Lecture 3

CE 200
DETAILS OF CONSTRUCTION

Topics:

Site Exploration

Standard Penetration Test

Bearing Capacity of Soil

Foundation Types

TODAY'S TOPIC

- Site Exploration,
- Standard Penetration Test (SPT);
- Bearing Capacity of Soil,
- Types of Foundation
  - Shallow Foundation and Brief Idea about Mat;
  - Deep Foundation

STEPS IN FOUNDATION ENGINEERING

- Understand project and site
- Identify possible foundation alternatives
- Conduct soil investigation
- Characterize site
- Engineering analysis to evaluate alternatives
- Develop recommendations and write reports
- Monitor design, construction and performance

GEOTECHNICAL SITE EXPLORATION

- Geotechnical Engineering

Geotechnical engineering, also known as geotechnics, is the branch of civil **engineering** concerned with the **engineering** behavior of earth materials. It uses the principles and methods of soil mechanics and rock mechanics for the solution of **engineering** problems and the design of **engineering** works



- Site Exploration

Gathering information regarding the type and nature of soil at the site for designing safe, sound and economical foundation for a structure



PURPOSE OF SITE EXPLORATION

- To evaluate the general suitability of the site for the proposed project
- To fix the value of safe bearing capacity
- To select an economical and safe type of foundation
- To fix the depth of foundation
- To predict the likely settlement
- To know the underground water level
- To forecast the difficulties likely to be encountered during construction

Safe bearing capacity can be theoretically defined as the permissible load the soil can withstand such that it neither fails in shear nor exceeds permissible settlement limits

* Settlement is most likely to occur when increased vertical stresses are applied to the ground

INFORMATION REQUIRED FROM A SITE INVESTIGATION

- Nature of the deposit (Geology, recent history of filling etc.)
- Depth, thickness and aerial extent of each soil stratum
- Location of ground water table
- Engineering properties of soil
  - shear strength,
  - compressibility,
  - permeability etc. that affects the structure

:The water table is the upper surface of the zone of saturation. The zone of saturation is where the pores and fractures of the ground are saturated with water. It can also be simply explained as, the upper level, below which the ground is saturated

USE OF INFORMATION FROM SITE INVESTIGATION

Interpretation of data obtained through soil exploration generally provides information to decide on:

- Type of foundation
- Safe load capacity of foundation
- Settlement of foundation
- Causes of settlements, tilts and cracks in the existing structures
- Identification and solution of excavation problems

PLANNING OF SITE INVESTIGATION

- The planning of site investigation aims at obtaining the maximum information with minimum investment.
- There are mainly two methods: indirect and direct, consisting of four phases of obtaining the required information from a subsurface investigation. Phase-1 includes the indirect method while the other three phases are included in the direct method.

SITE EXPLORATION PHASES

Phase 1: Indirect Method

• Obtaining available information: Phase I (i.e. collection of geologic map, topographic map, aerial photograph, soil survey report, hydrological data etc.)

•**Phase II, III & IV: Direct Method**

SITE EXPLORATION PHASES

Field reconnaissance: Phase II

First examination of the area by the engineer along with other specialist such as geologist, geotechnical engineer, land-survey etc.

The principal jobs are:

- To study the existing structures for its foundation construction, defects, cracks
- Identify exposed soil profile and rock outcrop
- To locate high water marks on bridge abutment
- Gather history of flood and scour level from local people

SITE EXPLORATION PHASES

Preliminary Investigation: Phase III

This stage should undertake the following steps:

- Thorough understanding of geology of site
- More details of the subsoil strata like thickness of the individual strata by performing bore holes.
- Detailed Investigation

SITE EXPLORATION PHASES

Detailed investigation: Phase IV

- Planning and execution of open pits and/ or additional boring, as dictated by the preliminary investigation
- Collection of soil samples for laboratory tests
- Field tests including sounding, probing and geophysical tests

CONSIDERATIONS IN A SITE INVESTIGATION

The following factors are to be considered in a site investigation:

1. Cost of Exploration: The cost of subsoil investigation depends on the extent and scope of the work to be done. However, as a general guide line the cost of the investigation should be estimated as 0.05 to 0.2 % of the total cost of the project or 0.5 to 1% of the cost of the structure.

CONSIDERATIONS IN A SITE INVESTIGATION

2. Number and location of exploratory boring:

Both the number and location of borings is governed by the degree of sensitivity of the structure to be built. In exploration of areas of limited extent, the number of borings should preferably be not less than 4 and should preferably be located near the corners of the area. For large projects usually a grid system is used for the borehole locations

CONSIDERATIONS IN A SITE INVESTIGATION

3. Spacing of boring

The spacing of boring depends on the subsoil condition of the site. For uniform soil condition, spacing between the borings is more. Where as, for erratic or non-uniform soil conditions borings are usually closely spaced.

CONSIDERATIONS IN A SITE INVESTIGATION

4. Depth of boring

Depth should be such as to give adequate information about changes in properties of underlying strata

METHODS OF SITE EXPLORATION

1. Test pits
2. Probing
3. Sub-surface sounding
4. Boring
5. Geo-physical method

:The sounding methods consist of measuring the resistance of the soil with depth by means of penetrometer under static or dynamic loading

1. TEST PITS

- Cheap method of investigation to shallow depth
- Allows visual inspection of strata

Limitations: undisturbed sampling difficult, collapse in granular soils or below ground water table.

A sample that is as undisturbed as humanly possible, as distinct from a sample disturbed by boring tools. Special appliances are used to obtain such samples from boreholes, and the material is preserved in its natural state in airtight containers. Disturbed samples, usually obtained by drilling methods and. Undisturbed samples that are taken by carefully cutting blocks of soil of by driving tubes into the soil mass.

TEST PITS





Fig. Test Pits

TEST PITS

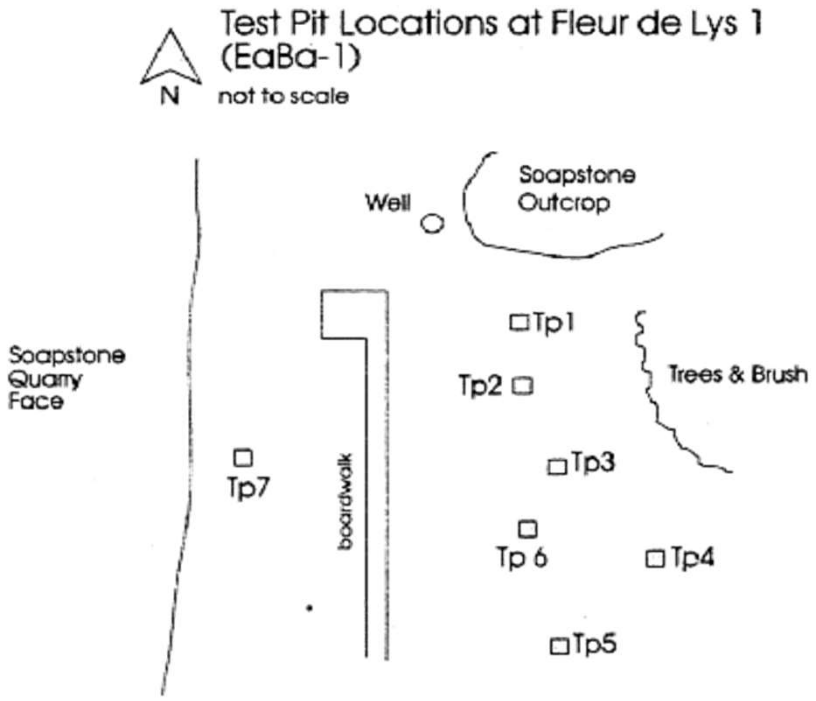




Fig. Test Pit Arrangement

2. PROBING

- Steel bar (25-40 mm dia.) with a pointed end driven in the ground
- Method suitable for soft soil
- Rough idea of nature of strata obtained from the number of blows required
- Results cannot be completely relied upon

PROBING







Fig. Probing Instruments

3. SUB-SURFACE SOUNDINGS

- Measuring the variation in resistance offered by the soil with the depth by means of penetrometer
- Penetrometer: Mild steel cone fitted to steel rod or Standard Split Spoon Sampler
- Test methods are:

- SPT test: Standard penetration test
- DCPT : Dynamic cone penetration test
- CPT: Static Cone Penetration Test
- Plate Load Test

Standard Penetration Test (SPT)

Advantages

Simple equipments
Low cost
Do not require much expertise for field operations
Disturbed samples are collected

Disadvantages

Much variation in the results i.e. poor repeatability

Coduto/Geotechnical Engineering, Principles and Practice/p71

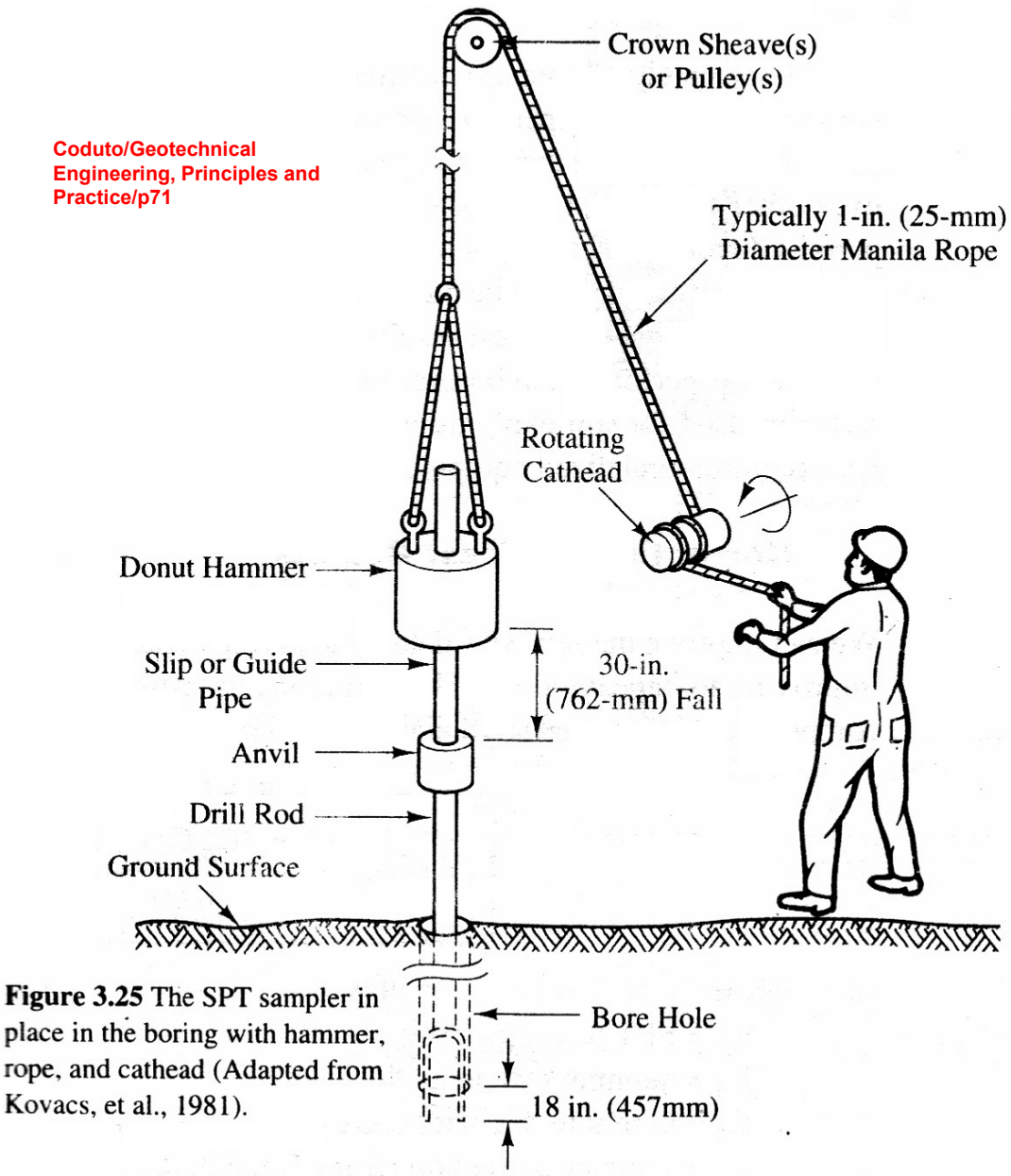


Figure 3.25 The SPT sampler in place in the boring with hammer, rope, and cathead (Adapted from Kovacs, et al., 1981).

STANDARD PENETRATION TEST (SPT)

- Penetrometer driven in the ground with
  - 650 Newton weight
  - from a height of 750 mm
- Number of blows required = N value of soil
- N values correlated with engineering properties

TEST PROCEDURE AND BLOW COUNT (N)

- Raise and drop the hammer 0.76 m successively by means of the rope and cathead, using no more than two and one forth wraps around the cathead.
- The hammer should be operated between 40 and 60 blows per minute and should drop freely.
- Record the number of blows for each .15 m of the penetration.
- The first 0.15 m increment is the "seating" drive.

SPT Correlations

It is important to know the energy ratio relevant to the SPT-N value used in the correlation .

SPT ~ Undrained Shear Strength, c_u
SPT ~ OCR
SPT ~ Relative Density
SPT-N value ~ Peak friction angle

Relative comparison of SPT-N value for cohesive and cohesionless

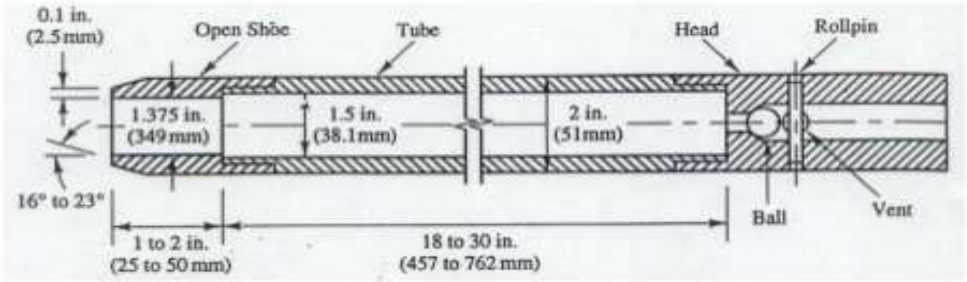
Table 5.3 Penetration Resistance and Soil Properties on Basis of the Standard Penetration Test

Peck,Hensen,Thornburn p.114

Sands (Fairly Reliable)		Clays (Rather Unreliable)	
Number of Blows per ft, N	Relative Density	Number of Blows per ft, N	Consistency
		Below 2	Very soft
0–4	Very loose	2–4	Soft
4–10	Loose	4–8	Medium
10–30	Medium	8–15	Stiff
30–50	Dense	15–30	Very stiff
Over 50	Very dense	Over 30	Hard

SPT INSTRUMENT DETAILS

Standard Split Spoon Sampler (SPT)

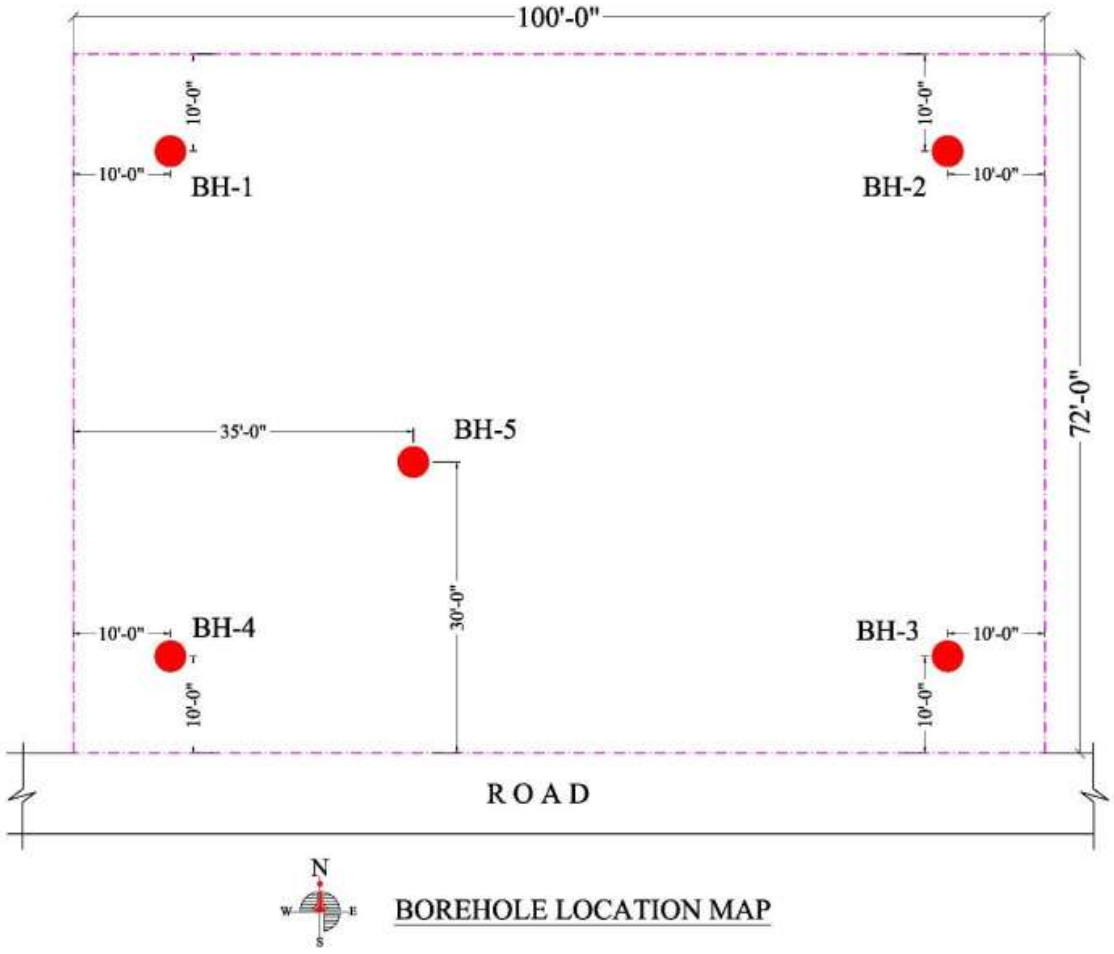


- Thick wall (0.25in) cylinder
- Sampling tube is split along the length
- Hammered into the ground

SPLIT SPOON SAMPLER



EXAMPLE OF REPORTING

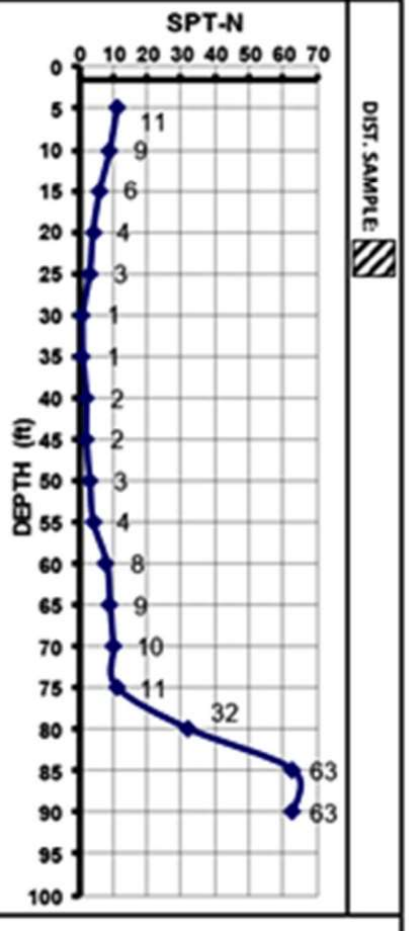


BOREHOLE LOCATION MAP

Bore Log

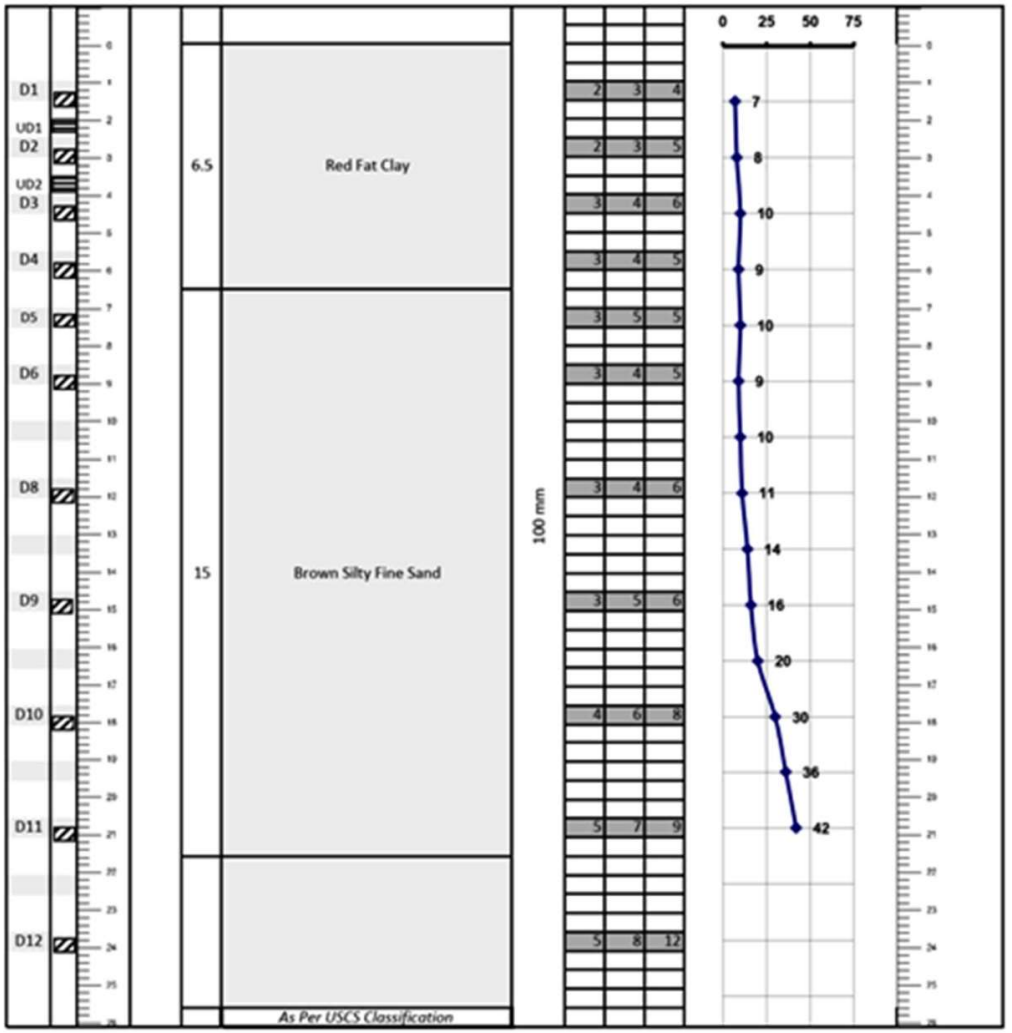
PROJECT :	G+9=10 (Ten) Storied Residential Building
CLIENT :	
LOCATION :	Bashundhara Residential Area, Dhaka
BORE HOLE NO.:	BH-02
METHOD OF DRILLING	Percussion

DATE	SAMPLE ID	TYPE OF SAMPLE	DEPTH (ft)	THICKNESS (ft)	SOIL LAYER DESCRIPTION	LOG	DIA. OF BORING	GRAPHICAL REPRESENTATION OF SPT N VALUE	NOTE
Boring Date: 31 -10 -2020	D-1 to D-18		0' – 90'	7.5'	Gray loose silty sand (SM)		4 in		DIST. SAMPLE
				15'	Gray very soft to soft silt (ML)				
				15'	Gray very soft Elastic Silt (MH)				
				30'	Gray soft to stiff Lean Clay (CL)				
				15'	Gray dense to very dense silty sand (SM)				



BOREHOLE LOG

CLIENT :	
PROJECT :	Existing 12-storied Garments Building
LOCATION :	241, Tejgaon, Dhaka
BORING DATE :	18/06/2014
BOREHOLE NO :	BH-2
GROUND LEVEL:	+ 0.00 m from Road
GROUND WATER TABLE:	- 0.3 m from Road
BOREHOLE DIA :	100 mm



4. BORING

- Auger boring
- Shell and auger boring
- Wash boring
- Percussion boring
- Rotary boring

Auger boring is defined as a trenchless application in which a casing pipe is jacked into the earth's surface while simultaneously rotating helical augers remove the excavated soil. Augers are used in cohesive and other soft soils above the water table.

AUGER BORING

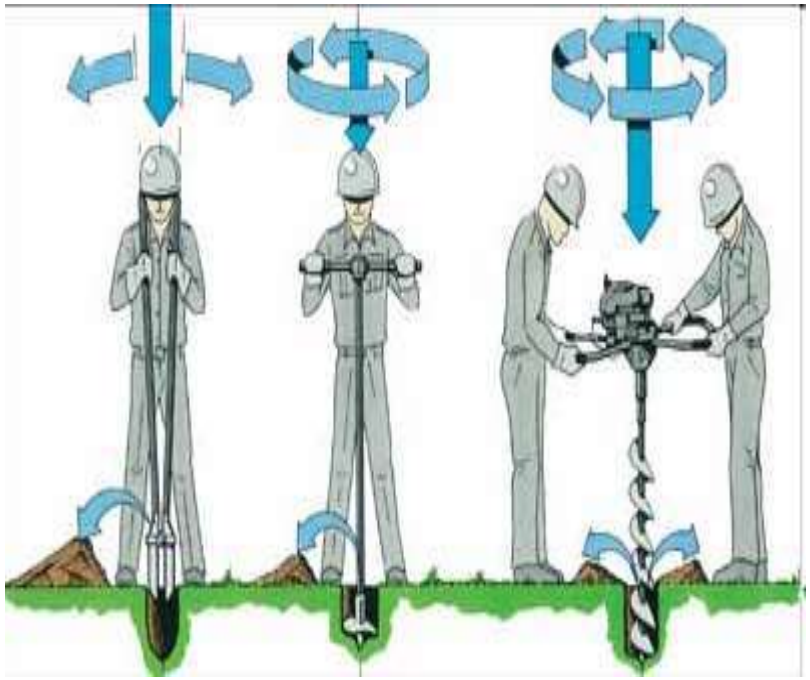


Fig. Hand Augers

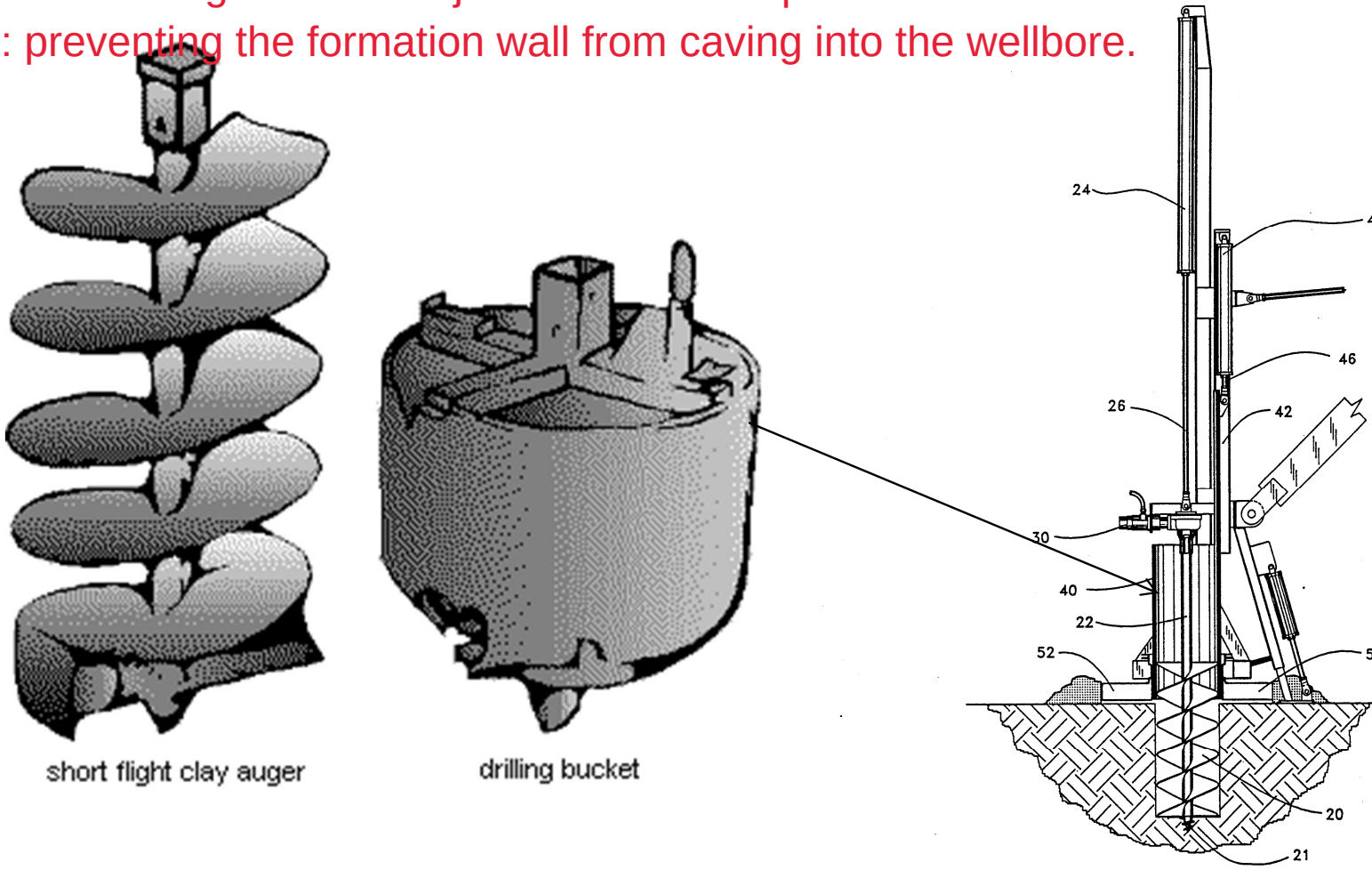


Fig. Power driven auger.

Shell and Auger boring is a mobile tripod rig towed by a 4×4 wheeled drive vehicle. The rig is powered by a diesel engine and requires a working headroom of approximately 6.7m. Casing allows stability to be maintained within a borehole where loose and water bearing granular soils are present.

SHELL & AUGER BORING

Casing is a large diameter pipe that is assembled and inserted into a recently drilled section of a borehole. The casing forms a major structural component of the wellbore and serves several important functions: preventing the formation wall from caving into the wellbore.



A wellbore is a hole that is drilled to aid in the explorati on and recovery of natural resource

Fig. Shell and Auger Boring Instruments

WASH BORING

a boring system by which material loosened by a bit is borne to the surface in the annular space between the bit and casing by water forced down through the pipe bearing the bit

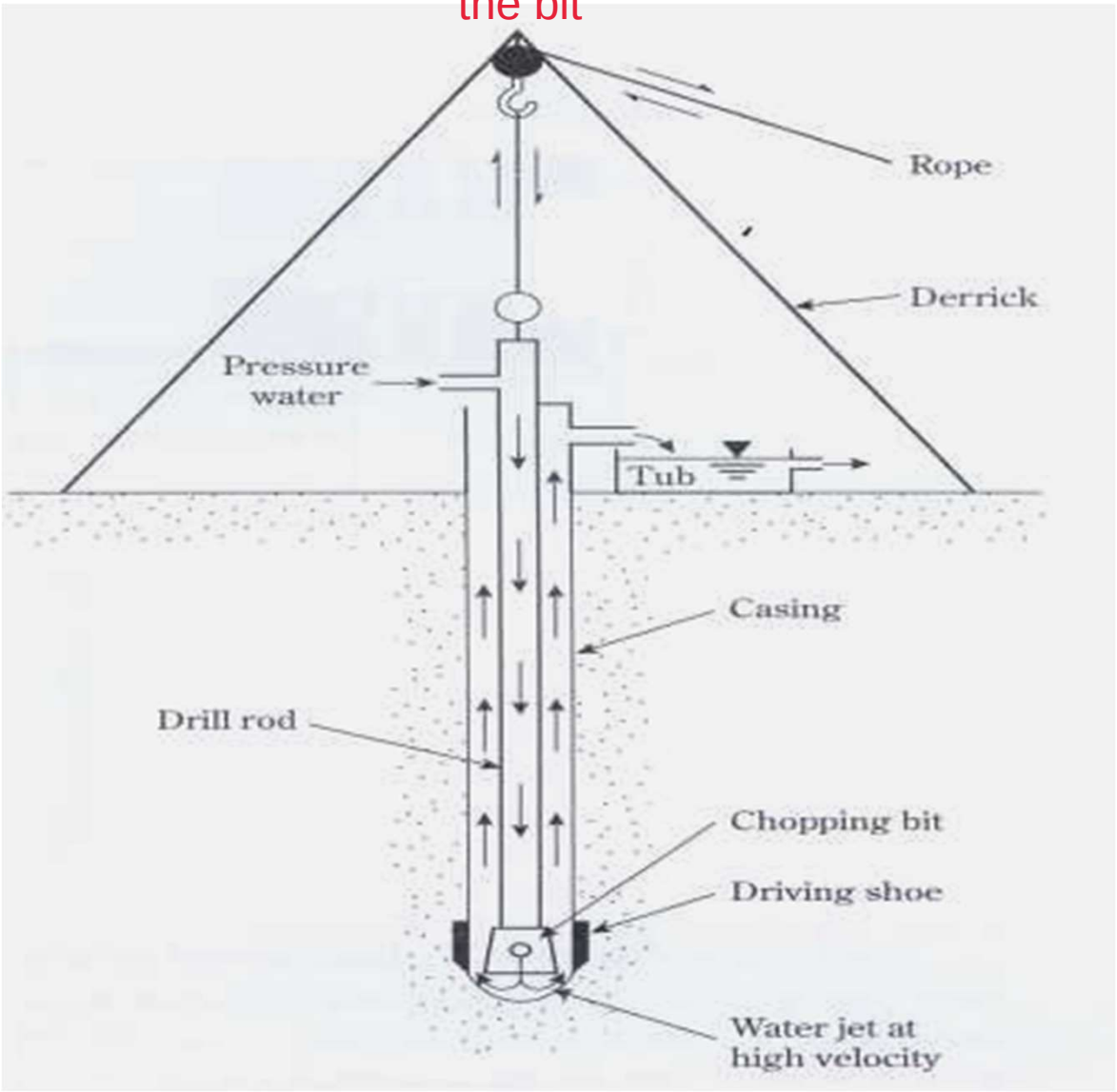


Fig. Schematic Diagram of Wash Boring Setup.

Drilling with a chisel-shaped bit which is repeatedly struck against rock to form a hole. It produces very fine debris, which can be washed away by drilling fluid.

PERCUSSION BORING

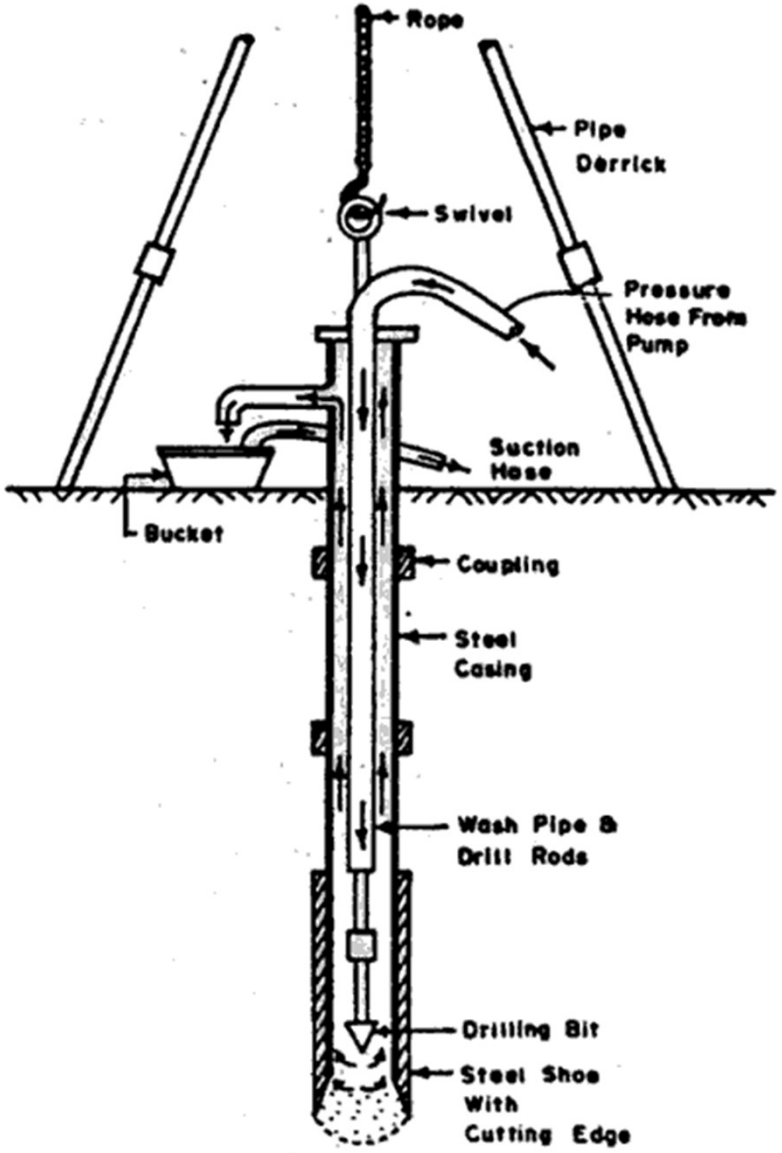


Fig. Schematic Diagram of Percussion Boring Setup.

A system of boring, using usually hollow rods, with or without the production of rock cores. Rock penetration is achieved by the rotation of the cutting tool.

ROTARY BORING

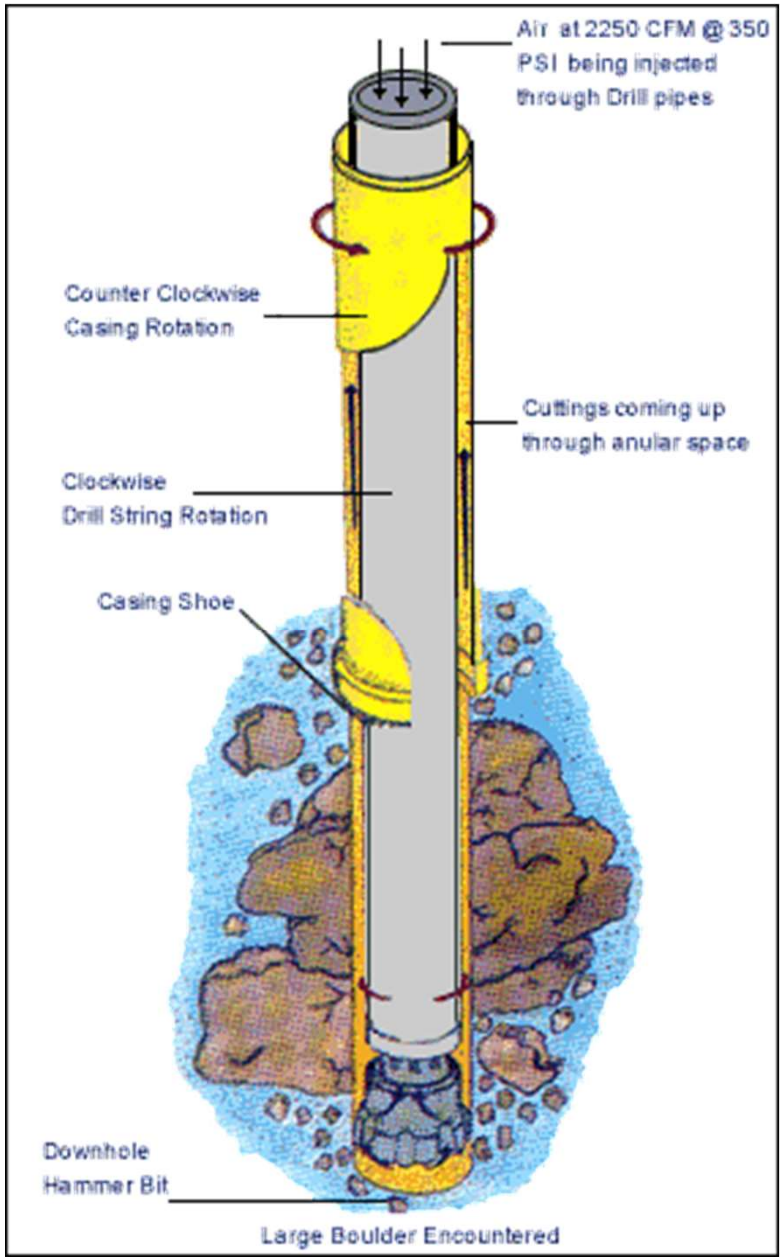




Fig. Rotary Boring

5. GEO-PHYSICAL METHOD

Geo physical methods are used when soil exploration has to be carried out over a large area and where speed is of prime consideration.

There are 4 methods of geo physical survey:

1. Seismic refraction method
2. Electrical resistivity method
3. Magnetic method
4. Gravitational method

SOIL SAMPLE

- Depending on the structure and arrangement of the soil sampled as compared to the insitu, soil samples may be classified as:

1. Undisturbed Sample: A sample is said to be undisturbed if all the constituents of the sampled soil are present in the sample in the similar arrangement and structure. That is the soil sample is the replica of the insitu soil.
2. Disturbed Sample: A soil sample is considered as disturbed while any sort of disturbance occurs in it.

BEARING CAPACITY OF SOIL

The maximum load per unit area which the soil can carry without yield or displacement

shear strength/resistance is the strength of a material or component against the type of yield or structural failure when the material or component fails in shear.

Commonly used terms:

1. Ultimate bearing capacity: It is the maximum pressure that a foundation soil can withstand without undergoing shear failure.

:Shear failure can be defined as a failure that takes place due to insufficiency of shear resistance available between the materials.

2. Net ultimate Bearing Capacity: It is the maximum extra pressure (in addition to initial overburden pressure) that a foundation soil can withstand without undergoing shear failure.

BEARING CAPACITY OF SOIL

3. Safe bearing capacity: It is the safe extra load the foundation soil is subjected to in addition to initial overburden pressure

4. Allowable Bearing Capacity: It is the maximum pressure the foundation soil is subjected to considering both shear failure and settlement.

q_u for cohesive soil from SPT

Consistency	N_{cor}	q_u, kPa
Very soft	0-2	<25
Soft	2-4	25-50
Medium	4-8	50-100
Stiff	8-15	100-200
Very Stiff	15-30	200-400
Hard	>30	>400

where q_u is the unconfined compressive strength.

After knowing value of q_u (Unconfined compressive strength), use Skempton Equation.

Skempton's Bearing Capacity Factor N_C

Skempton (1951) for Saturated clay soils and strip foundations suggested

$$q_u = CN_c + \gamma D_f$$

$$q_{nu} = q_u - \gamma D_f = CN_c$$

C is half of unconfined compressive strength (Recall unconfined compression test)

BEARING CAPACITY FOR COHESIONLESS SOIL

q_u for cohesionless soil from SPT

N_{cor}	Compactness	Relative density, D_r (%)	$\phi°$
0-4	Very loose	0-15	<28
4-10	Loose	15-35	28-30
10-30	Medium	35-65	30-36
30-50	Dense	65-85	36-41
>50	Very Dense	>85	> 41

After knowing value of angle of internal friction, use bearing capacity equation

METHODS OF IMPROVING BEARING CAPACITY OF SOILS

- Increasing the depth of footing
- Drainage
- By blending granular material
- By confining the soil in an enclosed area
- By driving sand piles

Piling is defined as being foundations that are driven or bored through the ground along a certain length of area to carry and transfer loads to soil considered to be weak in structure due to the soil conditions. Piles can be made from various materials, like steel, timber, in-situ or precast concrete

ASSIGNMENT

- Describe briefly the Standard Penetration Test method of site exploration with neat sketches. Describe the precautions needed for reliable results.

CE 200
DETAILS OF CONSTRUCTION

Topic:

Shallow Foundation

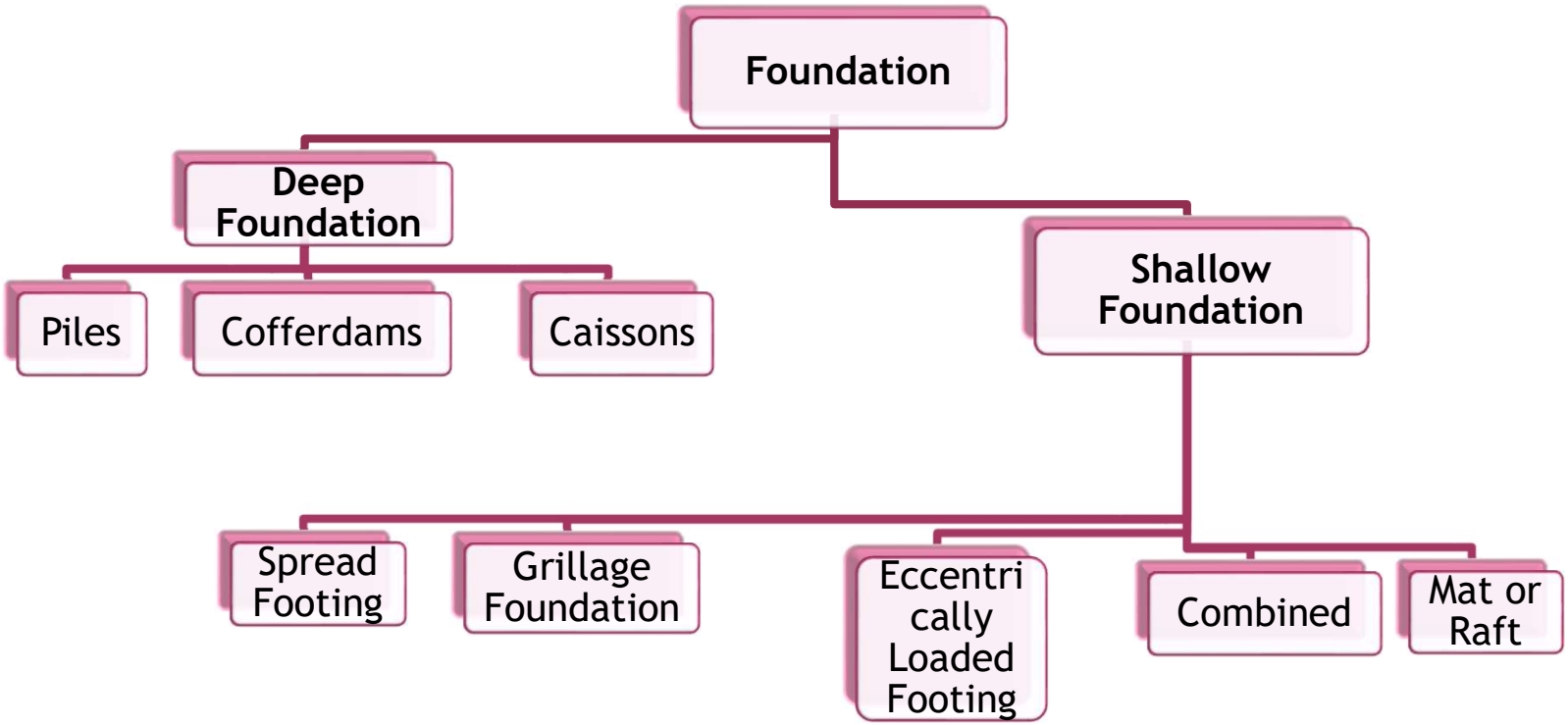
DEFINITION OF FOUNDATION

- The lowest part of a structure which provides a base for transmitting the loads of the structure to the soil below.

PURPOSE OF FOUNDATION

- To distribute weight of the structure over large area
- To prevent unequal settlement
- To provide a level surface
- To increase the stability of the structure by preventing overturning

TYPES OF FOUNDATIONS



FACTORS AFFECTING DEPTH OF FOUNDATION

- Load of Structure
- Soil Condition
- Surroundings

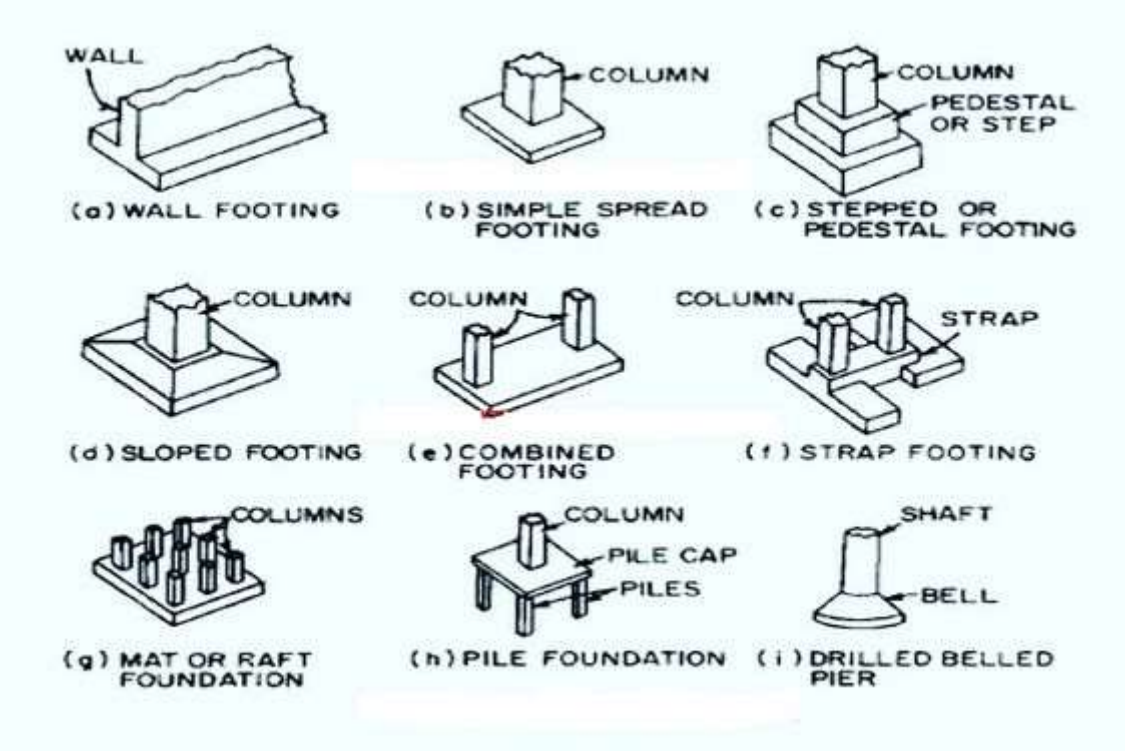
SHALLOW FOUNDATION

- Distributes structural loads to the earth at relatively shallow depth below the GL.

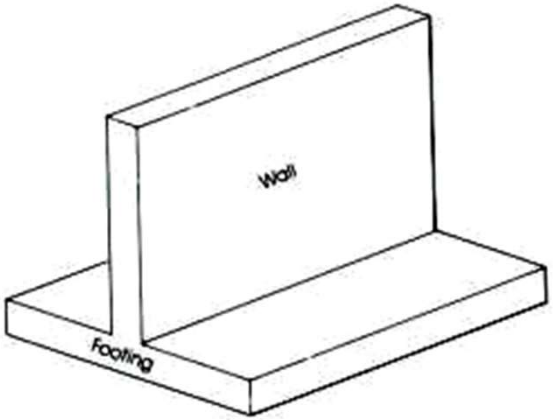
SPREAD FOOTINGS

- Base of the member transmitting load to soil is made wider so as to distribute the load over wider area.
- Types:
  - **Wall footings**
  - **Reinforced concrete footings**
  - **Inverted arch footings**
  - **Column footings**

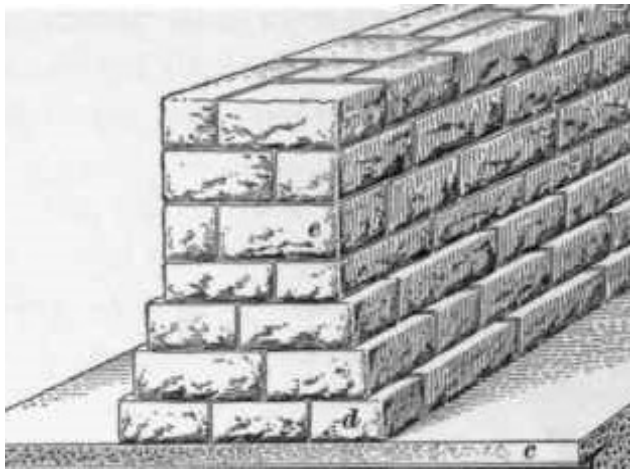
Foundation Types

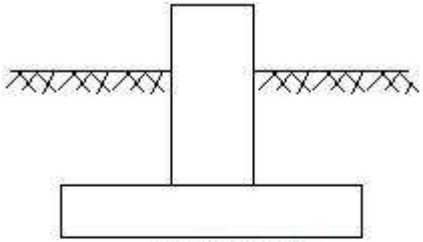


WALL FOOTINGS

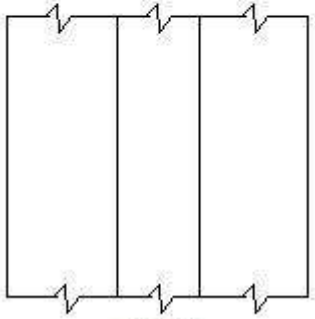


Wall footing.

