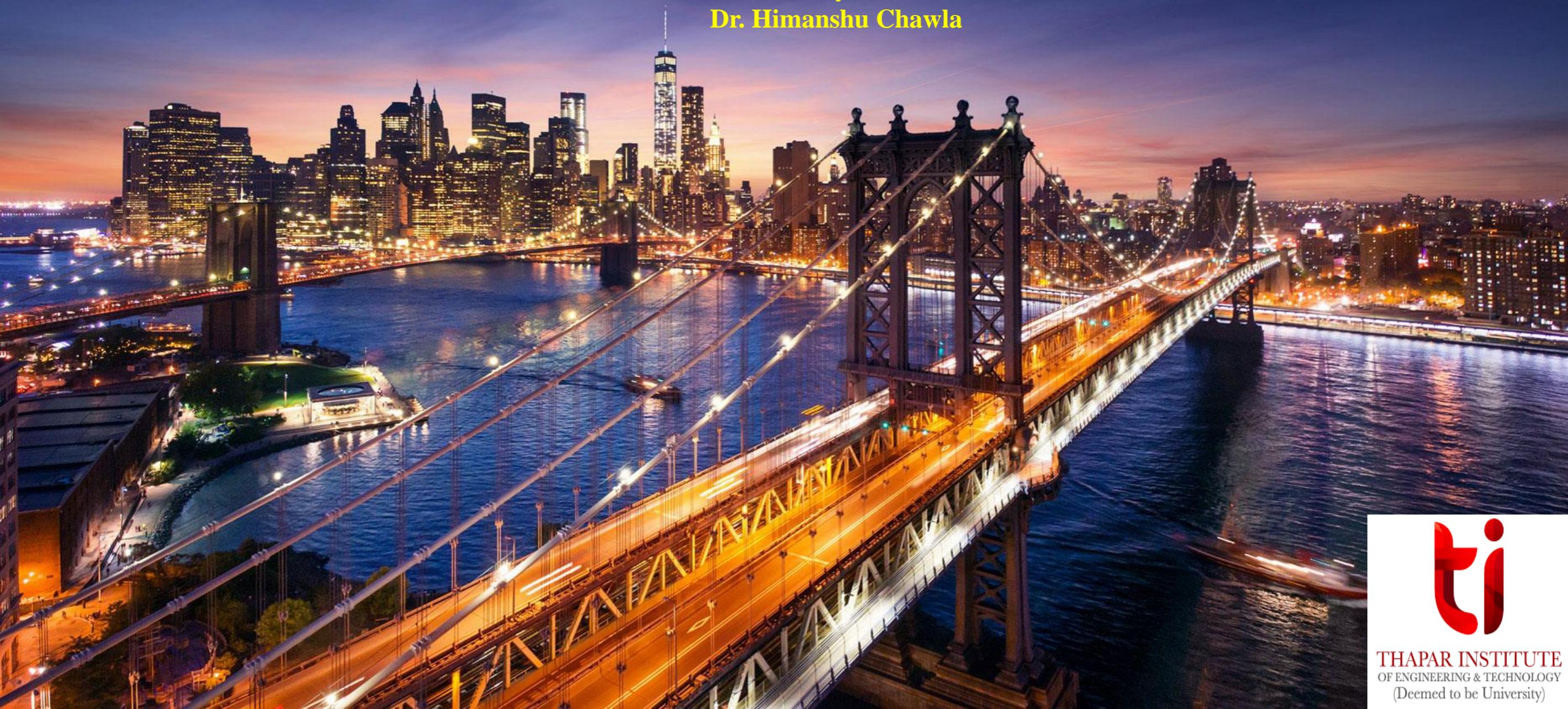


Lecture 10
SHALLOW FOUNDATION

By
Dr. Himanshu Chawla



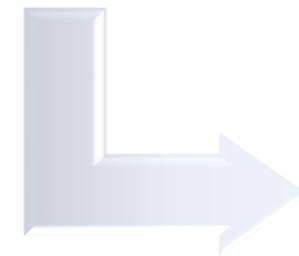
Building Components



SHALLOW
FOUNDATION



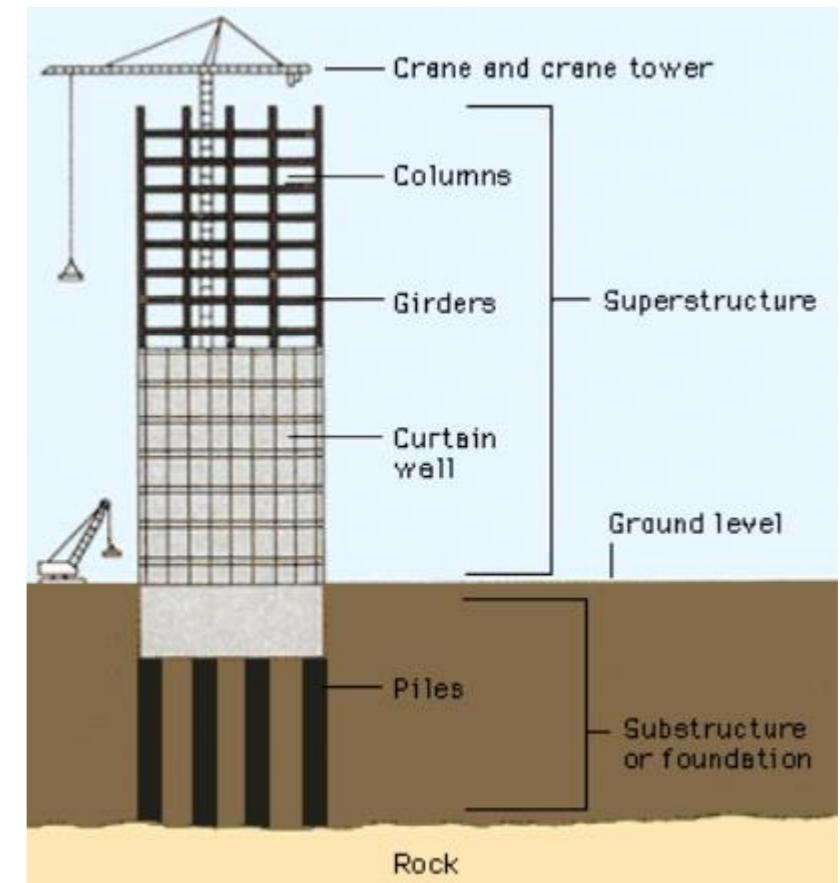
ISOLATED
FOOTING



COMBINED
FOOTING

Introduction

- A structure essentially consists of two parts, namely the super structure which is above the plinth level and the **substructure** which is below the plinth level.
- Substructure is otherwise known as the foundation and this forms the base for any structure.
- The soil on which the foundation rests is called the “foundation soil”.

