23CE503:STRUCTURAL ENGINEERING - I (RCC)

Topic: Unit- V : FOOTINGS

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Topic: Unit- V : FOOTINGS

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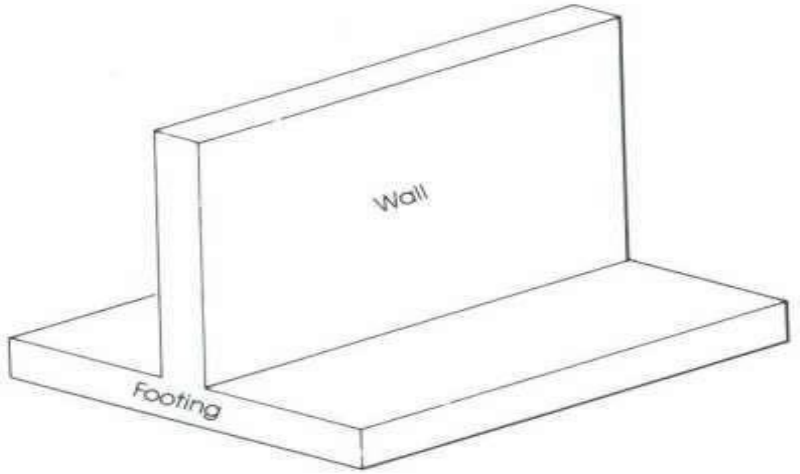
Footing

Definition

Footings are structural members used to support columns and walls and to transmit and distribute their loads to the soil in such a way that the load bearing capacity of the soil is not exceeded, excessive settlement, differential settlement,or rotation are prevented and adequate safety against overturning or sliding is maintained.

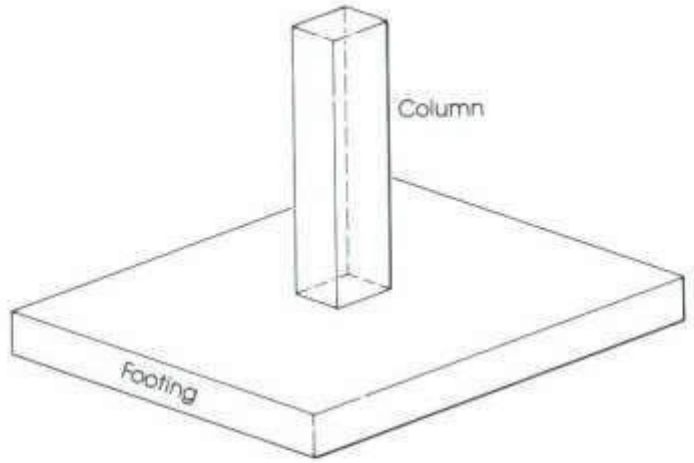
Types of Footing

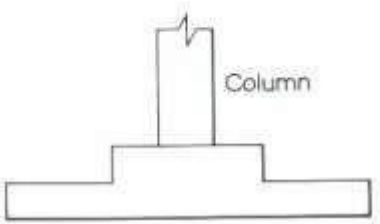
Wall footings **are used to support structural walls that carry loads for other floors or to support nonstructural walls.**

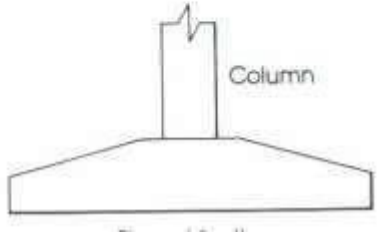


Wall footing.

