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Section :- "B"

Semister :- 6th

Subject :- PRCD 1

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Question No 1. (1)

Given Data.

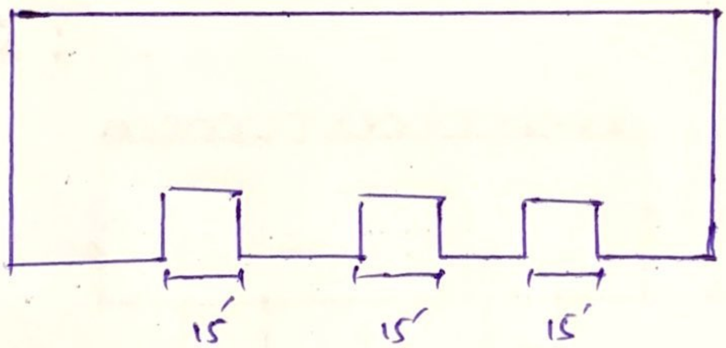
Clear span b/w support = 15'

factored live load = 160 lb/ft^2

service floor finished load = 20 lb/ft^2

f_c' = 4000 Psi

f_y = 40 ksi



Step 01:-

Minimum Thickness

By using formula

$$t_{min} = l/28 = 15/28 = 6.4 \cong 6.5''$$

As $f_y \rightarrow 40$ ksi

so we will multiply a factored with this thickness.

factor $(0.4 + \frac{fy}{100})$

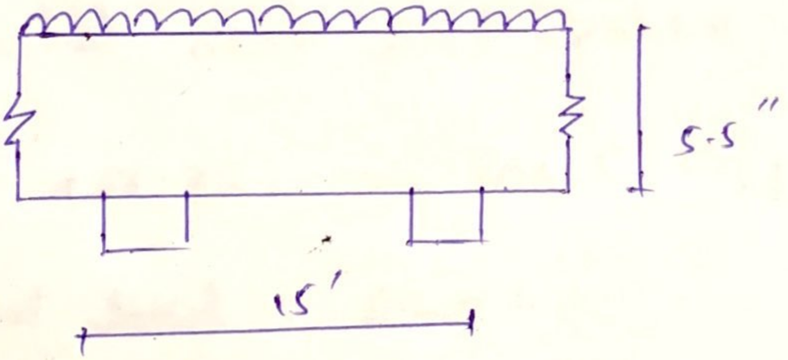
$(0.4 + 40/100) \Rightarrow 0.8$

Hence the minimum thickness will be

6.5×0.8

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

Step 02:



By formula

d = t - clear cover - 1/2 (dia of main bar)

$5.5 - 0.75 - 1/2\ (5/8)$

$d = 4.5$

Step 03:-

self weight of slab

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

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

$\Rightarrow 68.75$ lb/ft

Step 04:-

Total factored load

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

so the factored dead load will be

$D.L = 1.2\,(20 + 68.75) \Rightarrow 106.5$ lb/ft^2

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

$106.5 + 160$

$\Rightarrow 266.5$ lb/ft^2

$\Rightarrow 0.2665$ k/ft^2

Step 05:-

Ultimate moment

By using formula $M_u = W_u \times l^2/8 \Rightarrow \frac{0.2665 \times (15)^2 \times 12}{8}$

$\Rightarrow 89.94$ kp inch

Step 06:-

Area of steel for main bars. by trial and repeat method.

Trial 01:-

Let depth of compression block

$a = 0.2 \times t$

$= 0.2 \times 5.5$

$= 1.1''$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{29.94}{0.90 \times 40 \times \left(4.5 - \frac{1.1}{2}\right)}$$

Trial 02:-

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{40}{0.85 \times 40 \left(4.5 - \frac{0.6}{2}\right)}$$

$A_{st} = 0.59\ inch^2$

Trial 03:-

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

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

So we will use $A_{st} = 0.59 m^2$

Step 07:-

Area of steel for distribution reinforcement

$A_{min} = 0.002 \times b \times t \rightarrow$ (for Grad 40 steel)

$0.0002 \times 12 \times 5.5 \Rightarrow 0.132 \text{ in}^2$

Step 08:-

Spacing for main bars

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

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

Area = $\pi/4 \, (6/8)^2 = 0.442 \text{ in}^2$

Step 09:-

Spacing for distribution bars.

