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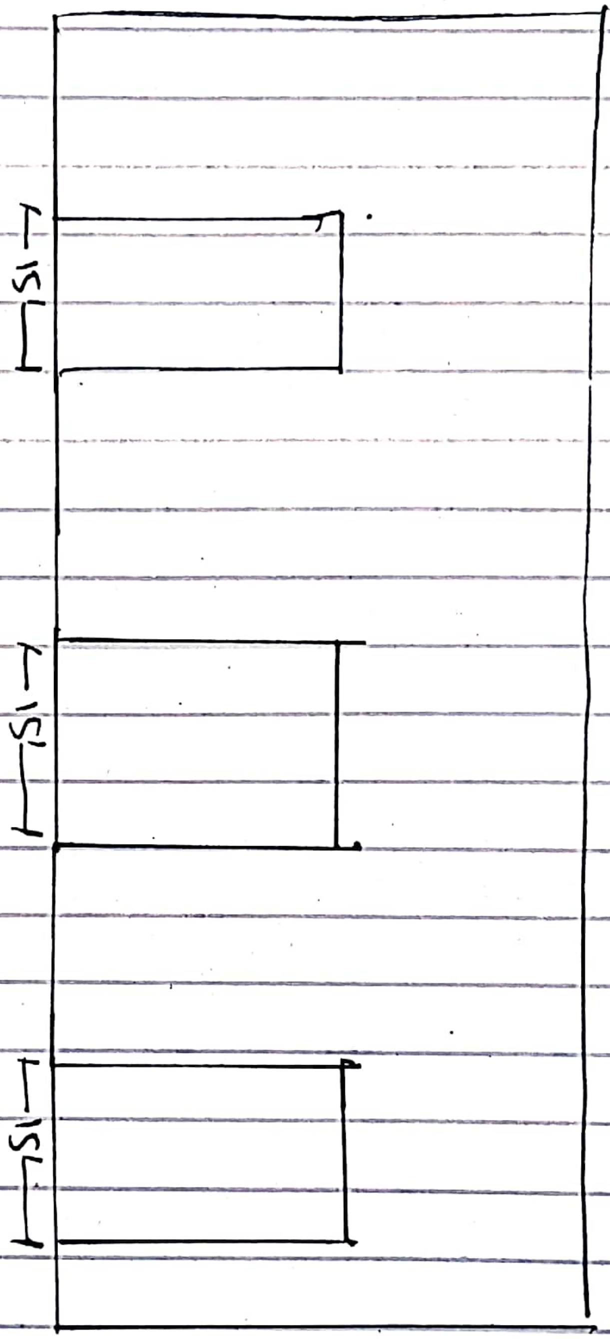
7530

PRCD-1

Final Exam.

Sol



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Step 1 :-

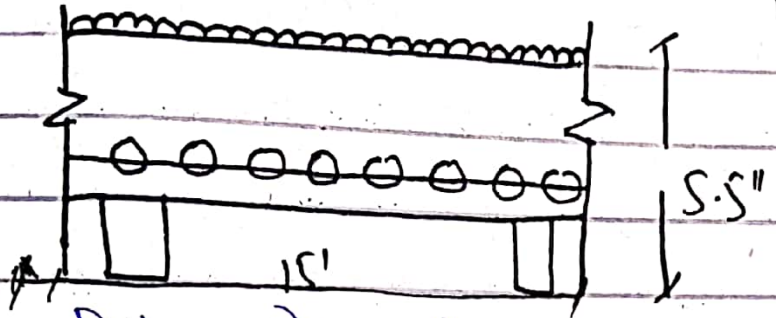
Minimum thickness = $T_{min} = 15/28 = 6.5$

6.5×0.8

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

$\because$ Factor = $(0.4 \times \frac{40}{100}) = 0.8$

Step 2 Effective depth



By formula

$d =$ t − clear cover − 1/2 (dia of mainbar)

$d = 5.5 - 0.75 - 1/2(5/8)$

$d = 4.5''$

Step 3

Self wt of beam

$= t/12 \times \gamma_c$

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

Step 4 "Total fractured load"

