FOREST ENGINEERING Batch 2021-22

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FOREST ENGINEERING

- Necessary for sustainable management of forest, land, and water resources
- To achieve economic, environmental, and social objectives

Syllabus

Building construction, quality of materials, specification and field checks, site selection, planning and construction of forest structures, site selection and construction, preparation of estimate of a building, requirement of building material for construction plinth area and cube rate estimates, analysis of rates, foundation design for load bearing walls, forest roads-classification, geometric design, alignment and earth work estimation, construction designs in areas prone to floods, cyclones and earthquakes, etc, designs of retaining wall and construction etc., bridges – designs of forest bridges, small culverts, causeways, water harvesting structures and soil conservation works-check dams, anicuts, spill ways, design of river training works etc, design of water harvesting structures in habitat management; locations, watch towers, design of coastal shelters, design and construction of buildings with bamboo as resource material.

Lecture modules
Forest Engineering Theory:

1- Building construction, Quality of Materials, Specification and field checks, Site selection.

2- Requirement of building material for construction.

3- Preparation of estimate of a building, plinth area and cube rate estimates, analysis of rates.

4- Foundation design for load bearing walls.

5- Planning and construction of forest structures, Site selection and construction.

Lecture modules
Forest Engineering Theory:

6- Forest roads-classification, geometric design, Alignment and earth work estimation.

7- Construction designs in areas prone to floods, cyclones and earthquakes etc.

8- Designs of retaining wall and construction etc.

9- Bridges designs of forest bridges, Small culverts, Causeways.

Forest Engineering Theory:

10- Water harvesting structures and soil conservation works-check dams, Anicuts, Spill ways, Design of river training works etc., Design of water harvesting structures in habitat management, Locations,

11- Watch towers, Design of coastal shelters,

12- Design and construction of buildings with bamboo as resource material.

Forest Engineering (Practical):

1- Drawing-plan, Elevation and section of building,

2- Drawing-plan, Elevation and section of Check-dams, Bridges with span up to 6m,

3- Estimating earth work from longitudinal section.

4- Site visit (If required)

Basic concept of Engineering

Balance between
Economy and Safety/ Functionality

Building Construction Overview

Building

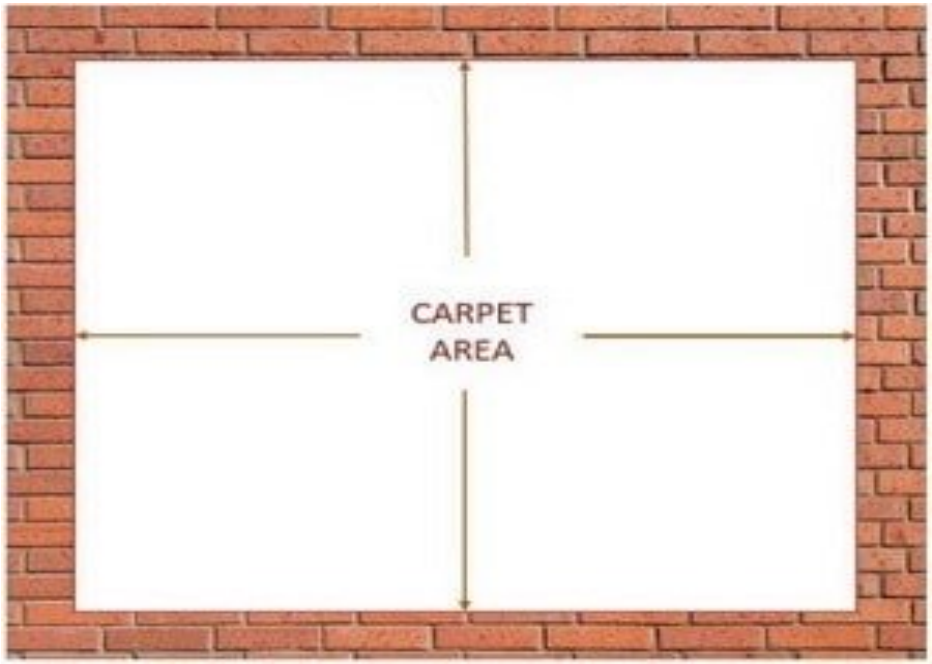
Any structure for whatsoever purpose and of whatsoever materials constructed and every part thereof whether used as human habitation or not and includes foundation, plinth, walls, floors, roofs, chimneys, plumbing and building services or any wall enclosing or intended to enclose any land or space.

Height of Building

The vertical distance measured from the average level of the ground around to the terrace of last liveable floor.

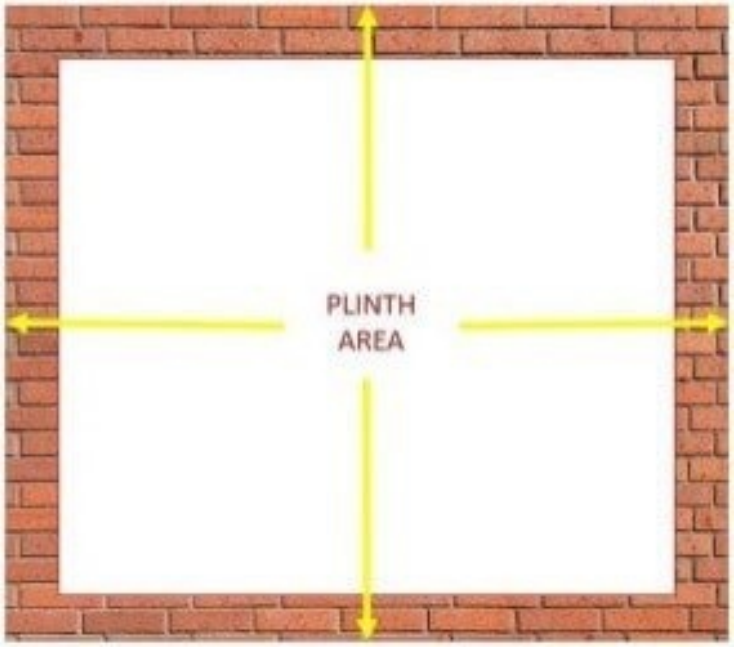
Carpet Area

The covered area of the usable rooms at any floor level (excluding the area of the wall)



Covered Area/Plinth Area

Ground area covered by the building immediately above the plinth level.



