GOVERNMENT POLYTECHNIC KENDRAPARA

DEPARTMENT OF CIVILENGINEERING

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Subject code/Name- CEPC 201 TH:1 Building Construction

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CHAPTER -1

Overview of Building Components

1. Classification of Buildings (NBC of India)

According to the National Building Code (NBC), buildings are classified based on occupancy (how the building is used) into nine main groups:

Group A - Residential Buildings: Any building providing sleeping accommodation for normal residential purposes, with or without cooking/dining facilities (e.g., houses, apartments, hotels, dormitories).

Group B - Educational Buildings: Buildings used for school, college, or university education (e.g., schools, universities, training institutes).

Group C - Institutional Buildings: Buildings used for medical treatment, care of persons suffering from illness or infirmity, or for penal detention (e.g., hospitals, sanatoria, nursing homes, jails).

Group D - Assembly Buildings: Buildings where groups of people gather for amusement, recreation, social, religious, or patriotic purposes (e.g., theaters, cinema halls, assembly halls, places of worship).

Group E - Business Buildings: Buildings used for transaction of business, record keeping, or professional services (e.g., offices, banks, libraries).

Group F - Mercantile Buildings: Buildings used for display and sale of goods, either wholesale or retail (e.g., shops, stores, markets).

Group G - Industrial Buildings: Buildings where products or materials are fabricated, assembled, or processed (e.g., factories, power plants, refineries).

Group H - Storage Buildings: Buildings primarily used for storage or sheltering of goods, vehicles, or animals (e.g., warehouses, cold storages, freight depots).

Group J/I - Hazardous Buildings: Buildings used for storage, handling, or manufacturing of highly combustible or explosive materials.

2. Types of Building Constructions

Buildings are classified based on their structural system:

Load Bearing Structure: In this structure, the walls (brick or stone) carry the entire load of the building (floors and roof) and transfer it to the foundation. Suitable for low-rise buildings.

Framed Structure: A structural system consisting of vertical members (columns) and horizontal members (beams) that form a skeleton to carry all loads. Ideal for high-rise buildings and modern designs.

Composite Structure: A hybrid structure using both load-bearing walls and framed structural elements together.

3. Building Components

A building consists of two main parts: the Substructure (below ground) and Superstructure (above ground).

A. Substructure (Foundation & Plinth)

Foundation: The lowest part of a building, located below ground level. Its function is to safely transmit the entire load of the building to the soil.

Plinth: The portion of the structure between the ground level and the finished floor level of the ground floor. It connects the foundation to the superstructure and prevents dampness from entering the walls (DPC is provided here).

B. Superstructure (Above Ground Level)

Walls: Vertical components that enclose space, divide rooms, and provide privacy.

Partition Wall: A thin internal wall used to divide the floor space into rooms.

Cavity Wall: A wall constructed with a gap (cavity) between two leaves to provide thermal insulation and prevent moisture penetration.

Sill: The lower part of a window opening, typically made of concrete or stone.

Lintel: A horizontal beam provided over openings like doors and windows to support the wall load above them.

Doors and Windows: Openings in walls to provide access, light, and ventilation.

Floor: A horizontal component separating different levels of a building.

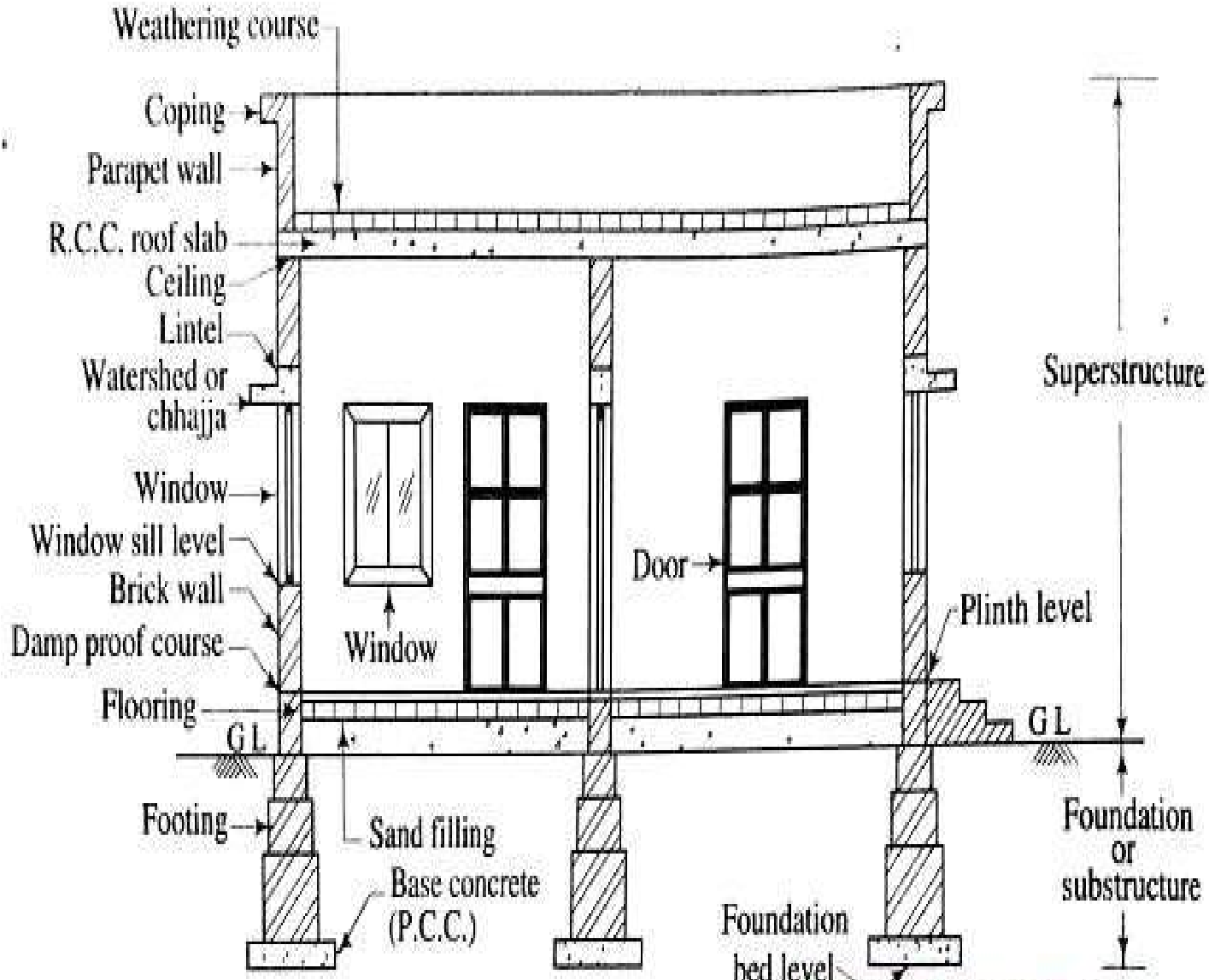
Mezzanine Floor: An intermediate floor between two main stories, usually part of the floor below it.

Roof: The top-most covering of a building designed to protect against weather elements (rain, sun, wind).

Columns: Vertical structural elements that carry loads from beams and roofs to the foundation.

Beams: Horizontal structural members designed to support loads from slabs and transfer them to columns.

Parapet: A short-height wall (roughly 1m) constructed at the edge of a roof or terrace for the safety of occupants.



