CE 0732-1204

Details of Construction and Estimation Sessional

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BASIC COURSE INFORMATION

Course Title	**Details of Construction and Estimation Sessional**
Course Code	**CE 0732-1204**
Credits	**01**
CIE Marks	**30**
SEE Marks	**20**
Exam Hours	**2 hours (Semester Final Exam)**
Level	**2^{nd} Semester**

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Course Title: Building Estimation

Covered Course: Details of Construction and Estimation Sessional

COURSE CODE: CE 0732-1204
CREDIT: 01

CIE MARKS: 30

SEE MARKS: 20

CO1	**Develop Proficiency in RCC and Steel Structures: Students will gain detailed knowledge and hands-on experience in analyzing and designing reinforced concrete and steel structures.**
CO2	**Master Earthwork and Foundation Estimation: Students will learn to calculate earthwork quantities and foundation costs accurately for efficient project budgeting.**
CO3	**Generate Accurate Structural Detailing: Students will acquire skills in column, beam, and slab detailing and estimation, ensuring compliance with engineering standards.**
CO4	**Perform Comprehensive Building Costing: Students will apply their learning to estimate the total project cost for a 6-storey building, integrating structural and material considerations for realistic budget planning.**

Sl.	Course Contents	Hours	CLOs
1	Details of Construction (Types of Building, Beam, Column, Slab, Foundation, Brick Masonry Structures, Steel Structure Fundamentals)	35	CLO 1, CLO 2
2	Basic Calculation of Estimation of Construction Materials	05	CLO 3
3	Complete Estimation of a Residential Building	30	CLO 4

References:

Wayne. J. Del Pico, 2012, Estimating Building Costs for the Residential and Light Commercial Construction Professional-Second Edition, John Wiley & Sons, ISBN: 978-1- 118-09941-4.

Calin M. Popescu, Kan Phaobunjong, Nuntapong Ovararin, 2003, Estimating Building Costs, CRC Press, ISBN 9780824740863 - CAT# DK2807.

WEEK	TOPIC	TEACHING-LEARNING STRATEGY	ASSESSMENT STRATEGY	CORRESPO-NDING CLO_S
01-02	Building, Foundation	Lecture, Discussion	Individual project evaluation	CLO1
03-04	Beam, Column, Slab	Lecture, Discussion	Individual project evaluation	CLO3
05-06	Brick Masonry, Stair	Lecture, Discussion	Individual project evaluation	CLO1
07	Steel Structure Fundamentals	Lecture, Discussion	Individual project evaluation	CLO2
08	Basic Calculation of Estimation of Construction Materials	Lecture, Discussion	Individual project evaluation	CLO3
09-14	Estimation of a Residential Building	Lecture, Discussion	Individual project evaluation	CLO2
15-16	Doubt Solving	Discussion		
17	Final Assessment	Lab Quiz, Practical exam	Written, Viva	CLO1

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ASSESSMENT PATTERN

CIE- Continuous Internal Evaluation (30 Marks)

SEE- Semester End Examination (20 Marks)

SEE- Semester End Examination (40 Marks) (should be converted in actual marks (20))

Bloom's Category	**Tests**
Remember	**05**
Understand	**07**
Apply	**08**
Analyze	**07**
Evaluate	**08**
Create	**05**

CIE- Continuous Internal Evaluation (100 Marks) (should be converted in actual marks (30))

Bloom's Category Marks (out of 100)	Lab Final (30)	Lab Report (10)	**Continuous lab performance** (30)	Presentation & Viva (10)	External Participation in Curricular/**Final Project Exhibition** (10)
Remember/**Imitation**	05		05	02	Attendance 10
Understand/**manipulation**	05	05	05	03	
Apply/**Precision**	05		05		
Analyze/**Articulation**	05		05		
Evaluate/**Naturalisation**	05	05	05		
Create	05		05	05	

WEEK 01-02

Details of Construction

Building and Foundation

1. Building

A **building** is a structure with a roof and walls standing more or less permanently in one place, such as a house or factory. Buildings come in a variety of sizes, shapes and functions, and have been adapted throughout history for a wide number of factors, from building materials available, to weather conditions, to land prices, ground conditions, specific uses and aesthetic reasons. Buildings serve several needs of society – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. A building as a shelter represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful).

1.1 Types of buildings

Buildings can be classified into different categories from different perspective. Many buildings fall into multiple categories simultaneously. In general, building can be of following types:

i. Residential Building
ii. Educational Building
iii. Institutional Building
iv. Assembly Building
v. Business Building
vi. Mercantile Building
vii. Industrial Building
viii. Storage Building
ix. Hazardous Building

i. Residential Building: This type includes the buildings for dwelling such as apartment houses, dormitories, hotels etc.

ii. Educational Building: The buildings those are used for school, college, day care purposes where group of people gathers fall into this category.

iii. Institutional Building: This type of buildings includes those where liberty of inmates is restricted. These buildings are for some specific purposes such as hospital, nursing homes, jails, orphanages etc.

iv. Assembly Building: The buildings or parts of building where groups of people gather for social, religious, civil, travel or amusement purposes can be classified as assembly building. Such buildings can be auditorium, exhibition halls, museum, gymnasium etc.

v. Business Building: These buildings are generally used for business transactions, keeping accounts, records etc. For instances, library, bank etc.

vi. Mercantile Buildings: This type of building is used for shop, malls, stationary where goods are stored and displayed for whole or retail sales purpose.

vii. Industrial Building: The buildings where fabrications, assembly, processing etc. of materials of all kinds take place are categorized as industrial building.

viii. Storage Building: These Building are used for storing goods or products such as ware house, cold storages, garages, grain elevators etc.

ix. Hazardous Building: The Buildings where highly combustible, explosive or toxic, corrosive or poisonous materials are stored are classified as hazardous building.

Fig. 1.1 Residential building

Fig. 1.2 Educational building

Fig. 1.3 Institutional building

Fig. 1.4 Assembly building

Fig. 1.5 Business building

Fig. 1.6 Mercantile building

Fig. 1.7 Industrial building

Fig. 1.8 Storage building

Fig. 1.9 Hazardous building

Why types of buildings is a concern:

1.To know the design load for the building

2.To know the best orientation of the building as per its purpose of use. BNBC 2020 is followed in this regard in Bangladesh.

1.2 Load Transfer Path

Load transfer path depends on the type of structure of the building. Broadly, building structures can be of 2 types:

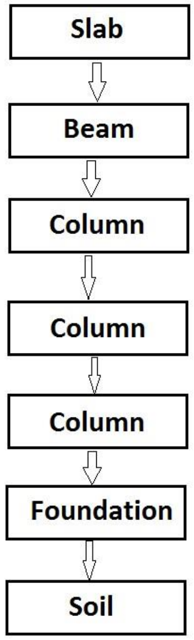
i. Frame structure / Non-load bearing structure
ii. Load bearing structure

i. Frame structure: Frame structure consists of slab, beam, column, foundation which bear all the loads of building. Here the walls of the building are usually for partition purpose, these partition walls do not take part in the load bearing mechanism of the building.

1.2.1 Load transfer paths in frame structure

Loads passing path for typical frame structure:

Typically, in frame structures, load passes from slab to beam, beam to column and finally column to foundation.



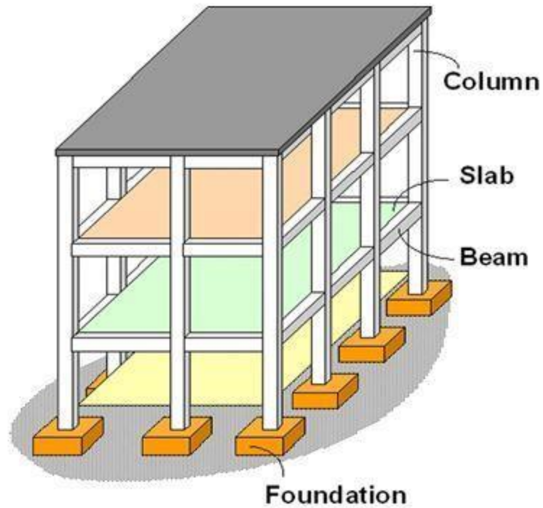


Fig. 1.10 Typical load transfer path in Frame structure

Fig. 1.11 Frame structure

Loads passing path for flat plate structure:

Load transfers directly from slab to column in case of flat plate or flat slab where no beams are constructed.

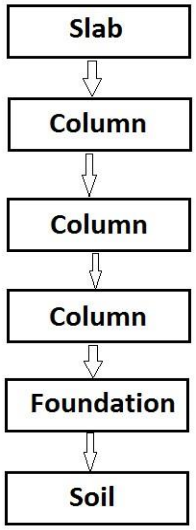
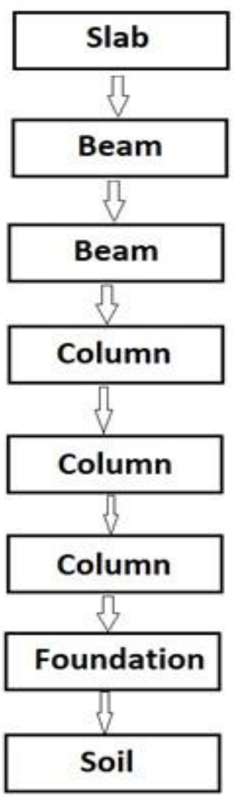


Fig. 1.12 Load transfer structure

Fig. 1.13 Flat plate structure path in flat plate

<u>Loads passing path for structure with secondary beam</u>:

This happens when a secondary beam is constructed between 2 primary beams. In this case, this secondary beam is not directly connected to any column.



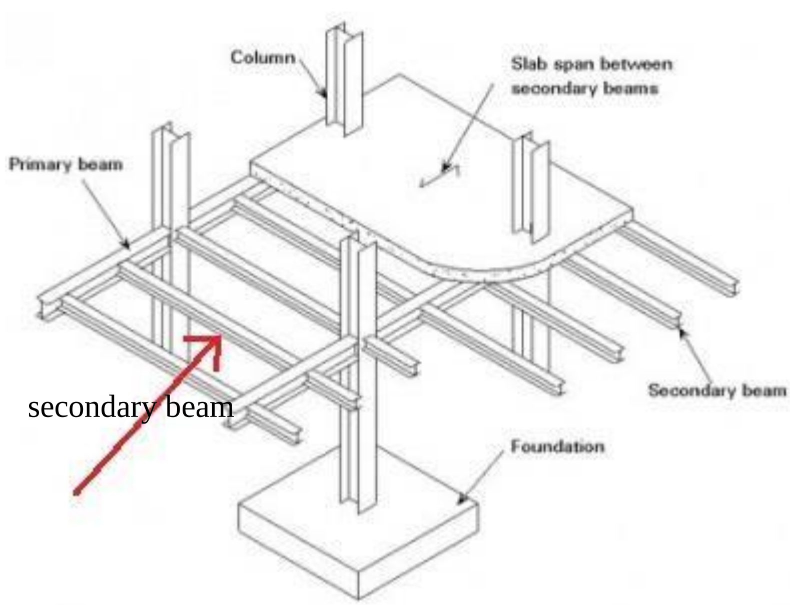


Fig. 1.14 Load transfer path in frame structure with secondary beam

Fig. 1.15 Frame structure with secondary beam

Loads passing path for structure with deep beam:

This occurs when some columns at basement are required to remove in order to make more space for vehicles to park or other purposes. The deep beam constructed at that level carries the load from column and transfers it to the remaining columns at base level.

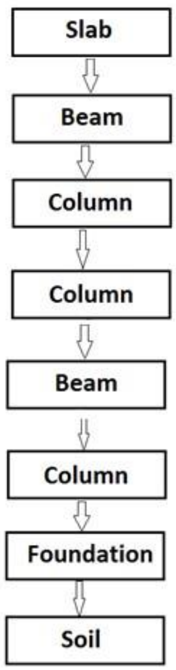


Fig. 1.16 Load transfer path in structure with deep beam

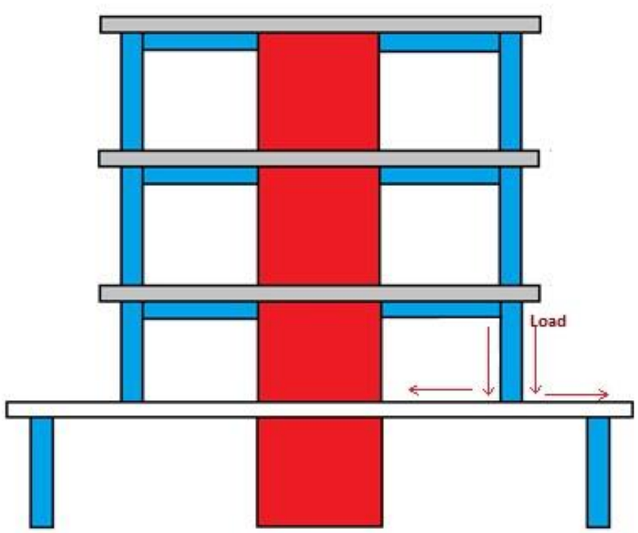


Fig. 1.17 Frame structure with deep beam frame

ii. Load Bearing Structure: In this structure, the walls of the building bear the load coming from the beam or directly from the slab and these walls subsequently transfer the load to the foundation.

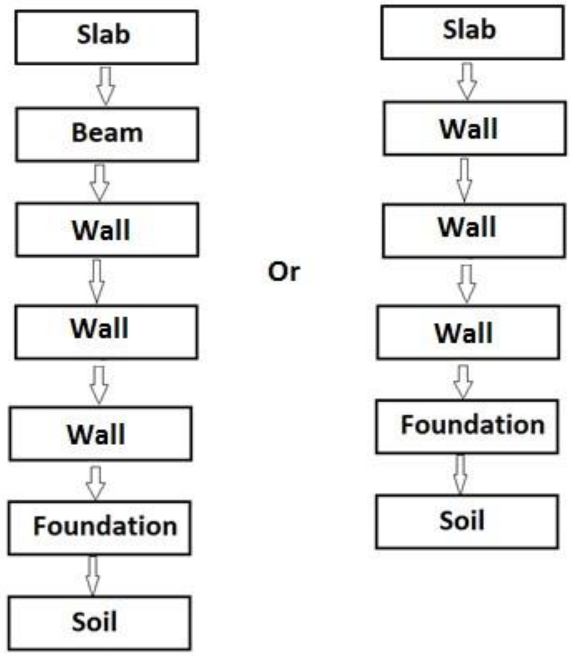


Fig. 1.18 Load transfer path in load bearing structure

1.3 Components of Building

Generally a building is divided in 2 major parts:

i. Super structure
ii. Sub structure

i. Super structure: This is the part of the building above the ground surface that is visible after the completion of the construction work. Example: Plinth, column, beam, slab etc.

ii. Sub structure: This is the part of the building below the ground surface that is not visible after the completion of the construction work. Example: Foundation, shore pile etc.

In a broader sense, the components of a building can be classified as follows:

- Foundation
- Plinth
- Walls
- Beams
- Columns
- Floors
- Doors, Windows
- Stairs
- Roof
- Building finishes

- Building service

Foundation: Foundation transfers all kind of load coming from the super structure to the soil in such a way that it doesn't exceed the bearing capacity of the soil of that place.

Plinth: This is the floor of the building immediately above the ground surface. Plinth restricts the rain water or other materials from entering directly to the ground floor.

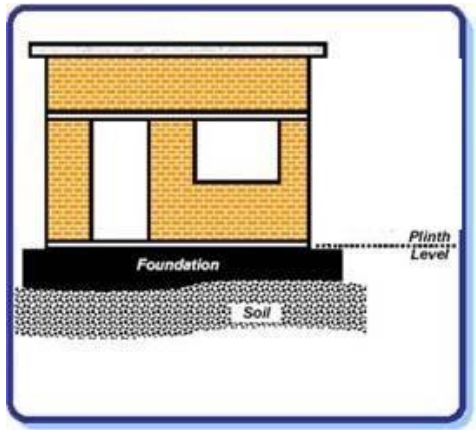


Fig. 1.19 Plinth

Walls: In frame structure, walls are constructed for partition purpose, walls provide separation of floor spacing and also protect the inside space from sun, rain and other direct weathering effect. In load bearing structure, walls participate in load transfer procedure of the building.

Beams: Beams are horizontal members which take load coming parallel to its cross section. It can also take axial loads. Beams are mainly designed to resist bending.

Columns: Columns are vertical members that mainly take axial load (predominantly compression).

Floors: Floors are plane firm surface of slab which provides accommodation on a given plot. People stand on floors. Furniture, goods or other materials are kept or placed on floors.

Doors, windows: Door is the passage path through walls. It provides access to building, rooms etc.

Windows are the open parts of walls with transparent cover for the purpose of ventilation, light and vision.

Stairs: Stairs are connectors between one floor to the next floor. It consists of steps (tread, rise).

Roof: It is the top surface of the building which usually protects the building from rain, sun, light, snow etc.

Building Finishes: Building finishes make the building complete to live in, such as plastering, placing tiles/ mosaic, painting, white washing etc.

Fig. 1.20 Building finishes

Building services: These are mainly the utility parts of a building such as water supply, electricity connection, gas connection, sanitation system etc.

Fig. 1.21 Building services

1.4 Technical Terms

Balcony: Balcony is one kind of cantilever. It provides passage through different rooms. It also provides sitting out places.

Basement: It is the lower floors of the building which are below or partially below ground level.

Sunshade: It is an outside cantilever projection from the lintel that is situated above windows.

Courtyard: It is a place fully/partially surrounded by building and permanently open to sky.

Damp Proof Course: It is a course that consists of water proof materials used in different parts of building to prevent water penetration or dampness.

Floor Area Ratio (FAR): IFAR Floor area ratio (FAR) is the measurement of a building's floor area in relation to the size of the lot/parcel that the building is located on. FAR is expressed as a decimal number, and is derived by dividing the total area of the building by the total area of the parcel (building area / plot area).

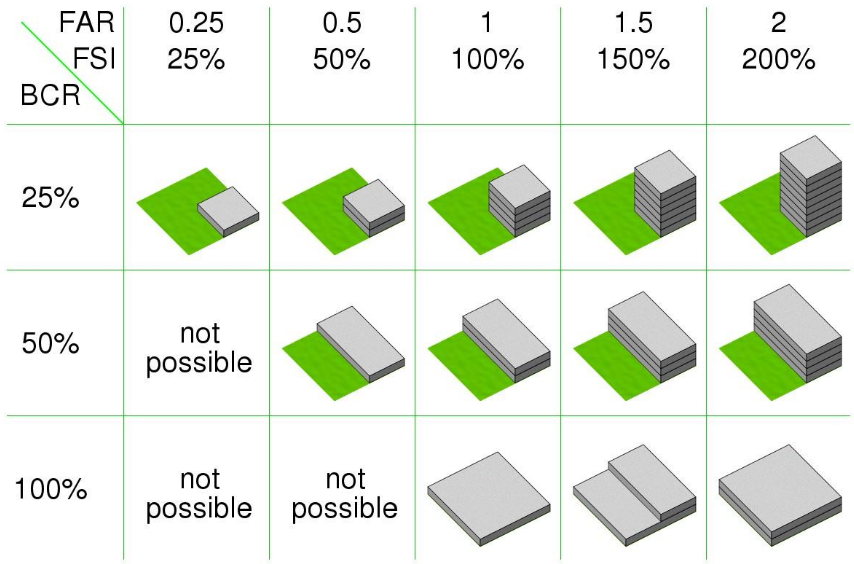


Fig. 1.22 Comparison of floor area ratio (FAR) or floor space index (FSI) and building coverage ratio (BCR)

Footing/ Foundation: It is the lower part of the structure directly connected to soil to transmit loads to the ground/ soil without stressing the soil beyond its bearing capacity.
Garage: It is a building or portion of a building used for shelter, storage or parking of vehicles.
Ground floor: It is the floor that is nearest to the ground surface around the building.
Parapet: It is a low wall or railing built along the edge of a roof of a building.
Partition wall: It is the non-load bearing wall of the building which is used for partitioning the spaces of the floors.
Porch: It is a covered surface supported on pillars or otherwise for the purpose of pedestrian or vehicle approach to a building.
Room height: It is the vertical distance measured from the finished floor surface to the finished ceiling surface.
Storey: The portion of a building included between the surface of any floor and the surface of the floor next above it, or if there is no floor above it, then the space between any floor and ceiling next above it is called a storey.
Structural wall: It is load bearing wall which carries the load of building along with its own weight.
Cornice: It is the slightly extra projected part of slab.
Storey height: It is the center to center distance between two consecutive slabs, or distance between floor of a slab to the next floor, or from one roof to the next roof.

