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Section B

Semester 6th

Subject Plain & Reinforced Concrete Design - I

Submitted To,

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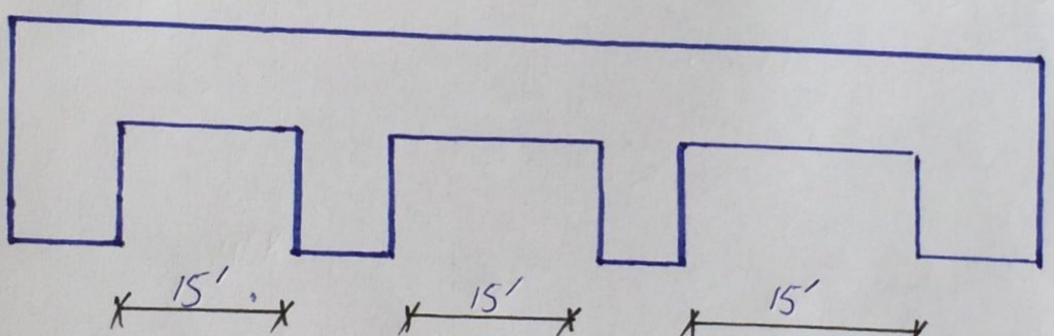
QNO(01):- page ① ID# 7831

Given Data:-

- 3 equal Spans Concrets slab
- Clear Span b/w Support = 15 ft
- Factored live load = 160 lb/ft³
- Service Floor Finich load = 20 lb/ft³
- $f'c$ = 4000 psi
- fy = 40 ksi

Solution:-



Step ① Minimum thickness:-

According to Formula

$$t_{min} = L/28 = 15/22 = 6.4 \approx 6.5''$$

As fy → 40ksi

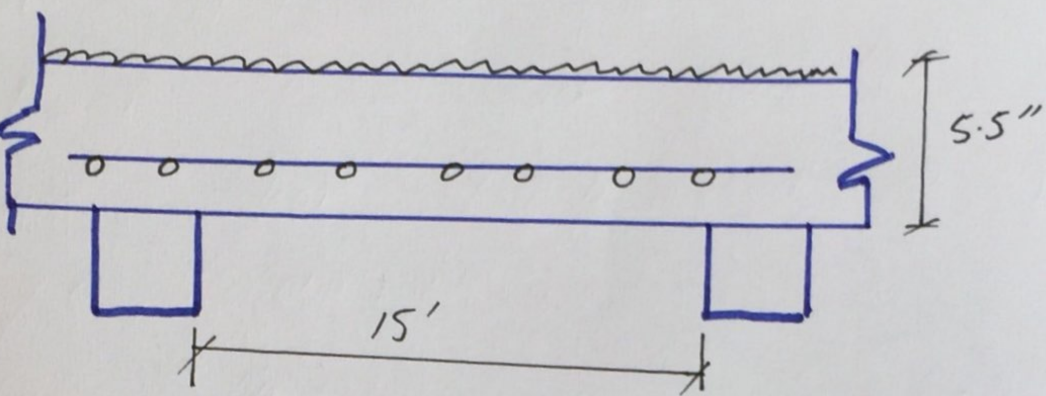
So we will multiply a Factor with this thickness. Factor = $\left(0.4 + \frac{fy}{1000}\right)$

Factor = 0.8

Hence the minimum thickness will be 6.5 * 0.8

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

Step ②:- Effective depth:-



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 ③:: Self weight of Slab:-

By Formula

$\frac{t}{12} * \gamma_{concrete}$

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

Step ④:- Total Factored load:-

Factored 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
or 0.2665 K/ft^2

Step (4)(5):- Ultimate Moment:-

According To Formula

$$M_u = \frac{w_u * l^2}{8} = \frac{0.2665 * (15)^2}{8}$$

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

Step (6):- Area of Steel For main Bars By Trial and repeat Method:-

Trial (1) let depth of Compression block

$a = 0.2 * t$
$= 0.2 * 5.5 = 1.1''$

0.55
142.2

$$A_{st} = \frac{M_u}{\phi * f_y (d - a/2)} = \frac{89.94}{0.9 * 40\,(4.5 - 1.1/2)}$$

