Fayoum University

Faculty of Engineering

Department of Civil Engineering

CE 402: Part A

Shallow Foundation Design

Lecture No. (5): Strap Footing

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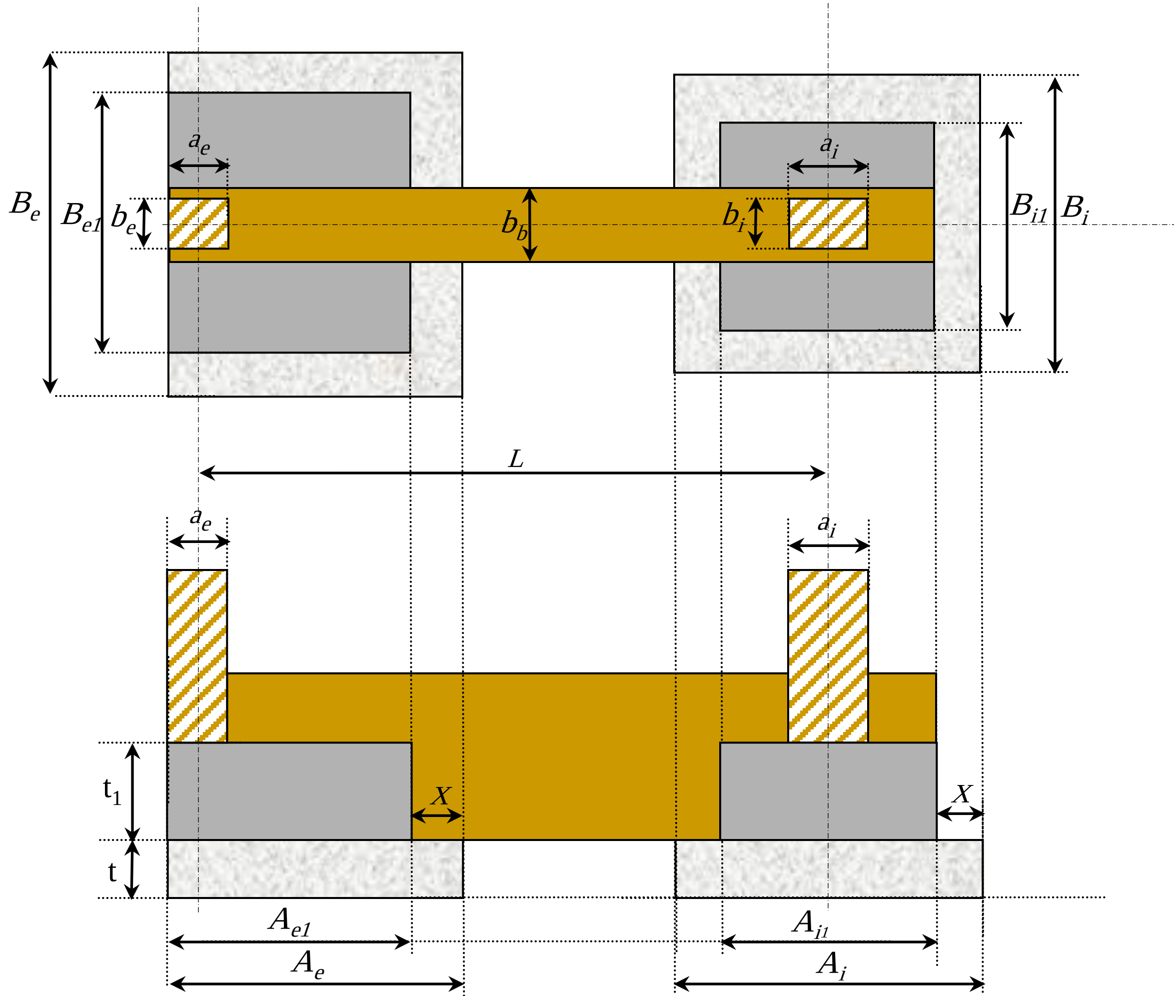
Strap Footing

- Cantilever footing. A cantilever or strap footing normally comprises two footings connected by a beam called a strap. A strap footing is a special case of a combined footing.

- A strap footing is used to connect an eccentrically loaded column footing close to the property line to an interior column as shown in the Figure.

