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Section :- "B"

Subject :- PRCD 1

Departement :- Civil Engineering

Semester :- "Six"

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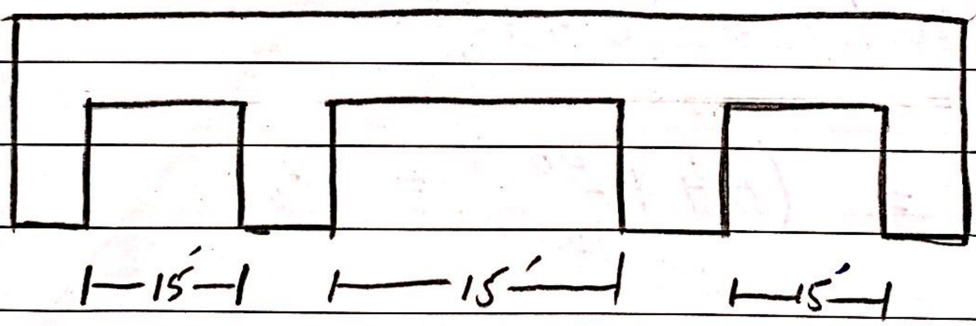
QNo1

Ans:-

Given Data:-

- => Clear Span b/w Supports = 15ft.
- => Factored live load = 160 lb/ft^2.
- => f'_c = 4000 Psi.
- => F_y = 40 ksi.
- => 3 equal spans Concrete Slab.
- => Service floor finish load = 20 lb/ft

Solution:-



Step #1

Minimum Thickness :—

By using formula

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

$$t_{min} = \simeq 6.5''$$

As $f_y \longrightarrow 40$ ksi
So we will multiply a factor with this thickness

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

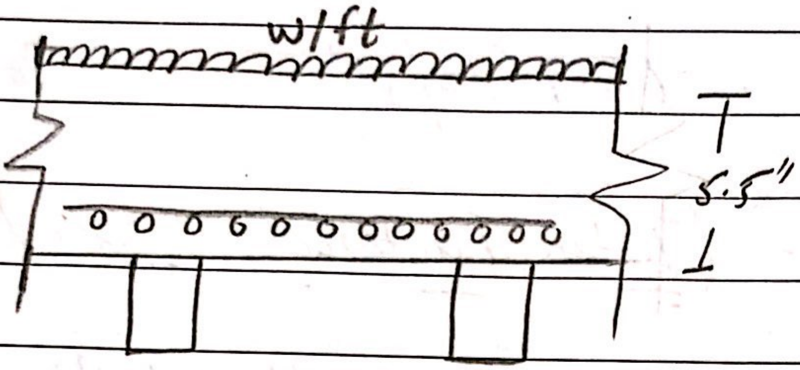
$$= \left(0.4 + \frac{40}{100}\right) = 0.8$$

$$\text{Factor} = 0.8$$

Hence the minimum thickness will be 6.5×0.8

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

Step # 2 :- (Effective Depth)



By formula

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

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

$d = \simeq 4.5''$

Step # 3 :- (Self wt of Slab) :-

By using Formula.

$\frac{t}{12} + \gamma_{concrete}$

$= \frac{5.5}{12} \times 150$

$= 68.75\ lb/ft^2$

Step # 04:- (Total Factored Load)

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

So the factored Dead load will be

$D.L = 1.2\,(20 + 68.75)$

$D.L = 106.5\ lb/ft^2$

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

$= 106.5 + 160$

$= 266.5\ lb/ft^2$

$= 0.2665\ K/ft^2$

Step # 5 (Ultimate Moment):-

By using Formula

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

$$\boxed{M_u = 89.94 \text{ Kip-inches}}$$

Step # 6:-

Area of Steel for Main Bars By Trail And Repeat Method:-

Trial # 01:-

Let depth of Compression block

$a = 0.2 \times L$

$a = 0.2 \times 5.5$

$a = 1.1''$

$$Ast = \frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{1.1}{2})}$$

Trial #02:-

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12}$$

$$\Rightarrow 0.62 in^2$$

$$AsT = \frac{Mu}{\phi \times fy \times (d - \frac{a}{2})} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.6}{2})}$$

