

Chapter # 02

FOUNDATION.

A large of buildings make
maximum force that it bears called
though while this maximum load
that soil can withstand called
bearing capacity of soil.

Foundation:-

Foundation can be define as;

"The lowest artificially built part of the building which transmit the load of building to soil laying underneath is called foundation."

→ The soil or solid ground on which foundation rest is called foundation bed.

Usually we have to increase the contact area of foundation bed with soil underneath it. Because by doing so the load is distributed easily and stress will reduce due to which collapse of building will not occur in case if lateral force is applied. Its mechanism is same as nail hit down in wall so it will not even disturb if more load (lateral) is applied.

Purpose of Foundation:-

i. To distribute the load of building over a large area in order to bring maximum load that building can bear into safe.

bearing capacity.

(2) In order to remove unequal & equal settlement from building we give foundation.

(3) To provide resistance to lateral load in case of fast breeze flow or earthquake come.

(4) In order to maintain the level of building we provide foundation so that it not move downward underneath soil & disturb or collapse the building.

(5) To increase the stability of structure as a whole.

Types of foundation:-

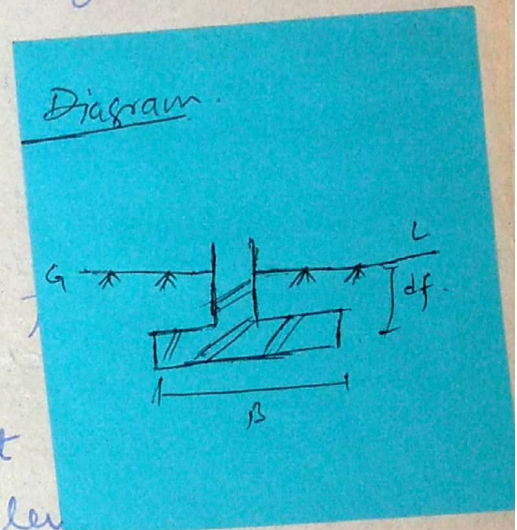
There are two types of

(a) Shallow Foundation:-

"The foundation that nearest part of ground level is just beneath the soil."

→ This foundation is preferred in that case when soil condition is good as it cost less. Shallow foundation consist of one component called footing. So it means Foundation & footing are two different terms.

If the depth of foundation is less or equal to breadth of foundation called shallow foundation.



2. (b) Deep foundation:-

"The foundation that is provided deep under ground level."

This type of foundation is provided in sandy place in order to give more stability to structure in case of lateral load.

If the depth of foundation is more than breadth of foundation called deep foundation.

SELECTION OF FOUNDATION:-

If we not know the following information about structure we cannot decide the foundation for that structure.

① Type of Building - (superstructure)

It means which kind of building we are going to construct. For example if we made just one storey building then shallow foundation is enough but if we want high multistorey building we should give deep foundation in order to transmit load to soil successfully.

(2) Types & Intensity of load:-

We have find the type & intensity of load that will act on the foundation. For e.g In Japan we should construct such a building with foundation that can transmit the earthquake lateral load. Which is one

of the factor.

→ Our building such that can take wind load, dead load, live load also its own weight.

(3) Nature & Bear of Soil:-

The foundation that we make in some place how is soil condition there. How much soil can bear load.

On the basis of these three factors we can decide which type of foundation suit.

Foundation Soil:-

The earth's mineral material which is incombustible and inorganic, can be classify as soil or rock.

Soil & rocks are found beneath ground level. The difference is that a material in which the molecules (particles) are bonded tightly and not want to move away from each other called rocks.

Whereas the particles of soil are not integrated but consist sediments.
→ When rock disintegrate we call it as soil in geotechnical term.

Foundation soil is defined as:
When we excavate ground and it transmit load to ground we call it

foundation soil.

When we excavate ground we first find soil (soft) on further excavation we get hard layer of rock i.e. hard stratum.

We will excavate till we not get hard stratum so that load successfully transmit.

Types of soil:-

There are different types of soil on which foundation lies, which are discussed below.

1. Gravel & Shingle:-

Type of soil which consist of coarse material and formed by disintegration of rock.

→ Its size usually range from 3mm - 200mm.

⊗ If size more than 200mm called boulder.

Characteristics:-

- Not swell when wet.
- Not shrink when dry.
- Not effect from freezing of water.
- It can transport load of building successfully to earth because of its maximum strength.
- It does not press when load is applied.