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

Use # 5 bars so

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

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

Step # 10: (6)

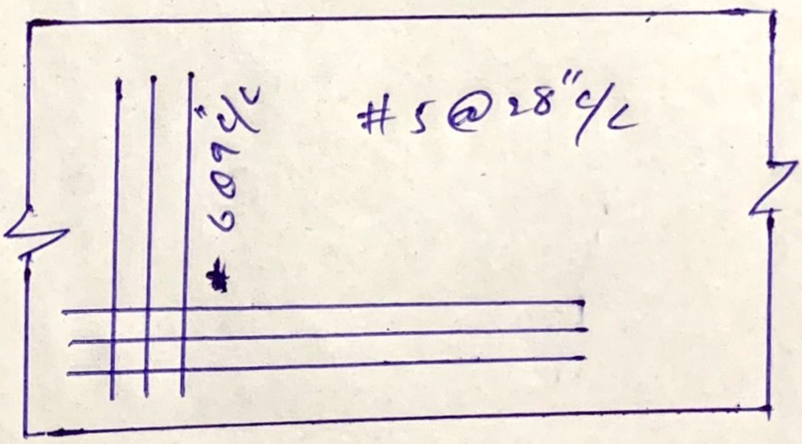
Find sketch

$f_c' = 4\,ksi$

$f_y = 40\,ksi$

Main steel #06 at 9" c/c

distribution steel #05 at 2.8 c/c



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Question - 2

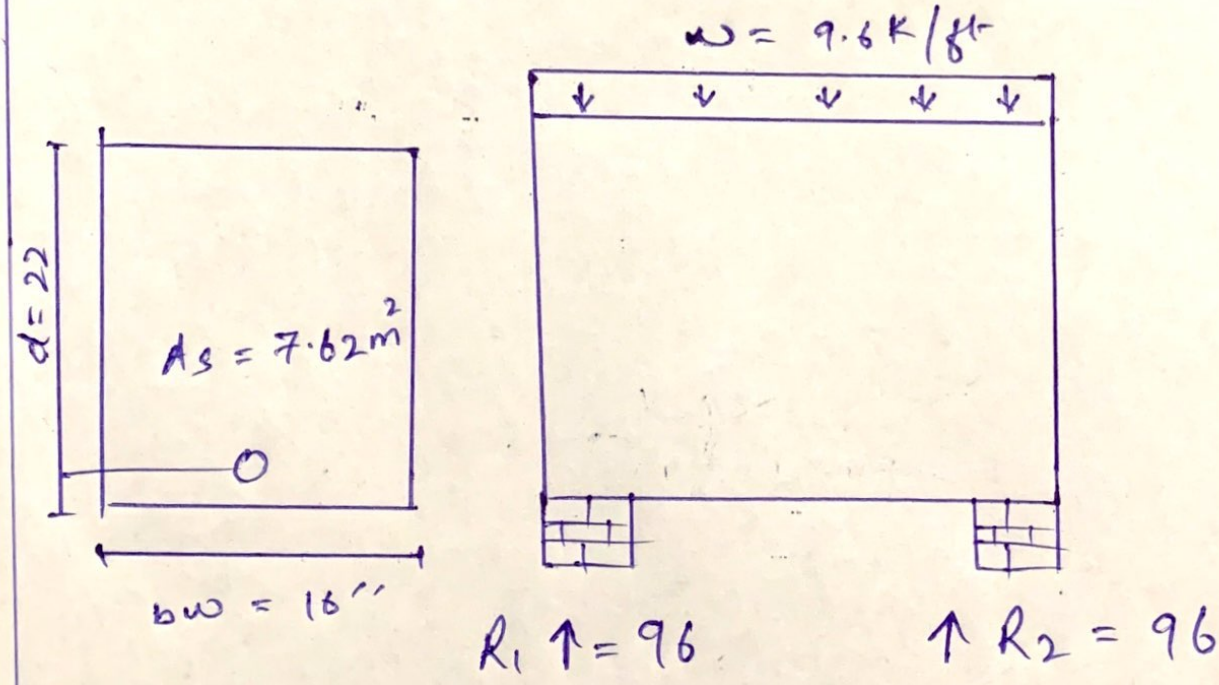
Solution

Find unit load of beam

so $b \times \gamma_c$

$\frac{16}{12} \times 150 =$ 200 lbs. $\Rightarrow$ 0.2 k/ft

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



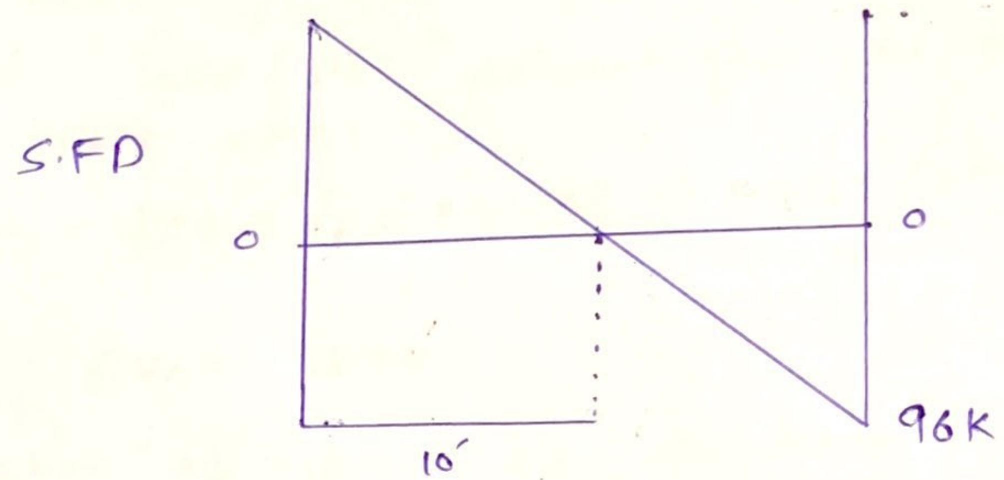
Step # 01

Find the values of R_1 & R_2

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

Step = 02:-

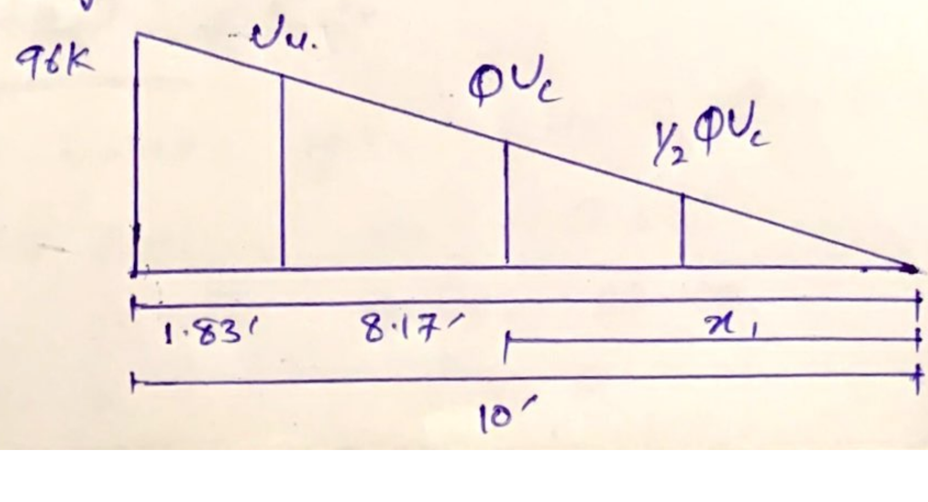
Draw its shear force Diagram



Step : 03

find the values of critical stress "Vu" and it's location.

As we know that critical section is located at distance "d" from face of support = a = 22" = 1.83' value of critical shear at distance "d" by similarty of Triangle.



from similar As $\frac{96}{10} = \frac{Vu}{8.17}$

$Vu = 78.43K$

Step 04:-

Find the value of "ϕV_c & $\frac{1}{2}\phi V_c$" and also its distance from zero shear to right side.

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

$\phi V_c = 33.40$

location of ϕVc by similarity of As

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

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

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

$x_2 = 1.74'$

Step 05 :-

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

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

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03\ K$

Step 06 :-

check on section adequay

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

$= 133.57\ K$

As $\phi V_s < \phi 8 \sqrt{f_c'}\ b_w d \Rightarrow$ Its means section is adequate

Step. 07 ::

Check on Maximum Spacing for stirrups.

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

$\Rightarrow 66.79K$.

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

Thus maximum spacing will be selected from the following fours condition

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

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

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

$A_v = \frac{\pi}{4}\left(\frac{3}{8}\right)^2 = \frac{0.22 \times 6000}{0.75 \times 4000 \times 16.}$ $A_v = 0.11 \times 2$, $A_v = 0.22$

17.40

4) $S_{max} \quad \frac{A_v \times f_y}{50 \times b_w} \Rightarrow \frac{0.22 \times 60000}{5 \times 16}$

$\Rightarrow 16.50$

from the above four condition least value of spacing from # 03 U shaped will be selected so

