International Scientific Conference *People, Buildings and Environment 2016* (PBE2016)
29 September – 1 October, 2016, Luhacovice, Czech Republic, www.fce.vutbr.cz/ekr/PBE

IMPACT OF THE SELECTED REMEDIATION METHODS ON THE LIFETIME OF ETICS

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Abstract

Information about technology for ETICS repair is unsystematic; it is narrowed down to remediation of cracks in plaster, failures in aesthetic character, or mechanical damage. The method for choosing remediation of ETICS failure is usually based on a subjective decision. The research was comprised of mapping criteria, according to where there is a choice of remediation measures and surveys of their importance. When choosing remediation, results were used from previous analysis of available technologies and a database of remediation measures. Methodology of selection based on preferred criteria was verified in the experiment, expressing the impact of remediation methods on the life of ETICS. The shortcomings-stage of the decision-making process is set out in the conclusion and the reasons for the application of multi-criteria decision model.

Key words

ETICS, repair, the lifetime of ETICS, identification of failures

To cite this paper: *Petro, M., Antošová, N., Nagy, J. (2016). Impact of the selected remediation methods on the lifetime of ETICS. In conference proceedings of People, Buildings and Environment 2016, an international scientific conference, vol. 4, Luhačovice, Czech Republic, pp. 271-278, ISSN: 1805-6784.*

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1 INTRODUCTION

The term and form of remediation for construction relates mainly with their technical condition and the actual remaining lifetime. Remedial measures should be planned so that the construction would preserve reliability with minimum costs of maintenance, repair or reconstruction. In practice, most of the technological solutions for ETICS remediation begin to plan at a time when the failures are already identified on the construction. In fact, the cost of a secondary repair solution and protection of constructions implemented before the development of any failures is a fraction of the total costs invested in the reconstruction or renovation of the work [1]. The same principle when approaching this issue also covers the construction of thermal insulation composite systems. The current view on the solution for ETICS shortcomings is narrowed to the area of identified failures, finding the causes of failures and the subsequent learning of mistakes which consists of adjusting the normative principles (adjusting the policy design, the technological rules, adjusting the principles of implementation, maintenance ...). Information about repair technologies is unsystematic, narrowed down to remediation of cracks in the final layer, solutions of shortcomings of an aesthetic character, or mechanical damage. Even if there is a proposal for repair technology of ETICS failures, the way it is selected is usually based on a subjective decision more or less by erudite owner or building manager.

2 METHODOLOGY OF WORK

The basic hypothesis of this work is the selection of appropriate remediation technologies for specific ETICS problems based on a number of factors, i.e. the criteria and conditions for implementation. The linkage exists among particular criteria and we assume they affect the result. However, they often act against each other, they are mutually exclusive, or where appropriate, cumulative. The goal of efficient design is to achieve acceptable consistency. Each of the criteria requires deeper analysis; comprehensible expression of the content with the possibility to respond on criteria met, and expresses the importance of criteria, so the degree of preference and achievement of an objective or an acceptable compliance can be determined. The entry conditions for a proposal on the use of possible remediation technologies are defined in the database of remediation intervention. The entry conditions depend on the extent of damage, the actual thermo-technological properties of the failure type, and the level of quality implementation that can be achieved.

CRITERIA ENTRY CONDITIONS

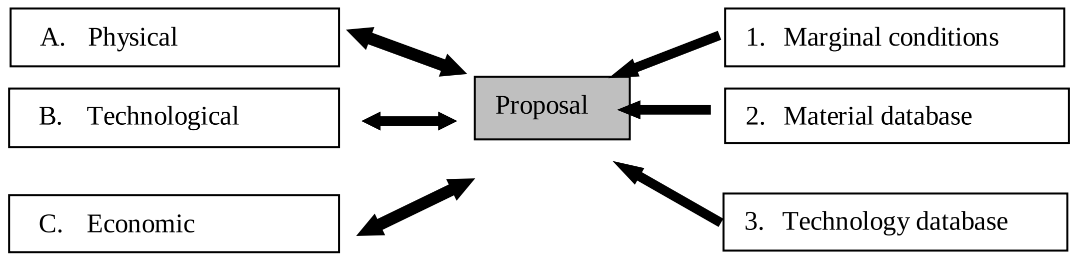

Fig. 1 Statement of the linkages between criteria and entry conditions of the selection [Author]