Components of a building

CHAPTER -2
Construction of Substructure

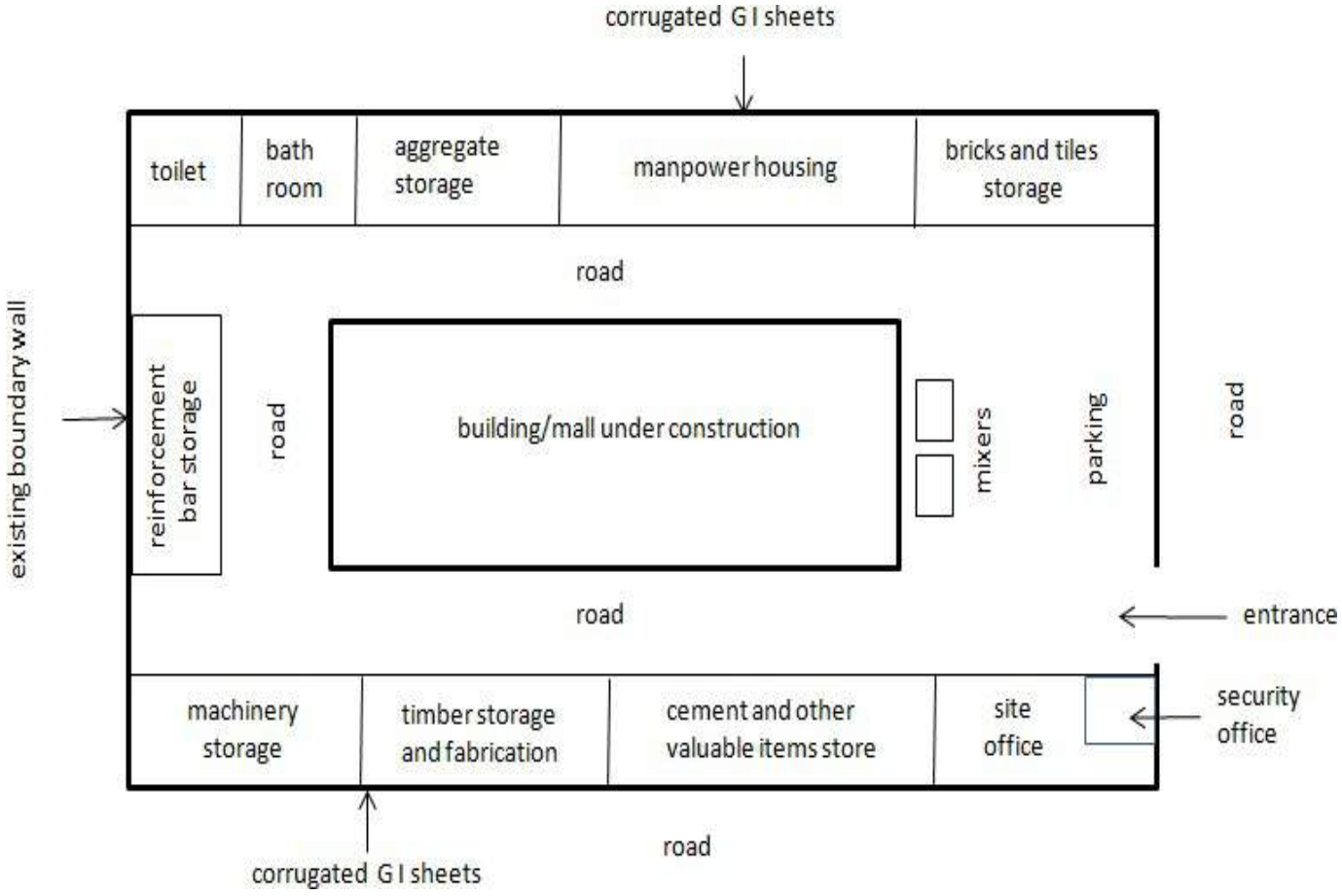
Substructure construction involves clearing the site, precise layout using centerline/face line methods, and excavation with timbering for safety. Foundations are classified into shallow (footings, rafts) and deep (piles, wells) types based on soil capacity, supported by dewatering, plinth filling, and structural reinforcements.

JOB LAYOUT :

Job layout can be defined as a drawing of the proposed construction site which shows different locations such as entry point, exit point, equipment, and material stores, temporary facility, site office, and place where workers will stay.

Job layout helps us to plan the construction site in such a way that different construction resources like tools, machinery, materials, manpower, etc. can be arranged easily and optimal uses of construction space can be achieved. More complex the construction project or larger in scale detailed job layout is necessary as it helps in detailing and managing space on site. Following are the main purpose of job layout:

- It helps in reducing the completion time for the construction.
- It provides easy movement of equipment from one point to another.
- It helps in reducing wastage and deterioration of the material.
- It saves time by delivering and making a uniform flow of material at the site.
- It provides more safety to the worker at the site.
- The output from manpower and equipment can be increased using the job layout.



Site Clearance:

Site clearance is the process taken to prepare a building site for its construction. It involves the clearance of vegetation, dead root mats, living or dead trees, and subsoil for a minimum depth of 30 cm from the ground surface. Site clearance also involves the work related to the demolition of any prior structure before the actual construction takes place.

The following recommendations are considered during the process of the site clearance:

(1) The area to be cleared is marked properly.

(2) The trees and vegetation on the site are to be cleared off. The details of the trees to be cut should be listed and the trees and vegetation are removed manually or mechanically.

(3) The topsoil is excavated using the excavating equipment. The excavators are used for the removal of the soil

(4) All the depressions and pits created during the process of clearing the trees and during the removal of the vegetation must be filled and compacted properly. The excavated soil is used for this purpose.

(5) The water can be used during the compaction of the pits. The density of the compacted pits should be near the surrounding area.

(6) If the structures exist in the area, these should be demolished mechanically. The demolition waste is dumped at the approved dumping sites, and the useful waste is stored properly. The soil that is excavated must be stored properly. These materials can be removed using tractors and dumpers

(7) The ground can be leveled using the dozers if required.

EARTHWORK:

The process of the excavation and deposition of excavated material is known as earthwork. The earthwork includes the excavation, loading, transportation, deposition, compaction, and improvement of the soil. After the clearance of the site, the earthwork begins. Earthwork can be defined as engineering work that involves moving the soil or processing the soil from the earth's desired shape required for construction purpose. Earthworks mainly required heavy machinery equipment for the excavation of soil and backfill. Heavy machinery is generally used due to the involvement of large quantities of the material which has to be moved.

Excavation for Foundation:

Excavation can be defined as a process that helps in transferring subsoil, rock, or any other material using machinery and tools. It includes trenching, tunneling, earthworks, and wall shafts. One of the common practices using excavation is building construction. Excavation is primarily used in foundation for digging, trenching, and site development.

Excavation for small buildings is done manually using pick axes, spades, crowbars, etc. For deep foundations and for large buildings, excavation is carried out by using machinery for earth cutting. Setting out is done first to carry out excavation at the site. The Excavation is done on hard soil where the depth of the foundation is less than 1.5 m, trench sides don't require external support. In case of loose soil or deeper excavation, some type of support is required from preventing the sides to fall. Strutting and timbering are done continuously depending on the type of soil and foundation depth. In general, excavation trench width is kept equal to the width of foundation concrete, because wider excavation is not good for the strength and economy of the building as wider excavation is to be filled later by losing soil. The foundations should be checked for depth and width while excavating.

Earthwork for Embankment:

Earthwork is the engineering work using machinery and tools for moving or processing subsoil and underground rocks. The subsoil may be transported from one location to another or formed into any shape that is required for the construction. Earthwork generally involves cutting and filling and machine excavation at the site.

Materials for Plinth:

- Soil
- Murrum Soil
- Sand

Tools and Plants for Excavation:

- Spade
- Shovel
- Hoe
- Trowel
- Pickaxe
- Rammer
- Crow bar
- Basket

(a)

(b)

(c)

(d)

(e)

- ❖ Different types of machine tools used in construction are as follows:

- Tracked Excavator
- Bulldozer
- Roller
- Backhoe Excavator
- Loader

Tracked Excavator

Backhoe

FOUNDATION:

The word 'foundation' has emerged from the Latin word 'fundare'. The word 'fundare' means to 'set on a solid base'. Foundation is the lowermost part of the structure which transfers the load of the superstructure and other loads to the ground. A foundation may be defined as a solid base on which the structure rests.

The foundation plays a major role in the stability and strength of the structure. As the ultimate load from all the building components is to be transferred through the foundation, it is essential to construct the foundation carefully.

FUNCTIONS OF FOUNDATION:

The foundation is one of the most important parts of the building. The structural elements like columns, , and slabs transfer the load to each other but it is the foundation that ultimately transfers beams the load of the whole structure to the earth. So, the foundation plays a vital role in the safety and serviceability of a structure. The major functions of the foundation are discussed as follows:

(1) A foundation provides a hard and level surface that is suitable for the construction of a superstructure over it.

(2) The foundation distributes the load from the structure to a larger area which helps in reducing the load intensity. We know that pressure is the ratio of force to area. If the area is larger the pressure reduces. The foundation acts on the same principle. The load of the structure is distributed by the foundation and transferred to the ground. The larger the area of the foundation, the lesser will be the load intensity and the safer will be the structure.

(3) The load is distributed uniformly by the foundation. If the load is distributed non-uniformly or unevenly, there can be differential settlements in the base. The differential settlements can cause cracks in the building components. In extreme cases, even failure of building components can occur.

(4) There is a significant impact of winds and earthquakes on the buildings. The wind and earthquake loads have a tendency to overturn the building due to their horizontal impact. The foundation binds the superstructure and provides lateral stability to the structure.

(5) The foundations save the components of the building from the cracks during the movement of the soil. The soils can expand or contract which can cause the cracking of the structural components of the buildings. Special measures during the construction of the foundation are taken to save the structure from cracking.

(6) The foundation reduces the impact of undermining and scouring on the building.

TYPES OF FOUNDATION:

- The foundations can be classified into two types which are the **shallow foundation** and **deep foundation**.

SHALLOW FOUNDATION:

A footing is the part of the foundation that transfers the load to a larger area. The base of the column or wall is enlarged to increase the area at the bottom, known as footing. Foundation is the combination of footings. Shallow foundations can be further classified into the following categories:

- Spread footings
- Combined footings
- Strap footings
- Mat (Raft) foundations

- ***Spread footings:***

  As the name suggests, the spread footings are the footings that distribute the load to the earth by spreading the load over a larger area. The area at the base of columns or walls can be spread in different ways. Based on the different shapes of the spread footings, the spread footings can be further divided into the following six types:
  - Single column footing
  - Stepped column footing
  - Sloped column footing
  - Strip wall footing
  - Stepped wall footing
  - Grillage footing

- ***Grillage foundation:***

A grillage foundation consists of a combination of beams laid over each other resting on the layer of concrete. The area is spread at the bottom of the column by the combination of beams to spread the superimposed loads. The grillage foundation provides more stability and strength and can take very high loads.