Fig. 1.23 Balcony

Fig. 1.24 Basement

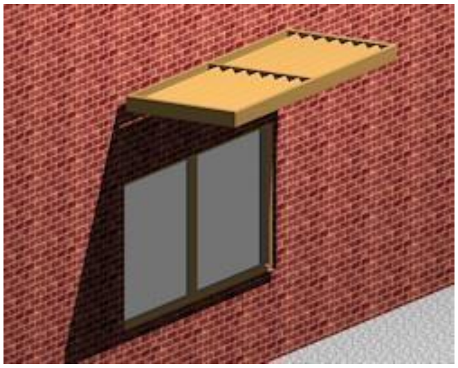


Fig. 1.25 Sunshade

Fig. 1.26 Courtyard

Fig. 1.27 DPC

Fig. 1.28 Parapet

Fig. 1.29 Porch

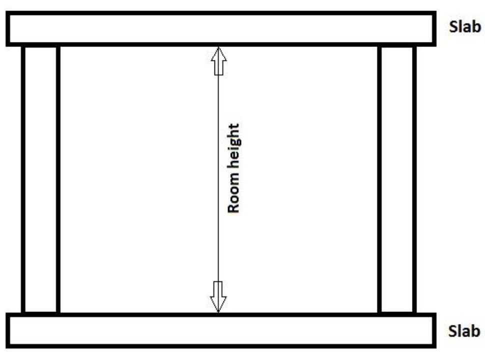


Fig. 1.3 Room height

2. Foundation

2.1 Site Exploration

As self weight and all other type of load that comes to a structure is finally transferred to the soil beneath it, the designer should have adequate information regarding the type and nature of soil available at different depths at the site for designing safe, sound and economical foundation for a structure. The aim is to get as much information about the physical properties and characteristics of the underlying material at site as well as details of other geological features of the area. All these attempts and activities are termed, in a broader sense, as '**Site Exploration**'. More specifically, <u>purposes</u> of site exploration are:

- Determination of safe bearing capacity of soil.
- Selection of a safe and economical foundation type.
- Determination of depth of foundation.
- Prediction of the settlement of foundation.
- Locating ground water level.
- Forecasting the difficulties which are likely to be encountered due to nature of subsoil during construction.

2.1.1 Methods of site exploration

i. **Test Pit**

ii. Boring

  a. Auger boring

  b. Shell and auger boring

  c. **Wash boring**

  d. Percussion boring

  e. Rotary boring iii. Probing

iv. Subsurface sounding

v. Geophysical method

Test Pit:

- The holes which are large enough to permit the entry of persons for inspection are called
  'Test pits'.
- Pits are square in plane and are dug by hand or by excavating equipment.
- In cohesion less soils the sides of the test pit are sharply sloped.
- In cohesive soils, at depth below 3m, bracing is required to keep the sides of the pit vertical.
- Comparatively expensive thus used for structure having shallow foundations (up to 3 meters).

Fig. 2.1 Test Pit

Wash boring:

- <u>Step 01:</u> Three legged pipe derrick is placed
- <u>Step 02:</u> Centering and Placing of Augur
- <u>Step 03:</u> Placement of temporary casing
- <u>Step 04:</u> Provision for water supply by hose pipe
- <u>Step 05:</u> Using bentonite

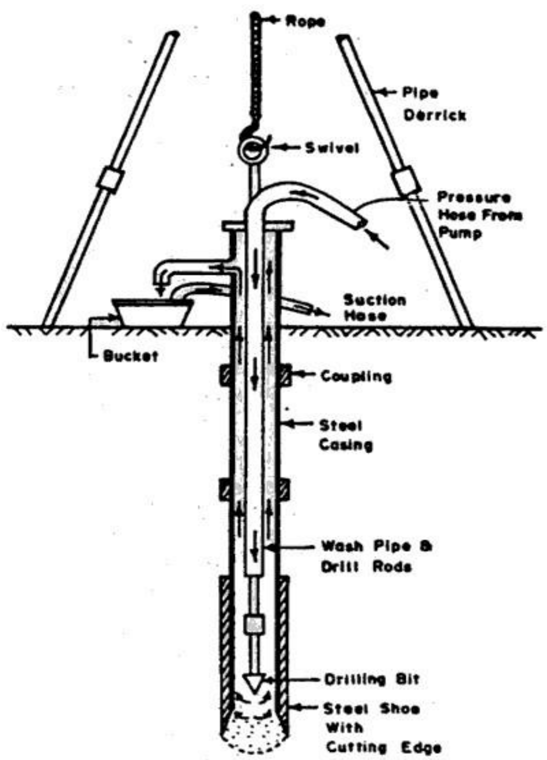


Fig. 2.2 Wash boring

Fig. 2.3 Placement of pipe derrick

(step 01)

Fig. 2.4 Centering and Placing of Augur

(step 02)

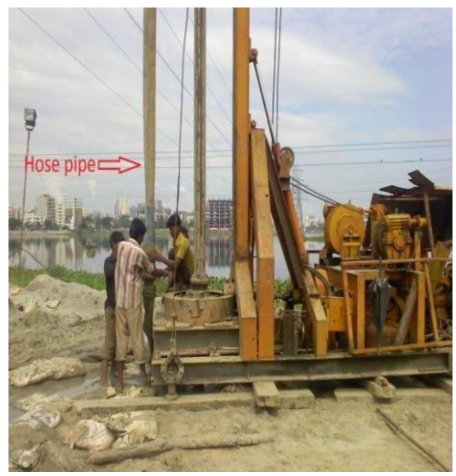


Fig. 2.5 Temporary casing placement **Fig. 2.6** Provision for hose pipe

(step 03) (step 04)

Fig. 2.7 Using bentonite (step 05)

2.2 Foundation

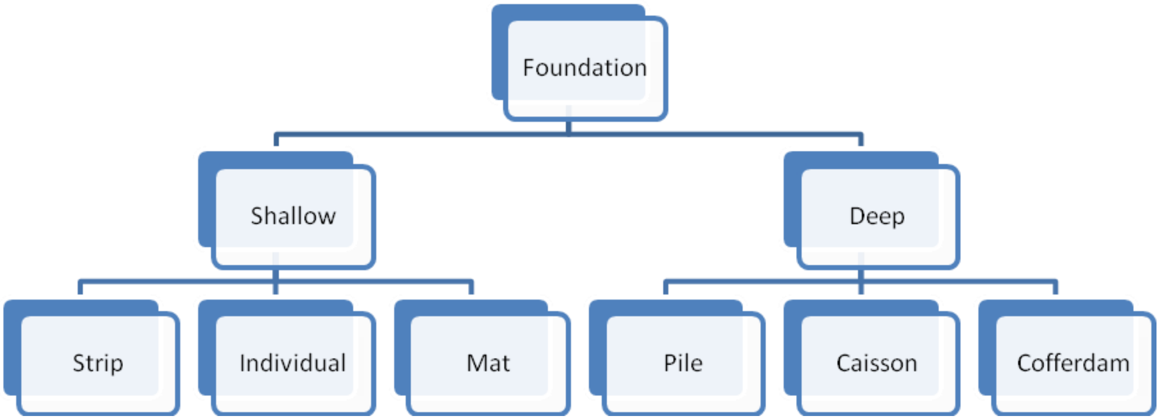
About foundation

- It is the lowest part of a structure below ground level.
- Has direct contact with ground.
- It provides a base for the super-structure through the artificial arrangement of concrete block, piles, raft etc.
- It distributes the load of structure over a large area without stressing the soil beyond its capacity.

Necessity of Foundation

- To distribute the weight of structure over a large area without stressing the soil beyond its capacity.
- To load the sub-stratum evenly and prevent unequal settlement or differential settlement.
- To provide a level surface that facilitates subsequent construction works.
- To take the structure deep into the ground and thus increase its stability by preventing overturning.

Types of Foundation



2.2.1 Strip/ Wall/ Continuous Footing

This type of foundation is used under structure with load bearing wall.

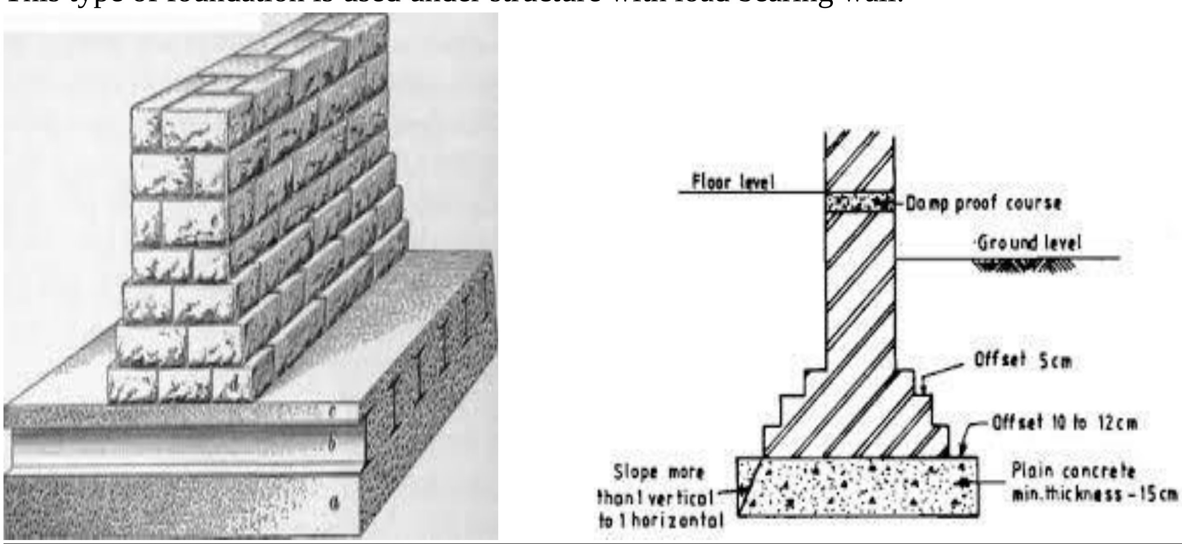


Fig. 2.8 Strip footing

2.2.2 Individual/ Isolated Footing

This type of foundation is used under structure with columns. This foundation is of two types:

a. single footing and b. combined footing

a. Single Footing:

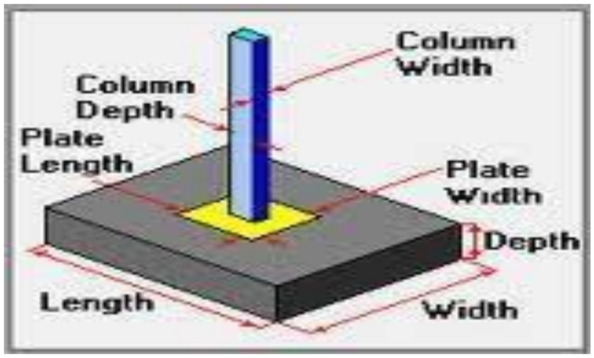


Fig. 2.9 Single footing

Construction steps of a single footing:

- Step 01: Excavation of trench
- Step 02: Leveling and dressing
- Step 03: Brick Flat Soling (BFS) placement
- Step 04: Cement Concrete (CC) layer placement
- Step 05: Shuttering/ formwork (must be leak proof) placement
- Step 06: C.C. block (to maintain clear cover) placement
- Step 07: Rebar Placement
- Step 08: Casting of Concrete, C:FA:CA=1:1.5:3/1:2:4, w/c ratio=0.42-0.5
- Step 09: Compaction (to avoid segregation)
- Step10: Removal of shuttering
- Step 11: Curing
- Step 12: Backfilling

Fig. 2.10 Excavation of trench (step 01)

Fig. 2.11 Leveling and dressing (step 02)

Fig. 2.12 Brick flat soling placement **Fig. 2.13** Shuttering placement

(step 03) (step 05)

Fig. 2.14 C.C. block placement (step 06)

Fig. 2.15 reinforcement placement
(step 07)

Fig. 2.16 Casting of concrete
(step 08)

Fig. 2.17 Compaction of concrete
(step 09)

Fig. 2.18 Curing of concrete

(step 11)

b. Combined Footing:

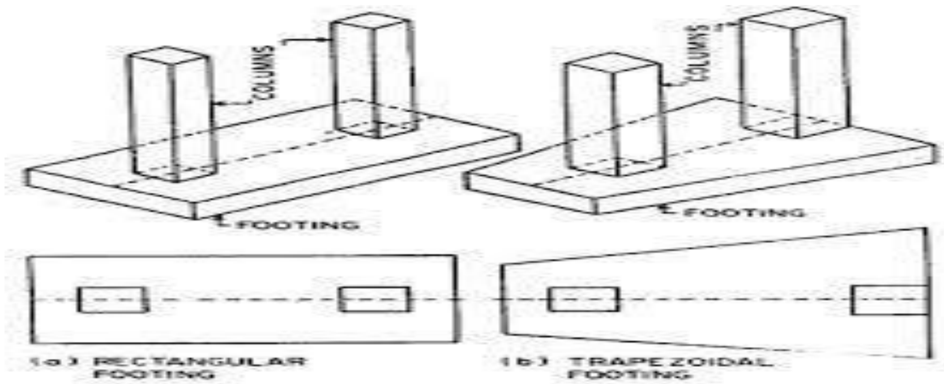


Fig. 2.19 Combined foundation

Combined footings are provided when:

- Two internal columns are so close that the two isolated footings overlap.
- Space outside the external column is limited by property line. Bearing capacity of soil is too low.

For a combined footing:

- Area of footing = Total Load/ Allowable Bearing Capacity of soil
- Center of gravity of footing must coincide with center of gravity of load.

2.2.3 Mat/ Raft Footing

When Required

- When foundation area cover 50-60% of the total plot area (i.e. when bearing capacity is too low)
- Basement needed

Fig. 2.20 Mat foundation

<u>Advantages:</u>

- Greater space (basement)
- Reduce differential settlement

<u>Disadvantages:</u>

- Costly
- Shore protection is needed
- During construction ground water level may rise, which may cause the loss of contact with soil.
- Water may seep inside
- When raft thickness is high, problem may arise due to heat differences.

Construction steps of a mat footing:

- <u>Step 01:</u> Leveling
    - To provide an accurate networks of height
- <u>Step 02:</u> Shoring
    - Shoring is the process of supporting an unsafe structure by building a temporary structure.
    - Shoring is commonly used before installing the foundation.
    - Supports the surrounding loads until the underground levels of the building are constructed

- To protect from shear failure of soil.
- Can be of 3 types: Concrete pile shore, steel sheet shore and timber shore.

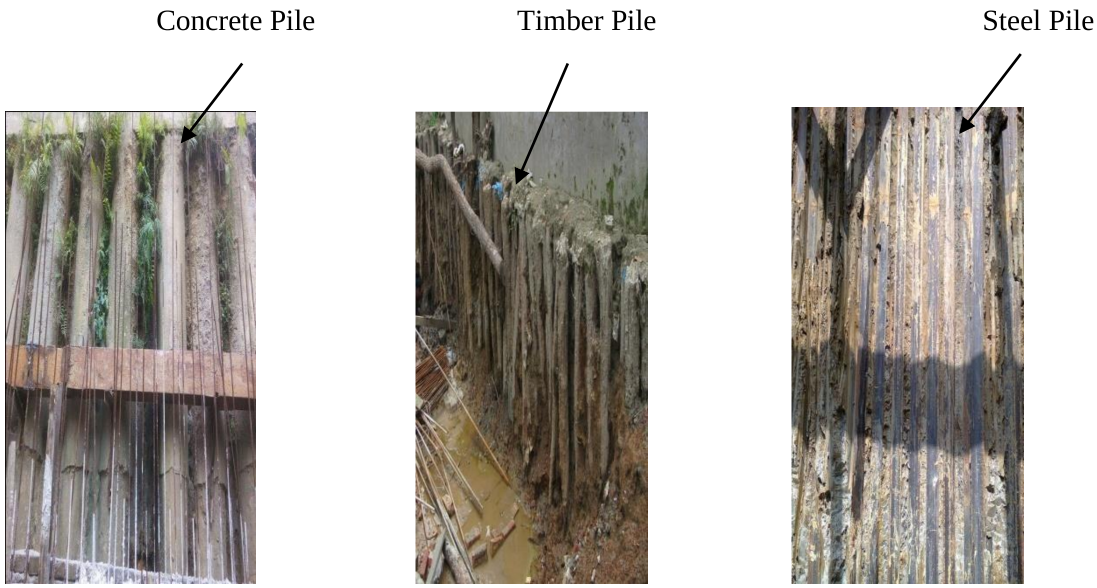


Fig. 2.21 Different types of shore pile

- <u>Step 03:</u> Soil Excavation

Fig. 2.22 Soil Excavation

□

Step 04: Providing Strutting and Bracing

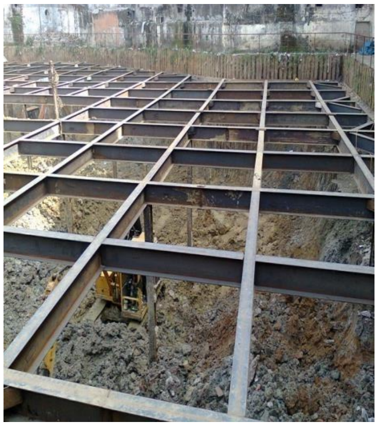


Fig. 2.23 Strutting and bracing

• Step 05: Compaction and Leveling of Soil

Fig. 2.24 Leveling

Fig. 2.25 Sand Layer

Fig. 2.26 Compaction

• Step 06: Provide Polythene, BFS, CC Layer

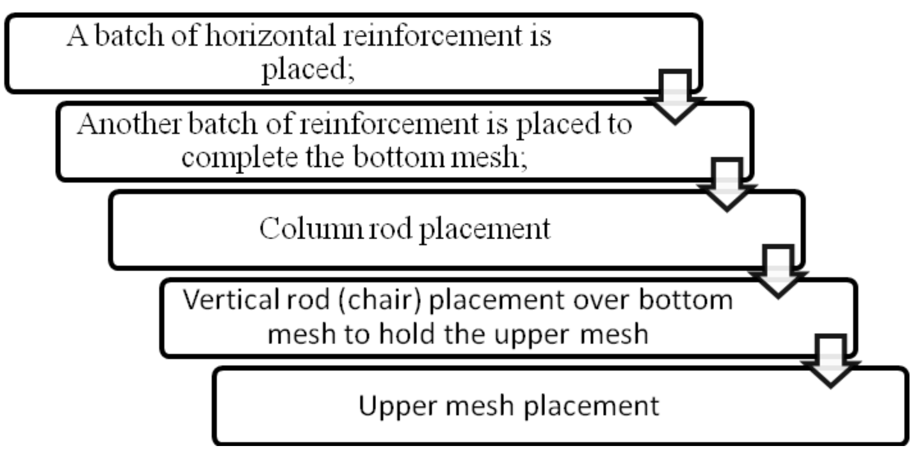
□ :

Fig. 2.27 Polythene **Fig. 2.28** CC layer **Fig. 2.29** Leveler

<u>Step 07</u> Placing CC block beneath bottom layer reinforcement

Fig. 2.30 Placing CC block

- <u>Step 08:</u> Placing of Reinforcement



□ :

Fig. 2.31 Reinforcement placing (Bottom mesh)

Fig. 2.32 Reinforcement placing (Top mesh)

Step 09 Concreting

Fig. 2.33 Concrete casting

- Step 10: Vibrating

□ :

Fig. 2.34 Concrete compaction

- <u>Step 11:</u> Leveling

Fig. 2.35 Leveling

<u>Step 12 </u>Curing

Fig. 2.33 Concrete curing

□ :

2.2.4 Pile Foundation

A pile is a long slender foundation member, made either of timber, structural steel or concrete which might be cast-in-situ or driven and acts as a structural member to transfer the load of the structure to a required depth in deep foundations carrying a load which may be vertical or lateral or lateral plus vertical.

