Name: M. ABBAS

IDNO : 7852

PRCD-I

Final Exam

26 – 06 – 2020

1.6* 0.2 x

(1)

Q No 1

Live Load = 160 Psf

Service Load = 20 Psf

$f'_c = 4000\,psi$

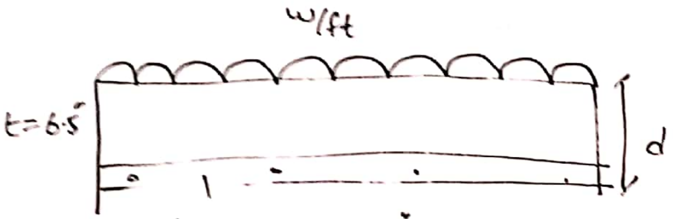
$f_y = 40\,ksi$

SOLUTION:

Step: 01

$$t_{min} = \frac{L}{28} = \frac{15}{28} \times 12 = 6.42 \approx 6.5''$$

Step: 02 : Effective



Clear cover = 3/4 = 0.75

$$d = t - (\text{Clear cover} - \tfrac{1}{2}(d_{M.B}))$$

$$= 6.5 - (0.75 - \tfrac{1}{2}(4/8))$$

$$= 6''$$

Step: 03 : Self wt of Slab

$$= \frac{t}{12} \times \gamma_{concrete}$$

$$= \frac{6.5}{12} \times 150$$

$= 81.25$ Psf

Step: 04 (Total factored Load)

$W_u = 1.2(81.25 + 20) + 160$

$= 121.5 + 160$

$= 281.5$

$= 0.281$ Ksf

Step: 05

Ultimate Moment

$$M_u = \frac{W_u \times l^2}{8} = \frac{0.281 \times 15^2}{8} \times 12$$

$= 94.8$ k"

Step# 06

Area of steel for Main Bars By Trial and Repeat Method

Trial # 01

Let

$a = 0.2 \times t$

$= 0.2 \times 6.5$

$= 1.3$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)}$$

$$= \frac{94.8}{0.90 \times 60 \times (6 - 1.3/2)} = 0.32 \text{ in}^2/\text{ft}$$

Trial 02:

$$a = \frac{A_s \times f_y}{0.85 \times f'_c \times b} = \frac{0.32 \times 60}{0.85 \times 4 \times 15} = 0.37''$$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{94.8}{0.90 \times 60 \times (6 - \frac{0.37}{2})}$$

