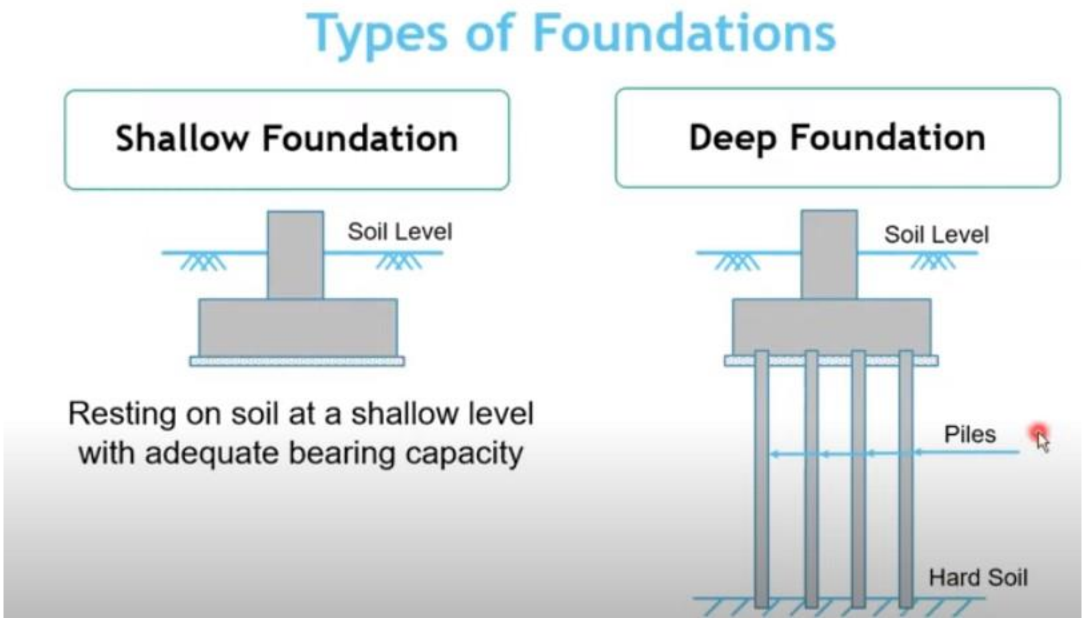
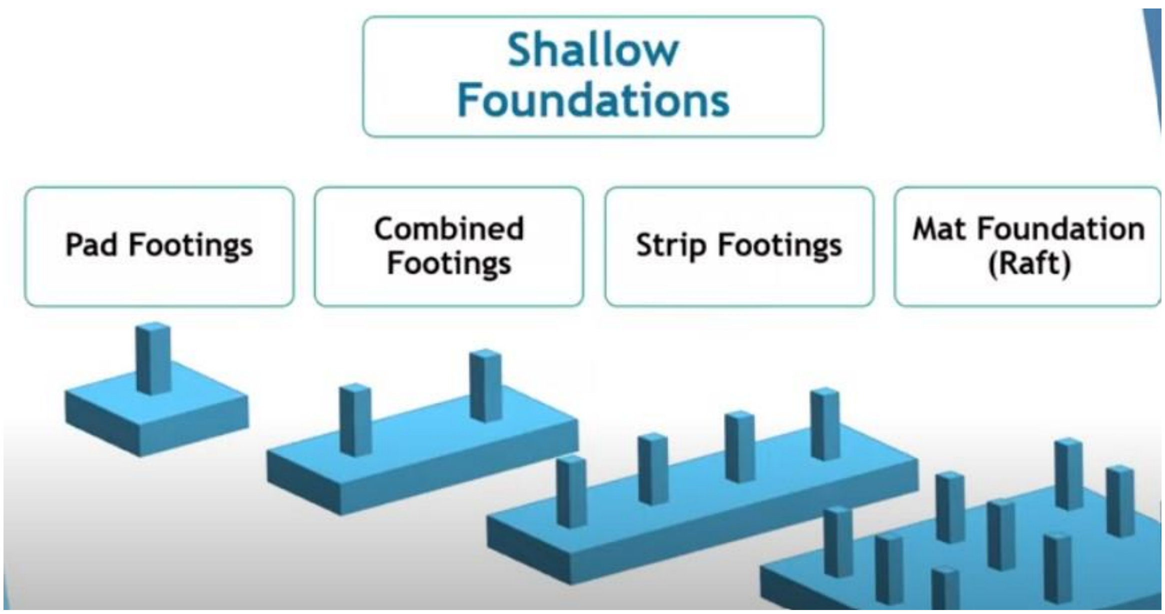
Design of single footing





