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SUBJECT:. PRC-1

SEMESTER:. SENIOR.

DATE:. 26 JUNE, 2020

PRC-1

Q1):- Given Data:-

Clear Span = 15ft

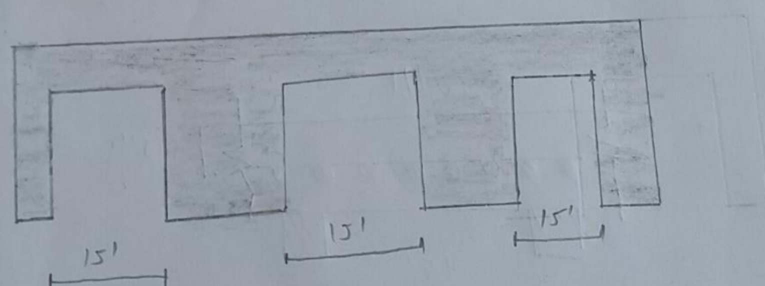
Factored Live load = 160psf

Service Floor load = 20psf

$f_c' = 4000psi$

$f_y' = 40ksi$ or. $40,000\ psi$

Solution:.



Step #01.

Minimum Thickness.

We Know that,

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

$$\boxed{t_{min} = 6.5''}$$

As,

$f_y = 40\,ksi$

So, we will multiply a factor with this thickness.

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

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

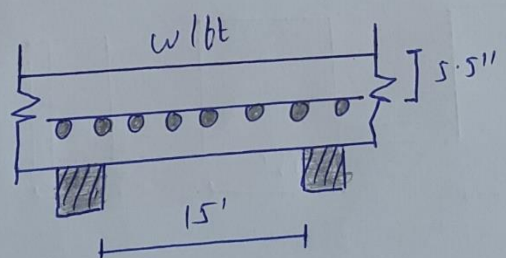
$$\boxed{Factor = 0.8}$$

Hence, the minimum thickness will be

$$6.5 \times 0.8$$

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

Step #02. Effective Depth.



By formula.

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

$$d = 5.5 - 0.75 - 1/2(5/8)$$

$$\boxed{d \simeq 4.5''}$$

Step # 03.

Self wt of Slab.

By formula,

$\gamma_c = 150\ lb/ft^3$

Self wt = $t/12 + \gamma_{concrete}$

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

Step # 04.

Total Factored Load.

Factored Live Load = $160\ lb/ft^2$

So Factored Dead Load = (D.L) = $1.2(20+68.75)$

Total Factored load = D.L + L.L.

$= 106.5 + 160$

Total factored Load $\boxed{= 266.5\ lb/ft^2}$

Step # 05

Ultimate Moment.

We know that,

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

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

Step #06

Area of Steel (Ast).

Trial #01

Let depth of Compression block.

$$a = 0.2 \times t$$

$$a = 0.2 \times 5.5$$

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

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

$$\boxed{Ast = 0.63\ in^2}$$

Trial #02

$$a = \frac{Ast \times fy}{0.85 \times fc' \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} = \boxed{0.62\ in = a}$$

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

$$\boxed{Ast = 0.59 in^2}$$

Trial #03.

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

$$Ast = \frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{0.57}{2}\right)}$$

$\boxed{Ast = 0.57 in^2}$ So, we will select it.

Step #07

Ast for Distribution Bars.

$A_{s min} = 0.002 \times b \times t$ (for Grade - 40 Steel)

$A_{s min} = 0.002 \times 12 \times 5.5$

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

Step #08

Spacing for main Bars.

$Spacing = \frac{A_b}{A_s} \times 12$

We select #6 Bar

dia $= (6/8)''$

$Spacing = \frac{0.442}{0.57} \times 12$

$Area = \frac{3.14}{4} (6/8)^2$

$\boxed{A = 0.442 \text{ in}^2}$

$\boxed{Spacing = 9.30'' \; c/c}$

$\approx 9'' \; c/c$

Step #09.

Spacing for Distribution Bars

$Spacing = \frac{A_b}{A_s} \times 12$

$A = \frac{\pi}{4} d^2$

Select #5 Bar

$A = \frac{3.14}{4} ((5/8))^2$

$\boxed{A = 0.31 \text{ in}^2}$

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

$Spacing = 28.18'' \; c/c$

$\simeq 28'' \; c/c$

Step # 10

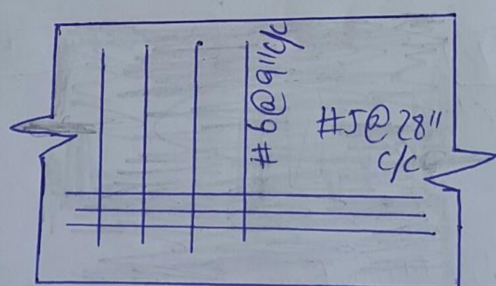
Final Sketch.

