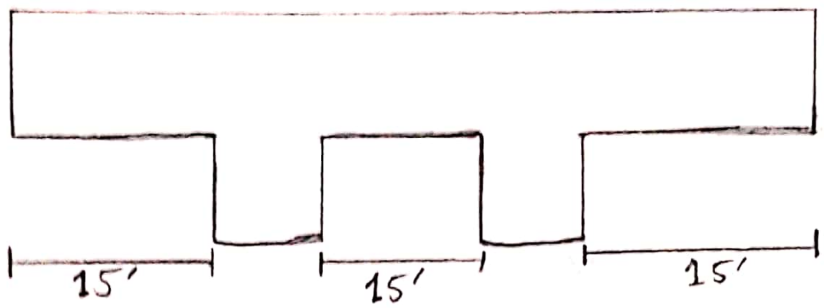
Name	Yaseen Kamal
ID #	7794
section	A
paper	PRCD-I
Semister	6th.

Question # 01:

Given Data:

- 3 equal spans concrete slab
- Clear span b/w supports = 15'
- Factored live load = 160 lb/ft²
- Service floor finish load = 20 lb/ft²
- $f'_c = 4000$ psi
- $F_y = 40$ Ksi

Solution:



Step # 01: (Minimum Thickness)

By using formula

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

As $F_y \rightarrow 40$ Ksi

So we will multiply a factor with this thickness

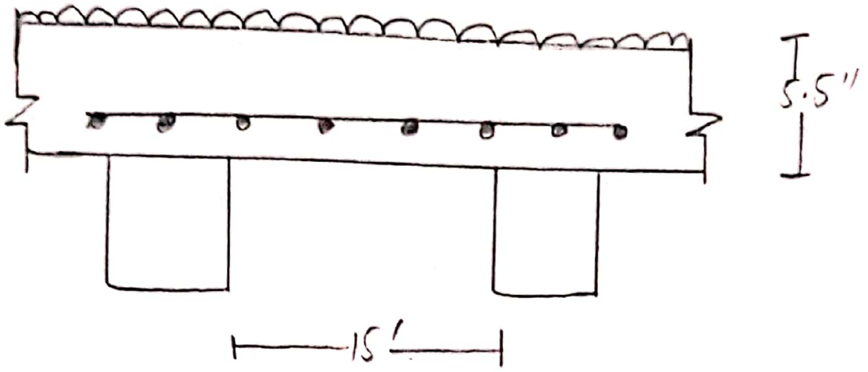
$$\text{Factor} = \left(0.4 + \frac{F_y}{100}\right)$$

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

Hence the minimum thickness will be 6.5×0.8

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

Step #02: (Effective Depth)



By formula

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

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

$d \cong 4.5''$

Step # 03: (Self Wt. of slab)

By formula

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

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

Step#04: (Total Factored Load):

Factored live 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 = $D.L + L.L$

$= 106.5 + 160$

$= 266.5 \ lb/ft^2 = 0.2665 \ K/ft^2$

Step# 05 (Ultimate Moment):

By using formula

$$M_u = \frac{W_u \, l^2}{2} = \frac{0.2665 \times (15)^2}{8} \times 12$$

$$= 89.94 \text{ Kip-inches}$$

Step# 06: Area of Steel For Main bars By Trail and Repeat Method:

Trail # 01:

Let depth of compression black

$$a = 0.2 \times t$$

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

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

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

Trail # 02:

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times} \Rightarrow 0.62 \text{ in}^2$$

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

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

Trail # 03:

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

$$A_{st} = \frac{89.94}{0.90 \times 110 \times (4.5 - \frac{0.57}{2})} = 0.59 \text{ in}^2$$

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

Step#07: Area of Steel for distribution reinforcement.

By formula

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

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

Step # 08: spacing for main bar.

By formula.

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

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

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

Step # 09: spacing for distribution bars.