Fractured L·L = 160 lb/ft²

D·L = 1·2(20+68·75) = 106·5 lb/ft²

Total Fractured load = D·L + L·L

= 106·5 + 160

= 266·5 lb/ft²

= 0·265 k/ft²

Step 5 Ultimate moment

$$M_u = \frac{w_u \times L^2}{8} = \frac{0.266 \times 15^2 \times 12}{8}$$

$M_u = 89.94$ kip-inch

Step 6

Ast for Main bars

Trial 1

let $a = 0.2 \times t$

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

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

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

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Trial 2

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

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

$$A_{st} = \frac{89.94}{0.90 \times 40 \times (4.5 - 0.62/2)} = 0.59 \text{ in}^2$$

Trial 3

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

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

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

Step 7:-

Ast for Distribution Reinforcement

$A_{min} = 0.02 \times b \times t \rightarrow$ (For Grade 40 steel)

$= 0.132 \text{ in}^2$

Step 8

spacing for main bars

$$\text{Spacing} = \frac{A_b}{A_{st}} \times 12$$

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

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

$$\text{Spacing} = \frac{0.442}{0.59} \times 12 = 8.98'' \approx 9''$$

Step 9

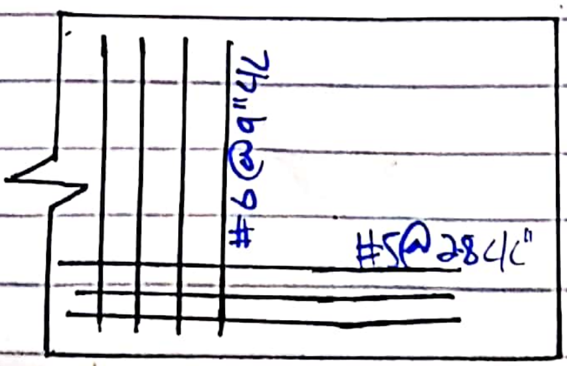
Spacing for Distribution bars

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

using #5 bar , $A_b = \frac{3.14}{4} \times \left(\frac{5}{8}\right)^2 = 0.31 in^2$

$$\text{Spacing} = \frac{0.31}{0.132} \times 12 = 2.8'' \, c/c$$

Step 10 Sketch



$f_c' = 4ksi$
$f_y = 40ksi$
Main steel #6 at 9" c/c
Dist bars #5 at 2.8" c/c

Q21:- A simply --- final diagram.

