SHREE

3RD CHAPTER – ELEMENTS OF CIVIL ENGINEERING AND MECHANICS

CONSTRUCTION MATERIAL AND EQUIPMENTS

Cement

Cement is a binding material. It binds two or more material together to increase the strength and bonding properties.

Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as hydraulic or the less common non-hydraulic, depending on the ability of the cement to set in the presence of water.

cement, in general, adhesive substances of all kinds, but, in a narrower sense, the binding materials used in building and civil engineering construction. Cements of this kind are finely ground powders that, when mixed with water, set to a hard mass. Setting and hardening result from hydration, which is a chemical combination of the cement compounds with water

Types of Cement

1. **Ordinary Portland Cement (OPC)**
2. **Portland Pozzolana Cement (PPC)**
3. **Rapid Hardening Cement**
4. **Low Heat Cement**
5. **White Cement**

1. **Ordinary Portland Cement (OPC)**

Ordinary Portland cement is the most widely used type of cement, which is suitable for all general concrete construction. It is the most commonly produced and used type of cement around the world, with annual global production of around 3.8 million cubic meters per year. This cement is suitable for all kinds of concrete construction.

2. Portland Pozzolana Cement (PPC)

Portland pozzolana cement is prepared by grinding pozzolanic clinker with Portland cement. It is also produced by adding pozzolana with the addition of gypsum or calcium sulfate or by intimately and uniformly blending Portland cement and fine pozzolana. This cement has a high resistance to various chemical attacks on concrete compared with ordinary portland cement, and thus, it is widely used. It is used in marine structures, sewage works, sewage works, and for laying concrete underwater, such as bridges, piers, dams, and mass concrete works, etc.

3. **Rapid Hardening Cement**

Rapid hardening cement attains high strength in the early days; it is used in concrete where formworks are removed at an early stage and are similar to ordinary portland cement (OPC). This

cement has increased lime content and contains higher c3s content and finer grinding, which gives higher strength development than OPC at an early stage.

The strength of rapid hardening cement at the three days is similar to 7 days strength of OPC with the same water-cement ratio. Thus, the advantage of this cement is that formwork can be removed earlier, which increases the rate of construction and decreases the cost of construction by saving formwork cost.

4. Low Heat Cement

Low heat cement is produced by maintaining the percentage of tricalcium aluminate below 6% by increasing the proportion of C2S. A small quantity of tricalcium aluminate makes the concrete to produce low heat of hydration. Low heat cement suitable for mass concrete construction like gravity dams, as the low heat of hydration, prevents the cracking of concrete due to heat.

This cement has increased power against sulphates and is less reactive and initial setting time is greater than OPC.

5. White Cement

It is prepared from raw materials free from Iron oxide and is a type of ordinary portland cement, which is white. It is costlier and is used for architectural purposes such as precast curtain wall and facing panels, terrazzo surface, etc. and for interior and exterior decorative work like external renderings of buildings, facing slabs, floorings, ornamental concrete products, paths of gardens, swimming pools, etc.

Applications of cement

Cements may be used alone (i.e., "neat," as grouting materials), but the normal use is in mortar and concrete in which the cement is mixed with inert material known as aggregate. Mortar is cement mixed with sand or crushed stone that must be less than approximately 5 mm (0.2 inch) in size. Concrete is a mixture of cement, sand or other fine aggregate, and a coarse aggregate that for most purposes is up to 19 to 25 mm (0.75 to 1 inch) in size, but the coarse aggregate may also be as large as 150 mm (6 inches) when concrete is placed in large masses such as dams. Mortars are used for binding bricks, blocks, and stone in walls or as surface renderings. Concrete is used for a large variety of constructional purposes. Mixtures of soil and portland cement are used as a base for roads. Portland cement also is used in the manufacture of bricks, tiles, shingles, pipes, beams, railroad ties, and various extruded products. The products are prefabricated in factories and supplied ready for installation.

BRICKS

A brick is a type of construction material used to build walls, pavements and other elements in masonry construction. Properly, the term *brick* denotes a unit primarily composed of clay, but is now also used informally to denote units made of other materials or other chemically cured construction blocks. Bricks can be joined using mortar, adhesives or by interlocking.

Bricks are usually produced at brickworks in numerous classes, types, materials, and sizes which vary with region, and are produced in bulk quantities.

The construction of any building constitutes a lot of things. These components include cement, sand, soil, and, most importantly, bricks. Without bricks, every building would be incomplete. So it becomes imperative to know about the different types of bricks used on a day-to-day basis to construct houses, the shopping malls we visit, hospitals, schools, etc.

The most common ones are sun-dried clay bricks, burnt clay bricks, engineering Bricks, concrete bricks, fly ash bricks, fire bricks, and sand lime bricks.

Known about the brick masonry

1. **Burnt clay bricks**
2. **Sun-dried clay bricks**
3. **Concrete bricks**
4. **Fly ash bricks**
5. **Sand lime bricks**
6. **Firebricks**

1. **<u>Burnt clay bricks</u>**

- **These bricks are used for building columns, walls, foundations, and more.**
- **They are abundantly used in construction and are thus known as common bricks.**
- **Construction workers need to plaster or render the bricks with the help of mortar to help improve the strength of the bricks, water resistance, and insulating ability.**

These bricks are again classified into four categories consisting of first, second, third, and fourth classes. Modern construction involves mostly this kind of bricks which are versatile.

2) <u>Sun-dried clay bricks</u>

These bricks are one of the oldest types and were used in cities like Jericho, which is in modern Palestine and areas of Southern Turkey.

