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Assignment = #01

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Example: Design a raft footing for five story building having Dimension 23x20 the raft has x side spacing of 7m and y side spacing of 6m the pla of the raft is shown is fig 1.

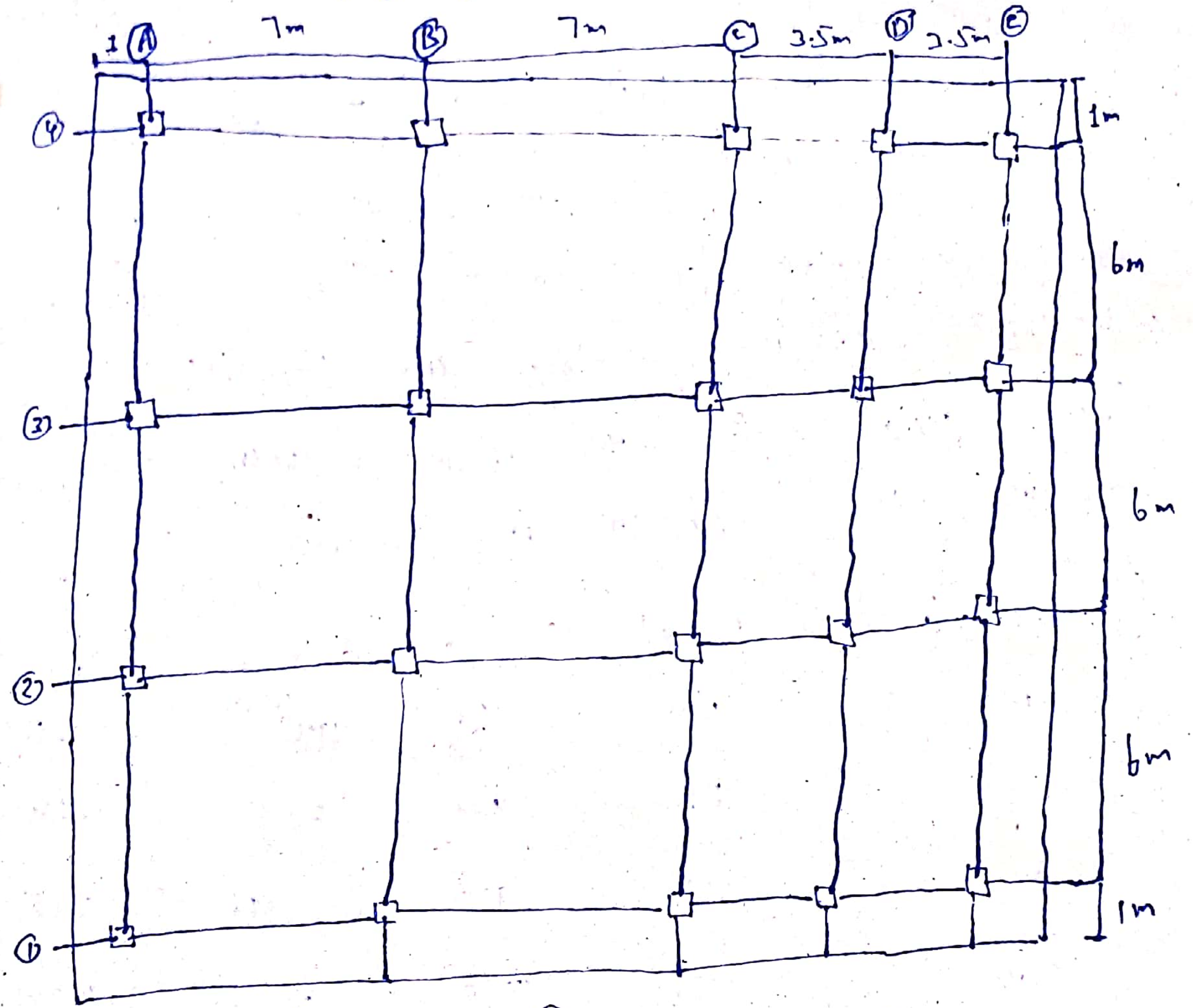


Fig (1) Raft Layout

Step # 01

Total aerea of Raft $= [((3\times7)+1+1)\times((3\times6)+1+1)]$

$= 23\times20 = 460 m^2$

Step # 02 coulums Loads in Raft

This Raft is design for 5 story industrial Building with dead and Live Load.

