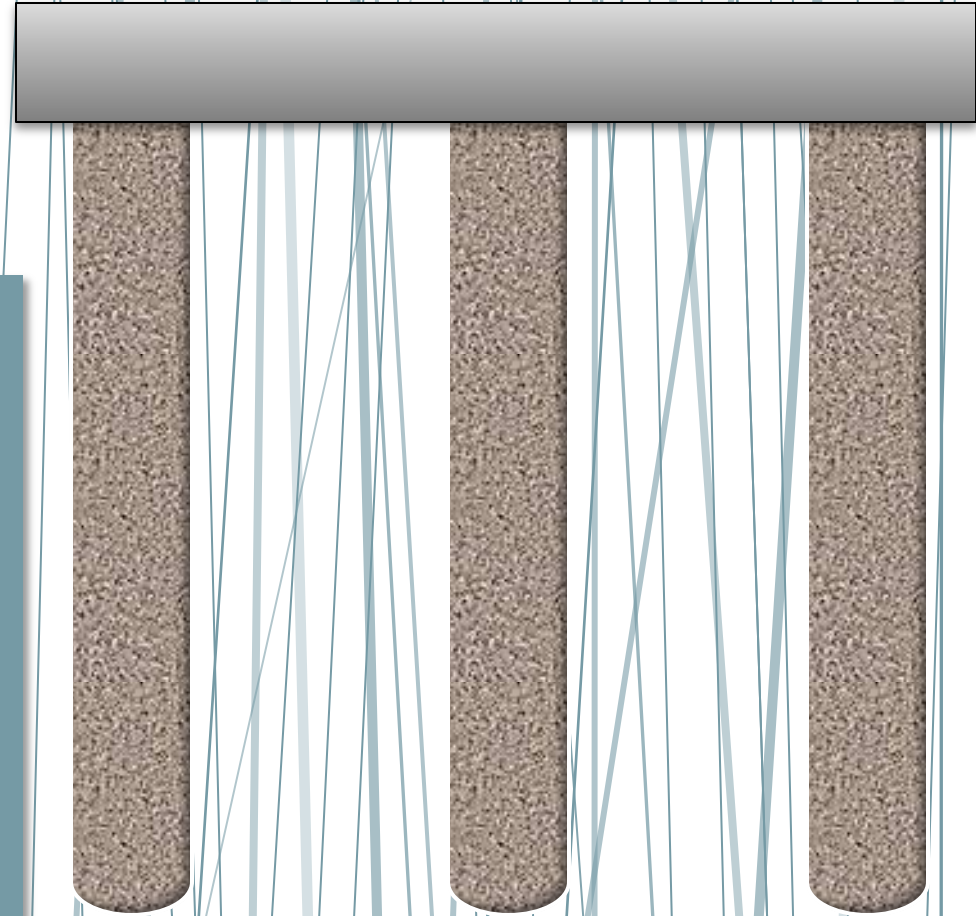


PILE FOUNDATION



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

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 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.

