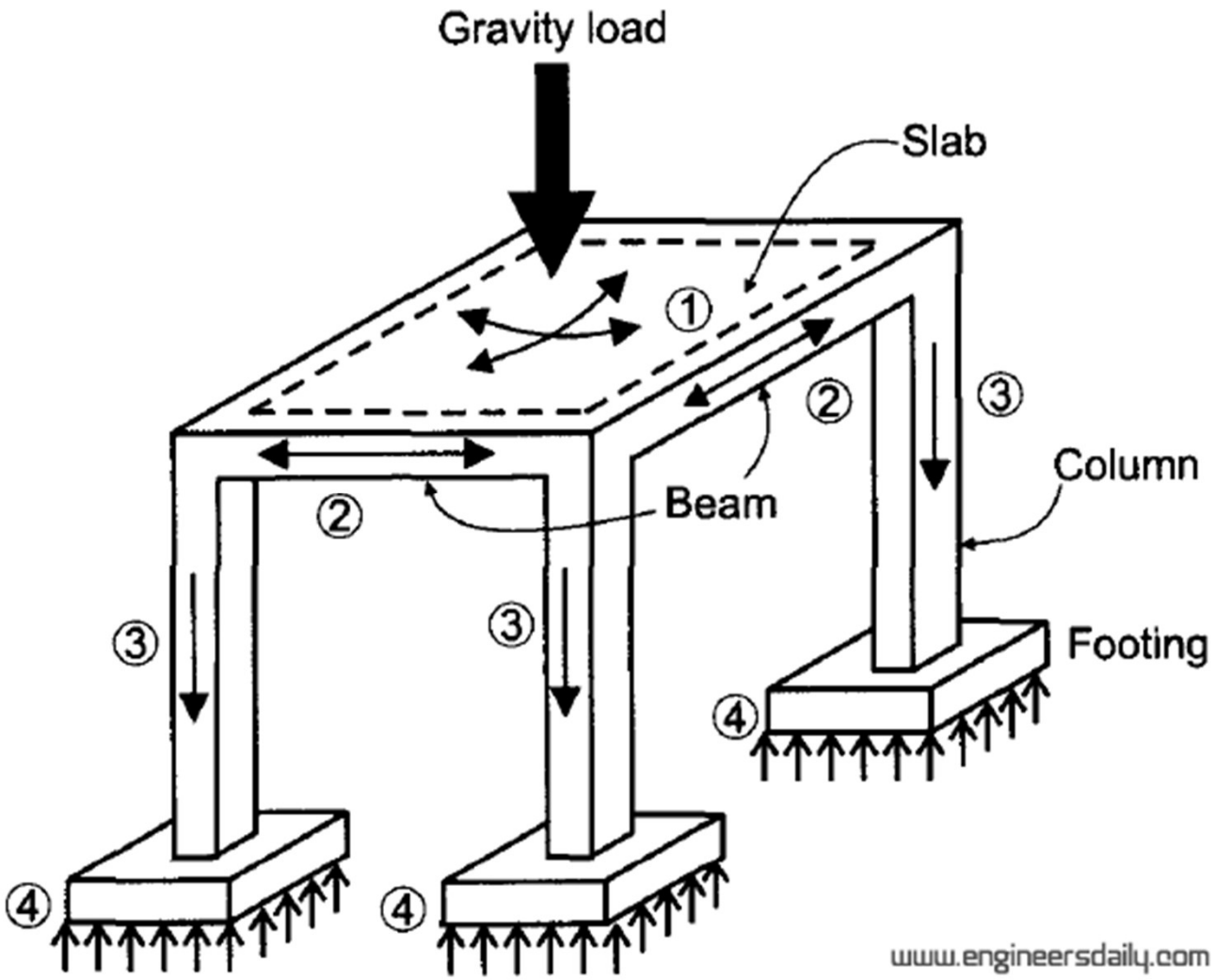
EWCE200

Details of Construction and Quantity Surveying Sessional

Abdullah Muhammad Asif
Lecturer
DEWCE, MIST



Load Transfer Path in Structures

TODAY'S TOPICS:

- Site Exploration
- Bearing Capacity of Soil
- Site Exploration Techniques
- Foundation Types

Site Exploration

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

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)

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

1. TEST PITS

hole dug by geotechnical engineers to visually evaluate ground conditions

- 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.

