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Semester # 4th

M.S # Transportation Engineering INU Peshawar.

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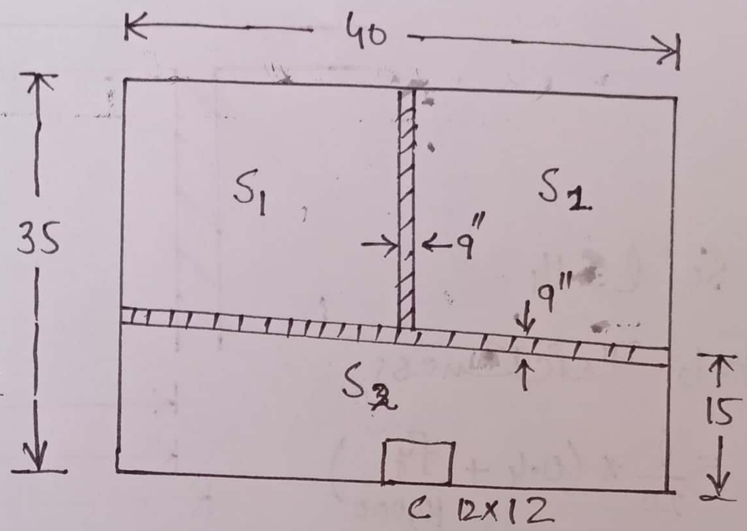
P#1

$f'_c = 3\,ksi$

$f_y = 40\,ksi$

Load on slab

= 4" mud, 2" brick tiles



(1) Design of S_2

Step 1 Size of slab

$M = \frac{l_b}{l_a} = \frac{40}{15} = 2.66 > 2$

So design one way slab.

let $h = 6"$

According to ACI 8.7.

(i) $l = l_n + h_f$

$l = 14 + \frac{6}{12} = 14.5$

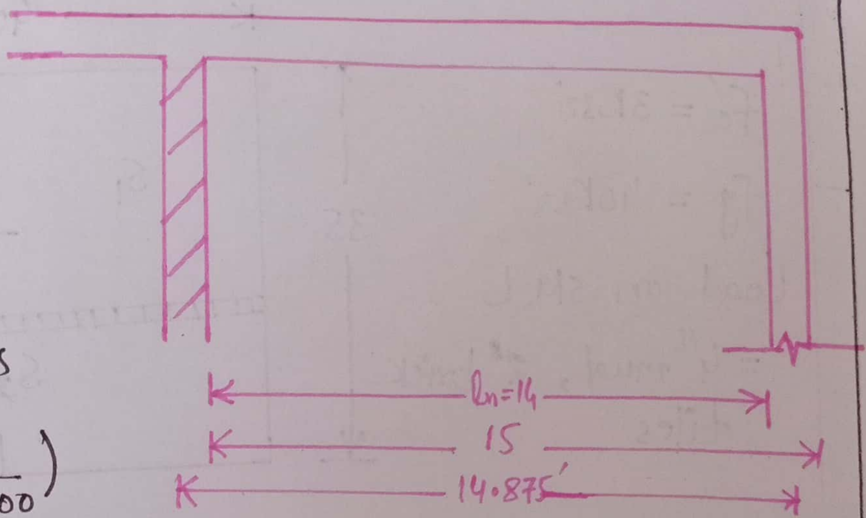
(ii) C/c distance b/w supports

$= l_n + \frac{9}{24} + 0.5$

$= 14 + 0.375 + 0.5$

$= 14.875'$

P#2



So $l = 14$

Slab Thickness

$$= \frac{l}{20} * \left(0.4 + \frac{f_y}{10,000}\right)$$

$$= \frac{14}{20} * \left(0.4 + \frac{40,000}{10,000}\right)$$

$$= 6.72$$

So $h_f = 7''$

$$d = h_f - 0.75 - \frac{3}{8}(2)$$

$$d = 7 - 0.75 - \frac{3}{4}$$

$$d = 5.5''$$

Step#2: Loading

Material	Thickness	γ	Load = γ x Thickness
slab	7	0.15	0.0875
Mud	4	0.12	0.04
Brick	2	0.12	0.02

Scanned with CamScanner

P# 3

Service D.L = 0.1475 Ksf

Service L.L = 40 psf = 0.40 Ksf

F. load = 1.2 DL + 1.6 LL

= 1.2 (0.1475) + 1.6 (0.4)

= 0.241 Ksf

Step 3 Analysis:

$$M_u = \frac{W_u l^2}{8}$$

$$= \frac{0.241 \times (14)^2}{8}$$

= 5.9 0ft K/ft

= 70.8 in K/f

Step 4 Design:

$$A_{s\,min} = 0.002\, b h_f$$

= 0.002 (12)(7)