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

We use #5 bars So; dia $(5/8)''$

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

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

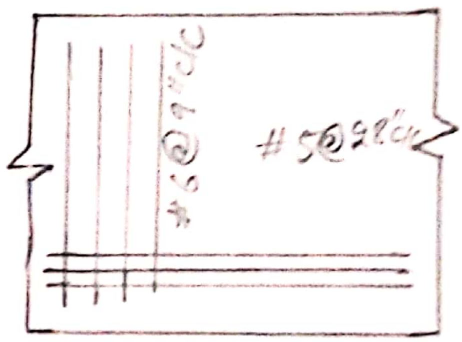
Step # 10:

$f_c' = 4ksi, f_y = 40ksi$

Main steel #6 at 9" c/c

Distribution steel

#5 at 28" c/c



QNO.2):

Solution:

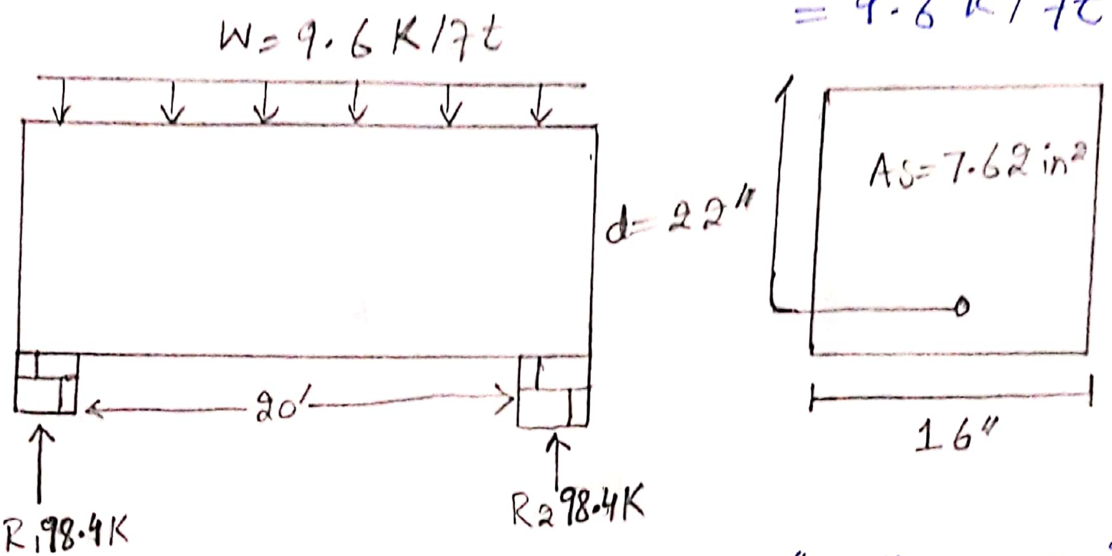
At first find unit load of beam

So 6 × 8c

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

Total factored load $= 9.4 + 0.2$

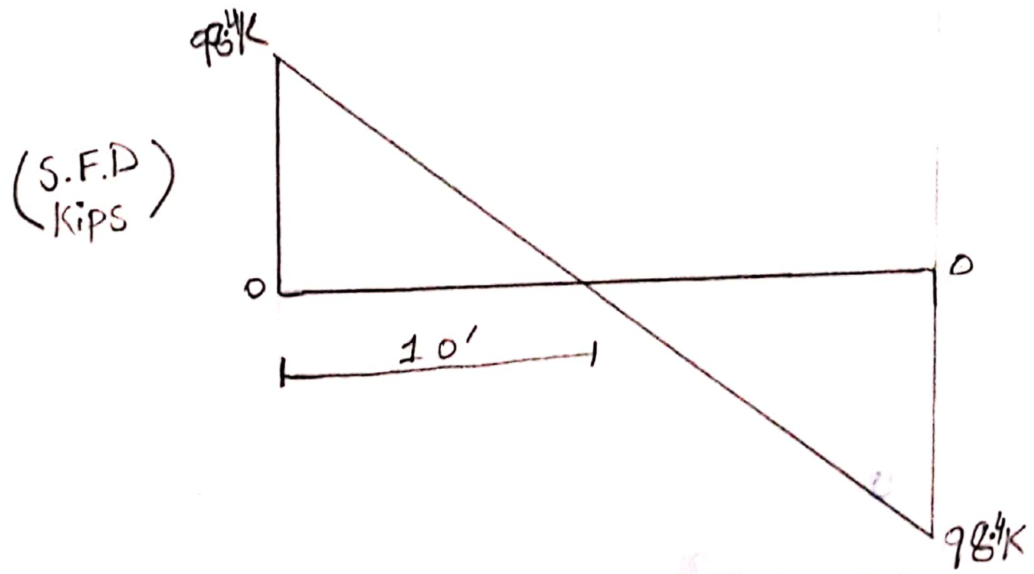
$= 9.6\ K/ft$



Step#01: Find value of "R_1" and "R_2".

