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Section	A
Program	BE (civil)
Module	6th Semest Final
Paper	PRCD - I.
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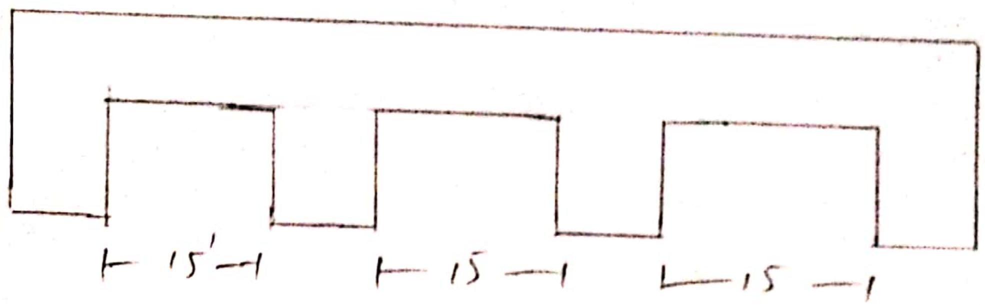
Question No 01.

Given data :-

- 3 equal Span Concrete Slab
- clear Span b/w Supports = 15 ft.
- Factored live load = 160 lb/ft^2
- Service floor finsh load = 20 lb/ft^2
- $f_c' = 4000$ psi
  $f_y = 40$ ksi

Sol :-



Step 01 (Minimum Thickness):-

By using formula

$$T_{min} = L/28 = 15/28 = 6.4 \simeq 6.5''$$

As $f_y \rightarrow 40$ ksi

So we will multiply a factor with this thickness

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

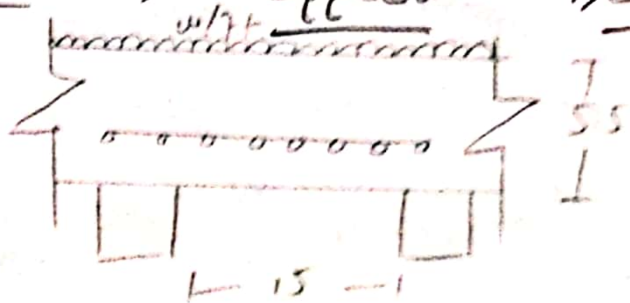
$$= \left(0.4 + \frac{40}{100}\right)$$

$$= 0.8$$

Hence the minimum thickness will be
6.5 x 0.8

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

Step 2 :-> Effective Depth :-



By formula

d = t - clear cover - ½ (dia of main bars)

= 5.5 - 0.75 - ½ (5/8)

$d \doteq 4.5''$

Step 3 :-> Self weight of Slab :-

By formula

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

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

Step 4 :- Total factored load :-

Factored live load = 160 lb/ft^2

So Dead load will be

D.L = 1.2 (20 + 68.75)

Total Factored load = D.L + L.L

= 106.5 + 160

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

Step 5:- Ultimate Moment :→

By using formula

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

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

Step 6 :- Area of Steel for Main Bars By Trial and Repeat Method :-

Trial 01 :- let depth of compression block

$$a = 0.2 \times t$$
$$= 0.2 \times 5.5$$
$$= 1.1''$$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - 1.1/2)}$$

$$\boxed{A_{st} = 0.63 \text{ in}^2}$$

Trial 2 :-

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

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

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - 0.6/2)}$$

$$\boxed{A_{st} = 0.59 \text{ in}^2}$$

Trial 03 :-

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

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

$$= 0.59 in^2$$

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

Step 07 :- Area of Steel for Distribution Reinforcement.