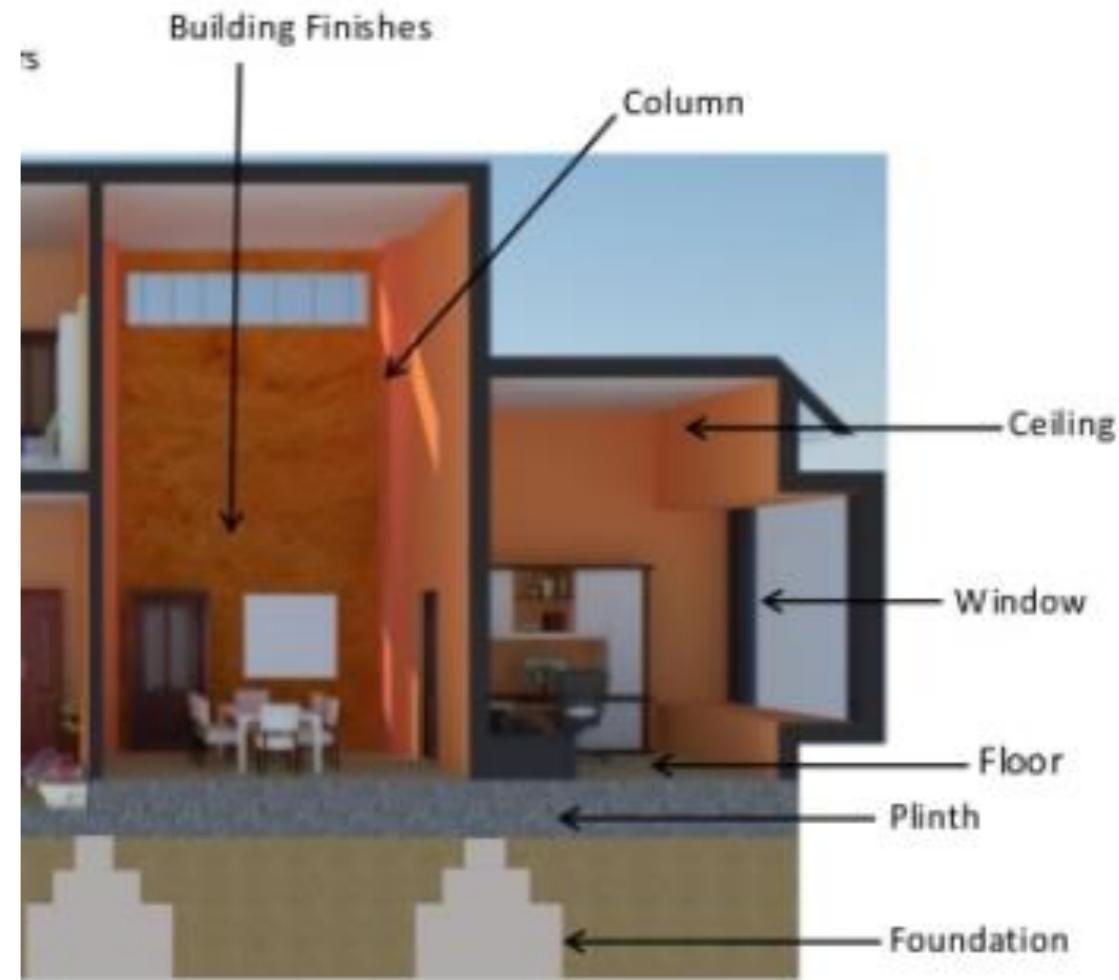


Foundation

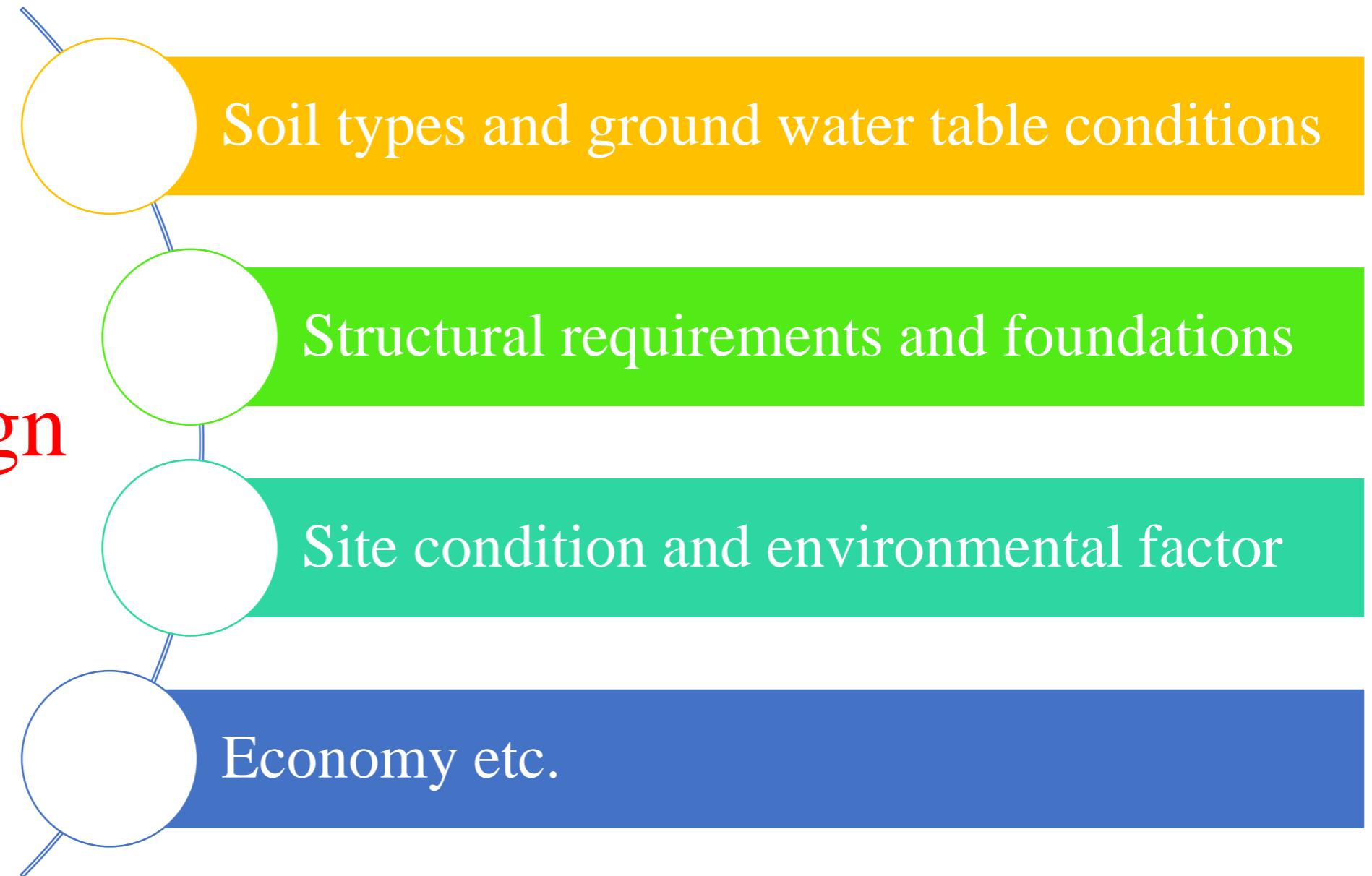


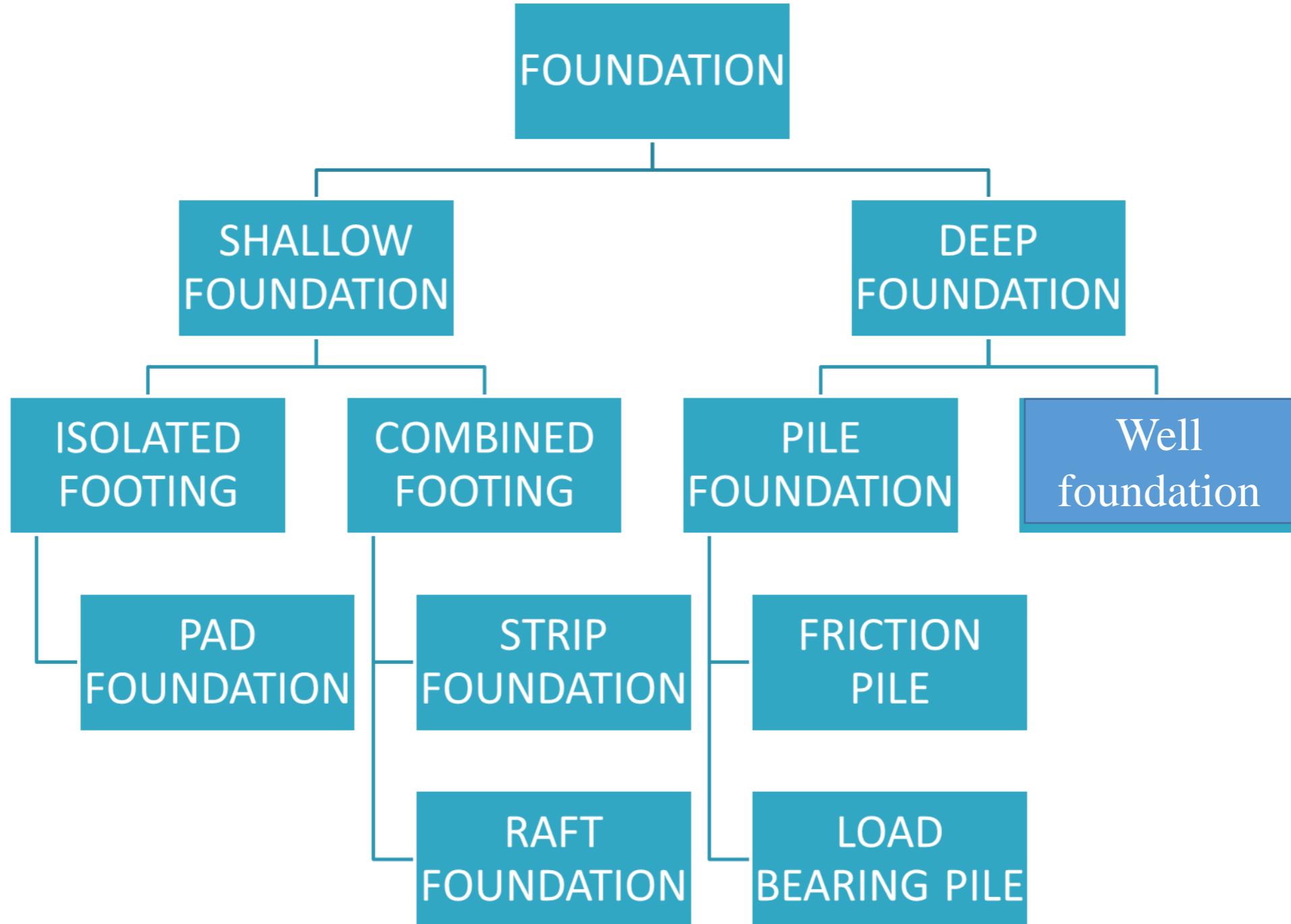
Objectives of a Foundation

- A foundation is provided for the following purposes:
- To distribute the total **load coming on the structure** on a **larger area**.
- To support the structures.
- To give enough **stability** to the structures **against** various disturbing forces, such as wind and rain.
- To prepare a level surface for concreting and masonry work.



Factors affecting design of foundation





Shallow Foundation (Spread Foundation)

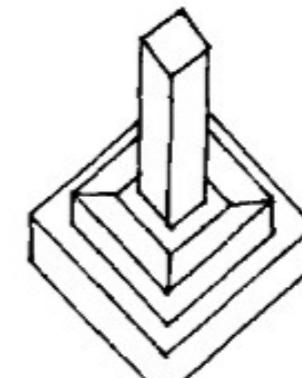
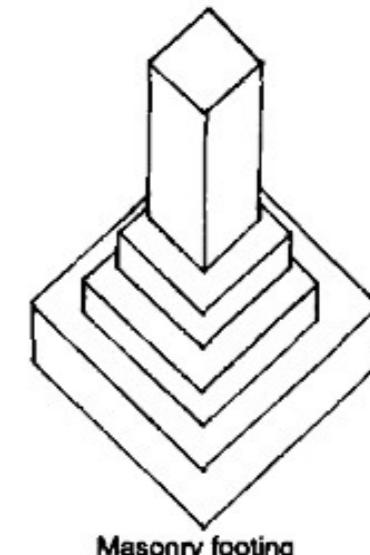
Depth of foundation is less than or equal to its width.

In framed structures where several columns are to be constructed, isolated footings can be adopted.

If masonry footing is provided, steps are given and the foundation area is thus increased so that the stresses developed at the base is within the limit.

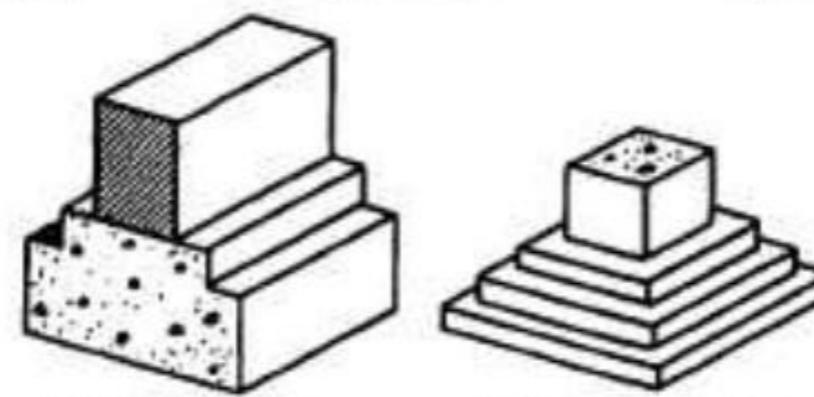
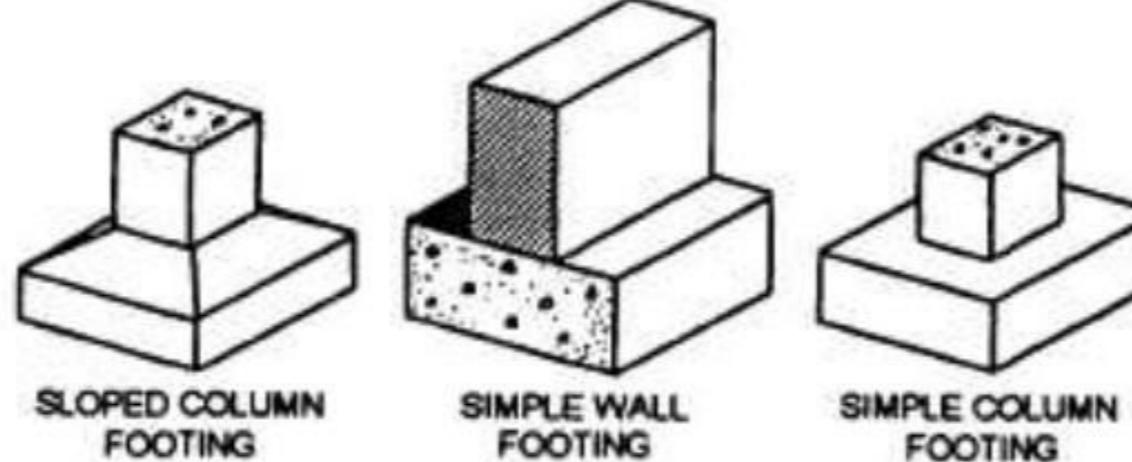
Isolated footing (single footing, column footing):

The columns involved can be provided with masonry or concrete footing.



Foundation...

- Isolated footing (single footing, column footing)...



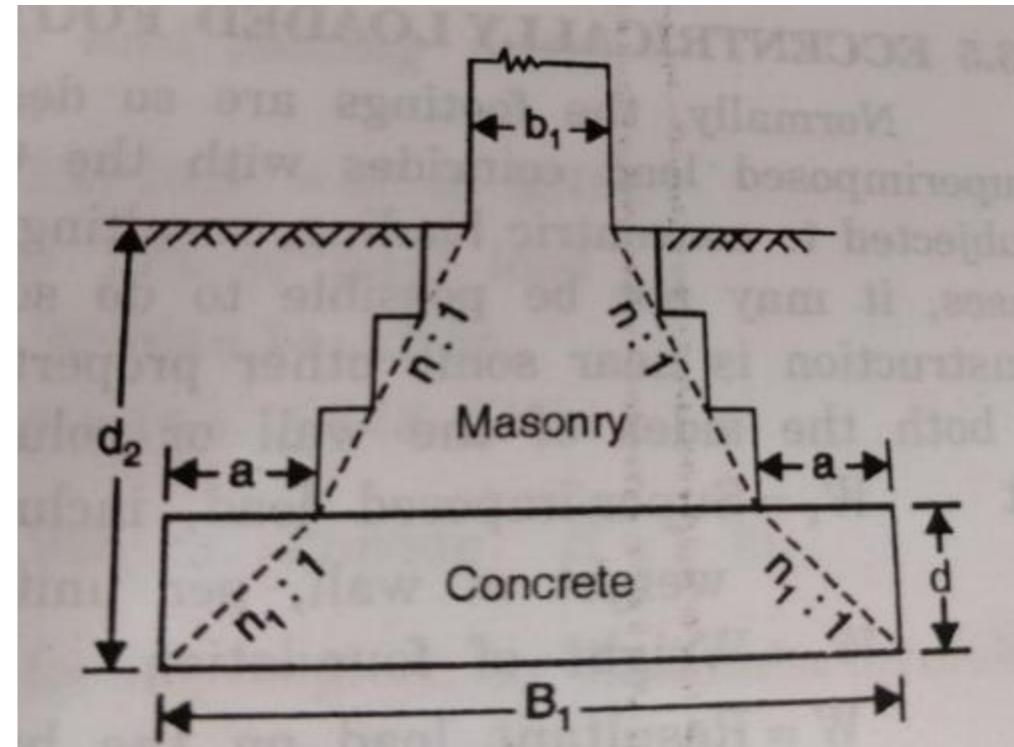
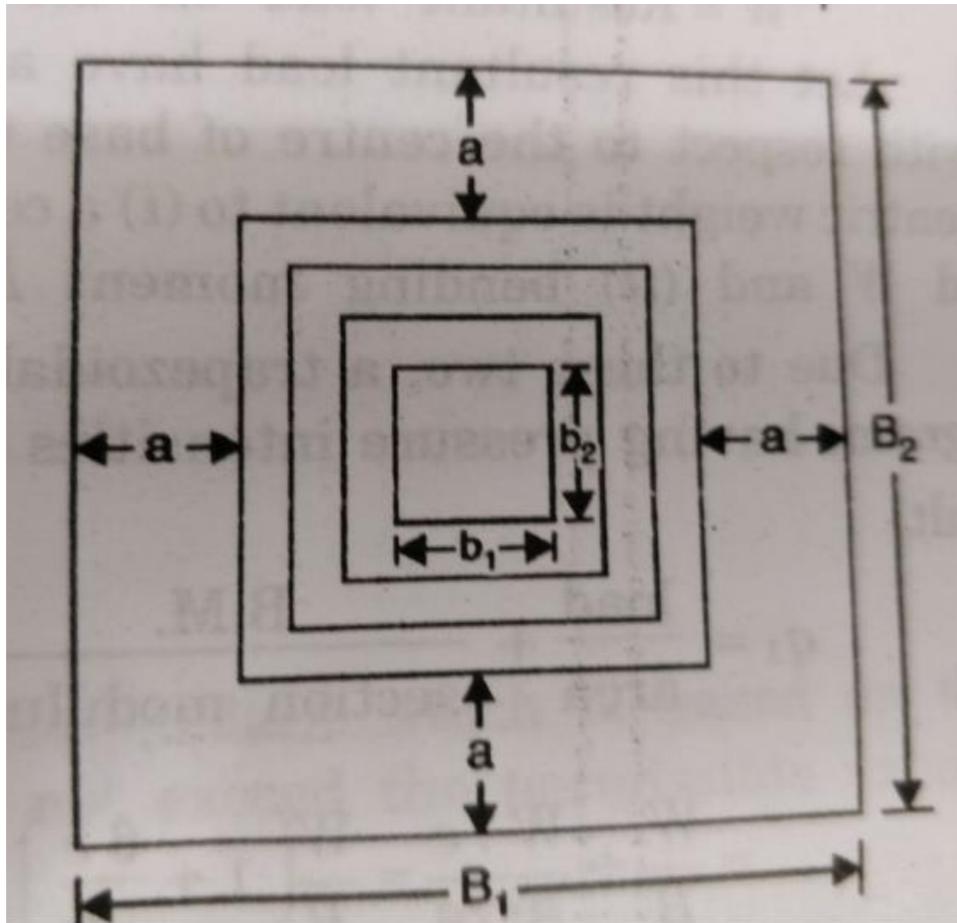
STEPPED WALL FOOTING STEPPED COLUMN FOOTING