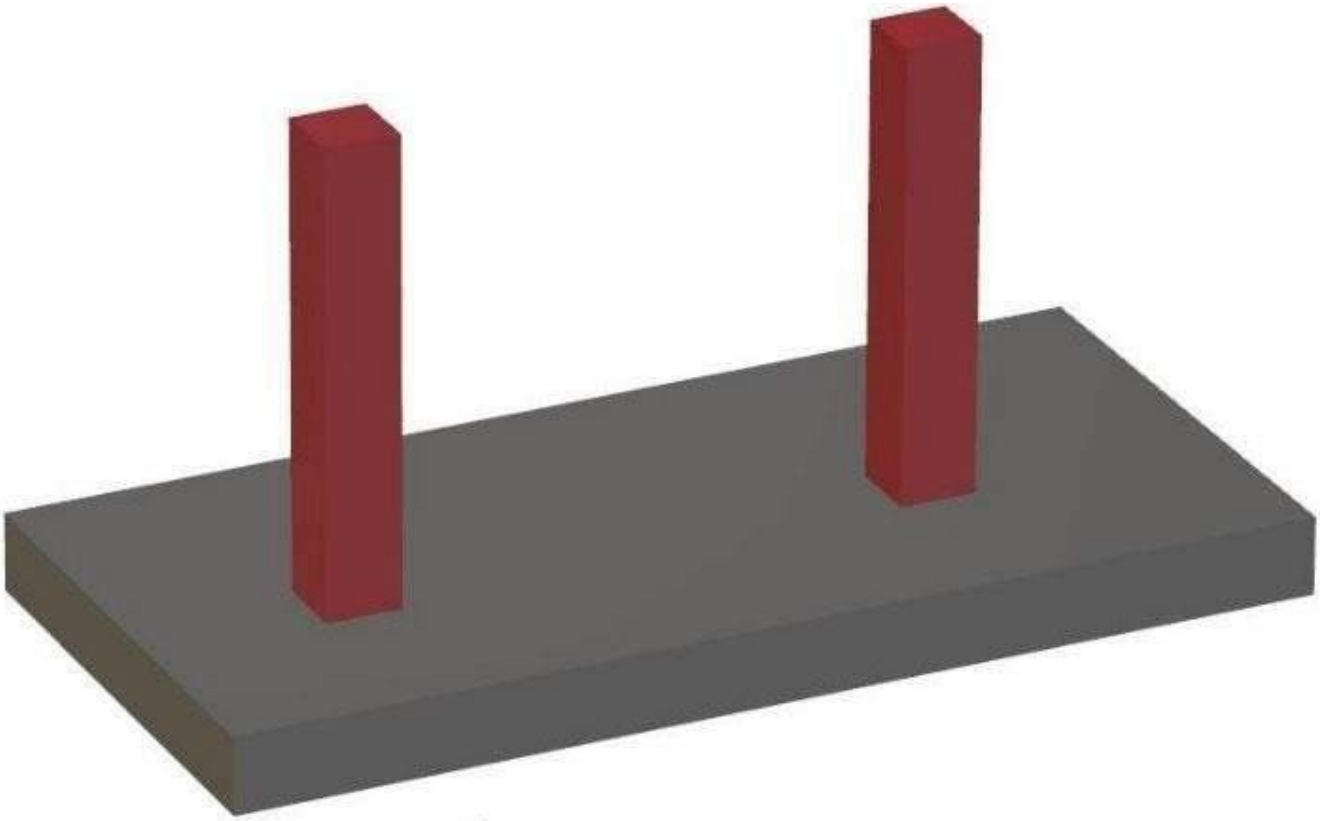
During the construction of the grillage footing, the following recommendations are considered:

- The grillage foundation is provided for the heavy load of columns or steel stanchions if the bearing capacity of the soil is poor.
- The depth of the grillage foundation is kept from 1 m to 1.5 m.
- In the steel grillage foundation, the steel beams are separated by pipe separators of 25 mm diameter and spacers of 20 mm diameter. The distance between the steel beams should be sufficient so that concrete can get compacted easily. The minimum clearance between the beams can be kept 8 cm.
- The minimum concrete cover of 15 cm is provided to the lower beams and 10 cm for the upper beams.
- In case of timber grillage foundation, the timber boards of 8 m to 10 cm thickness are stacked form the timber grillage. The maximum spacing between the timber beams can be 38 cm.

Combined footings:

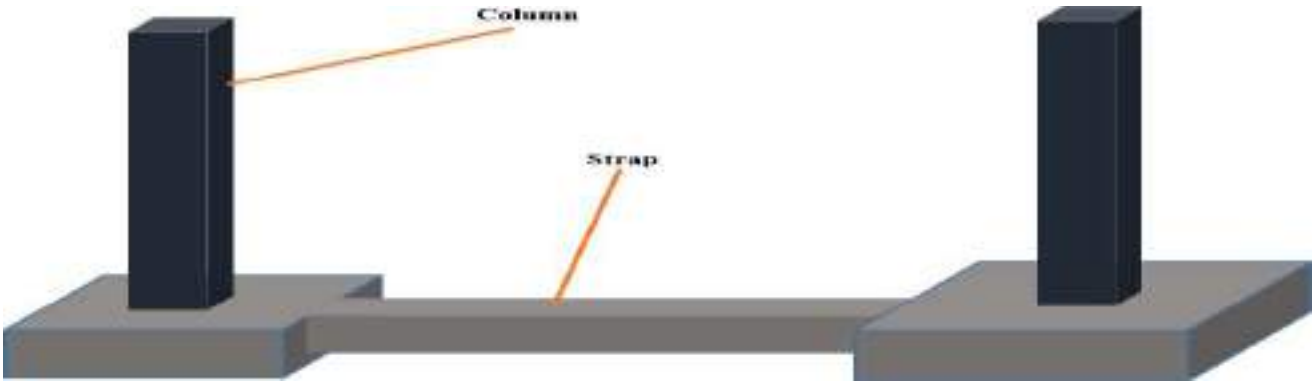
Sometimes if the columns are constructed near to each other, it is not possible to provide the individual footings. So, a combined footing for two or more columns is provided. The combined footings are more economical as compared to the individual footing for each column. The combined footing can be of the following three types:

- Rectangular combined footing
- Trapezoidal combined footing
- Combined column wall footing



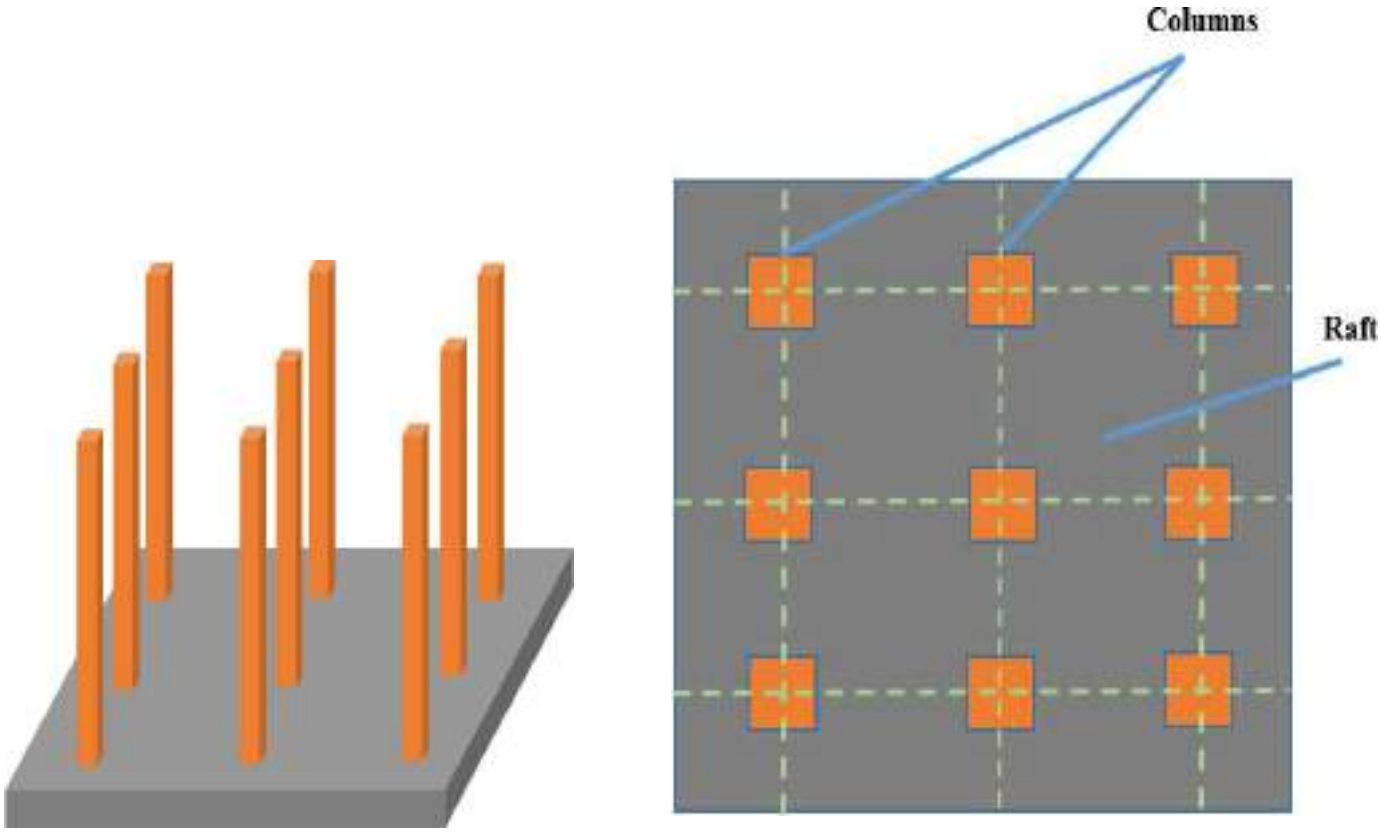
Strap footings:

A strap footing is a special type of combined footing. The combined footing can only be used if the columns are not much far from each other. If the columns have a larger distance between them, the trapezoidal footings become narrow. In this case, the bending moments can increase significantly, leading the structure to fail. The strap may be defined as a beam connecting the column's individual footings.