- **These bricks are not strong enough to be used for load-bearing purposes.**
- **Moreover, they are also not the durable type being the weakest ones in the group. These are primarily used for temporary masonry.**
- **These bricks are a mixture of water, loamy soil, and straw. Brick makers might include clay, manure, or sand to increase their strength and prevent the bricks from cracking.**
- **The mixture is placed in a mould under direct sunlight, and the bricks are left to dry. After drying, these bricks are removed from the mould for use.**
- **A good thing about these bricks is they are affordable.**

3) <u>Concrete bricks</u>

- **This type of brick is made from solid concrete. And afterwards, the mix is poured into custom moulds so that they can have different shapes and sizes.**

- **It can also be made directly in the construction site by mixing cement, sand, and other aggregates in the ratio of 1:2:4. One can also increase the strength by bringing a little change in the mixture. In that case, the mixture ratio for cement, sand and aggregates would be 1:3:6.**

- **These concrete bricks are used for outdoor walls, facades, and internal brickworks.**

4) Fly ash bricks

- **These bricks are made using class C or F fly ash, cement, quicklime, aluminium powder, water, and gypsum.**
- **Fly ash bricks help to reduce the number of toxic metals released into the environment by reusing them.**
- **It is a byproduct of coal-fired power plants containing toxic metals like arsenic, mercury, chromium, etc.**
- **As they are cast in a machine mould, they are very uniform in shape.**
- **These bricks come in small sizes because the durability of the brick decreases as size increases leading to cracks in the slabs.**
- **They can be used as an alternative to burnt clay bricks because of their low absorption rate and high compressive strength.**

6) Sand lime bricks

- **Sand lime bricks have high compressive strength, so they are a standard option for building load-bearing walls in houses and high-rise buildings.**
- **They are made using a mixture of sand, lime, and possibly a colour pigment. They can also be manufactured using heat and pressure to accelerate the chemical reaction, resulting in bricks with a smooth, uniform finish ideal for construction projects.**
- **The most important points about these bricks are fire resistance and acoustic insulation, thus protecting the building from any fire or sound.**
- **They are mainly used in the construction of hospitals, schools, etc.**

7) Firebricks

- **This brick is made of fireclay, a clay containing silica and alumina. This is why they can withstand temperatures greater than 3000 degrees.**
- **It can easily hold up low temperatures and rapid changes between hot and cold weather.**
- **These bricks make walls and structures highly resistant to heat and fire, like chimneys, fireplaces, brick grills, and fire pits.**
- **They would never crack, chip, or break from heat stress. This type of brick is one of the best because of its significant features and qualities.**

Bricks are classified Based on the quality

- **First class bricks**

These bricks are made up of good quality clay, regular in shape and size, and have sharp edges and smooth surfaces. They have a cherry red or copper colour as they are thoroughly burnt. These bricks make a ringing sound when struck. They are good quality bricks used for all kinds of superior nature works.

- **Second class bricks**

These bricks are moulded by ground moulding, so they have moderate quality. Though they have some irregularities in shape and structure, they also make ringing sounds like first-class bricks. Even these bricks are good for making permanent structures and even load-bearing ones.

- **Third class bricks**

With unfair edges and irregular shapes, third-class bricks are of poor quality. They are ground moulding and burnt in clamps. This is why they are sometimes overburnt or underburnt. Due to the above reasons, they are mainly used for constructing temporary structures.

- **Fourth class bricks**

These bricks are brittle and are not at all sustainable for use in construction. They are crushed so that one can use them in their broken form in road constructions, foundations, and more. They are used for manufacturing brickbat concrete.

SAND

Sand is a material obtained naturally from the locations like rivers, seas, beaches, and desserts. Sand is a granular material which consists of particles of finely divided rock. Sand, consisting of tiny particles, is formed by the weathering of rocks.It is one of the important building materials used for various purposes.

Types of Sand

Sand is classified into different categories, based on the size of the particles of sand, color of sand, shape of particle of sand, structure of sand, location of availability of sand, texture of sand, etc.

1. **River sand**
2. **Concrete sand**
3. **Pit sand**
4. **M – sand**
5. **Fill sand**
6. **Utility sand**

1. River Sand or Natural Sand

River sand is naturally occurring sand obtained from the banks of river. It is the most widely used type of sand for construction. River sand is fine particle sand. It has a smooth texture. So it is used for plaster works where a smooth finish is required and also used for RCC works.

The color of river sand is whitish-grey type. Due to the smooth and fine texture, this sand makes a good bond with cement, aggregates, and water to form concrete. The river sand is extensively used for construction purposes since the river sand is cheaper in terms of cost as it is obtained naturally.

2. Concrete Sand

The name itself indicates that the concrete sand is made up of crushed concrete particles. This type of sand is generally used in concrete works. Concrete sand provides strength and stability to a building.

The concrete fragments are crushed and the larger particles in the mixture are removed to make the mixture feasible for use. The concrete sand is used widely to level the base for layers, patios, and walking paths. The concrete sand usually consists of fine particles. So it is also used to fill up the voids between coarse aggregates.

3. **Pit Sand**

Pit sand is a type of naturally occurred sand which is obtained from the pits into the soil, at a depth of 2 to 4 meter below the level of the ground. The particles of pit sand are coaster than other types of sand. So before using, the pit sand is screened properly so that the unwanted particles from the sand are removed. The pit sand is generally used for mortars. Due to the presence of iron – oxide in it, the pit sand appears to be of red–orange color.

4. **M – Sand or Artificial Sand**

   M – Sand is the short name for "Manufactured Sand". This is artificial sand, manufactured in the factory itself. Due to the increase in demand for good quality sand, the quantity of naturally occurring sand is decreased day by day. So to compensate for the increasing demand & shortage of naturally occurring sand, artificial sand is manufactured. As M – Sand is artificially prepared, it has some advantages over the naturally occurring sand such as:

i) The cost of transportation of sand from the river banks to the construction site is eliminated.
ii) It is free from impurities and unwanted particles.
iii) Better quality of material obtained due to its manufacturing under a controlled environment.

