



# INTRODUCTION TO CIVIL ENGINEERING

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# Engineering

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



# Civil Engineering

It is the oldest branch of professional engineering, where the civil engineers are concerned with projects for the public or civilians.



# INTRODUCTION TO CIVIL ENGINEERING

- Oldest branch of engineering, where the civil engineers are concerned with projects for the public or civilians
- It is called as General engineering because civil engineering uses the principles and information provided by other branches of engineering while erecting civil engineering structures





# INTRODUCTION TO CIVIL ENGINEERING

**The role of Civil engineers is seen in every walk of life or infrastructure development activity such as**

- Shelter - low cost houses to high rise apartments
- Roads – Village roads to Highways
- Dams, Irrigation tanks, Canals
- Supplying safe and potable water
- Sewage treatment and Solid waste disposal
- Hydro- electric and thermal power plants – Generating electricity
- Transportation – Railways, Harbour and airports
- Bridges across streams, rivers and seas
- Tunnel across mountains



# **BRANCHES OF CIVIL ENGINEERING**

- 1. Surveying**
- 2. Structural engineering**
- 3. Geotechnical engineering**
- 4. Hydraulics and Water resources**
- 5. Environmental engineering**
- 6. Construction Planning and management**
- 7. Transportation engineering**

# I. Surveying

- Surveying is the science and art of determining the relative positions of various points above, on or below the surface of the earth.
- The relative positions in surveying are determined by measuring horizontal distances, vertical distances (elevations), horizontal angles and vertical angles accurately by using various surveying instruments.



# I. Surveying

## Important Objectives of Surveying:

- To determine areas, volumes and other related quantities.
- To layout or to mark the positions of the proposed structure on the ground.
- To take measurements and to determine the relative positions of the existing features on or near the ground.



# I. Surveying

**Surveying is Generally Divided into 2 types:**

1. Plane Surveying
2. Geodetic Surveying





# I. Surveying

**Surveying is Generally Divided into 2 types:**

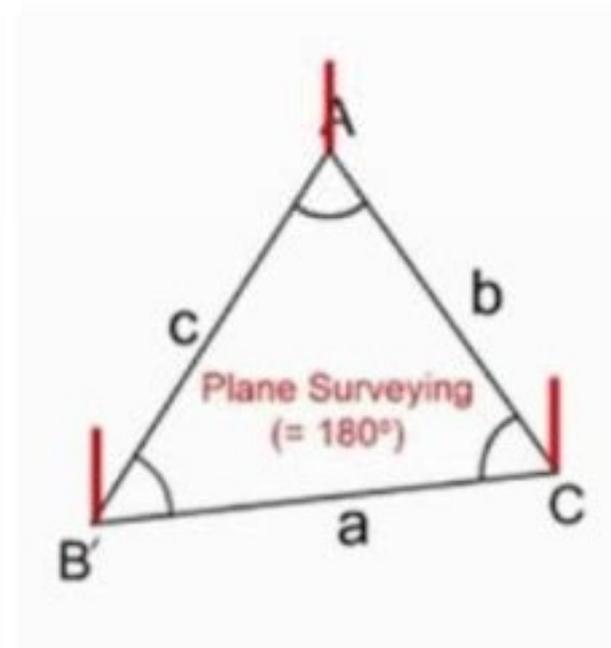
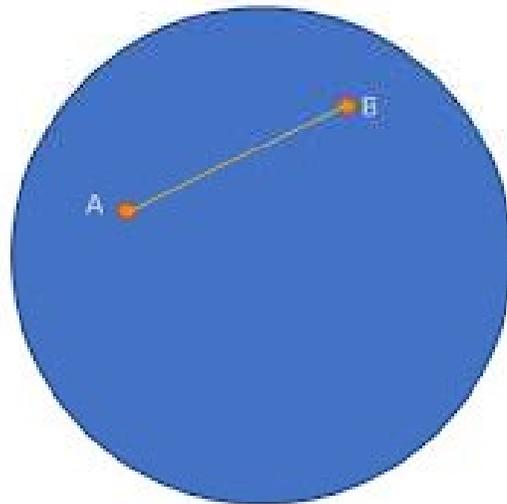
## I. Plane Surveying

- It is the type of surveying in which the curvature of the earth is neglected and it is assumed to be a flat surface.
- Plane Surveying can safely be used when one is concerned with a small portion of the earth surface and the areas involved are less than 250 sq.km or so.
- In plane surveying, the angles of polygons and triangles are considered as plane angles. It is used for relatively small areas.
- A curved line on the surface of the earth is considered as mathematically straight.

# I. Surveying

Surveying is **Generally Divided** into 2 types:

## I. Plane Surveying



# I. Surveying

**Surveying is Generally Divided into 2 types:**

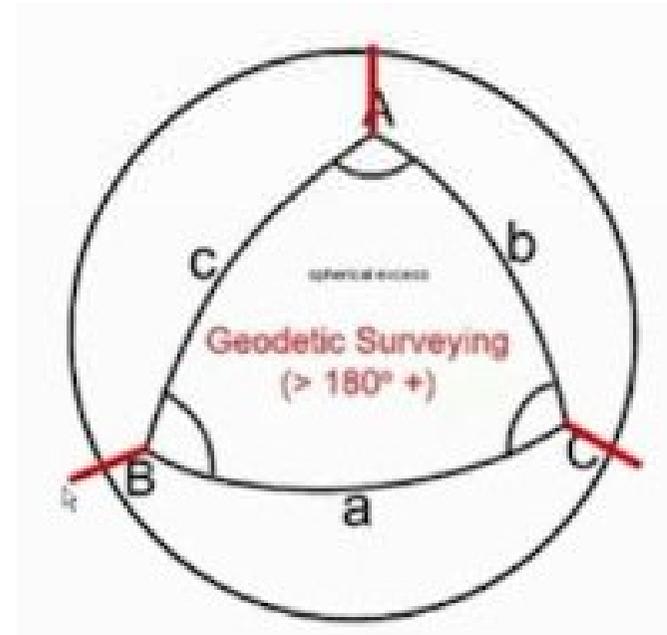
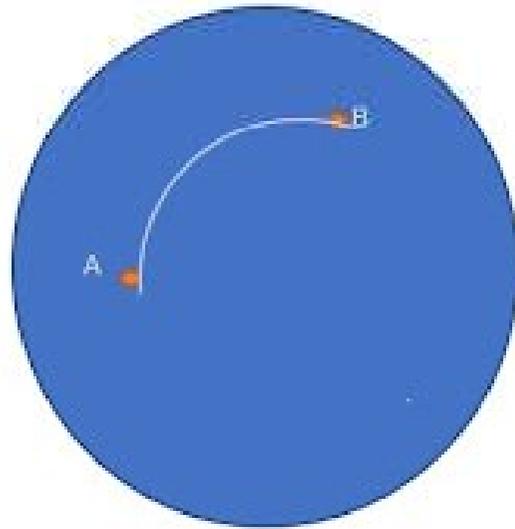
## 2. Geodetic Surveying

- It is the type of surveying in which the curvature of the earth is taken into consideration and a very high standard of accuracy is maintained.
- It is used for large areas and it is used for establishing precise points of reference or control points.
- Geodetic Surveying can be used when one is concerned with a larger portion of the earth surface and the areas involved are more than 250 sq.km.
- The angles of polygons and triangles are considered as Spherical angles.
- A curved line on the surface of the earth is considered as Arc.

# I. Surveying

Surveying is **Generally Divided into 2 types:**

2. Geodetic Surveying



| Plane Surveying   | Geodetic Surveying  |
|---|---|
| Curvature of earth is not taken into account.   | Curvature of earth is taken into account.   |
| The line joining any two points is treated as a straight line.  | The line joining any two points is treated as the arc of the circle.  |
| Length up to 12KM is treated as plane surveying.  | Length more than 12KM is treated as geodetic surveying.   |
| A triangle formed by joining three points is considered as plane triangle. Knowledge of trigonometry is required. | A triangle formed by joining three points is considered as spherical angles. Knowledge of spherical trigonometry is required. |
| Knowledge of plane trigonometry is required.  | Knowledge of spherical trigonometry is required.  |
| Area up to 196 Sq. Km. is treated as a plane  | Area more than 196 Sq. Km. is treated as geodetic surveying.  |
| It is less accurate and less correct.   | It is more accurate and more correct.   |
| Used in general civil engineering survey project work   | Used for the precise location of a widely distant area.   |

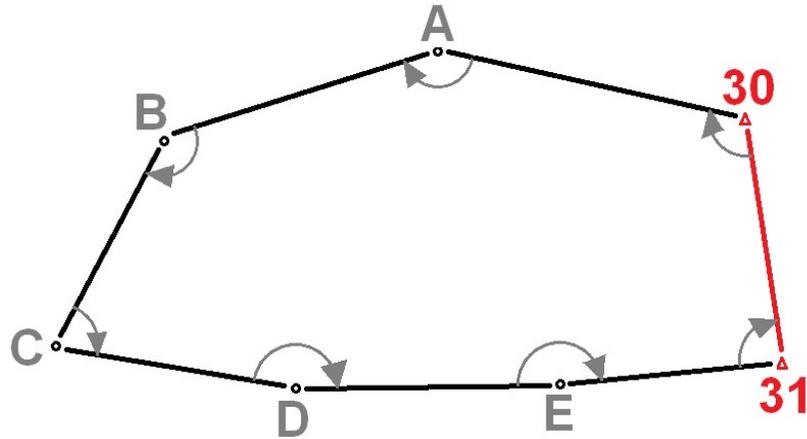
# I. Surveying

## Classification based on the function

- **Control Survey:** It consists of establishing the horizontal and vertical positions of widely spaced control points using the principles of geodetic surveying.
- **Land Survey:** It is used to determine the boundaries and areas of tracts of land. Surveys are also used to provide data for making a plan of the area. A cadastral survey is done for marking legal boundaries of land.
- **City Survey:** These surveys are conducted within the limits of a city for urban planning. These are required for the purpose of layout of streets, building, sewers, pipes, etc.

# I. Surveying

## Classification based on the function



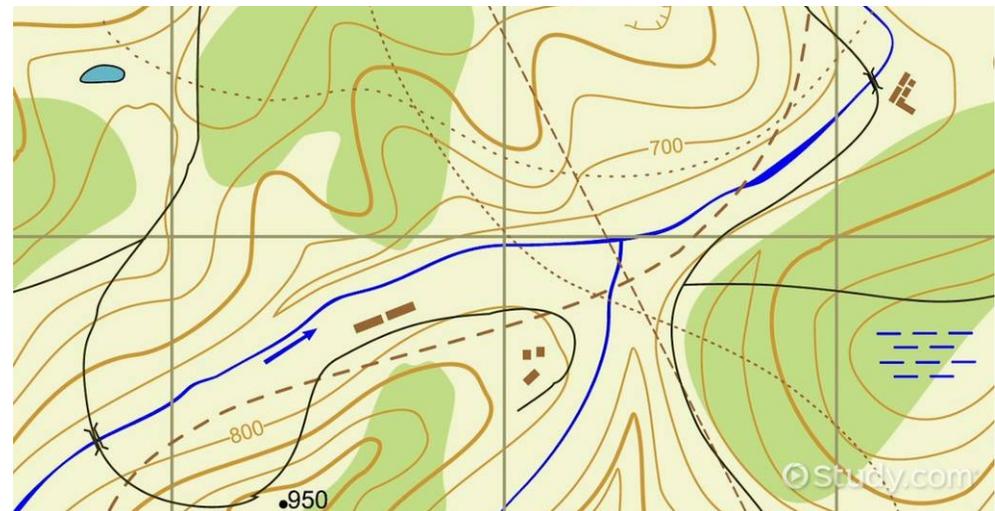
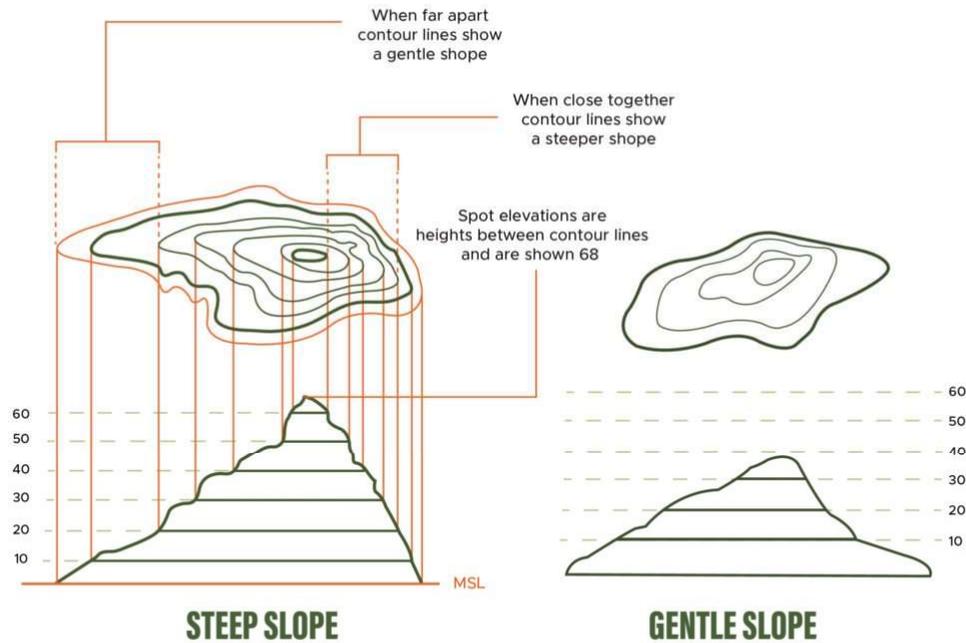
# I. Surveying

## Classification based on the function

- **Topographical Survey:** Topography is defined as the shape. These surveys are required to establish horizontal locations of the various points as well as their vertical locations. It is carried out to describe the existing natural features like rivers, mountains, forests and manmade features (villages, building, roads & transmission lines) etc.
- **Route Survey:** These are special types of topographical surveys conducted along a proposed route for a highway, railway, sewer line, etc. This also includes the staking out and calculations of the earth work.

# I. Surveying

## Classification based on the function



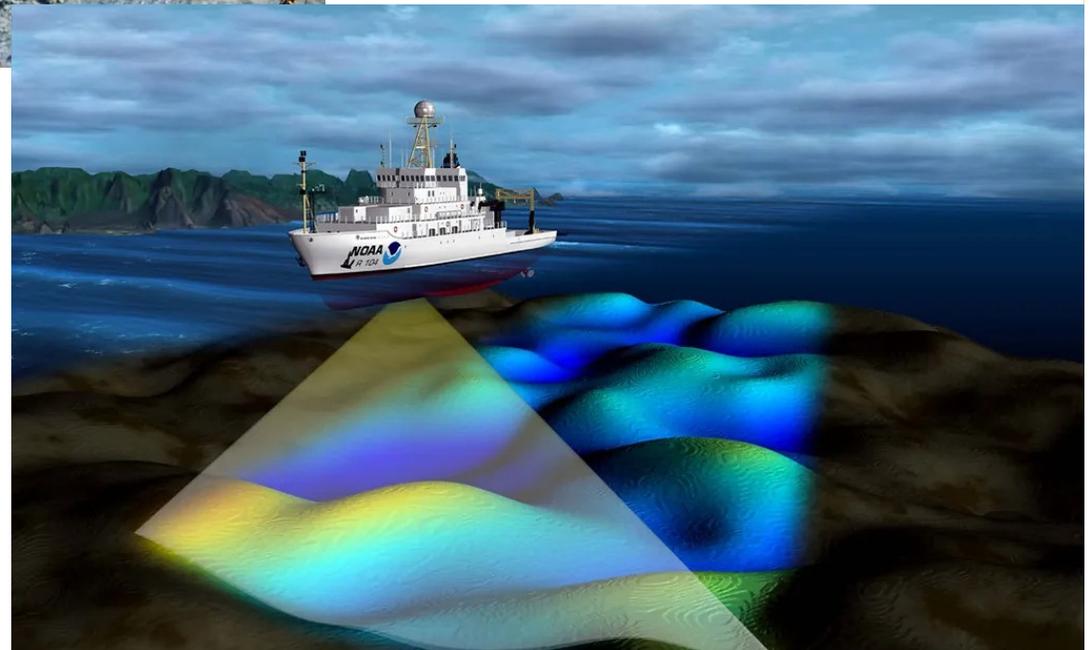
# I. Surveying

## Classification based on the function

- **Mine Survey:** It will be carried out to determine the relative positions and elevations of mines, shafts, bore holes etc for underground works.
- **Hydrographic Survey:** It is carried out on or near the body of water, such as lakes, rivers, bays, harbors. Marine surveys are special types of hydrographic Surveys. These cover a broader area near sea for offshore structures, navigations, and tides etc.

# I. Surveying

## Classification based on the function



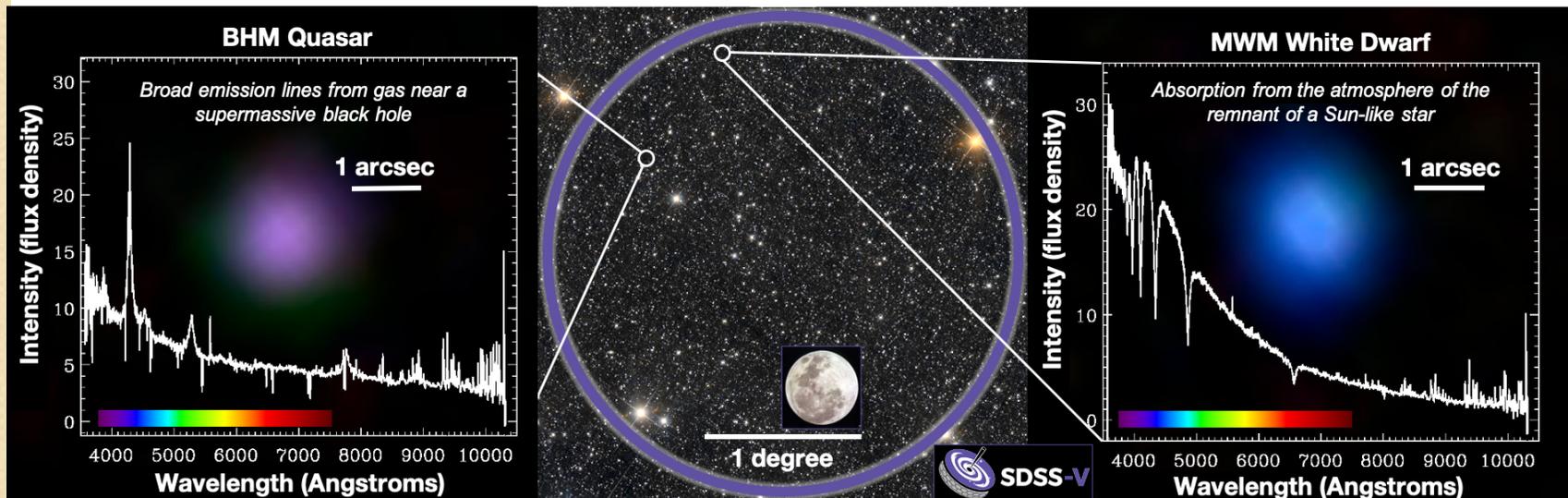
# I. Surveying

## Classification based on the function

- **Engineering Survey:** It is conducted to collect data for designing and planning of engineering works such as buildings, roads, bridges, dams, reservoirs, sewers and water supply line.
- **Astronomic Survey:** It is carried out for determination of latitudes, longitudes azimuths, local time etc for various places on the earth by observing heavenly bodies (the sun or stars).

# I. Surveying

## Classification based on the function



# I. Surveying

## Classification based on the function

- **Satellite Survey:** It is conducted to obtain intercontinental, inter-datum and inter-island geodetic ties all the world over by artificial earth satellites.
- **Geological Survey:** It is carried to obtain information about different strata of earth's surface for geological studies.
- **Construction Survey:** After the plans have been prepared and the structures designed, the construction survey is conducted.