= 0.168 in²

Now $a = \frac{A_{s\,min} f_y}{0.85 f_c' b}$

$$= \frac{0.168 \times 40}{0.85 \times 3 \times 12}$$

a = 0.219 in

P#4

$$\phi M_n (min) = \phi A_{s min} f_y \left(d - \frac{a}{2}\right)$$

$$= 0.9(0.168)(40)\left(5.5 - \frac{0.219}{2}\right)$$

$$= 32.6 \text{ inK} < M_u$$

Therefore

$$A_s = \frac{M_u}{\phi f_y \left(d - \frac{a}{2}\right)}$$

Take $a = 0.2d$

$$= 0.2(5.5)$$

$$= 1.1$$

$$A_s = \frac{70.8}{0.9(40)\left(5.5 - \frac{1.1}{2}\right)}$$

$$A_s = 0.39 \text{ in}^2$$

$$\Rightarrow a = \frac{0.39(40)}{0.85 * 3 * 12} = 0.509$$

$$\Rightarrow A_s = \frac{70.8}{0.9(40)\left(5.5 - \frac{0.509}{2}\right)}$$

$$\Rightarrow A_s = 0.37$$

$$a = \frac{0.37 * 40}{0.85 * 3 * 12} = 0.483$$

$$A_s = \frac{70.8}{0.9(40)\left(5.5 - \frac{0.483}{2}\right)} = 0.37.$$

So take ~~or~~ $A_s = 0.37 \, in^2 \longrightarrow$ OK

using #4 bars

$$\text{spacing} = \frac{\text{Area of bar}}{A_s}$$

$$= \frac{0.20}{0.37} * 12$$

$$= 6.48 \approx 6''$$

use #4 bars @ 6" c/c

Step 5: Temprature bars

$$A_{st} = 0.002 \, b h_f$$

$$= 0.002 (12)(7) = 0.168 \, in^2$$

use #3 bars

$$\text{spacing} = \frac{A_b}{A_s} = \frac{0.11}{0.168} = 7.85$$

$$\approx 7.5''$$

use #3 bars 7.5" c/c

Checks:

spacing should be less of min of

(i) $3h_f = 3 \times 7 = 21''$

(ii) $18 = 18''$

Our case 6" —— OK

For temprature bars

(i) $5h_f = 5 \times 7 = 35$

(ii) 18"

our case 7.5" —— OK

Design of S_1

Step1 Sizes $= \frac{l_b}{l_a} = \frac{20}{20} = 1 < 2$

So two way slab

$$h_{f\,min} = \frac{\text{Perimeter}}{180}$$

$$= 12\left[\frac{2(20+20)}{180}\right]$$

$h_{f\,min} = 5.33$

Let $h = 7''$

Step2: Loads

Factored Load $= W_u = 1.2\,D.L + 1.6\,LL$

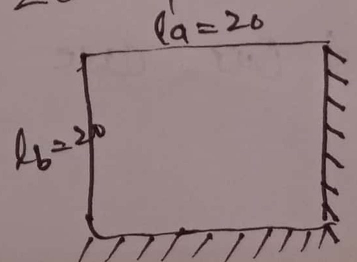
$= 1.2(0.1475) + 1.6(0.04)$

$= 0.241$ Ksf

Step3: Analysis

$l_a = 20$ & $l_b = 20$

$m = \frac{l_a}{l_b} = \frac{20}{20} = 1$



2 end cont

So case 4

P# 7

Case 4 (m = 1)

Co-eff for -ve M		Co-eff for D.L +ve M		Co-eff for L.L +ve M	
C_a neg	C_b neg	$C_{a\,D.L}$	$C_{b\,D.L}$	$C_{a\,L.L}$	$C_{b\,L.L}$
0.05	0.050	0.027	0.027	0.032	0.032

$M_{a\,-ve} = C_{a\,-ve} * w_u * l_a^2$

$= 0.050 * 0.241 * 20^2 = 4.82$ ft.K

$= 57.84$ in.K

$M_{b\,-ve} = 0.50 * 0.241 * 20^2 = 4.82$

$= 57.84$ in.K

$M_{a\,+D.L} = C_{a\,+dL} * w_{u\,(D.L)} * l_b^2$

$= 0.027 * (1.2\,(0.241)\,(20)^2$

$= 3.12$ K.ft $= 37.49$ in.K

$M_{b\,-D.L} = C_{a\,dL} * w_{u\,(L.L)} * l_b^2$

$= 0.027 * 1.2\,(0.241)\,(20^2)$

$= 3.12$ K.ft $= 37.49$ in.K

$M_{a\,(+L.L)} = 0.322 * 1.6\,(0.04)\,(20)^2$

$= 0.81$ K.ft $= 9.83$ in-K

[P#8]

$M_b\ (+L.L) = 0.81\ Kft = 9.83\ in K$

Finally we have

$M_a\ -ve = 57.84\ in K$

$M_b\ -ve = 57.84\ in K$

$M_a\ +(D.L+L.L) = 37.49 + 9.83$

$= 47.32\ in K$

$M_b\ +(DL+LL) = 37.49 + 9.83$

$= 47.32\ in\text{-}K$

Design

$A_{s\,min} = w_u\, b h_f$

$= 0.002 * 12 * 7 = 0.168\ in^2$

$a = 0.219$ as above.