Pile applications

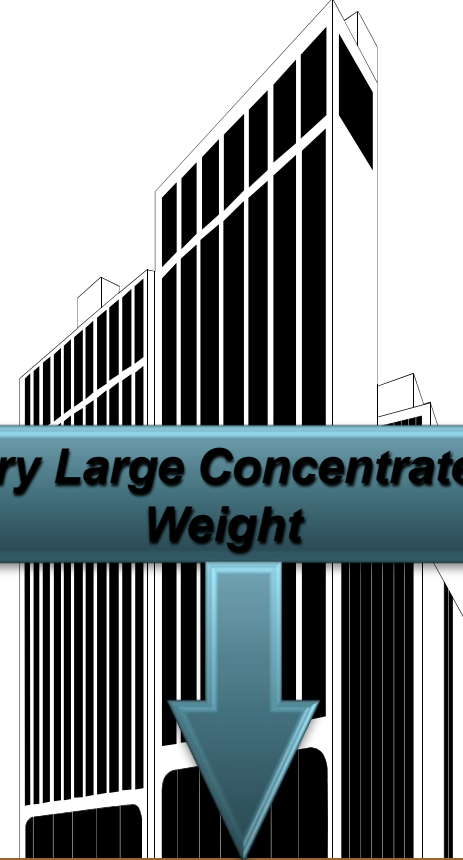
Low Weight



Large Distributed Weight

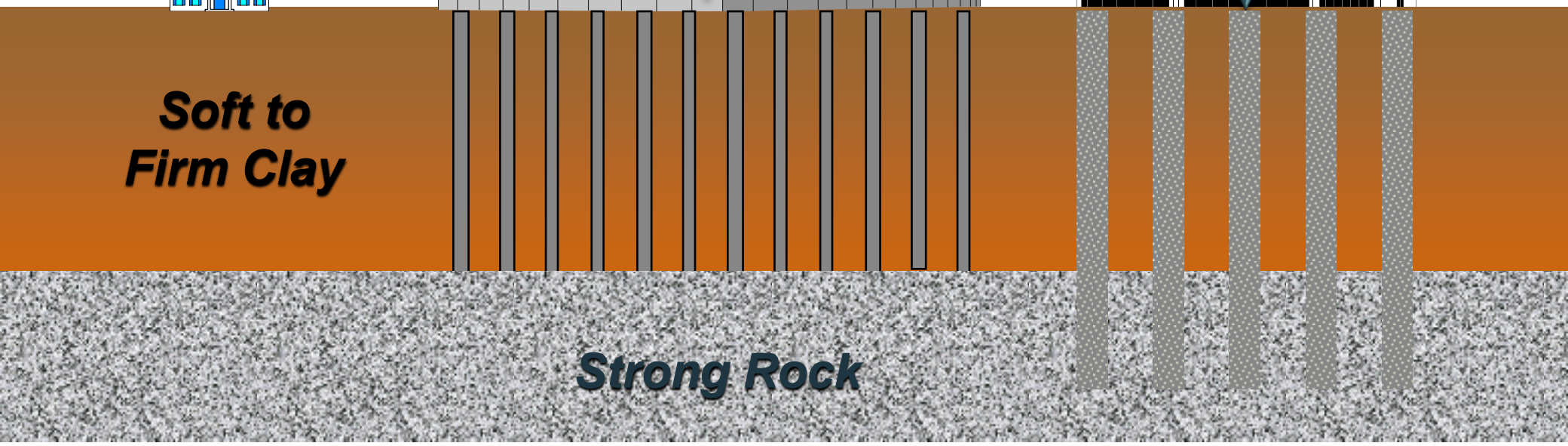


Very Large Concentrated Weight



Soft to Firm Clay

Strong Rock



Loads coming on pile foundations

- All the loads from the super structure like,
 - 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**