sol

Step 1

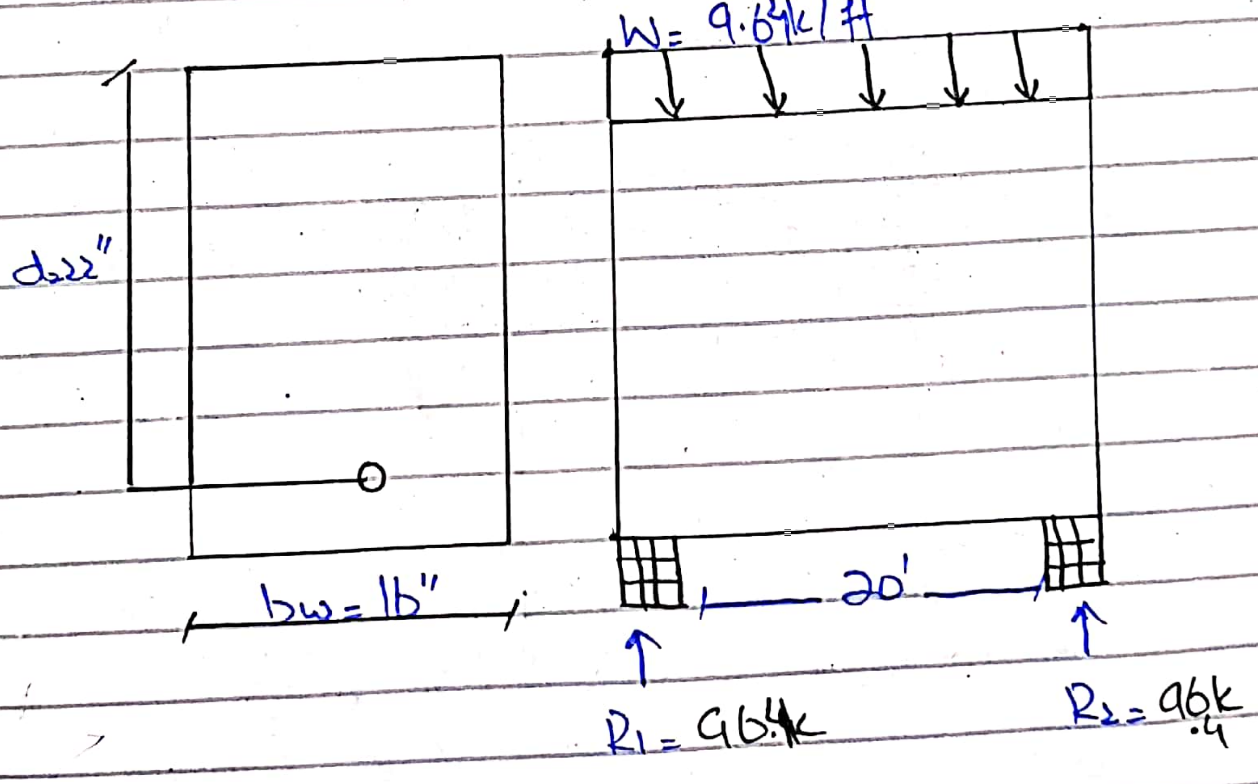
Finding unit load of beam so

$b \times \gamma_c = \frac{16}{12} \times 150 = 200 \frac{lb}{ft} = 0.2 \frac{k}{ft}$

Now $1.2 \times 0.2 = 0.24$

Total fractured load $= 9.4 + 0.24$

$= 9.64 k/ft$

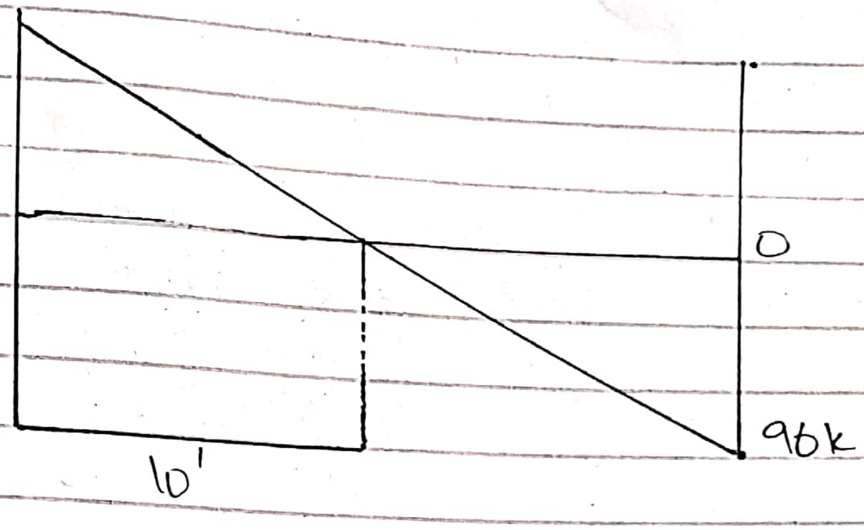


Step 2:-

Finding R_1 & R_2

Total load $= 9.64 \times \frac{20}{2} = 96.4k$

Step 3 :- S.F.D



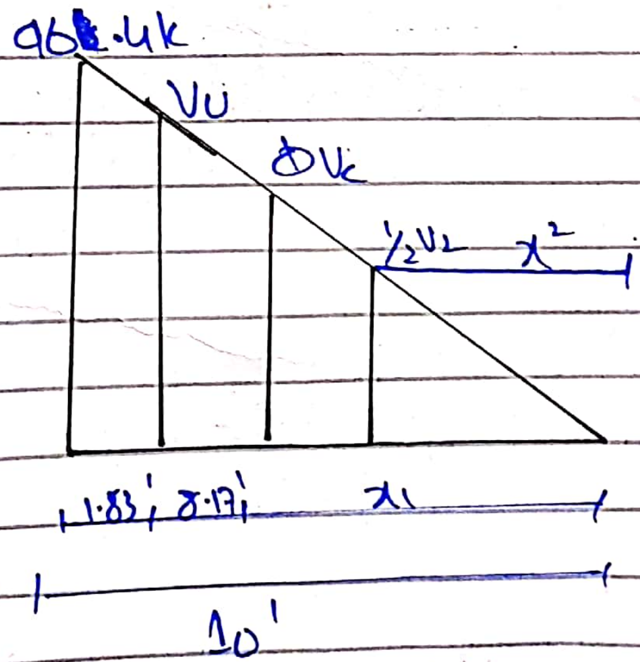
Step 4

Finding V_u & its location

we know critical section is located at distance from support

$d = 22' = 1.83'$

By Similarity triangles.



