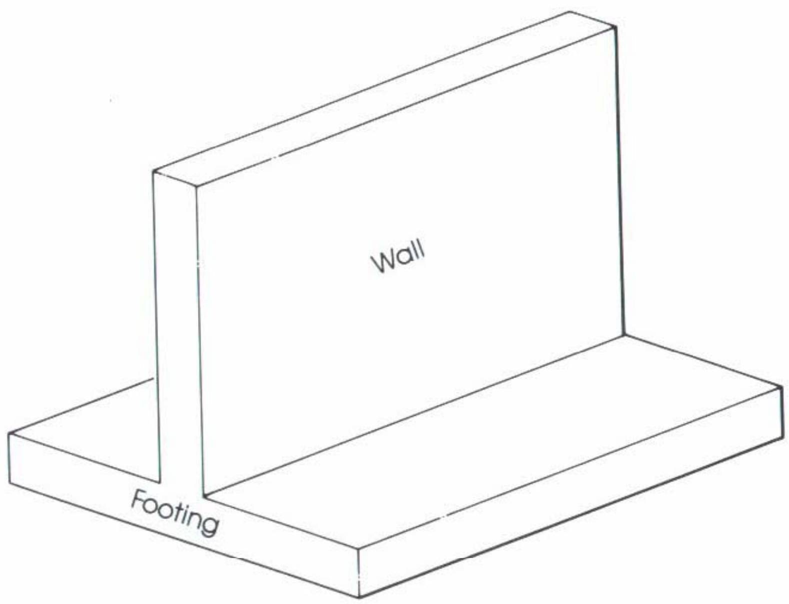
Footing Design

Types of Footing

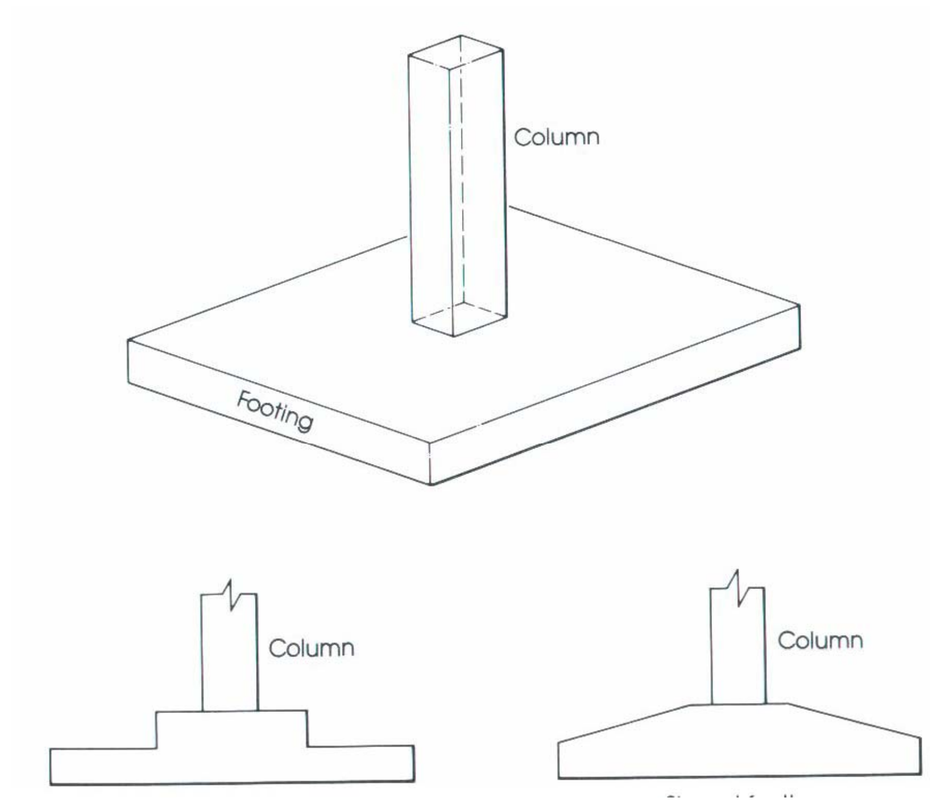
Wall footings are used to support structural walls that carry loads for other floors or to support nonstructural walls.



Wall footing.

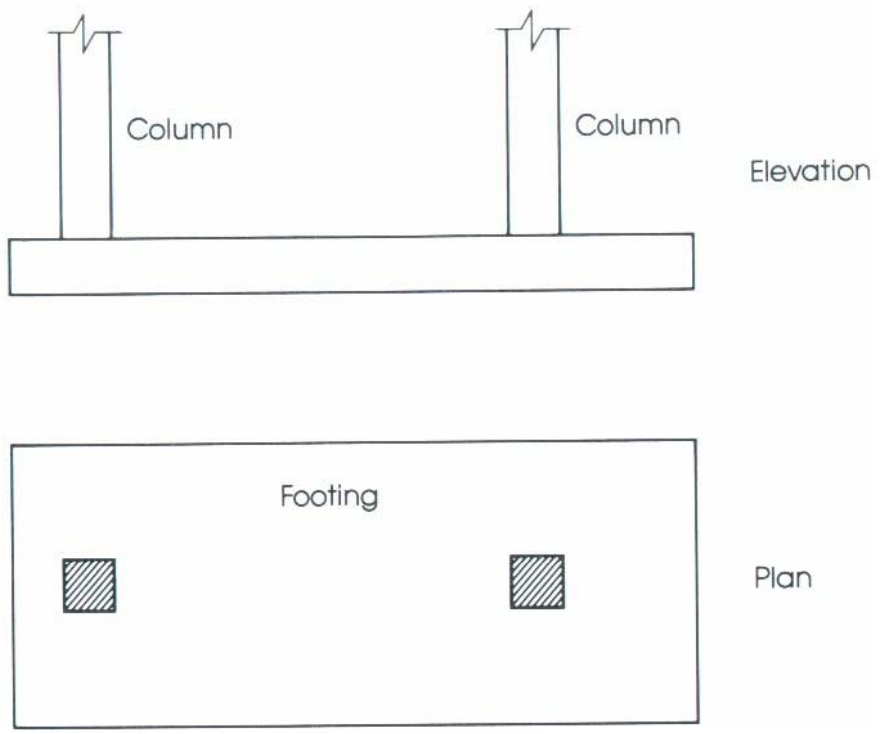
Types of Footing

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.



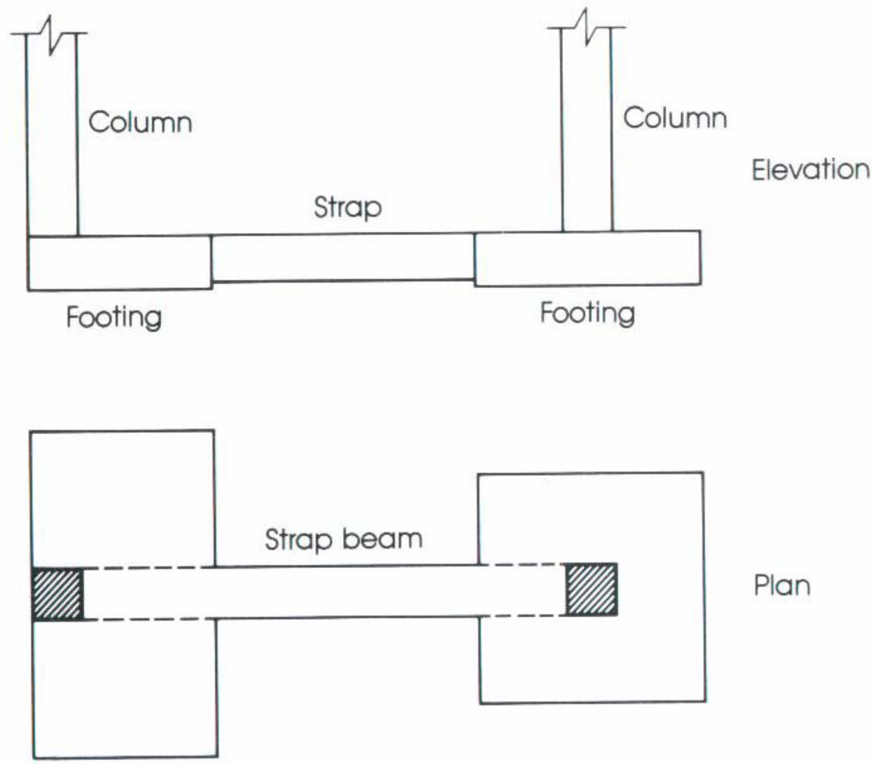
Types of Footing

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



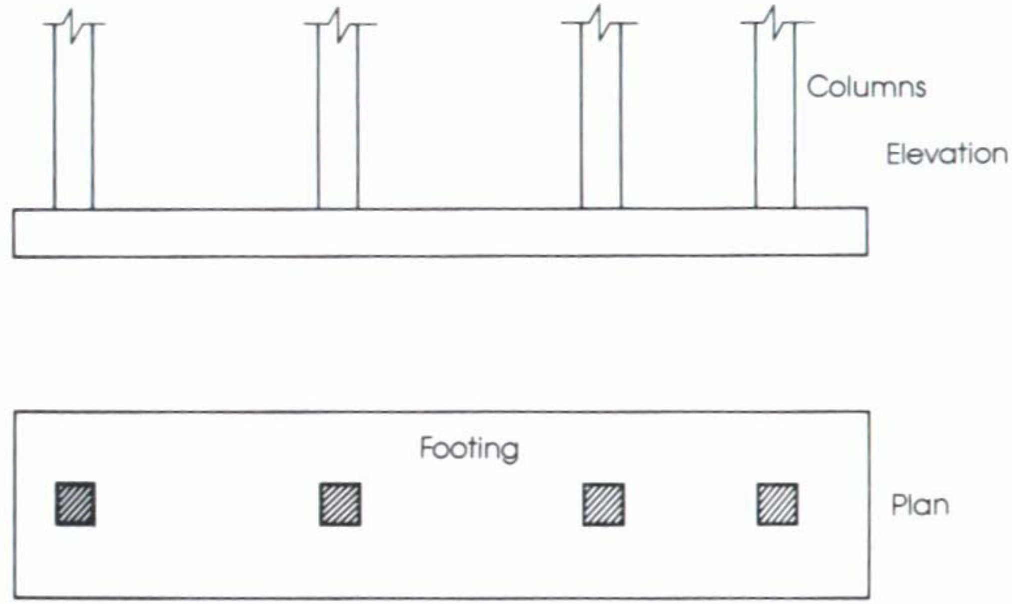
Types of Footing

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.



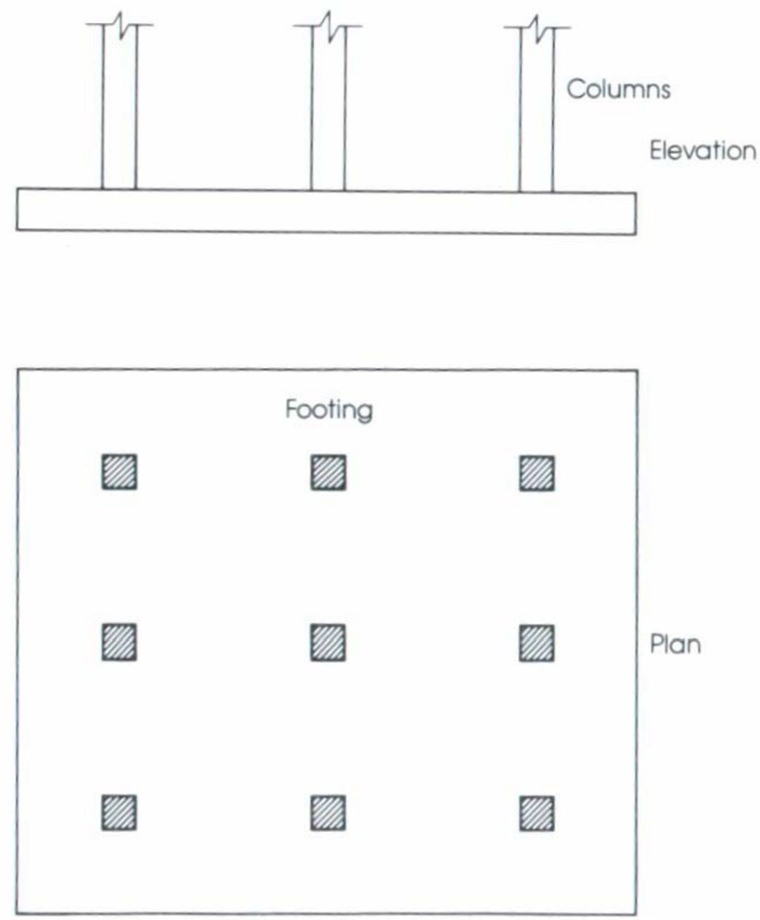
Types of Footing

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



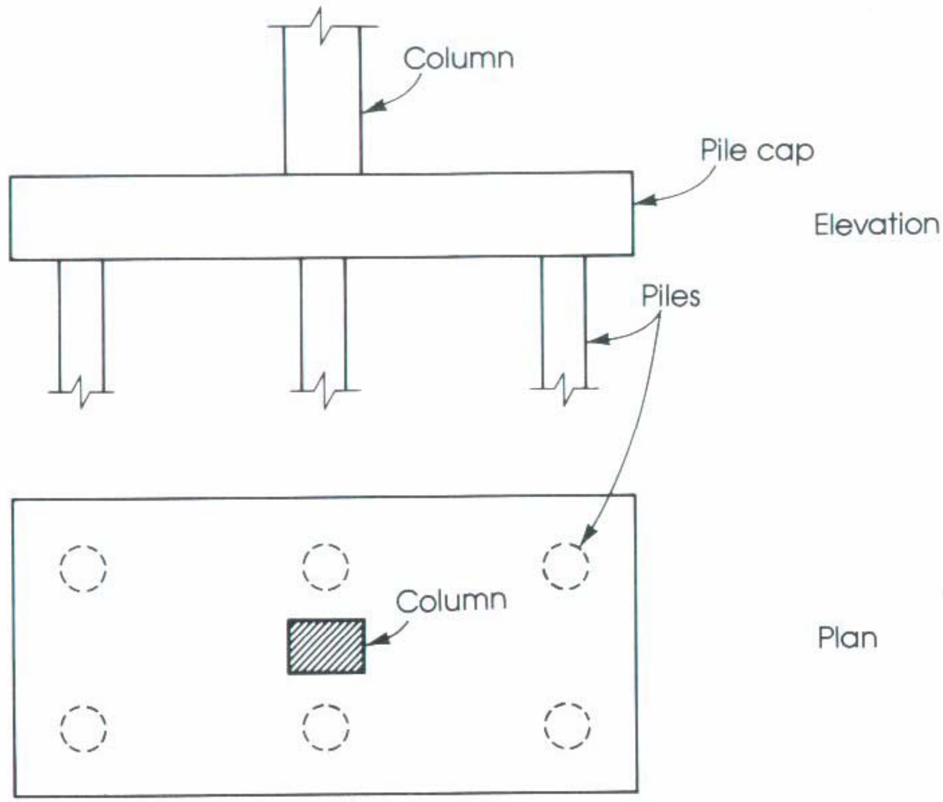
Types of Footing

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.