Loading

The following service loads may be used:-

$N_u = 1L.L + 1.6\ D.L$ (live load +dead load)

$N_U = 1.0\ W.L + 1.0\ D.L$ (wind load+ dead load)

$N_u = 0.8L.L + 1.0\ D.L + 0.8\ W.L$ (Live load + dead load+ wind load)

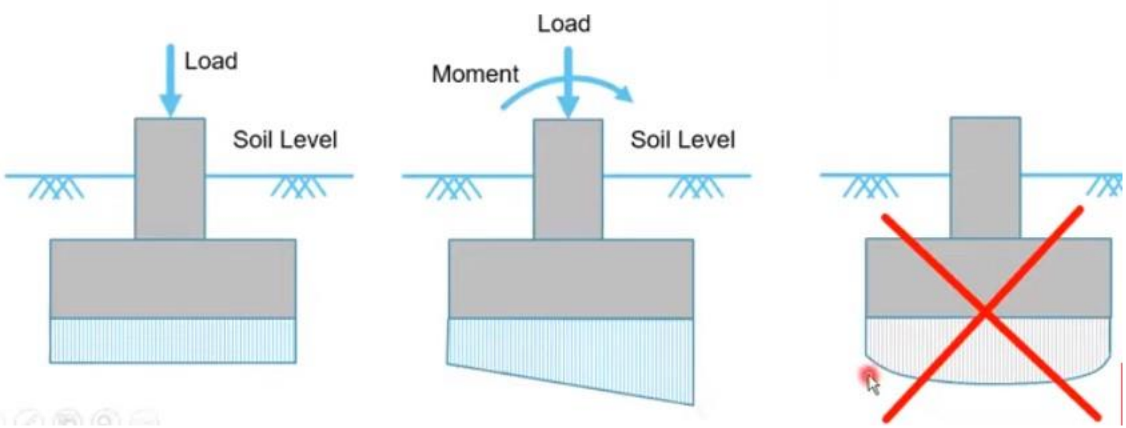
The bearing pressure q_o under the footing should not exceed the allowable bearing pressure q_{all}