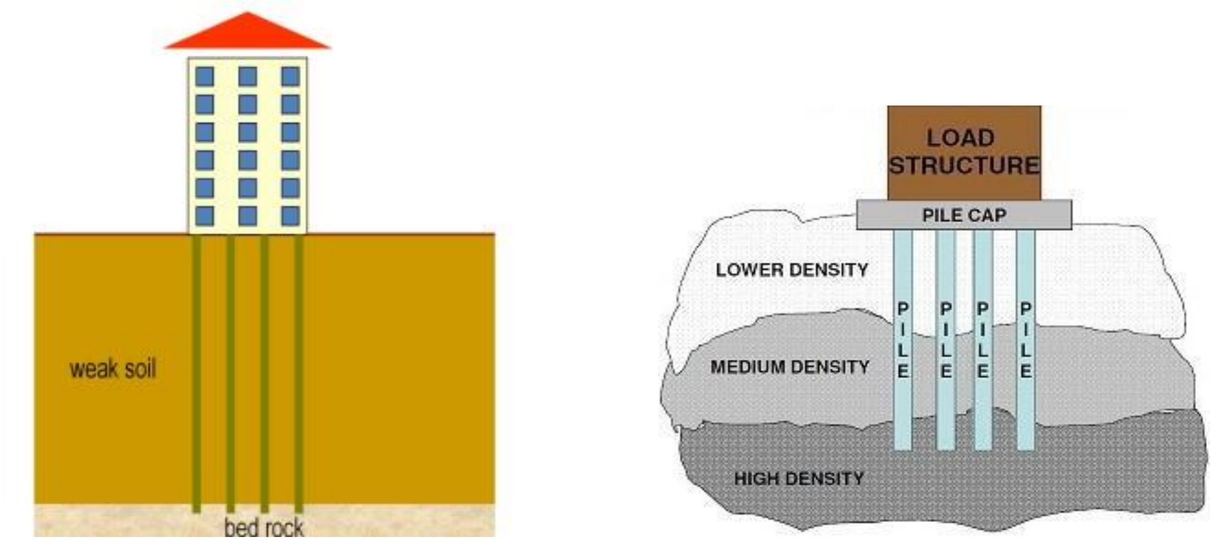


Fig. 2.34 Pile foundation

Pile foundation is generally used when:

- Single or combined foundation at a suitable depth is not possible.
- The stratum of required bearing capacity is at a greater depth.
- Structure is situated on the sea shore or river bed, where there is danger of scouring action of water.
- Steep slopes are encountered.
- In compressible soil or water-logged soil or soil of made-up type.

Piles are used for foundation of building, trestles, bridges and water front installation. In general, pile foundation provides a common solution to all difficult foundation site problem.

Types of Pile A. Function wise

1. Bearing pile
2. Friction pile
3. Shore/sheet pile
4. Anchor pile
5. Batter pile
6. Fender pile
7. Compaction pile

B. Material wise

1. Timber pile
2. Sheet pile
3. Concrete pile
4. Composite pile

Bearing pile:

Here, End bearing capacity > Skin friction

Friction Pile:

Here, Skin friction > End bearing capacity

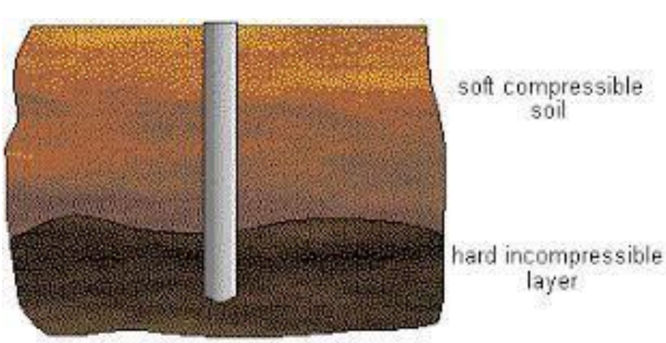


Fig. 2.35 Bearing pile

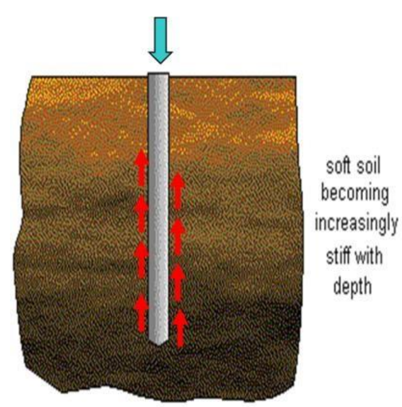


Fig. 2.36 Friction pile

Timber Pile:

When a timber column is installed vertically in the ground to at least 4m depth below the ground surface in order to bear load then it is called Timber Pile.

Advantages:

- Comparatively low cost and available
- As its length isn't long enough so it can be driven rapidly
- In comparison to concrete and steel pile it is more elastic
- No heavy machinery is required for this pile construction/ driving

Disadvantage:

- Its length is limited to some extent
- Its bearing capacity is comparatively low than the others
- It is vulnerable to seasoning in dry and wet seasons
- As it is an organic material, it can be attacked by insects and can be decayed by salt Its strength isn't high enough, so might be damaged while driving in soil

Steel Pile:

When a long slender column of steel is driven into the ground to carry a vertical load then it is called Steel Pile.

Advantages :

- As the cross-sectional area is very small, steel pile doesn't cause much soil displacement while being driven into the soil
- As the cross-sectional area is small and as steel is of high strength, steel pile can penetrate through rock and many hard substratum while being driven into soil.

Disadvantage :

- To avoid corrosion, the surface of the steel pile should be coated with coal tar or some other type of coating to prevent this corrosion.

Fig. 2.37 Timber pile

Fig. 2.38 Steel pile

Concrete Pile:

Fig. 2.39 Concrete pile **Advantages:**

- It is not responsive to GWT, so it is durable
- It can be given any shape or length that is required
- In comparison to timber pile, its bearing capacity is high. As a result, total number of pile required is less
- It is non-corrosive unlike steel pile
- The construction materials for concrete (cement, sand, aggregate etc.) are available almost everywhere

Disadvantages:

- It is costly than timber piles
- Expensive reinforcement is required to bear the handling stress
- Elaborate technical supervision and heavy driving machine is required
- Precast pile needs more carrying cost and space to be worked on

Types of Concrete Pile

i. Pre-cast Pile (Driven Pile)

i. Cast-in situ Pile (Bored Pile)
ii. Prestressed Concrete Pile

i. Pre-cast piles (Driven Piles):

The precast concrete pile is a prefabricated, high-strength concrete column, impact driven into the soil by means of an adjustable hydraulic or diesel hammer

Application Field:

- As it can ensure full strength by proper maintaining, so this pile is used for heavy weight structure
- As it is prefabricated, it can be used for under water construction

Shape:

- Circular
- Square
- Octagonal

Construction Steps of Precast Pile

- **Step 01:** Constructing reinforcement casing consisting of main bar and ties/stirrups
- **Step02:** Placing of CC blocks to maintain clear cover
- **Step 03:** Placing of Shuttering
- **Step 04:** Inserting steel-cap for the sharp edge at the driving end.
- **Step 05:** Casting of concrete
- **Step 06:** Compacting / Vibrating
- **Step 07:** Leveling the top surface
- **Step 08:** Curing

Fig. 2.40 Reinforcement

casing construction
(step 01)

Fig. 2.41 Placing of shuttering

(step 03)

Fig. 2.42 Inserting steel cap

(step 04)

Fig. 2.43 Casting of concrete

(step 05)

Fig. 2.44 Compaction of concrete

(step 06)

Fig. 2.45 Leveling top surface

(step 07)

Fig. 2.46 Curing of concrete

(step 08)

Advantages of Pre-cast Pile:

- They can be cast well before the commencement of the work resulting in rapid progress of work.
- Their construction can be well supervised and any defect detected can be rectified before use.
- Their reinforcement remains in their proper position and do not get displaced.
- They can be driven under water.
- They can be loaded soon after they have been driven into the desired path.

Disadvantages of Pre-cast Pile:

- They are heavy and great difficulties experienced for their handling and transporting.
- They are subjected to the driven shocks after the concrete has set. This may result in unsound construction.
- Pre-cast pile cannot be much longer in length.
- Pre-cast pile driving creates shock that can harm other structures.

Pile Driving

Pile can be driven by 4 processes:

1. By Drop Hammer
2. By Steam Hammer
3. By Water Jets
4. By Borig

ii. Cast-In-Situ Piles (Bored Piles):

In case of cast-in-situ piles, a borehole is made by wash boring or other suitable methods, reinforcement casing is placed inside the borehole and finally fresh concrete is poured inside the hole, thus the pile is casted where is will stay for its lifetime.

Construction Steps of Cast-In-Situ Pile <u>Step 01:</u> Wash Boring

<u>(i) Three legged pipe derrick placing:</u>

First, on the ground a three legged pipe derrick is place which holds.

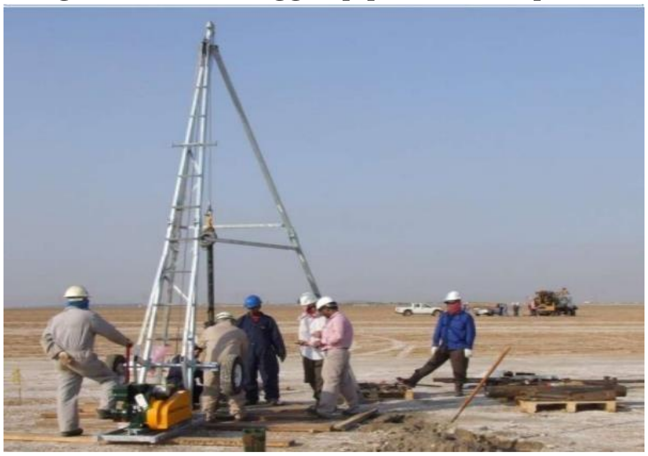


Fig. 2.47 Der rick Placing

(ii) Centering and Placing of Auger:

After placing the pipe derrick a circular shape (with conical sharp peak) auger is placed with the pipe derrick to loose the soil.

Fig. 2.48 Centering and Placing of Auger

(iii) Temporary casing/Drive pipe inserting:

After digging for some depth a hollow steel pipe is inserted into the hole for a certain depth so that soil pressure coming from the lateral side of the hole cannot collapse soil into the hole.

Fig. 2.49 Temporary Casing insertion

(iv) Water (bentonite) supply by hose pipe:

A pipe is usually lowered into the casing pipe to supply water (bentonite slurry) into the hole to loose the material of the bottom of the hole. This pipe is named wash jet pipe or wash pipe or hose pipe. The upper end of the pipe is connected to a water (bentonite slurry) supply source which supplies water (bentonite slurry).

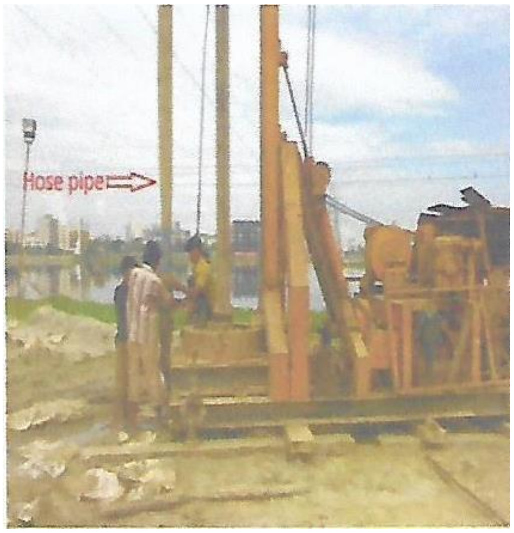


Fig. 2.50 Provision for hose pipe

(v) Using Bentonite:

Bentonite is used with water to make the water dense so that this water can withstand the pressure of the soil at gradual greater depth. Bentonite is recycled for reuse.

Fig. 2.51 Using Bentonite

<u>Step 02:</u> Construction of reinforcement casing consisting of stirrups and main rod

- Bending of stirrups
- Reinforcement cutting
- Making spiral rod for reinforcement
- Placing the rod horizontally
- Placing circular CC block peripherally to maintain clear cover
- Placing the reinforcement in the hole

Fig. 2.52 Reinforcement casing placing

<u>Step 03:</u> Welding

When another casing is required to insert then its bottom end is welded with the top end of the inserted casing

Fig. 2.53 Welding of casings

Step 04: **Casting Concrete using Tremie pipe**

A pipe is then inserted up to the bottom of the hole, then concrete is being cast through the large funnel shape cup.

Fig. 2.54 Concrete casting by tremie pipe

Step 05: **Vibrating**

The tremie pipe is at a time being up and down, shaken and vibrated to ensure the proper compaction

Step 06: **Curing**

After filling up the hole with concrete, then it is cured for about 28 days

Step 07: **Removing the impure concrete from the top**

After curing, the top part of each pile which is made of impure concrete is removed.

Step 08: **Pile cap construction**

After removing the impure concrete, the upper part of the rods will be exposed. These rods are connected with pile cap rods and the casting of pile cap occurs.

WEEK 03-04

Details of Construction

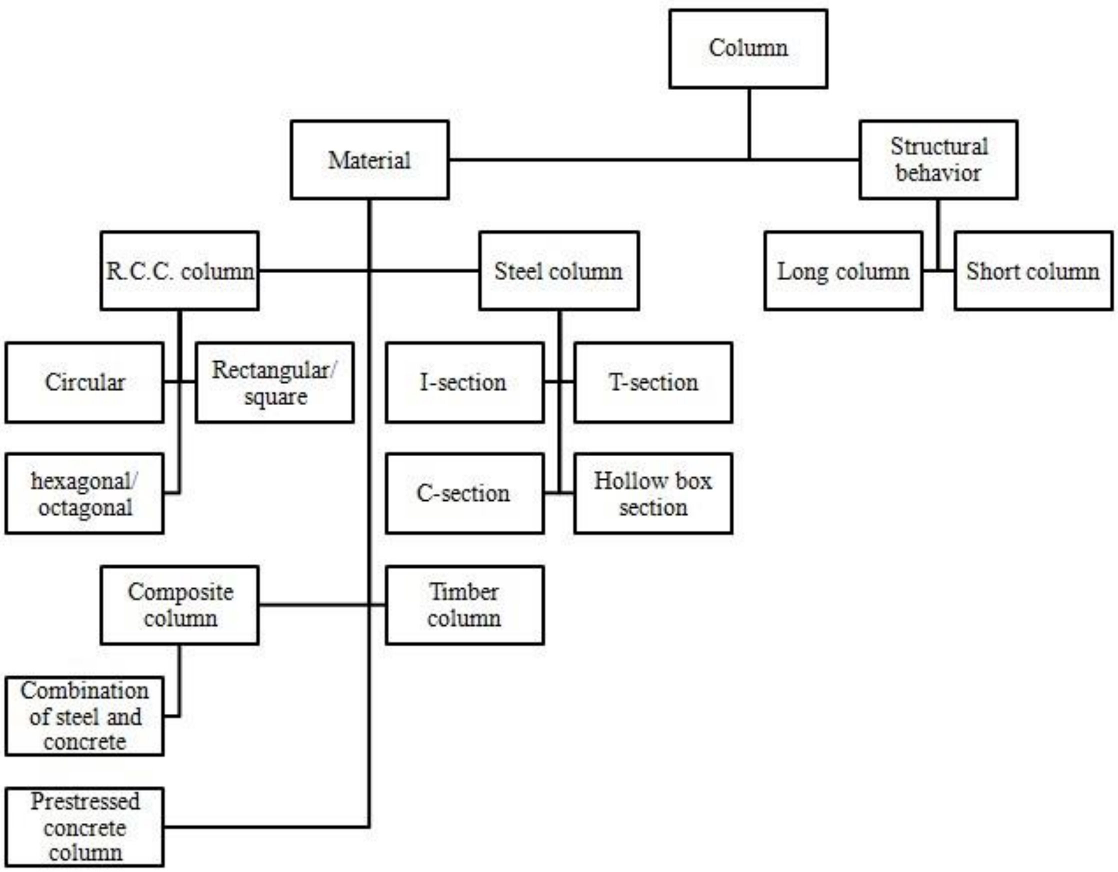
Beam, Column, Slab

3. Column,Beam and Slab

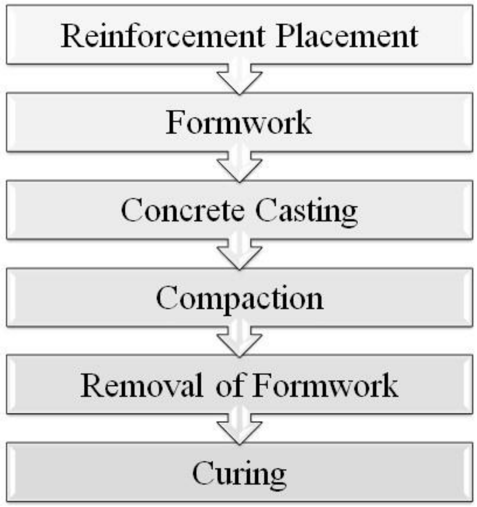
3.1 Column

- Structural member that predominantly takes axial load (predominantly compression).
- Column may need to take shear force and bending moment as well.
- It is the most important structural member from load carrying point of view.
- Should be given importance in analysis, design and construction stages.

