MODULE-1

CIVIL ENGINEERING DISCIPLINES AND BUILDING SCIENCE

What is engineering?

Engineering is a term applied to the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied to the efficient use of the materials and forces of nature.

OR

It is a profession of converting scientific knowledge into useful practical applications, where the materials and force in nature are effectively used for the benefit of mankind. An Engineer is a person who plays a key role in such activities.

Define Civil Engineering?

Civil engineering is the oldest, broadest and simple of the various engineering fields. It is mainly related to planning, analysis, design, construction and maintenance of buildings, roads, bridges, dams, tunnels and other structures by the use of physical laws and mathematical equations and theory of mechanics.

Scope of different field of civil engineering:

1. Surveying
2. Structural Engineering
3. Geotechnical Engineering
4. Hydraulics & Water Resources
5. Transportation Engineering
6. Environmental Engineering
7. Construction planning &Project management
8. Earthquake Engineering
9. Remote Sensing and GIS

i) Surveying:

- It is the science/ art of map making.
- It mainly deals with various types of measurements and plotting of maps/plans.
- To start any development (construction) activity in an area, the relative positions of various objects in the horizontal and vertical directions are required. This is achieved by surveyingthe area.
- Unless maps are drawn, no development work and construction can be undertaken.
- Earlier, conventional/traditional instruments used for surveying are – chain, tape, leveling instruments, etc.
- Modern instruments are distance meter, total stations, theodolite, etc.
- Modern technologies are photogrammetry and remote sensing(GPS) have made surveying easier.

- Some of the common instruments used for surveying are,
  - Chain
  - Tape
  - Compass
  - Auto Level
  - Theodolite
  - Total station
  - GPS
  - Drones
- **Classification of surveying**
  - **Plane surveying**

    In this type of surveying, the effect of curvature of the surface of earth is not taken into account. Therefore, plane surveying is adopted for small areas. And the degree of accuracy of plane survey is relatively low.
  - **Geodetic surveying**

    In geodetic surveying the curvature of the earth's surface is taken into account. Geodetic surveys are carried out for large distances and areas with a high degree of precision. In India, Survey of India, a Government department, undertakes the work of geodetic surveying.

ii) Building Materials:

- The materials used for the construction of any structures are called as building materials.
- Shelter is basic need for every human being.
- To get good shelter (in terms of durability, safety and maintenance), materials used in building construction should be of good quality.
- The important factors considered while selecting materials are- Durability, strength, appearance, cost, availability and labour requirements.
- Building material are mainly divided into i) Natural – Sand, stone, timber etc.
  ii. Artificial (man-made)- bricks, cement, concrete, flooring or roofing tiles, steel, glas etc.
- Concrete: Mixture of fine aggregates (river sand), coarse aggregates (Jellies), cement and water.
- Fine aggregates – Each particle size less than 4.75 mm IS sieve.
- Coarse aggregates – Particle size more than 4.75 mm.
- Mortar:- Mixing of cement and sand with water is called as mortar.
- RCC (Reinforced cement concrete):- Composite materials of concrete and steel is termedas RCC.

iii) Geotechnical Engineering:

- It mainly deals with the study of soil, its types of soil and their properties.
- Soil property may changes from place to place, depth (layer to layer) to depth even in the same place, season to season.
- Any building, bridge, dam, retaining wall etc. consist of components like foundations. The foundation is laid from a certain depth below the ground surface till a hard layer is reached. The soil should be thoroughly checked for its suitability for construction purposes. The study dealing with the properties and behavior of soil under loads and changes in environmental conditions is called geo-technical engineering.
- Geotechnical engineers analyze the soil to determine its suitability to support extreme loads.
- Proper geotechnical engineering is essential for a safe and secure structure.

Following are the uses of Geo-Technical Engineering

- To assess the quality and strength of soil or rock to construct civil engineering structure.
- To design retaining walls for soil retainment.

- To decide type of foundations for different type of structures.
- For design of underground structures such as Tunnels, Shafts, Conduits.
- Design of earthen dams for storage of water. • For the design of Roads for transportation facilities.

iv) Structural Engineering:

- It mainly deals with analysis and design of various structures like.
- Steel structures – trusses in industrial building, Towers etc.
- Concrete structures- buildings, bridges, dams etc.
- **Analysis:** Assessing or determining the internal forces or stresses developed in structural components of any structures due to applied load is called as analysis. For example structural components in building are beam, column etc.
- **Design:** Fixing or finding the suitable dimensions (breadth, depth, length etc.) for structural components of any structures using various methods is called as design.
- **Example:** Load acting on a structure is ultimately transfer to ground (soil) through beams, columns, foundation etc. When the load acts on the structure, the various components are subjected to internal stresses (offer resistance to applied load).
- **Structural engineers design steel, concrete, or timber framed structures such as:** Tall buildings and towers, bridges, dams, retaining walls, foundations, stadiums.

Following are the uses of Structural Engineering

- Analysis and design of Dams, Bridges, Stadiums, Auditoriums, Multi – storied Buildings.
- Analysis and design of power generation stations
- Analysis and design of steel industrial structures
- Repair, rehabilitation and maintenance of structures
- Design of nuclear Power plants.
- Design of structural reinforcement for different type of structural components

v) Construction Planning and Project Management:

Construction Planning

- It deals with the different types of construction of structures like buildings, roads, bridges, etc.
- Construction of underground Tunnels using modern equipment's.
- Construction of floating structures.
- Earlier days only man power is utilized for construction. But development of new technology i.e manufacture of new machineries like cranes to lift weight, painting machines, plastering machines, concrete or tar laying machines have made the construction easy and faster.
- It mainly includes excavation of soil, construction of foundation, concreting, finishing etc with different techniques and methods.