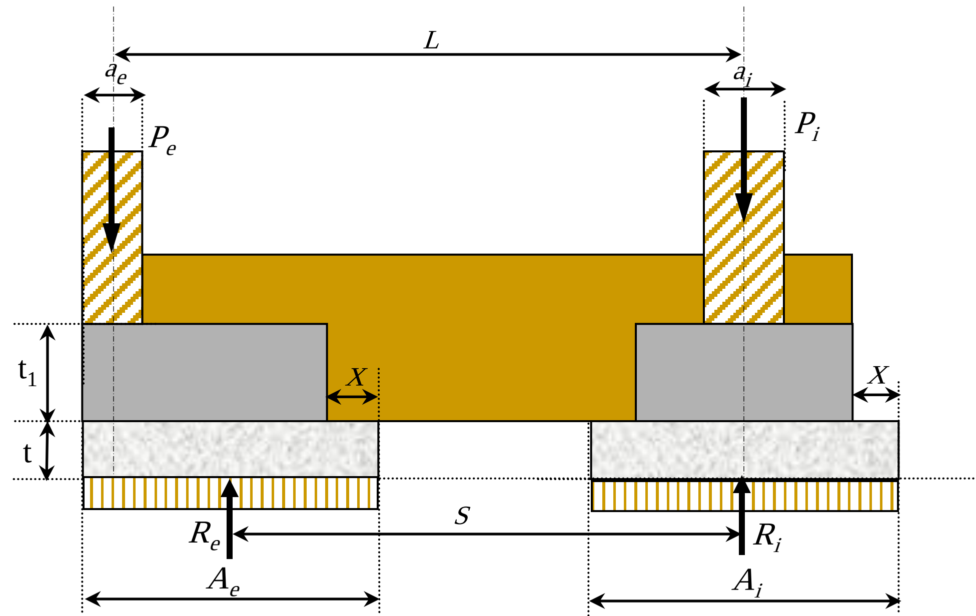
Strap Footing



Plain Concrete (P.C.) of Exterior Footing

Assumptions for Design :

1. *Uniform stress distribution below footings.*
2. *No stress below the strap beam.*
3. *The strap beam is weightless.*



$$Assume: A_e = \sqrt{\frac{1.30P_e}{q_a}}$$

$$S = L + \frac{a_e}{2} - \frac{A_e}{2}$$

$$R_e = \frac{p_e * L}{S} + 0.10P_e \longrightarrow \text{Get } (R_e)$$

$$Area = A_e * B_e = \frac{R_e}{q_a} \longrightarrow \text{Get } (B_e)$$

Assume t=0.25 to 0.40

Dim. of P.C. = A * B * t

Reinforced Concrete (R.C.) of Exterior Footing

$$A_{e1} = A_e - X$$

$$B_{e1} = B_e - 2X$$

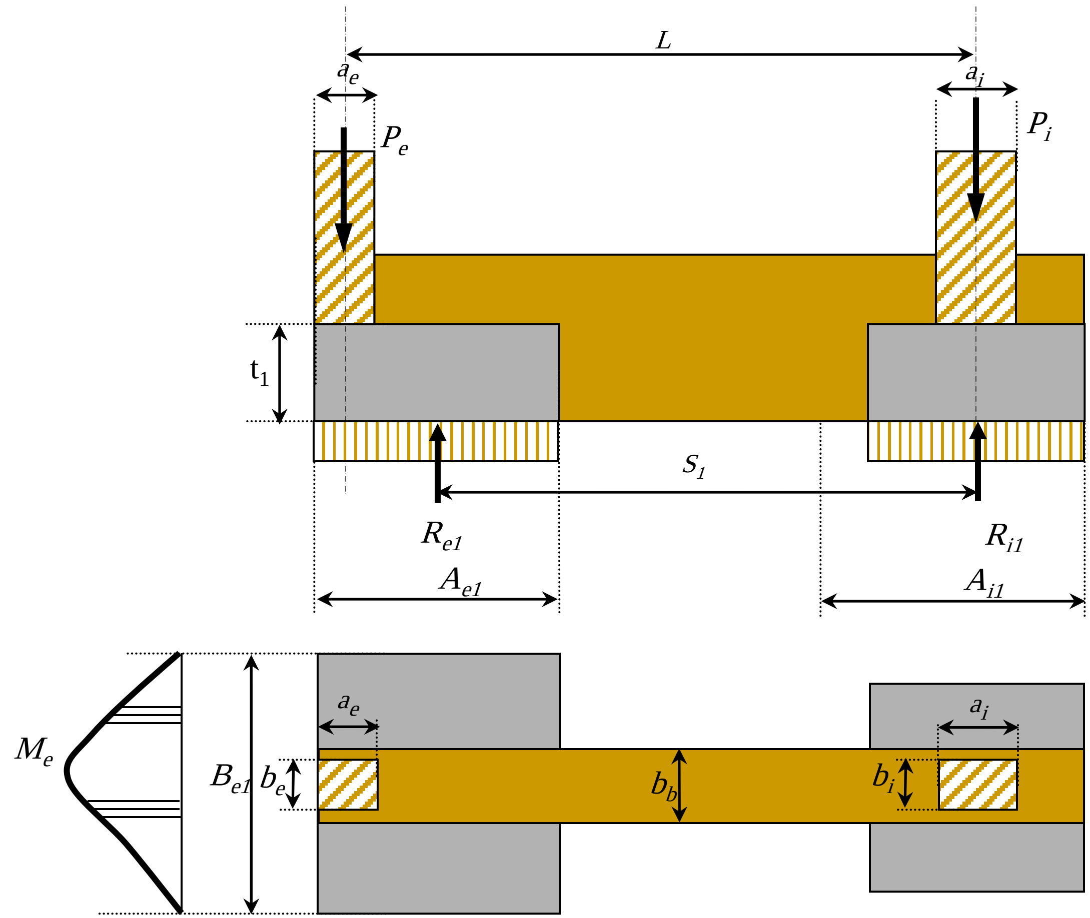
$$S_1 = L + \frac{a_e}{2} - \frac{A_{e1}}{2}$$