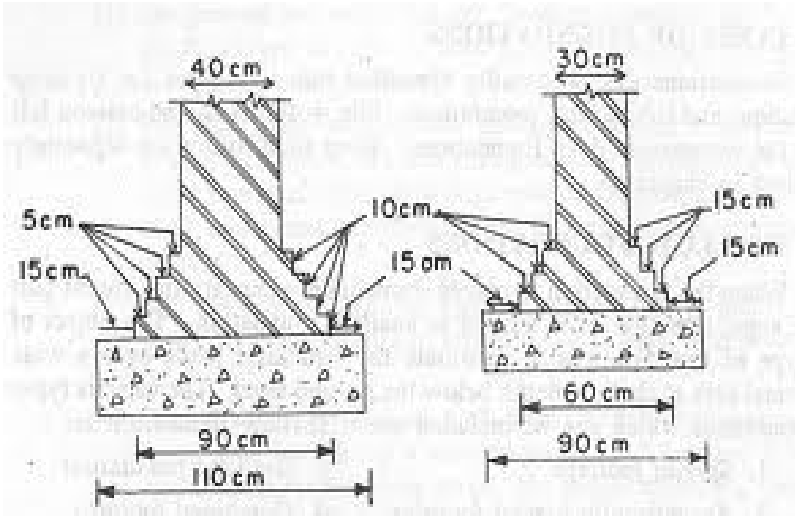




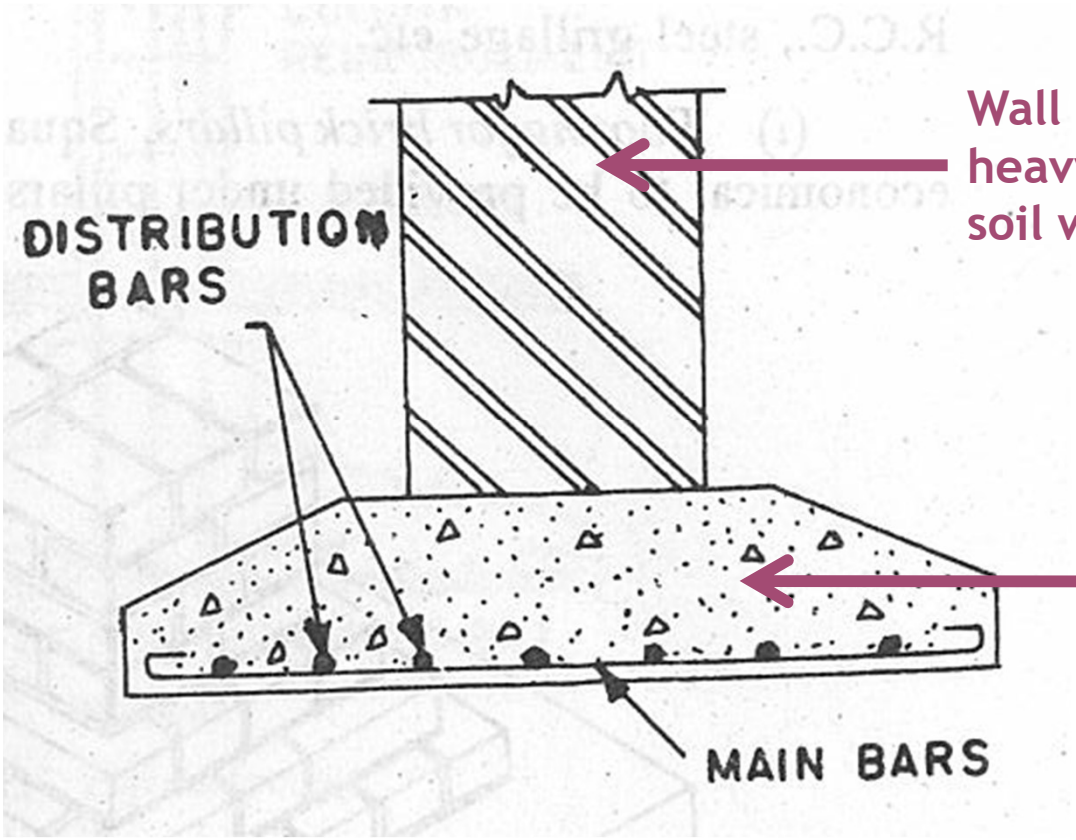
ELEVATION



PLAN



REINFORCED CONCRETE FOOTINGS



Wall subjected to relatively heavy loading and resting on soil with low bearing capacity

Reinforced concrete footing

INVERTED ARCH FOOTINGS

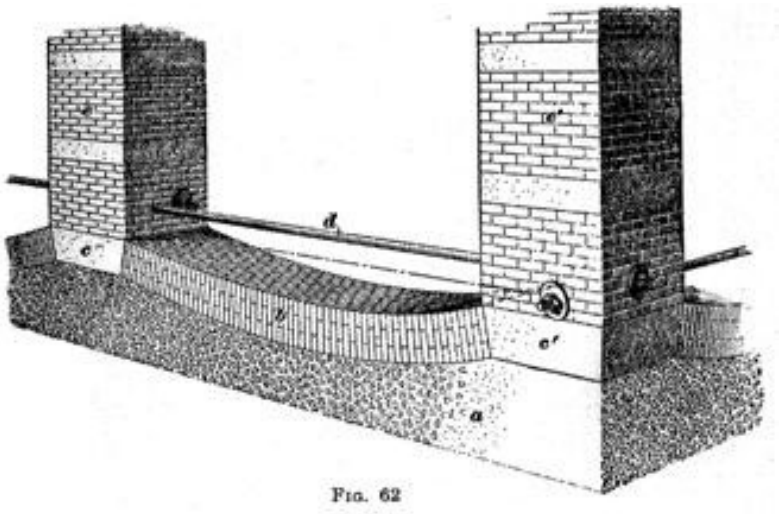


FIG. 62

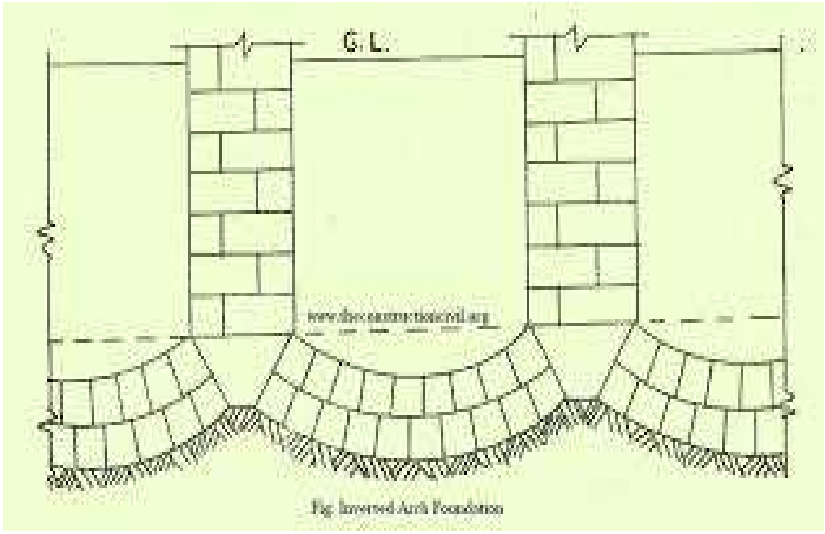
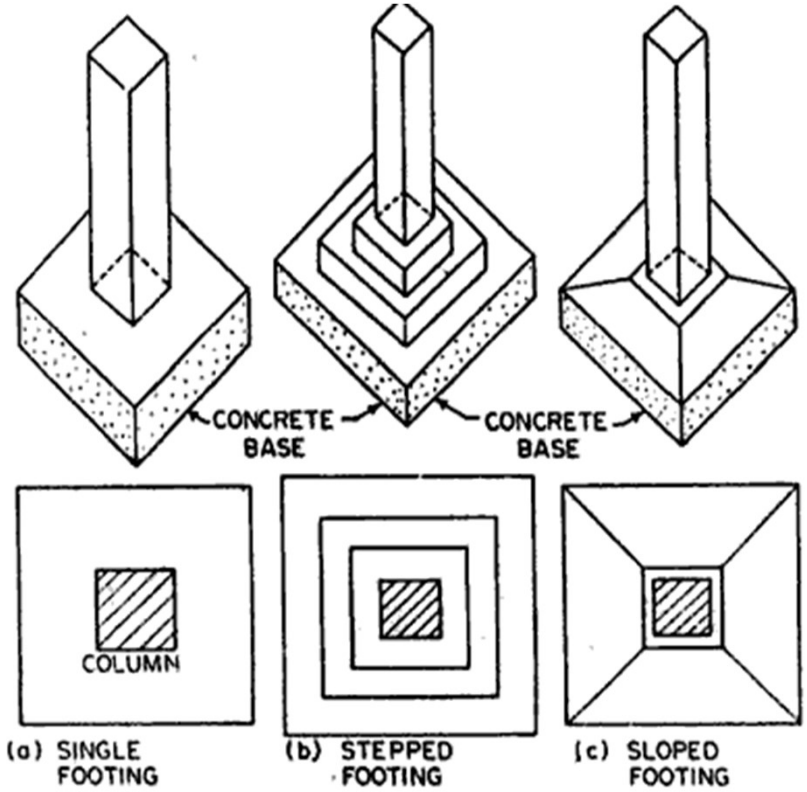


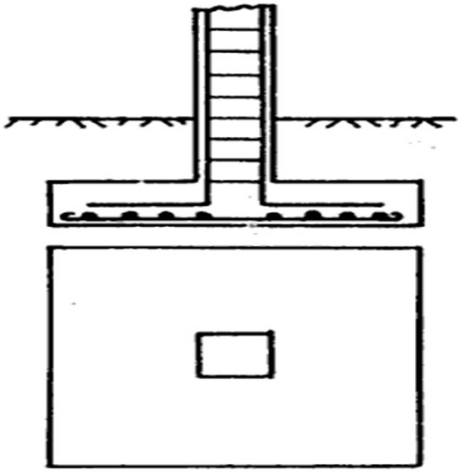
Fig. Inverted Arch Foundation

COLUMN FOOTINGS (INDEPENDENT FOOTINGS)

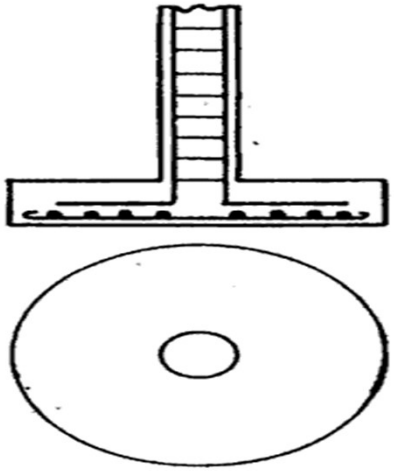




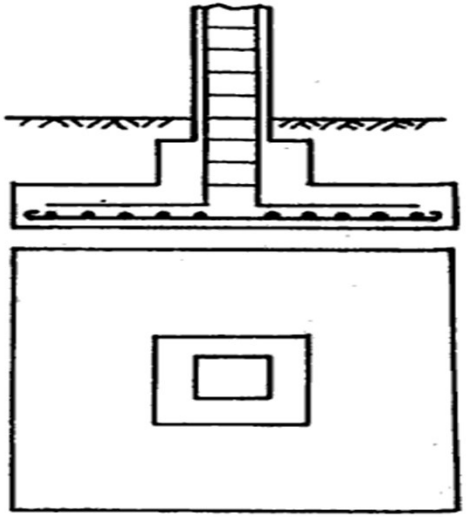
COLUMN FOOTINGS (INDEPENDENT FOOTINGS)



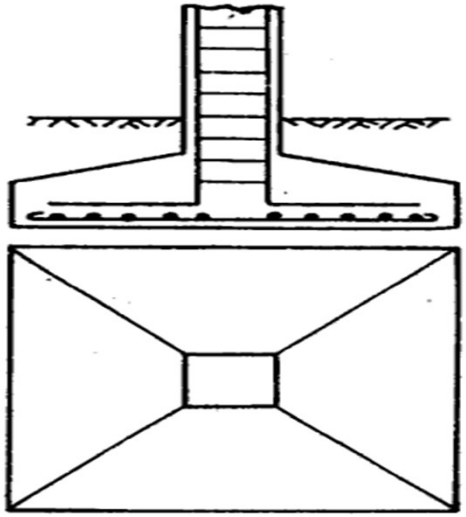
(a) Square Footing



(b) Circular Footing



(c) Square Footing With Padestal.

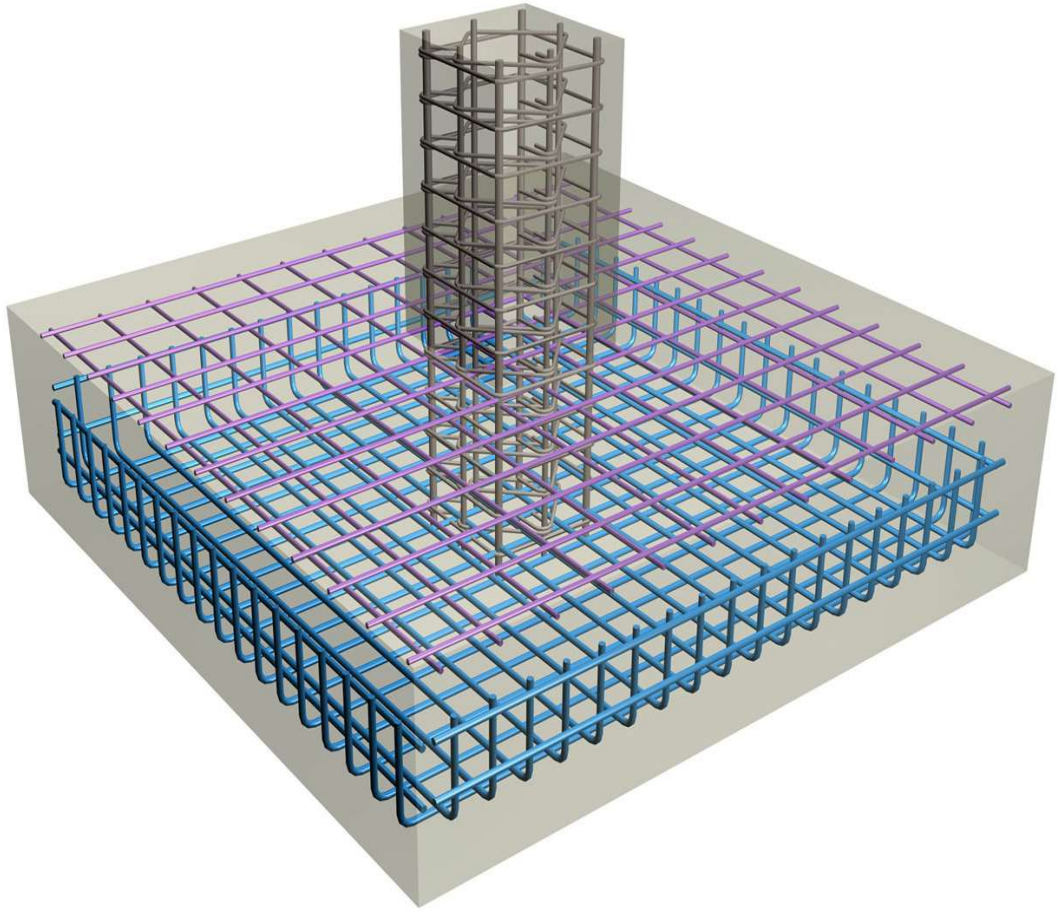


(d) Sloped Footing

STEPS OF CONSTRUCTION OF COLUMN FOOTINGS

- Excavation
- Leveling and Dressing
- Brick Flat Soling
- C.C. Layer
- Formwork
- Reinforcement
- Concrete Casting
- Removal of formwork
- Curing
- Backfilling

REINFORCEMENT OF COLUMN FOOTING



FORMWORK/SHUTTERING

- Temporary construction provided for laying cast-in-situ concrete to required shape.
- Support the concrete member until it cures sufficiently to become self supporting.
- Types:
  - steel
  - timber

FORMWORK/SHUTTERING



Steel Shuttering



Wooden Shuttering

REQUIREMENTS OF A GOOD FORMWORK

- Able to be erected and de-shuttered fast.
- Good concrete quality and surface finish can be achieved.
- Should be rigidly constructed and efficiently propped and braced to withstand all types of dead and live loads during construction.
- Should be as light as possible.
- Should rest on firm base.
- The joints in the formwork should be tight against leakage of cement grout.
- The material of the formwork should be cheap, easily available and should be suitable for reuse.
- The material of the formwork should not warp or get distorted when exposed to the elements.

COMPARISON BETWEEN TIMBER AND STEEL FORMWORKS

- Economical for small construction jobs
- Design flexible and easy to erect
- Has good thermal insulation which makes it useful to be used in colder regions
- Can easily be made into any shape or size

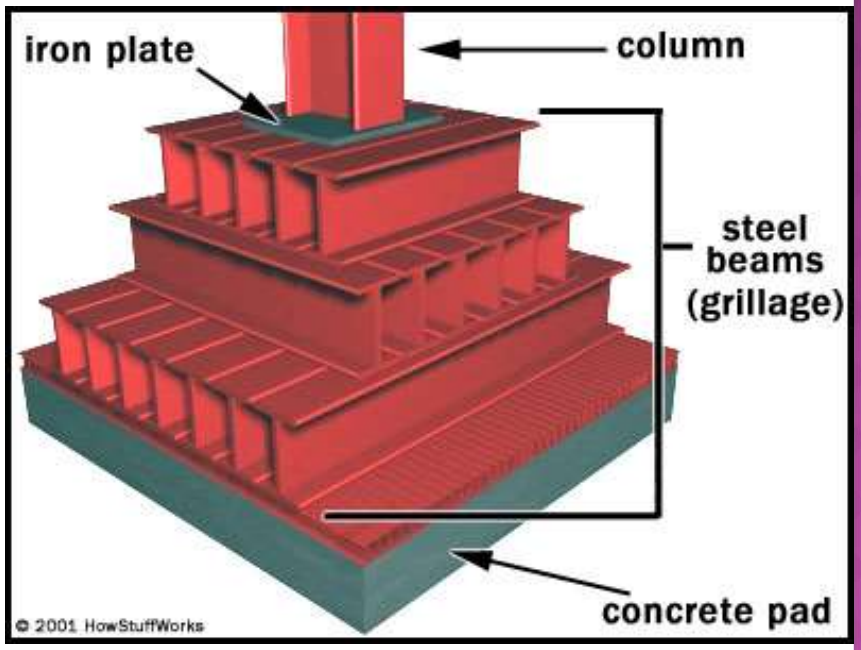
TIMBER FORMWORK

- Strong, durable & have longer life
- Reuses can be assumed to vary from 100 to 120 whereas timber varies from 10 to 12
- Can be installed & dismantled with greater ease & speed
- Excellent quality of exposed concrete surface obtained
- No danger of formwork absorbing water from the concrete

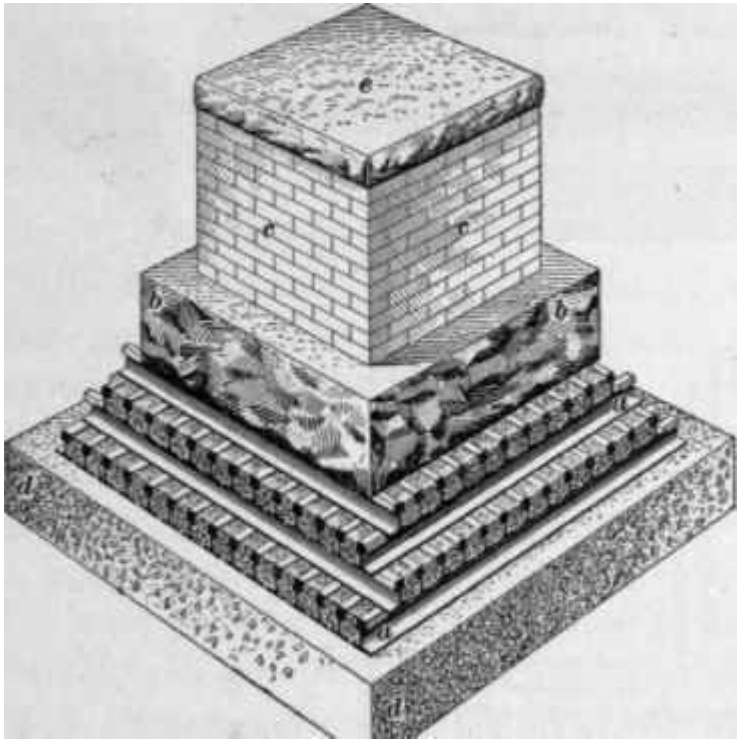
STEEL FORMWORK

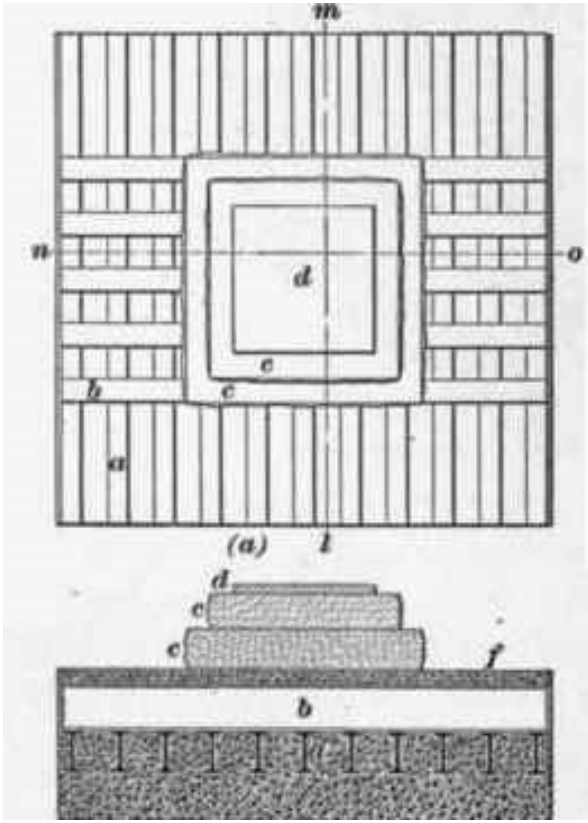
GRILLAGE FOUNDATIONS

- Used when heavy structural loads from columns are required to be transferred to a soil of low bearing capacity
- Avoids deep excavation
- Types:
  - Steel Grillage
  - Timber Grillage

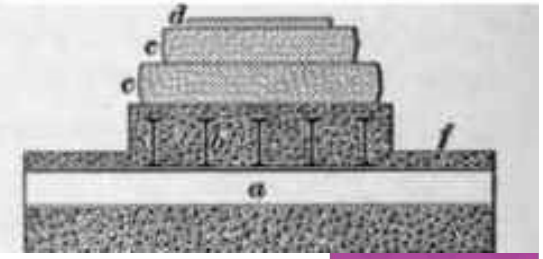


GRILLAGE FOUNDATIONS





Section n-o

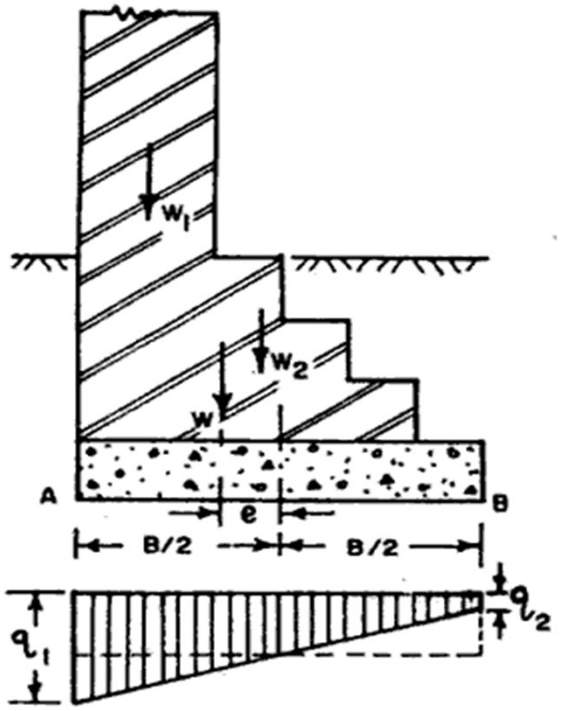


Section l-m

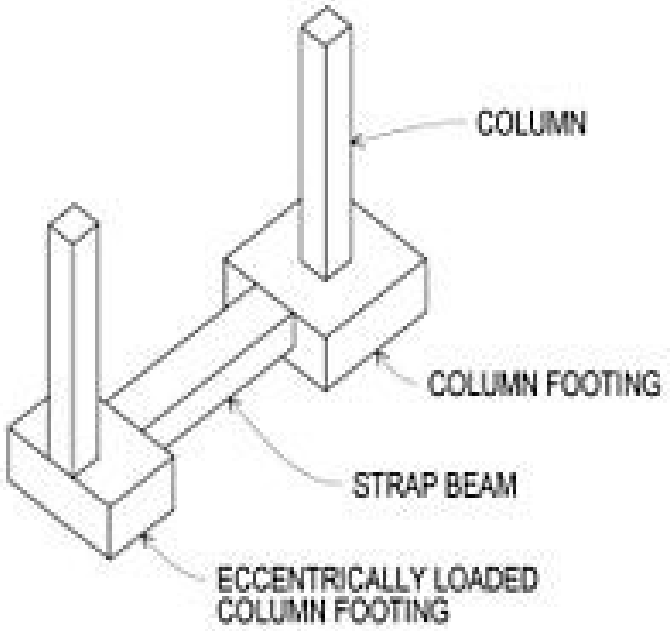
ECCENTRICALLY LOADED FOOTINGS

- Formed when the c.g. of the imposed loads does not ***coincide*** with the c.g. of the supporting area of base.
- Found when walls or columns are to be placed close to ***property lines***.
- Stability is ensured by:
  - offsetting the footings
  - providing strap footing

ECCENTRICALLY LOADED FOOTINGS



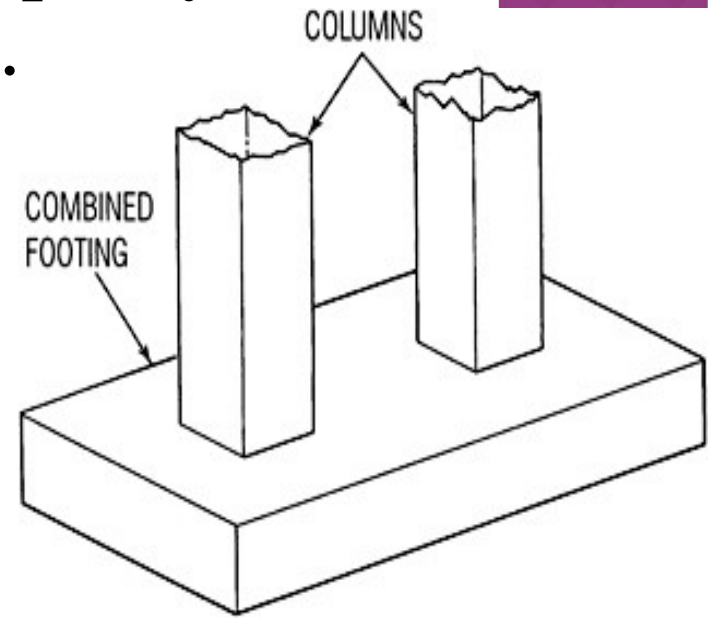
Stability provided by offsetting the footing



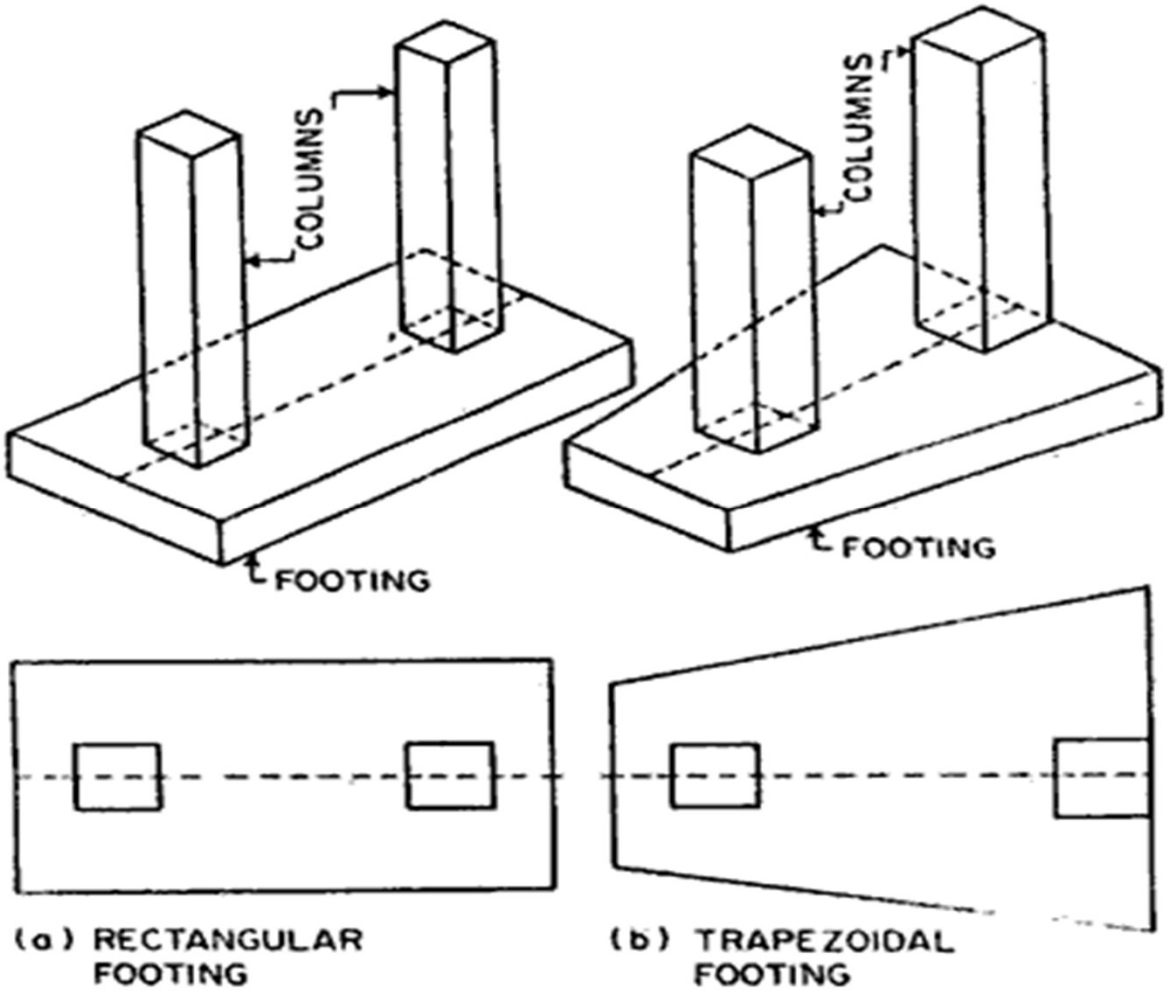
Stability provided through a cantilever beam acting about a fulcrum

COMBINED FOOTING

- Supports more than one column.
- Used when the columns are so close to each other that their individual footings would overlap.
- Also provided when the property line is very close to one column.



TYPES OF COMBINED FOOTINGS



RAFT OR MAT FOUNDATION

- Consists of thick R.C.C. slab covering the entire area of the bottom of the structure like a floor.



RAFT OR MAT FOUNDATION

- Warranted for:
  - heavy concentrated structural loads in site having low bearing capacity
  - structure liable to subsidence

Subsidence is the sudden sinking or gradual downward settling of the ground's surface with little or no horizontal motion

STEPS OF CONSTRUCTION OF MAT FOUNDATION

1. Soil test
2. Shore pile construction
3. Excavation
4. Form work
5. Leveling & Dressing
6. C.C. layer construction
7. Column positioning
8. Reinforcement
9. Concrete Casting
10. Curing

SHORE PILES





Shoring and Auxiliary Structures

STEPS OF CONSTRUCTION OF MAT FOUNDATION



Excavation



Leveling

STEPS OF CONSTRUCTION OF MAT FOUNDATION



Brick Flat Soling



C.C. Layer

STEPS OF CONSTRUCTION OF MAT FOUNDATION

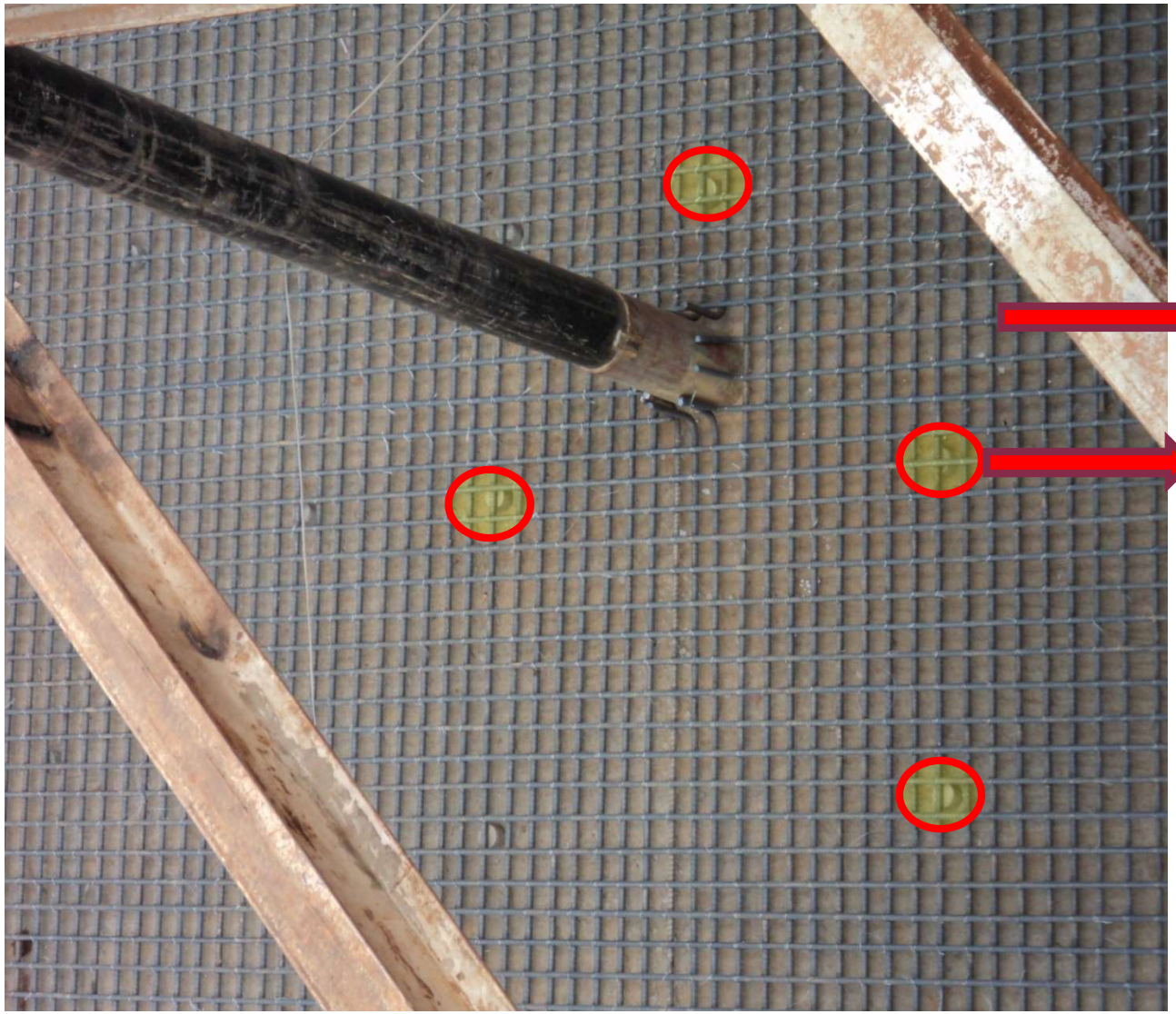


Damp Proof Course



Positioning of Column

STEPS OF CONSTRUCTION OF MAT FOUNDATION



Bottom layers' reinforcement

C.C. Block

REINFORCEMENT

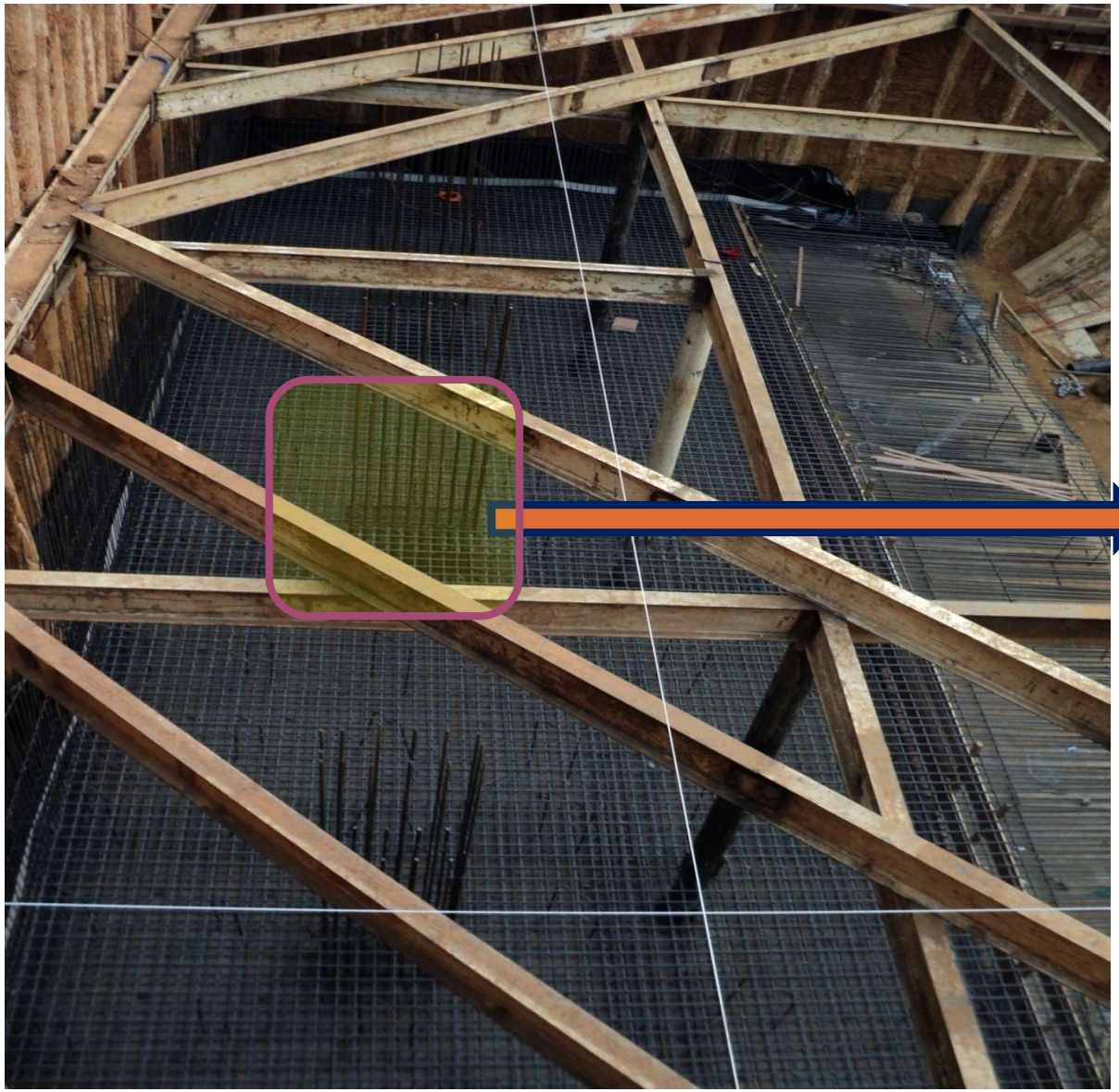


Top layer

Chair

Bottom layer

REINFORCEMENT





SHUTTERING AND RETAINING WALL



CONCRETE CASTING AND COMPACTION





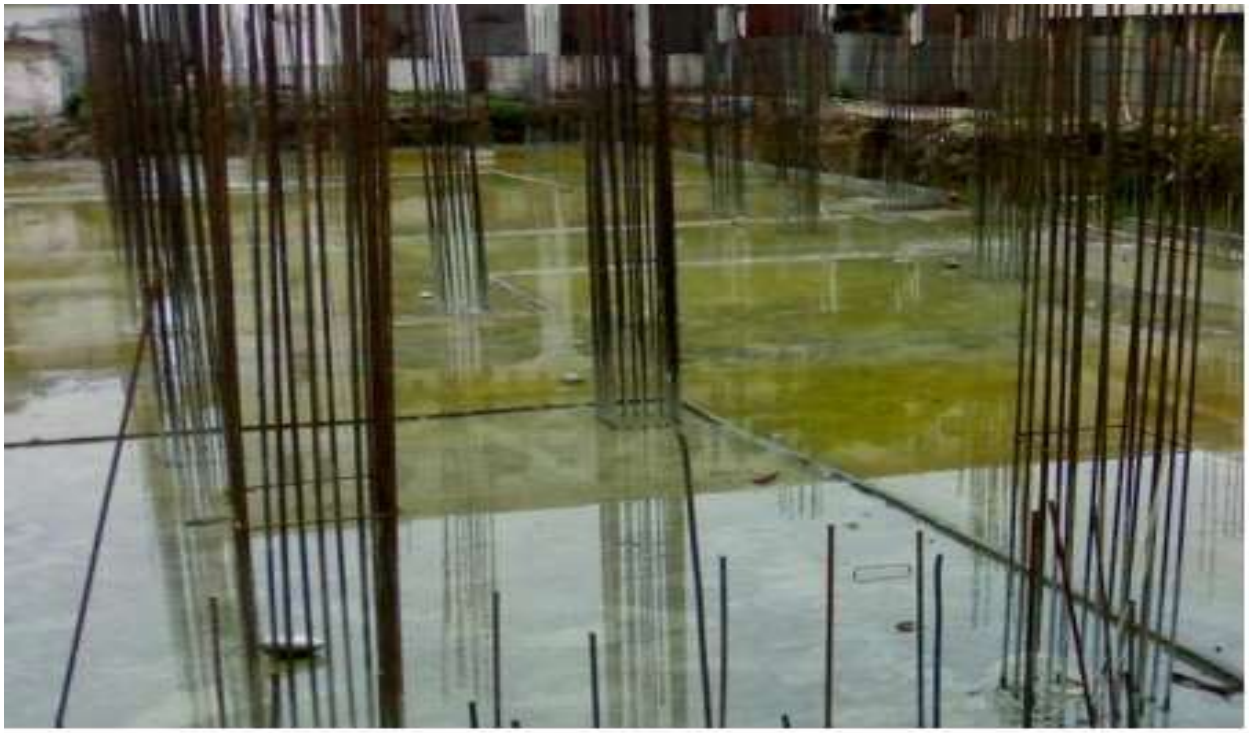
CONCRETE CASTING CONTD ...



Concrete is cast in parts

Curing is the maintaining of adequate moisture content and temperature in concrete at an early age so that it could develop properties the mixture was designed to achieve. Curing begins immediately after finishing and placement so that the concrete can develop the desired durability and strength

CURING

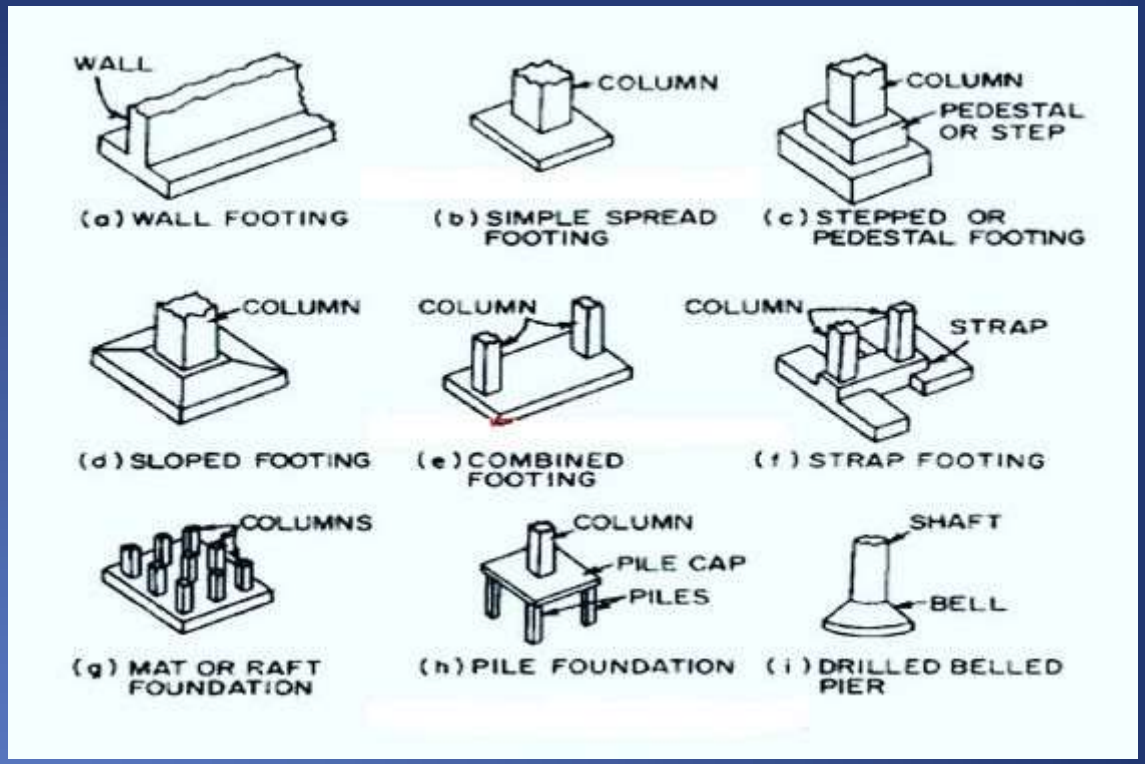


ASSIGNMENT

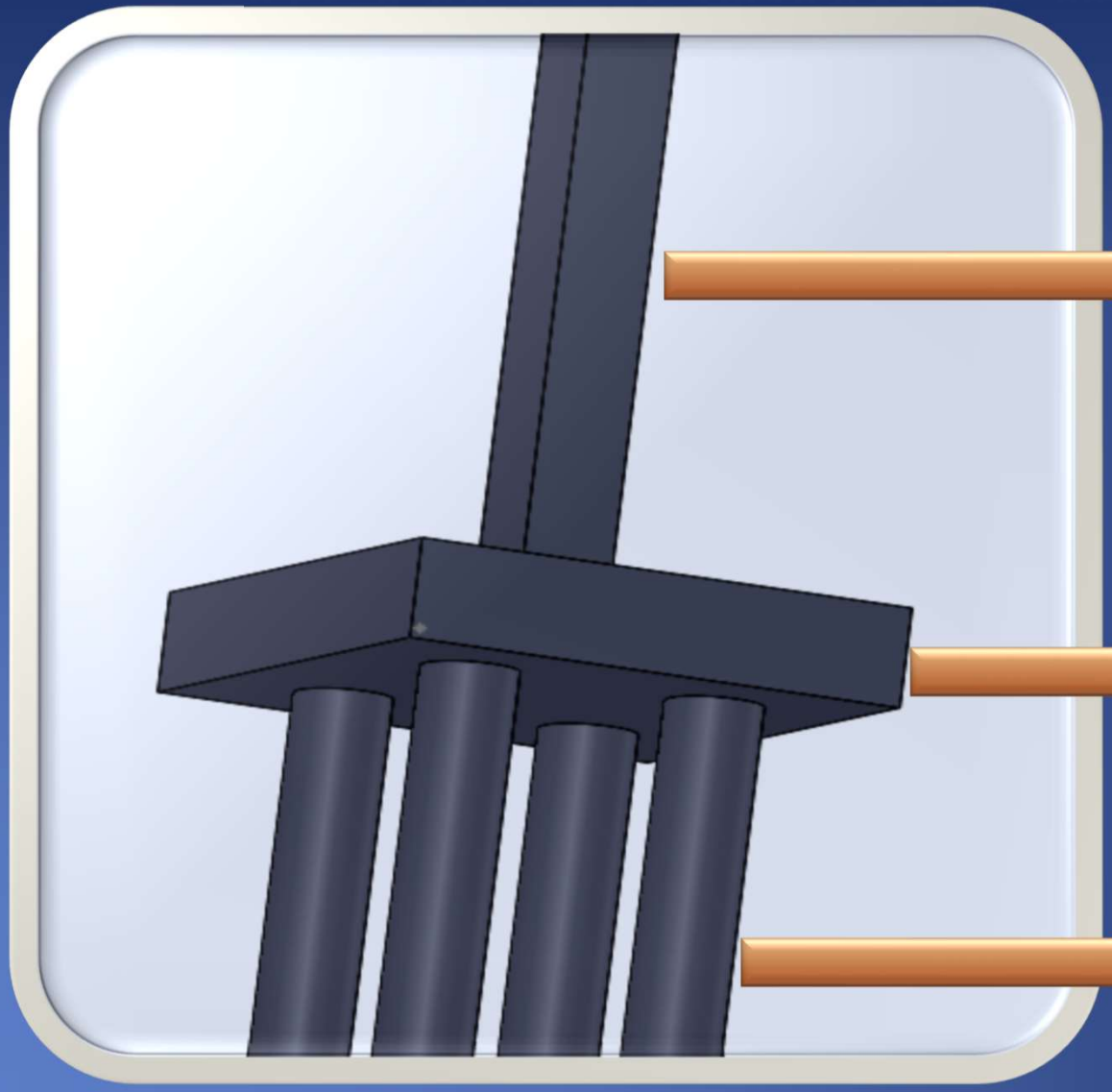
- State the different types of shallow foundations you recommend under different situations and soils.

DEEP FOUNDATION

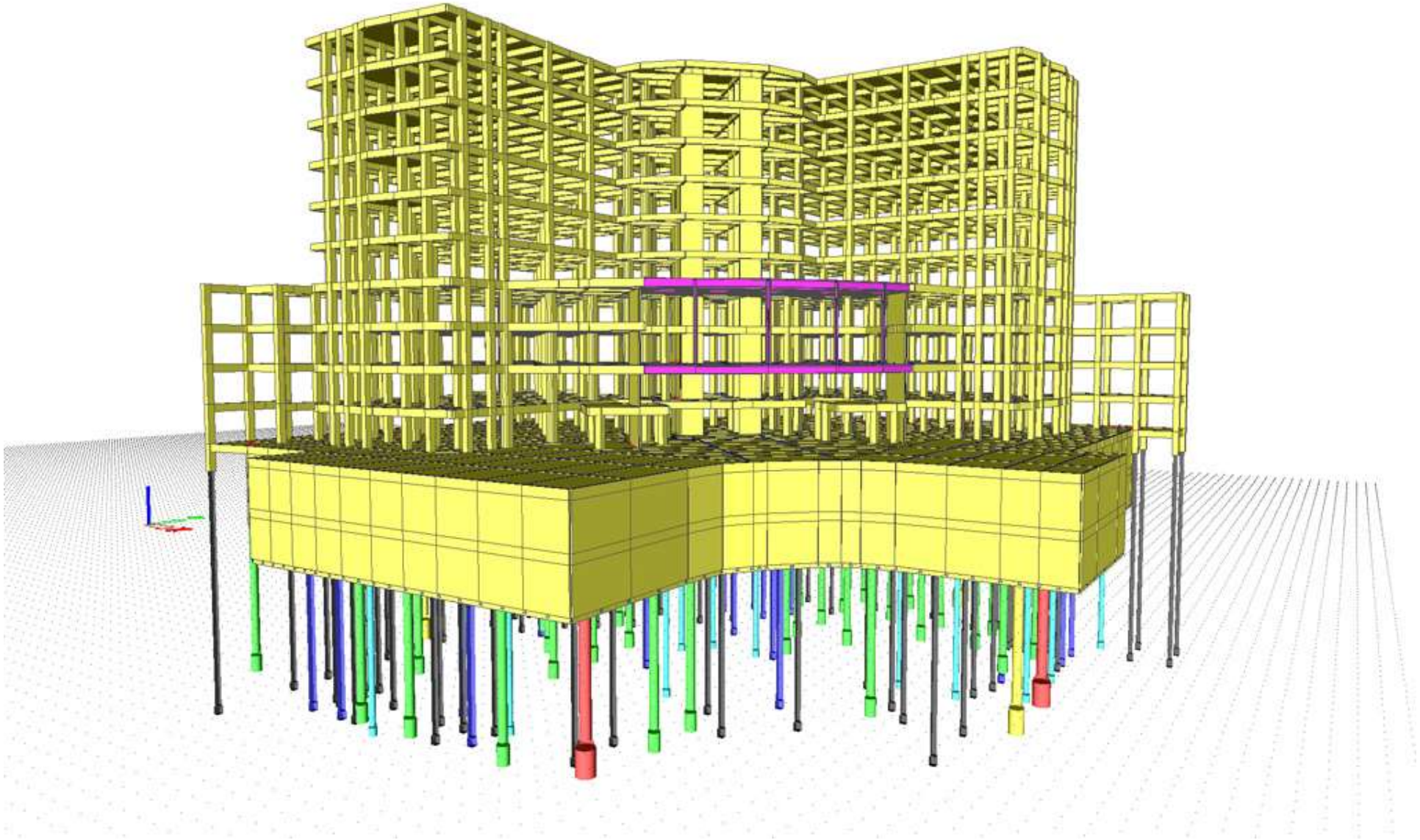
Different Types of Foundation



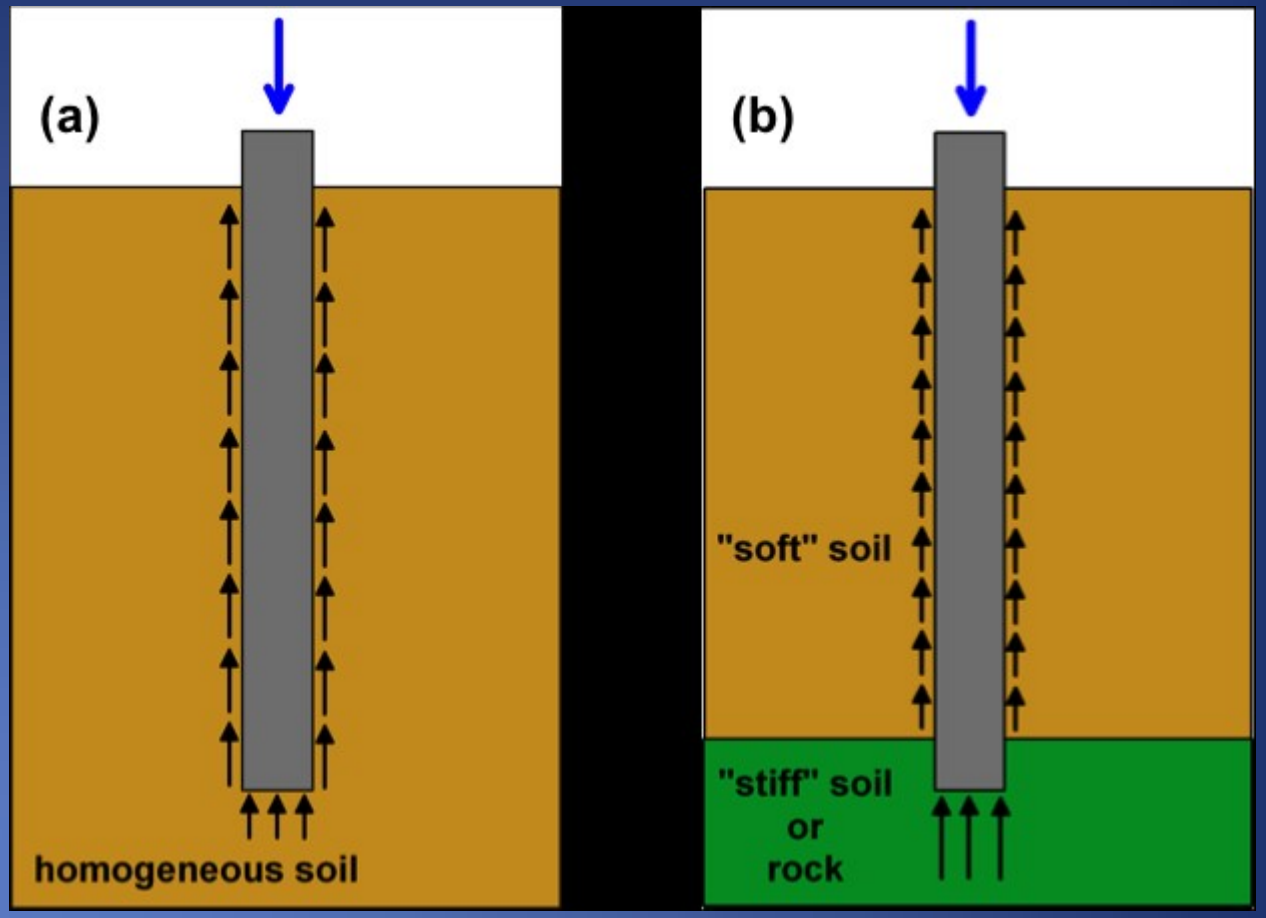
DEEP FOUNDATION



PILE BENEATH STRUCTURE



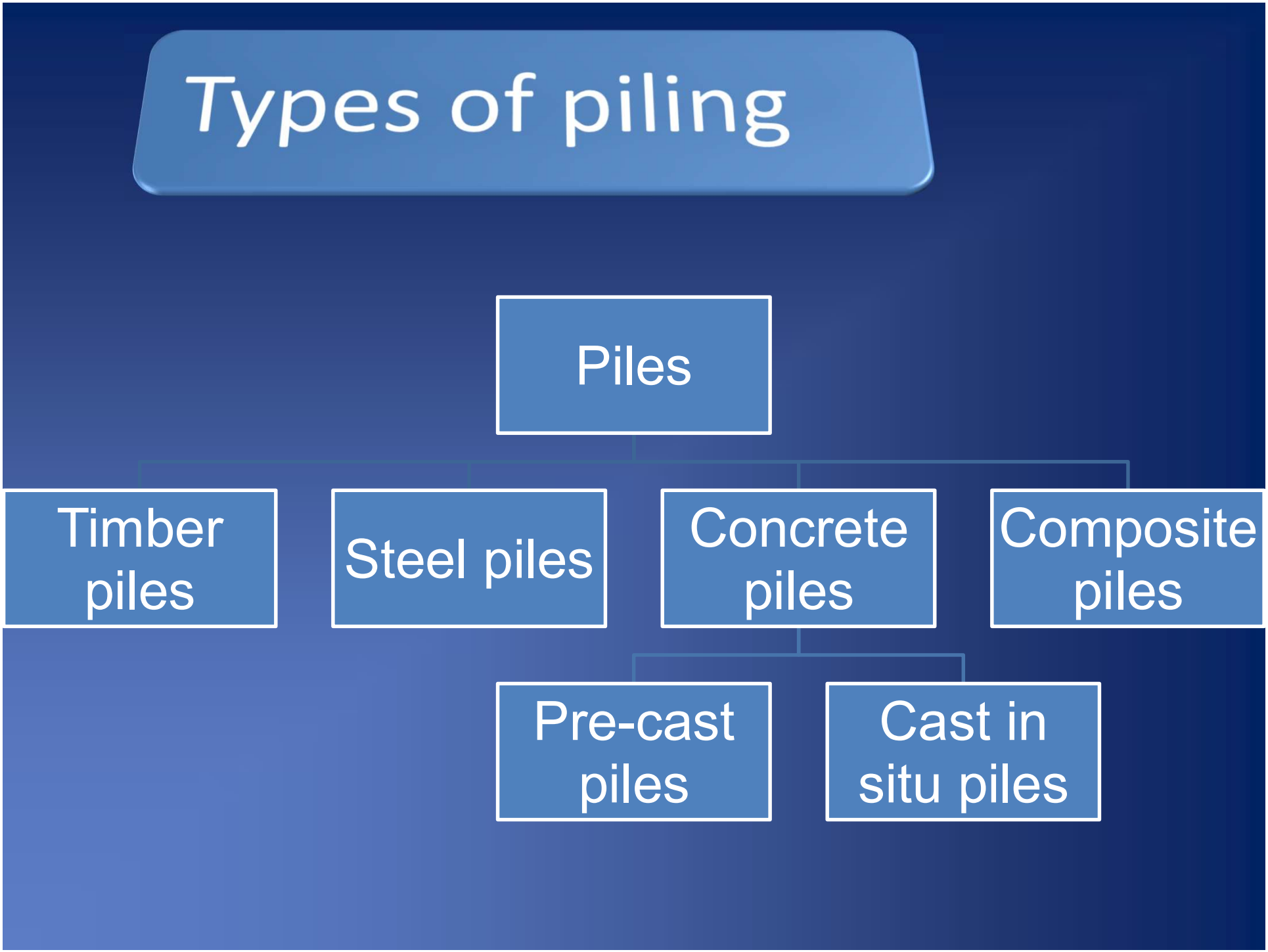
Load carrying mechanism by piles and End Bearing Piles



Friction Pile

End Bearing Pile

Types of piling



Pre Cast Piles



- Displacement Pile
- Piles of any size are made in advance and then used at the site

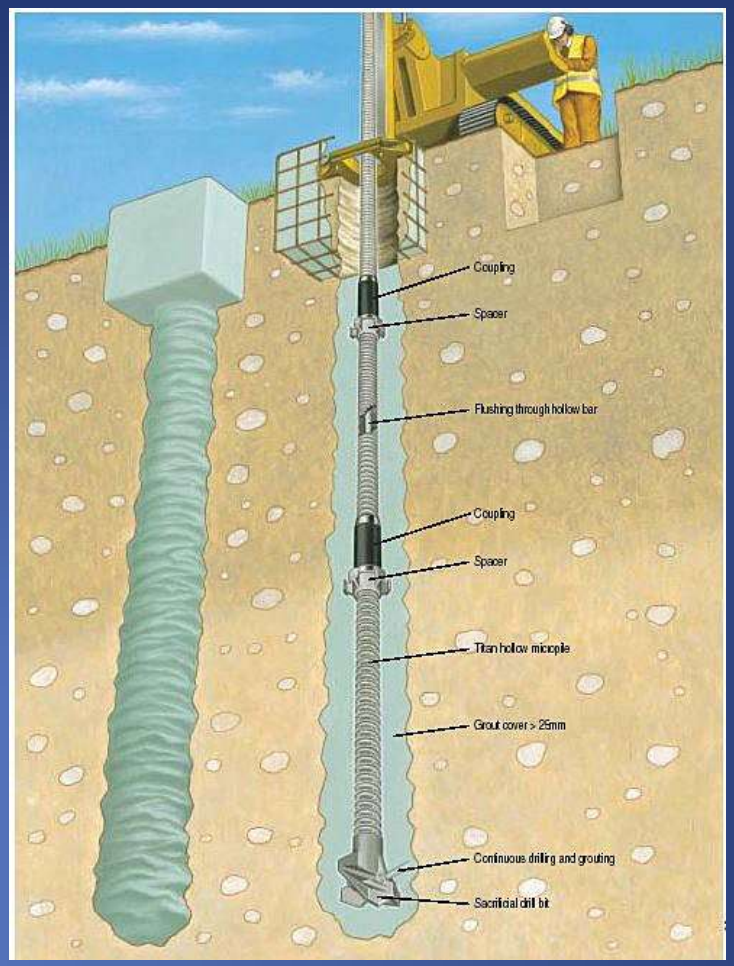


Cast-in-Situ/Bored Piles

- Non-displacement pile in which a hole of the specified diametre is bored to the required depth.
- Cast with concrete of specified strength after the reinforcement is placed into the hole.



Cast-in-situ Pile



Timber Piles



- ✓ Is the first material used in piling work

Steel Pile

- ✓ Can be driven in very long lengths
- ✓ Liable to corrosion above the soil line
- ✓ More expensive than timber or concrete



Composite Piles

✓ Combinations of materials are used.

✓Most common materials are steel and concrete.



Pile Cap

- It is a thick concrete mat that rests on driven concrete or timber piles.
- Provides stability to the foundation in soft and unstable ground
- It distributes the load of the building into the piles.

