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FACULTY OF RNGINEERING AND TECHNOLOGY (DEPARTMENT OF CIVIL ENGINEERING)

BUILDING CONSTRUCTION

DIPLOMA (IInd YEAR/ IIIrd SEM)

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LECTURE-04
INTRODUCTION (FOUNDATION)

- Till now we discussed the different structural elements viz. beams, slabs, staircases and columns, which are placed above the ground level and are known as superstructure. The superstructure is placed on the top of the foundation structure, designated as substructure as they are placed below the ground level.

- The elements of the superstructure transfer the loads and moments to its adjacent element below it and finally all loads and moments come to the foundation structure, which in turn, transfers them to the underlying soil or rock.

- Thus, the foundation structure effectively supports the superstructure. However, all types of soil get compressed significantly and cause the structure to settle. Accordingly, the major requirements of the design of foundation structures are the two as given below (see cl.34.1 of IS 456):

I. Foundation structures should be able to sustain the applied loads, moments, forces and induced reactions without exceeding the safe bearing capacity of the soil.

II. 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.

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:

I. 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. 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.

INTRODUCTION

II. 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.

III. 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.

IV. 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.periodic inspection and maintenance are practically impossible for the foundation structures.

V. 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.

INTRODUCTION

The foundation systems are required to meet the following important requirements:-

I. The basic requirement for any structure regarding its load resisting capacity is that the structure shall be constructed in such a way that the combined dead loads, live loads, horizontal loads like earthquake and wind load can be resisted carried and transmitted to the ground safely without any structural damage, deflection and distortion.

II. Foundation should be taken sufficient in deep into the ground so that the structure is not affected by ground movement such as swelling. Shrinking, freezing. The landslide also should not affect the stability of the building. The structure should be safe against the damage and distress.

III. Foundation base should be rigid so that the differential settlement are minimised, especially in a case when superimposed loads are not evenly distributed over the foundation.

IV. Foundation should also be so located that its performance is not affected due to any unexpected future influence like earthquake and overloading.

V. Foundations must be designed to resist the ultimate loading cases combination to resist both overturning and sliding.

VI. Foundation should resist attack from chemicals in soil. Groundwater and soil may contain different types of chemicals which are harmful to the foundation concrete, the most aggressive of which are sulphates. Sulphate attack can usually be offset by using sulphate resisting cement, but even this will not be a perfect alternative to the problem unless sufficient care is taken in placing the concrete, by vibrating and curing.

VII. Foundation should be taken deep enough to resist the overturning, though soil bearing capacity is good at sufficient depth. And also deep enough so as to be free from swelling and swelling.

TYPES OF FOUNDATION STRUCTURES

Foundations are mainly of two types:

I. shallow and

II. deep foundations.

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.

- The strength of the soil, expressed as the safe bearing capacity of the soil, is normally supplied by the geotechnical experts to the structural engineer.

- Shallow foundations are also designated as footings.

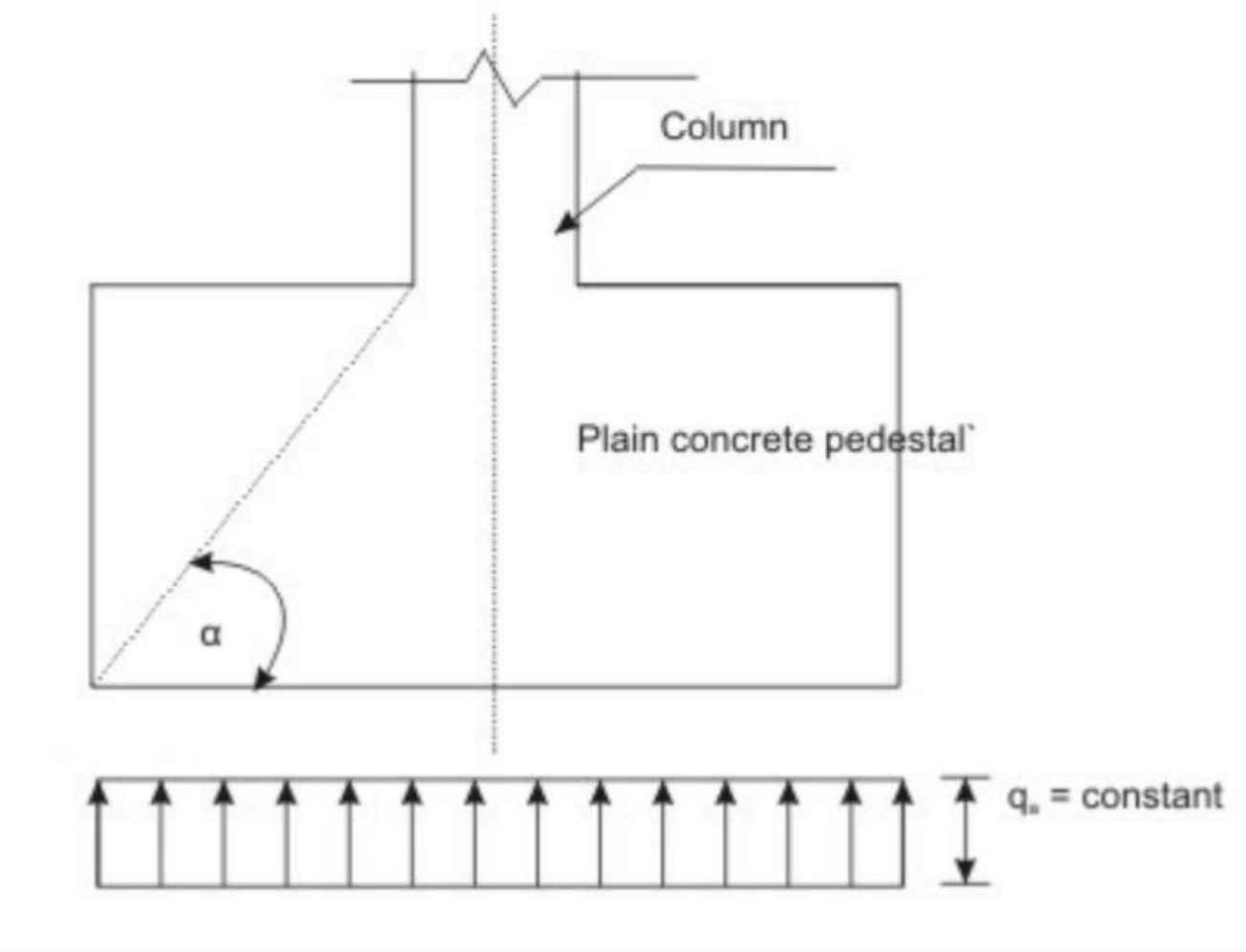
The different types of shallow foundations or footings are discussed below:-

