

Lecture 11

DEEP FOUNDATION

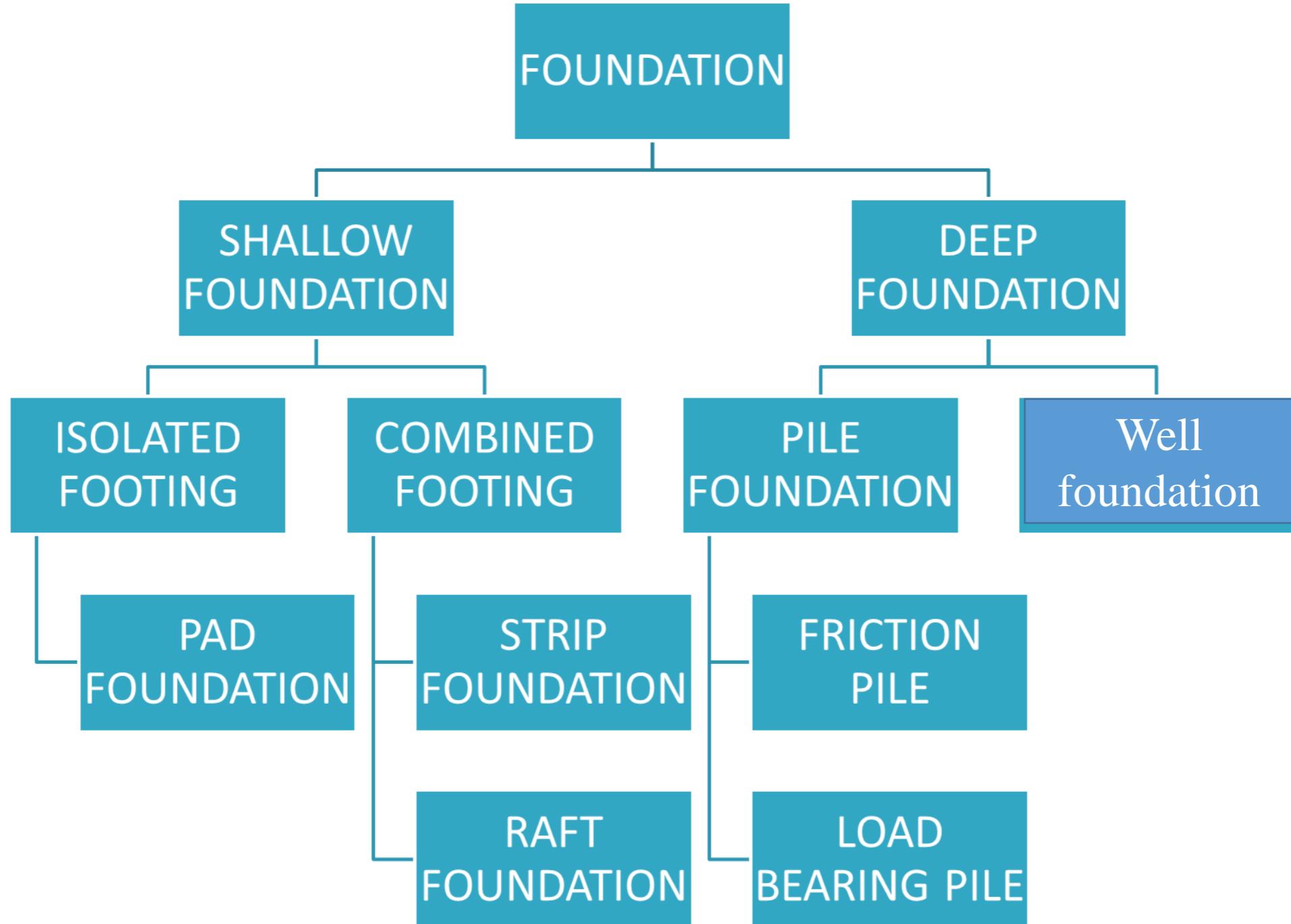
UCE306: ARCHITECTURE DRAWING AND BUILDING CONSTRUCTION

by

Dr. Himanshu Chawla



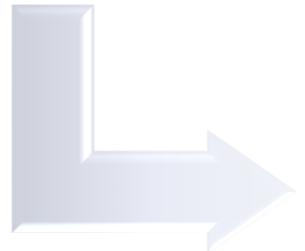
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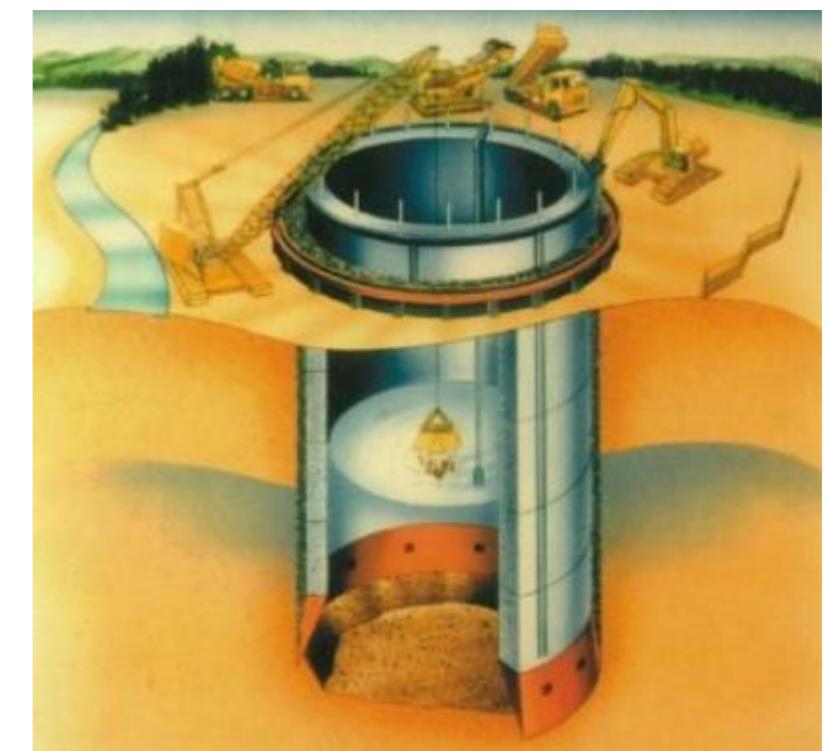
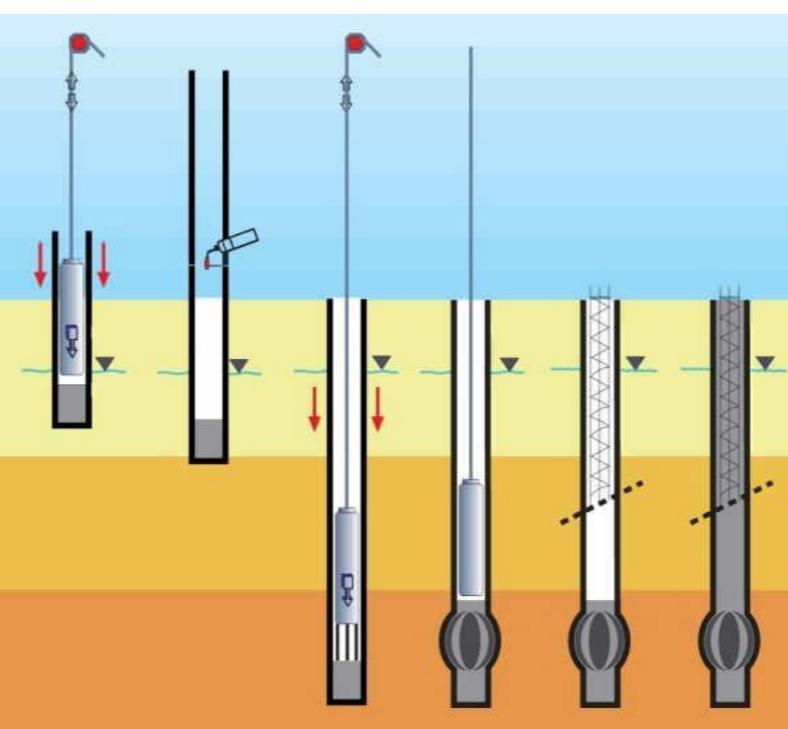
DEEP
FOUNDATION



PILE
FOUNDATION



WELL
FOUNDATION



Deep Foundations

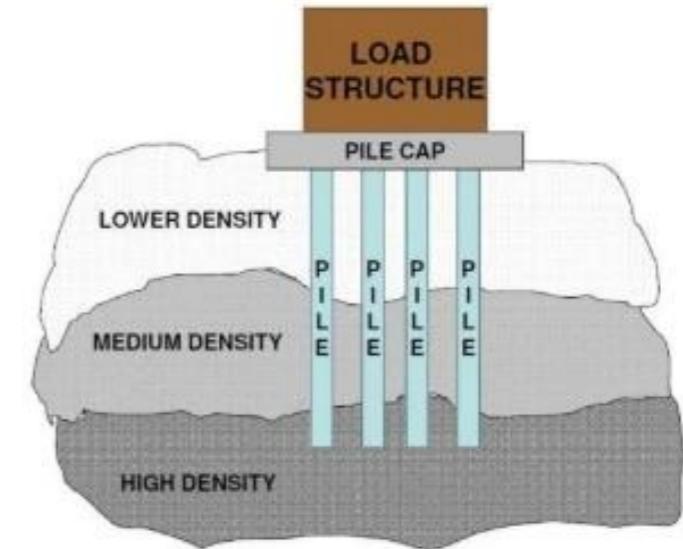