TEST PITS



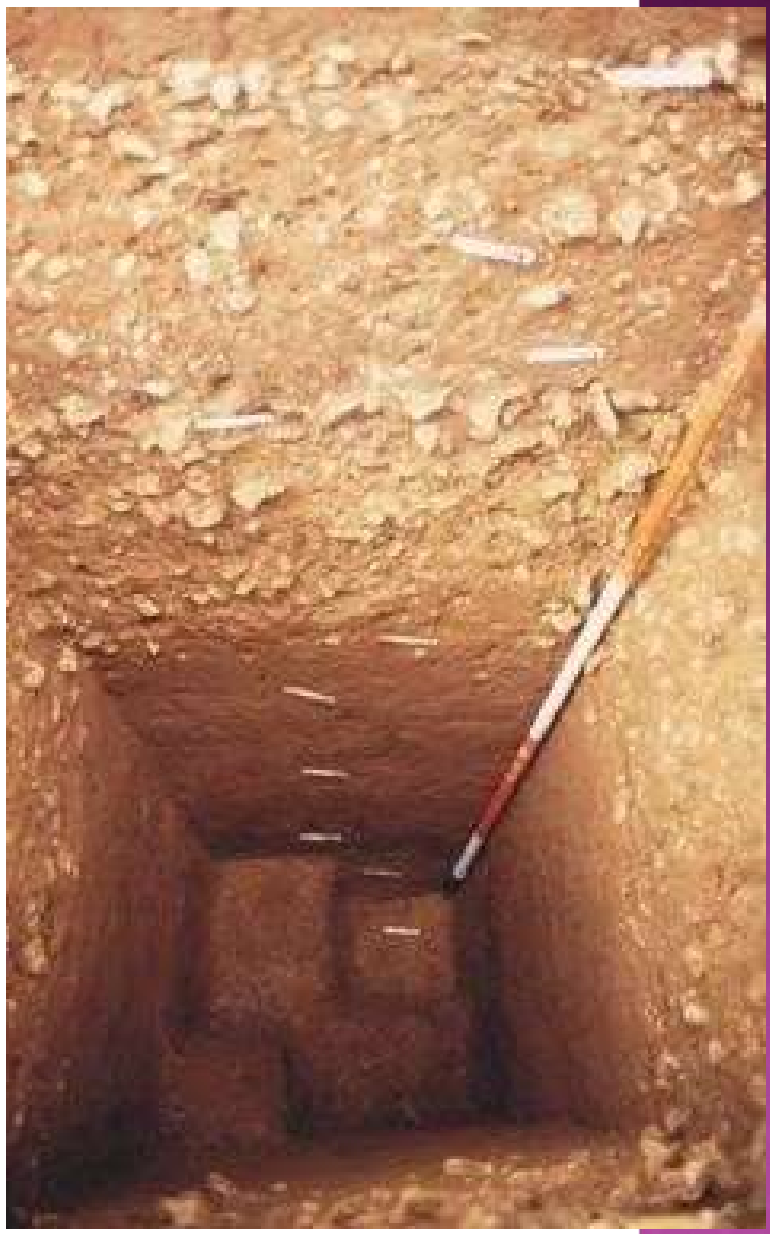


Fig. Test Pits

TEST PITS

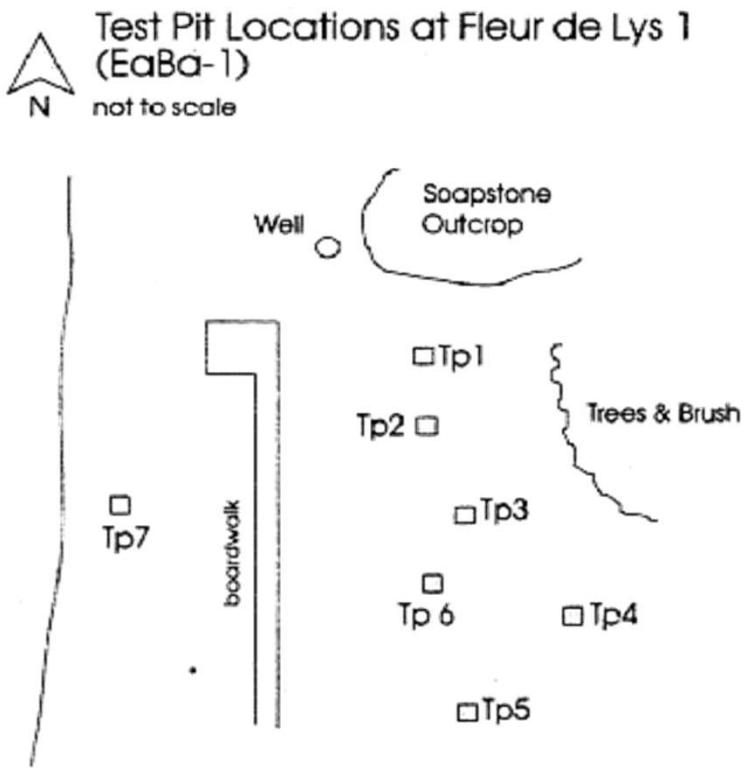




Fig. Test Pit Arrangement

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





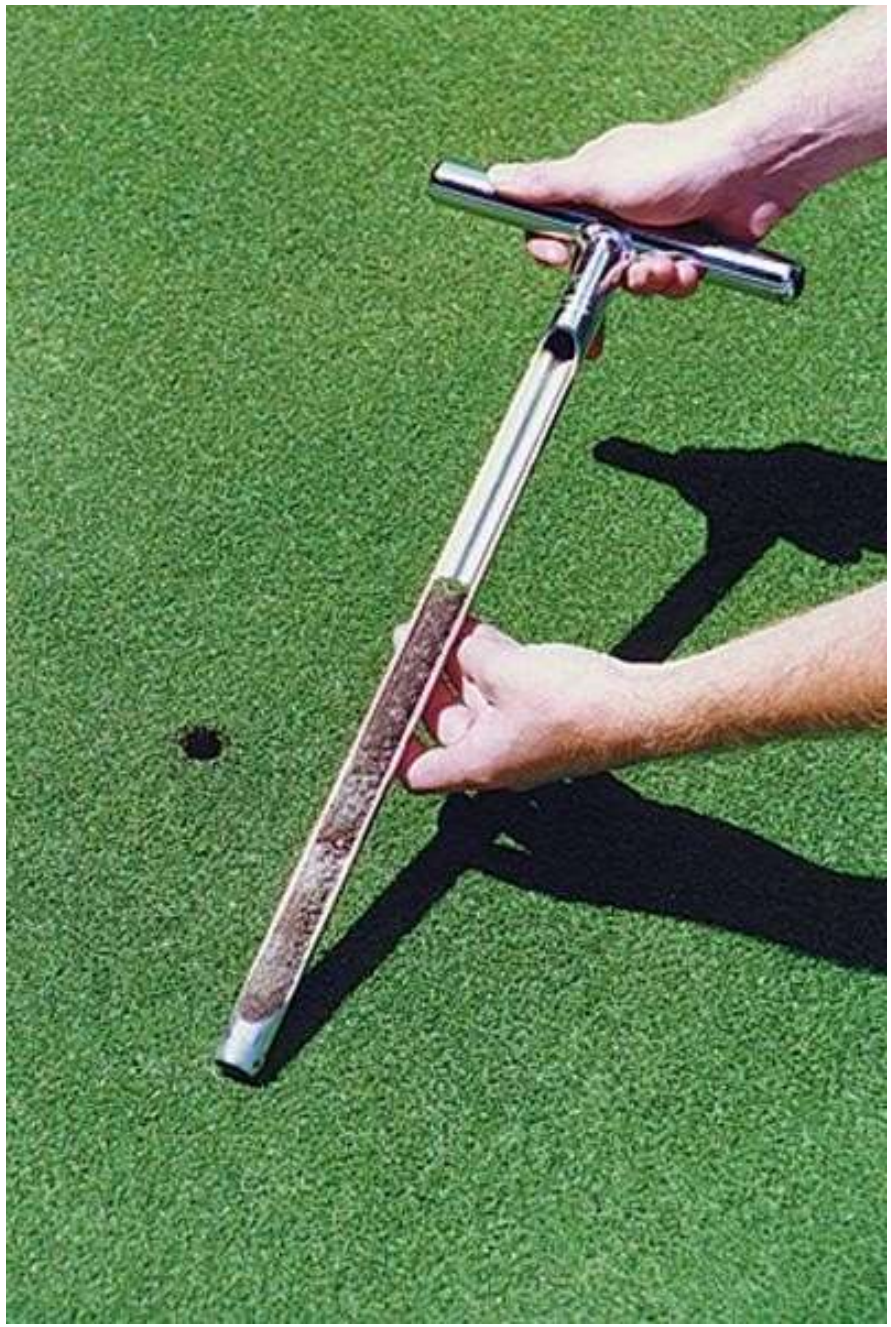


Fig. Probing Instruments

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)