Note:- This type of soil is best for all types of foundations. Provide good foundation bed.

(2) Sand:-

It is regular, angular or rounded grain having grain size varies from 0.075 to 2mm.

Properties:-

- Not swell when moist or wet.
- Not shrink when dry.
- It is not effected from cohesion.
- It is not effected by the action of frost (A thin layer of ice formed when cold).
- It does not allow water to rise up by Capillary level.

Note:-

Coarse sand provide good foundation bed as it not allow foundation to escape or move down. Whereas fine dry sand or sand saturated with water not good for foundation.

(3) Silt:-

It is finer variety of soil having size vary from 0.002mm to 0.06mm.

Properties:-

- It can be shrink in case of dry & swell in case of wet.
- It is relative impervious i.e. It stop the passing of light (not transparent).
- It is superior as sand.
- It is found in river (bed), canals, reservoir etc.

Note:-

Silt is not consider good for foundation.

(4) Clay:-

It consist of microscopic and sub microscopic particles of rock. It size (particle) varies or less than 0.002mm.

Properties:-

- (*) It has cohesive property.
- (*) When wet it swells & heaves while shrink & crack when dry.
- (*) Clay is hard when dry but when wet it can be flown away.
- (*) It consolidates under load and may cause settlement of structure.

Note:-

This - soil is suitable for light structures. In this type of soil we should take greater care because it is difficult to excavate when in dry condition.

(5) Alluvial Soil:-

The soil that is carried by force of water with itself is called alluvial soil.
→ Also called transported soil.

→ When solid particles mixed with water, soil so by reducing speed of water some of large solid particles settle, on further reduction of speed of water other fine soil settled this

of soil is called alluvial soil.

Exp:-

River deposit soil.

Properties:-

- (*) It is plastic but consolidate under load.
- (*) It is Cohesive Soil.
- (*) It cracks on drying.

Note:-

It is best soil for foundation bed for light structures.

(6) Reclaimed Soil:-

The soil that is used for filling of under lying low areas.

→ It also called made up soil.

Properties:-

- It consists of ashes, refuse, old iron pieces, ballast etc.
- Reclaimed soil is usually porous.
- Its strength bearing is low.

Note:-

Not good for foundation bed.

7) Black Cotton Soil:-

→ Also called peat or bungan. It is inorganic in nature. Usually found in Central or Western India.

Properties:-

- With stand to high pressure when in dry state.
- Swell when confined b/w walls.

- It is dark grey or black in colour.
- It becomes so soft during raining.

Engineering Classification:-

This classification is done by building Code of Pakistan on the basis of foundation.

i- Type SA:- (Soil Type A)

This type of soil is best for shallow foundation. Commonly available soil. If we excavate ground we found early strata of rocks that is stable and cannot be press if some load is applied.

ii. Type SB:- (Soil Type B)

This type of soil is combination of soil & rock. But the percentage of ^{rock} soil is more than ^{soil} rock. Also best soil for foundation.

(iii) Type SC:- (Soil Type C)

Type of soil which is combination of stiff soil & soft rock is small proportion.

(*) The residential building foundation will be built in one of the above three soil.

iv) Type SD:- (Soil Type D)

It is good soil but can be compress due to which we excavate more if

found such soil in order to get hard stratum.

v) Type SE:- (Soil Type E)

It is soft soil, not good for foundation.
→ If we excavate more than we can built structures in this type of soil.

vi) Type SF:- (Soil Type F)

The soil whose properties not like other known soil and need more investigation. Such type of soil called soil type F.
(*) Special case of soil.

SUB SURFACE INVESTIGATION:-

It is defined as;

The investigation or evaluation of different layers of soil to get (obtain) data of ground for safe & economical design of foundation of different structures called sub surface investigation.

→ "To study about soil whether it is good or not for different buildings".

→ It is also called soil exploration or soil survey.

→ By doing this process we obtain data which help us to select appropriate and suitable foundation for a building.

It is also sub soil investigation if we have a building that is settle or crack occur there so we excavate its foundation in order to know the cause due to which it happens.

(*) Objectives of Sub Soil Investigation:-

We excavate ground we get the following data.