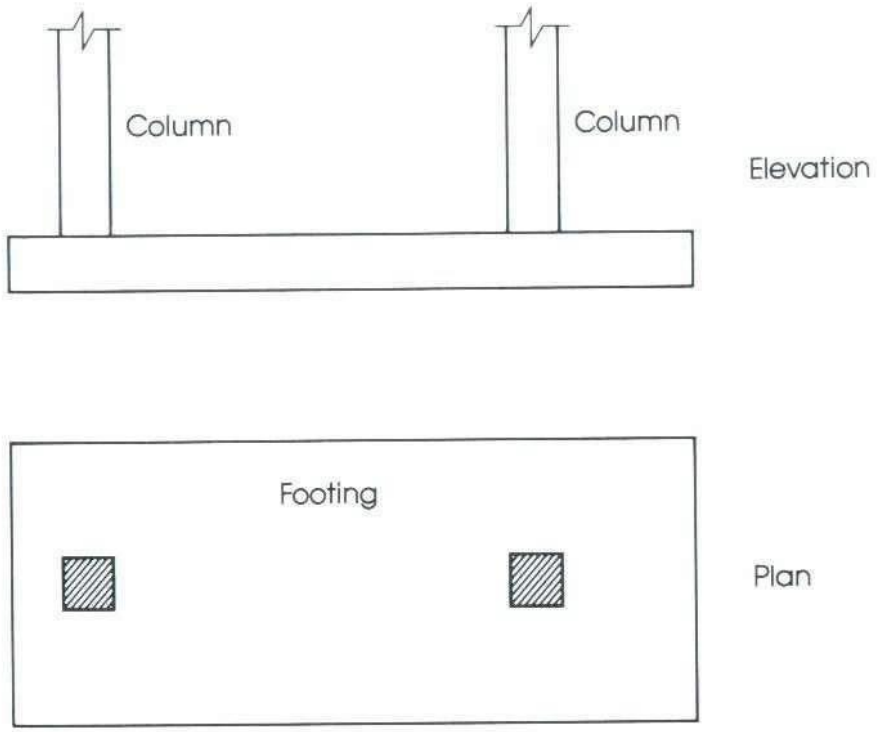
Isolated or single footings are used to support single columns. This is one of the most economical types of footings and is used when columns are spaced at relatively long distances.





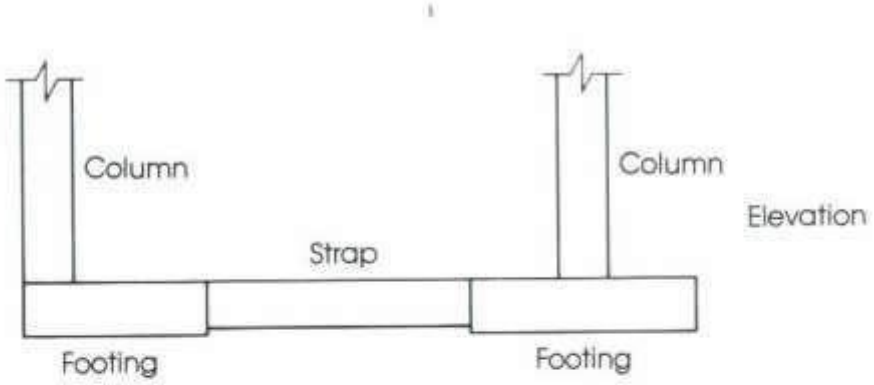


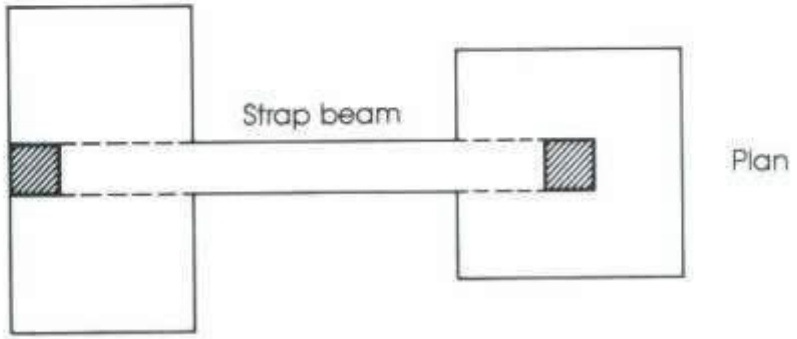
Combined footings usually support two columns, or three columns not in a row. Combined footings are used when tow columns are so close that single footings cannot be used or when one column is located at or near a property line.