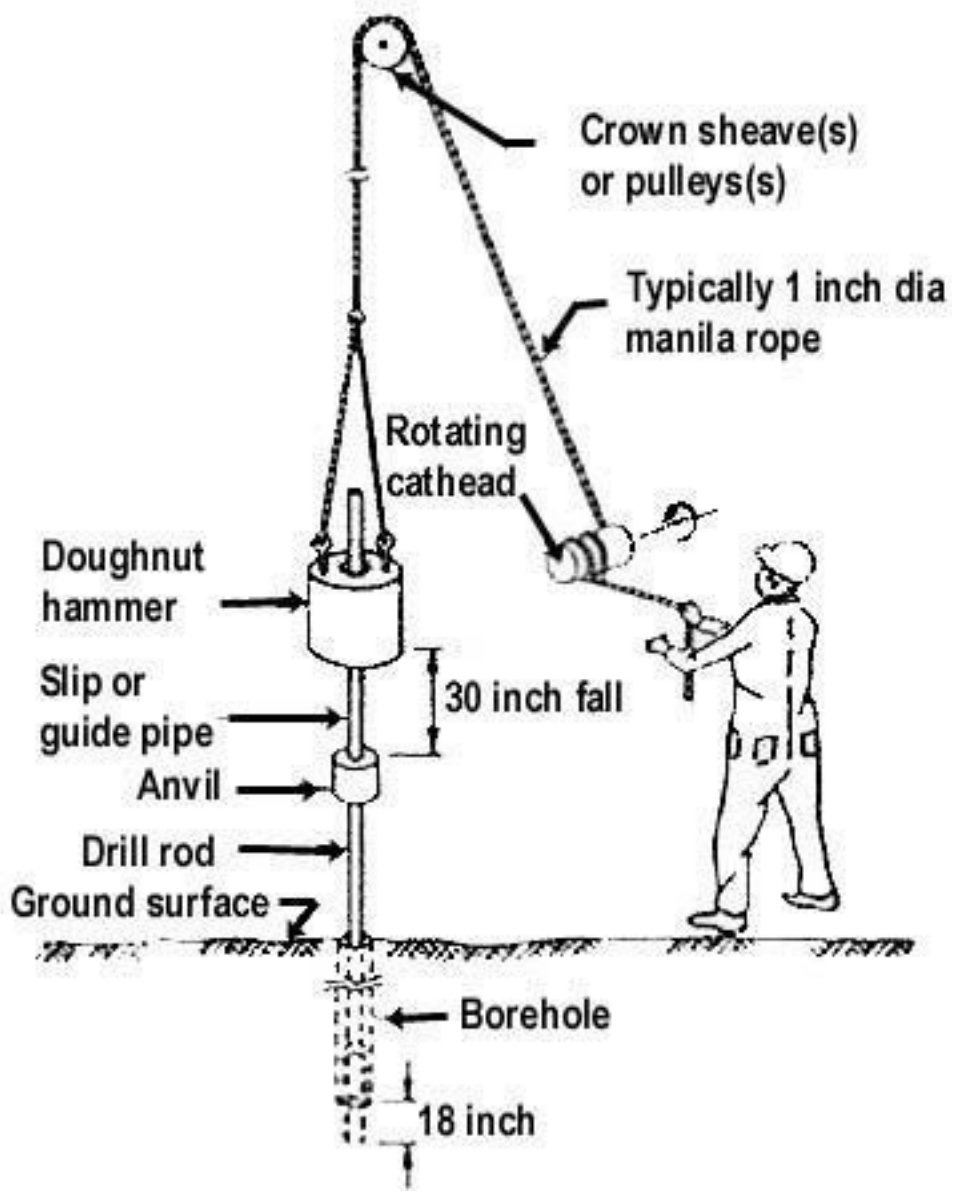


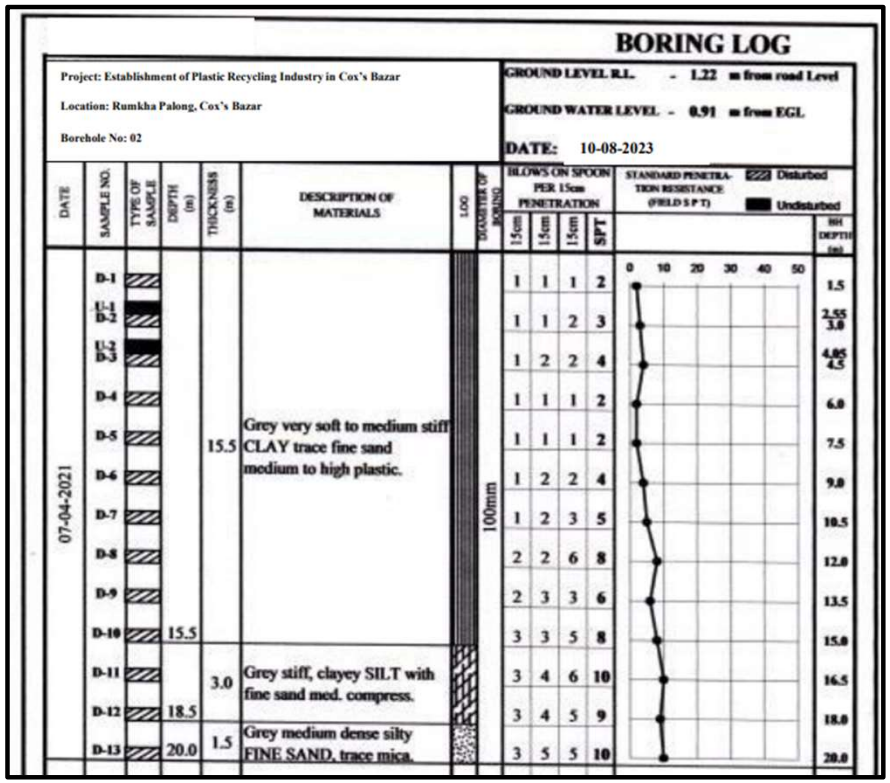
Fig. Schematic Diagram of SPT Setup.

STANDARD PENETRATION TEST (SPT)

- Penetrometer driven in the ground with
  - ✓ 650 Newton weight (63.5kg)
  - ✓ from a height of 750 mm (30”)
- 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 0.76m successively by means of rope and cathead, using no more than two and one fourth 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 0.15 m of the penetration.
- The first 0.15 m increment is the ‘seating’ drive.



BORING LOG

Project: Establishment of Plastic Recycling Industry in Cox's Bazar

Location: Rumkha Palong, Cox's Bazar

Borehole No: 02

GROUND LEVEL R.L. - 1.22 m from road Level

GROUND WATER LEVEL - 0.91 m from EGL

DATE: 10-08-2023

DATE	SAMPLE NO.	TYPE OF SAMPLE	DEPTH (m)	THICKNESS (m)	DESCRIPTION OF MATERIALS	LOG	DIAMETER OF BORING	BLOWS ON SPOON PER 15cm PENETRATION 15cm	15cm	15cm	SPT	STANDARD PENETRATION RESISTANCE (FIELD S P T)	RH DEPTH (m)
07-04-2021	D-1						100mm	1	1	1	2		1.5
	U-1 D-2							1	1	2	3		2.55 3.0
	U-2 D-3							1	2	2	4		4.05 4.5
	D-4							1	1	1	2		6.0
	D-5			15.5	Grey very soft to medium stiff CLAY trace fine sand medium to high plastic.			1	1	1	2		7.5
	D-6							1	2	2	4		9.0
	D-7							1	2	3	5		10.5
	D-8							2	2	6	8		12.0
	D-9							2	3	3	6		13.5
	D-10		15.5					3	3	5	8		15.0
	D-11			3.0	Grey stiff, clayey SILT with fine sand med. compress.			3	4	6	10		16.5
	D-12		18.5					3	4	5	9		18.0
	D-13		20.0	1.5	Grey medium dense silty FINE SAND, trace mica.			3	5	5	10		20.0

Disturbed

Undisturbed

DRILLING LOG

Drilling Location : Sumberejo District, Olak Alen Village - Blitar

Project Name : Landslide Research

Company : Thesis - Research

Elevation : - m

Total Length of Drill : 30 m

Drill Machine : Spindel

Bor Master : Serilus Bani

Analysis By : Rety Winonazada

Check analysis By : Joko Apranto, ST

STANDART PENETRATION TEST (SPT TEST)

Scale	Depth (m)	Thikness (m)	GWL	Symbol	Description	Consistensy	Core Recovery (%)	SOIL CLASSIFICATION	Method Sample UDS & SPT	Thikness (m)	Depth (m)	Blows Penetration Each 15cm 15 cm	15 cm	15 cm	N Blows N2+N3 30cm	N Value Graph
-0,5											-0,5					
-1,0		2,00			Silty Sand			SP-SM			-1,0					
-1,5										0,50	-1,5					
-2,0	2,0					Loose				0,45	-2,0	2	3	3	6	
-2,5											-2,5					
-3,0		2,00			Silty Sand			SP-SM			-3,0					
-3,5										0,50	-3,5					
-4,0	4,0					Loose				0,45	-4,0	4	4	5	9	
-4,5											-4,5					
-5,0		2,00			Silty Sand			SP-SM			-5,0					
-5,5										0,50	-5,5					
-6,0	6,0					Medium Dense				0,45	-6,0	5	5	7	12	
-6,5											-6,5					
-7,0		2,00			Silty Sand			SP-SM			-7,0					
-7,5										0,50	-7,5					
-8,0	8,0					Medium Dense				0,45	-8,0	5	5	7	12	
-8,5											-8,5					
-9,0		2,00			Silty Sand			SP-SM			-9,0					
-9,5										0,50	-9,5					
-10,0	10,0					Medium Dense				0,45	-10,0	6	6	7	13	
-10,5											-10,5					
-11,0		2,00			Silty Sand			SP-SM			-11,0					
-11,5										0,50	-11,5					
-12,0	12,0					Medium Dense				0,45	-12,0	7	8	8	16	
-12,5											-12,5					
-13,0		2,00			Silty Sand			SP-SM			-13,0					
-13,5										0,50	-13,5					
-14,0	14,0					Dense				0,45	-14,0	10	11	13	24	
-14,5											-14,5					
-15,0		2,00			Silty Sand			SP-SM			-15,0					
-15,5										0,50	-15,5					
-16,0	16,0					Dense				0,45	-16,0	10	14	16	30	
-16,5											-16,5					
-17,0		2,00			Silty Sand			SP-SM			-17,0					
-17,5										0,50	-17,5					
-18,0	18,0					Very Dense				0,45	-18,0	10	14	19	33	
-18,5											-18,5					
-19,0		2,00			Silty Sand			SP-SM			-19,0					
-19,5										0,50	-19,5					
-20,0	20,0					Very Dense				0,45	-20,0	12	17	23	40	
-20,5											-20,5					
-21,0		2,00			Silty Sand			SP-SM			-21,0					
-21,5										0,50	-21,5					
-22,0	22,0					Dense				0,45	-22,0	10	14	16	30	
-22,5											-22,5					
-23,0		2,00			Silty Sand			SP-SM			-23,0					
-23,5										0,50	-23,5					
-24,0	24,0					Very Dense				0,45	-24,0	14	19	24	43	
-24,5											-24,5					
-25,0		2,00			Silty Sand			SP-SM			-25,0					
-25,5										0,50	-25,5					
-26,0	26,0					Very Dense				0,45	-26,0	14	21	26	47	
-26,5											-26,5					
-27,0		2,00			Silty Sand			SP-SM			-27,0					
-27,5										0,50	-27,5					
-28,0	28,0					Very Dense				0,45	-28,0	16	23	28	51	
-28,5											-28,5					
-29,0		2,00			Silty Sand			SP-SM			-29,0					
-29,5										0,50	-29,5					
-30,0	30,0					Very Dense	BOR STOP			0,45	-30,0	18	24	28	52	

LEGENDS SYMBOLS AND RANGE OF VALUE

LEGEND :

- Standard Penetration Test (SPT)
- Undisturbed Sample (US)
- Disturbed Sample (DS)
- Ground Water Level (GWL)