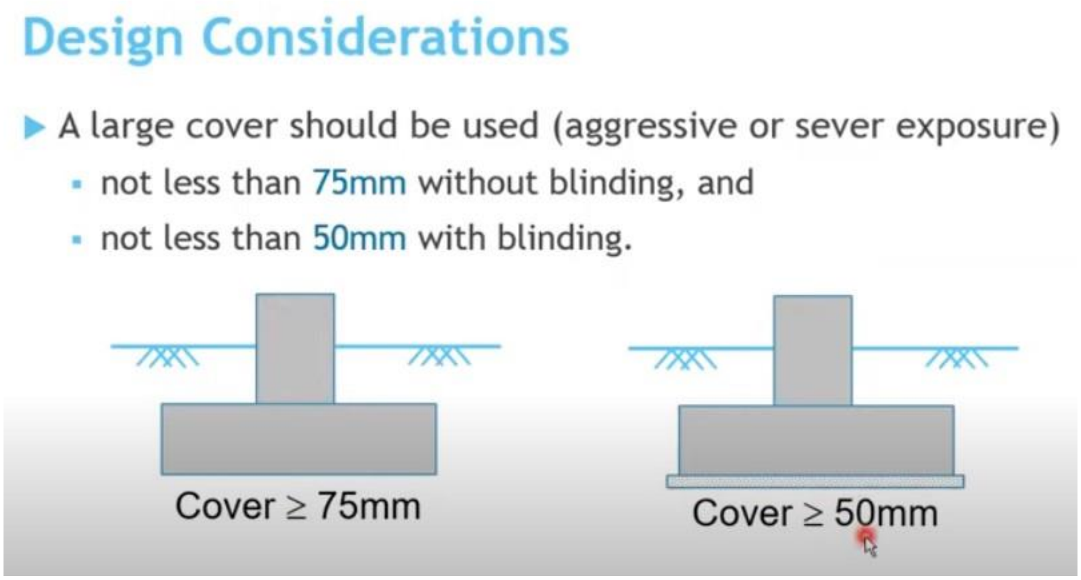
Typical Allowable Bearing Values

Rock or Soil	Typical bearing value (kN/m^2)
Massive igneous bedrock	10 000
Sandstone	2000 to 4000
Shales and mudstone	600 to 2000
Gravel, sand and gravel, compact	600
Medium dense sand	100 to 300
Loose fine sand	less than 100
Hard clay	300 to 600
Medium clay	100 to 300
Soft clay	less than 75

