ID 7786

Section · A

Given:-

Factored live load = 160 lb/ft^2

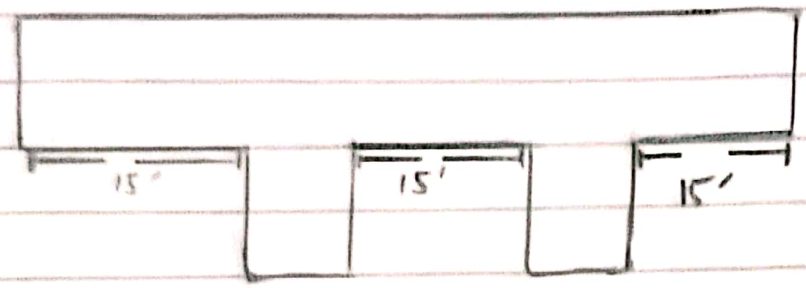
Service floor finish load = 20 lb/ft^2

Clear span b/w support = 15 ft

$f'c$ = 4000 Psi

fy = 40 ksi

Formula + Solution:-



Minimum thickness:-

As we know that for over hanging slab we L/28 so,

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

$t_{min} = 6.5''$

As the Fy is no 60 ksi so factor will be multiplied

$\text{Factor} = \left(0.4 + Fy/100\right) \Rightarrow \left(0.4 + \frac{40}{100}\right)$

Factor = 0.8

Minimum thickness will be 6.5 x 0.8

t_{min} = 5.2 or 5.5"

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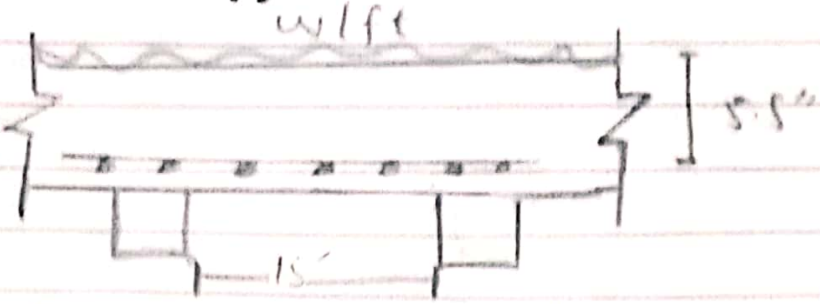
Step 2 :- effective depth :-



As we know that

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

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

$d \cong 4.5''$

Step 3 :- Slab's self weight :-

$\Rightarrow \frac{t}{12} + \gamma_c$

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

$= 68.75 \ lb/ft^2$

Step 4 :- T. Factored load.

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

Factored dead load $= 1.2(20 + 68.75)$

$= 106.5 \ lb/ft^2$

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

$= 106.5 + 160$

$= 266.5 \ lb/ft^2$

$= 0.2665 \ k/ft^2$

Step 5 Ultimate momentum :-

By Using formula

$Mu = \frac{W_u \times L^2}{8} = \frac{0.2665 \times 15^2}{8} \times 12$

$= 89.94$ kip-inches

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Section A

Step 6:- Area of steel for main bar by Trial and Repeat method.

Trial 1:-

Let depth of compression blow is

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

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

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

Trial 2:-

$a = \frac{A_{st} \times fy}{0.85 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} = 0.62 in^2$

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

$A_{st} = 0.59 in^2$

Trial 3:-

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

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

$0.59 in^2$ will be used.

Step 7:-

Area of steel for distribation Reinforcement

By formula

$A_{min} = 0.002 \times b \times t$

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

Step 8:-

Spacing for main bars:

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section A

By formula

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

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

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

Step # 9 spacing for distribution bars.

