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Section : "B"

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Q NO # 2.

Solution

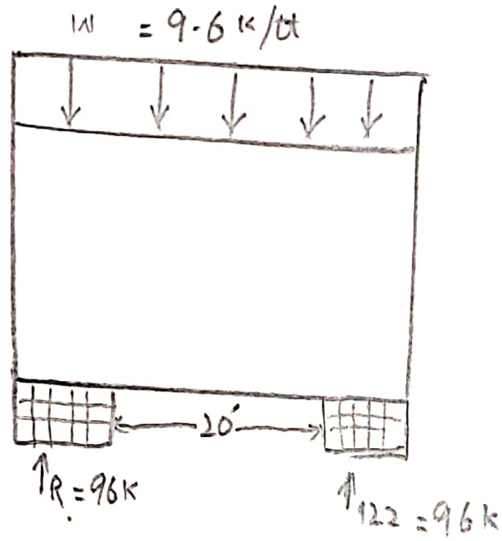
First of all we find the Unit load of beam So;

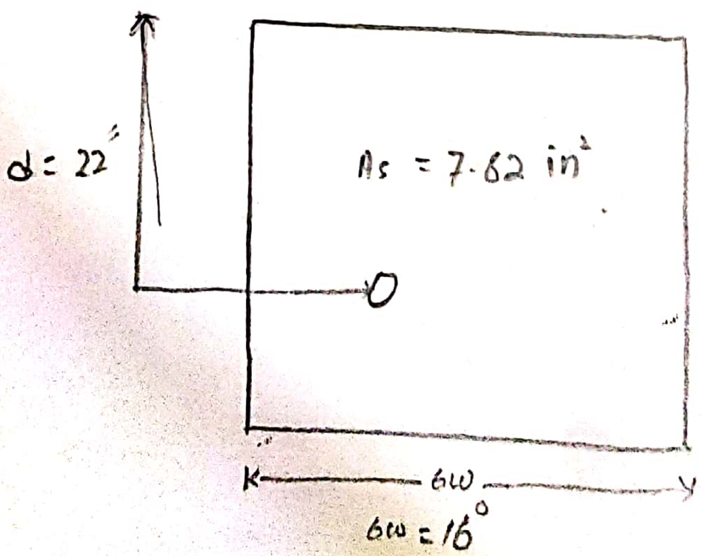
$\Rightarrow b \times \gamma_c$

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

So;

total factored load = $9.4 + 0.2 \Rightarrow 9.6\ k/ft$

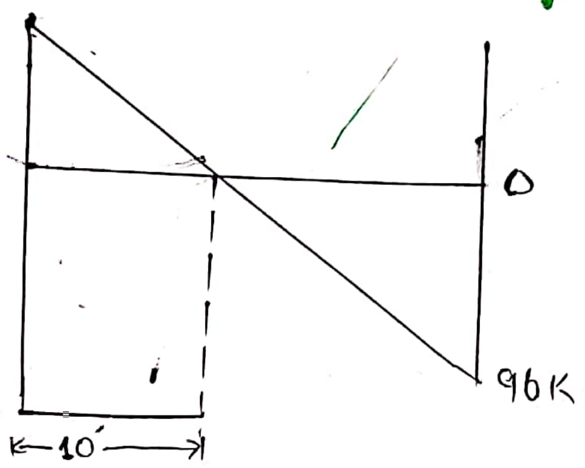




Step # 2

⇒ Draw its shear force diagram:

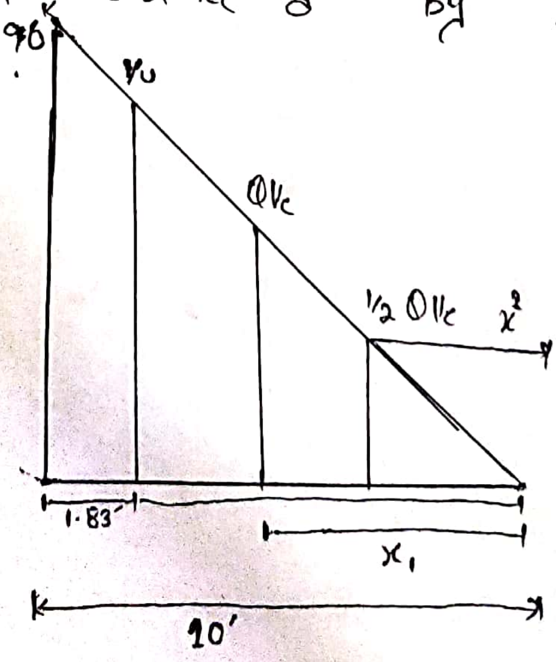
S.F.D



Step # 3

Find value of critical stress "V_u" & it's Location.