# I. Surveying

**Classification based on the function**



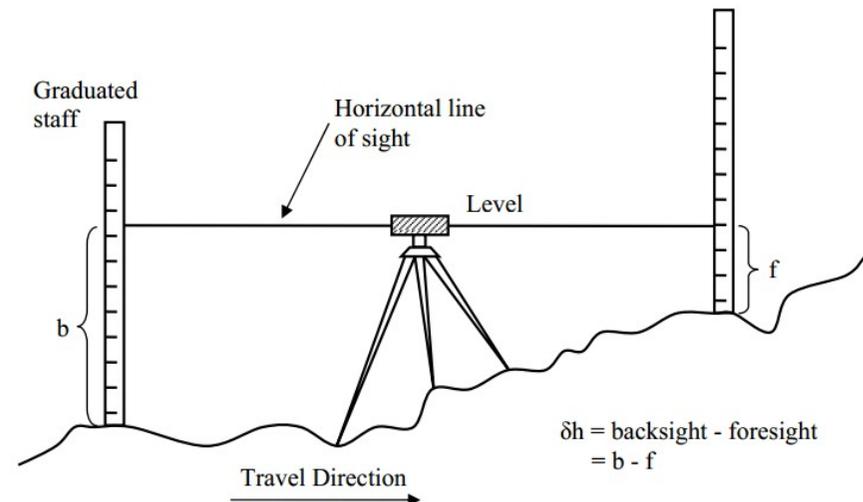
# I. Surveying

## Classification based on the instrument

- **Chain Surveying:** This is the simple type of surveying in which only linear measurements are taken with a chain or tape. It is generally used when high accuracy is required.
- **Compass Surveying:** Horizontal angles are measured with the help of a magnetic compass. The compass survey is not very accurate.
- **Leveling:** It is used for determination of relative elevations (RL) of various points in the vertical plane with leveling instruments.

# I. Surveying

## Classification based on the instrument



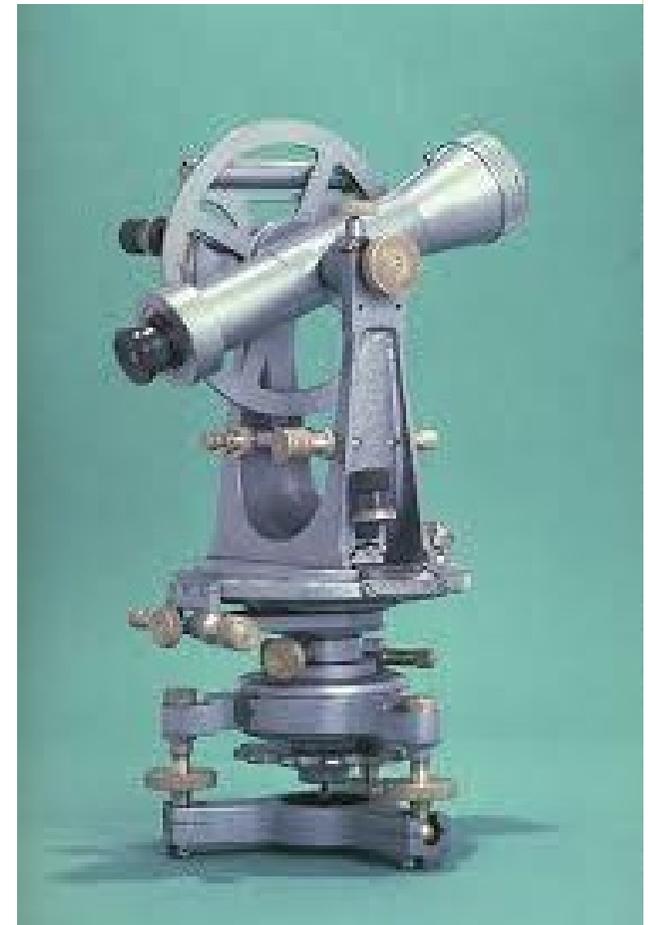
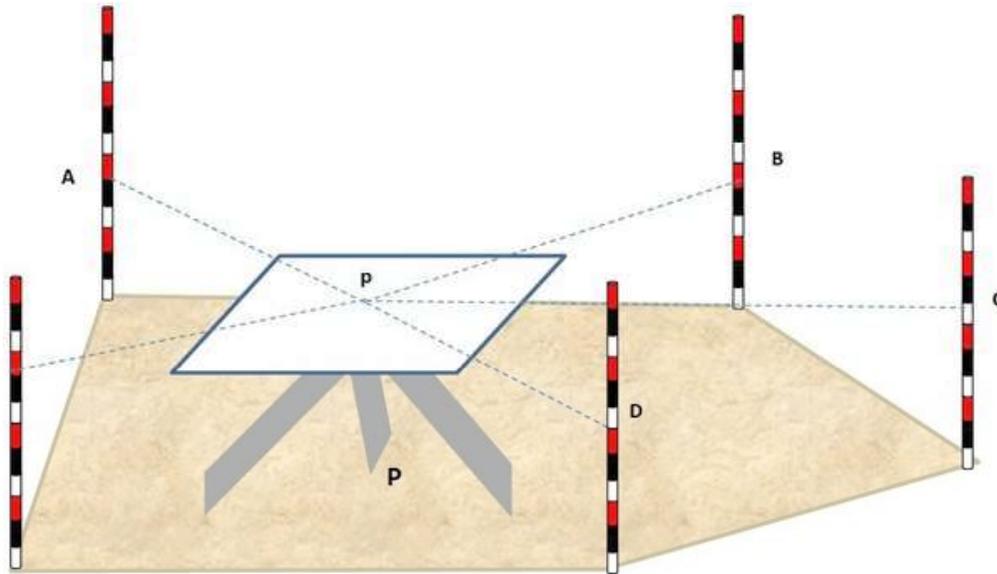
# I. Surveying

## Classification based on the instrument

- **Plane Table Surveying:** Map is prepared the field while viewing the terrain after determining the directions of various line and taking the linear measurements with a chain or a tape. The accuracy of the plane table surveying is low.
- **Theodolite Survey:** A theodolite is a very precise instrument for measuring horizontal and vertical angles. These can be broadly classified into Traverse and Triangulation.

# I. Surveying

## Classification based on the instrument



# I. Surveying

## Classification based on the instrument

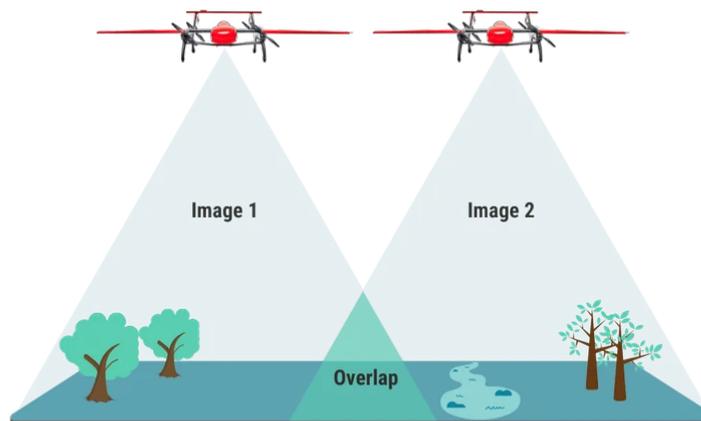
- **Tacheometric Survey:** Horizontal angles, horizontal distances and elevations are measured with a tacheometer. These are not very accurate but these are extremely convenient for determining topographical details.
- **Photogrammetric Survey:** It is used for topographic mapping of vast areas. These are extremely useful for obtaining topographical details of areas which are difficult to reach.

# I. Surveying

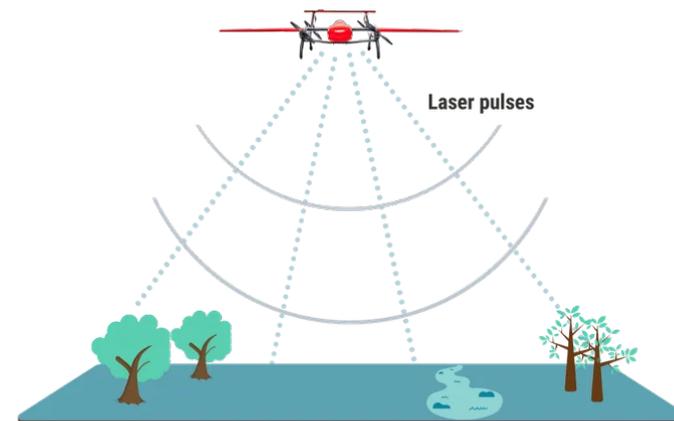
## Classification based on the instrument



Photogrammetry



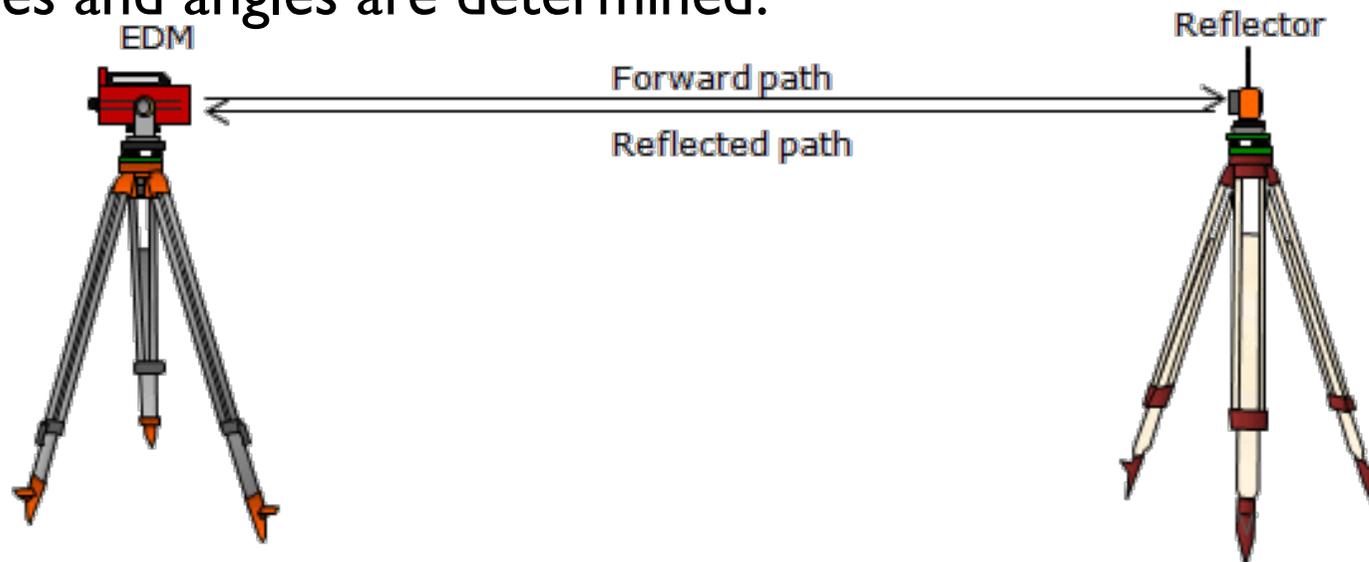
LiDAR



# I. Surveying

## Classification based on the instrument

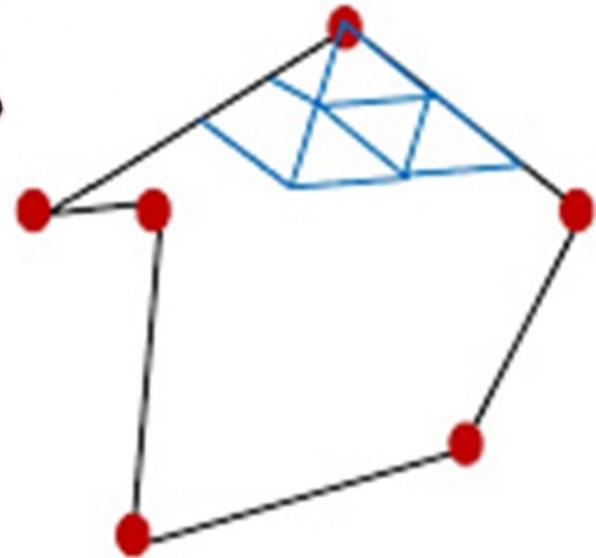
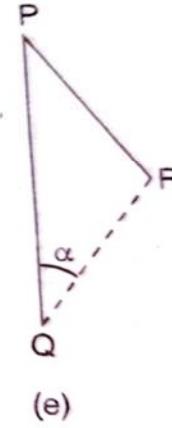
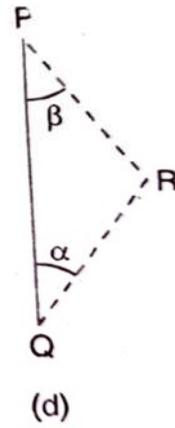
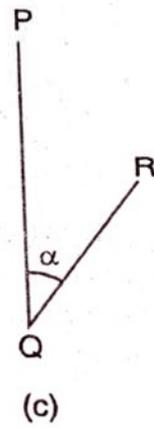
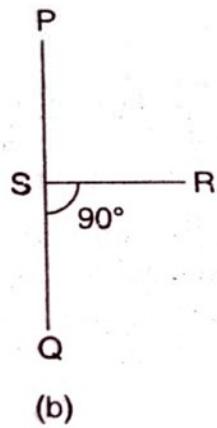
- **EDM Survey:** Trilateration is a type of triangulation in which all the three sides of each triangle are measured accurately with EDM instruments. The angles are computed indirectly from the known sides of the triangles. Thus, all the sides and angles are determined.



# I. Surveying

## Principles of Surveying

1. Location of a point by measurement from two points of reference
2. Working from whole to part





# I. Surveying

## **Necessity of Surveying**

- It helps to collect field data
- To prepare plan or map of the area surveyed.
- To set out field parameters at the site for further engineering works.
- To establish boundaries of land.
- To analyse and to calculate the field parameters for setting out operation of actual engineering works

## 2. Building Materials



Bricks



Cement



Concrete



Sand



Reinforcement



Glass



Plastic



Wood



Tiles

## 2. Building Materials

- This deals with the study of materials used for construction.
- Brick, tiles, soil, cement, stone, steel, aggregates, glass, wood, plastics etc. include construction materials.
- Some are natural and many are man-made.
- This deals with the proper use of desired material economically and safely.
- The mechanical properties of these materials shall be sufficient to avoid failure and excessive deformation and provide durability.

### 3. Construction Technology

- Construction Technology deals with planning the different activities like manpower, materials & machinery, so that the construction is completed in time and in an economical manner.



# 3. Construction Technology

## Scope:

- It gives guidelines regarding the execution of construction work to be carried out.
- It helps in preparing construction schedule. Schedule is a systematic path of different activities carried out one after another.
- It helps in proper management of material, labour and equipment.
- It helps in arranging for finance and due to proper construction management, there is financial and overall control on the work.

# 4. Structural Engineering

It deals with the study of analysis and design of structures



# 4. Structural Engineering

## Scope:

- Sections of structural elements like beams, columns, slabs, etc. are designed.
- It includes design of reinforced cement concrete (RCC) and steel structures.
- Structural analysis is done to calculate stresses in structural components on the basis of loads, acting on structures.
- Design of multi-storeyed buildings, towers, retaining walls, water tanks, bridges require skills and knowledge of structural engineering.
- Analysis and design of Dams, Bridges, Stadiums, Auditoriums, Multi - storied Buildings.
- Analysis and design of power generation stations & steel industrial structures.
- Repair, rehabilitation and maintenance of structures.

# 5. Geotechnical Engineering

The study of properties & behavior of soil under loads & changes in environmental conditions is called Geo-technical engineering.



# 5. Geotechnical Engineering

Structures transfer the superimposed load to the ground underneath, through appropriate foundations and the load must be distributed in such a way that there shouldn't be damage to the structure



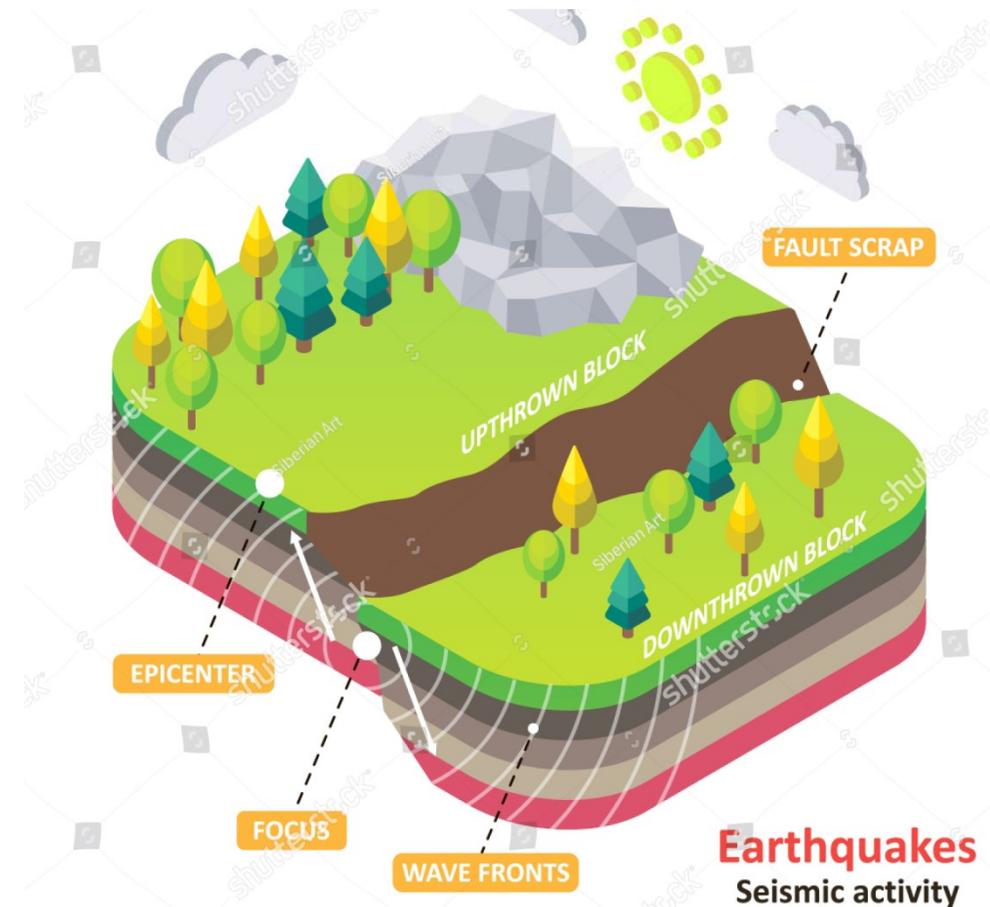
# 5. Geotechnical Engineering

## It includes

- Study of soils- formation, Composition and properties
- Study of rocks- types, properties, strength and deformation characteristics
- Design and analysis of various earth structures – Embankments, Dams, Retaining walls, etc.
- Site investigation, sub-soil exploration and field tests
- Ground improvement techniques

# 5. Geotechnical Engineering

Earthquake engineering – Effects of earthquakes on foundation soil, different seismic hazards, soil improvement to withstand/ minimize seismic hazards, etc.



# 5. Geotechnical Engineering

- It deals with investigate the soil and bedrock
- It helps to select the type of foundation
- It deals with the design of foundation for buildings, dams, retaining wall, bridge, road pavement
- It helps to study the effect of soil
- It deals with the study of compaction of soil.
- For design of underground structures such as Tunnels, Shafts, Conduits.

## 6. Hydraulics & Water Resources Engineering

**Hydraulics:** It deals with the study of mechanics of water and its flow characteristics. It also deals with the planning and manage the flow and storage of water.