Project Management

- Planning for Construction Equipment and Machinery for construction project.
- Deals with planning, scheduling and execution of construction activity related to a project.
- Comprises of men, material, time and money management
- Emphasis will be on new construction practice such as pre-cast construction and prestress constructions, safety of men and material, utilization of marginal materials etc.

Following are the scopes of Construction Technology,

- Planning for Construction Equipment and Machinery for construction project.
- Deals with planning, scheduling and execution of construction activity related to a project.
- Comprises of men, material, time and money management
- Emphasis will be on new construction practice such as pre-cast construction and prestress constructions, safety of men and material, utilization of marginal materials etc.
- Construction of underground Tunnels using modern equipment's.
- Construction of floating structures.

vi) Fluid Mechanics, Hydraulics and Water Resources and Irrigation Engineering:

Hydraulics

- As we know that water is an very important need for all human beings.
- It mainly deals with study of mechanics of water and its flow characteristics like pipe flows, open channel flows, dams, irrigation, hydropower etc.
- Applications: - Determination of fluid properties such as density, vapour pressure etc.
- Design of valves, pipes, gates etc.
- Design of hydropower system etc.

Water Resources and Irrigation Engineering:

- It deals with tapping or storage of water and supplying water to agricultural fields (for crop cultivation), to drinking purposes and to other domestic/ industrial uses. Hence suitable water resources are identified and it is stored.
- Identifying, planning, building water retaining structures like dams, tanks and carrying stored water to needy area is known as water resource engineering.
- Irrigation: - Artificial supply of water to crops by different methods (Drip, Sprinkler irrigation) is called as irrigation.
- The important basic human needs i.e water and food are taken care by irrigation engineering directly or indirectly.

Following are the uses of Fluid Mechanics, Hydraulics and Water Resources and Irrigation Engineering

- To record the total discharge of water from rainfall from catchment areas
- To design the reservoir capacity to store the water • Water quality management and pollution control.
- Scope for usage of water for garden and recreational centres.
- Design of water supply systems for the cities and industries.
- Flood mitigation, land drainage and culverts for control of water.
- To measure the discharge of water in rivers for design of bridges.
- Design of hydroelectric power plants for generation of electricity.
- Design of Pumps and turbines.
- Design of water supply schemes for the city which includes design of pipes and pumps.
- Design of canals to carry water to irrigation land from dams.
- Design of Weirs for Dams

vii) Transportation Engineering:

- It plays a very important role in economic development of country.
- It mainly deals with study of existing transportation systems and their improvement for safe drive.
- It mainly includes design, construction and management of roads, railways, navigation and air-routs.
- The various modes of transportation are: Road ways, Railways, Airways and Water ways.
- Traffic management including traffic signals, number of lanes (width of roads), parking facilities and curves are also a part of transportation engineering.

Following are the scopes of Transportation Engineering,

- It involves planning, design, construction, operation and maintenance of transportation facility.
- Planning and design of air strip runways, roads, harbours and railways
- Maintenance and up gradation of harbours, airports, railway system based on requirements.
- It contributes economic, industrial, social and cultural development of any country.
- Design of traffic signals for control of traffic

viii) Environmental Engineering (water supply and sanitary engineering)

- This is an important branch of civil engineering which covers both water supply and sanitary engineering.
- The importance of clean environment was felt with the rapid growth in population, and growth in urbanization and industries.
- The science of civil engineering deals with the subject of tapping water from different sources, testing its quality, purification processes and distribution of water to the consumers.
- Similarly, the environmental engineering encompasses the subject of treatment of wastes which originate from different sources and deals with the removal of harmful substances in these wastes by different processes.
- The impact of wastes originating from industries is felt by living organisms if such wastes contain toxic substances.
- The Central Government as well as state governments have enacted laws for the protection of environment needed for the safe living of human beings.

Following are the scopes of Environmental Engineering,

- Involves collection of water, Purification and supply for drinking.
- Waste water collection, treatment and disposal
- Air pollution control and treatments.
- Solid waste management and control
- E-Waste management control and Treatment
- Construction waste management and control

ix) Remote sensing and GIS

- This is one of the new fields.
- The improvement in space technology, availability of GPS enhanced the scope of geographic information system.
- Good mapping technique helps to get required information accurately and quickly to effectively manage and monitor the available resources for optimal use.
- GIS is an high tech equivalent of map. It represents a means to locate ourselves in relation to world around us. It deals with measurement, mapping, monitoring and modelling of geographic information around us.

x) Earthquake engineering

- An Earthquake is a sudden and rapid shaking of the ground due to passage of vibrations beneath caused by transient disturbance of elastic or gravitational equilibrium of rocks.
- The scientific study of earthquakes is called seismology.
- Earthquakes are measured using observation from seismometers.
- Seismic waves are recorded on instruments called seismographs.
- The time, location, and magnitude of an earthquake can be determined from the data recorded by seismograph stations.
- Earthquake with magnitude of about 2 or less are usually called micro earthquakes, are generally recorded only on local seismographs.
- Events with magnitudes of about 4.5 or greater, are strong enough to be recorded by sensitive seismographs all over the world.
- Great earthquakes have magnitudes of 8 or higher.

Building materials:

1. Bricks
2. Cement & mortars
3. Plain Concrete
4. Reinforced &Pre-stressed Concrete
5. Structural steel
6. Construction Chemicals.

