Chapter 03: **CONCRETE STRUCTURES**

II- Fondations construction techniques

1. FOUNDATION: -

It is a part of structural system that supports and anchors the superstructure of a building and transmits its loads directly to the earth. Foundation of a building as the name implies is the starting of a building construction on site really. Types of building, nature of soil and environmental conditions are the major determinant of type of foundation. Choosing a kind of foundation depends on, ground conditions, groundwater conditions, site – the environment (the buildings nearby) and structure of our building.

Purpose:-

There are numerous reasons a foundation is provided, some of which are:

- The most crucial purpose of providing Foundation is Structural Stability. Strength of the foundation determines the stability of the structure to be constructed.
- A properly designed and the constructed foundation provide an even surface for the development of superstructure at a proper level at over a firm bed.
- A well-designed foundation prevents the lateral movement of the supporting material (which is the soil in this case) and thus ensuring the safety of the superstructure from the detrimental effects of the lateral movements of soil.
- The foundation serves the purpose of completely distributing the loads from the structure to a large base area, and then the soil underneath. This uniform transfer of loads helps in avoiding unequal settlement of the building, which is one of the detrimental defects in building construction.

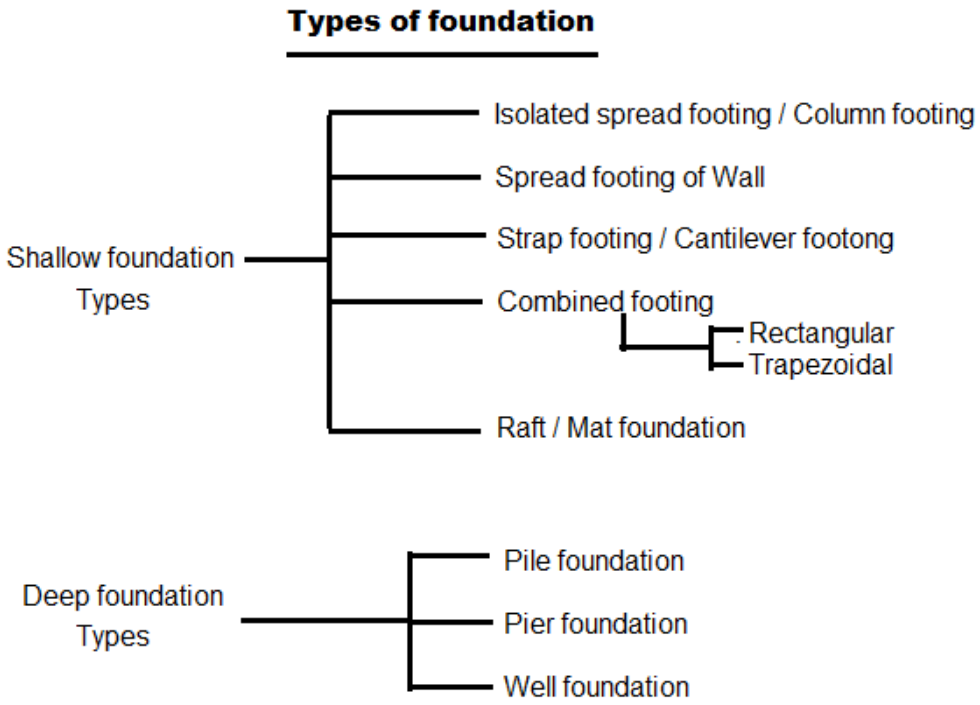
Types of Foundation:-

1. Shallow foundation: If the depth of foundation is less than the width of foundation then it is known as Shallow or stepped Foundation. It can be used where the bearing capacity of soil on which the structure is to be constructed is maximum. Minimum depth of this Foundation is 800mm and maximum depth not to be taken more than 4 meters.

2. Deep foundation: If the depth of footing greater or equal to the Width of footing, it is known as the deep Foundation. Deep Foundation is used where the bearing capacity of the soil is very low. The load coming from the superstructure is further transmitted vertically to the soil.

Difference between Foundation and Footing:

- Foundation is a structure which transfers the loads from the superstructure to the ground, while footing is the foundation which is in contact with the earth.
- A foundation can be shallow and deep, while a **footing** is a type of a **shallow foundation**. so, all footings are foundations but all foundations cannot be footings.