$$AsT = 0.59 in^2$$

Trial # 3:-

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

As fy → 40 ksi

So we will multiply a factor with this thickness

$$Factor = \left(0.4 + \frac{fy}{100}\right)$$

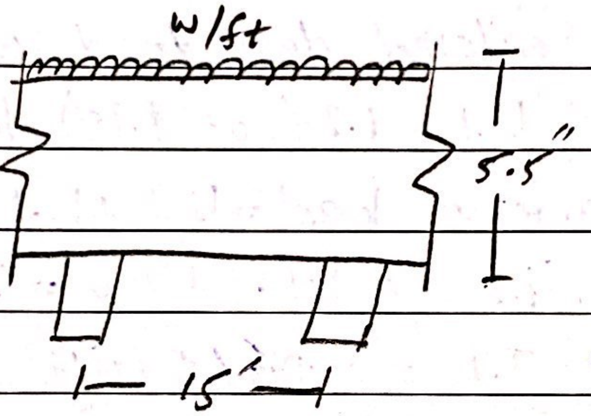
$= \left(0.4 + \frac{40}{100}\right) = 0.8$

Hence the minimum thickness will be 6.5×0.8

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

Step # 2 :-

Effective Depth :-



By Formula

$d = t - \text{Clear cover} - \frac{1}{2}(\text{dia of main bars})$

$= 5.5 - 0.75 - \frac{1}{2}\left(\frac{5}{8}\right)$

$d = 4.5''$

Step # 3 :- Self weigh 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

$T.L = 106.5 + 160 = 266.5 \ lb/ft^2$

$\cdot \ T.L = 0.2665 \ K/ft^2$

Step # 5 :-

Ultimate Moment :-

By using Formula

$M_u = \frac{W_u \times L^2}{8} = \frac{0.2665 \times (13)^2 \times 12}{8}$

$M_u = 89.94$ Kips - inches

$$A_{ST} = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{0.57}{2}\right)} = 0.59 in^2$$

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

Step # 06:-

Area of Steel for distribution reinforcement.

By Formula

$A_{min} = 0.002 \times b \times 2$ → (For Grade 40 steel)

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

Step 7:-

Spacing for main bar.

By Formula.

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

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

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

Step # 8 :-

Spacing for distribution bars.

$$\text{Spacing} = \frac{A_b}{A_{ST}}$$

we use #5 bars so

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

$$\text{Spacing} = \frac{0.31}{0.132} \times 12 = 2.81 \approx 28''$$

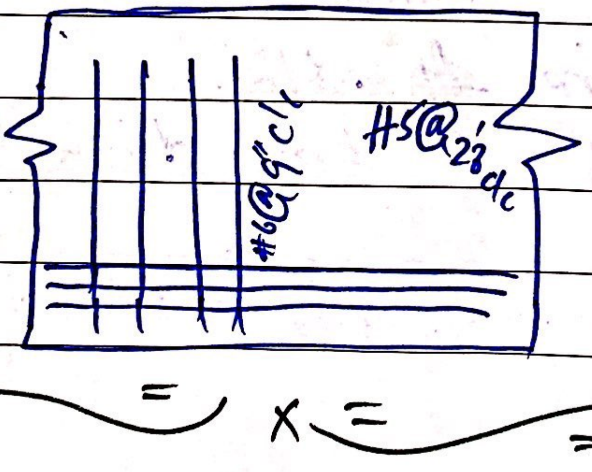
Step # 10 :-

Find Sketch.