1. Bricks

- Bricks are obtained by moulding clay in rectangular blocks of uniform size and then by drying and burning these blocks.
- As bricks are of uniform size, they can be properly arranged, light in weight and hence bricks replace stones.
- Classification: Bricks can broadly be divided into two categories.
  (i) Unburnt or sundried bricks (ii) Burnt bricks

(i) **Un burnt or Sun-dried bricks**- Un burn or sun dried with the help of heat received from sun after the process of moulding. These bricks can only be used in the constructions of temporary and cheap structures. Such bricks should not be used at places exposed to heavy rains.

(ii) **(ii) Burnt Bricks**: The bricks used in construction works are burnt bricks and they are classified into the following 3 categories.

- First class bricks
- Second class bricks
- Third class bricks

➢ **First Class Bricks: -**

❑ Plain surface, sharp edges and size with tolerance in dimensions + or -3%

❑ Uniform red or brownish colored.

❑ High crushing strength, not less than 10.7 N/mm2

❑ Machine molded ❑ Efflorescence- NIL ❑ Water absorption less than 15%.

❑ USE: They are used for the exterior wall brick works, short columns and arches.

- **Second Class Bricks: -**

❑ Slightly uneven faces and edges with tolerance in dimensions +-8%

❑ Uniform colored but may be slightly over burnt.

❑ High crushing strength, not less than 7 N/mm2

❑ Hand molded

❑ Efflorescence- Little

❑ Water absorption less than 20%.

❑USE: They are used for internal walls and compound walls.

- **Third Class Bricks**

❑May be distorted with blunt edges.

❑ Over burnt or under burnt and non-uniform color.

❑ High crushing strength, not less than 3.5N/mm2

❑ Hand molded

❑ Efflorescence- Large

❑ Water absorption less than 25%.

❑USES: They are used for flooring, paving, small brick foundations and brick bat lime concrete (B.B.L.C.).

➢ Tests conducted on bricks: -

Following tests are conducted on bricks to determine their quality for construction,

- Absorption test.
- Crushing strength test.
- Hardness test.
- Shape and size.
- Color test.
- Soundness test.
- Structure of brick.
- Presence of soluble salts (Efflorescence Test)

2. Cement

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together.

Grade of Cement

The grade of cement is generally differentiated in terms of indicates the strength of cement. The strength of cement is generally measured as compressive strength. Compressive strength is the strength of cement molded in a standard cube, after 28 days of curing.

- **33 Grade Cement:** 33 grade cement means that the compressive strength of the cement after 28 days is 33N/mm2 when tested as per Indian Standards under standard conditions.
- **43 Grade Cement:** 43 grade cement means that the compressive strength of the cement after 28 days is 43N/mm2 when tested as per Indian Standards under standard conditions.
- **53 Grade Cement:** 53 grade cement means that the compressive strength of the cement after 28 days is 53N/mm2 when tested as per Indian Standards under standard conditions.

Types of Cement

1. Ordinary Portland Cement (OPC)

Ordinary Portland Cement also known as OPC is a type of cement that is manufactured and used worldwide. OPC cement are available in three grades, such as 33 Grade, 43 Grade, 53 Grade.

2. Portland Pozzolana Cement (PPC)

Portland pozzolana cement is prepared by grinding fly ash 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 (fly Ash).

3. Portland Slag Cement

Portland slag cement is the type of Portland cement obtained by mixing Portland cement clinker and gypsum with granulated blast furnace slag in suitable proportions and grinding them into a thorough and intimate mixture.

The Portland slag cement can also be manufactured by separately grinding Portland cement clinker with gypsum and blast furnace slag. Then, later mixing them both thoroughly in suitable proportions.

The product resulting from this manufacturing process is blended cement which has physical properties similar to ordinary Portland cement.

3. Mortar

Mortar is the mixture of cement, sand and water.

Uses of Mortar

- Mortar is used between the joints of the bricks during the construction of wall.
- It is used to give a soft even bed between different layers of brick or stone masonry for equal distribution of pressure over the bed.
- It is used in plastering works to hide the joints and to improve appearance.
- Used in the manufacture of precast pipes, plant pots and precast water tanks.
- Used for repair of cracks
- It is used for molding and ornamental purpose.

Types of Mortar

1. Lime Mortar:

   It is a mixture of lime (fat lime or hydraulic lime), sand and water
2. Gauged Mortar:

   It is a mixture of cement, lime, sand and water.
3. Surkhi Mortar :

   It is a mixture of lime, surkhi and water.
4. Cement mortar:

   It is a mixture of cement, sand and water
5. Lime Pozzolana Mortar:

   It is a mixture of lime, Pozzolana, sand and water
6. Mud Mortar:

   Mud mortar is a type of mortar where mud is used as a binding material and saw dust, rice husk ash or cow dung is used as fine aggregate.
7. Aerated Cement Mortar:

   Basically it is a cement mortar in which air entraining agent is added to increase plasticity and workability
8. Heavy weight Mortar:

   Density of mortar is high.
9. Light Weight Mortar:

   Lightweight mortar is the type of mortar which is prepared by mixing saw dust, rice husk,

jute fibers, coirs, asbestos fibers etc. along with sand and lime or cement.

Requirements of Mortar

- It should be capable of developing good adhesion with the building units such as bricks, stones etc.
- It should be capable of developing the designed stresses.
- It should be capable of resisting penetration of rain water.
- It should be cheap.
- It should be durable
- It should be easily workable
- It should not affect the durability of materials with which it comes into contact.
- It should set quickly so that speed in construction may be achieved.
- The joints formed by mortar should not develop cracks and they should be able to maintain their appearance for a sufficiently long period.

4. Concrete: -

Concrete is obtained by mixing cement, fine aggregate (sand), coarse aggregate(crushed stone) and water in a definite proportion.