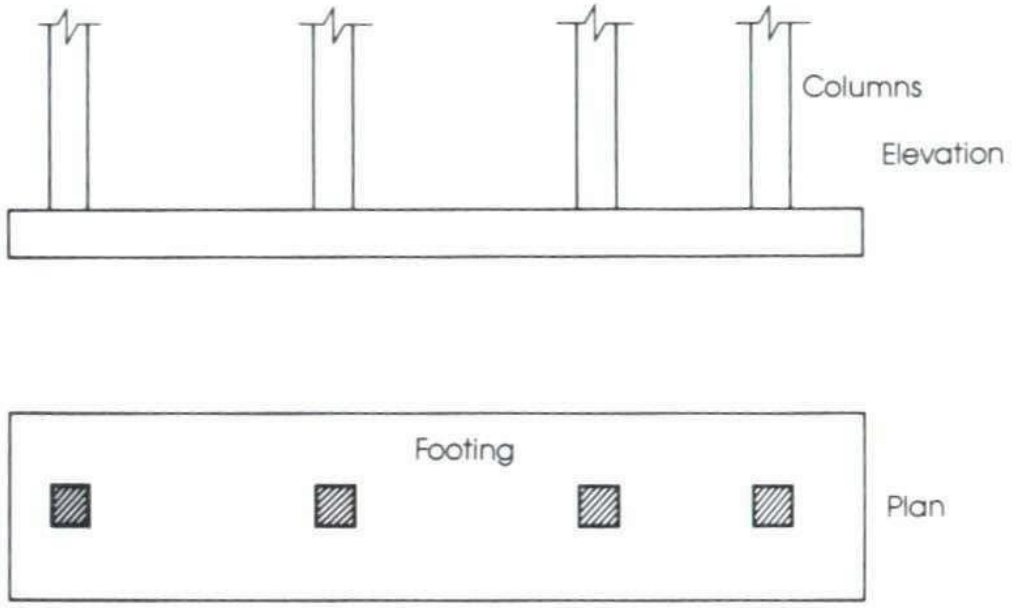
Cantilever or strap footings consist of two single footings connected with a beam or a strap and support two single columns.

This type replaces a combined footing and is more economical.

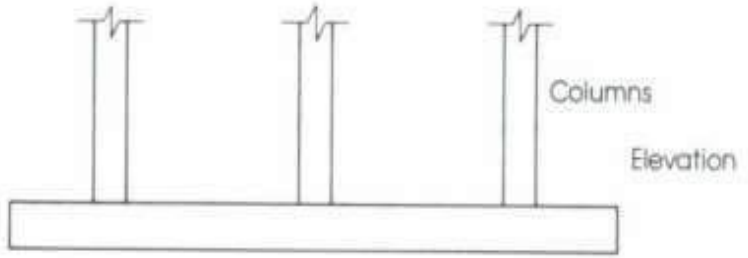


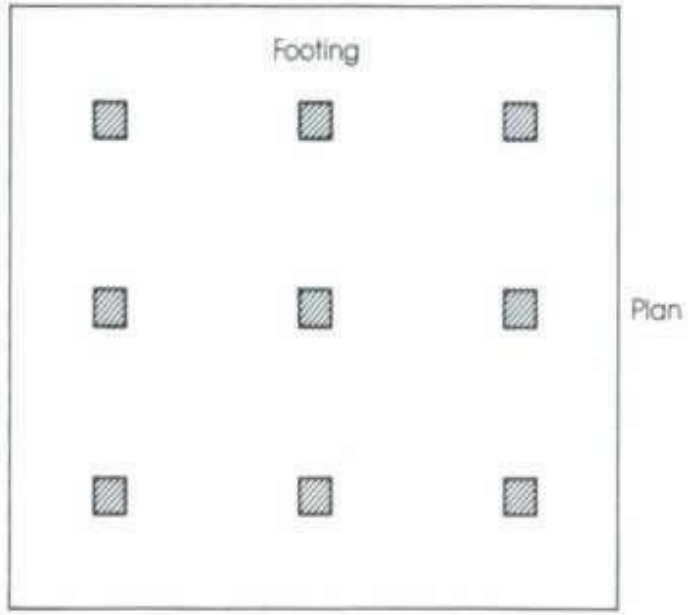


Continuous footings support a row of three or more columns. They have limited width and continue under all columns.