$$R_{e1} = \frac{P_e * L}{S_1}$$

$$p_n = \frac{1.50 R_{e1}}{A_{e1} * B_{e1}}$$

$$M_e = P_n \frac{\left[(B_{e1} - b_b)/2\right]^2}{2}$$

$$d = C\sqrt{\frac{M_1}{b * F_{cu}}}$$



$$t_1 = d + \text{cover}$$

$$A_{se} = \frac{M_e}{f_y * d * j}$$

Interior Footing

$$Area = A_i * B_i = \frac{1.15 P_i}{q_a}$$

$$A_i = B_i = \sqrt{Area}$$

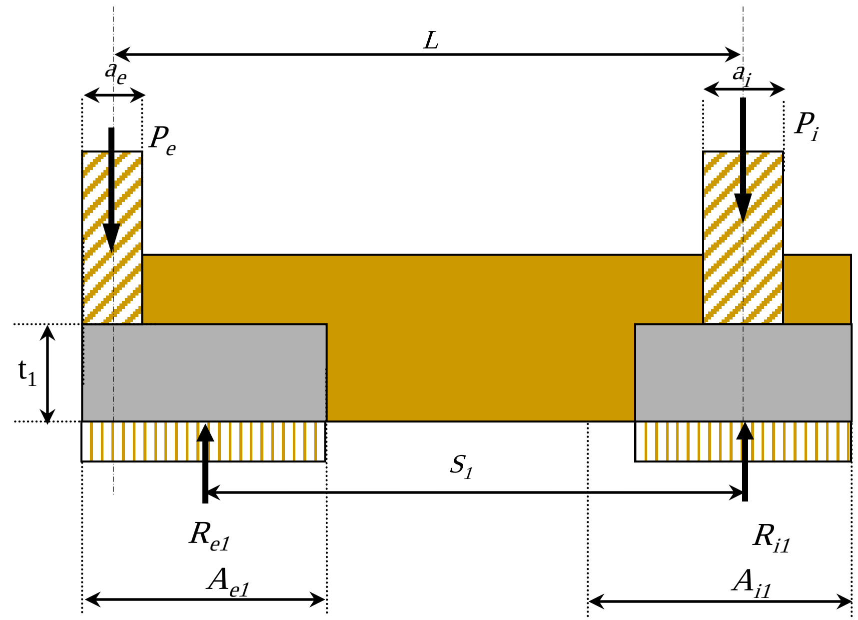
$$A_{i1} = A_i - 2X$$

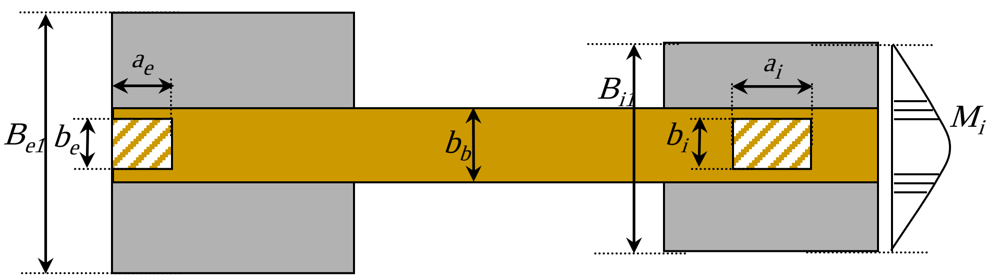
$$B_{i1} = B_i - 2X$$

$$p_n = \frac{1.50 R_{i1}}{A_{i1} * B_{i1}}$$

$$M_i = P_n \frac{[(B_{i1} - b_b)/2]^2}{2}$$