PLAIN CONCRETE PEDESTAL FOOTINGS

- Plain concrete pedestal footings are very economical for columns of small loads or pedestals without any longitudinal tension steel (see cls.34.1.2 and 34.1.3 of IS 456).

- The angle α between the plane passing through the bottom edge of the pedestal and the corresponding junction edge of the column with pedestal and the horizontal plane shall be determined

TYPES OF FOOTING



PLAIN CONCRETE PEDESTAL FOOTINGS

TYPES OF FOOTING

ISOLATED FOOTINGS

- These footings are for individual columns having the same plan forms of square, rectangular or circular as that of the column, preferably maintaining the proportions and symmetry so that the resultants of the applied forces and reactions coincide.

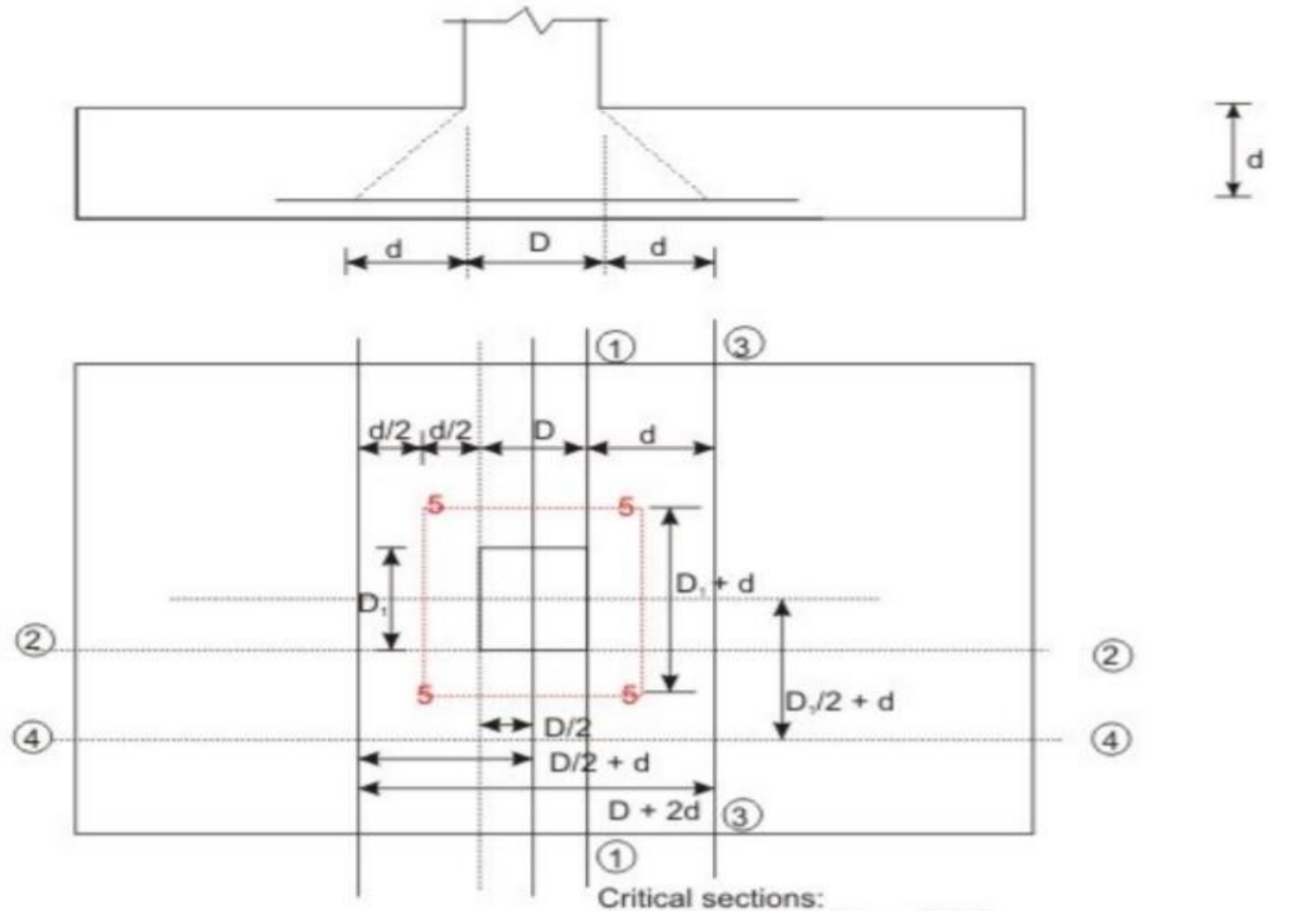
- These footings, consist of a slab of uniform thickness, stepped or sloped. Though sloped footings are economical in respect of the material, the additional cost of formwork does not offset the cost of the saved material. Therefore, stepped footings are more economical than the sloped ones.

