

3. Types of foundation & foundation materials



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- Shallow Foundations
- Deep Foundations

Introduction

- Why different types of foundations?
- General types of foundations

➤ Why different types of foundations?

What type of foundation you choose will depend upon many factors:

- **Structure:** type, use, loadings, code requirement.
- **Ground:** layers, subsurface soil condition, groundwater.
- **Cost**

➤ General types of foundations

Foundation might be:

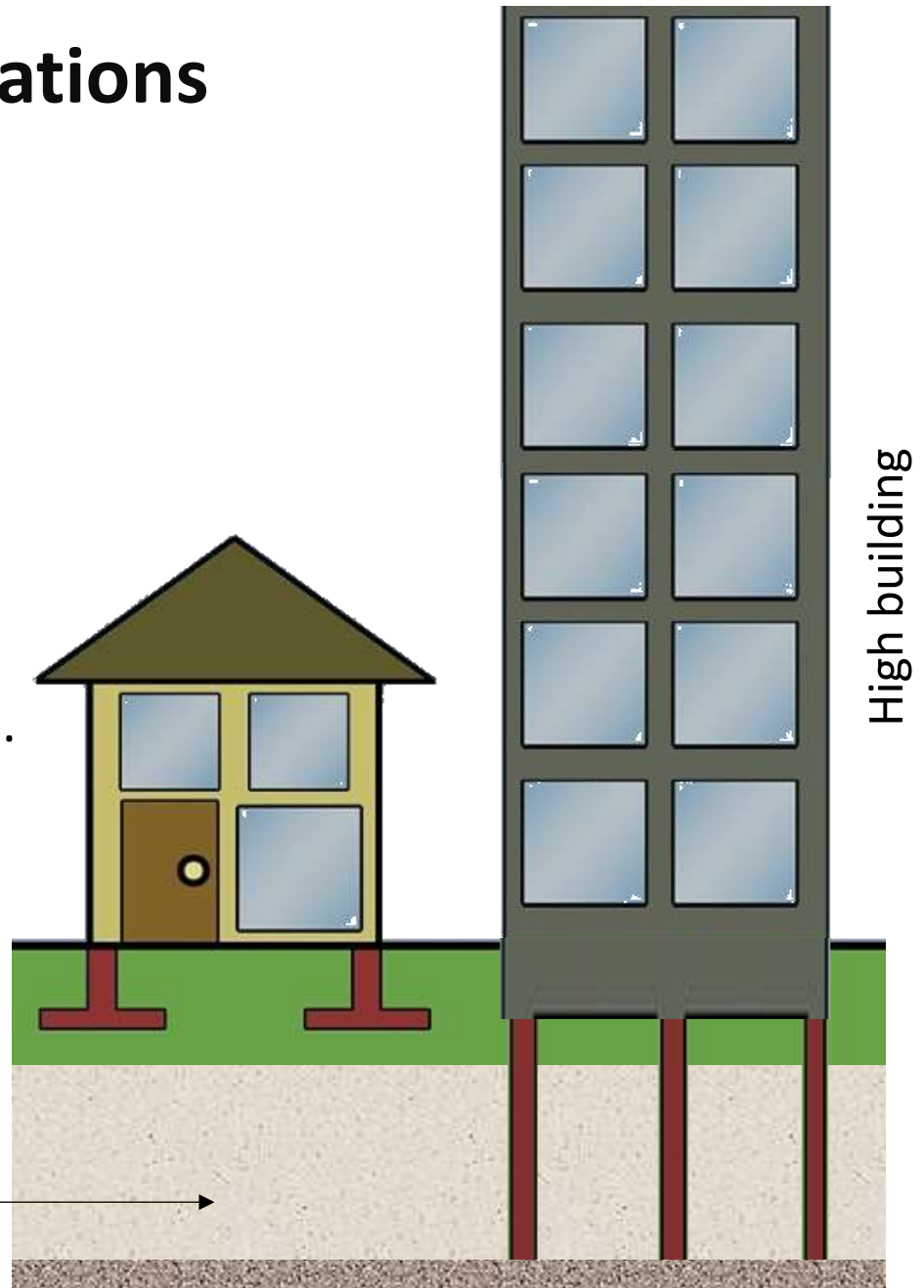
- Shallow, or
- Deep

They could be constructed from:

- Concrete (reinforced)
- Steel
- Other materials: Timber, Stones,...

*Low-rise building supported by
Shallow foundations
(footings)* →

*Deep foundation
(piles)* →

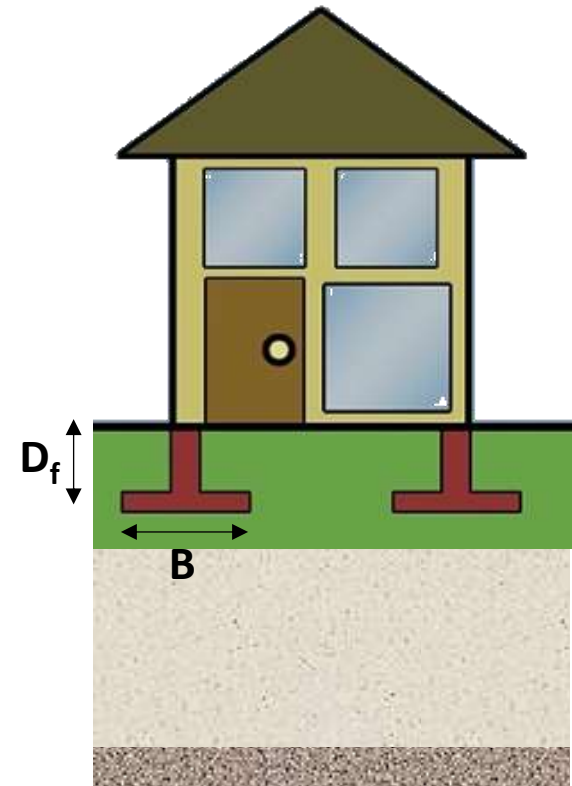


Shallow foundations

- Definition
- Advantages
- Types of shallow foundations

➤ Definition

- Shallow foundations are those founded near to the finished ground surface; generally where the founding depth (D_f) is less than the width of the footing (B) and generally less than 3m.
- Shallow foundations are used when surface soils are sufficiently strong and stiff to support the imposed loads.
- They are generally unsuitable in weak or highly compressible soils, such as poorly-compacted fill, peat, and alluvial deposits, etc.



