Name :- Shahzeb

Roll No :- 15629

Assigment :- (1)

Submitted To :- sir fawad khan

Submitted by :- shahzeb

IQRA National University
Peshawar

Assigment

Design Raft footing for reinforced concrete multi story structure it should cover

1. All design step.
2. proper loading criteria -
3. proper structure Drawing -

Sol:-

Sir I am going to design a raft footing for the 5 stories commercial purpose - the date i assume are as under -

$f_y = 400\,MPa$

$f_c = 30\,MPa$

$E = 200000$

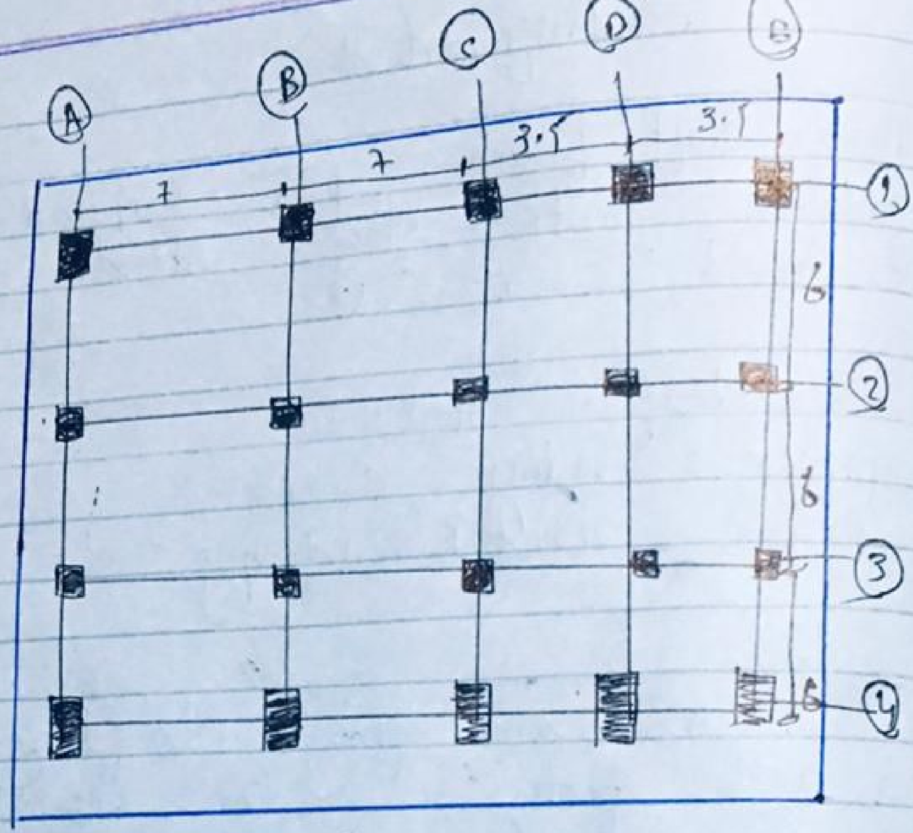
Soil unit weight $= \gamma_{soil} = 15\,KN/m^3$

Allowable Bearing stress $= q_a = 100\,KN/m^2$

concret unite weight $= 25\,KN/m^3$.