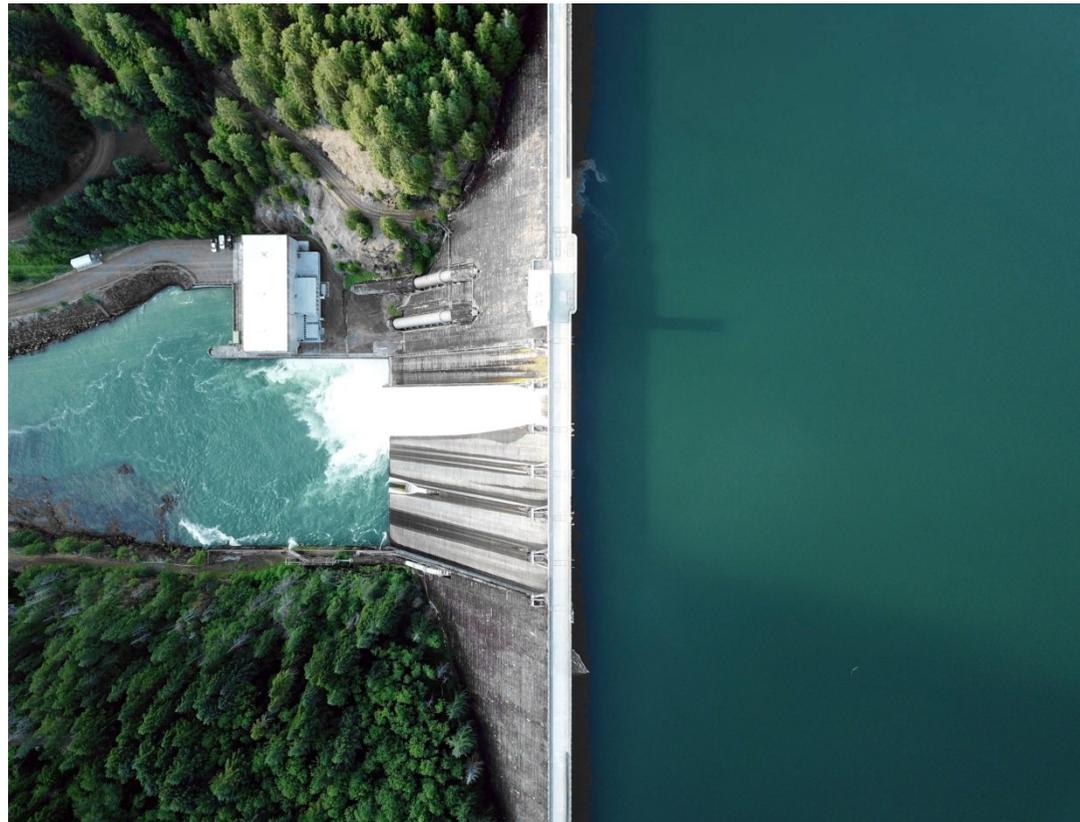
## 6. Hydraulics & Water Resources Engineering

### **Scope: Hydraulics**

- To measure the discharge of water in rivers for design of bridges.
- Design of hydro 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

## 6. Hydraulics & Water Resources Engineering

**Water Resources Engineering:** Water resource engineering deals with study of planning, designing and developing water resources.



## 6. Hydraulics & Water Resources Engineering

### **Scope: Water Resources Engineering**

- To arrive 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 centers.
- Design of water supply systems for the cities and industries.
- Flood mitigation, land drainage and culverts for control of water.

## 7. Transportation Engineering

Transportation engineering deals with the study of various transport system includes roadways, railways, airways & waterways



# 7. Transportation Engineering

## Scope:

- It involves planning, design, construction, operation and maintenance of transportation facility.
- Planning and design of air strip runways, roads, harbors and railways.
- Maintenance and up gradation of harbors, 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.
- It helps to develop the roads to remote places.
- It involves accident study for safe and comfort transport system.

## 8. Environmental Engineering

Environmental engineering is also called as **water supply and sanitary engineering** is a professional discipline concerned with protecting people from adverse environmental effects as well as protecting ecosystems and improving the quality of the environment. Environmental engineering provides methods and facilities **for wastewater management, water and air purification, waste disposal and recycling, and other purposes** pertaining to human health and benefit.



## 8. Environmental Engineering

### Scope:

1. Involves collection of water, Purification and supply for drinking.
2. Waste water collection, treatment and disposal.
3. Air pollution control and treatments.
4. Solid waste management and control.
5. E-Waste management control and Treatment.
6. Construction waste management and control
7. Design of sedimentation tanks, filter beds, treatment plants etc. for water purification.
8. Sewage should be systematically collected and then dispose into natural environment after providing suitable treatment.

## 9. Construction planning & Project management

**Construction planning is the process of identifying the steps required to build a structure. It involves defining what actions need to be completed, creating an ordered timeline of events, staffing the project and determining the necessary materials and equipment.**



## 9. Construction planning & Project management

A well-crafted construction plan is important to keep the project on **schedule and within budget**. It can also help ensure the overall quality of the project meets your **client's standards**. Finally, having a construction plan can increase your team's productivity and efficiency by streamlining communication.

### **Scope:**

The scope of construction planning and project management encompasses a wide range of activities involved in the **successful execution of construction projects**. It covers the entire lifecycle of a project, from its conceptualization and planning stages to its completion and delivery.



## 9. Construction planning & Project management

Here are some key areas within the scope of construction planning and project management:

1. **Project Initiation:** This involves identifying the project's objectives, feasibility analysis, preliminary budgeting, and securing necessary approvals and permits.
2. **Project Planning:** Developing a comprehensive project plan that includes defining project scope, setting project goals, creating a work breakdown structure (WBS), estimating resources and costs, and developing a project schedule.



## 9. Construction planning & Project management

- 3. Risk Management:** Identifying potential risks and uncertainties, assessing their potential impact on the project, and developing strategies to mitigate or manage those risks throughout the project's lifecycle.
- 4. Procurement and Contracting:** Identifying and procuring the necessary materials, equipment, and services required for the project. This includes preparing and managing contracts with suppliers, subcontractors, and vendors.
- 5. Resource Management:** Allocating and managing resources effectively, including labor, equipment, materials, and finances, to ensure efficient project execution



## 9. Construction planning & Project management

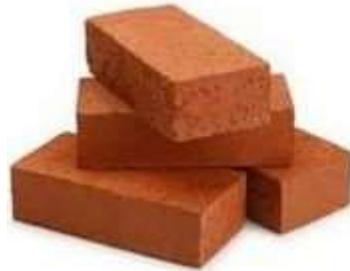
6. **Project Execution:** Overseeing and coordinating the activities of various project teams, including architects, engineers, contractors, and subcontractors, to ensure that the project is executed according to the plans and specifications.
7. **Quality Management:** Implementing quality control measures to ensure that the project meets the required standards and specifications. This involves conducting inspections, testing, and quality assurance procedures throughout the construction process.



## 9. Construction planning & Project management

8. **Communication and Stakeholder Management:** Establishing effective communication channels and managing relationships with project stakeholders, including clients, regulatory authorities, local communities, and other interested parties.
9. **Project Monitoring and Control:** Continuously monitoring the project's progress, comparing it to the project plan, identifying deviations, and implementing corrective actions when necessary to keep the project on track.
10. **Project Closeout:** Managing the project's closure, including conducting final inspections, obtaining necessary approvals, ensuring all contractual obligations are met, and documenting lessons learned for future reference.

# Basic Materials for Construction



Bricks



Cement



Concrete



Sand



Reinforcement



Glass



Plastic



Wood



Tiles

# Basic Materials for Construction

- Building materials are materials that are used in the construction and production of various structures.
- A variety of materials are used in the construction of a building, whether natural or artificial, raw or mixed, each with unique characteristics.
- Every building material has unique properties that make it suitable for a variety of applications.



Bricks



Cement



Concrete



Sand



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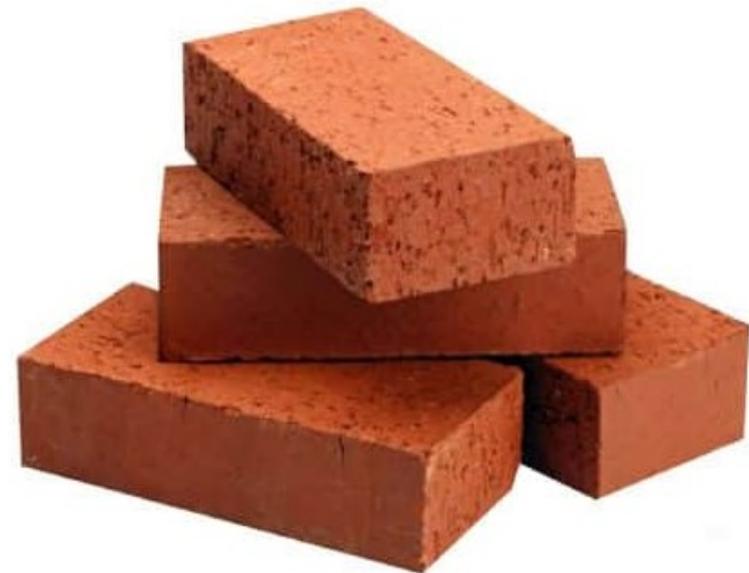


Tiles

# Basic Materials for Construction

## I. Bricks

- A brick is a type of construction material used to **build walls**, pavements and other elements in masonry construction. It is of **rectangular in shape** and of size that can be handled conveniently by one hand. Brick may be of **burnt clay or mixture of sand and lime**.
- Constituents of a good Brick  
/ Composition of a good Brick: A good brick earth should contain the following constituents, (Next Slide)



# Basic Materials for Construction

## I. Bricks

### I. Silica:

- Brick earth should contain about 50 to % of silica.
- It is responsible for **preventing cracking, shrinking and warping of raw bricks.**
- It also **affects the durability of bricks.**
- If present in **excess, then it destroys the cohesion between** particles and the brick becomes brittle.

# Basic Materials for Construction

## I. Bricks

### 2. Alumina:

- Good brick earth should contain about 20% to 30% of alumina.
- It is responsible for **plasticity characteristic of earth, which is important in moulding operation.**
- If present in **excess, then the raw brick shrinks and warp** during drying.

# Basic Materials for Construction

## I. Bricks

### 3. Lime:

- The percentage of lime should be in the range of **5% to 10%** in a good brick earth.
- **It prevents shrinkage of bricks on drying.**
- It causes **silica in clay to melt** on burning and thus **helps to bind it.**
- **Excess of lime causes the brick to melt** and brick loses its shape.

# Basic Materials for Construction

## I. Bricks

### 4. Iron oxide:

- A good brick earth should contain about **5% to 7% of iron oxide.**
- It gives **red colour to** the bricks.
- It improves **impermeability and durability.**
- It **gives strength and hardness.**
- If present in **excess, then the color of brick becomes dark blue or blackish.**
- If the quantity of iron oxide is comparatively less, the brick **becomes yellowish in color.**

# Basic Materials for Construction

## I. Bricks

### 5. *Magnesia:*

- Good brick earth should **contain less a small quantity** of magnesia about 1%.
- Magnesium in brick **earth imparts yellow tint to the brick.**
- It is **responsible for reducing shrinkage**
- **Excess of magnesia leads to the decay** of bricks.

# Basic Materials for Construction

**Types of Bricks** : There are two types of bricks:

## *1. Traditional Bricks:*

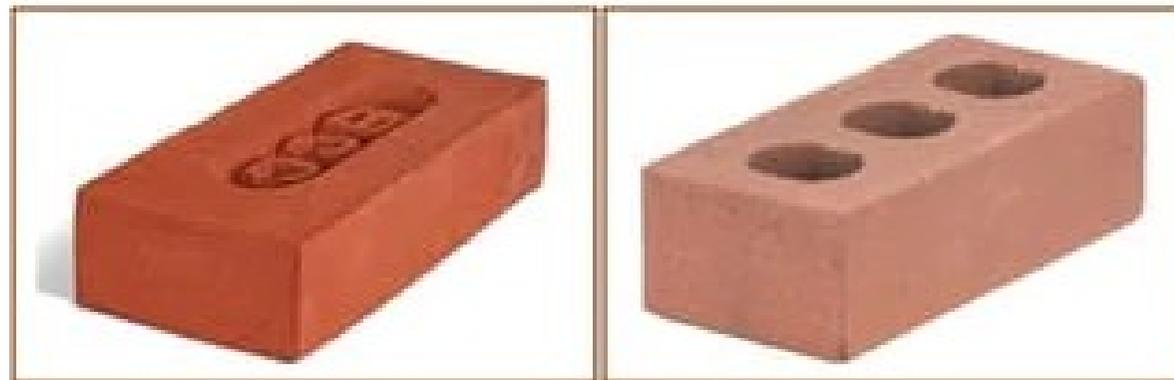
Those bricks which have **not been standardized in size** are called traditional or conventional bricks. The dimensions of traditional bricks vary and depend on region and place. The length varies from 210 mm to 250 mm, the width varies from 100 mm to 130 mm and the thickness varies from 70 mm to 100 mm.

# Basic Materials for Construction

**Types of Bricks :** There are two types of bricks:

## **2. Modular Bricks:**

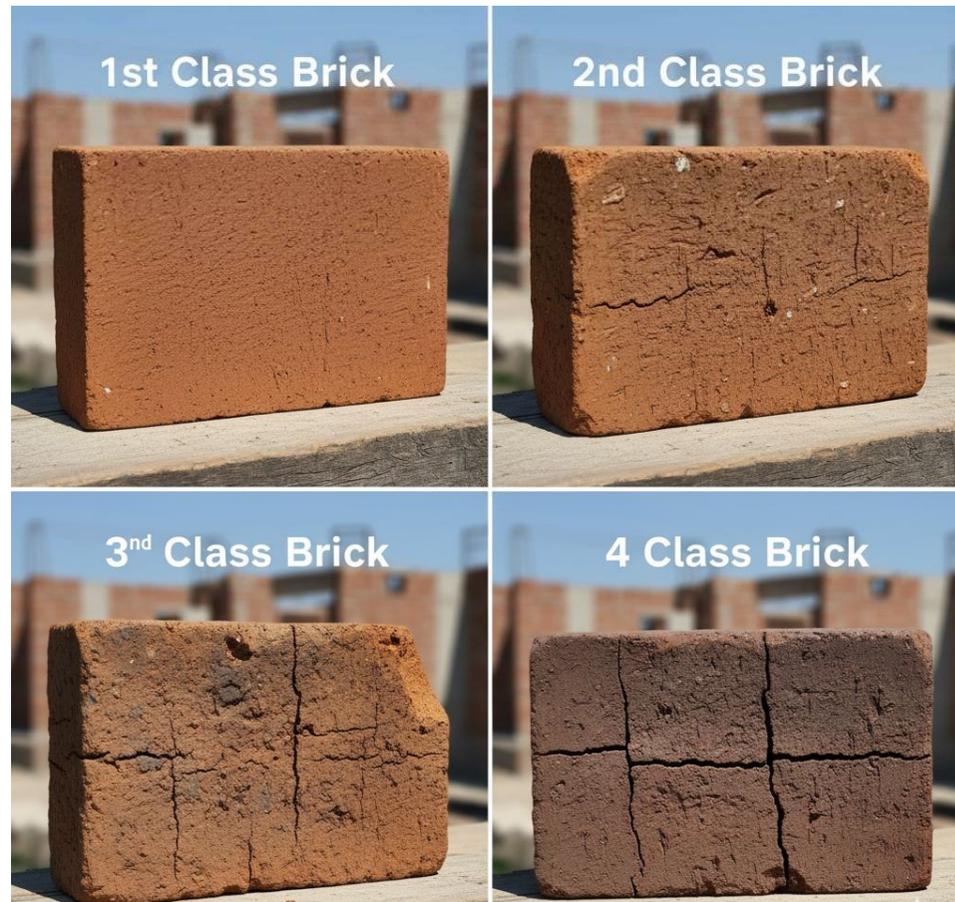
Modular bricks are bricks **made to a dimensional specification**. Standard size of Modular brick = 19 cm × 9 cm × 9 cm Nominal size of a brick with mortar = 20 cm × 10 cm × 10 cm.



# Basic Materials for Construction

## *Classification of Bricks:*

On the basis of quality, Bricks are of the following kinds:



# Basic Materials for Construction

**Classification of Bricks:** On the basis of quality, Bricks are of the following kinds:

***1. First Class Brick:***

- The size is standard.
- The colour of these bricks is well burnt, regular texture, uni



# Basic Materials for Construction

**Classification of Bricks:** On the basis of quality, Bricks are of the following kinds:

## ***I. First Class Brick:***

- The absorption capacity is less than 10%, crushing strength is, 280kg/cm<sup>2</sup> (mean) where it is 245 kg/cm<sup>2</sup> (minimum).
- It doesn't have efflorescence.
- It emits a metallic sound when struck by another similar brick or struck by a hammer.
- It is free from pebbles, gravels or organic matters.
- It is generally used in a building of long durability, say 100 years for building exposes to a corrosive environment.

# Basic Materials for Construction

## *Classification of Bricks:*

### *2. Second Class Brick:*

- The size is standard
- Colour is uniform yellow or red.
- It is well burnt, slightly over burnt is acceptable.
- It has a regular shape; efflorescence is not appreciable.
- The absorption capacity is more than 10% but less than 15%.
- Crushing strength is 175kg/cm<sup>2</sup>(mean) where the minimum is 154 kg/cm<sup>2</sup>.
- It emits a metallic sound when struck by another similar brick or struck by a hammer
- It is used for the construction of one-storied buildings, temporary shed when intended durability is not more than 15 years.



# Basic Materials for Construction

## ***Classification of Bricks:***

### ***3. Third Class Brick:***

- The shape and size are not regular.
- The colour is soft and light red coloured.
- The texture is non-uniform.
- It is under burnt, slightly over burnt is acceptable.
- The absorption capacity is more than 15% but less than 20%.
- The crushing strength is 140kg/cm<sup>2</sup>(mean) where the minimum crushing strength is 105kg/cm<sup>2</sup>.
- It emits a dull or blunt sound when struck by another similar brick or struck by a hammer.



# Basic Materials for Construction

## ***Classification of Bricks:***

4. ***Fourth Class Brick:*** These are the over burnt bricks with irregular shape and dark color. These bricks are used as aggregate in foundation, floors, etc.



## **Basic Materials for Construction**

***Qualities of a good bricks / Characteristics of a good brick:***

Qualities of a Good Brick:

Uniform Shape, Rich Color, Smooth Texture, High Strength



## Basic Materials for Construction

### *Qualities of a good bricks / Characteristics of a good brick:*

- Bricks should be uniform in color, size and shape. Standard size of brick should be maintained.
- They should be sound and compact.
- They should be free from cracks and other flaws such as air bubbles, stone nodules etc. with sharp and square edges.
- Bricks should not absorb more than  $\frac{1}{5}$  of their own weight of water when immersed in water for 24 hours (15% to 20% of dry weight).
- The compressive strength of bricks should be in range of 2000 to 5000 psi (15 to 35 MPa).

## **Basic Materials for Construction**

### ***Qualities of a good bricks / Characteristics of a good brick:***

- Salt attack hampers the durability of brick. The presence of excess soluble salts in brick also causes efflorescence. The percentage of soluble salts (sulphates of calcium, magnesium, sodium and potassium) should not exceed 2.5% in brunt bricks.
- Brick should not change in volume when wetted.
- Bricks should neither overburnt nor under-brunt.
- Generally, the weight per brick should be 6 lbs. and the unit weight should be less than 125 lbs. per cubic ft.
- The thermal conductivity of bricks should be low as it is desirable that the building built with them should be cool in summer and warm in winter.