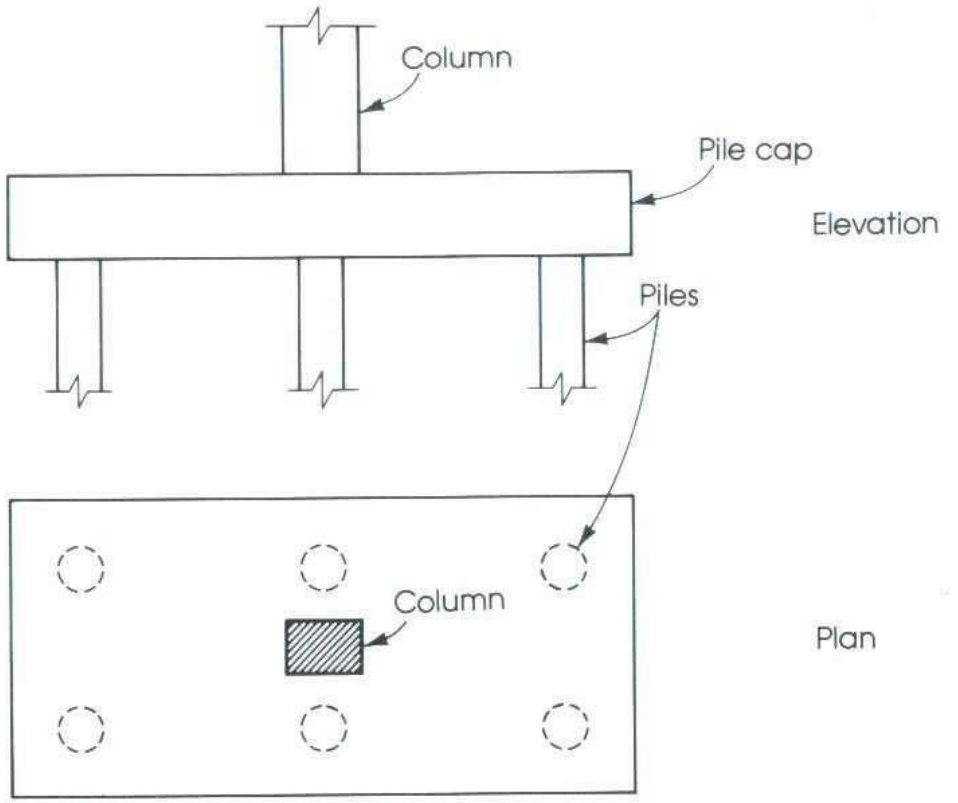


Rafted or mat foundation consists of one footing usually placed under the entire building area. They are used, when soil bearing capacity is low, column loads are heavy single footings cannot be used, piles are not used and differential settlement must be reduced.





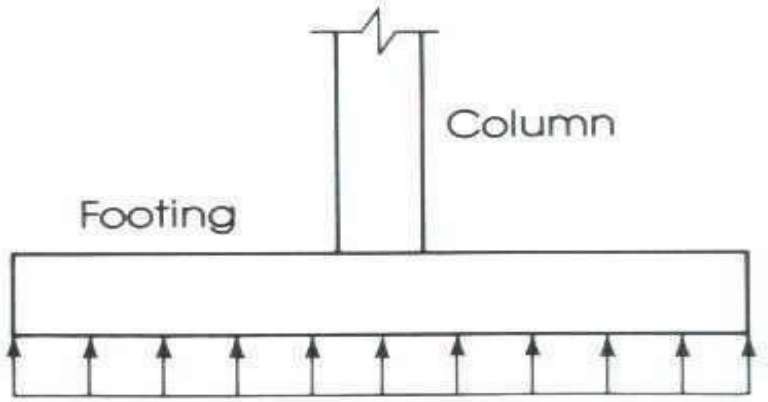
Pile caps are thick slabs used to tie a group of piles together to support and transmit column loads to the piles.