There are mainly three types of cement concrete

1. Plain cement concrete (P.C.C)
2. Reinforced cement concrete (R.C.C)
3. Pre-stressed Concrete (P.S.C)

1. Plain cement concrete (P.C.C)

Plain Cemenet Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens with time.

Grade of PCC:

- IS 456-2000(Indian Standard Code Book) has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40. In this designation the letter M refers to the mix and the number to the specified 28-day cube strength of mix in N/mm^2. The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

Factors Influencing the Strength of PCC:

1. Ratio of the cement to the mixing water
2. Ratio of cement and aggregate
3. Grading of the aggregate
4. Shape, size, texture of the aggregate
5. Mode of compaction
6. Curing method and the curing temperature
7. Concrete Mix
8. Rate of Loading
9. Moisture conditions
10. Age of the cement
11. Gel - space ratio
12. Age of concrete
13. Maximum size of the aggregates
14. Water -Cement Ratio
15. Porosity

Types of Plain Cement Concrete (PCC):

1. **Normal Strength Concrete**

The concrete that is obtained by mixing the basic ingredients cement, water and aggregate will give us normal strength concrete. The strength of these type of concrete will vary from 10 MPa to 40MPa. The normal strength concrete has an initial setting time of 30 to 90 minutes that is dependent on the cement properties and the weather conditions of the construction site.

2. **Lightweight Concrete**

Concrete that have a density lesser than 1920kg/m3 will be categorized as lightweight concrete. The use of lightweight aggregates in concrete design will give us lightweight aggregates. Aggregates are the important element that contributes to the density of the concrete. The examples of light weight aggregates are the pumice, perlites, and scoria. The light weight concrete is applied for the protection of the steel structures and are also used for the construction of the long span bridge decks. These are also used for the construction of the building blocks.

3. **High-Density Concrete**

The concretes that have densities ranging between 3000 to 4000 kg/m3 can be called as the heavyweight concrete. Here heavy weight aggregates are used. The crushed rocks are used as the

coarse aggregates. The most commonly used heavy weight aggregates is Barytes. These types of aggregates are most commonly used in the construction of atomic power plants and for similar projects.

4. **Air Entrained Concrete**

These are concrete types into which air is intentionally entrained for an amount of 3 to 6% of the concrete. The air entrainment in the concrete is achieved by the addition of foams or gas - foaming agents. Some examples of air entraining agents are resins, alcohols, and fatty acids.

5. **High-Strength Concrete**

   The concretes that have strength greater than 40MPa can be termed as high strength concrete. This increased strength is achieved by decreasing the water-cement ratio even lower than 0.35.

6. **High-Performance Concrete**

These concretes conform to a particular standard but in no case, will be limited to strength. It has to be noted that all the high strength concrete can be high-performance type. But not all high-performance concrete (HPC) are high strength concrete. Standards that conform to the high-performance concrete are enlisted below:

- Strength gain in early age
- Easy placement of the concrete
- Permeability and density factors
- Heat of hydration
- Long life and durability
- Toughness and life term mechanical properties

2. **Reinforced cement concrete (RCC)**: -

concrete has a very high compressive strength but low in tensile strength. Wherever tensile forces are involved like in slabs and beams, it is recommended not to use plain concrete. So, adding steel to the concrete is the solution, as we know it has high tensile strength and also possesses good compressive strength. However, the bond between concrete and steel works well and when these two are combined called reinforcement. After the alliance, the material is known as Reinforced Cement Concrete.

Advantages of Reinforced Cement Concrete

Structures made from reinforced concrete are stable and durable. It possesses high compressive and high tensile strengths. It is economical, and the maintenance cost is almost ignorable. R.C.C has the least chances of buckling and rusting. It has resistance to fire and other climatic changes.

R.C.C structures are aesthetically up to the mark and do not require cladding. The material is available everywhere around the world and does not require expertise for working on it; normal skilled labour can also work with it.

Uses of Reinforced Cement Concrete

- R.C.C is widely used construction material from foundations to the rooftops of the building. Some of its chief uses are listed below:
- It is used as a structural element in beams, columns, footings, lintels, stairs, roofs and slabs.
- It is used for pre-casting railway sleepers and electric poles.
- It is used for paving in airports, roads and high traffic areas.
- Pipes and conduits have been constructed from reinforced concrete
- Reinforced concrete is used for construction of bridges of small, medium and long spans resulting in aesthetically superior and economical structures in comparison with steel bridges
- It is used for constructing various structures like water tanks, dams, bins, silos, bunkers, bridges, retaining walls, underwater structures, towers, multi-storey buildings, docks and harbours.
- R.C.C is the most used building material for almost all types of structures and is also used in atomic plants to prevent danger from radiations emitting from it.

3. Prestressed Concrete (PSC)

Prestressed concrete is a system devised to provide sufficient precompression in the concrete beam by tensioned steel wires, cables, or rods that under working conditions the concrete has no tensile stresses or the tensile stresses are so low that no visible cracking occurs.