# Basic Materials for Construction

## 2. Cement

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

### Ingredients of Cement:

- The general percentage of the ingredients of which cement is made of is given below: ***Ingredient Percentage in cement***
  - Lime 60-65%
  - Silica 17-25%
  - Alumina 3-8%
  - Magnesia 1-3%
  - Iron oxide 0.5-6%
  - Calcium Sulfate 0.1-0.5%
  - Sulfur Trioxide 1-3%
  - Alkaline 0-1%





## Basic Materials for Construction

**2. Cement :** The main features of cement ingredients along with their functions and usefulness or harmfulness are given below:

**I. Lime:** Lime is calcium oxide or calcium hydroxide.

- The presence of lime in a sufficient quantity is required to form **silicates and aluminates of calcium.**
- **Deficiency in lime reduces the strength of the property** to the cement.
- **Deficiency in lime causes the cement to set quickly.**
- **Excess lime makes cement unsound.**

# Basic Materials for Construction

## 2. Cement

**2. Silica:** Silicon dioxide is known as silica.

- A sufficient quantity of silica should be present in cement to dicalcium and tricalcium silicate.
- Silica imparts strength to cement.
- Silica usually presents to the extent of about 30 percent cement.

**3. Alumina:** Alumina is Aluminium oxide.

- Alumina imparts **quick setting property to the cement.**
- Excess alumina weakens the cement.

# Basic Materials for Construction

## 2. Cement

### 4. *Magnesia*: Magnesium Oxide.

- Magnesia should not be present more than 2% in cement.
- Excess magnesia will reduce the strength of the cement.

### 5. *Iron oxide*:

- Iron oxide imparts color to cement.
- It acts as a flux.
- At a very high temperature, it imparts into the chemical reaction with calcium and aluminum to form tricalcium alumino-ferrite.
- Tricalcium alumino-ferrite imparts hardness and strength to cement.

# Basic Materials for Construction

## 2. Cement

### **6. Calcium Sulfate:**

- This is present in cement in the form of gypsum
- It slows down or retards the setting action of cement.

### **7. Sulfur Trioxide:**

- It should not be present for more than 2%.
- Excess Sulfur Trioxide causes the cement to unsound.

### **8. Alkaline:**

- It should not be present more than 1%.
- Excess Alkaline matter causes efflorescence

# Basic Materials for Construction

## 2. Cement : Field tests on cement:

- ***Date of Manufacturing:*** As the strength of cement reduces with age, the date of manufacturing of cement bags should be checked.
- ***Cement Colour:*** The colour of cement should be uniform. It should be typical cement colour i.e. grey colour with a light greenish shade.
- ***Whether Hard Lumps are Formed:*** Cement should be free from hard lumps. Such lumps are formed by the absorption of moisture from the atmosphere.
- ***Temperature Inside Cement Bag:*** If the hand is plunged into a bag of cement, it should be cool inside the cement bag. If hydration reaction takes place inside the bag, it will become warm.

# Basic Materials for Construction

## 2. Cement : Field tests on cement:

- **Smoothness Test:** When cement is touched or rubbed in between fingers, it should give a smooth feeling. If it felt rough, it indicates adulteration with sand.
- **Water Sinking Test:** If a small quantity of cement is thrown into the water, it should float some time before finally sinking.
- **The smell of Cement Paste:** A thin paste of cement with water should feel sticky between the fingers. If the cement contains too much-pounded clay and silt as an adulterant, the paste will give an earthy smell.

# Basic Materials for Construction

## 2. Cement : Field tests on cement:

- **Glass Plate Test:** A thick paste of cement with water is made on a piece of a glass plate and it is kept under water for 24 hours. It should set and not crack.
- **Block Test:** A 25mm × 25mm × 200mm (1"×1"×8") block of cement with water is made. The block is then immersed in water for three days. After removing, it is supported 150mm apart and a weight of 15kg uniformly placed over it. If it shows no sign of failure the cement is good.



# Basic Materials for Construction

## 2. Cement: Uses/Functions of Cement I.

- It is used in mortar for plastering, masonry work, pointing, etc.
- It is used for making joints for drains and pipes.
- It is used in concrete for laying floors, and roofs and constructing lintels, beams, stairs, pillars, etc.
- It is used where a hard surface is required for the protection of exposed surfaces of structures against the destructive agents of the weather and certain organic or inorganic chemicals.
- It is used for precast pipes manufacturing, piles, fencing posts, etc.



# Basic Materials for Construction

## 2. Cement: Uses/Functions of Cement I.

- It is used in the construction of important engineering structures such as bridges, culverts, dams, tunnels, lighthouses, etc.
- It is used in the preparation of foundations, watertight floors, footpaths, etc.
- It is employed for the construction of wells, water tanks, tennis courts, lamp posts, telephone cabins, roads, etc.
- It is used for the water-tightness of the structure.



# Basic Materials for Construction

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# Basic Materials for Construction

## 3. Cement Mortar:

Cement Mortar is a homogenous mixture of cement, sand and water. Different types of mortars are used in masonry construction based on their applications, binding materials, strength, bulk density and their purposes.



# Basic Materials for Construction

## 3. Cement Mortar: Properties of Cement Mortar

- Well-proportioned and well laid mortar provides an **impervious surface**.
- When water is added to dry mixture of cement and sand, **hydration of cement occurs**, and it binds with sand particles and the surrounding surfaces of masonry and concrete.
- **The leaner mix is not capable** of closing the voids in sand, and hence the plastered surface will remain porous.

# Basic Materials for Construction

## 3. Cement Mortar: Uses of Cement Mortar

- To bind masonry units like stone, bricks, blocks, cement
- For Plastering on walls and slabs to make them impervious.
- As a filler material in Ferro cement works and stone masonry.
- To fill cracks and joints in the wall.
- Use of cement mortar gives a neat finishing work to wall and concrete work.
- For pointing the joints of masonry.
- For preparing the building blocks

# Basic Materials for Construction

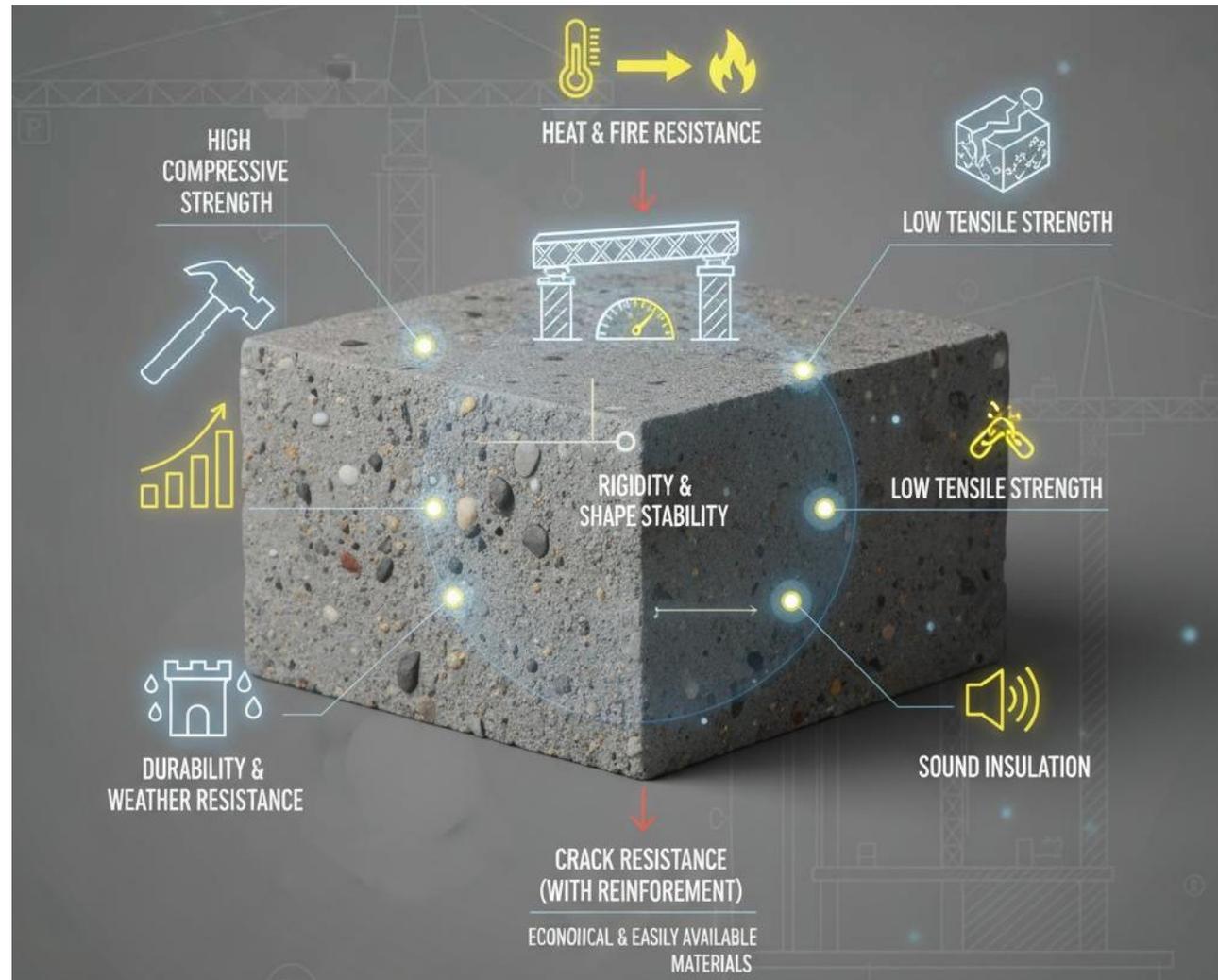
## 4. Plain Cement Concrete (PCC)

- Plain cement concrete is the mixture of cement, fine aggregate(sand) and coarse aggregate without steel.
- PCC is an important component of a building which is laid on the soil surface to avoid direct contact of reinforcement of concrete with soil and water.



# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC): Properties of PCC:



# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC)

- **Properties of PCC:**

1. **Compressive strength:** The compressive strength of PCC lies between 200 to 500 Kg/cm<sup>2</sup> .
2. **Tensile strength:** The tensile strength of plain cement concrete lies between 50 to 100 Kg/cm<sup>2</sup>.
3. **Density:** The density of concrete ranges from 2200 Kg/m<sup>3</sup> to 2400 Kg/m<sup>3</sup>.
4. **Durability:** It is more durable.
5. **Workability:** PCC should be very feasible. Mixing, handling, and transporting it should be simple.

# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC)

- **Mixing of plain cement concrete (PCC):** Mixing of PCC can be done either manually or by using machine.

### *1. Hand mixing:*



# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC)

- **Mixing of plain cement concrete (PCC):** Mixing of PCC can be done either manually or by using machine.

### *1. Hand mixing:*

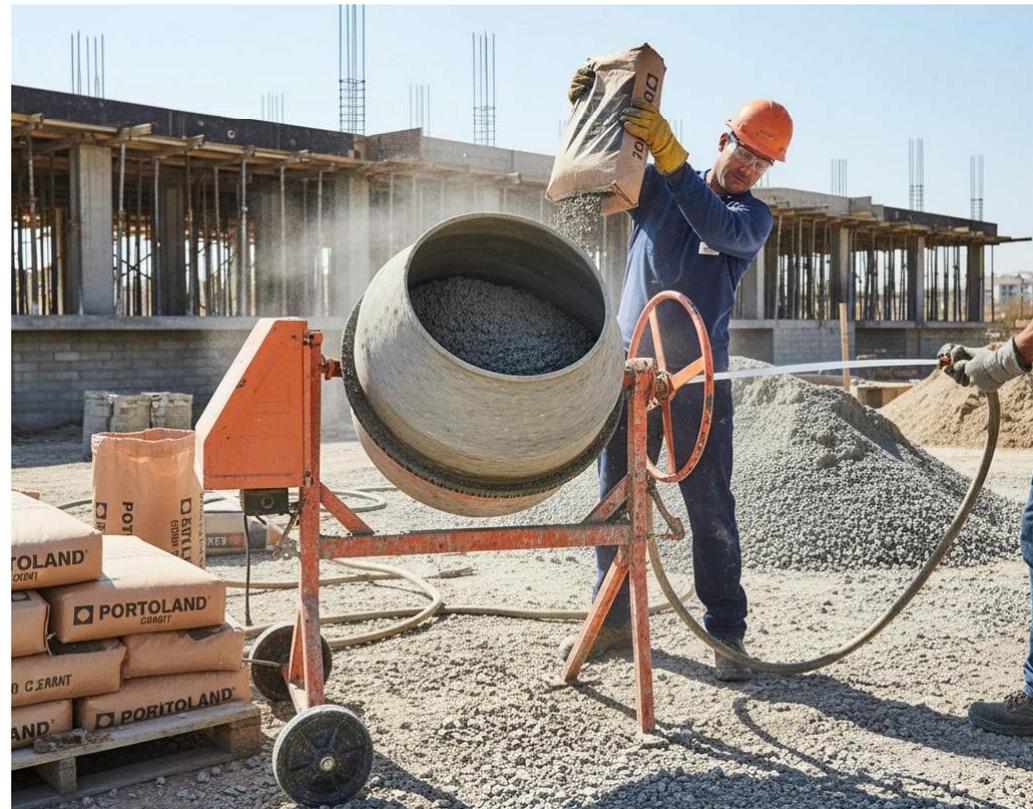
- Plain cement concrete is allowed to be done by hand mixing only for small works.
- The base must be clean, watertight slab, or a steel platform on which the concrete is mixed.
- Sand and cement are mixed with coarse aggregate. Lastly, water is added and the mixture is mixed properly.

# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC)

- **Mixing of plain cement concrete (PCC):** Mixing of PCC can be done either manually or by using machine.

### *2. Machine mixing:*



# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC)

- **Mixing of plain cement concrete (PCC):** Mixing of PCC can be done either manually or by using machine.

### ***2. Machine mixing:***

- The quantity of dry aggregate, fine aggregate, and cement is measured and should be placed in their respective hoppers.
- The dry materials should be mixed in the mixture and water is added while the drum is motion.
- The mixing should have a plastic mix of uniform colour.

# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC)

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- The dry materials should be mixed in the mixture and water is added while the drum is motion.
- The mixing should have a plastic mix of uniform colour.

# Basic Materials for Construction

## 4. Plain Cement Concrete (PCC): Advantages

- As a base below all types of foundations to provide a **hard and level surface for laying the foundation.**
- As the base below the floor on the ground floor. At the plinth level, PCC provides a hard and level surface **for laying floor tiles.**
- Below **load-bearing walls as a foundation.**
- At plinth level to act as a **damp-proof course (DPC)**
- As coping over top of **parapet walls to protect the wall from rain.**
- For **pavement and roads**
- For mass concrete structure **such as retaining walls**

# Basic Materials for Construction

## 5. Reinforced Cement Concrete (RCC)



# Basic Materials for Construction

## Importance of Recycling and Reuse in Civil Engineering

### 1. Conservation of Natural Resources

- Recycling and reuse reduce the demand for new raw materials, helping conserve limited natural resources.

### 2. Reduction of Environmental Pollution

- By decreasing the volume of waste sent to landfills and lowering extraction activities, recycling minimizes soil, water, and air pollution.

### 3. Energy Savings

- Reusing and recycling materials lowers energy consumption associated with producing and transporting new materials.

### 4. Cost Efficiency

- Construction costs are reduced by minimizing new material purchases and lowering disposal expenses.

### 5. Enhancement of Sustainability Performance

- Recycling and reuse improve the overall sustainability rating of civil engineering projects by supporting responsible material consumption.

### 6. Reduction of Construction Waste

- Efficient material recovery reduces the total waste generated during construction and demolition.

### 7. Improvement of Resource Efficiency

- Recycling ensures that materials are used to their full potential, improving overall project resource efficiency.

### 8. Compliance With Regulations

## Effective Management of Construction Waste

### 1. Waste Segregation at Source

- Separating materials such as concrete, metal, wood, plastics, and soil at the site enables better recovery and reduces contamination.

### 2. Reduction and Optimization of Material Use

- Efficient design, accurate procurement, and optimized construction processes help reduce excess material usage.

# Basic Materials for Construction

## 5. Reinforced Cement Concrete (RCC)

- **Purpose of providing Reinforcement in Concrete:** As you know that, **Concrete has a very high compressive strength, but** it is low in tensile strength.
- Thus, when only the **compressive loads are acting on** the concrete surface, then there is **no need of using reinforcement in it.**
- 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, however, as we know, has a very high tensile strength (and also have good compressive strength).

# Basic Materials for Construction

## 5. Reinforced Cement Concrete (RCC)

- Hence, when these two (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.**
- Such a material is known as Reinforced Cement Concrete. It has proved extremely useful and reliable in engineering construction.



# Basic Materials for Construction

## Plain Cement Concrete (PCC)

Does not contain any steel reinforcement.

Suitable mainly for resisting compressive forces.

Low tensile strength.

Used for simple structural and non-structural components.

Cannot resist bending and shear effectively.

Less durable under vibration and dynamic loads.

Overall structural performance is limited.

Requires less skilled labour for construction.

Lower initial cost.

Mostly used where loads are small.

## Reinforced Cement Concrete (RCC)

Contains steel reinforcement (rebars) embedded in concrete.

Suitable for resisting both tensile and compressive forces.

High tensile strength due to reinforcement.

Used for structural components carrying loads.

Can resist bending, shear, torsion effectively.

More durable under vibration, seismic and dynamic loads.

Structural performance is significantly improved.

Requires skilled labour for placing reinforcement.

Higher initial cost due to steel reinforcement.

Used where higher strength and load-bearing capacity are needed.

# Basic Materials for Construction

## 5. Reinforced Cement Concrete (RCC): Advantages

- The **maintenance cost of reinforced** concrete is very low.
- In the structure like footings, dams, piers etc. reinforced concrete is **the most economical construction material**.
- It acts like **a rigid member with minimum deflection**.
- As reinforced concrete can be moulded to any shape required, it is widely used in precast structural components. It yields rigid members with minimum apparent deflection.
- Compared to the use of steel in structure, reinforced concrete requires less skilled labour for the erection of the structure.

# Basic Materials for Construction

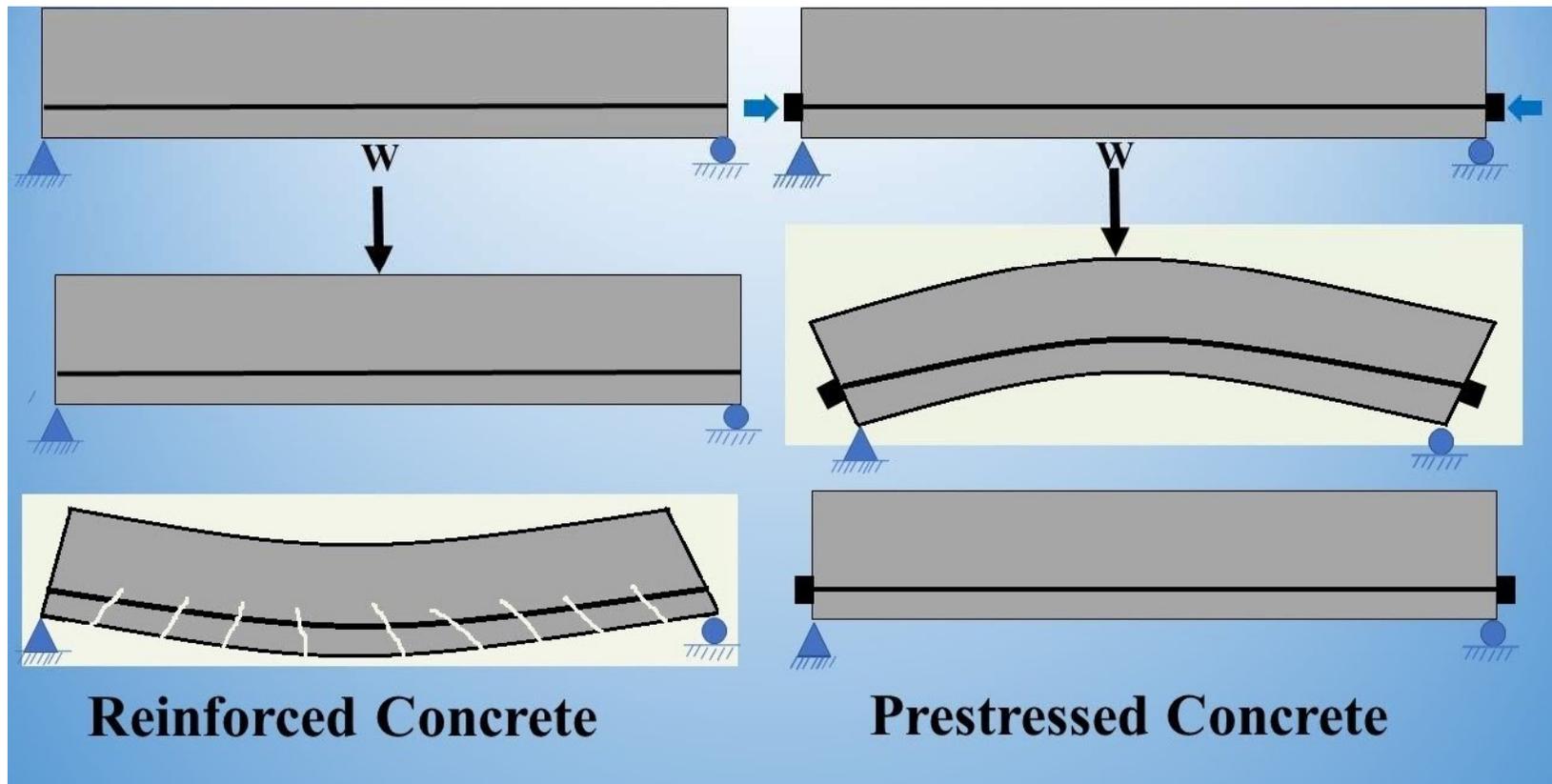
## 6. Pre-Stressed Concrete (PSC)

- Pre-stressed concrete is a form of concrete where initial compression is given in the concrete before applying the external load so that stress from external loads are counteracted in the desired way during the service period.



