Name	Sajid Saleem
ID#	7793
Section	A
Subject	PRCD I
Submitted to	Sir Fawad
Semester	6th

Given Data

3 equal Span Concrete slab

Clear Span b/w Supports = 15 ft

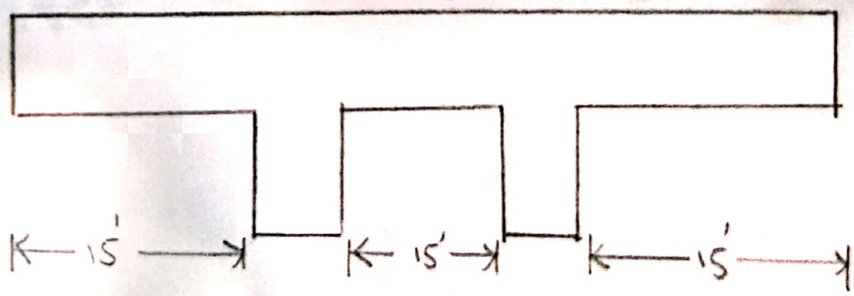
Factored live load = 1600 lb/ft^2

Service floor finish load = 20 lb/ft^2

f'_c = 4000 psi

f_y = 40 Ksi

Solution



Step#01 Minimum thickness

By Using formula

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

As $f_y \rightarrow 40$ ksi

So we will multiply a factor with this thickness

$$\text{Factor} = \left[0.4 + \frac{f_y}{100}\right]$$

$$= 0.4 + \frac{40}{100} = 0.8$$

=

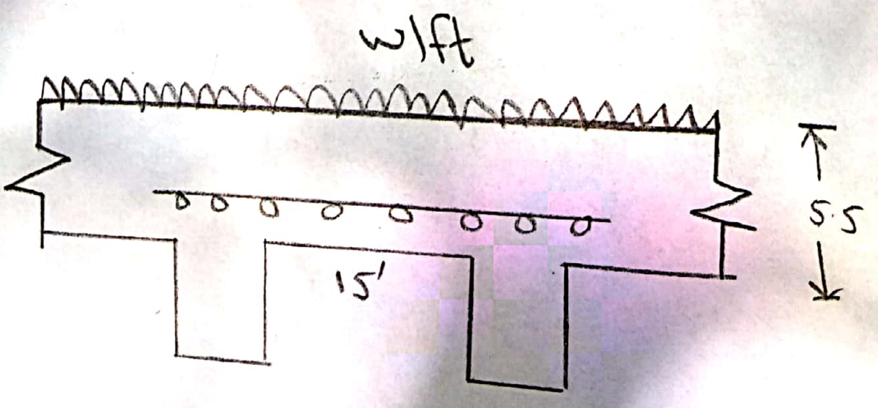
Hence the minimum thickness will be

6.5×0.8

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

$$\boxed{t_{min} = 5.5''}$$

Step #2 Effective depth



By formula

By formula

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

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

$d \cong 4.5''$

Step#03 (self weight of slab)

By formula

$t/12 + \gamma_{concrete}$

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

$= 68.75\ lb/ft^2$

Step#04 (Total Factored load)

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

So the factored Dead load will be

IV

$D \cdot L = 1.2(20 + 68.75) = 106.5 \text{ lb/ft}^2$

Total factored load = $D \cdot L + L \cdot L$

$= 106.5 + 160$

$= 266.5 \text{ lb/ft} = 0.2665 \text{ k/ft}^2$

Step #05 Ultimate moment

By Using formula

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

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

Step #06 Area of Steel For main Bar by trail & Repeat Method

Trial #01

let depth of Compressive block

$a = 0.2 \times t$

Scanned with CamScanner

$$P = 5$$

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

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

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

Trail #02

$$a = \frac{A_{st} \times fy}{0.55 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} \Rightarrow 0.62 \text{ in}^2$$

$$A_{st} = \frac{Mu}{\phi \times fy \times (d - \frac{a}{2})} = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{0.6}{2}\right)}$$