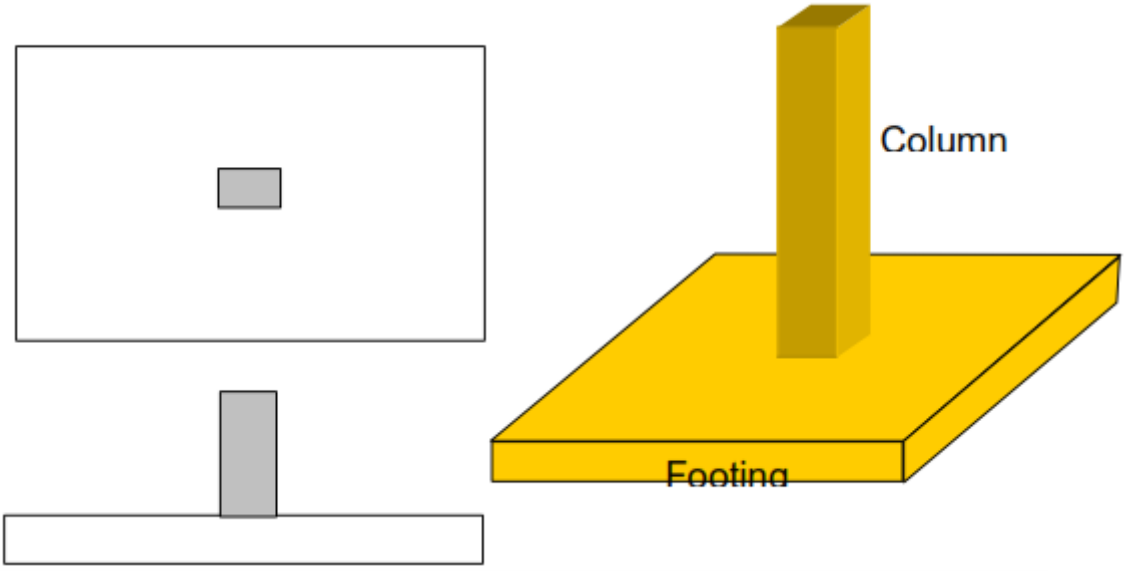
SHALLOW FOUNDATIONS

- They are usually located no more than 6 ft below the lowest finished floor.
- A shallow foundation system generally used when
  - The soil closes the ground surface has sufficient bearing capacity
  - Underlying weaker strata do not result in excessive settlement.
- The shallow foundations are commonly used most economical foundation systems

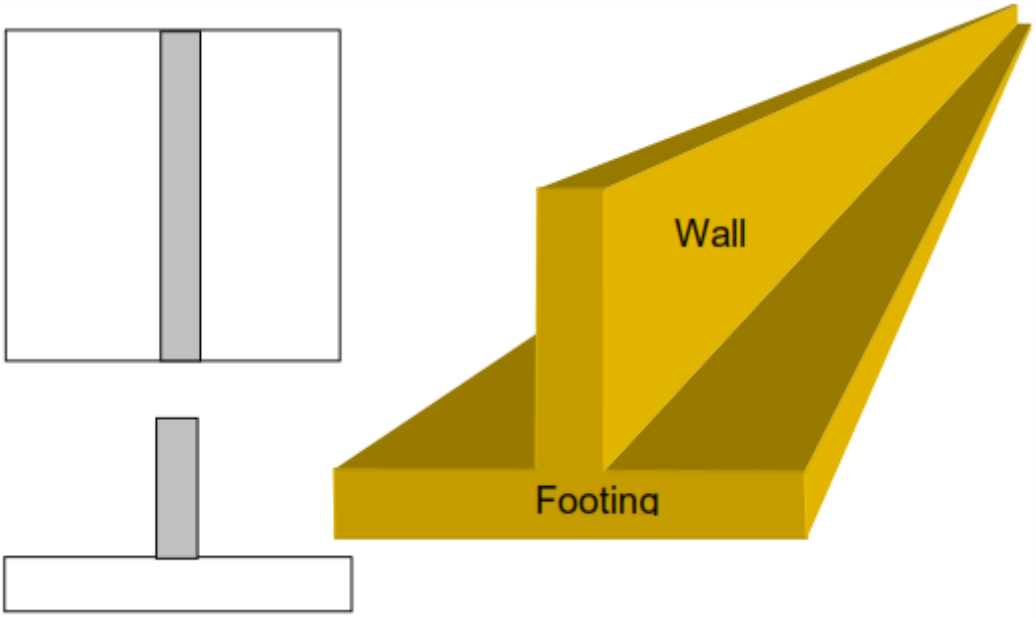
Types of spread footing: (either for Column or for Wall)

a) Single pad footing.
b) Stepped footing for a column.
c) Sloped footing for a column.
d) Wall footing without step.
e) Stepped footing for walls.
f) Grillage foundation.