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

We use # 5 bars So

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

Spacing $\frac{0.31}{0.132} \times 12 = 2.81'' \equiv$

Step 10:-

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

Main steel # 6 at 9" c/c

Distribution steel # 5 at 28" c/c

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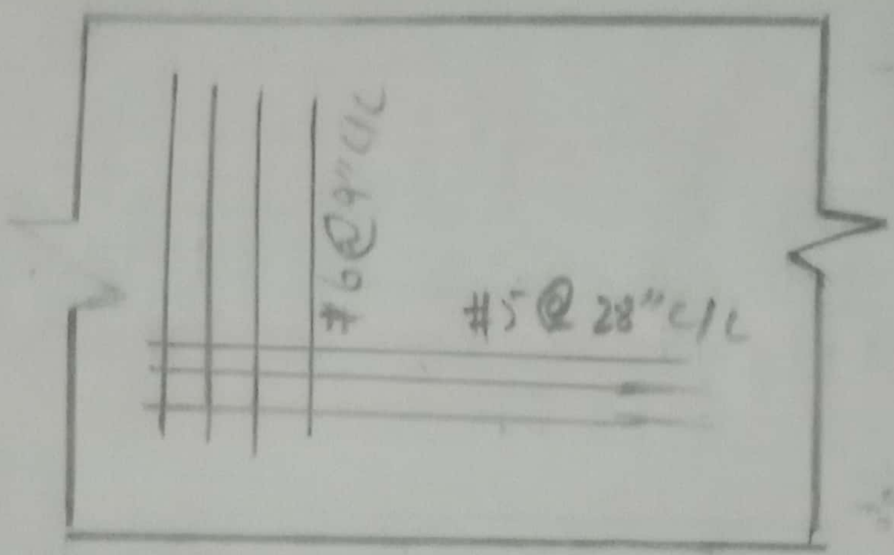

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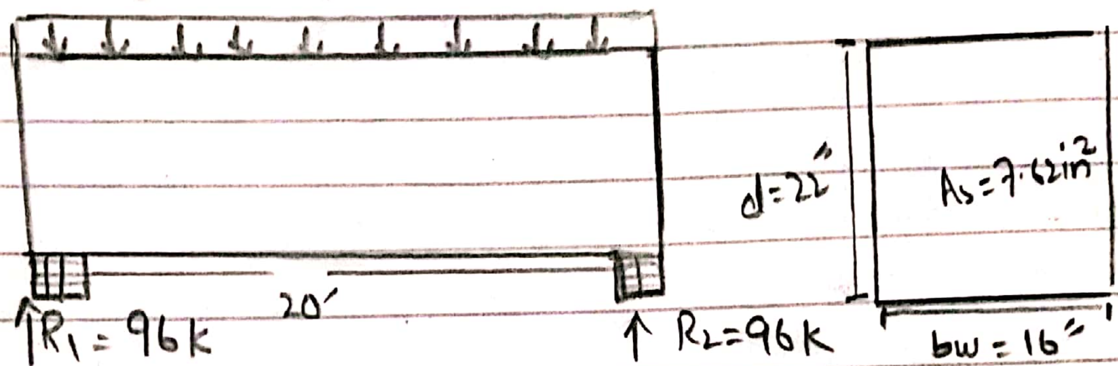
Section A