$A_{st} = 0.63 in^2$

Trial (2)

$$a = \frac{A_{st} * f_y}{0.85 * f'_c * b} = \frac{0.63 * 40}{0.85 * 4 * 12}$$

$a = 0.62''$

$$Ast = \frac{mu}{\phi * fy * (d - a/2)} = \frac{89.94}{0.90 * 40 * (4.5 - \frac{0.63}{2})}$$

$Ast =$ ~~0.63 in2~~ 0.59 in2

Trail ③

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

$$Ast = \frac{89.94}{0.90 * 40 * (4.5 - \frac{0.57}{2})} = 0.59 \text{ in2}$$

So we used **Ast = 0.59 in2**

Step ⑦: **Area of Steel For distribution reinforcement**

using Formula

$A_{min} = 0.002 * b * t$ → (For grad 40 Steel)

$= 0.002 * 12 * 5.5 = 0.132$ in2

Step ⑧ using Formula

Spacing $\frac{Ab}{Ast} * 12$

we used #6 bar dia $= (6/8)''$

Area $\frac{\pi}{4} (6/8)^2 = 0.442$ in2

Step ⑨:: Spacing For distribution bars:-

Spacing = A_b / A_{st} used #5 bar

So

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

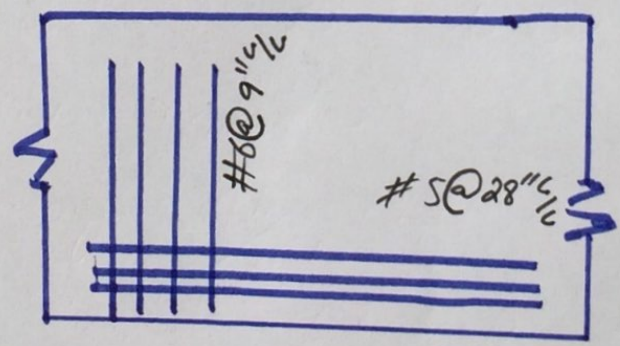
Spacing = $\frac{0.31}{0.132} * 12 = 2.8'' \cong 28''$ c/c

Step ⑩ Final Sketch Finding:-

$f'c = 4ksi$, $fy = 40ksi$

Main Steel #6 at 9" c/c

Distribution Steel #5 at 28" c/c



QNO(02):-

Solution:-

First we will Find unit load of beam.

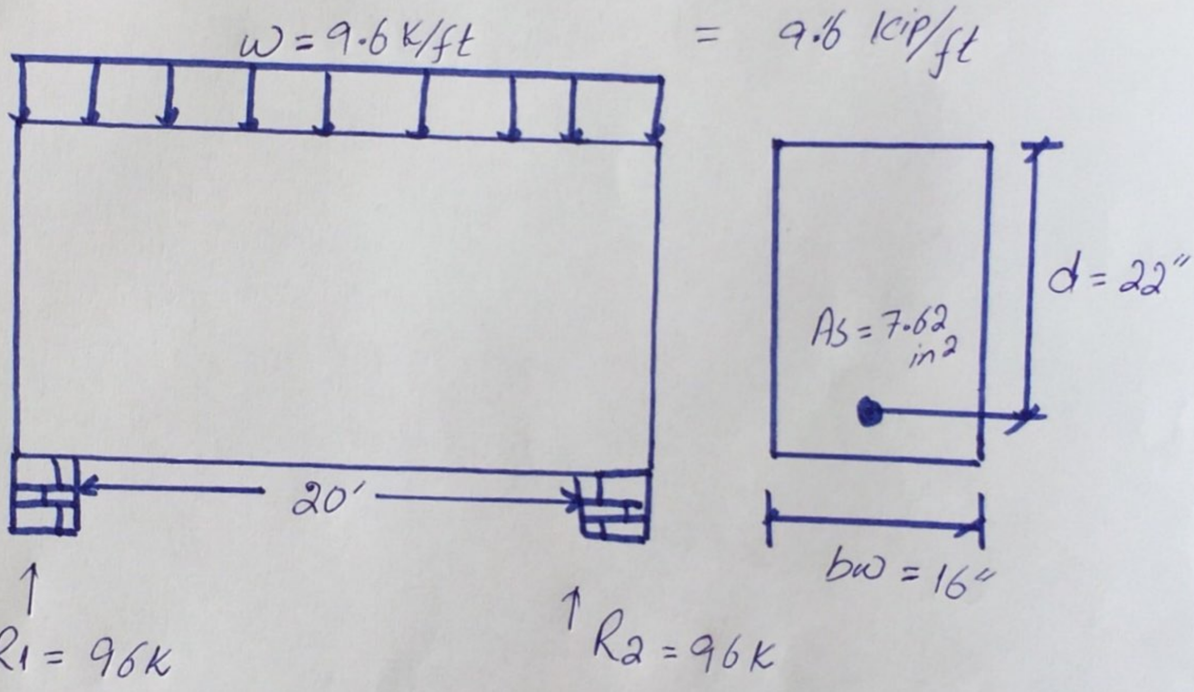
As $b * \gamma_c = \frac{16}{12} * 150 = 200\ lb/ft$