The entry conditions also depend on the climatic conditions during the proposed repair implementation, secure or extend the system's lifetime whilst achieving the improved thermo-technological properties. The general principle: the wider the range of conditions which will suit the proposed remediation measure, the greater the functionality that will be guaranteed. According to the figure 1, there are the linkages between criteria and entry conditions of the selection:

Excessive favouritism of one group of criteria or suppression of other groups generally results in distorted information, i.e. inappropriate, uneconomical and incorrect choice. The research work was therefore comprised of a criteria survey, according to where there is a choice of remediation measures and the importance of any given individual criteria. The decision-making process for selecting the technology repair includes a number of factors (not in order of importance):

- Price of intervention
- Labour intensiveness of repairs, remediation,
- Fulfilment of functional requirements of ETICS with the identified failure,
- Extent of the failure,
- ETICS age,
- Lifetime of remediation intervention,
- Economic efficiency and more...

In principle, each factor is the expression of the set of an ETICS' physical properties, technological conditions and restrictions which is a part of an implementation of remediation measures that stand in opposition to the economic aspect. Economic point of view can be expressed by the lifetime of carried out intervention or by extension of the ETICS' lifetime after the remediation measures [2]. In cases where a subjective decision depends on several criteria, methods of multi-criteria evaluation are most frequently used in technical sciences, which are, for example, compared by the importance of individual criteria [3].

Tab. 1 Output from the research about the preferences of criteria importance for the selection of technology remediation [2]

Name of criterion	Importance [%]
Mechanical resistance and stability of ETICS	19.44
Thermo-technical requirements	19.44
Volume change	9.72
Labour intensity of remediation intervention	8.33
Conditions of implementation	5.56
Compliance with the original construction and remediation intervention	1.39
Lifetime of technology intervention	18.06
The cost of further maintenance	2.78
Age and lifetime of ETICS	15.28

In the long term research of preferred individual criteria that were reflected by the owners or managers of buildings with ETICS construction, the importance of each criterion emerged according to the table 1 (according to specification criteria [2]).

It follows from the above that this method of selection of remediation measures prefers technical indicators of ETICS which were obtained after intervention and extend the lifetime of the building construction.