5. **Fill Sand**

Fill sand is mainly used for filling. The fill sand is a mixture of fine particles of sand and aggregates. This type of sand can be used for several purposes during the construction work as the fill sand possess excellent properties of compaction.

Fill sand can also be utilized as a base material for the activities like laying the concrete, paving, and filling large holes. The fill sand is also known as utility sand. Like pit sand, the fill sand or utility sand is also composed of coarse particles. The size of its particles is relatively larger.

6. **Utility Sand**

Utility sand is a type of artificial sand manufactured from high quality industrial quartz. This sand provides excellent compaction and superior mechanical properties due to their uniform grain shapes. It can be suitably used in corrosive environments since they are non-reactive.

STEEL

Steel is an iron alloy composed of carbon content ranging from 0.03% to 1.075%, and often other elements. Many people get confused between Steel and iron. The difference between Steel and iron is that iron is used as the base metal to produce Steel.

There are different types of steel used in the construction industry.

One of the significant advantages of Steel is that Steel has high tensile strength. Thus it becomes an essential component for constructing buildings, infrastructure, construction tools, etc. Steel is also one of the most produced raw materials in the construction industry.

Types of Steel Used in Construction Works

1. **Rebar Steel**
2. **Mild Steel**
3. **Structural Steel**
4. **Light Gauge Steel**
5. **Carbon Steel**
6. **Alloy Steel**

1. **REBAR STEEL**

Steel rebar, often known as reinforcing or fortifying Steel, is used as a strain device in reinforced concrete or masonry structures. Rebar steel can hold the structure together even under enormous pressure. Rebar steel is available in various yield strengths, necessary elasticity, chemical composition, and elongation percentage parameters.

2. **MILD STEEL**

Mild Steel, also known as MS, is the most prevalent Steel used in the construction industry. It's incalculably strong and long-lasting. Mild Steel helps in making a solid foundation for any type of structure. Mild Steel is beneficial in construction because of its strength. It does not break when bent and is exceptionally flexible.

3. **STRUCTURAL STEEL**

Structural Steel is a category of Steel that is used as a construction material for making structural steel shapes. A structural steel shape is a profile that is formed with a specific cross-section and follows certain standards for chemical composition and mechanical properties. One advantage of structural steel is that it is very ductile, sturdy, and durable. Structural steel can be molded in almost any shape, depending on the construction.

4. **LIGHT GUAGE STEEL**

Light gauge steels are made up of thin sheets that adhere to strict specifications. A very basic example of light gauge steel is the Light gauge steel joists, both are widely accessible in hardware stores, and they are both flexible and safe.

Tiles

Tiles are usually thin, square or rectangular coverings manufactured from hard-wearing material such as ceramic, stone, metal, baked clay, or even glass. They are generally fixed in place in an array to cover roofs, floors, walls, edges, or other objects such as table-tops. Alternatively, tile can sometimes refer to similar units made from lightweight materials such as perlite, wood, and mineral wool, typically used for wall and ceiling applications.

Tiles are often used to form wall and floor coverings, and can range from simple square tiles to complex Tiles are most often made of ceramic, typically glazed for internal uses and unglazed for roofing, but other materials are also commonly used, such as glass, concrete and other composite materials, and stone.

Flooring Tiles

Tiles are widely used for flooring in kitchen, bathrooms, parking lots, rooftops and also used as table tops for dining rooms. Tiles are made from materials like ceramic, porcelain, glass, stone or metal. We can use tiles for any decorating style, as they are available in a number of sizes, shapes, colors, and textures.

Tiles are mostly preferred nowadays compared to granite because of its advantages like stain and scratch resistant, low maintenance, easy to install and don't fade when exposed to sunlight or high or low temperatures.

Tiles Design & Types of Tiles

1. **Ceramic tiles**
2. **Porcelain Tiles:**
3. **Vitrified Tiles**
4. **Glass Tiles**
5. **Digital Tiles**
6. **Mosaic Tiles**

1. Ceramic Tiles

These are the most common type of tiling used for flooring. They are made up of silica and clay which are made hard at high temperatures. There are two types of tiles designs in ceramic and they are Glazed tiles and Quarry Tiles. Glazed tiles come with a glaze coating, which is added after firing ceramic tiles to get in different colours and textures.

These tiles come with good styles and available in different colours compared to Quarry tiles and also offer stain and water resistant.

Quarry tiles are unglazed tiles which are mostly use in parking lots, footpaths because of its roughness and skid resistance. These tiles come in red, grey and brown colours and come in square, rectangle, and hexagon shapes.

2. Porcelain Tiles

These tiles are made by using finely grained clay at higher temperatures compared to ceramic tiles. They are denser, stronger and absorb moisture better and costlier than ceramic tiles. They are available in all finishes and use for both indoor and outdoor installations.

3. Vitrified Tiles:

Vitrification is done to make these tiles. They contain clay and silica materials and are harder than ceramic tiles. They have a low water absorption rate and can remain intact to wear and tear.

We can find various types in these like Glazed vitrified tiles, Porcelain vitrified tiles, and Double charge vitrified tiles which are different from one another in thickness, style, and colour factors.

4. Glass Tiles

These tiles are made using sand and recycled glass, which make them eco-friendly. These tile designs are mostly used for decorating walls in the living room, also used in kitchen and bathrooms.

Because of the popularity, they are using in all expensive places like hotels, palaces, commercial complexes and makes the room brighter by its reflecting properties. No fading and stain free.

