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Section	B
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Q:: NO:: 02

A simply supported rectangular beam 16" wide .... Draw a sketch of your final diagram

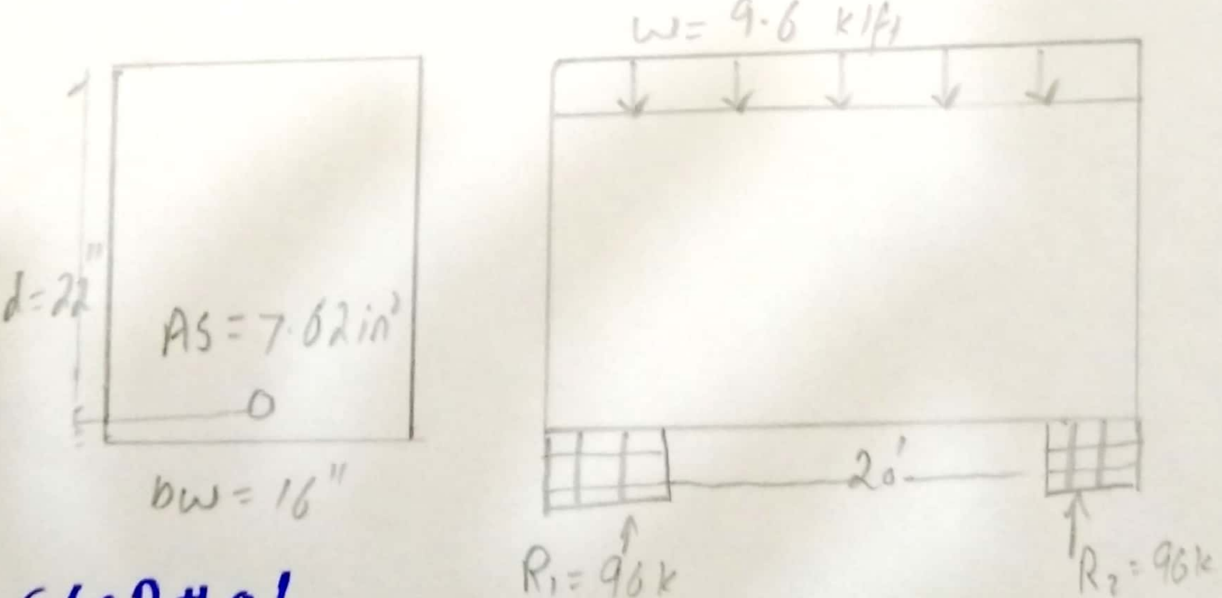
Sol:: First of all find the unit load of beam

