ID # 6938 **PRCD I** Page # 01

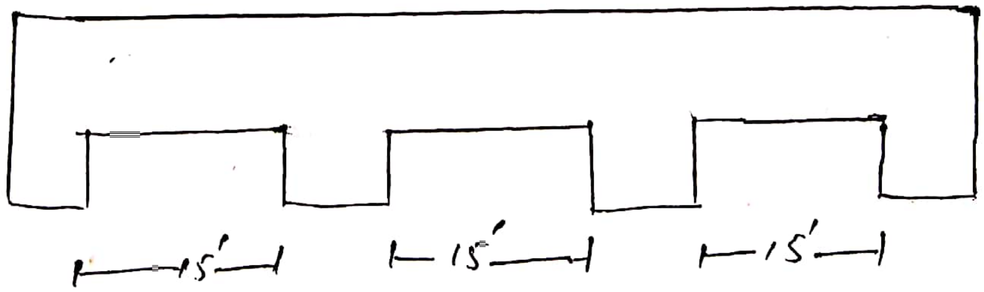
Name: Shahzeb_Khan Section - A

Q No: 01

## Given data:

- ⇒ 3 equal spans Concrete Slab
- ⇒ Clear span b/w supports = 15 ft
- ⇒ Factored live load = 160 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:

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

As $f_y \rightarrow 40$ ksi

So will multiply a factor with the thickness

$$factor = \left(0.4 + \frac{f_y}{100}\right)$$

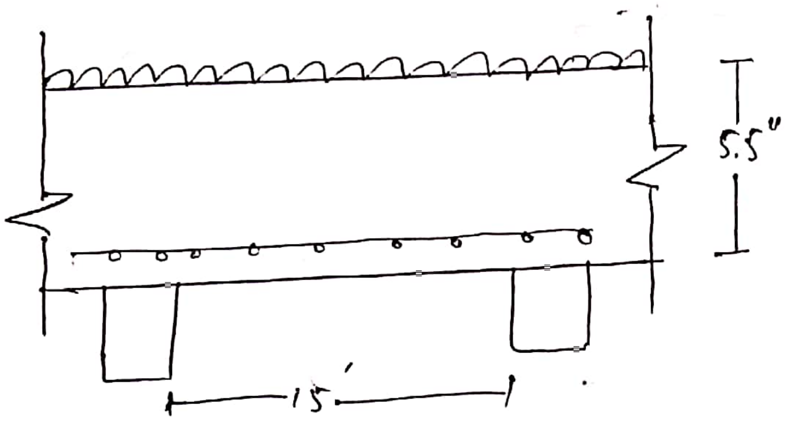
$$= \left(0.4 + \frac{40}{100}\right) = 0.8$$

Hence the minimum thickness will be

$6.5 \times 0.8$

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

Step # 2




By formula

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

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

$d = 4.5"$

Step # 3 ( Self wt. of slab )

By formula

$\frac{t}{12} + \gamma_{\text{reconcrete}}$

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

Step # 4 ( Total factored load )

Factored live load = 160 lb/ft²

So the factored dead load will be

D.L = 1.2 (20 + 68.75) = 106.5 lb/ft²

Total factored load = D.L + L.L

= 106.5 + 160

= 266.5 lb/ft² ⇒ 0.2665 k/ft²

Step # 5. ( Ultimate moment : )

By using formula

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

= 89.94 kip- inches

Step # 6 : Area of steel for main Bars by Trial and Repeat method.