5. Digital Tiles

Digital Printing Technology is used to print high-resolution images on the glazed tile surfaces. Nowadays all glazed tiles are printed by this technology in all creative looks.

6. Mosaic Tiles

These are not particularly tiles, the arrangement of tiles in smaller shapes on walls called mosaic style. They are arranged layer by layer on outside walls for decorative appearances.

Some of the Tiles brands

1. **Orient bell tiles**
2. **Somany tiles**
3. **Cera tiles**
4. **Nitco tiles**
5. **Kajaria tiles**
6. **Varmora tiles**

Paints

Paint is a liquid pigment that, after application to a solid material, and allowed to dry, adds a film-like layer to protect, add color, or provide texture.

Paint can be made in many colors—and in many different types. Most paints are either oil-based or water-based, and each has distinct characteristics.

Types of Paint

1. **Oil paint**
2. **Emulsion Paint**
3. **Enamel Paint**
4. **Bituminous Paint**
5. **Aluminium Paint**
6. **Anti-Corrosive Paint**
7. **Synthetic Rubber Paint**
8. **Cement Paint**
9. **Speciality home paints: Lasts long, protects longer**

1. Oil paint

Paints are divided into two categories - oil-based paints and water-based paints.

Oil paints are usually applied as a primer, undercoat and a finish coat. In the past oil paints were heavily relied on because of its durability and longevity on surfaces, however water-based paints are now at par. Known for their gloss and durability, oil paints stand for a rich finish, water-resistant properties and long-lasting abilities.

1. **Applications, benefits and tips to consider when choosing oil paint:**
2. **Use on metals, walls, doors, windows and stained surfaces for durability**
3. **Highly recommended for trim work**
4. **Use in non-humid areas since drying time takes longer than 24 hours**
5. **Easy to clean and easy to apply**

2. Emulsion Paint

Unlike traditional oil paints, majority of emulsions are water-based paints with fast-drying characteristics. It's the popular choice for paint contractors since it's alkali resistant, rich in texture and has stronger colour retention abilities, making it a long-lasting paint choice. As a homeowner, your biggest advantage with water-based emulsions is that it does not leave an odor and dries quickly. Acrylic emulsions offer your beautiful home resistance to cracking with its versatile and flexible finish through the years.

Applications, benefits and tips to consider when choosing emulsion paint:

6. **Mould and mildew resistance.**
7. **Low on VOCs (Volatile Organic Compounds), making it a good non-toxic choice**
8. **Easy to apply on exterior walls and interior walls too**
9. **Offers a range of wall finishes like satin, egg shell, glossy, matt etc.**
10. **Emulsion-painted walls are easy to clean, so let your kids loose!**
11. **Emulsions vary from weather-protectants to luxury, ultra HD interior finishes (have your pick!)**

3. Enamel Paint

As an oil-based solvent, enamel paints are characterized by key qualities of oil paints like slow-drying abilities and hardness.

It is an expensive choice for a homeowner, but enamel paints also render high durability, strong adhesion, provide glossy finish and are water and stain resistant.

Applications, benefits and tips to consider when choosing enamel paint:

1. **Perfect for humid and wet spaces like bathrooms and kitchen metals**
2. **Best for walls that need protection**
3. **Highly popularized for woodwork, metal work and window work**
4. **Offers good coverage, hardness and colour retention**
5. **Long-lasting choice for certain wood surfaces and meta**

4. Bituminous Paint

Along with common paints, there are many types of industrial paints used to coat pipes, irons, woods and external work. Characterized by a black, tar-like appearance and good alkali-resistant properties, bituminous paint is formulated using dissolved asphalt and/or tar.

Although this type of paint is water-proof, it is generally not suited for areas exposed to the sun, since it deteriorates in sunlight. To achieve a certain colour, pigment can always be added to this type of paint.

Applications, benefits and tips to consider when choosing bituminous paint:

1. **Provides a protective, water-proof, weather proof, chemical and corrosion-resistant layer**
2. **Ideal for metal work, pipe work, wood work, underwater structures**
3. **Ideal for exteriors such as ladders, shafts, and other iron work**
4. **Helps in providing rust resistance for metal application**

5. Aluminium Paint

Aluminium paint is a type of paint coating that is made by mixing aluminium particles or flakes with oil/spirit varnish. The type of varnish can be used as per the requirement since spirit varnish leads to a shorter drying period.

The benefits of using this type of paint are resistant to electricity, weather, corrosion and is waterproof. Aluminium paints give a silvery finish and are strong and durable paints due to the resin in it.

Applications, benefits and tips to consider when choosing aluminium paint:

1. **Used for hot water tanks, hot pipes, masonry, oil storage tanks etc.**
2. **Used for metals and woods too**
3. **Popular for being electricity and corrosion-resistant.**

6. Anti-Corrosive Paint

Made from anti-corrosive elements like linseed oil, zinc chrome and fine sand, Anti-Corrosive Paints are ideal for metallic surfaces. As its name suggests, it helps prevent corrosion on various surfaces, mainly metallic in nature.

Applications, benefits and tips to consider when choosing anti-corrosive paints:

1. **It is used for steel and iron work**
2. **Mainly used for pipes, external structures and metallic work**
3. **It is cost-effective, black in colour and a strong, long-lasting choice**

7. Synthetic Rubber Paint

Synthetic Rubber Paints are formulated from dissolving synthetic resins and by adding suitable pigments and solvents to it. Due to pigments being added, any colour can be attained. You will find this paint on concrete surfaces, walls and floors since it's weather-resistant and has properties that make it alkali and acid resistant too.