→ $f_c' = 4$ ksi

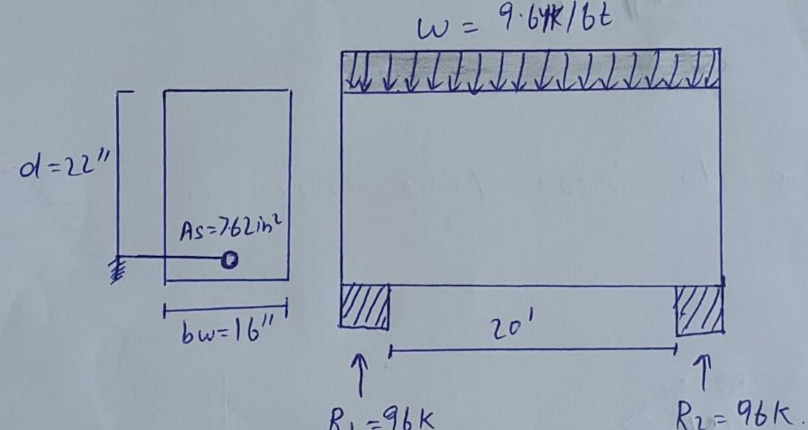
→ $f_y' = 40$ ksi

→ Main Steel #6 at 9" c/c

→ Distribution Steel #5 at 28" c/c.



QNo: 2) :. Given Data :.



Solution:.

At first we find the Self wt of the Beam

So, $b \times \gamma_c$

$= \frac{16}{12} \times 150$

$= 200$ lb/ft $\boxed{= 0.2 \text{ k/ft}}$

Total Factored Dead Load $= 1.2(200)$ lb/ft

$= 240$ lb/ft

or

$= 0.24$ k/ft

So, Factored Load $= 9.4 + 0.24$

Factored Load $= 9.64$ k/ft

Step #01

Find the values of R_1 and R_2.

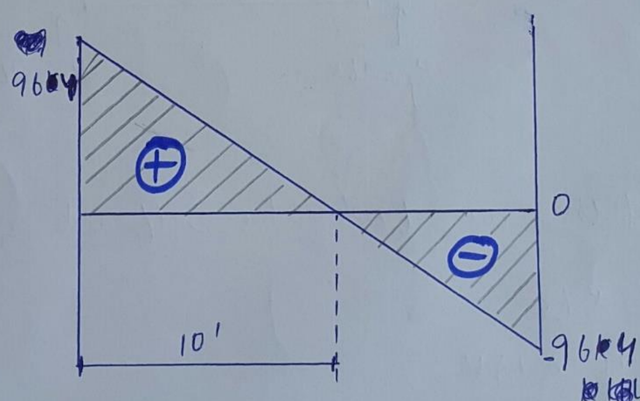
Total Load $= \dfrac{9.64 \times 20}{2}$

$\boxed{\text{Total Load} = 96.4}$ klbt.

Step #02

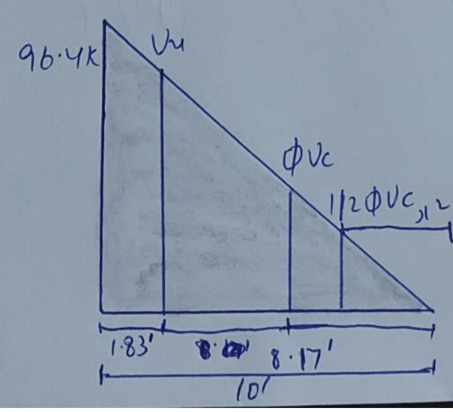
Draw its Shear force Diagram.

S.F.D



Step #03.

Find the values of Critical Stress "Vu" and it's location.



From Similar Δ's.

$$\frac{96.4}{10} = \frac{V_u}{8.17}$$

$$\boxed{V_u = 78.75K}$$

Step #04.

Now find ϕV_c and $1/2\,\phi V_c$ and its's distance from zero shear to right side.

$$\phi V_c = \phi \times 2 \times \sqrt{f_c'} \times b_w \times d$$

$$\phi V_c = \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000}$$

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

Location of ϕV_c by similarity of Δ's.

$$\frac{96.4}{10} = \frac{33.40}{x_1}$$

$$\boxed{x_1 = 3.46'}$$

Now,

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

Location of $1/2\,\phi V_c = \frac{96.4}{10} = \frac{16.70}{x_2}$

Location of $1/2\,\phi V_c = \boxed{(x_2) = 1.73'}$

Step #05

Values of ϕV_s ($V_u = \phi V_s + \phi V_c$)

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

$\phi V_s = 78.75 - 33.40$

$\boxed{\phi V_s = 45.35k}$

Step #06

Check on Section Adequacy.