$$= 0.30 \text{ in}^2/\text{ft}$$

Trial : 03

$a = 0.35$

$A_s = 0.30 \text{ in}^2/\text{ft}$

Step : 07

Area of Steel for distribution bar

$$A_{s\,min} = 0.0018 \times b \times t$$

$$= 0.0018 \times 15 \times 6.5 = 0.17 \text{ in}^2/\text{ft}$$

Step: 08

Spacing for Main Bar

$$S = \frac{A_b}{A_s} \times 12$$

$$= \frac{0.20}{0.30} \times 12 = 8 \simeq 8\frac{1}{2}\ c/c$$

Step: 09

Spacing for Distribution bar

$$S = \frac{A_b}{A_s} \times 12$$ let try # 4 bar

$$= \frac{0.20}{0.175} \times 12 = 13.71 \simeq 14$$

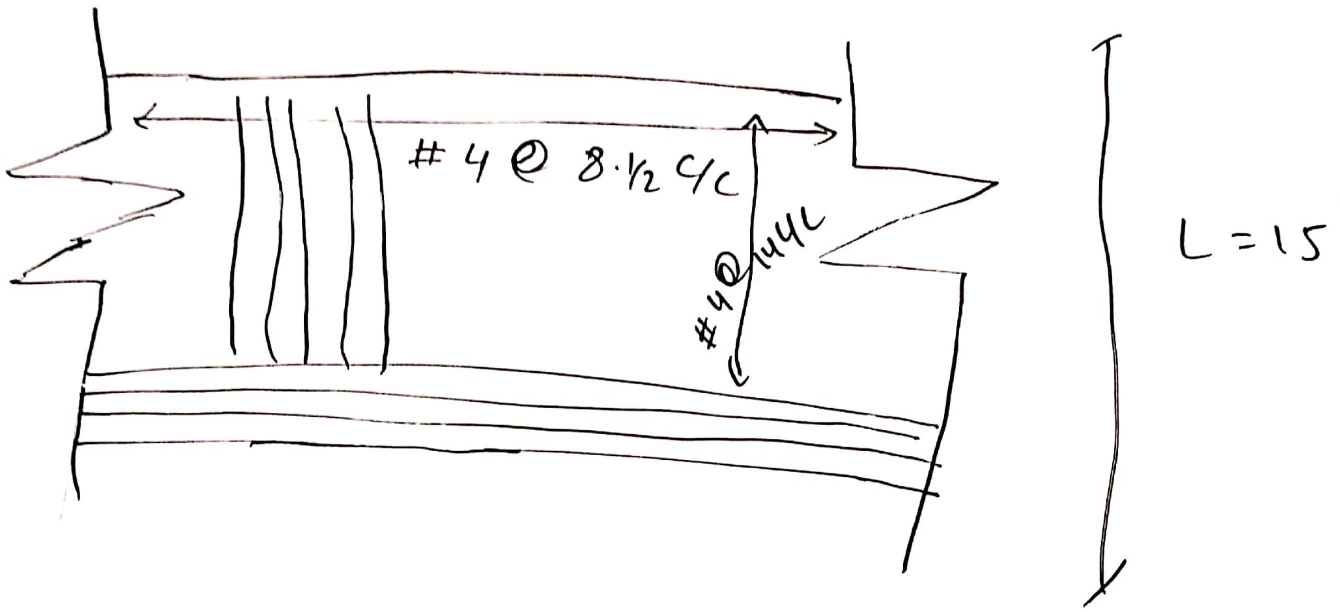