By formula

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

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

Step 08 :- Spacing for main bars :-

By formula

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

we use #6 bar dia $= (6/8)''$

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

Step 09 :→ Spacing for Distribution bars:-

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

we use #5 bars 80

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

$$\text{Spacing} = \frac{0.31}{0.132} \times 12 = 28.1'' \simeq 28''\ c/c$$

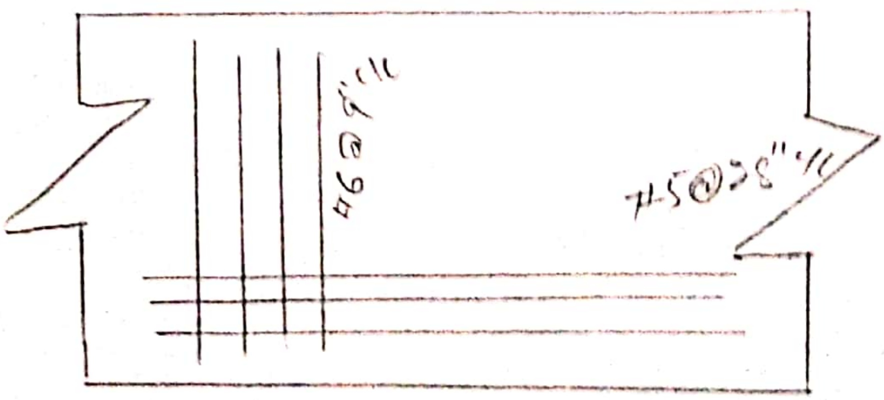
Step 10 :- Final sketch:-

$f_c' = 4\ ksi$

$f_y = 10\ ksi$

Main steel #6 at 9" c/c

Distribution Steel #5 at 28" c/c



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Question 02

A Simply Supported beam ......
.... Draw a Sketch
you Final Diagram.