Applications, benefits and tips to consider when choosing synthetic rubber paint:

1. **It dries very quickly and maintains consistency and uniformity on large expanses**
2. **It is cost-effective, chemical-resistant and weather-resistant**
3. **Widely used on concrete walls, large surfaces, floors, grounds etc.**
4. **It will be long-lasting despite weather and wear and tear of surfaces**

8. Cement Paint

Traditionally known as whitewash or cement paint, distemper paint is a paint variant that comprises of lime, chalk, pigment, water and glue. It happens to be one of the oldest types of paint. Contemporary versions of it are in paint form, or else traditional distempers are available in powder form and need to be mixed for application on walls.

Applications, benefits and tips to consider when choosing cement paint:

1. **No cracking due to sunlight**
2. **Can be applied on cement and rough interiors/exteriors without primers**
3. **A cheaper medium of paint and application**

9. Speciality home paints: Lasts long, protects longer

You may have heard about antifungal, waterproofing and crack-bridging paints. There are specific types of home paints for exterior and interior walls that focus on protecting walls from climatic conditions, domestic situations and wear and tear.

From UV resistant, water-based exteriors to holistic weather protectants, speciality home paints target wall and climate concerns with aesthetic value as brownie points. Here's a special mention to eco-friendly, healthy home paints for interiors too, that are specially designed for a safer environment without the presence of harmful chemicals and vapours.

Applications, benefits and tips to consider when choosing a speciality home paint:

1. **Perfect for exteriors, buildings and weather-prone areas**
2. **Easy to apply and high coverage material**
3. **Targets specific concerns like algal issues, dust, longevity, climate etc.**
4. **Functional yet aesthetically pleasing**

CONCRETE

Concrete is a mixture of Cement, fine aggregate, coarse aggregate and water.

PCC and RCC are types of construction materials that are used to build structures like buildings, bridges, and roads. PCC stands for Plain Cement Concrete while RCC stands for Reinforced Cement Concrete.

The main difference between PCC and RCC is the inclusion of steel bars in RCC, which adds strength and durability to the concrete.

This makes RCC more suitable for larger and more complex construction projects, while PCC is used for smaller and simpler projects.

- **PCC: PCC is made by mixing cement, sand, and water together. It is a strong and durable material, but it can break if there is too much weight or pressure on it.**
- **RCC: RCC is made by adding steel bars or mesh to PCC. This makes it even stronger and more able to withstand heavy loads.**

PCC	RCC
PCC is made with just cement, sand, and water.	RCC has steel bars or mesh added to it.
PCC is less strong than RCC.	RCC is more strong than PCC.
PCC is generally used for smaller structures.	RCC is used for larger and heavier structures.
PCC is more economical to use compared to RCC.	RCC is less economical to use compared to PCC.
PCC is not as strong as RCC and can break under heavy loads.	RCC can withstand heavy loads due to the steel bars inside.

Plain cement concrete is a cement mixture commonly used for paving and flooring and is also known as PPC. It is one of the most important elements in a building structure. PCC is laid on the soil surface and acts as a shield for the reinforced concrete against direct contact with soil and water.

RCC

RCC is a material which consist about combination of concrete and steel together.

Purpose of Reinforcement in Concrete.

As, Concrete has a very high compressive strength, but it is low in tensile strength. But where tensile forces are also involved, as in, beams and slabs, there is a very high risk of its failure when plain concrete is used.

Steel has a very high tensile strength and when concrete and steel are combined together, a material of construction is obtained that is capable of withstanding all the three types of forces likely to act upon a structure, i.e., compressive loads, tensile stresses, and shear forces.

The main principle in the preparation of the reinforced cement concrete is to make a structural material in which Steel serves the purpose of bearing the main tensile stresses and concrete bears the main compressive forces.

Placement of Reinforcement:

It requires very complex and careful design considerations for each member of reinforcement concrete. Thus, the size, shape, spacing, and location of reinforcement will be entirely different in a slab, beam and column.

6. **In beams, for example, steel bars may be required more in the lower sections i.e. at below neutral axis and in fixed beams, in the end, sections as well where the tensile stresses are most effective.**
7. **Beam depth is divided into two zones compression zone and tension zone.**
8. **The top section of the beam may need no reinforcement. The horizontal reinforcements are often tied up with square stirrups at suitable intervals.**
9. **These stirrups also provide additional strength to the Reinforced Cement Concrete against shearing stresses.**
10. **The reinforcement requires the minimum prescribed covering of concrete. The covering is essential to protect the reinforcement from deterioration under attack from weathering agencies and also from casual fires.**
11. **The concrete covering varies from 25 mm to 80 mm depending on the environment in which the RCC member has been placed.**
12. **It is also important that the reinforcement must be clear of rust, dust, and grease at the time of placement. This will ensure a better bond between concrete and reinforcement.**

Advantages of using RCC

(i) Structures made from Reinforced Concrete are durable.
(ii) It has a high compressive strength (due to concrete).
(iii) It has a high tensile strength (due to reinforcement).
(iv) It is resistant to fire and other climate changes.
(v) Easily available almost anywhere in the world.
(vi) Too much expertise is not required for working on it, normal skilled labor can also do it.
(vii) It can be molded in any form, shape.
(viii) It can be used in any part of the structure i.e., from foundation to the top roofing.
(ix) Repairing cost is almost nil.
(x) It is more economical compared to other materials.

PRE –STRESSED CONCRETE

Concrete can withstand a great amount of compressive stress but ithas very low tensile strength. Becauseoflow tensile strength,concrete gets cracked due to subjected to maximum load.