- The adjoining soil below footings generates upward pressure which bends the slab due to cantilever action. Hence, adequate tensile reinforcement should be provided at the bottom of the slab (tension face).

- Clause 34.1.1 of IS 456 stipulates that the sloped or stepped footings, designed as a unit, should be constructed to ensure the integrated action. Moreover, the effective cross-section in compression of sloped and stepped footings shall be limited by the area above the neutral plane.

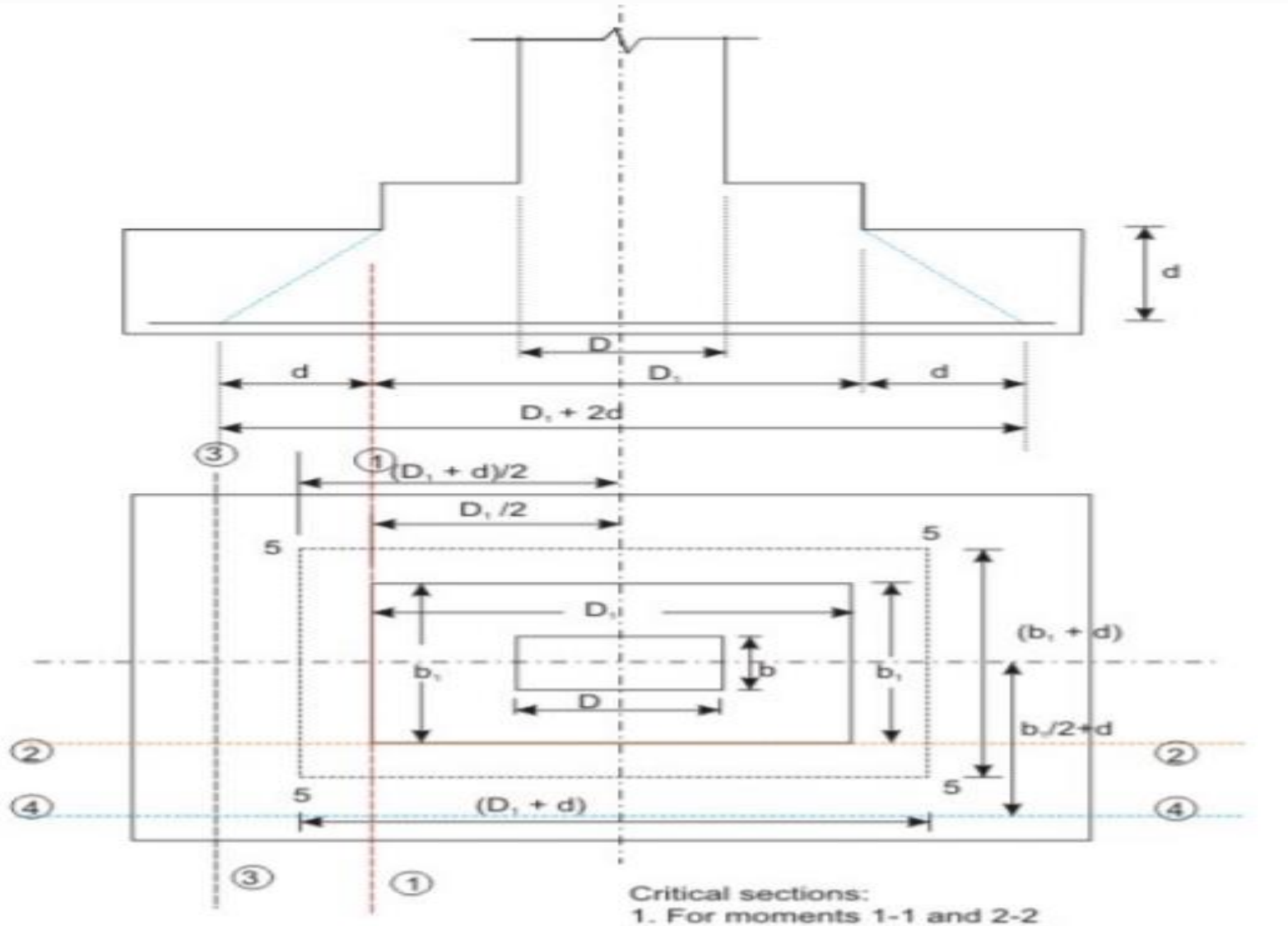
- Though symmetrical footings are desirable, sometimes situation compels for unsymmetrical isolated footings (Eccentric footings or footings with cut outs) either about one or both the axes.