- (*) We come to know about different ^{types of} soils after evaluation on it in laboratory.
- (*) We also know (familiarize) about water table that is change from season to season in different regions.
- (*) We come to know about layer of soil, rock etc and how much its depth are.
- (*) We obtain data on basis of which we design foundation of building.
- (*) We come to know about thickness & variation of soil with depth.

Method of Sub Surface Investigation:-

The following methods are usually adopted for sub surface investigation.

(1) General Inspection of Site:-

This method of sub surface investigation greatly depend on experience of engineer

or a person who looking the site.

In this method the skilled & experienced visit to site and on basis of his experience he/she inspect soil by investigate little.

This method depend on experience of a person.

(*) Through his general inspection he/she can tell about soil type, soil condition whether best or not for foundation bed, drainage condition.

→ This method not disturb soil.

Information that is collected:-

The following informations are collected during general inspection method.

1. The nature of ^{soil} ~~ground~~ whether it is soft, hard, moisty or water lodged (no).
2. The type of soil by visually.
3. About behaviour of ground due to seasonal variation in ground water level.
4. Give information about drainage.
5. If there is plumbing pipe disconnect or broke then layers will become wet so also give information about neighbour area.

(2) Test Pit or trial Pit Method:-

In this method a pit (square like structure) of suitable dimension i.e (5x5x10) that can be excavate beneath the ground level

at site of working place in order to see the soil types and strata of soil at different depth below ground level. Such method is called test pit or trial pit method.

→ These test pits are large enough so that examiner of soil can easily come inside it.

→ In case of cohesion soil, the test pit are made to be vertical.

→ Where in case of cohesion less soil, the test pit is made to be at slope.

(*) By measuring tape we can measure the soil type, different strata of soil and depth of these strata which is called test pit log.

(*) The depth of test pit depend upon type of building.

(*) These pits are not excavate below the ground water level. If water come in digging so we will stop excavating.

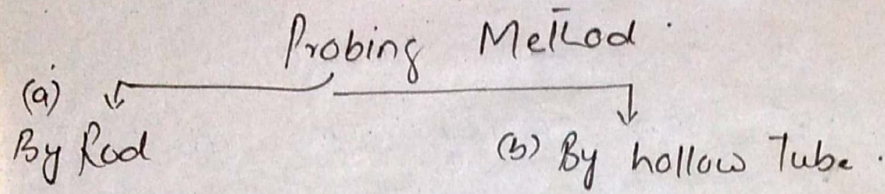
Suitability:-

→ This method is used for structure having shallow foundation.

→ This method is limited to excavate upto 3m. This is its range.

(3) By Probing Method:-

The method in which soil investigation is done with the help of steel rod or hollow tube is called Probing method.



(a) By Rod:-

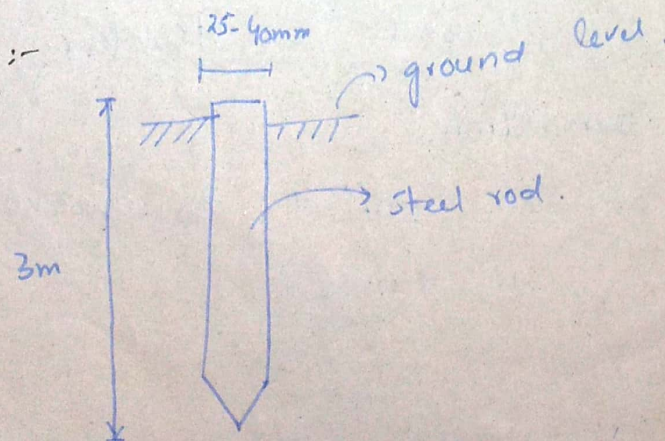
The rod is 3m in length with diameter ranges from 35mm to 40mm, having a pointed end at the bottom as shown in fig.

→ The pointed end is driven into the ground until hard strata is obtained.

→ The nature & type of soil is mostly depend upon the number of strokes which are used to driven into ground.

→ The soil nature can also be investigate from the soil that stick with pointed end when the rod is driven out.