Sol :→ First of all find the unit load of beam

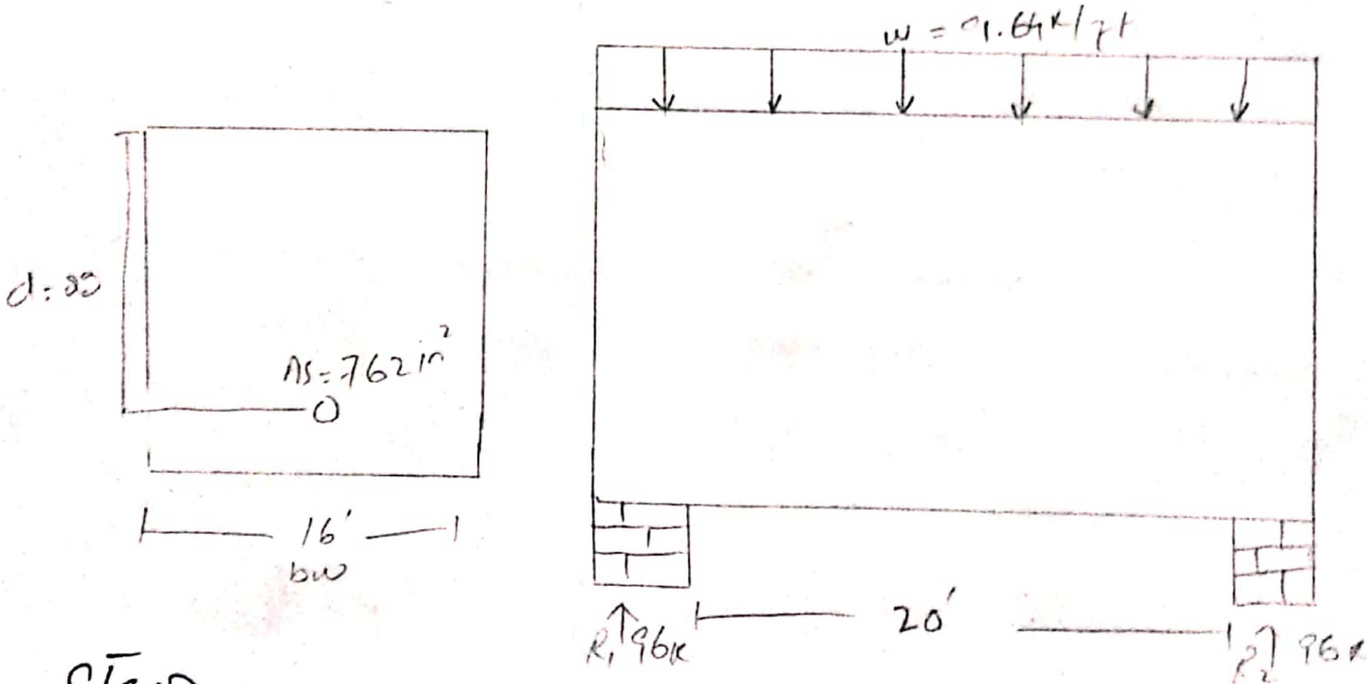
So b x rc

$= \frac{16}{12} \times 150 \Rightarrow 200\ lb/ft = 0.2\ K/ft$

$= 1.2 \times 0.2 = 0.24$

So total factored load $= 9.4 + 0.24$

$= 9.64 K/ft$



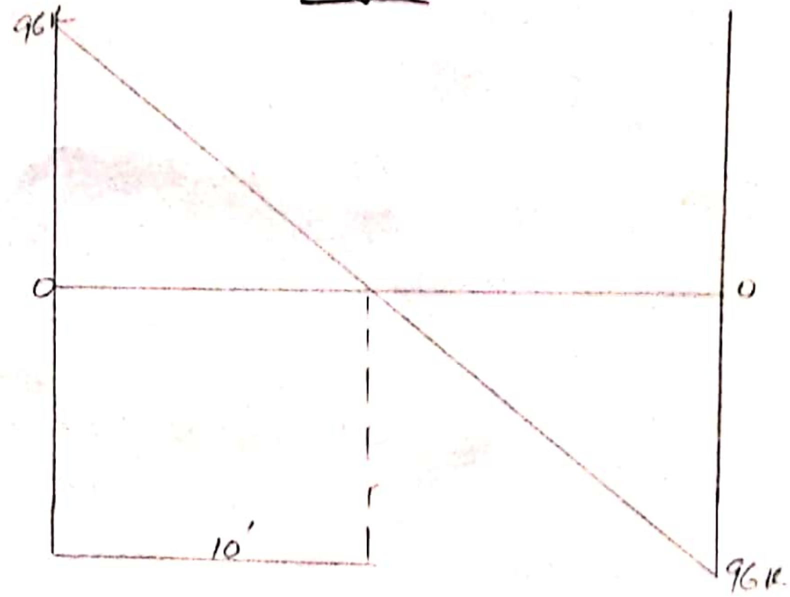
Step 01 :- Find the value of R_1 & R_2

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

$= 96K$

Step 02 :→ Draw its Shear Force Diagram:-

S.F.D (kips)

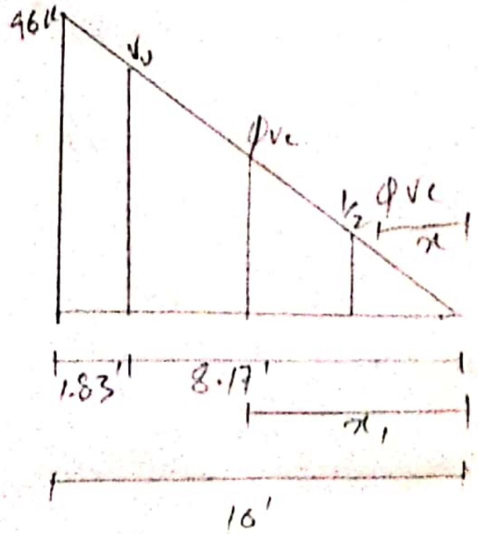


Step 03 :→

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

As we know that Critical Section is located at distance "d" from face of Support = 0.22" = 1.83'

So value of Critical Shear at distance "d" by similarity of triangles



From Similar Δ's

$$\frac{96}{10} = \frac{V_u}{8.17}$$

$$\boxed{V_u = 78.43K}$$

Step 04 :→ Find the value of "ϕV_c" & "$\frac{1}{2}\phi V_c$" & also its distance from zero shear to right side :-

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

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

location of ϕV_c by Similarity of Δ's

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

$$x_1 = 3.48'$$

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

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

$$\boxed{x_2 = 1.74'}$$

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

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

$\phi V_s = 78.43 - 33.40$

$$\boxed{\phi V_s = 45.03K}$$

Step 06 :→ Check on Section adequacy:-

↳ $\phi \times 8 \times \sqrt{f'_c} \times b_w \times d = \dfrac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 133.57K$

As $\phi \times 8\sqrt{f'_c} \times b_w \times d > \phi V_s$ ↳ It (means Section is adequate)

