Name # M=IKRAM

ID # 7874

Sec # B

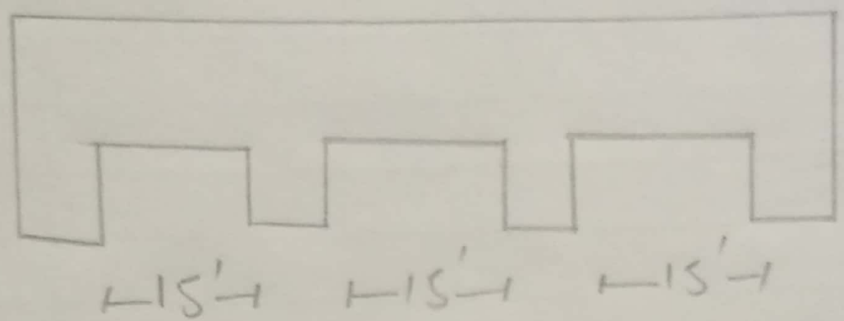
Sub # PRC

Scanned with CamScanner

Ans:

Q:- 1

Sol:-



Step # 1: (Mainimum Thickness)

By using formula

$t_{min} = L/28 = 15/28 = 6.4$

$\approx 6.5''$

As $F_y \rightarrow 40$ ksi

So we will multiply

a factor with thin thickness

$$\text{factor} = \left(0.4 + \frac{Fy}{100}\right)$$

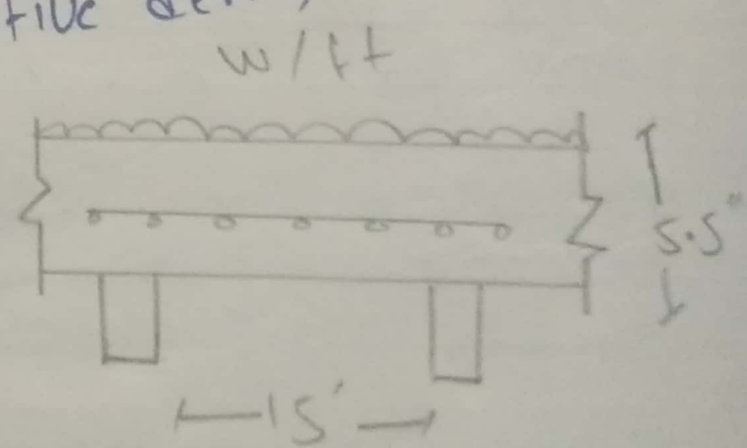
$$= \left(0.4 + \frac{40}{100}\right) = 0.8$$

Hence the minimum thickness will be

$$6.5 \times 0.8$$

$$t_{min} = 5.2 \approx 5.5''$$

Step: 2: (effitive depth)



By formula

$$d = t - \text{clear cover} - \tfrac{1}{2}(\text{dia of main bar})$$

$$= 5.5 - 0.75 = \tfrac{1}{2}(5/8)$$

Scanned with CamScanner

$d = 4.5''$

Step#3: (Self wt of Slab)

By formula

$\frac{t}{12} + \gamma$ Concrete

$= \frac{5.5}{12} \times 150 = 68.75\ lb/ft^2$

Step#4: (Total factored load)

Factored live load $= 160\ lb/ft^2$

So the factored Dead load will be

$D.L = 1.2(20 + 68.75) = 106.5\ lb/ft^2$

Total factored load $= D.L + L.L$

$= 106.5 + 160$

$= 266.5\ lb/ft^2 = 0.2665\ k/ft^2$

Scanned with CamScanner

Step #5 (Ultimate moment)

By using formula

$$M_u = \frac{W_u \times L^2}{8} = \frac{0.2665 \times (15)^2}{8} \times 12$$

$$= 89.94 \text{ kip-inch}$$

Step #6: Area of Steel

For Main Bars By Trial and Repeat method.

