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ID :- 7866

SECTION :- "B"

SMESTER :- 6th

SUBJECT :- PRCD - I

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QNO # 2:

Solution:

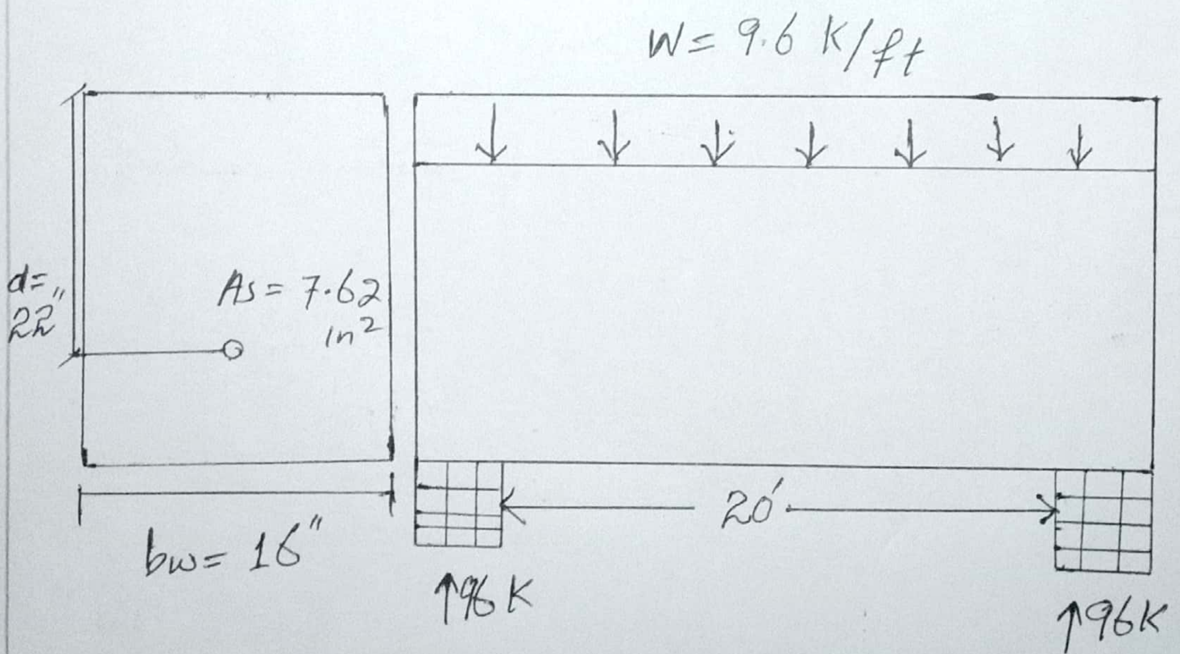
First of all find the unit load of beam so $b \times \gamma_c$