SOIL CLASSIFICATION SYMBOL

GRAVEL	: G
SAND	: S
SILT	: M
CLAY	: C
ORGANIC	: O
WELL	; W
POOR	; P
HIGH	; H
LOW	; L

COHESIVE SOIL

CONSISTENSY	N VALUE
VERY SOFT	0 - 1
SOFT	2 - 4
MEDIUM SOFT	5 - 8
STIFF	9 - 15
VERY STIFF	16 - 30
HARD	31 - 60
VERY HARD	> 60

GRANULAR SOIL

DENSITY	N - VALUE
VERY LOOSE	: 0 - 4
LOOSE	: 5 - 10
EDIUM DENSE	: 11 - 24
DENSE	: 25 - 50
VERY DENSE	: > 50

ROCK QUALITY DESIGNATION (RQD)

DESCRIPTION	R 20 %
VERY POOR	< 25
POOR	25 - 50
FAIR	51 -75
GOOD	76 - 90
EXCELLENT	> 90

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

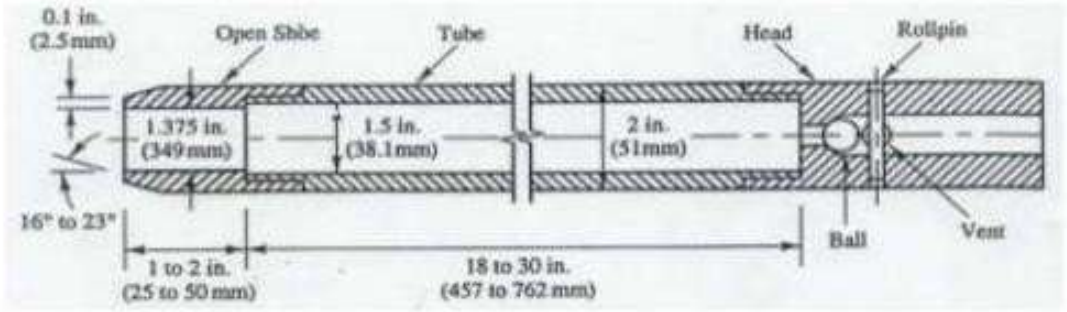
Table 5.3 Penetration Resistance and Soil Properties on Basis of the Standard Penetration Test

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)

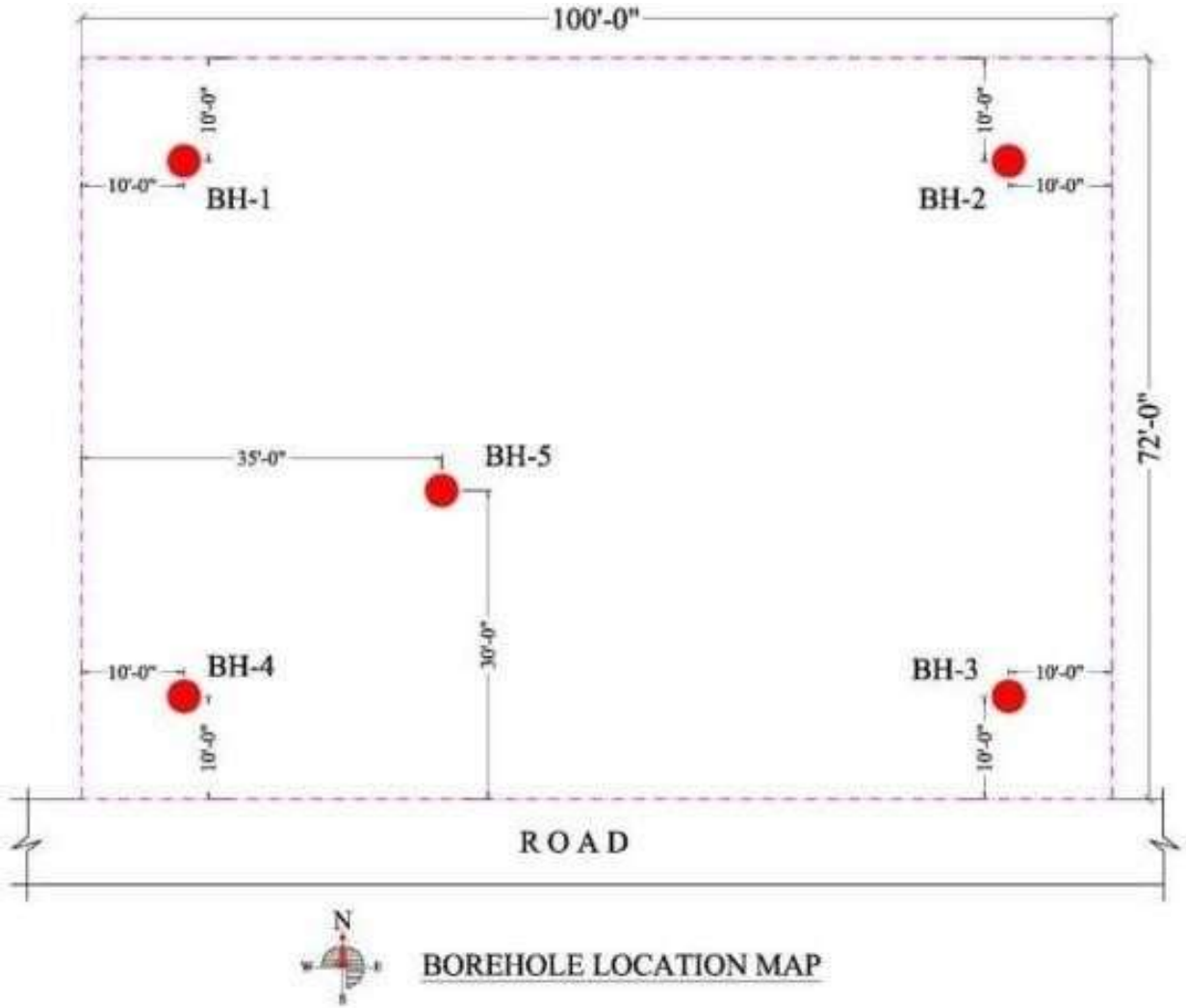


- Thick wall (0.25in) cylinder
- Sampling tube is split along the length
- Hammered into the ground