3.1.1 Classification of column



3.1.2 Construction steps of column



Main vertical reinforcement placement

- Column is casted directly over the footing
- It is then continued maintaining vertical alignment

Fig. 3.1 Placing column reinforcement

Main vertical reinforcement requirement

- Minimum 4 main bar (rectangular column)
- Minimum 6 main bar (circular column)

Overlapping/ Splicing of Rods

- Provided mainly in the mid span

- Overlapped in sufficient amount to transfer load
- Tied with wires
- Not all rods are spliced at same level
- Avoided near support

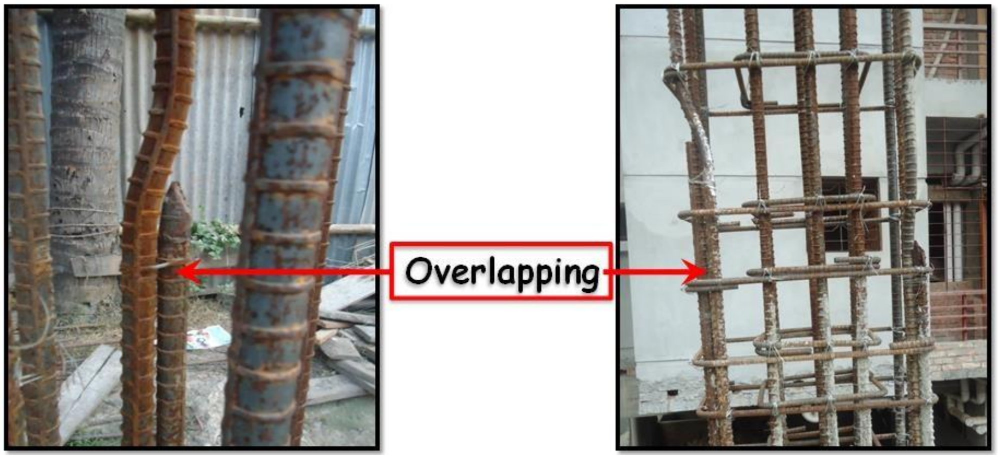


Fig. 3.2 Splicing of main rod

Ties

- To prevent bursting out effect
- To maintain the vertical rods in position
- To take shear

Fig. 3.3 Ties of column

Types of Ties

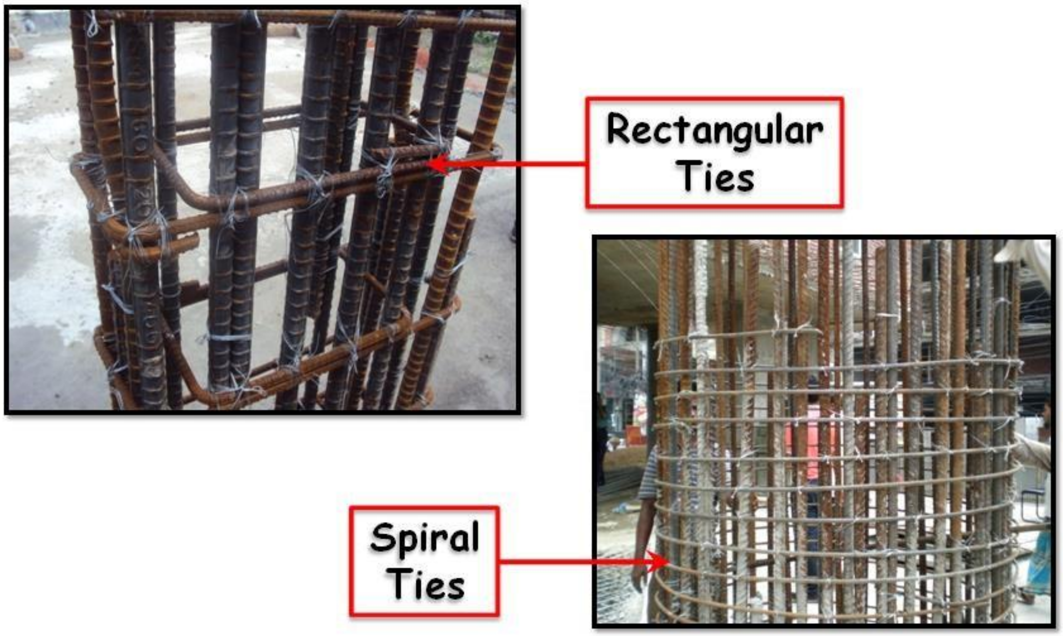


Fig. 3.4 Types of ties

Placement of tie bars

- Close ties are used near support
- Close ties are also used where rods are overlapped

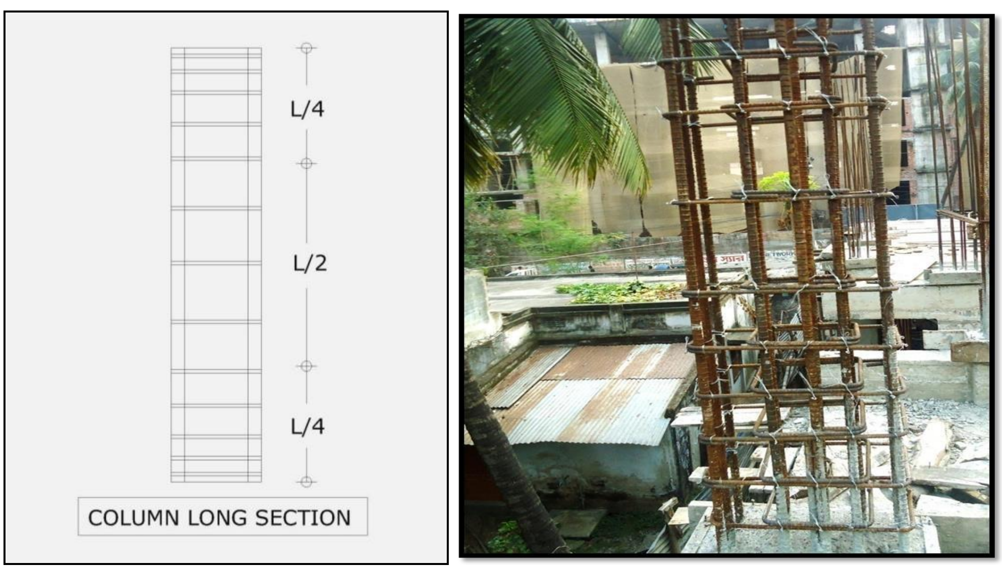


Fig. 3.5 Spacing of ties

Hooks

Fig. 3.6 Hooks

Formwork or shuttering

Fig. 3.7 Steel shuttering

3.1.3 Concrete casting

- Casting of concrete
- Using vibrator for compaction

Fig. 3.8 Concrete Casting

Fig. 3.9 Use of vibrator

Concrete casting in multiple lifts

Concrete casting for column is often done in multiple lifts to avoid:

- Difficulties of compaction
- Segregation
- Heat entrapment during hydration

Fig. 3.10 Concrete Casting in two lifts

Binding of old and new concrete by groove

- A piece of wood or brick is used as groove
- It is used to bind new and old material

Fig. 3.11 Groove

Removal of formwork and curing

- Formwork is removed approximately after 3 days
- Curing is continued for 28 days and gunny bag is used for curing

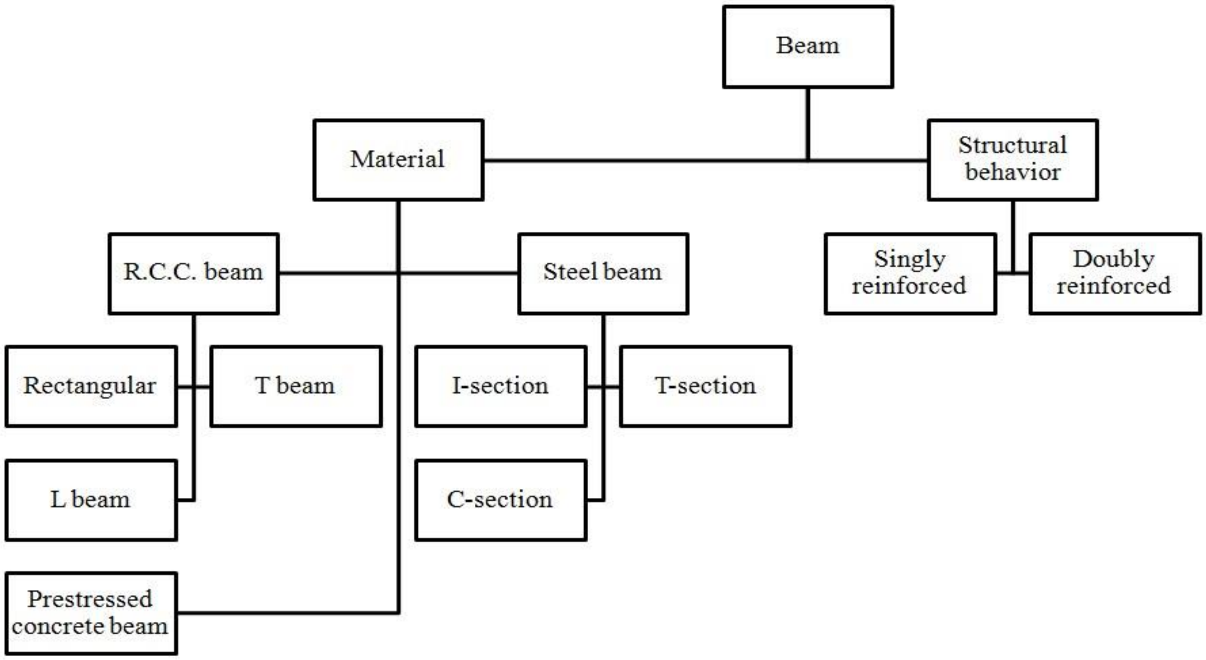
Fig. 3.12 Removal of shuttering

Fig. 3.13 Curing by gunny bag

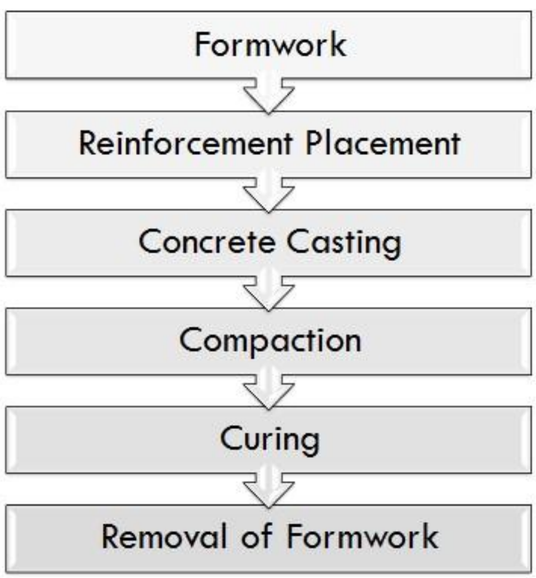
3.2 Beam

- Beams are those structural members which predominantly take moment and shear.
- Beam also need to take axial forces (compression and tension)

3.2.1 Classification of beam



3.2.2 Construction steps of beam



Formwork of beam

Fig. 3.14 Steel formwork

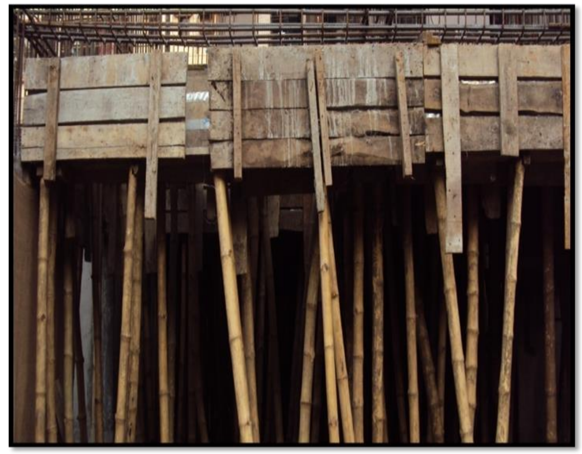


Fig. 3.15 Timber formwork

Measures for retaining water

- Steel sheet is used to make leak proof
- Polythene is also used

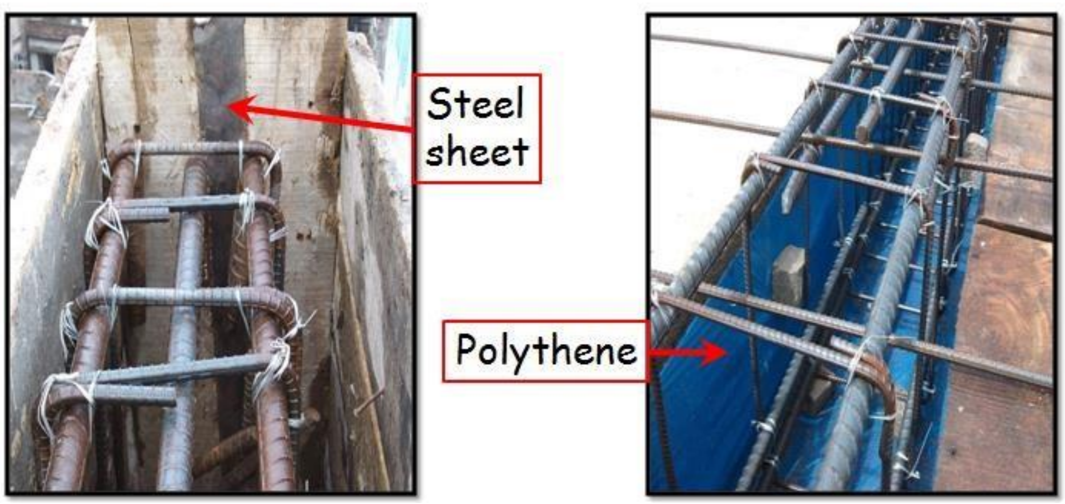


Fig. 3.16 Steel sheet **Fig. 3.17** Polythene **Reinforcement of beam**

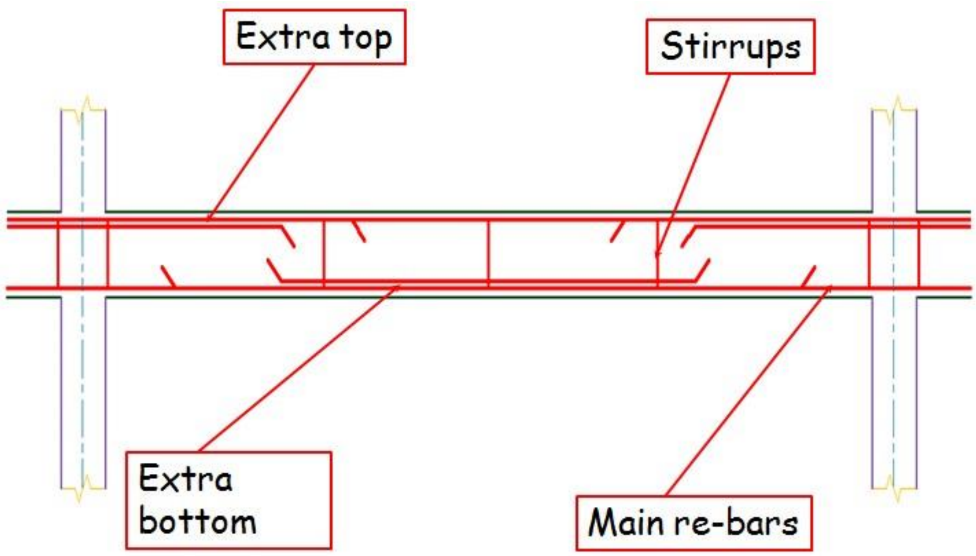


Fig. 3.18 Reinforcement of beam

Stirrups

- Stirrups in beam function like ties in column
- Main purpose is to ensure horizontal alignment and to resist shear

Fig. 3.19 Stirrups

Hooks

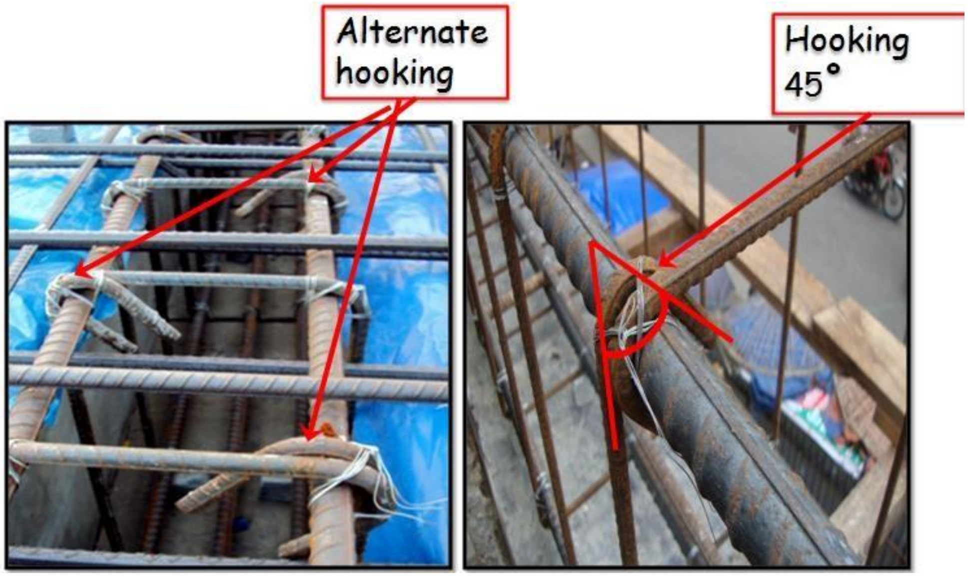


Fig. 3.20 Hooks

Spacing of stirrups

- Close stirrups are used near joints

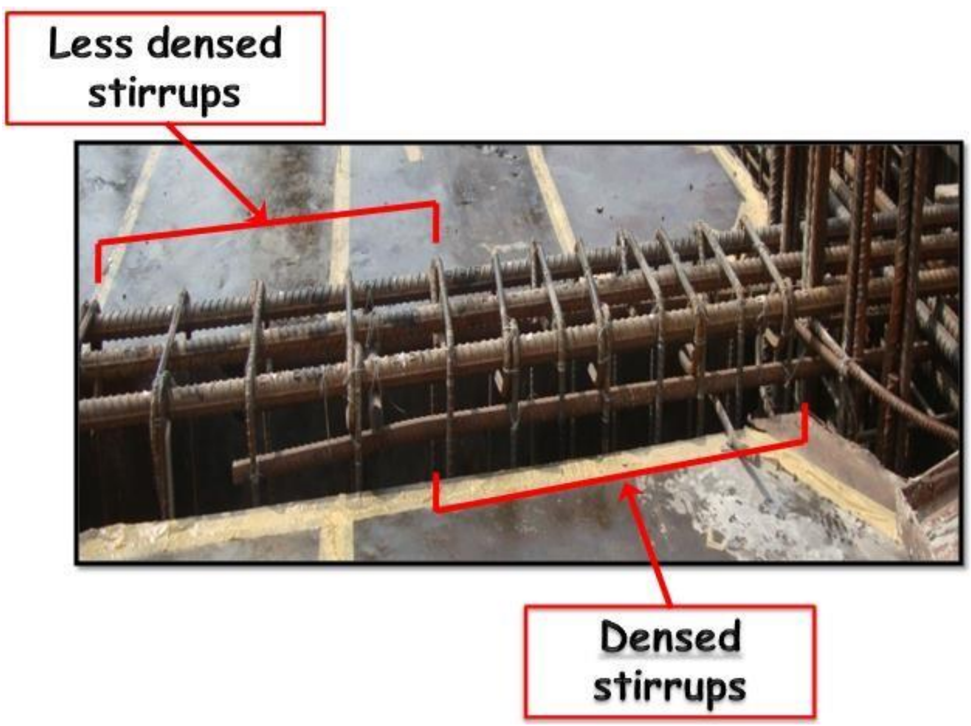


Fig. 3.21 Spacing of stirrups

Clear cover

 C.C blocks are used to maintain clear cover

Fig. 3.22 C.C blocks

Casting and curing

- Generally casting of beam is done along with slab
- Sometimes at first, the lower part of beam is casted, and then the upper part is casted along with slab
- Curing of beam is done along with that of slab

Fig. 3.23 Monolithical casting of beam and slab

3.3 Slab

• A RCC (Reinforced Cement Concrete) slab is a broad, flat plate, usually horizontal, with top and bottom surfaces parallel or nearly so. It may be supported by RC beams, masonry or RC walls, structural steel members, directly by steel members or continuously by ground.

