Chapter 11
Bearing Capacity and Foundations: Shallow and Deep

ABSTRACT

Foundations are structural elements that transmit loads from structures to the underlying soil. The choice of the appropriate type of foundation is governed by some important factors such as the nature of the structure, the loads exerted by the structure, the subsoil characteristics, and the allotted cost of foundations. The primary design concerns of foundations are settlement and bearing capacity. The design must also take into consideration the requirements of safety, dependability, serviceability, functional utility, and economy. The chapter considers the modes of failure and several methods of determining the ultimate bearing capacity of foundations. The procedure and considerations in the design of shallow foundation are discussed. The chapter examines the types, situations calling for the use, advantages and disadvantages, load-carrying capacity, and design of deep foundations. The efficiency of the group of deep foundations is discussed. The group capacity can be determined by the use of empirical formulas and by the rational/equivalent method. Negative skin friction, its causes, capacity, and ways of reducing its effect are considered.

11.0 FOUNDATIONS: SHALLOW AND DEEP

Foundations are structural elements that transmit loads from structures to the underlying soil. A foundation can be defined as the supporting base of a structure which forms the interface across which the structural loads are transmitted to the underlying soil or rock. In most cases, foundations in civil engineering are constructed of plain or reinforced concrete, notable exceptions being roads, embankments and dams. Foundations must be designed to maintain soil pressures at all depths within the allowable bearing capacity of the soil and also must limit total and differential movements to within levels that can be tolerated by the structure.

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11.0.1 Classes of Foundations

There are two main classes of foundation namely shallow foundations and deep foundations, Figure 1.  

Shallow foundations, often called footings, are usually, embedded about a meter or so into soil. One common type is the spread footing which consists of strips or pads of concrete (or other materials) which extend below the swell and shrink line in the tropical countries or frost line in the temperate countries and transfer the weight from walls and columns to the soil or bedrock.

A footing is actually an enlargement of the base of a column or wall for the purpose of distributing the load on the supporting soil at the appropriate pressure. There are different types of footings to suit the nature of the structure.

A deep foundation is used to transfer a load from a structure through an upper weak layer of soil to a stronger deeper layer of soil. There are different types of deep footings including impact driven piles, drilled shafts, caissons, helical piles, and earth stabilized columns.

A Caisson (monopole) foundation is a type of deep foundation which uses a single, generally large-diameter, structural element embedded into the earth to support all the loads (weight, wind, etc.) of a large above-surface structure.

In shallow foundations, the depth of the footing ($D_f$) is generally equal to or less than the width ($B$) of the footing. Deep foundations are foundations where the depth of the footing ($D_f$) is greater than the width ($B$) of the footing.

The choice of the appropriate type of foundation is governed by some important factors such as

1. The nature of the structure,
2. The loads exerted by the structure,
3. The subsoil characteristics,
4. The allotted cost of foundations.

Therefore to decide about the type of foundation, subsoil exploration must be carried out. Then the soil characteristics within the affected zone below the building should be carefully evaluated. The allowable bearing capacity of the affected soil strata should then be estimated. After this study, one could then decide whether shallow foundations or deep foundations should be used.

Shallow foundations, such as footings and rafts, cost less and are easier to execute while deep foundations usually cost more and require well trained engineers to execute. However the engineer should prepare an estimate of the cost of the most promising type of foundation which represents the most acceptable compromise between performance and cost.

11.0.2 Design Considerations

The building

1. Must not settle excessively.
2. Must be placed at depth sufficient to prevent damage from surface environmental effects (frost, swelling and shrinkage, erosion and scour).
3. Must not cause failure of supporting soil (Bearing Capacity criteria).