Deep Foundations are those, in which the depth of the foundation is very large in comparison to its width.

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.

The major types of Deep Foundation are:

- (i) Pile foundation
- (ii) Well foundation



Pile foundation



Well foundation

What is pile foundation. . .?

The pile foundation is used to describe a construction for the foundation of a wall or a pier, which is supported on the pile.

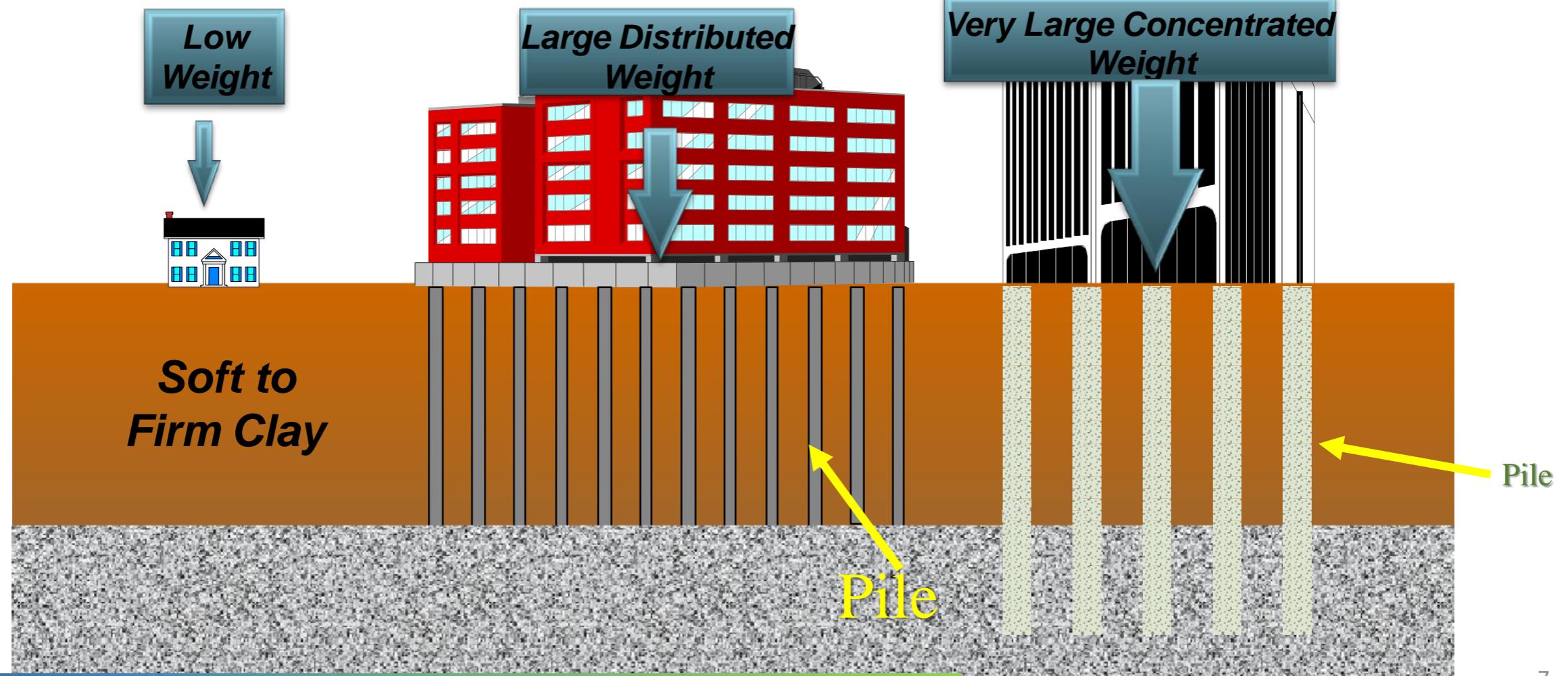
Where it is placed ...?