$$d = C \sqrt{\frac{M_i}{b * F_{cu}}}$$





$$t_1 = d + \text{cover}$$

$$A_{si} = \frac{M_i}{f_y * d * j}$$

Strap Beam

$$R_{i1} = P_i + P_e - R_{ie}$$

$$w_i = \frac{R_{i1}}{A_{i1}}$$

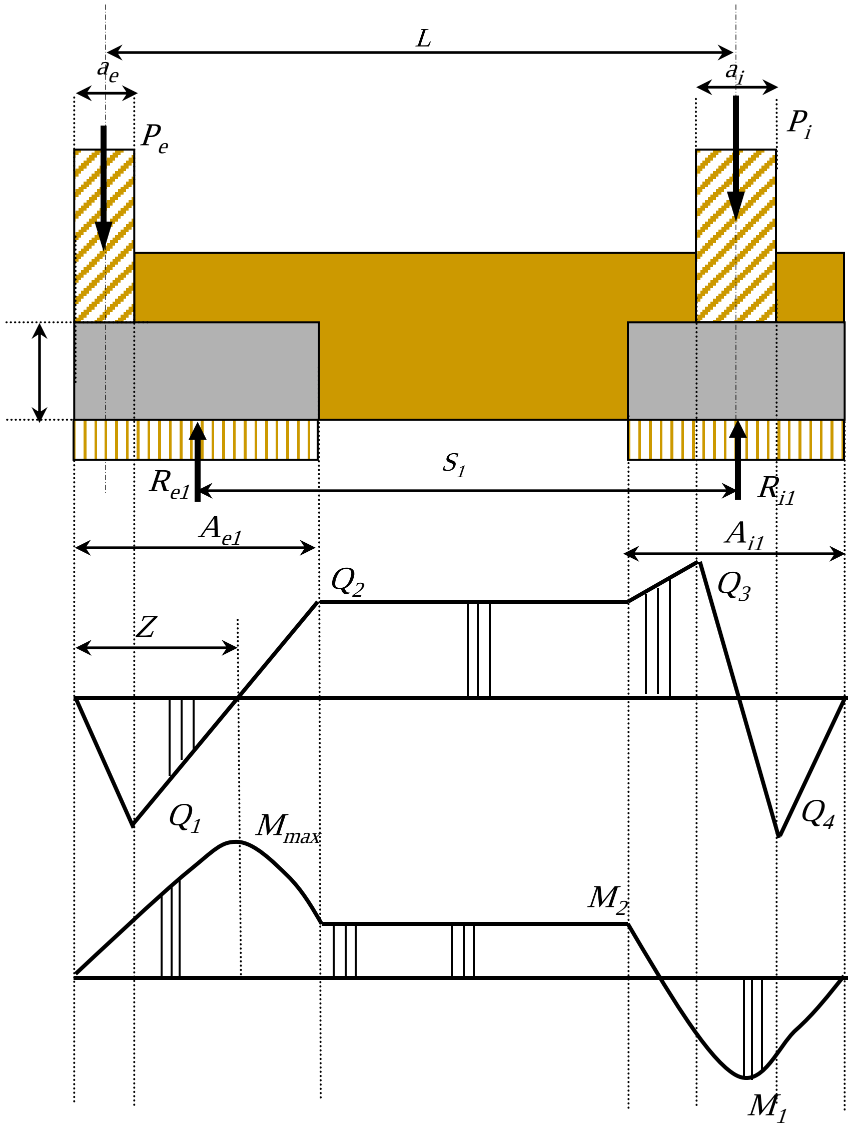
$$w_e = \frac{R_{e1}}{A_{e1}}$$

$$w_e Z - 1.50 P_e = 0.0 \longrightarrow$$ Get (Z)

$$M_{\max} = \frac{w_e Z^2}{2} - P_2 \left[Z - \frac{a_e}{2} \right]$$

$$M_1 = w_i \frac{\left[\frac{A_{i1} - a_i}{2} \right]^2}{2}$$

$$d = C \sqrt{\frac{M_{\max}}{b * F_{cu}}}$$



Strap Beam (Shear)