$\phi M_n(min) = w_2\, b h_f$

$= 0.9(0.168)(40)(5.5 - \frac{0.219}{2})$

$= 32.6\ in\text{-}K$

Now All moments are more Than ϕM_{min}

So For $M_a(+ve) = M_b(-ve) = 57.84\ in\text{-}K$

Let $a = 0.2d$

$= 0.2(5.5) = 1.1$

$$A_s = \frac{57.84}{0.9(40)(5.5 - \frac{1.1}{2})}$$

$A_s = 0.324\ in$

P# 9

$$a = \frac{0.324 \times 40}{0.25 \times 3 \times 12} = 0.423''$$

$$As = \frac{57.84}{0.9(840)\left(5.5 - \frac{0.423}{2}\right)} = 0.303 in^2$$

$a = 0.394$

$As = 0.303\ in^2$

So $As = 0.303\ in^2$

Use #3 bars

$$spacing = \frac{Ab}{As} * 12$$

$$= \frac{0.71}{0.303} * 12 = 4.35''$$

use #4 bar

$$spacing = \frac{0.20}{0.303} * 12 = 7.9 \approx 7.5''$$

use #3 @ 4" c/c

For $Ma + (D.L + L.L) = Mb + (D.L + L.L) = 47.32$

Let $a = 0.2d = 1.1$

$$As = \frac{47.32}{0.9 * 40 * \left(5.5 - \frac{1.1}{2}\right)} = 0.265 in^2$$

$$a = \frac{0.265 \times 40}{0.85 * 3 \times 12} = 0.34''$$

Scanned with CamScanner

P# 10

$A_s = 0.246\ in^2$

$a = 0.322''$

$A_s = 0.246\ in^2$

So take $A_s = 0.246\ in^2$

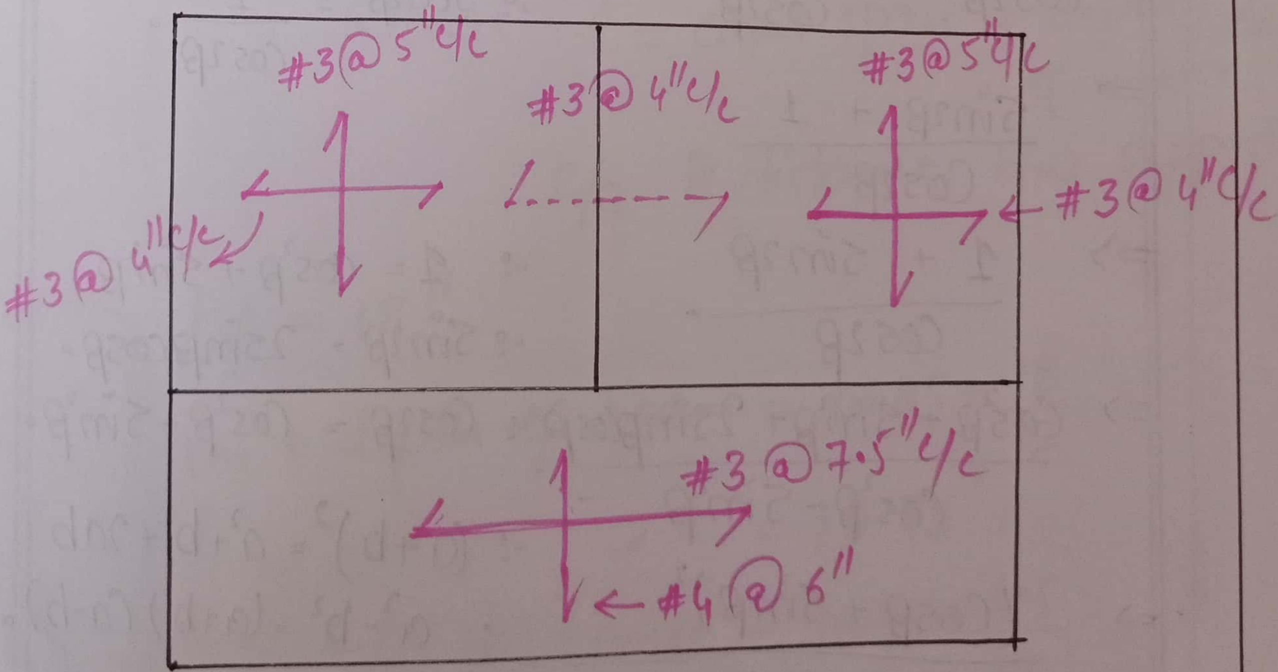
use #4 bars

spacing $\frac{0.20}{0.246} * 12 = 9.75$

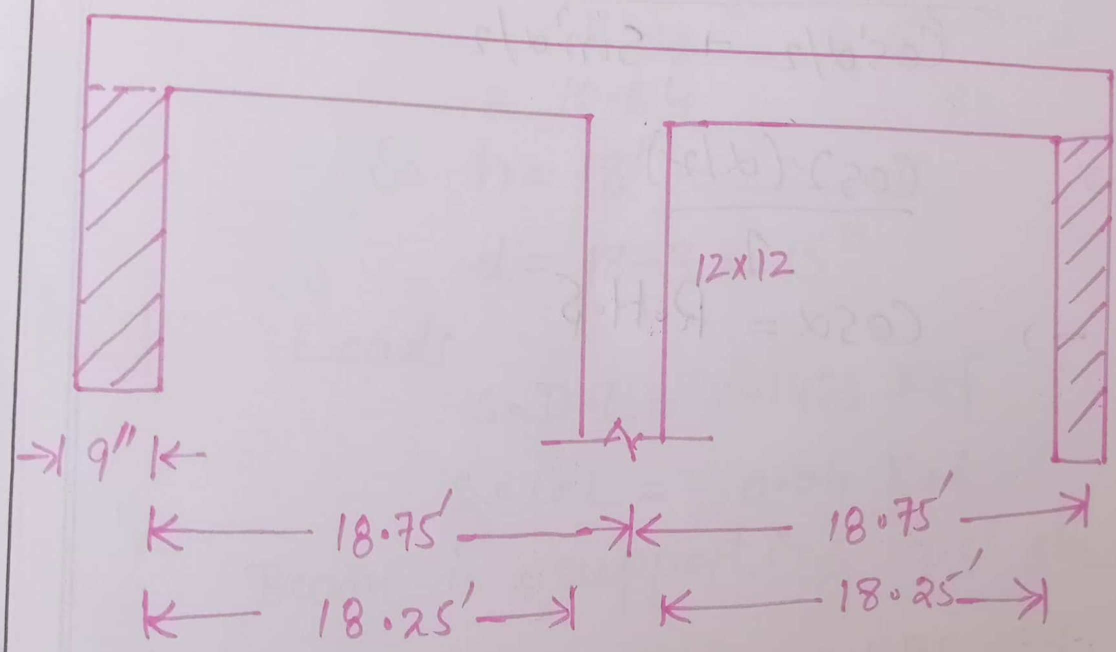
use #3 bars

spacing $= \frac{0.11}{0.246} * 12 = 5.36$

