply & sewage system (45%), while significantly less have participated in gas infrastrucutre projects (17%), in railroad network projects (10%) and in electricity, telecommunication projects (10%).

The value of the largest infrastructure projects they have taken part in, for 77% of engineers, was more then 10 EUR millions.

3.2 Part 2: Analysis of Project and Risk Management Practice in Serbia

Almost all participants agree or strongly agree that project risk management is an important area of project management (97% of respondents), that project risk management application is important for success of the construction project (also 97%), and that project risk management should be applied on construction projects in Serbia (94%).

However, although the awareness of the project risk management importance and the need for it exist, there is a lack of knowledge on the subject in Serbia. From figure 3 it is notable that only 32% of respondents is very familiar or familiar with Project Risk Management (PRM) tools. To compare, 82% of respondents is very familiar or familiar with Project Management (PM) tools. Also, there is a significant difference between the number of domestic companies which have implemented PRM system/standard, comparing to those which have implemented PM system/standard. While more then half of respondents (51%) answered there are some techniques or full system for PM implemented in their company, for PRM it is only 22% (fig.4).
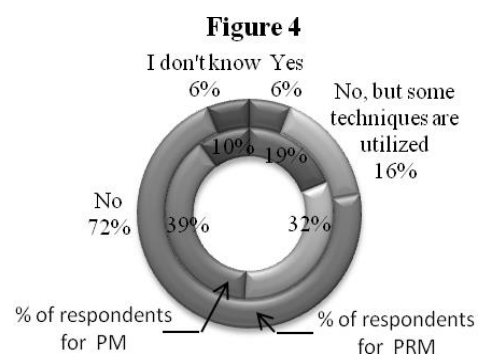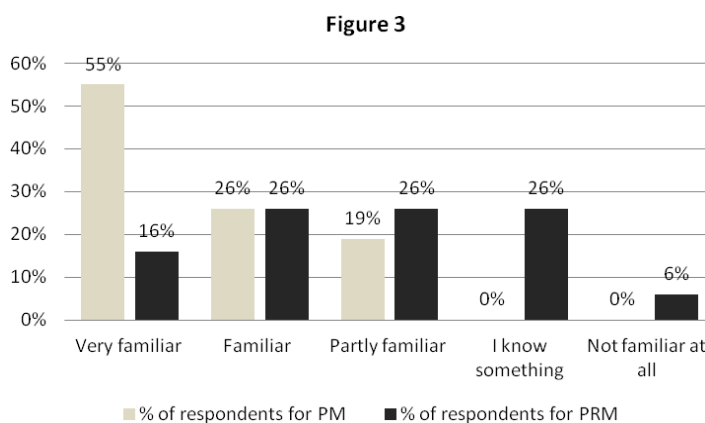
Fig. 3) Familiarity with PM/PRM tools; Fig. 4) Answers to the question: "Does your company has implemented PM/PRM standard/system?"

The major problems of PRM practical application on projects in Serbia are, starting from the most significant, evaluated as: organizational problems, no recognition of importance from top management, political, legal and financial problems. The level of interest in finding out

more about PRM on a scale from 0 (no interest) to 4 (very interested) among respondents has a mean of 3.45.

3.3 Part 3: Evaluation of Major Risks in Relation to Infrastructure Project Cost, Schedule and Quality of Works

The survey feedback in this part includes two groups of data, the probability of occurrence of each risk and its impact of consequence on basic project objectives. The respondents were asked to evaluate the probability of occurrence and the impact of risks from the list on infrastructure construction project cost, time and quality performance. The qualitative five-point scales were offered for evaluation of each risk in both of these groups of questions. Data analysis method, adopted as method from previous researches [14,15,21], is further described.

The qualitative scales were converted into numerical scales, where both for probability and impact "very high" takes value of 1, "high" takes value of 0.75, "medium" takes value of 0.5, "low" takes value of 0.25 and "very low" takes value of 0.1. Further steps were: 1) averaging the evaluated probability for occurrence of each risk; 2) averaging the evaluated impact of each risk on project cost, time and quality; 3) deriving a risk rating for each of cost, time and quality, by multiplying their respective probability and impact average scores. The rating of all risks, separately for project cost, time and quality performance is shown in table 1.

The risks with ratings above 0.5 are considered critical and their ratings are presented in bold letters in table 1. Since the value "high" in qualitative scales responds to the value of 0.75, the most critical risks are those with values of both probability and impact "high" or "very high", which, because of multiplication, gives ratings of at least 0.56. The highest rating regarding possible project cost increasing have the risks: Corruption (0.57), Lack of financial resources for project realization (0.57), Domestic market financial risk (0.55), Design defects (incl. BoQ) (0.54), Political risks in Serbia (0.51), Inadequate control from customer in design phase (0.50), Inadequate initial surveys conducted (0.50) and Contractual issues (0.50). The risks with highest rating regarding project time performance are: Lack of financial resources for project realization (0.61), Domestic market financial risk (0.57), Corruption (0.55) and Political risks in Serbia (0.52). In respect of project quality performance, the only critical risk is the Lack of financial resources for project realization (risk quality rating 0.52). The highest ratings considering all three project performance indicators (cost, time, quality) has, as well, the Lack of financial resources for project realization, after which comes the Corruption.

Received results mostly correspond to the results of previous surveys of construction projects risks in developing countries. The highest rated risks for China were, regarding project cost performance: Price inflation and Design variations, regarding time - Project funding problems, while regarding Quality: Tight project schedule and Contractor management ability [15], where a least correspondance was noticed. For Indonesia, the Inflation, Defective design, but also Unforessen Site conditions were evaluated as risks with the highest impact on construction projects [13], while for Indian road projects the most significant risks were: Delay in land acquisition, Delay in financial closure, Direct political risks [16], which are all risks also rated very highly in this study.

Tab. 1)   Ratings of risks for Serbian infrastructure projects

	LIST OF RISKS	RISK RATING		
No.	**RISK**	**COST**	**TIME**	**QUALITY**
General market risks				
1	Political risks in Serbia	**0,51**	**0,52**	0,32
2	Domestic market financial risk	**0,55**	**0,57**	0,36
3	Legal risk in Serbia	0,43	0,44	0,26
4	Corruption	**0,57**	**0,55**	0,42
Risks in Feasibility and Design phase				
5	Inadequate initial surveys conducted	**0,50**	0,48	0,35
6	Inadequate Terms of Reference	0,48	0,46	0,40
7	Design contract issues	0,41	0,39	0,33
8	Design company organizational issues	0,37	0,37	0,31
9	Design technology issues	0,29	0,28	0,28
10	Inadequate control from customer in design phase	**0,50**	0,44	0,46
Risks in Construction phase				
11	Unforseen ground conditions	0,39	0,39	0,26
12	Design defects (incl. BoQ)	**0,54**	0,48	0,41
13	Contractual issues	**0,50**	0,44	0,36
14	Contractor company organizational issues	0,44	0,48	0,46
15	Construction technology issues	0,34	0,35	0,36
16	Resource issues	0,31	0,31	0,30
17	Bad quality of materials	0,20	0,19	0,24
18	Lack of financial resources for project realization	**0,57**	**0,61**	**0,52**
19	Lack of control and support from the Engineer, Engineer's incompetence	0,34	0,33	0,37
20	Exproipriation problems	0,48	0,49	0,25
21	Unforseen extremely adverse climatic conditions	0,12	0,14	0,12
22	Accidents on site	0,18	0,17	0,13
23	Force Majeure	0,10	0,10	0,08

3.4   Part 4: Analysis of Problems and Possible Application of BIM as a Risk Avoiding Technique

In this part, respondents were firstly asked about their familiarity with BIM technology and how much they apply BIM. Then, their opinion was examined on how much BIM technology application could improve construction project performance and what are the major problems in relation to BIM practical application on construction projects in Serbia.

33 % of the respondents are familiar or very familiar with BIM technology. The frequency of respondents personal application of BIM on a scale from 0 (never) to 4 (very often) has a mean of 0.69. The level of interest in finding out more about BIM on a scale from 0 (no interest) to 4 (very interested) among respondents has a mean of 3.35. This shows, similar as for PRM, that the application of BIM is poor, but professionals are very interested in learning about BIM. It might be further concluded that interest in BIM is justified with the opinion of 91% of respondents who agree or strongly agree that applied BIM could enhance planning

and control of construction project performance (project cost, time, quality). Assumption of this study that BIM could be considered as a risk avoiding technique is, with such a result, confirmed.

The major problems in relation to BIM practical application for construction projects in Serbia are, starting from the most significant, evaluated as: organizational, no recognition of importance from top management, financial, political, legal. The only difference among problems evaluation regarding BIM and PRM application in Serbia is that for BIM financial problems are on the third place, while for PRM they were evaluated as the least important.

4   CONCLUSION AND RECOMENDATIONS

In this paper, results of still ongoing infrastructure construction project risks survey for projects settled in Serbia are presented. Construction PRM practice in Serbia was analyzed, evaluation of major risks in relation to infrastructure project cost, schedule and quality performance was done and analysis of problems and potential application of BIM as a Risk avoiding technique was performed. Although there are more advanced techniques for risk analysis and evaluation, in this research Probability-Impact analysis was applied, as a first step toward more complex risk modelling.

It was found out that there is a strong support and interest for PRM application on projects in Serbia, but lack of knowledge on the subject and poor practical application exist. Among the 23 risks in the predefined risk list, corruption and lack of financial resources for project realization were the highest rated regarding possible project cost increasing. Regarding project time performance, it was the lack of financial resources for project realization, as well as it was for the project quality performance. The results of the survey confirmed that BIM should be considered as one of possible risk avoiding techniques. The major problems in relation to both PRM and BIM practical application in Serbia are identified as organizational and no recognition of importance from top management.

The significance of this result is that it provides an empirical basis for the development of more complex risk models and further systematic analysis and management of infrastructure construction project risks in Serbia. The application of PRM would have the ultimate benefit of enhanced performance of projects, which is important for all stakeholders and construction industry as a whole.

Although the study reported here has to be placed within a clear context of its limitations, it could be recommended for further researches that this type of surveys should be conducted in other developing countries, especially in countries in the South East European region. In that way, the results could be compared and a more general conclusions could be made.

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PERMITTING AND IMPLEMENTATION OF CONSTRUCTION IN THE COMPARATION OF GEODETIC ACTIVITIES

Michal Paulík[1], Robert Geisse[2], Mikuláš Šveda[3]

Abstract

The aim of this work is to detect problems of permitting and realization of construction service under Act no 50/1976 Coll. On Land-use Planning and Building Order (the Building Act), in its amended and implemented regulations in the comparison of the Act no 215/1995 Coll. Geodesy and Cartography, in its amended and implemented regulations. Special attention is given to a geodetic basis for project activities and on the pursuit of surveyors in the execution of rights of the builder under the building permit. First part contains the definition of basic terms of the legislation. The main part describes the basic principles of construction process, implementation of construction and surveying activities necessary for the structural design, execution of construction work until its registration in the land registry. The paper describes the maps in the region of catastral maps, coordinate systems used in Slovak republic, materials and method of demarcation of construction and building orientation in order to issue the occupancy as well as the entire process of building process and materials needed for construction permits.

Key words

Conduct final inspection, construction administration, geodetic surveying, implementation structure, project construction, project preparation, the setting of the land and building.

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1   INTRODUCTION

This work is done as a compiled summarization document with elements of an original document. This means that the paper includes knowledge which was taken from other documents (laws, regulations, and other publications on the subject). By summarizing, the paper creates new value and in the same time in terms of compilation this paper repeats information which was taken from other documents, which are adapted to the aim of this article. At the same time the document includes new information as well as proposals for modification and methodology, which as a result of a research, are described in the core of the paper and especially at the end of this work.

Documents are dealing with detection of design problems, authorization and realization of plant construction, where the basic source of legislation and legal nature is the Act. No. 50/1976 [1] of statute and its implementing regulations, mainly regulation no. 453/2000, which is implementing certain provisions of the Building Act. [2]. In terms of geodetic activities substantive rule and the source of legal nature is Act. No. 215/1995 about Geodesy and Cartography, as amended (hereinafter the Law on Geodesy) [3] and it´s implemented regulations especially regulation 461/2009 Z.z. [4]. With this regulation, the law of National Council of Slovak Republic is administered no. 162/1995 Z.z. [5] about real estate, registration of ownership and other rights regarding real estate (Cadastral Act), as amended.

The main aim of this paper is to describe the process of building permit under the Building Act which is followed by pre-project and project preparation. After the actual building permit, its realization and final inspection specialized comparison with geodetic activities. The basic condition for investment on construction are the property rights (or other than ownership relationship) to the land governed by the Building Act (§ 139 of the Building Act) [1]. The content of the ownership right is so-called triad of authorization formulated by the classic Roman jurisprudence. It concerns the right to keep the thing (ius possidendi), the right to use the thing and enjoy its fruits and benefits (ius utendi et fruendi) and right to dispose it (ius disponendi). The inherent right of the owner is considered the right of protection against any unauthorized interference with property rights. In this article, the two forms of rights of the land (ownership law / other than ownership law) called only as ownership law. The right to carry out the construction in terms of the ownership cannot be considered as the right to dispose with the land with own discretion. The title belongs to the so-called substantive rights which are identified with respect to their absoluteness and relativity.

The fundamental basis for this work were already mentioned documents of legal nature such as the law on Surveying and Construction Act and their implementing regulations and professional publications (technical and legal orientation) in this issue. These are adequately characterizing the current state of knowledge to which this thesis interlocks.

Timeliness of the issue is clear as construction is a limiting factor for development of villages and its regulation and rectification is the main condition for sustainable development and other environmental factors.

The concept of writing of the paper was designed in the way that it can dedicate in separate units to each individual determined issue (Civil rights / Geodesy) under the scope of this work. The parts are arranged in ascending order by time line nature of the process. The expected results and benefits for union is very detailed assessment of both issues in one work, pointing out shortcomings and proposing new modifications at the end.

2 BUILDING PROCESS AND SURVAY

2.1 Current status of the field

Currently, the main source of the civil rights is Act. 50/1976 Coll. the Planning and Building Regulations, as amended (the Building Act) [1]. Historically, it can be noted that formation of the Czechoslovak Republic in 1918 was the general success of the construction law in Austria - Uhorsko as in previous period because of Dual Monarchy different regulations were applicable for the territory of present Slovakia and the Czech Republic. In the territory of Slovak Republic, there were so called civil statutes and in the territory of Czech Republic, there were so called construction schedules. The unification of the legal situation in Czechoslovakia became only with the Law no. 280/1949 Coll. of zoning and building communities followed by government regulation No.51/1950 Coll. about planning and regulation communities. No. 93/1950 about building communities, which have been engaged by several regulations. This Act repealed all previous legislation of civil rights which were valid in Czechoslovakia [6].

For the purpose of this work we will focus on the construction of the current source of law and that´s the Building Act and its implementing regulations. In the second part of the paper The Building Act is addressing to the authorization to carry out construction activities and selected activities, Building Regulations in section no. 2 Authorization for construction and implementation of selected activities in construction, § § 44 - 46d. Selected activities in construction are activities, which are affecting the protection of the public interests in construction, these activities include [1]:

- Project activities;
- Management and execution of construction
- Selected geodetic and cartographic work activities;

In this work we focus on selected geodetic work and cartographic activities. Selected activities in construction may be performed only by personal entity, which have obtained permission to carry out these activities (beneficiary) according to special regulations. For the performance of selected geodetic and cartographic work activities is no law. 215/1995 [3] Coll. about geodesy and cartography in conjunction with the Act. 216/1995 Coll. [7] for Chamber of Surveyors and Cartographers. Until now the rules in selected activities, in construction for the corporate entity, were not clearly amended as yet. It is starting from the status of authorized persons which under the law no. 138/1992 Z.z. [8] perform this activity on their own behalf and at their own risk as a "freelance" or on behalf of and responsibility of the legal person as its employee. Verification of professional and ethical competence by the content and verification procedure is always regulated by law - code, to which is in the European Economic Area transported from the European Union legally binding act. In the area of construction is statute of the European Parliament and Council. 2005/36/EC on the recognition of professional qualifications [8].

Responsible building surveyor is responsible for properly installed and updated geodetic points, for drafting staking networks, for constructing staking networks, for staking out a control measurement of geometric parameters of the spatial position of the construction, for designation of existing underground lines on the surface, for measuring and displaying of objects in the actual implementation of building to comply with zoning and building permits[9].

Documents from the surveyors, which are presented in the process of managing construction law can be divided according to different types of administrative proceedings as well as its previous and subsequent processes. In general, we can conclude that the range of geodetic and cartographic activities in the planning process, pre- project preparation, project preparation, the licensing process, implementation and use of buildings, mainly depends on the type of building structure, its complexity as well as the purpose to serve.

2.2 A comprehensive overview of geodetic activities sorted by phases of the building process

In this part we deal with a relationship between building process and geodetic activities. Whole part is divided to individual steps of building. The phases are: planning and preparation- projection- permission- building construction- operation of construction. (See Tab. 1).

Tab. 1) Surveying ctivities in accordance with the construction process[10]

The building process	Geodetic activities
Planning and preparation	- special work when surveying - special work when choosing the locality - producing of documents as a support of the project
Projection	- project of surveying network - project of surveying of object - setting out drawings - project of control measurements - creation of sketches or drawings of staking out boundaries of land ownership
The authorization procedure	- § 3 ed. no. 453/2000 Z.z. (to § 35 of the Building Act) - § 8 and 9 of the Decree. no. 453/2000 Z.z. (To § 58 of the Building Act) - § 17 of the Decree. no. 453/2000 Z.z. (To § § 79 and 80 of the Building Act)
Construction of buildings	- staking out the spatial position - detailed standout - control measurements - documentation of actual realization of construction
Operation of construction	- control measurement of geometric parameters - long-term measurement of displacements and deformations

Planning and preparation

Preparation of documentation in support of the project can be divided into two parts: preparation of documents in the field of engineering geodesy and preparation of documents in land registry.

Preparation of documents in the field of engineering geodesy contains mainly targeting planimetry and elevation of interested locality. Targeted planimetry and altimetry includes detailed trend of existing planimetry and altimetry, surface features of utilities and waveforms utilities either underground or overhead.

Preparation of documents in the Land defines the boundaries of land ownership in the area of interest. However we can see the problem with accuracy of cadastral maps here. Geodesy, Cartography and Cadastre defines in terms of guidance no. KO-1163/2004 [11] the quality

codes of cadastral maps. The code of quality on the map and its scale states to us the extreme variation in the calculation of the bill. Based on the quality code on the map, maps in cadastral surveyor can take a stand the positional on the accuracy of the maps its origin, and based on his he should be able to determine the property boundaries. Maps can be divided to analogue maps (paper maps), non-numeric vector maps and numeric vector maps [12].

Numeric Vector Maps with quality code 1 - were created by new mapping on the ground or reprocessing of the original digital maps in vector form. These are the most accurate cadastral maps. Its middle coordinate error is defined as a method of measuring 0.14 meters (until 2011) or 0.08 m (after 2011).

Numeric Vector Maps with quality code 2 - were created by readjusting of numeric maps, where position data of points were cartometricly done. The accuracy of this kind of maps cannot be definitely determined, it depends on the processing of the original documents.

Numeric Vector Maps with quality code 3 - they incurred by digitalization of the non-numeric maps and they were taken over to the land registry.

Numeric Vector Maps with quality code 4 - they incurred by digitalization of the non-numeric maps and they were not taken over to the land registry.

We have to take the positional accuracy of cadastral maps with quality codes 3, 4 and analogue maps from the context of their origin (mapping) and their accuracy can be taken up to 5 meters. From all of that above can be said that the accuracy of the boundaries of land ownership can be clearly defined only by the geodetic based on the diversity of the fund in the cadastral maps of Slovak Republic, this cannot be used to create a coordinating position construction copies of cadastral maps, but there must be a base within the boundaries of property surveyors. There are two products made surveyors in order to define the property boundaries for the area. This is a geometric plan (in case if there is a separation of land for the construction or reconstruction of the legal status of the original property) or a surveying drawing (in case if there is a demarcation of land registered in the land - register C-CN). Register E-KN is an inventory and description of the original property registered in the land register in 1964.Register C-KN inventory and description of existing real estate field.

Projecting

In grossing of demarcation drawing of the land border its followed by Decree of the Geodesy Cartography and Catastre no. 461/2009 Coll. [4] implementing the Act of the National No.162/1995 Coll, (Cadastral Act) [5], as amended and Directive for the construction of geometric plans and staking of land (S 74.20.73.43.00) [12] as amended. Demarcation of the geodetic work which indicates the position in the field of break points of the boundary. Documents on the demarcation of land provided by the competent land administration in the district to which cadastral territory belongs. The resulting elaborate of demarcation of the land includes:

- surveying outline (title block, diagram),
- technical report on the demarcation of land boundaries,
- a list of coordinates of break points demarcate boundaries
- a protocol on demarcation of the border lands.

Protocol on demarcation of the boundary is the most important legal document of the protocols. In this Protocol, all owners affected by the demarcation are agreeing with the

demarcation. Interested parties may express their disagreement, or they may indicate objections to demarcation. In case of disagreement, the parties may demand the exact positioning of the disputed boundaries in the land court. Set boundaries of land shall be permanently marked in all the break points of the boundaries of the land, if owners and other authorized people agree to the location of these points; otherwise they will be marked temporarily. Setting out drawing is certified by an authorized surveyor and cartographer and the relevant administration of assets will indicate on the sketch the receipt of copy of the general cadastral documentation.

The demarcation of the boundaries of the property setting out sketch and signed protocol and demarcation of the land border, ownership boundaries can be regarded as correct and there shouldn't occur any objections of owners of neighboring parcels because of ambiguities in the boundaries between plots.

Approval procedure

From the diction individual provisions of the Decree. Ministry of the Environment. 453/2000 Z.z., from which they are implementing certain provisions of the Building Act its clear, that the petitioner in planning and building civil proceedings under the Act shall submit layout drawings of the current status of the territory based on the cadastral maps with the marking of the subject of zoning and location showing the links to the surroundings [6]. This drawing is at the end of the land-use proceedings and after decision is given an integral attachment. In the process of building permit applicant presents the overall situation of building (the stop plan) normally in the scale of 1:200 up to 1:500 clearly showing the land boundaries and parcel numbers according to the Land, including land adjacent as well as other existing buildings, underground network and hardware devices; staking drawings or stopping plans clearly showing the geometric parameters of simple construction. In the process of flat inspection it can be attached to the application for a certificate of occupancy, in case of building to which geodetic operations are provided by authorized surveyors and cartographers, evidence of processing of final Elaborate security measurement and the display of objects of actual realization of construction (in case of the underground network hardware must be before covering, geometric plan in accordance with regulations of the Land). This document is not filled if there wasn't change in the outer limits of the ground plan of construction.

The Building Act [1] regulates the building stakeout in its six sections Surveying buildings in §75 and §75a. Before construction, changing structures, landscaping and mining operations on the surface the developer must ensure that the setting of building is done by personal entity or legal person authorized to carry out the geodetic and cartographic activities. Qualitative conditions and the final elaborate demarcation separates regulation and that's law no. 215/1995 Coll. [3] in § 5 and §6. Staking is done by staking drawings and within the compliance with zoning and building permits. The building office may, at the simple (§ 139b, para. 1 of the Building Act), minor (§ 139b, para. 6 and 7 of the Building Act) and temporary construction, changes to these buildings and the landscaping (§ 71 of the Building Act) minor demarcation to waive beneficiaries. In this case, the compliance of the building with the documentation in the building proceeding is upon the responsibility of the builder. In the case that the demarcation of the spatial position is removed by authorized person, responsibility for determining of the spatial position is upon person, who asked for their permission from the Building Authority. The evidence of precision in spatial position shall be submitted for final approval from the building office by developer. In case of buildings and landscaping, which

do not require substantial inspection, builder clips on the evidence of demarcation within the stored documents. [1]

The alleviation from the delimitation of simple, minor and temporary structures was introduced by nouvelle of Building Act from year 2000. The decision of the Building Authority about the demarcation of the building is always necessary to be under laid by the building permit [1].

Realization of buildings

The construction can be done solely on the basis of a valid building permit and on the building plot. The first of these conditions doesn't apply in the case of small structures exhaustively listed in § 55, para. 2 and § 139b, para. 6, 7 and 8 of the Building Act, that can be made on the basis of notification. The exception are as well as buildings defined in § 56 of the Building Act, which is sufficient to implement the zoning of the location of the building. The Base for the contractor of the building for its implementation is the decision (and its alternation) and documentation certified in the previous building proceeding. This documentation, along with the site diary must be continuously available on site with accordance of § 98, para. 2 Building Act in case of the inspection or the state building supervision. Building and construction law knows even buildings, which are not covered in admissions or reporting requirements, they are so-called maintenance work in accordance with § 139b, para. 15 Construction Law. From the nature of these buildings it's assumed that for their realization will not be required any geodesic surfaces [13].

Building plot according to § 43 h of the Building Act is that part of the territory which is designated by local plan or zoning plan or land use decision to fill the land and built the building. Vacant land which is part of agricultural land (Act no. 220/2004 Coll. On the protection of agricultural land) or the forest fund (Act no. 365/2005 Coll. on Forests) can be determined in local plan or zoning plan as building plot if are fulfilled conditions for its withdrawal from agricultural land or forest fund or if it's in urban zone [14].

Construction is defined in § 43 of the Building Act as building construction which was built by construction works of construction products which is rigidly connected to the ground or which offset requires modification of the substrate [13].

By association with the ground it's meant: [1]

- Connection to a solid foundation;
- Strengthening with the machinery parts or welding on a solid foundation in the ground or any other building;
- Firm piles or anchor ropes with anchor in the ground or to another building;
- Connection to the network hardware equipment of the area;
- Location of the underground.

Building Act before the 2000 amendment did not define this basic concept. This definition has been taken from the European Union law Council Directive no. 89/106/EEC which specifies the term "strong connection to the earth" and that's by the taxative delimitation of all possible technical ways [1].

In essence, we can conclude that the building is started by the ditch which means that the setting of the building is preparatory work, which is not the subject to authorization or

reporting. The form and method of delimitation, realization and the base for demarcation are described in detail in the "authorization procedure" in its second paragraph.

3   RESULTS AND DISCUSSION

The aim of the research in this study was to detect problems of permitting and construction services under construction right in comparison with the geodic law. Special attention was given geodetic basis in various stages of either design or licensing activities as well as the realization and use of the building. By expanding of fundamental principles of civil procedure it was pointed out the importance of role of surveying activities. The research was done by accumulating of sufficient documentation in a form of legal and technical literature of the issue by studying, analyzing, literary analysis and then by comparing the various provisions.

From the application practices carried out in the careers and also on the above findings, we can conclude that under current law it is not adequately defined and it is not firmly established for the builders that they can perform construction based on documentation, where as a base would be the layout of the borders done by authorized surveyor and copy of the elevation and planimetric plot orientation. The importance of such document should be also clearly stated in the implementing decrees of the Building Act. The advantage of this would be the elimination of neighborhood disputes regarding the determination of boundaries of land ownership which sometimes can extend the construction for extremely long time in some cases even for years. (we can mention case, which is well known and it has been going on for 18 years and it has been dealt by numerous administrative authorities, courts and the prosecution). The building permit process and then subsequent realization which could be used on purposed lands could result to law or zero percentage of neighborhood disputes which would mean application of civil law and other objections under § 137 of the Building Act. [1]

Despite the fact that the Building Authority in its decision-making activities is not only driven by input from the claimer of the proceedings, but within their own business they can get the information needed to proper assessment of this proposal, it can be said that at this stage of such investigation can be already considerably delayed. At the same time it will significantly affect the basic rules of good conduct under § 3 of Act no. 71/1967 Coll. on administrative proceedings. [8]

4   CONCLUSION

The increase of the land prices, concentration of buildings, building boom and last but not least the increased legal awareness of people caused higher standards for the application of technical regulations and the construction in its all stages and segments. This requirement was also reflected in the work which is done by Surveyors and Cartographers. These are in the range of their activities (Selected professional activities) have to carry out full professional and especially criminal liability for failure to comply with these obligations which are arising within building rules and regulations on geodesy and cartography. Although the legal and technical regulation of both fields were adjusted several times in the past and adapted to current social needs, especially social and market situation, we can concluded that there is still room to improvement.

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EVALUATION AND SELECTION OF BUILDING CONTRACTORS BY PUBLIC CLIENTS IN POLAND

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Abstract

Public orderers in Poland when evaluating and selecting contractors are obliged to obey the rules dictated by Polish law. In order to investigate the clients' practical methods of acquiring contractors, the authors analysed the Public Procurement Bulletin announcements about the results of construction orders awarded. The analysis revealed the growing popularity of two procedures: the open tender, in which the evaluation of contractors' qualifications is rather imprecise, and the sole source contract, which does not involve bidding. The number of bids in which the only criterion is the price is increasing. The solution to the problems involved here may be the introduction of one of the forms of contractor prequalification. The article also briefly discusses verification systems of contractors applying for a public contract which are used in EU countries.

Key words

Certification, contractor selection, open tender, public klient.

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1   INTRODUCTION

Public orderers are obliged to select a contractor in accordance with the rules imposed by Polish law. Since 2nd March 2004 there has been an Act on Public Procurement Law of 29th January, 2004 in force (Journal of Laws of 2010, No. 113, item. 759 and No. 161, item. 1078) [1]. The Law enumerates eight procedures of awarding contracts. They include:

- open tender
- restricted tender
- negotiations with announcement
- competitive dialogue
- no announcement negotiations
- sole source contract
- inquiry about the price
- electronic bidding.

The two final procedures are not used in construction contracts. The open and restricted tenders are the basic procedures, meaning that the orderer may employ them without providing the reasons for doing so. The choice of any other procedure is regulated by the above-mentioned Act.

According to the Act on Public Procurement Law, an order for construction works may be awarded exclusively to those contractors who comply with the particular conditions specified in the procedure. The conditions concern, in the first place, the technical capacity, as well as the financial and economic condition of the contractor. Their verification is performed individually for each public procurement procedure. A relevant regulation specifies the list of subjective and objective documents which the orderer can require from contractors. Contractors' qualifications are thus verified on the basis of the documents handed in at the initial stage of the bidding procedure or of negotiations, and how detailed the verification is depends on the value of the order and the orderer's decision.

From the point of view of the contractor, the above mentioned procedures of granting orders can be divided into two groups:

- single rank procedures (open tender, no announcement negotiations) in which the evaluation of the contractor's competence (according to the complies/not complies formula) and the choice of the bid is performed in a one-stage procedure;
- twofold rank procedures (restricted tender, negotiations with an announcement, competitive dialogue) in which the evaluation of the contractor is clearly separated from the bid's price.

The twofold rank procedures consist of two principal stages:

- stage I – involves contractor's prequalification during which a subjective evaluation of the contractor is performed;
- stage II – comprises the bidding of the invited contractors' offers during which evaluation of the previously shortlisted bids takes place.

Generally speaking, the twofold rank procedures allow the client to check more effectively the contractor's capacity to comply with the order, therefore they should lead to a situation where only these offers are submitted which are valid and which secure an appropriate compliance with the order. The contractor, on the other hand, bears lower costs of participation in the procedure since his/her chances to accomplish the order are decided on

during the subjective evaluation at the early stage of the procedure, before he/she carries the costs of bidding.

In many countries the procedure of prequalification is commonly used as a before-tendering contractor selection method. To build a model comprising all conditions of prequalification process is not an easy task. In contractor evaluation numerous criteria are taken into account. In many countries there were many researches carried out on the criteria used by construction owners [2, 3, 4]. In the literature there are several models which can be used in the process of construction work selection [5, 6, 7, 8, 9, 10]. Some authors have formed prequalification models using the Analytical Hierarchy Process (AHP). Such models were developed by Mahdi et al. [5]. On several occasions artificial neural networks were used to build a prequalification model. Such models were worked out by, among others, Lam et al. [6] and Elazouni [7]. A prequalification model, based on fuzzy sets, was presented by Li et al. [8] and Plebankiewicz [9]. A support vector machine model was discussed in [10].

Bearing in mind that Polish regulations say nothing about contractor prequalification, the twofold rank procedures, especially the basic restricted tender, should be more commonly used by public clients.

The criteria for the selection of offers can be either price or price and other criteria relating to the subject of the order. If the price is the only criterion, the orderer is obliged to choose the cheapest bid. In the latter case the orderer can choose the bid which additionally has advantages other than just its price. Here what is significant is not only specifying the criteria but also assigning appropriate weight to them.

The sole source contract is an exception since there is no choice involved. The orderer negotiates contract conditions with the contractor of his/her choice, so there are no evaluation criteria necessary.

The aim of the article is to analyse the methods of selecting contractors which public clients use and to highlight the possibility of a better way of evaluating contractor's competence.

2   EVALUATION AND SELECTION OF A CONTRACTOR – RESULTS OF THE ANALYSIS

In order to investigate the methods of acquiring contractors by public clients, announcements about construction contracts awarded published in the Public Procurement Bulletin [11] were studied. For a detailed analysis those published in December 2011 were chosen. The results were compared with analogous results of the studies performed in 2010 and 2006. The orderers were the public sector units who were classified according to the Public Procurement Law as public investors, and whose residence was the city of Cracow.

In the analysed period of 2011, 95 announcements were published. The average value of the contracts awarded reached 754 877 PLN. The lowest contract value was 7 334 PLN. The highest contract value was 9 002 330 PLN and concerned the contract for the reconstruction of a bridge along the DW 780 thoroughfare in the town of Chelmek.

Figure 1 presents the ordering procedures employed by orderers on the basis of the announcements of December 2011 concerning contracts awarded. Figure 2 depicts the procedures of awarding construction contracts in the years 2006, 2010 and 2011.

Over the analysed years the most common procedure was the open tender. The second most frequent procedure proved the sole source contract. In comparison to the analogous studies performed in 2006 [12], a significant increase in the use of this procedure could be observed: in 2006 it was a mere 1,5%, 24% in 2010 and 15% in 2011. The sole source contract was employed especially in supplementary orders. Yet taking into consideration the fact that it is the least competitive procedure, its increasing popularity in public procurement seems disturbing. The other procedures revealed by the analysis included the restricted tender and no announcement negotiations; however, their usage is not significant.
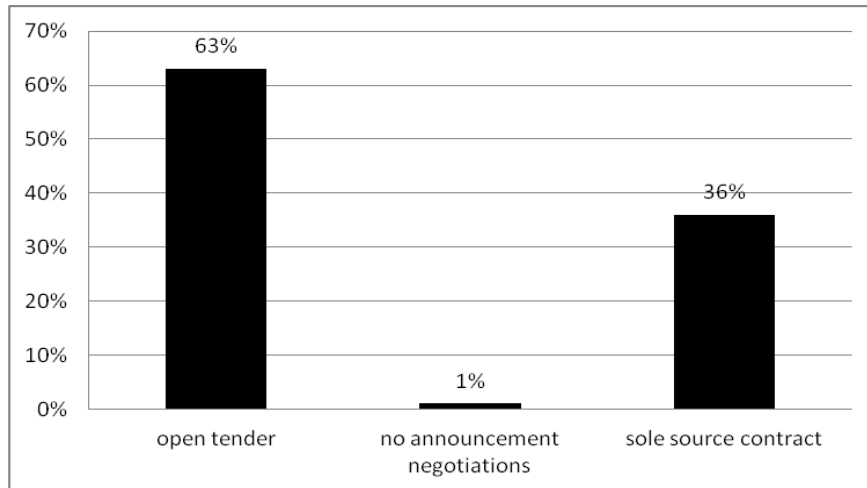
Fig. 1)   Procedures of awarding construction contracts – December 2011.

Source: authors' own materials
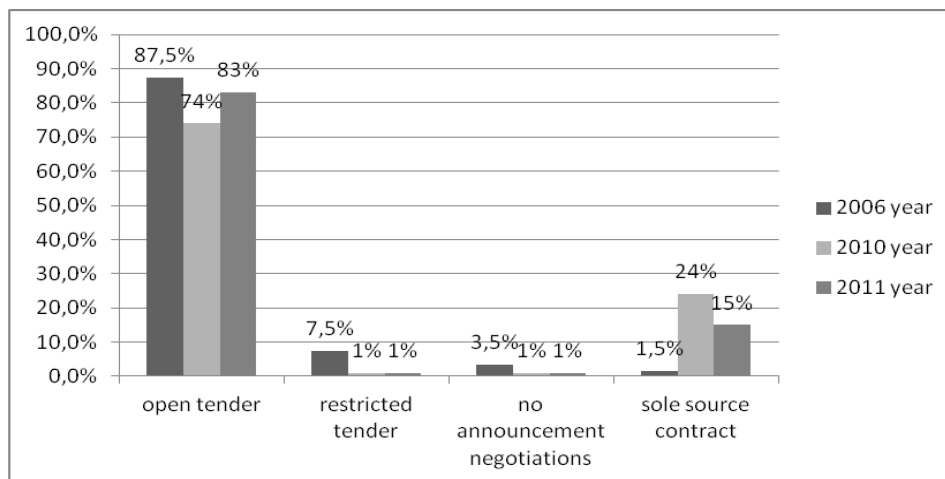
Fig. 2)   Procedures of awarding construction contracts – 2006, 2010, 2011.

Source: authors' own materials

The subsequent analyses concerned only these contracts which involved open tender and no announcement negotiations. They included 61 individual procedures.

For each procedure there were 6 offers on average. The smallest number of bids handed in was 1 and the largest – 27. In comparison to analogous studies done in 2006 one can notice an increase in competitiveness, namely, in 2006 there were 3 bids on average. The data published in the Reports of the Public Procurement Office's [13] confirm this tendency: in 2009 construction procedures attracted on average 4, and in 2008 – 3 bids.

The difference between the lowest and the highest bid price only in 29% of procedures did not exceed 10%. In 31% of the analysed procedures the difference was greater than 40%, which proves how varied the prices of the bids were (Figure 3). Figure 4 presents the results of analogous studies performed in 2010 and 2006.
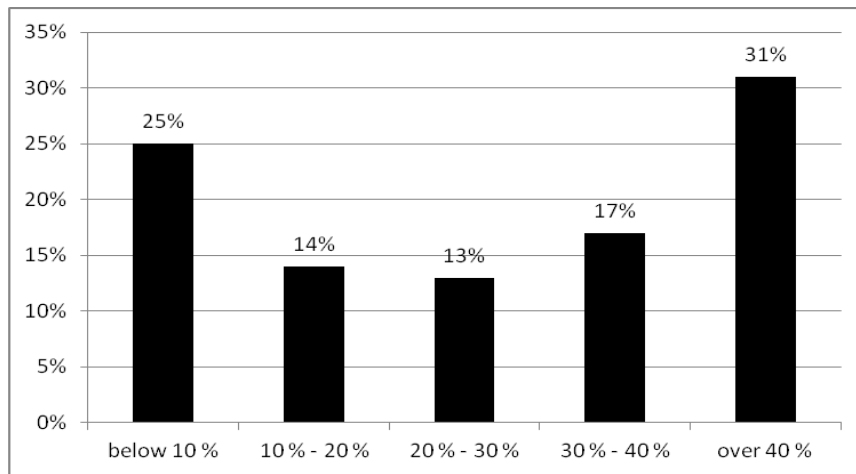
Fig. 3)   Differences between the lowest and the highest bid price – December 2011.

Source: authors' own materials
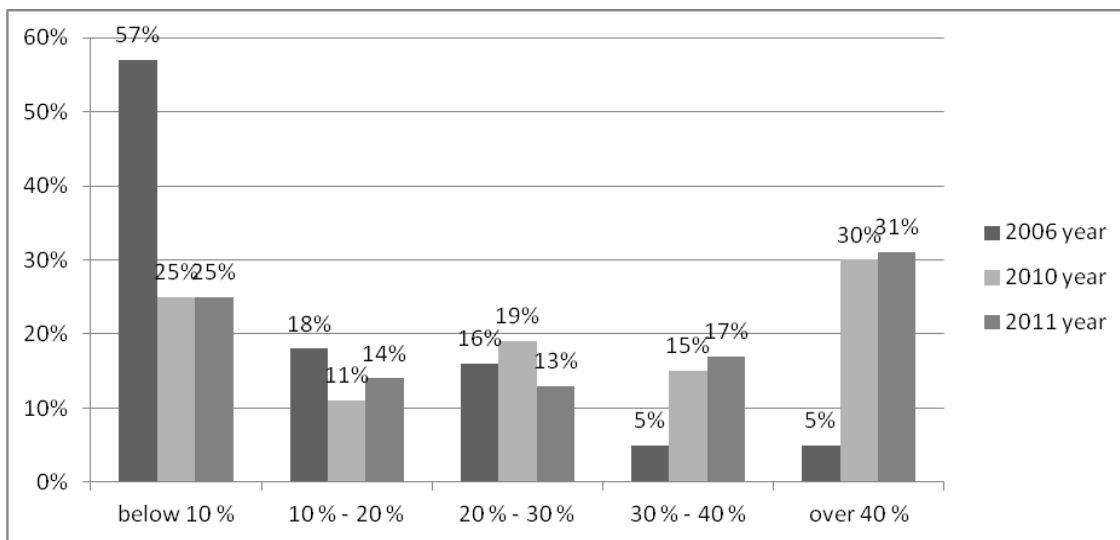
Fig. 4)   Differences between the lowest and the highest bid price – 2006, 2010, 2011.

Source: authors' own materials

Figure 4 illustrates an increasing variety of the prices declared by contractors. In 2006 as many as 57% of cases revealed that the difference between the lowest and the highest price was not greater than 10%, but in 2010 and 2011 it rose to 25%. At the same time, the number of procedures in which the difference exceeded 40% rose from 5% in 2006 to 30% and 31% in 2010 and 2011 respectively.

In all announcements the orderers provided a list of documents they required to prove that contractors possess the rights to perform activities encompassing the completion of the subject of the contract, that they have the necessary knowledge, experience and technical potential, that they have at their disposal people capable of perform the contract, and that their

economic and financial condition allows to perform the contract. If any of the required documents was missing, the contractor was disqualified. In many cases, though, the orderers limited the number of requirements, which was reflected in such records as: "The Orderer does not specify any particular requirements" or "The Orderer in this respect does not specify any requirements that the Contractor is obliged to demonstrate in a special way".

To select the most advantageous bid one criterion was most frequently used: the lowest price criterion. It was employed in 85% of procedures. In analogous studies of 2006 the criterion applied to 84,5% of procedures. The Reports of the Public Procurement Office's confirm the tendency to the increasing use of price as the sole criterion.

The only supplementary criterion which the orderers employed in the analysed procedures was guarantee. However, in these cases the weight of this criterion was insignificant, namely merely 5% or 10%. Therefore, despite the supplementary criterion, the bid with the lowest price was chosen.

3   CONTRACTOR SELECTION PROCEDURES USED IN THE EU

Article 52 of Directive 2004/18/WE of the European Parliament and of the Council of 31st March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts [14] says that Member countries may introduce official lists of approved contractors or certification by certification bodies established in public or private law. Many EU countries use this regulation to maintain official lists or registration systems. The aim of a registration, which may be understood as a formalized prequalification system, is to point in advance to those contractors who are capable of completing certain kinds of orders. The information required from contractors is verified at the registration stage and then it is periodically checked and updated. When a specific contract is to be awarded, there is no need to verify the contractor's competences anew, except for a situation when it is necessary to update the existing information. Thus the contractor does not have to supply all the documentation to prove his/her competences for each procedure, as it happens in Polish legal conditions, and the evaluation of the contractor is much more precise.

There are three models used in EU countries [15] to verify contractors applying for public contracts. They include a license system, certification system and information-about-contractor system.

The license system allows only those contractors who have been qualified for the official list may apply for awarding them a public contract. On a list qualification is performed by a relevant state authority or a body governed by the state. The license is issued when all the required evaluation criteria are complied with. Such systems are in operation in, for instance, Belgium, Spain, Italy and Portugal.

Certification systems investigate whether contractors comply with the standard minimal qualification conditions. If they do, they are awarded a "quality mark" or a certificate for a limited period of time. Certification can be performed by either state or private institutions appointed especially for this task. Systems of this kind function in, for example, France, Great Britain, Slovakia and Germany.

The final tenderer's competence verification model is the information-about-contractor system. Such systems do not define any standard minimal conditions of taking part in a procedure but only receive from contractors documents proving their compliance with the

conditions, analyse whether the documents are complete, up to date and, to some degree, reliable, and subsequently they store the documents in an electronic form. A database created in this way is available online. Such information is collected in, among others, Austria and Great Britain [15]. In some countries there exist mixed systems incorporating elements of the three systems described above.

Evidence for the fact that an appropriate evaluation of contractor competence is vital for EU countries is provided by a document of 2002 prepared jointly by the Technical Committee TC 330 of the European Committee for Standardization (CEN) and the Technical Committee TC 218 of the European Committee for Electrotechnical Standardization (CENELEC) "Qualification of construction enterprises" [16]. The document regulates the requirements for qualification bodies, the procedure of applying for qualification and the process of application, the qualification criteria and the rules for qualification of construction companies.

4   POSSIBILITIES OF CHANGES IN EVALUATION AND SELECTION OF THE CONTRACTOR

The need to design and implement a certification system became obvious in Poland already before her accessing the EU. As it was observed at that time, despite the fact that certification was optional, Polish companies without such type of documents could have problems with acting effectively on the European market. One of the attempts to introduce a certification of Polish contractors was undertaken in 1993 by the Wielkopolska Chamber of Construction (WIB) [17, 18]. It started to create a system proving the technical, organizational and economic reliability of the bidders offering delivery, works and services in construction. The procedures they proposed form a compromise between European regulations and the specific Polish conditions. On 1st January 1996 WIB began a certification system of job qualifications. At the same time, WIB proposed to launch a legislative procedure introducing to the Public Procurement Law in force at that time regulations facilitating the acquisition of orders for the certified companies. Unfortunately, these propositions were not included in the Public Procurement Law.

Suggestions concerning changes in the existing laws appeared also in the following years. While the Polish Parliament was debating the government bill on the act amending the act on Public Procurement Law, in 2007 the Polish Chamber of Commerce presented a proposition of a certification of entrepreneurs applying for a public contract [14]. The proposition was based on issuing certificates by certificating institutions acting according to the quality assurance procedures in accordance with the European norms of ISO series, widely used in Poland and the European Union. The President of the Public Procurement Office was to become the registering body in the certification system and, having asked the Council of Public Procurement for opinion, was to develop requirements specifying the scope of the certificating individual's investigation into whether a contractor complies with the tender participation conditions, as well as the minimal technical and personnel requirements which a company wishing to be included in the list of certificating individuals should fulfill. Accreditation of certificating individuals was to be done by the Polish Centre of Accreditation (PCA). The Certification Program was intended to take into account, among others, the regulations of the Directive 2004/18 of the Council of 29th January 2004, the Public Procurement Law and the regulations of the Prime Minister of 19th May 2006 on the types of documents the orderer may require from the contractor and the forms in which these documents may be handed in. The Certification Program was to be the basis for issuing certificates by all certifying individuals registered in the certification system led by the

President of the Public Procurement Office. This solution, just like the others concerning certification suggested earlier, was not included in the alteration of the Public Procurement Law.

In February 2011 building companies addressed the President of the Public Procurement Office declaring that they are ready to participate in works on amendments to the Public Procurement Law. They pointed to the need to introduce an obligation to employ selection criteria other than price in proceedings for awarding public contracts. They drew attention to the fact that using price as the only criterion leads to undesirable situations. For instance, it happens that fraudulent companies take part in bidding despite having no competent engineering and technical personnel, their own contracting, equipment or appropriate experience. Such companies often present documents whose reliability is disputable.

When there are no legal solutions, it is worth designing a procedure of a voluntary certification of construction companies. An Internet platform with a list of certified contractors, including essential information concerning certification would be especially helpful. A place on such a list would not only advertise the contractor's company but also increase investors' trust. In the case of contracts whose worth does not exceed the so-called EU thresholds and which do not demand any documentation proving the contractor's compliance with the tender participation requirements, the orderers could abandon it altogether.

5   CONCLUSION

Polish law which public borderers' must obey does not take into consideration any methods of prequalification or certification of building contractors. The evaluation of contractors' competences is verified at the initial stage of the bidding procedure or negotiation. The procedure most frequently used is open tender in which evaluation is rather superficial. Moreover, the fact that the increasing use of the sole source contract where no evaluation of contractors or offers applies is disturbing. The investigation into this problem revealed one more issue; namely, the number of procedures in which the sole criterion is the price is increasing. The analysed procedures employed one supplementary criterion – it was the guarantee, which appeared in 6% of the procedures weighing only 5% or 10%. As it is frequently mentioned, such a situation may lead to the choice of incompetent contractors and subsequent problems with an appropriate completion of the venture.

Introducing an official list of contractors or a contractor certification system would help to avoid this problem. EU Directives allow such solutions and many countries have already employed them. Using one of these systems increases the chances of finding a competent contractor and facilitates the bidding procedure by decreasing the number of documents the contractor needs to hand in as they may be replaced by, e.g. a single certificate.

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TIME-COST OPTIMIZATION OF A CONSTRUCTION PROJECT BY GENETIC ALGORITHM

Nataša Praščević[1], Živojin Praščević[2]

Abstract

One optimization procedure of a construction project related to the optimal time of execution of its acitivities and the project as a whole, is presented in this work. The direct costs, that are related to duration of activities separately, and indirect costs, that are related to duration of the whole project, are taken into account. The problem is formulated as a mathematical program with nonlinear objective function and linear constraints that depend on the mutual relationships between activities, their durations and costs. The binary and continuous parameter genetic algorithms are used to solve this problem using corresponding computer program that is written in MATLAB programming language by the authors. One example will be included in the paper to ilustrate proposed procedure with corresponding conclusions.

Key words

Cost optimization, genetic algorithms, project planning.

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1   INTRODUCTION

Project planning and control of its execution are ones of the most important duties of the project management team. They include project scheduling, determination and utilization of necessary resources and costs for realization of the project. As it known, a huge number of references about these issues exists in the literature. These problems are closely connected and interrelated, and must be all together considered in the project planning. In this procedure all relevant factors and conditions for the project execution should be taken into account. Duration of the project and its activities execution should be done in the contracted or earlier prescribed time with minimal costs and rational resource utilization. This problem is very complex and difficult for solving, especially for large projects with very big number of activities. In practice, necessary time, resources and costs for every activity are determined firstly, and then early and last times of the starts and finishes of the activities, critical path and histograms of resource and costs. In the early stage of development of methods for project planning and control, at the sixties years of the last century, the first methods for the cost optimization and resource leveling were proposed, based on application of mathematical programming. (Keely 1961, Fulkerson [1] 1961, and others). Fondahl 1961 proposed "precedence" network diagram for presentation of a project activities and their relationships and developed noncomputer method of heuristic optimization. This method has been improved by Trbojevic 1978. Later some authors have developed methods based on searching techniques and Monte Carlo simulations.

2   TIME-COST RELATIONSHIPS

Total costs of the project are usually divided on direct and indirect costs. Direct costs are assigned to the individual activities, while indirect costs are related to the whple project. In direct costs are included cost of labor, materials, energy, machinery and other resources, and they are calculated for every activity of the project separately. Indirect costs are common costs that construction company must spend for doing business. They include managerial and administrative expenses, preparation of the tender, costs of the site office, application of safety programs, job supervising etc. For every activity A_i ($i=1,2,….,n$) may be calculated *minimal* and *maximal time* of its execution. Minimal time TC_i is also called *crash time*, and represents the shortest time in which one activity could be executed in the given work conditions with applied technology and available resources. Maximal time TN_i is also called *normal time*, and represents the longest reasonable time in which one activity might be executed in the given work conditions an available resource. Harris [2] and some other authors have introduced *conventional time* TE_i which represents conventionally derived activity duration. Generally, relationship between these times is

$$TC_i \leq TE_i \leq TN_i \tag{1}$$

Direct costs decreases during time, while indirect cost increases during time. Time-cost relationship for direct cost may be linear (Fig. 1a), piece linear (Fig. 1b) and continuous curvilinear (Fig. 1c). The curvilinear and piece linear relationships are more realistic then linear ones, especially for the activities with long duration. In the linear programming model of a project cost optimization the linear and piece linear time/cost relationships are used for direct and indirect costs, and then problem solved using simplex algorithm of linear programming. In the the literature exist different proposals for the nonlinear time-cost relationships.
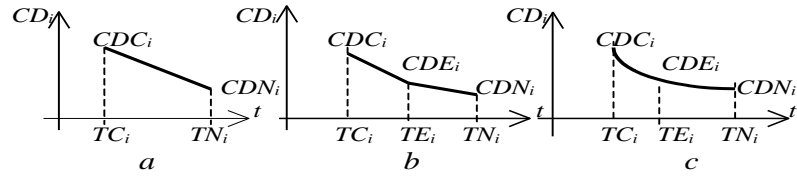
Fig. 1) Time-Cost relationships

According to characteristic times TCi, TEi and TNi for every activity Ai (i=1,2,…, n) are determined crash (TC), conventional (TE) and normal (TN) time of the whole project execution. For these times should calculate corresponding indirect costs: CIC for crash time, CIE for the conventional time and CIN for the normal time of the project execution, and further applying quadratic cost-time relationship, indirect costs for current time of the project execution t may be determined (Fig. 2). The total costs of the project execution at current time t is

$$CT(t) = CD(t) + CI(t) \qquad (2)$$

where $CD(t)$ are direct, and $CI(t)$ are indirect costs. Direct costs are

$$CD\,(t) = \sum_{i=1}^{n} CD_i(t_i), \quad i = 1,2,.....,n; \qquad (3)$$

where n is number of activities A_i, and t_i is period of time for the execution of an activity A_i.

Time t of the project realization depends of duration of activities and is equal to the time of last finish LF_n of the last activity A_n $t = LF_n$. Applying Lagrange's interpolation formula direct $CD_i(t)$ and indirect $CI(t)$ costs at time t, may be expressed by the next formuli:

$$CD_i(t_i) = L_C(t_i)CDC_i + L_E(t_i)CDE_i + L_N(t_i)CDN_i, \qquad (4)$$

where

$$L_C(t_i) = \frac{(t_i - TE_i)(t_i - TN_i)}{(TC_i - TE_i)(TC_i - TN_i)}; \quad L_E(t_i) = \frac{(t_i - TC_i)(t_i - TN_i)}{(TE_i - TC_i)(TE_i - TN_i)},$$

$$L_N(t_i) = \frac{(t_i - TC_i)(t_i - TE_i)}{(TN_i - TC_i)(TN_i - TE_i)}; \quad i = 1,2,...,n.$$

(5)

In a similar way, the indirect cost $CI(t)$ which increases during time as it shown in Fig.2, may be expressed in terms of indirect costs $CIC(TC)$, $CIE(TE)$ and $CIN(TN)$ that are calculated for the characteristic times of the project execution TC, TE and TN.
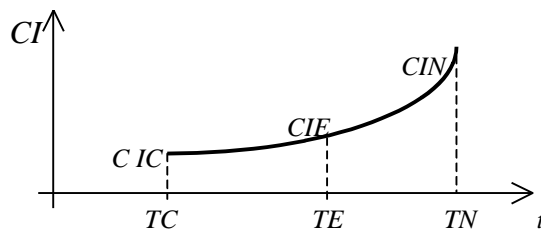
Fig. 2) Time - Indirect cost relationship

Excluding index i from the formuli (5) obtains corresponding expressions for calculation of the indirect costs $CI(t)$.

For current time t_i, which corresponds to execution of an activity A_i, are valid next inequalities

$$TC_i \leq t_i \leq TN_i, \quad i = 1,2,.....,n; \tag{6}$$

Time of the project execution t is also

$$TC \leq t \leq TN. \tag{7}$$

Between activities in the precedence network diagram exist n_r links, and for every link j (Fig. 3) which connects starting activity A_s and finishing activity A_f, for which is valid

$$LF_f - LF_s \geq t_s, \text{"finish to start" relationship} \tag{8}$$

$$LF_f - LF_s - t_s + S_j \geq t_f, \text{for "start to start"relationship with staring time lag } S_j \geq 0, \tag{9}$$

$$LF_f - LF_s \geq F_j \quad \text{for "finish to finish" relationship with finishing time lag } F_j \geq 0. \tag{10}$$

$$s = 1,2,.....n - 1; \quad f = 2,3,.......n; \quad j = 1,2,.....n_r.$$

LF_f and LF_s denote last finish of the activities A_s and A_f. For the first activity A_1 is $LF_1 = t_1$, and for the last activity A_n in the network diagram $LF_n = t$.

The objective function (2) and linear constraints (6) to (10) constitute mathematical program for the cost optimization. If cost function (2) is linear one, that is linear programming problem, and if this function is nonlinear this is then the nonlinear programming problem. In this case, for the objective function is used quadratic form according to expressions (3) to (5). Besides direct numerical methods for solving this problem, many authors proposed methods based on Monte Carlo simulation, genetic and evolutionary algorithms and similar methods.

3   GENETIC ALGORITHMS

Genetic algorithms (GAs) are search methods for optimization based on analogies with natural genetics recombination and natural selection. In GAs are employed numerical mechanisms which are similar to natural genetic operators in biological evolution. These algorithms were firstly developed 1975 by Holland [3] and Goldberg.[4]. In the genetic algorithm are firstly simulated n_{chr} *chromosomes* $(chrom)_k$ as an array (string) of a variable values, which are called *genes*. In this case of the cost optimization, genes are duration of activities $t_1, t_2,....., t_n,$ or

$$(chrom)_k = [t_{k1}, t_{k2},.......,t_{kn}], \quad k = 1,2,.......n_{chr} \tag{11}$$

The set or group of chromosomes, which interact together, is called *population*, and n_{chr} is the number of chromosomes in the population. The problem of optimization is to find minimum or maximum of the objective function z

$$z = \min(\max) f(t_1, t_2,.....,t_n) \tag{12}$$

with constraints $g_i(t_1, t_2,.....,t_n) \le 0, \qquad i = 1,2,.....,m.$ (13)

In GAs the objective function is called *fitness function,* and its optimal value is obtained iteratively in several steps. Depending on the presentation of parameters (genes) in the chromosomes, genetic algorithms may be with binary encoded parameters (BGAs) and with continuous (decimal) parameters (CGAs). In this work continuous GAs are used, where genes are expressed as real continuous numbers in the decimal system with floating point. The matrix of chromosome population $\mathbf{H}_p$ contains $(n_{ch} \times n)$ elements. The procedure of determination of the objective (fitness) function (12) subjected to constraints (13) using is performed in several steps: randomly generation of initial population of chromosomes, calculation of the fitnnes function for every chromosome, natural selection of chromosomes acording to their fitness functions, paring of chromosomes for reroduction using crossover operator, mutation of chromosomes, forming of new (better) generation of chromosomes for numerical iteration and calculation of new fitness functions. At the end performs test of convergence and termination of numerical process in which are determined values of unknown variables (genes) and corresponding objective (fitness) function. This process is detaily described in the literature (see for example book written by Haupt and Haupt [5]).

4   OPTIMIZATION OF COSTS

For optimization of the costs for a given project, with defined network diagram, using genetic algorithm with continuous values, next procedure is proposed in this work.

For every activity A_i calculate durations TC_i, TE_i and TN_i and corresponding direct costs CDC_i, CDE_i and CDN_i.

With these durations using, known CPM method, calculate separately times of project execution TC, TE and TN as the last finishes (LF_{nac}) of the last activity of the project. For these values calculate corresponding indirect costs $CI(TC)$, $CI(TE)$ and $CI(TN)$.

Chose number of chromosomes n_{chr} that represents number of possible solutions of the problem. Generate possible duration of activities t_i as integer random numbers

$$t_{ki} = \text{round}[TC_i + (TN_i - TC_i)rand]; \qquad i = 1,2,\ldots, n; \tag{14}$$

where *rand* denotes random number of the uniform distribution, and formulate matrix of initial population of chromosomes $\mathbf{H_0}$. One chromosome $(chrom)_k$ *represents* one set of possible duration of activities

$$(chrom)_k = [t_{k1}, t_{k2},......,t_{k,na}]; \qquad k = 1,2,......,n_{ch}. \tag{15}$$

In practice durations of activities are expressed, usually, as integer number of days, so in the Eq. (14) is used operator *round*. In some situations this values may be simulated as real numbers. These expressions satisfy the constraints of time conditions (7), calculated time t of the project execution, which corresponds to the generated durations t_i, satisfies constraint (8), so that is not necessary to use the objective function augmented by penalty or other functions.

Formulate objective function for total cost $CT(t)$ by formula (2), taking into account expresions (3) to (6). In step 2 of GA calculate values of fitness function CT_k for every chromosome $(chrom)_k$. Sort chromosomes in increasing array according to the fitness function. Haupt and Haupt [5] have proposed to use big number of initial chromosomes and

discard the half of these chromosomes which have an unsuitable fitness function. In the next iterations number of chromosomes is one half of the initial number. For the natural selection (step 3) discard one half of the chromosomes with worse fitness functions (died chromosomes), and keep other chromosomes (survived chromosomes) for reproduction. Using crossover operator, as it described in ref. [4], obtain new population of chromosomes. Choose rate of mutation and choose number of mutations and mutate chromosomes. For randomly selected chromosome $(chrom)_i$ and activity A_j exchange existing duration of this activity t_{ij} with new randomly determined duration t_{ij} that satisfies constraint conditions (7). Here is proposed another method of mutation. Randomly select two chromosomes $(chrom)_i$ and $(chrom)_k$ and activity A_j and then mutually exchange duration t_{ij} with t_{kj} and vice versa. For new generation of chromosomes determine corresponding durations t of the project by CPM method, calculate direct, indirect costs and objective function $CT(t)$. Sort chromosomes in increasing array and find minimal value of objective function. Compare this minimal value with minimal values in n_{conv} previous iterations. If condition of convergence is not satisfied go to step 3. If this condition is satisfied take obtained vales of the activity durations and costs as optimal solutions. According to this procedure, the authors of this work has developed a computer program in MATLAB programming system.

5   EXAMPLE

To illustrate proposed procedure of the cost optimization next example is presented for one small project taken from the book (Trbojević [6]). Precedence network diagram with 14 activities is presented on Fig. 3. Characteristic durations and direct costs are given in Table 1. For these input data are calculated crush TC, conventional TE and normal TN times of the project execution using CPM method and then corresponding indirect costs CIC, CIE and CIN. These values are: TC=23 days, TE=37days, TN=59 days: CIC=15 000 €, CIE=24 500 € and CIN=56 500 €. Number of chromosomes in ininitial population (first iteration) is n_{ich} = 160, in subsequent populations n_{chr} = 80. Number of variables (genes) in the chromosomes n_g = 14, rate of mutation μ = 10%. Number of iterations for the convergence control is n_{conv} = 6. Applying mentioned computer program after 10 iterations are obtained results that corresponds to the optimal solution.
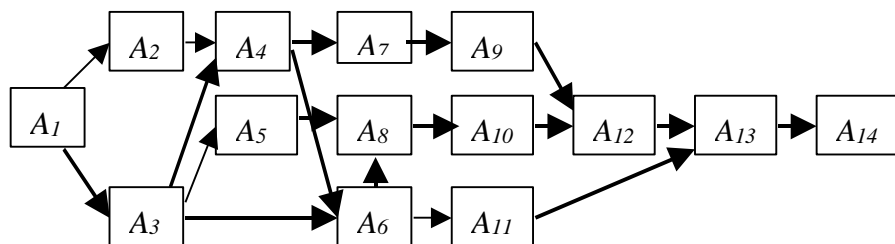
Fig. 3)   Precednce network **diagram**

Tab. 1) Duration and direct costs of activities

A_i	TC_i day	TE_i day	TN_i day	CDC_i €	CDE_i €	CDN_i €	A_i	TC_i day	TE_i day	TN_i day	CDC_i €	CDE_i €	CDN_i €
A1	4	6	9	18.000	12.500	8.000	A8	2	4	7	14.000	8.000	4.000
A2	2	3	5	10.000	6.400	4.500	A9	4	6	9	18.200	13.000	8.700
A3	2	4	6	12.600	8.600	5.000	A10	2	3	5	11.000	6.400	4.000
A4	7	10	15	30.000	20.000	14.000	A11	3	5	7	14.300	10.000	6.100
A5	4	6	9	18.000	12.000	8.000	A12	2	4	7	14.400	8.400	4.800
A6	1	2	3	6.200	4.000	2.000	A13	1	2	4	4.500	2.000	1.500
A7	2	3	5	10.800	6.800	4.000	A14	1	2	3	2.000	1.000	500

Optimal duration of the project is T_{opt} = 47 days. Optimal costs of the project are: direct costs CD_{opt} = 83 047 €, indirect costs CI_{opt} = 36 459 € and total cost CT_{opt} =119 506 €.

6 CONCLUSION

Proposed method of costs optimization has more advantages over other methods of clasical mathematical programming. Using GAs is possible to solve the problem with more realistic time-cost nonlinear functions. Other numerical solutions of nonlinear programs with this function are very difficult or even impossible. To obtain a good solution by Gas, it is necessary to take large number of chromosomes in the chromosome population, which requires a lot of time for the computer processing, especially for the network with large number of activities. Because of that, recommends to take a large number of chromosomes in the initial population, and than according to principle of natural selection, for the subsequent iterations take one half of that initial number of chromosomes. This procedure is recommended in the first phase of a project planning with smaller number of activities.

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MODELLING POST-TENSIONED SLABS USING KINEMATIC CONNECTIONS

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Abstract

The development of big shopping centres and underground garages in cities has forced the application of monostrand unbounded prestressed cables for plates of 16 m span.

Modeling of PT slabs of different thickness is described, using the finite element method. The issue of compatibility of the node connections on middle plane steps, and modeling of PT loads, was resolved by kinematical relationships of eccentric nodes. This procedure is preferable in comparison to some simplified methods. The described method has been incorporated in the original software program called GRAFeM and applied in numerous buildings in Croatia. This paper describes modelling issues using two real life examples.

Key words

Arena Centar, eccentric, kinematic connections, PT slabs, publics garage, stress compatibility.

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1   INTRODUCTION

Constant thickness PT slabs resting on columns are rational only to about 10 meters span. Increasing spans impose the concept of slabs strengthened by beams, drop caps/panels or shallow wide beams in one or both directions. Due to the change in position of neutral axis in the areas of these strengthening elements, pairs of membrane forces occur in finite element axis, for vertical loads. One searches for the model that will give stresses as realistic as possible, and the stiffness of such strengthened slab. Together with a theory, this paper will address two types of strengthened slabs using the examples of complex large span structures built last year in Croatia.

2   DESCRIPTION OF THE PROCEDURE

Placing both elements in a same plane (Fig.1) underestimates the stiffness of the system, because of this assumption neutral axis (for vertical load) remains mutual in the middle of the beam and slab elements [1]. Similar situation occurs if instead beam element put an element of slab with greater thickness. The consequence of this situation is unrealistic stress condition of upper and lower edge of the slab without compatibility of longitudinal stresses in the jump zone. In reality, neutral axis changing the height along the girders and transverse in section, and in rib zone is located around the lower edge of slab. Of course in such a model prestressing load (including the P·e effect) can not give real deflection and stresses.
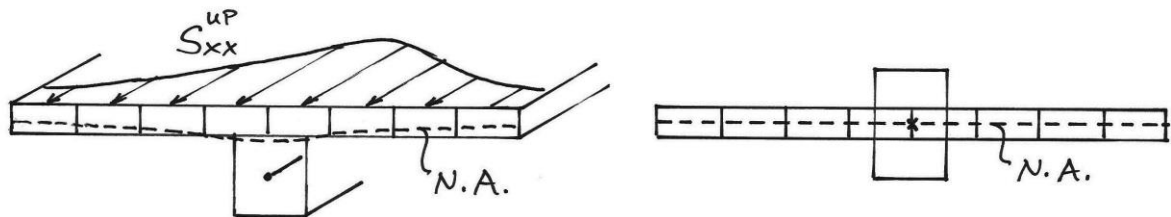
Fig. 1)   Out of plane and in-plane modelling

Some programs offer a solution with fictitious increasing of beam height and intervention in the matrix of elasticity of such element. In this way may be obtained closes state to realistic stiffness, but still there remains the problem of unrealistic boundary stresses. In author's solution in GRAFeM computer program, this issue solved by eccentric position of the nodes of slabs or beam elements and their kinematical connections (master-slave options). Kinematic condensation of master and slave nodes [2], [3], [4], [5] establishes their equal translational displacement while the relationship of the rotation displacement is linear (Fig 2). This is true if consider assumption of vertical incompressibility of slab, small displacements and sections are flat after deformations. While in this case number of equations in the global stiffness matrix was not increased. The problem of prestress load modeling is also resolved by kinematical connected eccentric nodes in which, by default layout form, passing stick elements negligible stiffness with default prestressing force. Therefore, the prestressing load is resolved at a general level by the geometry of fictitious sticks at discrete points, without analytical formulas to determine the components of pressure and deflective force which are a function of tendons curvature. When summed, the components of prestress forces are in equilibrium.

$$u_x^S = u_x^M - \varphi_y^M(z^S - z^M)$$

$$u_y^S = u_y^M - \varphi_x^M(z^S - z^M)$$

$$u_z^S = u_z^M + \varphi_y^M(x^S - x^M) + \varphi_x^M(y^S - y^M)$$

$$\varphi_x^S = \varphi_x^M, \qquad \varphi_y^S = \varphi_y^M, \qquad \varphi_z^S = \varphi_z^M = 0$$
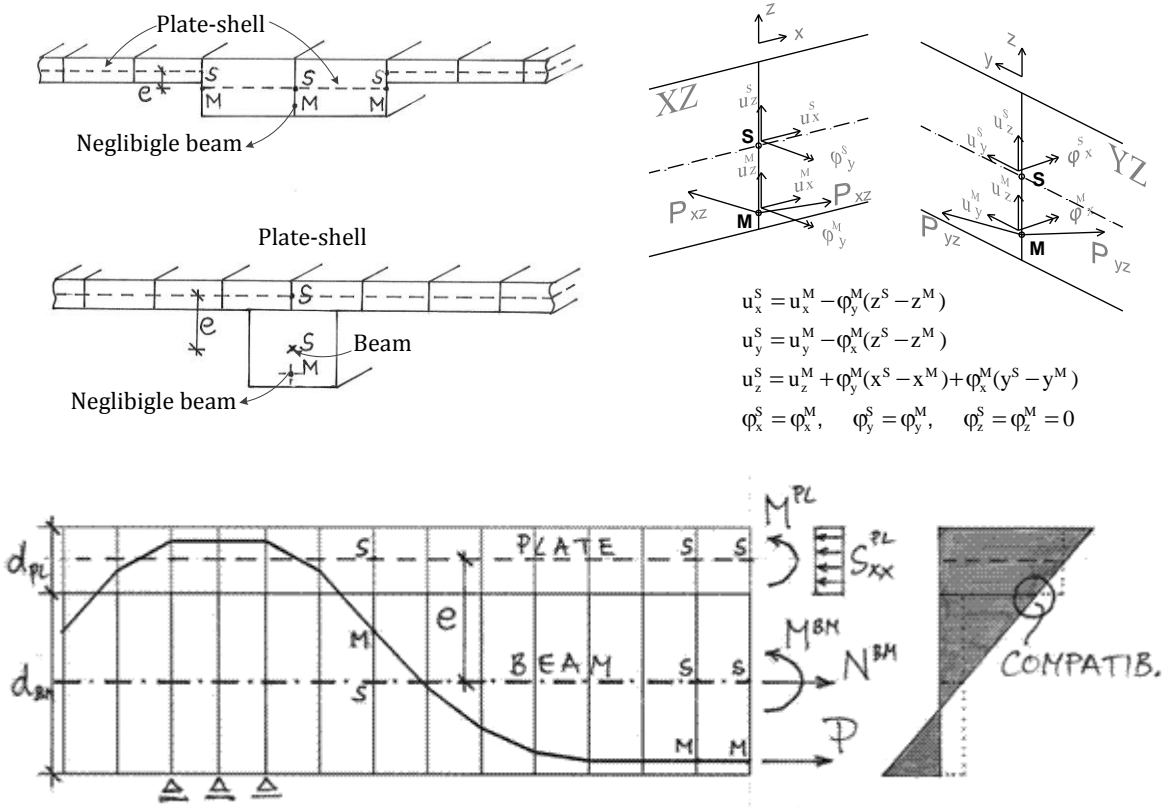
Fig. 2)   Kinematic relationships between 'master' and 'slave' nodes

3   DESCRIPTION OF MODELLING USING TWO REAL LIFE EXAMPLES

The Arena Center Zagreb covers an area of 175,000 m^2 (Fig 3) which accommodates more than 220 different shops, a bowling alley and a multiplex cinema with IMAX theatre. There are 3500 parking spaces, most of which are housed in one underground level. IN an eight month period we executed 72.000 m² of post-tensioned slabs using BBR VT unbonded system.
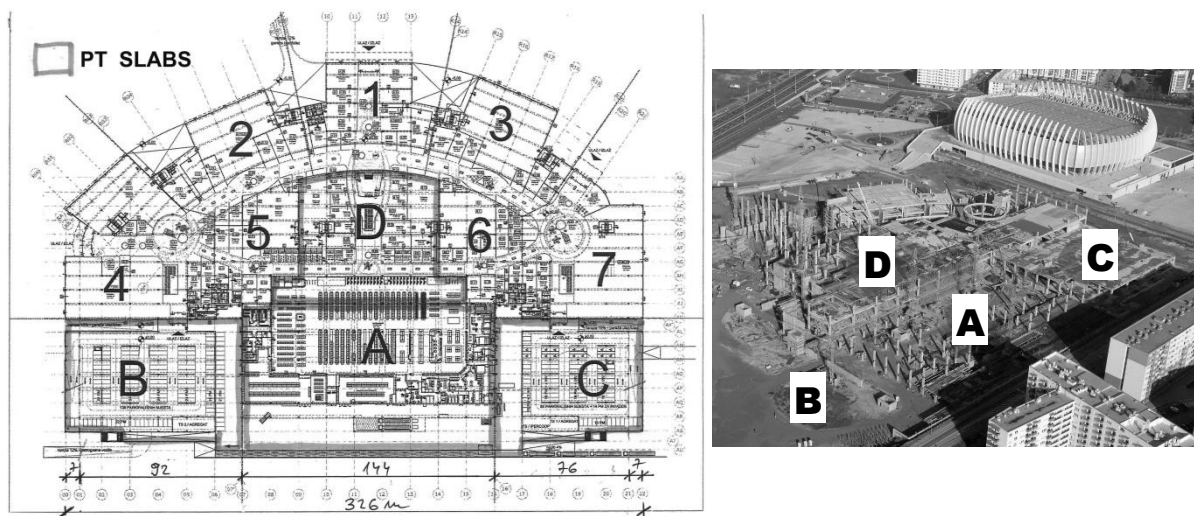
Fig. 3)   General and aerial view of Arena Centar complex

The PT slabs were designed using the shallow beam concept [6], [7]. The general column layout is 8 by 16 m (Fig 4), except where supermarket design specifications demanded a 16 m by 16 m grid. The beam depth is 50 cm to 55 cm, with slab thicknesses of 20 to 25 cm, depending of the load requirement. The exceptions was 16 m by 16 m area with 60 cm beam and 30 cm slab (Fig 7). Tendons are banded only in beams in the 16 m direction – elsewhere they are distributed.
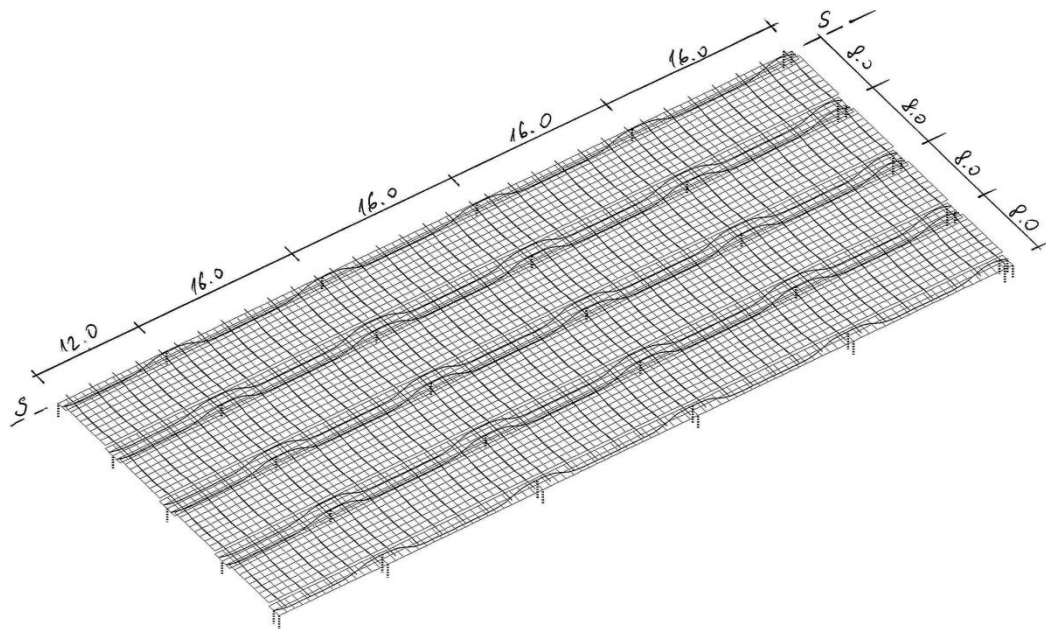
Fig. 4)   Model of PT slab (8 by 16 m), dil. B

Slender PT slabs enabled optimal space utilization and we managed to insert one additional slab in parking sections B and C (Fig 5). In section A, an 8 m wide PT strip was left in the middle to be cast and stressed at the end – because of its 144 m length. Section D is geometrically more complex, with cantilevering galleries and pedestrian bridges. Complex area was 6.9 long cantilever used as a restaurant terrace (Fig 6). The slab incorporating the cantilever was produced on a 16 by 6 meter grid, so that the cantilever was longer than the adjacent slab span. This demanding structure was resolved with a shallow beam grid 60 cm deep and a 20 cm slab. The second complex area was curved beam spanning 18.5 m and a 9.5 by 4.5 m light well opening. We found unbonded post-tensioning technology to be great advantage – due to speed and practicality of execution, larger casting segments and faster working progress even in the winter mounts.

Underground public garage Capuchin Square Varazdin is a ground plan dimensions 77 x 79 m with 443 parking spaces (Fig. 8). Total area of two underground levels are 12 370 m^2. Above the upper slab will be a 1.0 m height layer of the future town square. Base slab and the walls are the classic RC structures, while the ceilings are PT slabs. Central slab is loaded only by traffic operation has beam sizes 50/60 cm between which the slab which is 16 cm thick (Fig 9). The upper slab beam carries much greater loads (DL + layers + traffic = 8.5 +18.0 +7.0 kN/m²) and has dimensions 75/90 cm with slab 24 cm thick. The groundwater level is slightly above the middle slab level, and the construction in dry environment ensures the continuous pumping of water by wells, this solution showed better than originally planned injection of subsoil.

Fig. 5)   Free tendon layout and inserted parking slab between two levels (8 by 16 m),
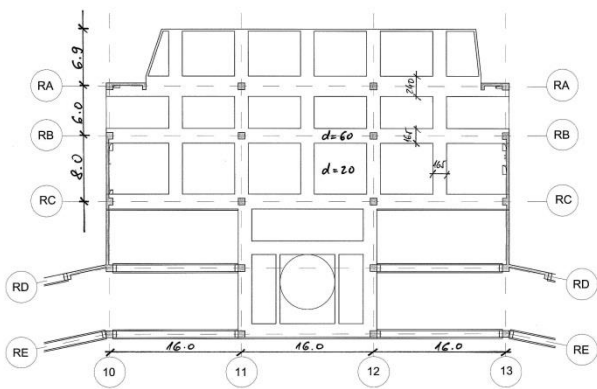
Fig. 6)   6.9 long cantilever used as a restaurant terrace

Fig. 7)   Concreting of 16 by 16 m grid market, complex area zone of 18.5 m curved beam

With the approaching of work completion estimation of stiffness was done by measuring the beam deflection to confirm the accuracy level of theoretical results compared to actual. First measure of the beams lower edge deflection is analyzed on the load increment of 60 cm thick gravel mound. Fig. 10 shows good matching with analyzed theoretical model. Deflections of the first field would be higher if at the time of measurement gravel mound was not finished 3-4 meters before the edge of the wall.
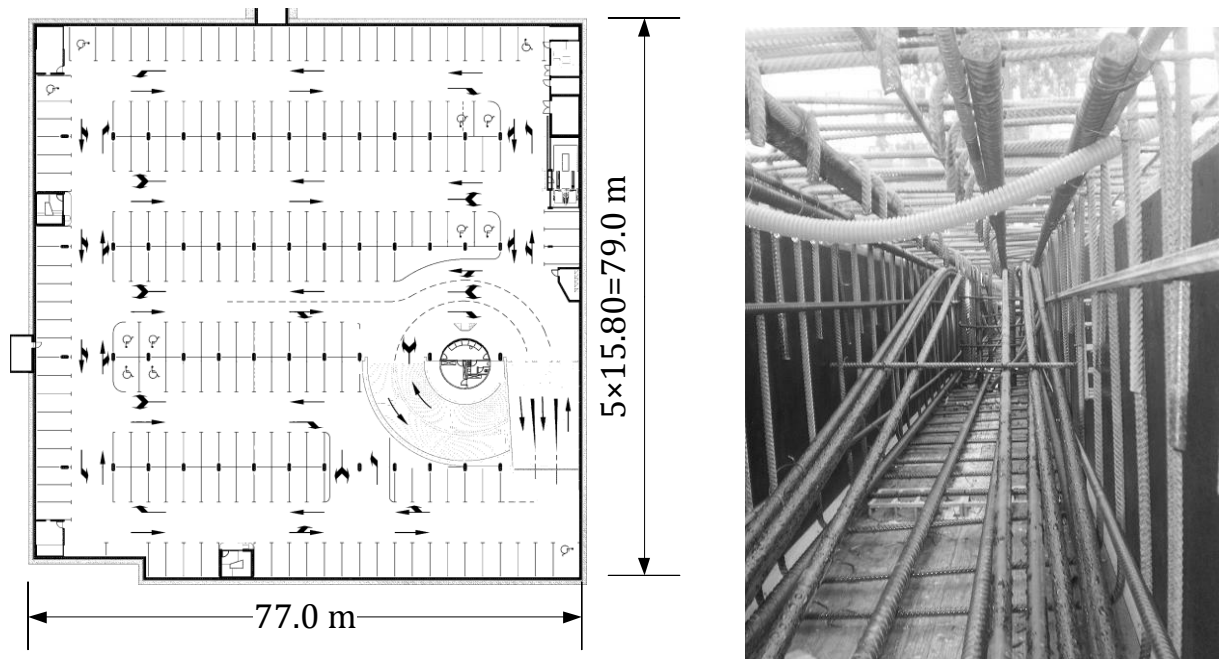
Fig. 8) Plan of garage ground-floor, spans 15,8 x 5.0 m and beam tendon layout

Fig. 9) Constructing and arranging of underground garage interior
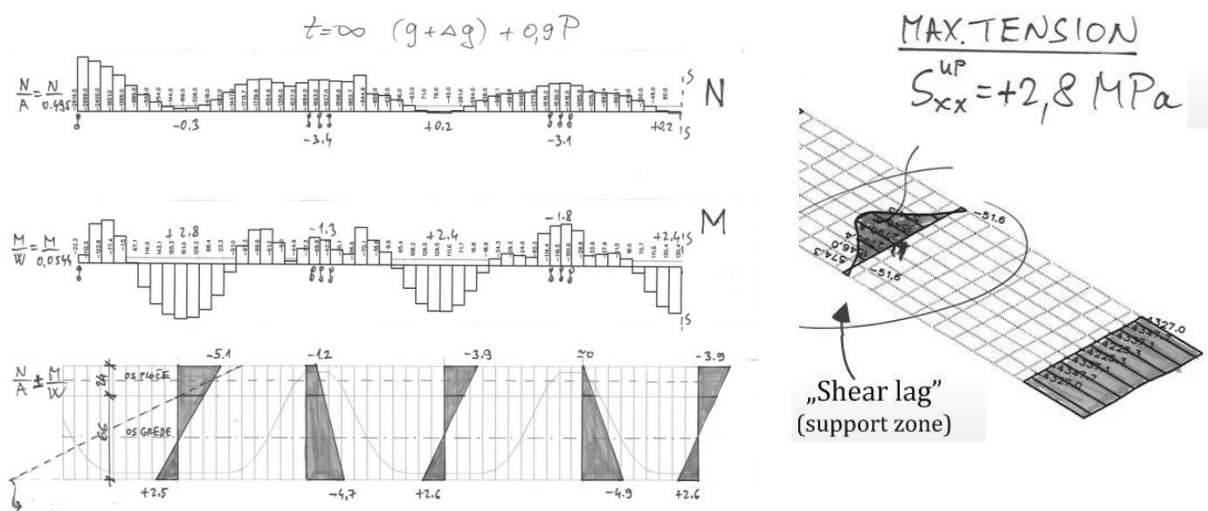
Fig. 10) Stress state of the beam (load $g+g_1+0.9P$) and the slab ($g+g_1+q+0.9P$)

The second measurement was done for the moving load, it was two trucks with a load of gravel so that each weighs 30 tons . Position is selected so that beam line is maximally loaded in the first field, and then in another field (Fig. 11). Again, this results of measurements confirmed the correctness of the calculation model [8]. After unloading, residual deflections were 10-15% (this is the zone that close to the limits of accuracy of the measuring geodetic device).
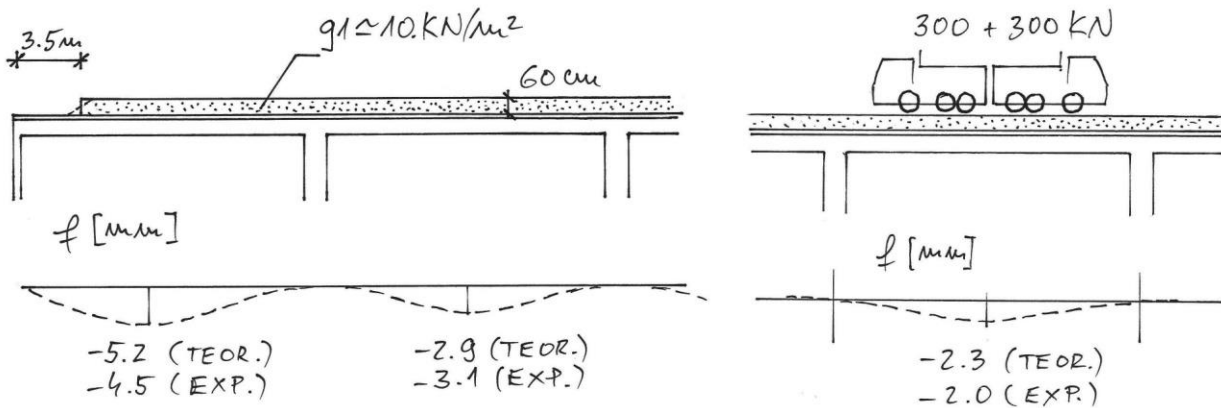
Fig. 11) The deflection test of the beam with mound gravel thick 60 cm and traffic test load

4 CONCLUSION

Over the past 7 years PT slab ceiling structure have undergone extensive application in Croatia. Along with practical examples, the authors developed their own method of modeling prestress loads for slabs of different thickness and in combination with beams. In terms of rationality PT Panel, experience proved to be a very good, as were testing of vertical vibration and displacement which showed good agreement with the theoretical model.

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CONSTRUCTION MARKET INTEGRATION AND ORGANIZATIONAL READINESS – CASE OF CEE REGION

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Abstract

In contrast to international construction literature which deals with issues on providing services or products in alien environment, this paper investigates exogenous market changes and respective consequences. Authors recognize the phenomenon in case of market integration process. That trend affects Central and Eastern Europe (CEE) region heavily in case of politically induced market integration. Market integration induces substantial change in business logic which is presented through an empirical case study. Authors comment on integration process in light of organizational readiness for larger, mature market as well as mechanisms that companies use to adapt to new business environment. This paper aims to help understand the influence of institutional change over industry through the strategy lens. Empirical evidence shows the importance of industry change readiness where reactive instead of proactive strategy endangers long-term sustainability of local firms.

Key words

Civil engineering, construction, change, integration, market, market barrier.

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1   INTRODUCTION

Aim of this research is to investigate industry change in times of intensive market transformation with corresponding scenarios and consequences for the local construction industry. This phenomenon is traced in case of local market integration within a larger market. This is common in the CEE region when transition economies integrate within a common EU market. In that situation, companies are going through the process similar to internationalization yet we identify that the major difference is that such process is exogenous in nature. The companies actually find themselves in reactive state to possible market loss due to new market barriers and obsoletion of customary market logic.

In construction industry, institutional logic can be set in two categories i.e. industry wide logic and project logic. Friedland and Alford [in 10] interpret institutional logics as sets of principles that prescribe how to interpret organizational reality, what constitutes appropriate behavior, and how to succeed or provide guidelines on how to interpret and function in social situation. Industry wide logic includes institutional framework for local industry like regulative framework, syndicates, policymaking and dialogue with public authorities, degree of vertical integration. Project logic on the other hand is related to a specific project that includes procurement logic used, licenses for specialist suppliers, quality assurance standards and degree of integration among contractors and suppliers. Real project setting is based on interdependences of the two. Although out of scope of this paper, Hakannson and Jahe [1] find that Thompson's classification of serial, pooled and reciprocal interdependencies need to be broadened to provide understanding of possible combinations of the logics, i.e. hybrids so firms can precisely adopt logic categories to actually compete in desired niche or a market segment. Due to nature of business lifecycle in AEC industry, project logic is initially embedded in procurement logic or the project's "rules of the game". These are drafted by the project owner at the sole beginning of the project and resemble a market entry barrier.

In relation to the above, authors take interest in changes induced by market integration (case study of EU procurements standards influencing local industry) and scenarios and consequences of such change with spotlight of this paper being on organizational response to change in public procurement logic. Market integration is achieved through change in both, industry wide and project related rules. And while, changes in regulation usually take industry sustainability into account, the project related rules defined by the project owner are not bounded to the industry. In this paper we analyze scenario when procurement logic change is imposed that doesn't take into account local industry capabilities. The lenses we use are the one of local general contractor and consider strategic consequence for the phenomenon.

This paper presents an initial research report related to this research problem. The methodology of choice is case study which describes the scenario of market barrier induced by project owner. Upon presented case study, authors comment implications of change in procurement logic and it's implication for long term sustainability of local industry.

2   THEOREY REVIEW

For investigation of construction industry and related industry exogenous changes induced by integration of economic structures we base ourselves on that institutions and institutional change affect the performance of economies, both in short and long term period [2]. Institutional frameworks are either success or failure in terms of consequences for industry

performance i.e. *some economies develop institutions that produce growth and development, while others develop institutions that produce stagnation.*

In case of Croatian market integration within the EU market, institutional change influences transaction and production costs which in consequence changes industrial landscape. *Institutional change creates incentives structure in an economy, and organizations will be created to take advantage of the opportunities provided within a given institutional framework.* The question remains if such changes allow sustainability for local industry or in this case local construction firms. Institutions can act detrimentally to the industry and degrade its attractiveness. Peng [3] deals with strategic choices that organizations make during the time of fundamental institutional transitions that is *sweeping numerous emerging economies*. While Peng concentrates on industries switching from planned to market based systems, such as liberalization and privatization the point of inflection should be considered also in case of market integration. Such changes, also called institutional transactions, are likely to introduce, at least in the short run, considerable chaos and increased costs, as new institutions emerge to replace old ones [Oliver, 1992 - in 3]. In this case we apply the same structure saying that uncertainty, chaos and increased costs induced by a new market barrier will remain until new strategies are tested to replace old ones.

Construction industry, a project oriented industry, remains distinctively fragmented in structure due to uniqueness of the projects and consequentially required organizational flexibility [4, 5]. This fragmentation allows industry to exercise numerous organizational variants and application of various business models. The industry is depicted as loosely coupled system [6] that relies heavily of professional communities and industry related regulative framework. North [2] argues that the internally induced change depends upon kinds of skills and knowledge fostered by the structure of an economy as they *shape the direction of change and gradually alters the institutional framework*. Both, professional communities and regulative framework are developed within market and are heavily embedded within institutional setting. Such intensive interaction can cause cluster like surroundings. *The development of a cluster is strongly influenced by local social networks, which often forms a unique development trajectory through a process of self-reinforcing, and path-dependence occurs not only in technical choices, but also in intra-firm management practices as well as inter-firm relationships and interaction between firm and the supporting institutions. Embeddedness is a double-edged sword. Strong embeddedness sometimes hampers the upgrading of development path and results in lock-in. Collective inertia resulting from strategic interdependence, fixed mental model in shared value and norms, and limited information spillovers and cooperation within local bounders, will bound the development on a lower path concludes that it is vital for clusters in developing countries to upgrade their development path in order to gain sustainable competitiveness, and how to deal with lock-in is an important issue* [7].

The factors that shape institutional setting of specific market are social, economical and political in nature. Therefore recognition and adoption of institutional prerequisites is required for organizational development [8]. Further, institutional development is result of parallel processes of innovation and synchronization in the system done by multiple agents therefore it is an environment complex in nature. Organizations constantly adapt to institutional complexity through choice of business model and processes architecture. Each of these arrangements incurs cost [9] that tends to fall as time passes [3]. Organizational complexity is taken into account in planning resources and risk management, therefore has a major influence on overall costs in the industry. In case of radical change and limited organizational response industry attractiveness can be substantially reduced, leaving the market potential i.e.

sales capacity to foreign firms. Institutional framework that is only partially reformed, and therefore inconsistent and unstable allows foreign firms, which when entering transition countries have to adapt strategies which reduce exposure to highly alien markets, to compete aggressively using economy of scale and organizational maturity as advantage while local companies try to deal with intense institutional complexity during integration period.

Scott [8] argues that institutional complexity is in continual flux, but organizations experience it differently and to different degrees. An organization's position within a field shapes the form and intensity of complexity that it will experience *such that, "central" highly embedded organizations may be more exposed to the tension of multiple institutional logics as compared to less embedded "peripheral" organizations. Characteristics of the organization its structure, ownership, governance, and identity can make it particularly sensitive to certain logics and less so to others. Given that organizations experience complexity to varying degrees, it follows that they will differ in how they might respond. More than often, firms face incompatible prescriptions derived from multiple institutional logics.* These responses are important because they can have major implications for organization's access to critical resources. Survival of an organization may even be at stake. Strategic responses to highly incompatible prescriptions or demands are risky in nature and need to be tested. For theoretical purposes, therefore, it matters that we understand the relationship between institutional complexity and organizational responses. As Pache and Santos [10] recently observed that while *institutional scholars acknowledge that organizations are often exposed to multiple and sometimes conflicting institutional demands, existing research makes no systematic predictions about the way organizations respond to such conflict.*

3 RESEARCH DESIGN

All markets go through an intensive transformative phase from time to time, weather caused by political, technological or economical instances. *Central and Eastern Europe (CEE) has provided unique societal quasi-experiments, which represent opportunities to test the applicability of existing theories in international business and management studies and to develop new ones* [11]. Meyer and Peng imply on a plethora of scenarios that contribute understanding of key issues like institutional strategies of local incumbents and entry and growth strategies of entrepreneurs. For analyzing change in institutional logic in case of market integration and respective consequences authors enclose case study as empirical evidence.

3.1 Case study

A case study of procurement for onsite erection services is analyzed. The service procured is construction of Bioscience incubation and maturity centre – Biocenter. The goal for the project owner is to establish a center of excellence in biosciences with state of the art infrastructure allowing high quality research as well as technology diffusion through spin-off companies. Estimated value of the services procured is 10 million EUR and construction site is located within the city of Zagreb. The facility procured is a laboratory building that will house complex laboratory components with modularity in mind which is important for future sustainability of the facility.

In the tender selection process, a two step approach is used in which at first all bids are analyzed if they are respond appropriately to all tender requirements. In the second run, technical and financial attractiveness of the offers is analyzed.

The case study described is obviously related to Croatian market that is in integration phase into common EU market. Procurement logic applied is drafted by EU commission and for EU market and no changes are done to adapt it for use in Croatia. Authors collected empirical data through engagement in the procurement process i.e. analyzing offers, discussing the tender with the project owner (public authority) and tender commission acting on behalf of project owner and the bidders itself.

4   FINDINGS

Project owner, a local public authority introduces EU procurement standards due to EU Commission funding of a project. Due to uniqueness of the project, EU procurement preconditions set an entry barrier which is hardly achievable by the local companies. The main reason is market size and recession period that affects the market for 3-4 years. Precisely, a standard precondition implied that reference should be provided for same type of projects with value 20-30% higher than the estimated worth of procurement. In relation to the above, local companies mainly could not adhere to the imposed condition due to relative novelty of this type of project within a market and poor business activity as a result of recession. Additionally, tender documents condition specific skills of the bidder's personnel that are not found within the local market.

Twelve bids are received in the tender procedure out of which single standing local companies were seldom able to prove required technical capabilities in terms of references. On the other hand, bids with appropriate references were mostly the joint ventures in which local firms were supposed to do majority or all the works while the foreign partner provided only references required by the tender. This represents strategic response of local firms that have recognized anticipated the incoming EU standards and acted upon. In additional informal inquiry, authors have learned that foreign partners were troubled with understanding the local legislative framework when ad-hoc joint venture contracts were drafted. This correlates with Karhunen's findings related in field of foreign direct investments [12] where local knowledge is praised to be crucial for business and where agglomeration (in this case joint-venture) with local firm is a must. Joint-venture with a local firm *provides an effective channel for the sharing of sensitive and tacit knowledge about local business environments*. Further on, some of the bidders have expected that impressive references would be taken into account in the selection process.

At last, the tender is won by a local firm, one among the largest and most mature within a local market. The chosen firm was arguably able to provide for all requirements of the tender. It should also be noted that project owner made decision upon the attractiveness of end price which proved to be way more competitive than the other bids. The question that remains outside the focus of this paper is whether the cost difference incurred due to the cost of joint venture (institutional complexity) or predatorily bidding of the local firm. This case shows that introduction of rather incremental standard can be detrimental for the whole industry. In relations to externally induced market barrier we recognize the logic of market niche, a market segment bound by the market barrier. In terms of systems theory market niche can act as a market itself, which means it depends upon investment cycle, surrounding markets and industries. This proves to be important in this case, where tender was open during the time of heavy recession and when companies, in state of fragile stability, were imposed with additional institutional complexity. For the described case study, project procurement has caused changes in dominant business logic in the transition market. Therefore authors introduce a framework for monitoring dynamics based upon Karhunen approach [12] in her

investigation of post-socialist institutional transition in Russia and its implications for business strategies in the St. Petersburg hotel industry. *The development of the institutional context is divided into three periods: socialist, early transition and late transition. The strategies of foreign hotel enterprises characteristic of each period are investigated with respect to entry/ownership mode, product, supply and human resource management strategies, and sales and marketing. In this ex-post investigation Karhunen finds that degree of integration varied between the three time periods examined, foreign and local enterprises differ especially during the period of rapid institutional change.* Karhunen research strategy remains the trajectory of the follow-up to this paper.

In that quest authors consider following three stage framework in which companies develop their business:

- Pre integration stage
- Integration stage and
- Integrated stage

Originally, national markets have been developed internally with local/domestic firms embedded in institutional setting. At time, surrounding markets have been mutually influencing each other to the extent of innovation transfer (regulative, technological or other) which have been cautiously tested with the local industry. This set of circumstances we call **Pre-integration stage**. In light of loosely coupled system view of construction market that would mean that market output depends dominantly upon local investment capacity and locally developed institutional framework. The level of interaction between the industry and the institutional environment is facilitated through mature mechanisms (Chamber of commerce, Industry initiatives etc.). In that term, the product or service are procured in line with the industry capabilities. This allows industry to develop through inherent learning by selectively importing innovative solutions and by applying these in domestic setting. Competitiveness is sourced through organizational learning and organizational sensing is focused towards the single market.

In term of current trends of globalization, European Union enlargement or other politically or economically run processes, markets often tend to get more and more integrated. When alien market logic penetrates integrating market a transition takes place with new competitive logic appearing along with new players who seek growth and market share. This stage we call **Integration stage.** In this stage, institutional environment deliberately (e.g. political will) introduces alien business logic, a logic developed within another market that differs in maturity, size and institutional background. This stage should not be mistaken for market logic change being induced within the industry/local market. Construction, an industry influenced substantially by public framework and investments (in role of regulator or project owner) industrial community mechanisms have a role to take after the industry sustainability in relation to the regulative framework development or investment cycle/capacity. In this stage, organizational rents are „no man's land" (still ambiguous and relatively inexpensive) and market niche is formed in which companies seek market share by application of different business strategies. The market niche, in early formation stage becomes a testing field followed by high operational risks and costly failures in case wrong strategy is used. Recognizing the problem of understanding the creation of market niche in project business in relation to organizational architecture and competences is paper's contribution to organizational theory and project management knowledge base as well as starting point for this research follow-up.

Integrated market is a stage in which dominant market business logic completely over takes local business logic. The local procurement and value chain consider overall market and competitive advantage rests on universal factors rather than locally drafted. The anticipative horizon for firm is substantially broadened and firms search strategies within new/larger market in which they can utilize their capabilities. Term local market remains obsolete.

5   CONCLUSION

Construction market can be perceived as loosely coupled network bounded by common institutional base. Yet, markets are affected by the environment, and one of those trends is market integration within a larger, more mature market. Such integration causes externally induced changes and in some case introduction of rather incremental standard can be detrimental for the whole industry. This paper has showed an empirical example of such market behavior. In this scenario, local industry carves out strategic responses in search of appropriate organizational rent. Most common strategy is joint venture while other strategies (e.g. buyout, diversification or partnering) have not been recognized in the empirical study yet should be further investigated for construction projects. Aligning procurement standards with the new market should be anticipated on time by local industrial community and proactively steered by the local industry community as the consequences are long-lasting. Otherwise, foreign firms can easily overcome operative difficulties in the alien environment as subordinate local firm perform mostly all works and foreign joint venture partner remains passive until enough operating experience is amassed and at the same time takes the margin for the cause of providing prerequisite references. This paper sets a research path that leads towards investigation of strategy choices in relation to organizational competences and organizational sustainability in integrating market.

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POSSIBILITIES AND OPPORTUNITIES OF CONSTRUCTION WASTE DISPOSAL WITH PROJECT LIFE-CYCLE

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Abstract

Construction and demolition waste makes up 1/4 of the total waste generated in the European Union. A construction and demolition waste is generated during whole life cycle of construction - design phase, realization phase, occupation phase and demolition phase. On the other hand, the sustainable design of construction in the design phase presents possibility for the significantly reduce a volume of generated construction waste. In this phase, we are able to identify and quantify the volume and sort of construction waste. Based on this information, it is possible to determine the possibilities of construction waste disposal and the costs for its treatment.

This paper deals with proposal of option to reduce construction and demolition waste in the design phase as well as in the realization phase of constructions. The first part of paper describes possibilities of modern methods of construction use in the design phase of construction. The second part of paper describes the opportunities of cost reduction for the construction ways disposal. There is describes a proposal of cost prediction for construction waste disposal through the most widely used of economic software Cenkros Plus.

Key words

Construction, construction and demolition waste (CDW), life cycle of construction, modern methods of construction (MMC), prediction, waste disposal.

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1   INTRODUCTION

The increasing environmental impact from the construction becomes a serious problem that can cause significant damage, not only to ecosystems but also to the health and wellbeing of field workers and nearby residents [1] of building sites. Therefore, is necessary to approach and continuous effort within the industry in order to achieve the objectives sustainable construction and reducing of the environmental impacts of construction in each life cycle phase (construction project, realization, occupation, management and demolition) of buildings.

The authors Shen and Zhang [2] suggest that the impacts of construction activities on the environment include:

- competition for land with other activities such as agriculture;
- adverse effect on the plots of land which are developed, and their environment, such as changing their ecological characteristics;
- consumption of substantial volumes of physical resources, both renewable and non-renewable;
- production of substantial volumes of wastes;
- consumption of large amounts of energy during the processing of materials, the construction process and in the use of constructed items;
- contribution to air pollution from the dust and substances, including some toxic ones, which are released during the production and transportation of materials, and in some construction operations; and
- disruption of the lives of the people living in the vicinity of the project through traffic diversions, noise pollution and others.

The submitted paper deals with the production of construction waste in each life cycle phase, the possibilities of waste reduction and prediction of waste volume and costs for waste disposal already in design and realization phases.

2   ORIGIN OF CONSTRUCTION WASTE

Construction and demolition waste (CDW) present a quarter of total originated waste amount in the European Union (EU). It follows that the treatment and another reusing of CDW is a current subject within waste management not only in Slovakia, but also in other states of EU.

The development in the field of construction production has a significant impact to production of waste derived from the construction industry. Slovak construction industry achieves the best results and valuation in the years 2006 – 2008. On the other hand, we were the witnesses a significant decrease of total construction production in 2009 influenced the global financial crisis.

The trend in the field of waste generation in the analysed period (2000 – 2009) has a decreasing tendency. Construction and demolition waste presents 17,54% of the total waste production in Slovakia. Important is the fact, that the proportion of hazardous waste within CDW presents 1 – 5%. Thus, CDW is suitable for reusing or recycling and does not require a special treatment and disposal. Table 1 illustrates a CDW generation and management in Slovakia in the context of state in the selected countries. As we can see, many EU countries have difference approaches of construction and demolition waste recycling in the present.

Currently, the issue of waste disposal is interesting for the government and public. The recovery – reusing and recycling is supported by government in accordance the environmental policy of EU. Although, almost all financial funds are directed to supporting of the separation, reusing and recycling of waste, the landfilling presents a main form of waste disposal (see tab. 1).

Tab. 1)   Construction and demolition waste generation and management in the selected countries [3 and authors]

Country	Construction and demolition waste [mil. t]	% Recycled / Reused	% Landfilled
Slovakia (2008)	4,4	49	31
Germany	59	85	15
UK	30	51	40
France	24	15	85
Italy	20	9	91
Spain	13	<5	>95
Netherlands	11	90	10
Belgium	7	87	13
Austria	5	76	15
Portugal	3	<5	>95
Denmark	3	81	13
Greece	2	<5	>95
Sweden	2	21	79
Finland	1	45	55
Ireland	1	<5	>95
Luxembourg	0	na	na
USA (1996)	136	30	70

2.1   Origin of construction waste in the context of life cycle of construction

The construction does not present only benefit for environment and society, but has a quantity of negative influences, which are include in the life cycle of construction. The life cycle of construction consists of four basic phases:

1) design of construction,
2) realization of construction,
3) occupation of construction,
4) demolition of construction (fig. 1).

One of the elements negatively affected the environment is a waste origin. On the other hand, we are able to influence the amount and type of construction waste in each phases of this life cycle.

One way of reducing construction waste in first phase – *design of construction* – presents the sustainable design of construction through Building Information Modelling (BIM). This suitable tool allows a modelling by multi-disciplinary superimposed information within one model. It creates an opportunity for sustainability measures to be incorporated early in the design process [4]. BIM can support the construction design in the following aspects of sustainable design what present the way of reduce to negative environmental impacts as well:
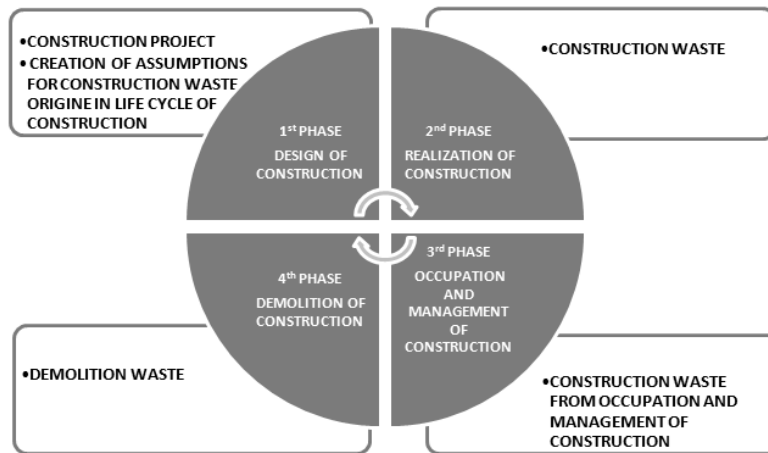
Fig. 1)   Life cycle of construction

- building orientation (to select the best building orientation that results in minimum energy costs),
- building massing (to analyze building form and optimize the building envelope),
- energy modelling (to reduce energy needs and analyze renewable energy options such as solar energy),
- water harvesting (to reduce water needs in a building),
- sustainable materials (to reduce material needs, to use recycled materials and to use of new modern methods of construction),
- site and logistics management (to reduce waste and carbon footprints).

As we can see, one of BIM use benefit presents a reduction of origin construction waste by sustainable materials.

The realization phase of construction is characterized by waste generation from basic, auxiliary, preparatory and transport building processes. In this phase, the construction waste came from the realization of construction processes in the building site. The suitable way to waste reduction on site is the separating, disposal eventually the recycling of construction waste. The emphasis is on:

- increasing of disposal waste measure, mainly by waste reusing and in-site waste recycling,
- increasing of recycling measure with the aim to make the products with higher added value,
- minimization of total costs, which are needed on unit of recycled material production.

The last phase of life cycle presents the demolition of construction. The quality and composition of construction and demolition waste can largely influence the realization of demolition of building structure, construction or their parts. The choice of the optimal demolition technology always depends on the particular case. Consideration has to be given to the impact of the demolition on particular reconstructed structure, nearby objects and the surroundings [5]. The demolition works can be carried about in particular (Fig. 2):

- manually,
- mechanized,
- explosive.

Another possible approach to the demolition and destruction of structures of their parts is the deconstruction of buildings elements – deconstruction of structures (dismantle of structure)

a) **manually demolition of structures**   b) **demolitions through the mechanization**

c) demolition of construction by explosion   **d) deconstruction of structures**

Fig. 2)   Demolition and deconstruction of building structures

The most acceptable way of demolition work in term of the subsequent use of construction and demolition waste is the deconstruction of construction into the individual construction elements. On the other hand, we can say, that this method is used in our conditions at least, although the obtained components do not require major adaptations.

In terms of the waste management would be appropriate to apply the hand demolition, or mechanized demolition combined with manual, where already at the building site would be provide a primary pre-sorting of particular construction waste. On the other hand, this demolition is difficult and ultimately ineffective. The least suitable demolition method is the demolition through the explosive, what presents a complete destruction of structures parts that cannot be subsequently sorted to types of waste.

The part of each demolition technology has to be a careful separation of individual waste components in terms of its future use. It is clearly shown that the separation of particular types of waste already on the building site is far more effective and cheaper than in the recycling centre. During the demolition works is easier to separate the mineral debris from other materials, especially wood, plastics, tar cardboard, metals,…

During the demolition works is important to emphasize:

- separation of contaminated materials from uncontaminated,
- separation of foreign materials from mineral debris intended to recycling. It is closely connected with the creation of sorting logistics system already on the building site, where is providing the separation of these parts in the several separate containers. There are particular the metals, organic materials – the used wood, some minerals materials – stones, mortar, and other mainly hazardous waste – paints, asbestos.
- separation of inert mineral debris at least the basic types – brick rubble, concrete rubble, bitumen debris and excavated soil [6].

3 REDUCIGN OF CONSTRUCTION WASTE THROUGH MODERN METHODS OD CONSTRUCTION

Modern methods of construction (MMC) primarily involves the manufacture of constructions in factories, with potential benefits such as faster construction, fewer housing defects, reductions in energy use and waste [7] and offer significant potential to minimise construction waste [8]. Modern methods of construction have been shown to achieve a dramatic reduction in the waste generated on site. MMC is reasonably common in building construction but are less often used in civil engineering. For civil engineering projects, MMC can include use to pre-cast (pre-fabricated) components or preassembled structure. Prefabrication can be defined as a manufacturing process, generally taking place at a specialized facility, in which various materials are joined to form a component part of a final installation [9].

a)   b)
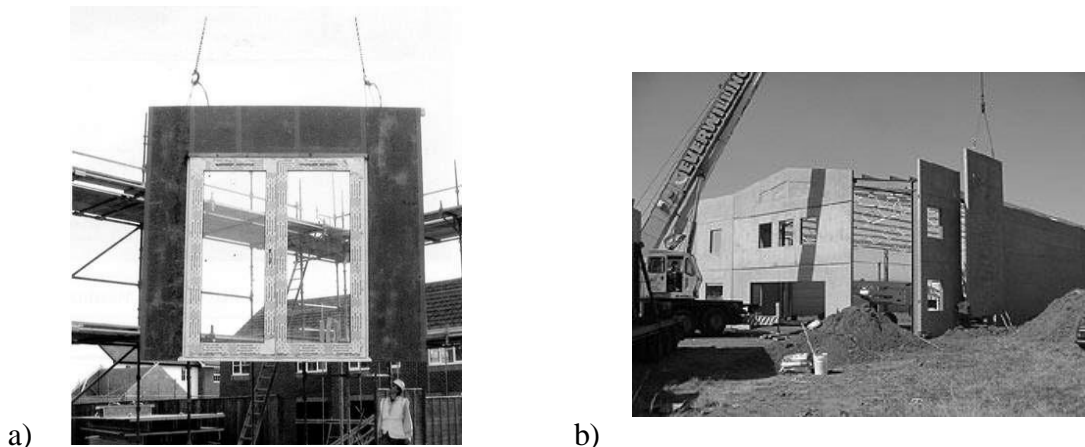
Fig. 3)   Modern method of construction through a) – timber frames, b) – pre-cast structural panels

We can suggest the main advantages of MMC are economic, environmental and social [7, 10]. on environmental benefits of MMC which can be divided into these three main groups:

- Energy savings – houses built using MMC typically require less energy to heat because of increased levels of insulation fitted in the walls and roof, and also less air leakage from the building.
- Construction waste – the amount of waste produced using MMC is likely to be reduced because factory materials can be ordered to exact specifications, and there is a lower risk of on-site spoilage, e.g. through wet weather. However, there is little research confirming such reductions.

- Transport – building constructions in factories may reduce the total number of trips to a building site. This is of growing importance as more house building takes place on 'brownfield' sites in inner-city areas. Little detailed analysis has been conducted to date on transport benefits, but they are likely to vary considerably depending on the distance between the building site and the factory.

Modern methods of construction have been shown to achieve a dramatic reduction in the waste generated on site. MMC is reasonably common in building construction but is less often used in civil engineering.

During the processing of this paper have been analysed 4 selected studies intended in reduction of CDW by MMC and the comparison of conventional and modern method of construction [3, 8, 11, 12].

The authors Tam et al. [11] processed a research, in order to explore wastage reduction by adopting prefabrication, 30 construction projects adopting conventional construction and modern construction (prefabrication) have been measured. Although wastage levels may vary from different types or natures of project, the wastage levels are believed to be affected by the adoption of conventional in situ and modern (prefabrication) construction methods. A structured survey was conducted to measure the wastage level for the different construction methods. The average wastage level (in per cent) for various construction trades, namely, concreting, rebar fixing, bricklaying, drywall, plastering, screeding and tiling, are measured for the two groups of projects adopting conventional in situ trades and modern method (prefabrication) in Table 2.

Tab. 2)   Wastage level between conventional and modern method of construction [11]

Trades	Average wastage level in (%)		Percentage of waste reduction
	Conventional method of constr.	Modern method of construction	
	CMC	MMC	(%)
Concreting	20	2	90
Rebar fixing	25	2	92
Bricklaying	15	NA	NA
Drywall	NA	5	NA
Plastering	23	0	100
Screeding	25	NA	NA
Tiling	27	7	74

According to Table 2, the average wastage level of the conventional construction method is much higher than that of prefabrication in the trades of concreting, rebar fixing, plastering and tiling. This result shows that the wastage levels vary with different trades when prefabricated (modern) building components are adopted; therefore, the standardized designs of building can reduce the wastage levels effectively. The private housing projects generate the highest wastage levels especially for steel reinforcement, which may reflect from the non-standardized building structures resulting in different sizes of formwork, reinforcement, and brick/block work that generate higher levels of material wastage.

4   OPPORTUNITIES OF COST REDUCTION FOR THE CONSTRUCTION WASTE DISPOSAL

Within the processing of sustainable design of construction for realization phase of construction is realized a quantity takeoff of needed construction works and material. The

takeoff presents the species, volume and cost evaluation of construction works and material in the budget. Based on this input, the constructor is able to specify the type, price and quantity of needed building material and construction works [14]. One way of reducing costs for waste disposal presents a prediction of these costs already in the phase of design and realization of construction.

4.1 Prediction of construction waste volume

Currently, we are able to determine the volume of construction waste before the realization phase only by a not accurate estimate based on previous experience of constructor. In most cases, construction waste is simply estimated globally in the projects. The one of the main hindrances of accurate determination of waste volume is the lack of data, studies and the poor documentation of waste generation. The author Llatas [13] processed the model for the determination of volume waste. This model develops three basic tools: the first tool is a systematic structure of the construction process in order to identify in the project the building/sitework elements and their materials and components. The second implementation is a waste classification system in order to obtain the list of waste coded according to the European Waste List (EWL). And finally it provides some analytical expressions that estimate the amount of packaging waste, remains and soil. Seven types of waste can be distinguished, - excavated earth, concrete, masonry blocks, mortar, aggregate, plaster mixture and tiles. Based on the information from quantity takeoff, the waste volume was determine through five factors (FP – packaging waste factor, FR – remains factor, FS – soil factor, FC – conversion factor a FI – increased volume factor). Consequently, these wastes are classified according the EWL.

The submitted paper provides a system utility tool for prediction of volume waste in the phase of quantity takeoff processing. This is able to do by the use of the database constructively and economic software Cenkros Plus which is widely extended in Slovak construction environment. This software allows the determination of costs, volume and type of construction material, machinery and works and the costs of particular items.

The accurate prediction of volume and type origin construction waste during the construction process is suitable by the completion of technological – organizational variant (TOV) in the Cenkros Plus database (tab. 4). Figure 4 provides an output (in Slovak) from database Cenkros Plus – technological-organizational variant for concreting of foundation slabs.

There is necessary the TOV to supplemented with information about the volume and costs valuation of construction waste, which generated during the realization of particular process (table 3). Obviously, the Cenkros Plus database is extensive. Given that, it is suitable to supplement the data about the construction waste only to selected items:

- excavated earth,
- concrete,
- masonry blocks,
- mortar,
- aggregate,
- plaster mixture,
- tiles.

The largest volume of construction wastes origin just during the works realization with these construction materials.
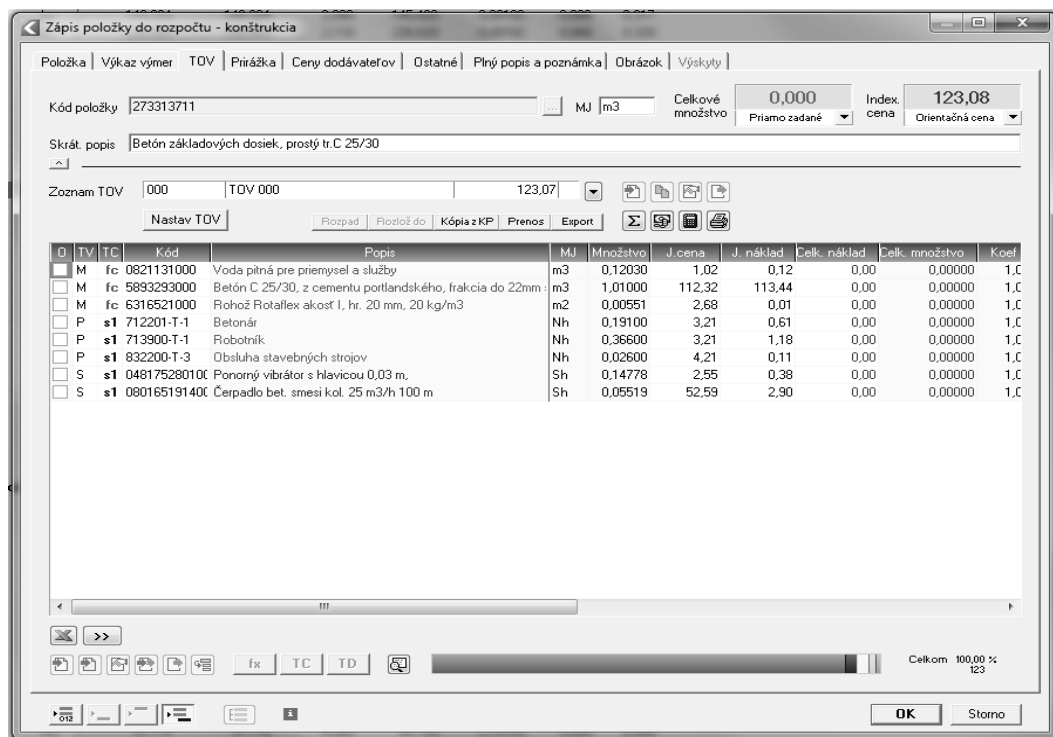
Fig. 4) Technological-organizational variant for concreting of foundation slabs [15].

Tab. 3) Completion of technological-organizational variant in Cenkros plus database

O	TV	Code	Description	UM	Volume
	M	0821131000	Water for industry and service	m3	0,12030
	M	5893293000	Concrete C 25/30 , Portland cement, 22mm fraction	m3	1,01000
	M	6316521000	Mat Rotaflex, size 20 mm, 20 ks/m3	m2	0,00551
	W	0821131000 - A	Water for industry and service	m3	0,01203
	W	5893293000 - A	Concrete C 25/30 , Portland cement, 22mm fraction	m3	0,10100
	W	6316521000 - A	Mat Rotaflex, size 20 mm, 20 ks/m3	m2	0,00055

The table 3 provides the example of completion of technological-organizational variant by the volumetric assessment of the generated waste during the realization of 1 unit of measure (UM) concreting of foundation slabs. The generated construction waste is marked by the symbol "W". Similarly, it is possible to process the cost valuation of construction waste.

5 CONCLUSION

The sustainable design of construction in terms of construction waste generation and management is also connected with the use of new innovative construction technologies which provide the reduction of construction waste then decreasing of the total cost for the waste disposal and the elimination of negative impact of construction to the environment. The modern method of construction presents one of the new environmental friendly technologies. The submitted paper will deal with the analysis and description of waste prevention by use of modern methods of construction, prediction of volume and costs characteristics in the design phase of construction and the opportunities of waste reduction in the all life cycles phases of construction. The paper provides an opportunity of determining of volume, type and cost of

generated construction waste and its disposal through the specialized economic software Cenkros Plus. This method presents the systematic tools which is able to contribute to sustainable design of constructions.

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EFFECT OF MANUFACTURING TECHNOLOGY ON QUALITY OF SLABS MADE OF REGULAR CONCRETE

Bohdan Stawiski[1], Tomasz Kania[2]

Abstract

In spite of multidirectional and extensive studies regarding concrete carried out so far, opinions concerning its uniformity in slab elements are differentiated. Generally the opinion that concrete is a quasi-uniform material prevails. Even quite frequently observed cases of strong damage to one surfaces on access roads, parking lots or cement foundations are not able to shake the belief of the designers in its good uniformity. The belief, because tests do not support this opinion.

Tests were undertaken to check the ordinary concrete (OC) strength at various depths from the surface. Measurements were conducted on borehole materials collected from the structures and on cut off concrete pieces in case of the roads. Tests were made on the samples of concrete slabs from constructions erected during the last sixty years. Ultrasound method has been used. Distributions of concretes and cement mortars compression strengths at the thickness of tested layers (slabs) were shown.

Differences of strengths depending on thickness are very high, they contradict popular opinions about uniformity of regular concrete in structures. Knowledge about the actual distribution of concrete strength allows designing and manufacturing of such structures with higher quality and stability. Hints were given how to improve quality of horizontally formed concrete structures.

Key words

Compression strength, concrete, non-destructive test method, ultrasound method.

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1   INTRODUCTION

The raised topic apparently seems trivial. It is obvious that the worse is manufacturing technology, the worse should be the quality of concrete element. However, regular concrete subjected to vibration in the earth's gravitational field, behaves according to the physical laws and tends toward segregation of components. Another factor, not connected with the technological process, is beginning to have an effect on concrete quality. Coarse aggregate falls downwards and water with air contained in concrete mix moves upwards. This phenomenon is well known by concrete researchers, however quantitative evaluation of changes in strength appearing for this reason encounters quite considerable difficulties. This is connected with the methodology of conducting the strength tests, consisting in testing of large material samples. Even if concrete samples are cut out from the examined structure, they have relatively large dimensions; the coarser is aggregate in the concrete, the larger samples should be. The larger the sample is, more difficult it is to test changes in concrete compression strength in those slabs where thickness is comparable with height of the sample.

The subjects of testing are concrete slabs formed in a horizontal position (flat formed). Slab thickness is usually small, between 11 and 19 cm, sometimes 20 – 25 cm, more rarely approx. 30 cm. European Standard samples for concrete testing are either *bars 15 x 15 x 15 cm* or *cylinders with height 30 cm, twice as large as the diameter Ø=15 cm* [1]. Following Trtnik et al. [2] *ultrasound method is one of the most popular non-destructive techniques used in the assessment of concrete properties*. Pulse velocity can be measured if the path length is known. It is then possible to assess the properties of concrete. In the literature can be found the researches of *relation between the ultrasonic wave velocity and concrete compressive strength* [2, 3, 4, 5]. Aggelis et al., and other authors [6, 7, 8, 9] emphasises the *strict dependence between pulse velocity and concrete structure imperfections*. In [10] Hassan et al. introduce the *usability of this non-destructive test method in concrete elastic properties prediction*. Described above types of concrete ultrasound testing have been performed with use of the cylindrical plate contact heads which can cause a problems in case of rough or uneven layers researches or comparison of properties on short distance of the sample. Bearing in mind the difficulties mentioned above, tests performed by the authors were carried out with use of the spot heads, which allow to measure the physical properties heterogenity of anisotropic material samples. Practical application of the point heads ultrasonic testing can be found in the papers [11, 12, 13, 14].

The main purpose of this study was to investigate the effect of compressive strength heterogeneity of horizontally formed concrete structures. The subjected tests were conducted on borehole material collected from existing slab structures made at various times. The objective of such approach was to examine the *problem of concrete compression strength distribution, in elements formed in industrial conditions, throughout their thickness*, raised by Greig in [15]. Slabs formed in laboratory conditions are made with special care with respect to their forming, appropriate consistency, condensing time etc. It was assumed that only testing of slab elements formed under average conditions, in construction sites (not with the thought in mind that they will be tested) may give a reliable answer to the question asked.

2   METHODOLOGY OF SELECTING SLABS FOR TESTING

Access to (and selection for testing of) such elements which show any defects e.g. parking lot slabs or access roads which have surface damage is relatively easy (fig. 1).
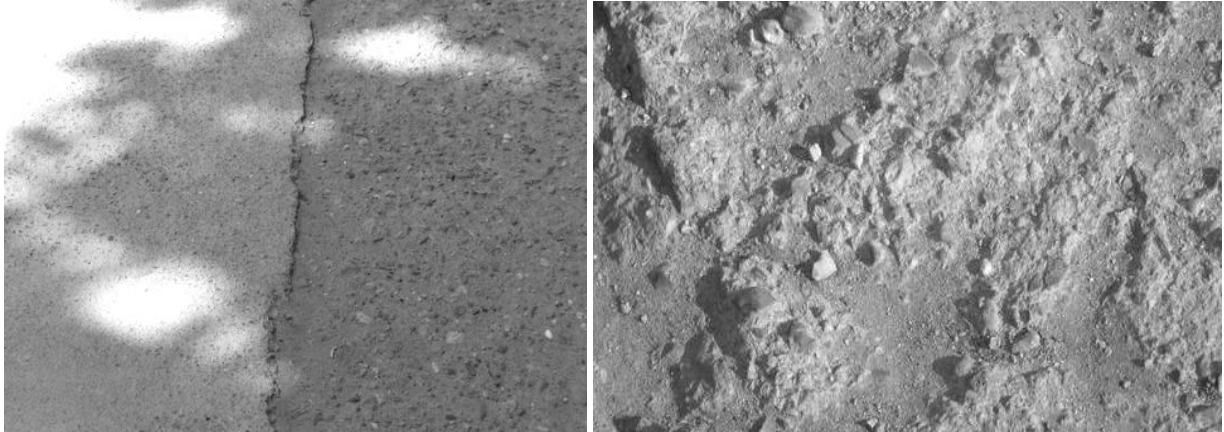
Fig. 1)   Examples of road surface made of concrete with crushed surface

Testing of slabs only superficially damaged would be tendentious and it would be impossible to generalize it to cases not showing any damages. The presented tests include also the results of checking flooring in an industrial building erected before the war (before 1939). This building was intended for modernization, the flooring slab itself did not show any damage, from the top it was covered with many layers of floor. The bottom slabs of tanks for agricultural production were tested before they were handed over for use, the examination was conducted because of shrinking cracks, the foundation slab under the industrial floor was also checked because of shrinking cracks appearing in the floor. Generally, the slabs from which borehole material was sampled for testing, apart from the road, did not show any symptoms of surface weakening. In macroscopic evaluation, they were in good condition.

3   APPLIED TESTING METHOD

Borehole materials with diameters 8 or 10 cm were cut out in a direction perpendicular to the slab (fig. 2) and were tested using the ultrasound passing method (fig. 3).
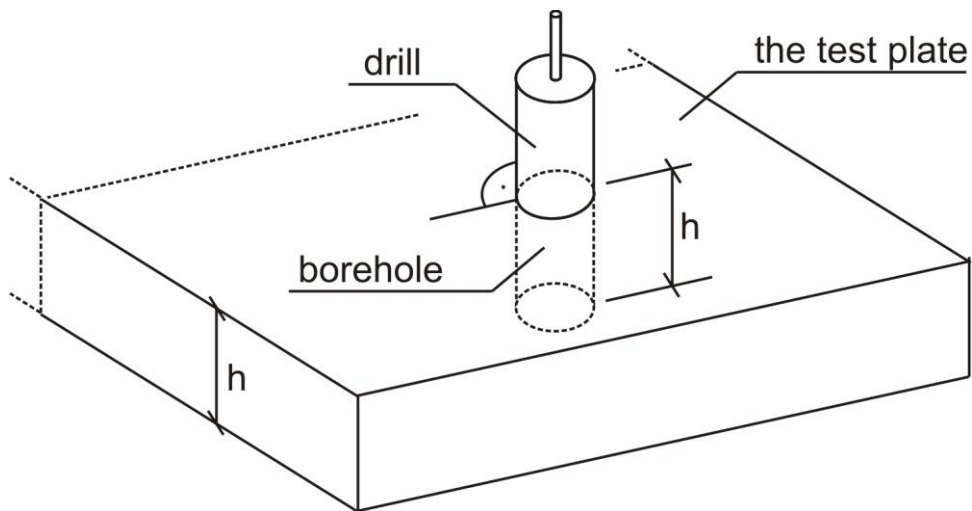
Fig. 2)   Method of sampling borehole material from concrete slabs made during various periods over the last sixty years
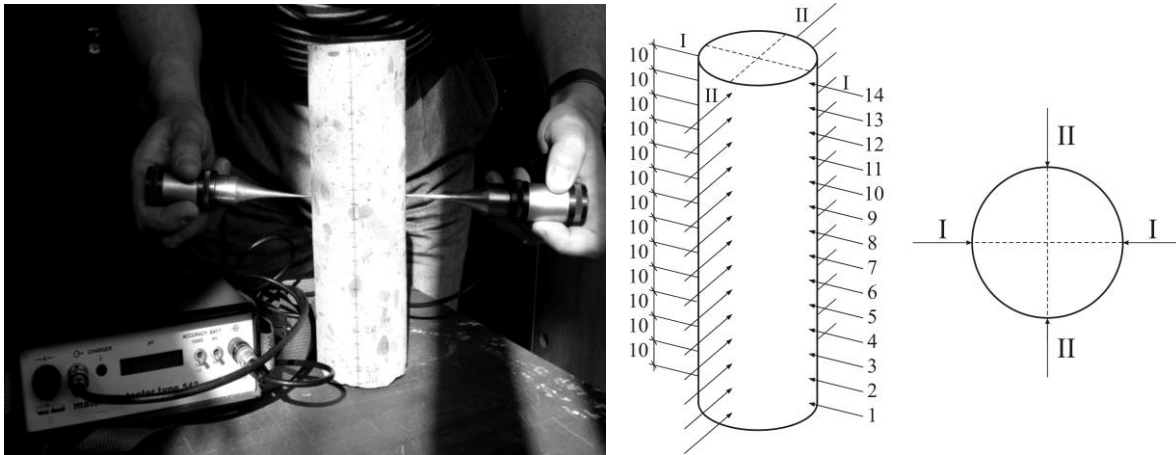
Fig. 3) Method of testing borehole materials with ultrasounds, using the passing method, in two directions I and II

Measurements using this method were conducted on planes located at a distance of 1.0 cm from each other. Therefore, in a slab 15 cm thick, passing time was determined in 14 planes, in a 25 centimetre slab passing time t_i, rate of longitudinal wave C_{Li} and compression strength f_{ci} were determined in 24 planes (the first and last measurement level was located 0.5 cm from the borehole base).