Raft foundations:

The raft foundation is also known as the mat foundation. The raft foundation is provided throughout the base of the superstructure as a mat. It is a continuous slab that supports a number of columns. The mat foundation transfers the load of all the components of the building to the earth. The raft foundation also reduces the differential settlements.



DEEP FOUNDATION

We know that the shallow foundations transfer the load to the hard stratum below the ground by means of footings. Sometimes the hard stratum under the ground lies at a significant depth. In this case, it is not feasible to provide a shallow foundation. If the hard stratum lies deep below the ground, a deep foundation can be provided. A deep foundation is the type of foundation that has more depth than its width. Deep foundations are of the following three types:

- Pile foundation
- Well foundation or caissons
- Cofferdams

Pile foundation:

A pile may be defined as a slender long column made of timber, concrete, steel, or composite material that is used to transfer the load of the structure through its bottom or friction action or by a combination of both. The diameter of the piles is generally equal to or less than 0.6 m. Based on the mechanism of transfer of the load, the piles may be classified further into the following three types:

- End bearing piles
- Friction piles
- Combined piles

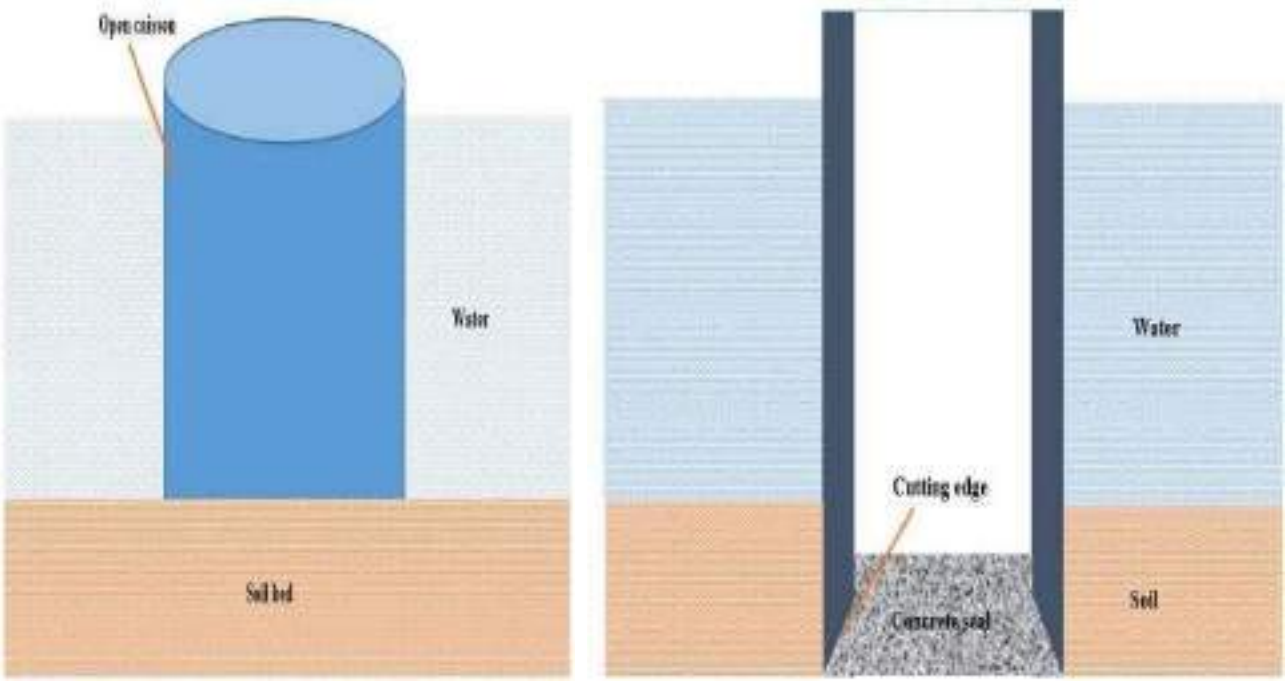
The piles can be made of different materials. The piles can be classified into the following four categories based on the material:

- Timber piles
- Steel Piles
- Concrete Piles
- Composite piles

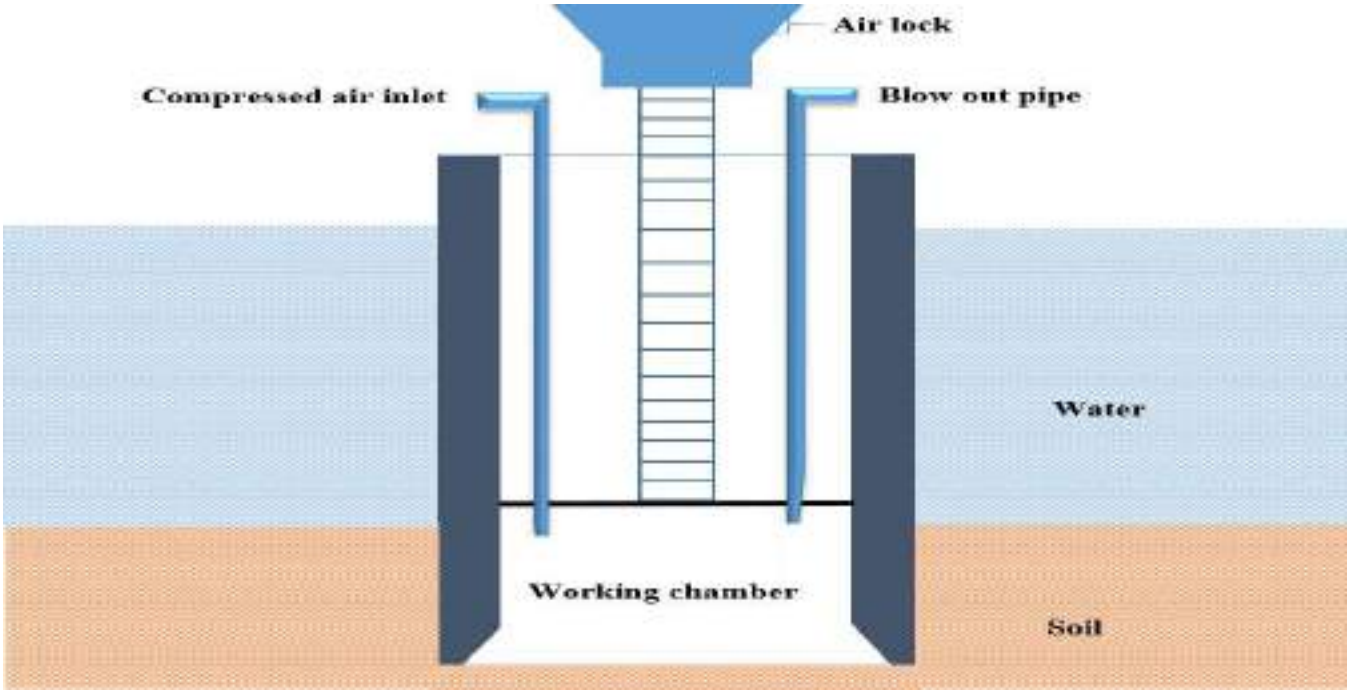
Caissons:

Caissons are box or cylindrical type structures that are hollow in nature. The caissons are fabricated on ground and penetrated at the waterbed. The caissons are used to support the bridges in the water bodies. The caissons are of the following three types:

- Open caissons or well foundation
- Floating or closed caissons
- Pneumatic caissons