Pile Cap



Pile cap for two piles



Pile cap for three piles

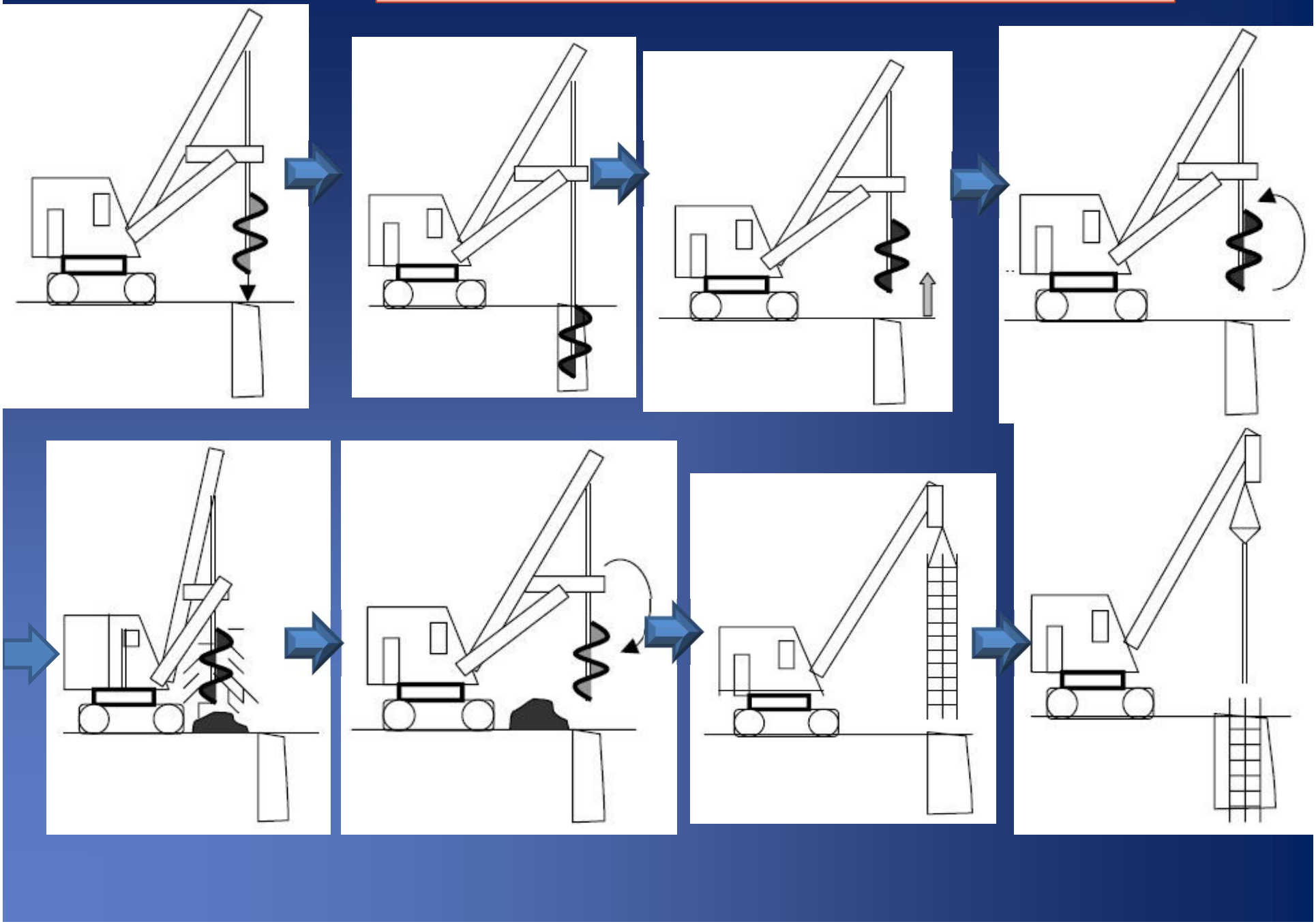


Pile cap for four piles

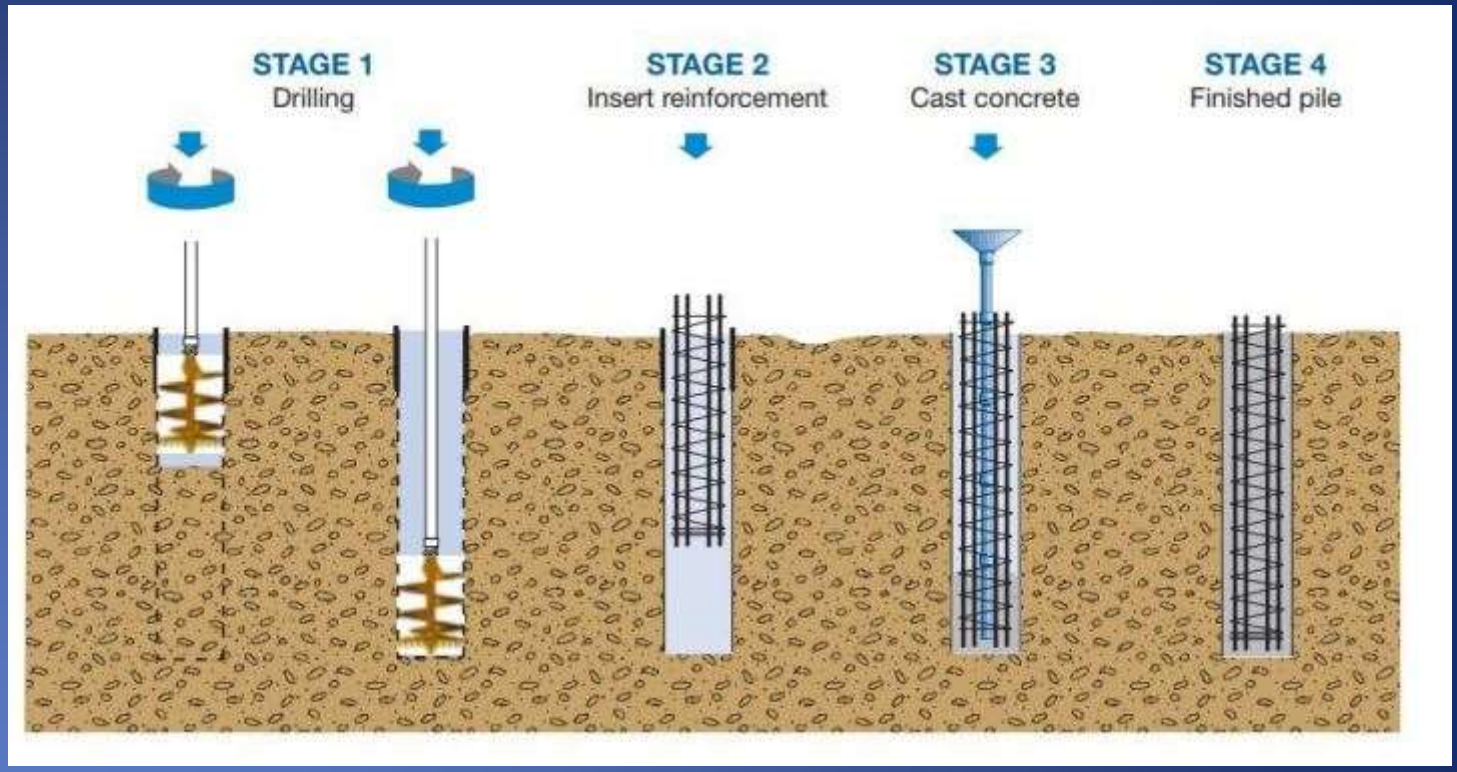
Necessity of Pile Foundation

- If the soil near the surface do not have sufficient bearing capacity to support the structural loads
- If the estimated settlement of the soil exceeds tolerable limits
- To increase factor of safety of heavy load structures

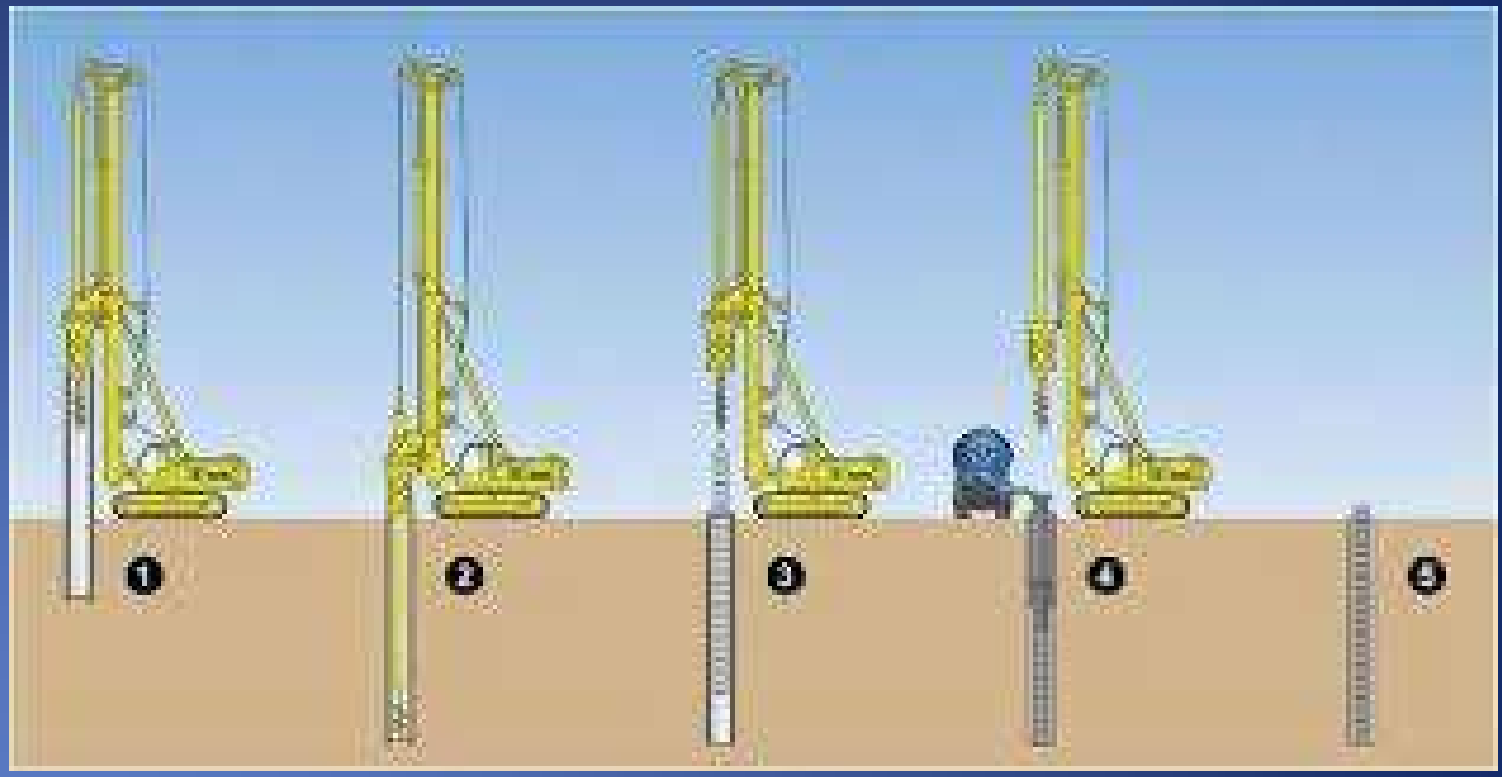
Procedure for Bored Pile Construction



Steps of Construction : Bored Pile



Rotary Drilling for Cast In Situ Pile



Cast-in-situ Pile Construction



Tripod

Tripod Placing





Augar Placement

AUGER

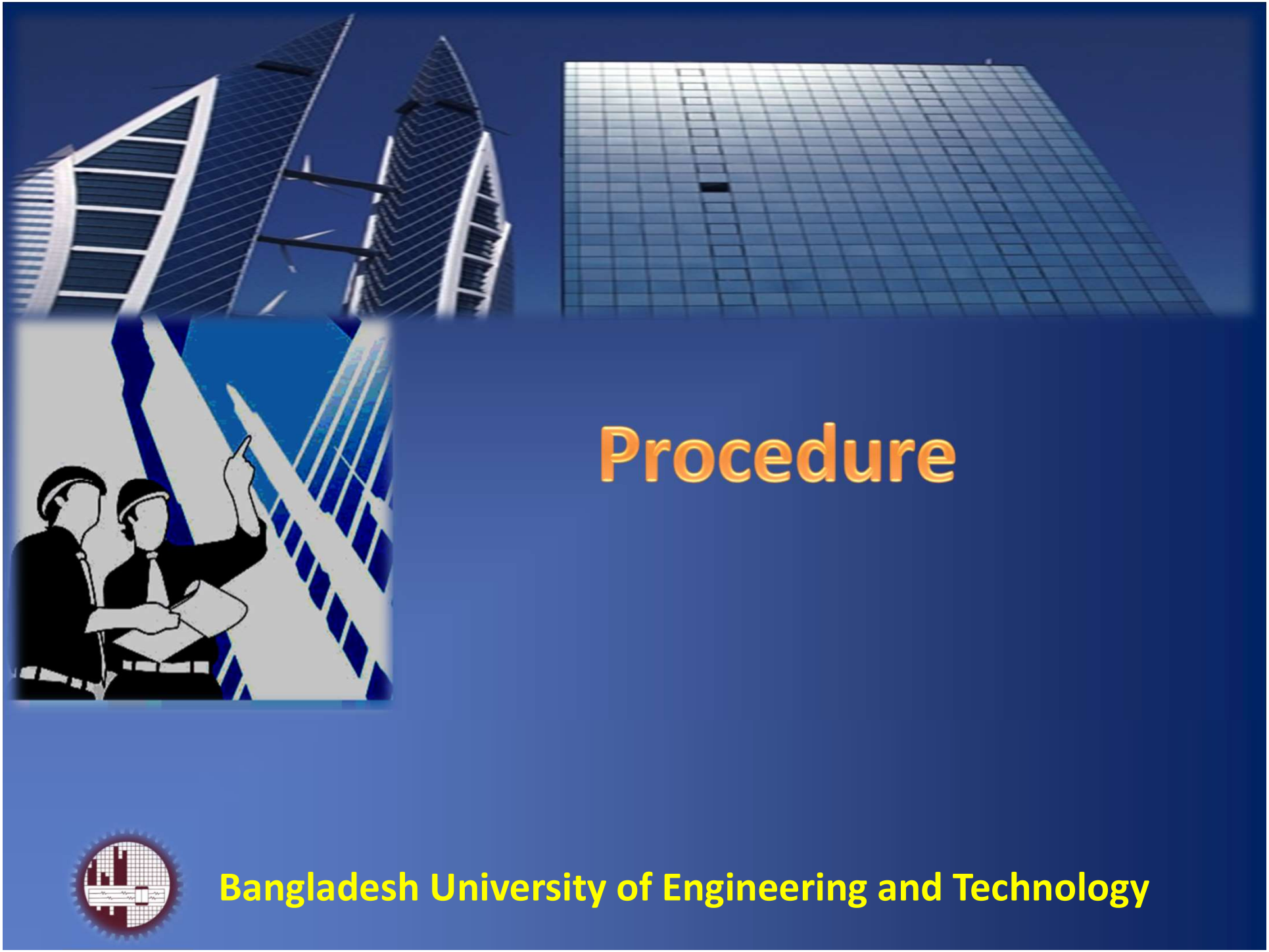


Drilling



Joint




Procedure
Bangladesh University of Engineering and Technology

PREPARATION OF THE HOUSE



CONNECTING THE AUGER TO THE RIG



1. HOOKING THE AUGER TO THE ROPE OF THE RIG.

CONNECTING THE AUGER TO THE RIG



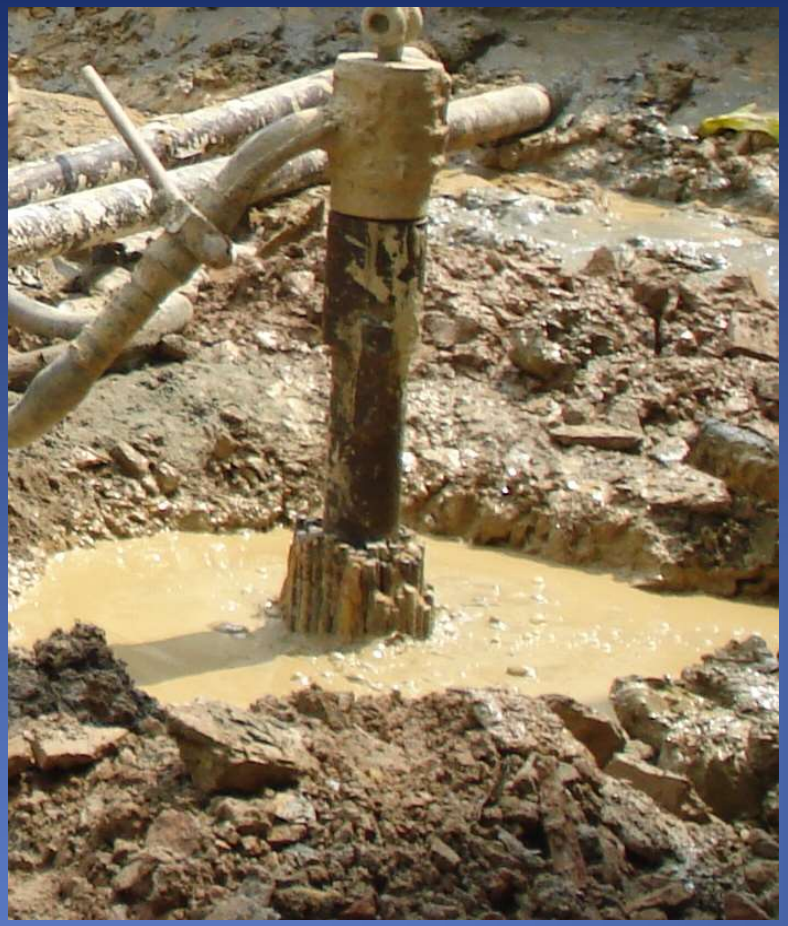
2. CONNECTING THE HOSE PIPE TO THE AUGER.

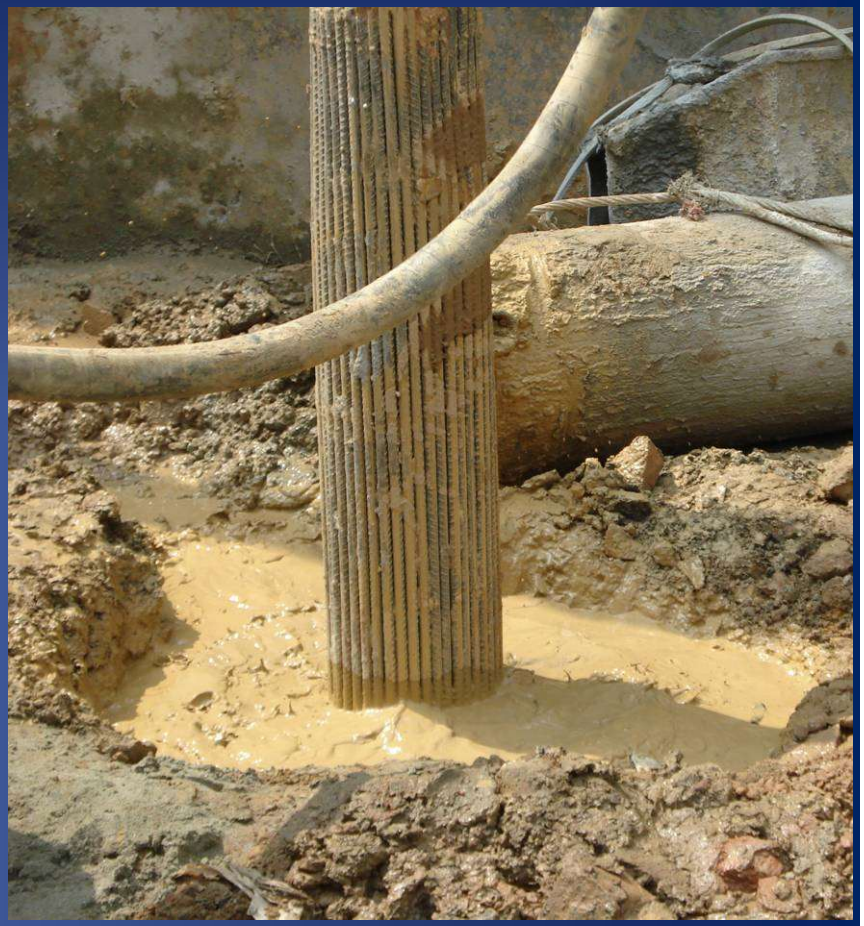
CENTERING



CENTERING THE AUGER BY MOVING THE RIG

BORING





MUD COMING OUT OF THE BORE HOLE

DRIVING THE CASING



THE CASING HELPS TO DRIVE THE AUGER IN THE SAME PLACE

BORING THROUGH THE CASING





CONNECTING THE DRILLING ROD



1. HOOKING THE DRILLING ROD WITH THE ROPE OF THE RIG

CONNECTING THE DRILLING ROD



2. CONNECTING THE HOSE PIPE TO THE DRILLING ROD

CONNECTING THE DRILLING ROD



3. JOINING THE DRILLING ROD TO THE HEAD OF THE AUGER BY THREADING

BORING WITH THE DRILLING ROD



3 X DRILLING ROD(20')

+

AUGER(15')

=

75' BORE HOLE

BRINGING OUT THE DRILLING ROD





PREPARATION OF THE REINFORCEMENT



1.SPIRAL REINFORCEMENT BARS ARE DRIVEN INTO THE STRAIGHT BARS

PREPARATION OF THE REINFORCEMENT

LOGITUDINAL BARS



SPIRAL BARS

PREPARATION OF THE REINFORCEMENT





2. SPIRAL BARS ARE JOINED WITH THE STRAIGHT BARS WITH WIRES.

3. THE BARS ARE WELDED FOR EXTRA STRENGTH.





Rebar Placement

DRIVING THE REINFORCEMENT





REINFORCEMENT BARS ARE WELDED AFTER PLACING

SETTING UP THE TREMIE PIPE



JOINING BY THREADING



CLAMPING THE TREMIE PIPE

SETTING UP THE FUNNEL





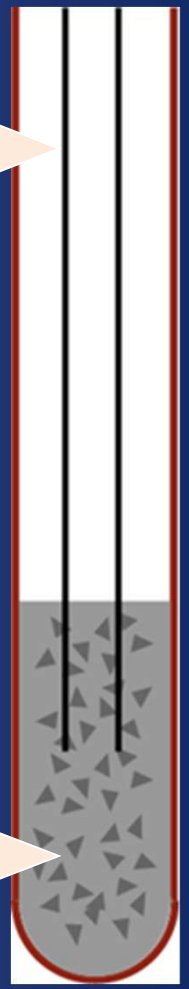
CONCRETE CASTING



TREMIE PIPE

CONCRETE FALLING INTO THE BORE HOLE FROM THE BUCKET THROUGH THE FUNNEL

CONCRETE



PILE CAPS









Some Problems of construction

Bangladesh University of Engineering and Technology



A destructive natural problem is:

Excavation Problems:

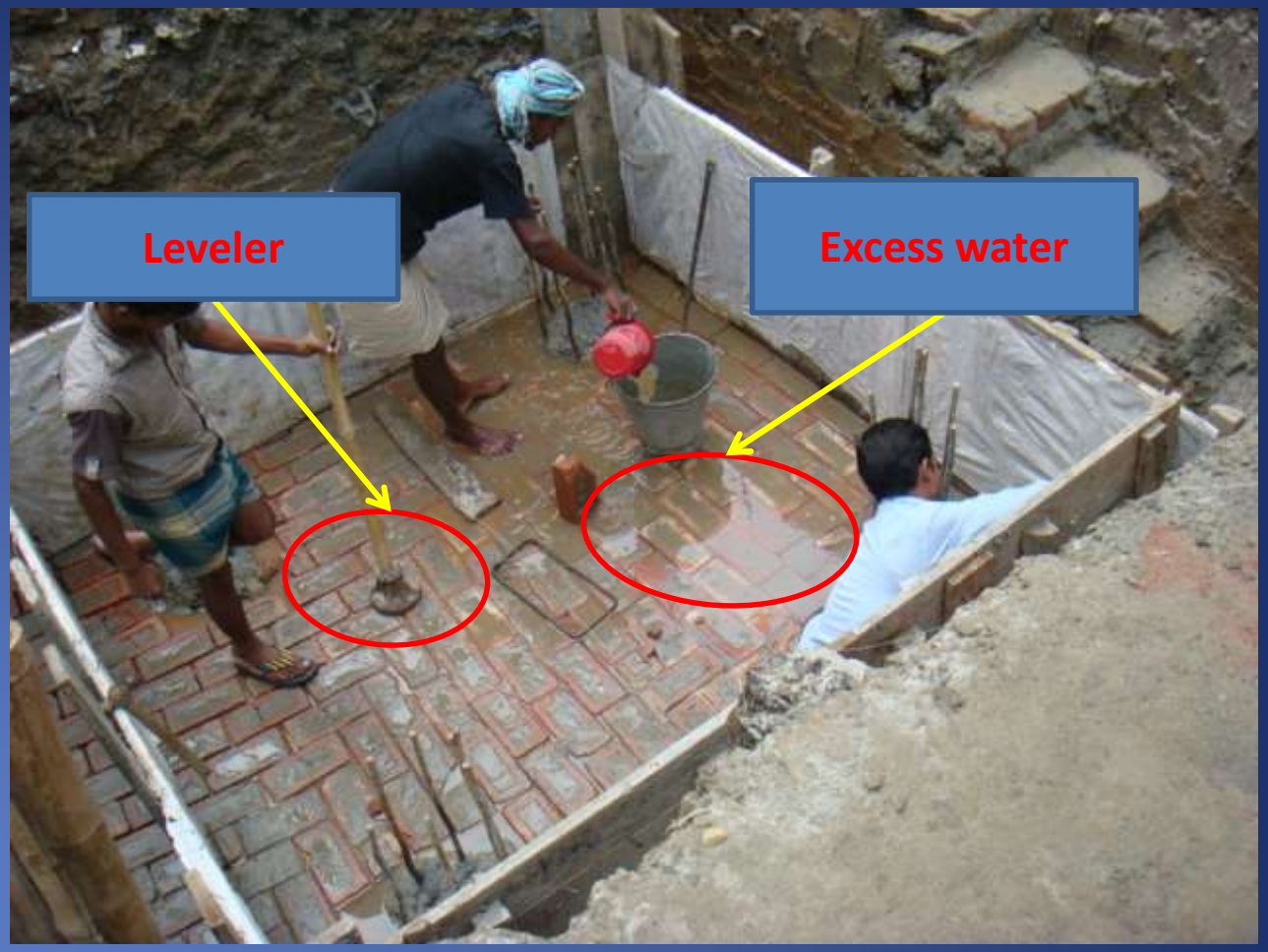


1. Rain water make the soft soil clay and it is easy to collapse.

2.Rain water can stay in the excavated area.

polythene

Draining the extra water manually



Vibrator touching reinforcement



Pile Cap Rebar



Excess water in concrete



For part by part work , there arise

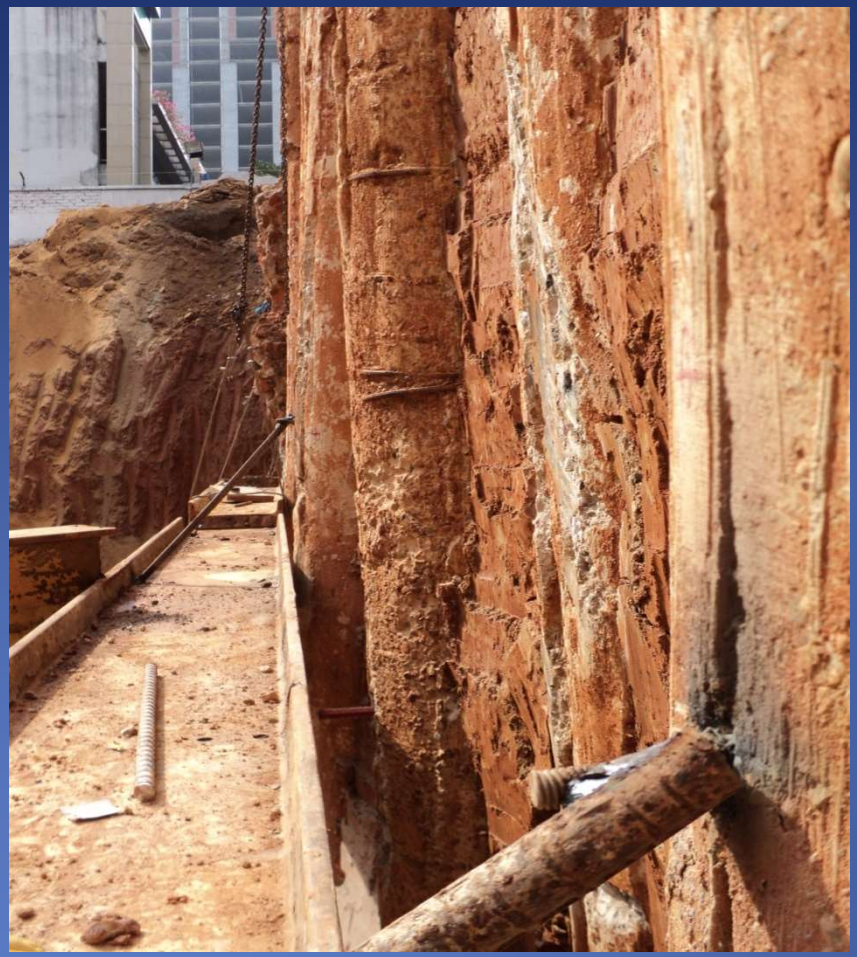
Joining effect:



Construction Joint

Water stopper

Construction Problems:



Piles were not on the same line



A displaced pile is creating problems for reinforcement work



THANKS

Bangladesh University of Engineering and Technology

CE 200
Lecture 2

Types of Building
& its Components
Design Loads
Frame Structure
Load Bearing Structure

Types of Buildings

- Occupancy Wise
  - Residential Building
  - Business Building
  - Mercantile Building
  - Industrial Building
  - Educational Building
  - Storage Building
  - Assembly Building
  - Hazardous Building
- Material Wise
  - Concrete Building
  - Steel Building
  - Masonry Building

Height/Story Wise
- Single Story Building
- Low-rise Building
- High-Rise Building
- Super High-Rise Building

Shape Wise
Rectangular Building
Curved Building
Flat Roof Building
Pitched Roof Building

Types of Building

- A structure consisting of walls, floors and roofs erected to provide space for different uses.

- Buildings can be classified depending on the character of occupancy or the type of use.
- Building can be classified depending on the type of materials used
- Building can be classified base on height/story
- Building can be classified based on shape of the structure

BNBC 2020: Classification

Table 3.1.1: Summary of Occupancy Classification

Occupancy Type	Subdivision	Nature of Use or Occupancy	Fire Index*
A: Residential	A1	Single family dwelling	1
	A2	Two families dwelling	1
	A3	Flats or apartments	1
	A4	Mess, boarding houses, dormitories and hostels	1
	A5	Hotels and lodging houses	1
B: Educational Facilities	B1	Educational facilities up to higher secondary levels	1
	B2	Facilities for training and above higher secondary education	1
	B3	Pre-school facilities	1
C: Institution for Care	C1	Institution for care of children	1
	C2	Custodial institution for physically capable adults	1
	C3	Custodial institution for the incapable adults	1
	C4	Penal and mental institutions for children	1
	C5	Penal and mental institutions for adults	1
D: Healthcare Facilities	D1	Normal medical facilities	2
	D2	Emergency medical facilities	2
E: Business	E1	Offices	2
	E2	Research and testing laboratories	2
	E3	Essential services	2
F: Mercantile	F1	Small shops and market	2
	F2	Large shops and market	2
	F3	Refueling station	2
G: Industrial Buildings	G1	Low hazard industries	3
	G2	Moderate hazard industries	3
H: Storage Buildings	H1	Low fire risk storage	3
	H2	Moderate fire risk storage	3
I: Assembly	I1	Large assembly with fixed seats	1
	I2	Small assembly with fixed seats	1
	I3	Large assembly without fixed seats	1
	I4	Small assembly without fixed seats	1
	I5	Sports facilities	1
J: Hazardous Building	J1	Explosion hazard building	4
	J2	Chemical hazard building	4
	J3	Biological hazard building	4
	J4	Radiation hazard building	4
K: Garage	K1	Parking garage	2
	K2	Private garage	1
	K3	Repair garage	3
L: Utility	L	Utility	2
M: Miscellaneous	M1	Special structures	2
	M2	Fences, tanks and towers	1

* Fire Index: fire index is an absolute number, Occupancy group having same fire index may be permitted as mixed occupancy and different fire index shall be separated or detached as per provisions of this Code.

Types of Building

1. **Residential Building:** Used for private dwellings

Example: Apartment houses, dormitories, hotels etc

2. **Educational Buildings:** Used for instruction, education, recreation or day care purposes

Example: School, college, university, day care center etc

3. **Institutional Building:** Used for medical or other treatments or care of persons suffering from physical or mental illness, care of infants and aged persons, penal or detention in which liberty is restricted

Example: hospitals, nursing homes, jails, orphanages, prisons, mental hospitals etc

Types of Building

4. **Assembly Building:** Where group of people can gather for amusement, recreation, social, religious, civil and similar purposes

Example: Restaurants, theater, gymnasiums, place of worship etc

5. **Business Building:** Used for transaction of business, for keeping records and accounts

Example: Court house, city hall, libraries etc

6. **Mercantile:** Used as shops, stores, for display and sale

Example: Shopping centers, display centers, retail etc

Types of Building

7. **Industrial Building:** Where products or materials of all kinds and properties are fabricated or processed

Example: Mills, gas plants, refineries etc

8. **Storage Building:** Used for storage of goods and wares.

Example: Warehouses, hangers, garages etc

9. **Hazardous Building:** Used for storage, handling, manufacture or processing of highly explosive materials

Example: Acid & alkalis producing buildings, nuclear power plants etc

Components of Building

- Building can be broadly divided into two parts:

I. Sub structure: portion of building below ground level

II. Super structure: portion of building above ground level

Components of building can be summarized as:

1. **Foundation:** Lowest part of any structure below ground level which is in direct contact with ground.

Purpose:

a) Gives a firm base for the whole structure

b) Transmits all loads from the super structure to the soil

- In case of load bearing structure it could be spread footing
- In framed structure it could be individual column footing, combined footing, mat or piles

Components of Building

2. **Plinth:** Portion of building between the ground and the top of the floor immediately above the ground.

Purpose:

a) Prevent rain water & insects entering into the building

3. **Walls:** Constructed by building units like bricks, blocks, hollow bricks etc.

Purpose:

a) Enclose the floor space in desired pattern
b) Walls provide privacy, security
c) Gives protection against rain, sun, cold and other adverse effects of the environment

Components of Building

- For a well planed layout walls should be provided such a way that it would provide

i. Maximum carpet area &
ii. Minimum area of circulation

- Walls can be divided into two categories

1. Load bearing wall: used in non framed structure
2. Non load bearing wall: used in framed structure

Components of Building

4. Column: Vertical load bearing member in framed structure

Purpose:

a) To support the gravity load from slab & beam

b) To carry the load to the foundation

- Pier is a vertical load bearing member like column which is used in load bearing walls to strengthen the wall for resisting lateral pressure without buckling

Components of Building

5. Floors: Flat supporting elements of a building.

Purpose:

a) Divide a building into different floor levels

b) Provide a dry & firm platform for people

- Depending on the position floors can be categorized as:

i. Basement Floor: Floors below natural ground level

ii. Upper Floor: Floors above natural ground level and termed as ground floor, 1st floor, 2nd floor and so on

- Each floor mainly consists of two parts:

i. Sub Floor: Structural component of floor which supports all the loads

ii. Flooring: Covering layer of desired specification

Components of Building

6. Doors, Windows & Ventilators:

Purpose:

a) Provide air & ventilation in the building

b) Provide day light & vision

- Door & Window mainly consists of two parts:

i. Frame: permanently held in position

ii. Shutter: moving part of the door

Components of Building

7. Stair: A structure composing a number of steps connecting one floor to another

Purpose:

a) Permit safe & easy communication between floor to floor

b) Connects one floor with another

8. Roof: Uppermost component of a building

Purpose:

a) Cover the space below

b) Prevents rain, sun, wind etc.

- A roof can be flat, curved or pitched in shape

Components of Building

- Roof is consists of two components:

i. Roof decking: structural component

ii. Roof covering: finishing or covering above roof decking. Materials like lime concrete, tiles, GI sheets etc is used as roof covering.

Purpose of roof covering:

a) Provide suitable slope for draining of rain water

b) Act as insulation layer for providing thermal comfort to the users

Components of Building

9. Building Finishes: plastering, white washing, painting, surface finishing etc

Purpose:

a) Protects the surface from adverse weathering effects

b) Provide decorative effects

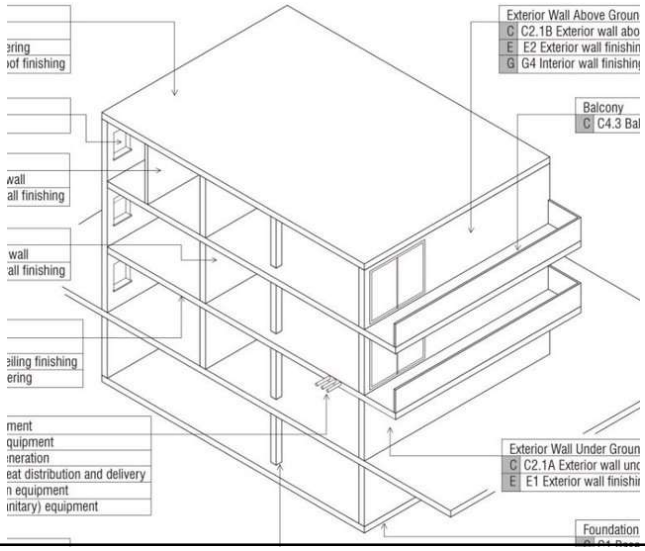
10. Building Services: water supply, drainage, electricity, fire safety etc

Purpose:

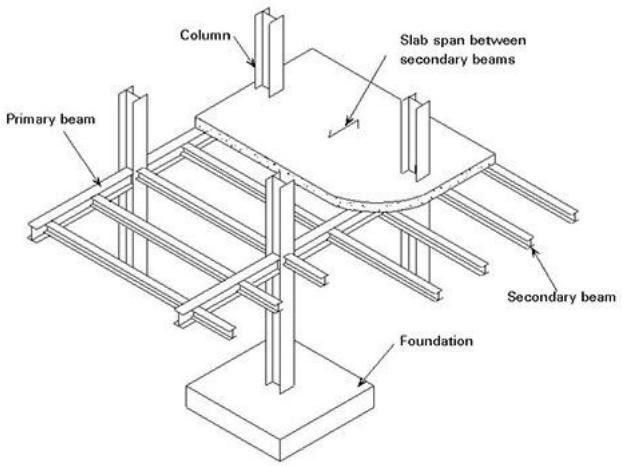
a) Meet the basic needs of modern facilities

b) Provides safety & comfort to the users

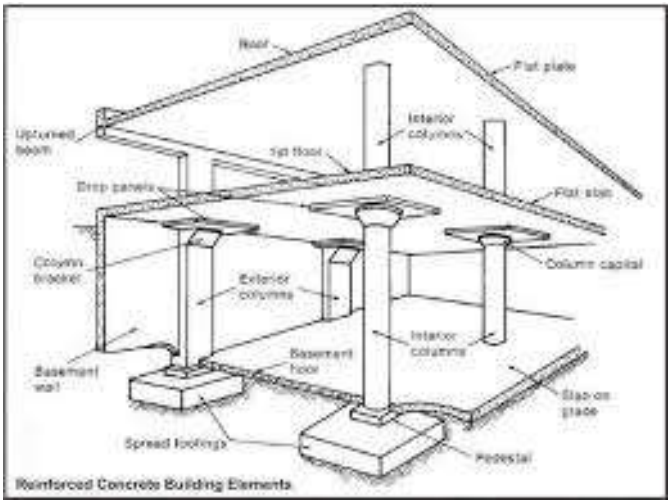
Building Componets



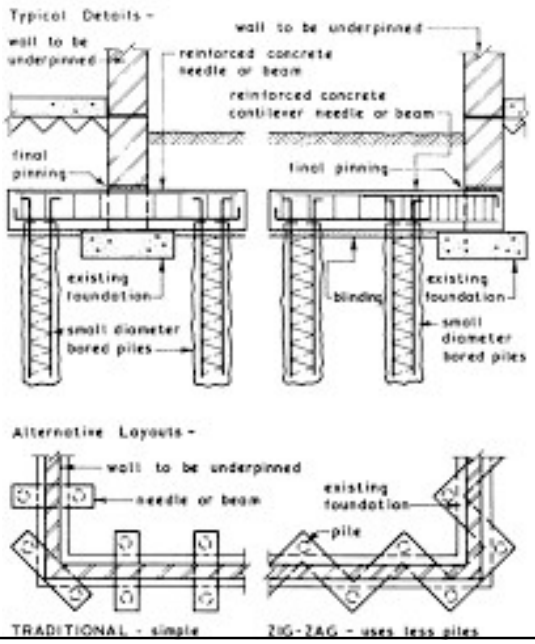
Building Components (Frame Structure)

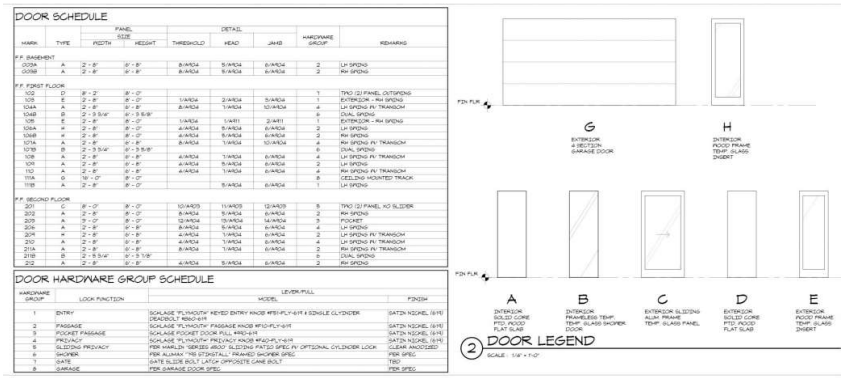


Building Componets



Substructure Components





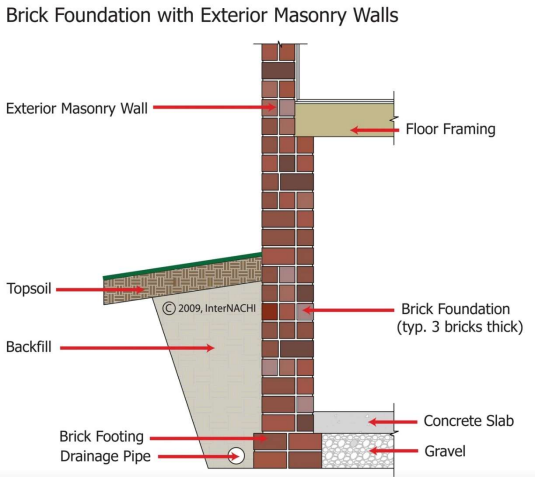
DOOR SCHEDULE

MARK	TYPE	PANEL SIZE WIDTH	PANEL SIZE HEIGHT	DETAIL THRESHOLD	DETAIL HEAD	DETAIL JAMB	HARDWARE GROUP	REMARKS
P.F. BASEMENT								
005A	A	2' - 8"	6' - 8"	8/AR24	5/AR24	6/AR24	2	LH SWING
005B	A	2' - 8"	6' - 8"	8/AR24	5/AR24	6/AR24	2	RH SWING
P.F. FIRST FLOOR								
102	D	8' - 2"	8' - 0"				1	TPO (2) PANEL OUTSWING
103	E	2' - 8"	8' - 0"	1/AR24	2/AR24	5/AR24	1	EXTERIOR - RH SWING
104A	A	2' - 8"	8' - 0"	8/AR24	1/AR24	10/AR24	4	LH SWING W/ TRANSOM
104B	B	2' - 3 5/4"	6' - 3 5/8"				6	DUAL SWING
105	E	2' - 8"	8' - 0"	1/AR24	1/AR11	2/AR11	1	EXTERIOR - RH SWING
106A	H	2' - 8"	8' - 0"	6/AR24	5/AR24	6/AR24	2	LH SWING
106B	H	2' - 8"	8' - 0"	6/AR24	5/AR24	6/AR24	2	RH SWING
107A	A	2' - 8"	8' - 0"	8/AR24	1/AR24	10/AR24	4	RH SWING W/ TRANSOM
107B	B	2' - 3 5/4"	6' - 3 5/8"				6	DUAL SWING
108	A	2' - 8"	8' - 0"	6/AR24	1/AR24	6/AR24	4	LH SWING W/ TRANSOM
109	A	2' - 8"	8' - 0"	6/AR24	5/AR24	6/AR24	2	LH SWING
110	A	2' - 8"	8' - 0"	6/AR24	1/AR24	6/AR24	4	RH SWING W/ TRANSOM
111A	G	16' - 0"	8' - 0"				8	CEILING MOUNTED TRACK
111B	A	2' - 8"	8' - 0"		5/AR24	6/AR24	1	LH SWING
P.F. SECOND FLOOR								
201	C	8' - 0"	8' - 0"	10/AR29	11/AR29	12/AR29	5	TPO (2) PANEL XO SLIDER
202	A	2' - 8"	8' - 0"	8/AR24	5/AR24	6/AR24	2	RH SWING
203	A	3' - 0"	8' - 0"	12/AR24	13/AR24	14/AR24	3	POCKET
204	A	2' - 8"	8' - 0"	8/AR24	5/AR24	6/AR24	4	LH SWING
209	H	2' - 8"	8' - 0"	6/AR24	1/AR24	6/AR24	2	LH SWING W/ TRANSOM
210	A	2' - 8"	8' - 0"	6/AR24	1/AR24	6/AR24	4	LH SWING W/ TRANSOM
211A	A	2' - 8"	8' - 0"	8/AR24	1/AR24	6/AR24	2	RH SWING W/ TRANSOM
211B	B	2' - 8 5/4"	6' - 3 7/8"				6	DUAL SWING
212	A	2' - 8"	8' - 0"	6/AR24	5/AR24	6/AR24	2	RH SWING

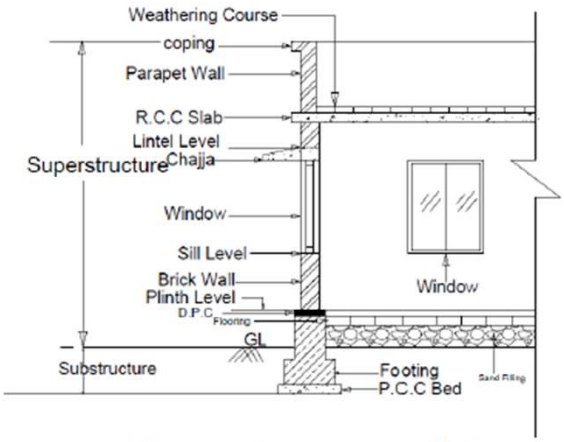
DOOR HARDWARE GROUP SCHEDULE

HARDWARE GROUP	LOCK FUNCTION	LEVER/PULL MODEL	FINISH
1	ENTRY	SCHLAGE "FLYMOUTH" KEYED ENTRY KNOB #FSH-FLY-619 X SINGLE CYLYINDER DEADBOLT #B662-619	SATIN NICKEL (619)
2	PASSAGE	SCHLAGE "FLYMOUTH" PASSAGE KNOB #FSH-FLY-619	SATIN NICKEL (619)
3	POCKET PASSAGE	SCHLAGE POCKET DOOR PULL #PRD-619	SATIN NICKEL (619)
4	PRIVACY	SCHLAGE "FLYMOUTH" PRIVACY KNOB #FSH-FLY-619	SATIN NICKEL (619)
5	SLIDING PRIVACY	PER HAMLIN SERIES 4800 SLIDING PATIO SPEC IV, OPTIONAL CYLINDER LOCK	CLEAR ANODIZED
6	SHOWER	PER ALUMAX "PS 1/2"INSTALL" FRAMED SHOWER SPEC	PER SPEC
7	GATE	GATE SLIDE BOLT LATCH OPPOSITE CANE BOLT	TBD
8	GARAGE	PER GARAGE DOOR SPEC	PER SPEC

Building Components (Masonry Wall)

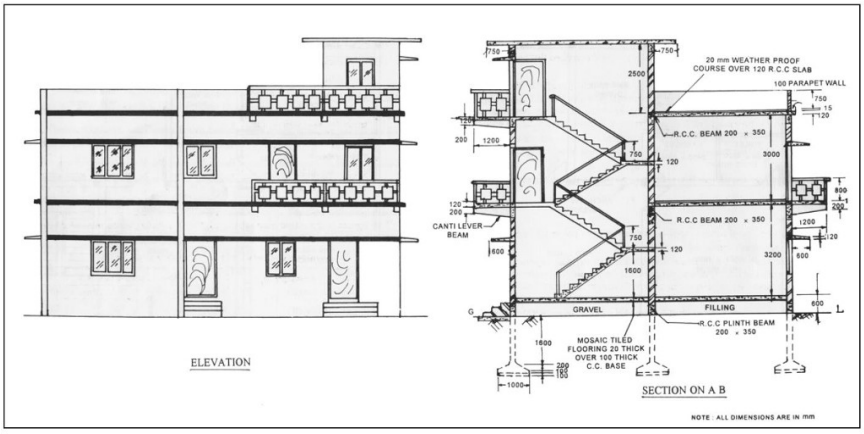


Building Section (Masonry Wall Type)

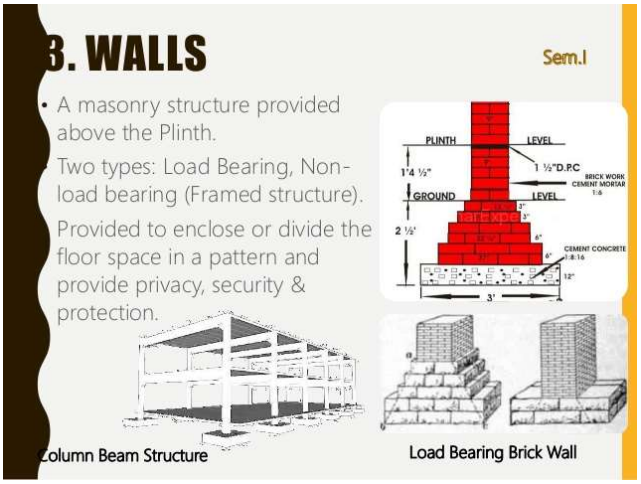


Section of Load Bearing Wall

Elevation and Section of Building



Frame Structure Vs. Masonry Walls



Finishing Items/Schedule of a Building

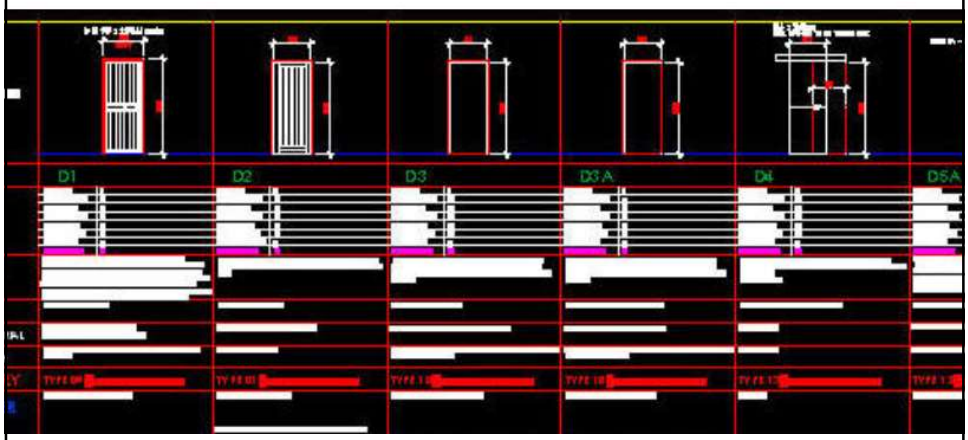
A **Finish Schedule** is a form of product specification writing that outlines the materials desired on a **construction** project. Specifically, a **Finish Schedule** outlines floor, wall, ceiling materials and excludes lighting, windows, doors, and furniture.

Finish Schedule

NTERIOR FINISH SCHEDULE

ACE	FLOOR	BASE				WALLS				WAINSCOT				CEILING			REMARKS
NAME		NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST	FINISH	HEIGHT	CROWN	
RONALD REAGAN SUITE																	
ENTRY	PORC	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT1		ADJ/AFS	
PARLOR	PORC	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT1		ADJ/AFS	3/4", 1 1/2" ST2 COUNTERTOP
VANITY	PORC	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT4		ADJ/AFS	
TOILET	PORC	ST2	ADJ/AFS	ST2	ST2	SFS	SFS	SFS	SFS	-	-	-	-	PT4		ADJ/AFS	1 1/4" ST2 COUNTERTOP
BEDROOM	CPT	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT1		ADJ/AFS	
TOILET	ST2	ST2	ST2	ST2	ST2	SFS	SFS	SFS	SFS	-	-	-	-	PT4		ADJ/AFS	3/4", 1 1/4" ST1 COUNTERTOP AND TUB DECK, ST2 SHOWER
TOILET	ST2	ST2	ST2	ST2	ST2	SFS	SFS	SFS	SFS	-	-	-	-	PT4		ADJ/AFS	N/A
FOYER	PORC	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT1		ADJ/AFS	
BEDROOM	CPT	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT1		ADJ/AFS	
VANITY	ST2	ADJ/AFS	ADJ/AFS	ADJ/AFS	ADJ/AFS	SFS	SFS	SFS	SFS	-	-	-	-	PT1		ADJ/AFS	3/4", 1 1/2" ST2 COUNTERTOP
TOILET	ST2	ST2	ST2	ST2	ST2	SFS	SFS	SFS	SFS	-	-	-	-	PT4		ADJ/AFS	3/4", 1 1/2" ST2 COUNTERTOP AND TUB DECK

Door Schedule: Example



Types of Loads

1) Dead Loads Gravity load
2) Live Loads
3) Environmental Loads
   - Wind load Lateral load
   - Earthquake load
   - Snow load
   - Rain load
   - Flood load

Impact loads (Special type)

Loading

- Buildings are designed to carry all gravity loads and lateral loads to be seen during construction and service.
- Must consider sequential loading (particularly during construction)
- Types of Loading:
  - Dead (Weight of structure & fixtures)
  - Live (Occupancy Loads)
    - Impact (hammering, marching on a bridge, machines that have vibrations)
    - Snow
    - Wind
    - Temperature (expanding and shrinking)
    - Seismic

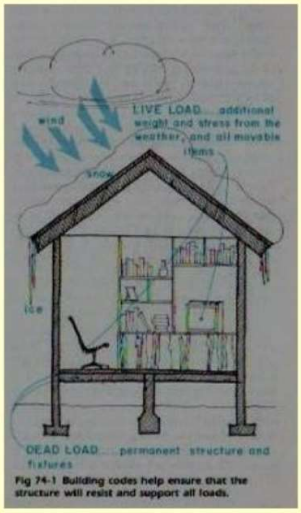
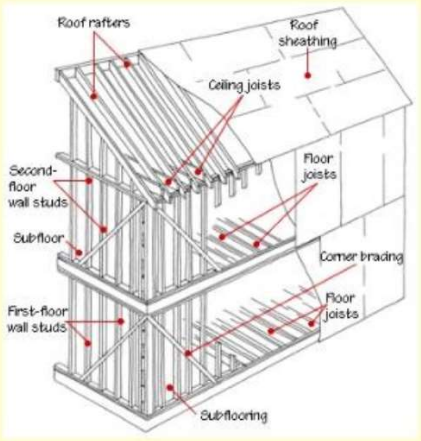


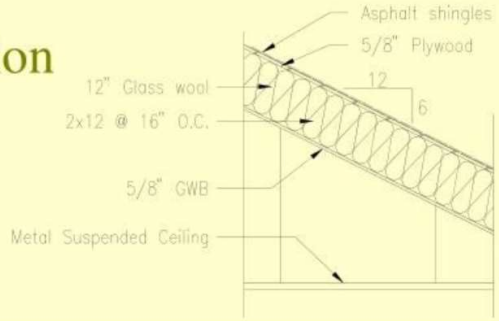
Fig 74-1 Building codes help ensure that the structure will resist and support all loads.

Dead Load

- **Dead loads** are the weights of all items permanently attached to the structure.
- Dead loads in a residential structure are usually calculated at 20 lbs psf (per square foot).
- Partitions (interior walls) are usually 20 lbs psf.



DL Roof Calculation

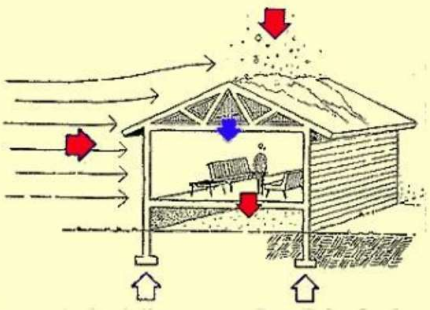


Roof Dead Load

	Slope/12	Flat	Slope Adjusted	
Asphalt Shingles	6	2.5	1.12	2.8 psf
5/8" Plywood	6	1.8	1.12	2.0 psf
2x12 @ 16" O.C.	6	3.3	1.12	3.7 psf
Insulation	6	3.6	1.12	4.0 psf
5/8" GWB	6	2.8	1.12	3.1 psf
Suspended Ceiling	0	1.8	1.00	1.8 psf
Misc				1.5 psf
Total				19.0 psf

Live Loads

- Live loads are any loads that are not permanently attached to the structure.
- Live loads in a residential structure generally are expected to be 40 lbs psf (per square foot).



What do the Two white arrows represent?

Forces are equal and opposite so the white arrows indicate an upward force on the bottom of the footing to support the house.

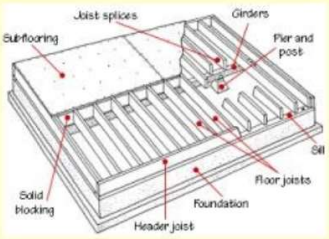
What do the three red arrows represent?

Wind, Snow, People, Furniture all live loads.

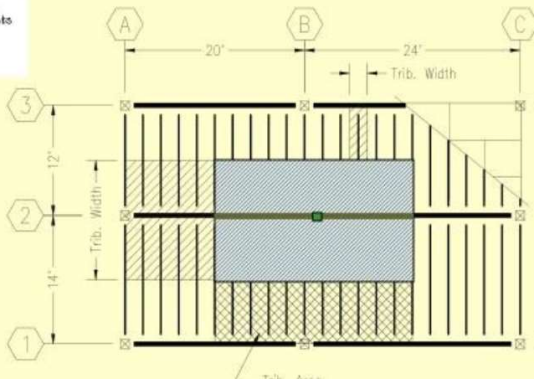
What does the blue arrow represent?

Attic storage which is also a live load.

Tributary Area On A Floor



- Applied load is uniformly distributed.



Each member supports the load and transfers it to a larger member.

Tributary area on the post or lally column.

Building Codes

- **Building Codes**

  Regulations established by a local government describing the minimum structural requirements for buildings. Specifications involve the foundation, roofing, plumbing, electrical, and other matters of safety and sanitation.



"Sorry, but you're in violation of building codes. You can only use lo-cal hi-fiber wood here."