# Basic Materials for Construction

## 6. Pre-Stressed Concrete (PSC)



# Basic Materials for Construction

## 6. Pre-Stressed Concrete (PSC)

- **Need for Prestressing Concrete:**

- Concrete is weak in tension and strong in compression. This is a weak point of concrete that results in early flexural cracks mainly in flexural members like beams and slabs. To prevent this, the concrete is induced with compressive stress deliberately (prestressing) and this stress counteracts with the tensile stress the structure is subjected to during service condition. Hence the chances of flexural cracks are reduced.
- The pre-compression that is induced as a part of prestressing helps to enhance the bending capacity, the shear capacity and the torsional capacity of the flexural members.

# Basic Materials for Construction

## 6. Pre-Stressed Concrete (PSC)

- **Need for Prestressing Concrete:**

- A compressive prestressing force can be applied concentrically or eccentrically in the longitudinal direction of the member. This prevents cracks at critical midspan and supports at service load.
- A prestressed concrete section behaves elastically.
- The full capacity of the concrete in compression can be used over entire depth under full loading in the case of prestressed concrete. structure is subjected to during service condition. Hence the chances of flexural cracks are reduced.

# Basic Materials for Construction

## 6. Pre-Stressed Concrete (PSC): Advantages

- The prestressing of concrete by using high tensile steel improve the efficiency of the materials
- The prestressing system works for a span greater than 35m.
- Prestressing enhance shear strength and fatigue resistance of concrete.
- Dense concrete is provided by prestressing systems thus improving the durability.
- Best choice for the construction of sleek and slender structures..

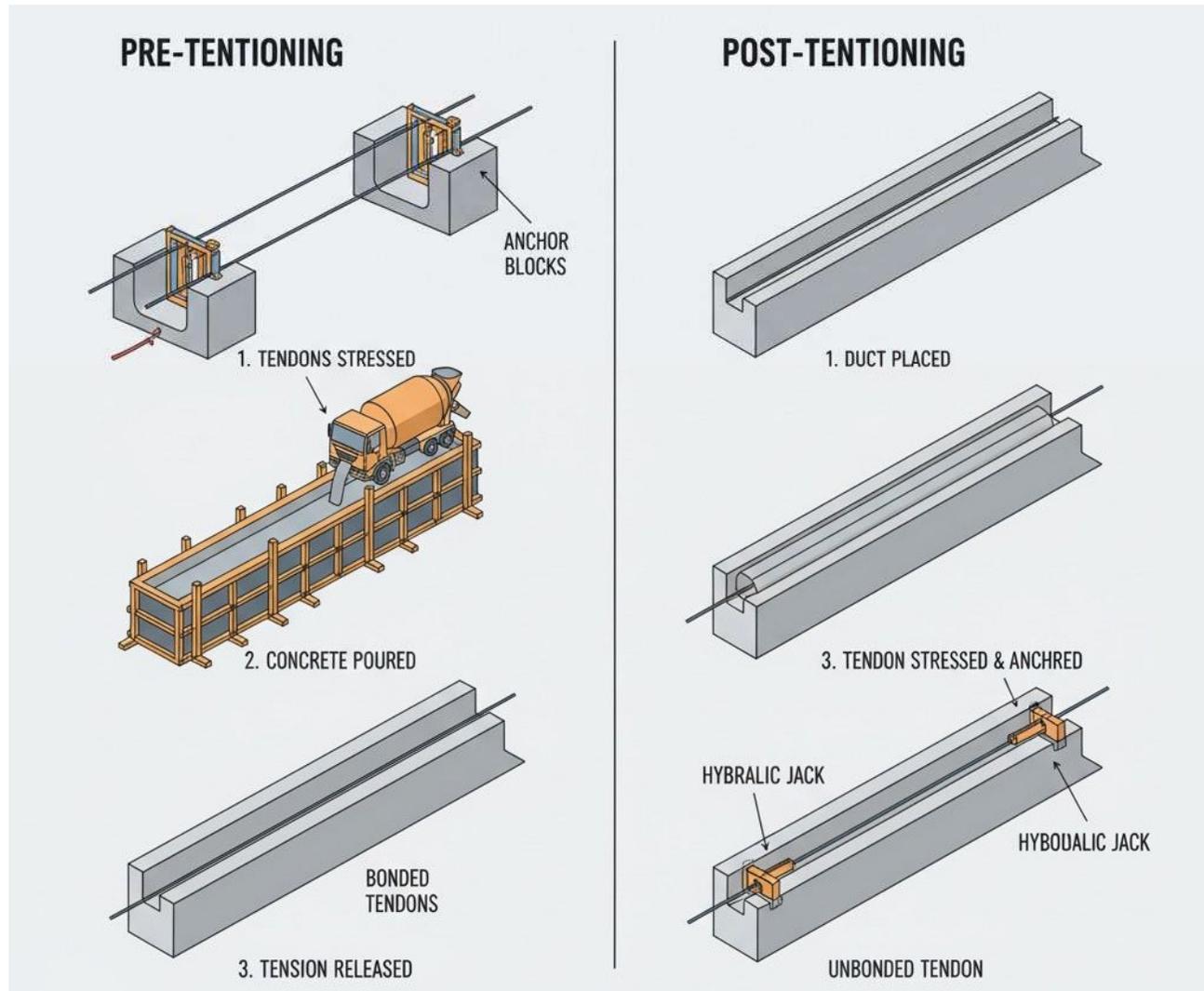
# Basic Materials for Construction

## 6. Pre-Stressed Concrete (PSC): Advantages

- Prestressing helps to reduce the dead load of the concrete structure.
- Prestressed concrete remains uncracked even at service load conditions which proves the structural efficiency.
- Composite construction by using the prestressed concrete unit and cast-in-unit derives the economic structure.

# Basic Materials for Construction

## 6. Pre-Stressed Concrete (PSC): Methods



# Basic Materials for Construction

## 7. Structural Steel: Methods

- Structural Steel is a special kind of Steel. It is used for construction purposes.
- Due to its **rigidity and high strength-to-weight** ratio, structural Steel is mainly employed in buildings.
- Structural Steel is **used in houses, warehouses, airplane hangars, educational facilities, bridges, stadiums, etc.**
- Structural Steel is Steel that contains carbon, not more than **2.1%. These are also called Carbon Steel**, and structural Steel typically **has a carbon content of less than 0.6%.**

# Basic Materials for Construction

## 8. Construction Chemicals:

- Construction chemicals are used along with various building materials at the construction site to **improve workability, to increase efficiency, add effectiveness and to protect the part of any structure, or to accelerate the speed of construction work.**
- Most construction chemicals are used as hardening agents either for **surface application, coating or as repair materials** and is also effective as a **waterproofing chemical.**

# Structural Elements of Building

## I. Foundation



# Structural Elements of Building

## I. Foundation

Foundation is the lowest part of the building or the civil structure that is in direct contact with the soil which **transfers loads from the structure to the soil safely**. The foundation for each structure is designed such that:

- The underlying soil below the foundation structure does not undergo shear failure
- The settlement caused during the first service load or have to be within the limit
- Allowable bearing pressure can be defined as the pressure the soil can withstand without failure.

# Structural Elements of Building

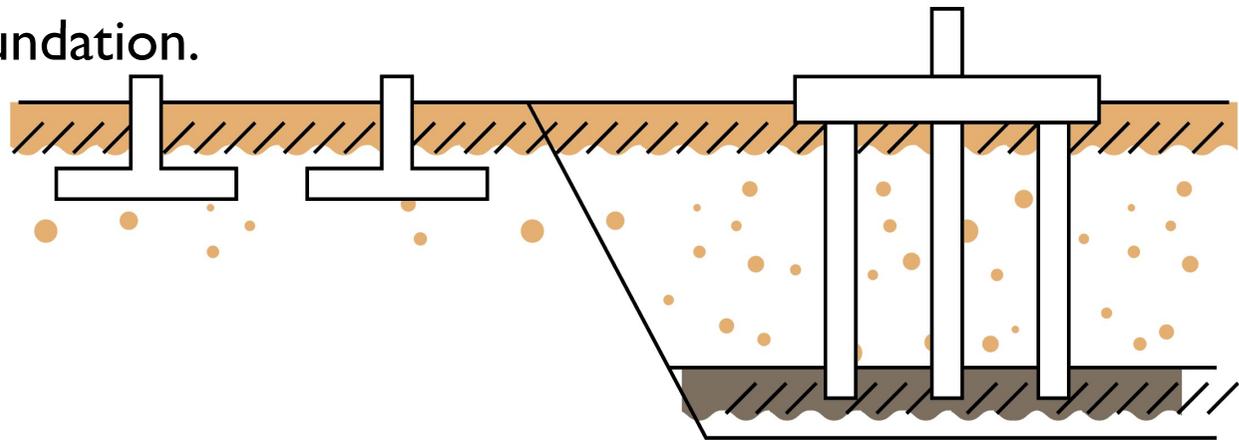
## I. Foundation

### Classification of Foundations:

Based on the depth of foundation, foundation can be classified as

1. Shallow foundation.

2. Deep foundation.



Shallow Footings

For top shallow layer of soil that can bear the equal distribution of weight. Ideal for smaller projects.

Deep Footings

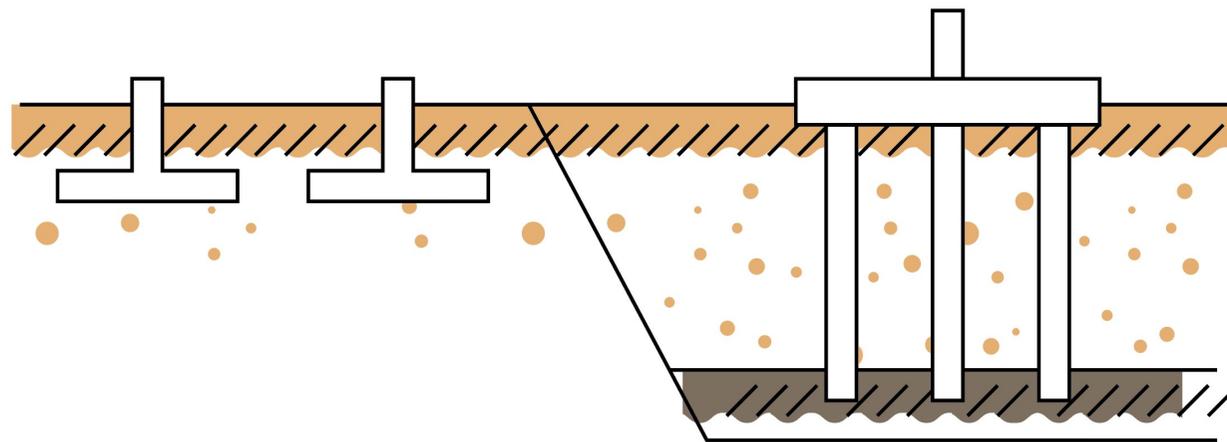
For deep layers of soil and bedrock to ensure structural integrity.

# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

- A foundation that is placed near the surface of the earth or transfers the loads at a shallow depth is called the shallow foundation.



Shallow Footings

Deep Footings

# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### **a. Individual Footing or Isolated Footing:**



# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

##### **a. Individual Footing or Isolated Footing:**

- Individual footing or an isolated footing is the most common type of foundation used for building construction.
- This foundation is constructed for a **single column and also called a pad foundation.**
- The shape of individual footing is **square or rectangle** and is used when loads from the structure is carried by the columns.
- **Size is calculated based on the load** on the column and the safe bearing capacity of soil.

# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### ***b. Combined Footing:***



# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### **b. Combined Footing:**

- Combined footing is constructed when **two or more columns are close enough** and their isolated footings overlap each other.
- It is a combination of isolated footings, but their structural design differs.
- The shape of this footing is a **rectangle** and is used when loads from the structure is carried by the columns.

# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### **c. *Spread footings or Strip footings and Wall footings***



# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### **c. *Spread footings or Strip footings and Wall footings***

- Spread footings are those whose base is **wider than a typical load-bearing wall foundation.**
- The wider base of this footing type **spreads the weight from the building structure over more area** and provides better stability.
- Spread footings and wall footings are used for individual columns, walls and bridge piers where the bearing soil layer is within 3m (10 feet) from the ground surface.
- **Soil bearing capacity must be sufficient to support the weight** of the structure over the base area of the structure.

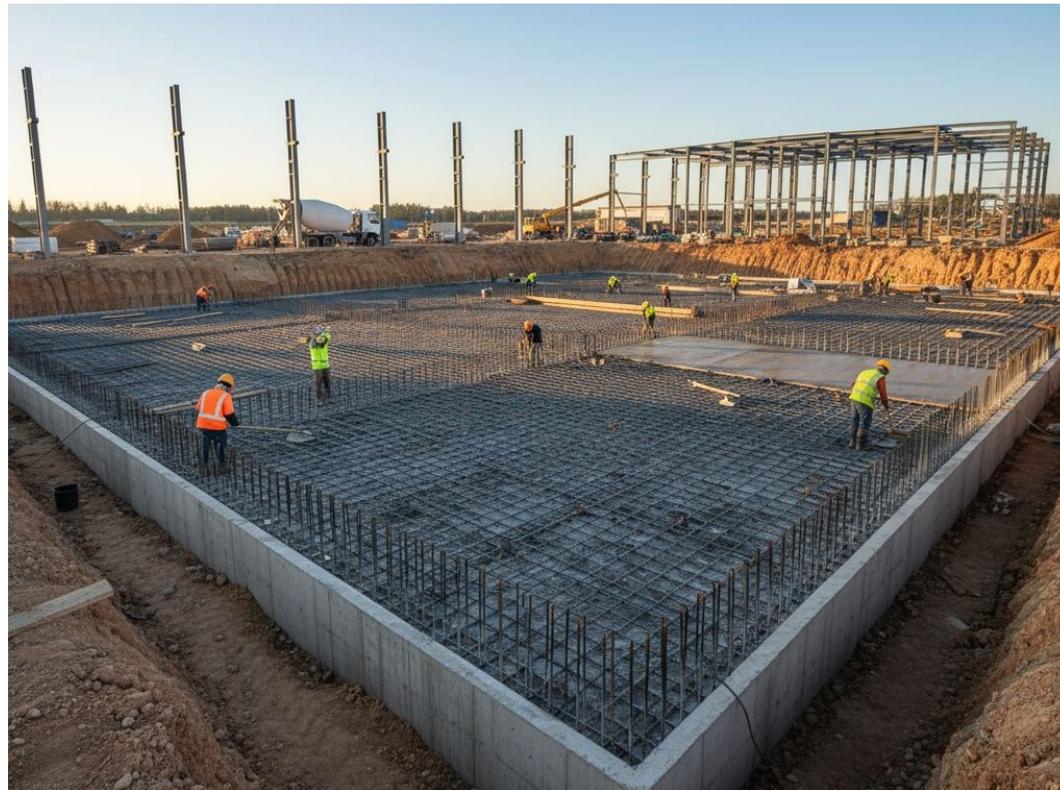
# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### **d. Raft or Mat Foundations**



# Structural Elements of Building

## I. Foundation

### *I. Shallow foundation:*

#### **Types of shallow foundation:**

#### **d. Raft or Mat Foundations**

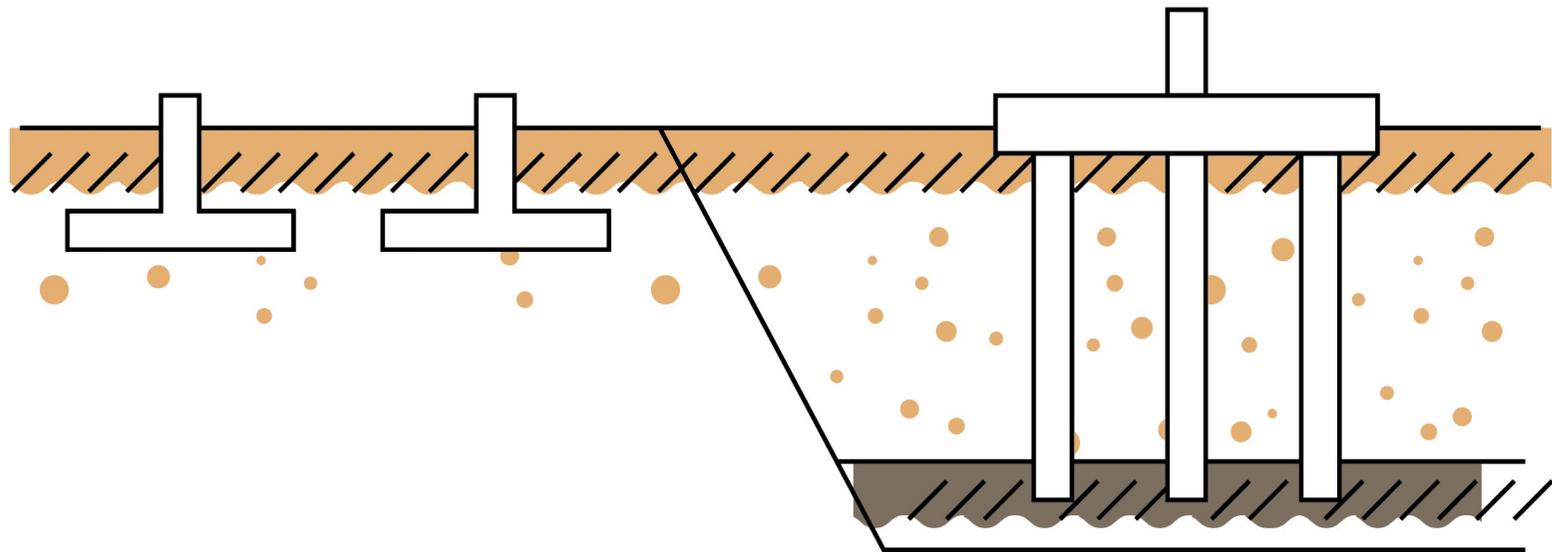
- Raft or mat foundations are the types of foundation which **are spread across the entire area of the building** to support heavy structural loads from columns and walls.
- The use of mat foundation is for columns and walls foundations where the **loads from the structure on columns and walls are very high.**
- This is used to **prevent differential settlement of individual footings**, thus designed as a single mat (or combined footing) of all the load-bearing elements of the structure..