Step 07 :→

Check on min Spacing for Stirrups:-

$\phi \times 4 \times \sqrt{f'_c} \times b_w \times d = \dfrac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 66.79K$

As $\phi 4\sqrt{f'_c}\, b_w d > \phi V_s = 45.03K$

Thus max spacing will be Selected from the following factor condition

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

2) $d/2 = 22/2 = 11''$

3) $S_{max} = \frac{Av \times fy}{0.75 \times \sqrt{f'c} \times bw}$

$Av = \frac{\pi}{4}(\frac{3}{8})^2 = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16}$

$Av = 0.11 \times 12$

$Av = 0.22$

$S_{max} = 17.40''$

4) $S_{max} = \frac{Av \times fy}{50 \times bw}$

$= \frac{0.22 \times 60000}{50 \times 16}$

$= 16.50$

From the above four condition least value of spacing from #3 U shaped will be selected so,

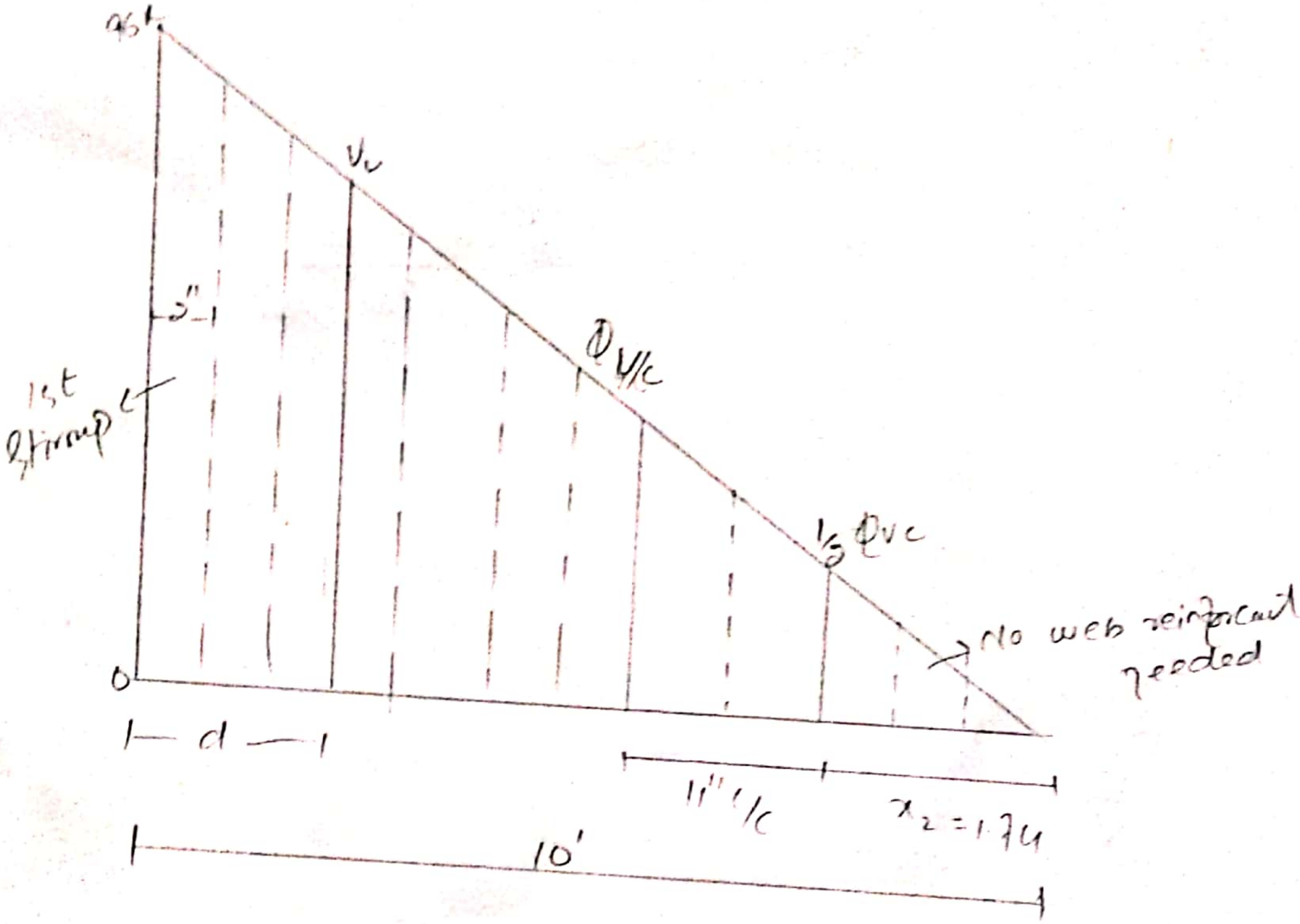
$S_{max} = 11'' c/c$

<u>Step 08</u> :→ Spacing of Stirrup from/at critical section.

$S = \frac{\phi \times Av \times fy \times d}{Vu - \phi Vc} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$