Q2 **A simply.... ?**

Unit load of Beam:- $\frac{16}{12} \times 150 = 200\,lb/ft$ or $0.2\,k/ft$

So total factored load $= 9.4 + 0.2$
$= 9.6\ k/ft$

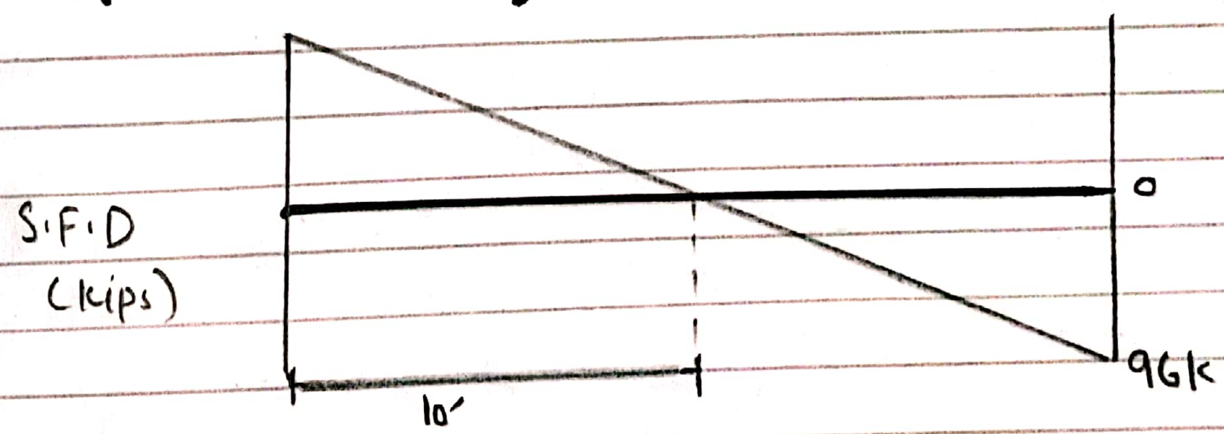


Step 1:-

Values of R_1 & R_2 = ?

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

Step 2:- Shear force diagram



Step 3:-

Value of critical Stresses & location

As we know that critical section is located at section or distance "d" from face of support.

$d = 22'' \Rightarrow 1.83'$

Value of critical shear at distance "d"

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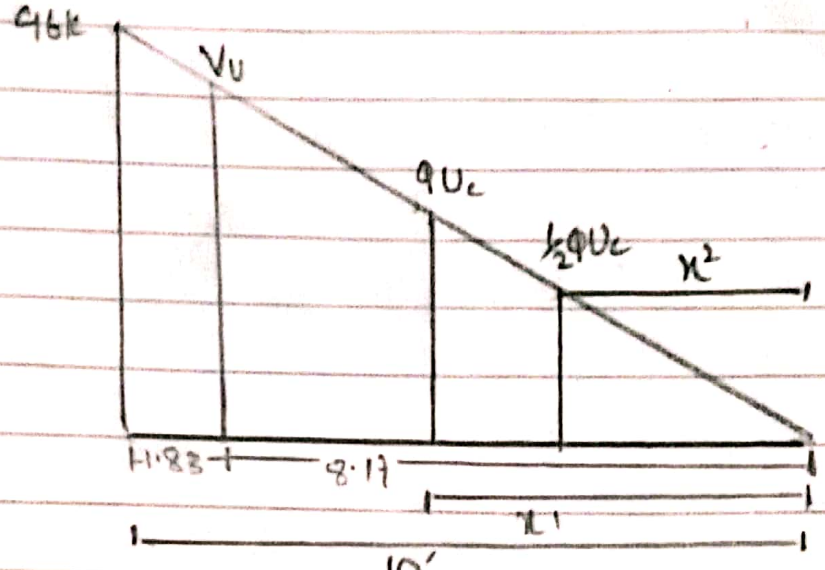
Section A

by similarity of triangles



from Similar triangle = $96/10 = Vu/8.17$

$Vu = 78.43$ k

Step 4:- find value of φVc & ½φVc

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

$\phi V_c = 0.75 \times 2 \times \sqrt{4000} \times 6 \times 16 \times 2 / 1000$

$\phi V_c = 33.40$ k

location of φVc by similarity of Δs

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

$x_1 = 3.48'$

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

location of ½ φVc => $96/10 = 16.70/x_2$

$x_2 = 1.74'$

Step #5 Value of φVs

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

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03$ k

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Section A

Step 6:- Check out Section adequacy :-

$\phi \times 8 \times \sqrt{f_c'}\ b_w \times d \Rightarrow$

$\Rightarrow 0.75 \times 8 \times \sqrt{4000} \times 16 \times 22/1000$

$= 133.57k$

As $\phi \times 8 \sqrt{f_c'} \times b_w \times d > \phi V_s$ (Section is adequate)