Trial #1:

let depth of compression block

$$a = 0.2 \times t$$

$$= 0.2 \times 5.5 = 1.1''$$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)}$$

Scanned with CamScanner

$$= \frac{89.94}{0.90 \times 40\left(4.5 - \frac{1.1}{2}\right)}$$

Trial#2: $A_{st} = 0.63 \, in^2$

$$a = \frac{A_{st} \times f_y}{0.55 \times f_c' \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} \Rightarrow 0.62 \, in$$

$$A_{st} = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{0.6}{2}\right)}$$

$A_{st} = 0.59 \, in^2$

Trial#3:

$$a = \frac{0.59 \times 40}{0.85 \times 4 \times 12} = 0.57''$$

Scanned with CamScanner

$$Ast = \frac{89.94}{0.90 \times 40 \left(4.5 - \frac{57}{2}\right)}$$

$$= 0.59 \, in^2$$

So we will use $Ast = 0.59 \, in^2$

Step#7: Area of steel for distribution reinforcement

$A_{min} = 0.002 \times b \times t$ → {for Grade 40 steel}

$= 0.002 \times 12 \times 5.5 = 0.132 \, in^2$

$$\boxed{= 0.132 \, in^2}$$

Scanned with CamScanner

7

Step#8: Spacing for Main bar

By formula

Spacing $\frac{Ab}{Ast} \times 12$

we use # 6 bar dia $= \left(\frac{6}{8}\right)''$

$$Area = \frac{\pi}{4}\left(6/8\right)^2 = 0.442 \, in^2$$

Step# 9: Spacing for distribution bar

$$Spacing = \frac{Ab}{Ast}$$

we use # 5 bar so

Scanned with CamScanner

$dia = \left(\frac{5}{8}\right)''$, $Area = \frac{\pi}{4}\left(\frac{5}{8}\right)^2$

$$= 0.31\ in^2$$

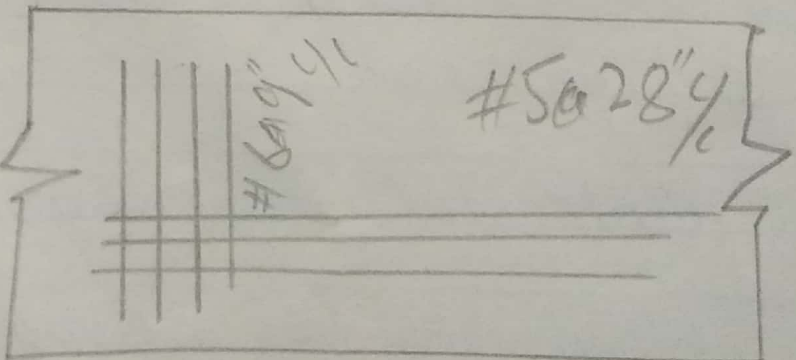
$$Spacing = \frac{0.31}{0.132} \times 12 = 28.18 \approx 28''\ c/c$$

Step#10: find Sketch.

