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Dept	Be (civil) 6th Semester
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Subject	PRCD-1
Paper	Final term
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Q.No#1:-

Ans:-

Given Data:-

3 equal Span Concrete Slab

Clear Span b/w Supports = 15ft

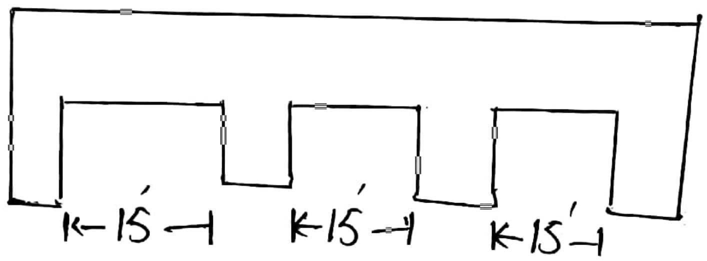
Factored live load = 160 lb/ft²

Service Floor Finish load = 20 lb/ft²

$f'c = 4000\,psi$

$fy = 40\,ksi$

Solution:-



Step No #1:- Minimum Thickness

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

As $Fy \rightarrow 40\,ksi$

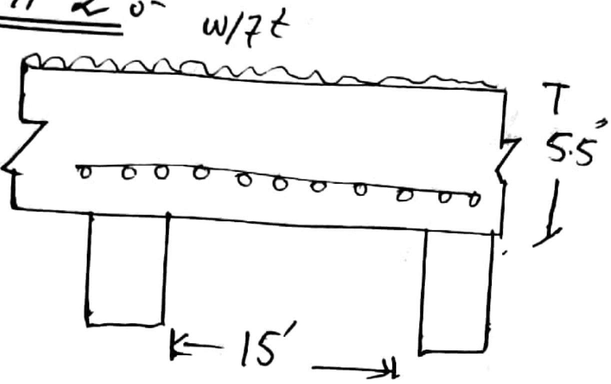
So we will multiply a factor with this thickness

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

The minimum Thickness will be 6.5×0.8

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

Step No# 2:-



Formula

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

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

$d = 4.5''$

Step No 3:- Self wt. of slab

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

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

Step No# 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 = $D.L + L.L \Rightarrow 106.5 + 160$

$= 266.5 \ lb/ft^2$

$= 0.265 K/ft^2$

Step #5:- Ultimate Moment:-

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

$$= 88.94 \text{ Kip-inches}$$

Step #6:- Area of steel for Main Bars By Trail and repeat method:.

Trail # 01:-

Let depth of compression block

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

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{88.94}{0.90 \times 40 \times (4.5 - \frac{1.1}{2})} = 0.632 in^2$$

$A_{st} = 0.59 in^2$

Trail NO #2:-

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{0.632 \times 40}{0.85 \times 4 \times 12} = 0.57''$$

$a = 0.57'$

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Step # 7:-

Area of steel distribution reinforced

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

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

Step NO # 8:- Spacing for main bars

Spacing $\frac{A_o}{A_{st}} \times 12$ use #6 bar dia $= \left(6/8\right)''$

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

Step NO # 9:- Spacing for distribution Bar

$Spacing = \frac{A_B}{A_{st}} =$ We use #5 bars

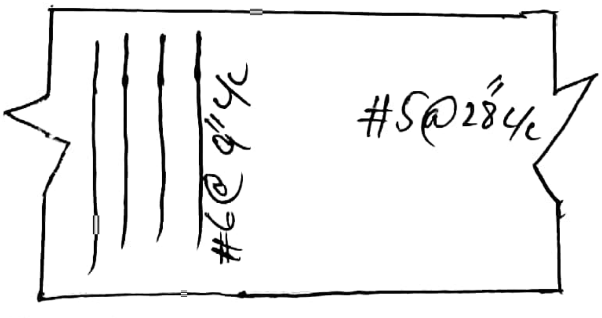
$dia = \left(5/8\right)''$ $Area = \frac{\pi}{4}\left(5/8\right)^2 = 0.31\ in^2$