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

Trail #03

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

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

P = 6

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

Step#07

Area of Steel for distribution reinforcement

By 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 #08

Spacing for main bars

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 bar so

$dia = \left(\frac{5}{8}\right)''$

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

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

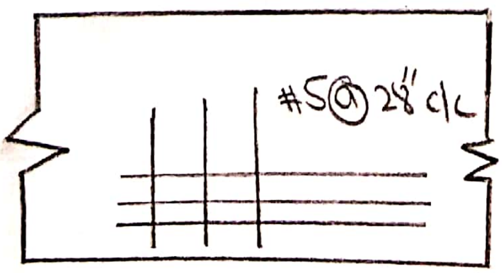
Step #10

Find sketch

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

main steel #6 at 9" c/c

Distribution steel #5 at 28" c/c



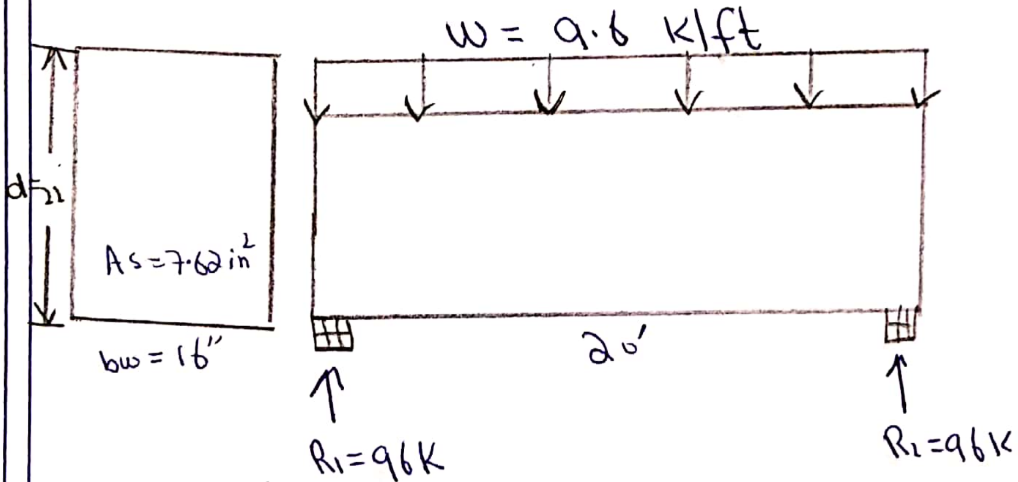
Sol First of all find the Unit load of beam

So $b \times \gamma_c$

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

So total factored load = $9.4 + 0.2$

$= 9.6$ K/ft



Step # 01

Find the value of R_1 & R_2

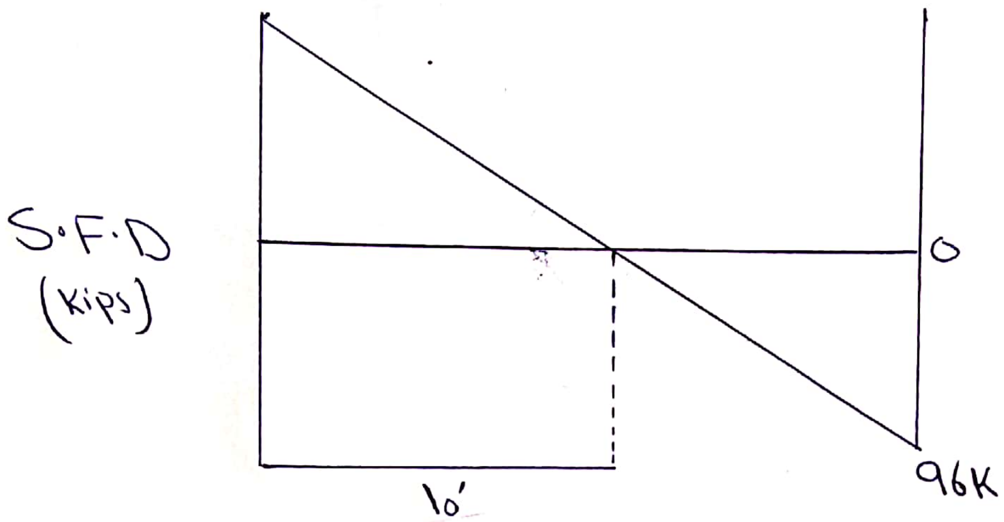
Total load = $\frac{9.6 \times 20}{2} = 96$ K