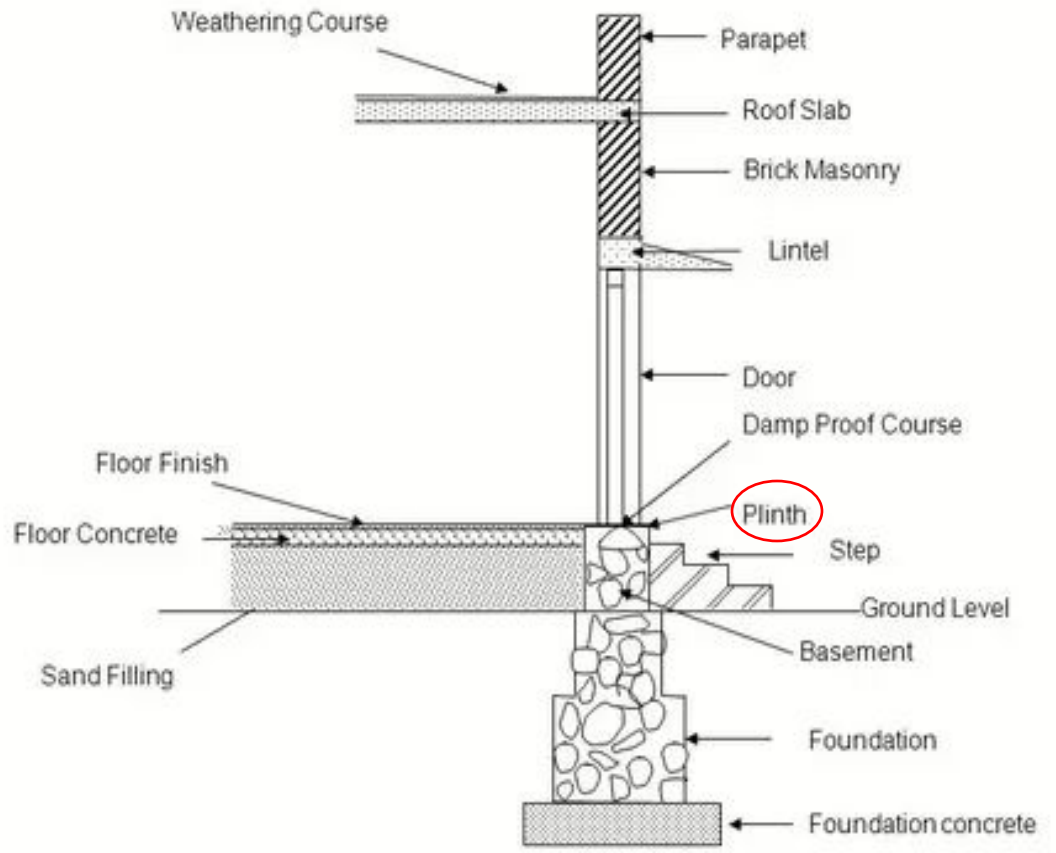
Floor Area Ratio (FAR)

The quotient obtained by dividing the total covered area (plinth area) on all floors by the area of the plot:

$$\text{FAR} = \frac{\text{Total covered area of all floor}}{\text{Plot area}}$$

Plinth

The portion of a structure between the surface of the surrounding ground and surface of the floor, immediately above the ground.



COMPONENTS OF A BUILDING

CLASSIFICATION OF BUILDINGS

Based on occupancy.

a) Residential;
b) Educational;
c) Institutional;
d) Assembly;
e) Business;
f) Mercantile (will include both retail and wholesale stores);
g) Industrial (will include low, moderate and high fire hazards);
h) Storage; and
j) Hazardous

REQUIREMENTS OF PARTS OF BUILDINGS

Plinth: The plinth or any part of a building or outhouse shall be so located with respect to the surrounding ground level that adequate drainage of the site is assured.

The height of the plinth shall be not less than 450 mm from the surrounding ground level.

Height of Habitable Rooms

- The height of all rooms for human habitation shall not be less than 2.75 m (9 feet)
- In the case of pitched roof, the average height of rooms shall not be less than 2.75 m.
- The minimum clear head room under a beam shall be 2.4 m.
- In the case of air conditioned rooms, a height of not less than 2.4 m measured from the surface of the floor to the lowest point of air conditioning duct or the false ceiling.

Height of Educational and industrial buildings

a) Educational : Ceiling height 3.6 m (12 feet) for buildings all regions; in cold regions, 3 m (10 feet)

b) Industrial : Ceiling height 3.6 m (Factory Act, 1948 and rules therein shall govern such heights, where applicable)

Staircase

The following minimum width shall be provided for

staircases for respective occupancies

a) Residential: 1.25 m (4 feet)

c) Public building: 1.80 m (6 feet)

d) Assembly : 2.00 m

e) Educational : 1.80 m

f) Institutional : 2.00 m

g) All other occupancies : 1.50 m

Staircase

Minimum tread:

The minimum width of tread without nosing shall be 300 mm. However, for one or two family dwelling, it may be reduced to not less than 250 mm.

Maximum riser: The maximum height of riser shall be 150 mm. For one or two family dwelling, it may be increased to not more than 190 mm. ***The number of risers shall be limited to 12 per flight***.

Head Room: The minimum head-room in a passage under the landing of a staircase shall be 2.2 m.

Plinth Area

Plinth area shall mean the built up covered measured at the floor level of the basement or of any storey.

For the purpose of plinth area, following shall be included:

a) Area of the wall at the floor level excluding plinth offsets, if any.

b) Shafts for sanitary, water supply, garbage chute, electrical fire fighting, air-conditioning and lift.

c) Stair case

Plinth Area

d) In case of open verandah with parapets:

1) 100 percent areas for portion protected by the projections above, and
2) 50 percent area for the portion unprotected from above.

e) 100 percent area for the balcony protected by projection above and 50 percent area of the unprotected balcony;

Plinth Area

The following shall not be included in the plinth area:

a) Area of loft
b) Area of architectural band, cornice, etc
c) Area of vertical sun breaker or box louver projecting out and other architectural features, for example slab projection for flower pot, etc.
d) Open platform
e) Terrace
f) Open spiral/service stair cases
g) Area of mumty, machine room, towers, turrets, domes projecting above terrace level.

Types of Loads

Two broad categories:

- Dead loads
- Live loads

Specific terms for dead loads and live loads:

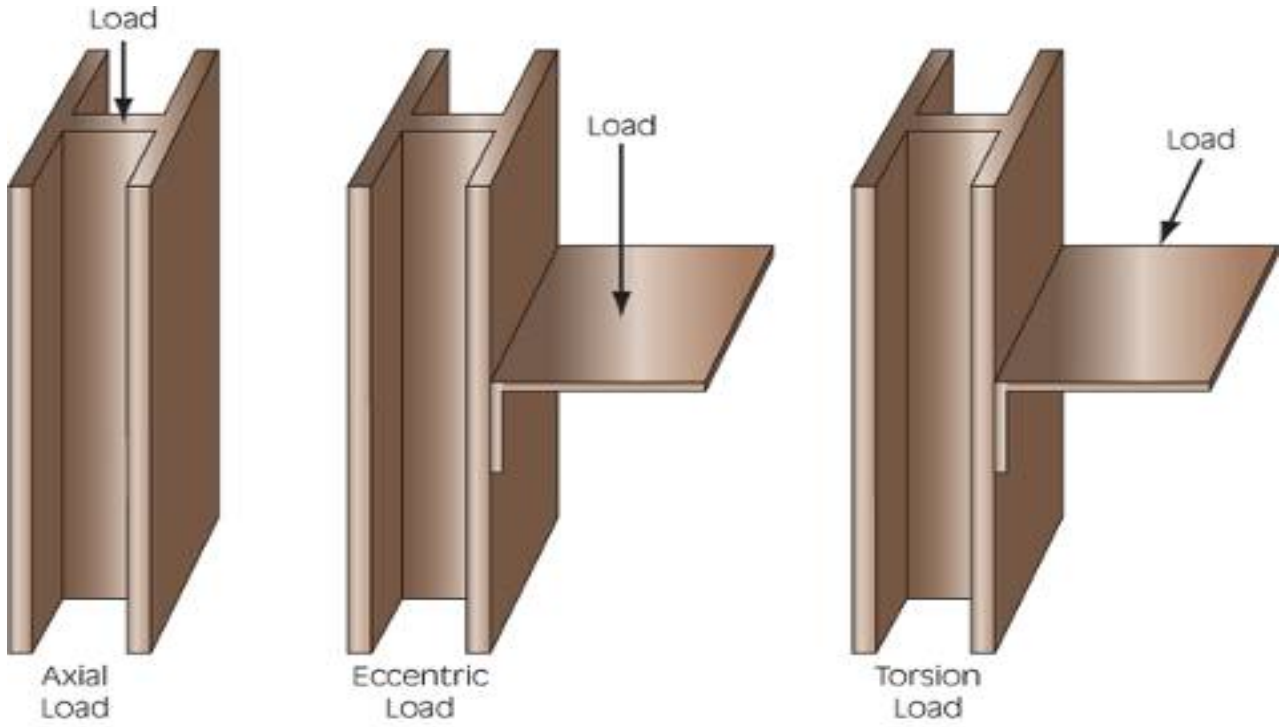
- Concentrated load
- Distributed load
- Design load
- Fire load
- Wind load

Imposition of Loads

Loads must be transmitted to structural elements

Terms associated with imposition:

- Axial load
- Eccentric load
- Torsion load



Application of Loads

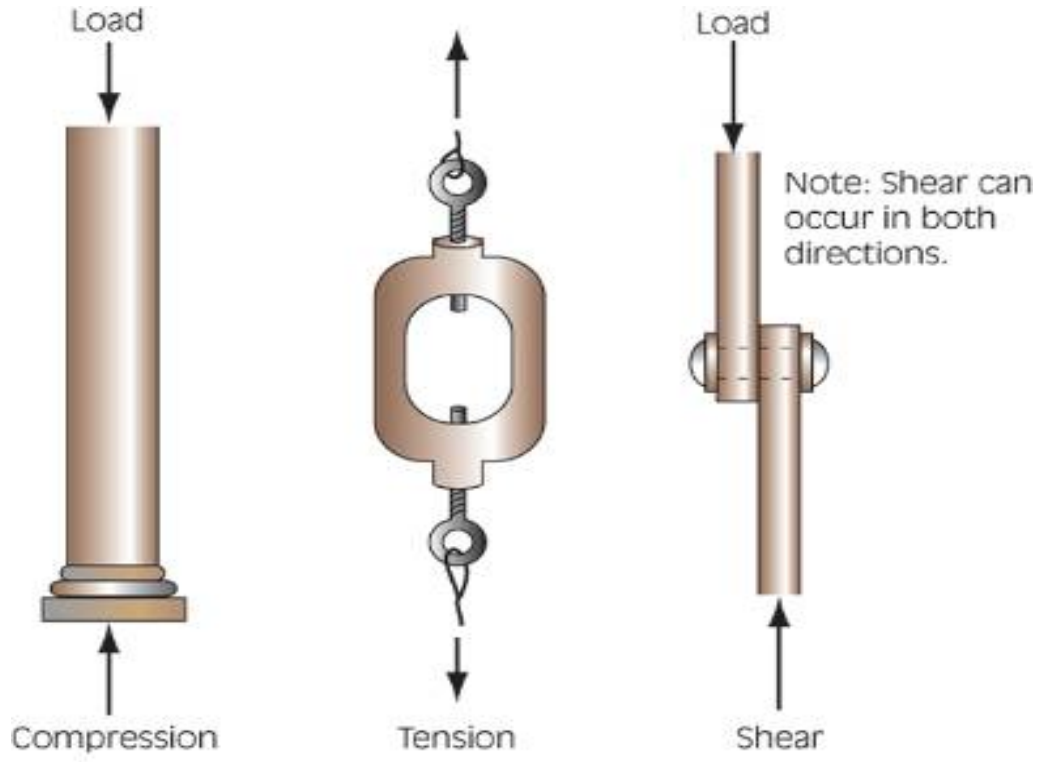
In above figure:- There are three types of loads that can be transmitted through a structural member: axial, eccentric, and torsion.

Forces

Loads imposed on materials create stress

Stress and strain: defined as forces applied to materials:

- Compression
- Tension
- Shear



Types of Loads

Loads are applied to a structural member as compression, tension, and shear forces.

Structural Elements

Buildings are an assembly of structural elements designed to transfer loads to the earth

Can be defined simply as:

- Beams
- Columns
- Walls
- Connections

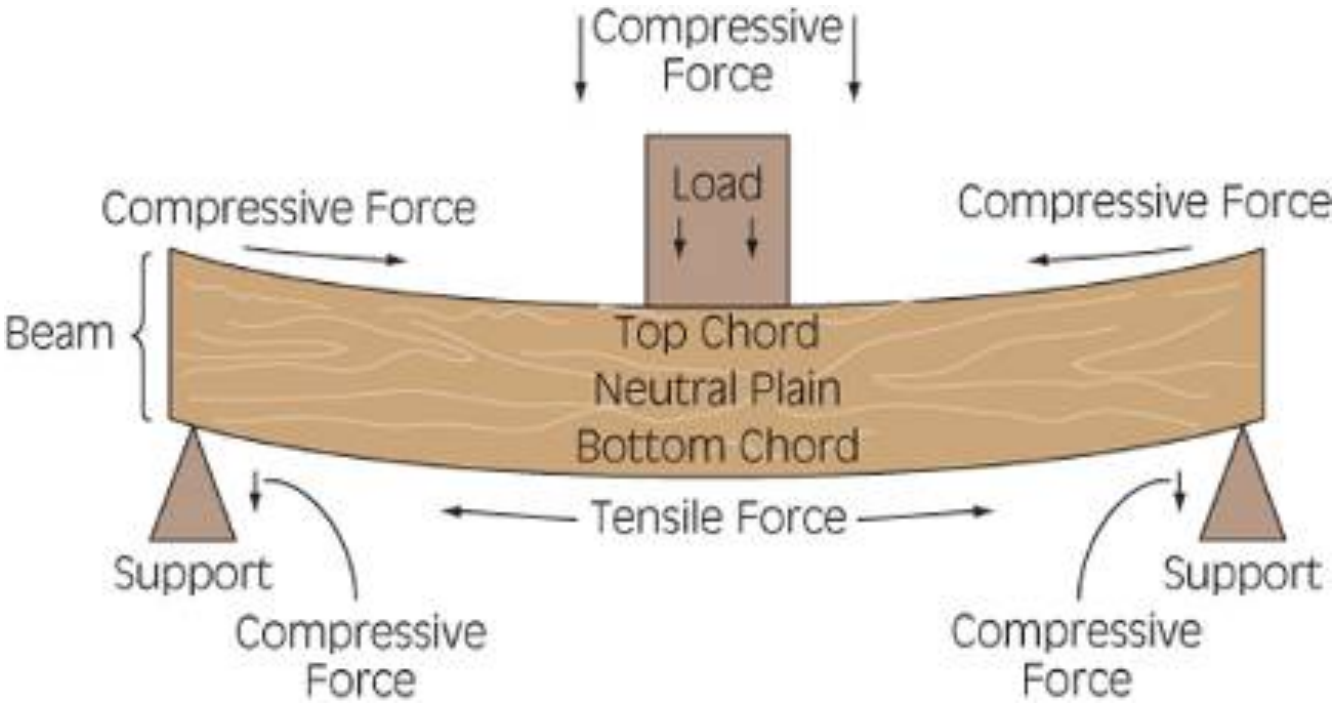
Beams

Transfers loads perpendicular to its length

Types of beams:

- Simple beam
- Continuous beam
- Cantilever beam
- Lintel
- Girder
- Joist
- Truss and Purlin

Beams



A beam transfers a load perpendicular to the load—creating compressive and tensile forces within the beam.

Columns

Any structural component that transmits a compressive force parallel through its centre

Typically support beams and other columns

Generally vertical supports of building

Can be vertical, horizontal, or diagonal.

Walls

Really long, but slender

Two categories:

- **Load-bearing walls**
  - Carries weight of beams, other walls, floors, roofs, other structural elements
  - Also carries weight of the wall itself
- **Non-load-bearing walls**
  - Need only support its own weight
  - Example: partition wall

Factor Effecting for use of material for structure elements

Many factors determine which material is used to form structural elements:

- Cost
- Application
- Engineering capabilities
- Adaptability

Performance of Common Building Materials under Stress and Fire

Material	Compression	Tension	Shear	Fire Exposure
Brick	Good	Poor	Poor	Fractures, spalls, crumbles
Masonry block	Good	Poor	Poor	Fractures, spalls
Concrete	Good	Poor	Poor	Spalls
Reinforced concrete	Good	Fair	Fair	Spalls
Stone	Good	Poor	Fair	Fractures, spalls
Wood	Good w/grain; poor across grain	Marginal	Poor	Burns, loss of material
Structural steel	Good	Good	Good	Softens, bends, loses strength
Cast iron*	Good	Poor	Poor	Fractures

*Some cast iron may be ornamental in nature and not part of the structure or load bearing.

Wood

Most common building material Relatively inexpensive

Marginal resistance to forces compared to weight

Native wood with more mass takes longer to burn before strength is lost

Engineered wood

- Plywood delaminates when exposed to fire
- Some composites fail through exposure to heat without burning

Steel

Mixture of carbon and iron ore

Excellent tensile, shear, and compressive strength

Popular choice for:

- Girders
- Lintels
- Cantilevered beams
- Columns

Loses strength as temperatures increase

Concrete

- Mixture of cement, sand, gravel, and water

Excellent compressive strength

- All concrete contains some moisture
- Under heat, moisture expands and causes concrete to crack and spall
- Concrete can stay hot long after the fire is out.

Masonry

- Common term that refers to brick, concrete block, and stone
- Used to form load-bearing walls
- Veneer wall supports its own weight
- Mortar holds units together and have little or no tensile or shear strength
- Excellent fire-resistive qualities

Relationship of Construction Type to Occupancy Use

Many officials and builders first look at anticipated use of building

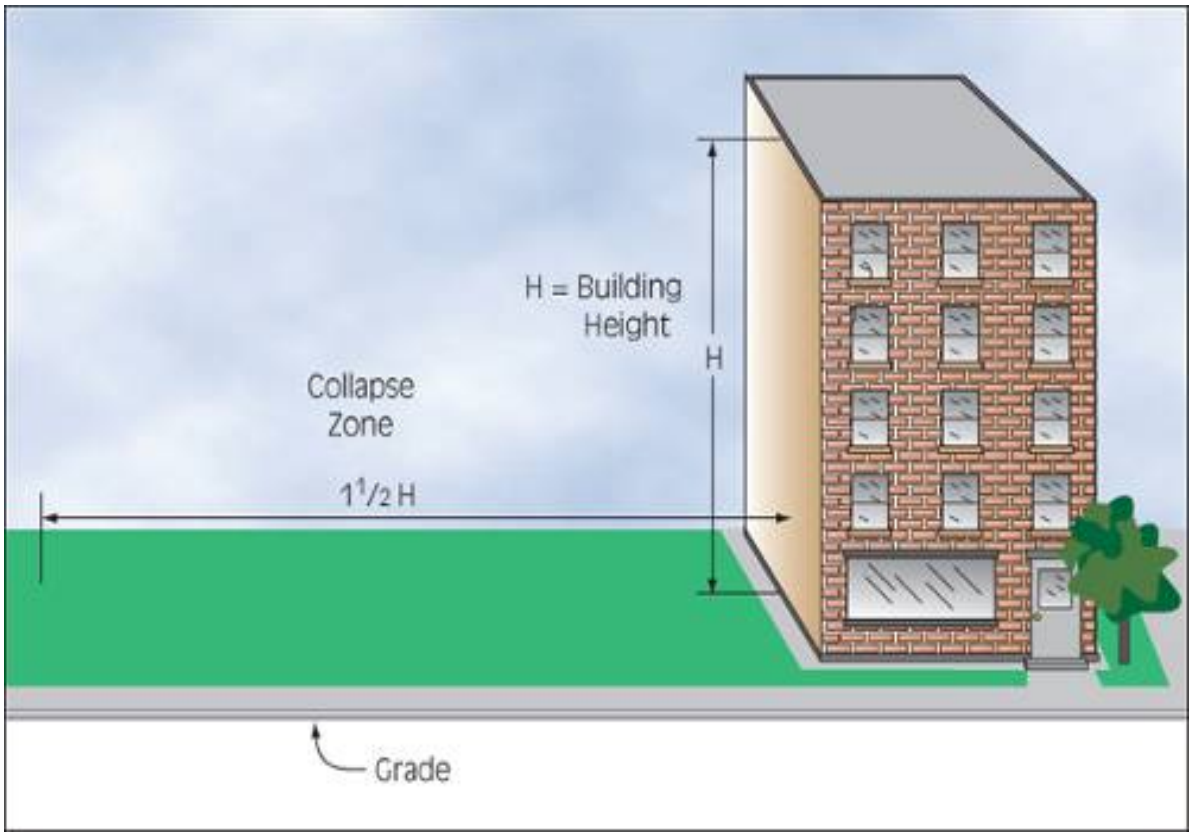
Occupancy classifications:

- Residential
- Office Building
- Commercial/Business
- Industrial
- Education

Collapse Warning Signs

Factors anticipating collapse:

- Deterioration of mortar joints and masonry
- Overall age and condition of building
  Cracks
- Signs of building repair
- Large open spans
- Bulges and bowing of walls
- Sagging floors

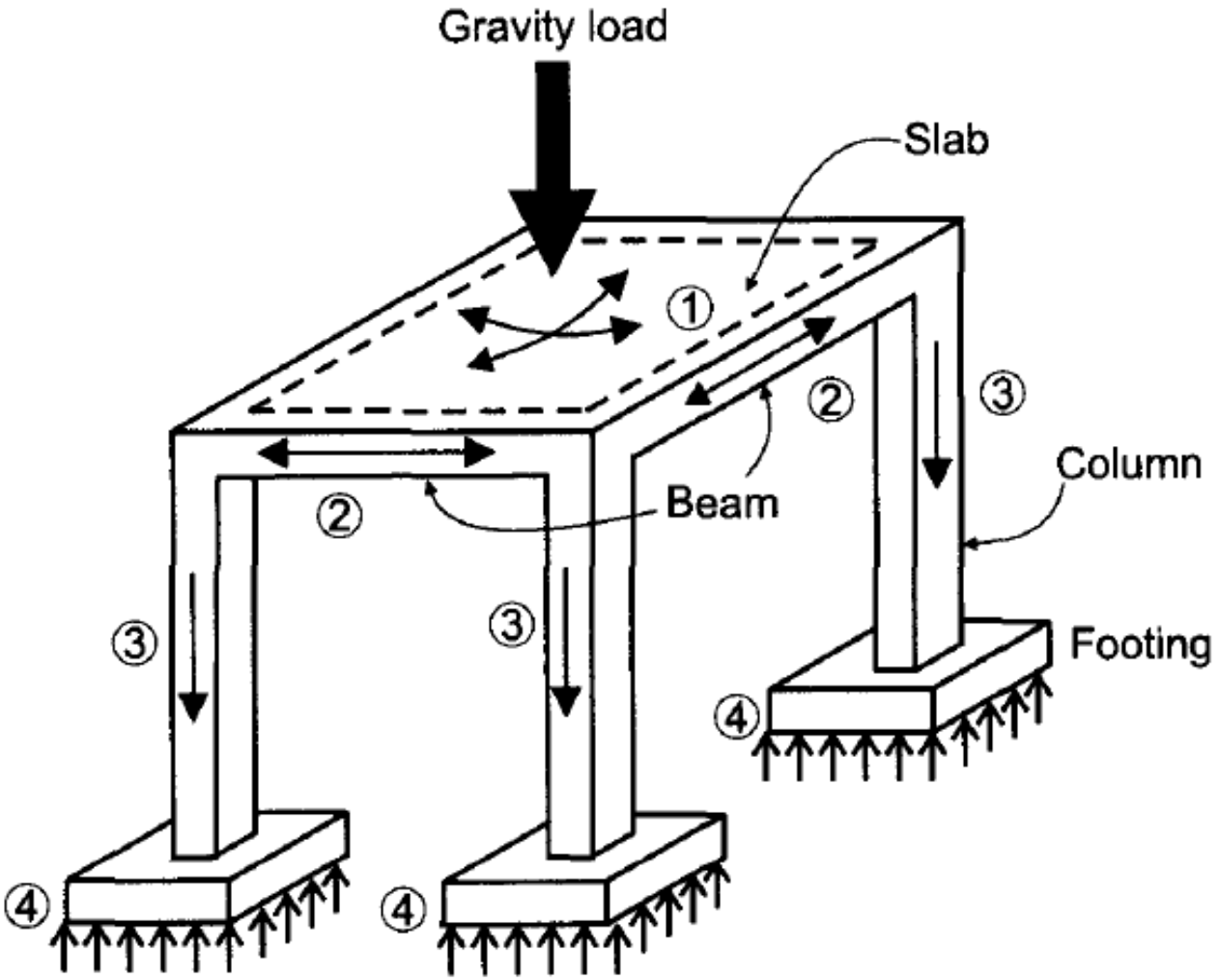


A minimum collapse zone should be 1½ times the height of the building.

Structural Elements

Footings
Columns
Beams
Slab

Load Transfer Mechanism



FOOTINGS

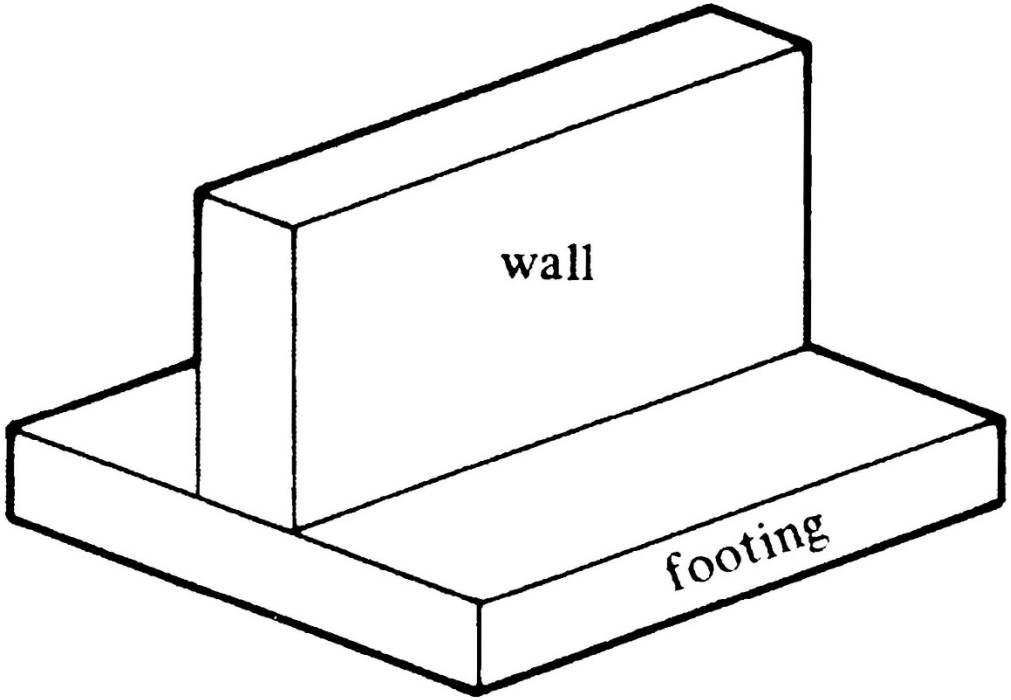
What is a Footing

- Support structural members and transfer loads to the soil
- Structural members are usually columns or walls