➤ Advantages

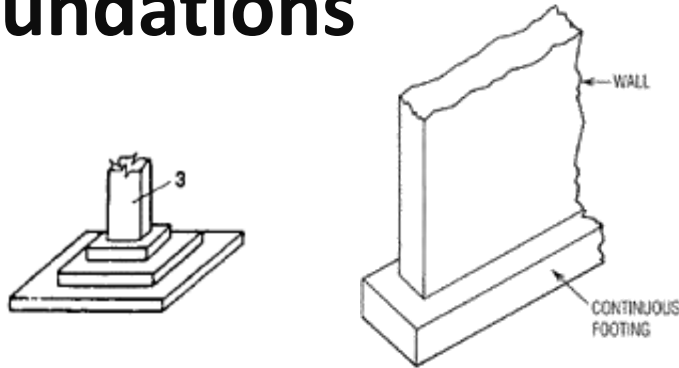
- Cost (affordable)
- Construction procedures (simple)
- Material (mostly reinforced concrete)
- Labor (doesn't need high experience)



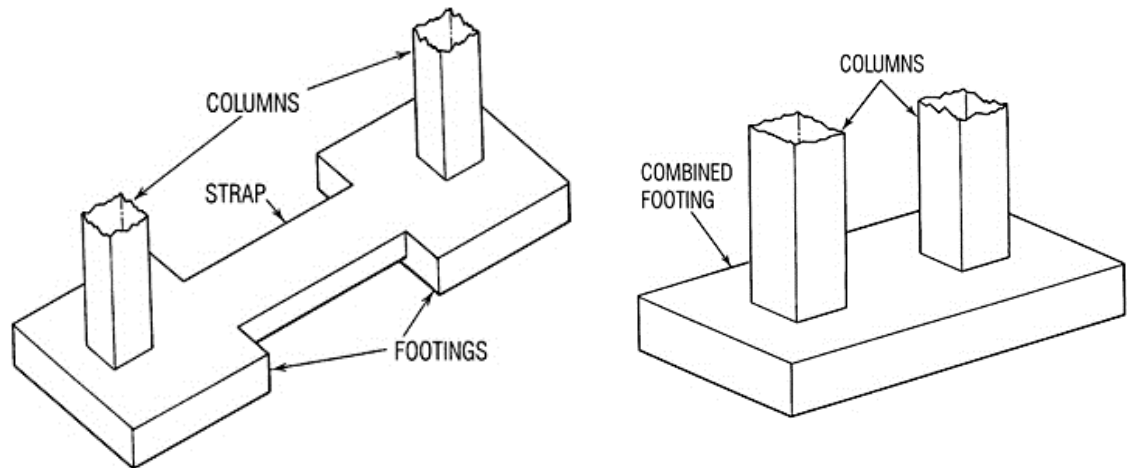
Types of shallow foundations

Shallow Foundation

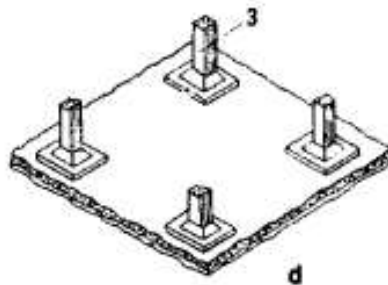
1 Spread



2 Combined



3 Mat (Raft)



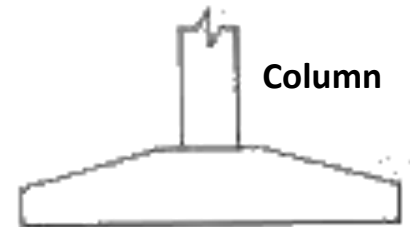
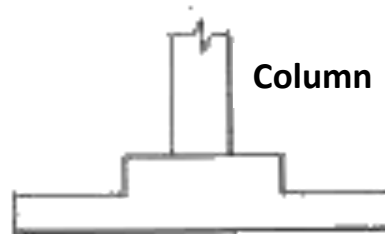
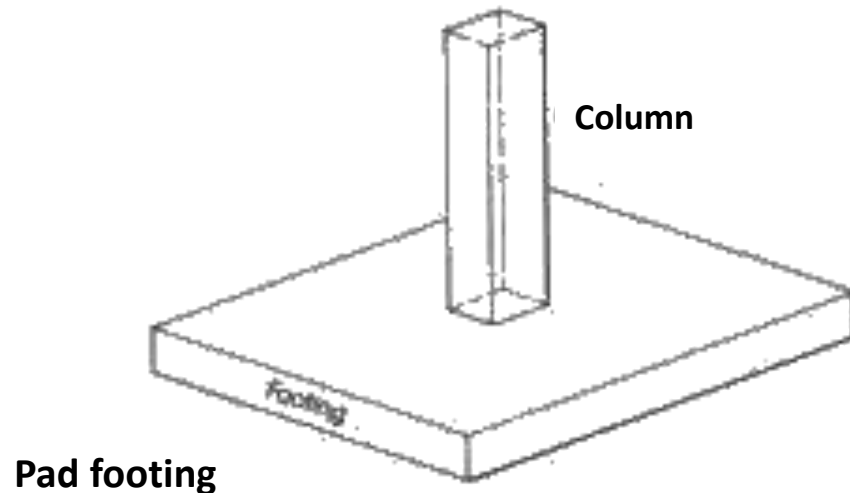
Types of shallow foundations

Shallow Foundation

1 Spread

- **Pad foundations**
-

often rectangular or square and are used to support single columns. This is one of the most economical types of footings and is used when columns are spaced at relatively long distances.



➤ Types of shallow foundations

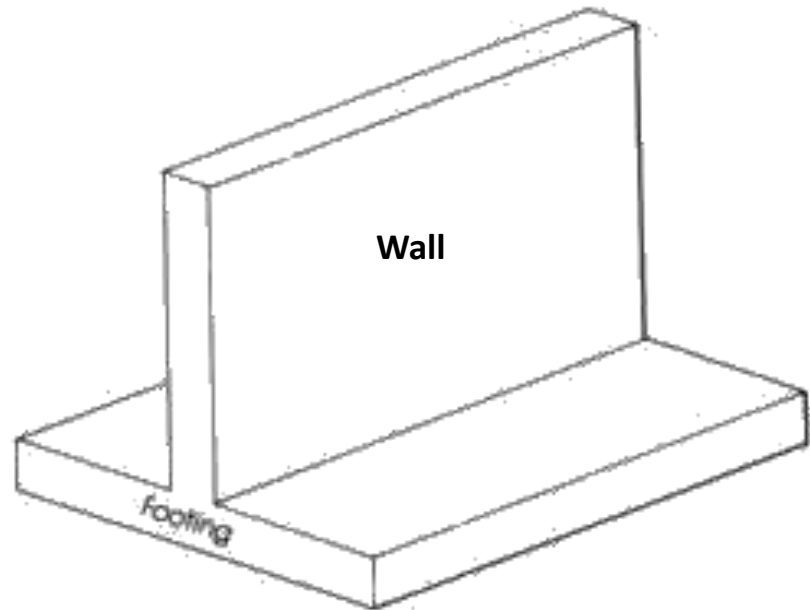
Shallow Foundation

1 Spread

- Pad foundations
- **Strip foundation**



Strip footings are **continuous** foundation used to support **walls**.



Strip, continuous, or wall footing

Types of shallow foundations

Shallow Foundation

1

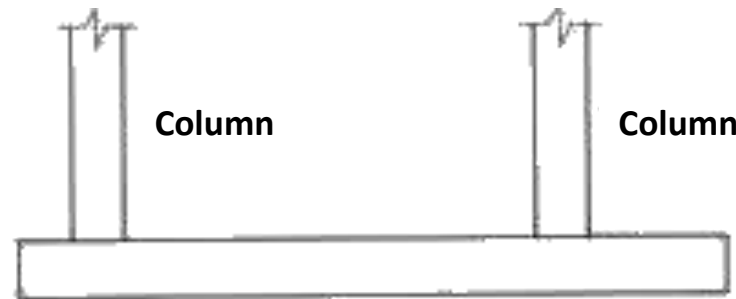
2

Combined

- Rectangular →
-
-

3

Combined footings are used when two columns are so close that single footings cannot be used or when one column is located at or near a property.