# Structural Elements of Building

## I. Foundation

### 2. *Deep foundation:*

Foundation that is placed at a greater depth or transfers the loads to deep strata is called a deep foundation



Shallow Footings

Deep Footings

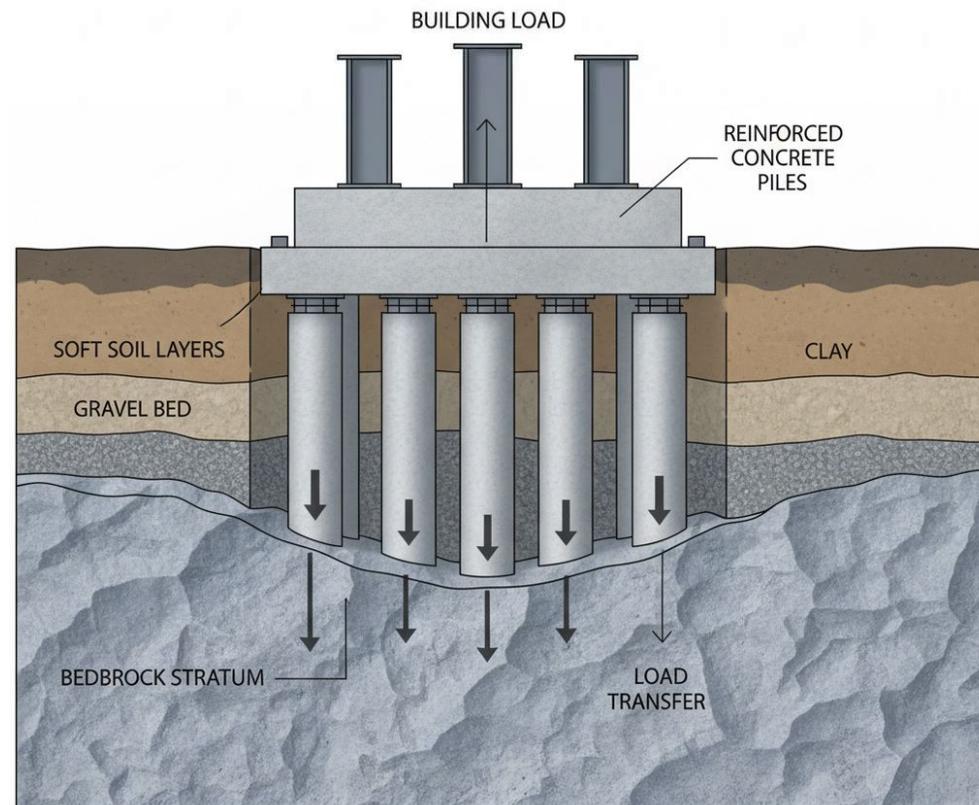
# Structural Elements of Building

## I. Foundation

### 2. Deep foundation:

#### Types of shallow foundation:

##### a. Pile Foundations:



# Structural Elements of Building

## I. Foundation

### 2. Deep foundation:

#### Types of shallow foundation:

##### a. *Pile Foundations:*

- Pile foundation is a type of deep foundation which is used to transfer heavy loads from the structure to a **hard rock stratum much deep below the ground level.**
- Pile foundations are used to transfer heavy loads of structures through columns to hard soil strata which is much below ground level where **shallow foundations such as spread footings and mat footings cannot be used.**
- **This is also used to prevent uplift of the structure** due to lateral loads such as earthquake and wind forces.

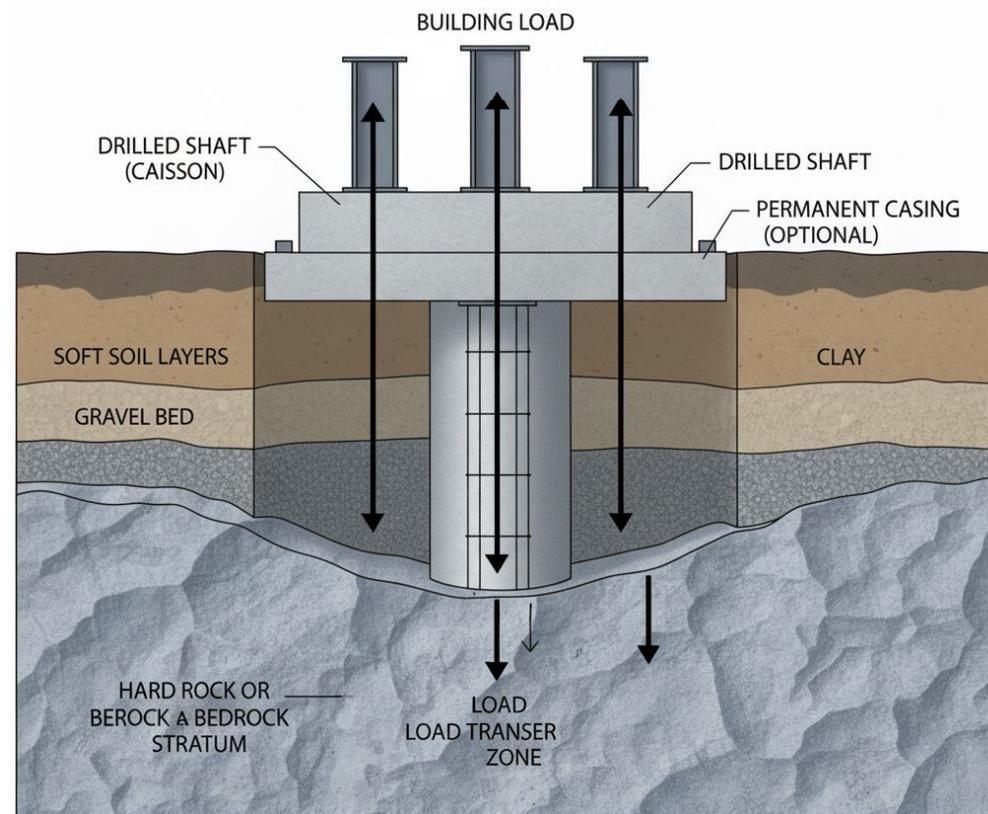
# Structural Elements of Building

## I. Foundation

### 2. Deep foundation:

#### Types of shallow foundation:

#### b. Drilled Shafts or Caisson Foundation:



# Structural Elements of Building

## I. Foundation

### 2. Deep foundation:

#### Types of shallow foundation:

#### *b. Drilled Shafts or Caisson Foundation:*

- Drilled shafts, also called as caissons, is a type of deep foundation and has an action similar to pile foundations discussed above, but are high-capacity cast-in-situ foundations.
- It resists loads from structure **through shaft resistance**, toe resistance and/or combination of both of these.
- The construction of drilled shafts or caissons are **done using an auger**

# Structural Elements of Building

## I. Foundation: Purpose

- Foundation are the main reason behind the stability of any structure. **The stronger is the foundation, more stable is the structure.**
- The proper design and construction of foundations provide a **proper surface for the development** of the substructure in a proper level and over a firm bed.
- Specially designed foundation helps in avoiding the **lateral movements of the supporting material.**

# Structural Elements of Building

## I. Foundation: Purpose

- A proper foundation **distributes load on to the surface of the bed uniformly.** This uniform transfer helps in avoiding unequal settlement of the building. Differential settlement is an undesirable building effect.
- The foundation serves the purpose of completely distributing the load from the structure over a large base area and then to the soil underneath. This load transferred to the soil should be within the allowable bearing capacity of the soil.

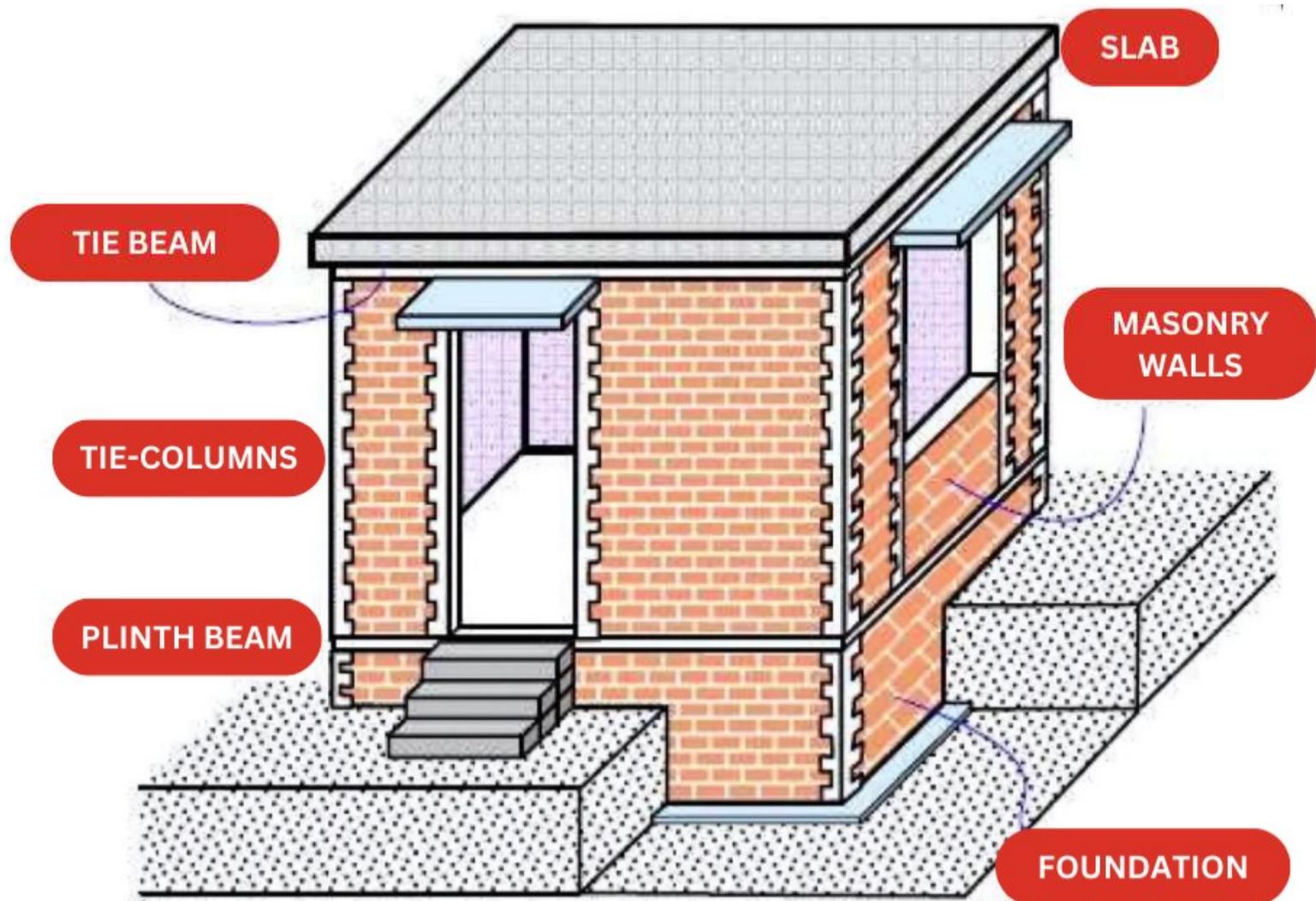
# Structural Elements of Building

## I. Foundation: Functions

- Provide overall lateral stability for the structure
- Foundation serves the function of providing a level surface for the construction of substructure.
- Load Distribution is carried out evenly.
- The load intensity is reduced to be within the safe bearing capacity of the soil.
- The soil movement effect is resisted and prevented.

# Structural Elements of Building

## 2. Plinth



# Structural Elements of Building

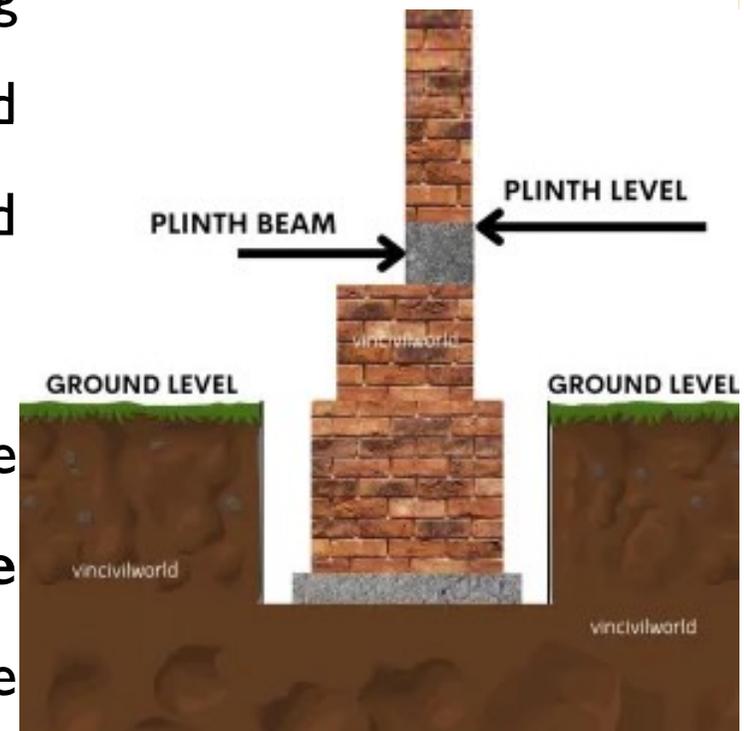
## 2. Plinth

- A plinth level forms the foundation of a house.
- It is a rectangular block of stone on which a column and pillar of a building stands.
- It is a wall between the ground level and the ground floor level. Column bears the weight of the building's structure but all this weight presses down on the column.
- The main function of a plinth in construction is to distribute the load of the columns over the foundation evenly.

# Structural Elements of Building

## 2. Plinth: Uses

- It **evenly distributes and disperses the load of the columns** to the foundation evenly.
- It acts a **barrier** or a retaining wall that keeps the concrete filled ground floor below the raised floor of the building.
- The plinth doesn't allow the dampness and **moisture of the ground floor** to reach the building's top structure.



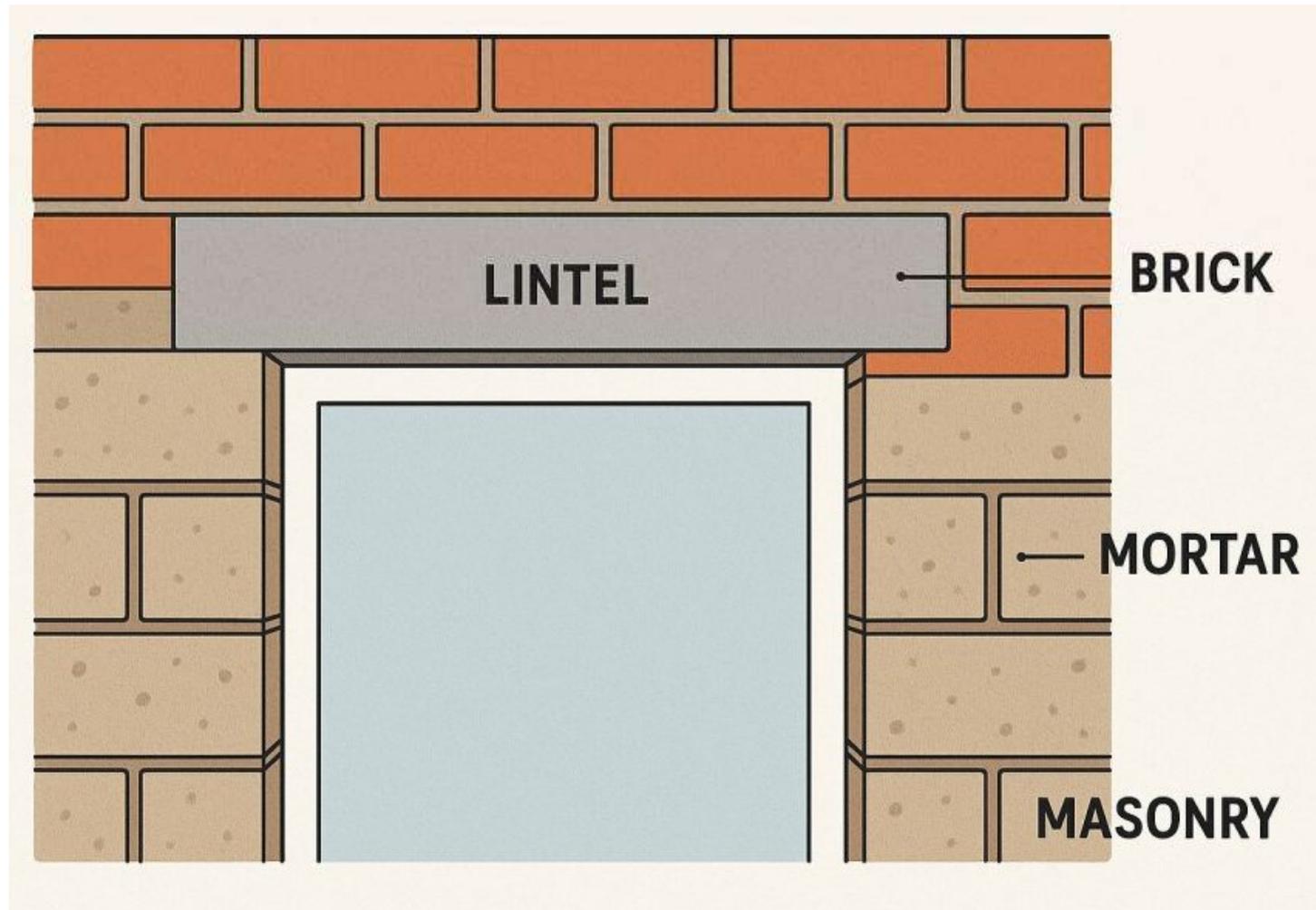
# Structural Elements of Building

## 2. Plinth: Uses

- In framed structure houses and buildings plinth beams are used as a **barrier for protection from water seepage**.
- Plinth protects the rest of the house from **dampness**.
- It is a kind of waterproofing sheet laid above the ground floor level to protect the house from any damage because of added moisture.
- Gives **strength and durability** to the residential unit.
- Provides a better **aesthetic appeal** to the building.
- It also prevents **cracks in the building when the foundation suffers from settlement**.

# Structural Elements of Building

## 3. Lintel:



# Structural Elements of Building

## 3. Lintel: Different Types

- Reinforced cement concrete (RCC)
- Stone
- Wood/timber
- Bamboo
- Steel

# Structural Elements of Building

## 3. Lintel: Uses

- The primary function of the lintel is **to take loads** originating from the wall directly above the opening and transfer them to the side walls or stone pillar support.
- Lintel also acts as a **safeguard for the windows and doors**.
- Continuous lintels may provide support in **masonry structures against lateral loads like wind or earthquakes**.

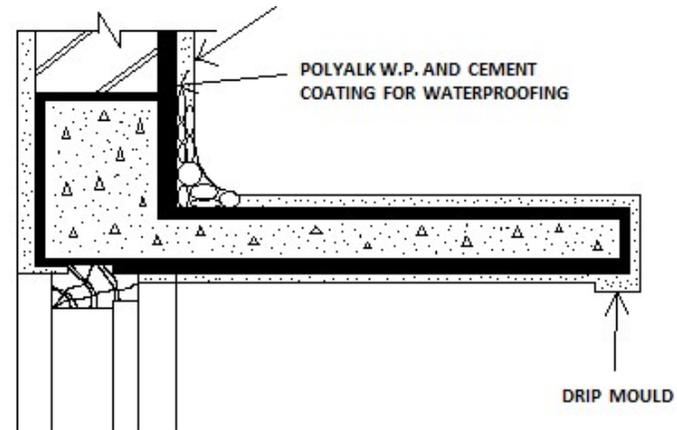
# Structural Elements of Building

## 3. Lintel: Uses

- The **chimney above the fireplaces can be supported by lintels.**
- It is possible to enhance the **architectural beauty of a building** by selecting decorative lintels. Lintel architecture would be a good matter of concern here.
- Lintels may support a small distance of a path. It could be referred to as a lintel bridge.