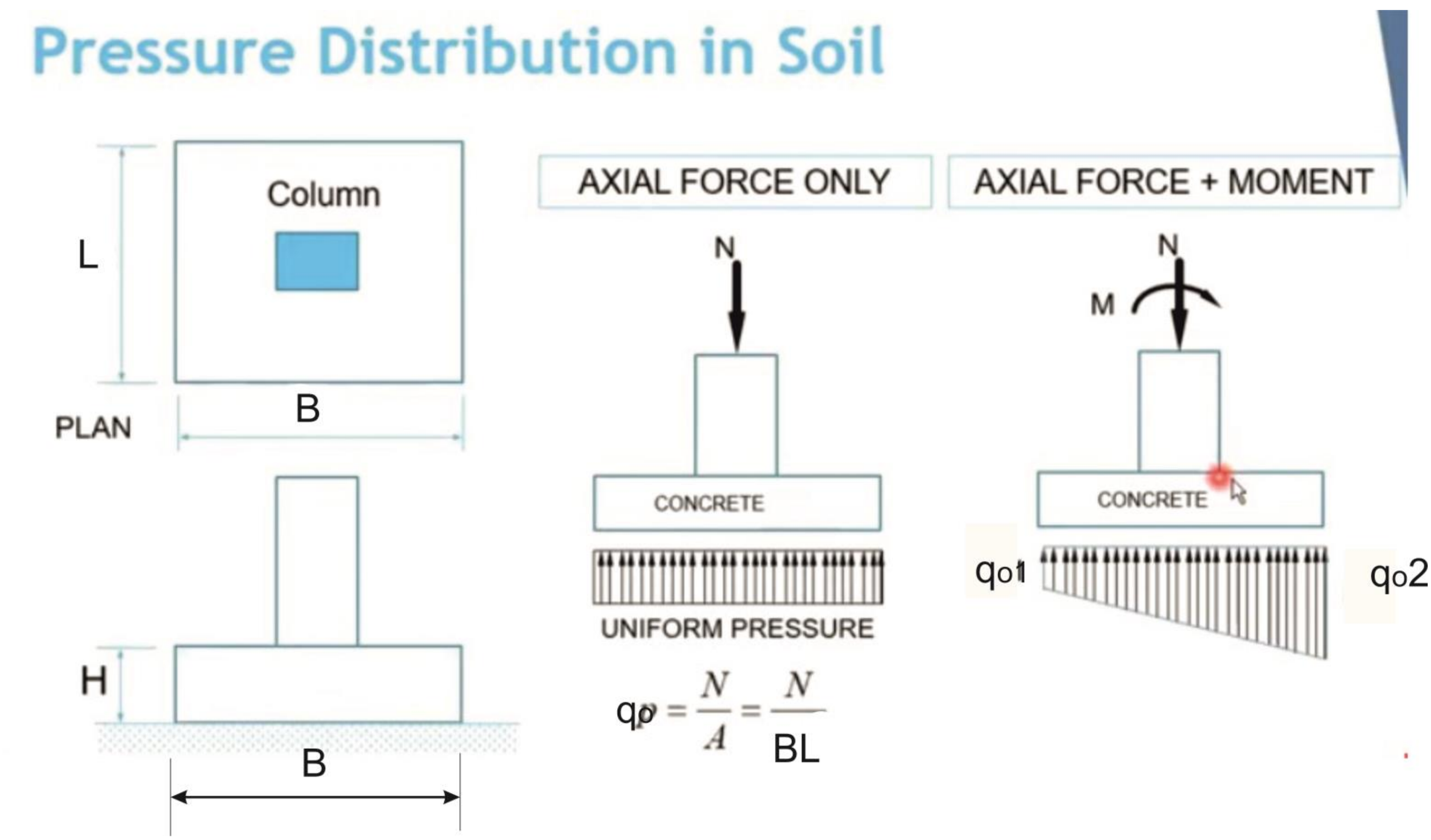
Design Considerations

- Assume linear distribution of soil pressure across the base of the footing.





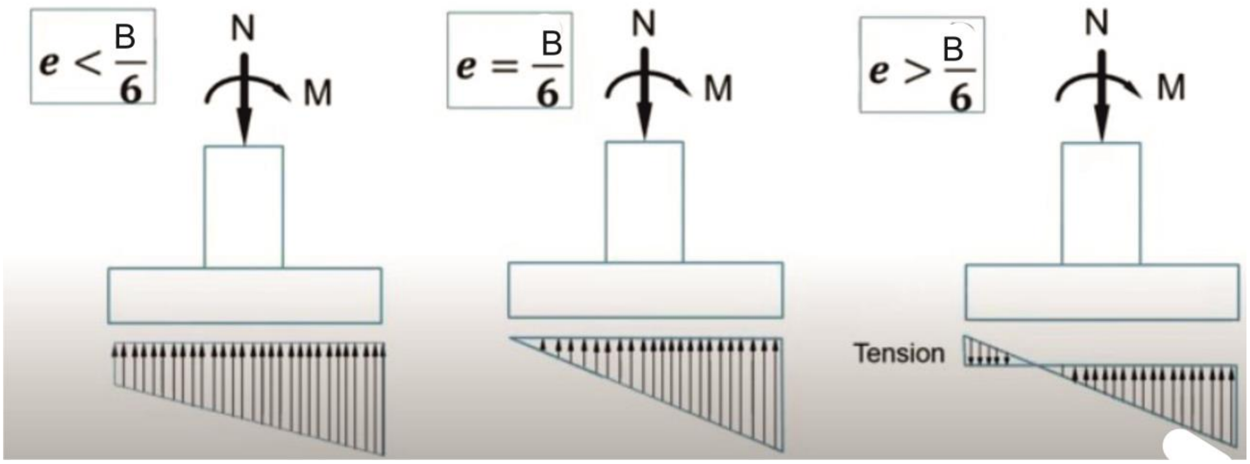
Use grade of concrete $f_{cu} \geq 35\ MPa$ =35000 KN/m2



$$q_{o1} = \frac{N}{BL} - \frac{MY}{I} = \frac{N}{BL} - \frac{M\frac{B}{2}}{\frac{LB^3}{12}} = \frac{N}{BL} - \frac{6M}{LB^2}\ , \qquad q_{o2} = \frac{N}{BL} + \frac{MY}{I} = \frac{N}{BL} + \frac{M\frac{B}{2}}{\frac{LB^3}{12}} = \frac{N}{BL} + \frac{6M}{LB^2}$$