In several cases, fragments of road slabs cut out from a bigger whole were available. In those cases, the surface method was used. Spot heads were applied at two points on the surface and they were moved vertically by 1 cm. A constant measurement base of 70 mm was used (fig. 4).
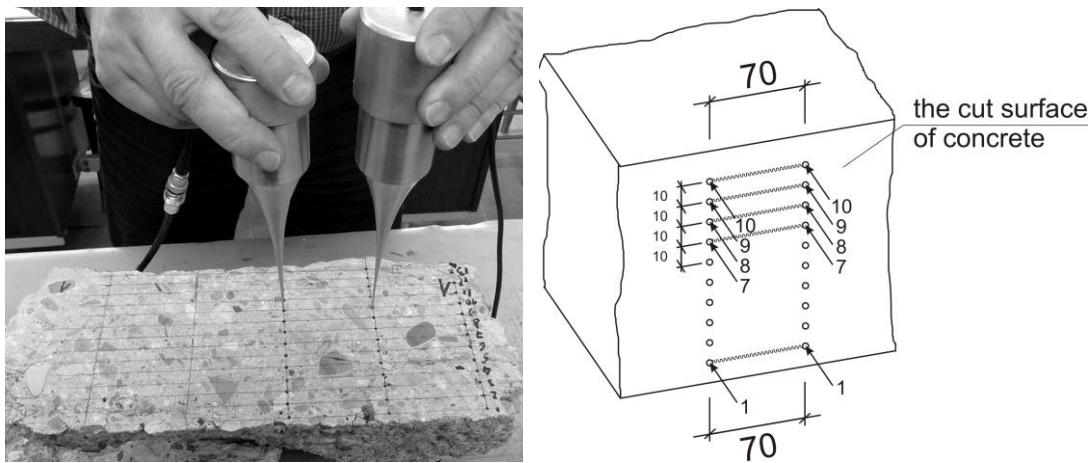
Fig. 4) Method of testing of cut out concrete samples using the ultrasound superficial method.

4 PRINCIPLE OF DETERMINING CONCRETE STRENGTH BASED ON THE ESTABLISHED ULTRASOUND RATE

The examined borehole materials were cut into samples with length equal to their diameter. To the ultrasound rate determined in the middle of the height of each sample, destructive

strength was assigned as determined on the strength machine as a relation of destructive force P to the surface area of cross-section A (1).

$$f_{cz} = \frac{P}{A} \ [\text{MPa}] \tag{1}$$

In this way, several pairs of results were obtained: strength - rate ($f_{cz} - C_L$) in the passing method, ($f_{cz} - C_P$) in the superficial method. Correction dependency f_{cz} (C_L) or f_{cz} (C_P) assumed from other tests of similar concretes or from the literature [1] was moved to set f_{cz} (C_L) or f_{cz} (C_P). In this way, the scaling curves established hypothetically were used to convert the rate of ultrasound wave in the given cross-section at the borehole height into concrete compression strength in this cross-section. The results obtained showed certain spreads (fig. 5). The examined dependencies were replaced with trend lines. It turned out that linear trend lines are best.

a)   b)
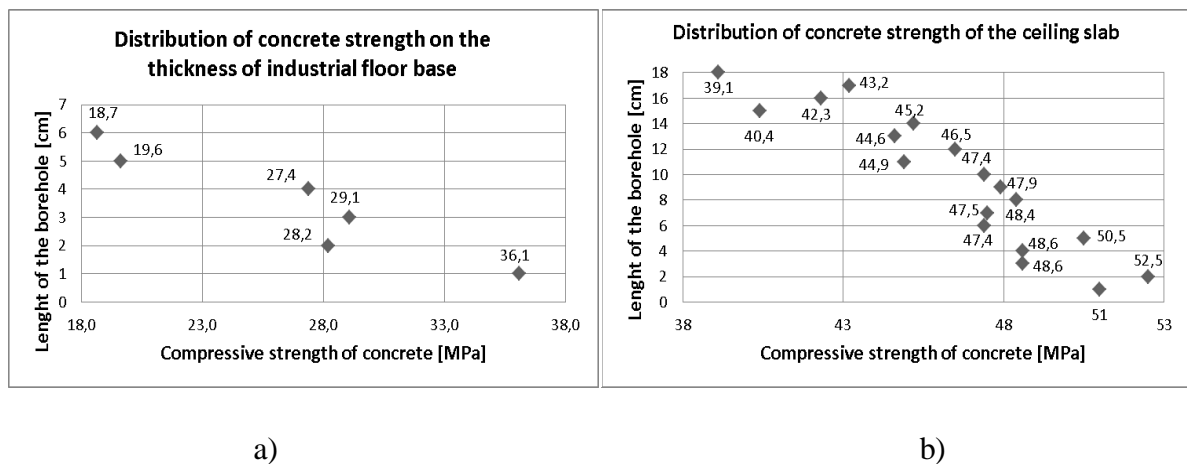
Fig. 5)   Concrete compression strength along the borehole length shows a certain spread a) weak concrete with high percentage of water, b) strong concrete with small percentage of water (made of high plasticity substance)

5   ANALYSIS OF OBTAINED RESULTS

The tested concretes had only one common property, they belonged to the group of regular concretes and they were compacted by means of vibration. All of them were clearly weaker in the top part and stronger than the designed values in the bottom part. The progress of the examined dependency in all cases is very similar (Fig. 6).

All tested slabs, even though they were made at different periods of time, have similar distribution of strength for element thickness. The relation of strength in upper layers f_{cg} to strength in lower layers f_{cd} is:

- in flooring of the industrial building of 1938 – 0.56,
- in open parking lot slab of 1975 – 0.41,
- in bottom slab of agricultural building of 1998 – 0.42,
- in monolithic Filigran flooring slab of 2007 – 0.41.
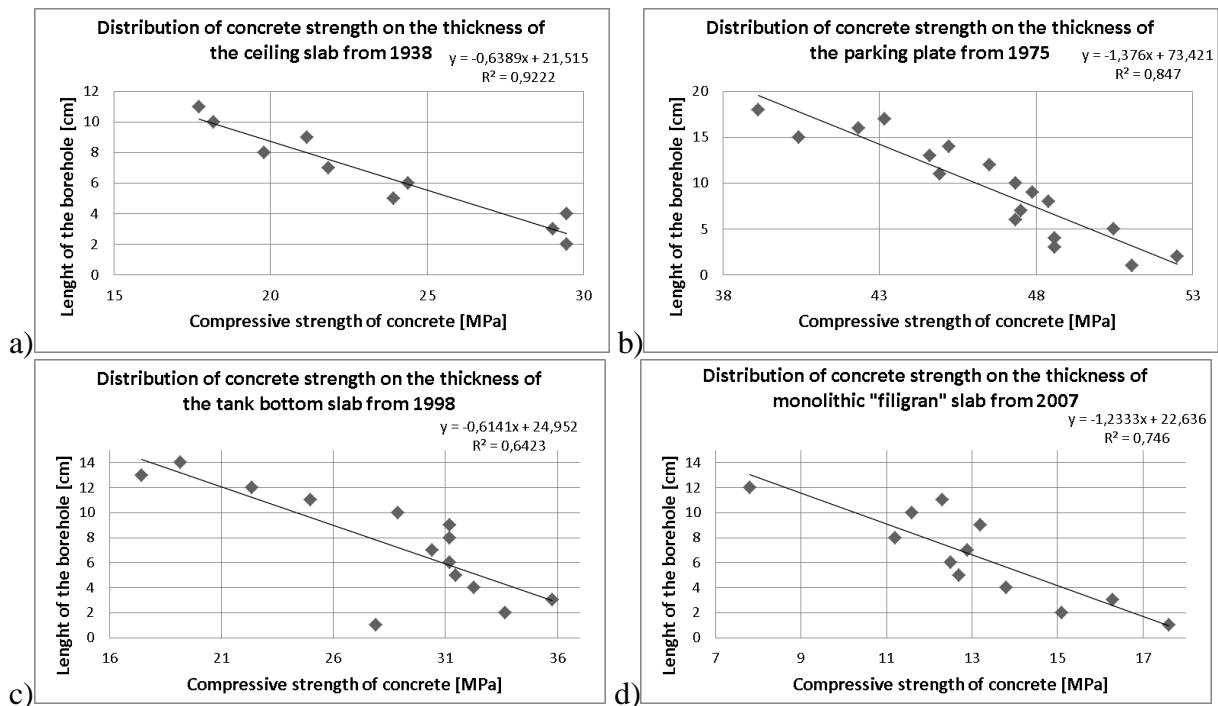
Fig. 6) Change of concrete compression strength by thickness of slab formed in various periods: a) flooring in an industrial building, b) parking lot slab, c) bottom slab of tank, d), flooring slab – Filigran

In general terms, it can be assumed that the top layers of concrete elements formed in horizontal position are 50% - 60% weaker than the bottom layers. After thorough analysis of a very high number of examined borehole materials, with respect to the place at which concrete strength is the same as the designed concrete class, it turned out that this place is half of the slab thickness. From this obvious conclusion given in [16] can be confirmed about how samples should be taken from the structure where the goal of testing is to establish the class of concrete used for construction of the structure: *the middle plane of the sample should overlap the middle plain of the examined slab*.

6 DISTRIBUTION OF CONCRETE STRENGTH BY THICKNESS OF BAR SAMPLE USED FOR TESTING CONCRETE STRENGTH

If the phenomenon of concrete strength differentiation appears in slabs, then it should also appear in samples which have thickness similar to slabs. A series of 50 bar samples 15 x 15 x 15 cm made at the site of the concrete mass producer using high plasticity concrete were tested. Due to the high number of elements being checked, measurements were carried out only in three cross-sections: in the middle of the sample height, 2 cm from the top and 2 cm from the bottom surface (fig. 7).
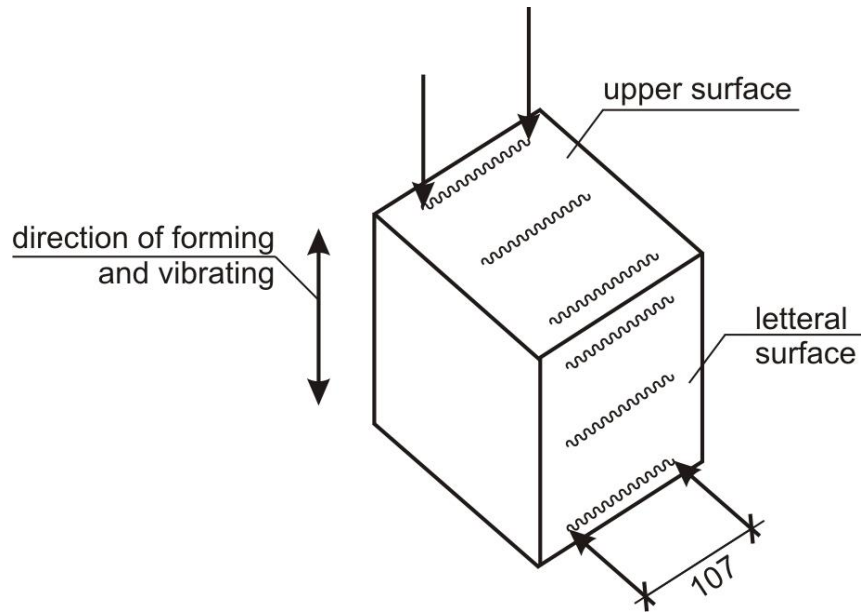
Fig. 7) Method of testing bar samples 15 x 15 x 15 cm made of high plasticity concrete class B20.
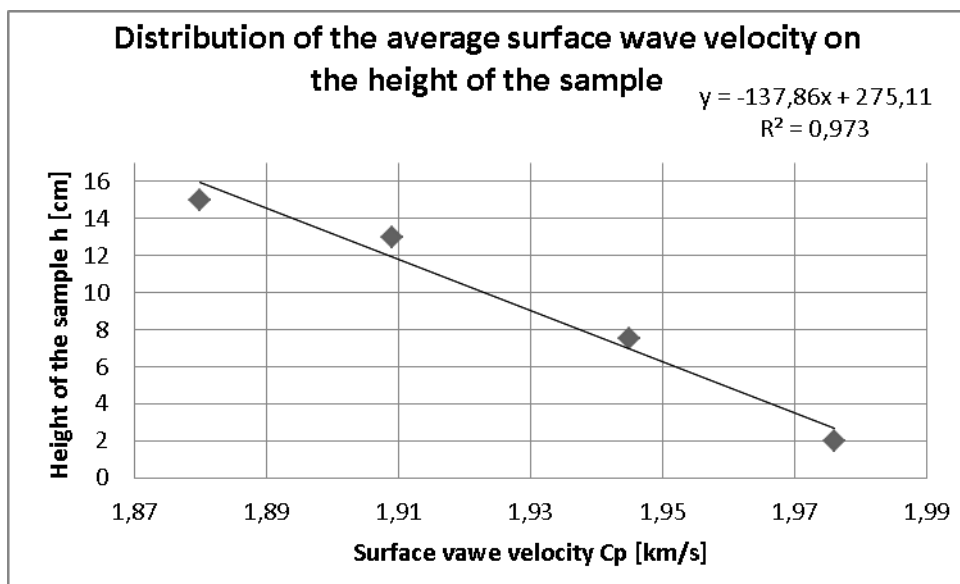
Fig. 8) Graph of the average rate of surface wave at various levels of lateral surface of the bar sample.

Distribution of surface wave rate at various levels is shown in fig. 8 and strengths in fig. 9. Strength was calculated from the correlation dependency determined using the statistical method (2).

$$f_c = 2.01 \exp C_p^{3,5907} \text{ [MPa]} \qquad (2)$$
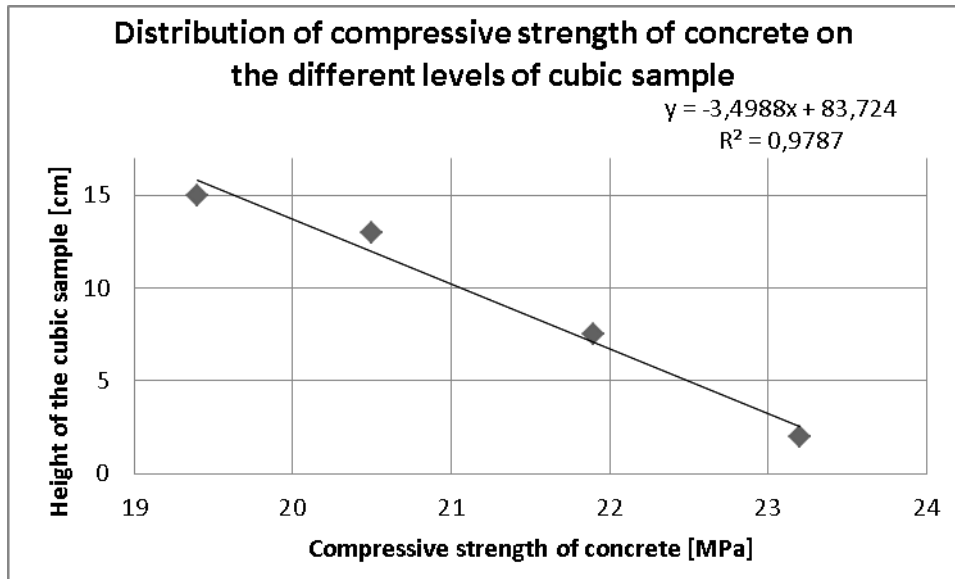
Fig. 9) Chart of concrete compression strength determined using the ultrasound method at various levels of the bar sample.

Concrete strength in bar sample elements is also not constant along their height: the relation of concrete strength near the top surface to concrete strength near the bottom surface is f_{cg}/f_{cd} = 0.74, so the difference is smaller than in slabs but still quite considerable. Such a result is probably affected by the greater care taken during the formation of the samples and the thick consistency of the concrete mass. The question was also asked, in which cross-section in the concrete sample is the determined strength consistent with the result obtained from destructive tests in the strength testing machine? It turned out to be the middle cross-section. The strength in the middle of the sample height determined using the ultrasound method is compliant with destructive strength. The same result was obtained even when neighbouring cross-sections were weaker according to ultrasounds tests.

7   CONCLUSION

The presented tests indicate that with respect to the strength of this material, horizontally formed concrete products should not be regarded as homogenous elements along their thickness, or even quasi homogenous. Differentiation of strength along thickness for horizontally formed slabs made of regular concrete is essential because it reaches 50 per cent, sometimes even more. Bearing in mind the fact that very similar results are obtained when old and contemporarily made concretes are tested, *the discussed phenomenon should be treated as an objective feature of regular concretes* as it has been stated by the author in [16, 17]. If the strength differentiation shown is ignored, then in case of typical distribution of strength along the thickness of a horizontally formed slab (fig. 10) the following strengths are obtained:

- if the tests are conducted on the top surface, the obtained compression strength is f_{cg} = 18MPa
- if the tests are conducted on the bottom surface, compression strength will be determined at the level of f_{cd} = 30 MPa
- designed strength is equal to strength in the middle of the slab thickness, therefore f_c = 24MPa.
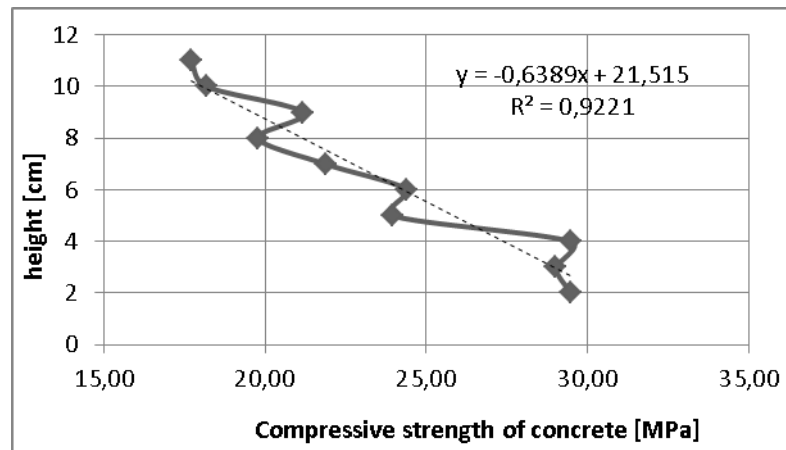
Fig. 10) One typical distribution of concrete strength along the thickness of horizontally formed slabs, compacted by means of vibration, obtained in the tests

Intensity of vibration, compacting time and consistency of concrete mass have very significant influence on the presented difference of strength between the top and bottom layer. At the current stage of testing, the relation of concrete strength in the top layer to strength in the bottom layer was established at the level of 0.41-0.50. In elements made of high plasticity concrete, carefully compacted, this relation can be at the level of 0.74.

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ECONOMIC INCENTIVES TO IMPROVE OCCUPATIONAL SAFETY AND HEALTH PERFORMANCE

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Abstract

Improvement of occupational safety and health (OSH) in company can involve the financial benefit not only in form of money saving in connection with number of occupational injuries decreasing. The OSH requirements are not out of accord neither with the goal of maximum profit in company performing the construction, because disregarding of construction safety risks can imply construction costs or construction time increasing. In many member states of European Union (EU) are offered various types of financial rewards to employers which invest in employees health and safety improvement; from insurance premium variation, state subsidies and grants, incentives based on tax systems, to better conditions of bank loans for company with the best indicators. The paper deals with problems of OSH in construction industry, with economic aspects of OSH and economic tools intend for motivation to OSH improvement. It also presents the initiative of European Agency for Safety and Health at Work intent on promotion of economic incentives in OSH within EU member states and on research of such economic incentives issues.

Key words

Awarding incentives, construction safety, economic aspects of occupational health and safety, economic incentives, occupational health and safety, safety incentives.

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1 INTRODUCTION

The occupational safety and health is the factor having impact on a company income and the safety performance and level of safety keeping definitely influence the profit formation or losses rise in a company. The costs and losses developed by occupational injuries influence the profit of a company negatively. Even if precautionary measures to improve OSH in a company involve additional costs apart from a benefit, these costs may reflect in unbroken work, in reduced sickness absence, in optimal working conditions and safety culture and thus in lower fluctuation and better company reputation. Providing the safe working conditions, suitable to employees needs, signifies their higher satisfaction, productivity enhancement and improvement of production value. This can prove in reduction of production costs, in competitiveness increase and consequently in company profit improvement. Investment in high quality of OSH remains the company competitiveness and this contributes to increase the power to care customers and to achieve more contracts.

2 ECONOMIC ASPECTS OF OCCUPATIONAL SAFETY AND HEALTH

Except that good OSH practices in company surely present a social and legal obligation, strong safety performance can imply many favours for a contractor. The most meaningful contributions resulting from high level of OSH performance involve [1]: brand value and goodwill, winning and retaining business customers, corporate social responsibility, employee motivation and commitment, productivity, managed insurance costs, lower costs of accidents and illness and investor confidence. The economic contribution of safety arrangements in working place is presented mainly by reduced claims and losses resulting in company in case of working injuries or other unexpected incidents.

The structure of OSH economic aspects in terms of a company involves mainly [2]:
- costs for establishment and retaining regular OHS conditions, which are expended mainly on performance of relevant regulation requirement,
- costs and loss as wrong OSH conditions implication in case of unexpected incidents as working injuries, occupational illnesses or other health damage, equipments imperfection or costs and loss pertinent to hindered and to health dangerous working environments inclusive of loss as lower productivity implication and
- contributions pertinent to realization of arrangements for OSH conditions improvement including contributions coming from company competitiveness advance.

The costs for establishment and retaining of good OSH conditions are the costs for prevention of unexpected incidents occurrence and costs for safe production assurance. The amount of costs for good OSH conditions establishment depends on initial OSH conditions in company. There are mainly capital costs for new production and non-productive equipments or modifications of existing equipments (eventually overhead charges for equipments putting into operation or operating costs pertinent to operation, control and maintenance), costs for organizational assurance of arrangements performance, for safety service, for trainings, purchasing of collective and personal protective equipments, safety signalization, etc.

The companies can lose too much finance as working injuries and occupational diseases implications. This can be serious mainly in small companies. But sometimes is difficult to convince employers and top managers of good OSH profitability. In particular the tradesmen in construction usually underestimate the occupational safety; they do not take out any

accidental insurance. They must rely on themselves in case of accident. They cannot ask for any compensatory damages from the company for which they worked, as it is standard in case of regular employees.   They can only exact the compensation from the company for which they worked with the help of the court, however only when the police discover that the injury happened as implication of inaccurateness in OSH by the company. The structure of economic implications of working injuries in company is presented in Tab. 1.

Tab. 1)   The structure of economic implications of working injuries in company [2]

Economic implications of working injury	Direct costs	wage compensation in case of ill or injured person temporal disablement
		compensation of material damage as working injury implication
		costs for working injury damage repair, material damage of company (equipment damage, sources devaluation, etc.)
		other costs directly relating to an injury (transport of injured person, legal proceeding costs, wages loss and travel expenses compensation for witness in court, etc.)
	Indirect costs	accident insurance and surcharges payment
		costs relating to injury agenda execution
		costs for overtimes of employees working more during injured person absence, eventually costs for new worker training, etc.
		costs for first aid kit, sanitary material providing
	Production losses	production losses as implication of injured person or his co-workers working time decrement (first aid giving, organization of injured person transport, involvement in injury investigation, witness in court, etc.)
		production losses as implications of low labour productivity of injured person (mainly in case of his working power decrease) and of his co-workers (excitement implication)

The companies usually do not pay the all costs relating to working injuries or diseases. Some of the costs must be often paid by employees and by society. For example the company do not need to pay the costs of employees' health care or disability pension. In many European countries, they have the regulations ordering to shift payment responsibility back to company or to person who caused the costs. This can be considered as one from economic incentives to injuries prevention in the future.

Economic or other sanctions present the type of economic tools to penalize the business organizations or subjects who do not perform the statutory requirements in terms of occupational safety and health. From OSH point of view, there are employed the sanctions administered by the Labour Inspection Body, eventually by other similar supervisory body. The sanctions should be considered not only as consequential arrangements, if their administration principles are known, it can have a preventive effect. It is concerned to these forms of sanctions:

- penalty on defaulting the statutory regulations and obligations contained in collective labour agreements or on defaulting the legal statements of labour inspection bodies and other similar supervisory bodies;
- penalty for work performance without regulation authority or certification;
- prohibition of using the working and service objects and areas, machines, equipments and other technical equipments, operation processes, substances, activities and works, which directly endanger safety and health of workers and other people in working place or around, eventually are out of accord with code.

3 OCCUPATIONAL SAFETY AND HEALTH PERFORMANCE IN CONSTRUCTION SECTOR

The complex and dynamic nature of the construction industry and its on-site work patterns is widely recognized. Due to the hazardous and complexity of work, safety is a serious problem within the construction industry. The construction industry is over-represented in workplace injury and death statistics in most parts of the world. Despite mechanization, the industry remains labour-intensive and workers are exposed to dynamic, high risk environments on the various projects and construction sites. The International Labour Organisation [3] reports that construction industry accounts for 30 – 40 % of the world`s fatal injuries. One hundred thousand workers are killed on construction sites every year, one person killed every five minutes. The sector remains one of the most dirty, difficult and dangerous with poor working conditions; it is internationally a generally risky business. The reasons for the poor safety record may correlate with many factors such as high – risk nature of construction work, low knowledge and a lack of trade risk awareness of tradesmen, building terms decreasing, high proportions of unskilled and temporary workers, complicated contractor system with big amount of subcontractors, absence or malfunction of safety management system especially in small construction companies and tradesmen, personal behaviour, etc.

The construction industry in Slovakia involves around 180 thousand people, or 8,3 % of total nation labour force. From 179 551 people in 2010, the tradesmen are the most, there are 110 066 persons.   The least contribution from employees number point of view present the companies with 250 and more employees, only 14 640 persons are there employed. In small construction companies with less than 50 persons are employed approximately 33 thousand people and in medium sized firms, there are employed around 21 thousand people [4]. From around 180 thousand people in construction sector only 36 thousands work in medium or large sized companies, where generality has established the OSH management system. From the year 1992, there has been recorded around 309 fatal injuries in Slovak construction sector [3].

The report of National Labour Inspectorate of Slovak Republic about the safety performance in inspected companies in 2010 [5] introduces, that the construction sector for long time belongs to the most risky sectors in terms of OSH performance. The most often inadequacies in construction in terms of the owners/clients are: they do not communicate a prior notice to the competent authority (Regional Labour Inspectorate) before construction works start, they do not appoint any coordinators for safety and health matters for any construction site on which more than one contractor is present, they do not ensure that prior to the setting up of a construction site a safety and health plan is drawn. From contractors' point of view, in the sites, there are not appointed any authorized persons responsible for salvage and evacuation operations and for first aid treatment. Attendance of workers in the site is not properly recorded; safety conditions and responsibilities for safety in sites shared by many contractors are not places under any contract. Next inadequacies typical for sites include: defects of portable elementary ladders, they are not ensured against displacement and, there are dangerous places on ascension level, places with hazard of fall from height are not ensured, scaffoldings have dangerous platforms, etc. The inspections results mention that occupational safety performance reflexes the recent economic conditions. The production recession as the consequence of the economic crisis signifies less finances which may be invested by employers into occupational safety matters. The employers want usually save money and so they save in fields which do not directly impact the production process.   The abysmal difference between safety performance in companies with less than 10 people and in companies with more than 100 people, which is naturally the disadvantage of small

employees, still persists. While employees in small companies rarely deal with the matters of occupational safety, in medium and large sized companies are established the OSH management systems. Better approach to OSH is evident in companies with foreign owner. Mostly the foreign owners transferred to related company the culture from the home foreign company, which is in higher level in terms of occupational safety. Although the construction industry is over the whole Europe evenly the world over considered as one from the most dangerous sectors not only. The EU construction industry is estimated to be worth €902 billion a year, and with accident and ill-health costs in the sector totalling 8.5% of project costs, that means that poor OSH standards in construction could be costing over 75 billion EUR each year. It is represented by nearly 200 EUR for each member of the population [6].

Completion on time, on budget and with the specified quality is widely recognised as the major objectives of a construction project. From the client perspective, it is ideal that a project is completed in minimum time, at minimum cost, and with the best quality. However, it is often difficult to achieve these major objectives in practice, especially for large and complex projects. A large number of research efforts have been made to identify various possible solutions to performance problems, according to which project performance can be improved. According to Bubshait [7] clients can provide time incentive for early completion, cost incentive for cost saving, quality incentive for zero or minor defects, and sometimes safety incentive for complying with stricter safety rules and standards. In addition, different types of incentives can be combined in order to make improvement in two or more performance areas. The combination of incentives is often called multiple incentives, which have proven complicated to manage but may be fairly successful. In recent years, the importance of incentive mechanisms to project success has received an increasing recognition from construction researchers and practitioners. For example, Love et al. [8] emphasised that project participants' behaviours can be aligned through the use of incentives towards a project's performance objectives. Similarly, Rose and Manley [9] saw the use of incentives as a key means of improving project performance by simulating the motivation to work harder and smarter in pursuit of high-order performance objectives.

4   OCCUPATIONAL SAFETY AND HEALTH ENHANCEMENT THROUGH ECONOMIC INCENTIVES

The economic incentives to improve safety and health involve the fiscal tools to promote the workers motivation to improve their OHS performance. It is concerned to rewarding the subjects for safe and well working conditions. Economic incentives as financial advantages granted to companies or organizations that improve their working conditions include in particular [10]:

- insurance premium variation
- incentives based on tax systems or tax structures
- state subsidies, grants and financing.

In many European countries, as well as in other continents, there are several economic incentives programs in order to force employers to promote their employees OSH. These economic instruments often consist in linking fiscal incentives to good OSH performance of a company, for example with lower accident insurance premiums or tax rates. This presents the substantive relation between insurance charges of a company and its indicators in regard to OSH, hence companies with low injury and diseases rate pay lower insurance fees.

By the Social Insurance Code in our country, no. 461/2003 [11] the accident insurance tariff rate relates to hazardousness of different occupations. The different types of employers are

divided into ten groups according to hazardousness. The hazardousness group is defined in compliance with safety risks of different groups of economic activities specified in sector classification of economic activities. Each employer is classified into one hazardousness group. This is made by the Social Insurance Bureau according to predominant group of economic activities performed by the employer. Different insurance tariff rate belongs to different group. It is graded from 0,3% to 2,1% of assessment base. The key transformation of the Social Insurance Code involved establishment of so called bonus – accident insurance rate reduction (additional compensation) and mallus – additional charge of accident insurance; applied depending on results of working injury and working diseases rate of specific employer.

By the system of bonus – mallus the employer is to some extend able to control his own payments defined by the system of accident insurance. In the Social Insurance Code are stated following principles for bonus – mallus system attachment [11]:

- The additional charge of accident insurance is prescribed to employer when the rate of his occupational safety risk is higher than the average safety risk rate estimated in all employers classified (for the purpose of accident insurance rate estimation) to the same group of economic activities. The rate of additional charge (%) depends on rate of average safety risk overload (%). The additional charge rate is established for one year period followed the year when the overcharge was estimated.
- The accident insurance rate reduction is prescribed to employer in case when the rate of his occupational safety risk in relevant period is lower as the average safety risk rate of employers classified to the same group of economic activities.

The insurance tariff can be increased by four percents, if the safety risk rate of employer goes over the one group average by two hundreds percents. The average overload by less than one quarter is not penalized. The employer accounting better rates of safety risk (from 25% to 50%) than the average of similar employers can set up a claim to insurance tariff reduction by half percent. If such employer statistic results are better by more than three quarters, he will pay the insurance tariff by two percents lesser.

The empirical assessment of tariffs, when the insurance rate is determined by insured events progress in the company, may be effective. On the other hand it may be little bit dangerous if the economic incentives depend on past accident rates in the company. The accident rate in companies, mainly in smaller, can be markedly influenced by statistic oscillation. There is the possibility that the companies absolutely underestimating OSH are rewarded by some economic incentives form because they had luck, however the companies with accident rate influenced by fully random coincidences are penalized even though their OSH management is on high level. In 2009, the United States Government Accountability Office issued a report that found that safety incentive programs "can provide disincentives for workers to report injuries and illnesses to their employers." One of the possibilities to avoid it consists in benefits and awards ordering according to "the future risks" and so supporting the companies which are taking actions for example by establishing of OSH management systems or by new equipments purchasing and putting into operation. Similarly the tax tariff may serve as a tool to influence the company performance. For example the companies which are purchasing new technologies and establishing new equipments, more safe than minimal statutory requirements command, should pay lower tax tariffs. Or the state should offer some finances or provide easy availability of financing through bank loans to these subjects which endeavour to do better occupational safety conditions. So the state government may support the subjects to buy safe machines and equipments or which in general invest in safer working conditions.

Sometimes the regulations are not enough substantial or motivational, the economic incentives application can act as an effective method stimulating the companies to invest in OSH conditions improvement. The economic incentives perfect the law regulations procurement, they provide financial advantages and so they increase the severity of OSH economic aspect.

The success factors of economic incentives dedicated to suggest the employers to improve their OSH performance involve [10]:

- the incentive scheme should not only reward past results of good OSH management, i.e. past accident rates, but should also specific prevention efforts which aim to reduce future accidents and ill-health,
- the incentive scheme should be open to all sizes of companies and pay particular attention to the special needs of small and medium companies,
- the incentive should be high enough to motivate employers to participate,
- there should be a clear and prompt relation between the desired prevention activity and the reward,
- the incentive system should have clear awarding criteria and should be as easy to use as possible, to keep the administrative burden low for both participating companies and incentive-offering organisations,
- if the incentive needs to target a large number of companies, insurance or tax-based incentives with precisely defined criteria are most effective - "closed system",
- if the desire is to promote innovative solutions for specific areas, subsidy schemes are most effective – "open system".

Similarly, employers or other subjects (i.e. Labour Inspection Body) can apply economic incentives as a tool to improve the employees' involvement/interest to OSH in a company. In performance results evaluation, the employers should have a respect to OSH regulations observance and motivate the employees to better safety performance through some types of awards or otherwise by penalties. Moreover the salary allowance (e.g. in case of work in unfavoured and unwholesome environment) can be regarded as a sort of economic incentive instrument. It can promote the employees compliancy to work in conditions endangering their health perhaps even attempting their lives. But this cannot be considered as right aiming incentive. By its applying, the employees are not involved to OSH conditions improvement and are not motivated to better the OSH performance.

5   PROJECT ON ECONOMIC INCENTIVES ESTABLISHED BY EUROPEAN AGENCY FOR SAFETY AND HEALTH AT WORK

The commission of the European Parliament prepared in 2007 the strategy about improvement of quality and productivity at work: Community strategy 2007 – 2012 on health and safety at work [12]. The overall objective of the ambitious strategy has been to reduce by 25% the total incidence rate of accidents at work per 100 000 workers in the EU 27 (twenty seven states of the European Union).

The European OSH strategy notes that *occupational health and safety plays a vital role in increasing the competitiveness and productivity of enterprises and contributing to the sustainability of social protection systems because it results in reduced costs for occupational accidents, incidents and diseases and enhances worker motivation. Occupational accidents and diseases represent an enormous financial burden for public and private social protection systems and require an integrated, coordinated and strategic response, as well as cooperation*

between the main parties involved in the European Union with regard to the development of Community and national policies. The European Union members had to adopt this strategy and to prepare the optimal arrangements abreast of its nation. The European Commission aims to encourage all the parties involved to make a concerted effort to reduce the high cost of occupational accidents and diseases and to make well-being at work a tangible reality for all European citizens.

The EU strategy on OSH recognises that there is a need to use economic incentives to motivate enterprises to apply good practice in their prevention work. The European Agency for Safety and Health at Work (EU-OSHA) contributes to meeting this need by providing information on the types of economic incentives that are most likely to succeed. Research executed by the agency has shown that external economic incentives can motivate further investments in prevention in all companies and thus lead to lower accident rates. The primary target audience are subjects that can provide economic incentives to improve OSH, such as insurance companies, social partners or governmental institutions. These subjects are thought to be important intermediaries to stimulate further efforts in OSH in their cooperating companies, e.g. as insurances clients. Therefore there has been established a network of such institutes in form of an expert group, which supports the project with advice and helps to promote the agency research results.

The long term project of EU-OSHA, started in 2008 and will run until 2013, was inspired by aforementioned European OSH Strategy 2007-2012. The Agency collaborates with an expert group of organizations that were nominated by the EU member states. The project includes a few of specific projects carried out by the EU-OSHA Topic Centre – a consortium of European research institutes.

At the end of 2010 was delivered a comprehensive report titled *Economic incentives to improve occupational safety and health: A review from the European perspective* and a few of other products. The products involves a fact sheet summarising the report, two articles in the Scandinavian Journal for Work, Environment and Health, a collection of case studies to find in the good practice database of EU-OSHA webpage. A series of expert group workshops was held and are documented in events section of the EU-OSHA webpage. The Agency economic incentives expert group not only gives advice and input to Agency activities related to economic incentives, but helps promote the products among stakeholders. The project and its results have been presented at conferences and workshops in numerous European countries, such as Bulgaria, Cyprus, Czech Republic, Germany, Italy, Sweden, Slovenia and the UK.

The report summarizing the results of EU-OSHA research [13] suggests that economic incentive schemes encouraging companies to invest in risk prevention are a cost-effective option for governments looking to cut the numbers of work-related accidents and illnesses.

The EU-OSHA report includes the review of actual research on economic incentives, the review of government policy in different EU member states relative to rewarding systems and the set of case studies with particulars about employment of incentives in different European states and in series of sectors. The report evaluates the effectiveness of various incentives systems and identifies several success factors. Many EU member states already offer various types of financial awards to companies which invest in employees' safety and health at work. These awards involves the lower insurance tariffs, state grants and other grants, as tax holiday as well as privilege conditions of bank loans attainability for companies with the best results concerning the OSH. The method of limiting the finances when e.g. the government provides a grant in proportion to the costs which a company expends to OSH is thought to be an excellent one of OSH improvement. As one from examples, in Spain, there is the grant intend

on the support of financing the exchange of dangerous equipments in small and medium sized construction companies as well as the grand dedicated to the support of modular scaffoldings purchase in small and medium construction companies.

Three from fourteen case studies highlighted in the project provided sufficient data to conduct a cost–benefit analysis. All three resulted in a positive payout ratio, ranging from 1.01 – 4.81 Euros return for every Euro invested. According to EU-OSHA Director Jukka Takala, the economic incentives project has already encouraged different EU Member States to learn from each other, and exchange good practice in designing incentive schemes. The report reflects a growing interest in economic incentives, as a means of motivating organisations to invest in occupational health and safety. There is increasing recognition that enforcement of regulations is not enough on its own, if the EU is to reach the target of a 25% reduction in workplace accidents, set out in its Community Strategy on Health and Safety.

The literature review, introduced in the report, includes seven concrete examples of economic incentive schemes applied in practice, divided into country-, sector- and case-specific studies. One sector-specific study examined incentives in the construction industry. There is analyzed the research conducted by researchers from Poland [14]. They looked for the impacts on the safety performance of US construction firms. They identified two different categories of safety incentive programmes. There were injury/illness-based programmes, which are based on the number of injuries/illnesses as a criterion to reward workers and teams and behaviour-based programmes, which took worker behaviour at the site as a criterion for awarding incentives, for example offering suggestions about how to improve job site safety, attending safety meetings and training, etc. The main finding of the research was that incentives in general are effective at improving many of the safety performance metrics used in construction although differences within the industry regarding perceptions of incentive effectiveness exist. By the research, craft workers have a more favourable opinion of the effectiveness of safety incentive programmes than do company managers. Interestingly, rewards based on crew versus individual performance, injury versus behaviour performance and different time periods for giving the awards made no difference to the effectiveness of the programmes among the sampled companies. Surprisingly, the companies that used only tangible awards, e.g. money or gifts, had slightly better safety performance measures compared with those that employed both tangible and intangible awards e.g. time off or certificates.

6   CONCLUSION

The state is able to impact indirectly the occupational safety and health performance of enterprises as good as individuals through economic tools motivating to OSH improvement. Thereby are integrated the normative tools as laws, restrictions and directives, standards and technical standards. These tools by grants and subsidies from state budget and objective funds, by insurance tariff discounts and by tax reductions covering the costs for OSH into deductable item are regarded as the effective suggestion to invest into workers OSH. Involvement of enterprises in establishment of safer working conditions increases with employment of differentiated insurance tariffs which imply that working injury costs expend this one who caused the accident.

Let us ask a question at the end: What exactly can the most effectively motivate the employers, companies' managers, to support the safe and health working conditions of their workers? Certainly the occupational safety and health reason by him, hence worker

protection, its health and life protection. This motivation has juridical and human as well as economic aspect. Awareness of real losses caused by working injuries and other ineligible events, eventually their enumerating, can promote the incentives system. The incentives economic aspect does not consist only in fear of injuries outcomes. Moreover, it embodies in achievement of higher labour productivity and employees initiative, if the work is well organized.

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IMPACT OF VALUE MANAGEMENT AND LOCAL KNOWLEDGE APPLICATION ON THE SUSTAINABLE CONSTRUCTION PROJECTS IN WESTERN BALKANS

Nebojsa Surlan[1], Zoran Cekic[2]

Abstract

In the majority of construction projects, resources and budget are defined in project`s initial stages. The Client requirements defined through their value system are the bases for Project Brief that will in turn influence the project to its completion. This research presents the process of Value Management (VM) Workshop on international project in Western Balkans. VM Workshop and its Job Plan are utilised through Paired comparison exercise in order to define Client priorities for the project. After the application of local knowledge information, mini-Delphi excercise is undertaken to measure again Client value system. Result of the VM Workshop indicated that Client value system was impacted by local knowledge. Conclusion is that VM Workshops present a valid process to influence Project Brief with local knowledge and impact wider project goals.

Key words

Design brief, job plan, project management, value study.

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1   INTRODUCTION

Most of project`s resources and finances are committed in project`s earliest stages. A ratio of 1:5:200 has been first suggested by Evans et al. in [1] - a Report by UK Royal Academy of Engineering. It states that if the initial construction costs of a building is 1, then its maintenance and operating costs over the years is 5, and the business operating costs (salary of people working in that building) is 200. This was later disputed by Hughes et al. in [2], of the University of Reading School of Construction Management and Engineering who presented figures of approximately 1:0.4:12 as more realistic. Nonetheless, this is still a significant ratio that indicates how, very early in a project life-cycle, there is a need to undertake key decisions that have major financial impact on the overall project. In order to support this process and base decisions on a structured approach to Client requirement capturing, Value management was developed. This research will show how this approach was applied on a construction project in Western Balkans. The Client wishes defined through their value system have been used as a base for defining Project Brief. That will further influence the project from early design stage, through construction and all the way to its completion and operation.

2   LITERATURE REVIEW

Kamara et al. in [3] note the problem in briefing as inexperienced client organization may find it relatively difficult to define their requirement in briefing. Kamara at al. in [4] reconfirms that currently briefing process is not considered to provide optimum in defining and understanding client needs. This problem can be resolved through application of VM workshops by experienced and trained Value managers. Kelly and Male in [5] state that once VM is realized, the client's value system can be used to audit the client's use of a facility in relation to its corporate strategy, project brief, emerging design and production method.

However, before client can impact the brief in a structured manner it is necessary to prepare foundation for VM workshops. Kelly at al. in [6] confirms this detailing that it is necessary to recognize the purpose of the briefing documents, the responsibilities being taken by various members of the construction team, the change management regime, the constraints, the drivers and the language to be used to ensure complete understanding by all members of the team whether construction professionals or lay client members. Kelly concludes by stating that the brief is a document that will contain the project mission and goal descriptions from the strategic brief along with the performance specification requirements of the project brief. Weatherhead at al. in [7] similarly requires to ensure the stakeholders and project team understand the client's objectives. The client may be able to provide more detailed information about the proposed facility and offer supporting information such as a statement of need, an extract from the business plan, or a strategic brief which sets out the performance requirements. In this case, the workshop facilitator has something to work from; otherwise, the workshop must start by the participants from the client organization being asked to explain their needs or objectives for the project and the overall needs and risks facing the client's business. Yahya at al. in [8] concludes that improving communications between parties is the most significant solutions to problems in briefing.

SAVE in [9] defines the value methodology various version under names Value Analysis (VA), Value Engineering (VE), and Value Management (VM). Other value improvement processes also qualify as value studies as long as they adhere to the Job Plan and perform Function Analysis as part of their total process.

3   PROBLEM STATEMENT

The aim of this research is to present a VM approach on a sustainable construction project in Western Balkans in defining Client requirements in early stages. Research is undertaken before Design Brief and any Design have commenced, and there is ample opportunity to impact on the Project outcome.

Male at al. in [10] defines several opportunities for a VM Workshop, as it can be seen in **Fig.1**. Even though other authors allow for opportunities later in the Project life-cycle, it is generally acceptable that the earlier VM Workshop is organised, the bigger impact will have on the project. Charette is best suited and it has been applied in a project discussed later in this research.

a project awareness	b Client develop-ment	A Inception	B Feasibility	C Outline proposals	D Scheme design	E Detail design	F Production information	G Bills of quantities	H Tender action	J Project planning	K Site operations	L Completion	M Feedback
Pre-brief		Briefing		Concept design		Detail design				Site operations			
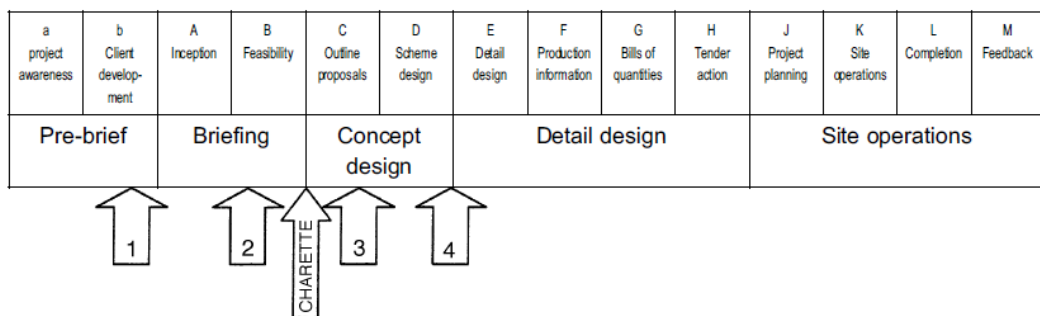
Fig. 1)   VM opportunities with reference to the RIBA modified Plan of Work [11].

4   METHODOLOGY

SAVE in [9] defines basic concepts in Value methodology:

Value Study -- The overarching objective of a value study is to improve the value of the project.

Job Plan – Provides the structure for the Value Study which is part of a three-stage process (see **Fig. 2**): Pre-Workshop preparation, Value Workshop which applies the Job Plan and Post-Workshop documentation and implementation

Value Methodology – Provides the process and structure that is used to apply the Value Job Plan used in the Workshop.

Value Standard – Establishes the specific six-phase sequential Job Plan process and outlines the objectives of each of those phases. It does not standardize the specific activities that are used to accomplish each phase.
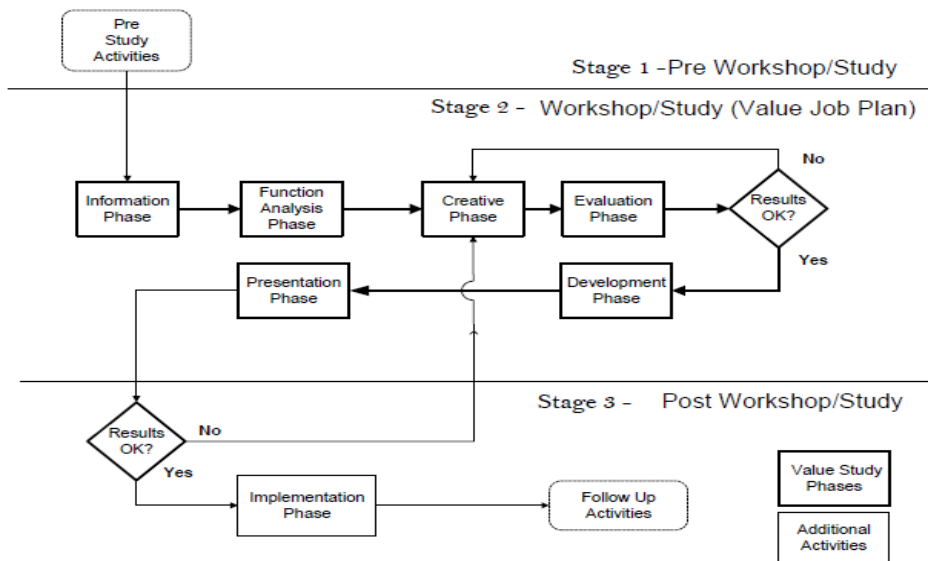
Fig. 2)   Value Study Process Flow Diagram

In the beginning of the workshop, Client representatives were informed about the background to value parameters to be discussed. A thorough explanation and clarifications were presented based on NAO in [12] consideration of value parameters:

- Ensure effective project management and delivery - relates to the management processes used, and the selection of an integrated team working throughout the supply chain
- Achieve the required financial performance - defined by the business case for the project. It includes achieving the optimum balance between capital costs, a building's operating and maintenance costs and residual whole-life value
- Minimize building operation and maintenance costs, and environmental impact - Issues to do with maintaining, operating and cleaning the facility once it is in use. This also includes minimizing impact on the environment and environmental sustainability
- Impact positively on the locality - describes issues that relate to the building's aesthetics, the way it conveys the organization's corporate image, and the building's relationship to its context.
- Maximize business effectiveness - describes how the facility delivers the benefits required by the business case. This includes issues relating to staff productivity, unit costs of production and ease of working. It also includes creating environments that employees and users enjoy and that encourage effective business processes
- Comply with third party requirements - describes statutory and other requirements including planning consent. Covers all aspects of Health and Safety both during and after construction, and addresses adherence to Central Government guidance

Kelly at al. in [6] outlines a range of techniques for managing the project from inception to completion and includes an extensive section on the management of the asset for the benefit of the client. Kelly in [13] propose the use of six possible courses of research action, namely case vignettes, interviews, Delphi, action research, grounded theory and mathematical logic but conclude that only first three were considered valid approaches. Kelly (2007) in [13]

further concludes that evidence supports that the value parameter can be ordered for preference through a process of paired comparison.

5   METHOD

In the beginning of the workshop, Clients were informed about the background to value parameters to be discussed. A thorough explanation and clarifications were presented based on NAO in [12] consideration of value parameters. Case study examples were provided to highlight critical importance of individual parameters and how they fit in the overall VM picture. Procedure of Paired Comparison was presented and discussed. Only when client representatives have grasped the full understanding of the matter, workshops have proceeded. Paired comparison method is used to rank parameters by value (compare two parameters at the time). Agreed result of individual parameters is registred and result is entered in column score. Percentage weight is calculated. Final score is then calculated with highest result being assigned score 10 and the rest curve graded down. All results were immediately recorded in excel sheet with automatic calculation pre-prepared. Due to this and agreed limited WS scope, WS have finished fairly quickly, and were concluded in matter of hours.

6   RESULTS

Following results were obtained though paired comparison exercise as presented in **Tab. 1**:

Tab. 1)   Results of paired comparison exercise from a project in Western Balkans

	B	C	D	E	F		Score	Weight	Weighted Score
								%	
A	A	A	A	E	A	1. Maximize business effectiveness	4	26.67	8
B		C	B	E	B	2. Ensure effective project management and delivery	2	13.33	4
C			D	E	C	3. Achieve the required financial performance	2	13.33	4
D				E	D	4. Minimize building operation and maintenance costs, and environmental impact	2	13.33	4
E					E	5. Impact positively on the location of the facility	5	33.33	10
F						6. Comply with third party requirements	0	0.00	0
							15	100.00	

7   CONCLUSION

Single most important value parameter for Client was defined as Impact positively on the location of the facility. It is very closely followed by Maximize business effectiveness. These parameters indicate that Client intention was to develop a project that is visually very impressive and presentable, but still will retain sustainable approach to construction where it will maximise business effectiveness. The project in question is mixed use tourist development inclusive of luxury hotel and villas, so priorities are reflected in this.

Parameters Ensure effective project management and delivery, Achieve the required financial performance and Minimize building operation and maintenance   costs and

environmental impact are deemed less important is such a development type. Comply with third party requirements are left as least important. These parameters have been transferred to designers as bases for Design Brief. Project will be monitored and success will be measured as per NAO in [12] recommendations.

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CONSTRUCTION INDUSTRY IMPROVEMENTS TO CREATE MORE ENERGY EFFICIENT CONSTRUCTION PROCESS AND BUILDING OPERATION

Kristián Szekeres[1]

Abstract

This paper presents new trends and practice in focusing on the innovative conceptual and constructional solutions which fulfill the requirements of sustainable construction. The biggest challenge of the 21st century in building sector is how to use energy and other non-sustainable resources more efficiently and how to reduce waste, pollution and environmental degradation at once. Energy consumption is the best and simplest proxy we have for how our buildings and built environment affect global climate change. The ways how to reduce the amount of energy required for operation of buildings and urban areas vary. In this paper I would like to create a brief view on the new trends and practices in construction focusing on the innovative conceptual and constructional solutions. At the present time the increasing prices of traditional energy sources push buyers and suppliers towards innovations. New construction concepts in combination with facilities for energy productions from renewable resources allow creating new buildings which are energetically neutral. It means they do not need conventional energy resources for their functioning and they enable the minimization of the environmental impact. This falls into the energetic and environmental concept of the EU.

Key words

Building operation process, construction process, energy efficiency.

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1   INTRODUCTION

Today the origin of the major part of the energy used worldwide is not from the renewable sources. Because of the quick demographical and economic development of emerging markets the energy consumption grows dynamically every year. The same problem is with the raw material consumption. There is a theory about oil peak which was created by M. King Hubbert in 1950´s. Oil has an important role in energy economics. The term "oil peak" refers to that specific point in time when the Earth's oil supply will finally reach that theoretical maximum of global petroleum extraction. After the oil peak will reached a progressive decline will start where the demand for oil will finally exceed the available supply of oil. Different sources determine different dates of the reach of oil peak. The most often mentioned dates are from period of years 2015-2020. The theory is based on the observed production rates of both individual oil wells, as well as that of conglomerate fields of oil wells and on the actual worldwide oil demand. This theory can be applied to all non-renewable raw materials. The result of predicted changes for the global economy is serious. European Union's dependence on import of energy sources and some types of raw materials is evident. In the near future in parallel with the exhaustion of non-renewable resources their price will be less and less predictable on the open market. That means in addition to the increasing energy expenses there is a great risk and uncertainty in development planning for investors, public sectors and households. The only way how to reduce the future negative effects is to decrease the independence on non-renewable energy and raw material sources. New technologies are partly available and partly under development. The main problem and barrier of the penetration of new technologies is the higher price in comparison with traditional solutions. Construction industry is one of the biggest consumer of energy and raw materials. Increasing energy and raw material prices and the slowly changing customers demand push to the construction sector to be more innovative. Over the Europe occur new research projects cofinanced with public sector which aim is a development of new technological solutions and management practices. In this paper I would like to create a brief view on the new trends and practice in construction focusing on the innovative conceptual and constructional solutions which fulfill the requirements of sustainable construction.

1.1   Goals in field of energy efficiency of construction sector

The European Union (EU) has pledged to cut its energy consumption by 20 % by 2020 compared to projected levels from 1990. Energy efficiency is the most cost-effective way of reducing energy consumption while maintaining an equivalent level of economic activity. Energy saving is the EU's most immediate and cost-effective way of addressing the key energy challenges of sustainability, security of supply and competitiveness as set out in the strategic objectives of the 'Energy Policy for Europe'. EU leaders have stressed the need to increase energy efficiency as part of the '20-20-20' goals for 2020: saving 20% of the EU's primary energy consumption, a binding target of 20% reduction of greenhouse gas emissions and 20% renewable energies by 2020 [1]. Energy consumption in residential and commercial buildings represents around 40% of total final energy usage. It is responsible for 36% of the European Union's total CO2 emissions. This sector is expanding which is bound to increase its energy consumption. Therefore, reduction of energy consumption and the use of energy from renewable sources in the buildings sector mean that important measures need to be taken to reduce the Union's energy dependency and greenhouse gas emissions. [2] [3].

1.2   Sustainable construction

Sustainable building design, construction and operation require innovations in both engineering and management areas at all stages of a building's life. The lifespan of buildings is composed of a series of interlocking processes, starting from initial architectural and structural design, through to actual construction, and then to maintenance and control as well as to eventual demolition or renovation of buildings. [4]

It means that new constructions must fulfill special requirements which are [5]:

- Low energy consumption during the whole life cycle of the construction (especially during the realization process),
- Prior uses of renewable energy sources during the operation process,
- Maximize saving drinking water and minimize sewage water production,
- Maximize uses of local construction materials,
- Minimize uses of non-renewable construction materials for example concrete, stone brick etc.,
- Minimize waste production during the construction process,
- Barrier-free and adaptable design of interior,
- Secure the demand of inhabitants for the quality of surrounding environment (during and after the construction process).

According to the data collected by European Statistics Office (Eurostat) we can conclude [6] that:

- The consumption of non-metallic minerals (from raw materials) grew the fastest in EU between 2000 and 2007 driven by sand and gravel for construction.
- Demand for sand and gravel between 2000 and 2007 fell by about 20% in Germany, Italy and the Netherlands and it grew by more than 50% in 13 EU Member States (EL, PT, ES, PL, IE, RO, SI, SK, BG, LT, EE, LV, MT).
- The construction sector was obviously a major driving force behind the changes in material consumption across the EU.
- Between 2004 and 2008 the generation of hazardous waste per capita in the EU rose by 2% per year from 181 kg to 196 kg. This was mainly driven by increases in hazardous waste from the construction sector (+10.3% per year) and from water supply, sewage, waste management and remediation activities (+7.2% per year).

Because construction industry is distinguished by high amount of raw material consumption and waste production future development has to focus on solving these problems too.

2   EXAMPLES HOW TO INCREASE ENERGY EFFICIENCY AND TO SECURE SUSTAINABILITY IN CONSTRUCTION SECTOR

The European Union is the biggest market place in the world which has tried to introduce low energy and eco-friendly technologies for a long time. As evidence of these efforts there are different programs and initiatives which focused to encourage the research in the area of environment protection and energy saving. Also other developed countries like USA, Great Britain, Australia, Canada etc. have their own support programs to encourage the decrease of energy consumption during the construction and building operation process and to encourage

creating sustainable buildings. The most interesting designs and innovations are presented in the next subheads.

2.1   Energy efficient houses

Energy efficient house is any type of house that uses less energy from any source than a regular one. Optimization of energy consumption is a relatively old idea. The first experimental projects occurred in the 1970s (DTU zero-energy house, DenmarkPhilips Experimental House, Germany, Super insulated houses in USA e.tc.).

Today, there are five main categories of energy efficient houses:

- Low energy buildings,
- Ultra low energy buildings/Passive houses,
- Zero energy buildings,
- Energy plus buildings,
- Autonomous buildings.

There is no global definition for low-energy buildings, but it generally indicates a building that has a better energy performance than the standard energy efficiency requirements in building codes. German "Low Energy House" (Niedrigenergiehaus) standard defines the maximum energy consumption limit of 50 kWh/m² per year for space heating. Low-energy buildings typically use high levels of insulation, energy efficient windows, low levels of air infiltration and heat recovery ventilation to lower heating and cooling energy, sometimes passive solar building design techniques or active solar technologies.

Definition of a passive house is: "A Passive House is a building, for which thermal comfort can be achieved solely by post heating or post cooling of the fresh air mass, which is required to fulfill sufficient indoor air quality conditions - without a need for recirculated air" [7]. In our conditions the term "Passive house" implies that: the building does not use more than 15 kWh/m² per year in heating and cooling energy and total primary energy consumption (primary energy for heating, hot water and electricity) does not exceed 120 kWh/m² per year.

The term zero-energy building is often used to describe a building with zero net energy consumption and zero carbon emissions annually. The specificity of zero-energy buildings is that the remaining energy needs are entirely covered with renewable energy sources. It means that a building with zero net energy consumption annually can be autonomous from the energy grid supply, but in practice that means that in some periods power is gained from the grid and in other periods power is returned to the grid.

Energy plus buildings are buildings that on average over the year produce more energy from renewable energy sources than they import from external sources. This is possible to achieve with a combination of small power generators and high building energy efficiency.

Autonomous buildings are buildings designed to be operated independently from infrastructural support services such as the electric power grid, gas grid, municipal water systems, sewage treatment systems, storm drains, communication services, and in some cases, public roads. Advantages of autonomous buildings are: reduced environmental impacts, increased security (less independence on public services which is safer and more comfortable during civil disaster or military attacks) and lower costs of ownership.

The cost of energy efficient building is generally higher due to the extra costs associated with improved insulation of all building components. Exact information on these additional costs was difficult to find, in particular for countries with less developed low energy markets. "Additional costs for low energy buildings cannot be predicted with precision, in all cases they depend on specific conditions. Up to 10% extra upfront investment costs are reported, but with clearly declining trend." [8]

2.2 Green Buildings

Concepts that take into account more parameters than solely energy demands are labeled with special terms such as eco-building or green building. Green, or sustainable, building is the practice of creating and using healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition. U.S. Environmental Protection Agency defines Green Buildings at their home page as follows: "Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort." [9]

Fig. 1)   Masterpiece of sustainable architecture - California Academy of Sciences, San Francisco   [Photo author]

Basic principles and characteristics of green buildings are:

- integration into the local environment,
- uses eco-efficient building materials (local resources, natural materials, application of recycled materials, easy to exchange construction elements),
- high energy efficiency,
- optimized operation process.

There is no global definition and methodology to classify green – buildings. There are some different methodologies which are used to certificate green buildings such as: LEED (USA), BREEAM (Great Britain), DGNB (Germany). A good example of green buildings in USA – California Academy of Sciences in San Francisco - is presented on figure 1.

2.3   Industrialized, Flexible and Demountable (IFD) constructions

The IFD concept aims to conceptualize and develop the organizational, technological and commercial framework and support communication/information systems to deliver client-oriented Industrialized, Flexible and Demountable buildings. These buildings offer clients/users a higher degree of freedom of choice through the use of factory-made, interchangeable building components [10]. The IFD concept addresses both client needs for quality and flexible buildings, shorter delivery time and lower costs, and societal needs for sustainability and safe and healthy work environment. Through demountability, all elements of a building can be fabricated, yet the degree of flexibility is secured by the endless possibilities to compose those fabricated elements together to make a building that suits its users. The IFD concept focuses its attention on waste management and the recycling/re-use of construction. The use of industrialized building components in IFD buildings saves large amounts of material resources.

Fig. 2)   Prototype of the energy optimized home - Velux Soltag, [Photo author]

Good examples of the adaptation of IFD concept are experimental constructions SOLTAG (presented on Figure 2) and ATIKA developed by VELUX company. These constructions offer a possibility of extension of residential and non-residential buildings. SOLTAG is a living home, designed as an energy-generating climate shield. SOLTAG is a prime candidate for a sustainable home of the future with optimum living conditions for people. SOLTAG produces energy and a healthy indoor climate for houses and residents without "polluting" its surroundings. The house is self-sufficient in terms of energy for heating, and creates CO_2-neutral heating through solar energy.

Other interesting experimental construction for creating high-rise houses has been developed at the division of building technology –department of civil and architectural engineering at The Royal Institute of Technology (KTH) in Sweden called Symphony. This concept allows:

- optimization of the construction technology to minimize production time, material waste and global environmental impact as well as significantly improving the total economy,

- buildings with components and material combinations that can literally be dismounted and reused or recycled,
- an internal space that is possible to reconstruct for future requirements since the construction system makes the plan highly flexible and variable [10].

3   CONCLUSION

Energy and non-renewable raw material consumption affect us all. New sustainable construction methods emerged in the last few years. They allow us to achieve the ambitious goals defined by the Directive 2010/31/EU of the European parliament and of the Council on the energy performance of buildings which is complemented continuously.

Measures to promote the transfer of new construction methods and technologies into practice

It is suggested that we create conditions at national level to encourage business start-ups in the field of environmental technology within the existing system of support for small and medium enterprises. New businesses in the construction industry should focus on development and manufacturing of new flexible, low energy structures in the construction of housing units based on renewable materials. The development of new solutions should involve Slovak technical universities, which in addition to their professional capacities could also use the creative potential of students of engineering and doctoral studies. Involving students should have a double effect as it would also help to deepen students' environmental thinking.

Measures to increase the demand for new solutions

Environmental fees for the production of greenhouse gases in addition to supporting the creation of additional resources for environmental investments are also important in terms of the settlement of differences between LCC structures built in a traditional and environmentally progressive design. They create pressure to improve energy efficiency and reduce energy consumption, and thus contribute to the predictable rise in energy prices. Currently in Europe the term "Green Public Procurement (GPP)" is often used. This is a new method of procurement by which public authorities integrate environmental characteristics into the procurement process. Public sector together with the household sector should be the most important pillar of the new market for "green goods and services ".

Measures to guarantee return on investment

Economic efficiency of use of renewable sources of energy and energy-efficient solutions is subject to the amount of energy prices and also the amount of allowances applicable to emissions trading. The public sector has to guarantee a minimum purchase price of electricity produced from renewable resources and also the minimum price per unit of emission allowances.

Measures to amend existing legislation and technical standards

The aim is to adopt new legislative measures so that the prescribed stringent criteria would be able to be fulfilled only by those entities that use new technologies.

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PARTNERING IN CONSTRUCTION PROJECTS – STEP BY STEP

Srdjan Topalovic[1], Dragan Arizanovic[2]

Abstract

Partnering in construction projects in the beginning of the 90s became one of the "holy grails" of the theoretical, and in some cases, practical applications (design, procurement) of the construction industry. Since then, the application of partnership relationships was mostly influenced by change (growth) of particular segments of construction which meant that further promotion of this new approach can be more attributed to academics and researchers than to actual participants in the projects.

Due to an extended period of crises in south-east Europe in the last decade of the 20th century, this approach had no real application in Serbia and adjacent countries. After the year 2000, the possibility of high profits did not motivate employers to build special relationships with contractors which would require time and human resource allocation. Contractors, on the other hand, were not willing to reinforce their supply chains with strategic partnerships, since growing supply and a continuous lowering of prices were promising signs of further expansion.

However, the lack of practical application cannot be attributed only to external but also to internal factors. Employers (both public and private), as well as contractors, are conservative in business performance and not aware of potential benefits. Furthermore, the existing legal environment rarely enforces any obligatory/optional mechanisms for application of procedures aiming at improved communication between the contractual parties and the improvement of cooperation.

For this reason the authors propose a step by step introduction. The first area of implementation could be alternative dispute resolution by using well established dispute boards and project mediation schemes.

Key words

Alternative dispute resolution, construction industry, dispute boards, partnering.

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1 CURRENT STATE IN THE CONSTRUCTION SECTOR IN THE REPUBLIC OF SERBIA

The construction sector in Serbia is one of the most important industries both in Serbia and the in region as a whole. Before we assess the current situation, we shall look at some of the statistical data since the year 2001. The total number of persons employed in the construction (Table 1) sector has constantly been decreasing over the last decade [1]. The reasons for this are numerous, but certainly one of them is the transition of the Serbian economy.

Tab. 1) Total number of employed persons vs. total number of persons employed in construction

	2001	2002	2003	2004	2005	2006
Total	1,752,231	1,676,831	1,611,633	1,580,137	1,546,471	1,471,750
CONSTRUCTION	99528	95212	91828	91090	90733	88204
%	5.68	5.68	5.70	5.76	5.87	5.99
	2007	**2008**	**2009**	**2010**	**2011**	**2011/09**
Total	1,432,851	1,428,457	1,396,792	1,354,637	1,342,892	1,336,569
CONSTRUCTION	85551	85589	82032	74506	72405	72063
%	5.97	5.99	5.87	5.50	5.39	5.39

As can be seen in the third row of the Table 1, the percentage of persons employed in construction is more or less constant and ranges between 5.4 and 6 percent. One can conclude that the construction sector shares its destiny with all economic operators in Serbia. However, if we compare the value of the executed works (Figure 1), these figures can be interpreted differently.
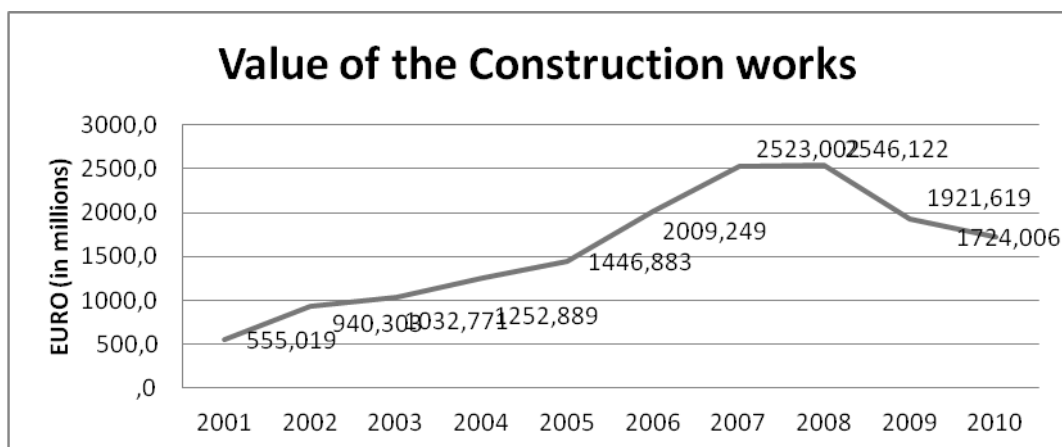
*this is the value excluding the value of the land, engineering services and VAT

Fig. 1) Value of construction works

During the transition period a number of state owned companies were closed. A second important factor is the very high percentage of employees working illegally in the construction sector, which were the first casualties of the economic crisis. Finally, the current number of employees is likely to be incorrect since it is very difficult to believe that a decrease of 32% in the value of construction works from 2008 to 2010, only resulted in a 13% decrease in the number of persons employed. Transition in Serbia revealed all the flaws in the

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construction sector but (not surprisingly) lead to significantly increased production rates. The high rise in the value of construction works enabled companies to achieve high profits without paying too much attention to relationships with other players in the market. That attitude proved wrong when the crisis started. However, before we continue with the benefits of partnering, we shall examine the judicial system in Serbia related to litigation.

2   INEFFICIENT JUDICIAL SYSTEM

This may, particularly in the region, be a misleading statement, taking into consideration the current state of the judiciary in all transitional countries. This statement may be the "long story – short conclusion" of a number of researches in the European Union in late 90s. Such conclusion(s) managed to attract attention to the European Union where the Green Paper [2] was published in 2002, followed by public debate, and almost finalised, taking into consideration that the draft Directive [3] was prepared for adoption regarding alternative dispute resolution. We shall have a look on statistical data in Serbian courts (Figure 2) where number of new court cases is ranging from 25000 to almost 42000 in year 2012.

New litigation cases

25336	27620	25546	30261	41804	31670
2006	2007	2008	2009	2010	2011
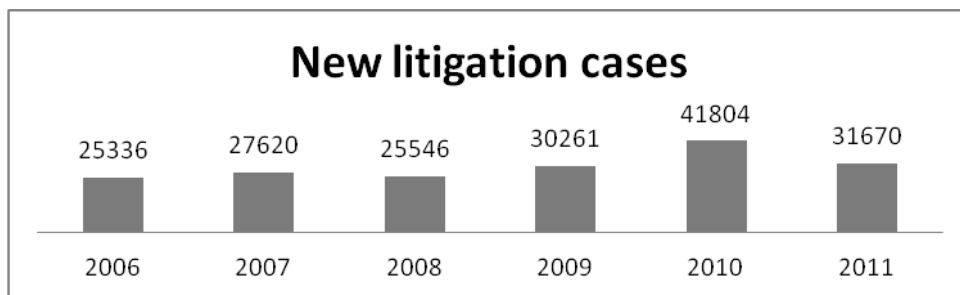
Fig. 2)   Number of new cases in commercial courts in the Republic of Serbia [4]

However, it should be borne in mind that, related to the decisions of the judges in the courts [5], since the total number of judges in, for example, the commercial courts, is only 140, this means that every year, related only to litigation cases, every judge would have to make 200 to 300 (in 2010) decisions. According to the President of the Belgrade Commercial Court [6] approximately 10% of all cases are construction related.

However, even more troubling are the results of the annual World Bank's study "Doing business" [7]. According to that study, the Republic of Serbia is ranked 92nd. Compared to the region, only Bosnia and Herzegovina has a worse ranking. The study covered 10 areas. These are: starting a business, dealing with construction permits, obtaining electricity, registering a property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency.

It is very important to point out (Table 2, column 5), that costs (calculated as a percentage of the claim) are in the range of 30%, which is approximately 20% higher than the average in Europe, but more worrying is that the average time needed for enforcing contracts (Table 2, column 4) is 635 days which is 65% higher when compared to the average 387 days in Eastern Europe and Central Asia.

Tab. 2) Historical overview of elements related to Enforcing Contracts

Year	Ease of Doing Business - Rank	Enforcing Contracts - Rank	Enforcing Contracts - Time (days)	Enforcing Contracts - Cost (% of claim)	Enforcing Contracts - Procedures (number)
DB2004	..	..	1028	33.4	39
DB2005	..	..	1028	33.4	39
DB2006	..	..	635	28.4	36
DB2007	..	..	635	28.4	36
DB2008	..	..	635	28.4	36
DB2009	..	..	635	28.9	36
DB2010	..	..	635	28.9	36
DB2011	88	94	635	28.9	36
DB2012	92	104	635	31.3	36

3   PARTNERING IN CONSTRUCTION

Construction projects and the construction industry, as a whole, are in crisis. Whilst the crisis in Serbia is, at present, a consequence of world economic turmoil, it is also a consequence of transition. The authors wish, however, to point out that the period of relative prosperity in construction at the beginning of the 21st century was not effectively used for new cooperation models where partnering was the model most often praised but lately more often disputed.

Construction projects have not always been in crisis, nor have crises had an impact in such a large number of countries. Rather, the characteristics of these projects displayed that they have always been multidisciplinary and multidimensional. The preparation of technical documentation for construction projects includes experts in various fields. Experience shows that these experts, with different educational background and with a focus on different goals, very often "speak different languages". Apart from this, projects are extremely sensitive to the price-time-quality triangle. Therefore, changes in one of the "sides" of the triangle inevitably influence at least one of the remaining two "sides". All of the above, together with a number of other factors of disturbance, lead to unhealthy relationships between the employer and the contractor which result in loss of time and money. The implementation of investment projects generates a number of "stress loaded" situations which potentially expose the project to risks and, therefore, a more efficient solution to these problems must be found.

Management, defined as the "systematic approach of leading individuals and groups, activities and operations applying resources that organization have available", positions itself as an answer to challenges of modern business and, we may freely say, to our entire civilisation. The purpose of *management* is to enable achievement of the planned goals by coordination of the efforts of the individuals.

Partnership is one of many areas of management which was the subject of studies both by academics and practitioners and recognized as a success in many areas of commerce. Although known and acknowledged as a social practice, partnering in construction has certain specifics which require additional explanation and definition of more precise roles. Simultaneous to a process and a result, Partnership is also a journey. This generic duality also describes the popular definition: *"Partnership is a management approach applied by two or more organizations aiming to achieve specific business goals by maximising usage of resources of the involved parties. This approach requires that parties collaborate openly and with mutual trust based on common goals, **agreed and accepted method for dispute resolution** and an active search for permanent and measurable improvements."*

Since the late 80s, partnership promotes improvement of the performance of participants in the projects through a collaborative approach. These improvements were recognized as a part of the re-engineering of all business processes for securing an improved quality of business management (TQM). These processes are designed to remove obstacles of integration of potentials of all project participants, to elevate efficiency of risk control and consequently to increase the profits of all. Since lack of communication was the inevitable ingredient of almost every dispute, it was clear which direction should be taken.

Partnership will change the mindset of managers and employees of the companies where it is practised. Everything may be determined by the project where agreement is limited by the specific endeavour, or it may be developed as a strategic alliance regardless of the type and number of projects. Enormous efforts are required to transform expectations and hopes of this approach to a continuous process which grows through development and implementation. Nowadays the repeated necessity of team work here represents "conditions which create conditions". Therefore, training of staff must be outsourced, using trainers with experience and a certain amount of charm, which is absolutely necessary to promote cultural characteristics required for successful development of the team.

A change in the approach of individuals involved in different segments of partnership can increase the benefits of all parties significantly compared to the simple execution of tasks required from that individual. The quality of the approach is determined by a readiness and capability to understand the partner and finding a solution that will solve a partner's needs and/or problems in an effective and efficient way. Trust can only be earned, it cannot be imposed. It is a reward for fulfilment of agreed tasks, for collaboration even if it not explicitly asked for. Only in that way, at any moment and for any issue, can one gain a sincere ally and reach synergic results which are more than the sum of the individual results of each participant.

Profit is the basic but not the only motive for partnerships and all parties should transparently present methods of working and perceived obstacles (organizational, technological and financial) in order to reach that already calculated profit. Why is this painful openness necessary? Because partnerships are based on trust and cannot be used for making comparative advantages which are the result of withheld information. Therefore, everything should be done with the aim of creating open communication where, for example, in proposals for changes of the project flow (with adequate supporting particulars), the other partner must reply in the same manner and within a reasonable time. Trust is the key factor to success, therefore, it is not surprising that most of the successful cases of partnerships were developed between partners who already had good relationships and had already had positive experiences.

In simple terms, partnership is a program for improving communication between individuals and companies engaged on engineering projects in order to achieve an improved performance of the final product: highway, bridge, irrigation system... This means that there is no such thing as an "improvement framework". Thus, partnership can be defined by a particular project where the program is within the timeframe of the project or it can be developed as a strategic alliance of several companies not linked to a particular project and in longer timeframe. Strategic and long-term partnerships usually provide all parties with significant benefits and the opportunity for development whilst at the same time benefitting the client.

Although this type of cooperation is not easy and demands significant efforts to be established, practice shows that most of the business entities involved in partnership relations consider them very useful. Further efforts in increasing trust are contrary to adversary

competitiveness which, in the construction sector, is accepted as *"conditio sine qua non"*. However, it must immediately be pointed out that a partnership is about a state of mind (evolutionally altered) correlated with a set of business procedures.

When may one expect benefits from partnership? When should it be tried even if there is no previous experience? Firstly, in infrastructure projects. The reason is that these projects are the focus of professionals and the social community, imply political causes/consequences, link many participants (big companies but also governmental institutions), are often subject to notoriously bad design documentation and to unresolved property issues along road alignments, etc.

Which benefits are the result of partnering? Amongst others, the following:

- Improved construction technology (due to the contractor's early involvement),
- Better planning and a shorter time for delivery of the product/service,
- Staff professional development and creation of possibilities for innovation,
- Business stability, which encourages self-confidence of employees,
- Investments in HR and technical resources.

Due to the well known characteristic of construction projects it is understandable that participants want to use contracts to determine the rights and obligations as well as to prescribe mitigation measures and solutions for potential problems. One can say that contracts are necessary to determine mitigation measures and liabilities for risks which are not under control of the managers. Extensive contracts with actions and reactions of both sides prescribed in detail, (de)motivate contracting parties to "look" on the outside for a partner in order to resolve unexpected problems, whilst a partnership is intended to remove obstacles to communication. Nevertheless, regardless of the nature of the partnership, it is recommended that partnerships also be regulated with a contract. Further, in order to maximize effect, that contract should enter into force as early as possible in the project cycle. Similar to archery, a small error in setting the path of the arrow will lead to missing the target altogether.

It should be borne in mind that, when we are talking about partnerships and contracts, procurement of the works on infrastructure projects or procurement of goods are often subject to particular laws and regulations which exclude partnerships. Procurement procedures are by default open tender procedures and strategic partnerships are not possible with prospective employers.

The Contract, whether it is short term (project based) or strategic, always has its own lifespan. Thus, before signing, it must be ensured that the appropriate clauses for termination are included. Sometimes partnerships succeed and sometimes not, and parties should prevent not to alienate with each other more on the end of (un)successful partnerships then it was a case before.

Every partnership relationship (most often project-based relationships) will face problems which have to be resolved prior to continuation of further activities. It is not beneficial to constantly require the justification of the relationship. Furthermore, project communication should determine: who, when, how and how often communication shall be exchanged. It is particularly important to prescribe procedures in the case of disputes – procedures, responsible persons, etc., and what is, possibly, the most important in such cases, the object should be to find the best solution to the problem rather than to find someone to "crucify".

Efficient dispute resolution is a highly motivating process that can be usefully utilized for development of skills required in complex situations. Every problem is also a challenge at the same time and partner and partnership maturity depends how this challenge is dealt with. The bottom line is that a mature partnership is a precondition for organizations to be orientated towards a "win-win" solution of disputes and on a personal level it is a precondition towards development of empathy in individuals, which form the team, which will bring new "energy" and synergy into the organization.

Ultimately, what can be said about partnering in the construction sector in Serbia? Unfortunately, not very much. After the year 2000 the possibility of high profits (resulting from openness of the transitional market and a growing productivity rate) did not sufficiently motivate employers to build special relationships with contractors which would require time and human resource allocation. Contractors, on the other hand, were not willing to reinforce their supply chains with strategic partnerships, since growing supply and a commensurate continual drop in prices were promising signs of further expansion. There are some examples of relationships that approximate partnerships but not in a formal way and this are mainly related to contractor-supplier relationships. What was more often the case were joint venture or consortium groupings of local and foreign contractors on individual projects. However, these JV/consortiums were frequently even more diverse in essence than the relationship between contractors and employers. A recent case gives a very clear example of this situation. The lead partner, due to a minor dispute with the local company, threatened to "demote" the junior partner to the status of sub-contractor and to reduce his price by 10%. Apart from being completely contrary to the JV agreement, this was contrary to all principles of any kind of partnership.

Therefore, such situations may lead to the following conclusion: If one was required to define the two most important characteristics of partnerships it certainly would be (i) communication and (ii) effective dispute resolution. Consequently the authors propose that organizations (particularly those inexperienced in partnerships) should firstly adopt and incorporate various alternative dispute resolution procedures in their agreement as a first step toward the establishment of partnerships.

4   MEDIATION

The term Alternative Dispute Resolution (ADR) is often used to describe a wide variety of dispute resolution mechanisms that are alternatives to full-scale court procedures. The term can refer to everything from facilitated settlement negotiations, to arbitration systems, mini trials, mediation, and particularly in construction, to dispute boards as well to other procedures. In the Table 3 an overview of different goals of the parties to the disputes is presented and probability of achieving these goals regarding selected ADR procedure.

Mediation is an alternative way of settling disputes based, firstly, on the principle of respecting the interests of all the parties, represented by the people authorized to make decisions, i.e. to alter the contract. Other principles of mediation are voluntarism, informality and confidentiality both of the process and the information presented during the procedure.

Mediation is also regarded as one of the best ways to settle disputes because the contracting parties reach a settlement on their own, instead of the dispute settlement being forced upon them from outside. This provides the opportunity to re-establish severed links between parties.

Tab. 3) Comparison between ADR and court proceedings[3]

Goals of the parties to the dispute	ADR procedure			Court proceedings
	Mediation	Making a non-binding decision	Making a binding decision	Judgement
Cost minimisation	☺☺☺	☺☺☺	☺	0
Fast dispute resolution	☺☺☺	☺☺☺	☺☺	0
Preservation of privacy	☺☺	☺☺	☺☺	0
Maintenance of relations	☺☺☺	☺☺	☺	0
Inclusion of parties	☺☺☺	☺	☺	0
Linking the disputed issues	☺☺☺	☺	☺	0
Obtaining neutral opinion	0	☺☺☺	☺☺☺	☺☺☺

Legend:

☺☺☺ = high probability of the parties to the dispute achieving the goals

☺☺ = probable achievement of the goals of the parties to the dispute

☺ = low probability of the parties to the dispute achieving the goals

0 = high probability of the parties to the dispute not achieving the goals

The objective of mediation and the mediator (that should only direct the process, and not make decisions instead of or on behalf of the parties in the dispute) most frequently boils down to influencing the parties to „lower" their expectations, which then makes it possible to reach an agreement. It should be pointed out that in the process of mediation only partial attention is paid to facts and the provisions of the law.

Perhaps the best definition of a successful result of mediation was given by Mr. Ferdinad Fourie (manager of the department for contract and indemnity request management at Kivit Corporation in the US) – "both parties are equally dissatisfied with the result of mediation".

The Republic of Serbia, with the assistance of many international organisations (where the WB and EU had a leading role) embraced alternative dispute resolution, specifically mediation, and included the respective Law on mediation in the legal system. Initial results were more than promising. Results from 2004 to 2009 [8] show that more than 1850 cases were solved by mediation of which 375 were commercial cases. Total funding released as a result of mediation exceeded 45 million US$. What can be considered as the greatest achievement was that the average time required for reaching agreement was 20 days with a success rate of approximately 75%. However, in the subsequent two years, due to political turmoil related to the general election of judges, all enthusiasm appears to have vanished. A new revised law was prepared in order to include previous experiences and to rectify some perceived flaws. Hopefully this law will enter into force since the results of two case studies show that, due to the mediation procedure, benefits in construction can be multiple. Case 1: A dispute between a main contractor and a number of sub-contractors and suppliers of equipment. Twelve separate mediation agreements were signed and all of them prior to the commencement of court litigation. For Case 2 here are the main characteristics of the mediation agreement. 1. Parties agreed that party A owes party B a total sum of XXX Euro as

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[3] According To The Table From Literature: F. Sander, S. Goldberg, "Fitting The Forum To The Fuss: A User Friendly Guide To Selecting An ADR Procedure", Negotiation Journal, January 1994, P. 49–68

the balance remaining for delivered equipment. 2. Parties agreed that, in accordance with article 1 of this agreement, party A shall repay the debt in the following 11 months. The value of each instalment shall be subject to current financial capabilities of party A. 3. Party B shall not calculate or request the payment of any interest if the debt is repaid in accordance with this agreement.

5 CONCILIATION

Conciliation is a process where, like mediation, a third party is present with one significant difference. The third party may give its opinion and even make recommendations if the parties cannot reach agreement and jointly refer to the conciliator for a recommendation.

Conciliation is particularly important in projects financed by the European Commission (such as projects financed from funds of Instrument for Pre-Accession – IPA), which are implemented in accordance with the procedures prescribed in the Practical Guide to Contract procedures for EC external actions –PRAG. According to the General Conditions of Contract, if a dispute arises, parties are obliged to try to resolve it via an Amicable Settlement. If that is not possible, one party will request from the other party to try to resolve the dispute by conciliation. In cases where the European Commission is not one of the parties (for example in decentralized procedures), the role of the third party may be entrusted to the EC. Only if conciliation has no result, will disputes be subject to arbitration or litigation in accordance with the Special Conditions of contract.

6 ADJUDICATION

Historically, Dispute Resolution Boards were „born" in the USA as a consequence of increased competition which lead to a significant reduction of profit margins in the construction sector after the Second World War. Aiming at restricting these reduced profits, contractors started to utilize all available means. Because of the traditional culture of litigation in the USA, additional costs started to impact the overall construction industry. The National Committee for tunneling technology sponsored the study of contracting practice under the title "Better Contracting for Underground Construction"[9]. One of the important conclusions was related to the impact of arbitration and litigation costs on the construction sector. Although the "Boundary Dam" project was recorded in Washington in 1960 where the "Joint Consulting Board" was established as the predecessor of the DRB, it is considered that the first DRB was used in 1975 during the construction of the Eisenhower tunnel on the interstate I-70 in Colorado. The result was astonishing. Three disputes were presented to the board and not a single one was processed further to arbitration or court.

On the other side of the ocean, in the United Kingdom, the "trigger" was Sir Michael Latham's study "Constructing the Team" [10]. After several unsuccessful projects and continuous complaints from all participants in the construction sector (primarily Employers on the low quality of executed works), the UK Government initiated the mentioned study. Specific deficiencies are easiest to be seen in the following statements: The construction industry is „incapable of delivering for its customers", and „lacking respect for its employees". It was also characterized as „ineffective", "adversarial" and „fragmented'". Recommendations were essentially simple and related to enabling team work and making partnerships. Of course, in such an environment, attention must be paid to prevention and when not possible, to the quick resolution of disputes. Therefore, adjudication was recommended as a tool for dispute resolution.

Contracting parties have three possibilities of selecting the type of dispute boards. As has already been pointed out, the first possibility is the Dispute Review Board – DRB, which gives recommendations which are not binding on the parties in a dispute The second possibility is the Dispute Adjudication Board – DAB which reaches binding decisions. Commencing from 2004 [11] the International Chamber of Commerce – ICC, offered a third, hybrid-type possibility, namely the Combined Dispute Board – CDB, which gives recommendations, which can be binding decisions if one of the parties in the dispute asks for it, and the Board concludes that it is justifiable.

7   CONCLUSION

In this paper, the authors opted to present the predominantly positive aspects of partnering. Recently, some of the studies (for example, [12] and [13]) expressed criticism towards actual results. Analysing the situation in the construction sector in Serbia and surrounding region, we are still in the rudimentary stage of potential applications of the concept. As concluded before, alternative dispute resolution is one of the key elements that may determine partnership as successful or not. On the other hand, the results of ADR are easily recognized and therefore much "closer" to acceptance by professionals, managers and other stakeholders in the sector. As in many other areas, the construction sector should first learn to "walk" before it can "run". Mediation may be the first step toward partnerships. It is a non-confrontational, fast and relatively inexpensive (compared to other options) way to resolve disputes and to establish good and beneficial communication between parties to the contract, which one day, may become partners.

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STREET LIGHTING IN THE TECHNICAL UNIVERSITY OF CRETE CAMPUS

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Abstract

This paper aims to record the current state of the TUC Campus street lighting network, to localize the existing weaknesses of it and to expose proposals for the improvement of its characteristics. On the parts of the campus that this research examines, exists a network of 258 metallic lighting columns, of different heights and oldness, where each column bears one to four lamps. During the conduction of the survey became obvious that a significant portion of the users considers that the existing lighting levels is not satisfying. The data provided by the maintenance section of the Technical Department of TUC revealed, generally, the insufficient provision of funds for the maintenance of the network and the absence of an implemented innovative policy which can lead to energy saving. This paper presents general information related to the topic of street lighting and its positive contribution to road safety and criminality indices. It describes the procedure that was followed for the field recording of the existing infrastructure using a GPS. It analyses the characteristics of the columns and lamps of the lighting network. It presents the questionnaire used for the survey and its results. The last part of the paper is dedicated to proposed lighting systems for energy saving (e.g. photovoltaic systems) and the cost evaluation of the purchase and installation of such systems.

Key words

Energy saving, field recording, lighting systems, questionnaire, street lighting.

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1   INTRODUCTION

There are two kinds of lighting ; natural lighting during daytime, coming from the sun, and artificial lighting which comes from other sources (usually electricity), necessary when there is insufficient or no natural light. In accordance with the "correct lighting" specifications, lighting should cater for visual comfort, that is the capacity to allow for an unhindered function of vision, from every perspective.

Street lighting is an important public utility which provides social and financial benefits, through a framework of reasoned energy use and restriction of light pollution. Street lighting contributes to regulated traffic and thus to the reduction of road accidents, to an increased feeling of security when on the road, to the creation of a favourable climate for businesses, and to the holding of social and public events during evening hours [1,2,3,4,5,6].

The ideal lighting installation should enable the driver to perceive : a) the condition of the road section which lies ahead covering the next 5 to 10 seconds, b) the position and movement of his own vehicle and of all the other vehicles on the road, c) the existence of any obstacles on the road surface, and d) the vertical and horizontal road signposting [2].

It is worth mentioning that research findings in Greece, 2001, show that 25% of the road accidents taking place at night on roads with no lighting, are fatal. The corresponding percentage for accidents taking place on lit roads is three times lower. A strong confirmation of the above is the fact that the same analogy applies for G. Britain, which holds the lowest rates of fatal accidents in the EU. Although it would be difficult to establish a direct correlation between restricted vision accidents, it is widely accepted that a disproportionately large number of accidents occur at night, and that accidents involving running-over pedestrians, cyclists and motorbikes riders in the city increase significantly in insufficient lighting conditions [7]. According to the same research, the existence of street lighting appears to cause a 49% reduction in accidents involving (injured) casualties.

Street lighting is desirable in all cases; nevertheless, it is only implemented in cases such as parts of extra-urban roads with heavy traffic loads, certain road parts for which research indicates obvious improvement in road safety with lighting application, and other cases, where the existence of street lighting is undisputable.

The management of the Campus Electric Lighting Network is an issue of utmost importance, both from an environmental and a financial point of view. From an environmental point of view, given the current global environmental situation, which is problematic, and taking into consideration the role of a Technical University with an Environmental Engineering Department, then the promotion and application of energy saving systems is more than obvious. From a financial point of view, due to the considerable funding cuts in operational costs of all Higher Education Foundations.

The lighting network of the tarmac laid sections, which comprise the streets and parking areas of the Campus, consists of a wide network of electric lighting posts. These are mainly of conventional technology and were placed in different periods of time due to successive extensions in the Campus, which means they have different technical characteristics and age. The Technical Service of the TUC is responsible for their operation and maintenance. The operation of the above lighting system is complemented by the operation of lighting posts which exist in pedestrianized streets, courtyards and athletic courts.

The usefulness of this particular case of lighting lies in that it provides road safety to the users after sunset. Drivers of vehicles, riders, - mostly students or employees at the Campus – and pedestrians, are considered as the users, who make use of the facilities for walking or other athletic activities. Although crime levels in this area are in fact very low, one cannot ignore the contribution of street lighting to the prevention of petty crime incidences. Furthermore, the existence of lighting during night hours is conducive to the aesthetic upgrading of the place, by enhancing the architectural identity of the buildings, while it positively affects the psychology of those who intend to enter or stay on the Campus during night hours.

This paper, by applying existing theoretical knowledge onto the specific needs of a space, attempts to improve the road safety provided by Electrical Lighting and to operate the lighting network with less energy requirements from conventional energy sources.

2   METHODOLOGICAL APPROACH

2.1   Recording of primary data

In the process of recording the electric lighting infrastructure in the road network and parking spaces of the Campus, a hand GPS, type Mobile Mapper Pro was used. Its technical characteristics include its capacity to follow powerful office software and to provide a clear and simple data representation for processing and other use applications.

During the measurement of coordinates of every post position, qualitative parameters were also filled in such as :

- Type of post, with the options of old and new,
- Height of post, with the options of high and low,
- Post condition, with the options of rusted and not rusted, and
- Number of lamps, with the options of one, two and three.

The classification of a post as old or new depending on the lamp system it bears and as high or low was based on a comparison between the existing posts. The classification as rusted or not, was to some extent subjective (Fig. 1).

Overall, on the Campus streets there were recorded (Fig. 2) : 86 lighting posts with one lamp, 9 posts with 2 lamps and 1 post with 3 lamps. On the parking sites of the Campus there were recorded 21 posts with 1 lamp, 12 posts with 2 lamps and 29 posts with 4 lamps.

The authority responsible for the operation and maintenance of the street lighting network in the TUC, is the maintenance department of the Technical service of the foundation.

The street lighting network of the TUC is equipped with OSRAM lamps, HQI-E type, 250w, which generate warm light, or HPI, PHILIPS, of the same power, which generate cold light. In the lighting system of the road network, every lamp comes with a transformer of 125W power, a starter and a capacitor. The starter induces the start of lamp operation and then it deactivates, while the existence of a capacitor is necessary, since there is a transformer in the system, so as to function as the electricity cosine correction.

Fig. 1)   Examples of lighting posts
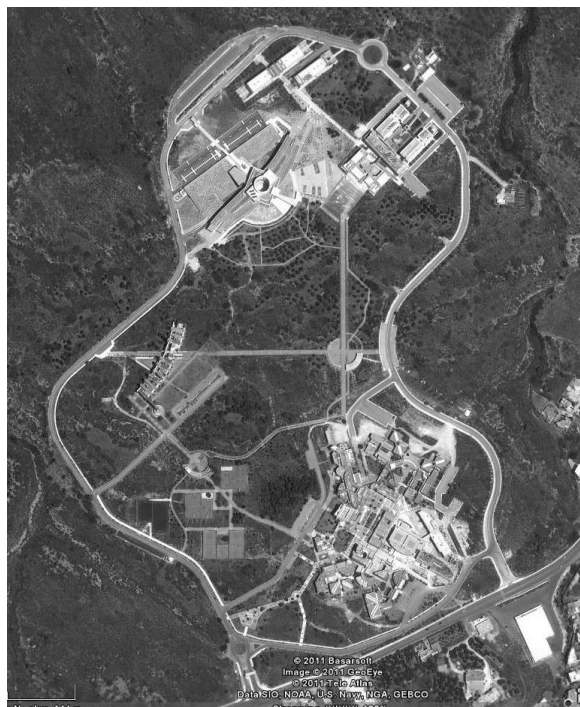
Fig. 2)   The Campus road network

The parking sites are equipped with H125/E27/Kolorlux General Electric lamps, but these only include a transformer of 125 W. According to the current legislation though, all conventional lamps are to be gradually replaced by economic ones (fluorine lamps). For this reason, whenever a lamp replacement is required, the new lamp is an economic one, of 23-32 W (the 32W ones are fitted in posts with one lamp), and their operation does not require the existence of a transformer.

The posts used fall into two categories, according to their height. The two categories share some common characteristics, with the exception of the higher part of the posts in which the lamp is fitted where there are differentiations as to the lamp size and shape requirements. Posts of lower height were placed only on certain parking sites in the past. Posts which were

fitted many years ago were made of iron, while the more recently fitted ones, such as the ones in front of the basketball court, are stainless. It is worth mentioning the existence of certain newly fitted posts at the new parking site of the Environmental Engineering Department, consisting of two parts, of which the higher one has the capacity to move through its connection to the other part, so as to lower to a height low enough so as to render the use of crane baskets for its maintenance, unnecessary.

The TUC Campus has a certain network of utility holes of very large cross-section and was created in the initial construction phase. Through this network it is possible to periodically conduct any extensions on the other networks (e.g. water network), or on the lighting network by using the cables hole. When the buildings under construction cannot be provided for by these utility holes network, its extension is achieved through other means (by placing plastic spirals enclosing the cables underground, aerial, etc), which is virtually an extension of the utility holes infrastructure.

As regards the operation hours of the Electric Lighting network, it remains active throughout the night, since the start and end of its operation are activated by photocells.

As regards the maintenance, whereas there is intention on the part of the Technical service to conduct it twice a year, it is in fact conducted once annually. The maintenance procedure conducted by the Technical service regards the replacement of lamps, transformers, capacitors and starters, but not the maintenance of posts, since the required funding for this cause is not available. The foundation does not own a basket bearing crane and it has had to lease one every time it was required, with the exception of two concessions by the former mayor of Akrotiri, to use theirs.

2.2 The opinion of the Campus users

In order to record the users' opinion, a questionnaire was designed and materialized. The results show that although the entire body of the Campus users have never been involved in an accident within the Campus limits, they nevertheless feel that the lighting conditions are such, that the possibility of a road accident cannot be excluded. We should also take into consideration that the TUC, as an institution, is bound to see its community members continuously increasing, even at a slow pace, which augments the possibility of a road accident.

The highest rates of dissatisfaction which are observed in the answers given by the users of the Environmental Engineering and the Production Engineering and Management buildings may be due to the incorrect or incomplete positioning of lighting posts around the Department buildings in question and to the insufficiency of the lighting provided because of the network's number of years and insufficient maintenance.

The network maintenance is carried out less often than required in order to work properly, which will probably prolong the users' dissatisfaction about the lighting standards and also lead to irreparable damage on the lighting posts.

3 PROPOSALS

3.1 Proposals for the improvement of the existing situation

There is no doubt that the funding of the Technical service, maintenance department for the maintenance and upgrading of the lighting network in the Campus streets and parking sites, will improve the existing situation. Specifically, the availability of funding resources will

ensure staff payroll, availability of the necessary equipment, purchase of consumable materials, and will allow for the repair or replacement of lighting systems when out of order or when their performance is so weakened that they do not fulfil the lighting standards. In the same vein, it will be possible to supervise the condition of the network posts so that they can be restored when necessary, before any irreparable damage occurs. In addition, an adequate staff presence will ensure the necessary interventions in the network of street and parking site lighting, when required. For instance, in cases of newly erected buildings, change of use in existing buildings, or increase of traffic load.

Based on data collected from the Technical service, the energy requirement of each high post lamp is 250W. As regards the low lighting posts which are to be found only in the parking sites, they had 125W lamps fitted in. We assume that all parking sites bear 125W lamps, although a considerable percentage of them have been replaced by economic ones, of less power. Based on these data, the current overall energy requirement of the Electric Lighting in the Campus streets and parking sites is 47,875 W.

From a specific site we received the overall duration of power cuts in 2011 for the geographic coordinates of Crete, and knowing that during these hours the Campus lighting network is activated through photocell, we can establish the annual consumed energy of the street lighting network. Thus, the overall annual consumed energy for the lighting network in 2011 is:

$$47.875 \text{ W} \times 3.137,9 \text{ h} \approx 47,9 \text{ kW} \times 3.137,9 \text{ h} \approx 150.226 \text{ kWh} \tag{1}$$

Part of the energy saving interventions during the operation of Electric Lighting networks is the replacement of conventional lamps with LED ones [8,9,10]. Although the use of LED lamps for street lighting is not widespread yet due to the initial high cost, it could be an alternative suggestion for the TUC. According to Tables 1 and 2, the initial cost will have been recouped within three years from their instalment. Replacing the lamps in the parking sites will bring about a similar outcome.

Apart from the economic and environmental benefits, the quality improvement of the lighting provided after the lamp replacement with LED ones should not be overlooked. It is also worth mentioning some additional advantages of LED lamps : one of these is the preservation of their brightness throughout their lifetime, the reason being the emission of (on average) eight times more intense brightness than a conventional lamp, along with their low voltage low temperature operation. Furthermore, the malfunctioning of a LED does not affect the operation of the rest in the system.

Also, their operation in low constant voltage (usually 12v/24 Vdc) ensures low electrocution hazard levels. An additional advantage of LED lamps is the exceptional anti-shock protection, since their construction does not include yarn or glass, and because of their small size; last but not least, these lamps have low infrared and ultraviolet emission levels.

To sum up, the replacement of the existing lamps with LED ones will have a tangible positive effect on the users' satisfaction with the quality of light produced. Also, the environmental and economic benefits ensuing from this intervention are considerable, while the installation cost may be considered as a deterrent.

Tab. 1) Long term economic benefit after the replacement of the street lamps

	LED 70 W	MH 250 W
Life span (h)	50.000 (approx. 16 years)	12.000
Average market price (€)	120	15
Overall electricity consumption for a full life span of a LED batch (kWh)	437.500	1.562.000
Overall cost of electricity consumption (€)	39.000	140.000
Lamp replacement overall cost MH (€)		7.500
Overall economy from a LED batch after a full life span. (€)	108.500	

Tab. 2) Annual economic benefit from street lamps replacement.

	LED 70 W	MH 250 W
Annual electricity consumption cost (€)	2.440	8.750
Annual economic benefit (€)	6.310	
Overall cost of LED purchase (€)	6.310	
Time needed to recoup LED cost (yr)	2,38	

3.2 Use of renewable energy sources

Although the replacement of the existing conventional lamps with LED ones leads to reduced electricity consumption of the network (according to current data), one should not overlook the possibility to exploit solar energy in order to sustain the network, since it is sunny on Crete for the biggest part of the year [11,12]. Also, in spite of the fact that there is a small number of photovoltaic panels on the Campus either as part of a pilot project or for research purposes (Fig. 3), the prospects of using solar energy in order to cover the needs of the lighting network haven t been explored.

In general, a photovoltaic panel installation can be dealt with, with two different approaches. The first one is to place autonomous panels, one on each lighting post. The second one is to create a set of panels, placed on a building roof or any other large flat surface. As regards the second way, there can be two alternative suggestions, depending on the way the incoming energy is distributed. So, synoptically the three alternative options are :

- Installation of autonomous panels on the lighting posts.
- Installation of a set of panels on a flat surface and storing of the produced energy into batteries.
- Installation of a set of panels on a flat surface and distribution of the electric energy to the National Electric Generator Board.

- It is worth mentioning that a photovoltaic panel installation should be combined with LED lamps fitted in the lighting network, so that the two energy saving practices act in synergy; for practical reasons also, since the required panel surface would be smaller. A comparison of the three available options is given in the Table no. 3.

The roof of the Sciences Department building is a suggested surface for panel installation. Its surface area is approximately 1,000 m^2 . It is also possible to approximately calculate the surface area occupied by each panel, which is 2m^2 and the aisle between the panels – for accessibility reasons – which is 1m^2. In other words, the overall surface area required is (2 m^2 + 1 m^2) × 100 panels = 300 m^2, which is of course a fraction of the available surface area.

Fig. 3)   Photovoltaic panels installed on a Campus expanse

Tab. 3)   Available options for the installation of photovoltaic panels on the Campus.

Possible scenario	Cost
Installation of autonomous panels on the posts (€).	Approximately 300.000 [www.suncon.gr].
Installation of a set of panels on a flat surface and storing of the produced energy into batteries (€) .	Approximately 230.000 [www.e-shop.gr]
Installation of a set of panels on a flat surface and distribution of the electric energy to the National Electric Generating Board (€).	Approximately 80.000 [www.e-shop.gr]

To conclude, the installation of autonomous photovoltaic panels on each post is not considered cost effective, while it is virtually technically impossible to install panels of sufficient capacity on street light posts. The preferred alternative would be the installation of a photovoltaic panels set on a flat surface (the roof of the Sciences Department building was proposed for this purpose) and the distribution of the produced electricity to the National Electric Generating Board. In addition, the alternative of using batteries to store the energy is not preferable either, due to the high cost of the batteries required. Finally, it is of outmost importance that the installation of photovoltaic panels is accompanied by the replacement of conventional lamps with LED ones.

4   DISCUSSION

The expected economic stagnation of educational institutions for the near future,in combination with the fact that the Campus site is ideal for solar and wind energy exploitation and that a department of environmental studies is included in the TUC, make the use of Renewable Sources of Energy for the power supply of the lighting network a very probable outcome for the near future.

The network of electric street and parking sites lighting plays an important role in the smooth regulation of Campus activities. However, it has no homeogenity due to successive extensions corresponding to Campus extensions. Some important issues to examine, concerning the electric lighting network in question, are the positions of the existing posts and of the new

ones and the lighting levels they provide. The importance of the aforementioned issues is justified by the large number of people active on the Campus who consider the lighting insufficient, when answering the questionnaire. Being aware of the general declining economic situation for the higher education institutions, but also of the perpetually small funding percentage allocated to them, one realizes the difficulty in implementing the present research, and even more so, in making interventions.

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FLOW-SHOP SCHEDULES IN CONSTRUCTION

Zoltán András Vattai[1]

Abstract

It is a rare situation when Construction Managers have free hand to establish the optimal sequence of jobs (civil engineering objects, buildings, etc.) to be erected for to achieve say the shortest overall execution time. The order of jobs are typically determined by individual contracts (by clients) or by some practical considerations (accesses, logistics, technological relations, functions, etc.). It is less commonly known that with no other factors changed the sequence of jobs ab ovo define minimum overall execution time achievable. Within special conditions the sequence of jobs may have significant effect on minimum overall execution time, even more, this effect theoretically can be non-limited (!). The phenomenon is known and studied deeply in Operations Research (Management Science) for Manufacturing Industry (Production Management) and is referred as Flow-Shop Scheduling Problem. The paper is addressed to some managerial aspects of Flow-Shop Schedules – in fields of Construction.

Key words

Computer applications, construction management, flow-shop, industrialized construction, scheduling.

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1   INTRODUCTION

Utmost effective arrangement of production elements in manufacturing industry is imaged by assembly-lines most famous early representative of which is Chicago butchers' disassembly line inspired production line fully introduced at Ford Motor Company in 1910 producing ten thousand cars a day in years of its maturity. This kind of arrangement of production processes not only provides the highest productivity at lowest unit cost in case of mass production, but also promotes mechanization integrating machine series in production procedures right to man-less totally automated manufacturing plants. This later sentence contains three key terms: highest productivity, lowest unit cost, mass production.

These key terms – better said pre-conditions or expectations – are not too easy to implement in Construction Industry. On-site production is highly exposed to disturbing effects and to changing conditions; pursuing lowest unit cost may lead to more and more incorrect and/or unsustainable market competition; and needs for mass construction is typical rather in post-disaster periods when fast and massive reconstruction/redevelopment is a key consideration.

This later was the case – for example – after World War II in Europe (especially in Middle and in Eastern Europe), and is the actuality in some disaster-stricken developing countries of our days too. Introducing and favouring so called "Industrialized Construction" resulted in frequently criticized districts (housing plants) of soulless uniform block houses and spiritless uniform public buildings still characterizing landscapes of bigger cities in countries of Eastern Europe. That was the era of Belt-System Construction, when troops of "workers' armies" had built thousands of houses of the same structure, when progression lines of succeeding jobs on linear schedules hastened to shape perfection – the ultimate parallels (See Fig. 1).
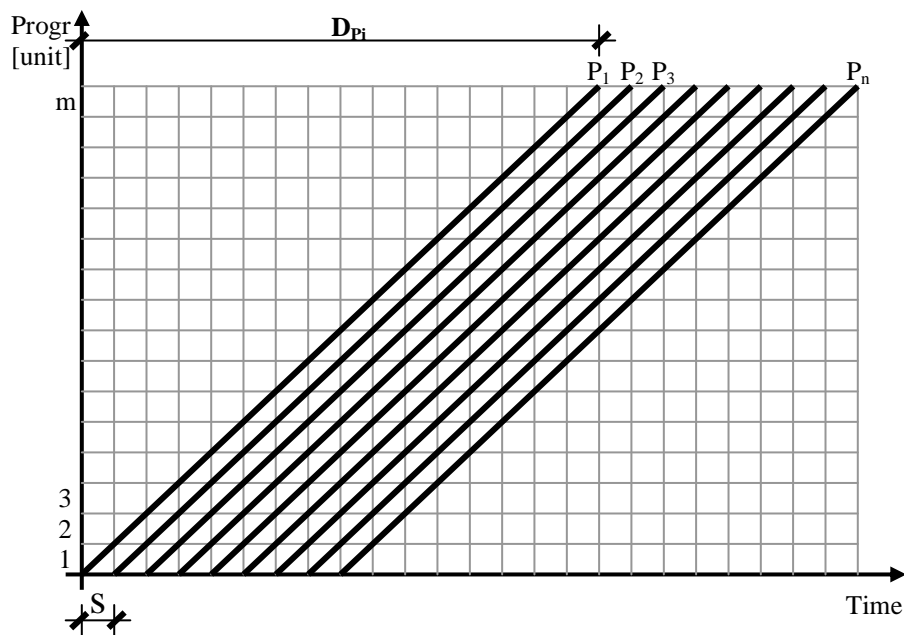
Fig. 1)   The ultimate parallels – the Synchronized Belt

2   FLOW-SHOP SCHEDULES

Mass production – by its nature – can satisfy needs in quantity in a relatively short period, but due to changing expectations and needs for variety manufacturers soon faced the challenge of

uneven production times (per unit) on units of machine series and confronting preferences of consumers ("clients") and of manufacturers ("contractors" – in Construction Industry).

Though thinking it over in short it can be seen clearly it is less widely known that sequence of products (buildings) to be processed – when having the same machines (resources) assigned to all products (buildings) – may have significant effect on production (construction) time of individual products (buildings) and on overall production (construction) time of all.

Figure 2. demonstrates time effect of sequence of buildings ('A' and 'B') to be erected by the same two subcontractors ('a' and 'b'). At top we see separate schedules with individual technological breaks (grey stripes indicating succession times between succeeding jobs) and combined ones below when all jobs are integrated in one common Master Schedule.
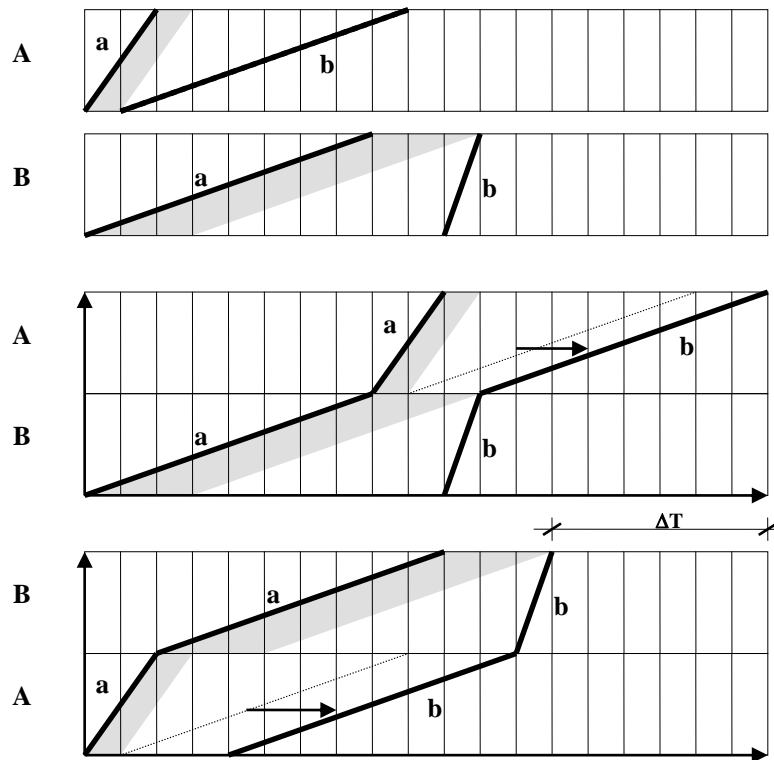
Fig. 2)   In what a sequence?

Due to typically given (fix) technological order of processes (activities, jobs) on buildings of the same technology (first we build the foundation, after the wall, and after the roof, etc.) this effect may be multiplied – even more, theoretically can be unlimited (!).

Figure 3. demonstrates effect of sequence of series of two kinds of products ('A' and 'B') having different production times at succeeding machines. At product 'A' production time (D) on each second machine is significantly bigger than on the odd ones (which is nearly 0), while at product 'B' it is the opposite. Both product series consist of 'm' pieces of products (here m=3) and all of them are to be produced by the same 'n' pairs of machines (here n=3).

Fig. 3) Master Schedules having different sequences of the same products

When comparing overall execution time of the "best" sequence (T') and that of the "worst" (T") increasing the number of units ('m') in the series and/or the number of pairs of machines ('n') we get the theoretical result "unlimited" (ratio of the two tends to be 0 – See Fig. 4).

$$\frac{T'}{T''} = \frac{t_1'+t_2'}{t_1''+t_2''} \approx \frac{m \cdot D_a + (n-1) \cdot D_a}{m \cdot D_a + m \cdot n \cdot D_a} = \frac{(m+n-1) \cdot D_a}{m \cdot (n+1) \cdot D_a} = \frac{m+n-1}{m \cdot (n+1)}$$

$$\lim_{m \to \infty} \frac{T'}{T''} \approx \lim_{m \to \infty} \frac{m+n-1}{m \cdot (n+1)} = \lim_{m \to \infty} \frac{m}{m \cdot (n+1)} + \lim_{m \to \infty} \frac{n}{m \cdot (n+1)} - \lim_{m \to \infty} \frac{1}{m \cdot (n+1)} = \frac{1}{n+1} + 0 - 0$$

$$\lim_{n \to \infty} \frac{T'}{T''} \approx \lim_{n \to \infty} \frac{m+n-1}{m \cdot (n+1)} = \lim_{n \to \infty} \frac{m}{m \cdot (n+1)} + \lim_{n \to \infty} \frac{n}{m \cdot (n+1)} - \lim_{n \to \infty} \frac{1}{m \cdot (n+1)} = 0 + \frac{1}{m} - 0$$

$$\lim_{\substack{m \to \infty \\ n \to \infty}} \frac{T'}{T''} \approx \lim_{\substack{m \to \infty \\ n \to \infty}} \frac{m+n-1}{m \cdot (n+1)} = \lim_{\substack{m \to \infty \\ n \to \infty}} \frac{m}{m \cdot (n+1)} + \lim_{\substack{m \to \infty \\ n \to \infty}} \frac{n}{m \cdot (n+1)} - \lim_{\substack{m \to \infty \\ n \to \infty}} \frac{1}{m \cdot (n+1)} = 0 + 0 - 0$$

Fig. 4) Theoretical effect of sequence on Total Execution Time

In a realistic case – of course – effect of sequence is not unlimited but can be so significant that restless endeavours are made in our days too to find optimal sequence of products in various production environments to achieve the best indices of various target functions.

In 1973 researchers had suggested a kind of reference system to identify scheduling problems by classification according to availability of machines and further restrictions completed by indication of actual target function [1]. Using this coding system our scheduling problem can be identified as F|overlap|C^{max} to be read as:

The job is Flow-Shop scheduling with no limit on number of machines ('F'), where overlap in time is allowed at processing by succeeding machines (more machines can act on the same

product in the same time) ('overlap') and the aim is to minimize the overall execution time identified by completion time of the last product ('C^{max}').

Flow-Shop as a basic class of scheduling problems embraces a set of conditions on production environment too:

- There are 'm' products to be scheduled on 'n' machines (each product must be processed by each machine);
- Order of machines at processing products is given and is the same for each product (technological order of machines is fixed and known);
- Order of products must be the same on each machines;
- Machines are performing their only job (special machines for each process);
- Processes are performed by single machines (one machine available for each job).

Substituting words of "product" and "machine" by "building" and "team" we can recognize preliminary conditions of establishing a belt-system construction [2].

To demonstrate variety of scheduling problems and their coding we may mention Job-Shop Scheduling (J), where technological orders of machines are given but may differ by products; P refers to situation when parallel machines are used and each machine can perform any job; 'pre-emption' indicates when processing of a product can be broken at machines; 'idle' refers to allowed workless periods of machines between succeeding products, while 'no-wait' warns us when it is unacceptable; 'res1,res2' identifies limited availability of resources; also target functions can be the minimum of sum of completion times (ΣC_i), minimum of sum of delays-, lateness- or tardiness (ΣD_i, ΣL_i, ΣT_i); and so on, to mention the most frequent ones only.

3   THE MATHEMATICAL CHALLENGE

One of the hardest challenges at scheduling Flow-Shop production is the so called "NP hard" or "non-polynomial" characteristic of the problem. Due to no existing polynomial algorithm (when number of needed steps of solution can be estimated as some polynomial function of size of set of products) exact solution can only be gained by some kind of enumeration and in extreme situations all possible sequences should be tested. To find the optimal sequence may need extremely long time [3].

To make it tangible: Assuming a super computer testing a million different sequences in a second it would take more than 77 thousand years to test all possible sequences of 20 products only ($20! = 2.43 \cdot 10^{18}$; $2.43 \cdot 10^{12}$ sec $>$ 77000 years).

F2||C^{max} (Scheduling m products on 2 machines) is one of a few delighting problems for which there exists a polynomial solution – first published by S. M. Johnson in 1954 [4]. Having more than two machines the problem seems to be stubbornly NP hard.

Integrating special needs and more realistic conditions of Construction Management typically implies extension of the original problem even more deepening difficulties of finding optimal solutions and of proving their optimality.

For example:

Restriction of "uniform order of machines on products" ("uniform technology") would be hurt (should be released) at situations when not all machines (all jobs) are needed to produce each

products ("missing jobs allowed") – though relative order of machines remain the same. (See Fig. 5)
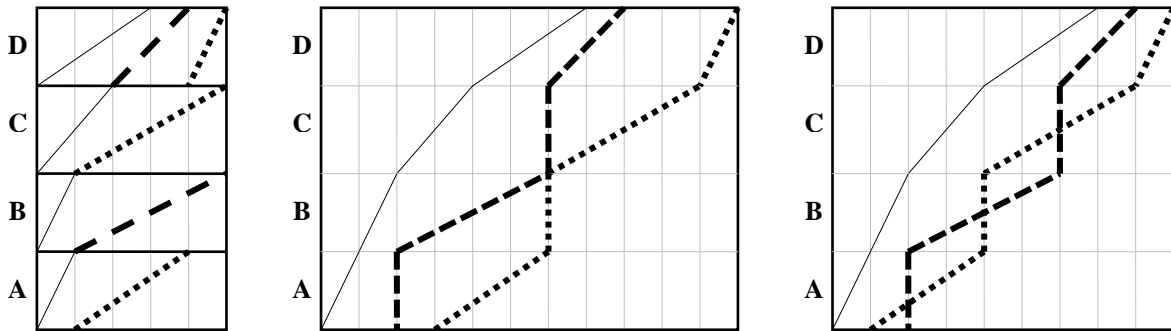
Fig. 5) "No missing jobs" and "Missing jobs allowed"

Setting restraint of "no idle times" would eliminate possibility of resolving paradox situations when – proportionally or virtually – increasing duration of an activity results in decreasing overall execution time. (The phenomenon is know as "Duration Paradox") (See Fig. 6)
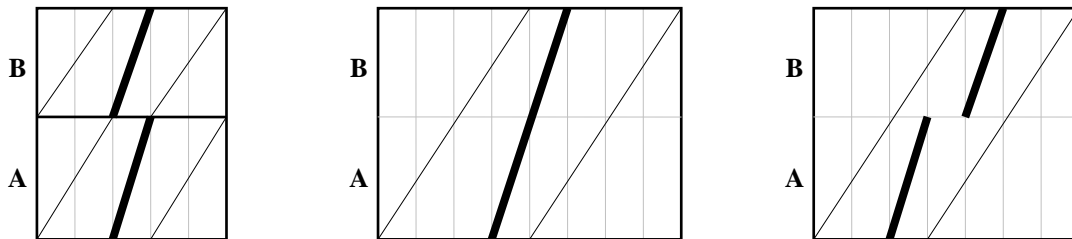
Fig. 6) "No idle times" and "Idle times allowed"

Special needs (e.g. technological breaks, manipulation areas) of construction – especially at performing finishing jobs or installing building mechanics – can generate situations when releasing restraint of "order of products on machines should be the same" (and "passing" gets be "allowed") can result in time savings too. (See Fig. 7)
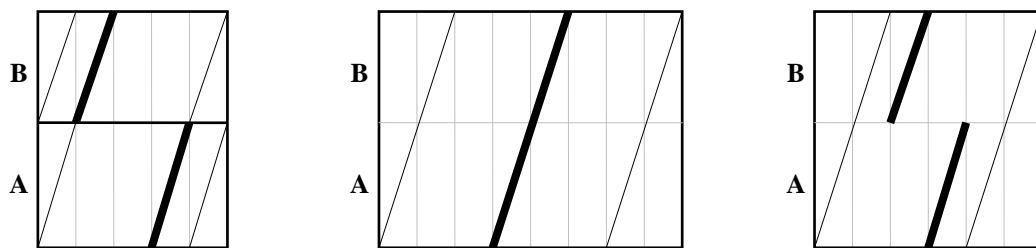
Fig. 7) "No passing" and "Passing allowed"

Most characteristic difference between Manufacturing and Construction management is that at manufacturing the product is moving from machine to machine, while at Construction machines (teams) are moving from product to product (from building to building). Typical size of a construction product (building) enables more machines (teams) working on it ("overlapping" – machines in time when processing the same product is – "allowed"). These differences vanish when considering manufacturing sequences of whole product series or when "building" large products (ships, aircrafts, etc.) and also when constructing structures (buildings) of strictly limited accesses. (See Fig. 8)

On Figure 8. P_i denotes Process i, D_i represents duration of process i, F_i is for succession time after Finishing process i and S_i is for that after Starting process i, while CR_i stands for a technological break after process i – in general.
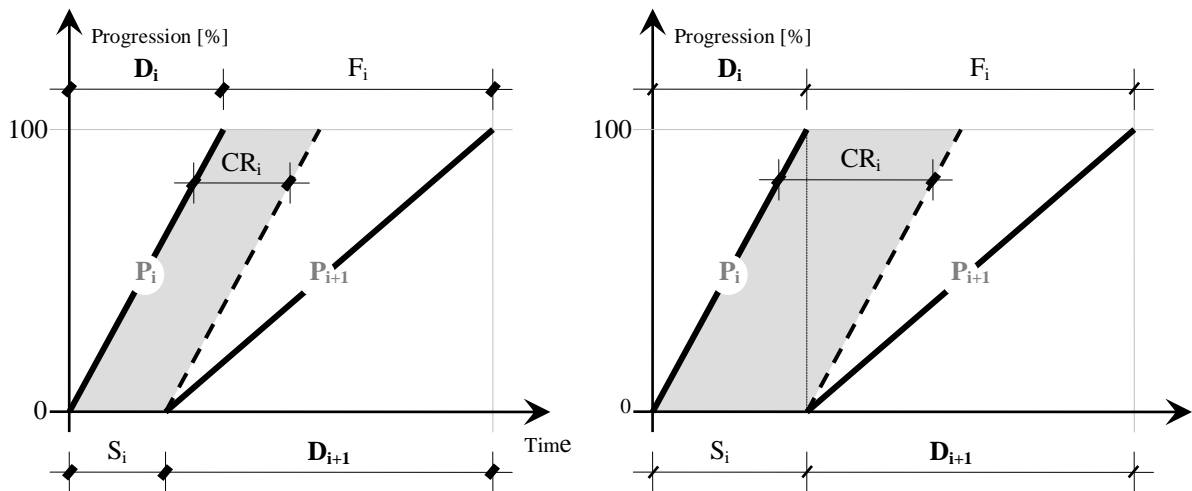
Fig. 8) "Overlapping allowed" and "No overlapping allowed"

… And optimal solution of a variant (of Flow-Shop Problem) – against all expectations – can not be derived from optimal solution of an other variant (of it)!

Flow-Shop problem seemingly provides everlasting wide fields for researchers to develop newer and newer principles and algorithms for to turn the unbeatable to a practically useful tool (e.g. [5]). Special Issues of Scientific Periodicals are regularly publishing summaries or comparisons of new achievements (e.g. [6]). The latest branches of researches are testing combinations of (heuristic) algorithms and/or intelligent search engines (memetic algorithms) while finding a relatively good solution for practical use tends to be preferred rather than achieving a theoretically optimal one (e.g. [7]). At Department of Construction Technology and Management of Budapest University of Technology and Economics also tough efforts have been made to bring theoretical ways of finding optimal schedules closer to daily practice. As part of research a special software have been developed to provide exact solution for variants of scheduling problems having been also equipped with facilities to test theorems and ideas of various other approaches too.

After modelling and testing potential effects of sequences on total execution time of a master schedule we tested five principal ways of developing optimal schedules:

- For to gain certain optimum and to check any other trials enumerative algorithms had been developed, later improved and accelerated by some methods of filtering (Total-, Partial- and Implicit Enumeration);
- Building sequence as a kind of series of optimal matches with the hope of deriving the problem back to a kind of Assignment Problem so it could be solved by Linear Programming (Arranged Branch & Bound);
- Finding partially optimal solutions for simpler cases and combining them for more complex situations. Adapting some fast and proved algorithms to our purposes (Johnson's Algorithm);
- Producing an initial sequence and improving it gradually via series of consecutive modifications (Pair-wise Exchanges);

- For to test/measure return on all our efforts, a pure and primitive way of finding optimal sequence – by chance (Random Sampling).

After long time of examinations, after numerous trials and hypotheses falling apart as leaves from trees none of the principal ways above proved to be either the only or the best way of constructing/finding optimal sequence. None of the "advanced" techniques and/or approaches proved to be either unquestionably or more outstandingly better or effective for our purposes than the most primitive way of Random Trials. But the same time we found that elaborating a proper estimate on likely optimum is more promising a challenge. Having it, we could judge optimality of any sequence found or produced, and we could judge likely return on our efforts to find an even better solution if the one present would not serve our satisfaction [8].

4   THE MANAGERIAL CHALLENGE

Our original intention was to resolve conflicts of preferences of individual clients and those of contractors contributing in construction projects. A synchronized belt would represent not only highest efficiency at utilizing available resources, but could provide shortest overall execution time of all- and shortest completion time of each individual products/buildings too.

Understanding and accepting a proper sequence of buildings by both parties (clients and contractors) could also promote conflict management and achieving project goals too [9].

When thinking of Belt-System Construction (Flow-Shop Schedule) we typically assume a large common resource pool (assembly-line) being set for to build (produce) mass amount of buildings (products). There are two problems with that statement in our days: 1.) No common resource pool (such as ones possessed by typical state owned construction companies in East European countries some decades ago) exists; 2.) No mass need (for new-built uniform/typed houses) exists.

Huge state-owned construction companies falling apart large number of small independent specialized companies appeared on construction market. No central (state-owned) investment ("National Development") Departments (even no dedicated-, or powerless government of it), but huge bulk of individual development "projects" having their own individual preferences. Project Management rules over Construction Management – destructive effect of which can be traced throughout the World, even in developed countries too.

Mathematics behind is less problematic! We can find optimal solution for sequencing our jobs – of course, not as solving a pure Flow-Shop Problem. The bigger conflict emerged – from managerial aspects – is that Schedules of this kind (Belt-System Construction) and especially optimality of it is extremely sensitive to any changes in conditions or in data considered. A slight change in a duration and optimality of the sequence developed turns to be questionable. With the new modified set of data or amongst the new conditions there might be another sequence proving to be optimal – and the new optimal sequence hardly can be derived from the original one. And – due to the relatively long completion periods – construction is highly exposed to changes of any kind (plans, expectations, regulations, environment, etc.).

Also, in era when Belt-System Construction (or "Industrialized Construction") was favoured and promoted not only mass needs for new-built homes and infrastructure characterized economies of "still developing" countries, but lack of available resources too. In developed economies there are "abundant" promptly available or soon accessible resources. In our days – due to economic crisis – conflicts are spiring at over-capacities, resulting in unsustainable

market competitions and/or in intensive migration of working power, even more, in masses of skilled work forces discarding their original professions …

Economic environment seemingly does not promote application of Flow-Shop Schedules in Construction in our days. But before some starts to bury potentials in Flow-Shop Schedules we should turn our attention to smaller scales and partial jobs of Construction. We may think of not only whole complex buildings but performance of some dominant resources (machines, craftsmen, material), some key technological processes, or – interchanging the two axes of a linear schedule – the technological order itself of some (likely "finishing") processes too.

Seeing endeavours to decrease weather- and labour-exposed characteristic of construction Flow-Shop Scheduling may play its role at prefabrication and/or in phase of product planning (of system elements of e.g. steel structures, formworks, building services, etc. to be installed).

Technology defines appropriate order of processes generally. But at some large-scale regional developments where fleets of heavy machinery are to be applied expectation of most effective operation of expensive machinery may force rethinking feasible technological orders and/or sequences of sub-tasks to be performed.

We also have to keep in mind that if something was constructed, it must be maintained, repaired, reconstructed or demolished too. Panel houses of past decades having built in large amount now are in state of necessary renewal – generating massive need for reconstruction.

Finally: Till now we had focused our attention on mass production, on massive needs, and had forgotten the other side, the case of strictly limited access of resources. As a paradox of developed economies – due to economic crisis generated migration and discarding mentioned above – when demands tend to emerge we may get in situation where lack of skilled workers and insufficient experiences grow to a leading problem – as it can already be detected at some traditional professions (e.g. masons, carpenters, tinsmiths) and at some investments of high priorities.

Flow-Shop Scheduling is an interesting and ever-challenging mathematical problem. Though it is relatively rare a situation in Construction when we are free to determine the order of jobs to be performed, we have to keep in mind that establishing a proper sequence may inhere potentials of improvement, and we must not forget contrary effects of forgetting about it. As university teachers at BUTE DCT&M, intending to widen complex view of our students by curricula we lay special emphasis on calling their attention to possibilities and consequences of merely choosing the proper (say: "optimal") sequence for performance.