$$Q_1 = P_e - w_e * a_e$$

$$Q_2 = P_e - w_e * A_{e1}$$

$$Q_3 = P_i - w_i * \left[\frac{A_{i1} - a_i}{2} + a_i\right]$$

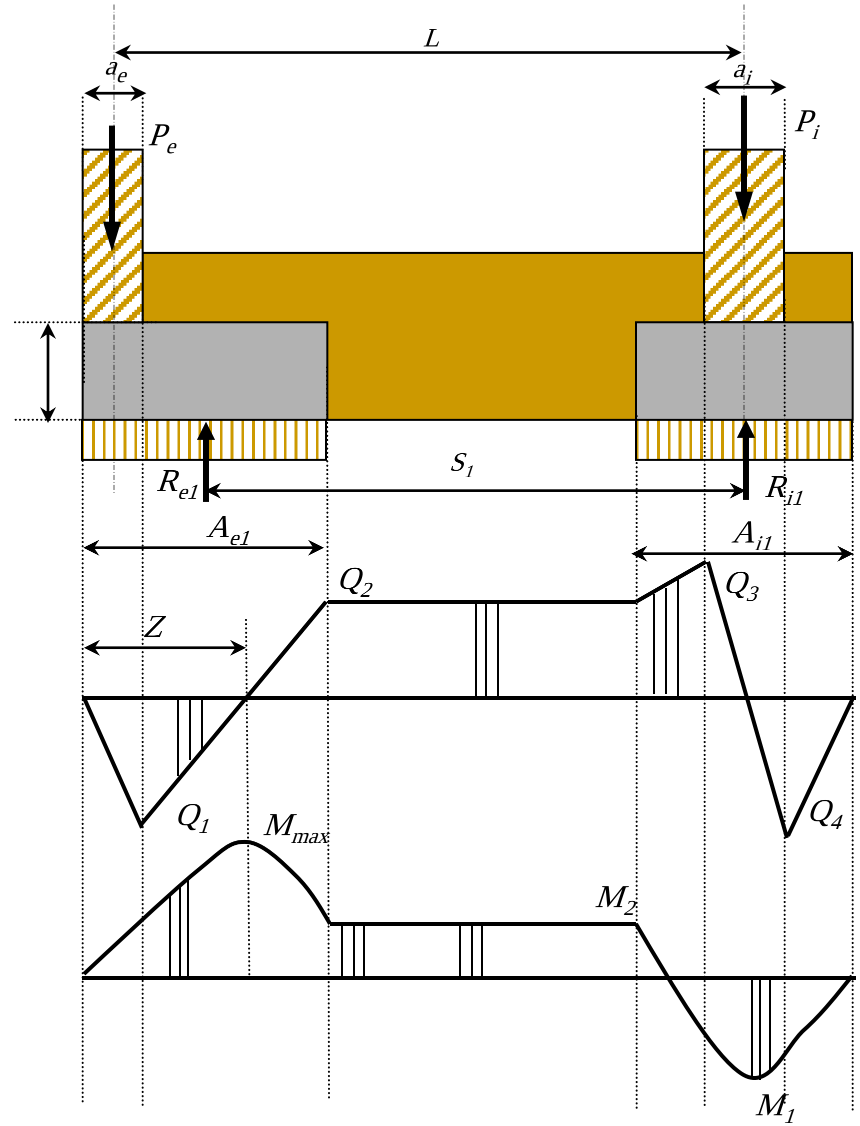
$$Q_4 = w_i * \left[\frac{A_{i1} - a_i}{2}\right]$$

$$Q_s = Q_3 - w_i * d$$

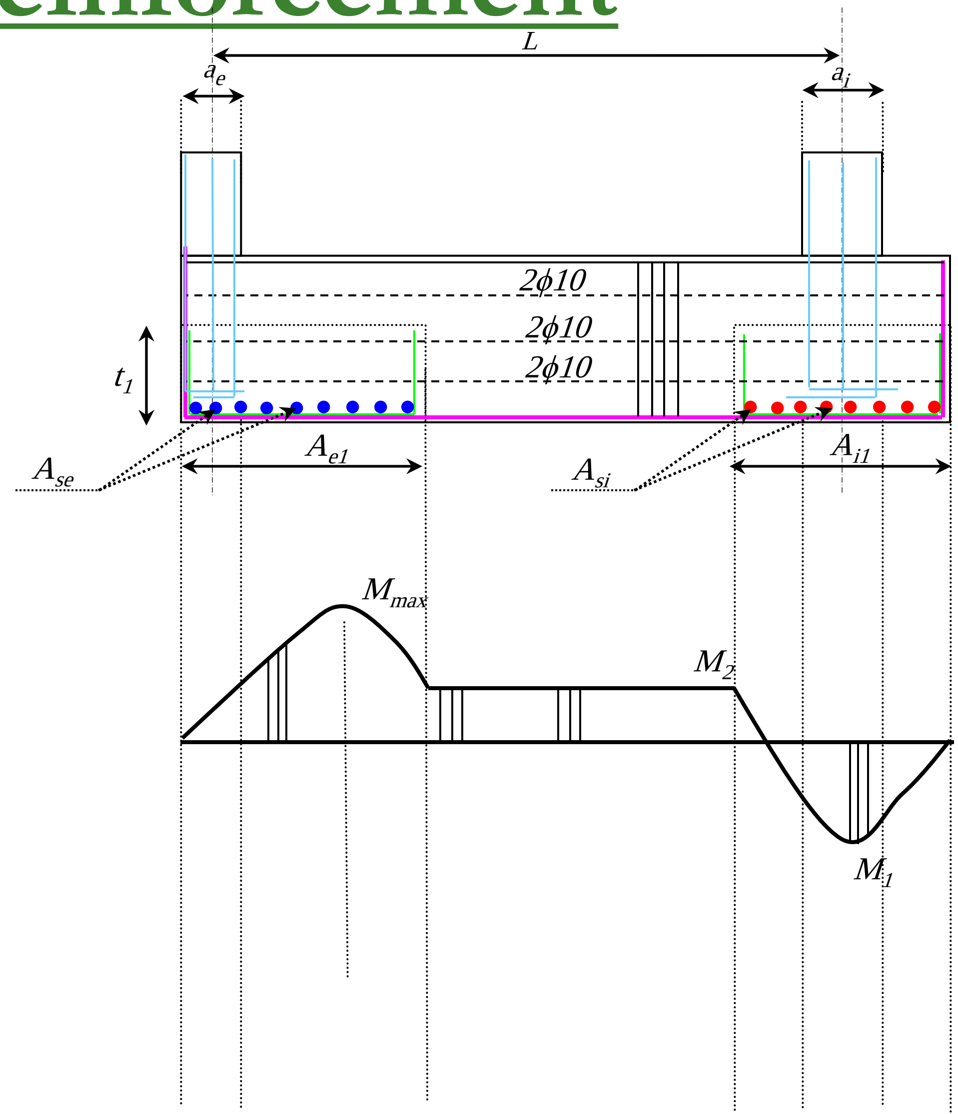
$$q_s = \frac{Q_s}{b_b * d} \le q_{su}$$