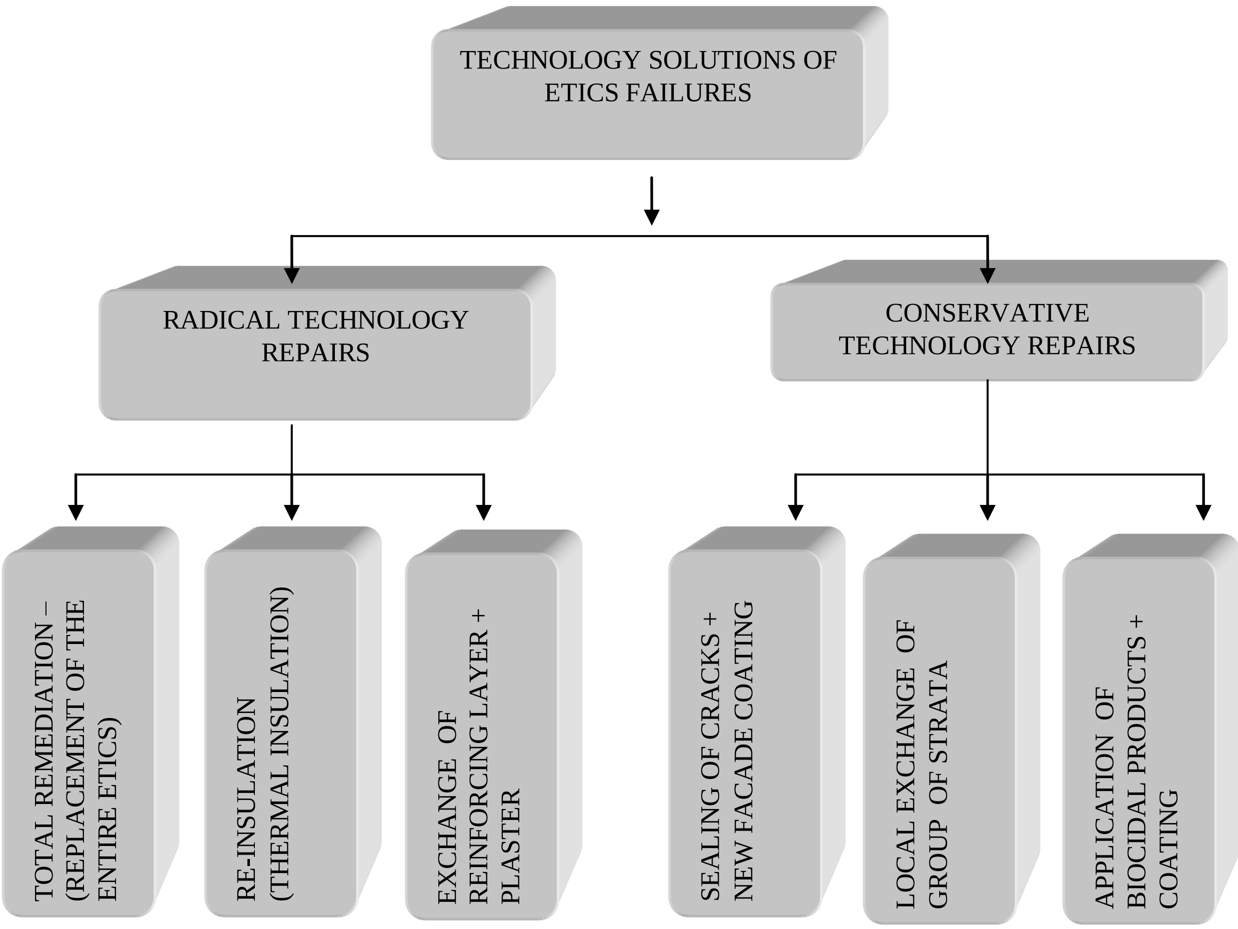

Fig. 2 Scheme for the selection of remediation measure [Author]

Analysed and summarised technologies were used in determining the impact of the technology choice on the lifetime of ETICS, suitable for solving the most frequently occurring failures by [4]. The selection was made from a repair and remediation measures database of ETICS according to [2], which can be used for several types of failures, whether in the basic alternative I (conservative), or alternative II (radical). This is depicted in the figure 2.

3 EXPERIMENT

Reflection of experiment work consisted in verification methodology that allows decision making in the planning process and operational solutions to insulation system failures. The criterion is an economic indicator which is expressed in the cost for each appropriate remediation intervention and possibility of keeping or extending the lifetime of existing insulation construction.

3.1 Input data

The selected object for the implementation of the verification of the selection methodology had constructed additional thermal insulation without further specification. It shows for comparison

with the standard requirements of the findings that the object with constructed insulation had failures in the strata according to [5], [6] to the following extent:

- Separation of final adjustment from a reinforcing layer (formation of air bubbles in 35% of the total area).
- Surface cracks in the shape of a Y.
- Continuous cracks copying the position of insulation plates.
- Pillow effect.

Probes inserted into the strata were used to determine for the specification of the materials and technologies, and they showed material used and the method of implementation was as follows:

- The base under insulation construction consists of brickwork with cavities
- Insulation material consists of polystyrene 60mm in thickness
- Anchoring of insulators with the number of anchors 2 per one square meter at an object height of nine meters
- Bonding of insulating plates on targets, when connecting the insulation surface with the base constituting less than 40% of the surface
- The absence of diagonal grids in the corners of window openings
- Locally detected insufficient anchorage length of anchors in the base
- Incorrect way of reinforcing layer implementation where the reinforcing grid was not covered with mortar on both sides

Insulation age was 20 years, whilst the basic ETICS lifetime is 30 to 35 years according to [7]. The detection range of anomalies was after detailed diagnostics of 30-50% of the total area of the facade. Functional and thermo-technical criteria of ETICS construction did not meet the present requirement for thermal insulation [6].