3.3.1 Classification of slab

- Can be broadly classified into two categories:
  - One way slab ○ Two way slab
- Other categories:
  - Edge supported slab/ slab on beam ○ Flat slab ○ Flat plate slab ○ Waffle slab

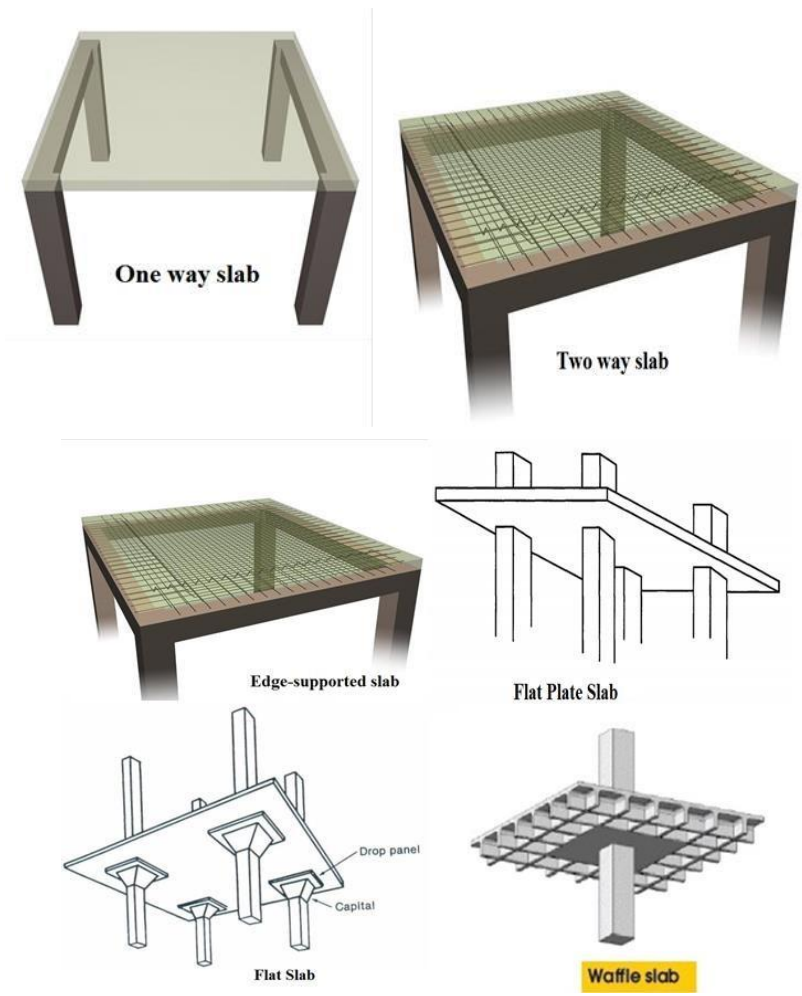
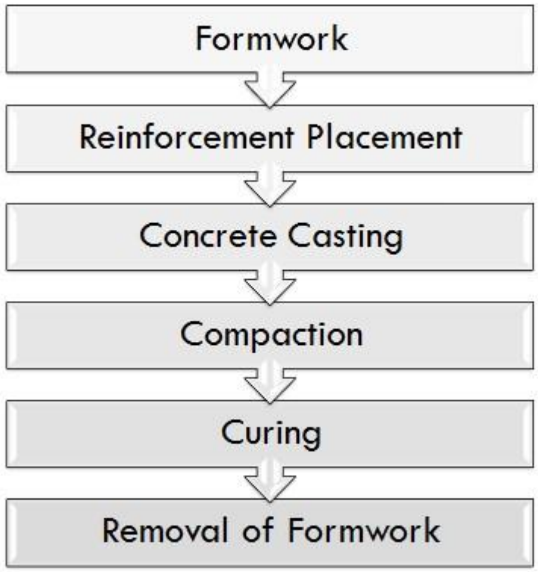


Fig. 3.24 Types of slab

3.3.2 Construction steps of slab



Formwork

Types of formwork

- Steel formwork
- Timber formwork

Fig. 3.25 Steel formwork

Fig. 3.26 Timber formwork

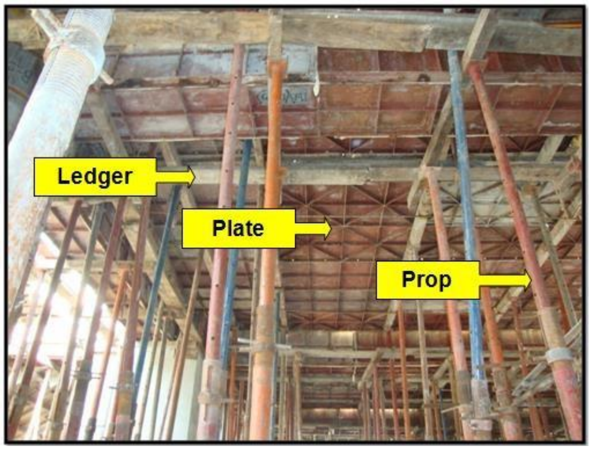


Fig. 3.27 Formwork/ shuttering

Fig. 3.28 Placement of steel sheet

Maintaining clear cover

Fig. 3.29 C.C. block

Concrete casting

Fig. 3.30 Concrete casting

Compaction

Fig. 3.31 Compaction

Leveling

Fig. 3.32 Leveling

Slab curing by ponding method

Fig. 3.33 Ponding

WEEK 05-06

Details of Construction

Brick Masonry, Stair

4. Brick Masonry

4.1 General features

- Brick is a compressive member
- Made from clay
- Brick structures are generally known as masonry structures where individual bricks are bonded with mortar.

Some brick masonry structures

Fig. 4.1 Duplex home

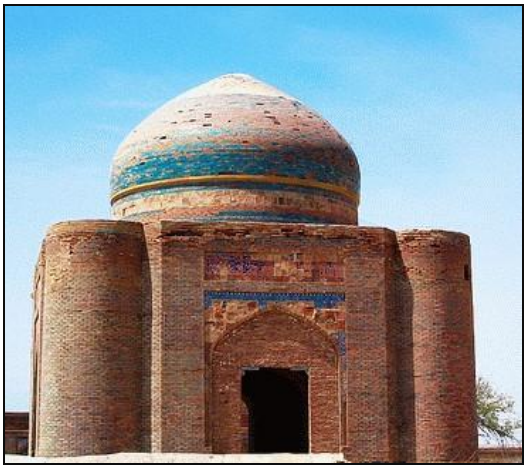


Fig. 4.2 Dome

Fig. 4.3 Arches

Fig. 4.4 Arch Bridges

Fig. 4.5 Pavement

4.2 Types of brick

- Dry Pressed: Clay is mixed with a minimal amount of water (up to 10 percent), then pressed into steel molds under pressures from 500 to 1500 psi (3.4 to 10.3 MPa) by hydraulic or compressed air rams. Suited for clays of very low plasticity.
- Wire cut: Clay is pugged with the help of water and then extruded through a die to produce a column of clay. An automatic cutter then slices through the clay column to create the individual brick. Suited for stiff muds having water in the range of 10 to 15 percent.

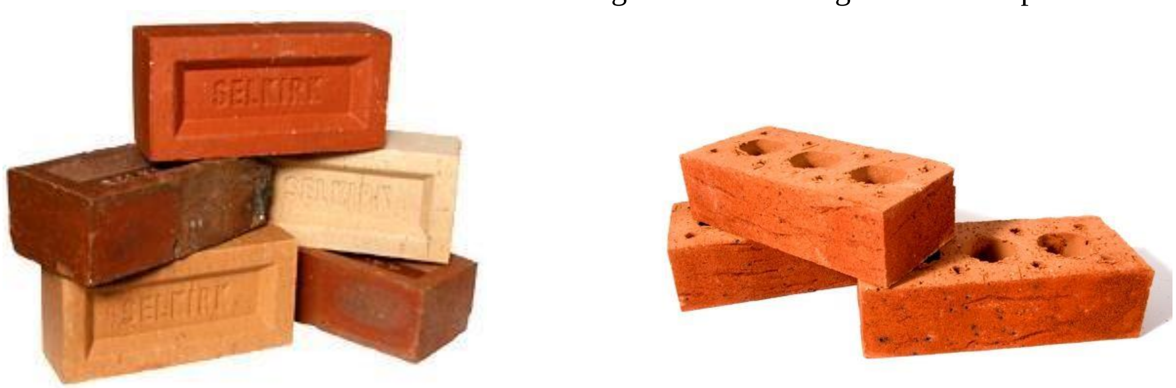


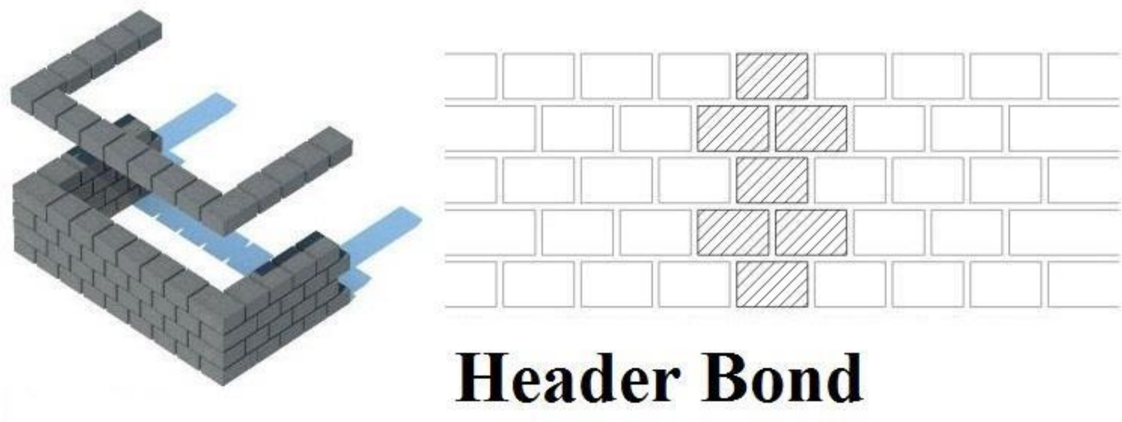
Fig. 4.6 Different types of brick

Brick dimensions

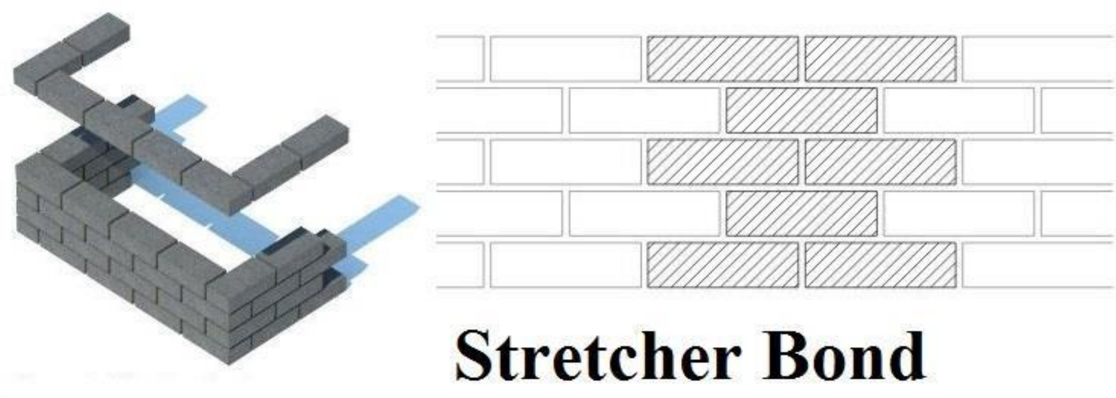
- With mortar: 10″×5″×3″
- Without mortar: 9.5″×4.5″×2.75″

4.3 Types of bonds in brick works

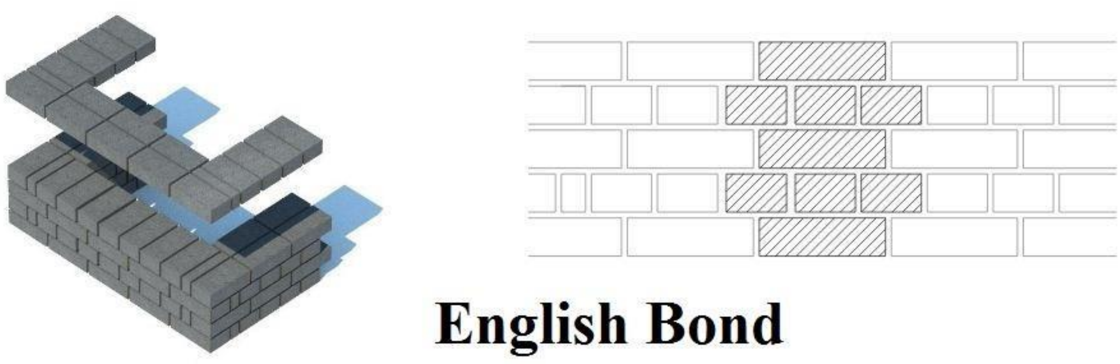
- English bond: Alternate courses of header and stretcher
- Flemish bond: Each course contains alternate header and stretcher
- Heading bond: All the bricks are laid as headers
- Stretching bond: All the bricks are laid as stretcher



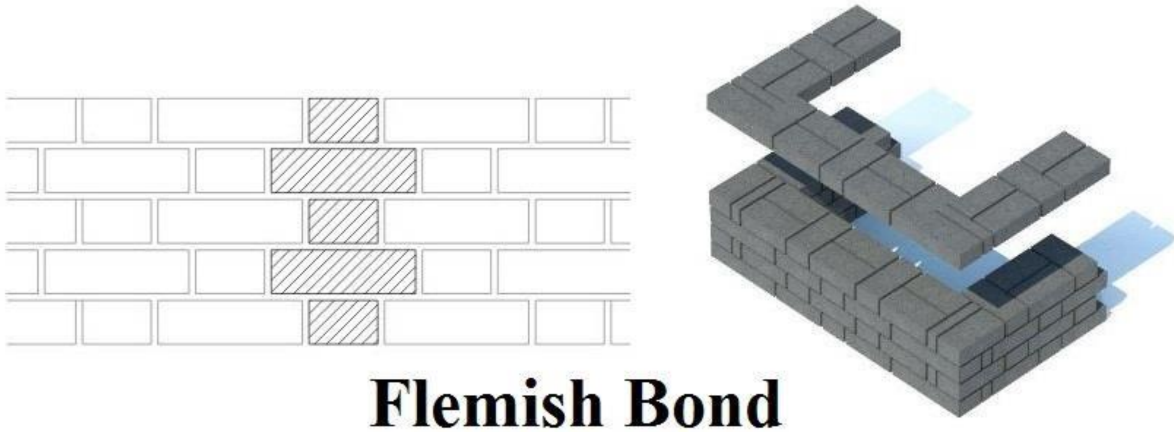
Header Bond



Stretcher Bond



English Bond



Flemish Bond

4.4 General Principles to be observed in brick masonry construction

- Use good quality bricks (uniform color, well burnt, exact shape and size)
- Before using brick, it should be soaked in water for 2 hours, so that bricks do not absorb water from mortar
- Bricks should be laid with frog pointing upward
- Construction of brick wall should start from joint or corner
- Courses should be perfectly horizontal
- Verticality of wall should be ensured by frequently checking using plumb-bob
- If work is stopped at a place, but is intended to be continued the next day, that place should be left with a toothed end
- Holdfasts for doors and windows should be embedded in brick masonry with cement mortar or concrete at time of constructing the wall itself
- Wall should be regularly cured for 2 weeks

4.5 Defects in brick masonry

- Sulphate attack
- Crystallization of salts from bricks
- Corrosion of embedded iron or steel
- Shrinkage on dryings

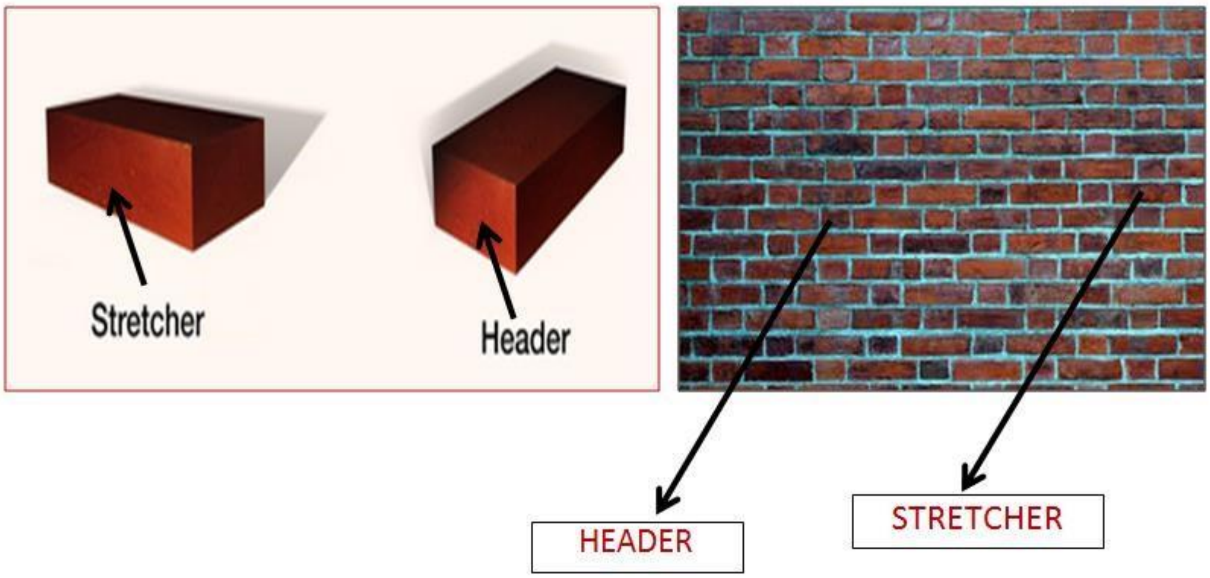


Fig. 4.7 Header and stretcher

4.6 Structural limitation of brick masonry

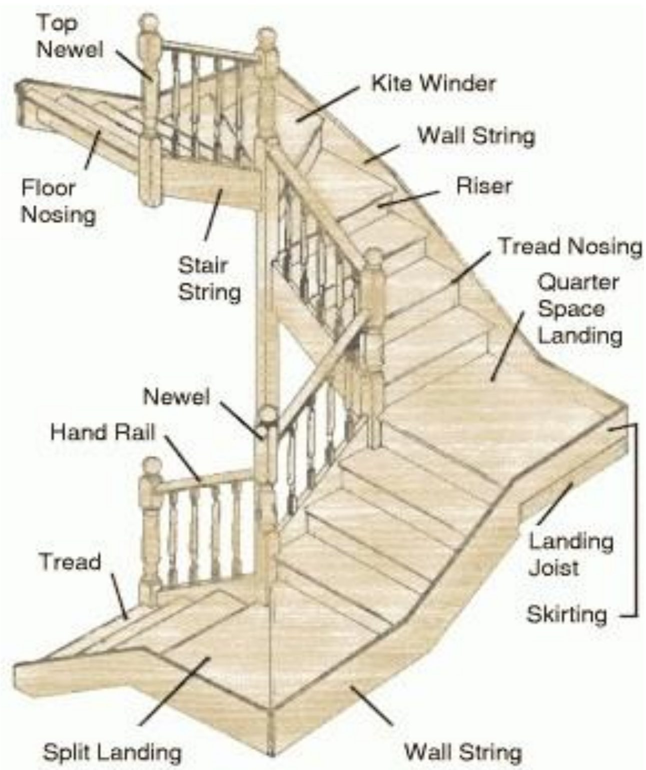
One problem with masonry walls is that they rely mainly on their weight to keep them in place; each block or brick is only loosely connected to the next via a thin layer of mortar. This is why they do not perform well in earthquakes, when entire buildings are shaken horizontally. Many collapses during earthquakes occur in buildings that have load-bearing masonry walls. Besides, heavier buildings having masonry suffer more damage.