Eccentric Loading (N & M)

- For N and M loading, the eccentricity "e" is defined as: ⟹ $e = \dfrac{M}{N}$

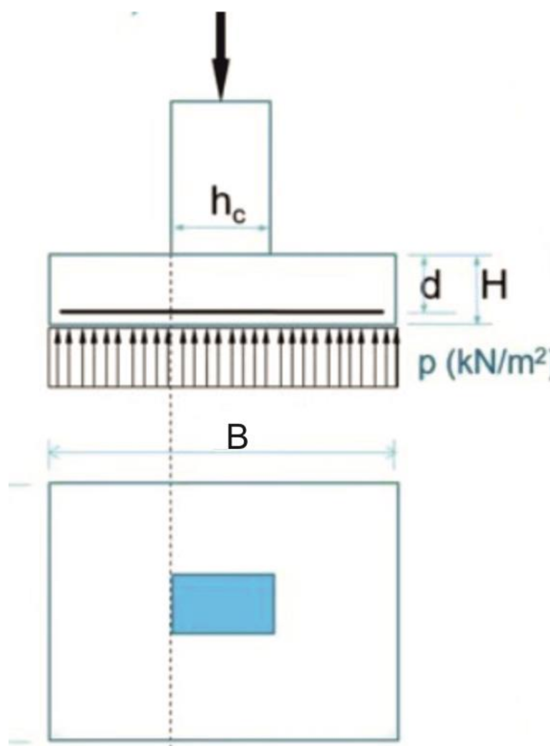


Never allow to use $e > \frac{B}{6}$, since the soil is weak in tension stresses.

Design for moment reinforcement

The single footing works like a cantilever loaded with the soil pressure resistance (q_o).

The maximum moment in the single footing is located at the face of the column.