So use #3 @ 5" c/c



Beam Design



Min Thickness of beam for one end coutinous

$$h_{min} = \frac{l}{18.5}$$

where l = clear span + depth of member $\leq$ c/c distance b/w supports

Let $h_f = 18''$

$$l_n + \text{depth of beam} = 18.25 + \frac{18}{12}$$

$$= 19.75'$$

$$c/c \text{ distance} = 18.75 + \frac{4.5}{12}$$

$$= 19.125$$

So $L = 19.75'$

P#12

$$h = \frac{19.75}{18.5}\left[0.4 + \frac{40,000}{100,000}\right]$$

$= 10.24$

So $h = 18''$ ——— OK

$d = 18 - 3 = 15''$

Step 2 Loads

S.D.L = 0.1425 Ksf

S.L.L = 0.04 Ksf

Beam is supporting 7.5' slab

S.D.L From slab = 0.1425 × 7.5

$= 1.068$ K/ft

S.L.L From slab = 0.04 * 7.5 = 0.3 K/ft

Beam self weight $= \left(\frac{18 \times 12}{144}\right) 0.15$

$= 0.225$ K/f

Total D.L = 1.293 K/ft

$W_u = 1.2\,D.L + 1.6\,LL$

$= 1.2(1.293) + 1.6(0.3)$

$= 2.03$ K/ft

Step 3 Analysis

(i) At interior support

$-ve\ Moment = \frac{1}{9}(2.03)(18.25)^2$

$= 75.12\ Kft = 901.5\ in\text{-}K$

At Mid span

$+ve\ Moment = \frac{1}{11}(2.03)(18.25)^2$

$= 61.46\ Kf$

$= 737.6\ in\text{-}K$

$U_{int} = 1.15\,(2.03)\left(\frac{18.25}{2}\right)$

$= 21.30K$

$V_{int} = 21.30 - (2.03 * 1.25)$