Design Criteria of Footings

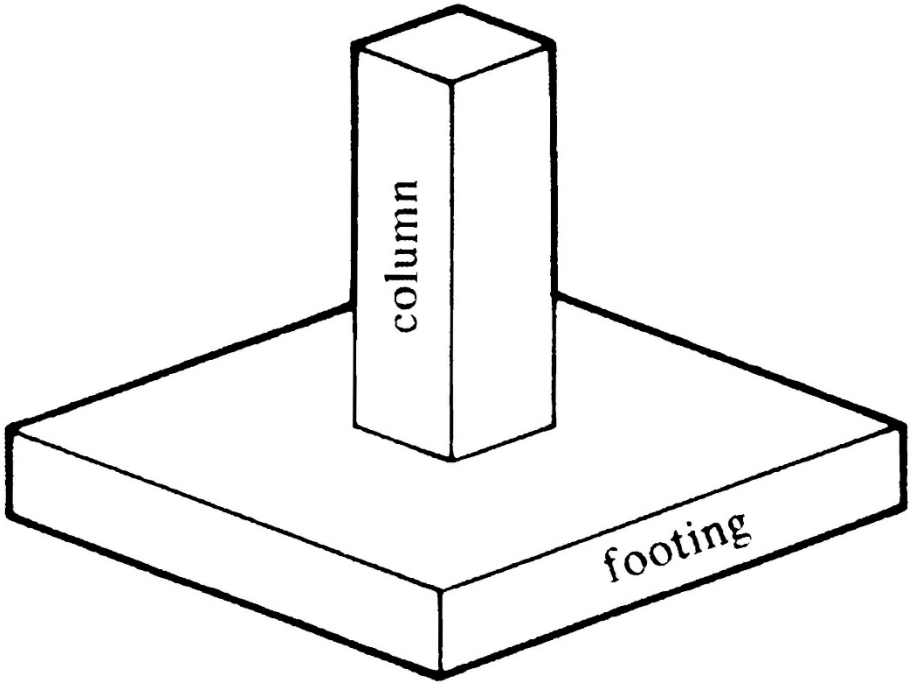
- Prevent bearing failure, sliding and overturning
- Prevent excessive settlement or tilting
- Excavation to reach a depth with satisfactory bearing capacity

Wall Footings



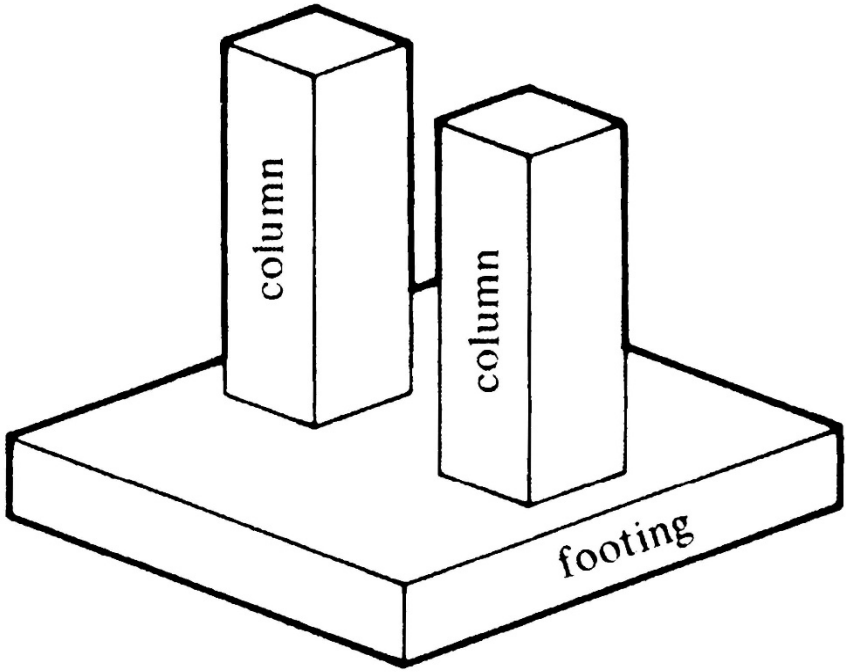
- Load bearing structures
- loads relatively light
- bearing capacity is good

Isolated Square Footing



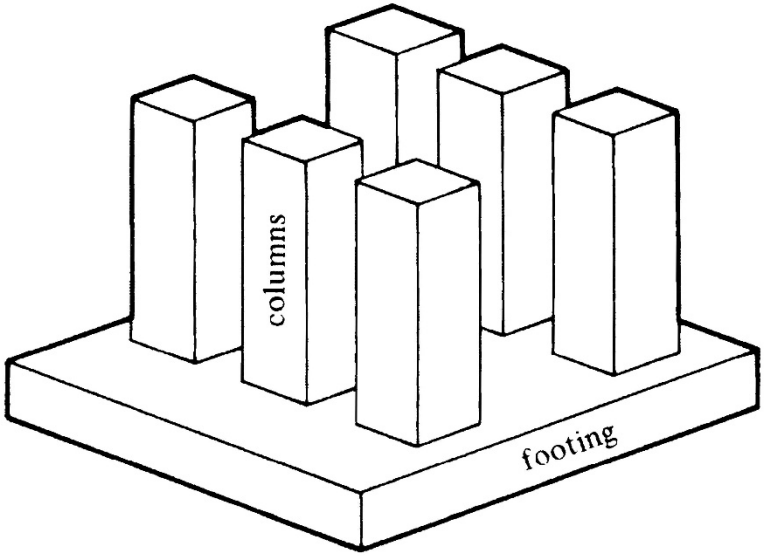
- loads relatively light
- bearing capacity is good
- columns not closely spaced

