BW001
TECHNOLOGY OF CONSTRUCTIONS I

7th WEEK

CONCRETE AND REINFORCED CONCRETE STRUCTURES

CONSTRUCTION TECHNIQUES

INTRODUCTION

➢ CONCRETE

- Concrete is a composite material in which a binding material mixed in water on solidification binds the inert particles of well graded fine and coarse aggregates.
- **Cement and lime are generally used as binding materials**, whereas sand cinder is used as fine aggregates and crushed stones, gravel, broken bricks, clinkers are used as coarse aggregates.

+ Concrete can handle the compression stresses 10 times more than the tension and the most of loads in our life is compression.
+ Concrete is a britile material which gives the advantage to make a rigid structure.
+ Easy to handle over specially now there is plants that give you ready mix concrete.

– Concrete is weak in handling tension.
– Because concrete is a brittle material the strength upon shear (specially at 45 degrees) must be checked.
– Needs another material to reinforce it against excessive shear and tension.

QUALITIES OF GOOD CONCRETE

- **STRENGTH**
  The concrete should be able to withstand the stresses that it is subjected to. It is quite strong in compression but weak in tension.
- **DURABILITY**
  It should be durable enough to resist the effect of weathering agents.
- **DENSITY**
  The concrete should be well compacted so that there are no voids or hollows left. It should weigh 3000 kg/m^3.
- **WATER TIGHTNESS**
  When used for construction of water retaining structures such as dams, elevated tanks and water reservoirs then this property of concrete becomes very important. Otherwise the moisture inside the RCC would corrode steel and leakage would start resulting in the ultimate failure of the structure.
- **WORKABILITY**
  It should be easily workable.
- **RESISTANCE TO WEAR AND TEAR**
  When used in floors and in the construction of roads the concrete should be able to withstand abrasive forces.

QUALITIES OF GOOD CONCRETE

- **INGRADIANTS OF CONCRETE**
  - The concrete consisting of cement, sand and coarse aggregates mixed in a suitable proportions in addition to water is called cement concrete.
  - In this type of concrete cement is used as a binding material, sand as fine aggregates and gravel, crushed stones as coarse aggregates.

- **GREEN CONCRETE & SET CONCRETE**
  - Freshly prepared concrete till it has not yet set is called *wet or green concrete.*
  - After it has thoroughly set and fully hardened it is called *set concrete* or just concrete.

TYPES OF CONCRETE

- **Concrete are classified into different types:**

1. According to binding material used in concrete.
2. According to design of concrete.
3. According to purpose of concrete.

TYPES OF CONCRETE

- **LIME CONCRETE**
  - PLACING OF LIME CONCRETE

    Placing of concrete shall be completed within three hours of adding water in case of concrete is prepared with hydraulic lime.

    Concrete should be well cured for a period of at least 10 days.

  - USES

    Lime concrete is generally used for the sake of economy in foundation works, under floors, over roof and where cement is not cheaply and easily available in required quantity.

- **LIME CONCRETE**
  - The concrete consisting of lime, fine aggregates, and coarse aggregates mixed in a suitable proportions with water is called lime concrete.
  - In this type of concrete hydraulic lime is generally used as a binding material, sand and cinder are used as fine aggregates and broken bricks, gravel can be used as coarse aggregates.

TYPES OF CONCRETE

- **REINFORCED CEMENT CONCRETE (RCC)**
  - USES

    RCC is commonly used for construction of slabs, beams, columns, foundation, precast concrete.

- **REINFORCED CEMENT CONCRETE (RCC)**
  - The cement concrete in which reinforcement is embedded for taking tensile stress is called reinforced cement concrete.
  - In this type of concrete the steel reinforcement is to be used generally in the form of round bars - 6mm to 32mm dia.
  - This concrete is equally strong in taking tensile, compressive and shear stresses.
  - Usual proportions of ingredients in a reinforced concrete are 1 part of cement : 1-2 parts of sand : 2-4 parts of crushed stones or gravel.