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

Step 08 :-

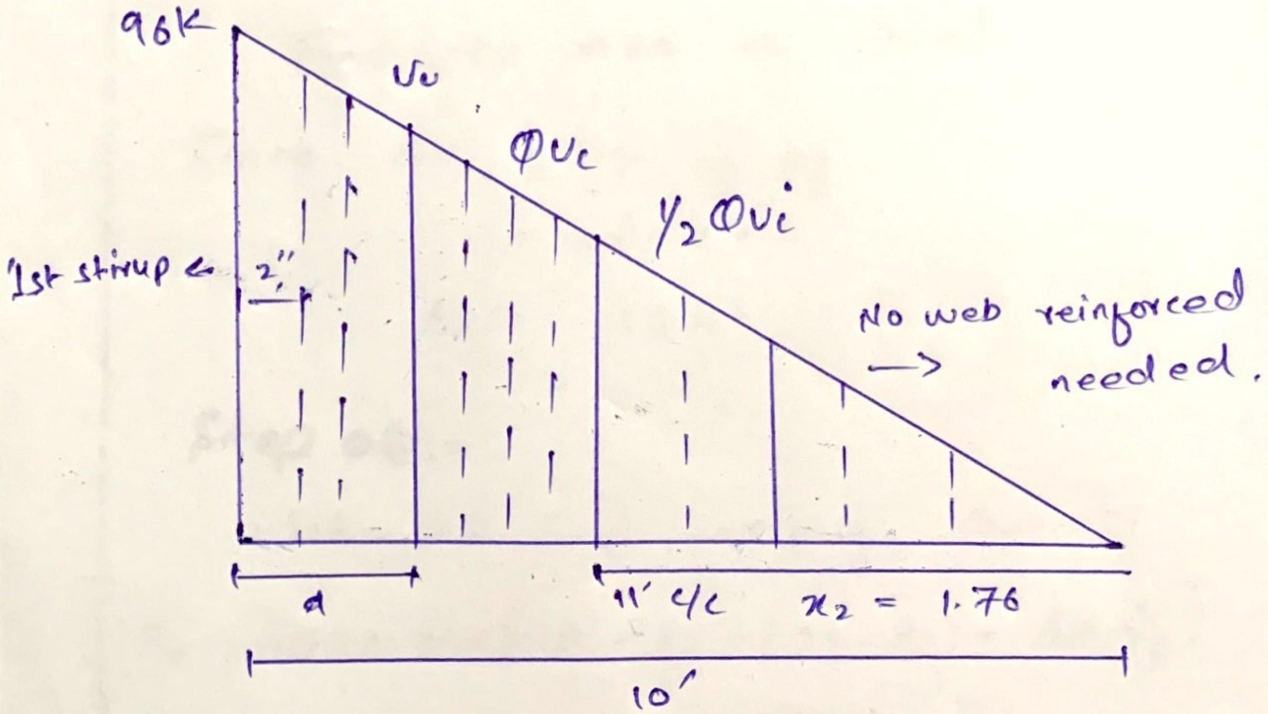
spacing of stirrupp from at coiticale section.

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

$$\Rightarrow 48.4'' \cong 5'' \text{ c/c}$$

Step 09 :-

find sketch.



As we know that first stirup from face of support

$$\Rightarrow \frac{5}{2} = 2.5 \cong 2''$$

Question No. 03

Solution:-

Step 01:-

find gross area of concrete

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

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

Step 02:-

Find the area of steel.

Since $As = 5\%$ of Ag

$= 0.05 \times 144$

$As = 7.2 \text{ in}^2$

Step 03:-

Ultimate load carrying capacity

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

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

$Pu = 466.50K$

Step : 04

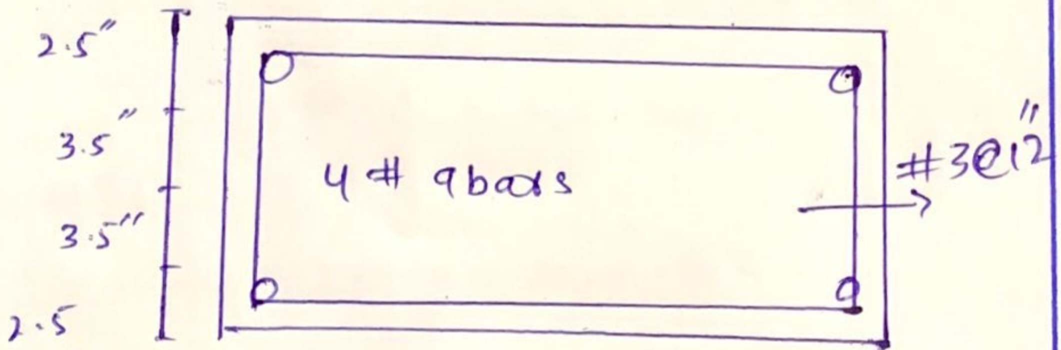
sketch and design of ties (c/c to

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

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"
So c/c distance b/w ties = 12"



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

Question: No 04

Design a square footing.... skatch of your final design.