5. Stair

A stair may 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 posts, hand rails and baluster, so designed and constructed as to provide an easy and quick access to the different floors, rendering comfort and safety to the users. The enclosure containing the complete stairway is termed as staircase.

Stairs may be made from various materials like timber, stones, bricks, steel, plain concrete or reinforced concrete. The selection of the type of material to be used to depend upon the aesthetical importance, funds available, durability desired and fire resisting qualities expected.

5.1 Technical Terms



Stringer

Fig. 5.1 A Typical Stair with its components

1. **Steps:** A portion of a stairway comprising tread and riser which permits ascent or descent from one floor to another.

2. **Tread:** The horizontal upper part of a step of a step on which foot is placed in ascending or descending stairway.

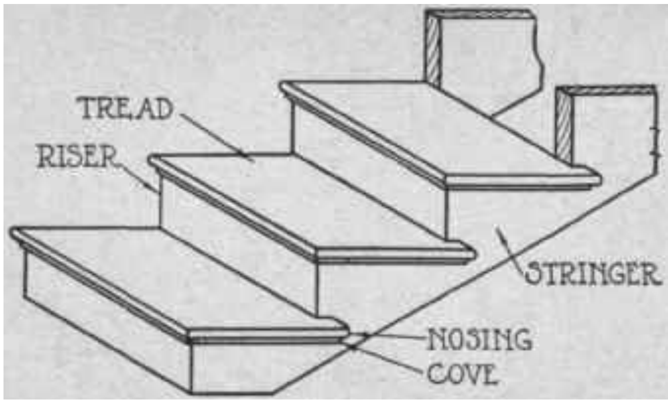


Fig. 5.2 Tread

3. Riser: The vertical portion of a step providing support to the tread.

Fig. 5.3 Riser

4. Flight: A series of steps without any platform, break or landing in their direction.

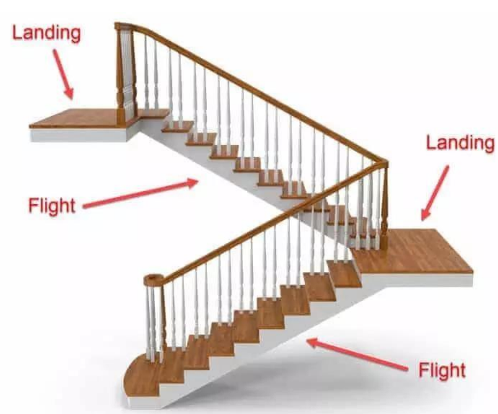
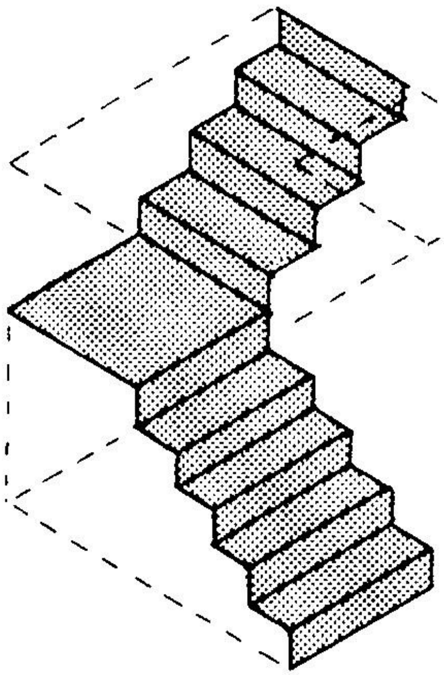
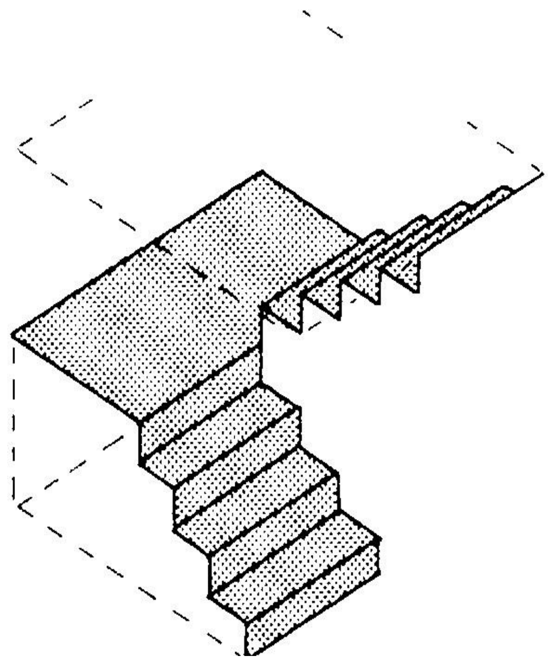


Fig. 5.4 Flight

5. **Landing:** A platform or resting place provided between two flights. A landing extending right across a stair case is termed as half space landing and the one extending only half across a stair case is called a quarter space landing.



Quarter space landing



Half space landing in dog legged stair **Fig.**

5.5 Types of Landing

6. **Nosing:** The outer projecting edge of a tread is termed as nosing. Nosing is usually rounded to give good architectural effect to the treads and makes the stair case easy to negotiate.

7. **Pitch or Slope:** It is the angle which the line of nosing of the stair makes with the horizontal.

8. **Hand Rail:** It is provided to render assistance in negotiating a stair way. It is supported on balustrades and usually run parallel to the slope of the stair.

9. **Head Room or Head Way:** It is the clear vertical distance between the tread of a step and the soffit of the flight or the ceiling of a landing immediately over it.

5.2 Requirements of a Good Stair

The general requirement of a good stair may be divided into the different heads, described below:

(i) **Location:** It should be so located that sufficient light and ventilation is ensured in the stairway. If possible it should be located centrally so as to be easily accessible from the different comers of the building.

(ii) **Width of stair:** Width of a stair varies with the situation and the purpose for which it is provided. The usually adopted average value of the stair width for public and residential building is 18m and 90cm respectively.

Figure 1: Pitch

(iii) **Length of flight:** For the comfortable ascent of stair-way the number of steps in a fight should be restricted to a maximum of 12 and minimum of 3.

(iv) **Pitch of stair:** The pitch of long stair should be made flatter by introducing landings to make the ascent less tiresome and less dangerous. In general, the slope of stair should never exceed 40□ and should not be flatter than 25□.

(v) **Materials:** The stair should preferably be constructed of materials which possess fire resisting qualities.

(vi) **Head room:** The head room or the clear distance between the tread and soffit of the flight immediately above it should not be less than 2.14m.

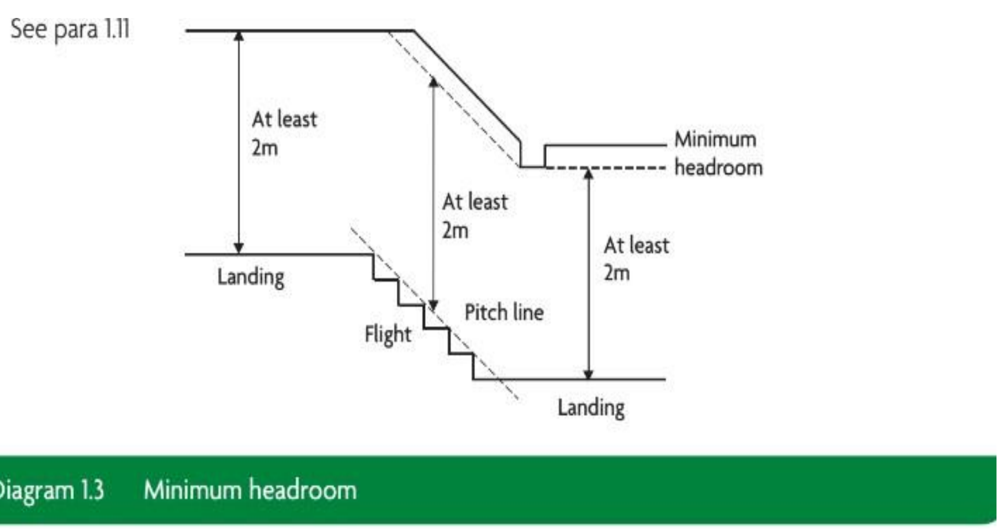


Fig. 5.6 Preferable Headroom

(vii) **Winders:** The introduction of winders in stair should be avoided as far as possible. They are liable to be dangerous and involve extra expense in construction.

Fig. 5.7 Winders

(viii) **Balustrade:** The open well stairs should be provided with balustrade so as to minimize the danger of accidents.

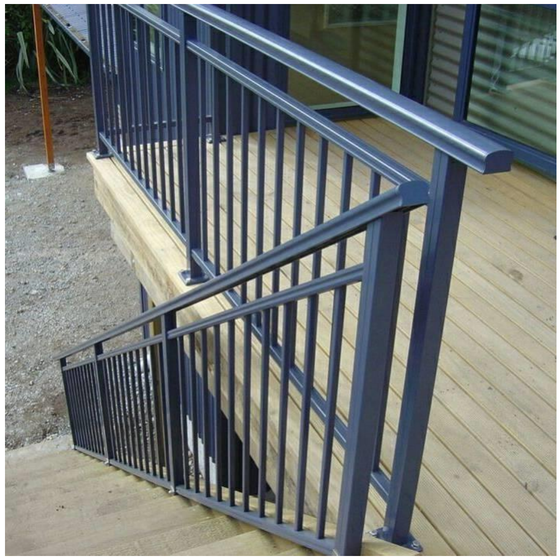


Fig. 5.8 Balustrade

(ix) **Landing:** The width of landing should not be less than the width of stair.

(x) **Step proportions:** The rise and tread of each step in a stair should be of uniform dimensions throughout. The ratio of the "going" and the "rise" of a step should be proportioned as to ensure a comfortable access to the stairway.

5.3 Classification of Stair

The different forms of stairs may be classified under the following main heads:

(i) Straight stairs
(ii) Dog-legged stairs
(iii) Open-newel stairs
(iv) Geometrical stairs
(v) Circular stairs
(vi) Bifurcated stairs

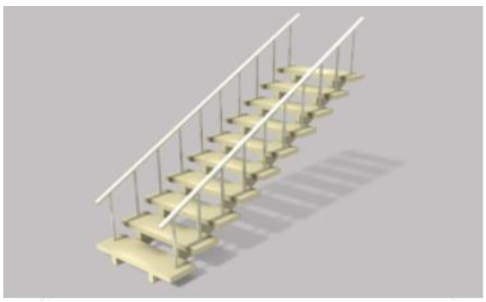


Fig. Straight stairs

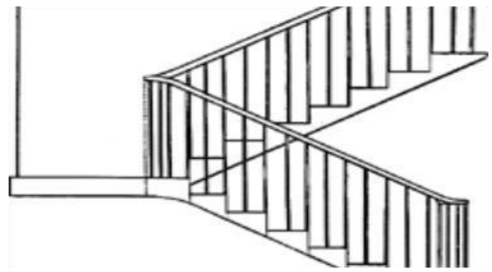


Fig. Dog-legged stairs

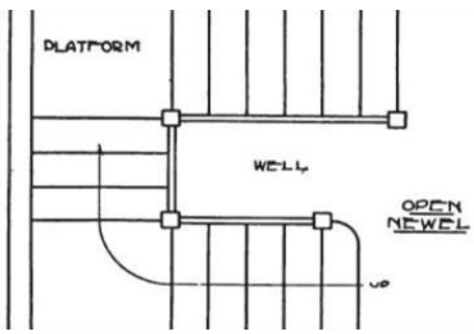


Fig. Open-newel stairs

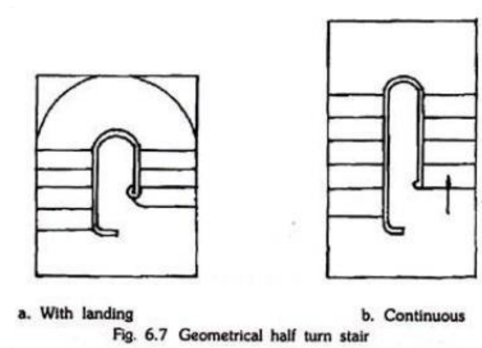


Fig. Geometrical stairs

Fig. Circular stairs

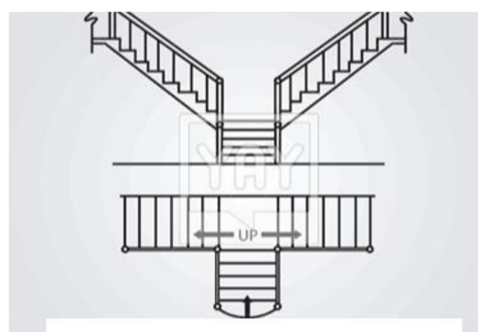


Fig. Bifurcated stair

Fig. 5.8 Different Types of Stair

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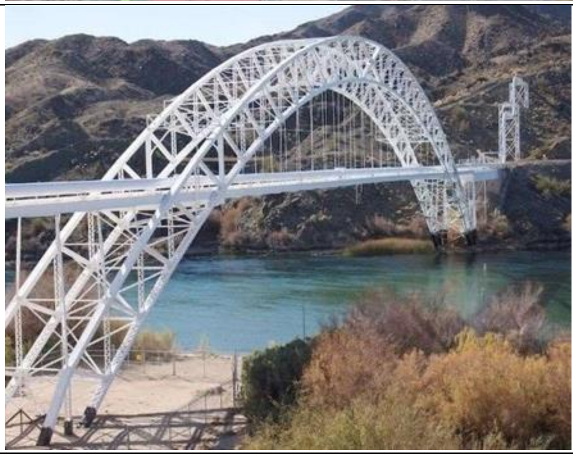
WEEK 07

Details of Construction

Steel Structure Fundamentals

6. Steel Structure Fundamentals

Steel Structure: a structure which is made from organized combination of structural steel members designed to carry loads and provide adequate rigidity. Steel structures involve substructure or members in a building made from structural steel Types of Steel Structure:

Truss structures (bar or truss members)	
Frame structures (beams and columns)	
Arch	

Advantages of Steel:

a) High strength per unit weight especially when compared to concrete. This can reduce the size of the elements in the structure and increase the living space.

b) Uniformity: that reduces the effect of time on steel as compared to concrete that changes throughout its life.

c) Elasticity: steel is elastic, that is it follows Hook's Law as long as its stresses do not exceed its yielding stress. So, steel behaves closer to design assumptions as compared to other materials

d) Moment of inertia of steel is accurately calculated where as that of concrete changes as the cracks move up towards the neutral axis and past it.

e) Durability and performance: If properly maintained the properties of steel do not change appreciably with time.

f) Ductility: since steel is a ductile material, it can undergo extensive deformations after which increased stresses are required for failure to occur. This is a property that can save lives.

g) It is easier to add to a steel structure than it is to a concrete structure mainly due to connections.

h) It is faster to build a steel structure than it is a concrete structure due to its lightness compared to concrete, it requires no curing time, and the members are easily connected (bolted, welded, and riveted).

i) Reliability: Steel Structures are very reliable. The reason for this reliability is uniformity and consistency in properties, and better-quality control because of factory manufacture.

j) Possible Reuse: Steel sections can be reused after a structure has been disassembled. Steel also has very good scrap value.

Disadvantages of Steel:

a) Maintenance cost: steel requires maintenance against corrosion. However, this cost may be eliminated by using atmospheric corrosion-resistant steel such as A242 and A588.

b) Fireproofing costs: steel will not ignite. However, at 1200°F steel has very little strength. Its temperature should not exceed 800°F beyond which its strength is reduced quickly.

c) Buckling: can occur when long slender steel members are exposed to compressive loads. To avoid buckling, a larger cross-section is needed which will increase cost.

d) Fatigue: is caused by a large number of repetitive tensile stress variations. This can reduce the strength and ductility of the steel causing a sudden failure.

e) Aesthetics: A considerable amount of money has to be spent on steel structure to improve their appearance.

Steel Design Specifications:

The specifications of most interest to the structural steel designer are those published by the following organizations.

- American Institute of Steel Construction (AISC)
- American Association of State Highway and Transportation Officials (AASHTO)
- American Railway Engineering and Maintenance-of-Way Association (AREMA)
- American Iron and Steel Institute (AISI)

Design Methodology

The design of a structural member entails the selection of a cross section that will safely and economically resist the applied loads. The fundamental requirement of structural design is that the required strength not exceed the available strength; that is,

Required strength ≤ available strength

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WEEK 08

Details of Construction

Basic Calculation of Estimation of Construction Materials

7. Estimation of a Residential Building

7.1 Basic Calculation of Estimation of Construction Materials

❖ Find out the quantities in 100 cft cement concrete. Mix ratio (C: FA: CA= 1:2:4) and shrinkage factor 1.5.

➢ Volume of concrete (before mixing) = $100 \text{x} 1.5 = 150$ cft Required materials:

Cement= $\frac{1}{1+2+4} \text{x} 150 = 21.428 \text{ cft} = \frac{21.428}{1.25} \text{ bags} = 17.142 \text{ bags} \approx 18 \text{ bags}$

(1 bag cement= 1.25 cft= 50 kg)

FA= $\frac{2}{1+2+4} \text{x } 150 = 42.856 \text{ cft}$

CA= $\frac{4}{7} \text{x} 150 = 85.712 \text{ cft}$

❖ Find out the quantities in 100 cft brick masonry. Factor of safety= 1.2 for wastage. Mortar mix ratio (cement: sand) = 1:4 and shrinkage factor 1.5.