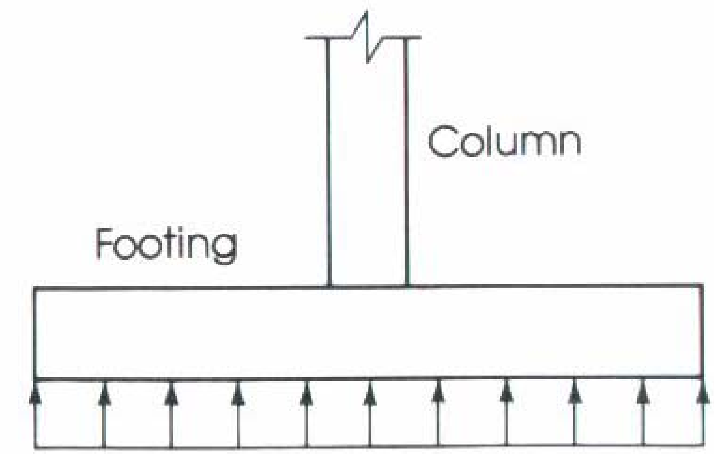
Types of Footing

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

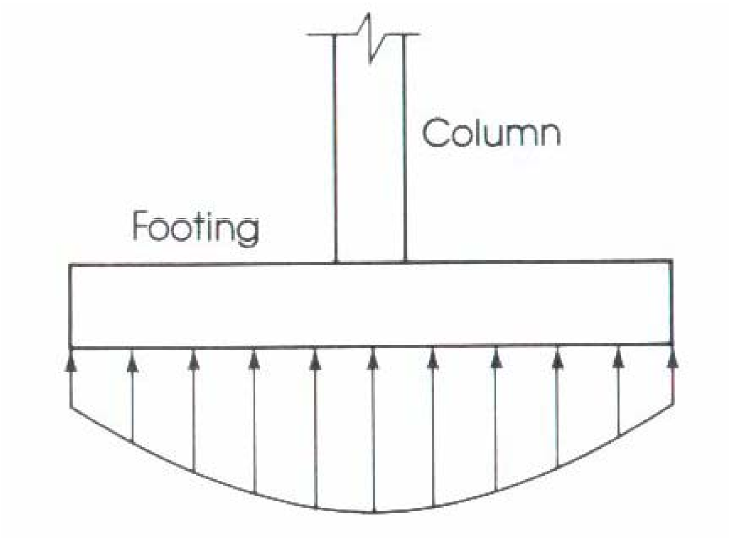


Distribution of Soil Pressure

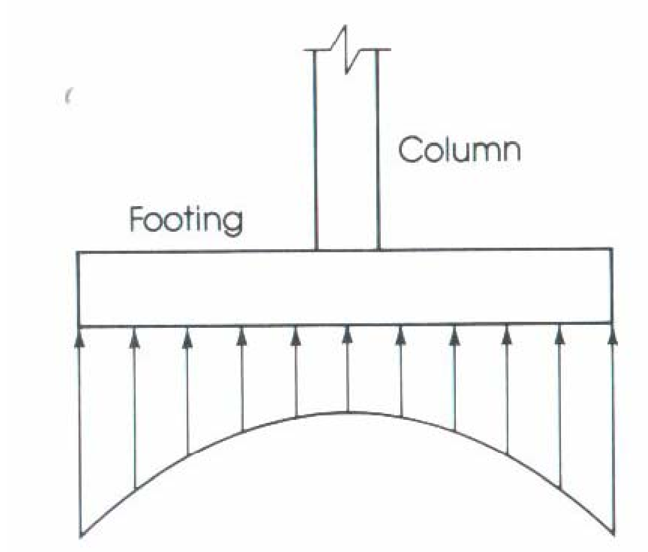
*When the column load **P** is applied on the centroid of the footing, a uniform pressure is assumed to develop on the soil surface below the footing area. However the actual distribution of the soil is not uniform, but depends on may factors especially the composition of the soil and degree of flexibility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



Distribution of Soil Pressure



Soil pressure distribution in cohesionless soil.



Soil pressure distribution in cohesive soil.

Eccentrically loaded footings

Footings are frequently designed for both axial load and moment. Moment may be caused by lateral forces due to wind or earthquake, by lateral soil pressures or by thrust at the base of a column.

The pressure distribution on the base of footing that support combined concentric load P (at the centroid of footing) and moment M is given by the following equation

$$p = \frac{P}{A} \pm \frac{Mc}{I}$$

where $c =$ the distance from the centroid perpendicular to the axis of bending moment.

$I =$ the moment of inertia of footing around the axis of bending.

In the footing , minimum pressure will be zero when the compressive pressure as a result of direct load equals tensile stresses produced from moment,

$$\frac{P}{A} = \frac{Mc}{I} \Rightarrow e = \frac{M}{P} = \frac{I}{Ac} = \frac{BL^2/12}{(BL)(L/2)} = \frac{L}{6}$$

In case that eccentricity is small such as

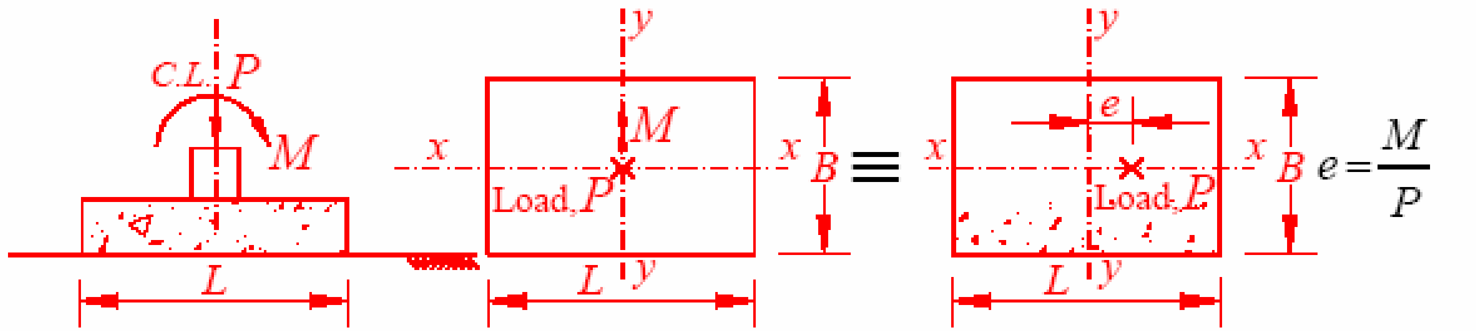
$$e < \frac{L}{6}$$

then pressure distribution shape will be a trapezoidal

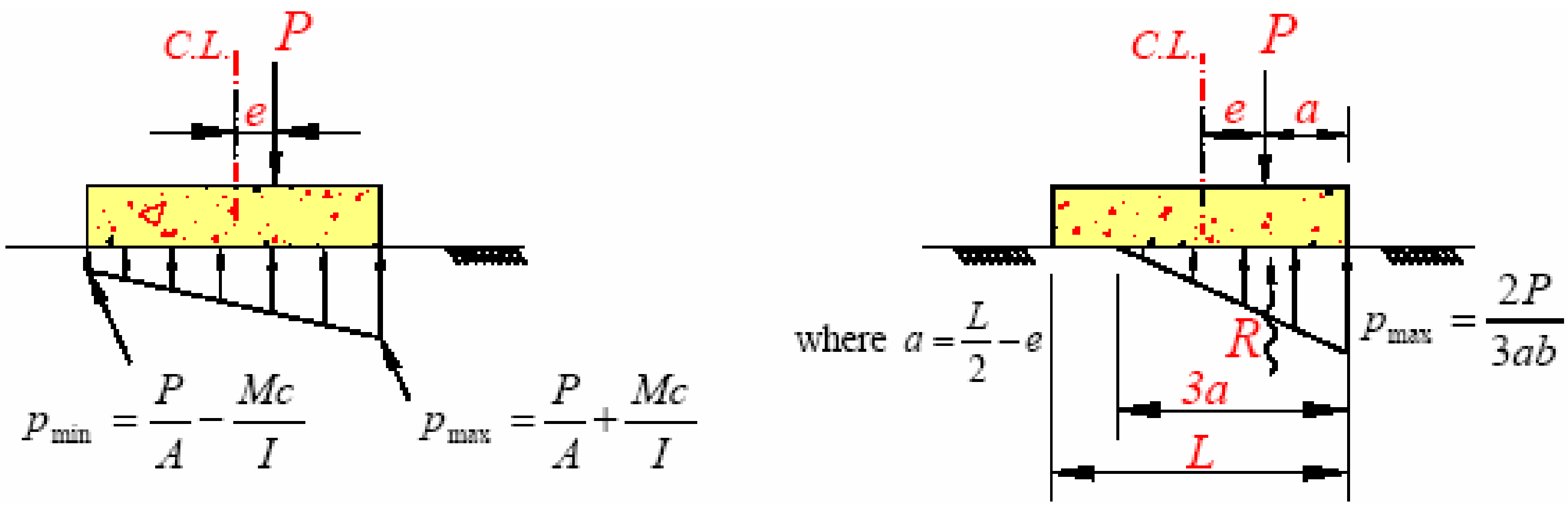
In case that eccentricity is large such as

$$e > \frac{L}{6}$$

then a triangular stress distribution will develop over a portion of the footing



(a) Footing under combined load and moment (b) Footing under eccentric load



(c) Small eccentricity of load, *e*<*h*/6 (d) Large eccentricity of load, *e*>*h*/6

Soil pressure under an eccentrically loaded rectangular footing

Eccentrically loaded footings Example

Isolated Footing

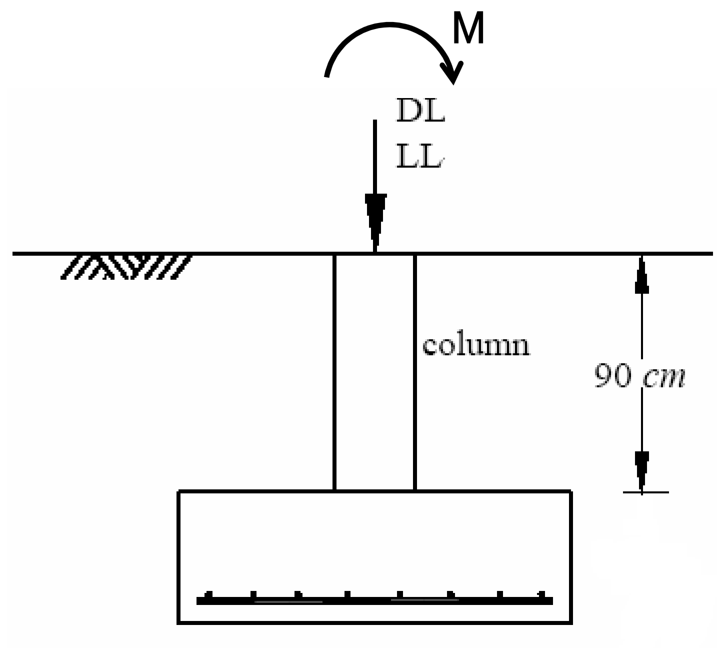
D.L = 900 kN

L.L = 450 kN

Ms = 150kN.m

Mu=200kN.m

q_{all} =200kpa



Area required approximated

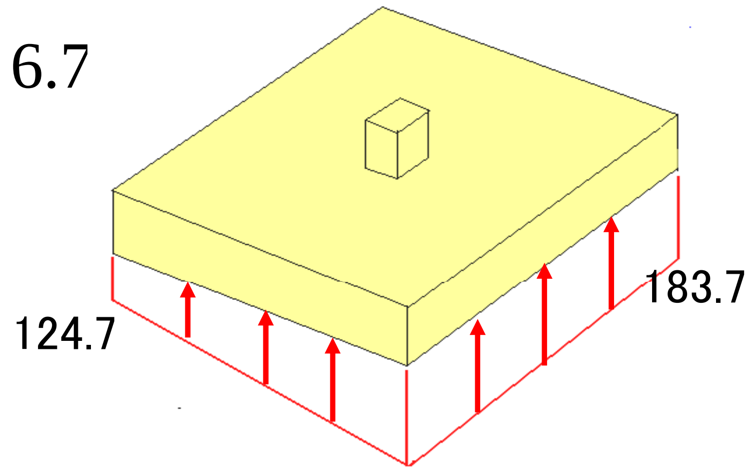
$$q_{all(net)} = 20t/m^2 = 200kPa$$

$$A_g = \frac{P_s}{q_{all(net)}} = \frac{(900+450)\times 10^3}{200\times 10^3} = 6.7$$

$$use \quad (3.5m \times 2.5m)$$

$$A = 8.75m^2$$

$$I = \frac{3.5^3 \times 2.5}{12} = 8.9m^4$$

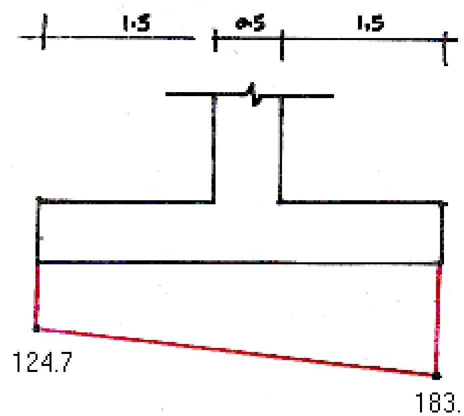


Check stress

$$e = \frac{M}{P} = \frac{150}{1350} = 0.111 < \frac{L}{6} = \frac{3.5}{6} = 0.583$$

$$\frac{P_s}{A} + \frac{M_s C}{I} = \frac{1350}{8.75} + \frac{150 \times \frac{3.5}{2}}{8.9} = 183.7kPa$$

$$\frac{P_s}{A} - \frac{M_s C}{I} = \frac{1350}{8.75} - \frac{150 \times \frac{3.5}{2}}{8.9} = 124.7kPa$$



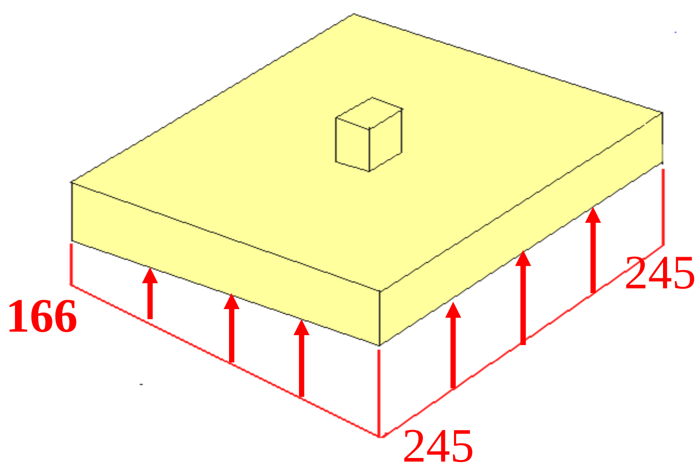
Ultimate pressure under footing

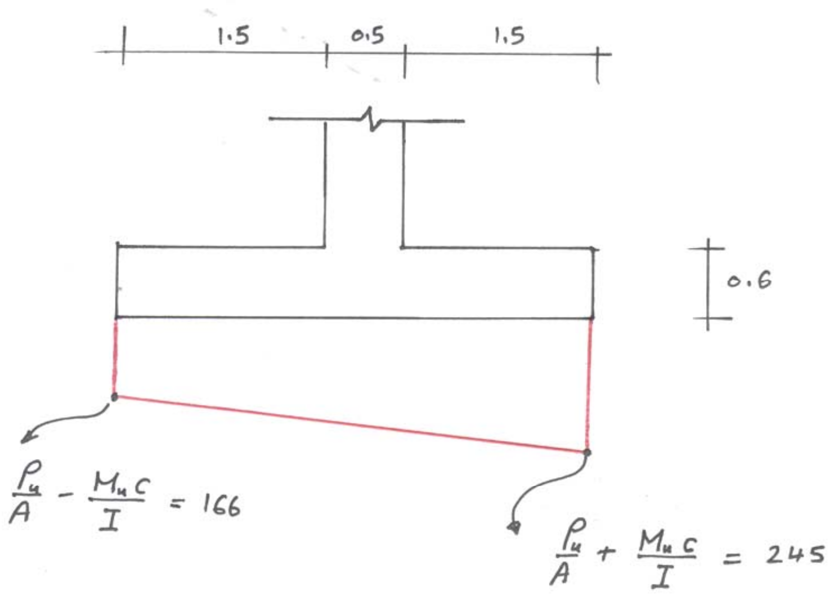
$$P_u = 1.2(900) + 1.6(450) = 1800kN$$

$$M_u = 200kN.m$$

$$\frac{P_u}{A} + \frac{M_u C}{I} = \frac{1800}{8.75} + \frac{200 \times \frac{3.5}{2}}{8.9} \approx 245kPa$$

$$\frac{P_u}{A} - \frac{M_u C}{I} = \frac{1800}{8.75} - \frac{200 \times \frac{3.5}{2}}{8.9} \approx 166kPa$$





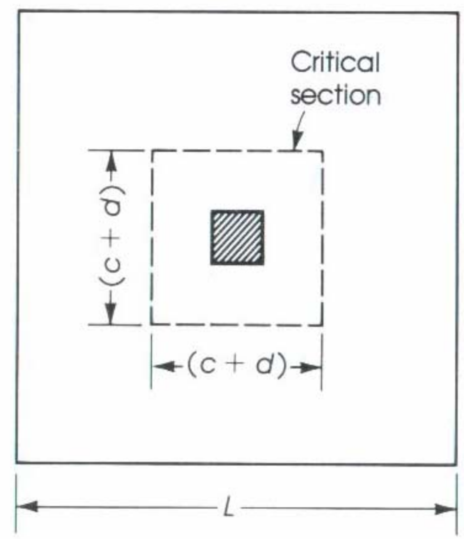
Check Punching Shear

$$b_o = 4[(530+400)] = 3720cm$$

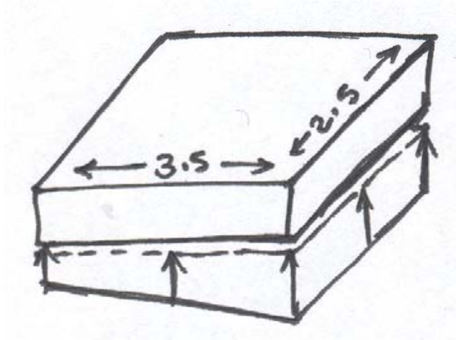
For square column the suitable ϕV_C equation *is* :