Cross section



Plan view

Types of shallow foundations

Shallow Foundation

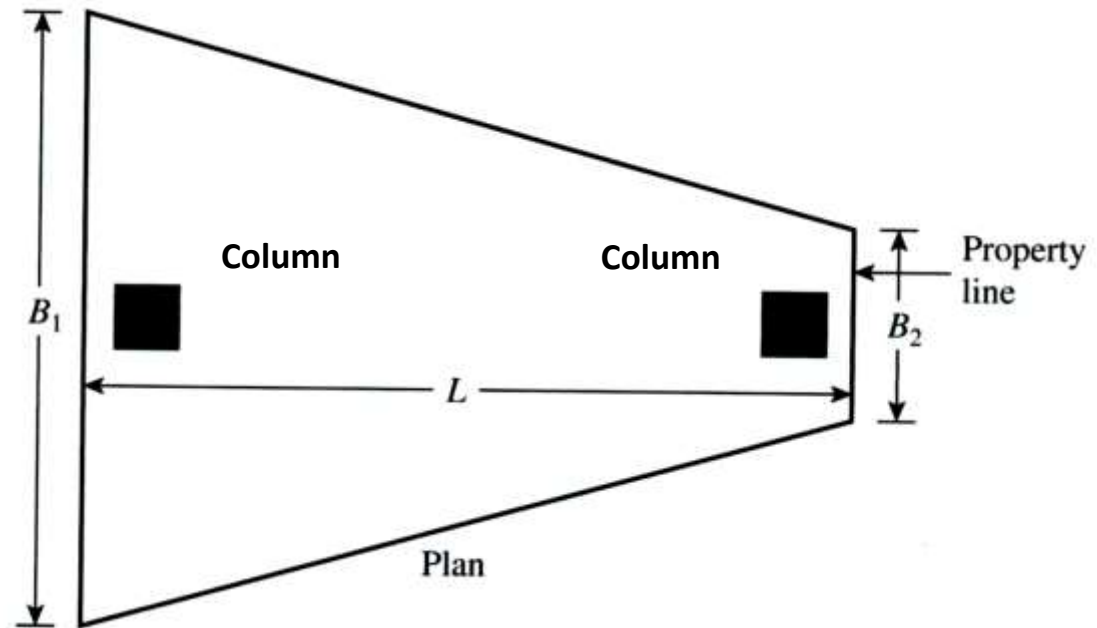
1

2

Combined

- Rectangular
- Trapezoidal

3



View plan of Trapezoidal combined Footing

Types of shallow foundations

Shallow Foundation

1

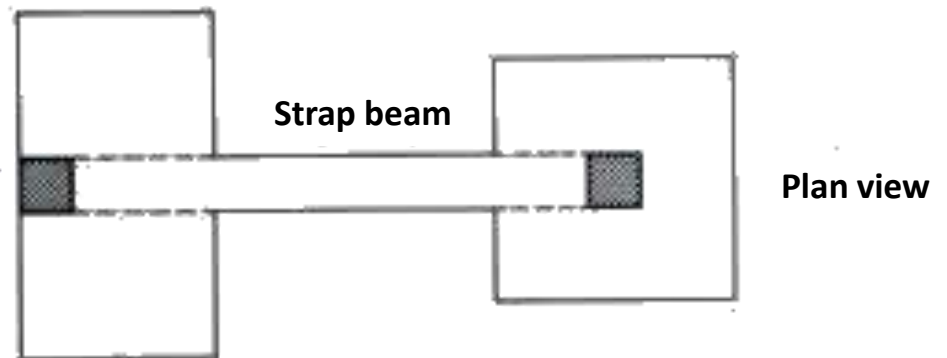
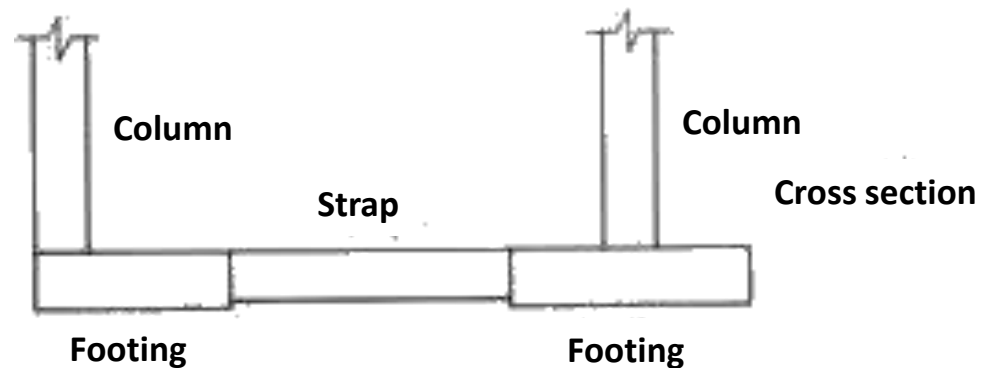
2

Combined

- Rectangular
- Trapezoidal
- **Strap** →

3

Consist of two single footings connected with a **beam** or a strap and support two single columns. This type replaces other combined footings and is more economical.



Types of shallow foundations

Shallow Foundation

1

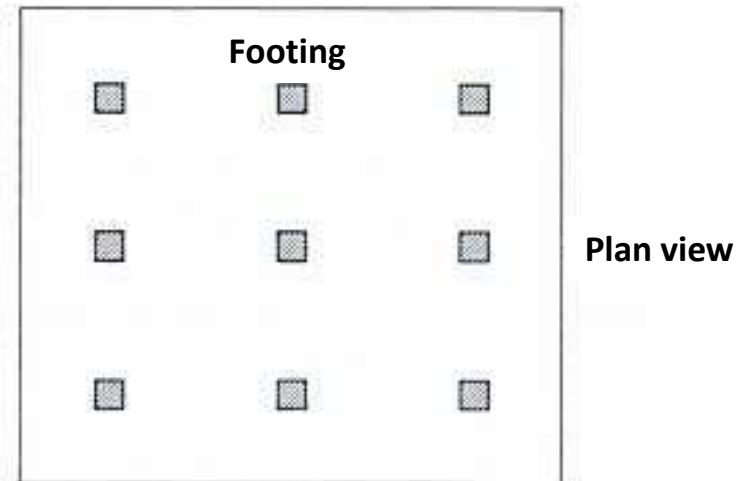
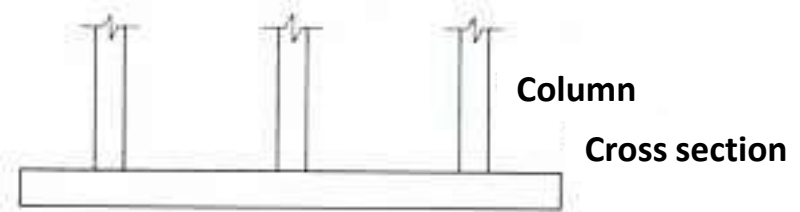
2

3

Mat (Raft)



Consists of one slab usually placed under the entire building area.