Foundation...

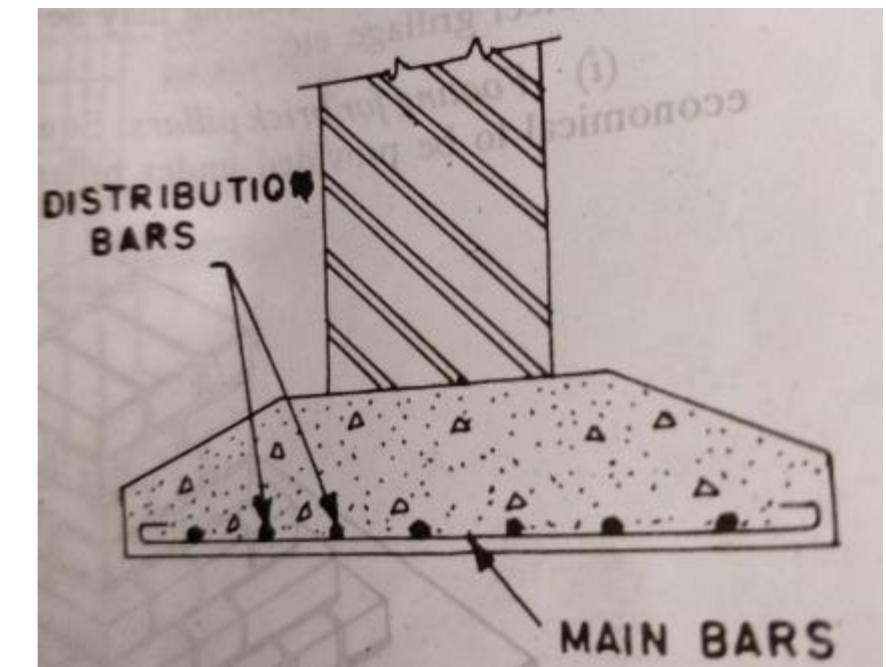
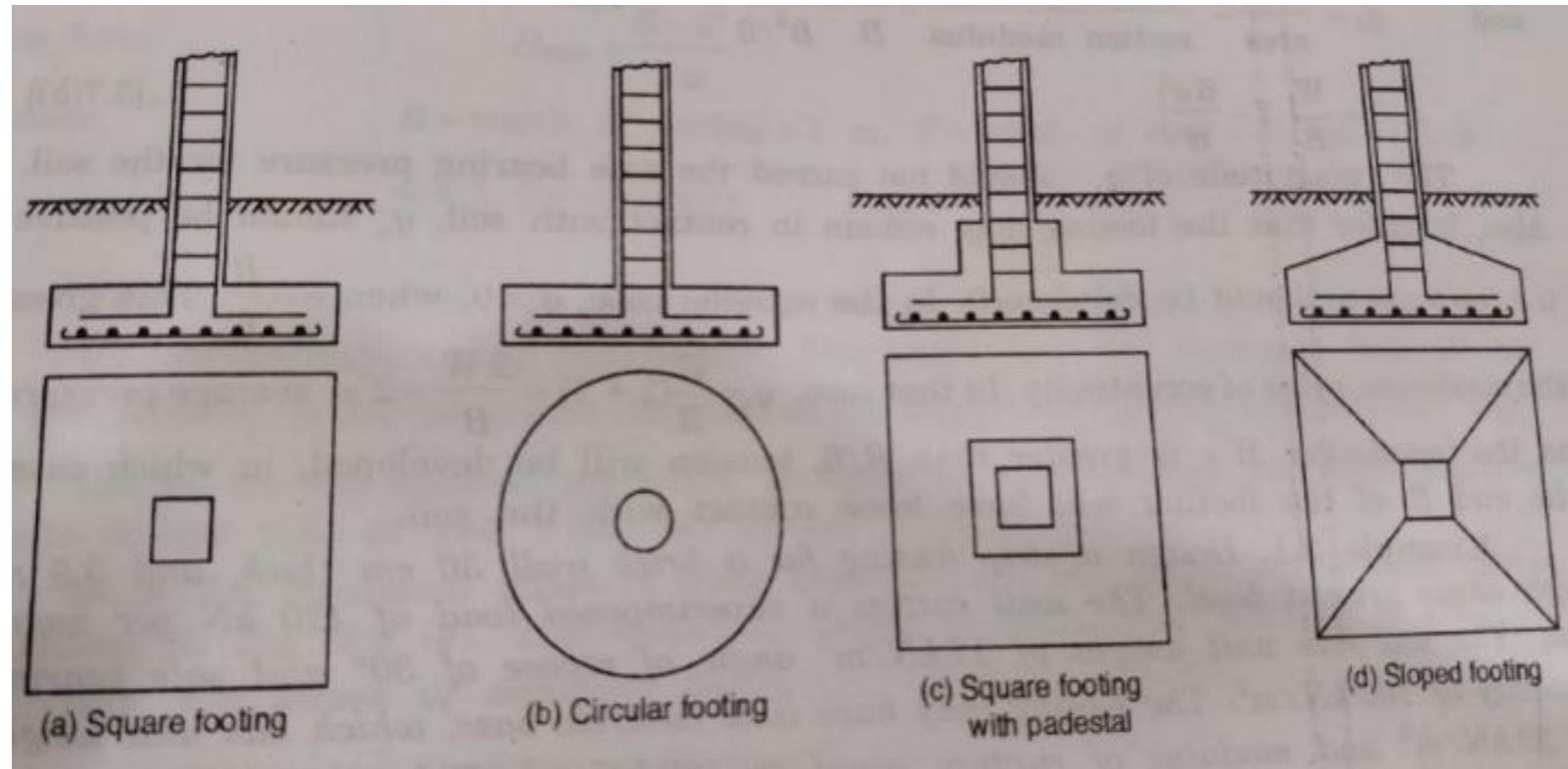
- Isolated footing (single footing, column footing)...