$= \phi \times 8 \times \sqrt{f_c'} \times b_w \times d$

$= \dfrac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$\boxed{= 133.57k}$

As,

$\phi \times 8 \times \sqrt{f_c'} \times b_w \times d > \phi V_s$

It means section Adequate.

Step #07

Check on minimum spacing for stirrups.

$\phi \times 8 \times \sqrt{f_c'} \times b_w \times d = \dfrac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000} \boxed{= 66.79k}$

As,

$\phi 4 \sqrt{f_c'} b_w d > \phi V_s = 45.35k$.

Thus maximum spacing will be selected from the following four conditions, 1):. $S_{max} = 24''$

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

3):- $S_{max} = \frac{Av \times fy}{0.75 \times \sqrt{fc'} \times bw}$

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

$\uparrow$ U-Stirrups.

4):. $S_{max} = \frac{Av \times fy}{50 \times bw} = \frac{0.22 \times 60000}{50 \times 16}$

$S_{max} = 16.50.$

From the all above least value will be selected. So, $S_{max} = 11''$ c/c.

Step # 08

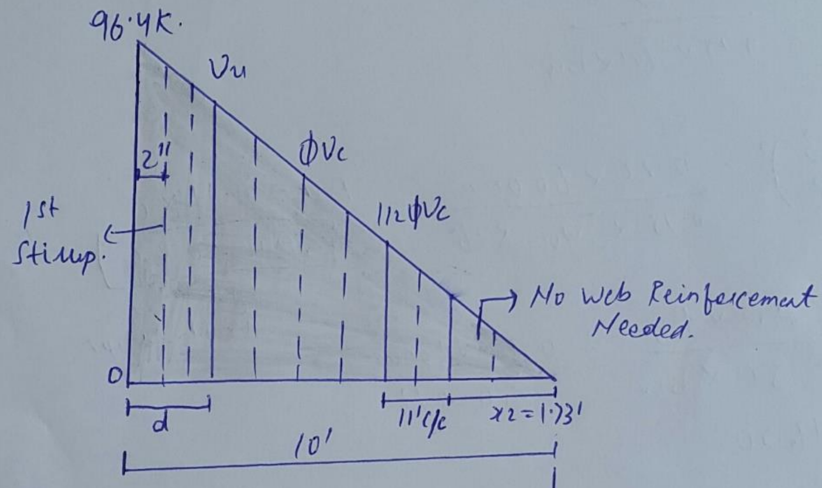
Spacing of Stirrups from / At Critical Section.

$S = \frac{\phi \times Av \times fy \times d}{Vu - \phi Vc} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.75 - 33.40}$

$S = 4.80'' \cong 5''$ c/c.

Step # 09.

Final Sketch.



Q.No:: 3):.. Given Data:.

$f_c' = 4000psi$ or $4ksi$
$f_y' = 60ksi$

Step #01

Find Gross Area of Concrete.

$Ag = b \times b$ (Since it is square tied Column)

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

Step #02

Area of Steel.

Since $As = 5\%$ of Ag.

$As = 0.05 \times 144$

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

Step #03

Ultimate Load Bearing Capacity.

$Pu = \phi \times 0.80 \times [0.85 \times f_c' \times [Ag - As] + As \times f_y)$.

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

$\boxed{Pu = 466.50k}$

Step #04.

Sketch and Design of Ties (C/C to distance)

From the below value we will choose the least value of all.

Thus

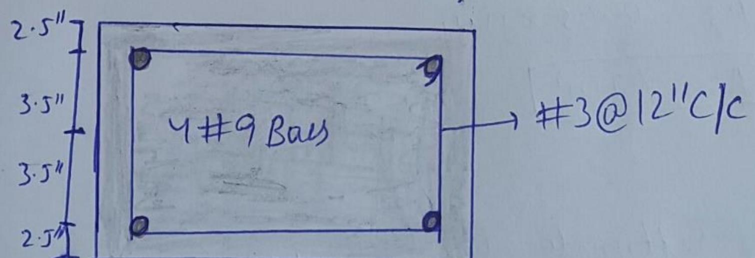
1). 16 x dia of long Bar $= 16 \times 9/8$

$\boxed{= 18''}$

2). 48 x dia of Tie Bar $= 48 \times 3/8$

$\boxed{= 18''}$

3). least column dimension = 12", so c/c distance b/w ties = 12"



Note:

Since it is 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 the tie stirrup instead spiral stirrup.