BNBC 2020
Dead Load
(Weight of building materials)

Table 6.2.1: Unit Weight of Basic Materials

Material	Unit Weight (kN/m³)	Material	Unit Weight (kN/m³)
Aluminium	27.0	Granite, Basalt	26.4
Asphalt	21.2	Iron - cast	70.7
Brass	83.6	- wrought	75.4
Bronze	87.7	Lead	111.0
Brick	18.9	Limestone	24.5
Cement	14.7	Marble	26.4
Coal, loose	8.8	Sand, dry	15.7
Concrete - stone aggregate (unreinforced)	22.8*	Sandstone	22.6
- brick aggregate (unreinforced)	20.4*	Slate	28.3
Copper	86.4	Steel	77.0
Cork, normal	1.7	Stainless Steel	78.75
Cork, compressed	3.7	Timber	5.9-11.0
Glass, window (soda-lime)	25.5	Zinc	70.0

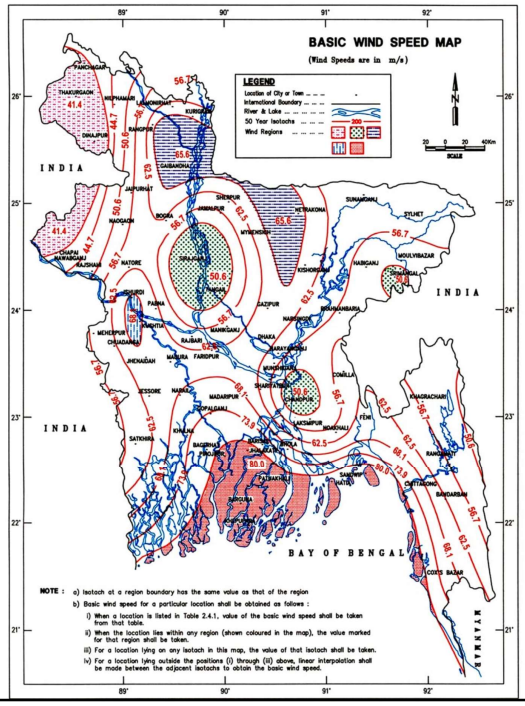
* for reinforced concrete, add 0.63 kN/m³ for each 1% by volume of main reinforcement

BNBC 2020
Live Loads

Table 6.2.3: Minimum Uniformly Distributed and Concentrated Live Loads[a]

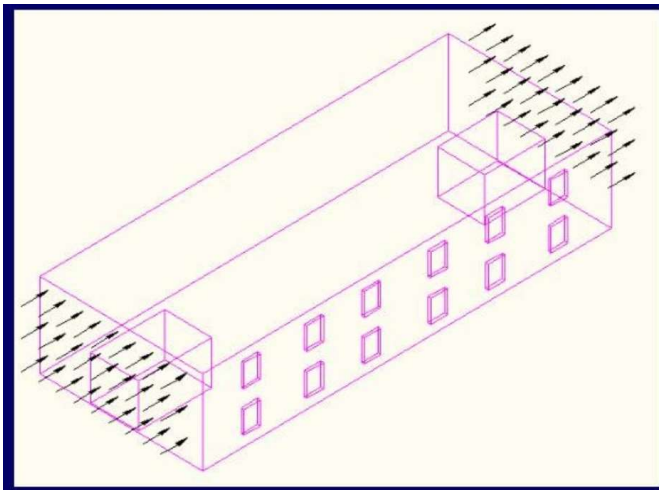
Occupancy or Use	Uniform kN/m²	Concentrated kN
Apartments (see Residential)		
Access floor systems		
Office use	2.40	9.0
Computer use	4.80	9.0
Armories and drill rooms	7.20	--
Assembly areas and theaters		
Fixed seats (fastened to floor)	2.90	--
Lobbies	4.80	--
Movable seats	4.80	--
Platforms (assembly)	4.80	--
Stage floors	7.20	--
Balconies (exterior)	4.80	--
On one- and two-family residences only, and not exceeding 19.3 m²	2.90	--
Bowling alleys, poolrooms, and similar recreational areas	3.60	--
Catwalks for maintenance access	2.00	1.33
Corridors		
First floor	4.80	--
Other floors, same as occupancy served except as indicated		
Dance halls and ballrooms	4.80	--
Decks (patio and roof)	Same as area served, or for the type of occupancy accommodated	
Dining rooms and restaurants	4.80	--
Dwellings (see *Residential*)	--	
Elevator machine room grating (on area of 2,580 mm²)	--	1.33
Finish light floor plate construction (on area of 645 mm²)	--	0.90
Fire escapes	4.80	--
On single-family dwellings only	2.00	--
Fixed ladders	See Sec 2.3.11	
Garages (passenger vehicles only), Trucks and buses	2.0[b,c]	
Grandstands	See *Stadiums and arenas, Bleachers*	
Gymnasiums—main floors and balconies	4.80	--
Handrails, guardrails, and grab bars	See Sec 2.3.11	
Hospitals		
Operating rooms, laboratories	2.90	4.50
Patient rooms	2.00	4.50
Corridors above first floor	3.80	4.50
Hotels	See *Residential*	
Libraries		
Reading rooms	2.90	4.50
Stack rooms	7.20[d]	4.50
Corridors above first floor	3.80	4.50

BNBC 2020



Wind load

- Wind pressure to be used in design should be based on a wind velocity having a specific mean recurrence interval.
- The flow of air close to ground is slowed by surface roughness, which depends on density, size and height of buildings, trees, vegetation etc.
- Velocity at 33ft (UBC: Sec 1616) above ground is used as the basic values for design purpose.



Earthquake Load

Factors effecting earthquake response of structure

Structure response to an earthquake primarily depends upon:

- Mass
- stiffness
- natural period of vibration
- damping characteristics of structure
- location from epicenter
- topography & geological formation.

BNBC 2020

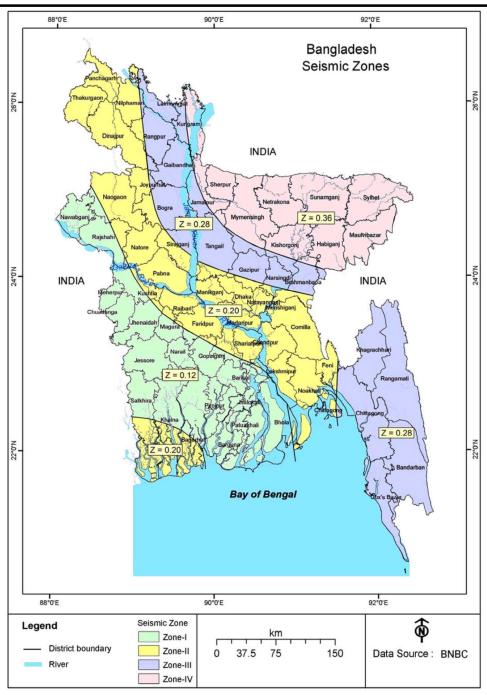
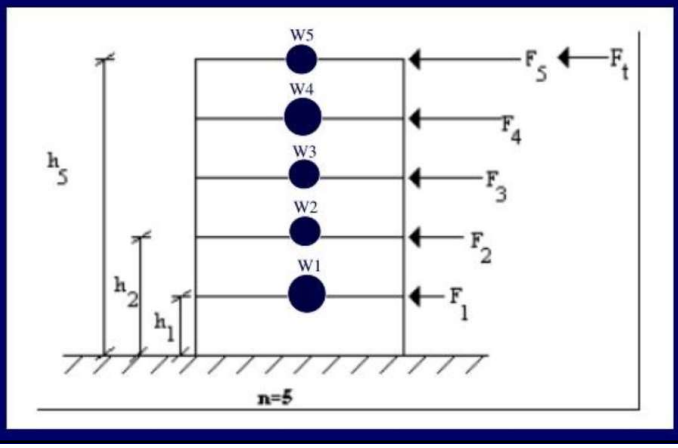


Figure 6.2.24 Seismic zoning map of Bangladesh

Earthquake Load UBC 97

- Total force shall be distributed over height in the following manner:



Impact Load

- Spring Example
- It is customary to express Impact load as percentage of static force.
- Effect of impact load is taken into account in calculation of loads.
- If impact is 25 %, Live load is multiplied by 1.25
- According to AISC live load on hangers supporting floor and balcony construction should be increased by one-third for impact.

Assignment

1) Explain different components of a building with the help of sketches wherever possible.

~~2) Prepare a finish schedule for multistoried apartment building including door/window schedules.~~

CONCRETE

Three Gorges Dam



The project used 27.2 million m^3 (35.6 million cu yd) of concrete







Constituents

- Cementing material (cement, lime)
- Coarse Aggregate (brick chips, stone chips)
- Fine Aggregate (sand)
- Water
- Admixtures



Types

- Cement Concrete (CC)
- Reinforced Cement Concrete (RCC)
- Lime Concrete (LC)
  - Lime concrete cannot be made reinforced, as lime eats away the steel in due course of time.

Advantages & Disadvantages

Advantages:

- Versatile
- Economical
- Strong and Durable
- Fire resistant

Disadvantages:

- Low tensile strength
- Low ductility
- Volume instability
- Low strength to weight ratio

PROPERTIES OF FRESH CONCRETE

Concrete uniformity has generally been measured in terms of compressive strength, slump, unit weight, air content, and content of coarse aggregate or cement. That is, when all the constituents are in proper uniform state to be a fresh concrete for use, that is called uniformity

- Workability
- Segregation
- Bleeding
- Setting Time
- Uniformity

Concrete workability basically refers to how easily freshly mixed concrete can be placed, consolidated and finished with minimal loss of homogeneity. Generally the workability of concrete is determined by how fluid the mix is (i.e. the cement to water ratio).

Segregation of concrete is the separation of cement paste and aggregates of concrete from each other during handling and placement. Segregation also occurs due to over-vibration or compaction of concrete, in which cement paste comes to the top and aggregates settles at the bottom.

BLEEDING in concrete is a phenomenon in which free water in the mix rises up to the surface and forms a paste of cement on the surface known as “laitance” .Bleeding occurs in concrete when course aggregates tends to settle down and free water rises up to the surface. Bleeding is a type of segragation, in which water comes out of concrete.

The action of changing mixed cement from a fluid state to a solid state is called setting of cement and time required for it to set is called setting time of cement. Setting time of cement is same as setting time of concrete



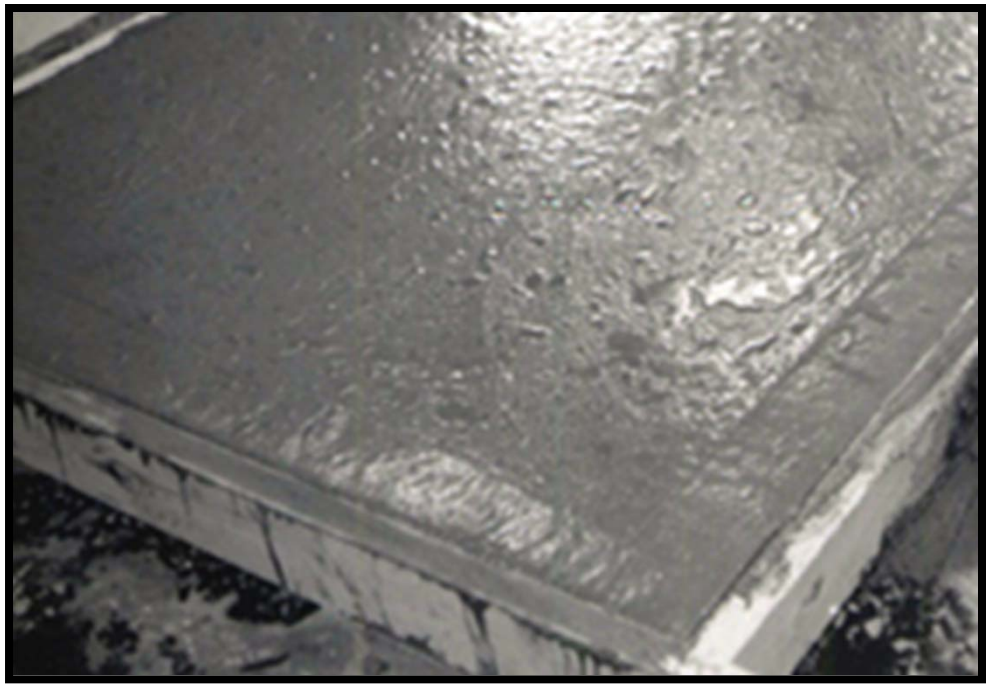
Workability



Measurement of workability by slump test



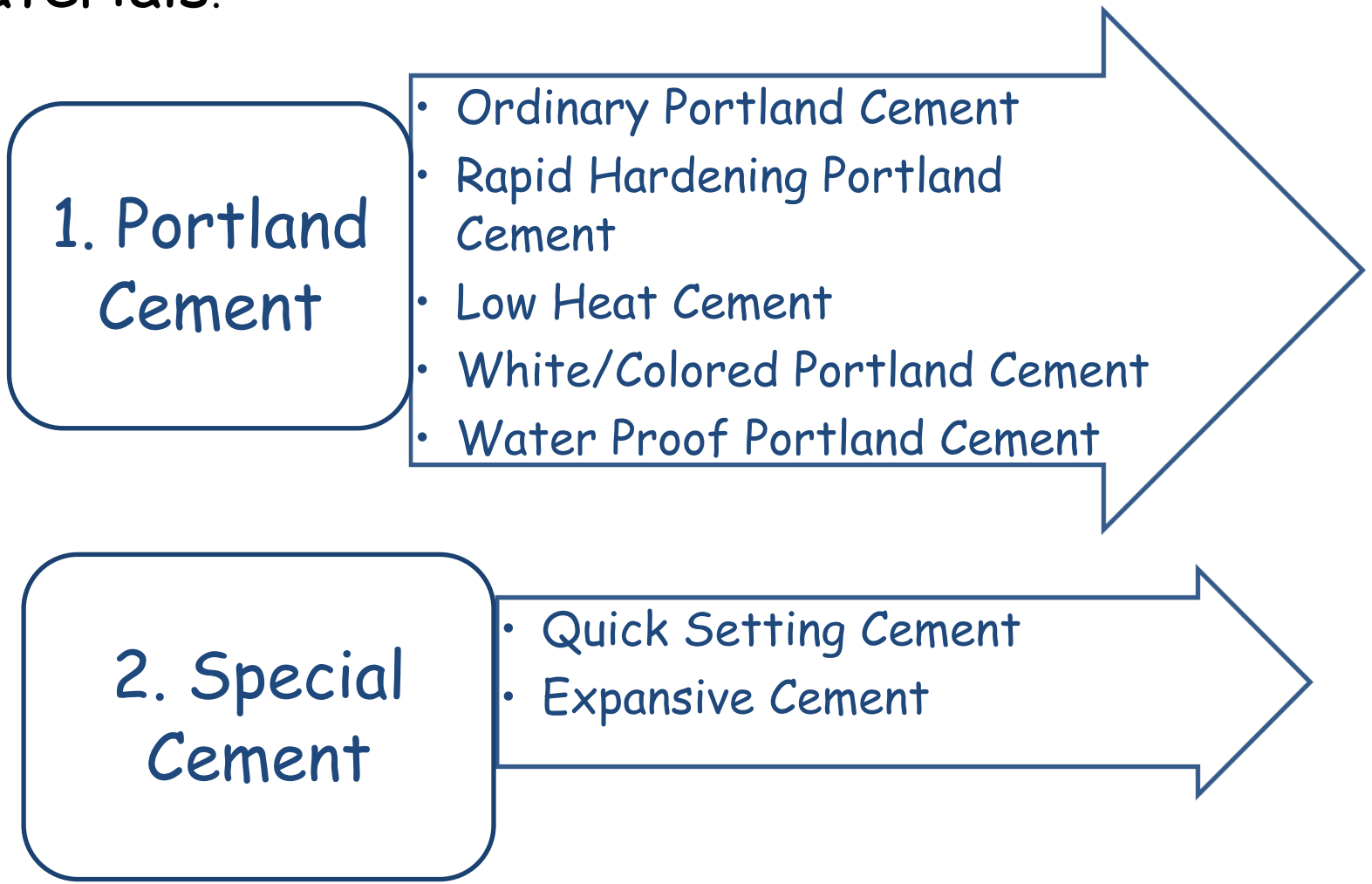
Segregation



Bleeding

CEMENTING MATERIAL

Any substance which acts as a binding agent for materials.



STORAGE OF CEMENT

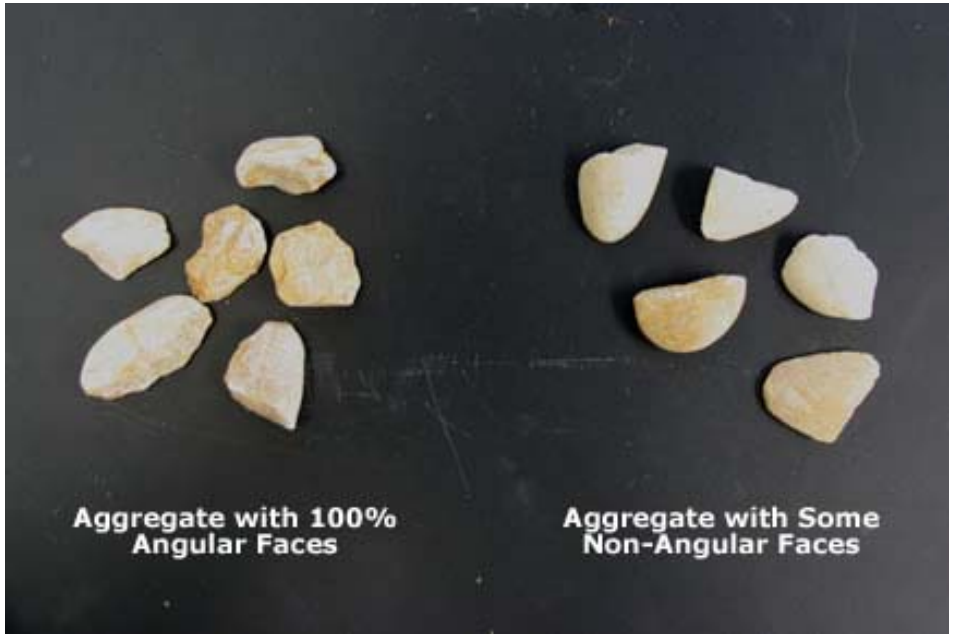
- Protection from rain, sun, winds and moisture
- Stored in dry, leak proof and moisture proof sheds
- Stacked on wooden planks placed above slab
- Space should be kept between the exterior wall and the stacks
- The maximum height of the stack should not exceed 15 bags
- In monsoon when cement bags need to store for very long period, cement stacks should be completely enclosed by polythene sheet or some other water proofing membrane.

AGGREGATE

- Course Aggregate (CA)
- Fine Aggregate (FA)
- Silt
- Loam: A soft deposit consisting of sand, silt and clay in about equal proportion



Rounded



Angular: well defined edges



Elongated

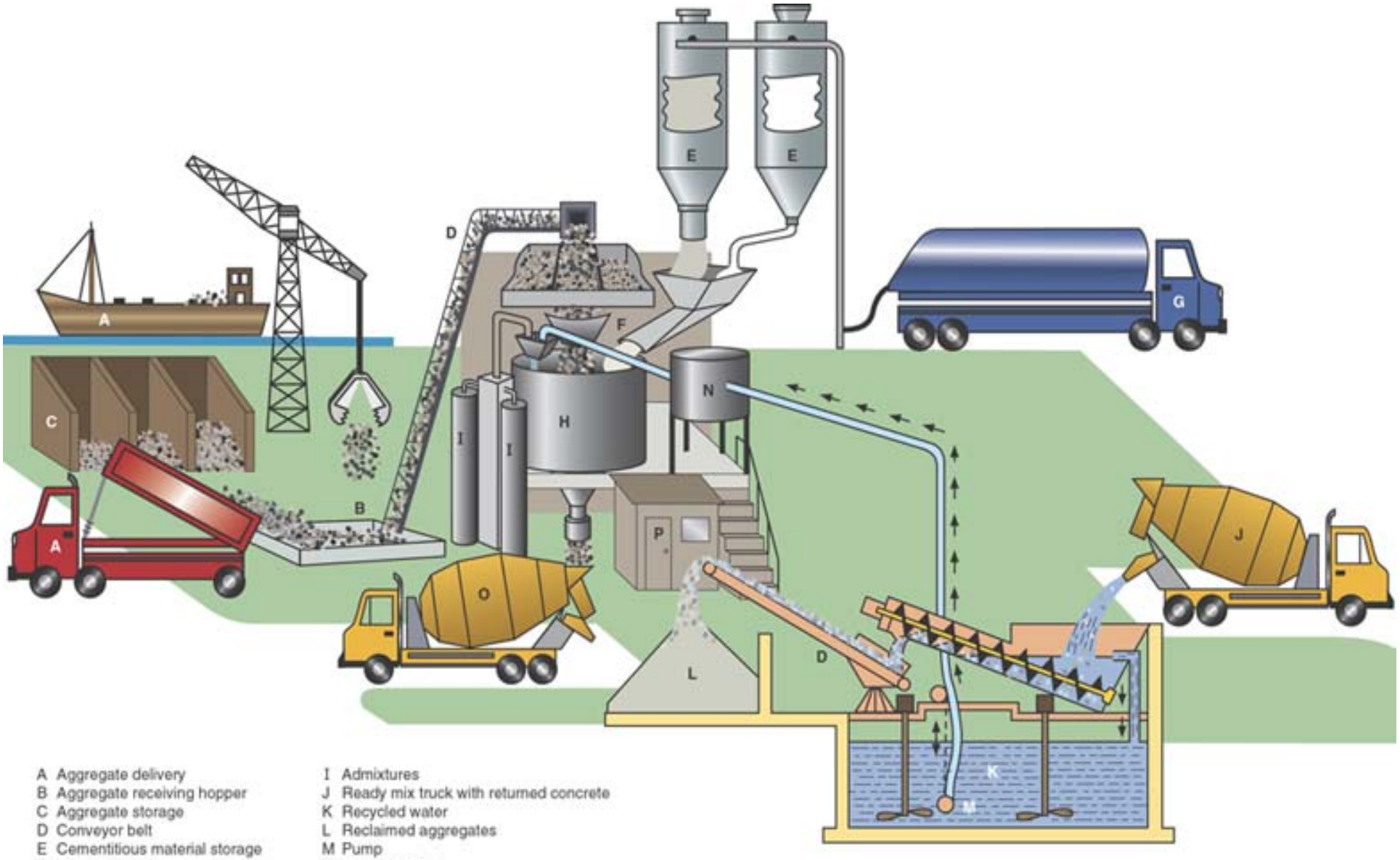


Flaky

MIXING OF CONCRETE

- Ready-Mix concrete: In this type ingredients are introduced into a mixer truck and mixed during transportation to the site.
  - Wet – Water added before transportation
  - Dry – Water added at site
- Mixing at the site
  - Hand mixed
  - Mixer mixed

READY MIX CONCRETE



A Aggregate delivery
B Aggregate receiving hopper
C Aggregate storage
D Conveyor belt
E Cementitious material storage
F Weigh hopper
G Cement delivery
H Mixer
I Admixtures
J Ready mix truck with returned concrete
K Recycled water
L Reclaimed aggregates
M Pump
N Water storage
O Concrete loaded in ready-mix truck
P Control room

MIXİNG AT SITE



Mixer mixed



Hand mixed

- Undermixing → non-homogeneity
- Overmixing → danger of water loss, brekage of aggregate particles

ADVANTAGES & DISADVANTAGES OF RMC

Advantages:

- Reduced construction cost and time
- Ensured Quality
- Reduced maintenance cost
- Useful for densely populated area

Disadvantages:

- The traveling time from the plant to the site
- Generation of additional road traffic.
- Admixture is added to increase the time span before setting and to increase workability.

RMC Companies in Bangladesh

- NDE Ready Mix Concrete
- ABC Ready Mix Concrete
- Shah Cement Ready Mix Concrete
- Concord Ready Mix Concrete
- SEL Ready Mix Company etc.

TRANSPORTING THE CONCRETE

- Concrete prepared has to be transported to its place of use before hydration of cement starts.
- During transportation, efforts should be made to prevent segregation of concrete.

PLACING OF CONCRETE

- To avoid segregation, concrete should not be dropped from height more than 1m.




gettyimages
alexandrumagurean
175511542

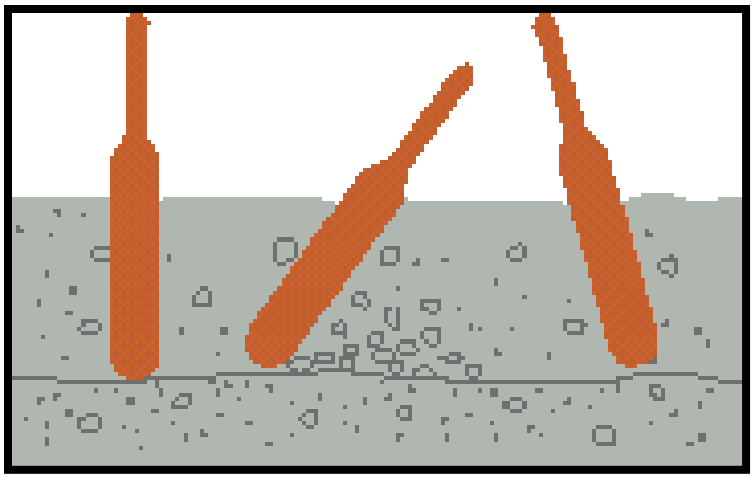




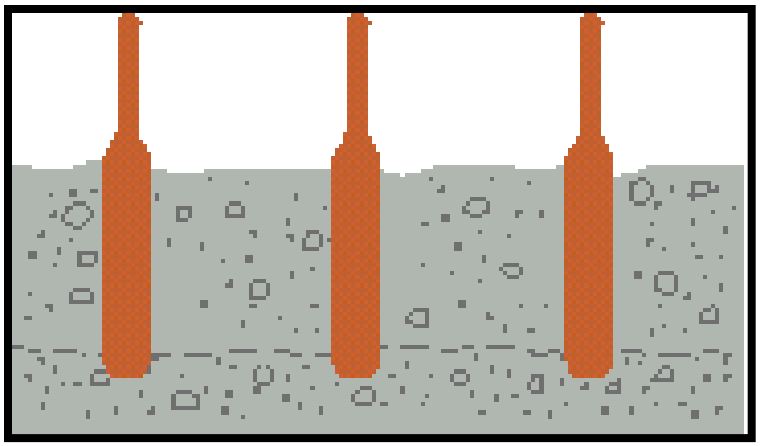

Download from
Dreamstime.com
This watermarked comp image is for previewing purposes only
ID 52471731
Aisyaqilumar | Dreamstime.com

COMPACTION OF CONCRETE

- The process of compacting concrete consists essentially of the elimination of entrapped air. This can be achieved by:
  - Tamping or rodding the concrete
  - Use of vibrators



Incorrect



Correct

CURING OF CONCRETE

- Using wet covers
- Sprinkling
- Ponding
- Water proof plastics



Sprinkling



Wet covers

Curing of concrete is defined as providing adequate moisture, temperature, and time to allow the concrete to achieve the desired properties for its intended use



Ponding



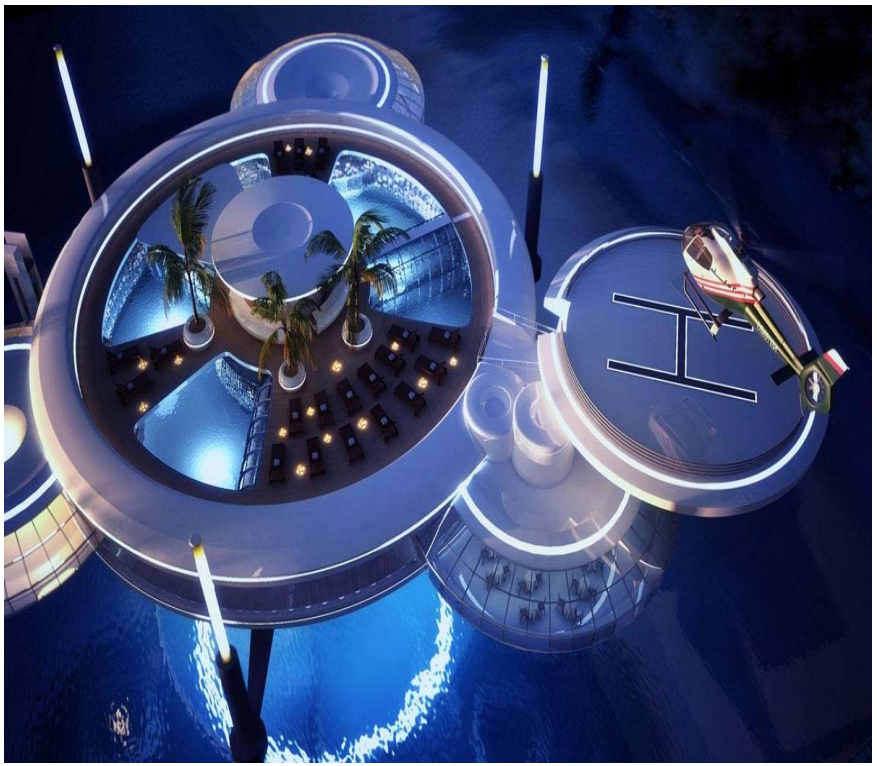
Water proof plastic

Under Water Concreting

Required when concrete has to be placed under water



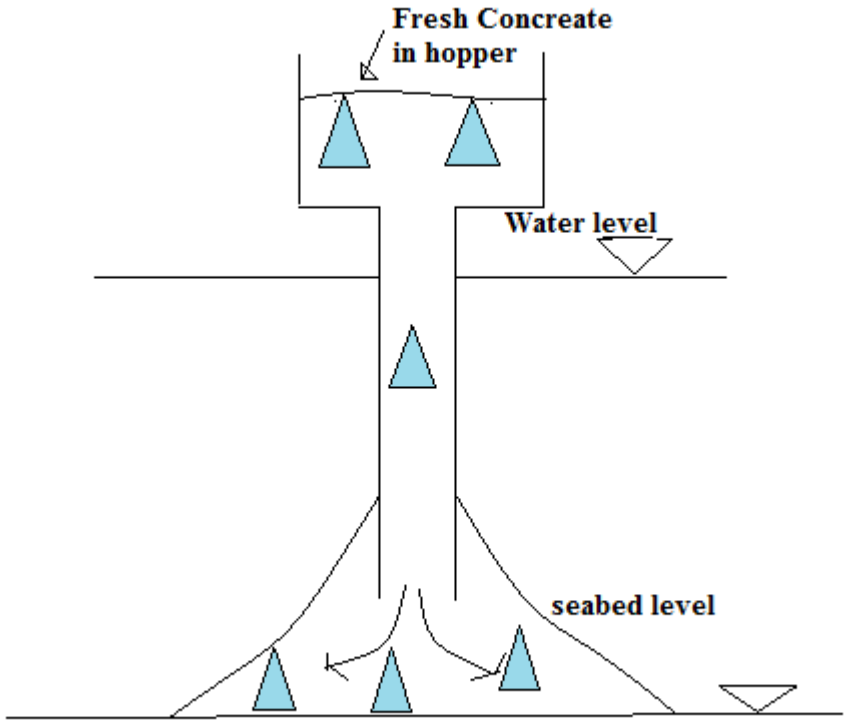
Palm Island, Dubai



Under Water Hotel, Dubai

Problems of Under Water Concreting

- Cement wash out
- Segregation
- Water entrapment



Characteristics of Under Water Concrete

- **Flowability**

Concrete must be able to flow out easily under water and completely fill the placement area without trapping water inside.

- **Self Compaction**

As it is impractical to use mechanical vibrator under water, the concrete must compact itself by its own weight.

- **Rapid Hardening**

Concrete is required to harden quickly under water to prevent cement wash out.

Concrete Production

Offshore concrete production

Concrete production from a floating batch plant



Concrete Production

Onshore concrete production

Concrete delivery on transit mixer



Concrete Placement

Mainly two method for placing concrete under water

- **The tremie method**: places concrete solely by gravity in an open air environment.

- **Skip/Bottom opening bucket:** a bottom bucket equipped with a rolling gate is used

Tremie Method

- Consists of a rigid pipe suspended vertically below water and a hopper fixed at the top of the pipe to receive concrete.

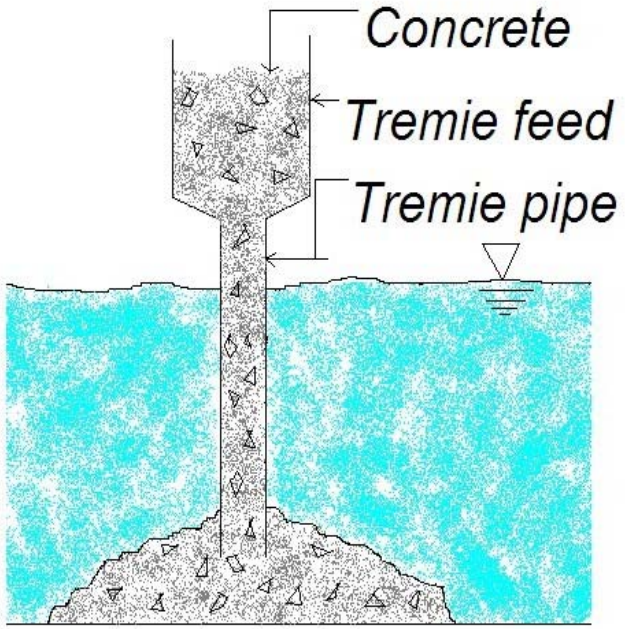


Fig:Placing concrete Under Water

Tremie Method

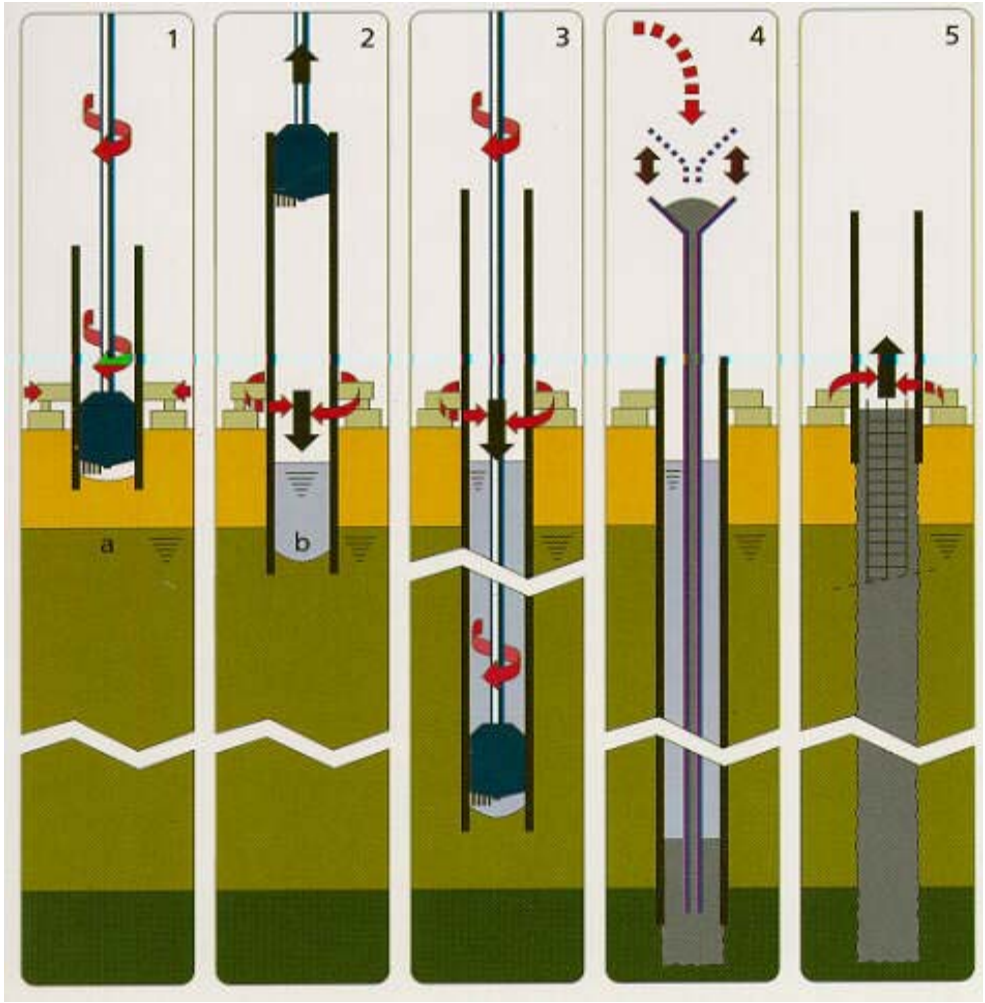
Advantages:

- Most reliable way of placing high quality concrete

- Concrete can be deposited in a continuous and controlled flow speed with little turbulence

Tremie Method

- The tremie pipe is embedded in fresh concrete to a minimum depth of 2 ft
- Vertical movement of tremie pipe should be limited
- Horizontal movement is generally prohibited



Construction procedure

Tremie Method



Placement of tremie pipe

Tremie Method



Tremie pipe placement

Concrete Protection

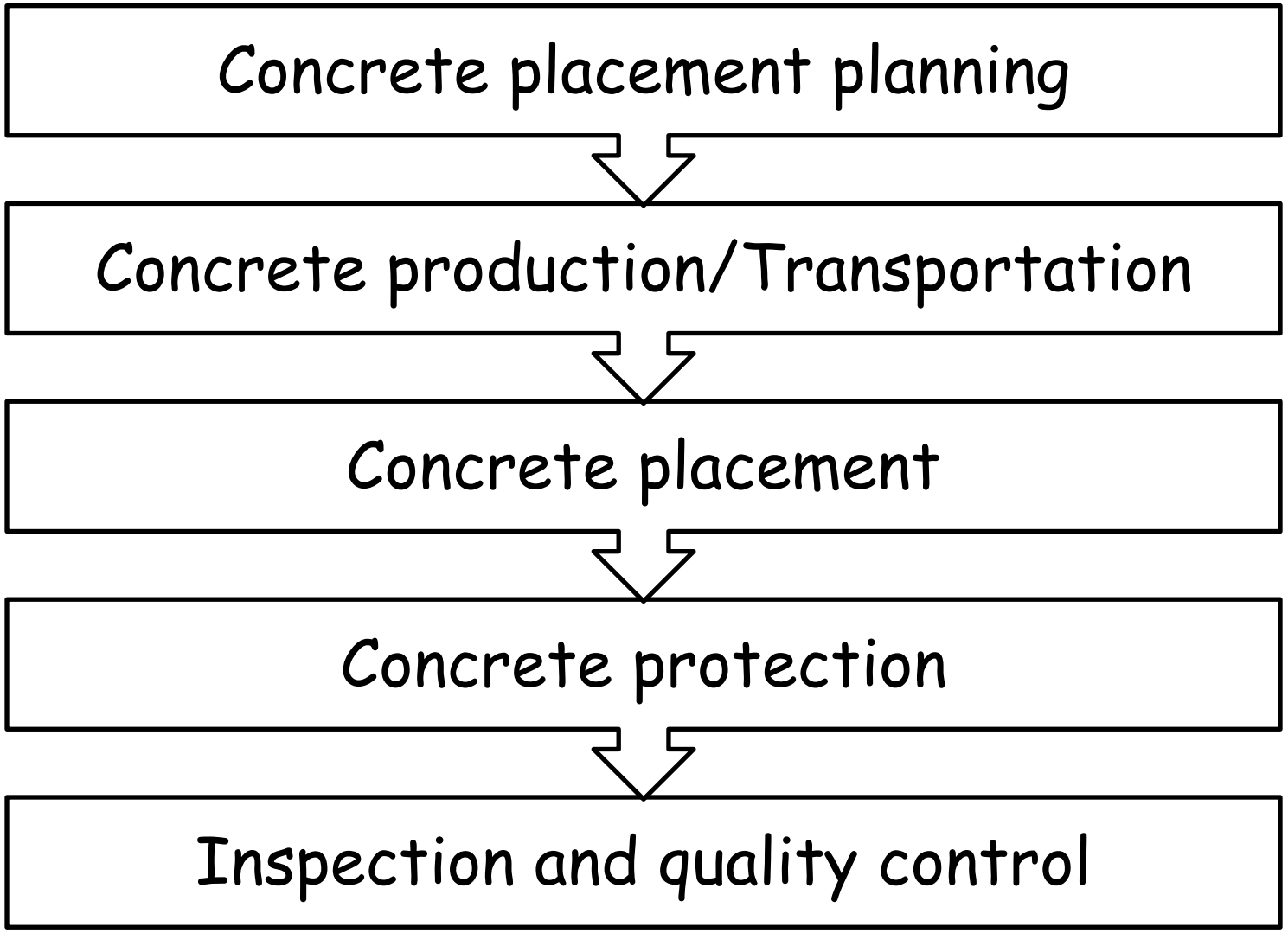
- It needs special protection from water current before it gain strength
- No pipe driving is allowed near concrete placement before it sets
- Sand bags can be used to shield the concrete
- Curtains of heavy canvas can be used to control the current

Quality Control

The following five critical items needs continuous monitoring throughout the concrete placement:

1. The rate of concrete placement
2. The depth of concrete at various locations
3. Volume of concrete produced vs volume of in place concrete measured
4. Concrete delivery system
5. Embedment depth of the tremie

Steps of Under Water Concreting



ASSIGNMENT

Brick, Stair, Roof

CE 200 Details of Construction

BRICK

The term brick is used to denote a building unit made of shaped clay, but in modern times it is used to refer to any stone or clay based building unit that is joined with cementitious mortar when used in construction.

Types of Bricks:

Bricks may be categorized in different ways, like material used, Shapes, Process of Manufacturing etc.

Based on Raw Materials and Method of Manufacturing (fired or non-fired), there are five common types of bricks:

- Burnt clay bricks
- Sand lime bricks (calcium silicate bricks)
- Concrete bricks
- Fly ash clay bricks
- Firebrick

Burnt Clay Bricks

Burnt clay bricks are the classic form of brick, created by pressing wet clay into molds, then drying and firing them in kilns. This is a very old building material—the type of brick found in many of the ancient structures of the world. In appearance, these bricks are solid blocks of hardened clay, usually reddish in color.





Sand Lime Bricks

Sand lime bricks (also known as calcium silicate bricks) are made by mixing sand, fly ash and lime. Pigments may also be added for color. The mixture is then molded under pressure to form bricks; the materials bond together by a chemical reaction that occurs as the wet bricks dry under heat and pressure. These bricks are not, however, fired in kilns in the same manner as burnt clay bricks.





Concrete Bricks

Concrete bricks are made from solid concrete and are growing in popularity among homeowners. Concrete bricks are usually placed in facades, fences, and provide an excellent aesthetic presence. These bricks can be manufactured to provide different colors if pigments are added during production. This is non-fired brick.





Fly Ash Clay Bricks

Fly ash clay bricks are manufactured with clay and fly ash. Because fly ash contains a high volume of calcium oxide, this type of brick is sometimes described as self-cementing. However, it expands when exposed to moisture. This tendency to expand, however, can also produce pop-out failure. Fly ash clay brick has the advantage of being lighter in weight than clay or concrete brick. This is non fired bricks.





Fire Bricks

Also known as *refractory bricks*, these are manufactured from specially formulated earth with a high aluminum oxide content. After burning, these bricks can withstand very high temperatures without their shape, size, or strength being affected.





Some Brick Structures

- Duplex Home



- Mosque's Dome





- Pavement

Some Brick Structures (contd.)

- Arches



- Arch bridge



Bangladesh Standard Specification BDS 208

Compressive Strength:

Grade	Mean for twelve halved bricks	Minimum for individual halved bricks
S	280 kg^f/ cm^2	245 kg^f/ cm^2
A	175 kg^f/ cm^2	154 kg^f/ cm^2
B	140 kg^f/ cm^2	105 kg^f/ cm^2

Water Absorption:

Water absorption by weight shall not exceed 20% for bricks of B grade and 15% for bricks for A grade and 10% for bricks of S grade.

Grade S: This of bricks may be used for breaking into aggregate for plain and reinforced concrete and for making base course for pavement

Grade A: This type of bricks may be used in construction of buildings of long duration.

Grade B: This type of bricks may used for one stored building, temporary shed, where intended durability is not very high.

Brick dimensions

Conventional Dimension:
General Dimension: 10”x5”x3”(With mortar)
Nominal size: 9.5”x4.5”x2.75” (Without mortar)
As per BDS 208:
Length : 24cm Width: 11.5 cm and Height/Depth: 7cm

Brick Bats: A fragment of brick.

General Principle to be observed in Brick masonry construction

Article 9.3;
Page no: 231;
Building Construction by Sushil Kumar

There are **25** points that should be thoroughly studied.

9·3. GENERAL PRINCIPLES TO BE OBSERVED IN BRICK MASONRY CONSTRUCTION

Brick masonry is classified as first class or second class according to the type of bricks used (whether first class or second class) and according to the method of laying. The strength of masonry work, however, depends very much upon the type of material used, nature of workmanship and supervision. Bad workmanship assisted by lack of supervision may lead to unsound construction inspite of the materials used being of the best possible type. The general principles which should be observed for a sound brick masonry construction are given below. (The technical terms used in this chapter have already been described in the chapter on Stone Masonry.)

(1) The bricks used in a good work should be sound, hard and well burnt with uniform size, shape and colour. They should have no cracks or flaws and a fractured surface should be free from holes, grit or lumps of lime etc. The surface of the bricks should be such that no mark should be made when scratched by the finger nail. The bricks when struck together should produce metallic ringing sound and they should not break when dropped from a height of 90 to 120 cm. on the ground. The bricks should not as a rule absorb water more than 20% of their weight when dry, when immersed in water for twenty-four hours.

(2) The bricks should be thoroughly soaked in clear water before use for suitable period so that the water just penetrates the full depth of bricks. This not only helps in removing the dirt, dust and other soluble salts (which cause efflorescence) from the bricks, but also reduces their tendency of suction of water from wet mortar. *In case, however, masonry is to be carried out in mud or fat lime mortar, the bricks should not be soaked in water before use.*

(3) The bricks should be laid on a full bed of mortar. They should be slightly pressed into the bed mortar while laying so as to ensure proper adhesion. All the courses should be laid truly horizontal and all the vertical joints should be truly vertical.

CS Scanned with CamScanner

(4) All the joints should be properly flushed and filled with mortar so that no cavity is left in between.

(5) In case of walls two brick or more in thickness, the joints should be grouted at every course in addition to bedding and flushing with mortar.

(6) No brick-bats should be used in the work except when it is absolutely necessary for obtaining the specified bond.

(7) Brick work is generally laid in the English bond. In all cases, it should be ensured that a proper bond is maintained throughout the work.

(8) Only specified mortar of a good quality should be used in the work, taking great care that uniform mortar joint is obtained throughout the construction. Thickness of joints should not exceed 13 mm in any case.

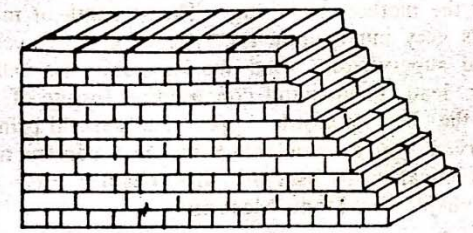


Fig. 9·1

Raking back of a brick wall

(9) Unless brick -on-edge is specified, the bricks must be laid on their proper beds with their frogs pointing upwards.

(10) The courses of bricks at the plinth, window sill, floor/roof level and at the top of parapet wall should invariably be laid with brick on edge.

(11) The progress of work in raising masonry should be such that all the connected brick work should be carried up in uniform layers at one level. It should be ensured that no part of the wall should preferably rise more than 100 cm. than the rest of it. When it is not possible, the work should be raked back according to the bond. The walls should be raised up truly vertical.

(12) The buttresses, counterforts etc. should be built up course by course, maintaining proper bond with the main wall and should not be added or joggled afterwards.

(13) Iron fixtures like pipes, hold-fasts of doors and windows etc., which are to be fixed in the brick wall should be embedded in cement mortar or in cement concrete.

Scanned with CamScanner

(14) The face joints are generally raked to a minimum depth of 10 to 15 mm. when the mortar in the joints is still green. This is done to provide proper key for the plastering or pointing.

(15) Plastering should be done after about 28 days of completion of brick masonry. This permits adequate time for the shrinkage in masonry and concrete to take place before plastering operation is carried out.

(16) In works where plastering or pointing is not desired, the mortar joints should be struck flush and finished at the time of laying.

(17) All the finished masonry work should be kept wet for at least seven days.

(18) When an existing wall has to be strengthened by making it thicker, 20 cm x 20 cm x 10 cm. (dimensions of one brick) recesses are cut in the existing wall. The recesses are staggered taking care that one recess is made in every sq. metre of the wall. This enables the new work to be properly bonded to the old one. This operation is termed as *back-bonding*.

(19) When it is desired to increase the length of the wall under construction at a future date, the wall is stopped with a toothed end. This is necessary to ensure continuous bonding between the old and the new work.

(20) It is found that with an average winter-summer temperature differences of about 100°F, a brick masonry wall expands by about 10 mm. in every 30 m. length of wall. Hence it is desirable to provide minimum 18 mm. wide expansion joints after every 30 to 45 m. length of wall.

(21) When timber floor or roof is required to be supported on masonry walls, the ends of timber joists (supporting the floor or roof) should rest on corbels or brackets as far as possible. In cases where the ends of timber joists have to be built into the wall itself, it is necessary to apply suitable preservative treatment to the embedded portion of the joists and in addition some space should be left around them to minimise chances of attack by termite and to ensure free circulation of air.

(22) Bed blocks of stone, concrete or reinforced concrete should be provided at the ends of beam (it may be of timber, steel or R.C.C.) carrying heavy loads.

(23) The bearing of R.C.C. floor or roof slab resting on brick masonry walls should not be less than the effective depth of slab or 10 cm., which ever is more.

(24) As a general practice, quoin brick should be headers and stretchers laid in alternate courses and the bond is developed by placing a quoin closer next to the queen header.

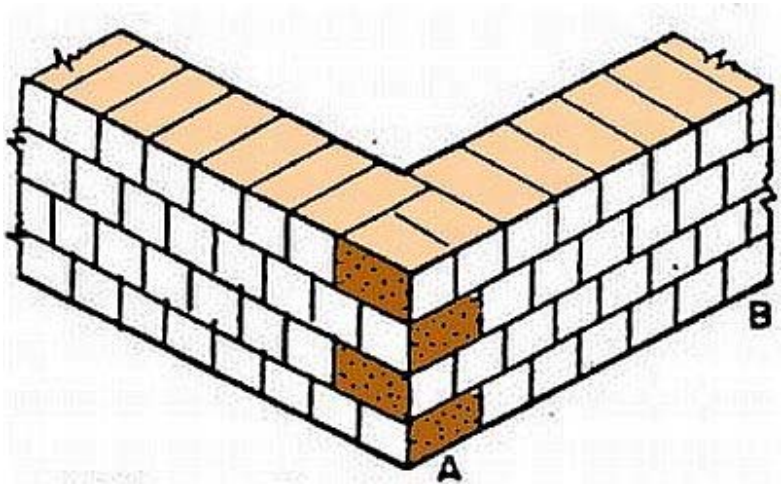
(25) Half brick partition walls should be reinforced with suitable

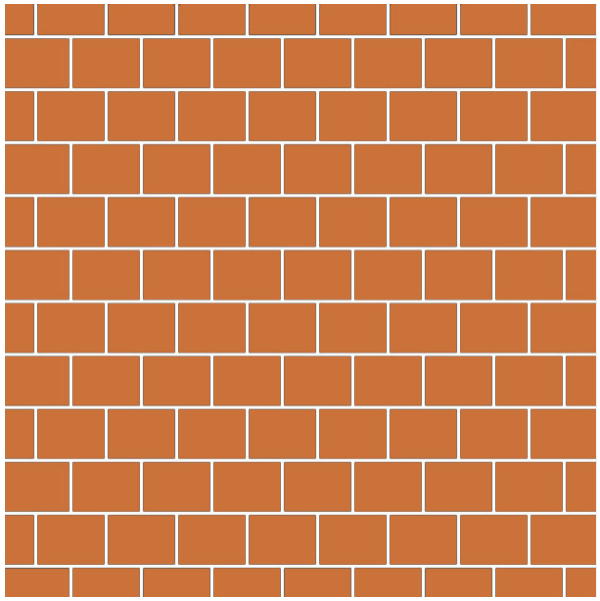
Scanned with CamScanner

Types of Bond

There are several types of bond for brick. Some commonly used are:

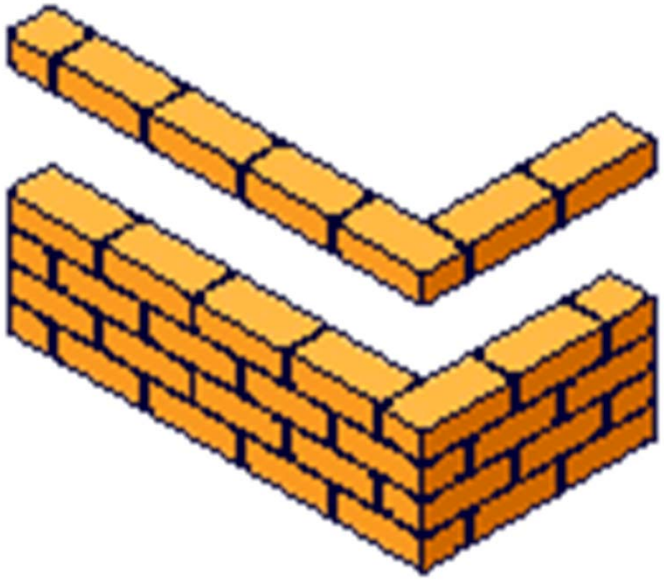
- **Header Bond**
- **Stretcher Bond**
- **English bond**
- **Flemish bond**
- **Herringbone Bond**

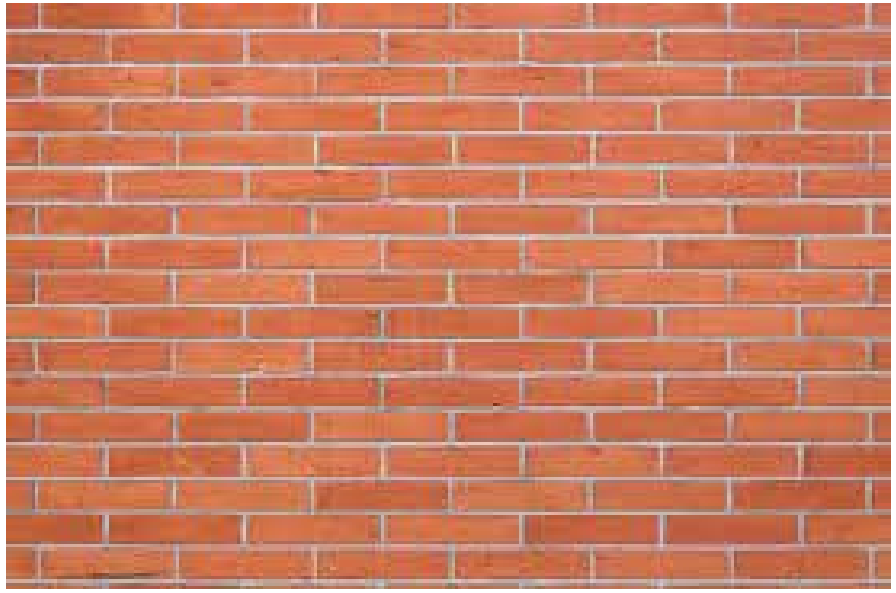




•Since header bonds lacks strength in pressure transmission along the length of the wall, it is not preferable to use this kind of bond for load bearing walls.
•Header bond is useful when the design demands curved surfaces to be constructed. In such cases, stretcher bond cannot be used. Apart from using it for curved surface, it can also be used for the brickwork in foundations.

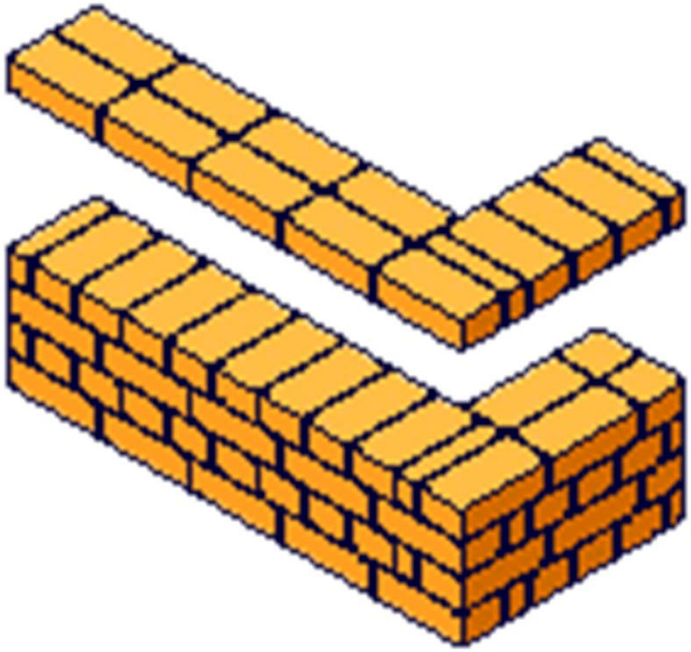
Header Bond





A commonly used bond, a pattern is made only using stretchers, with the joins on each course centred above and below by half a brick.
This type of bonding is not particularly strong.

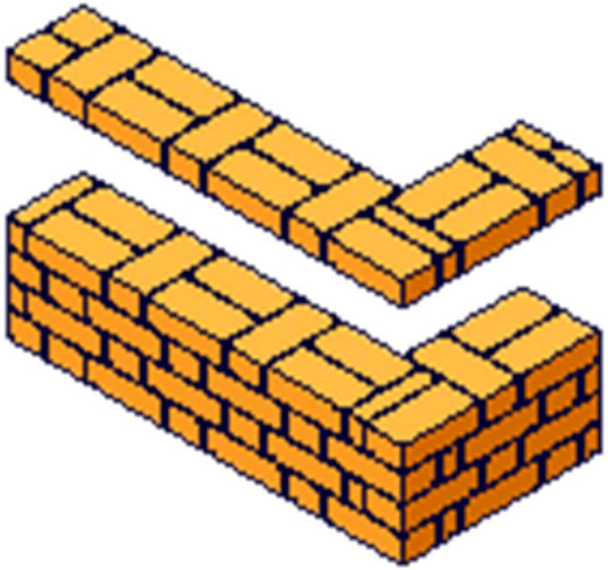
Stretcher Bond

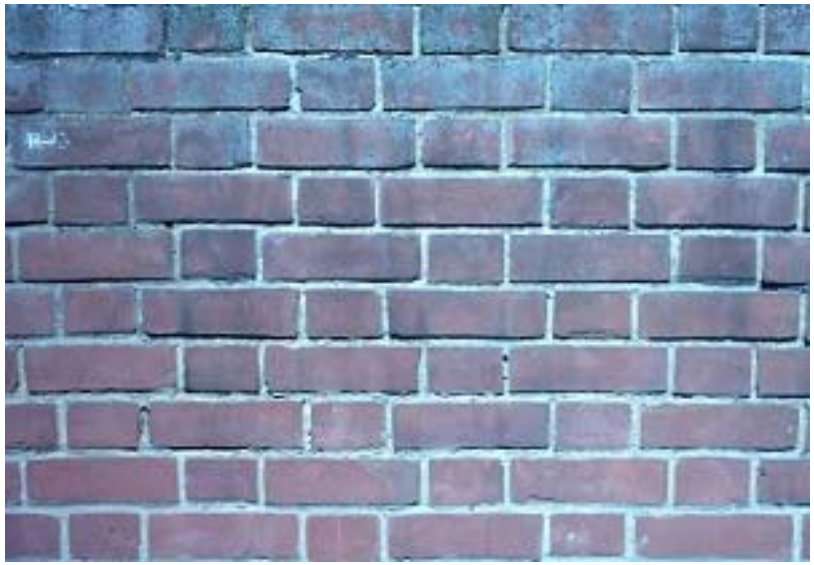




This is a pattern formed by laying alternate courses of stretchers and headers.
The joins between the stretchers are centered on the headers in the course below.
This is one of the strongest bonds but requires more facing bricks than other bonds.