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 530 \times 3720 / 1000 = 2464.5kN$$

$$V_U \approx \frac{(166+245+166+245)}{4}(3.5 \times 2.5) = 1798kN$$



Check Beam Shear



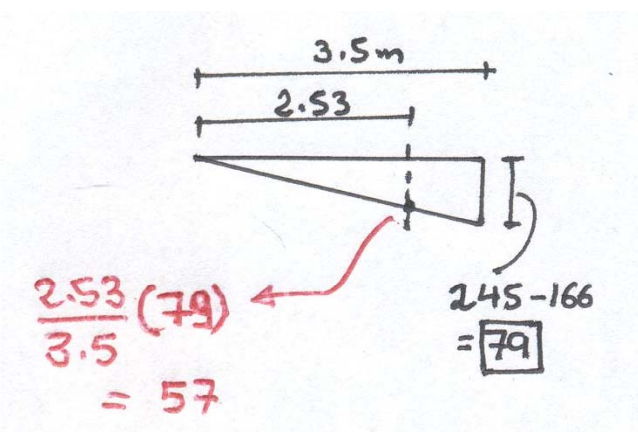
$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 530 \times 2500 / 1000 = 828.13kN$$

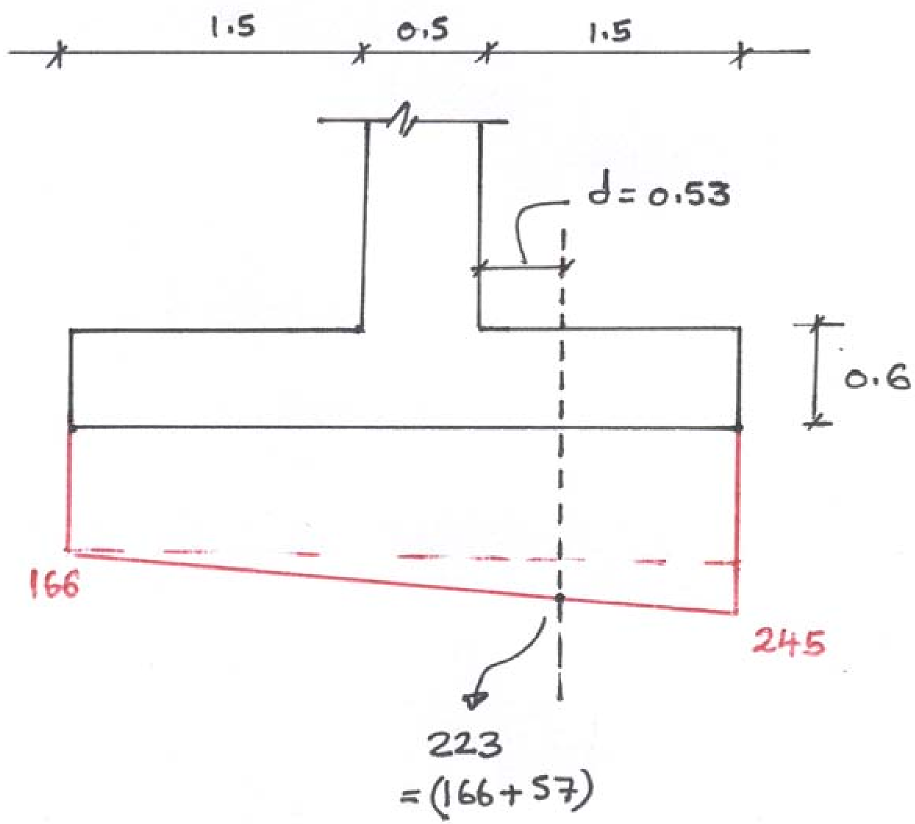
V_U at $\underline{\underline{d}}$ from column face $\Rightarrow$

$$V_U = \left(\frac{223 + 245}{2}\right) * (1.5 - 0.53) * 2.5$$

$$= 567.5kN$$

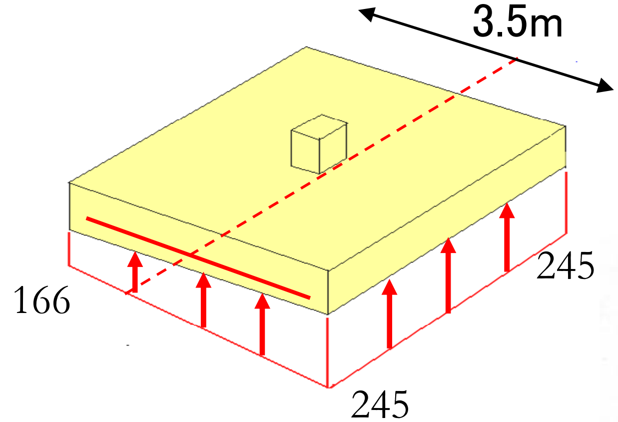
$$V_U < \phi V_C$$

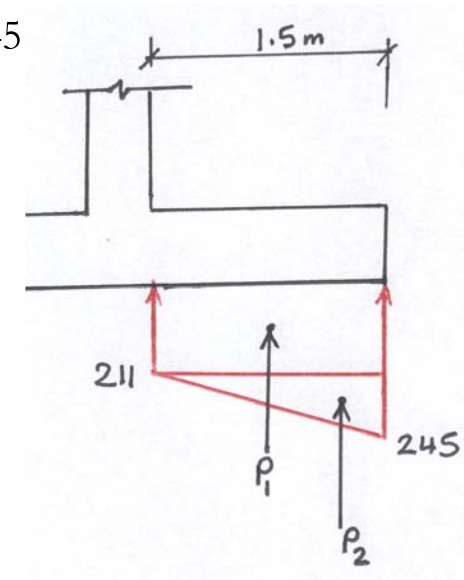




Bending moment design

Long direction





M_U at d from column face $\Rightarrow$

$$P_1 = 211(1.5)(2.5) = 791.25kN$$

$$P_2 = \tfrac{1}{2}(245-211)(1.5)(2.5) = 63.75kN$$

$$M_U = P_1(0.75) + P_2(1) = 791.25(0.75) + 63.75(1) = 657.2kN.m$$

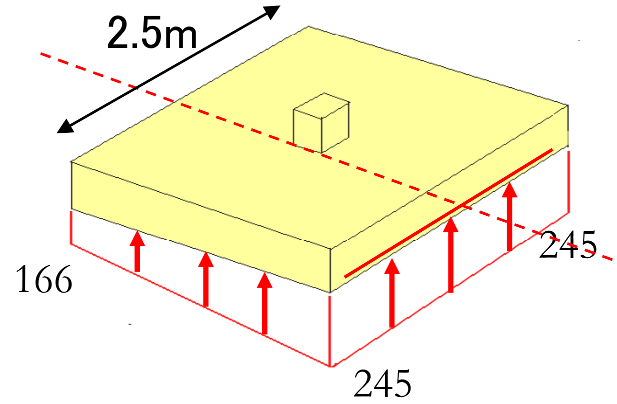
$$\text{b} = 2500, \text{d} = 530mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^6 * 657.2}{0.9(0.85)25 * 530^2 * 2500}}\right] = 0.00254$$

$$A_S = 0.00254 \times 530 \times 1000 = 1346mm^2 \approx 13.5cm^2 \quad use\ 7\phi16/m \quad \text{long direction}$$

Bending moment design

Short direction



M_U at d from column face $\Rightarrow$

$$M_U = \left(\frac{(245+166)}{2}(1\times3.5) \right)0.5 = 719.25 kN.m$$

$b = 3500, d = 530mm$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^6 * 719.25}{0.9(0.85)25*530^2*3500}}\right] = 0.002$$

$A_S = 0.002\times530\times1000 = 1060mm^2 \approx 10.1cm^2$ short direction

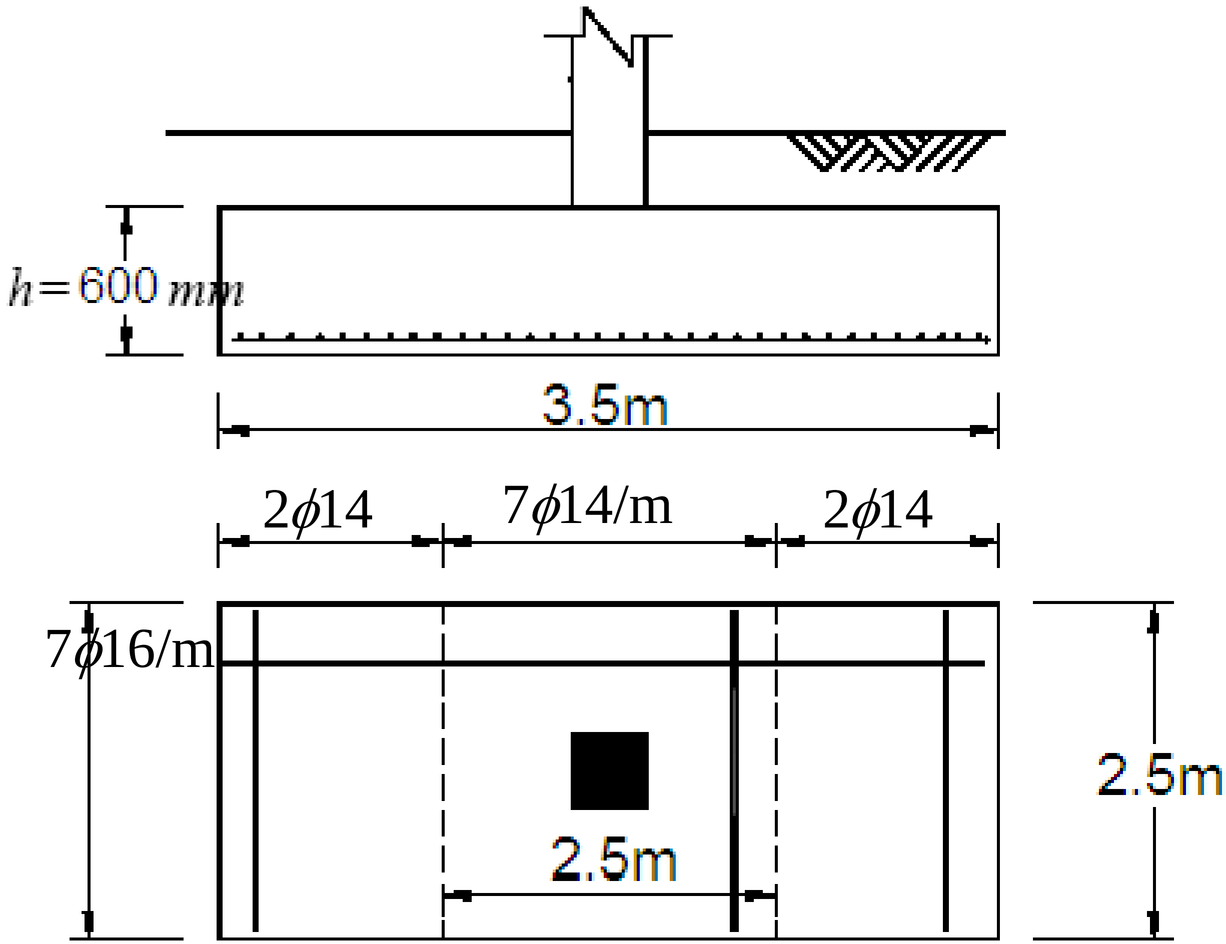
$$\text{Central band ratio} = \frac{2}{\beta + 1}$$

$$\beta = \frac{\text{Long side dimension of footing}}{\text{Short side dimension of the footing}}$$

$$\beta = \frac{3.5}{2.5} = 1.4$$

$$\frac{2}{\beta + 1} = \frac{2}{2.4} = 0.83$$

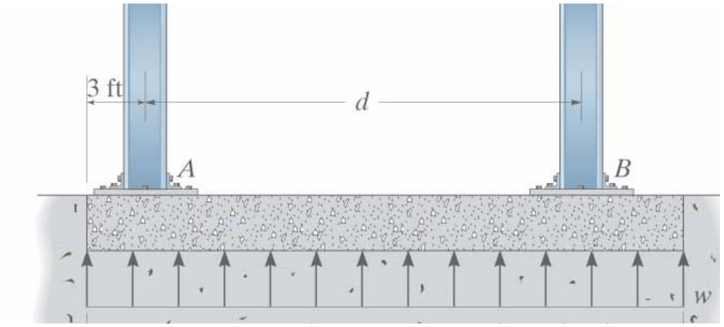
$$\text{Central band of short direction} = 0.83\ As = 0.83\ (10.1) = 8.6 cm^2$$