(a) **Isolated spread footings** under individual columns which can be square, rectangular or circular.



(b) Wall footing is a continuous slab strip along the length of wall



(c) Combined footings support two or more columns. These can be rectangular or trapezoidal in plan.

➢ A combined footing is necessary in following **three reasons**:

- Columns are placed **very close to each other** so that their individual footings overlap each other
- When **bearing capacity of soil is less** so it is required to have a more spread area for footing and so footing of adjacent column may overlap
- When external column is **close to property line**, it is not possible to provide isolated footing for that column because it may be extended beyond the property line and so combined footing solves the problem

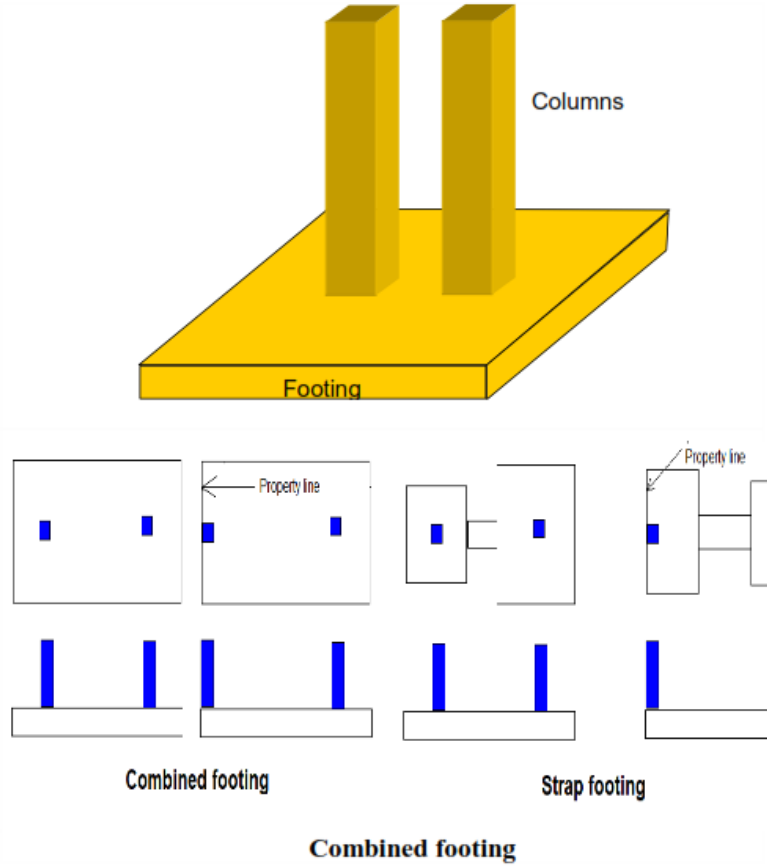
➢ The **essential condition** to satisfy in **combined footing** is that, c**entroid of footing area should coincide with resultant of column loads** so that **soil pressure distribution is uniform under soil.**

➢ **Types of combined footing**:

- Combined footing (Rectangular):
- Combined footing (Trapezoidal):

If outer column near property line carries a heavier load

- Strap footing
- Raft / mat foundation



Combined footing

(d) Strap or Cantilever Footing

- Strap footings are similar to combined footings.
- Reasons for considering or choosing strap footing are identical to the combined one.
- In *strap footing*, the foundation under the columns is built individually and connected by a **strap beam**.
- Generally, when the **edge of the footing cannot be extended beyond the property line**, the **exterior footing is connected by a strap beam with interior footing**.

(e) Raft / mat foundation:

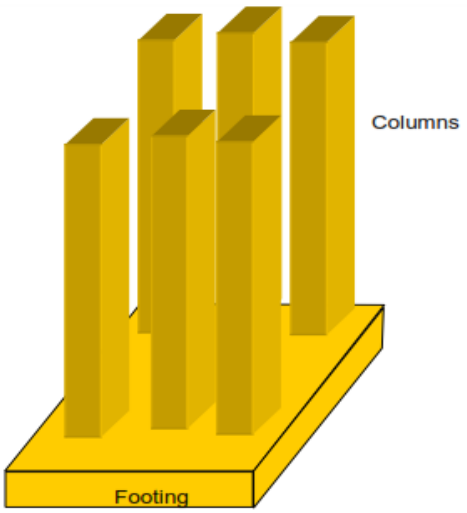
- This is a large continuous footing supporting all the columns of the structure.
- This is used when soil conditions are poor but piles are not used.
- Raft foundation is provided
- When **load** transmitted by **columns** are so **heavy** or **allowable soil pressure** are so

small that individual footings if provided would **cover more than about half** of the area, then it is better to provide a continuous footing called raft foundation under all columns and walls