$f'_c = 4 ksi$, $f_y = 40 ksi$

main steel # 6 at 9" c/c

Distribution steel # 5 at 28" c/c

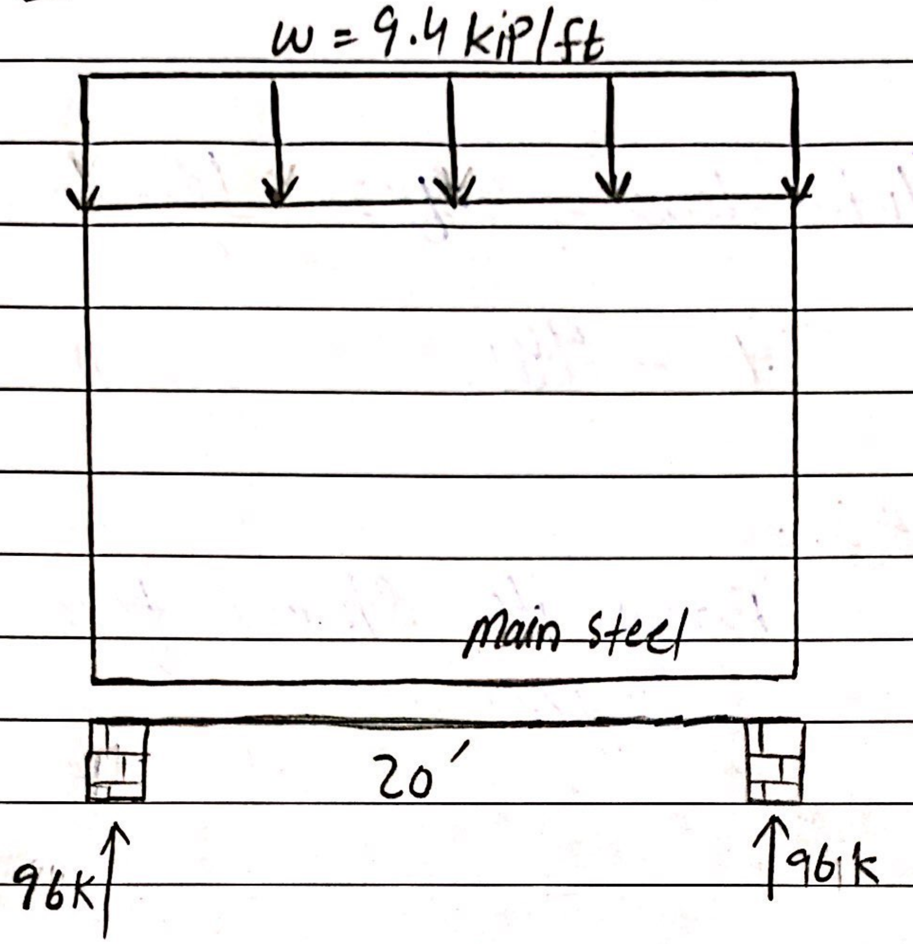


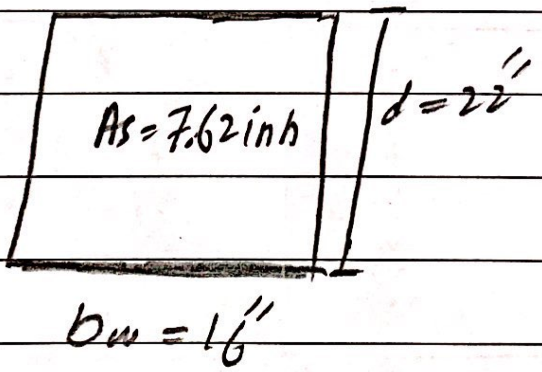
x = = x = = = X

Q No 2

Ans

Solution:-





Step #01

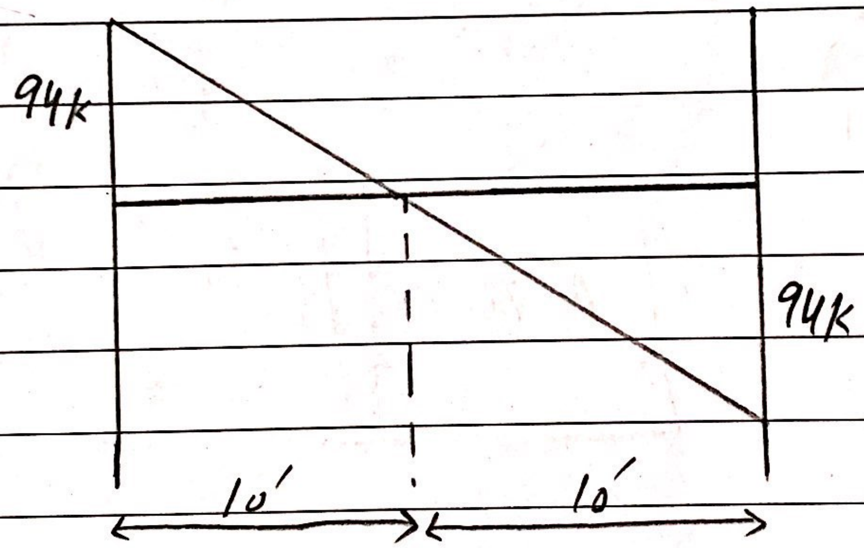
Find values of R_1 and R_2.

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

T.L = 96K

Step #2:

Draw its Shears force diagram.