SPLIT SPOON SAMPLER



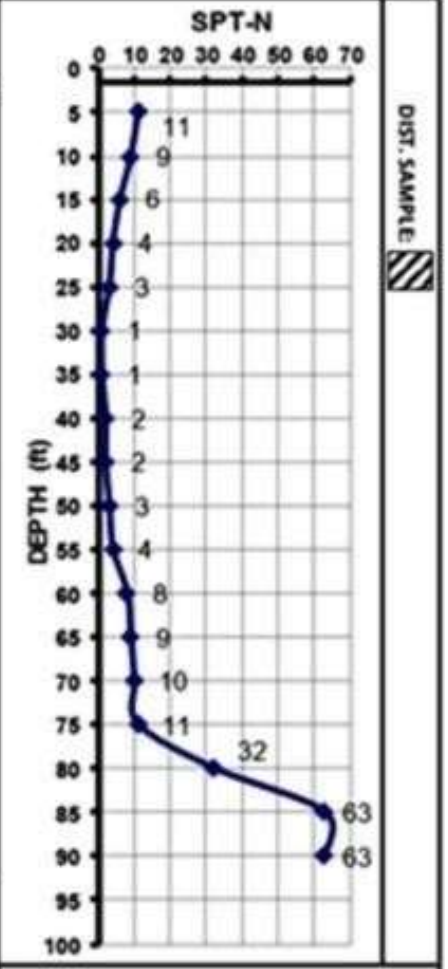
EXAMPLE OF REPORTING



Bore Log

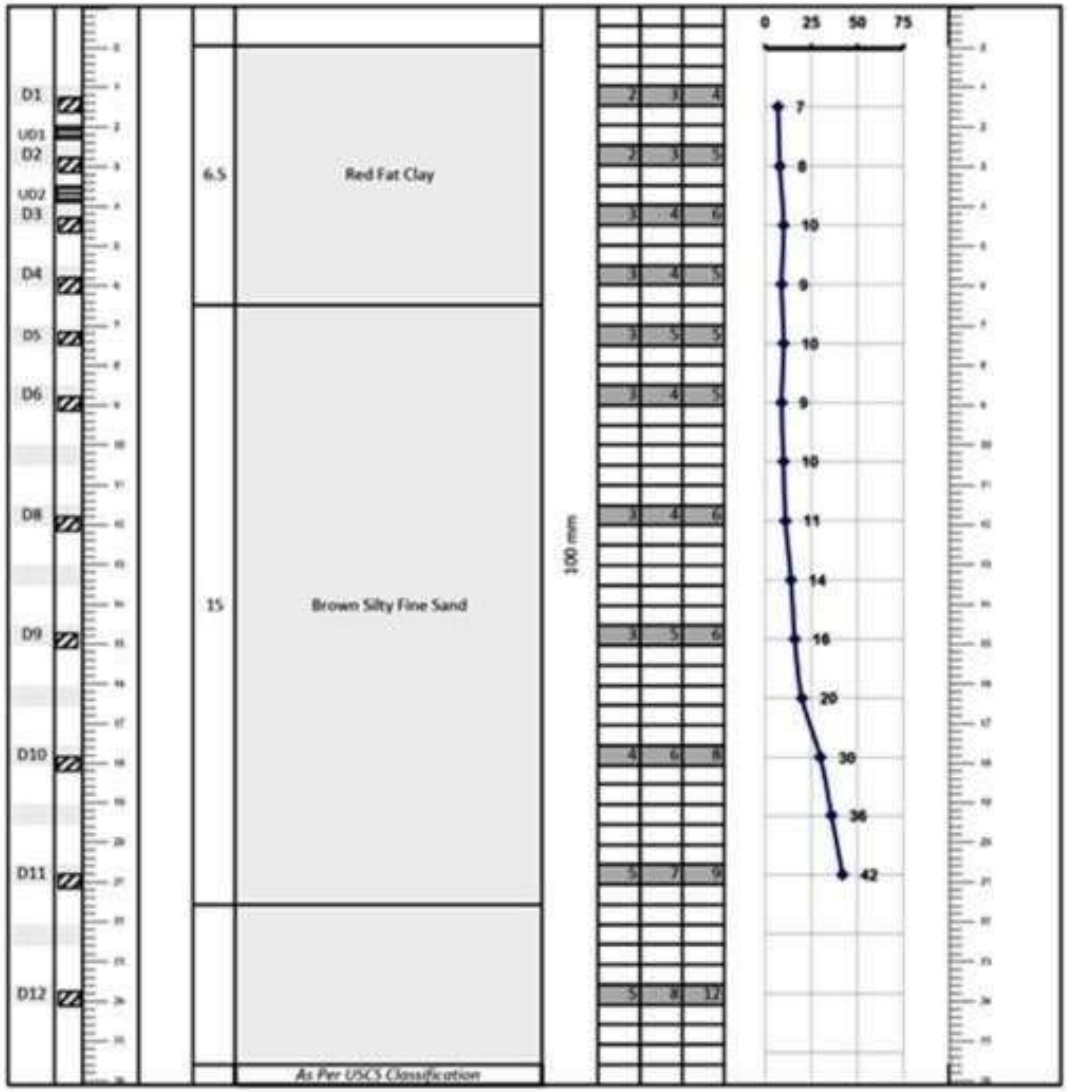
PROJECT :	G+9=10 (Ten) Storied Residential Building
CLIENT :	
LOCATION :	Bashundhara Residential Area, Dhaka
BORE HOLE NO.:	BH-02
METHOD OF DRILLING	Percussion

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' to 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



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

Commonly used terms:

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

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 Pressure: It is the maximum pressure the foundation soil is subjected to considering both shear failure and settlement.

METHODS OF IMPROVING BEARING CAPACITY OF SOILS

- Increasing the depth of footing
- Drainage — Reduces excess water in the soil
- By blending granular material — Improves particle interlock and friction
- By confining the soil in an enclosed area — Restricts lateral movement of soil
- By driving sand piles

Foundation

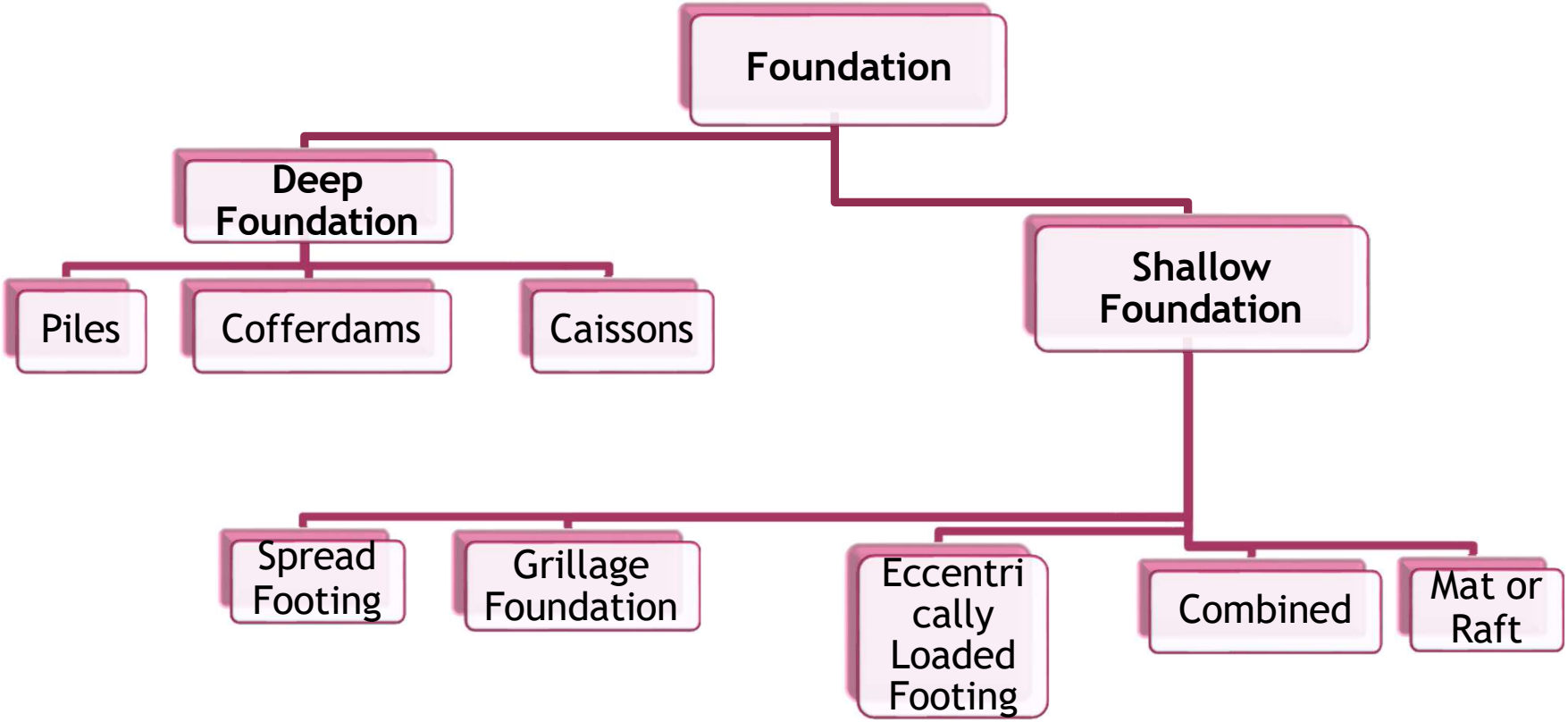
DEFINITION OF FOUNDATION

The lowest part of a structure which provides a base for transmitting the loads on 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

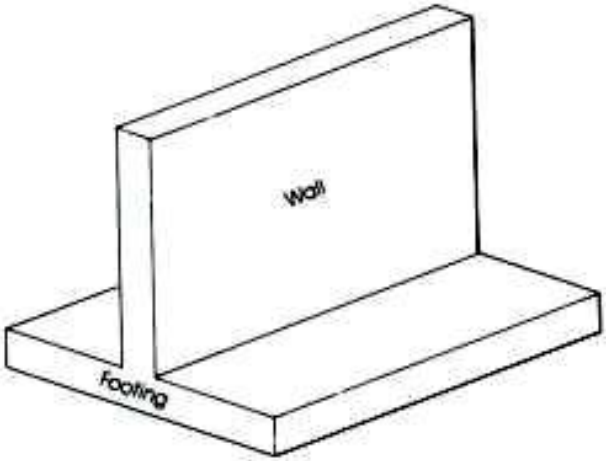
SHALLOW FOUNDATION

- Distributes structural loads to the earth at relatively shallow depth below the GL.
- A shallow foundation system generally used when
  - the soil close to the ground surface has sufficient bearing capacity, and
  - underlying weaker strata do not result in undue settlement.
- The shallow foundations are commonly used most economical foundation systems.