The piles may be placed separately or they may be placed in the form of cluster throughout the length of the wall.

Where it is adopted ...?

- Piles are adopted when the loose soil extended to a great depth.
- The load of the structure is transmitted by the piles to hard stratum below or it is resisted by the friction developed on the sided of the piles.

Pile Foundation



Application of piles.....

The piles are applicable at the places where,

- The load coming from the structure is very high & the distribution of the load on soil is uneven
- The subsoil water level is likely to rise or fall appreciably.
- The pumping of subsoil water is too costly for keeping the foundation trench in dry condition.
- The construction of raft foundation is likely to be very expensive or it is likely to practically impossible.
- The piles are considered to be long when their length exceeds 30 meters.
- The structure is situated on sea shore or river bed and the foundation is likely to be adopted by the scouring action of water.
- The piles are also used as anchors. They may be designed to give lateral support or to resist an upward pressure of uplift pressure.

Loads on Pile Foundation

- The loads from the super structure are
 - Live loads
 - Dead loads
 - Wind loads
 - Seismic load
- The loads from the surrounding soil in case of seismic event.
- Water loads in case of off-shore structure.

Pile materials

The materials which are used in the construction of piles are as follows :-

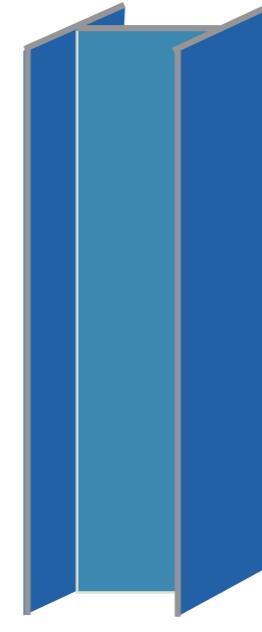
- Timber piles
- Steel piles
- Concrete piles



Timber



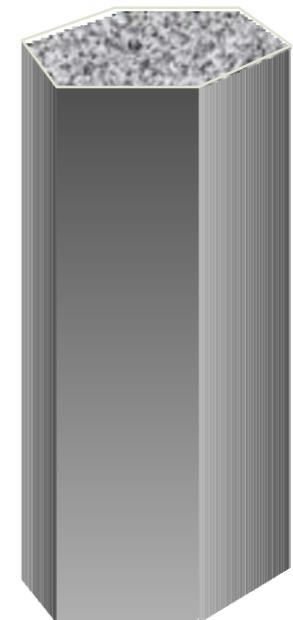
Steel Pipe



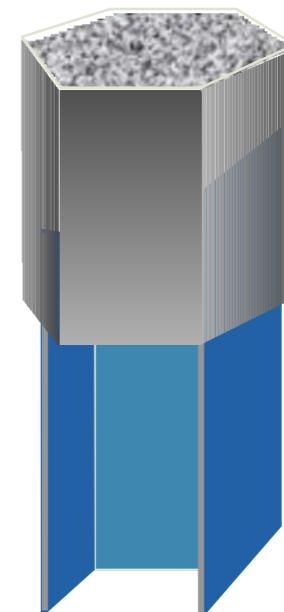
Steel H



Concrete



Pre-cast
Concrete



Composite

Timber

Steel

Concrete

Types of pile

- I. Load bearing piles
- II. Non-load bearing piles

I. Load bearing piles :-

- It bear the load coming from the structure.
- Piles are generally driven vertically or in near vertical position.