Open Caission



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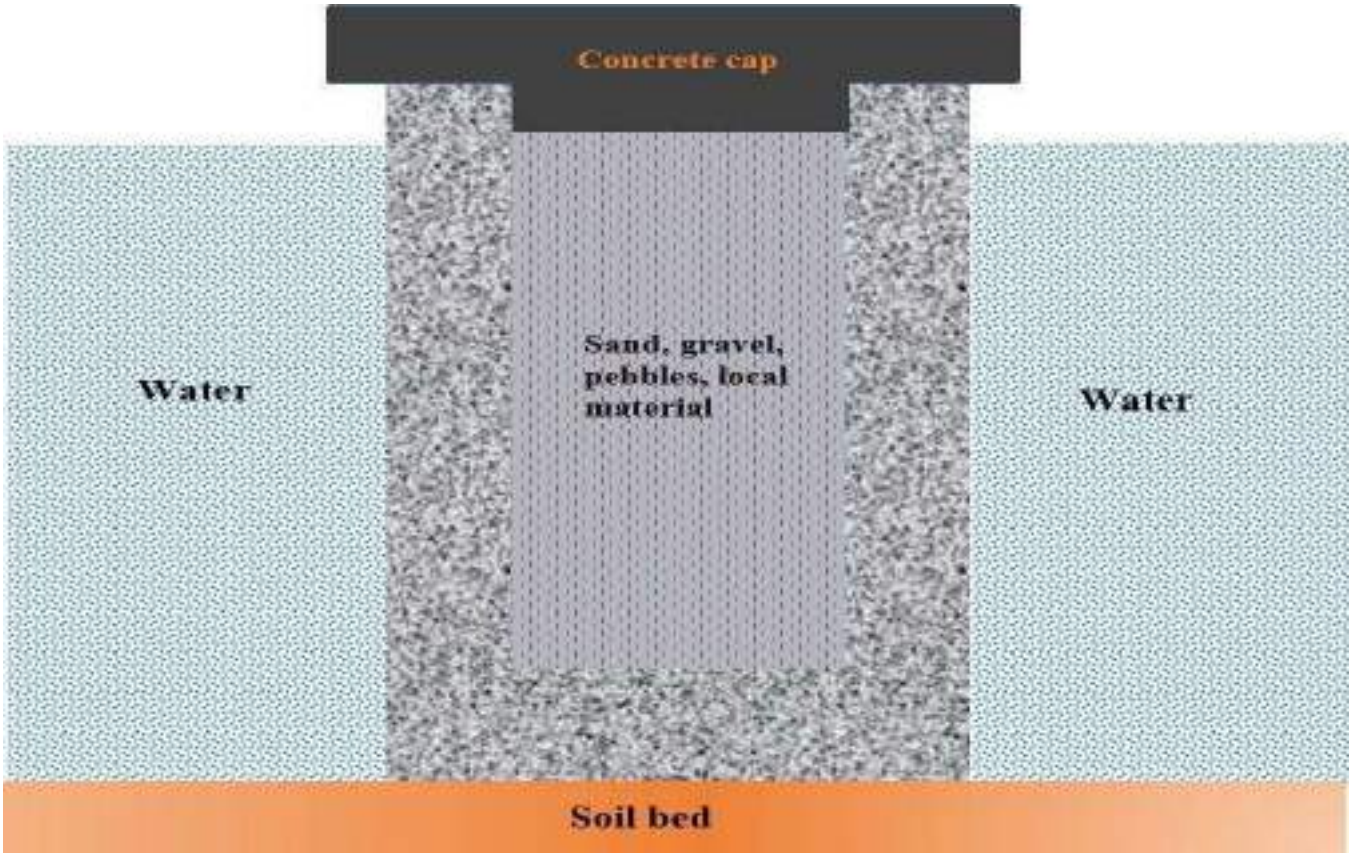


Floating or closed caission

Cofferdams:

A cofferdam is a temporary, watertight enclosure built in a body of water to allow the enclosed area to be pumped dry, creating a dry working environment for construction. These structures are used for projects like building bridge piers, docks, or dams, and they can be made from various materials like earth, rock, steel sheet piles, or concrete.

Purpose:

- To create a dry space for construction work in an area that is normally underwater.
- To protect workers and equipment from water and soil during construction.
- To allow for the construction of permanent structures, such as foundations for bridges, in rivers, lakes, or on coastlines.
- To be used in areas with high groundwater tables where deep excavations are required.

Types of cofferdams

- *Earth-fill cofferdams:* Used in shallow water, these consist of earthen embankments.
- *Sheet pile cofferdams:* A common type that uses interlocking steel sheets driven into the ground to form a wall.
- *Rock-fill cofferdams:* Constructed by filling a contained area with rocks.
- *Cellular cofferdams:* Large, circular or D-shaped structures formed by connecting multiple sheet piles, used for deeper water.
- *Crib cofferdams:* Use a horizontal framework of timbers to create pockets that are filled with earth or stones, often used in deep water.

❖ **Difference between Shallow and Deep Foundation:**

Feature	Shallow Foundation	Deep Foundation
Depth	Close to the ground surface	Extends to deeper, more stable soil or rock layers
Load Transfer	Transfers load to the soil near the surface	Transfers load through weaker upper soils to a stronger layer below
Typical Use	Lighter structures on stable, near-surface soil	Heavy structures or unstable, weak surface soils
Depth Metric	Usually less than three meters deep, with depth generally less than the width	Often extends beyond three meters, with depth greater than the width
Cost	Generally cheaper and easier to construct	More expensive and time-consuming due to complex construction

❖ **Difference between Caisson and Cofferdam:**

Feature	Caisson	Cofferdam
Purpose	To provide a permanent, stable foundation for structures	To create a temporary, dry working environment for construction below water level
Lifespan	Permanent	Temporary; removed after construction is complete
Construction Method	Often prefabricated offsite and sunk into place, or sunk in stages and filled with material	Built on-site from materials like sheet piles, earth, or timber to surround an area
Role in Final Structure	Becomes part of the finished structure (e.g., a bridge pier)	Is removed after the permanent work is done
Examples	Bridge piers, docks, and deep foundations	Building permanent dams, bridge piers, or oil platforms

CHAPTER -3
Construction of Superstructure

1. Introduction to Stone Masonry

- Stone masonry is the construction of structures using natural stones bonded together with mortar.
- It is one of the oldest and most durable methods of construction used in buildings, bridges, retaining walls, and monuments.
- Stones used may be either dressed (ashlar) or undressed (rubble) depending on the type of masonry.
- It provides high compressive strength, durability, and resistance to weathering.
- Stone masonry is commonly used in load-bearing structures where strength and longevity are important.

2. Terms Used in Stone Masonry

- **Facing**: The exposed outer surface of the wall made with well-dressed stones to provide good appearance and durability.
- **Backing**: The inner portion of the wall behind the facing, generally made with cheaper or rough stones.
- **Hearting**: The interior filling between facing and backing, consisting of small stones and mortar, which strengthens the wall core.
- **Through Stone (Bond Stone)**: A long stone placed across the full thickness of the wall to tie both faces together and improve structural stability.
- **Corner Stone (Quoin)**: Specially selected and well-dressed stones placed at the corners of the structure to provide strength and proper alignment.
- **Cornice**: A projecting course provided at the top of the wall to protect it from rainwater and enhance appearance.

3. Types of Stone Masonry

A. Rubble Masonry

- Rubble masonry consists of stones that are either undressed or roughly dressed and laid in irregular shapes.
- It is economical and commonly used for foundations and low-cost construction.
- Mortar joints are usually thicker, and appearance is not very important.

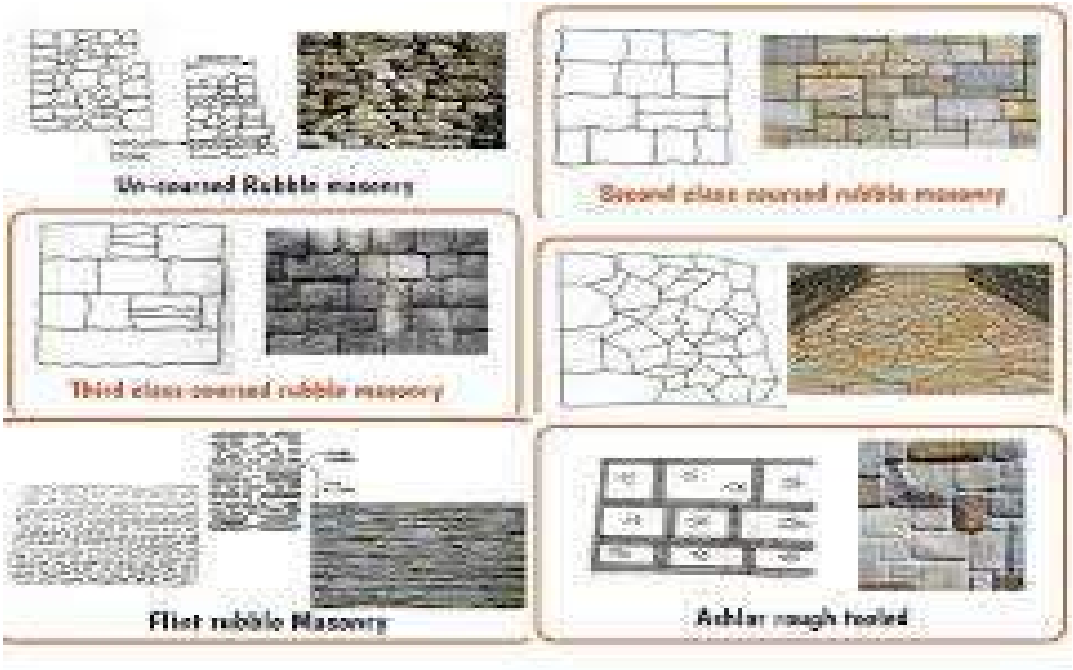
Types of Rubble Masonry:

- **Random Rubble Masonry**: Stones are laid without any regular pattern; commonly used in rural construction.

- **Coursed Rubble Masonry**: Stones are roughly dressed and arranged in horizontal layers or courses for better strength.
- **Polygonal Rubble Masonry**: Stones are shaped into polygonal forms, improving appearance and bonding.
- **Dry Rubble Masonry**: Stones are laid without mortar, mainly used in pitching, retaining walls, and temporary works.

B. Ashlar Masonry

- Ashlar masonry consists of finely dressed stones of uniform size and shape.
- It provides high strength, durability, and excellent appearance.
- Mortar joints are very thin and uniform.