5   CONCLUSION

Flow-Shop Scheduling is a famous 'NP hard' problem in fields of applied mathematics. Being developed for to model manufacturing mass amount of technologically similar products on assembly-lines it can be considered as an ancestor of belt-system construction of past decades in Eastern Europe when industrialized methods had been adapted in construction to satisfy mass construction needs in a relatively short time in a scarce economic environment.

Studying possibilities of applying Flow-Shop Scheduling techniques for to develop optimal schedules of mass construction we find that contemporary economic environment does not support it. No mass need, no lack of technical resources and no common resource pools. Own preferences of individual projects are also not promoting sequential development strategies.

In a changed economic environment expectations against sequencing should be re-judged. It may help achieving common project goals. It may help increasing efficiency of utilization of resources at prefabrication and it can guide us when designing large regional infrastructural projects too. But most of all: it can play essential role in bringing attention of philosophers and practitioners of construction management that changing age-old traditions (e.g. when scheduling onsite jobs) or developing a proper sequence of objectives (tasks, buildings) may result in significant savings in time-spans – and in all other efforts.

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MANAGING CONSTRUCTION PROJECTS THROUGH 4D PERSPECTIVE: GALA 2012 – PROJECT MANAGEMENT SOFTWARE

Mladen Vukomanović[1], Mladen Radujković[2], Maja Marija Nahod[3]

Abstract

Benefits that come from project management in construction industry are very weak. Furthermore, construction projects have great issues with communication, particularly among different stakeholders: designers, planers, contractors, supervisors etc. This communication is especially evident of terms of quality delivered amongst different stakeholders. In order to deal this issue, we have developed GALA 2012, an innovative project management software application for integrating 3D building design with cost, which managers can use for an integrated 4D approach for managing projects. The application consists of a preset database of normative and predefined analysis of cost. During its development, GALA has been tailored for construction markets (bills of quantities (BoQ), work diaries, invoices, project schedules, histograms and S-curves etc.) similar to the Croatian and nowadays is used by many construction professionals and faculties in the region. Even though GALA has been validated in practice, further development is forthcoming, especially in collaboration abilities on enterprise level.

Key words

Construction industry, cost, integration, project management software, time, 4D.

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1   INTRODUCTION

Competitive pressures within construction industry have forced companies to reexamine their management techniques and to improve their "modus operandi". The industry has been accused of being the worst, wasteful, inefficient and ineffective [1]. Every project is a combination of many events and interactions, planned or unplanned, with changing participants and processes in constantly changing environment, throughout the lifetime of the project [2, 3]. Project management should always achieve success which is often viewed trough cost, time and quality. Projects, managed trough MS Project, Fast track, Super Project, Primavera, or any other PM solution, represent a model of behavior of a project [4]. Still, some divergences exist and are shoving the downsides of the model. Thus managers must try to minimize them and insure a higher level of performance. Such divergences are never completely explained because of the nature of construction work and uncertainties associated [5]. Only in 2003, private companies spent more than 1.5 billion £ on tools for performance measurement [6, 7].

Only closed-loop and holistic system will ensure continuous improvement, crucial to achieving better goals. Ideally such systems should be stable, respond quickly to changes and be robust to small amount of noise [8]. Time lags are very malicious, and can degrade performance significantly [9]. Project managers should view construction projects in the holistic manner and try to integrate and balance all phases and objectives in achieving PM success. Unfortunately, many are still managing in intuitive and "ad hoc" fashion and try to allocate resources across various project areas[10]. Many authors criticized present performance measurement methods as time and cost consuming. Recent research, on 1500 world project [11, 12], showed the lack of systematic performance measurement and poorly adjusted control systems [9, 13]. In this context, we have tried to design a software application – GALA 2012 – that will integrate cost and time in construction projects and enable managers with the ability to control PM success.

Gala2012 is a software application which was placed on market in 2001. In the beginning the application was developed as a tool for one construction company in Croatia, but owning to extremely positive reactions to its use it was quickly placed on the market. The application heads toward establishing and maintaining control over cost, time and resources in construction projects. Furthermore is brings an innovative project management concept for integrating 3D building design with cost and time. This paper will present concept of Gala2012 and its implementation to operational phases of construction projects.

2   THE CONCEPT

The application has been designed in accordance with common phases of a construction project and has been adjusted to the construction industry practices in Croatia and related industries of the neighboring countries.

Figure 1 shows schematic data flow within GALA. The application uses normative and standards in civil engineering, combines them with empirical normative and project information as the input to the process. Process generates output information, such as: bills of quantities, analysis of costs, invoices, project schedules, histograms, S-curves (material, work, machine and cost), etc. Managers can then proceed with the monitoring phase (actual vs. planned) and if there is a need, conduct control. The figure 1 also shows how the project data could be represented by 3D design in IFC export version.
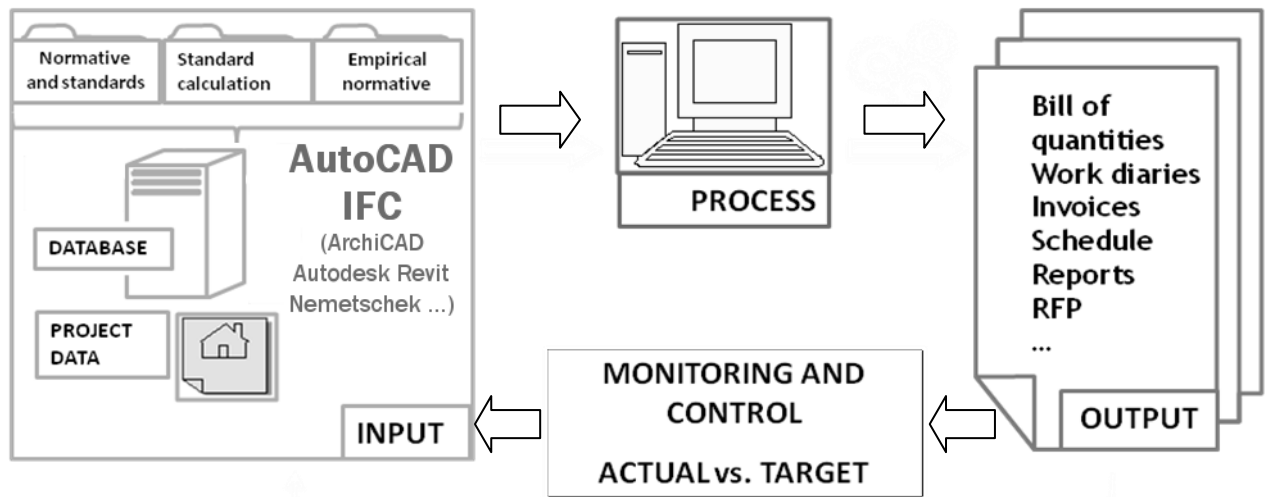
Fig 1)   GALA 2012 process diagram
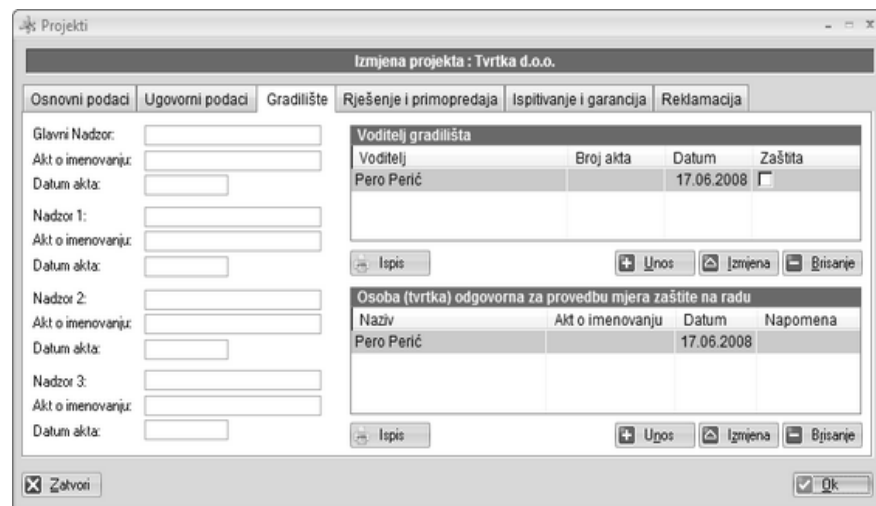
Fig 2)   Producing project documentation

3   STARTING FROM PROJECTS

The application is project oriented and starts with the first model, entitled Projects. In "Projects" (see figure 2), managers can generate a number of documents related to the 'Projects' which are common to construction project management practice. These are: Decision on founding of the construction site, Appointment of the Project Manager, Appointment of the Construction safety officer, Delivery request, Delivery records, Certificates, Guarantees, Complaints, Correspondences, incoming documents. All documents are easily accessible and of uniform design.

4   BILLS OF QUANTITIES

4.1   Analysis of cost

The concept of the application is such that enables an unlimited number of bills of quantities for a single project (see figure 3).
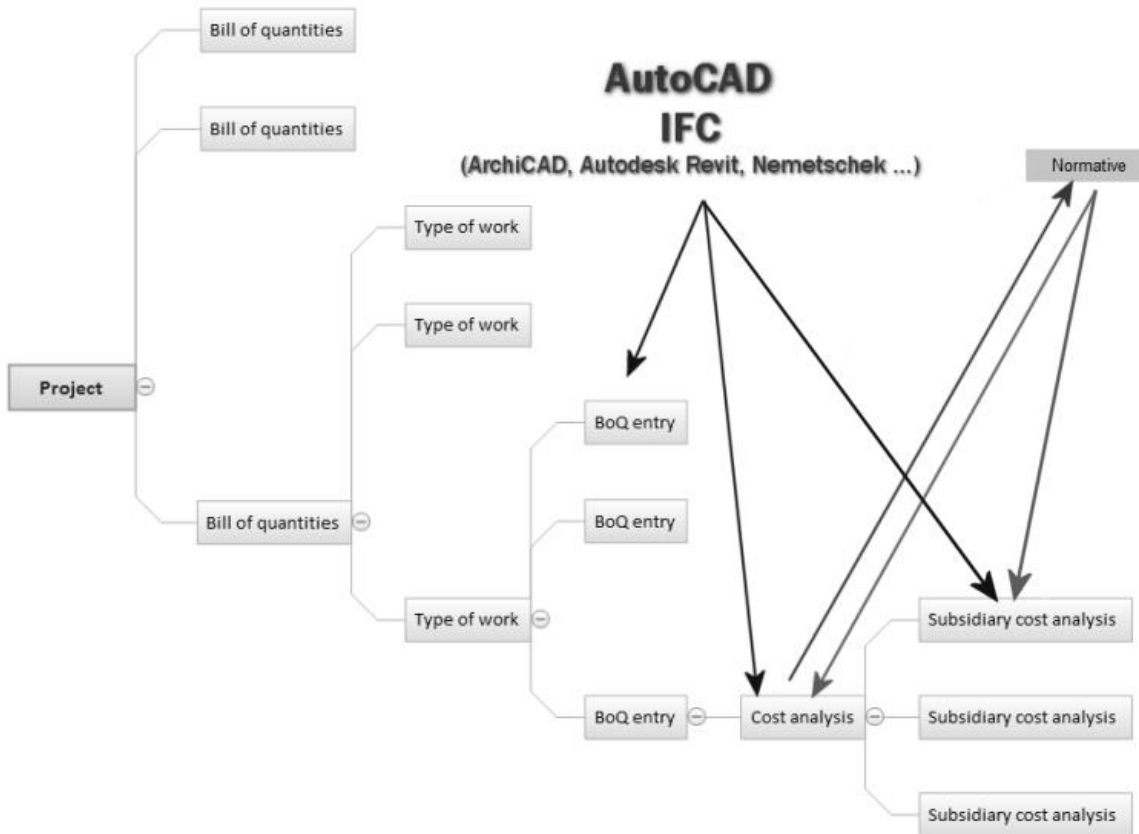
Fig 3)   Calculation process diagram

Each BoQ can have its resources price lists (work, material, machines) as well as different factors of work, materials and machines. By producing and calculating items in the bill of quantities, the user receives information on necessary resources for each particular item as well as the cost and profit of each of the items. Cost analysis (see figure 4) is made in such a way as to allow an unlimited number of supplementary analyses at an unlimited number of levels.

Norms of work, materials and machines include 21 work types, 9750 groups and over 25,000 normative. They contain norms for building constructions (preparatory works, ground works, prefabricated elements, bricklaying, roofing, armoring, concrete works, carpentry, facade works, transport of materials, pre-stressed concrete); civil engineering (ground works, civil engineering, preparatory works, bricklaying, concrete works, bracing, concrete works, external waterworks, sewage, drainage, scaffoldings, wooden bridges and ducts, iron bridges, foundation engineering, melioration works, tunnel works, road maintenance, macadam roads, cobbled roads, bitumen roads, railways) and final works (tiling, artificial marble, terraces, flooring, glass cutting, house-painting, waterproofing and insulation works, plumbing and locksmith works, carpentry, electrical fitting, waterworks, sewage, sanitary equipment, air-conditioning, central heating).

The database is open for updating, so the users can enter new data (norms based on experience) or change the existing ones. The total cost of the Project can be reached by calculating on the level of the bill of quantities, by changing factors of work, material or machines as well as by applying different price lists which enables recalculations of the whole bill of quantities or one of its parts. Users can change price or particular items in the bill as well as by giving special discounts or bonuses on the whole bill.
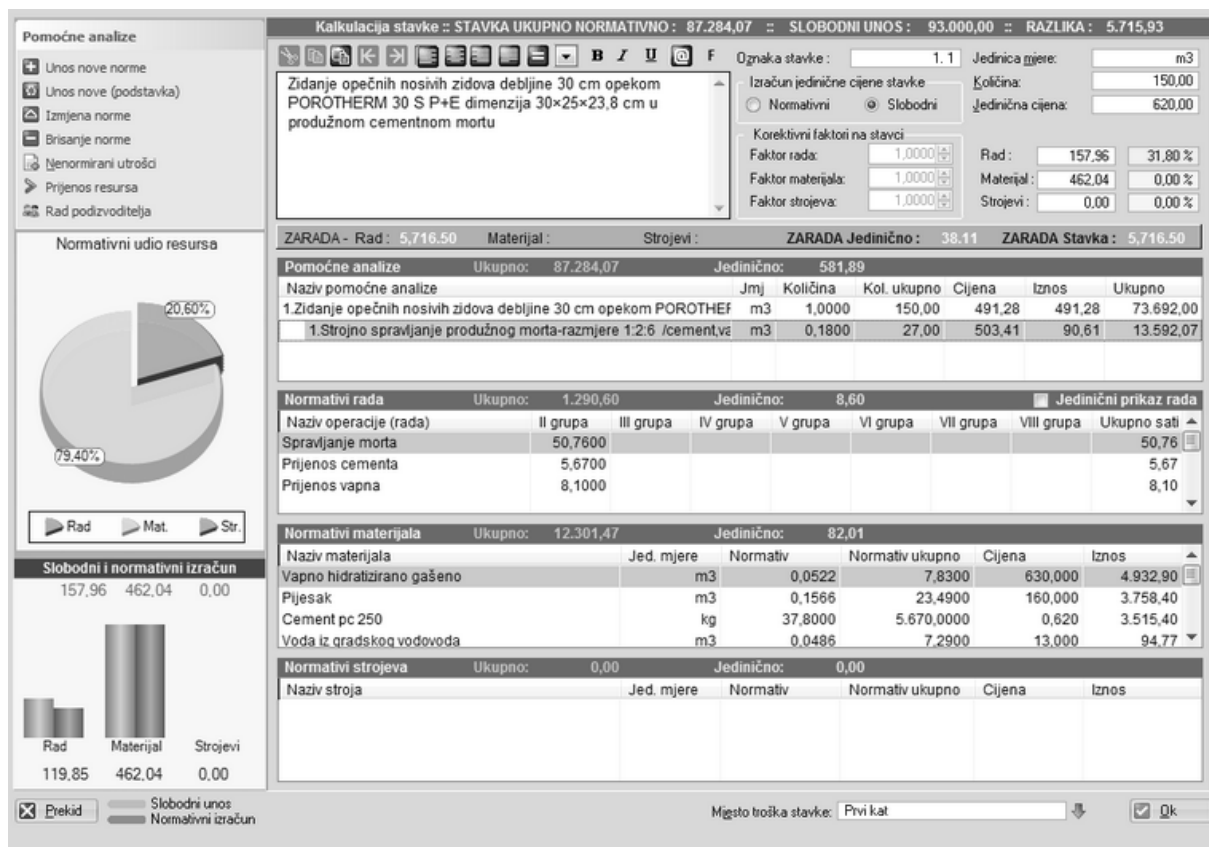
Fig 4) Calculation of an item by an unlimited number of analysis

4.2 Subcontracting

Since subcontractors have a respective share in construction projects, managers can create bills of quantities, export them in MS Excel and deliver it to the subcontractor (figure 5). By importing data and comparing items of subcontractor's bill of quantities, the user can conclude on the most favorable subcontractor. In this way, managers get an overview of necessary resources, materials and machines for the given task. Moreover, it enables recalculating the prices of particular resources for the whole bill. The ratio between expected income and expenses for the whole bill of quantities and its control in each of the items is crucial for defining the total amount of the offer. The calculation of income is based on the calculation of the required resources for each of the items in the bill. The calculation of each item or the whole project is done by using price lists (unlimited number of price lists) of work, materials and machines multiplied by factors of work, materials and machines. The labor factor can contain the profit factor, and the selling price of an item can be changed (so can the price of each of the resources). The information on the planned profit, i.e. income and costs are always presented either at an item level or the BQ level.

4.3 Importing QUANTITIES FORM IFC

The cost analysis is also possible through IFC 3D model (figure 6). Gala2012 imports the layout for every object (the right hand side in figure 6) with all of the pre-designed characteristics (dimensions, depth, density…). The data is automatically transferred into the bill of quantities. User can choose whether one object (i.e. concrete beam) becomes a separate

item in the bill of quantities or more different items. In this way construction planners are gaining the ability to calculate the project cost in an interactive 4D way.

Fig 5) Taking over subcontractor's bill of quantities and conducting
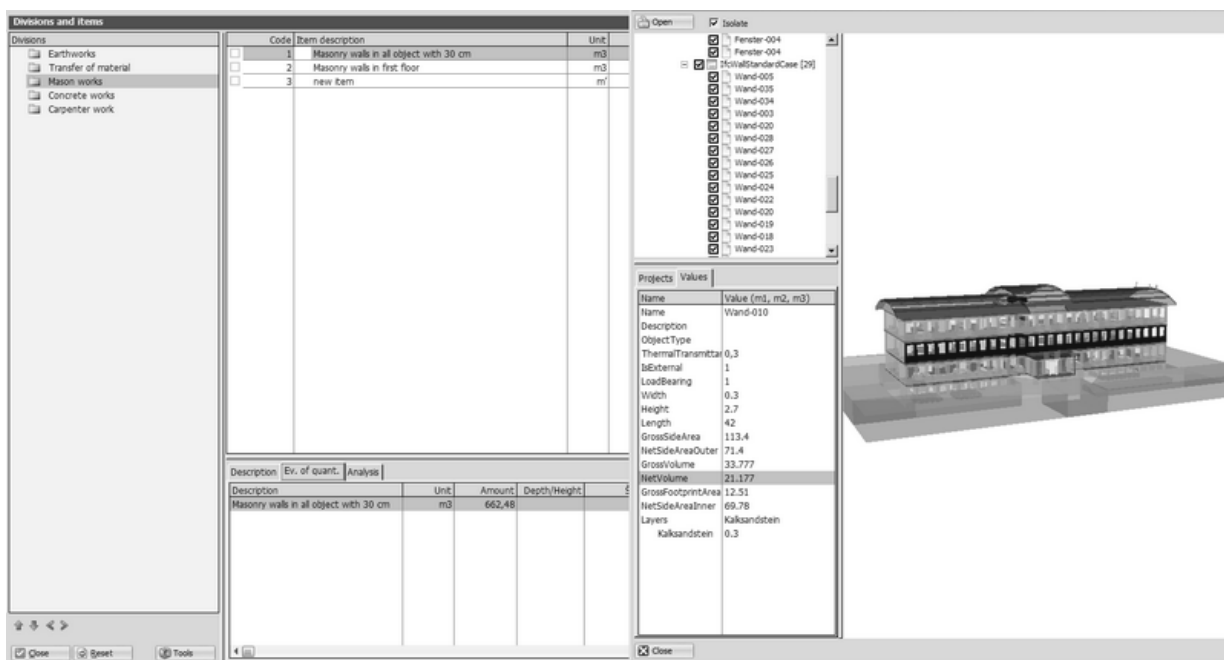
Fig 6) Drag and drop method in assigning activities to WBS items

5 SCHEDULE

5.1 Drafting a project schedule

GALA directly transfers cost analysis and associated resources as activities of project schedule. They can be linked into one or divided into more activities for further use in

different items of the WBS structure. It is possible to delete an activity or add a new one and change the technology, resources or their prices.

Managers can effectively use charts and numerical data on requested resources for different technologies and for particular items for decision making and the selection of the most appropriate technology and most favorable supplier.
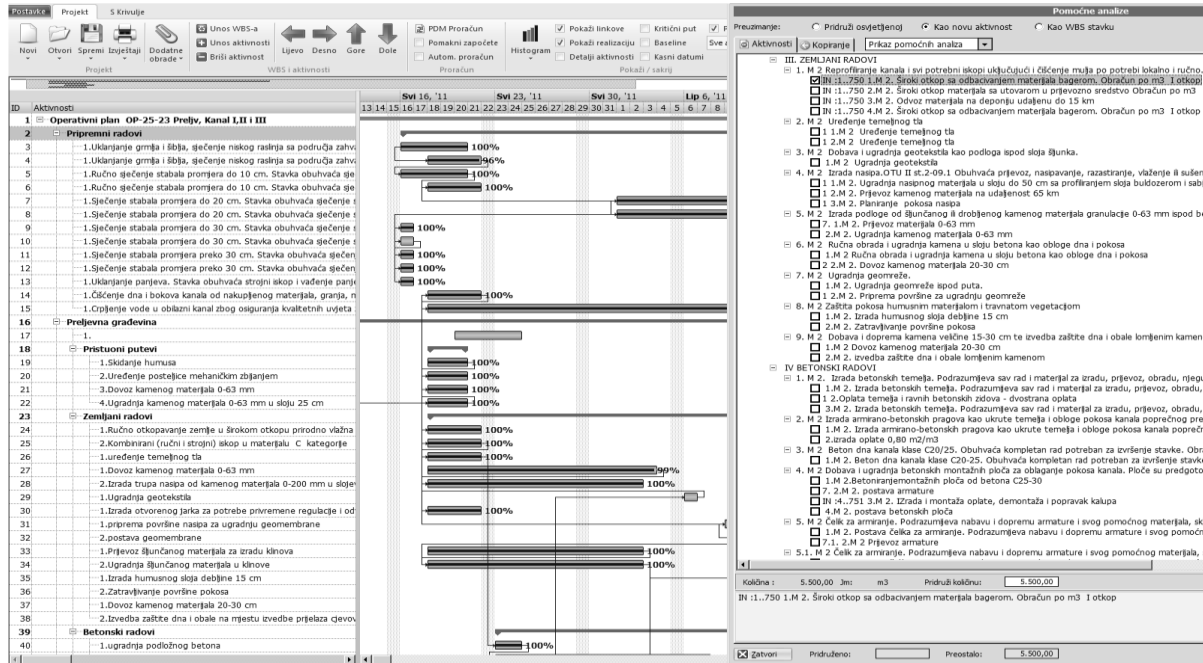
Fig 7)   Drag and drop method in assigning activities to WBS items

Activity duration is calculated by using normative of resources that have been assigned to the activities. The activities can be distributed within WBS. It is also possible to produce more work plans, where the user calculates based on different calendars and assigned activities to different WBSs (see figure 7).

Having created the schedule draft, a final project schedule can be created. Activities can be linked by four forms of connection (Start-Start, Start-Finish, Finish-Start, Finish-Finish) and a delay can be added (see figure 7). Precedence diagramming method (PDM) is used to calculate the duration of a project, whether from the beginning or the end of the project depending on the selected method. In planning the sequence of the activities, a great assistance plays the histogram of work force. Automatic calculations of critical activities as well as late dates for performing individual activities are of great use to the project manager and can be included in the view. The S curve of late and early beginnings in the realization phase can be supplemented by the third, green, line (see figure 8). Project managers can create more projections of the project schedule by using different calendars. In correlation with it one receives the requirements concerning the work force, material and machines as well as the expected income and expenditure. All the data are relevant for the continuance of the process of acquiring the material and equipment or for the decision making in the divisions for human resources management.

A schedule for certain subcontractor GALA will display only the activities pertaining to him.
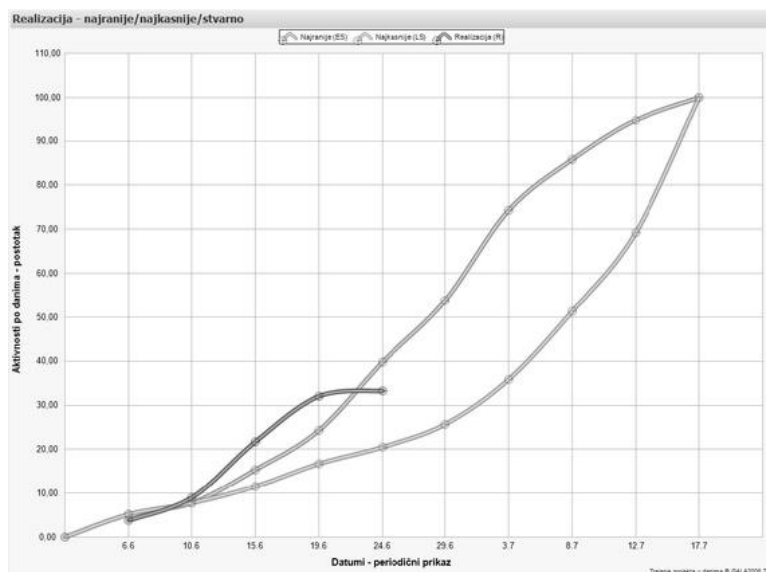
Fig 8)   S-curves in Gala

The schedule can be obtained in the form of a table, a Gantt chart, a table and a Gantt chart, and networks, and the reports are, along with the numerical data, obtained in forms of a histogram and an S-curve. A simultaneous overview (see figure 9) of a Gantt chart and histograms is especially interesting and there are 10 predefined forms: the number of activities, the type of workers, the number of workers, the selected material, and the chosen machine – early and late dates.

6   WAREHOUSE ACTIVITIES, CONSTRUCTION LOG BOOK AND "SITUATION" – CONSTRUCTION INVOICE REPORT

Warehouse activities are a part of working processes on a construction site. By logging and making of receipts, requisition slips, internal delivery notes and delivery orders, each project manager can control the warehouse condition and the expenditure of materials. By entering the realization (on the daily base or for a period) the user can create a requisition slip from the work order and thus affect the warehouse, which makes it easier to monitor the warehouse condition. Based on agreed cost estimates, the sheets of a construction log book are created automatically. Final measurements of completed work can be entered into the book sheets or data from logged realizations can be taken over.

The authors have recognized this kind of adjustment as critically needed for as simple and as fast operation as possible. Each sheet of the book has an unlimited number of final measurements, which have an unlimited number of calculation formulas. On site mangers can add pictures or schemes which definitely represent a detail necessary for fulfilling the book (see figure 10). Based on entered quantities in the book sheets and the agreed price from the cost estimate, the value of the "situation" is calculated. Such concept enables managers to control costs in cumulative fashion and estimate future payments. The authors have also recognized this kind of adjustment as critically needed for as simple and as fast operation as possible.
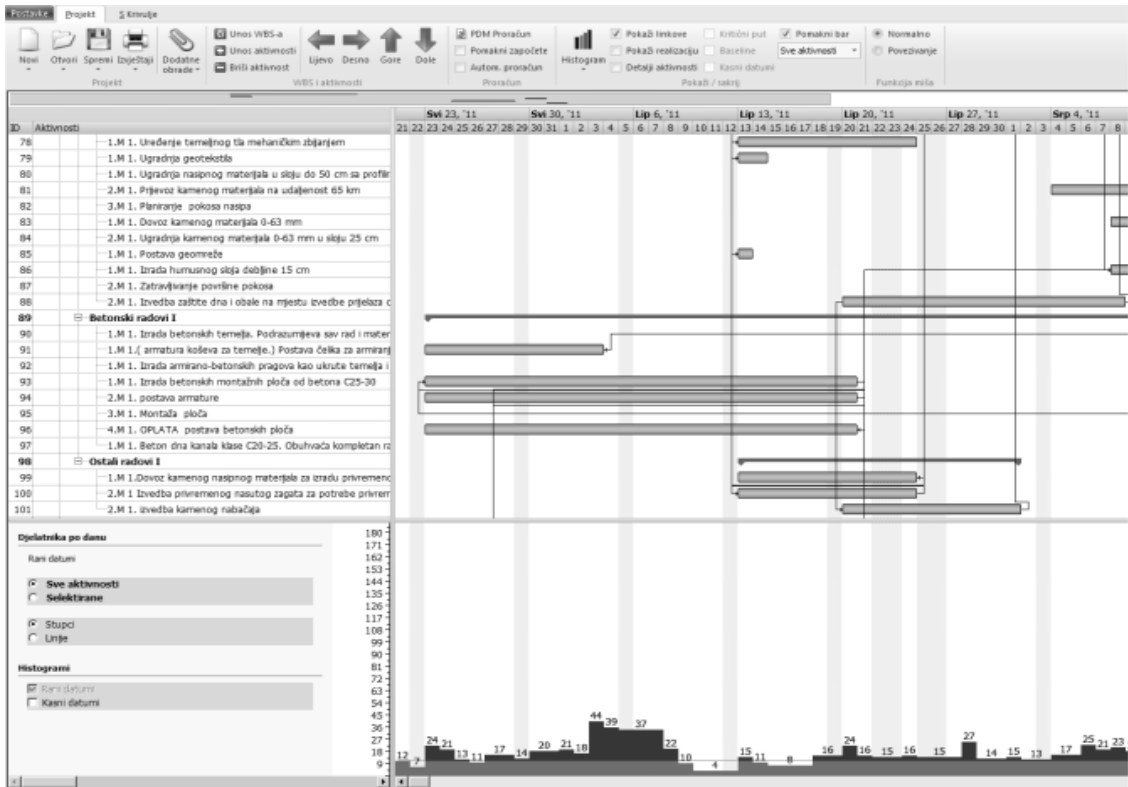
Fig 9) A Gantt chart and histogram
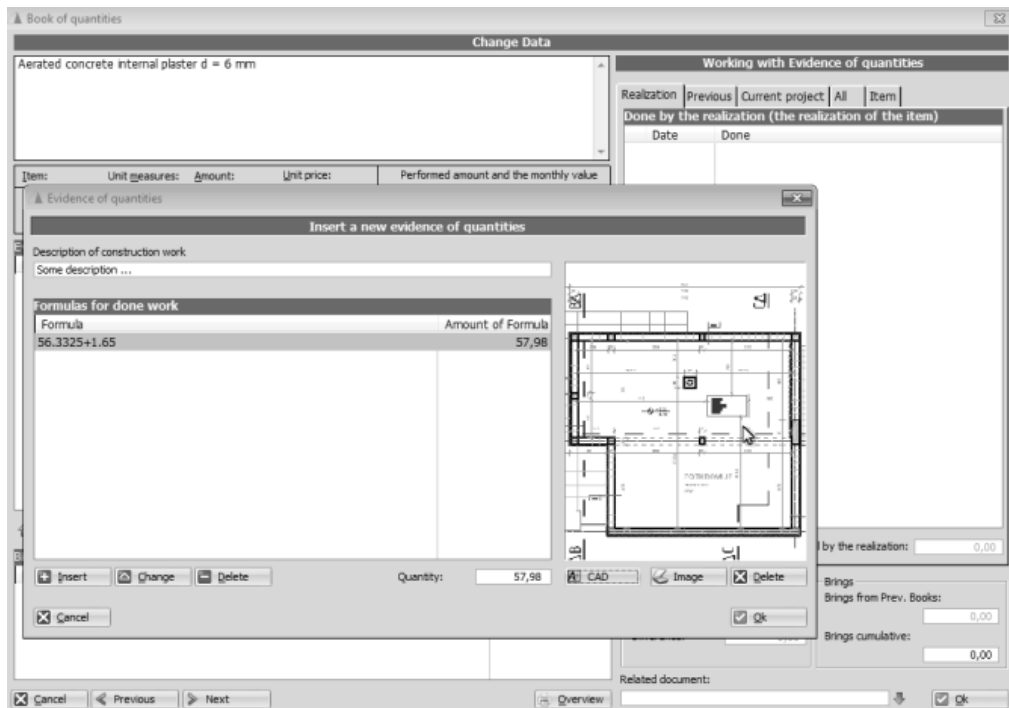
Fig 10) Entering final measurements with a formula

7 DISCUSSION AND CONCLUSION

During GALA 2012 implementation in practice we found very positive feedback from its users. The application has been used in companies dealing with building construction, civil engineering and final works in construction. Due to its simple usage and user friendly working interface, the application has been well accepted in practice. We have also found suggestions of the users very helpful and the application is daily perfected and updated. The program has been also used in educational facilities, high schools and faculties (Faculty of Civil Engineering in Zagreb). By implementing the application in educational purposes we have gained precious advice, as well as the assistance in tackling with new issues.

The application correlates with the ISO standard, and therefore respective documentation is included. Printouts of these documents are easily adaptable to look exactly the way it is set in the standards. We have also conducted market analysis. We could not find any similar product that integrates bill of costs, resources with project schedule and thus enables construction managers with ability to have a holistic view. In that way we hope that we have produced a unique and effective tool for successful construction management.

This paper has presented the concept of Gala2012 – software application for project management in construction. The concept has been divided into bidding and contracting phase, scheduling phase, realization phase and payment. We have integrated cost, time and resources and thus have enabled construction managers with more holistic tool. Furthermore, we have connected 3D design with cost estimation in order to make the application even more interactive. With it, project managers can generate: bills of quantities (BoQ), work diaries, invoices, project schedules, histograms and S-curves (material, work, machine and cost) and manage procurement on site.

Finally, GALA is fully compatible with Croatian construction market and with similar ones in the region. By its use project managers gain full control over project process and can manage working processes and cost in more efficient and effective way and therefore make more rational decisions. The software still needs improvement, i.e.: moving GALA onto enterprise level, collaboration initiatives, communication with other applications (5D visualization: connection the schedule with existing 4D model) and its use with mobile devices (PDA) in everyday management processes.

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CREATING MODELS FOR PROJECTS IMPROVING THE THERMAL-TECHNICAL PROPERTIES OF BUILDINGS – THEORETICAL BASIS

Miloslav Výskala[1]

Abstract

Creating models for projects to improve the thermal-technical properties of buildings is based on the technical, technological and thermo-physical properties of the given buildings and structures. Legislative and technical standards must be taken into account to the extent that the resulting model of problem-solving fully corresponds with these regulations. Economic aspects and the effectiveness of model variants are based on comparing costs of various investment options and savings in the cost of operation of the building in the horizon of the expected life cycle of a building.

Key words

Energy performance of buildings, life cycle of buildings, model, thermal-technical properties.

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1   INTRODUCTION

At the beginning of each project lies a vision, an idea, or a simple need: the need to create something new, unrepeatable or the need to satisfy other (primarily human, social) needs. Each project, especially the economic project, is born into a particular, hostile and competitive environment.

The success of the project depends on knowing the environment in which the design is formed. For projects of an economic and technical nature, this primarily means the economic principles specific to the region and applicable technical standards, regulations or practices. [1]

Making important economic decisions is now unthinkable without a thorough analysis of the main economic indicators (and the relationships between them). However, our knowledge of economic indicators, as well as other, mainly technical, input data, parameters and trends are equally important for successfully carrying out the project.

2   LIMITING CRITERIA FOR MODEL ROLES

The starting point for the design of measures to improve the modelling of thermal-technical properties of buildings are legislative regulations and technical standards. Their tightening, according to [2], is one of the preconditions for increasing energy efficiency on a global scale. The existing regulations in the Czech Republic are based on and fully respect European law.

The defining document of the European Union in the field of thermal protection of buildings is the Directive of the European Parliament and the Council Directive 2002/91/EC of 16 December 2002 on the energy performance of buildings, as amended and restated by the European Parliament and the Council 2010/31/ES of 19 May 2010.

The choice of measures for improving the thermal insulating properties of structures is not limited only to legislative and technical regulations. There are also technical limitations arising when one chooses a combination of technological and insulating materials. A correct choice of procedures demands a thorough knowledge and professional assessment of their suitability in each modelled variation.

Total costs broken down according to construction of the building envelope can be determined using indicative prices of available price systems and comparing them with the resulting savings in operating costs, especially for heating, and within the expected life cycle of the building converted to cash flows in accordance with generally applicable rules.

The model is clearly defined:
- legislative aspects of the issue, in accordance with:
  - Act No. 183/2006 Coll., On town planning and building regulations,
  - Act No. 406/2000 Coll. Energy management,
- National technical standards and calculation methods:
  - ČSN 73 0540 Thermal protection of buildings,
  - ČSN EN ISO 10077 Thermal performance of windows, doors and shutters
  - ČSN EN ISO 13370 Thermal transfer with soil,
  - ČSN EN ISO 13789 Transmission heat loss coefficient,
  - ČSN EN ISO 13790 Heat use for heating,

- technological aspects, the applicability of selected technologies,
- standardized building structures and works with the target cost.

Model variants must comply with all these limiting factors. The investment option that will be selected is that which is economically efficient under the circumstances. Modelling is necessary to take into account the experience and requirements of the inhabitants of objects summarized in [3].

Before starting with the model problem, it is necessary to examine whether the object examined corresponds to the basic principles of this building in terms of energy consumption and optimize the ratios defined by [4]:

- ratio of building surface to building volume
- ratio of total window area to total wall area
- ratio of total window area to indoor space volume
- ratio of total window area to total floor area
- ratio of north window area to north wall area
- ratio of north wall area to indoor space volume
- ratio of north wall area to total wall area
- ratio of roof area to indoor space volume
- ratio of roof space volume to indoor space volume.

3   INPUT MODEL PARAMETERS

First entered input parameters of the model are based on zero investment options. Zero option represents the current state of the object.

Technical parameters of the object are inserted: the construction footprint of the building divided by its envelope defined in [5, 6]. The measurement method corresponds with the envelope calculation method [5, 6]. Generally, it is always on the plan view dimensions for floors, ceilings and outer walls. Volume of building is determined from the overall internal dimensions without taking into account the internal load-bearing walls or partitions. Dimensions filled window and door sizes means quoted dimensions according to project documentation.

The basic thermal-technical quantity is the thermal transmittance U [W/m^2·K]. With transparent structures it is also necessary to set the selected physical properties (permeability, frame size, air permeability). The calculation of the final thermal transmittance value can be determined on the basis of project documentation. However, it should be checked whether the target value is adjusted by the thermal resistance to heat transfer on the inner and outer sides. It is also necessary to take into account the effect of thermal bridges.

Combining technical parameters and thermal quantities, it is possible to determine the value of the specific heat flow rate H [W / K] [6] according to the general formula:

$$H = A \cdot U, \qquad \qquad [W/K] \qquad \qquad (1)$$

where A is surface of the construction [m^2] and U is the thermal transmittance [W/m^2·K] [7].

Other common input variables need not be entered because the model is limited to the calculation of heat loss by transmission, assuming constant ventilation heat loss and total heat

gains. These values remain unchangeable on all model variants and therefore do not affect the calculation.

An ideal basis for an initial determination of basic characteristics is the output of computer software, for example PROTECH. Inserting data from existing software can prevent potential errors in the calculation. A summary of the inserted values is shown in Table 1.

Tab. 1)   Inserted values

Indicator (description)	Designation	Unit	Calculated value
Project documentation			
Total internal floor area	Agross	[m2]	
Total area of the building envelope	A	[m2]	
A perimeter walls	-	[m2]	
A floor	-	[m2]	
A ceiling	-	[m2]	
A roof	-	[m2]	
A windows	-	[m2]	
A doors	-	[m2]	
Internal volume	Vi	[m3]	
Converted volume of heated space	Vc	[m3]	
The ratio of the volume of the building and envelope	A/Vc	[m2/m3]	
Technical standards			
Thermal transmittance	U	[W/m^2·K]	
U perimeter walls	U	[W/m^2·K]	
U floor	U	[W/m^2·K]	
U ceiling	U	[W/m^2·K]	
U roof	U	[W/m^2·K]	
U windows	U	[W/m^2·K]	
U doors	U	[W/m^2·K]	
Internal design temperature	θ	[°C]	
Projected number of persons	-	-	

4   CALCULATION PROCEDURE

After all required input parameters are entered, the model is able to calculate an ideal, most effective investment option.

Calculation for the zero option proceeds in several consecutive sequences for a set of structures and building envelope thermal-technical properties. The partial calculated value is specific transmission structures heat flow rate H_D [W/K] defined by equation (1), and indirect thermal transmittance (over unheated spaces and soil). Thermal transmittance depends on the general area of the building envelope constructions A [m^2] and thermal transmittance U [W/m^2·K]The result is the specific heat transfer H_T [W/K], in which the sum of the loss of air exchange H_V [W/K] represents the total specific heat flow rate of the building H [W/K].

In the following steps, according to [6], are provided the:

- total heat flux transmittance for each month of the year Q_T [MJ],
- total negative heat flux (heat loss) Q_L [MJ],
- internal heat gains and solar gains,

- annual heat demand for heating $Q_{dem, H}$ [W/K] .

The resulting value in the first sequence is the specific heat demand for heating EPA [kWh/m2·a], based on which a building can be included in some of the energy classes in accordance with Decree No. 148/2007 Coll. On the energy performance of buildings [8]. The end of this phase is completely defined by the zero variant modelling tasks.

5   MODELING VARIANTS

Based on the determination of specific heat demand EPA [kWh/m^2·a] for the energy class of a given building, one can proceed to entering the general technological techniques for improving the thermal and technical properties of the building in construction of the building envelope and begin to model investment options.

The technological processes are also necessary to assign suitable insulators. In this step, the model is entirely dependent on the input parameters from the user, which must meet the requirements of technical skills and knowledge of applicable technology or the existence of project documentation. An example of selecting technology for improving the thermal and technical properties of roof structures is given in Table 2.

Tab. 2)   Applicable technologies and insulators for the roof structure

Part of the building envelope	Construction	Technology	Specifications	Insulant
Roofs	Flat, terrace	Single-layer	PLUS	Polystyrene EPS
			DUO	Polystyrene XPS
		Double flat roofs		Polystyrene EPS
				Mineral wool
				Cellulose
		Suspended ceiling		Mineral wool
	Sloping	Between rafter	From the inside	Mineral wool
			From the outside	Mineral wool
			Blown	Cellulose
		Above rafter		Mineral wool
		Under rafter		Mineral wool
		Combination		

The basis for determining the investment cost is to determine the unit price construction and insulation materials.

Costs must be converted to the unit of measure and divided into:

- assembly costs (installation),
- the cost of the insulator,
- other related costs.

In order to make this division, it is necessary to create groups of costs corresponding with a technology. The groups of these costs can be modified based on a specific assignment. Fixed costs can be considered as the cost of installation and other related costs. The cost of the insulator is of variable character (it increases with increasing thickness of the insulating material).

Table 3 gives an example of a group of costs for flat roofs. Technology PLUS [9]. Other related costs include repair of the existing roof structure [10].

Model variants differ primarily in insulator thickness, and therefore cost structures. Part of this cost is offset by energy savings.

The result of this modelling phase is the selection of investment options, which fully meet the requirements defined in Section 2.

Tab. 3)   Example group of cost for flat roofs

Part of the building envelope			**Flat roof**		
Technology			**Single layer flat roof**		
Technological adaptations thermal and technical properties			**Single layer flat roof PLUS**		
Costs					
Technology		Insulator	Other related costs		
Description	Code TSKP		Description	Code TSKP	
Bonding thermal insulation			Maintenance of coating roofing	712 310 902	
with penetration, one layer, whole	713 141 111	spec.	Penetration	712 311 101	
with penetration, one layer, spot	713 141 121	spec.	Material in the specification		
Bonding thermal insulation			Design asphalt roofing	712 341 559	
without penetration, one layer, whole	713 141 131	spec.	Material in the specification		
without penetration, one layer, spot	713 141 135	spec.			

Then, the parameters for economic modelling are entered: the expected length of the operational phase of the life cycle of the building, the method of heating the building and the type of fuel used. From these parameters we can determine the partial operating costs of the building (heating costs) zero option and option modelled.

In the final assessment phase variants, all of the cost savings and anticipated financial model in a cash flows are based on an indicator for evaluating life-cycle costs of the building (BLCC). In terms of investment in improving the thermal properties of buildings, it is necessary to know the building's life cycle costs (LCC) [11] and their expression in time.

The BLCC indicator assesses the cost of construction in the present, i.e. at the time of the evaluation, so all future costs and/or cost savings converted to their present value must be considered. The calculation of indicators can be expressed by the following relationship [12]:

$$BLCC = \sum_{i=0}^{n} \frac{1}{(1+r)^i} \sum_{j=1}^{t} C_{ij} \qquad \text{[CZK]} \qquad (2)$$

Where:

Cij   costs associated with the technical parameters of the building in the year i [CZK],

i   year in which the expense arises,

n   length of the life cycle in years,

r   discount rate [%/100].

Optimally, this should demonstrate the lowest life cycle costs for the balance of the cost on one side and heat savings on the other. For modelling is not only necessary to search economically optimal solutions. For investment decisions must not only take into account this aspect, but also other aspects which cash flows cannot be expressed.

6   CONCLUSION

Modelling tasks for improving the thermal properties of buildings may be used for new construction and renovation projects. The user can use the modelling results to determine the optimal investment option. The model rejects wasteful and insufficient options. Conversely, the model evaluates the most effective option, provided that the conditions listed above are observed.

The application of the optimal solution is possible while respecting the economic return on investment. The phases of the model can be briefly summarized as follows:

- setting of restrictive criteria,
- determination of EPA,
- decision on the technologies,
- choice of insulators,
- evaluation of the cost of selected variants,
- determination of life-cycle costs,
- final evaluation of alternatives.

This processing model can help to evaluate thermal-technical properties of objects, and is a find friendly solutions for the future.

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A SCIENTIFIC APPROACH FOR SUSTAINABLITY OF CONCRETE

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Abstract

Concrete is known to be the one of the most important construction materials, yet it has an enormous impact on the environment. It seems that concrete is not so compatible with the demands of sustainable development. However, it is the fact that Portland cement is not particularly environmentally friendly as a huge carbon footprint is left on the Earth due to the vast emission of carbon dioxide during the production of Portland cement. Therefore, to support sustainable development, we have to use as little Portland cement as possible in concrete production. Currently, there are ways that concrete can increase its compliance with the demands of sustainable development, such as to increase the use of supplementary cementitious materials and to increase reliance on recycled materials. However, these methods are rather empirical and there are still many aspects of concrete behaviour that are beyond our comprehension. In this regard, a new approach for concrete sustainability is proposed, which is to transform the conventional concrete technology into modern concrete science by developing new theories after investigating the factors governing the behaviour of concrete. A number of new theories have been developed regarding particle packing and rheology of concrete, as reported in this article. This scientific approach can reform the way how concrete mix is designed, slash carbon dioxide emission and promote sustainability.

Key words

Sustainable development, sustainability of concrete, particle packing, rheology of concrete.

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1   INTRODUCTION

Sustainable development has become a set of self-evident rules. Although there may be political conflicts between those who wish to preserve the environment and those who support development, sustainability and development are actually not mutually exclusive. In fact, we should strike a balance between development in land use and environmental preservation, which is to improve our quality of life without adversely affecting our environment.

The concrete industry has a large impact on sustainability. Concrete is the backbone material for most of the construction today because of its low cost and versatility. However, the success of concrete also carries with great costs in terms of adverse impact on the environment. Worldwide, billions tons of concrete are being produced each year. This requires vast amounts of natural resources for aggregate, huge amount of water and enormous amount of energy in cement production. It has been estimated that the production of eact ton of Portland cement generates approximately one ton of carbon dioxide into the atmosphere. The excess amount of carbon dioxide is contributing to global warming and the cement industry alone is responsible for about 7% of all carbon dioxide generated in the world [1]. Furthermore, the demolition of concrete structures generates construction debris and demolition waste, which is particularly burdensome to those metropolitan areas facing solid waste disposal problem. The sheer volumes of aggregate, water consumption, energy requirement, carbon footprint and generation of construction and demolition waste all together appear that concrete is not so environmentally friendly. However, it is not as bad as it seems. It is the fact that Portland cement is not particularly environmentally friendly. To support sustainable development, our primary goal is to use as little Portland cement as possible.

This article summarizes the ways of how the concrete industry can increase its compliance with the demands of sustainable development and more importantly, to propose a new approach for concrete sustainability, one that look into the factors governing the performance of concrete, reform the way how concrete mix is designed, slash carbon dioxide emission and promote sustainability. The basis of our approach is to examine the particle interactions, to develop a new particle packing model and to incorporate new theories for rheology of concrete.

2   RECENT SUSTAINABLE CONCRETE TECHNOLOGY

There are ways that the concrete industry can increase its compliance with the demands of sustainable development, which basically falls into three categories: increase the use of supplementary cementitious materials, increase reliance on recycled materials and enhance the performance of concrete.

2.1   Increase the use of supplementary cementitious materials

Since the production of Portland cement is not environmentally friendly and is responsible for much of the carbon dioxide generated in the world, the use of Portland cement should be reduced. The cement consumption per unit volume of concrete mix can be reduced by partially substituting the Portland cement by various cementitious materials. The most commonly used cement substitutes include fly ash (FA), ground granulated blast furnace slag (GGBFS) and condensed silica fume (CSF), all of which are by-products of the industrial process. By turning the by-products of the industrial process into useful cement substitutes,

disposal cost of industrial waste can be avoided and hence value is added to the industrial by-products.

One of the main reasons that FA has been widely utilized in concrete is that it reduces the cost of concrete materials as it is less expensive than Portland cement. The effects of FA on various properties of concrete have been under investigations such as that reported in [2]. Problems are associated with the use of FA as there is a relatively slow rate of strength development leading to a risk of inadequate strength at the normal age of loading. Therefore, overcoming the early age properties of FA is still a challenge.

Partial replacement of Portland cement with GGBFS is found to greatly reduce the permeability of concrete as the pore size in cement matrix is reduced through the reaction of GGBFS with the calcium hydroxide and alkalis released during the hydration of Portland cement. The reduced in permeability can therefore improve the sulphate resistance of concrete, reduce the potential expansion due to alkali-silica reaction, reduce the penetration of chloride within the concrete and improve the resistance to corrosion of reinforcement [3]. However, it has the same problem as that of FA, which is the relatively slow rate of strength development.

CSF has become a key ingredient for high-performance concrete as the utilization of CSF in concrete substantially increases the compressive strength and durability of concrete [4]. Because of its importance for the production of high-performance concrete, its cost has exceeded that of Portland cement and CSF is not available only as an industrial by-product but also produced for the concrete industry specifically [1].

2.2   Increase reliance on recycled materials

Vast amounts of virgin aggregates are being quarried for the production of billions tons of concrete each year. On the other hand, concrete debris resulting from demolition is creating burden to valuable landfill. Therefore, it is both economical and environmentally friendly to use such debris for production of new concrete as it conserves natural resources and relieves solid waste disposal problem. Although there are problems associated with the use of recycled concrete such as fluctuation in quality, contaminants residues within the recycled concrete and high porosity of recycled aggregate, recycled concrete can still be applied to projects where high performance of concrete is not required, e.g. low strength concrete applications.

In addition to concrete debris, post-consumer glass is another example of recycled materials for concrete. In Hong Kong, as of 2010, only 3.3% of the post-consumer glass were recycled or reused [5]. The majority of post-consumer glass became waste glass and ultimately ended up in landfills. However, the existing landfills in Hong Kong will soon be filled up. To relieve the landfill crisis, it is imperative to promote recycling of post-consumer glass. Currently, the recycled post-consumer glass in Hong Kong is used for the production of concrete paving blocks only, where the recycled glass is in the form of crushed glass sand replacing natural river sand [5]. It has been known that the alkali in the cement paste would react with the silica in the glass via the alkali-silica reaction (ASR) to produce a gel, which might cause severe damage to the concrete structures due to the ASR induced expansion. It was found unsatisfactory to use glass as substitutes for coarse aggregates in concrete because of the substantial loss in compressive strength and the excessive ASR induced expansion. Nevertheless, studies have shown that if the glass was grounded to an optimum fine particle size, the pozzolanic behaviour of ground glass would be activated and even overwhelm the ASR [6]. It was found that a smaller particle size of ground glass would result in a higher

activity of pozzolanic reaction, a higher compressive strength in concrete as well as a lower ASR induced expansion. The use of ground glass as supplementary cementitious materials seems feasible although further research is needed. This provides an alternative for the use of post-consumer glass in Hong Kong.

A third example of recycled materials for concrete is the dredged material. Ocean dumping of dredged material is prohibited because it is highly contaminated by heavy metals, oils, dioxins, etc. Therefore, the dredged materials have to be disposed of in landfills or marine dumping sites at great costs. However, the dredged material can be treated and transformed into green construction material. For example, in Hong Kong, the dredged marine mud has been used as part of foundations of the Kai Tak Site and the public rental housing development of the Housing Authority [7]. The marine mud, which was green-treated and mixed with sand and cement, was backfilled and compacted in layers about 300mm thick around the core foundation of pile caps underground. The greening of marine mud saved approximately HK$8 million in disposal costs and should be adopted in future public and private works.

2.3   Enhance the performance of concrete

We have discussed the use of supplementary cementitious materials to reduce the cement consumption per unit volume of concrete mix. Here, we focus on the slash in overall cement consumption, which can be achieved by developing high-performance concrete (HPC) through improvement in strength and durability for instance. An increase in concrete strength leads to a reduction of total volume of concrete needed. For example, it has been found that the use of Grade 100 concrete instead of Grade 45 concrete can reduce the volume of concrete needed for the vertical elements by 30% [8]. Since the Grade 100 concrete was produced by adding pulverized fly ash and condensed silica fume to the concrete mix rather than increasing the cement used per unit volume of concrete mix, the overall cement consumption dropped significantly due to the large volume of concrete saved. On the other hand, an improvement in concrete durability leads to an increase in service life of concrete structure, thus cutting the costs of future redevelopment and maintenance work. For example, if the structures built today have a service life of 100 years instead of the conventional 50 years, at least half the material for future replacement can be saved and the frequency for future inspection and repair work can be reduced. Therefore, development in HPC can conserve natural resources, reduce overall cement consumption, and remarkably extend the service life of concrete structures and save future redevelopment and maintenance work.

3   PROBLEMS FACED BY THE DEVELOPMENT OF HPC

In fact, the development of HPC aims to enhance performance of concrete in various attributes, which includes strength, workability, dimensional stability and durability. Nowadays, the concrete technology has been advanced so much that with the use of CSF; HPC of compressive strength over 150MPa can be reached [4]. Furthermore, the workability of HPC has been improved which enables pumping to a great height. The self-consolidating concrete, a derivative of HPC that is highly workable, flowable and non-segregating, can spread into confined spaces, fill formwork even to the far-reaching corners, and pass through even the most congested reinforcing steel bars without any mechanical compaction but place itself by its own weight. The dimensional stability of concrete has also been improved as the problems of thermal and shrinkage cracking associated with high cement paste volume has been resolved. The durability of concrete structures built today is also good enough to last for

more than a century even in marine environment. Although HPC has been ameliorated, there are still some problems associated with the development of HPC.

First, the mix composition of HPC is still primarily designed by trial mixing, which means that the effect of the concrete constituents on the various performance attributes cannot be informed unless tests are carried out. However, the trial mixing process is tedious and time-consuming and is therefore non-economical and inefficient.

Second, even for the same design mix composition of HPC, the variation in physical properties of concrete constituents such as particle size distribution, particle density, packing density and specific surface area would result in fluctuation of performance of HPC. As a result, the quality control of HPC is made difficult. To cover the risk of fluctuation in performance of HPC, concrete structures are often over-designed, resulting in an increase in production cost and a waste of natural resources. Therefore, what we need is not just high performance, but also high robustness in the production of HPC, which is the ability of concrete to have a consistent performance despite expected or unexpected variations in the properties of concrete constituents.

Third, the various performance attributes of HPC are often contradictory to each other. For example, the use of CSF can substantially increase the strength and durability of concrete. However, the concrete mix with CSF added is often found to be too cohesive, which may not be flowable enough for pumping or workable enough for filling formworks. Another example is related to the use of superplasticizers (SPs). With the use of SPs, water demand for a certain workability requirement can be reduced so that a lower water/binder (cement and cementitious materials) ratio can be adopted to increase the strength of concrete. However, just a slight over dosage of SPs could lead to segregation, bleeding and sedimentation. Therefore, mix optimization for all round HPC is still a challenge.

Due consideration of the development of HPC is so important for concrete sustainability, an in-depth understanding of how the various mix parameters would affect the behaviour of concrete is needed for mix optimization and robustness design of concrete. In this regard, a new approach for concrete sustainability is proposed, which is to transform the conventional concrete technology into modern concrete science by developing new theories after investigating the factors governing the behaviour of concrete. A number of new theories have been developed regarding particle packing and rheology of concrete, as introduced herein.

4   PARTICLE PACKING

The packing of solid particles is a major factor affecting the behaviour and performance of many materials made-up of solid particles. As concrete mixture can be regarded as a pack of aggregates in a matrix of cement paste, packing density of aggregate is a key factor governing the various performance attributes of HPC. To promote sustainability of concrete, our primary goal is to reduce the use of Portland cement, which can be achieved by maximizing the packing density of aggregate so that the volume of cement paste used to fill up the voids between the aggregates can be reduced. In this regard, particle packing models for packing density estimation is essential for mix optimization of HPC.

Many theoretical particle packing models have been developed over the past 80 years. The linear packing density model (LPDM) is one of the well-known models developed by Stovall et al. [9], which takes into account particle interaction effects such as the loosening and wall effects, which occur between coarse and fine particles if their size difference is not

sufficiently large. When the coarse particles are dominant, the packing of the coarse particles could be loosened by the addition of fine particles of which the size is not small enough to fit entirely into the voids of the coarse particles. This is known as the loosening effect. On the other hand, when the fine particles are dominant, each and every coarse particle would be surrounded by a sea of fine particles which tend to have larger voids near the surface of the coarse particles. This is known as the wall effect.

For binary mix, LPDM generally generates packing density curves giving a sharp peak at the volumetric fraction which yields the maximum packing density, r_1*, similar to that shown in Fig. 1. In reality, however, the experimental packing densities generally lie on a smooth curve with a flat peak where the experimental packing densities are always lower than that predicted by LPDM. To make the matter worse, the discrepancies between the experimental packing densities and the theoretical packing densities predicted by LPDM for binary mix lead to even large discrepancies for ternary mix. To reduce the discrepancies, the compressible packing model (CPM) was modified from LPDM by de Larrard by incorporating a compaction index to take account of the effect of compaction in different packing processes [10]. Although CPM was found to provide good packing density estimation for both binary and ternary mixes, the accuracy of the model highly depends on the value of the compaction index, which is not easy to be determined.
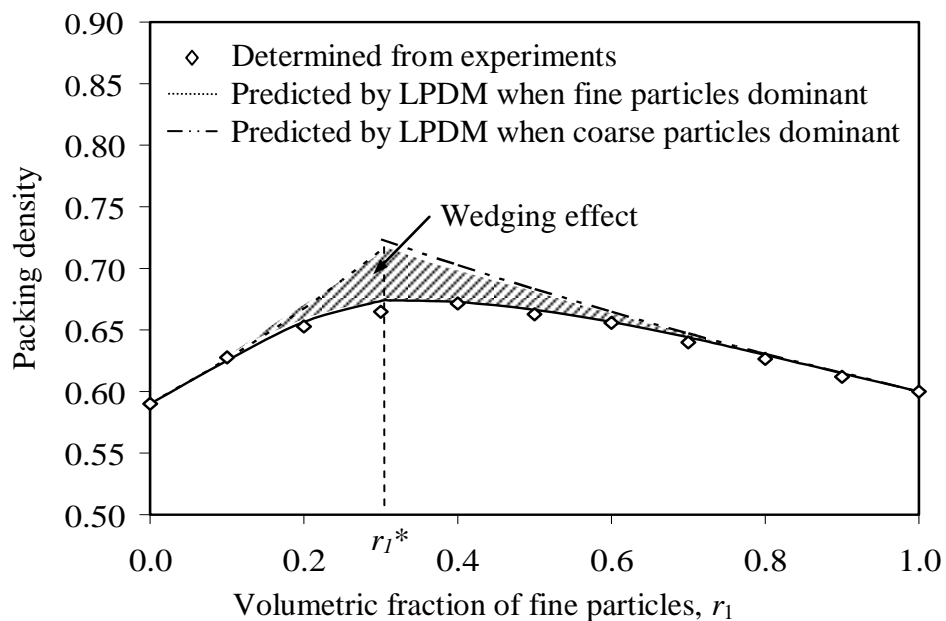
Fig. 1)   Packing density against volumetric fraction of fine particles

Research has been conducted in The University of Hong Kong and a new particle interaction effect, namely the wedging effect, as shaded in Fig. 1, has been proposed to explain the discrepancies. The wedging effect can be explained in two scenarios for binary mix, i.e. when the coarse particles are dominant and when the fine particles are dominant. When the coarse particles are dominant, some of the fine particles may be trapped in the narrow gaps between the coarse particles instead of filling the voids between them, thereby wedging the coarse particles apart, causing the solid concentration near the surface of the coarse particles to be lower as illustrated in Fig. 2. On the other hand, when the fine particles are dominant, some of

the coarse particles may place themselves into the sea of fine particles by almost touching each other instead of discretely and evenly. The space between the coarse particles can no longer accommodate a single layer of fine particles, thereby wedging the fine particles sideway, forming gaps between the coarse particles that are unoccupied by fine particles and causing the solid concentration near the surface of the coarse particles to be lower as illustrated in Fig. 3. By looking into the particle interactions between particles, a new particle packing model, namely the 3-parameter packing density model (3PPM) has been developed with the loosening, wall and wedging effects incorporated [11]. The new model has been tested against the experimental packing densities. It has been found that 3PPM can accurately predict the packing density for binary mix and ternary mix of mono-sized spherical glass beads, which is inspiring and encouraging as it would be a useful tool for mix optimization of HPC in the near future.
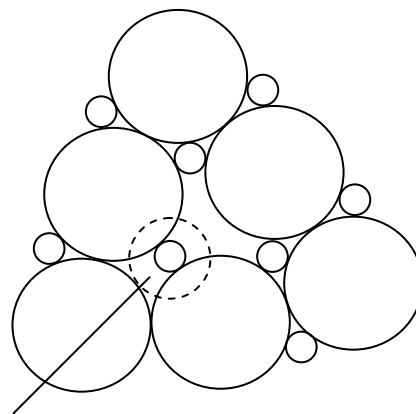
Wedging effect

Fig. 2)   The wedging effect when coarse particles are dominant
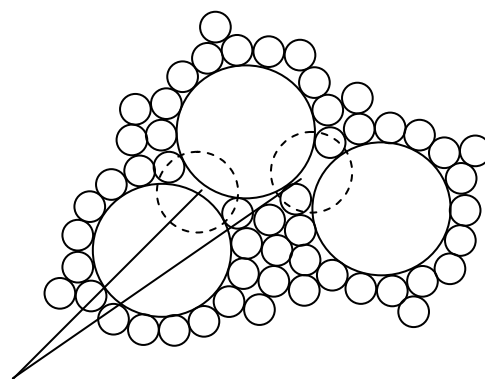
Wedging effect

Fig. 3)   The wedging effect when fine particles are dominant

5   RHEOLOGY OF CONCRETE

Concrete mix appears to be solid and rigid, but when subjected to an external force, it flows and changes its shape to fit the mould just like liquid. Therefore, concrete exhibits properties that are both solid-like and liquid-like and is a typical yield stress fluid. The rheological properties of yield stress fluid are usually described by yield stress and apparent viscosity,

where yield stress is the shear stress that initiates the flow and apparent viscosity describes the resistance to flow that is defined as shear stress divided by shear rate. Rheological models are available for yield stress fluids, such as the Bingham model and the Herschel-Bulkley model. However, these models are only useful in providing phenomenological descriptions of rheological properties but do not provide an understanding of the behaviour of yield stress fluids. To better understand the rheological behaviour of concrete, it is essential to explore the factors determining its solid-and-liquid-like behaviour so that a scientific approach or the so-called know-why approach can be adopted for mix optimization design of HPC.

Robinson [12] introduced a concept that the specific viscosity is not only proportional to the volume concentration of the suspended solids but also inversely proportional to the volume of free liquid in the suspension. The free liquid is the liquid outside the suspended particles contributing to fluidity, which is not entrapped within the packed particles when the volume concentration is sufficiently high. There exists an upper limit of the volume concentration of the suspension, which is reached when there is just enough liquid to fill the voids between particles. In this case, there is no free liquid which makes fluid flow impossible and the suspension becomes a porous solid with infinite viscosity. Later, Powers [13] proposed the excess paste theory by postulating that it is the excess paste, the paste in excess after filling the voids between the aggregates, which contributes to the workability of mortar and concrete. Therefore, by increasing the packing density of aggregates, a concrete with higher workability can be produced. The free liquid introduced by Robinson and the excess paste proposed by Powers, despite of different names, share the same notion that the excess fluid, no matter in liquid form or in paste form, is one of the major factors affecting the rheological behaviour of suspension such as concrete. Actually, the upper limit of the volume concentration of suspension is equivalent to the packing density of the suspended particles under dry condition. With the availability of particle packing models such as 3PPM, the packing density of particles can be accurately estimated so that the excess fluid can be easily computed. When applying to concrete, optimizing the packing density of the constituent particles is a key to produce HPC with high workability and flowability.

Although maximizing the packing density is generally considered a good strategy for mix optimization of HPC, maximum packing density does not necessarily equivalent to optimum packing density because the increase of the total solid surface area of the concrete constituents due to the addition of ultra-fine particles such as CSF may increase the cohesiveness of binder and deteriorate the workability and flowability of mortar and concrete [14]. Therefore, the notion of water film thickness has been proposed in The University of Hong Kong [15], which incorporates the effects of packing density, solid surface area of particles and water content by postulating that the excess water, the water that is not filling the voids between particles in the cement/mortar/concrete mix, plays a role in contributing to the workability and flowability of the corresponding mix. The water film thickness has a physical meaning of the average thickness of excess water coating the constituent particles of cement/mortar/concrete mix, which can be computed by dividing the volume of excess water by the total solid surface area of particles in the mix. A water film thickness of zero implies that the water content is just enough for filling the voids between the constituent particles in the mix and a negative water film thickness has a physical meaning that the water content is not enough even for filling the voids between the particles in the mix. It has been found that an increase in water film thickness is usually accompanied by an increase in workability and flowability. Therefore, water film thickness can provide mix optimizers with a good measure of the workability and flowability of concrete.

6   CONCLUSIONS

Concrete is by far the most widely used construction material in the world majorly due to its low cost and versatility. However, the concrete industry has an enormous impact on the environment such as the vast amount of natural resources and energy required for the production of concrete. Nevertheless, concrete is actually inherently environmentally friendly. It is the fact that Portland cement is not so environmentally friendly due to the huge amount of energy required in production and the large amount of carbon dioxide released into the atmosphere.

Currently, there are ways that concrete can increase its compliance with the demands of sustainable development, which can be summarized as follows: (1) to increase the use of supplementary cementitious materials; (2) to increase reliance on recycled materials; (3) to enhance the performance of concrete. These ways are rather empirical and there are still many aspects of concrete behaviour that are beyond our comprehension. As a result, an in-depth understanding of how the various mix parameters would affect the behaviour of concrete is needed for mix optimization and robustness design of concrete. In this regard, a new approach for concrete sustainability is proposed, which is to transform the conventional concrete technology into modern concrete science by developing new theories after investigating the factors governing the behaviour of concrete.

In this regard, The University of Hong Kong has been working on the theories of particle packing, particle interaction and water film thickness, which are evolving into modern concrete science and applying to mix optimization and robustness design of high-performance concrete. For particle packing and particle interaction, a new particle interaction effect has been proposed, namely the wedging effect, which may occur, when the fine particles are trapped in the narrow gaps between the coarse particles instead of filling the voids between them or when the coarse particles place themselves into the sea of fine particles by almost touching each other instead of discretely and evenly. The wedging effect, together with the loosening and wall effects have been incorporated into a new particle packing model, namely the 3-parameter packing density model, which has been found to accurately predict the packing density of binary and ternary mixes of mono-sized spherical glass beads. We can envisage that the new model would become a useful tool in mix optimization of high-performance concrete. For water film thickness, it has been found that the solid surface area of particles also plays an important role in the rheological behaviour of cement/mortar/concrete mix. Based on a more scientific approach, we can further contribute to the sustainability of concrete via mix optimization, which can enhance the performance of concrete and reduce the cement consumption.

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LEGISLATIVE CONDITIONS OF PROPRIETARY HOUSING IN RESIDENTIAL BUILDINGS IN THE SLOVAK REPUBLIC

Jana Zajacová[1]

Abstract

Dignified housing is a basic life need of every man. Therefore problem of housing is still relevant and belongs to the monitored areas of public life.

Proprietary housing is the most widespread form of housing in Slovakia, especially in detached houses or residential buildings. Another alternative of housing is tenancy housing.

Contribution is focused on the problem of housing in residential buildings; it deals with legislative conditions of proprietary housing in residential buildings in Slovakia, describing the rights and duties of the apartment owners, analyses forms of building administration, points out the advantages and disadvantages of individual forms of building administration. At the same time it deals with the problem of the owners of the restituted residential buildings and the regulated rents.

Key words

Apartment ownership, proprietary right, residential house.

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1   INTRODUCTION

The habitation is ranked among elementary human requisites that involve various aspects. It's not related only to assure a roof over one's head, so doesn't represent only satisfaction of needs, but with habitation cohere social aspects and social status of man too. With habitation is inseparable coupled question of construction home and social upcountry.

Access to good quality and affordable accommodation is a fundamental need and a right not only in Slovak Republic. Meeting this need is still a significant challenge also in a number of European Union countries. That's why experts in their various publications and articles analyze the conditions of living [1], point at their positive and negative sides, researching social aspects [2] [3] of housing and the influence of housing policies of some countries on the development of housing. [4] [5]

For the majority of inhabitants in Slovak Republic is just apartment in house unit always the most available resource for satisfaction of life-long requisites habitation. Reasons of people's interest in acquiring their own habitation can be for example isolation of kids in maturity, establishment of own families, attractive vacancy outside of present abode. Another aspect of modern task of apartment along liquidated questions of habitation is long-time investment of free financial resources.

According to available data, concerning the present status of habitation solution with focus on living at apartment house in Slovak Republic is possible to state, that living at apartment houses is being realized by two of basic modes, namely:

- ingestion of apartments according to a legal title, that is of property right – practically the term possessive habitation is used as well,
- according to a rent relation – practically the term rent habitation is used.

At possessive habitation the owner of the apartment enters various legal relations and bears an adequate legal responsibility too. Therefore is it necessary to realize all aspects of ownership, primarily that in compare with finds apartment it brings for apartment owner wide warranties and decisions to dispose with apartment, but on the other hand it is necessary remark, that providing default incident and responsibilities connected with ownership exists too risk and real possibility of extinction ownerships apartment, at which apartment owner after extinction ownerships of apartment has no right to ensure any housing unit replacement. The objective of the paper is to analyze the conditions of housing in apartment buildings, point at their positive and negative aspects as well as at their deficiencies in jurisdiction and their consequences that limit the dispositional rights of owners of the apartments in the restituted apartment buildings regarding the regulated tenancy.

2   DEVELOPMENT OF RESIDENTIAL BUILDING-UP IN SLOVAKIA

Slovakia belongs to countries, whose development in the area of housing politics was markedly affected already by the end of the 2.World war or by year 1948, when the Communist Party took over the power. To general practices concerning housing problem belonged in those times nationalizing of apartments and houses as well as soil into common state ownership. Declarative aim of nationalizing and deprive and consecutive rationing of apartments and houses to inhabitants by then criterions was to cover insufficient places for housing caused by 2.World war. In Slovakia, as well as in other countries of eastern bloc, was centralized planned economy, the free market didn't work i.e. offer and demand were controlled by state. Existence of any social housing at this time is very controversial, because

with the exception of very small proportion of private building-up, was all housing offering and financing exclusively by the state. [6] The period from the end of 2.World war to the fall of communist regime in the year 1989 can divide into five following terms: 1948 – 1955, 1956 – 1963, 1964 – 1970, 1971 – 1980 and 1981 – 1988. [7]

The first period is characteristics of increase housing building-up, at which modal was "...state (communal) building-up and individual building-up, which oneself centered above all into the country". [8] Individual building-up did not exist at all in towns. Half of 60 years, i.e. the second period, was tinged by expressive migration of inhabitant into the cities, what had subsequently influence on increase of demand of housing, therefore was accepted program of industrialization in building industry in the year 1955. [7] At the same time the first implication of pre-war poor quality building-up started to manifest, though orientation to building-up of new apartments is hold over, instead of restoration old housing unit fund. The quality of housing is improving and the first decisions of individual building-up in towns are detected. In the year 1959 come into being two new molds of building-up – cooperative and establishment building-up. In the early 80's the legal regulations were accepted, which adapted the housing specifications, housing with apartments etc. At this time also there is a change of passing onto new technologies – so-called paneled system and housing policy oneself case shifts primarily on fast home building in highest quantities. [8] For the end of this period is typical expressive difference in individual building-up in Slovakia and in Czech Republic, even though that created one state. While houses building-up in Slovakia created 60% of general building-up in Czech it was only 15%. This difference was caused primarily by absence of formal style of building-up and by effort of inhabitants to provide for them more perfectly housing in bid by mass home building.

Throughout 80 years, i.e. at fourth term, housing building-up digest the top, in towns come into being big housing development and peak achieving establishment residential construction too from the reason of workers stabilization in towns. However financing sidelong of the state is reducing, what subsequently caused fall of housing building-up in last the fifth term. Shortage finance makes itself felt on building-up, need of restoration and so-called rehabilitation of housing unit fund, inequality between towns and country in number of applicants for apartment (in towns immense sums of applicants so far in the village stay vacancy housing). [7]

Period after 2nd world war very negative influenced policy making habitation on long years and some negatives hold over up to this day. State monopoly in this politics incurred expressive bipolarity of housing unit fund, where aside existed in a body erected flats of low qualities in uniform housing development, and on the other quality live at houses has raised, that created only ultralow interest from the total housing unit fund. [8] The absence of functioning market with housing, state fixing the price of housing or directive specified height of rent, absolutely didn't reflect real spending on building-up, what caused incalculable casualties for economy and immense liabilities. The consequences were markedly corrupt and devastated housing fund in the late 90 years.

By the year 1989 was then housing policy centralized and state guarded the housing for all inhabitants – state central guarded building-up in a variety of ways, allocated all sorts of habitation, operated residential buildings primarily of state and cooperative apartments and dominated centralized administrative system of apartments redistributing.

Situation has changed after fall of communist regime - housing unit building - up in Slovakia started to transform. The previous rationing was replaced by commercial, which emanated

from idea that flats are goods and are separated on base of supply and demand. [9] As state had not financial resources on renewal of housing unit fund, alienated this property on communes and cities, through those was further from-marketed to original tenants to ownership in very profitable sideline costs. These housing however were in considerably inconvenient condition, what exact from new owners no small investments in repair. In that time also assumed, that arrival of private investments is focusing on purchase whole objects, of which oneself subsequently become lodgings. These assumes oneself however underflow and great mass of housing unit fund was taken by privatization, what caused that even though that by conception of habitation from the year 1994 had to exist 20 % housing unit fund keeping on provision habitation for social worse off groups of inhabitants, poop from the year 2000 state, that in lands of communes stayed only 6,2 % of rental housing units (on comparison in country EC achieving share of public rent housing unit fund ca 18 %. [10] Besides considerable expensiveness on repair housing unit fund, at what state had not sufficiency financial resources, cause massively privatization too legislative as favoritism owners of apartments as tenants.

Since 1993, when independent Slovak Republic was created, came in the area of habitation and housing building-up to many changes. State in that time needed quite anew to build politics of habitation. One of important decisions of politicians was division of tasks within politics of habitation on three levels (central, regional and local). State stayed important person involved, who desisted from involving itself into housing building-up, but accepted the task of being a creator of skeleton documents, through which it strove to define fundamental principles and rules, in which housing policy of Slovakia would further move.

From creation of independent Slovak Republic was the problem of habitation well-known as concept of housing determined by several legislative documents and otherwise by conception of state housing unit politics working-out on a regular basis on quinquennium. Since 1994 have been working-out globally five conceptions, of which the latest was approved in the year 2010 with horizon by the year 2015. Interesting index which characterizes housing unit building-up in Slovak Republic is intensity of housing unit building-up, which express number of completion apartments on 1000 inhabitants. The figure nr.1 presents the intensity of building up housing units in Slovak Republic in the years 1995 – 2009. In the year 2009 reached worth 3,47, what introduce historic uppermost worth hereof index since 1993 (least was in the year 1995, when oneself build only 1,15 apartment on 1000 inhabitants). And concerning of uppermost worth of this index in the year 2009, always they are not these attributes on such level as with majority countries of European Union.
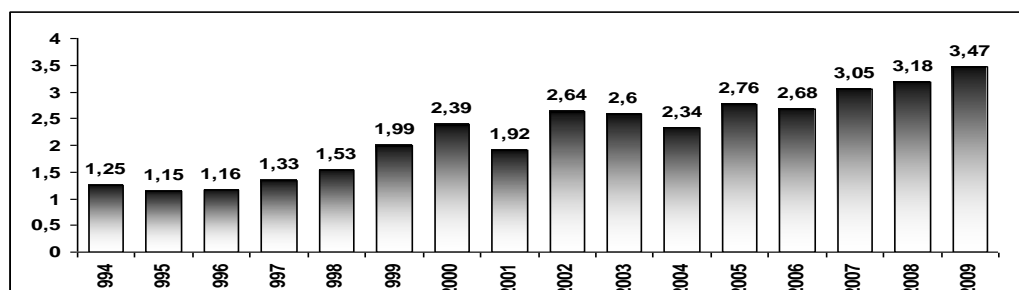
Fig. 1)   Intensity of housing unit building-up in Slovak Republic in period from 1994 to 2009 the number of completed apartments/1000 inhabitants.

For comparison for example in the year 2004 had mentioned indicator value 4,0 in Netherlands 4,9 in Denmark 5,2 in Austria 5,8 at Finland 6,0 in France 12,6 in Spain and

19,0 in Ireland. In countries that passed similar transformation process as Slovak republic, had the intensity of housing unit building-up in the year 2004 worth 2,8 in Poland, 3,2 in Czech republic, 3,5 in Slovenia and 4,3 in Hungary (by publication Housing statistics in the European Union 2005/2006).

3   APARTMENT OWNERSHIP IN FLAT BUILDINGS

In the past was problem of using apartments in Slovakia working out in prevalent measure through rent habitation following legal modifications inclusion in Civil Code. [11] Situation has markedly changed in 1993, after acceptation of a law about ownerships of apartments and non-residential premises [12], that has opened the possibility of apartments acquirement in flat-buildings in ownerships, at which the preference right to acquire apartments in ownerships had tenants of those apartments.

In present time the possessive housing in Slovakia presents most widespread form of housing. At summation of inhabitants, homes and apartments in the year 2001 were from total number of apartments in Slovak republic 75,9 % apartments at citizen ownerships (ca 50 % in houses and 26 % in flat-buildings), at ownerships of housing associations were 14,9 % apartments and at ownerships by other subjects were ca 9,2 % apartments. By foundations received from statistic finding about ownerships housing unit fund to 31.12.2008 and by following educated guess possessive housing in Slovakia representing to introduction term ca 94,5% steady occupied apartments. Property housing is generally budget for housing of central and higher earnings group of population.

At solution of question about apartment selection, in that future owner would like to live and acquire it into one's ownership, it comes into the account various alternatives. Ownership of apartment is possible acquire from owner of residential house, or directly from the owner of apartment in older residential house. At purchase of apartment in new building the future owner of apartment should be cautious and present hike attention to commercial terms of contract, eventually contracts, following those he has obtain ownership of new apartment. In this case it would be for future owner the best and in the eye of the law too safest, if he pay for complete apartment till after it's done and after house inspection. Mentioned solution is in consideration of situation on real-estate market and in consideration of big interest in new housing enough unreal and such progress of building companies and investors practically is very exceptional and rare. If a person is interested to obtain apartment into ownerships in new residential house, he has to make reservation with big time advance, eventually close agreement about work or contract for future purchasing agreement, where object shall be a new apartment. In such case it is important in mentioned agreement arrange payment conditions like this, that in stage number of buildings in the process of construction he paid future owner only small part of costs apartment. Practically oneself in mostly cases the future owner tie into the bargain, that will be price apartment pay out gradually, by installment calendar arranged in agreement, at which majority costs apartment pays already during building-up and after house inspection pay for already only 10-20% from general costs apartment. In this manner action payment condition is highly probable, that money acquired from installment future owner apartments uses constructing company as investor on building-up housing unit house. In this situation is future owner at risk, that in case, that the construction company or investor won't be able to collect sufficient amount of money from future owners, won't be able to proceed in building-up (for example then, if sale of apartment is not in such volume and temporary time table, that investor has planned and calculated for

requisites continuously building-up). Therefore it is necessary to pay closer attention to ways, according to which a person acquires the ownership of apartment.

Responsible position belongs primarily to agreements and very important is their content and conditions, that are yourself contracting parties arrange, because only good agreement forms real assumption on trouble free ingestion ownerships apartment.

3.1   Manners of acquirement ownerships apartments

If somebody has sufficiency of financial resources, is able to oneself decide solve one's housing unit question thereby, that acquire in one's ownerships apartment in housing unit house. At the same time it depends on single prospective owner, whether will be choosing apartment in ownerships in old home houses, or decides for purchase brand - new apartment in new building house.

Ownership of apartment or non-residential premises is possible to acquire in following way:

- On the strength of the contract about assignment of apartment. These agreements enclose documentary assignee of ownerships with house owner or with juridical person, who has the right of house management or with apartment owner, eventually of non-residential premises.
- On the strength of the contract about building-up, inbuilt or superstructure of the house. Agreement in writing includes exact determination of mutual discretions and duties of builders at building-up house.
- By inheritance under the provision § 460 and subsequently Civil Code. [11] By this manner it is possible to acquire apartment or non-residential premises in housing unit house into ownerships only in case, if benefactor was the owner of apartment or non-residential premises. Heritage is acquired by death of benefactor. Certificate about heritage and resolution about heritage are basis of record of possessive law in land registry of immovable properties. Ownership of apartment isn't possible to acquire by inheritance, if benefactor was only tenant of cooperative apartment or tenant of apartment at ownerships of the state, associate, commercial company, etc.
- By decision of governmental instrumentality, (for example following decision of the court), namely by day designation in this decision. In case, that in decision isn't particular day given, by day of acquirement of legal force introduction arrangements.

At inscription way of acquirement possessive laws along with ownership of apartment in housing unit house acquire always also part owners concern in common sections, common machinery housing unit house and on accessories and generally even part owners concern in grounds, on that is flat-building built and in some cases part owners concern in adjacency grounds.

At the same time it is necessary call attention to important reality, that on contractual acquirement of possessive laws to flats and in housing unit house by contemporary legal modifications oneself claim fulfillment of two assumption. One of them is bargain in written form with all of prescribe appropriateness, at which utterances of party to a contract must fall to the same document. Valid contract of transfer of apartment ownerships or non-residential premises however still hasn't in consequence acquirement, or transfer of possessive law. The additional factum juridicum must come up to it, namely deposit into land register of personal estates that have constitutive effects. By deposit in land register of personal estates oneself

acquire ownership of apartment and non-residential premises (of all personal estates) and agreement oneself becomes effective.

3.2   Discretions and duties of apartment owners

With the ownership of apartment in housing unit house the owner acquires specific laws, but at the same time takes through not a small quantity of duties.

One of basic laws of owner is right to treat with flat by one's own reflection and arrangements. The owner of apartment has right to transfer his apartment and rights therewith linked on other natural or juridical person, for which he doesn't need any approval or permission. Mentioned is valid in case, that owner has his apartment in exclusive ownership and on apartment are no liabilities, rights of using or another legal constraints ordered in favor of the third part (for example right of lien on credits of creditor, whom apartment owner owe financial resources). With flat like this the owner is able to load freely. It means, that he can sell it, give it, commute it into another apartment, eventually in others property, establish testament about it for case of his death. He is also able to lease the apartment for a limited period of time or on indefinite time to other natural or juridical person, eventually give only certain part of the flat in sublease to other person. The owner is able to use his apartment to ensure financial assets (safety of borrowings or loan) and establish on apartment lien in favour of credits or creditor (e.g. banks).

To own an apartment in a flat-building means to have also part owners reference to common property. Owner has not only responsibilities to apartment, which belongs to him, but also towards common property. To elementary responsibilities of apartment owner belong duty in due course and in time to pay fee for filling connection with ingestion of apartments, as well as stipulate monthly contribution into fund operations, maintenance and depreciation reserve and providing house administration through manager too stipulate fee for this administration.

Ownership of apartments in residential buildings is individual in those, that owner of apartment can't guard alone as individual some filling connection with ownership of apartment. It's going primarily on lighting of common sections of house, waste disposal, cleaning cesspool, using elevator, delivery of warmth and warm water, supply of water from water companies and waste-water discharge. It is needed in housing unit house guard even additional activities, how's e.g. working, maintenance, repairs and sustaining of common sections and common appointments, contiguous grounds and accessories, working of an account of house at the bank, exaction of claims and arrears at fund operations, maintenance and depreciation reserve and other areas, as well as different activities directly related to ingestion of house en bloc. To manage mentioned common businesses of all owners in housing unit house is according to law created an administration of housing unit house. Administration of housing unit house takes place of duplicity way:

- By founding the community of apartment owner.
- By closed contract about performance administration with manager.

On administration is not allowed of existing together several molds of administration. On administration in one house can be bargain only with one manager or only one contract for community. In case, that owner acquire apartment in housing unit house, where already owns have they sufferance form administration, new owner owes come up to this form of administration, who elected majority of apartment owners and non-residential premises in housing unit house. If is created community of apartment owners, they care owns alone. In this case can come to problems at management of apartments in that reasons that owners of

apartments have different professions and they are not experts in the field of management of housing unit fund. If they contract agreement about housing management, common matters of apartment owners safeguards manager. Manager can be corporate entity or natural person entrepreneur that has in line of business or in object activities message and maintenance housing unit fund.

If owner of apartment wants to influence quality of habitation in building house effectively, has discretions and duties attend on management of house and determine vote how co-owner common sections, common furnished, accessories and grounds about progress connection with management of common property, with its working, maintenance and repair, eventually of modernization housing unit house.

Owner apartment has discretions and duties attend on administration of house and determine vote how co-owner common sections, common furnished, accessories and grounds about progress connection with administration of common property, with its working, maintenance and repair, eventually of modernization housing unit house.

To control administration has owner accordingly right to look into documents related to administration of house and evacuation fund operations, maintenance and depreciation reserve. At exercise rights owner in housing unit house oneself go out on principle straight of all owners, namely regardless of this, whether to own apartment or non-residential premises indoors is person, corporate entity, housing association or village.

Ownership apartment in housing unit house oneself mark thereby, that owner apartment obligatory near used by one's apartment have regard for of others owner apartment in housing unit house. Every one of them has namely too right to undisturbed ingestion ownerships of apartment.

Law about ownerships apartment and non-residential premises is saving owner duty to keep apartment and non-residential premises in the state of competence on in due course ingestion. Therefore owner has to in due course and on time guard maintenance and repairs in apartment, what is for example repair timing in apartment, sewage waste, repair of fusible radiators, aloud caretaker of malfunction water-gauge. Repairs in owner's apartment are not paid from fund for operations, maintenance and repair, but charges incurred are paying every owner alone.

Abidance of responsibilities go towards undisturbed and peaceful coexistence of owners in housing unit house, what should be behalf of all owners, that be living in pleasant environs. If resort to broad breach duties, f owner offhand harms apartment or non-home space, common sections of house, common house devices, common non-residential premises, facilities, if digestedly violation staid housing of other owners apartment or if jeopardy safeness and infringe good manners indoors, is able on base of lex judicialis to loose on his ownership apartment. Financial assets (safety of borrowings or loan) and establish on apartment lien in favor of credits or creditor (e.g. banks).

4　APARTMENT OWNERSHIP AND ANALYSIS OF PROBLEMS WITH REGULATED TENANCY

Weighty and long-lasting problem of apartment owners in some home houses in Slovak Republic is one's limits disposition laws by regulated tenancy.

Concept „regulated tenancy" oneself reinvented on territory today's Slovakia after social changes, that are come into being in the year 1989, when by so-called„ restitution laws" oneself return housing unit houses to original owner or their successor. These housing unit houses were backspacing to warranty person included persons that had to individual apartments bested in these home house rental rights.

Responsibilities controlled rent was and on the present always hold over protection of tenants in apartment bested in home house instead of self-willed by increasing the rent, that would tenant not able to pay.

Nobody oneself didn't think not only above economic impact, that are controlled rent causes to owners this personal estates how nor' above that, that being invasion essential rights this owner, guarantee by constitution SR as well as international agreements, that is of Slovak Republic bound, because they can't with one's ownership treat without restraint load, use it, keep it, prevent it's devaluation or destruction, whether have out of it adequate edict.

On the present is controlled rent re-format by measure Department of the Exchequer Slovak Republic nr 01/R/2008 about regulation price apartment. This enactment causes, that edict from receipts controlled finds is not enough for home owners nor' on deck necessary load necessary to ensure proper and safe operations of home, but nor' on creation fund depreciation reserve, that would be used on renewal housing unit fund as well as maintenance and modernization housing unit house. Results of this are historical buildings in downtowns that are in desolate technical conditions.

According to our opinion is offered extortionate fine protection of apartment tenants in comparison with zero protection offers to owners of restituted homes, who at the same time by limitation of execution of their rights supply social task of the state in the area of housing unit policies.

On 15th September 2011 came into force law nr. 260/2011 about determination and ways of arrangement of tenemental relations that includes conditions and terms of determination of tenancy in apartments with regulated tenancy. [13] This law gave to subjects, who were houses with apartments issue frame within the frame restitution, possibility tell rent too without report reason, namely till 31. March 2012. Period of notice at like this quits is 12 month. In case of houses, where legal proceedings about their issue or designation of ownership are in progress, renter will be able to denounce the rent of apartment without any reason in two months since legal force dictum on issued personal estate with cancellation term six months. In like manner can be rent expelled providing legal lex judicialis about transfer of rent or exchange of a flat. The notice of the termination of renting the apartment must be delivered not only to the tenant, but it is necessary to deliver copy to the municipality too. The reason is, that the municipality could to advise tenants to possibility hand over for application housing unit replacement. For assignment substitute rent apartment with regulated tenancy it is needed to apply to 30.9.2012. Pretension to housing unit replacement has only tenant, who about housing unit replacement requests and at the same time fulfil the condition of material housing unit distress. If the municipality cannot provide housing unit replacement at latest term provisions in law (until 31.12.2016), owe following written application of the owner of the apartment every month pay amount - a difference between marketer monthly rent and controlled monthly rent, until administration housing unit replacement. Until the administration housing unit is replaced, owner of the apartment with regulated tenancy unilaterally is able to increase arranged monthly rent once a year.

- In the year 2011 about 20% from treble rent calculation to 15.9.2011
- In years 2012 to 2015 yearly about 20% from treble rent calculation in past year.

Mentioned enactment stands certain shift at solving problems of owners in restituted houses, though providing, that state creates not only de jure, but also financial instruments and conditions, following that shall possible executing building-up new substitute apartments for tenants, who owe to hand over apartments to owners pending secure adequate housing unit replacement by introduction law.

5   CONCLUSION

At creating of conditions for the development of habitation operate even in Slovak Republic several subjects with its specific activity, namely: citizen, state, self-government and private sector. In market economy primary responsibility for reservation of own habitation carries the citizen, who must ensure all activities and operations related to preparation and realization of investments and at the same time solve all problems related with using the apartment (safety of financial sources, administration and working, maintenance and repairs).

Citizen as an apartment owner in applying possessive laws enters various legal relations and bear adequate legal responsibility. Important task at acquirement of real-estates on housing present contractual relations, according to which the rights and duties connected with habitation as well as his financing are re-formatted. Good agreement and its detailed content creates fundamental prerequisite for creating a stability and certainty at housing and others treating with realty. On the contrary, limitations in contracts can have in consequence disputes between participants of contractual relation and in extreme case can happen, that an agreement itself becomes invalid, or can come even to dissolution of a contract for example on base of rescission of contract.

Implication and impact on contracting parties in this case are very grave, primarily then, if financing of habitation has been solved with credits or loans. As a consequence of wrong purchasing agreement can purchaser loose the ownership of the apartment; however this fact doesn't change or negates the duties of the purchaser in relation to a bank or another financial institution to pay back the credit, that purchaser draws to pay for cost of acquisition and for the acquirement of the ownerships of the apartment. These impact limitations in contractual condition can come into being until after developed contractual relation with temporal distance, but negative economic impact can be for contracting parties very grave until liquidating. For that introduced reason it is needed to pay a closer attention to them already at the negotiation about contractual conditions and at closing concrete agreements, according to which the possessive rights or other rights to personal estate on habitation should be acquired.

Legislative in the area of habitation and disposal of property for habitation should develop and be set up for discovering and removing „gaps" in laws and other enactments regulating problems of habitation. State should in case of identification of inconsistency and limitations elastic react by nouvelle, or new actual enactments in the area of habitation and disposal with realty.

Activities of the state should be then focused primarily on creating of necessary legislative frames for single subjects in sector of habitation, creation of economic tools of allocating, credit and tax policies, as well as on inevitable methodical activity in this area.

To important responsibilities of the state in the area of habitation development belong also formation of conditions for increasing the efficiency of economy, decreasing unemployment and growth of real income of consumer sector as fundamental prerequisites for improvement of habitation levels, his availability for inhabitants and shortening of time periods necessary for assurance of own habitation.

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PROBLEMS THAT OCCUR DURING CONSTRUCTION PROJECT REALIZATION IN THE REPUBLIC OF MACEDONIA

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Abstract

Construction project realization is a complex process that is determined by numerous changeable factors that interact with each other. These factors are the source for many problems that occur during the realization of construction projects. In the paper the sources for problems are divided into three groups and analysed. The first group is connected with the participants in construction project realization. The second group consists of factors related to external construction project influences. The third group of sources for problems is related to the factors relevant to the structure location and its surroundings.

The past and current situation of these three sources of problems are analysed in the paper. The findings are supported by the survey data. The survey covered participants in construction project realization in the Republic of Macedonia. The analysed findings are the basis for suggestions given in conclusion for construction project realization problem-solving.

Key words

Construction project, factor, realization, problem.

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1   INTRODUCTION

Many authors state that the construction industry still suffers from inefficiency and ineffectiveness; thus the construction industry has been proclaimed as the worst among all industries [1, 2, 3]. The construction process is difficult and deals with numerous problems. For example, the authors in [4] introduce the fact that the field of construction engineering, organization and management is extremely large and people involved in it deal with a *wide spectrum of problems: from legal questions in the construction industry to mechanization*. Many problems are global while others are specific for a certain region or a country.

In the Republic of Macedonia, construction project realization is challenged by numerous changeable factors that interact with each other. These factors are the source of many problems that occur during project realization. Identifying the sources of these problems is necessary for choosing measures to reduce their negative impact on project realization.

Consequently, the objective of this paper is to identify the sources of problems and to provide recommendations to reduce their negative impact on construction project realization in the Republic of Macedonia.

2   SOURCES OF PROBLEMS IN REALIZATION OF CONSTRUCTION PROJECTS

In order to detect the major problems and reasons for their occurrence, the authors carried out an analysis about the realization of construction projects. During the problem investigation, past and current problems and their impacts on projects were taken into account. The problem analysis was based on the survey results. The survey covered 57 respondents – personnel in various professions, mostly from small and medium-sized construction companies who have worked in projects in the roles of Investor, Designer, Supervisor, Consultant, Contractor or Subcontractor in various stages of implementation of construction projects. The survey has been carried out by sending the questionnaire to respondents by e-mail as well as by the personal attendance of the investigators in the companies. The analysis of the survey results indicates that the sources of problems can be grouped into three interdependent groups of problems which are related to (1) participants in construction project realization, i.e. the Investor, Contractor, Designer, Supervisor, Consultant and other participants, (2) external construction project influences, such as the economy, politics, law, sociocultural conditions, etc. and (3) factors relevant to structure location and its surroundings, such as topography, geotechnical factors, climate, ecology and other factors.

Many of the issues presented below have been discussed by numerous authors in foreign literature, e.g. the problem of competitiveness [5], selection of project participants [3], estimation of construction costs [6], availability of financial resources by means of credit [7], utilization of prefabricated constructions [8], use of appropriate SW [9] or specifics in the field of public procurement [10, 11, 12]. However, the analysis presented in this paper is focused solely on the particularities of the Macedonian construction industry.

2.1   The sources of problems for participants in construction project realization

The first group of sources of problems is connected with the participants in construction project realization: the Investor, Contractor, Designer, Supervisor, Consultant, Subcontractors and other participants. The most characteristic sources of problems associated with the project participants are:

- High competitiveness of foreign participants in the projects. Foreign participants in construction projects, pursuant to the Macedonian Law on Construction [13] can undertake all the same positions as the domestic participants. According to the relevant legislation, the bidding for the larger civil engineering projects must be international. This leads to an increasing number of foreign companies which apply for civil engineering projects. Beside positive experiences from the presence of international companies in a domestic market, there are serious problems and obstacles for both sides, domestic and foreign parties alike. The foreign companies are more competitive compared to the domestic ones, while the domestic companies usually work as subcontractors, for lower prices, or don't participate at all [14]. According to the survey, 57.90% of respondents answered that their company was engaged in projects with foreign participation and 24.56% did not work on such projects. 17.54% of respondents did not know whether the companies for which they worked have collaborated with foreign participants.
- Inappropriate choice of project participants – selection of participants who, despite having the necessary licenses, do not have enough experience, references and resources for implementation of certain activities. Sometimes, the choice of participants is adequate, but the personnel provided by them are inadequate. Therefore, the participants in the projects use the possibility of involving consultants which complicates the work coordination due to an increasing number of participants. According to the survey, 49.12% of respondents said that during project realization consultants were engaged, 31.58% gave a negative response and 19.30% did not know whether consultants were engaged in the projects.
- Substandard mutual agreements between the participants in the projects, so disputes during project realization are common. The main reasons are usage of contracts that are taken from other projects and usage of contracts that do not respect the particularities of the specific project.
- Limited financial resources of project participants, especially in the projects that require significant financial resources – these problems are especially characteristic for the small companies that participate in the projects. In such circumstances, the contractor is put into a situation where it is forced to finance the construction.
- Developed Project programs that do not fully respect the wishes, the possibilities and the needs of the investor. The result is that changes are made to the project during its realization.
- Insufficient use of prefabricated or semi-prefabricated methods of facility construction. The commonly applied construction method is rationalized-classical, which increases the duration of construction. Only 40.36% of the respondents answered that their company designed or constructed a prefabricated or semi-prefabricated facility. 42.10% of the respondents answered no, while 17.54% of the respondents answered that their company has partly applied this construction method.
- Lack of an official Macedonian methodology and standards for project management. The country has not yet adopted a methodology for managing construction projects that would include all phases and activities of the project's lifecycle. Consequently, each of the project's participants implements their own methodologies.
- No satisfactory mutual communication between the participants involved in the project. According to the survey, only 28.07% of the respondents believe that the communication among participants in the projects is satisfactory, while 42.10%

feel that it is only partially so and for 29.83% the communication is not satisfactory.

- Insufficient availability of licensed software. Most of the domestic participants in the realization of the construction projects are small companies for which licensed software is expensive, so they use alternative software, which might affects the reliability of project results. According to the survey, 29.82% of the respondents' companies have licensed software, 29.82% answered no and 40.36% answered only partially.

- Lack of thorough research on available resources for project realization. Companies enter into projects without thoroughly exploring their possibilities in terms of resources, primarily machinery that has an influence on project duration. The average age of certain machinery and equipment they have, particularly in the case of small contractors, is older than 7 years.

- Personnel – this is the source of most of the problems. The participation of personnel with different engineering experience and references who have not worked together previously, with different cultures and traditions, creates problems during project realization. The most characteristic problems caused by personnel are:
  - Lack of fundamental research to select the most appropriate organizational structure for a particular project. Often an organizational structure is applied that proved effective in the implementation a previous project, without taking into account the specifics of the current project.
  - A process for construction project manager licensing is not established. According to the Law on construction, the Investor is given the opportunity to appoint a manager of construction, but it is a legal entity. The issues related to project managers as individuals have not been sufficiently addressed. There is no adequate training for construction project managers. The country has no accepted models, concepts and standards for construction project management based on contemporary project management methods, techniques and software and that would correspond to the actual conditions for the project realization, regulated by appropriate legal regulations [15].
  - Transfer of engineers from one enterprise to another is common. New engineers need time to get up to speed with the project realization.
  - Appointment of unsuitable engineers to perform tasks associated with the project. Appointment of engineers that have adequate licenses but not the necessary professional experience is common. According to the survey, 50.88% of respondents said that suitable engineers are appointed, 22.81% answered no and 26.31% partly.
  - Obligating engineers to work on multiple projects or perform multiple activities on individual projects simultaneously. This is typical for the engineers of the small companies that participate in the projects, because their resources are limited. 71.93% of the respondents said that the engineers are engaged in multiple activities at the same time, 5.26% answered no and 22.81% partially.
  - Lack of or frequent changes in professional manpower, particularly for specific types of activities during project realization.
  - Lack of motivation of most of the employees, primarily because of low wages and harsh working conditions.
  - Unsatisfactory teamwork among the participants in the project. Often there is a lack of necessary discussion for overcoming any doubts and ambiguities prior

to the execution of work. According to the survey, only 33.34% of the respondents felt that teamwork in the companies they worked for was satisfactory, while for 17.54% it was not satisfactory and 49.12% of the respondents were partially satisfied.

– Infrequent training of technical staff to improve their education and knowledge in areas relevant to construction project realization. Based on the survey results, technical staff requires additional training in several areas. The survey results are shown in Table 1.

Tab. 1) Survey results concerning the need for additional training of technical staff in different areas

Additional education (areas)	Yes (%)	No (%)	Partially (%)
Information technology	86.96	3.51	9.53
Law	49.12	28.07	22.81
Management	59.65	7.02	33.33
Project documentation	63.16	10.53	26.31
Construction technology	70.17	1.75	28.08
Economy	47.37	28.07	24.56

2.2 Sources of problems related to external factors for project realization

The second group of sources of problems consists of factors related to external construction project influences, such as the economy, politics, law, sociocultural conditions, etc.

- *Legal factor* – this factor covers legislation. Typical problems caused by the legal factor are:
  – Frequent changes in laws, primarily because of their harmonization with European legislation.
  – Increased costs for activities due to the frequent changes in laws. In fact, almost always the changes in the laws result in changes to certain activities undertaken in project realization.
  – The legislation does not include all segments of the work of the participants in the projects. Despite frequent changes in law, there are still significant questions about the work of participants in construction projects that are not specified by legislation. According to the survey, only 3.51% of respondents felt that the existing legislation covering the work of the participants in the project is good, 19.30% think it is bad and 77.19% of respondents believe that it should be supplemented.
  – The legislation does not include all segments of the implementation of construction projects. There is a lack of sufficient guidelines, rules, etc. which regulate issues related to certain aspects of project realization and give freedom to project participants for other aspects of this realization. According to the survey, only 14.04% of respondents stated that the legislation covers all segments of the construction of facilities, 36.84% said no and 49.12% felt that legislation only partially covered all segments of the realization of construction projects.
  – Some changes and amendments to the law have been adopted without sufficient consultation of the construction public and without sufficient respect of the specific conditions for construction project realization. For example, in accordance with the law on the building industry, the levels of project documentation for facilities are divided as follows: project for preparatory

works, basic design, project for realization and project for use and maintenance of the facility. In fact, in order to shorten the time obtaining necessary approvals and permits for the facility, since the last year presentation of Design Documentation for a Planning Permit is not required. Omission of an idea project causes many problems in construction project realization. According to the results of the survey, only 8.77% of the respondents felt the process of getting the necessary approvals and permits for construction of facilities is simple, 75.45% felt it is complicated and 15.78% of the respondents do not know.

- In accordance with the Law on public procurement [16], a system for electronic auction is in place. Electronic bidding achieves low prices that are sometimes not realistic. On the other hand, electronic auctions do not cover all public procurement, which complicates the procedures for public procurement. The decision to choose the best offer can take up to 100 days, which for the participants in construction projects causes supplementary costs for bank guarantees which relate to the tender. Sometimes in bidding, the project duration is taken as a key factor. So, to fulfil this criterion, the schedule is inadequately presented in the offers. Taking this into account, it is clear why only 47.37% of the respondents in the survey responded that the tender procedure for selecting the best bidder in the country is poor, 33.33% of the respondents have no clear opinion about the tender procedure and only 19.30% of the respondents are satisfied with the organization and execution of the best bidder selection.

- Contracts between the project participants – the most frequently used contracts are turnkey contracts, unit price contracts and international contracts in the building industry according to the FIDIC standards. However, there is no official database of contracts that are most appropriate for construction projects (with respect to their positives and negatives). It happens that contracts are concluded by staff without appropriate experience or without sufficiently clear contract clauses. According to the survey, most respondents – 71.93% – had problems during work due to unprofessional agreements made between project participants, only 3.51% had not met with such a problem and 24.56% partially.

- The Law on health and safety at work [17] is harmonized with the relevant EU Directives. However, in the Republic of Macedonia civil engineering is among the most dangerous professions for human health and safety. In accordance with the legislation, project participants should employ people professionally trained for safety and health at work, but in the difficult economic conditions that construction companies face, these employees often perform activities that do not ensure health and safety at work. According to the survey, on the issue of safety and health at work, 40.35% of the respondents consider enough attention paid to safety and health during construction, 19.30% answered no and 40.35% partly.

- *Political factor* – in the Republic of Macedonia, the political factor has numerous and varied influences on construction project realization. This is indicated by the results of the survey. According to the survey, 77.19% of the respondents agreed that the political factor affects the realization of construction projects, only 1.75% of the respondents feel that the political factor has no impact and 21.06% answered partly (Figure 1).
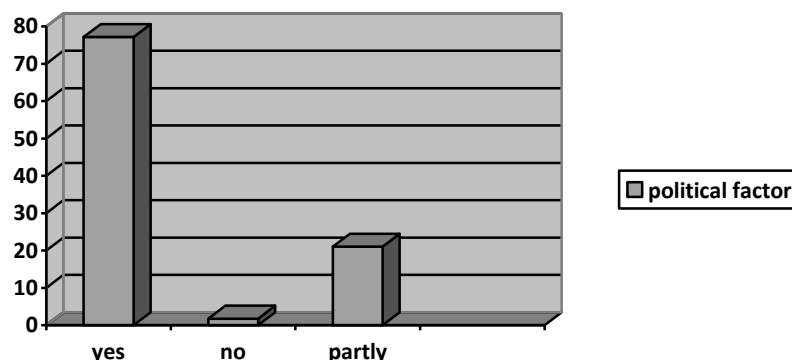
Fig. 1)   Survey results concerning the impact of the political factor

During realization of construction projects, the political factor has a particular impact, primarily in projects funded with state participation. The problems caused by this factor exist because of its impact on the:

- – financing of the projects,
- – choice of the optimal variant for the project,
- – duration of certain activities,
- – schedule for carrying out works,
- – selection of participants in the project,
- – procurement and deployment of resources, especially in cases where resources are supplied by importation etc.

- *Economic factor* – the impact of economic factors is high, especially in recent years, because of the global economic crisis and the recession, and because of the overall economic situation in the country. Only 35.09% of survey respondents believe that economic conditions in the country are favourable for construction project participants' operations, 59.65% believe that economic conditions aren't favourable and 5.26% did not know.

  The most characteristic problems caused by economic factors are:

  – The lack of official prices per item for different types of works and for different facilities; these would be useful, especially in tender procedures. Therefore, during the comparison of the bids, huge differences in prices occur among different vendors, for the same kinds of works and almost for the same type of facility.
  – Insufficient funds for financing the capital facilities. The legislation offers the possibility of providing financial resources for realization of the construction projects from domestic and foreign sources, and also from a combination of sources. Foreign financial institutions as reliable sources of financing are attractive in the country. The possibility of public-private partnership is not utilized, nor is the possibility of using private capital to finance projects of interest to the state. Interruption of activity execution or delay due to the untimely provision of funds is common.
  – Under-used opportunity for phased project realization, and thus phased investment (in cases where it is possible for the specific project).
  – Lack of favourable credit lines for the participants in the implementation of construction projects. Existing loans are characterized by high interest rates,

demand for the provision of mortgages, short grace periods, complex procedures to be completed in order to receive credit and so on.

– Rare depth analysis regarding the choice of the optimal method of payment for work (when participants have the opportunity to choose the method of payment). Macedonian construction practice commonly uses two ways of paying for the work: price per unit and a single price.

– Untimely payment of work performed. Although the deadlines for payment of work performed are defined with the contracts between the project participants, in Macedonian construction practice on-time payment for executed work is rare (although the Law on Construction offers the possibility of submitting a bank guarantee for charging the work). This problem is especially characteristic of projects where investors are state and local institutions. Disputes connected with such problems are often resolved in court.

– Calculating the difference in prices is common in Macedonian construction practice, primarily because of the rising prices of basic materials for the job. Since the duration of project realization can be long, usually the contract entities may calculate the differences in prices (so-called price adjustment). According to the survey, 78.95% of respondents met with such an occurrence (calculating differences in prices), while 17.54% did not know and a minimum of 3.51% did not have such an experience when working on construction projects (Figure 2).
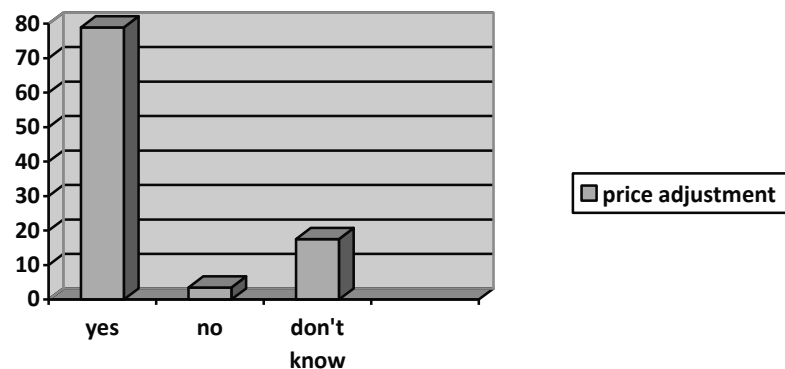
Fig. 2)   Survey results concerning the occurrence of price adjustment

Calculating the differences in prices leads to increasing the total costs for the construction of the facilities. Consequently, most facilities are built with higher costs than planned. 47.37% of survey respondents have constructed facilities with higher costs than planned, 22.81% of respondents reported the opposite and 29.82% did not know the answer.

2.3   Sources of problems related to structure location and its surroundings

The third group of sources of problems is related to the factors relevant to the structure location and its surroundings, such as topography, geotechnical factors, climate, ecology and other factors. Characteristic causes of problems connected with these factors are:

• Newly created situations of factors are not tracked on time. Factors change over time and these changes must be constantly monitored (as an example of geotechnical factors, the occurrence of landslides on the site or a different category than the soil in the project documentation).

- Unrealized interactions and mutual influences of one factor on another. In fact, factors and conditions are insufficiently studied, not only their existence, but also possible future conditions and their potential impacts on the project.
- Insufficient or delayed fundamental research. Studies and research related to the location of facilities and its environment are typically expensive and of long duration. Therefore, investment in them is often insufficient. For some factors, their impacts on construction project realization – and the necessity of studying them – are not perceived in time. For other factors, the suitable substrates for quality research are missing. Such a situation results in a need for thorough study of the factors even after encountering problems in the work on site. It further requires additional time, money and effort. Sometimes, data is required from various institutions that is not easy to get. Therefore, during project realization problems arise connected with:
  - climate and meteorological factors,
  - definition of property, e.g. legal issues with landowners,
  - underground installations or archaeological sites in the works on site,
  - inadequate supply of resources needed for the project,
  - locations for landfills for materials, i.e. their determination during the works (as they often are not defined in the project documentation) etc.

Table 2 shows survey results regarding the factors of location of facilities and its immediate environment.

Tab. 2)   Results of a survey regarding the factors of location of facilities and immediate environment

Factor	Yes (%)	No (%)	Don't know (%)
Climate	49.12	38.60	12.28
Geotechnical	52.63	21.05	26.32
Cadastre	71.93	7.02	21.05

3   CONCLUSION AND RECOMENDATIONS

Realization of a construction project is a complex process determined by numerous factors. These factors are sources for problems during project realization, such as problems connected with the engagement of participants, the unit prices of works, payment of works in terms of performing the activities, the communication between participants, personnel motivation, teamwork among participants and a host of other problems.

The consequences of that situation are insufficient use of experiences from previously finished or on-going projects, the need for changing the projects (new or unpredicted activities arise during the project realization because of new requests by project participants), taking over responsibilities by project participants who are unable to complete in a timely and quality fashion, the appointment of unsuitable personnel to perform certain tasks, the urgent need for solving problems and frequent meetings for coordination and synchronization of activities of the project participants, etc.

The situation described above leads to delays in the implementation of projects that impact on the performance of the works, increase project costs and affect the overall operation of the project participants.

Considering all this, and given the fact that every construction project is unique and has its own specifics, it is not possible to make recommendations relevant to all construction

projects. The basic prerequisites for reducing the sources of problems during realization of a construction project are:

- taking measures to reduce the negative impact of the problems identified in the survey for the purposes of this paper,
- a thorough study of the factors that determine the realization of construction projects – a project approach for studying the factors should be used wherever possible, as this allows the timely consideration of resulting changes in one factor and its alignment with other factors,
- application of methodologies/concepts and standards for project management that are based on modern methods and techniques of planning, monitoring and control and will respect the specific conditions for the realization of projects in all phases of the project's lifecycle. Given the complexity and variability of the factors that determine the project's realization, these methodologies/concepts need to constantly innovate,
- exchanges and usage of experiences from other, especially similar projects,
- a public presentation of the project in various phases of its realization,
- increased cooperation and consultation between project participants, especially in view of the preparation of the project documentation in relation to the common works that should be taken. If possible, the supervisory authorities, the construction contractors and the suppliers should be included in the design phase, although it is not usual. This allows the preparation of project documentation as an iterative process in which each participant in the project can make a contribution in the selection and realization of the optimal variant for the project. This would lead to the elimination of some of the problems that would arise during the project realization.

The authors of the paper believe that the analyses and recommendations given in this article will serve as source of knowledge for other civil engineering projects.

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SECTION II

WATER MANAGEMENT AND WATER STRUCTURES

THE EFFECT OF PH INFLUENCE ON THE RELEASE OF HEAVY METALS FROM CONTAMINATED SEDIMENT

Magdaléna Bálintová[1], Marián Holub[2], Petra Pavliková[3]

Abstract

Surface waters receive contaminants via local anthropogenic activities and through riverine inputs. Within these systems, contaminants partition between aqueous and solid phases (sediment, suspended particulate matter and biota). The partitioning behaviour and spatial distribution of contaminants are highly regulated by hydrodynamics, biogeochemical processes and environmental conditions such as redox, pH, salinity and temperature of the individual system. The paper deals with the study of the pH effect on the release of heavy metals and sulphates from sediment from aquatic environment influenced by acid mine drainage.

Key words

Acid mine drainage, heavy metals, pH, sediment.

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1   INTRODUCTION

Anthropogenic activities such as mining and smelting of metal ores have increased the prevalence and occurrence of heavy metal contamination at the Earth's surface. Specifically, opencast mining activities have a serious environmental impact on soils and water streams, having generated millions of tons of sulphide-rich tailings. [1] Moreover, acidic drainage resulting from the oxidation of sulphides leads to the leaching of large quantities of cations, e.g. Fe^{2+}, Mn^{2+}, Pb^{2+}, Cu^{2+}, Zn^{2+}, etc. [2]

Mobility of heavy metals in the nature is mainly determined by their sorption ability in natural sorbents. [3] Also this is the way how heavy metals are bound into river or creek sediments. Sorption properties of metal ions are crucial for the evaluation of metal ion behaviour in the natural environment. [4]

Sorption processes in surface waters can affect the length of the transport positively and also negatively. The negative influence (i.e. retardation) occurs in the case of slowly flowing water when dissolved substances are sorbed mainly on clayey sediment fractions. [5]

Changing of ambient conditions, in which are sediments located, may cause the release of chemical or physical – chemical bound heavy metals. One of the changes, which may occur either due to hydrologic or other conditions (eg. acid rain), is a pH change of the aqueous environment.

This paper deals with study of pH change on distribution of heavy metals in the sediment - water system. Because the studied sediments are directly affected by acid mine drainage, the samples were tested at pH values in the range from 4 to 6.

2   MATERIALS AND METHODS

In this study two sediment sampling localities along the Smolnik creek were chosen (Fig. 1).
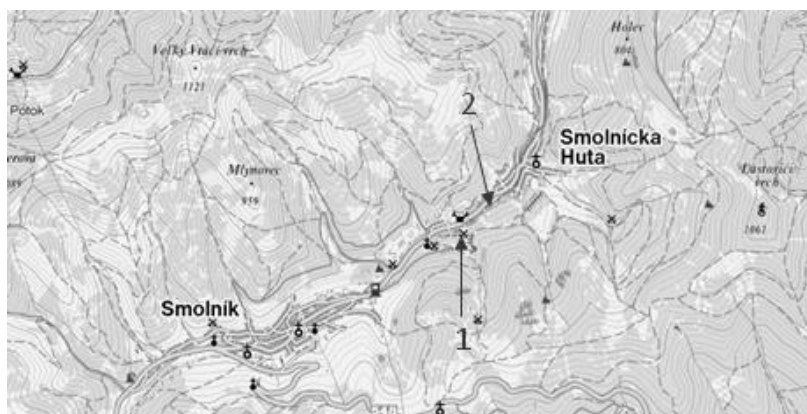
Fig. 1)   Sediment sampling localities

The sample no. 1 was taken from the tank (Fig. 2) where acid mine drainage directly flows out from old mining work through the shaft Pech. This water has a pH of 3 – 4 and directly influences the quality of the sediment.
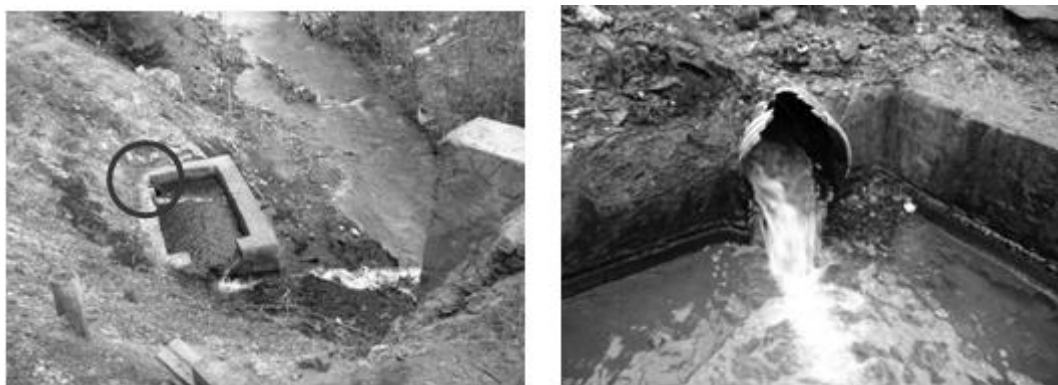
Fig. 2)   The discharge of acid mine water from the shaft Pech

The second sample was taken from the Smolnik creek, which flows through the valley of the former mining area, approx. 200 m below the shaft Pech (Fig. 3).

The sediment samples were dried, homogenized, sieved through a 0,063 mm sieve and analyzed.
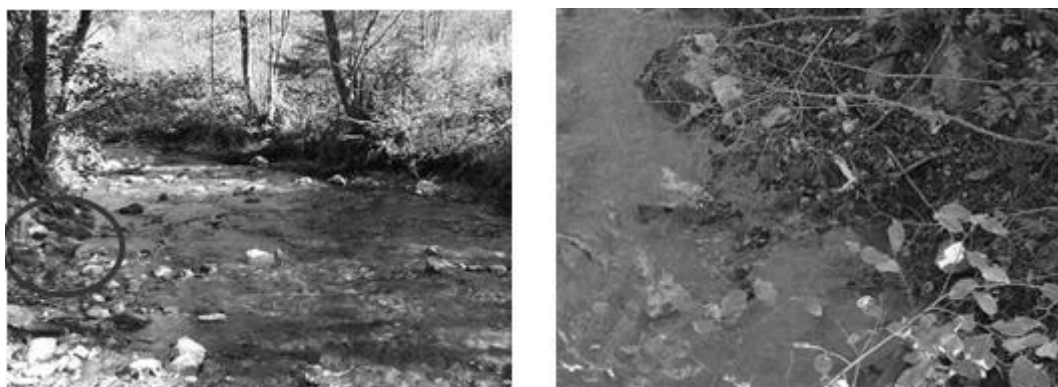
Fig. 3)   The Smolnik creek, sampling site No. 2

The determination of chemical composition was realized by the XRF method using SPECTRO iQ II (Ametek, Germany). For this purpose the sediment samples were prepared as tablets with diameter of 32 mm by mixing of 5 g of sample and 1 g of dilution material (M-HWC) and pressed at pressure of 0,1 MPa/m2.

The first part of experiments was oriented towards the determination of the metal ions quantity released from the sediment after 24 hours. 5 g of each sediment sample (no. 1 and no. 2) was mixed with 200 ml of distilled water. The samples were filtered after 24 hours. The pH change was measured by pH meter inoLab ph 730 (WTW, Germany) and the presence of Cu, Fe, Zn, Mn and Al was determined by colorimeter DR890 (HACH LANGE, Germany).

The next experiment investigated pH influence on the release of heavy metals. 5 g of sediment sample (no. 1 and no. 2) was mixed with 200 ml of distilled water and pH of each suspension was adjusted to the required value (4,4 – 6,0) by adding of H2SO4 solution (pH=4,2). After stabilization of pH, the suspensions were filtered and the quantity of released metal ions was determined. All experiments were performed at laboratory conditions.

3   RESULTS AND DISCUSSION

In Tab. 1 are presented concentrations of heavy metals and sulphates in the samples of sediments from shaft Pech and Smolnik creek by XRF analysis.

Tab. 1)   Chemical analyses results of the sediments by XRF method

Parameter	Unit	Sample no. 1	Sample no. 2
SO42-	[%]	10,9	0,36
Na	[%]	<0,2	1,0
K	[%]	0,63	2,01
Ca	[%]	0,12	0,27
Mg	[%]	0,44	0,80
Fe	[%]	33	5,42
Mn	[%]	0,02	0,06
Al	[%]	2,37	6,54
Si	[%]	2,54	17,48
Cu	[%]	0,0756	0,0363
Zn	[%]	0,0128	0,0191
As	[%]	0,1975	0,0092
Cd	[%]	<0,00005	<0,00005
Pb	[%]	0,1081	0,0110

The measured results show that the concentrations of heavy metals and sulphates (eg, SO42-, Fe, As, Pb) are several times higher in the sediment sample no.1 as in the sediment sample no.2. This fact causes the acid mine drainage effluent from the shaft Pech, which affects the quality of sediments.

After determination of input values (chemical composition of sediments) the study of pH influence on the release of heavy metals from sampled sediments was performed. The measured pH values of the leachates and distilled water are shown in Tab. 2. The table clearly shows that the sediment leachate no.1 has value of pH more than half lower as the sediment leachate no.2.

Tab. 2)   The measured pH values of leachate samples and distilled water

	pH	Temp [°C]
Distilled water	7,07	24,7
Sample no.1	2,85	25,2
Sample no.2	6,14	25,1

In Tab. 3 are shown the measured concentrations of heavy metals and sulphate in leachate samples of sediment no. 1 and no. 2. Results of the experiment show that the content of heavy metals in sediment extract no. 1 is higher than in sediment extract no. 2. Manganese is the most released metal from the sediment to leachte.

In Tab. 4 are presented the measured concentrations of heavy metals in leachate at the appropriate pH and their graphical presentation (Fig. 4).

Tab. 3) Concentrations of heavy metals and sulphate in leachate samples of sediment no. 1 and no. 2

Sample	Heavy metals										Sulphates	
	Cu		Fe		Zn		Mn		Al			
	[mg/l]	%	[mg/l]	%	[mg/l]	%	[mg/l]	%	[mg/l]	%	[mg/l]	%
No.1	1,83	9,68	4,90	0,06	0,02	0,625	1,5	30	0,23	0,04	130	4,7
No.2	0,02	0,22	0,04	0,003	<0,02	-	0,8	5,3	0,25	0,015	26	28,8

Tab. 4) Concentrations of heavy metals in leachate at the appropriate pH

pH	Heavy metals									
	Cu		Fe		Zn		Mn		Al	
	[mg/l]	%	[mg/l]	%	[mg/l]	%	[mg/l]	%	[mg/l]	%
4,4	0,10	1,1	0,49	0,02	<0,02	-	1,6	10,67	0,125	0,007
4,7	0,05	0,55	0,48	0,04	<0,02	0,42	1,3	8,67	0,088	0,005
4,8	0,05	0,55	0,34	0,036	<0,02	0,42	1,1	7,34	0,059	0,004
5,3	0,04	0,44	0,04	0,003	<0,02	-	0,9	6	0,045	0,003
6,0	0,03	0,33	0,03	0,002	<0,02	0,42	0,2	0,33	0,062	0,004
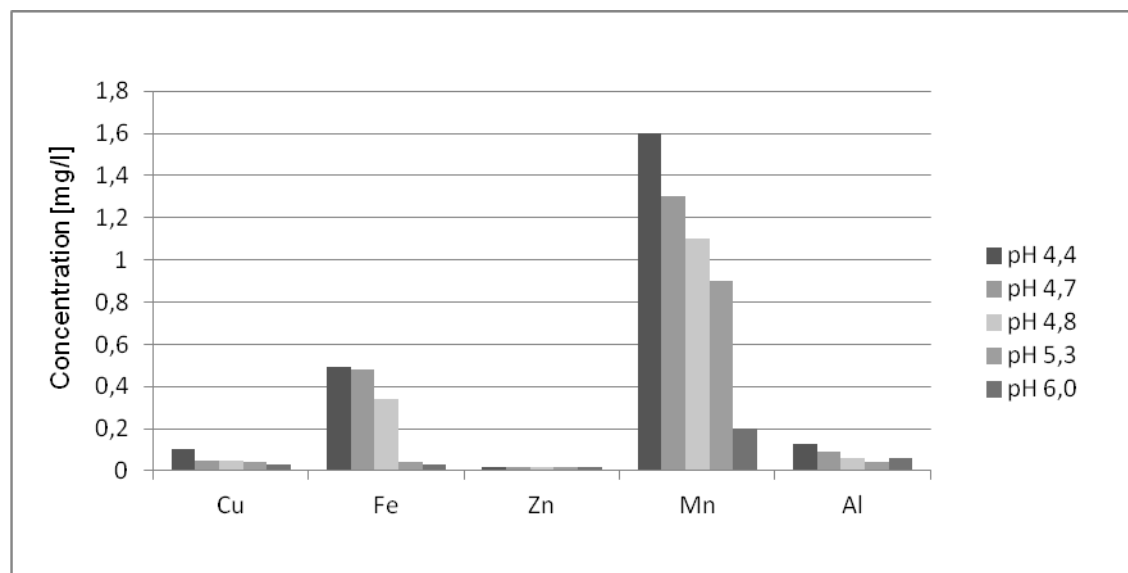
Fig. 4) Graphical presentation of the heavy metals release at the different pH value

The results confirm the literary data [6,7] that the content of heavy metals in leachates is increased by reduction of the pH.

4   CONCLUSION

Sediment disturbance can lead to changes in the chemical properties of sediment that stimulate the mobilisation of contaminants. Published data are focused on the release of contaminants from sediment into distilled water or solution of sulphuric acid with various values of pH. Research shows that changes in pH can accelerate desorption and partitioning of contaminants in sediment influenced by acid mine drainage. Decreasing of pH can increase the solubility of metals in sediment and increasing of the toxic metals concentration in water environment.

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NON-INTRUSIVE METHODS FOR MEASURING THRESHOLD OF PARTICLE MOVEMENT AND PRESSURES ON A ROUGH BED

Ahmet Ozan Celik[1], Panayiotis Diplas[2]

Abstract

At high Reynolds numbers, it is reasonable to consider that the instantaneous drag and lift forces result from the pressure distribution over the entire surface of a sediment grain in turbulent channel flow. Such information is directly relevant to the movement of bed material. Accurate incipient motion models require the information gathered simultaneously or at least under identical bed and flow conditions for the movement of the grain, the forces acting on it and the flow velocities immediately upstream of the grain. We present results from flume experiments where the simultaneously measured near bed flow velocity - surface pressures acting on a grain and the simultaneously measured near bed velocity - grain entrainments were measured to examine the particle entrainment mechanism. A simplified bed geometry consisting of spherical particles was used in the experiments to reduce the complexities associated with the variations in the bed and flow details. The instantaneous pressures acting on a fully exposed, fixed grain were measured simultaneously with local flow velocity. In addition, a separate laser based particle tracking system was employed to measure the movements of a mobile grain. The local flow velocity was measured synchronously with a laser Doppler velocimeter near the bed. The experimental methods and their limitations are presented. The relationship between individual pressures, forces approximated from the pressures, and their correlation with local flow velocity patterns was examined using statistical methods. The implications for incipient conditions were also discussed.

Key words

Incipient motion, laser Doppler velocimeter, particle tracking system, pressure measurements.

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1 INTRODUCTION

It is well known now that the fluctuating drag and lift forces acting on individual grains due to turbulent flow are responsible for incipient motion of sediment. For an accurate representation of the phenomenon, force or moment balances have been utilized using the magnitude of fluctuating forces to establish the condition for threshold of movement in deterministic and probabilistic models [1, 2, and 3 among others]. According to these approaches, which are based on the magnitude of instantaneous forces, extreme flow events near the bed exerting high forces (above a critical value) on individual grains will always cause particle entrainment. However, as shown by Balakrishnan [4] and by Diplas et al. [5], high-magnitude turbulent flow events occurring immediately upstream of a grain are typically very short-lived, which cause them to be ineffective for completely dislodging the grain from its initial position, even when they are well above a given critical value. On the contrary, turbulent events of not as high magnitude (still above a critical minimum value) but lasting longer were observed to be able to fully dislodge the grain from its pocket. These findings, which were obtained from direct observations of threshold of movement of a test grain, together with synchronously measured near bed flow velocity, suggest that the magnitude of fluctuating forces acting on individual grains, even its extreme values, is insufficient for predicting the initiation of movement and therefore characterizing threshold conditions. Celik et al. [6] showed that the bed particle entrainment rate at low mobility conditions is extremely sensitive to the minute changes in flow parameters, such as the bed shear stress for the bed of spherical particles under uniform flow conditions. A considerable change in sediment movement rate was observed not only as a result of such modifications of uniform flow conditions but for unsteady flow conditions as well. Nelson et al. [7] and Sumer et al. [8] reported such results, where the turbulence intensity, TI, of the flow field was increased using various methods.