Load Types	Load Case	Load value (KN/m^2)
service	Dead	$2.5 KN/m^2$
slab own wieght assumed	Dead	$(25 KN/m^3)(0.2m) = 5 KN/m^2$
flooring	Dead	$1 KN/m^2$
Live load	Live	$7 KN/m^2$

fig

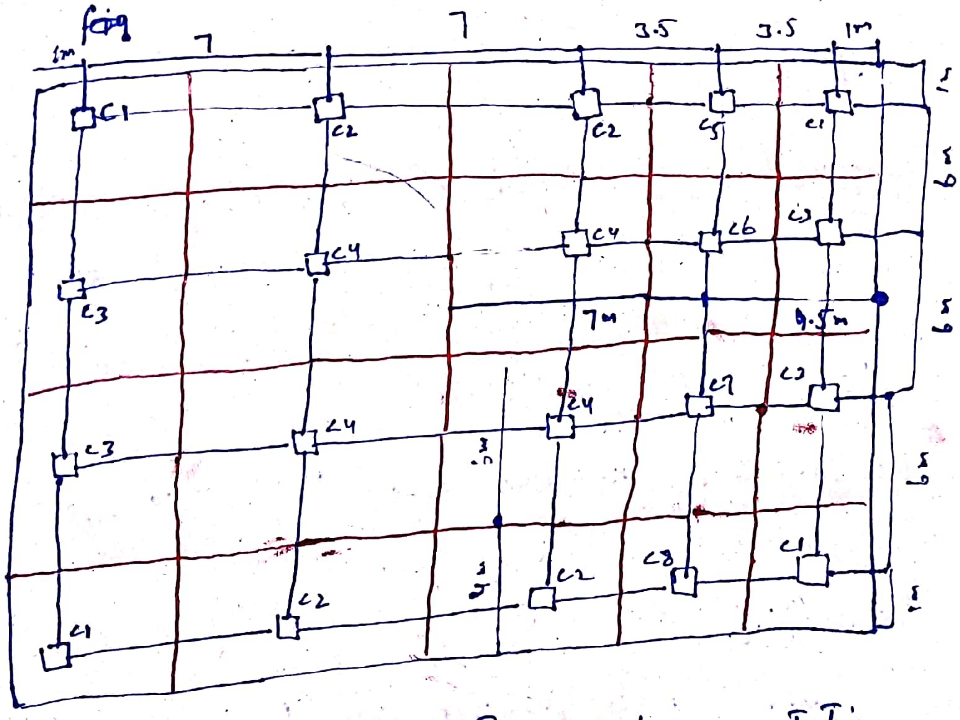


Figure ② shows The coulums notation and The rid Line show The Turbidity aeras That covered by The Coulum

Load per squre meter of The coulums

General dead Load stress = $(5+2.5+1)\ \frac{KN}{m^2} \times$ no of floors

$= (5+2.5+1)\times 5 = 42.5\ KN/m^2$

General Life load stress $= 7\times 5 = 35\ KN/m^2$

Coulums loads

Axial Deadload $= \frac{\text{Stress}}{A} \times$ Turbity Aerea

Colum Type 01

Axial unfactored deadload $= 42.5\times(4\times 4.5) = 765\ KN$

" " Live load $= 35\times(4\times 4.5) = 630\ KN$

Total serice axial Load $=$ 1395 KN

ultimate axial load $= 1.2(765) + 1.6(630) = 1926\ KN$

colum Type ②

Axial unfactored Deadload $= 42.5\times(4\times 7) = 1190\ KN$

" " Live load $= 35\times(4\times 7) = 980\ KN$

Total $=$ 2170 KN

ultimate $= 1.2(1190) + 1.6(980) = 2996\ KN$

Colum Type 4

Axial unfactored Deadload $= 42.5\times(7\times 6) = 1785\ KN$

" " Live $= 35\times(7\times 6) = 1470\ KN$

Total = 3255 kN

ultimate axial load = 1.2(1148) + 1.6(945) = 2889 kN

Coulum Type (3)

Axial unfactored dead load = 42.5 × (4.5×6) = ~~1785~~ 1148 kN

" " Live load = 35 × (4.5×6) = 945 kN

Total service axial load = ~~1785~~ 1148 + 945 = 2093 kN

ultimate axial load = 1.2(1785) + 1.6(1470) = 4494 kN

Extra Coulum Load: These coulum are placed in the right edge of the raft and they are external coulum ~~they~~ that are carried by the raft and will caus movment around x-axis and y-axis