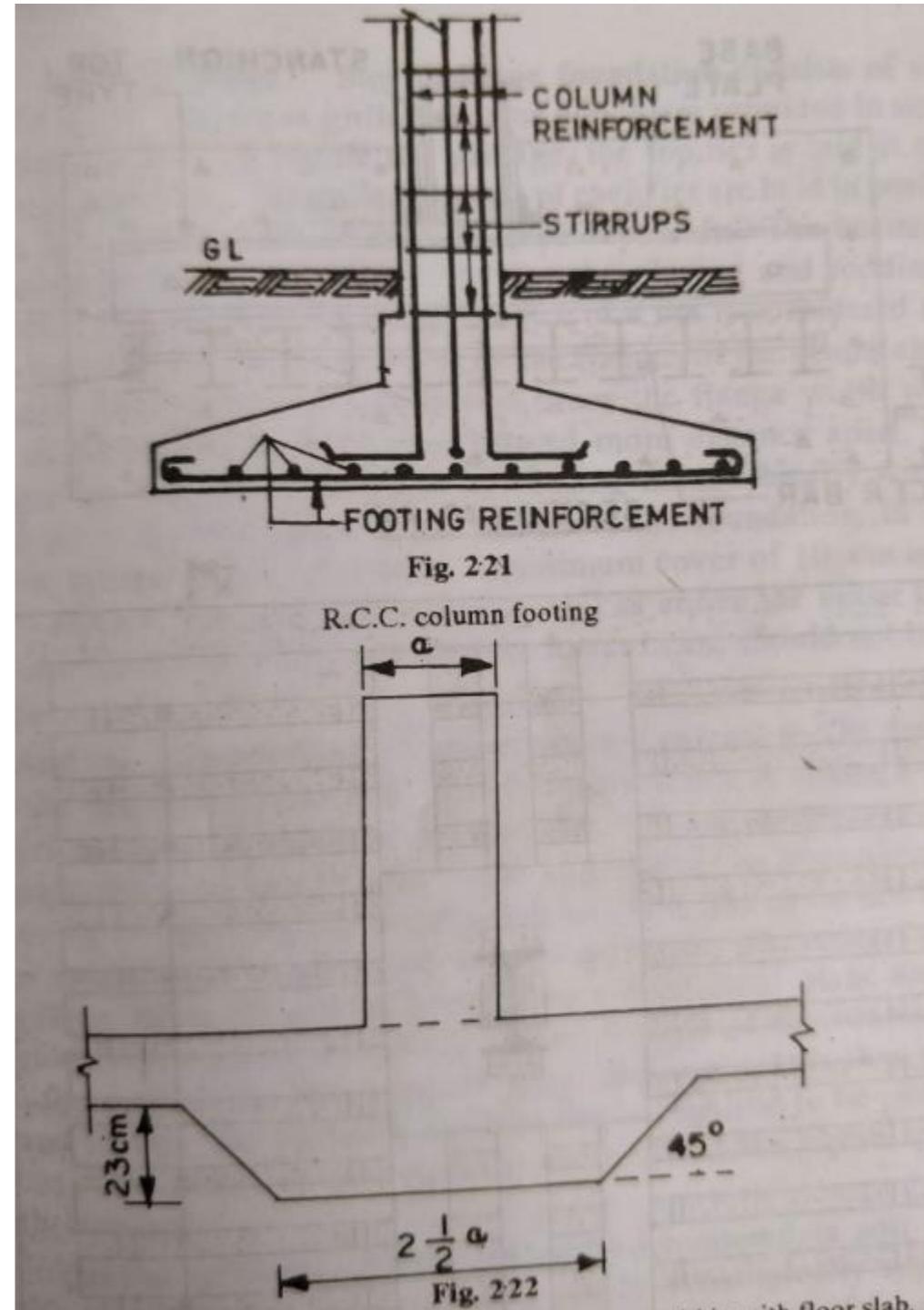
Masonry Foundation



RCC FOUNDATION



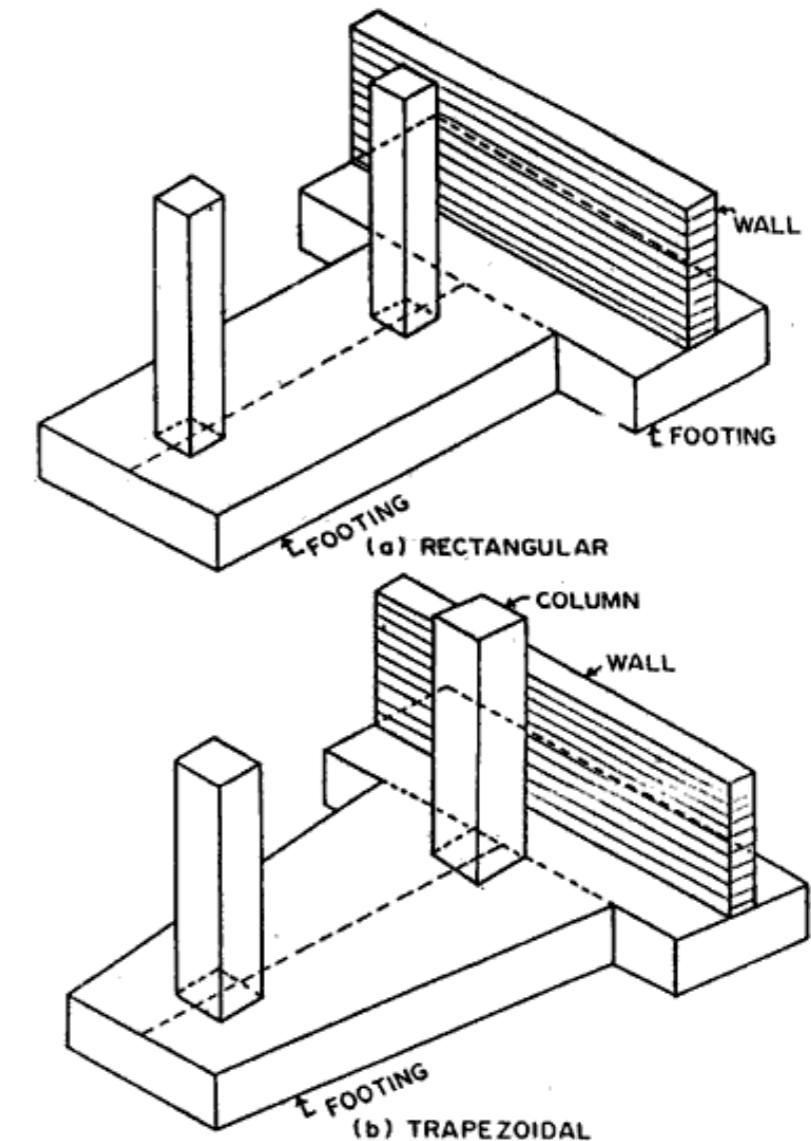
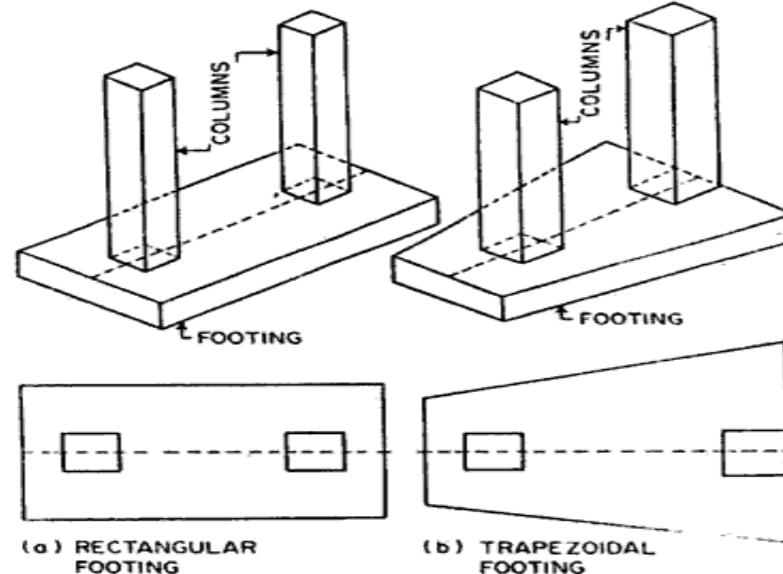
RCC FOUNDATION



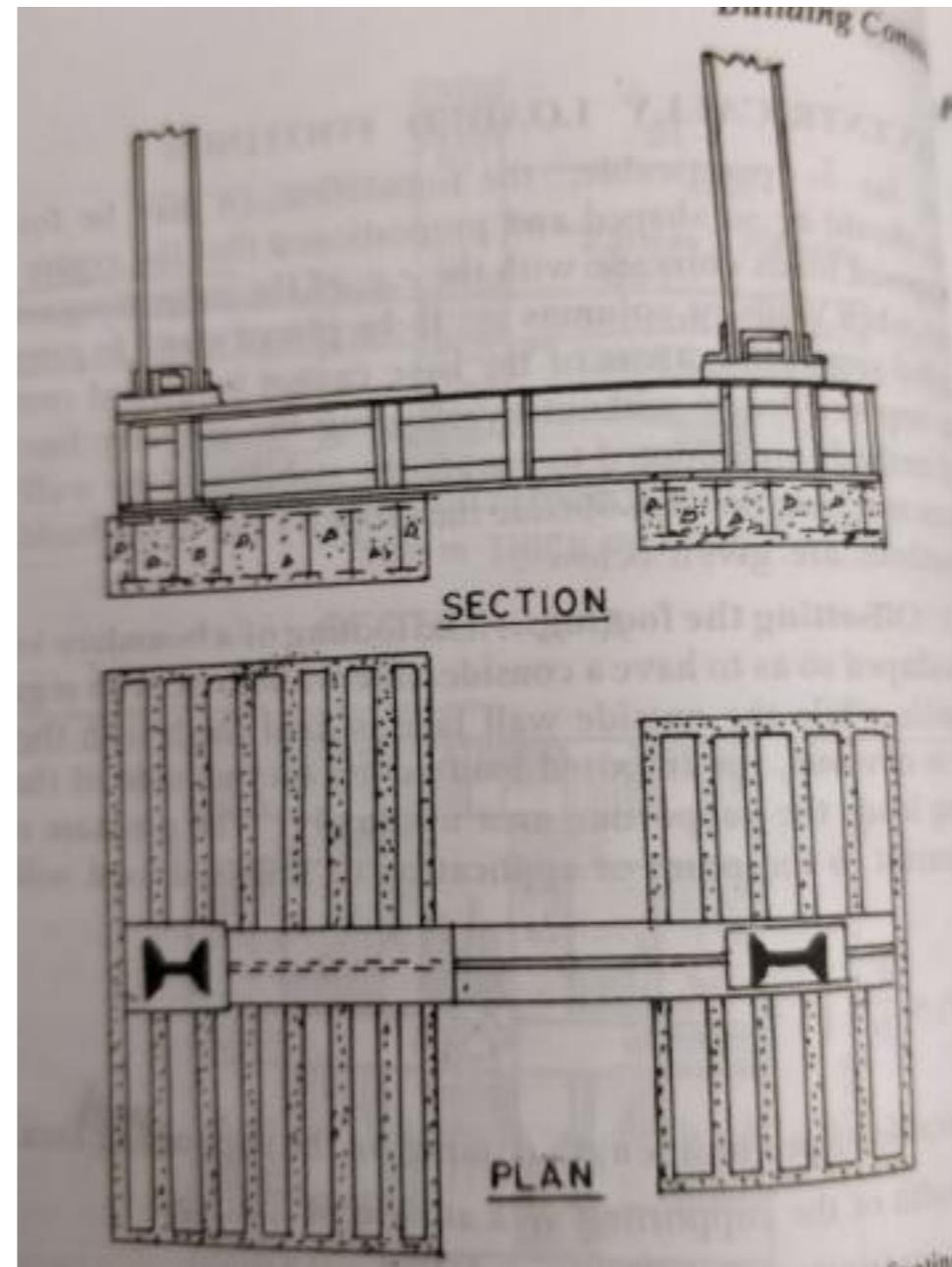
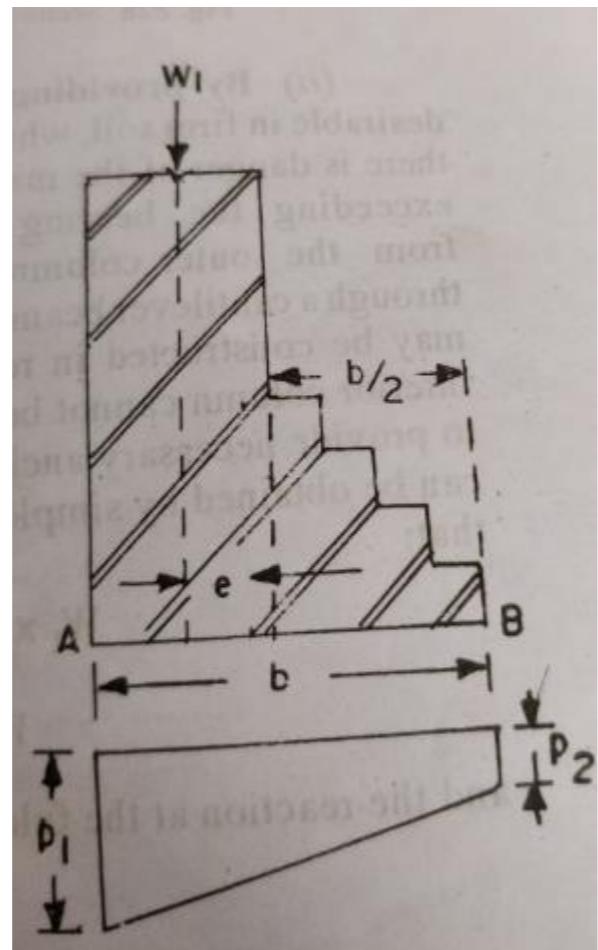


Combined Footing

- This type of footing is adopted when the space between two columns is so small that the foundation for individual columns **will overlap**.
- A combined footing is so proportioned that center of gravity (CG) of the supporting area is in line with the **CG** of the **two columns** loads. Hence, a combine footing may be rectangular or trapezoidal in shape.
- Rectangular shape** is only possible where loading conditions is such that either **two columns are equally loaded** or the interior column carries greater load