3.2 Decision-making process

The basic expectation of a remediation measure is a balance between the investments made and the lifetime of the intervention. Proposal of various remediation measures resulting from research and diagnosis is as follows:

I. Total remediation - reconstruction of the building construction,
II. Additional insulation construction, “re-insulation" of already existing ETICS - renovation of existing ETICS construction,
III. New reinforcing layer - the repair of ETICS construction.

Alternative technologies enter into the decision-making process, and they are considered to meet the required technical criteria for insulation and also the feasibility in the given conditions (reconstruction, restoration, and repair).

3.3 Impact of remediation methods on the lifetime of the ETICS

Any technical intervention into the building structure has its own economic dimension, which can be represented by the costs and causes prolonged by physical lifetime of the construction [8, 9]. Knowing the cost of remedial measure (No), knowledge of the initial cost of the building construction (C), residential value of the construction (H) and basic residential value of the construction (Tz) extending of lifetime can be determined (ΔT) as follows [8, 9].:

$$\Delta T = T_Z * N_O/H \qquad \text{[Year], [8]} \qquad (1)$$

The condition of the correct results of expressed residential life is a reflection on the cost of repairs at the same price level as the cost of acquisition.

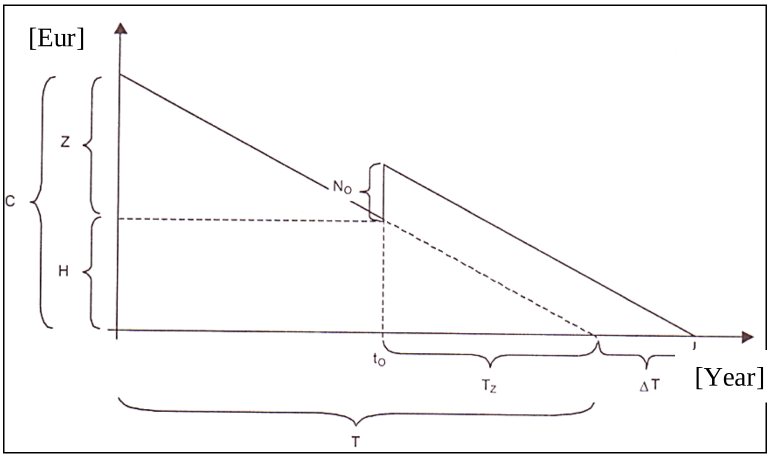

Fig. 3 Relationship of remediation interventions for extending the lifetime of the construction [8]

Relationship No. 1 [8] which is depicted in the figure 3. has been used for reflecting the impact of the selected remediation method on the lifetime of the building structure, and it shows the impact on the investments involved into the building or its construction on the overall lifetime of the building and any extension. Costs (No) in this case are an estimate of the cost of implementation of alternative remediation measures. The costs expressed the economic criteria for the selection of remediation measures to be taken into account. Basic lifetime is considered into the calculation, taking into account the actual technical condition of the lower level interval according to [8, 9], which corresponds to 30 years. It is depicted in the table 2.

Tab. 2 Economic indicators of alternatives solutions for insulation failures (Author)
**Nh – Standard hour*

Alternative technologies	Total labour content [Nh/m^2]	Price [€/1m^2] excluding VAT
I. Total remediation (reconstruction)	1.993	43.41
II. „Re-insulation“ (renovation)	1.640	37.26
III. New reinforcing layer (repair)	1.229	25.60

Itemised budget including a measures report was created in program CENKROS 4, CU 2/2016. A reflection in the impact of funds to extend the lifetime with the overall costs required for remediated surfacing of thermal insulation is processed according to [8, 9] and it is shown in the figure 4.