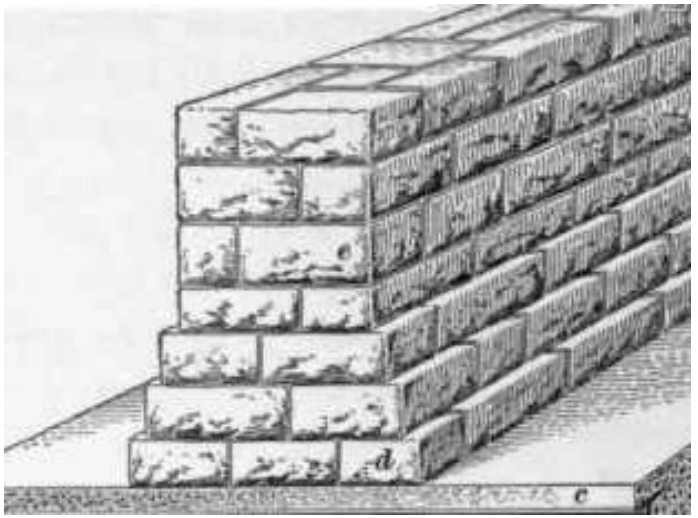
SPREAD FOOTINGS

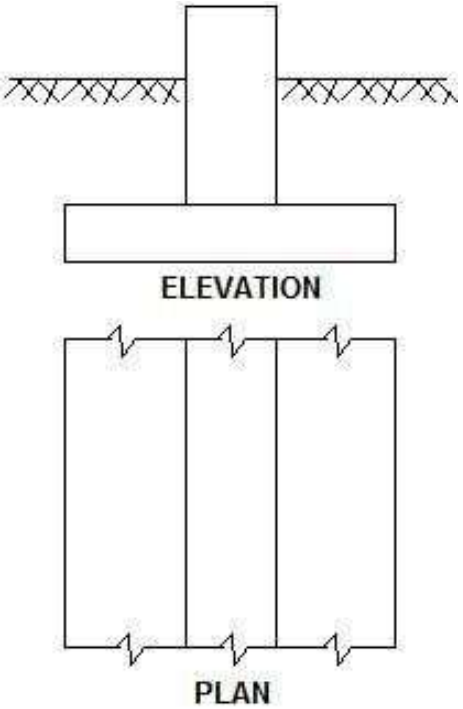
- Base of the member transmitting load to soil is made wider so as to distribute the load over wider area.
- Broadly speaking, all types of shallow foundations can be referred to as spread footing foundations.
- However, from design and construction point of view, they have been designated separately.
- Types:
  - **Wall footings**
  - **Column footings**

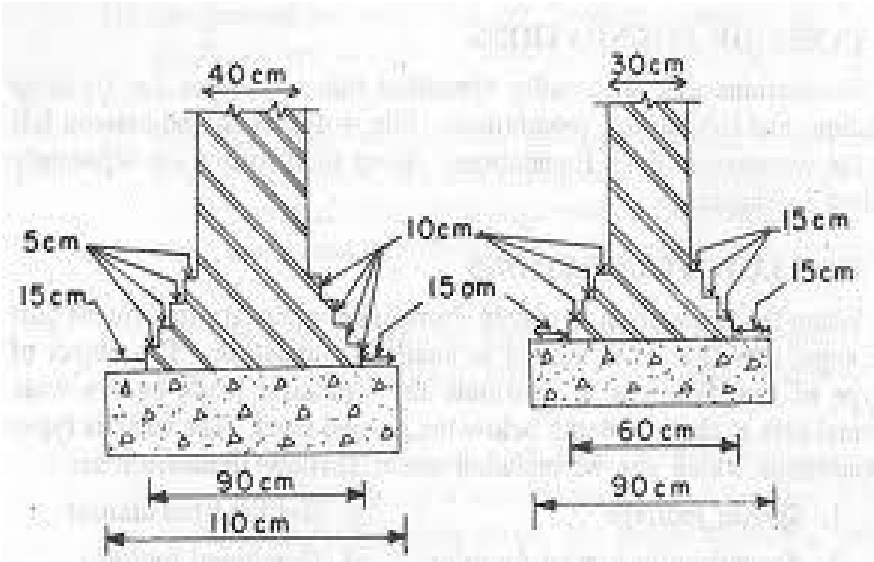
WALL FOOTINGS



Wall footing.

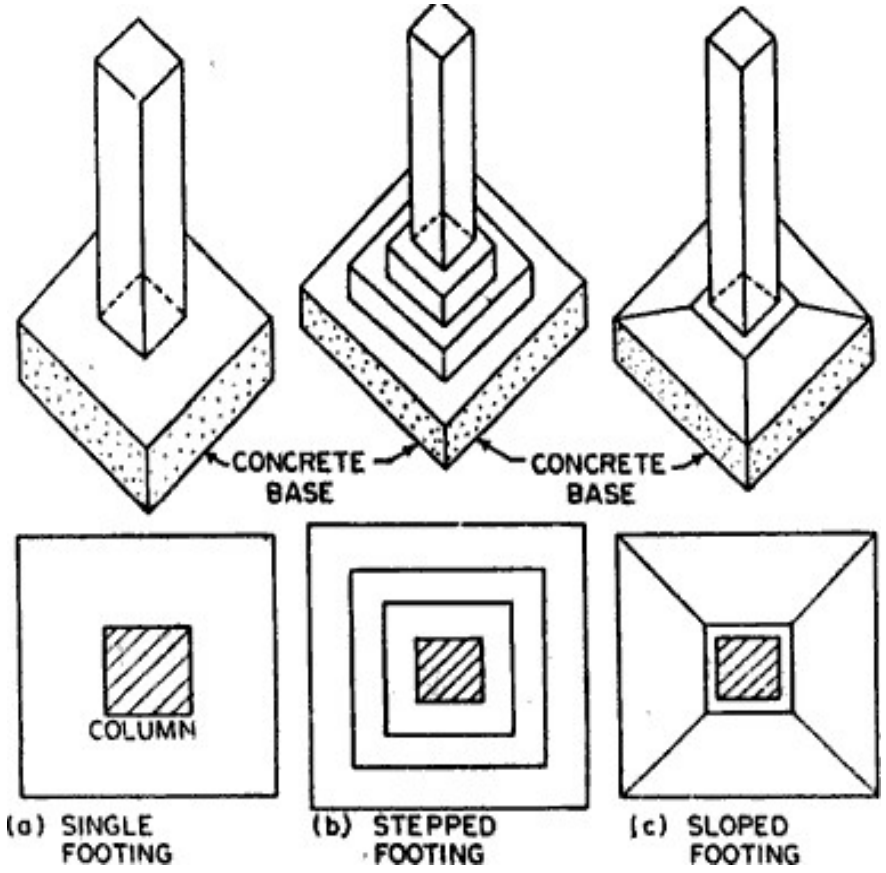




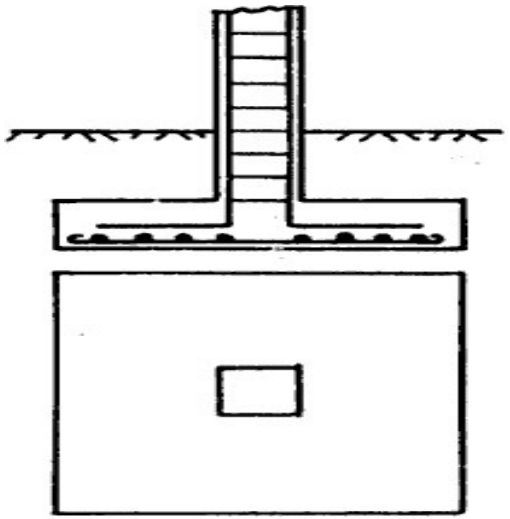


COLUMN FOOTINGS (INDEPENDENT FOOTINGS)