# Structural Elements of Building

## 4. Chejja



# Structural Elements of Building

## 4. Chejja

- Chejja is overhang or projection from the lintel which is provided to protect the doors and windows from **sunlight and rain.**
- It is characterized with large support brackets with different artistic designs.
- Variation is also seen in its size depending on the importance of the building on which it features or the choice of the designer

# Structural Elements of Building

## 5. Masonry wall



# Structural Elements of Building

## 5. Masonry wall

- A masonry wall is a wall made from materials which have traditionally been cemented together with the use of mortar.
- Masonry walls can be used as structural walls in buildings, and they can also be utilized to create barriers between property lines or different areas on a property.
- Masonry walls render strengths, lastingness to the structure, and help to maintain indoor and outdoor temperature as well as keeps protect the buildings from the outside world.
- Depending on the motor mix materials, there are various types of Masonry Walls used in building constructions.

# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

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



# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

### 1. *Load-bearing masonry wall:*



# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

### 1. *Load-bearing masonry wall:*

- *A load-bearing wall is a wall that bears a load reposing upon it, which depends on weight construction and the work of foundation structure.*
- *Usually, this type of wall is used for large buildings. e.g. housing or tall buildings construction work.*
- *It is mainly made with brick, concrete blocks, or stone.*
- *The load-bearing wall helps to transfer weight from the roof to the foundation.*

# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

### 2. Reinforced masonry wall:



# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

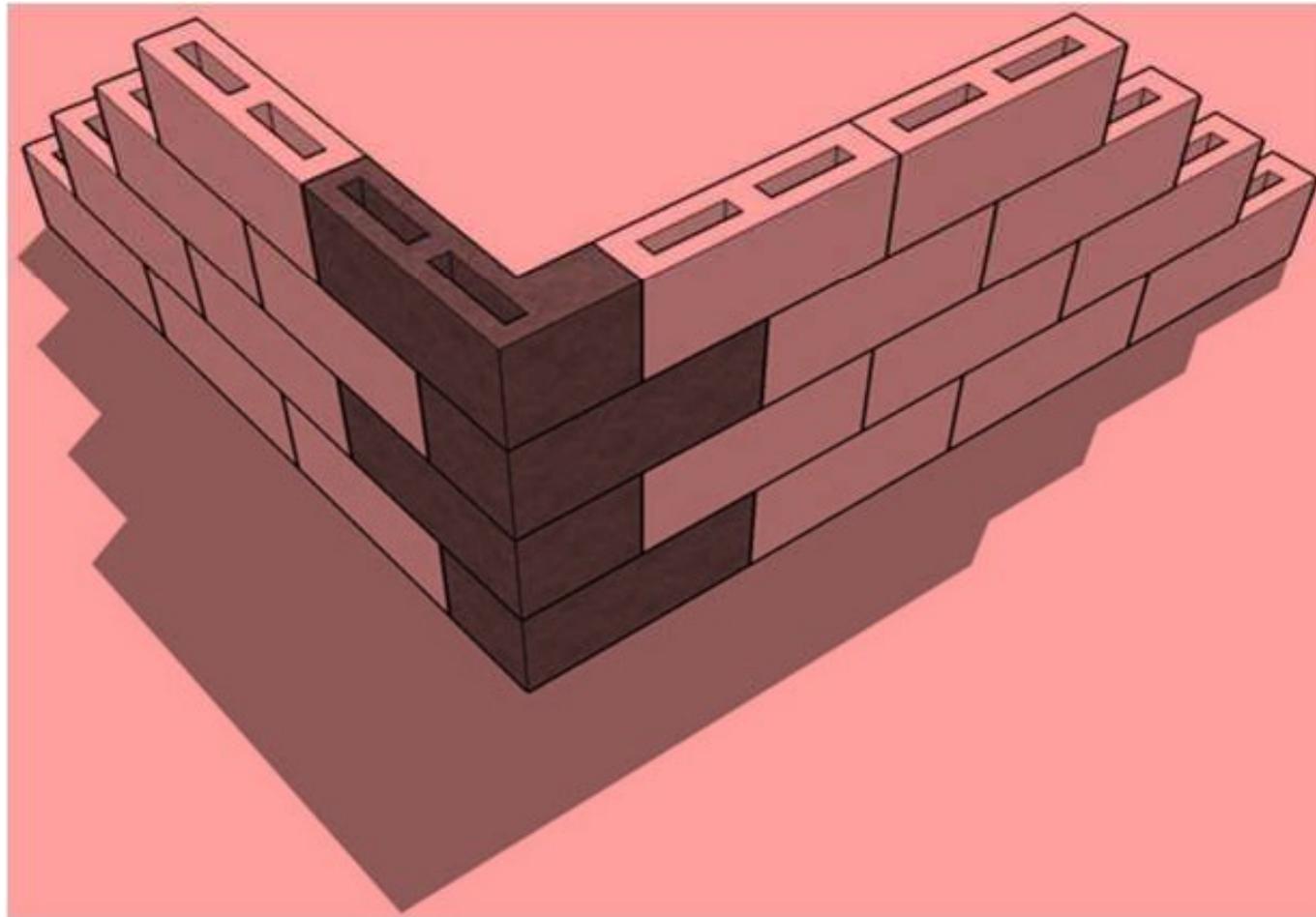
### 2. Reinforced masonry wall:

- *A reinforced masonry wall is made with any type of brick, concrete, or other types of masonry materials that strengthened the use of other building's materials to increase resistance to deterioration due to weight-bearing or other forms of stress.*
- *This type of wall could be non-load-bearing or load-bearing.*

# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

### 3. *Hollow/Cavity Masonry Wall:*



# Structural Elements of Building

## 5. Masonry wall : Types of Masonry Wall:

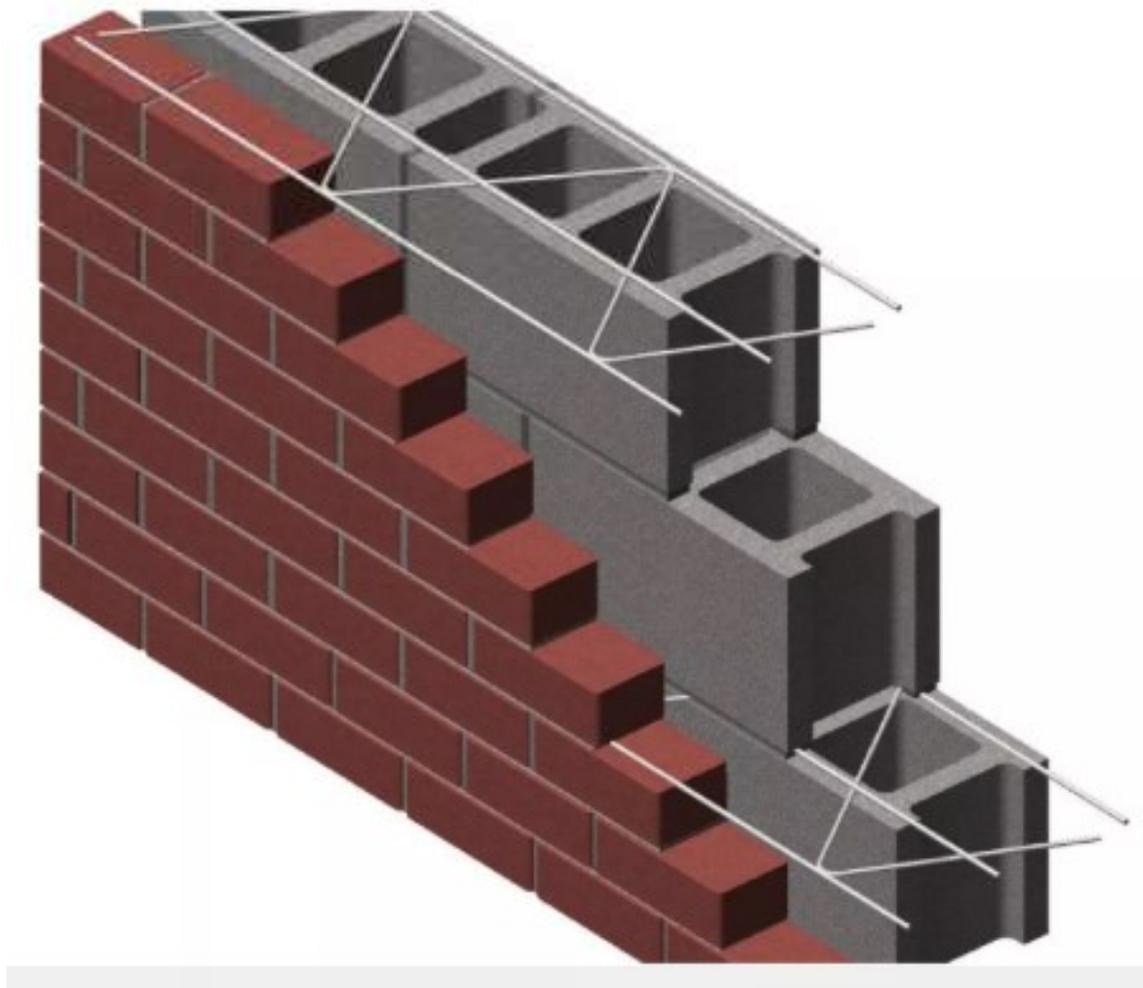
### 3. *Hollow/Cavity Masonry Wall:*

- *Hollow masonry walls are made with cement blocks.*
- *This type of masonry wall is used to stop dampness from getting inside the building.*
- *It creates a hollow area between the outside and inside of masonry walls.*
- *Cavity walls will also assist with climate control.*
- *Modern masonry walls are constructed from hollow masonry units or combined hollow and solid masonry units.*

# Structural Elements of Building

5. Masonry wall : Types of Masonry Wall:

4. *Composite Masonry Walls:*



# Structural Elements of Building

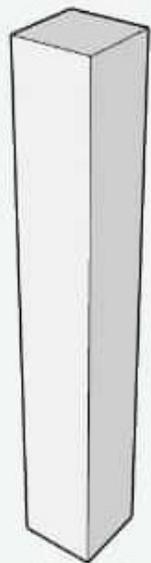
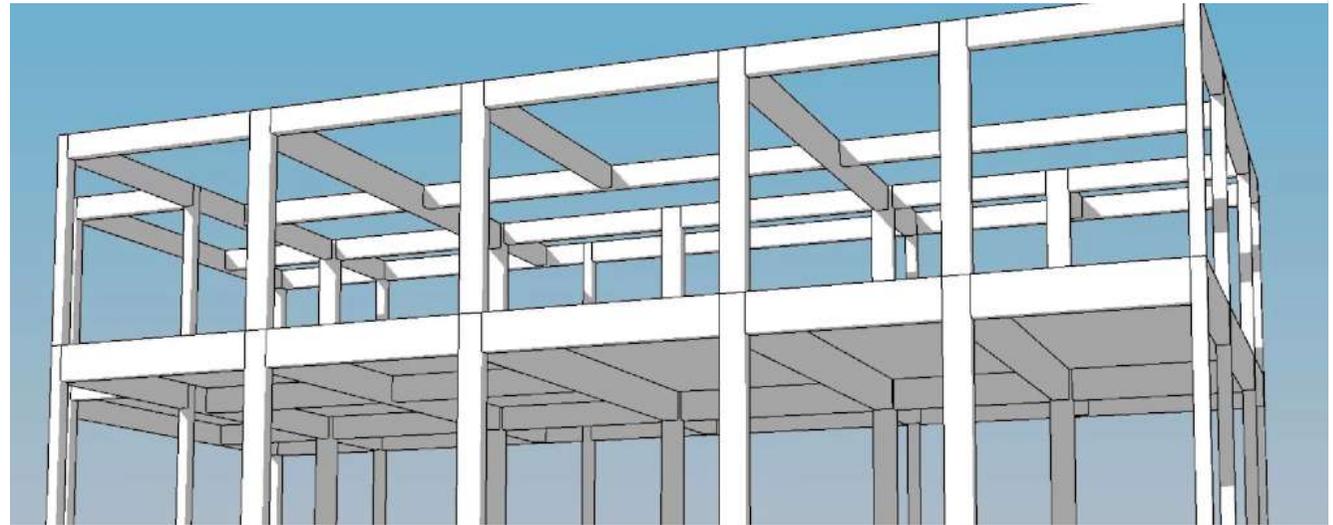
## 5. Masonry wall : Types of Masonry Wall:

### 4. Composite Masonry Walls:

- *Composite Masonry walls are made with the combination of two or more building materials; stones and bricks or hollow bricks and bricks.*
- *The purpose of this type of wall construction is –reduce the overall cost of construction and make the structure durable by providing materials of better quality and good workmanship in the faces.*
- *Composite masonry walls work to improve the appearance of a structure by covering up the inferior works by the use of superior quality material in the desired positions.*
- *This type of wall is better because it is cost effective and optically appealing*

# Structural Elements of Building

## 6. Column



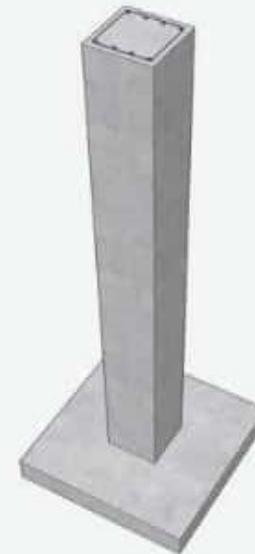
**Rectangular  
Column**



**Circular  
Column**



**Axially Loaded  
Column**



**Reinforced Concrete Column**



# Structural Elements of Building

## 6. Column

- Column is a vertical structural member that carry loads mainly in compression.
- It might transfer loads from a ceiling, floor slab, roof slab, or from a beam, to a floor or foundations.
- Commonly, columns also carry bending moments about one or both of the cross-section axes.

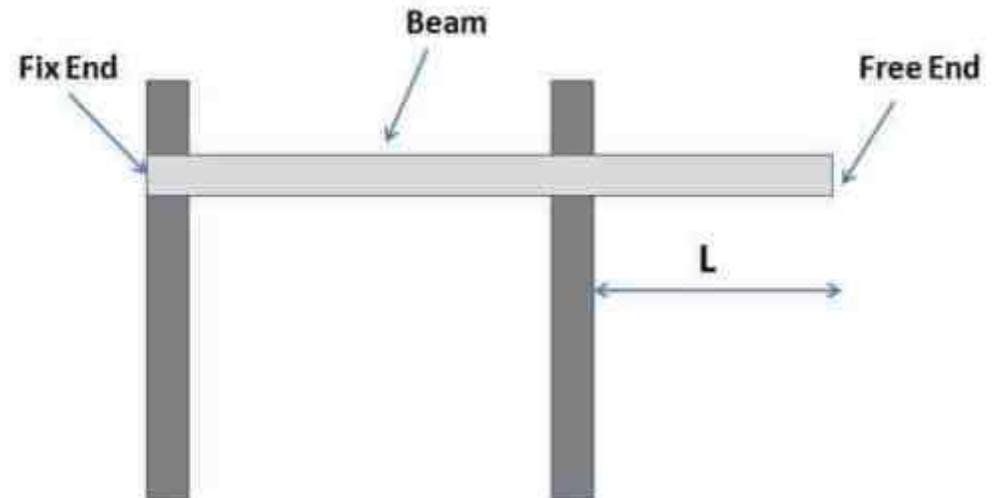
# Structural Elements of Building

## 6. Column: Functions of column:

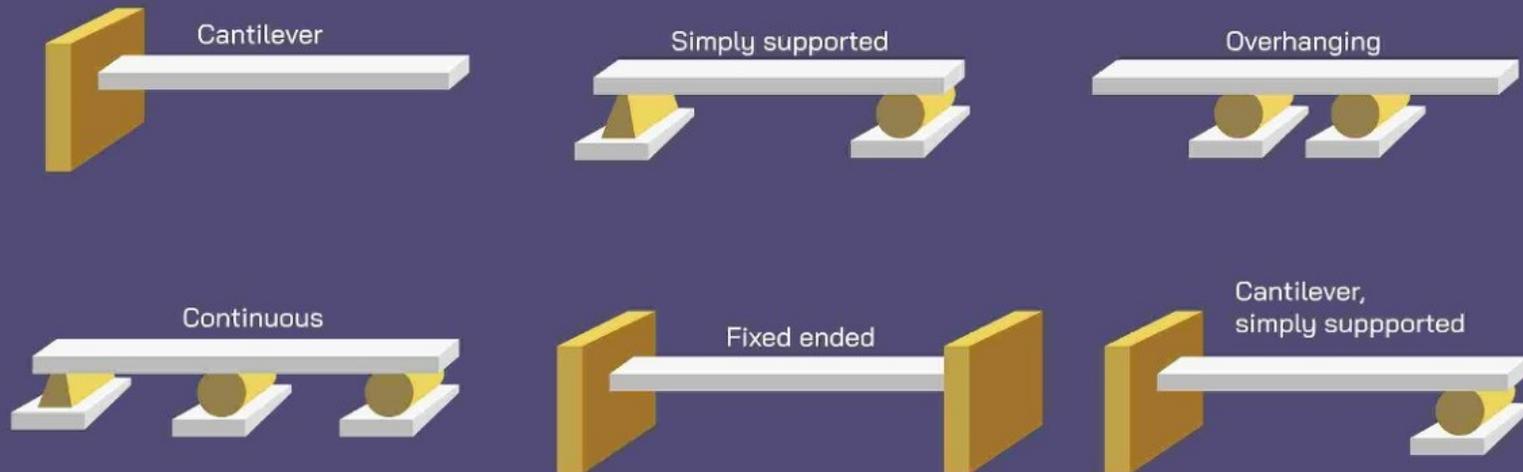
- Columns transfer the **weight of the floors, walls, and roof** to the foundation, ensuring that the structure remains stable and secure.
- Columns help **maintain the vertical alignment** of the building, ensuring that the floors and walls are properly supported.
- They resist horizontal forces and prevent **the building from tilting or collapsing.**
- Columns also serve as **architectural elements that** divide the space within a building.
- It improves durability of building.

# Structural Elements of Building

## 7. Beams



### BEAM TYPES



# Structural Elements of Building

## 7. Beams

- It is a structural element that is capable of withstanding load primarily by resisting its bending forces.
- They are made of steel or reinforced concrete (RCC) or steel.