Footing

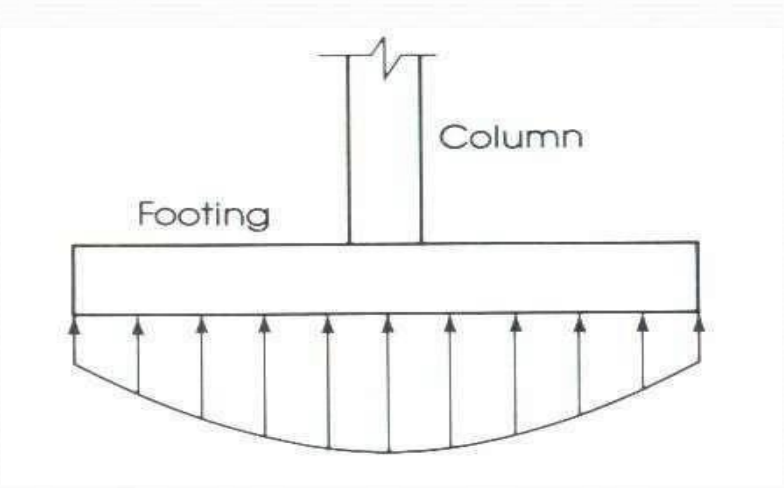
Distribution of Soil Pressure

When the column load P is applied on the centroid of the footing, a uniform pressure is assumed to develop on the soil surface below the footing area. However the actual distribution of the soil is not uniform, but depends on may factors especially the composition of the soil and degree of flexibility of the footing.

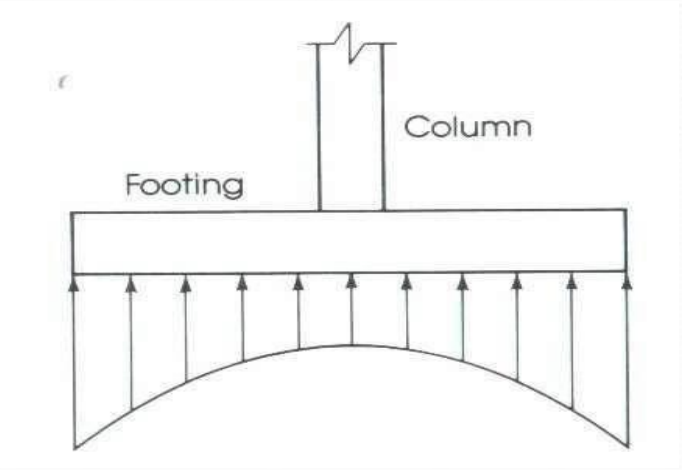


Footing

Distribution of Soil Pressure



Soil pressure distribution in cohesionless soil.



Soil pressure distribution in cohesive soil.

Footing

Design Considerations

Footings must be designed to carry the column loads and transmit them to the soil safely while satisfying code limitations.

* The area of the footing based on the allowable bearing soil capacity
* Two-way shear or punching shear.
* One-way bearing
* Bending moment and steel reinforcement required

Footing

Design Considerations

Footings must be designed to carry the column loads and transmit them to the soil safely while satisfying code limitations.

* The area of the footing based on the allowable bearing soil capacity
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Footing

Size of Footing

The area of footing can be determined from the actual external loads such that the allowable soil pressure is not exceeded.

$$\text{Area of footing} = \frac{\text{Total load (including self - weight)}}{\text{allowable soil pressure}}$$