Types of Prestressing:

1. Pre-tensioning

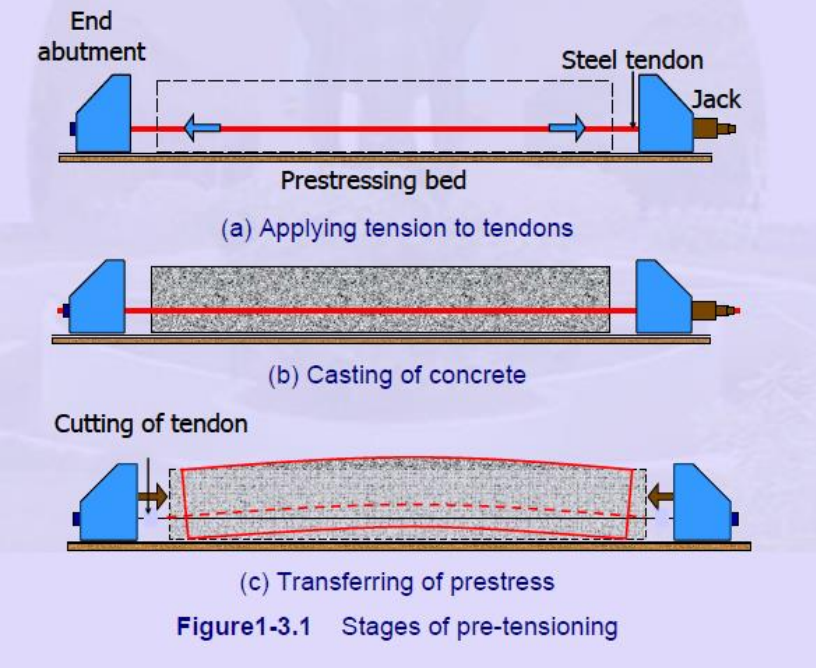


Figure1-3.1 Stages of pre-tensioning

- In this method, the concrete is prestressed with tendons before it is placing in position.
- This method is developed due to the bonding between the concrete and steel tendons.
- Pre-tensioning is preferred when the structural element is small and easy to transport.
- In this method, similar prestressed members are prepared.
- Pre-tensioning members are produced in mould.

2. Post-tensioning

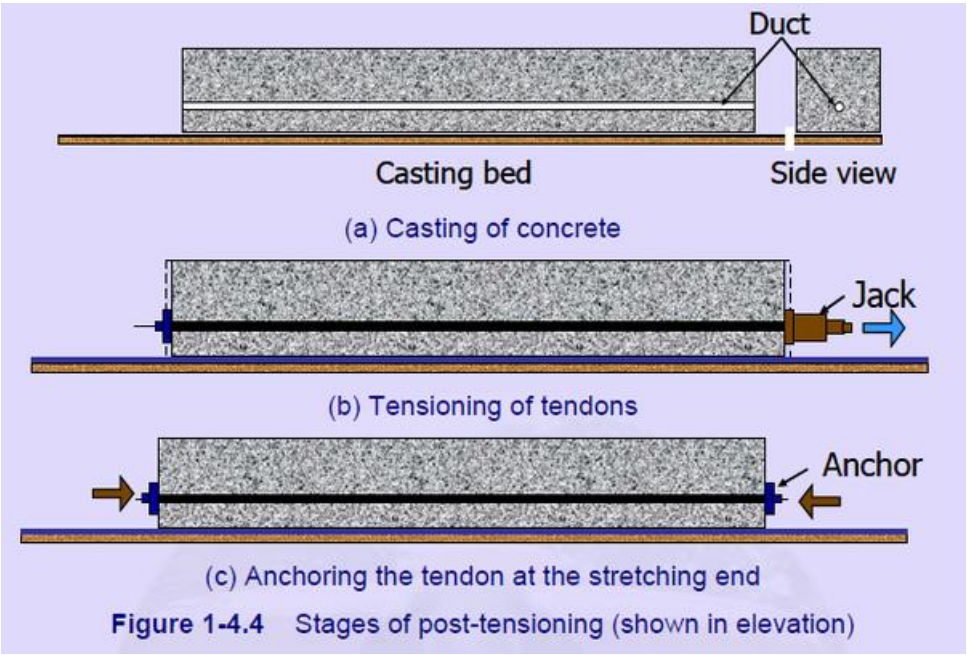


Figure 1-4.4 Stages of post-tensioning (shown in elevation)

- In this method prestressing is done after the concrete attains sufficient strength.
- This method is developed due to bearing.
- Post-tensioning is preferred when the structural element is heavy.
- In this method, products are changed according to the structure.
- Cables are used in place of wires and jacks are used for stretching.

5. Steel: -

- Steel is an alloy of iron and carbon containing carbon from 0.25 to 1.25%.
- Steel is highly elastic, ductile, malleable, forgeable and weld- able.

Types of steel: -

a. Mild steel
b. TOR steel
c. High tensile steel

➢ Mild steel: -

- Mild steel is a plain carbon steel.
- The % of carbon alloy is < 0.25%.
- It used as structural as well as non-structural steel in form of various sections like I section, channel angle and in form of round bars as a reinforcement in concrete.
- Mild steel bars are designated as Fe-250.
- Where 250 is yield strength in N/mm^2.
- Fe denotes the ferrous metal.

➢ TMT OR TOR steel

Thermo Mechanically Treated or TMT bars are high-strength reinforcement bars that feature a tough outer core and a soft inner core. To put it simply, it is a form of HYSD steel, where the steel bars after undergoing the mandatory heat treatment process.

➢ High tensile steel wires (tendons)

- Two wires are spun together to form the strand.
- A group of strands or wires are placed together to form a pre-stressing tendon.
- A group of tendons form a prestressing cable.
- Their ultimate strength ranges from 1500 to 2350 N/mm^2.

Use of steel: -

- As a structural material in trusses, beams and in the form of various sections**.**
- As a non-structural component for grills, windows, doors.
- In the fabrications of steel pipes, tanks etc.
- Used as a corrugated sheets which act as roof over the structure.
- Mild steel is used as a distribution steel and TOR steel is used as a main steel in RCC.
- High tensile steel cable are used in pre-stressed concrete.

6. Construction Chemicals

1. Adhesives

- Adhesives have rich bonding properties apart from weatherproofing and waterproofing
- They are widely used in all types of construction works which include panel fixing, tile fixing, and floor covering.