$$= \frac{16}{12} \times 150$$

$$= 200\,lb/ft = 0.2\,K/ft$$

So total factored load $= 9.4 + 0.2$

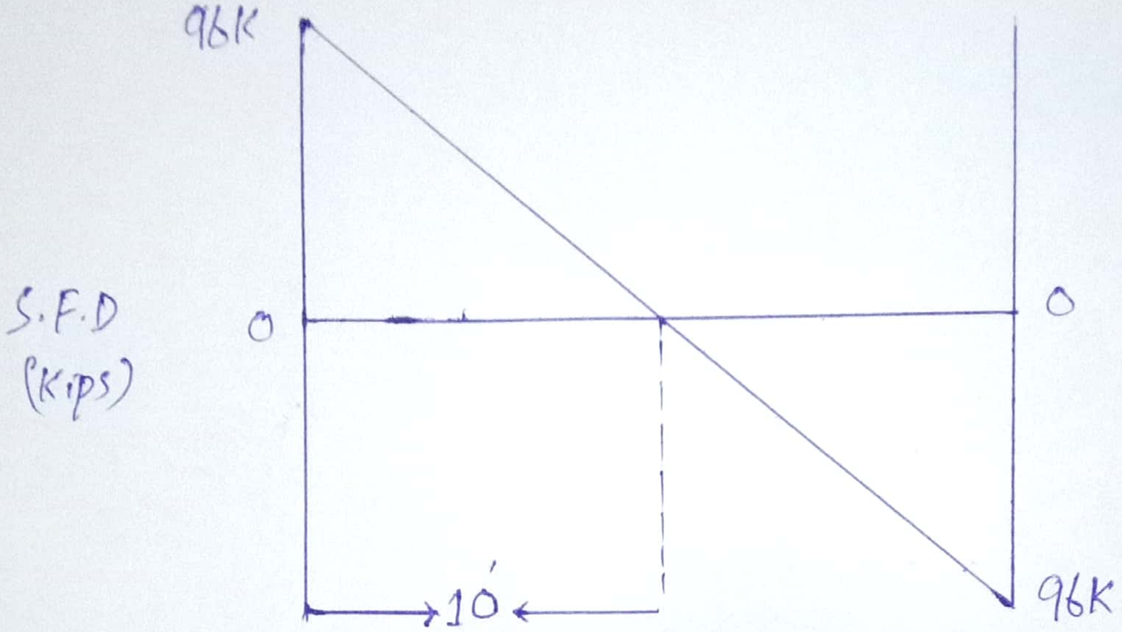
$$= 9.6\,K/ft$$



Step 01: Find the values of R_1 and R_2

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

Step 02: Draw its shear force diagram



Step 03: Find the value of critical stress "V_u" and its location

As we know critical section is located at distance "d" from face of support = $d = 22'' = 1.83'$

Value of critical shear at distance "d" by similarity of Triangles.

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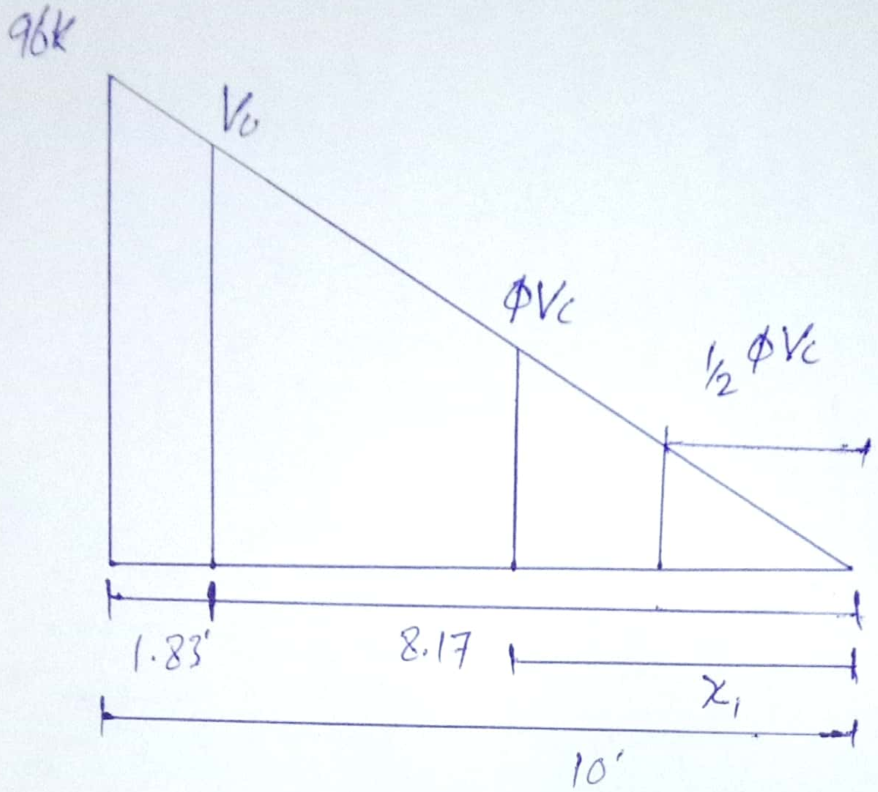

From similar Δ's $\frac{96}{10} = \frac{V_u}{8.17} \Rightarrow V_u = 78.43 \text{ Kp}$

Step : 04 Find the value of "ϕV_c" and "$\frac{1}{2}\phi V_c$" and also it's distances from zero shear to right side.

$$\phi V_c = \phi \times 2 \times \sqrt{f'_c} \times b_w \times d = \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000}$$

$$\boxed{\phi V_c = 33.40 \text{K}}$$

Location of ϕV_c by similarity of Δ's

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

$$\boxed{x_1 = 3.48'}$$

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x_2}$

$\Rightarrow$ $x_2 = 1.74'$

Step 05: Value of ϕV_s $(V_u = \phi V_s + \phi V_c)$

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

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03K$

Step 06: Check on Section

$\Rightarrow \phi \times 8 \times \sqrt{f_c'} \times b_w \times d = \frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 133.57K$

As $\phi \times 8 \times \sqrt{f_c'} \times b_w \times d > \phi V_s \rightarrow$ IT means section is adequate.