TYPES OF FOOTING
UNIFORM AND RECTANGULAR FOOTING



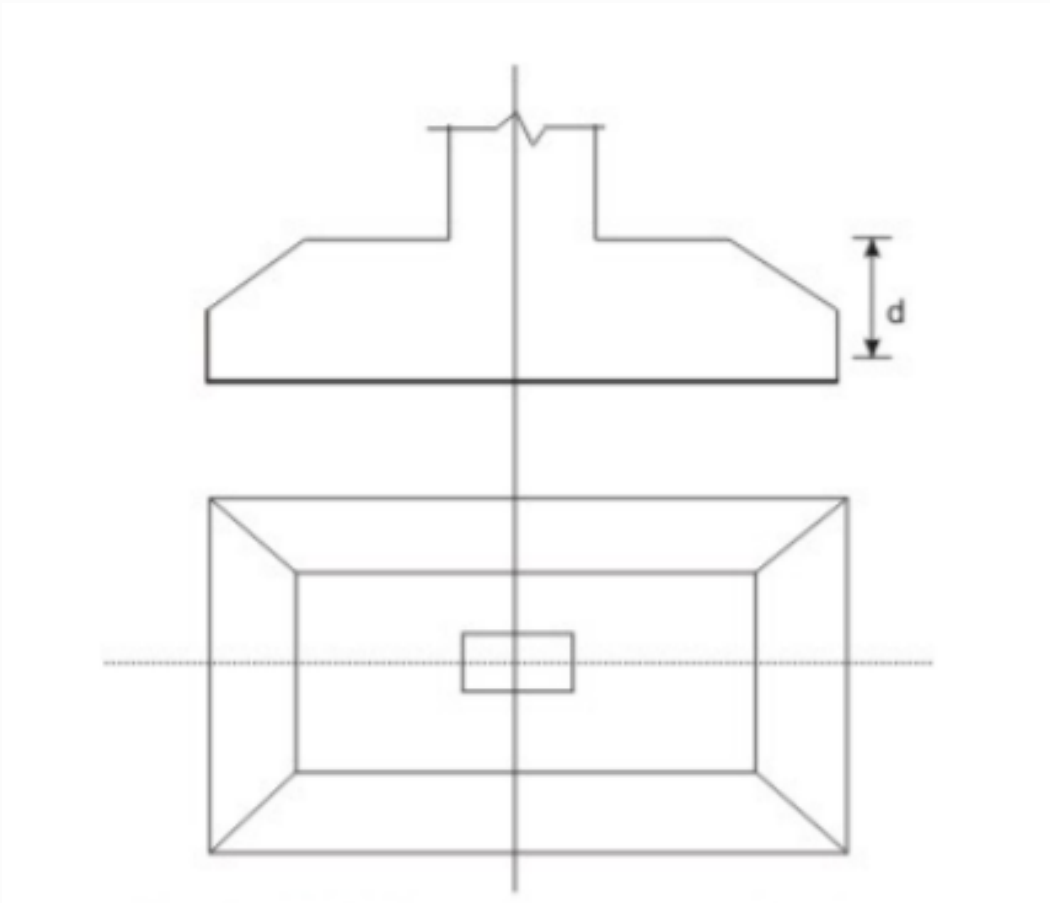
Critical sections:
1) For moments 1-1 and 2-2
2) For one-way shear 3-3 and 4-4
3) For punching shear perimeter marked by 5 5 5 5