Step 7 :- 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 $\phi 4 \sqrt{f_c'}\ b_w d > \phi V_s = 45.03k$

Max spacing will be selected from

i) $S_{max} = 24''$ ii) $d/2 = 22/2 = 11''$

3) $S_{max} = \dfrac{A_v \times f_y}{0.75 \times \sqrt{f_c'}\ b_w} \Rightarrow \dfrac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16} = 17.40''$

$\therefore A_v = \dfrac{\pi}{4}\left(\dfrac{3}{8}\right)^2 \Rightarrow 0.11 \times 2 \Rightarrow 0.22$

4) $S_{max} = A_v \times f_y / 50 \times b_w = \dfrac{0.22 \times 6000}{50 \times 16} = 16.50$

$S_{max} = 11''$ C/C $\therefore$ (least value of spacing for 3, U shaped)

Step 8 :-

Spacing of Stirrup from / at critical Section:-

$S = \dfrac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c}$

$= \dfrac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$

$= 48.4''$ or $5''$ C/C.

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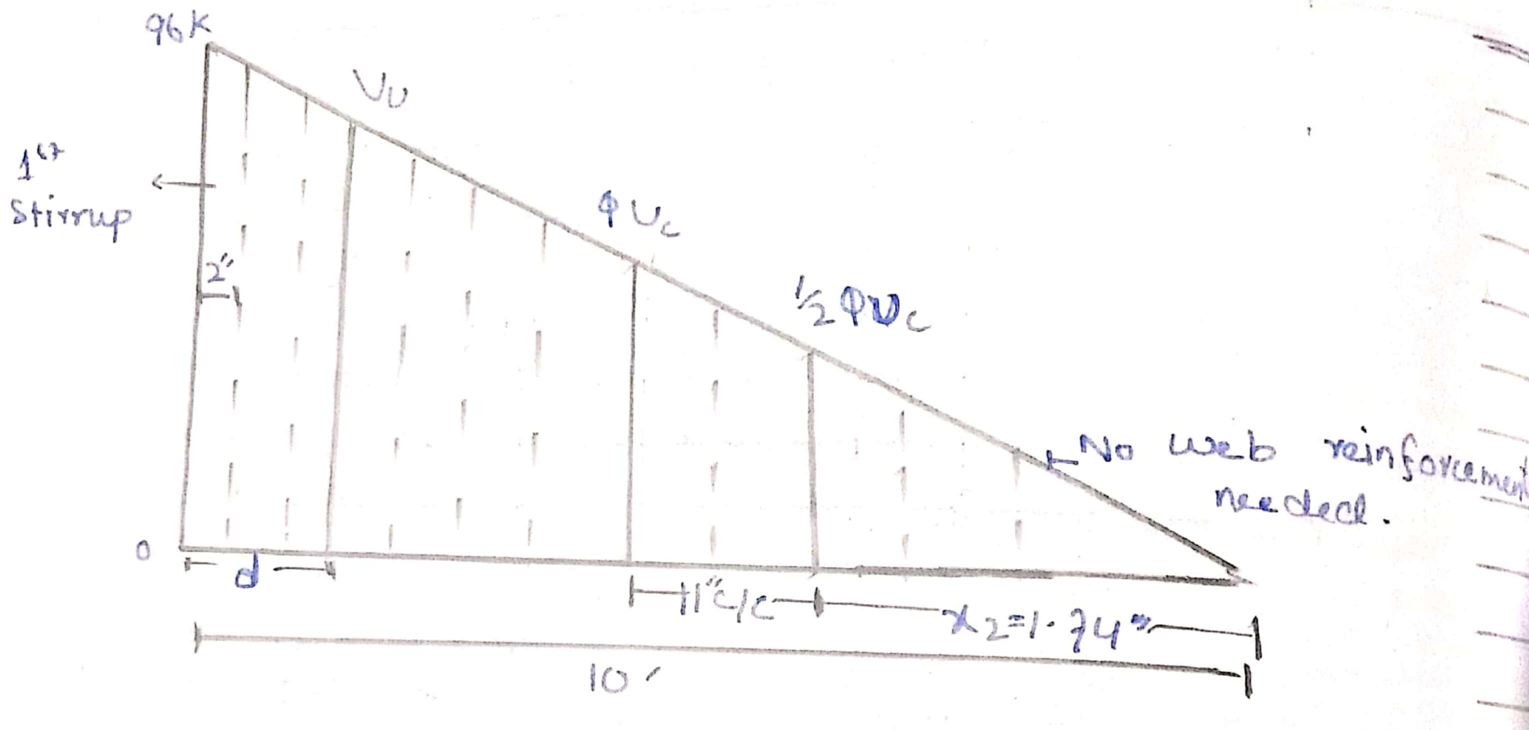

