Kashif Khan

ID # 7846

Section # B

Semester # 6Th

Subject # P.r.c.d.I

Instructor # Fawad Khan

Date # 26-06-20.

(QUESTION - 01)

Given :

⇒ 3 equal spans Concrete slab .

⇒ Clear span b/w supports = 15 ft

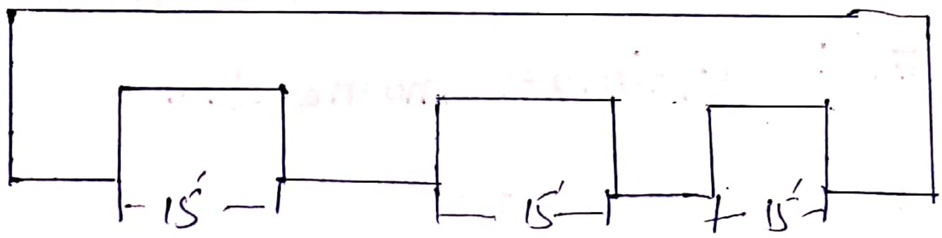
⇒ Factored live load = 160 lb/ft^2

⇒ Service floor finish load ⇒

⇒ $f'c$ = 4000 psi

⇒ fy = 40 ksi

Sol



Step # 1 (Minimum thickness)

By using formula.

$$t_{min} = L/22 = \frac{15}{22} = 6.4 \approx 6.5''$$

As fy → 40 ksi

So we will multiply a factor with this thickness.

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

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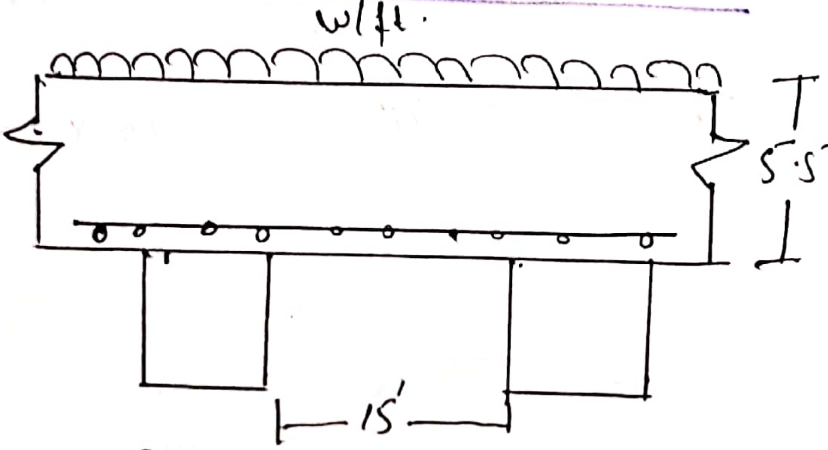
Hence The minimum thickness would be

6.5×0.8

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

Step :2 Effective Depth :



By formula.

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

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

$d = 4.5$

Step # 03 Self wt of slab :

By formula:

$\frac{t}{12} + \gamma$ concrete.

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

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Step # 04 :->

Total Factored load

Factored ~~# 04~~ :

load = 160 lb/ft^2

So factored Dead load will be

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

total Factored load = D.L + L.L

$= 106.5 + 160$

$= 266.5\ lb/ft^2$

$\Rightarrow 0.2665\ k/ft^2$

Step # 5: **Ultimate moment:->**

By using formula

$$M_U = \frac{W_U \times L^2}{8} = \frac{0.2665 \times (15)^2}{8} \times 12$$

$= 89.94$ kip-inches

Step # 6

Area of steel For main Bars By By trial and Repeat Method :->

Trial # 01

Let depth of compression block.

$a = 0.2 \times t$

$= 0.2 \times 5.5$

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

Trial # 02

$a = \frac{Ast \times Fy}{0.85 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12}$

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

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

$AST = 0.59$

Trail # 03.

$a = \frac{0.59 \times 40}{0.83 \times 4 \times 12} = 0.57''$

$AST = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.6}{2})} \Rightarrow 0.59 \text{ in}^2.$

Step # 07

Area of steel for distribution reinforcement.

By formula:

$$A_{min} = 0.002 \times b \times t \rightarrow (\text{For Grad 40 Steel})$$

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

Step # 08

Spacing for main bars.