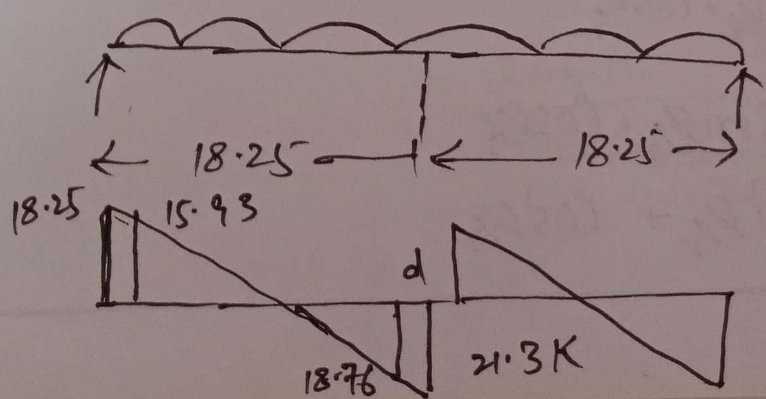
$= 18.76$

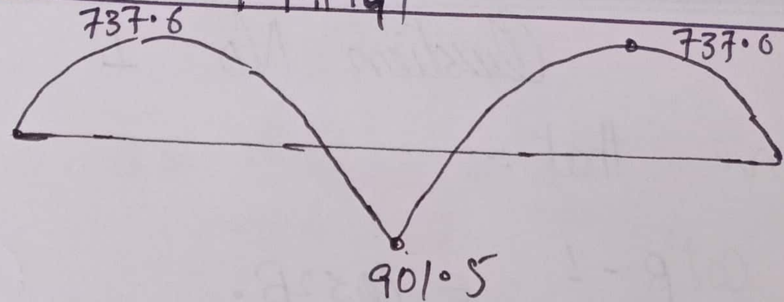
$V_{ext} = \frac{w_u l_n}{2} = \frac{2.43 * 18.25}{2}$

$= 18.52K$

$V_{u\,ext} = 18.52 - (2.03) - 1.25)$

$= 15.98K$





Design ÷

(i) For +ve Moment

ⓐ beff # for L beam

(i) $bh_f + b_w = 6*7+12$

$= 54''$

(ii) $b_w = \frac{\text{Span length of beam}}{12}$

$= \frac{12+(18.75*12)}{12}$

$= 30.75''$

So $b_{eff} = 30.75''$

ⓑ Check if beam is design as rectangular beam o L beam

Assumed $a = 5''$

Trial #1 $A_s = \frac{M_u}{\phi f_y (d - \frac{a}{2})}$

$= \frac{208.14}{0.9(40)(15 - \frac{15}{2})}$

$A_s = 0.462 \text{ in}^2$

P# 17 (15)

$a = \frac{A_s f_y}{0.85 f_c' b_{eff}} = \frac{0.462 * 40}{0.85 * 3 \times 24.875}$

$a = 0.29'' < h_f = 5''$

$A_s = 0.389\ in^2$

$a = 0.25$

Thus $A_s = 0.39\ in^2$

Step 4 :- Check For Max and Min reinforcement

$A_s(min) = 0.005\ (12 \times 15)$

$A_s(min) = 0.9\ in^2$

$A_s(actual) < A_s(min)$

So A_s selected $= 0.9\ in^2$

using appendix A Table A.12

use 3#5 bars

P# 16

Shear Design for Beam

$d = 15'' = 1.25'$

$V_u (ext) = 6.39\,K$

$V_u (int) = 7.58\,K$

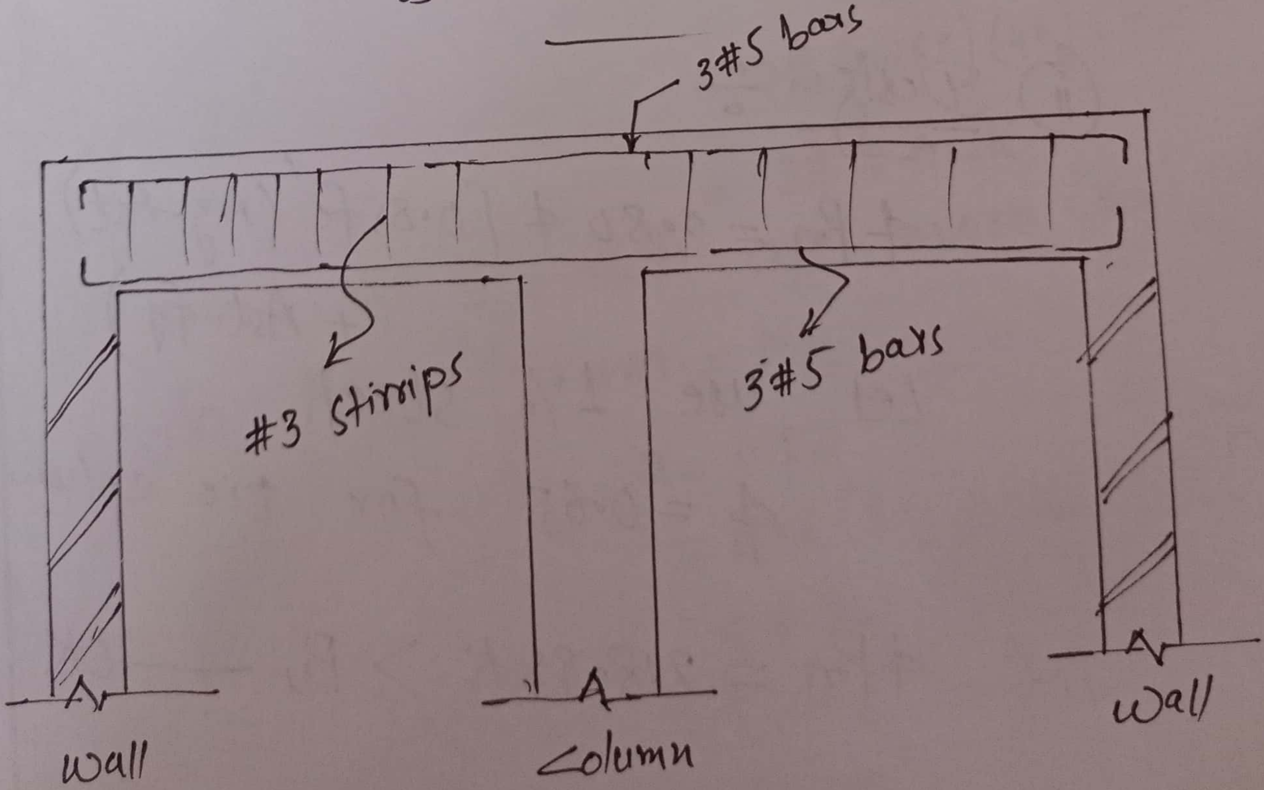
(a) Check wether reinforcemt is needed or not