TYPES OF CONCRETE

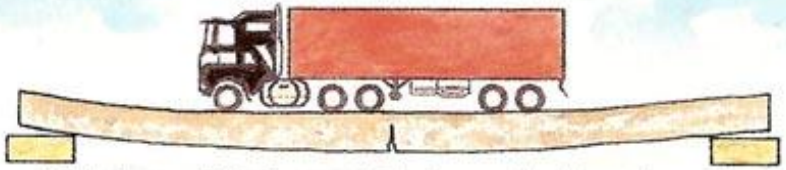
- **REINFORCED CEMENT CONCRETE (RCC)**
  - Composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and/or ductility.
  - The reinforcement is usually, though not necessarily, **steel reinforcing bars (rebar)** and is usually embedded passively in the concrete before the concrete sets.
  - Reinforcing schemes are generally designed to resist tensile stresses in particular regions of the concrete that might cause unacceptable cracking and/or structural failure.
  - Modern reinforced concrete can contain varied reinforcing materials made of steel, polymers or alternate composite material in conjunction with rebar or not.
  - Reinforced concrete may also be permanently stressed (in compression), so as to improve the behaviour of the final structure under working loads.

TYPES OF CONCRETE

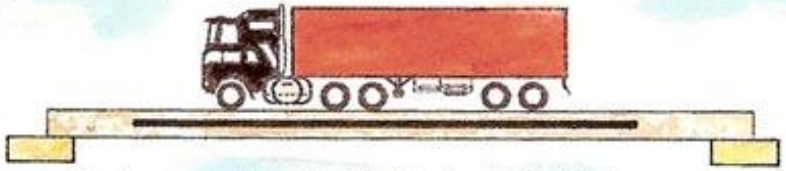
2. According to design of concrete

1

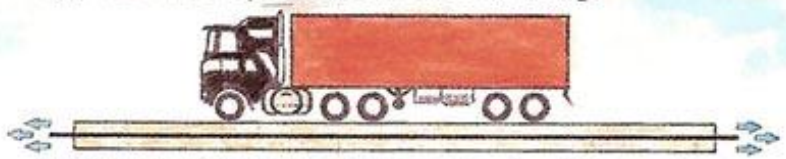
▲ A concrete beam will begin to bend when heavily loaded.



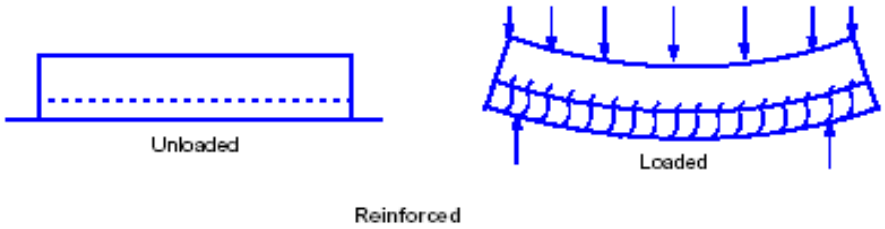
▲ The base of the beam starts to crack where the concrete is pulled apart.



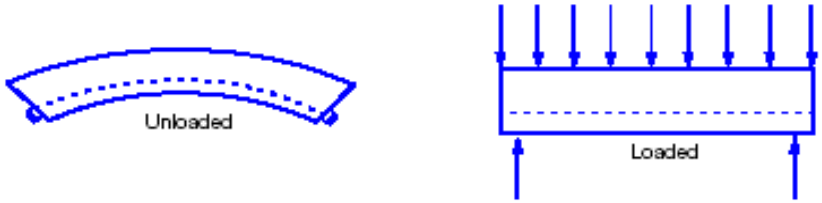
▲ Placing a steel rod inside the beam holds the concrete together and stops the beam from cracking.



▲ Stretching the rod and then releasing it to squeeze the concrete makes the beam very strong.