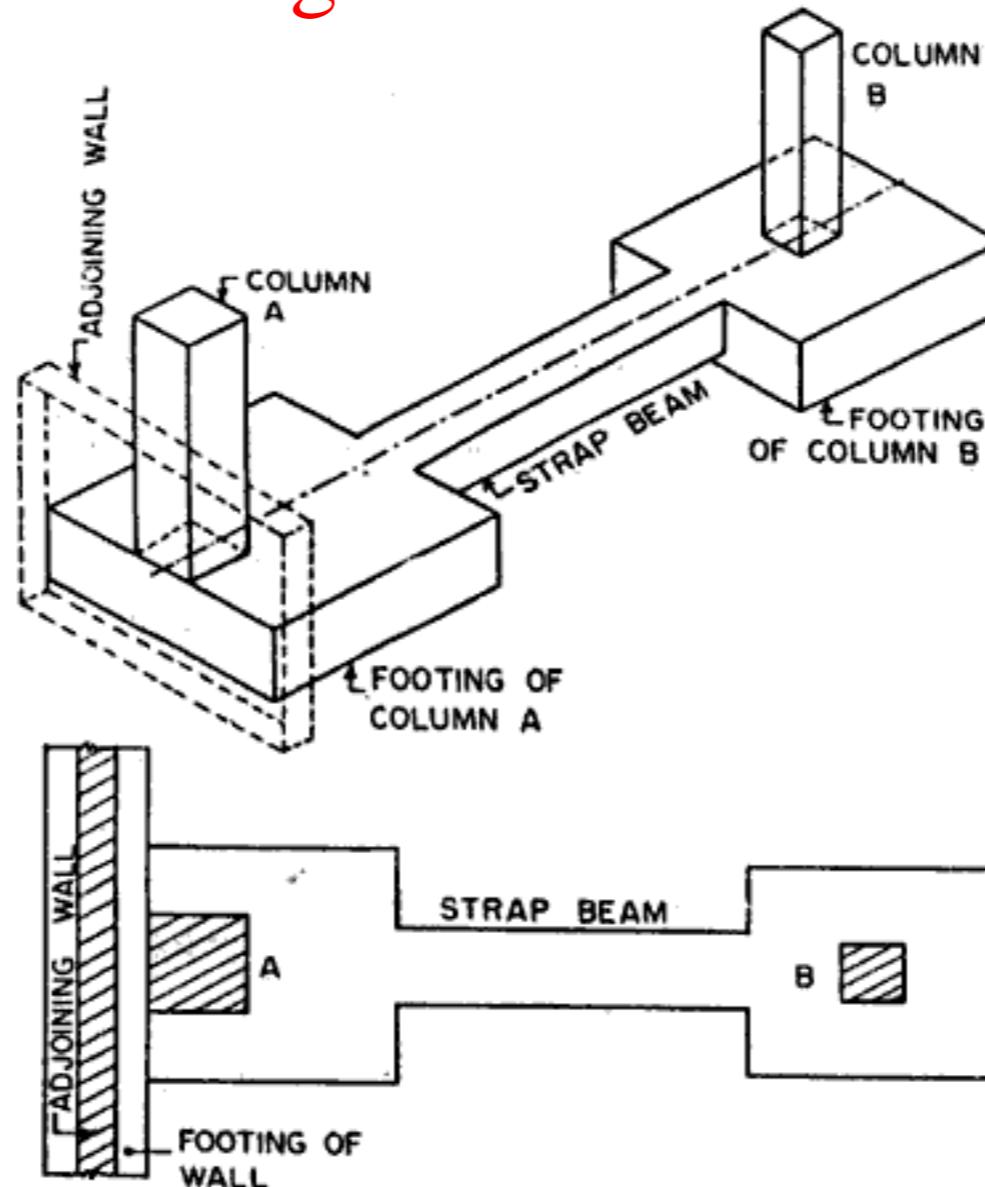
Eccentric Loading on Foundation



For more detail refer to book "Building Construction" by Sushil Kumar

Strap footing/Cantilever footing

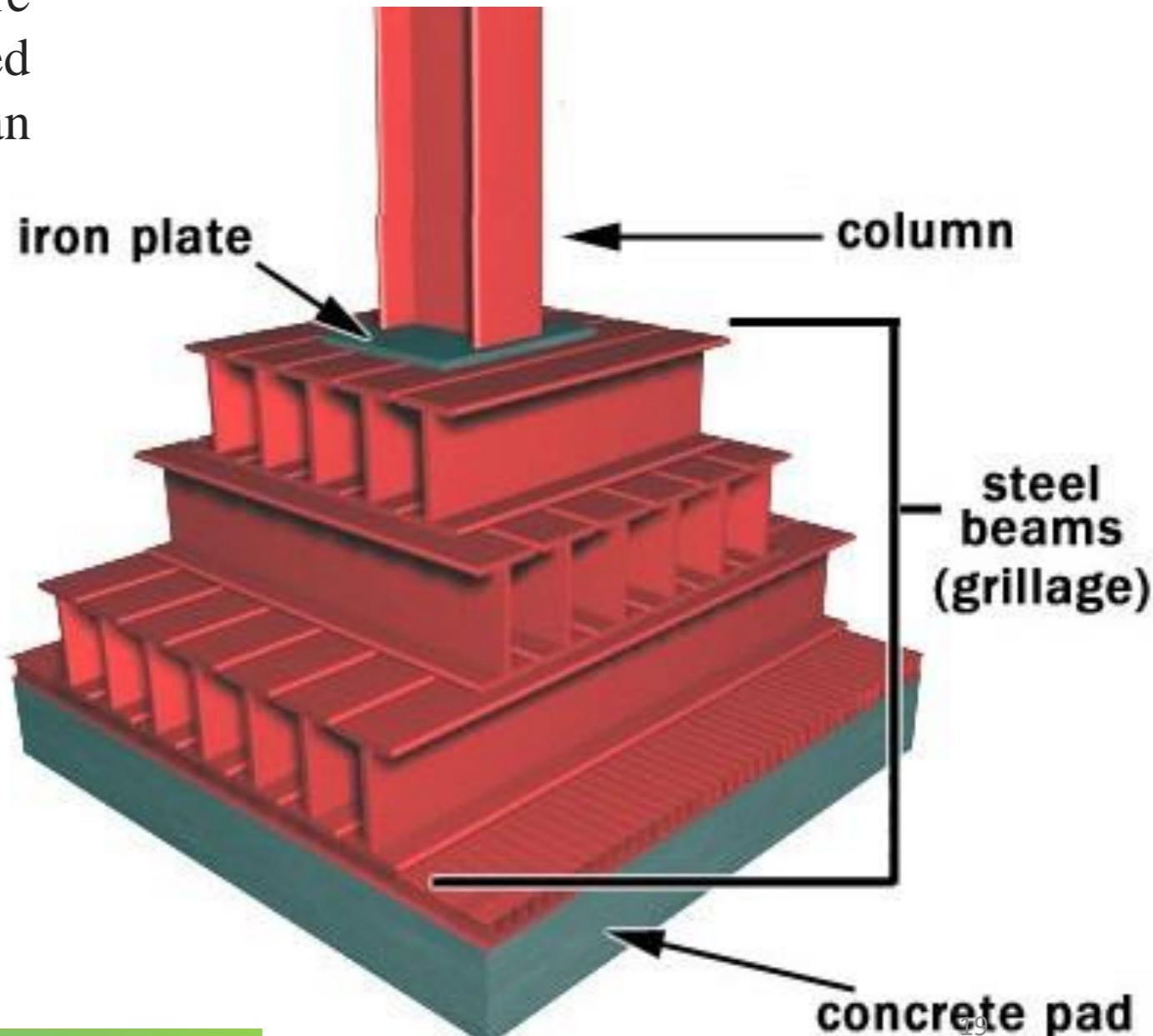
Solution of Eccentric Loading on Foundation is connecting with another footing by a beam or provide combined footing



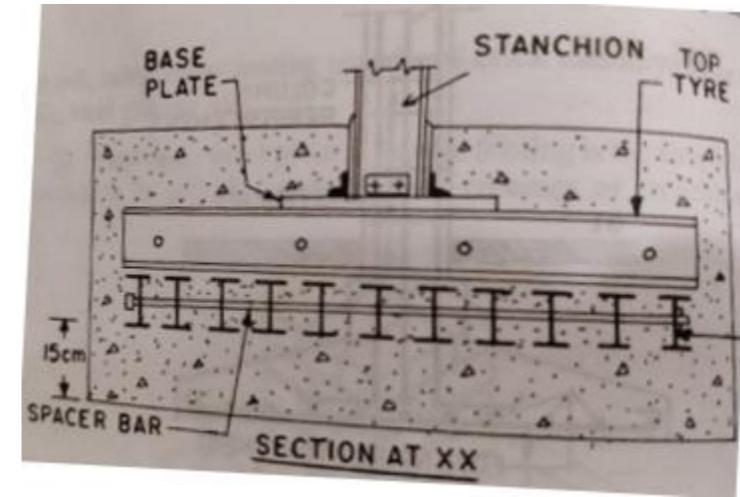
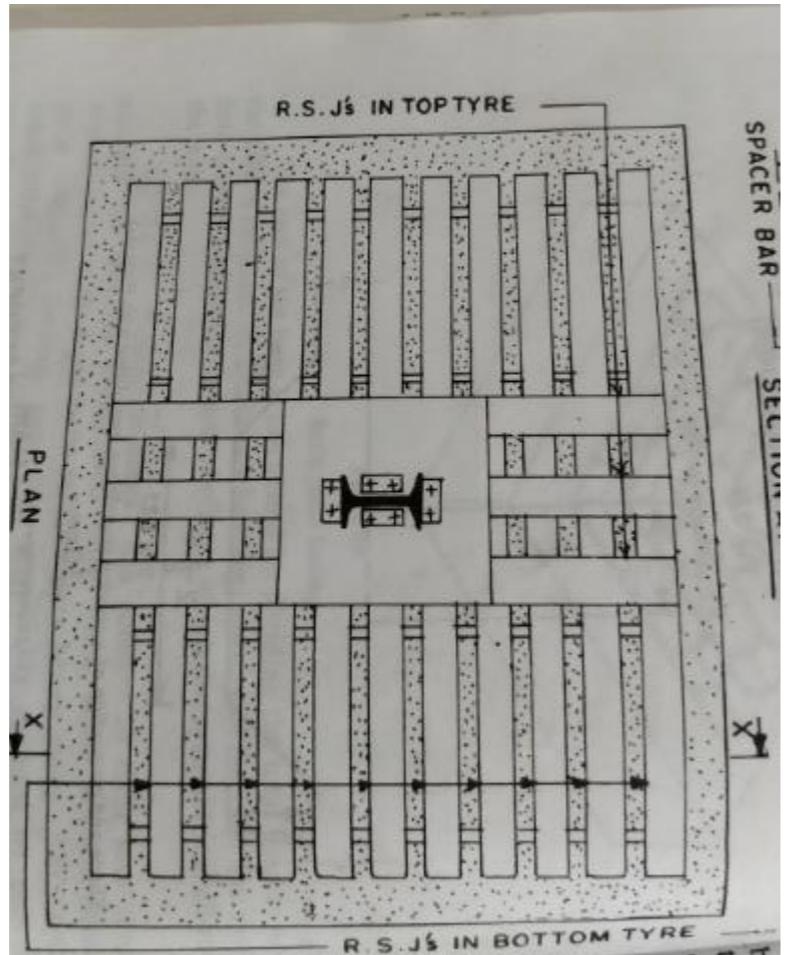
Grillage Foundation

A **foundation** which consists of one, two or more tiers (layers) of beams (typically steel) superimposed on a layer of concrete to disperse load over an extensive area is **grillage foundation**.