➤ Types of shallow foundations

Shallow Foundation

1

2

3

Mat (Raft)

Raft foundations are used, when soil bearing capacity is low, column loads are heavy, single footings cannot be used, piles are not used, and differential settlement must be reduced.



Types of shallow foundations

Shallow Foundation

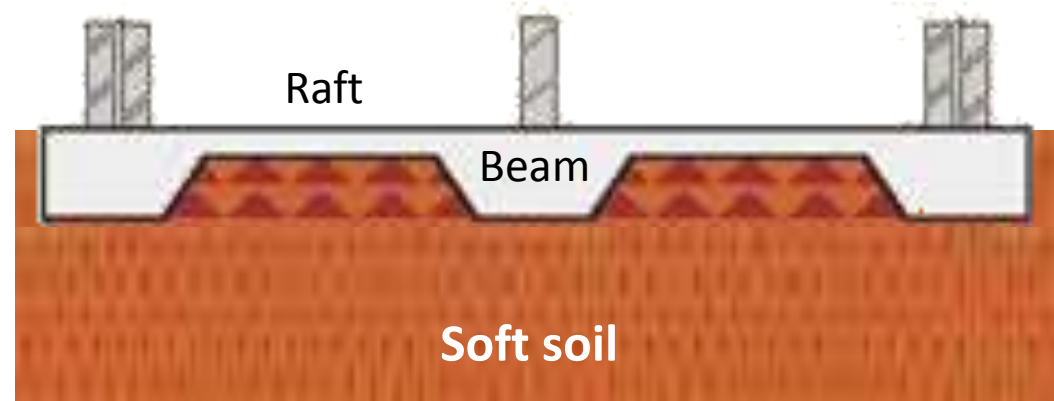
1

2

3

Mat (Raft)

A raft foundation normally consists of a **concrete** slab which extends over the entire loaded area. It may be stiffened by ribs or **beams** incorporated into the foundation.

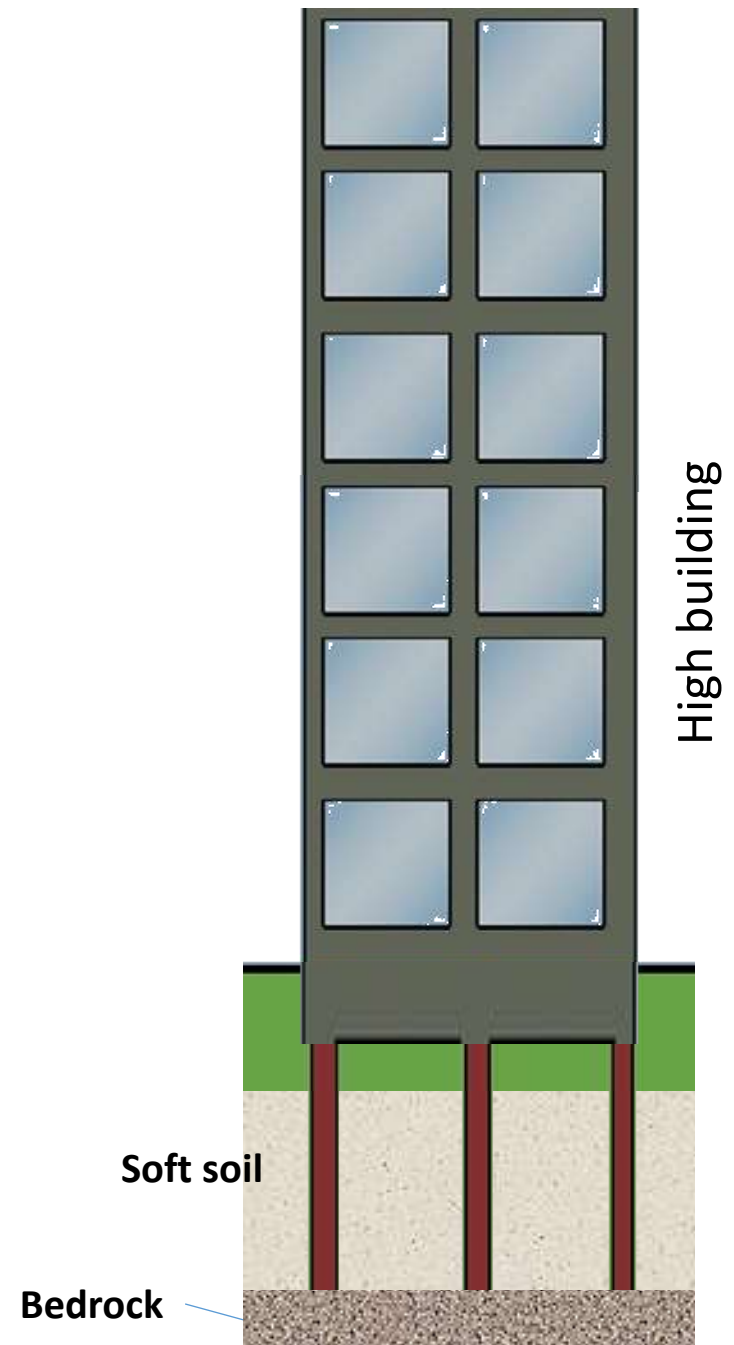


Deep foundations

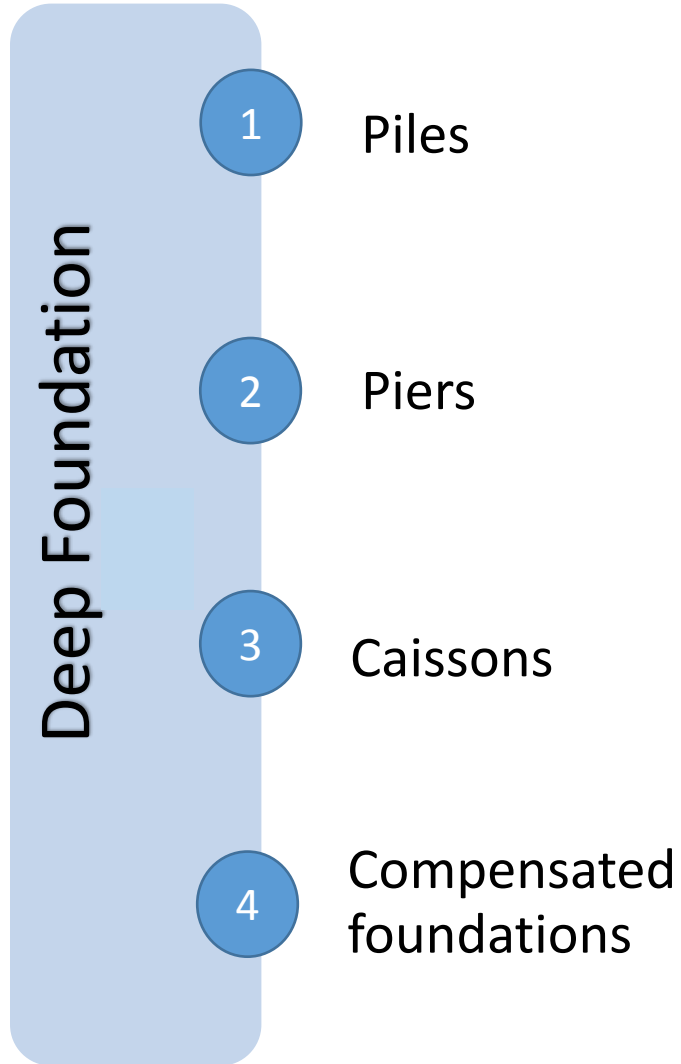
- Definition
- Types of deep foundations