Step # 02

Draw it shear force diagram

B

P = 9

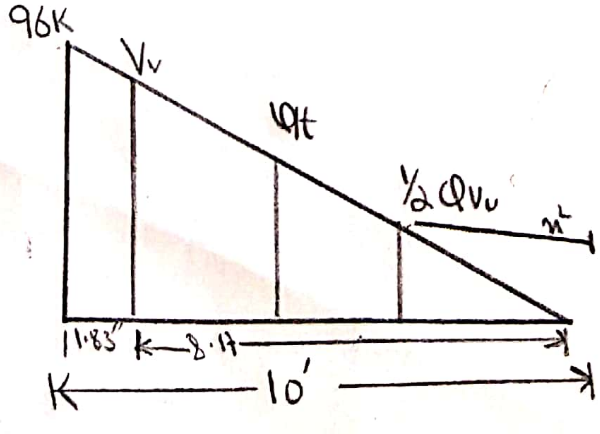


Step#03

Find the value of Critical Stress "V_u"
& its location

As we know that critical section is located at distance "d" from face of support

$d = 22'' = 1.83''$ value of critical shear at distance 'd" by similarity of triangles



$P = 10$

From Similar Δ's $\frac{96}{10} = \frac{V_v}{8.17}$

$$V_v = 78.43K$$

Step#04

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

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

$$\phi V_c = 33.40K$$

location of ϕV_c by Similarity of Δs.

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

$$x_1 = 3.48'$$

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

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

$$x_2 = 1.74'$$

Step # 05

Value of ϕV_s $\left(V_v = \phi V_s + \phi V_c\right)$

So $\phi V_s = V_v - \phi V_c$

$\phi V_s = 78.43 - 33.40$

$$\boxed{\phi V_s = 45.03 K}$$

Step# 06

Check on section adequacy.

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

$= 133.57$ K

As $\phi \times 8\sqrt{f_c'} \times b_w \times d > \phi V_s$ It means section is adequate.

Step#07 check on min spacing for Stirrups.

$\phi \times 4 \times \sqrt{f_c'} \times b_w \times d = \dfrac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000} = 66.79K$

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

Scanned with CamScanner

Thus max spacing will be Selected from the following four Condition

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

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

3) $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'_c} \times b_w} = 0.$

$A_v = \frac{\pi}{4}\left(\frac{3}{8}\right)^2 = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16}$ $A_v = 0.11 \times 2$, $A_v = 0.22$

$= 17.40''$

4) $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 60000}{50 \times 16} = 16.50$

From above four Condition, least Value of spacing from #3 U shaped will be Selected So, $S_{max} = 11''$ c/c