$f_c' = 4ksi$, $f_y = 40ksi$

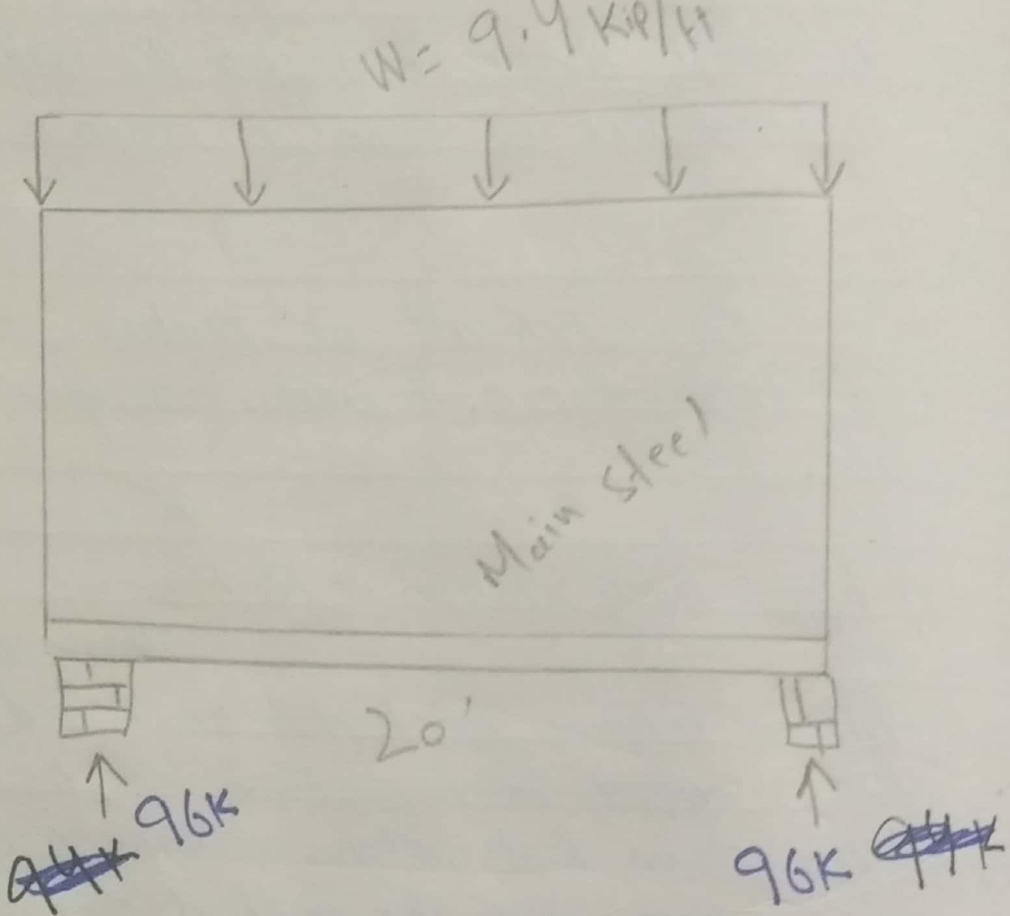
Main steel #6 at 9" c/c

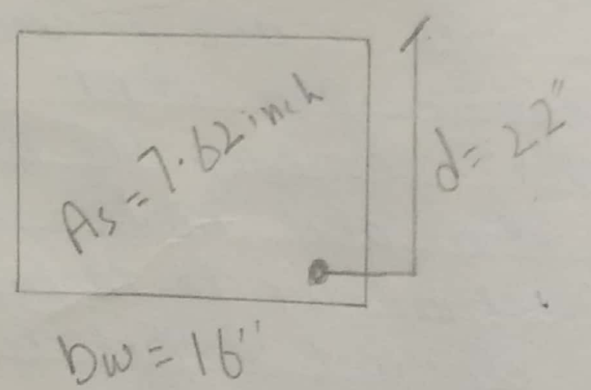
Distribution steel #5 at 28" c/c



Q: 2

Sol:-





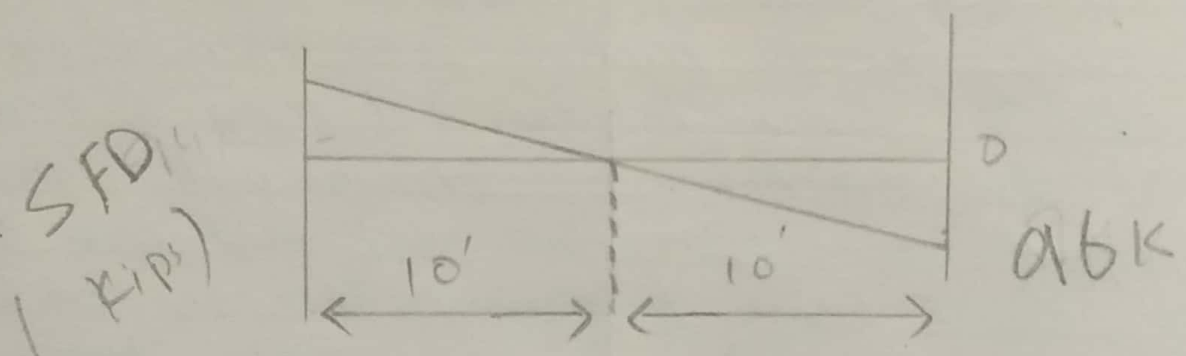
Scanned with CamScanner

Step# 1: find Values of R_1 and R_2

Total load = $9.6 \times 20 = \frac{192}{2} = 96k$

