# Review of Foundation Engineering

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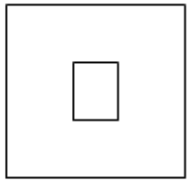
# Foundation

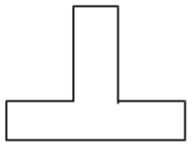
- Foundation is a part of a structure which transmits loads directly to the underlying soil or rock.
- A foundation plays an important role as an interface between the load carrying components of a structure to the ground.
- Types of Foundation include: Shallow Foundation, Mat Foundation and Deep Foundation

# Shallow Foundation

- Shallow foundation is selected if the supporting soil is close to the surface. The foundations are located just below the lowest part of the superstructures they support.
- The means of support is usually either a footing, which is often simply an enlargement of the base of the column, or wall that it supports, or a mat or raft foundation, in which a number of columns are supported by a single slab.
- The enlarged size of the footing (compared with the column it supports) gives an increased contact area between the footing and the soil. The increased area serves to reduce pressure on the soil to an allowable amount, thereby preventing excessive settlement or bearing failure of the foundation.

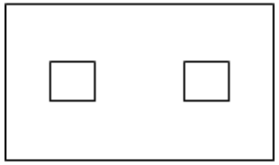


Plan

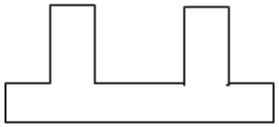


Elevation

a. Individual Footing

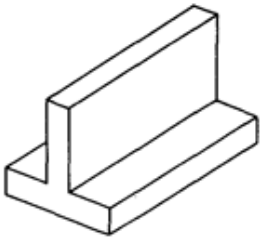


Plan

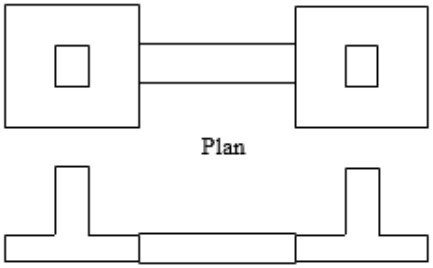


Elevation

b. Combined Footing



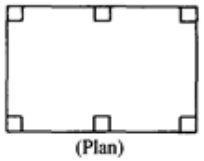
c. Strip/Wall Footing



Plan

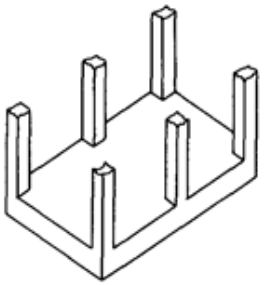
Elevation

d. Strap Footing



(Plan)

(Elevation)



e. Mat/Raft Footing

Figure 1.1 Types of shallow foundation

# Deep Foundation

- Sometimes, the soil near the surface is incapable of supporting structural load. In such cases, deep foundations may be used to transmit the load of the structure to firmer soil or rock at a greater depth below the structure. For deep foundations, the means of support is usually a pier, drilled shaft or group of piles.