Step #08

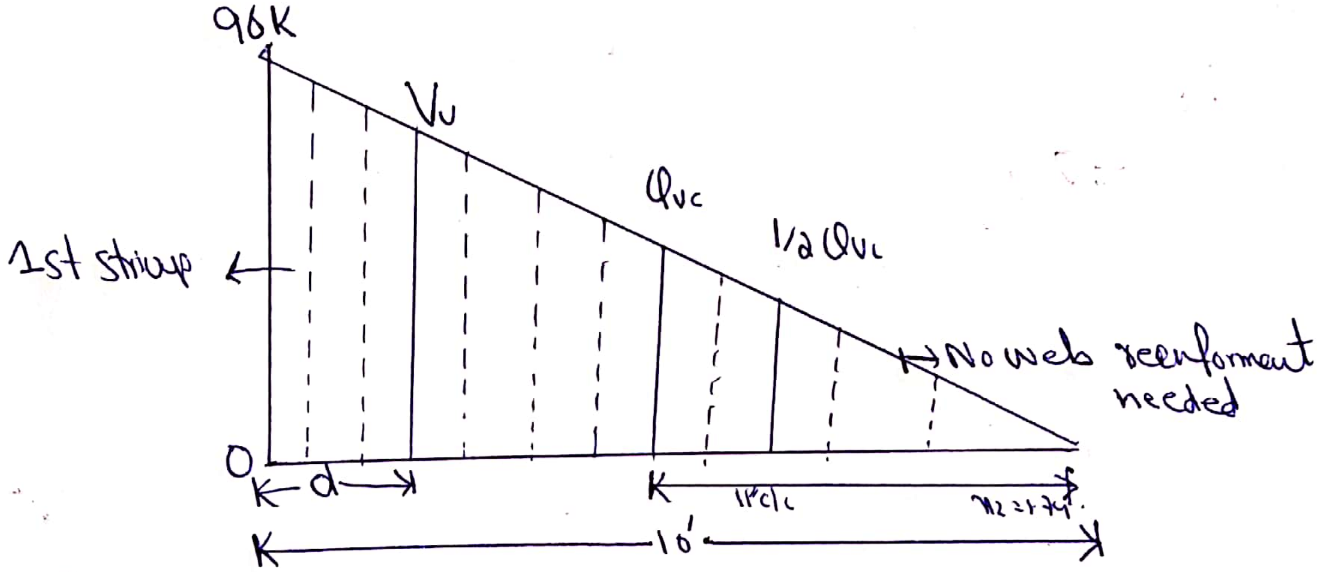
Spacing of Stirrup from / at critical Section

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

$$= 48.4'' \approx 5'' \text{ c/c}$$

Step #09

Find Sketch



الف

P=14

Ans 3

Step#1

Find gross area of Concrete

$A_g = b \times b$ (since it is squre tie Column)

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

Step#2

Find the area of steel

Since A_s = 5% of A_g

$A_s = 0.05 \times 144$

$A_s = 7.2\ in^2$

Step#3

Ultimate load Carring Capacity

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

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

$P_U = 466.50\ K$

Step #04

Sketch & design of Tie (c/c distance)

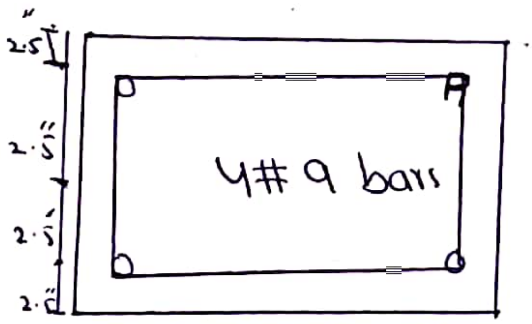
From the below value we choose the least value of all thus

i) 16 x dia of long bar = 16 x 9/8

ii) 48 x dia of Tie bar = 48 x 3/8

iii) least Column dimensions = 12"

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



Since it is a tied squre column so there is no spiral sturrip used. the strripps used is of rectangular shape due to the specification of the structure. thus we will use tie stirrups instead.

Ave 4

P-16

Step#01

~~Total weight~~ h = 24"

Step#2

Total weight = wt of Soil + wt of RC

= 3×120 + 2×150

= 660 psf = 0.660 ksf

Step#3

Effective bearing Capacity

$q_e = q_a - W$

$q_e = 2.50 - 0.660$

$q_e = 1.84$ ksf

Step#4

Required Area of foundation

Scanned with CamScanner

$$A_{req} = \frac{\text{Service load}}{q_e} = \frac{100 + 120}{1.84} = 119.57 ft^2$$