Solution:-

Step 01:-

Let $h = 24''$

Step 02:-

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

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

$= 660 \text{ Psf} = 0.660 \text{ ksf}$

Step 03:-

Effective bearing capacity.

$q_e = q_a - w$

$= 2.50 - 0.660$

$q_e = 1.84 \text{ ksf}$

Step 04:-

Required Area for foundation

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

$= 119.57 \text{ ft}^2$

Step # 05

Since foundation is square.

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

Step # 6

Upward bearing capacity of soil.

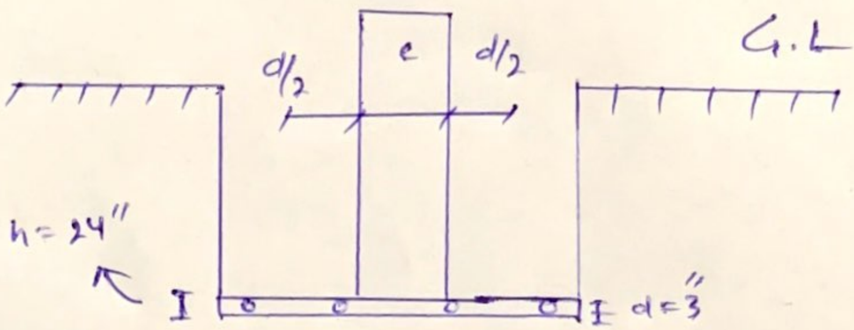
$$q_{up} = \frac{\text{Factored load}}{"B"^2} = \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$$

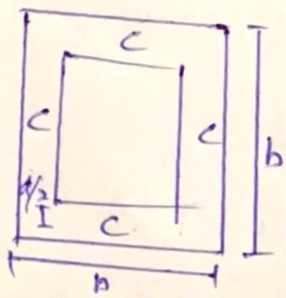
$$q_{up} = 2.58\ K/y^2$$

Step # 07

Punching shear

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





$d = h - c.c - \text{dia of bar} - \frac{1}{2} d_b$ ∵ take # 8 bar

dia $= \frac{8}{8}'' = 1''$

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

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

St

Step #08

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

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

$V_{u2} = 289.60k$

Step # 09

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

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

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

Step # 10

Beam shear / one way shear check

$V_{u1} = q_{up} \times B, [B/_2 - c/_2 - d)$

$V_{u1} = 2.58 \times 11 \times [11/_2 - 16/_2 - 19.5]$

$V_{u1} = 90.95k.$

Step # 11

self shear velocity

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

$$= \frac{0.75 \times 2 \times \sqrt{4000} \times (11 \times 12 - 16)}{1000}$$

$\Rightarrow$ 110.04 K > V_{ui} $\Rightarrow$ OK

Step 12 :

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

$$\Rightarrow 2.58 \times 11/8 \times (11 - 16/12)^2$$

M_u = 331.49K ≡ 3977.93K

Step 13 :-

Area of steel for main bars by trials and repeat method.

Trial 01 :-

Let $a = 0.2 \times 2.4 = 4.8''$

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

$\Rightarrow$ 8.56 in^2

Trial 02:-

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

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

Trial 03:-

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

$$A_s \cdot \frac{3977.93}{0.90 \times 60\,(11 - 1.28/2)} = 7.7 \text{ in}^2$$

so that area $= 7.1 \text{ in}^2$

Step 14:-

check the main reinforcement by the following 03 method

a) $A_{s\,min}$ $0.0018 \times B \times h = 0.0018 \times (1 \times 12) \times 24$
$\Rightarrow 5.70 \text{ in}^2$

b) $A_s\ min = \frac{200}{f_y} \times b \times d = \frac{200}{6000} \times (11 \times 12) \times 19.5$
$\Rightarrow 8.58 \text{ in}^2$

c) A_s min $= 3 \times \frac{\sqrt{f'_c}}{f_y} \times B \times d = 3 \times \frac{\sqrt{3000}}{6000} \times (11 \times 12) \times 19.5)$

$= 7.05 \text{ in}^2$

from above value the greater value will be selected this A_s min $= 8.58 \text{ in}^2$

Step 15:-

Using # 8 bar

No of bars $= \frac{A_s}{A_b} = \frac{8.58}{0.783} \Rightarrow 10.92$

11 bars in each direction.