Although recent findings illuminate the mechanism of particle entrainment due to turbulent flow processes, they are based on observations of particle movements and indirect estimates of instantaneous forces from near bed velocity measurements. Accurate data on forces/pressures acting on rough walls with synchronous near bed flow velocity data under threshold conditions is still lacking, with the exception of recent noteworthy efforts from Hofland et al. [9], Schmeeckle et al. [10], Detert et al. [11], and Dwivedi et al. [12]. These recent force/pressure measurements highlight the significance of sweep type of events near the bed on high drag forces accompanied by upward lift force. On the other hand, incipient motion models using the impulse concept requires better understanding of the uncertainties in estimating instantaneous drag forces (i.e. the variation in the instantaneous drag coefficient values reported by Schmeeckle et al. [10]), the role of lift force, and the turbulence intensity on particle dislodgement. One obvious need is to measure the forces, the near bed flow velocity and the particle entrainment rate under identical bed and flow conditions without disturbing the flow condition. Such conditions should also represent threshold flow conditions.

The aim of this study is to investigate the near bed flow events and associated force magnitudes and obtained from direct measurements of pressures acting on a spherical particle. Entrainment rate of a mobile test grain was also measured under identical flow conditions. Experimental results are discussed in the context of incipient motion.

2   EXPERIMENTS

In this study we present simultaneously measured near bed flow velocity - surface pressure data and the simultaneously measured near bed velocity - particle entrainment data to examine the particle entrainment mechanism. The configuration of flume test section used in both experiments were identical and consisted of a 12.7 mm diameter, d, spherical grain resting on two layers of well packed identical spheres as shown in Fig. 1. This simplified bed geometry was preferred to reduce the complexities associated with the variations in the bed and flow details in an effort to identify the underlying dominant physical mechanism. The flume tests were performed in fully developed uniform open channel flow at near threshold conditions for a range of particle Reynolds numbers ($Re* = u*d/v$, where $u*$ is the friction velocity and v is the kinematic viscosity).

In the mobile particle experiments, entrainment of a mobile, Teflon® grain was recorded utilizing a separate laser-based system that detects its displacement [13]. A spherical particle, identical in size to the mobile grain, was instrumented with low-range pressure transducers and it was securely attached to the flume bed, to measure the instantaneous surface pressures simultaneously at its front (p_1), back (p_2), top (p_3) and bottom (p_4) as shown in Fig. 1.

In the particle entrainment and pressure experiments, mobile and instrumented grains were placed on the centerline of the flume bed. The instantaneous near bed velocity components, u and w, in the streamwise and vertical directions respectively, were measured one particle diameter upstream of the mobile/instrumented grain along its centerline via the use of a 2D laser Doppler velocimeter (LDV). Sampling duration was 15 minutes. A Cartesian coordinate system (x, y, z) where x is streamwise along the flume axis, y is spanwise across the flume, and z is perpendicular to the flume bottom was adopted in this study. Reference 14 is suggested for more details on the measurements of particle entrainment and pressures.
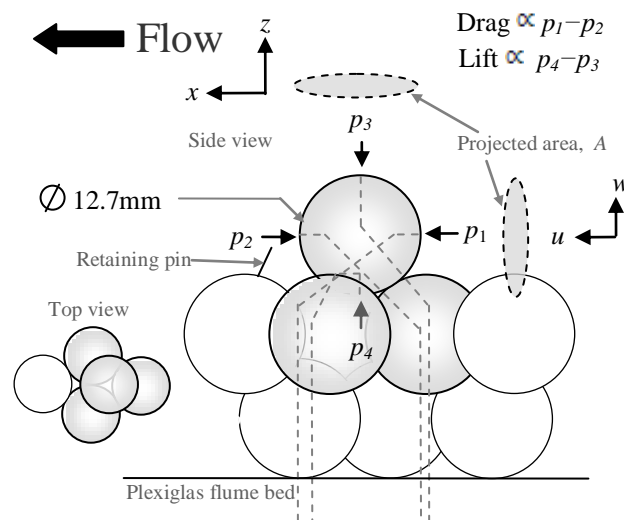
Fig. 1)   Bed configuration of mobile and instrumented particle experiments.

3   EXPERIMENTAL RESULTS

We conducted flume experiments under various uniform flow conditions. These conditions represent the threshold flow for the test particle used in the experimental study of Celik et al. [6]. Below are the highlights from the particle entrainment and pressure experiment results.

3.1   Particle entrainment tests

The calibration of the particle tracking system (He-Ne laser based) was performed *in situ* and resulted in a resolution of 10 μm over the full 1 mm range of motion of the test particle. With the given high sensitivity and non-intrusive nature of the particle tracking system, it was possible to capture the episodes of particle movement due to fluctuating turbulence forces. Representative time series of, u^2, and simultaneously measured photo-detector output, which then using the calibration factor could be converted into linear displacement are given in Fig. 2. Dased and solid vertical lines in the plots indicate detected particle movements. Secondary vertical axes in the top plot indicates binary 0,1 signal which implies nomovement and detectible particle movement respectively. Explanation of the solid vertical lines in the bottom plot is as follows. A: beginning of a rocking event, B: beginning of a pivoting event, C: instant when the test particle reached the retaining pin, D: instant when the test particle started rolling back to its original pocket, E: instant when the particle reached its original pocket.
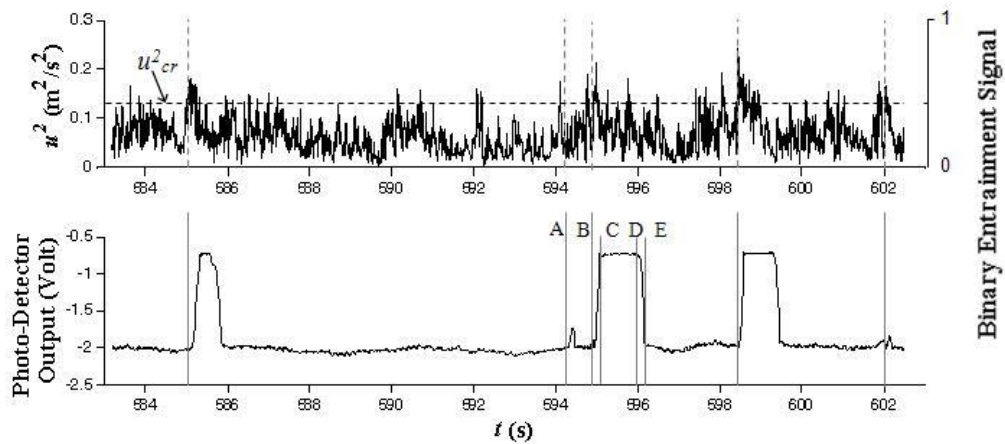
Fig. 2)   Bed configuration of mobile and instrumented particle experiments.

Using the particle tracking technique that offers high temporal and spatial resolution in detecting the motion of a single test particle we found that the particle entrainment rate is extraordinarily sensitive to minute changes in the gross flow parameters. That is, a 35% increase in the bed shear stress resulted in a nearly 50-fold increase in the particle entrainment rate. This finding exemplifies the inadequacies of incipient motion models that employ time-space average flow parameters and suggest that deterministic and stochastic models that depend on local time-space averaged shear stress to define the threshold of particle movement must be used cautiously. Also careful observation of the velocity fluctuations accompanied by particle movement and those were not revealed that not every peak, even with extremely high magnitudes resulted in particle entrainment. The implicaction here is that not only the magnitude of the instantaneous forces acting on the grain (approximated by the near bed flow velocity) but also the durations over which their high magnitude is sustained plays a role in identifying accurately the threshold of particle movement [5, 14].

3.2   Pressure Measurements

The static calibration of the transducers used in this study revealed a linear response with static calibration factors (mV/cm of water column) for all transducers. According to the dynamic parformance tests, the transducer's frequency response was sufficient to resolve the relevant flow structures with sizes on the order of one test grain diameter [14].

Figure 3 illustrates the qualitative relation between the velocity and pressure signals by showing the representative time histories of u, w and the simultaneously measured pressures in. A strong similarity in the temporal variations between u and p_1 (front) is observed. This is expected as p_1 is located at the stagnation point, and so anticipated to be closely related to u^2. In Fig. 3, a negative correlation is apparent between p_1 and the other three pressure signals. The time lag associated with this negative correlation is on the order of h/U (~200 ms, estimated from cross-correlation function between u and p_1).
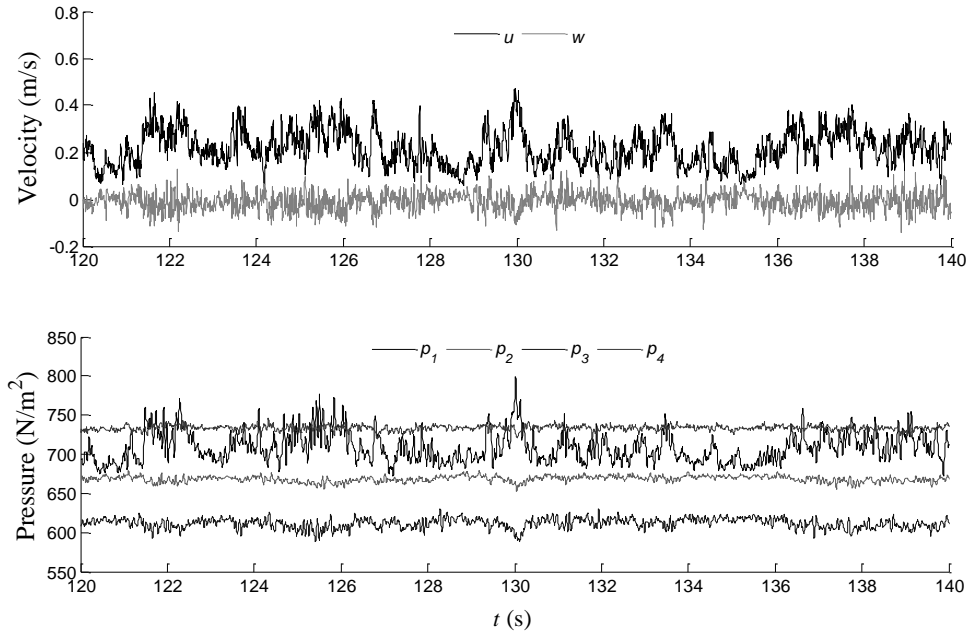
Fig. 3) Representative time series of, u, w (top figure) and simultaneously measured surface pressures (bottom figure).

The magnitude of the fluctuations in p_2, p_3 and p_4 are very low compared to p_1. Among the former three, p_3 (top) fluctuates widely relative to p_2 (back) and p_4 (bottom) for both the uniform and cylinder wake flows. p'_{rms}, of p_1 was consistently larger than those of p_2, p_3, and p_4 by factors of 4, 3 and 5 respectively for the uniform flow conditions tested. The ratio of root-mean-square (rms) of pressure fluctuations, over the bed shear stress, τ_0, with respect to particle Reynolds number is given in Fig. 4 for the 9 uniform flow conditions. Shear stress values were calculated using ρu_*^2, where ρ is the density of water. An average value of 3 for p'_{rms}/τ_0 is reported in the literature for rough walls (references 3 and 15 provide reviews on this topic). In our experiments, we obtained values close to 3 only for p_2 and p_4 (back and bottom pressures respectively). For p_1 and p_3 this ratio was near 18 and 7 respectively. p_1 and p_3 therefore are expected to make the major contributions to the fluctuations of pressure forces acting on the grain. The very high values of p'_{rms}/τ_0 for p_1 and p_3 also indicate the inadequacy of the approaches based on shear stress in describing the flow induced pressures and forces acting on fully exposed bed material. Furthermore, they highlight the need to account for the continuous record of the fluctuating pressures in particle movement.

Next, drag and lift forces were estimated from the measured pressure differences [14]. The plots of cross-correlation functions (CFFs) between the flow velocity components and the drag and lift forces are given in Figs. 5 and 6 respectively. Besides the expected patterns in the flow velocities and the lift force, dependency of the instantaneous drag force on w is apparent. This is consistent with the findings of Hofland *et al*. [9]. The instantaneous lift force

is correlated with u to some degree ($R = 0.37$, Fig. 6). Interestingly, the lift force shows a very weak correlation with w. This finding does not support the models occasionally employed for incipient motion criterion, where the instantaneous lift is associated with the instantaneous vertical velocity squared.
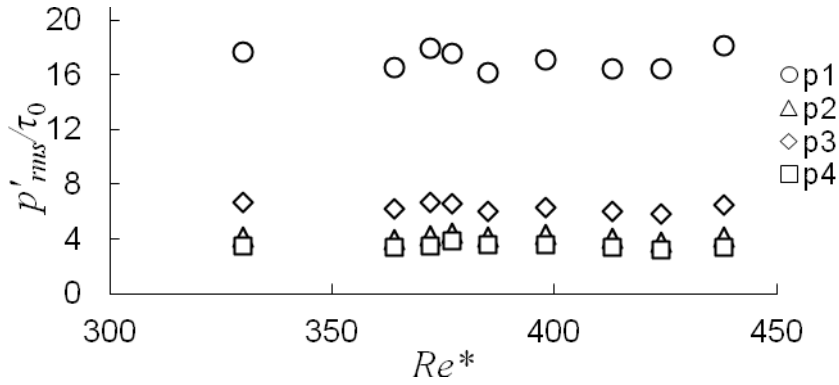
p'_{rms}/τ_0 vs. Re^* plots.
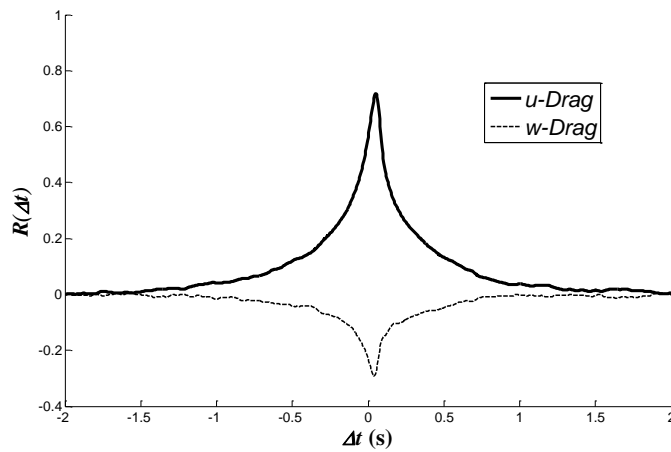
Fig. 4) CCFs between u and drag force (bold line and) w and drag force (dashed line).
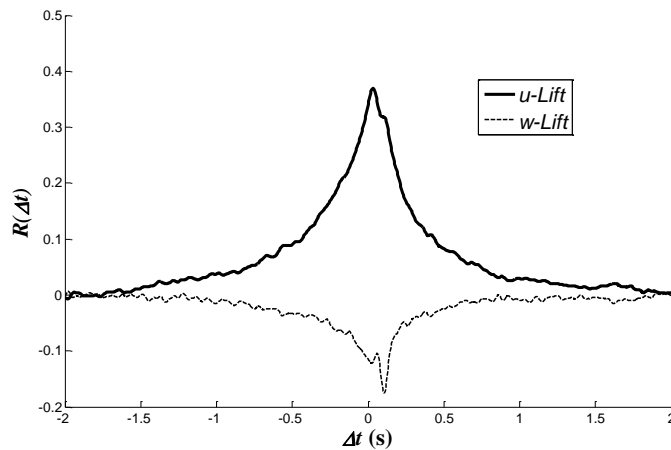
Fig. 5) CCFs between u and lift force (bold line and) w and lift force (dashed line).

4   CONCLUSION

In this work, two experimental method were described which were used to measure the *particle entrainment* and *near bed pressures* together with the local flow velocity. The experimental data were analyzed to describe the features of the particle movement, turbulent pressures and their relations to near bed velocity. Experimental results show that the particle entrainment rate is strongly influenced by minute changes in the flow conditions. Also instantaneous pressures acting in the front, back and the top of the grain are correlated to each other. These pressures are also strongly influenced by the local flow velocities. Drag and lift forces were estimated from the measured pressure differences. Analysis of the force and velocity components suggests that the instantaneous drag and lift forces are both correlated to the near bed streamwise velocity, drag being most pronounced. Weak negative correlation was also observed between the vertical flow velocity component and the drag and lift forces. Results presented here are very useful for more realistic incipient motion models. Instantaneous coupling of drag and lift forces and particularly their temporal variations and durations need to be understood well for a better threshold flow criterion.

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HOUSEHOLD WATER CONSUMPTION IN TURKEY: AN APPLICATION OF DATA MINING

Muharrem Düğenci[1], Filiz Ersöz[2]

Abstract

Excessive usage, including by households, of water in areas with over-abstraction can result in serious problems. Improvement in the efficiency of water use is a key issue if the increasing demand for water occurs in the long term. Data mining is the science and technology of exploring and analyzing data from different perspective and summarizing into useful information. Thanks to data mining software data from many different dimensions is analyzed to categorize and summarize the relationships identified. In this paper, household water consumption data are introduced and the valuable knowledge was produced and reported to institution to be used for setting next year objectives on water consumption. The data used as an indicator is for consumption per capita, for all household purposes. Based on information from Ankara Provincial Water and Sewerage Authority. In this study, 133.107 household's water consumption data is used. The result of this study indicates that one of the most important variable is cut off or turn off water meter. In order to the importance of other variables affecting water consumption; number of households, settlement, water meter age and water meter brand.

Key words

Chaid algorithm, data mining, decision tree, household water consumption.

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1   INTRODUCTION

Water is a basic resource which is required by food safety, ecosystem and biologic diversity, development of urban and rural areas, healthy life and hydroelectric energy [1]. Over population in the world will affect the water consumption per capita and other resources further [2].

Water supplying to the people is a public service. In Turkey, water management is carried out by municipalities or Water and Sewage Administrations in Metropolitan Municipalities. In future, it will be required to use information technology and modern scientific methods for water management.

There are some number of study about water demand estimation and household water consumption in literature. Seung and Hood Yoo estimated household tap water demand function using the data from a survey conducted on households in the Korean metropolitan cities in 2002 by employing a sample selection model and found that there exists sample selection bias then corrected [3]. Katko et al. analyzed the specific household water consumption of various types of housing, housing ownership, metering and billing arrangements in Finland and showed that household water consumption levels of about 120 l/capita/day, or even less, can be attained, as maintaining a high standard of service levels [4]. Harlan et al. executed a social survey to examine the effect of income on individual water consumption and domestic water usage. By getting the results from multivariate statistical methods, they found that monthly mean indoor use of water is about 1970 gallons (7457 liter) and this amount varies with season [5]. Wong et al. carried out a work on water consumption by using gradual regression which is one of the classifier methods. They found that variables of number of household, ages, educational level, mean income is related with rural water consumption [6].

In this study, variables that affect the monthly water consumption of households in Ankara were investigated by using data mining. Basic aim for data mining is to establish data patterns that are not determined previously. CHAID algorithm used in this study is one of the classifier methods based on estimation and forecasting. For forecasting models, estimating a result sets is calculated based on input sets. The aim in forecasting models is to form a classifier that determines a new object if it belongs to any class. The steps on Knowledge Discovery in Database (KDD) are shown in figure 1 [7].
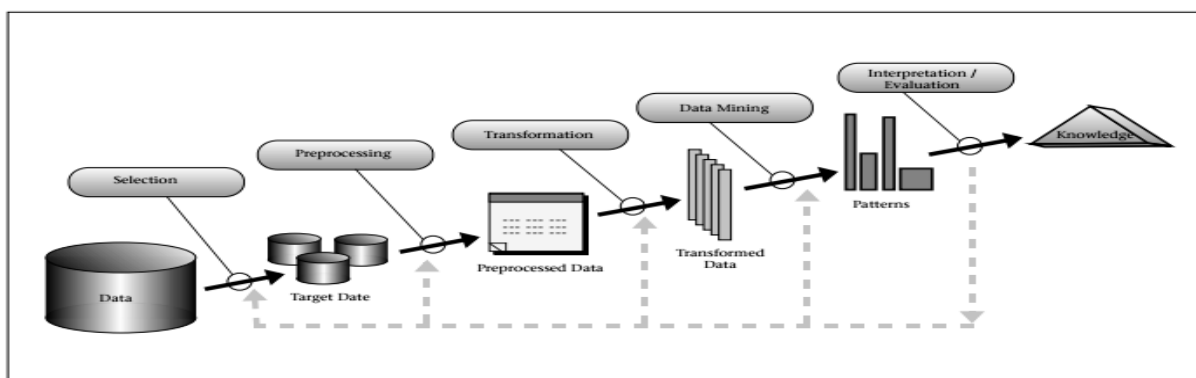
Fig. 1)   An overview of the steps that compose the KDD process

1.1 Data selection

It is the step that determines the selection criteria. Even though data cluster comprising similar data, more important ones should be selected. Data, which is taken from Water and Sewerage Authority of Ankara Metropolitan Municipality (ASKI), used in this study is the water consumption amounts that comprise household monthly water bills. This water consumption is recorded first. Then the amount of bill is calculated. The price of bill is calculated finally. The data that is taken from ASKI and MERNIS are given in figure 2.

Settlement	Monthly Consumption	Water Meter Brand	Age of Water Meter	Cutting of Water Meter	Number of households
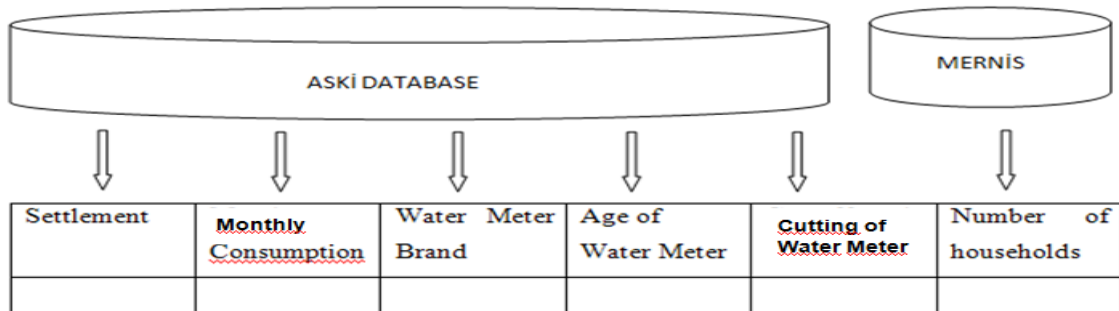
Fig. 2)   The data form ASKI and MERNIS

In this study, identity number, water meter type, name and family name of the customer, customer type and district are selected in data selection step. During the process, name of official recorded the customer; telephone number and such other information were eliminated. Personal data such as customer number, identity number, name and family name were taken as key columns for matching purpose.

Data used in data mining are from database of the institution, however sometimes data from outside of the institute can be taken. In this frame, additional information such as sex, place of birth of customers whose identity numbers are known in ASKI database are taken from MERNIS. Number of households was taken from census based on address system. ASKI is currently calculating and using water consumption per household. Using the number of households, we have calculated water consumption per capita.

1.2 Data pre-processing

Data quality is a key element in data mining. Data pre-processing has an important place in data mining to improve the reliability. Data pre-processing is an operation comprising of data cleaning, data aggregation, data transformation and data reducing. Data cleaning requires some steps such as to identify outliers and removing the incoherency. Obtained data may have wrong input, missing or invalid data or outliers. Data cleaning and pre-processing steps are to remove out of range values namely noises. In this study, missing data and outliers are identified by using Audit processor in SPSS then all deficient values, outliers and incoherent data are removed. Additionally, cleaning and normalization processes are done to get a mean distribution.

1.3 Data transformation

Data obtained by data transformation is transformed into appropriate forms. Data transformation may comprise one or more processes of some different processes such as correction, integration, generalization and normalization.

In this study, one year water consumption of 129.259 customers is examined. Settlement information is directly taken from ASKI database. This data fully exist for all customers. Monthly water consumption is subjected to data cleaning. Since the recording period is not always 30 days, whole 30 days water consumption value is calculated for these none 30 days water consumptions. This calculated water consumption is called S30. A mean water consumption value is used for analysis. Since the brand names and meter ages are not included in customer database, brands names and ages of meters are acquired from 1.244.040 water meter change work order data which is recorded for 18 years. Brand names are not given namely since the brand names are trademarks and they are not asked to mention instead of like A, B, C are used. Information about customers whose water is cut-off because of none or late payment is taken from cut off work order. Customers whose water is cut off at least once a year are designated with (Y=Yes) and customers whose water is never cut off is designated with (N=No).

1.4 Data reduction

This step is used to reduce the number of variables in data will be used. Repeated data, noises and irrelevant features are removed in this step. In this step working duration of data mining is improved and data mining techniques is applied to reduce data set to have better results. Each column of the tables were examined separately, if they are suitable for using in data mining by means of data unity and data noisy. Some private information of customers such as address, telephone, identity and some institutional information such as record date, meter number etc. are excluded since they do not effect on water consumption.

Even though water consumption is recorded monthly, season data were not used because of only one year period was studied. A S30 monthly water consumption value is used after calculating below.

$$S\,30 = \frac{MWC}{LR-PR} \; x \; 30 \tag{1}$$

Where MWC is raw recorded monthly water consumption, LR is last recording date and PR is previous recording date. Similarly, some detail information about water cut-off and meter change, meter change time, operator and hand terminal number were excluded.

1.5 Data mining

For data mining mission, appropriate algorithm of data mining is defined in this step. Data mining can be executed on models of classification, clustering and association analysis. Decision tree and CHAID algorithm were adapted as data mining classifier. Decision tree functions are popular tools for classification and forecasting. Dependent variable namely target (responsible variable) are represented by branch and bounds. Tree is constructed top to down. The most important variables among the variables are affecting the target splits to sub branches. Smaller branches having leaf and small branches grow step by step with enlarging of tree. Method for CHAID algorithm; enlarging of tree is stopped by algorithm in case of irrelevant data.
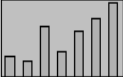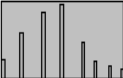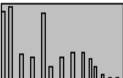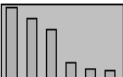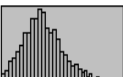
1.6 Interpretation and evaluation

Interpretation step evaluates the information comprised by result reports. Before the knowledge discovery in database, interpretation and evaluation step may solve the inconsistencies originating from new and discovered knowledge.

In this study, researching the factors that affect household water consumption and acquisition of knowledge are studied to support the decision makers of Water and Sewerage Authority of Ankara Metropolitan Municipality. A data mining analysis, based on IBM SPSS Modeler Professional Clementine a professional data mining tool, was worked to discover insights in data, make decision on how to determine household water consumption.

2 DATA ANALYSIS & RESULTS

The household water consumptions and the factors affecting the distribution of the descriptive statistics of variables used in the investigation are given in figure 3 below.

Field	Sample Graph	Type	Min	Max	Mean	Std. Dev	Skewness	Unique	Valid
[A] Settlement		Set	--	--	--	--	--	7	129259
(#) Number_of_Households		Range	1.000	8.000	3.778	1.606	0.509	--	129259
[A] Cutting_of_Water_Meter		Set	--	--	--	--	--	2	129259
(#) Age_of_Water_Meter		Range	2.000	16.000	5.820	3.328	0.653	--	129259
[A] Brands_of_Water_Meter		Set	--	--	--	--	--	6	92184
(#) Households_Water_Consump...		Range	0.500	24.998	7.963	3.710	0.766	--	129259

Fig. 3) Descriptive statistics and distribution of data

As shown in figure 3, the number of people in households at least 1 up to 8 persons household were determined. The most common number of housholds that have been identified 4. In general approximate ages of water meter (counters) obtained, minimum 2, maximum no more than 16 years old. The average age of the household water meter have been found were 5.8 ± 3.3. In the study. There are a total of 6 different brands of the water meter when you look at the counter brands, and most common brands were the 3 main brands. The most of the name of brands that have been identified A. Each household water consumption by at least 0.5 ton, up to 25 ton and the average water consumption was observed to be 7.9 ± 3.7 tons.

Data mining technique to investigate the factors affecting water consumption, classification method, Chaid algorithm (modeling) was performed. The findings related to Chaid model are given in figure 4 below.
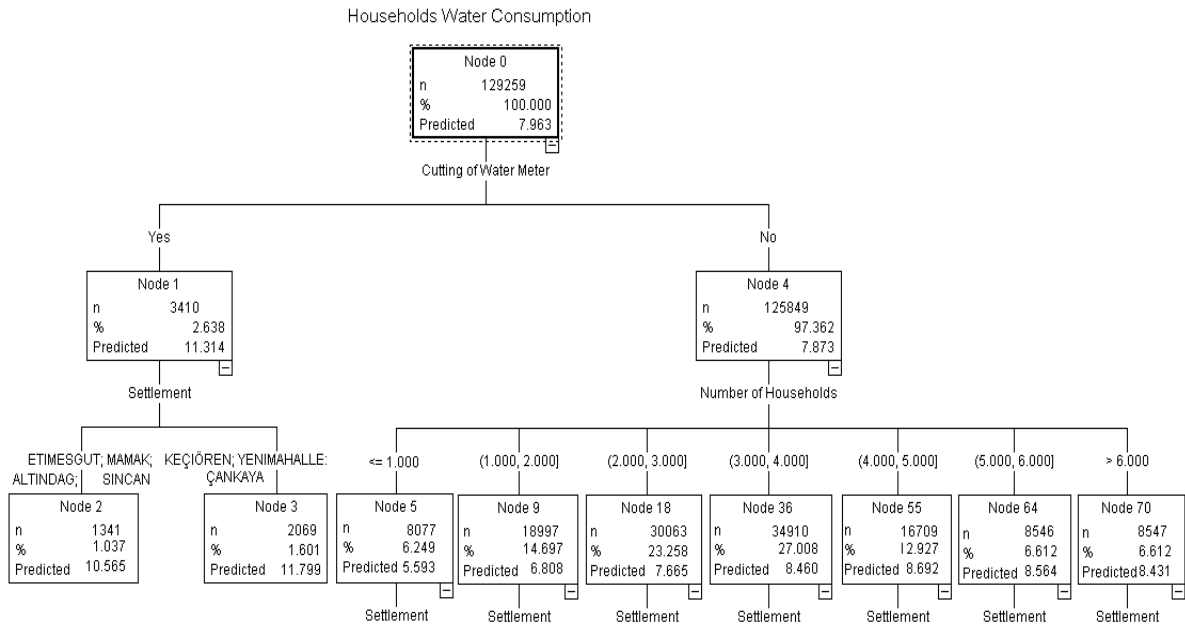
Fig. 4) Chaid tree for household water consumption

The factors affecting water consumption, the number of persons' age of the counter, the counter brand, Cutting of Water meter, the settlement of the residential areas are all examined, the most important factor affecting water consumption observed is the cutting of water meter. The average monthly water consumption of a household, 7.9 tons of water, whilst the average water use in areas of where regular water cuts occur, is 11.3 tonnes per month. It is thought that, the situation is caused by households who can not pay/delay might be down to subscribers that tend to have over-consumption and at times due water cuts.
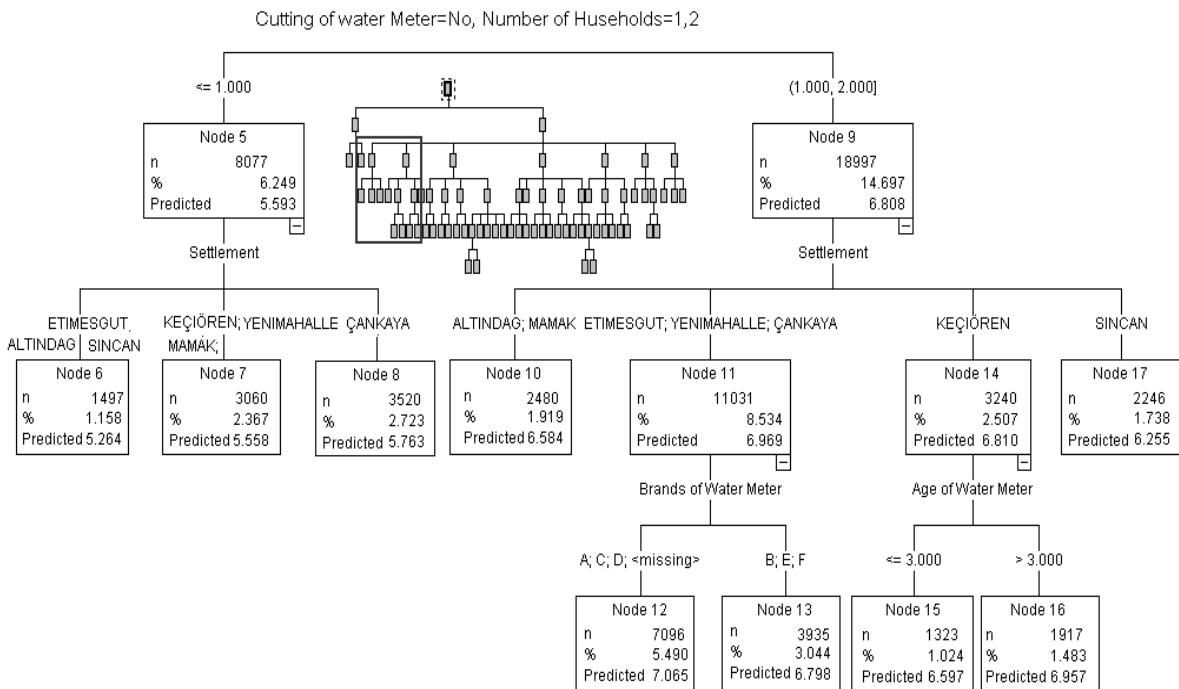
Fig. 5) The water consumption of household which non-cuttoff and have 2 or less member

The water consumption of households with 1 or 2 persons is shown in figure 5. The water consumptions settlement (district) is decisive, single-person households living in Çankaya 5.7 tons and the consumption of water was observed to be higher in other districs. Trends in water consumption by two-person families with clustering occurred around 4 different settlements, of which the consumption characteristics of separate people living in Sincan district, and was found to be Keçiören district. With Altındağ-Mamak district, a group formed by Etimesgut observed in regions such as Yenimahalle and Çankaya. It is found that in households with 2 persons living in residential areas such as Etimesgut-Yenimahalle-Çankaya water consumption is seen to be affected by the water counters. 2-person households living in Keçiören water consumption distinguishing factor is the age of water meter. To determine water consumption of households living in Sincan-Keçiören district, the water meter less than 3 years of age has become an important factor.
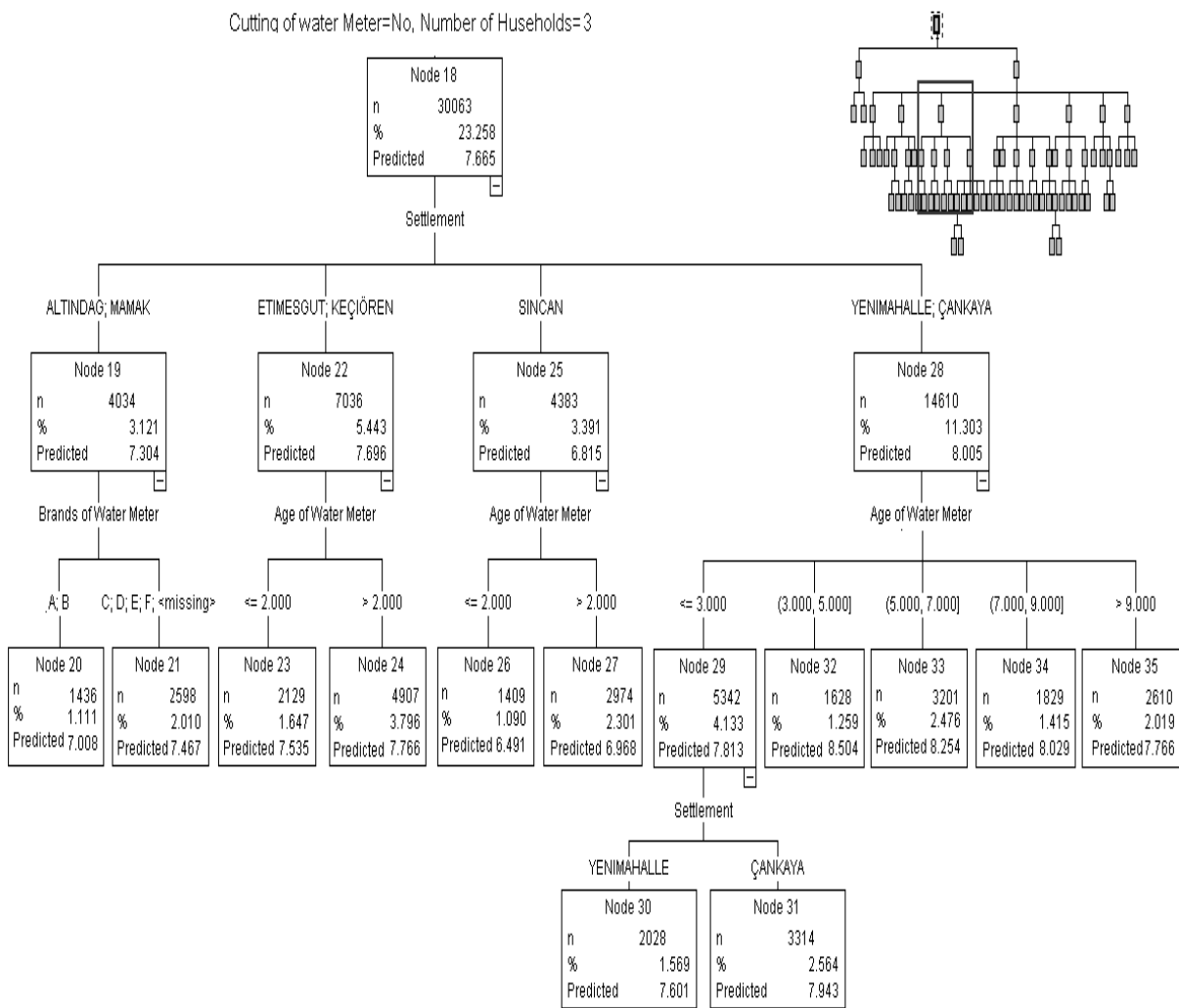
Fig. 6) The water consumption of household which non-cuttoff and have 3 member

The number of households increased from 2 to 3, the average consumption per household produces 6,8 tons to 7,6 tons shown in figure 6. Age of water meter whether less or more than 2 years of age in Sincan district, Etimesgut and Keçiören district have produced a decisive breakdown. The average water consumption is determined by the water counters that

4-5 years old in Çankaya-Yenimahalle district is 8.5 tons per meter, 5-7 years old ones 8.2 tons of water consumption per meter, 8-9 age group 8 tons, and 9 and above age meters 7.7 tonnes.
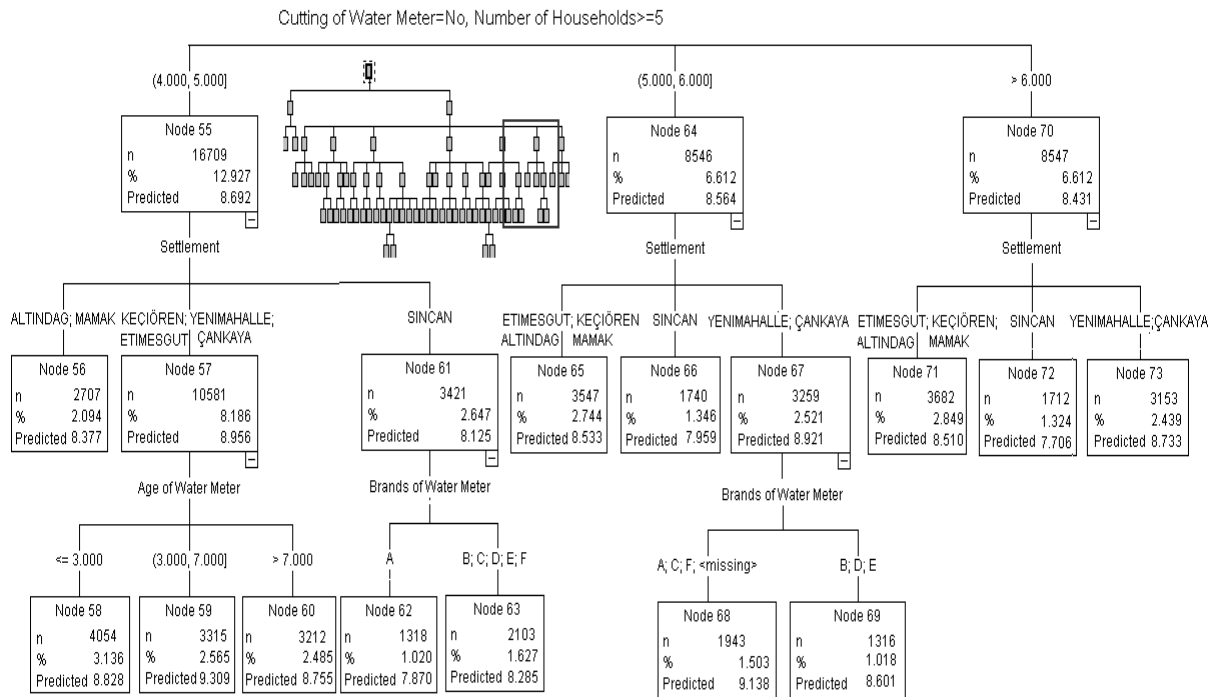
Fig. 7)   The water consumption of household which non-cuttoff and have 4 or more member

As shown in figure 7, water consumption of 4 and 5-member families were divided into 3 groups according to region differentiation. In the regions of Sincan and Altındağ-Mamak, 5 people households water consumption averaged 8.1 tons and 8.3 tons, respectively. Water consumption in Altındağ-Mamak households was classified without the need for a separate parameter. In Etimesgut, Keçiören, Çankaya and Yenimahalle districts, water consumption showed a significant deviation according to the age of water meters.

Water meters were divided into three age groups: 0-3 years old water meters, 4-7 years old and older than 7 years old. In 5 people households of Sincan, the measured water consumption was different according to the water meter brand. Brand A measured 5% lower consumption than the other water meter brands. 5 and 6-people households in the classification of water consumption; Altındağ, Etimesgut, Keçiören, Mamak water consumptions were similar. Settlements variable have been influential in Sincan district alone. The classification of the water consumption of households and counter Yenimahalle-Çankaya brand has emerged as a decisive factor. Water consumption of more than 6 people were living in households by place of residence were similar. Households water consumption trends in Sincan did not show similarity to other residential areas.

3   CONCLUSION

In this study, the average daily water consumption per household was 7963 liters per month (30 days). The average water consumption per person per day for the province of Ankara were obtained as 70 liters. This figure represents more realistic value over recent years,

reflecting the large amount of data is a feature. Except for the results obtained by the city of Ankara, the other metropolitans such as; Istanbul, Izmir, Bursa, Adana and Gaziantep can be obtained for other comparative results.

According to the laws in force in the electricity, water and gas meters periodic inspection is due every 10 years. The findings of this study, water meters, especially for this period is long, it reveals that the withdrawal of is up to 7 years.

This study based on a finding obtained by the other, is that a significant effect on water consumption of localization. In Ankara; Altındağ, Mamak, Yenimahalle district residents is similar to the trends in water consumption. Water consumption characteristics of the Sincan region in terms of subscribers has been observed to be different from other districts. In addition the maximum water consumption was observed in Çankaya settlement. Çankaya has specific characteristic interms of high income and social level. Sincan on the opposite is a low income district and the amount of water consumption is the lowest amongst Ankara districts. The reasons for these differences can be considered as the subject of a separate study.

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MEASUREMENT OF RADON LEVELS IN THERMAL WATERS OF KONYA, TURKEY

Mehmet Erdoğan[1], Fatih Özdemir[2], Nuretdin Eren[3]

Abstract

^{222}Rn (Radon) is the first and most important natural source of the radiation which people are exposed. Radon is a gas phase material, tasteless, odourless and colourless. It is an alpha-emiting nobel gas and it can be found in various concentrations in soil, air and in different kind of water. We have shown the results of radon concentration measurements in thermal water taken from sources and lakes located in thermal water region around Konya which is located in the middle of Turkey. The radon activity concentrations in water samples were measured by using the AlphaGUARD PQ 2000PRO radon gas analizer. It is found that the concentration ranged from $0,2205 \pm 0,0234$ to $70,3380 \pm 3,5518$ Bq/L for radon. Also we have calculated the maximum and the minimum annual effective doses in the range of 0.0000463 mSv.y^{-1} to 0,0147 mSv.y^{-1} in spring.

Key words

AlphaGUARD, effective dose, radiation, radon, thermal waters.

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1   INTRODUCTION

Human has been exposed to natural radiation since the world exists. They are mainly the decay of radioactive elements and their products in the crust of Earth (Uranium and Thorium series etc.) and cosmic rays from outer space. 222Rn is the main source of natural radiation and has a half-life of 3.82 days and generated from radioactive transformation of 226Ra (Radium) in the 238U (Uranium) decay chain in the crust of Earth. It generates radioavtive products which are 214Po (Polonium) and 218Po and its products decay by emitting 7.69 MeV and 6 MeV α particles, respectively. Also they contribute over 90 % to the total radiation dose received due to radon exposure [1]. In some countries, radiation dose to people caused by inhaled radon daughters constitutes more than 50% of the total [2].

Radon is soluble in water and its solubility increases rapidly with decreasing temperature [2]. Therefore, much attention was given to the dissolved radon concentration at the water source because of radon's potential public health hazard [3-11]. Also radon is related to geologic formations (including faults) because fault zones are preferential pathways for liquid transport. During transport of the liquid, radon gas escapes from the rocks and minerals to the surrounding liquid phase such as ground and thermal waters. So, the radon concentration levels in ground and thermal waters are generally higher than surface water [11]. Also ground water circulating in active volcanic areas display high radon content, especially if issuing from geothermal systems [12]. In parallel with, the high concentrations of radon in ground and thermal waters cause a great risk not only for people who ingest it but also in air for people who inhale it [13].

This paper shows the results of radon concentrations of thermal waters and lakes located in the thermal water region obtained during spring in Konya, Turkey. The aims of study are to draw a general picture of the natural radioactivity of thermal waters in different regions in Konya and to evaluate the doses to the populations resulting from their consumption.

2   MATERIALS AND METHODS

2.1   Sampling procedure for Thermal waters

Konya is a city with an area of 38,873 km2 (excluding the lakes) and an estimated population of 2 million people. The latitude and longitude of Konya city are 36o41´ - 39o16´ North and 31o14´ - 34o26´ East, the altitude is 1016 m above sea level [14]. The water samples were collected from ten different thermal waters and from two lakes which are Ilgın Lake (sample#11) and Beyşehir Lake (sample#12) in the first half of 2012 during spring. Thermal water samples were collected from different regions which are Ilgın (samples#1- #4), Hüyük (samples#5- #6), Seydişehir (samples#7- #9), and Ismil (sample#10) as shown in the map in Figure 1. Water samples were directly taken from the their sources. Also water samples were put into a 500 ml plastic bottles that were completely filled and immediately closed tightly in order to avoid bubbles and radon escape. All samples were transported to the Nuclear Physics Laboratory in Selçuk University to determine radon concentration.

2.2   Experimental techniques

An experimental technique which we will briefly summarized below but described in detail by Kochowska et al. in [15] was employed. Radon concentration in water was measured using a professional radon monitor AlphaGUARD PQ 2000PRO (GENITRON-SAPHYMO, Frankfurt, Germany).
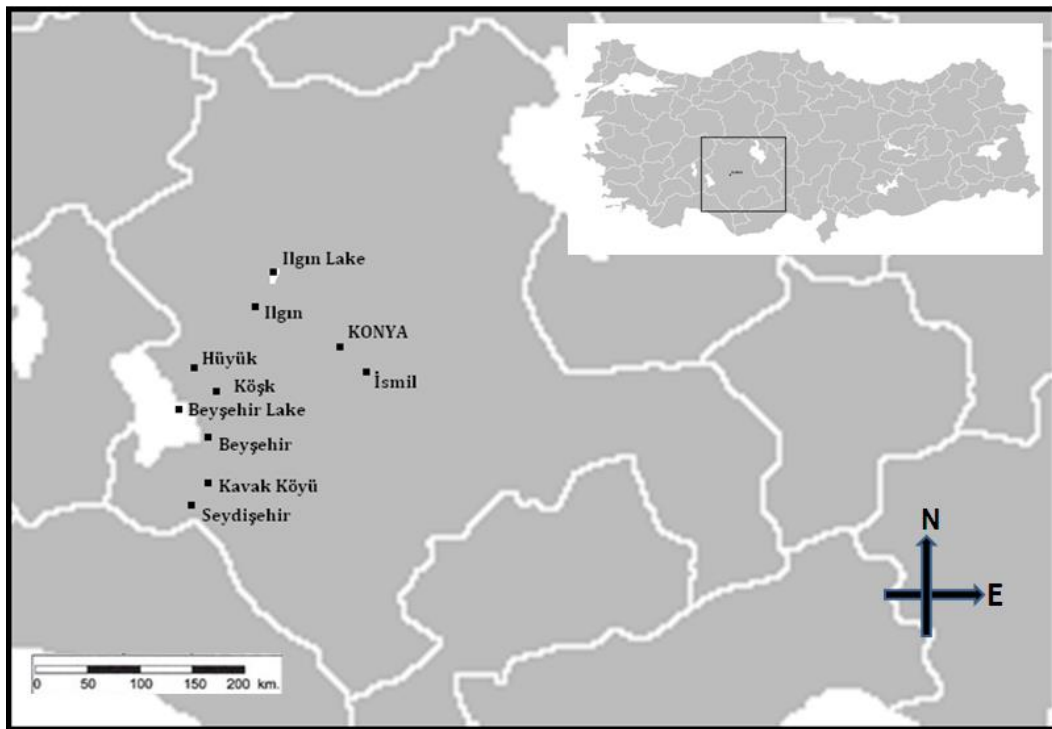
Fig. 1)   Map of Konya showing the location of water sampling.

This is an ionisation chamber, designed for measuring radon in air, water and soil. It is suitable for continuous measurements of radon and has a measurement range of $2 - 2,000,000$ Bqm-3 ($0.05 - 50,000$ pCi/L) with a sensitivity of 5 cpm for 100 Bqm-3 (3 pCi/L). For water measurements an additional equipment AquaKIT was used. Figure 2 shows the set-up for radon measurements in water samples. In a close gas cycle, radon was expelled from the water samples (placed in degassing vessel) using a pump. The security vessel was connected with the degassing vessel. All drops would deposit in it if they had got into the gas cycle during the degassing process. The pressure of the water vapour was thus minimised for the radon monitoring. The background of the empty setup was measured for 10 minutes before every water-sample measurement. After that, the water was injected into the degassing vessel, and the AlphaGUARD and AlphaPUMP were switched on. After 10 minutes, the pump was switched off and the AlphaGUARD remained switched on for another 20 minutes, so the radon measurement was continued. This cycle was repeated three times in order to obtain a better precision. The AlphaGUARD monitor worked in a 'flow' mode and radon concentration was recorded every minute. The flow rate of the pump was 0.5 L/minute. The AlphaGUARD ionisation chamber is a part of this gas cycle as well.

Radon concentration in the water samples was determined with the AlphaGUARD. Whereas, this value is not the radon concentration in the water sample since the radon driven out had been diluted in air within the measurement set-up, and a small part of the radon remained diluted in the watery phase. For quantifying the dilution effect the exact interior volume in the measurement set-up (Vsystem) is required. The quantity of radon remaining in the sample can be determined by the introduction of the distributing coefficient k which describes the temperature dependant quantity of the sample which remains chemically dissolved. For this reason, it is shown in [15] that radon concentration in the measured water samples determines by Equation 1.

$$c_{water} = \frac{c_{air}\left(\dfrac{V_{system} - V_{sample}}{V_{sample}} + k\right) - c_0}{1000} \qquad (1)$$

C_{water} = Rn-concentration in water sample [Bq/L]
C_{air} = radon concentration [Bq/m³] in the measuring set-up after expelling the radon indicated by AlphaGUARD)
C_0 = Rn-concentration in the measuring set-up before sampling (zero level)[Bq/m³]
V_{system} = interior volume of the measurement set-up [mL]
V_{sample} = volume of the water sample [mL]
k = radon distribution coefficient

Calibration of the measuring system has been carried out by Genitron Instruments, Germany recently, with a guaranteed stability for 5 years.
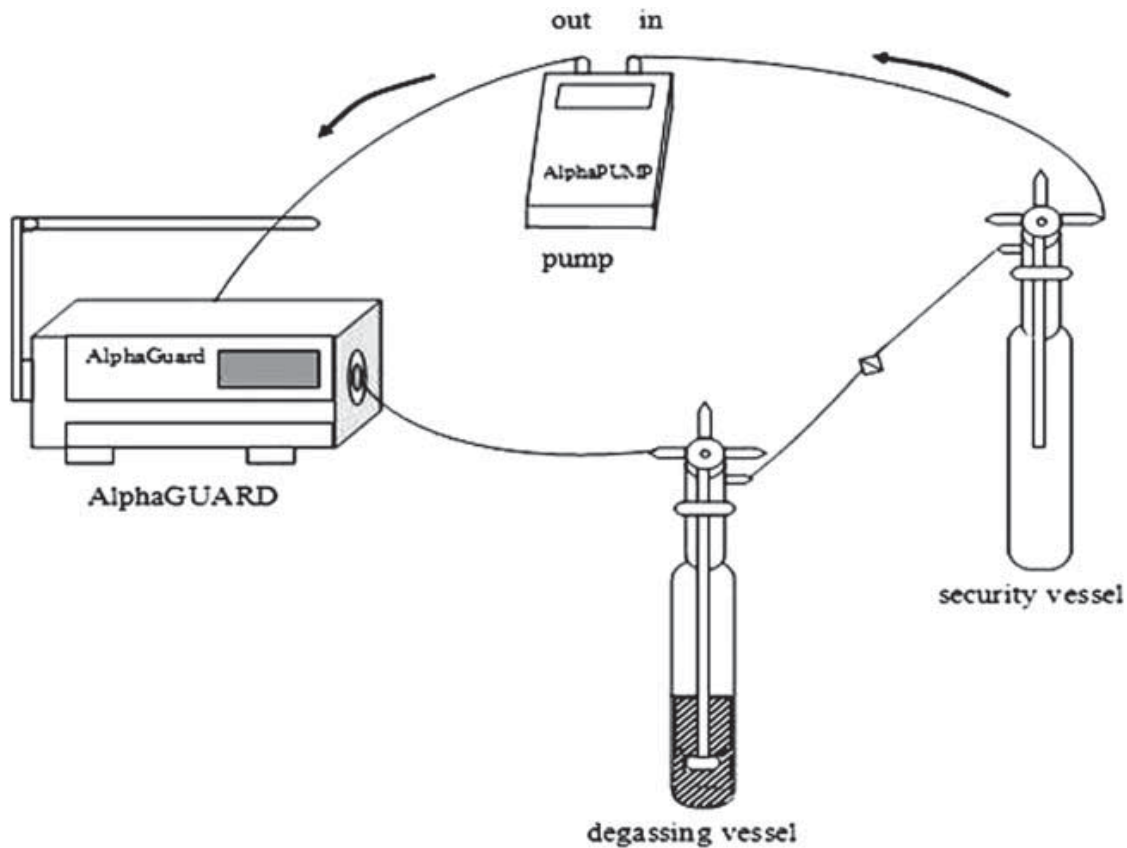
Fig. 2) Schematic view of the experimental set-up

3 CONCLUSION

The radon concentrations from ten different thermal waters and two different lakes located in thermal water region around Konya have been measured as shown in Fig. 1 and Tab. 1. Radon concentration results changed between 0.2205 ± 0.0234 Bq/L and 70.3380 ± 3.5518 Bq/L. Radon levels in thermal waters of different regions of Turkey have been found to be at various values for examples Western Anatolia (0.14-5.77 Bq/L) [16], Afyon city (0.085-44.57

Bq/L) [17] and Bursa city (2.513-82.553 Bq/L) [3]. Also in other some countries, these values have been found to be higher than Konya (Turkey) for examples Greece (10-304 Bq/L) [9] and Venezuela (0.1-576 Bq/L) [10].

Tab. 1)   Activity concentrations of ^{222}Rn in thermal waters and lakes from Konya, Turkey

Sample number	Place	Radon concentration ± standard error (Bq/L)
1	Ilgın	31.7481 ± 4.1290
2	Ilgın	70.3380 ± 3.5518
3	Ilgın	14.3132 ± 1.6702
4	Ilgın	12.0219 ± 1.4740
5	Hüyük, Köşk	3.2318 ± 0.2811
6	Hüyük, Köşk	1.8573 ± 0.2931
7	Seydişehir	2.9320 ± 0.1982
8	Seydişehir , Kavak	0.5997 ± 0.1061
9	Seydişehir , Kavak	1.2132 ± 0.0531
10	İsmil	6.8363 ± 0.3278
11	Ilgın Lake	0.2205 ± 0.0234
12	Beyşehir Lake	0.3872 ± 0.0944

Radon in water may lead to exposures from the ingestion of drinking water and from the inhalation of radon released to air when water is used. The conversion coefficient of radon in water to air depends on many factors [18]. It has been supposed that 10 Bq/L of 222Rn in water contributes about 1 Bq.m-3 of 222Rn to the indoor air [19]. The average contributions of radon concentration in thermal water to indoor radon are given in Table 2. The increase in the indoor-air radon concentration induced by thermal water in Konya city is from 0.060 ± 0.010 to 7.034 ± 0.355 Bq.m-3. Thus, an average concentration of radon in water of 10 kBq.m-3 implies a contribution of 1 Bq.m-3 to radon in air; for an air exchange rate of 1 h-1, the radon entry rate is 1 Bq m-3 h-1. In the UNSCEAR report, a value of 9 nSv.h-1 per Bq.m-3 was used for the conversion factor (effective dose received by adults per unit 222Rn activity per unit of air volume), indoor occupancy of 7,000 hours per year and 0.4 for the indoor equilibrium factor of 222Rn indoors [2]. It can be seen that the annual effective dose for thermal water is between 0.0001 and 0.0147 mSv as shown in Table 2.

Results have shown that radon concentrations from ten different thermal waters and two different lakes located in thermal water region around Konya changed between 0.2205 ± 0.0234 Bq/L and 70.3380 ± 3.5518 Bq/L. The highest radon concentrations in this region have been found in Ilgın (sample #2). However, the lowest radon concentrations have been found in Ilgın Lake (sample #11) as shown in Tab. 1. The USEPA [20] has recommended 11 Bq/L of radon in water as safe limit. However, UNSCEAR [2] has recently recommended 4-40 Bq/L of radon in water as safe limit for drinking purpose. According to these recommendations, four out of twelve sites gave much.
 So, samples #1-2-3-4 should not be consumed especially for drinking. It can be related that Ilgın is close to fault zones. The contribution of radon concentration in these waters and lakes to indoor radon concentration in Konya is found between 0.022 ± 0.002 Bq.m^{-3} and 7.034 ± 0.355 Bq.m^{-3}. Also the annual effective dose to the dweller owing to the inhalation of radon emanating from thermal waters and lakes, located in thermal water region, in Konya is calculated to be in the range of 0.0000463 mSv to 0.0147 mSv.

Tab. 2) The contribution of radon concentration in drinking water to indoor radon concentration and the effective dose of drinking water for the inhalation in Konya, Turkey.

Sample number	Contribution (Bq.m^{-3})	Annual effective dose (mSv)
1	3.175 ± 0.413	0.0066
2	7.034 ± 0.355	0.0147
3	1.431 ± 0.167	0.0030
4	1.202 ± 0.147	0.0025
5	0.323 ± 0.028	0.0006
6	0.186 ± 0.029	0.00039
7	0.293 ± 0.020	0.0006
8	0.060 ± 0.010	0.0001
9	0.121 ± 0.005	0.0002
10	0.684 ± 0.033	0.0014
11	0.022 ± 0.002	0.0000463
12	0.039 ± 0.009	0.0000813

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SCOUR AT ENGINEERING STRUCTURES UNDER STRATIFIED BED: DEVELOPMENT IN TIME

Jelena Govsha[1], Boriss Gjunsburgs[2]

Abstract

The scour at abutments and elliptical and straight guide banks with a stratified bed under steady and unsteady clear-water conditions was studied. Tests were performed with uniform sand, standard deviation, one or two layers of different grain diameters, and different sequence and thickness of the layers. New methods for computing the depth of scour development in time and elliptical guide banks under stratified bed conditions are presented. Method are confirmed by tests results. At a stratified river bed, the most critical conditions for structures occur when a fine-sand layer lies under a coarse-sand layer. According to the results obtained in tests and by the method presented, the depth of scour is always greater when a fine-sand layer is under a coarse-sand layer(s). Using the mean grain size on the top of the river bed for calculating the scour depth, neglecting stratification, can lead to wrong results and possible damages and losses.

Key words

Clear-water conditions, scour, steady a unsteady flow, stratified bed, uniform sand.

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1   INTRODUCTION

The damage of the engineering structures in river flow because of scour at the foundations always leads to considerable economic and environmental losses. The scour at stratified bed conditions can be one of the reasons for failure of structures, but this phenomenon has not yet been studied well.

The influence of stratification on the scour depth near bridge structures is confirmed by Ettema [1], Raudkivi and Ettema [2], Kothyari [3], Kothyari et al. [4], Garde and Kothyari [5], FHWA-RD-99-188 [6],Melvile & Coleman [7],Gjunsburgs tal.[8],[9],[10],[11],[12],[13].

The aim of the present study is to elucidate influence of the river bed stratification on the scour depth at elliptical guide banks under clear water conditions.

The tests were carried out for different hydraulic conditions and uniform sands, with two layers and two mean size diameters, and their different sequence.

The differential equation of equilibrium for bed sediment movement in clear water is used, and a calculation method for the scour development in time at the head of elliptical guide banks in the stratified bed conditions is elaborated and confirmed by experimental data. This method allows one to calculate the scour depth in layers with different mean grain size, thickness, and sequence combination.

At a stratified river bed, the most critical conditions for engineering structures occur when a fine-sand layer lies under a coarse-sand layer. As soon as the coarse layer has been scoured and removed by the flow, the scour is rapidly developing in the next fine-sand layer. In this case, the dominant grain size for computing the depth of scour at foundations under stratified bed conditions is the mean diameter of grains of the second layer or of the next one, where the scour stops. According to the results obtained in our tests and by the methods presented, the depth of scour is always greater when a fine-sand layer is under a coarse-sand one. The calculation of scour depth near hydraulic structures in flow by using only the data on grain size on the top of the river bed and neglecting the stratification of the river bed can lead to wrong results and finally to considerable damages and losses.

2   EXPERIMENTAL SETUP

The tests were carried out in a flume 3.5 m wide and 21 m long. Experimental data flumes in the open flow conditions are presented obtained in in Table 1.

The flow distribution between the channel and floodplain was studied under open flow conditions. The rigid bed tests were performed to investigate changes in the velocity and water level in the vicinity of the embankment and at the head of the elliptical guide banks. During the sand-bed tests, we studied the scour development in time at a stratified bed, with different grain sizes in the first and second layers. The area 1m up and down at a bridge crossing model had a sand-bed for studying scour processes near the head of the elliptical guide banks.

The tests were performed for the contraction rate Q/Qb= 3.66-4.05 (where Q is the flow discharge and Qb is the discharge through the bridge opening under open-flow conditions).

Tab. 1) Tests data for open flow conditions

№	L	hf	V	Q	Fr	Rec	Ref
	cm	cm	cm/s	l/s			
L1	350	7	6.47	16.60	0.078	7500	4390
L2	350	7	8.58	22.70	0.102	10010	6060
L3	350	7	10.30	23.60	0.124	12280	7190
L7	350	13	7.51	35.48	0.066	13700	9740
L8	350	13	8.74	41.38	0.075	16010	11395
L9	350	13	9.90	47.10	0.087	14300	14300

The depth of water on the floodplain was 7 and 13 cm. The thickness of the layers with different grain sizes 0.24and 0.67mm with a standard deviation was equal to 4, 7, and 10cm. The Froude number in the open-flow conditions varied from 0.078 to 0.1243, densimetric Froude numbers –from 0.62 to 1.65, and the slope of the flume was 0.0012. The opening of the bridge model was 80cm. The condition that FrR=Frf was fulfilled, where FrR and Frf are the Froude numbers for the plain river and for the flume, respectively. The tests in the flume lasted for 7 hours. The development of scour was examined for different flow parameters in time intervals within one 7-h step and within two steps, 7 hours each. The tests were carried out with one floodplain model and one side contraction of the flow. The dimension of the upper part of an elliptical guide bank, namely the length, was calculated according to the Latishenkov (1960) method and was found to be dependent on the flow contraction rate and the main channel width. The length of the lower part of the guide bank was assumed to be half of the upper part.

3 SCOUR DEVELOPMENT IN TIME UNDER STRATIFIED RIVER BED CONDITIONS

At the head of the guide banks, the concentration of streamlines, a sharp drop in water level, and a rapid increased in velocity were observed.
To calculate the local velocity, we used the Bernoulli equation for two cross sections of a unit streamline. The local velocity at the head of the guide banks for the plain river bed was found from the formula

$$V_{lel} = \varphi\sqrt{2g\Delta h} \tag{1}$$

where φ = velocity coefficient; Δh = backwater value [14].
The critical velocity at the plain river bed is determined as:

$$V_0 = \beta \cdot 3.6 d_i^{0.25} h_f^{0.25} \tag{2}$$

where d = mean grain size on the top of the river bed; h_f = water depth on the floodplain.
In modeling the scour development in time it was found that the discharge across width of the scour hole before and after the development the scour hole is $Q_f = Q_{se}$, where Q_f is the discharge across width of the scour hole with the plain bed and Q_{se} is the discharge with the equilibrium depth h_{equil}.

$$mh_{equil}h_f V_{lel} = \left(mh_{equil}h_f + \frac{mh_{equil}}{2}h_{equil} \right) \cdot V_{lt} \tag{3}$$

where m = the steepness of scour hole, mh_{equil} = width of the scour hole, V_{lel} = local velocity with a plain bed, h_f = water depth in the floodplain and V_{lt} = local velocity at the equilibrium scour depth h_{equil}.

The local velocity V_{lt} can be determined from Equation 3:

$$V_{lt} = \frac{V_{lel}}{\left(1 + \dfrac{h_{equil}}{2h_f}\right)} \tag{4}$$

The critical velocity V_{0t} at the equilibrium stage can be determined through the mean depth of flow $h_m = h_f(1 + h_{equil}/2h_f)$:

$$V_{ot} = \beta \cdot 3.6 d_i^{0.25} h_f^{0.25}\left(1 + \frac{h_{equil}}{2h_f}\right)^{0.25} \tag{5}$$

where β = reduction coefficient of the critical velocity of the bended flow determined by using the Rozovskiy [15] approach.

The local velocity on the surface of the second layer is found by the formula:

$$V_{lt2} = \frac{V_{lel}}{1 + \dfrac{H_{d1}}{2h_f}} \tag{6}$$

where H_{d1} = the thickness of the first layer of the river bed with the grain size d_1.

The critical velocity on the top of the second layer is equal to:

$$V_{ot2} = \beta 3.6 \cdot d_2^{0.25} h_f^{0.25}\left(1 + \frac{H_{d1}}{2h_f}\right)^{0.25} \tag{7}$$

The differential equation for equilibrium bed-sediment movement under clear water conditions at the head of elliptical guide bank has the form:

$$\frac{dv}{dt} = Q_s \tag{8}$$

where $v = 1/5\pi m^2 h_s^3$ = volume of the scour hole; t = time; Q_s = sediment discharge out of the scour hole; h_s = depth of scour; m = scour hole steepness.

The left-hand part of Equation12 can be written as:

$$\frac{dv}{dt} = \frac{3}{5}\pi m^2 h_s^3 \frac{dh_s}{dt} = a h_s^2 \frac{dh_s}{dt} \tag{9}$$

The sediment discharge at the initial stage was determined by the Levi (1969) formula:

$$Q_s = AB \cdot V_{lel}^4 \tag{10}$$

where $B = mh_s$ = width of the scour hole; V_l = local velocity at the head of the guide bank with a plain bed; A = parameter in the Levi [16] formula.

The parameter A at the plain river bed was determined as:

$$A = \frac{5.62}{\gamma}\left(1 - \frac{\beta V_o}{V_{lel}}\right)\frac{1}{d_i^{0.25} \cdot h_f^{0.25}} \tag{11}$$

where γ = specific weight of sediments; $V_o = 3.6 d_i^{0.25} h_f^{0.25}$ = critical velocity; d_i = grain size of the bed materials; h_f = water depth in the floodplain.

The sediment discharge upon development of the scour is:

$$Q_{si} = A_i \cdot mh_s \cdot V_{lt}^4 = b \frac{h_s}{\left(1 + \dfrac{h_s}{2h_f}\right)^4} \tag{12}$$

where V_{lt} = local velocity at the depth of scour h_s, $b = A_i m V_l^4$.

The parameter A_i with scour depth developing in time was determined as:

$$A_i = \frac{5.62}{\gamma}\left[1 - \frac{\beta V_o}{V_{lel}}\left(1 + \frac{h_s}{2h_f}\right)^{1.25}\right] \cdot \frac{1}{d_1^{0.25} \cdot h_f^{0.25}\left(1 + \dfrac{h_s}{2h_f}\right)^{0.25}} \tag{13}$$

$$\frac{\beta V_{ot}}{V_{lt}} = \frac{\beta V_o}{V_l}\left(1 + \frac{h_s}{2h_f}\right)^{1.25}$$

Taking into account Equations 9 and 12, Equation 8 can be written as:

$$ah_s^2 \frac{dh_s}{dt} = b \frac{h_s}{\left(1 + \dfrac{h_s}{2h_f}\right)^4} \tag{14}$$

Separating and integrating the variables yields:

$$t = D_i \int_{x_1}^{x_2} h_s\left(1 + \frac{h_s}{2h_f}\right)^4 dh_s \tag{15}$$

where $\qquad D_i = \dfrac{a}{b} = \dfrac{\pi \cdot m}{1.67 A_i \cdot V_l^4}$

$$N_i = \frac{t_i}{4D_i h_f^2} + N_{i-1} \tag{16}$$

where $N_i = 1/6 x_i^6 - 1/5 x_i^5$; t_i = time interval.

Calculating the value of N_i, we find x_i and scour depth:

$$h_s = 2h_f(x - 1)\, k_m k_\alpha \tag{17}$$

where k_m = coefficient depending on the side-wall slope of the guide bank; k_α = coefficient depending on the angle of flow crossing.
To find the depth of scour in the second layer with a grain size d_2, we must know the local V_{lt} and critical V_{0t} velocities and parameters Ai_2, Di_2, Ni_2, Ni_1, x_2 and h_s in the layer H_{d2} with grain size d_2.
The parameter Ai in the second layer is determined as:

$$A_{i2} = \frac{5.62}{\gamma}\left[1 - \frac{\beta V_{02}}{V_{lel}}\left(1 + \frac{H_{d1}}{2h_f}\right)^{1.25}\right] \cdot \frac{1}{d_2^{0.25} \cdot h_f^{0.25}\left(1 + \dfrac{H_{d1}}{2h_f}\right)^{0.25}}$$

(18)

where $V_{02} = \beta 3.6 d_2^{0.25} h_f^{0.25}$ is the critical velocity of flow for the grain size d_2, since the layer with exactly this diameter lies on the top of the river bed.

D_{2i} is calculating by using A_{2i}:

$$D_i = \frac{a}{b} = \frac{\pi \cdot m}{1.67 A_i \cdot V_l^4}$$

(19)

After integrating Equation 15 with new variables, we obtain:

$$N_2 = \frac{t_i}{4D_2 h_f^2} + N_1$$

(20)

Calculating the value N_{i2}, we find x_2 and the scour depth in the next layer:

$$h_{s2} = 2\,h_f\,(x_2 - 1)\,k_m \cdot k_\alpha$$

(21)

4   RESULTS

The flow pattern at the head of the elliptical guide banks was modified. It was found in the testthat the flow velocities reduce almost to zero when approaching the bridge crossing construction and then gradually increase. At the head of the elliptical guide bank, we observe the concentration of streamlines, a sharp drop in water level, and a local increase in the velocity. It is the local velocities near the guide banks that form the scour hole.
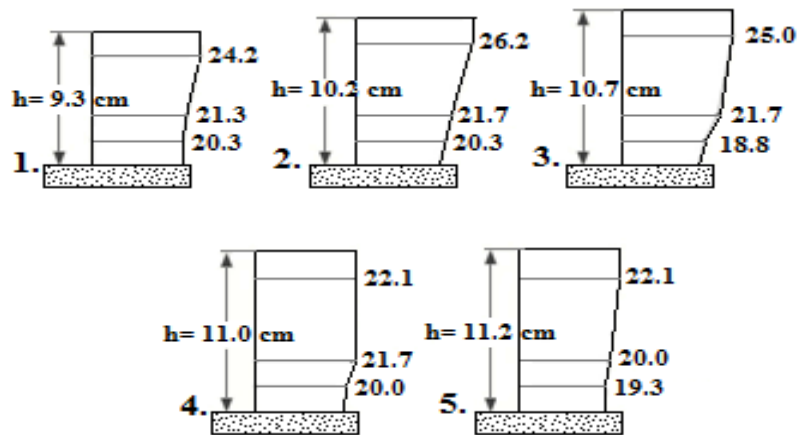
Fig. 1)   Vertical distribution of velocities in time at the head of guide bank during the scour in 30 (1), 80 (2), 240 (3), 360 (4), and 420 min (5); test EL3.

With development of scour in time, under steady flow conditions, the local velocities reduces and becomes equal in vertical distribution at different depth of scour (Figure1).
Figure 2 illustrates the scour depth and respective variations in the local V_{lt} and critical V_{0t} velocities, as measured experimentally and calculated in one layer with uniform sand.

Depending on the sequence of layers, the critical velocity V_{0t} either increases, when the grains of the second layer are coarser, or reduces, when these grains are finer. The local velocity V_{lt} reduces more raidly if the second layer has grains of a smaller size.
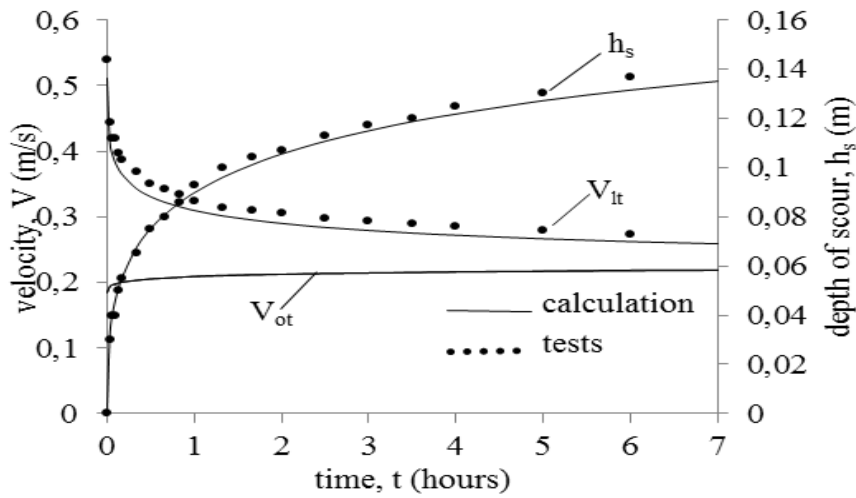
Fig. 2) Changes in scour depth and in the local and critical velocities V_{lt} and βV_0 varying with time under steady flow; one-sand layer; test EL 6.

Figures 3 and 4 present the scour depth and variations in the local V_{lt} and critical V_{0t} velocities with time, at a different sequence of the layers –the layer with fine grains on the top of the coarse-grain layer, and vice versa.
Figure 3 shows, as an example, the scour depth and the development of local and critical velocities in time (test EUL5), in the first layer with $d_1 = 0.24$ mm and in the second layer with $d_2 = 0.67$ mm.
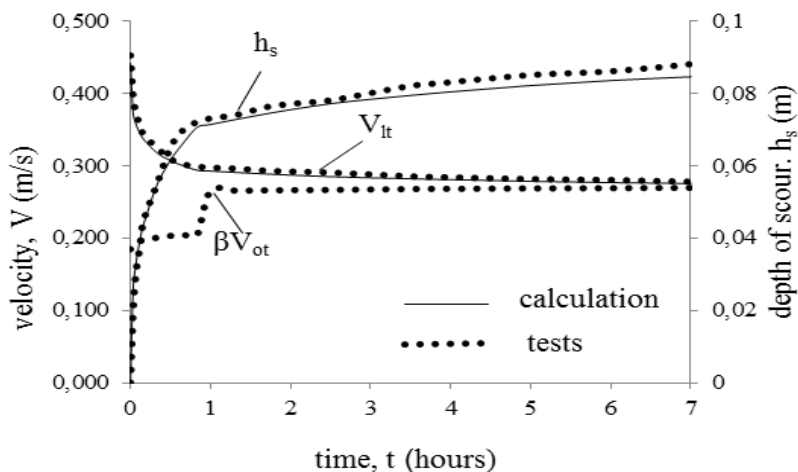
Fig. 3) Changes in scour depth and in the local V_{lt} and critical βV_{0t} velocities; $d_1 = 0.24$ mm in the first layer and $d_2 = 0.67$ mm in the second one: test EUL 5

The depth of scour develops rapidly in fine-sand layer; in the second, coarse-sand layer it continues, but more slowly. On the surface of the second layer, the critical velocity sharply increases with increasing grain size, and then the depth of scour development decreases.

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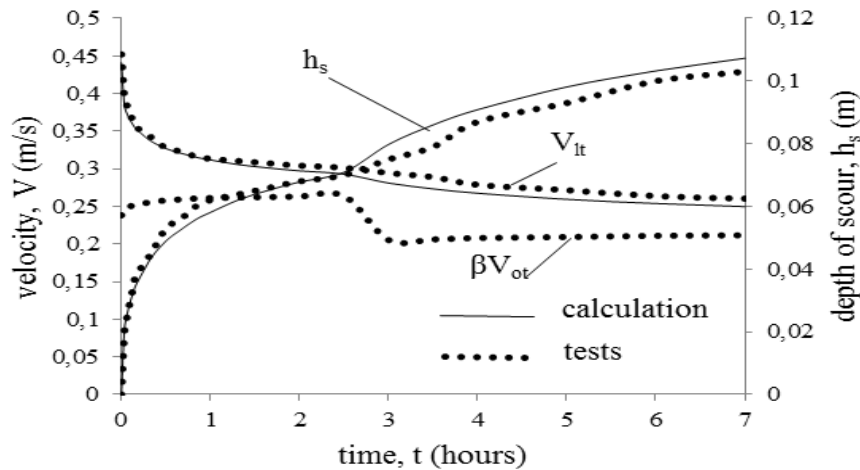
Fig. 4) Changes in scour depth and in the local V_{lt} and critical βV_{0t} velocities, with $d_1 =$ 0.67 mm in the first layer and $d_2 = 0.24$ mm in the second one; test EUL2

In Figure 4, the scour depth andthedevelopment of local and critical velocities in time at adifferent sequence of the layers are shown (test EUL2).

The grain diameter was d1= 0.67 mm in the first layer and d2= 0.24 mm in the second one. It took more time to reach the surface of the second layer Hd1= 7 cm than in the previous test, EUL5, but the scouring in the second layer developed at a higher speed. On the top of the second layer, the critical velocity rapidly reduced owing to the decreased grain size (d2= 0.24 mm).

Table 2 presents a comparison between experimental and calculated data for the depth of scour with different sequence and thickness of the layers The values of scour depth measured in tests and computed by the method suggested agree satisfactorily.

On the border of two layers with different grain size,d1/d2or d2/d1, the scour development changes its intensity: the rapid scouring continues in the following fine-sand layer or slows down if the second layer is coarse. scour with different sequence and thickness of the layers agree satisfactorily.

On the border of two layers with different grain size,d1/d2 or d2/d1, the scour development changes its intensity: the rapid scouring continues in the following fine-sand layer or slows down if the second layer is coarse.

According to experimental results and the method proposed, the scour depth is greater if the coarse-grain layer lies on the top of the river bed and a fine-grain layer goes after it, and the depth is smaller if the fine-grain layer lies on the surface of the river bed (Table 2).

5 CONCLUSIONS

It was found that the scour depth depends on the river bed stratification, as well as on thethickness and sequence of the layers. The most criticalconditions for structures occur whea fine-sand layer occurs under a coarse-sand layer.

Tab. 2) Comparison between experimental and calculated values of scour depth under stratified bed conditions

Test	hf	d1	d2	H1	H2	hs test	hscalc	$\dfrac{h_s\ test}{h_s\ alc}$
	cm	mm	mm	cm	cm	cm	cm	
EUL1	7	0.67	0.24	4	46	8.0	8.46	0.86
EUL4	7	0.24	0.67	4	46	5.6	5.74	0.98
EUL2	7	0.67	0.24	7	43	10.3	10.73	0.96
EUL5	7	0.24	0.67	7	43	8.6	8.44	1.04
EUL3	7	0.67	0.24	10	40	12.4	12.13	1.02
EUL6	7	0.24	0.67	10	40	11.4	11.12	1.02
EUL7	13	0.24	0.67	4	46	6.6	6.97	0.89
EUL10	13	0.67	0.24	4	46	10.0	10.88	0.92
EUL8	13	0.24	0.67	7	43	9.4	9.99	0.95
EUL11	13	0.67	0.24	7	43	12.6	13.38	0.94
EUL9	13	0.24	0.67	10	40	13.6	14.58	0.93
EUL12	13	0.67	0.24	10	40	17.6	17.82	0.99

As soon as the coarse layer has been scoured, the scour is rapidly developing in the next fine-sand layer. In this case, the dominant value of grain size for computing the depth of scour at foundations under stratified bed conditions is the mean diameter of the second layer or of the next one, where the scour stops. According to the results obtained in tests and by the method presented, the depth of scour is alwaysgreater when a fine-sand layer is under a coarse-sand layer(s). The calculation of scour depth near hydraulic structures in flow by using only the data onthe mean grain size on top of the river bed and neglecting the stratification of the river bed can lead to wrong results and finally to considerable damages and losses.

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MULTIPLE FLOOD AS THE CAUSE OF FAILURE OF ENGINEERING STRUCTURES IN RIVER FLOWS

Gints Jaudzems[1], Boriss Gjunsburgs[2], Jelena Govsha[3]

Abstract

The scour development with time during multiple floods, equilibrium stage and the assessment of flood damage risk for engineering structures have been investigated. A method for computing scour development with time at engineering structures during multiple floods was used. The test confirmation of the method allows as to perform computer modelling of scour processes and to estimate the influence of floods with different probability, duration, sequence and frequency on the depth of scour. It was found that the scour parameters increase with decrease in probability and with increasing duration and frequency of the floods. The sequence of floods can increase or reduce the scour development with time, depending on their probability. The successive floods of the same probability considerably increase the value of the scour depth.

Key words

Hydrograph, scour, modelling, multiple floods.

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1   INTRODUCTION

Transport system infrastructures, such as roads, bridges, dams, and water intakes in rivers, are under permanent impacts of multiple floods. To estimate their safety and stability during scour development at hydraulic structure foundations, a multidisciplinary approach, involving the principles of hydraulics, hydrology, morphology, geology, and so on, is required.

During the past few decades equilibrium and temporal depth of scour at engineering structures has been studied by many authors, and new approaches have been elaborated by Cardoso & Bettess [1], Kothyari & Ranga Raju [2], Balio & Orsi [3], Radice et al. [4], Hager et al. [5], Armitage & McGahey [6], Yanmaz & Celebi [7], Grimaldi et al. [8], Gjunsburgs et al. [9, 10, 11], Tregnaghi & Marion [12], and Yanmaz & Kose [13]. For computing the equilibrium depth of scour flow parameters at the peak of the flood with unrestricted or restricted duration (some hours or days) was used. However, in the nature the flow load on engineering structures are in the form of a hydrograph and multiple floods form scour holes.

The scour hole parameters (depth, width, and volume) during floods under clear-water conditions in the floodplain are summed up and increase from flood to flood. Hence, it is impossible to predict how multiple floods will affect the scour depth at the abutment and to know whether it will or will not be destroyed after a current or forthcoming event, whether the scour depth will exceed or not the designed equilibrium depth if the floods are higher than the calculated ones, and how long the structure will stay undamaged and safe enough after unexpected multiple flash floods.

Using the differential equation of equilibrium of the bed sediment movement in clear water, a method for calculating the scour development in time at engineering structures during floods has been elaborated. The agreement between the experimental and calculated results [9] allows us to use this method for computer modelling of the scour process in nature during floods with different probability, duration, frequency, and sequence. This method enables us to compute the scour depth at any stage of the flood during the maintenance period or at the stage of designing the bridge crossings.

It was found that the scour parameters increase with decreasing probability and with increasing duration and frequency of the floods. The sequence of floods can increase or reduce the scour development in time, depending on their probability. The successive floods of the same probability considerably increase the value of scour depth.

2   SCOUR DEVELOPMENT IN TIME DURING MULTIPLE FLOODS

The differential equation of equilibrium for the bed sediment movement in clear-water conditions has the form:

$$\frac{dw}{dt} = Q_s \tag{1}$$

where w is the volume of the scour hole, which, according to the test results, is equal to $1/6\pi m^2 h_s^3$, t is a time, and Q_s is the sediment discharge out of the scour hole. The volume and shape of the scour hole are independent of the contraction rate of the flow [9].

The left-hand part of Eq. (1) can be written as

$$\frac{dw}{dt} = \frac{1}{2}\pi m^2 h_s^2 \frac{dh_s}{dt} = a h_s^2 \frac{dh_s}{dt} \tag{2}$$

where h_s is the scour depth, m is the steepness of the scour hole, and $a = 1/2\pi m^2$.

The sediment discharge was determined by the Levi [14] formula:

$$Q_s = AB \cdot V_l^4 \tag{3}$$

where $B = mh_s$ describes width of the scour hole, V_l is the local velocity at the abutments with a plain bed, and A is a parameter in the Levi [14] formula.

The discharge across the width of a scour hole before and after the scour is determined as follows:

$$Q_f = Q_{sc} \cdot k \tag{4}$$

where Q_f is a discharge across the width of the scour hole with a plain bed, Q_{sc} is the discharge across the scour hole with a scour depth h_s, and k is a coefficient of changes in discharge because of scour, which depends on the flow contraction [9].

Now we have

$$mh_s h_f V_l = k\left(mh_s h_f + \frac{mh_s}{2}h_s\right) \cdot V_{lt} \tag{5}$$

where mh_s is the width of the scour hole, h_f is a water depth in the floodplain, h_s is the scour depth, and V_{lt} is the local flow velocity at a scour depth h_s. From Eq. (5) the local velocity for any depth of scour is

$$V_{lt} = \frac{V_l}{k\left(1 + \dfrac{h_s}{2h_f}\right)} \tag{6}$$

The critical velocity at the plain bed V_0 can be determined by the Studenitcnikov [15] formula $V_0 = 3.6 d_i^{0.25} h_f^{0.25}$, where d_i is a grain size of the bed materials. The critical velocity V_{0t} for any depth of scour h_s and for the flow bended by the bridge crossing embankment is

$$V_{0t} = \beta \cdot 3.6 \cdot d_i^{0.25} \cdot h_f^{0.25}\left(1 + \frac{h_s}{2h_f}\right)^{0.25} \tag{7}$$

At a plain river bed, the formula for $A = A_l$ reads

$$A = \frac{5.62}{\gamma}\left(1 - \frac{\beta V_0}{V_l}\right)\frac{1}{d_i^{0.25} \cdot h_f^{0.25}} \tag{8}$$

where γ is a specific weight of sediments.

The parameter A depends on the scour, local velocity V_l, critical velocity V_0, and grain size of the bed material during the floods:

$$A_i = \frac{5.62}{\gamma}\left[1 - \frac{k\beta V_0}{V_l}\left(1 + \frac{h_s}{2h_f}\right)^{1.25}\right] \cdot \frac{1}{d_i^{0.25} \cdot h_f^{0.25}\left(1 + \frac{h_s}{2h_f}\right)^{0.25}} \tag{9}$$

Then, we replace V_l in Eq. (3) with the local velocity at any depth of scour V_{lt} from Eq. (6). The parameter A in Eq. (3) is replaced with the parameter A_i from Eq. (9). The sediment discharge upon development of the scour is

$$Q_s = A_i \cdot mh_s \cdot V_{lt}^4 = b\frac{h_s}{k^4\left(1 + \frac{h_s}{2h_f}\right)^4} \tag{10}$$

where $b = A_i m V_l^4$.

The hydraulic characteristics, such as contraction rate of the flow, the velocities V_0 and V_l, the grain size in different bed layers, the sediment discharge, and the depth, width, and volume of the scour hole, varied during the floods.

Taking into account formulas (2) and (10), the differential equation (1) can be written in the form

$$ah_s^2\frac{dh_s}{dt} = b\frac{h_s}{k^4\left(1 + \frac{h_s}{2h_f}\right)^4} \tag{11}$$

After separating the variables and integration of Eq. (11), we have:

$$t = D_i \int_{x_1}^{x_2} h_s\left(1 + \frac{h_s}{2h_f}\right)^4 dh_s \tag{12}$$

where $x_1 = 1 + h_{s1}/2h_f$ and $x_2 = 1 + h_{s2}/2h_f$ are relative depths of scour and $D_i = \frac{k^4 a}{b} = \frac{\pi \cdot m \cdot k^4}{2A_i \cdot V_l^4}$.

According to the method, the hydrograph was divided into time steps, and each step in turn was divided into time intervals. It was assumed that D_i was constant inside the time interval.

After integration with new variables, $x = 1 + h_s/2h_f$, $h_s = 2h_f(x-1)$, and $dh_s = 2h_f dx$, we obtain

$$t = 4D_i h_f^2 \left(N_i - N_{i-1} \right) \tag{13}$$

Where $N_i = 1/6x_i^6 - 1/5x_i^5$, $N_{i-1} = 1/6x_{i-1}^6 - 1/5x_{xi-1}^5$, $x = 1 + h_s / 2h_s$ are the relative depths of scour.

From Eq. (13), the value of N_i can be found

$$N_i = \frac{t_i}{4D_i h_f^2} + N_{i-1} \tag{14}$$

where t_i is a time interval.

Using the graph $N = f(x)$ for the calculated value of N_i, we find x_i and the depth of scour at the end of time interval:

$$h_s = 2h_f \left(x - 1 \right) \tag{15}$$

We assume that the scour depth depends on the slope of the side wall [16] described by the coefficient k_m and on the angle of flow crossing [17] described by the coefficient k_α. In our study, the angle of flow crossing was 90° and $k_\alpha = 1$.

Then, Eq. (15) can be given in the form

$$h_s = 2h_f \left(x - 1 \right) \cdot k_m \cdot k_\alpha \tag{16}$$

To determine the scour depth development during the flood or multiple floods, the hydrograph was divided into time steps with duration of 1 or 2 days, and each time step was divided into time intervals up to several hours. For each time step, the following parameters must be determined: the water depth in the floodplain h_f; contraction flow rate Q/Q_b, where Q is the discharge of flow and Q_b is the discharge in the bridge opening under open-flow conditions; the maximum backwater Δh determined by the Rotenburg [18] method (a comparison of the values of Δh obtained in the tests with those calculated by Rotenburgh [18] was illustrated earlier [9] and gave good results); grain size d_i; thickness H of the bed layer with d_i; the specific weight γ of the bed material. As a result, we have V_l, V_{lt}, V_0, V_{0t}, A, A_i, D_i, N_i, N_{i-1}, x, and h_s at the end of time intervals and finally at the end of the time step. For the next time step, the flow parameters were changed because of the flood and because of the scour developed during the previous time step. The experimental data for open flow conditions, as well as comparisons between the values of local velocities and scour depth at the abutment obtained in tests and calculations have been presented previously [9]. Comparison results between the experimental and calculated scour depth at the abutments was in good agreement.

3   MODELLING OF MULTIPLE FLOODS

Based on the method described, a computer modelling of the time-dependent scour during multiple floods with different probability, duration, frequency, and sequence was performed.

The duration was changed for each separate flood in the series of multiple floods. Investigation was made on the influence of the flood probability on the time-dependent scour development. The peak discharge was changed for the series of multiple floods.
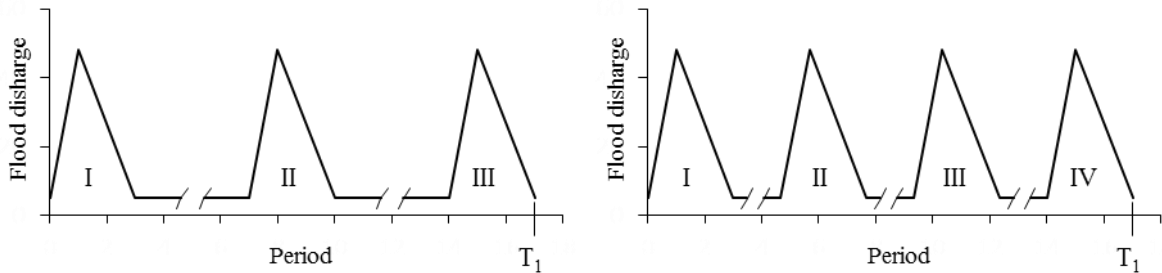
Fig. 1) Multiple floods with different frequency

The multiple floods with different frequency were modelled. The period of multiple floods was assumed similar however flood number was changed during this time (Fig.1). Two, three and four floods were modelled during equal multiple floods period.

The influence of the sequence of floods with a different probability on the time-dependent scour development was examined according to three scenarios (Fig.2). Left part of Figure 2 shows a scheme of three floods of the same probability. The high flood follows by two lower floods in the middle scheme and two floods with higher probability are followed by the flood with less probability right scheme of Figure 2.
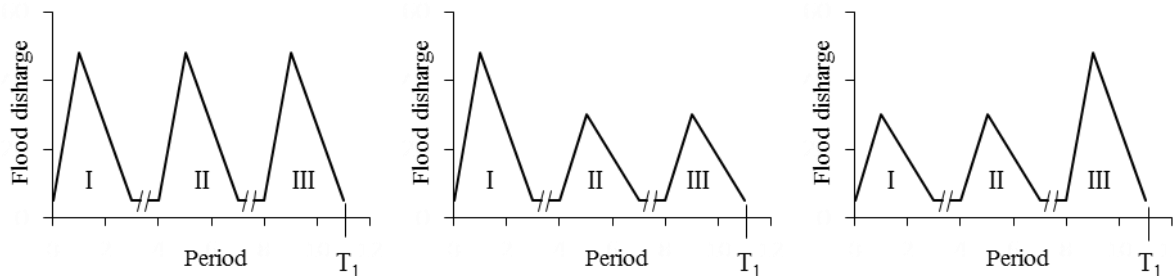
Fig. 2) Multiple floods with different sequence

4 RESULTS

The contraction of the river flow by engineering structures leads to considerable changes in flow pattern, local increase in velocities, and origin of turbulence, eddy and vortex structures. The patterns of the scour development in time have the rapid development at the start of the scour process and gradual reduction with time.

The scour development in time for the floods of different duration is illustrated in Figure 3. It is seen that the scour depth increases with the flood duration, i.e., the greater duration, the deeper the scour depth.

Figure 4 shows the scour development in time for the discharge with a return period of 1 and 4 times over 100 years. The scour hole at the abutments is deeper for the flood of a lower probability.
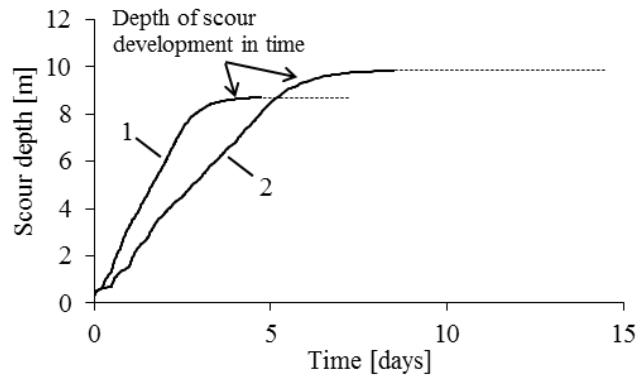
Fig. 3)   Scour development with time: 7-day duration (1) and 14-day duration (2).
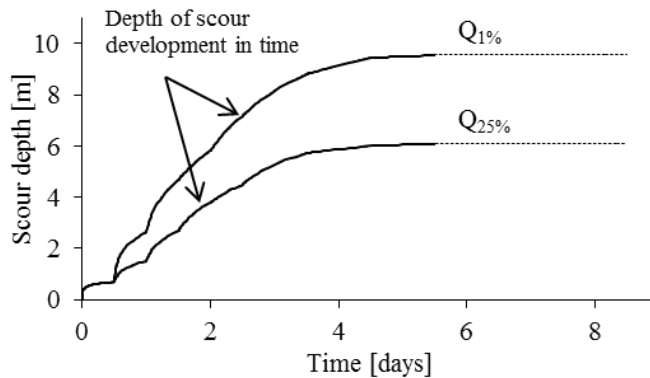
Fig. 4)   Time-dependant scour development with discharges of different probabilities.

To investigate the influence of the flood frequency on the scour development in time, we choose a period of, for example, 5 years and suppose that, during this period, we have three or four floods of the same probability.

It is obvious that an increase in the frequency of the floods is accompanied by an increase in the scour depth, and it follows from Figure 5 that the scour depth after two floods at an accepted period of time hs1 is less than that after four floods occurred during the same period hs2. After every flood, the depths of scour are summed up, and finally the equilibrium stage can be reached.
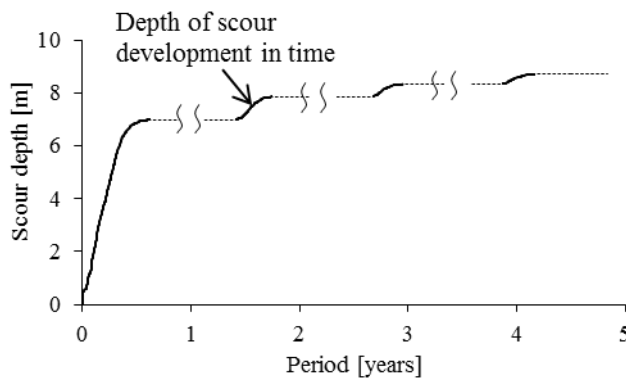
Fig. 5)   Scour development with time for floods with different frequencies.

The influence of the sequence of floods with a different probability on the scour development in time was examined according to three scenarios (Fig.2). The left scheme of Figure 2 shows three floods of the same probability. The scour starts when the floodplain is flooded and increases rapidly. Because of the scour hole developed, in the second flood, the scour process starts at the step of hydrograph when $V_{lt\ II} \geq \beta V_{0t\ II}$ and has less duration, while for the third flood the velocities change due to the scour developed after the two previous floods, and it begins at $V_{lt\ III} \geq \beta V_{0t\ III}$ (Fig.6, curve 1).

The middle scheme of Figure 2 shows the sequence of multiple floods where the high flood was followed by two lower floods. As seen from Fig.6 (curve 2), during the first flood, the scour depth develops and remains the same till the next flood. The local velocity V_{lt} reduces [Eq.(6)] but the critical velocity V_{0t} increases [Eq.(7)] because of the scour depth developed during the previous flood. In the next flood, the capacity of the flow is not sufficient to remove sediments out of the scour hole, and V_{lt} is less than βV_{0t}. In the second and third floods, the scour depth remains the same, as after the first flood.
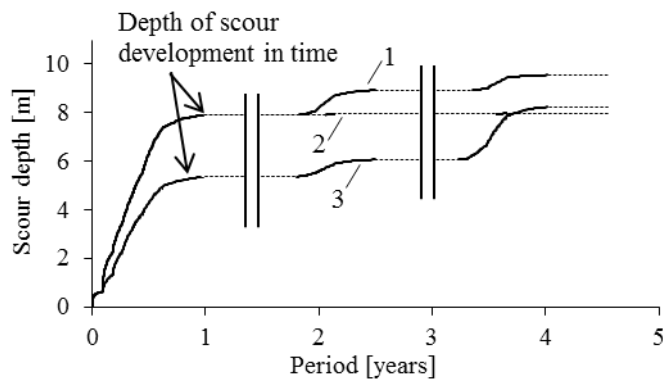
Fig. 6)   Scour development with time for floods of different sequences

The third scheme of multiple floods sequence presented scenario when two floods with a return period of 25 years are followed by the flood with a return period of 100 years. The scour depth develops during the first and the second floods; in the third flood, the scour starts at the step of hydrograph when $V_{lt} \geq \beta V_{0t}$ and develops rapidly due to the increased discharge of the flow (Fig.6, curve 3).

5   CONCLUSIONS

Water flow in rivers during floods strongly impact transport system infrastructure- roads, bridges, dams, etc. Frequency and intensity of flood events with high water levels and considerable discharges becomes more frequent and increases the loads on engineering structures in rivers and at the same time the possibility to be damaged. The stability of intakes, piers, abutments, guide banks and spur dikes in floods depends on the depth and dimensions of the scour hole at foundations.

A computer modelling of the scour process was performed, and the influence of multiple floods with different probability, duration, frequency, and sequence on the scour depth at the abutments was determined. The time-dependant scour development was found similar for all calculations, namely the rapid development at the start of the scour process was followed by its gradual reduction with time. It was found that, the scour development depends on the flow hydraulics, the river-bed parameters, the multiple floods probability, frequency, sequence and duration. At the flood peak, a scour hole is usually formed. Although the scour process can be

continued further, it stops, because the flood is time-restricted. The scour time is always less than the flood duration. At the next flood of the same probability, the scour process does not start when the floodplain is flooded, but at another time step, closer to the flood peak. This happens because of the scour hole developed in the previous flood, which reduces local flow velocity and flow capacity to remove sediments. The duration of the scour process at the second and forthcoming floods is less than at the previous floods. The scour hole depth, width and volume increase from flood to flood.

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IMPROVING THE MANAGEMENT OF RAPID SAND FILTRATION PROCESS TROUGH MODELING

Suvada Jusic[1]

Abstract

In usual practice, management of the work of rapid sand filters, as facility of DWTP (Drinking Water Treatment Plant), mainly depends on experience, training and conscience of operators from plant. Very often it is usual practice where they do not pay much attention to possible improvements and savings. The appropriate changes of operational parameters lead to more efficient management and means optimization of the filter. In practice, the possibilities of positive effects of operational parameters are not sufficiently exploited. The aim of this paper is to show how efficiently manage these parameters. This means less reliance on operator experience. Application of modeling is a challenge and a way to improve management of water treatment process. The paper defines all the modeling parameters (Stimela environment of modeling) of conventional rapid sand filtration, with detailed analysis of operational and output / control parameters of this process. It is shown effective application of the filtration modeling through examples of two PWTP from BiH. By appropriate management/changes in input parameters may lead to improvements in the management of the process in the way of cost reduction, better use of energy and chemicals and reduction of emissions on the environment.

Key words

Management, modeling, operational parameters, rapid sand filtration.

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1 INTRODUCTION

This paper seeks to show how the application of mathematical modeling of water treatment process can contribute to the management effectiveness of the Drinking Water Treatment Plant (DWTP). Access to the current method of the plant control is common practice (experience of employed operators) or, at best, experimental methods (pilot studies). Modeling is a challenge to manage, without conducting a number of costly experimental or pilot studies, and without heavy reliance on experience. Using the modeling capabilities, the goal is to ensure water quality in accordance with standards of drinking water quality (safe water supply), and thereby minimize operational costs and negative impact on the environment (e.g., to minimize losses of water to wash the filters, the consumption of chemicals, energy, etc). Finally, the introduction of modeling is supposed to mean the possibility of more efficient water treatment processes.

The paper discusses the process of rapid sand filtration, and its modeling and control. Consideration and definition of the process itself is, in fact, definition of its parameters.

2 PARAMETERS OF RAPID SAND FILTRATION PROCESS

Table 1 provides an overview of filtration process parameters on conventional rapid sand filters. Specifically, these are the parameters of modeling the process of filtration, which are needed to be defined within the Stimela [1]. The Stimela is modeling environment, intended to support the water treatment processes [2]. It is developed at the TU (Technical University) Delft in Netherlands. These parameters can be grouped into input, operational/manipulative and output/control parameters [3]. Below are briefly explained these parameters, which define the filtration process.

Tab. 1) Rapid sand filters – Overview of relevant parameters for modeling [4]

Parameters of Filtration		
Input	Design parameters	filter surface area, filtration rate, filter bed height, number of bed layers, water level above the filter bed , filter porosity, grain size
	Disturbance parameters	water flow, the concentration of pollution (suspended solids, turbidity), temperature
Operational or manipulative parameters		filtration cycle time / filter run time, backwashing time, start time for backwashing
Output – Control parameters		concentration of filtered water pollution (suspended solids i.e. turbidity), disposition of pressures in the fill (pressure losses)
Calibration parameters		Lambda – coefficient of filtration, clogging constant, massdensity of the flocs, number of completely mixed reactors

The input design parameters determine the process physically and are defined in the project documentation, based on project criteria. These project criteria were determined based on experience or experimental or pilot studies. Modeling also provides the ability to define the project criteria or parameters. In the plant already built the input design parameters generally cannot be changed. Any modifications are possible in the reconstruction of some facility, such as changing the filter fills.

Disturbance parameters affect the effectiveness (results) of the process. They are the function of the quantity and the quality of unfiltered or raw water. These parameters affect the

operation of the plant and cannot be controlled or at least not easily. These are quality parameters of unfiltered water - the concentration of various parameters, temperature and quantity parameters – flows.

Manipulative / operational parameters are changed when the disturbance parameters negatively affect the control parameters in order to maintain the control parameters in the plant in the defined limits (prescribed by the drinking water guidelines, for example). Modeling provides an opportunity for appropriate changes to operational parameters with the aim of more adequate management and therefore optimizing the process. This paper discusses the opportunities and applications of modeling the process of rapid filtration in this direction.

Features and operation of the filters, i.e. the quality of filtered water (filtrate), or the mode quality of filters are generally defined by *control parameters*, namely: the concentration of pollution particles (mainly of suspended and colloidal) and pressure losses through the filter filling.

When modeling, it should also define the *calibration parameters*, which are determined by the characteristics of a particular plant or operation. Calibration or testing of models is performed experimentally by measuring the corresponding data on the pilot or the actual station. Some of the calibration parameters, for the filtration process, are listed in Table 1.

3   MANAGEMENT OF FILTER OPERATION

Management of filter operation is usually done by maintaining a constant level, constant speed of filtration or decreasing speed of filtration [5]. In practice, washing, or regulating mode of filtration are caused by one or more of the following factors:

- Pressure losses – if losses increase, water level rises automatically above the filter filling, which initiates the need for washing.
- Turbidity – if the filtrate turbidity starts to increase, this indicates that the impurities are retained in the filter filling, again caught by water flow and carried away through the filling into the filtrate. This of course refers to the immediate washing of filters.
- Time – many plants wash filters using fixed schedule, adapted to the characteristics of water, which is treated (for example every 24 hours).
- Flow – some plants determine the water quantity that should be filtered between two washes.

The time to reach the limit values of control parameters of turbidity (t_1) and the pressure drop (t_2) depend on most of the mode of filters (filtration rate, filtration cycle time, ...), but also the size and nature of the filter fill, and the concentration, size and nature of particles in unfiltered water. For optimal operation of the filter, it is necessary to adjust adequately these two periods of time (t_1 and t_2). This optimization means actually finding an optimum filtration cycle time, or time period of operation between two washings ($t_{opt.}$). Figure 1 presents the dependence of control parameters through two cycles of filtration. For the most economically designed filter there should be that is $t_{opt.} = t_1 = t_2$. However, for practical reasons, it is important that the maximum value of pressure drop is reached in a time t_2 shorter than time t_1, corresponding to the breakthrough of filtrates [6]. Precisely, with an appropriate modification of operational parameters, it is possible to satisfy this condition and find the optimal filtration cycle, or an optimal time of filtration cycle (t_{opt}).
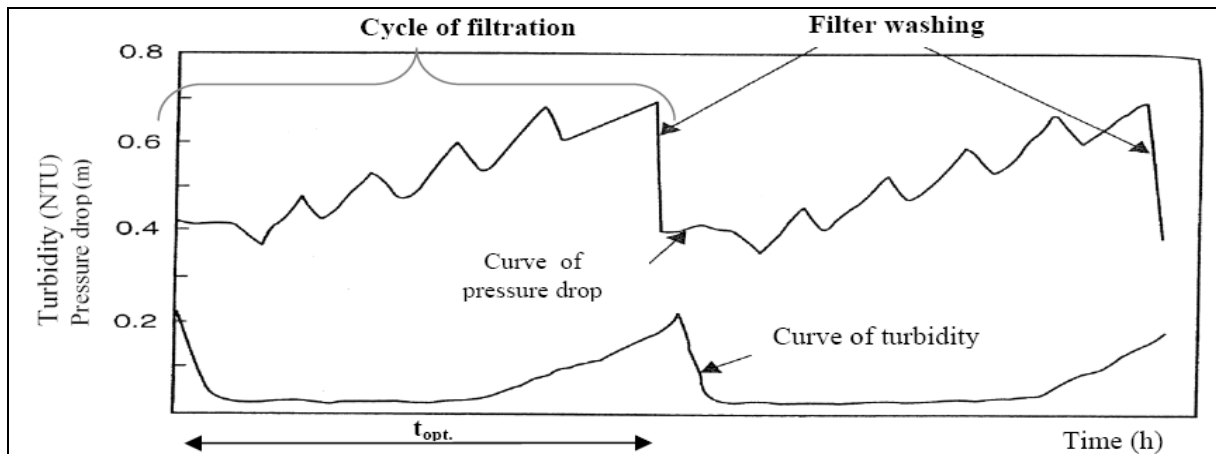
Fig. 1) A typical diagram of the dependence of filtered water turbidity and pressure losses in time – two cycles of filtration [6]

Management of filter operation is subordinated to the required quality of the filtrates. In achieving this quality, affect the level of prior preparation of water (via input disturbance parameters), as well as operating mode i.e. cleaning of filters. The management of the filter mode is affected by the operational parameters, especially by the filtration cycle time and backwashing time (Table 1). Basic benchmark/indicator for possible changes and corrections of input and operational parameters are the output, i.e. control parameters. If they are not within prescribed limits (drinking water guidelines), it approaches to the appropriate corrections, or changes in operational parameters. Operational parameters allow an active control and thereby optimization of filtration, because they can be changed [7]. In practice, in the plant operation, the possibilities of positive effects of operational parameters are insufficiently utilized and largely depend on experience, training and diligence of operators. Precisely the modeling provides the possibility of more efficient use, or changes of these parameters.

4 THE MANAGEMENT OF RAPID SAND FILTRATION PROCESS THROUGH MODELING

The application of a model assumes the knowledge of this model, then the characteristics of the process, and disposal with the appropriate database, i.e. parameters of the process from that facility [4]. Database of filtration modeling in the Stimela environment means definition of input and operational/manipulative parameters, and the understanding and evaluation of calibration parameters defined according to Table 1. Certainly, database includes defining, collecting and analyzing the output control parameters for testing the model. Only after the steps performed of calibration and validation (testing) we can approach to more effective application of the model. To sum up, in order to efficiently use of modeling, for example to improve the management process, it is necessary previously to:

- define the basic characteristics of the plant, or the process,
- define database for modeling,
- test the model (perform calibration and verification),
- discuss the results of modeling for the purpose of effective use of the model.

The issue of filtration process, which is defined by modeling, is primarily focused on detailed consideration of output parameters. When modeling or simulating the process of filtration, the output control parameters are shown mainly graphically, i.e. in diagrams (graphical output)

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and a lot of attention is directed towards the clearer visualization of output parameters [2]. For example, the results of simulations in the model, double layer filter of the Stimela environment, provide graphical representation of output parameters (Figure 2), and the graphical representation of changes in concentration of particulate pollutants (suspended solids) of filtrates and pressure drop in time (Figure 2, left) and graphical representation of changes in pressures at a depth of filter filling: Lindquist's diagram (Figure 2, right) [6].
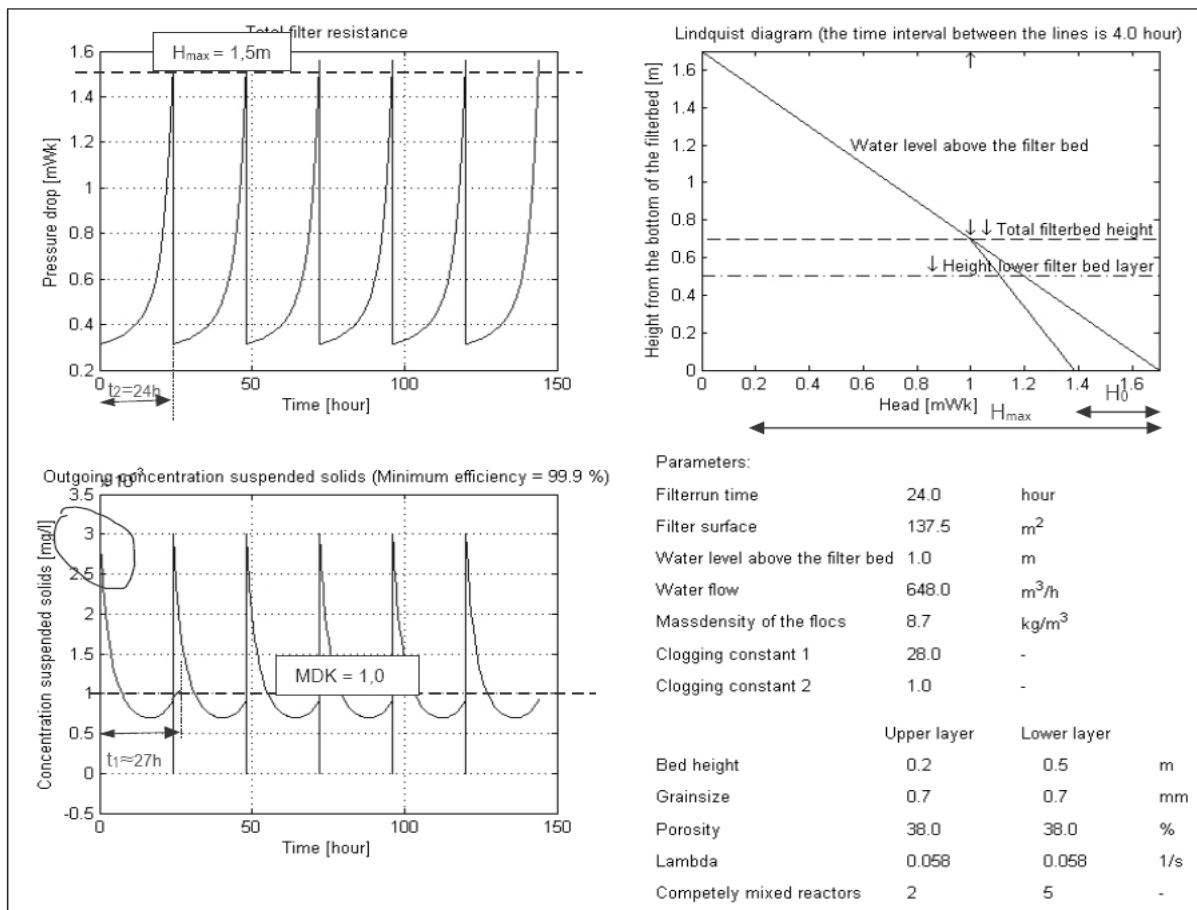
Fig. 2) Graphical presentation of output results of the calibrated model (I type of the fill)

Discussion of the modeling results assumes a good understanding of this graph, in order to effectively implement the model to meet the limit values of control parameters (maximum concentrations defined by the drinking water guidelines, Hmax - maximal loss of pressure, t2 < t1).

Table 2 shows the legality of impacts of the change (increase or decrease) in the value of operational parameters on the behavior of output results and efficiency of the model. The analysis of Table 2 shows that increasing the filtration cycle time, with the invariance of all other parameters of calibrated model, managed to achieve a significant increase in pressure loss in the fill (vacuum phenomenon), and the turbidity of filtered water also increases. On the other hand, backwashing time reduction causes an increase in pressure drop in the fill, and the filtrate turbidity increase, i.e. pollution concentrations.

Table 3 shows the effect of changes in the characteristics of different types of fill, as the input design parameters, on calibration, operational and control parameters of the filtration process.

Tab. 2) Impact of changes in operational parameters on the behavior of the model output results [6]

Operational parameters		Output / control parameters		Comment:
		Pressure drop	Concentration of water pollution	
Filtration cycle time (h)	↗	↗	↗	significant increase of pressure drop
	↘	↘	↘	-
Backwashing time (min)	↗	↘	-	concentration without changing
	↘	↗	↗	significant increase of pressure drop

With the analysis of Table 3 it can be seen that, for example, reducing the values of the input design parameters (related to the characteristics of the fill) means also reduction in filtration cycle time, as well as operational parameter. This is logical given that the fill of finer grain size, low porosity and level causes faster clogging of the surface fill layer, and thus the need for more frequent washing of the fill. Fill of larger grain size, higher porosity and level allows greater use of fill per a depth and therefore longer cycle time, i.e. longer filtration cycle time.

Tab. 3) Impact of changes in input parameters on other model parameters [6]

Parameters:		Input - Design			Calibration				Opera-tional	Output - Control			
										simulation values		limit values	
		Filter bed height (m)	Grain size (mm)	Filter porosity (%)	Lambda (1/s)	Clogging constant (-)	Massdensity of the flocs (kg/m³)	Number of completely mixed reactors (-)	filtration cycle time (h)	Pressure drop (m)	Turbidity (NTU)	Pressure drop (m)	Turbidity (NTU)
Direction of change		↘	↘	↘	↗	↗	↘	↘	↘	↘	↘	const	const

Table 3 shows the effect of changes in the characteristics of different types of fill, as the input design parameters, on calibration, operational and control parameters of the filtration process. With the analysis of Table 3 it can be seen that, for example, reducing the values of the input design parameters (related to the characteristics of the fill) means also reduction in filtration cycle time, as well as operational parameter. This is logical given that the fill of finer grain size, low porosity and level causes faster clogging of the surface fill layer, and thus the need for more frequent washing of the fill. Fill of larger grain size, higher porosity and level allows greater use of fill per a depth and therefore longer cycle time, i.e. longer filtration cycle time.

Up to previous laws (Table 2 and Table 3) it has come through the application of the filtration modeling on examples of two plants (DWTP) in BiH. In fact, a series of simulations were performed and it has come to different results or certain conclusions. The following section briefly presents examples of these two modeling applications.

5 EXAMPLES OF IMPROVING THE FILTRATION MANAGEMENT THROUGH MODELING

Application of the model (from the Stimela environment) was conducted in two plants (DWTP), which use the conventional rapid sand filters - "Crkvice" in Zenica and "Tilave" in Sarajevo, BiH [6]. This chapter provides a summary of the results of effective application of filtration modeling in the direction of more efficient operations of filters through optimizing the filtration cycle time (operational parameter) and optimizing the filter fill type (the input design parameters). Effective application of the model assumed the implementation of steps listed at the beginning of Chapter 4, i.e. pre-defining characteristic of these plants, databases, testing models and after that effective use of the model. As analyzed in Chapter 3, optimizing the filtration cycle time means actually finding the optimal time period of operation between two washing (topt.). So, for example, in order that the filter performs optimally, it is important that the pressure drop Hmax reached in time t2 equal to or slightly shorter than the time t1, which corresponds to the breakthrough of the filtrates (Figure 1, Chapter 3). This rule is used when applying modeling of filtration at the plants "Crkvice" and "Tilave." Of course, the other, previously mentioned limitations have been used (for example, regarding the time of simulation of models, water quality guidelines, etc.)

Problems, related to the filtration at DWTP "Crkvice", are the lack of adequate regulation of the filter and insufficient quantity of water for washing. This directs the course of modeling application on the analysis of changes in operational parameters related to washing of filters and, in this regard, the ability to efficiently control the filter (filtration extension cycle, reducing the required quantity of water for washing etc). In applying the model at DWTP "Crkvice" it is defined the optimal value of filtration cycle time, for different values of input turbidity. Specifically, it was shown that the existing filtration cycle time (common practice - 24 hours) may be extended. More optimum filtration means, among other things, longer duration of filtration cycle time, which means less water consumption for washing, less consumption of chemicals, less consumption of electricity for water pumping, for example, reduced production of waste water/wash water...

The issue of filtration at PWTP "Tilave" is related to the old, worn and battered fill, and its inappropriate height. This directs the course of application of the filtration model towards finding optimal characteristics of the fill, i.e. the optimal input design parameters, related to this choice and the selection of optimal operational parameters. In order to select the optimal type of fill for the existing conditions at DWTP "Tilava" it has been taken into account different criteria and defined objectives to meet those criteria. The criteria of economy, simplicity were used, i.e. maximum use of existing plant capacity, and modern criteria in this area (for example, higher speeds of filtration, criteria of higher surface load of filters, extending filtration cycle time, thus reduction of quantity of water for washing). Discussing the modeling results for different types of fills, taking into account the abovementioned criteria, it was selected a fill, which largely meets the set criteria. The proposed fill allows also the retention of existing structural feature of the building and equipment (for example, the existing dimensions and position of channels for washing may be retained).

6 CONCLUSION

Appropriate changes in operational and input design parameters allow more efficient use of existing capacity - facilities, equipment (pumps, for example), the wash water, electricity, chemicals (coagulants), etc. The filtration operation costs and environmental impact are

determined, among other things, by the frequency of washing and by type of filter fill. Using modeling it is possible rapid and inexpensive analysis of large number of alternatives in a way that by changing of operational or design input data of the water treatment process follows the impact on output/control parameters. In this way, it is possible by modeling select appropriate type of filter fill bed, and appropriate operational parameters (filtration cycle time, for example). Also, modeling i.e. simulation of the impact of such changes, for example the operational parameters on the output parameters can support the operator in making decisions in the management of plant operations. In addition, during the application of modeling it is proved educational effect, given the possibility to provide a better understanding of the process, increasing insight into how different parameters affect the process. The aim is, by varying values of operational or input design parameters to understand how these parameters influence the output e.g. the turbidity and pressure drop in case of filtration process.

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ERLANG DISTRIBUTION FOR THE WATER ROBOT

Vladimir Križaić[1]

Abstract

By means of studying, recording and analysis of the on—the-site data related to the functioning of Conject robot used for the maintenance of civil engineering constructions, the distribution of the functioning of the robot as related to the distribution of construction workers' labour was found.

By means of the graphic interpretation of the obtained data, The Erlang distribution of the functioning of the robot was found. The depending days can in turn be used for the purpose of defining novelties in standardisation in the realm of construction business, especially when the new technologies-namely robotics- are implied..

Key words

Erlang distribution, model standardisation norm, robot, standardisation, vectoral norm.

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1   WATER AS RESOURCE – INTRODUCTION

Water is one of the main resources of life on the Earth. The very lifecycle of water in our planet shows a constant, cyclic movement and transformation of water through the three natural states of matter in both the horizontal and the vertical cycles. The vertical cycle is directed towards the sky and then back to the ground whereas the horizontal cycle is directed toward the big sea (the oceans, that is) and the rivers with the energy potential from which the man can experience benefits or disasters.

The features of water are used in various life processes. Besides its natural uses, water can as well be used in some man-designed processes by means of technological changes. Through the investigating and studying of the natural processes, scientists detect parameters that are in turn used for the new processes. As it has already been mentioned, water can have both pleasant and obliterating effects. The recent *Tsunami* is a memorable macro-energy outburst that could– if boiled down to the micro or nanotechnology - be controlled and yields significant benefits, especially in the water robots-the Conject robots.

2   CONJECT ROBOT – NEXT CHAPTER

The contemporary construction age has faced a new phase of the investment cycle after the extensive use of the reinforced concrete – the omnipresent artificial rock- in the course of the previous century. The maintenance of buildings expanded in the late 20th century due to a large-scale deterioration of the reinforced concrete structures caused by the adverse effects of human and natural factors.
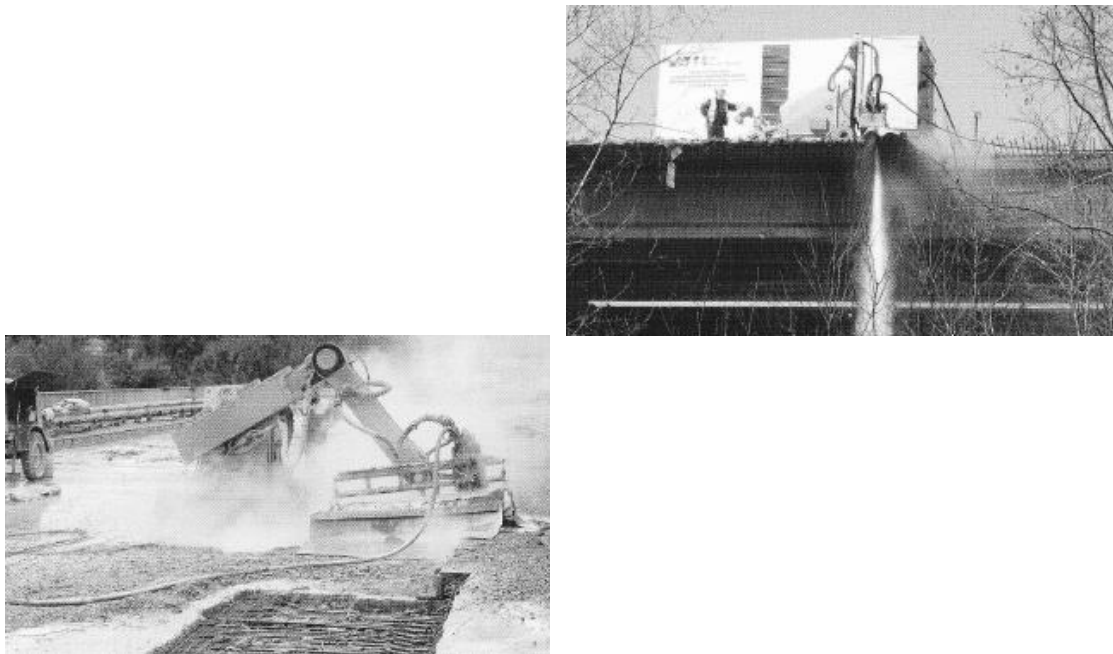
Fig. 1)   Conject robot 364 and a hydropump – the technology of hydrodemolition

To replace the worn-out reinforced concrete decks in civil engineering constructions (bridges, overpassess and viaducts), a new water robots (or Conject robots) technology has been developed. This is the technology of demolishing concrete with the water resource. If this

technology of demolition by means of robots producing a high-pressure water jet is closely observed and if the respective literature is consulted, the efficiency of the robots (developed from a Swedish innovation (figure 1) turns to amount an average of 0.35 – 1.5 m^3/h, depending on the type of the robot and the hardness of concrete.

As the machine is operated by two engineers, the overall norm amounts from 1.3 to 6h/m3. The discrete norm [1,2] of 3 h/m3 is usually used for the theoretical calculations.

3   ERLANG DISTRIBUTION FOR THE WATER ROBOT OPERATION – NEXT CHAPTER

Based on the monitoring of a typical construction site, namely the restoration of a bridge over the Sava River on the Zagreb bypass section of the motorway at Ivanja Reka, the data was used for a statistics analysis of the standards of operating for a Conject robot (figure 2). The various monitored variables of operating for Conject robots 361, 362 and 364 are shown in Table 1 [3,4,5].

361	Damjanović	Drljan	ploča 5/7	2	0,06	1,6	70	6,72	11	0,61
361	Ozimec	Vedrina	ploča 5/7	1	0,06	1,6	58	5,568	11	0,51
361	Palijan	Butorac	ploča 5/7	1	0,06	2	55	6,6	11	0,60
361	Kovačić.Z	Ivšić	ploča 5/7	1	0,06	1,5	75	6,75	11	0,61
361	Kljajić	Ciprić	ploča 5/7	2	0,06	1,6	72	6,912	11	0,63
361	Miličević	Krivokuča	ploča 5/7	2	0,06	2	34	4,08	10	0,41
361	Damjanović	Drljan	ploča 5/7	2	0,06	1,5	59	5,31	11	0,48
361	Kovačić.Z	Ivšić	ploča 5/7	1	0,06	1,5	58	5,22	10	0,52
361	Šobak	Osti	popravci	1	0,06	2	10	1,2	11	0,11
361	Glavica	Vedrina	ploča 5/7	1	0,06	1,6	66	6,336	10	0,63
361	Damjanović	Drljan	ploča 5/7	2	0,06	1,5	60	5,4	11	0,49
361	Miličević	Krivokuča	ploča 5/7	2	0,06	2	50	6	10	0,60
361	Kljajić	Peškir	ploča 5/7	2	0,06	1,6	60	5,76	11	0,52
361	Kovačić.Z	Ivšić	ploča 5/7	1	0,06	1,6	85	8,16	11	0,74
361	Glavica	Vedrina	ploča 5/7	1	0,06	1,6	80	7,68	11	0,70
361	Butorac	Osti	ploča 5/7	1	0,06	2	48	5,76	11	0,52
361	Damjanović	Drljan	ploča 5/7	2	0,06	1,6	80	7,68	9	0,85
361	Miličević	Krivokuča	ploča 5/7	2	0,06	1,6	50	4,8	11	0,44
361	Kljajić	Ciprić	ploča 5/7	2	0,06	2	74	8,88	12	0,74
361	Palijan	Butorac	ploča 5/7	1	0,06	2	51	6,12	10	0,61
361	Ozimec	Ivšić	ploča 5/7	1	0,06	1,8	54	5,184	11	0,47

Fig. 2)   Data obtained from monitoring the variables of Conject robots operation

Fig. 3)   Conject robots in work

When the given database is sorted in accordance with the given variables, it turns out that the efficiency depends on the depth of hydrodemolition that in turn depends on the sort of concrete. The density of the efficiency frequency is plausibly shown by means of the Erlang distribution that stemmed from the binomial limited distribution, i.e. from the Poisson distribution [6]. For the purposes of performing calculations and planning, the mathematical expectation or arithmetic mean or –technically speaking- the weight point of The Erlang

distribution will suffice to determine the average robot efficiency. The mathematical expectation of the continuous The Erlang curve (figure 3) is larger than the discrete distribution as the constant line fills the blank spaces of the discrete distribution (1).

$$E(y_x) = \int_{-\infty}^{\infty} x(y_x)dx > \sum_i \frac{x_i y_i}{\sum_i y_i} \tag{1}$$

The expectation of the Erlang distribution is known, i.e. (2)

$$E(y_x) = \frac{k+1}{\lambda}; y_x = \lambda \frac{(\lambda x)^k}{k!} e^{-\lambda x} \tag{2}$$
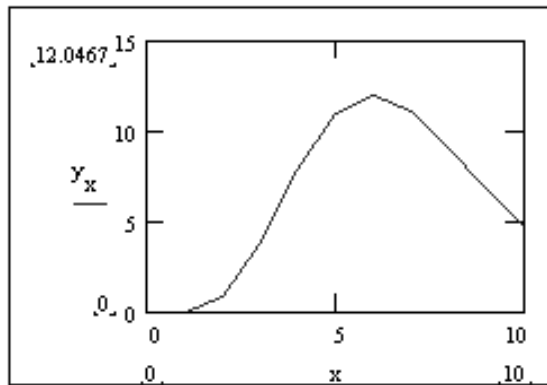
Fig. 4)   The Erlang distribution for the monitored one month period of works at the above mentioned bridge

By means of a detailed monitoring of the operation of the robot and the previous and the final tasks, it is possible to define parameters and variables on which the given distribution depends or the efficiency (working standard) of the water robot, i.e. their functional dependency can be expressed. In this way, the efficiency and the standard nearly match; however, some more precise models of hydrodemolition can be defined as well.

4   VECTORAL NORM – CONCLUSION

By means of discovering and modelling the functional dependencies of a certain type of work, a constant process of modernization and standardization of norm is started. A further input of data into the construction site database and the processing of the data lead to the optimal results and the contemporary processing is already optimal one. In the same manner as for the temporal component of the operating resource, the functional dependencies can as well be modelled for the constructors' equations or engineering or other scientific achievements of the equation expressing the material or engineering and transportation requirements of the resource. When the static standardization is teamed with the structural programming that is a crucial support to the given modelling, the static standardization turns into the dynamic standardization [7,8,9,10], i.e. into the vectoral norm or efficiency.

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SOIL WATER EROSION DEGREES IN BANJA LUKA AREA

Mihajlo Markovic[1], Milana Misic[2], Boris Markovic[3], Hamid Custovic[4]

Abstract

Soil water erosion as one of the main causes of land degradation on the whole territory of Bosnia and Herzegovina is also a serious problem present in Banja Luka area. Negative soil water erosion effects are expressed in decline of soil quality related to agricultural productivity as well as in the risk for the environment, especially water contamination. The qualitative measurement of soil water erosion degrees in Banja Luka area has been assessed by using field study method. According to the assessment criteria used soil water erosion in Banja Luka area grouped into seven degrees. The obtained degrees of soil water erosion are shown in table, graphically as well as on map, using GIS method.