Steel Grillage Foundation

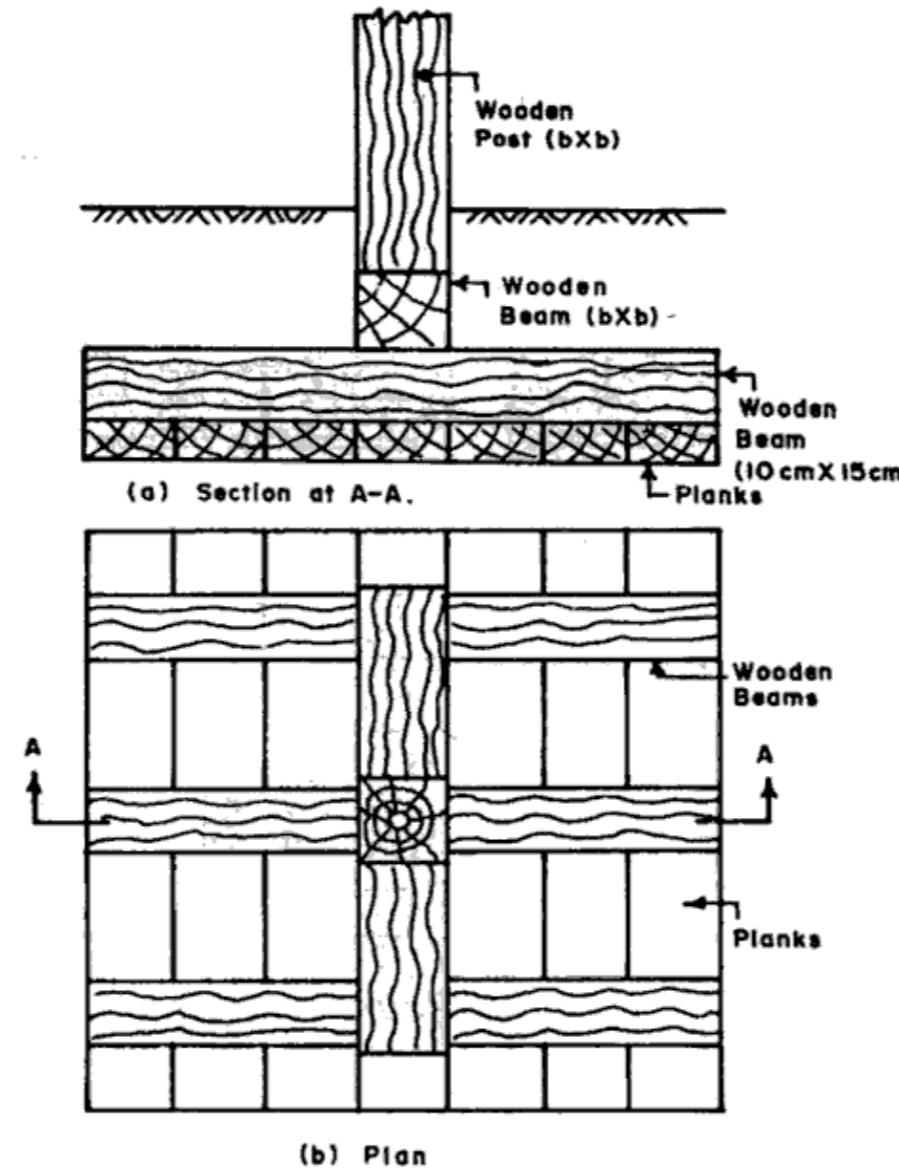


Grillage Foundation



Steel grillage foundation

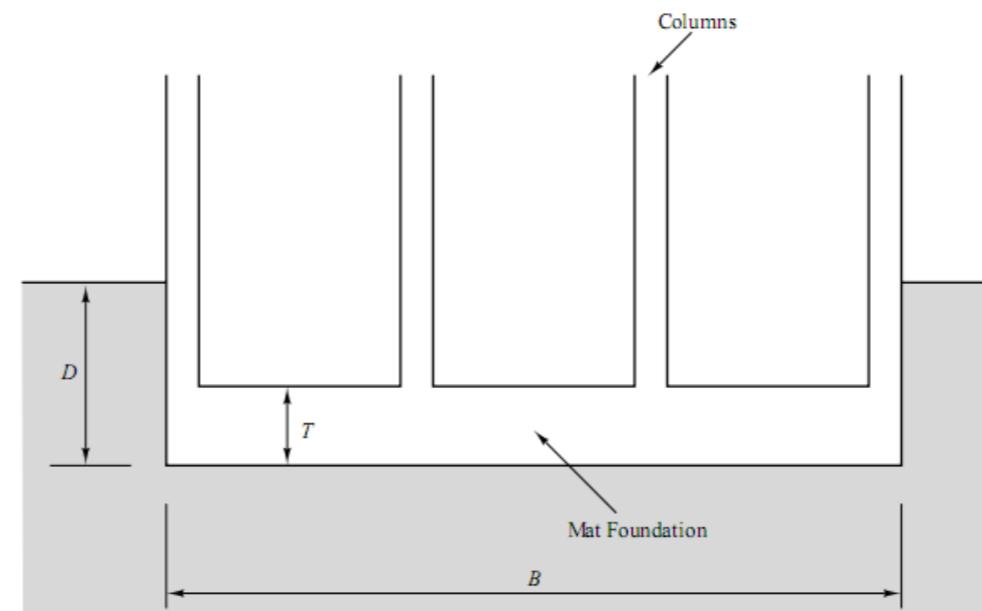
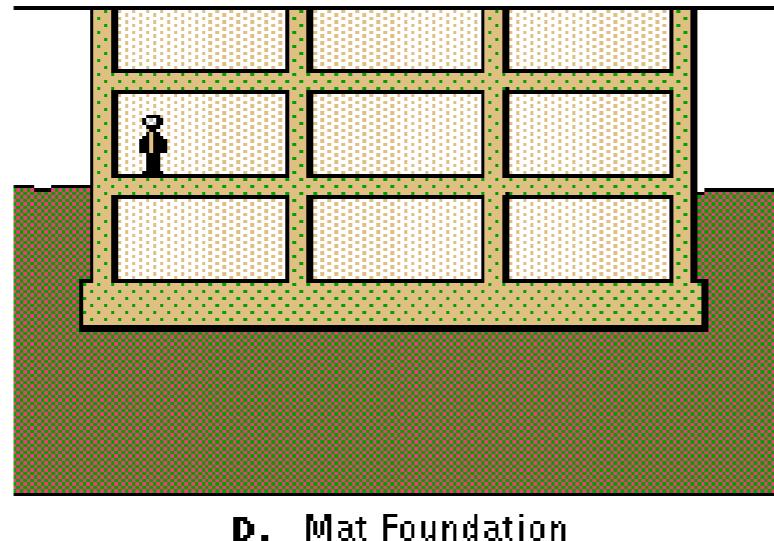
Timber Grillage Foundation



For more detail refer to book "Building Construction" by Sushil Kumar

RAFT FOUNDATION

- A foundation system in which essentially the entire building is placed on a large continuous footing.
- Usually large concrete slab supporting many columns.
- Commonly used as foundation for silos, chimneys, large machinery.
- It is a flat concrete slab, heavily reinforced with steel, which carries the downward loads of the individual columns or walls.



A mat foundation supported directly on soil.

RAFT FOUNDATION



Raft foundation is generally suggested in the following situations:

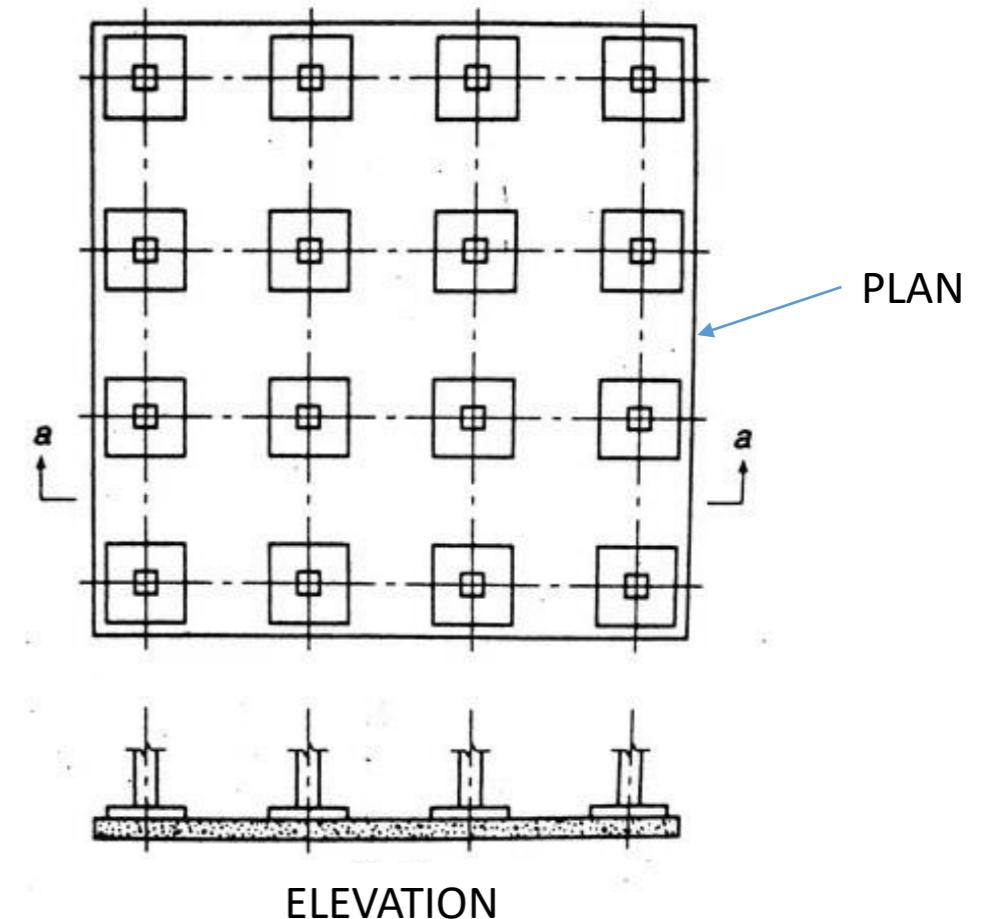
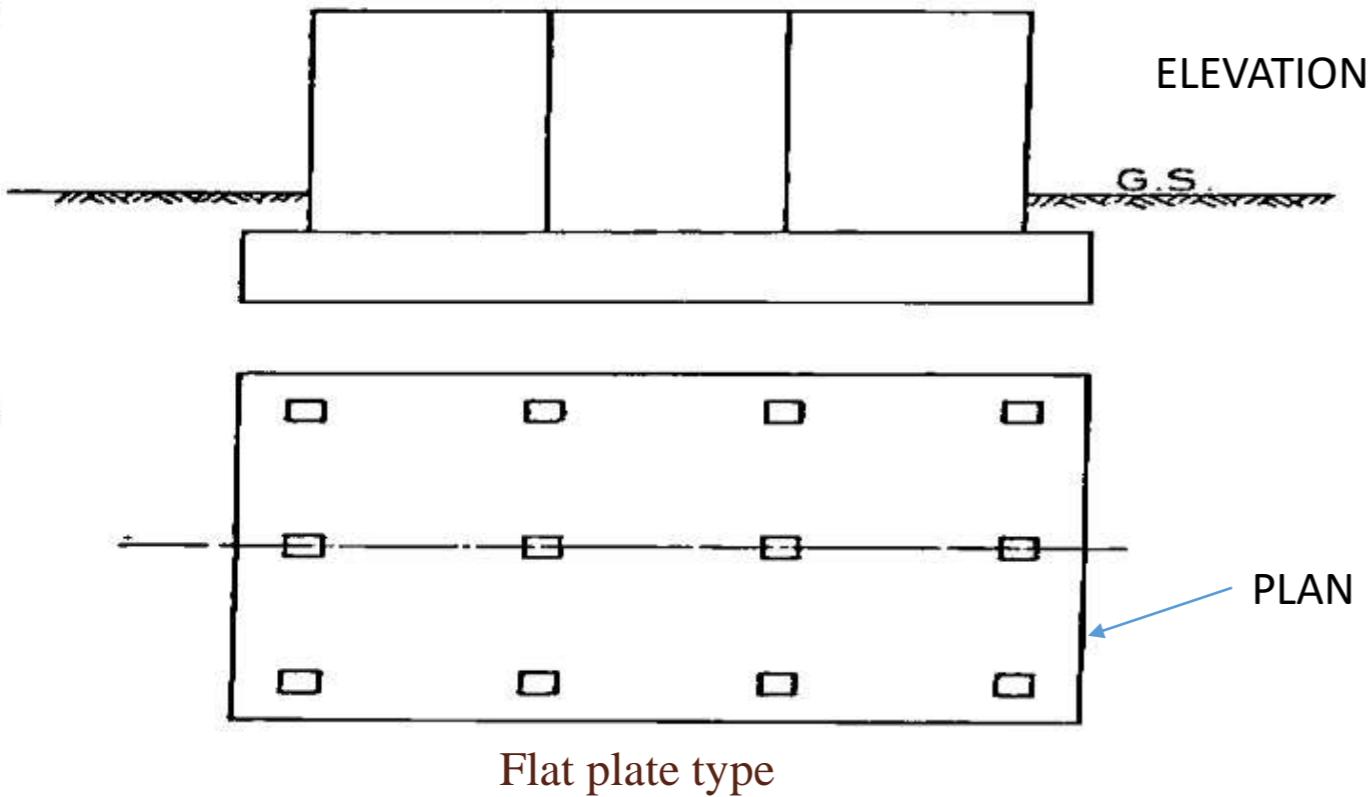
- Whenever building loads are so heavy or the allowable pressure on soil so small that individual footings would cover more than floor area.
- Whenever soil is highly compressible and it is difficult to define and assess the extent of each of the weak pockets or cavities and, thus, estimate the overall and differential settlement.
- When structures and equipment to be supported are very sensitive to differential settlement.
- Where structures naturally lend themselves for the use of raft foundation such as silos, chimneys, water towers, etc.
- Floating foundation cases wherein soil is having very poor bearing capacity and the weight of the superstructure is proposed to be balanced by the weight of the soil removed.
- Buildings where basements are to be provided or pits located below ground water table.
- Buildings where individual foundation, if provided, will be subjected to large widely varying bending moments which may result in differential rotation and differential settlement of individual footings causing distress in the building.

TYPES OF MAT FOUNDATION

- Flat plate type
- Flat plate thick under Columns
- Beam and slab construction
- Box structures
- Mats placed on piles

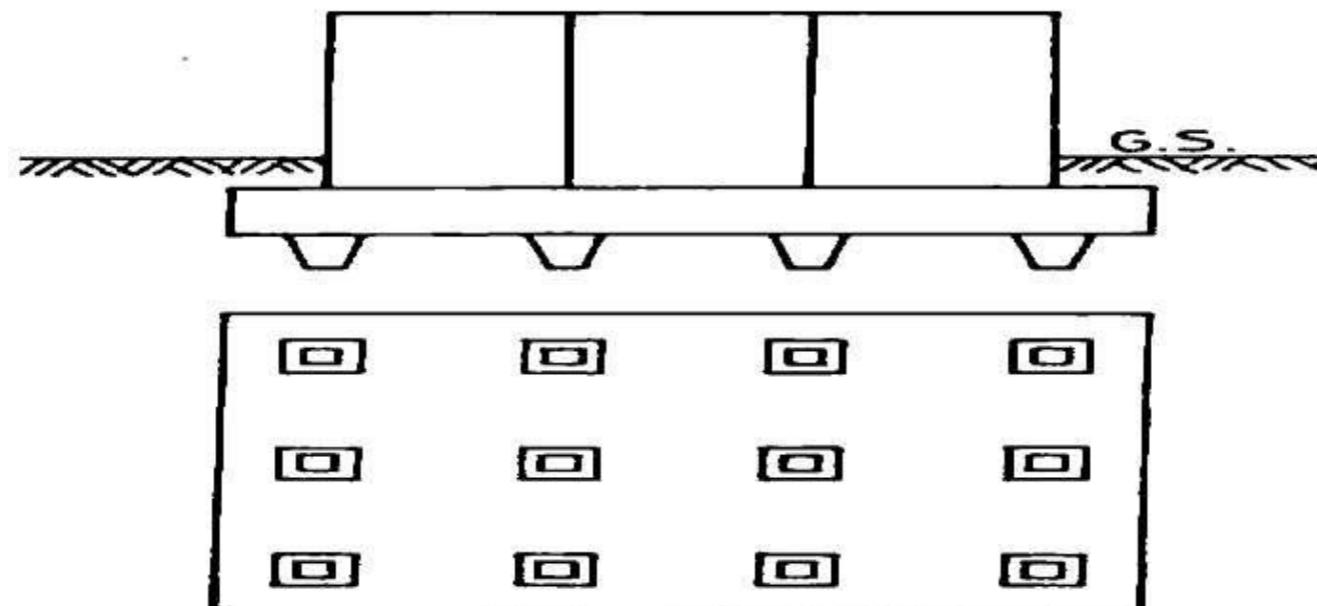
Flat plate type

A mat of **uniform thickness** is provided. This is most suitable when the column loads are relatively light and the **spacing of columns** is relatively **small and uniform**.