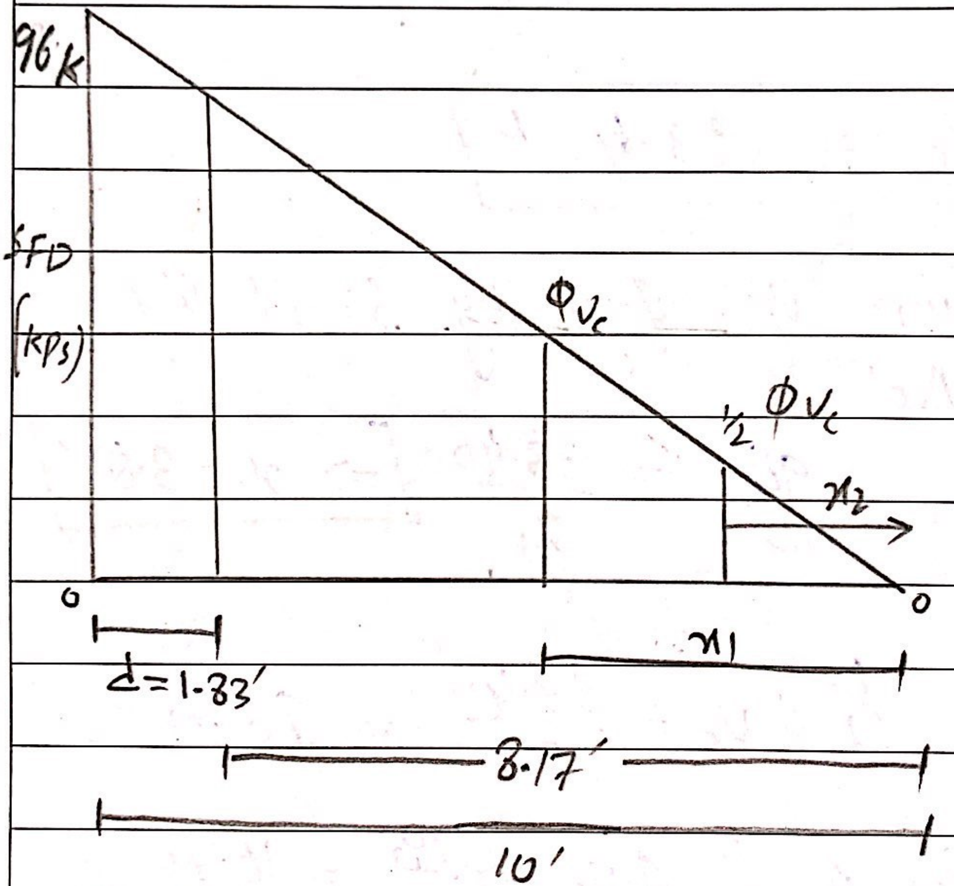


Step # 03:-

Find the value of Critical Shear "V_u" and its location.

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

value of Critical Shears at distance 'd' by Similarity of triangle



Step # 04:-

Find the value of 'ϕV_c' and ½ 'ϕV_c' and also its distance from zero shears to right side

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

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

$$\boxed{\phi V_c = 33.40\,k}$$

Location of ϕV_c by similarity of "Δs"

$$\frac{96}{10} = \frac{33.40}{x_3} \quad \boxed{\Rightarrow x_1 = 3.4'}$$

Now

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

Location of ½ $\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x_2}$

$x_r = 1.74'$

Step # 05:-

Value of ϕV_s

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

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

$\phi V_s = 45.03K$

Step # 06:-

Check on Section adequacy

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

$= 133.57K$

As

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

=> It means Section is adequate.

Step # 07:-

Check on Maximum Spacing for Stirrups

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

$$= 66.79 \text{ Kip}$$

As

$$\phi 4\sqrt{f_c'} \, b_w d > \phi V_s = 43.40K$$

So Max Spacing will be Selected from Following Four Conditions.

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

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

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

From above four conditions, Least value of spacing for # 3, 2 legged stirrup will be selected so $S_{max} = 11''$ c/c

Step # 08:-

Spacing of Stirrup from/at Critical section.

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

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

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QNo3

Ans:. Step # 01 :-

Find gross area of Concrete

Ag = bxb (Since it is square tied Column)

Ag = 12x12 = 144 in² (Actual).

Step # 02 :-

Find the area of Steel.