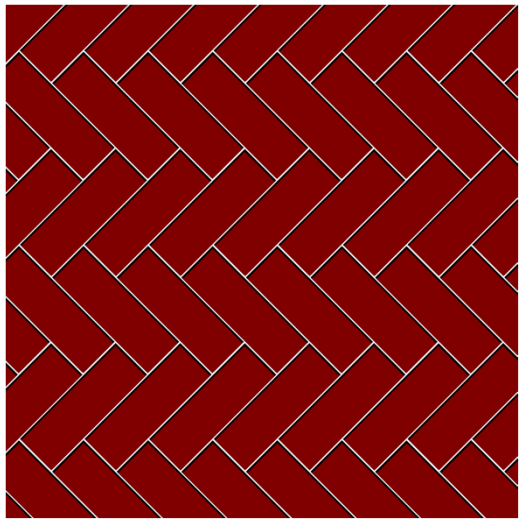
English bond





This is formed by laying headers and stretchers alternately in each course.
The headers of each course are centered on the stretchers of the course below.
This bond is strong and often used for walls which are two-bricks thick.

Flemish bond





In **herringbone bond** bricks are laid at an angle of 45° to the direction of the row, instead of horizontally. Alternate courses lie in opposing directions, resulting in a zigzag pattern.

Herringbone Bond

Defects in Brick Structures

- Sulfate Attack
- Crystallization of salts from bricks (Efflorescence)
- Corrosion of embedded steel
- Shrinkage on drying

Sulphate Attack

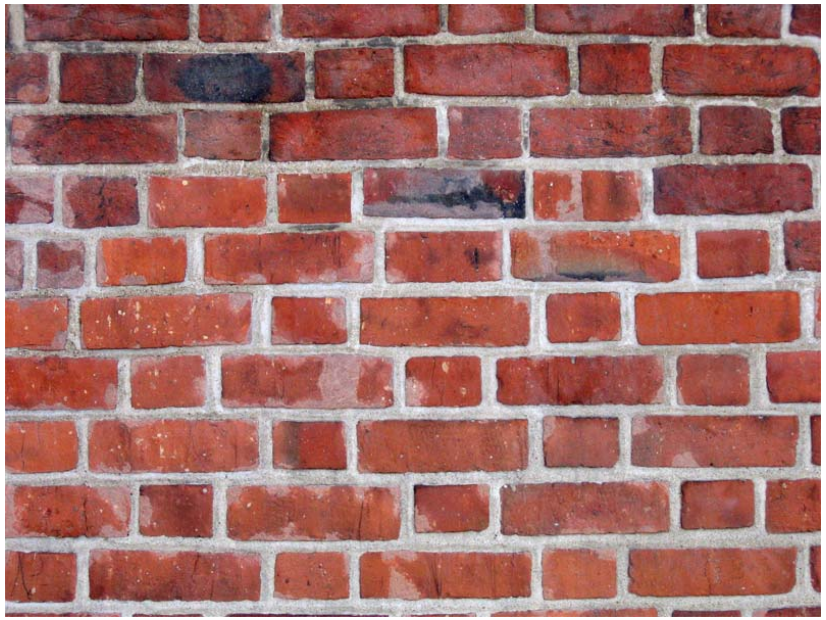
It is caused by a reaction between sulfates in solution and a constituent of Ordinary Portland Cement known as tricalcium aluminate. he reaction between the sulfates and the tricalcium aluminate forms a compound known as calcium sulfo-aluminate. This compound expands as it forms, leading to cracking in the mortar joints, followed by general deterioration and the loss of the mortar's 'bonding' function.



Efflorescence

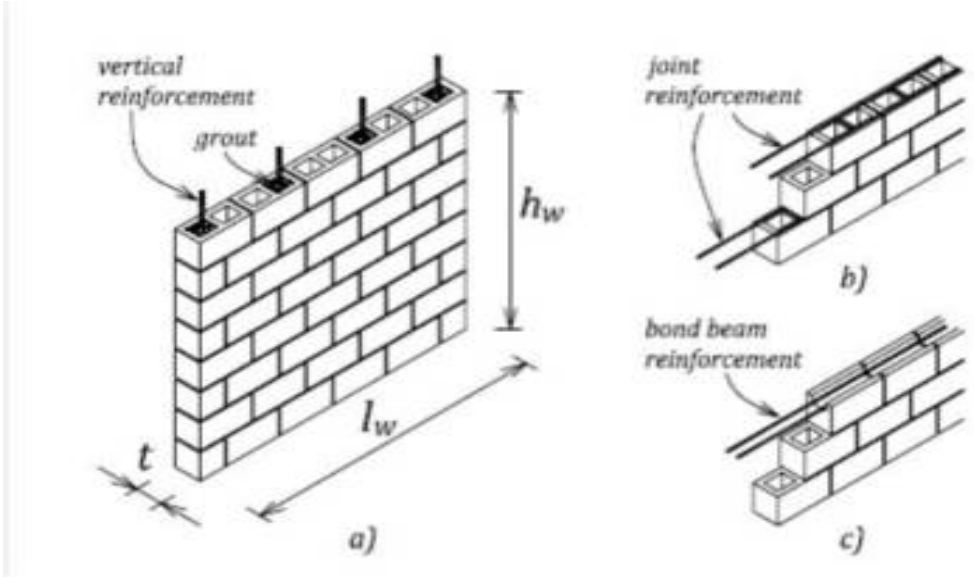
Efflorescence is caused by soluble salts in solution being brought to the surface as water in the wall dries out. It is usually a harmless, temporary problem,. The main concern is the unsightly appearance caused by the white staining that it produces.





Corrosion of Embedded Steel

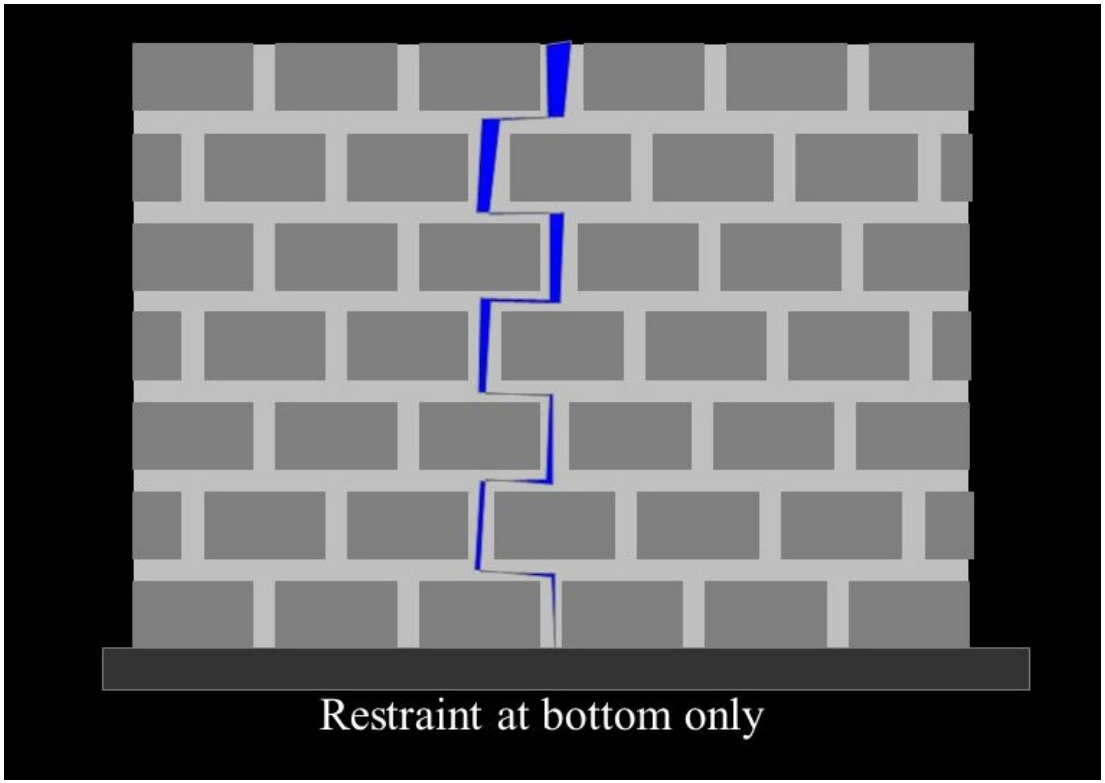
If steel embedded in brick work get corroded, it expands, creates pressure on brick work. Subsequently brick work cracks.





Shrinkage or Drying

Brick work swells with the absorption of water and subsequently shrinks when water evaporates.
In the process of shrinking it develops cracks in the masonry joints.

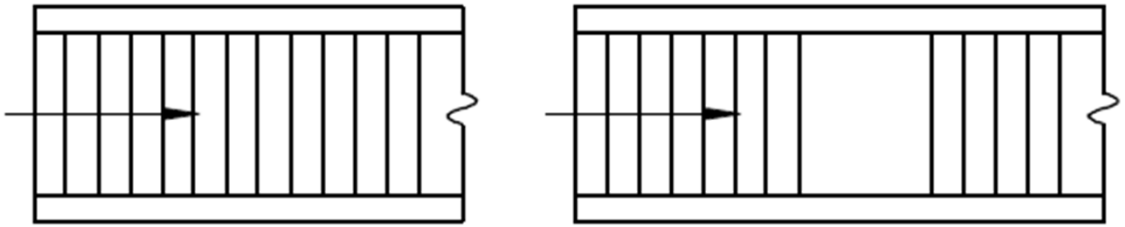


STAIR

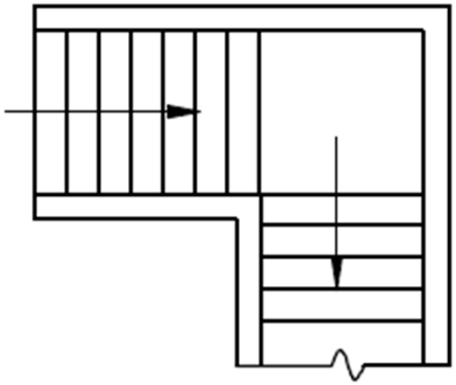
Stair

- Series of steps provided as a means of vertical movement between various floors.
- Stair-case: Enclosure containing the complete stairway.
- Materials used in stairs: timber, stones, bricks, steel, plain concrete or reinforced concrete.

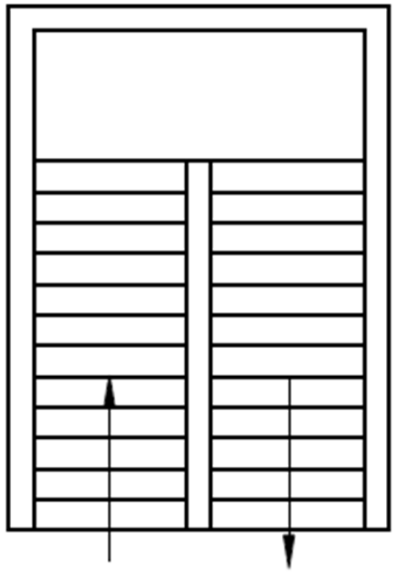
Common Types of Stairs



Straight flight stairs

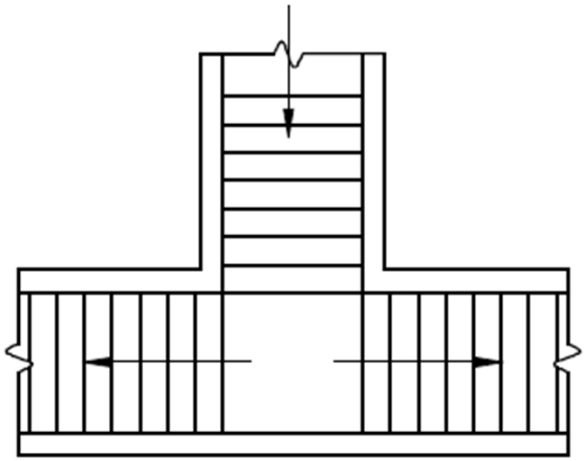


Quarter-turn stair

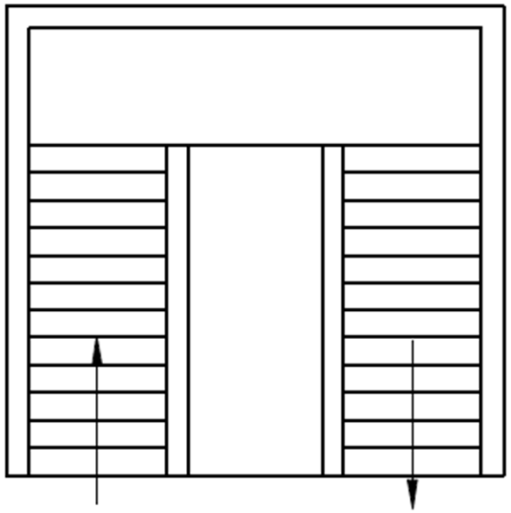


Half-turn stair

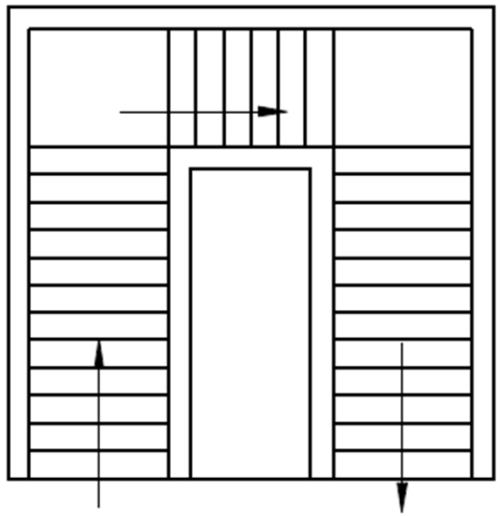
Common Types of Stairs (cont..)



Branching stair

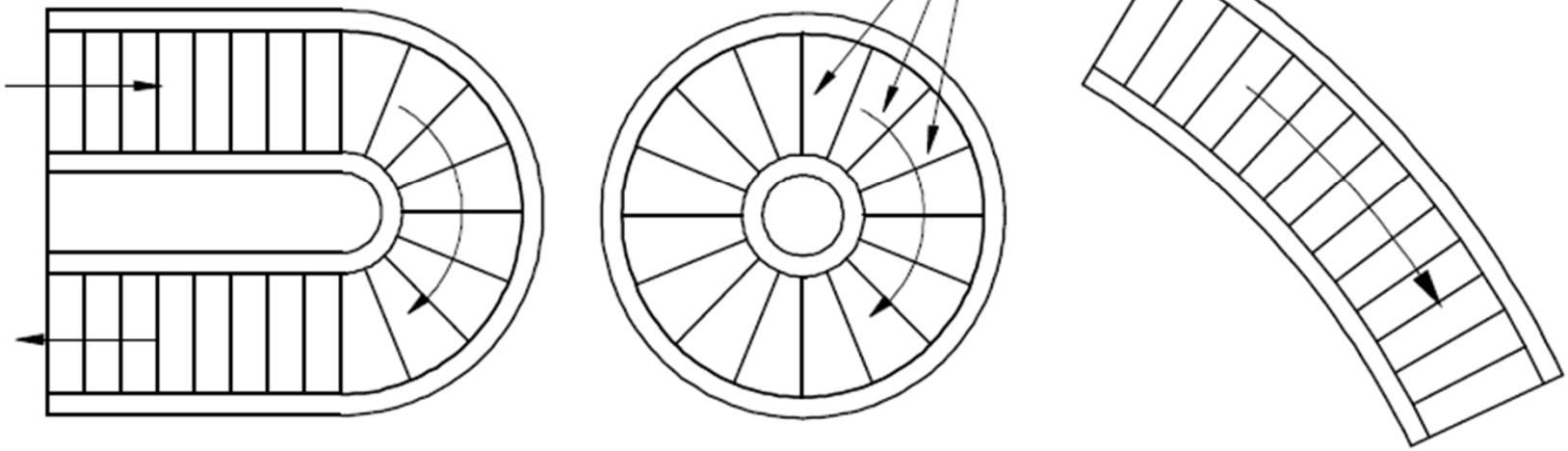


Open-well (half turn)



Open-well with quarter turn landing

Common Types of Stairs (cont..)



Circular

Spiral

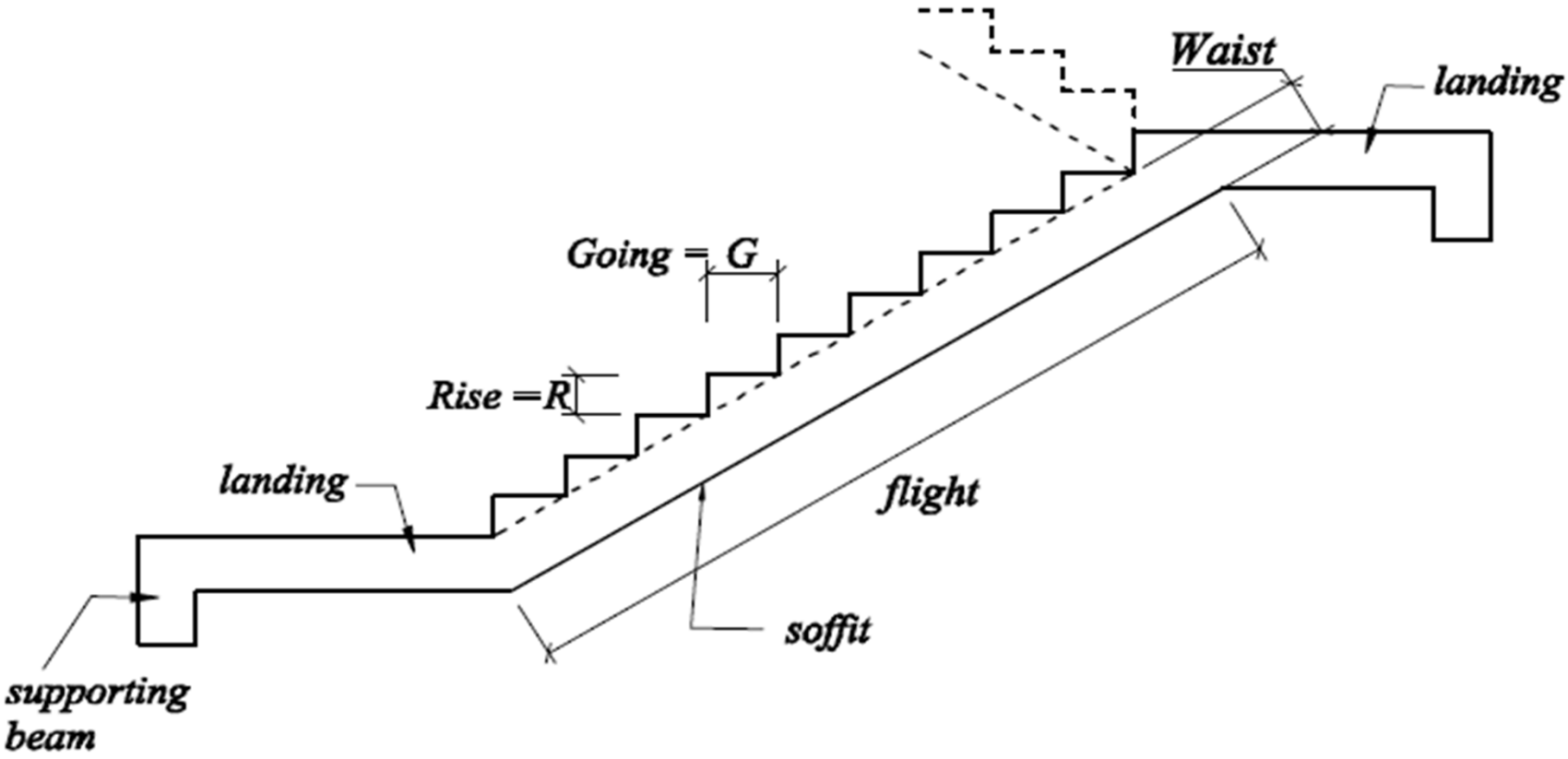
Elliptical

Geometrical stairs

Technical terms related to stairs

- **Flight:** Series of steps without landing
- **Landing:** Platform provided between two flights
- **Steps:** Made from a series of horizontal treads with risers in between
- **Tread:** Horizontal upper portion of a step on which the foot is placed during ascent/descends
- **Riser:** Vertical portion of a step
- **Rise:** Vertical distance between two consecutive treads

Technical terms related to stairs (cont..)



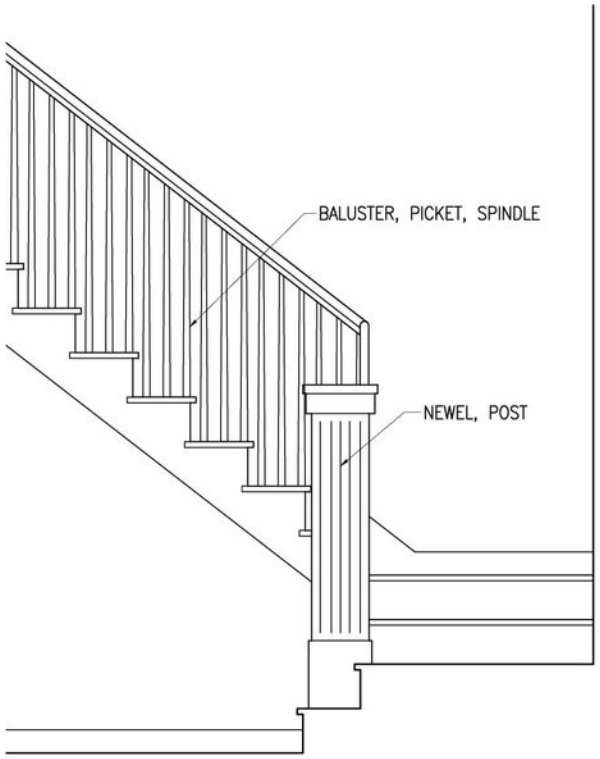
Technical terms related to stairs (cont..)

- **Going:** Distance measured horizontally from the face of one riser to the face of the next riser
- **Nosing:** The exposed edge of a tread, usually projecting with a square, rounded or splayed edge
- **Waist:** The least thickness of a stair slab
- **Soffit:** Bottom surface of a flight
- **Pitch:** Angle with the horizontal

Technical terms related to stairs (cont..)

- **Head-room:** Clear vertical distance between tread of a step and soffit of the flight immediately over it
- **Hand-rail:** Rail of metal/wood on the side of a stair fixed at about waist high parallel to the slope of stair provided to render assistance to the users
- **Baluster:** Vertical member provided for protection and to support the handrail; Placed between steps and handrails
- **Newel:** Post supporting the hand rail where the balustrade changes its direction




BALUSTER, PICKET, SPINDLE
NEWEL, POST

Requirements of a good stair

- **Location:** Sufficient light and ventilation
- **Width:** Varies with situation; however should follow the standard recommended dimensions according to the building types
- **Length of Flight:** For comfort 3≤no. of steps≤12
- **Pitch:** 25°≤pitch≤40°
- **Head room**: Minimum 7’-8’
- **Materials:** Having fire resisting qualities
- **Width of landing:** Not less than width of stair
- **Dimension of a step:** For comfort tread = 10”-12” & riser = 4”-6”

ROOF

Details of Roof

- **General elements of roof**
  - Parapet
  - Roof covering
  - Overhead water tank
  - Lift machine room
  - Rain spouts
  - Plumbing lines
- **Special elements of roof**
  - Swimming pool
  - Garden
  - Cycle track
  - Community centre
  - Telecommunication tower
  - Helipad



Parapet Wall



Telecommunication Tower over Roof



Helipad over Roof

CE 200: DETAILS OF CONSTRUCTION

LECTURE 9

TOPICS OF TODAY'S LECTURE

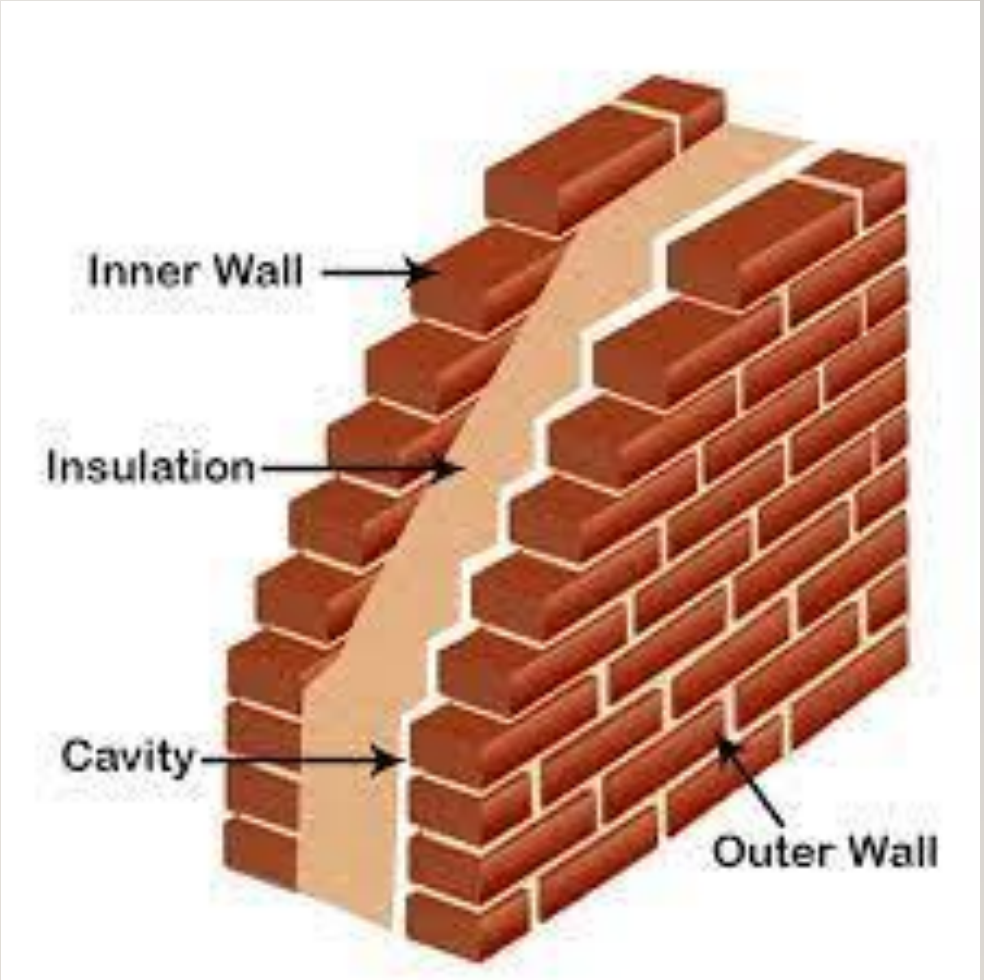
- Cavity Walls
- Partition Walls
- Lintels
- Arches

CAVITY WALLS

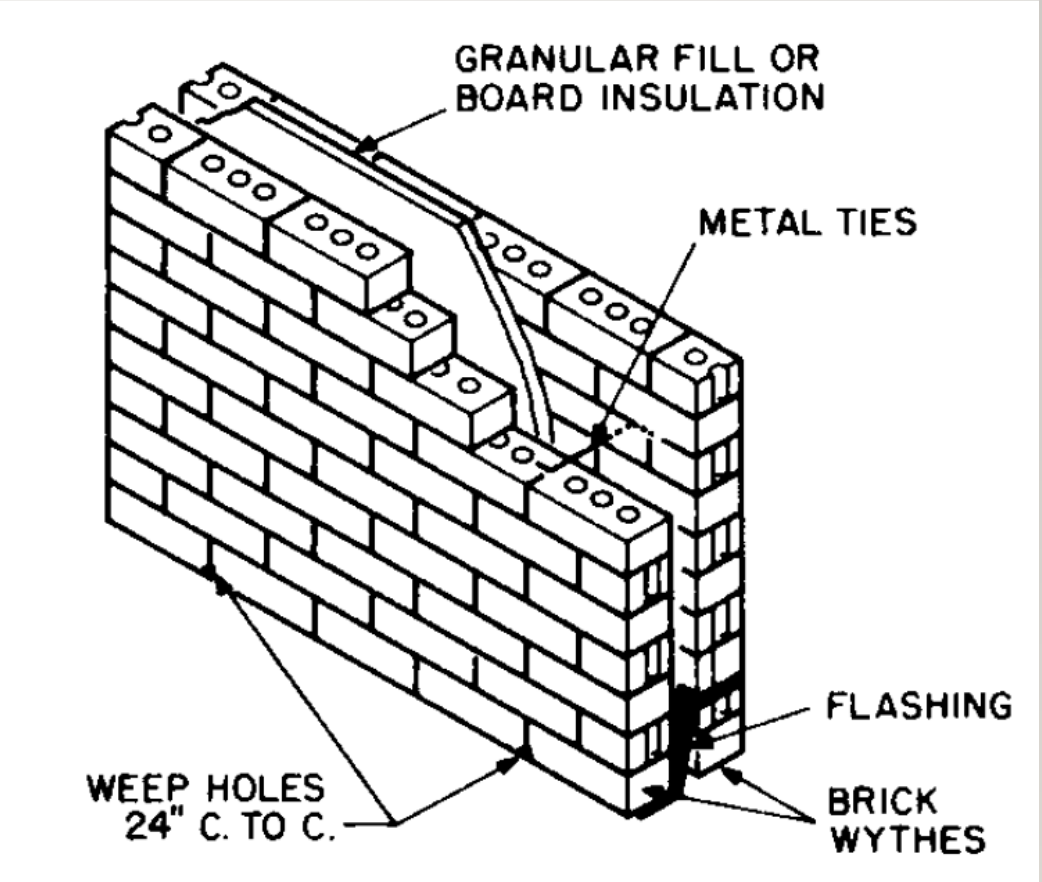
WHAT IS A CAIVITY WALL?

BNBC 2020 Definition:

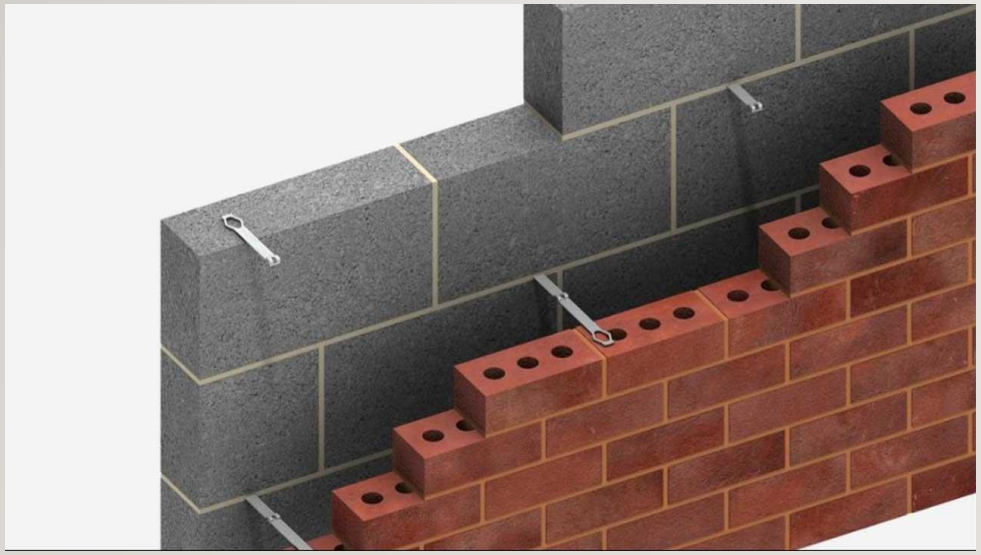
A wall comprising two limbs each built-up as single or multi-wythe units and separated by a 50-115 mm wide cavity. The limbs are tied together by metal ties or bonding units for structural integrity.

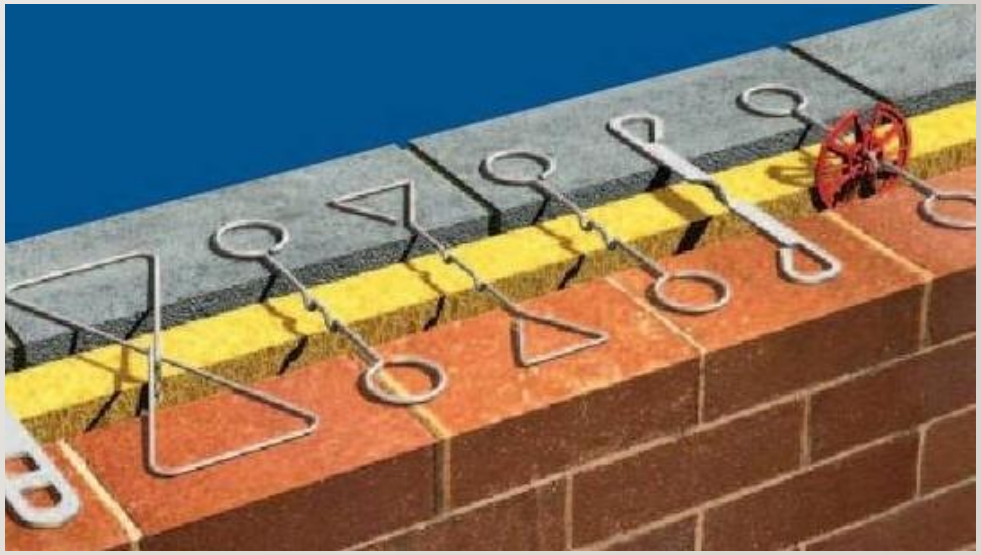


CAVITY WALL DETAILS

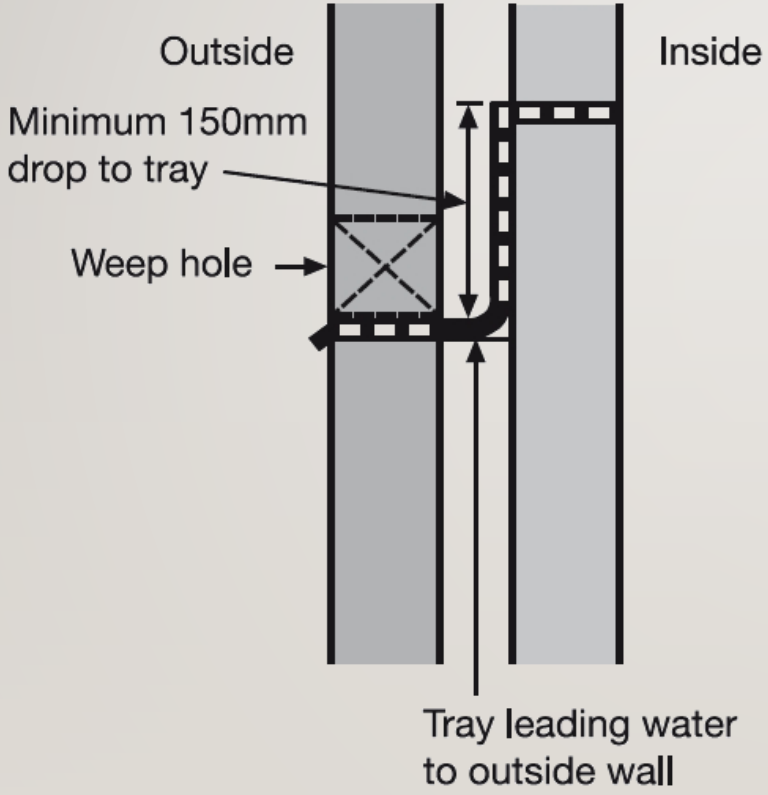


METAL TIES





FLASHING AND WEEP HOLES





CAVITY WALL INSULATION







- Mineral wool
- Polyurethane foam
- Glass wool

ADVANTAGES OF CAVITY WALLS

- Thermal insulation
- Sound insulation
- Damp prevention
- Efflorescence prevention

PARTITION WALLS

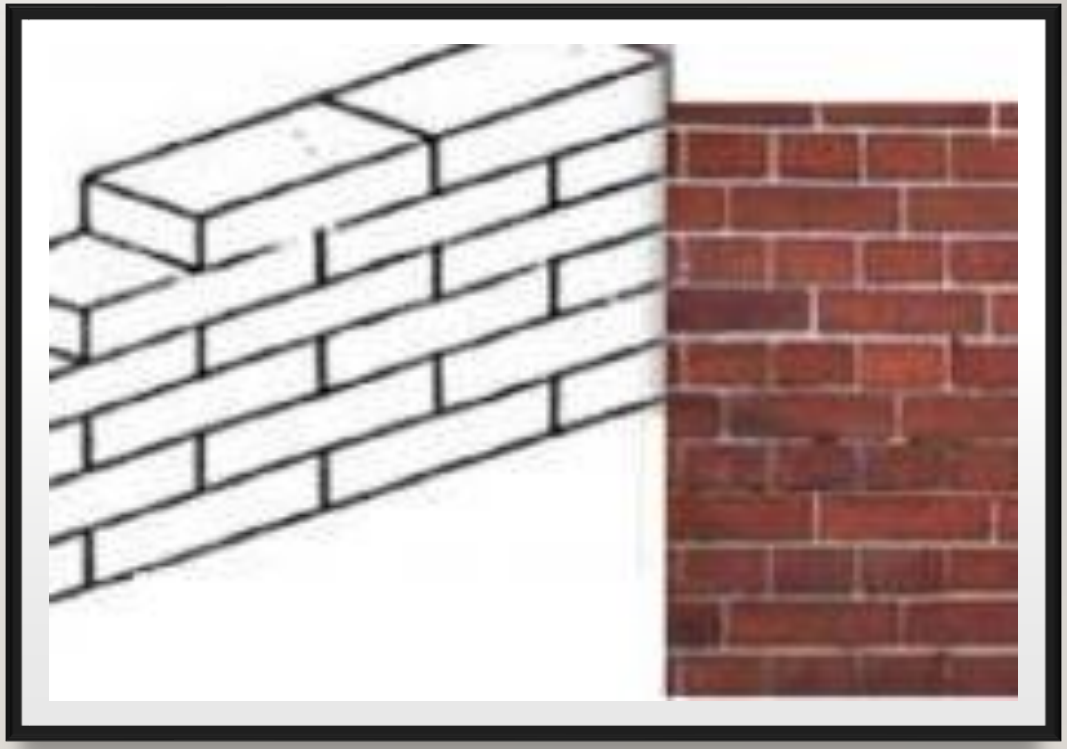
PARTITION WALL AND ITS TYPES

According to BNBC 2020, a partition wall is an interior non-load bearing wall, one storey or part storey in height. Depending upon the material used partition walls may be divided into the following different types:

- Brick partitions wall
- Hollow block partition wall
- Glass partitions wall
- Concrete partitions wall
- Plasterboard partition wall
- Metal lath partition wall
- G.I. sheet partitions wall
- wood-wool partition wall
- Timber partitions

BRICK PARTITION WALL

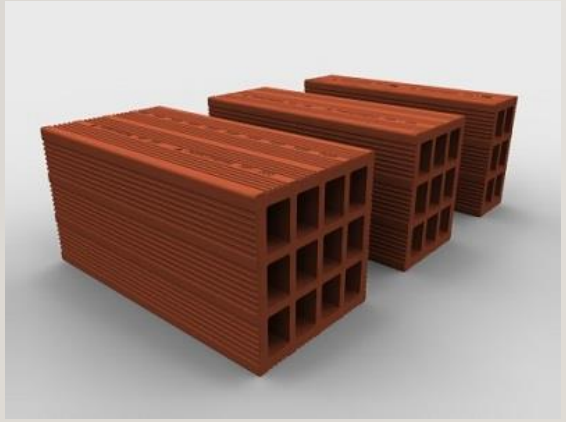
- It is constructed from plain bricks, and it is common and cost effective
- The bricks are laid as stretchers in cement mortar.
- Thickness of plain brick partition wall is 10cm or half a brick.
- Recommended height is maximum 2m for construction in a day
- It may be plastered on both sides
- Strong and fire resistant if the brick wall is constructed properly



HOLLOW BLOCK PARTITION WALL

Hollow Block Partitions are made up of different materials. The usually used materials for making hollow clay blocks are:

- Clay or Terracotta Hollow Blocks
- Fly ash Hollow Blocks
- Cement Concrete Hollow Blocks



- Hollow clay bricks are commonly employed for light partition wall
- The blocks are placed in mortar
- Hollow brick partition walls are rigid, economical, strong, fire resistant, and good heat sound insulator.
- The sizes of the hollow blocks differ with the texture of the material.
- The thickness of this type of partition wall varies between 6 cm to 15 cm.
- Hollow brick partitions walls are constructed in similar manner as structural load bearing walls.
- Grooves are provided on top, bottom, and sides of block to improve the bond between the block and plaster.

GLASS PARTITION WALL

They are cheap, light, and easy in construction and provide reasonable privacy and sound insulation. such walls are constructed from glass sheet or hollow glass blocks.





CONCRETE PARTITION WALL

Cast-in-situ concrete partition walls

- Thickness ranges from 80mm to 100mm
- It is poured monolothically with intermediate columns
- It is rigid and stable both in vertical and horizontal directions but the formwork is costly.
- The reinforcement consisting of mild steel bars is placed in the center of the wall thickness.

Precast concrete partition walls

- The wall is built from precast concrete slab units
- Precast unit thickness ranges from 25mm to 40mm
- Precast units are secured to precast posts
- Joints shall be filled with mortar



PLASTERBOARD PARTITION WALL

- Plaster slabs or plaster boards are made from burnt gypsum or plaster of paris, mixed with sawdust or other fibrous material to reduce its weight
- Units of plaster slab prepared in an iron or timber mould with size 1 to 2m long, 30cm high and 50 to 100mm thick.
- they are equipped with suitable grooves to create rigid joints



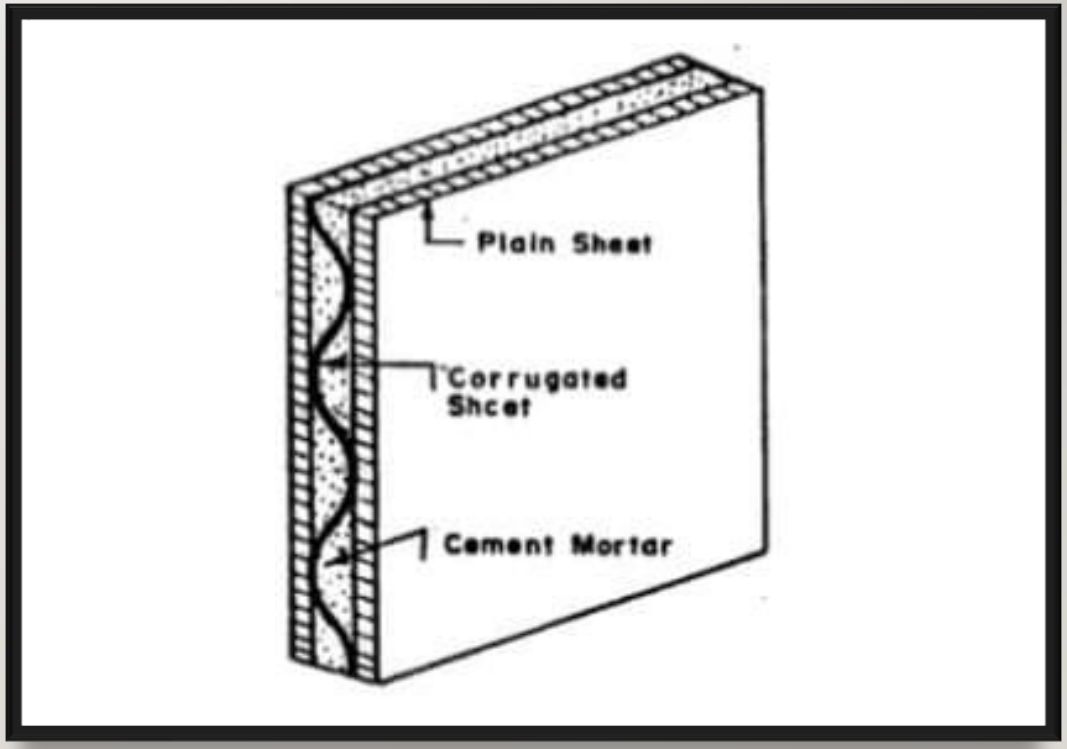
METAL LATH PARTITION WALL

- Metal lath partition wall are thin, strong, durable and considerably fire resistant.
- Metal lath partition walls are constructed by placing 2cm or 2.5cm channels vertically (called studs) and fixing metal lath to it on one side.
- Plaster is applied to both the sides of the metal
- If hollow partition is required, metal lath is fixed to the channels on both the sides and then plaster is applied.



GI SHEET PARTITION WALL

- Partition walls constructed from galvanized sheet fixed to wooden or steel frame.
- It is mostly adopted in works of temporary character.
- Such walls are economical, light and fairly rigid if constructed properly.



WOOD-WOOL PARTITION WALL



- Wood wool consist of long tangled wood fibers, uncompacted, coated and bound together with cement or plaster, and with a rough open surface which provides an excellent key for plaster.
- It is good heat and sound insulator

TIMBER PARTITIONS

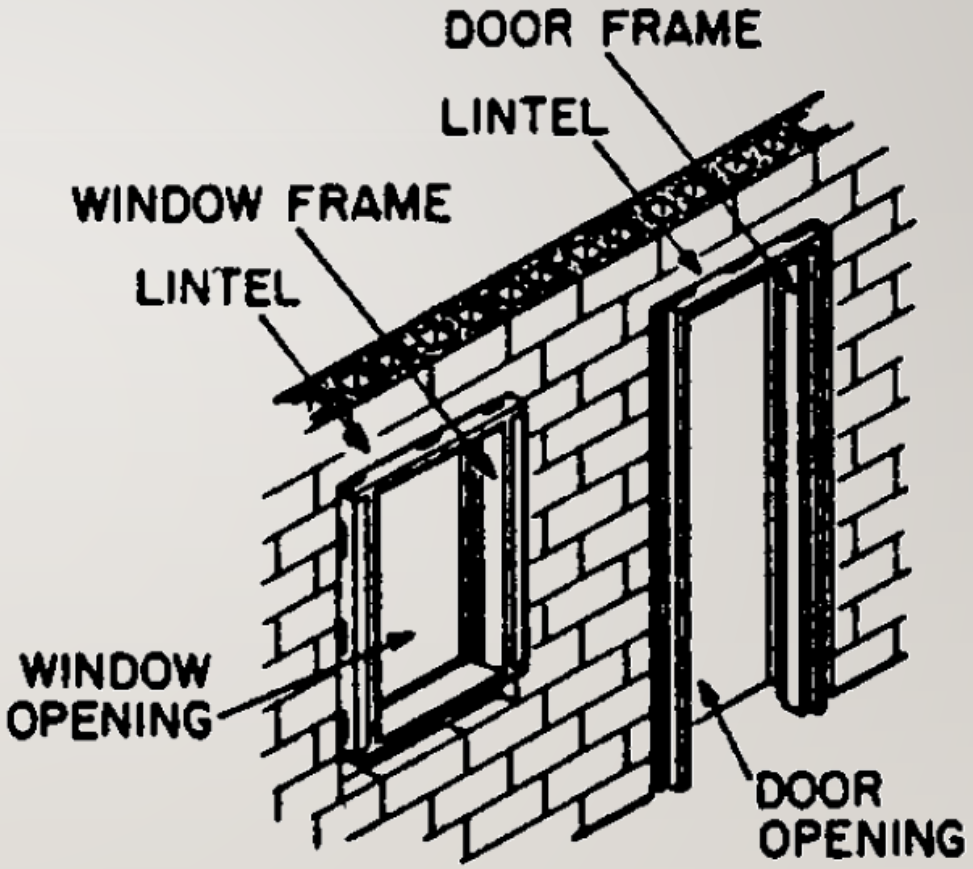
- This type of partition walls that consists of a wooden framework is either supported on the floor below or by side walls.
- The framework consists of a rigid arrangement of timber members which may be plastered or covered with boarding etc from both the sides.
- Such partitions are not fire-resistant and the timber forming the partition is likely to decay or be eaten away by white ants.
- The use of timber partition walls is decreasing.



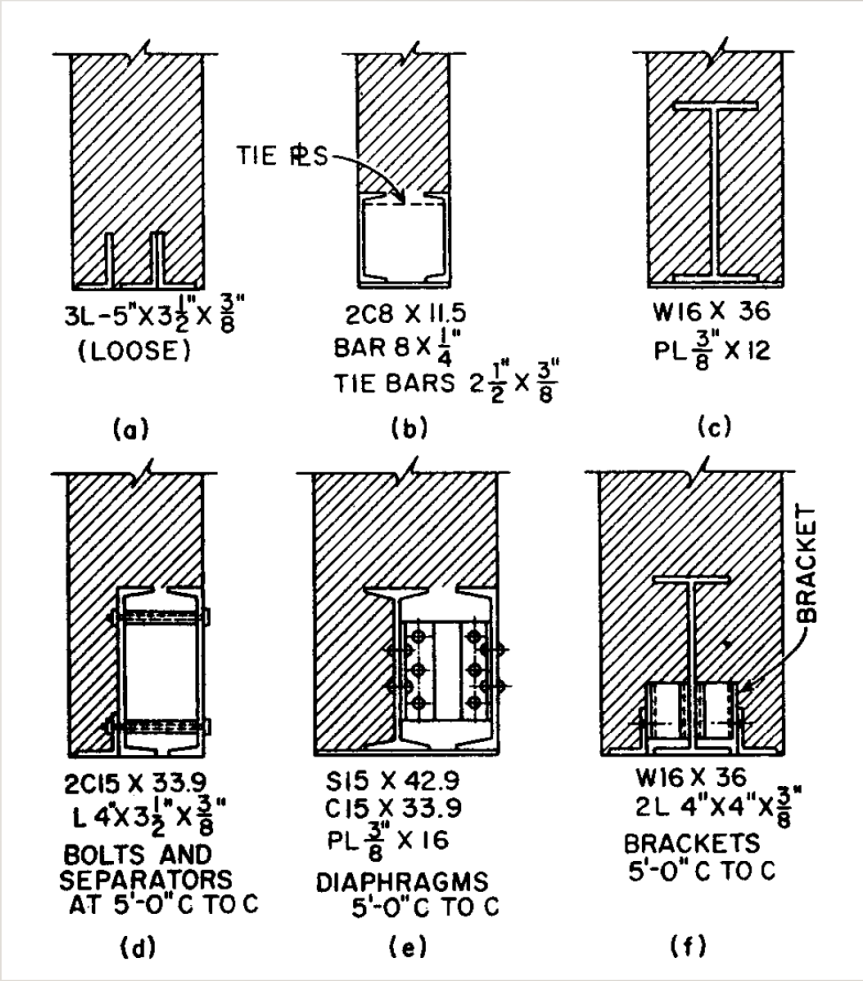
LINTELS

WHAT IS A LINTEL?

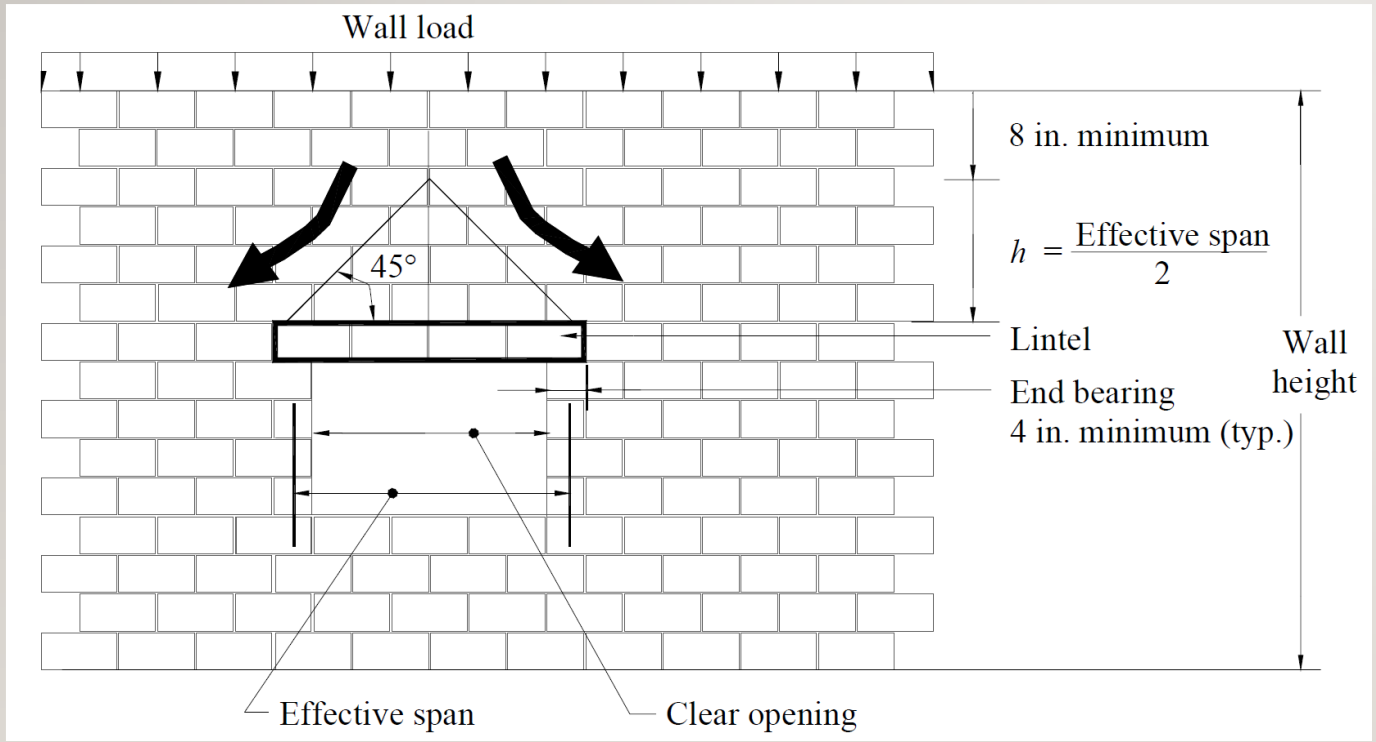
Lintels are light horizontal beams that support walls at floor levels in multistory buildings or that carry the part of walls above openings for doors and windows.

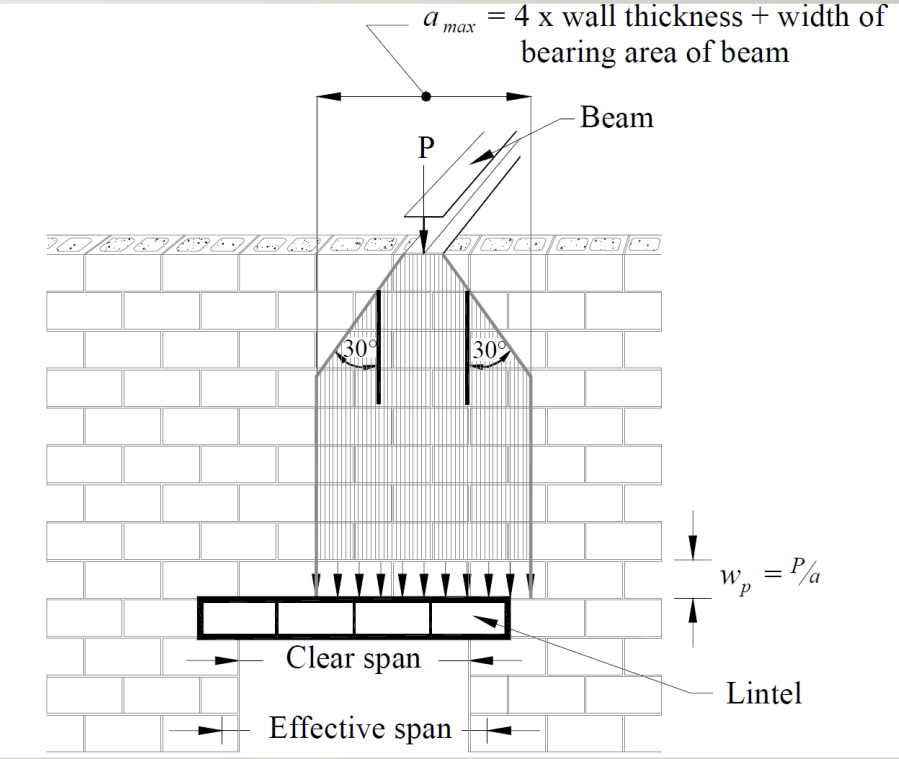


STEEL LINTEL



LINTEL LOADING



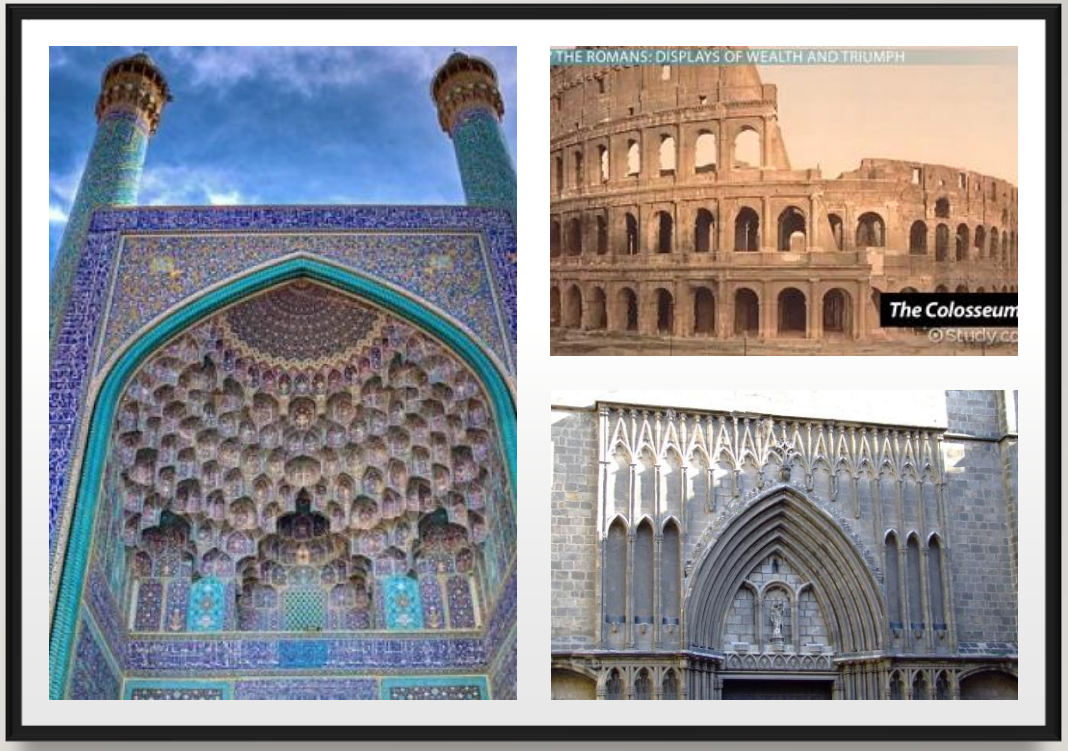


ARCHES

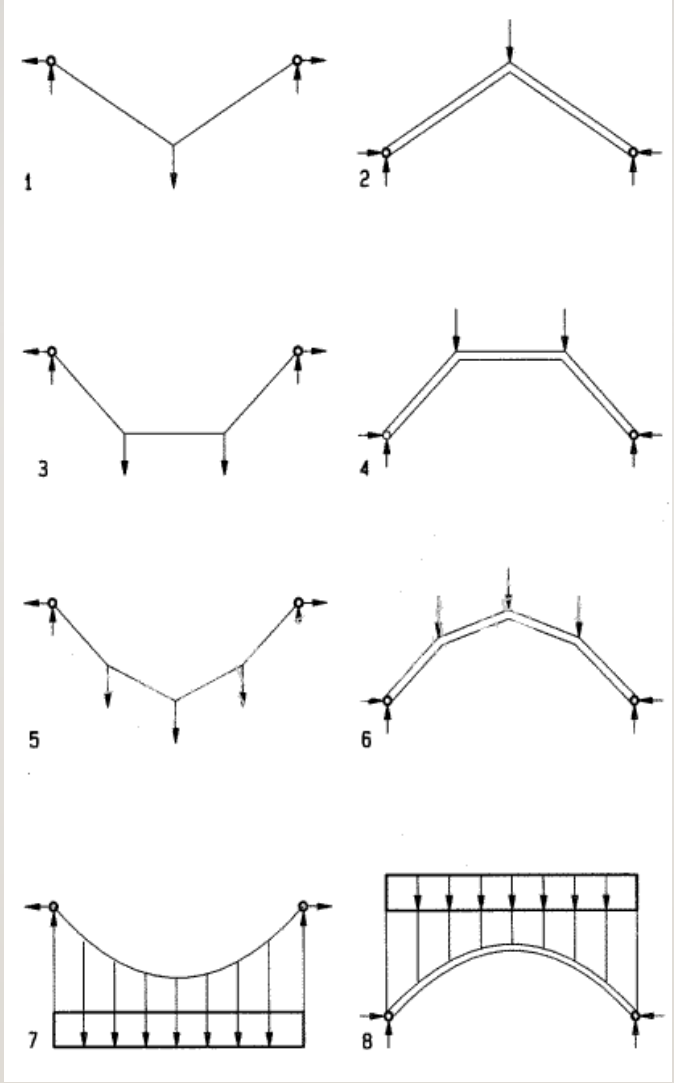
HISTORY OF ARCH

Arch, in architecture and civil engineering, a curved member that is used to span an opening and to support loads from above.