Key words

Banja Luka, degree**,** soil erosion.

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1   INTRODUCTION

Soil is one of the most threatened environmental resources today. Activities aimed at the protection of soil in the world, and especially in our country, are at serious odds with that fact. Soil erosion caused by water as one of the main causes of land degradation on the whole territory of Bosnia and Herzegovina [1] is also a serious problem present in Banja Luka area. It is one of the most dangerous, very complex, and in our country not enough studied the process of soil degradation. Soil erosion by water is a widespread problem throughout Europe [2].

Water erosion can be caused by climate, relief, geological substrate, soil, vegetation and human being. Soil water erosion has a lot of negative effects, which are expressed in: removal of topsoil, sometimes and subsoil, reduction levels or loss of soil organic matter, breakdown of soil structure, decrease rooting depth, which decreases the amount of water, air, and nutrients available to plants, loss of nutrients and decline of soil quality related to agricultural productivity as well as in the risk for the environment, especially water contamination. Nutrients removed by erosion are no longer available to support plant growth onsite, but can accumulate in water, where such problems as algal blooms and eutrophication may occur. Deposition of eroded materials can obstruct roadways and fill drainage channels. Sediment can damage fish habitat and degrade water quality in streams, rivers, and lakes. This creates a less favourable environment for plant growth. Knowledge of the actual size and importance of this problem in general, of a later date, so this issue is still on the sidelines of professional interests, and especially the general public in our country.

Rational management of natural resources, including soil, is a fundamental and undeniable prerequisite for the survival and development of modern society, which relies on renewable natural resources and environmentally sustainable development.

Key economy branch of sustainable development is agriculture, which is, an inseparable part of that concept, actually a prerequisite of the protection of all natural resources, especially those that are considered as conditionally renewable, such as soil.

One of the main tasks of the current agronomic and environmental science in our country is taking care of the soil as non-renewable and irreplaceable natural resource. Care of the soil should be permanently kept current as a matter of survival and sustainable economic development.

2   MATERIAL AND METHODS

2.1   Research area

Study area is the territory of Banja Luka municipality which is located in northwest part of Bosnia and Herzegovina and Republic of Srpska entity. This locality covers an area of 1239 km2.

The Banja Luka municipality has almost rectangular shape in the north-south direction. The eastern part of the area is bigger and belongs to the catchment of the Vrbas river. The western part is smaller and belongs to the catchment of Gomjenica river. Maximum distance between the north and south end points of this territory is 55 kilometres, and the western and eastern point is 40 kilometres (as shown in figure 1). The area has a temperate continental climate, with very cold winters and hot summers. The climatic conditions are often modified with

morphological characteristics of the terrain and other local factors. Average annual air temperature is 10.8oC and annual amplitude is 20.7oC (difference of average air temperatures between the coldest and hottest month). The coldest month is January, with an average air temperature of -0.2oC and the warmest month is July, with an average temperature of 20.9oC. The average annual sum of precipitation is 1049.6 mm. During the last analysis, annual rainfall ranged from 685.1 mm to 1281.2 mm. Maximum monthly average sum of rainfall is 111.8 mm, in June, while a minimum is 62.6 mm, in February.
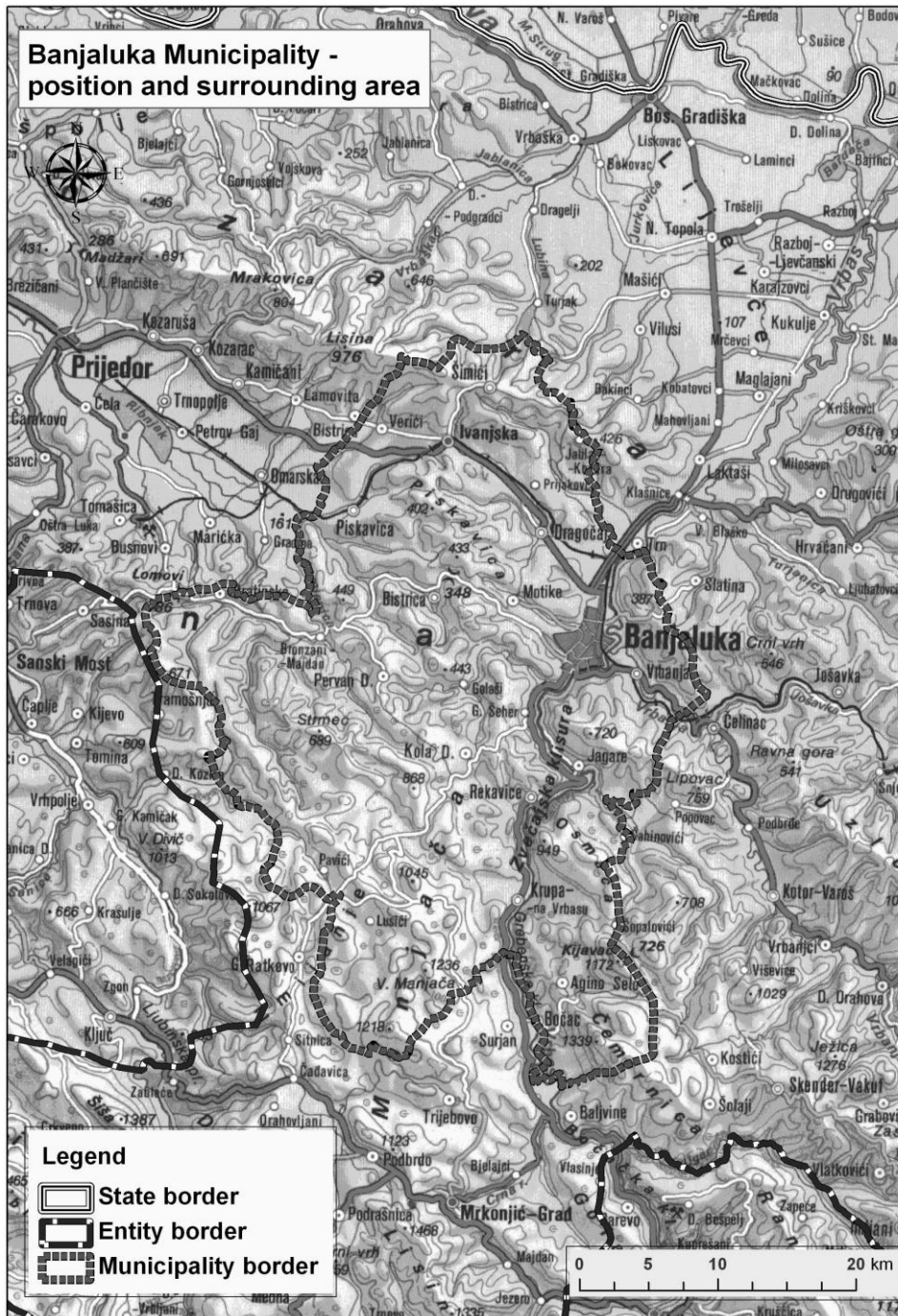
Fig. 1)   Study area

Relief of the Banja Luka municipality is presented in hypsometric zones, which are due to better visibility divided into six zones. The division is shown numerically. Hypsometric zones, corresponding area and participation in percent are shown in table 1.

Tab. 1) Hypsometric zones depending on altitude (in ha and %)

Hypsometric zones	Altitude	ha	%
1	Up to 200	14,842	11.98
2	200-400	48,842	39.40
3	400-600	37,421	30.20
4	600-800	10,846	8.75
5	1000-1200	9,107	7.35
6	1200-1399	578	0.47
	Total	123,898	100.00

According to the previous data, in table 1, it is evident that most of the studied territory is situated at the altitude between 200 and 600 m (70% of area), indicating that this is undulating and hilly area.

Slope is also one element of relief and important factor for water erosion. Slopes, corresponding area and participation in percent are shown in table 2.

Tab. 2) Slopes and corresponding area, in ha and %

Slope (%)	ha	%
Flat and very gentle (0-2)	13,257	10.7
Gentle (2-5)	12,142	9.8
Moderate (5-7)	9,912	8.0
Steep (7-15)	49,064	39.6
Very steep (15-25)	30,974	25.0
Abrupt (25-40)	8,549	6.9
Total	123,898	100.00

As shown in table 2, the biggest areas are occupied by steep (39.6%) and very steep (25.0%) slopes, or in total 64.6%, that are highly vulnerable to water erosion.

The characteristic of the Banja Luka area is the diversity of geological substrates and their age (sandstone, siltstone, clay, shale, conglomerates, breccias, serpentine, marl and marl-limestone, hard limestone, dolomite, etc.). Limestone and dolomite cover the largest area [3, 4, 5].

Soils belong to two soil orders: automorphic and hydromorphic. The automorphic soils cover 93.1% of the territory. The area is characterized with 41 cartographic soil units out of 24 are defined at the level of type or subtype and 17 units are heterogeneous, as the combination of two or more soil types (15 units are as mosaics and two as strings). Dominant soils are: calcic cambisols and dystric cambisol, then albic luvisol, stagnic luvisol, etc. [3, 5, 6, 7, 8, 9].

One of the very important factors of erosion is vegetation. Risk level of natural vegetation is lower than that of artificial vegetation. The risk level will increase in the region where large area of natural vegetation was replaced by artificial vegetation [10].

2.2 Method

The qualitative assessment of soil water erosion degrees in Banja Luka area has been used. This method of erosion estimation was adopted and used in the field study during opening the soil profiles in period of the soil map preparation of Bosnia and Herzegovina in scale 1:50000. According to this assessment criteria used soil water erosion in Banja Luka area is grouped into seven degrees, from E0 to E+ [11].

From E0 to E5 the soil water erosion is gradually increased, and E+ means soil accumulation (as shown in table 3). The obtained degrees of soil water erosion are shown in table, graphically as well as on the map, using GIS method.

3 RESULTS AND DISCUSSION

The degrees of soil water erosion at soil profile opening locations are assesed during the field research. The obtained results are shown in table 3, figure 2 and 3.

Tab. 3) Number of soil profiles according to degree of soil erosion and their participation in the Banja Luka area (in %)

Degree of erosion	Mark of erosion degree	Number of investigated soil profiles	Participation (%)
E0	No visible erosion	493	45.1
E1	Weak erosion - 0-25% removal of topsoil	306	28.0
E2	Moderate erosion - 25-75% removal of topsoil	196	17.9
E3	Strong erosion - 75-100% removal of topsoil	65	6.0
E4	Very strong erosion – topsoil removed in total and 25-75% of subsoil	17	1.6
E5	Extreme strong erosion – more than 75% of subsoil removed	6	0.6
E+	Accumulation – bringing of soil material (colluvium and alluvium)	9	0.8
Total		1092	100.0
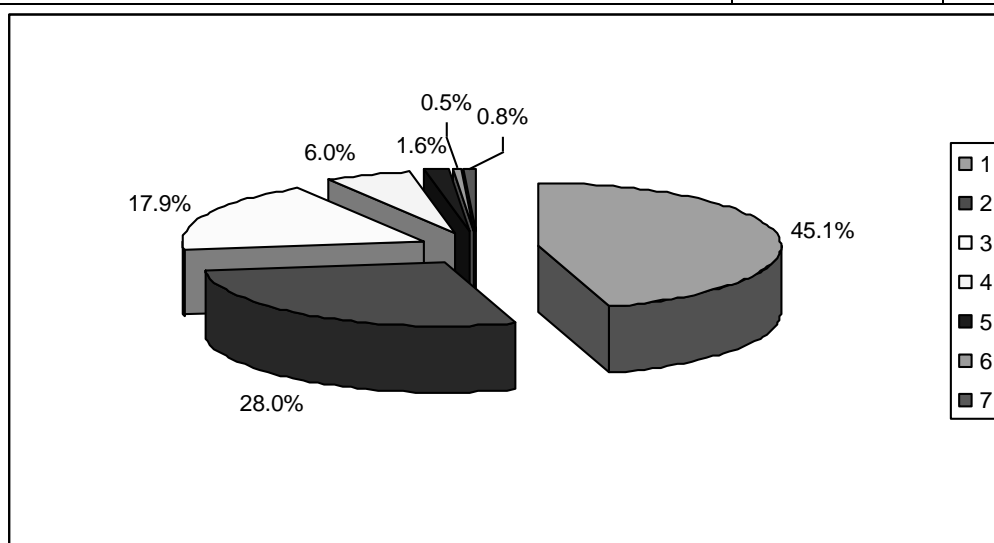
Fig. 2) Participation of soil profiles according to degree of erosion

in the Banja Luka area (in %)

575

Degrees of soil water erosion in Banja Luka municipality area

Legend

○ E_0 No visible erosion

◑ E_1 Weak erosion
0-25% removal of topsoil

◒ E_2 Moderate erosion - 25-75% removal of topsoil

◕ E_3 Strong erosion - 75-100% removal of topsoil

● E_4 Very strong erosion – topsoil removed in total and 25-75% of subsoil

◫ E_5 Extreme strong erosion – more than 75% of subsoil removed

⊖ E_+ Accumulation – bringing of soil material (colluvium and alluvium)

0 2,5 5 10 km

Fig. 3) Map of soil water erosion degrees in Banja Luka area

About 710 km2 or 57.3% of total research area is exposed to various grades of soil water erosion in this area.

The areas exposed to water erosion on the basis of the used assessment method are shown on the map (figure 3). Those areas with stronger erosion are more under agricultural land, at the

lower altitude, mainly in the north, north-west and central part of the Banja Luka municipality.

The soil erosion degrees are weaker in areas at the higher altitude which are more under forests, pastures and meadows.

Karst zone of the Banja Luka area extends south of the Banja Luka-Bronzani Majdan road and Vrbanja river and west of the Manjača mountain to the Osmače, Tisovac and Čemernica mountains, on the east bank of the Vrbas river. Very strong effects of erosion are present in this zone due to the nature of the karst and broken relief, especially on dolomite fields (as is the case in Dujakovci and between Zdenci and Gornji Pervan). The same effect is observed in many areas on hard limestone: in Krmine, Ljubačevo and zone above the river Vrbas canyon (as shown in figure 1 and 3).

Erosion processes are also present on a relatively small part of the area, northwest from Banja Luka town. This is a narrow zone of downstream of Crkvena river, on both banks, partly Petrićevac and Motike, and then Drakulić and Šargovac and also partly Zalužani, Dragočaj and Gradina (as shown in figure 3).

Beside climate, geology, soil, topography and vegetation, the human being is the most important cause of soil erosion in the studied area. This is due to an inappropriate land management, which includes: inadequate crop rotation with small number of plants in planting and very high participation of row crops, inadequate system of cultivation and inappropriate to the local agro-ecological conditions, permanent ploughing at the same depth, cultivation in the direction of inclination, frequent cultivation which causes compaction and structure deterioration, decrease in humus content, etc.

One of the main measure to protect the soil from erosion is exclusion of areas with steep slope from intensive cultivation and conversion them to grasslands and forest areas. Jankauskas et al. [12] emphasises that grass-grain crop rotations and sod-forming perennial grasses decreased soil erodibility and thus could assist both erosion control and the ecological stability of the vulnerable hilly-undulating landscape. The introduction of legumes and grasses in crop rotation is very important measure in intensive agricultural practice. Afforestation of bare land is one more measure in soil protection against erosion. So natural forest conservation and natural restoration of degraded forest will provide the biggest benefits for soil erosion control [13]. Vegetation cover could reduce runoff and erosion efficiently [14].

4   CONCLUSION

Degrees of soil water erosion have been studied using the qualitative field assessment in Banja Luka area. Although this method of erosion estimation is not modern, it was adopted from soil scientists during basic soil map preparation in our country.

According to this method soil water erosion in Banja Luka area is grouped into seven degrees, from E_0 to E_+.

From the total research area (1239 km^2) about 57.3% (or 710 km^2) is exposed to various grades of soil water erosion.

Analysis showed that from the total 1092 researched points on 45.1% of them there is no visible erosion, on 28.0% erosion is weak, on 17.9% is moderate, on 6.0% is strong, on 1.6% is very strong, on 0.6% is extreme strong and on 0.8% is present accumulation.

The results showed that agricultural land at lower altitude is under stronger erosion processes than forest land and grassland at higher altitude.

Effective erosion protection is impossible without more detailed research of the major causes of erosion in specific agro-ecological and production conditions. The most essential issue is appropriate method of erosion research, which is in use in Europe nowadays.

The recommendations are to develop the adequate and precise method of soil water erosion measurement and monitoring as well as to convert vulnerable areas from the agricultural lands to the forests and grasslands.

The preventive measures of soil protection should be used whenever it is possible.

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EQUILIBRIUM SCOUR STAGE AT THE STRAIGHT GUIDE BANKS IN PLAIN RIVERS

Roberts Neilands[1], Boriss Gjunsburgs[2], Jelena Govsha[3], Romans Neilands[4]

Abstract

The guide banks can be used to protect bridge abutments by redirecting stream flow through a bridge opening, and transfer scour away from abutment to prevent scour potential damage. But scour hole does not disappear, it is developing at the head of a straight guide bank and according to some studies can be greater in size than that at abutment. According to experimental data a streamline concentration, a local increase in flow velocity, vortex and eddy structures, flow separation, an additional flow contraction by a separation zone, and a scour hole were observed at the head of the straight guide banks. The equilibrium scour at the straight guide banks was studied and new method for equilibrium depth of scour calculation was elaborated and verified by experimental data. Hybrid modelling of scour depth development in time and experimental data were used for validation of the method. Equilibrium scour depth reflects the maximum value of the local scour hole that can be reached at the guide bank at a certain flood probability. Equilibrium scour depth should be calculated at the straight guide banks for design and extreme flood events to ensure the reliability of the structure for a lifetime.

Key words

Equilibrium, floods, local scour depth, modelling, straight guide banks.

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1   INTRODUCTION

Such bridge structures, as abutments, are exposed to the flow in floods, inducing flow contraction, reducing effective bridge opening and leading to the local scour at abutment foundations and possible failures of these structures.

The guide banks, formerly known as spur dikes, can be used in these cases to protect abutment by redirecting stream flow through a bridge opening, and removing scour away from abutments to prevent damage caused by scour. The two major enhancements guide banks bring to bridge design are (1) reduce the separation of flow at the upstream abutment face and thereby maximize the use of the total bridge waterway area, and (2) reduce the abutment local scour due to lessening turbulence at the abutment face [1], [2]. Guide banks are also used to protect highway embankments.

However, scour hole does not disappear, it is developing at the head of the straight guide bank and has a greater size than that at the abutment [3].

The straight guide banks considerably change the flow pattern. An additional contraction of the flow by a separation zone reduces the flow area at the opening of the bridge crossing and increases the backwater value, slopes, flow velocities, and non-uniformity of the flow velocities and scour at the alignment of the bridge. The length of a separation zone depends on the contraction of the flow by the bridge.

The shape, upstream and downstream length, elevation, orientation to the bridge opening, control of bridge scour, and other factors of the guide banks were studied by different authors like Rotenburg [4], [5], Latishenkov [6], [7], Apmann and Ali [8], Neill [9], Bradley [10], Richardson and Simons [11], Lagasse et al. [1], [12], [2], and others.

There are 3 main shapes of the guide banks available in literature: straight, elliptical, and straight with aligned head. According to tests and methods proposed by Gjunsburgs et al. [3], the scour depth at the straight guide banks was found greater than that at the elliptical guide banks and abutments with equal time, hydraulic, and river parameters.

The concentration of streamlines, a local increase in flow velocity, vortex and eddy structures, flow separation, an additional flow contraction by a separation zone at the alignment of bridge crossing, and the development of a scour hole were observed at the upstream head of the straight guide bank [3].

Estimation of the equilibrium scour depth at the head of guide bank is critical to successful design of the bridge opening to ensure the reliability of the whole bridge structure in flood events. Equilibrium scour depth reflects maximum value of the scour hole that can or cannot be reached at the guide bank at a certain flood probability. Equilibrium scour depth should be calculated at the straight guide banks for design and extreme flood events to ensure safety of structure for a lifetime. Thus, substantial adverse structural, economical and environmental consequences can be prevented in advance.

Based on previous studies on local scour development in time at abutments [13], [14], elliptical guide banks [15], [16], straight guide banks [3], and equilibrium scour studies at abutments [17], the equilibrium scour stage at straight guide banks in floodplain was studied and results are presented in this paper.

The method of scour depth development estimation at the straight guide banks in time (in flood events) and experimental data by Gjunsburgs et al. [3] were used in hybrid modelling of the local scour depth development and validation of new method for calculation of the equilibrium scour depth at the straight guide banks in plain rivers.

For bridge structures with guide banks, the potential scour depth development in floods with different probability, sequence, frequency, duration, and equilibrium scour depth should be evaluated at the straight guide banks to ensure safety of the engineering structure.

2   EXPERIMENTAL DATA

The tests were carried out at the Transport Research Institute (Russia) in a flume 3.5 m wide and 21 m long. The tests were carried out with rigid bed and sand bed under open flow conditions studying local flow velocity, flow contraction, flow separation, changes in water level in the vicinity of the guide bank, and clear-water scour development in time at the straight guide banks.

The experimental setup, data for the open-flow conditions, and investigation results of the local scour development in time at the straight guide banks were published earlier by Gjunsburgs et al. [3].

According to setup the dimensions of the upper part of a straight guide bank, namely length, was calculated according to Latishenkov method [7] and was found to be dependent on the flow contraction rate and the main channel width. The length of the lower part of the straight guide bank was assumed to be half of the upper part.

3   EQUILIBRIUM SCOUR DEPTH CALCULATION METHOD

The contraction of the river by bridge embankments with straight guide banks considerably alters the flow pattern. The streamlines become curved; the concentration of streamlines, increased longitudinal and transverse slopes of the water surface, a local increase in velocity, vortex and eddy structures, and the origin of a flow separation zone (between the extreme streamline and the straight guide bank) can be observed. The flow is redirected by the straight guide bank to the opposite riverbank in the case of a one-side contraction or to the centre of bridge opening in the case of a two-side contraction. The additional contraction of the flow by the separation zone significantly increases the flow velocities and the scour non-uniformity at the opening of the bridge crossing.

Approaching the bridge-crossing model, the longitudinal flow velocity along the extreme streamline reduces and, not far from the straight guide bank, becomes almost zero. At the head of the guide bank, the flow velocity is sharply increasing; the water level shows a sharp drop, and the scour hole is developing.

With development of the scour hole at the straight guide bank, the local flow velocity decreases. The discharge across the width of a scour hole also changes.

Based on the flow-continuity relation, the discharge across the width of a scour hole before and after the scour can be defined as:

$$Q_f = k_{str} \cdot Q_{sc} \tag{1}$$

where Q_f – discharge across the width of the scour hole with a plain bed, Q_{sc} – discharge of he scour hole with a scour depth h_s, and k_{str} – coefficient of changes in the discharge due to scour at the straight guide bank (Fig.1).
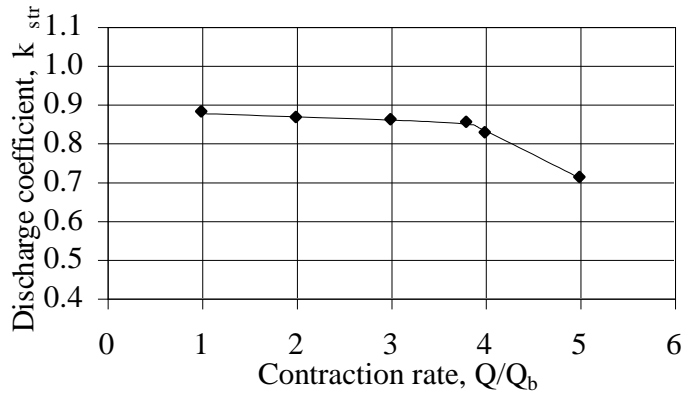
Fig. 1) Coefficient kstr versus the flow contraction rate Q/Qb

The coefficient k_{str} depends on the flow contraction rate Q/Q_b (Fig.1) according to experimental data by Gjunsburgs et al. [3], where Q – total flow discharge, and Q_b – flow discharge in the bridge opening in open-flow conditions.

The equation (1) can be written as follows, assuming cone-shaped scour hole geometry:

$$mh_s \cdot h_f V_l = k(mh_s h_f + \frac{mh_s}{2} \cdot h_s) \cdot V_{lt} \tag{2}$$

where m – slope of the scour hole wall, h_s – depth of the scour hole, h_f – water depth in floodplain, V_l – local flow velocity, and V_{lt} – local flow velocity after time t at a scour depth h_s.

It was found in tests that the local flow velocity is changing with the flow contraction rate, the length of the separation zone, and the Froude number of open-flow conditions [3]. The local velocity at the head of the straight guide bank was found according to the formula:

$$V_l = \varphi_{str} \sqrt{2g \cdot \Delta h_{str}} \tag{3}$$

where φ_{str} – velocity coefficient for the straight guide banks; g – gravitational acceleration; and Δh_{str} – maximum backwater determined by the Rotenburg and Volnov [18].

In the rigid bed conditions, the changes in the local velocity and water level were measured for different flow contraction rates, and the values of φ_{str} were found. Figure 2 shows the velocity coefficient φ_{str} as a function of the flow contraction rate Q/Q_b [3]. With increasing flow contraction rate, the velocity coefficient φ_{str} decreases.
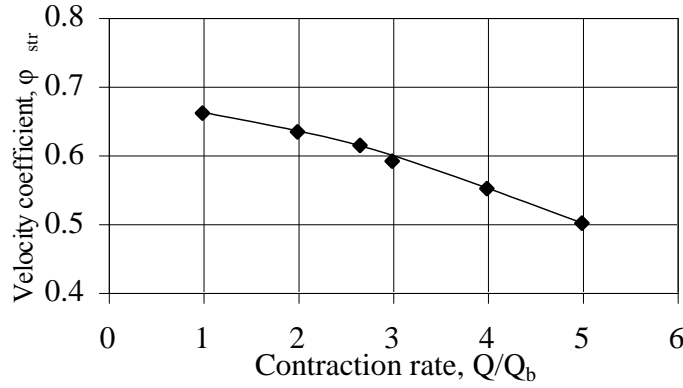
Fig. 2)   Velocity coefficient φstr versus the flow contraction rate Q/Qb

The velocity coefficient φ depends on the shape of the guide banks; at the elliptical guide banks, the value of φ_{el} was found higher than that of φ_{str} at the straight guide banks [3]. The hydraulic losses at the straight guide banks are higher than those at the elliptical guide banks, and consequently the value of φ_{str} is smaller than φ_{el}.

Maximum backwater level at the straight guide banks can be found according to Rotenburg and Volnov [18]:

$$\Delta h_{str} = \frac{V_K^2}{2g}\left[\left(\frac{Q}{Q_b}\right)^2 - 1\right] + \frac{Li_0}{2}\sqrt{\frac{Fr}{i_0}}\left[\left(\frac{Q}{Q_b}\right)^2 + 1\right] + \frac{V^2}{g} \tag{4}$$

where V_K – average flow velocity in bridge opening in open-flow conditions, Q – total discharge of the flow, Q_b – flow discharge in the bridge opening in open-flow conditions, L – river width, i_0 – river slope, Fr – Froude number, V – average flow velocity in open-flow conditions.

Local flow velocity at any depth of scour h_s then can be found from equation (2):

$$V_{lt} = \frac{V_1}{k_{str}\left(1 + \frac{h_s}{2h_f}\right)} = \frac{\varphi_{str}\sqrt{2g\Delta h_{str}}}{k_{str}\left(1 + \frac{h_s}{2h_f}\right)} \tag{5}$$

For clear-water scour initial phase the critical flow velocity of the beginning of sediment movement V_0 can be found by Studenitcnikov formula [19]:

$$V_0 = 3.6d_i^{0.25}h^{0.25} \tag{6}$$

where d_i – median grain size of the bed material, and h – average flow depth. Average flow depth over scour hole in floodplain can be expressed: $h = h_f (1 + h_s/2h_f)$.

Thereafter critical flow velocity V_{0t} at any depth of scour h_s, is given by:

$$V_{0t} = \beta \cdot V_0 \left(1 + \frac{h_s}{2h_f}\right)^{0.25}$$

(7)

where β – coefficient of reduction in the critical flow velocity due to vortex structures.

According to investigation by Rozovskij [20] on circulation of curved river flow, it was found that curved flow streamlines induces flow turbulence and vortex structures near protruding obstacle, and flow velocity, which is necessary for sediment motion, reduces because of turbulence (coefficient β depends on the Reynolds number). It was assumed that coefficient β = 1.0 for laboratory flume, and $\beta = 0.8$ for natural river conditions [20].

The local flow velocity V_{lt} is decreasing and velocity V_{0t} is increasing with development of the scour hole and increasing scour depth h_s. The clear-water scour reaches the equilibrium ($h_s = h_{equil}$) and ceases when V_{lt} becomes equal to V_{0t}. The relation between local velocity and critical velocity at which initiates sediment motion can be expressed as follows, by using Eqs. (5) and (7):

$$\frac{V_l}{k_{str}\left(1 + \frac{h_{equil}}{2h_f}\right)} = \beta V_0 \cdot \left(1 + \frac{h_{equil}}{2h_f}\right)^{0.25}$$

(8)

The equilibrium depth of scour at the straight guide banks can be determined from (8) as follows:

$$h_{equil} = 2h_f \left[\left(\frac{V_l}{k_{str}\beta V_o}\right)^{0.8} - 1\right]$$

(9)

where h_f – water depth in floodplain, V_l – local flow velocity, k_{str} – coefficient of changes in the discharge due to scour at the straight guide bank, β – coefficient of velocity V_0 reduction because of flow vortex structures, V_0 – critical flow velocity of the beginning of sediment movement.

To analyze the method, Eq. (9) is transformed to a form that shows clearly that equation contain dimensionless parameters and characteristics of the flow and riverbed:

$$h_{equil} = 2h_f \left[\left(\frac{\varphi_{str}\sqrt{2g\left\{\frac{V_K^2}{2g}\left[\left(\frac{Q}{Q_b}\right)^2 - 1\right] + \frac{Li_0}{2}\sqrt{\frac{Fr}{i_0}}\left[\left(\frac{Q}{Q_b}\right)^2 + 1\right] + \frac{V^2}{g}\right\}}}{3.6 \cdot k_{str} \cdot \beta \cdot 3.d_i^{0.25} h_f^{0.25}}\right)^{0.8} - 1\right]$$

(10)

In the general form, the relative equilibrium depth of scour is a function of the following parameters:

$$\frac{h_{equil}}{h_f} = f\left(\frac{Q}{Q_b}; P_K; P_{Kb}; \frac{Fr}{i_0}; \frac{h}{h_f}; \frac{d_i}{h_f}; H_{strat}; \frac{V_l}{k_{str}\beta V_0}; k_m; k_s; k_\alpha\right) \qquad (11)$$

where Q/Q_b – flow contraction rate, P_K – kinetic parameter of the open flow, P_{Kb} – kinetic parameter of the flow in bridge opening in open-flow conditions, Fr/i_0 – ratio of the Froude number to the river slope, h/h_f – relative flow depth, d_i/h_f – dimensionless grain size, $V_l/k_{str}\beta V_0$ – ratio of the local velocity to the critical velocity at which the sediment movement starts, k_{str} – coefficient depending on the flow contraction rate, β – coefficient of reduction in the critical velocity due to vortex structures, and according to other studies H_{strat} – stratified riverbed conditions, k_m – coefficient depending on the side-wall slope of the structure, k_s – coefficient depending on the structure shape, and k_α – coefficient depending on the angle of flow crossing.

4 COMPARISON OF CALCULATED AND EXPERIMENTAL EQUILIBRIUM SCOUR DEPTH VALUES

To verify presented calculation method of equilibrium scour depth at the straight guide banks, calculated equilibrium scour depth values were compared to experimental values and relative error was estimated.

Hybrid modelling of scour depth development in time and definition of equilibrium stage were used to estimate experimental values of equilibrium scour depth and time as follows.

4.1 Computer modelling of the scour depth development in time

The experimental data and method for estimation of scour development in floods at the straight guide banks by Gjunsburgs et al. [3] were used for computer modelling of the scour depth development in time. Method for estimation of scour development in time during floods was confirmed by experimental data of laboratory tests with duration of 7 hours. By using computer modelling, the duration of laboratory ST tests of 7 hours were prolonged until rapid scour depth development stopped and equilibrium stage could be defined (Fig.3).

According to the method by Gjunsburgs et al. [3], the flood hydrograph is divided into time intervals and time steps. The hydraulic characteristics, the backwater value, the flow contraction rate, the flow velocities V_o and V_l, the grain size in different layers of the bed, the sediment discharge, as well as the depth and width of the scour hole varies during floods. For each time step, the following parameters must be determined: h_f – water depth in the floodplain, Q/Q_b – flow contraction rate, Δh – maximum backwater, d_i – median grain size, H – height of the bed layer with d_i, and γ – specific weight of the bed material. As a result, we have flow velocities: V_{lt}, V_{0t}, parameters: A_i, D_i, N_i, N_{i-1}, and scour depth h_s at the end of time intervals and finally at the end of the time step. For the next time step, the flow and bed parameters were changed because of the flood and the scour developed in the previous time step.

In our case - the duration of each steady state simulation ST test was divided into time intervals of constant duration of 1 minute. At the end of each time interval there is a change in local flow velocity and in velocity at which the sediment movement starts, because of changes of scour hole in previous time interval. It means that with increase of scour depth at the end

of each time interval, current cross section increases, decreasing local flow velocity V_{lt}, on the other hand, velocity at which sediment movement starts V_{0t} increases because of increase of total flow depth (sum of initial flow depth and scour depth developed in previous time interval).

By using computer modelling, the number of time intervals and duration of the simulations are not restricted. The key consideration here is to determine an appropriate criterion, which defines the equilibrium stage for each of the experimental tests.

4.2   Experimental equilibrium scour depth

The equilibrium depth of scour can be reached in equilibrium time. Duration of the clear-water scour development in time can be very long because small grains of the bed material are removed continuously from scour hole. The question is when to stop and accept the equilibrium stage of scour, and which criteria to use for the estimation.

The literature studies shows that different criteria are proposed for the estimation of the equilibrium stage of the scour at abutments by Cardoso et al. [21], Grimaldi et al. [22], Coleman et al. [23], and other authors. Definition of equilibrium stage is important problem because it is directly bounded to the test duration. In general, three different criteria are proposed: (a) – in tests with different duration by measurement confirmation, (b) – of the pattern of time development of the scour depth, and (c) – estimation of scour increase in succeeding 24 hours in tests have been proposed [22].

According to Coleman et al. [23], it was accepted that if the variation of the scour depth in following 24 hours $\Delta h_{s,24h} \leq 0.05 \cdot h_f$, where h_f – flow depth in floodplain, then it is assumed that equilibrium stage is reached. Since computer modelling of scour depth development in time were used, it was possible to find equilibrium stage – equilibrium time and depth at most precise scour depth changes in time.

Computer modelling of scour depth development at straight guide banks were done for 12 ST tests (Table 1). Example of scour depth development modelling results and definition of equilibrium scour stage of test ST26 is showed in Fig.3.
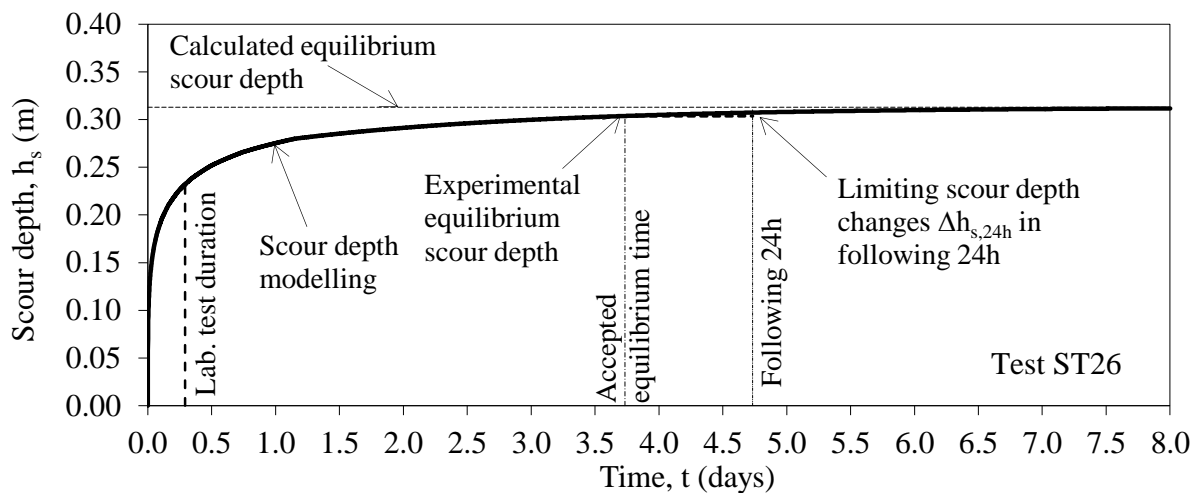
Fig. 3)   Scour depth modelling for test ST26

The development of a scour depth is inherent with a rapid scour depth development at the beginning with followed slow development stage until equilibrium stage is reached.

The computer modelling of ST tests showed that scour development did not stop at experimentally obtained equilibrium time, in fact, it continued up to several days, but with insignificant increase in scour depth. For practical purposes it was assumed that such accuracy as $\Delta h_{s,24h} = 0.05 \cdot h_f = 0.0035m$ are acceptable for given tests, because in spite of relevant increase in time, insignificant increase in scour depth was observed until scour development stops, and in nature duration of the floods is restricted.

4.3 Validation of the method

To verify suggested equilibrium depth of scour calculation method, the calculated scour depth values were compared to the experimentally obtained equilibrium scour depth values, as showed in Table 1. Results show close agreement.

A percent relative error was calculated for each of the tests:

$$\varepsilon_{equil} (\%) = \frac{\left(h_{equil.Calc} - h_{equilExp}\right)}{h_{equilExp}} \cdot 100 \qquad (10)$$

where $h_{equil.Calc}$ – equilibrium depth of scour calculated by the suggested method, and $h_{equil.Exp}$ – equilibrium depth of scour obtained experimentally.

Relative error varied from 2.9 to 6.7 percent for most part of tests, which is acceptable (Table 1). The average relative error for these tests is 3.9 percent.

Tab. 1) Comparison of the experimental and calculated data for equilibrium scour stage

Tests	Δh (cm)	Q/Qb	tequil.Exp (days)	hequil.Exp (cm)	hequil.Calc (cm)	εequil (%)
ST26	6.290	5.69	3.73	30.374	31.281	3.0
ST27	2.880	5.27	1.76	18.109	18.688	3.2
ST28	5.820	5.69	3.22	28.903	29.896	3.4
ST29	2.260	3.66	1.30	13.728	14.211	3.5
ST30	3.670	3.87	1.91	19.533	20.143	3.1
ST31	3.950	3.78	2.14	20.456	21.042	2.9
ST32	1.110	2.60	0.67	7.949	8.335	4.9
ST33	1.656	2.69	1.07	11.671	12.115	3.8
ST34	1.098	2.65	0.65	7.806	8.193	5.0
ST35	0.422	1.56	0.05	1.288	1.640	27.3
ST36	0.575	1.66	0.20	3.296	3.653	10.8
ST37	0.770	1.67	0.40	5.467	5.834	6.7

The exceptions are tests ST35 and ST36, where calculated relative error was 27.3 and 10.8 percent, respectively. It is explainable with setup of these tests - hydraulic conditions with smallest contraction rate and smallest backwater level, resulting in smallest calculated scour depth and equilibrium stage, and consequent shortest time of scour development – 0.05 and 0.20 days, respectively. Because of these conditions, the scour development was still at the end of the rapid development phase for defined experimental equilibrium stage, resulting in biggest differences of calculated and experimental equilibrium scour depth because of defined $\Delta h_{s,24h}$.

5   CONCLUSIONS

The equilibrium scour at the straight guide banks was studied and new method for equilibrium depth of scour estimation was elaborated and verified by experimental data. The equilibrium stage of a scour hole is achieved when the local flow velocity at the head of the straight guide bank calculated at the flood peak becomes equal to the velocity of the beginning of sediment movement.

To verify presented calculation method of equilibrium scour depth at the straight guide banks, calculated equilibrium scour depth values were compared to experimental values and relative error was estimated. Results are acceptable.

Theoretical analysis of the suggested method was presented and showed that relative equilibrium scour depth depends on: flow contraction rate, kinetic parameter of the open flow and flow in the bridge opening, ratio of the Froude number to the river slope, relative flow depth, dimensionless grain size, ratio of the local velocity to the critical velocity at which the sediment movement starts, stratified riverbed conditions, side-wall slope of the structure, structure shape, and angle of flow crossing.

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CONTRIBUTION TOWARDS THE COMPOSING OF HYDRAULIC SCHEMES FOR MULTIPURPOSE USE OF WATER RESOURCES

Ljupcho Petkovski[1], Stevcho Mitovski[2]

Abstract

Complex water resources systems aimed for full utilization of the available water potential are capital infrastructure systems in particular region. The development and progress of the region in high degree depends on the successful planning, construction and use of the complex water resources systems. Key subsystem of these systems is the hydraulic scheme - dam and appurtenant structures from aspect of technical and functional safety as well as due to the high investment. Therefore, composition of the hydraulic scheme as one of the first stages in the water resources systems planning bears enormous strategic burden in the water resources systems planning. The composition of hydraulic schemes depends from numerous factors that can be classified in three basic groups: (a) natural factor (topographic, geologic, hydrologic conditions), (b) hydraulic scheme type (according to the water resources type and pressure) and (c) construction and exploitation conditions (according to the possibilities for multipurpose and double use of water). Above mentioned factors are conditioning water resources systems to be treated as unique problems and therefore in the process of planning should be applied the experience based knowledge but it is also necessary exclusion of the template approach. The aim of the paper is to classify the basic assumptions at composition of hydraulic schemes during the choice of most favourable solution for dam Rechani with appurtenant structures on river Orizarska, in vicinity of Kochani, Republic of Macedonia.

Key words

Appurtenant structures, composing, dam, hydraulic scheme, water resources.

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1   INTRODUCTION

Complex hydro systems with aim - full utilization of the available water potential, are capital infrastructure systems for a certain region. The region development and advancement is in high degree dependable on the successful planning, construction and use of the complex hydro-systems. Key sub-system of these water resources systems is the dam with appurtenant structures from the aspect technical and functional safety and due to the high investment cost. Namely, dams with water reservoirs are systems with highest potential hazard for the downstream river valley and therefore they must satisfy the rigid criteria for static [1], seismic [2], seepage and hydraulic [3] safety. In the same time, verification of the functional safety of the hydro-system [4, 5, 6] or determination of degree of fulfilment of the given objectives for the water consumers from analytical aspect is far more complex - compared with other civil engineering systems. Therefore, the composition of the hydraulic scheme as one of the stages in the hydro system planning has huge strategic weight on the water resources designing. The hydraulic scheme composition depends on various factors systemized in three basic groups: (a) natural factor (topographic, geological, hydrological conditions), (b) hydraulic scheme type (according to the water resources category and pressure) and (c) condition for construction and exploitation (according to the possibilities for multipurpose and two-way use of the water). Named various factors are conditioning hydraulic schemes to be treated as unique systems and therefore during the planning should be used experience knowledge, but it is necessary exclusion of the pattern approach [7]. The aim of this paper is to systemize the basic postulates at composition of hydraulic schemes gained at choice of most favourable concept for dam Rechani with appurtenant structures on Orizarska Reka, in nearby of city Kochani, Republic of Macedonia.

2   BASIC PARAMETERS OF HYDROSYSTEM ORIZARSKA REKA

Realization of the hydro system (HS) Orizarska Reka is of vital interest for the development of municipality Kochani, Republic of Macedonia. In fact, construction of HS Orizarska Reka will be accelerant or for more dynamic development of the relatively passive middle-east region of Republic of Macedonia, Fig. 1.

Fig. 1)   Middle-east region of Republic of Macedonia and display of the project area.

The element that is making the system controllable apropos the element that enables time transformation of the water from the catchment area of Orizarska Reka is the active storage of the reservoir Rechani. By creating of the reservoir Rechani, the management with the water resources of Orizarska Reka will be improved, that will enable:

- quality water supply of the population (around 90,000 inhabitants) and industry of four municipalities that gravitate towards this region: Kochani, Vinica, Cheshinovo-Obleshevo and Zrnovci,

- irrigation with increased reliability of surfaces suitable for intensive agricultural production (around 1,500 ha), Fig. 2,

- electric energy production with two or three small hydro power plants,

- ennobling of the small water, protection form flood and development of tourism, sport and recreation.

Fig. 2)   Rise fields in nearby of city Kochani

The complex HS Orizarska Reka is composed of several sub-systems, which are independent civil engineering parts, Fig. 3. An approach for realization of the Project in several stages has been chosen in order to fulfil several criteria, such as: a) time (project realization in shortest time period), b) financial limits (actual limited financial limits for completion of the full technical documentation – investigations and design). Therefore, realization of the HS Orizarska Reka is divided in six stages, according to the following schedule:

- Stage I – access road. The access road to dam site Rechani is planned on the right side of the valley with length of 5.5 km, at which is used section of the existing paved road of 6.0 km.
- Stage II – hydraulic scheme Rechani. The hydraulic scheme is composed of dam Rechani with appurtenant structures: diversion tunnel with upstream cofferdam, spillway structure, bottom outlet, intake structure and water consumers' pipeline.
- Stage III – alimentation water supply head race. With this head race, composed of Tyrolean intake at Golema Reka, tunnel with length of 800 m and surface pipeline will enable additional input of water in reservoir Rechani from catchment area that does not gravitate towards Orizarska Reka.
- Stage IV – water supply. The water supply subsystem is composed of following structures: common near-dam type intake and common main head race channel to division point, main head race with water treatment plant for water supply of Kochani and the surrounding settlements, main head race channel with water treatment plant for water supply of Vinica and surrounding settlements.

- Stage V – energy production. The hydro energetic system is composed of following small hydro power plants (HPP): HPP 1 – reservoir hydro power plant, HPP 2 – derivation flow hydro power plant and eventual HPP 3. According to the preliminary estimations it can be expected average annual power production of 19.7 Gwh/year.
- Stage VI - irrigation. With the meliorative sub-system composed of main intake for irrigation and secondary pipelines for irrigation agricultural area of 1,500 ha can be irrigated.
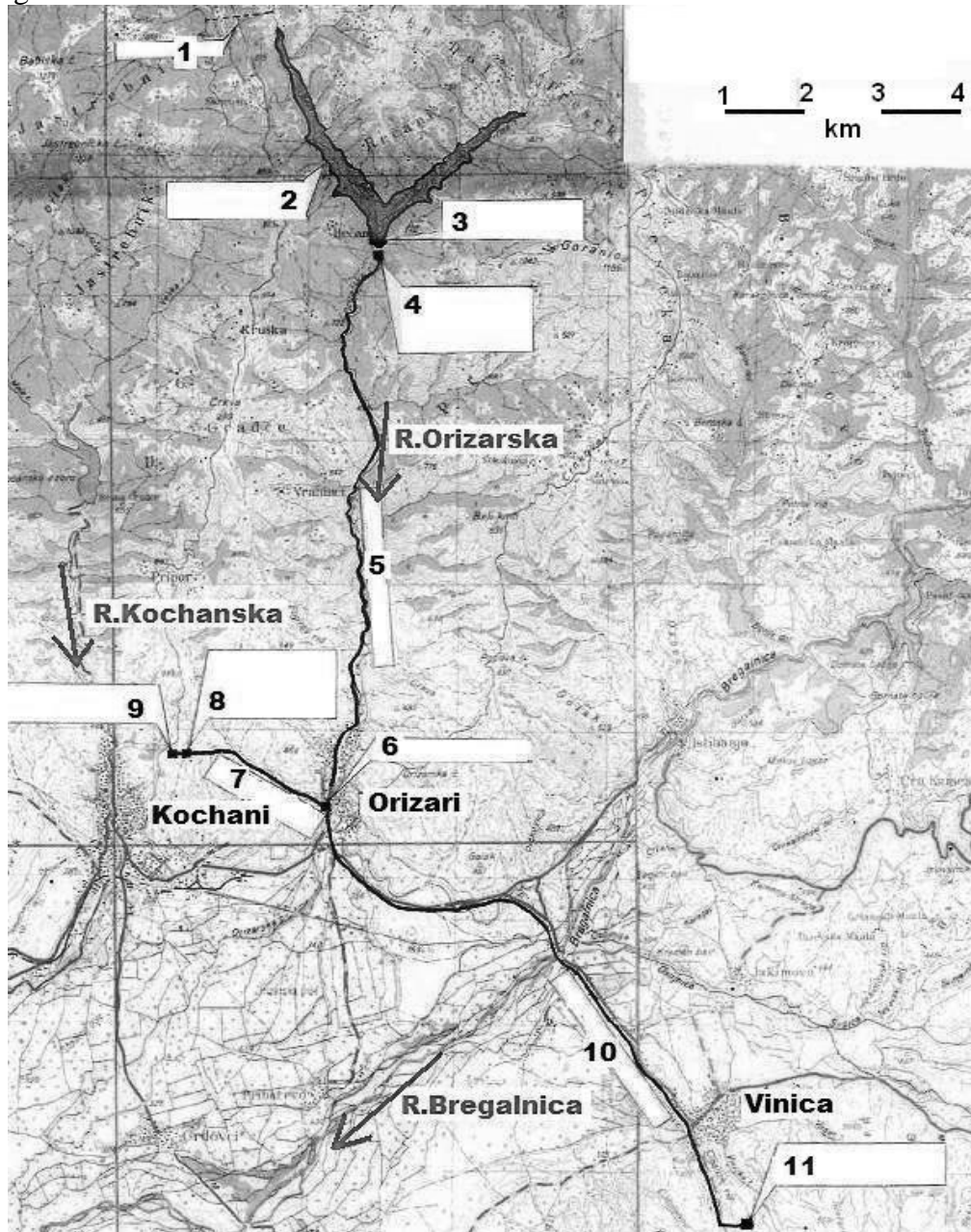
Fig. 3) Layout of HS Orizarska Reka. (1) Head race tunnel from Golema Reka, L = 800 m, (2) Reservoir Rechani, Znwl = 846 m asl, V = 23 Mm^3, (3) Dam Rechani, H = 77 m, (4) HPP 1, Qins = 2.2 m^3/s, E = 6.8 GWh/y, (5) Head race no. 1, Q = 877 l/s, L = 8.69 km, (6) Division shaft, (7) Head race no.2, Q = 667 l/s, L = 2.49 km, (8) HPP 2, Qi = 0.67 m^3/s, E = 3.46 GWh/y, (9) Water treatment plant Kochani 455.0 m asl, (10) Head race no. 3, Q = 210 l/s, L = 2.48 km, (11) Water treatment plant Vinica 515.0 m asl

Key sub-system of the complex multipurpose water resources system Orizarska Reka is hydraulic scheme Rechani. This hydraulic scheme is river type at high pressure, that should enable multipurpose and double use of the water resources. The hydraulic scheme is composed of dam Rechani, with height above terrain H = 77.0 m, with appurtenant structures: diversion tunnel, upstream cofferdam, bottom outlet and spillway structure. In accordance with the available technical documentation and the time frame of the chosen dynamics for realization of the HS Orizarska Reka, "the decision maker" has adopted following basic parameters of hydraulic scheme Rechani:

a)   normal water level 646.0 m asl,

b)   location of the dam site at around 500 m downstream of the joint of rivers Bela and Crna and

c)   dam site to be partitioned with embankment dam.

In accordance with the adopted basic parameters of hydraulic scheme Rechani was prepared Project assignment for preparation of Preliminary design for "Optimal dam type and most favourable composition of appurtenant structures". In this Project task was adopted to analyze three types of embankment dam: 1) earth fill dam with central clay core, 2) rockfill dam with asphalt diaphragm and 3) rockfill dam with facing of geomembrane. Also it was necessary to analyze two types of spillway structure by free spillway: a) shaft and b) side spillway. For the choice of dam and spillway type was adopted criteria based on "minimization of the investment" where all alternative solutions should be at same level of technical analysis and to fulfil same level of structural – static and seismic [8], seepage, hydraulic and hydrologic safety. Having in consideration the fact that dam type has influence on numerous measurable and non-measurable indicators (beside the economic valorisation), it was adopted the choice of optimal dam type [9] to be additionally checked with application of the concept of multi-criteria optimization [10].

3   APPURTENANT STRUCTURES DISPOSITION, TYPE AND PARAMETERS

For protection of the construction pit during construction, in accordance with the hydrological, geological and topographic conditions and on base on the analyzed dam types a method with river diversion from the river bed has been adopted. For inflow of the construction water is planed pair of two structures: diversion tunnel and upstream cofferdam. The upstream cofferdam has been designed as independent embankment structure, located upstream from the upstream dam toe. This choice has been made for the alternative rockfill dam with facing of geomembrane in order permanent watertight element (facing of geomembrane) not to be part of the temporary structures, independently that placing of the cofferdam outside of the dam body will increase the length of the diversion tunnel.

The topography in the zone of the dam site conditions location of the spillway structure to be on the left bank thus obtaining most favourable direction of the terminal part (for dissipation of the energy of the spillway discharge). In the same time, the topographic factor, apropos curve of the river bed in layout with convex section at the right bank, conditions location of the diversion tunnel in the right bank. In this manner is gained least length of the diversion tunnel, comfort rock layer and minimization of the sections supposed to be constructed in curve, Fig. 4.

At the dimensioning of the diversion tunnel concept of adaptation of the tunnel in service stage of HS Rechani has been adopted as intake structure and in the same time as bottom outlet [10]. By the chosen location is enabled part of the tunnel during service period to be used as bottom outlet for incident, partial or full reservoir emptying. A middle concrete plug will be constructed for that purpose and in the downstream section will be installed steel pipeline ending with bottom outlet gate.

The bottom outlet at normal exploitation of HS Rechani will be used as part of the intake structure for the primary water consumers (water supply, ecological discharge and irrigation) and for energy utilization of the water power. For that purpose, in the nearby of the entrance portal of the diversion tunnel, the diversion tunnel will be connected with water intake tower by vertical shaft.
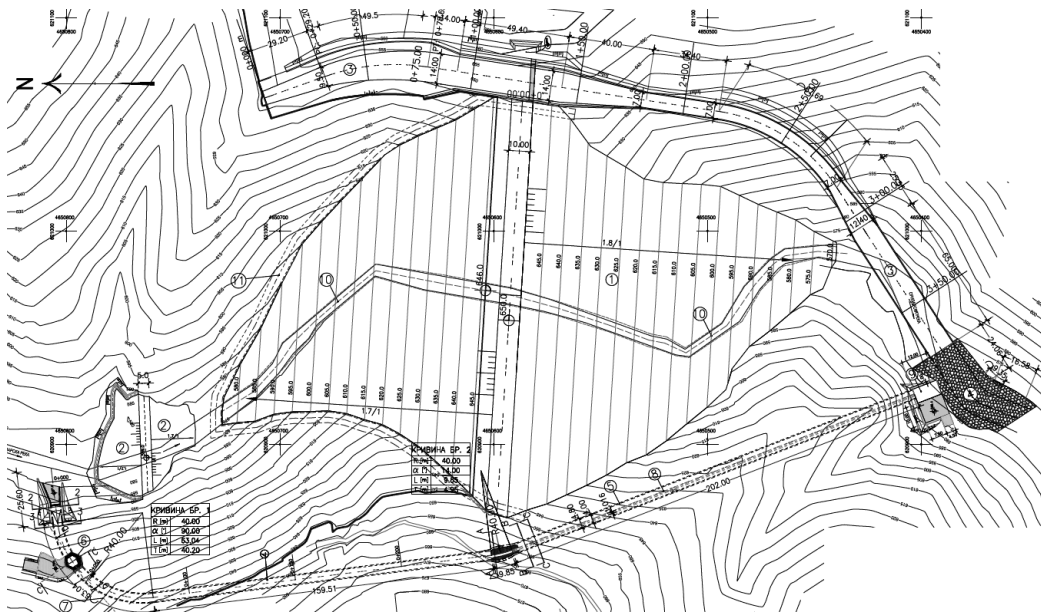
Fig. 4) Layout of hydraulic scheme Rechani at normal water level in the reservoir Znn = 646m asl (1) dam body with dam crest at 650 m asl, Hk = 80 m, (2) upstream cofferdam, crest at 589 m asl, H=12.5 m, (3) side channel of side-channel spillway, Lp = 78.7 m, chute and stilling basin at 565 m asl, Ls = 65m, (4) riseberm, Lr = 55 m, (5) diversion tunnel at 577.5 to 566 m asl, Dt = 4.0 m, Lt = 440 m, (6) intake tower at 610 m asl, Dn = 8.55 m, (7) access bridge axis, (8) steel pipeline of the bottom outlet, Dc =1.0 m, Lc = 223.8 m (9) gate house at 569.4 m asl, (10) drainage blanket, (11) grouting gallery.

The advantages of the multipurpose intake tower, in the same time serving as entrance structure of the head race structure of the future water consumers and entrance structure of the bottom outlet are:

a) intake of surface water from the minimal operating level 610.0 m asl up to maximal operating level 646.0 m asl (important for securing warmed surface water for the irrigation)

b) full closure of the inflow (in initial period of adaptation of the diversion tunnel in bottom outlet),

c) keeping of low level in the reservoir (adaptation period),

d) controlled outlet (ensuing the dynamics if first impoundment),

e) rapid drawdown of the reservoir level (incident use as bottom outlet in service period), from normal water level to dead storage,

f) tenable accessibility (during tunnel adaptation and first reservoir impounding) to the manipulating devices for gates of the intake tower at dam crest plateau 650 m asl.

At each side of the hexagon are adopted per two intake fields (Fig. 5) with total number of openings in intake tower 6×2 = 12. Height of each opening is adopted at 1.5 m that will enable water intake at twelve different levels between minimal and normal reservoir level (Fig.6). The inflow sills in the openings will be elevated at 36/12=3.0 m, apropos first at 610.0 m asl, second at 613.0 m asl up to the twelve at elevation 643.0 m asl. In this manner is enabled water intake at certain depth below the reservoir surface due to the water consumers' needs (irrigation and/or water supply).
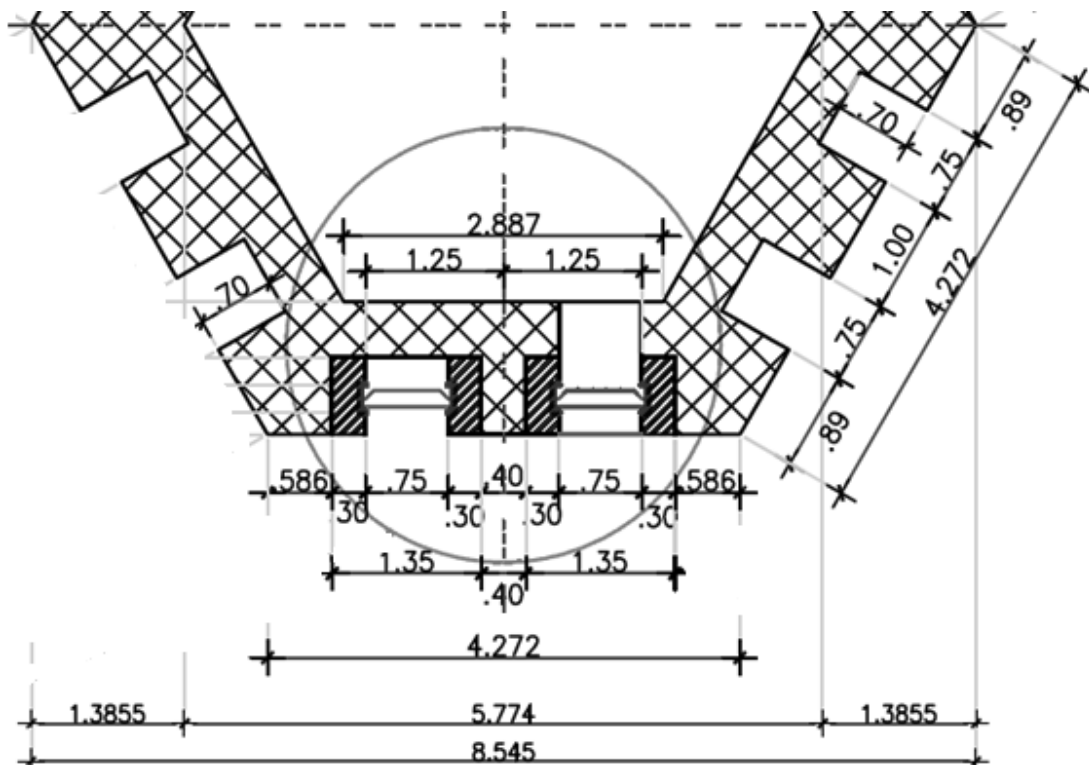
Fig. 5)   Layout of the intake tower in hexagonal shape at elevation 613.5 m asl, through field of gate no.2.

For regulation of the water consumers discharges the gates of the openings in the intake tower should be opened and closed one after another. At reservoir emptying (or rapid drawdown) the first is opened the top gate. Contrary, at reservoir impounding (or rising of the level) the bottom gate is always closed first. In case of reservoir incident emptying the intake tower would serve as entrance structure for the bottom outlet and all gates should be opened one after another. In this case we have maximal flow velocities in the entrance structure apropos this is authoritative scenario for dimensioning of the openings and grid of the openings.

After the construction of the intake tower with the concrete elements of the first stage with let 12 rectangular openings 0.75 x 1.50 m for water inflow and with elevations of the bottom edges at height of 3.0 m are installed guide elements. These guide elements are installed from elevation of erection bay in the intake tower (650.0 m asl) up to the bottom edge of all of the 12 gates. After the guide elements installation they are fixed with anchors in the concrete of

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first stage and afterwards is concreted second stage and the guide elements (left and right) for each of the 12 gates are conjugated in the intake tower body.

In continuous is displayed conceptual solution for bottom outlet gate house (Fig. 7) equipped with regulatory cone gate and overhaul gate d = 100 cm as well and fork (downstream of the overhaul gate) at angle of 60 ^{o} for service pipeline d = 75 cm plugged by flange outside of the gate house.

Fig. 6)   Scheme of field no. 1 and no. 2 (from total of 12 field) of the intake tower.

For dimensioning of the spillway structure is adopted flood with significantly small probability p = 0.01% apropos with return period T = 10,000 years. In the analysis of the retention capacity of the artificial lake is applied hydrological model through the water balance in the reservoir. In the hydraulic analysis of the spillway value of m = 0.46 is adopted for the spillway coefficient of the side-channel spillway (or shaft) and spillway length has been calculated that secures required overflow height H_p = 2.0 m. So, the necessary effective spillway length of the spillway structure is L = 78.7 m according to the criteria maximal reservoir level not to overflow over K_{max} = 648.0 m asl. Authoritative discharge for dimensioning of the spillway structure is Q_{max}^{PR} = 467.5 m^3/s apropos the retention capacity of the reservoir is rather modest around 90%.

Two types of spillway structures are analyzed – shaft and side channel spillway both in the downstream section continuing in chute and terminal parts stilling basin and riseberm. Classic structures for water flow energy dissipation are designed due to the location of the bottom outlet gate house immediately downstream. The two analyzed alternatives of the spillway structure are at same level of research and equalled regarding the technical point of view. The cost of the shaft spillway alternative is 9.6 millions €, while the side-channel spillway alternative is 4.2 millions € [11].Therefore in the next stage of the project documentation –

preparation of Basic design for dam Rechani with appurtenant structures is adopted side-channel spillway.

Fig. 7)   Layout of the bottom outlet gate house (1) regulatory gate, (4) overhaul gate, (7) axis of service pipeline d = 0.75 m, (8) axis of basic pipeline D = 1.0 m.

4   CONCLUSION

Hydraulic scheme is a group of hydraulic structures that are interconnected in the frames of the joint work of the hydro system. The hydraulic scheme configuration depends on hydraulic scheme type, on the hydro system exploitation and on the natural factor at the dam site, primarily of the topographic, hydrological and geological conditions. The hydraulic scheme planning is in the group of "heavy" structured and unique problems due to the uniqueness of the natural factor and deferent water consumer needs. At hydraulic scheme composing apropos choice of optimal configuration of dam and appurtenant structures should be excluded the pattern approach, but also to take in consideration the basic postulates of the lasting engineering practice. In fact, these principles should be treated as guidelines that if followed, will get a harmonious and proper solution of the hydraulic scheme. The guidelines taken in consideration at composing of hydraulic scheme Rechani as key sub-system of hydro system Orizarska Reka (Kochani, Republic of Macedonia) are: 1) each structure as composite part of the hydraulic scheme should be adequate on the purpose, 2) each structure with its function should enable regular service of the hydraulic scheme in total, 3) structures during the course of joint work should not interfere one another, 4) the hydraulic scheme should act as one compact set, 5) each structure should fulfil safety requirements, 6) the chosen materials should be most appropriate, 7) the economy of each structure separately and of the hydraulic scheme in total should be maximally fulfilled, 8) at the designing stage to be applied most advanced world accomplishments in the theory and practice for the appropriate structures and 9) the structures should fulfil the aesthetic condition and harmonization with the environment.

By meeting the above mentioned guidelines is disposed the most favourable configuration of the river hydraulic scheme at high pressure Rechani, assigned for several water consumers and with capacity for two way water resources exploitation.

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LANDFILL LEACHATE CHARACTERISATION AND TREATMENT WITH MEMBRANE TECHNOLOGY

Amra Serdarevic[1]

Abstract

Waste management, in most countries, is considered as an appropriate solution for community to dispose municipality solid waste on the sanitary landfill. That approach is nowadays the most common and the cheapest way to eliminate municipal solid waste (MSW). In spite of many advantages, generation of heavily polluted leachates and methane presents significant, negative impacts on environment. Year after year, the presence of landfill leachate impact on environment has forced authorities to put more and more stringent requirements for sanitary landfills. Process of transformation of existing wild dumps and open new sanitary landfills in Bosnia and Herzegovina started together with all related issues like leachate treatment or methane collection. All necessary legislation has been developed and adopted. The paper is focused on review of landfill leachate quality and treatment process with an objective to meet the required standards. Today, the use of membrane bioreactor technologies (MBR) or reverse osmosis (RO), either as a main step in a landfill leachate treatment chain or as single post-treatment step appeared to be an indispensable means of achieving purification. At the end, in the paper the example of Sarajevo sanitary landfill and results of landfill leachate treatment with applied membrane biological reactor (MBR) were briefly presented.

Key words

Landfill leachate, membrane biological reactor (MBR), membrane technology, reverse osmosis (RO), sanitary landfill.

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1   INTRODUCTION

Worldwide, disposal of solid waste varies, mostly depending on the legal framework - strategies, development of the state as well as political and economic situation in the country. Thus, solid waste disposal methods include open dump, sanitary landfill, incineration, mechanical – biological treatment, recycling, reduction, composting, etc. Sanitary landfill is the most common municipal solid waste (MSW) disposal method due to such advantages as simple disposal procedure, low cost, and landscape conversion in to green field areas after the closure procedure.

However, disposal at the sanitary landfill is characterized with some negative impact to the environment such as production of highly contaminated leachate that represents major drawback of this method [1]. The main environmental problem of sanitary landfills is the potential risk of groundwater pollution and subsequent influence on surface water quality. Leachate is formed primarily by the percolation of precipitation water (as long as the rainfall is greater than the rate of water evaporation) through an open landfill or through the cap of a completed site.

The quality of the leachate depends on the initial waste composition of the landfill and further on the biological, chemical and hydraulic state of the landfill. As long as a landfill is used, and for some years after it has been closed, the site should be supervised in regard to the issues of leachate and landfill gas..

In selection of an appropriate technology for leachate treatment, the first step should be determination of the water balance of a landfill and definition of input data of quantity and quality of the leachate. This depends on meteorological conditions (temperature, precipitation, evaporation), on the hydraulic characteristics and the initial conditions of the waste material and the years of landfill operation.

 The conditions within the landfill change with time; the character of the biological processes and the hydraulic characteristics change in the lifecycle of the landfill from aerobic to anaerobic condition, resulting in changing of water balance conditions in time as well as changes of the quality of the leachate form acid to mature phase.

The way the landfill is developed and managed also influences the quality and quantity of the leachate.

In the present paper, brief overview of leachate characterization and appropriate treatment technology are given and shortly discussed. Thereafter, situation at the sanitary landfill in Sarajevo, Bosnia and Herzegovina is presented, emphasizing the landfill leachate treatment pilot plant and testing results.

2   QUALITY AND QUANTITY OF THE LEACHATE

The leachate collection system consists of many individual components aiming to collect the leachate for treatment. The design of the leachate collection system and technology for treatment depends on the leachate quality and quantity.

The current practice of leachate collection and removal system design for landfills has limitations due to uncertainties associated with a key design parameters, leachate production rate and other specific parameters related to climate and metrological date, etc. The question

about quantities and how much leachate will be generated in a particular landfill is a difficult one and varies from landfill to landfill

Climate and particularly rainfall would have a big influence on leachate production, but site operational practices like size of the cells, technology of disposal, type of waste and moistures also has an important role. For a new landfill the only method available would be to model the landfill water balance for landfill operation phase and after closure phase. Amount of the leachate quantity for design of landfill leachate system based on this method, would require a lot of assumptions, sensitive analysis and "predictions".

Estimating the leachate quantity for an existing landfill is easier if quality leachate generation rate data is available as result of leachate measurement. It is very important to check reliability of the existing date and necessary take into account current situations and further development plans (type and amount of incoming waste, number of population, etc)

2.1 Leachate quality

The scope of quality parameters varies considerably which always makes difficulties for the choice of input parameters of the treatment plants. Also, quality indicators significantly change over time. In any case, the characteristics of new landfill leachate have lower pH, higher concentrations of organic pollution, while the older landfills generally change to a much lower ratio of BOD / COD, pH is alkaline, higher concentration of nitrates, chlorides etc.

Tab. 1) General leachate characteristics depending on the age and size of landfill [2]

Parameters - all in mg/L except pH and BOD/COD ratio	Reference							
	Urbini et al. (1999)		Tchobanoglous et al. (1993)		Robinson (1995)		Irene and Lo (1996)	
	"Young" leachate	"Mature" leachate	"Young" leachate	"Mature" leachate	"Young" leachate	"Mature" leachate	Active land-fill	Closed land-fill
	(< 2 years)	(> 6.5 years)	(< 2 years)	(>10 years)				
BOD	24000	150	2500-3000	10-20	11900	260	1600	160
COD	62000	3000	3000 - 60000	100-500	23800	1160	6610	1700
TOC	NG	NG	1500 - 20000	80-160	8000	465	1565	625
BOD/COD	0.39	0.05	0.67	0.04-0.1	0.5	0.2	0.24	0.09
NH4 -N	1400	350	10-800	20-40	790	370	1500	2300
pH	5.8	8	4.5-7.5	6.6-7.5	6.2	7.5	5.6-7.3	7.9-8.1

As an example, the BOD/COD ratios, which is a very important, will be particularly discussed. BOD/COD ratio represents the proportions of easily biodegradable organics which contain primarily a major form of carbon. The lower ratios are observed for the higher oxidation conditions (older landfills).
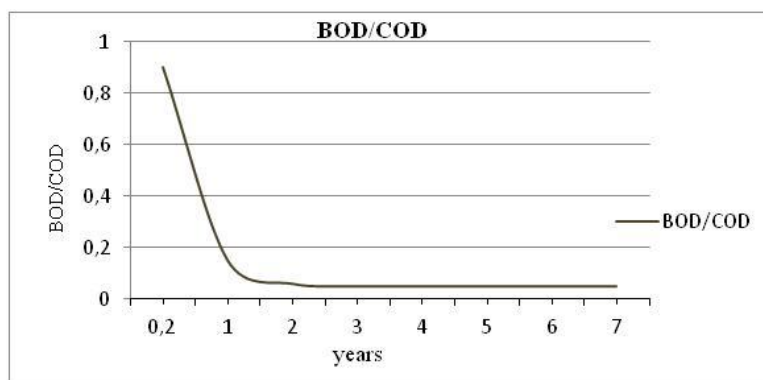
Fig. 1)   Changes of BOD/COD ratio in relation to the ages of landfill [3]

Figure 1 shows the change in BOD / COD ratio due to the landfill ageing. The ratios first decrease sharply within approximately one or two year and then slightly change or stay as constant value with increasing landfill age. This means, that the proportions of biodegradable organics decrease already greatly after about one year and half. After this period, the microbiological reactions of BOD degradation are limited.

After one year and half, because BOD/ COD ratios are smaller, show that the treatment of leachate usually requires an extra chemical treatment or additional pre-treatment. That require options for treatment plant to change and upgrade in time.

Also, very large range of ammonium, COD and other parameters are shown in lot of research and studies. That is a one of the reasons why it has been started with testing a new technology for leachate treatment.

Very important issue for leachate treatment is to meet a standard according to relevant legislation.

Mainly, that depends on the possibilities of disposal and limited values (max. allowed concentration) for effluent of the plant.

2.2   Disposal of leachate and brief overview of the treatment options

Leachate, collected in lagoon, could be recirculated at the active zone of the landfill. That is a good solution, especially for the young landfill with no significant amount of waste and leachate. Apart from recycling leachate between different cells on a landfill site, leachate can be disposed to sewer, to a river or collected and transported to the another treatment site.

Generally, the most appropriate solution for leachate disposal is to a local watercourse or sewer, although on-site treatment is prerequisite. As mentioned before, leachate treatment can be performed in different ways, depending on the nature and amount of the leachate. Aerated lagoons are used for weak and young leachate. This is sometimes combined with reed bed plant before discharge to a watercourse.

High concentrations of ammonia can be removed by 'stripping'[4] The leachate pH is increased to 10.5 and flashed off to atmosphere under vacuum conditions. Invariably, the leachate needs to be heated first. This disposal route has a very high operational cost due to the pH increasing to the more than 10 and leachate should be heated first.

The most cost-effective choice of treatment for high concentration of BOD, COD and ammonia is intense biological oxidation. Conventional processes with activated sludge (CAS), sequence batch reactor (SBR) are the most commonly used technologies. The SBR is a form of activated sludge treatment. CAS plants use an aerobic/biological tank followed by secondary clarification tank for settlement. The SBR combines this process into a single unit tank with several operation cycles (filling, aeration, settling, discharging). However, CAS and SBR have their negative aspects due to the range of oscillations in leachate quality or different problems with sludge settling and separation which can be overcome with membrane technology. Membrane biological reactor (MBR) is combination of biological treatment and membrane filtration/ separation process. MBR is often referred to as a modification, or advancement of the activated sludge (AS) process [5].

The application of membrane bioreactor (MBR) technology for the treatment of landfill leachate is not new but it is still rare mainly due to the high capital cost as well as significant energy consumptions and cost of operation and maintenance (module changing, chemical for cleaning, etc.).

Usually, applied technology for leacheate treatment has to change over time, and unit with biological treatment has to be combined and upgrade with, for example, physical – chemical treatment or membrane technology.

2.3   Membrane technology and type of membrane

The application of membranes has divided by pore size and by driving force on to microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO).

Usually. micro and ultrafiltration unites has to be used as pre-treatment for RO units, to remove high molecular weight colloidal compounds and suspended solids, in order to prevent blocking of the RO membranes. RO plants have to operate at high pressures in order to overcome the osmotic pressure of the liquids being concentrated. RO concentrate has to be back onto the landfill site. In summary, RO has a role to play in the treatment of leachate, but not as the primary process. RO can be installed after an MBR process where there is a need to remove low molecular weight compounds from the treated leachate. Still, RO for leachate comprises high capital cost as well as operation and maintenance costs [6].

2.4   MBR technology

Membrane biological reactor (MBR) systems essentially combine conventional biological wastewater treatment with membrane filtration. MBR processes separate solids through membrane filtration rather then by sedimentation in secondary clarifiers. The biological treatment configuration of MBR facilities depends on the levels of organic and nutrient required for the facility. MBR systems can incorporate anaerobic – anoxic basins for nutrient removal into designs.

The main division is into two basic types of MBR unit; submerged MBR plants and side-stream MBR plants.

Submerge MBR plants usually are used for treatment of municipal wastewater with lower pressure and operation costs. For industrial wastewater treatment, side stream configuration and module out of the biological units is recommended. There are many membrane and MBR manufactures of submerge and side stream membrane type and modules as well as a lot of

literature and papers regarding their operation, but mostly for industrial or domestic wastewater. The literature would reply that viewing the treatments of municipal effluent with leachate is not a fair comparison. They would be quite correct in pointing out that leachate is a collection of very difficult chemical compounds, and that its treatment can be troublesome. However, Wehrle (Germany) has installed 85 sidestream MBR plants to date, of which 58 are installed to treating landfill leachate [7].

"Guidelines" for choose appropriate MBR technology depends of wastewater strengths and volume.

For example: for low-strength/high-volume wastewater –sewage – low MF/UF energy costs per cubic metre are important and this requirement is usually best met by a submerged membrane MBR process while for high-strength/low-volume wastewater – for example industrial effluent, the tubular sidestream MBR is more often the better technology solution.

The most important issue with the MBR plants is the cost of energy, and submerged membranes compared with the sidestream design are the better choice. However, for those that are operating MBR plants, membrane fouling is a topical issue and there are many options for keep membrane clean and in good conditions. Landfill leachate MBR sludge is more difficult to filter compare to domestic or municipal sludge which has a relatively low fouling factor, and it is suitable to be treated by submerged MBR systems. Application and performance of membranes are very important as empirical data for further design and operation of MBR plants. Therefore, on-site trials and testing operation of the different type of membrane are recommended before initiating an MBR design.

Also, it is important to stress advantage of MBR vs. CAS to operate with high concentration of MLSS (up to 25 kg/m^3 MLSS), which minimizes reactor volume for a given sludge loading. However, membrane flux performance deteriorates with an increase in MLSS, and the optimal sludge concentration is on average 17–20 kg/m^3. Sludge foaming is often a problem associated with treating high strength wastewater (leachate). For leachate which usually consists complex organic substances, it can be necessary to operate in a low F/M (sludge loading), long sludge age. A low F/M loading is necessary for nitrification and the production of surplus sludge is minimised. Plants can be designed to incorporate a denitrification stage if required. Denitrification takes place in an anoxic tank, in front of the aeration tank, and receives raw wastewater and recycled thickened sludge from the MF/UF unit. There is possibility to add methanol to this tank as necessary to ensure an adequate carbon source.

As a mentioned before, although a number of MBR system manufactures have emerged in recent years, available immersed systems generally consist of one of two basic membrane shape types:

- Hollow Fibre
- Flat Sheet

The selected submerge MBR technology with hollow fibres for leachate treatment at the Sarajevo sanitary landfill has been used for the first time in BiH and the testing results will be briefly presented in this paper.

3   SARAJEVO SANITARY LANDFILL AND LEACHATE TREATMENT

3.1   Sarajevo sanitary landfill

The waste generated in Sarajevo Canton has been disposing at the Sarajevo landfill – Smiljevici since 1963. The Sarajevo landfill is set up in a depression on the location of Smiljevici, with distance of 3 km from the city area. The landfill is located on a natural slope and oriented to a narrow valley of a small stream.

The technology of waste disposal on the Sarajevo sanitary landfill, based on waste compacting in layers, daily covering of waste, collecting and drainage of surface waters, minimized possibility for landfill leachate.

The landfill leachate (generated from the "old" waste) has been collected by drainage systems of the whole landfill area. There is also a drainage system laid on the multibarier layers of the landfill active area, where the waste is daily disposed for collection of the "young" leachate. The leachate was, as a first solution, collected in a basin and directed to the recipient, a small stream "Lepenicki potok", without any treatment. According to Law stipulation the heavily polluted water, such as landfill leachate, must be treated and because of these requirements the problem of Sarajevo landfill leachate had to be solved [8,9].

The main design for leachate treatment plant was made in 2006, using data on monitoring and analyses of the quantity and quality of the leachate at the Sarajevo sanitary landfill. The MBR pilot plant was set up according to the main design, in order to make tests on site and get results for selected technology for leachate treatment at the Sarajevo landfill.

The testing operation period lasted from 2008 to beginning of 2011.

The parameters of quality and amount of leachate generated at the Sarajevo sanitary landfill are obtained from one year monitoring, The plant is designed for flow of 5 l/s max.

The MBR plant has been in function as a membrane bioreactor for treatment of leachate from Sarajevo sanitary landfill since 2008.

The components of the plant are shown on Fig.3. There are two tanks (first as a process aerobic and second one as membrane reactor) shown on the Figure 2. The total tanks volumes are 1000 m^3. Four membrane modules (contains 194 membrane cartridges) were immersed into the second tank. A scheme of MBR plant at Smiljevici – Sarajevo sanitary landfill is shown on Figure 3 and the main design parameters are given in Table 2.

3.2   Experimental operation of the MBR plant in Sarajevo

Tests applying MBR technology and experimental work on the MBR device for treatment of leachate were performed in the period form May 2008 to December 2010. The membrane reactor modules were installed in aeration tank. The type of membrane is a hollow fibre, made of PE with properties that allow the membranes work in aggressive wastewater. Membrane modules are composed of organic porous hollow fibre (HF) and micro pore 0.2 µm. The outer diameter of the fibre is 0.4 mm, length of 0.7 to 1 m, which are combined into bundles and wrapped around the PVC carrier. Carrier has a suction port for permeate and an outlet for compressed air for air backflush of membranes, as external cleaning.

Tab. 2)   Main parameters of MBR Sarajevo [10,11]

Project parameter	unit	value
Total volume of the tanks (V)	m^3	1000,00
MLSS (SM)	$kgDS/m^3$	10,00
Sludge loading (F/M)	$kgBOD_5/kgDS,d$	0,052
Volumetric loading (Bv)	$kgBOD_5/d,m^3$	0,52
SRT	d	16
Membrane surface	m^2	2364
Average flux	$l/m^2,h$	7 -11
NOP (TMP)	mbar	0,35

The normal operation is set up in cycle of 3 minutes of suction and 30 sec. for air and water backflush. Of course, increasing backflush flux leads to more loss permeate and reduce net flux. The system is set up for backflush limited on max. 30% of total daily amount of permeate [10].

Leachates of deep and shallow drainages were collected in a collection sump located in front of the plant (Figure 3). In order to achieve a stabile work of the MBR system, according to design, it was necessary that the concentration of MLSS is in the range of 8 to 10 g/L but in operation MLSS was in the range from 2,5 g/L to 6 g/L. The main reasons are often interruption of operation due to the mechanical failure of different parts of the plant, significant oscillation in quality and quantity of leachate, loss of solids by foaming or by dilution with feedwater, etc.

The established process for biological treatment with filtration through submerged membranes has shown very good results in a testing period regarding removal of organic pollution and suspended solids. The results, expressed in percentage of removal, are presented in the Table 3.

The samples of raw leachate (influent) have been taken in the collection sump, set up in front of the pilot plant, and effluent have been taken at the outlet of the permeate storage tank. The laboratory tests were done three times per week.

The inflow was set up to approximately 3 l/s (average). The membrane flux rate, defined as a volume rate through the membrane surface, was in the range from 8 l/m^2.h to 11 l/m^2.h. The concentration of dissolved oxygen in the first tank was in the range of 2,5 mgO_2/l, and from 2 to 6,0 mgO_2/l in the second tank. The range of mixed liquor suspended solids concentrations (MLSS) was from 3 to 6 g/l.

As mentioned before, the process has been set up into circles of Normal Operation Time. The permeate pump, permeate valve and the water backwash pump were controlled automatically, and every 3 minutes the permeate pump stopped for 30 sec, for backwashing.
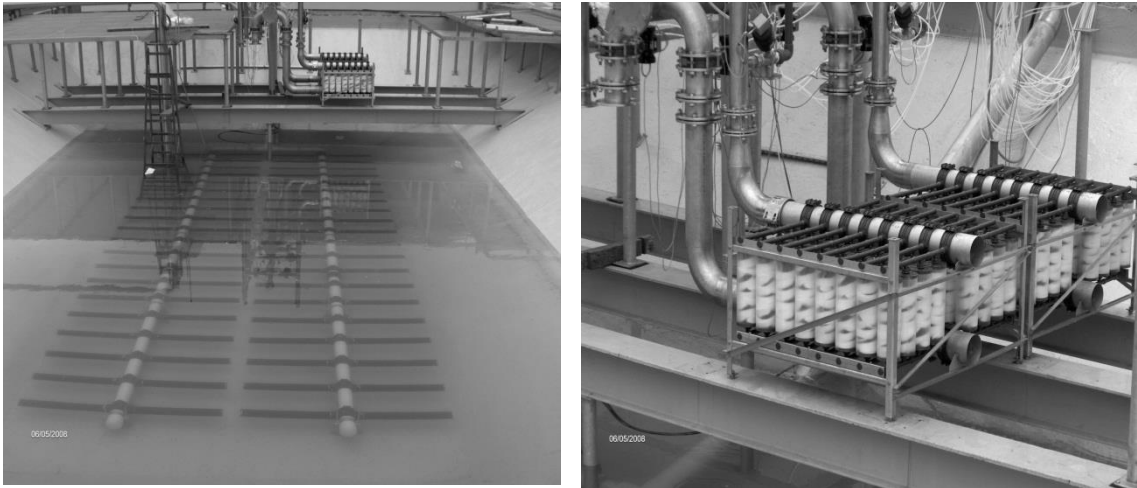
Fig. 2)   Instalation of the membrane modules – system of deep, coarse bubble aeration (left) and horizontal mounted membrane modules (8x8 cartridges) [10]
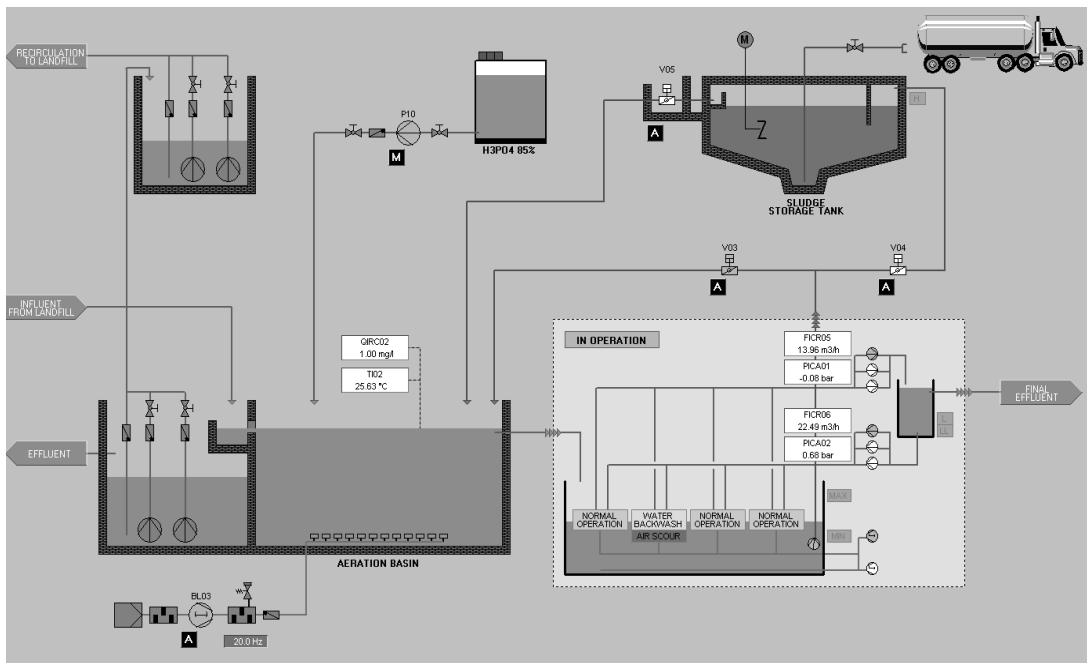
Fig. 3)   Scheme of MBR submerge plant at the Sarajevo landfill [11]

3.3   Testing operation results

Under the operational conditions, the BOD and COD degraded, resulting in a low BOD concentration in effluent. The most average effects were done for organic pollution removal (BOD$_5$ 92 % and COD 43% (with significant oscillation form 11% up to 78%), then 89 % of ammonium was removed. Up to 86 % of suspended solids and 93 % of turbidity were also decreased. The chemical cleaning of the membrane was carried out, every 7 to 15 days, at the site (Cleaning in place – CIP) with Sodium Hypochlorite.

The concentration of the MLSS was measured as residual of the dry solids matter in sample of 100 ml (mixed liquor samples was heated at 105^0 C) and range was between 3 g/l to 6 g/l. The temperature of the mixed leachate in the reactor was in the range of 12^{0}C to 26^{0}C.

According to the analyses of the MBR operation from July 2008 – December 2010 year and the results are presented as efficiencies:

$$E=\frac{S_0\text{-}S}{S_0}\times100\%\tag{1}$$

Where is : S_o - concentration in the influent (mg/l)

S – concentration in the effluent (mg/l)

The results of the plant testing operation are shown in table 3 as treatment efficiencies for typical parameters.

Tab. 3)   Treatment effectiveness for main quality paremeters - MBR Sarajevo [10,11]

Quality parameter Statistic parameter	Efficiencies (%) of treatment in testing operation - period 2008 - 2010							
	TSS	COD	BOD_5	NH_4-N	TKN	Sulfides	Turbidity	Conductivity
Number of samples	66	74	76	76	75	45	71	70
X_{sr}	86	43	92	89	87	63	93	26
st,dev	12	15	9	9	8	18	8	11
Min.	21	11	56	48	51	19	49	3
Max.	99	78	100	100	98	95	100	67

4   CONCLUSIONS

The fact remains that energy and operation costs are the main reasons why the application of MBR plants in the leachate treatment sector has not followed its success in treatment of domestic or industrial wastewaters.

The low-energy sidestream or submerge MBR could give the optimum solution, combined the benefits of submerged and sidestream membranes into one system. The results from the MBR treatment plant in Sarajevo, compromise biological and submerge treatment and proved that it is possible to achieve goals for low/medium strength leachate. The MBR technology solution applied at the Sarajevo landfill should be able to meet current legal requirements for industrial effluents discharging into sewers.

However, during the testing operation, various problems have occurred. Mostly, there were mechanical failure, administrative procedure and waiting for spare parts and all of that had strong and significant impact on biological treatment and whole process. However, the membrane has shown remarkable flexibility and endurance in complex environments with highly polluted – strong wastewater. Although the results of established biological treatment and membrane filtration can meet a standard of the effluent according to the maximum allowed concentration and a system is low – energy, there are still some reasons why the submerge or sidestream MBR has not been often recommended or used for leachate treatment. The leachate from older (> 2 years old landfills) landfill are stronger in COD and ammonia, and not usually recommended for biological treatment. The MBR plant requires very careful handling, regular cleaning, supply chemicals, replacement modules (still too high) which significantly increases the cost per m^3 of purified water. Therefore, it is necessary to make an analysis of improvements, installation of anoxic and anaerobic zone as well as

other solutions (membrane performance enhancer, PAC) that would create better working conditions of MBR plant.

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FLOOD PROTECTION MEASURES ON THE ENNS RIVER

Georg Schuster[1], Thomas Pfaffenwimmer[2], Gerold Hepp[3], Ahmed M. Moussa[4], Cedomil J. Jugovic[5]

Abstract

In the city of Steyr the Enns River causes frequent inundations in some exposed areas. The endangered areas encompassed by this project are situated on the outer side of a river bend. Next to the settlement area, an estuary of a small creek is also located. Therefore, the residential estate may be overflowed on two sides – by the river Enns and by the creek called Ramingbach. However, the requests of the stakeholders were challenging, because the flood control levees should be avoided. To protect the settlement area, different alternative measures were tested on physical and numerical models: several changes in the riverbed, such as deepening of the riverbed stream up and down, and widening of the river bend on the inner side.

The aim of this contribution is to present different alternative ways of flood protection besides levees, to evaluate them, and to discuss them basing on the results of physical and numerical simulations.

Key Words

Enns river, estuary, flood control measures, flood water, groin, levee, river bend, river bifurcation, sidearm.

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1   INTRODUCTION

The city of Steyr is frequently affected by flood waters of the river Enns. Therefore different protection measures were developed and implemented. A notably often damaged area in the city of Steyr is a settlement situated between the outer river bend side of the river Enns and a small creek called "Ramingbach". The essential change of the river flow direction provokes a significantly higher water level on the outer side of the bend. Additionally the flow velocities of the river are reduced by the river bend and the estuary of the creek. These reduced flow velocities cause an increase of the water level, not only locally at the river bend, but also upstream, where the center of the city is situated. Thus, a solution should be found, to reduce the water level locally at the residential area as well as upstream in the center of the city.

1.1   Geographical and geological situation

The project area is situated in the city of Steyr in Upper Austria. The hydrological situation of the study area is presented in Fig. 1. In the city the Steyr River flows into the Enns River. Downstream of this estuary a creek called Ramingbach discharges into the Enns River. The affected area of this project is situated upstream of the Ramingbach estuary, beside the Ramingbach, on the outer bend of the Enns River.

Fig. 1)   Map of the area (Source: Google Maps)

On the left side of the Ramingbach Creek the wide plane of the settlement is situated so that on the right side a twenty meter high rock wall of a geological terrace rises. The inner side of the river bend is dominated by a wide gravel bank on the slip-off bank. Thus the river is restrained between the slip-off bank and the rock wall.

Geologically the city is characterized by glacial terraces, which influence the river morphology. Yet, the areas which are mainly endangered by high water, like the settlement at estuary of the Ramingbach, are situated on incoherent gravel depositions on the floodplain level. These gravel depositions are aquifers with a high water permeability. Therefore, the groundwater level is highly influenced by the water level of the rivers. The ground water level increase occurs very fast, with only a very short delay to the water level in the river. This can be seen by the fast flooding of numerous basements near the river.

1.2 Test area

To test different measures to reduce the high water level, physical and numerical models are used. The modeled area includes river and foreland about one kilometer upstream of the residential area "Fischhubsiedlung" and about 500 m downstream of this settlement. Fig. 2 shows the extent of the modeled area as well as the measured profiles. In the profiles terrains and water levels where measured in nature. In the numerical and physical models in the profiles water levels and the flow velocities are measured.

Fig. 2)   Plan view of the modeled area.

As shown in Fig. 2 the modeled area covers the whole river bend, the "Fischhubsiedlung" settlement, the "Ramingbach" creek, the "Rederinsel" island with the sidearm and the "Rederbrücke" bridge. Hence, measures directly in, as well as measures upstream, of the river bend can be tested. The effects of the variants on the water level in the settlement and upstream in the center of the city is evaluated.

2   OBJECTIVES

The objective of the project is to find a solution to protect not only the settlement at the outer side of the river bend, but to reduce the water level upstream in the center of the city as well. In addition levees to protect the settlement should be avoided. The avoidance of levees has different reasons:

1. Due to the high water permeability of the soil, the construction of levees would also make the installation of a sealing of the underground necessary. Though, because of the installation of the underground-sealing, a pump station would also be necessary, which drains the groundwater, coming from the higher back-country, into the "Enns"

river. Therefore the construction and the operation of a solution with a levee would be cost intensive.

2. The construction of a levee would also imply a constriction of the river. The reduction of the cross section on the left side by the gravel bank and on the right side by the cliff would be amplified by the levee and may cause higher flood water levels in the river bend as well as also upstream in the city center.

3. Beside these technical reasons to avoid the construction of levees, the involved residents would also prefer other alternatives. Their primary interest is to preserve the natural landscape.

3   METHODOLOGY

Basing on these preconditions a pilot survey with one- and two-dimensional models was started to find promising measures. The results of this pre-study were three proposed measures:

- Widening the river profile downstream of the river bend;
- Widening of the inner side of the river bend by removing the accumulated gravel bank.
- Lowering of the river bed alongside of the "Rederinsel" island, where a bedrock threshold cause a shallow water area;

Yet, the results of the one- and two-dimensional models can only provide suggestions, because they cannot handle the helicoidal flow of the river bend [1]. Furthermore the test area includes several regions with pronounced three dimensional flow conditions:

- Diversion over a threshold of the "Enns" river into the sidearm upstream of the "Rederinsel" island;
- Confluence of the sidearm into the river downstream of the "Rederinsel" island;
- River bend flow, which provides significant lateral flows;
- Inflow of the "Ramingbach" creek upstream of the rock face.

Based on the results of the pilot survey, a physical scale model was constructed, to check the provided solutions. Therefore the following variants are tested and evaluated also on the physical scale model:

- Reducing the water level downstream of the river bend by widening the flow profile;
- Removing the gravel bank on the inner side of the river bend to widen the cross section;
- A combination of widening the downstream and widening the inner bank of the river bend;
- Triple combination of widening the downstream, widening the bend and lowering the river bed alongside of the "Rederinsel" island.

The different variants are evaluated primarily on the high water level of a 100-yearly flood. During the experiments flow velocities were measured and tracer tests were conducted, but they are only used to understand flow processes. The objective of the project is only the lowering of the flood water levels. Furthermore, since a cascade of power plants constrains

the bed load transport in the "Enns" river, sediment transport processes were not included in the simulation.

4   ANALYSIS AND DISCUSSION

4.1   Initial Condition

The initial condition of the project area is the starting point of the project. It is important to understand the prevailing situation to find adequate solutions for this challenge. The water level of the initial condition can be found in the following variants as reference water level. Therefore it will not display here. Yet, the distribution of the velocity in the cross section is an important base to design promising solutions. Since in the physical model the flow velocity measurement can be conducted only at a minimum water depth of 4,5 cm, the areas with a lower water depth in the physical model (and therefore no velocity measurements) are outlined in Fig. 3 by the "Shallow Water Line". Although no velocity measurements were done in these areas, it could be noticed that the flow velocities were significant less than in the river bed.

Fig. 3)   Distribution of the flow velocities in the cross sections

The sidearm along the "Rederinsel" island shows nearly the same flow velocity as in the main river. Thus in the sidearm an essential percentage of the discharge is transported. Actually a portion of 32 % of the whole discharge flows through the sidearm at a 100-yearly flood. Downstream the velocity distributions in the river bend give an unexpected result. Usually the maximum of the velocity in the cross section would be expected in the outer side of the river bend [2]. In conformity with Apmann [3] is the causality therefore the influence of the flow boundary and the change of the stream based on the water depths at the cutbank and the slip-off bank. So the main flow is deflected to the outer side of the river bend. Furthermore the maximum of the flow velocity is turned more to the outer side, as the exterior river bank is steeper [4] [5]. Wittmann and Böss [6] found in their test runs and nature observations, that principally on the beginning of a river bend, the maximum flow velocity is shifted to the inner side. Yet, in the further course of the river bend the maximum flow velocity moves to the

outer side of the bend. The acceleration on the inner bank at the beginning of the bend is based on the streamline curvature and the lateral and radial pressure drop. Induced by the centrifugal force an increase of pressure occur, which leads by the energy equation to a velocity minimum. Consequently, based on the combination of the centrifugal force, momentum, mixing- and flow separation processes the second flow of river bends typically arise and the maximum flow velocity moves on the outer face of the bend [7] . This change of acceleration-deceleration on the inner side and deceleration-acceleration on the outer side occur in the region of the river bend vertex.

However, as in the Introduction already described, the presented river bend of the "Enns" river is not only a river bend. It is, actually a superposition of an estuary, an abrupt change of the foreland level due to the rock cliff and a river bend. Thus the characteristics of the local change of the maximum flow velocity diverges form the description above. It starts with the missing boundary at the beginning of the bend, where the settlement area is widely flooded. Indeed there is a bank at normal flow, yet during high water the bank is not in accordance with a typically cutbank. Furthermore the inflow of the "Ramingbach" creek and the rock cliff provoke high turbulences and reduce the flow velocity of the "Enns" river locally essential. Thus the water level rises in the "Enns" river in this area, which causes a higher water level in the "Ramingbach" creek itself. Not until downstream of the estuary the rock wall provide a steep river bank; the maximum flow velocity is shifted to the exterior river bank.

Hence it seems that this region, including the flooded foreland of the settlement, the estuary of the creek, the rock cliff and the slip-off bank may be the crucial point to reduce the water level in the "Enns" river.

4.2   Reducing the water level downstream

This measure includes the widening of the river bed downstream of the physical model. Therefore a numerical model is used to calculate the water level downstream of the physical model. The resulting water level is 0,56 m lower and provides the boundary condition on the outflow of the physical model.

In Fig. 4 the water levels on the right and the left riverbanks are shown for the Initial condition and the variant which downstream water level is reduced by 0,56 cm. On the diagram a reduction of the water levels can be seen up to the upstream beginning of the river bend (Profile 13). The highest reduction of the water level in the river bend can be measured on the left bank (inner side of the river bend) with a mean value of 0,25 m. The reduction of the water level on the exterior right bank is with 0,15 m average less than on the left bank. Also the flood water level in the residential area is only about 0,10 m lower than at the initial conditions. The water level upstream of the river bend is not significant reduced by this variant.

4.3   Widening of the inner side of the river bend

In this variant the impact of a widening of the inner bank of the river bend is tested. This means also, that the water level at the model outflow is the same as in the initial conditions.

For the test, the gravel bank on the inner side of the bend was removed on a length of about 450 m. The widening can be seen in Fig. 5.
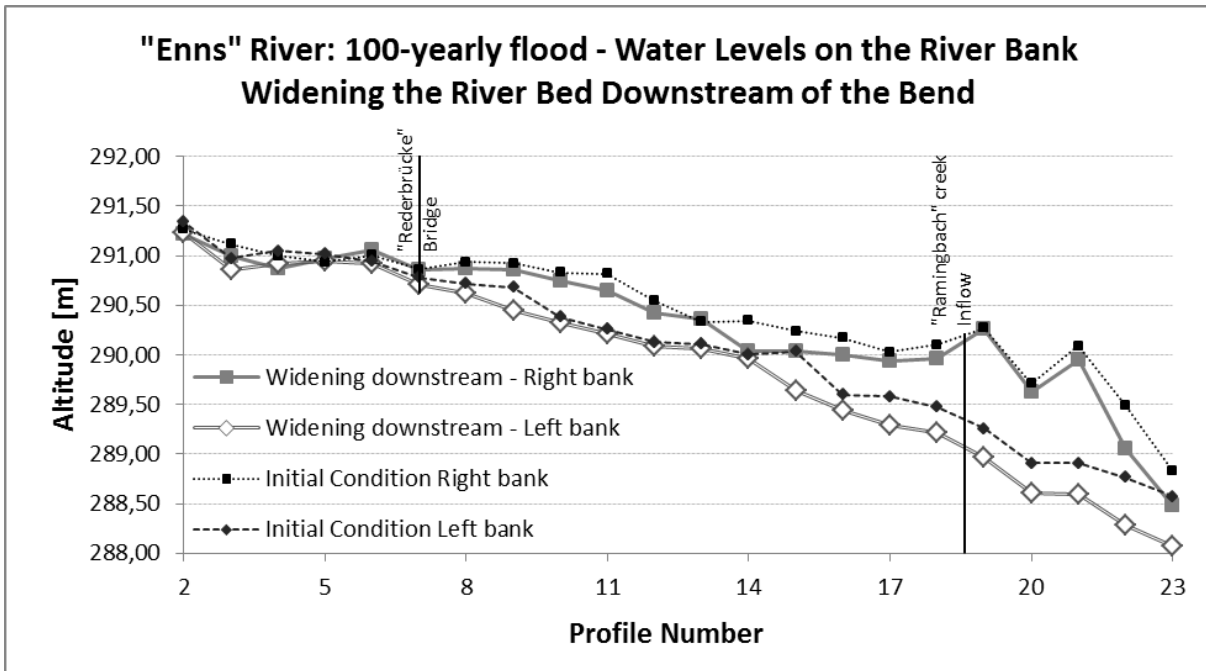
Fig. 4)   Reducing the water level downstream – Water levels on river banks
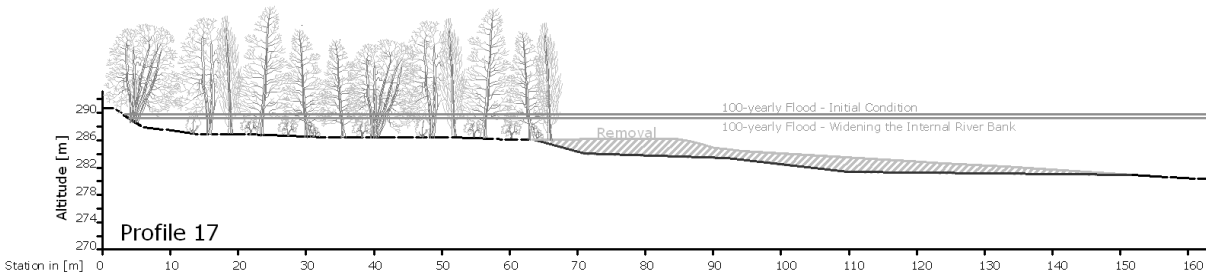
Fig. 5)   Cross section of widening of the inner side of the river bend

Fig. 6 presents a comparison of the water levels between the initial condition and after widening the interior river bank. The widening in the inner bank of the river bend brings a significant reduction of the water levels not only in the river bend, but also upstream. Yet, downstream the water level at the model outflow is the same as in the initial conditions. For a 100-year flood an averaged reduction of 0,40 m can be measured. The maximum reduction occurs in the inside of the bend at profile 15 with a by 0,68 m lowered water level. Although already the numerical model predicted, the result is maybe surprising. On the one hand the reduction of the water level is major; on the other hand the results of a 2D model in a river bend (including all the influences from the flood plain, the creek inflow and the rock cliff) in such distinct three-dimensional flow conditions are not always reliable. [8]

4.4   Combination of widening downstream and widening the inner bank of the river bend

Reducing the water level downstream of the river bend by a widening brings mainly a reduction of the water level up to the inflow of the "Ramingbach" creek. Widening of the inner bank of the river bend reduces the water level mainly in the river bend and upstream to

the "Rederinsel" island. Thus both measures are combined to achieve a water level reduction in the whole area.
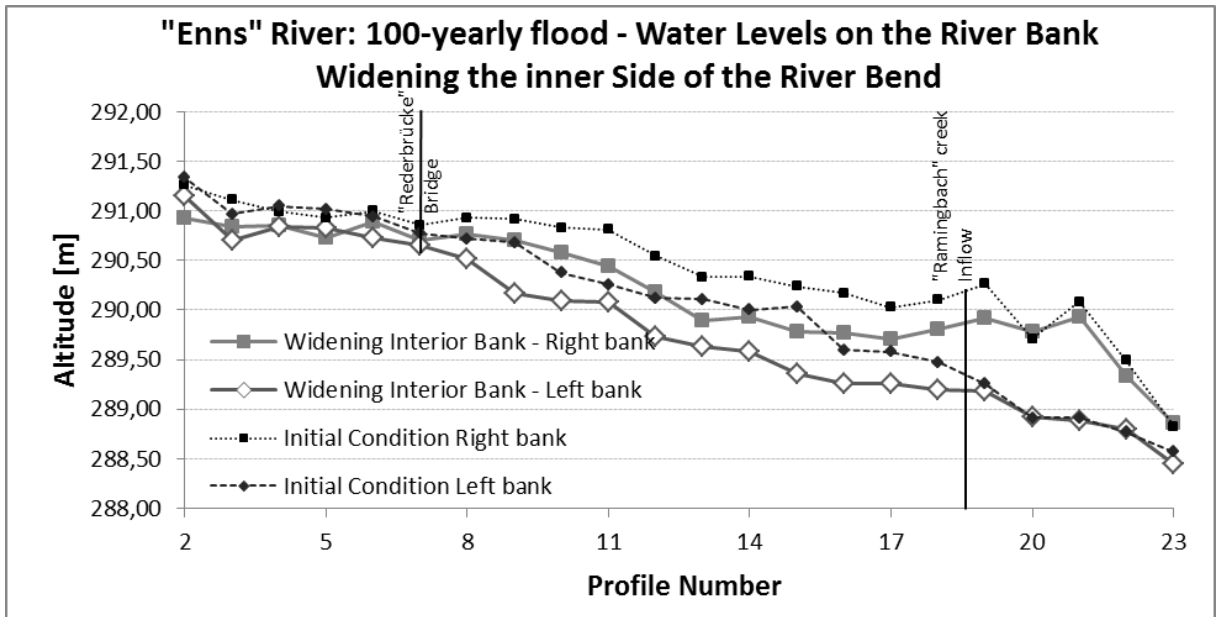
Fig. 6) Widening of the inner side of the river bend – Water levels on river banks
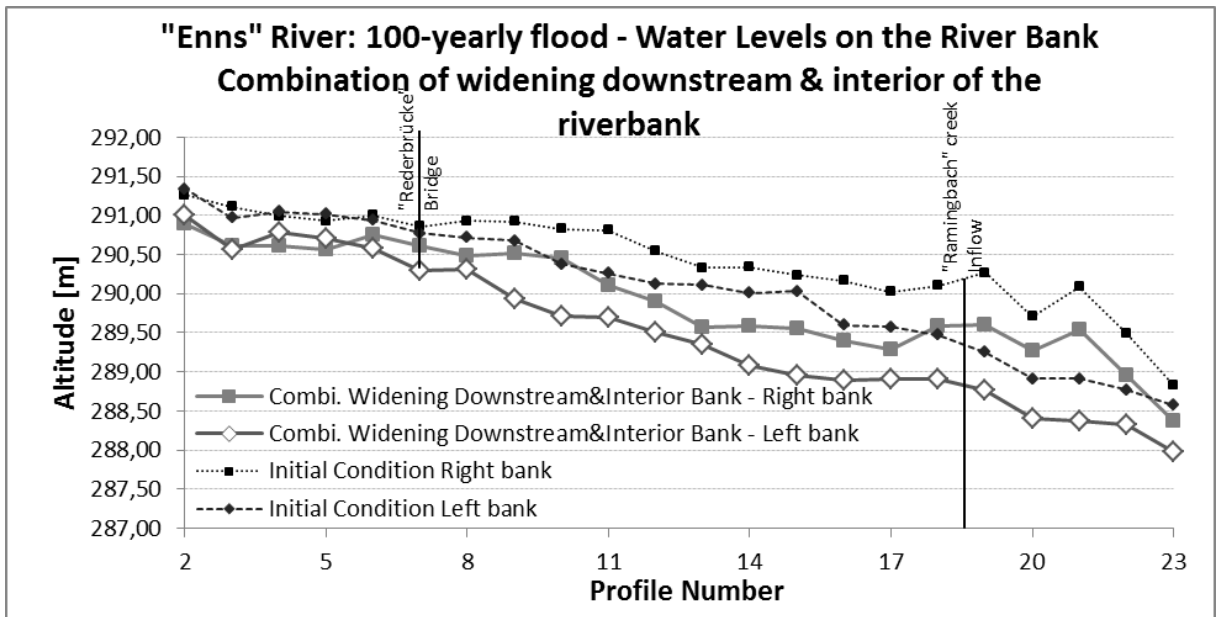
Fig. 7) Combination of widening downstream and interior of the riverbank – water levels

As it can be seen in Fig. 7 the water level reduction is essential. On the exterior bank of the river bend the water level is 0,70 m lower than in the initial situation. Thus widening the inner bank of the bend affords to extend the water level reduction downstream of the bend to the areas upstream of the bend.

4.5 Triple combination of widening downstream, widening bend and lowering the river bed alongside of the "Rederinsel" island

Alongside of the "Rederinsel" island a bedrock threshold cause a shallow water area (shown in Fig. 2). On the one hand this natural barrier inhibits a further extension of the water level reduction in the river bend upstream. On the other hand it causes also an additional increase of the water level upstream basing on the heightening of the river bed due to the bedrock threshold. Therefore the river bed of the "Enns" river is lowered along the "Rederinsel" island by 2,40 m and the river bed of the sidearm is deepened by 1,40 m. Fig.8 shows a cross sectional view where the removal is highlighted.
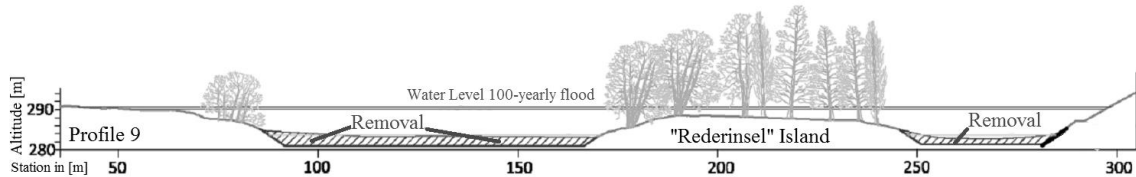
Fig. 8) Cross sectional view of the deepening of the river bed

As expected, the deepening of the river bed causes a reduction of the water level alongside the "Rederinsel" island and upstream. Therefore by this triple combination of measures the center of the city is saved at a 100-yearly flood.
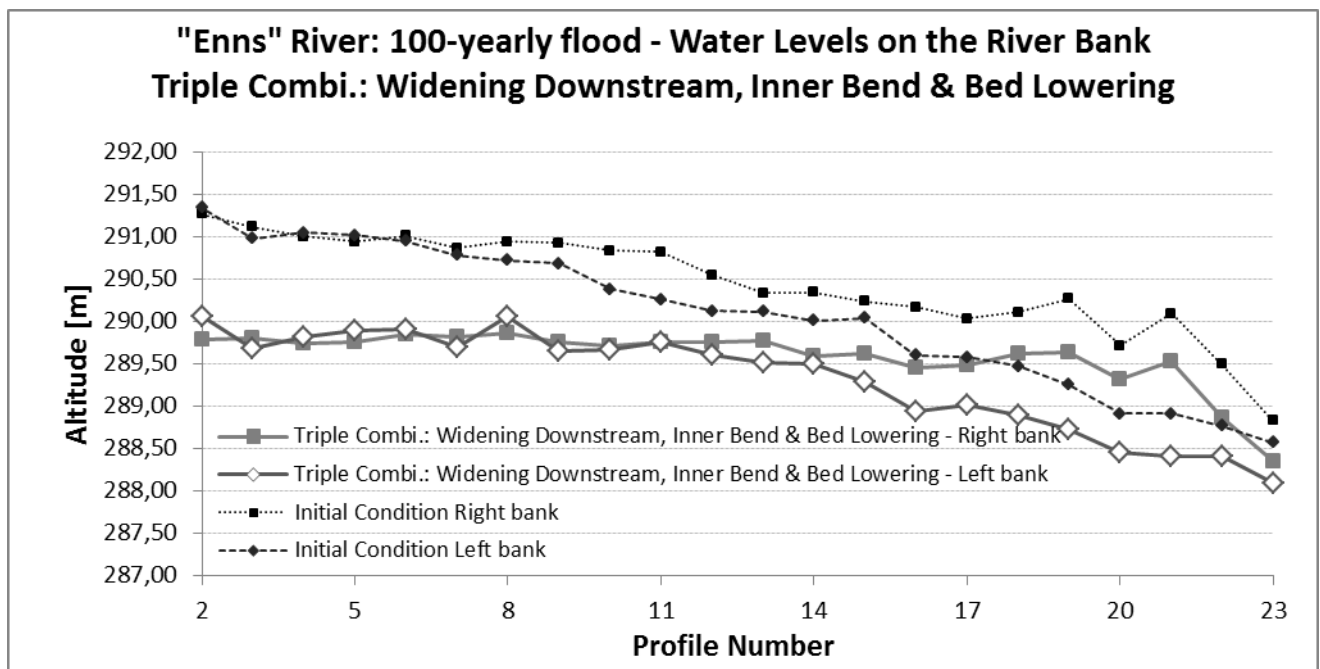
Fig. 9) Triple combination of widening downstream, widening bend and lowering the river bed – Water levels on the river banks

In Fig. 9 it can be seen that there is an extensive reduction of the water level alongside of the "Rederinsel" island up to 1,35 m. The water level is averaged over the deepened area is 0,98 m. The water level in the river bend is not affected by the measure.

The significant changes in the water levels cause also an essential change in the flow velocity at the side arm, but only marginal changes in the main river. Thus the portion of the discharge

in the sidearm is reduced from 32 % in the initial condition to 16 % in the triple combined variant.

5   CONCLUSION

The experiments highlight three different methods to reduce the flood water level in a region which is influenced by a river bend:

- Reduction of the water level downstream
- Widening of the river bend on interior bank
- Lowering the river bed upstream of the river bend

The reduction of the water level downstream of the river bend was realized by widening the profile downstream of the river bend. This effectuates a lower water level only up to the river bend. The essential change of the flow direction, the restriction by the rock cliff and the inflow of the creek are the limiting factors of the discharge. Thus the reduction of the water level downstream has no effect upstream of the river bend.

The widening of the river bend on the interior bank causes mainly a reduction of the water levels in the region of the river bend itself. The reason therefore is the high flow velocities in the inner side of the river bank (see Fig. 3). By deepening and widening the area of the highest flow velocities, the discharge can also be increased and the water level decreased.

Basing on the results of the widening of the interior bank of the bend, the combination with the reduction of the water levels downstream is the next logical step. Through this combination a wider area can profit by the reduced water levels downstream.

In the final measure the last obstacle in the modeled area was removed. The rock threshold caused a shallow water section in the "Enns" river. This barrier limited water level reduction upstream of the "Rederinsel" island. Due to the deepening of the river bed an essential reduction of the flood water level could be achieved, which prevents inundating of the city center up to a 100-yearly flood.

Furthermore, the installation of groins and trainingwalls in the river bend region were tested. By these measures it was possible to reduce the water level regionally, but they also cause a similar increasing of the water level upstream. Therefore these variants were rejected, and because of the limited space here, not presented.

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USING POLLUTION LOAD INDEX FOR THE ASSESSMENT OF HEAVY METALS POLLUTION OF SEDIMENT IN THE SMOLNIK CREEK IN SLOVAKIA

Eva Singovszká[1], Magdaléna Bálintová[2]

Abstract

Natural environment which is polluted by heavy elements is considered as an universal problem. The heavy metals released in the environment as the result of human activities, atmospheric depositions, and erosions would finally enter into the aqua systems. Because heavy metals are toxic, stable in the environment and have potential to combine with the nutritive continuum, they are considered as one of the most significant pollutant in aqua systems.

The pollution load index (PLI) represents the number of times by which the heavy metal concentrations in the sediment exceed the background concentration, and gives a summative indication of the overall level of heavy metal toxicity in a particular sample. The aim of this study was the monitoring of heavy metal levels in sediment samples from Smolnik creek. The degree of contamination in the sediments of the Smolnik creek, for the metals Ca, Mg, Fe, Mn, Al, Cu, Zn, As, Cd, Pb and sulphate has been evaluated using pollution load index (PLI). In this article the high PLI values about 2 for the samples influenced by acid mine drainage (AMD) indicate the strong signs of pollution deterioration. The decrease of PLI values downstream due to dilution and dispersion of metal content with increasing distance from source area were confirmed, too.

Key words

Acid mine drainage, heavy metals, pollution load index, sediment quality.

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1   INTRODUCTION

In Slovak Republic there are some localities with existing AMD generation conditions. The most critical values were observed in the abandoned deposit Smolník. The stratiform deposit Smolník belongs to the historically best-known and richest Cu – Fe ore deposits in Slovakia. In 1990 the mining activity at the locality was stopped. The mine was flooded till 1994. In 1994 an ecological collapse occurred, which caused the fish-kill and the global negative influence on the environment. The mine-system represents partly opened geochemical system into which rain and surface water drain. The continuation of AMD generation at the locality of Smolník is not possible to stop and there is no chance for situation self-improvement. It is necessary to respect this situation, monitor the quality of these waters and develop methods for their treatment. That was the reason for starting a systematic monitoring of geochemical development in acid mine drainage in 2004 in order to prepare a prognosis in terms of environmental risk and use of these waters as an atypical source of a wide range of elements [1-4].

The surface water chemistry of a river at any point reflects several major influences, including the lithology of the catchment, atmospheric inputs, climatic conditions and anthropogenic inputs. Identification and quantification of these influences should form an important part of land and water resources management within a particular river catchment [5]. River sediments, derived as a result of weathering, are major carrier of heavy metals in the aquatic environment, the physico – chemical processes involved in their association being precipitation, adsorption, chelation, etc. Besides the natural processes, metals may enter into the aquatic system due to anthropogenic factors such as mining operation, disposal of industrial wastes and applications of biocides for pest. The concentration in sediments depends not only on anthropogenic and lithogenic sources but also upon textural characteristics, organic matter contents, mineralogical composition and depositional environment of the sediment [6].

River borne sediments, especially the suspended matter, act as a major carrier and source of heavy metals in the aquatic system. Geochemical study of sediments, to evaluate the concentration of heavy metals, is necessary as it helps to assess the ecotoxic potential of the river sediment [7].

The aim of this article is to evaluate the degree of contamination in the sediments, which is determined with the help of Pollution load index (PLI). The PLI is aimed at providing a measure of the degree of overall contamination at a sampling site. Sediment geo-accumulation index is the quantitative check of metal pollution in aquatic sediments [8].

2   MATERIAL AND METHODS

In order to study the interaction between AMD and surface water and sediment, five sampling localities along the Smolník creek were chosen. Two localities were in the upper part of the Smolník creek without contamination by acid mine waters from shaft Pech (1 – outside the Smolník village, 2 - small bridge - crossing to the shaft Pech) and another two sampling localities were located under the shaft (4 - 200 m under the shaft Pech, 5 – inflow to the Hnilec river). Also there was monitored the AMD quality from the shaft Pech (3-shaft Pech-accumulated AMD water tank). Sediment sampling localities are shown in Fig. 1.

Thirty sediments samples were collected from Smolnik creek during years 2006-2011. The chosen physical and chemical parameters were determined by multifunctional equipment

METTLER TOLEDO in situ and chemical analyses of sediment samples were realized in accredited laboratory of State Geological Institute of Dionýz Štúr, Spišská Nová Ves.
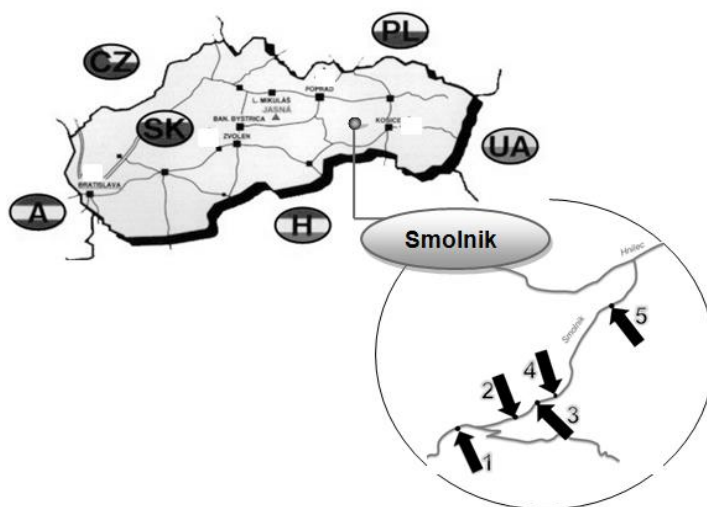
Fig. 1)   Location of the Smolník creek on the map of the Slovak Republic and sampling localities

2.1   Pollution load index (PLI)

The PLI represents the number of times by which the metal content in the sediment exceeds the background concentration, and gives a summative indication of the overall level of heavy metal toxicity in a particular sample [9].

Pollution load index PLI, for a particular site, has been evaluated following the method proposed by Thomilson et al. [10]. This parameter is expressed as:

$$PLI = \left(CF_1 \times CF_2 \times CF_3 \times \text{.................} \times CF_n\right)^{1/n}$$

Where, n is the number of the metals (eleven in the present study) and CF is the contamination factor. The contamination factor can be calculated from the following relation:

$$CF = \frac{Metal\ concentration\ in\ the\ sediment}{Background\ value\ of\ the\ metal}$$

(1)

The contamination factor scale and pollution load index scale is shown in the Tables 1 and 2.

Tab. 1)   The contamination factor scale [11]

CF < 1	low contamination
1 ≤ CF ≤ 3	moderate contamination
3 ≤ CF ≤ 6	considerable contamination
CF > 6	very high contamination

Tab. 2)   The pollution load index scale [12]

PLI < 1	denote perfection
PLI = 1	present that only baseline level of pollutants
PLI > 1	deterioration of site quality

3   RESULTS AND DISCUSION

Assessment of contamination has been done on the basis of mean concentration values described in the Table 3. The sample no. 1 was taken as a background value of the metal because it is situated above the pollution source (above shaft Pech).

Tab. 3)   Mean concentration of heavy metals in the Smolnik creek for sample site 1, 4, 5

	SO42-	Ca	Mg	Fe	Mn	Al	Cu	Zn	As	Cd	Pb
	[%]					[mg/kg]					
S1	0,02	0,313	0,793	4,14	0,09	7,41	130	152	44,5	0,5	42,3
S4	0,93	0,305	0,762	8,41	0,06	6,50	442	207	154,8	0,5	198,5
S5	1,23	0,213	0,630	12,26	0,05	5,97	560	233	106,3	0,5	114,0

The results of contamination factors and pollution index are shown in the Table 4. Contamination factor for Ca, Mg, Mn, Al indicate low contamination. The CF for Fe, Cu, Zn, As, Cd and Pb shows moderate to considerable contamination. SO42- shows very high CF values (> 6) that means very high contamination.

Tab. 4)   Contamination factor (CF) values in the sediment of Smolnik creek

	CF										
	SO42-	Ca	Mg	Fe	Mn	Al	Cu	Zn	As	Cd	Pb
S4	46,25	0,97	0,96	2,03	0,667	0,88	3,40	1,36	3,48	1	4,69
S5	61,60	0,68	0,79	2,96	0,556	0,81	4,31	1,53	2,39	1	2,69

There is, in general, a decrease in PLI values downstream indicating dilution and dispersion of metal content with increasing distance from source area. The high PLI values 2,119 (S4) and 1,984 (S5) indicated strong signs of pollution deterioration for both sample sites. The Table 5 shows the results of PLI of metals in the sediment of Smolnik creek.

Tab. 5)   Pollution load index (PLI) of metals in the sediment of Smolnik creek

	PLI
S4	2,119
S5	1,984

4   CONCLUSION

Smolník deposit belongs to the many localities in Slovakia, where the unfavourable influence of acidic water on the surface water can be observed. Because of decreasing pH and heavy metal production, acid mine drainage discharged from abandoned mine Smolník (shaft Pech) contaminates the downstream from the Smolník mine works to confluence of the stream with the Hnilec river.

Pollution severity and its variation along the sites was determined with the use of pollution load index. This index is a quick tool in order to compare the pollution status of different places. Pollution load index (PLI) values ranged from 1,984 – 2,119 clearly indicate the area of Smolnik deterioration of site quality.

The data obtained from this study will become part of baseline data and also important to the environmental agency as a policymaker for proper environmental management. This study also provides initial information to the relevant agencies and authorities in preparing preventive plan to control of heavy metal and other pollution from industries for direct discharge to the rivers.

Acknowledgements

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APPLIED OF SATELLITE REMOTE SENSING DATA AND GIS IN SOIL EROSION AND CRITICAL LAND ANALYSES

Agus Suharyanto[1]

Abstract

Critical land classification can be analyzed using combination between Top Soil Thickness – Soil erosion method, and BRLKT methods. Both methods are needed soil erosion data as one of input data. The soil erosion data can be analyzed using USLE (Universal Soil Loose Equation) and MUSLE (Modified Universal Soil Loose Equation) methods. Landcover is one of most important data in the critical land classification analyzes using BRLKT method. This data have 50% weight. Landcover condition is classified in to five categories i.e. very good, good, fair, poor, and very poor. Each category have score 5, 4, 3, 2, 1 respectively. To analyzed this landcover classification, satellite remote sensing data is proposed to use in this research. NDVI analyzes using satellite remote sensing data will be used to estimate the landcover classification.

It is costly and time consuming if the soil erosion and critical land classification analyzed using traditional method. To increase the accuracy and to reduce the analyzing time, GIS (Geographic Information Systems) is proposed to use for calculating soil erosion and critical land classification in this research.

From the research result it can be seen that GIS is very effective and efficient to analyze the soil erosion and critical land classifications. Percentage of landcover estimated using NDVI method is very effective and accurate. From the result of the research it can be seen that combination between BRLKT method and soil erosion method using USLE is produced the critical land classification nearest with the land condition in the field.

Key words

Critical land, GIS, landcover, satellite remote sensing, soil erosion.

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1 INTRODUCTION

Base on explanation described in Prakash et al. [1], one of the most important data in land capability analysis, especially in watershed management is critical land. There are many methods to analyze the critical land. Among them are Soil Thickness (ST) and BRLKT (*Badan Rehabilitasi Lahan dan Konservasi Tanah* – Land Rehabilitation and Soil Conservation Agency) methods as introduced in Hardjowigeno [2]. The common data as the input data to analyze the critical land using both methods is soil erosion. Soil erosion data can be analyzed using USLE (Universal Soil Loose Equation) and MUSLE (Modified Universal Soil Loose Equation) methods. For BRLKT method, beside of soil erosion data, percentage of vegetation cover (PVC), slope, and land management are needed as input data. As introduced in [3], government emphasizes that BRLKT method was decided as method to analyze critical land condition in Indonesia from 1988 after decided by Ministry of Forestry. Four parameters as input data are need in critical land analysis using BRLKT method. Those parameters as input data are percentage of vegetation cover, slope, soil erosion, and land management. Each parameter has weight 50, 20, 20, and 10 respectively. The biggest weight of those parameters is PVC. The PVC has score 5, 4, 3, 2, and 1. If the land covered by vegetation more than 80%, the PVC score is 5. With the same case score 4, 3, 2, 1 are given if the PVCs condition are $61-80\%$, $41-60\%$, $21-40\%$, and less equal than 20%, respectively.

Usually, PVC can be analyzed using land use map, aerial photo interpretation, and manual interpretation from satellite remote sensing data. Base on theoretical frame, Satofuka et al. [4] mentioned that PVC interpreted from aerial photo has highest precision result. This method needs availability of aerial photograph periodically and the interpretation process is costly and time consuming. Satellite remote sensing data is one of digital data can be use to analyze land cover condition included vegetation cover. PVC will be estimated using NDVI (Normalized Difference Vegetation Index) analysis. NDVI is ratio between digital value (DV) of near infra red band and DV of red band as mentioned in Morawitz et al. [5]. The DV will be generated from satellite remote sensing data. Based on Morawitz et al.[5] and Tittebrand et al. [6] research result, the value of NDVI ratio is represented as the PVC. Because of all of the data used on the soil erosion and critical land analyses are spatial data, Geographic Information Systems (GIS) will be used as tool in this research. Each data is represented by layer, and analysis will be done by overlapping layer by layer.

As mentioned above, the soil erosion will be analyzed using USLE and MUSLE methods. These data will be used as one of input data to analyze critical land classification. ST and BRLKT will be used to analyze critical land classification. Therefore, four critical land classifications will be found from this research. The four critical land classifications are (1) critical land analyzed using ST with soil erosion generated by USLE method, (2) critical land analyzed using ST with soil erosion generated by MUSLE method, (3) critical land analyzed using BRLKT with soil erosion generated by MUSLE method, and (4) critical land analyzed using BRLKT with soil erosion generated by MUSLE method.

Base on research background as described above, the purposes of this research can be defined as follows.

1. To find out the effectiveness of NDVI as input data to analyze the critical land.
2. To make understanding the procedure how to analyze critical land using ST and BRLKT methods base on the GIS.
3. To find out the best method to classify critical land from four classified critical lands produced from this research.