Flat plate thick under columns

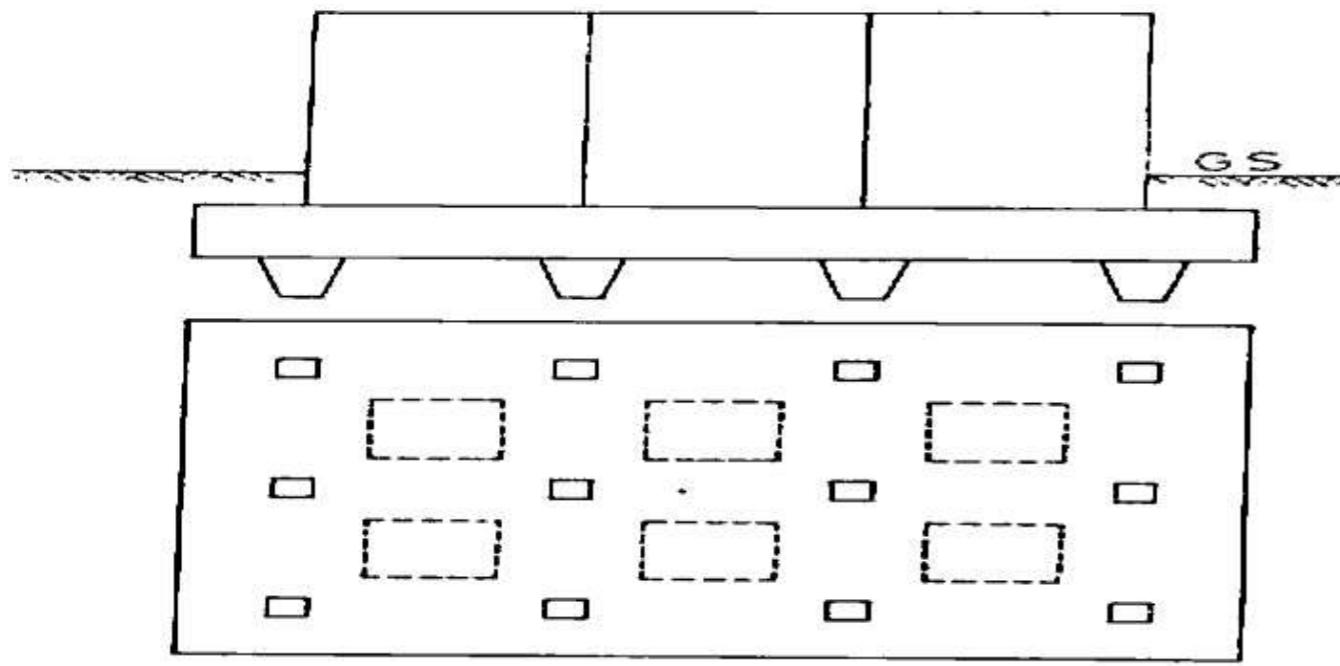
- When the column loads are heavy, this type is more suitable than the flat plate type.
- A portion of slab under the column is thickened to provide enough thickness for negative bending moment.



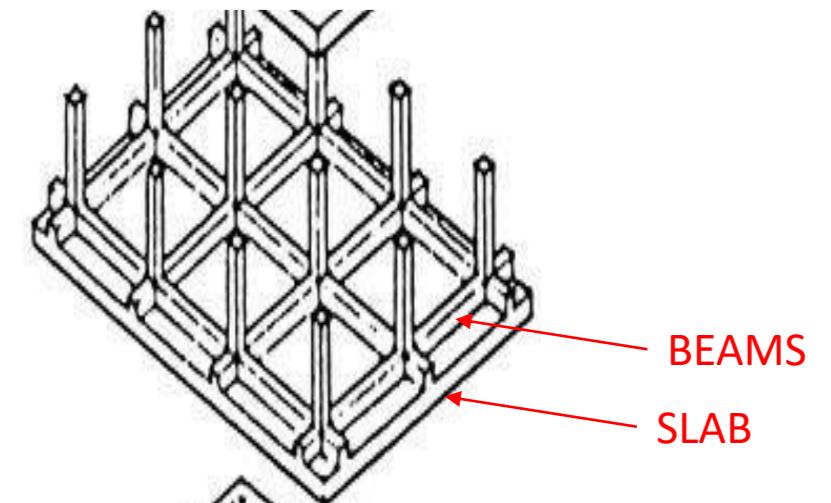
Flat plate thick under columns

Beam & slab construction

- The beams run in two perpendicular directions and a slab is provided between the beams.
- This type suitable when the bending stresses are high because of large column spacing and unequal column loads.



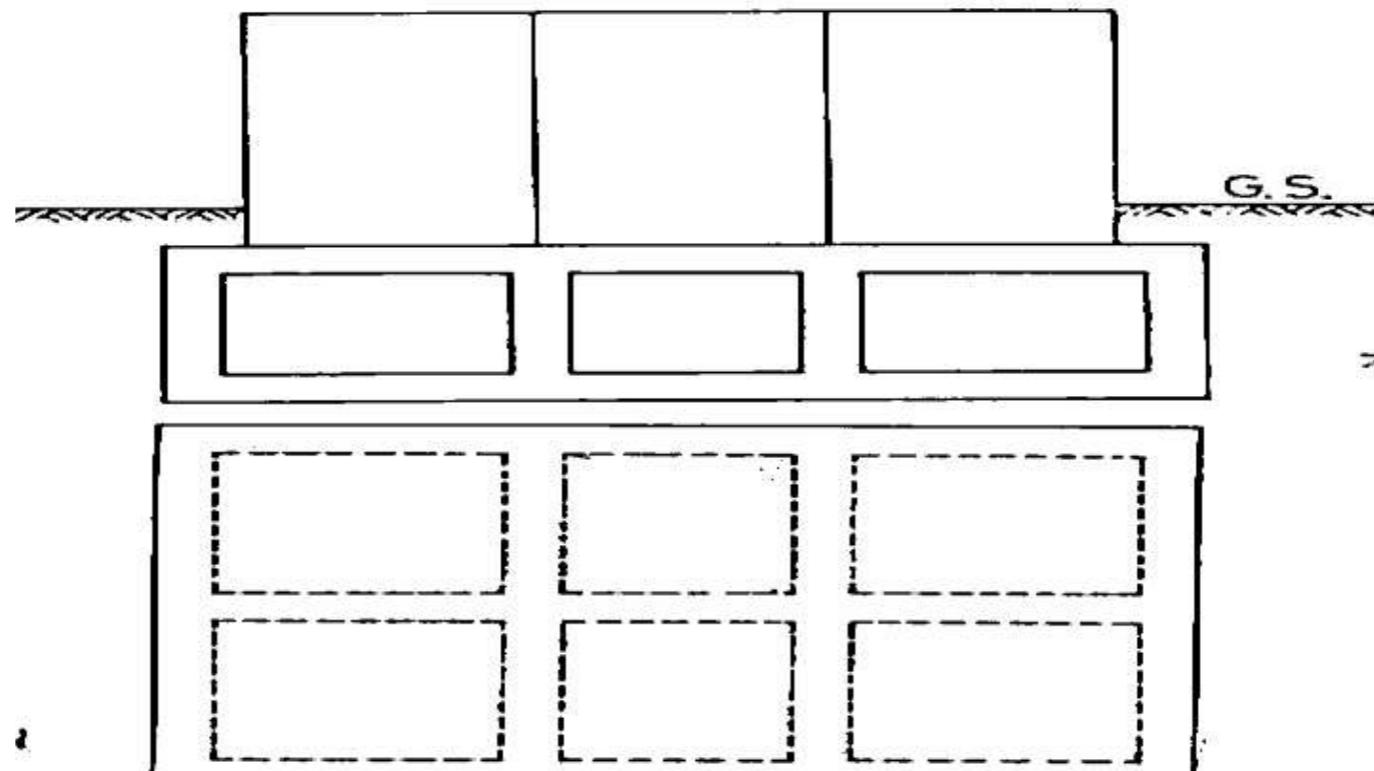
Plan
Beam and Slab Construction.



Beam & slab type/ribbed

Box structures

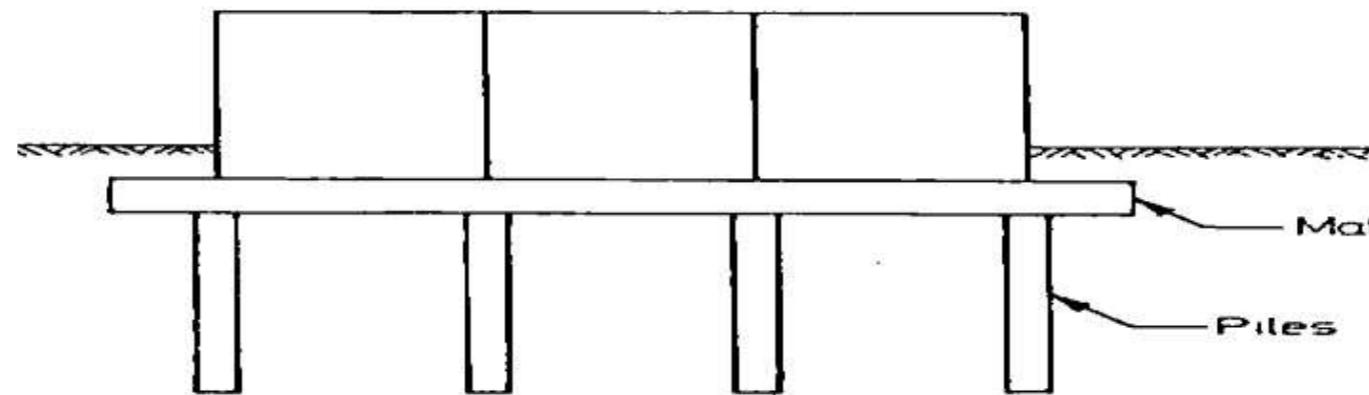
A box structure is provided in which the basement walls act as stiffeners for the mat. This type of mat foundation can resist very high bending



Box structures

Mats placed on piles

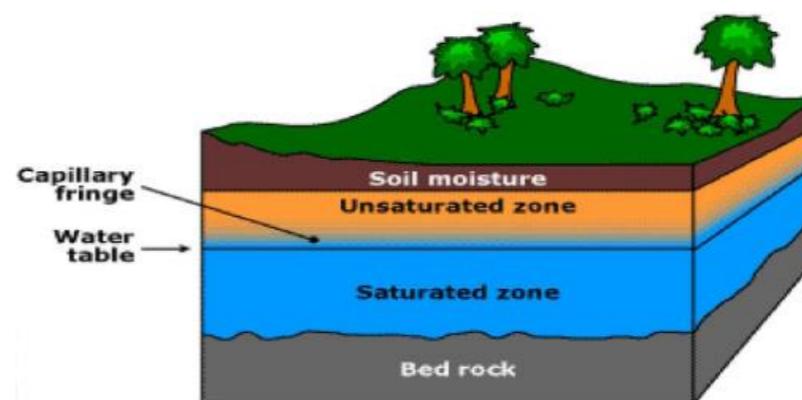
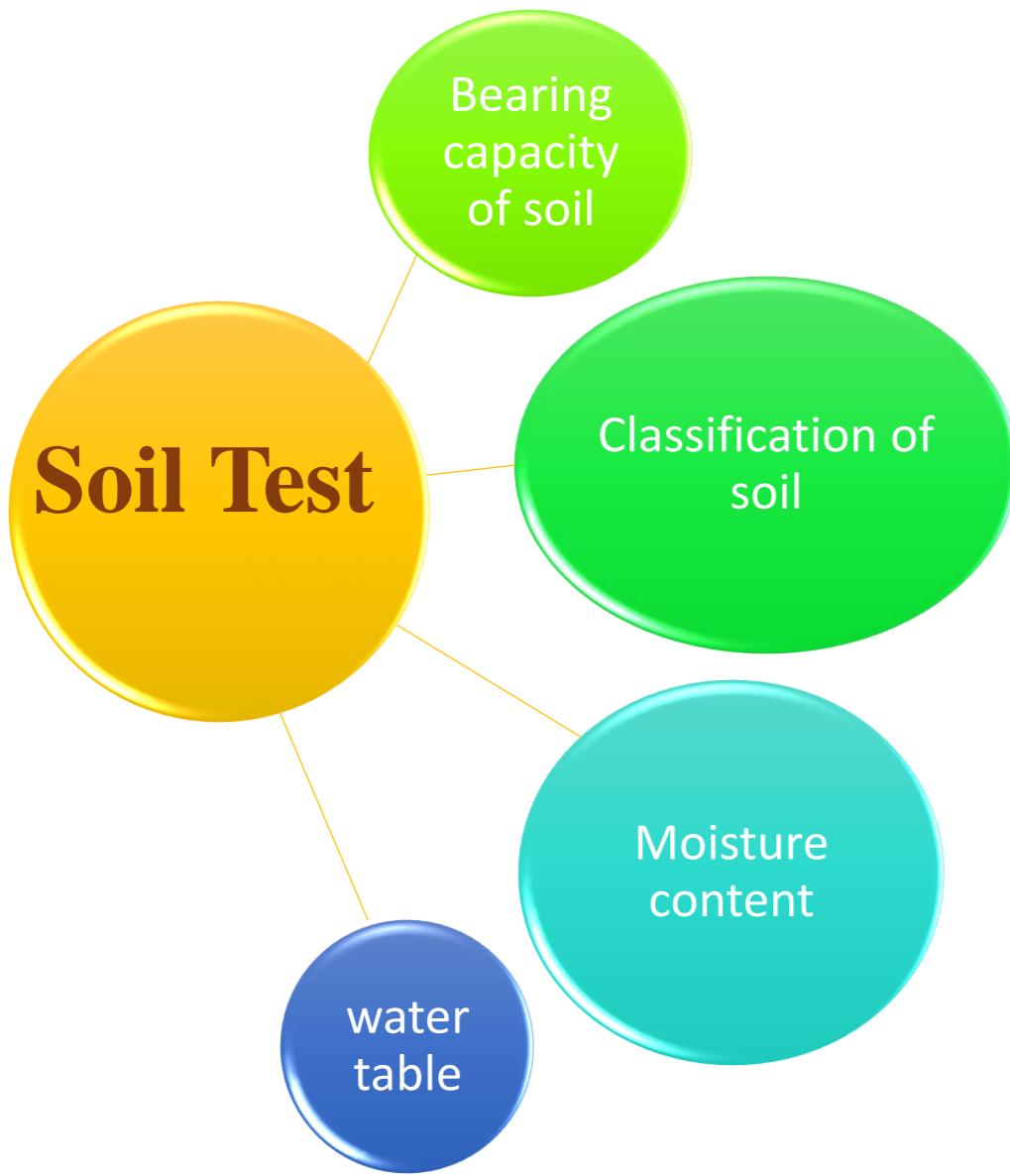
- The mat is supported on piles in this type of construction.
- This type of mat foundation is used where the soil is highly compressible and water table is high.
- This type of construction reduces the settlement and also control the buoyancy.