## Trial #01

Let depth of Compression block

$a = 0.2 \times t$

$= 0.2 \times 5.5 = 1.1''$

$$Ast = \frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{89.94}{0.90 \times 40 (4.5 - \frac{1.1}{2})} = 0.63 \text{ in}^2$$

## "Trial #02"

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times (12)} = 0.62 \text{ in}^2$$

$$Ast \; \frac{Mu}{\phi \times fy \times (d - \frac{a}{2})} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.6}{2})} = 0.59 \text{ in}^2$$

$Ast = 0.95 \text{ in}^2$

## Trial #03:

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

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

So we will use Ast $0.59 \text{ in}^2$

**Step # 07: <u>Area of steel for distribution reinforcement</u>**

By formula

$A_{min} = 0.002 \times b \times t \Rightarrow$ (For Grade 40 steel)

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

**Step #08 <u>Spacing for main bars</u>**

By formula

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

We use #6 bar dia $(\frac{6}{8})''$

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

**Step #09 <u>Spacing for distribution bars:</u>**

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

We use #5 bar so

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

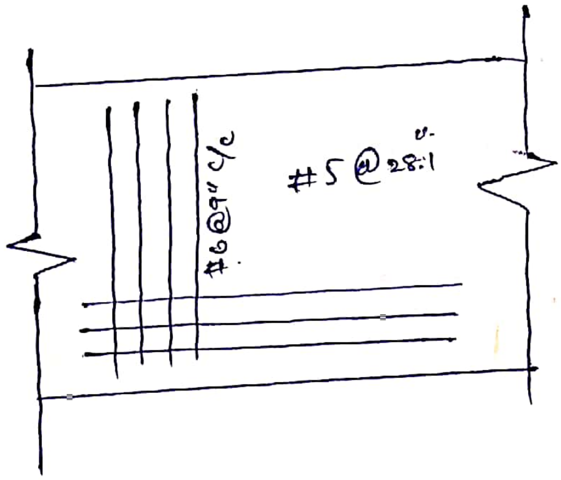
Spacing $= \frac{0.31}{0.132} \times 12 = 2.81'' \simeq 28''$ c/c

Step #10 <u>Final Sketch</u>

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

main steel #6 at 9" c/c

Distribution steel #5 at 28" c/c



Q NO! 02

Given data:

Breadth = 16"

Effective depth = 22"

Total factored load = 9.4 kips/ft

Span = 20'

area of steel = 7.62 in²

$f'_c$ = 4000 Psi

$f_y$ = 60000 Psi

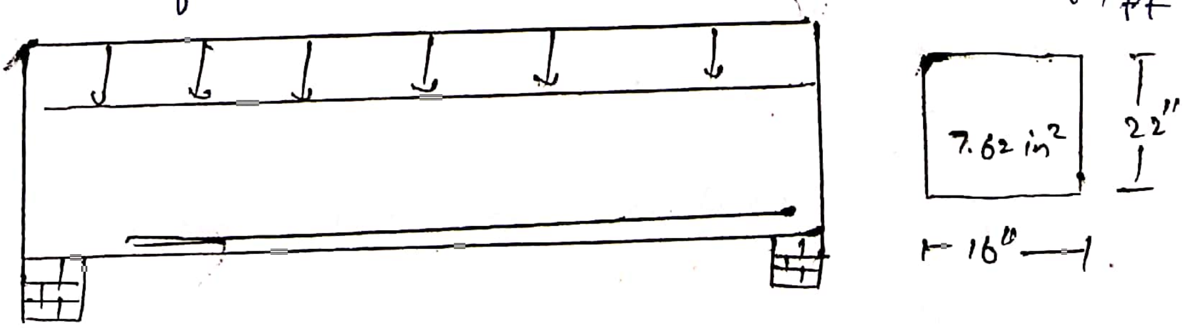
Solution

Find the self-weight of beam by formula;

$= b \times t \times 150 \ lb/ft^3$

$= \frac{16}{12} \times \frac{22}{12} \times 150 = 366.67 \ lb/ft = 0.3666 \ k/ft$