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2 BASIC THEORY

As mentioned before, the soil erosion will be analyzed using USLE and MUSLE methods. Das [7] described those soil equations and can be shown on equation 1 and 2, respectively.

$$E = R \times L \times S \times K \times C \times P \qquad (1)$$
$$E = Rw \times K \times L \times S \times C \times P \qquad (2)$$

Where:

E	= Estimated gross soil erosion (ton/ha/yr)	K	= Soil erodibility factor
R	= Rainfall erosivity factor	C	= Crop management factor
L	= Slope length factor	P	= Conservation practice factor
S	= Slope gradient factor	Rw	= Surface runoff erosivity

Here:

$$Rw = 9{,}05 \, (Vo.Qp)^{0,56} \qquad (3)$$
$$Vo = Ra \, . \, e^{(-Rc/Ro)} \qquad (4)$$
$$Rc = 1.000 \, . \, Ms.\rho b. \, RD. \left(\frac{Et}{Eo}\right)^{0,50} \qquad (5)$$
$$Ro = Ra/Rn \qquad (6)$$

Where:

Vo	= Surface runoff volume (m^3)	Ms	= Field capacity soil moisture (%)
Qp	= Peak discharge (m^3/sec.)	ρb	= Specific weight top soil (mg/m^3)
Ra	= Sum of monthly rainfall	RD	= Effective deep of root (m)
Rc	= Soil moisture capacity	Et/Eo	= Ratio of actual (Et) and potential (Eto) evapotranspirations

Usually, the slope length and slope gradient factors were analyzed together and become topographic factor (LS). The rainfall erosivity, soil erodibility, and topographic factors can be analyzed using the following equations.

$$R = 6{,}12 \, (RAIN)^{1,21} \, (DAYS)^{-0,47} \, (MAXP)^{0,53} \qquad (7)$$

Where:
RAIN = Average annual rainfall intensity (cm)
DAYS = Annual average number of rain days (days)
MAXP = Average maximum daily rainfall intensity per month for one year (cm)

$$K = \{2{,}713 \, M^{1.14} \, (10^{-4})(12 - a) + 3{,}25 \, (b - 2) + 2{,}5 \, (c - 3)\}/100 \qquad (8)$$

Where:

M	= particle size parameter	b = soil structure code
a	= percentage of organic matter	c = soil permeability class

$$LS = L^{1/2} \, (0{,}00138 \, S^2 + 0{,}00965 \, S + 0{,}0138) \qquad (9)$$

Where:
L = Slope length (m)
S = Slope gradient (%)

Critical land analyses were done by ST and BRLKT methods. The critical land classified using ST method can be done by combination between soil thickness data and soil erosion data. The classification of critical land using ST method can be seen in Table 1. From this

Tab. 1)   Critical Land Using ST Method

Soil Thickness (cm)	Soil Erosion Level (ton/ha./year)				
	I	II	III	IV	V
	(< 15)	15 - 60	61 - 180	181 - 480	> 480
> 90	VL	L	M	H	VH
61 - 90	L	M	H	VH	VH
30 - 60	M	H	VH	VH	VH
< 30	H	VH	VH	VH	VH

VL = Very Light, L = Light, M = Medium, H = Heavy, VH = Very Heavy

table it can be seen that if soil thickness is $60 - 90$ cm and soil erosion is $61 - 180$ ton/ha/year, the land could be classified into heavy condition of critical land. By the same way, the critical land condition in the research area will be classified. The second method used to analyze critical land condition is BRLKT method. The input parameters of this method are PVC, soil erosion, slope, and land management. Each parameter have weight are 50, 20, 20, and 10, respectively. Base on the each parameter condition, scoring are given to each parameter. The step to analyze critical land using BRLKT method shows in Figure 1. Score of each parameter can be calculated by timing weight and score of each parameter. The total score is
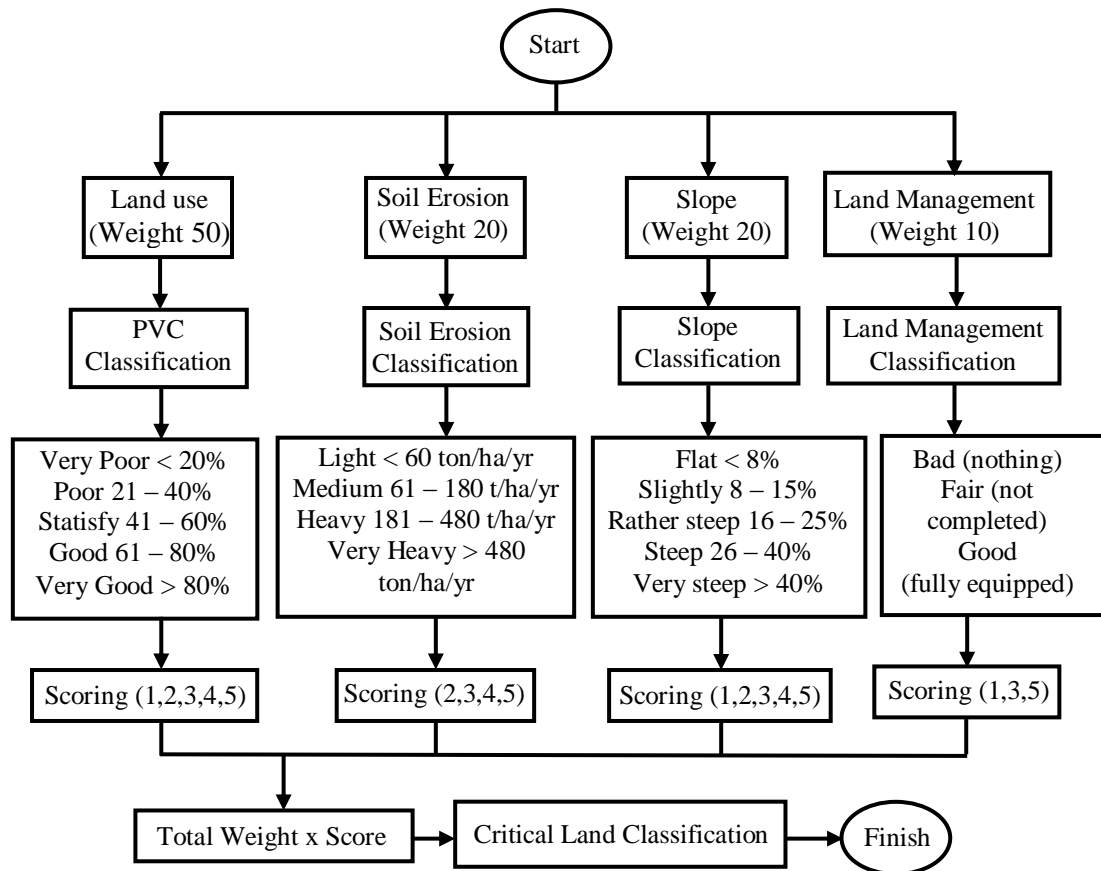
Fig. 1)   Flow Diagram of BRLKT Analysis

sum of score of each parameter. By looking the value of total score the land critical condition can be classified base on the criteria shown in Table 2. For example if the land have PVC in good condition, soil erosion in medium class, slope in steep condition, and land management in fair condition therefore, the total score of that land can be calculated as follows.

Total score = (50x4) + (20x4) + (20x2) + (10x3) = 350.

Tab. 2)   Critical Land Score

No.	Critical Land Level	Total Score
1	Very Critical	120 - 180
2	Critical	181 - 270
3	Rather Critical	271 - 360
4	Potential to Critical	361 - 450
5	Not Critical	> 450

Base on the total score wrote in Table 2, the land is classified to rather critical level. By the same way the score for others unit land can be calculated. Finally, the critical land level of the research area can be classified and land critical map can be generated. This analysis will be done using GIS and total score calculation will be done using geostatistical method.

From Figure 1, it can be seen that the biggest weight of parameters to analyze critical land using BRLKT method is PVC. It is very difficult to analyze PVC using manual method, such as interpretation of land use map, interpretation aerial photograph, and classified from satellite remote sensing data according to manual procedure. Therefore, in this research the NDVI will be used to predict PVC. NDVI have value from -1 to 1. Through the Suharyanto et al. [8] preview research absolute value will be used in this research; it means the NDVI value will be from 0 to 1. Nakagawa et al. [9] determined that zero means that area is not covered by vegetation, and 1 means that area 100% covered by vegetation. Base on the NDVI value, the classification of PVC as shown in Figure 1 can be predicted. The prediction are PVC less than 20% is equal to NDVI less than 0,2, PVC 21 − 40% is equal to 0,21 <NDVI < 0,4, PVC 41 − 60% is equal to 0,41 <NDVI < 0,6, PVC 61 − 80% is equal to 0,61 <NDVI < 0,8, and PVC > 80% is equal to NDVI > 0,8. By using this prediction, the PVC condition of Lesti watershed can be classified.

As experience by Suharyanto [10] the soil erosion and critical land if analyzed using manual method, it will be time consuming and costly. By looking the parameters need to analyze soil erosion and critical land, it can be concluded that all parameters refer to spatial data. Base on this characteristic, GIS will be applied to run the soil erosion and critical land analysis. Consequently, layers for each parameter should be developed. On the soil erosion analysis, layers R, Rw, LS, K, and CP will be developed and overlaid. To calculate the value of soil erosion (E) in Ozcan et al. [11] mentioned that geostatistical method can be applied. The critical land analyzed using ST method was done by overlaid soil thickness layer and soil erosion level layer. Base on combination as shown in Table 1 the critical land of Lesti watershed is classified. The next critical land is classified using BRLKT method. PVC, soil erosion, slopes, and land management layers were developed base on the GIS rule. With overlapping of all layers, the critical land base on total score result is classified due to Table 2.

3   RESULT AND DISCUSSION

This research was done on Lesti watershed occupied 63.750 km^2. This watershed located in Southern part of East Java Province, Indonesia. Lesti watershed divided into three sub basins, namely Lesti Hulu sub basin, Lesti Hilir sub basin, and Genteng sub basin. In Harianto [12] the author mentioned that the outlet of Lesti watershed is Sengguruh dam, which is as cover dam of Sutami reservoir. Because of high soil erosion rate from Lesti watershed, Sengguruh cover dam is necessary to protect the sedimentation on Sutami reservoir. The topographic conditions are from flat land to hilly area with slope from 0% until more than 45%. Six soil types were found in the research area. There are 11 rainfall stations are used in this research. These rainfall stations are distributed in the whole area of Lesti watershed. The illustration of the Lesti watershed condition can be shown in Figure 2. In summarized, the materials were used in this research are:

1. Indonesian Topographic Map in scale 1:25.000 for 15 sheets.
2. SPOT satellite Remote Sensing data with path and row numbers are 297 - 366 and acquisition date on July 16, 2009.
3. Soil type map in scale 1:100.000
4. Soil thickness map in scale 1:100.000
5. Daily rainfall intensity data from 11 rainfall stations on 10 years series (2000 – 2009)

| 15 < E | 15 <= E <= 60 | 60 < E <= 180 | 180 < E <= 480 | E > 480 |
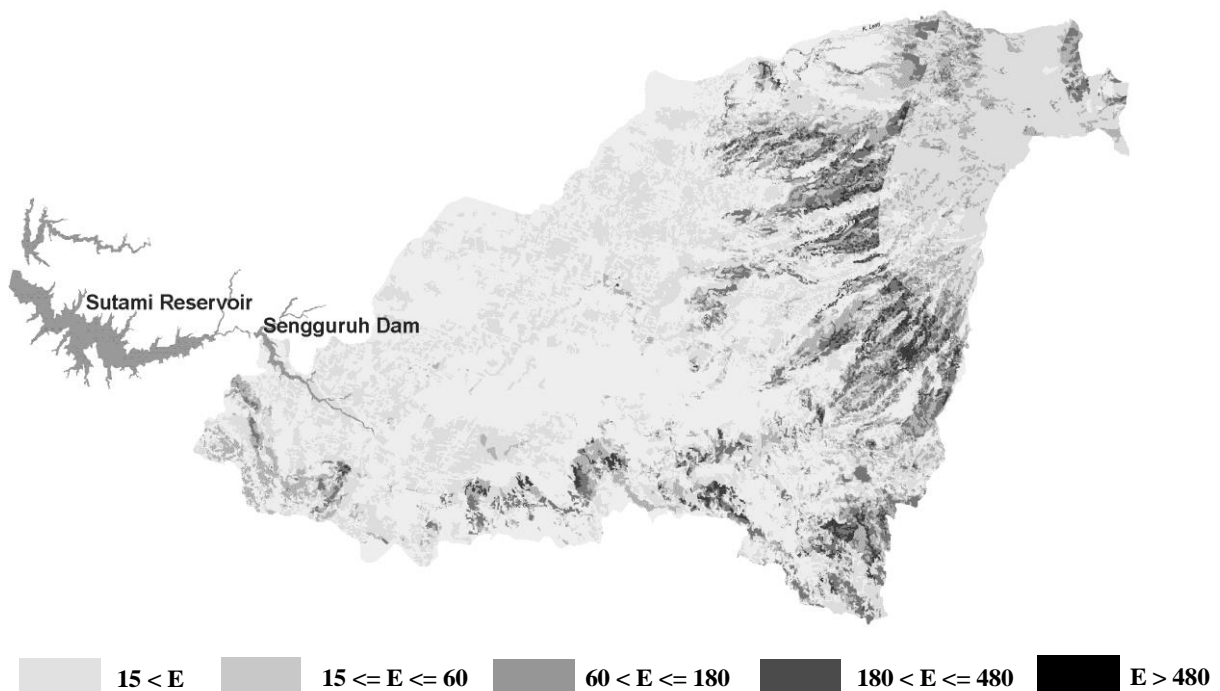
Fig. 2)   Soil Erosion Map USLE

The first step of the analyzing process in this research is determination of the watershed boundary. By interpreting contour pattern from the topographic map, the watershed boundary was delineated. After the boundary of Lesti watershed can be decided, the soil erosion was analyzed. Consequently, the parameters needs to analyze soil erosion should be generated. In principle, the analyses were done as follows. Rainfall erosivity factor was analyzed base on the 11 rainfall stations with 10 years daily rainfall data from 2000 until 2009. The unit map of rainfall erosivity factor is Thiessen polygon, which is generated from 11 rainfall stations. As described in Rodríquez and Suárez [13] the slope length and slope gradient factors were

analyzed together as topographic factor. This layer was developed by classifying slope base on contour data with class interval as shown in Figure 1. Layer soil erodibility was developed base on the soil type map. The crop management and conservation practice was combine as one factor namely land management factor (*CP*). The attribute of this layer (*CP*) was analyzed base on the land cover map generated from SPOT data. After spatial and attribute data of all parameters of USLE method is ready, the processing of overlay was done. By using geostatistical process, the classified soil erosion level data and map can be found as shown in Table 3 and Figure 2. The same way was done for calculating the soil erosion using MUSLE

Tab. 3)   Soil Erosion Level

Soil Erosion Level	Estimated Soil Erosion	Percentage Area	
		USLE	MUSLE
Very Light	< 15 ton/ha/y	45.704	20.921
Light	15 - 60	34.164	22.874
Medium	61 - 180	11.729	21.938
Heavy	181 - 480	6.731	22.227
Very Heavy	> 480	1.673	12.040

method. Unit map of surface runoff erosivity (*Rw*) calculation is sub basin on Lesti watershed. After overlapping all layers, the soil erosion classified using MUSLE method on Lesti watershed can be found as shown in Table 3. From this table it can be seen that soil erosion calculated with USLE have different result with MUSLE method. Both soil erosion data used as input data for calculating critical land using ST and BRLKT methods. From Table 3 it can be seen that soil erosion evaluated using MUSLE be spread evenly for each level. Almost 20% of Lesti watershed area was classified into each level from very light until heavy levels. Only 12% of Lesti watershed was classified into very heavy level. On the other hand, using USLE almost area of Lesti watershed was classified into very light and light level. More less 45% of Lesti watershed was classified into very light level and approximately 35% was classified into light level. Only 8,5% of Lesti watershed was classified into heavy and very heavy levels. How far, the affected of these classified soil erosion to the critical land analysis will be investigated.

Critical land was classified using ST and BRLKT methods. For ST method, soil thickness layer and soil erosion level layers were overlaid. Base to the combination pattern show in Table 1, critical land of Lesti watershed was classified. The classified critical land of Lesti watershed can be shown in Table 4. There are two data of critical land classified using ST

Tab. 4)   Critical Land of Lesti Watershed

Critical Land Level	Percentage of Area (%)			
	Soil Thickness		BRLKT	
	USLE	MUSLE	USLE	MUSLE
Not Critical	39.922	18.399	2.201	0.000
Potential to Critical	35.256	21.865	8.157	0.171
Rather Critical	13.099	21.407	40.487	28.639
Critical	8.348	23.725	38.162	56.682
Very Critical	3.374	14.604	10.993	14.508

method. First is critical land classified with soil erosion classified using USLE and second one is classified using MUSLE. The next critical land is classified using BRLKT method. Four layers were developed in this process. First layer is PVC, was developed based on the NDVI analyses result. Second layer is soil erosion level, was developed base on the USLE and MUSLE soil erosion analyses. Third layer is slope, was developed base on the topographic map. The last or fourth layer is land management, was developed base on landcover map and land management statistical data of Lesti watershed. Landcover was classified using unsupervised classification method with maximum distance classification. This method is described in Mather [14]. The developed four layers was overlaid, and due to the rule show in Figure 1 the total score was calculated using geostatistical method. Critical land of Lesti watershed was classified due to classification rule show in Table 2 base on the total score calculation result. Two critical land classifications were found from the BRLKT analysis. First is critical land classification with soil erosion data input analyzed using USLE and second one is critical land classification with soil erosion data input analyzed using MUSLE. The critical land classified using BRLKT can be shown in Table 4. Figure 3 is shown critical land map classified using BRLKT method with input soil erosion was analyzed using USLE. From Table 4 it can be concluded that the distribution pattern of critical land level classified using ST method is similar with distribution pattern of soil erosion level too. This similarity of distribution pattern was occurred because only two parameters used to classify the critical land using ST method. Those parameters are soil thickness and soil erosion level.
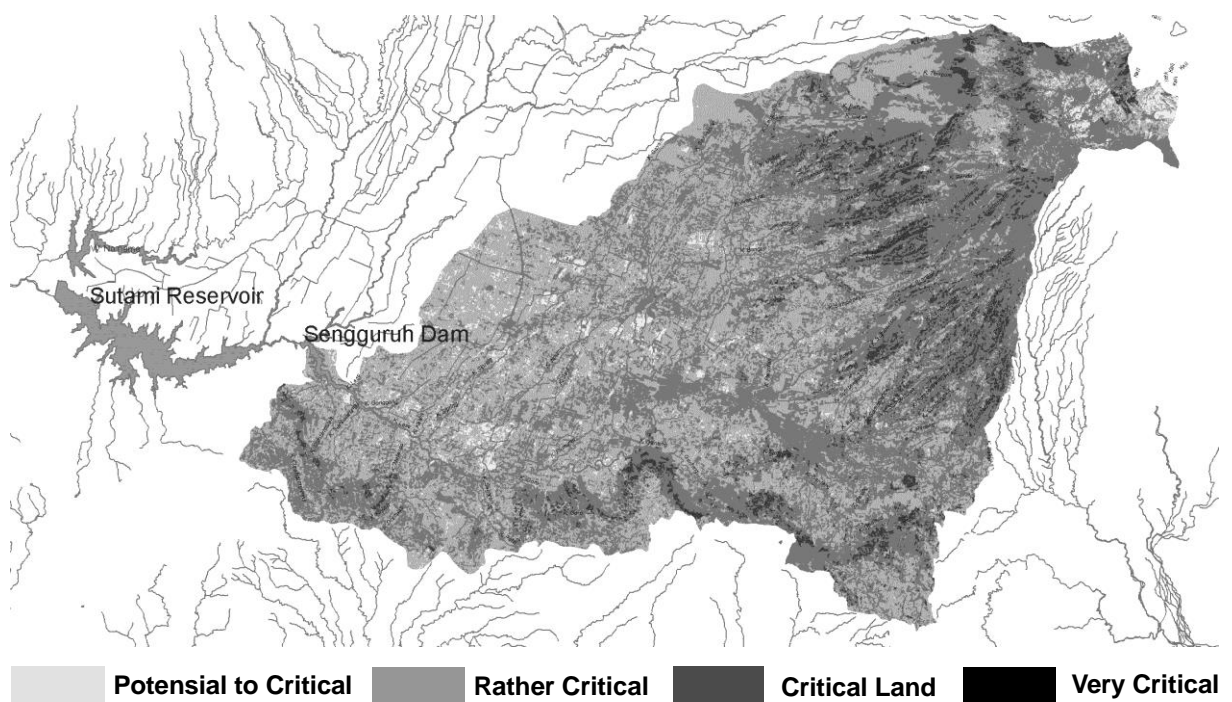
Fig. 3)   Critical Land was Classified Using BRLKT with USLE Soil Erosion

The distribution pattern of critical land classified using BRLKT method with soil erosion input data calculated using USLE is different with soil erosion calculated using MUSLE method. With input soil erosion data calculated using USLE, the biggest area of critical land in Lesti watershed is rather critical level with area is 40,487% of total area. Otherwise, with input soil erosion data calculated using MUSLE, the biggest area of critical land in Lesti watershed is critical level with area is 56,683% of total area. From Table 4 can also be said that there is no area classified into not critical and potential to critical levels in critical land

level classified using BRLKT with soil erosion input data calculated using MUSLE. Therefore, in this research the best result of the classified critical land level using ST and BRLKT methods should be investigated. Here, the best result means the classified critical land level condition is nearest with the ground condition.

To find out the best method of critical land classification, 25 locations were selected as samples for ground check. Five samples for each critical land level were selected. The geographic coordinate of sample were measured using hand held GPS (Geodetic Positioning Systems). By comparing between the critical land condition observed from ground check and critical land from classification result on the same area for each sample, the checked off or agreement of critical land condition can be found. The best method of critical land classification will be selected for the method those have highest number agreement of sampling number. From the agreements between critical lands were found from ground check and from the classification result shows that the highest agreement is critical land classified using BRLKT method with soil erosion input data analyzed using USLE. The agreement is 92%, it mean two samples only it was not agreed. From this agreement it can be seen that PVC generated from NDVI can be used as input data in critical land analysis using BRLKT method. The PVC data is very important, because have weight 50 from 100 total weight. From this result it can be recommended that critical land analysis using BRLKT with soil erosion analyzed using USLE can be used in Indonesia.

In this research, all parameters data of critical land analysis such as rainfall erosivity, slope, soil erodibility, landcover, PVC, soil erosion, etc. are stored layer by layer in GIS format. The formatted data are both in spatial and attribute formats. Therefore, if one or more parameter data changes only data relating with the layer will be changed. Critical land can be classified again by overlapping related layer using GIS process with the one or more new layer data. This classification process is very effective and efficient.

4 CONCLUSION

Percentage of Vegetation Cover (PVC) data is one as important input data in the critical land analysis using BRLKT method. This data was classified base on NDVI data generated from SPOT satellite remote sensing data. The classified critical land using BRLKT method with soil erosion classified using USLE as one of input data have 92% agreement with ground check data. Therefore, it can concluded that PVC classified base on NDVI is effective as input data to analyze the critical land.

All parameters data used in the critical land analyses are stored in GIS format. Both of spatial and attribute data are stored layer by layer for each parameter. The critical land analysis can be done by overlapping the layers relating to the parameters need. After overlapping process, critical land can be classified using geostatistical process. This classification process is fast and precise. Base on the critical land classification process was using GIS procedure, it can be concluded that the procedure how to analyze critical land using ST and BRLKT is very effective and efficient.

The accuracy of classified critical land using ST and BRLKT methods was estimated by comparing with the field condition observed by ground check. Critical land level classified using BRLKT method with soil erosion classified using USLE as one of input data has 8% disagreement. From this result it can be concluded that the highest accuracy of classified critical land from four classified critical lands produced in this research is critical land classified using BRLKT method with soil erosion generated from USLE. Therefore, it can be

recommended that BRLKT critical land classification method with soil erosion analyzed using USLE as one of input data should be used to classify critical land in watershed area in Indonesia.

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FLOOD PROTECTION MEASURES IN THE REPUBLIC OF CROATIA

Marija Šperac[1], Anamarija Rabi[2]

Abstract

Flood protection in the Republic of Croatia is a very complex process due to the vast hilly and mountainous areas with high rainfall intensities, large lowland river valleys, cities and valuable goods of the potentially affected areas, and lack of built and maintained protective systems. It is estimated that flooding potentially threatens about 15% of state land territory of which the greater part is now protected with different levels of security. Natural floods which occur in Croatia can be divided into five basic groups: river flooding due to heavy rains and/ or rapid melting snow and torrential flooding of small streams due to the short-term high-intensity rainfall, flooding in karst areas due to heavy rains and/or rapid snow melt and insufficient capacity of permeable natural sinks, flooding inland waters in lowland areas, glacial floods. Flood protection measures to be implemented are: structural measures and non-structural measures.

Key words

Flood protection, nature park, non-structural measures, structural measures, water management.

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1   INTRODUCTION

A flood is an overflow of water that submerges land. The Europian Union (EU) Floods Directive defines a flood as a covering by water of land not normally covered by water [1]. In the sense of "flowing water", the word may also be applied to the inflow of the tide. Flooding may result from the volume of water within a body of water, such as a river or lake, which overflows or breaks levees, with the result that some of the water escapes its usual boundaries [2], or may be due to accumulation of rainwater on saturated ground in an areal flood.

Flood defense is of strategic importance for each country. Human sacrifice and suffering, as well as the size of direct and indirect losses resulting from floods give a special dimension to the seriousness of approach in the design, construction, maintenance and management of hydro-technical systems for flood control. Communities worldwide face dangers due to floods induced by natural events or technical failures. These vulnerabilities are increasing due to continued settlement along coastlines and in floodplains, and may be exacerbated in future by climate change [3].

Natural floods which occur in Croatia can be divided into five basic groups: river flooding due to heavy rains and/or rapid melting snow and torrential flooding of small streams due to the short-term high-intensity rainfall, flooding in karst areas due to heavy rains and/or rapid snow melt and insufficient capacity of natural sinks permeable interior flood waters in lowland areas, glacial floods [4].

2   FLOOD PROTECTION IN CROATIA

The continental area of the Republic of Croatia is 56.538 km2, with 35.131 km2 (62 %) belonging to the Danube River Basin, and 21.407 km2 (38 %) to the Adriatic Sea Basins. The Danube flow in Croatia constitutes the state border with Serbia (Fig. 1) with the total length of about 135 km. Dikes along the Danube River have been built on the Baranja section, from the Croatian - Hungarian state border down to the Drava River mouth, approximately 100 km in length. This area is mainly protected of 100-year flood period. In Croatia, the basin of the Danube there are two natural wetlands: Kopački rit and Lonjsko polje. They are a good indicator how safe natural wetlands receive high water and do not threaten human property. In north-western vicinity of the Drava mouth into the Danube River, in the triangle of Danube and Drava rivers and the Hungarian state border, is the Nature Park Kopački rit. The area downstream of the Drava River mouth to the state border with Serbia near the town of Ilok is mainly protected by high riverbanks. Nature Park Lonjsko polje is located in the central part of the Croatia and it is the largest protected area, not only in Croatia but also in the Danube River basin.

Flood protection in Croatia is conducted according to the State Flood Protection Plan adopted by the Government of the Republic of Croatia. However, carrying out of flood protection of local waters systems rests on flood protection plans for river basins gradually adopted by county assemblies on the basis of proposals put forward by Hrvatske vode (*Croatian Waters*).

Flood protection plans include [5]:

- list of measures to be taken prior or in case of flood occurrence;
- water levels at which certain sectors initiate preparation, regular protection;
- emergency protection or emergency status;
- regulations on the equipment and materials to be prepared for flood protection;

- list of companies which will conduct flood protection;
- list of experts involved in flood protection (names, duties, authorities and responsibilities);
- methods of informing the public on occurrences and measures during flood protection;
- survey of ice protection measures on watercourses.
- Hrvatske vode, the company which coordinates the work of individual services for protection against harmful effects of water within regional departments, is in charge of implementing operative measures of flood protection.
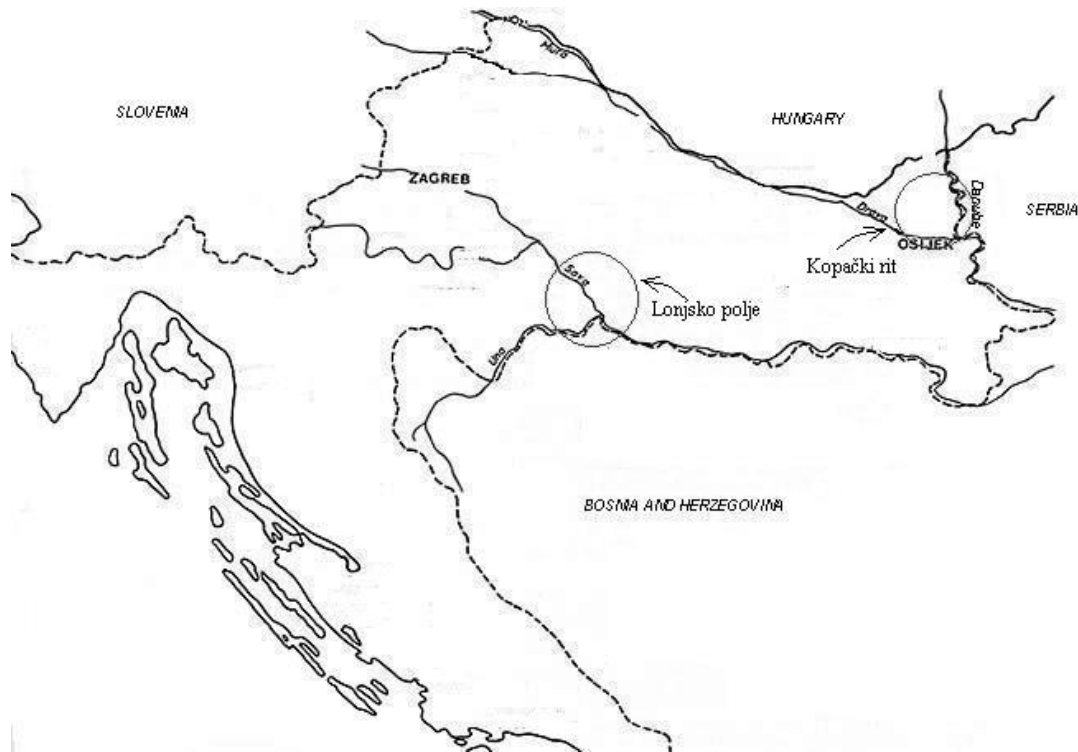
Fig. 1)   Rivers Sava, Drava and Danube as the state borders of Croatia

2.1   Structural flood control measures

Regardless of the type of hydro system to protect against flooding, there is always the likelihood of its occurrence. This probability has a twofold origin. One is related to the probability of occurrence of hydrological events that exceed design requirement basis from which the system was designed and built. Other is related to the failure possibility of individual system elements. Failures may occur due to electrical engineering and hydromechanical equipment, human factors, or to demolition of buildings or intolerable strain. There are different approaches to the prevention of damage resulting from flooding. The first approach "Absolute" protection of the built system which includes a range of flood for hydrologic events in large return periods 100-1000 or more years. State institutions are responsible for the prevention, insurance and possible failure of the prevention systems as well as the compensation due to the failure. Another approach to shared responsibility. The user of land can be insured against damage from flooding with an insurance company. Premium insurance will depend on the size of the risk that comes by flood and on the land. The assessment will show whether the land is worth such an arrangement. The second approach is mainly used in when it comes to protecting agricultural land and/or when the system protection flooding and its maintenance exceeds the value of damage prevented. The

system for passive protection is protection from flooding area so as to affect the prevention of the consequences. In this approach, where hydrological event causes a large water wave, we must let the water stream so as not to flood the surrounding area. The system of active flood protection affects the cause of flooding, which is a water wave. Different interventions affect the remodelling of the water wave, or its 'flattening'. Its shape changes in time and/or spatial redistribution of water quantity. Preventing leakage of water in parts of the hinterland, and the increasing speed of propagation of water wave's embankments adversely affect downstream river sections in terms of flood. These adverse effects are short and relate only to the occurrence of floods, and in all other periods dams do not affect the water regime. Dams are usually constructed of natural materials and at a sufficient distance from the river beds, so it does not affect coastal ecological characteristics watercourses.

Construction of multipurpose reservoirs allows the efficient use of water for various purposes, and if their volume is large enough to use for receiving parts of large volumes of water waves, and thus to relieve the maximum flow at the downstream. Increased releases of water in the drier periods of large reservoirs can be used to recharge small waters, so to regulate the water regime.

2.2   Non-structural flood control measures

Operational flood defense of the state waters is conducted in accordance with the State plan of flood control adopted by the Croatian Government [6]. Operational flood defense of the local waters is conducted in accordance with the plans for flood catchment areas brought by the county assembly based on the proposal of Hrvatske vode.

Monitoring and forecasting of meteorological phenomena. For more efficient implementation of the operational flood defense part of the relevant flow gauage is automated, which ensures that the data on water levels in the field is available to centers for flood protection in real time.

Systematic forecasting of water levels and flow in Hrvatske vode is carried out for 5 characteristic locations in the section of River Sava from the state border with neighboring Slovenia to Jasenovac (Jesenice, Zagreb, Rugvica, Sisak - Crnac and Jasenovac), and for River Kupa in Karlovac, but this is insufficient.

Water resources. In order to prevent inappropriate use of land necessary for the maintenance and improvement of water regime, i.e. for the normal functioning of the existing water management system, for its regular economic and technical maintenance, and for their development, the Water Act stipulates that water resources are the land parcels that comprise the aquifer and abandoned riverbed of inland surface water, decorated unfurnished inundation zone and the islands in the aquifer.

Land parcels that belong to water resources and are owned by the Republic of Croatia. For other land parcels that are not owned by the Republic of Croatian and they belong to the water resources, Republic of Croatia has a priority of first buy.

Financial asset insurance from uncovered flood risks. There is practically no financial asset insurance from uncovered flood risks, which is mainly a result of acquired habits related to the former social order. With changes of ownership relations and development of market economy, such measures will be increasingly applied, which will require appropriate adjustments to the relevant institutions [4].

2.3 The role of wetlands in flood protection

Importance of wetlands is a known significant natural heritage. Wetlands are generally part of the riparian areas along the river. One of the most important benefits of wetlands is a natural defense against   flooding. Floodplain wetlands successfully 'absorb' the excess water - water is poured slowly and controlled, and the river loses its force. This area of the river may be wide, only a few tens of meters, but when you consider the miles of the belt, then the amount of water that can soak up is huge. In Croatia, in the basin of the river Danube there are two natural wetlands Kopački rit and Lonjsko polje. They are a good indicator how safe natural wetlands receivine high water and do threaten human property. Kopački Rit is a flooded area in the northeast Croatia in the confluence of the river Danube and one of the largest alluvial areas in Europe. This area during the year significantly changes its appearance depending on the intensity of flooding, mainly from Danube and much less from the river Drava. Fig. 2 shows the aerial view of ponds, meadows and forests in Kopacki Rit. Due to its preservation as rare wetland ecosystems of great biodiversity and outstanding scientific and ecological value, Kopacki Rit in 1967 got the status of the protected area. The area of 17 730 hectares the Nature Park and Special Zoological Reserve were assigned as an area of international importance being part of the Natura 2000 Networking Program.

Fig. 2)   Aerial view of ponds, meadows and forests in Kopacki Rit [7]

Nature Park Lonjsko polje is the largest protected area, not only in Croatia but also in the Danube River basin, which is included in Ramsar List of Wetlands on February 3, 1993 [8]. Rivers Sava, Una, Kupa, Lonja and Struga meet on the area of Nature Park Lonjsko polje (Fig.3). The river Sava is a river in Southeast Europe, a right side tributary of the Danube river discharging in Belgrade. The dynamics of these rivers are very complex. Therefore, in this area floodings are unpredictable and may occur at any period of the year. It is among the most vulnerable parts of the swamp in the world. Wetlands are cheap and efficient flood protection system.
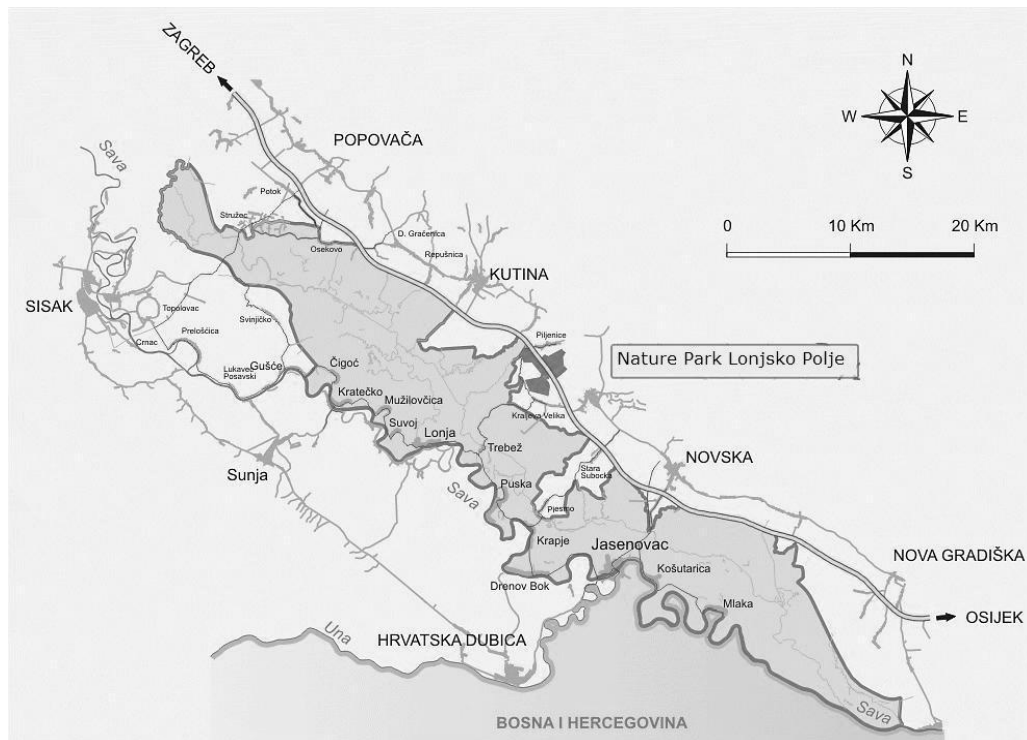
Fig. 3)   Map of Lonjsko polje [9]

3   CONCLUSION

The cause of flooding are extremely heavy rains or rapid melting of snow combined with a significantly reduced ability to detain stormwater in areas (mainly because of damage of the country – e.g. drained wetlands, farmland, and drainage).

The total catchment area hydrological response to intense rainfall is determined by its natural environment, a whole complex of characteristics of the river basin.

Preventive measures for flood protection in the entire basin take into account the mutual interactions of the effects of individual measures. For effective protection against flooding it is necessary to select an appropriate combination of catchment planning in order to maintain or enhance the natural retention capacity of soil and vegetation, and technical measures that affect the reduction of peak flood flow of the waves and protect banks. It is necessary to balance the situation between the demands for further urbanization and economic use of space and the need to use the land to slow runoff and water retention in the catchments. For the planning of protective measures it is necessary to use reliable data and information about existing and planned land use of hydrometeorological and geomorphological characteristics of an area, the vegetation cover, and the types of soils. It necessary to apply advanced IT that allow amendments to existing knowledge on the formation of floods, improve knowledge regarding the propagation of flood waves, and also allow assessment of the effectiveness of selected measures in the basin and along the river. For the effective operation of flood control it is necessary to constantly improve existing systems for hydrological forecasting and information transfer and use that information to provide all the relevant factors during the flood, and facilitate the implementation of plans for flood control.

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A MULTICRITERIA FLOOD HAZARD ASSESSMENT IN THE SELECTED COUNTRIES

Martina Zeleňáková[1], Lenka Gaňová[2]

Abstract

Flood events are part of nature. They have always existed and will continue to exist. Floods can be hazardous, but are also a very important ecological factor for riverine ecosystems and species. Due to the present change in the Earth's climate the precipitation pattern will also change. Humid areas will generally become more humid and arid areas more arid. The amount of precipitation will also fluctuate more sharply. In general, this means a greater probability of hazardous flooding and unexpected risk. The results of recent studies have substantiated these apprehensions. There is therefore an urgent need to introduce mitigation measures to ensure that these areas are protected so that erosion and flooding is minimized. The first step in achieving this is to identify the nature and extent of vulnerability of the areas under consideration. One of the best possible approaches for identifying flood vulnerable areas is to use multicriteria analysis and geographical information systems (GIS). The aim is to provide more flexible and more accurate decisions to the decision makers in order to evaluate the effective factors.

The paper deals with flood hazard and vulnerable areas assessment using multicriteria methods and geographical information system in Turkey, India and Nigeria.

Key words

Causative factors, flood, geographical information system, multicriteria analysis.

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1   INTRODUCTION

Flooding can result not only in costly damage to property, but can also pose a risk to life and livelihood. The flood damage caused by heavy rainfall is one of the most important natural disasters and affects human life and social development [1].

Activities in flood plains and catchment areas such as land clearing for urbanization or agriculture, or construction of infrastructure such as highways, roads and bridges across the flood plain may increase the magnitude of flooding, which in turn increases the damage to property and life [2]. Flood related problems and many other applications proved that these problems could be solved through planning studies and detailed projects about flood prone areas [3]. At present, one of the ways to study and understand flood behavior is by generating flood extent models and mapping flood-vulnerable areas [4].

A GIS – based multicriteria flood risk assessment methodology was developed and applied for the mapping of flood risk in much country. The aim in integrating multicriteria decision analysis (MCDA) with geographical information systems (GIS) is to provide more flexible and more accurate decisions to the decision makers in order to evaluate the effective factors. The selection of criteria that has spatial reference is an important step in MCA [5].

Multicriteria analysis (MCA) methods have been applied in several studies in the world wide [5, 6, 7]. MCA method was used to analyze and find the flood vulnerable areas in study areas. The main aim of these studies was to generate a composite map for decision makers by using main effective factors causing floods.

2   FLOOD HAZARD AND FLOOD VULNERABLE AREAS ASSESSMENT

2.1   Flood vulnerable areas assessment in Turkey

Yalcin et al. [5] applied a GIS-based multicriteria evaluation in order to analyse the flood vulnerable areas in south-west coast of the Black Sea. The Ranking method and Pairwise comparison method were introduced and applied. The West of Black Sea in the north of Turkey has the heavy local rains and snow melting, especially in springs. In this region, there are two main river basins: Filyos Basin and Bartın Basin. Being a floodprone area, Bartın is selected as the study area (fig. 1).
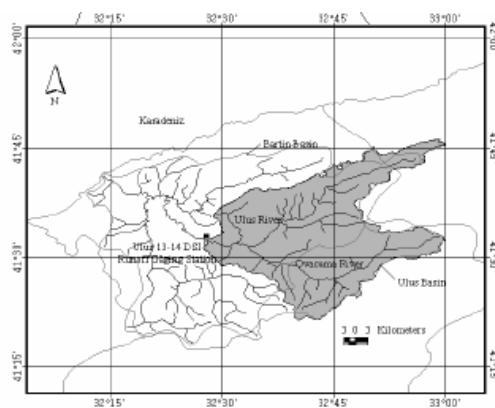
Fig. 1)   Study area

The evaluation procedure consisted of the following steps: assessment of vulnerability structure, producing map layers, cartographic modelling and sensitivity analysis. For selected causative factors (annual rainfall, size of watershed, slope of watershed, gradient of main drainage channel, drainage density, land use and soil type), the criterion values were generated.

The criterion weights were calculated as 0.26, 0.21, 0.17, 0.16, 0.10, 0.06, and 0.04 respectively for annual rainfall, size of watershed, basin slope, gradient of main drainage channel, drainage density, land use and type of the soil. With the input values in pairwise comparison and weights calculated, consistency ratio (CR) was found as 0,042. This indicated a reasonable level of consistency in the Pairwise comparison of the factors. Three composite maps showing the flood vulnerable areas were created using multicriteria evaluation methods with GIS, namely Boolean method and two WLC methods are presented in figure 2.
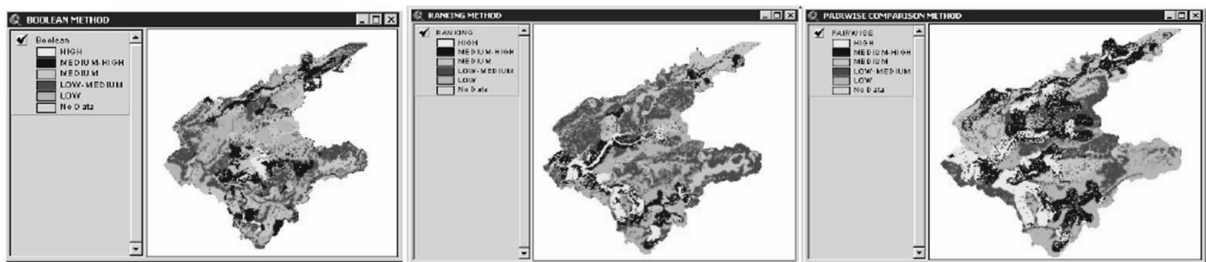
Fig. 2)   The final map that is created with Boolean method, Ranking method and Pairwise comparison method

The flood vulnerable areas in the study region were evaluated in five classes – high, medium-high, medium, low-medium and low.

After the flood vulnerable areas were determined, the areas at risk were obtained by overlaying the vulnerable areas with the cadastral parcels (fig. 3).
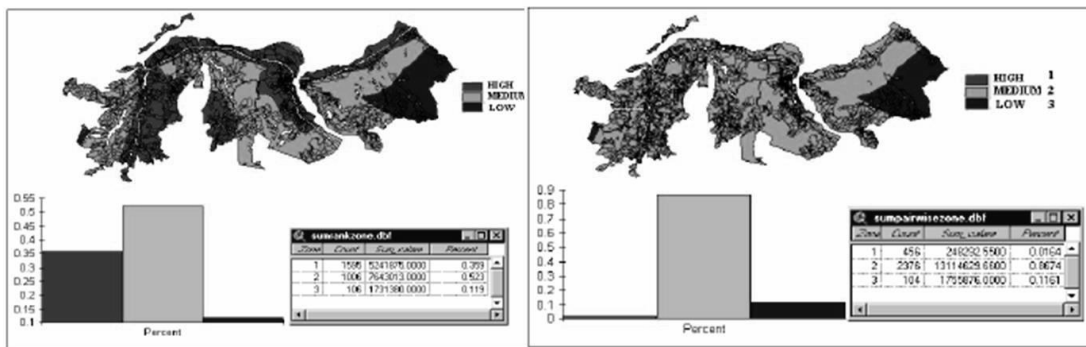
Fig. 3)   Areas under risk according to the risk degree and the percentage - Ranking method and Pairwise comparison method

In order to represent the information of the parcel at risk, a database was created. Block number, parcel number, total area of the parcel, flooded area, owner name-surname, address had been entered in the database.

2.2   Flood hazard assessment in India

Chadran et al. [6] presented an efficient methodology to accurately delineate the flood hazard areas in Vamanapuram River Basin in a GIS environment. The Vamanapuram River Basin is bounded by Nedumangad Taluk of Thiruvananthapuram district in the South, Kottarakkara Taluk of Kollam districts in the North, Tamil Nadu in the East and Arabian Sea in the West. The watershed has a total area of 691.46 km2. The map of Vamanapuram River Basin is shown in the fig.4.
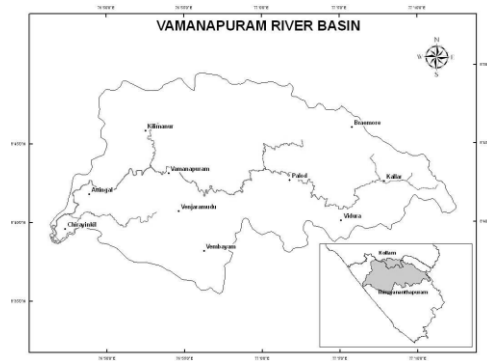
Fig. 4)   Schematic Diagram of Vamanapuram River Basin

A number of contributing factors including annual rainfall, size of watershed, slope of watershed, gradient of river and stream, drainage density, type of soil and land use, communication line and infrastructures are considered for rating the degree of hazard by means of weighting.

Data and software used to create the flood hazard map in Vamanapuram River Basin are: topographic sheets (Map scale 1:50 000), satellite imagery, land use map (Toposheed+Satellite imagery), soil data (Kerala State Landuse Board), rainfall data (Annual rainfall data of 1977-2000 were collected from IDRB, Trivandrum), computer hardware and software which include ArcGIS 9.1.

The methodology can be divided in to mainly two phases:

- Preparation of maps
- Analysis and compilation of flood hazard map

After digitizing and plotting the maps, the rank of each factor was given on the basis of its estimated significance in causing flooding. The rank of each factor is follows: average annual rainfall = 8, size of watershed = 7, slope of watershed = 6, gradient of main drainage channel = 5, drainage density = 4, land use = 3, type of soil = 2, communication lines and infrastructure = 1.

Besides, each factor was divided into a number of classes and each class, weighted according to the estimated significance for causing flooding. The maximum weight for each class of every factor is 8 whilst the minimum is 2. The total weight used for considering the rate of probability of flooding, defined as score is calculated as below:

Score of each factor = rank of factor x weight of factor class

In the next step, a map of every contributing factor compiled and the weight identified. In the procedure, the net probability of occurrence of flooding in each flood hazard zone is estimated from the total sum of the weight of each contributing factor considered. To obtain this total sum weight, all of contributing factor maps was overlaid. The total weight (Score) for

estimating the probability of flooding in a particular flood hazard zone = the sum of every contributing factor. All of these processes, the compilation of contributing factor maps, the overlaying of all maps and the calculation of total weight were obtained by applying ArcGIS 9.1. Flood hazard map was prepared (fig.5) and hazard areas were calculated.
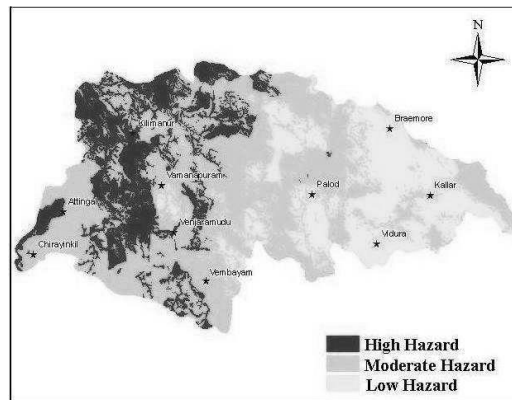
Fig. 5)   Flood hazard map

From the flood hazard map prepared, the high hazard area is found to be 178.94 km^2 (25.88%), moderate hazard area is found to be 380.95km^2 (55.09%) and low hazard area is found to be 131.83 km^2 (19.03%).

2.3   Flood vulnerable areas assessment in Nigeria

Yahaya et al. [7] identified flood vulnerable areas in Hadejia-Jama'are RiverBasin Nigeria by using a spatial multicriteria evaluation technique. Pairwise comparison method (Analytical hierarchy process-AHP) and Ranking method were applied in the study.

The Hadejia-Jama'are River Basin lies in the northeastern corner of Nigeria (lat 12° 26″ N and long 10°04″) within Kano, Jigawa, Bauchi, Yobe and Borno States. At Gashua the area is drained by the Hadejia and Jama'are rivers, the principal rivers of the basin, is 61,120 km2. These rivers merge to form the Yobe which flows on to reach Lake Chad at Yau draining a total area of 84,138 km2.

Basically two phases are applied in this study to analyze the flood vulnerability structure: to determine effective factors causing flood and to apply several approaches to multicriteria evaluation (MCE) in a GIS environment to evaluate in finding the flood vulnerable areas. To evaluate the flood vulnerable areas, two approaches were used: Boolean overlay approach, and Weighted linear combination (WLC) approach. While Boolean overlay is used for Boolean approach, in WLC approach two methods are used: Ranking and Pairwise comparison method.

The selection of criteria that has spatial reference is an important step in multicriteria decision analysis. The criteria used in this study were selected due to their relevance in the study area, these are listed: rainfall (precipitation) – C1, drainage network of the river basin – C2, slope of the basin – C3, soil type – C4, land cover – C5.

There are several stages to prepare this data for GIS environment. Arc View 3 V3.2 with ArcGIS V9.1was used as professional GIS packages, for the purpose of manipulating and processing data within a GIS environment. Matlab was also used in the calculations of the matrix for Pairwise comparison technique (Analytic hierarchy process).

All the spatial data created in different layer are converted into compatible GIS format, and then the attributes tables created for each particular layer by using ARCGIS.

Multicriteria analysis is applied in producing and combining spatial data describing the causing factors. In the first part, the vulnerable areas are produced by numerically overlaying a map layer describing the study area. This overlay is carried out as a Boolean overlay. All criteria are combined by logical operators such as intersection (AND) and union (OR).

In the second part Ranking method was used. In Ranking method, every criterion under consideration is ranked in the order of the decision maker's preference. To generate criterion values for each evaluation unit, each factor was weighted according to the estimated significance for causing flooding. The inverse ranking was applied to these factors. 1 is the least important and 5 is the most important factor. Using Rank sum method the criterion weights were calculated as listed in following table 1.

Tab. 1)   Weight assessment by Rank sum method

Criterion	Straight Rank	Weight (n-rj+1)	Normalized Weight	Weight in %
1	1	5	0.333	33.3
2	2	4	0.267	26.7
3	3	3	0.200	20.0
4	4	2	0.133	13.3
5	5	1	0.067	6.7
Sum		15	1	100

In the third part Pairwise comparison method is used in determining the weights for the criteria as listed in following table 2.

Tab. 2)   Square pairwise comparison matrix of the selected criteria

Criterion	C1	C2	C3	C4	C5	Priority vector
C1	1	2	2	2	4	0.339
C2	0.5	1	2	2	4	0.255
C3	0.5	0.5	1	2	4	0.197
C4	0.5	0.5	0.5	1	4	0.152
C5	0.25	0.25	0.25	0.25	1	0.0574
Total	2.75	4.25	5.75	7.25	17	1

A composite map (fig. 6) showing the flood vulnerable areas were created using multicriteria evaluation methods with GIS. In this application, the range numbers are designated as high, medium, low on the output map depicting the level of flood vulnerability of the study area, percentage of each zone to flood vulnerability was also calculated as 48.4 %, 19.47 %, 32.13 % respectively, the first shows areas less susceptible to flood and as it progresses the vulnerability structure increases**.**

The flood vulnerable map can give planners, insurers and emergency services a valuable tool for assessing flood risk. Each of them needs to assess risk for more than one scenario. A project including these vulnerability maps should be used on land planning and management alternatives.
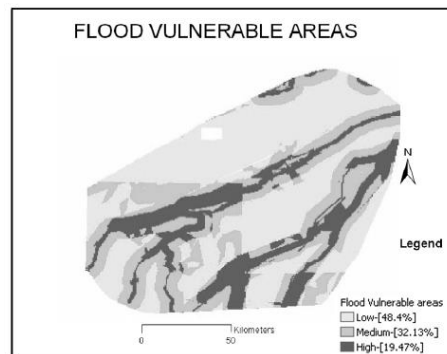
Fig. 6)   Flood vulnerable areas

3   CONCLUSION

The increase in damage due to natural disasters is directly related to the number of people who live and work in hazardous areas and who continuously accumulate assets. Activities in flood plains and catchment areas such as land clearing for urbanization or agriculture, or construction of infrastructure such as highways, roads and bridges across the flood plain may increase the magnitude of flooding, which in turn increases the damage to property and life. At present, one of the ways to study and understand flood behaviour is by generating flood extent models and mapping flood-vulnerable areas.

Accurate and current floodplain maps can be the most valuable tools for preventing severe social and economic losses from floods. Accurately-updated floodplain maps also improve public safety. Early identification of flood-prone properties during emergencies allows public safety organizations to establish warning and evacuation priorities.

This paper presents using multicriteria analysis and geographical information system for flood hazard and flood vulnerable areas assessment in India, Nigeria and Turkey.

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ASSESSMENT OF STRESSORS IN ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Lenka Zvijáková[1], Martina Zeleňáková[2]

Abstract

Hydraulic structures give rise to various stressors that significantly affect the environment. The aim of this paper is the identification of selected stressors and application the risk assessment methodology for quantification risk of these stressors on the environment. The risk assessment methodology has been used primarily to assess the environmental risks associated with the proposed activities. The aim is to propose and evaluate the risk index for selected stressors in the Environmental Impact Assessment process.

Key words

Assessment, EIA - Environmental Impact Assessment, likelihood, probability, risk, stressor.

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1   INTRODUCTION

Environmental degradation and the depletion of natural resources induced by human activities have attracted steadily growing concerns in the last decades. Such concerns made evident the necessity for the planning authorities to count on sound information about the possible environmental consequences of development actions. One of the tools available to satisfy this need is represented by the procedure of Environmental Impact Assessment (EIA). This procedure involves the systematic identification and evaluation of the impacts on the environment caused by a proposed project. EIA is now applied worldwide [1].

The weaknesses of the EIA process are methods used within the EIA. The challenge for environmental research is to improve the guidance provided to impact analyses so as to encourage good practice within EIAs, and to eventually strengthen the consideration of environmental issues in the decision-making concerning new projects. To this end, the application of risk assessment to EIA has been chosen as the subject of this research.

Any project entails a set of activities over period of time, project activities occur either during the construction period or during the operations or in both periods. Such activities generate some stressors, which may have impacts on the environment. Types of environmental stressors typically include noise, air pollution, radiation, vibration, waste, etc.

Is a growing need to establish adequate indicators to assist in the decision-making process regarding matters of projects. Likewise, environmental impact assessments require the indicators to be based not only on thorough scientific foundation [2].

The environmental impact quantitative assessment is generally carried out following two different strategies. One of these strategies is based on the direct quantification of the experts' judgements using ordinal scales. After this judgement process the quantification is weighted and aggregated [3], [4], [5]. In this case, the experts' opinion is the only reference available for the evaluation of the environmental impact. Hence, the suitability of the assessment depends entirely on the preparation, experience and objectivity of the experts.

The other strategy is to quantify the impacts by using indicators in order to obtain the difference of environmental quality between "with project" and "without project" situations [6], [7], [8]. This strategy is desirable because it allows for verifiable assessments to be made [9].

However, the appropriateness of the quantification depends on the reliability of the indicators used [10]. Quantifying the environmental impacts is often problematic. This paper provides an overview of the environmental impacts of the hydraulic structures.

2   MATERIAL AND METHODS

The aim of this paper is to classify the impact of stressors to the environment by the risk index calculation. To accomplish this task was used choose Universal Matrix of Risk Analysis (UMRA) which has two phases [11]:

1. Verbal phase of the UMRA focuses on the identification of
   - vulnerable components of the environment,
   - stressors that threaten environmental components.

The result of this phase (Tab.1) is the initial matrix which is used in the numerical phase.

2. Numerical phase includes:

- estimation the likelihood (probability),
- determination the consequences,
- calculation of the risk index for each stressor.

Both likelihood and consequence are expressed by qualitative measures using either descriptive words (description of impact) or quantitative measures (numerical values).

The numerical phase focuses on the risk index calculation. Risk index (RI) is a function of two key parameters: likelihood (L) and consequence (C)

$$RI = L \times C \tag{1}$$

It is necessary to establish the parameters of the likelihood and consequences the impact of stressor for the determination of the risk index.

3 RESULTS AND DISCUSSION

A simple matrix of interactions of "stressors" and environmental "impact to..." is shown in Tab. 1. It presents impact of stressors to compounds of the environment (marked as ●).

Tab. 1) Identification of impact stressors to the environment

Stressor \ Impact on	population	rock environment, minerals, geodynamic phenomena	climatic conditions	atmosphere	water ratios	land	fauna, flora and their habitats	country – the structure and land use, landscape	protected areas and their buffer zones	territorial system of ecological stability	urban complex and use of land	cultural and historical monuments, cultural values of incorporeal character	archaeological and paleontological sites and important geological sites	other
Floods	●				●	●	●	●	●	●	●	●	●	

Prerequisite for effective assessment of the potential impact of hydraulic structure to the environment is a set of criteria for determination the level of the likelihood and the consequence. Selection, arrangement and evaluation of the criteria in the final assessment are complex and time demanding process. Important prerequisite for the creation of purpose oriented set of criteria is the correct classification of each the numerical or verbal characteristics.

Determination of these values is based on the standards, laws or literature, as well as subjective suggestions. All level of consequences and likelihood at Table 2 and their characteristics were determined after reviewing scientific resources.

Tab. 2)   Criteria for determine level of likelihood and consequence

	Impact to population			
Stressor: Floods	Likelihood „L"	Territory with the existing potential significant flood risk (see [3])	Consequence „C"	Permanently resident population (n)
	0,25	no	0,25	0 - 100
	0,50	no	0,50	101 – 500
	0,75	yes	0,75	501 – 1000
	1	yes	1	≥ 1001

	Impact to water ratios			
Stressor: Floods	Likelihood „L"	Territory with the existing potential significant flood risk (see [3])	Consequence „C"	Designated flow Q_n (m^3.s^{-1})
	0,25	no	0,25	$\geq Q_{100}$
	0,50	no	0,50	$< Q_{100}$
	0,75	yes	0,75	$< Q_{50}$
	1	yes	1	$\leq Q_{20}$

	Impact to land			
Stressor: Floods	Likelihood „L"	Land cover type (see [13])	Consequence „C"	Technical flood protection measures (-)
	0,25	grassland landscape	0,25	construction of a dry tank and stabilization of the stream
	0,50	agricultural landscape	0,50	regulation and stabilization of the stream in an urban zone, ensure the regulation of runoff water and flow capacity in the stream
	0,75	agricultural forest landscape	0,75	maintenance of the river basin, the river bed and riparian vegetation
	1	urban landscape	1	no technical flood protection measures are implemented

	Impact to fauna, flora and their habitats			
Stressor: Floods	Likelihood „L"	Territory with the existing potential significant flood risk (see [3])	Consequence „C"	Qualifying point (see Tab. 3)
	0,25	no	0,25	0 – 1
	0,50	no	0,50	2 – 5
	0,75	yes	0,75	6 – 9
	1	yes	1	≥ 10

	Impact to country - the structure and land use, landscape			
Stressor: Floods	Likelihood „L"	Territory with the existing potential significant flood risk (see [3])	Consequence „C"	Interruption or alteration of riverbeds (km)
	0,25	no	0,25	0 - 2
	0,50	no	0,50	3 - 4
	0,75	yes	0,75	4 - 5
	1	yes	1	6 and more

Stressor				
Stressor: Floods	Impact to protected areas and their buffer zones			
	Likelihood „L"	Territory with the existing potential significant flood risk (see [3])	Consequence „C"	Location of the proposed activity (according to the Slovak legislative on Landscape protection)
	0,25	no	0,25	outside the protected area
	0,50	no	0,50	at least one protected area with the highest 1. – 2. protection level of 1 groups and in a protected area of 2 and 3 groups
	0,75	yes	0,75	at least two protected areas with the highest 3. – 4. degree of protection and in a protected area of 2 and 3 groups
	1	yes	1	in three or more protected areas
Stressor: Floods	Impact to territorial system of ecological stability (TSES)			
	Likelihood „L"	Technical flood protection measures (-)	Consequence „C"	Interference in the TSES (point), (see Tab. 4)
	0,25	construction of a dry tank and stabilization of the stream	0,25	0 – 10
	0,50	regulation and stabilization of the stream in an urban zone, ensure the regulation of runoff water and flow capacity in the stream	0,50	11 – 15
	0,75	maintenance of the river basin, the river bed and riparian vegetation	0,75	16 – 20
	1	no technical flood protection measures are implemented	1	≥ 21
Stressor: Floods	Impact to urban complex and use of land			
	Likelihood „L"	Territory with the existing potential significant flood risk (see [12])	Consequence „C"	Estimate flood areas (km^2)
	0,25	no	0,25	0 – 50
	0,50	no	0,50	51 – 100
	0,75	yes	0,75	101 – 150
	1	yes	1	≥ 151
Stressor: Floods	Impact to cultural and historical monuments, cultural values of incorporeal character			
	Likelihood „L"	Number of monuments (number)	Consequence „C"	Designated flow Q_n ($m^3.s^{-1}$)
	0,25	0 - 2	0,25	$\geq Q_{100}$
	0,50	3 - 5	0,50	$< Q_{100}$
	0,75	6 - 8	0,75	$< Q_{50}$
	1	> 8	1	$\leq Q_{20}$
Stressor: Floods	Impact to archaeological and paleontological sites and important geological sites			
	Likelihood „L"	Number of sites (number)	Consequence „C"	Designated flow Q_n ($m^3.s^{-1}$)
	0,25	0	0,25	$\geq Q_{100}$
	0,50	1	0,50	$< Q_{100}$
	0,75	2	0,75	$< Q_{50}$
	1	≥ 3	1	$\leq Q_{20}$

Tab. 3) Indicators for the assessment of environmental stressor for impact to fauna, flora and their habitats (it is necessary select relevant indicators and to count the assigned points)

Impact category	Indicators	Points
Habitat	Loss and degradation of vegetation and seagrass beds	1
	Fragmentation: increased number and isolation of habitat patches	1
	Increased abundance of snags	1
	Change in abundance and distribution of aquatic plants	1
Biota	Change in numbers or abundance of significant species	1
	Fish kills	1
	Change in fisheries production	1
	Reduction in extent and condition of coral	1
	Germination and establishment of indigenous riparian species	1
	Change in number and abundance of exotic fish species	1
	Change in number and abundance of exotic weed species	1

Tab. 4) The allocation of points for elements of the territorial system of ecological stability (TSES)

Importance	Indicator	Number – n	Area (ha)	Weight – v	n x v
supraregional	biocentre	1		3	3
	biocorridor	1			3
	interaction element	1			3
regional	biocentre	1		2	2
	biocorridor	1			2
	interaction element	1			2
local	biocentre	1		1	1
	biocorridor	1			1
	interaction element	1			1
					Σ

The combined likelihood-consequence levels could then be inserted in a risk matrix, see example of the risk matrix in Table 5. The lowest value of the risk factor may be 1 (likelihood = 1; consequence = 1) and the highest is 16 for each impact of stressor.

We have decided to use four distinct levels of risk: Low, Medium, Serious and High. Our risk level definitions are presented in Tab. 4.

The risk value for each stressor impact is calculated as the product of consequence and likelihood values, illustrated in a two-dimensional matrix (Tab. 4). The shading of the matrix visualizes the different risk levels. Based on the acceptance criteria, the risk level "High" is decided to be unacceptable. Any source of stressor impact at this risk level must be treated in order to have its risk reduced to an acceptable level.

Tab. 5)   An example of the risk matrix

Level of likelihood	Level of consequences			
	1	2	3	4
1	1	2	3	4
2	2	4	6	8
3	3	6	9	12
4	4	8	12	16

Risk categories				
	Low	Medium	Serious	High

4   CONCLUSION

This paper addresses the application of risk assessment to the procedure of Environmental Impact Assessment. The approach is based on the use of UMRA method to predict and quantify level of risk, and to assess the relevance of the predicted impacts. This paper is aimed at clarifying the criteria used in the environmental review of water management projects. The methodology is currently under development and an important defines more stressors and they impact to the environment and calculate they risk index.

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NUMERICAL MODELING OF SUSPENDED SEDIMENT PROPAGATION IN SMALL TORRENTS

Elvis Žic[1], Nenad Bićanić[2], Tomasz Koziara[3], Nevenka Ožanić[4]

Abstract

This paper describes the Solfec computational code used to simulate multi-body systems with constraints. The Solfec code implements an instance of the Contact Dynamics (CD) method by Moreau and Jean, therefore the constraints are handled implicitly. One of the main goals of the software is to provide a user-friendly platform for testing formulations and solution methods for the (dynamical) frictional contact problem. It also serves as a development platform for other aspects of time-stepping methods (e.g., contact detection, time integration). The code applies several kinematic models (e.g., rigid, pseudo-rigid, finite element), contact detection algorithms, time integrators and constraint solvers (e.g., penalty, Gauss-Seidel).

This paper also describes a method used to develop a computer code written in the Python programming language that is needed to produce a numerical model of suspended sediment propagation. The resulting computer code was applied to data from the Salt Creek stream in the Dubračina River basin. The paper also provides graphical representations of the Mud Flow simulation in the hypothetical example inside of the Salt Creek stream erosional base. Finally, some basic input parameters necessary for an efficient creation and execution of the numerical model are characterized and described in more detail.

Key words

Numerical modeling, Salt Creek stream, SOLFEC program, suspended material.

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1   INTRODUCTION

An unbound rock material analysis is important for assessing risk and delimitating vulnerable areas where mitigation measures are required. A numerical model is the most accurate and efficient tool for debris flow and mud flow analyses. Debris flows travel at an extremely rapid velocity and can impact large areas that are often far from their source. The prediction of debris flow propagation (including the deposition area and the impact within it is called a "runout analysis", [1]. Debris flows (*DFs*) are a type of mass wasting process. Mass movement processes can be categorized by certain parameters, such as the release mechanism, material type, sediment composition, proportion of the solid phase, velocity, time of the event, slope of the movement plane, material behavior, and the physical processes that occur during the mass movement, [2]. Using classification and definitions given by Stiny (1910) and Sharpe (1938), debris flow can be defined as an extremely rapid flow in a steep, confined channel that is deposited on a debris fan. Debris flow occurs after a flood, and it is a viscous mass (non-Newtonian fluid) consisting of water, soil, gravel, rocks and woods. Mudflows (*MFs*) can be defined as a fine-grained debris flow, [3,4]. Debris is a mixture of sand, gravel, cobbles, and boulders and can contain organic material (e.g., logs, tree stumps, tree trunks). The consistency of debris is non-plastic or weakly plastic. Mud is defined as a soft, remolded clayey soil with a significantly plastic matrix (sand or finer) and liquidity index during motion of greater than 0.5, [2,4,5]. Debris flows and mudflows have similar water concentrations, but they have different solid particle sizes. Debris flow, like other gravitational mass movements, can be divided into several phases: the initiation phase, in which the initial mass is released; the transition phase, in which the initial mass propagates along the travel path; and the deposition phase, in which the mass stops and is deposited on a colluvial fan, [1,2].

DFs are unsteady and non-uniform because they move downslope as waves or series of waves. They are pulsating flows in which surges are separated by a watery intersurge flow. DFs are typically mobilized from either numerous small landslides or one large landslide. Mobilization occurs under the following three conditions: the failure of the mass, a sufficient amount of water to saturate the mass and a sufficient conversion of gravitational potential energy to internal kinetic energy. When the initial landslide mass rides on the torrent bed deposits, an undrained loading process may generate a high pore-water pressure within the torrent deposits. This high pore-water pressure helps incorporate those deposits into a moving mass. Debris flow models should easily give flow velocity, flow depth, discharge and debris volume as outputs. Moreover, models should require few adjustable input parameters.

The main objectives of application in numerical modeling of suspended sediment propagation are: 1. increasing knowledge on flood flow, preconditions for debris flow occurance, debris flow development, run out and deposition 2. analysis and determination of geological characteristics and its influence on flood flow/landslide/debris flow occurrence 3. to determine critical values for triggering and threshold factors for flood flow, debris flow and landslides in specific geological conditions. A numerical model of suspended sediment propagation has also applications in developing early warning systems on the catchments.

2   INTRODUCTION TO THE SOLFEC COMPUTER CODE

Solfec is a computational code used to simulate multi-body systems with constraints. Because the Solfec code implements an instance of the Contact Dynamics (CD) method by Moreau and Jean [6], the constraints are handled implicitly. One of the main goals of the software is to

provide a user-friendly platform for testing formulations and solution methods for the (dynamic) frictional contact problem. It also serves as a development platform for other aspects of time-stepping methods (e.g., contact detection, time integration). The code implements several kinematic models (rigid, pseudo-rigid, finite element), contact detection algorithms, time integrators and constraint solvers (e.g., penalty, Gauss-Seidel), [7,8]. First, suppose that there are four different bodies, as shown in Figure 1.
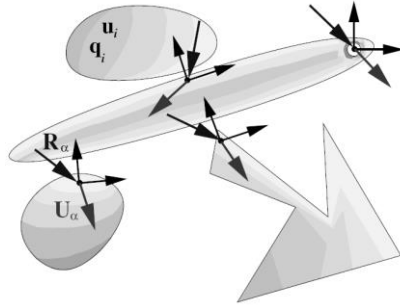
Fig. 1)   Four different bodies for the SOLFEC program application

The placement and velocity of each point in every body are determined by a configuration q_i and velocity u_i, respectively. Let q and u collect the configurations and velocities of each of the bodies. If the time history of velocity is known, the configuration time history can be computed as

$$q(t) = q(0) + \int_0^t u\,dt \tag{1}$$

The velocity is determined by integrating Newton's law

$$u(t) = u(0) + M^{-1}\int_0^t \left(f + H^T R\right)dt \tag{2}$$

where M is an inertia operator (assumed as constant here), f is an out-of-balance force, H is a linear operator, and R collects some point forces R_α. A number of local coordinate systems (local frames) are monitored while integrating the motions of the bodies. There are four local frames in Figure 1, each of which is related to a pair of points that typically belong to two distinct bodies. An observer embedded in a local frame calculates the local relative velocity u_α of one of the points as viewed from the perspective of the other point, [7]. Let U collect all of the local velocities. Then, a linear transformation H can be found, such that

$$U = Hu \tag{3}$$

The local relative velocities are influenced by applying local forces R_α. This can be collectively described by the implicit relationship

$$C(U,R) = 0 \tag{4}$$

The implicit relationship shown in equation (4) must be solved at each moment of time to integrate equations (1) and (2). The Solfec input file is essentially a Python source code because a Python interpreter is embedded in Solfec. At the same time, Solfec extends Python by adding a number of objects and routines. In the Solfec program, several objects are easily created using the Python programming language. Every object in the Solfec program has a number of specified entities that define the characteristics and shape of the object. One of the most common objects created within the Solfec program is a MESH object. An object of type

MESH describes an arbitrary volumetric mesh comprised of tetrahedrons, pyramids, wedges, and hexahedrons.

2.1 Detection of contact points in the SOLFEC program

As shown in Figure 2, a contact point and normal direction result from an overlap of two convex objects. The point and normal direction derived from an overlap are well defined for non-smooth geometry.
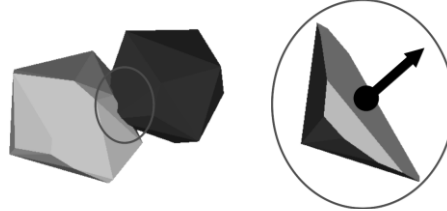
Fig. 2) A contact point and normal direction extracted from an intersection of two convex objects

At this point, all possible volumetric overlaps will be detected by applying the contact detection algorithm. Because identically meshed bodies are perfectly adjacent to each other, a clutter of contact points are generated by all of the adjacent element volumes. A heuristic sparsification algorithm filters out the redundant contact points. All contact points are examined and compared with other contact points that are adjacent through common bodies, [7]. Topological adjacency of contact points indicates that they have been created between mesh elements that are topologically adjacent.

2.2 Defining the surface and bulk materials in the SOLFEC program

The Signorini-Coulomb's law is used to define surface material in the Solfec program. The velocity Signorini condition reads

$$\overline{U}_N \geq 0 \qquad R_N \geq 0 \qquad \overline{U}_N R_N = 0 \tag{5}$$

where $\overline{U}_N = U_N^{t+h} + \eta \min(0, U_N^t)$ is the velocity restitution coefficient, U_N is the normal relative velocity, and R_N is the normal reaction. The Newton impact law is accounted for due to $\overline{U}_N$. The Coulomb's friction law reads as follows:

$$\begin{cases} \|R_T\| \leq \mu R_N \\ \|R_T\| < \mu R_N \implies U_T = 0 \\ \|R_T\| = \mu R_N \implies \exists_{\lambda \geq 0} U_T = -\lambda R_T \end{cases} \tag{6}$$

If the friction force is smaller than μR_N, then sticking occurs. Sliding occurs if the friction force is μR_N and has a direction opposite to that of the slip velocity. A bulk material is assigned to a volume. For this assignment, the Kirchhoff-Saint Venant law is used. This method simply extends the linearly elastic material to the large deformation regime and is suitable for large rotation, small strain problems, [7,8].

2.3 Solvers in the SOLFEC program

Development of solvers for unilateral dynamics is one of the main driving forces behind Solfec. Solvers can be developed through the classical Gauss-Seidel approach of Contact Dynamics or a somewhat modified penalty solver of the Discrete Element Method. The equation of local dynamics in the Gauss-Seidel method is

$$U_\alpha = B_\alpha + \sum_\beta W_{\alpha\beta} R_\beta \tag{7}$$

where U_α is the relative velocities and R_α is the reactions at constraint points. U_α, R_α, and B_α are three vectors, and $W_{\alpha\beta}$ is a 3x3 matrix block. Each constraint equation can be formulated as follows:

$$C_\alpha(U_\alpha, R_\alpha) = 0 \tag{8}$$

$$C_\alpha\left(B_\alpha + \sum_\beta W_{\alpha\beta} R_\beta, R_\alpha\right) = 0 \tag{9}$$

Diagonal block problems are solved until the reaction change is sufficiently small. The Gauss-Seidel paradigm corresponds to the fact that the diagonal problem is solved using the most recent off-diagonal reactions [7], which prevents a perfectly parallel implementation. The penalty solver is quite straightforward. On each processor, the constraints are split into *Contacts_i* (the contact constraints) and *Others_i*, (the bilateral constraints). Next, the contacts are updated using the *spring-dashpot* model, and a local Gauss-Seidel solver is used to calculate the reactions of the bilateral constraints.

3   APPLICATION OF THE SOLFEC PROGRAM ON THE SALT CREEK STREAM

In the Croatian-Japanese research project entitled "PROJECT ON RISK IDENTIFICATION AND LAND-USE PLANNING FOR DISASTER MITIGATION OF LANDSLIDE AND FLOODS IN CROATIA", a group of scientists from the Faculty of Civil Engineering University of Rijeka (Flash-flood and Debris Flow Working Group, WG2) carried out systematic observations of the meteorological and hydrological parameters of the Salt Creek stream's catchment area in real time using ombrografs, water level instruments, satellite radar, flow meters (based on the Doppler effect) and piezometers (to monitor groundwater levels). These data were collected to conduct numerical and hydrological analyses of the measured parameters and to develop simulation models of floods, mudflows and flow, which can provide early warnings of floods and torrential phenomena burglary and evaluate the rates at which they coincide with landslides.

The Salt Creek stream (Slani potok) is located in the Dubračina River catchment area, located in Primorsko-Goranska County in the hinterland of Crikvenica city, which extends from the northwest to southeast, parallel to the Adriatic coast (see Figure 3). The Dubračina River catchment area is 43.5 km^2. There is intense erosion in the Dubračina River catchment area, particularly on the slopes of the Salt Creek stream, where the so-called landscape type "badlands" has formed, [9]. Numerous active and calmed landslides, together with erosion, represent the dominant geomorphic processes and major geological hazards. The karst carbonate rocks (mainly Upper Cretaceous and Paleogene limestone) are represented on the slopes of the peak areas of the basin and cover 55% of basin area, [10]. Limestone cliffs located at the northeastern edge of the basin represent the edge of the karst plateau. The central and hypsonometric lower parts of the Dubračina basin are characterized as scrolling

within the slope sediments, composed of a mixture of particulate clay with fragments of sandstone and limestone. Instable slopes in the Dubračina basin are caused by geomorphological processes (fluvial erosion in the foot of the slope) and physical processes (intensive short-term rainfall).
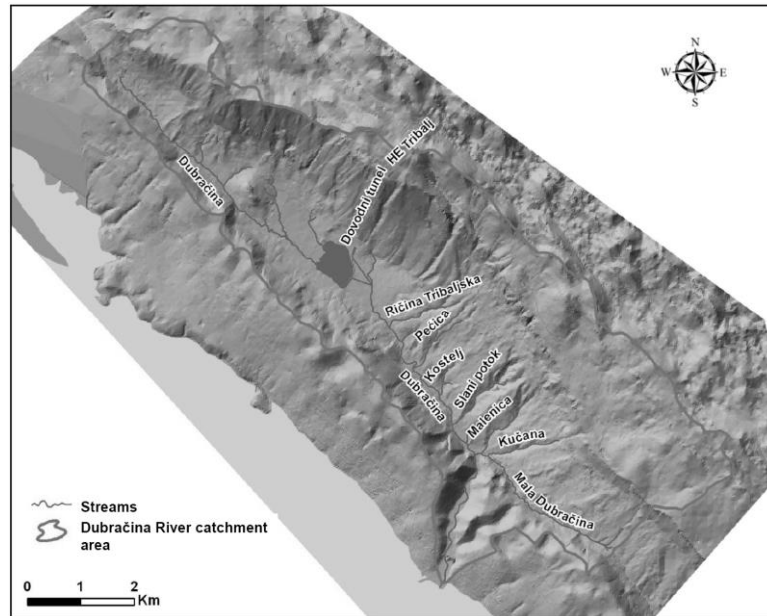

Fig. 3)   Hydrographic network in the Dubračina River catchment area, [11]

Fig. 4)   a) Salt Creek stream (winter period), b) erosion base of the Salt Creek stream

The Salt Creek catchment area, which is approximately 2 km^2, is located at altitudes ranging from 50 to 700 m.a.s.l. The lower part of the catchment area (0,9 km^2) is covered with flysch and produces most of the surface runoff, [12]. The upper part of the basin is mostly rocky ledge and produces a negligible amount of surface runoff. In the contact zone of karst and flysch, there are many overflow sources that make up the bulk of water balance in the dry season (see Figure 4). The affected surface of the erosion base is approximately 3 km^2, so they compromise the surrounding settlements in Belgrad, Baretići, Grižane and Kamenjak, as well as the surrounding roads (see Figure 4). Despite numerous rehabilitation measures implemented during the 20th century, there is still a general degradation of the terrain and thus properties of a "permanent disaster" [13].

### 3.1 Spatial and temporal discretization
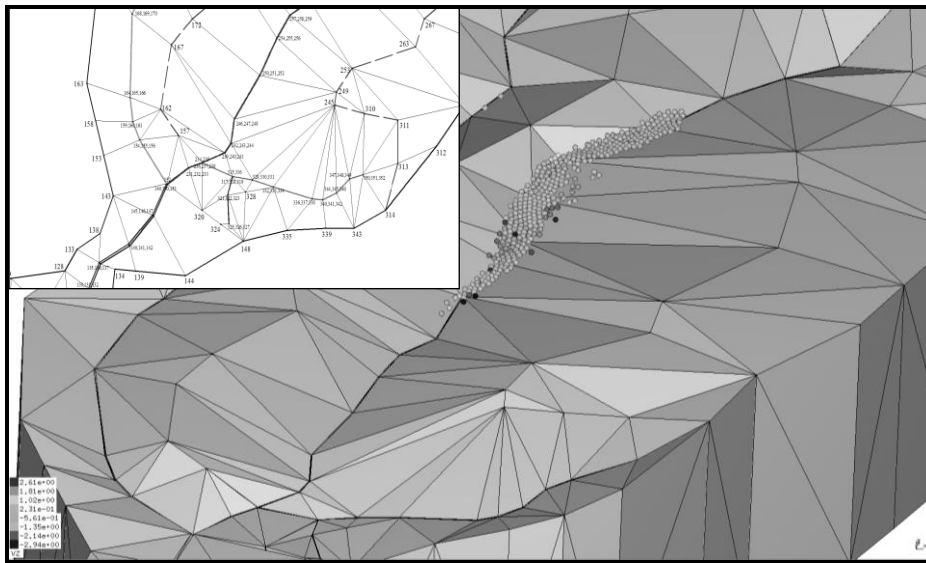
Fig. 5)   Generation of mesh elements on the Salt Creek erosion base, (Žic, 2010)

The mathematical model for solving debris and mud flows is a system of differential equations. Once the model is set, the resolution on the computer needs to be adjusted (i.e., the appropriate method for discretization of space and time needs to be used within the Solfec application). The Solfec program uses the FEM to solve the governing equations and discretize the space. This method divides the domain of solutions into a finite number of adjacent control elements arranged in arbitrary triangles, tetrahedra and hexahedra (Figure 5). In addition to selecting the appropriate type of numerical mesh, an approximation that will be used in the discretization process needs to be chosen. In the FEM, it is necessary to choose the shape functions (elements) and their weight functions. When selecting the shape functions, the simplicity, ease of implementation, accuracy and computational efficiency of the options must be considered. In the FEM implemented in the Solfec program, the domain is broken up into a set of discrete volumes or finite elements, which are generally unstructured (two-dimensional spaces are typically triangles or quadrangles, while three-dimensional spaces are tetrahedra or hexahedra). When unstable flows are computed, time (the fourth dimension) must be taken into account; time, as well as space, must be discretized. After the spatial derivatives in the main equations are discretized the associated system of nonlinear differential equations shown below is obtained.

$$\frac{d\vec{u}}{dt} = \vec{F}(\vec{u}, t) \tag{10}$$

This equation can be integrated in time using a method for solving the unstable flow problem. All methods of computation are advanced through time step-by-step, or "marching" *(time-marching methods),* to meet the weather conditions.

3.2   Numerical code and simulation
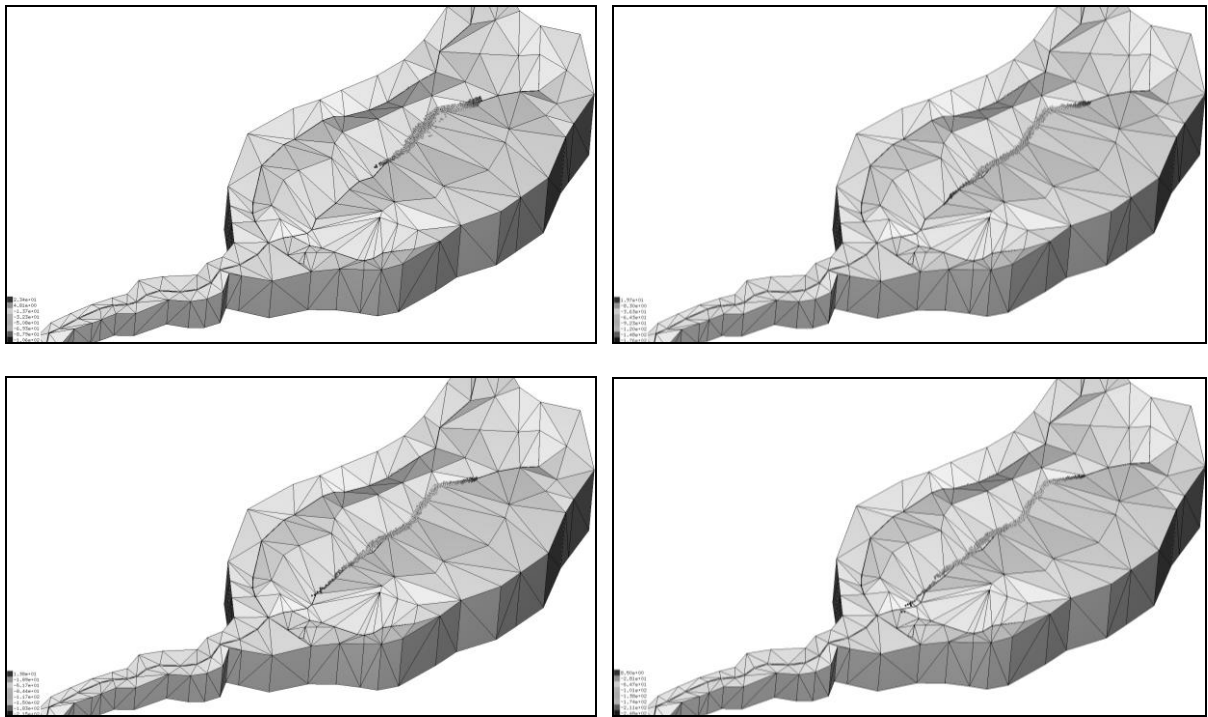
Fig. 6)   Debris flow simulation in the case of the Salt Creek erosional base, (Žic, 2010)

To carry out simulations in the Solfec program, previously printed numeric code needs to be implemented using the Python programming language. Each source code in the Solfec program can be upgraded with the aforementioned structures and routines. The input file that specifies the geometry of the terrain (generating mesh using finite elements) can be connected with defined commands in the Python code, Figure 6. Individual Solfec objects were created to define both the surface material by which the flow propagated and type of material (shape, size, physical properties, and so on) that will be propagated downstream. When writing numerical code, the input parameters (Young's modulus, Poisson's ratio, friction coefficient, cohesion coefficient, and so on) must be defined such that the contact between the fluid and immobile soil or suspended (unbound) materials due to the flow are precisely described. The next step in the numerical code is to define the numerical scheme and iterative methods for solving differential equations. One of the most used iterative methods in the Solfec program is the Gauss-Seidel method, which is a special case of the SOR method (*Successive over-relaxation method*). This method converges two times faster than the Jacobi method, although there are many effective methods. Choosing an integration method (i.e., the approximation model of the movement of suspended unbound rock material over time) is of great importance for models that use a set of differential equations. The integration scheme's biggest problem is that, by choosing the maximum time step, the stability and accuracy of the calculation must be taken into account. For stable integration, a small time step is required, so the time steps should not have been restricted at a size much smaller than the error for limiting the space. For this reason, it is necessary to perform many time steps. After writing a numerical code, the simulation is executed based on the defined input parameters.

Shown in Figure 6 are the simulations for debris flow propagation on the Salt Creek erosional base. In these hypothetical models of flow, a relatively large diameter of the grain material (*d=0.3* m, in nature they are large stone screens) came into the torrent because the particles

with a small grain diameter (1 mm or less) create a large number of mathematical operations (large number of contact points) when executing the simulation, which requires a lot of memory (i.e., the existence of a cluster (super computer)).

Within the simulation in the Solfec program, users may view the following derived physical quantities at any time: particle displacements in the x, y and z directions (D_X, D_Y, D_Z, respectively), the velocity of particles (V_X, V_Y and V_Z), the various strains in a particular direction or plane (S_X, S_Y, S_Z, S_{XY}, S_{XZ}, S_{YZ}), forces in contact points, reactions of particles with the surrounding terrain, the reaction between the particles, and many other physical quantities (see Figure 7).
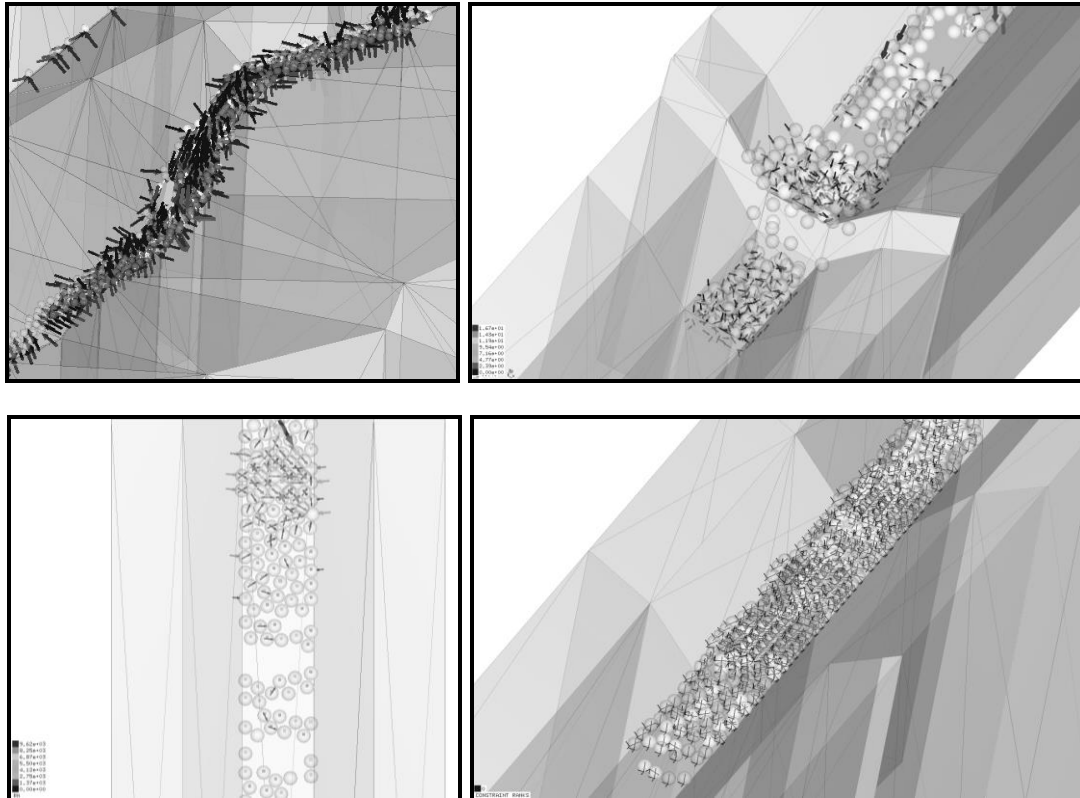
Fig. 7)   Visual representation of the contact points, contact forces, tangential stresses and cutting forces within the Solfec program

4   CONCLUSION

The uncontrolled propagation of unbound rock material causes significant material and human losses. If the anticipated volume of unbound suspended matter, the range of distance, and the depth and speed of propagation can be estimated through mathematical modeling, significant losses could be avoided. Moreover, data from modeling can be used as input data in risk studies (geohazard analysis), which define hazardous work areas and appropriate protective measures. In recent decades, the phases of numerical flow modeling of unbound materials have been widely implemented within the framework of Continuum Mechanics (CM), so many new, sophisticated numerical models have been developed. Most of the available models are based on a heterogeneous and multi-phase mass movement as a single-phase continuum. The Solfec program can be used to carry out simulation analyses of debris and mud flows, enabling more efficient and better estimates of input parameters that define the creation and launch of debris material in a particular area. The program also provides a

quantified value for all input and output parameters that are necessary for the calibration and verification of numerical models. The program can be used to assess geohazards and to determine safe and rational assessments of the appearance of debris and mud flows that are based on the critical geomorphological and hydrogeological parameters of the soil.

Acknowledgements

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SECTION III

LANDSCAPE MANAGEMENT

URBAN LANDSCAPES IN TRANSYLVANIAN VEDUTISM

Iulia Ciangă[1]

Abstract

The artistic style, veduta, best known due the influence of the Venetian School of Painting from Italy, put, for the first time, on spotlight the urban landscape, transforming it in a central topic starting with 17th century. Veduta has become also well-known in Transylvania, region of nowadays Romania, representing a beneficial Eastern spatial extension of the Renaissance and Age of Enlightenment. The study and acquaintance with the vedute of the Transylvanian cities have therefore become a foray into the history of the development of urban structure, as well as into the social-historical reality specific to the Transylvanian areas of the 18th and 19th centuries. Veduta reveals its importance as a significant source of information besides its artistic value.

Key words

City, Transylvania, urban landscape, veduta.

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1   INTRODUCTION

The spatial-temporal analysis of human settlements offers the possibility of familiarity with the urban system whose characteristics are strong related with the territorial location and its course in time. Natural conditions and the involvement of varied human communities belonging to different cultures have led to the development of a complex and original urban landscape that have become a frequent topic for the representations of post-Renaissance and Enlightenment Art.

The study of the artistic urban views may be consider an interesting instrument for a chronological analyze of the cities, been a real possibility to carry out a comparative study on the developmental trends of urban landscapes and their components, using veduta as temporal mark for the present urban physiognomy.
An interesting phenomenon is the continuity of the urban development, with its overlapping territorial urban "strata" which gives it specific character and personality.

2   URBAN LANDSCAPE

2.1   General Aspects

Geographical environment as interference of the four inter-connected geo-spheres (lithosphere, hydrosphere, atmosphere and biosphere) has evolved in time maintaining its natural dominant characters up to the prehistoric period.

Human community, part of the biosphere, through its characteristics, began gradually to pull away from the initially biosphere environment and started to change the initial natural characteristics. Men's activity have led, in recent decades, to the apparition of the fifth component, that of the „antroposphere", changing the character of natural environment with profound effects in the medium and long term.

They may be also called constructed landscapes whose production is marked by successive steps from the city, urban concentration, urban metropolis, conurbation, megalopolis with the downward trend toward urban "invading" of the geographically environment, in the framework of „Ecumenopolis" phenomenon.

2.2   Generations of Transylvanian settlements, up to 19th century

Transylvania, central region of nowaday Romania, Fig. 1, has one of the most compex urban system in the country, due to its eventful past, influence of various human cummunities and

its changeable administrative-territorial status. (It was conquered by the Hungarian kings at the beginning of the 2nd millennium, becoming more independent in 1526 as Principality of Transylvania, in 1699 was annexed by the Habsburg Empire, and became part of the Dual Austria-Hungarian Monarchy in 1867. Transylvania was united with Romanian Kingdom in 1918.)

Transylvanian urban system, Fig. 2, has been developed in time, under the influence of specific social, economic and historical conditions carried out over a period of almost a millennium (11th-21st century), under the influence of a natural frame, dominated by a hill and valley morphology, belonging to an intra-Carpathian depressionary area, of large-scale and rich in forests, up to 1st part of the second millennium. The name of Transylvania is related with the forests („trans" meaning „over", and „silva" meaning "forest").

The oldest settlements in Transylvania, that kept their urban functions over the time, are the ones specific to the **Antiquity** (106-271 AD), belonging to the Roman province of Dacia Felix, reflecting the features of Roman urban civilization. (Apulum-Alba Iulia, Napoca-Cluj Napoca, Potaissa-Turda).

Fig. 1)   Transylvania, region of nowaday Romania

The genesis of the new generations of the cities has been individualized in the following epochs: feudal, modern and contemporary.
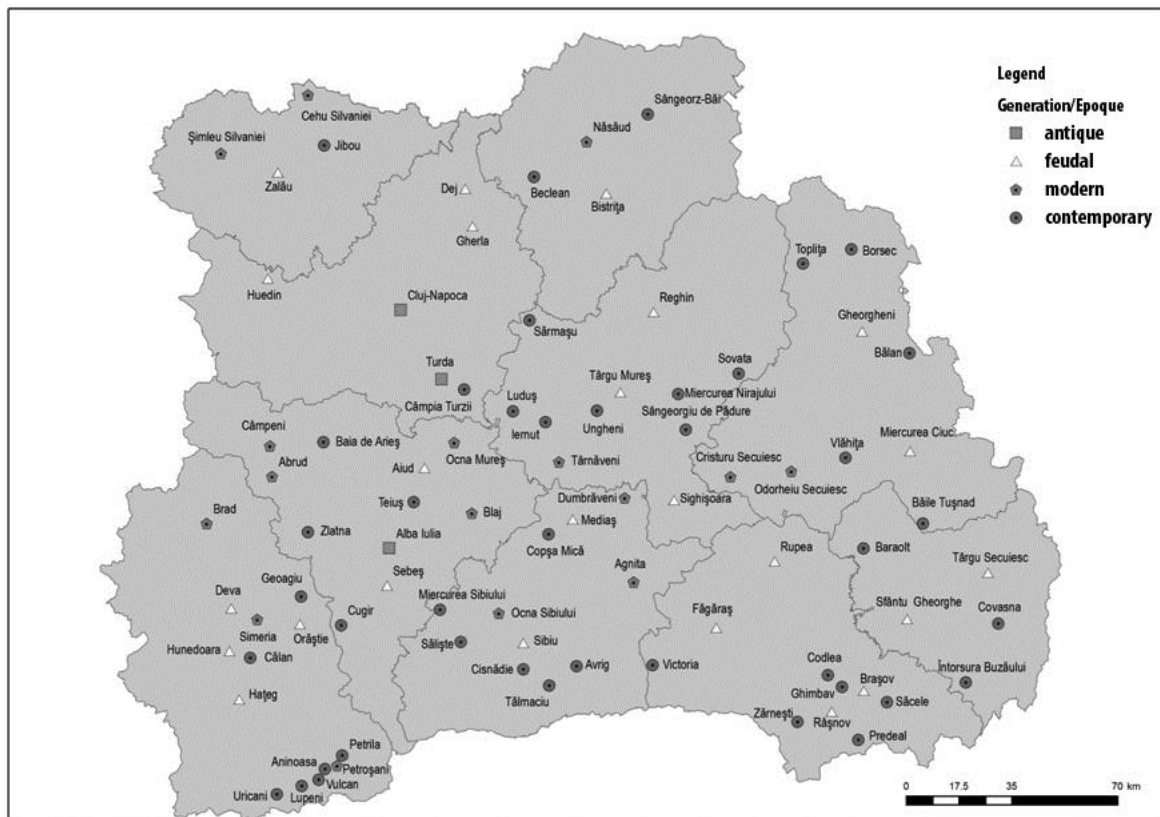
Fig. 2)   Generation of Transylvanian urban settlements (future cities)

Urban phenomenon in Transylvania's area has been resumed, after a long pause, in the first part of the 1ˢᵗ millennium, along with Hungarian Conquest, and been influenced in its evolution by the varied communities present here: the native one-the Romanians, the dominant one-the Hungarians, the colonized one-the Saxons, and other important communities, that imposed later, like the Armenians or the Jews (from the18th century), and others.

Due the colonization of Saxons, people of German origins, coming from Saxony, or Luxembourg, started a new period for the urban settlements of Transylvania, the **age of feudalism**. These colonists, which had also the status of „ospites", were granted with special privileges and supported to built and defense the new fortified cities, „burgs", similar with those from the mountain areas of Central and Western Europe, giving a German interpretation to the region of Transylvania, *Siebenburgen*. [1]

There are noted for this category the cities: Braşov (Kronstadt), Sibiu (Hermanstadt) , Sebeş (Mulbach) in the southern part of Transylvania, Sighişoara (Sesburg) and Mediaş (Mediasch) in the Târnave Plateau, Reghin in the eastern part, at the entrance to the rocky Defile of Topliţa-Deda, and Bistriţa (Bistritz) in the north eastern part.

Cluj city owes its developing to a Saxon community who has also brought the contribution to its urban personality, similar with the other fortified cities already mentioned.

Main of the feudal cities, with some of the components still preserved until today, were related to the big water courses that facilitated the traffic and links through roads present from the Roman Antiquity, between the lower part of the valleys and versants or slopes. Most of the cities have the geographical position on the meadows and fluvial terraces relief, with differences of tens of meters between the "upper city" and the "lower city", (Alba Iulia, Sibiu, Aiud), or there been predominantly developed in the meadow of the valleis, like Mediaş, Bistriţa, Târgu Mureş, Făgăraş. [2]

Another category of towns and cities took advantage of the dominant forms of relief in the neighborhood of the courses of valleys, where, the fortifications were exclusive areas of defense, dominant in altitude, the city having developed subsequently outside this area. (Sighişoara, Deva, Hunedoara)

In a special situation are to be found cities from the depressionary area of the Oriental Carpathians' Mountains, developed in the immediate vicinity of the mountains, the feudal city being bound with the mountains by fortified structures (Braşov, Râşnov, Miercurea Ciuc).[2]

The component "intra muros", has conferred, to a large part of the Transylvanian cities, the physiognomy reflected in the „burg" landscape type, especially due the preserved parts of the historic center, kept pristine throughout the time. The most expressive physiognomy of the historic center belongs to the Sighişoara city, kept well preserved on both horizontal and vertical plans. This situation is related with the morphological conditions, namely, the relief. The cities Cluj, Braşov and Sibiu can be placed in the category of the cities with historical centers that have been preserved just in the horizontal plane, with significant changes in the vertical one, over time. [3]

The cities of the **modern period** have continued the development of some older and rural settlements, the urban status being determined by functions related to the activities with industrial character.

The typical examples are the cities Petroşani and Hunedoara, favored by the coal and steel industry, also the cities Ocna Sibiu and Ocna Mureş that exploited the salt resources. Other places were stimulated by the development and exploitation of resources such as natural gas, the case of the Târnăveni city.

Another factor, which has contributed to the development of urban settlements in the 19th century, has been the construction of the railways, which accelerated the development of some settlements that have become important railway nodes, as Simeria.

During the 18th and 19th centuries is noted the urban development of some settlements stimulated by the imposition of the Romanian communities which provided them with economic, cultural and administrative functions, like cities of Blaj and Năsăud.

3   URBAN LANDSCAPES IN TRANSYLVANIAN VEDUTISM

3.1   Transylvanian vedutism in European context

The man in the course of time has had different attitudes toward the surrounding environment, using nature as shelter and resource, according to encountered needs. Another perspective over these "needs" is given by Lisa Findley, namely that of "exercising power" through conquest and control of space, in support of this comment she is quoting Le Corbusier which in 1948 said: "The occupation of space is the first proof of existence". [4]

Exercising this power over new conquered territories has been and is illustrated by maps and works, with cartographic character, from the most ancient times as a "proof of taking in possession of the territories concerned". [5]

From the first primitive maps (such as the one from the Bronze age, Val Camonica of Capo and Ponte, Lombardy, of the village Bedolina [5] up to those of present carried out using advanced technology of global location, GIS, these representations of the areas under the observation and control of man have known varied stages of evolution and representations.

Such representations will be generate in time by the efforts of cartographers such as Sebastian Munster (1489-1552) with "Chosmographia" (1544), Abraham Oertel (Ortelius (1528-1598) with the "Theatrum Orbis Terrarum" (1564) or Gerardus Mercator (1512-1594) with Atlas of Europe, becoming more and more customized (like the regional and cadastral maps or the maps focused on cities plans). Artists and men of science of Renaissance will be more and more preoccupied to capture the tridimensionality of these maps by combining information of topographic character with architectural details. [5]

Giovanni Antonio Canal (Canaletto) (1697-1768), representative of the Venetian School of Painting from Italy, considered the most well known "pittor da vedute" of his times [6], will elevate this kind, through its realistic, but at the same time loaded with poetry, works, using mechanical dispositive, such as „camera obscura", as well as the engravings methods for the multiplication of his drawings.

The multiplication techniques would be a very important factor for spreading the culture and artistic influences, and also for raising the popularity of the Transylvanian urban landscape.

A new technique of multiplication, of images and text, the lithography, will be considered "the artistic and scientific event of the 18th centuy". The invention was attributed to Alois

Senefelder (1771-1834), from Munich. This technique has made possible "the democratization" of art due the reduced costs involved in production. [7]

This process arrived to Vienna together with Senefelder and spread along also in Transylvania, Austrian province at that time, reaching Sibiu in the first place, in 1821, then also the cities Cluj-Napoca, Brasov and Medias. This process was facilitated by the lithographic institutes founded in these cities. First lithographic institutes, from Romania, will be set up at Sadu and Sibiu, under the leadership of Michael Bielz (1787-1866) and Franz Neuhauser the Young (1763-1836). [7]

The landscape will be a notorious topic, being approached from a "realistic-documentary" perspective orientated toward capturing past, Transylvania been represented most common by medieval vestiges. [7]

The most consistent contribution of the 19th century to the Transylvanian urban landscape art have had the local or foreign artists like: Franz Neuhauser the Young (1763-1836) from Sibiu, Ludwig Rohbock (cca. 1820-1880), from Nurnberg, Franz Jaschke (1775-1842), another traveler artist. They've contribute with their drawing, paintings, engravings or lithographs to the making of the first image albums over the cities of Transylvania, „the most unknown Imperial province". The series will be suggestive entitled "Pittoreske Reise durch Siebenburgen" (Picturesque Journey in Transylvania), initiated in 1814, unfinished, based on the Franz Neuhauser the Young works. [7]

Other similar projects would be "Sammlung der vorzuglichsten Ansichten von Siebenburgen" (Collection of the main views from Transylvania) and "Vorzuglishe Ansichten des Furstenthums Siebenburgen" (The main views from Principality of Transylvania). [7]

One of the significant and complex artistic personalities from Cluj city was Carol Szathmari Popp (1812-1887). In 1843 he has finished the series of „Erdely Kepekben" (Transylvania in images), project that would succed to highlight Transylvanian urban landscape from a romantic perspective. [7]

After 1860, the lithographic process will be often replaced with the photographic one, more cheaper, and accessible, even if would be considered less artistic.

The 19th century has represented both an innovation and artistic time as well, new attitudes have been developed regarding aesthetic values, namely, the conservation and protection or the collecting spirit, Transylvanian vedute being also today carried in private or public collections.

3.2 Urban landscapes in Transylvanian vedutism

The making of urban artistic views, in different periods of time, differs from many causes; they been carried out by different individuals, in different manners, more or less subjective, using techniques and customized colors. As time passes, these works of art capture different realities and changes to previous landscapes, determined by evolution or regression of the urban reality phenomenon. Also the basic place of reception, where once the observation was possible, becomes, sometimes, inaccessible because of emphasized urban density.

Part of a more complex research, which intend to compare the artistic representations of Transylvania's cities of the 18th and 19th centuries with the actual situation of the urban landscape, the present study is focused on the case study of Cluj-Napoca city.

Cluj-Napoca, is one of the Romania's big cities, being the administrative centre of the county Cluj, with a complex functional profile based on industry and services. [8]

It is also a city with an interesting urban and historical evolution, being developed, since the ancient times, due to its favorable position near the great imperial road which was crossing the Roman province, Dacia Felix from the south west to the north.

The city core, or "the old city", founded in the second half of 13th century, marked today by the dominant tower of the St. Michael's Church (Biserica Sfântul Mihail), represents, also today, the main point of attraction of the city.

The St. Michael's Church, one of the first and the most powerful visual symbols of Cluj-Napoca, is a construction with a long evolutionary process, more than 130 years, (the 2nd half of the 14th century till the 2nd half of the 15th century), passing through more "re-design" phases, the architectural elements of the various stages of Gothic style being a standing proof for this. The last phases were carried out in Neo-gothic style during the 7th decade of the 20th century. [9]

The variety of trades and crafts will contribute to the commercial flowering of the city, as well as, the numerous privileges offered by Hungarian kings, culminating with the moment when Cluj-Napoca was granted whit the status of „civitas regia" (royal city). These privileges will be reflected over the urban physiognomy, by the progressive enlargement of the fortified enclosure. A good example would be the strengthening of the defense wall with 20 towers after 1405, which will be managed by the local guilds. [10]

One of the best-known is Turnul Croitorilor (the Taylors' Tower), which defended the south-east of the enclosure, much more exposed to attacks. It is also maintained today. The same goes for the Turnul Săpunarilor (the Soap Makers' Tower), called also Turnul Pompierilor (the Firemen's Tower), on the side of the former north wall of the city. [10]

Fig. 3)   (View of Cluj from the Citadel Hill)

Source: National Austrian Library, Images Collection, Vienna, inv. Pk95_10

Between the 15th and the beginning of the 16th centuries the consolidation of the city walls continued, the city developing inside its walls as well.[9]

The Hapsburg monarchy will contribute to reinforce the walls and towers of the city in 1711 , and also built a fortress with bastions and stone gates [10], for the use of imperial garrison on the Citadel Hill (Dealul Cetățuie) in 1716. [9]

These actions will be followed by the building of the Jesuits Church and monastery (on University Street), Minorite Church (on Eroilor Street) and the Unitarian Church (on 21st of December, 1989 Boulevard), between 1718-1724. Such will be introduced a new style in the religious architecture, the Baroque style. [9]

A fact that represents one of the modern components of the Transylvanian cities is the starting process of demolition of the fortified structures (walls and towers of the city), beginning in Cluj-Napoca in 1841, with the intention of providing more space for the future buildings and access routes. These ideas were generated by the Viennese cultural environment and will be known as the "Ringstrasse Era". [11]

Cluj-Napoca has benefited, between 1867 and 1918, of the implementation of some "architectural programs" supported by the Government of Budapest which aim was to modernise the Transylvanian cities, both from the operational and aesthetic perspective. Architects, from Budapest and Vienna, will activate in "the capital of Transylvanian Hungarians" [12], bringing in, the newest European functional models which will prove to be highly durable, most operating at the present. These programs were dedicated to various functional urban branches such as administration, justice, education, culture, health, finance even tourism. The architecture of this period was dominated by the Historicism style manifested through new created Neo-gothic, Neo-Renaissance or Neo-Baroques buildings. [12]

The vedute representing Cluj-Napoca, Fig. 3 and Fig. 4, highlight the positioning of the city toward the Citadel Hill and Feleac Hill, which enclose it to the north and south sides, Someş river being a favorable factor in creating a good ambient for living, the city been developed especially along the river.

During the contemporary era, the evolution of the city was led to a gradual invasion of the versants, this process transformed itself into a "battle for the best panorama over the city". With certain exceptions, (the promenade area of Citadel Hill, the Central Cemetery (Házsongárd Cemetery), the Botanical Garden, the student campuses or the medical institutions with tradition in Cluj city, that remained untouched), the „new created" urban cover presents sometimes a chaotic character, with crowded buildings (hotels, residences or private institutions) formed in the transition period, after 1989.

For emphasizing the changing tendencies in urban Transylvanian landscape has been used a dual, comparative method, very familiar in the field of advertising, known better as "before and after". This method does not always favor the second situation, in the present case, the urban landscape from nowadays Cluj-Napoca city.

The figure no. 3, with its left side veduta represents a panorama of Cluj observed from the Citadel Hill. There can be noticed the northern side of the fortified city wall, still present at the moment the painting was done, a late feudalism being specific for Transylvania's cities. The artist was very careful with the angle of observation, all the churches constructed up to that time (beginning of the 19th century) being well illustrated (St. Michael's Church, Franciscan Church, Reformat Church, Jesuits' Church, Minorite Church, and the Unitarian Church). One could imagine the typical feudal narrow streets network, looking to this image, with "serried" buildings, with one, or two floors, dominated by the higher buildings, the churches. It is also marked the tendency of the "extra muros" extension given by the houses glued to the wall, but outside of it.

The right side photograph creates a contrast with the previous image, due the great concentration of the buildings and the large occupied area characterized by overlapping types and styles of constructions, belonging to different ages. The most powerful contrasts are between the historical feudal structures and those specific to socialist period, (dwelling units), or those specific to transition (offices of banks, or private institutions), distinguished by height, sometime excessive, reflecting materiality, futuristic and sometimes unattractive appearance, suffering due the lack of the aesthetic integration in the urban areas.

Veduta, from figure no. 4 (left image), represents the southern side of the city of Cluj seen at a later moment, after the demolition of the walls, with its replica, or the natural consequence, the spread of the urbanization phenomenon outside the old limitations, (right photograph).

Fig. 4)   View of Cluj (from the Feleac Hill)

Source: National Austrian Library, Images Collection, Vienna, inv. 00000001

An example that underline the documentary value of the vedute is represented in figure no. 5. This illustrates an elegant mansion in the famous garden of count Miko Imre, situated on the Feleac Hill (left image).
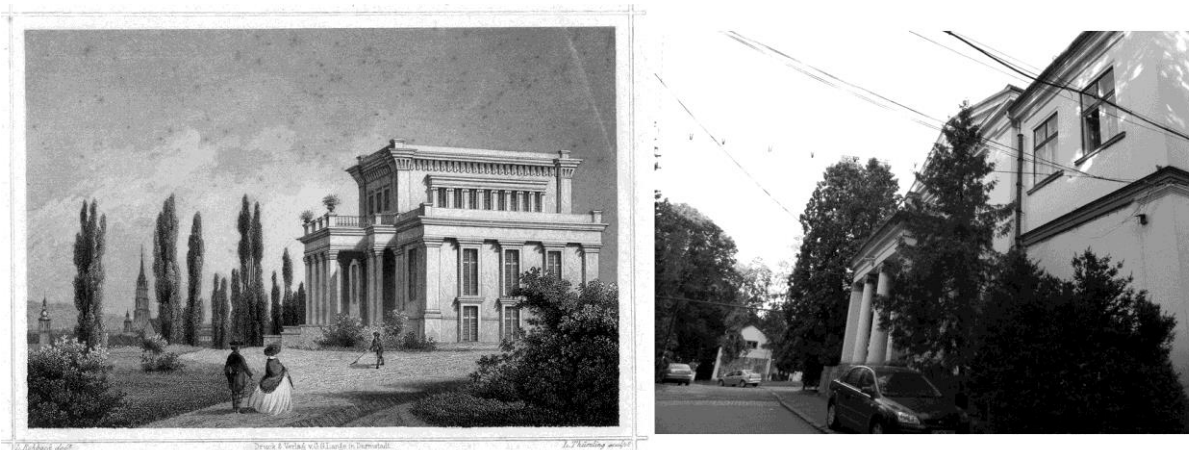
Fig. 5)   View of Cluj from the Feleac Hill

Source: „Lucian Blaga" Central University Library, Cluj-Napoca "Gheorghe Sion" Collection, inv. XVII.55

The building doesn't exist anymore in its original form, as a neoclassic villa. It hosted, around 1856, the Transylvanian Museum, then, when the garden starting to be transformed in a

botanical garden has been used as an auxiliary building for the botanical or chemistry institute [12]. Today, the surrounding park became a multifunctional area hosting the university medical complex of buildings from the Clinicilor Street, the Geography Faculty, the Zoological Museum and the main student campus in Cluj, „Haşdeu".

4   CONCLUSION

- City, as a defining element of the geographic anthropogenic space, represents an important topic of research, one of geographers main concerns being that of defining the phenomenon and its materializations in landscape.
- The urban landscape imposes itself as a subcategory of the anthropogenic landscape characterized by urban spatial expansion, vertical development, physionomyc diversity (regarding the age and temporal evolution, functional complexity, differentiated involvement of human communities).
- "Veduta reveals its importance as a significant source of information, helping therefore to complete the historical data from a different perspective as compared to that of the written manuscripts, namely, from the perspective of the image creator." [13]
- As the pressure of our consumer society is increasing, the necessity for intelligent urban planning policies became more important, and tendencies like "Ecoregionalism", embracing the idea of a better coordination between "new interventions and existing background", become more relevant. [14]

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APPROACHES TO THE FLOOD-CONTROL MEASURES IN THE MAJOR SLOVAK RIVERS IN THE PAST AND PRESENT

Mária Ďurechová[1]

Abstract

The principle of flood protection is not only in building water reservoirs , dikes and dams to alleviate the effect of flood waves , but also in building a replacement river basin . Water control structures and water courses have been and are expensive . In recent years, almost the entire territory of Slovakia fights with the hundred storm water , increasingly we see the devastating effects of floods. We forgot the prevention. As in the past , so today we have to solve this problem with comprehensive approach . More than 20 years , the Slovak water structures were given only minimal attention. Today after repeating the devastating floods, the river basin remediation problems and regulation of the water flows reached the table of the water managers and politicians again. Will they return to more or less known, less expensive procedures used in the past in many towns and cities to protect their properties immediately , or after a detailed analysis of the current status they will approach for more comprehensive, long-term but technically and financially demanding solutions? The overall improvement in the situation could also contribute from deregulation of the certain rivers, returning to its natural status weher periodic flooding simply belongs. Part of this would be a re-connection of the various side channels and dead branches to the main flow and cleaning all floodplains from all items which do not belong there.

Key words

Flood protection measures, protective dams, regulatory adjustments, small dams of flows, the Danube Commission (CID), waterway.

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1 REGULATORY TREATMENTS OF THE RIVER FLOWS IN THE AREA OF CZECHOSLOVAKIA AFTER YEAR 1918.

As a result of the political and economical changes associated with the dissolution of the monarchy and the constitution of the successor states in the Central Europe there were created new transport needs . There have also changed the conditions for solving transport issues related to further development of the river transport and waterways. Projects for the construction of the connecting river and canal waterways treatment developed before the World War I in accordance with the interests of traffic monarchy were necessary after the Czechoslovak state to adapt to its real transport needs. Disputes and different interests of groups, farmers , water managers and economists arising from setting priorities to address water problems were largely limited due to the financial possibilities of the state. Ultimately, however, they led to the continuous postponement of adoption of the law and made the Czechoslovakia in 1931, had elaborated the concept of water works and regulatory work to national rivers [1] .

Inflexible government approach in dealing with water issues was experienced particularly in Slovakia, where the delayed interest of Ugrian state of the hydraulic work resulted in a lower technical level and the number of water works .

In the Czech countries even before the coup, there was carried out the decisive part of water management and regulation work on the initiative of local candidates, whether entrepreneurs or municipalities that participated only in the formation of state building programs as well as their financing and implementation. After 1918, in the districts of state supervision for the completion of the work already undertaken and preparation of new projects was taken over by Länder Commission to modify the river in Prague, which was managed directly by the Ministry of Public Works.

1.1 Water activities of the state administration in the management of the regulatory work on the river Danube

Regardless of the division of competences in the field of the water transport , in 1919 there was adopted Act . 330/1919 Coll . jurisdiction in matters of construction of waterways [2], which create legal preconditions for the fulfillment of obligations to Czechoslovakia in the socalled status of the Danube. By signing the resolution of the International Danube Commission (CID), the state ranked among the other Danubian States and among other things, took responsibility for maintaining the navigation fairway and depth of the Czechoslovak Danube [3]. All powers related to the provision and management of the regulatory work on the Danube was passed to the Ministry of Public Works .Their funding is not directly involved in the state.

With systematic work on the Danube it was began in mid 1920, after leaving the Hungarian troops . Work performed in the early years were in the nature of maintenance work. After the extensive reconstruction of the regulatory structures to the moderate water, which during the war did not receive enough attention, there began deepening the river bed dredging and fords focusing on the Czechoslovak- Hungarian section, which significantly limited the passage. At that stage of the regulatory work all the modifications have led only to transient improvement of navigation conditions in a short time (every two years) had to repeat. Without extensive building modifications there would not be technically possible to achieve a lasting improvement navigational depth.

Representatives of Czechoslovakia therefore asked the Executive Committee of the Danube Commission for approval to restore the broken regulatory work for a little water, which was began by Uhorsko. To implement the project in the new political and economic conditions there must also be obtained CID approval and consent of the adjacent coastal state and that for two reasons. Firstly, because the Danube River forms the natural border of the critical state. Any foreign intervention in the "wet " the border into the river bed could be described as an infringement of national sovereignty . No less serious it was the second reason. If the state was adjacent to the agreed proposal, it undertook a legal obligation to pay half of the cost . Austria and Czechoslovakia agreed to a proposal after the signing of an agreement regulating work began. Adjustments to the little water to the Czechoslovak- Austrian section led to the elimination of the worst obstacles to local ford lock in Devin, Bugelbach and other places of the common border. At the same time across the field there were made the technical preparatory work for detailed editing sections, which were the biggest obstacles to navigation in the area and stop or decrease the Bos and Vajta. Raising levees and building new fortifications of the banks and parallel dikes did not improve only sailing conditions, but also reduced the risk of potential damage in the case of floods and ice formation .

The Hungarian party refused any participation in the regulatory work in Czechoslovakia . Representatives of the Hungarian government did not agree with the proposal or contract to carry out maintenance works on the Danube frontier. Only under pressure, the CID Resolution 1923, Czechoslovakia managed to close at least one year agreement with the Hungarian shipping companies MFTR, which was also involved in the reconstruction from to their own interest[4]. Both states agreed in 1927 the common work and time on the Czechoslovak-Hungarian border at mile stretch from 1850 to 1815. At this time, it became clear that due to poorly designed trails Danube riverbed in the late 19th century even a small adjustment to the water would not improve navigation conditions on the section between Bratislava and Budapest. The only solution would be construction of a connecting channel , as proposed by the Expert Group has since 1908, when preparing projects for little regulation of the Danube water. To implement costly and technically demanding construction, like twenty years later, there was unable to find sufficient funds. Navigability of the Danube to the whole area of the common border was maintained until 1938 only by exported dredging and alluvial gravels [5].

1.2   The system of water works Gabcikovo – Nagymaros

Although the length of the Danube flowing through the territory of Slovakia is only 172 km, while simultaneously leading to both banks of our country only 22.3 km in length, has this European river of immense importance for Slovakia, it is not only a rich source of water, but also transcontinental traffic artery that connects the Atlantic Ocean to the Black Sea. Navigability of the Danube in the 50th the last century, the status of the dam began to complicate in Vienna Freudenau. After completion of the dam in Austria "flowed" into the profile of the Danube riverbed in Bratislava instead of the original from 650 to 720 thousands m3 gravel annually, only about 150,000 cubic meters. However flow rate under Freudenau VD was not changed, and therefore at Bratislava profile bottom of the Danube continued to dicrease. The consequences were disastrous, not only for forestry, but also to ports in Bratislava. Those were at the times of low flows suddenly "too high", and ships simply could not anchor. The bottom of the ports could not be dig because it would breach the conditions which were established harbor walls. At risk there were aslo the sources of drinking water. The inundation of surrounding areas was in fact Bratislava waterworks wells, which would constantly fall to the bottom and loose their original yield. Bottom demonstrably decreased in Bratislava profile up to 1.7 m. Construction of Waterworks System Gabcikovo- Nagymaros

should achieve improving flood protection areas, improvement of navigation conditions on the section from Bratislava to Budapest, renewable energy production and finally the development of the region. Also it was reckoned with the increased protection of floodplain forests in the river branch system inland delta of the Danube, which seemed to be threaten by the constant decrease of the bottom and level of flow. In retrospect it is clear that the cause of decrease was not only reduced to the bottom sediment run, but contributed to a decrease in the bottom by the enormous dredging gravel, which were used in the construction of prefabricated houses on the right bank of the Danube in Petrzalka.

Construction of Waterworks System Gabcikovo- Nagymaros was enrolled into the history of hydraulic engineering by longstanding political disputes that accompanied the preparation of the dam. The contract was concluded 23.09.1977, was ratified by both parliaments and signed by the presidents. So it became the character of the law and thus had the highest legal force. Contract 77 was based on the principles of cost-sharing in the ratio of 50:50% , the main objects should be owned by both countries in equal proportions. Both States were to share equally in the proceeds. While in Slovakia the construction work took place under the terms originally agreed, the Hungarian party on its field gradually stopped the works. Since May 1989, Hungary openly opposed the construction of water works and tried to prevent its completion and commissioning. Proceedings of professionals and of course the politicians did not lead to any reasonable solution , so even when the Czechoslovak government decided that Hungary, despite objections by the Gabcikovo waterworks on the Slovak side will be completed. In May 1992 Hungarian Government unilaterally ended Contract '77. It took about 18 months, it was necessary to replace degree Dunakiliti dam with power station with installed capacity of 25 MW in Čunovo, and to dam the Danube on the Slovak territory to even get water to the turbine in Gabcikovo. In October 1992, VD was put into operation, although not all objects have been fully completed [6].At the request of the Hungarian side, the issue was addressed to the International Court of Justice in Hague (ICJ). After about four years preparing the ICJ delivered its judgment in September 1997 in favor of Slovakia, as successor of the former Czechoslovakia [7].

1.3   Strategy of the European union for the Danube region

Water line between Western and Eastern Europe creates a unique Danube space with great economic, cultural and civic potential. Social exploitation of this potential is the result of advancing cooperation of the countries, most of which are already a part of the EU. Danube waterway can become one of the pillars of privileged cooperation in the Danube area. The length of the Danube is nearly 3,000 kilometers on its way through Europe runs through the six Member States. Danube is one of the trans-European corridors, which are the priority axis for inland waterway routes across the EU. Danube Strategy is an historic opportunity to implement the long-term recovery program in Danube region and effectively exploit the potential of the Danubian States. First , a preliminary draft of the Action Plan Danube Strategy, the European Commission in July 2010, a year later the program was adopted.

2   SOLUTION OF THE FLOOD SITUATION ON THE RIVER VAH

2.1   Few words about the vanished inland delta of Vah

In the early 20th century the inland delta of the Danube formed all the alluvial cone of Bratislava. At these places the river slowed its speed and store bearing sediments. As a result of accumulation prevailing activity there have been created many river arms and islands, creating a sort of inland delta. This process, when the flow meanders in its sediments, causing

bank erosion and abundant branches was also typical for Vah under the town Nove Mesto. Inland delta of course did not have such parameters as Danube, but formed an important structure of the flow, which virtually disappeared until the time of construction of Váh degrees.

Vah originally raced in freshwater lakes in Ilava and Trenčin valley. Under the town Nove Mesto, where Vah leaves Trencin valley, the terrace were not produced since the river after leaving the gate Beckovská entered the vast plains. Since the barriers towards the mouth of the Vah gradually slowed speed and save massive silt [8]. Although the Slovak usually referred to as the mountainous country , few people realize that a considerable part of the territory (41 %) is occupied by the lowlands. Below there are the lowlands of Slovakia (unlike other countries) to understand the altitude of 93, 7 m to 300 m. Along major rivers, which clearly belonged to the Vah, affecting lowland alluvial plains as their spurs in the form of flat to high relief to the north of Slovakia. Outcrops along the Danube plain affect Vah up to Bytča . After such elevated alluvium Vah already flowed in Trencin and Ilava Basin. Agrarian mound, formed under the gate as Beckovska caused the small Carpathian streams could not get into the bed of the Vah upstream, but opened into Dudváh River, which flows in parallel with it . Today it sounds cheerfully the efforts of our ancestors, who were only a few decades trying to divert part of the waters from Jablonka Čachtice to Vah and found that actually digging trough " uphill ". It was managed only a few years later, when Čachtický relief channel was built, which leads substantially lower - at Horna streda Biskupicky derivation channel. This process was and is still going on in the bed of the Vah.

Until the construction of the Vah cascade sediment movement in the alluvial plain almost natural, as well as their accumulation in the plane Beckovska gate. Vah here in bed sediment deposition, and during the floods along the river bed, has created a wide river floodplains with typical meanders and blind, and a tangle of dead branches in different stages of development . Most complex system - the inland delta, created under section Vah in Piestany. In itself Vah after flowing uphill agrarian vale complicated situation of water in less plains, often quite distant from the main bed. So in addition to Vah itself with various systems developed, this stretch of river bordered system of periodic bog and marshes , which are associated with each different is the main stream, especially during spring floods. Besides melioration works to the demise of river side alluvial water contributed significantly Vah cascade construction. Once it is operational , a substantial portion of the Vah shunt was in the water channel, the old - the original bed, in some places was diverted, represents only a fragment of the former designer Vah valley. Very significantly there was changed an inundation area. The initial conditions when Vah during flooding spreads widely and created extensive floodplain associated with riverside marsh and swamp , as a result of regulatory intervention and building retention areas (Sĺňava) , has become a thing of the past [9] .

After the completion of the Vah cascade was its low fully adapted to the use of energy, resulting in a fairly significant decline in groundwater levels in some sections. When we add virtually no sediment supply from the upper parts of a continuous flow of the river is digging into the ground , we can understand why the original floodplain and suffers from drought dried up the original floodplain communities.

2.2 Vah Cascade – principle of flood protection

Vah cascade was already designed in forty years. As the first one was built in 1936 Ladce hydroelectric power, and a dam built in Dolni Kočkovce because it was the first hydroelectric project ever built on Vah. Until then, in locations around Vah there were frequent floods.

The situation in Považie was significantly worse than the situation in eastern Slovakia. Every year, the state contributed to this hearty snow water and precipitation in northern Slovakia, especially in Kysuce and Orava , which met in the spring months most streams in this area Kysuce and Orava. Flood waves caused caused the most damage in Povazieon the lower section of Vah, which were flooded towns and villages. In the last century it was designed solution that is now shown to be very happy. This was just Vah cascade .

After the final construction of the Vah cascade, the old bed of the Vah River replaced the artificial channel, which is several meters depth. Given the diversity of the terrain is Vah cascade sometimes 7 meters above the original river bed below, and municipalities do not have problems with ground water due to the excellent insulation. Vah cascade almost entirely replaced the river Vah. Cascade still carries up to 9/10 of the total catchment area and Vah serves for electricity in many surrounding villages. The rest of the volume of water is discharged into the bed of the river Vah. The system of protection to flood still serves without major problems. Last manifested most recently in spring 2012. Very often, however, there is a sharp rise in Vah's tributaries. In these cases Vah cascade increased water flow, thus achieving faster transfer and mitigate flood wave. However Vah cascade can not handle the full flow of the river Vah , and thus had to be unavoidable discharge of water into the trough . River Vah in this case in some places has left the river bed, but the water never significantly endanger people's property.

3   CHANGES OF THE APPROACHES TO FLOOD PROTECTION

After repeating the devastating floods in the recent years many professionals have realized that it is necessary to change the current method of the flood protection Building ever higher dikes leads nowhere and limitation of the water flows clearly exceeded the tolerable level. It is at least partially to return the rivers the area, which naturally belongs to them. One option is to build a dry tanks, which would be used only in the case of flooding. For better, however, the experts consider to upload dams on the rivers, and remove the obstacles that slow run off. In some areas they have already started to use up the retention exploitation potential of the area:

- small dams of flows,
- infiltration pits,
- increase forest cover and reducing the amount of troughs,
- centour line management

This is just one way. At the beginning we said that in this case for a comprehensive approach to flood protection it is essential to pay attention to the water works, which for years fulfill their protective function against floods. Their number in Slovakia is sufficient and there is no need to build new ones [10]. In areas where there is inadequate flood protection can be used as well as other forms:

- flood dams,
- baypass channels,

3.1   Revitalization Country Program 2010 - 2012

The revitalization of the country and integrated river basin management of the SR Government approved in its meeting held on 27.10.2010 as a cross- marketing program aimed at revitalizing of the damaged sections of the country through its retention capacity of regeneration. The program led to its integrated approach to the restoration of ecosystem

functions and the country was part of the normal economic and land policies, culture, landscape management and water management. It was funded by the EU and should show, among other things, what direction the towns and cities in this area would be nut .