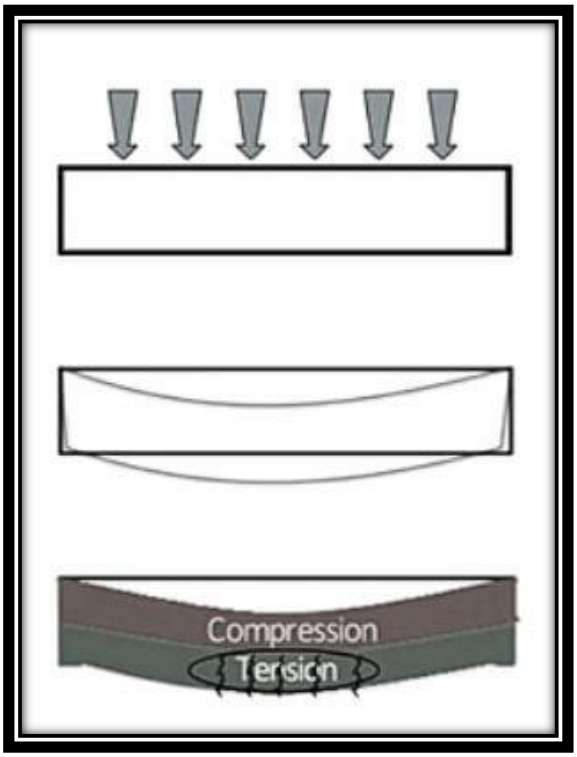
In prestressed concrete Internal stresses areinduced before it's application so that it can counter balance the load or stresses produced in concrete due to external load.

Why Prestressed should be used

Before concrete fails, cracks are formed in itand then structure collapses and cracks are formed due to deflection or moment in structure.When water comes in contact with these cracks steel gets corroded.

To avoid these cracks. To increase the strength of member and to reduce the deflectionpre-stressing is done.

Pre-stressing means tensioning the reinforcement.



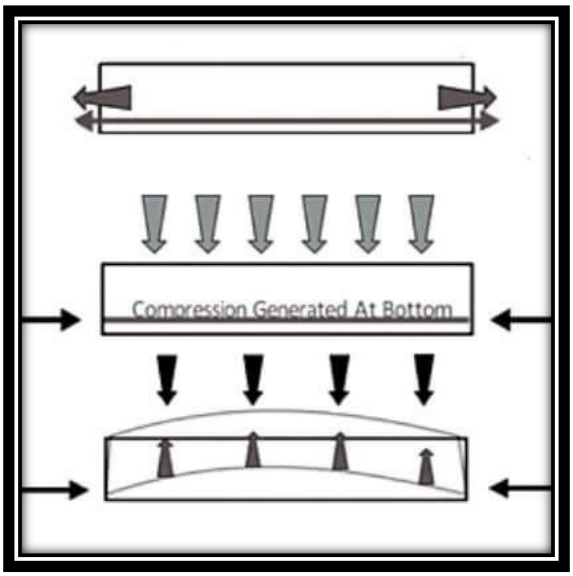
BEAM BEHAVIOUR UNDER LOADING CONDITION

Here compression develops at top portion and tension develops at bottom portion of the beam.

So, steel bars are added at bottom portion of beam to resist these tensile stresses.

In pre-stressing the tendons are stretched along the axis and concrete is poured.

After that when the tendons are released the compression is generated at the bottom which tries to counterbalance the compression due to loading at the top part of the beam. The upward forced along the length of the beam counteract the service loads applied to the member.



BEAM BEHAVIOUR EFFECT IN PRESTRESSING

PRE-CAST CONCRETE

Precast concrete is a construction material created by pouring concrete into a preshaped mold. The concrete is then left to cure in an appropriate environment. Once cured, the mold is removed and reused.

The precast concrete product is then taken to the job site and used for the project. For instance, if designed to be walls, the precast concrete walls are typically lifted into position by a crane on site.

The precast concrete method is very different from the conventional way concrete was used, cast-in-place.

In the conventional method, the concrete is formed into the desired shape at the project location and left to cure. There is no transportation involved.

STEPS FOR MAKING PRE-CAST

7. **To make precast concrete structures, first, the molds are prepared. The molds are reusable and prepared in the shape that the precast concrete will have.**
8. **Once the molds are done, the concrete mix is poured into it. After pouring, the mixture is left to cure. Factors like temperature and humidity are precisely controlled during the curing process.**
9. **Once cured, the molds are removed, and the finished product is shipped to the job site.**

Since the molds can be shaped in any form, precast concrete comes in many different shapes and sizes. However, when the size of products becomes larger, the weight becomes an issue. Therefore, you won't find very large single precast concrete panels.

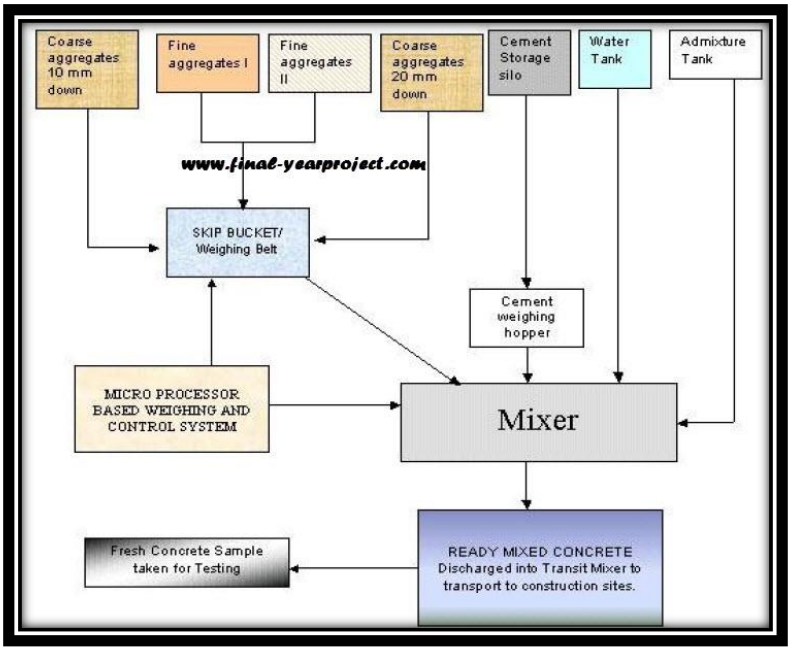
Materials Used in Precast Concrete

Many different components go into making a precast concrete structure. These materials include:

- **Cement: This is the most important material in precast concrete. The National Precast Concrete Association sets the requirements for what quality of materials you need to use to create high-quality precast concrete as an NPCA-certified plant.**
- **Generally, Ordinary Portland Cement (OPC) Grade 43 and 53 are used in precast concrete. For precast concrete created for harsh conditions (such as tidal environments), Portland Pozzolana Cement and Portland Slag Cement are used.**
- **Water: The ratio and purity of water are key factors in creating a superior precast concrete mix design. The water mustn't contain any impurities, as particles in water can degrade the mix quality.**
- **Supplementary Cementitious Materials (SCMs): These are generally industrial by-products and sometimes natural materials that exhibit the properties of cement. These are mixed in Ordinary Portland Cement to improve its hydration properties.**
- **Aggregate: The type of aggregate is typically chosen based on the mix design for a specific precast concrete structure. A project manager will typically consider factors such as durability, color, or texture. Special Aggregate can be used.**

RMC [READY –MIX CONCRETE]

Ready Mixed Concrete is a is manufactured in a factory or within a batching plant based on the standard required specifications. The prepared concrete mix is then taken to the work site within transit mixers mounted over a truck. This type of concrete guarantee higher durability and sustainability. As the work is carried out by an expert supplier, the mixture formed is precise and of higher quality. Special concrete mixtures too can be made efficiently by this concrete manufacturing method.



READY MIXCONCRETE PLANT WORKING

Types of Ready Mixed Concrete

There are three types of ready mix concrete (RMC) depending upon the mixing of the various ingredients as given below:

1. **Transit mixed concrete**
2. **Shrink mixed concrete**
3. **Central mixed concrete**

1. Transit mixed concrete

It is also called dry batched concrete because all the basic ingredients including water are charged directly into the truck mixer. The mixer drum is revolved fast at charging speed during the loading of the material and after that it continues rotating at a normal agitating speed. In this type of ready mix concrete, also three types of variations are possible as given below: Concrete mixed at job site While being transported towards the destination, the drum is revolved at a slow or agitating speed of 2 rpm, but after reaching the site just before discharging the material, it is revolved at maximum speed of 12 to 15 rpm for nearly 70 to 100 revolution for ensuring homogeneous mixing.

2. Shrink mixed concrete

The concrete is partially mixed in the plant mixer and then balance mixing is done in the truck mounted drum mixer during transit time. The amount of mixing in transit mixer depends upon the extent of mixing done in the central mixing plant. Tests should be conducted to establish the requirement of mixing the drum mixer.

3. Central-mixed concrete

It is also called central batching plant where the concrete is thoroughly mixed before loading into the truck mixer. Sometimes the plant is also referred as wet-batch or pre-mix plants. While transporting the concrete, the truck mixer acts as agitator only. Sometimes, when workability requirement is low or the lead is less, non-agitating units or dump trucks can also be used.

CONSTRUCTION EQUIPMENTS

A] EXCAVATOR

Excavators are popular earthmoving vehicles that feature a bucket, arm, rotating cab and movable tracks. These components provide superior digging power and mobility. It allows this heavy equipment to perform a variety of functions, from digging trenches and breaking holes to lifting away waste and excavating mines. An excavator is a must on job site when we need to lift heavy amounts of soil and materials.

The most common excavator types are as follows:

7. **Crawler Excavators**
8. **Wheeled Excavators**

9. **Dragline Excavators**
10. **Suction Excavators**
11. **Skid Steer Excavators**
12. **Long Reach Excavators**
13. **Mini Excavators**

1. **Crawler Excavators**

Crawlers run on two large endless tracks and are optimal for mining and heavy-duty construction jobs. Also known as compact excavators, these excavators use hydraulic power mechanisms to lift heavy debris and soil.

CRAWLER EXCAVATOR

Their chain wheel system allows them to slide down and scale hills with less risk, making them suitable for grading hilly areas and landscaping uneven terrain. While slower than other excavators, crawlers provide greater balance, flexibility and stability overall.

2. **Wheeled Excavators**

Wheeled excavators are similar in size and appearance to crawlers but run on wheels instead of tracks. Replacing tracks with wheels makes them faster and easier to maneuver on concrete, asphalt and other flat surfaces while still offering the same power capabilities.

WHEELED EXCAVATOR

Because wheels offer less stability on uneven ground than tracks, wheeled excavators are commonly used for roadwork and urban projects.

3. **Dragline Excavators**

The dragline excavator is a larger excavator that operates with a different process. The equipment utilizes a hoist rope system that attaches to a bucket via a hoist coupler. The other side of the bucket is affixed to a dragline that runs from the bucket to the cab.

DRAGLINE EXCAVATOR

The hoist rope raises and lowers the bucket while the dragline pulls the bucket toward the driver. Due to their weight, draglines are often assembled on-site. The unique system of this type of excavator is commonly used in large-scale civil engineering projects like canal dreading.