Mats placed on piles

Construction Procedure of Raft Foundation





EXCAVATION



Placing Reinforcement

A batch of horizontal reinforcement placing

Another batch of reinforcement placement to complete the bottom mesh

Columns rod placement

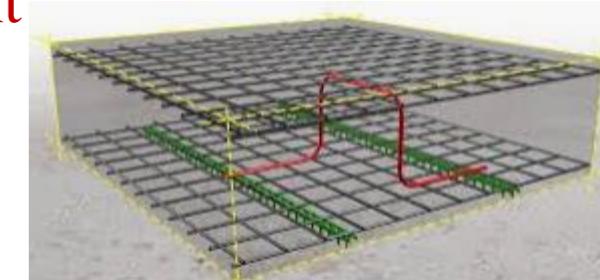
Vertical rod placement over bottom mesh to hold the upper mesh then upper mesh placement



Column rods

Bottom Reinforcement

Chair bars



Form Work

- Timber form work
- Plastic form work
- Steel form work



Steel form work



Timber form work

Plastic form work

Placing of Concrete



Curing

The process of maintaining the moisture and temperature conditions of concrete for hydration reaction to normally so that concrete develops hardened properties over time.



Merits of Mat Foundation

- Raft foundation is economic due to combination of foundations & floor slab.
- Require little excavation.
- Can cope with mixed and poor ground condition.
- It reduces different settlement.

Demerits

- It require specific treatment for point loads.
- Edge erosion occur if not treated properly.

Foundation in Black Cotton Soil

- Black cotton soil called **expandable soil**.
- It is very dangerous due to its **volumetric changes** with the change of atmospheric condition.
- Due to **more swelling & shrinkage** formed cracks and sometimes **wide 15 to 20 cm** and deep about **2.5 to 4 m**.

Precautions for Foundation in Black Cotton Soil

- Foundation should be taken at such depth where cracks can not extend. Depth at least 1.5 m.
- If depth does not exceed 1.5 m then entire black cotton soil may be removed and foundation should be laid on hard bed.
- Foundation or masonry work does not directly contact with B.C. soil, it can be done by wider & deeper trench for foundation by filling sand or moorum on either side or below foundation.
- Bed of foundation should be made firm or hard by ramming per 30 cm layer, moorum should be 15 cm each layer which is well watered & rammed.
- Construction should be made in dry season if possible.

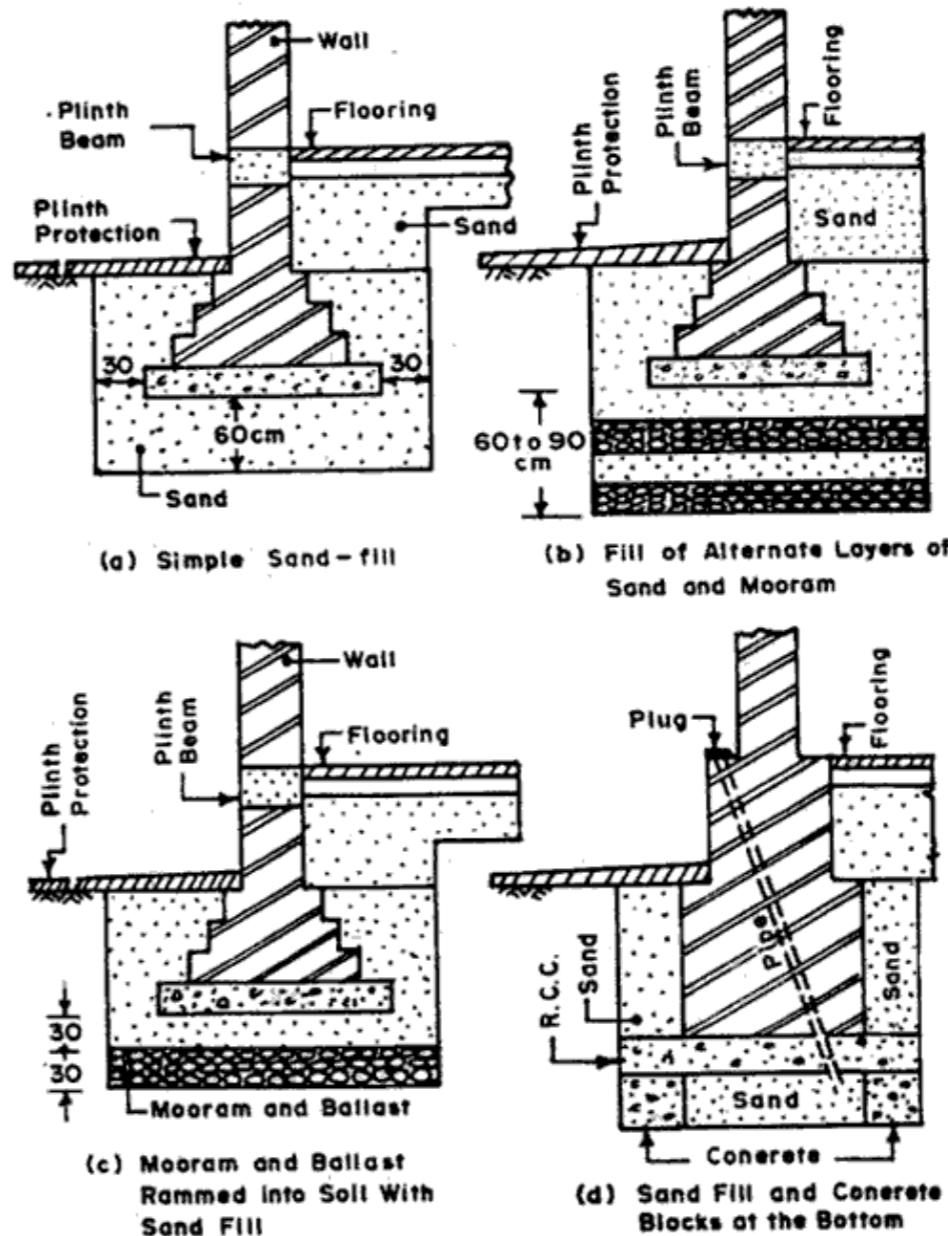
Types of Foundation in Black Cotton Soil

1. Strip or Pad foundation
2. Pier Foundation
3. Under-reamed pile foundation

It should be provided for medium load,

When swelling pressure are relatively high, alternate layer of moorum and sand are provided which will act as spring, and can compress or expand with sub soil movement,

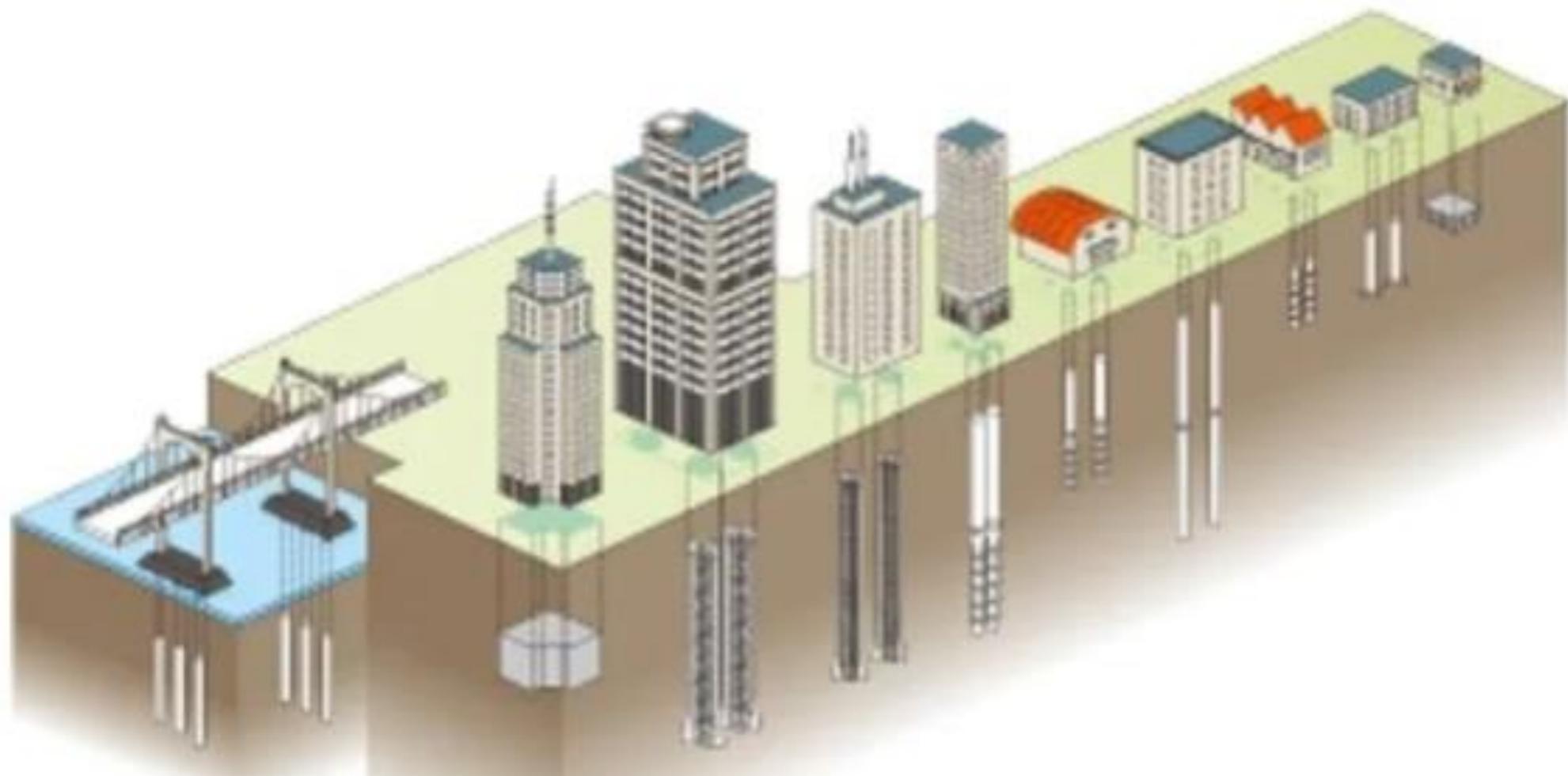
When soil is soft or poor B.C. 30 cm thick ballast or moorum should be provide and rammed 30 cm thick layer of course sand.



References

- Building Construction by Sushil Kumar
- **Building Construction** by B.C. Punmia; Ashok Kumar Jain and Arun Kumar Jain
- **Building Construction & Materials** by Gurcharan Singh

THANKYOU



**THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY**
42
(Deemed to be University)