➤ Definition

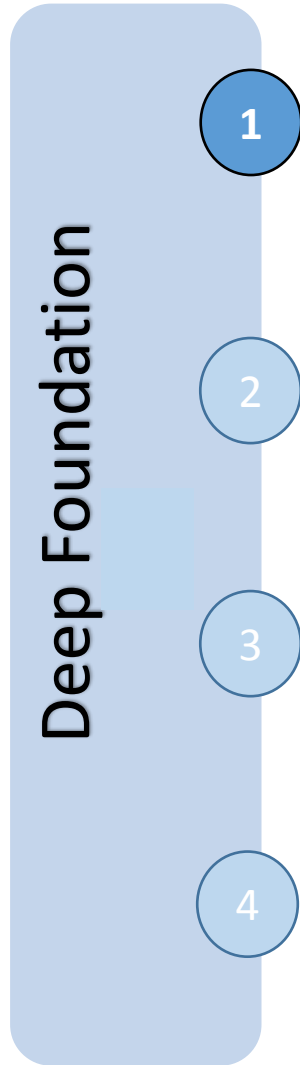
- Deep foundations are those founded too deeply below the finished ground surface for their base bearing capacity to be affected by surface conditions, this is usually at depths >3 m below finished ground level.
- Deep foundations are used when there are weak soils near the surface or when loads are very high, such as very large skyscrapers.
- Deep foundations derive their support from deeper soils or bedrock.



➤ Types of deep foundations



➤ Types of deep foundations

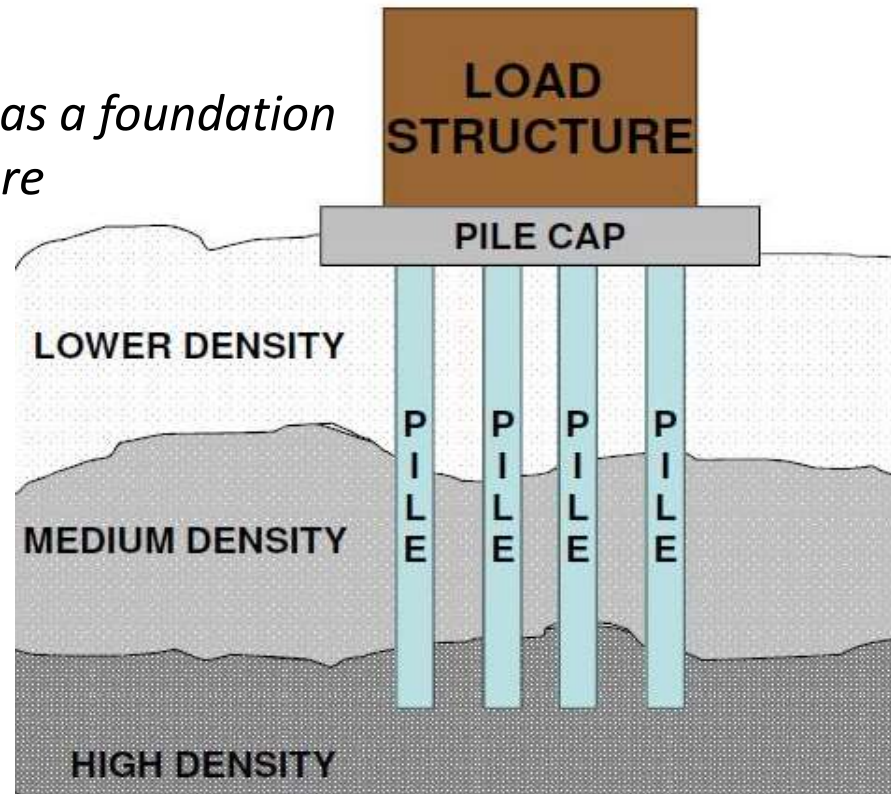


1 Piles

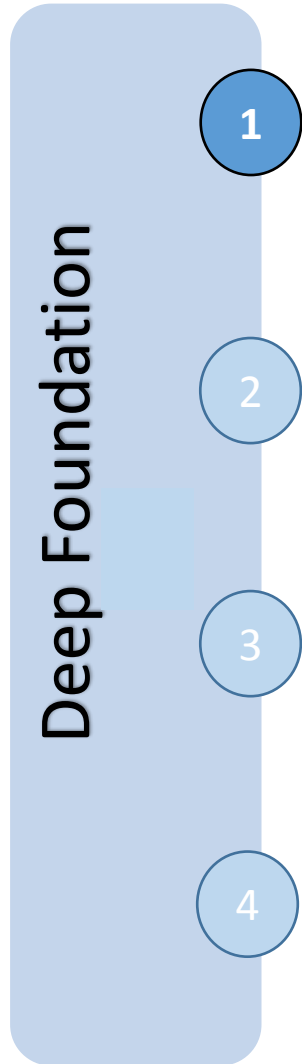


Piles are relatively long, slender members that transmit foundation loads through soil strata of low bearing capacity to deeper soil or rock strata having a high bearing capacity.

Piles used as a foundation for structure



➤ Types of deep foundations



Piles

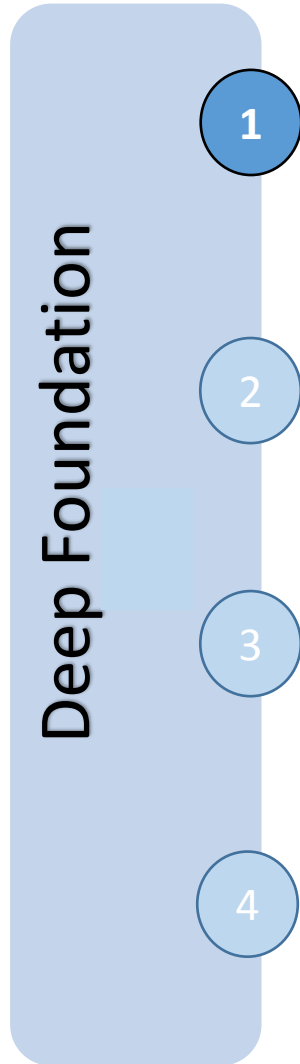


In addition to supporting structures, piles are also used to anchor structures against uplift forces and also to assist structures in resisting **lateral** and overturning forces.