Step: 10 Final Summary

$f'_c = 4ksi$, $f_y = 40ksi$ $t = 6.5$

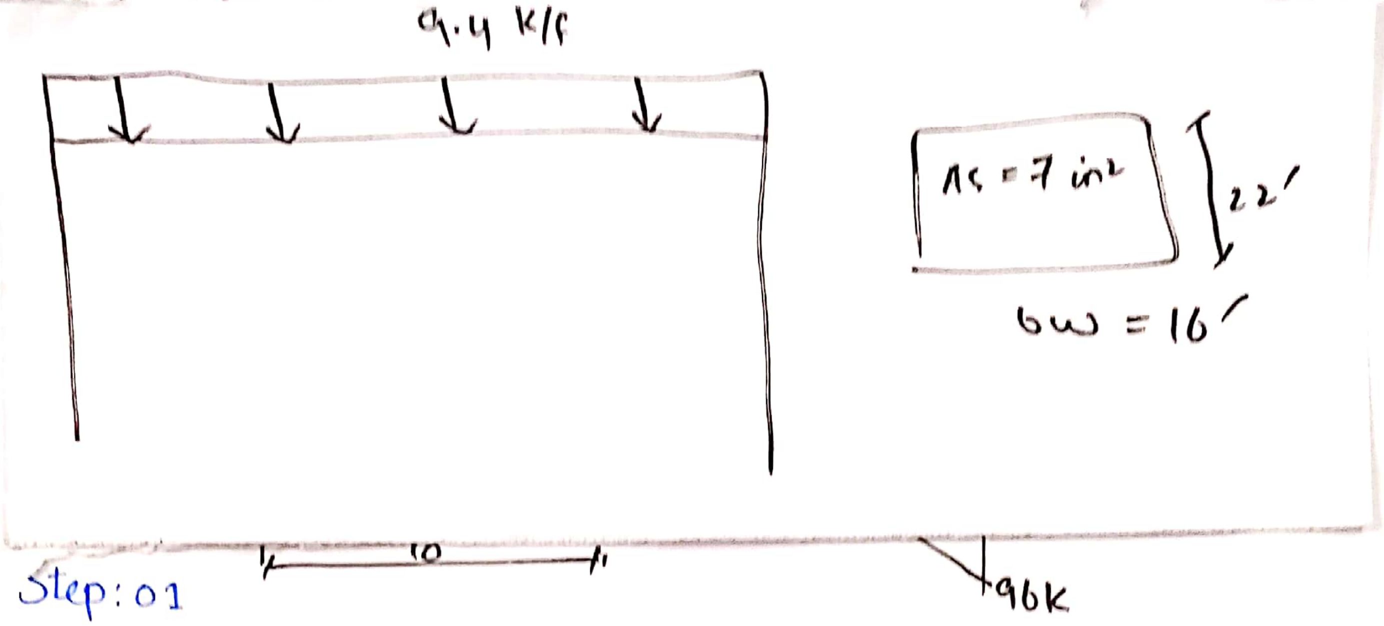
Main steel #4 at $8\frac{1}{2}$ c/c

Distribution steel # 4 at 14" c/c

(5)



Q NO 2



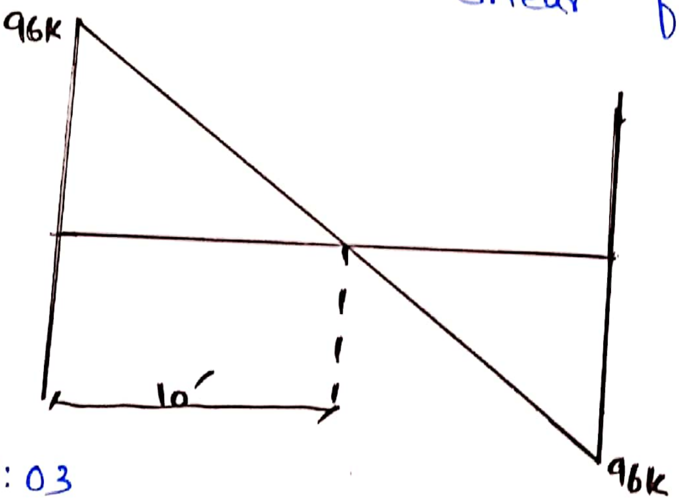
Step: 01

Find value of rxns

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

Step: 02

Draw its shear force diagram

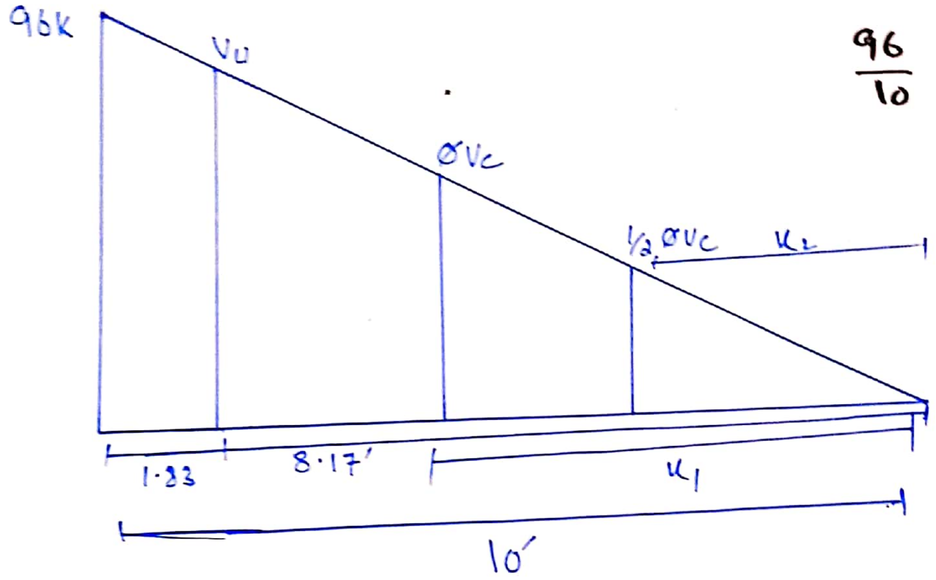


Step: 03

Find the value of critical S[illegible] "V[illegible]" and its location

As we know that critical section is located at distance 'd' from face of support = 1-83'