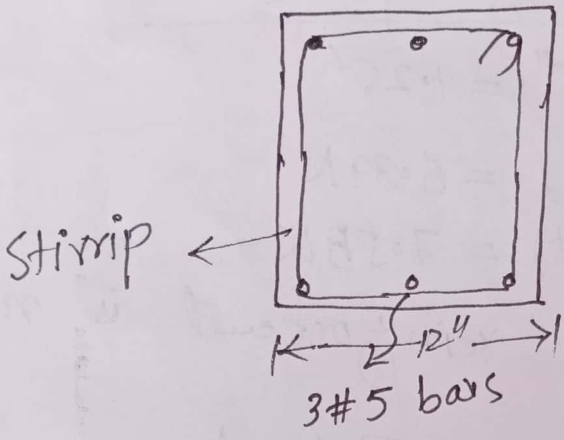
$$\phi V_c = \frac{\phi\, 2\sqrt{f_c'}\, b_w d}{1000}$$

$$= 0.75 \times 2\sqrt{3000} \times 12 \times \frac{15}{1000}$$

$$\phi V_c = 14.78 > V_u(ext)$$

Thus no shear reinformemt is needed.





Column Design

Load on column

$P_u = 2 V_{int} = 2 \times 21.30$

$= 42.60 K$

$A_g = 12 \times 12 = 144 \ in^2$

$f_c' = 3 Ksi \quad f_y = 40 Ksi$

(ii) Design :

$\phi P_n = 0.80 \phi [0.85 f_c' (A_g - A_{st}) + A_{st} f_y)$

Let use 1% steel

$\phi = 0.65$ for tie column

$\phi P_n = 218.98 K > P_u$ — OK

$A_{st} = 0.01 * 144 = 1.44\ in^2$

use # 6

No of bars = $\frac{1.44}{0.44} = 3.27$

So use 4 # 6 bars

Tie bars

Use # 3 tie bar for # 6 main bars.

spacing for tie bars

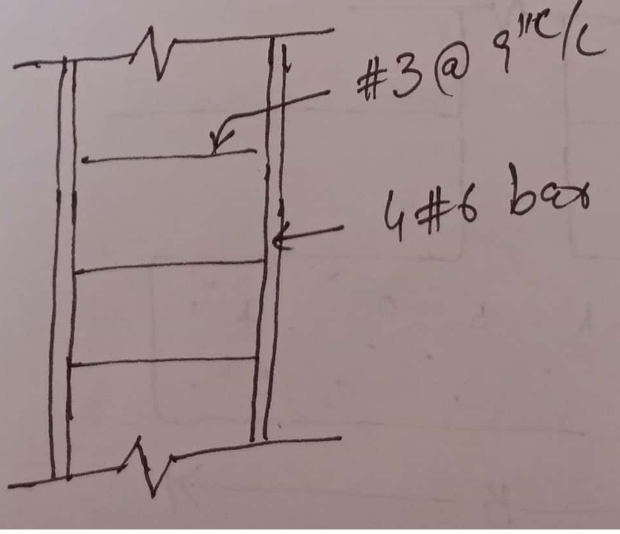
Min of

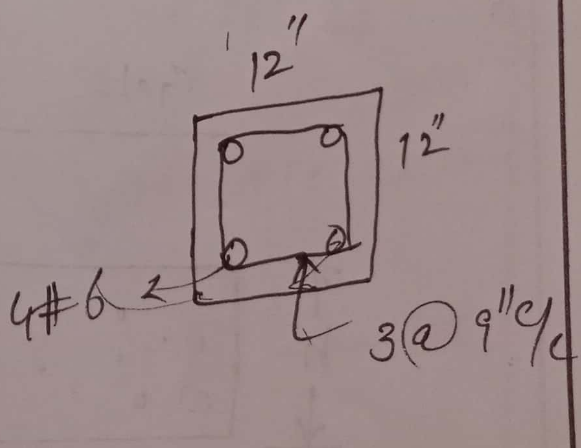
(i) $16 d_b = 16 \times \frac{3}{4} = 12''$ c/c