Step 07: Check on min spacing for stirrups.

$\phi \times 4 \times \sqrt{f_c'} \times b_w \times d = \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 66.79K$

A $\phi \times 4\sqrt{f'c}\, b_w d > \phi V_s = 45.03K$ Thus max spacing will be selected from the following four conditions:

1- $S_{max} = 24''$

2- $\frac{d}{2} = \frac{22}{2} = 11''$

3- $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'c} \times b_w}$

4- $S_{max} = \frac{A_v \times f_y}{50 \times b_w}$

$\therefore A_v = \frac{\pi}{4}\left(\frac{3}{8}\right)^2 = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16} \Rightarrow A_v = 0.11 \times 2 = 0.22$

$= 17.40''$

No

(4) $\Rightarrow \frac{0.22 \times 60000}{50 \times 16}$

$\Rightarrow 16.50''$

From the above four conditions, least value of spacing for #3, U-shaped stirrup will be selected so

$$S_{max} = 11'' \; c/c$$

Step 08: Spacing of stirrups from/at critical section.

$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$$

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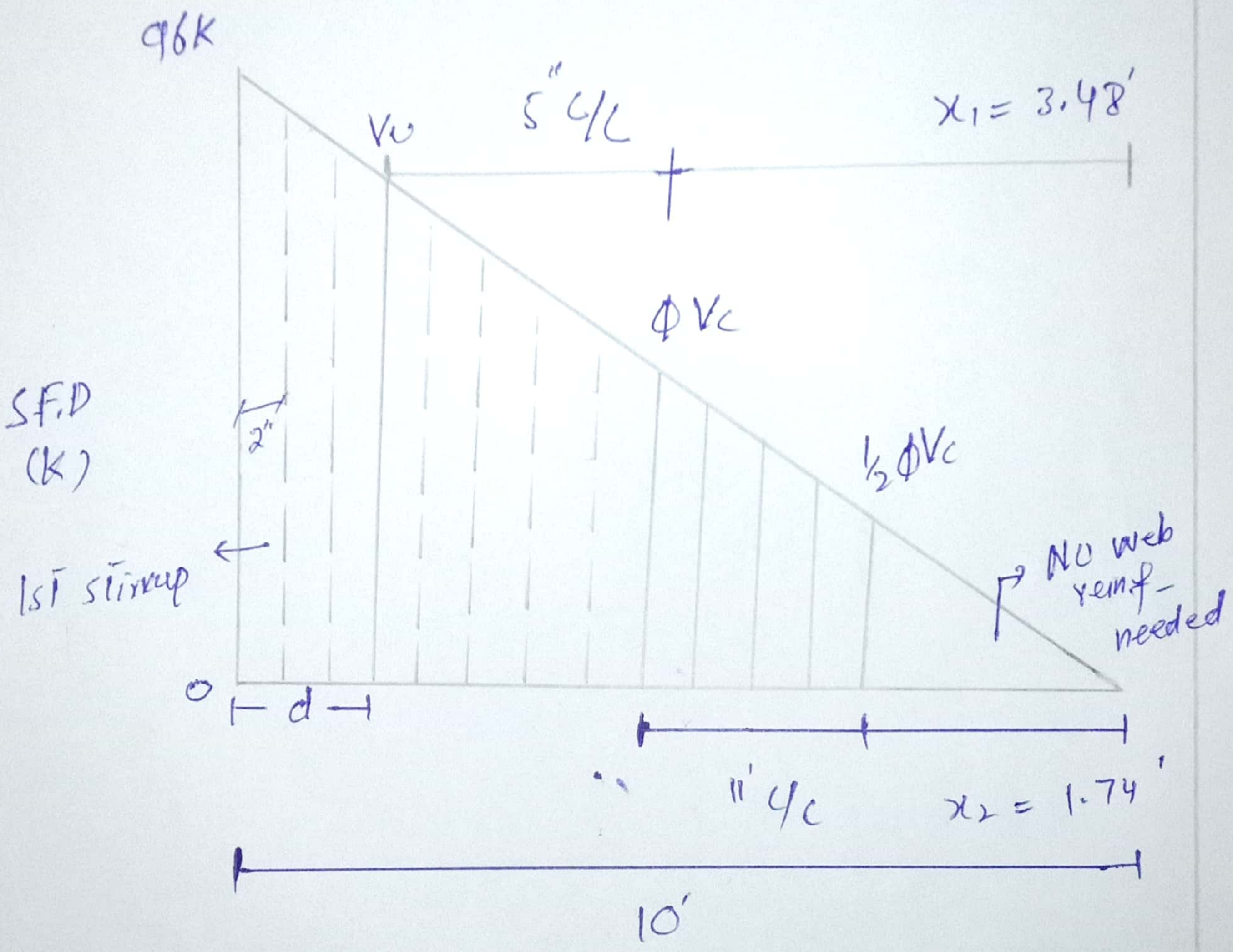
$4.84'' \approx 5''$ c/c