⇒ As we know that critical reaction is located at distance "d" from face of Support $d = 22'' = 1.83$ ft value of critical shear at distance "d" by Simplarity of triangular:



From similar Δ's

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

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

Step # 4

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

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

Put value:

$$\Rightarrow \frac{0.75 \times 2\sqrt{4000} \times 16 \times 2}{1000}$$

$$\Rightarrow \boxed{\phi V_c = 33.40\,k}$$

⇒ Location of ϕV_c by similarity of Δ's.

$$\Rightarrow 96/10 = 33.40/x_1$$

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

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

⇒ Location of $\frac{1}{2}\phi V_c$:

$$\Rightarrow 96/10 \Rightarrow \frac{16.70}{x_2}$$

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

Step # 5.

Value of ϕV_s $[V_u = \phi V_s + \phi V_c]$.

So;

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

$\Rightarrow \phi V_s = 78.43 - 33.40$

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

Step # 6.

Check on Section adequacy:

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

$\Rightarrow \boxed{133.57\,K}$

As:

$\Rightarrow \phi \times 8 \sqrt{f'c} \times b_w \times d > \phi V_s \longrightarrow$ It means section is adequates;

Step # 7.

Check on min spacing for stirrups:

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

As;

$\phi\, 4 \sqrt{f'c} \times b_w \times d > \phi V_s = 45.03\,K$

$\Rightarrow$ Thus:

max. spacing will be seclated from the following four condition.

(i); $S_{max} = 24''$

(ii) $d/2 = 22''/2 = 11''$

(iii) $S_{max} = \dfrac{A_v \times f_y}{0.75 \times \sqrt{f'c} \times b_w}$

$\Rightarrow AU = \pi/4 \, (3/8)^2 \Rightarrow \dfrac{0.22 \times 60000}{0.75 \sqrt{4000} \times 16}$

$AU = 0.11 \times 2$

$AU = 0.22$

$= \boxed{17.40''}$

(4) $S_{max} = \dfrac{Au \times fy}{50 \times b'w}$

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

$\Rightarrow \boxed{S_{max} = 16.50}$

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

So;

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

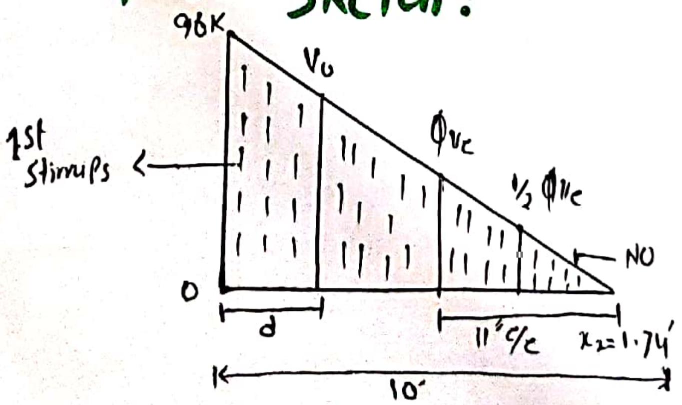
Step # 8.

Spacing of stirrup from / at critical section:

$\Rightarrow S = \dfrac{\Phi \times AU \times fy \times d}{Vu - \Phi vc} \Rightarrow \dfrac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$

$\boxed{S = 48.4'' \approx 5'' \, c/c}$

Step # 9. Find Sketch:



(★): As we know that first stirrup from face of support =

$\Rightarrow \boxed{5/2 = 2.5 \approx 2''}$

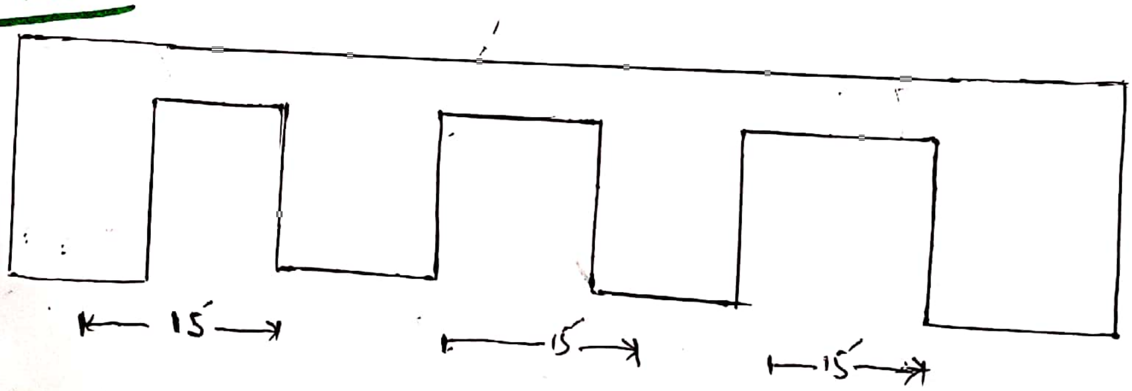
Q No # 1. A reinforcement concrete slab is ....

.... Draw & sketch of your find Dia?

⇒ **Given data :**

* clear span b/w support = 15′
* Factored live load = 160 lb/ft²
* service floor finish load = 20 lb/ft²
* fy = 40 ksi

Solution :



Step # 1.

Minimum Thickness :

by using formulas:

⇒ $t_{min} = L/28 \Rightarrow 15/28$

$t_{min} = 6.4 \approx 6.5''$

As ; fy ⟶ 40 ksi

⇒ So we will multiply a factor with this thickness.

$\Rightarrow$ Factor $= \left[0.4 + \frac{fy}{100}\right]$

$\Rightarrow fy : 40$

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

Factor = 0.8

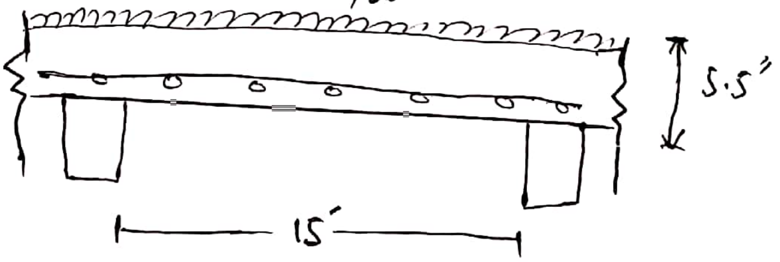
Hense the minimum Thickness will be:

6.5×0.8

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

Step # 2.

Effective Depth.



By formula:

$\Rightarrow d = t -$ clear Cover $- \frac{1}{2}$ (dia of main bars).

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

$d = 4.5''$

Step # 3

Self weight of slap:

By Formula:

$\Rightarrow \frac{t}{12} * \gamma$ concrete.

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

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:

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

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

Step # 6.

Area of steel of main bars by Trial & repeat Method:

Trial # 1 :

Let depth of compression block.

$a = 0.2 \times t$

$= 0.2 \times 5.5$

$$\boxed{a = 1.1''}$$

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

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

Trial # 2 :

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

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

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

Trial # 3 :

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

$$A_{st} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.57}{2})} \Rightarrow$$

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

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

Step # 7:

Area of steel for distribution reinforcement:

By Formula:

$$A_{min} = 0.002 \times b \times w \Rightarrow \text{(Grade 40 steel)}.$$

$$= 0.002 \times 12 \times 5.5 \Rightarrow$$

$$\boxed{A_{min} = 0.132\ in^2}$$

Step # 8. Spacing for main bars:

By formulas:

Spacing:

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

We use #6 bar dia = (6/8)"

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

Step # 9. Spacing for distribution bars:

Spacing: ⇒ A_b/A_{st}.

We use #5 bars So;

⇒ dia = (5/8)" , Area = $\frac{\pi}{4}(5/8)^2$ ⇒ 0.31 in^2

Spacing = $\frac{0.31}{0.132} \times 12$

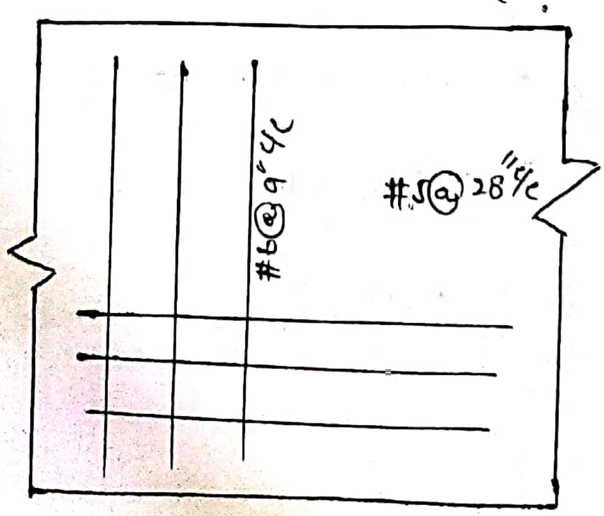
⇒ 28.1 ≈ 28" c/c.