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

Step NO # 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



Q. NO# 2

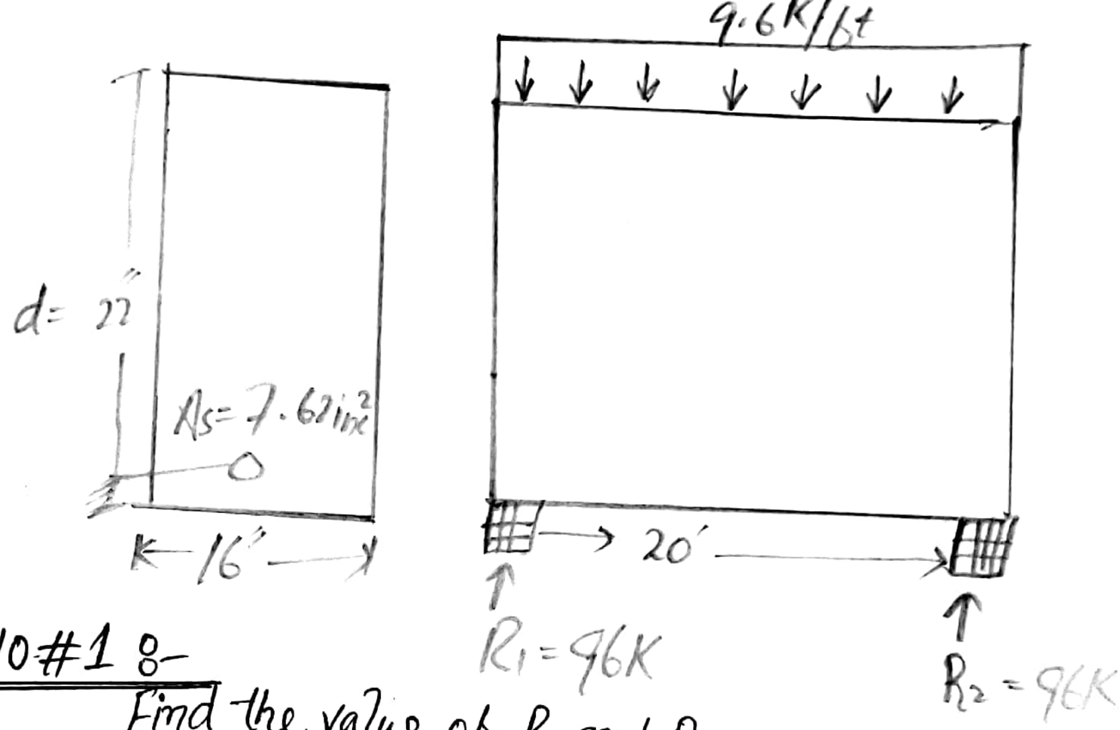
Ans:-

Solution:- Find the Unit load of beam:-

So $b \times h \times \gamma_c$

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

Total Factored load:- $9.4 + 0.2 = 9.6K/ft$

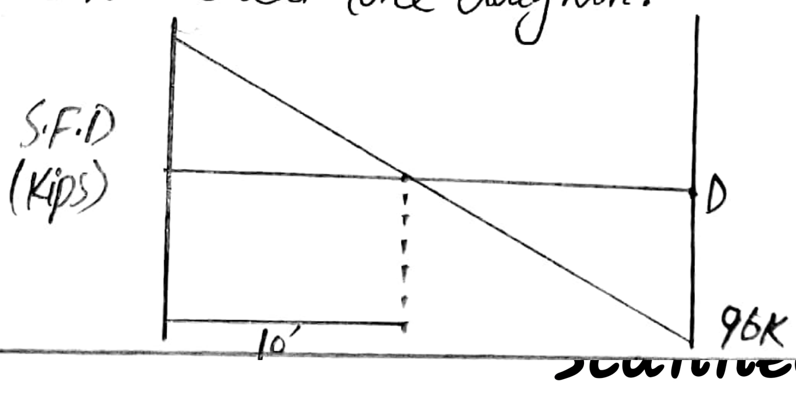


Step NO#1:-

Find the value of R_1 and R_2

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

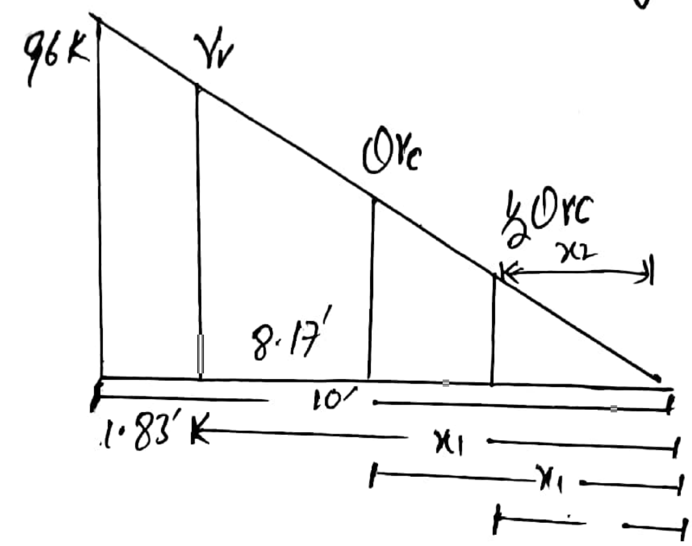
Step NO#2:- Draw Shear force daigram:-



Location:-

As we know the Critical Section is located at distence "d" from face of support = a = 22" = 1.83' (unit conversion).

Value of Critical Shear at distence "d" by Similarity of traingless.



From Similar Δ's $\frac{96}{10} = \frac{V_u}{8.17}$ ⇒ 78.432 Kips

Step No #4:- Find the value of (ØVc) and ½ ØVc and also its distences from zero Shear to raight side

$\phi V_c = \phi \times 2 * \sqrt{f'c} \times b_w \times d = \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000}$ = 33.40K

Location of ØVc by Similarity of Δ's

$\frac{96}{10} = \frac{33.40}{x_1} = 3.47'$ $x_1 = 3.47'$

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

location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x_2} \Rightarrow x_2 = 1.73'$

Step NO#5:-

value of ϕV_s $\quad (V_u = \phi V_s + \phi V_c)$

$\phi V_s = V_u - \phi V_c = 76.80 - 33.40 \Rightarrow 43.40K$

Step NO#6:-

Check on Section adequency

$\phi * 8 * \sqrt{f'_c} \times b_w \times d = \frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000} = 133.57\ K$

As $\phi V_s < \phi 8 \sqrt{f'_c}\, b_w d \Rightarrow$ It means Section is adequate.

Step No#7:-

Check on maximum Spacing For Striups

$\phi \times 4 \times \sqrt{f'_c} \times b_w \times d \Rightarrow \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000} = 66.79\ Kip$

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) $\frac{d}{2} = \frac{22}{2} \Rightarrow 11''$

3) $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'_c} \times b_w} = 17.40''$

4) $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = 16.50''$

From above four condition, lest value of spacing for #3, 2 legged Stirrup will be Salected