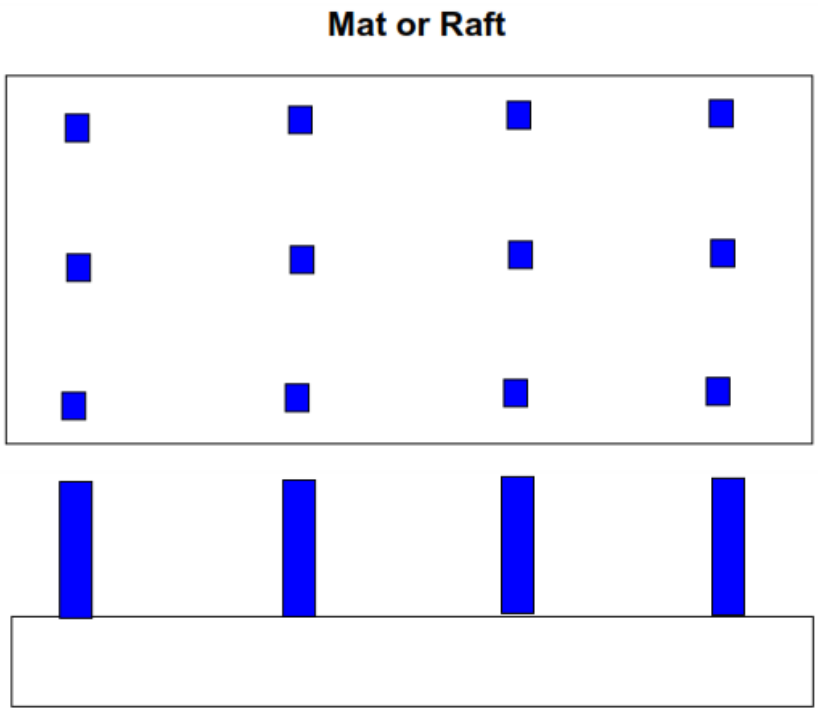
- Raft foundations are used to reduce settlement of structure located above heavy compressible deposits i.e. they control differential settlement

 Types of raft foundation:

- **Solid raft** (A continuous slab covering all the columns)
- **Ribbed raft** (mat with a central hollow region when all the columns are connected by a continuous beam which gets supported on the raft slab



Raft foundation



DEEP FOUNDATION

1. PILE **FOUNDATION**

- A **pile** is a **slender column** provided with a **cap** to receive the **column load** and transfer

it to **undelaying soil layer / layers**.

- Pile **foundation** is a common type of deep foundation.
- Pile is a slender member with a small cross-sectional area compared to its length.
- It is used to transmit foundation loads to a deeper soil or rock strata when the bearing capacity of soil near the surface is relatively low.
- Pile transmits load either by skin friction or bearing.
- Piles are also used to resist structures against uplift and provide structural stability against lateral and overturning forces.
- They are used to reduce cost, and when as per soil condition considerations, it is desirable to transmit loads to soil strata which are beyond the reach of shallow foundations.

Mat or Raft

- Soil with higher **bearing capacity** is at a greater depth.
- When the foundation is subjected to a **heavily concentrated load**
- The foundation is subjected to **strong uplift force**
- Lateral forces are relatively pre dominant
- In **marshy places** where soil is wet soil/ soft soil/ water logged/ low laying area
- When the **topsoil laye**r is **compressible** in nature.
- In the case of bridges, when the **scouring** is **more** in the **river bed**.
- When it is very expensive to provide **raft** or **grillage**.

2. PIER FOUNDATION

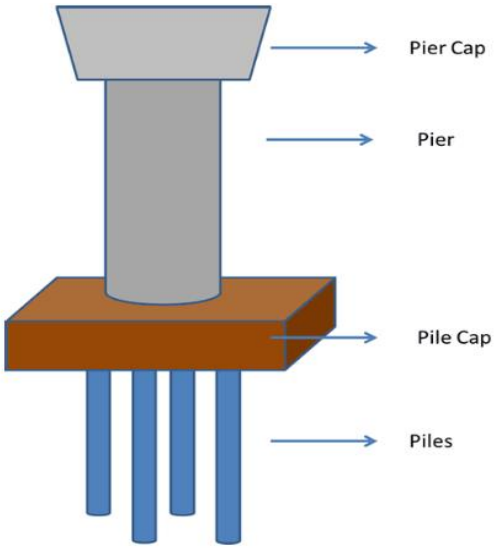
Pier is a deep foundation structure above ground level that transmits a more massive load, which cannot be carried by shallow foundations. It is usually shallower than piles.