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Q3 **Step 1:-**

Gross area of concrette:-

$Ag = b \times b$ (square tied column)

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

Step 2:-

Area of steel

Since $As = 5\%$ of Ag

$= 0.05 \times 100$

$Ag = 7.2 \; in^2$

Step 3:-

Ultimate load carrying capacity

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

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

$Pu = 466.40 \; K$

Step 4:- from the below value we choose the least value of all thue

1) 16 x dia of long bar = 16 x 9/8 = 18"

2) 48 x dia of tie bar = 48 x 3/8 = 18"

3) least column dimension = 12" = C/C d b/w ties 12"

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

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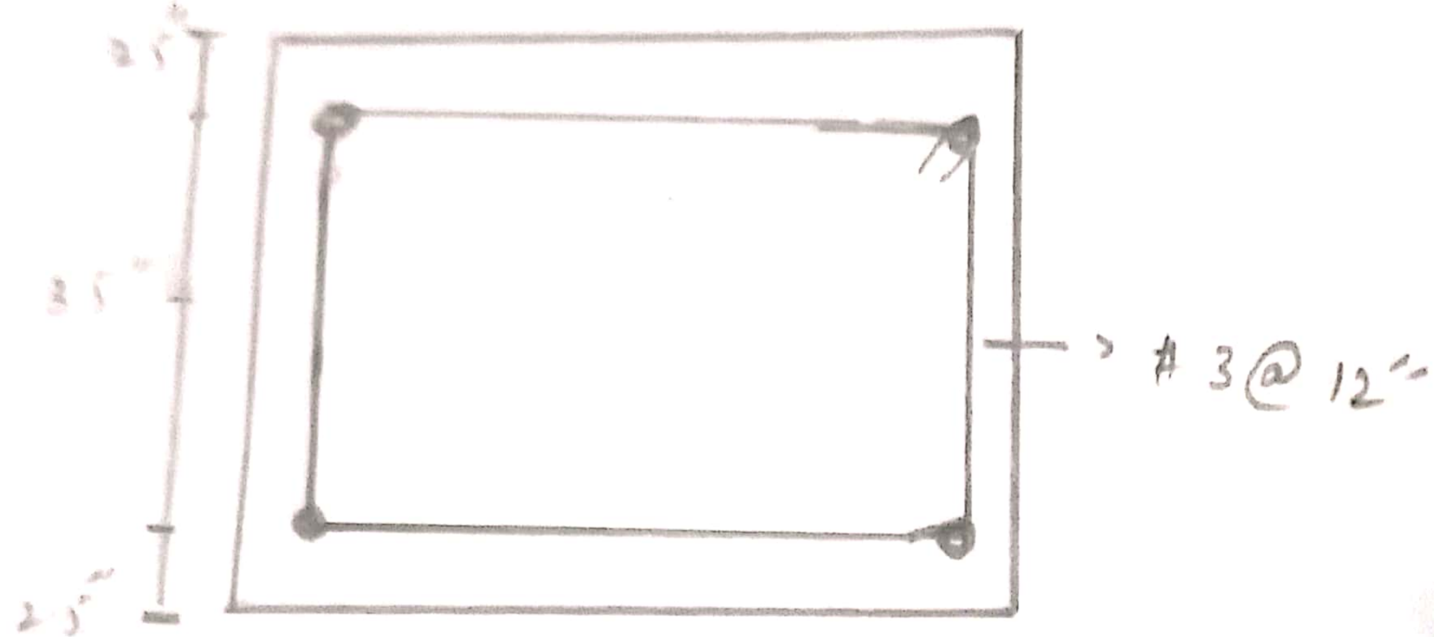