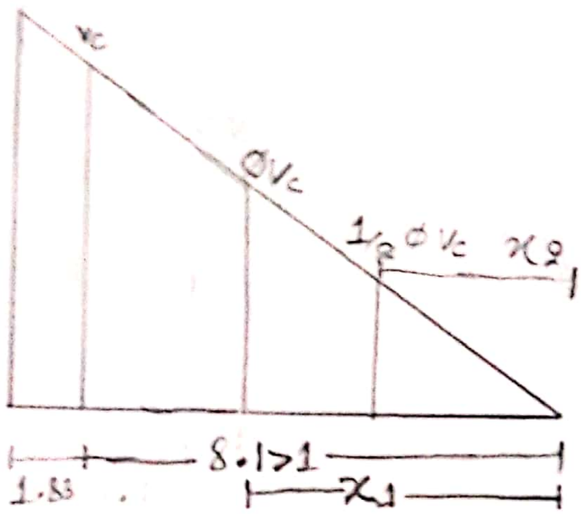
Total Load $= \frac{9.84 \times 20}{2} = 98.4K$

Step#02: Draw its shear force diagram.



Step#03 Finding value of critical (b) stress "V_u" & its location.

As we know that critical location is located distance "d" from face of support $d = 22'' = 1.83'$ value of critical shear at distance "d" by similarity triangles.



From similar Δ'S $\frac{96}{10} = \frac{V_u}{8.17}$

$$V_u = 78.43K$$

Step#04: Finding value of "ϕV_c" and "$\frac{1}{2}\phi V_c$" and its distance from zero shear to right side.

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

$$\phi V_c = 33.40K$$

Location of ϕV_c by similarity of Δs'

$$\frac{98.4}{10} = \frac{33.40}{x_1}$$

$$x_1 = 3.39'$$

Scanned with CamScanner

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{98.4}{10} = \frac{16.70}{x_2}$

$\boxed{x_2 = 1.69'}$

Step #05 Find value of ϕV_s ($V_u = \phi V_s + \phi V_c$)

So we have

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 80.39 - 33.40$

$\boxed{\phi V_s = 46.99 \text{ Kips}}$

Step# 06: Check section Adequacy

$\phi \times 8 \times \sqrt{F'c} \times bw \times d = \frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$\boxed{= 133.57K}$

133.57K > ϕV_s (mean section is adequate)

Step# 07: Check mini spacing for stirrups

$\phi \times 4 \times \sqrt{F'c} \times bw \times d \Rightarrow \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= \boxed{66.79K} > \phi V_s = 44.03K$

Thus max spacing will be selected from the following 4 conditions.

1. $S_{max} = 24''$
2. $d/2 = \frac{22}{2} = 11''$
3. $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{F'c} \times bw}$

$\therefore A_V = \frac{\pi}{4}\left(\frac{3}{8}\right)^2 \quad \therefore A_V = 0.11 \times 2 = 0.22$