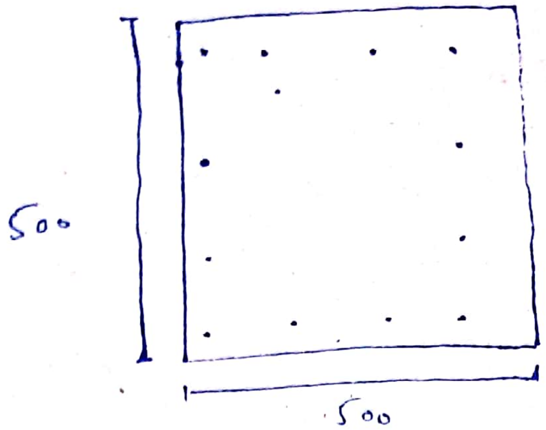
The axial load of orignal coulum are extra coulum are shown in figure.

Column No	D-Load	LL	Total Service Load	WU
C1	765	630	1395	1296
C2	1190	980	2170	2996
C3	1148	945	2093	2889
C4 (Max)	1785	1470	3255	4494
C5 (ex)	500	300	800	1080
C6 (ex)	450	250	700	940
C7 (ex)	400	200	600	800
C8 (ex)	350	150	500	660

Coulumn Dimension and rienforcement

Design Column is PCA. D = 500mm 500mm

The design of coulumn will ressist all colum max load of 4494KN



$$Pc = \phi Pn = (0.7)(0.8)[(0.85fc'Ag + fy Ast)]$$

$$\phi Pn = (0.7)(0.8)[(0.85(30)(500)(500) + 400(4562))]$$

$$Pc = 4592KN > Pu = 4494KN$$

The properTy used in the design are in Table (4)

Soil Type	Loose sand
Effective bearing stress for soil	100KN/m2 = q.
Sub grad mudulus	20000 KN/m3
fck	30Mpa
fy	400

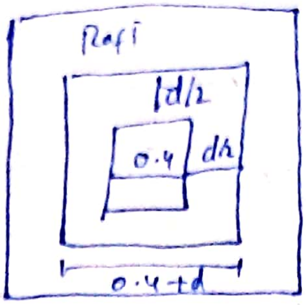
q_e = 100 kN/m²

Total maximum Service axial Load = 3255 kN

Area of Single Square footing = $\frac{1.1(3255)}{100}$ = 35.8 m²

$B \times B$ = 35.8 => $\sqrt{35.8}$ = 6m x 6m

3. Raft Thickness



$u = (b_o)(d)(\phi)(0.34)\sqrt{f_c'}$ ACI-05 11.12.2.1.c

u = 4994 kN = 4.494 MN

b_o = 4(0.4+d) = 1.6+4d

~~4494~~ 4.494 = (1.6+4d)(d)(0.75)(0.34)$\sqrt{30}$

4.494 = (1.6d + 4d²)(1.397)

3.2169 = 1.6d + 4d²

0 = 4d² + 1.6d − 3.2169

Solve for d

d = 700 m

Thickness of the raft = 700+75+25

= 800mm

3.5 Raft depth check

One way shere.

Vu = Maximum sheare − (d) (wsoil)

To determine the wsoil; the average soil(w) the average soil pressure should be determine in the maximum load strip for the y- strip CSy4 have max value in C4 which is equal. To 2173.51 KN

CSy3 will be analyzed separately

To calculate, qall of soil

$$q_{all} = \frac{\text{Total fact. load in CSy3}}{\text{Area of strip}}$$

$$q_{all} = \frac{C_2 + C_4 + C_4 + C_2}{(\text{width of S})(\text{length of S})}$$