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Sec A

Q4 Design a square - - - ?

Step 1:-

$h = 24''$

Step 2:-

Total weight = wt of soil + wt of Rc

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

Total wt $= 660$ Psf $= 0.660$ ksf.

Step 3:-

effective bearing capacity, $q_e = q_a - w$

$q_e = 2.50 - 0.660$

$q_e = 1.84$ ksf

Step 4:-

Required area for foundation

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

$A_{req} = 119.57 \ ft^2$

Step 5:-

Since foundation is square $A_{req} = b \times b$

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

Step 6:-

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

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

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

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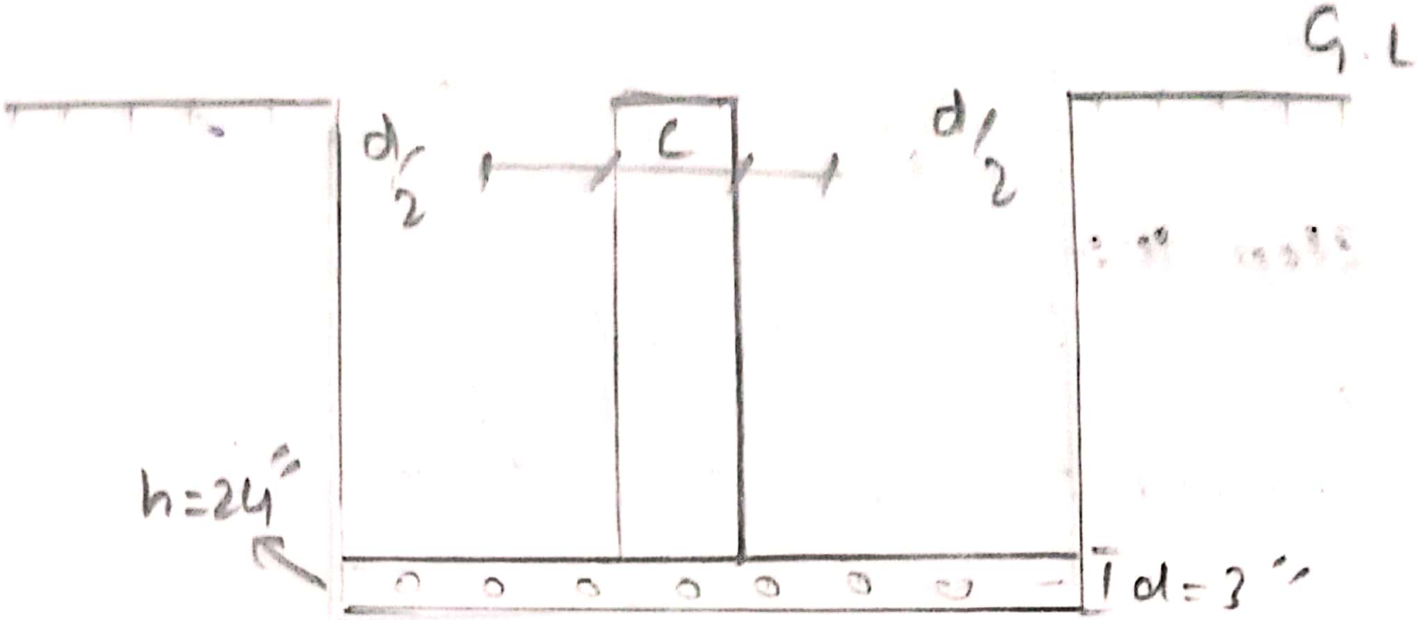