$$S_{max} = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16}$$

④ $S_{max} = \frac{A_V \times f_y}{50 \times b_W}$

$$= \frac{0.22 \times 60000}{50 \times 16} = 16.50$$

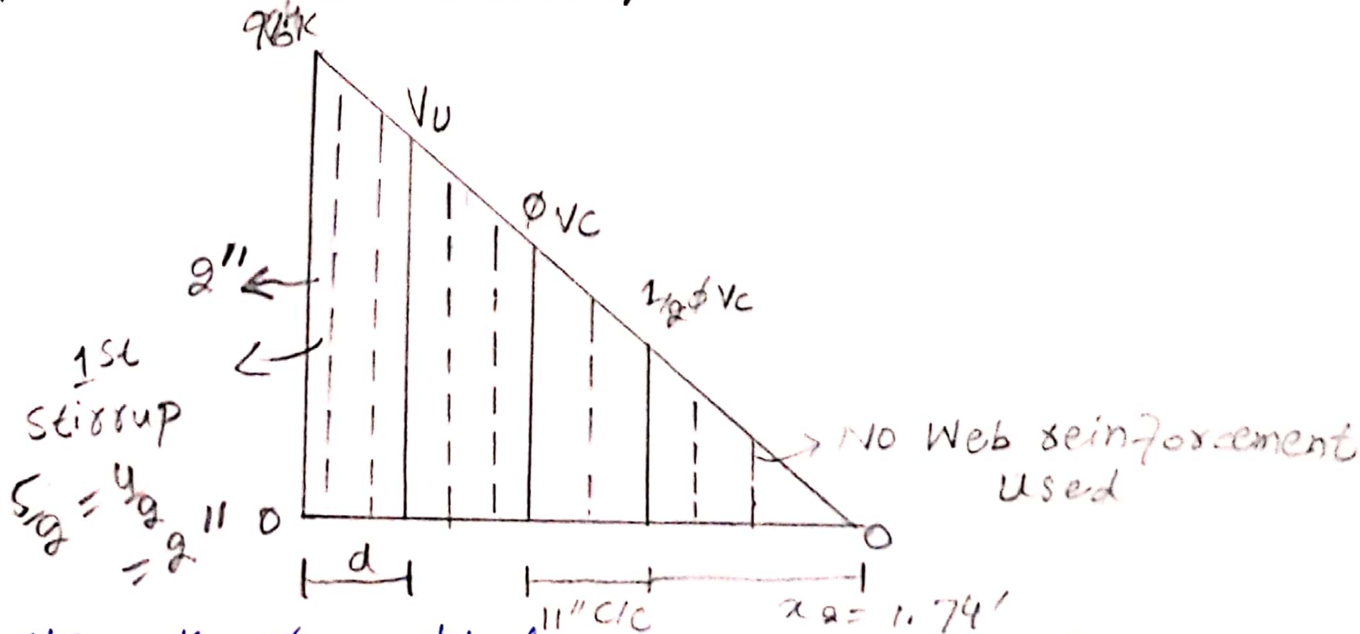
From the above 4 conditions, least value of spacing for # 3 U shapped will be selected so $S_{max} = 11'' C/C$

Step # 08 Spacing of stirrup from at critical section.

$$S = \frac{\phi \times A_V \times f_y \times d}{V_U - \phi V_C} = \frac{0.75 \times 0.22 \times 60 \times 22}{80.39 - 33.40}$$

$$S = 4'' C/C$$

Step # 09 Final Sketch



We know that first stirrup from face of support $= S/2 = 2.5 \approx 2''$

QNO.3:

solution:

Step# 01: Find grass area of concrete.

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

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

Step# 02: Find the area of steel.

Since $A_s = 5\%$ of A_g

$= 0.05 \times 144$

$A_s = 7.2 in^2$

Step# 03: Ultimate load carrying capacity

$P_U = \phi \times 0.80 \times [0.85 \times f'c \times (A_g - A_s) + A_s \times f_y]$

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

$P_U = 466.50K$

Step# 04: Sketch & design of Ties (c/c to distance)

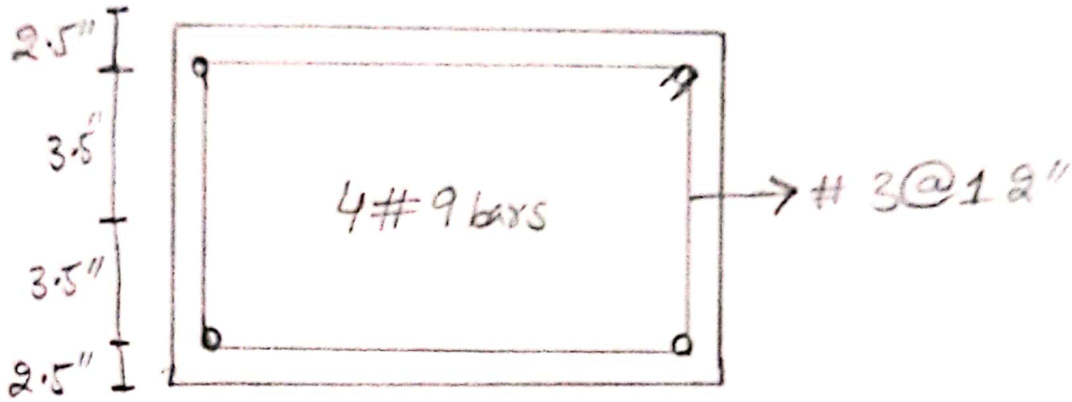
From the below value we chose the least values of all thus;

1) $16 \times$ dia of long bar $= 16 \times 9/8$
$= 18''$

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

3) Least column diamension $= 12''$

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



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

Q4):

Step#01: Let $h = 24''$

Step#02: Total weight = wt of soil + wt of RC

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

$= 660\ psf = 0.660\ ksf$

Step#03: Effective bearing Capacity.