Structural drawing -

(2). 15629



(1) Area of Raft = $3\times7+(1+1)\times3\times6(1+1)$

$= 23\times20$

$= 460\,m^2$

(2) column load on the raft -

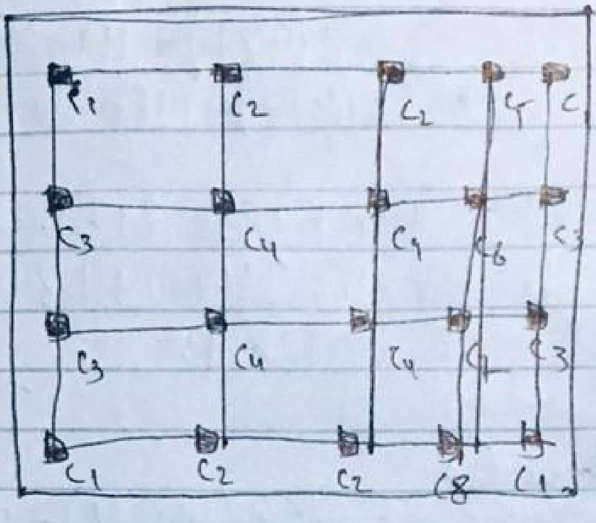
D.L = $2.5\,kN/m^2$

slab own weight = $25\,kN/m^2\times0.2 = 5\,kN/m^2$

flooring = $1\,kN/m^2$

L.L = $7\,kN/m^2$

③ 15629



Total ~~dead~~ dead load of all stories –

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

Total live Load $= 7 \times 5 = \boxed{35 \, KN/m^2}$

→ Column Load type ① (C1)

$$D.L = 42.5 \, KN \times (4 \times 4.5) = 765 \, KN$$

$$L.L = 35 \times (4 \times 4.5) = 630 \, KN$$

Total Service Axial Load $= 765 + 630$
$= 1395 \, KN$

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

→ column type (2)

$D.L = 42.5 \times (4 \times 7) = 1190 KN$

$L.L = 35 \times (4 \times 7) = 980 KN$

Service Load = $1190 + 980 = 2170 KN$

Ultimate Load = $1.2(1190) + 1.6(980)$

$= 2996 KN.$

→ column type (3)

$D.L = 42.5 \times (4.5 \times 6) = 1148 KN.$

$L.L = 35 \times (4.5 \times 6) = 945 KN.$

total service Load = $1148 + 945 = 2093 KN.$

Ultimate axial load = $1.2(1148) + 1.6(945)$

$= 2889 KN.$

→ column type 2

$D.L = 42.5 \times (7 \times 6) = 1785 KN$

$L.L = 35 \times (7 \times 6) = 1470 KN.$

Service Load = $1785 + 1470 KN.$

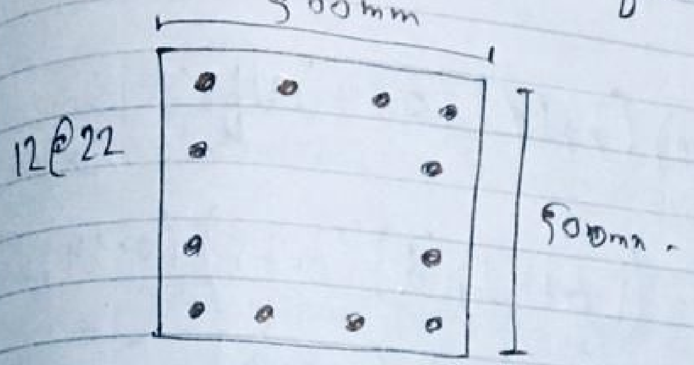
Ultimate load = $1.6(1785) + 1.6(1470)$

$= 4494 KN.$

other columns load.

	D.L	L.L	Service Load	Ultimate
C5 =	500	300	800	1080
C6 =	450	250	700	940
C7 =	400	200	600	800
C8 =	350	150	500	660

column dimention with Reinforcement -



$P_c = \phi P_n = (0.7)(0.8[0.85 f_c' A_g + f_y A_{st})$

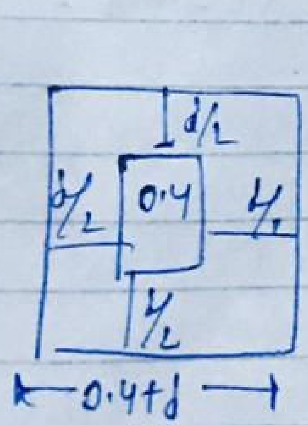
$P_c = \phi P_n = (0.75)(0.8)(0.85)(30)(500)(500)$