Step#5

Since foundation is squre

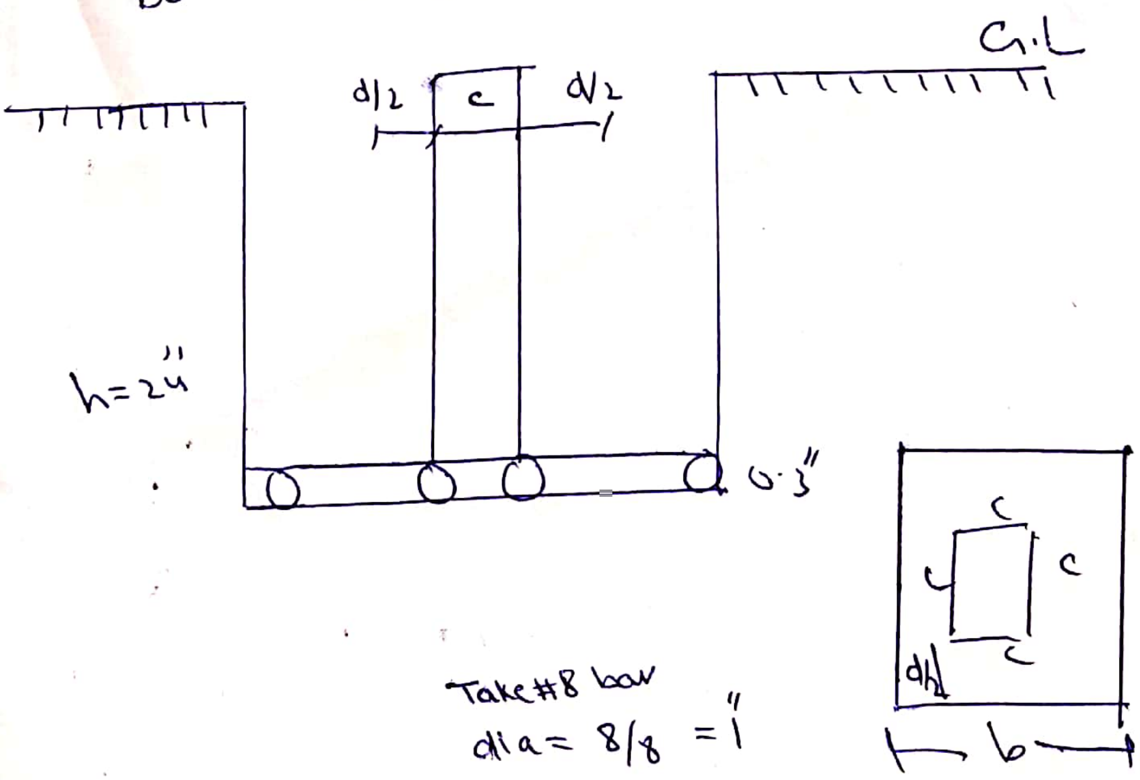
$$A_{req} = b \times b = 119.57 \Rightarrow 12'$$

Step#6 Upward bearing capacity of soil

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

Step#7 Punching Shear

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



Take #8 bar

$dia = 8/8 = 1''$

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

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

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

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#9

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

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

$\phi_{u/p} = 525.38$

Step#10

Beam shear one way shear check

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

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

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

Step#11

Self Shear Capacity

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

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

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

$p = 20$

Step#12 Ultimate moment

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

$Mu = 331.49K \simeq 3977.93K'$

Step#13

Area of steel for main bar by trail & Repeat method

trail#01

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

$$As = \frac{Mu}{\phi \times fy \left(d - \frac{a}{2}\right)} = \frac{3977.93}{0.85 \times 60 \times 11 - \frac{4.8}{2}} = 1.53''$$

Trail#02

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

Trail#03

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

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

So that area = $7.1\ in^2$

Step#14

Check the min reinforcement by following 03 method

a) $As_{min} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$
$= 5.70\ in^2$

b) $As_{min} = \frac{200}{fy} \times B \times d = \frac{200}{60000}(11 \times 12) \times 19.5$

$= 8.58\ in^2$

c) $As_{min} = \frac{3 \times \sqrt{f_c'}}{fy} \times B \times d = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$

$= 7.05\ in^2$

From above value greater value will be selected

thus $As_{min} = 8.58\ in^2$

Step#15 Using #8 bar

$A_b = 0.785\ in^2$

$$\text{No of bar} = \frac{A_s}{A_b} = \frac{8.58}{0.785} = 10.92 = 11$$

11 bar in each directn