$h = 600\ mm$
3.5m
2ϕ14
7ϕ14/m
2ϕ14
7ϕ16/m
2.5m
2.5m

Footing Design
Part II

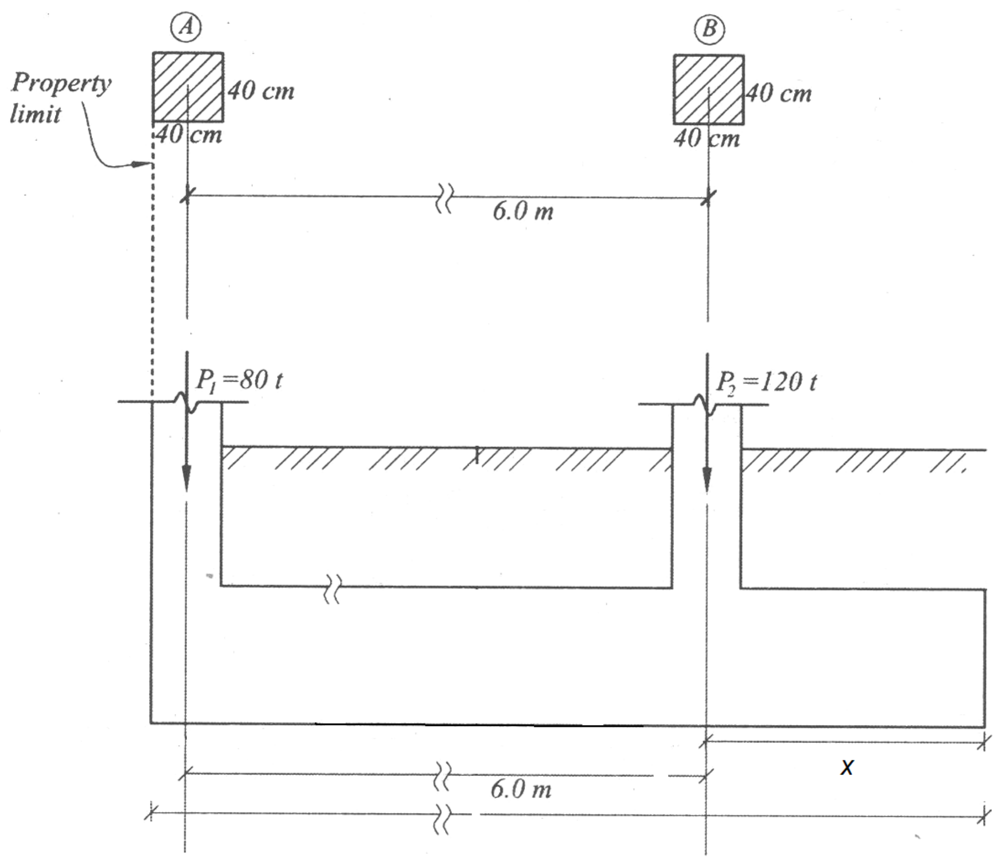
Combined footing



Example 1

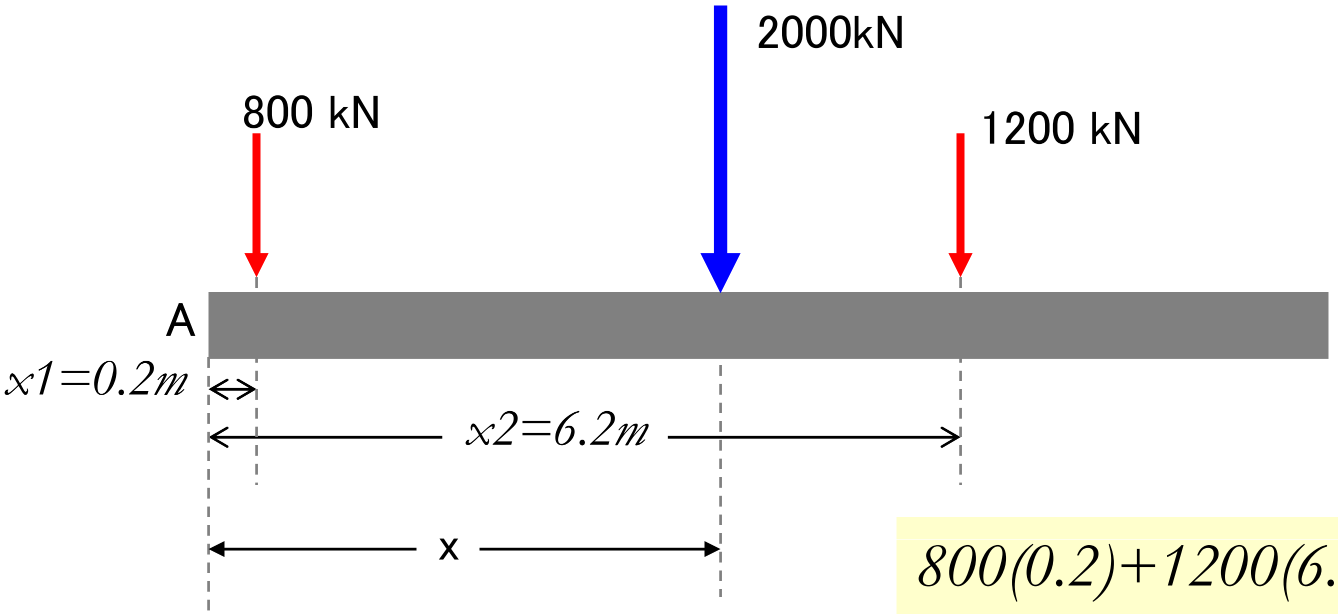
Design a combined footing As shown

$q_{all(net)} = 20t/m^2 = 200kPa$ $f'_c = 25\,N/mm^2$ $f_y = 420\,N/mm^2$

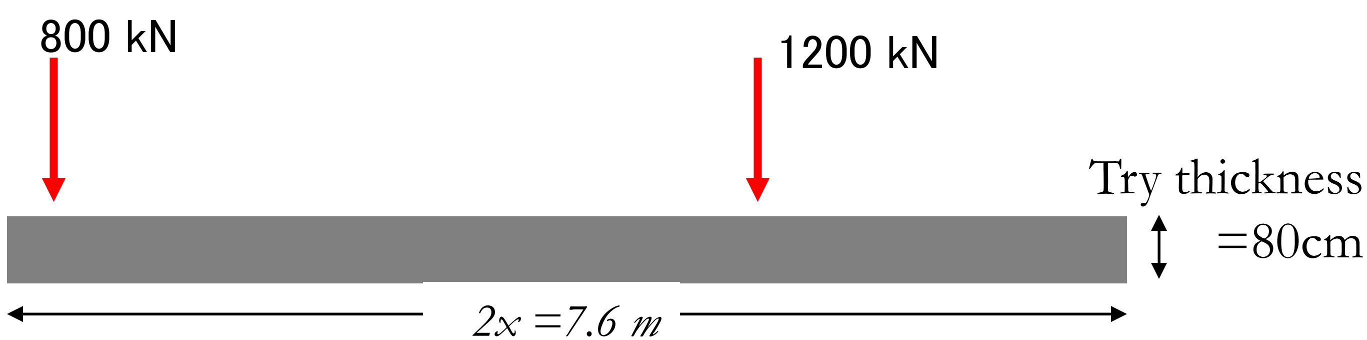


Dimension calculation

The base dimension to get uniform distributed load



$$800(0.2)+1200(6.2)=2000(x)$$
$$x = 3.8m$$



Area required

$$q_{all(net)} = 20t/m^2 = 200kPa,$$

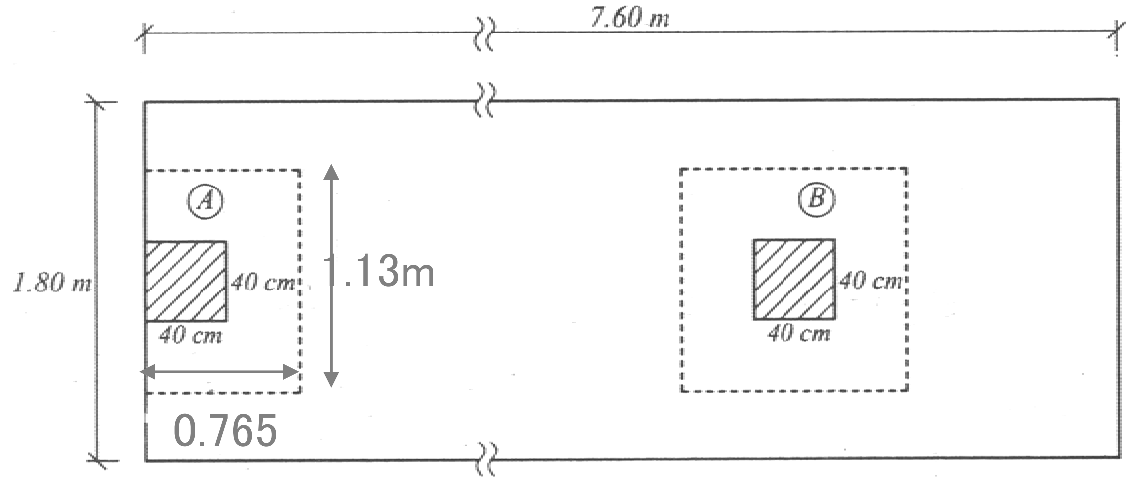
$$P_u = 1.3(P_s) = 1.3(2000) = 2600kN$$

$$A_g = \frac{P_s}{q_{all(net)}} = \frac{2000\times10^3}{200\times10^3} = 10m^2 \approx 7.6*1.8$$

$$q_u = \frac{P_u}{A} = \frac{(2600)\times10^3}{7.6*1.8} = 190\times10^3 Pa = 190kPa$$

Check for punching Shear

d = 730 mm



A

$$b_o = 2(765) + 1130 = 2260mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 730 \times 2260 / 1000 = 2062.3kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{30 \times 730}{2260} \right) \times \frac{\sqrt{25}}{12} \times 730 \times 2260 / 1000 = 6027kN$$

$$V_U = 800(1.3) - 1.13 * 0.765 * 190 = 875.8kN \ < \ \phi V_c \qquad \text{oK}$$

B

$$b_o = 4\left[(730+400)\right] = 4520mm$$

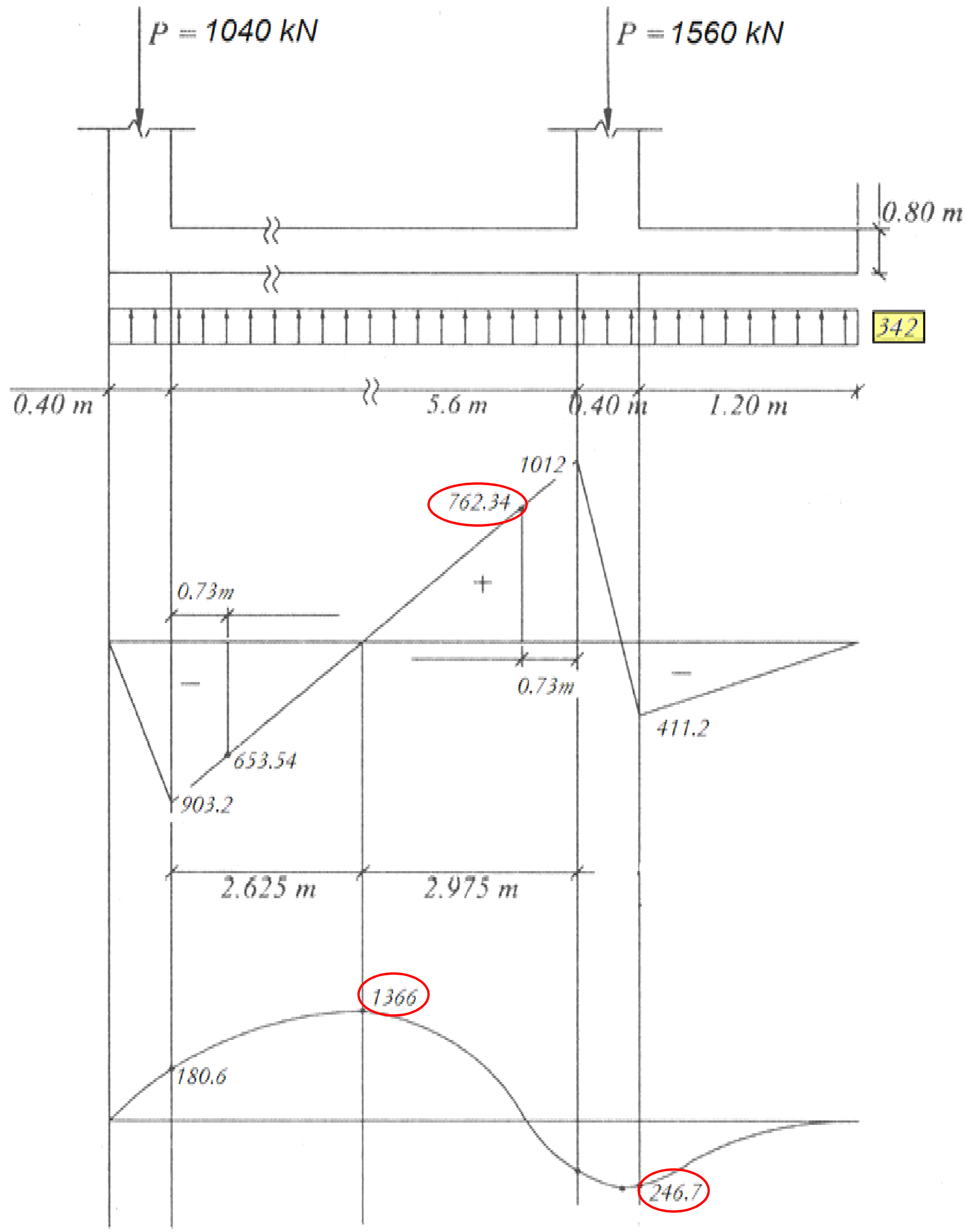
$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 730 \times 4520 / 1000 = 4124.4kN$$

$$\phi V_C = \phi\left(2 + \frac{\alpha_s d}{b}\right)\frac{\sqrt{f_c'}}{12} b_o d = 0.75\left(2 + \frac{40 \times 730}{4520}\right) \times \frac{\sqrt{25}}{12} \times 730 \times 4520 / 1000 = 13322.5kN$$

$$V_U = 1200(1.3) - 1.13 * 1.13 * 190 = 1317.4kN \; < \; \phi V_c \qquad \text{oK}$$

Draw S.F.D & B.M.D

Stress under footing
$= 190 * 1.8 = 342\ kN/m$



Check for beam shear

b = 1800mm, d = 730mm

$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 730 \times 1800 / 1000 = 821.25kN$$

$$Max. \rightarrow V_U \text{ at } \underline{\underline{d}} \text{ from column face} = 762.34kN$$

$$V_U < \phi V_C$$

Bending moment Long direction

$$-ve\ M = 1366 kN.m$$

$$\text{b} = 1800 mm, \text{d} = 730 mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 1366}{0.9(0.85)25 * 730^2 * 1800}}\right] = 0.0039$$

$$A_S = 0.0039 \times 730 \times 1000 = 2847 mm^2 = 28.5 cm^2 \quad use\ 9\phi 20/m \quad \text{Top}$$

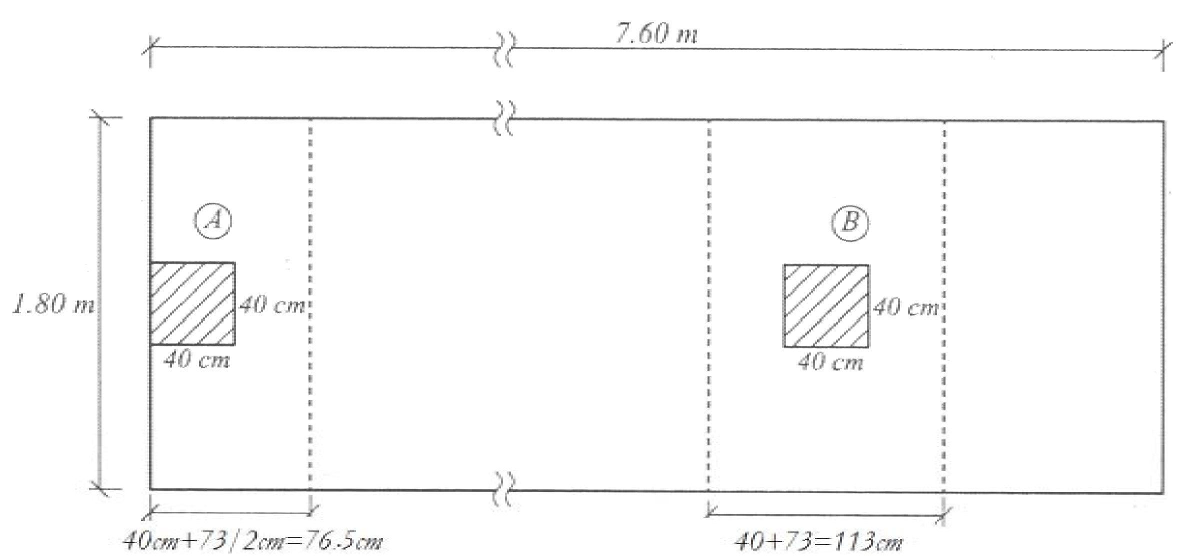
$$+ve\ M = 246.7 kN.m$$

$$\text{b} = 1800 mm, \text{d} = 730 mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 246.7}{0.9(0.85)25 * 730^2 * 1800}}\right] = 0.0007 < \rho_{\min}$$

$$A_{S\min} = 0.0018 \times 800 \times 1000 = 1440 mm^2 = 14.4 cm^2 \quad use\ 7\phi 16/m \quad \text{Bottom}$$

Bending moment Short direction



Under Column A

$$M = \frac{1040}{(1.8*0.765)} \times \frac{0.765}{2}\left(\frac{1.8-0.4}{2}\right)^2 = 141.6$$

$$b = 765mm, d = 730mm$$

$$\rho = 0.85*\frac{25}{420}\left[1-\sqrt{1-\frac{2\times10^6*141.6}{0.9(0.85)25*730^2*765}}\right] < \rho_{min}$$

$$A_{S\,min} = 0.0018\times800\times765 = 1101.6mm^2 = 11cm^2 \quad use\; 7\phi14/m$$

Under Column B

$$M = \frac{1560}{(1.8*1.13)} \times \frac{1.13}{2}\left(\frac{1.8-0.4}{2}\right)^2 = 212.33$$