So the factor load will = 1.2 (0.3666) = 0.44 kips/ft

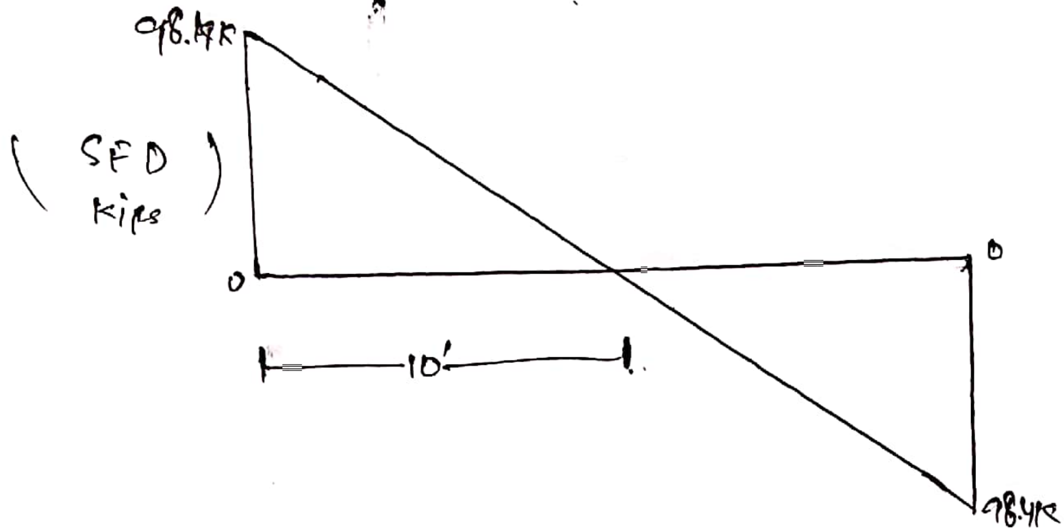


Step #01 : Reaction values

$$\text{Total load} = \frac{9.84 \times 20}{2} = 98.4 \text{ kips}$$

Hence both the Support Contains 98.4 kips

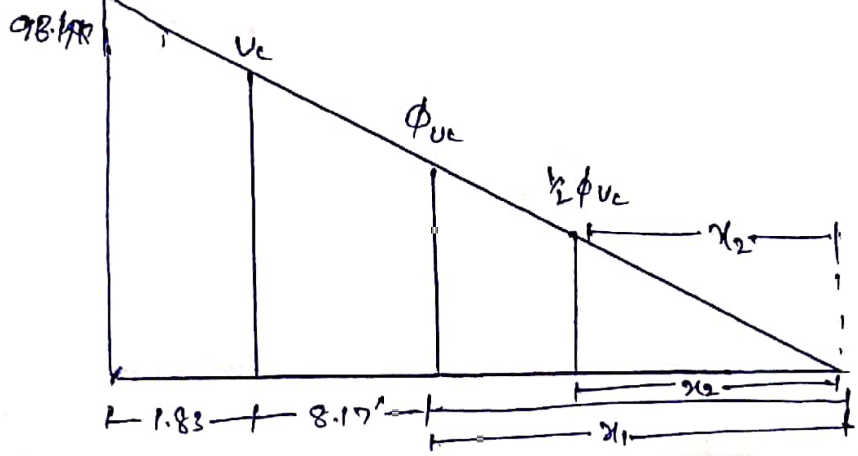
Step # 2 Draw its Shear force diagram




Step #03 Finding value of critical 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 $\frac{96}{10} = \frac{V_u}{8.17}$

$V_u = 78.43\ K$

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

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

$\phi V_c = 33.40\ K$

Location of $\phi V_c$ by similarity of Δ's

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

$x_1 = 3.38'$

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x_2} \Rightarrow x_2 = 1.69'$

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

So we have

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 80.43 - 33.40$

$\boxed{\phi V_s = 46.03k}$

## Step #06 Check Section Adequacy:

$\phi \times 8 \times \sqrt{f'c} \times b_w \times d = \dfrac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000} = 133.57k$

$133.57k > \phi V_s$ (means Section is adequate).