By March 2012 three projects were carried out by implementing of revitalization program, which involved successively 23, 190 and 354 municipalities. Some municipalities also repeatedly, total 488 municipalities. Seasonal work for six months gained 7,700 people, including more than 2/3 were job seekers who have renewed and expanded their job skills in socially and environmentally useful work. The program also contributed to the development of small and medium businesses and residents access to towns and villages not only new technologies but also the sense perception and understanding of revitalization measures to restore degraded sections of the country, with the use of construction machinery and vehicles.

4   CONCLUSION

The rivers have gradually converted to equal flows sandwiched between narrow dikes and lost the natural floodplains. The amount of water that the river should have released did not dicrease. On the contrary, river basins are facing huge storm waves. The amount of rainfall is more concentrated. In 2010, Slovakia had rainfalls to 1255 mm, which is 165% of the long-term average, we had 184 days of flood activity. Our territory was affected by all types of flooding (ice, melting snow, extreme rain). Felling of forests, scrublands and plowing also significantly reduced the ability of soil to retain and store water. It is broader and flows faster into a river basin that have a chance to pay it. It is now clear that this way the path does not lead. In many European countries, experts have reviewed approaches to water management in the late 19th and early 20th century. One way it is to deregulate and return to its natural state, which are simply periodic flooding . Part of this would re-connect the various side channels and dead branches to the main flow and even eviction from all floodplains, which does not belong there. However there are often the human dwellings built in the wrong places, whose long-term protection is more costly and less effective. And this is obviously a problem.

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GARDENING EXHIBITIONS IN EUROPE – THEIR HISTORY AND INFLUENCE ON THE SHAPING OF GREEN AREAS

Anna Hoła[1]

Abstract

The paper presents the over 200 hundred year long history of gardening exhibitions in selected European countries, e.g., Belgium, the UK, France and Germany, from small exhibitions to national, international and worldwide horticultural events. The reasons for holding such exhibitions are explained and the role of the latter in the encouragement of contemporary trends in the design of multifunctional green areas is highlighted. Attention is drawn to the fact that the exhibitions have contributed to the creation of countless parks and urban recreational areas and from the middle of the last century, to the restoration of environmentally degraded areas. The paper is illustrated with iconographic material.

Key words

Aims of holding exhibitions, gardening exhibitions, history of exhibitions.

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1   INTRODUCTION

The beginnings of the art of exhibition date back to the 1750s. The development of this art was spurred by the advances in science and technology, and the consequent economic transformations, which took place in the second half of the 18th century and the first half of the 19th century. This process, referred to as the industrial revolution, started in the UK – the then leader in technological progress, and over time spread to include France and the other European countries. The manufactured goods would be promoted at craft and industry exhibitions held in many European cities. The exhibitions offered an opportunity to exchange experience between the manufacturers and so contributed to the further development of industry. Also the art of gardening could be admired at such exhibitions since plant and floral arrangements would often be part of the decor of the exhibition halls and pavilions. Moreover, skilfully arranged greenery enriched the surroundings of the exhibition buildings and while being a place of relaxation for the visitors it also functioned as an exhibit representing the current achievements in its own field.

Specialized exhibitions devoted exclusively to gardening began to be held in Europe at the beginning of the 19th century. They significantly contributed to the development and spread of the art of gardening among the society and provided the stimulus for creating numerous parks and recreational areas.

This paper presents an outline of the history of gardening exhibitions, highlighting the aims motivating their organizers. Also their contribution to the shaping of urban green areas is indicated.

2   OUTLINE OF THE HISTORY OF GARDENING EXHIBITIONS IN EUROPE

The first gardening exhibitions in Europe had a rather incidental character. Single specimens of different plant species, usually belonging to merely a few growers, would be put together in an accidental manner. The exhibitions were organized by nature societies, which would be set up from the beginning of the 19th century, such as: the Royal Horticultural Society in the UK, the Royal Society for Agriculture and Botany in Belgium and the German Society for Supporting the Planting of Gardens in the Prussian Kingdom.

Over time, when it was found that the exhibitions would significantly contribute to encouraging new trends and to greater awareness of gardening art among the society, larger shows, bringing in exhibitors from a wider region, began to be organized, as evidenced by the numerous shows, held as early as in the 1840s, dedicated to selected plant species, which attracted gardening experts and lovers, providing an opportunity for the exchange of experience. Moreover, seasonal exhibitions, at which plant species attractive in the particular months or seasons of the year were exhibited, would be organized [1].

The form of gardening exhibitions in the second half of the 19th century was influenced by the world exhibitions which began to be held since the 1850s. The first world exhibition – the Great Exhibition of the Works of Industry of all Nations – was held in London in 1851. The exhibitions started a new era of free competition for all nations regardless of the prevailing geopolitical conditions, and gave rise to the later Expo exhibitions. Moreover, they provided and ideal model and encouragement for various European organizations and countries for putting on thematic exhibitions, including gardening exhibitions, with an ever greater reach and status.

Since the middle of the 19th century, besides numerous regional and local events, domestic, international and even worldwide gardening exhibitions began to be organized. Special building structures, such as exhibition palaces and halls would be erected for this purpose. Later the large exhibition structures were superseded by smaller pavilions and kiosks, with most of the gardening exhibitions situated outdoors. The extensive outdoor exhibition areas would be given the shape a formal or informal park, interesting in its form thanks to, among other things, the differentiation in terrain elevation or the introduction of water bodies. In addition, the exhibitions had an impressive programme which, besides exhibitions of flowers, plants, vegetables and fruits as well as gardening work aiding equipment and tools, often included layouts of green areas which were to serve different functions, thematic garden exhibitions and presentations of landscaping solutions characteristic of different cultures and historic periods.

The above trends in the shaping of exhibition areas still persisted in the first half of 20th century, even though the organization of exhibitions in that period was suspended twice because of the military operations of War I and II conducted in Europe.

In the 1950s the tradition of holding gardening exhibition was eagerly resumed. However, because of the intense economic and civilization transformations taking place in the second half of the 20th century, the exhibitions were given a new format. Up to this day, regular exhibitions annually put on the same already developed site have been widely held. They are often highly specialized, being devoted to, e.g., solely flower arrangements or garden landscaping (e.g. the International Garden Festival at Chaumont-sur-Loire). An example of other events held today are exhibitions whose successive editions are staged in different cities. Owing to this, successive environmentally degraded areas are revitalized as part of exhibition projects (e.g. BUGA).

In the course of the two centuries, i.e. from the beginning of the 19th century to the present times, the vogue for organizing gardening exhibitions has spread all over Europe. The gardening exhibition art has developed particularly dynamically in Belgium, the UK, France and in the German Lands.

According to the available sources [1, 2], the first gardening exhibition was held in Ghent, situated within today's Belgium, where in 1809 the first public show of plants was held in a small inn (fig. 1a). The show was so successful that its originator – the Royal Society for Agriculture and Botany – decided to hold annual summer and winter exhibitions. In the next years the frequency with which the exhibitions were held did not decrease and so on the occasion of the 25th anniversary of the establishment of this society the latter organized (in 1834) the 50th exhibition and three years later, the first in Europe international flower show.

Since 1893 up to this day the world-famous flower and plant exhibitions in Ghent have been held, under the name Floralies of Ghent, every five years. The exhibition promotes mainly native products, but for quite some time now it has had an international character. It was popularized in 1913 (fig. 1b) when the world Expo exhibition was held in Ghent. The latest edition of Floralies of Ghent was held in April 2010 (fig. 1c) [3].

Also the UK has had a rich history of gardening exhibitions, where, around 1820, various societies of flower growers would put on exhibitions of novelties for which the best producers would receive awards. Among the numerous societies active there the most eminent was the Horticultural Society of London, which already since the end of the 1820s would organize flower festivals on the estate belonging to the Dukes of Devonshire in Chiswick.
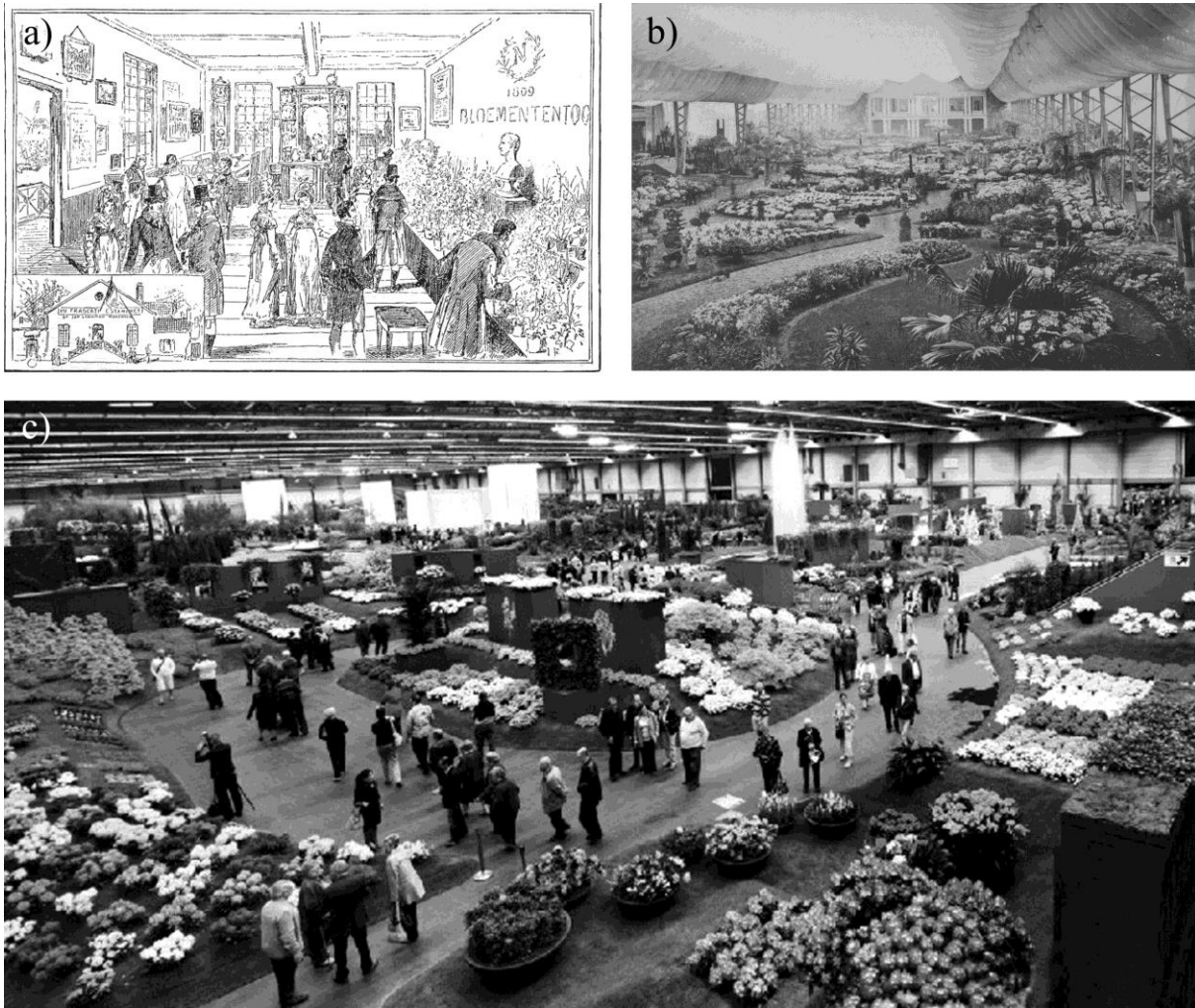
Fig. 1)   Gardening exhibitions in Ghent: a) print by Charles Baltet, showing first gardening exhibition on Continent in 1809 [1], b) 1913 photograph showing another edition of Floralies of Ghent exhibition [4], c) photograph showing latest edition of Floralies of Ghent exhibition held in 2010 [5].

In 1862, after it was granted state funding, it changed its name to the Royal Horticultural Society. Since that time for the next 26 years the successive editions of the Great Spring Show organized by this society would be held in the royal Kensington Garden. In 1888, Temple Gardens were selected as the venue for the show and at the beginning of the 20th century the show was moved to the premises of the Chelsea Royal Hospital where starting from 1913 up to this day the exhibition has been held under the name the Chelsea Flower Show (fig. 2). The other exhibitions organized by the Royal Horticultural Society include the Hampton Palace Flower Show (held since 1990), the Tatton Park Flower Show (held since 1999) and the Spring Flower Show Cardiff whose first edition dates back to 2005 [6].

When writing about gardening exhibitions in the UK, it is hard not to mention the first in this country, and the second on the Continent, international exhibition, called the International Horticultural Exhibition, which in 1866 was held in London [2]. Also France has been rich in all kinds of exhibitions. Among the numerous societies active on its territory one should distinguish the Gardening Society founded in Paris in 1827. The Society, put on its first exhibition in 1831, and later it was renamed to the National Gardening Society of France [9].

Fig. 2)   Chelsea Flower Show: a) photograph featuring Mary Queen of Great Britain during show in 1913. [7], b, c, d) photographs of gardens exhibited in 2012. [8].

The Society organized many regional and nationwide exhibitions and provided patronage for such gardening events as the International Horticultural Exhibition held in Paris in 1895 [10] and the Horticultural Show held during the Paris World Expo in 1900 [11].

Besides Paris, the other major horticultural centres were: Troyes, where the first chrysanthemum show on French soil was held in 1888, Nice, Grenoble, Amiens and Lyon. Also in Marseilles and in the university town Caen numerous exhibitions devoted to different branches of horticulture have been held [1].

One of the most prestigious in Europe, contemporary gardening events in France is the "Floralies" International Flower Festival held in Nantes since 1956. The Festival is held every five years and its latest edition took place in 2009 [12]. One of the more interesting events is the annual International Garden Festival at Chaumont-sur-Loire, the idea of which consists in managing garden space according to the theme set by the exhibition organizers. For example, the leitmotif of the exhibition gardens presented in Chaumont in 2011 was "Gardens of the Future or the art of happy biodiversity" (fig. 3) [13].

The art of horticultural exhibition has very dynamically developed also in the German Lands where from the 1820s many gardening societies have been formed. The oldest of them – the Society for the Support of Horticulture in the Prussian Kingdom – was founded in Berlin in 1822. The Society organized, among other things, great outdoor hyacinth shows and the widely regarded spring shows presenting flowering greenhouse plants [2]. The major German horticultural centres are: Hamburg, Essen, Frankfurt am Main and Hanover, where the first International Horticultural Exhibition on German soil was organized in 1869 (fig. 4).
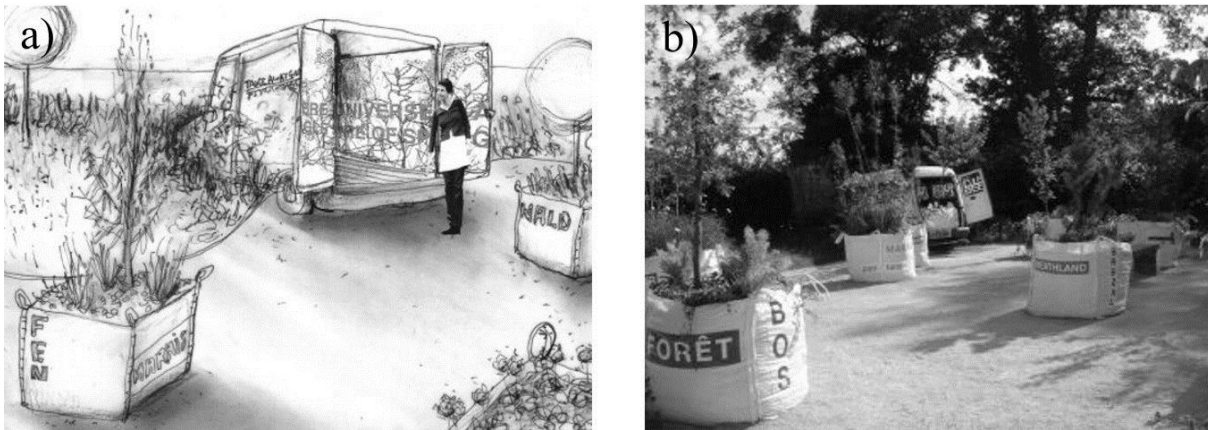
Fig. 3) "The take-away garden" – one of gardens presented during International Garden Festival at Chaumont-sur-Loire in 2011 [13]: a) garden design by Jo Chapman and Steve Papps, b) photograph showing actual garden.
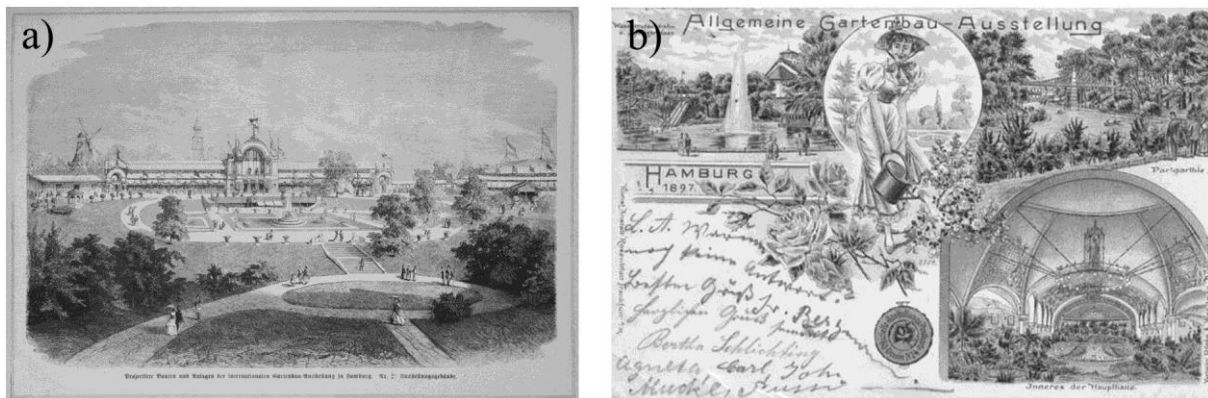
Fig. 4) Horticultural exhibitions on German soil: a) print showing land management and exhibition structures at International Horticultural Exhibition in Hamburg in 1869 [14], b) postcard issued on occasion of General Horticultural Exhibition being held in Hamburg in 1897 [15].

Also Dresden has greatly contributed to the development of horticulture, where in 1828 under the patronage of the "Flora" Society for the Advancement of Botany and Horticulture the first garden art exhibition on German soil was organized. This city also hosted numerous international exhibitions in, for example, 1878, 1896, 1907 and 1926 [2].

Among the events held today the greatest and most prestigious are the regularly held National BUGA Exhibition, first held in 1951 in Hanover, and the Internationale Gartenbau-Ausstellung IGA held every ten years since 1953 [2].

3   AIMS OF ORGANIZING GARDENING EXHIBITIONS AND THEIR INFLUENCE ON THE SHAPING OF URBAN GREEN AREAS

A survey of the available literature, archival materials and internet sources shows that during the over two hundred year long history of gardening exhibitions in Europe not only their reach and programmes, but also the aims the societies organizing them have been changing.

Invariably the primary task of the exhibitions organized in both the 19th century and today has been to promote the plant material and so to propagate gardening in the society and encourage new trends in the art of gardening. Equally important has been to provide an opportunity for the exchange of experience between the exhibitors and the growers coming from different regions. This exchange would then translate into their ever greater achievements and further development of horticulture.

At the end of the 19th century much importance began to be attached to the educational aspects of gardening exhibitions. Therefore the exhibited plants would be arranged depending on their features, for example, varieties requiring similar growing conditions would be put together. Over time exhibitions began to be enriched with lectures and talks on various topics relating to the art of gardening. Also educational were the layouts of parks and gardens, the books or magazines on gardening as well as the results (in the form of drawings and diagrams) of experiments carried out on plants grown in different conditions and the statistics giving the visitors some idea about the condition of horticulture in different regions, presented during exhibitions [1].

Sometimes gardening art exhibitions would be exploited for political purposes, as exemplified by the German exhibitions in the years 1934-1939. When the National-Socialist Party of Workers came to power in Germany, German culture and art was reduced to the role of a propaganda tool and the aim of all the exhibitions organized lavishly on a grand scale during that period was to glorify the achievements of the Third Reich and demonstrate its power [2].

The gardening exhibitions held for years have resulted in numerous urban green areas in the form of parks laid out on the exhibition grounds, remaining after the successive exhibitions were closed and the exhibition buildings were dismantled. In this way, for example, the Trocadéro Gardens came into existence after the world Expo in Paris in 1878, as well as the Jan Kiliński Park in Lvov, put to public use when the National Exhibition ended there in 1894 and the Ujazdowski Park in Warsaw, which was laid out on the grounds previously repeatedly used for various exhibitions [16].

Many of the exhibitions held in the 1950s and 60s contributed to the rebuilding of cities after the war damage since the cleanup work done as part of the exhibition projects covered not only green areas allocated for putting on the exhibitions, but also the neighbouring buildings and some of the utilities. This was the aim of the first BUGA exhibition held in Hanover in 1951. In the years 1967-1993 in the next editions of this regular exhibition the existing green areas were renovated and new green areas were established, while in the period 1995-2007 efforts were concentrated on the revitalization and activation of environmentally degraded areas. An example here can be the successful revitalization of the vast area in Cottbus, previously used as the storage yard for old planes, carried out as part of the BUGA exhibition held in this city in 1995 (fig. 5).

The idea of the BUGA exhibitions organized after the year 2007 has been to create ecological spaces in the centres of cities. This emphasis on the increasing value of urban green areas and the promotion of the ecologically sustainable development of cities is in the opinion of the BUGA exhibition organizers vitally important, especially in the context of today's knowledge on climate change, environmental pollution and the continued sealing of the soil [18].

Fig. 5)   BUGA horticultural exhibition in Cottbus in 1995: a) photograph from 1975 showing grounds before revitalization [17], b) photograph from 1995 showing park laid out as part of revitalization project [18].

4   CONCLUSION

As indicated in this paper the first public display of plants took place in Ghent in 1809. It initiated countless gardening exhibitions held in many European cities. Belgium, the UK, France and Germany are the countries with particularly rich tradition in this regard. Such old and prestigious exhibitions as the Chelsea Flower Show in London, the BUGA and IGA exhibitions in Germany and the International Flower Festival "Floralies" in Nantes have been held to this day.

On the basis of the survey of the available publications, archival materials and internet sources, several reasons for which gardening exhibitions have been held, such as the encouragement of contemporary trends in the art of gardening, the education of the society in gardening and the exchange of experience between growers, contributing to the development of gardening, can be distinguished. Another particularly important function of horticultural exhibitions has been to spread the love of gardening art, which over time has resulted in the expansion of urban green areas to which the parks laid out and the areas revitalized as part of the exhibition effort would be added.

The above aims are still relevant to the exhibitions held nowadays. Moreover, it appears that in recent years the aims have been evolving towards the creation of ecological spaces in city centres and the promotion of sustainable ecological development.

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BASIC PRINCIPLES OF DESIGNING ENVIRONMENTALLY COMPLIANT STRUCTURES FOR PEOPLE

Thomas Macoun[1], Ulrich Leth[2]

Abstract

Built structures comply with the principles of social, ecological and economical sustainability. Special attention has to be paid to the fact that human perception and assessment and ultimately human behaviour is influenced by various unconscious aspects. Savings of body energy have a positive connotation in all means of movement and are perceived as progress. This ultimately leads to car-oriented settlement structures as the body energy consumption is at its lowest when driving a car. One of the effects is the spreading of settlement structures and by that the exceeding of energetical limits of pedestrians and cyclists. The attractiveness of those areas as a living space declines. When trying to optimize the system, these feedback loops have to be taken into account.

Key words

Assessment, human perception, indicators, spatial planning, sustainability, transport planning.

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1 INTRODUCTION

The implementation of environmentally compliant structures is in need of a wider perspective. On one hand the environmental topic is closely linked to sustainability. On the other hand various definitions of 'environment' exist in different fields. Humans tend to assess environmental aspects from an individual point of view. But human perception is adapted to short time frames, quick changes, tangible scales, small social groups and especially to the limited capacity of our senses. As a result, local environmental problems (e.g. noise) are weighted higher than sustainability issues.

In the past decades the planning of settlement and utilization structures as well as infrastructures was based on economic, mostly business considerations. Ecologic and social aspects were rarely taken into account. Design followed the aim of time and cost advantages, status considerations and the like.

It is crucial to appreciate the feedback between man-made environment (settlement and infrastructures) and mobility behaviour. In order to design sustainable structures it is mandatory to create an environment which enables a sustainable mobility behaviour.

2 LESSONS LEARNED

The structures that were built during the last decades followed quality standards which were oriented towards the dominant means of transport of this era, the car. This is true not only for the design of public street spaces but also of whole settlements (parking lots next to the apartments, dedication of building land without adequate public transport accessibility). As a result the basic functions (housing, working, shopping, and leisure) fell apart, thus exceeding the biological and organizational limits of walking, biking and PT.

The prioritization of cars – by designing structures mainly for the "needs" of cars – is not solely rooted in economic considerations (automotive industry, road and railway industry, etc.). The use of the car becomes attractive through body energy savings for the driver as well as the fact that it saves time and costs in current structures.

The needs of car drivers and their quality expectations were codified unquestioned in laws, guidelines and fact sheets. The needs of pedestrians, bikers or PT users were given less weight. Also time savings for car drivers and the transit functions of roads were weighted higher than the amenity value for residents. In turn this environment shaped by humans influences the (mobility) behaviour of the people in a lot of ways.

3 CRITERIA, INDICATORS AND LIMITS TO ENVIRONMENTALLY COMPLIANT PLANNING

3.1 Constants and variables in transport and spatial planning

Fundamental constants and variables of human travel behaviour can be explained through biological and social reasons. Mobility (defined as the number of out-of-house trips per person per day, independent of duration and means of transport of the trip) as well as daily mobility time are constants when viewing the transport and spatial system in an integrated way. Variables are mode choice (modal split) and trip and travel distances. The constant 'average mobility time' together with higher velocities (esp. in road traffic) has led to increased travel distances.

The car-oriented mobility behaviour – quantified by the modal split – is reflected in higher traffic volumes and ultimately increased greenhouse effects and thus crosses the borders of sustainability.

3.2   Social criteria, e.g. quality of life

When striving for environmentally compliant structures, individually perceivable and effective structures have to be kept in mind as well as the necessity of planners to control the parameters in a way that a sustainable system status can be reached. To begin with it is crucial to build compact settlement structures in order to prevent the falling-apart of basic functions (New Charta of Athens [1]) and thus minimize the dependence on the car. Further on the use of non-sustainable energy sources must be reduced. According to the present state of knowledge this is only feasible by switching to alternative energy sources (renewables).

Anyway, there is no form of mobility which completely lacks walking (walk to the PT stop, walk to the parking lot). Holistic approaches in terms of a human ecological perspective are needed (e.g. passages and arcades as a protection against all weather conditions, embracing walking distances). The relevant speed in settlements is the pedestrians'. This speed is also curial for the perception of people's living environment, of public streets and places and of the assessment of quality of life in settlements. Possibilities of perception, needs, skills and behavioural causes of the people are decisive.

3.3   System borders and their influence on the choice of suitable criteria

It is necessary to distinguish the terms environment, surrounding outside world, individual distance and umwelt.

Various disciplines define the term 'environment' in their own words. 'Human ecology' (Vienna school of human ecology [2, 3]) defines environment as distorted image of the surrounding outerworld in the brain (internal model "environment" = environment according to Uexküll / Uexküllian environment [4]), due to different perception and assessment. This transformation of the 'surrounding outside world' into umwelt in the Uexküll sense is common for all living beings. As perception and assessment are based on evolutionary predefined structures and on different experiences, status expectations and goals, every human has his own (image of the) environment - his umwelt. Viewed that way there are millions of umwelten.

The common definition of environment (as e.g. in environmental impact assessment) means the view at the individual's 'surrounding outside world' (habitat) (=Haeckelian environment [5]) from an individual point of view.

In his daily routine the individual moves within his specific habitat (housing, place of work/school, leisure) e.g. in his home district keeping his individual distance to other people. Within this distance (individual space, aura = virtual space) he will be affected for example by effects caused by emissions from the surrounding outside world to a different extent in any situation of his daily trip chain. For an individual's assessment (e.g. situations in PT at peak hours, etc.) it is decisive how personally affected they are.

Example: Table 1 shows exemplary characteristics of various criteria for the different scientific system border definitions. E.g. 'impacts' such as exhaust gases, wear and noise are detected as emissions in the 'surrounding outside world'; from the individual point of view immissions are important, but in reality perceived immissions are critical – esp. from a political point of view and concerning the perceived quality of life.
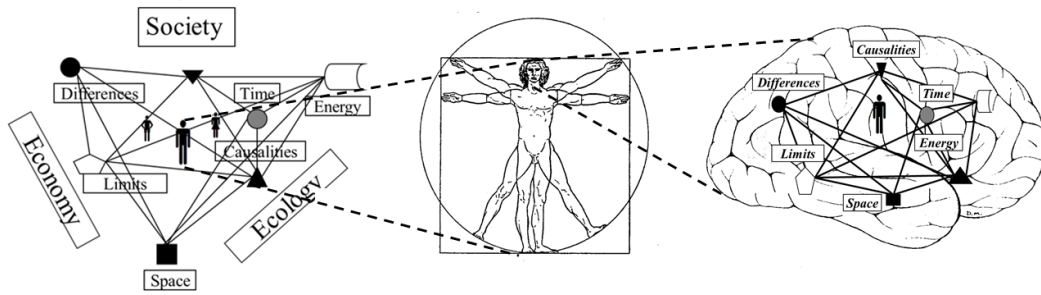
Fig. 1) Drawing of the relations between surrounding outside world (left), individual distance (center) and *umwelt* (right)

Tab. 1) Different system borders and criteria: surrounding outside world, individual distance (aura), *umwelt*; in [6]

criteria	surrounding outside world (habitat, living space) Haeckelian environment	individual distance, aura (objective individual surroundings)	umwelt (subjective individual "environment"), Uexküllian environment)
space (range)	local-global (working, living, shopping, leisure)	aura (30 cm - 2 meters)	mental- maps
time	status quo, prognosis	obj. travel times (trip chains)	subj. perceived travel times
impacts	emissions	immissions	perceived immissions
measuring problems	objective measurability, local measurement	objective measurability (sampler), dose uptake (survey)	subjective rating (survey)
investigated subject/object	average values (individual not covered)	individual deviations (mobility behaviour)	individual perception (genetically, psychologically etc. caused)
(system-) borders	ecologic borders	biologic borders	"Thoughts are free" (excessive or insufficient mental workloads)

The circumstances of our perception strongly determine our experience of urban structures. Both the individual situations depending on location, mode and speed of transport as well as time, season, climatic and other influences play an important role. The design of public road spaces has to follow the perception of travellers at walking speed.

4   EVOLUTIONARY IMPLICATIONS OF HUMAN ABILITIES TO PERCEIVE

The perception of the individual depends on its basic abilities of sensing, which can partly be enhanced by technical equipment. Assessment methods are based on the perceived environmental problems. Perception and assessment are carried out by activating the total background experience of man including the goals, positive or negative feedback as well as status (Fig. 2).
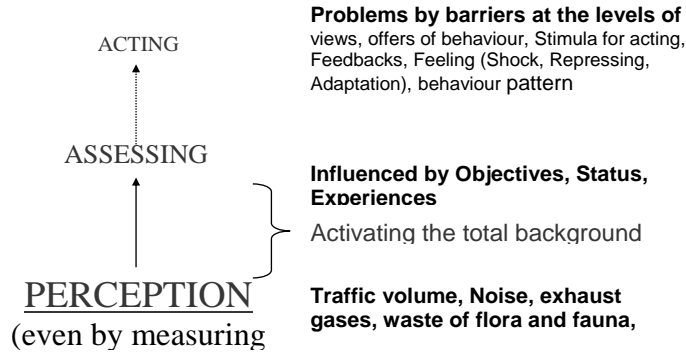
Fig. 2) Process of perceiving, assessing and acting [6]

The process of perception and learning follows a spiral path. Every experience influences future expectations, which determine the experiences to come in return.

This spiral process happens on any level from the precellular level (e.g. flowing of energy) to cultural levels (objectives of groups). Only a few are perceived actively (conscious) while the most powerful levels are unconscious (Fig. 3). It is crucial to bear that fact in mind when analysing weighting procedures as the conscious levels are (obviously) always overrepresented in any assessment method.
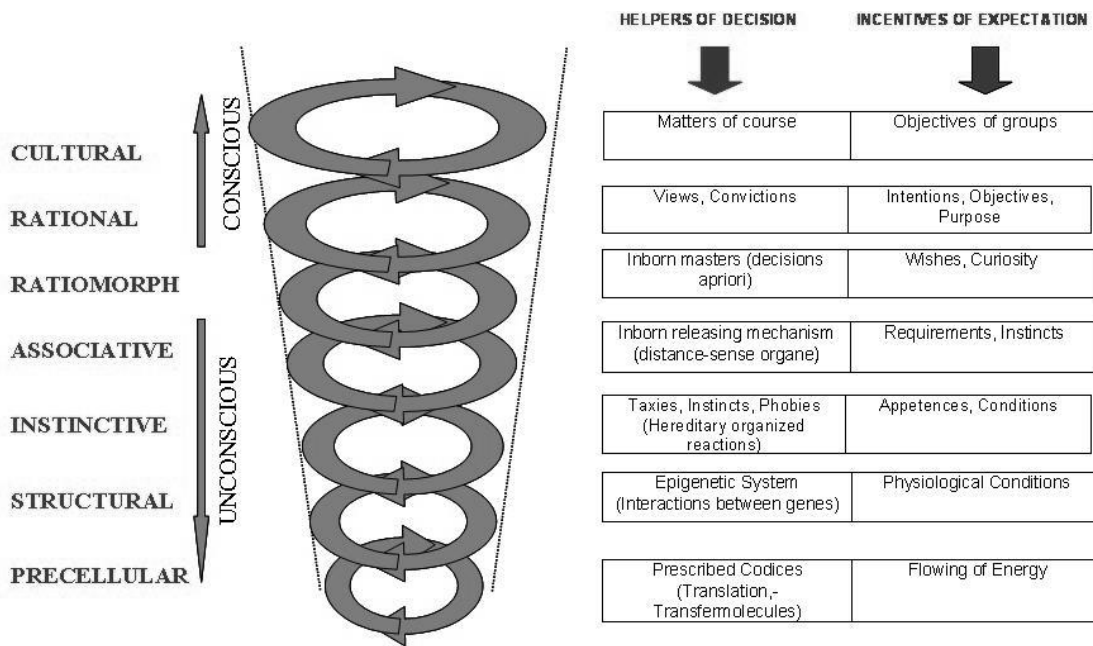
Fig. 3) Evolutionary layers of expectation and experience [7]

One of the deepest evolutionary levels that affects all levels above is the one related to the body energy. It can be determined as the main level. Energy saving was the most successful strategy for survival in evolution. It is probably the deepest rooted driving force for behaviour in general and human behaviour in particular. A car driver, for example, requires only half of the body energy per unit of time, or even less compared to a pedestrian. But during the same time he moves ten or even twenty times faster. This acceleration must create an unimaginable and wonderful effect of strength and superiority which is much stronger than culture and

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ethics or anything else which can be derived from the later and weaker levels of consciousness in human evolution.

By providing attractive public road space, the willingness to accept a 300 m walk can be increased from 30% to 70% (see Fig. 4). The attractiveness of public spaces for pedestrians, cyclists and PT users can – e.g. by enhancing the attractiveness of the walk to the PT stop – even contributes to a modal split change.

Humans take in their surroundings (the surrounding outside world) with their senses. At the same time inner sensors detect the body energy consumption.
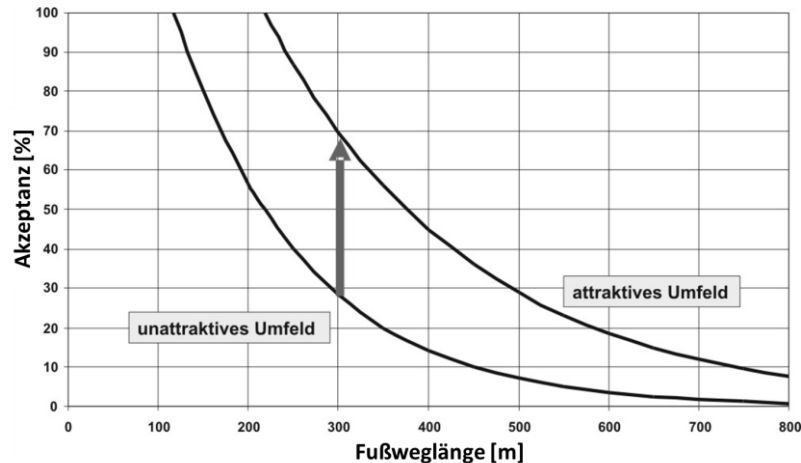
Fig. 4)   Comparison of accepted walking distances in attractive and unattractive surroundings [8]

5   PRINCIPLES FOR DESIGNING PUBLIC SPACE

The function of public space is torn between being a living space or a traffic space. Public space as a living space is mainly a place of social interaction. It is a place for staying, communicating, for recreation and adventure, neighborhood as well as a complex network of various uses of social proximity.

Beside material claims such as supply and disposal, increasingly immaterial and qualitative claims emerge.

In order to grasp the amenity value of road spaces one has to abandon the statistical approach in favor of the analysis of trip chains.

High emotional quality of experience as a result of amenity value originates from the succession of structural elements, also from the generation of attractive, unobstructed movement rooms for the individual means of transport.

Shopping malls already implement these lessons learned. Beside the high (mostly car-) accessibility, most malls draw their attractiveness from internally locking out road traffic. They generate spaces for communication and rest, offering safety to families and children, creating human-ecologic appealing conditions (protection from rain, snow, wind, sun, etc.).

Tab. 2)   Basic claims concerning public road space [9]

material claims	manifestation
transport	movement (transit function)
(supply-)technical	supply and disposal
social und (human-)ecological	communication, ecology and amenity value function

immaterial claims	
orientation	memorability, direction, continuity, scale
identity	originality, local characteristic
social usability	safety, meeting social standards
identification	participation, commitment
design quality	beauty, attractivity, aesthetics
amenity value	security

6   MATERIAL CLAIMS

6.1   Traffic (road space)

Traffic quality consists of traffic safety for all road users, the quality of traffic flow and the accessibility by all transport modes.

Due to their special exposure weaker road users such as elderly people, handicapped and children should be paid extra attention. Depending on their deficits, full attention, perception, reaction and compliance of rules cannot be taken as a given for these groups. Furthermore behavioural patterns of disabled have to be regarded which are difficult to quantify. These include limited mobility, lower walking speeds, sensitivity to steps and steep ramps as well as limited perceptibility of signals in information.

These conflicts must be resolved by cooperation of the road users.

6.2   Surroundings (road environment)

The quality of public spaces in the surroundings is determined by traffic emissions (e.g. noise, air pollution, and vibration), microclimate, land consumption and social usability.
The quality of the microclimate can be increased through roadside planting (bush and tree planting) for dust binding, for better air quality (humidity, temperature), and for shadowing as well as through water (standing and floating waters, fountains, and irrigation). Open waters are to be used as functional and design measures.

Surface sealing should be minimized.

The separation effect of roads depends on a combination of multiple factors such as road width, traffic volumes and speeds. When trying to reduce this separation effect it is crucial to design safe crossings by using crossing aids – in accordance with the functional requirements on the road space.
Beside those functional requirements, also supply technical, economic and (human-)ecologic aspects have to be considered.

7   PLANNING PRINCIPLES

Planning principles are important on political and partially on implementation level.

Due to the various requirements on roads in built-up areas and the difficulty of individual regulation, no overall standard can be applied. The new RVS (Austrian road standard) – as an interdisciplinary interface – refers to the complexity of public space planning.

The following principles are to be employed the reach the defined targets [9]:

- non-motorized road users should be given priority in the planning and design of roads
- network elements with important linking function should be bundled
- the barrier effect of roads should be prevented
- historic ties as well as care and conservation of landscape and settlement characteristic should be retained
- function of open space and quality of design of the road space should be increased
- type of use of the dwellings is to be taken into account
- hierarchy of traffic network should be coordinated with the urban development
- in prevailing resident areas through traffic should be prevented
- adjusted speed of motorized road traffic should be targeted
- weak road users are to be protected

Assessment processes need objectives. These objectives stem from the main functions of public space in settlements – living space (dwelling function) and traffic space (transit function). From these objectives we have exemplarily derived key criteria, which can be complemented by further targets (s. Table 3)

Substantial implications stem from these objectives.

Examples:

- The increase of reachability of transport systems (PT stop, parking lot, bike rack) is undoubtedly a functional objective with effects on the mobility behaviour. Furthermore an attractively situated bike rack can also contribute to other e.g. intermodal targets.
- Attractiveness as a partially design objective has – such as e.g. the avoidance of 'fear spaces' – impacts on the mobility behaviour and by that on functional objectives. Attractiveness can also be used to reach intermodal targets.

8   CONCLUSION

Planning always has to be oriented on objectives, never on the status-quo.

Right now almost exclusively material, in some cases design objectives are dealt with in the decision-making process. In future planning human-ecologic and long-term objectives have to be included at least equally in the assessment.

The basis of assessment is a step-by-step evaluation from the point of view of children, disabled, elderly persons, residents, bikers, etc.

The assessment from a human-ecologic point of view should ensure the attractiveness and dwelling quality especially for pedestrians (temperature, exposure to weather, sense of security, etc.). These measures are particularly important for the access to PT stops.

Beside the consideration of the mentioned criteria the preservation of a certain degree of freedom is essential. This means free spaces which can be used attractively by residents and adjacent businesses autonomously (e.g. semi-public pavement cafés, etc.).

Tab. 3) Target system – examples for criteria based on material and formal main objectives

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MAIN OBJECTIVES (long term)

intermodal targets (combinations, e.g. bike racks at PT stops, redistribution of space)
microclimate targets (e.g. dust binding, evaporation performance, share of sealed surfaces)
flexibility against changes in external basic conditions (e.g. temperature increase, heavy rain events)
energy-minimizing solutions (e.g. compliant modal split)

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HUMAN-ECOLOGICAL AND FUNCTIONAL OBJECTIVES

body energy saving solutions (e.g. reduction von barrier effects, lowering of sidewalks)
communication spaces, dwelling spaces („enlivenment")
weather protection (e,g. arcades, flying roofs)
inclusion of all population groups (children, elderly, disables, „protection of the weak ")

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IMMATERIAL AND DESIGN (aesthetic) OBJECTIVES

optic arrangement in trip chains (from a pedestrian point of view)
clear structures, identity, orientation
avoidance of ‚fear spaces' (hidden spaces)

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MATERIAL AND FORMAL OBJECTIVES

traffic requirements (e.g. reachability)
costs (costs for investment and maintenance, choice of materials)
choice of surface (e.g. choice of material, color/temperature, leaching ability)
furnishing

</td></tr>
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EARLY STUDY ON FACTS AND PERCEPTIONS OF INDOOR PLANTS AND INDOOR NOISE LEVELS

Christina Eviutami Mediastika[1], Floriberta Binarti[2], Laurensia Indah Murwani Yulianti[3]

Abstract

Two types of plants were used in a study to see employee perceptions and facts of plants in reducing indoor noise level, i.e. Sansevieria trifasciata and Scindapsus sp. Each type were planted in containers and placed inside cubicles of two offices. The noise levels were measured using sound level meters and taken in 3 periods, i.e. without plants, with Sansevieria, and with Scindapsus in place. Questionnaire surveys among employees and leaves' absorption coefficient (α) measurement were also conducted. Both leaves showed significant α at high sound frequencies, i.e. 0.6. But, the meters showed very insignificant noise difference before and after plantings, i.e. only 3 dB with no regard of plant types. Fluctuation of 3 dB is hardly noticed by human hearing instruments. Whilst, the surveys showed contradictory results, 60% (1st office) and 22% (2nd office) of employees agreed that noise level was lowered after plantings. These showed that indoor plants might create more pleasant environment for employees to feel undisturbed by noise, where actually the noise remained at similar levels.

Key words

Cubicle rooms, employee perception, indoor plants, noise levels.

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1   INTRODUCTION

The use of plants as elements of built environment and building design has long been known, especially within the last 30 years, where architect include plants in their design either for outdoor or indoor decorations. It is usually aimed to create aesthetic aspect of given conditions. Some are also to function as lungs to absorb pollution [1] and to create more comfortable microclimatic conditions [2]. Studies on the usage of greenery in the indoor environment with function to reduce indoor pollution have shown a prospective result [3,4]. Here, researchers suggest the use of particular type of indoor plants; i.e. those with little maintenance, such as ability to live with minimum sun exposure and water. One of the suggested is snake plant or in scientific named as Sansevieria trifasciata laurentii [5], which is a kind of robust plants.

Apart from capability of absorbing indoor pollutant, some people also believe that plants are capable of reducing the intrusion of outdoor noise into the interior space. However, some are still unconvinced [6]. This negative opinion is supported by theories which explain that plants has no capability on reducing noise based on the fact that plants has never become a complete solid and dense material as is required for noise insulation [7]. However, it is true that plants may absorb or impede noise propagation [8]. Hence, it is predicted that plants work better within indoor environment to overcome indoor background noise problem which level and vibration is lesser than those occur outdoor. Air and objects within indoor environment are also easier to control and usually are in steady condition that will minimise noise reduction affecting factors.

Open-plan office divided into numbers of cubicles was chosen as role model . Each cubicle in this office suffers from indoor background noise, since one cubicle cannot entirely block sound transmission from other cubicles. There are options to stop noise dispersion using absorbent linings, such as thick carpets, hanging ceilings and porous walls. Despite using these conventional materials, usage of indoor plants to lower indoor background noise in open-plan office is proposed here. It is expected that indoor plants will perform as absorbent linings and can be used either by itself or in conjunction with conventional absorbent linings. The use of indoor plants will also benefit in the improvement of indoor air [3] and to more general global warming issue. User opinions on noise levels before and after installation of greenery were also to be studied.

2   OBJECTIVE

The aim of this study is to see any positive correlations between user perceptions and facts regarding the use of indoor plants, particularly Sansevieria trifasciata laurentii and Scindapsus sp to reduce indoor background noise levels (qualitative aspects).

3   THEORETICAL APPROACH

Plants consist of leaves which has unique surface with stoma and delicate hair [9]. These are just similar to properties of material used to absorb sound, such as soft surface perforated panels. However, since stoma and hair are very delicate, it will only work for high frequency noise, i.e. noise that is not entitled of vibration. The small porous surfaces provide high frequency absorption [10]. A study by Costa [8], showed that particular indoor plants were capable of absorbing sound as shown by Table 1.

Tab. 1)   Absorption Coefficient Provided by Particular Indoor Plants [8]

Plant species	Sound Frequency (Hz)					
	125	250	500	1000	2000	4000
Ficus benjamina	0.06	0.06	0.10	0.19	0.22	0.57
Howea forsteriana	0.21	0.11	0.09	0.22	0.11	0.08
Dracaena fragrans	0.13	0.14	0.12	0.12	0.16	0.11
Spathiphyllum wallisii	0.09	0.07	0.08	0.13	0.22	0.44
Dracaena marginata	0.13	0.03	0.16	0.08	0.14	0.47
Schefflera arboricola	-	0.13	0.06	0.22	0.23	0.47
Philodendron scandens	-	0.23	0.22	0.29	0.34	0.72

This research shows that plants are generally more efficient in absorbing high frequency sound. This is because sound at low frequencies are of longer wavelength [11] which could not be absorb by such tiny leaf and stoma. Leaf is also a non solid material which usually used to absorb sound of low frenquencies .

The plants studied by Costa showed promising absorption coefficient. However, they mostly request careful maintenance [12]. Ficus benjamina need to be kept in specific level of humidity and particular level of light so not to cause leaf turning yellow. Howea forsteriana also need careful watering and particular light level for growing. Both Draceana (fragrans and marginata) are robust plants, but they may grow more then 3 m tall, so it will only suit offices with high ceilings. Spathiphyllum wallisii need sufficient indirect light to borne its beautiful flower. Schefflera arboricola need careful maintenance, such as light, water and pruning. Philodendron scandens is a kind of climbing plants thus will need frames for further growing. It is not saying that all those kind of plants are not worth it to be utilized indoor, but there is another kind of plants which is more robust and almost free maintenance, which is called Sansevieria trifasciata (refer to Figure 1). Beside its robustness and minimum maintenance, unlike other plants that release CO_2 at night, this Sansiviera converts CO_2 into O_2 [13]. So it is safe to be kept within offices that expand their working period up to night time. There are about 600 types of Sansevieria around the world, but the most famous is Sansevieria trifasciata, which is also commonly known as snake plants. Its origin is Western Africa. There are some types of Sansiviera trifasciata (about 18 types), among the famous are laurentii, hahnii, and golden hahnii.

As a member of cactus plants family, Sansevieria trifasciata does not demand on water. Although originally comes from Western Africa, a region with abundance solar, Sansevieria trifasciata does not demand on excessive solar light. It can be put indoor, even in a remote area from transparent windows. Indeed, it does need to be placed outdoors for sun exposure, but this can be done merely once every week or once every two weeks at the longest [12]. Stiff leaves of Sansevieria trifasciata will not easily fade and change color so they will be charming most of the time. In particular, Sansevieria trifasciata laurentii has slim and tall posture; a perfect posture to block sound dispersion. As a comparison, Philodendron scandens was also planned to be studied here. The reason in using Philodendron scandens is because this offers greatest absorption coefficient among the measured plants as is shown by Table 1. It also does not require any specific indoor climatic condition unless frames for further growing. Leaves of Philodendron scandens which is thin, soft, and round shaped may also be compared to leaves of Sansevieria trifasciata which is thick, stiff and ribbon alike shaped.

However, within very limited natural resources, it was difficult to prepare the Philo, therefore, Scindapsus sp (refer to Figure 2) which has similar characteristic to those of Philo and widely available was then used to substitute.

Fig. 1)   Sansevieria trifasciata laurentii

Fig. 2)   Scindapsus sp

4   METHODOLOGY

The study was conducted as empirical study by field research, which is a comprehensive between qualitative and quantitative aspects. People working in two offices are the focus of this study. Type of offices to study is limited to open-plan office divided into numbers of cubicle, where one cubicle may suffer noise from adjacent or far cubicles. It is also limited to offices that do not use any absorbent linings such as carpets, or porous ceilings and walls. Administration office of Faculty of Engineering of Atma Jaya Yogyakarta University (AJYU,

refer to Figure 3) and Design Graphics dan Mechanical Engineering office of PT. Alstom Power Indonesia, Surabaya (refer to Figure 4) and their employees, were the focus of this study. Noise perception and expectation of these types of workers are to be analysed, in order to see the its correlation to indoor noise levels before and after installation of plants.

Fig. 3)   Administration office of AJYU

Fig. 4)   Design Graphics dan Mechanical Engineering office of PT. Alstom

At the first stage, existing noise levels within the two office were studied. The investigation processes in this level may be grouped as follows:

- Measurements of existing background noise levels.
- Data collection (questionnaire surveys and interviews) of employees perception and expectation on the existing background noise.
- Laboratory measurement of leaves' absorption coefficient.

At the second stage, Sansevieria trifasciata plants are placed in the offices. One medium container (contains of approximately 8 mature plants of 80 cm height, as in Figure 1) of Sansevieria trifasciata laurentii is placed in each cubicle. Minimum area of a cubicle in an office is 1,2 m^2 [14]. After placement of plants, measurements, questionnaire surveys and interviews were again conducted.

At the third stage, Sansevieria trifasciata laurentii was substituted by Scindapsus sp. One medium container (contains of approximately 80 cm height, as in Figure 2) of Scindapsus sp is placed in each cubicle. In AJYU office there were 10 employees stays in 10 cubicles, so

there were 10 containers of each type of plants placed for the entire office. Whilst in Alstom office, 34 containers of each type of plants to fit within 34 cubicles for 34 employees. From here, we could learn whether there is any indoor background noise reduction after placing this particular plants, and whether it is match to office employees perceptions and expectations.

5 QUESTIONNAIRE SURVEYS RESULT

All employees within the room of both AJYU and Alstom were respondents for interviews and questionnaire surveys. Both at AJYU and Alstom, 90% of the employees are male, which caused difficulty in describing whether there was any different opinion between male and female. Thus the gender factors were disregarded. Comprehensive answers of the questionnaire is presented in Table 2.

Tab. 2)   Questionnaire Results

No.	Item	AJYU office	Alstom office
1.	Age	between 36 to 55 years of age	between 25 to 50 years of age
2.	Duration of employments in the offices	varies from under 1 year - over 5 years	varies from under 1 year - 3 years
3.	Opinion on the existing background noise levels	80% said 'fair' 20% said 'too much/over the standard'	75% said 'fair' 25% said 'too much/over the standard'
4.	Opinion on the disturbance levels	80% said 'no disturbance' 20% said 'sometimes difficult to focus on work'	78% said 'no disturbance' 22% said 'sometimes difficult to focus on work'
5.	Expectation of further conditions to the office room	80% suggested the room to be renovated 20% said nothing (abstain)	72% suggested the room to be renovated 28% said nothing (abstain)
6.	Basic knowledge on plants as noise reduction materials	50% knew about it 50% knew nothing	40% knew about it 60% knew nothing
7.	Further expectation on the use of plants to reduce indoor noise levels	70% believes plants will do the task 30% knew nothing	44% believes plants will do the task 56% knew nothing
8.	Part of plants that may reduce noise levels	60% said leaves 40% knew nothing	50% said leaves 50% knew nothing
9.	Plants creates better visualization	80% agreed 20% felt distracted	65% agreed 35% felt no difference
10.	Opinion on noise reduction	60% agreed on noise reduction after placement of plants 40% disagreed	22% agreed on noise reduction after placement of plants 78% disagreed
11.	Opinion on plants was reducing indoor noise levels (from those who agrres on item number10)	75% noise reduction was caused by plants 25% noise reduction was caused by other factors	73% noise reduction was caused by plants 27% noise reduction was caused by other factors

6 INDOOR NOISE LEVELS AND ABSORPTION COEFFICIENT OF LEAVES

Indoor background noise levels were collected in 3 groups of time using Sound Level Metres (SLM) DEKO – SL 130 digital. The SLM was set in an A-weighting network. The 3 groups, i.e. existing noise conditions, after installation of Sansevieria trifasciata laurentii, and after installation of Scindapsus sp. Each group of data collecting was conducted for 3working days during working hours. However, 30 minutes after the working hour starts and 30 minutes before the working hour ends were not recorded, considering non steady noise levels caused by transition time of employees entering and leaving the room. There were 3 different measurement positions within each office to collect the average background noise levels,

using 3 SLM. The collected data were then calculated into L_{eq} values. The L_{eq} represents equivalent background noise levels during 3 groups of time measurement and 3 days-each of groups. Since the data was recorded every second, there were thousands of values collected. Here, will only be reported the final data after calculated into L_{eq}. Both at AJYU and Alstom offices, there were no significant difference on noise levels between existing condition and after the use of Sansevieria trifasciata laurentii and Scindapsus sp. There was noise reduction after placement of plants which varies from 0,33 to 3,94 dBA. However, the difference between plants was so small, i.e. below 1 dBA. At Alstom, the condition was worse, i.e. no noise levels difference between existing and after use of plants (all differences was below 1 dBA).

On one hand, the insignificant noise levels differences in both offices showed that there was no impact on using indoor plants to reduce indoor noise. On the other hand, the laboratory measurement of leaves' absorption coefficient using impedance tube, showed a promising result, especially for frequency of 2000 Hz onwards as is shown by Table 3.

Tab. 3)   Absorption Coefficient of Sansevieria and Scindapsus leaves

Frequency Band	Sansevieria (α_1)	Scindapsus (α_2)
250	0.156	0.137
315	0.095	0.125
400	0.166	0.182
500	0.228	0.242
630	0.306	0.261
800	0.195	0.216
1000	0.210	0.301
1250	0.251	0.417
1600	0.261	0.275
2000	0.411	0.633
2500	0.309	0.300
3150	0.617	0.539
4000	0.493	0.680
5000	0.477	0.531

Table 3 shows that leaves with their delicate hair and stoma absorb sound better at high frequencies, as was reported by Costa [8] and Harris [10], that small porous surfaces provide high frequency absorption. However, this was not correlate to the findings that the use of plants has insignificant effect on indoor noise reduction, which means leaves barely absorb noise. This might means that the indoor noise of the two offices were mostly of low frequencies or the number of containers of plants should be increased. The increase of plants may not be a good option since some respondents have said to be distracted by placement of plants.

7   CONCLUSION AND RECOMMENDATION

From the interview and questionnaire collected, we learn that although major respondents quote that indoor noise levels can be accepted, they were still expecting on room renovation to improve indoor noise levels quality. There was noise levels difference between before and after the placement of plants, and between the use of Sansevieria and Scindapsus. However, these are too small to be noticed by human hearing instruments [15]. This means that employee opinions of plants reducing indoor noise (60% of AJYU office and 22 % of Alstom

office) were only a perception which might be supported by their prior knowledge on plants capabilities to reduce pollution including noise.

From this study we may learn that people opinion on the use of plants were masking by their prior knowledge which is actually did not correlate to the facts showed by field measurements of the indoor noise levels. According to leaves' absorption coefficient measurement, the use of plants to absorb sound is recommended for higher frequencies. This correlate to that of Costa [8] and thus for further study, the indoor noise frequencies of particular room need to be studied prior to the use of plants.

Acknowledgement

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MANAGEMENT AND MONITORING OF VISITORS IN THE PRŮHONICE PARK (CZECH REPUBLIC)

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Abstract

World heritage Sites are iconic tourist attractions recognized as the world's most significant cultural and natural places and visited by many tourists every year. This is the case of Průhonice Park, classified as a UNESCO World Heritage Site in 2010, and one of the most intensively used parks in the Czech Republic. That the Průhonice Park attracts so many people is very positive but it also points to serious challenges. In fact, the impact caused by hundred thousands of visitors constitutes a serious threat to the integrity of the park every year. This report presents a research program concerning the management and monitoring of recreational activities in the Průhonice Park, carried out in order to help ensure protection of the park's resources and the quality of the visitor experience. The program of research consisted of three different components, namely, the estimation of recreational demand achieved through the counting of visitor tickets purchased at the entrances, visitor profiling and analyzing visitor motivations, preferences and perceptions obtained through the application of visitor's questionnaires, and understanding the spatial and temporal patterns of visitor use conducted by using GPS data loggers to collect visitors travel data. All data were processed within a Geographic Information System (GIS), providing a reliable tool for the park management. Thus a good planning and management at the Průhonice Park depends on the combination of these techniques, and the application of a long-term monitoring in order to preserve the natural and cultural values for which it was classified.

Key words

Průhonice park, recreation management, visitor monitoring, world heritage sites.

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1   INTRODUCTION

Clearly tourism has become a global financial power, being one of the world's largest economic sectors, supporting more than 260 million jobs worldwide and generating some 9.1% of global GDP [1]. This is particularly so in Czech Republic where the total contribution of Travel & Tourism to GDP was expected to be 8.0% of GDP in 2011 [2]. With studies predicting continued growth worldwide in the coming decades, tourism is an increasingly important factor in the planning and management, mainly at UNESCO World Heritage Sites (UWHS), one of the major sectors of tourism destinations. UWHS are well-known tourist attractions presented in nearly all countries, experiencing similarly growth in tourism from international and national markets. Nowadays tourism is no longer recognized the benign economic industry as in the past purported it to be. This fact presents several challenges for managers of UWHS who need to manage those sites in order to reconcile the recreational and touristic demand with heritage conservation and protection of their resources.

In the world exist 936 UWHS in 153 different countries, being twelve of them localized in Czech Republic. The historic center of Prague, UWHS since 1992, includes the Průhonice Park on its boundaries based on the UNESCO committee´s decision at its meeting in Brazil (August 2010). Classify as a cultural property, Průhonice Park is located 15 km southeast of the Prague city, in the small community of Průhonice, within the region *Praha-západ*. Due to its high natural and cultural values and privileged location within the Prague Metropolitan Area, is one of the most intensively used parks in the Czech Republic. The Průhonice Park consists of 242,2 hectares of closed area, with about 28,3 km of trail system, and supports a number of recreation opportunities defined both spatially and temporally. Some areas and times are relatively heavily used while other areas and times accommodate relatively low levels of use. The number of visitors each year and the amount of their movements leads inevitable to some disturbance or damage in the park resources and visitor experience [3]. The Průhonice Park management has to balance between this dual task, the requirement of protecting the quality of park resources for future generations, and the responsibility of providing appropriate public enjoyment and access for these resources [4]. Therefore concerns about the quality of the recreation experience and the potential resource and experiential impacts of recreation and tourism in Průhonice Park have emerged. This paper presents the response to this concerns, a program of natural and social science research conducted to develop a consistent approach for collecting, monitoring and managing visitor data for informing Průhonice Park management, planning and decision-making processes. Specifically, the components of this research and paper are:

- Estimation of recreation demand through the counting of visitors numbers based on the tickets purchased at the entrances and application of questionnaires to visitors with annual ticket;
- Visitor profiling and analyzing visitor motivations, preferences and perceptions by using specially designed questionnaires;
- Understand the spatial and temporal patterns of visitor use, collecting daily data of travel routes by using GPS data loggers with visitors.

All information collected was processed within a Geographic Information System (GIS) and in appropriated statistical program (SPSS Statistics 17.0). An application of GIS and SPSS enables performance of spatial intersection operations with statistical data in a prompt and exact way, proving itself a powerful and reliable tool for park management. Thus a good planning and management at the Průhonice Park depends on the combination of these procedures and techniques, and the application of a long-term monitoring in order to achieve

the challenge to preserve for future generations the quality of natural and cultural values for which it was classified, and provide suitable visitor enjoyment and access for these resources.

2   STUDY AREA

One of the major tourist destinations are parks due to their physical attractiveness, beautiful landscapes and open space for leisure activities. These areas are important for recreation and leisure. The Průhonice Park is located 15 km southeast of the Prague city (1 233 211 inhabitants) in the small community of Průhonice, region of *Praha-západ* (Czech Republic), making it easily accessible to a largest concentration of population (Fig.1). The Park is one of the "crown jewels" of the national historical parks, and since August 2010 is classified a UWHS, being one of the most intensively used parks in the Czech Republic. The Park is public, covers an area of 242,2 hectares and can be traveled through its 28,3 km of trail system. Structurally the park is divided into two parts by the main district road leading to the existence of tree official entrances. The park has also some uncontrolled entrances and exits, and park trails are used by visitors, local residents, and others. Its big touristic and recreational potential is due to its luxuriant vegetation and historic character which are in a perfect combination with the surrounded landscape. Průhonice Park has been described as a place where the natural meet the artificial and the combination of topography, geology history, and location have created a perfect landscape of scenic beauty unequaled along the Czech Republic. The area is rich in history, landscape beauty, scientific interest, flora, fauna, and recreational values. Today's, this rich combination of natural, cultural, and scenic resources – together with a host of exceptional scientific and recreational opportunities – contribute to the significance of Průhonice Park in the national and international context. A visitor centre, botanical garden, and a historical castle complex are situated there. The castle complex is not open to the main public being the place where operates the Institute of Botany of the ASCR, the organization responsible for the management and maintenance of Průhonice Park.
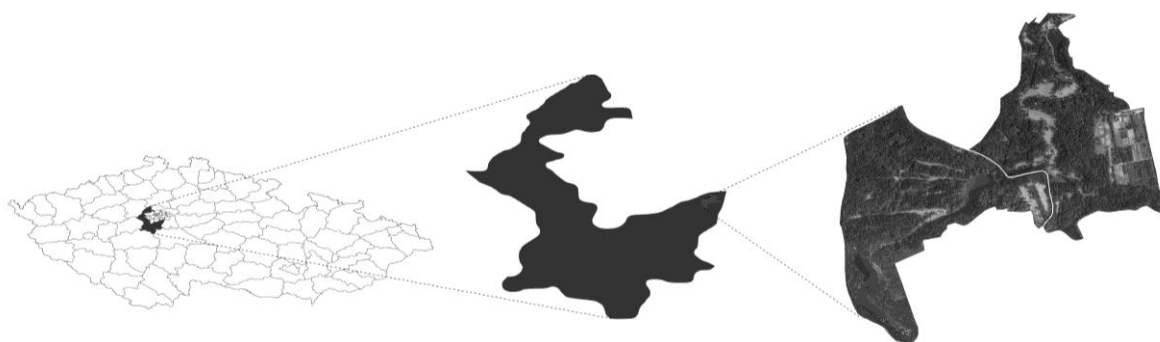
Fig. 1)   Location of Průhonice Park

3   METHODS

A comprehensive understanding of recreational and touristic use at Průhonice Park will help protect resources while avoiding excessive regulations that unnecessarily overburdened park visitors. The Průhonice Park research is divided into three main phases: estimation of recreational demand; visitor profiling and analyzing visitor motivations, preferences and perceptions; and the understanding of spatial and temporal patterns of visitor use. The present

research phases allow park managers to explore the possibility of implementing site-specific solutions based on nature conservation and visitor's satisfaction, helping to reduce the impacts of human activity and contributing to the sustainable management of the area.

3.1 Estimation of Recreational Demand

This phase of the study presents the results of visitor estimation at Průhonice Park for the period 2008-2010, based on a method of visitor counting, through the number of daily tickets purchased and a visitor survey. The main emphasis was placed on estimate the visitor demand at Průhonice Park and designs a statistically valid, reliable and uniform method of collecting and reporting public use data to be part of a long-term visitor monitoring program. Estimate visitor demand is essential in park management since allows calculate economic input provided by tourism, estimate the economic value of the recreation experience, predict the level of public enjoyment or satisfaction, understand how to meet the needs of the visitors, and determine if Průhonice Park has enough visitor capacity to meet the current demand [5], [6]. The estimation of recreational demand at Průhonice Park is the result of a three-phase study: number of daily ticket purchased between 2008 and 2011; visitor questionnaire applied to visitors purchasing annual tickets; and an estimation of the potential number of families (2 adults and 2 child) entering the park with annual tickets.

Průhonice Park is a public place where visitors need to pay admission fee (ticket) at the entrances of the area to get in. Since 2008, the main entrance of the park has a point of sale with computer terminals, where automatically collect the day and entry-hour of the visit, and the type of entry. This method allows analyzing visit and visitor data in various ways that were not possible before. The data collected in Průhonice Park gives an overview of the daily visits dynamics throughout the years. Trends, "normal" fluctuations, and possible changes related to management can be distinguished when these data are analyzed. As in many parks, visitation in Průhonice Park is not distributed regularly over time. The estimation of visitor use showed that the daily number of visitors fluctuates considerably. The extreme "peaking" character of the park use can be explained by differences between the days of the week, by holiday periods or free days, and by weather conditions. The weekly visitation results identified Saturdays and Sundays as the busiest days of the week (19,4% and 22.4% respectively) while Wednesdays were calmest (7.2%). The calmest days overall were weekdays that were not public or school holiday periods. This characteristically irregular temporal distribution of recreation use creates several potential problems to the management of the park, as crowing and conflicting uses, leading to appear environmental and social impacts. Weather has always a strong influence on park visitor numbers. When conditions are poor and the temperatures goes to negative values the visitor numbers were very low with only 5.9% of total visitors counted on these days. Visitor numbers were highest when weather conditions were good. Průhonice Park ranks among the top of national parks in visitation, and receives a vast number of visitors each year. Since the computer system of registration was adopted in 2008, the park has averaged 154312 thousand visits annually, and more than 617 249 thousand visits have been estimated between 2008 and 2011 (Tab. 1). The highest visitation was 177 667 thousand in 2010 and the lowest was 133 153 thousand in 2008. This growth is substantial corresponding to 18.7%, however visitation in 2011 declined again to 161 911 thousand visitors.

Most visitors came between April and October, with the months of April and May sustaining the most intensive use (Fig.2). The major reason of the highest visitor affluence in those months is the spring blooming flowers, especially the rhododendrons.

Tab. 1)   Estimation of the visit demand to Průhonice Park for the period 2008 – 2011

Years	Visits	V.A	%
2008	133153	-	-
2009	144518	11365	7,86
2010	177667	33149	18,66
2011	161911	-15756	-9,73
Total	617249	-	-

In fact, on a sunny day in May more than three thousand visitors are able to reach the park. The Průhonice Park exhibits a use season typically of those areas. Very little use is in the winter and spring, and summer use are heavy, particularly on weekends. On a per acre basis Průhonice Park may be one of the most intensively used national parks. The total number of visitors and their concentration over few months and at few locations are a true challenge for park managers.
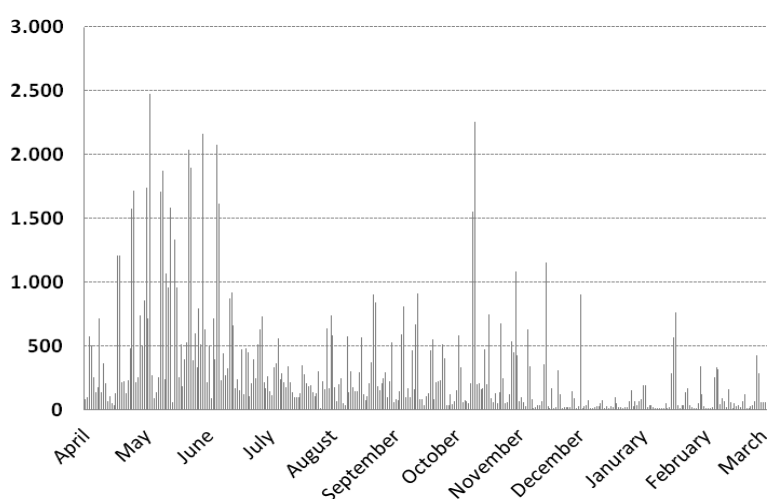
Fig. 2)   Daily fluctuations in the number of visits to the Průhonice Park (April 2010 - March 2011)

3.2   Visitor profiling and analyzing visitor motivations, preferences and perceptions

This stage of the research describes a social research program conducted in 6 sampling in 2012, during the peak spring use season with the purpose of providing knowledge about the current visitation in Průhonice Park. A total of 263 visitors were contacted, and 211 accepted, completed and returned a 19-question survey, resulting in an 83 percent response rate. The goal of this research was to gather data and report on: demographic and socioeconomic characteristics of visitors to Průhonice Park, travel characteristics of visitors, recreation activities and use patterns, and experience of possible problems. Thus it was possible to provide a snapshot of the visitor population in Průhonice Park and assist park managers with important decision-making data related to maintaining high quality recreation experiences and protecting the local resources.

Who are Průhonice Park visitors (visitor characteristics): sixty-six percent of respondents were female. Respondents ranged from 16 to 85 years old, but the age distribution of visitors shows a young adult profile as the majority range from 26 to 40 years (40%). Nearly all adult visitors were high school graduates (96.6%), and more than half had a college or higher degree (53.5%). Over 56 percent of respondents were from Prague region (NUTS 3) and 39 percent of respondents reported a total household income of 20,000 Kč or more. About one-third of visitors were making their first visit to Průhonice Park, and more than one-fourth of visitors with previous experience have visited the park more than 10 times. About half of respondents visit the park between 1 and 5 times a year.

What type of visit makes Průhonice Park visitors (visit characteristics): in terms of their trip characteristics over half were with family and accompanied by one person. Sixty-five percent of the individuals surveyed reported spent between 1 to 3 hours visiting the park. Eighty percent of visitors noted that they had planned to visit the Průhonice Park, and that was their primary destination. Since many visitors were making their first visit to the park, and many consider the park to be their primary destination, this demonstrates the high influence of the Průhonice and its power of attraction in the context of Prague Metropolitan Area, even for people who had never been there. Popular park activities focus on walking, taking pictures and view plants and flowers, especially in the spring season when rhododendrons are blooming.

What kinds of experiences do they seek (visitor motivations and preferences): identification of recreation experiences transcends the simple identification of popular activities; experiences describe underlying motivations that lead visitors to choose particular places (or settings), or to engage in specific recreation activities [7]. While visitors indicate many motivations to visit the park, the most important were to *make a trip and enjoy the scenery of the area; see flowers/plants; experience the natural quiet of the area; and enjoy the good weather*. In general, visitors are able to attain these recreation experiences, which seem to focus around escaping and enjoying the uniqueness of the Průhonice Park landscape.

Experience of possible problems (visitor perception): While visiting the park, visitors may experience problems that detract and decrease their recreation experience. These problems might be connected to resource quality, social conditions, provision of services, facility design or management conditions [7]. Overall, no problem received more than 8% rating, and more than half of respondents considered reported that no problem either did not detract at all from their experience or that they did not experience. Thus, no situations should be considered true problems. However, *dead fish in the ponds* (8%) and *too many people at recreation sites* (5%) were the most rated problems in Průhonice Park.

3.3   Understanding the spatial and temporal patterns of visitor use

This phase presents a GPS survey carried out during 11 days (2012) with 112 visitors in order to collect spatial and temporal patterns of visitors use, using ten GPS tracking devices (GPS loggers). The purpose of the Průhonice Park GPS research was primarily to understand and analyze the visitor behaviors and activities spatially and temporally within park boundaries, and use a cross-disciplinary research approach which will allow a broad discussion about the dynamics between visitors, park spaces, and flows. The GPS survey consisted in ask a random sample of visitors to answer an initial socio-demographic questionnaire and then carry out a GPS devise during their visit to the park. The survey have contacted to almost all types of visitors of different ages and social backgrounds at different days of the week and times of the day. Thus was possible to compiled information and new knowledge about the

actual activity of visitor inside the park. The data collected through GPS units was processed within a GIS (ArcMap 10) and the questionnaire information was analyzed in an appropriate statistical program (SPSS Statistics 17.0) in order to produce a model of occupation of the park, defining several parameters in order to produce a good planning and management at the Průhonice Park. Such data allowed identify places and intensities of visitor use, providing significant information of the locations people visit, their travel routes, and the amount of time spent at these locations (temporal and spatial aspects of visitor use).

Temporal aspects of visitor use: GPS receivers recorded visitor position every 5 seconds and characteristics of the complete visit could be generated. Therefore, the tracking data was analyzed to understand the temporal patterns of visitor use in Průhonice Park. Visitor-tracking data was used to determine the average time visitors spent in the park and in different sites within the area (Tab. 2). According to the findings, visitors spent an average of 2 hours and 3 minutes within the Průhonice Park, and 38 percent of the total visitors spent between 1 and 2 hours on their visit.

Tab. 2)   Analysis of temporal patterns of visitor use

Average Total Time (hh:mm)	Max. Time (hh:mm)	Min. Time (hh:mm)	Standard Deviation
2:03	4:33	0:31	0,037

Temporal aspects of visitor use can be analyzed and used at different scales. At a large scale this information can inform managers about length of stay in an area, and at small scale can give information regarding specific sites of interest [8].

Spatial aspects of visitor use: GPS-based tracking data can be mapped to illustrate the extent of use within an area. In Průhonice Park, visitors were tracked and mapped, giving an indication of connections and flows as well as areas of intensified use. This information is pertinent to managers since is able to provide a systematic knowledge of the visitor use within the park. The park is clearly most used in the first part of the park (Fig. 3). Visitors travelled in average 4,203 km within the park, 19 percent of the total visitors between 2 and 3 km, and 10 km in maximum (Tab.3).

Tab. 3)   Analysis of spatial patterns of visitor use

Average Total Length (km)	Max. Length (km)	Min. Length (km)	Standard Deviation
4,203	10,055	0,200	2,104

4   CONCLUSION

There is no doubt that is because of the good location in the Prague suburbs and unspoiled nature, that Průhonice Park has become a very popular among the domestic and international population. In fact, the massive size of the numbers from the visitor estimation illustrates the importance of this outdoor area. Most of the visitors like to spend their free day in park, walking, taking pictures, viewing plants, etc.
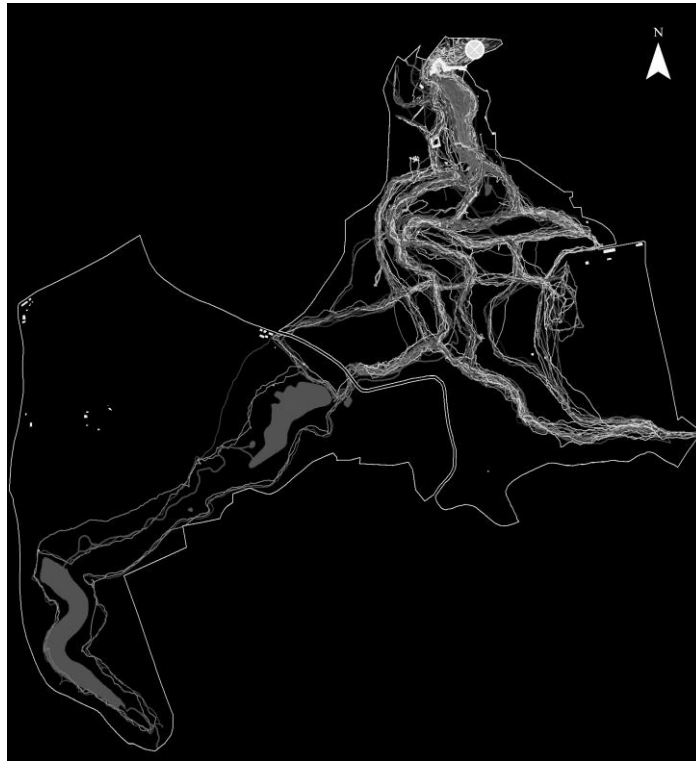
Fig. 3)   Extent of visitor use in Průhonice Park

As more visitors come to the park, increase the need for produce a correct management protecting the local natural and cultural resources and maintain the satisfaction among the people (quality of the recreation experience). Therefore, the established ecological and social program of research provide an important basis for a correct manage and monitoring of the current resource and social conditions at Průhonice Park. This study can be appropriate and will be helpful as options are considered and decisions are made in resources management planning efforts. Different models and techniques were established on this study contributing to improve current methodological approaches. The methods developed to estimate recreational demand, the application of a social survey to gather information about visitors and visits, and the use of GPS devises to record visitor routes at Průhonice Park, provided reliable, accurate, and important data necessary for its management and conservation efforts. A serious management a monitoring program must be taken in Průhonice Park, and regular periodic reviews allowing changes within a social and ecological context should be carried out in order to update management actions. Thus it is believed that a good planning and management at the Průhonice Park depends on the combination of these techniques, and the application of a long-term monitoring in order to preserve the natural and cultural values for which it was classified.

Acknowledgements

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THE APPLICATION OF GROUP DISCRIMINATION TECHNIQUES TO PREDICT THE POTENTIAL DISTRIBUTION OF TURPENTINE TREE

Kürşad Özkan[1], Özdemir Şentürk[2]

Abstract

Predictive modelling techniques have been commonly used in conservation planning and ecosystem management. Such models have been developed for different organisms such as animals, insects, reptiles and plants. This study was addressed to build potential distribution models of turpentine tree (*Pistacia terebinthus* L. subsp. *palaestina* (Boiss.) in the Yukarigokdere forest district of the Mediterranean region, Turkey. In the study, the data were collected from 119 sample plots. By using environmental data (i.e. elevation (ELVN), parent material (ROCK), slope (SLOP), radiation index (RI) and topographic position index (TPI)) as explanatory variables, visual assessments of the potential distribution probability of the turpentine tree based on different modelling techniques (discriminate analysis (DA), logistic regression analysis (LR), generalised addictive model (GAM) and classification tree technique (CT)) were performed. The best models of LR and DA were obtained by means of ELVN and RI while the best model of GAM was obtained by ELVN and SLOP. With regard to the applied CT, the optimal tree model was built by ELVN, ROCK, RI and SLOP. The results of all predictive models revealed that elevation is the most important factor influencing the distribution of the turpentine tree. The modelling techniques were compared to one another using receiver-operating characteristic (ROC) curves and, GAM indicated the best performance.

Key words

Correlative models, habitat suitability, non-wood forest products, turpentine tree.

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1   INTRODUCTION

In response to the needs of environmental managers and conservationalists, a wide variety of recent biogeographical distribution models have been applied to a selection of biological problems. They have been used to predict the potential distribution of fishes, aquatic plants, terrestrial animal species and terrestrial plant species [1]. Among plant species, more recently non-wood forest products have become the priority areas of interests for forest managers. Because there are many villages surrounding the Forests and, a considerable amount of the incomes of the people living in those villages is based on forest resources, particularly non-wood forest products.

One of the most important non-wood forest products, turpentine tree (*Pistacia terebinthus* L. subsp. *palaestina* (Boiss.)) is a member of the Anacardiaceae family and locally called as "Menengiç" in Turkey [2]. This deciduous bushy tree has a wide distribution in Asia and Mediterranean basin. It is especially very common around southern Turkey where it grows to a height of up to 5-6 m on rocky, degraded areas with open vegetation or in pine forests from just above sea level to 1400-1500 m [3]. It intensity prefers relatively humid sites in lower elevations and southern aspects by avoiding the places where extreme cold climates prevail [4,5]. It means that environmental factors in particular climate are a driving factor on the distribution of turpentine tree. Also climatic factors play important role in the variation of volatile oil components of the species [6]. Reddish-purple blossoms that appear on it between March and around April display a visual feast in the nature. It has small globular fruits which turn brown when ripe and shiny leaves with a strong resinous smell [7]. Many parts of this plant have rich tannin and resinous substances. It has been, therefore, utilized as aromatic and medicinal plant by the people for a long time [8,9,10,11].

In the context of community based management, modelling predictive distribution of turpentine tree is crutial to develop the management strategies for its' sustainable use. The essential requirements for modelling predictive distribution are based on environmental data at a suitable scale (i.e. altitude, slope degree, aspect and soil properties) and accurately georeferenced collection data for a given species [12,13,14]. Various statistical techniques are available for modelling species distribution. Correlative models are particularly applied to cases where an initial prediction of the potential distribution of a given species is required, especially when the biology of the species is not well known [15]. Those models that use both presence and absence locality records to make predictions have been referred to as *group discrimination techniques*. Examples of group-discrimination techniques include those models based on discriminant analysis (DA), logistic regression analysis (LR), classification tree technique (CT) and generalised additive model (GAM) [15].

In the present study, we assessed the performance of *group discrimination techniques*, by using presence-absence data of turpentine tree in the Yukarıgökdere forest district of the Mediterranean region, Turkey.

2   MATERIAL AND METHODS

2.1   Site description

Yukarıgökdere forest district is located in the Lakes subregion of the Mediterranean region and, situated between north latitudes of 4166319 and 4189999 m and east longitudes of 303212 and 313122 m with an area about 8000 ha (Fig. 1). Limestone is dominant parent material. Locally also conglomerates and ophiolitic melanges are present. Elevation ranges

between 800 m and 2000 m asl. In the district, a translation climate prevails between Mediterranean climate and continental climate with an average annual rainfall of 751 mm and an annual average temperature of 13.03 °C. The forest is mainly composed of *Pinus brutia* (Brutian pine), *Pinus nigra* (Crimean pine), *Juniperus exelsa* (Crimean juniper), *Cedrus libani* (Lebanon cedar), and *Ouercus* (Oaks) species. The district is rich in endemic species with 61 endemic plant taxa [16,17].
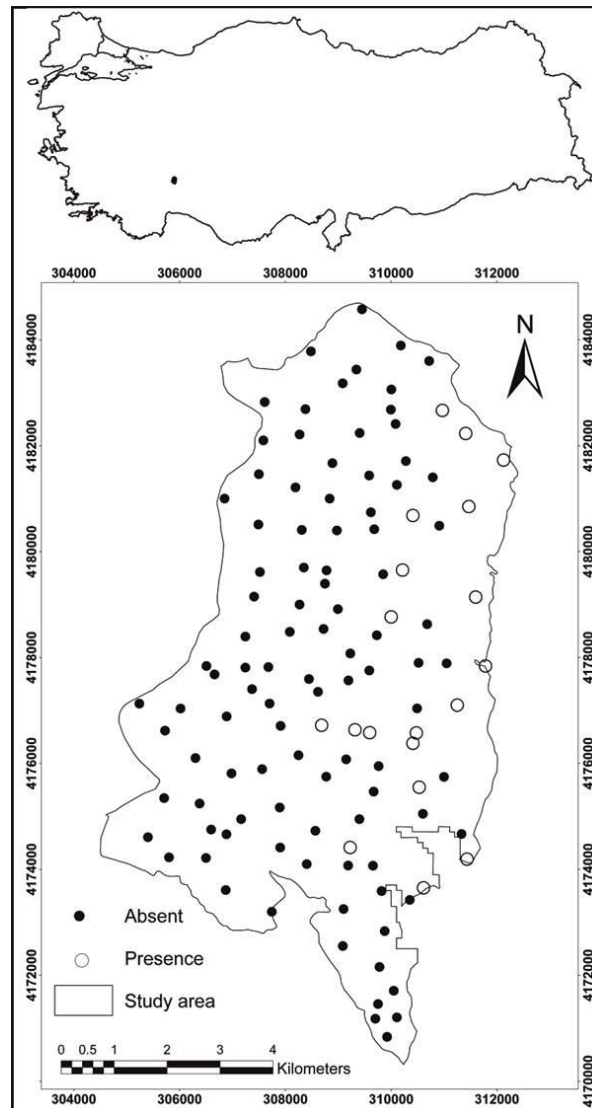
Fig. 1)   The study area and the sampling plots occupied and unoccupied by turpentine tree

2.2   Data and statistical evaluation

The data were collected from one hundred and nineteen sample plots. At each sample plots, presence and absence data of turpentine tree were recorded (Fig. 1). To provide distribution models of turpentine tree, discriminate analysis (DA), logistic regression analysis (LR), generalised addictive model (GAM) and classification tree technique (CT) were applied by using binary data of the species and environmental layers (i.e. elevation (ELVN), parent material (ROCK), slope (SLOP), radiation index (RI) and topographic position index (TPI)).

DA, a supervised classification, involves the determination of a linear equation like regression that will predict which group the case belongs to. DA assumes a multi-variate normal

distribution of the predictor variables and a common within group co-variance of the variables for all points defining vector presence and vector absence [18]. Like DA, LR, a generalized linear model (GLM) used for binomial regression, is used to distinguish between two or more groups. While either technique can be used for such applications, LR is generally preferred when the response variable is dishotomous (presence/absence) [19]. GAM is a non-parametric version of GLM, which is produced from multiple linear regression analysis (MLR) [20]. GAM uses transformation techniques that are independent for each predictor variable, which are counted together to calculate the response variable [1]. This allows exploration of shapes of species response curves to environmental gradients, and allows the fitting of statistical models in better agreement with ecological theory [21,22]. CT is a nonparametric tree building technique. The essential purpose of CT is to partition the main data into homogeneous subgroups. In this way, the data is represented by a tree structure [23,24] (Breiman et al., 1984; Navarrate et al., 2011).

To identify the best model, The Area Under the Curve (AUC) of the Relative Operating Characteristic (ROC) was calculated for each of all models [25].

3 RESULTS

We used a DEM of the Yukarigökdere district for calculation of four digital terrain models (i.e. ELEV, SLOP, RI and TPI) as raster layers with a spatial resolution of 1 ha (100x100 meter). Parent material map composed of 3 main bedrock types (i.e. limestone group including neritic limestone, pelagic limestone and charty limestone with Halobia (a), conglomerate (b) and ophiolitic melange (c)) was also constructed by transforming to the same size grid.

As mentioned before, response data was obtained from the 119 sampling points. We have detected the presence of turpentine tree in 19 sampling points (Fig. 1).

A stepwise procedure was performed for DA. The function was found highly significant (p< 0.000) with a Wilks' Lambda value of 77.3%. Variance-co-variance matrices were found equivalent (Box's M=6.307, p=0.109). Instead of canonical discriminant function, fisher linear discriminant functions ($Y0$=-22.809+0.033*ELVN-2.036*RI and, $Y1$=-16.231+0.026*ELVN-0.225*RI) were, therefore, used to generate a potential distribution map. To this end, the standardized values (Yi=xfi / (xfmax-xfmin)) of the differences (xf) between the estimation values obtained from $Y0$ and $Y1$ equations were calculated for each of all cells.

LR was performed with a forward stepwise precedure. Like DA, ELVN and RI were found the best predictors. Nagelkerke R Square showed that about 44% of the variation in the response variable was explained by the logistic model. The obtained LR model was: *The occurrence of turpentine tree probability (p) =exp* $^{(9.491\ -0.10*ELVN\ +2.133*RI)}$ */ (1+exp* $^{(9.491\ -0.10*ELVN\ +2.133*RI)}$).

With respect to the applied CT technique, 10 fold cross-validations were run to obtain optimal tree model. This tree model produced 5 nodels and 4 splits. The tree model was built by ELVN, ROCK and RI (Fig. 2). According to the tree model, the most suitable sites for turpentine tree seem to be the areas below approximately 1292 metre, where limestone and conglomerate are predominant parent material. (Fig 2).
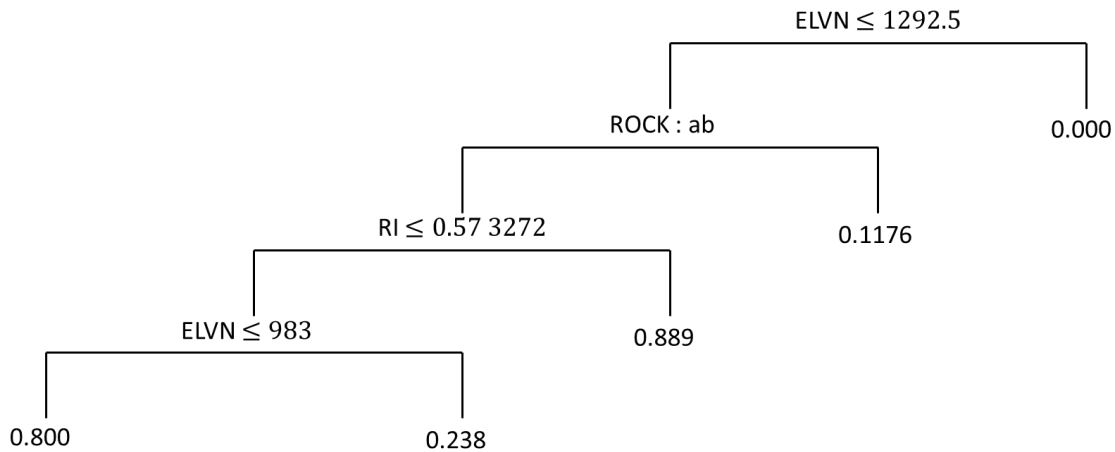
Fig. 2) Classification tree model and distribution probability map of turpentine tree in the Yukarigokdere Forest District of the Mediterranean region, Turkey

Before performing GAM, a quasi-binomial model was chosen. The best model was taken by means of ELVN and RI. The stepwise selection of predictors for turpentine tree selected the following model: *The occurrence of turpentine tree probability= s(ELVN, 4) + S(SLOP) (explained deviance: 56%)*. Where *s* is the spline smoother, 4 is d.f. for the spline smoother. The predictor's partial response is shown in Fig. 3, where the suitable sites for turpentine tree are characterized by ELEV values lower than approximately 1300 m. asl. and slope values between 15 % -25 %.
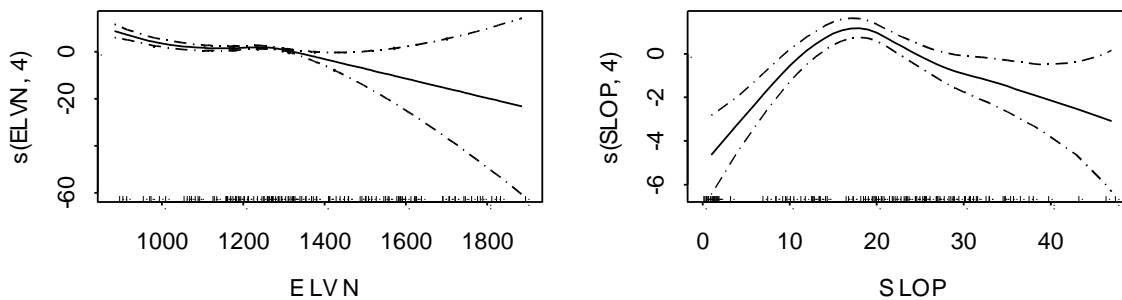

Fig. 3) Response curves of the presence/absence to the predictor variables in the GAM analysis (center line). The y-axes are based on partial residuals, and indicate the relative influence of each explanatory variable on the prediction.

ArcInfo GIS was used to create the potential suitability models as maps and given in Fig. 4. According to the results of the applied ROC analysis, to compare the models, GAM was found the best model with a AUC value of 0.960. The AUC value of CT was found 0.942 while those values for DA and LR were 0.882 and 0.883 respectively (Fig. 4).

4   DISCUSSION AND CONCLUSIONS

Group discrimination techniques were used to create potential distribution models for turpentine tree in the Yukarıgökdere forest district of the Mediterranean region, Turkey. The distribution models were built by using four topographical layers (ELVN, SLOP, RI, and TPI) and a parent material map.
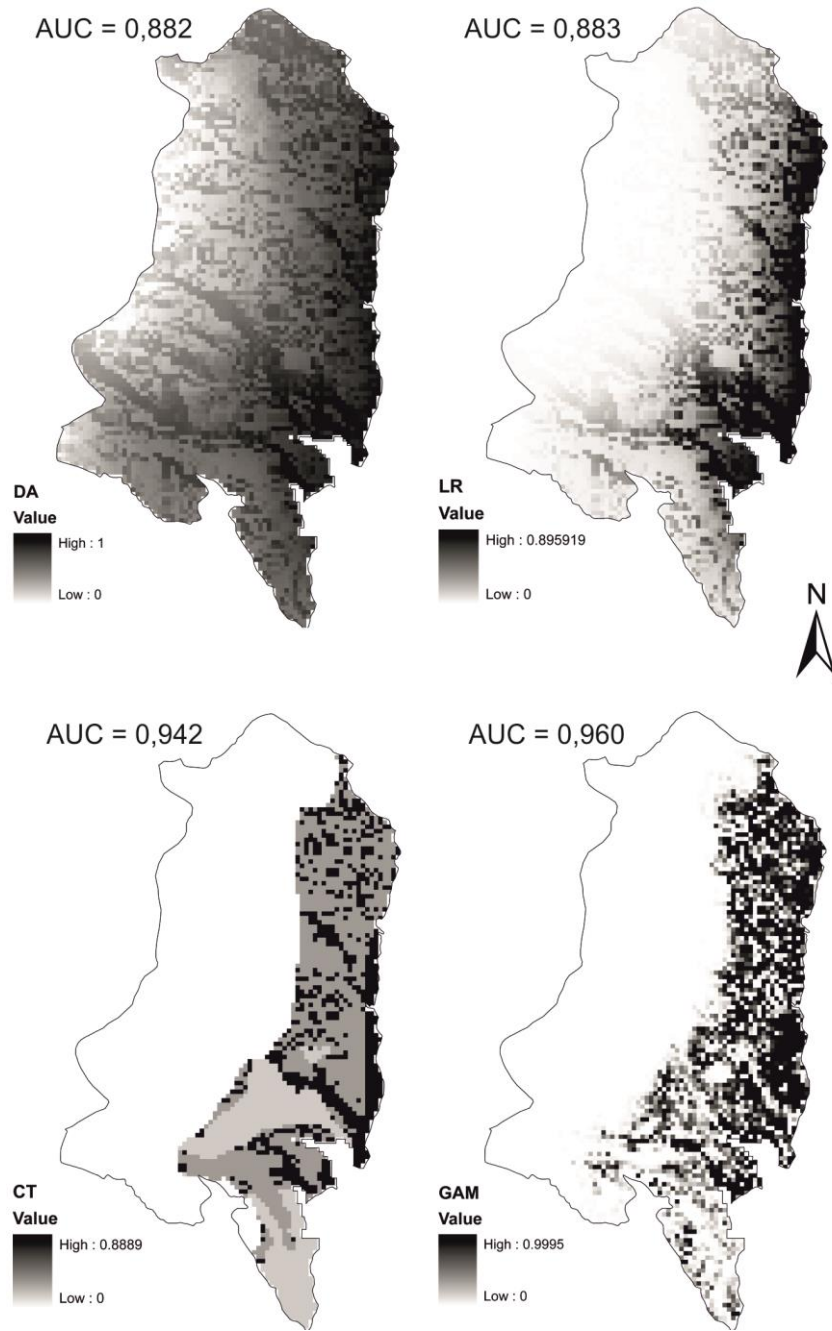
Fig. 4)   Potential distribution maps of turpentine tree according to the applied group discrimination techniques in the Yukarıgökdere Forest District of the Mediterranean region, Turkey

Under the explanatory variables, all models predicted the distributions within the district and exhibited high AUC (ROC) values. However, GAM and CT predicted higher values than DA and LR. Predictors of the LR and DA models are ELVN and RI. Those are ELVN and SLOP for GAM and ELVN, ROCK and RI for CT.

The GAM model was selected as the best predictive model due to having the highest model performance value. Also its results show a parallel with our observation. The findings obtained from GAM reveal that the suitable sites for turpentine tree correspond to the lower elevations and slope values between 15-25 %. Those results are logical from ecological point

of view. Because turpentine tree is a well-known Eu-Mediterranean element and, most of plant species belonging to Eu-Mediterrranean communities such as *Dafne serisian*, *Quercus coccifera*, *Quercus infectoria*, *Styrax officinalis*, *Fontanesia philliraeodies*, *Jasminum fruticans*, *Palirus spina-cristi*, *Phillyrea latifolia* and *Phlomis grandiflora* var. *grandiflora* [26,27,28] are found together with turpentine tree in the lower sites of the district [17].

Even thought the flats or slightly slope areas in the lower elevations seem to be the suitable sites for turpentine tree, not surprisingly, the species is rare or absent in those areas. Because flats or slightly sloping areas are more productive sites for Brutian pine (*Pinus brutia*), Crimean pine (*Pinus nigra*) and Oak species (*Quercus* spp.) and, those species have established more closed stands in those areas [17]. As a result, turpentine tree couldn't exist under those stands due to being a high-light requiring species.

In the study, expected results were achieved from the performances of the statistical approaches point of view. Namely, DA is a linear statistical method that falls behind to explain nonlinear relationships. To use DA, the explanatory variables should be normally distributed as well. However, explanatory variables (environmental variables) are generally nonnormal. Because of this reason, this method is rarely used for spatial distribution modelling. Unlike DA, LR can be used when the explanatory variables are nonnormal [29]. The relationship between the predictor and response variables is not a linear function in logistic regression; instead, the logistic regression function is used, which is the logit transformation of *a probability of occurrence (p)*. In other words, the logistic or logit function is used to transform an 'S'-shaped curve into an approximately straight line and to change the range of the proportion from 0–1 to $-\infty$ to $+\infty$. However, even thought LR have been used for a long time as a predictive distribution model, it is inadequate for curvilinear or bell shaped nonlinear relationships. To explain such relationships, the best methods are CT or GAM. Those methods have been, therefore, much more commonly used than LR to predict species distribution. In comparison of GAM with CT, GAM gives generally more interpretive results than CT. Because the number of prediction values of CT are based on the number of terminal nodes whereas GAM model predicts the values referring the values of explanatory variables.

In addition to the properties of the distribution models, it should be noted that there generally exists bell shaped relationships between distribution of organisms and environmental factors in the mountain forest ecosystems in particular karstic mountain forest districts like Yukarıgökdere forest district. That is probably main reason why GAM was found the best predictive model by this study.

There are many forest villagers living in the forest districts of the Mediterranean region. A considerable amount of those people's incomes is based on forest resources, particularly non-wood forest products. That is why this study was conducted to generate a potential distribution map of turpentine tree, one of the most important non-wood forest products by using different correlative models in a mountainous district from the Mediterranean region.

Many valuable non-wood products are native as well as turpentine tree in the Mediterranean region. To determine the ecological properties of those species, more importantly, to generate their potential distribution maps, an integrated project should be prepared by the shareholders. In this way, the fundamental studies can be achieved and accurate strategies can be developed intended for sustainable delivery of the forest goods and services on the basis of community based management and functional planning in the different districts of the Mediterranean region.

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AESTHETIC REQUIREMENTS FOR BRIDGE PIERS

Ilze Rozentale[1], Ainars Paeglitis[2]

Abstract

The bridge designers should try to find an ideal balance between structural integrity, economy, buildability, aesthetics and durability. Bridge's structures should harmonize with landscape.Today the bridge design features are mostly the topical issue of designers often not having instruments to estimate the real output related to visual qualities. Some methods have been developed to examine bridge interaction with landscape by 3D modeling and photomontage in landscape.

Transport infrastructure development usually must ensure decreasing of project costs, increasing the social and economic benefits and also reducing the negative impact on the landscape. During the last years the society has accepted documents giving procedures for evaluation of the structural appearance on surrounding landscape. The European Landscape Convention defines the landscape as a part of territory whose features draw from natural and anthropogenic factors and consequently, interrelationships. The Convention gives clear and objective methods to assess the landscape's visual quality.

This paper deals with aesthetic requirements for bridge piers, and according to the Convention analyzes two categories of piers: short piers and tall piers. The key to improve the appearance of a not tall pier is eliminating or minimizing the pier cap, minimizing the number of columns. Problems of short hammerhead piers can be minimized with appropriate proportions. Tall piers are easier to design because both structure and aesthetics point in the same direction: emphasizing vertical members. The paper presents the analysis of bridge piers built in Latvia in the last decade.

Key words

Aesthetic requirements, pier caps, pier shape, short piers, tall piers.

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1   INTRODUCTION

Bridge piers are important bridge design elements. They do not only provide the transferring loads caused by transport and structure self-weight to the foundation, but they are also important landscape elements.   Bridge piers can take different forms, configuration and size.

The main objective of this paper is to develop the basic aesthetic requirements for bridge piers in order to give a visually light, slender, horizontally continuous structure with a transparent space beneath the bridge. Aesthetic requirements are based on the basic visual design aspects – line, shape, form and additional visual characteristics that can significantly affect piers influence on the bridge as a whole system– unity, order and proportion. According to the requirements output piers are conditionally divided into short and tall piers. The great attention is focused on the short piers, which have great aesthetic problems because of their proportions. The paper examines solutions of bridge piers in Latvia.

2   PRINCIPLES OF BRIDGE PIER AESTHETIC ASSESSMENT

Aesthetic requirements are discussed in the book written by Frederick Gottemoeller "BRIDGESCAPE: The Art of Design Bridge" [1] who is giving recommendations for creation of pier forms and paying attention to cap problems and pier placement. The author has developed guidelines based on the relative division into short and tall piers. The study of Burke M.P., Montoney J. [2] identifies some outstanding design manuals on bridge aesthetics and lists a number of primary design guidelines, but Hunt I. [3] discuss the current practice regarding aesthetic bridge design.   The article of Sie-Young Moon "Aesthetic Approach on Bridge Pier Design" [4] published in 2009 is devoted to the aesthetic aspects of pier design. In the article the author gives visual aspects (Fig.1) and visual characteristics (Fig.2) of pier design. The schemes developed by Sie-Young Moon are more directly related to the solution of piers, but less emphasize total visual quality of pier and whole construction. However, the attention should be paid to the given classification of vertical pier shapes. Also Sarah Longstreth Billington has touched the questions of pier aesthetic in his study "Improving Standard Bridges Through Aesthetic Guidelines and Attractive, Efficient, Concrete Substructures" 5]. Objectives of this research was to develop visual guidelines for improvement of the aesthetics and efficiency of widely used moderate - span bridges in Texas and provide useful guidelines and examples for improvement of the aesthetics and efficiency of substructures for standard bridge systems. This study was devoted to the application of precast and cast-in-place concrete piers. Summarizing the existing aesthetic guidelines for bridge design, S.L.Billington has noted that most of them could be educational and can provide ideas for bridge designers. Inspecting the objects the mentioned author concluded that there is a tendency to utilize a successful solution which is not always economically and aesthetically successful according to other conditions. The authors of the present paper have an opinion that the draft of aesthetic guidelines included in the paper is useful. There the three blocks: form, composition, entity have been outlined. It should be noted that the authors of all studies based on the opinions and given determinants of aesthetic bridge appearance developed by Fritz Leonhardt „Bridges: Aesthetics and Design" [6]. There are not deep studies about aesthetic and visual aspects of bridge piers design in Latvia.
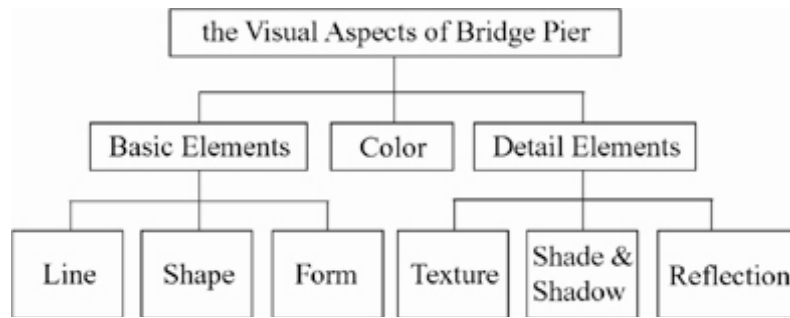
Fig. 1)   A classification of the visual aspects of bridge pier design [4]
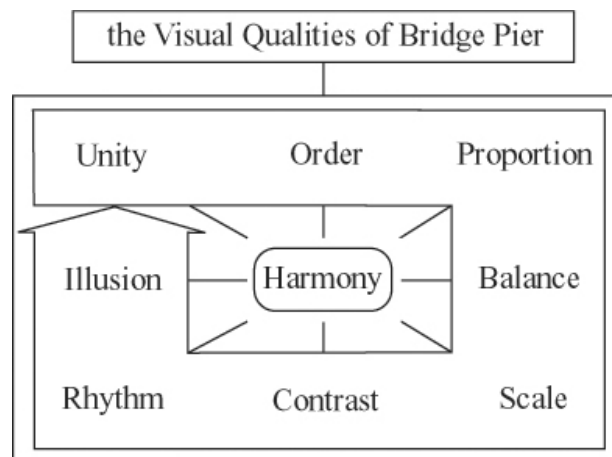
Fig. 2)   A classification of the visual qualities of bridge pier design [4]

The following pier classifications for the aesthetic assessment of pier are possible:

1. According to the height the piers could be divided into small and high piers (fig. 3)) [1].
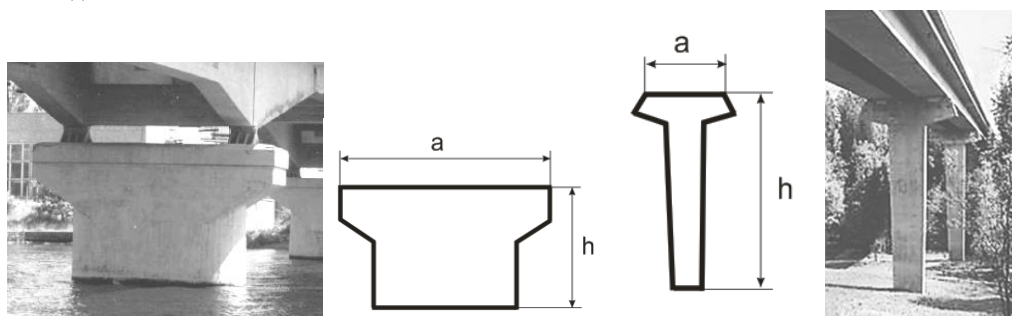
a) Small pier a>h   b) Tall piers a<h

Key:
a – length of the pier at the top
b – exposed height of the pier

Fig. 3)   Definition of short and tall piers. a) Pier of the bridge in Kundzinsala; b) Pier of the river Lorupe bridge [7]

2. According to the shape/form piers could be divided:
   a. By Frederick Gottemoeller classification – solid piers, hammerhead (T-type), multi – columns with or without pier caps and pile piers, [1];
   b. By Sie-Young Moon classification (fig. 4)).
3. According to the material the piers could be classified as concrete, stone, steel, wood.
4. According to the structural solution the piers could be divided as cast-in-place piers and precast piers.

3   TYPICAL PIER STRUCTURES OF BRIDGES IN LATVIA

There are three periods in bridge construction in Latvia:

1. The period up to 1941 including the Russian Empire and the period of the independent Republic of Latvia,
2. The period from 1941 to 1991 including the period of the USSR;
3. The period from 1991 including the period of independent Republic of Latvia regained its independence in 1991
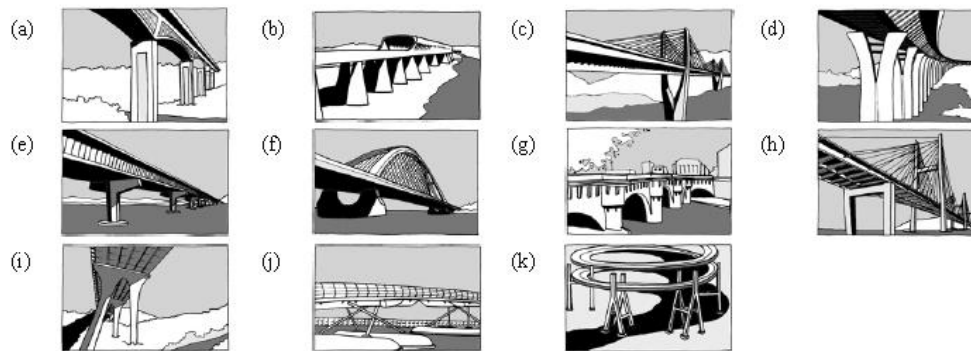

Fig. 4)   Vertical shapes of piers: (a) I -type, (b) II -type, (c) V –type, (d) Y –type, (e) T –type, (f) U –type, (g) Arch –type, (h) Square –type, (i) PI(Π) –type, (j) X –type, (k) Mixed -type [4]

Each period is characterized by different structural solutions of bridge and its elements, the materials used and aesthetic quality.

Construction period until 1941

Construction period is characterized by stone masonry piers or solid concrete piers, that feature a rectangular shape with/without structure specially designed for pier protection – starling. Special weather conditions cause the necessity of starling – ice melting in the spring (see Figure 5)). Stone piers are characterized by the bridge over the river Abava in Kandava (1873), the bridge over the river Venta in Kuldiga (1874). At the beginning of the 20th century stone piers replaced the massive concrete piers keeping the characteristic stone pier shape with/without starling, such as the bridge over the river Gauja in Sigulda (1937), the bridge over the river Salaca (1909). The timber bridges with different piers forms are typical for the same construction period (see Figure 6)). Examples include the bridge over the river Gauja in Valmiera (1934), where piers retained massive stone pier form, but pier form, which can be considered as multi-column piers, are shown by the bridge over the river Pedele in Valka (see Figure 7)).
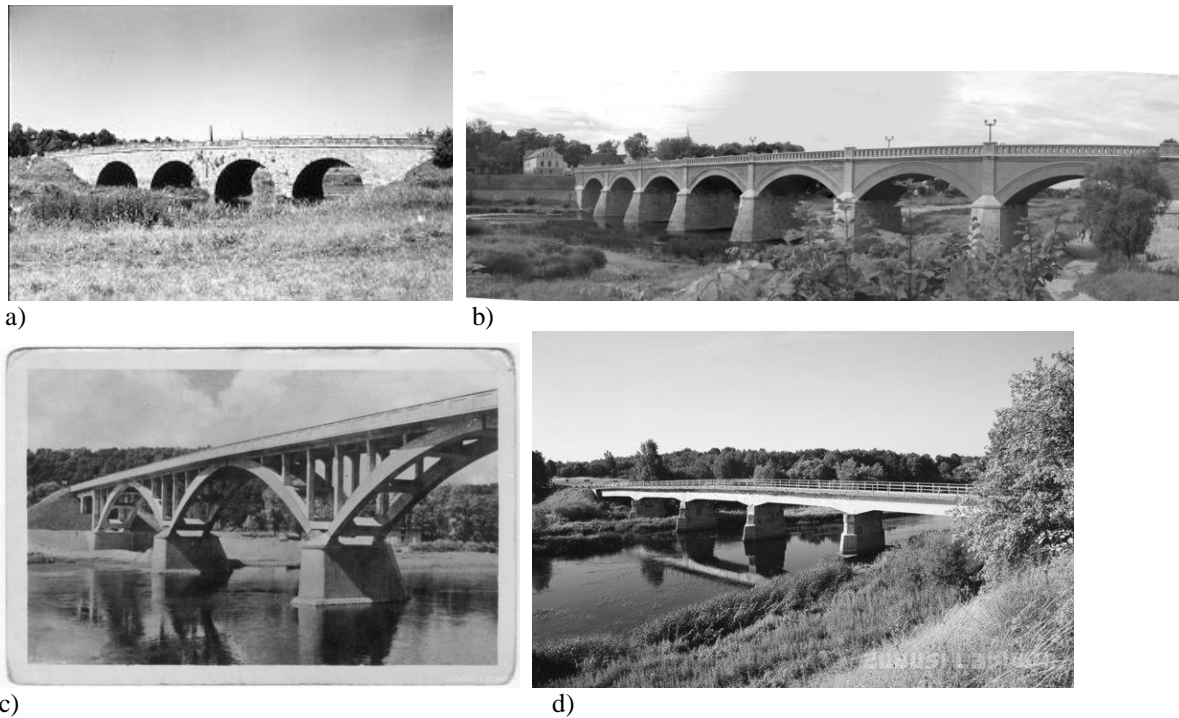
Fig. 5) Examples of the stone and massive concrete piers in Latvia until 1941: a) Bridge over the river Gauja in Valmiera; b) Bridge over the river Venta in Kuldiga; c) Bridge over the river Gauja in Sigulda; d) bridge over the river Salaca near Vecsalaca [7]

Fig. 6) Examples of the timber piers in Latvia until 1941: a) Bridge over the river Gauja in Valmiera; b) Timber bridge; c) Bridge over the river Pedele in Valka

Construction period from 1941 until 1991

Under the influence of political and economic situation in Latvia the precast concrete structures were mostly used. The main objective in designing was the economy of material, easy and quick construction, which could be achieved by using a standard construction. The period is characterized by multiple-columns or pile bents with pile caps. At this time the aesthetic issues were considered as secondary. During this period a number of bridges were constructed with sloping piers, which are a visually successful solution. The examples of bridge piers could be seen in Figure 7.
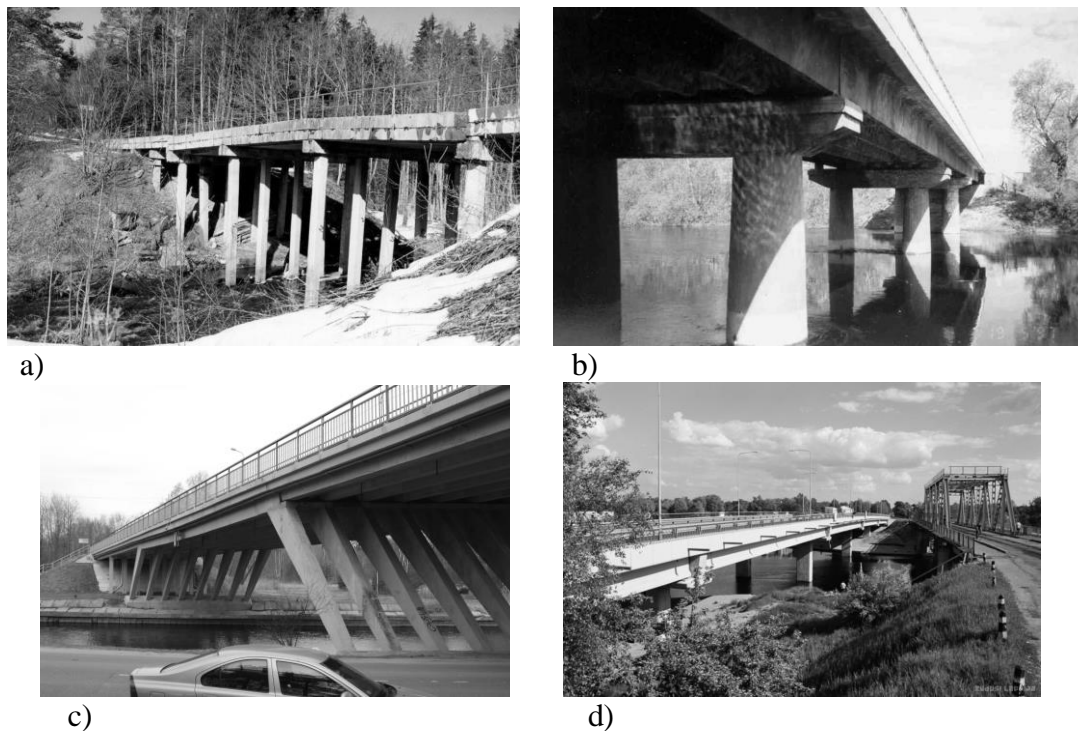
Fig. 7)   Examples of the bridge piers in Latvia in the period from 1941 until 1991: a) Bridge over the river Riezupe in Kuldiga region; b) Bridge over the river Aiviekste; c) Bridge over the Channel Kisezers-Baltezers; d) Bridge over the river Bullupe [7]

Construction period starting from 1991

Construction period is characterized by the construction of monolithic concrete piers. In addition to the traditional pier types, the wall type piers appeared and new solutions of piers were searched to minimize caps or minimize their influence. A new approach to aesthetic was evolved and technologies were developed helping the designers to evaluate design solutions before the realization of the project. In Figure 8 the pier solutions in construction period from 1991 have been summarized.

4   ASSESSMENT OF BRIDGE PIERS

Only the assessments of small piers specific for the bridges in Latvia due to the flat topography have been given in the paper. The assessment is given only for the pier structure and its impact on overall structure and landscape regardless of the material and bridge type. The assessment criteria of aesthetic and visual quality have been developed on the basis of verities in the studies of Fritz Leonhardt, S.L.Billington and Sie-Young Moon:

1. Shape/form:
    vertical pier shape regardless of the pier material;
    proportions – balance and harmony between the elements;
    order – symmetry and lines, number of directions and edges.
2. Composition:
    character – impact on viewers;
    order in composition – view beneath the bridge (open view, restricted view, closed view). The principle also includes the effects on the landscape;
    proportions – impact on overall bridge appearance and landscape.

Fig. 8)   Examples of the bridge piers period starting from 1991: a road) Bridge over the river Gauja in Valmiera; b) Bridge over the river Gauja in Adazi; c) Bridge over the river Gauja near Senite; d) Bridge over the A2; e) Bridge over the river Dzirla; f) Bridge over Meza street in Riga

The usage of established pier types remained in all periods of bridge construction in Latvia: solid piers, solid piers with two columns, multi – columns with or without pier caps, hammerhead (T-type) piers and pile piers with caps. In addition to above listed pier types the wall type piers are used in construction.

In Tab.1 the assessment of aesthetic qualities and visual impact for only some piers type bridges in Latvia have been summarized. Piers are analysed using visually previously accepted criteria. Sometimes evaluating the individual criteria the contradictory assessments result according to the assessor's feelings and the criterion of the assessment.

Fig. 9)   Assessment of bridge piers in Latvia

Bridge	Assessment	
 Bridge over the river Venta in Kuldiga	Pier type and shape/form	Solid pier with starling Vertical form – arch-type [4]. The form is geometrically simple Proportions – the pier width and height in relation to the arch create a sense of stability and visual harmony Order – the pier symmetric to front edge of starling
	Composition	Character - solid, create a sense of stability Order – a restricted view beneath the bridge. An oblique angles view can be completely obstructed. Significant impact on the surrounding landscape. Proportions – overall bridge appearance – harmonious, corresponding principles of Fritz Leonhardt [6], adapts in landscape
Pier assessment (bridge aesthetic assessment)	Solid pier with consistent proportions. The bridge fulfils aesthetic requirements for stone arch bridges. Visually adapts into the landscape.	
 Bridge over the river Uzava (before reconstruction)	Pier type and shape/form	Multi-column pier with caps Vertical form – adequate to I-type [4] Proportions – proportion of pier height is disarranged by the cap, which appears as an additional element Order – cap disarranges the principle forming an additional surface and creating eyesight problems
	Composition	Character - cap creates a visual complexity Order – columns restrict a view beneath the bridge. Significant impact on the surrounding landscape. Order defects the beneath of the bridge. Proportions – in the placement of multi-column the ratio between the column spacing and span length has not been considered - forming the "column forest".
Pier assessment (bridge aesthetic assessment)	Pier cap end interrupts the horizontal smooth of lines. Pier cap end is the brightest surface of the bridge which firstly attracts the attention. "Column forest" covers up the view beneath the bridge. The aesthetic issues have not been taken into the consideration in the constructive solution of the pier and bridge.	
 Bridge over the river Uzava (after reconstruction)	Pier type and shape/form	Multi-column pier without caps Vertical form – adequate to I-type [4] Proportions – well-proportioned Order – piers visually simple without additional edges and lines
	Composition	Character - simple piers with clearly perceived function Order – an open view beneath the bridge Proportions – the ratio between the columns spacing and span length have been taken into the consideration in the placement of multi-column piers

Pier assessment (bridge aesthetic assessment)	Open view beneath the bridge. The bridge successfully adapts in the environment. The horizontal flow of structure lines has been maintained.	
Bridge over the river Gauja in Valmiera	Pier type and shape/form	Solid pier with two columns Vertical form – adequate to U-type [4] Proportions – successful ratio between the base of solid pier and column-type elements Order – piers visually simple without additional edges and lines
	Composition	Character - simple piers with clearly visible function Order – an open view beneath the bridge Proportions – piers visually adapt in overall structure
Pier assessment (bridge aesthetic assessment)	Open view beneath the bridge. The bridge successfully adapts in the environment. The horizontal flow of structure lines has been maintained.	
Bridge over Meza Street in Riga	Pier type and shape/form	Pier of one element Vertical form – adequate to T-type [4] Proportions – the elements of piers symmetrically around the axis of symmetry, harmony between the elements of the piers Order – piers visually simple without additional edges and lines
	Composition	Character - simple piers with clearly perceived function Order – a restricted view beneath the bridge Proportions – piers visually adapt in overall structure
Pier assessment (bridge aesthetic assessment)	Restricted view beneath the bridge. The bridge successfully adapts in the environment. The horizontal flow of structure lines has been maintained. Pier form is suitable for developing the families of piers	
Bridge over the river Gauja in Adaži	Pier type and shape/form	Solid pier with two columns Vertical form – adequate to U-type [4] Proportions – successful ratio between the base of solid pier and column-type elements Order – piers visually simple without additional edges and lines
	Composition	Character - simple elegant shape with clearly visible function Order – a restricted view beneath the bridge Proportions – piers visually adapt in overall structure
Pier assessment (bridge aesthetic assessment)	Solid piers partly restrict the view beneath the bridge. The bridge successfully adapts in the environment. The horizontal flow of structure lines has been maintained.	

5   CONCLUSION

Construction period from 1941 until 1991 is characterized by standard solutions of piers (multiple-columns/ pile piers with pile caps) leading to the unattractive appearance of bridge in many cases. The main problem is related to superstructure. It is important to consider the

ratio of pier width, spacing of separate columns/piles and span length. It is significant to search for new solutions minimizing or eliminating the cap end in order to obtain a harmonious landscape, aesthetically pleasing bridge solution (for example, bridge over the river Uzava before and after the reconstruction).

Reconstruction period from 1991 provides with many examples of a new approach to the bridge design. That results in construction of aesthetically qualitative bridges, which harmoniously adapt in the landscape. Usage of new technologies such as 3D modelling allows estimating the pier form/shape, its impact on the overall bridge solution and surrounding landscape before the project is fulfilled. 3D modelling can help to develop a new aesthetically and visually qualitative pier forms.

Taking into account previously collected results the following main recommendations for the design aesthetic pier can be formulated:

- Minimizing cap or visible surfaces of hammerhead (T-type) pier overhang end;
- Pier width should be proportional to the superstructure height, span lengths and exposed height of piers;
- Minimizing number of columns in multi-column piers;
- Piers and bridge as a whole should be in harmony with surrounding environment;
- Avoid the use of solid piers, if possible.

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REVIVAL OF PEDESTRIAN SPACES IN PALIMPSEST CITIES APPROACHES – CASE OF STUDIES: YAZD AND FLORENCE

Mojgan Sadeghi Benis[1], Mohammad Motallebi[2]

Abstract

Reviving pedestrian areas in Palimpsestic cities which have many identity layers are only possible in two different methods; which are based on analytical inference of Palimpsest. The principle of one of these methods is separating the palimpsest layers and protecting and reviving those patterns and maintaining the highest efficiency of them. In this method each layers are under study. Such method is visible in reviving the pedestrian areas in Yazd. Although most of these areas in Yazd have lost their continuity in the past few decades as a result of recent developments, the main approach in the remaining areas is protection and renovation. Thus these areas don't hold practical and infrastructural roles in the city.

In second method which is based on "Palimpsestuous" inference is driven out of emergence of the new identity and key layers involved. Emerging attraction could play a key role in developing the use of pedestrian areas. In Florence; the pedestrian areas in the historical and modern parts of the city are in harmony with each other. Extensive supervision on construction has prevented the destruction of the historical areas. Such attitude in Florence contrary to Yazd has caused these areas to have a key role in preservation of infrastructure of Florence and life of its citizens and help the preservation of the historical part of the town.

Key words

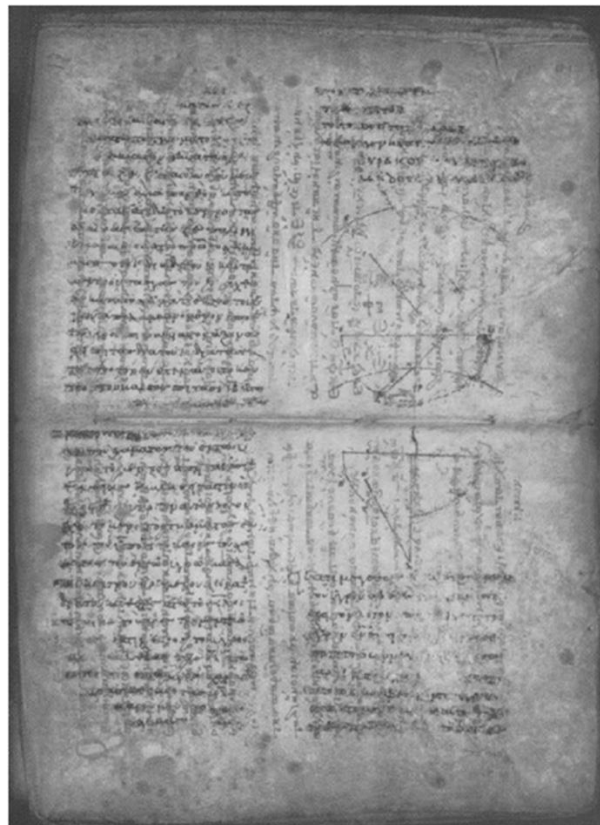Florence, palimpsest cities, palimpsest reading, pedestrian spaces, Yazd.

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1   INTRODUCTION

In Oxford dictionary the term "Palimpsest" is defined as "a manuscript or piece of writing material on which later writing has been superimposed on effaced earlier writing" [1](Fig. 1).

This concept portrays something with diverse layers formed during ages historically and as a result layers overlay each other one after another and generally, created a situation that parts of layers from different eras are visible in it. In many historical cities which have experienced changes in their structure, Palimpsest concept is quite conspicuous. During different eras some of such cities have received many changes due to political, cultural and economic reasons and thus exhibit Palimpsest nature by having several historical layers and some others have changed in contemporary era which, clearly consist of two inseparable layers. A historic city with either of the two before-mentioned structures is, a "Palimpsest city". However the first group has more complexities and change and replacement in the corresponding structure involve more complicacy difficulty and sensitiveness. Palimpsest cities contain entity and memory layers as well as materialistic showcase within architectural structures. Hence, any change in them should be applied based on this layer-like structure.

Fig. 1)   Palimpsest [2]

2   PALIMPSEST READING, IDEA-SHAPING FACTOR

Like every other city, pedestrian spaces are one of Palimpsest cities' components. But what makes these spaces' importance doubled, are their effect in identity apprehension in Palimpsest cities. In Palimpsest cities, each sector comprises of semantic layers, and therefore, paying attention to pedestrian spaces for better understanding of these layers is very important. In Palimpsest cities in one hand, a macro-scale comprehension of the city could not

best imply hidden definitive concepts in urban spaces and on the other hand, interference in urban spaces to reform carriageways and penetrating into valuable urban fabric is difficultly possible. These two reasons could be a good justification for paying attention to revival of pedestrian spaces in palimpsest cities. However another approach could also be taken into account. This is the same approach taken into account in many historical cities at the beginning of modern era – among them is what was considered in some places of Tehran city historical fabric. This approach is a non-Palimpsest approach that targets removing historical layers and replacing modern urban spaces with them. But undoubtedly, in the current period and after ratifying Athens Charter [3] and successively, Florence Charter [4] as well as UNESCO conventions, such approach has specifically been abolished and as a result is not subject of this essay.

But, regarding revival of pedestrian spaces, preserving historical layers and fabrics in Palimpsest cities, different approaches could be considered. Sara Dillon [5] distinguishes between two types of analytical reading based on the Palimpsest. A "Palimpsestic" reading involves separating the different layers of the Palimpsest; in other word, unraveling and destroying Palimpsest. A "Palimpsestuous" reading, on the other hand, preserves the structure of the Palimpsest and seeks to trace the incestuous and encrypted text that constitute the Palimpsest fabric [5]. The difference between these two is not denying Palimpsest but in the type of encounter analysis. it is obvious that the idea of layers separation – if possible at all- will lead to non- Palimpsest. This is because it clears out concepts based on Palimpsest which are result of semantic interaction of different layers and creates disjointed layers which do not have any semantic relationship and the best; each has a semantic meaning peculiar to their own entity and no semantic synergy will emerge on them.

In the second approach, aim is highlighting semantic and discovery of semantic layers which have appeared from the anterior and posterior layers' synergy. Emphasis on reading the original manuscript indicates the attention to retrieval of lost or faded semantics and is yet not only lessening the semantic values of initial manuscripts but also helps to upgrade them. This is because it increases fabric identity and brings a good ground for Palimpsest zones recognition. This theory has a better flexibility and has a good pre-set commitment for preserving a Palimpsest structure. This commitment unconsciously means being bond to conjunction of Palimpsest structure with the new structure because new structure intrinsically could add new layers to Palimpsest layers.

For the usage of this approach in regard with revival of pedestrian areas in Palimpsest cities, the alliance of pedestrian spaces within historical fabrics and pedestrian walkways of modern urban fabrics could be pointed out. This alliance, although seems to be very tangible in physical point of view, but in its social aspects, there will be some problems because, life in modern and historical fabrics have some differences with each other both in style or structural and requirements points of view.

Based on Henry Lefor [6], before emerging modernity, in nineteenth century, space and living in it have some reciprocal relationship. But after emerging abstract space in modern era, pedestrian spaces due to the relationship they have with traditional style of life, changed to some functional spaces and the only mean for establishing space relationships. This is when pedestrian spaces in modern fabrics have usually multifunctional characteristics and not only have a good role in communication but also have changed to a place where urban art, supplying goods and services and aesthetic attractions exist and where shaping public relationships and even fashion introduction happens. These differences have caused

pedestrian spaces to be treated as a "passageway", notwithstanding the fact that they are still considered as semantically meaningful.

This inclination to modern pedestrian spaces will result in finding out historical fabric values and this will end in a tendency from the residents to change such fabrics.

This could bring about some adverse effects. Some would be destroying the historical fabric by residents or if some strict rules and regulations by the authorities and government resist it, they will be forced to abandon historical districts and migrate to newly build modern districts. This will also result in not paying attention to historical places and fabrics and their gradual destruction.

For avoiding such situation, two methods could be proposed each would bring some opportunities and some threats. One method is rehabilitation and refurbishment of historical buildings and pedestrian spaces joining them in historical fabrics for fascinating tourists, is to make some attractions for them. This has been tried out by different projects in Iran and other places in the world. Here the threat is eventually what is achieved has no significant benefit for local residents. This is because although tourism is a means for economic development but its affluence is influenced by many factors. On other hand, security restrictions within historical zones are a hindrance for the residents to gain economic benefits from the tourism.

The second method is to introduce some new identification elements in the fabric of historical space. Such identifying elements could be extracted from Palimpsest layers and magnified them, refer to the case of Lake Market, Nottingham, UK [7]. Such new identification elements which necessarily are proportional to today's human needs, could bring space liveliness and according to Lefor [6], could bring sociological space within the real space and hence improve the residence motives for residency. Here the role of pedestrian spaces as conjunctional elements and a place for emergence of ne identification elements is of sheer importance.