so $b \times \gamma_c$

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

so total factored load $= 9.4 + 0.2$

$= 9.6$ k/ft

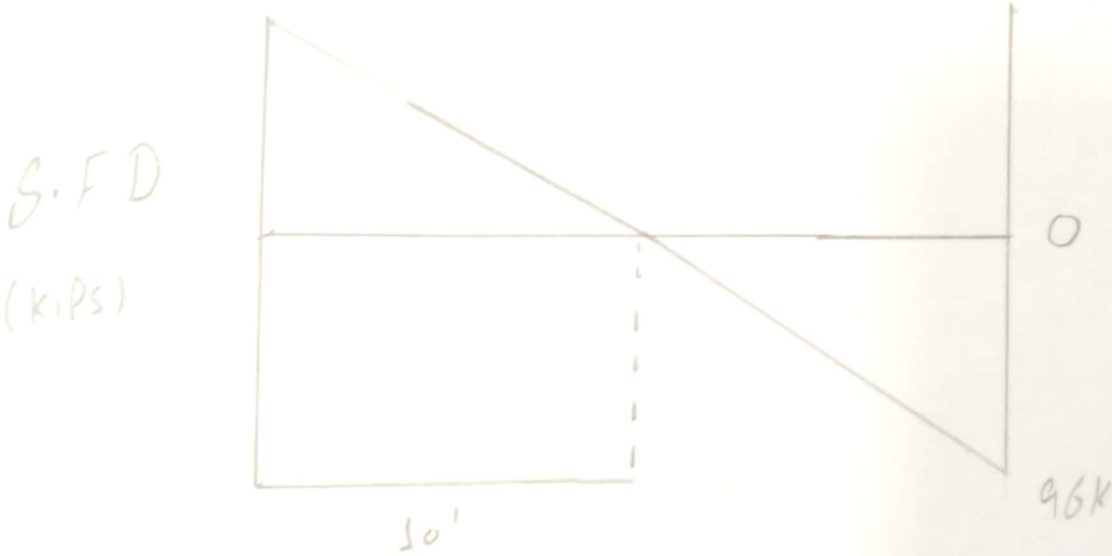


Step # 01

Find the value of R_1 & R_2

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

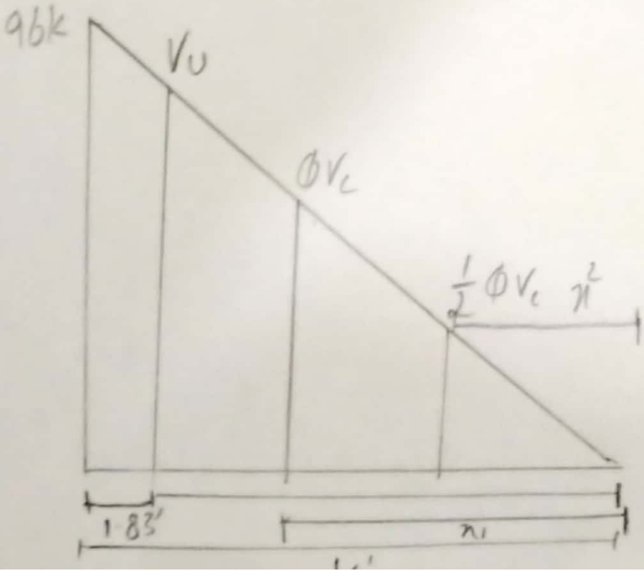
Step#02: Draw its Shear force diagram.



" Step#03:

Find the value of critical stress "Vu" and its location.

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



From similar Δ's

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

$$\boxed{V_u = 78.43\,K}$$

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

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

$$\boxed{\phi V_c = 33.40\,K}$$

Location of ϕV_c by similarity of Δs

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

$$\boxed{x_1 = 3.48'}$$

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

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

$$\boxed{x_2 = 1.74'}$$

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

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

$\phi V_s = 78.43 - 33.40$

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

Step:06:: "Check on section adequacy"

$\Rightarrow \phi \times 8 \times \sqrt{f'c} \times bw \times d = \dfrac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 133.57k$

As $\phi \times 8\sqrt{f'c} \times bw \times d > \phi V_s \rightarrow$ It means section is adequate

"Step:07"

Check on min spacing for stirrups

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

As $\phi 4\sqrt{f'c} \times bwd > \phi V_s = 45.03k$

Thus max spacing will be selected from the following four condition.

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

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

3) $S_{max} = \dfrac{Av \times fy}{0.75 \times \sqrt{fc} \times bw}$

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

$$A_v = 0.22$$

4) $$S = \frac{A_v \times f_y}{50 \times b_w}$$

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

$$= 16.50$$

From the above four condition, least value of spacing from #3, U shaped will be selected

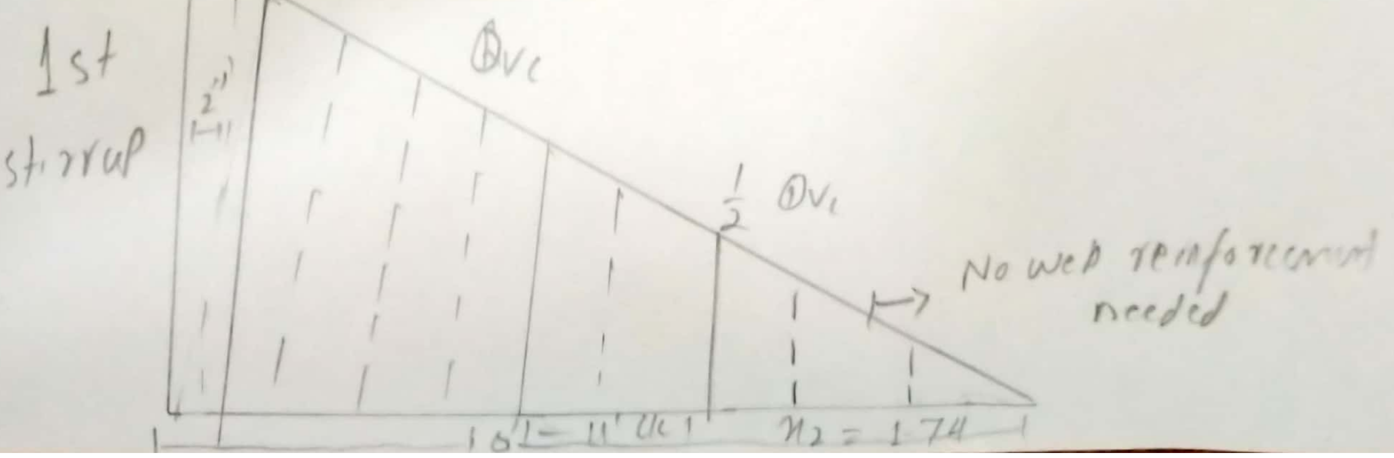
So $S_{max} = 1.1$ "C/C

Step#08: Spacing of stirr up from/at critical section.