## Step #07 Check mini spacing for stirrups.

$\phi \times 4 \times \sqrt{f'c} \times b_w \times d = \dfrac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000} = 66.79k$

$66.79k > \phi V_s = 44.03k$

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

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

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

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

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

$S_{max} = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16} = 17.40''$

∴ As we are using #3 U-Stirrups so it has dia $(3/8)''$ and Area $0.11\,in^2$ for 2 legged, we will multiply it by 2

$0.11 \times 2\,2\,in^2$

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

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

From the above 4 conditions least value of spacing for #3 U shaped will be selected

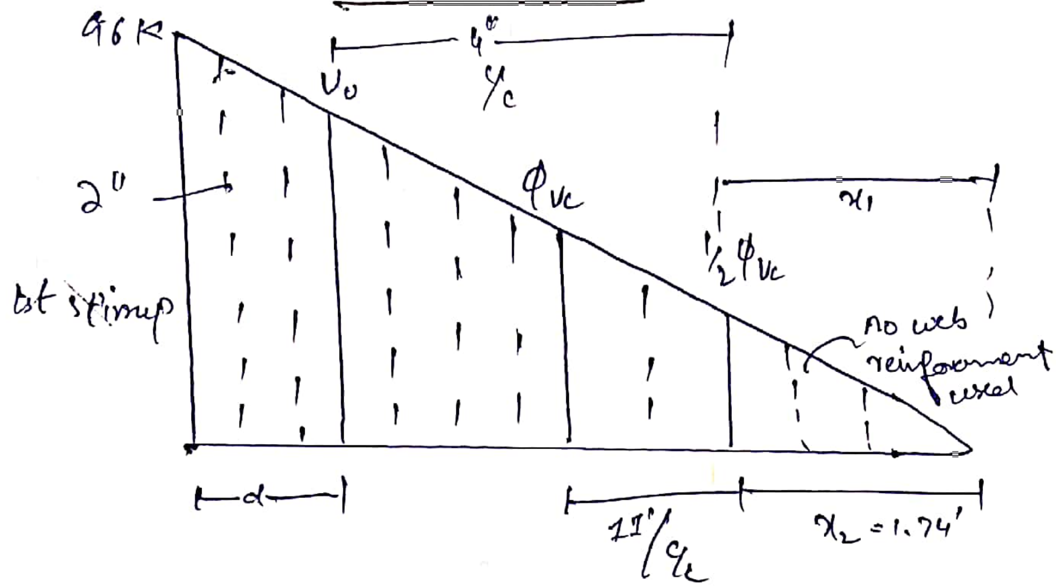
So $\boxed{S_{max} = 11''\ c/c}$

Step #08 Spacing of stirrup from at critical Section

$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{80.43 - 38.40} = 4.4$

$S = 4.846 \simeq 4'' \; c/c$

Step # 09 Final Sketch:




We know that first stirrup from face of support $= \frac{S}{2} = \frac{4}{2} = 2''$

Q No! 03

Solution:-

Step # 01 Find gross area of Concrete

$A_g = 6 \times 6$

$A_g = 12 \times 12 = 144\ in^2$ (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 carring capacity

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

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

$\boxed{P_u = 466.50\ k}$

Step # 04 :-

Sketch & design of Ties (c/c to distribution

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

1- 16 x dia of long bar = 16 x 9/8 = 18"

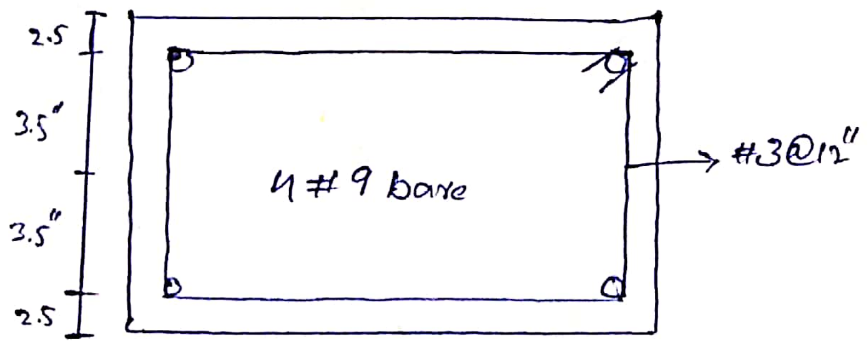
= 18"

2- 48 x dia of Tie bar = 48 x 3/8 = 18"

= 18"

3- least Column dimension = 12"

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



Since it is a tied square column so there is no spiral stirrup used, The stirrups used is of rectangular Shape due to the specification of the Structure Thus we will use tie Strirrups instead.