4. **Suction Excavators**

Suction excavators feature a suction pipe capable of providing up to 400 horsepower. The excavator first releases a water jet to loosen the ground. The pipe, which contains sharp teeth at the edge, then creates a vacuum that carries away soil and debris up to 200 miles per hour. They are also known as vacuum excavators.

SUCTION EXCAVATOR

5. **Skid Excavator**

As like standard excavators, skid steers have booms and buckets that face away from the driver. This orientation allows the attachments to reach over the cab instead of around it, making these excavators useful in more narrow areas and tricky turns.

SKID EXCAVATOR

They are often used for digging pools, site cleaning, residential work and debris removal, where space is more limited and objects are spread far apart.

6. Long Reach Excavator

As its name suggests, a long reach excavator features a lengthier arm and boom sections. The design allows for better operation in hard-to-reach locations. The excavator's extendable arm can reach over 100 feet horizontally.

LONG REACH EXCAVATOR

These excavators are best used for demolition projects like structural crumbling and breaking down walls over bodies of water. Different attachments can be affixed to the arm to perform additional jobs such as shearing, crushing and cutting.

7. Mini Excavator

In recent years, more contractors are using mini excavators, a smaller and lighter version of the standard excavator capable of minimizing ground damage and fitting through crowded, narrow sites like parking lots and indoor spaces.

MINI EXCAVATOR

Also known as compact excavators, mini excavators typically incorporate reduced tail-swing or zero tail-swing to sharp tighter turns and avoid contact with any obstacles.

B] PAVER MACHINE

A paver (road paver finisher, asphalt finisher, road paving machine) is a piece of construction equipment used to lay asphalt concrete or Portland cement concrete on roads, bridges, parking lots and other such places. It lays the material flat and provides minor compaction. This is typically followed by final compaction by a road roller.

PAVER MACHINE

The asphalt is added from a dump truck or a material transfer unit into the paver's hopper. The conveyor then carries the asphalt from the hopper to the auger. The auger places a stockpile of material in front of the screed. The screed takes the stockpile of material and spreads it over the width of the road and provides initial compaction.

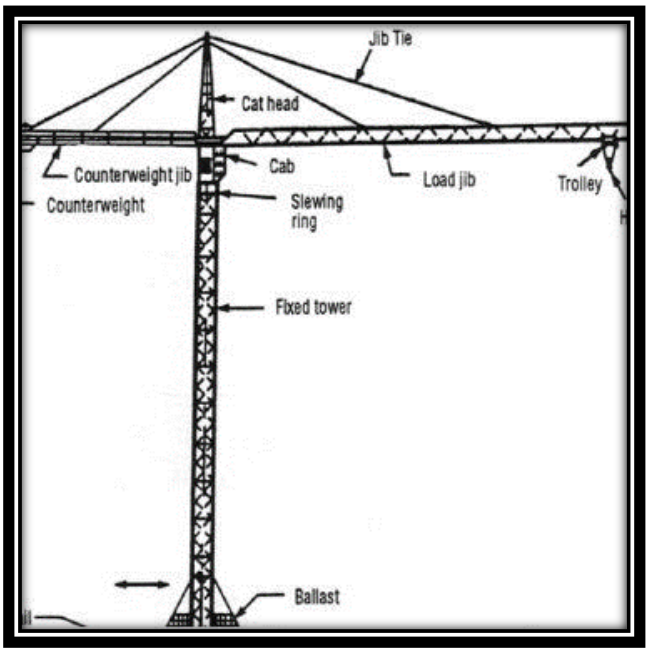
In order to provide a smooth surface the paver should proceed at a constant speed The need for constant speed and material supply is one of the reasons for using a material transfer unit in combination with a paver. A material transfer unit allows for constant material feed to the paver without contact, providing a better end surface.

C] TOWER CRANE

Tower cranes are a common fixture at any major construction site. They're pretty hard to miss — they often rise hundreds of feet into the air and can reach out just as far. The construction

crew uses the tower crane to lift steel, concrete, large tools like acetylene torches and generators, and a wide variety of other building materials.

Components of Tower Crane



TOWER-CRANE

1. Base

It is the single most crucial component in keeping the crane upright. The concrete foundation is poured in advance of the crane installation process. This base serves as an anchor for the crane.

2. Mast

The mast is the set of truss-like columns that allow the crane to reach its desired height. They are not one solid column but pieces that can be easily bolted together to other parts of the crane. The crane is secure due to the concrete foundation and the mast columns.

3. Slewing unit

The crane can swing into different positions thanks to the slewing unit's gear and motor set-up.

4. Working arm

It extends perpendicular to the mast and contains the hook and trolley to hoist the cargo.

5. Machinery arm

This structure, called a "counter jib," is where the crane's counterweights and balancing pulleys are kept.

6. Hook and trolley

The hook serves as the primary mechanism for supporting weight when transporting cargo. The hook may be moved towards and away from the mast on a trolley, and it can also be raised and lowered. The trolley is outfitted with several wires and pulleys to accomplish this.

7. Operator cab

The crane's slewing unit is connected to its control centre. The operator must ascend ladders within the mast to reach the cab.

Principle working of Tower Crane

Tower cranes have very straightforward operating principles. Overturning forces are balanced by the concrete pad and counterweights suspended from the equipment arm. So, while a crane is empty, it is slightly unbalanced due to the counterweights, and it is when loads are being hauled, the crane is steady.

A winch connected to the trolley through steel cables pulls loads. The crane's stability is affected by the distance at which the load is hauled from the mast, as this is where overturning forces are generated. Heavier loads are hoisted nearer the mast than lighter ones to reduce the resulting forces.

The crane has a maximum load restriction and a load-moment limit switch to prevent overloading. These switches monitor the 'collapse' and trigger an alarm if a predetermined value is reached.