Piles used as a retaining wall

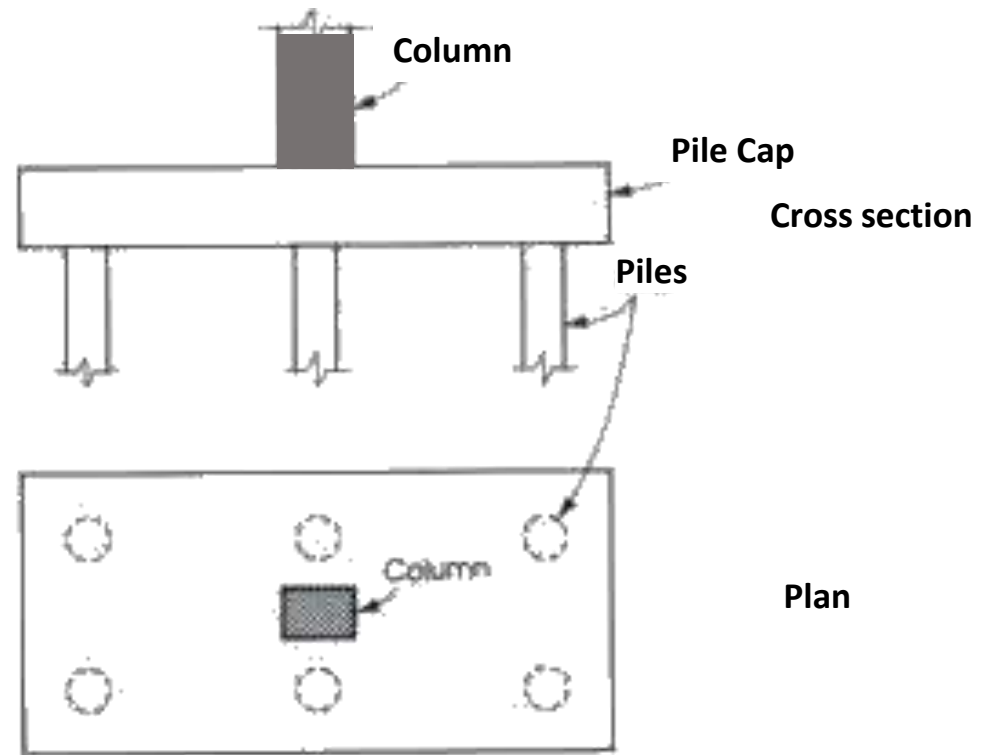
➤ Types of deep foundations



Piles



Pile caps are thick slabs used to tie a group of piles together to support and transmit column loads to the piles.



➤ Types of deep foundations



Figure 1: Two views of a toppled 13-storey apartment building that buried one worker in Shanghai on 27th June 09. Photo: Reuters

➤ Types of deep foundations

Deep Foundation

1

Piles



Pile length and size should be designed to tolerate all possible loading conditions.