Types of Ashlar Masonry:

- Ashlar Fine Masonry: Stones are perfectly dressed with smooth surfaces and thin joints.
- Ashlar Rough Tooled: Stones have a rough surface with neatly dressed edges.
- Ashlar Rock Faced: Outer surface is rough while edges are dressed, giving a natural look.
- Ashlar Chamfered: Edges of stones are beveled for decorative purposes.
- Ashlar Block in Course: Large stone blocks arranged in regular courses.

◆ **4. Joints in Stone Masonry**

- Joints are the spaces between stones filled with mortar to ensure bonding and load transfer.
- Proper jointing is essential for strength, durability, and stability of masonry.

Types of Joints:

- Bed Joints: Horizontal joints that support vertical loads.

- Vertical Joints: Joints between adjacent stones; should not be continuous.
- Butt Joints: Simple joints where stones meet directly.
- Rebated or Tongue and Groove Joints: Interlocking joints that improve bonding and strength.

Purpose of Joints:

- To distribute loads uniformly
- To improve bonding between stones
- To prevent cracks and settlement
- To accommodate slight movements in the structure

5. Selection of Stones for Masonry

- Stones should have high compressive strength to withstand loads.
- They must be durable and resistant to weathering effects.
- Stones should be free from cracks, cavities, and defects.
- They should have low water absorption to avoid dampness.
- Stones must be easily workable for dressing and shaping.
- The color and texture should be suitable for aesthetic requirements.

6. Precautions in Stone Masonry Construction

- Stones should be cleaned and properly wetted before laying to ensure good bonding.
- Masonry should be constructed in level courses, and proper alignment must be maintained.
- Through stones should be provided at regular intervals to improve bonding.
- Vertical joints should not be continuous, as they weaken the structure.
- Only good quality mortar should be used, and joints must be completely filled.
- Large stones should be placed at the bottom, and smaller stones in upper portions.
- Work should be carried out layer by layer, avoiding excessive height at one time.
- Proper curing must be done for sufficient time to gain strength.
- Avoid using small chips on the exposed face of masonry.

7. Advantages of Stone Masonry

- High durability and long life
- Excellent resistance to weather and fire
- Good compressive strength
- Aesthetic and natural appearance
- Requires less maintenance

8. Disadvantages of Stone Masonry

- High cost of materials and labor (especially ashlar)

- Heavy weight increases foundation load
- Requires skilled workmanship
- Construction is slower compared to brick masonry

BRICK MASONRY (SUPERSTRUCTURE)

1. Introduction to Brick Masonry

- Brick masonry is the construction of structures using bricks bonded together with mortar.
- It is widely used due to economy, availability, and ease of construction.
- Suitable for walls, piers, partitions, and load-bearing structures.

2. Terms Used in Brick Masonry

- **Header**

  Brick laid with its short face (end) visible on the wall face.
- **Stretcher**

  Brick laid with its long face visible.
- **Closer**

  A cut brick used to maintain proper bond (e.g., queen closer, king closer).
- **Quoin**

  Corner bricks of a wall that provide strength and alignment.
- **Course**

  A horizontal layer of bricks.
- **Face**

  Outer exposed surface of the wall.
- **Back**

  Inner surface of the wall.
- **Hearting**

  Inner filling of wall between two faces.
- **Bat**

  A portion of brick cut across width or length.
- **Bond**

  Arrangement of bricks to ensure proper interlocking.
- **Joints**

  Space between bricks filled with mortar.
- **Lap**

Overlap between bricks in successive courses (usually ¼ brick).

- **Frog**

  Depression on top of brick to hold mortar.

- **Line**

  Thread used to keep bricks in straight alignment.

- **Level**

  Ensures horizontal alignment.

- **Plumb**

  Ensures vertical alignment of wall.

3. Bonds in Brick Masonry

Purpose of Bond

- To ensure strength and stability
- To distribute load uniformly
- To prevent vertical cracks

Types of Bonds

1. Header Bond

Header bond is a brick masonry pattern where only the headers (shorter 9cm x 9cm faces) are visible in each course, used for full-brick thick walls (18cm) and often in curved structures like arches. It features a half-width overlap created by using three-quarter brick bats in alternating courses.

Key Aspects of Header Bond:

- **Appearance:** Only the shorter (header) faces of the bricks are exposed, creating a clean, uniform look.
- **Use Cases:** Highly effective for constructing curved walls, foundation footings, and walls that require significant structural strength.
- **Construction:** Bricks are laid horizontally, but with their ends facing outwards. Each course is staggered by half the width of a header to avoid continuous vertical joints.
- **Components:** To break the vertical joints, three-quarter bats are typically used as quoin closures at the beginning and end of each course.
- **Limitations:** It is generally not ideal for walls less than one brick thick.

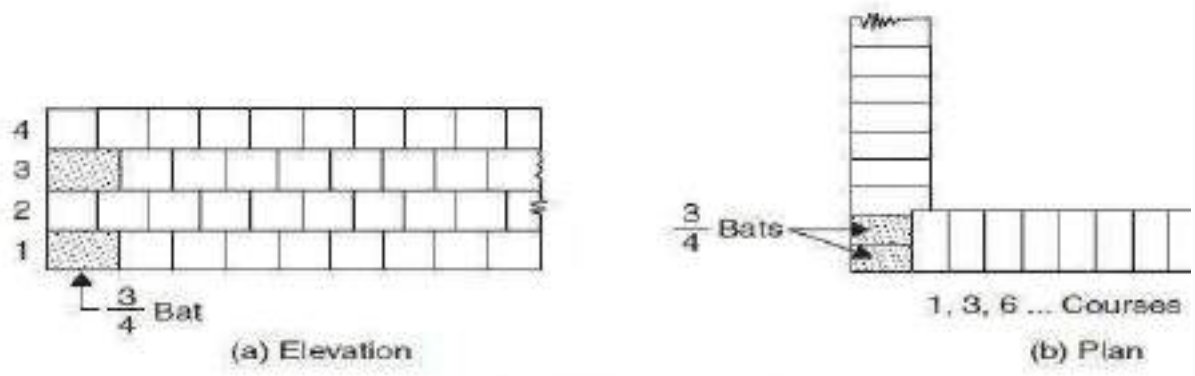
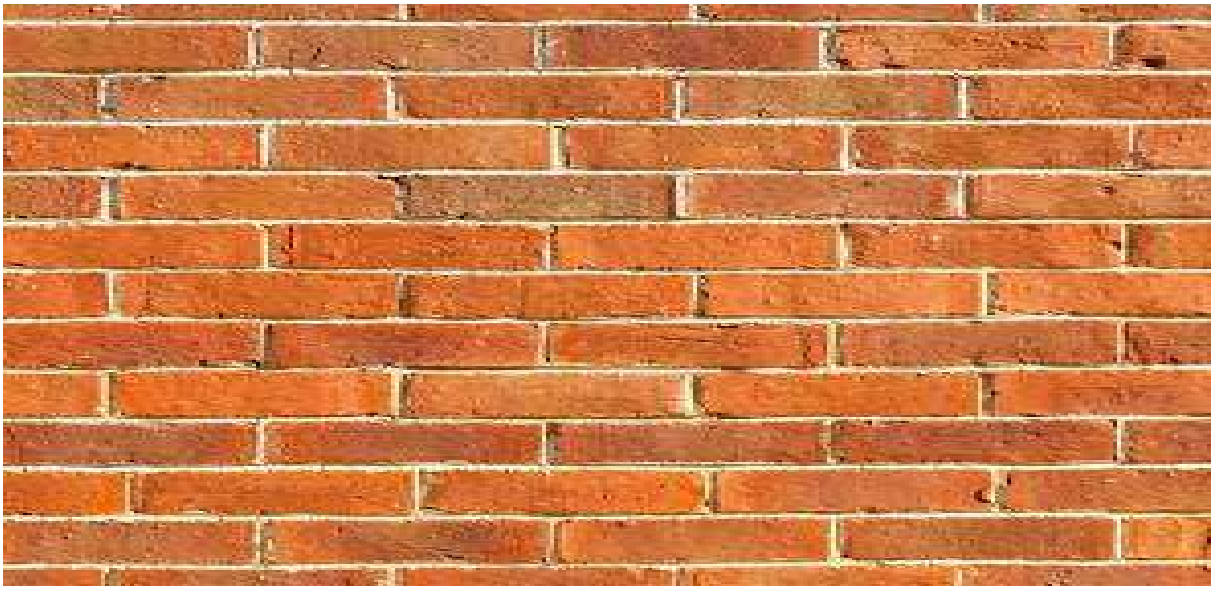


Fig. 8.5. Header bond

2. Stretcher Bond

- **Appearance:** All bricks are laid as stretchers on the face of the wall, with vertical joints staggered by half a brick from the course above and below.
- **Thickness:** Used for walls that are "half-brick" thick (usually around 4.5 inches or 112.5mm), making them ideal for exterior cladding in framed structures, partition walls, and garden walls.
- **Stability:** While easy to build, they have less load-bearing capacity compared to bonds with headers, such as English bond.
- **Bonding:** Stretcher bonds are frequently used in cavity walls and sometimes with reinforced concrete or steel frameworks.