Combined Footing



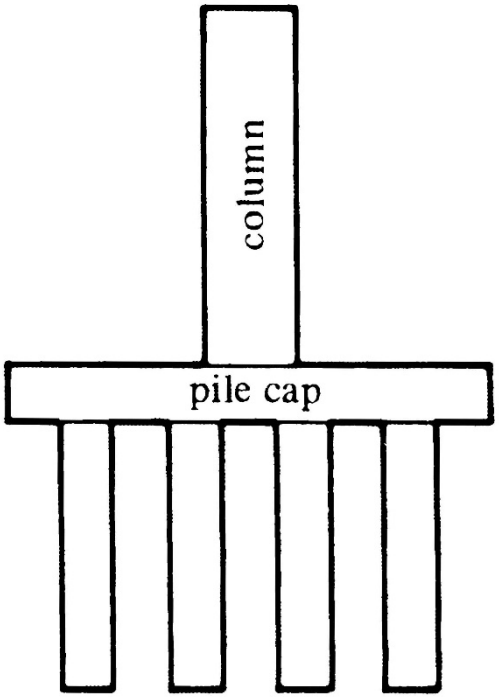
- Support two or more columns
- Heavily loaded columns
- Closely spaced columns
- Columns near property line

Mat/ Raft Footing



- Continuous concrete slab supporting many columns
- Soil strength relatively low
- Large column loads
- Isolated spread footings would cover more than 50 percent of area reduce differential settlement

Pile Cap with Pile foundation



- Soil strength very low
- Excessive Column loads

Soil Pressures

- Allowable soil pressure may be determined by a geotechnical engineer
- When soil exploration is not feasible, values provided by building codes may be used
- Factor of safety is typically 3

Common Terms

Used in Building Construction

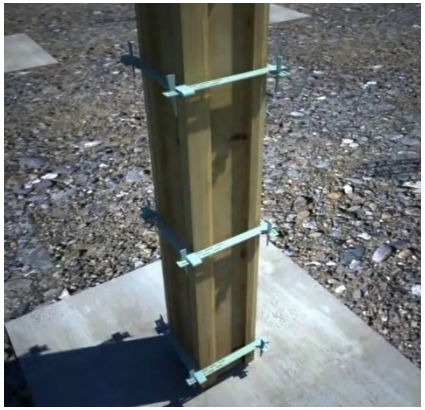
Excavation / Earth Work

Unit	**Volume**	**cum (cubic meter)** **cft (cubic feet)**

PCC – Plain Cement Concrete

Unit	**Volume**	**cum (cubic meter)** **cft (cubic feet)**

Shuttering / Formwork



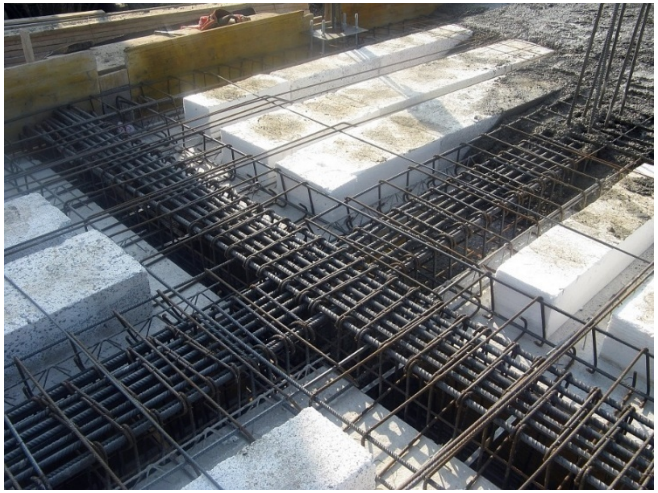
Unit	**Area**	**sqm (square meter)** **sqft (square feet)**

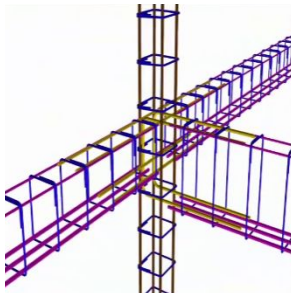
Removal of Formwork

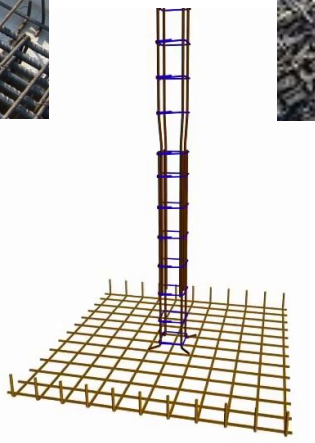
Type of Formwork	Minimum Period before removal
Vertical Formwork to columns, beams & walls	16-24 hrs
Soffit formwork - Slabs	03 days
Soffit formwork – Beams	07 days
Props- Slabs 1. Span upto 4.5 m 2. Span over 4.5 m	 07 days 14 days
Props – Beams 1. Span upto 6 m 2. Span over 6 m	 14 days 21 days

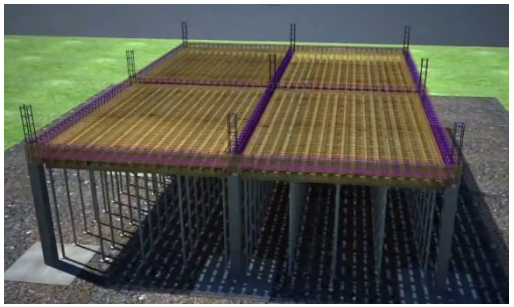
IS 456 (2000)

Reinforcement









Unit	**weight**	**kg** **MT (Metric Ton)**

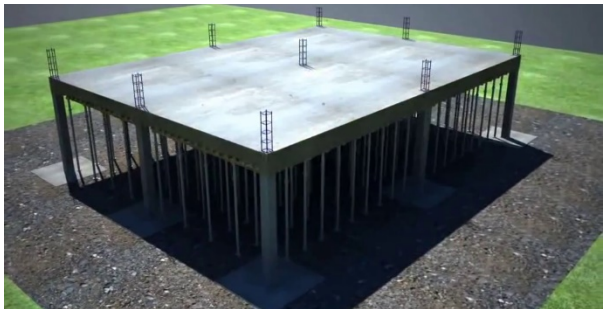
Reinforcement Details

- Always from a trusted source – SAIL, RINL, TATA steel etc.
- Always collect invoices from contractors with test certificates

Grade of Steel	Use
Fe 250	Don’t Use anywhere
Fe 415	Try not to use these
Fe 500 (D)	**Use these**

IS 456 – Plain & Reinforced Concrete
IS 5525 –Reinforcement Detailing

RCC (Reinforced Cement Concrete)



Unit	**Volume**	**cum (cubic meter)** **cft (cubic feet)**

RCC

- Components of RCC
  - Cement
  - Fine Aggregate
  - Coarse Aggregate
  - Admixtures (recommended)
- Always use Cement from trusted source – ACC, Ultra Tech, Jaypee cement
- Compaction & Curing
- Grades of RCC – M10, M15, M20, M25, M30, M35, M40 etc

Grade of RCC	Use
M15 or less	Only in PCC
M20 to M30	RCC – General construction
M35 & higher	RCC – high strength