TYPES OF FOOTING
STEPPED AND RECTANGULAR FOOTING

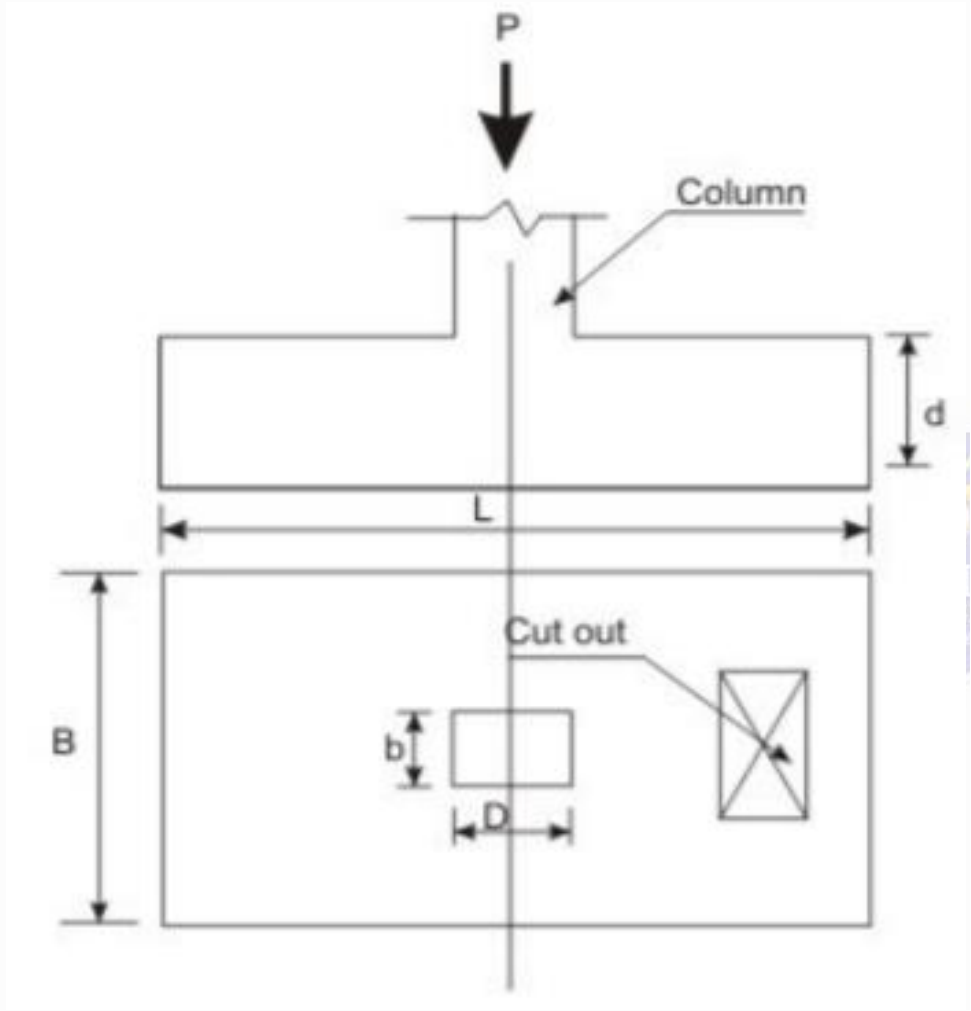


Critical sections:
1. For moments 1-1 and 2-2
2. One way shear 3-3 and 4-4
3. Two-way punching shear marked by 5555

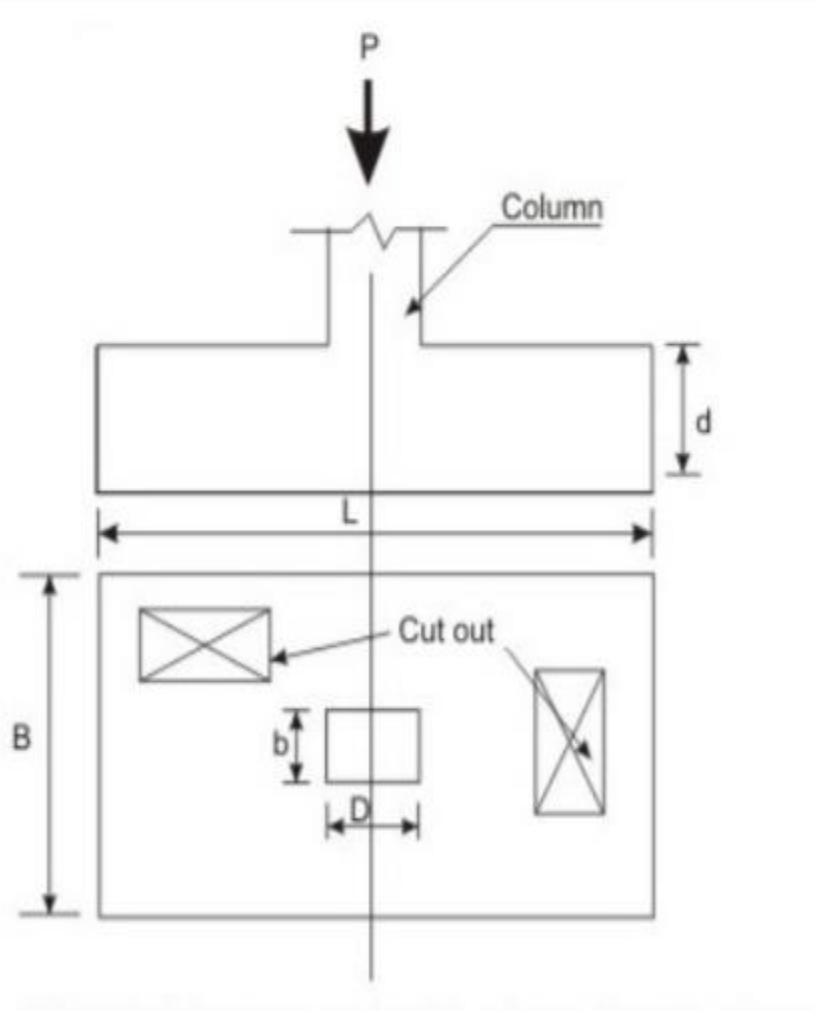
TYPES OF FOOTING
SLOPED AND RECTANGULAR FOOTING



TYPES OF FOOTING
UNSYMMETRICAL FOOTING ABOUT X-AXIS (a) AND BOTH AXIS (B)



(a)