or $= 0.2\ Kip/ft$

Now

Total Factored load $= 9.4 + 0.2$

$= 9.6\ Kip/ft$

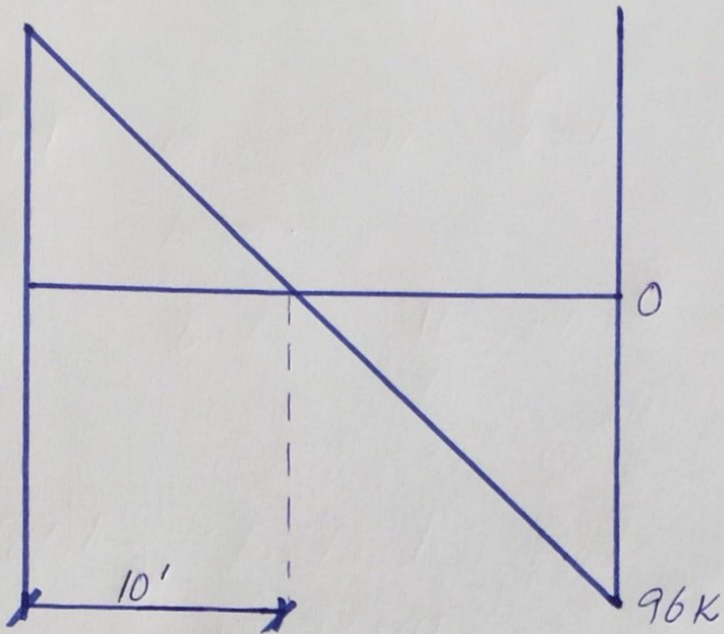


Step①:-

Find the value of R_1 and R_2

Total load $= 9.6 * 20 = 96K$

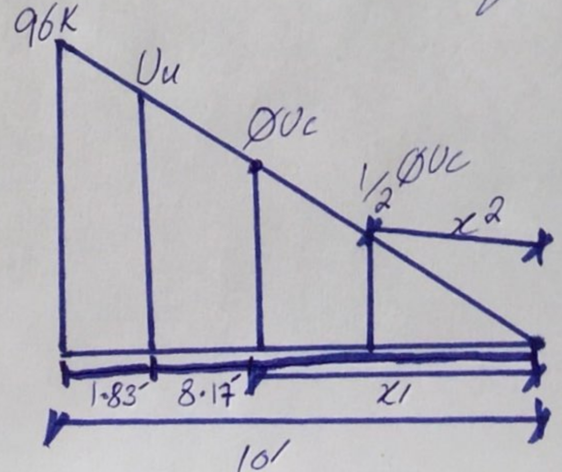
Step ②:- "Draw its Shear Force diagram"



Step ③:- Find the value of Critical ~~Section~~ stress (U_u) and is location. ~~at~~

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.