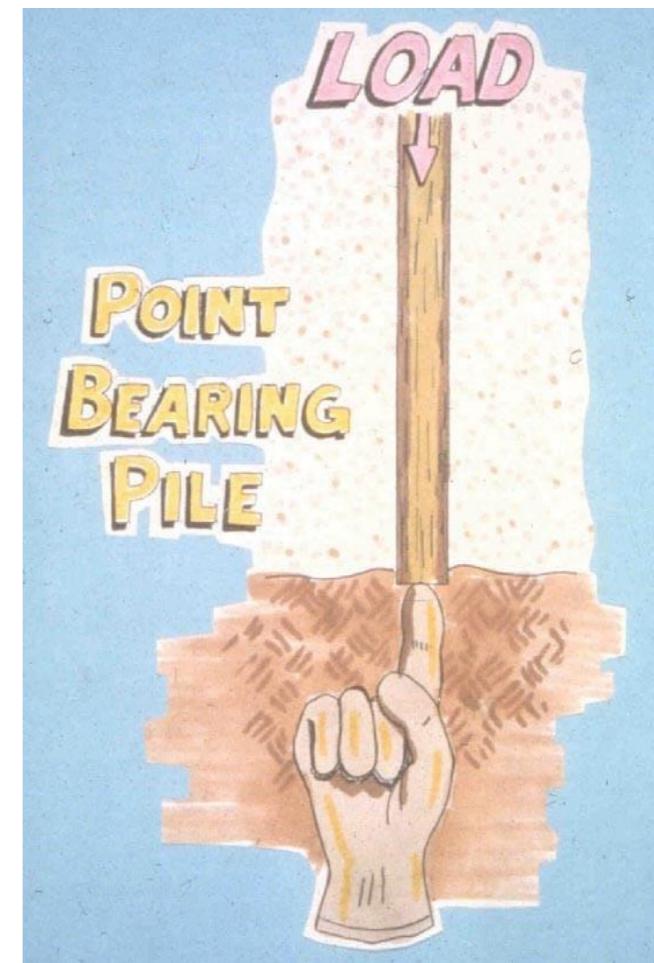
When a horizontal force has to be resisted, the inclined piles may be driven in an inclined position and such inclined piles are termed the batter piles

Load bearing piles are of two types

- i Bearing piles, ii. Friction Piles

Bearing piles

- This piles penetrate through the soft soil and their bottoms rest on a hard bed. Thus, they are end bearing piles and act as columns or piers.
- The soft ground through which the piles pass also gives some lateral support and this increases the load carrying capacity of the bearing piles.
- Transmit most of their loads to the load bearing layer (dense sand or rock). Most of the pile capacity inferred from the end bearing point.



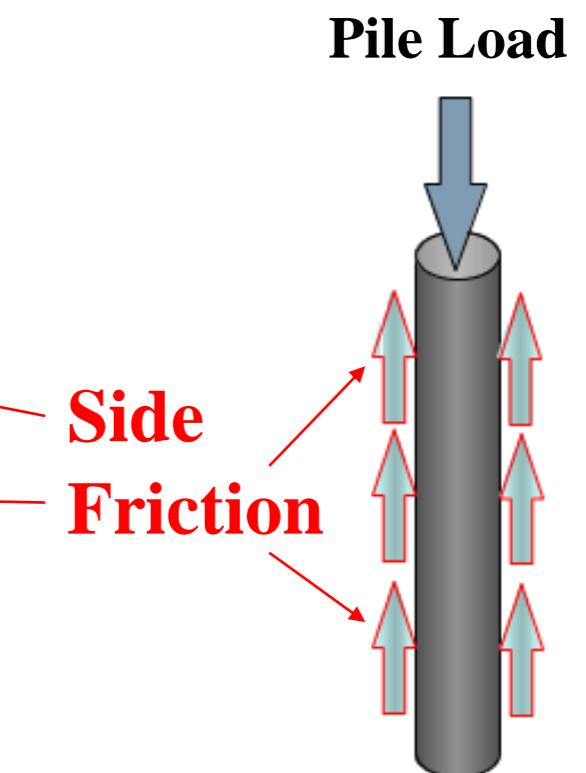
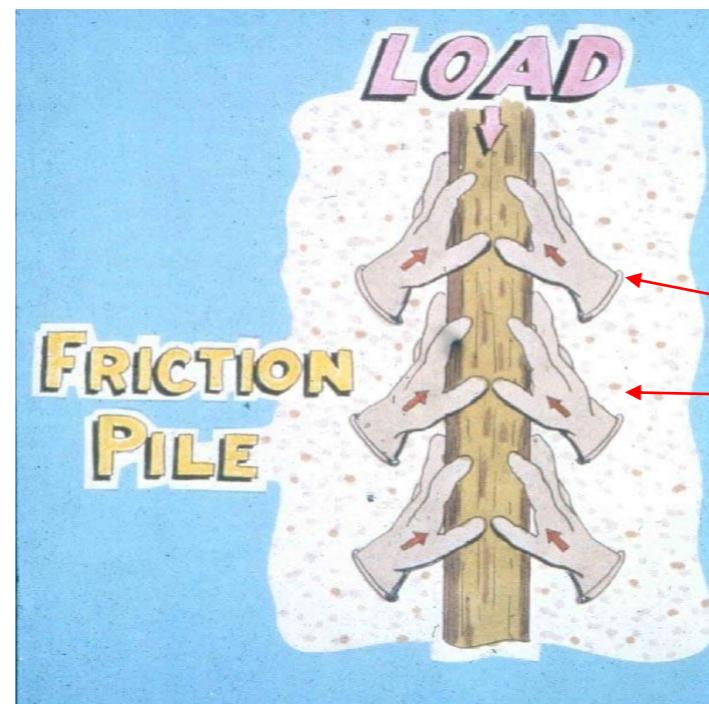
Pile Load



End
Bearing

Friction piles

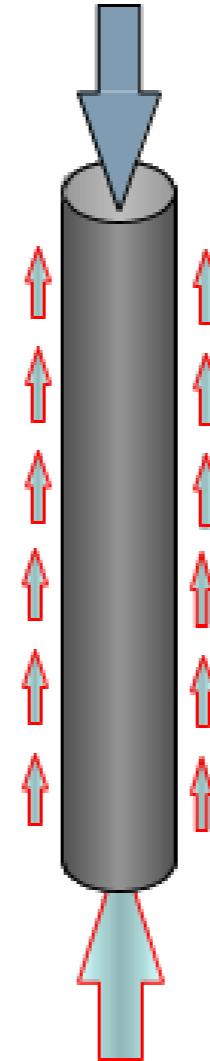
- When loose soil extends to a great depth, the piles are driven up to such a depth that the frictional resistance developed at the sides of the piles equals the load coming on the piles.
- Great care should be taken to determine the frictional resistance offered by the soil and suitable factor of safety should be provided in the design.
- Transmit most of their load through the layers through which the piles pass, i.e., mostly through the surface friction with the surrounding soils.