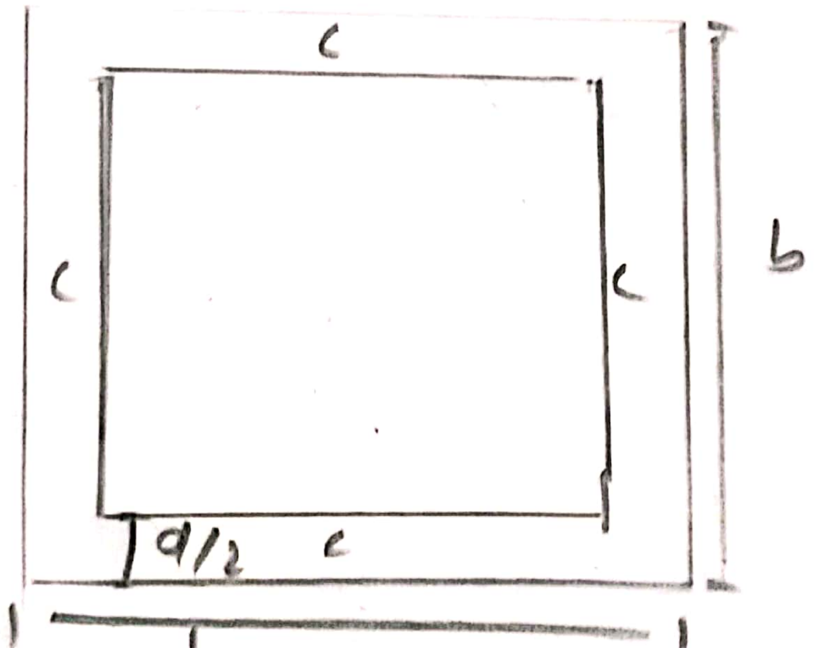

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$d = 24 - 3 - 1 - \frac{1}{2}(1) = 19.5''$

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

Step 8:-

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

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

$V_{u2} = 289.60k$

Step 9:-

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

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

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

Step 10:-

Beam shear / one way shear check

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

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

$V_{u1} = 90.95k$

Step 11:-

Self shear capacity

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

$= \frac{0.75 \times 2 \times \sqrt{4000}\ [11 \times 12 \cdot 16]}{1000}$

$= 110.04k > V_{u1} \Rightarrow$ ok.

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Sec A

Ultimate momentum:-

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

$M_u = 331.49\,k' \simeq 3977.93\,k$

Step 13:- Area steel for main bars

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

$A_s = M_u / \phi \times f_y \times (d - a/2) = 3977.93 / 0.90\times 60 = 8.56\,in$

Trial 2 $a = \frac{A_s \times f_y}{0.85\times f_c' \times b} = \frac{8.56\times 60}{0.85\times 3\times 11\times 12} = 1.53''$

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

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

$A_s = \frac{3977.93}{0.90\times 60 (11 - \frac{1.28}{2})} = 7.1\,in^2$ this will be used

Step 14:- $A_{s\,min} = 0.0018\times B\times h = 0.0018\times (11\times 12)\times 24$

$= 5.70\,in^2$

b) $A_{s\,min} = \frac{200}{f_y} \times B\times h = \frac{200}{6000} \times 11\times 12\times 19.5$

$= 8.58\,in^2$

c) $A_{s\,min} = \frac{3\times \sqrt{f_c'} \times B\times d}{f_y} = \frac{3\times \sqrt{3000}\,(11\times 12)19.}{60000}$

$= 7.05\,in^2$

from the above greater value

8.58 will be used

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Step 15:-

Using 8# bar

$A_b = 0.785$ in

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

11 bars in each directions

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