Q No! 04

Step # 01

Sol $h = 24''$

Step # 02:

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

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

$= 660$ psf $= 0.660$ ksf

Step # 03 Effective bearing Capacity

$q_e = q_a - w$

$= 2.50 - 0.660$

$q = 1.84$ ksf

Step # 04 Required 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,

$A_{req} = B \times B$

$= 119.57 \Rightarrow B \cong 11'$

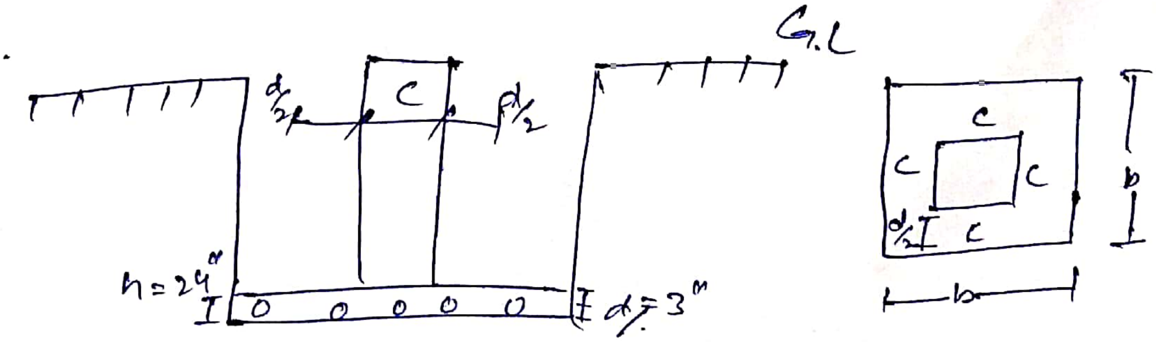
Step # 06 upward bearing Capacity of soil

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

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

Step # 7 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 $= \frac{8}{8}'' = 1''$

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

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

Step # 08 $\quad V_{u_2} = q_{up} \times \left[B^2 - (c+d)^2\right]$

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

$V_{u_2} = 289.60k$

Step # 09 $\quad \phi V_{c/p} = \phi \times 4 \times \sqrt{f'c} \times b_o \times d$

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

$V_{c/p} = 525.38$

Step # 10 $\quad$ Beam. shear one way shear check

$V_{u_1} = q_{up} \times b \times \left[\frac{B}{2} - \frac{c}{2} - d\right]$

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

$V_{u_1} = 90.95k$

Step # 11

Self shear capacity

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

$$\frac{0.75 \times 2 \times \sqrt{4000} \times [11 \times 12 \times 18]}{1000}$$

$$= 110.04\ K > V_{U1}$$

Step # 12 ultimate moment

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

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

Step # 13 Area of Steel for main bars by Trial & Repeat method.

Trail #01

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

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

Trail #02

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

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

Trail #03

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

$$A_s = \frac{3977.93}{0.90 \times 60 (11 - \frac{1.28}{2})} = 7.197 in^2$$

So that the area is $= 7.1 in^2$

Step # 14 : Check the min reinforment by following 03 method.

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

b) $A_{s\,min} = \frac{200}{f_y} \times B \times d = \frac{200}{60000} \times (11 \times 12) \times 19.5 = 8.58\,in^2$

c) $A_{s\,min} = \frac{3 \times \sqrt{f'_c}}{f_y} \times B \times d = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$

$= 7.05\,in^2$

From the 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

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