(ii) $48 d_{sb} = 48 * \frac{3}{8} = 18''$ c/c

(iii) Least Column dimension = 12'' c/c

So use # 3 tie bars @ 9'' c/c





Footing Design

Column Size = 12" * 12"

$f_c' = 3 Ksi$ $f_y = 40 Ksi$

Let $q_a = 2.204\ K/ft^2$

(i) Sizes :-

Let $h = 1.5' = 18"$

$d_{avg} = h - 3 - \text{one bar dia}$

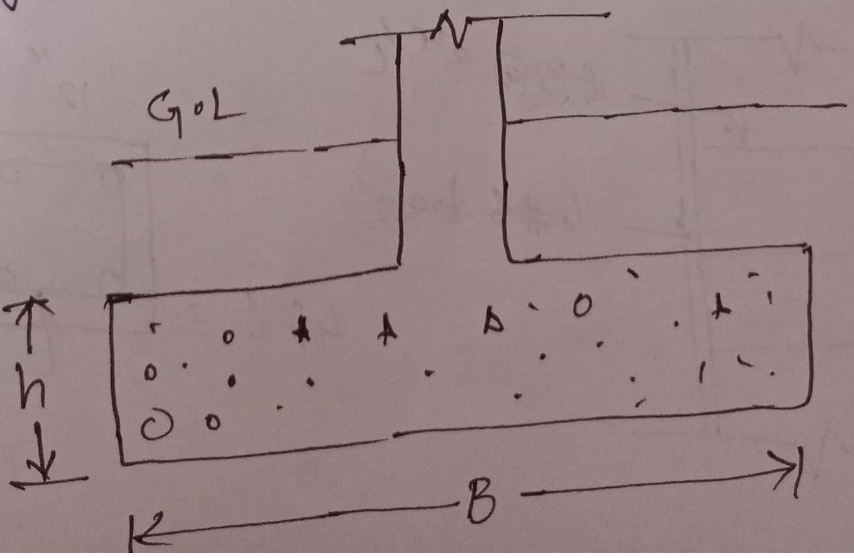
$= 18 - 3 - 1.2 = 14"$

use #8 bars

$b_o = 2(c.c + d_{avg}) + (c + d_{avg})$

$b_o = 104"$

Assume depth of footing from ground level = Z = 5



As There is concrete and soil b/w base & G.L so

$$W = \gamma_{fill}(z-h) + \gamma_c h$$

$$= 100(5-1.5) + 150(1.5)$$

$$= 575 \text{ psf} = 0.575 \text{ Ksf}$$

q_e = bearing pressure to carry column service load

$$q_e = q_a - w$$

$$= 2204 - 575$$

$$= 1629 \text{ psf}$$

Now

Area of Footing

$$A_{req} = \frac{\text{Service load on col}}{q_e}$$

$$= \frac{1.15 w_s l_n/2}{1629}$$

$$= \frac{1.51(1.593)(18.25)/2}{1629}$$

$$A_{req} = 10.25 \text{ ft}^2$$

$B \times B = \sqrt{10.25}$

$= 3.20$

So $B = 4'$

Loads :-

$q_u = \dfrac{\text{Factored Load}}{\text{Area}}$

$= \dfrac{2(21.3)}{16}$

$= 2.66\ \text{Ksf}$

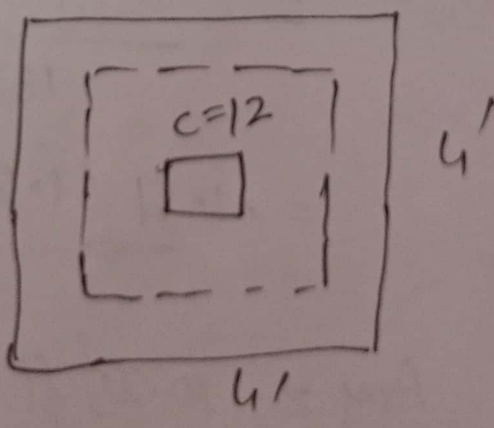
③ **Analysis**

(i) Punching shear

$V_{up} = q_u B^2 - q_u (C + d_{avg})^2$

$= 2.66\,(4)^2 - 2.66\left(\left(\dfrac{12+14}{12}\right)^2\right)$

$V_{up} = 9.34\ K$

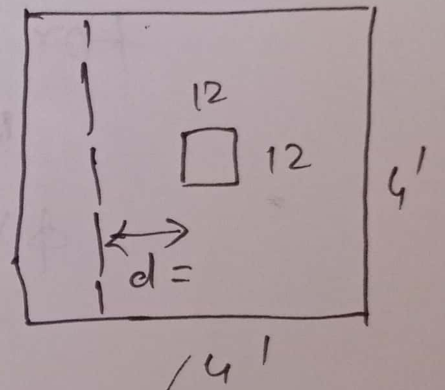


Beam Shear

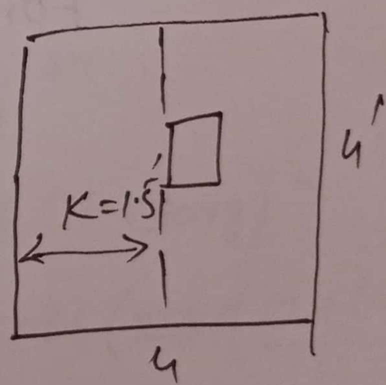
$$V_{ud} = q_u \left\{ \left(\frac{B-C}{2}\right) - d_{avg} \right\} B$$