2. Sealants and Caulks

- Sealants and caulks are construction chemicals that are used to block an opening surface or small cracks to prevent liquid, gas or moisture leakage that can damage the construction.

3. Epoxy Grouts

- These chemicals are used for grouting and has high durability property and can be applied even in extremely high temperatures.
- These chemicals are quite expensive

4. Admixtures

- Admixtures are used to modify the flow characteristics, strength and durability of concrete

5. Concrete Curing Compound

- These are natural and synthetic resins, waxes, solvents of high volatility at atmospheric temperatures.
- After applying on freshly built concrete, a moisture absorbent film is shaped by the compound

6. Polymer Bonding Agents

- These are specially designed to apply it as a bonding element with concrete and other cement-based products in exterior or interior applications.

7. Protective and Decorative Agents

- Sometimes, in order to prevent the risk of corrosion, a layer of metallic or non-metallic coating of specific material is applied to the surface of Concrete.
- This layer is called 'Protective Coating'.
- Polymers, epoxies, and polyurethanes are mostly used materials in a non-metallic protective coating.
- Aluminium, zinc, and chromium are the materials used for metallic protective coatings.

8. Water Repellents

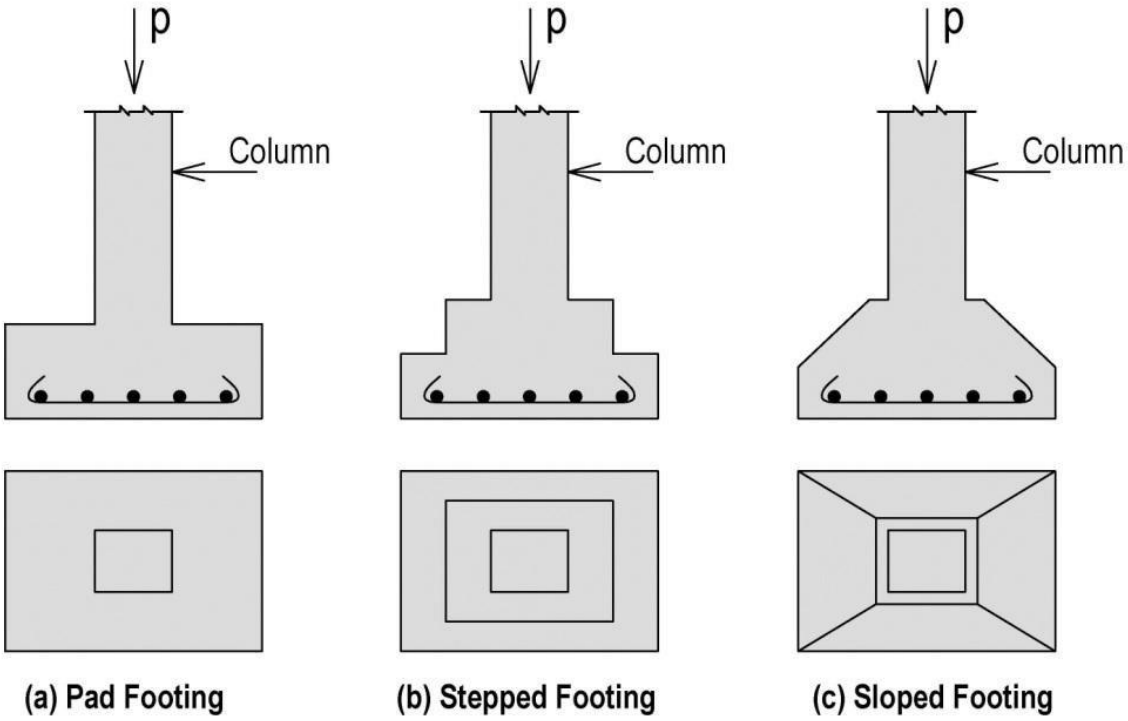
- These construction chemicals come with water repellents.
- They are extensively used to protect masonry and concrete from the adverse effects of water or moisture.

  Eg. Acrylic protective coating

STRUCTURAL ELEMENTS OF A BUILDING

1. Foundation
2. Plinth
3. Lintel
4. Chejja
5. Masonry wall
6. Column
7. Beam
8. Slab
9. Staircase

1. Foundation



- A Foundation is the lowest part of the building structure resting on soil below ground level.
- This is the first structural unit to be constructed for any building construction.
- Its main function is
    - Transfer All loads of building through beam and column arrangement.
    - Distribute the load evenly and safely to the ground.
    - Prevents settlement of the building.

Types of Foundation

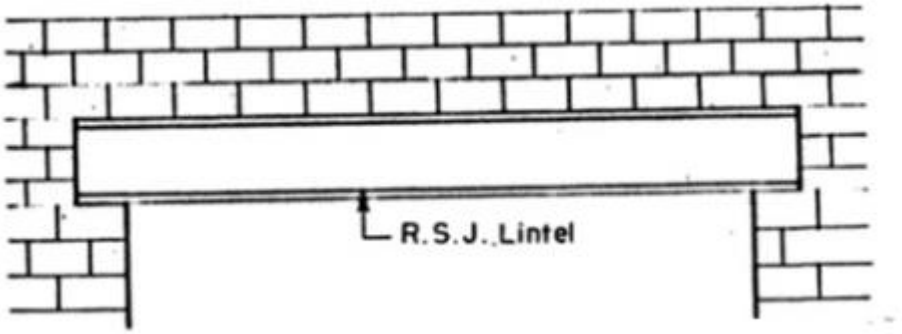
Following are different types of foundations used in construction:

1. **Shallow foundation**
    - Individual footing or isolated footing
    - Combined footing
    - Strip foundation
    - Raft or mat foundation
2. **Deep Foundation**
    - Pile foundation
    - Drilled Shafts or caissons

2. Plinth

- The plinth is a part of the foundation constructed either at or above the ground.
- Plinth is the offset created between ground level and the superstructure of the building.
- It is made by constructing a brick/stone wall or RCC beam from the ground level to the flooring level of the building.
- Plinth constructed by RCC beam is called a Plinth beam.
- Its main function is
    - To prevent the entry of moisture from the ground surface to the building superstructure
    - To take up the load of the wall coming over it.