$= 4.834'' \cong 5''\ c/c$

Step 9 :- Final Sketch



Question 3

Calculate the axial ..... Design neccessary Spirals.

Ans:→

Step 01 :– Finding gross areas of Concrete :→

$Ag = b \times b$ (Since it is square tied column)

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

Step 2 :–

Find the area of Steel :→

Since $As = 5\%$ of Ag

$= 0.05 \times 144$

$As = 7.2\ in^2$

Step 03 :– Ultimate load Carrying capacity :–

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

$= 0.65 \times 0.80 [0.85 \times 4 \{144 . 7.2) + 7.2 \times 60]$

$Pu = 466.50\ K$

Step 04:- Sketch & Design of Ties (c/c To Distance)

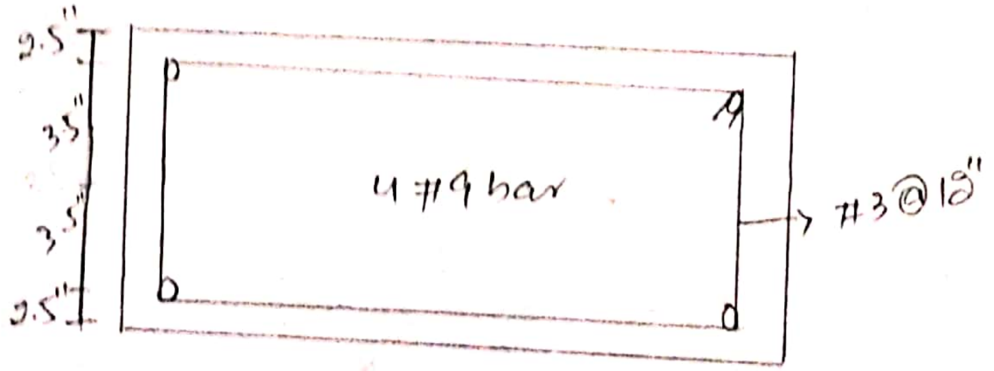
From the below value we choose the least value of all thus.

1) 16 x dia of long bar = 16 x 9/8

2) 48 x dia of Tie bar = 48 x 3/8

= 18"

3) least column dimension = 12"



Since it is a Tied Squar column 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.

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Question 04

Design a Squar footing..... Sketch of your final Design.