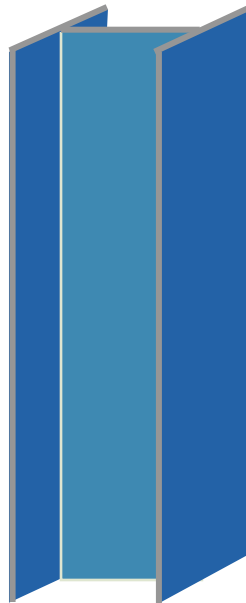
Pile materials



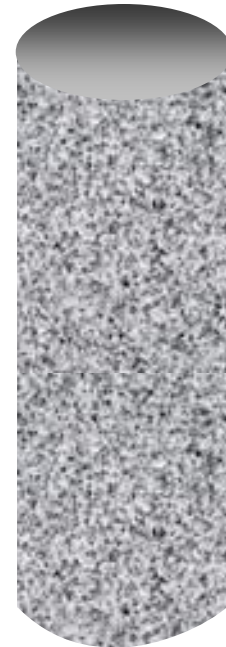
Timber



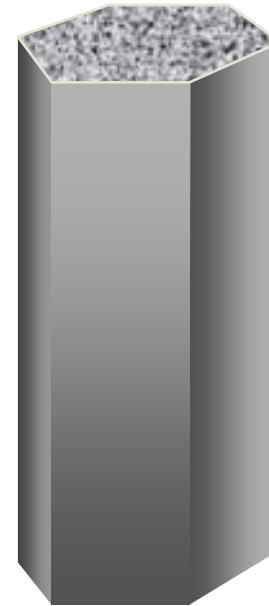
Steel Pipe



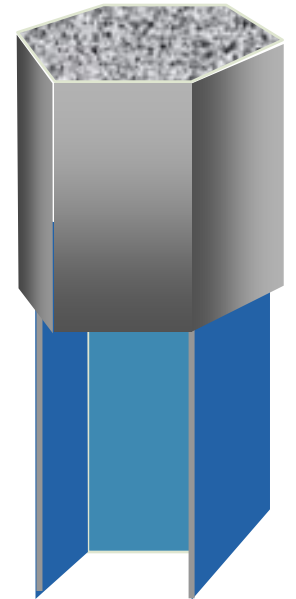
Steel H



Concrete



Pre-cast
Concrete



Composite

Timber

Steel

Concrete

Types of pile

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

I. Load bearing piles :-

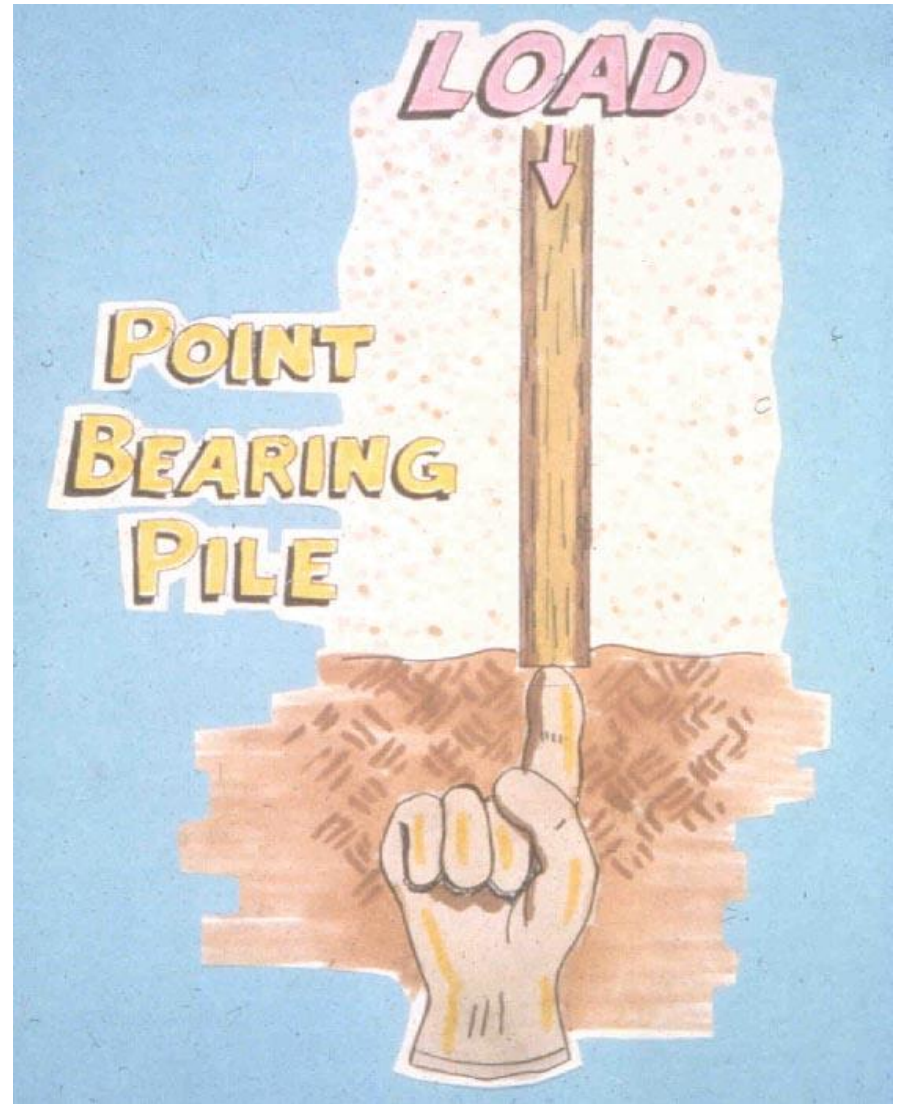
- It bear the load coming from the structure.
- The Piles are generally **driven vertically** or in near vertical position.
- When a **horizontal forces to be resisted**, the inclined piles may **be driven in an inclined position** and such inclined piles are termed the **batter piles**
- Load bearing piles are divided into,
 - i. **Bearing piles**
 - ii. **Friction Piles**

Bearing piles

- This **piles penetrate to 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.