3. Lintel

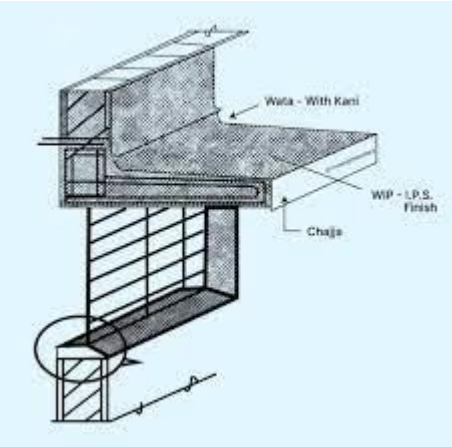


- Lintels are constructed above the wall openings like doors, windows, etc.
- Normally, lintels are constructed by reinforced cement concrete.
- In residential buildings, lintels can be either constructed from concrete or brick or stone masonry.
- Its main function is to support the weight of the wall coming over the opening.

Types of Lintel

1. Timber Lintel
2. Stone Lintel
3. Reinforced Brick Lintel
4. Steel Lintel
5. RCC Lintel

4. Chejja

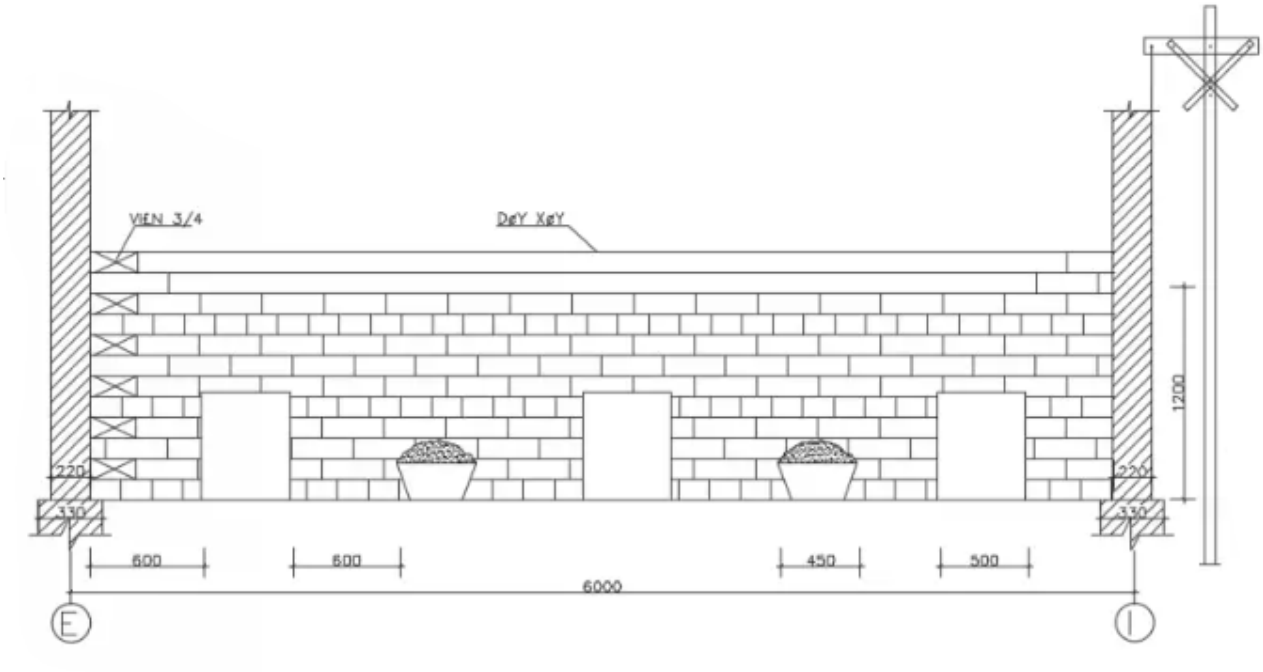


- This is a structure that is generally constructed above the window and projected outside from the window face.
- Chejjas can also be provided above doors.
- Chejjas are constructed from reinforced cement concrete.

Advantages of providing Chejja

- It protects the house from external sunlight.
- It protects the house by providing a barrier for rain water to enter.
- It can be used to place the compressor of AC.
- Chajja helps to protect the wooden windows from rain and sun.
- Chajja serves as an aesthetic decoration to the building.

5. Masonry Wall

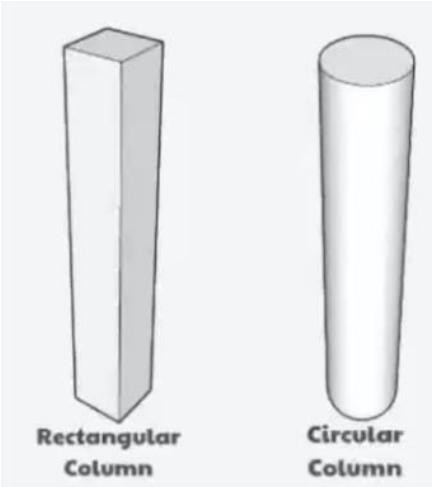


- Walls are vertical elements of a building which support the roof.
- They provide an enclosure and protect against wind, sunshine, rain etc.
- Doors and Window openings are provided in the walls for ventilation and access to the building.
- It can be constructed using stones, bricks, concrete blocks, etc.
- Different types of bonds are used for constructing walls.
- The main function of masonry wall is to provide an enclosure and protect against wind, sunshine, rain etc.
- The main components of masonry wall are
    - Masonry Units: Mud bricks, Cement concrete bricks, hollow bricks
    - Masonry Mortar: Mortar is used between the joints of the brick layers.