Friction piles + Bearing piles

In this case, load is resisted by end bearing point and frictional resistance developed at the sides of the piles.

Pile Load



Side Friction

End Bearing

Timber Piles

Relatively inexpensive

- Usually limited to short lengths.
- Low capacity.

Advantages:

Easy handling. Non-corrosive material. If permanently submerged then fairly resistant to decay.

Disadvantages:

May require treatment to prevent decay, insects, and borers from damaging pile. Easily damaged during hard driving and inconvenient to splice.

Steel Piles

Advantages:

- High axial working capacity.
- Wide variety of sizes.
- Easy on-site modifications.
- Fairly easy to drive, minimal soil displacement, good penetration through hard materials (with shoe).

Disadvantages:

High cost, difficulty in delivery, relatively higher corrosion, noisy driving.

Concrete Piles

Advantages:

High capacity, relatively inexpensive, usually durable and corrosion resistant in many environments (not marine).

Disadvantages:

Handling, splicing, and transportation difficulties (for precast piles). Soil caving in cast insitu piles.

Pile spacing

The center to center distance of successive piles is known as pile spacing.

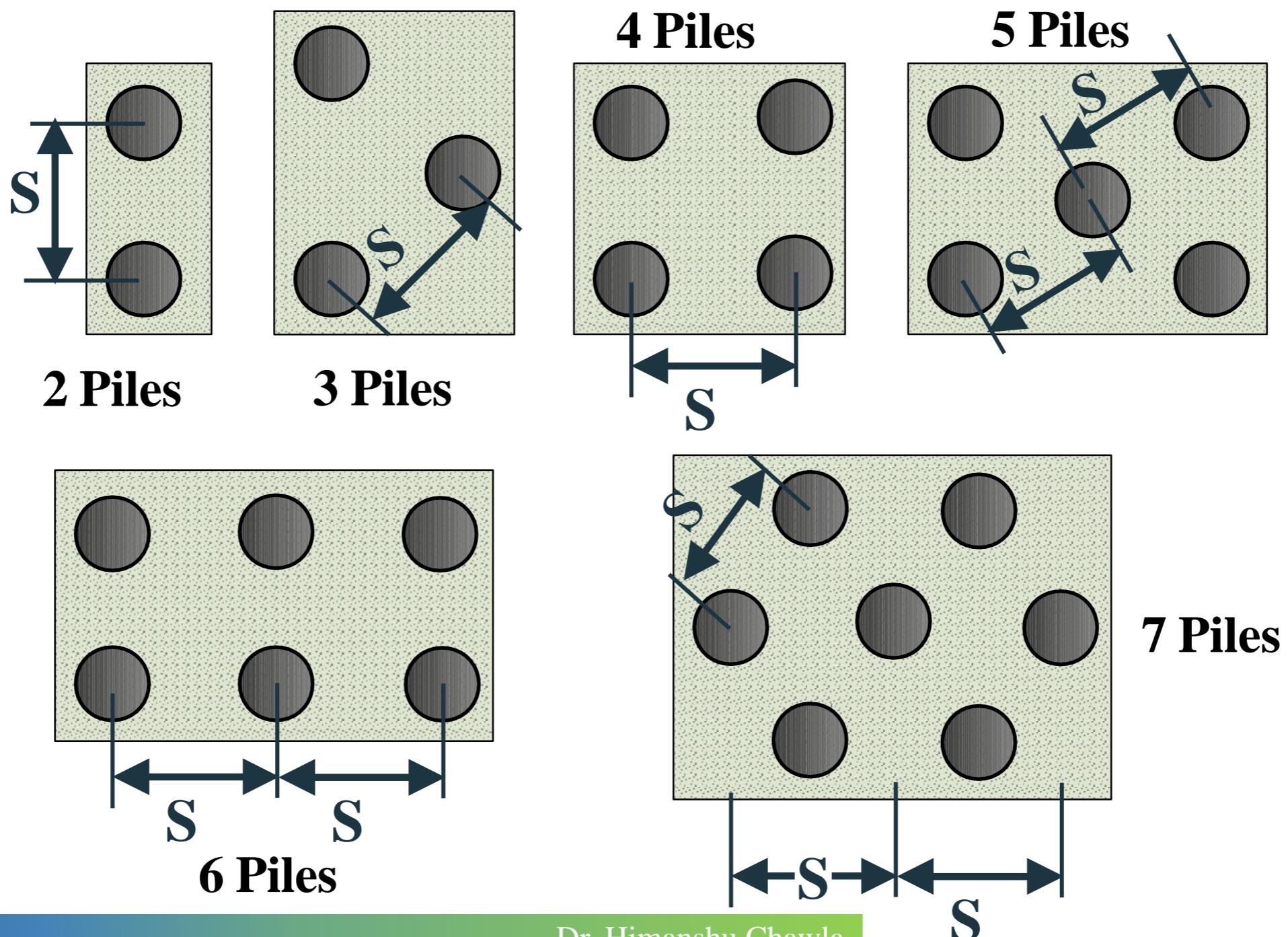
It has to be carefully designed by considering the following factors,

- Types of piles
- Material of piles
- Length of piles
- Grouping of piles
- Load coming on piles
- Obstruction during pile driving
- Nature of soil through which piles are passing.

