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SECTION # "B"

SUBJECT # PRCD-I

Smester # 6^{th}

Date # 26/JUNE/2020

Submitted to #

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Q No. 2

Solution:-

First of all find the unit load of Beam so

$b \times \gamma_c$

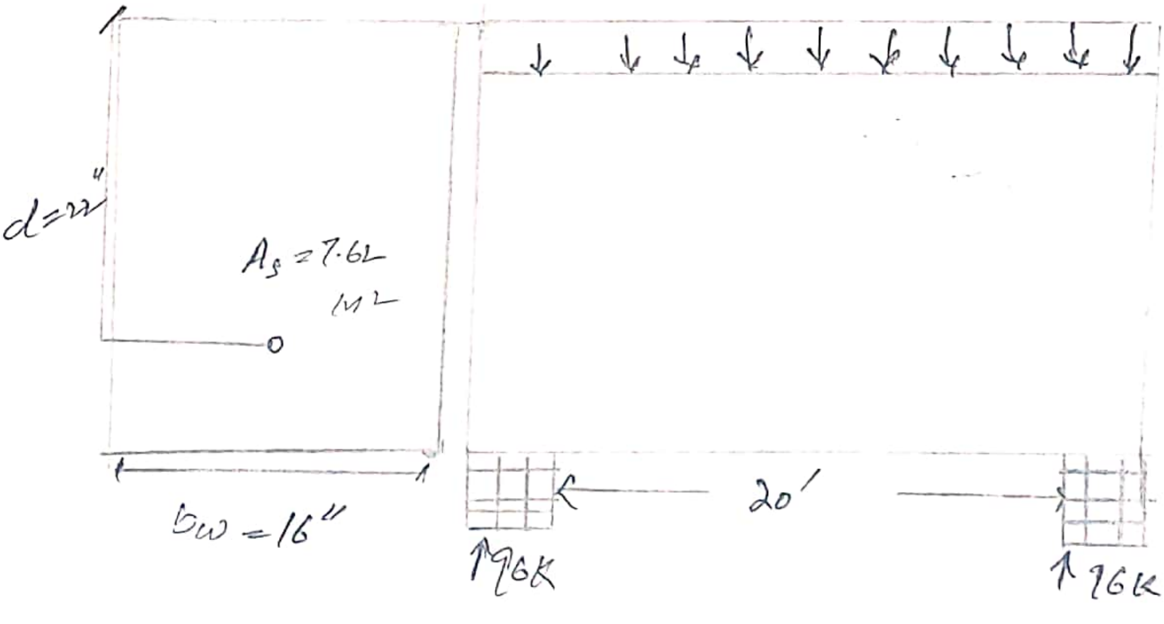
$= \frac{16}{12} \times 150$

$= 200 \text{ lb/ft} = 0.2 \text{ K/ft}$

So total factored load $= 9.4 + 0.2$

$= 9.6 \text{ K/ft}$

$W = 9.6 \text{ K/ft}$



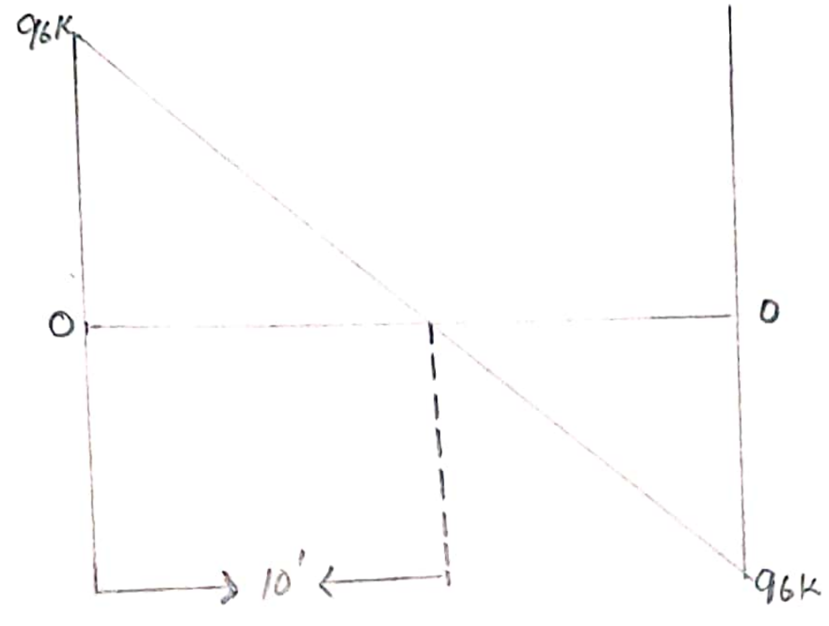
⇒ STEP-NO #1

Find the value of R_1 and R_2.

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

⇒ **STEP #02**

S.F.D (kips)

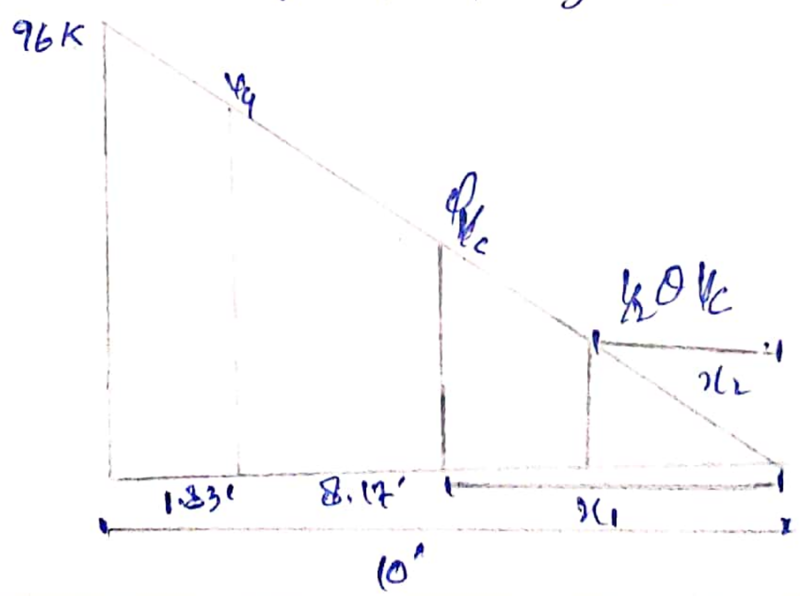


STEP # 3 :

Find the value of critical stress "V_u" and it's location.

As we know 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 Similar Δ's

$$\frac{96}{10} = \frac{V_u}{8.17} \Rightarrow V_u = 78.43k$$

⇒ STEP # 4

Find the value of "ϕV_c" and "$\frac{1}{2}\phi V_c$" and also it's distances from zero Shear to right side.

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

$$\phi V_c = 33.40K$$

Location of ϕV_c by similarity of Δ's

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

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