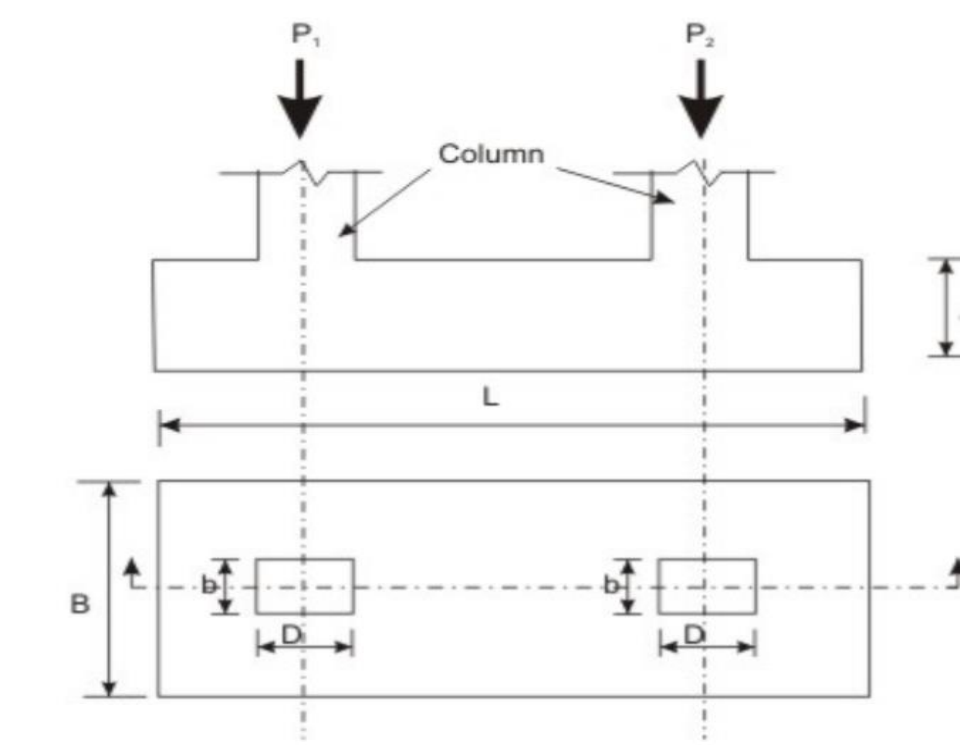


(b)

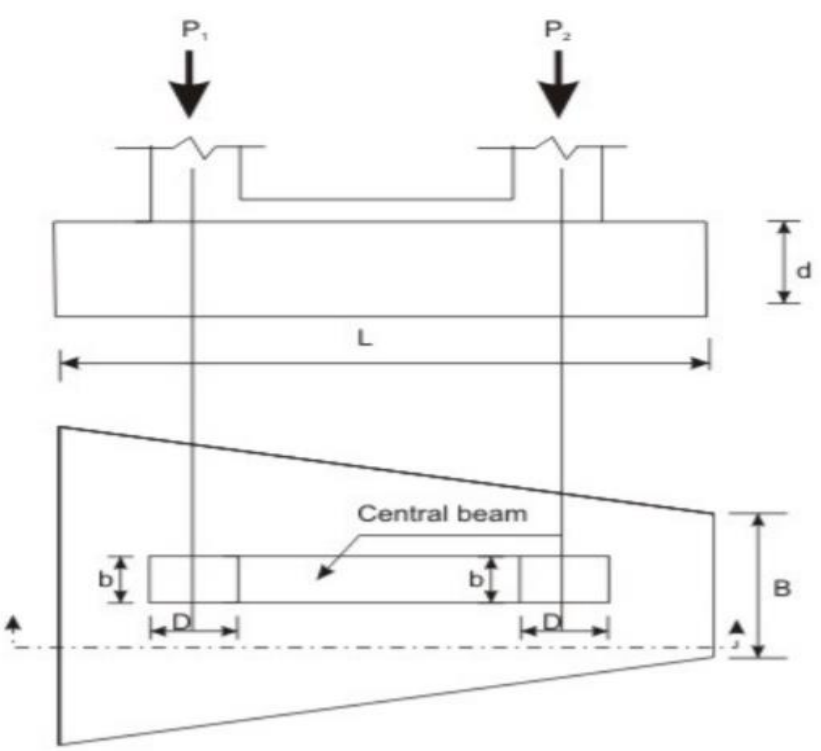
TYPES OF FOOTING
COMBINED FOOTINGS

- When the spacing of the adjacent columns is so close that separate isolated footings are not possible due to the overlapping areas of the footings or inadequate clear space between the two areas of the footings, combined footings are the solution combining two or more columns.

- Combined footing normally means a footing combining two columns. Such footings are either rectangular or trapezoidal in plan forms with or without a beam joining the two columns..