$$q_{all} = \frac{2996 + 4494 + 4494 + 2996}{(3.5)(20)} = 214\ KN$$

width of strip

$\therefore W_{soil} = 214 \times 3.5$

$W_{soil} = 749 kN/m$

Assuming: $d = 800 - 75 = 725 mm$

$V_u =$ Max shear $- (d)(w_{soil})$

$V_u = 2173.5 - (0.725)(749)$

$V_u = 1630.5$ kN

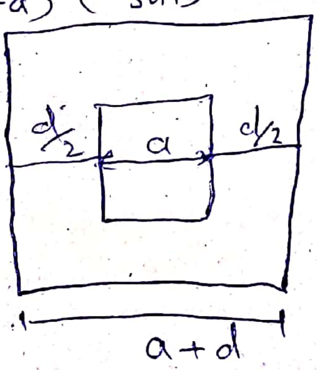
$$d = \frac{(V_u)(1000)}{(0.75)(\sqrt{f'_c})(\frac{1}{6})(B)} = \frac{(1630.5)(1000)}{(0.75)(\sqrt{30})(\frac{1}{6})(3500)}$$

$= 680.4 mm$

$d = 680.4 mm < d = 725$ ok

(3.5) Two way shere interior column.

$V_u =$ coulum axial load $- (d+a)^2 (w_{soil})$



To determine the wsoil

The average soil pressure should be determine The maximum loads strips.

$d = 725 mm$

- $V_u = 4494 - (0.725 + 0.5)^2 (214) = 4172.9 kN$

$b_o = 4(500 + 725) = 4900 mm$

$$d_m = \frac{(V_u)(1000)}{(0.75)(\sqrt{f_c'})(\frac{1}{3})(b_o)} = \frac{(4172.9)(1000)}{(0.75)(\sqrt{30})(\frac{1}{3})(4900)}$$

$d_m = 622.6\ mm < d = 725$ ok

(3.6) **Soil pressure check**

$$q = \frac{Q}{A} \mp \frac{M_y x}{I_y} \mp \frac{M_x y}{I_x}$$

$A = 460\ m^2$

$I_x = \frac{23(20)^3}{12} = 15333.3\ m^4$

$I_y = \frac{20(23)^3}{12} = 20278.3\ m^4$

Q = sum of all load colums

$Q = 4(1395) + 4(2170) + 4(2093) + 4(3225) + 800 + 700 + 600 + 500$

$Q = 38252\ KN$

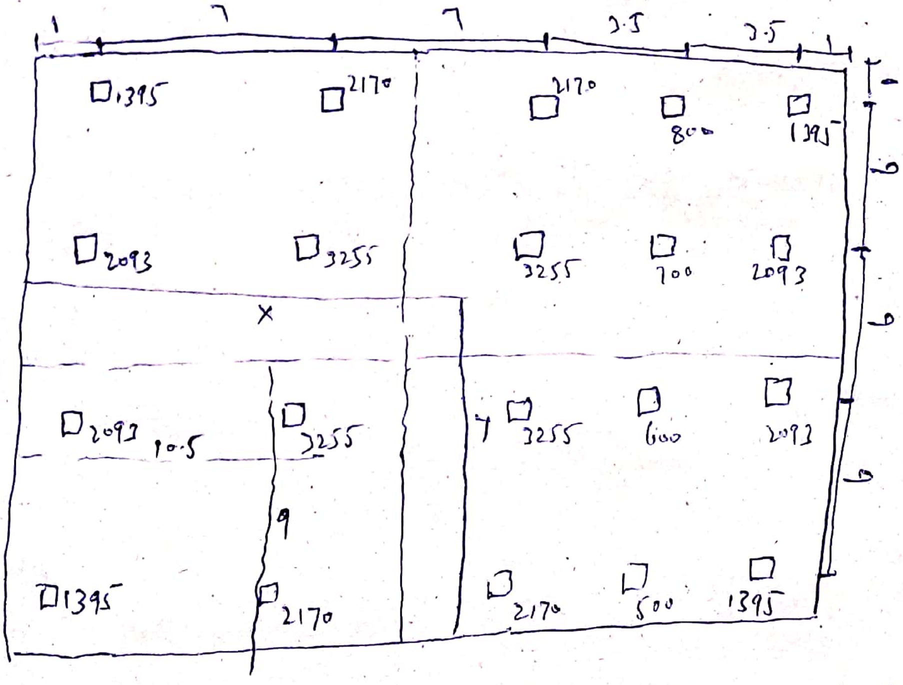


figure 10 column Total service dead Load calculated My :

$My = Q\,e_x$

$e_x = \bar{X} - 10.5$

$\bar{X} = \frac{1}{38252}\left[227850 + 45500 + 146496\right]$

$\bar{x} = 10.976m$

$e_x = 10.976 - 10.5 = 0.4758m$

$My = 38252 \times 0.4758 = 18200\ KN.m$

calcute Mx :