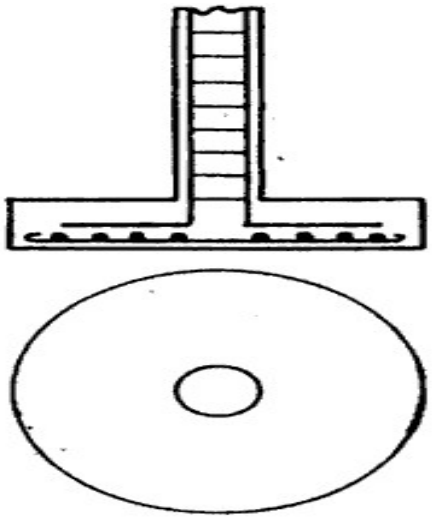




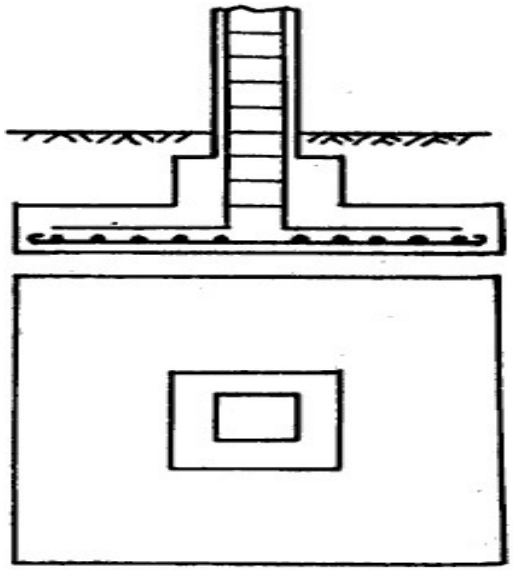
COLUMN FOOTINGS (INDEPENDENT FOOTINGS)



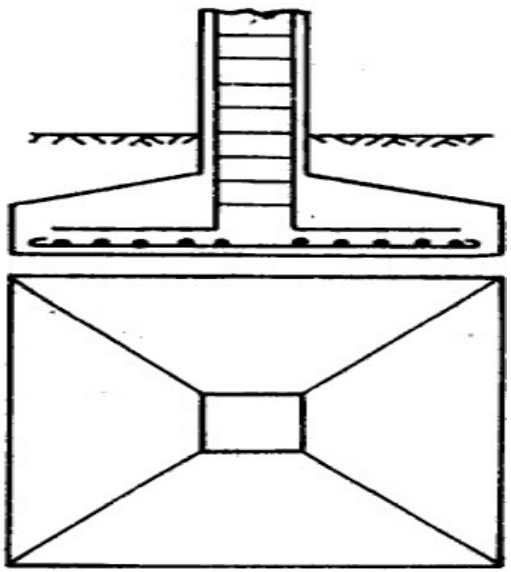
(a) Square Footing



(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



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

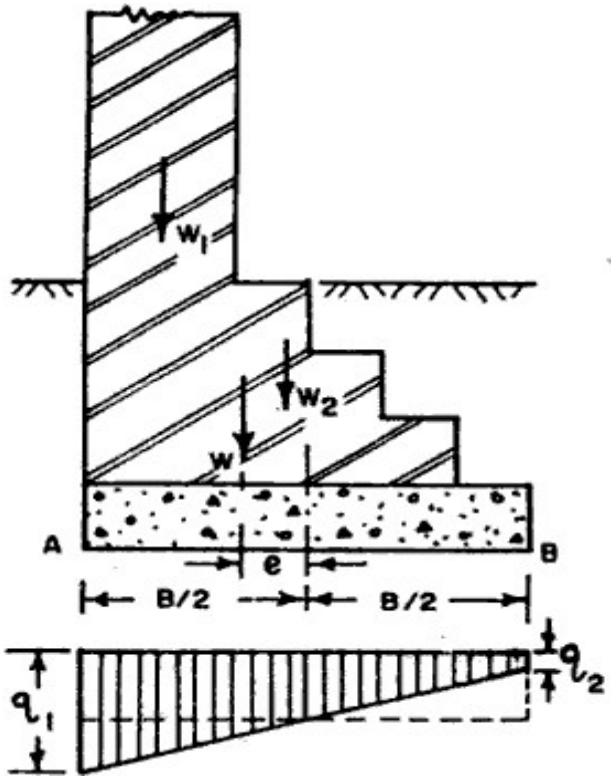
REQUIREMENTS OF A GOOD FORMWORK

- Able to be erected and de-shuttered fast.
- Good concrete quality and surface finish can be achieved.
- Should be rigidly constructed and efficientlypr opped and braced to withstand all types of deadand 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.

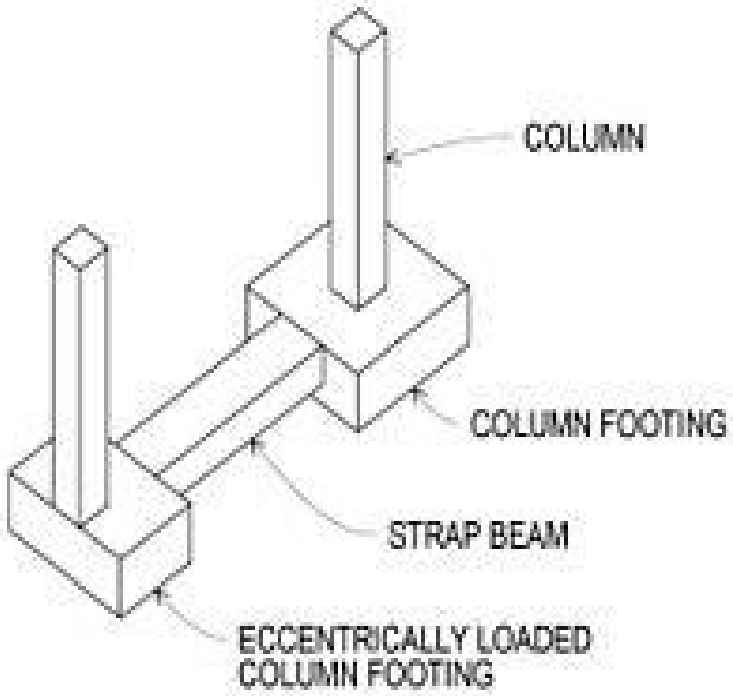
ECCENTRICALLY LOADED FOOTINGS

- 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 columnsare to be placed close to ***property lines***.
- Stability is ensured by:
  - offsetting the footings
  - providing strap footing