COMBINED FOOTING WITHOUT CENTRAL BEAM

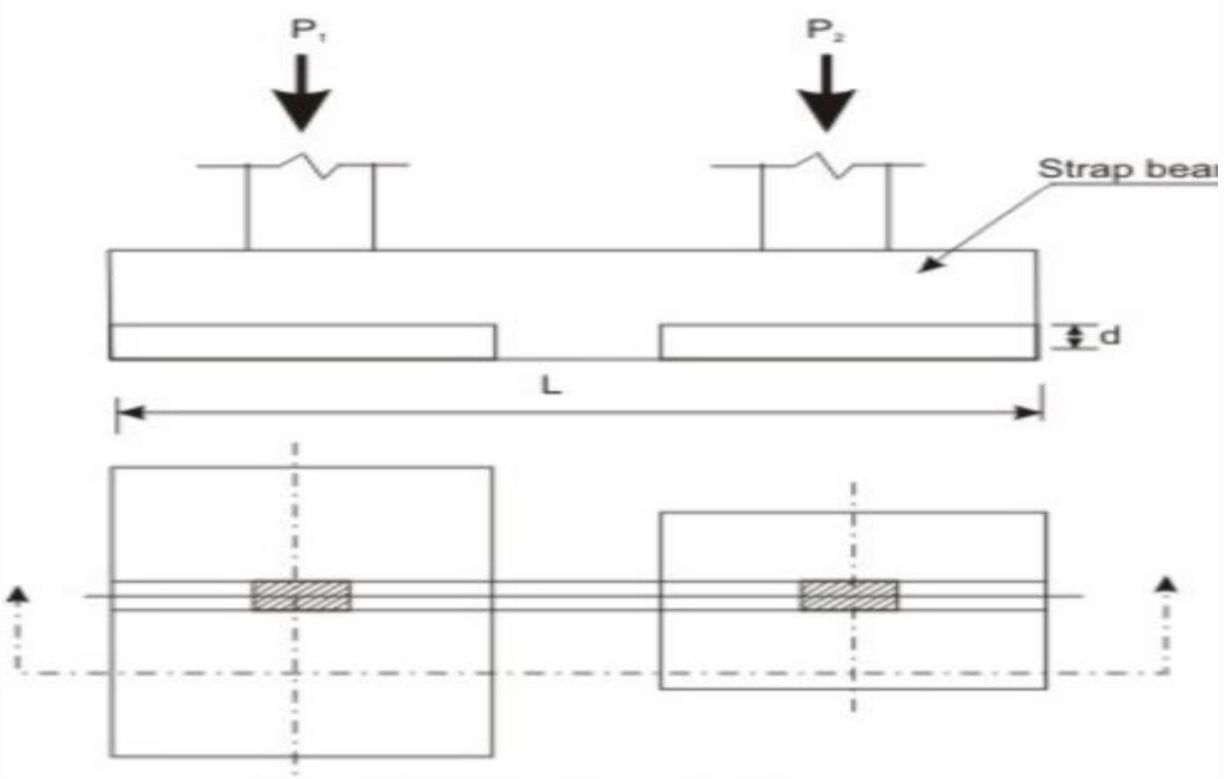


COMBINED FOOTING WITH CENTRAL BEAM

STRAP FOOTINGS

- When two isolated footings are combined by a beam with a view to sharing the loads of both the columns by the footings, the footing is known as strap footing.

- The connecting beam is designated as strap beam. These footings are required if the loads are heavy on columns and the areas of foundation are not overlapping with each other