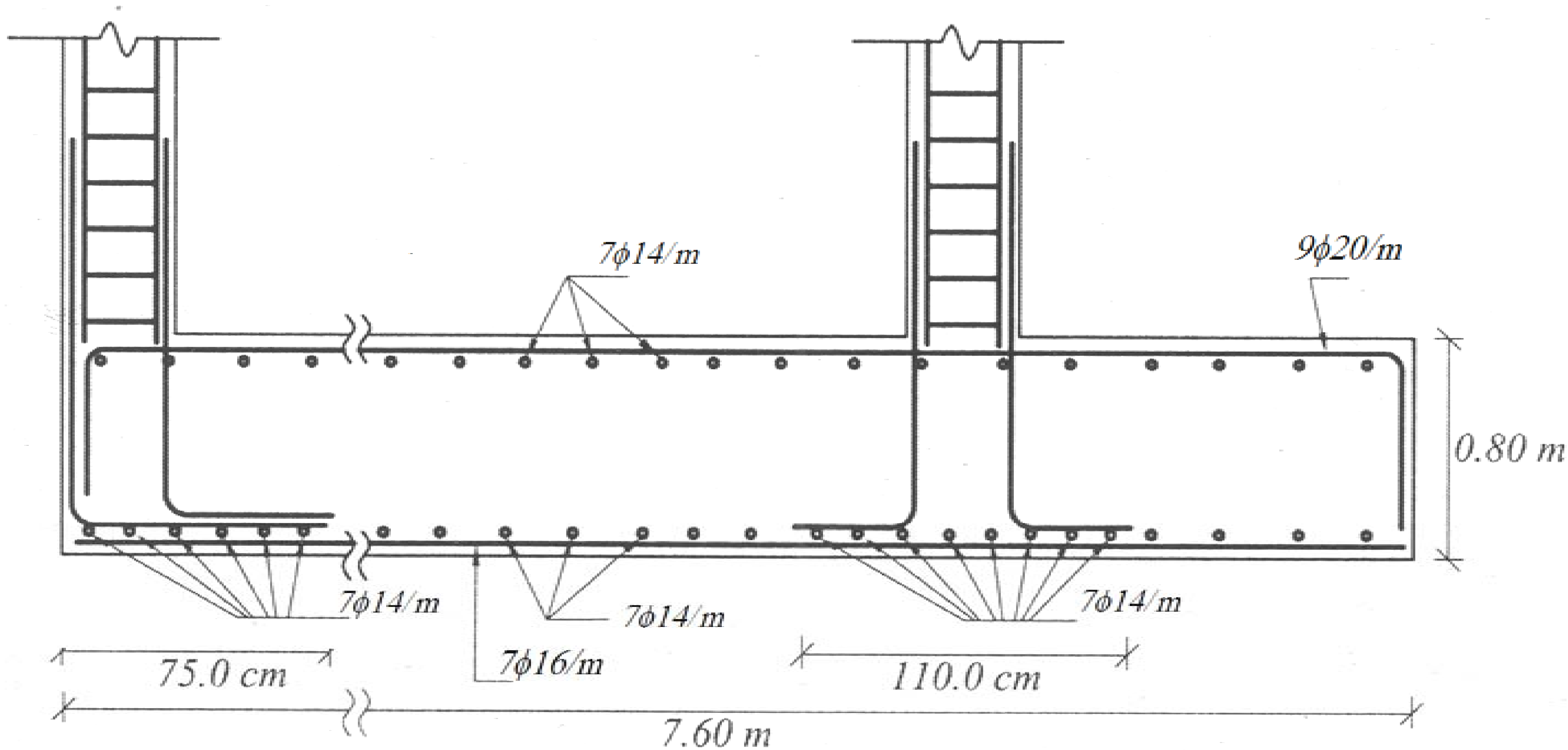
$$\mathrm{b} = 1130mm,\ \mathrm{d} = 730mm$$

$$\rho = 0.85*\frac{25}{420}\left[1-\sqrt{1-\frac{2\times10^6*212.33}{0.9(0.85)25*730^2*1130}}\right] < \rho_{\min}$$

$$A_{S\min} = 0.0018\times800\times765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi14/m$$

Shrinkage Reinforcement in short direction

$$A_{S\min} = 0.0018\times800\times765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi14/m$$


7ϕ14/m
9ϕ20/m
0.80 m
7ϕ14/m
7ϕ14/m
7ϕ14/m
7ϕ16/m
75.0 cm
110.0 cm
7.60 m

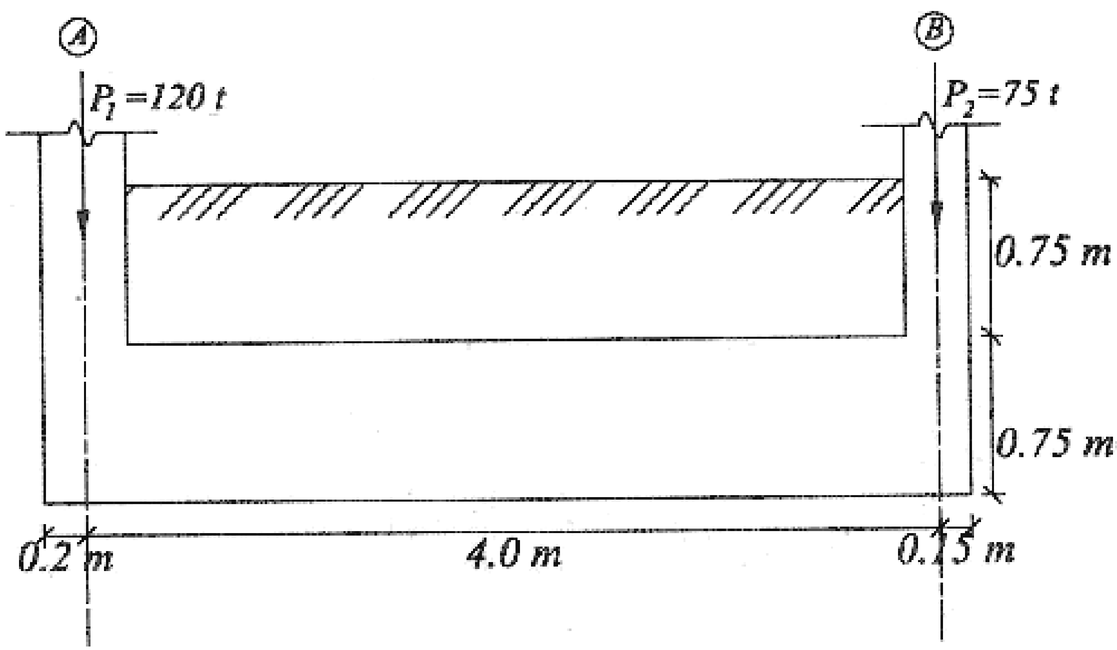
Footing Design
Part III

Combined footing, strip footing, & Mat foundation

Example 2

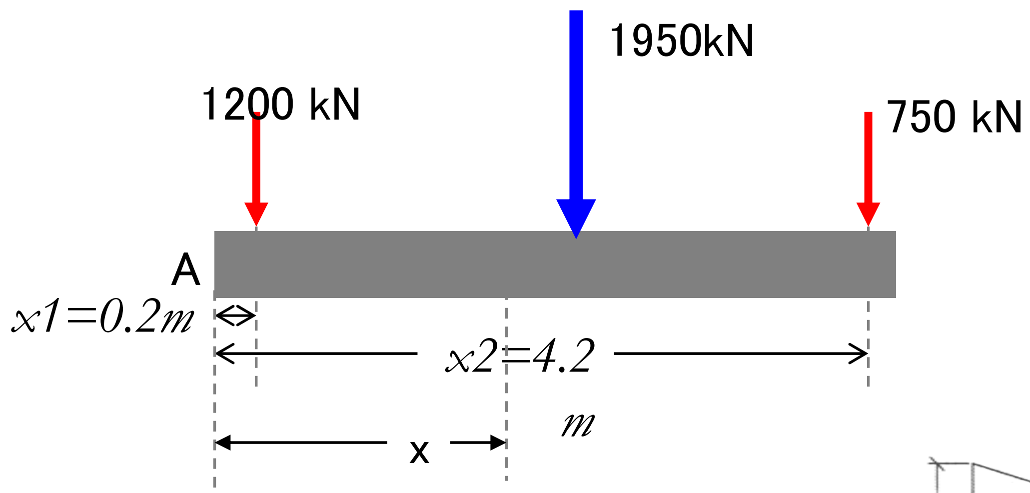
Design a combined footing As shown

$q_{all(net)} = 18\, t/m^2 = 180 kPa$ $f_c' = 25\, N/mm^2$ $f_y = 420\, N/mm^2$



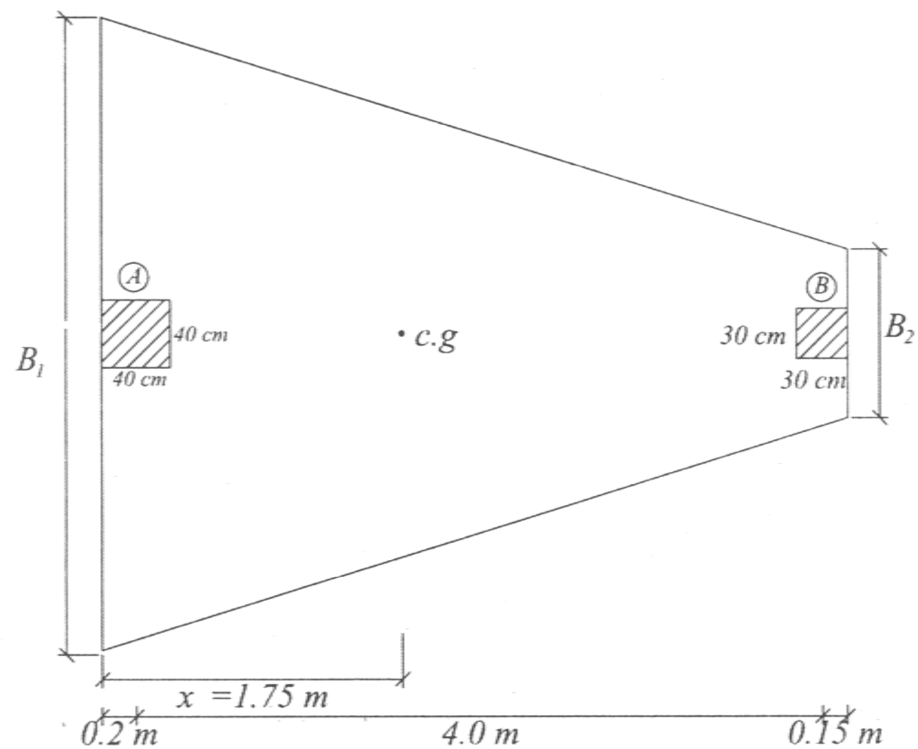
Dimension calculation

The base dimension to get uniform distributed load



$$750(4.2)+1200(0.2)=1950\ (x)$$
$$x = 1.75m$$

$$x=\left(\frac{B_1+2B_2}{B_1+B_2}\right)\frac{L}{3}$$



Area required

$$q_{all(net)} = 20t/m^2 = 200kPa,$$

$$A_g = \frac{P_s}{q_{all(net)}} = \frac{1950\times10^3}{180\times10^3} = 10.8m^2$$

$$\left(\frac{B_1+B_2}{2}\right)L = 10.8$$

$$\left(\frac{B_1+B_2}{2}\right)4.35 = 10.8$$

$$\left(\frac{B_1+B_2}{2}\right) = 2.5$$

$$B_1 + B_2 = 5$$

$$x = \left(\frac{B_1+2B_2}{B_1+B_2}\right)\frac{L}{3} = \left(\frac{5+B_2}{5}\right)\frac{4.35}{3}$$

$$1.75 = 1.45 + 0.29B_2$$

$$B_2 = 1m$$

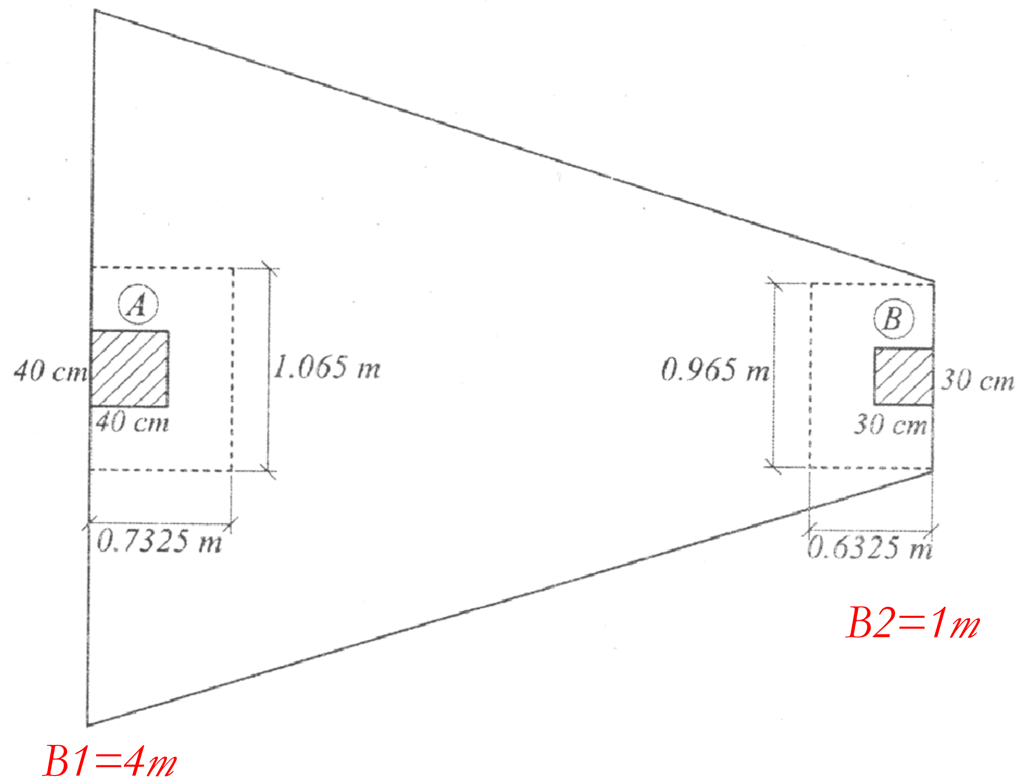
$$B_1 = 4m$$

$$q_u = \frac{P_u}{A} = \frac{1.3(1950)\times10^3}{10.8} = 235\times10^3\,Pa = 235kPa$$

Check for punching Shear

h= 750mm

d = 732 mm



A

$$b_o = 2(732) + 1065 = 2590mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 665 \times 2590 / 1000 = 2160.4kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{30 \times 665}{2590} \right) \times \frac{\sqrt{25}}{12} \times 665 \times 2590 / 1000 = 5222kN$$

$$V_U = 1200(1.3) - 1.065 * 0.733 * 235 = 1376.6kN \; < \; \phi V_c \qquad \text{oK}$$

B

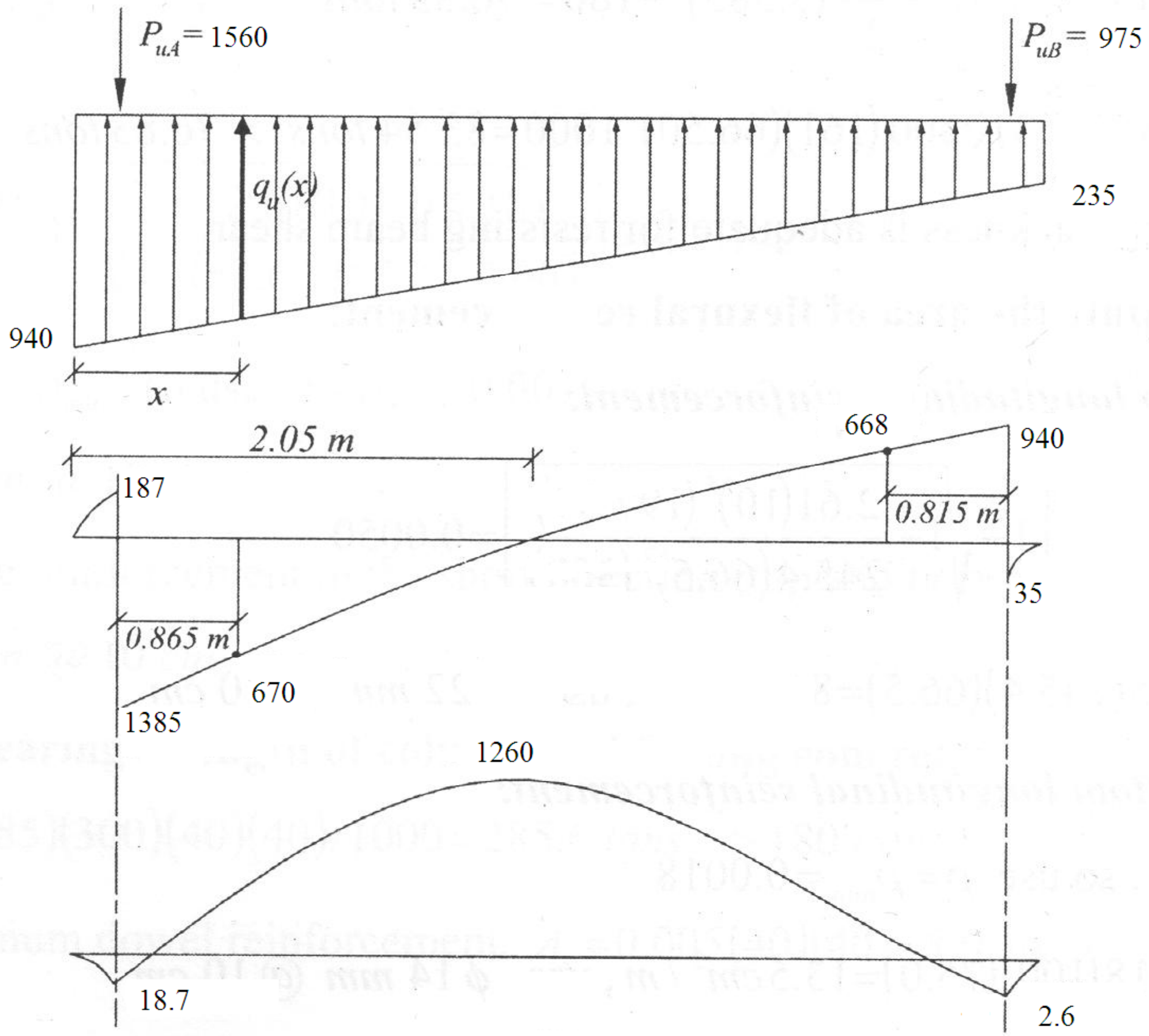
$$b_o = 2(633) + 965 = 2231 \ mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 665 \times 2231 / 1000 = 1854.5 kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{30 \times 665}{2231} \right) \times \frac{\sqrt{25}}{12} \times 665 \times 2231 / 1000 = 5273 kN$$