From Similarity Δ's

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

$$\boxed{U_u = 78.43K}$$

Step ④:- Find the value of "ϕV_c" and "$\frac{1}{2}\phi V_c$" and also its distance From zero Shear to right side.

$$\phi V_c = \phi * 2 * \sqrt{f'c} * bw + d$$

$$= \frac{0.75 * 2\sqrt{4000} * 16 + 22}{1000}$$

$$\phi V_u = 33.40K$$

Location of ϕV_{dc} by Similarity of Δ's

$$\frac{96}{10} = \frac{33.04}{x_1}$$

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

Now $\frac{1}{2}\phi V_{dc} = \frac{33.04}{2} = 16.70K$

Location of $\frac{1}{2}\phi V_{dc} = \frac{96}{10} = \frac{16.70}{x_2}$

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

Step ⑤:- Value of ϕV_s ($U_s = \phi V_s + \phi V_c$)

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

$$\phi V_s = 78.43 - 33.04$$

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

Step ⑥ :- Check on Section adequancy:-

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

$$= 133.57K$$

As $\phi * 8 * \sqrt{f'c} * bw * d > \phi Vs$

It mean that Section is adequate.

Step ⑦ :- Check on Maximum Spacing For Stirrups :-

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

$$= 66.79K$$

As $\phi * 4 * \sqrt{f'c} * bw * d > \phi Vs = 45.03K$

Thus the maximum Spacing will be Selected from following For Conditions.

① $S_{max} = 24''$

② $\frac{d}{2} = \frac{22}{2} = 11''$ ⊙ $Av = 0.22$ ⊙ $fy = 60000$

③ $S_{max} = \frac{Av * fy}{0.75 \sqrt{f'c} * bw} = 17.40''$ ⊙ $Av = 0.22$

④ $S_{max} = \frac{Av * fy}{50 * bw}$

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

From the above four Condition last value of Spacing from #3, U Stpad will be selected So.