Strength design requirements

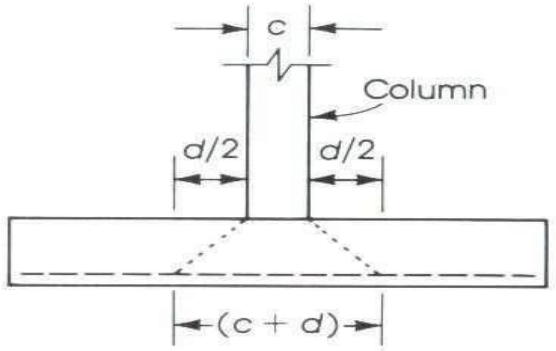
$$q_u = \frac{P_u}{\text{area of footing}}$$

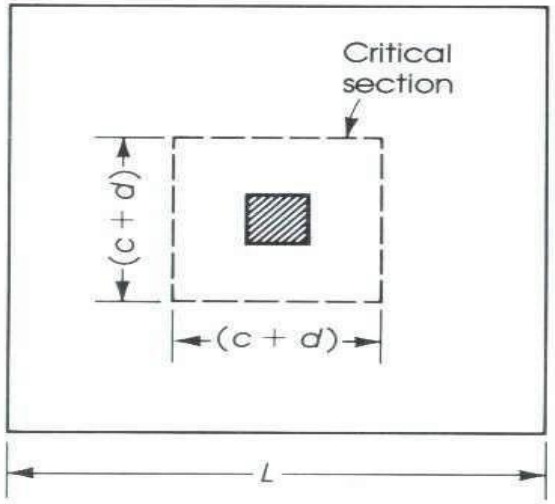
Footing

Design of two-way shear

1 Assumed.

- 2 Determine b_0:
  - $b_0 = 4(c+d)$ for square columns where one side = c
  - $b_0 = 2(c_1+d) + 2(c_2+d)$ for rectangular columns of sides c_1 and c_2.





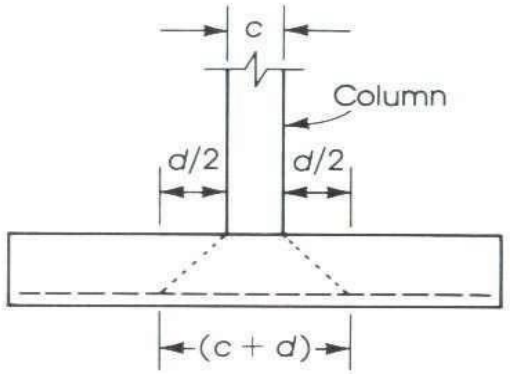
Footing

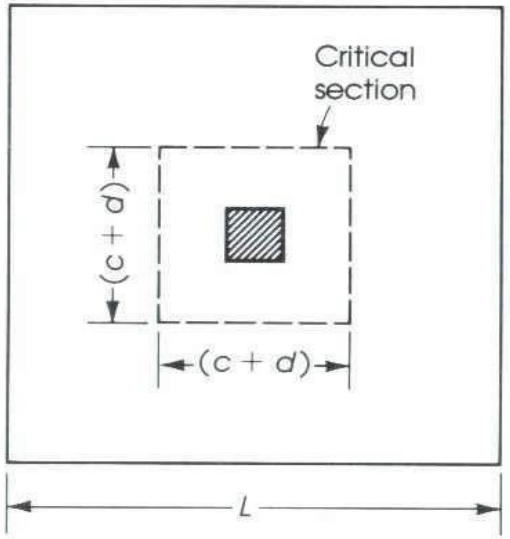
Design of two-way shear

3 The shear force V_u acts at a section that has a length $b_0 = 4(c+d)$ or $2(c_1+d) + 2(c_2+d)$ and a depth d; the section is subjected to a vertical downward load P_u and vertical upward pressure q_u.