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.**

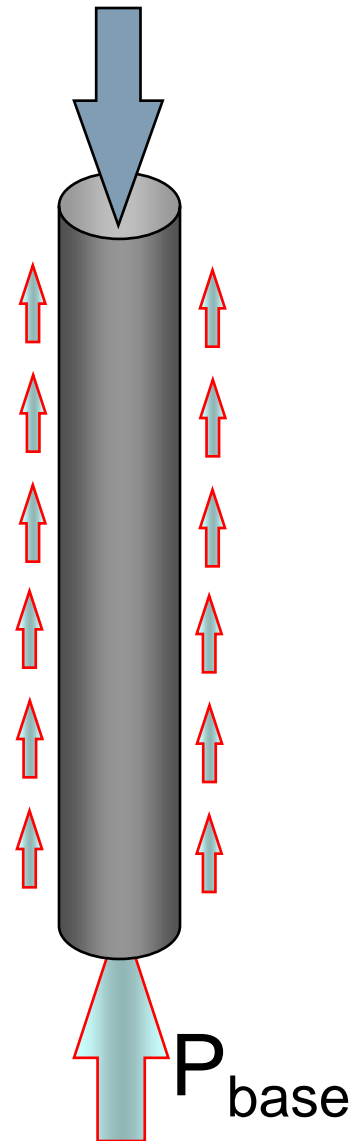


Bearing Piles

Pile Load, P

Side Friction

End Bearing

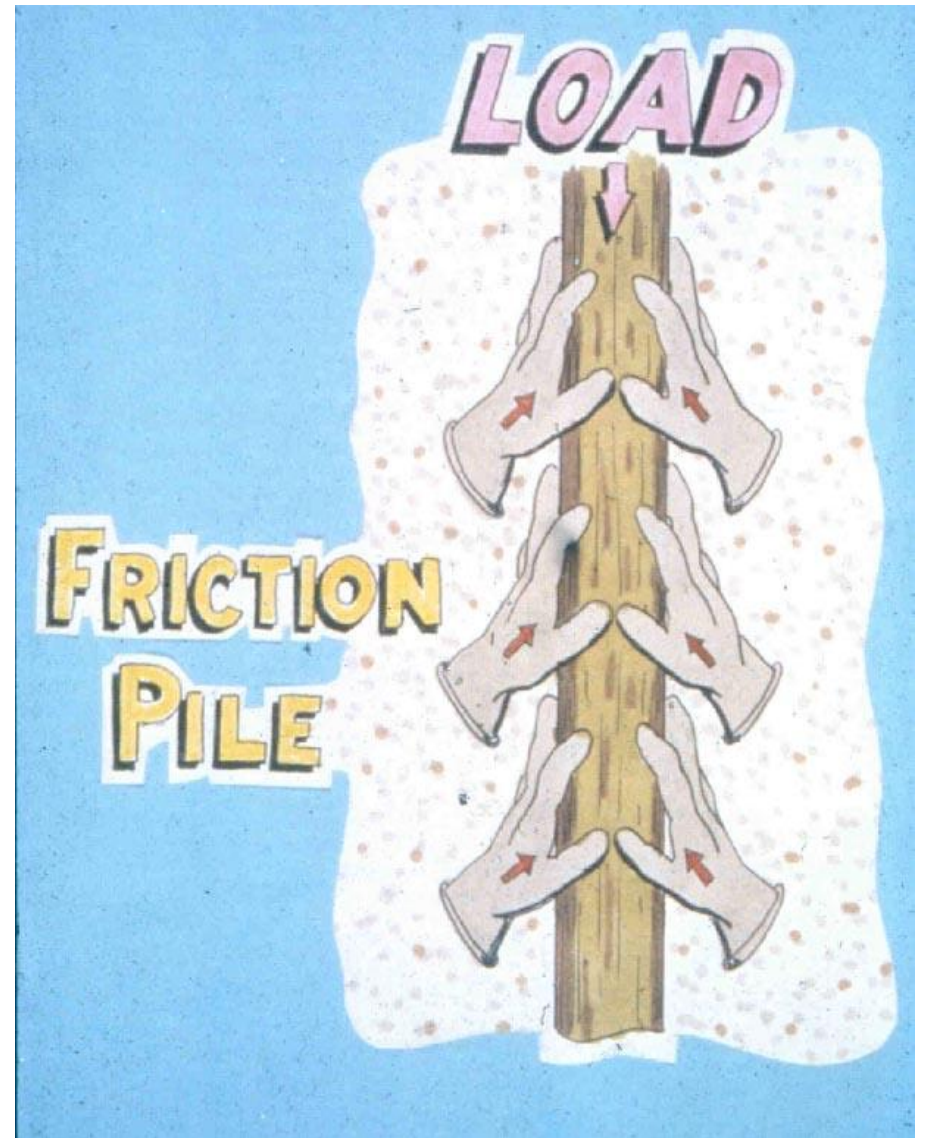


Friction piles

- 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.**

Friction piles

- Transmit most of their load through the layers through which the piles pass, i.e., mostly through the surface friction with the surrounding soils.