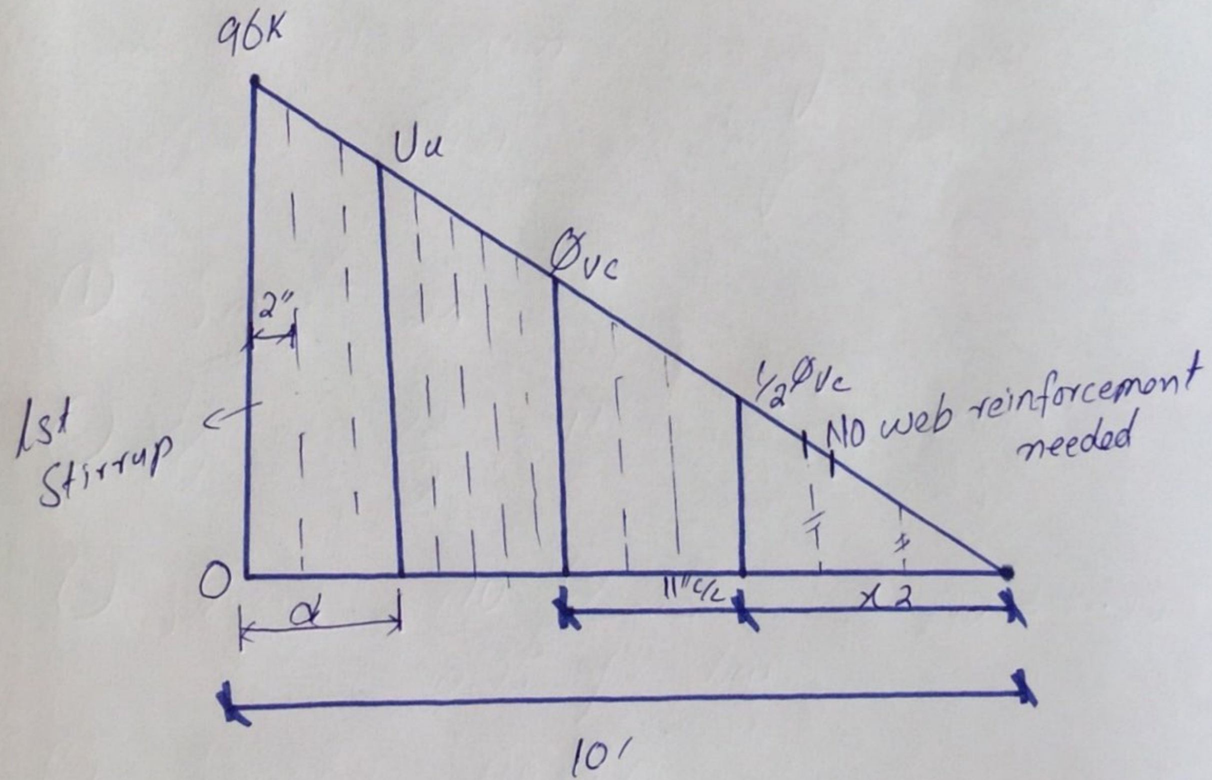
$S_{max} = 11''$ c/c

Step ⑧ :- Spacing of Stirrup From/at critical Section:-

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

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

Step ⑨ :- Final Sketch:-



QNO(03) :-

Step (1) :- Find gross area of Concrete:-

A_g = b*b (Since it is Squaretied column)

A_g = 12*12 = 144 in^2 (Actual)

Step (2) :- Find gross area of Concrete:-

Since A_s = 5% of A_g

= 0.05 * 144

A_s = 7.2 in^2

Step (3) :-

Ultimate load carring Capacity

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

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

$$\boxed{P_u = 466.50K}$$

Step (4) :- Sketch (Design of ties) c/c to distance

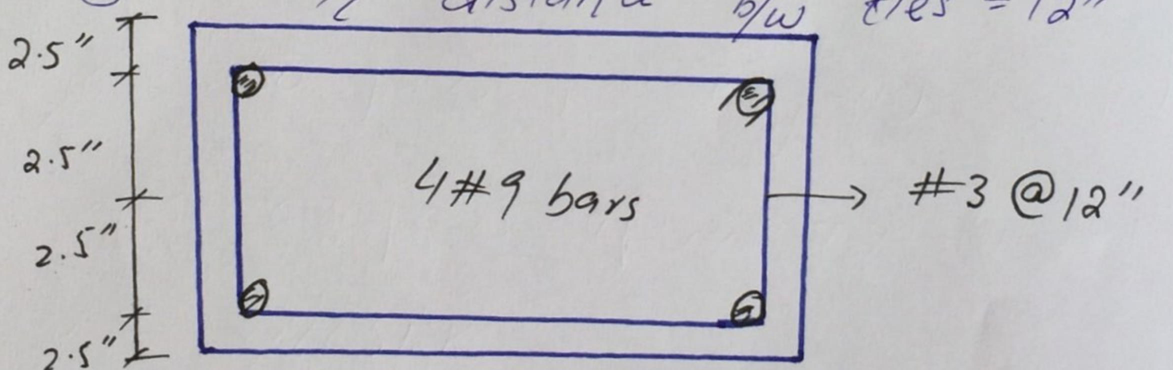
From the above value we chose the least value of all thees.

(1) 16 * dia of long bar = 16 * 9/8
= 18"

(2) 48 * dia of tie bar = 48 * 3/8
= 18"

(3) least column dimension = 12"

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



Since it is a tied squar column so there is no spiral strip used is of rectangular shape due to the specification of the structure there we will used tie stirrups instead. //