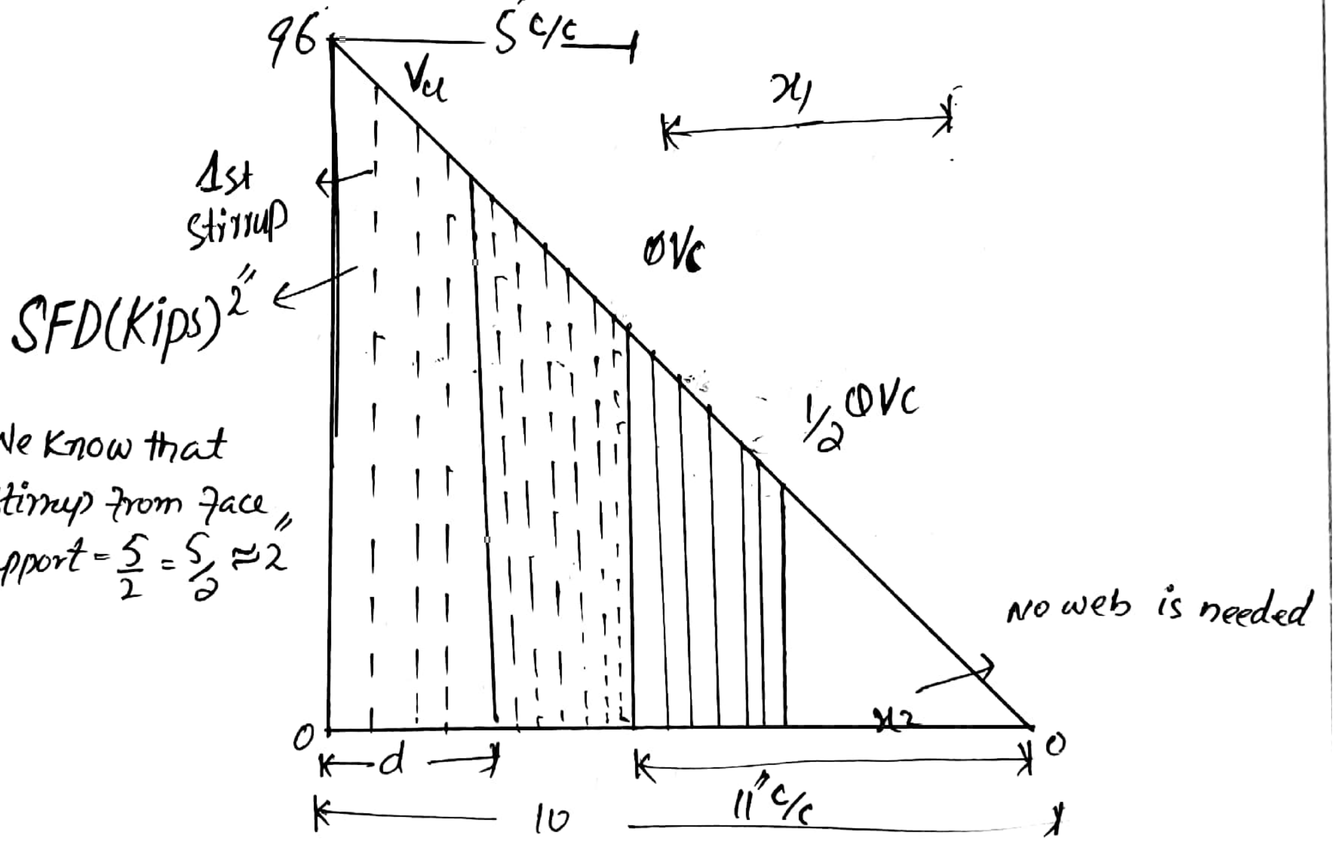
So, $S_{max} = 11'' c/c$

Step No #8:- Spacing of Stirrups from at Critical Section

$$S = \frac{\phi * A_v \times F_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{76.80 - 33.44}$$

$S = 5'' c/c$

Step No #9:- Final Sketch.



Q.NO#3:

Ans:

Step# 01:- Find Gross area of concrete:-

$A_g = b \times b$ (Since it is square tied colum)