$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.46}$$

Step #09 Find Skitch

$$= 4.84'' \approx 5'' \, C/C$$



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As we know that first stirrup from face of support

$$\Rightarrow \frac{5}{2} = 2.5 \approx 2''$$

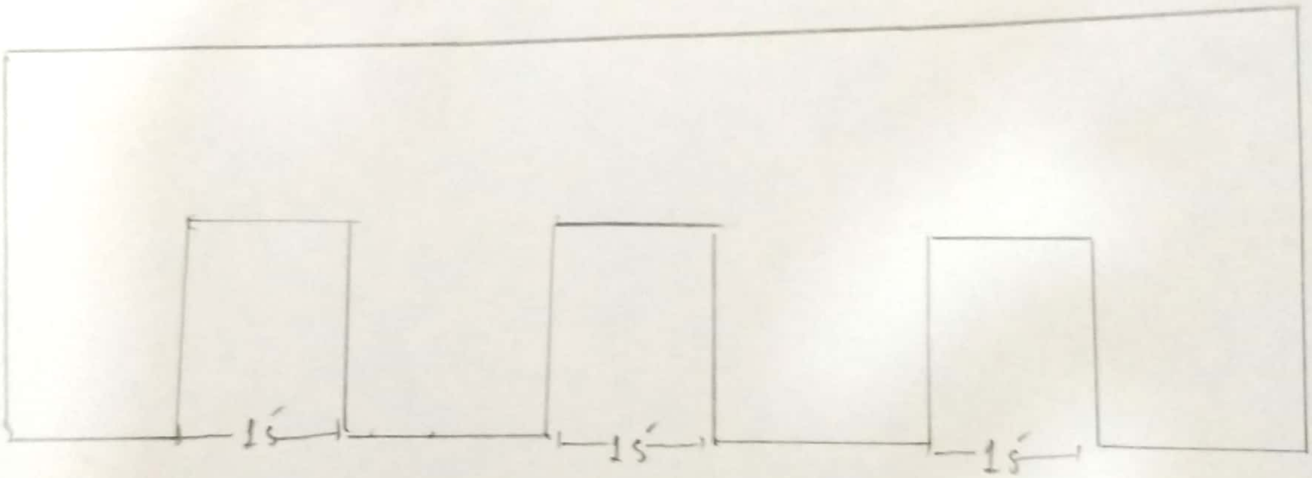
Scanned with CamScanner

Q:1) A reinforcement concrete slab is.. ------ Draw sketch of your final design.

Given data:

- Clear span b/w support = 15'
- Factored live load = 160 lb/ft^2
- Service floor finish load = 20 lb/ft^2
- f_y = 40 ksi

Sol:



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

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

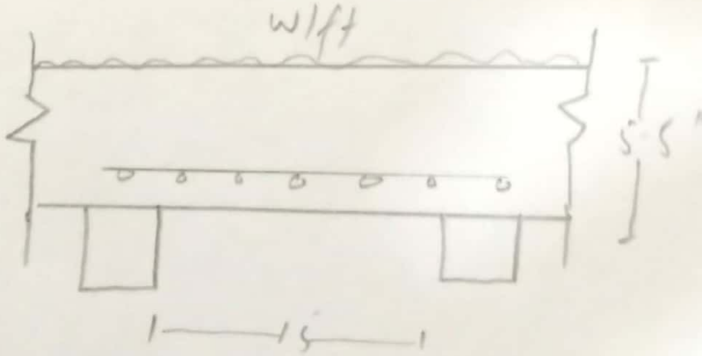
$$= \left(0.4 + \frac{40}{100}\right) = 0.8$$

Hense the minimum thickness will be

6.5×0.8

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

Step #02" effective Depth



By formula

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

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

$d = 4.5''$

Step:03 self weight 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/ft²

So the 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 #05. ultimate moment

By using formula

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

$$\boxed{M_U = 89.94 \text{ kips - inches}}$$

Step#6:

Area of steel for main bars by Trial and relort Method.