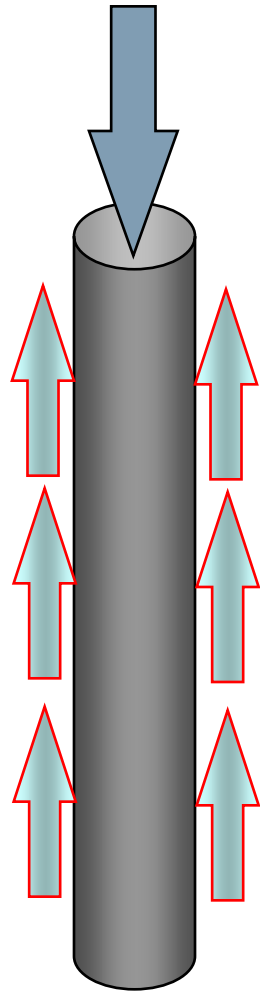


Friction Piles

Pile Load, P

Side Friction

End Bearing



P_{base}

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:

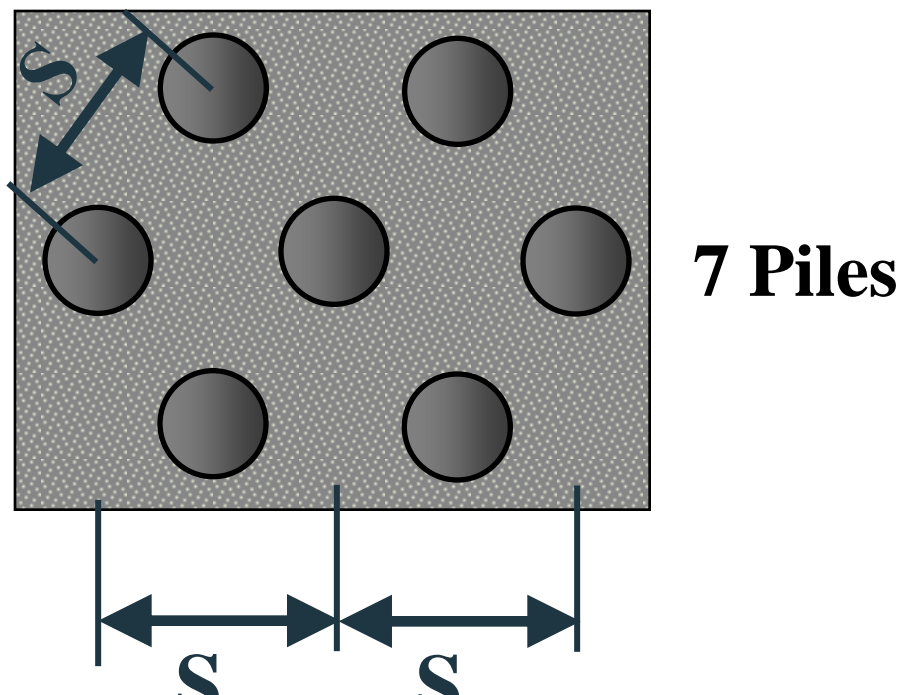