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

Step# 02:- Find the area of steel

Since $A_s = 5\%$ of A_g

$= 0.05 \times 144 \Rightarrow 7.2\ in^2$

Step# 03:- Ultimate load carrying capacity

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

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

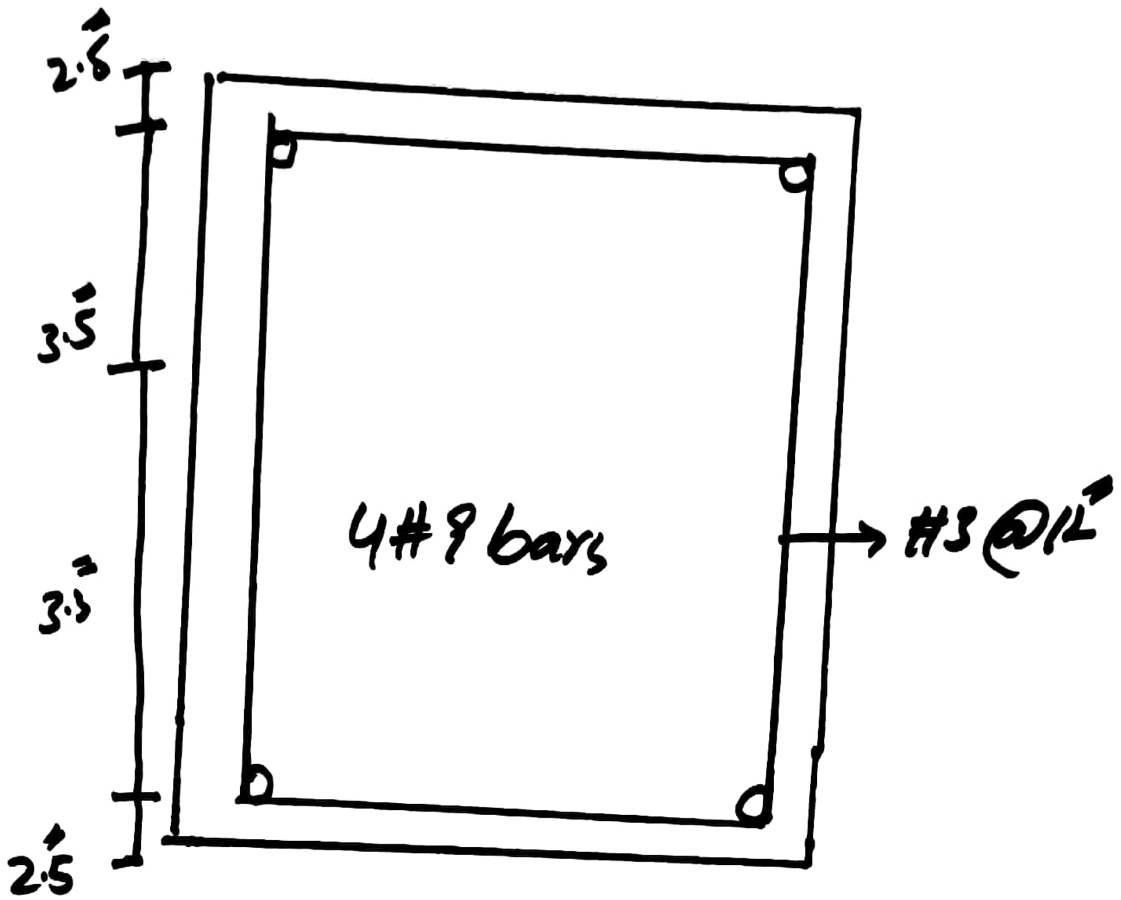
$P_u = 466.50K$

Step# 04:- Sketch and Design of Ties ($\frac{c}{c}$ to dist)

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

1) $16 \times$ dia of long bar $= 16 \times 8/8 = 18''$
2) $48 \times$ dia of Tie bars $= 48 \times 3/8 = 18''$

Lest common dimension $= 12''$, $\frac{c}{c}$ distence $\frac{b}{w}$ ties $= 12''$



* Since it is a tied Square colum so there is no Spirae Stirrup used, the Strip used is of rectangular Shape due to the Specification of the Structure, thus we will use tie stirrups instead.