Q No:- 4) Solution:-

Step :- 01

let $h = 24''$

Step # 02.

Effective Bearing Capacity

$q_e = q_a - w$

$q_e = 2.50 - 0.660$

$\boxed{q_e = 1.84\,ksf}$

Step # 03.

Required Area for foundation.

$$Area = \frac{Service\ load}{q_e}$$

$$= \frac{100+120}{1.84}$$

$\boxed{Area = 119.57\,ft^2}$

Step # 04.

Total weight = wt of soil + wt of RC.

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

$\boxed{= 660\,psf}$

660 psf or 0.660 ksf.

Step # 05.

Foundation in Square.

$$Area = b \times b = 119.57 ft^2$$
$$B \simeq 11'$$

Step # 06

Upward Bearing Capacity of Soil.

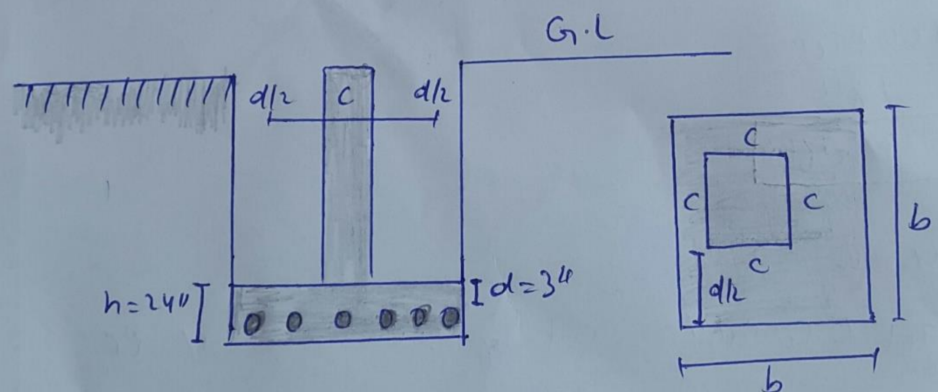
$$q_{up} = \text{Factored load} / B^2.$$

$$q_{up} = (1.2 \times 100) + (1.6 \times 120) / 11^2.$$

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

Step # 07.

Punching Shear.



$$d = h' - c.c - \text{dia of bar} - 1/2 \, db.$$
$$d = 24 - 3 - 1/2 (1) = 19.5''$$
$$b_o = 4 \times (16 + 9.5) = 142''$$

Step # 08.

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

$$V_{u2} = 2.58 \times (11^2 - (16+19.5)^2)$$

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

Step # 09.

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

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

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

Step # 10.

Beam Shear / 1 way Shear Check:

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

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

$$\boxed{V_{u1} = 90.95k}$$

Step:-11

Self Shear Capacity.

$$\phi V_c = \phi \times 2 \times \sqrt{f_c'} \times b \times d.$$

$$\phi V_c = 0.75 \times 2\sqrt{4000} \times 11 \times 12.16 / 1000$$

$$\phi V_c = 110.04k > V_{u1} \rightarrow OK.$$

Step #12.

Ultimate Moment

$$M_u = \frac{q_{up} \times B}{8} \times (B - C)^2$$

$$M_u = \frac{2.58 \times 11}{8} \times \left(11 - \frac{16}{2}\right)^2$$

$$M_u = 331.49k' = \boxed{3977.3k''}$$

Step # 13.

Ast for member by Trials.

Trial #01

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

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{4.8}{2}\right)} \quad \boxed{A_{st} = 8.56 in^2}$$

Trial #02

$$a = \frac{A_{st} \times f_y}{0.85 \times b \times f_c'} = \frac{8.56 \times 60}{0.85 \times 3 \times (11 \times 12)} \quad \boxed{= 1.53''}$$

$$A_{st} = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{1.53}{2}\right)} \quad \boxed{A_{st} = 7.197 in^2}$$

Trial #03.

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

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

So, $\boxed{Area = 7.1\ in^2}$

Step #14.

Checking Minimum Reinforcement.

① $As_{min} = 0.0018 \times b \times h = 0.0018 \times (11 \times 12) \times 24$

$As_{min} = 5.70 in^2$

② $As_{min} = \frac{3 \times \sqrt{fc'}}{fy} \times B \times d. = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$

$As_{min} = 7.05 in^2$

Greater value will be selected for Asmin.

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

Step #15.

No. of Bars.

Using #8 Bar.

$Ab = 0.785 in^2$.

$$\text{No. of Bars} = \frac{As}{Ab} = \frac{8.58}{0.785} = \mathbf{10.92} \cong 11 \text{ Bars.}$$

→ 10.92 ≅ 11 bar in Each direction.