➢ Volume of brick masonry= $100 \text{x} 1.2 = 120$ cft

Nominal size of brick (with mortar) = 10”x5”x3”

No. of Bricks required= $\frac{120}{\frac{10}{12} \text{x} \frac{5}{12} \text{x} \frac{3}{12}} = 1382.4 \approx 1383$

Volume of 1383 no. of bricks with mortar= $1383 \text{x} \frac{10}{12} \text{x} \frac{5}{12} \text{x} \frac{3}{12} = 120.052 \text{ cft}$

Actual size of brick without mortar= 9.5”x4.5”x2.75”

Volume of 1383 no. of bricks without mortar= $1383 \text{x} \frac{9.5}{12} \text{x} \frac{4.5}{12} \text{x} \frac{2.75}{12} = 94.091 \text{ cft}$

Volume of mortar required= $120.052 - 94.091 = 25.961$ cft

- Calculate quantity of cement and sand like previous problem.

7.2 Unit Weight of Some Important Materials

Table 3.1: Unit Weight of Some Important Materials

Materials	**Unit Wt. (lb/cft)**
Brick work	120
Cement	90
RCC	150
Mild steel	490

7.3 Assignment

Question (1): Find out the ingredients required for making 20 ft x 18 ft concrete slab (thickness = 5 inch). Given, mix ratio = 1: 1.5: 3.
Answer (1): cement = 32.72727273 bags; sand (fine aggregate) = 61.36363636 cft & brick/stone chips

(coarse aggregate) = 122.7272727 cft.

Question (2): Suppose, you have 50 bags of cement. What volume of concrete you can make from this 50 bags cement with a mix ratio of 1: 1.25: 2.50. Answer (2): 197.9166667 cft dry concrete.

Question (3): Suppose, you have 5000 Nos. of full size brick. You want to make a brick wall. What will be the volume of brickwork?
Answer (3): 434.0277778 cft.

Question (4): In question (3), determine the number of cement bags & volume of sand if mortar mix ratio is 1:4.
Answer (4): 22.52604167 bags of cement; 112.6302083 cft sand.

Question (5): Given a 10 inch thick brick wall having a length of 30 feet and height of 10 feet. The wall contains two doors (7 feet height & 3.5 feet width) and two windows (4 feet height & 6 feet width) and a continuous lintel (25 feet length & 6 inch height). Using a factor of safety of 1.2 and cement: sand ratio in mortar = 1: 4, Estimate the no. of bricks, no. of bags of cement & sand required for the construction of the wall.
Answer (5): No. of bricks = 2195; cement = 9.88695 bags & sand co: 49.43475 cft.

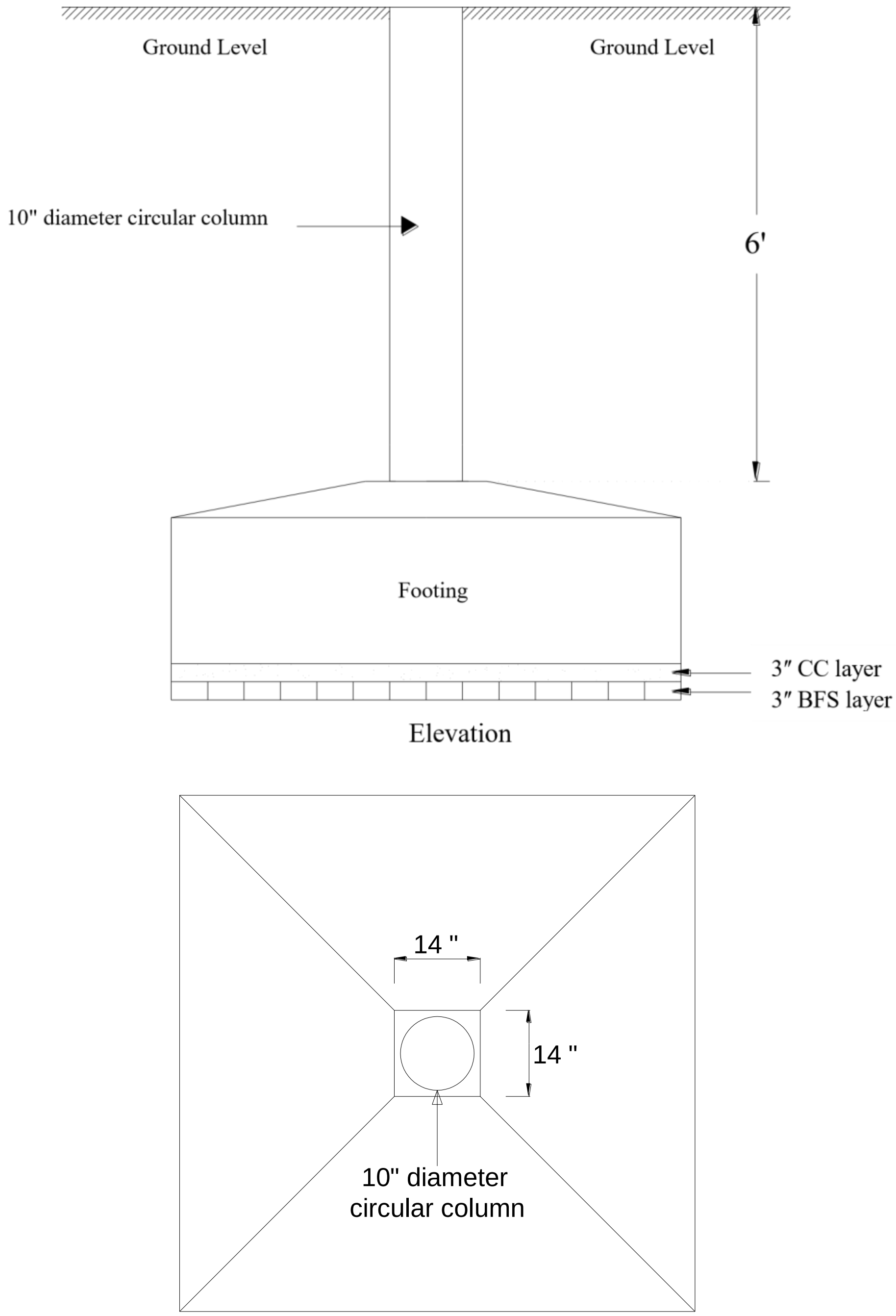

Figure 3.1: Plan and Elevation of Foundation for Question 7 of Assignment

WEEK 09-10

Complete Estimation of a Residential Building

Earthwork Excavation, Brickwork in Foundation

3.4 Worked Out Problem

Estimate the materials required for the following residential building. Also find out the cost of all materials.