Q#4

Ans:-

Solution :

Step#01:-

Let $h = 24''$

Step#02:-

Total weight = wt of soil + wt of RC

$3 \times 120 + 2 \times 150 = 660 psf \Rightarrow 0.660$

Step#03:-

Effective Bearing Capacity

$q_e = q_a - w = 2.50 - 0.660$

$q_e = 1.84\ KSf$

Step#04:-

Required Area for Foundation

$Area = \frac{S.L}{q_e} = \frac{100+120}{1.84} \Rightarrow Area = 119.56ft^2$

Step#05:- Since foundation is square

$Area = B \times B = 119.56 \quad B \Rightarrow 11'-56''$

Step # 6:-

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

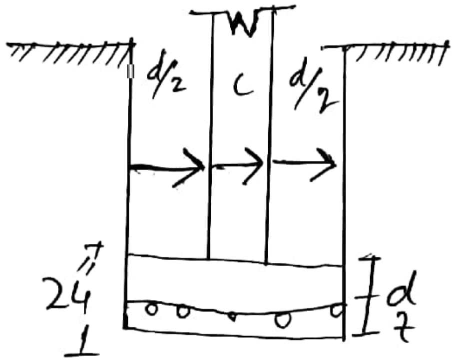
$$= \frac{1.2 \times 100 + 1.6 \times 120}{(119.56)^2}$$

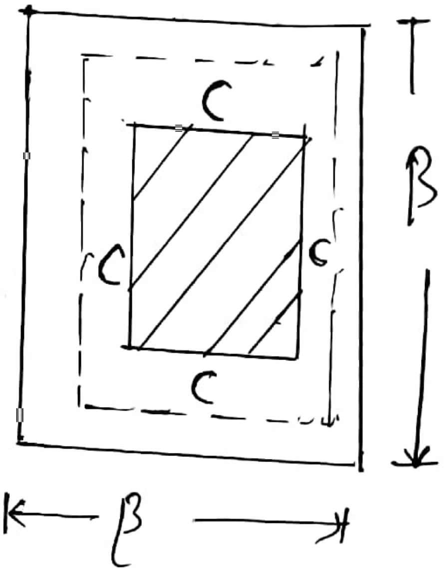
$$\boxed{q_{up} = 0.021\ k/ft^2}$$

Step # 7:-

Ponching Shear

$b_o = 4 + (c+d)$





d = h − clear Cover − dia of bar − ½ × db

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

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

Step # 08:-

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

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

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

Step # 09:- $\phi V_{cp} = \phi \times 4 \times \sqrt{f'c} \times b_o \times d$

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

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

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

$V_{u_1} = q_{up} \times B \times [\frac{B}{2} - \frac{c}{2} - d]$

$= 2.58 \times 11 \times [11/2 - 16/2 - 19.5]$

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

Step # 11:- Self Shear Capacity

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

$= \frac{0.75 \times 2 \times \sqrt{4000} \times (11-16)}{1000} = \boxed{110.04K < V_{u_1} \rightarrow OK}$

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Step # 12:- Ultimate moment

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

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

Step # 13:-

Area of Steel for main bars by trail and repeat method

Trail # 01:-

let $a = 0.2 \times h = 0.2 \times 24 = \boxed{4.8''}$

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

$\boxed{8.56 in^2}$

Trail # 02:-

$$a = \frac{A_s \times f_y}{0.85 \times f'c \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times 11 \times 12} = 1.53'$$

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

Trail # 03:-

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

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

Step#14:-

Check the main reinforcement by the following three method

$\Rightarrow A_{s\,min} = 0.0018 \times B \times h = 0.0018 \times 11 \times 12 \times 24$

$A_{s\,min} = 5.70 \, in^2$

★ $A_{s\,min} = \dfrac{200}{f_y} \times B \times d = \dfrac{200}{60000} \times 11 \times 12 \times 19.5$

$8.58 \, in^2$

$\Rightarrow A_{s\,min} = \dfrac{3 \times \sqrt{f'_c}}{f_y} B \times d = \dfrac{3 \times \sqrt{3000}}{60000} \times 11 \times 12 \times 19$

$7.05 \, in^2$

★ Greater value will be selected

$A_{s\,min} = 8.58 \, in^2$

Step#15:-

Using #8 Bars $A_b = 0.785 \, in^2$

No. of bars $= \dfrac{A_s}{A_b} = \dfrac{8.58}{0.785} = 10.92 \approx 11$ bars in each direction.

End