$$= 2.66 \left\{ \left(\frac{4-\frac{12}{12}}{2}\right) - \frac{14}{12} \right\} 4$$

$$= 3.54K$$



Bending Moment



$$M_u = q_u B \, K^2/2$$

$$K = \frac{B-C}{2}$$

$$K = 18'' = 1.5'$$

$$M_u = 266 * 4 * \frac{1.5^2}{2}$$

$$= 11.97 \text{ K ft}$$

$$= 143.64 \text{ in.ft}$$

(4) Design :- For Punching shear

$V_{up} = 9.34K$

$\phi V_{cp} = \phi 4\sqrt{f_c'}\, b_o\, d_{avg}$

$= 239.2K > V_{up}$ — OK

For beam shear

$V_{ud} = 3.54K$

$\phi V_{cd} = \phi 2\sqrt{f_c'}\, B\, d_{avg}$

$= 55.210K > V_{ud}$ — OK

For Moment

Let $a = 0.2 d_{avg}$

$= 0.2 * 14$

$= 2.8''$

$A_s = 0.31\ in^2$

$a = 0.101\ in$

$A_s = 0.286\ in^2$

$a = 0.093\ in$

$A_s = 0.286\ in^2$

So $A_s = 0.286\ in^2$

Checks

$$A_{min} = \frac{3\sqrt{f_c'}}{f_y}(B\,d_{avg}) \geq \frac{200}{f_y} B\,d_{avg}$$

$$= \frac{3\sqrt{3000}}{40000} \times 4 \times 12 \times 14 \geq \frac{200}{40,000} * 4 \times 12 \times 14$$

$$2.76 \geq 3.36 \quad \text{Not ok}$$

So $A_{s\,min} = 3.36\ in^2$

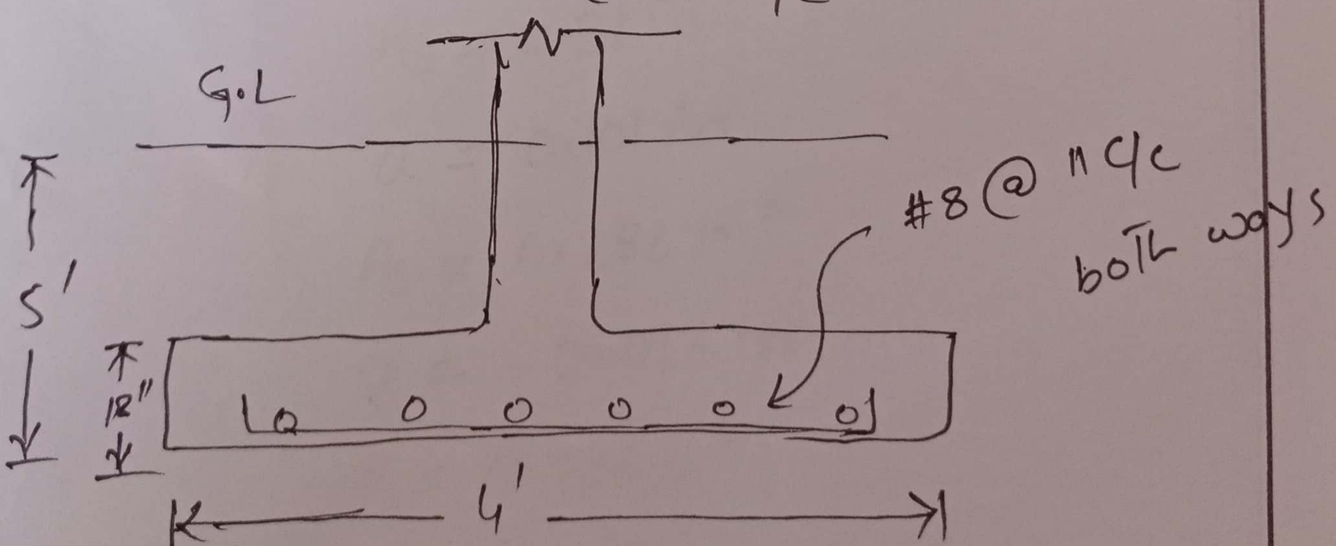
use #8 bar

$$\text{spacing} = B * \frac{A_b}{A_s}$$

$$= 4 * 12 * \frac{0.79}{3.36}$$

$$= 11'' \ c/c$$

use #8 @ 11" c/c



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