Value of critical shear at distance "d" by Similarity of Δs



For similar Δs

$$\frac{96}{10} = \frac{V_u}{8.17}$$

$$V_u = 78.43$$

Step:04

Find Value of ϕV_c and $1/2\,\phi V_c$ and also it distance from zero shear to right side

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

$$= \frac{0.75 \times 2\sqrt{4000} \times 16 \times 22}{1000} = 33.40k$$

Location of ϕV_c by similar Δs

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

Now

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

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

$$x_2 = 1.73$$

Step : 05

Value of ϕV_s :

$$V_u = \phi V_s + \phi V_c$$

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

$$= 78.43 - 33.40$$

$$= 45.03K$$

Step : 06 :

Check on section adequary

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

$$= 133.57K$$

As

$\phi V_s < \phi 8\sqrt{f'c}\, b_w d$ Section is adequate tep: 07 : Check on Maximum Spacing for Stirrups

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

$$= 66.79 \text{ kip}$$

As $\phi 4\sqrt{f'c}\, bwd > \phi Vs = 45.03K$

So, ~~Max~~ Mini spacing will be selected from following four condition

1- $S_{max} = 24''$ 2 - $\frac{d}{2} = \frac{22}{2} = 11''$

3 - $S_{max} = \frac{Av \times fy}{0.75 \times \sqrt{f'c} \times bw}$

$= 17.40''$

4 - $\frac{Av \times fy}{50 \times bw} = \frac{0.22 \times 60{,}000}{50 \times 16}$

$= 16.50''$

From above four Condition, Least value of spacing for # 3, 2 legged Stirrup will selected

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

Step : 08

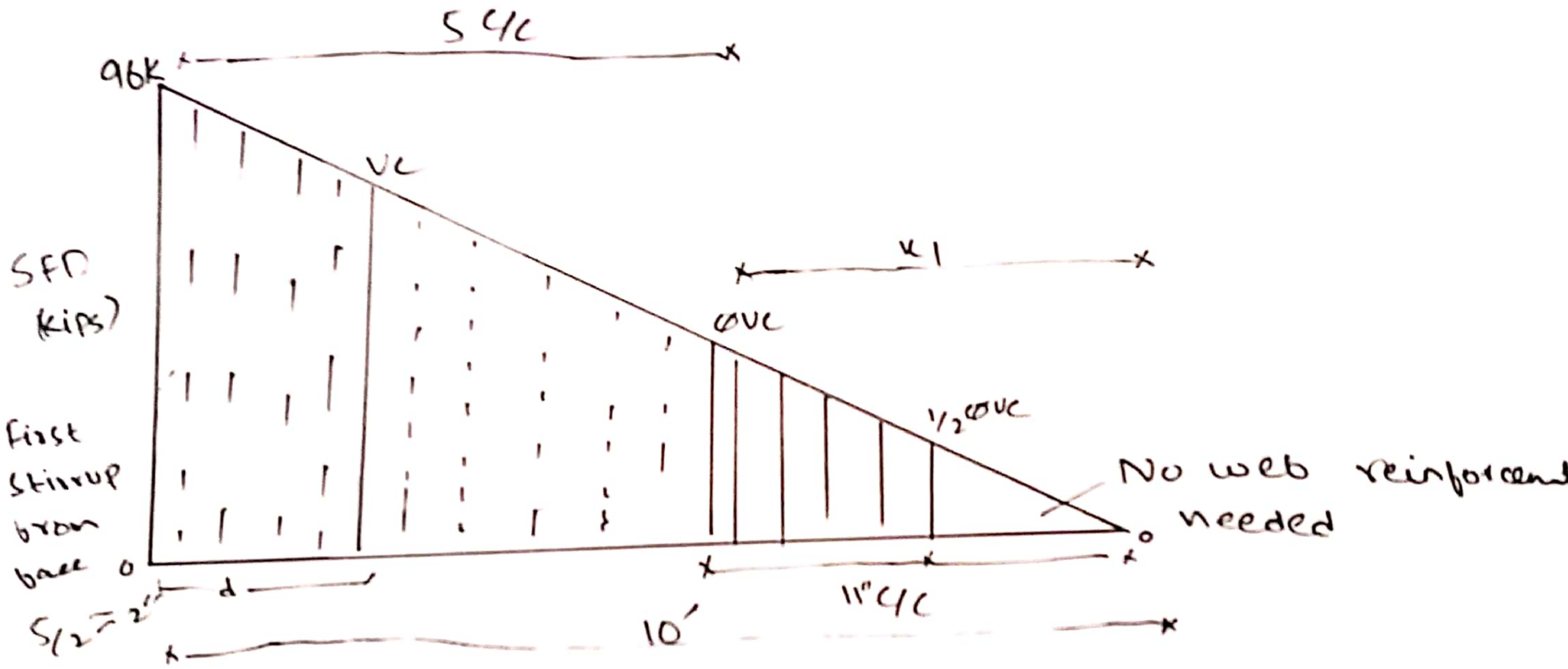
$$S = \frac{\phi \times Av \times fy \times d}{Vu - \phi Vc} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$$