unit load $= b \times \gamma_c = \frac{16}{12} \times 150 = 200 \approx 0.2k/ft$

Step# 2: Draw Shear force Diagram



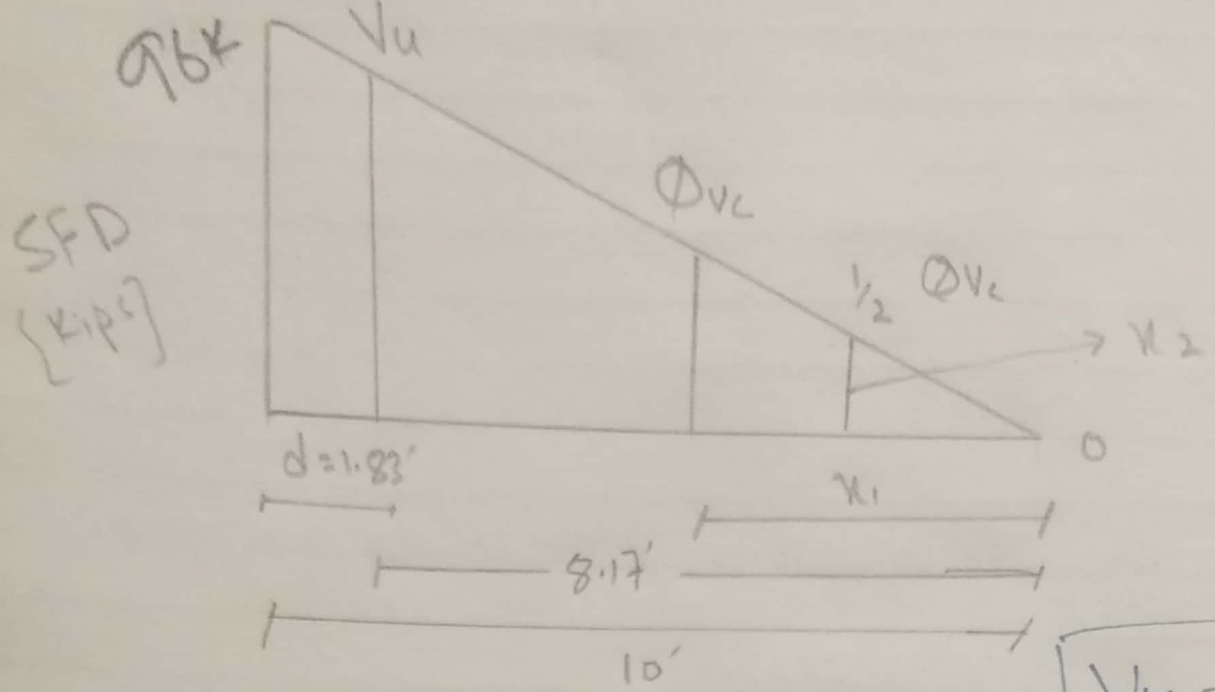
Step# 3:

Find the value of Critical Shear 'Vu' and it's location.

As we know that critical Section is located at distance 'd' from face of $= d = 22'' = 1.83'$

Scanned with CamScanner

Value of Critical Shears at distance 'd' by Similarity of triangles.