" Trial #01:

Let depth of compression block

$a = 0.2 \times t$

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

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - \frac{a}{12})} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{1.1}{2})}$$

$A_{ST} = 0.63\ in^2$

" Trial # 02

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} = 0.62\ in^2$$

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

$A_{ST} = 0.59\ in^2$

Trial #03 "

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

$$A_{ST} = \frac{89.94}{0.90 \times 40 \times (4.5 - 0.87)} = 0.59 in^2$$

So we will be $A_{ST} = 0.59 \ in^2$

Step:07: Area of steel for distribution reinforcement

By formula

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

$= 0.002 \times 12 \times 5.5$

$\boxed{= 0.132 in^2}$

Step:08 Spacing for main bars

By formula

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

we use #6 bar dia = $\left(\frac{6}{8}\right)''$

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

Step:09:. Spacing for distribution bars

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

we use #5 bars so

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

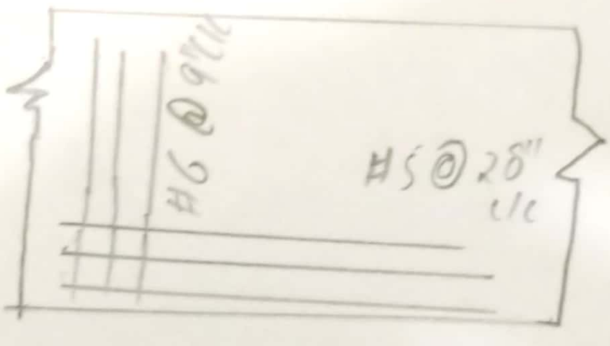
$spacing = \frac{0.31}{0.132} \times 12 = 28.1'' \approx 28$

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 :- 03

calculate the axial ultimate.... design necess ary spirals.

"Step: 01": Find gross area of concrete.

$Ag = b \times b$ (since it is squaretied column)

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

"Step: 02" Find the area of steel

Since $As = 5\%$ of Ag

$= 0.05 \times 144$

$As = 7.2\ in^2$

Step #03 :

Ultimate load carrying capacity

$Pu = \phi \times 0.80 \times [0.85 \times f'c \times (Ag - As) + As \times fy$

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

$Pu = 466.50\ k$

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

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

1)- 16 x dia of long bar = 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 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.

is

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Q: No: 4

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

Step: 01

Let $h = 24''$

Step: 02: Effective bearing capacity.

$q_e = q_a - W$

$= 2.50 - 0.660$

$q_e = 1.84\ ksf$

Step: 04. Required Area for foundation

$$Area = \frac{\text{service load}}{q_e} = \frac{100+120}{1.84} = \boxed{119.57\ ft^2}$$

" Step: 05: Since foundation is square

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

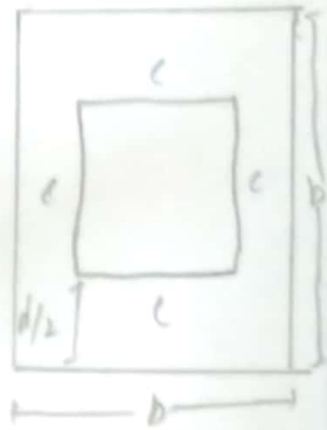
Step: 06 "Upward bearing capacity of soil"

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

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

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
$\text{dia} = 8/8" = 1"$

$b_o = 4 \times (16 + 9.5) = 142"$

Step:08:

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

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

$V_{u2} = 289.60\,k$

Step:09

$\phi V_{up} = \phi \times 4 \sqrt{f_c'} \times b \times d$

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

$\phi V_{up} = 525.38\,k$

Step:10 :- Beam shear one way shear check stress.

$$V_{U1} = q_{uP} \times B \times \left[\frac{B}{2} - \frac{C}{2} - d\right]$$

$$V_{U1} = 2.58 \times 11 \times \left[\frac{11}{2} - \frac{\frac{16}{12}}{2} - 1.95\right]$$

$$\boxed{V_{U1} = 90.95k}$$

Step#11 self capacity.

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

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

$$= 110.04k > V_{U1} \Rightarrow O.k$$

Step: 12 ultimate moment:

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

$$\boxed{M_u = 331.49k'} \simeq 3977.93k''$$

Step:13 Area of steel for main bars by Trial & Repeat method

Trial #01

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

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

Trial #02

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

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

Trial No:03

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

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

So that area $= 7.1\ in^2$

Step: 14: Check the min reinforcement by the following 03 method

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

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) $A_{s\,min} = \frac{3 \times \sqrt{f'_c}}{f_y} \times B \times d = 3 \times \sqrt{30000} \times (11 \times 12) \times 19.5$

$= 7.05\ in^2$

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 bar $= \frac{A_s}{A_b} = \frac{8.58}{0.783} = 10.92 \approx 11$ bars in each direction