### *Beams are used in the structure to*

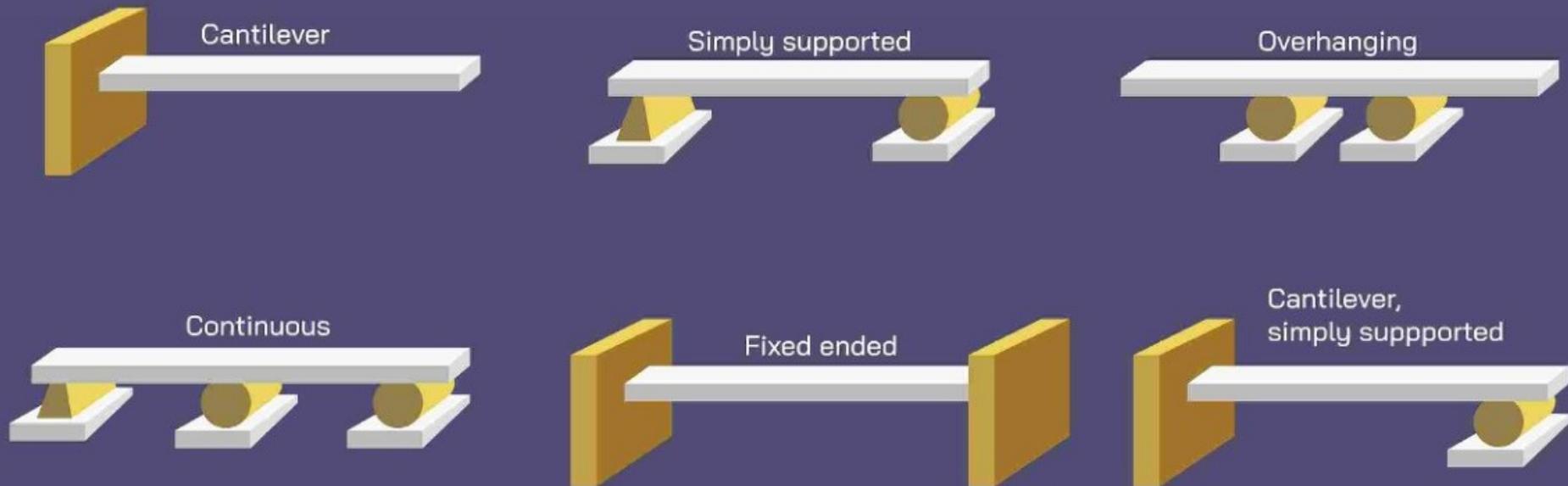
1. Resist loads
2. Counter bending moment and shear forces.
3. Connect the frame.
4. Provide a uniform distribution of loads

# Structural Elements of Building

## 7. Beams: Classification of beams:

According to the support conditions

### BEAM TYPES



# Structural Elements of Building

## 7. Beams: Classification of beams:

### According to the support conditions

1. **Simply Supported Beams:** *A simply supported beam is supported at both ends. These beams are primarily used in general construction.*
2. **Continuous Beams:** *A beam that has more than two supports this kind of beam is called a continuous beam. Two or more two supports are used between these beams, and these beams are similar to the simply supported beams.*

# Structural Elements of Building

## 7. Beams: Classification of beams:

### According to the support conditions

- 3. Fixed Beams:** *A beam that is fixed at both ends is called a fixed beam. Fixed beams are not allowed the vertical movement or rotation of the beam. In this beam, no bending moment will produce. Fixed beams are only under the shear force and are generally used in trusses and other structures.*
- 4. Cantilever Beams:** *It's one end fixed in-wall or column, and the other side is free. These beams are generally used in bridge trusses and other structural members.*

# Structural Elements of Building

## 7. Beams: Functions of Beam:

- The primary function of beam is to **carry and transfer the loads imposed on a structure.**
- Beams support the **weight of floors, walls, roofs, and any other** imposed loads such as furniture, equipment, or people. They distribute these loads to the columns.
- Beams prevent **sagging, deflection, or excessive** bending of the structural members they support.
- They improve overall **stability of the building.**

# Structural Elements of Building

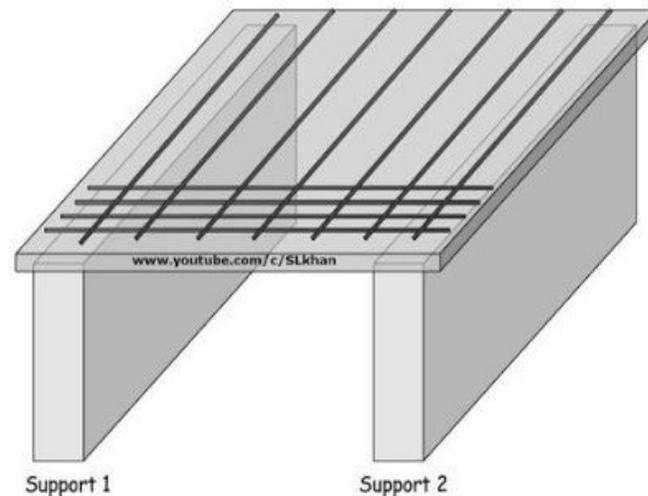
## 8. Slab



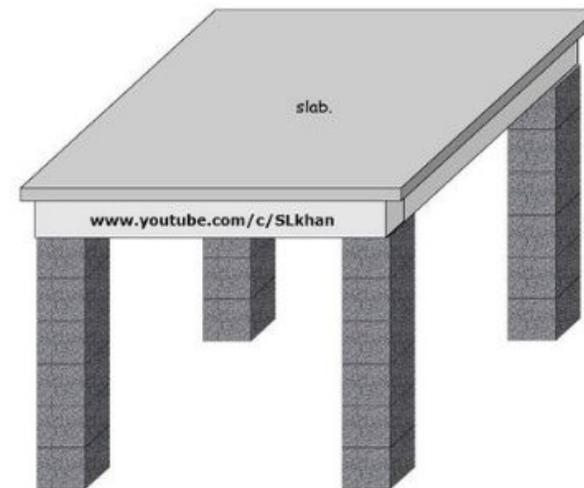
# Structural Elements of Building

## 8. Slab

- Slab is a structural element, made of concrete that is used to create flat horizontal surfaces such as floors, roof decks, and ceilings.
- Generally, a slab is 100 to 150 mm thick and supported by beams, columns, walls.



**One Way Slab**

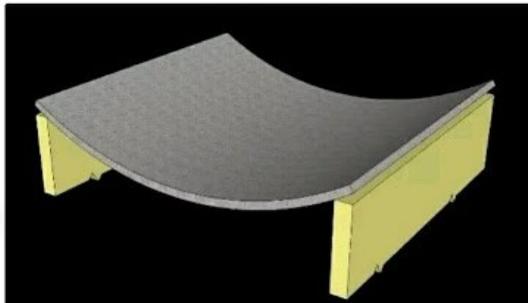
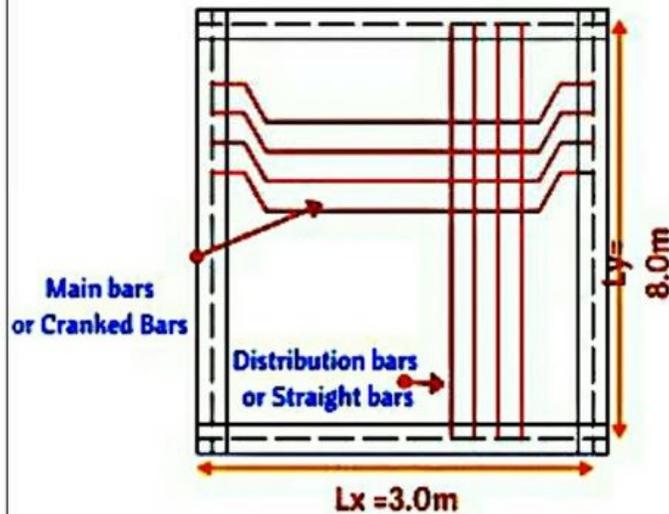


**Two Way Slab**

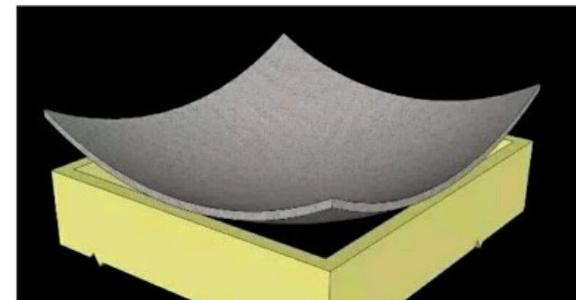
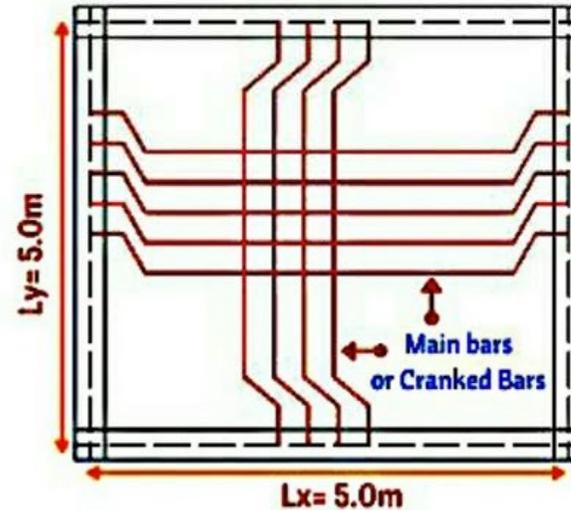
# Structural Elements of Building

## 8. Slab: Types of Slabs:

# ONE WAY SLAB vs TWO WAY SLAB



D  
I  
F  
F  
E  
R  
E  
N  
C  
E



# Structural Elements of Building

## 8. Slab: Types of Slabs:

### 1. One-way slab:

- One-way slab is a slab in which the ratio of longer spans to shorter spans ratio is more than or equal to 2.
- In a one-way slab, primary reinforcement is required and given only in one direction.
- In a one-way slab, the load distribution is in one direction for shorter spans.

# Structural Elements of Building

## 8. Slab: Types of Slabs:

### 2. Two-way slab:

- Two-way slab is a slab in which the ratio of longer spans to shorter spans ratio is less than 2.
- In a two-way slab, main reinforcement is needed and given in both directions.
- In two-way slab, the load distribution takes place in four sides.



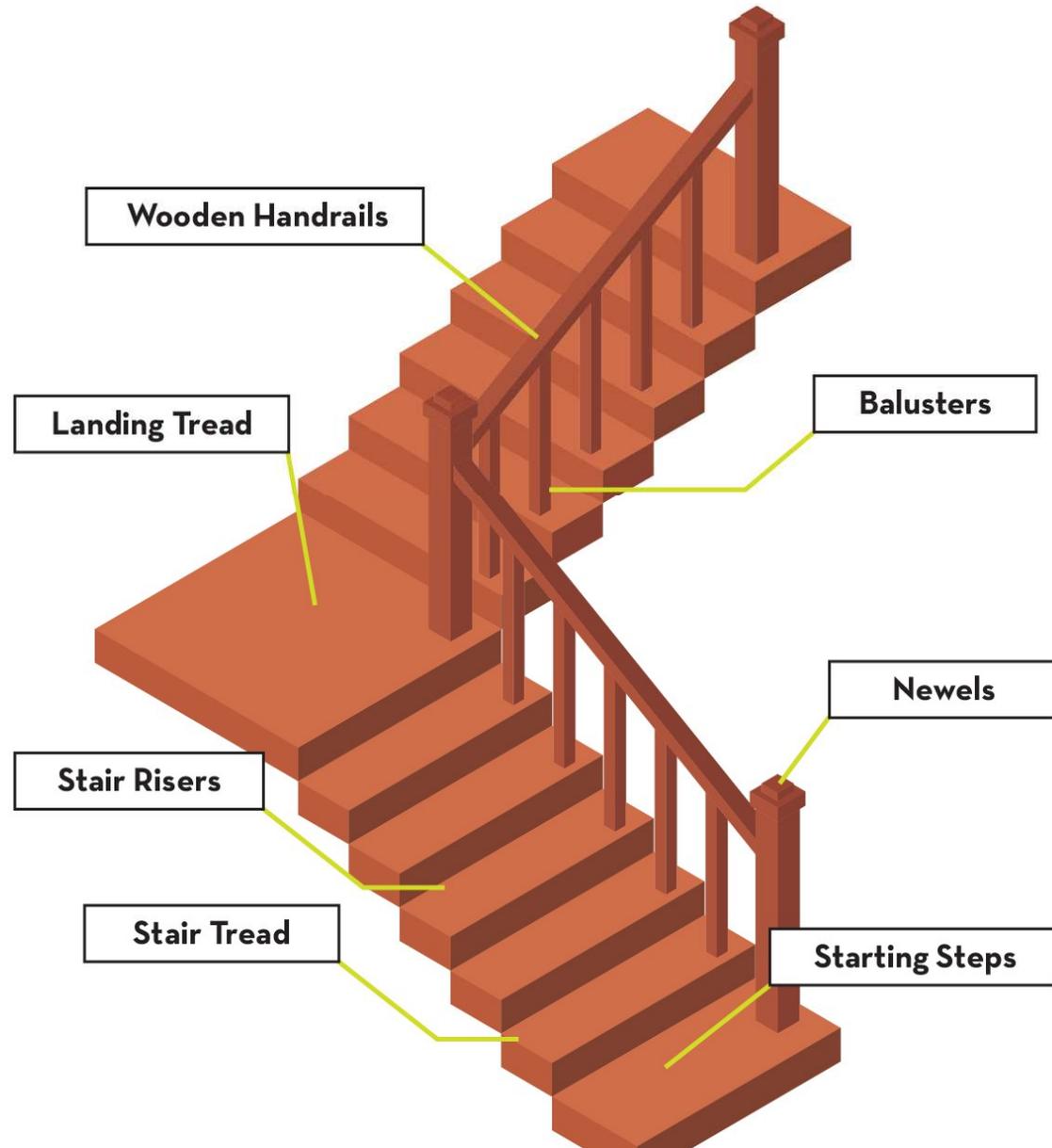
# Structural Elements of Building

## 8. Slab: Functions of Slab:

- It provide flat surface.
- It supports the load.
- It is sound, heat and fire insulator.
- It offers privacy for occupants.

# Structural Elements of Building

## 9. Staircase



# Structural Elements of Building

## 9. Staircase:

- Staircase is an important component of a building providing access to different floors and roof of the building.
- It consists of a flight of steps and one or more intermediate landing slabs between the floor levels. Stairs can be defined as series of steps suitably arranged for the purpose of connecting different floors of a building.
- It may also be defined as an arrangement of treads, risers, stringers, newel post, hand rails, and baluster, so designed and constructed as to provide an easy and quick access to the different floors.
- Stairs can be made of concrete, stone, wood, steel or combination of any of these.

# Structural Elements of Building

## 9. Staircase: Parts of Stairs:

- **Step:** *It is a portion of stairs which permits ascent & descent.*
- **Tread:** *It is the upper horizontal portion of step upon which the feet is placed.*
- **Riser:** *The vertical portion between each tread on the stair.*
- **Handrail:** *A handrail is a rail that is designed to be grasped by the hand so as to provide stability or support.*
- **Baluster:** *It is vertical member of wood or metal supporting the handrail.*
- **Newel Post:** *This is the vertical member which is placed at the ends of flights to connect handrail.*
- **Run:** *It is the total length of stairs in a horizontal plane, including landings.*

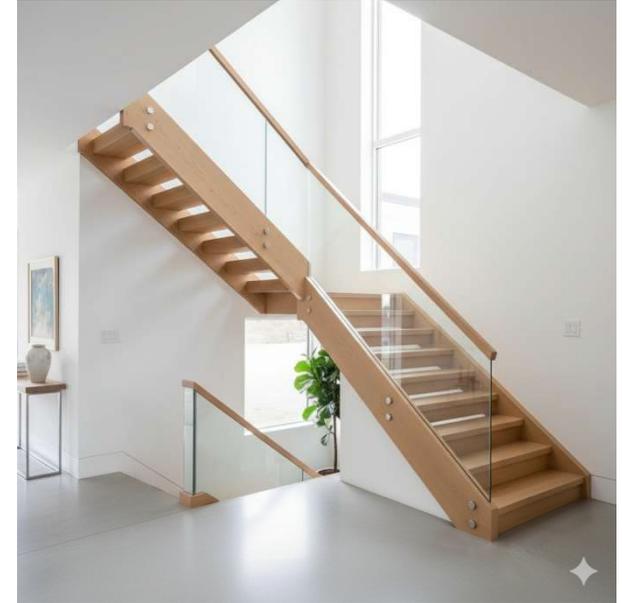
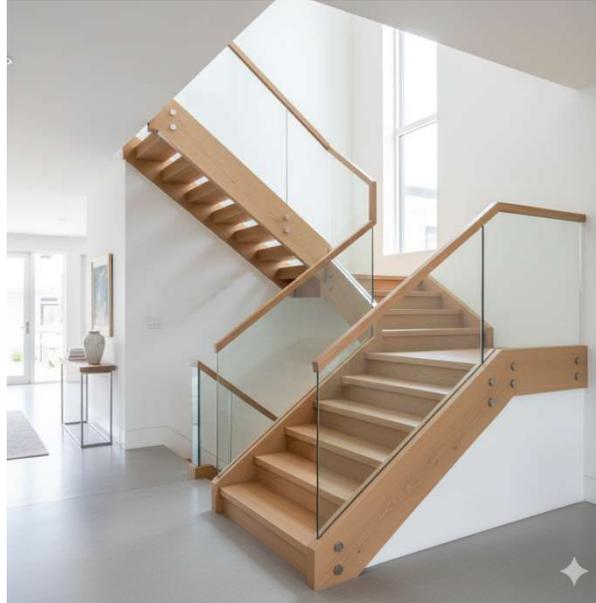
# Structural Elements of Building

## 9. Staircase: Types of Stairs:

1. Straight stairs
2. Quarter turn stairs
3. Half turn stairs
4. Three quarter turn stairs
5. Circular stairs
6. Spiral stairs

# Structural Elements of Building

## 9. Staircase: Types of Stairs:



# Structural Elements of Building

## 9. Staircase: Types of Stairs:

### 1. Straight Stairs:

These are the stairs along which there is no change in direction on any flight between two successive floors.

### 2. Quarter turn stairs:

They are provided when the direction of flight is to be changed by  $90^\circ$ . The change in direction can be affected by either introducing a quarter space landing or by providing winders at the junctions.

# Structural Elements of Building

## 9. Staircase: Types of Stairs:

### 3. Half Turn Stairs:

- It can be either dog-legged or open newel type.
- In case of dog legged stairs the flights are in opposite directions and no space is provided between the flights in plan.
- On the other hand, in open newel stairs, there is a well or opening between the flights and it may be used to accommodate a lift.
- These stairs are used at places where sufficient space is available.

# Structural Elements of Building

## 9. Staircase: Types of Stairs:

### 4. Three Quarter Turn Stairs:

These types of stairs change their directions through 270 degrees. In other words, direction is changed three times with its upper flight crossing the bottom one. In this type of construction an open well is formed.

### 5. Circular Stairs:

These stairs, when viewed from above, appear to follow circle with a single center of curvature and large radius. These stairs are generally provided at the rear of a building to give access for servicing at various floors. All the steps radiate from a newel post in the form of winders. These stairs can be constructed in stone, cast iron or R.C.C.

# Structural Elements of Building

## 9. Staircase: Types of Stairs:

### 6. Spiral Stairs:

These stairs are similar to circular stairs except that the radius of curvature is small and the stairs may be supported by a center post. Overall diameter of such stairs may range from 1 to 2.5 m.

# Structural Elements of Building

## 9. Staircase: Functions of Stairs:

- Provide an access from one floor to another.
- Provide a safe means of travel between floors.
- Provide a degree of insulation where part of a separating element between compartments in a building.
- Provide a suitable means of escape in case of fire.
- Provide a mean of conveying fittings and furniture between floor levels.

# Structural Elements of Building

## 9. Staircase: Requirements of a good stair:

- **Location** - it should preferably be located centrally, ensuring sufficient light and ventilation.
- **Width of stair** - the width of stairs for public buildings should be 1.8 m and for residential buildings 0.9 m.
- **Length** - the flight of the stairs should be restricted to a maximum of 12 and minimum of 3 steps.
- **Pitch of stair** - the pitch of long stairs should be made flatter by introducing landing.
- The slope should not exceed 400 and should not be less than 250.

# Structural Elements of Building

## 9. Staircase: Requirements of a good stair:

- **Head room** - the distance between the tread and soffit of the flight immediately above it, should not be less than 2.1 to 2.3 m. this much of height is maintained so that a tall person can use the stairs with some luggage on its head.
- **Materials** - stairs should be constructed using fire resisting materials. Materials also should have sufficient strength to resist any impact.
- **Landing** - the width of the landing should not be less than the width of the stair.

# Structural Elements of Building

## 9. Staircase: Requirements of a good stair:

- **Winders** - these should be avoided and if found necessary, may be provided at lower end of the flight.
- **Step proportions** - the ratio of the going and the rise of a step should be well proportioned to ensure a comfortable access to the stair way.