Vu = 78.43k

Step#4:

Find the Value of 'ΦVc' and 1/2'ΦVc' and also it's distance From Zero Shear to right side

$$\phi V_c = \phi \times 2 \times \sqrt{f'_c} \times b_w \times d$$

$$= \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000}$$

$$\phi V_c = 33.40K$$

Scanned with CamScanner

location of ϕV_c by Similarity of Ds

$$\frac{96}{10} = \frac{33.40}{x_1} \Rightarrow$$

~~X = 3.4~~

$X_1 = 3.4$

Now

$$\frac{1}{2}\phi V_c = \frac{33.40}{2} = 16.70K$$

location of $\frac{1}{2}\phi V_c \Rightarrow \frac{94}{10} = \frac{16.70}{X_2}$

~~$X_2 = 1.704$~~ **$X_2 = 1.74'$**

Step# 5:

Value of ϕV_s

$(V_u = \phi V_s + \phi V_c)$

So $\phi V_s = V_u - \phi V_c = 78.80 - 33.40$

$\phi V_s = 45.03K$

Scanned with CamScanner

Step# 6:

Check on Section adequacy

$\phi \cdot 8 \cdot \sqrt{f_c} \cdot b_w \cdot d = \frac{0.75 \cdot 8 \sqrt{4000} \cdot 16.22}{1000}$

$= 133.57K$

As

$\phi V_s < \phi 8 \sqrt{f_c'} \cdot b_w . d$

=> It means Section is adequate

Step# 7: Check on Maximum spacing for stirups

$\phi \times 4 \times \sqrt{f_c} \times b_w \times d = \frac{0.75 \cdot 4 \sqrt{4000} \cdot 16.22}{1000}$

$= 66.79\,kip$

As

$\phi 4\sqrt{f_c'}\,b_w d > \phi V_s$ ~~= 175.40k~~

So Max Spacing will be Selected from following Four Condition.

(1) $S_{max} = 24''$ (2) $d/2 = \frac{22}{2} = 11''$

(3) $S_{max} = \frac{0.22 \times 60000}{0.75\sqrt{4000} \times 16} = 17.40$

(4) $S_{max} = \frac{0.22 \times 60,000}{50 \times 16} = 16.50''$

Scanned with CamScanner

from above four Condition least Value of Spacing for #3, 2 legged Stirup will be Selected

So $S_{max} = 11''$ c/c

Step#8

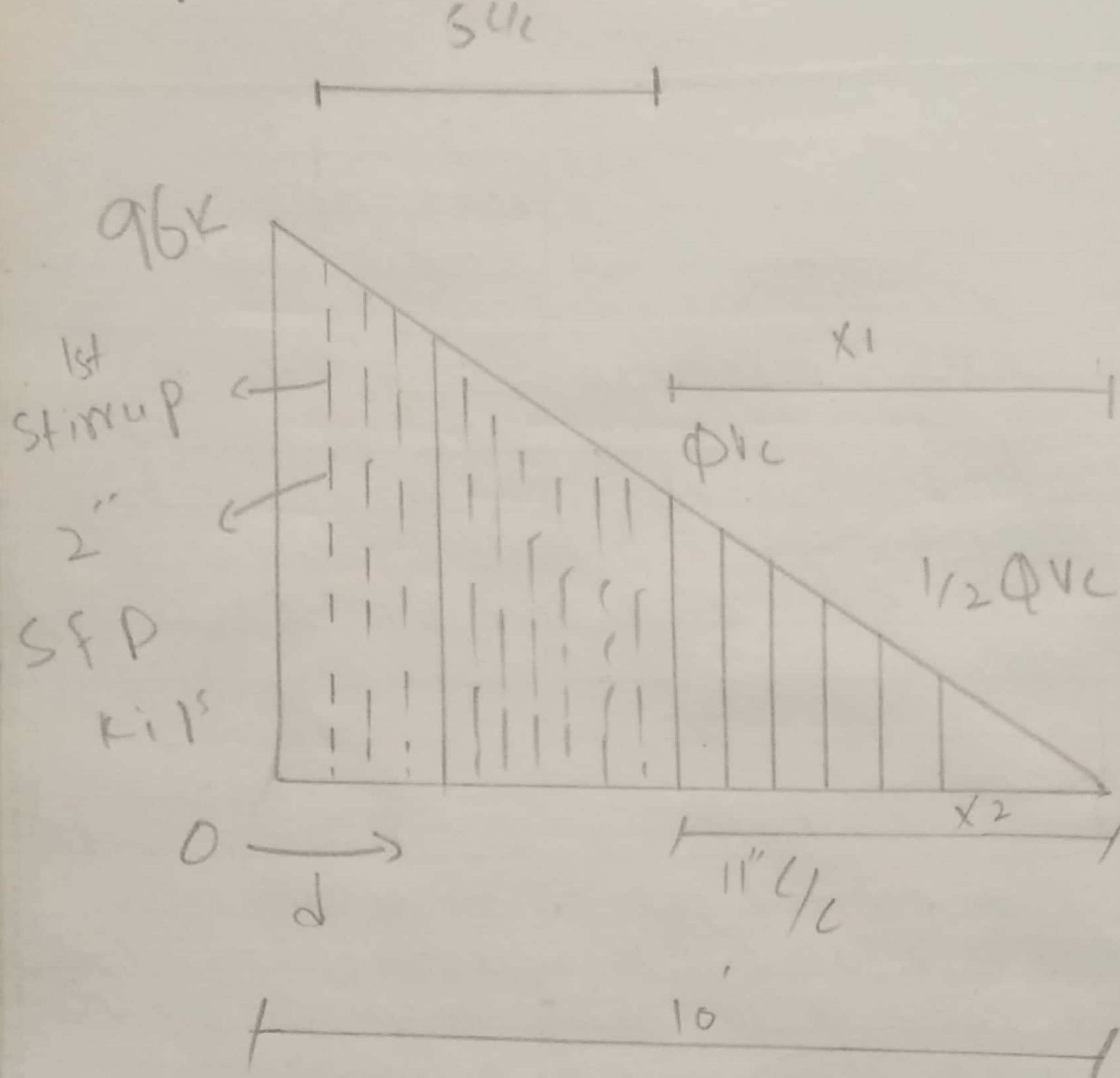
Spacing of Stirup from/at critical Section