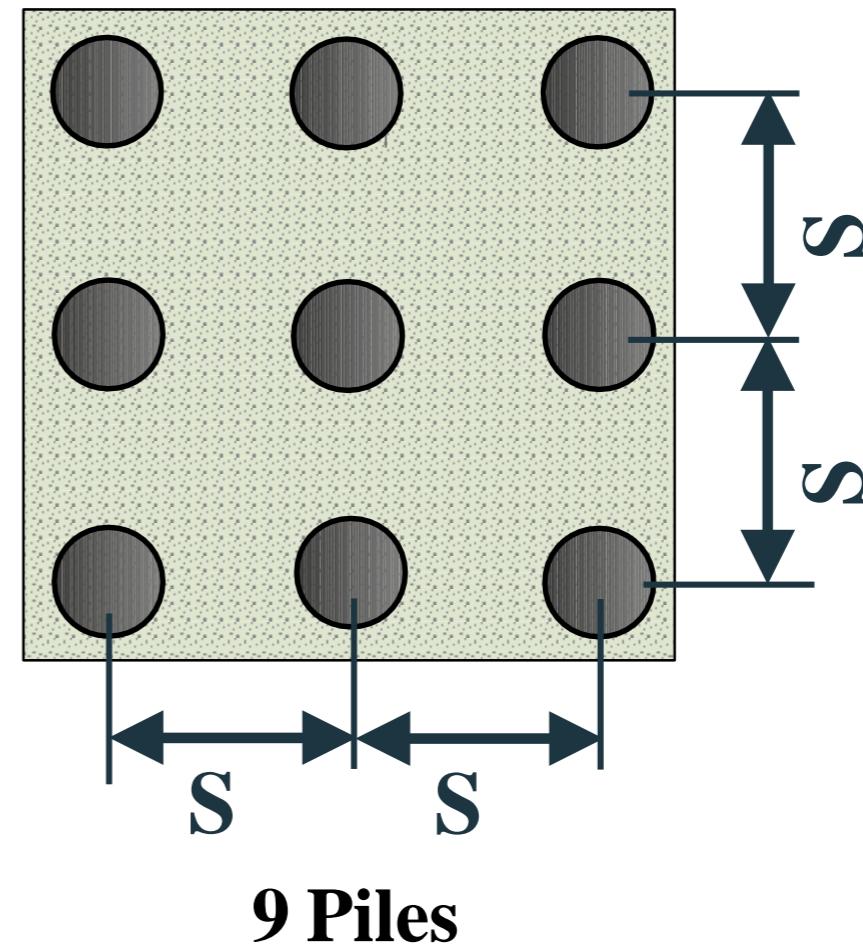
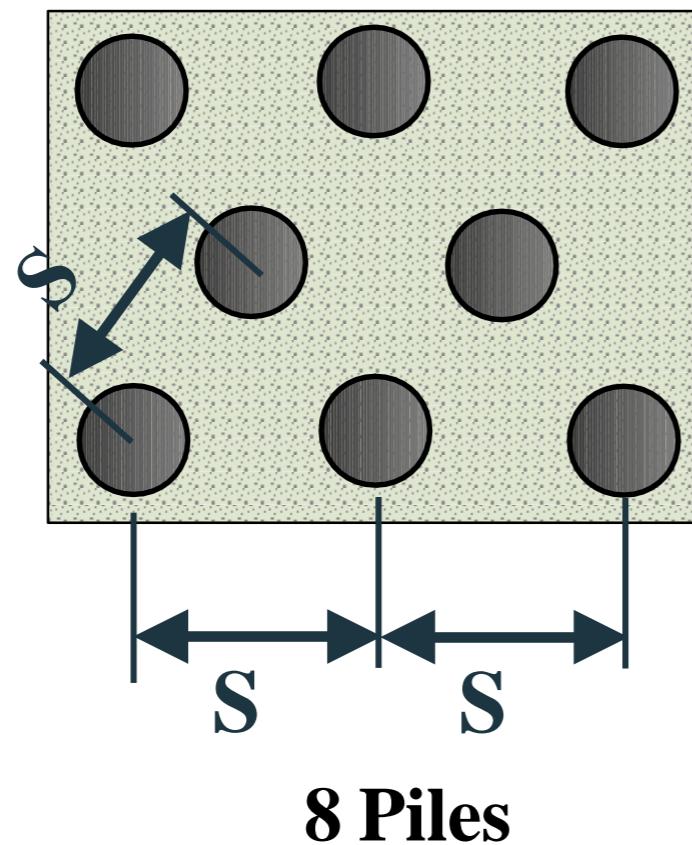
The spacing between piles in a group can be assumed based on the following:

- 1- Friction piles need higher spacing than bearing piles.
- 2- Minimum spacing (S) between piles is 2.5.
- 3- Maximum spacing (S) between piles is 8.0.

Pile spacing



Pile spacing



Non - Load bearing piles

This piles are used to function as the separating members below ground level and they are generally not designed to take any vertical load. This piles are also known as the sheet piles.

The materials used for the construction of non load bearing piles are,

- i. Timber sheet piles
- ii. Steel sheet piles
- iii. Concrete sheet piles

Sheet Piles

Sheet piles are used for the following purposes:

- To construct retaining walls in docks, and other marine works.
- To protect erosion of river banks.
- To retain the sides of foundation trenches



Non - Load bearing piles

Non load bearing piles are used for the following purposes:

- To isolate foundations from the adjacent soils. This prevents escape of soil and passage of shocks and vibrations to adjoining structure.
- To prevent underground movement of water like to construct a cofferdam, it requires a water tight enclosure in the construction of foundation under water.
- To prevent the transfer of machine vibrations to the adjacent structures.
- To construction of retaining wall.
- To protect the river banks.
- To retain the sides of foundation trenches.

Pile Driving

- The process of forcing the piles into the ground without excavation is termed as the pile driving.
- The piles should be driven vertically.
- However, a tolerance of eccentricity of 2 % of the pile length is permissible.
- The eccentricity is measured by means of plumb bob.

The equipments required for pile driving are as follows,

- Pile fames
- Pile hammers
- Leads
- Winches
- Miscellaneous

Pile Installation

Pile Installation is as important as design. There are two methods for the installation of piles.

- Installation by Driving
- Installation by Boring



Installation of pile by driving

Installaltion by Driving

- Usually Driven piles are driven into the ground by impact force which causes considerable stresses in the piles.
- The forces and accelerations induced in the pile during driving are recorded using a data logger called Pile Driving Analyzer(PDA).
- The data obtained by PDA will be used to study the pile integrity and potentially dangerous defects like honey combing, cracks, presence of foreign matter, etc.
- The PDA works on the principles of wave propagation.