Reinforced

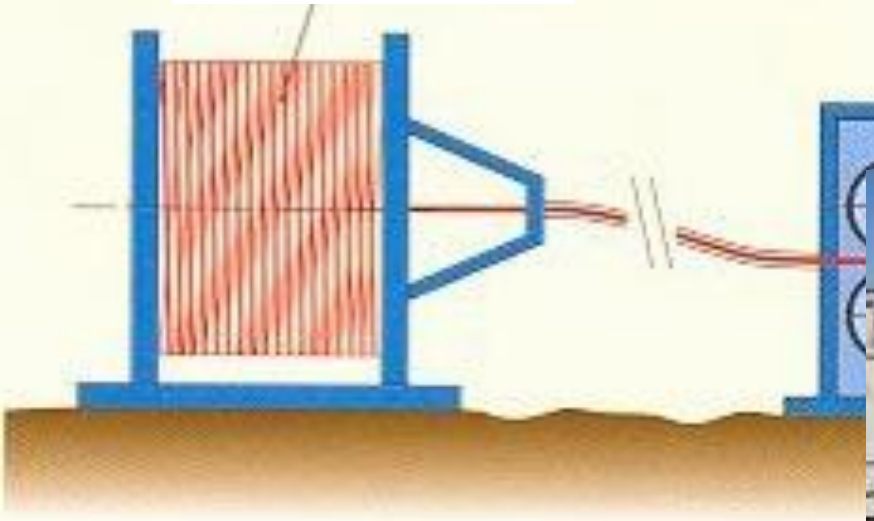


Prestressed

TYPES OF CONCRETE

- **PRE - STRESSED CEMENT CONCRETE (PCC)**

ROLL WITH CABLE



JOSTLING EQUIPMENT

PRESTRESSING CABLE

TYPES OF CONCRETE

3. **According to purpose of concrete**

According to purpose concrete is classified into following types.

- **VACUUM CONCRETE**
  - The cement concrete from which entrained air and excess water is removed after placing it, by suction with the help of vacuum pump is called vacuum concrete.
  - In this concrete the excess water which is added to increase workability but not required for the hydration of cement of concrete is removed by forming vacuum chambre.

- **AIR ENTRAINED CONCRETE**
  - The concrete prepared by mixing aluminum in it is called air entrained, cellular or aerated concrete. In this concrete bubbles of hydrogen gas are liberated which forms cell and make the concrete cellular.

  - USES

    This concrete is used for lining walls and roofs for heat and sound insulation purpose.

TYPES OF CONCRETE

3. **According to purpose of concrete**

According to purpose concrete is classified into following types.

- **LIGHT WEIGHT CONCRETE**
  - The concrete prepared by using coke breeze, cinder or slag as coarse aggregate is called light weight concrete. The concrete is light in weight and posses heat insulating properties.

  ➢ USES

  This concrete is used in making precast structural units for partition and wall lining.

TYPES OF CONCRETE

DESCRIPTION OF WORK	GRADE OF CONCRETE
Concrete in columns, beams.	1:1:2
Water retaining structures, piles, precast work or dense concrete.	1:1.5:3
RCC beams, slabs, columns.	1:2:4
Foundations for buildings, mass reinforced works.	1:3:6
For mass concrete work.	1:4:8

WATER CEMENT RATIO

- In the preparation of concrete the water cement ratio is very important.
- For normal construction the water cement ratio is usually 0.5.
- Adding to much water will reduce the strength of concrete and can cause segregation.

- For different ratio of concrete the amount of water for 50 kg of cement is:

Concrete ratio	**Water quantity**
1:3:6	34 liter
1:2:4	30 liter
1:1.5:3	27 liter
1:1:2	25 liter

SLUMP TEST

- Slump test is a test conducting before concrete to be used for casting.
- The purpose of slump test is to determine the water content in concrete and its workability.

EQUIPMENT FOR SLUMP TEST:

1. BASE PLATE.
2. TROWEL TO MIX CONCRETE.
3. STEEL TAMPING ROD.
4. SLUMP CONE.
5. RULER.

VALUES:

- Mass concrete work 2.5 to 5 cm
- Ordinary beams and slabs 5 to 10 cm
- Columns and retaining walls 7.5 to 12.5 cm