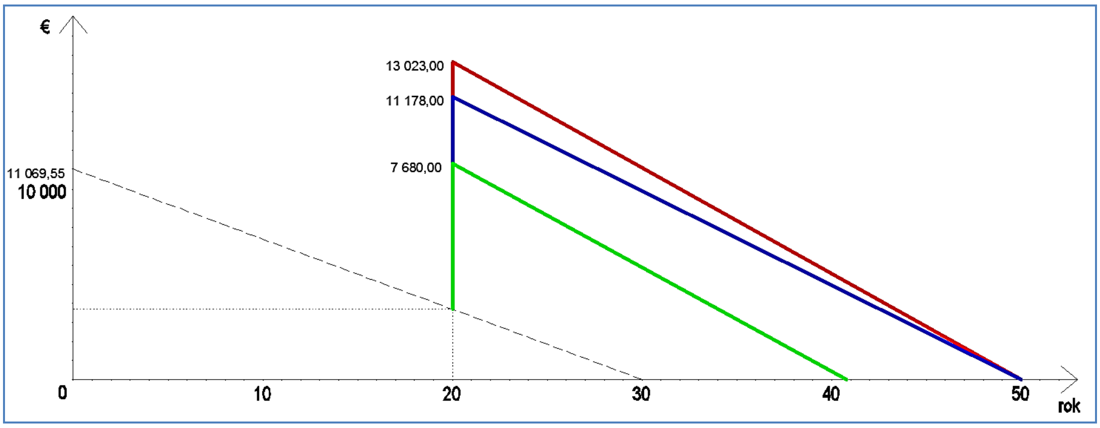

Fig. 4 Diagram of the impact of remediation method for lifetime extension of ETICS construction. Prepared by [7]. Legend: red: var. I., blue: var. II., green: var. III.

The difference of cost between alternative I and alternative II is minimal. Alternative I becomes the new construction, from which it is expected to achieve the same status as the current characteristics and requirements. However, taking into consideration the age of the building represented (50 years) and its basic lifetime (80 years), the lifetime extension of ETICS construction can be considered by taking into account the lifetime of the whole building. For this reason, lifetime extension is restricted by the end of the building's lifetime. Lifetime extension when using different technologies is depicted in the table 3.

Tab. 3 Evaluation of alternatives solutions of insulation failures in term of lifetime extension (Author)

Alternative technologies	**Lifetime of thermal insulation**	
	Estimated basic lifetime [Year]	Lifetime extension by remediation [Year]
I. Total remediation (reconstruction)	30	30
II. „Re-insulation" (renovation)	30	30
III. New reinforcing layer (repair)	30	20.5

4 CONCLUSIONS AND DISCUSSION

From the experiment we can assume that the selection process that was carried out based on majority position the preferred criteria, delivers a clear result and a simple model for selection. The first two options do not show differences when assessing the impact of selected remediation technologies on ETICS lifetime. This condition is caused by a negligible difference of funds allocated for remediation measures as well as boundary conditions, which are determined by the total remaining lifetime of the building. The last alternative with the shortest lifetime requires the lowest cost and given the overall age of the building, it is not appropriate to exclude this from selection. The first two alternatives with the final effect are getting closer to the requirements for the energy performance of buildings required by 2020. It is also necessary to point out the risks of implementation arising from the stress of existing base construction, by using new or additional anchoring. Detailed solutions of overlapping construction by roof cladding, tinsmith elements, shifting the window openings into the inside lining, and thus changing the course of isolines in these critical details, can remain problematic. Other risks arise with the lack of empirical observations and proving the lifetime of remediation measures alternatives no. II and III. The lifetime extension expressed in terms of financial cost is then at the level of theoretical assumptions.

Based on experimental observations on the impact of selected remediation measures on ETICS lifetime it is clear that the one-stage decision-making model by using preferred criteria cannot be considered as final and effective. The basic hypothesis of multi-criteria decision-making requirements was confirmed. For instance, in the decision-making process additional physical, technical and technological criteria and entry boundary conditions should be taken into account, despite the fact that the survey was evaluated as the criteria with the minimal importance.

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