Step 09: Final Sketch.



(*) As we know that first stirrup from face of support

$$\Rightarrow \frac{5}{2} = 2.5 \approx 2''$$

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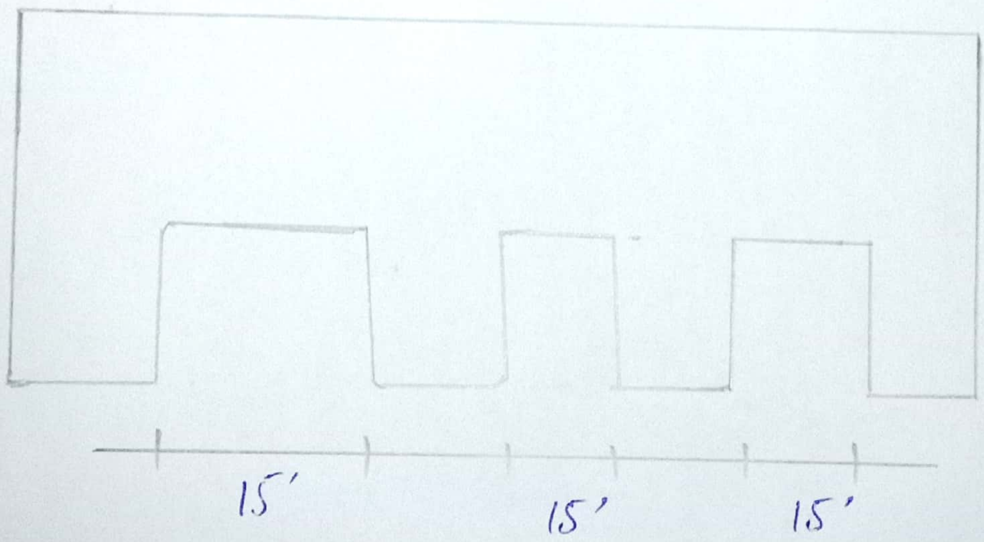
QNO# 01:

Solution:

Given DATA:

- Clear span b/w supports = 15'
- Factored live load = 160 lb/ft²
- Service floor finish load = 20 lb/ft²
- $f_c' = 4000$ psi
- $f_y = 40$ ksi



Step 01: Minimum Thickness

Using Formula

$$t_{min} = \frac{L}{28} = \frac{15}{28} = 6.4 \approx 6.5''$$

As $f_y = 40$ Ksi, so we will multiply a factor with this thickness

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$$\text{Factor} = \left(0.4 + \frac{f_y}{100}\right)^2$$

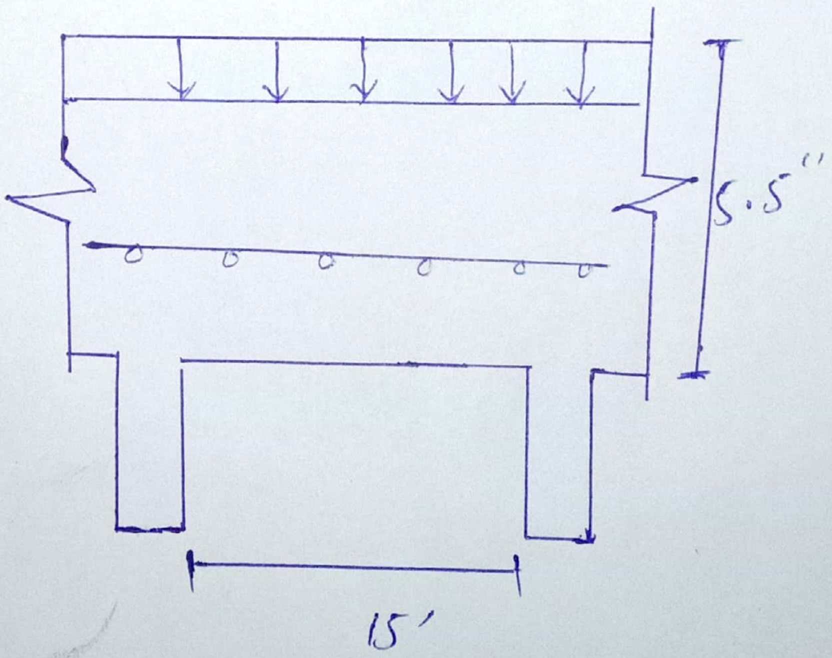
$$= \left(0.4 + \frac{40}{100}\right) = 0.8$$