$+ 420(4562)$

$P_c = 4592 KN > P_u = 4494 KN$ -

Raft thickness 2

$V = (b_o)(d)(\phi)(0.34)\sqrt{f_c'}$



Tension Shear Area -

(b) 15829

$U = 4494\ kN = 4.494\ MN$

$b_o = 4(0.4 + d) = \{1.6 + 4d\}$

$U = (b_o)(d)(\phi)(0.34)\sqrt{f_c'}$

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

$4.494 = 1.6d + 4d^2\ (1.397)$

$3.2169 = 1.6d + 4d^2$

$0 = 4d^2 + 1.6d - 3.2169$

$0 = 4d^2 + 1.6d - 3.2169$

solving

$d = 0.68m = 689mm \approx 700\ mm$

Thickness of Raft $= 700 + 75 + 25$ (Assume bar dia)

Thickness $= 800mm$

15629

Raft depth check

1) one way shear

V_u = Maximum shear − (d)(w_{soil})

C4S(4) have minum shear value
C4 which equal to 2173.5 KN.

$$q_{ut} = \frac{\text{Total factored Load in strip}}{\text{Area of strip}}$$

$$q_{ut} = \frac{C2 + C4 + C4 + C2}{(\text{width of strip})(\text{length of strip})}$$

$$q_{ut} = \frac{2996 + 4494 + 4494 + 2996}{(3.5)(20)}$$

$q_{ut} = 214\ KN/m^2$

$W_{soil} = 214\ KN/m^2$ (width of strip)

$W_{soil} = 749\ KN/m$

Assuming

$d = 800 - 75 = 725\ mm$

V_u = Max shear − (d)(W_{soil})

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

$V_u = 163.05\,KN$.

$$d = \frac{V_u(1000)}{0.75(\sqrt{f_c})\frac{1}{6}(B)} = \frac{1150(1000)}{0.75(\sqrt{30})(\frac{1}{6})3500}$$

$d = 680.4\,mm$.

$d = 680.4\,mm < 725$ / ok.

Two way shear

V_u = column Axial load $- (d+a)^2$ wsoil -

$q_{ult} = 214\,KN/m^2$

Assuming

$d = 800 - 75 = 725\,mm$

$V_u = 4494 - (0.75 + 0.5)^2 (214)$

$= 4172.9\,KN$.

$b_o = 4(a+d) = 4(500 + 725)$

$= 4900\,mm$ -

15629

$$d = \frac{V_u (1000)}{0.75 \left(\sqrt{f_c'}\right) \left(\frac{1}{3}\right) (b_o)}$$

$$d = \frac{(4172.9)(1000)}{0.75 (\sqrt{30}) \left(\frac{1}{3}\right) (4900)}$$

$d = 622.6\text{mm}$

$d = 622.6\text{mm} < d = 725$ / ok.

Soil Pressure Check:

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

A = Area of Mat = $460 m^2$

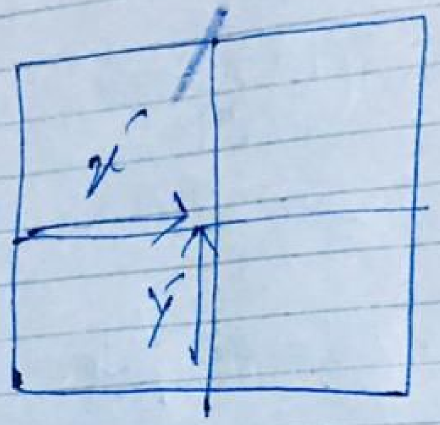
$$I_x = \frac{bh^3}{12} = \frac{23(20)^3}{12} = 15333.3\ m^4$$

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

Q = Sum of Service Load

$$Q = 4(C_1) + 4(C_2) + 4(C_3) + 4(C_4) + Extr$$

$$Q = 38252 \text{ kN}$$



Calculate My :

$$e_x = x' - 10.5$$

$$Q \times x' = Q_1(x'_1) + Q_2(x'_2) + \cdots$$

$$x = \frac{Q_1(x'_1) + Q_2(x'_2) + \cdots}{Q}$$

$$x = \frac{1}{38252}(227850 + 45500 + 146448)$$

$$x' = 10.976 \text{ m}$$

$$e_x = 10.976 - 10.5 = 0.4758 \text{ m}$$

$$M_y = Q e_x = 38252 * 0.4758 = 18200 \text{ kN.m}$$

Calculate:

$$e_y = Y' - 9$$

$$Q\,Y' = Q_1(y_1) + Q_2 y_2 + \cdots$$

$$Y' = \frac{Q_1(y_1) + Q_2(y_2) + \cdots}{Q}$$

$$Y' = \frac{1}{3852}(18)(1395 + 2170 + 2170 + 800 + 1395) + \cdots$$

$$Y' = \frac{1}{38252}[142740 + 138752 + 67776)$$

$$Y' = 9.907843\,m.$$

$$e_y = 9.90 - 9 = 0.07843\,m$$

$$M_x = Q e_y = 38252 \times 0.07843 = 3000\,kN/m$$

Now

$$q_i = -\frac{Q}{A} \mp \frac{M_y x}{I_y} \mp \frac{M_x y}{I_x}, \quad i = 1, 2, 3, 4.$$

where (−) show compression stress.

Q8,

(12) 15829

$$q_1 = -\frac{38252}{460} - \frac{18200(11.5)}{20278.3} - \frac{3000(10.5)}{15333.3}$$

$$q_1 = -83.157 - 10.321 - 2.054$$

(1) $q_1 = -95.532 < q_{Net} = 100\,KN/m^2$ / ok.

$$q_2 = -\frac{38252}{460} + \frac{18200(11.5)}{20278.3} - \frac{300(10.5)}{153333}$$

$$q_2 = -83.157 + 10.32 - 2.054 -$$

(2) $q_2 = -75.265 < q_{Net} = 100\,KN$ / ok.

$$q_3 = -83.157 + 10.321 + 2.054$$

(3) $q_3 = -70.89 < q_{Net} = 100\,KN/m^3$ / ok

$$q_4 = -83.157 - 10.321 + 2.054$$

(4) $q_4 = -91.424 < q_{Net} = 100\,KN$ / ok.

so all pressure value are in compression and they are less the net bearing stress of the soil = $100\,KN/m^2$

X- strip design-

(1) positive moment (Bottom Reinforcement)

$d = 100 - 75 = 725 mm.$

$M_u^+ = 1532 KN.m/m$
(Max)

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

go to table take $\rho = 0.008$

$A_s = 0.008 (b)(d) = 0.008 (1000)(725)$

$A_s = 6380 mm^2/m$

Use

13@25/m $A_s = 6381 mm^2/m$.

$$\text{spacing} = \frac{1000}{13-1} = 83 \text{ use}$$

$S = 80mm$. use 25@80mm

Check M_c:

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{6381 \times 400}{0.85 \times 30 \times 1000}$$

(14) 15829

$a = 100.1 mm$

$c = \frac{a}{\beta_1} = \frac{100.1}{0.85} = 117.1 mm$

$d = h - cover = 800 - 75 = 725 mm$

$\varepsilon_t = \left(\frac{d-c}{c}\right) \times 0.003 = \frac{725 - 117.7}{117.7} \times 0.003 =$

0.0154 > 0.005 (tension control

Us $\phi = 0.9$

$M_c = \phi (A_s)(f_y)(d - a/2)$

$M_c = (0.90)(6381)(400)\left(725 - \frac{100.1}{2}\right)$

$M_c =$ ~~HF~~ 1550.4 kN.m > Mu = 1532 kN.m

ok.

Use ϕ25@80mm for positive moment X-direction bottom Reinforcement

(ii) 15629

Negative moment (Top Reinforcement) -

$d = 800 - 75 = 725\,mm$ -

$M_u^{(-)}$ (Max) $= 1142.3\,KN/m$

$$\frac{M_u}{\phi b d^2} = \frac{1142.3}{(0.9)(1000)(725)^2} = 2.415$$

take ρ from table ρ = 0.0064 -

$A_s = 0.0064\,(b)(d)$

$A_s = 0.0064\,(1000)(725)$.