RCC Testing

Cube Test

Quantity of concrete Delivered (cum)	Number of samples
Less than 5	1
6 to 15	2
31 to 50	3
51 and above sample for each	4 plus one additional 50 cum or part thereof

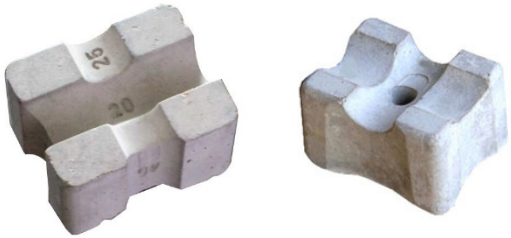
Non-Destructive Tests

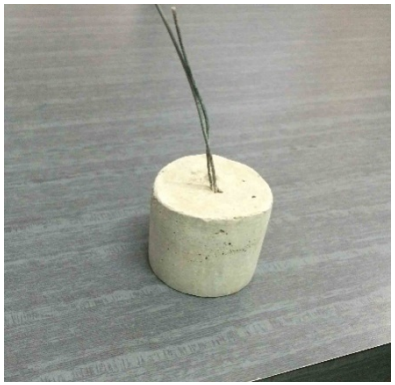
- Rebound hammer test
- Pulse velocity (sonic or Ultrasonic) test
- Core test

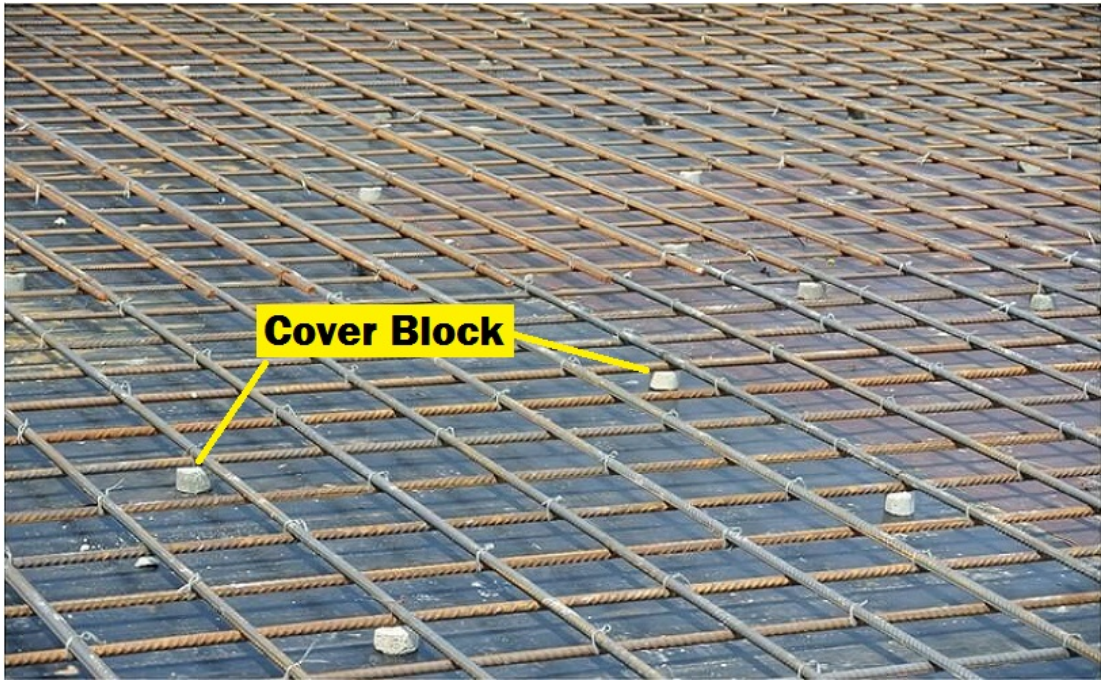
Brickwork

Unit	**Volume**	**cum (cubic meter)** **cft (cubic feet)**

Cover Blocks







Unit	**numbers**	**Number/ count/ piece**

Finishing / Misc.

Description	Unit
Flooring	Area-Square metre
Plaster	Area - Square metre
Stone work	Volume-Cubic metre
Wood work	Volume-Cubic metre/ Area - Square metre
Steel & Aluminum work	Kg/ area-square metre
Sanitary	Running-metre

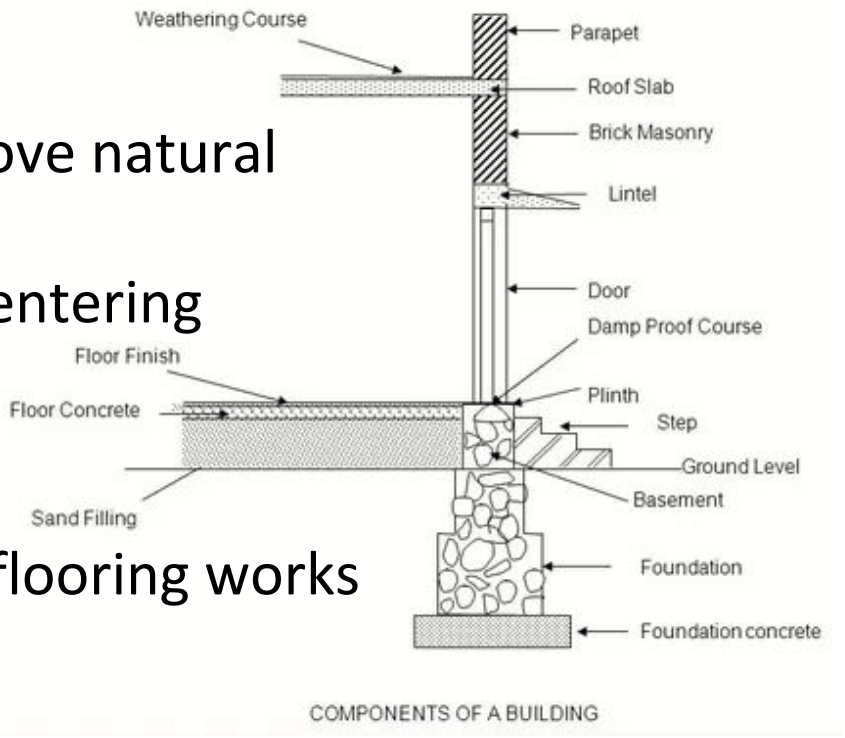
Plinth Level / Finished Floor Level

Plinth Level

- Top of Foundation
- Usually about 45-60 cm above natural ground level
- Prevent storm water from entering

Finished Floor Level

- Top level of the floor after flooring works



COMPONENTS OF A BUILDING

Your Responsibility

- Execute work as per specification
- Material from trusted source only
- Get all mandatory tests done
- Collect all invoices for material purchase
- Safety checks
- Resource Management

Thank you