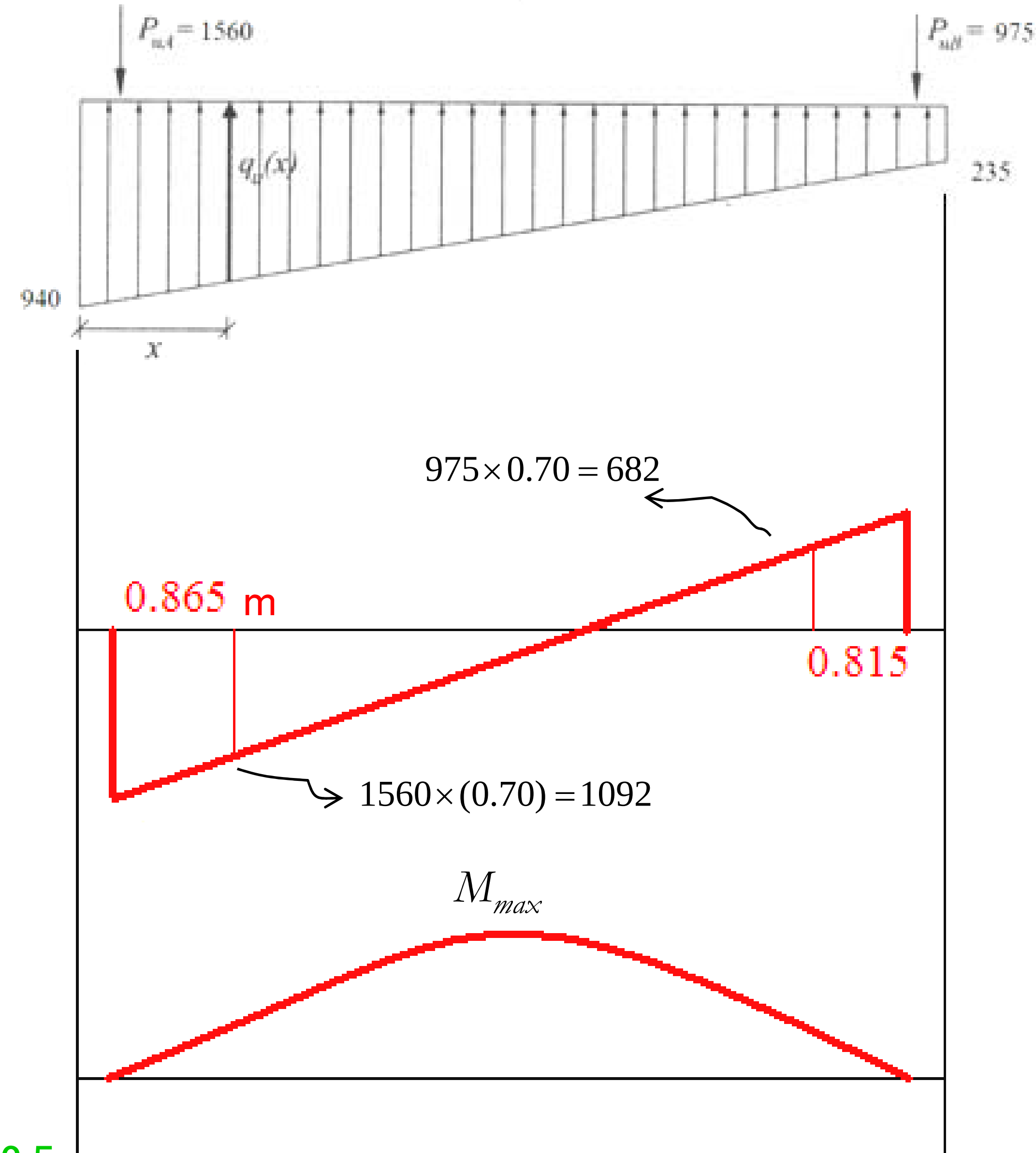
$$V_U = 800(1.3) - 0.965 * 0.633 * 235 = 896.5 kN \ < \ \phi V_c \qquad \text{oK}$$

Draw S.F.D & B.M.D



P_{uA}= 1560
P_{uB}= 975
$q_u(x)$
235
940
x
2.05 m
668
940
187
0.815 m
35
0.865 m
670
1385
1260
18.7
2.6

Empirical S.F.D & B.M.D



Convert trapezoidal load to rectangle

$$w_{ave} = 235 + \tfrac{2}{3}(940 - 235) = 705$$

$$-M_{\max} = \frac{wl^2}{8} = \frac{705(3.65)^2}{8} = 1174\ kN.m$$

Clear distance between column

B in moment design = ave. width = 2.5m

Check for beam shear

d = 665mm

$$b = 1 + 2(\tfrac{x}{L}) \times y$$

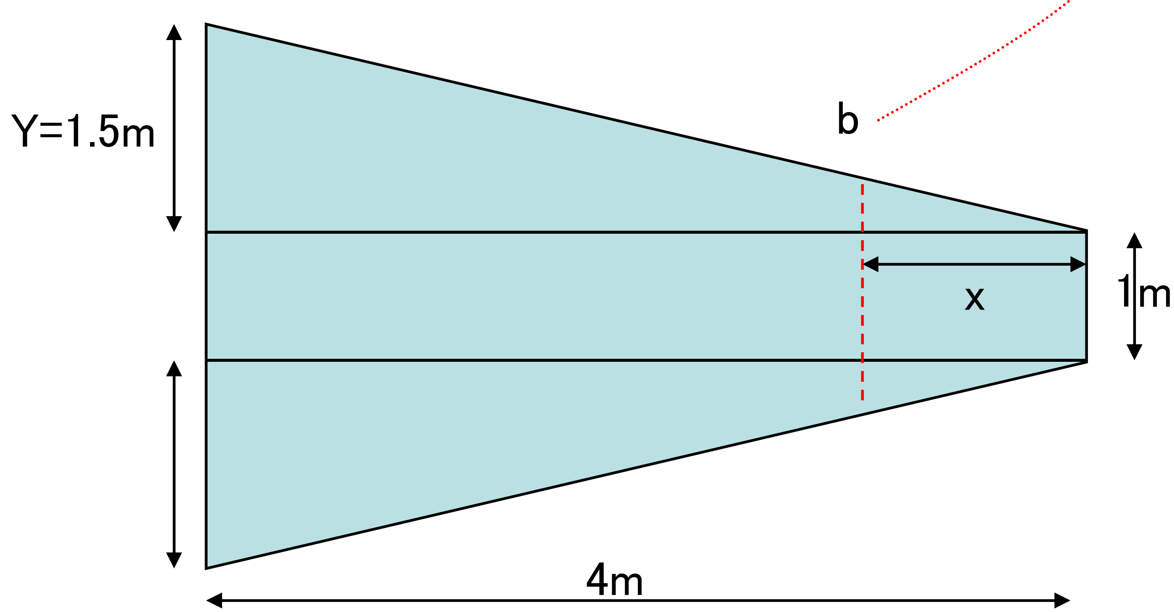
$$\text{at } x = 0.815 + 0.15$$

$$1 + 2(\tfrac{0.965}{4.35}) \times 1.5 = 1.7m = 1700mm$$

$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 665 \times 1700 / 1000 = 696kN$$

$$Max. \rightarrow V_U \text{ at } \underline{\underline{d}} \text{ from column B face (the most critical)} = 668kN$$

$$V_U < \phi V_C$$



Bending moment **Long direction**

Top

$b = 1 + 2(\frac{2.25}{4.35}) \times 1.5 = 2.60m = 2600$

$-ve\ M = 1260kN.m$

$\mathrm{d} = 730mm$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times 10^{6} * 1260}{0.9(0.85)25 * 665^{2} * 2600}}\right] = 0.003$$

$A_S = 0.003 \times 665 \times 1000 = 1995mm^2 = 20cm^2 \quad use\ 10\phi 16/m$ Top

Bottom

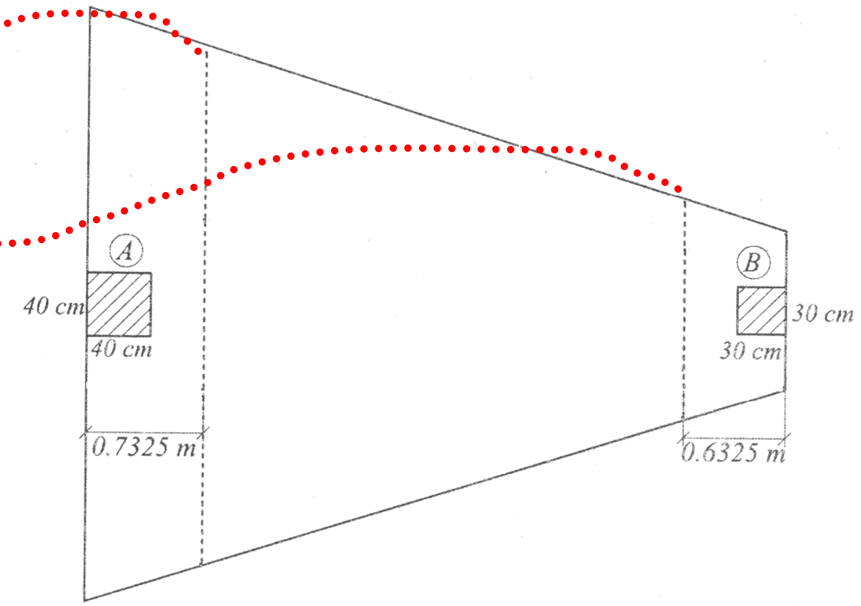
$A_{S\,\min} = 0.0018 \times 750 \times 1000 = 1350mm^2 = 13.5cm^2 \quad use\ 9\phi 14/m$ Bottom

Bending moment **Short direction**

Under Column A

$$b' = 1 + 2\left(\tfrac{3.62}{4.35}\right) \times 1.5 = 3.5m = 3500mm$$

$$b' = 1 + 2\left(\tfrac{0.633}{4.35}\right) \times 1.5 = 1.44m = 1440mm$$



$$b = \frac{3.5+4}{2} m = 3.75m = 3750mm$$

$$M = \frac{1560}{(3.75*0.733)} \times \frac{0.733}{2}\left(\frac{3.75-0.4}{2}\right)^2 = 583.6$$

$$\text{d} = 665mm$$

$$\rho = 0.85*\frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^6 * 583.57}{0.9(0.85)25*665^2*733}}\right] = 0.005$$

$$A_S = 0.005 \times 665 \times 733 = 3325mm^2 = 33cm^2 \quad use\, 10\phi 20$$

Under Column B

$$b = \frac{1.44 + 1}{2} m = 1.22m = 1220mm$$

$$M = \frac{975}{(1.22 * 0.633)} \times \frac{0.633}{2} \left(\frac{1.22 - 0.3}{2} \right)^2 = 84.6$$

$$\text{b} = 633mm, \text{d} = 665mm$$

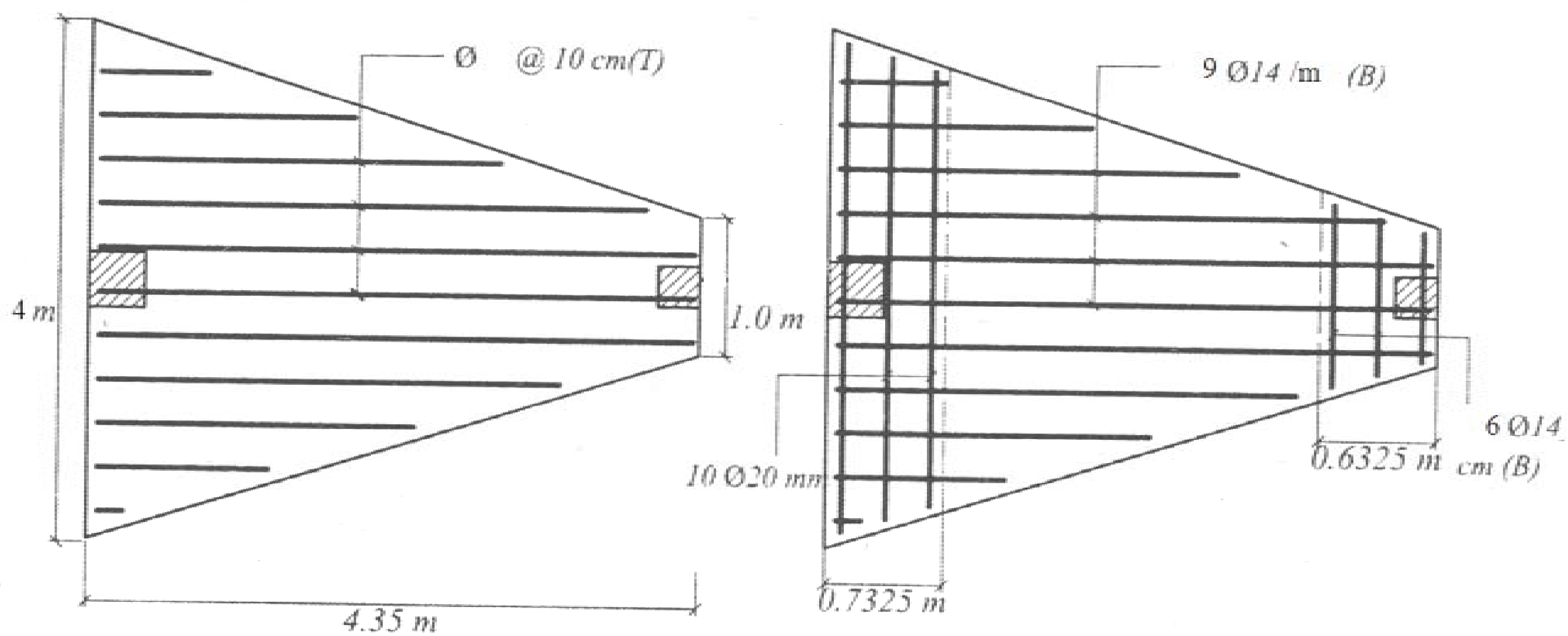
$$\rho = 0.85 * \frac{25}{420} \left[1 - \sqrt{1 - \frac{2 \times 10^6 * 84.6}{0.9(0.85)25 * 665^2 * 633}} \right] < \rho_{\min}$$

$$A_{S\min} = 0.0018 \times 750 \times 633 = 854.6mm^2 = 8.6cm^2 \quad use\ 6\phi 14$$

Shrinkage Reinforcement in short direction

$$A_{S\min} = 0.0018 \times 1000 \times 750 = 1350mm^2 = 13.5cm^2 \quad use\ 9\phi 14 / m$$