3   REVIVAL OF PEDESTRIAN SPACES IN YAZD AND FLORENCE

Yazd and Florence cities both have very ancient historical records. During different eras, they have experienced some transitions and changed to their current situations. These two cities could be named as multi-layer Palimpsest cities. Due to this, any modification in their structure necessitates knowing and understanding different containing layers.

Pedestrian spaces in Yazd city due to its special dominant, cultural entity and physical environment, has been formed into a special structure. Pedestrian walkways in Yazd city are narrowed and in organic form and always have tied up different important elements such as mosques, bathhouses and bazaars (Fig. 2). But in recent decades, city development, and mechanizing the life on one hand and cultural changes on the other hand, has introduced some important structural changes in pedestrian walkways of this city. The modern streets have made cuts in historical fabric of the city and have ruined the zones' cohesion. Some preeminent and paramount elements like mosques and traditional bathhouses or even bazaars have lost their historical entity and some new characteristics been imposed. By this change, pedestrian spaces in Yazd city have lost their focal role both in communicational and transits-like points of views. However their historical values have not been lowered.

Fig. 2) Pedestrian walkway structure in Fahadan – Yazd [8]

Such historical values have been a motive to revival of pedestrian walkways in some historical districts of Yazd city such as Fahadan District (Fig. 4). This revival predominantly has been briefed in repairing walls and floors of pedestrian walkways, repairing some historical locations and buildings along with the routes and assigning them to touristic spaces or changing their land use into hotels or restaurants. Overall, what has resulted is a tourist route that connects some key elements in city or district scale. Like before they are now show a same usage but with an unbalanced and heavier structural and aesthetics characteristics compared to semantic characteristics.

Fig. 3) Vaft and Sa'at square, Yazd [Photo by author]

Fig. 4)   Revived Pedestrian walkways in Fahadan, Yazd [Photo by author]

This has caused the rejuvenated pedestrian spaces of Yazd city to be considered as tourist routes and considering the light volume of tourists in many months of the year, they are not very popular for pedestrians. While the recently-built pedestrian streets in border of cities are suffering from crowds and heavy volume pedestrians, many pedestrian spaces in historical areas despite holding a higher semantic and identity rank compared to other pedestrian streets of Yazd, are almost empty. The reason to this should be sought in the type of vision to revival of pedestrian streets in Yazd historical fabric.

Compared to Yazd, Florence is very different. Due to ecological and cultural differences the pedestrian spaces in Florence are wider and apart from streets plazas are very important pedestrian zone in historical fabric of Florence city (Fig. 5).Pedestrian streets usually end up in plazas and each plaza is defined by a distinct building or distinct usage. The existence of plazas in pedestrian spaces in Florence is the origin to building up "halt spots" which are a place for gathering people since ancient times.

Although a similar pattern exists in Yazd city where people used them for some special religious ceremonies and gatherings, but they were taken into account in revival plan of pedestrian spaces in Yazd city (Fig. 3).

Pedestrian areas are all well connected to the newly-built vehicle carriageways in Florence city. Even in modern fabrics of cities, pedestrian spaces and plazas have been/are being built using historical fabric pattern (Fig. 6). This means that layers conforming Palimpsest structure are well recognized and the rehabilitation are done with considering such Palimpsest system. That is why not only the identity and semantic notion of urban spaces are preserved but also they have been infused into new structures.

The important point that is noteworthy to mention is how this infusion has been performed. Such areas have retained their structure but different usages have been assigned to them and they are all attractive to both tourists and residents. Shopping malls posing famous brands, Cafeterias, fast foods, art galleries and governmental and institutional buildings and, in one term, population attraction spots in city historical fabric within pedestrian areas, despite lessening semantic and attractiveness of Churches (which were some focal points in Florence

plazas) in modern eras have made pedestrian spaces a key feature in historical fabric of Florence city (Fig. 7~9).

Fig. 5)　　The structure of pedestrian spaces in Florence [8]
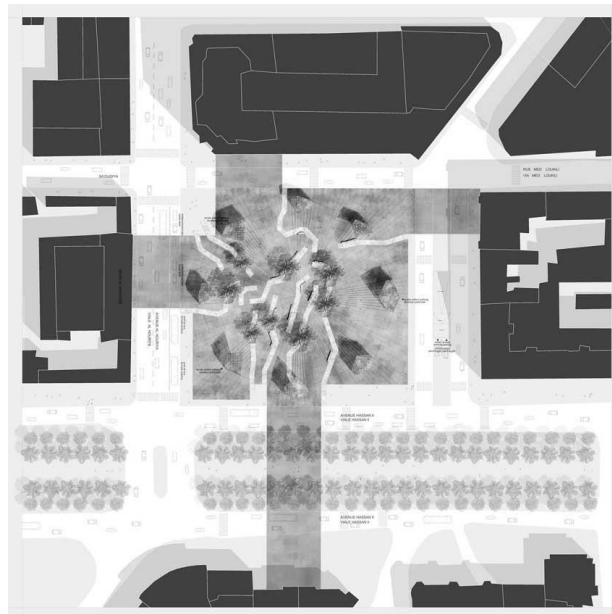
Fig. 6)　　Florence Plaza within the renovated part of the city [Mikou Design Studio]

In such situation, the historical fabric, not only has not lost its identity and attractiveness for residents, but also has transformed to the most valuable and precious part of city and hence there are fewer people feeling like to destroy or leave such areas.

Fig. 7)   Pitti Palace [Photo by author]

Fig. 8)   Clazaidoli pedestrian walkway during night time [Photo by author]

Fig. 9)   Clazaidoli pedestrian walkway during day time [Photo by author]

4   CONCLUSION

Any semantic or structural transition in Palimpsest cities are unintentionally affected by semantic and structural layers. Thus the type of encounter with these layers could be very deterministic. As mentioned before, for Palimpsest reading, two theories pointed out: Palimpsestic and Palimpsestuous.

Considering the description explained, these two theories and analyzing what is distinguishable from Yazd and Florence cities., we can conclude what happened in Yazd city is rather Palimpsest reading because there is no attention to old and new layers and the space between them and the new layers are formed without considering previous layers and rejuvenating old layers are done without paying attention to the identity and new meanings.

In other hand, Florence is a good sample of Palimpsestuous reading and the result is the formation of a logical and proportional relationship (both in structural ecological point of view) between modern and historical fabrics. This logical relationship solely provides livelihood and hyperactivity to historical fabric and creates a good belonging and protective feeling by upgrading the level of preciousness in the view of the residents. Hence it seems that considering Palimpsestuous reading and building up the visions for rejuvenating pedestrian spaces based on it could be a good aid to revivifying and rejuvenating good inhabiting areas in Palimpsest cities.

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LANDSCAPE AND GREEN ROOFS: KINDERGARTEN ARCHITECTURE

Danica Stankovic[1], Milan Tanic[2], Vuk Milosevic [3]

Abstract

Greening the roofs of buildings provide many ecological and economic benefits, including storm water drainage, energy saving, reduction of thermal effects, increasing the durability of roofing, as well as providing aesthetically pleasant environment. The paper treats aspects of implementation of extensive and intensive green roofs on different types of kindergartens. The analysis is based on researching building opportunities in Serbia. Having in mind that the existing building capacities in Serbia, spend huge amounts of energy, the research is focused on establishing the potential concepts for saving energy, without disturbing the comfort in kindergartens. As a part of scientific project conducted at Faculty of Civil Engineering and Architecture in Nis, in last couple of years has been surveyed a great number of kindergartens in Serbia mainly in south-eastern part of Central Serbia. There was sufficiently material to make an overview of field situation and make a draft framework for proposed improvement strategy. The paper goal is to explore the possibilities and suggest the best model for reconstruction and greening roofs in terms of the full revitalization of kindergartens regarding needs of children for high-quality environment in terms of both healthy and energy efficient environment.

Key words

Architecture, energy, environment, green roofs, kindergarten, landscape.

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1   INTRODUCTION

Site design is a fundamentally important aspect of sustainable design. Finding ways to build closer to nature, to the extent to which the urbanized nature will make the cities more liveable, not only for people but for plants. Governments everywhere recognize the benefits of green roofs and using them to realize a positive effect on the ecology of large polluted cities. Green roof technology is spreading. The resulting green cities could become more pleasant and healthier environments for people.

The greening of roofs and walls with vegetation has taken hold in a number of kindergartens around the world (Fig. 1). Building placement, orientation, massing, and layout decisions made early in the kindergarten design process can profoundly affect the energy impacts of the building. A high performance kindergarten protects the natural ecosystem by not employing any products and technologies that could pollute or degrade kindergarten site.

Fig. 1)   Oliver Kindergarten in Zaragoza (Spain**),** Carroquino Finner Arquitectos, 2007

2   GREEN ROOFS

Depending on the depth of planting and plant maintenance, green roofs can be divided into extensive green roofs and intensive green roofs.

Basic features extensive roofs: low weight; are impassable; low price; un-diverse vegetation; low maintenance. Vegetation layer consists mainly of a mixture of sand, gravel, broken bricks, peat, organic matter and certain types of land whose thickness varies between 5-15 cm with increasing weight of 73-170 kg / m^2 when fully saturated. Because of the shallow layers of vegetation and extreme microclimate on most roofs (desert-like conditions), the plants must be low with the characteristics of wild plants and should not require special conditions of irrigation and maintenance. The plants are usually watered only when the trash is not prime, and after one year of maintenance involves removing the roof and checking the regularity of the membrane two times a year. Extensive green roofs can be applied to flat roofs and pitched roofs with a slight incline, provided they have taken appropriate measures to prevent soil shear strength (Fig. 2).

Fig. 2)   Extensive green roof with low vegetation

Basic characteristics of intensive roofs: they passable; have a higher layer of soil andvaried vegetation and are therefore they weigh more; they are more expensive; and are more difficult to maintain.

Vegetation layer is based on the layer of earth 20-60 cm depth with increasing weight of 290-960 kg / m^2 when fully saturated. Because of the greater thickness of the soil the choice of plants is much broader and includes the planting of trees and shrubs, which form a complex ecosystem. The need for maintenance (especially for irrigation) are much more demanding and more frequent and irrigation systems are usually unavoidable. It is recommended that advice from a horticulturist, and the installation of the roofs need more experience than is the case for extensive roofs (Fig. 3). It should be noted that due to specific features of the site, building design, budget, customer wishes and offers of materials and plants, each green roof is different and in most cases a combination of intensive and extensive systems.

Fig. 3)   Intensive green roof with high vegetation

2.1   The construction and installation of a roof

The green roof is a system designed to meet all basic requirements of roofs. The system includes different layers: the sealing layer, the layers that drain excess water, and yet retain enough water to vegetation layers that prevent the penetration of plant roots through the membrane, and layers for thermal and acoustic insulation of the building.

The main layers of green roof:

- Vegetation layer - should contain the necessary nutrients and organic compounds in plants, should also effectively absorb and drain water.
- Substrate-humus layer - mineral material is compacted free compact sets to the substrate or layer filtering.
- The filtration layer - prevents the flowing off parts of the substrate from the upper layer of vegetation.
- Drainage layer - drainage layer is used to "overcome" surface and ground water that is transported from the roof through the gutters to the sidewalks.
- Waterproofing layer of protection against weeds - waterproofing consists of a flexible and highly flexible sheets. The next layer is a protective layer against plants with high mechanical strength and chemical resistance to attack plants.
- Thermal isolation - adding the isolation layer, green roof better regulates the temperature inside the building and reduces the energy required for heating and cooling facility.
- Waterproof membrane - the membrane is placed over the surface of the roof. Its main function is water retention.
- The lower bearing structure - supporting structure must have a minimum slope of 2%. [1]

2.2   Flat and pitched roofs

After the roof structure are placed the liner layer and the slope (swelling). Depending on the room, whether it is heated, there is thermal isolation with vapor barrier, which is placed over the protection of root penetration. The main layer of green roofs are drainage panels that retain moisture in their cells, necessary for the smooth and continuous outward migration of irrigation plants. The panels are set to open on the cell surface facing "up", contrary to the roof structure. Panel is placed over the geo-textile that serves as stabile-filter (impermeable to water and moisture from the ground to drain the panel, but not the dust and other particles). Overlap of the geo-textile is 10 cm.

By placing gravel around the perimeter of the roof and around the installation of elements prevents the leaking of dust and mud during a series of gutters precipitation. It also allows for the unimpeded flow of water through the gutter channels. As with flat roofs after the first layer of roofing is the insulation which in this case does not have a large number of layers as the flat roof. With overlapping layers is essential to ensure the overlap of 10-15 cm. For pitched roofs is strictly bottom-up begins with a coating in order to ensure safe flap water runoff. With regard to the heated rooms below the roof depends on whether it is used in pitched roof insulation. Vapor barrier is required. A layer of protection of root rib is placed over the vapor barrier. Then the "drainage panels" are set, according to the manufacturer. In the case of the sloping roof panels retain much less water and need more frequent watering during the growing season (Fig. 4).
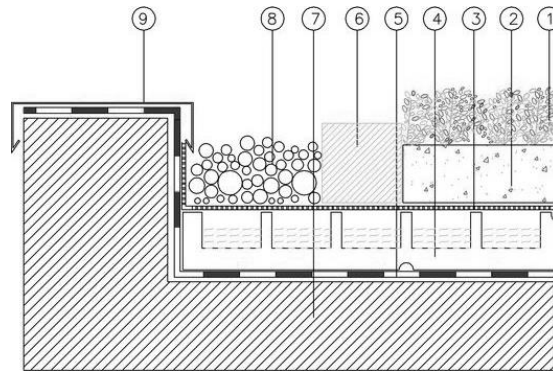
Fig. 4) Cross section of a flat green roof 1. Overgrowth, 2. The substrate (soil) 3. Stabilfilter, 4. Drainage panel, 5. A layer of protection against root, 6. Waterpermeable filter, 7. The roof structure, 8. Gravel, 9. Flashings

For pitched roofs there is a "holder" for the substrate. As the substrate would not flowing away along with the atmospheric precipitation and water which is the bay, there is a cell structure like a honeycomb in a hive of PVC. Then the mounds of earth or any suitable substrate for the area and the vegetation that is planted. The final layer, the vegetation, with pitched roofs are sets of parts that are already vegetated. Questions are in the form of rolls, which is the site unfold. In itself they have a substrate layer that allows rapid adaptation to new environments. The reason for this setup, instead of planting is the slope. Seed should swell with water and do not get the desired result. Such planting to avoid uneven distribution of vegetation. [2]

2.3   The benefits of green roofs

The benefits of a green roof can be divided into primary benefits and benefits of public importance.

The primary benefits:

- Energy conservation - during the summer vegetation green roof protects the building from the sun radiation and the evaporation process can reduce if not eliminate the heating. During the winter sunlight which creates an additional layer of vegetation reduces the amount of energy needed to heat buildings.
- Protection of roof membrane and extending its durability - green roofs protect the roof membrane of the large temperature changes, the negative impact of UV radiation damage that can cause movement of people.
- Sound insulation - green roofs, because of its structure, facility, and isolate the noise. Vegetation blocks the lower layer and the plants block higher frequencies of sound.
- Fire protection - has been shown that green roofs slow the spread of fire especially in the case when the saturated layer of vegetation.
- Additional benefits - schools can improve the curriculum construction of green roofs and the formation of the open classroom.

The benefits of public importance:

- The effect of urban heat island - decorated roof surface as an alternative to parks and other green spaces, by toning down the "urban heat island effect" through the process of evaporation of moisture and dry air.

- Water retention - green roofs are an important element in preventing local flooding.
- Reducing air pollution - Particles from the air are retained on the surface of the leaves, followed by precipitation absorbed by vegetation layer.
- Creation of habitats - green roofs can represent an alternative habitat for certain species of plants. [3]

3   THE LANDSCAPE AND KINDERGARTEN BUILDINGS

The landscape with green roof buildings remind us of how much the role of a natural biological systems in alleviating the extreme climatic conditions (Fig. 5). Governments everywhere recognize the benefits of green roofs and green roofs to realize a positive effect on the ecology of large polluted cities, and therefore more effort to provide benefits and assistance to owners of private buildings who want to put green roofs on their facilities.

Germany adds about 11 million m² of green roofs each year. In London, about 100.000 m² green roofs were installed in 2008. Shanghai, also installed a similar amount in 2008. In France, approximately 1 million m² of roofs are greened per annum. Similarly, approximately the same area was covered in 2009 in North America. [4]

Fig. 5)   Sun-house nursery designed by Christensen and Co. Architects in Denmark

The renovation process of buildings may have different ranges. This is implicated with condition of the buildings and financial support for the reconstruction. The scope of the reconstruction is conditioned with amount of available financial resources. Good financial basis may give possibilities to make a total makeover of the building including new green roof. Therefore the problem of reconstruction must be considered through priorities. [5]

The greening of roofs and walls with vegetation has taken hold in a number of kindergartens around the world. Sustainable kindergarten design incorporates the site's natural advantages and features to achieve the kindergarten's high performance goals. By embracing natural site conditions kindergarten design is environmentally responsive to the site as it enhances the building's performance. In this way children have opportunity to see directly how human activities impact ecological systems and can actively be immersed into learning about strategies to protect natural habitats. [6]

3.1   The opportunities for improving kindergarten practice in Serbia

For many years in Serbia there are great difficulties with investing in the construction of new children's preschool facilities and therefore the scope of works is at very modest scale.

However, even if the community was not at economic stagnation, and much more was built, the priority is reconstruction and adaptation existing buildings. In this context the goal is mainly their revitalisation (Fig. 6).

Fig. 6) Kindergarten „Kolibri" in Leskovac, Serbia and possibility of greening

As a part of scientific project conducted at Faculty of Civil Engineering and Architecture in Nis, in last couple of years has been surveyed a great number of kindergartens in Serbia mainly in south-eastern part of Central Serbia (Tab.1). [7]

Tab. 1) Kindergartens in Serbia and their roofs

Kindergarten	Tip of the roof	Surface of the roof (m^2)
Sunce in Kursumlija	pitched, tile	514.4
Kolibri in Leskovac	pitched, tile	538.7
Lane in Pirot	pitched, tile	315,1
Bosko Buha in Vranje	pitched, tile	457.8
Jozek inTrsrenik	pitched, tile	604,0
Nasa radost in Aleksandrovac	pitched, tile	379,7
Sunce in Cacak	pitched, tile	305.6
Nasa radosr in Krusevac	pitched, tile	388,1
Decja radost in Novi Pazar	pitched, tile	334,1
Djulici in Zajecar	pitched, tile	455,0

The reasons for that are: the preservation of existing buildings and improvement of accommodation conditions for children. The task is a complete revitalisation of building and improvement of environmental quality, as a result of improved characteristics of façade and roof layer too (Fig. 7).

Note (fig. 7): 1. The roof structure seventh drainage panels, 2. Layer for protection from root penetration, 3. Vapor barrier, 4. Insulation, 5. A layer of protection against penetration, 6. Waterproofing, 7. Drainage panels, 8. Stable filter (geo textile), 9. Substratum, 10. PVC membrane holding the substrate, 11. Overgrowth
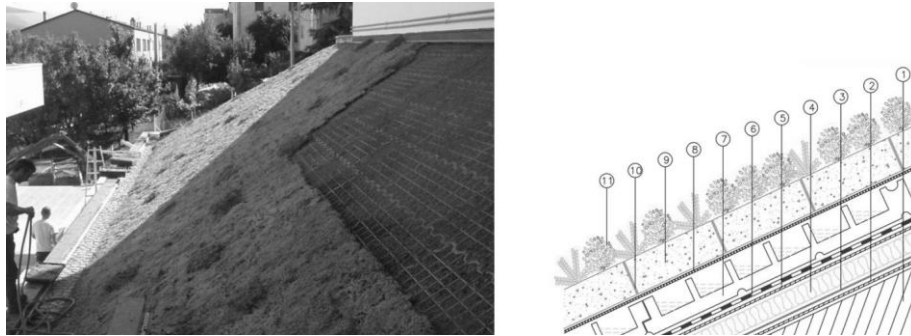
Fig. 7)   Cross section of a pitched green roof,

4   CONCLUSION

The trend to cover relatively small areas of ground with as many buildings and roads as possible for economic reasons while not providing sufficient green spaces has many adverse effects. The urban landscape can be positively transformed by turning a town's roofs and walls into green spaces, replacing the land lost to buildings and roads. Interconnected with bridges and ramps, green roofs can recreate a continuous living landscape at roof level, linked via 'green walls' with planting on the ground. The resulting green cities could become more pleasant and healthier environments for people. In the wider context, if all urban habitats are greened in this way more carbon will be captured through photosynthesis, thus compensating for some of the emissions presently created by the urbanization of the landscape. [8]

The infrastructure of green roofs have a tendency to become an important option when building both private and public buildings. In the 21 century solution to many problems that occur in urban areas as possible by placing green roofs. Living expenses suggest that green roofs cost the same or less than conventional roofs, and that their use carries with it numerous social, environmental and economic benefits. [9]

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TRACES OF HISTORICAL UTILIZATION OF LANDSCAPE FOOTHILLS OF BLANSKÝ LES

Marie Žvaková[1], Jitka Fialová[2]

Abstract

This article deals with the issue of baulks mapping. The first part focuses on a broader regional description of the Blanský les PLA and describes how people leave traces in the landscape. The next section focuses on important landscape features, particularly the baulks that were ploughed in the 1950s and 1960s. Currently, there is an effort to return the baulks in the landscape due to their erosion preventive function and landscape forming function.

Key words

Baulk, cost calculation, cultural landscape, grove, orchard.

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1   INTRODUCTION

Looking at the evolution of man and their effect on the landscape, we can see that we leave more and more significant traces on the landscape.

In the distant past, people – plant cultivators – took care of their fields. The stones they found were carried to the borders of their lands and left there. Thus baulks originated. Land borders were also often lined by paths or roads. Baulks were significant elements in the landscape. They served as a visible border of someone's land, prevented erosion, provided refuge for small animals and insects and also gave a lot of herbs. That is why in spring when the snow melted but it was still cold and damp, baulks were burnt. Old grass and herbs were burnt as they would prevent new plants from growing, nutrients were released. During the growing season baulks were scythed twice, like meadows. In the 1950s power in the territory of the Czech Republic was seized by the communist regime and agriculture collectivization or nationalization started. During this process, land owners were deprived of their possessions. The communist regime caused severe ecological damage to the Czech landscape due to the displacement of people from the areas along western and southern borders, deterioration of hundreds of buildings with inestimable value, ploughing of baulks and destruction of wayside shrines in the fields to erase people's memories. The motto of the time was: "After we plough the baulks in fields, we have to plough the baulks in people's heads and hearts" 0. However, this very same regime issued acts on protection of landscape and care of cultural monuments. The effect of these contradictory approaches was an origination of places that were neglected and places that were taken care of, devastated and also maintained places, deserted places and living places.

1.1   Objectives

The aim of the study was to continue work started in the Křemžská kotlina Landscape Revitalization Project (Generel revitalizace krajiny Křemžské kotliny) in the area of Blanský les Protected Landscape Area elaborated by DAPHNE ČR – The Institute of Applied Ecology for the purposes of the Administration of the Blanský les PLA 0, in non-forested land at the northern and eastern border in the foothills of Blanský les. Blanský les is an exceptionally well preserved landscape unit in southern Bohemia. The interest areas are located in the vicinity of small municipalities so we can expect a mutual influence of people and the landscape. Traces of human activity have been preserved here from distant past, e.g. baulks and old orchards. After discussions with the employees of the PLA Administration we focused the study on baulks. Besides, significant riparian and roadside stands were recorded in maps, as well as orchards at secluded dwellings and free standing trees. The study will serve the PLA Administration staff for their planning activities and the proposed measures aim to improve the area in question.

Based on the field data, we created a map which records baulks – both the current ones and the newly proposed ones – old orchards, arable lands, pastures and meadows. Another outcome is proposed landscape measures that are environment friendly and follow the historical utilization of the landscape.

The location of the Blanský les Protected Landscape Area can be seen in Fig. 1.
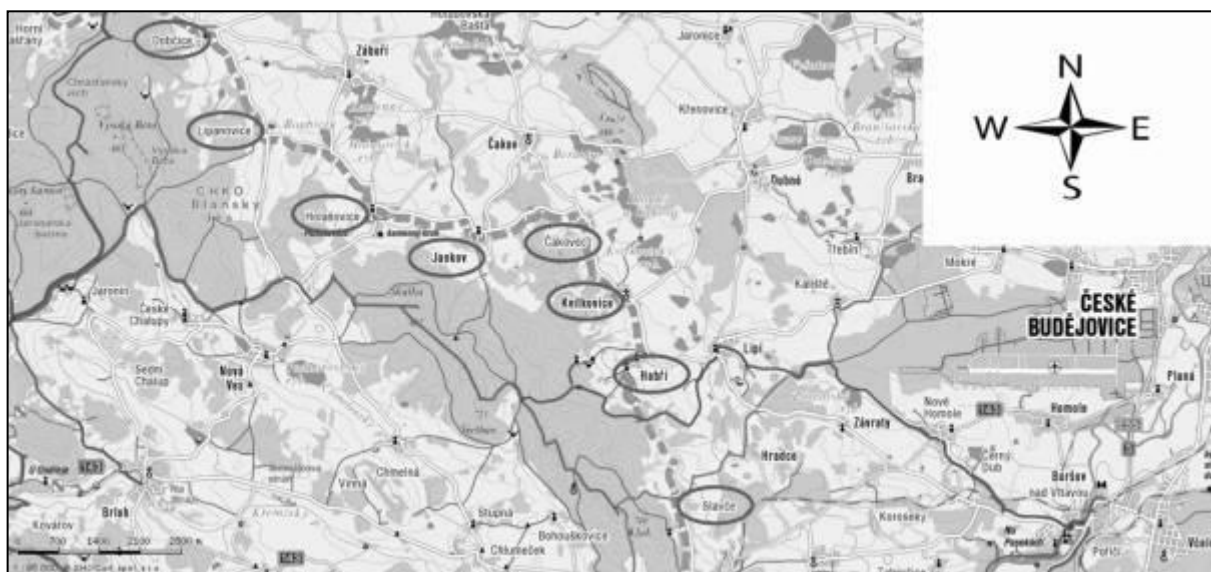
Fig. 1)   A map of the interest area (the ellipses show municipalities in whose territories mapping was conducted)

1.2   Literature review

Government Decree no. 335/2009 Coll. [3]

Landscape features, as defined by the Government Decree no. 335/2009 Coll., on types of landscape features, are nature- or man-made formations that are an inseparable part of the cultural landscape, divide it and help form its character. These are for example baulks, terraces, grassy valley lines, groups of woody plants, avenues and free standing trees.

A baulk is a continuous grass-covered linear formation that mainly serves for prevention of erosion by wind or water. It usually defines a border of a land unit or a part of the land unit, and it can include woody plants or a stone wall.

A terrace is a sloping linear formation with different terrace levels; it serves to prevent erosion by wind or water and diminishes the angle of parts of slopes. It usually delimits borders of a soil unit or its part and it can include woody plants or a stone wall.

A grassy valley line is an articulated sloping formation serving to prevent erosion by wind or water, delimiting the way of concentrated water runoff from a soil unit of arable land, or its part, it can include woody plants.

A group of woody plants is a non-linear formation consisting of at least two pieces of woody plants with maximum possible area of 2000 m2. Woody vegetation that is a part of the above-mentioned landscape features or woody vegetation performing a function of a forest in compliance with Art. 3 of Forest Act are not considered a group of woody plants in compliance with this definition.

An avenue is a linear formation consisting of at least 5 pieces of woody vegetation, usually with regularly repeating elements. Woody vegetation that is a part of the above-mentioned landscape features or woody vegetation performing a function of a forest in compliance with Art. 3 of Forest Act are not considered an avenue in compliance with this definition.

A free standing tree is a solitary woody plant with crown diameter of at least 8 m2 growing in cultural landscape outside a forest. Woody plants in baulks, terraces or grassy valley lines are not considered free standing trees.

Act no. 114/1992 Coll. [4]

The aim of this act on nature and landscape protection is to contribute to preservation and restoration of balance in the landscape, to protect the variety of life forms, nature values and beauties, to economize on natural resources and create the Natura 2000 system in the Czech Republic in compliance with the law of European Communities - in cooperation with relevant regions, municipalities, owners and land administrators. At the same time, the economic, social and cultural needs of inhabitants and regional and local circumstances need to be respected.

A notable landscape feature is defined by the act on nature and landscape protection as an ecologically, geomophologically or aesthetically valuable part of the landscape forming it typical appearance or contributing to its stability. These features can be forests, peat bogs, water currents, lakes, alluvial plains, wetlands, steppes, groups of trees, baulks, permanent grasslands, mineral and fossil deposits, artificial and natural rock formations, outcrops and exposures. A notable landscape feature can also include valuable stands in residential areas, including historical gardens and parks.

The Křemžská kotlina Landscape Revitalization Project [2]

The aim of this complex project, entrusted to and elaborated by the Institute of Applied Ecology (DAPHNE ČR) for the purposes of the Administration of the Blanský les PLA, provides several studies processing available data, information and field data with the aim to create a complex study giving information for revitalization, territorial system of ecological stability, territorial planning and land modifications. The project also proposes measures to improve or maintain the current condition of cultural, historical and aesthetical values. The last section of the project deals with hydrological properties and water regime in the cultural landscape.

PLA Blanský les Management Plan for 2008–2017 [5]

Based on the current condition and data on the development of the protected area, this expert conceptual document of nature protection proposes measures to maintain or improve the condition of the objects of protection in this area. The plan follows from the management plan valid for 1997–2006, which was extended to 2011.

Encyclopaedia of Bohemian Villages, 2nd part – South Bohemia [6]

Jan Pešta is an author of 5-part Encyclopaedia of Bohemian Villages, which captures the variety of the Bohemian country and countryside. The introduction to the second part comprehensibly describes the history of settlement and typical constructions in specific areas of South Bohemia. He defines 19 areas in this very region with characteristic type of constructions. The reader is also provided with basic identification data on selected villages as well as the description of the surroundings, landscape relations, a brief history of the village and a list of architecturally most valuable buildings and complexes. The book also includes a map of a stable cadastre from the first half of the 16th century and current photos.

Landscape in the Czech Republic [7]

People affect the landscape in various ways. At the beginning there was felling of forests with the aim to gain land for agriculture. Later, logging gained gigantic dimensions. Moreover, roads have always been built. Authors name several fields (forest development, agriculture,

landscape, grazing, roads, transport, industry, etc.) where we can find examples of human influence on the landscape in the past.

The orchards in Southern Germany

The study of Plieninger [8] explores the potential of historical maps to detect, measure and monitor changes of trees outside forests. The main goal is to assess local-level changes of scattered trees and orchards and their land-use determinants in two areas in Southern Germany between 1901/1905 and 2009. Firstly, overall landscape changes are recorded. Secondly, the spatial-temporal trajectories of scattered trees and their land-use determinants are identified. Thirdly, changes in quantity and fragmentation patterns of traditional orchards are analyzed in their relationship to overall land-cover change. The results confirm major losses in scattered trees, mainly due to urbanization, agricultural intensification, and land abandonment. They further reveal that, while orchards have persisted in total area, they have undergone critical changes toward a simplified landscape structure and loss of the traditional land-use mosaic, which is a characterizing feature of high nature value landscapes. Multi-temporal assessment showed that most trends have been continuous and did not change directions over time, but rather accelerated during periods of rapid change (most dramatically in the 1950-1990 period). The case of orchards and scattered trees illustrates a major problem of cultural landscapes in Europe: Semi-natural landscape features of high nature value are threatened by both intensification and abandonment of land uses. This makes their conservation a potentially costly enterprise, as both opportunity costs for lost alternative land uses and for conservation management costs arise.

2   METHODOLOGY

2.1   Selection of the territory and basic data

The territory was selected on the basis of the request from the Blanský les PLA Administration. The mapped territory is located in the northern and north-eastern part of the PLA in the foothills of Blanský les. The borders of the interest area where mapping was conducted follow non-forested lands of municipalities Dobčice, Lipanovice, Holašovice, Jankov, Čakovec, Kvítkovice, Habří and Slavče – all these are located in the Blanský les PLA. Through several personal visits and email communication with the Blanský les PLA Administration staff we gained various motivating information, which was then supplemented by information gained from books borrowed from Mendel University and South Bohemian University libraries. Some data was found on the Internet.

2.2   Field survey

Field work was conducted starting in autumn 2011. A map – orthophoto – was printed out of the map server [9] with 1 : 10 000 scale. This was used to record the current condition of the landscape, the utilization type of the land (e.g. pasture, arable land, permanent grassland), baulks, orchards, the need of changing the way of ploughing and proposals for new baulks.

2.3   Processing of results

The data and information collected during the field survey was used to create the map of the interest area using GIS Desktop application and maps. The created map records both the current and the proposed baulks, orchards, free standing trees, wetlands, riparian stands and roadside vegetation. The attribute tables use abbreviations for each of these elements: M (baulk), S (orchard), TTP (permanent graslland), OP (arable land), P (pasture) and MOK (wetland).

The geographical information system (GIS) is a computer system for gaining, storing, analysing and visualizing data that have a spatial relation to the Earth surface. This system enables us to create models of parts of the surface. [10]

A table with predefined parameters of each baulk was created to summarize the results: code, current condition, measure proposal type, implementation, cadastral area, affected lands, relation to the territorial system of ecological stability (TSES), relation to subsidies, limitations, alternatives, and photos with additional information.

2.4   Measure proposals and cost calculations

Based on the field survey, suitable landscape measures to improve the current condition of the territory were proposed. The study also includes calculations of average costs of establishing baulks with given dimensions.

3   RESULTS

3.1   Field survey

In total 32 current baulks were recorded and 10 new proposed. All data on baulks have been recorded in tables (see Tab.1) and in maps. For each proposed baulk there is the current condition, proposal type, implementation way, relation to the territorial system of ecological stability (TSES), limitations for land owner and possible proposal alternatives. The field survey also included the information about the current utilization of the land (arable land, pasture, permanent grassland - TTP). A new sum of baulks in the particular cadastral areas including the newly proposed ones will be 13 in the cadastral area of Lipanovice, 10 in the cadastral area of Holašovice, 4 in the cadastral area of Jankov u Českých Budějovic, one in the cadastral area of Habří u Lipí, 6 in the cadastral area of Slavče, one in the cadastral area of Kvítkovice u Lipí, and one in the cadastral area of Záboří u Českých Budějovic.

Tab. 1)   Field survey results – example of baulks

code	M – 1
current condition	existing baulk with grown trees (oak, aspen, birch, pine, blackthorn, rosehips)
proposal type	no measure necessary
implementation	
cadastral area	Lipanovice
lands	TTP – 1
relation to TSES	
relation to subsidies	
limitation	
alternatives	
photo	yes – 2x

The field survey further recorded 13 orchards located in a close vicinity of buildings (see Tab. 2). Most often these were solitary dwellingss in the cadastral areas of Habří u Lipí and Slavče. The scatteredness of human settlement connected by narrow roads and mosaics of fields, forests, meadows and lakes is typical of the South Bohemian countryside. The current condition of the fruit trees in orchards was good. They were usually apple orchards.

Tab. 2) Field survey results – orchards

code	cadastral area	type
S – 1	Lipanovice	cherry orchard
S – 2	Lipanovice	cherry orchard
S – 3	Habří u Lipí	apple orchard
S – 4	Habří u Lipí	apple orchard
S – 5	Habří u Lipí	apple orchard
S – 6	Habří u Lipí	apple orchard
S – 7	Habří u Lipí	apple orchard
S – 8	Jankov u Č. Budějovic	apple orchard
S – 9	Slavče	apple orchard
S – 10	Slavče	apple orchard
S – 11	Jankov u Č. Budějovic	plum orchard
S – 12	Jankov u Č. Budějovic	apple orchard
S - 13	Slavče	apple orchard

3.2 Creation of maps

The map and orthophotomap downloaded to ArcGIS Desktop from National Geoportal INSPIRE [11] and the TSES map downloaded from the map server of the Forest Management Institute [12] were used to record the current and the proposed baulks, orchards, wetlands, vegetation along streams and roads, arable land, pastures and permanent grasslands. In total the map shows 42 baulks, 10 out of which are newly proposed as an erosion preventive measure for arable land, and 13 orchards located at a solitary dwelling. They are marked as M – 1 up to M – 42 and S – 1 up to S – 13. (see Fig.2)

3.3 Proposal of measures

During the field survey we found two heavily waterlogged places where we recommended creating a wetland and design a biocentre. These are marked in the map as MOK – 1 and MOK – 2. It is necessary to change the way of ploughing in fields OP – 5 and OP – 7 – from ploughing perpendicular to the contour line to ploughing along the contour line. Both of these are on a slope and it is recommendable to prevent erosion of soil particles by changing the way of ploughing as well as by the proposed baulks. Also in field OP – 2, which is on a milder slope, it would be recommendable to plough along the contour line. Moreover, growing of wide-spaced vegetables at this place should be prevented. In the map these troublesome places are marked with three exclamation marks.

The interest area has a large proportion of pastures. Thanks to grazing, we can find a variety of plants (e.g. Gentiana cruciata, Veronica teucrium L.) and animals (e.g. Melitaea diamina) that are dependent on grass treading of grazing animals. Due to the big pressure on ground dairy cattle makes they are more suitable to flat terrain. Sheep are better for slopes. The areas of grasslands, meadows and baulks with weeds can be regenerated by goat grazing. [13]

Kender [14] says that baulks are proposed as a non-investment activity. It means they are established along with planting of woody plants and their optimum function will be achieved only in the years to come. It is necessary to make sure the baulks are established in the right way along contour lines so that ploughing to ridge is possible in the axis of the baulk and ploughing to furrow above the baulk. This creates an elevated platform of the baulk with a

shallow ditch. The line of the baulk needs to be sown with grass mixture to a minimum width of 5 m.

It is necessary to plant shrubs in the axis of the grassed band with individual high-stem woody plants. In the further years, the baulk starts to differentiate morphologically from the surrounding land due to the falling of organic mass from the woody plants. Baulks provide refuge, food and nesting opportunities for small organisms in the surrounding intensively used landscape. Baulks should be scythed to ensure a continuous offer of flowers for insects. The height of the vegetation should be one meter so that the baulk can serve as a game refuge after harvest. [15]

3.4 Cost calculation

The presented prices (see Tab. 3) of Nature Conservation Agency of the Czech Republic are without VAT and they include all common activities and material necessary within the given measure. In worse conditions it is necessary to add appropriate percents to the basic prices (BP): land accessibility BP + 10–20 %, steeper sloping BP + 10–30 %, divided lands BP + 5 % and waterlogged lands and peat bogs BP + 25–50 %.

Tab. 3) The mean cost of baulk establishment

Item	Quantity	Unit price	Total price in Czk
Grass sowing 5 x 100 m			350
Planting shrubs (incl. the price of seedlings)	30	120	3 600
Planting fruit trees (incl. the price of seedlings)	8	770	6 160
Digging holes for shrubs	30	45	1 350
Digging holes for fruit trees	8	230	1 840
Individual protection (including installation)	35	25	875
Tie and post 100 cm	8	75	600
Watering	280	350	630

The mean cost of a 5 x 100 m baulk established in arable land is 15,405 Czk without VAT. The cost includes planting of 8 fruit trees, 30 shrubs and grassing of the entire baulk area. The trees are planted among the shrubs individually each 10 m. Woody plants are planted in the baulk axis.

3.5 Public information about and history of baulks in the Blanský les PLA

The PLA Administration attempts to inform the public about the issue of baulks in the Educational Trail Brložsko – one of its stops contains an information board on "Baulks in the Landscape". It is located near a hill called Lepičův kopec, where baulks have been preserved in a very good condition. Another case where the PLA Administration dealt with the baulks was in the Křemžská kotlina Landscape Revitalization Project with a proposal of erosion preventive baulks. During the complex land modifications, baulks were proposed, uniquely the vanished were renewed, more often the vanished were compensated for in other places. The renewal consisted in terrain modifications and planting of trees and shrubs (territories Třísov, Chvalšiny and Chlum). Some baulks were established at the border of the National Nature Reserve Vyšenské kopce so that arable land was divided from the reserve borders. In one case, the Administration refused to sell a baulk from Nature Conservation Agency ownership to private ownership (in the territory of Brložsko) to protect it. Baulks are usually

maintained by scything or grazing. If the baulk is a part of a nature reserve or a natural monument, or specially protected species are represented there, self-seeded plants are cut out as accretion cutting.

4   DISCUSSION

Mapping and recording of baulks in the Blanský les PLA have not been conducted ever before. This study will serve the PLA Administration staff for their decision making concerning the territory and the proposed measures aim to improve the area. The issue of baulks has not been discussed in detail in any publication. Therefore, we had to consult a great number of books where only a few lines are devoted to baulks. Not even the Internet has any detailed and comprehensive information on baulks. Therefore, small parts of books and acts have been used. The assumption that a baulk is clearly visible in the landscape has been found not true. Baulk mapping depends on individual approach. A riparian stand along a stream looks like a baulk from distance. Baulks often continue forests so only after a detailed scrutiny of forestry maps we could establish whether the formation is a baulk or a part of forest. A correct determination whether a formation is a baulk or not was also facilitated by land registry compared with the current condition – where a band of stand is between fields or meadows dividing two lands, it is a baulk. Unfortunately, except for Jankov the land registry was not available. Moreover, due to the events 50 years ago many baulks disappeared from the landscape and from maps. Another problem we had to face was the correct distinction between baulks and groups of trees – a group of trees should be wider and shorter and the cadaster map should register it as a "forest". However, it is possible that some baulks developed into a group of trees.

5   CONCLUSION

The study presents the results of mapping of baulks, old orchards, vegetation along streams and roads and free standing trees. The area where mapping was conducted had been selected by the staff of the pertinent protected landscape area. It is located in non-forested territories of municipalities Dobčice, Lipanovice, Holašovice, Jankov, Čakovec, Kvítkovice, Habří and Slavče. This study, which was conducted at the instigation of Blanský les PLA Administration staff, will serve their decision making and planning activities. At the same time, the proposed measures aim to improve the area in question.

Field work was conducted in autumn 2011. In total, 42 baulks and 13 orchards were mapped in the north-eastern foothills of the Blanský les PLA. The data obtained through the field survey was used to create maps in ArcGIS Desktop. For each baulk its current condition, measure proposal and its implementation, the cadastral area, the connection to the TSES, possible financing and a photo were recorded. The possible sources of financing were listed for newly proposed baulks or baulks to be renewed. Two waterlogged places were found within the interest area and these can be used to create wetlands and local biocentres for ecological stability frame expansion. Changes in the way of ploughing were recommended for three fields – from ploughing perpendicular to the contour to ploughing along the contour line. Financial costs of baulk establishment are presented and their mean price calculated.
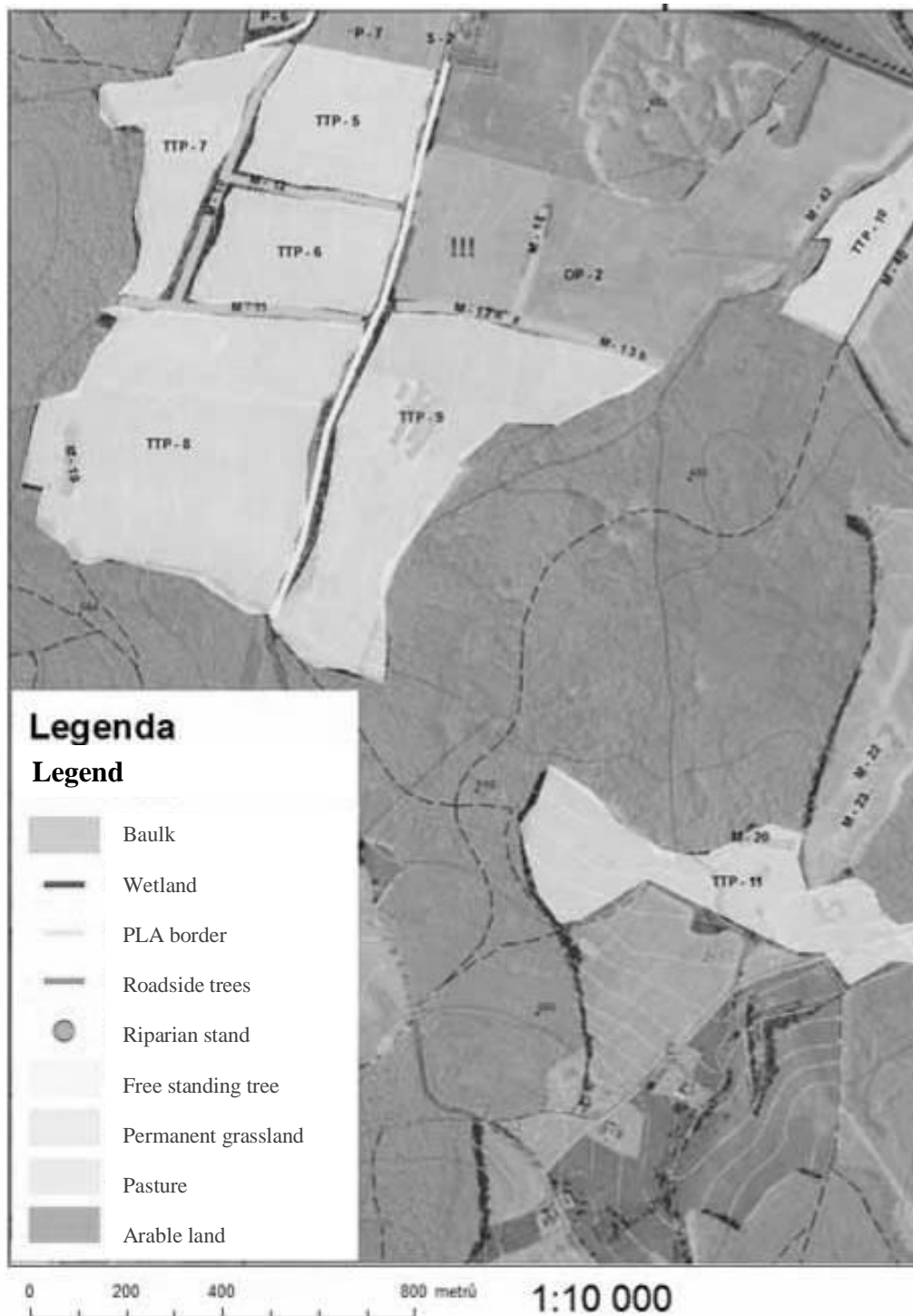
Fig. 2) An example of the map – cadastral areas of Lipanovice and Holašovice

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SECTION IV

UNIVERSITY TEACHING AND LEARNING OF CIVIL ENGINEERING

AN EVALUATION OF CIVIL ENGINEERING EDUCATION IN TURKEY FROM THE STUDENTS' POINT OF VIEW

Gülçağ Albayrak[1], İlker Özdemir[2], Uğur Albayrak[3]

Abstract

The main purpose of the study is the investigation of teaching qualities of some civil engineering departments in Turkey assessment by civil engineering students that are the main part of this teaching and offer solution proposals to improve the quality of the teaching. In this context, students' opinions about the universities they study and wish to study; development level of the faculty and the department; quality of courses and summer practices taken throughout their education and teaching programs; academic and scientific capabilities of faculty members and departments ; the city where the university is and mass transportation opportunities for going to university are investigated.

The research is a questionnaire-based study and applied on total 301 undergraduate students from 6 different civil engineering departments which are categorized as developed, developing and "newly established" according to some criteria like as the foundation date of department, number of faculty members etc. on the date of March 2011. Research data is evaluated by IBM SPSS Statistics v.20.0, that is a computer program used for survey authoring, data mining, statistical analysis, collaboration and deployment by the last edition as of the date of this study. In this study, a reliable and valid scale is created to specify the current levels of educational environment by defining of students' value criteria that are expected from higher education institutions in learning process.

Key words

Civil engineering education, problems in education, student survey.

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1   INTRODUCTION

Universities are high-level academic and research institutions that their missions are training the persons who have scientific and academicals knowledge and power of free thought and expression. Likewise the engineers who grow in these institutions expected outstanding skills. Therefore the aim of engineering education is to give modern science, and engineering knowledge to students and therewithal creativity, research techniques and methods of solving problem self. During engineering education, it is important to cultivate their ability to discover, analyze, and solve the problems to grow outstanding new engineers.

Civil engineering is the oldest engineering discipline when peoples started to give up a mobile existence, producing a need for the construction of shelter. Civil engineering is an engineering branch that aspect of life since the beginnings of human existence and has many working areas about the base of modern civilization infrastructure. Project and construction of buildings, hospitals, communication and industrial plants etc.; highways, roads, subway, railway and any transportation systems; ports, water supply and sewage systems so all structures are built by civil engineers.

The researches about providing quality in engineering education are accelerated in Turkey also whole world especially for well educated civil engineers by considering the effects on social life.

MUDEK (Association for Evaluation and Accreditation of Engineering Programs) which is a independent and private organization serving for the goal of contributing to the sweetening of quality of engineering education and teaching in Turkey. This function is done by means of the accreditation and assessment and getting information services for different engineering education programs. MUDEK is founded in 2002 and full member of ENAEE (European Network for Accreditation of Engineering Education) since 2006.

According to MUDEK, these main areas must be involved in civil engineering programs presented below:

- Mathematic including differential equations,
- Probability and statistics,
- Calculus-based physics,
- Qualification on general chemistry,
- Qualification on at least four of the agreed main areas of civil engineering,
- Experiment laboratory tests and analyze, interpret data on at least two of the agreed,
- Business-making, negotiation or quality-based selection processes in the tender procedure,
- How to interact with designers and builders to complete a project,
- Information about the issues of professional practice such as importance of adequacy and continuing education,
- Design ability in civil engineering lecture program by acquired information from design experience on vocational training [1].

Inadequacies of ordinary engineering education conditions are mentioned today in many national or international meetings. ASCE (American Society of Civil Engineering) also works on the education of civil engineering students. Knowledge and skills of future civil engineers for leadership among all engineering disciplines were argued on a conference named "The

vision for civil engineering in 2025" organized in 2006 [2]. In this conference, the main properties of future civil engineers to create a sustainable world and improve global life conditions are below:

- A master planner, builder and manager of the structural environment which is the main element of economic and social life,
- Protector of environmental and natural resources,
- Pioneer and integrator of ideas and technologies in the public, private sector and academic areas,
- Administrator of risks and uncertainties caused by natural disaster, accidents and any other threats,
- Leaders of the debates and decisions about environmental and structural policies.

2 INVESTIGATION OF CIVIL ENGINEERING EDUCATION IN TURKEY

It is argued that engineering education today is how contemporary and qualified because of rapid development in technology and continuously increment, form and dimension changes in the problems of universities [3]. In this case, near-future problems and solution suggestions in civil engineering education must be questioned with an extensive scope.

2.1 Literature

There are many studies in literature about the state of civil engineering education in Turkey. In these studies that are done in different dates; physical conditions and lecturers, laboratory and internship facilities, distribution and content of courses in civil engineering education are examined. On the other hand, problems and inadequacies in civil engineering departments compared to developed countries and employment after graduation. According to a common conclusion reached by the studies; changes in evaluation appraisals and lifestyles, incorrect approaches to education starting from primary school, perspectives of politicians to education, examinations like as a distorted race, and incompatibility of universities with the changing conditions are the major problems. For this reasons, solution of the problems given above is not only from the universities also the government point of view. The measures and changes taken from the universities will be useful for solving problems.

In 2008, according to a survey conducted by Chamber of Civil Engineers (IMO) which is a sub-organization of Union of Chambers of Turkish Engineers and Architects (TMMOB), a report is published in the name of "Reality of Civil Engineering Education in Turkey". In this report, the rate of preferring of civil engineering departments in matriculation is the between the first 3 choice is 57%, the after the first 5 choice is 27%. These ratios seems to be a good at first glance but considering matriculation in Turkey, preferring after the first 5 choice is made because of fear about non-entering any program in university so 27% of civil engineering students do not want to study in civil engineering departments actually.

2.2 Purpose and method of the study

The main purpose of the study is the investigation of teaching qualities of some civil engineering departments in Turkey assessment by civil engineering students that are the main part of this teaching and offer solution proposals to improve the quality of the teaching using value engineering principles under this as. Evaluation of civil engineering education from the students' point of view in Turkey is lacking in the literature so this investigation and study was performed in this direction. Data in the study was collected using survey with typical

five-level Likert-type scale which is the most widely used approach to scaling responses in survey research.

The format of the five-level Likert scale used in this study is given below:

1. Very Poor
2. Below Average
3. Average
4. Above Average
5. Excellent

In the survey, students' opinions about the universities they study and wish to study; development level of the faculty and the department; quality of courses and summer practices taken throughout their education and teaching programs; academic and scientific capabilities of faculty members and departments; the city where the university is and mass transportation opportunities for going to university are investigated by 20 different survey question.

Due to some restrictions such as time, cost and transport, research scope is restricted on total 301 undergraduate students from 6 different civil engineering departments which are categorized as developed, developing and newly established according to some criteria like as the foundation date of department, number of faculty members etc. Although the development level of universities can not be simply expressed in numbers; according to Saka and Yaman, development level of a university depends on number of publications in the reports prepared by The Turkey Council of Higher Education (YOK) which is responsible for the planning, coordination, governance and supervision of higher education in Turkey [4].

Inconsistent and inadequate information in the survey which was doing on the date of March, 2011 were separated and eliminated. The survey was applied on total 301 undergraduate students from 6 different civil engineering departments that 94 students from developed universities, 98 students from developing and 109 students from newly established can be shown in Table 1.

Tab. 1)   The distribution of participants by university level

University level	Number of students	Percentage (%)
Developed	94	31,2
Developing	98	32,6
Newly established	109	36,2
TOTAL	301	100,0

To interpret the survey data properly, take advantage of statistics and make an accurate analyzes. Various statistical analyse techniques are used to examine intergroup differences and relations, assumptions and interpretation of results. In this study, research data is evaluated by IBM SPSS Statistics v.20.0 that is a computer program used for survey authoring, data mining, statistical analysis, collaboration and deployment by the last edition as of the date of this study.

Furthermore reliability analysis and factor analysis were also performed regardless of the data are parametric or not. The level of statistical significance was 5% for all tests in this study,

Cronbach's alpha is a coefficient that commonly used as a measure of the internal consistency or reliability in a statistical analysis so multiple Likert questions in a survey are available that form a scale and to determine if the scale is reliable. Cronbach's alpha is a function of the number of survey data and the average inter-correlation among the data. Cronbach's alpha simply provides with an overall reliability coefficient for a set of variables, e.g. questions. If the questions reflect different underlying personal dimensions then Cronbach's alpha will not be able to discern between these. By the way Cronbach's alpha coefficient is not sufficient alone for reliability analysis of a survey. After the operations doing by IBM SPSS, Cronbach's alpha coefficient is determined 0,806 so it can be said that the survey is reliable. Contribution of each question to the survey reliability is evaluated and as a result, Question 20 reduces the Cronbach's alpha coefficient and survey reliability so this question put out from the survey.

2.3   Analysis of survey data

Today engineering education is wanted to be more effective by using quality criteria on the other hand new universities and engineering faculties established and student quota is increased in engineering departments in Turkey. Engineering education is to be considered with students and academicians so increasing in student quota have to be proportional to lecturer number. In Turkey, there are some differences between the civil engineering departments in terms of number of lecturers, laboratories, classrooms and computer facilities etc.

In this study, it is observed that educational and research activities with current academic staff are not sufficient in terms of student satisfaction. In upcountry of Turkey, there is not enough teaching staff in civil engineering departments because of many departments were founded without exhaustive planning in these regions. For this reason, first of all quality of existing civil engineering departments have to be improved instead of foundation of new engineering departments. Some measures should be taken to ensure education quality. Being faculty member should be made more attractive, some programs should be developed to train lecturers and buildings and classrooms, laboratories, library etc units have to be provided. It should not be allowed to establish new departments unless these conditions are provided. The student quota should be reduced when the budgets of civil engineering departments are increased.

Since increase of student number in civil engineering departments because of quota increment, taking the course again or student amnesty; make difficult for watching the courses and making exams. Lecturers work under difficult conditions such as low-wage, teaching at crowded classrooms, lack of time and resources etc. therefore the academicians can not enough research. Engineering knowledge develop rapidly day by day so the academicians have to renew yourself to transfer new information to the students and make scientific researches and ensure advancement in academic ranks. The survey results also showed that the students even in developed universities indicate mid-level in terms of the number of annual publications of the department. The students answer the questions as poor/ inadequate for the survey results in developing and newly established departments.

In addition to theoretical knowledge, applications of the theories in engineering are very important. Summer and interim internships which are the system of on the job training to gain experience in civil engineering contribute engineering education and engineering life. In the study, the level of internships in developed and developing universities seems to be sufficient but in newly established universities indicated as mid-level. For more efficient internship, this process has to strict rules controlled by a committee to build a uniform internship program,

monitor its effectiveness, and evaluation. In a civil engineering site, analytical abilities are not enough so the students must have both interpersonal and leadership skills.

In higher education, many new civil engineering departments founded with insufficient physical conditions so it can be easily said that "quantity rather than quality" whereas base of the engineering constituted by science and technology. Libraries equipped with national and international publications give research desires to the students and studies will always be open to innovation [5]. In this context, opinions from the students about education materials has been received so the state of education materials in developed universities is too much enough and in developing universities is very poor but in newly established universities indicated as mid-level. The number of research and text books in university libraries should be increased. Comfortable working environments in libraries should be prepared for students studies and access to information, internet, and photocopiers should be spread.

Especially in the last year of civil engineering education, using of fundamental and engineering sciences that students have should be teach to the students how to benefit from future. Otherwise students need somebody for teaching themselves about new issues meet in their professional lives [6]. According to the question which is about interpretation ability about the knowledge taught in lessons, there is a lack of this subject for 3 kinds of universities. The reason for this is existence of a system which based only give information and memorization. In order to giving interpretation ability to the students, course programs should be renewed as to advanced technology and requirements and should be dynamic and interactive.

How the students think about adequate numbers of current course in the survey. According to developed university students the course contents are up to date moderately on the other hand in developing and newly established universities the course contents are very poor in terms of updating. Civil engineering education in Turkey does not have equivalent quality between all Turkish universities and advanced countries therefore course contents should be upgraded consistently.

According to survey data, point of view of the community to the department will be negative for developing and newly established universities but for developed universities just the opposite. Students from developed universities defined their universities as "highly respected" then from developing universities as "medium respected" and from newly established universities as "slightly respected". From this evaluation can be said that people show respect to old and developed universities or may be civil engineering is not respectable job for all regions. To increase the social prestige of civil engineers, first of all the definition of civil engineering should be arranged by a knowledge-base. Civil engineers are not the persons who construct buildings only. Civil engineering departments and chambers of civil engineers have to be more effective to assure this. Civil engineering may be choosing in the first 5 preferences with realistic presentations to high school students instead of first 10 preferences [7].

Only 10 years ago, the students who want to study in civil engineering departments were chosen from among the more successful students today in Turkey and also U.S.A. These students had learning capacity and ability to get more knowledge even though using ineffective teaching methods [8]. After the 2000s, the students that prefer civil engineering have chosen among less capable students, these students may have high potential but they must make up for the deficiencies from elementary and secondary education. Today's students are accustomed to receive information for a short time; there is no patience to get the

information from books and long courses. For this reason, giving engineering education to these students using conventional methods is not efficient, but some lecturers are missing past years students and waiting for students change rather than system change instead of seeing the facts [9].

3   RESULTS

There are many problems in all levels of higher education system in Turkey and it known and have been expressed by everyone. Points of attention for the issue of civil engineering education is tried to express in this work. In this study, a reliable and valid scale is created to specify the current levels of educational environment by defining of students' value criteria that are expected from higher education institutions in learning process. The data and results obtained with a limited survey do not exactly reflect the current state of education but there are considerable similarities. In general, the following conclusions are presented after the evaluation of the survey data.

Tab. 2)   Averages of survey responses

	The Status of Preferring Department	Level of Development of the Department	Quality of Courses and Internships	Scientific Capacity of Department	City and Transportation
Developed	4.1	3.9	3.2	3.4	3.7
Developing	3.7	2.9	2.9	2.2	2.9
Newly Established	3.2	2.5	2.8	2.4	2.4

According to the survey, preference degree of civil engineering departments of the students from developed universities is 4.1 (average value) where the highest score is 5.0 and it means that "above average" according to interpretation and evaluation scale of the survey. Development level of the department or faculty for developed universities is average 3.9 that means "average". Internship and course content level of these universities is average 3.2 that means "medium". Although the students study at the country's leading higher education institutions, give 3.4 that mean "average". The students from developed universities (in 2 metropolitan cities) give 3.7 for transportation and city.

According to the participants from developing universities, preference degree of civil engineering departments is 3.7 that means roughly "above average". Development level of the department or faculty for developing universities is average 2.9 that mean "medium", similarly internship and course content level of these universities is average 2.9 that mean "medium". Scientific capacity of the department from students' point of view for developing universities is 2.2 that mean "below average", and the students give 2.9 for transportation and city that mean "average".

Preference degree of civil engineering departments of the students from newly established universities is 3.2 and it means that "average". According to the participants from newly established universities, development level of the department or faculty is 2.5 and this number is close to developing universities but very different from developed university score. Internship and course content level of these universities is average 2.8 that means approximately "medium". Scientific capacity of the department from students' point of view for newly established universities is 2.4 that mean "below average", and the students give 2.4 for transportation and city that are the small cities and its mean "below average".

4   CONCLUSION

According to the results from the questionnaires, an important part of the observed problems in civil engineering education is coming from national problems in higher education. Approaches of government to the problems in higher education are very important for a permanent solution but this approach is to be consensus with universities. Two main judgments can be presented about the civil engineering departments in Turkey. Firstly, civil engineering education performed without appropriate infrastructure, buildings and equipments except for a small number of qualified developed universities. Secondly, as a result of the first judgment, unemployment of the inadequate civil engineers is the other major problem. Expenditures from university budget for education of redundant civil engineers may be used for educating more qualified engineers.The civil engineering construction covering aspect of knowledge is very broad, this discipline is following the new knowledge, new technical, the new craft, the new material in project application, but the rapidly expand, this request civil engineering construction class talented person must have the broad aspect of knowledge and the new knowledge structure [10]. In recent years, it can be observed that engineering teaching and education spreads across the country but the quality decreases. Customers recognize that quality is an important attribute in products and services such as in engineering education quality can be defined with same arguments. All activities related to teaching should be directed to the satisfaction of students but limited facilities should be used effectively and efficiently. Highest productivity for the lowest cost is the main purpose for regeneration process of education in all countries. Education is a long, difficult and expensive process so a productive and sustainable education should be planned using the evaluation of civil engineering education in Turkey from the students' point of view.

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APPENDIX

Survey for civil engineering students	1	2	3	4	5
1) How much did you prefer your department?					
2) How is your department's level in your university in terms of being an effective department?					
3) Is it a rightfulness decision that you chose this department?					
4) Is your program's curriculum actual and adequate?					
5) How do you evaluate your department's scientific sufficiency compared with other civil engineering departments?					
6) What is your department's level in your faculty in terms of priority compared with other departments?					
7) Are there a lot of departments in your faculty?					
8) Is the number of academician of your department sufficient?					
9) Does your department attach importance to practice in the lessons and laboratories?					
10) Are there sufficient lessons that include theoretical and scientific methods?					
11) How much do you understand the topics that taught you?					
12) Is professional and institutional internship important in your university?					
13) Are the materials adequate like books, internet, and computer laboratories etc.?					
14) Does your city support your department?					
15) How is your city in terms of transportation and accommodation?					
16) Is your department's the number of publication (journal, article, project, research) sufficient in a year?					
17) How is your academicians' participation in changing programs for education and research?					
18) How is your department's participation level in evaluation and accreditation foundations like MUDEK, ADEK and ABET etc.?					
19) How is your employment opportunity after graduation?					
20) Are there a lot of deficiencies in your department?					

(Not write name, surname or comment. Only grade your opinion.)

Evaluation criteria:
(5): Excellent   **(4)**: Above average
(3): Average   **(2)**: Below average
(1): Very poor

INTERACTION BETWEEN PATHOLOGY AND TECHNOLOGY OF BUILDINGS

Naďa Antošová[1]

Abstract

Pathology of buildings is a scientific discipline in the field of building technology concerned with finding causes of undesired pathological problems, forecasting of building diseases and finding technologies for therapy, prevention and maintenance of buildings.

The existence of an interaction between pathology buildings and building technology is undeniable. Reality of high quality designs of buildings or construction sites does not preclude the formation and development of pathological conditions. The main cause is the impact of building technology, way of using and maintaining the buildings.

Key words

Building mycology, building technology, diseased buildings, pathology of buildings.

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1   INTRODUCTION

Building technology as a science discipline deals with the technology of building processes, their mechanization, labor content, choice optimization, health and safety at work, not excluding environmental protection. The theory of building process is further developed in preparation and construction-manufacturing process realization during construction site operation. In [1] the author introduce, „quality of theoretical knowledge allows to model construction processes, optimize and schedule them, as well as to comprehensively manage quality in construction processes on a theoretical but especially practical level".

Pathology is a general term to describe the unsound, abnormal, generally undesirable phenomena. Pathology as a science discipline has a similar structure, terminology and methodology. Abroad, the pathology of buildings devotes particular attention to the action of microorganisms like algae, fungi, mosses and lichens on building structures. Study and development of this scientific discipline has interdisciplinary basics. Specialists from posts of construction engineers, microbiologists, chemists etc. look for a joint action. However in this form the term scientific discipline is narrowed and therefore known as "Building mycology". Pathology deals with the construction deviation, abnormal life processes and phenomena of buildings. Furthermore, in [2] the author states „it examines and refers to the nature of the diseases causing abnormal conditions. It also investigates the structural and functional changes as well as building usage abilities resulting from the disease process. Furthermore, based on these generalized and systematically organized findings it continues to develop diagnostic methods, technologies and materials, their alternative and objectified solutions as a way of solving therapy and prevention of pathological conditions".
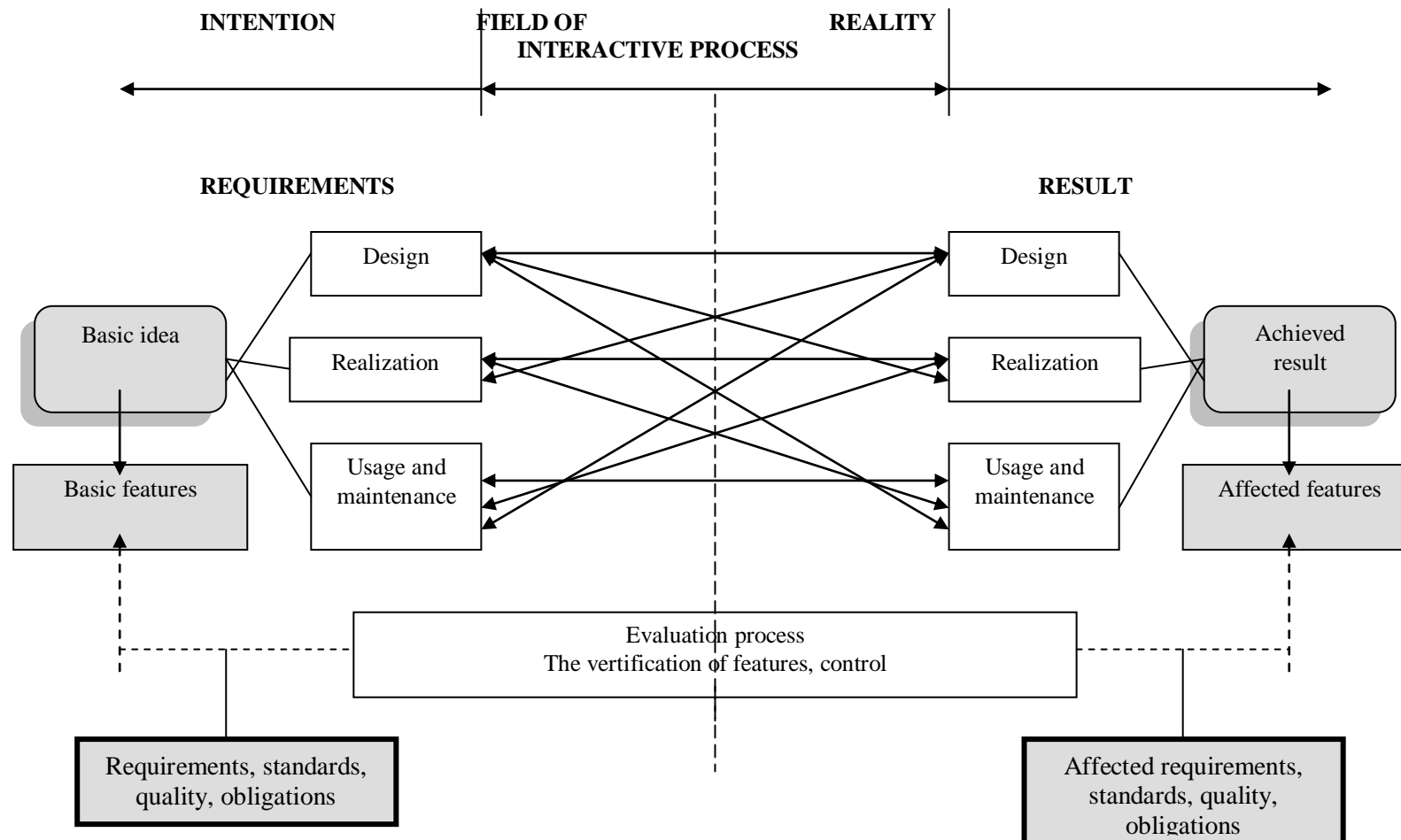
2   INTERACTION

2.1   Theoretical basis of the science discipline interaction

The existence of ties between pathology of buildings as a scientific discipline and building technology is undeniable. The interaction of any two elements creates prerequisites for relations that have particular common rules. However the interaction of pathology and building technology is specific. In most cases it is not possible to describe their interactions by approximate mathematical models, dependency or dependency features. The rules are dynamic, in constant development. In many cases it is not always possible to clearly determine the direction of ties. Dependencies are usually experimentally proven case studies, explicitly. We can certainly say that the pathological condition of structures occur even taking into account all known theoretical knowledge in the process of structural design and maximum quality control in the process of building performance. This is due to the input of number of subsystems' independent variables into the process of development, realization and the use of a structure as an integrated system.

The basic idea of technology and building pathology interaction is a building structure with predetermined and expected features. These are limited by requirements arising from legislation and standardized, quality or pre-arranged contract technical specifications.

INTENTION　　　　**FIELD OF**　　　　　　**REALITY**
　　　　　　　　　　　INTERACTIVE PROCESS

REQUIREMENTS　　　　　　　　　　　　　　　　**RESULT**

Basic idea

Design

Realization

Usage and maintenance

Design

Realization

Usage and maintenance

Achieved result

Basic features

Affected features

Evaluation process
The vertification of features, control

Requirements, standards, quality, obligations

Affected requirements, standards, quality, obligations

Fig.1)　　　　The theory of interaction between the intention and resulting technical condition of a structure

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The requirements are being transformed into the process of designing, realization, maintenance as well as the use of a structure (according to the scheme of Fig. 1). At time the actual result obtained shows other than expected parameters. It is influenced by a number of independent variables which affect and interact among each other. In many cases they are also mutually exclusive each other or intensify the effects of pathological (morbid or polymorbid) conditions and construction signs.

In practice it is impossible to determine the single factor without interaction with others. The results are influenced and distorted features of a structure. In this process the field of interactive process is seen as a period of time without a closer quantification.

Structure features are in their basic idea or even in the achieved results further distorted in time. We are talking about the action of specific environmental conditions, their unpredictable changes in expected life time, changes in the terms of use, operation of construction interventions, effects of aging or random contingencies. All the listed factors are considered as the principal means of interaction.

Water and moisture effect on the structure, in combination with micro-organisms and higher organisms is one of the most frequently occurring outcomes of the interaction of technology and pathology of buildings. Under moisture, we understand water in its full range, either being built-in in a structure or as an air moisture/humidity or vapor condensation, regardless of activity in or outdoors. But there are plenty of examples where humidity does not play an important role and it is not a carrier of interactions within the existence of organisms. Moreover it eliminates their existence.

The construction work, as the product of a number of activities in building technology is therefore a carrier of required or affected features - a pathological condition. The role of pathology of buildings is to objectify these affected and undesirable features so that they meet all the essential requirements for construction in accordance with valid legislation. Objectification is mainly understood as a determination of causes, treatment design, development of technology therapies and their modifications into the design, realization, maintenance or even the usage of a structure.

Therapy literally means the treatment or suppression of symptoms. In conjunction with building terminology, this term should be understood as a complex of technological solutions for building or structure sanitation that results in:

- remediation and mitigation of the condition,
- restoration of original features of the construction works,
- elimination of any progressive pathology conditions,
- objectification and improvement of the original functions and features of construction work,
- creation of new user qualities.

Long practical experiences, new knowledge of building technologies as well as experimental solutions are being used while applying the therapy. By observing the recovery efficiency of used technology on a structure new experiences on the effect of therapy, its service life, labor content and financial costs are obtained and verified. It also develops the hypothesis of circumstances of pathological conditions and professional activities in terms of prevention.

2.2 Verification of the interaction between technology and pathology of buildings

A recent example of the interaction between technology and pathology of buildings is a defect of the external wall with additional thermal insulation - insulation by contact system ETICS. In [3] the author introduce, „the main pathological example is plaster colonization by cyanobacterial algae in symbiosis with fungi (micromycets) in the form of spots up to continuous coating. They can be rarely seen on false ceilings, coated with slime. Green and black colors dominate. At this time no clear identification of the causes is known".

It should be noted that in the early stages of the use of a building all the essential requirements are fulfilled (set, expected, predetermined), transformed in the process of designing, realization, maintenance and use of the structure. During the use, however, despite the perfect design and realization of a construction there is a change of features due to the interaction and exclusion of various factors.

Experts in [4] [5] [6] [7] deal with multiple hypotheses. They look for the dependence of material base in combination with condensation on surfaces, showing the connection with the color range of surfaces as well as the connection with the realization defects. Highly specialized in [8] departments refer to the development of microorganisms in several areas, stating that the reason is overall change in environment (clean air, built-up areas, the restriction of pesticides in agricultural production, etc.). Observations and knowledge of related science disciplines show a lot of factors that determine or inhibit the vegetation of microorganisms on modern building materials. Many can be influenced by human activity in the process of design, realization or maintenance. Many remain unknown and beyond the control of dependence, many are mutually exclusive. The combination of several factors causes the fact that interaction becomes confusing; determination of one carrier is excluded. Interaction field as a time period for the development of the pathological condition is in [2] experimentally monitored and in this meaning it represents 4-6 years from when the structure is put into use.

Pathology of buildings, as already mentioned above, in addition to finding causes also deals with technology solutions, therapies, i.e. objectification of affected construction features. In biocorrosion of ETICS, the role of objectification of construction's characteristics is ensuring the ability to use these characteristics. Practice, managers, owners and ETICS users demand solutions. Permanent solutions which will ensure the expected durability of a structure with projected essential features of the work. However, since the causes are unknown, it is necessary to develop therapy and technology solutions towards correction and effect mitigation of the pathology condition, restoration of the original features of a structure and elimination of possible progression of pathological conditions.

In practice, the remediation technology is already experimentally proven and put in use using direct mechanical intervention in combination with chemical exposure. Direct methods of treatment technologies are the simplest feasible. However they are short-term methods and therefore they require a periodicity. The principle of technology involves the removal and eradication of micro flora on the ETICS surface. It is chemical action of microorganism cells and mechanical removal of all living matter, including organic elements, which is as a matter of fact the targeted method of cleaning. As a complementary solution it is possible to use some of the indirect methods. These are in the matters of inhibition and prevention of biocorrosion longer lasting, but in construction often not the easiest to accomplish. The indirect interventions are considered to cause a slowdown in the biological growth by modification of physical, chemical and environmental surface parameters so that it becomes

unsuitable for the development of algae. This is a modification of range and process of a regular ETICS maintenance, the elimination of high air humidity in the immediate vicinity - the supply of light and sunlight, shading reduction, removal of vegetation, volunteer weeds and moss from the surroundings etc.

From the example mentioned above, it is clear that the proposed technology treatment includes a wide range of construction processes. It also includes a method of mechanization, labor content determination, solution optimization, issues of health and safety at work, not excluding environmental protection. Generalization and organization of knowledge gained from dependency and cause findings and from proven treatment technology is therefore used for the design modification, realization and ETICS maintenance.

3   CONCLUSION

Educational process in the pathology of building is justified in engineering study programs, or lifelong learning programs, where students have sufficient theoretical knowledge and practical experience. The scientific discipline is dynamic. It follows up on constantly developing findings in terms of technology of construction processes and process configurations. It uses the latest trends and knowledge of construction physics, building structures, building materials. It also identifies buildings as material creations of a man which subject to the influence of the use, environment, aging effects as well as to random accidents. It takes into account the dynamic transition, it is difficult for self-study and continuous monitoring of changes, whether for the educator or educated.

Form of implementation and use of acquired knowledge is broad. Representation is not only in expertise activities. Generalized and systematically organized knowledge is applied mainly to the modification of building technology processes, their mechanization, labor content or choice optimization.

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TEACHING EXPERIENCE – ON-SITE LECTURES AND ON-SITE EXPERIENCE

Vjeran Mlinarić[1], Zdravko Linarić[2], Zvonko Sigmund[3]

Abstract

This paper is an overview of experiences gained through teaching two courses on the Faculty of Civil Engineering Zagreb, Croatia. These courses, "On-site lectures" and "On-site experience" are the only courses during the whole civil engineering educational program of the Faculty of Civil Engineering in Zagreb in which the students are gaining real on-site experience. "On-site lessons" course is being taught during the 6th semester of the Undergraduate study program, and the "On-site experience" course is taught during the 3rd semester of the Graduate study program for Building management students. The paper is also providing a short overview of the educational excursions which are organized for the students during their study and the courses.

Key words

Building site, On-site lectures and On-site experience, teaching experience.

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1   INTRODUCTION

In the last couple of decades the paradigm of learning/teaching has been changing from a teacher centred (teaching objectives) to a student centred (learning outcomes) approach to learning, i.e. from an input based to an output based approach. At the end of the educational process, students are expected to achieve certain competencies, defined as a combination of knowledge, skills and attitudes that will enable them to work and to professionally approach each set of problems in a professional environment [1]. New educational technology provides challenges, but at the same time potentialities to develop working practices in higher education [2].

The concept of study programs in civil engineering faculties in Croatia follows the tradition of high-quality university education of civil engineers in the region, which is also coordinated with modern European trends. The undergraduate university study program at the Faculty of Civil Engineering in Zagreb, Croatia, includes On-site lectures, and courses of On-site experience. In order to create full profile engineers capable of comprehending the on-site situation and coping with the professional real-life problems when constructing a structure, students in these courses are experiencing real construction sites. During these courses, students are educated in site planning, construction methods, building and safety codes and standards.

As an introduction to a project oriented study or a project based learning these two courses (On-site lectures and On-site experience) are a wonderful preparation for development of students' skills and competences at the undergraduate and graduate level.

2   WHAT IS PROJECT BASED LEARNING?

Project based learning is the reaction of the educational system to a need of flexible and dynamical learning. Project based learning is by the definition a systematical teaching method which is involving the student in the learning process while seeking for a problem solution oriented towards a specific project or a task. [3, 4]

For a longer period of time the educational professionals have been discussing the values of practical learning in comparison to the traditional learning. During the last few decades major developments in the learning theory, based on the researches in the medicine and psychology, have lead to the development of cognitive and behavioral learning models which are developing linkage between the students' knowledge and behavior. Learning is partially also a social activity which is developed within the margins of local, cultural and historical experience. In the project based learning the knowledge and the skills are gained by solving the problems and completing the project. The study program is created in a manner which encourages the students to evolve their knowledge needed for solving the problem. [3]

Alongside the changes in the education, the students' environment after graduation has changed drastically as well. Is clear that for the success of students, in professional life, knowledge is needed as well as the 'soft' skills. Professional life is seeking collaborative and communicative employees capable of planning on their own. [5, 6, 7]

3   ON-SITE LECTURES – PRE BOLOGNA EDUCATION

For a long time prior the transition to the Bologna school system Faculty of Civil Engineering in Zagreb had the On-site experience courses as an obligatory course for all students. The course was held during the summer time after the finished semester.

The On-site experience was held in duration of 25 working days on-site. The students were free to choose building sites on their own, otherwise the proper building site was suggested by the faculty. The visited building sites had to be large enough to provide a clear insight in to the whole building process. In order to complete the course successfully the student had to keep a journal of site visits consisting of two parts. The first part of the journal was consisting of general site plan and data including the data describing the site management organization, and materials transportation description. The second part consisted of description of the works conducted on site and the works conducted by the student personally.

4   ON-SITE EDUCATION

By the transition to the Bologna educational system the on-site education reformed alongside the transformations in the study program. The prior On-site courses were divided in two parts during the Bologna transition process. Now these two exist: On-site lectures and On-site experience. Due to the amount of students it is impossible to upkeep the same quality with the same teaching methods in both courses. Therefore the "On-site lectures" are organized using the classical teaching methods, whereas on the other hand the "On-site experience" is organized using project based teaching method aiming on best results developing students' professional and 'soft' skills.

4.1   On-site lectures

For the undergraduate students a obligatory course named "On-site lectures" was created. The course is held in the 6th semester in the formal duration of 3 hours. This course has an aim on introducing the students with the whole construction process beginning with the material production and preparation. The "On-site lectures" program consists of 7 − 8 different building sites per student group which mainly need to be placed within the public transportation range. Otherwise the transportation needs to be organized by the Faculty.

The latest "On-site lectures" program is covering working and construction sites having the emphasis on:
- Material production – stone quarry or gravel pits
- Material preparation – concrete production plant and/or reinforcement processing plant (Fig. 1)
- Construction site 1 – construction pit protection (Fig. 2 & 3)
- Construction site 2 – precast building construction site
- Construction site 3 –RC construction site (Fig. 4)
- Construction site 4 – road construction (Fig. 5)
- All construction sites – construction site organization and management

Fig. 1)   Stone quarry

Fig. 2)   **& 3)**   Construction pit protection

Fig. 4) RC construction and pit protection

Fig. 5) Precast concrete bridge construction

As this course has only a limited amount of time to bring the construction site and the construction industry closer to the students doesn't have project oriented tasks or knowledge to be gained. And for that matter in order to pass this course all students have to write a site visiting journal containing all the important construction site data. In the journal the student needs to summarize all the presented technological processes. The journal is afterwards presented and awarded with a grade.

4.2 On-site experience

The course „On-site experience" is an obligatory course, but only for students who chose the „Building organization and management" major. The course is held in the 3rd semester of the graduate student program. In this course students need to spend some time on a construction site of their choice, but which needs to be approved by the faculty staff in order to ensure the proper outcome of the class. The students are incorporated into the professional staff on-site. There they are presented with the whole building site planning process, building site organization and the construction processes. Within the construction company they are given

several tasks solving the site organization and management problems, they are enforced to conduct supervision of the works. This way the students are learning to constructively solve problems presented as well as how to interact with the workers.

The course results are evaluated by presentation of their experience focusing on the particular problems solved by the students.

5   CONCLUSION

Project based learning is the reaction of the educational system to a need of flexible and dynamical learning. A definition defines project based learning as a systematical teaching method which is involving the student in the learning process while seeking for a problem solution oriented towards a distinct project or a task.

The project based learning is differing from the classical learning methods in several aspects. The classical teaching methods had some elements of the project based learning, but often just after the classical learning methods aims have been fulfilled with the aim of presenting the previously adopted knowledge in the real life. In the project based learning the knowledge and the skills are gained by solving the exact problem.

Empirical researches have shown that project based learning is giving the best results when teaching the professional knowledge, but the classical teaching methods are superior when teaching the basic knowledge.

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APPLICATION OF MODERN METHODS OF PHOTOGRAMMETRY AND SOFTWARE PACKAGES IN TEACHING

Olivera Nikolić[1], Petar Pejić[2], Sonja Krasić[3], Vladan Nikolić[4]

Abstract

Teaching the subject of Descriptive geometry 3, at the Chair of Visual communications at the Faculty of Civil Engineering and Architecture of Nis, Serbia, was improved in 2011, by using contemporary software packages.

This paper will present the presentation and application procedures of the restitution method in education of students, using widely present software for 3D modeling - SketchUp and the program for calibration of photographs - Tgi 3D. In case of the previously existing procedures of studying the restitution and photogrammetry model, the acquired knowledge of the students remained theoretical. By way of the introduced changes, the acquired knowledge found the application in practice through modeling of real structures in the city of Nis, and in their publication on the global Google Earth service. In this way the students contribute to the improvement of tourist presentation of Niš and Serbia on the web service, and thus contribute to the development of the community. The results of the introduced changes are reflected in the increased number of students opting for this course and the number of modeled and presented structures.

Key words

Descriptive geometry, improving education, modelling, photogrammetry methods, software.

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1   INTRODUCTION

Through the curriculum of the subject Descriptive geometry 3, of the Chair of visual communications at the Faculty of Civil Engineering and Architecture of Nis, the students of the second year of Bachelor studies of architecture study the methods of restitution and photogrammetry, which are the processes inverse to the perspective image drawing. [1]

With the development of 3D presentations of structures on the Google Earth service, 3D maps of the places are created, facilitating movement and learning about various locations on the planet. The process of recovering 3Dstructure from2Dimages has been a central endeavor within computer vision, and the process of rendering such recovered structures is an emerging topic in computer graphics. [2]

The models of the structures placed on Google Earth have been designed in SketchUp software applying restitution and photogrammetry method, using a minimum of two photographs of the structure, taken from opposite angles.

The development of 3D maps was the reason for introducing the innovations in the curriculum of the Descriptive geometry 3 course, as it was concluded that by introducing the software to the teaching process and by educating the students to use it, production of a three-dimensional presentation of Nis, but also other towns in the region, taking into consideration the more than 70% of the students at the Faculty of Civil Engineering of Nis comes from other places in Serbia, could be initiated.

2   THE PREVIOUS WORKING METHOD

Through a training lasting one semester, using the traditional drawing method, the students solved three tasks with the preset layouts where the perspective drawing of the structure with one known dimension was given. Applying the restitution method, comprising firstly finding the vanishing point, horizon line, principal point and distant point, and then determination of dimensions, size and shape of the structure according to which the orthogonal projections of the structure, the layout and views are drawn, the students mastered the procedures of obtaining the dimensions and forms of the structure on the basis of the photograph or perspective drawing of the structure.

The knowledge acquired at the subject is widely applicable in architectonic practice. These methods can provide necessary data about dimensions, shape, views of the existing structures, all on the basis of the photographs of spatial structures. In this way it is possible to produce the design documentation of the building heritage structures, for which there are no plans and documents, or to restitute the contemporary structures whose data are not available. [3]

Apart from the wide application, the acquired knowledge of the students remained theoretical, as in their further work, they rarely drew in a classic way, using paper, ruler and pencil.

3   INTRODUCED INNOVATIONS IN EDUCATION

As in the contemporary architectonic practice, the 3D presentation of the structures is achieved by usage of software, thus the software is also used for restitution process.

Photogrammetry is progressively becoming the best technique to use for the metric survey of architectural objects. [4] For years, the restitution method is performed using CAD software, and the photogrammetry method using Google SketchUp.

The new curriculum was thus devised, so that the students have two hours of practice a week and thirteen weeks in a semester, to create a model of an existing structure in the city and place it on the 3D Warehouse service, from where it is transmitted to Google Earth, through the activities presented in Table 1. In the first weeks, at the beginning of the construction of models, the students get acquainted with the techniques of photographing the structure and choose the best perspective. The following two weeks, they master the ways to process the photographs in Photoshop, which comprises removal of superficial details from the environment (greenery, people, advertisements…) which in some way interfere with the display of facades. The following three weeks, the students are instructed how the Tgi3D Photoscan software operates, and which is used for calibration of chosen photographs and finding characteristic points on the structure. The following five weeks, the students model the structure in SketchUp, and paste the textures taken from the photographs of the existing structure, and bringing down the structure to the scale 1:1 according to the photograph of the fifth façade of the structure on Google Earth. The last week is intended for placing the structure on 3D Warehouse service, from which, after authorization the object is automatically set on Google Earth.

Tab. 1) New curriculum and activity

No.	Activity	Duration (week)
1.	Taking photographs of the structure in the field	2
2.	Processing the photographs in Photoshop	2
3.	Calibration of photographs in TGI software	3
4.	Production of models in SketchUp	5
5.	Lacing the structure on 3D Warehouse service	1

The model production process according to the mentioned activities will be presented on the example of modeling the temple of St. Emperor Constantine and Empress Helena.

3.1 Photogrammetry of the temple of St. Emperor Constantine and Empress Helena in Nis

In order to present an example of photogrammetry in this paper, the temple of St. Emperor Constantine and Empress Helena in Nis was chosen. As the structure is symmetrical, 3 photographs including one half of the structure were chosen (Fig 1). [5]


Fig. 1) Photographs of the temple of st. Emperor Constantine and Empress Helena in Nis

3.1.1 Calibration

Calibration of selected images was performed in the software package "Tgi3D SU PhotoScan Calibration Tool", by entering the characteristics of the camera that took them and by calibration of the common points visible in all photographs. (Fig 2a). The photographs adjusted in this manner were exported in *.skp format for the purpose of further drawing of the model.

3.1.2 Production of 3D model

SketchUp software was used for production of the 3D model on the basis of the previously calibrated photographs. By importing the file exported from the Tgi3D and by adjustment of the origin of coordinate system, the conditions for the start of modeling were created (Fig 2b).
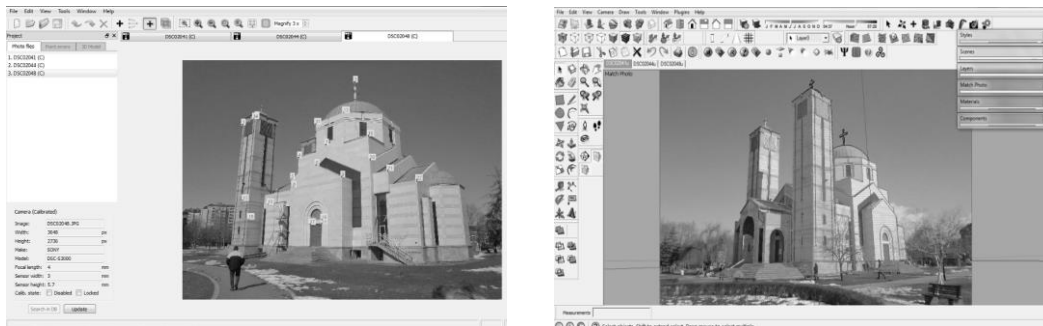
Fig. 2)   a) calibration of the photographs   b) production of three-dimensional model

A model of the Temple in an unknown scale was obtained. In order to scale the model, we needed knowledge of the distance of any two points on the structure. Finding of actual dimensions employed the web service Google Maps, with which the software package SketchUp is directly linked, and can take down a part of the terrain as a town planning map in actual size. The scaling was done in respect to the fifth façade of the structure, and it was scaled 1:1.

Apart from the actual size of the structure, by using the web service Google Maps, the precise global position and orientation of the structure were obtained. The structure positioned in this way can be, with the aid of Google Earth (Fig 3) service rendered globally accessible to everyone, and give a new, third dimension to 2D presentations of structures.
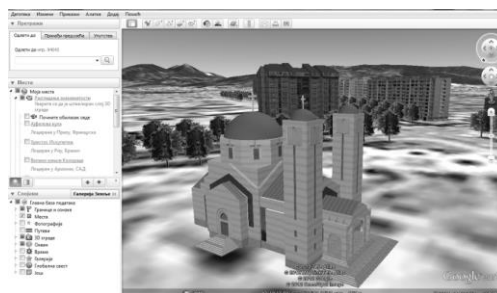
Fig. 3)   web presentation of the model

4   ACHIEVED RESULTS

At the time when the changes in teaching process were taking place, there were only several buildings in Nis on Google Earth. In the winter semester 2011/12, the test project transformation in teaching with the group of 12 students was conducted and 12 models of the existing structures chosen by the students, at various locations in the city were obtained.

At the beginning of 2012 the students who completed training, in cooperation with the employees of the Chair, applied with a project "3Dimensional presentation of Nis" for the Program for partnership and development of community, financed by the company „Philip Morris". The project relates to modeling and presentation on Google Earth, of the structures of central city Obrenoviceva street, urban entity „Sokace" and fifty historical and cultural monuments, and it will be realized by the end of April 2013. Around 200 buildings will be modeled through this project.

In the next semester, the new generation of students, 24 of them at the subject Descriptive geometry 3 and 24 of them on the course Modeling in architecture and town planning, will adopt methods of restitution and photogrammetry according to the successfully changed program.

By presenting Niš on Google Earth, the students contribute to the community and improve the tourist presentation, which is very important for the city approaching the central celebration of 1700 years since the signing of the Edict of Milan and adoption of Christianity, which will be held in Nis in 2013.

5   CONCLUSION

Computer assisted methods are more and more developed in education and new technologies are used enthusiastically by students. Different approaches as well as techniques are available: educational course information system, e-mail, electronic lecture materials in Internet or on CD/diskette, computer assisted lecturing, computer assisted exercises and distance learning. [6]

The conducted reforms in the curriculum of the subject Descriptive geometry 3 and the achieved results are a positive example of transformations which must occur in the majority of other subjects at the Faculty of Civil Engineering in Nis, and which are not the designing subjects. The knowledge acquired by the students at the Faculty, in various areas, must be practically applicable. This means that it is necessary to observe and research the needs of contemporary society, and implement the found solutions in the teaching program. It is also very important to use software and software additions which do not have wide field of application. On the chair for visual communications, this process began in 2008, and the majority of courses became very popular with the students in the meantime. The elective subjects such as Modeling in architecture and town planning, Geometrical surfaces in architecture, Descriptive geometry 3 are elected by 95% of students of architecture which proves the success of the introduced changes.

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IMPLEMENTATION OF THE EUROCODES IN TEACHING PROCESS AND DESIGN PRACTICE IN LATVIA

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Abstract

The paper presents the history and current situation of implementation of Eurocodes in Latvia. The specific challenges of using Eurocodes in the structural design industry and academic education are highlighted in the work. Based on examples of application of Eurocodes, some essential differences are analyzed that have **to** be considered by the National Technical Committee during the National Annexes development process. In close collaboration with the Ministry of Economics of the Republic of Latvia, a new Eurocodes National implementation plan has been developed for years 2013 – 2014.

Key words

Civil engineering, Eurocodes, higher education, Latvian Building Codes, structural design.

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1 INTRODUCTION

In the last few years the Latvian construction industry, manufacturing of construction products and the structural design industry are experiencing a shortage of qualified workers corresponding with the market requirements, and there is also a reduction in the number of students choosing the field of construction. This can be explained by the overall economical tendencies — reduction of demand in construction, as well as an overall reduction in the number of students caused by the decreasing population and the low birth rate in the beginning of 1990s.

In construction education and training the most significant shortage of specialists is evident in mastering the modern technologies. Introduction of contemporary practices and their development is hindered by obsolete professional qualification requirements and deficiencies in legislation, which, in contradiction with the EU policy guidelines and the practices implemented by other countries, fail to take into consideration the issues of competitiveness, work force mobility and public interests.

One of the main aspects related to the improvement of construction specialists' competitiveness and the quality of education, is a full and well-implemented transfer to the design methodology specified in Eurocodes that involves all parties connected with the construction process: state institutions, designers, manufacturers of construction products and education institutions [1].

The Eurocodes are a series of 10 European Standards, EN 1990 - EN 1999, providing a common approach for the design of buildings and other civil engineering works and construction products. Each Eurocode consists of several parts. There are 58 parts in all. They are the recommended means of giving a presumption of conformity with the essential requirements of the Construction Products Directive for construction works and products 2003/887/EEC that bear the CE Marking, as well as the preferred reference for technical specifications in public contracts. [2]. The Eurocodes are expected to contribute to the establishment and functioning of the internal market for construction products and engineering services by eliminating the disparities that hinder their free circulation within the Community. Further, they are meant to lead to more uniform levels of safety in construction in Europe [1].

The work with the Eurocode started in 1957. The first publications came in the mid 1980s. By 2006 the EN Eurocode parts were expected to be published. The Eurocodes were expected to be fully implemented and to replace all national standards by 2010 (Fig.1).

Some of the aims and benefits of the Eurocodes are: to provide common design criteria and methods; to provide a common understanding of construction products; to facilitate the exchange of construction services; to serve as a common basis for research and development; to allow the preparation of common design aids and software; to increase the competitiveness of the European civil engineering firms, contractors, designers and product manufacturers in their world-wide activities [3].

The basic standards of the Eurocodes are designed to be easily adapted to the legal framework of the member state by providing the recommended values that ensure a sufficient safety margin for structural design in all Europe. In the Eurocodes, many parameters and even some calculation methods are left in the competence of the member states. These parameters are called Nationally Determined Parameters, or NDP. When adopting a Eurocode, it must be

supplemented with a National Annex that has been developed and legally introduced in the specific member state and that includes the NDP values and other nationally applicable conditions not in contradiction with the standard.

The aim of the National Annex and the determination of NDP values is to adjust the Eurocode to the national conditions of each separate member state so as to avoid a decline of the structure safety level and a significant increase of construction costs, as well as to take into consideration the national construction traditions and local climate conditions once the structural design industry transfers from the national design regulations to the Eurocode system [1].

The draft National Annexes are prepared by a technical committee of standardization (TC), which then adopts the standard into the national system of standards. When developing the National Annexes, the Nationally Determined Parameters must be selected from the parameter range provided in the standards and in conformity with the national territorial (climatic) characteristics and construction traditions. The values, classes, symbols and the applicable methods of calculation (analytical design and testing methods) must be determined in such way as to not lower the level of structure safety and to avoid substantial increase of construction costs in comparison with the existing structural design requirements.

2 THE HISTORY OF IMPLEMENTATION OF EUROCODES IN LATVIA

In accordance with EU Commission Recommendation 2003/887/EEC of 11th December 2003 on the implementation and use of Eurocodes for construction works and structural construction products [2], in 2003 the competent authorities in Latvia started the implementation of structural design requirements corresponding with the Eurocodes. Several Cabinet Regulations were issued and a dual approach transition period was started in the design industry — a parallel application of Latvian construction standards and the Eurocodes.
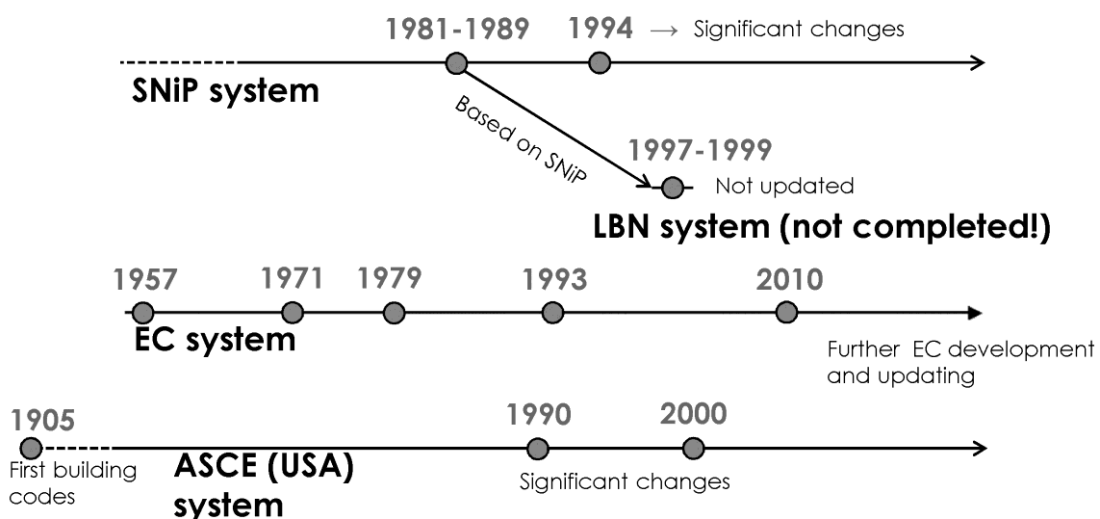

Fig. 1) Development of different building code systems

The Eurocodes' dual approach transition period will continue in Latvia until the Eurocode design standards are adopted and Cabinet Regulations determine that design works in the particular field must be carried out in compliance with only the Eurocode standards. Until then the customer of the building project and the author of the design can choose whether to

design the structures in accordance with the currently applicable Latvian construction standards (in case of metal structures — in accordance with the former Soviet SNiP system), or to apply Eurocodes.

It's necessary to note that the procedure for loads statistical analysis in Eurocodes is different from the procedure proposed in the SNiP system, which is the basis of the Latvian construction standard. Therefore, it is not permissible to use one method for determining the results of separate interim calculations if the basis is determined using the other method.

The next step in the implementation of Eurocodes was the Twinning project LV/2005-IB/EC/01 financed by the European Transition facilities funds. The Project was put into effect in June 2006 and carried out by one of the leading European applied research institutions – Deutsches Institut für Bautechnik (German Institute of Construction Technology). The project included training of Latvian experts by the leading German experts, preparation of methodological brochures and drafting of the first national annexes to the Eurocode standards. The following phase was training of the Latvian structural designers by the Latvian experts trained by the German experts. Next, practical training built on lectures prepared by the Latvian experts for Latvian structural designers took place. Detailed information about results of this project is available on the Ministry of Economics' homepage [4].

In order to ensure the adoption of the Eurocode standards in the regulatory enactment system applicable to construction, to support free movement of design services within the European Union and to improve the national construction standards system of Latvia, the Cabinet of Ministers issued a decree No. 455 "Regarding the national implementation plan of Eurocode standards for 2008-2011" of 29th July 2008, which supports the national implementation plan of Eurocode standards for 2008-2011 [5].

Due to an emergency with the state budget and lack of funding, on September 30th, 2009 the Decree of the Cabinet of Ministers No.455 was amended and some implementation activities were cancelled.

Nevertheless, in October 2010 the Eurocodes Subcommittee was established at the technical committee LVS/TC30 "Construction" of the Latvian national standardisation body. The main tasks of this Subcommittee are the drafting of National Annexes to the Eurocode standards, as well as a revision of Latvian texts of some of the previously translated Eurocode standards.

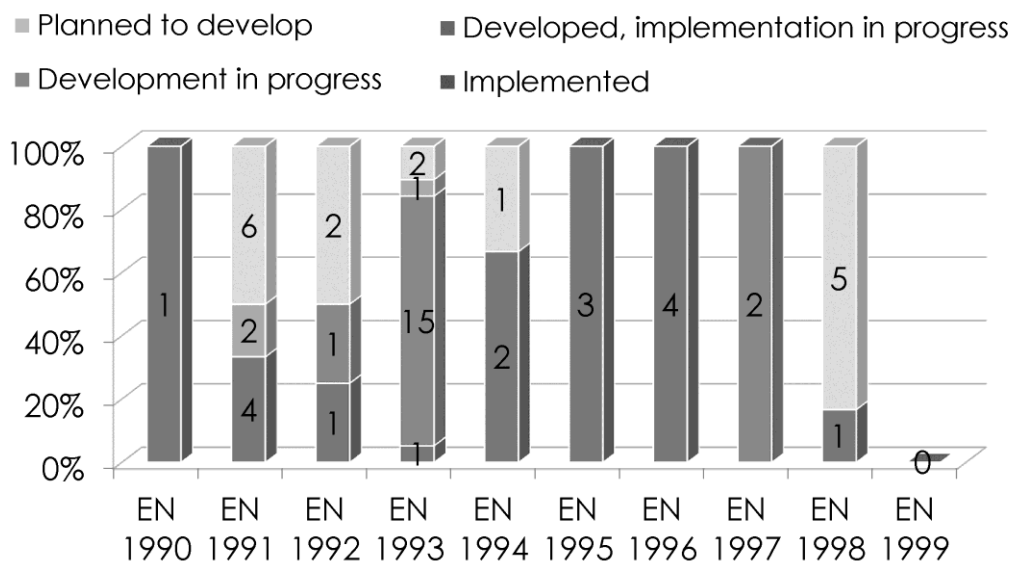## 3   CURRENT SITUATION OF EUROCODE IMPLEMENTATION IN LATVIA

At the moment, 28 of 58 Eurocodes are translated, adopted and included in the system of the Latvian national standardisation body (LVS). Within the scope of procurement contracts, 12 standards were translated in 2011 but were not registered. One translated standard not registered by LVS is being clarified in the Eurocodes Subcommittee of LVS/STK 30 "Construction". A contract has been signed for the translation of three more standards in 2012.

In addition to the primary standard documents, 47 corrections and seven amendments have been issued in the last few years and adapted in the status of a Latvian standard. Of these, four corrections and one amendment have been translated and registered in LVS, and 12 more corrections and one amendment have been translated within the scope or procurement contracts but have not been registered in LVS yet. A contract has been signed regarding the translation of three corrections in 2012.

According to the Latvian Law on Standardization, the application of standards is voluntary, and the Cabinet of Ministers can establish which Latvian national standards are mandatory. Therefore, a standard must be adopted in the status of a Latvian national standard. From the requirements of the Law on Standardization, as well as of the Latvian Constitution, the Official Language Law and the Law on Official Publications and Legal Information, it follows that when including the Eurocode standards into the regulated sphere and making their application mandatory, an obligatory requirement is translation of these standards into Latvian.

In order to provide full adoption of the Eurocodes into the system of regulatory enactments applicable in construction and to improve the national construction standardization system of Latvia by implementing the EU Commission Recommendation 2003/887/EEC on the implementation and use of Eurocodes for construction works and structural construction products [2], the Ministry of Economics in close cooperation with the Technical Committee for Standardization LVS/TC30 "Construction" has developed the new Eurocode national implementation plan for 2013-2014 [6], which provides for measures that have not been implemented during the previous Eurocode implementation period.

The plan stipulates that by the end of 2014 it is necessary to translate and register in the LVS system 17 standards, 31 standard corrections and 5 standard amendments, as well as to develop 26 National Annexes, to prepare amendments in legislation providing for design works in accordance with the Eurocode standards, and to inform the structural design specialists about the specifics of design regulated by the Eurocode standards. The current situation of development and implementation of NA in Latvia is shown in the diagram (Fig.2).

Fig. 2)   Current situation of development and implementation of NA in Latvia

The national parameters of the Eurocodes developed by LVS/TC30 in compliance with the EU Commission Recommendation 2003/887/EEC must be entered into the JCR (Joint Research Centre) data base [7]. In addition, the National Standardization Authority must set up a contact point so that all interested parties could receive information and clarification about the Eurocode standards (provision of cooperation with JRC, CEN/TC 250 and the Technical Standardization Committee of Latvia).

During the implementation of the plan it is necessary to amend or replace the existing structural design construction standards (LBN and SNiP). The Cabinet of Ministers will issue regulations about the design of steel structures, wood structures, concrete, steel and concrete composite structures, masonry structures, seismic structures, aluminium structures, and geotechnical design to be performed in compliance with the Eurocode design standards. This would not only substitute the existing structural design requirements but also expand this regulation by covering several spheres of design that were not regulated before: steel and concrete composite structures, aluminium structures and seismic structures. In the previously mentioned Cabinet regulations there will be indicated essential requirements for each structural design procedure and references to the relevant Eurocode standards and their National Annexes that in accordance with the Law on Standardization have been adopted in the status of a Latvian National Standard. These regulations, however, will not provide detailed technical solutions and calculation methods that would duplicate or contradict the content of the Eurocodes. For cases specified in the Eurocodes, the regulations will determine requirements for quality control and market surveillance.

4   SPECIFIC CHALLENGES OF USING EUROCODES IN LATVIA

CEN standards are always issued in three main languages: English, German and French. The text is usually translated from the English version, sometimes from German. In text translation and practical application there often are problems related to the polysemantic nature of the English language: one term in English can have up to ten different meanings. For this reason, the practical implementation of translations requires technical editing by a design specialist.

Since the Eurocodes are based on relatively new scientific studies resulting in the new materials and calculation methods, many new terms are coined that cannot be found in the Latvian technical dictionaries. In order to provide a translation that is closer to the original language of the Eurocodes, the Technical Committee had to expand the Latvian terminology and to start compilation of a special glossary of technical terms used in Eurocodes.

Practice shows that the texts of the Eurocode standards can be difficult to interpret both for design professionals, and for the students, because the original text utilises different traditions or technical terminology. For example, two-way slab or slab acting in two directions — (slab supported by outline, [plātne balstītā pa kontūru] in Latvian), beams with tension/compression reinforcement — (beams with simple/double reinforcement [sijas ar vienkāršo/divkāršo stiegrojumu] in Latvian). Some terms cannot be translated at all and need additional clarification or even illustrations, because the relevant structures or technologies have been rarely if ever used in the Latvian construction industry until now. Such terms include, for example, "confined masonry", "shell bedded masonry", "cavity wall", etc.

The verification procedures of the Eurocodes are based on the physical and mechanical properties of the used materials, and these properties are determined in accordance with harmonized EU testing standards. However, the majority of these standards do not correspond with the previous generation of standards, and it is not permissible to base calculations on testing data that has been obtained from still-existing LBN and SNiP standards. In addition, all these testing standards, same as Eurocodes, are available in the major European languages, therefore, to facilitate their application, they also need to be translated into the national language. The total amount of texts to be translated is much larger than the Eurocodes.

The problem with Eurocode 3 and Eurocode 9 is in consideration that there are no applicable Latvian construction standards on design of steel and aluminium structures. There are still former Soviet SNiPs applied in parallel to the relevant Eurocode standards. The new construction standards should replace the former Soviet SNiP codes.

Transition from the national LBN construction standards to the Eurocode will cause no conceptual problems in Latvia as both are based on the limit state method. The difference is in more detailed partial factors method and reference period of loads. In LBN system and in SNiP system used in the former Soviet Union the statistical reference period for snow loads is 10 years instead of 50 years in the Eurocode and for wind loads it is 5 years instead of also 50 years. Therefore, the nationally determined parameters (NDP) must be adjusted. A detailed comparison of all three codes is presented in author's earlier publication [8].

For the determination of NDP, EU member states may consider their existing design practice and design rules in order to maintain their traditional level of safety. Latvia as a member state has the advantage that the partial safety factor system for the design of structures has been already in use for many years by using SNiPs during the Soviet time. These standards were later incorporated into the LBN system. The disadvantage, however, is that the existing LBN system is not exactly fitting to the Eurocode partial factor system, which makes the adjustment of the LBN system to the new one somewhat difficult. Further in this article there are highlighted some essential differences that have to be considered in the process of adoption of Eurocodes when discussing the values of NDPs at the responsible technical committees.

Among design professionals that have started becoming acquainted with the Eurocodes or to apply them, there is some discontent due to the "recommending" nature of the Eurocodes, which is unusual for the experienced users of the mandatory LBN and SNiP standards. This "recommending" nature can be explained by the fact that, first of all, the Eurocodes are meant for all member states of the European Union, the traditions of which in some cases can be very different, therefore, the Eurocodes were agreed by way of coordination. Another reason is that, in the member states of the European Union, the final responsibility for the overall safety of the structure usually remains with the designer, even if the solutions have not been covered by Eurocode procedures. The tradition of the Soviet SNiP system is different: the designer is no longer responsible, if all requirements of the applicable standard have been observed.

Some difficulties in the introduction and application of the Eurocodes, as well as in the development of NDP, are related to the fact that Eurocodes were developed later than SNiP and LBN standards. As a result, the information to be processed by the designers is much broader and extensive than the one included in the previous standards. For several specific materials, procedures and phenomena, there are no direct analogies in the LBN and SNiP standards, for example, "shade air temperature", "shear lag", ect.

Some materials, structures and methods, on the contrary, were considered non-effective by the Eurocode designers in the initial stages of standard development, and as a result, they have not been included in the final text of the Eurocodes. For example, the Eurocodes do not provide verification procedures for such structures as rubble natural stone masonry and masonry reinforced by horizontal steel mesh. However, such structures are widely used in Latvia, and the lack of appropriate verification procedures causes significant problems during inspection and reconstruction works.

It is also worth noting that the Eurocodes mostly use more complicated structural analysis calculation models than LBN and SNiP, which causes difficulties during the studies, as they require advanced knowledge of mathematics and strength of material, for example, plates, shells and subframes instead of the simple or continuous beams widely used in LBN.

When applying the Eurocodes more extensively, it becomes evident that part of the verification procedures cannot be executed without the use of special computer software. For example, even medium-complexity buildings have such a high number of load combinations, that it is physically impossible to use manual calculations. The design rules for the joints of steel structures are also so time consuming that it is not possible to execute the calculations by hand.

In structural design, the procedures, same as terminology, are based on the traditions and experience of other countries (not Latvia), which means different approaches to the build-up of the structures. For example, rolled sections for steel structures are made according to different criteria and requirements, which in turn result in joint design principles and calculation methods that are completely different from the ones specified in the LBN standards and that are not familiar to the Latvian specialists.

Serious problems will be encountered when preparing the National Annexes to EN 1997 group of standards "Geotechnical design". Eurocode 7 standards are very general and do not contain verification methods of serviceability (e.g. settlement of foundations), which is a determining criterion for the Latvian grounds, and in numerous cases allow application of national design and testing methods. The national annexes to the above standard will be drafted in parallel with the amendments to the Latvian construction standards LBN 207-01 "Building Foundations and Grounds", LBN 214-03 "Pile Foundations and Grounds" and LBN 005-99 "Geotechnical investigation and testing" that will remain in force after implementation of the Eurocode standards. It means that the Geotechnical Eurocode (EN 1997) will be used together with the National Annex and the above LBN standards.

During the development of the National Annex, the Technical Committee for Standardization LVS/TC30 is closely cooperating with representatives of the industry and non-governmental organizations [9] by taking into account their opinion and practical experience.

In the main Latvian universities that prepare Civil Engineering specialists (Riga Technical University (RTU) and Latvia University of Agriculture (LLU)), the Eurocodes were fully incorporated into the study programmes and subjects starting from the academic year 2007/2008. When preparing the study materials, RTU professors are widely using the modern E-learning Management System system (Moodle), which allows the professors to conveniently create courses, prepare and upload tasks for the students, as well as to automatically test the students and process the results. For quality assesment purposes, an anonymous student questionnaire is organized at the end of each semester in relation to each study course and each professor. This allows quick incorporation of any necessary changes into the course programme.

The authors would like to note that the initial, deceptive assumption of Eurocode advocates in Latvia — that a transition to Eurocodes would require only a change of element verification methods and that the rest would remain the same — has not come true. This assumption was based on the idea that the basic science of structural analysis cannot change (Strength of materials and Structural mechanics) and that the materials remain the same (steel, concrete or timber). However, the changes are much deeper. The Eurocodes require different building

design methods and a deeper understanding of the behaviour of materials and structures [10]. In the last two years, the professors of structural engineering have had to change almost all visual aids used at the lectures, as well as to re-write the practical tasks.

In order to ensure more successful understanding of the Eurocodes, it is urgently necessary to expand the subject of Structural Mechanics, because the Eurocode procedures use calculation methods that are based on the laws of physics (plasticity, non-linear behaviour, second order effect), which have not received enough attention during the study process.

When analyzing the current position of the Eurocodes in the curriculum, the Committee of the study programme of the RTU Civil Engineering Faculty has recommended that in order to increase the competence of the new specialists it is necessary to increase the number of Structural Mechanics lessons in the Civil Engineering programme. This could be achieved by reducing the proportion of social subjects.

In spite of the fact that the introduction of the Eirocodes in Latvia is taking long time, some significant structures have already been designed in compliance with the Eurocodes, and these projects are currently under construction. Examples include the Latvian National Library project "Castle of Light" [11], the "Z-Towers" multifunctional high-rise building [12] and the reconstruction of Riga Motor Museum [13].

5   CONCLUSIONS

Considering the European harmonization trends, as well as the fact that for Latvia it would not be easy or even possible to maintain and update the LBN standards or to develop its own independent system of national building regulations. Therefore, Latvia has no alternative but to participate in the harmonized normative base of the European Economic Area.

In order to harmonize the construction industry, a more considerable financial and non-financial support is needed from the state institutions, not only for the translation of the standards, but also for their quicker and more intensive introduction in practice. It is necessary to support the development of clarifying methodology materials in Latvian. In Latvia there are no large structural design companies, manufacturers of structural elements, or computer software developers interested in it and ready to participate and sponsor the introduction of Eurocodes, like it was in the United Kingdom and Germany. Unfortunately, the last time book publishing in the field of structural engineering was supported by state, was during the Soviet Union period in the end of the 1980s.

The fact that the dual approach transition period has been so prolonged, negatively affects both the education process, and the students who are already graduating with knowledge of Eurocodes but are not yet saught after in the design industry, as the majority of the previous generation of specialists are using only the old LBN/SNiP system and are not familiar with the new system.

Despite the difficult economic situation in Latvia, the implementation of Eurocode standards according to the Latvian Eurocode National Implementation plan and the Recommendations 2003/887/EEC of the EU Commission from December 12th, 2003 with some delay is proceeding.

A step in the implementation of Eurocodes was the Twinning project LV/2005-IB/EC/01 financed by the European Transition facilities funds. However, this project did not fully reach

the goal due to fact that the German colleagues were not properly introduced to the design traditions existing at that time in Latvia.

The Latvian construction standards of structural design (and SNiP) are not exactly fitting to the Eurocode partial factor system, which makes the adoption of the Eurocodes somewhat difficult in the sense of determination of NDP and elaboration of National Annexes.

Considering the fact that the design approach used in the Eurocode standards is different from the structural design methodology specified in the current construction standards, as well as the interest of structural design professionals regarding the application of the Eurocode design standards, it is necessary to organize workshops for the practicing specialists in order to clarify the specifics of design as determined by the Eurocode standards. Furthermore, in order to ensure public availability of information about the requirements and specifics of design according to the Eurocode standards, it is necessary to prepare and distribute informative materials about the specific features of design regulated by the Eurocode standards.

The introduction of Eurocodes serves as an impetus for expanding and developing the Latvian technical terminology. As a result of the activities of the Technical Committee, a glossary of Eurocodes' technical terminology will be developed. It will be used in their professional activities by both structural design specialists, and university professors preparing the next generation of specialists conforming to the contemporary requirements of the Latvian and European design markets.

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DETERMINING THE CONSTRUCTION PIT SHAPE AND SIZE FOR THE WATER RESERVOIR DRAGONOŽEC – A STUDENT'S FINAL WORK

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Abstract

During the Professional Study of Civil Engineering on the Polytechnic of Zagreb, students are given knowledge in different areas. Upon completion of their studies all students have to perform one final project before they finish and that is called their final work.

This paper will show a student's final work that covers the planning of works for the Water Reservoir Dragonožec. The part where the construction pit excavation size and shape are determined will be especially reviewed.

A transformation of the building site will be shown through different phases of the pit excavation process.

This paper will also show the necessary knowledge and skills needed for the student to perform such a task, and the elements of the education process through which the students learn and acquire them.

Key words

Construction pit excavation, descriptive geometry, education process, planning of works, water reservoir.

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1   INTRODUCTION – STUDENT'S FINAL WORK

When students on the Polytechnic of Zagreb pass all of their courses they have to make one special project. This special project, also called final work, is a project that a student has to do on his own, using the knowledge acquired through his studies and with the guidance of his mentor. That project serves as proof that the student has obtained enough knowledge and skill to independently act in individual phases of the construction process.

The student's final work reviewed in this paper covers the planning of works for the Water Reservoir Dragonožec, which is situated in the village of Gornji Dragonožec about 15km south of Zagreb. The building of the water reservoir is made of reinforced concrete and is buried in the hillside at an altitude of about 245m above sea level and about 100m above the village of Gornji Dragonožec.

Students usually make their final work based on a real life problem which they have to solve. In usual circumstances a standard student's final work of this type includes:

- Information about the building, building site, construction works
- The organization of building processes
- Site organization
- Time planning (usually gantt chart and a network diagram)

Because of the specific nature of the building, which is almost entirely buried under ground, and due to the amount of the earthworks needed to be executed, the student had to especially address the problem of construction pit excavation. Since the rest of the student's final work is fairly straightforward and easily comparable to other final works of that type, this paper will try to concentrate solely on the problem of construction pit excavation.

2   CONSTRUCTION PIT EXCAVATION

Regardless of the fact that every construction pit excavation is a unique problem and has a unique solution, the process of determining the scope of the excavation always has these steps [1]:

- Building plan analysis
- Analyse additional data and information
- Determine the scope of construction pit excavation

These steps will have to be reviewed based on the specific case.

2.1   Building plan analysis

During this analysis we try to determine the overall shape of the building. Besides the ground-plan layout of the walls and concrete slabs, we also have to determine the depth of all parts of the building considered [1]. Except the ground-plan layouts it is always very useful to look at the various cross-section plans which contain data that can help us determine the depth of the building [1], [2], [3].

After the analysis of the building plans we can separate this project into these three parts:

- Access road
- The building of the water reservoir
- Drainage system which consists of various ducts and chambers

Access road has a fairly simple shape (T-shape) and the excavation for it has to be approximately 70cm below the relative zero height (the relative zero height is equal to 246,62m above sea level). The surface of the excavation pit for the access road is slightly sloped (less than 1%), but because the difference between the highest and the lowest point of the surface is not more than 5cm, we will assume that the surface is flat and horizontal, and that the height of the lowest point is the height of the whole surface. The excavation must also be wider for about 60cm on all sides because of the necessary road structure layers below the road surface.

In this case we can see that the building of the water reservoir consists of two parts, first is the part of the building which contains the entrance room and maintenance rooms (valve chamber, workshop, UPS), and the second is the part with the two water reservoir chambers. The first part has a depth of 52cm below the relative zero, and the second part is 12cm below relative zero.

The drainage system consists of ducts, chambers, pipes and canals, which are placed around the edge of the building and below the access road. The depths of those elements vary from 132cm below relative zero to 5cm above.

All of the mentioned heights are calculated based on the building itself and on the thickness of all necessary material underneath the building (bearing structure).

2.2   Analyse additional data and information

There is various additional information and data for the defining of construction pit excavation scope. The most important ones are [1], [2]:

- Type of soil
- Terrain configuration
- Size and shape of the construction site
- Existing objects – buildings, roads, trees
- New and temporary objects – buildings, roads

On this site the type of soil is mainly gravel mixed with clay in some areas, so the slope gradient will be 45 degrees measured from the horizontal plane [3].

The building site is at the top of a hill and the terrain configuration has no special features. The slope of the hill is approximately 5 degrees in all directions.

The construction site has a rectangular shape and is big enough so that the excavation slopes don't exceed the edge of the site [1], [2].

There are no existing objects on the site itself and none on the neighbouring sites. There is also no need for a temporary access road on site, because the final access road for the building will serve as a temporary access road for the whole duration of the construction.

2.3   Determine the scope of construction pit excavation

After we analysed the building plans and all of the additional data and information, we can conclude the following [1], [2]:

- The excavation is divided into three parts/phases (1 – access road, 2 – water reservoir building, 3 – drainage system) and they will be done consecutively in that order
- The surfaces of the excavation pit for all parts/phases are flat and horizontal and the depth for every part is calculated and noted
- Due to the type of soil the slope gradient for all parts/phases will be 45 degrees measured from the horizontal plane [3]
- There are no extra limitations for the excavation pit size and shape, and there is no need for a temporary access road

Based on the mentioned conclusions we can determine the excavation pit size and shape for all of the three parts/phases using constructive geometry methods [4], [5], [6].

Figure 1 shows the excavation pit size and shape for the first part/phase (access road).
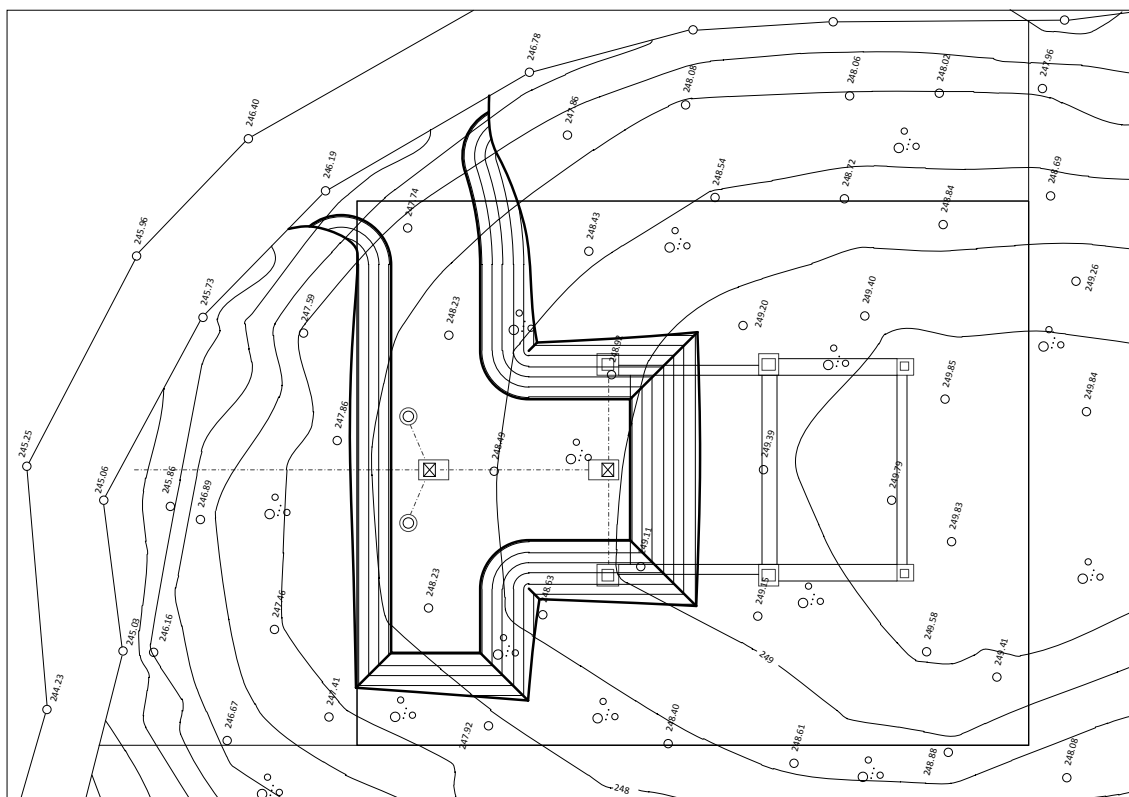
Fig. 1)   First phase/part of the excavation

Figure 2 shows the excavation pit size and shape for the second part/phase (water reservoir building). The difference in the depth of the two separate parts of the building is clearly distinct.

Fig. 2)   Second phase/part of the excavation

Fig. 3)   Third phase/part of the excavation

Figure 3 shows the final excavation pit size and shape. In that phase the smaller pits for the parts of the drainage system are excavated.

3 NECESSARY KNOWLEDGE AND SKILLS

The process of making this kind of project can be very complex, and if a student has to make it independently, he must acquire the necessary knowledge and skills needed to perform such a complex task. Those cannot be covered through one course during the study, but through a comprehensive approach and with a combination of several different courses.

This final work has included topics found in these courses:

- Construction Management
- Construction Technology
- Construction Machinery
- Planning Methods
- Organization of Construction Site
- Descriptive Geometry in Civil Engineering

The last two courses are especially important for the problem of construction pit excavation.

3.1 Organization of Construction Site

The goal of this course is that the students acquire knowledge of construction site organization as preparation for the process of building construction. The student also must learn how to plan and organize a construction site. During that process he has to make all the necessary calculations and plans, needed for the making of a construction site organizational scheme, and for the organization of the building construction [7].

During the course the students are taught how to calculate the amount of all of the necessary logistical, technical, technological, organizational and material resources needed to organize and perform the building construction. They are also taught how to assess the optimal variant of technological and logistical process organization, and to combine and connect the flow of process and resources needed [7].

On that basis the students have to make the "plan of building construction works" for a specific construction site, and to manage the preparation and organization of a construction site, and finally to manage the building construction works in accordance with all building regulations [7].

The students are also taught how to review and examine the accomplished goals, and to separate the logistical and organizational problems that occurred during the building process. Finally they try to give suggestions and solutions for those problems and in that way try to improve future projects [7].

3.2 Descriptive Geometry in Civil Engineering

Beside all of the professional courses mentioned earlier there are two fundamental courses needed to make this final work in its entirety, and those courses are Descriptive Geometry in Civil Engineering I and II.

The goal of these courses is that the students develop a capability of spatial visualization, creative thinking and to acquire knowledge of spatial problem solving through constructive methods. They learn how to show three-dimensional objects on a two-dimensional drawing and how to be capable of reconstructing objects on the basis of their projections [7].

The students are taught how to draw an object of three-dimensional space with various methods, for example Monge's projection, isometric projection and elevational projection [4], [5], [6]. The next step is to construct section curves of objects using these projection methods, and finally to use that knowledge in solving real-life problems.

One of the problems solved using these methods is that of roof surface construction based on the building edges (Figure 4) [4], [5], [6].
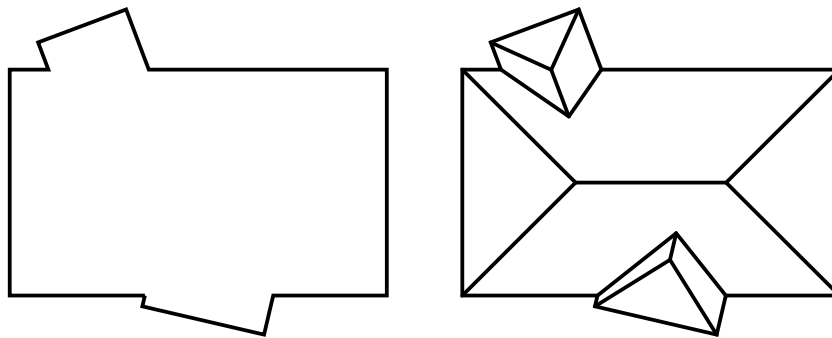
Fig. 4)   Roof surface construction

The other type of problem is when the student has to define earthworks needed to construct a road. The earthworks consist of excavations for the road cuts and drainage canals, and fills for road embankments (Figure 5) [4], [5], [6].
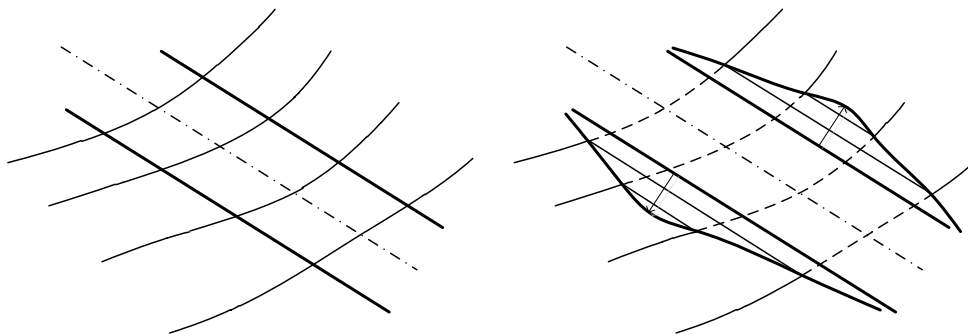
Fig. 5)   Example of a road embankment

Both mentioned problems are solved using elevational projection. Elevational projection is a projection that uses the base plan of an object with written heights of certain points which help determine the shape, size, slope, etc. of different objects [6]. This kind of projection is most similar to cartographic projections with contour lines.

Students are taught to solve these problems using traditional accessories like pen and paper but are also taught to use modern IT solutions like Autodesk AutoCAD.

4 CONCLUSION

This paper showed a student's final work that covers the planning of works for the Water Reservoir Dragonožec, especially the part in which the scope of the excavation pit was defined. Students have to acquire different knowledge throughout their studies, so that they could solve a problem like that. They acquire the necessary knowledge through fundamental courses on their first year of studies, e.g. Descriptive Geometry in Civil Engineering I and II, and later through professional courses e.g. Organization of Construction Site. It is necessary to say that the later course combines and expands various topics taught in other professional courses (e.g. Construction Management, Construction Technology, and Construction Machinery). The problem of construction pit excavation proved to be a problem easily solved when the student applies the knowledge and skills learned during his studies.

In the end we can safely say that the curriculum must always strive to connect different knowledge and to teach students to seek new ways of using them in solving real life problems in building practice.

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