Step # 10. Find Sketch:

⇒ f'c = 4 ksi , fy = 40 ksi

⇒ Main steel #6 at 9" c/c.

⇒ Distribution steel #5 at 28" c/c.



Q NO # 3

calculate the axial ultimate .... diagram.....?

Solution:

step # 1. Find gross area of concrete:

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

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

step # 2 ~~A_s =~~

Find Area of Steel.

Since: $A_s = 5\%$ of A_g

$= 0.05 \times 144$

$\boxed{A_s = 7.2 \ in^2}$

step # 3. ultimate load carrying capacity.

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

$\boxed{\phi = 0.65}$ $= 0.65 \times 0.80 \times [0.85 \times 4 \ [(144 - 7.2) + 7.2 \times 60]$.

$\boxed{P_u = 466.50 \ K}$

step # 4. Sketch & design of Ties (c/c) distance.

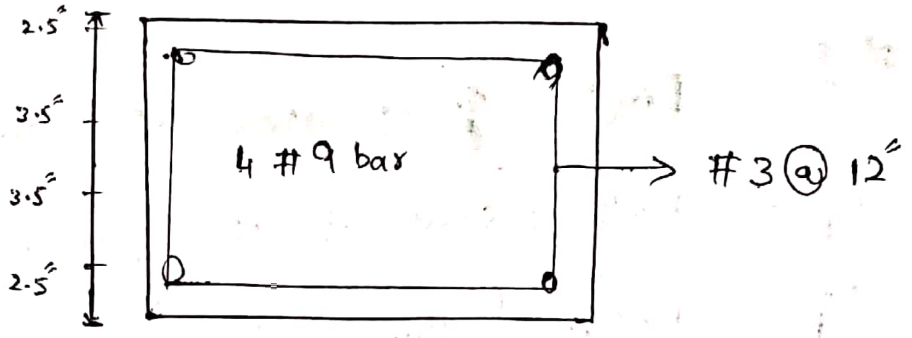
⇒ From the below value use choose the least value of all thus;

(i) 16 x dia of long bar = $16 \times 9/8$ = 18"

(ii) 48 x dia of Tie bar = $48 \times 3/8$ = 18"

(iii) least column dimesion = 12"

So; (c/c) distance b/w ties = 12".



⇒ Since it is a tied saquare column so there is no spiral stirrup used, the stirrup used is retangular shapes due to the specification of the structure thus we will ties stirrups instead.

xxx ——— xxx ——— xxx ——— xxx

Q NO # 4

Design a square footing.............Sketch Diagr?.

Solution:

step # 1.

Let :

$h = 24''$

Step # 2.

Total weight = wt of soil + wt of R.c.

$\Rightarrow (3 \times 120) + (2 \times 150)$

$= 660 \text{ Psf} = \boxed{0.660 \text{ ksf}}$

Step # 3.

Effective bearing capacity:

$q_e = q_a - W$

$= 2.50 - 0.660$

$\boxed{q_e = 1.84 \text{ Ksf}}$

Step # 4.

Requried Area for foundation.

$\text{Area} = \dfrac{\text{Service load}}{q_e} = \dfrac{100 + 120}{1.84} \Rightarrow \boxed{119.5 ft^2}$

Step # 5

Since foundation is square;