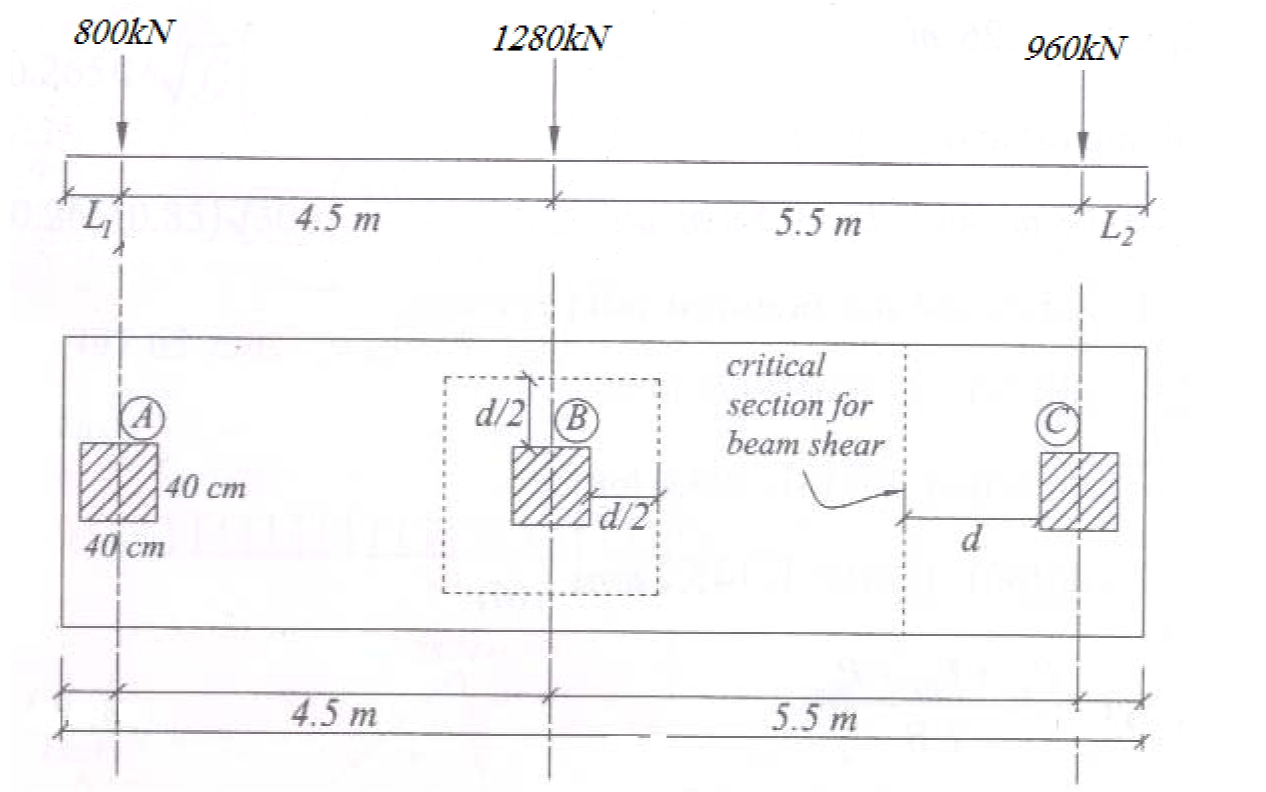
Reinforcement details



Example 3 (Strip footing)

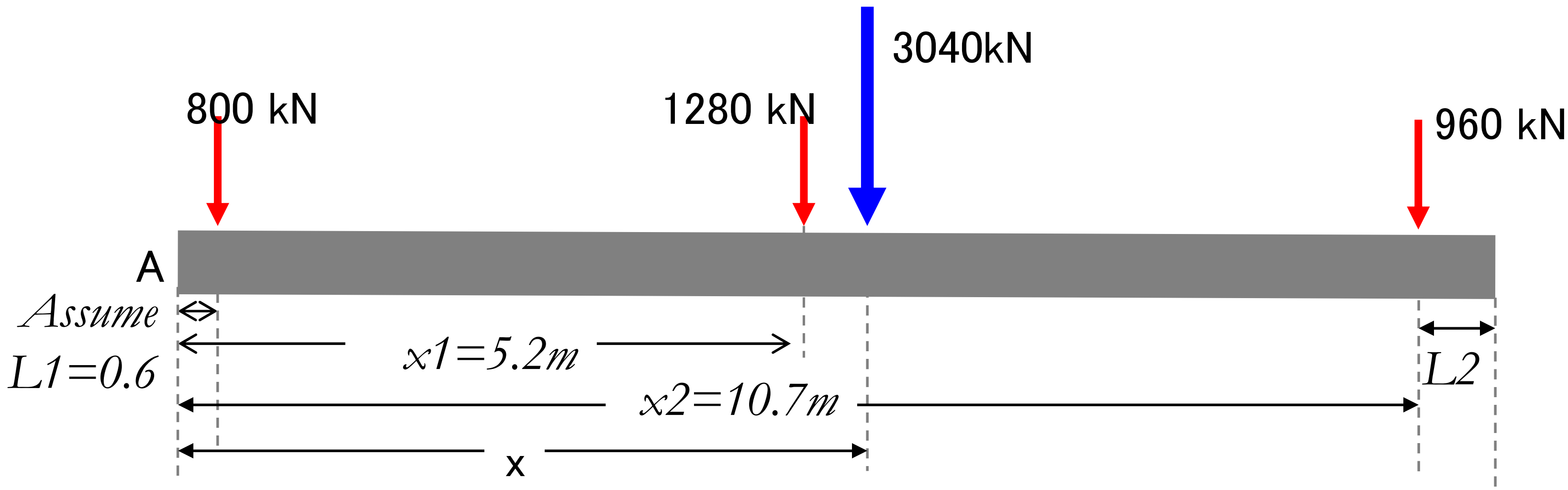
Design a combined footing As shown

$q_{all(net)} = 20t/m^2 = 200kPa$ $f_c' = 25\,N/mm^2$ $f_y = 420\,N/mm^2$

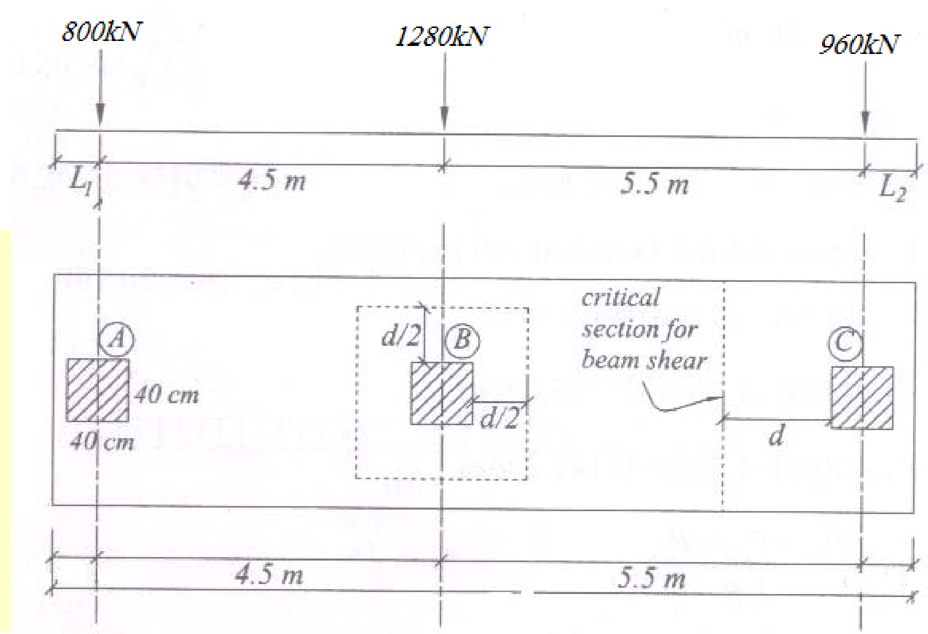


Dimension calculation

The base dimension to get uniform distributed load



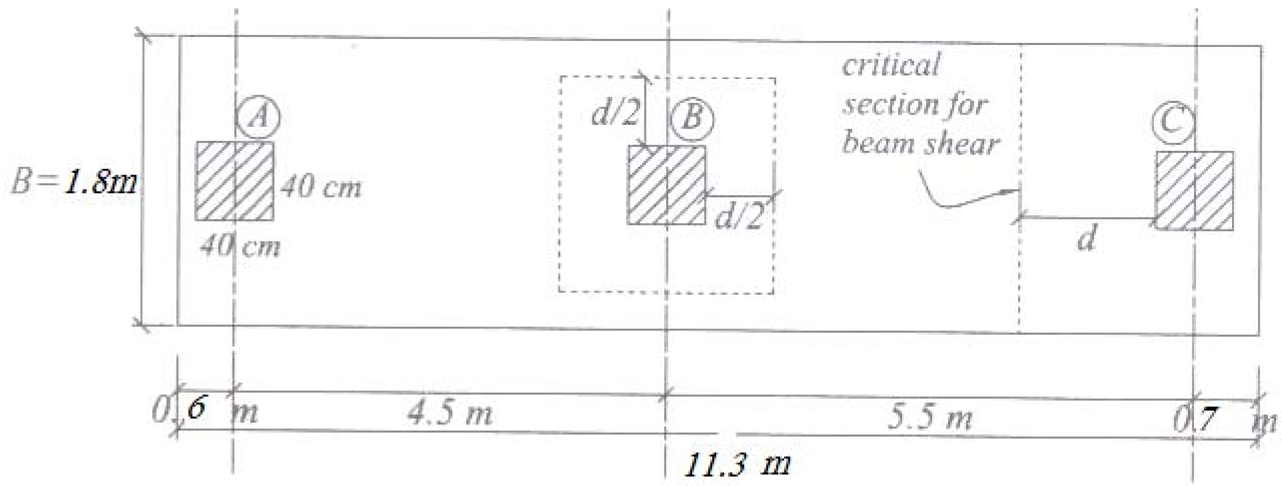
800(0.6)+1280(5.1)+960(10.6)=
3040 (x)
x = 5.65m,
2(x)=11.3m
L2=11.3 - (10.6)=0.7



$$q_{all(net)} = 18t/m^2 = 180kPa,$$

$$A_g = \frac{P_s}{q_{all(net)}} = \frac{3040\times10^3}{180\times10^3} = 16.9m^2 \approx 11.3m\times1.8m$$

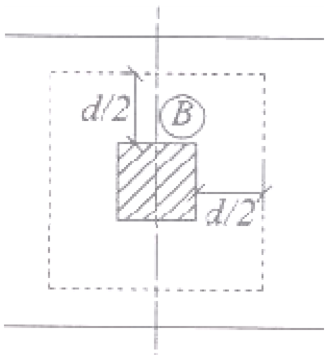
$$q_u = \frac{P_u}{A} = \frac{1.3(3040)\times10^3}{11.3\times1.8} = 195\times10^3\,Pa = 195kPa$$



Check for punching Shear

h = 700 mm

d=630mm



Example

B

$$b_o = 4(630 + 400)) = 4120mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 630 \times 4120 / 1000 = 3244.5kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{40 \times 630}{4120} \right) \times \frac{\sqrt{25}}{12} \times 630 \times 4120 / 1000 = 6584kN$$

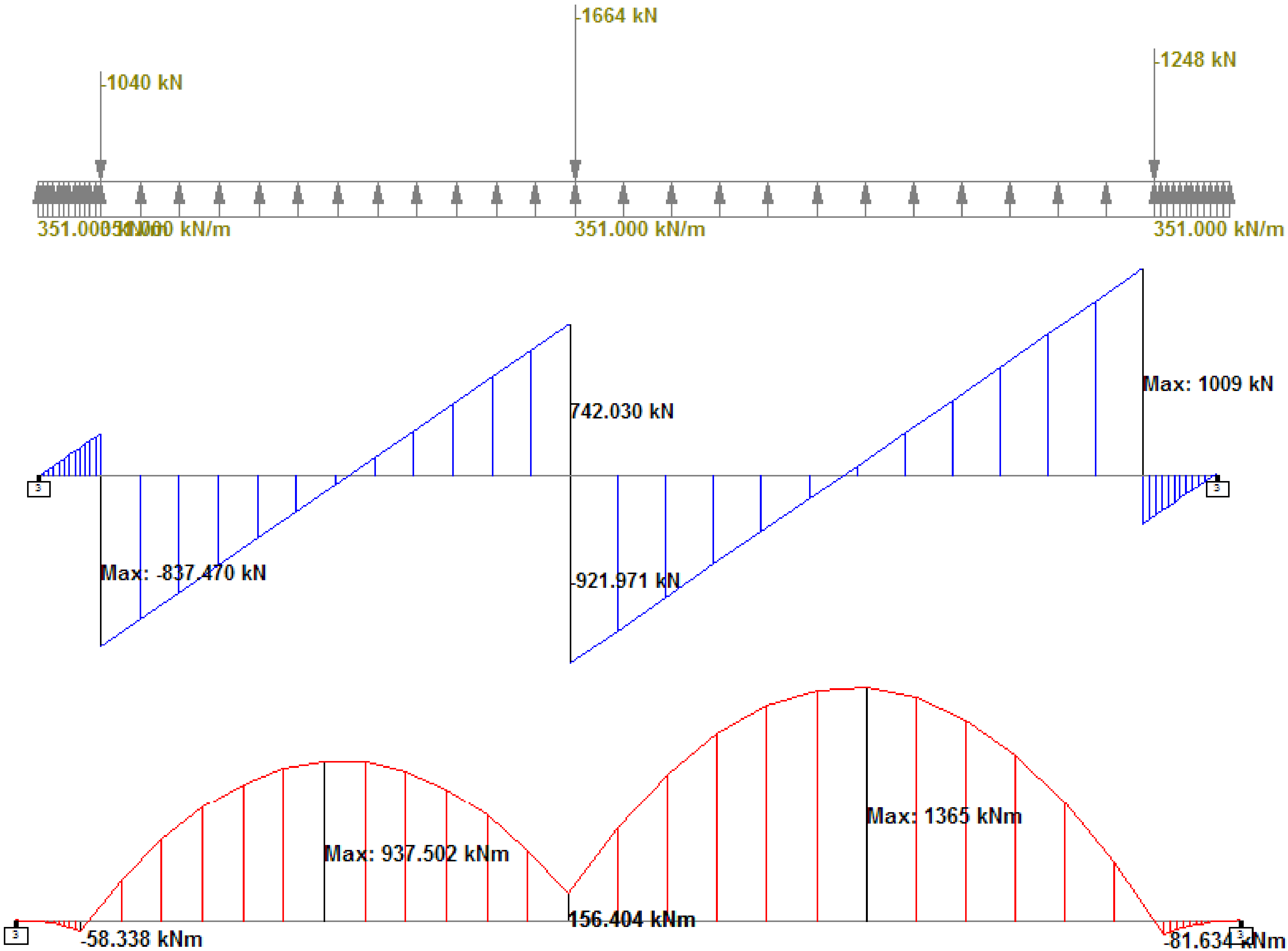
$$V_U = 1280(1.3) - 1.03^2 * 195 = 1457.1kN \; < \; \phi V_c \qquad \text{oK}$$

You can check other columns

Draw S.F.D & B.M.D

Stress under footing

$$= 195 * 1.8 = 351 \; kN/m$$



Check for beam shear

b = 1800mm, d = 630mm

$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 630 \times 1800 / 1000 = 708.75kN$$

$$Max. \rightarrow V_U \text{ at } \underline{\underline{d}} \text{ from column face} \approx 0.7(1009) = 706.3kN$$

$$V_U < \phi V_C$$

Bending moment **Long direction**

$$-ve\ M = 1366 kN.m$$

$$\text{b} = 1800 mm, \text{d} = 730 mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^{6} * 1365}{0.9(0.85)25 * 630^{2} * 1800}}\right] = 0.0053$$

$$A_S = 0.0053 \times 630 \times 1000 = 3362 mm^2 = 33.6 cm^2 \quad use\ 9\phi 22 / m \quad \text{Top}$$

$$+ve\ M = 246.7 kN.m$$

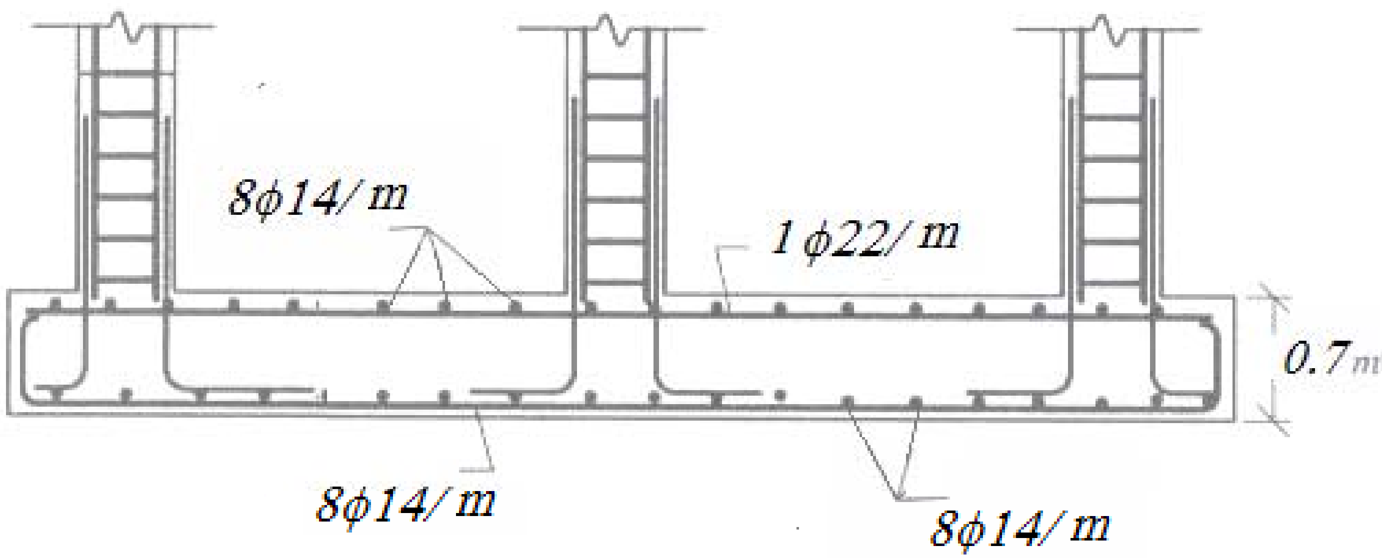
$$\text{b} = 1800 mm, \text{d} = 730 mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^{6} * 81}{0.9(0.85)25 * 730^{2} * 1800}}\right] < \rho_{\min}$$

$$A_{S\min} = 0.0018 \times 700 \times 1000 = 1260 mm^2 = 12.6 cm^2 \quad use\ 8\phi 14 / m \quad \text{Bottom}$$