Diagram:-



Note:-

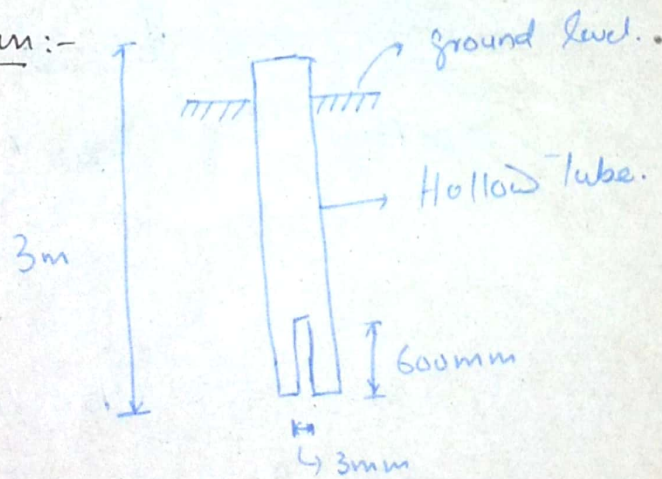
This method of soil investigation is limited upto 3m.

→ This method is used when there is soft soil like clay, gravel or sand.

(b) Hollow Tube:-

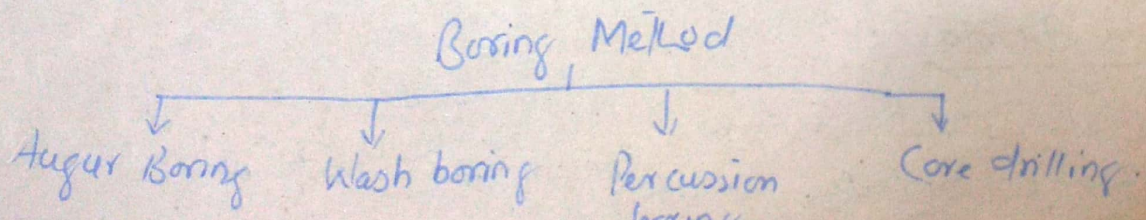
This tube is also 3m length having diameter ranges from 35mm - 50mm. It has slit of 3mm and height 600mm. When it is driven into ground, the number of strokes tell us about the nature of soil whether hard or soft. The soil investigation can also be carry after placing out hollow tube from soil & the soil remain in slit.

Diagram:-



(4) Boring Method:-

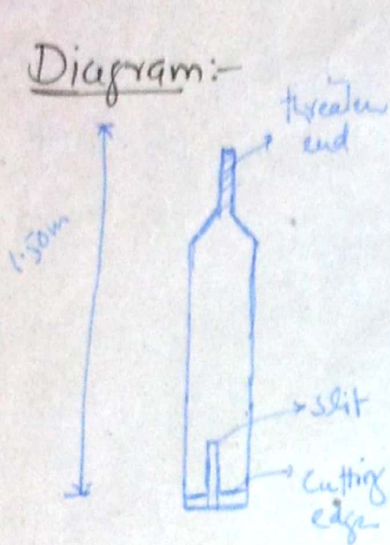
Boring method consist of



(i) Augur Boring:-

For Augur boring one of the following instruments can be used as shown below. In this method the Augur is placed (held) from handle and rotated. Due to rotation it will go down the ground. After each second of rotation & penetrating we will take out Augur and examine the soil in laboratory to see its nature and properties.

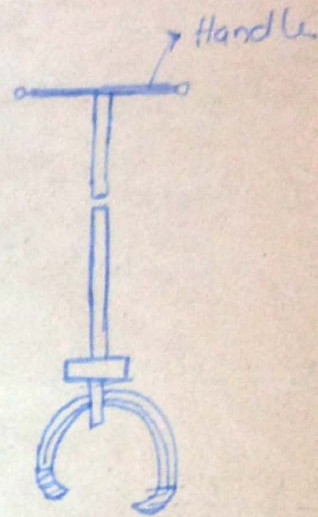
Diagram:-



Posthole Augur



Screw Augur



Shell Augur.

Note:-

This method is used for ordinary buildings built in clay or sandy places. This method is used for soil penetration up to 1.50m diameter.

Disadvantage:-

This method is not used for deeper holes where boulder, gravel or compact materials are there.

(ii) Wash Boring:-

" In this method a hollow Tube, also known as casing pipe or drive pipe, is driven into the ground and the materials inside the casing is washed out and bring to surface for inspection.

Parts & Working:-

In wash boring the following parts are used.

→ Casing pipe or drive pipe:-

It is 10 to 15cm in diameter which drive into ground upto certain depth.