$A_s = 4640\,mm^2/m$

use $10\phi25\,mm^2/m$ -

$A_s = 4909\,mm^2/m$ -

$$S = \frac{1000}{10-1} = 111.1$$ use $s = 110\,mm$

$< S_{max} = 450\,mm$

use 25 @ 110 mm

check Mc

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{4909 \times 400}{0.85 \times 30 \times 1000} =$$

$a = 77 mm.$

$$c = \frac{a}{B_1} = \frac{77}{0.85} = 90.6 mm$$

$$d = h - cover - stripp - \frac{d_b}{2} = 800 - 75 = 725 mm$$

$$\epsilon_t = \left(\frac{d-c}{c}\right) \times 0.003 = \frac{725 - 90.6}{90.6} \times 0.003$$

$\epsilon_t = 0.021 > 0.005$ (tension control)
then use 0.9.

$$M_c = \phi A_s (f_y)(d - a/2)$$

$$M_c = (0.90)(4909)(400)\left(725 - 77/2\right)$$

$M_c = 1213.2 KN\,m > M_u = 1532 KN.m$

so /ok.

use

25@110mm for Negative
X-direction - top Reinforcement.

15629

Y-Strip design :-

positive moment (Bottom Reinforcement) :-

$d = 800 - (75 + 25) = 700\,mm$

$M_{u(max)}^{+} = 1532\ KN.m/m$

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

take value of ρ from table-

$\rho = 0.009$

$A_s = 0.009\,(b)(d)$

$A_s = 0.009\,(1000)(700)$

$A_s = 6300\ mm^2/m$

Use $13 \text{ Ø } 25\ mm^2/m$

$S = \frac{1000}{13-1}$ 83 use 8mm

use $\phi 25$ @ 80mm.

Check Mc

$$a = \frac{A_s f_y}{0.85 \times f_c \times b} \quad \frac{6381 \times 400}{0.85 \times 30 \times 1000}$$

$= 100.1 mm.$

$$c = a/B_1 = \frac{100.1}{0.85} = 117.7 mm$$

$d = h - cover = 800 - 75 = 725 mm$

$$\varepsilon_t = \frac{d-c}{c} \times .300 = \left(\frac{725 - 117.7}{117.7}\right) \times 0.003$$

$\varepsilon_t = 0.0154 > 0.005$ (tention control).
than use 0.9

$$M_c = \phi A_s f_y (d - a/2)$$

$$M_c = (0.9)(6381)(400)\left(725 - \frac{100.1}{2}\right)$$

$M_c = 1550.4 KN/m > M_u = 1450 KN.m$

/ok

Negative moment (Top Reinforcement):

$M_u^-{}_{(max)}$ = 1532 kN.m/m.

$$\frac{M_u}{\phi b d^2} = \frac{1230.3}{(0.9)(1000)(700)^2} = 2.9$$

take value from table ρ = 0.0076

$A_s = 0.0076\, bd$

$A_s = 0.007(1000)(700)$

$A_s = 5300\ mm^2/m$

Use 11 ϕ 25 m $A_s = 5400\ m^2/m$

$$S = \frac{1000}{10-1} = 100$$

Use ϕ 25 @ 100 mm.

check Mc =

$$a = \frac{A_s f_y}{0.85 \times f_c \times b} = \frac{5400 \times 400}{0.85 \times 30 \times 1000}$$

a = 84.7 mm.

$$c = a/B_1 = \frac{84.7}{0.85} = 99.6\ mm$$

~~Mc~~ = ϕ

$$\varepsilon_t = \frac{d-c}{c} \times 0.003$$

$$\varepsilon_t = \frac{700-99.6}{99.6} \times 0.003 = 0.018 > 0.005$$

tension contr.-1.

Use $\phi = 0.9$ -

$$M_c = \phi A_s f_y (d - a/2)$$

$$M_c = (0.90)(5400)(400)\left(700 - \frac{84.7}{2}\right)$$

$M_c = 1278.5$ kN.m > $M_u = 1230.3$ kN.m

ok.

Use

ϕ25@100mm for Negative moment X direction -

	Moment	Reinforcement -
X strip		
Bottom	1532	ϕ25@80mm
To	1142.2	ϕ25@110mm
X strip		
Bottom	1450	ϕ25@80mm
top.	1230.3	ϕ25@100mm