Setup to produce impact on the pile

Data collector and Analyzer called pile driving analyzer (PDA)



Factors to be considered in Installation of pile by driving

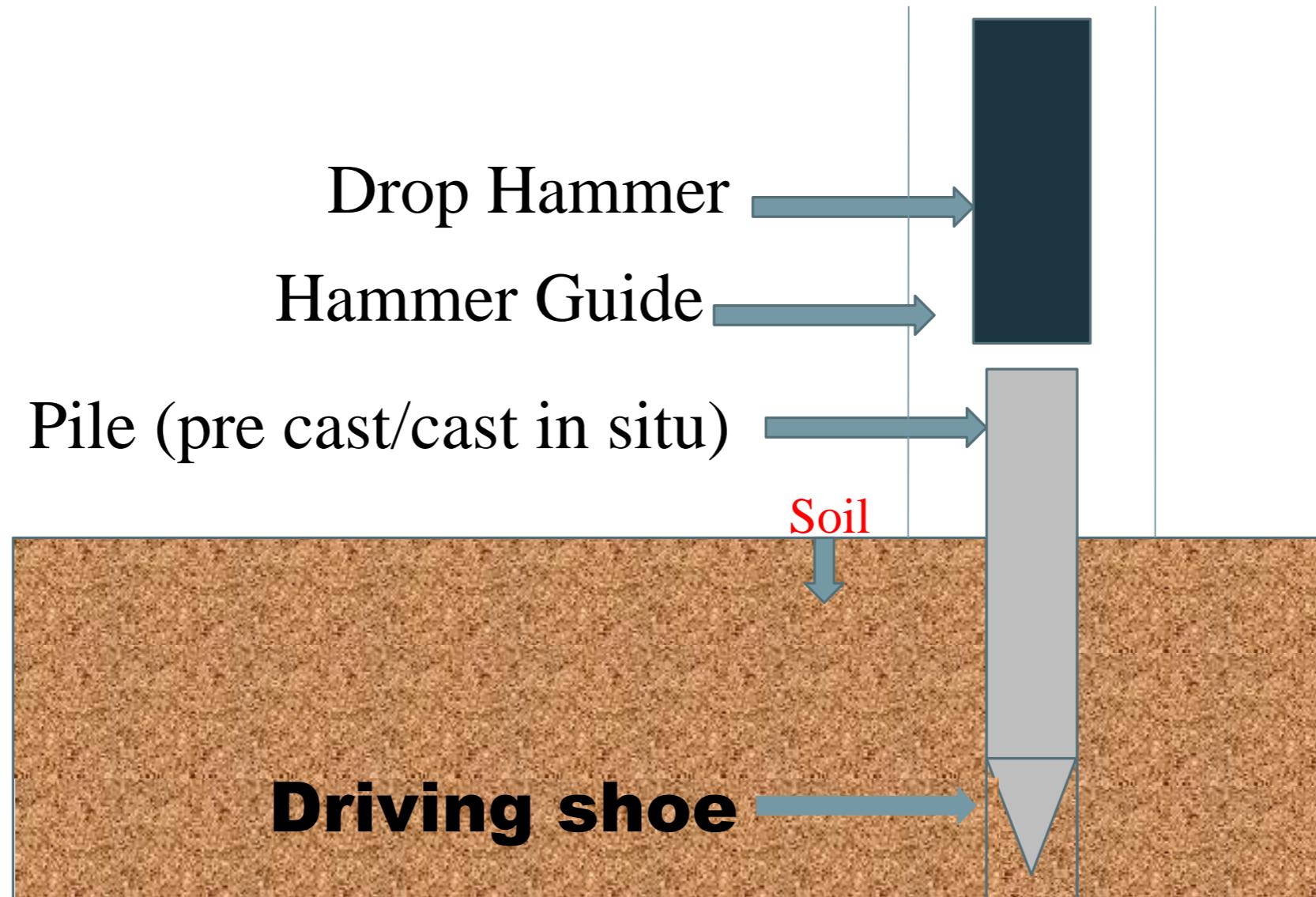
If the driving has to be carried out by hammer, then following factors should be take into consideration.

- The size and weight of the pile.
- The driving resistance which has to be overcome to achieve the desired penetration.
- The available space and head room in the site because the hammer has to be dropped from certain height.
- The availability of cranes.
- The noise restrictions which may be in force in the locality.