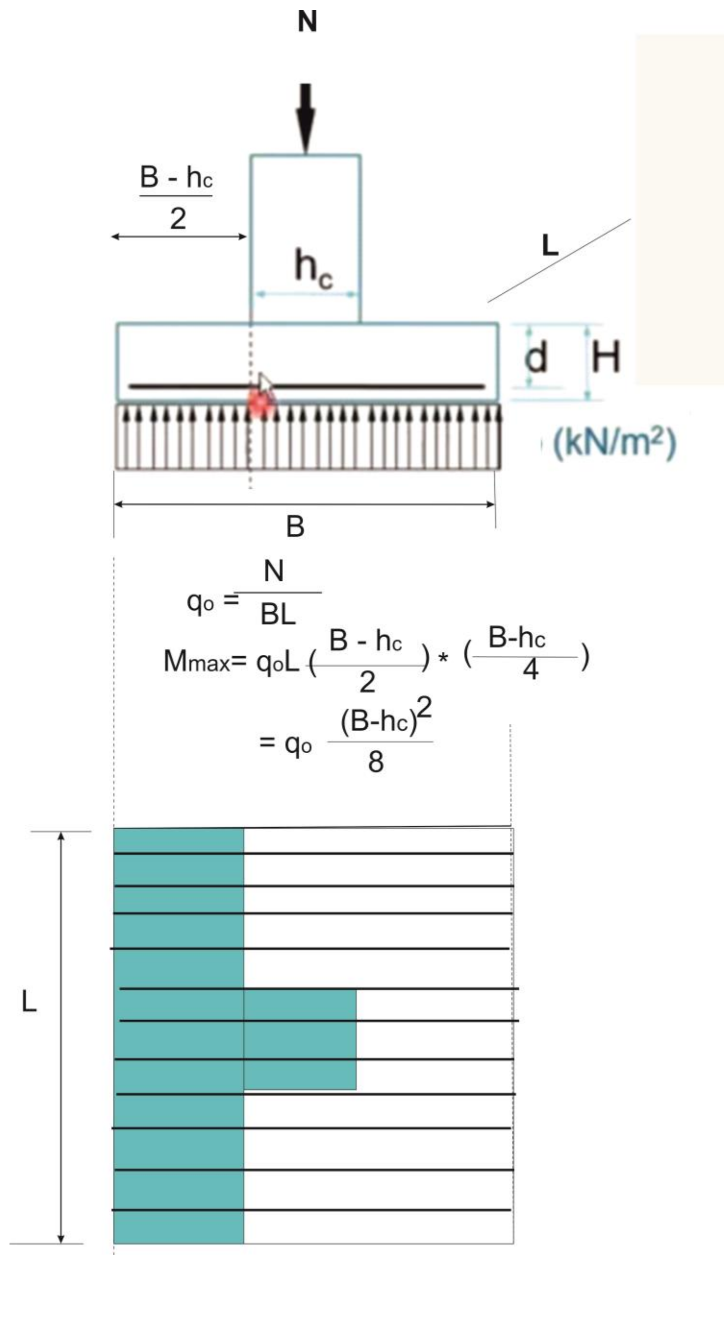


Reinforcement in long direction

$$K = \frac{M}{f_{cu} L d^2}$$

$$Z = d\left(0.5 + \sqrt{0.25 - K/0.9}\right) \leq 0.95d$$

$$A_s = \frac{M}{0.95 f_y Z} \quad , \quad (\text{mm}^2)$$



Check for Direct Shear (One-Way Shear)

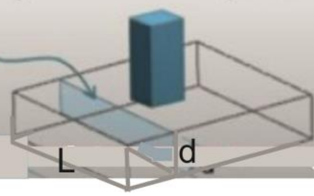
- The shearing force is calculated at the critical section for shear, i.e. **at distance 'd' from the face of the column.**

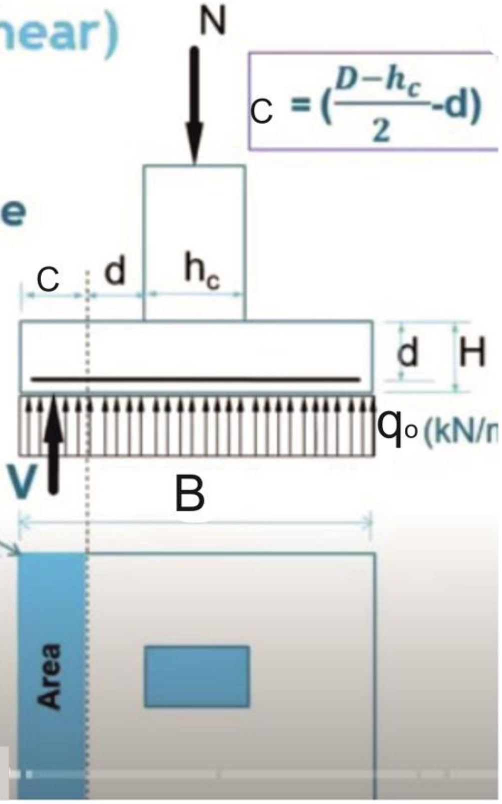
  $V = q_o$ (kN/m²) × **Area** (m²) → (kN)

  $= q_o$ (BL)

- **Shear Stress:**

  $v = V/(L \times d)$ (N/mm²)