$q_e = q_a - W$

$= 2.50 - 0.660$

$q_e = 1.84\ ksf$

Step#04: Requirement Area for foundation.

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

$= 119.57\ ft^2$

Step#05: Since foundation is square

$A_{req} = b \times b = 119.57 \approx 11'$

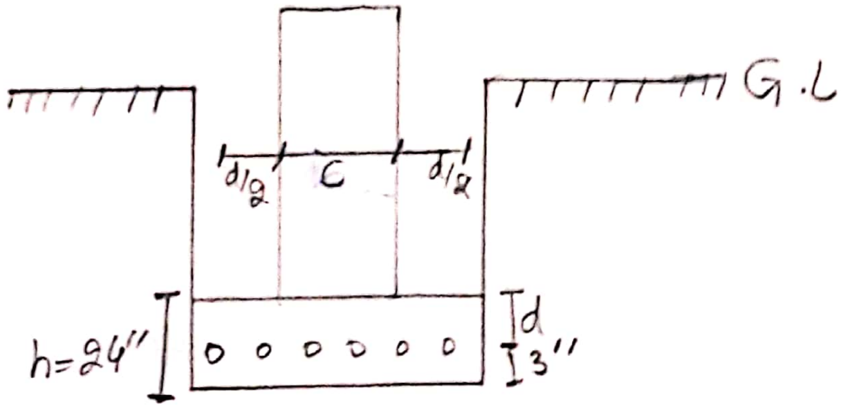
Step#06: Upward bearing Capacity of soil

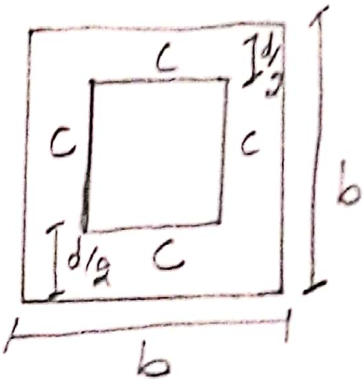
$q_{up} = \frac{\text{Factored Load}}{(B)^2} = \frac{1.2 \times 100 + 1.6 \times 1}{11^2}$

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

Step#07: Punching Shear

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





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

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

∴ Take #8 bar

dia $= (8/8)'' = 1''$

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

Step # 08:

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

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

$V_{u2} = 289.60K$

Step # 09:

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

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

$\phi V_{cp} = 525.38$

Step # 10: Beam var/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.

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

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

$$= 110.04 K > V_{u1} \Rightarrow \text{Okay}$$

Step # 12 Ultimate Moment.

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

$$M_u = 331.49 K' \approx 3977.93 K''$$

Step # 13: Area of steel for main bars by Trail and Repeat Method.

Trail # 01:

Let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{3977.93}{0.90 \times 60 \times (11 - \frac{4.8}{2})} = 8.56 \text{ in}^2$$

Trail # 02:

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

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

Trail # 03:

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

$$A_s = \frac{3977.93}{0.90 \times 60\left(21 - \frac{1.98}{2}\right)} = \boxed{7.1\ in^2}$$

So that area = $7.1\ in^2$

Step # 14: Check the min reinforcement by following 3 method:

a) $A_{smin} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$

$= 5.70\ in^2$

b) $A_{smin} = \frac{200}{fy} \times B \times d = \frac{200}{6000} \times (11 \times 12) \times 19.5$

$= 8.258\ in^2$

c) $A_{smin} = 3 \times \frac{\sqrt{f'c}}{fy} \times B \times d = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$

$= 7.05\ in^2$

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

Step # 15. Using # 8 bar

$A_b = 0.785\ in^2$

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