2

3

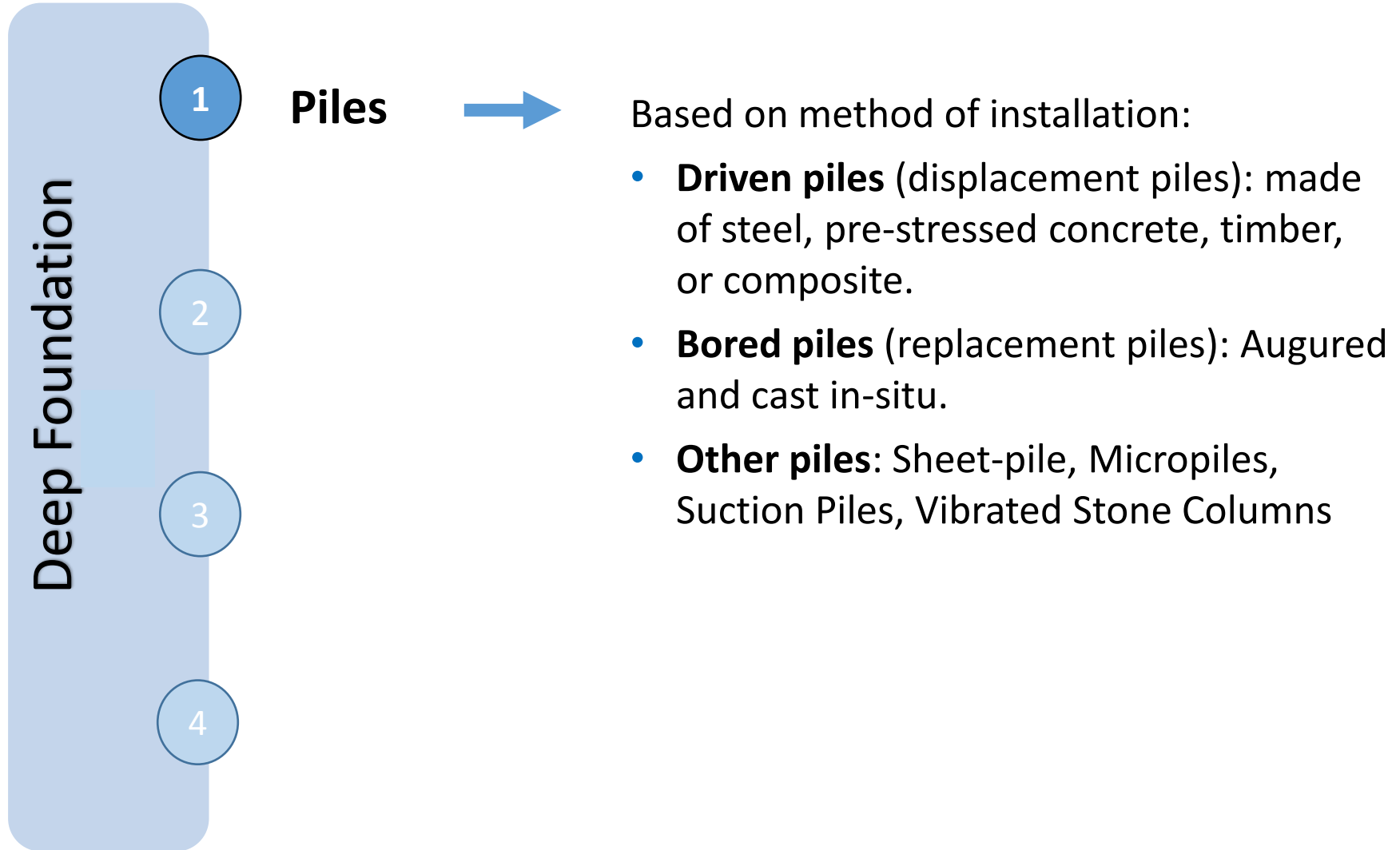
4



Shanghai building collapse

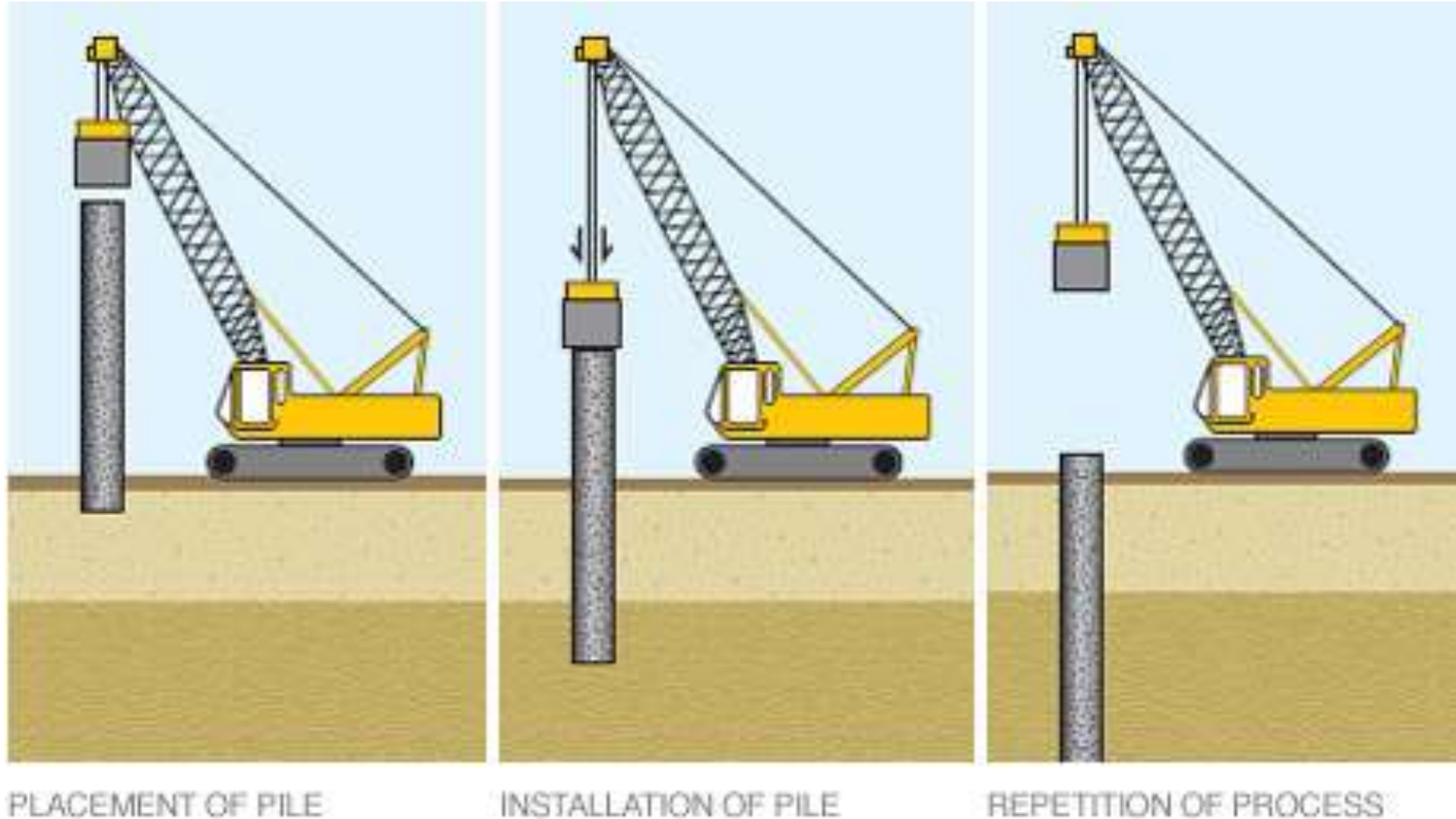


➤ Types of deep foundations



➤ Types of deep foundations

Driven Piles



➤ Types of deep foundations

Deep Foundation

1

Piles



Driven or displacement piles

2

- Advantages:-
 - may be inspected for quality and soundness before driving
 - not liable to squeezing or necking
 - construction not affected by ground water
 - can be left protruding above G.L. (useful in marine structures)
 - can withstand high bending and tensile stresses
 - can be driven in long lengths

3

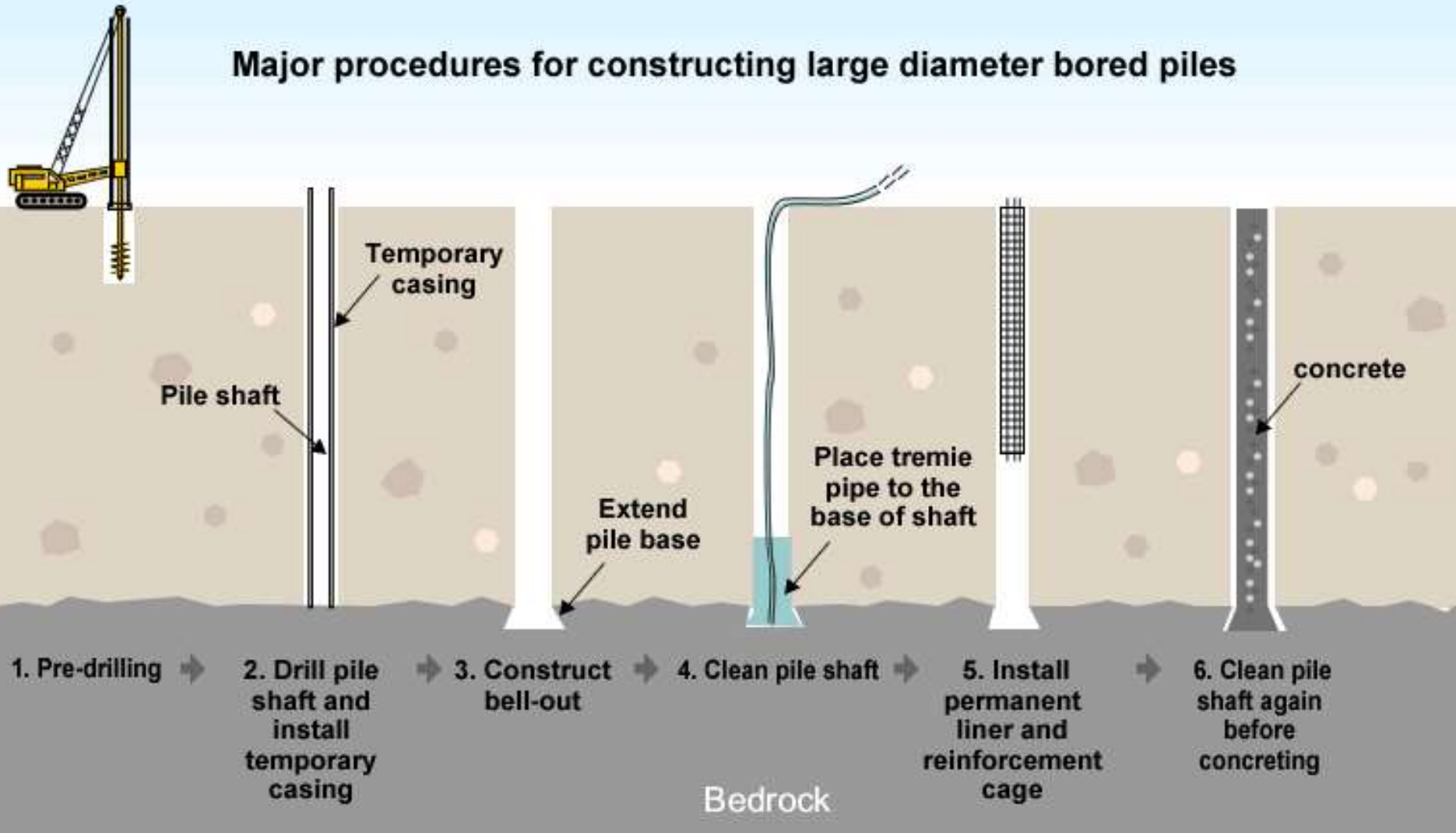
- Disadvantages:-
 - unjointed types cannot easily be varied in length
 - may break during driving
 - uneconomic if the design is governed by driving stresses rather than working stresses
 - noise and vibration during driving
 - displacement of soil may affect adjacent structures
 - cannot be driven in situations of low head room