From Similar triangle Δ's

$$\frac{96.4}{10} = \frac{V_u}{8.17}$$

$V_u = 78.43\ k$

Step 5

Finding ϕV_c, $\frac{1}{2}\phi V_c$

Also its distance from zero to shear to right side.

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

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

$$\phi V_c = 33.40\ k$$

Location of ϕV_c by similarity of Δ's

$$\frac{96.4}{10} = \frac{33.40}{x_1}$$

$$x_1 = 3.48'$$

Now

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

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

$$x_2 = 1.74'$$

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Step 6

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

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

$\phi V_s = 78.43 - 33.40 = 45.03\,k$

Step 7

Check on section odequway

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

$= 133.57\,k$

As $\phi \times 8\sqrt{f_c'} \times b_w \times d > \phi V_s$

Section is adequate

Step 8

Min spacing for Stirups

$\phi \times 4 \times \sqrt{f_c'} \times b_w \times d = \dfrac{0.75 \times 4 \times \sqrt{1000} \times 16 \times 22}{1000} = 66.79\,k$

As $\phi \times 4 \times \sqrt{f_c'}\, b_w d > \phi V_s = 45.03\,k$

Thus max spacing will be selected from the following condition

1) $S_{max} = 24''$
2) $d/2 = 22/2 = 11''$
3) $S_{max} = A_v \times f_y / 0.75 \times \sqrt{f_c'} \times b_w$

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$$3) \; A_v = \frac{\pi}{4}\left(\frac{3}{8}\right)^2 = \frac{0.22 \times 60{,}000}{0.75 \times \sqrt{4000} \times 16}$$

$$= 17.40$$

$A_v = 0.11 \times 2$
$= 0.22$

4) $S_{max} = A_v \times f_y / 50 \times b_w$

$$= 0.22 \times 60{,}000 / 50 \times 16$$
$$= 16.50$$

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

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

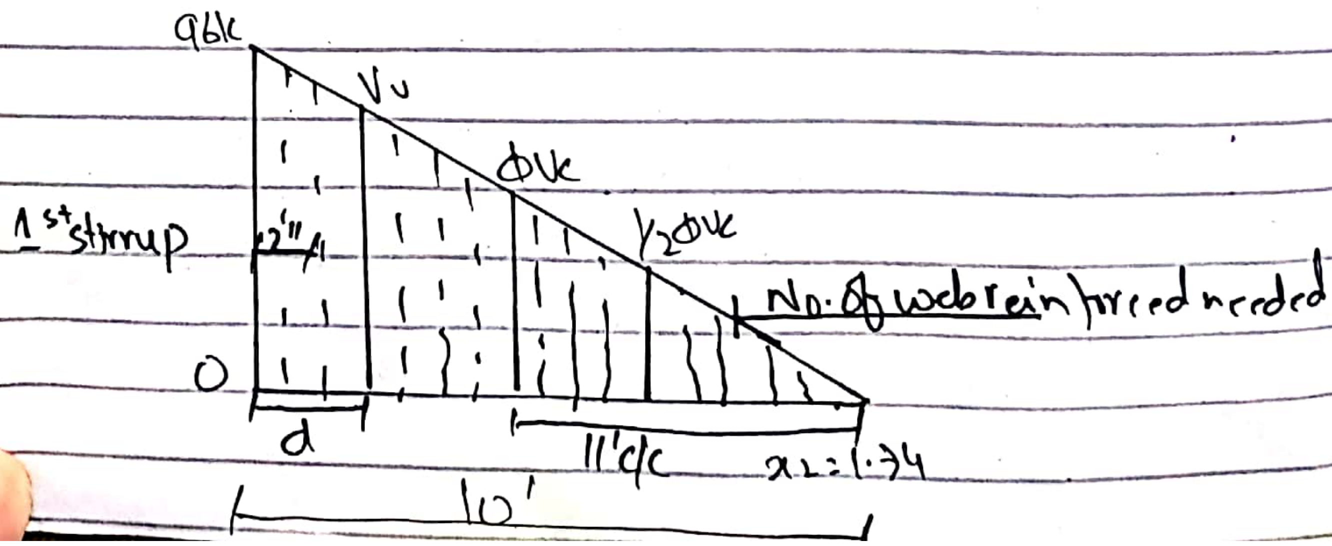
Step 9

spacing of Stirrup

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

$$S = 4.84'' \simeq 5'' \; c/c$$

Step 10 "Sketch"