Commonly used for:

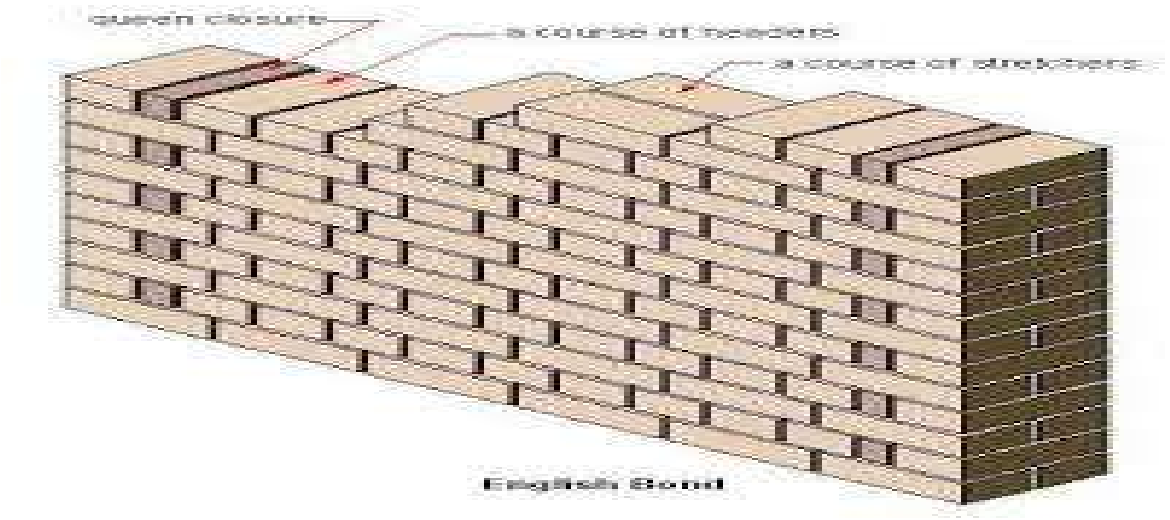
- **Partition Walls:** Non-load bearing interior walls.
- **Cavity Walls:** Outer leaf of brickwork.
- **Boundary/Garden Walls:** Thin, decorative walls.

3. English Bond (Strongest)

- **Optimal Strength:** The alternating pattern of headers and stretchers creates superior interlocking,

preventing long vertical joints from forming and enhancing the wall's shear resistance.

- **Structural Stability:** It is considered the most durable bond for load-bearing walls due to its ability to distribute loads effectively.
- **Appearance:** It features a clean look with headers in one course centered on the stretchers below, and requires queen closers next to quoin headers to break the vertical joint alignment.
- **Versatility:** While it requires more facing bricks, it is suitable for walls of all thicknesses.
- **Alternatives:** A variation, known as the , introduces a stretcher beside the quoin header in every alternate course, improving vertical joint separation.



4. Flemish Bond

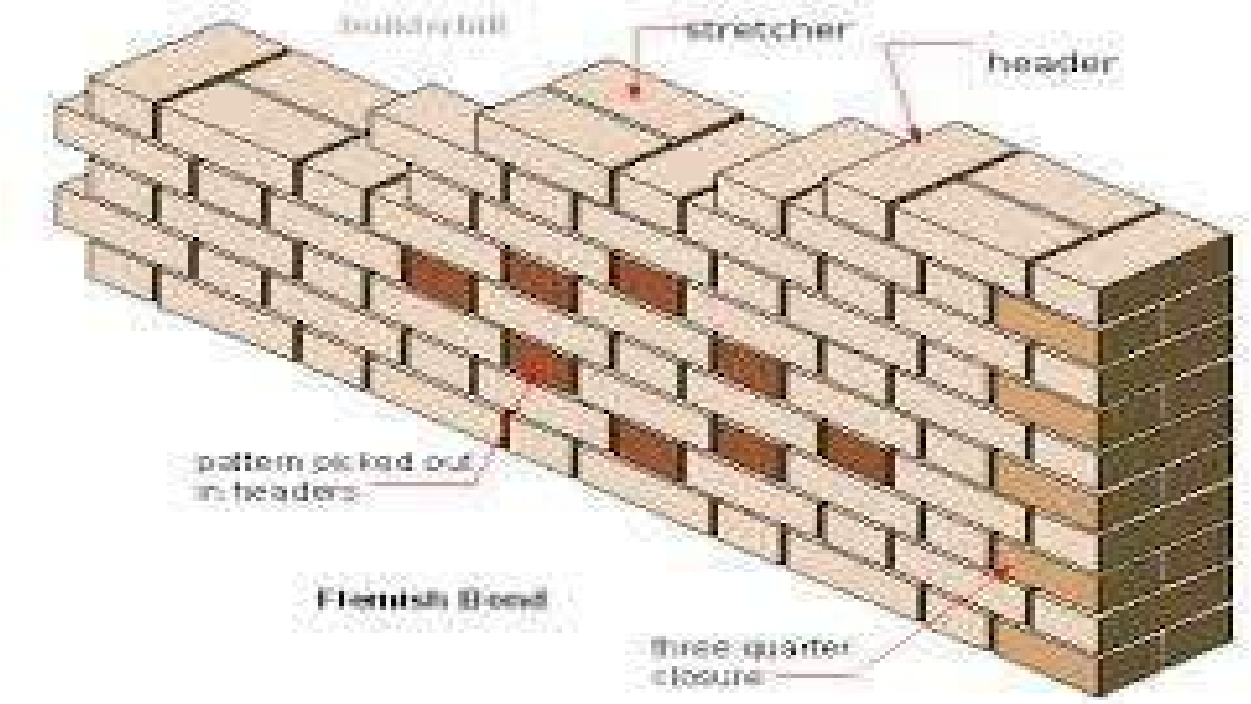
Flemish bond is a decorative brickwork pattern created by alternating headers (short end) and stretchers (long side) in every single course, with each header centered over the stretcher in the row below. Popular in 17th-century European and colonial architecture, it offers a visually appealing, patterned, and strong, yet less common, alternative to English bond, requiring skilled, precise installation.

Key characteristics and details include:

- **Appearance:**

Offers a distinctive, pleasing appearance often used in traditional or historical architecture.

- **Structure:** Alternates header-stretcher-header-stretcher in a single course.
- **Strength:** While often used for two-brick thick walls, it is generally considered weaker in load-bearing capacity compared to English bond.
- **Challenges:** Requires meticulous, skilled labor to manage consistent vertical joint alignment and often requires cutting many bricks (such as queen closers) to fit at corners.
- **Variation:** Known as "double Flemish" when both sides of the wall show the pattern, or "single Flemish" when only one side is seen.



4. Requirements of Good Brick Masonry

- Use good quality bricks (well-burnt, uniform size)
- Bricks should be soaked in water before use
- Use proper mortar mix
- Maintain uniform joints (10 mm thick)
- Ensure proper bonding pattern
- Vertical joints should not be continuous
- Courses should be level and plumb
- Joints should be fully filled with mortar
- Proper curing for 7–10 days

5. Junctions in Brick Masonry

Types:

- **T-junction**
- **L-junction (corner)**
- **Cross junction**

Purpose:

- To connect walls properly
- To maintain structural stability
- To avoid cracks at joints

Procedure:

- Use proper bonding (alternate bricks)
- Provide closers at junctions
- Ensure proper interlocking
- Maintain lap

🔹 6. Precautions in Brick Masonry

- Use uniform and sound bricks
- Soak bricks before laying
- Lay bricks with frog upwards
- Maintain proper line, level, and plumb
- Avoid continuous vertical joints
- Do not raise wall more than 1.5 m per day
- Protect masonry from rain and sun
- Ensure proper curing

🔹 7. Comparison: Stone Masonry vs Brick Masonry

Feature	Stone Masonry	Brick Masonry
Material	Natural stone	Burnt bricks
Strength	Very high	Moderate
Cost	High	Economical
Appearance	Natural look	Uniform
Labor	Skilled required	Less skilled
Construction speed	Slow	Faster

🔹 8. Tools and Plants Used

🔸 For Brick Masonry:

- Trowel
- Spirit level
- Plumb bob
- Line and pins
- Brick hammer
- Measuring tape

🔸 For Stone Masonry:

- Chisel
- Hammer
- Mallet
- Crowbar
- Mason's square

9. Hollow Concrete Block Masonry

- Uses hollow concrete blocks instead of bricks
- Blocks are larger → faster construction

Advantages:

- Lightweight
- Good insulation
- Less mortar required
- Faster work

10. Composite Masonry

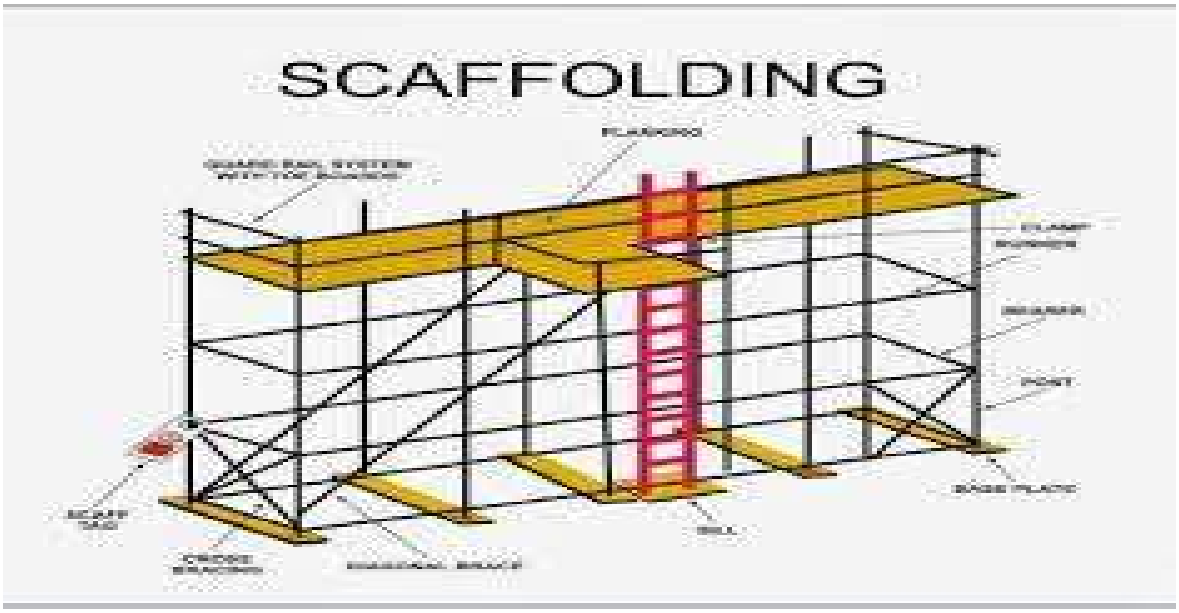
- Combination of **two different materials** (e.g., brick + stone)

Purpose:

- Reduce cost
- Improve strength
- Better appearance

Scaffolding

Scaffolding is a temporary structure used to provide safe working platforms for workers and materials at elevated heights during construction, maintenance, or repair.



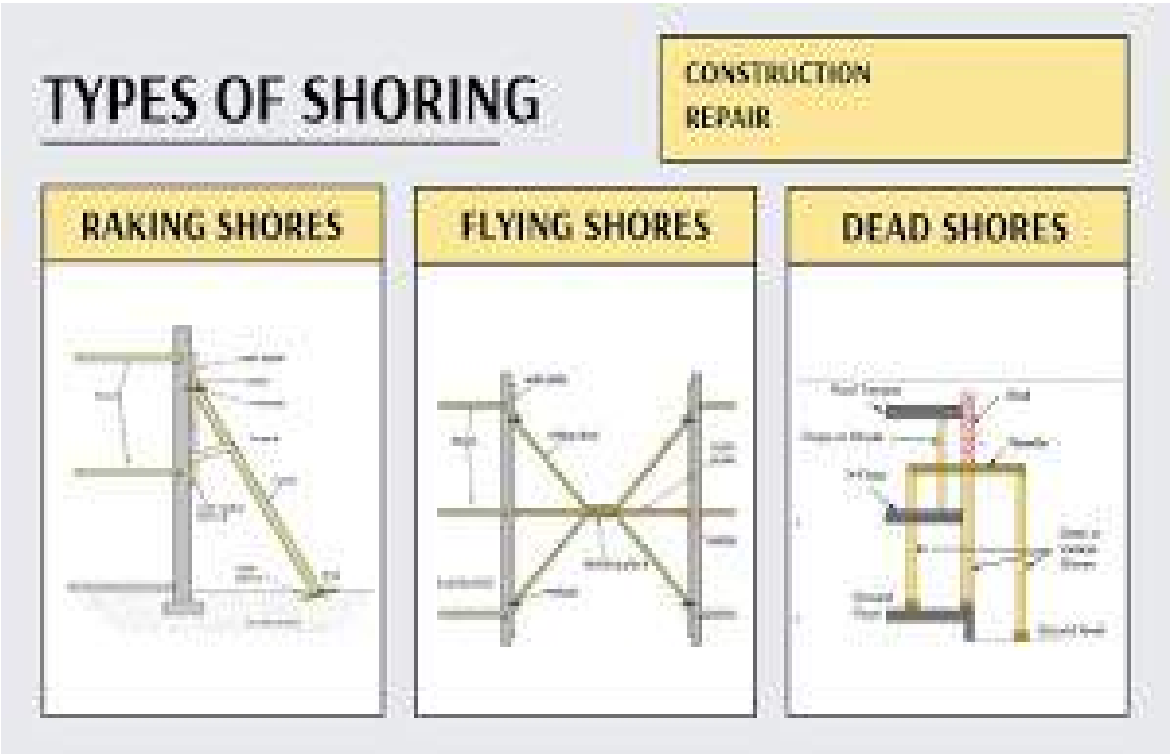
- **Purpose**: To provide access to hard-to-reach areas and a stable platform for performing tasks like masonry, painting, or window installation.
- **Types**:
    - **Single Scaffolding**: Typically used for brick masonry; consists of one row of standards.
    - **Double Scaffolding**: Used for stone masonry; features two rows of standards as making holes in stone walls is difficult.
    - **Cantilever (Needle) Scaffolding**: Supported by "needles" extending from the wall; used when the ground is unstable or for higher stories.
    - **Suspended Scaffolding**: Platforms hung by wire ropes or chains from the roof; ideal for painting or window cleaning.
    - **Trestle Scaffolding**: Supported on movable ladders or tripods; used for indoor maintenance.
- **Process of Erection**:
    - **Preparation**: Level the ground and place sole boards/base plates.
    - **Assembly**: Erect vertical standards and connect them with horizontal ledgers.
    - **Rigidity**: Add transoms and diagonal cross-braces for stability.
    - **Working Level**: Install planks (decking), guardrails, and toe-boards.
- **Process of Dismantling**: This must follow the **exact reverse order** of erection, starting from the top.
    - Remove guardrails and toe-boards.
    - Remove working platforms (planks).
    - Detach braces and ledgers systematically.
    - Finally, remove vertical standards and base plates.

Shoring

Shoring provides temporary structural support to prevent the collapse of unstable walls, buildings, or trenches.

- **Purpose**: To stabilize structures during excavation, demolition, or major repairs and to bear heavy loads like concrete slabs.
- **Types**:
    - **Raking Shoring**: Angled supports (rakers) used to brace leaning or unstable walls.
    - **Flying Shoring**: Horizontal supports placed between two parallel walls when the ground between them must remain clear.
    - **Dead Shoring**: Vertical supports placed directly under a structure to support heavy vertical loads during foundation repairs or wall replacements.

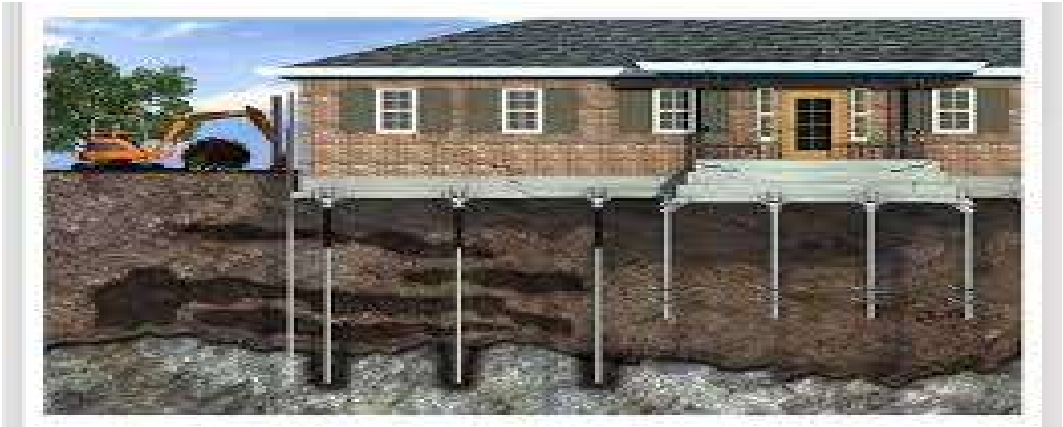
- **Excavation Shoring**: Includes methods like **Sheet Piling**, **H and I-beam shoring**, or **Hydraulic shoring** to prevent trench cave-ins.



Underpinning

Underpinning is a method of strengthening and stabilizing the existing foundation of a building.

- **Purpose**: Required when the original foundation is insufficient, the building's usage changes (increasing load), or nearby excavation compromises soil stability.
- **Common Types**:
  - **Mass Concrete (Pit Method)**: Traditional method extending the foundation to a stable deeper stratum by excavating in stages and filling with concrete.
  - **Pier and Beam**: Reinforced concrete beams transfer loads to mass concrete bases or piers.
  - **Mini-Piled Underpinning**: Uses small-diameter piles when stable soil is very deep (over 5m) or access is restricted.



Formwork

Formwork consists of temporary molds used to shape and support wet concrete until it hardens.

- Requirements: Must be strong enough to support the weight of wet concrete, watertight to prevent leakage, rigid to minimize deflection, and easy to remove without damaging the concrete.
- Materials: Common materials include Timber (cost-effective), Plywood (smooth finish), Steel (highly durable for repetitive use), Aluminum (lightweight), and Plastic.
- Types: Classified by the element they support—such as Slab, Beam, Column, or Wall formwork—or by specialized methods like Slipforming for continuous vertical pouring.
- Removal (Stripping): Formwork is removed only after the concrete has gained sufficient strength to support itself. Stripping usually starts with vertical members (sides of columns and beams) followed by horizontal members (soffits of slabs and beams).