$e_y = y' - 9$

$y' = \frac{1}{38252}\left(142740 + 136752 + 67776\right)$

$y' = 9.07843m$

$e_y = 9.07843 - 9 = 0.07843m$

$My = 38252 \times 0.07843 = 3000\ KN.m$

calculate soil pressure

$2_i = \frac{Q}{A} \pm \frac{Myx}{Iy} \pm \frac{Mxy}{Ix}$

$2_1 = \frac{38252}{460} - \frac{18200(11.5)}{20278.3} - \frac{3000(10.5)}{15333.3}$

$2_1 = -95.532 < 2_{neT} = 100\ KN/m^2$ ok

$$q_2 = \frac{-38252}{460} + \frac{18200(11.5)}{20278.3} - \frac{3000(10.5)}{15333.3}$$

$q_2 = -75.265 <$ $q_{net} = 100 \, kN/m^2$ ok

$$q_3 = \frac{-38252}{460} + \frac{18200(11.5)}{20278.3} + \frac{3000(10.5)}{15333.3}$$

$q_3 = -70.89 <$ q_{net} ok

$$q_4 = -\frac{38252}{460} - \frac{18200(11.5)}{20278.3} + \frac{3000(10.5)}{15333.3}$$

$q_4 = -91.424 <$ q_{net} ok

(6) ~~for Movment Design~~

(1) Possitive Movment

As — Mu   d = 725mm

Table 5 Show X Strip Movment

Strip Notation	Strip field	Movment Value +ve	Movment Value −ve
CSX1	Colum Strip	1144	1049.3
MSX1	Midle Strip	319.1	1063
CSX2	Colum "	1532	1142
MSX2	Midle "	476.6	1039
CSX3	Colum "	1520.3	1192.3
MSX3	Midle "	303.4	1064.3
CSX4	Colum	[illegible]	[illegible]

Table 6 show Y Movment

Strip Notation	Strip field	Movment value +ve	-ve
CSY1	Colum strip	943	960.3
MSY1	Midle "	26.1	927.7
CSY2	colum "	1450	1107.3
MSY2	Middle "	166.2	948.3
CSY3	colum "	1445	1230.3
CSY4	Midle	344	1193
CSY5	colum	939.7	1117.5

Y Strip Design : possitive Movment (Botom rienc)

$d = 725mm$

$Mu_{Max} = 1532 KN.m$

$$\frac{Mu^+}{\phi b d^2} = \frac{1532e6}{(0.9)(1000)(725)^2} = 3.238$$

Go To 24 Table → $\rho = 0.0088 > \rho_{min} = 0.0035$

→ $\rho = 0.0088 < \rho_{max} = 0.0244$

$AS = 0.0088(b)(d) = 0.0088(1000)(725)$

$AS = 6380\ mm^2$

use $13\phi25/m$ $AS = 6381\ mm^2/m$

$$S = \frac{1000}{13-1} = 83$$ use $S = 80mm < S_{max} = 450mm$

use $\phi25$ @ 80mm

Check Mc

$$a = \frac{As \times fy}{0.85 \times fc \times b} = \frac{6381 \times 400}{0.85 \times 30 \times 1000} = 100.1mm$$

$$\therefore c = \frac{a}{\beta_1} = \frac{100.1}{0.85} = 117.7mm$$

$d = 725mm$

$$\varepsilon_t = \left(\frac{725-117.7}{117.7}\right) \times 0.003 = 0.0154 > 0.005$$

Tension Controle

Then use $\phi = 0.9$

$$Mc = \phi(As)(fy)\left(d - \frac{a}{2}\right)$$

$$Mc = (0.9)(6381)(400)\left(75 - \frac{100.1}{2}\right)e^{-6}$$

$Mc = 1550.4$ KN.m $> Mu = 1532$ KN.m ok

use $\phi 25$ @ 80mm f +ve movment -x- bottom Rienforcement

(2) Nigitive muvment (Top RC).