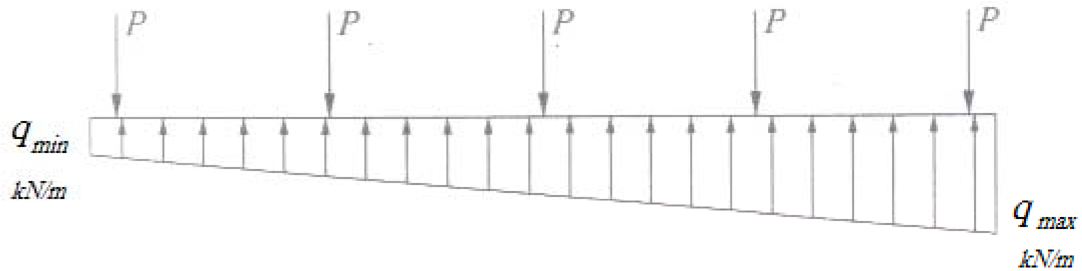
Design **Short direction** as example 1 *(lecture 11)*

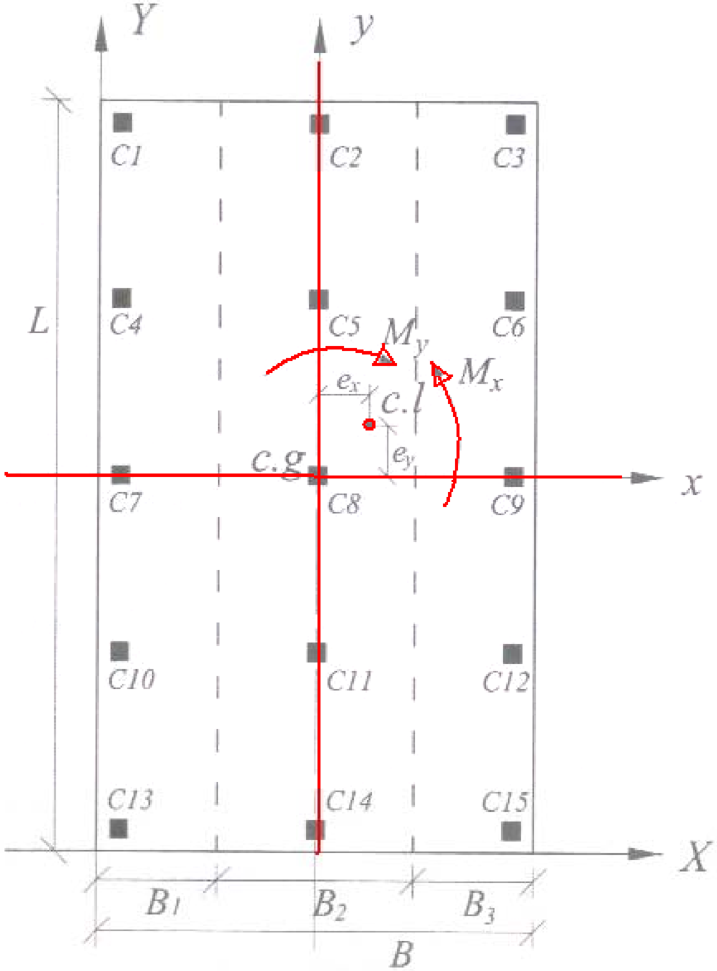
Reinforcement details

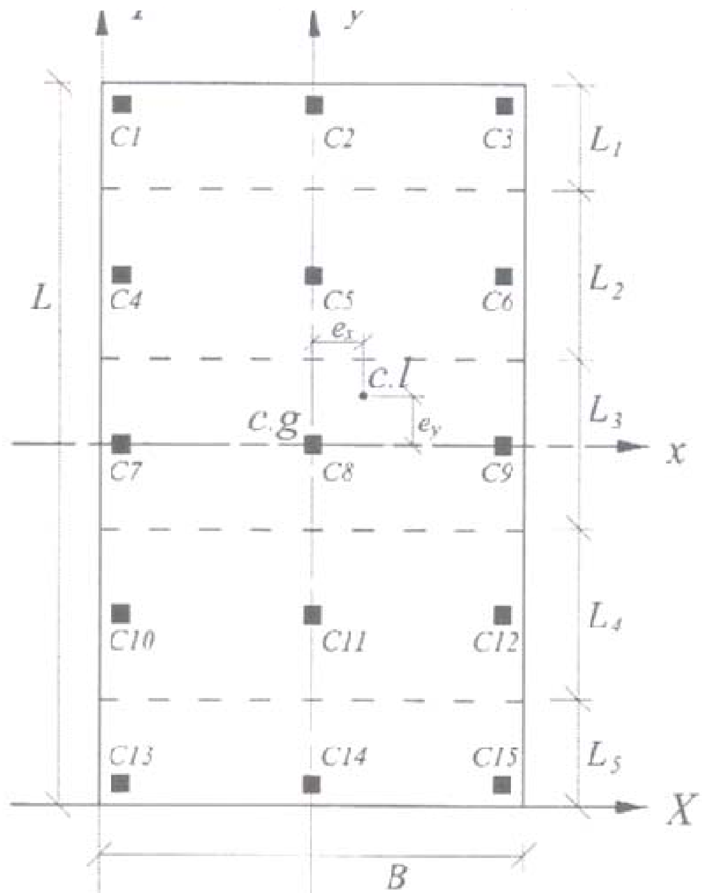


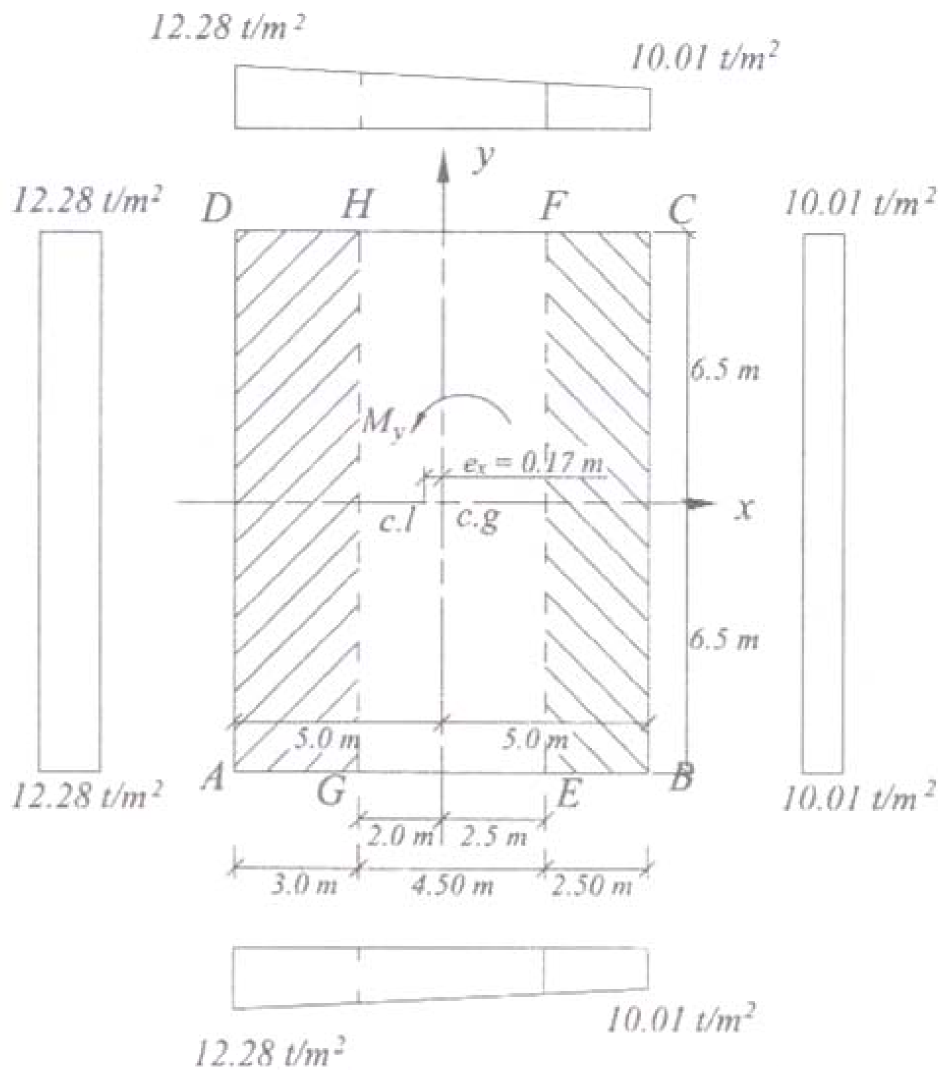
Mat Foundation

$$q = \frac{\sum P}{A} \pm \frac{M_x y}{I_x} \pm \frac{M_y x}{I_y}$$



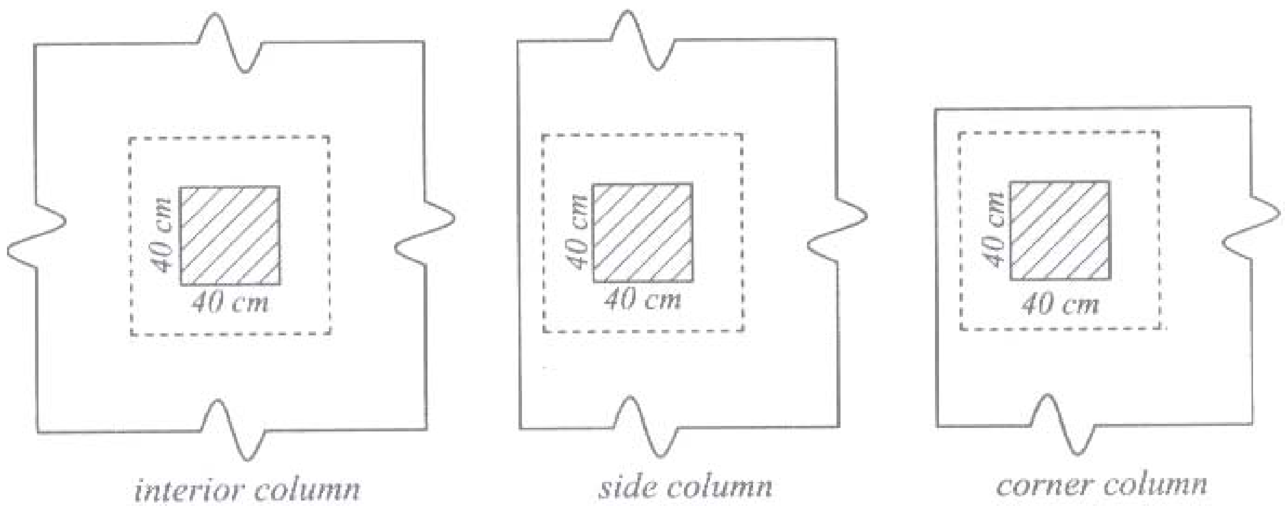






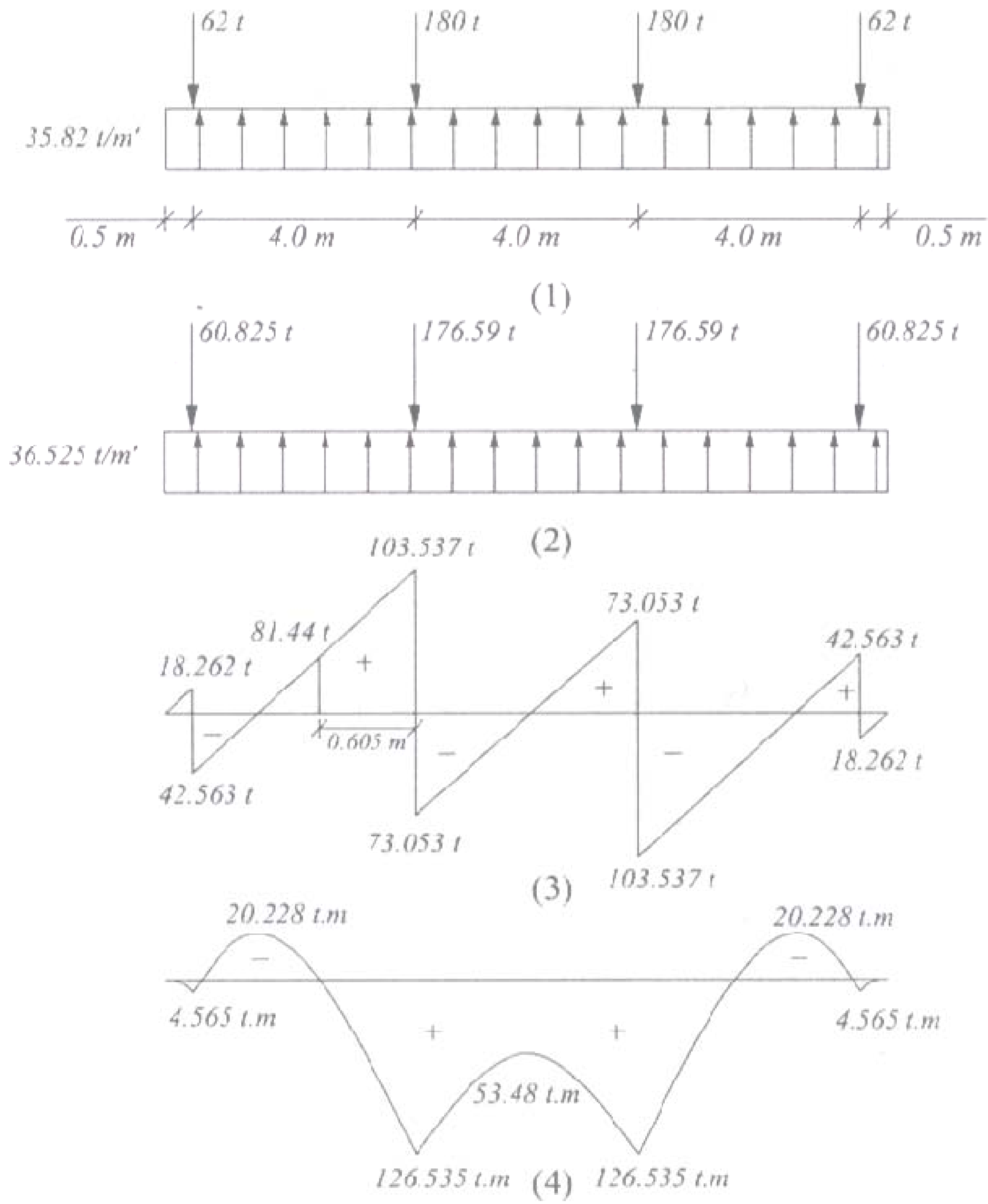
12.28 t/m²
10.01 t/m²
y
12.28 t/m²
D
H
F
C
10.01 t/m²
6.5 m
M_y
e_x = 0.17 m
x
c.l
c.g
6.5 m
5.0 m
5.0 m
A
G
E
B
12.28 t/m²
10.01 t/m²
2.0 m
2.5 m
3.0 m
4.50 m
2.50 m
10.01 t/m²
12.28 t/m²

Check for punching Shear



General Example, [Ref. 2]

Modified load



General reinforcement details