Spacing for main bars.

$$\text{Spacing } \frac{A_b}{A_{S1}} \times 12$$

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

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

Step # 09

Spacing for distribution bars.

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

we use # 5 bars so.

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

$$\text{Spacing} = \frac{0.31}{0.132} \times 12 = 2.81'' \approx 2.8'' \ c/c.$$

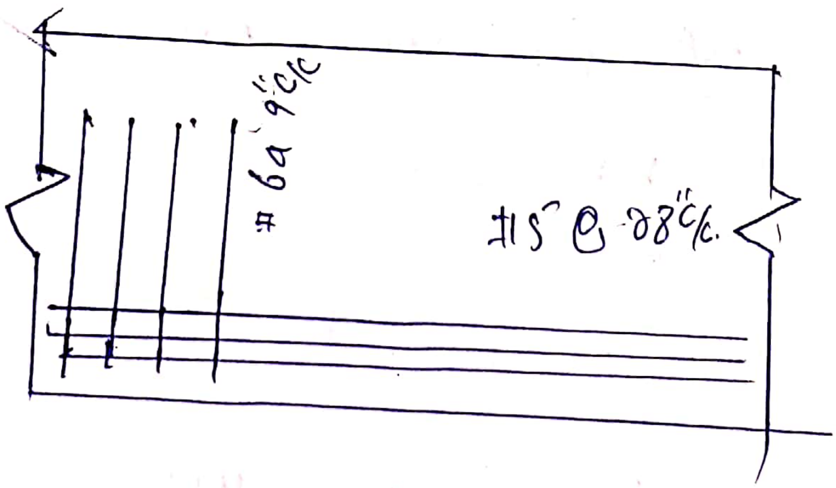
Step # 10

Find Sketch

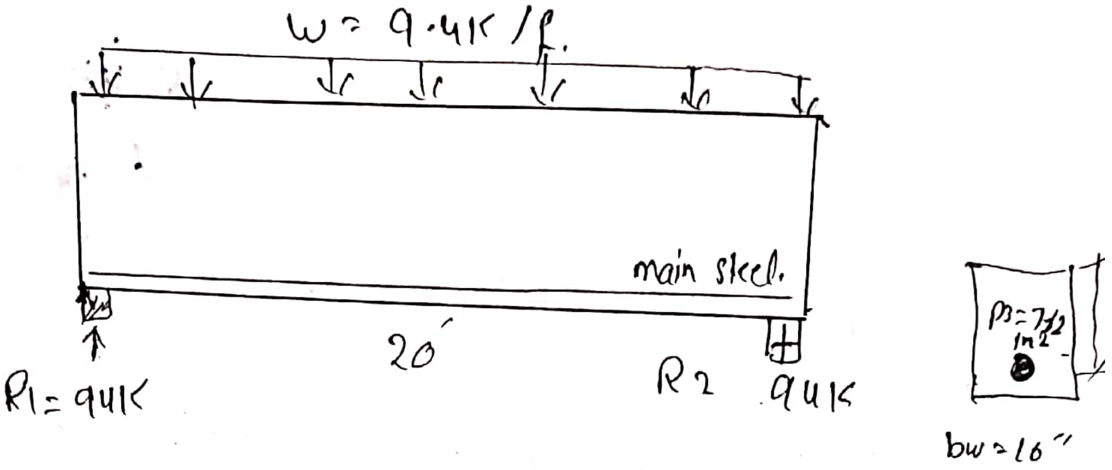
$f'_c = 4$ ksi , $f_y = 40$ ksi

main Steel #6 at 9" c/c

Distribution steel #5 at 28" c/c



Q: NO: 2



Solution:

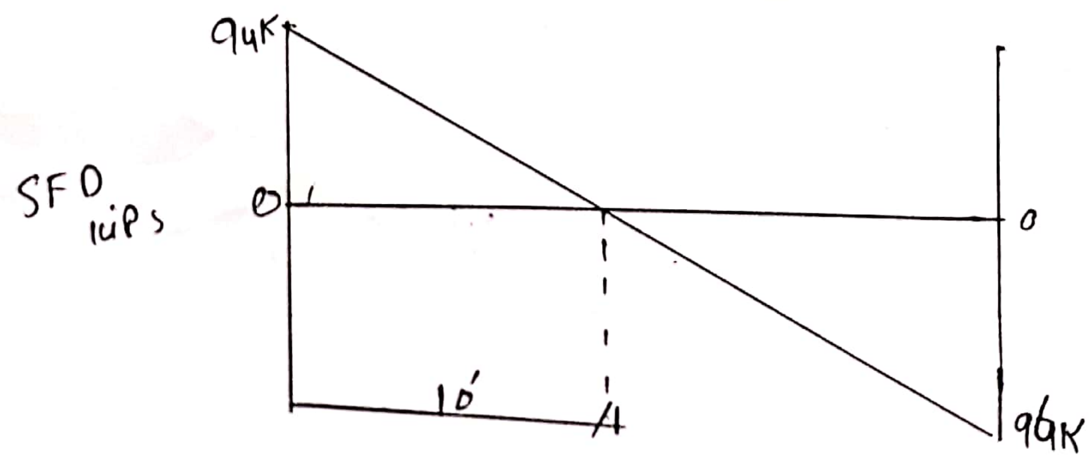
Step # 01

Find values of "R1" and R2.

Total Load = 9.6K/f => 9.6 × 20 / 2

= [crossed out] => [crossed out] => **96K**

Step # 2 Draw ist its Shear force diagram.

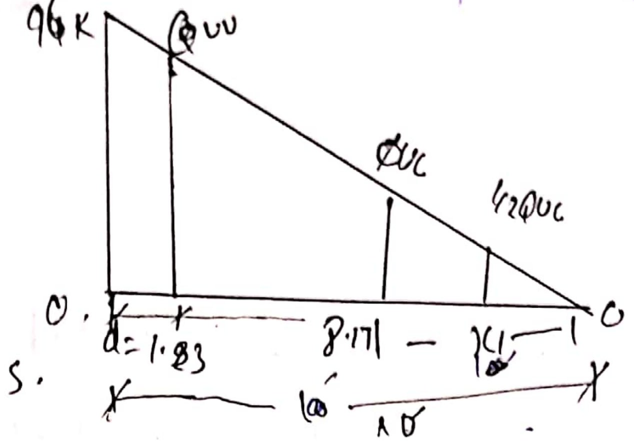


Step # 3

Find The value of critical shear Vu and its location, As we know that critical section is located at distance 'd' from force of support = d = 22" = 1.83'.

Value of critical shear at distance = d' = by similarity of triangles. 7846 (8)

from similar Δs



$$\frac{94}{10} = \frac{V_u}{8.17}$$

$V_u = 76.80$ kips.

Step # 4

Find the value of ϕV_c and $1/2\phi V_c$ and also its distance from zero shear to right side.

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

$$= 33.40\ K$$

Location of ϕV_c by similarity of Δ's.

$$\frac{94}{10} = \frac{33.40}{x_1} \Rightarrow \boxed{x_1 = 3.48'}$$

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{94}{10} = \frac{16.70}{x_2}$

$$\Rightarrow \boxed{x_2 = 1.78'}$$

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Step # 5

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

So $\phi V_s = V_u - \phi V_c = 78.43 - 33.40$

$= 45.03 K$ [45.03K]

Step # 6

Check on Section adequacy

$$\phi \times 8 \times \sqrt{f'c} \times b_w \times d = \frac{0.75 \times 8 \times \sqrt{4000} + 16 \times 22}{1000}$$

$$= 133.57 K.$$

As $\phi V_s < \phi 8 \sqrt{f'c}\, b_w d \Rightarrow$ It means section is adequet.

Step # 7:

Check on maximum Spacing for Stirrups.

$$\phi \times 4 \times \sqrt{f'c} \times b_w \times d = \frac{0.75 \times 4 \times 16 \times d}{1000}$$

$$\Rightarrow 66.79 \text{ KIP.}$$

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

So max spacing will be Selected from following Four Conditions.

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

2- $\frac{d}{2} = 11''$

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

$= 17.40''$

4- $S_{max} = \frac{A_v \times f_y}{50 \times b_w}$

$\frac{0.22 \times 6000}{50 \times 16}$

$= 16.50$

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From the above four codition: least value of spacing from #3, U shaped will be selected, so $S_{max} = 11'' \, c/c$

Step # 08:

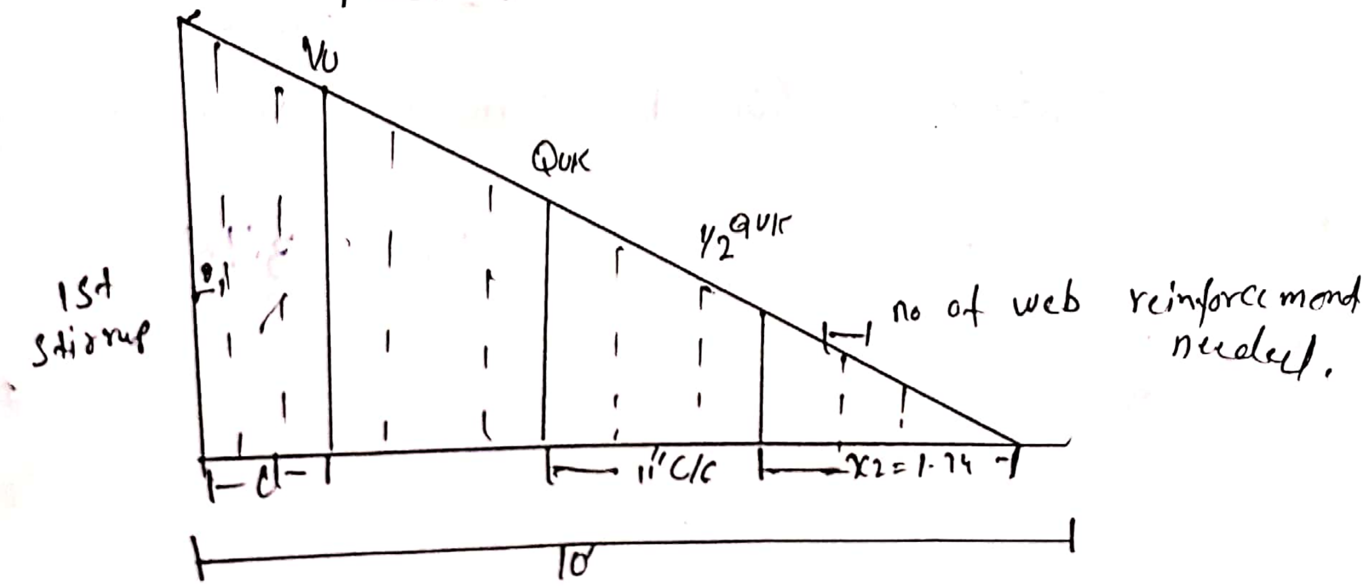
Spacing of stirrup from 1st critical section.

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

$$\Rightarrow 48.4'' \approx 5'' c/c$$

Step: 9

Find sketch



* As we know that 1st stirrup from face of support

$$\Rightarrow \frac{S}{2} \Rightarrow 2.5 \approx 2''$$

3 Calculate the axial ultimate ..... design necessary spirals.

Step # 01

Find grass area of concrete.

Ag = b×b (since it is squared column)

Ag = 12 × 12 = 144 inch² (Actual)

Step: 02

Find the area of steel :-

since As = 5% of Ag

= 0.05 × 144

As = 7.2 inch²

Step: 3

Ultimate load carrying capacity

Pu = Ø × 0.80 × [0.85 × f'c × (Ag − As) + As × fy]

= 0.65 × 0.80 × [0.85 × 4 (144 − 7.2) + 7.2 × 60]

Pu = 466.50 K

Step # 4

Sketch & design of Ties (c/c) to distance.

From the below value we chose the least value of all thus

1) 16 x dia of long bar = 16 x 9/8 = 18"
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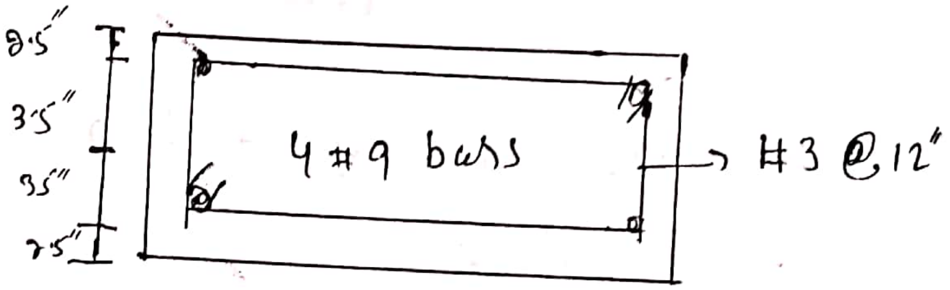
2) 48 x dia of bar = 48 x 3/8
= 18"

3) least column dimension = 12"
So c/c distance b/w ties = 12"



* Since it is tied square column so that is no spiral stirrup used. The stirrup used is of Rectangular shape due to the spacification of the structure. Thus we will use tie stirrups instead.