As we know that first stirrup from face of support $= 5/2 = 2.5 \simeq 2''$

Q.3

Q.3) Answer to Q.3

sol

Step 1

Finding Ag of concrete

$Ag = b \times b$ (since it is square tied coloum)

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

Step 2

Finding Ast

Since $As = 5\%$ of Ag

$= 0.05 \times 144$

$As = 7.2 in^2$

Step 3

Ultimate load carrying capacity

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

$$= 0.65 \times 0.80 \times [.85 \times 4(144 - 7.2) + 7.2 \times 60]$$

$Pu = 466.50 k$

Step 4

Sketch & design of Ties

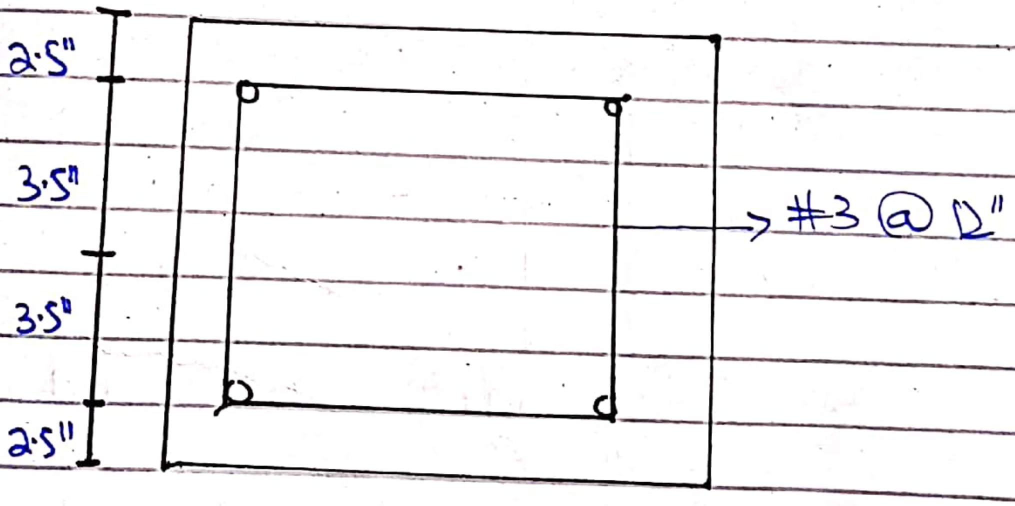
From below values we will choose least value.

1) $16 \times$ dia of long bar $= 16 \times \frac{9}{8} = 18''$

2) $48 \times$ dia of Tie bar $= 48 \times \frac{3}{8} = 18''$

3) Least coloum dimension $= 12''$

So c/c distance b/w ties $= 12''$



Since it is a tied square coloum so there is no spiral stirups used, the stirups use are rectangular shape due to the specification of the structures. Thus we will use tie stirups instead.