STEP 1

STEP 2

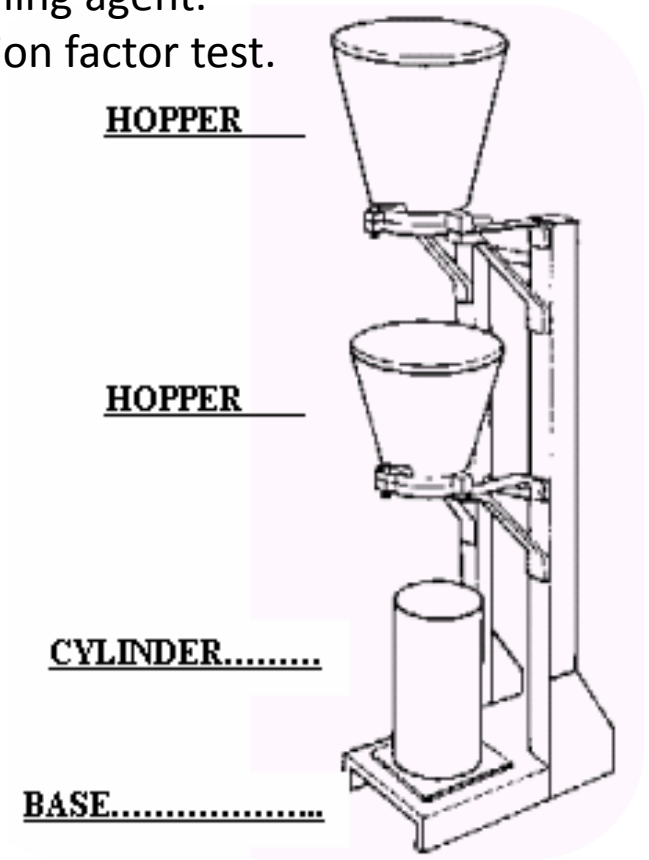
STEP 3

STEP 4

WORKABILITY OF CONCRETE

- It is the amount of work required to place concrete and to compact it throughly.
- Workability of concrete increases with the addition of water but it reduces the strength that's why it is not a desirable way of increasing the workability.
- Use of aggregates which are round and have smooth surfaces increases the workability.
- Workability could also be improved by adding air entraining agent.
- Workability of concrete is better determine by compaction factor test.

- **COMPACTION FACTOR TEST**
  - Cement concrete to be tested is placed in the hopper ***A*** and its bottom released. The concrete falling in hopper ***B*** achieves some compaction.
  - The bottom of hopper ***B*** is now released so that concrete now falls in cylinder ***C.*** surplus concrete is removed from the top of cylinder. Concrete in the cylinder is now weighed. Let this weight be W_1.
  - After cleaning the cylinder it is refilled with concrete in layers of 5cm each. Every layer of concrete is thoroughly compacted with an iron rod. Concrete in the cylinder is weighted again. Let this weight be W_2 .
  - The ratio of the two weights is known as compaction factor. Compaction Factor= W_1/W_2
  - A compaction factor of 0.85 represents a mix of poor workability, 0.92 represents medium and 0.95 represents good workability.



COMPACTION OF CONCRETE

- Compaction of concrete is very important in developing qualities like strength, durability, imperviousness by making the concrete dense and free from voids.
- In case of RCC compaction is done by pinning with an iron rod or even with trowel blade.
- Excess temping should be avoided as otherwise water, cement and finer particles would come to the surface and results in non uniform concreting.
- In case of important and big works, compaction of concrete is done with vibrator.
- Use of vibrator is best and the most efficient way of compacting concrete. It gives very dense concrete.
- Care should be taken not to make excessive use of vibrators otherwise the concrete becomes non homogeneous.