$$S = \frac{0.75 \times 0.22 \times 60 \times 22}{76.80 - 33.44}$$

$$\boxed{S = 5'' \text{ c/c}}$$

Scanned with CamScanner

Step #9:



As we know that first stirup from face of support

$= S/2 = 5/2 \approx 2''$

Q:3 :-

Ans:

Step#1: Find gross area of Concrete.

$A_g = b \times b$ (Since it's Squarefied Column)

$A_g = 12 \times 12 = 144\,in^2$ (Actual)

Step#2: Find the area of Steel.

Since $A_s = 5\%$ of A_g

$= 0.05 \times 144$

$A_s = 7.2\,in^2$

Step#3: Ultimate load Carrying Capacity

$P_u = \phi = 0.80 \times [0.85 \times f_c' \times (A_g - A_s) + A_s \times f$

$= 0.65 \times 0.80 [0.85 \times 4 [144 - 7.2] + 7.2 \times 60]$

$P_u = 466.50K$

Step#4: Sketch & design of tie (c/c to distance)

from the below value we choose the least value of all these:

1) - 16 x dia of long bar = $16 \times 9/8$

= 18"

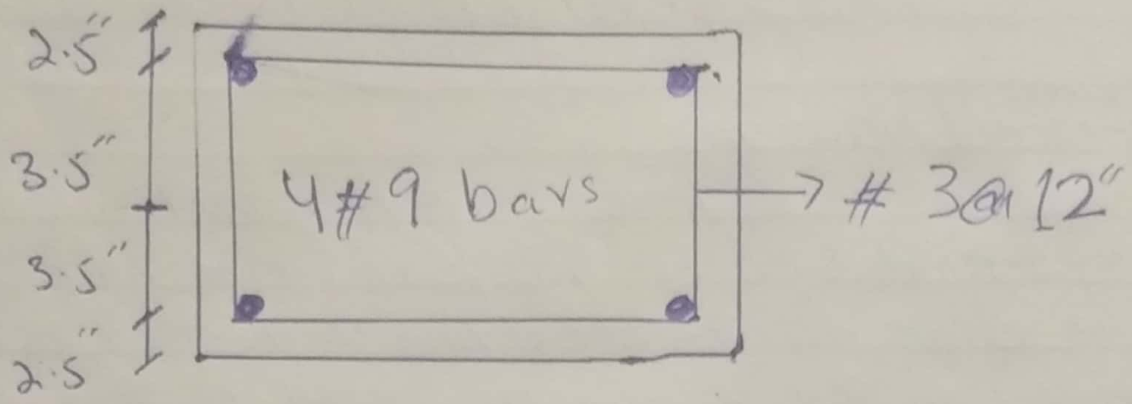
2) 48 x dia of Tie = $48 \times 3/8$

= 18"