Q.4

Q.4 Answer to Q.4

A.4

Step 1

Let $h = 24''$

Step 2

Effective Bearing Capacity

$q_e = q_a - w$

$= 2.50 - 0.660$

$q_e = 1.84$ ksf

Step 3

Required Area for foundation

Area = Service load / q_e

$= \frac{100+120}{1.84} = 119.57\ ft^2$

Step 3 Total weight = wt of soil + wt of R.C

Total weight = $3 \times 120 + 2 \times 150 = 660$ psf

660 psf = 0.660 ksf

Step 4

Foundation is square

$Area = b \times b = 119.57$

$B \approx 11'$

Step 5

Upward bearing capacity of soil

$q_{up} = \text{Factored load} / B^2$

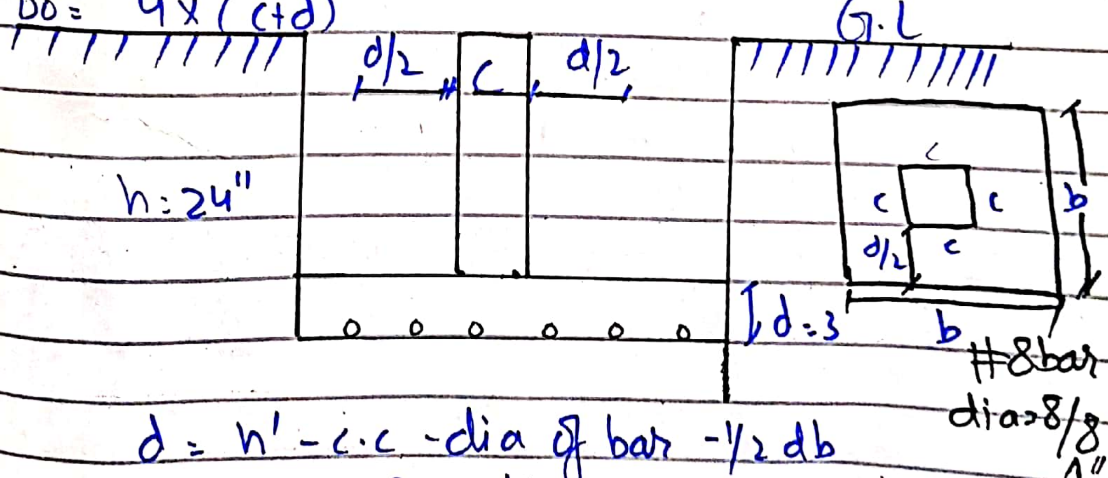
$= (1.2 \times 100) + (1.6 \times 120) / 11^2$

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

Step 6

Punching Shear

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



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

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

$b_o = 4 \times (16 + 9.5) = 142"$

Step 7

$$V_{U_2} = q_{up} \times [B^2 - (c+d)^2]$$

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

$$V_{U_2} = 289.60k$$

Step 8

$$\phi V_{up} = \phi \times 4\sqrt{f_c'} \times b_o \times d$$

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

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

Step 9

Beam Shear / 1way shear check

$$V_{U_1} = q_{up} \times B \times [B/2 - c/2 - d]$$

$$V_{U_1} = 2.58 \times 11 \times \left[11/2 - \frac{16/12}{2} - \frac{19.5}{12}\right]$$

$$V_{U_1} = 90.95k$$

Step 10

Sel7 Shear capacity

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

$$= 0.75 \times 2 \times \sqrt{4000} \times 11 \times 12.16 / 1000$$

$$= 110.04k > V_{U_1} \Rightarrow ok$$

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Step 11

Ultimate Moment

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

$$= \frac{2.58 \times 11}{8} \times \left(11 - \frac{16}{12}\right)^2$$

$$Mu = 331.49k' = 3977.3k''$$

Step 12

Ast for Member by Trials

Trial $\underline{1}$

(c) $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$$As = \frac{Mu}{\phi \times fy \times (d - a/2)} \quad \cancel{\frac{3977.93}{0.85 \times 3 \times 11 \times 12}}$$

$$As = \frac{3977.93}{0.9 \times 60(11 - 4.8/2)} = 8.56 in^2$$

Trial $\underline{2}$

$$a = \frac{As \times fy}{0.85 \times fc \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times (11 \times 12)} = 1.53''$$

$$As = \frac{3977.93}{0.90 \times 60 \times (11 - 1.53/2)} = 7.197 in^2$$

Trial 3

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

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

So Area = $7.1\ in^2$

Step 13

Checking min Reinforced by following Method.

(i) $As_{min} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$
$= 5.70\ in^2$

(ii) $As_{min} = \frac{3 \times \sqrt{Fc'} \times B \times d}{fy} = \frac{3 \times \sqrt{3000} \times (11 \times 12) \times 19.5}{60,000}$

$= 7.05\ in^2$

Greater value will be selected for
$As_{min} = 8.58\ in^2$

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Step 14

No. of bars

using #8 bar

$A_b = 0.785 \text{ in}^2$

$$\text{No. of bars} = \frac{A_s}{A_b} = \frac{8.58}{0.785} = 10.92$$

$10.92 \simeq 11$ bars in each direction.