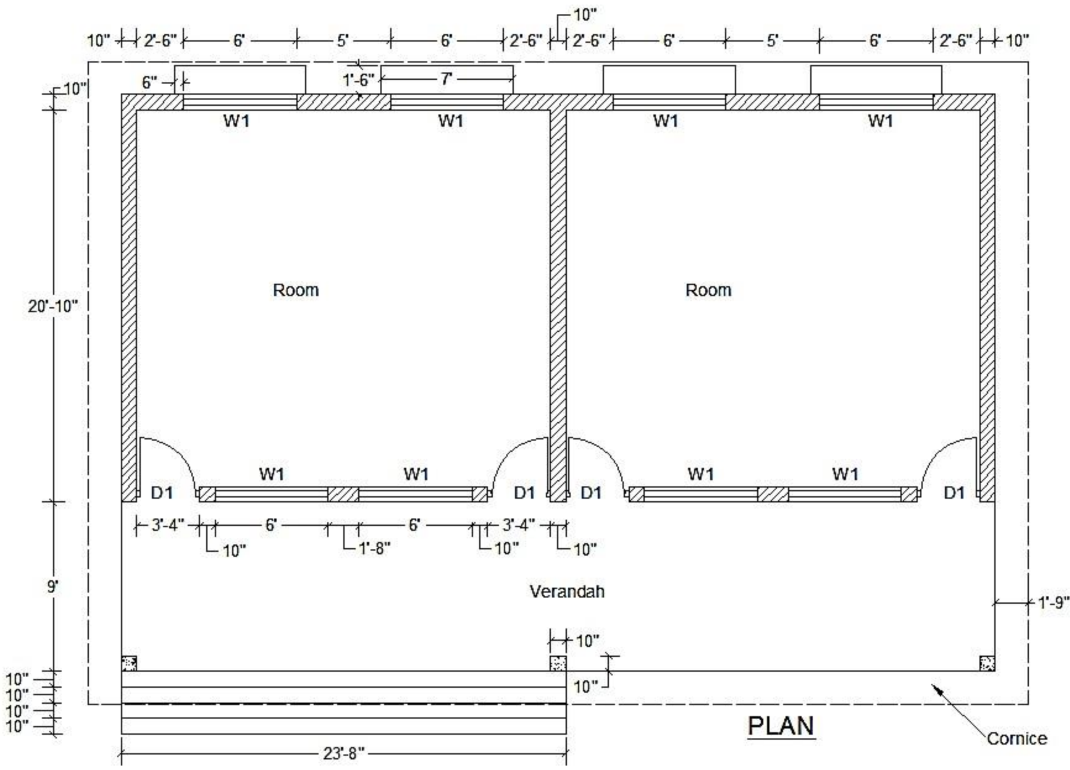

Figure 3.2: Building Plan

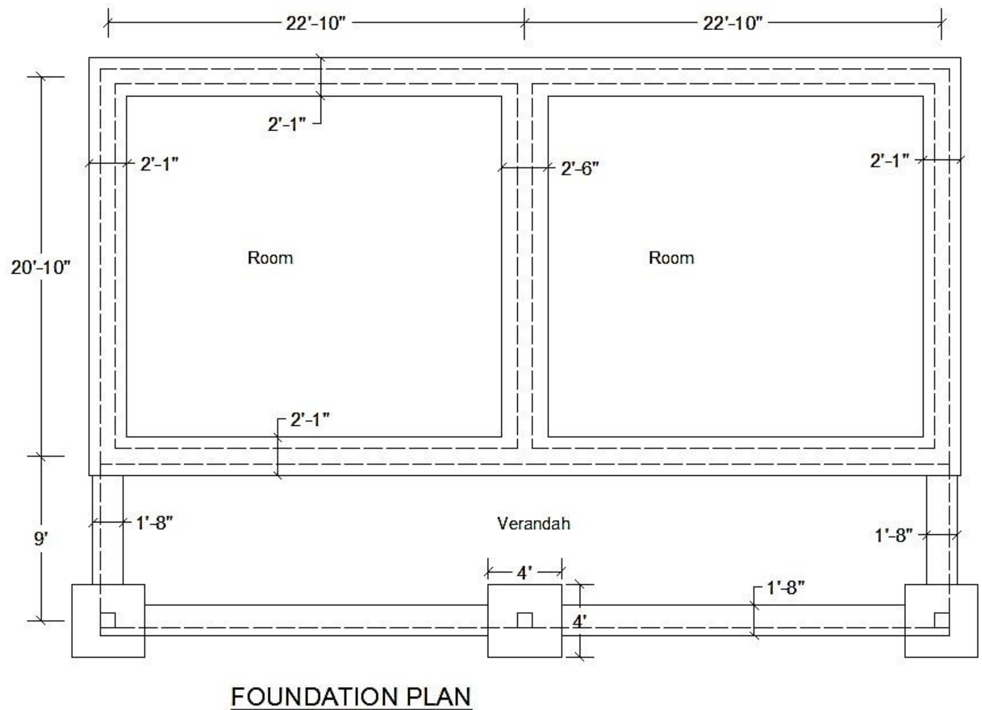

Figure 3.3: Foundation Plan

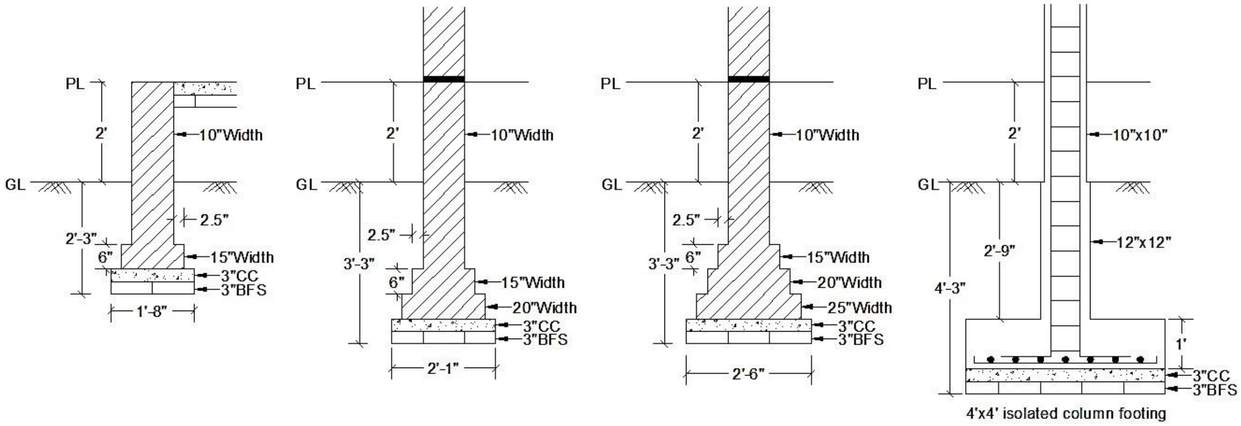

Figure 3.4: Cross Sections of Foundations

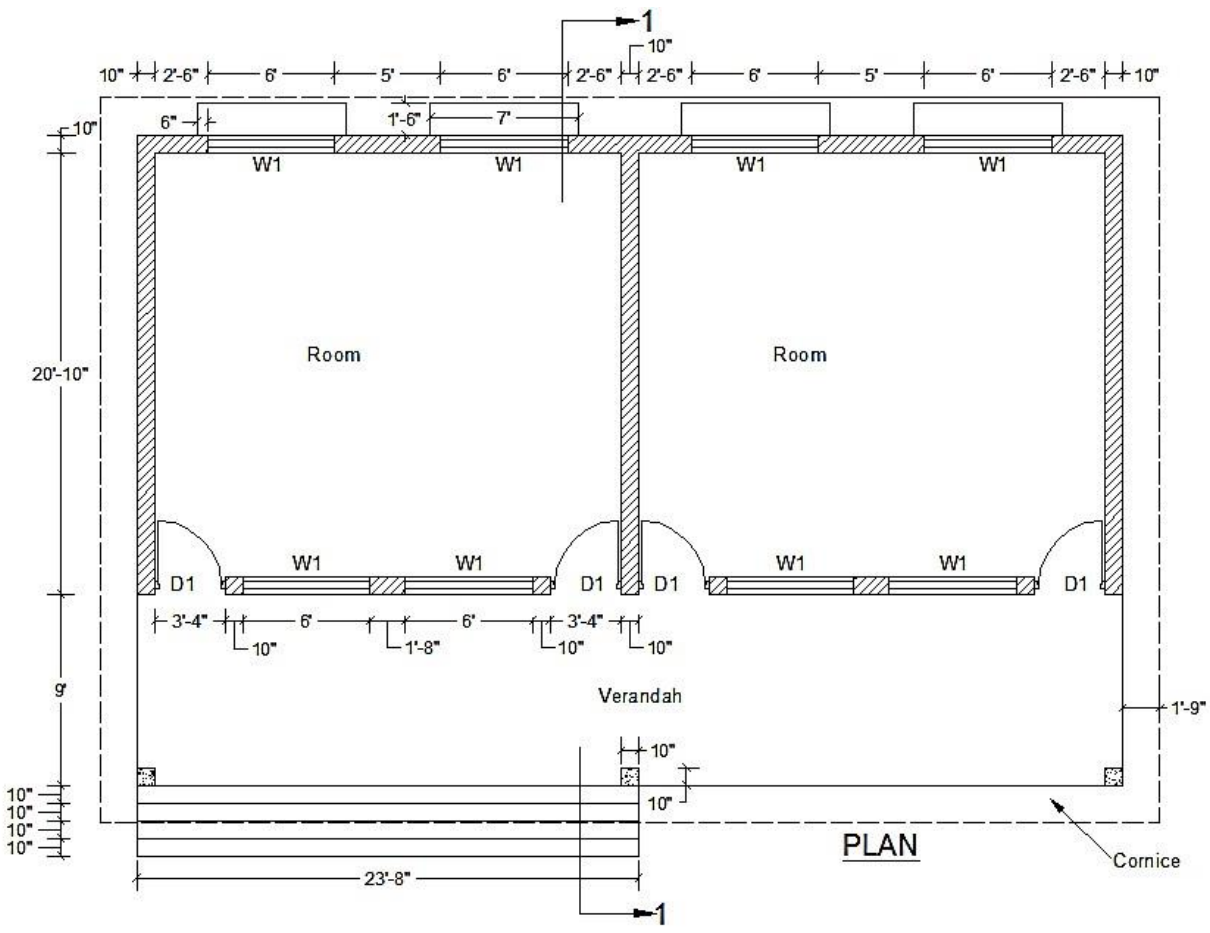

Figure 3.5: Building Plan with Section Lines

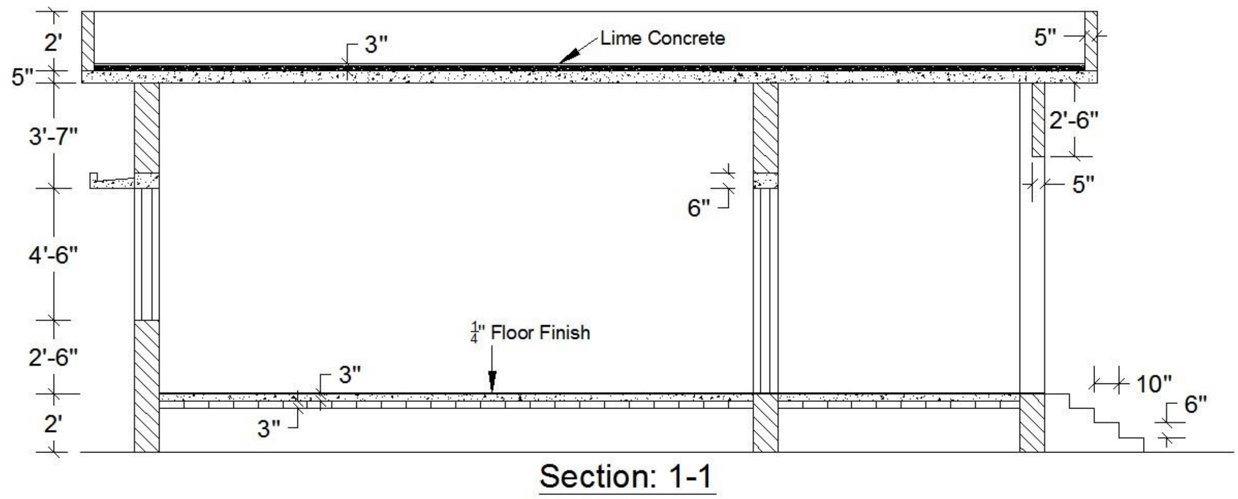

Figure 3.6: Elevation at Section 1-1

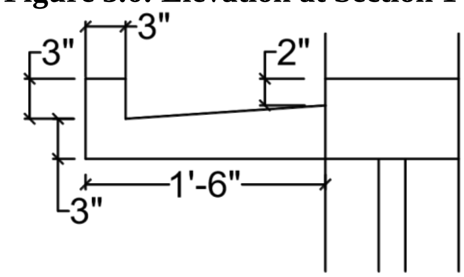

Figure 3.7: Sunshade

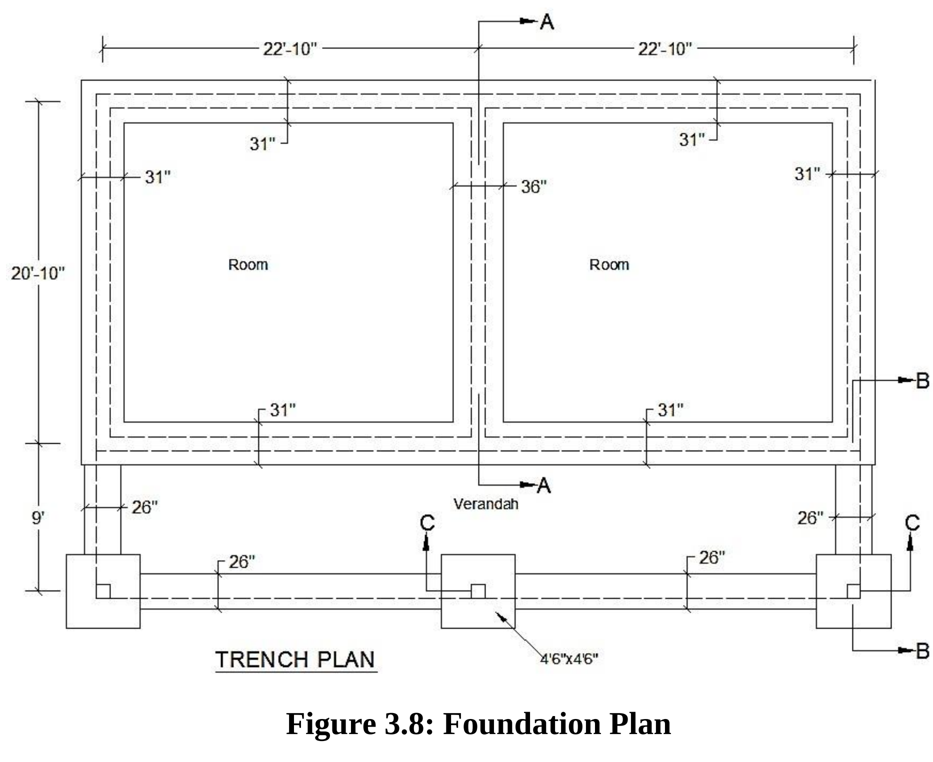

Figure 3.8: Foundation Plan

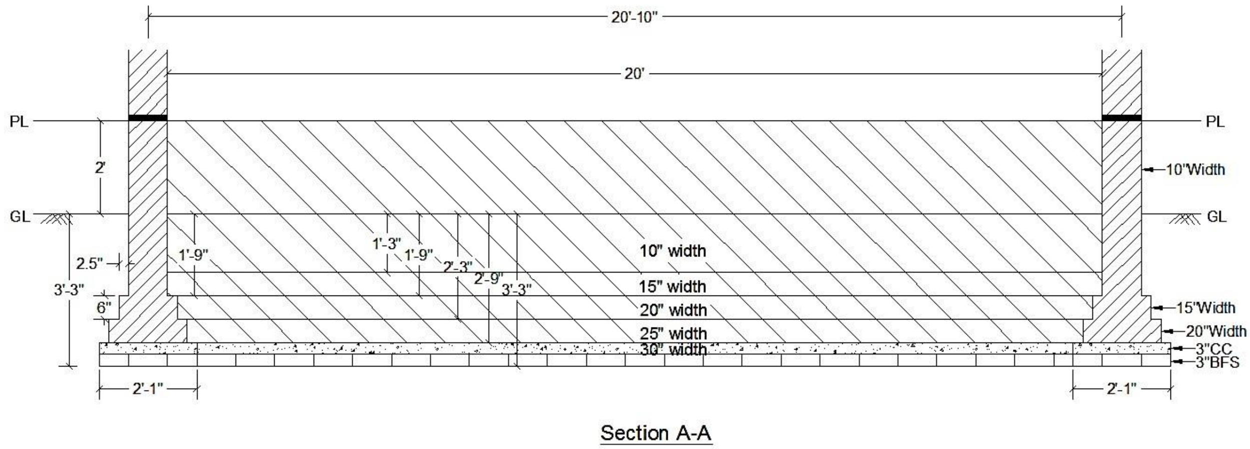

Figure 3.9: Elevation at Section A-A

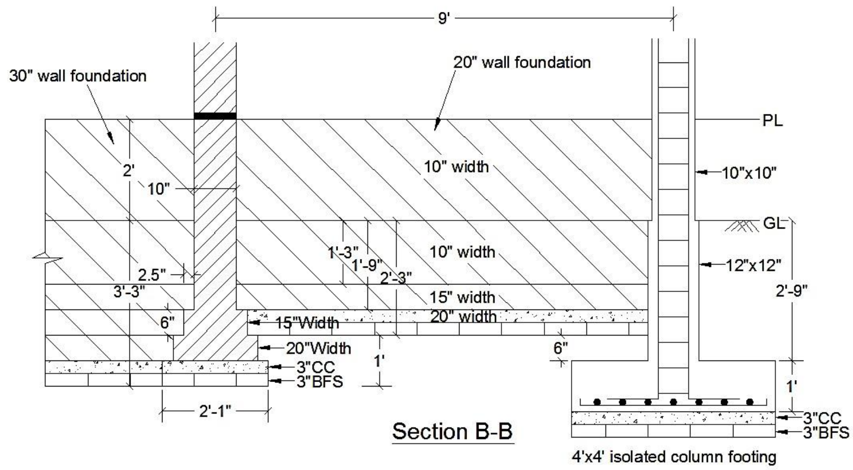

Figure 3.10: Elevation at Section B-B

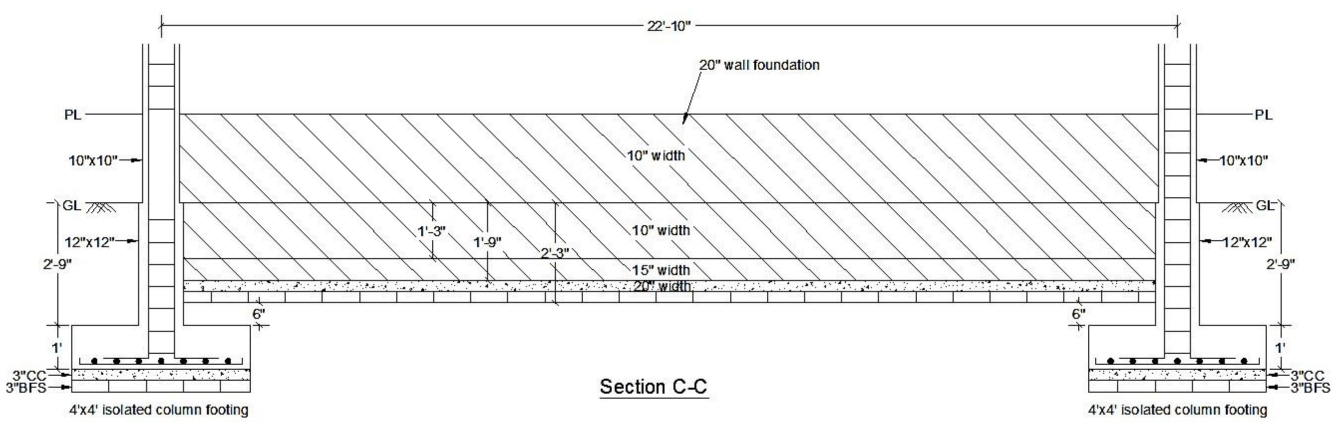

Figure 3.11: Elevation at Section C-C

Here,

V= Volume

L= Length along center line

B= Thickness/ Width

H= Height

Earthwork excavation: (Volume)

For 25” wall foundation-

Length= 20’10”x2+22’10”x4 = 133’

Width= 2’1”+3”x2 (extra in both side) = 31”

Height= 3’3”

Volume= LxWxH= 1116.65 ft^3

For 30” wall foundation- Length=

20’10”-31” = 18’3”

Width= 2’6”+3”x2 (extra in both side) = 36”

Height= 3’3”

Volume= L x W x H= 177.94 ft^3

Column foundation-

Volume= LxWxH= (4’6”x4’6”x4’3”) x3= 258.19 ft^3

For 20” wall foundation-

Length= (9’-31”/2-4’6”/2(column footing)) x2+ (22’10”-4’6”) x2 = 47’7”

Width= 20”+3”x2 (extra in both side) = 26”

Height= 2’3”

Volume= L x W x H= 231.97 ft^3

Total volume= (1116.65+177.94+258.19+231.97) = 1784.75 ft^3

BFS (one layer below foundation): (Area)

For 25” wall foundation-

Length= 20’10”x2+22’10”x4 = 133’

Width= 2’1”= 25” Area=

LxW= 277.08 ft^2

For 30” wall foundation- Length=

20’10”-2’1” = 18’9”

Width= 2’6”= 30”

Area= LxW= 46.875 ft^2 For

column foundation-

Length= 4’

Width= 4’

Area= LxW= 3x (4’x4’)= 48 ft^2

For 20” wall foundation-

Length= (9’-1’3”/2 (due to 25” wall foundation)-1’/2(due to column footing)) x2+ (22’10”-1’/2-1’/2) x2= 59’5”

Width= 1’8”= 20”

Area= LxW= 99.03 ft^2

Total Area of BFS= (277.08+46.875+48+99.03) = 470.985 ft^2

Cement concrete in foundation: (Volume)

To find volume of CC, multiply by the total area of BFS with thickness (3”). Total

volume of CC= 470.985 ft^2x3”/12= 117.75 ft^3

Brickwork in foundation (up to GL): (Volume)

For 25” wall foundation-

20” width: 133’x20”/12x6”/12= 110.83 ft^3

15” width: 133’x15”/12x6”/12= 83.12 ft^3

10” width: 133’x10”/12x21”/12= 193.95 ft^3

Total= 387.9 ft^3

For 30” wall foundation-

25” width: (18’9”+2.5”x2)x25”/12x6”/12= 19.97 ft^3

20” width: (19’2”+2.5”x2)x20”/12x6”/12= 16.32 ft^3

15” width: (19’7”+2.5”x2)’x15”/12x6”/12= 12.5 ft^3

10” width: (19’7”+2.5”x2)’x10”/12x15”/12= 20.83 ft^3

Total= 69.62 ft^3

For 20” wall foundation-

15” width: (59’5”+2.5”x2)x15”/12x6”/12= 37.4 ft^3

10” width: (59’5”+2.5”x2)x10”/12x15”/12= 62.33 ft^3

Total= 99.73 ft^3

Brickwork in foundation from GL to PL: (volume)

25” wall foundation= 133’x10”x2’= 221.67 ft^3

30” wall foundation= 20’x10”x2’= 33.33 ft^3

20” wall foundation= ((9’-5”-5”+22’10”-5”-5”) x2) x10”x2’= 100.56 ft^3

Total= 355.56 ft^3

RCC in footing up to GL: (Volume)

Base slab of footing= 3x (4’x4’x1’) = 48 ft^3

Column up to GL= 3x (1’x1’x2’9”) = 8.25 ft^3

Total= 56.25 ft^3

WEEK 11-12

Complete Estimation of a Residential Building

RCC Work, Brickwork in Superstructure

RCC in column from GL to PL: (Volume)

Concrete volume= 3x10”x10”x2’= 4.167 ft^3

DPC (Damp Proof Course): (Volume)

Thickness= 1.5”

25” foundation= 133’x10”/12x1.5”/12 =13.6 ft^3

30” foundation= 20’x10”/12x1.5”/12= 2.1 ft^3

Deduct (door strip) =4’x3’4”x10”x1.5”= 1.39 ft^3

BFS (one layer) in Floors: (Area)

Main room= 2 x (22’x20’) = 880 ft^2

Verandah= (46’6”-20” (due to foundation below)) x (9’-10”)= 366.1 ft^2

Total= 1246.1 ft^2

CC (cement concrete) in Floors: (Volume)

To find volume of CC, multiply by the total area of BFS with thickness (3”).

Total volume= 1246.1 ft^2 x 3”/12= 311.53 ft^3

Floor finish (thickness 1/4”): (Volume)

1. Main room= 2x22’x20’x0.25”/12= 18.33 ft^3
2. Door= 4x3’4”x10”/12x0.25”/12= 0.23 ft^3
3. Verandah= 46’6”x9’x0.25”/12= 8.72 ft^3

Deduct (due to column) = 3x10”x10”x0.25”= 0.043 ft^3

4. Stair steps= 4x23’8”x1’4”x0.25”/12= 2.63 ft^3

Total= 29.87 ft^3

Brick wall in superstructure: (Volume)

Wall= (133’+20’) x10”x10’7”= 1349.375 ft^3 Deduct:

1. Door (D1) = 4x3’4”x10”x7’= 77.78 ft^3
2. Window (W1) = 8x6’x10”x4’6”= 180 ft^3
3. Lintel over W1= 4x (6’+2x6”) x10”x6”= 11.67 ft^3
4. Lintel over D1+W1= (22’x2+10”+2x6”) x10”x6”= 19.1 ft^3

Total= 1060.825 ft^3

RCC in column: (Volume)

RCC volume= 3x10”x10”x10’7”= 22.05 ft^3

RCC in lintel: (Volume)

Lintel over W1= 4x7’x10”x6”= 11.67 ft^3

Lintel over D1+W1= 45’10”x10”x6”= 19.1 ft3; Total= 30.77 ft^3

RCC in roof: (Volume)

RCC volume= (46’6”+2x1’9”)x(30’8”+2x1’9”)x5”= 711.81ft^3

LC (Lime concrete) in roof: (Volume)

LC volume= (50’-10”) x (34’2”-10”) x3” = 409.72ft^3

Bricks in parapet: (Volume)

Brick= (2x (50’-5”+34’2”-5”)) x5”x2’ = 138.89 ft^3

Brick work in stair: (Volume)

1. 1st step: 23’8”x10”x6” =9.86 ft^3

2. 2nd step: 23’8”x20”x6” =19.72 ft^3
3. 3rd step: 23’8”x30”x6” =29.58ft^3
4. 4th step: 23’8”x40”x6” =39.44 ft^3

Total= 98.6 ft^3

R.C.C. in drop wall: (Volume)

Length= (9’-10”) x2+ (22’10”-10”) x2= 60’4”

Width= 5”

Height= 2’6”

Volume= 62.85 ft^3

R.C.C. in sunshade: (Volume)

RCC Volume= 4x ((3”x6”) + (0.5x (3”+4”) x15”)) x7’= 13.71 ft^3

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WEEK 13-14

Complete Estimation of a Residential Building

Plastering Work

Inside Plastering (thickness 0.25”): (Volume) Mix ratio- C:S= 1:6

1. Inside wall

a) Main room= 2x84’x (10’7”-10”skirting) x0.25”= 34.125 ft^3

Deduct, Door= 4x3’4”x (7’-10”skirting) x0.25”= 2.18 ft^3

Window= 8x6’x4’6”x0.25”= 4.5 ft^3

Total= 27.45 ft^3

b) Verandah= (22’10”x2+10”) x (10’7”-10”skirting) x0.25”= 9.45 ft^3

Deduct, Door= 4x3’4”x (7’-10”skirting) x0.25”= 2.18 ft^3

Window= 4x6’x4’6”x0.25”= 2.25 ft^3

Droop wall= 2x5”x2’6”x0.25”= 0.043 ft^3

Total= 4.98 ft^3

2. Ceiling

a) Main room= 2x22’x20’x0.25”= 18.33 ft^3

b) Verandah= 46’6”x9’x0.25”= 8.72 ft^3

Deduct, Column= 3x10”x10”x0.25”= 0.0434 ft^3

Drop wall= 60’4”x5”x0.25”= 0.524 ft^3

Total= 26.48ft^3

3. Edges

a) Door edges= 4x (6’2”+3’4”+6’2”) x10”x0.25”= 1.09 ft^3

b) Window edges= 8x (6’x2+4’6”x2) x10”x0.25”= 2.92 ft^3

Total= 4.01 ft^3

4. Drop wall (inside face)

a) Inside face= 60’4”x2’6”x0.25”= 3.14 ft^3

b) Bottom edge= 60’4”x5”x0.25”= 0.524 ft^3

Total= 3.66 ft^3

Total volume of inside plastering= 66.58 ft^3

Outside plastering (thickness 0.5”): (Volume) Mix ratio- C:S= 1:4

1. GL to PL= (46’6”x2+30’8”x2) x2’x0.5”= 12.86 ft^3

Deduct, Stair= 23’8”x2’x0.5”= 1.97 ft^3

Total= 10.89 ft^3

2. Outside wall= (46’6”+21’8”x2) x10’7”x0.5”= 39.61 ft^3

Deduct, Window= 4x6’x4’6”x0.5”= 4.5 ft^3

Sunshade= 4x7’x4”x0.5”= 0.39 ft^3

Total= 34.72 ft^3

3. Columns= 3x (10”x4) x (10’7”-10”) x0.5”= 4.06 ft^3

Deduct, Drop wall= 6x (2’6”x5”x0.5”) = 0.26 ft^3

Total= 3.8 ft^3

4. Stairs

1st step= 2x10”x6”x0.5”= 60 in^3= 0.035 ft^3, 2nd step= 2x60 in^3= 0.07 ft^3,

3rd step= 3x60 in^3= 0.1 ft^3, 4th step= 4x60 in^3= 0.14 ft^3

Total= 0.345 ft^3

5. Parapet

a) Inside= (49’2”x2+33’4”x2) x2’x0.5”= 13.75 ft^3

b) Outside= (50’x2+34’2”x2) x2’x0.5”= 14.03 ft^3

c) Top= (49’7”x2+33’9”x2) x5”x0.5”= 2.9 ft^3

Total= 30.68 ft^3

6. Sunshade

a) Bottom face= 4x (7’x1’6”x0.5”) = 1.75 ft^3

b) Side edge= 4x [{(6”x3”+0.5x (3”+4”) x15”)} x2x0.5”] = 0.16 ft^3

c) Front face= 4x (7’x6”x0.5”) = 0.58 ft^3

d) Top face= 4x {7’x (3”+3”+15.04”) x0.5”} =2.05 ft^3

e) Inside face= 4x (3”x7’x0.5”) = 0.29 ft^3

Total= 4.83 ft^3

7. Cornice

a) Side edge= (50’x2+34’2”x2) x5”x0.5”= 2.92 ft^3

b) Bottom edge= {(30’8”+1’9”) x2+ (46’6”+1’9”) x2} x 1’9”x0.5”= 11.76 ft^3

Total= 14.68 ft^3

8. Drop wall

Outside face= 60’4”x2’6”x0.5”= 6.28 ft^3

Total volume= 106.23 ft^3

Costing of a residential building

Example:

Table 3.2: Calculation of Costing of a Residential Building

Item No.	Item Description	Quantity	Price Per Quantity	Total Cost
01	Earthwork Excavation	1784.75 cft	2.13 tk/cft	3802 tk

Total Cost= X_1 tk

Electrification= 8% of total cost= X_2

Sanitary and water supply= 8% of total cost= X_3

Estimated cost= (X_1+X_2+X_3) tk

WEEK 15-16

DOUBT SOLVING

WEEK 17

FINAL ASSESSMENT