Since As = 5% of Ag

= 0.05x100

As = 7.2 in²

Step # 3 :-

Ultimate load Carrying capacity :-

$Pu = \phi \times 0.80 \times [0.85 \times f'c (Ag - As) + As + fy)$

$$P_u = 0.65 \times 0.80 \left[0.85 \times 4 \left[144 - 7.2 \times 60\right]\right]$$

$$\boxed{P_u = 466.50K}$$

Step # 4 :-

Sketch and design of Ties (c/c to distance) :-

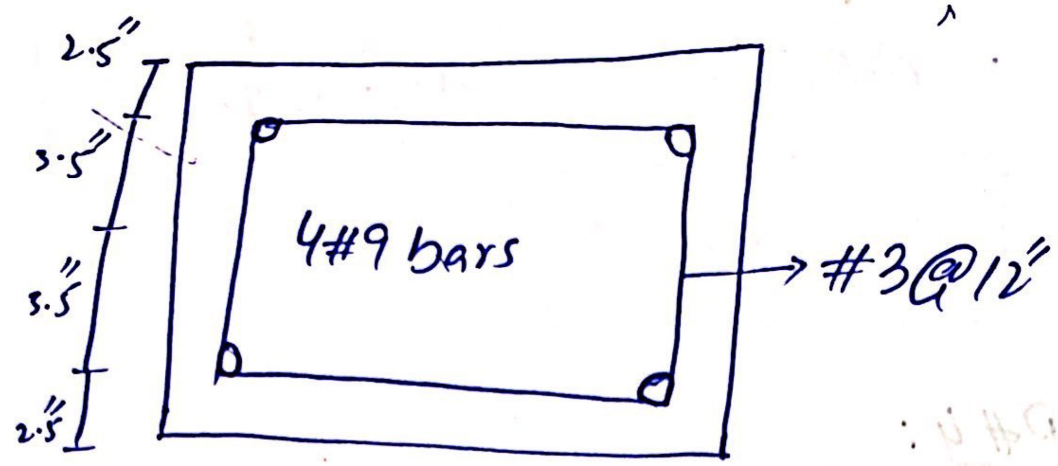
From the below value we choose the least value of all thus.

1) 16 × dia of long bar = 16 × 9/8
= 18″

2) 48 × dia of the bar = 48 × 3/8
= 18″

3) least Column dimension = 12″

So c/c distance b/w ties = 12″



* Since it is a tied Square Coloumn So there is no Spiral stirrup used. The stirrup used is of rectangular Shape due to the Specification of the Structure thus we will use tie stirrups instead.

Q No 04

Ans

Solution:-

Step # 1:- Let $h = 24''$

Step # 2:- Total weight = wt of soil + wt of Rc

$= 3 \times 120 + 2 \times 150 = 660$ Psf

$= 0.660$

Step # 03:- Effective bearing Capacity

$q_e = q_a - w = 2.50 - 0.660$

$q_e = 1.84$ ksf.

Step # 04:- Required Area of Foundation

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

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

Step #5:-

Since foundation is square

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

$B \Rightarrow 119' - 56''$

Step #06:-

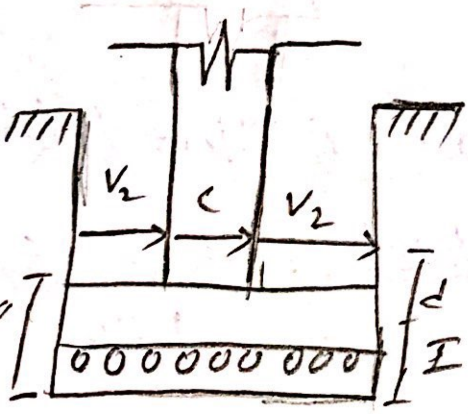
$$q_{up} = \frac{\text{factored load}}{(B)^2}$$

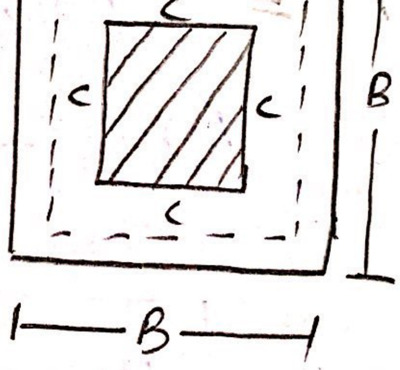
$$q_{up} = \frac{1.2 \times 100 + 1.6 \times 120}{(119.56)^2}$$

$$\boxed{q_{up} = 0.021\ k/ft^2}$$

Step #07:- Punching Shear

$b_o = 4 + (c + d)$





$d = h -$ clear cover $-$ 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 # 08:-

$$V_{v_2} = q_{vp} \times \left[B^2 - (c+d)^2 \right]$$

$$= 0.021 \left[(119.56)^2 - \left(\frac{16 + 19.5}{12} \right)^2 \right]$$

$$\boxed{V_{v_2} = 300}$$