Q:4

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

Step : 1

Let $h = 24''$

Step : 2

Total weight = wt of soil + wt of RC

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

$= 660$ psf $= 0.660$ ksf

Step # 03

Effective bearing capacity

$q_e = q_a - w$

$= 250 - 0.660$

$q_e = 1.84$ ksf

Step # 04 Required Area for foundation

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

$= 119.57\ ft^2$

Step #5

Since foundation is square.

$$\text{Area} = b \times b = 119.57 \Rightarrow B \cong 11'$$

step : 06:

upward bearing capacity of soil:

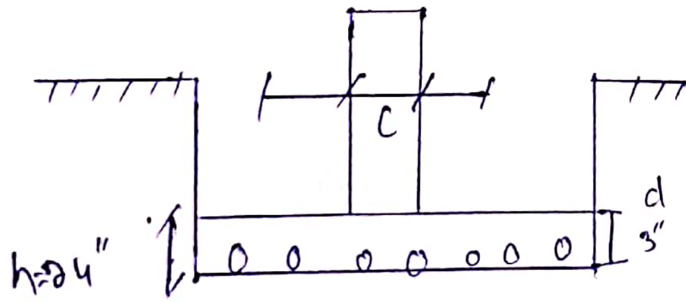
$$q_{up} = \frac{\text{Factored load}}{B^2} = \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$$

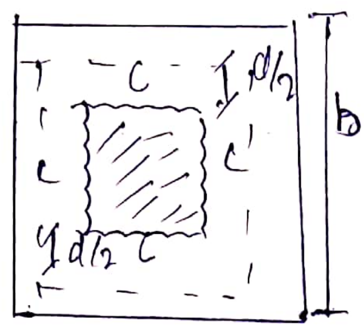
$$q_{up} = 2.58\ K/ft^2$$

Step. 07

Punching shear:→

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





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

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

∴ take #8 bar
dia = 8/8 = 1"

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

Step = 8 :

$$V_{u2} = q_{up} \times \left[B^2 - \left(\frac{c + d}{12}\right)^2\right]$$

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

$$V_{u2} = 289.60 \text{ K.}$$

Step # 9

$$\phi V_{up} = \frac{\phi \times 4 \times \sqrt{f'c} \times b \times d}{1000}$$

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

$$= 525.38 \text{ K}$$

Step#10 Beam shear / oneway shear check

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

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

$$V_{u1} = 90.95 \text{ K..}$$

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Step#11 : Self shear capicity:

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

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

$$= 110.04\ K > V_u \Rightarrow O.K.$$

Step #12 Ultimat moment

$$M_u = \frac{q_u \times B}{8} = \frac{2.58 \times 11}{8} \times \frac{(11-16)^2}{12}$$

$M_{ur} = 331.49K' = 3977.93K$

Step #13 Area of steel for main bars by trial & Repeat method.

⇒ Trial 1 :

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

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{3977.93}{0.9 \times 60 \times \left(11 - \frac{4.8}{2}\right)}$$

$= 8.56\ in^2$

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⇒ trial r :→

$$a = \frac{As \times fy}{0.85 \times f'c \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times 11 \times 12}$$

$$= 1.53$$

$$As \cdot \frac{3997.93}{0.90 \times 60 \times \left(11 - \frac{1.53}{2}\right)} = \frac{8.56 \times 60}{0..}$$

$$\Rightarrow 7.197 in^2$$

⇒ Trial : 3

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

$$AS = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{1.28}{2}\right)} = 7.1 \; in^2$$

So Thus area = 7.1 in².

⇒ Step # 14

Check the main reinforcement by the following as method.

$$As_{min} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$$

$$As_{min} = 5.7 \; in^2$$

$$As_{min} = \frac{200}{fy} \times B \times d = \frac{200}{6000} \times (11 \times 12) \times 19.5$$

$$\Rightarrow 8.58 \; inch^2$$

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From the above values greater value will be selected thus $A_{s\,min} = 8.58\ in^2$

Step # 15

Using # bars.

$A_b = 0.785\ in^2$

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

$\simeq$ 11 bars in each direction