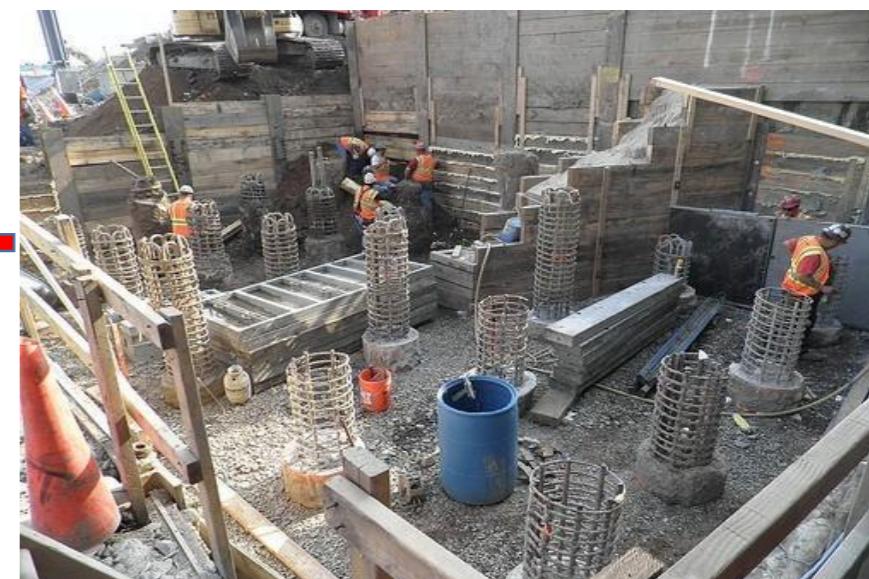
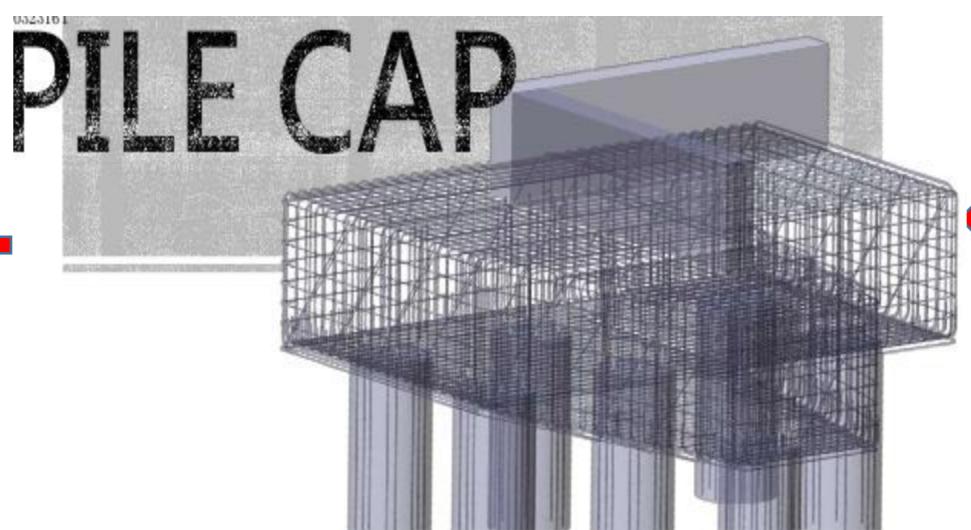
Other methods for pile driving

- Dropping weight
- Explosion
- Vibration
- Jacking (only for micropiles)
- Jetting

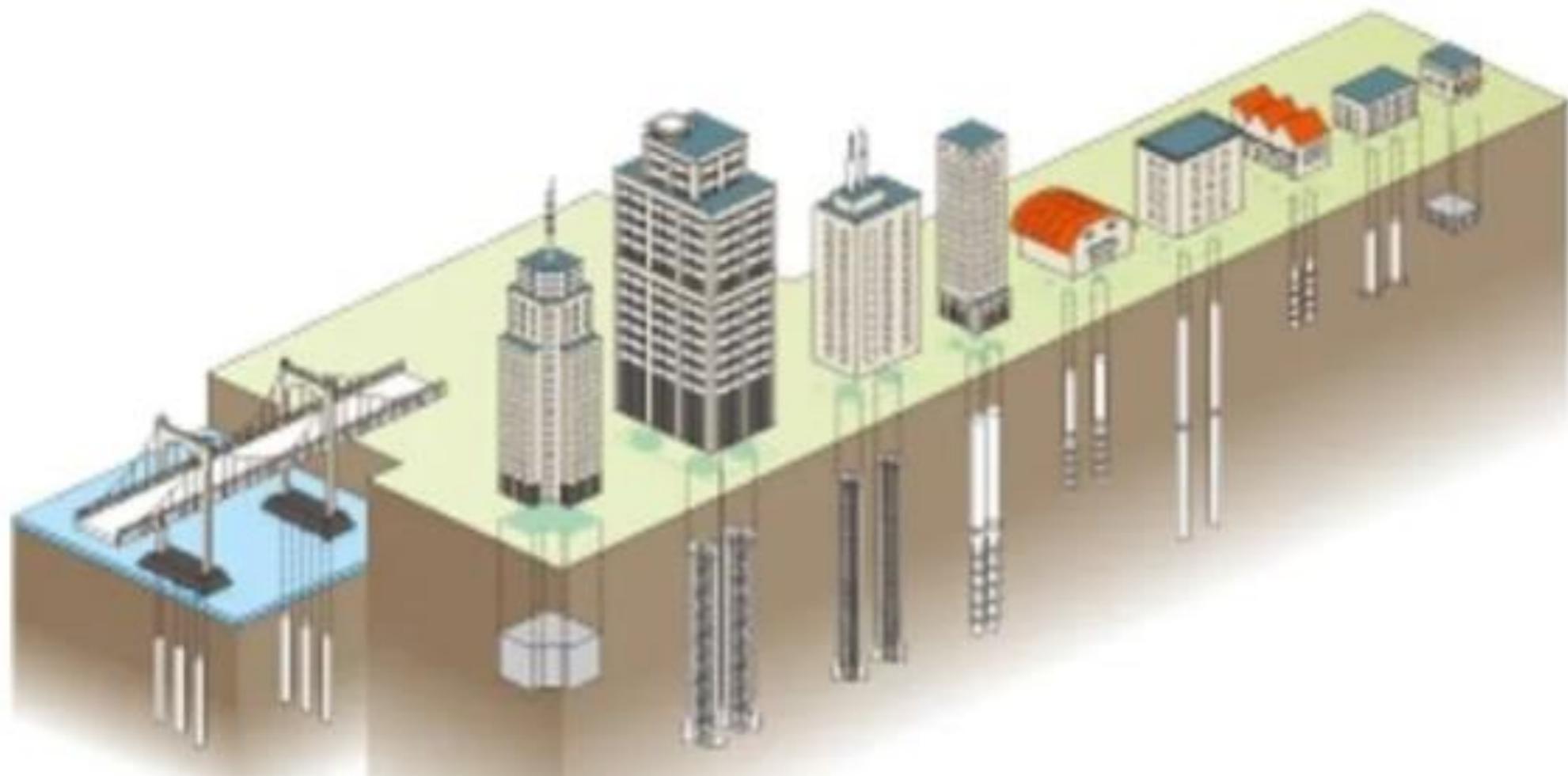
Schematic sketch of pile driving with hammer



Construction procedure of Cast In-situ Piles



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