$d = 725$

Mu^{-} max $= 1142.3$ KN.M

$$\frac{Mu^{-}}{\phi bd^2} = \frac{1142.3e^6}{(0.9)(1000)(725)^2} = 2.415$$

Go To 2a Table → $\rho = 0.0064 > \rho_{min} = 0.0035$

→ $\rho = 0.0064 < \rho_{max} = 0.0244$

$AS = 0.0064(b)(d) = 0.0064(1000)(725)$

$AS = 4640 \ mm^2$

use 10 $\phi 25$/m $AS = 4909 \ mm^2$

$S = \frac{1000}{10-1} = 111.1$ use $S = 110mm < S_{max} = 450 \ mm$

use $\phi 25$ @ 110mm.

<u>Check Mc</u>

$a = \frac{4909 \times 400}{0.85 \times 30 \times 1000} = 77mm$

$C = \frac{77}{0.85} = 90.6mm$

$d = h - cover - Stirrup - \frac{db}{2}$ $800 - 75 = 725mm$

$\varepsilon_t = \left(\frac{725 - 90.6}{90.6}\right) \times 0.003$

$= 0.021 > 0.005$ (T controle)

Then use $\phi = 0.9$

$Mc = (0.9)(4909)(400)\left(725 - \frac{77}{2}\right)e^{-6}$

$Mc = 1213.2 \ KN.m > Mu = 1532 \ KN.m$ ok

use $\phi 25$@ 110mm for −ve x-d

Y. Stirrip design

possitive movment (Bottom Rienfor)

$d = 800 - (75+25) = 70\ mm$

$Mu^{+v}_{max} = 1532\ kN.m$

$$\frac{Mu^{+v}}{\phi b d^2} = \frac{1450e6}{(0.9)(1000)(700)^2} = 3.288$$

→ Go To 24 Table → $\rho = 0.009 > \rho_{min} = 0.0035$

→ $\rho = 0.009 < \rho_{max} = 0.0244$

$AS = 0.009(1000)(700)$

$AS = 6300\ mm^2$

use $13\phi 25/m$ $AS = 6381\ mm^2$

$$S = \frac{1000}{13-1} = 83$$ use $S = 80\ mm < S_{max} = 450\ mm$

Check Mc

$$a = \frac{6381 \times 400}{0.85 \times 30 \times 1000} = 100.1\ mm$$

$$c = \frac{100.1}{0.85} = 117.7\ mm$$

$$\varepsilon_t = \left(\frac{725 - 117.7}{117.7}\right) \times 0.003 = 0.0154 > 0.005\ (TC)$$

Then use $\phi = 0.9$

$Mc = (0.9)(6381)(400)\left(725 - \frac{100.1}{2}\right)e^{-6}$

$Mc = 1550.4 > Mu = 1450$ ok

use Ø25 @ 80mm for +ve Y moument — bottom rienforcement

Nigitive Muument (Top Rec)

$d = 700mm$

$\frac{Mu^-}{Øbd^2} = \frac{1230.3 \times 10^3}{(0.9)(1000)(700)^2} = 2.790$

Go To 24 Table → $\rho = 0.0076 > \rho_{min} = 0.0035$

→ $\rho = 0.0076 < \rho_{max} = 0.0244$

$AS = 0.0076(1000)(700)$

$AS = 5300\ mm^2$

use 11 Ø25/m $AS = 5400mm^2$

$S = \frac{1000}{10-1} = 100$ use $S = 100mm < S_{max} = 450mm$

use Ø25 @ 100mm

Check Mc

$a = \frac{5400 \times 400}{0.85 \times 30 \times 1000} = 84.7mm$

$C = \frac{84.7}{0.85} = 99.6mm$

$d = 700mm$

$\varepsilon_T = \left(\frac{700 - 99.6}{99.6}\right)0.003 = 0.0181 > 0.005$ (T.C)

Then use $Ø = 0.9$

$MC = (0.9)(5400)(400)\left[700 - \frac{84.7}{2}\right)e^{-6}$

$MC = 1278.5 > Mu = 1230.3$ ok

use Ø25 @ 100mm for -ve Y movement — Top

Comparison Table

	M value	Manual design	
X strip			
Bottom As	1532	Ø25@80mm	6381mm²
Top As	1142.3	Ø25@110mm	4909 mm²
Y-strip			
Bottom As	1450	Ø25@80mm	6381mm²
Top As	1230.3	Ø25@100mm	5400mm²

8th Coulumn
safe design.

13Ø25 = 6381mm²

10Ø25 = 4909mm²

12Ø25 = 5890mm²

11Ø25 = 5400mm²