Pier foundation is a cylindrical structural member that transfer heavy load from superstructure to the soil by end bearing.

Unlike piles, it can only transfer load by **end bearing** only and by **not skin friction**.

Difference between Pile and Pier foundation

Pile	Pier
Piles are always below the ground level	Piers are always above the ground
Larger in length and smaller in diameter	Smaller in length and larger in diameter
Adopted when there is no hard bearing strata of soil available at reasonable depth	Adopted when there is hard bearing strata of soil available at reasonable depth but other types of foundation construction is not economical
Piles are driven through overburden soil into load bearing strata	Pier is drilled by drilling machine
Transfers full load through both bearing and friction action only	Transfers full load through bearing action only
Constructed at greater depth	Constructed at shallower depth
Resist greater intensity of load	Resist smaller intensity of load



PIER foundation with PILE

3. WELL / CAISSON FOUNDATION

Caisson foundation is a watertight retaining structure used as a bridge pier, construction of the dam, etc. It is generally used in structures that require foundation beneath a river or similar water bodies.

- The reason for choosing the caisson is that it can be floated to the desired location and then sunk into place.
- Caisson foundation is a ready-made hollow cylinder depressed into the soil up to the desired level and then filled with concrete, which ultimately converts to a foundation. It is mostly used as bridge piers.
- Caissons are sensitive to construction procedures and lack construction expertise.
  - There are several types of caisson foundations.

1. Box Caissons.
2. Floating Caissons.
3. Pneumatic Caissons.
4. Open Caissons.
5. Sheeted Caissons.
6. Excavated Caissons.

CAISSON Foundation

DETAILS OF PILE AND PILE CAP

Classification of Pile foundation:

1. Based on Function or Use:

a) **End Bearing Piles:**

These are the pile used to transfer loads through water or soft soil to a suitable bearing stratum.

b) **Friction Piles:**

This type of pile utilizes the frictional resistance force between the pile surface and adjacent soil to transfer the superstructure load.

c) **Combined end bearing and friction pile:**

This pile transfers the super-imposed load both through side friction as well as end bearing. Such piles are more common, especially when the end bearing piles pass through granular soils.

d) C**ompactor Piles:**

These are used to compact loose granular soil thus increasing their bearing capacity.

e) **Batter pile:**

A pile driven at an angle with the vertical to resist a lateral force

f) **Sheet Piles:**

Used as impervious cut-off to reduce seepage and uplift under hydraulic structures.

They are rarely used to furnish vertical support but are used to function as retaining wall

g) **Anchor pile:**

It provides anchorage against horizontal pull from sheet piling

h) **Tension/uplift pile:**

It anchors down the structures subjected to uplift due to hydro static pressure, seismic activity or due to overturning moment

2. Based on Materials:

a) Timber Piles

b) Concrete Piles

c) Steel Piles

d) Composite Piles

3. Based on construction process:

a) Bored Piling:

Bored piles are installed by auguring into the ground forming a hole into which concrete can be poured, thereby casting the pile in position.

b) Driven Piling:

Driven piles are driven or hammered into the ground with the use of vibration

c) Screw Piling

Screw piles are wound into the ground, much like a **screw** is wound into wood. This is an efficient means of installation and coupled with their mechanism of dispersing load, provides effective in-ground performance in a range of soils, including earthquake zones with liquefaction potential

d) Mini Piling

Mini piling is a variation on piling that uses a narrower diameter. This makes them light and inexpensive whilst still being able to support considerably heavy loads. For the most common type of mini piling a hollow steel shaft is screwed or drilled into the ground

e) Sheet Piling

Sheet pile walls are retaining walls constructed to retain earth, water or any other filling materials. These walls are thinner in section compared to masonry walls. Sheet pile walls are generally used for following: Water front structures, i.e. in building wharfs, quays and piers.

4. Classification of Piles based on the effect of Installation:

a) **Displacement** pile:(eg: **Driven** Cast in Situ concrete pile and Driven Precast concrete pile)

b) Non- Displacement pile: (eg: **Bored** Cast in Situ concrete pile, Bored Precast concrete pile)

According to material piles are as follow

a) Concrete pile

b) Wooden pile or Timber pile

c) Steel pile

d) Composite pile