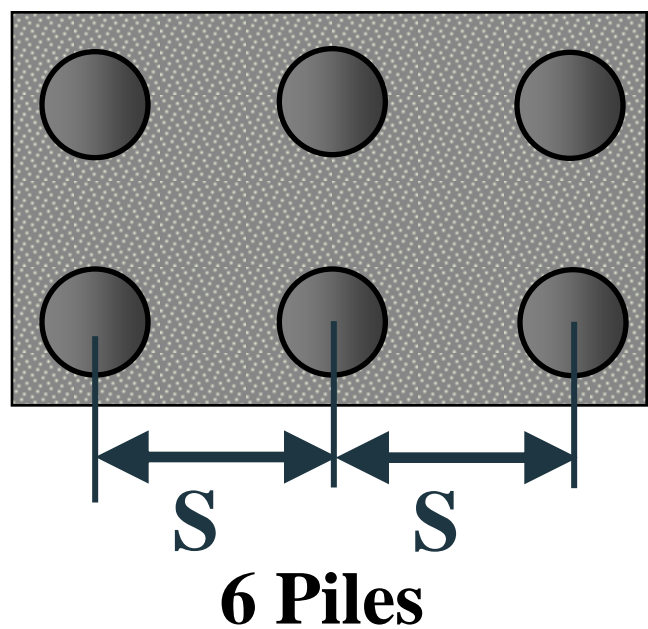
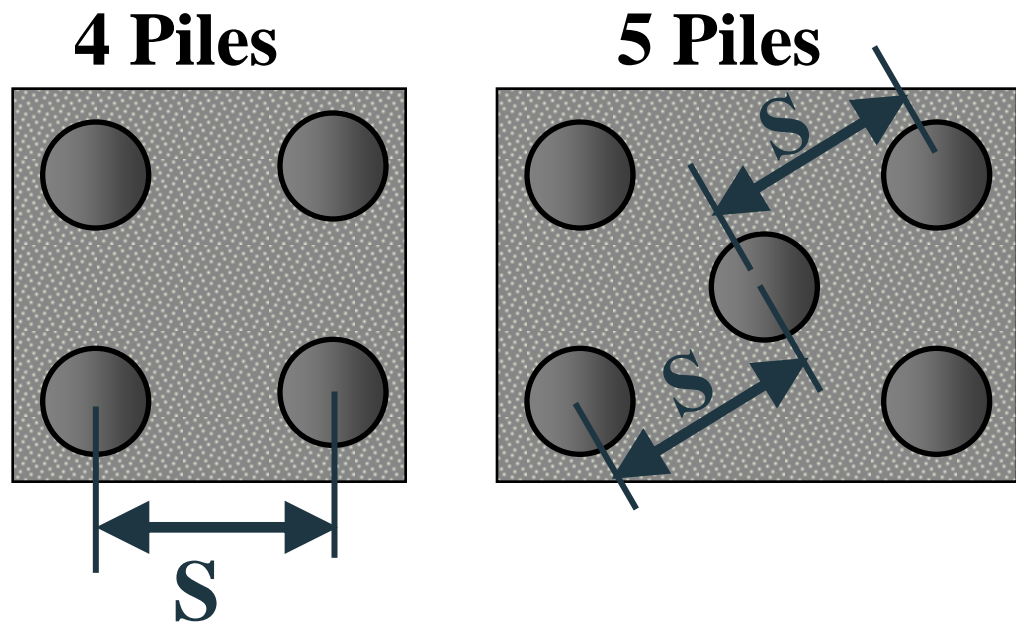
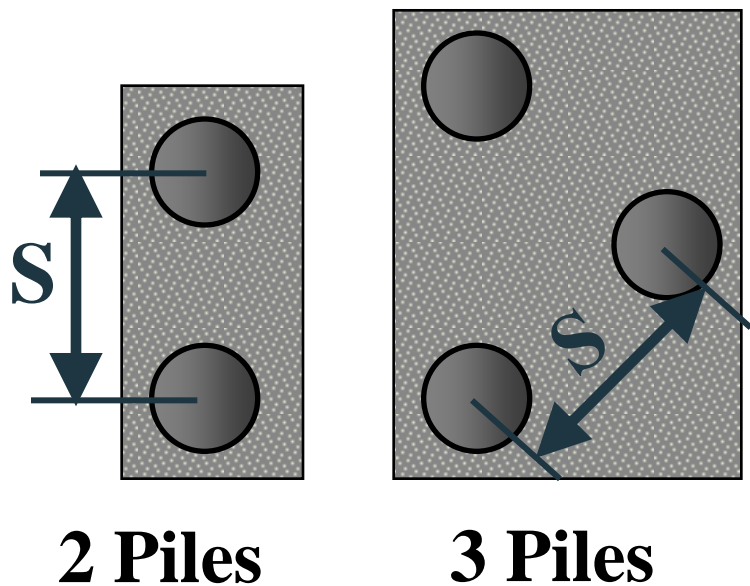
High capacity, relatively inexpensive, usually durable and corrosion resistant in many environments (not marine).