- Arches were known in ancient Egypt and Greece but were considered unsuitable for monumental architecture and seldom used.
- The Romans, by contrast, used the semicircular arch in bridges, aqueducts, and large-scale architecture. In most cases they did not use mortar, relying simply on the precision of their stone dressing.
- The Arabs popularized the pointed arch, and it was in their mosques that this form first acquired its religious connotations.
- Medieval Europe made great use of the pointed arch, which constituted a basic element in Gothic architecture.



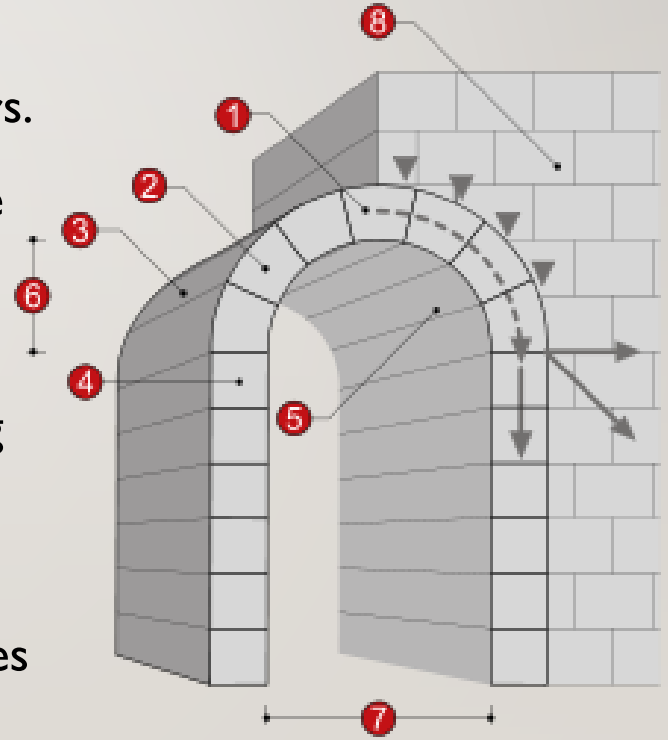
FUNICULAR SHAPE AND ARCHES





ARCH CONSTRUCTION

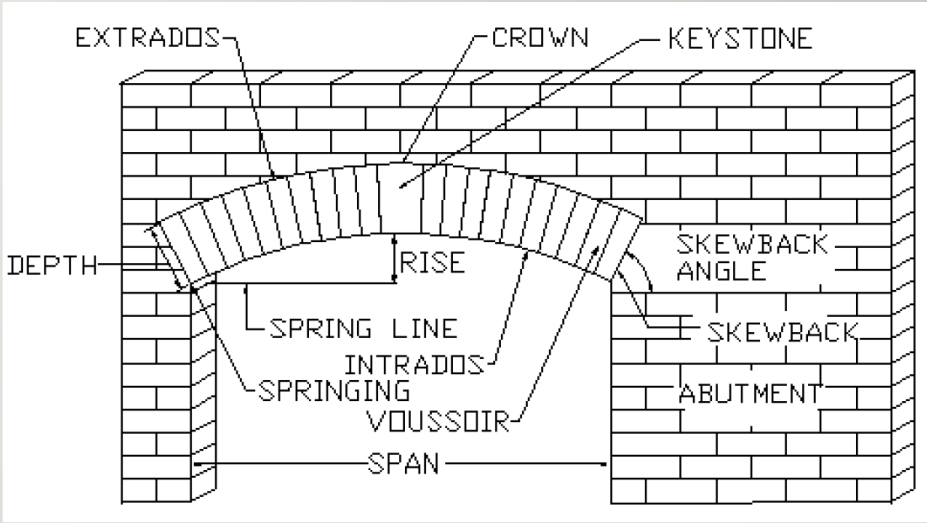
- Arch construction depends essentially on the wedge. If a series of wedge-shaped blocks—i.e., ones in which the upper edge is wider than the lower edge—are set flank to flank. These blocks are called voussoirs.
- Each voussoir must be precisely cut so that it presses firmly against the surface of neighbouring blocks and conducts loads uniformly.
- The central voussoir is called the keystone. The point from which the arch rises from its vertical supports is known as the spring or springing line.
- During construction of an arch, the voussoirs require support from below until the keystone has been set in place; this support usually takes the form of temporary wooden centring.



1. Keystone
2. Voussoir
3. Extrados
4. Impost
5. Intrados
6. Rise
7. Clear span
8. Abutment

OUTWARD THRUST

- Pressure downward on an arch has the effect of forcing the voussoirs together instead of apart. These stresses also tend to squeeze the blocks outward radially; loads divert these outward forces downward to exert a diagonal force, called thrust, that will cause the arch to collapse if it is not properly buttressed. Hence, the vertical supports, or posts, upon which an arch rests must be massive enough to buttress the thrust and conduct it into the foundation.
- Arches may rest on light supports, however, when they occur in a row, because the thrust of one arch counteracts the thrust of its neighbours, and the system remains stable as long as the arches at either end of the row are buttressed.

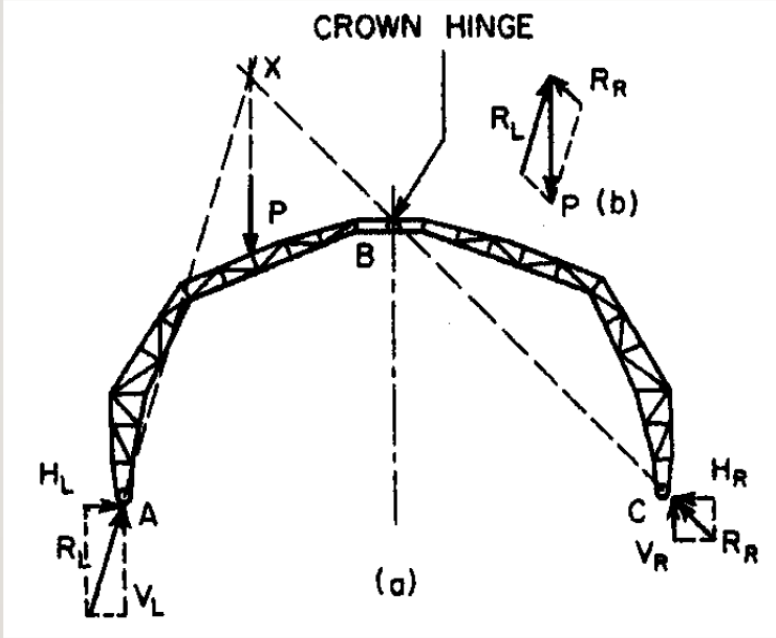


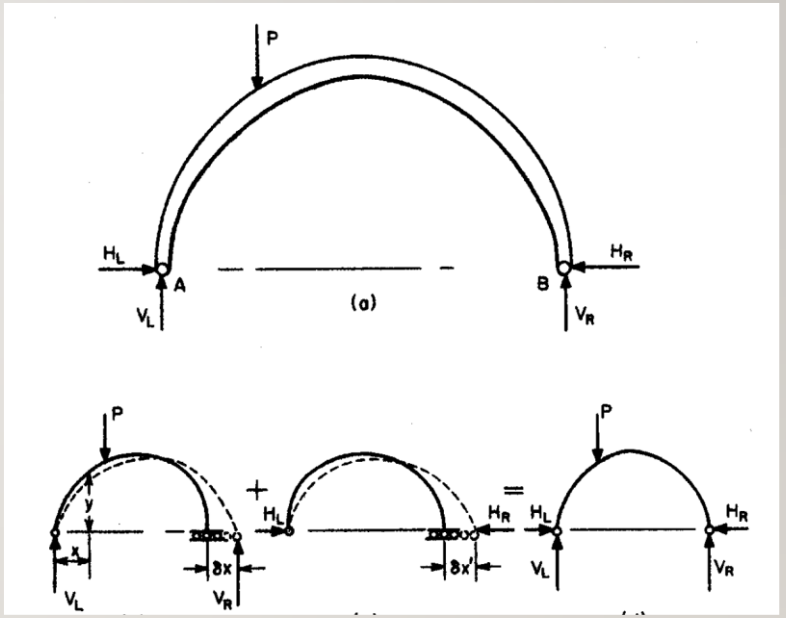
ADVANTAGES OF ARCH

In masonry construction, arches have several great advantages over horizontal beams, or lintels.

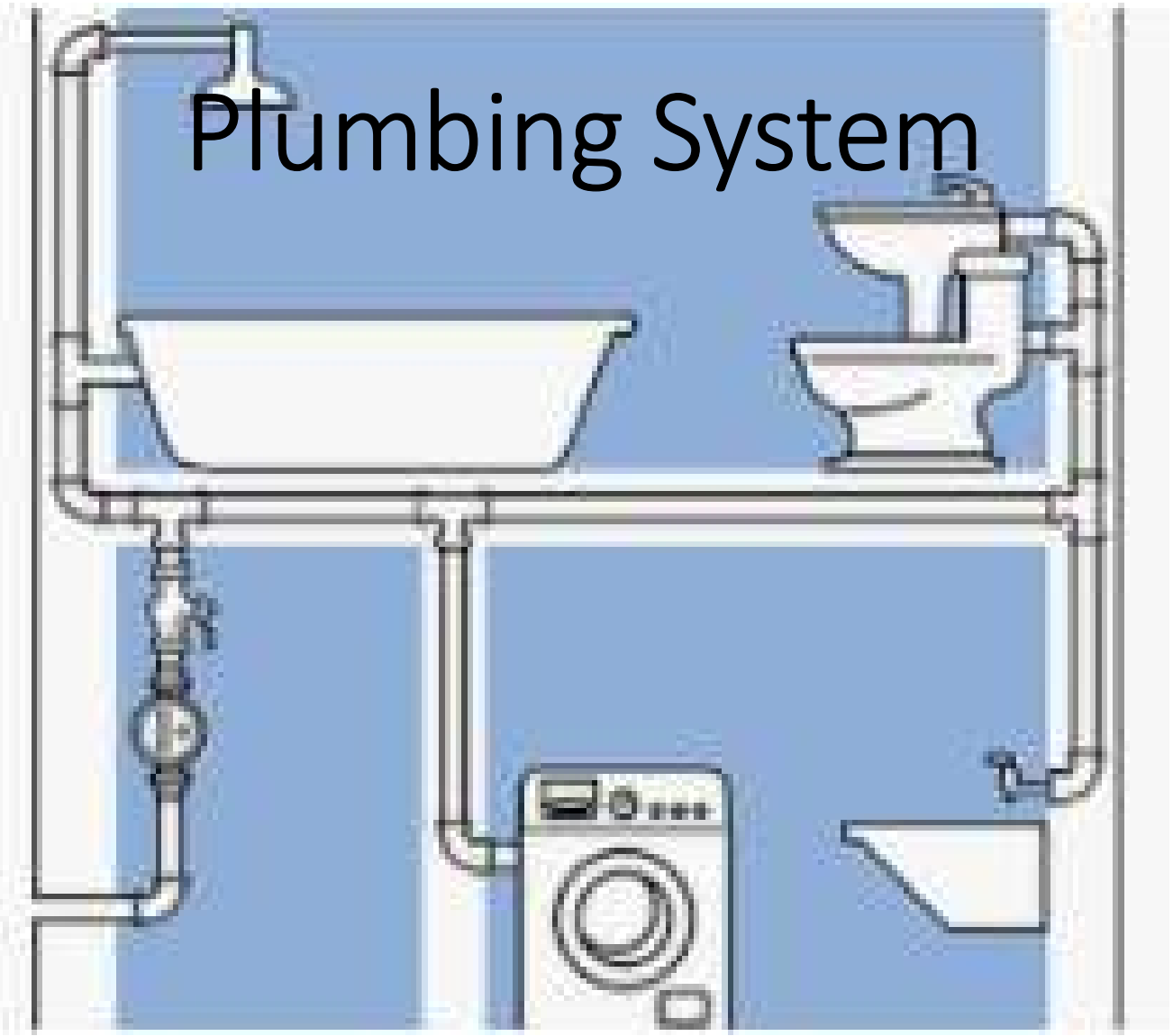
- They can span much wider openings because they can be made from small, easily carried blocks of brick or stone, as opposed to a massive, monolithic stone lintel.
- An arch can also carry a much greater load than a horizontal beam can support. This carrying capacity stems from the fact that pressure downward on an arch has the effect of forcing the voussoirs together instead of apart.

THREE HINGED VS. TWO HINGED ARCH





Plumbing System



What is Plumbing?

- The word ***Plumbing*** comes from the Latin word ***"Plum"*** means ***lead*** as pipes were once made from lead
- It is the art and science of creating and maintaining **sanitary conditions** in building used by humans.
- It is the art and science of **installing, repairing and servicing the pipes, fixtures, appurtenances necessary for bringing in water supply and removing liquid and water borne wastes.**

Plumbing System

- Refers to a system of pipes and fixtures installed **in a building** for the distribution of **potable water** and the removal of **water borne wastes**
- Includes all potable water supply and distribution pipes; all plumbing fixtures and traps; all sanitary and storm drainage system; vent pipes, roof drains, leaders, downspouts; all building drains and sewers including their respective joints and connections, devices, receptacles and appurtenances within the property; water lines in the premises; potable, tap, hot and chilled water pipes etc.

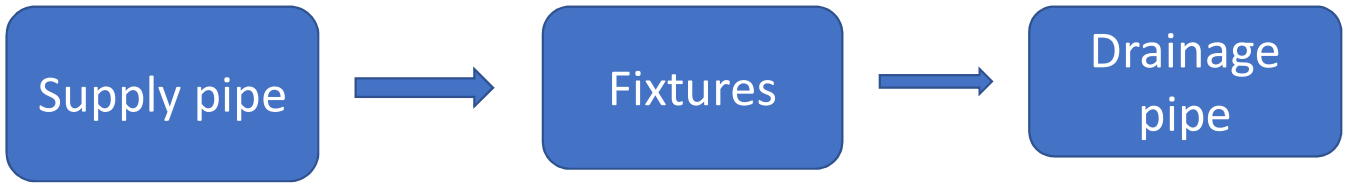
In simple words,

the system of pipes, tanks, fittings, and other apparatus required for the water supply, heating, and sanitation in a building is called plumbing system.

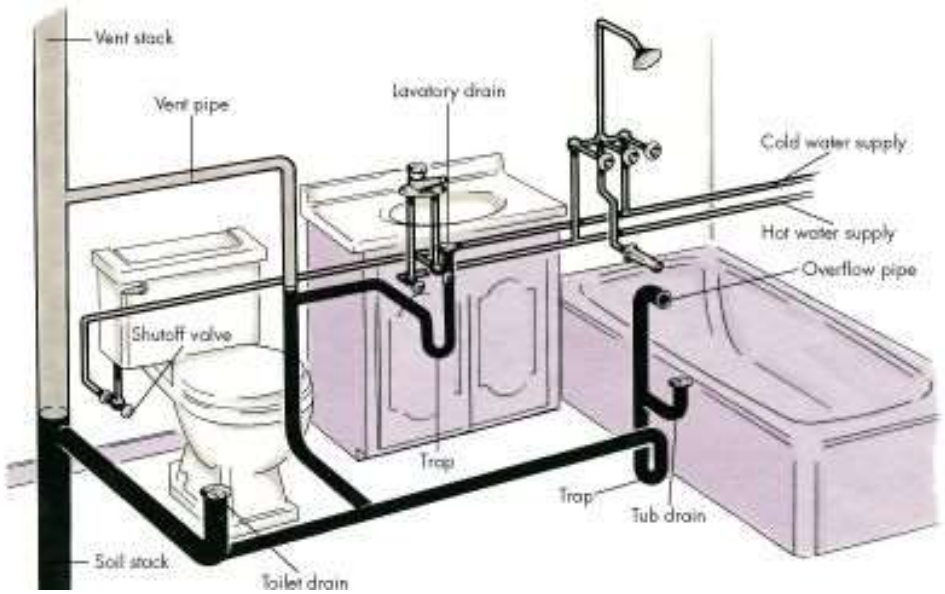
Plumbing system

Two main components of a building's plumbing system:

- Water supply
- Sanitary drainage



Plumbing System





History of Plumbing

- Copper pipes used in water supply was first discovered in ancient palace ruins in Indus valley which is about 5500 years old.
- Around 2500 years BC, Egyptians used copper pipes in their irrigation and sewerage system
- Romans were (500 BC – 450 AD) very advanced in the field of water supply and sanitation. They built Aquaduct to convey water from source to houses. Bath houses is another mentionable example.





History of Plumbing

- In 1500 AD, a type of water closet was developed
- Septic tank was introduced in mid 1800's.
- Modern sewerage system had begun operating in London in 1860.





Plumbing Components

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks













Plumbing Components: PIPES

- Steel pipe
- GI Pipe
- Cast Iron Pipe
- Copper pipe
- PVC pipe
- UPVC pipe
- MS Pipe
- Polypropylene
- HDPE



Steel pipes



Galvanized Iron pipes



Cast Iron pipes



P.V.C pipes

Types of different Pipes

COPPER PIPE



ADVANTAGES:

•**Longevity:** Copper has proven to be a reliable material that can last at least 50 years.
•**Durability:** Copper is a sturdy material that is not prone to leakage or corrosion.
•**Safety:** Bacteria cannot thrive in copper pipes, and copper will not pollute water in any way, so it is safe to transport drinking water.
•**Recyclability:** When copper pipes eventually need to be replaced, the material can be recycled.
•**Temperature Tolerance:** Copper is able to stand up to extreme temperature changes, including hot and cold water.

DISADVANTAGES:

- Labor intensive
- Prone to leaks
- Costly to repair
- Not easily modified
- Safety concerns



Types of different Pipes

GALVANIZED STEEL PIPE



ADVANTAGES:

- Low cost components
- Readily available
- Rated to high pressure
- Established (old) technology

DISADVANTAGES:

- Labor intensive
- Corrosion problems
- Prone to leaks
- Costly to repair/Safety concerns
- Not easily modified

Types of different Pipes

MILD STEEL (MS) PIPE

ADVANTAGES:

- Corrosion resistant/low pressure drop
- Chemical Compatibility
- Rated to high pressure

DISADVANTAGES:

- Labor intensive
- Material costs
- Costly to repair (labor)
- Safety concerns
- Low thermal conductivity



Mild-Steel (MS)Pipe

Types of different Pipes

CAST IRON (CI) PIPE

ADVANTAGES:

- Highly resistant to abrasion
- Highly Durable and practically Indestructible
- Fantastic sound-proofing qualities
- High Versatility
- Cheap to install



Cast Iron (CI) Pipe

DISADVANTAGES:

- Easily caught rust.
- Metallic taste in the water.

Types of different Pipes

POLY-VINYL CHLORIDE (PVC) PIPE

ADVANTAGES:

- Light in weight
- Tough
- resistant to chemical attack
- available in large lengths.
- Reduced cost of handling, transportation and installation.
- Less number of joints facilitates the speed and reduces chances of leakage.
- Rust resistant.
- Good elastic properties.

DISADVANTAGES:

- Labor intensive
- Prone to leaks
- Costly to repair (labor)
- Incompatibility issues
- Safety concerns



Types of different Pipes

UN-PLASTICIZED POLYVINYL CHLORIDE (UPVC) PIPE

ADVANTAGES:

- Corrosion resistant
- High strength
- Long life
- Low flow resistance
- Electrical insulation is good
- Light weight and simple construction

DISADVANTAGES:

- Resistance to mechanical shock is poor
- Expansion coefficient is large
- Pressure bearing capacity is weak
- Flame retardancy is poor.
- Drainage noise is large.



A plastic pipe made of polyvinyl chloride (PVC) resin and containing no plasticizer

Types of different Pipes

POLYPROPYLENE RANDOM COPOLYMER (PPR OR PP-RC)

ADVANTAGES:

- cost-effective
- corrosion resistance
- high temperature resistance
- environmental protection
- does not harm the human body



DISADVANTAGES:

- construction is troublesome
- hot melt construction is needed
- price is more expensive.

Mainly suitable for water supply pipes and hot water pipes of houses.

Types of different Pipes

HIGH-DENSITY POLYETHYLENE (HDPE) PIPE



Also known as high-density polyethylene structure wall thermal winding pipe

ADVANTAGES:

- Easy to match welding and electro-fusion welding to form a closed anti-seepage system.
- Light weight and easy to install and handle
- Strong wear resistance and excellent hydraulic performance
- Chemical corrosion resistance
- Good environmental adaptability and frost resistance
- Long service life
- Easy to recycle.

DISADVANTAGES:

- High thermal expansion
- Poor weathering resistance
- Subject to stress cracking
- Difficult to bond
- Flammable
- Poor temperature capability
- Low strength/stiffness

Plumbing Components

TAPS, VALVES AND STOPCOCKS

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks



TAP

Plumbing Components

TAPS, VALVES AND STOPCOCKS

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks



VALVES



USE

Plumbing Components

TAPS, VALVES AND STOPCOCKS

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks



STOPCOCK



USE

Plumbing Components

FIXTURES

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks



Lavatory



Water closet

Plumbing Components

FIXTURES

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks



TUB

Plumbing Components

WATER TANKS

- Pipes
- Taps, Valves and stopcocks
- Fixtures
- Water tanks





Types of Joints

- **Elbow joint**
- **U-Trap Joint**
- **Coupling**
- **Tee**
- **Cap**

Elbow Joint

- Pipe fitting installed between two lengths of pipe.
- Allow a change of direction, usually a 90° or 45° angle.
- Used for connecting hoses to valves and water pressure pumps.





U-trap joint

- A kind of u shape joint or trap joint
- Used in case of joining sanitary wastage pipes.





Coupling

- A very short length of pipe that allows two pipes to be joined.
- If the two ends of a coupling are different then it is usually referred to as an adapter.
- When the two ends use the same connection method but are of a different size, they are called reducing coupling or reducer.





Tee Joint

- Most common pipe fittings used for connecting pipes of different diameters.
- Made of various materials and available in various sizes and finishes.
- Extensively used in pipeline networks to transport two-phase fluid mixtures.



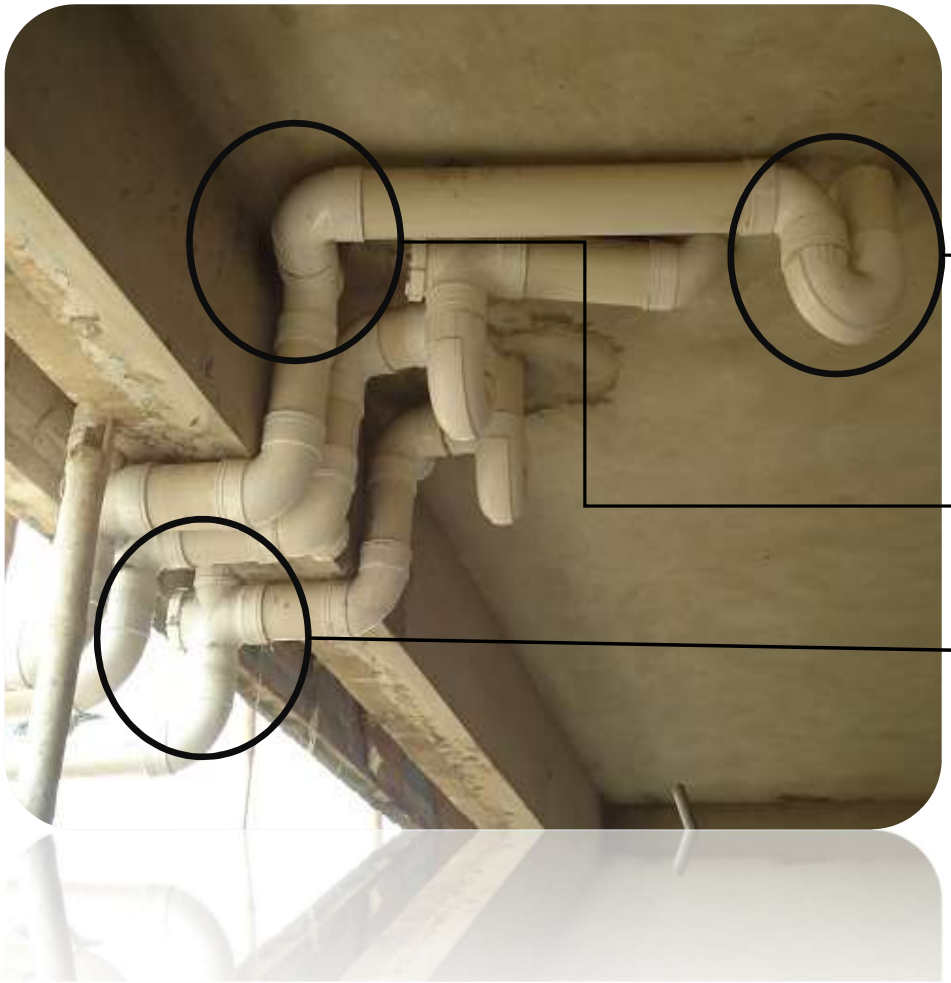


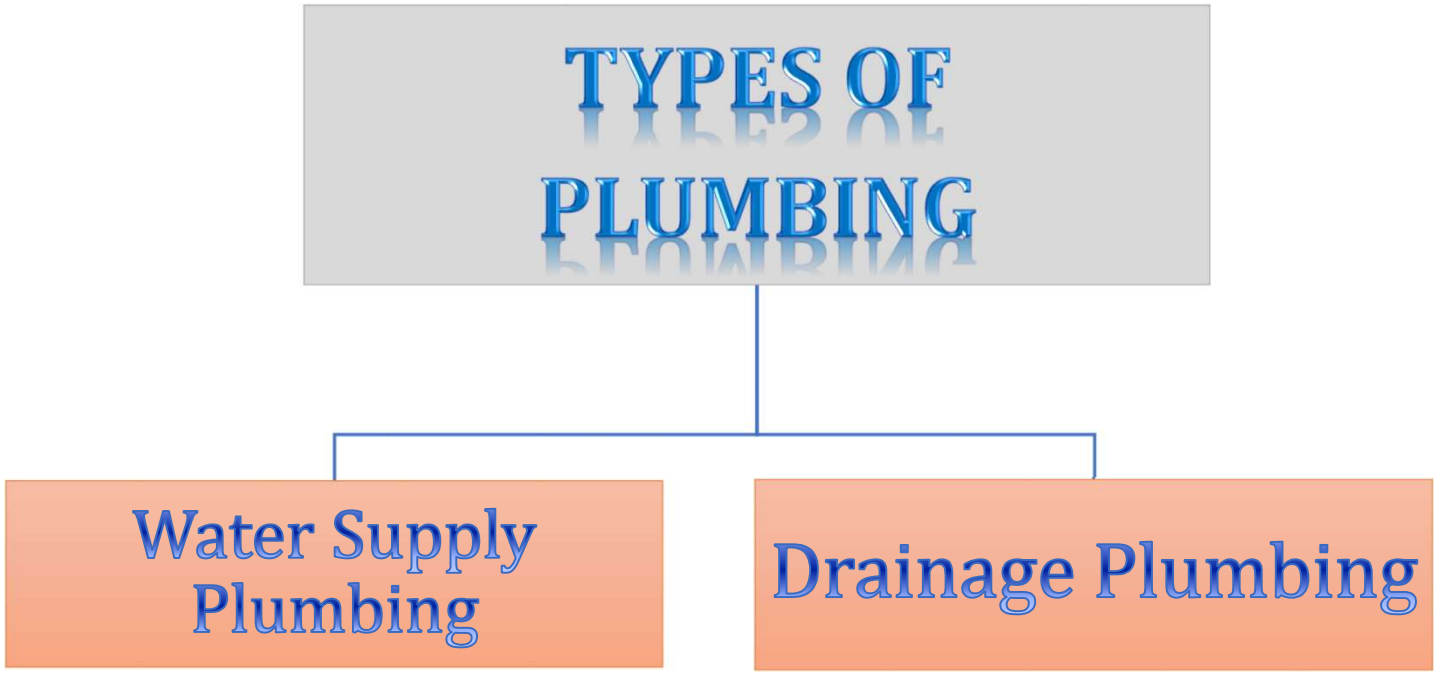
Cap

- A type of pipe fitting covering the end of a pipe.
- Usually liquid or gas tight.
- Used for providing a future connection point.



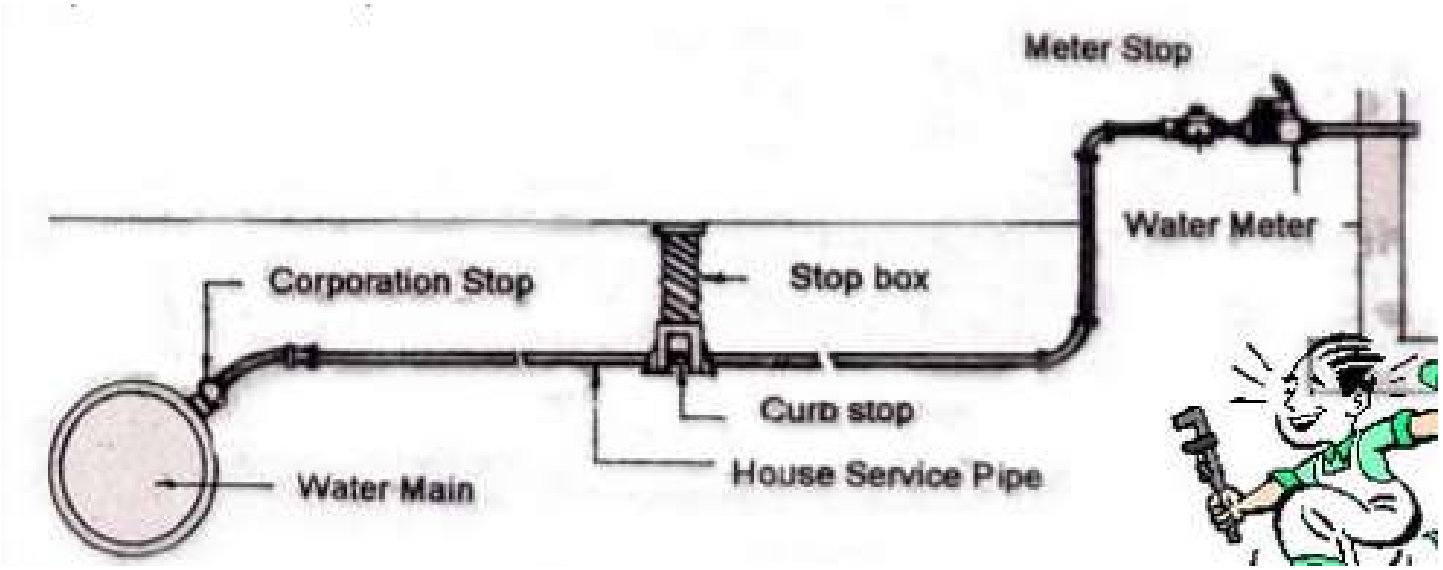
JOINTS IN PRACTICAL FIELD




TYPES OF PLUMBING
Water Supply Plumbing
Drainage Plumbing

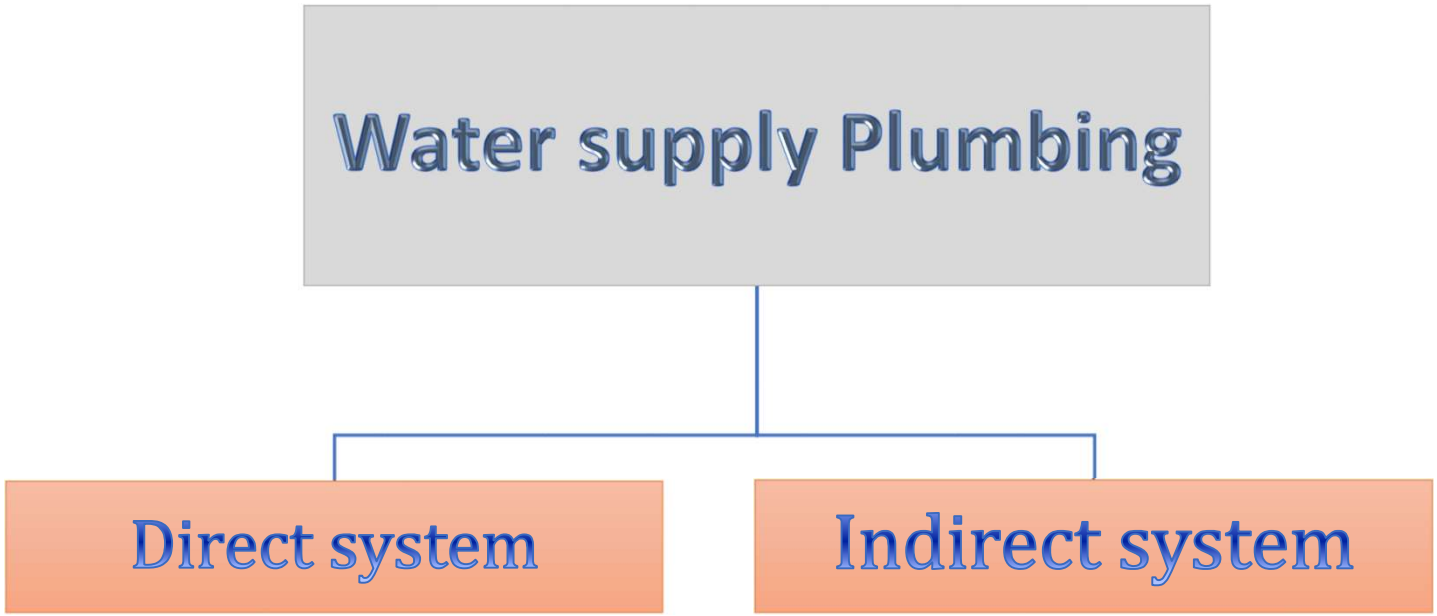
Water Supply

- House water connection



House water connection

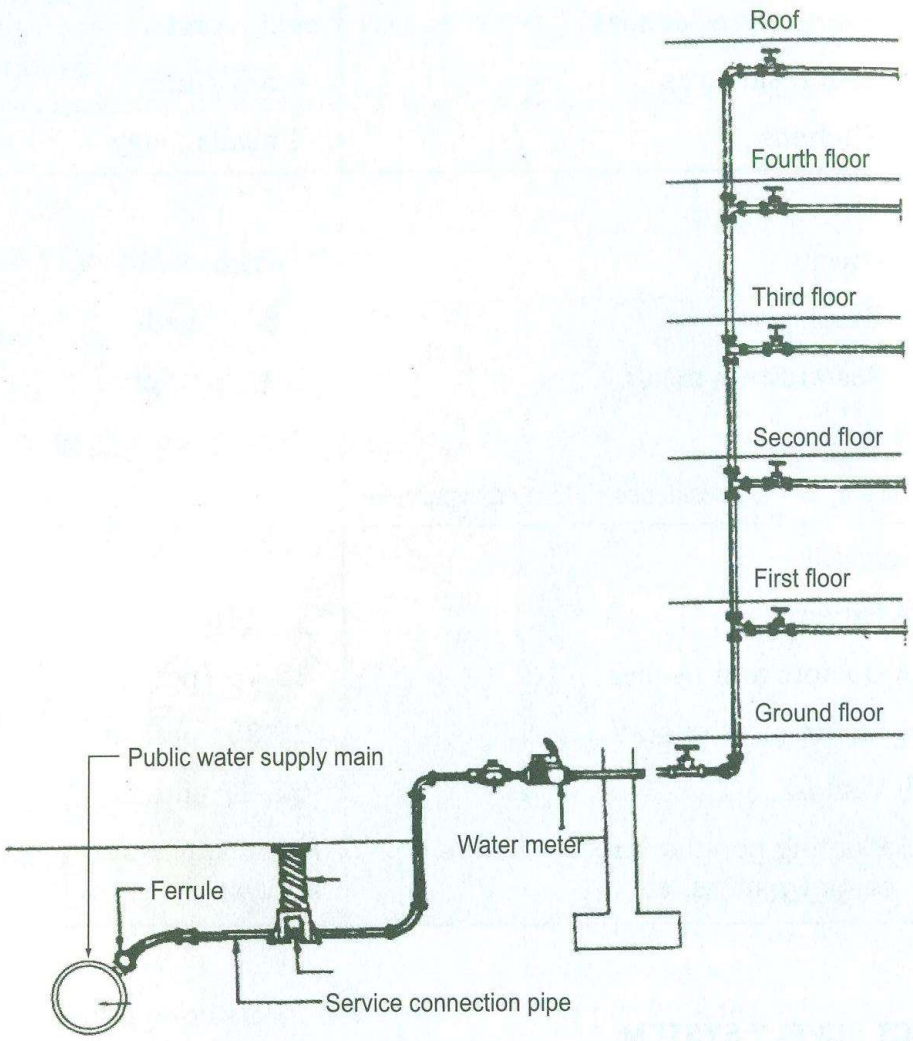
- Water main --- supply pipe installed and maintained by a public entity and on a public property
- Water service pipe --- from the water main to the building supply pipe
- Water meter --- measures the amount of water transported through the service pipe
- Valve --- a fitting used to control water flow (next to the meter)


Water supply Plumbing
Direct system
Indirect system

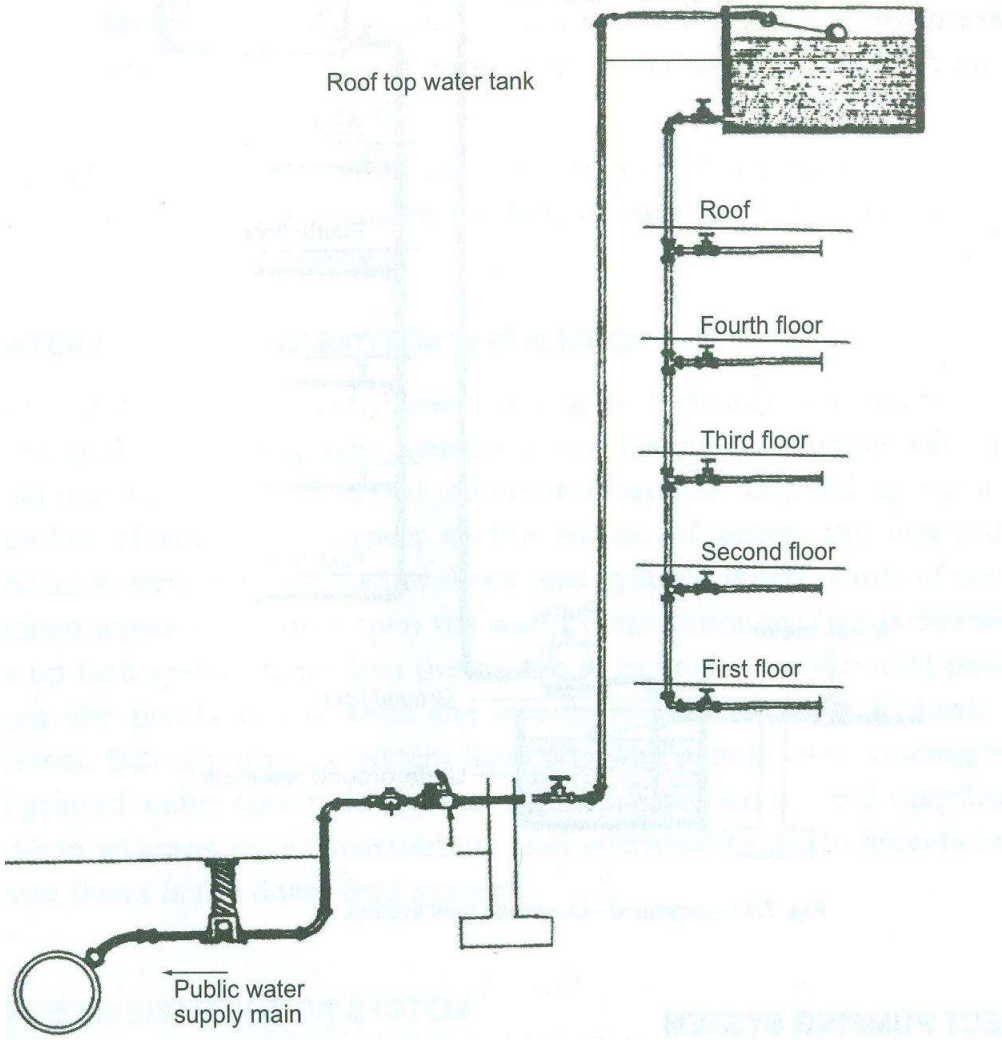
Water Supply system in a building

- Direct supply
- Overhead tank supply
- Underground overhead tank supply

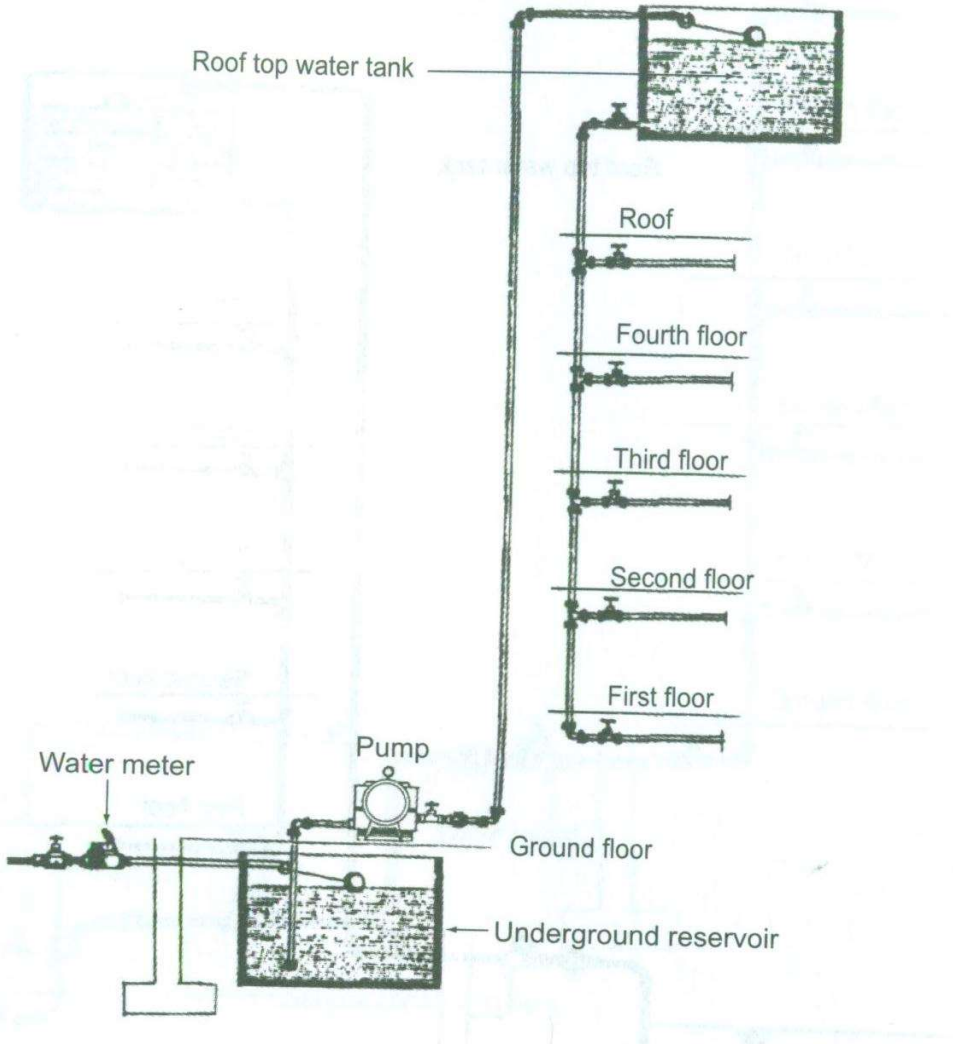
Direct Supply



Overhead Tank Supply



Underground & Overhead Tank Supply



Water Distribution System in Building

- Up Feed System
- Down Feed System

Up feed System

Water is supplied in suffucient pressure by machine or by providing mechanical energy







Down feed system

- water is distributed to the floors from the overhead storage tanks

- no need of extracting extra pressure because of gravitational energy water is distributed along the floors





One Pipe down feed Line



Many pipes down feed line

Design of water supply in Building

Principles governing the design

- Absolutely no risk of contamination – no cross connection, no back flow.
- Water supply and drainage pipe should not be laid very close to each other
- Enough protection for pipe damage
- Adequate pressure should be maintained

Water requirements in a Building

- Water quality: Safe, potable water
- Water quantity: Adequate quantity
- Pressure: Required pressure

Water Demand Calculation

Water requirement can be classified as:

- Residential water demand
- Industrial water demand
- Administrative water demand
- Water demand for common services
- Water demand for fire-fighting

Fluctuations in rate of water demand

- Average daily per capita water demand can be calculated from = $\frac{\text{Water required by total population in 365 days}}{\text{Population x 365}}$
- But it will not be possible to meet the fluctuations, if the average demand is supplied at all times.

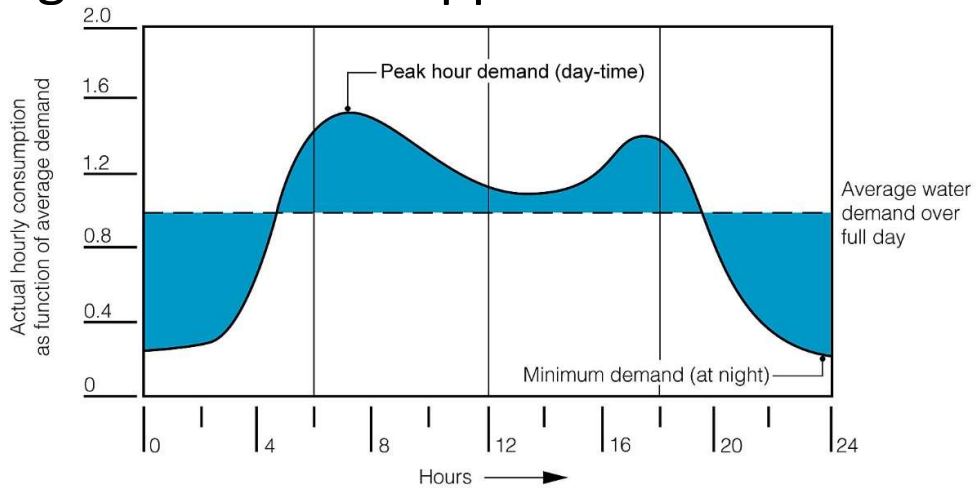


Fig: Daily variation in residential water demand

Peak Factor

- Total water demand should be calculated by considering suitable peak factors and time factors to meet instantaneous water demand.

- These factors for different zones may vary considering occupancy types, operations, operating hours etc.

Time Factor

- For other zones except residential area, water supply requirement is less than 24 hours. e.g., for office and most of the commercial facilities water supply is required only during working hours, commonly 8-hours.

- Time factor for industrial area (assuming two shift- each of 8 hours) = 24/ (8* 2) = 1.5

Water demand for any zone = Average water demand (lpd) x TF x PF

1. RESIDENTIAL WATER DEMAND CALCULATION

Step: 1 Calculate present population in the residential zone based on organogram.

Step: 2 Predict future population for a certain design period

$$\text{Future population} = P \times (1 + r)^n$$

P= Present population
r = Growth rate (%)
n = Design period (yr)

Step: 3 Depending on occupancy type, select per capita water consumption (lpcd) as per the BNBC 2020 [Table 8.5.1 (a) to (d)]

Step: 4 Calculate water demand in lpd for present population and for the expected design period

Water consumption (liter/day)= water requirement (lpcd) x water consuming population

Table 8.5.1(a): Water Consumption for Domestic Purposes in Residential Buildings (Cities/Big District Towns)

Category	Socio-economic group, Type of Building, Source and Other Facilities	Water Consumption	
		Full Facility (*lpcd*)	Restricted Facility (*lpcd*)
A	**Metropolitan Cities/City Corporation Area/District Towns**		
x	High income group:		
A1	Single family dwelling (with garden and car washing)	260	200
A3	Big multi-family apartment/flat (> 2500 sft)	200	150
y	Middle income group:		
y_1	Officer's qtr./Colony and moderate apartment (< 2000 sft)	180	135
y_2	Small building/staff qtr. and small apartment (< 1500 sft)	---	120
z	Low income group:		
z_1	Junior staff qtr./flat (< 1000 sft) and temporary shade	---	80
z_2	Stand post connection in the fringe area	---	65
z_3	Common yard (stand post) connection in the fringe area	---	50
z_4	Slum dwellers collection from road side public stand post	---	40

Source: BNBC 2020

Table 8.5.1(b): Water Requirement for Domestic Purposes in Residential Buildings (Pourashavas/Upazilas/Urban growth Centers)

Category	Socio-economic group, Type of Building, Source and Other Facilities	Water Consumption	
		Full Facility (*lpcd*)	Restricted Facility (*lpcd*)
A	**Pourashavas/Upazilas and Urban Growth Centre**		
y	Middle income group:		
A1	Single family dwelling (with garden)	---	150
A3	Officer's qtr./colony and moderate apartment (< 2000 sft)	---	135
A3	Small building/staff qtr. and small apartment (< 1500 sft)	---	120
z	Low income group:		
z_1	Junior staff qtr. /flat (< 1000 sft) and temporary shade	---	80
z_2	Private stand post connection in the fringe area	---	65
z_3	Common yard (stand post) connection in the fringe area	---	50
z_4	Slum dwellers collection from road side public stand post	---	40

Source: BNBC 2020

Table 8.5.1(c): Water Requirement for Domestic Purposes in Residential Buildings (Village Areas and Small Communities)

Category	Socio-economic group, Type of Building, Source and Other Facilities	Water Consumption	
A	Village areas/small community from hand tubewell, dugwells, ponds and rivers (non-piped water supply system)	**Full Facility (*lpcd*)**	**Restricted Facility (*lpcd*)**
z	Low income group:		
z_1	Private source (own tubewell/dugwell and pond)	---	50 - 60
z_2	Public sources (public tubewell/dugwell/ other sources)	---	40 - 50

Source: BNBC 2020

Table 8.5.1(d): Domestic Water Requirements for Various other Occupancies and Facility Groups

Class of Occupancy	Occupancy Groups	For Full[a] Facilities (*lpcd*)	For Restricted Facilities (*lpcd*)
A: Residential	A4: Mess, Boarding Houses, Dormitories and Hostels	135	70
	A5: Hotels and Lodging Houses (per bed)	300	135
B: Educational Facilities	B1: Educational Facilities up to Higher Secondary Levels	70	45
	B2: Facilities for Training and above Higher Secondary Education	100	70
	B3: Pre-School Facilities	50	35
C: Institutional	C1: Institution for Care of Children	180	100
	C2: Custodian Institution for Physically Capable Adults	180	100
	C3: Custodian Institution for the Incapable Adults	120	70
	C4: Penal and Mental Institutions for Children	100	60
	C5: Penal and Mental Institutions for Adults	120	70
D: Healthcare Facilities	D1: Normal Medical Facilities (Small Hospitals)	340	225
	Big Hospitals (Over 100 beds)	450	250
	D2: Emergency Medical Facilities	300	135
	Nurses & Medical Quarters	250	135
E: Business	E1: Offices	45	30
	E2: Research and Testing Laboratories	70	45
	E3: Essential Services	70	45
F: Mercantile	F1: Small Shops and Market	45	30
	F2: Large Shops and Market	45	30
	F3: Refueling Station	70	45
G: Industrial Buildings	G1: Low Hazard Industries	40	25
	G2: Moderate Hazards Industries	40	25

Source: BNBC 2020

2. WATER REQUIREMENT FOR ADMINISTRATIVE AND COMMON SERVICES

- Includes school, college, hospital, market, parking zone, park, hotel, office, bus stand, rail station, mosque, community center, auditorium, restaurants, fire service, police station etc.

3. WATER REQUIREMENT FOR INDUSTRIAL ZONE

- Water requirement for industrial purpose should include two aspects:

  (a) water use for industrial production,

  (b) water use for personal consumption.

- Appropriate assumptions (water required per unit weight of goods, restricted/unrestricted facility etc.) must be listed in calculating these water requirements.

a) Water requirement for production purpose

- Assume the weight of total finished goods per day in the factory
- Find the weight of the finished goods for a certain design period
- From book find the water requirement for per kg of finished goods (Water Supply Engineering by M.A. Aziz)
- Calculate the present and future water demand for production

b) Water requirement for personal consumption

- Calculate the total manpower in the factory per shift
- From BNBC select per capita water consumption per day
- Calculate total water demand

4. WATER REQUIREMENT FOR FIREFIGHTING

Assumptions:

- Only one fire incidence occurs per day
- Each station/ facility should be served by two fire hydrants at a time
- Nozzle diameter of the hydrant is **3 inches** (2r)
- Velocity of water in the pipe is **3 fps (V)**
- Each hydrant will supply water for **30 minutes (t)**

We know, Q = A x V

Where, A = Area of the pipe (πr^2)

V = Velocity of water

Q = Discharge of each hydrant

Volume of water for each hydrant = Q x t

No of hydrant working at a time = 2

- Calculate total water demand per day for firefighting (present + future)

Water requirements for fire fighting

Table 4.4.1
Fire Protection Flow Requirements

Building Type	Sprinkler System (l/min.)*	Standpipe and hose System (l/min.)*	Duration** (minute, min.)
Light hazard- I	1000	1000	30
Light hazard- II	1900	1900	50
Ordinary hazard- I	2650	1900	75
Ordinary hazard - II	3200	1900	75
Ordinary hazard - III	4800	1900	75

Notes:

* Values will be for one riser serving floor area of 1000 m^2.

** These durations shall be for a building up to the height of 51 m. For greater height of 51-102 m and above 102 m, the duration will be 1.25 times and 1.5 times of the specified values respectively.

Light hazard - I : Occupancy groups, A1, A2, A3, E1

Light hazard - II : Occupancy groups, A4, A5, B, C, D,E2, E3, I2, I4,

Ordinary hazard - I : Occupancy groups, I1, I3, I5, F2, F3, G1

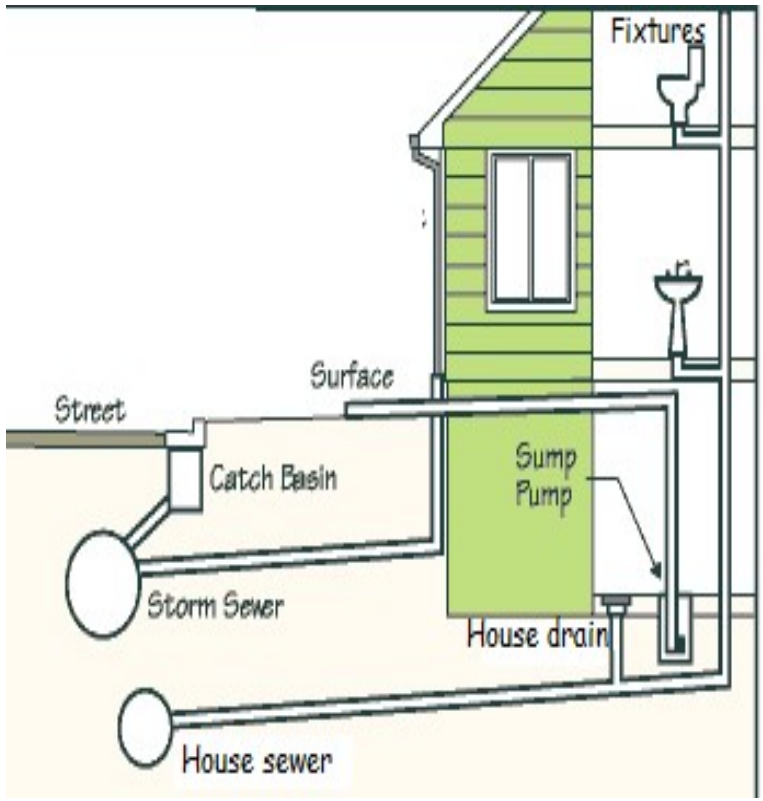
Ordinary hazard- II : Occupancy groups, G2 , H1

Ordinary hazard- III : Occupancy groups, H2

Extra hazard :Occupancy group J - pressure and flow requirement for this group shall be determined by Fire Department but shall not be less than required value for Ordinary hazard-III

DRAINAGE SYSTEM

The drainage system means the removal of all the water borne wastages in a distributed way.



Drainage Pipe Requirements

•Provision of adequate supports for drainage pipes during construction of building.

•Pipe lay out should be direct and simple. Pipes should be laid in straight lines.

•Any abrupt changes in the direction of flow should be avoided. The contained angle between two intersecting pipes should not be less than 45^{o}.

•Installation should not be done so as to impair structural safety of a building.

•The drainage pipes should be sufficiently strong and durable. They should also be air-tight and gas tight.

DRAINAGE SYSTEM

- The pipe-joints should be strong and leak proof.