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

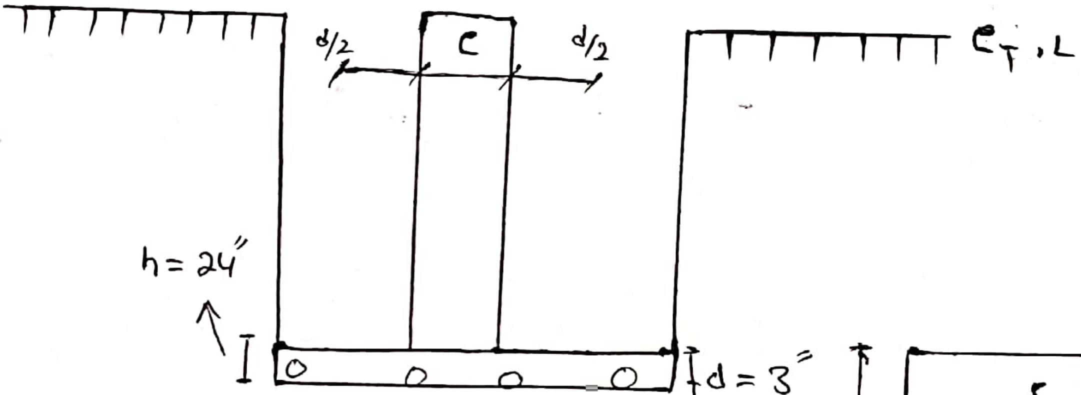
Step # 6. Upward bearing capacity of soil:

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

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

Step # 7. Punching shear:

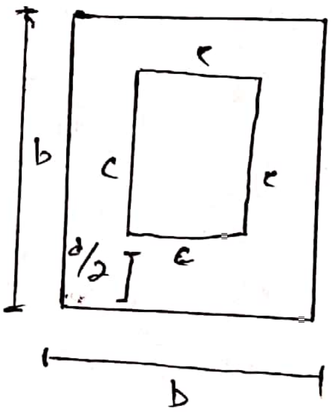
$$b_o = 4 \times (c + d)$$



$$\Rightarrow d = h - cc - \text{dia of bars} - \tfrac{1}{2} d_b$$

$$\Rightarrow 24 - 3 - 1 - \tfrac{1}{2}(1) = \boxed{19.5"}$$

$$b_o = 4 \times (16 + 19.5) \Rightarrow \boxed{142"}$$



Take #8 bars dia = $\frac{8}{8}$ = 1"

Step # 8.

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

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

$$\boxed{V_{u2} = 289.60 \ k}$$

Step# 9.

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

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

$$\boxed{\phi V_{c/p} = 525.38}$$

Step# 10.

Beam shear / one way Shear check.

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

$$V_{u_1} = 2.58 \times 11 \times \left(11/2 - \frac{16/2}{2} - 19.5 \right)$$

$$\boxed{V_{u_1} = 90.95 K}$$

Step# 11. **Self capacity:**

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

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

$$\Rightarrow \phi V_c = 110.04 K > V_{u_1} \Rightarrow OK$$

Step# 12

Ultimate moment:

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

$$\Rightarrow M_u = 331.49 K' \Rightarrow \boxed{3977.93 K''}$$

Step # 13

Area of Steel for main bars by Trial & Repeat method:

Trial # 1

Let:

$a = 0.2 \times h$

$= 0.2 \times 24 = \boxed{4.8''}$

As:

$= \dfrac{Mu}{\phi \times fy \times (d - a/2)} \Rightarrow \dfrac{3977.93}{0.90 \times 60 \times (11 - \frac{4.8}{2})}$

$\Rightarrow \boxed{As = 8.56 \text{ in}^2}$

Trial # 2

$\Rightarrow a = \dfrac{As \times fy}{0.85 \times f'c \times b} \Rightarrow \dfrac{8.56 \times 60}{0.85 \times 3 \times 11 \times 12}$

$\boxed{a = 7.197 \text{ in}^2}$

Trial # 3

$a = \dfrac{7.197 \times 60}{0.85 \times 3 \times 11 \times 12} \Rightarrow \boxed{1.28''}$

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

$\Rightarrow$ So that area $= 7.1 \text{ in}^2$.

Step # 14.

check the min reinforcement by the following 03 Method:

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

$A_{s\,min} = 5.70\ in^2$

(b) $A_{s\,min} = \frac{200}{f_y} \times B \times d \Rightarrow \frac{200}{6000} \times (11 \times 12) \times 19.5$.

$A_{s\,min} = 8.58\ in^2$

(c) $A_{s\,min} = \frac{3 \times \sqrt{f'c}}{f_y} \times B \times d \Rightarrow \frac{3 \times \sqrt{3000}}{6000} \times (11 \times 12) \times 19.5$.

$A_{s\,min} = 7.03\ in^2$

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

Step # 15.

using # 8 bar:

⇒ $A_b = 0.785\ in$

⇒ A_b of bars $= A_s / A_b = \frac{8.58}{0.785} \Rightarrow 10.92 \Rightarrow 11$ bars in each direction.

The End!