$$V_u = P_u - q_u (c+d)^2 \text{ for square columns}$$

$$V_u = P_u - q_u (c_1+d)(c_2+d) \text{ for rectangular columns}$$





Footing

Design of two-way shear

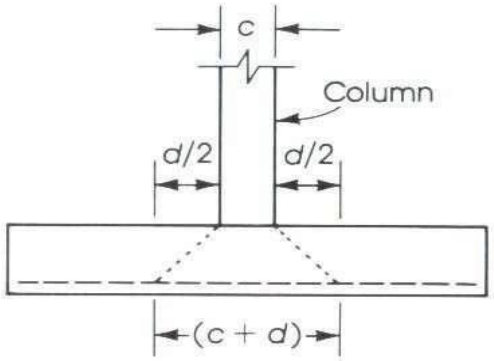
4 Allowable

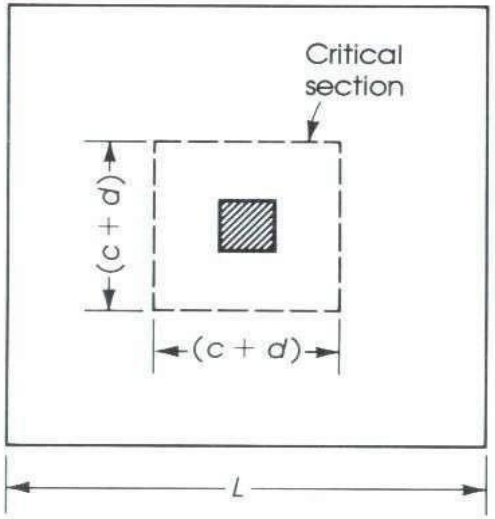
$$\phi V_c = \frac{}{4\phi} \sqrt{f_c}\, b_0 d$$

Let $V_u = \phi V_c$

$$d = \frac{V_u}{4\phi \sqrt{f_c}\, b_0}$$

If d is not close to the assumed d, revise your assumptions



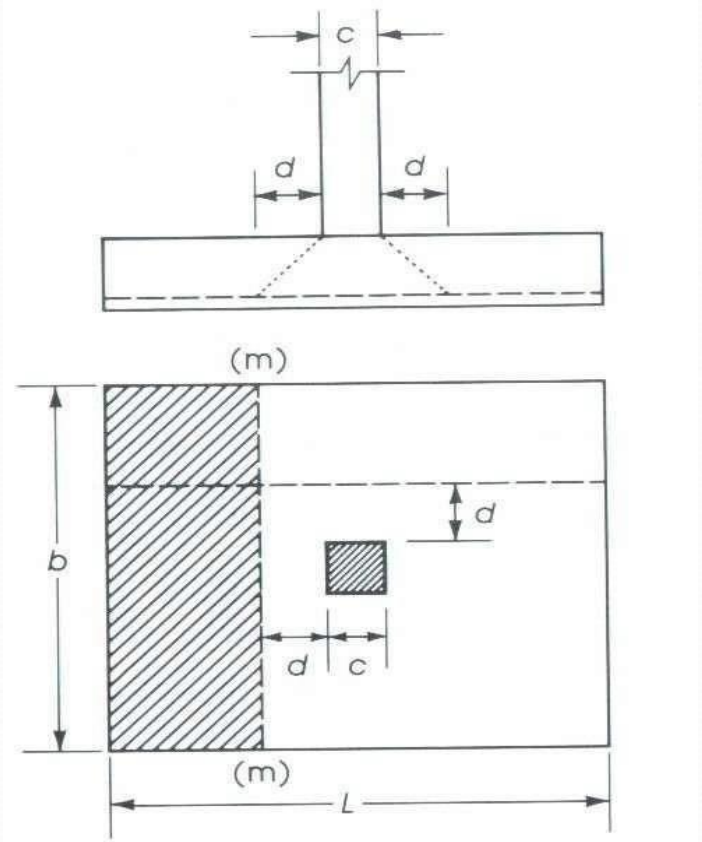


Footing

Design of one-way shear

For footings with bending action in one direction the critical section is located a distance d from face of column