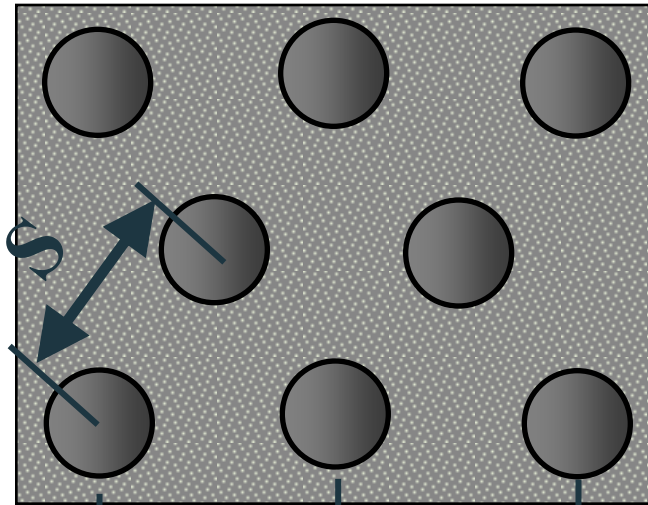
➤ Disadvantages:

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

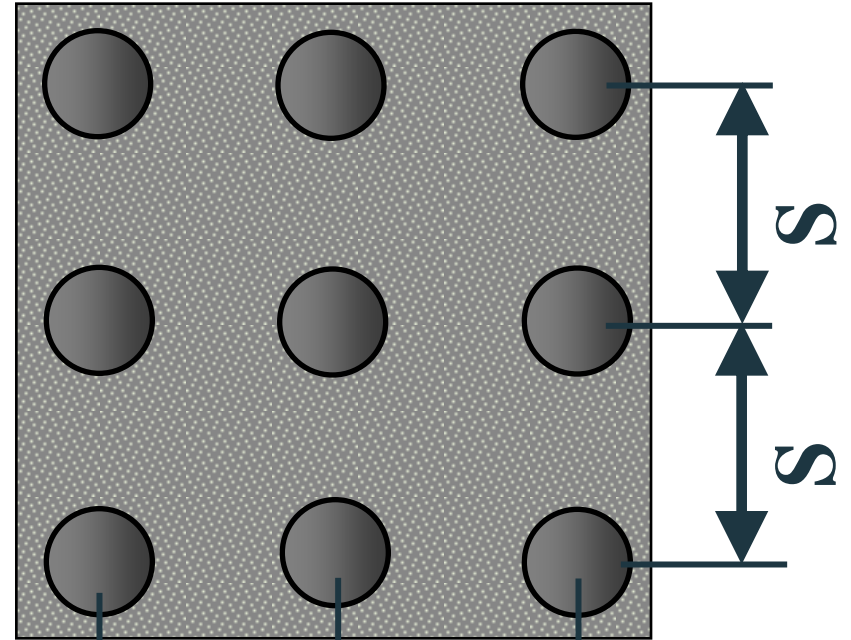
Pile spacing

- **The center to center distance of successive piles is known as pile spacing.**
- **It has to be carefully designed by considering the following factors,**
 - 1) **Types of piles**
 - 2) **Material of piles**
 - 3) **Length of piles**
 - 4) **Grouping of piles**
 - 5) **Load coming on piles**
 - 6) **Obstruction during pile driving**
 - 7) **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.**





8 Piles



9 Piles

Pile capacity

- There are two approaches for obtain the capacity of the pile,
 - **Field Approach**
 - **Theoretical Approach**
- **Field Approach :-** In this approach the **pile is loaded to the desired level** and its capacity is measured.

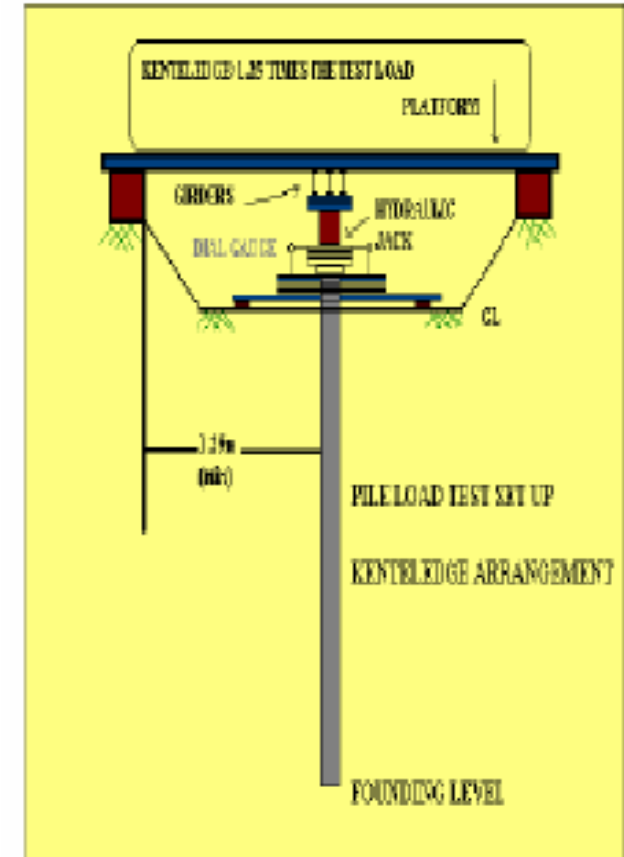
A **test pile of required dimensions is constructed in the field work** and load test is conducted to assess the capacity of the pile.

This approach gives more realistic estimate of pile capacity. However it **is time consuming** as well as **costly**.

Field setup for a Static Axial compressive load test on a single pile



FIELD SET UP



TEST SCHEMATIC DIAGRAM

Pile capacity

- **Theoretical Approach** :- In this approach the pile capacity is calculated using some formula in which the soil data is fed for obtaining the capacity.