4

Types of deep foundations

Bored piles

Major procedures for constructing large diameter bored piles



➤ Types of deep foundations

Deep Foundation

1

Piles



Bored or replacement piles

- Advantages:
 - length can be varied, very long lengths possible
 - removed soil can be compared with design data
 - penetration tests can be carried out in boreholes
 - very large bases can be possibly formed
 - drilling tools can break up boulders, obstructions,...
 - **little noise** and **vibration** during construction
 - no ground heave

2

3

4

- Disadvantages:
 - piles liable to squeezing and necking in soft soil
 - special techniques required for concreting in water bearing ground
 - concrete cannot be inspected after installation
 - enlarged bases cannot be formed in collapseable soil
 - cannot be easily extended above ground
 - boring may cause instability and settlement of adjacent structures

➤ Types of deep foundations

Deep Foundation

1

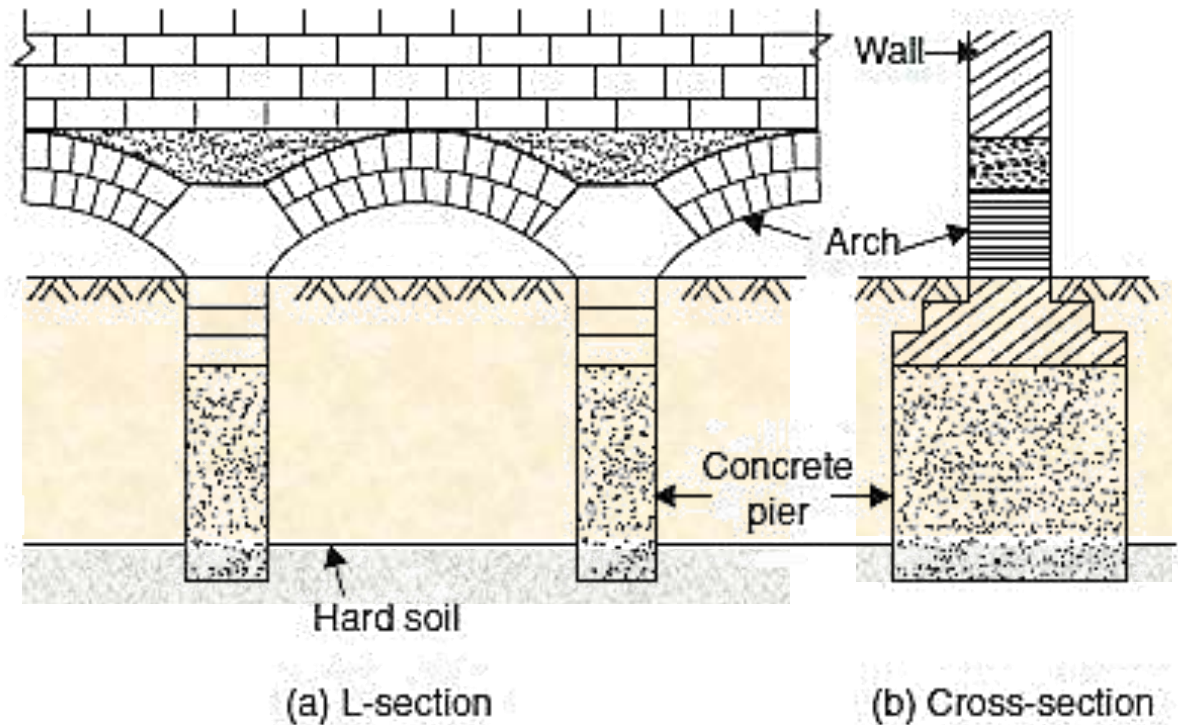
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Piers

3

4

Piers are foundations for carrying a heavy structural load which is constructed in-situ in a deep excavation.



➤ Types of deep foundations

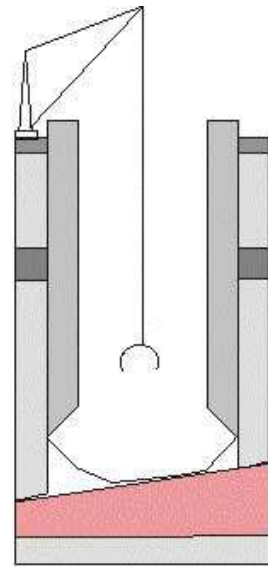
Deep Foundation

1

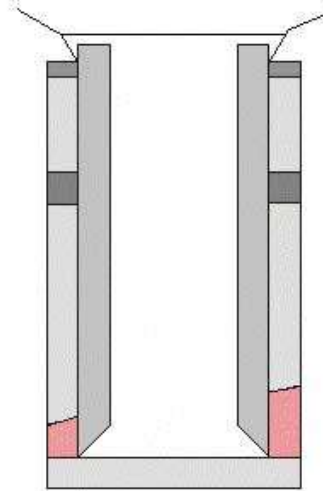
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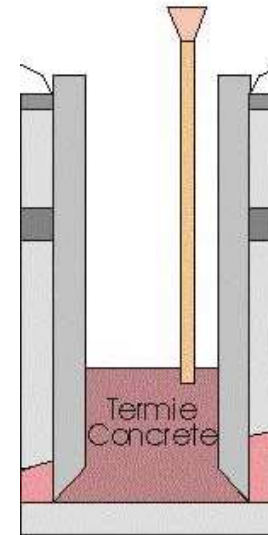
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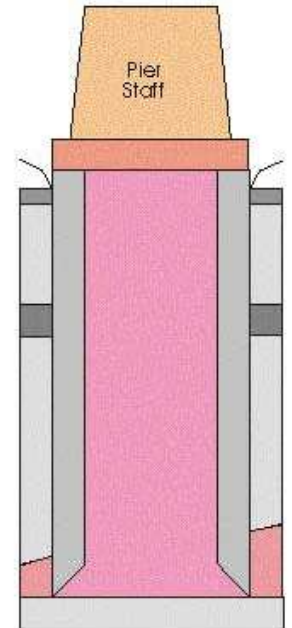
A



B



C



D

Caissons

Caissons are a form of deep foundation which are constructed **underwater** above seabed, then sunk to the required level by excavating or dredging material from within the caisson.

Types of deep foundations

Deep Foundation

1

- These are deep foundations in which the relief of stress due to excavation is approximately balanced by the applied stress due to the foundation.
- The net stress applied is therefore very small. A compensated foundation normally comprises a deep basement.

2

3

4

Compensated foundations