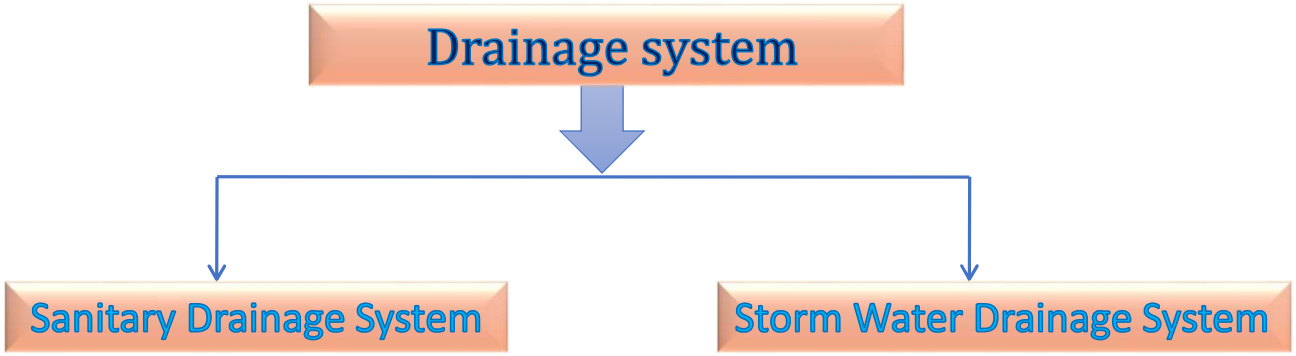
- The entire network of pipes should have ample means for cleaning and removing obstruction.

- Traps are required for every fixture.

- Any possibility of air-locks, siphonage, undue deposits and obstruction should be thoroughly looked into and avoided.

- Pipes when not embedded should run clear of the wall with a minimum clearance of 5 cm.

- Each stack should be suitably covered on top above roof by copper or galvanized iron wire dome.



Sanitary drainage system

The system that drains water from **sinks, tubs, showers, lavatories & soil matter from toilets** is known as Sanitary drainage system. Here two pipe system is commonly used.

Storm water drainage system

The system that collects **storm water/rain water** from roofs, yards & areaways is known as Storm water drainage system.

SANITARY DRAINAGE SYSTEM

Components

- House sewer
- House drain
- Soil, waste, vent stacks
- Fixture branches & branch vents
- Fixture traps
- Fixtures

SANITARY DRAINAGE SYSTEM

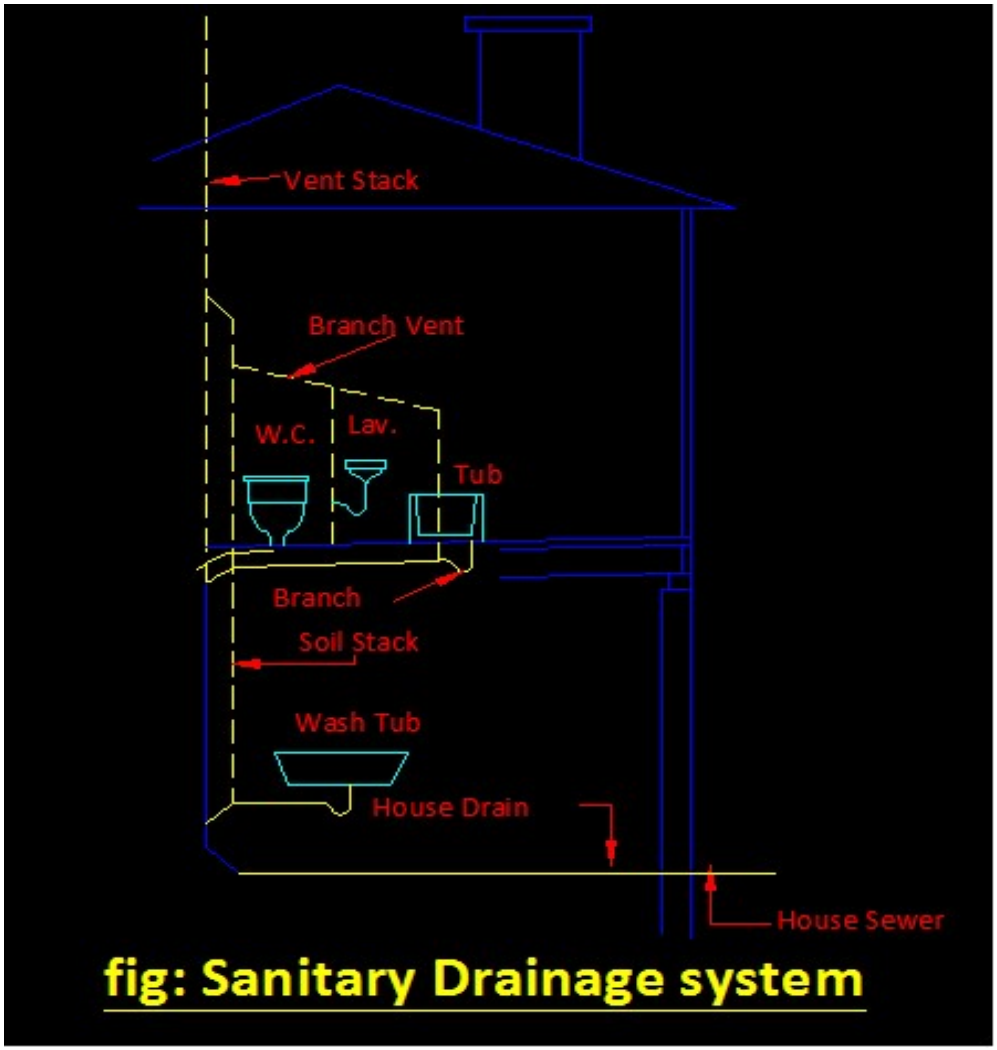


fig: Sanitary Drainage system

1. HOUSE SEWER

- portion of pipe that extends from the public sewer pipe in the street to about 3 to 5 feet from the house.
- Depending upon the local Plumbing codes the pipes may be of cast iron, galvanized steel, lead, copper, PVC or other approved materials.
- If the sewer line passes within 10 ft (3 m) of a drinking water supply line under pressure, the house sewer line must be leak proof.

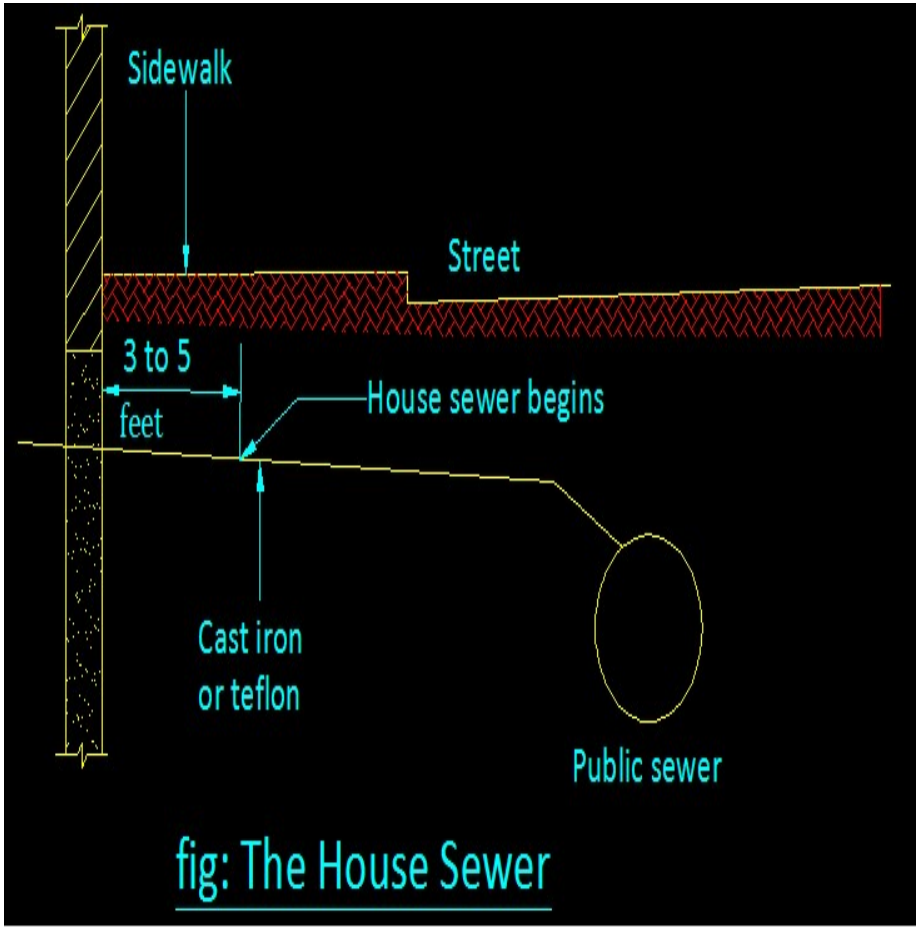


fig: The House Sewer

HOUSE DRAIN

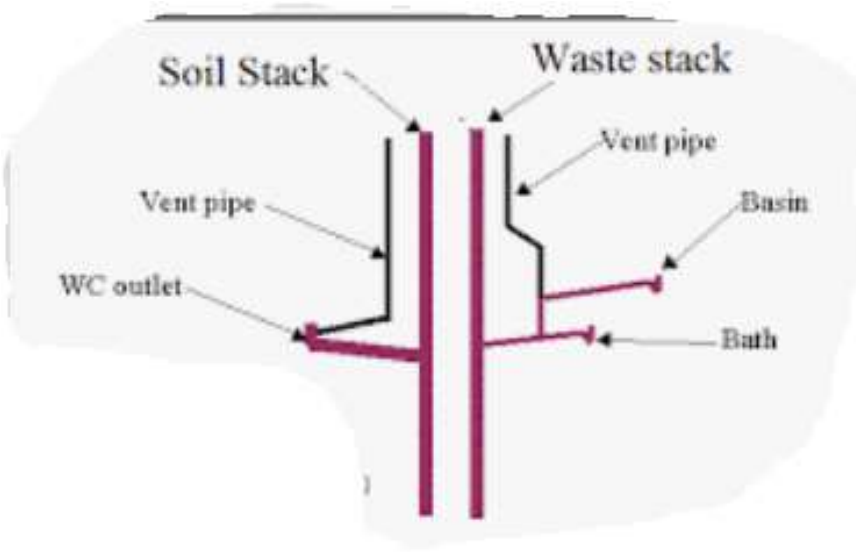
- The house drain is the horizontal pipe inside the house into which the vertical soil & waste stacks discharge.

- Since sewage in the house drain flows into the public sewer by gravity, the public sewer must of necessity be deeper below the grade line than the house drain.



Sanitary Pipes/Stacks

- **Soil Stack** – a vertical drain pipe that carries wastes from WC, Urinals etc.
- **Waste Stack** – a vertical drain pipe that carries wastewater from basin, sink, bathtub etc.
- **Vent Stack** --- a vertical pipe that vents out foul gases



SOIL, WASTE & VENT STACKS

- The vertical pipes of the sanitary drainage system.
- Distinction must be made between soil, waste & vent stacks.
- Soil stack receives the soil matter from the water closet.
- The lavatory & tub drain into the waste stack.
- The pipe above the point where the lavatory & the tub drain into the waste stack becomes a vent stack.
- Vent stack is provided to remove unwanted odorous gases and insects.

SOIL, WASTE & VENT STACKS

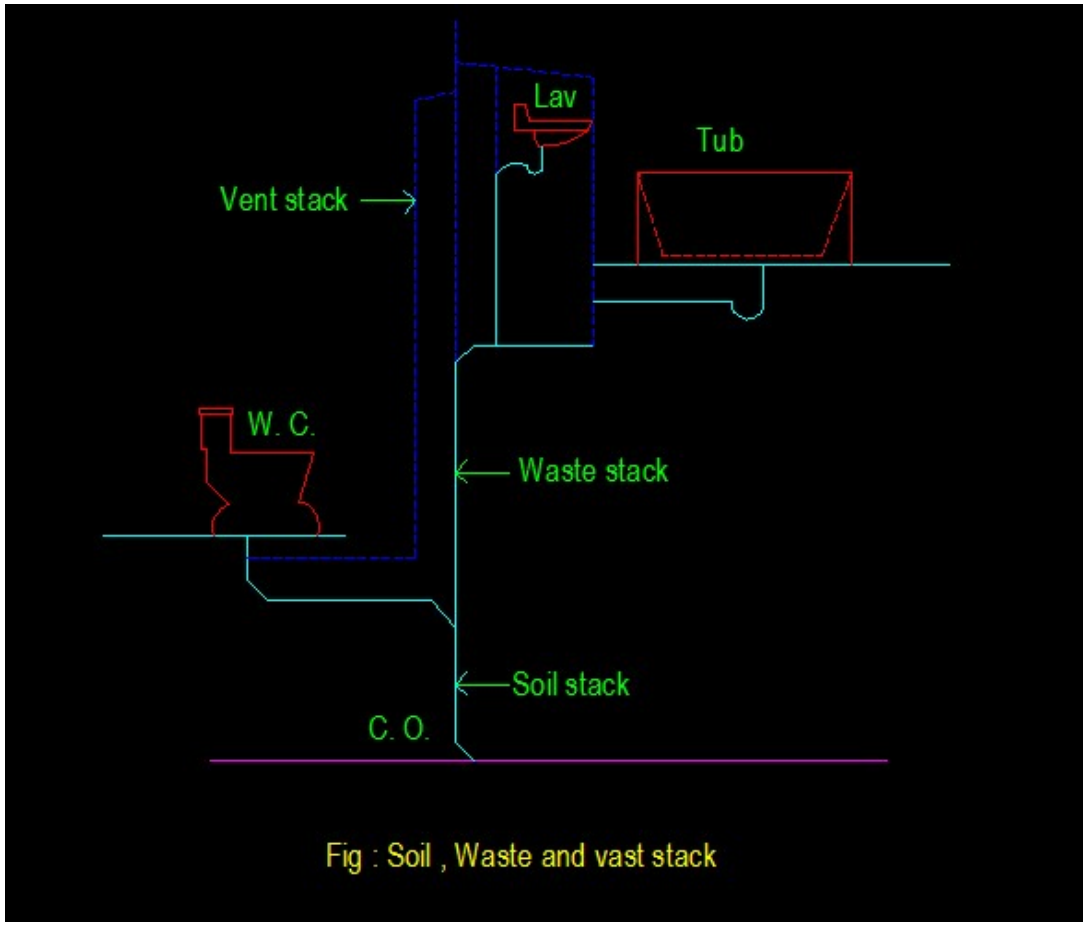


Fig : Soil , Waste and vast stack

SOIL, WASTE & VENT STACKS



VENT STACK



SOIL STACK

WASTE STACK

VENT STACK

FIXTURE BRANCHES & BRANCH VENTS

- Fixture branch is the horizontal pipe running from the fixture trap to the vertical soil or waste stacks.

- The fixture vents are the horizontal piping that run from near the fixture trap, then overhead of the fixture to the vent stack.

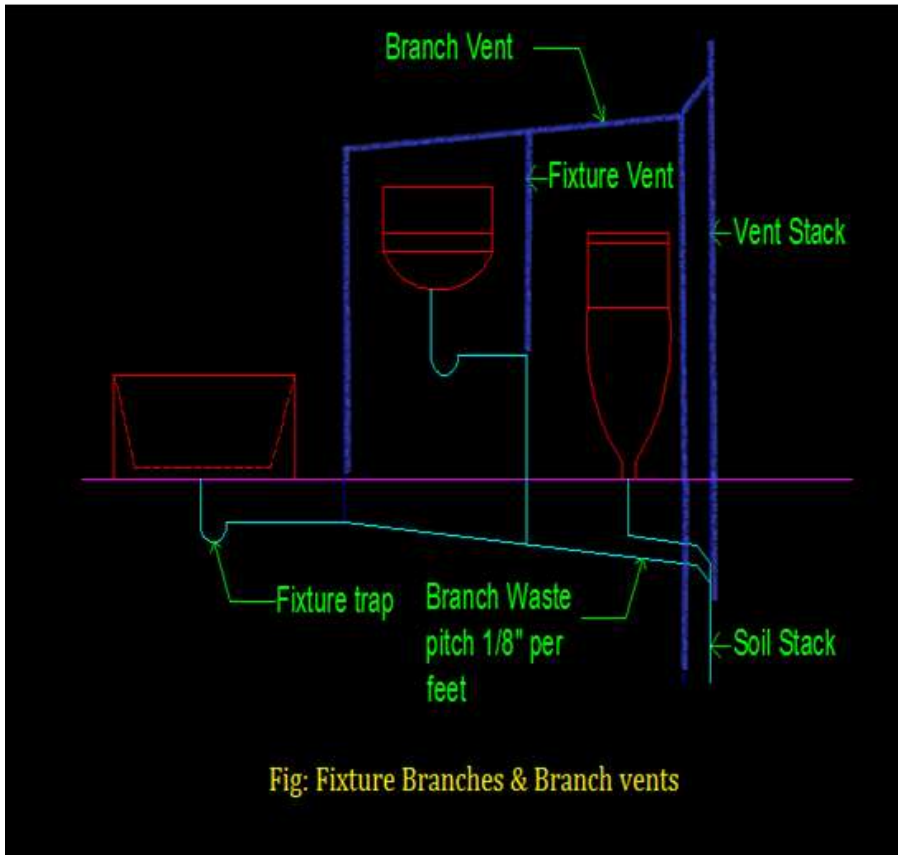
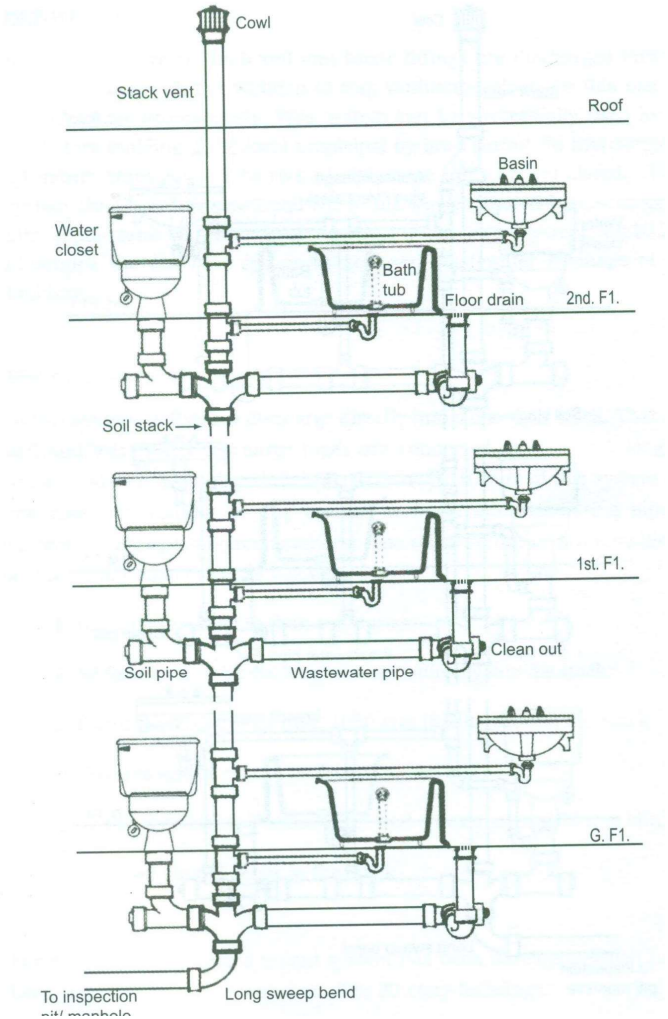


Fig: Fixture Branches & Branch vents

Building Drainage System: Soil and Waste Pipe System above grounds

- Single Stack system
- Partially ventilated Single Stack system
- One Pipe System
- Two Pipe System

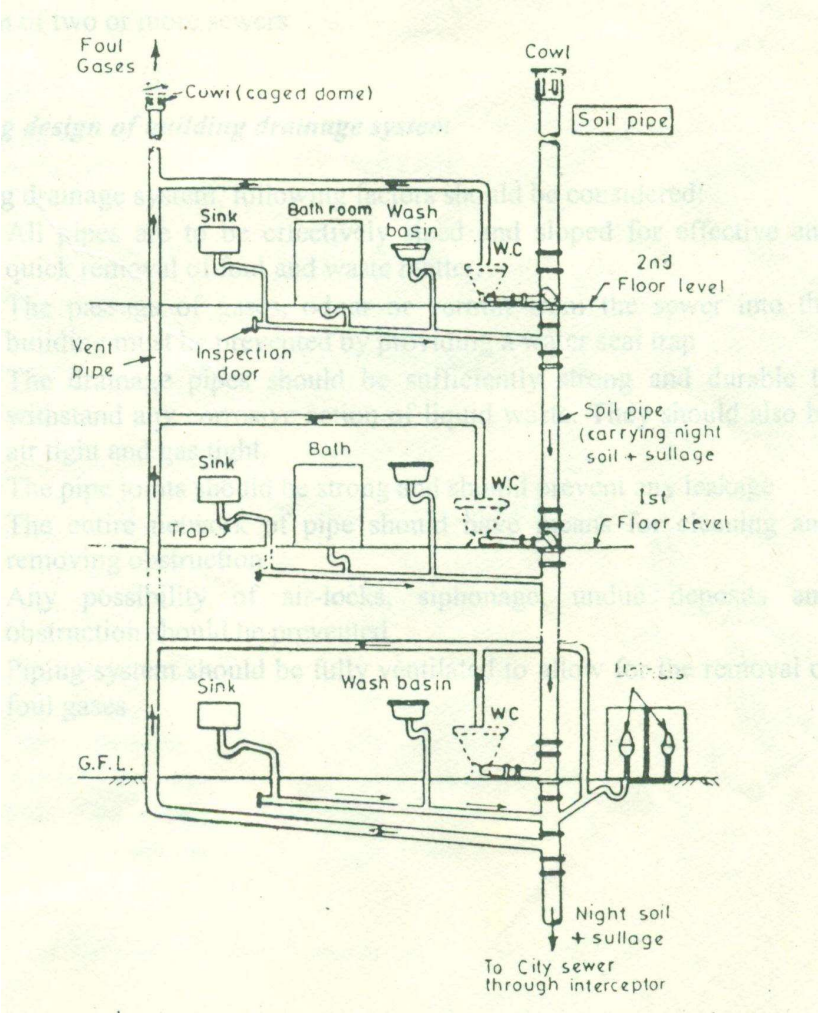
Single stack system



- All fixtures discharge directly into a common stack known as Single stack.
- Should not be installed in buildings more than six stories

- Advantages of single stack system
  - Simplicity in lay out, design, plumbing of the sanitary fixtures
  - Improved external appearances
  - More compact system
- Disadvantages
  - Air and waste from drainage pipes may be forced up through traps by back pressure due to blockage or bad design
  - Water in the seal may be evaporated in dry season or in absence of flushing for a long time
  - Self siphonage due to sudden discharge from appliance sucking away its own trap seal, due to discharge of another appliance in the system.

Partially ventilated single stack system



- Improved form of single stack system
- Traps of WC are separately ventilated by relief vent pipe.
- Sullage fixtures are not connected to the vent pipe.
- Less costly

One Pipe system: Soil and waste Fittings are discharged Into a common stack with addition of trap ventilation pipes.

- Advantages
  - Now widely used in modern multistoried building
  - High quality of pipes, fittings and installation techniques ensures reduction of blockage problem
  - Requires lesser space in pipe shafts and ducts

- Disadvantages
  - Costlier than single stack system

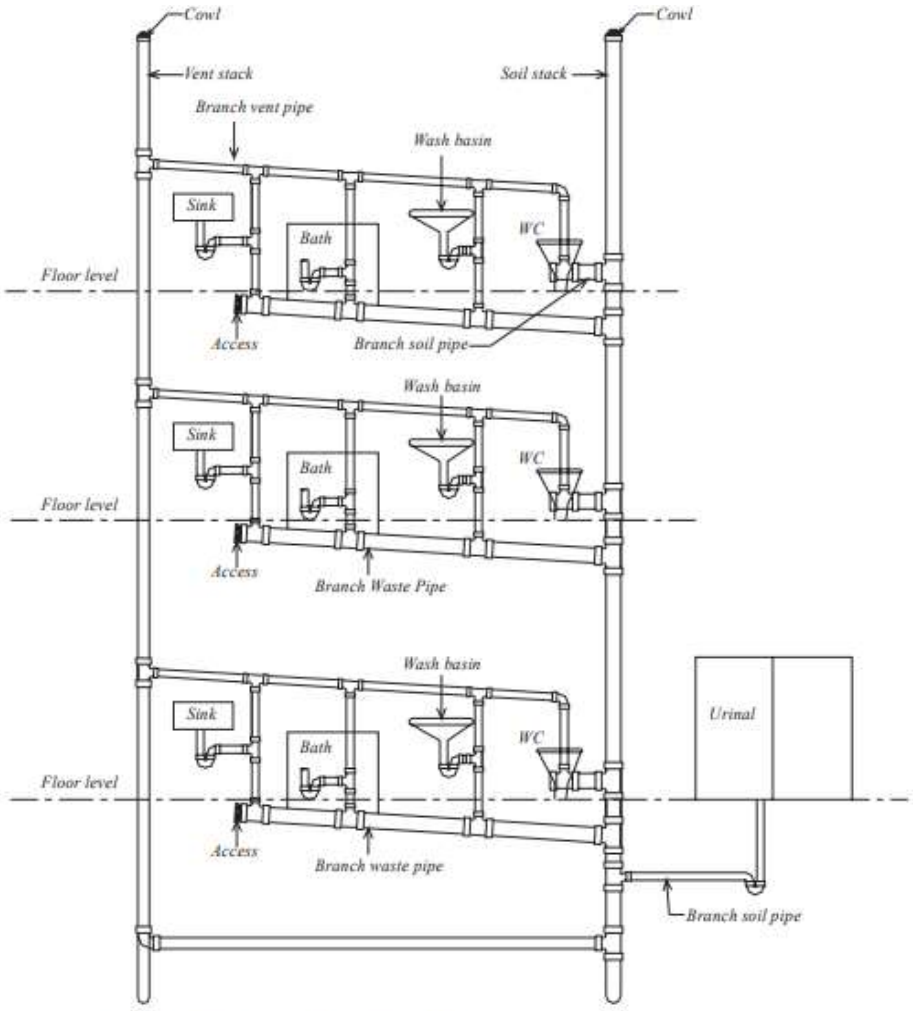
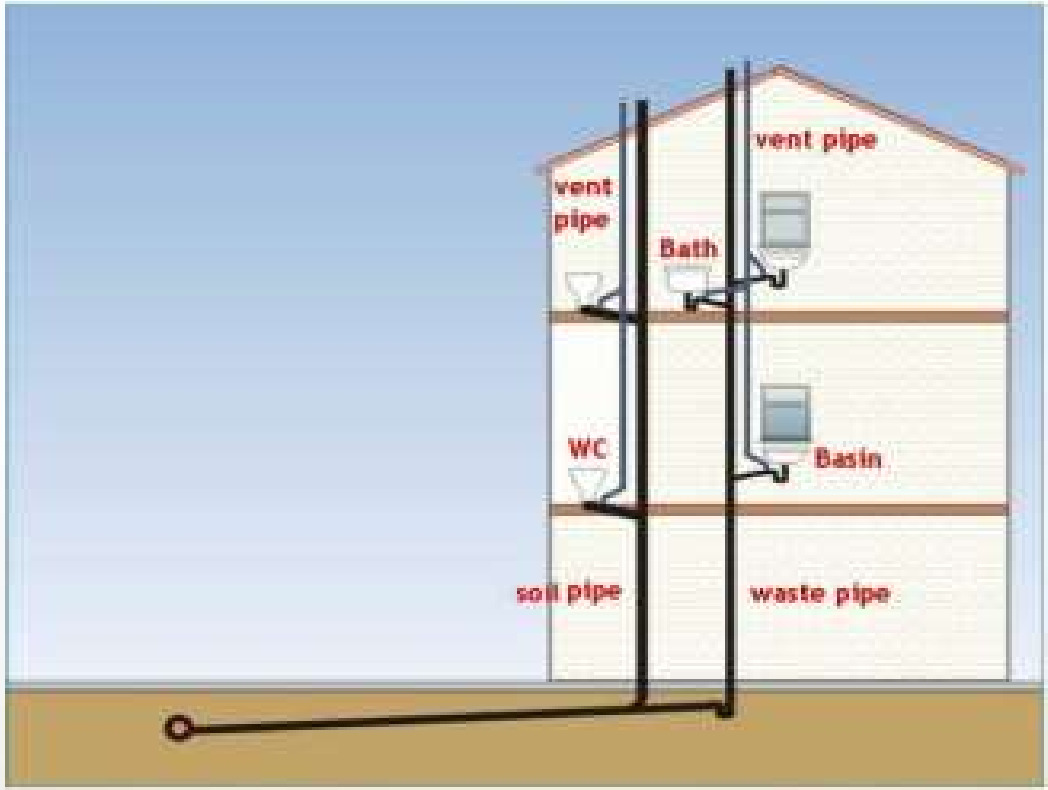


FIG. 8.6.2 DIAGRAM OF ONE - PIPE SYSTEM

Two pipe system



Two Pipe system

- Elements:
  - Soil pipe
  - Waste pipe
  - Vent Pipe

Advantages of Two pipe system:

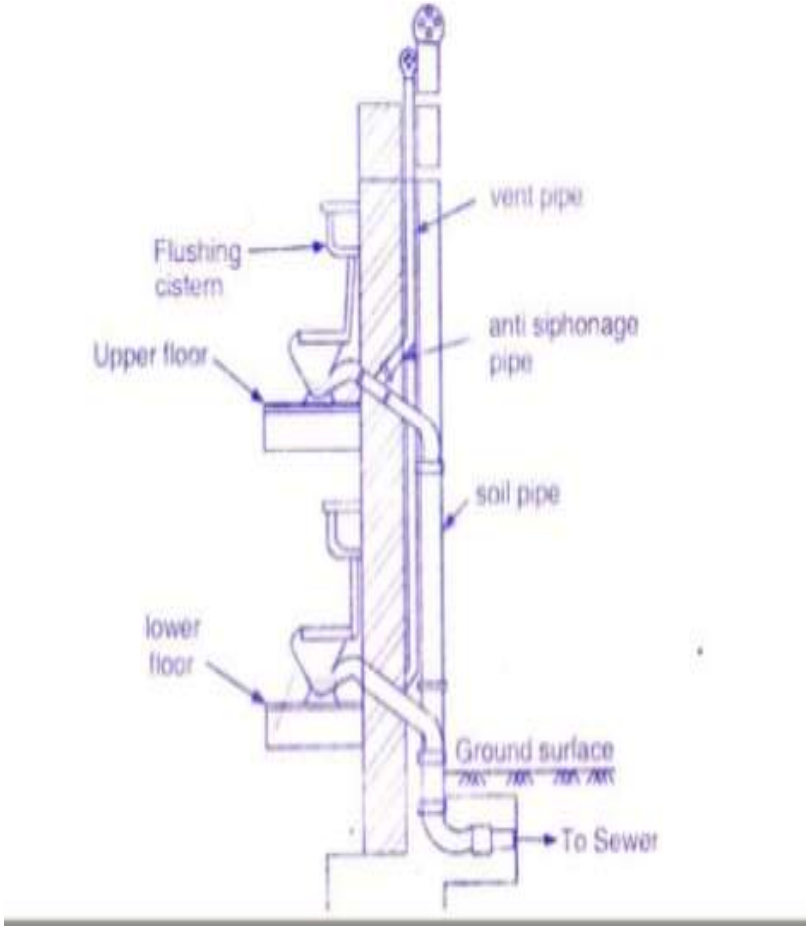
- Ensures segregation of the foul sewage from waste water
- No danger of back flow of sewage into waste fittings in case of blockage of soil pipe
- Separate waste stack permits arrest of solids from kitchen in gulley traps thus preventing from entering the sewer
- Reduce waste load for septic tank where there is no public sewer

Disadvantages

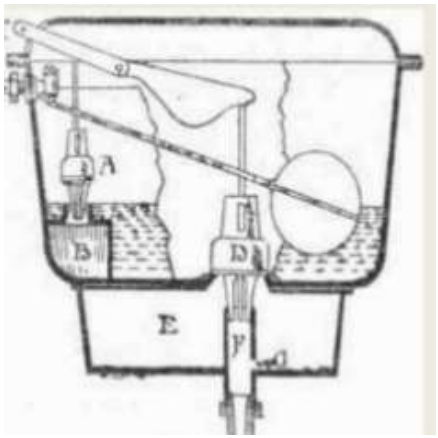
- Difficult to install in high rise buildings where the vertical stacks terminate in a service floor or in the ceiling of a basement
- Long external horizontal runs are required to reach external walls and lines connected to the sewer. Provision of gulley trap becomes difficult
- Requires more space
- Costly system
- Installation of more pipes needs more joints. So probability of leakage through joints increases

Flushing Cistern

- Flushing cistern is installed to flush WC and Urinal.
- It is made of cast iron, glazed earthen ware or vitreous china or plastic.
- For Indian WC, cistern are made of cast iron and fixed at a ht of about 1.75 m above the pan.
- For European WC, cisterns are made of vitreous china or plastic and are fixed at about 30 cm from top of the WC.

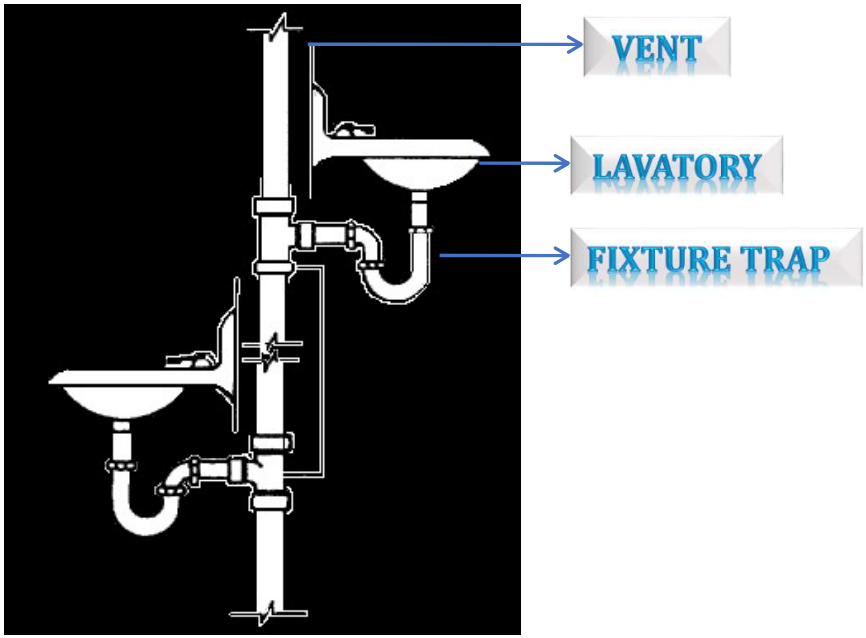






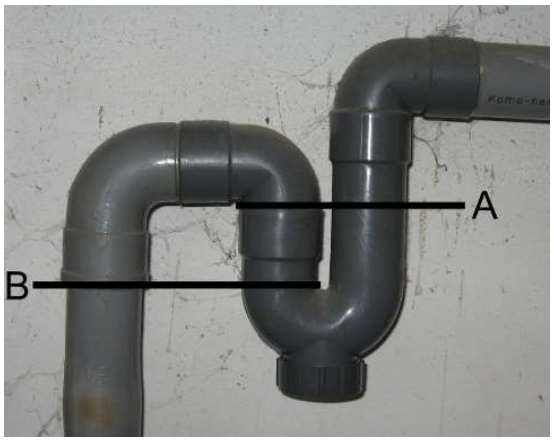
FIXTURE TRAPS

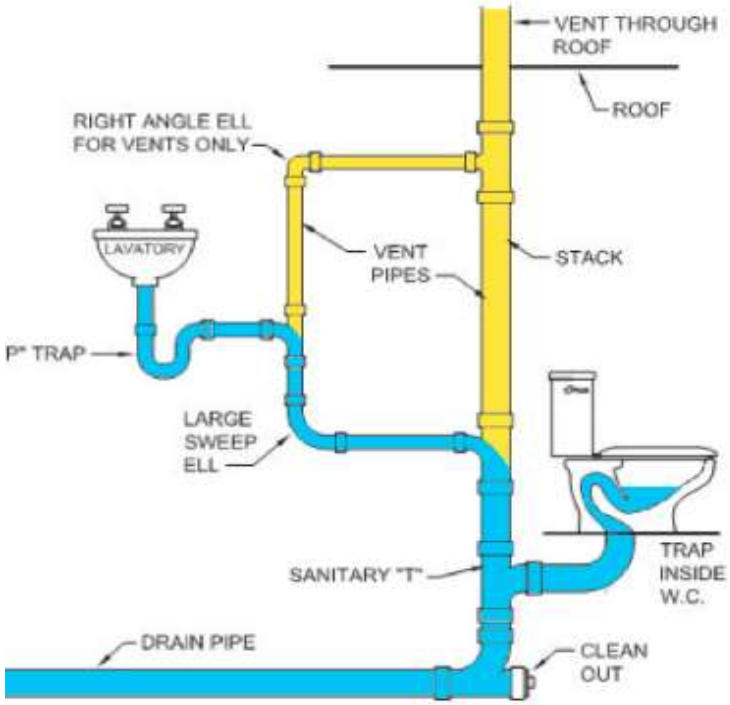
- Every fixture has a trap which is directly under the fixture & 'U' shaped.
- The trap has a water seal, that prevents odors & gases within the pipe from entering the living areas.
- Traps must be protected from freezing & must be vented to prevent siphonage of the fixture trap.



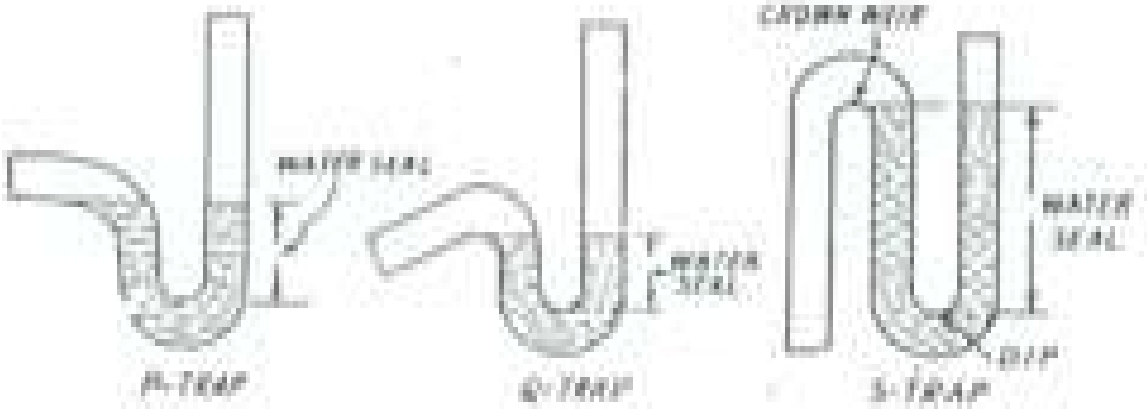
Traps

- ***Traps*** are fittings placed in drainage pipes, which prevent the passage of foul air or gases through drains, waste or soil pipes and thus prevent their entry into the interior of the houses or buildings. This is possible because traps are equipped with water seals having a minimum depth of 25 mm.





Trap Seal is the maximum vertical depth of liquid that a trap will retain, measured between the crown weir and the top of the dip of the trap



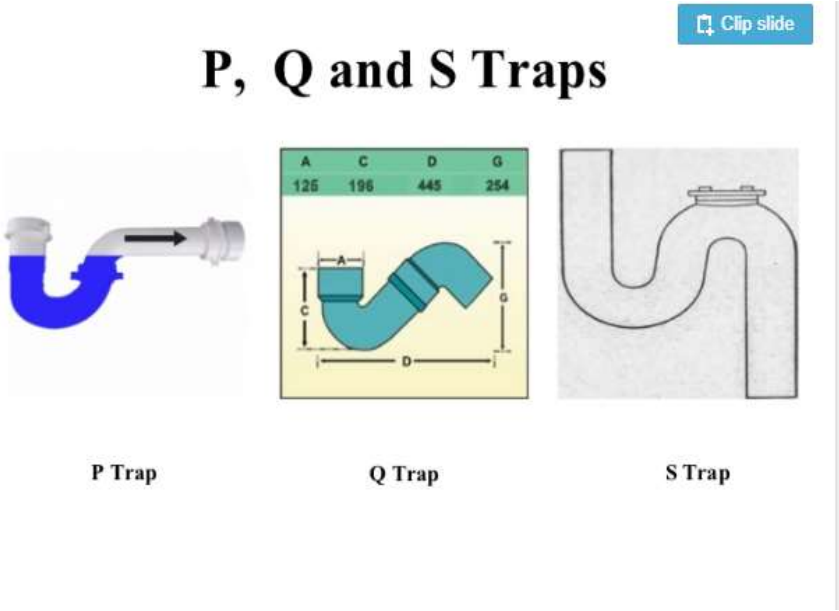
Trap

- Quality of a good trap:
  - Non absorbent having water seal at all times
  - Smooth
  - Provided with suitable access for cleaning

Types of Traps

- **According to shape**
  - P Trap exits into the wall behind the sink
  - Q Trap is used in toilet under WC
  - S Trap is used in siphonage pipe

- **According to use**
  - Floor trap
  - Gully Trap
  - Intercepting Trap



Type of Trap: Floor Trap

- Floor trap is used to admit sullage from the floor of rooms, bathroom, kitchen into the sullage pipe.

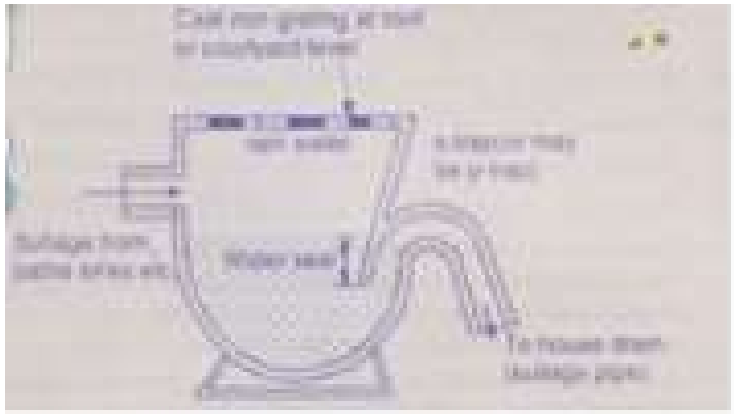




Type of Trap: Gully Trap

- A **gully trap** is provided outside the building **before connecting** to external sewerage line. It also collects waste water from the kitchen sink, wash basins, baths and wash area. It has deep water seal of minimum **50 mm depth** and it also prevents entry of bugs and insects from sewer line to waste water pipes.

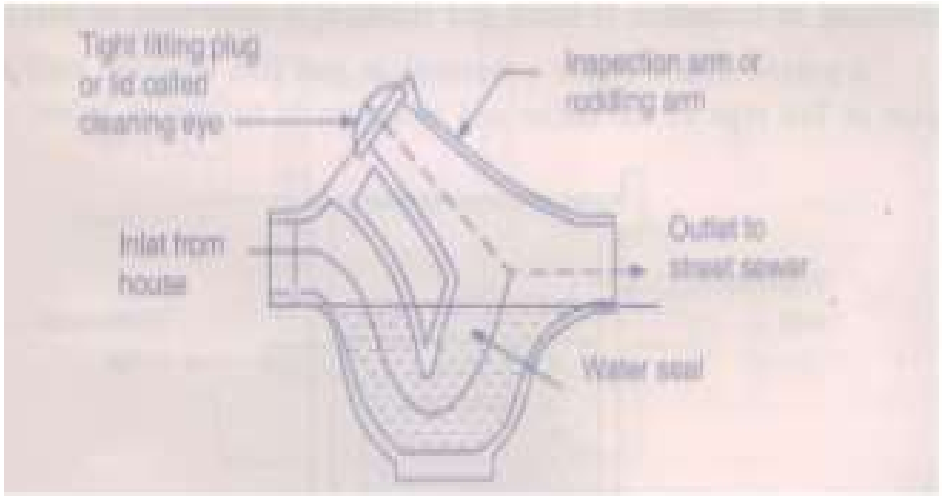




Type of Trap: Intercepting Trap

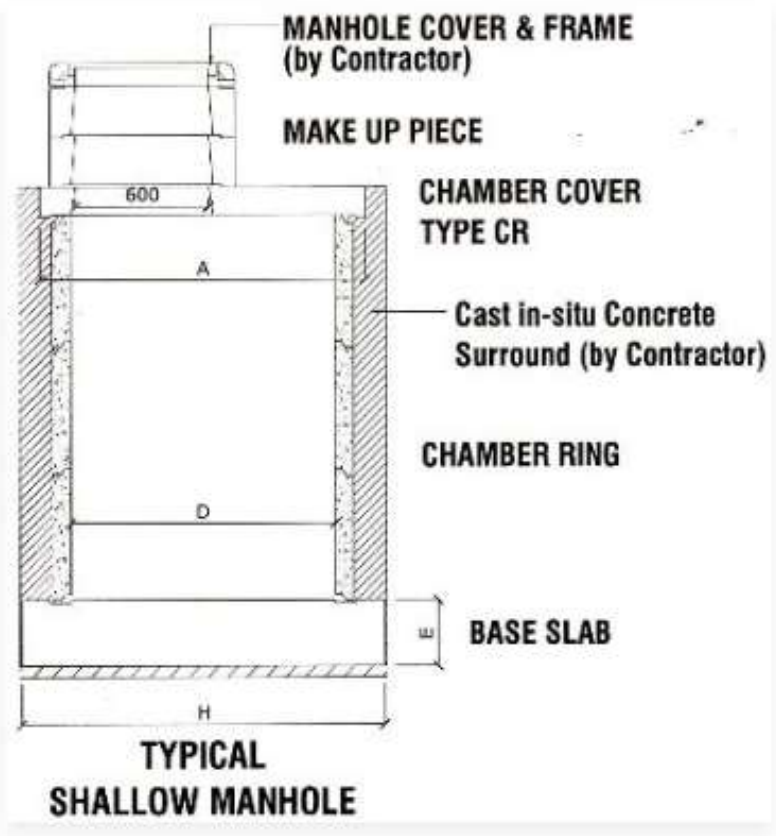
- This trap is provided at the last manhole of building sewerage to prevent entry of foul gases from public sewer to building sewer. It has a deep-water seal of 100 mm





Manhole

Manhole is a masonry chamber constructed at suitable interval along sewer line.



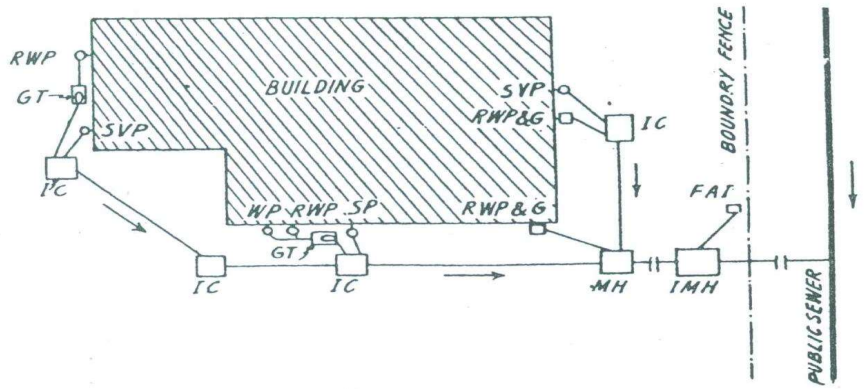
Manholes

- Functions
  - Serve as junctions to join one or more sewer lines
  - Offer means of access to inspect and clear lines of any accumulation or stoppages that may occur
- Locations of manholes
  - At every grade
  - At each junction in direction of sewer
  - At every junction of two or more sewer

Pipes for drainage

- Minimum sizes of drainage pipes

Soil pipe:	100 mm
Waste pipe, horizontal:	32 mm to 50 mm
Waste pipe, vertical:	75 mm
Vent pipe:	50 mm
Anti siphonage pipe,	
i) Connecting soil pipe:	50 mm
ii) Connecting waste pipe:	40 mm



Conventions

SP	= Soil pipe	GT	= Gully Trap
WP	= Waste pipe	MH	= Manhole
SVP	= Soil vent pipe	IC	= Inspection chamber
RWP	= Rain water pipe	IMH	= Intercepting manhole
RWP & G	= Rainwater pipe and gully	FAI	= Fresh air inlet

Typical Lay-out of House Drainage System.

Common Plumbing Problems

- Different kinds of metal pipes cannot be combined because of chemical reactions
- Joints can be broken during threading
- Leakage occurs during placement of pipes
- Water reservoir should be built in a certain height to ensure sufficient water pressure
- Backflow can occur due to faulty workmanship
- Pipe clogging can occur due to indiscriminate disposal



RECOMMENDATION

- Plumbing materials and workmanship should conform to accepted quality standards.
- Plumbing installations should be tested and disinfected before being put into service.
- Adequate training should be provided for plumbing professionals and the public should be made aware of the dangers of poor plumbing.
- Plumbing systems should be properly maintained.

RECOMMENDATIONS

- Wastes should be disposed of promptly and hygienically.
- Drainage systems should be of adequate size and easily cleaned.
- Drainage systems should be equipped with liquid seal traps.
- Hot water systems should be carefully designed to avoid health and accident hazards
- Deleterious substances should be excluded from sewers
- Backflow of sewage should be prevented.

YouTube videos on Plumbing

- https://www.youtube.com/watch?v=8jxRn-T_LCs
- https://www.youtube.com/watch?v=gp3Kie8fdf0
- https://www.youtube.com/watch?v=PzfPkBdRPWE


Thank
you

Lecture Notes on

Underpinning; Scaffolding; White Washing; Sound Insulation; Thermal Insulation

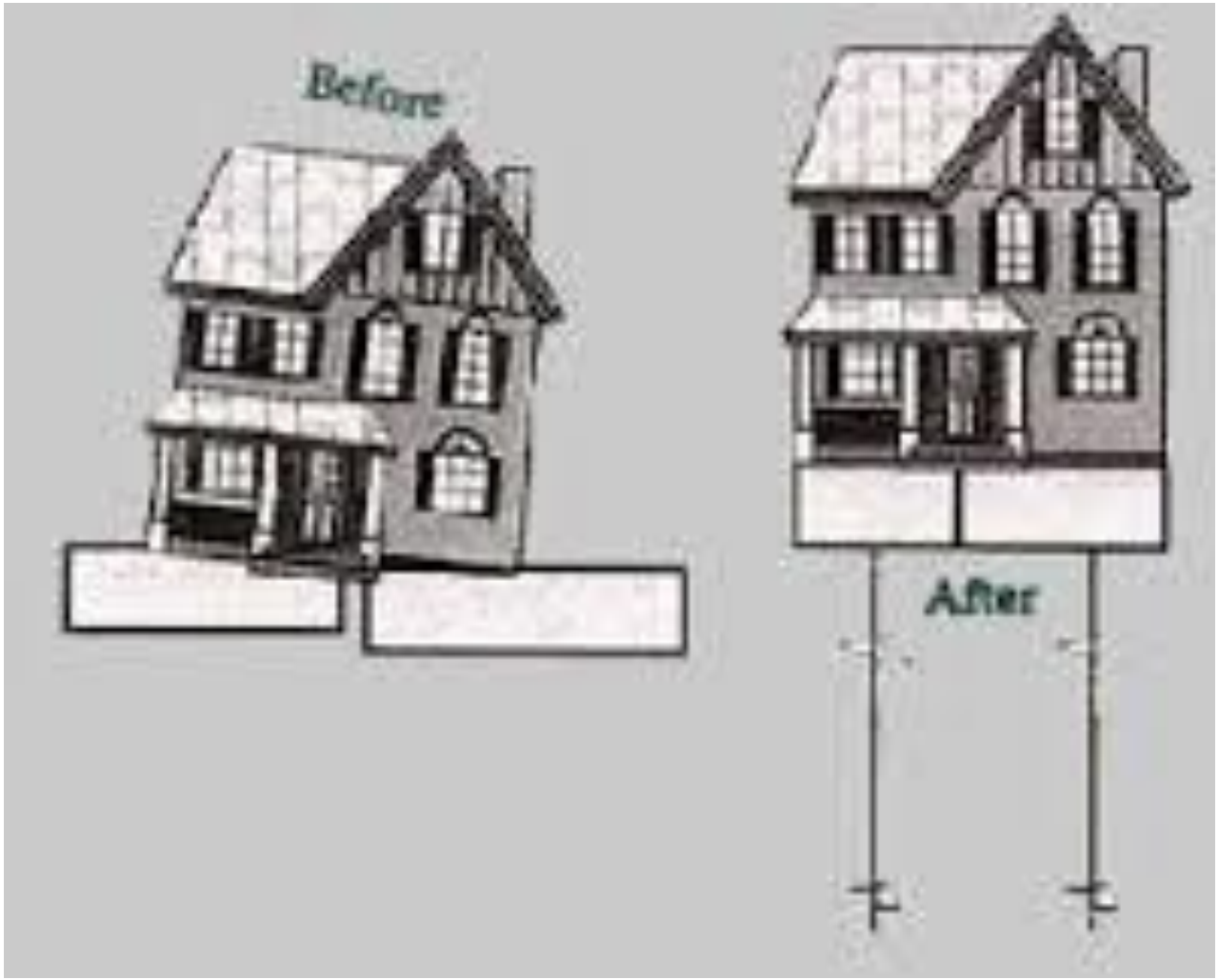
UNDERPINNING

Underpinning

- Underpinning is the process of strengthening and stabilizing the foundation of an existing building or other structure without disturbing its stability.






Before
After

Why it is necessary

Underpinning may be necessary for a variety of reasons:

- The original foundation is simply not strong or stable enough.
- The usage of the structure has changed.
- The properties of the soil supporting the foundation may have changed (possibly through subsidence) or were mischaracterized during design.
- The construction of nearby structures necessitates the excavation of soil supporting existing foundations.
- It is more economical, due to land price or otherwise, to work on the present structure's foundation than to build a new one.

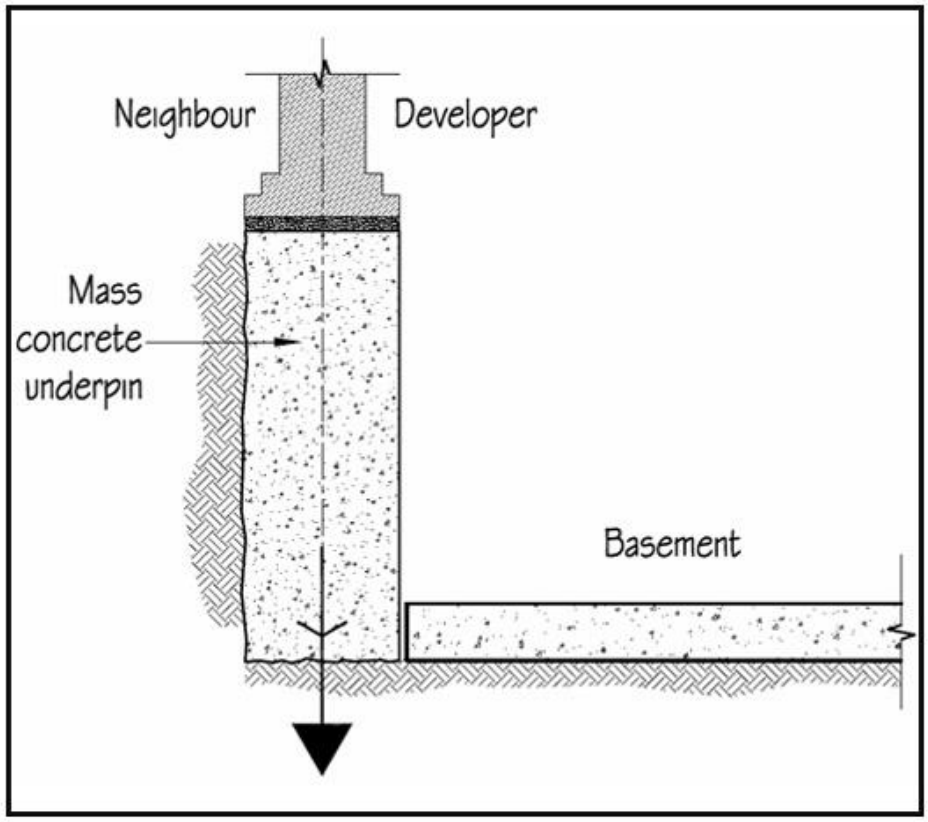
Common Methods

1. Mass Concrete Underpinning
2. Beam and base underpinning
3. Mini-piled underpinning

Mass Concrete Underpinning

- Known as Traditional Underpinning
- Strengthens an existing structure's foundation by digging underneath and sequentially pouring concrete in a strategic order.
- The final result is a foundation built underneath the existing foundation.
- Applied when the existing foundation is at a shallow depth
- Very simple, low cost and the continuity of the structure's uses during construction

Mass Concrete Underpinning



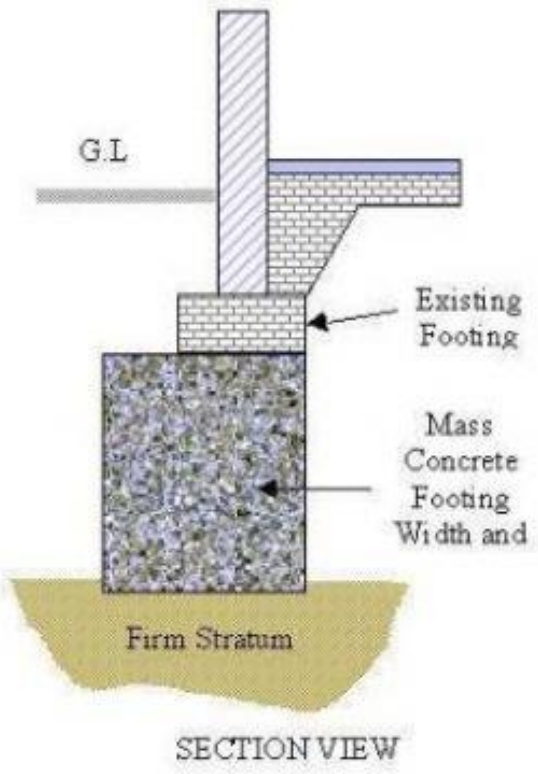


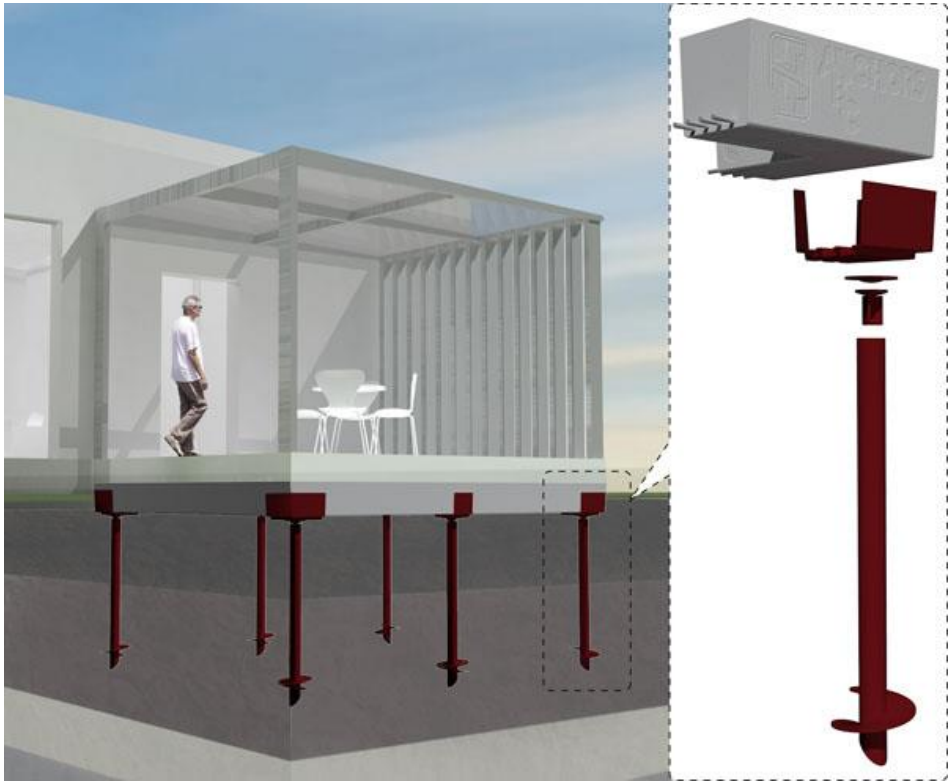
Figure 2 Traditional mass concrete underpinning

Beam & Base Underpinning

- More technically advanced adaptation of traditional mass concrete underpinning.
- **A reinforced concrete beam** is constructed below, above or in replacement of the existing footing.
- The beam then transfers the load of the building to mass concrete bases, which are constructed at designed strategic locations
- Base sizes and depths are dependent upon the prevailing ground conditions.
- Beam design is dependent upon the configuration of the building and the applied loads.