(*) Wash pipe:-

Then wash pipe also known as water jet pipe of diameter 2.5 to 5cm is lowered into casing pipe. This pipe is externally connected with water supply and internally (in ground) it is contracted so as to produce jet action. The water is forced down in wash pipe under considerable pressure. Due to hydraulic pressure the water get mixed with underlying soil and create a slurry mixture with soil which lift up in b/w the space between case pipe and wash pipe for evaluation. From this solution of soil & water we get information about strata & nature of soil.

Disadvantage:-

→ Due to fine particles not mixed quickly where as dense particles like rocks settle quickly.

which not help in identification of soil.
(x) Moreover the location of particular strata cannot be located easily.

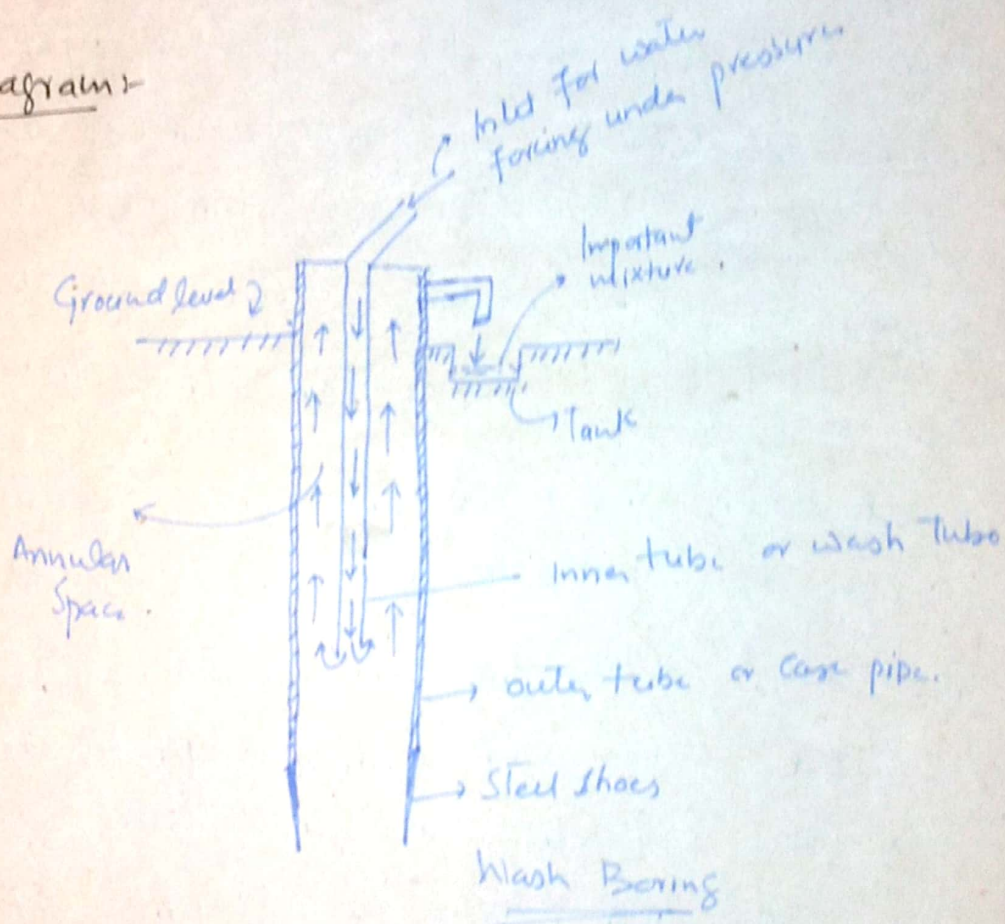
Advantage:-

However change in colour of mixture of water gives us identification of change in strata.

Note:-

This method is used to create or see the soil's nature upto 3m.

Diagram:-



(iii) Percussion Boring:-

In this method a hole is created by repeating blows with the help of bit or chisel.

In this case the strata is broken down by continuous blows of chisel with the help of machine. Since the particles in hole are grinded so we pour water in that hole in order to make slurry. The slurry is then put out and after drying of hole we investigate the soil.

Suitability:-

This method is suitable for hard strata where rocks and boulders are present.

iv) Core drilling:-

In this method a hole is made by rotating a hollow tube having a cutting bit or edge at bottom. The cutting bit forms an annular cut in strata of soil and leaves a cylindrical core of material in hollow tube.