Ans:→ **Step 01 :-**

let $h = 24''$

Step 02:-

Total weight = wt of soil + wt of RS

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

$= 660$ psf $= 0.660$ ksf

Step 04:- Required Area of foundation :-

$$\text{Area} = \frac{\text{Servise load}}{q_e} = \frac{100 + 120}{1.84}$$

$$\boxed{\text{Area} = 119.57 \text{ ft}^2}$$

Step 05 :- Since foundation is Squar

Area $= b \times b = 119.57 \Rightarrow B$

So $B \cong 11'$

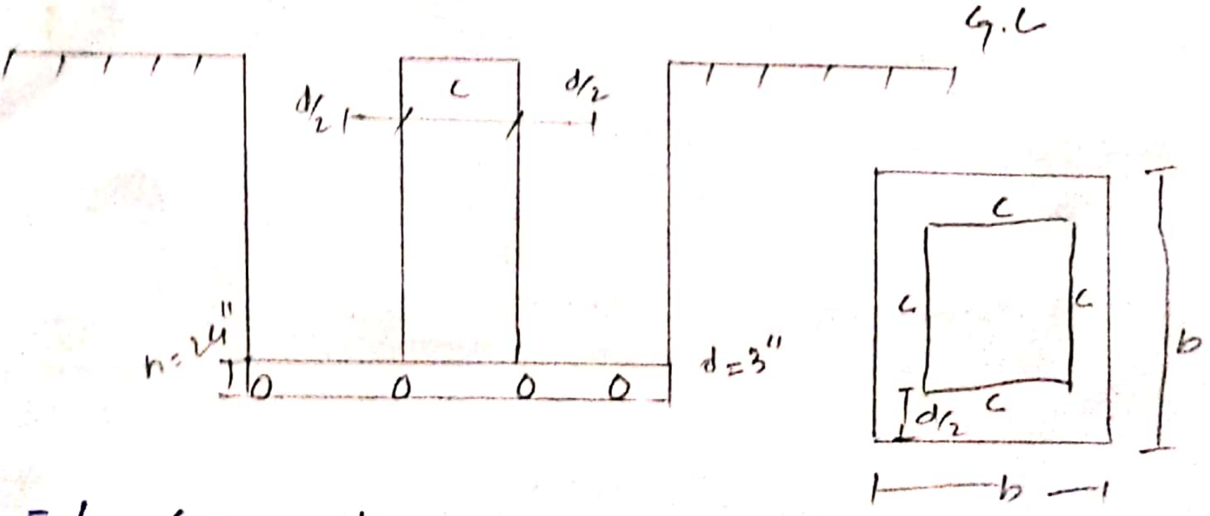
Step 06 :→ upward bearing capacity of Soil :→

$$q_{up} = \frac{\text{Factored load}}{(B)^2} = \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$$

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

Step 07 :→ Punching Shear :-

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



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

(Take #8 bar dia = 1")

$$d = 24 - 3 - 1 - \tfrac{1}{2}(1)$$

$$d = 19.5"$$

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

$$= 142"$$

Step 08 :→

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

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

$$V_{v_2} = 289.60 K$$

Step 09 :-

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

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

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

Step 10 :- Beam Shear/one way shear check :-

$$V_{v_1} = q_{up} \times B \times [B/2 - c/2 - d]$$

$$V_{u_1} = 2.58 \times 11 \times [11/2 - \frac{16/12}{2} - 19.5]$$

$$\boxed{V_{u_1} = 90.95 K}$$

Step 11 :- Self Shear capacity :-

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

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

$= 110.04K > V_{u_1} \Rightarrow O.K$

Step 12 :- Ultimate moment :-

$M_u = \frac{q_{up} \times B}{8} \times (B-C)^2 = \frac{2.55 \times 11}{8} \times \left(\frac{11-16}{12}\right)^2$

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

Step 13 :- The Area of the Steel for main bar by Trial & Repeat method

Trial 01 :-

let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

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

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

Trial 02 :-

$a = \frac{A_s \times f_y}{0.8 \times f'_c \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times 11 \times 12}$

$a = 1.53$

$A_s = \frac{3977.9}{0.9 \times 60 \times (11 - \frac{1.53}{2})} \Rightarrow A_s = 7.197 \text{ in}^2$

Scanned with CamScanner

Trial 03 :→

$$a = \frac{7.19 \times 60}{0.85 \times 3 \times 11 \times 12} = 1.28$$

$$A_s = \frac{3977.9}{0.90 \times 60 \left(11 - \frac{1.28}{2}\right)}$$

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

So area is $7.1 \ in^2$

Step 14:- Checking the min reinforcement by the following three method:-

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

$$\boxed{A_{s_{min}} = 5.70 \ in^2}$$

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

$$\boxed{A_{s_{min}} = 8.58 \ in^2}$$

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

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

$A_{s_{min}} = 7.05 \ in^2$

from above value greater will be selected so $\boxed{A_{s_{min}} = 8.58 \ in^2}$

Step 15:—

using # bars

$A_{bar} = 0.785 \ in^2$

$$\text{No. of bars} = \frac{A_s}{A_b} = \frac{8.58}{0.785}$$

$$= 10.92 \simeq 11 \text{ bars}$$

So 11 bars in each direction.