$$q_{su} = 0.75\sqrt{\frac{f_{cu}}{\gamma_c}}$$

Use Stirrups



Footing Reinforcement



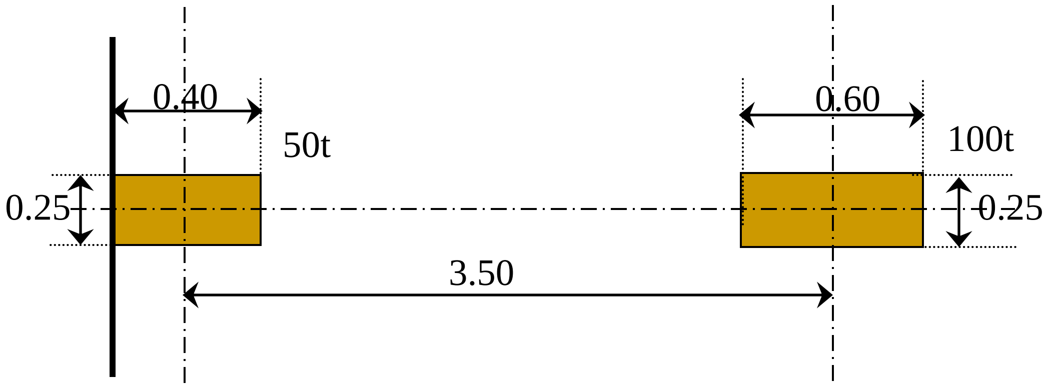
$$A_{top} = \frac{M_{\max}}{f_y * d * j}$$

$$A_{bot} = \frac{M_1}{f_y * d * j}$$

Design of Strap Footing

Example(1):

Make a complete design for a strap footing for the two columns shown in figure (2). The allowable gross bearing capacity is 1.40 kg/cm^2 and the foundation level is 2.0m below ground surface