$$\phi V_c = 2\phi \sqrt{f_c}\, b_0 d$$



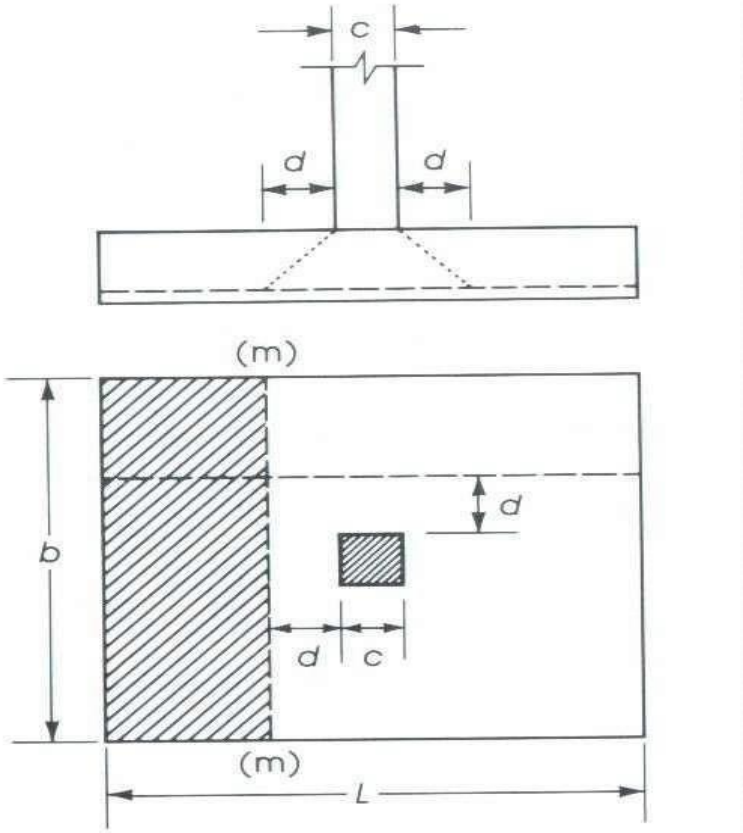
Footing

Design of one-way shear

The ultimate shearing force at section m-m can be calculated

$$V_u = q_u\, b\left(\frac{L-c}{2} - d\right)$$

If no shear reinforcement is to be used, then d can be checked

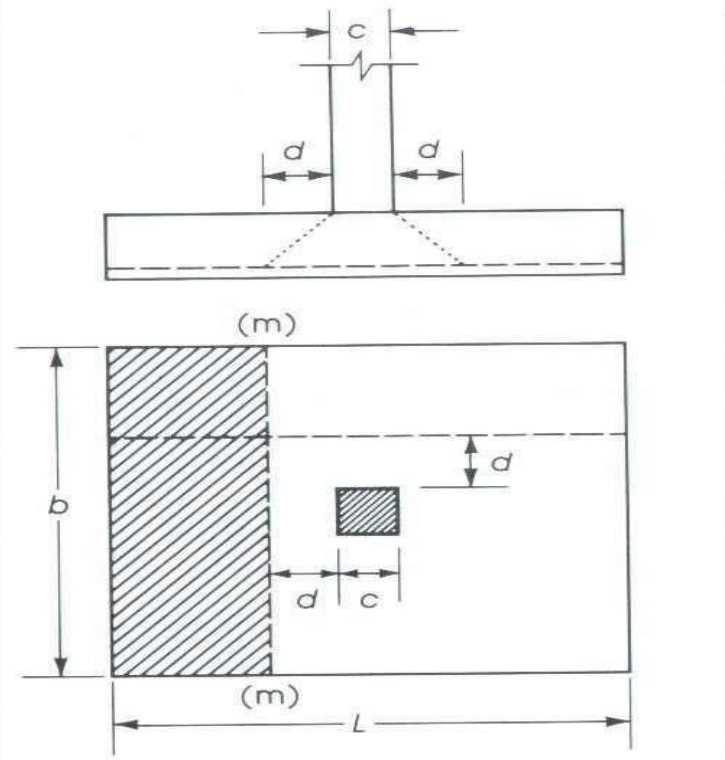


Footing

Design of one-way shear

If no shear reinforcement is to be used, then d can be checked, assuming $V_u = \phi V_c$

$$d = \frac{V_u}{2\phi \sqrt{f_c}\, b}$$



Thank You..