CURING OF CONCRETE

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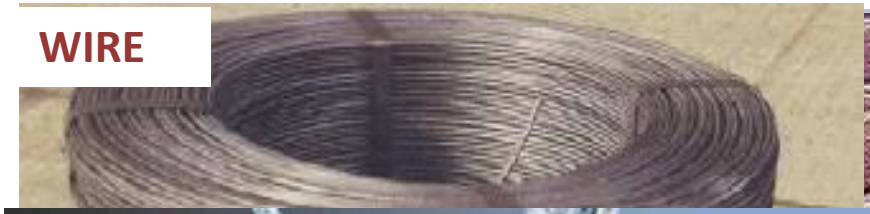
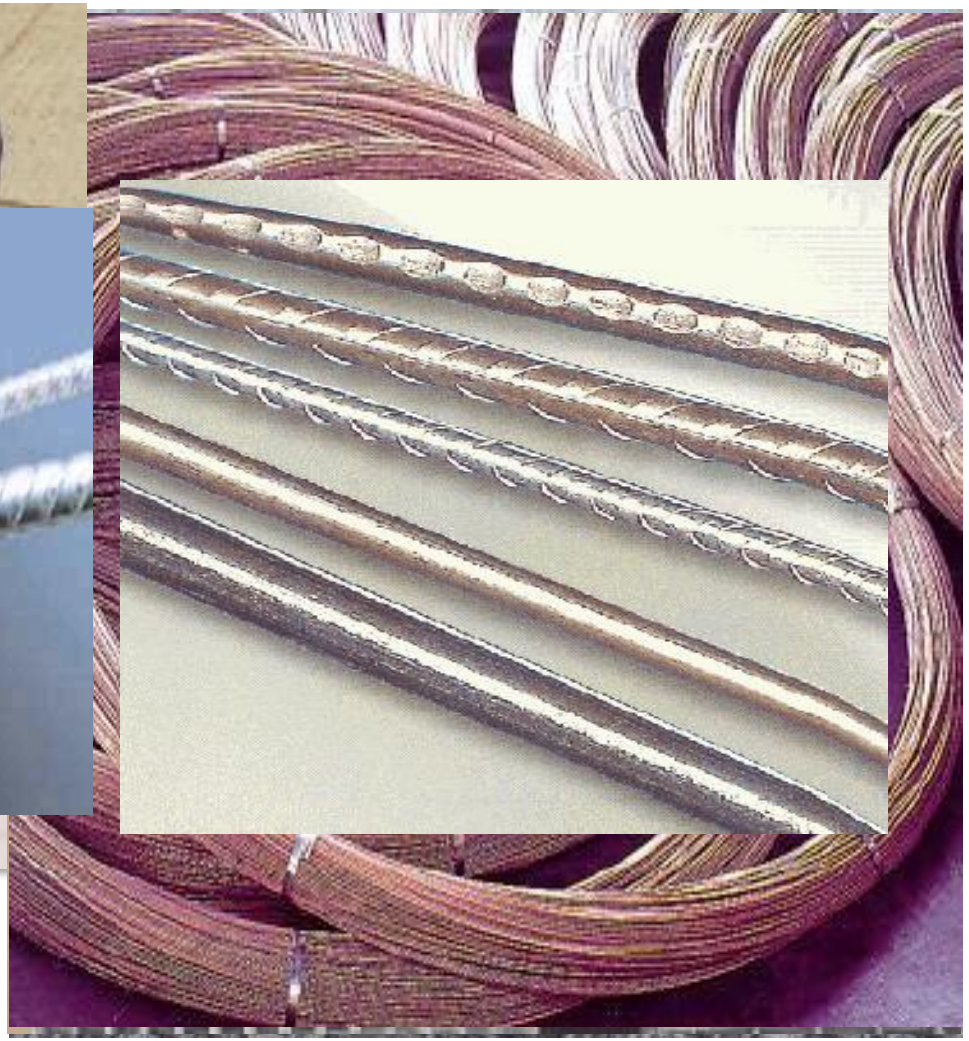
CONCRETE REINFORCEMENT

- **STEEL**





CONCRETE REINFORCEMENT

- **STEEL**
  - Primary reinforcement refers to the steel which is employed to guarantee the resistance needed by the structure as a whole to support the design loads.
  - Secondary reinforcement, also known as distribution or thermal reinforcement, is employed for durability and aesthetic reasons, by providing enough localized resistance to limit cracking and resist stresses caused by effects such as temperature changes and shrinkage.
  - Rebar cages are fabricated either on or off the project site commonly with the help of hydraulic benders and shears.
  - However, for small or custom work a tool known as a Hickey, or hand rebar bender, is sufficient. The rebars are placed by steel fixers "rodbusters" or concrete reinforcing ironworkers, with bar supports and concrete or plastic rebar spacers separating the rebar from the concrete formwork to establish concrete cover and ensure that proper embedment is achieved.
  - The rebars in the cages are connected either by **spot welding, tying steel wire, sometimes using an electric rebar tier, or with mechanical connections**. For tying epoxy coated or galvanised rebars, epoxy coated or galvanized wire is normally used.