$a_e = 0.40m.$ $b_e = 0.25m$ $P_e = 50t$

$a_i = 0.60m$ $b_i = 0.25m$ $P_i = 100t$

$q_a = 1.40kg/cm^2 = 14.0t/m^2.$

$f_{cu} = 250kg/cm^2.$

$f_y = 3600kg/cm^2$

Plain Concrete (P.C.) of Exterior Footing

$$Assume:\ A_e = \sqrt{\frac{1.30 P_e}{q_a}}$$

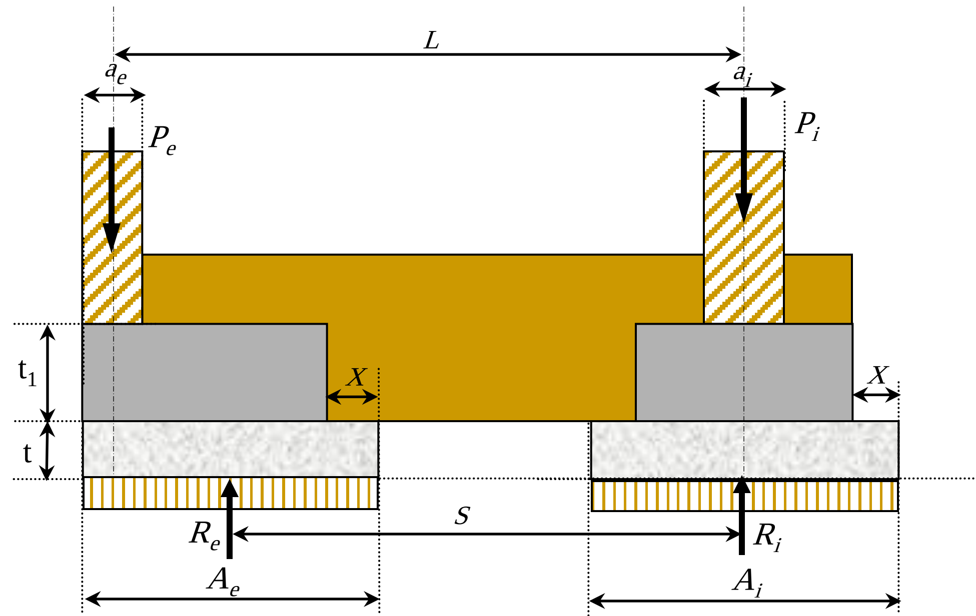
$$A_e = \sqrt{\frac{1.30*50}{14}} = 2.10m$$

$$S = L + \frac{a_e}{2} - \frac{A_e}{2}$$

$$S = 3.5 + \frac{0.40}{2} - \frac{2.10}{2} = 2.65m$$

$$R_e = \frac{p_e * L}{S} + 0.10 P_e \longrightarrow \text{Get } (R_e)$$

$$R_e = \frac{50*3.50}{2.65} + 0.10*50 = 71.0t$$



$$A_e * B_e = \frac{R_e}{q_a} = \frac{71}{14} = 5.07m^2 \longrightarrow B_e = 2.45\text{m}$$

Assume t=0.30

*Dim. of P.C. = 2.10 * 2.45 * 0.30*

(R.C.) of Exterior Footing

$$A_{e1} = A_e - X = 2.10 - 0.30 = 1.80m$$

$$B_{e1} = B_e - 2X = 2.45 - 0.60 = 1.85m$$

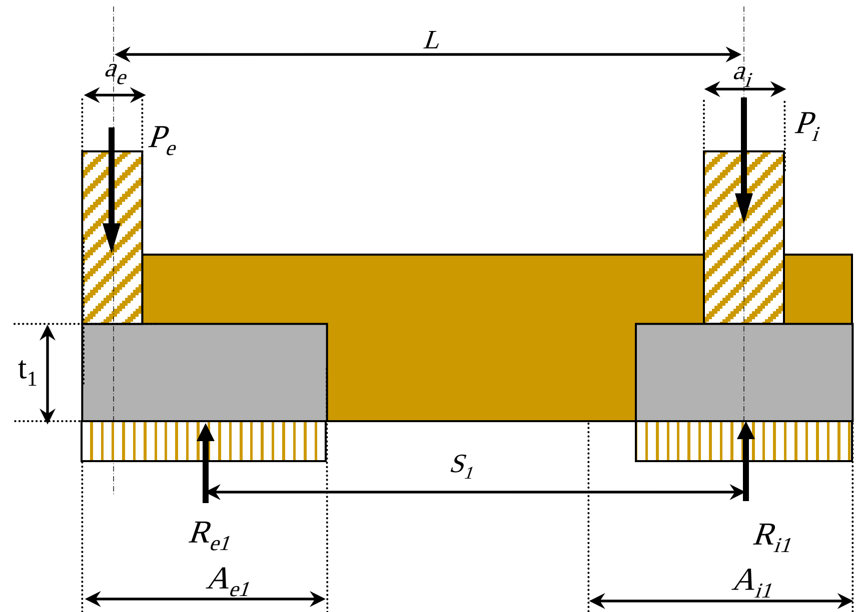
$$S_1 = L + \frac{a_e}{2} - \frac{A_{e1}}{2} = 3.50 + \frac{0.40}{2} - \frac{1.85}{2} = 2.775$$