Check for Punching Shear

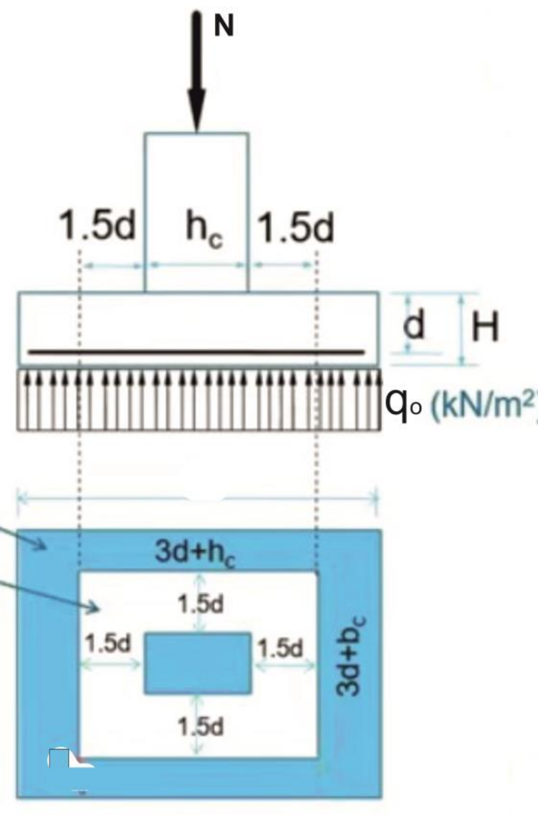
- The foundation can be punched by the column.
- The critical section for punching is at **1.5d from the face of the column.**
- $V_{punch} = q_o \times$ (Hatched Area) → kN

  $= q_o$ [BL - Punched Area]

  $= q_o [BL - (3d+h_c) \times (3d+b_c)]$

- **Punching Shear Stress:**

  $v = V_{punch}/[d \times 2(3d+h_c+3d+b_c)]$ (N/mm²)



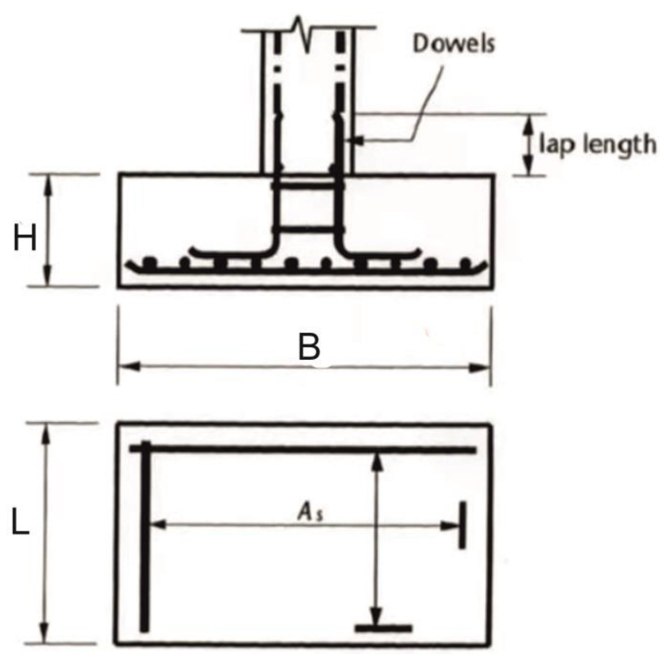
Design consideration of a single footing

1- Assume a suitable value for the thickness (H) and effective depth (d)
As a guide assume a shear stress of $(0.5v_U)$ N/mm, so that

$$d = \frac{N}{Column\ perimeter * 0.5v_U}$$

2- Approximate H to the nearest 50mm, where $(H_{min} = 300mm)$
3- Design the reinforcement required in two direction.
4- Check the critical shear stress at 1d from the column edge.
5- Check the critical punching stress at 1.5d from the column edge.
6- Draw a plan to show the footing dimensions and steel bars distribution.

Drawing



Reinforcement in Footings

- Footing should be reinforced in **two layers** forming a net, each layer resists moments its direction.
- For convenience, an **average effective depth** is used in calculating areas of steel in each layer.
- A layer of plain concrete (**blinding**) can be provided below the foundation.
- Reinforcement should extend at least a full tension **anchorage length** beyond the critical section for bending (≈40ϕ).