

## **UNIT V DESIGN OF FOOTINGS**

### **5.1 Concepts of Proportioning footings and foundations based on soil properties**

1. Foundation structures should be able to sustain the applied loads, moments, forces and induced reactions without exceeding the safe bearing capacity of the soil.
2. The settlement of the structure should be as uniform as possible and it should be within the tolerable limits. It is well known from the structural analysis that differential settlement of supports causes additional moments in statically indeterminate structures. Therefore, avoiding the differential settlement is considered as more important than maintaining uniform overall settlement of the structure.

In addition to the two major requirements mentioned above, the foundation structure should provide adequate safety for maintaining the stability of structure due to either overturning and/or sliding. It is to be noted that this part of the structure is constructed at the first stage before other components (columns / beams etc.) are taken up. So, in a project, foundation design and details are completed before designs of other components are undertaken. However, it is worth mentioning that the design of foundation structures is somewhat different from the design of other elements of superstructure due to the reasons given below. Therefore, foundation structures need special attention of the designers.

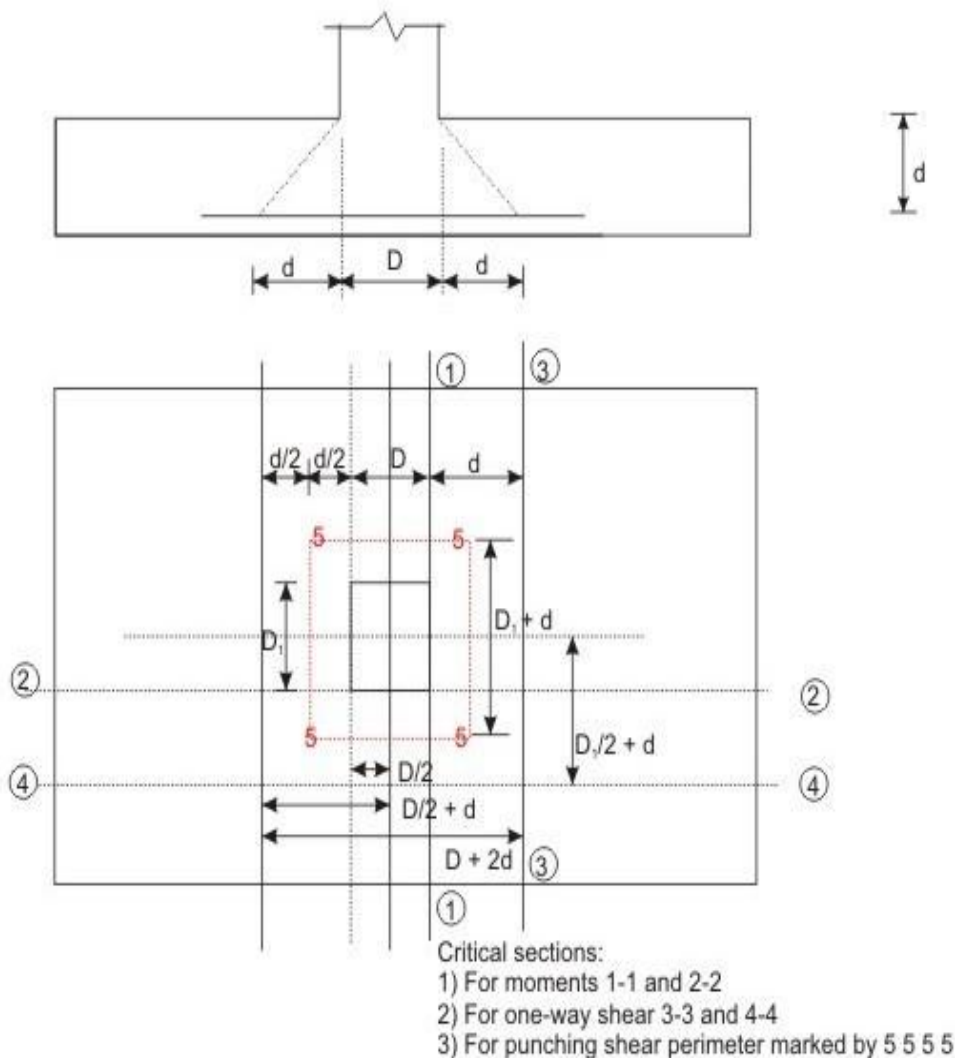
1. Foundation structures undergo soil-structure interaction. Therefore, the behaviour of foundation structures depends on the properties of structural materials and soil. Determination of properties of soil of different types itself is a specialized topic of geotechnical engineering. Understanding the interacting behaviour is also difficult. Hence, the different assumptions and simplifications adopted for the design need scrutiny. In fact, for the design of foundations of important structures and for difficult soil conditions, geotechnical experts should be consulted for the proper soil investigation to determine the properties of soil, strata wise and its settlement criteria.
2. Accurate estimations of all types of loads, moments and forces are needed for the present as well as for future expansion, if applicable. It is very important as the foundation structure, once completed, is difficult to strengthen in future.
3. Foundation structures, though remain underground involving very little architectural aesthetics, have to be housed within the property line which may cause additional forces and moments due to the eccentricity of foundation.
4. Foundation structures are in direct contact with the soil and may be affected due to harmful chemicals and minerals present in the soil and fluctuations of water table when it is very near to the foundation. Moreover, periodic inspection and maintenance are practically impossible for the foundation structures.
5. Foundation structures, while constructing, may affect the adjoining structure forming cracks to total collapse, particularly during the driving of piles etc. However, wide ranges of types of foundation structures are available. It is very important to select the appropriate type depending on the type of structure, condition of the soil at the location of construction, other surrounding structures and several other practical aspects as mentioned above.