Beam & Base Underpinning



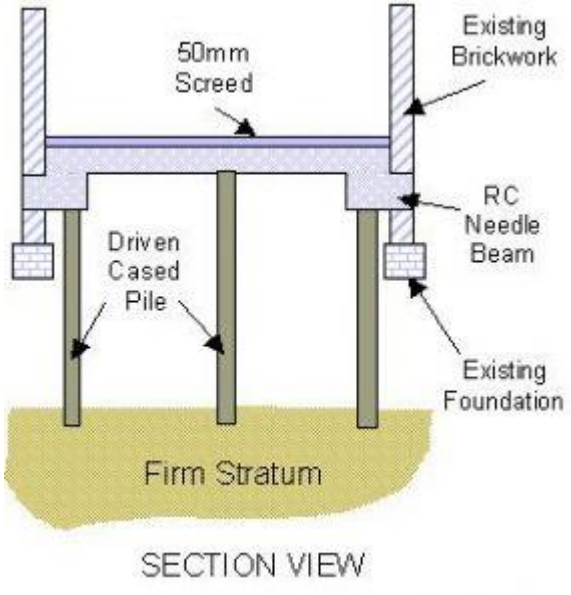


Mini Pile Underpinning

- Very useful where ground conditions are very variable, access is restrictive, environmental pollution aspects are significant, and structural movements in service must be minimal
- Generally used when the loads from the foundations need to be transferred to stable soils at considerable depths - usually in excess of 5.0 meters.
- May either be augured or driven steel cased

Mini Pile Underpinning





Mini Pile Underpinning





SCAFFOLDING

Scaffolding

- Temporary rigid structure having platforms raised up as the building increases in height
- The purpose of a working scaffold is to provide a safe place of work with safe access suitable for the work being done
- Provide a working platform for laborers

Scaffolding



Materials Used in Scaffolding

- Steel
- Bamboo





WHITE WASHING

WHITE WASHING

- Made from pure flat lime (white stone lime) or shell lime
- As a rough guide 5 liters of water should be added to each kg of lime
- Alum/common salt may be added to stick the coating well to the surface
- Usually applied to exteriors
- Used as a primary coating during paint

Preparation of Surface

- Use the sandpaper to remove any paint or lacquer that is currently on the surface
- Create the basic whitewash mixture
- Use the paint brush to apply long strokes to the surface
- Before the whitewash can completely dry, use a clean cloth to wipe

Application of White Wash

- Applied in a specified number of coats until the surface presents a smooth & uniform finish
- Usually three coats for new work and one/two coats for old work
- Each coat consists one top to downward stroke and other bottom to upward
- Similarly one horizontal stroke from left to right and another right to left
- Each coat be allowed to dry before the next one is applied

Purpose of White Wash

- For coloring (aesthetic purpose)
- Protect brickwork from moisture
- Removing germs

SOUND INSULATION

Sound Insulation/Sound Proofing/Acoustic Insulation

- Is a means of reducing the sound pressure with respect to a specified sound source and receptor.

- There are several basic approaches to reducing sound:
  - By increasing the distance between source and receiver,
  - Using noise barriers to reflect or absorb the energy of the sound waves,
  - Using damping structures such as sound baffles,
  - Using active anti-noise sound generators.

Commonly Used Methods

- Increasing Distance
- Damping
- Absorption
- Reflection
- Diffusion
- Room within a room
- Noise cancellation

Increasing Distance

- The energy density of sound waves decreases as they spread out
- By increasing the distance between the receiver and source results in a progressively lesser intensity of sound at the receiver.
- In a normal three dimensional setting, with a point source and point receptor, the intensity of sound waves will be attenuated according to the inverse square of the distance from the source.

Damping

- Damping means to reduce resonance in the room, by absorption or redirection (reflection or diffusion).

- Damping can reduce the acoustic resonance in the air, or mechanical resonance in the structure of the room itself or things in the room.

Absorption

- Absorbing sound spontaneously converts part of the sound energy to a very small amount of heat in the intervening object (the absorbing material), rather than sound being transmitted or reflected.
- There are several ways in which a material can absorb sound. The choice of sound absorbing material will be determined by the frequency distribution of noise to be absorbed and the acoustic absorption profile required.

Reflection

- In an outdoor environment such as highway or embankments, paneling are often used to reflect sound upwards into the sky.

Diffusion

- If a specular reflection from a hard flat surface is giving a problematic echo then an acoustic diffuser may be applied to the surface. It will scatter sound in all directions

Room Within a Room

- A room within a room (RWAR) is one method of isolating sound and stopping it from transmitting to the outside world where it may be undesirable.

Noise Cancellation

- Noise cancellation generators for active noise control are a relatively modern innovation.
- A microphone is used to pick up the sound that is then analyzed by a computer; then, sound waves with opposite polarity (180° phase at all frequencies) are output through a speaker, causing destructive interference and cancelling much of the noise.

THERMAL INSULATION

Thermal Insulation

- Thermal insulation is the reduction of heat transfer between objects in thermal contact or in range of radiative influence.
- Thermal insulation can be achieved with especially engineered methods, as well as with suitable object shapes and materials.
- Thermal insulation provides a region of insulation in which thermal conduction is reduced or thermal radiation is reflected rather than absorbed by the lower-temperature body.

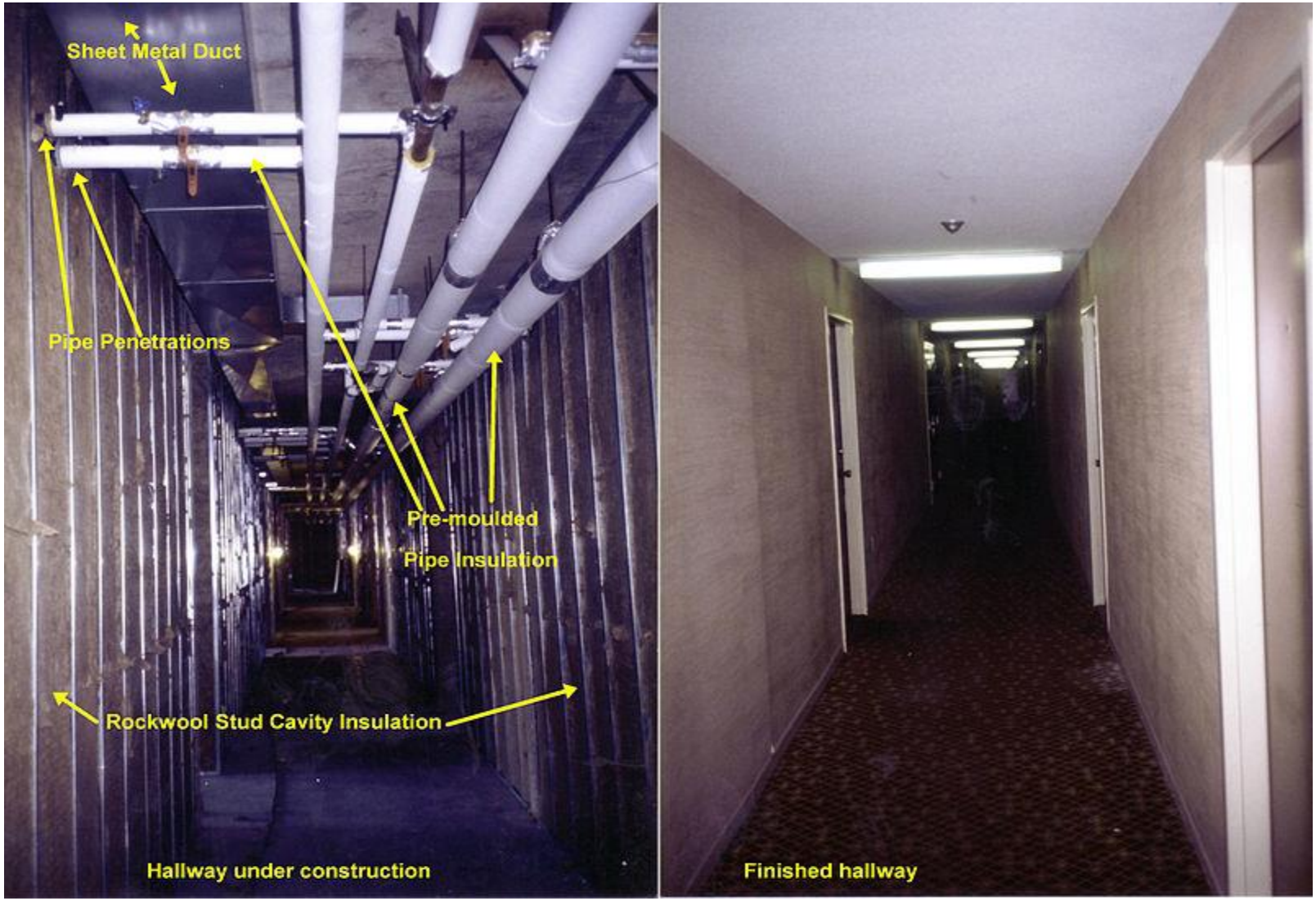


Figure: Thermal Insulation of a Hallway

Why Necessary

When well insulated, a building:

- Is energy-efficient, thus saving the owner money.
- Provides more uniform temperatures throughout the space. Thus producing a more comfortable occupant environment when outside temperatures are extremely cold or hot.
- Has minimal recurring expense. Unlike heating and cooling equipment, insulation is permanent and does not require maintenance, upkeep, or adjustment.
- Also reduce noise and vibration, both coming from the outside and from other rooms inside a building

Acoustics

What is Acoustics

Acoustics

Acoustics: is the science of sound which assures the optimum conditions for producing and listening to speech, music etc.

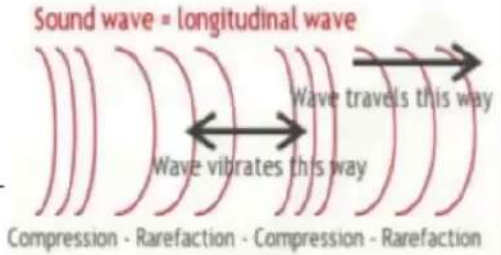
Acoustical design and construction is done to for dissipation of the noises, external and internal and insulation against sound.

Acoustics and Sound Insulation

Acoustics can be achieved by considering two aspects:

- proper control and remedy of the acoustical defects in buildings
- sound insulation

Acoustics and Sound Insulation



- Medium: Solid, liquid & Gas.
- velocity of sound depends on nature and temperature of medium.

Frequency or pitch: Number of cycle or vibrations / sec. Greater is no. of cycle higher will be the pitch.

- Pitch is the measure of quality of sound.

Cont...

Intensity or loudness of sound: flow of sound energy /sec through unit area.

- intensity is a measure of quantity of sound energy

Measurement of Sound: unit - Bel = 10 dB

Ear doen't respond in proportion to the intensity of sound, and that its response in proportional to the logarithm of the intensity of sound.

Cont...

Sounds or Noises	Intensity level (dB)		Feeling of sound
	Range	Average	
Pneumatic drill or aeroplane at a distance of 4 m.	120-140	130	Pain & Discomfort
Thunder, Air plane motors	100-120	110	Deafing
Noisy factory areas, loud street noise	80-100	90	very loud
Noisy home, average conversation	40-60	50	moderate
Quiet living room, quiet conversation and avg auditorium	20-40	30	faint

Acceptable Indoor Noise Level

Location Noise Sources in Different Buildings	Noise Levels (dB) range
Radio and TV studios	25-30
Music Room	30-35
Hospital Auditoria	35-50
Apartments, hotels, & homes	35-40
Conference rooms , small offices, and libraries	35-40
Court rooms and class rooms	40-45
Large public offices, banks and stores	45-50



Behaviour of Sound

- Sound originated from any source either as a speech or music, it is transmitted from the source in all directions.

- Sound travels till it strikes on some surface from where, a part of it is **reflected** back, a part being **absorbed**, or **transmitted.**

Cont....

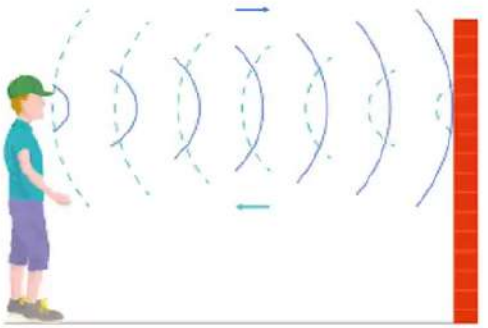
Refelction Coefficient: ratio of the reflected intensity over the incident intensity

Absorption Coefficient: ratio of energy absorbed by the area to the energy striking.

Transmission loss: reduction in intensity of sound in passing through the barrier or measure of the effectiveness of a barrier or surface in insulating against the transmission of sound.

Acoustical Defect

- **Echoes:** Echo is an indirect or a reflected voice which is heard just after the direct hearing of the voice coming from the same sound source.
- Echoe forms when time lag between the two voices or sound is about 1/17th of a sound and the reflecting surfaces are situated at a distance greater than 15m.
- Remedy of this defect is to select the proper shape of the auditorium and surfaces and to use the rough and porous material for interior surface.



Acoustical Defect

Reverberation: Prolongation of sound after the source producing it has died out.

Acoustical correction: Addition of absorption units, to make up the deficiency of actual absorption available for a hall or room in order to obtain optimum reverberation time or conditions.



Reverberation

- Reverberation time:
  - t >5 sec - very bad
  - 5>t >3 sec - bad
  - 3>t >2 sec - fairly good
  - 2>t >1.5 sec - good
  - 1.5>t >0.5 sec - very good
- Reverberation should be short for auditorium as a cinema theatre or public address.

Acoustical Defect

Sound Foci: when reflected sound rays meets at a point which causes concentration effect for the reflected echoes and creates a sound of large intensity.

- can be eliminated by providing geometrical designed shape of interior face including ceiling/providing absobing material.

Dead Spot: Side effect of sound foci. deficiency of reflected sound rays causes low sound intensity at some points.

Insufficient loudness: In large auditorium, due to lack of sound reflecting flat surfaces near the source or stage and excessive absorption of sound in the hall, results in this defect of insufficient loudness.

- Provide loud speaker

Defects and Recommended Remedies

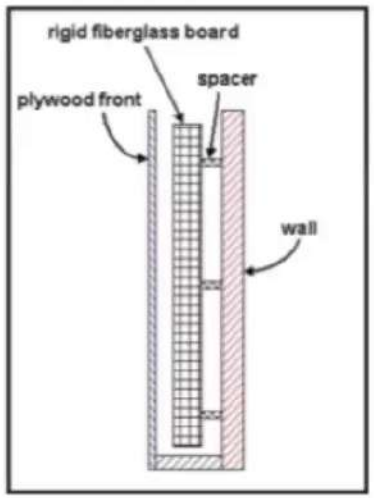
Defect	Causes	Recommendation	
		New Design	Existing Design
Excessive reverberation	Insufficient Absorption	Add absorbents	Add absorbents
Echoes	unsuitable shapes & proper reflecting surface	avoid unsuitable shapes & make offending surface highly absorbent	-
Sound Foci	Concave reflecting interior surfaces	avoid curvilinear interior	use absorbents on focusing surface
Deat spots	Irregular distribution of sound	provide even diffusion of sound	introduce suitable diffusers
Insufficient sound volume	lack of reflections close to source of sound or excessive absorption	disposition of hard reflecting surfaces near the source of sound. adjust absorption to give optimum reverberation	

Acoustics -Requirements and conditions

- Adequate sound intensity.
- Evenly distributed
- Clear and distinct
- Reach the audience with the same frequency and intensity
- Noise protection to be done

Resonent Panel's Absorbent:

- Semi hard material in the form of porous fibre boards.

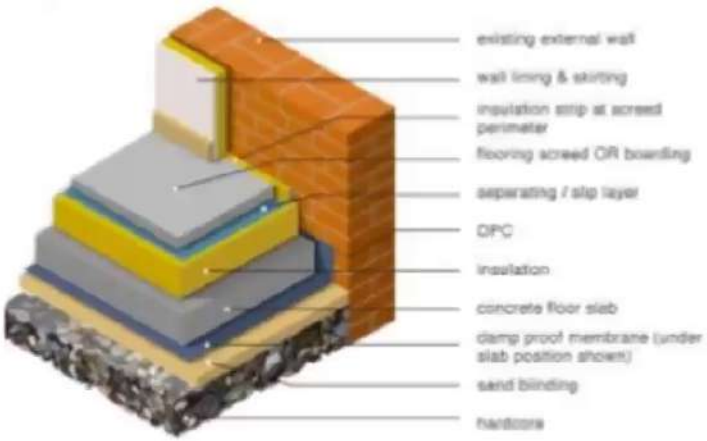


Noise Control & Sound Insulation

Floor & Ceilings(Horizontal barrier to noise):

- Use of resilient material on floors.





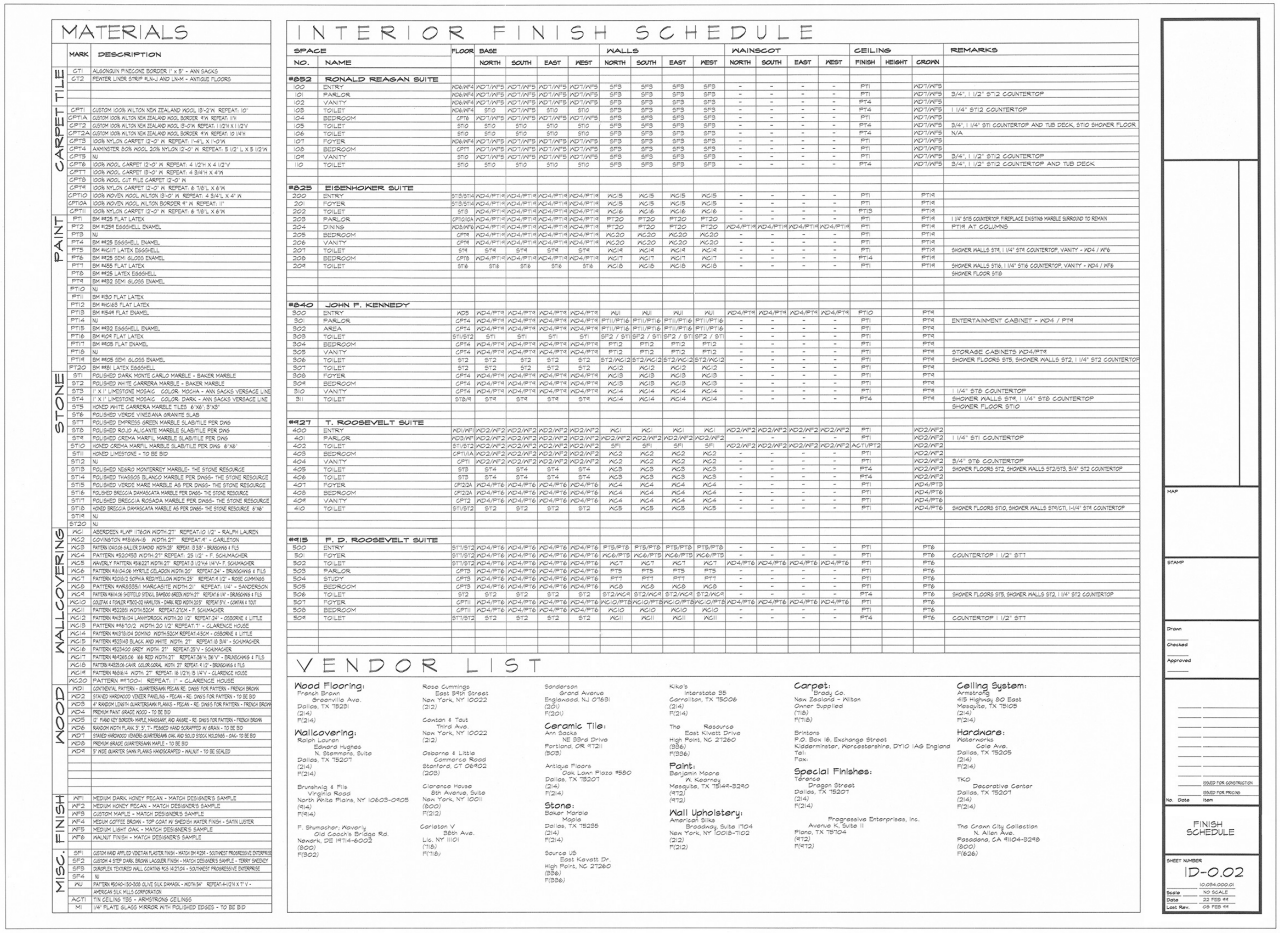
FINISH SCHEDULE

What is a finish schedule and why does it matter?

- A Finish Schedule is a form of product specification writing that outlines the materials desired on a construction project. Specifically, a Finish Schedule outlines floor, wall, ceiling materials and excludes lighting, windows, doors, and furniture.
- The reason Interior Designers and Architects create finish schedules is to communicate critical product information to the construction team. By using a finish schedule template, a designer can compile all the finish specification information into a concise document.

https://tothesource.com/posts/finish-schedule-template-for-more-accurate-documentation#:~:text=A%20Finish%20Schedule%20is%20a,windows%2C%20doors%2C%20and%20furniture.

Example



MATERIALS

	MARK	DESCRIPTION
CARPET TILE	CT1	ALGONQUIN PARSONS BORDER 1' x 1' - ANN SACKS
	CT2	FEATHER LINEN STRIP RUN-U AND 3UM - ANTIQUE FLOORS
CARPET	CPT1	CUSTOM 100% ALTON NZA ZEALAND WOOL, 13-0"W. REPEAT. 10'
	CPT1A	CUSTOM 100% ALTON NZA ZEALAND WOOL BORDER 4"W. REPEAT. 1'
	CPT2	CUSTOM 100% ALTON NZA ZEALAND WOOL, 2-0"W REPEAT. 1'2"X 1'2"X
	CPT2A	CUSTOM 100% ALTON NZA ZEALAND WOOL BORDER 4"W. REPEAT. 0' 1"X
	CPT3	100% NYLON CARPET 2'-0" W. REPEAT. 1'-4"L X 1'-0"X
	CPT4	ANNISTER 80% WOOL 20% NYLON 12'-0" W. REPEAT. 5 1/2"L X 5 1/2"W
	CPT5	NJ
	CPT6	100% WOOL CARPET 12'-0" X REPEAT. 4 1/2"L X 4 1/2"Y
	CPT7	100% WOOL CARPET 12'-0" W. REPEAT. 4 3/4"L X 4"W
	CPT8	100% WOOL, CUT PILE CARPET 12'-0" W.
	CPT9	100% NYLON CARPET 12'-0" W. REPEAT. 8 7/8"L X 8"W
	CPT10	100% ROVEN WOOL, ALTON 12'-0" W. REPEAT. 4 3/4"L X 4" W
	CPT10A	100% ROVEN WOOL, ALTON BORDER 4" W. REPEAT. 1"
	CPT11	100% NYLON CARPET 12'-0" W. REPEAT. 8 7/8"L X 8"W
PAINT	PT1	SW #928 FL AT LATEX
	PT2	SW #7069 EGGSHELL ENAMEL
	PT3	NJ
	PT4	SW #628 EGGSHELL ENAMEL
	PT5	SW #6011 LATEX EGGSHELL
	PT6	SW #628 SEMI GLOSS ENAMEL
	PT7	SW #628 FLAT LATEX
	PT8	SW #628 LATEX EGGSHELL
	PT9	SW #652 SEMI GLOSS ENAMEL
	PT10	NJ
STONE	PT1	SW #350 FLAT LATEX
	PT12	SW #6065 FLAT LATEX
	PT13	SW #6668 FLAT ENAMEL
	PT14	NJ
	PT15	SW #652 EGGSHELL ENAMEL
	PT16	SW #6047 FLAT LATEX
	PT17	SW #628 FLAT ENAMEL
	PT18	NJ
	PT19	SW #628 SEMI GLOSS ENAMEL
	PT20	SW #6611 LATEX EGGSHELL
	ST1	POLISHED DARK MONTE CARLO MARBLE - BAKER MARBLE
	ST2	POLISHED WHITE CARRERA MARBLE - BAKER MARBLE
	ST3	1" X 1" LIMESTONE MOSAIC - COLOR: MOCHA - ANN SACKS VERSACE LINE
	ST4	1" X 1" LIMESTONE MOSAIC - COLOR: DARBL - ANN SACKS VERSACE LINE
	ST5	HONED WHITE CARRERA MARBLE TILES 8"X8", 3"X3"
	ST6	POLISHED VERDE VINCENNA GRANITE SLAB
	ST7	POLISHED EMPEROR GREEN MARBLE ELASTILE PER DWG
	ST8	POLISHED SOLID ALICANTE MARBLE ELASTILE PER DWG
	ST9	POLISHED CREMA MARFIL MARBLE ELASTILE PER DWG
	ST10	HONED CREMA MARFIL MARBLE ELASTILE PER DWG. 8"X8"
	ST11	HONED LIMESTONE - TO BE BID
	ST12	NJ
	ST13	POLISHED VEIRAS MONTEREY MARBLE- THE STONE RESOURCE
	ST14	POLISHED THASSOS BLANCO MARBLE PER DWGS- THE STONE RESOURCE
	ST15	POLISHED VERDE MARE MARBLE AS PER DWGS- THE STONE RESOURCE
	ST16	POLISHED BRECCIA SARAGOLLA MARBLE PER DWGS- THE STONE RESOURCE
	ST17	POLISHED BRECCIA ROSADA MARBLE PER DWGS- THE STONE RESOURCE
	ST18	HONED BRECCIA SARAGOLLA MARBLE AS PER DWG- THE STONE RESOURCE 8"X8"
	ST19	NJ
	ST20	NJ
WALLCOVERING	WC1	ASSEMBLY FLAP 178304 WIDTH 27" REPEAT.10 1/2" - RALPH LAUREN
	WC2	GOVERNOR 993694-B WIDTH 27" REPEAT 9" - CARLETON
	WC3	PATTERN 060108 HILLER DIAMOND WIDTH 27" REPEAT 3 3/8" - BRUNSWIG & FILS
	WC4	PATTERN #850983 WIDTH 27" REPEAT 23 1/2" - F. SCHUMACHER
	WC5	VANDLY PATTERN #06627 WIDTH 27" REPEAT 3 1/2"W X 7 5/8"H - F. SCHUMACHER
	WC6	PATTERN #810406 MYRTLE GLADIOLI WIDTH 27" REPEAT 24" - BRUNSWIG & FILS
	WC7	PATTERN #2060 SOPHIA REPETITION WIDTH 27" REPEAT 4 1/2" - ROSE CUMMINGS
	WC8	PATTERN #WK655501 MARGARETTE WIDTH 27" REPEAT. 11/4" - SANDERSON
	WC9	PATTERN #06618 BOTTLE STENCIL BAMBOO GREEN WIDTH 27" REPEAT 6 1/4" - BRUNSWIG & FILS
	WC10	CELENA 5 TOILER STENCIL WHITE - CHELSEA RED WIDTH 27" REPEAT 9" - OSBORNE & LITTLE
	WC11	PATTERN #10285 WIDTH 52CM REPEAT 27CM - F. SCHUMACHER
	WC12	PATTERN #W7874-04 LAMPSHADE WIDTH 20 1/2" REPEAT 24" - OSBORNE & LITTLE
	WC13	PATTERN #9610-01 WIDTH 20 1/2" REPEAT 7" - CLARENCE HOUSE
	WC14	PATTERN #W7874-04 PIPING WIDTH 202CM REPEAT 45CM - OSBORNE & LITTLE
	WC15	PATTERN #10268 BLACK AND WHITE WIDTH 27" REPEAT 8 3/4" - SCHUMACHER
	WC16	PATTERN #10268 GREY WIDTH 27" REPEAT 29 1/2" - SCHUMACHER
	WC17	PATTERN #W7875-08 66 RED WIDTH 27" REPEAT 36 3/4"Y - BRUNSWIG & FILS
	WC18	PATTERN #60108 CAPE GUERLIDAL WIDTH 27" REPEAT 4 1/2" - BRUNSWIG & FILS
	WC19	PATTERN #8868-11 WIDTH 27" REPEAT 36 1/2"H X 18"W - CLARENCE HOUSE
	WC20	PATTERN #9700-01 REPEAT. 7" - CLARENCE HOUSE
WOOD	WD1	CONTROL PATTERN - GUARDSMAN PEGAL RE. DWG FOR PATTERN - FRENCH BROWN
	WD2	STAINED HARDWOOD VINTER PANELING - PEGAL - RE. DWG FOR PATTERN - TO BE BID
	WD3	4" RANDOM LENGTH GUARDSMAN PLANKS - PEGAL - RE. DWG FOR PATTERN - FRENCH BROWN
	WD4	FRENCH PANT GRADE WOOD - TO BE BID
	WD5	12" PANEL KIT BORDER - MATCH PANELING - RE. DWG FOR PATTERN - FRENCH BROWN
	WD6	RANDOM WIDTH PLANK 3" TO 7" - PEGGED AND SCRAPED W. BRASS - TO BE BID
	WD7	STAINED HARDWOOD STRIPED GUARDSMAN OAK AND SOLID STOCK MOLDINGS - DNU - TO BE BID
	WD8	FRENCH BRAID GUARDSMAN MAPLE - TO BE BID
	WD9	3" WIDE QUARTER SAWN FLARED HARDSCAPED - WALNUT - TO BE SCALED
MISC. FINISH	MF1	MEDIUM DARK HONEY PECAN - MATCH DESIGNERS SAMPLE
	MF2	MEDIUM HONEY PECAN - MATCH DESIGNERS SAMPLE
	MF3	CUSTOM MAPLE - MATCH DESIGNERS SAMPLE
	MF4	MEDIUM COFFEE BROWN - TOP COAT W/ SHEEN WATER FINISH - SATIN LUSTER
	MF5	MEDIUM LIGHT OAK - MATCH DESIGNERS SAMPLE
	MF6	WALNUT FINISH - MATCH DESIGNERS SAMPLE
	SF1	GESSO AND APPLIED VENETIAN PLASTER FINISH - MATCH SW #7029 - SOUTHEAST PROFESSIONAL ENTERPRISES
	SF2	GESSO 4 STEP DARK BROWN LACQUER FINISH - MATCH DESIGNERS SAMPLE - TERRY SMOKEY
	SF3	SIMPLEX TEXTURED WALL COATING #23 MOTTLE - SOUTHEAST PROFESSIONAL ENTERPRISES
	SF4	NJ
	AU	PATTERN #5040-30-000 SILVER SILK DAMASK - WIDTH 36" REPEAT 41"H X 1"Y - IMPERIAL SILK CORPORATION
	ACT1	1'X1' CEILING TILE - ARMSTRONG CEILINGS
	M1	1/4" PLATE GLASS MIRROR WITH POLISHED EDGES - TO BE BID

INTERIOR FINISH SCHEDULE

SPACE NO.	NAME	FLOOR	BASE NORTH	BASE SOUTH	BASE EAST	BASE WEST	WALLS NORTH	WALLS SOUTH	WALLS EAST	WALLS WEST	WAINSCOT NORTH	WAINSCOT SOUTH	WAINSCOT EAST	WAINSCOT WEST	CEILING FINISH	CEILING HEIGHT	CEILING CROWN	REMARKS
#852	**RONALD REAGAN SUITE**																	
100	ENTRY		WD8/WF6	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	ST3	ST3	-	-	-	-	PT1		WD7/WF5	
101	PARLOR		WD8/WF6	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	ST3	ST3	-	-	-	-	PT1		WD7/WF5	3/4" L 1/2" ST2 COUNTERTOP
102	VANITY		WD8/WF6	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	ST3	ST3	-	-	-	-	PT1		WD7/WF5	
103	TOILET		WD8/WF6	ST3	ST3	WD7/WF5	ST10	ST10	ST3	ST3	-	-	-	-	PT4		WD7/WF5	1 1/4" ST12 COUNTERTOP
104	BEDROOM		CPT6	WD7/WF5	WD7/WF5	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	-	-	-	-	PT1		WD7/WF5	
105	TOILET		ST3	ST3	ST10	ST10	ST3	ST3	ST3	ST3	-	-	-	-	PT4		WD7/WF5	3/4" L 1/4" ST1 COUNTERTOP AND TUB DECK, ST10 SHOWER FLOOR
106	TOILET		ST10	ST3	ST10	ST10	ST3	ST3	ST3	ST3	-	-	-	-	PT4		WD7/WF5	N/A
107	FOYER		WD8/WF6	WD7/WF5	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	ST3	-	-	-	-	PT1		WD7/WF5	
108	BEDROOM		CPT1	WD7/WF5	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	ST3	-	-	-	-	PT1		WD7/WF5	
109	VANITY		ST2	WD7/WF5	WD7/WF5	WD7/WF5	WD7/WF5	ST3	ST3	ST3	-	-	-	-	PT1		WD7/WF5	3/4" L 1/2" ST12 COUNTERTOP
110	TOILET		ST10	ST10	ST10	ST10	ST3	ST3	ST3	ST3	-	-	-	-	PT4		WD7/WF5	3/4" L 1/2" ST12 COUNTERTOP AND TUB DECK
#825	**EISENHOWER SUITE**																	
202	ENTRY		ST15/ST4	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	WC15	WC15	WC15	-	-	-	-	PT1		PT14	
201	FOYER		ST15/ST4	WD4/WF14	WD4/WF14	WD4/WF14	WC15	WC15	WC15	WC15	-	-	-	-	PT1		PT14	
203	TOILET		ST3	WD4/WF14	WD4/WF14	WD4/WF14	WC16	WC16	WC16	WC16	-	-	-	-	PT13		PT14	
205	PARLOR		CPT10/ST4	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT20	PT20	PT20	PT20	-	-	-	PT1		PT14	1 1/4" ST5 COUNTERTOP FIREPLACE EXISTING MARBLE SURROUND TO REMAIN
204	DINING		WD8/WF6	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT20	PT20	PT20	PT20	WD4/WF14	WD4/WF14	WD4/WF14	PT1		PT14	PT14 AT COLUMNS
208	BEDROOM		CPT8	WD4/WF14	WD4/WF14	WD4/WF14	WC20	WC20	WC20	WC20	-	-	-	-	PT1		PT14	
206	VANITY		CPT8	WD4/WF14	WD4/WF14	WD4/WF14	WC20	WC20	WC20	WC20	-	-	-	-	PT1		PT14	
207	TOILET		ST4	ST4	ST4	ST4	ST4	WC14	WC14	WC14	-	-	-	-	PT1		PT14	SHOWER WALLS ST8, 1 1/4" ST4 COUNTERTOP, VANITY - WD4 / WF6
209	BEDROOM		CPT8	WD4/WF14	WD4/WF14	WD4/WF14	WC17	WC17	WC17	WC17	-	-	-	-	PT1		PT14	
209	TOILET		ST8	ST8	ST8	ST8	ST8	WC15	WC15	WC15	-	-	-	-	PT1		PT14	SHOWER WALLS ST16, 1 1/4" ST6 COUNTERTOP, VANITY - WD4 / WF6 SHOWER FLOOR ST10
#540	**JOHN F. KENNEDY**																	
500	ENTRY		ACS	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	AU	AU	AU	AU	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT10		PT14
501	FOYER		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT1/WF16	PT1/WF16	PT1/WF16	PT1/WF16	-	-	-	-	PT1		PT14
502	AREA		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT1/WF16	PT1/WF16	PT1/WF16	PT1/WF16	-	-	-	-	PT1		PT14
503	TOILET		ST1	ST1	ST1	ST1	SF2 / ST1	SF2 / ST1	SF2 / ST1	SF2 / ST1	-	-	-	-	PT1		PT14	ENTERTAINMENT CABINET - WD4 / PT14
504	BEDROOM		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT12	PT12	PT12	-	-	-	-	PT1		PT14	
505	VANITY		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	WD4/WF14	PT12	PT12	PT12	PT12	-	-	-	PT1		PT14	STORAGE CABINETS WD4/WF14
506	TOILET		ST2	ST2	ST2	ST2	ST2	ST2/WC-25	ST2/WC-25	ST2/WC-25	ST2/WC-2	-	-	-	PT1		PT14	SHOWER FLOORS ST5, SHOWER WALLS ST2, 1 1/4" ST2 COUNTERTOP
507	TOILET		ST2	ST2	ST2	ST2	ST2	AC3	AC3	AC3	AC3	-	-	-	PT1		PT14	
508	FOYER		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	AC3	AC3	AC3	AC3	-	-	-	-	PT1		PT14	
509	BEDROOM		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	AC3	AC3	AC3	AC3	-	-	-	-	PT1		PT14	
510	VANITY		CPT4	WD4/WF14	WD4/WF14	WD4/WF14	WC14	WC14	WC14	WC14	-	-	-	-	PT1		PT14	1 1/4" ST6 COUNTERTOP
511	TOILET		ST8/ST	ST4	ST4	ST4	ST6	WC14	WC14	WC14	-	-	-	-	PT4		PT14	SHOWER WALLS ST4, 1 1/4" ST2 COUNTERTOP SHOWER FLOOR ST10
#427	**T. ROOSEVELT SUITE**																	
400	ENTRY		WD1/WF1	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	WC1	WC1	WC1	WC1	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	PT1		WD2/WF2
401	PARLOR		WD3/WF1	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	-	-	-	-	PT1		WD2/WF2
402	TOILET		ST1/ST2	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	SF1	SF1	SF1	SF1	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	ACT1/PT2		WD2/WF2
403	BEDROOM		CPT1/4	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	AC2	AC2	AC2	AC2	-	-	-	-	PT1		WD2/WF2
404	VANITY		CPT1	WD2/WF2	WD2/WF2	WD2/WF2	WD2/WF2	AC2	AC2	AC2	AC2	-	-	-	-	PT1		WD2/WF2
405	TOILET		ST3	ST4	ST4	ST4	ST4	AC3	AC3	AC3	AC3	-	-	-	-	PT4		WD2/WF2
406	TOILET		ST3	ST4	ST4	ST4	ST4	AC3	AC3	AC3	AC3	-	-	-	-	PT4		WD2/WF2
407	FOYER		CPT2A	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	AC4	AC4	AC4	AC4	-	-	-	-	PT1		WD4/WF18
408	BEDROOM		CPT2A	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	AC4	AC4	AC4	AC4	-	-	-	-	PT1		WD4/WF18
409	VANITY		CPT2	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	AC4	AC4	AC4	AC4	-	-	-	-	PT1		WD4/WF16
410	TOILET		ST1/ST2	ST2	ST2	ST2	ST2	AC5	AC5	AC5	AC5	-	-	-	-	PT1		WD4/WF16
#615	**F. D. ROOSEVELT SUITE**																	
500	ENTRY		ST1/ST2	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	PT5/PT8	PT5/PT8	PT5/PT8	PT5/PT8	-	-	-	-	PT1		PT16
501	FOYER		ST1/ST2	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	WC6/PT5	WC6/PT5	WC6/PT5	WC6/PT5	-	-	-	-	PT1		PT16
502	TOILET		ST1/ST2	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	AC7	AC7	AC7	AC7	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	PT1		PT16
503	PARLOR		CPT3	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	PT5	PT5	PT5	PT5	-	-	-	-	PT1		PT16
504	STUDY		CPT3	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	PT7	PT7	PT7	PT7	-	-	-	-	PT1		PT16
505	BEDROOM		CPT3	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	AC8	AC8	AC8	AC8	-	-	-	-	PT1		PT16
506	TOILET		ST2	ST2	ST2	ST2	ST2	ST2/WC8	ST2/WC8	ST2/WC8	ST2/WC8	-	-	-	-	PT4		PT16
507	FOYER		CPT1	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	WC10	WC10	WC10	WC10	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	PT1		PT16
508	BEDROOM		CPT1	WD4/WF16	WD4/WF16	WD4/WF16	WD4/WF16	WC10	WC10	WC10	WC10	-	-	-	-	PT1		PT16
509	TOILET		ST1/ST2	ST2	ST2	ST2	ST2	AC1	AC1	AC1	AC1	-	-	-	-	PT4		PT16

VENDOR LIST

Wood Flooring:
French Brown
Brownsville Ave.
Dallas, TX 75201
(214)
FI(214)

Wallcovering:
Ralph Lauren
Edward Hughes
N. Stemmons, Suite
Dallas, TX 75207
(214)
FI(214)

Brunswig & Fils
Virginia Road
North White Plains, NY 10603-0405
(914)
FI(214)

F. Schumacher, Waverly
Old Cooch's Bridge Rd.
Newark, DE 19714-6003
(800)
FI(302)

Rose Cummings
East 59th Street
New York, NY 10022
(212)

Carleton & Tout
Third Ave.
New York, NY 10022
(212)

Osborne & Little
Commerce Road
Stanford, CT 06902
(203)

Clarence House
8th Avenue, Suite
New York, NY 10011
(800)
FI(212)

Carleton V
36th Ave.
Lic, NY 11101
(718)
FI(718)

Sanderson
Grand Avenue
Englewood NJ 07631
(201)
FI(201)

Ceramic Tile:
Art Stone
NE 58rd Drive
Portland, OR 97221
(503)

Antique Floors
Oak Lawn Plaza #580
Dallas, TX 75207
(214)
FI(214)

Stone:
Baker Marble
Maple
Dallas, TX 75236
(214)
FI(214)

Source US
East Kennett Dr.
High Point, NC 27260
(336)
FI(336)

Kiko's
Interstate 35
Carrollton, TX 75006
(214)
FI(214)

The Resource
East Kivett Drive
High Point, NC 27260
(336)
FI(336)

Paint:
Benjamin Moore
N. Kearney
Mesquite, TX 75244-3260
(972)
FI(972)

Wall Upholstery:
American Silks
Broadway, Suite 1704
New York, NY 10018-1102
(212)
FI(212)

Carpet:
Brady Co.
New Zealand - Alton
Owner Supplied
(718)
FI(718)

Bintang
P.O. Box 18, Exchange Street
Kidderminster, Herdfordshire, DY10 1AS England
Tel:
Fax:

Special Finishes:
Terence
Dragon Street
Dallas, TX 75207
(214)
FI(214)

Progressive Enterprises, Inc.
Avenue N, Suite I
Plano, TX 75704
(972)
FI(972)

Ceiling System:
Armstrong
415 Highway 80 East
Mesquite, TX 75150
(214)
FI(214)

Hardware:
Hebenstreit
Cole Ave.
Dallas, TX 75205
(214)
FI(214)

TKO
Decorative Center
Dallas, TX 75207
(214)
FI(214)

The Crown City Collection
S. Allen Ave.
Pasadena, CA 91104-2248
(800)
FI(626)

MAP

SIGNAGE

Drawn
Checked
Approved

No.	Date	Item
		ISSUED FOR CONSTRUCTION
		ISSUED FOR PRICING

FINISH SCHEDULE

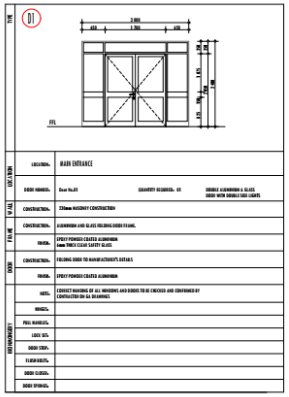
SHEET NUMBER
ID-0.02

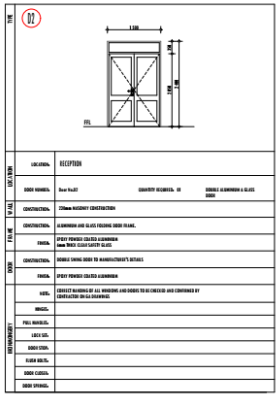
ID-DRAWING-001	
Scale	NO SCALE
Date	22 FEB 11
Last Rev.	09 FEB 11

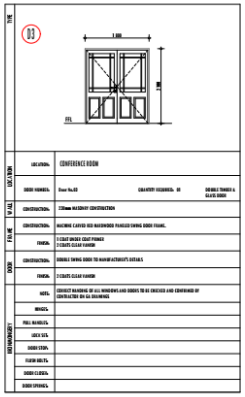
https://www.lifeofanarchitect.com/architectural-graphics-101-finish-schedules/

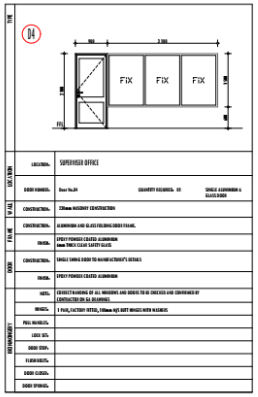
Door Schedule

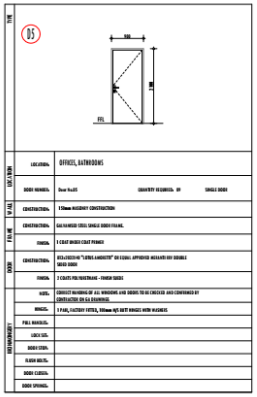
DOOR SCHEDULE

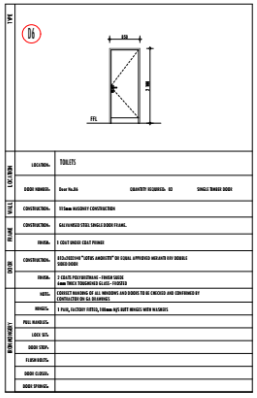


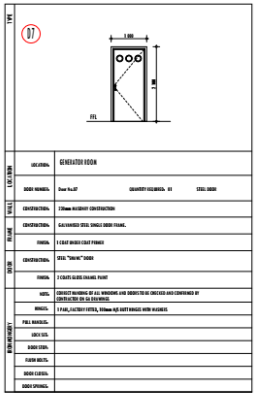










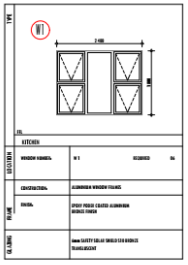


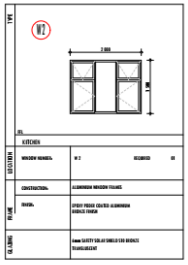
GENERAL NOTES

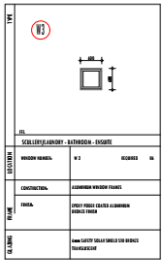
- All installation procedures to comply with good building practice and deemed to satisfy the Architect's requirements.
- This drawing to be read in conjunction with GA-layouts and all dimensions to be checked on site.
- Refer any discrepancies to the Architect in writing.

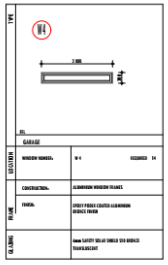
NOTE: CORRECT HANDING OF ALL WINDOWS AND DOORS TO BE CHECKED AND CONFIRMED BY CONTRACTOR ON GA DRAWINGS

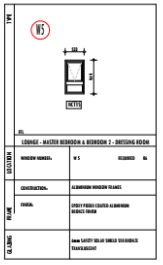
WINDOW SCHEDULE

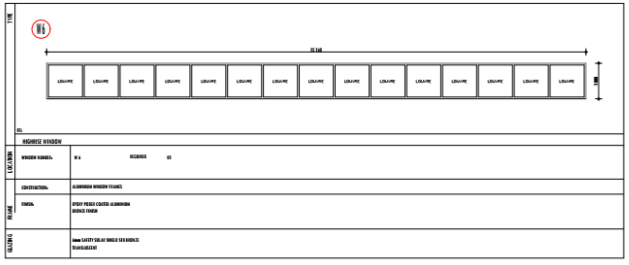


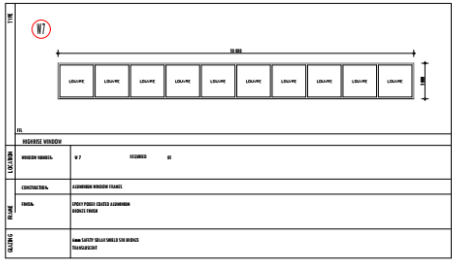


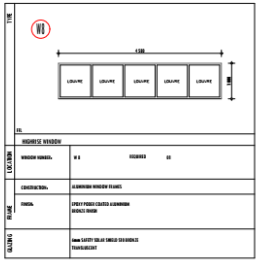












NOTES & LEGEND

CONSTRUCTION NOTES (All work to be in accordance with SABS 0400)

ROOF TRUSS
Roof pitch 3°
Prefabricated pitched steel roof trusses at maximum 1800mm centres designed and executed by an approved specialist fabricator and including bracing and detail shop drawings. Roof plan to be used as a guide only.

ROOF FINISH
0.6mm Kliplok 700 steel roof sheeting klipped to 75x150mm C-channel steel purlins at 1.1m c/c on 010 Bubble foil sisalation insulation on straining wires at 1m c/c nailed to steel trusses/rafters at 1.1m c/c secured to wall by anchor bolts (to suite). Provision made for Pink Aerolite blanket insulation in-between purlins.

FLAT ROOF
R.c. slab (to Eng's det) with DERBIGUM (Sarnam 195) waterproofing on 75mm min. screed to fall discharging to 0110mm down pipes with Fulbore heads

ROOF FLASHING
Approved durable GSI or other flashing and counter-flashing where roof abuts against wall and around any projection through the roof covering.

WALLS
Well burnt clay bricks of minimum 10Mpa nominal unit strength and class 2 mortar and comply with the national building regulations and 230mm thick concrete blockwork. For effective lateral support brickforce above and below window openings and at wallplate level and at every 3 courses. All external walls to be plastered blockwork and varnished brickwork.

WATERPROOFING
375 Micron gunplus brickgrip dampproof coursing extending over the full thickness of the wall to be installed at all window cills and at the level of the top of the surface bed at least 170mm above the adjoining ground. Vertical waterproofing membrane to be installed where any wall of a room is in contract with the ground

NATURAL LIGHT AND VENTILATION
All habitable rooms, bathrooms and toilet;ware to be provided with windows for the purposes of natural light and ventilation the total area of any such window is to be not less than 10% of the floor area of the room served by it (with a min of 0.7sqm) For natural light , and such window will be provided with opening for natural ventilation. The total area of which will be not less than 5% of the floor area of the room.

WINDOWS
Windows to be standard as manufactured by or similar approved

GLAZING
Glazing to comply with clause NW2_1 of the NBR All sliding doors to be fitted with safety glass

SURFACE BED
200mm 20Mpa concrete on 150m layers of well compacted approved suitable material.

WORK BELOW GROUND
All work below ground including foundations to engineers detail, foundation sizes and depths to be finalised on site to the satisfaction of the local authority and the structural engineer and as part of the NBR but in any case to be not less than 700 x 250

DRAINAGE
(In accordance with PART P of SABS 0400)
75mm deep seal traps used with all waste fittings. All i.e's to be marked at the surface and sealed. WC's to have "S" or "P" traps with side access cleaning eyes. All WMS's to have 032mm waste pipes and 040mm. waste pipes. No drainage bends or junctions in or under building. Reseal traps to all waste fittings.

Pipes Sizes:
wc: 0100mm, whb: 040mm, bath: 040mm, shw: 050mm,
bt: 050mm, sink: 040mm, uri: 040mm, jac: 050mm.
Nc soil pipes having a greater drop than 1:20 must be antisyphoned
0100mm pvc drain pipes laid to fall 1:40 min. Drains under buildings to be protected against load by being encased in concrete.

INDEX/FILE NO.

REVISIONS

NO.	DATE	INITIAL	REVISION DETAILS

ARCHITECTURAL DESIGN OFFICE
GOVERNMENT OF SWAZILAND
MINISTRY OF PUBLIC WORKS & TRANSPORT
PO BOX 58, MBABANE.
PHONE: 2409 9000
FAX: 2404 2321

PROJECT

PROPOSED NEW NATIONAL DISASTER EARLY WARNING CENTRE AT MBABANE-GOVERNMENT COMPLEX

TITLE

DOOR & WINDOW SCHEDULES

DESIGN GROUP

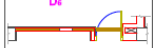
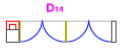
DESIGNATION	NAME	SIGNATURE	DATE
SR. ARCHITECT	T. Gwabe		
PROJECT ARCH.	N. Buthelezi		
DESIGNED	P.S. Dlamini		
DRAWN	P.S. Dlamini		
ENGINEER			

SCALE: NTS

DATE: February 2014

DRAWING NO.	CONTRACT NO.	CHKD	REV.
WT/53/14/004			

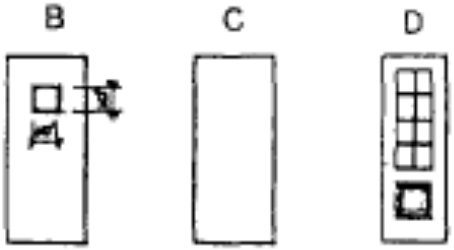
https://procurement-notices.undp.org/view_file.cfm?doc_id=34527

SL. NO.	SYMBOL	SIZE		TYPE	FRAME		PANEL		REMARKS
		WIDTH	HEIGHT		SECTION	MATERIAL	THICKNESS	MATERIAL	
01.	D1 	850	940	Swing with two louver panel	75X75	Chittagong Teak wood	38	Teak Chambal wood	Above False Slab of Toilets (Group Toilet)
02.	D1a 	850	1275	Swing with two louver panel	75X75	Chittagong Teak wood	38	Teak Chambal wood	Above False Slab of Toilets (Single Toilet)
03.	D2 	850	2100	Swing with one panel	75X50	Chittagong Teak wood	25	Teak Chambal wood	For Toilets
04.	D3 	950	2100	Swing with one panel	75X75	Chittagong Teak wood	38	Teak Chambal wood	For Toilets
05.	D4 	900	2100	Swing with one panel	—	—	—	—	Standard Fire Door With Vision Panel
06.	D5 	1000	2100	Swing with one panel	180X68	Chittagong Teak wood	38	Teak Chambal veneered Flash Door	Tea Room, Guest Room, Prayer Room, House Keeping etc.
07.	D6 	1000	2350	Swing with one panel	180X68	Chittagong Teak wood	38	Teak Chambal veneered Flash Door	Stationary Store, Record Room
08.	D7 	1000	2100	Swing with one panel	100X100	Chittagong Teak wood	38	Teak Chambal wood	With Vision Panel (Toilet, Office)
09.	D8 	1000	2100	Swing with one panel	38X38x6 Angle	Enamel Painted MS Angle Frame	18 swg	MS Sheet	Meter Room and For Roof (exit doors)
10.	D9 	1000	2100	Swing with one panel	100X50	Aluminium	5	Glass	For Manager, AGM, Clearing House
11.	D10 	1000	2100	Sliding with one panels	75X38	Aluminium	5	Glass	For Server Room
12.	D11 	1270	2100	Swing with one panel	180X68	Chittagong Teak wood	38	Teak Chambal wood	For Note Counting
13.	D12 	800X2	2100	Swing with two panels	150X68	Hollow MS Frame	38X38 12mmØ 25X25	Hollow MS Frame 95 c/c Solid MS Round Bar 375 c/c Solid MS Square Bar	For Secondary Entry as per design, Generator Room
14.	D13 	800X2	2100	Double Swing with two panels	75X38	Aluminium	5	Glass	For Office Entry
15.	D14 	1475X2	2350	Single Swing with two panels	X	X	10	Tempered Glass	Main Entry Door
		1475X2	2350	Rolling Shutter	100X25X5	MS U Channel	10mmØ	SHAPE ROD AS SHUTTER	Main Entry Door
16.	D15 	1600	3300	Rolling Shutter	100X25X5	MS U Channel	10mmØ	SHAPE ROD AS SHUTTER	For Stair
17.	D16 	1270	2100	Combined steel and Grill Door	X	—	—	X	For Vault & Locker as per Owner's Specification

DOOR SCHEDULE

MARK	ELEVATION TYPE	SIZE	MATERIAL	DETAILS THIS SHEET	REMARKS
1	B	3'-0" x 7'-0"	1¾" S.C. WOOD	6,7,8,9	WEATHERSTRIP
2	B	3'-6" x 7'-0"	1¾" S.C. WOOD	-	WEATHER STRIP SOLID H.M. FRAME
3	B	PR. 2'-0" x 7'-0"	"	4 & 10	1½ HR. RATED CLASS "B" DOOR & FRAME
4	B	PR. 2'-6" x 7'-0"	"		1½ HR. RATED CLASS "B" DR. SOLID H.M. FRAME
5	D	PR. 6'-0" x 7'-0"	WOOD		TO MATCH ADJACENT DOORS EXIST. WOOD FRAME
6	C	3'-0" x 7'-0"	1¾" S.C. WOOD	1	
7	C	3'-0" x 7'-0"	"	1	
8	C	2'-8" x 7'-0"	"	3	
9	C	2'-8" x 7'-0"	"	1	
10	C	2'-6" x 7'-0"	"	2	
11	C	PR. 2'-0" x 7'-0"	"	5	

DOOR TYPES



https://www.tpub.com/engbas/10-18.htm

Assignment for next class

- Draw a plan of a residential building in AutoCAD
  - The building will consist of
    - At least 4 rooms
    - Each room will have windows and doors
    - At least one Veranda with a sliding door
- Prepare Finish Schedule in AutoCAD
  - Exterior
  - Interior
- Prepare Door and Window Schedule in AutoCAD

Submission Details

1. AutoCAD Drawings (in **one** AutoCAD file)
   - Name the AutoCAD file as **Sudent ID_Full Name.dwg**

2. **One** PDF file (file name should be **Sudent ID_Full Name.pdf**)
   - Consisting of 3 pages
   - Plan of the building on Page 1
   - Finish schedule (both exterior and interior) on Page 2
   - Door and window schedule on Page 3

3. Two Assignments will be created on MS Teams
   - One for uploading the AutoCAD file
   - One for uploading the PDF file