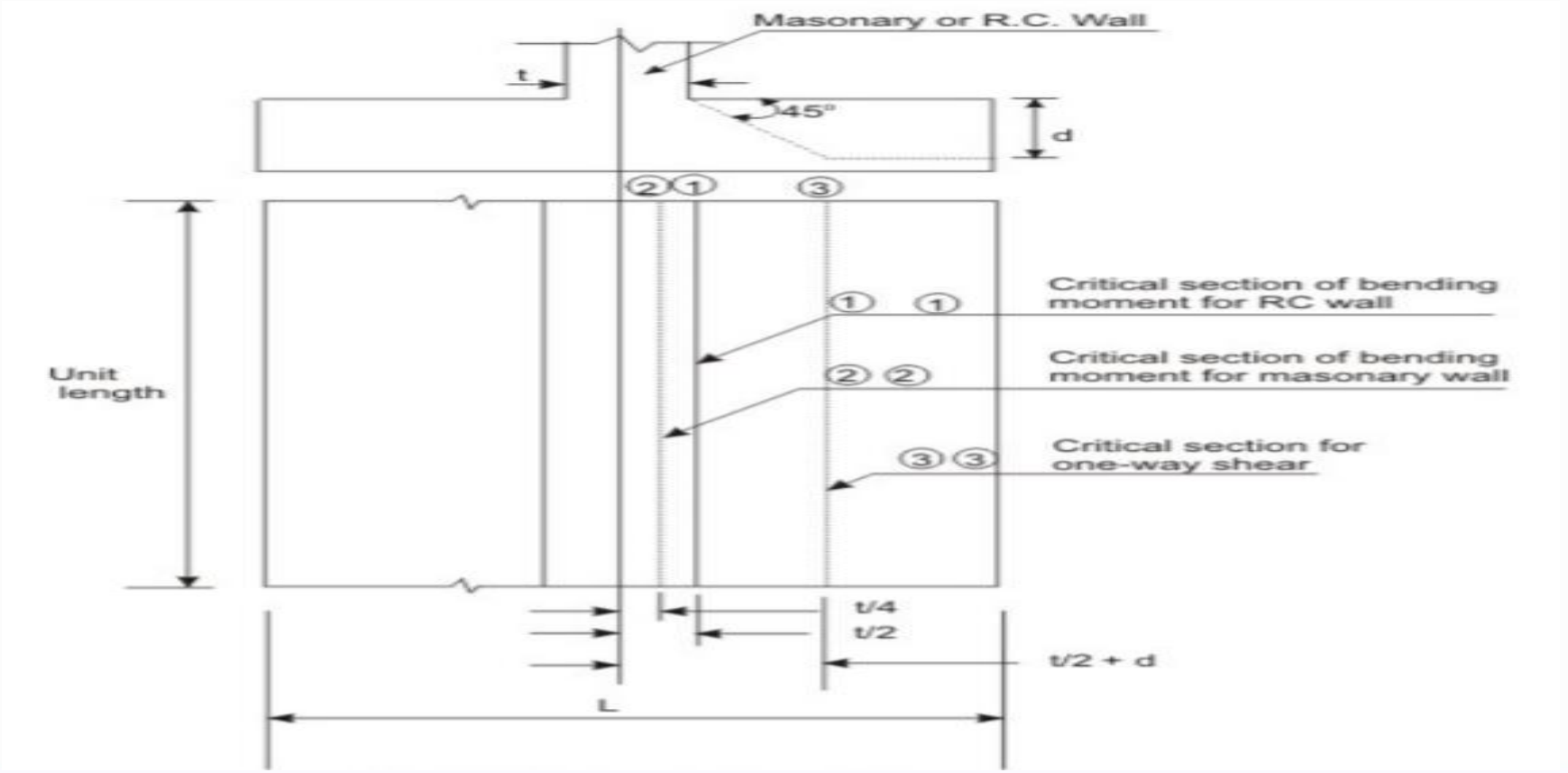


TYPE OF FOOTING
STRIP FOUNDATION

Strip foundation or wall footings, wall foundation

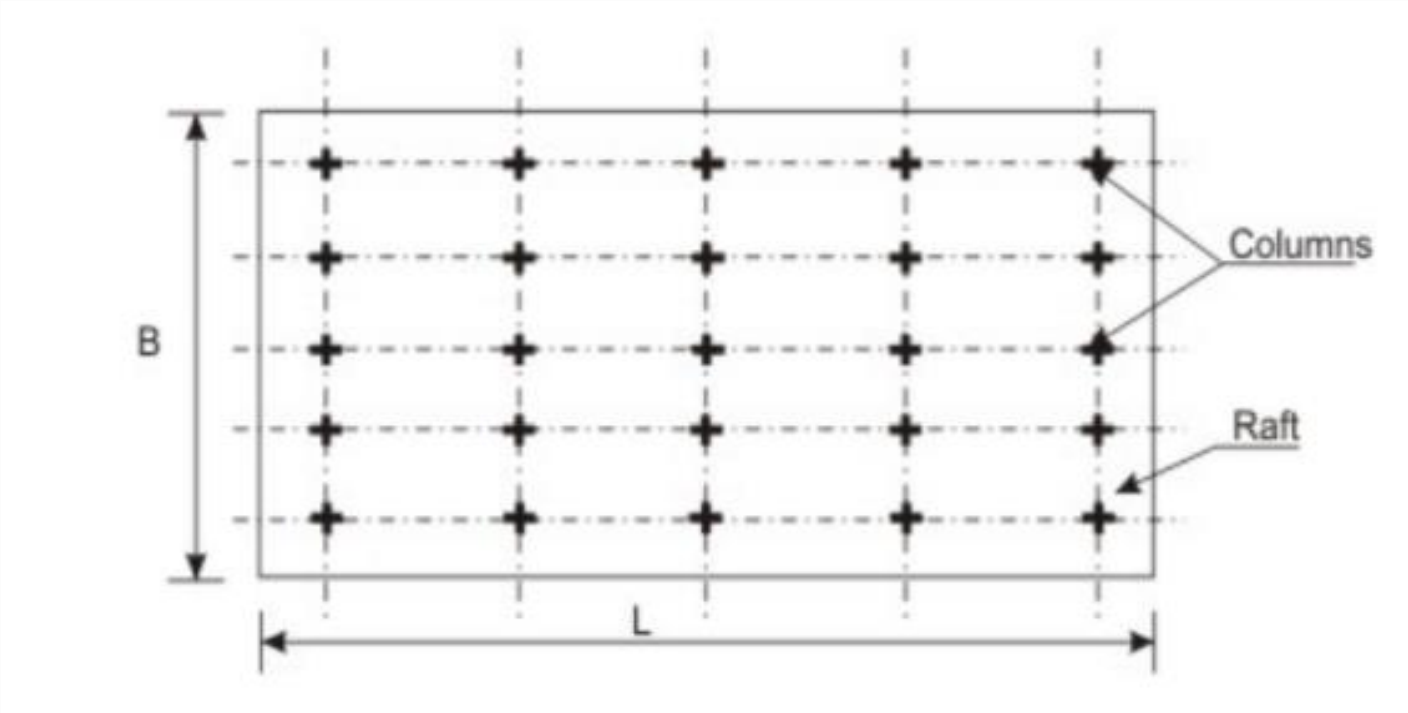
- These are in long strips especially for load bearing masonry walls or reinforced concrete walls. However, for load bearing masonry walls, it is common to have stepped masonry foundations.

- The strip footings distribute the loads from the wall to a wider area and usually bend in transverse direction. Accordingly, they are reinforced in the transverse direction mainly, while nominal distribution steel is provided along the longitudinal direction.



RAFT OR MAT FOUNDATION

- These are special cases of combined footing where all the columns of the building are having a common foundation.
- Normally, for buildings with heavy loads or when the soil condition is poor, raft foundations are very much useful to control differential settlement and transfer the loads not exceeding the bearing capacity of the soil due to integral action of the raft foundation.
- This is a threshold situation for shallow footing beyond which deep foundations have to be adopted.



THANK YOU