ECCENTRICALLY LOADED FOOTINGS

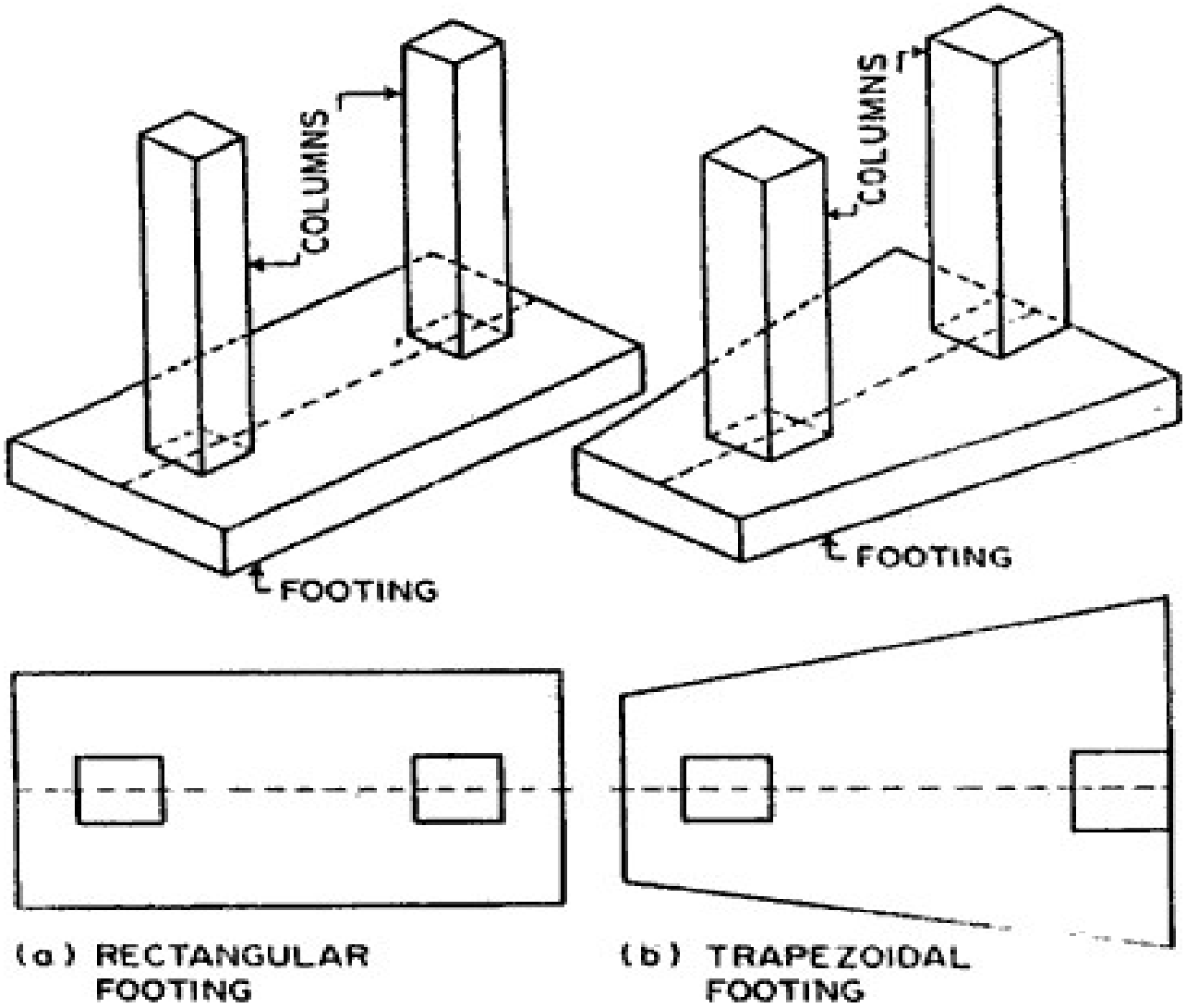


Stability provided by offsetting the footing



Stability provided through a cantilever beam acting about a fulcrum

COMBINED FOOTINGS



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.
- This is a large continuous footing supporting all the columns of the structure.
- This is used when soil conditions are poor but piles are not used.



RAFT OR MAT FOUNDATION

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

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



STEPS OF CONSTRUCTION OF MAT FOUNDATION



Excavation



Leveling

STEPS OF CONSTRUCTION OF MAT FOUNDATION



Brick Flat Soling

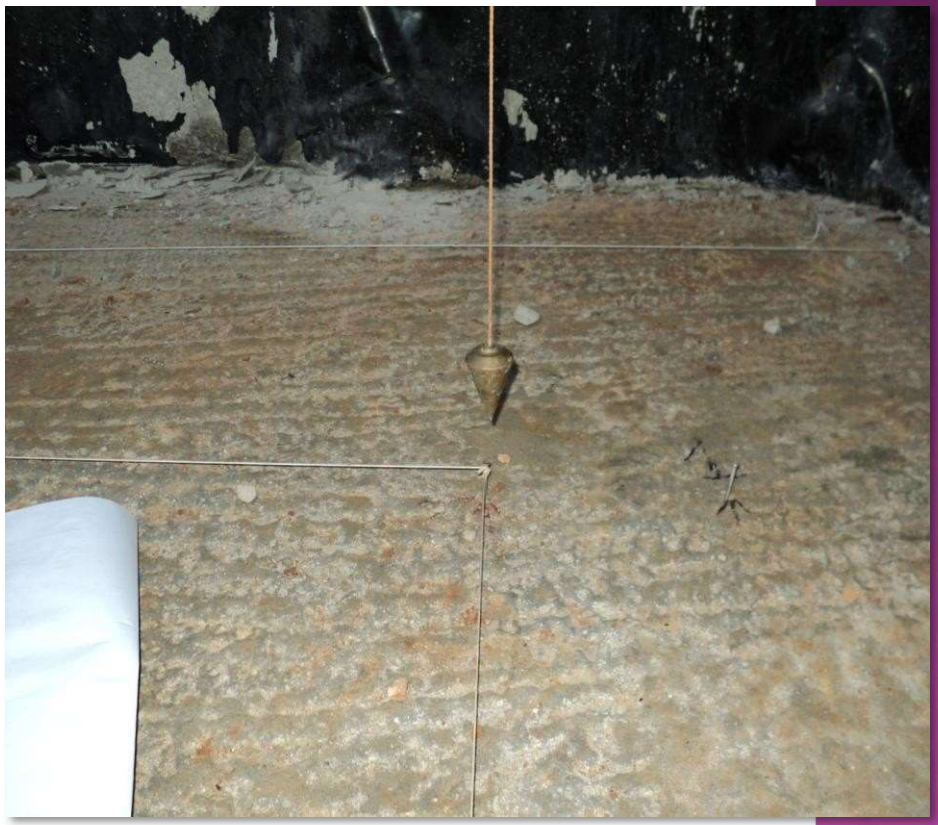


C.C. Layer

STEPS OF CONSTRUCTION OF MAT FOUNDATION



Damp Proof Course

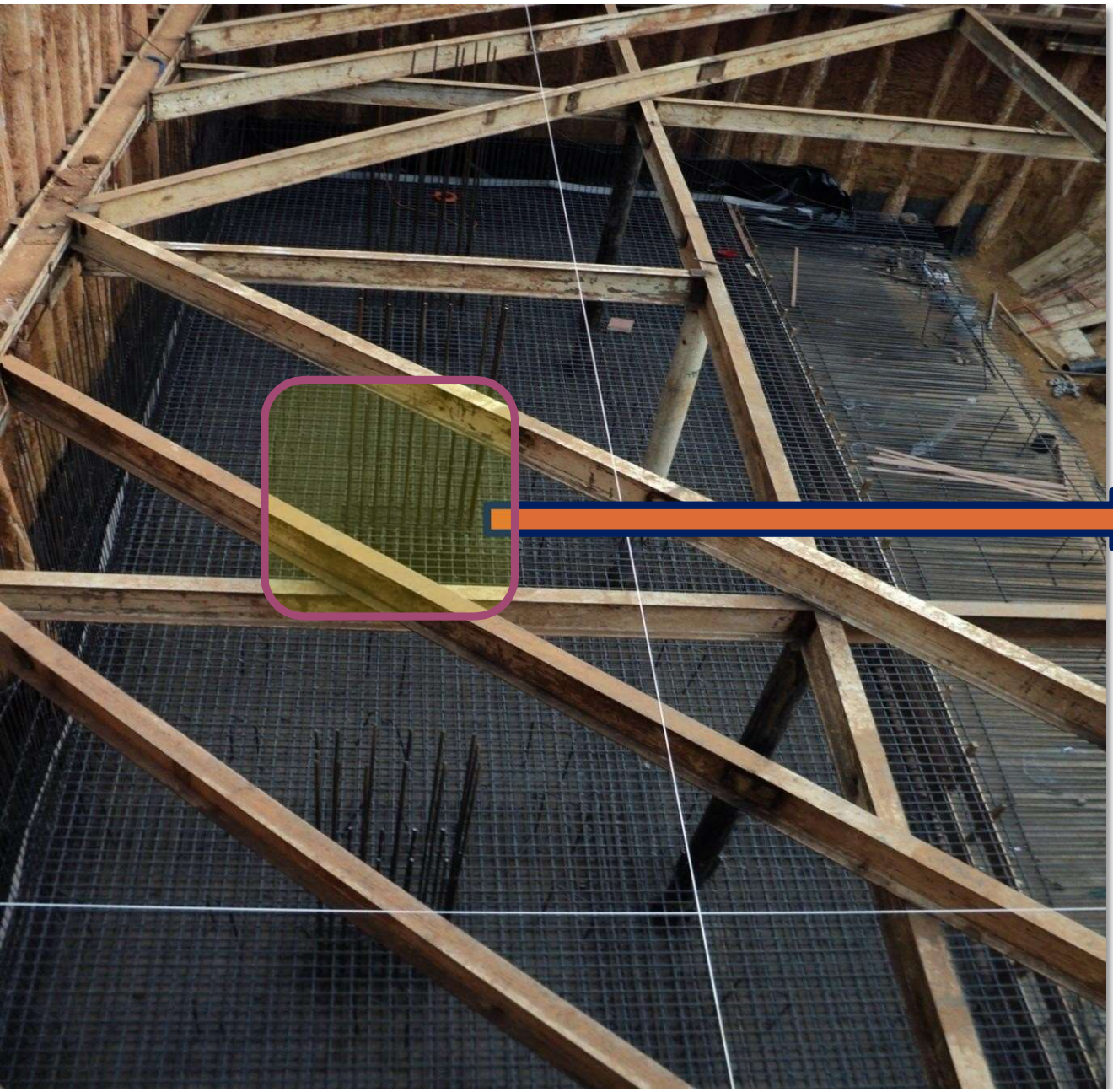


Positioning of Column

REINFORCEMENT



REINFORCEMENT





SHUTTERING AND RETAINING WALL



CONCRETE CASTING AND COMPACTION





CONCRETE CASTING CONTD ...



Concrete is cast in parts

CURING