Thus the minimum thickness will be

$$= 6.5 \times 0.8$$

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

Step 02: Effective Depth.



By formula

$$d = t - c.c - \frac{1}{2}\,(\text{dia of M.B})$$

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

$$\boxed{d = 4.5''}$$

Step 03: Self weight of the slab.

By formula $\Rightarrow \frac{T}{12} \times \gamma_c$

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

$$\Rightarrow 68.75\, lb/ft^2$$

Step 04: Total Factored Load:

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

So factored dead load will be

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

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

$$= 106.5 + 160$$

$$= 266.5\, lb/ft^2$$

$$= 0.2665\, k/ft^2$$

Step 05: Ultimate Moment

By formula

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

$$\Rightarrow \boxed{M_u = 89.94\, k\text{-}in}$$

Step 06: Area of steel for main bar by Trial and Repeat Method.

Trial # 01: Let $a = 0.2 \times t$

$= 0.2 \times 5.5$

$= 1.1''$

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

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

$$A_{ST} = 0.63 \text{ in}^2$$

Trial #02:

$$a = \frac{A_{ST} \times f_y}{0.85 \times f'_c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12}$$

$$\Rightarrow 0.62 \text{ in}^2$$

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

$$= \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.62}{2})}$$

$$A_{ST} = 0.59 \text{ in}^2$$

Trial # 03:

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

~~$A_{ST} = \frac{89.94}{0.85 \times 4 \times 12}$~~

$$A_{ST} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.57}{2})}$$

$$\boxed{A_{ST} = 0.59\ in^2}$$

So we will use $A_{ST} = 0.59\ in^2$

Step 07: Area of steel for disribution reinforcement.

By formula.

$A_{min} = 0.002 \times b \times t \rightarrow$ (For Grade 40 steel)

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

Step # 08: Spacing for main Bars.

By Formula.

$$Spacing = \frac{A_b}{A_{ST}} \times 12$$

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

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

$S = \frac{0.442}{0.95} \times 12 = 8.98 \approx 9''\ c/c$

Step # 09:

Spacing For distribution Bar.

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

We use # 5 bar, so

$dia = (5/8)''$, $Area = \frac{\pi}{4}(5/8)^2 = 0.31\ in^2$

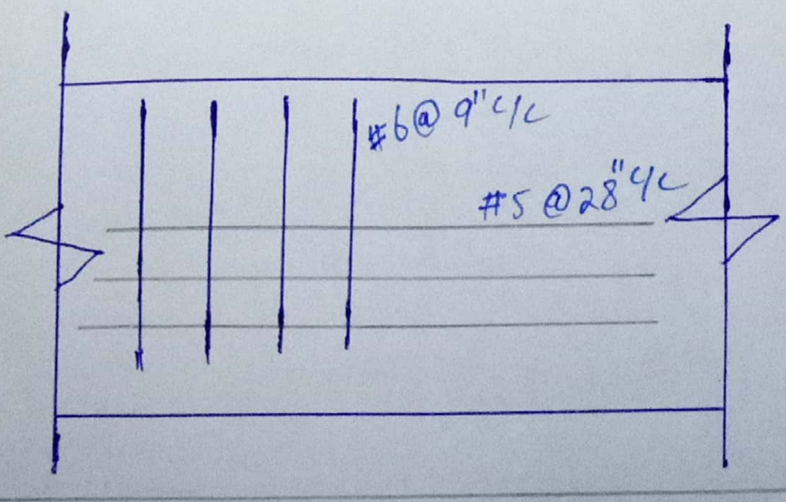
$spacing = \frac{0.31}{0.132} \times 12 = 28.1'' \approx 28''\ c/c$

Step#10: Final Sketch:

$f'c = 4ksi$; $fy = 40ksi$

Main steel # 6 at 9 c/c

Distribution steel # 5 at at 28'' c/c.