Bearing capacity of piles from soil parameters:

Static Formula Method
 $(Q_u = Q_b + Q_s)$

Embedded Length = D

$Q_u =$ Ultimate Bearing Capacity

$$Q_s = fA_s$$

$f =$ Unit Frictional Resistance

$A_s =$ Shaft Area (Pile surface area)

$q_b =$ Unit Bearing Capacity

$A_b =$ Area of Pile Base

$$Q_b = q_b A_b$$



Factors affecting pile capacity

- Surrounding soil
- Installation technique (like driven or bored).
- Method of construction (like pre cast or cast in situ).
- Location of pile in a group.
- Spacing of piles in a group.
- Symmetry of the group.
- Shape of pile cap
- Location of pile cap (like above soil or below soil).
- Drainage condition in soil.

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**

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,
 - i. Pile frames
 - ii. Pile hammers
 - iii. Leads
 - iv. Winches
 - v. 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

❖ Installation 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)



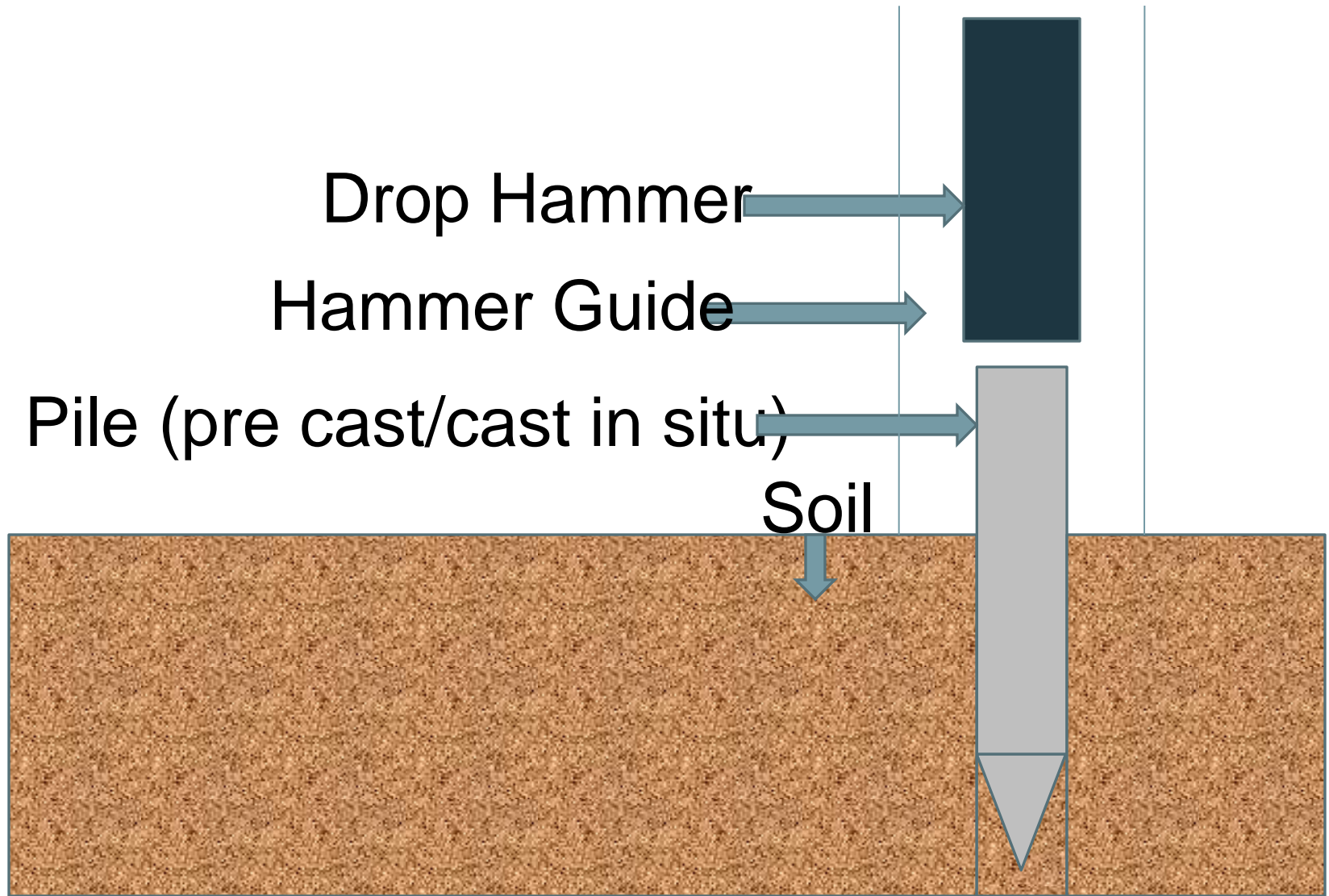
Factors to be considered in Installation of pile by driving

- 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 micro piles)**
- **Jetting**

Schematic sketch of pile driving with hammer



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