S=

S = 5 c/c

Step: 09

Final sketch



Scanned with CamScanner

QNo: 3

Step: 01:

Find Gross area of concrete

$A_g = b \times b$ (Square footing)

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

Step: 02

Find the area of steel

$A_s = 5\%$ of A_g

$= 0.05 \times 144$

$= 7.2 \; in^2$

Step: 03 Ultimate load carrying capacity

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

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

$P_u = 466.50k$

Step: 04

Sketch & design of ties (c/c to distance)

From below value we choose the least value of all these.

Scanned with CamScanner

- 16 x dia of long bars = 16 x 9/8

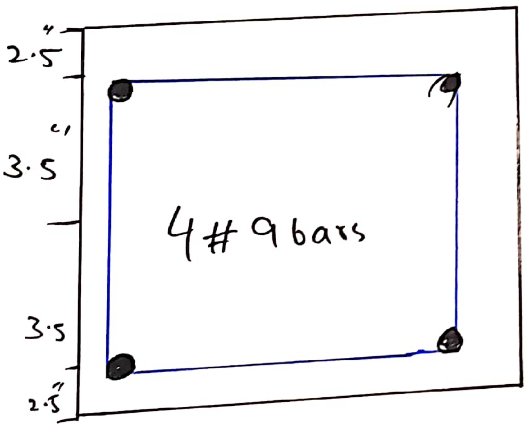
= 18"

2- 48 x dia of tie bar = 48 x 3/8

= 18"

3- Least Column dimension = 12"

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



It is a tied Square Column.

So there is no Spiral Column used, the stirrup used is of rectangular shape due to the specific of the structure thus we us tie stirrup instead of Spiral Stirrups.

Q No 4

Design a Square footing - - - -
Sketch the diagram.