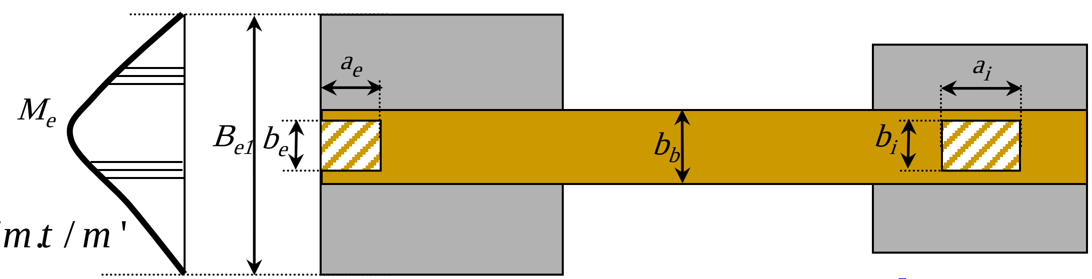
$$R_{e1} = \frac{P_e * L}{S_1} = \frac{50 * 3.50}{2.775} = 63.06t$$

$$p_n = \frac{1.50 * 63.06}{1.80 * 1.85} = 28.41t / m^2$$

$$M_e = 28.41 \frac{[(1.85 - 0.40)/2]^2}{2} = 7.47 m.t / m'$$

$$d = 5.0 * \sqrt{\frac{7.50 * 10^5}{100 * 250}} = 27.32 = 30cm$$





$$t_1 = 30 + 5 = 35cm$$

$$A_{se} = \frac{7.5 * 10^5}{3600 * 30 * 0.69} = 10.06cm^2$$

$$6\phi 12 / m'$$

Interior Footing

$$A_i * B_i = \frac{1.15*100}{14} = 8.22$$

$$A_i = B_i = \sqrt{8.22} = 2.90m$$

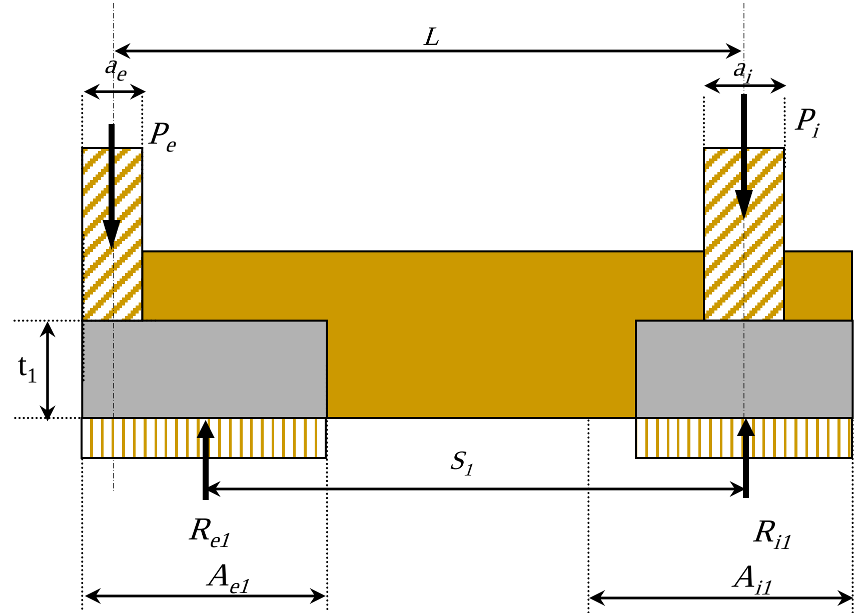
$$A_{i1} = 2.90 - 0.60 = 2.30m$$

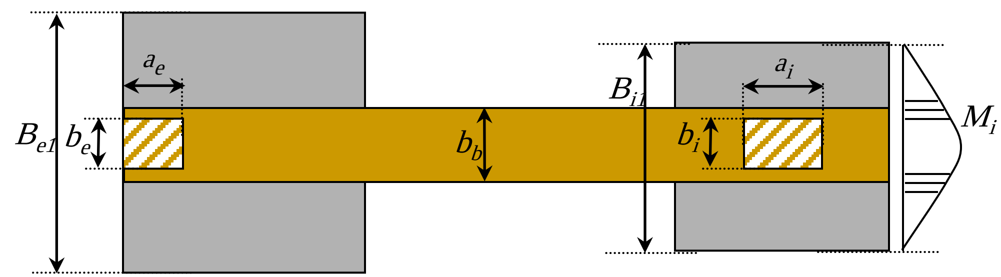
$$B_{i1} = 2.90 - 0.60 = 2.30$$

$$p_n = \frac{1.50*100}{2.30*2.30} = 28.36$$

$$M_i = 28.36 \frac{[(2.30-0.40)/2]^2}{2} = 12.80 m.t / m'$$

$$d = 5\sqrt{\frac{12.80*10^5}{100*250}} = 35.78 = 40cm$$





$$A_{si} = \frac{12.80*10^5}{3600*40*0.869} = 10.30cm^2$$

$$t_1 = 40 + 5 = 45cm$$

$$6\phi 12mm / m'$$

Strap Footing Program

Strap Footing
Excel Sheet