SPECIAL TYPE OF CONCRETE REINFORCEMENT

- **FIBER-REINFORCED CONCRETE**
  - Fiber reinforcement is mainly used in shotcrete, but can also be used in normal concrete.
  - Fiber-reinforced normal concrete is mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, pillars, foundations, etc.), either alone or with hand-tied rebars.
  - Concrete reinforced with fibers (which are usually steel, glass, or plastic fibers) is less expensive than hand-tied rebar, while still increasing the tensile strength many times.
  - The shape, dimension, and length of the fiber are important.
  - A thin and short fiber, for example short, hair-shaped glass fiber, is only effective during the first hours after pouring the concrete (its function is to reduce cracking while the concrete is stiffening), but it will not increase the concrete tensile strength.
  - Steel is the strongest commonly-available fiber, and comes in different lengths (30 to 80 mm) and shapes (end-hooks). Steel fibers can only be used on **surfaces that can tolerate or avoid corrosion and rust stains**. In some cases, a steel-fiber surface is faced with other materials.

SPECIAL TYPE OF CONCRETE REINFORCEMENT

- **FIBER-REINFORCED CONCRETE**
  - **Basalt fiber** is stronger and less exper
    the alkaline environment of portland
    reinforcement.
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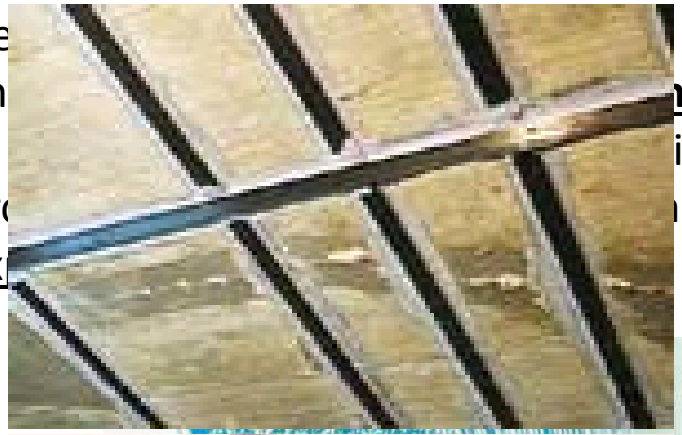

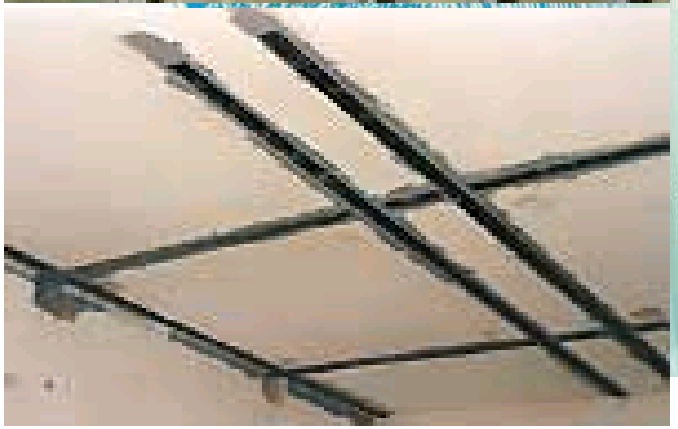

REPAIRS OF CONCRETE STRUCTURES

- **SHOTCRETE**
  - Shotcrete is, in effect, a version of a cast-in-place concrete wall.
  - Rather than placing concrete into forms, however, a fresh mix is sprayed onto wall panels that have been erected in the shape of the building.
  - A nozzleman applies concrete from a pressurized hose to encompass the reinforcement and build up the wall thickness, forming structural shapes that include walls, floors, roofs, and other assemblies.
  - This material has also been called “gunite” in reference to the nozzle or “gun” used to shoot material at the form face.
  - Any surface suitable for accepting fresh concrete can be used: wood, steel, and polystyrene are common.
  - Finishes are often applied directly to the concrete while it is still wet.