QNO(04):-

Solution:-

Step(1) Let $h = 24''$

Step(2) Total weight = wt of soil + wt of of RC

$= 3 * 120 + 2 * 150 = 660$ ksf

$= 0.660$ ksf

Step(3) Effective Bearing Capacity:-

$q_e = q_a - w = 2.5 - 0.660$

$q_e = 1.84$ ksf

Step(4) Required area For Foundation:-

$$Area = \frac{\text{Service load}}{q_e} = \frac{100 + 20}{1.84}$$

$$\boxed{Area = 119.56\ ft^2}$$

Step (5) Since foundation is Square

$$Area = B * B = 19.56 \Rightarrow B = 10.934$$

$$B \simeq 11'$$

Step (6) upward bearing Capacity

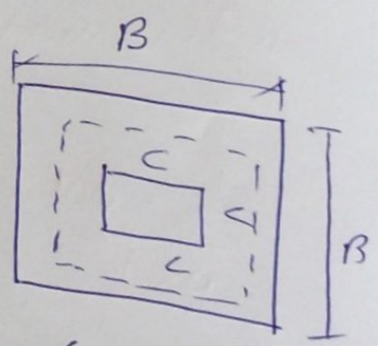
$$q_{up} = \frac{\text{Factored load}}{(B)^2}$$

$$= \frac{1.2(100) + 1.6(20)}{(10.934)^2}$$

$$q_{up} = 2.609\ K/ft^3$$

Step (7) punching shear

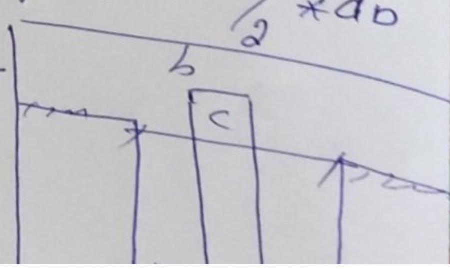
$$b_o = 4 * (c+d)$$



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

$$= 24 - 3 - 1 - \frac{1}{1} * 1 = 19.5$$

$$b_o = 4 * (16 + 19.5) = 142''$$



Step (8)

$$V_{u2} = V_{up} * (B^2 - (c+d)^2)$$

$$= 2.609 * \left[(10.934)^2 - \left(\frac{16+19.5}{12}\right)^2\right]$$

$$\boxed{V_{u2} = 229.078\ K}$$

Step (9)

$$\phi V_{c/p} = \phi * 4\sqrt{f'c} * b_o * d$$

$$= \frac{0.75 * 4 * \sqrt{3000} * 142 * 19.5}{1000}$$

$$\boxed{\phi V_{c/p} = 454.993} \Rightarrow \text{Okey}$$

Step (10) Beam Shear (One way Shear Check)

$$V_{u1} = V_{up} * B * \left(\frac{B}{2} - \frac{}{2} - d\right)$$

$$= 2.0609 * 10.934 \left(\frac{10.934}{2} - \frac{16}{2} - \frac{19.5}{2}\right)$$

$$\boxed{V_{u1} = 90.58}$$

$$\boxed{V_{u2} > V_{u1}}$$

Step (11) Self Shear capacity

$$\phi V_c = \phi * 2\sqrt{f'_c} * B * d$$

$$= \frac{0.75 * 2\sqrt{3000} * (10.934 * 12) * 19.5}{1000}$$

$$= 105.10 > V_{u1} \quad \text{Obey}$$

Step (12) Ultimate momont

$$M_u = \frac{V_{up} * B}{8} * (B - c)^2$$

~~Mu = ...~~

$$M_u = \frac{2.609 * 10.934}{2} * \left(10.934 - \frac{16}{12}\right)^2$$

$$M_u = 328.67 K' = 3944.07 K''$$

Step (13) Area of Steel for main bars by Trial Repeated method

Trial ① let $a = 0.2 * h = 0.2 * 24 = 4.8''$

$$As = \frac{Mu}{\phi * fy\,(d - a/2)}$$

$$= \frac{3944.09}{0.9 * 60 * (11 - 4/2)} = \boxed{8.56 in2}$$

Trial ②

$$a = \frac{4.2 * 60}{0.85 * 3 * 11 * 12} = 1.53''$$

Trial ③

$a = 1.28$

$\boxed{As = 7.1 in2}$

Step (14)

Checked main reinforment

$As_{min} = 0.0018 * B * h = 0.0018 * (10.934 * 12) 24$

$\boxed{As_{min} = 5.70 in2}$

Step (15) using #8 bar

$$\text{No. of bars} = \frac{As}{Ab} = \frac{8.58}{0.785}$$

$$= 10.92 \approxeq 11 \text{ bars in each direction.}$$

End