Types of Masonry Wall

1. Load-bearing masonry wall
2. Reinforced masonry wall
3. Hollow/Cavity masonry wall
4. Composite masonry wall
5. Precast masonry wall

6. Columns

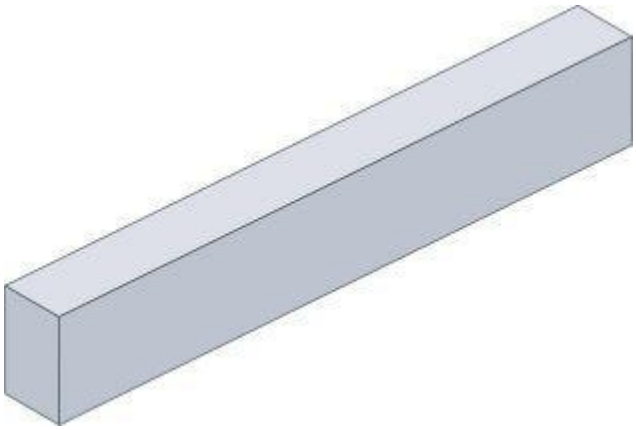


- Columns are vertical members constructed above the ground level to support any structural frame.
- Load Coming from the Slab and Beams are transferred to the columns and columns transfer the load to the footing safely.
- Columns can be of two types:
    - Architectural columns: They are constructed to improve the building's aesthetics
    - Structural columns: They take the load coming from the slab above and transfers it safely to the foundation.

Types of Columns

1. Rectangular/Square Columns
2. Circular Columns
3. Short Columns
4. Long Columns
5. Axially Loaded Columns
6. Column with Uniaxial Eccentric Loading
7. Column with Biaxial Eccentric Loading
8. Composite Columns

7. Beams



- Beam is a horizontal structural member used to carry vertical load, shear load and sometime horizontal load.
- It is the major component of building structures. It mainly used in construction of bridges, trusses, and other structures which carry vertical load.

Types of Beams

Based on Geometry

1. Straight beam
2. Curved Beam
3. Tapered Beam

Based on Material

1. Timber Beam
2. Reinforced Concrete beam
3. Steel Beam

Based on Cross section

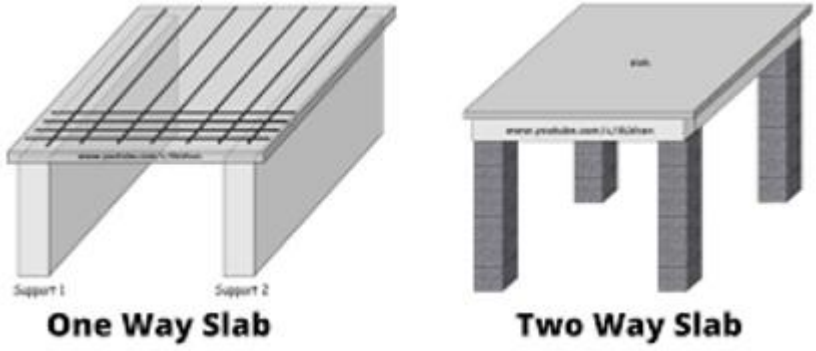
1. Rectangular Beam
2. T – Beam
3. I – Beam

Based on Type of support

1. Simply Supported Beam
2. Fixed Beam
3. Continuous Beam
4. Cantilever Beam

5. Over hanging Beam

8. Slabs

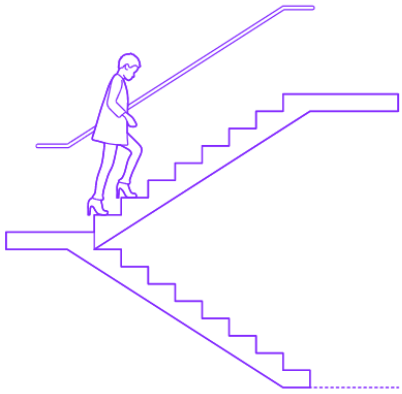


- Slabs are constructed to provide flat surfaces, usually horizontal in building floors, roofs, bridges, and other types of structures.
- The slab may be supported by walls or by reinforced concrete beams usually cast monolithically with the slab or by structural steel beams or by columns, or by the ground.

Types of Slabs

1. One way slabs
2. Two way slabs
3. Flat slabs
4. Grid slabs
5. Precast slab
6. Composite slab
7. Hollow core slab
8. Sunken slabs
9. Waist Slab
10. Projected slab

9. Stair Case



- A stair is a sequence of steps that connects different floors in a building structure.
- The space occupied by a stair is called as the stairway.
- Stairs can be constructed by wood, Steel, Brick or Stone, R.C.C etc.
- Its main function is
    - To provide an access from one floor to another.
    - To provide a safe means of travel between floors.
    - To provide a suitable means of escape in case of fire

Types of stairs

1. Straight Stair,
2. Dogged-legged Stair,
3. Open Newel Stair,
4. Circular Stair,
5. Spiral Stair,
6. Bifurcated Stair.