  - https://www.youtube.com/watch?v=_VWeSSwFvqU

REPAIRS OF CONCRETE STRUCTURES

TYPES OF CEMENT

- Depending upon our requirements i.e. using it at a suitable place, we use different types of cement.

  - **Rapid Hardening or High early strength Cement**
  - **Quick setting Cement**
  - **High Alumina Cement**
  - **Portland Slag Cement**
  - **Low Heat Cement**
  - **Air Entraining Cement**
  - **White Cement**
  - **Coloured Cement**
  - **Portland Pozzolona Cement**

COMPOSITION OF CEMENT

- Calcium Oxide (CaO) = 60 – 65%
- Silica (SiO_2) = 20 – 25%
- Aluminum Oxide = 4 - 8%
- Ferrous Oxide = 2 – 4 %
- Magnesium Oxide = 1 – 3 %

COMPOSITION OF CEMENT

- **RAPID HARDENING CEMENT**
  - This type of cement gets the strength faster than OPC, however its initial and final setting is same as those of OPC.
  - It contains more of tri-calcium silicate and is more finely grounded.
  - It gives out more heat while setting so it is as such unsuitable for massive concrete. It is used for the structures which are subjected to loads early e.G. Roads, bridges.

- **QUICK SETTING CEMENT**
  - It sets faster than the ordinary portland cement.
  - Its initial setting time is 5 minutes and the final setting time is not more 30 minutes.
  - It is required for making concrete that is required to set early as for lying under water or in running water.
  - Initial setting being very little there is always the danger of concrete having undergone its initial setting. Thus this type of cement is used in more special cases.

COMPOSITION OF CEMENT

- **LOW HEAT CEMENT**
  - The heat generated by cement while setting may cause the structure to crack in case of concrete.
  - This heat generation is controlled by keeping the percentage of tri-calcium silicate and that of tri-calcium aluminate low.
  - Its initial setting and final setting times are nearly the same as those of OPC.
  - It is not very suitable for ordinary structures because the use of cement will delayed time of drying. It will also need more curing.
  - At ordinary temperature it is used in thin layers.
- **PORTLAND SLAG CEMENT**
  - It is obtained by mixing clinker, gypsum and granulated slag in a proper proportion.
  - The properties of this cement is very similar to that of OPC which are as under.
  - It has lesser heat of hydration and has better resistance of soils, sulphates of alkali metals, alumina and iron.
  - It has better resistance to acidic water.
  - This type of cement is mostly used in marine works.

COMPOSITION OF CEMENT

- **AIR ENTRAINING CEMENT**
  - It is the OPC mixed with some air entraining agents.
  - The common air entraining agents are oils, fats and fatty acids etc.
  - These materials have the property of entraining air in the form of fine air bubbles.
  - The bubbles render the concrete to become more plastic, workable and more resistant to freezing.
  - However because of air entrainment the strength of concrete reduces and as such the quantity of air so entrained should not exceed 5%.
- **WHITE CEMENT**
  - It is the cement of pure white colour and having same properties as those of ordinary portland cement.
  - Greyish colour of cement is due to iron oxide (feo).
  - White cement is manufactured from chalk and clay free from iron oxide.
  - Oil fuel and not the coal is used for the burning of this cement.
  - It is much more costly than ordinary cement.

COMPOSITION OF CEMENT

- **COLOURED CEMENT**
  - Various coloured cement are prepared when required in special cases.
  - Suitable pigments are added with OPC to get red or brown cement but for other colours 5 – 10% of desired pigments are grounded with white cement.
  - Pigments used should be chemically inert and also durable so as they must not fade due to the effect of lights sun or weather.

- **PORTLAND POZZOLONA CEMENT**
  - Portland pozzolona cement is produced by grinding together portland cement and pozzolona.
  - This cement has properties similar to those of OPC and can therefore be used for all general purpose.
  - Portland pozzolona cement produces less heat of hydration and offers greater resistance to attack of aggressive water or sulphates bearing than OPC.
  - Portland pozzolona cement are particularly used in marine works. It takes a little longer to gain strength.
  - Ultimate strength of this cement is more than OPC.

THANK YOU
FOR YOUR ATTENTION

THAT‘S ALL FOLKS ☺