Step: 01

Let

$h = 24''$

Step: 02

Total weight = wt of soil + wt of Rc

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

$= 660 Psf = 0.66 ksf$

Step: 03 Effective bearing Capicity

$q_e = q_a - w$

$= 2.50 - 0.660$

$= 1.84 ksf$

Step: 04

Required area for foundation

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

$= 119.57 ft^3$

Step : 05

$A_{req} = b \times b$

$= 119.57 \Rightarrow B \approx 11$

Step:06 Upward Bearing Capacity of Soil

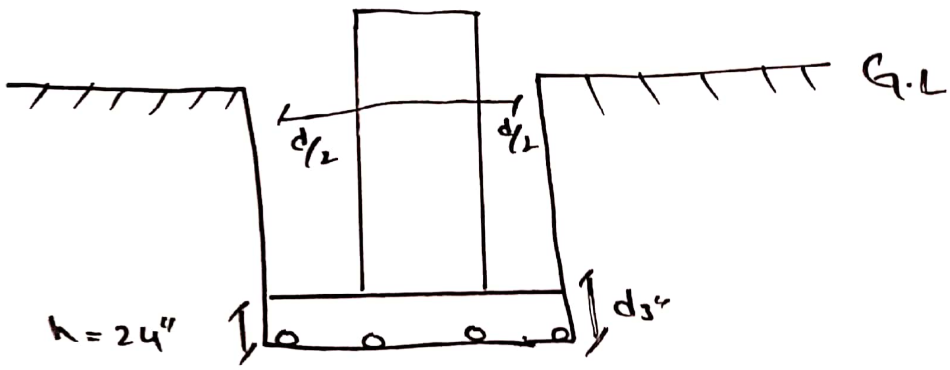
$q_{up} = \dfrac{\text{Factored Load}}{B^2} = \dfrac{1.2 \times 100 + 1.6 \times 120}{11^2}$

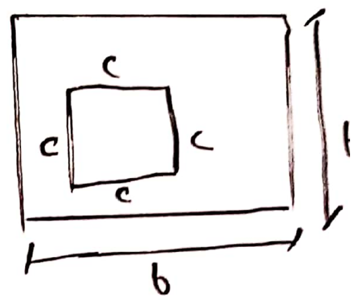
$q_{up} = 2.58\ K/ft^2$

Step: 07

Punching area

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





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

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

$= 4 \times (16 + 19.5) = 142"$

Step: 08

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

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

$$= 289.60K$$

Step: 09

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

$$= \frac{0.75 \times 3 \sqrt{4000} \times 142 \times 19.5}{1000}$$

$$= ~~525.38K~~ \quad 394.0K$$

Step: 10

Beam shear/ one way shear cheek

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

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

$$V_u = 90.95K$$

Step: 11

Self shear capacity

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

$$= \frac{0.75 \times 2\sqrt{1000} \times (11 \times 12.16)}{1000}$$

$$= 110.04 > V_{u1} \Rightarrow O.K$$

Step: 12

Ultimate Moment

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

$$= 331.49k' = 3977.93k$$

Step: 13

Area of steel for mainbars by trial & Repeat Method

trial 1:

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

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/_2)} = \frac{3977.93}{0.9 \times 60 \left(11 - 4.8/_2\right)}$$

$$= 8.56 in^2$$

trial: 2

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

$$= 1.53''$$

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

trial 3:-

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

$$A_s \quad \frac{3977.93}{0.90 \times 60 (11 - \frac{1.28}{2})}$$

So thus area $= 7.1 \text{ in}^2$

Step: 14

Check the min reinforcement by the following as method,

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

$$A_{s\,min} = 5.7 \text{ in}^2$$

$$As_{min} = \frac{200}{f_y} \times B \times d = \frac{200}{60{,}000} \times (11 \times 12) \times 19.5$$

$$= 8.58 \text{ in}^2$$

$$As_{min} = \frac{3 \times \sqrt{f'c}}{f_y} \times B \times d = \frac{3 \times \sqrt{300}}{60{,}000} \times (11 \times 12) \times 19.5$$

$$= 7.05 \text{ in}^2$$

From above values greater value will be selected thus $As_{min} = 8.58 \text{ in}^2$

Step : 15

Using # 8 bars

$A_b = 1 in^2$

$$\text{No of bars} = \frac{8.585}{1 in^2} = 9$$

$\simeq$ 9 bars in each direction.