**Types of Foundation Structures** Foundations are mainly of two types:

- (i) shallow and
- (ii) deep foundations.

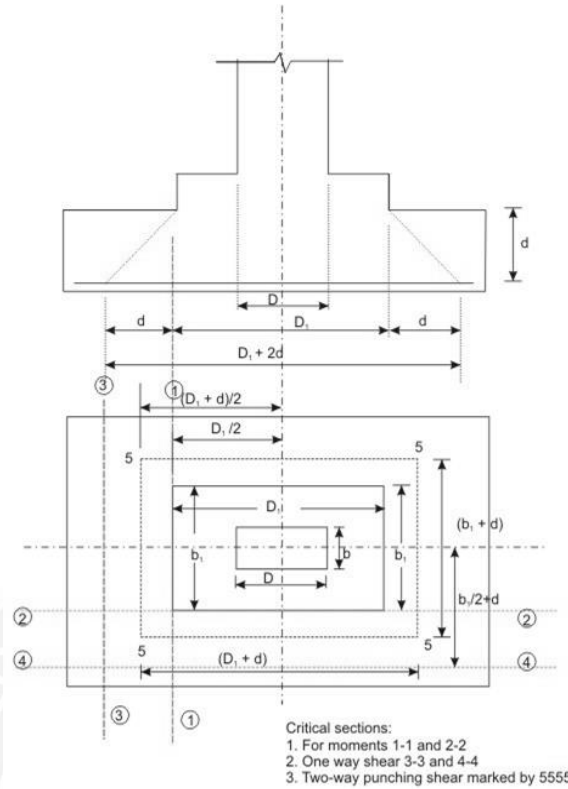
The two different types are explained below: (A) Shallow foundations Shallow foundations are used when the soil has sufficient strength within a short depth below the ground level. They need sufficient plan area to transfer the heavy loads to the base soil. These heavy loads are sustained by the reinforced concrete columns or walls (either of bricks or reinforced concrete) of much less areas of cross-section due to high strength of bricks or reinforced concrete when compared to that of soil.

### Isolated footings



**Figure: uniform and rectangular footing**

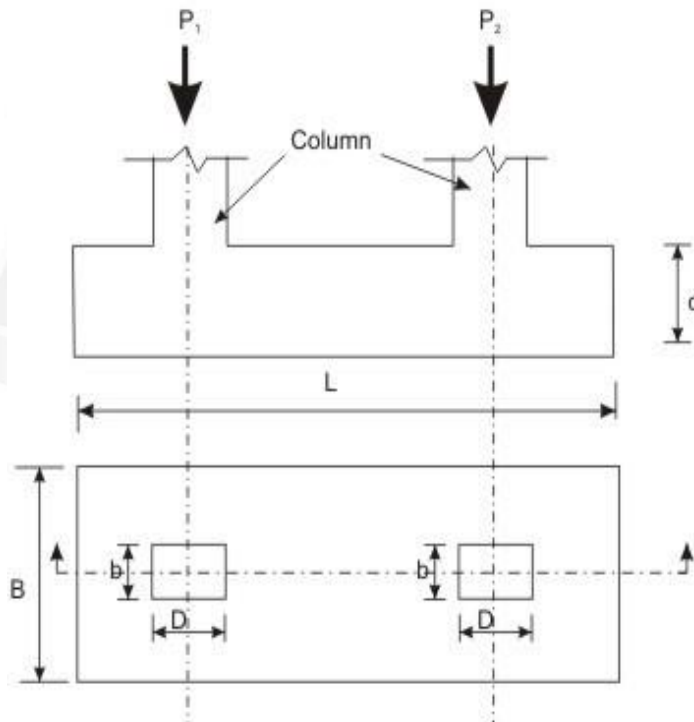
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**Figure: Stepped and rectangular footing**

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### Combined footings



**combined footing**

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