Scanned with CamScanner

3) least Column dimension = 12"

So c/c distance b/w ties = 12"



☆ Since it's a tied Square Column So there is no Spiral stirup used. the stirup used is of rectangular Shape due to the specification of the Structure thus we will use tie stirrups instead.

Q:4:-

Sol:-

Step # 1:

let $h = 24''$

Step # 2:

Total weight = wt of Soil + wt of R.

$= 3 \times 120 + 2 \times 150$

$= 660\,psf = 0.660\,ksf$

Step # 3: effective bearing Capacit

$q_e = q_a - W = 2.50 - 0.660$

$q_e = 1.84\,ksf$

Scanned with CamScanner

Step#4: Required area for foundation

$$A_{req} = \frac{\text{Service load}}{q_c} = \frac{100+120}{1.84}$$

$$\boxed{A_{req} = 119.56\ ft^2}$$

Step#5:

Since foundation is square:

$$A_{req} = B \times B = 119.56$$

$B \Rightarrow$ ~~119.56~~ $\sqrt{119.5} \Rightarrow B \cong 11'$

Step# 6:

$$q_{up} = \frac{\text{factored load}}{(B)^2}$$

Scanned with CamScanner

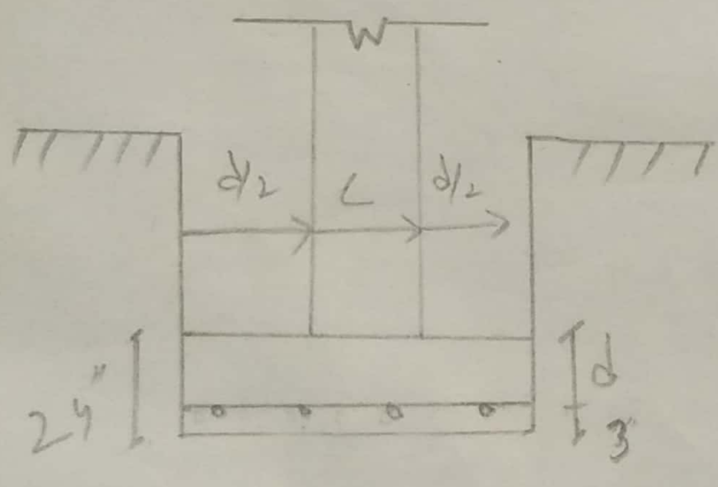
$$V_{up} = \frac{1.2 \times 100 + 1.6 \times 120}{(11)^2}$$

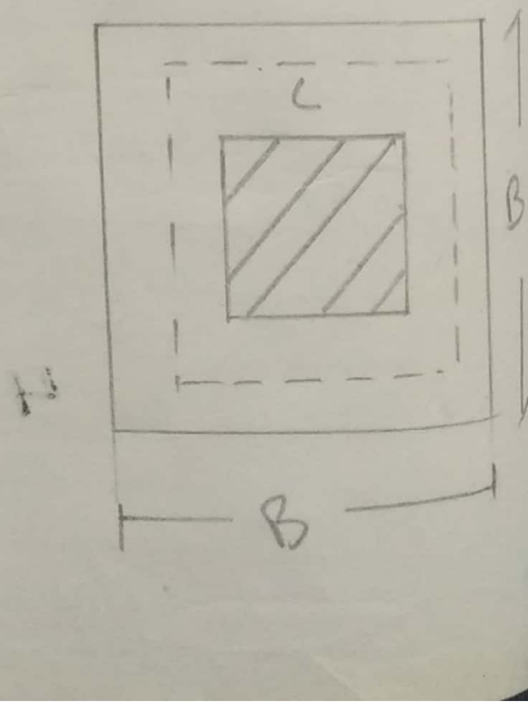
$$\boxed{V_{up} = 2.58\ k/ft^2}$$

Step#7:

Punching Shear:

$$b_o = 4 + (c + d)$$





$d = h - \text{clear cover} - \text{dia of bar} - \frac{1}{2} \times d_b$

$d = 24 - 3 - 1 - \frac{1}{2} + 1 = 19.5''$

$b_o = 4(16 + 19.5'') = 142''$

Step# 8:

$V_{u_2} = q_{up} \times \left[B^2 - (c+d)^2\right]$

$= 2.58 \left[(11)^2 - \left(\frac{16+19.5}{12}\right)^2\right]$

~~$V_{u_2} = 3800$~~

$$\boxed{V_{u_2} = 289.60K}$$

Scanned with CamScanner

Step # 9:

~~$\phi N_{up} = \phi \times 4 \times \sqrt{f'_c}$~~

$$\phi V_{up} = \phi \times 4 \times \sqrt{f'_c} \times b \times d$$

$$= \frac{0.75 \times 4 \times \sqrt{4000} \times 142 \times 19.5}{1000}$$

$$\phi V_{up} = 525.38$$

Step # 10:

$$V_{u1} = V_{up} \times B \times \left[\frac{B}{2} - \frac{C}{2} - d\right]$$

$$V_{u1} = 2.58 \times 11 \times \left[\frac{11}{2} - \frac{16/12}{2} - \frac{19.5}{12}\right]$$

Scanned with CamScanner

$V_{u1} = 90.95K$

Step# 11:

Self shear capacity:

$\phi V_c = \phi \times 2 \times \sqrt{f_c'} \times b \times d$

$= \frac{0.75 \times 2 \times \sqrt{4000}\,(11 \times 12 - 16)}{1000}$

$= 110.04K > V_{u1} \Rightarrow O.K$

Step# 12: ultimate moment:

$M_u = \frac{q_{up} \times B}{8} \times (B - c)^2 = \frac{2.58 \times 11}{8} \times \left(11 - \frac{16}{12}\right)^2$

$M_u = 331.49K' \approx 3977.93K''$

Scanned with CamScanner

Step#13:

Trial: 01,

let $a = 0.2 \times h = 0.2 \times 24$

$= 4.8''$

$$= \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{4.8}{2}\right)} = 8.56 \, in^2$$

Trial: 2:

$$a = \frac{8.5 \times 60}{0.85 \times 3 \times 11 \times 12} = 1.53''$$

$$As = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{1.53}{2}\right)}$$

$= 7.197 \, in^2$

Scanned with CamScanner

Trial: 3:

$$a = \frac{7.197 \times 60}{0.85 \times 3 \times 11 \times 12} = 1.28''$$

$$As = \frac{3977.93}{0.90 \times 60\left(11 - \frac{1.28}{2}\right)}$$

~~0.85x~~

$$\boxed{= 7.1\,in^2}$$

So that area $7.1\,in^2$

Scanned with CamScanner

Step#14: Check the min reinforcemet by the followng three Method

a) $As_{min} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$

$= 5.70 in^2$

(b) $As_{min} = \frac{200}{fy} \times B \times d = \frac{200}{60000} \times (11 \times 12) \times 19.5$

$= 8.58 in^2$

Scanned with CamScanner

(c) $A_{s\,min} = \frac{3 \times \sqrt{f_c'}}{f_y} \times B \times d = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12$

$= 7.05 \text{ in}^2$

from above value greater value will be selected thus

$A_{s\,min} = 8.58 \text{ in}^2$

Scanned with CamScanner

Step # 15: Using # 8 bar

$A_b = 0.785\ in^2$

$$\text{N of bar} = \frac{A_s}{A_b} = \frac{8.58}{0.785} = 10.92$$

$\approx$ 11 bars in each direction

Scanned with CamScanner