# Load Transfer Mechanism for Deep Foundation

By end bearing

By friction

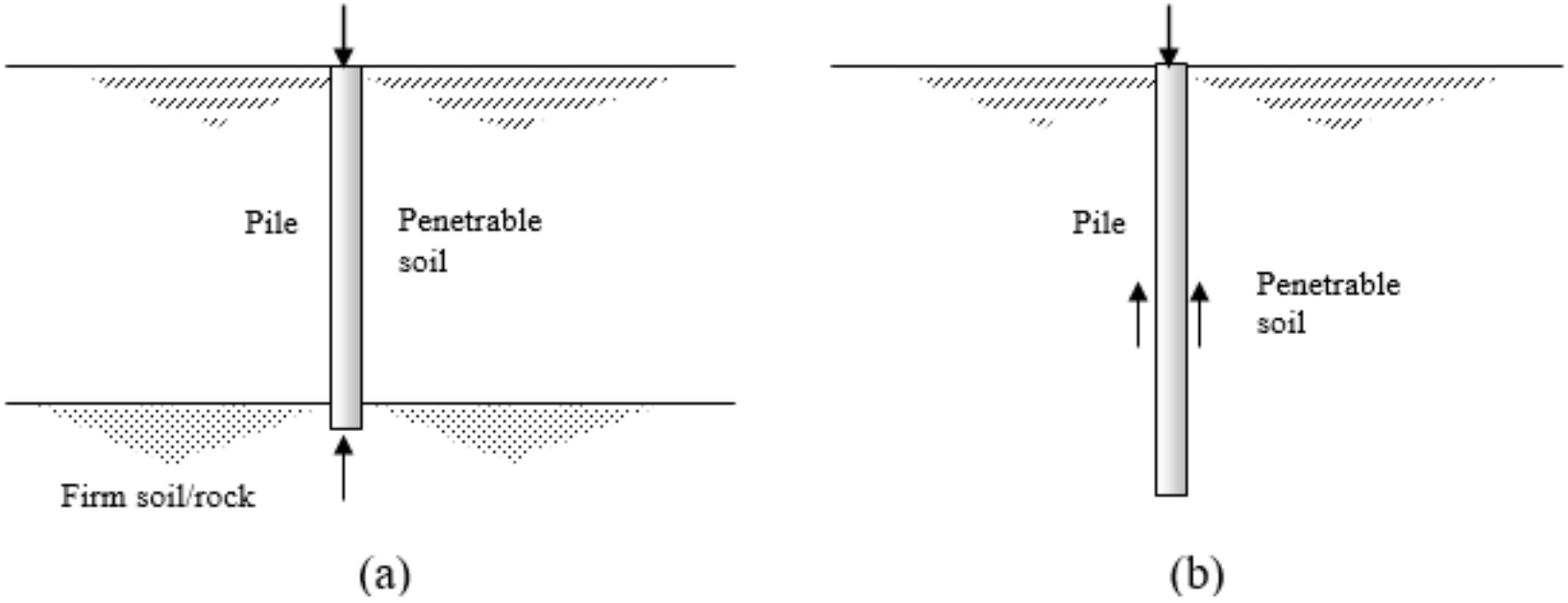



Figure 1.2 Load transfer mechanism in pile

# Piles should be selected as foundation if:

- Piles are needed when designing foundation of transmission tower, offshore platforms or basement mats subjected to uplifting force.
- Pile should extend to stable soil layer when the foundation soil is susceptible to swelling or collapse.
- Piles are required to support bridge abutments to avoid scouring at the foundation base.
- Piles are used extensively to resist both vertical and lateral loads from retaining structures and tall buildings, as well as harbor and offshore structures.

# Designing a Foundation

In designing a foundation of any civil engineering structures, one should know:

- The subsurface condition of the site. Soil profiles and soil parameters obtained from field and laboratory testing are required for selecting the type of foundation to be used and to determine the design of the foundation. It should be noted that the selection of design parameters based on site investigation is not an easy task for foundation engineers because it involves not only scientific principles gained through geotechnical engineering courses but also experience and engineering judgment.
- A rough estimate of the foundation loads can be calculated based on the layout of the structures and other information provided by the client. In general, a structure may be subjected to dead load, live load, earth pressure, water pressure, and possibly wind load or earthquake forces. Proportioning of the load applied to foundation for different types of structures at any particular location can be found in design manual or building code (SNI).

# Loads on Foundation

- **Dead load** refers to the overall weight of a structure itself including the weight of materials permanently attached to the structure and fixed service equipment. The load can be calculated if sizes and types of structural material are known.
- **Live Load** refers to weights of applied bodies that are not permanent parts of a structure including people, warehouse goods, furniture, etc. The live loads to be used in structural design of different types of structures are usually specified by local building codes (SNI).
- **Earth pressure** produces a lateral force that acts against the portion of substructure lying below ground or fill level. It is normally treated as dead load. In addition to lateral force, water can induce hydraulic uplift force to the structure. Lateral water pressure is generally balanced, but hydrostatic uplift must be counteracted by the structure's dead load or an anchoring system. Wind load is the most common load acting horizontally on all exposed surfaces of structures. Design wind loads can also be calculated based on building codes.
- **Earthquake Loads**

# Design Requirements

In the design of any foundation, the focus was to limit the applied load on foundation so that shear failure will not occur in soil. In this case, the factor of safety against shear failure of the supporting soil must be adequate. Higher factor of safety (usually between 2.5 and 3.0) is required in the design of foundation because of the uncertainties in loads and soil properties used for the design.

Furthermore, the settlement/movement of the foundation should be tolerable; in particular differential settlement should neither cause any unacceptable damage nor interfere with structural function. Excessive settlements rarely results in a collapse or partial collapse or localized failure in a structural member. More common consequences of settlement are unsightly wall and floor cracks, uneven floors (sags and slopes), sticking doors and windows, and similar. The limit of settlement of individual footing on sand is 50mm or 75mm for footing on clay. In most cases, the critical settlement is not the total settlement but rather the differential settlement. Distortion of less than 1/500 is prescribed.

# Design Requirements

Another consideration is the position of ground water table and the existence of weak layer below a strong layer. It is safer and more economical to place a shallow foundation above groundwater level. The presence of weak layer below a strong layer should be considered in the estimation of bearing capacity and settlement of the foundation.

The other requirement in the design of foundation is that the operations involved in the construction should have no adverse effect to the adjacent structures and services. The position of new footing or other types of foundation should be aligned to the exiting structures because these structures may be damaged by construction of new foundation nearby during the construction process or after placement of the new structure.

When designing a shallow foundation, one should consider the depth of embedment because deep excavation may cause cave-in. Depth of embedment must be adequate to avoid lateral squeezing of material from beneath the foundation for footings and mats. Similarly, protection against lateral squeezing due to excavation may be required for adjacent buildings. Furthermore, the foundation scheme may have to consider expansive soil conditions because the presence of substantial moisture can results in uplift pressure to the foundation.

# References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# Thanks for your attention