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QNO# 03:

Step# 01: FIND GROSS AREA OF CONCRETE:-

$A_g = b \times b$ (Since it is square Tied Column)

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

STep# 02: Find The Area of sTeel.

Since $A_s = 5\%$ of A_g.

$= 0.05 \times 144$

$A_s = 7.2 \, in^2$

Step# 03: Ultimate Load carrying Capacity.

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

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

$P_u = 466.50K$

Step# 04: Sketch and Design of Ties (c/c to distance)

From the below value we choose the least value of all thus

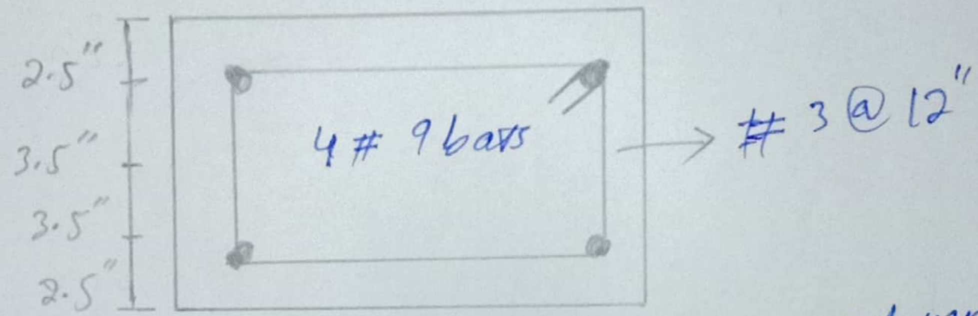
(1) $16 \times$ dia of long bar $= 16 \times 9/8 = 18''$

= ~~18"~~

② 48 x dia of Tie bar = 48 × 3/8
= 18"

③ Least Column Dimension = 12"

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



Since it is a tied square column So there is no spiral stirrup used, the stirrup used as of rectangular shape due to the specification of the structure Thus we will use the tie stirrups instead.

QNO# 04

Step # 01: Let h = 24"

Step # 02: Total weight = Wt of soil + Wt of R.c

= 3×120 + 2×150

= 660 PsT = 0.660 Ksf

Step # 03: Effective Bearing Capacity.

$q_e = q_a - W$

$q_e = 2.50 - 0.660 \Rightarrow$ $q_e = 1.84$ ksf

Step#04: Required Area for Foundation

$$A_{req} = \frac{\text{Service Load}}{q_e} = \frac{100+120}{1.84} \Rightarrow 119.57\ ft^2$$

Step# 05: Since Foundation is Square:

$$A_{req} = b \times b = 119.57 \Rightarrow B = 11'$$

Step# 06: Upward Bearing Capacity of soil:-

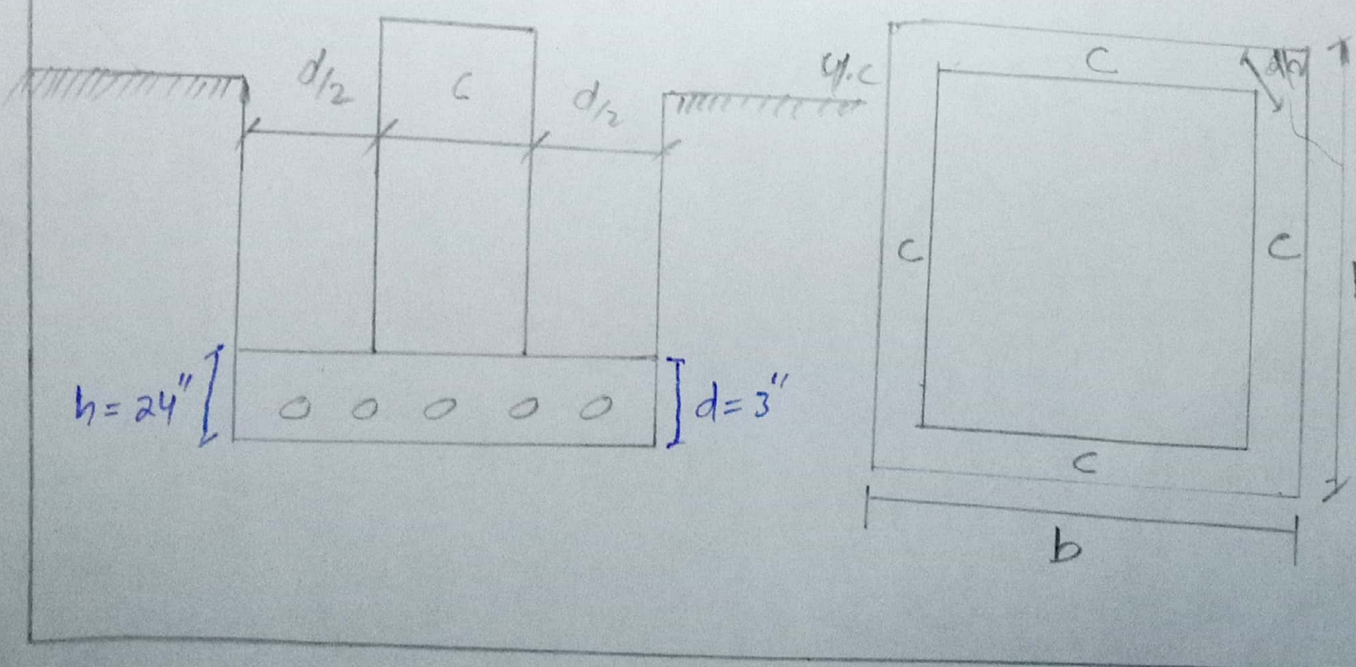
$$q_{up} = \frac{\text{factored Load}}{(B)^2}$$

$$= \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$$

$$q_{up} = 2.58\ K/ft^2$$

Step# 7: Punching Shear:

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



$d = h - c.c - \text{dia of bar} - \frac{1}{2} db$

$= 24 - 3 - 1 - \frac{1}{2}(1) = 19.5''$

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

$\therefore$ Take #8 bar.
dia $= 8/8 = 1''$

Step# 08:

$V_{u2} = q_{up} \times [B^2 - (\frac{c+d}{12})^2]$

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

$V_{u2} = 289.60K$

Step# 09:

$\phi V_{c/p} = \phi \times 4 \times \sqrt{f'_c} \times b \times d.$

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

$\phi V_{c/p} = 525.38$

Step# 10: Beam shear/ on way shear check.

$V_{u1} = q_{up} \times B \times [B/2 - c/2 - d].$

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

$V_{u1} = 90.95K$

Step # 11: Self Shear Capacity.

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

$$= 0.75 \times 2 \times \sqrt{4000} \times [11 \times 12 - 16]$$

$$= 110.04K > V_{U_1} \Rightarrow O.OK.$$

Step # 12: Ultimate Moment:

$$M_u = \frac{q_{up} \times B}{8} \times (B-C)^2$$

$$= \frac{2.5 \times 11}{8} \times \left(11 - \frac{16}{12}\right)^2$$

$$M_u = 331.49K' = 3977.93K''$$

Step # 13: Trial of steel for main bars by trial & Repeat method

Trial # 1: let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$$A_s = \frac{M_u}{\phi \times f_y \times \left(d - \frac{a}{2}\right)} = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{4.8}{2}\right)}$$

$$= 8.56 \text{ in}^2$$

Trial # 2:

$$a = \frac{A_s \times f_y}{0.85 \times 60 \times \left(11 - \frac{1.53}{2}\right)}$$

$$a = 7.197 \text{ in}^2$$

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Tial # 03:

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

$$As = \frac{3977.93}{0.90 \times 60 \left(11 - \frac{1.28}{2}\right)} = 7.1\ in^2$$

So That $A_{res} = 7.1\ in^2$.

Step # 14: Check the min reinforcement by the following 3 method.

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

$= 5.70\ in^2$

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

$= 8.58\ in^2$

ⓒ $As_{min} = \frac{3 \times \sqrt{f'c}}{fy} \times B \times d$

$= \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$

$= 7.05\ in^2$

From Above value greater value will be selected thus $As_{min} = 8.58\ in^2$

Step # 15: Using # 8 bar

$Ab = 0.785\ in^2$

No of bars $= \frac{As}{Ab} = \frac{8.58}{0.785} = 10.92 \simeq 11$ bars in each direction.