Step # 5: Value of ϕV_s $(V_u = \phi V_s + \phi V_c)$

So,

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

$$\phi V_s = 78.43 - 33.40$$

$$\phi V_s = 45.03K$$

STEP # 06 : Check ON SECTION:- (4)

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

$= 133.57\,K$

As $\phi \times 8 \times \sqrt{f_c'} \times b_w \times d > \phi V_s \rightarrow$ it means Section is equatic.

STEP # 07 : Check on min. Spacing for Stirrups.

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

$= 66.79\,K$

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

$\Rightarrow$ Thus max. Space will be selected from the following four conditions.

1 $\Rightarrow S_{max} = 24''$

2 : $d/2 = 22/2 = 11''$

3 : $S_{max} = \dfrac{A_u \times f_y}{0.75 \times \sqrt{f_c'} \times b_w}$

4 : $S_{max} = \dfrac{A_u \times f_y}{50 \times b_w}$

$\therefore A_u = \frac{\pi}{4}(3/8)^2$

$A_u = 0.11 \times 2$

$A_u = 0.22$

$= \dfrac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16}$

$= 17.40''$

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

$= 16.50''$

$\Rightarrow$ From the above four conditions least value of spacing for #3, U-Shaped stirrup will be selected So.

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

STEP # 08:

Spacing of Stirrups from | at critical section.

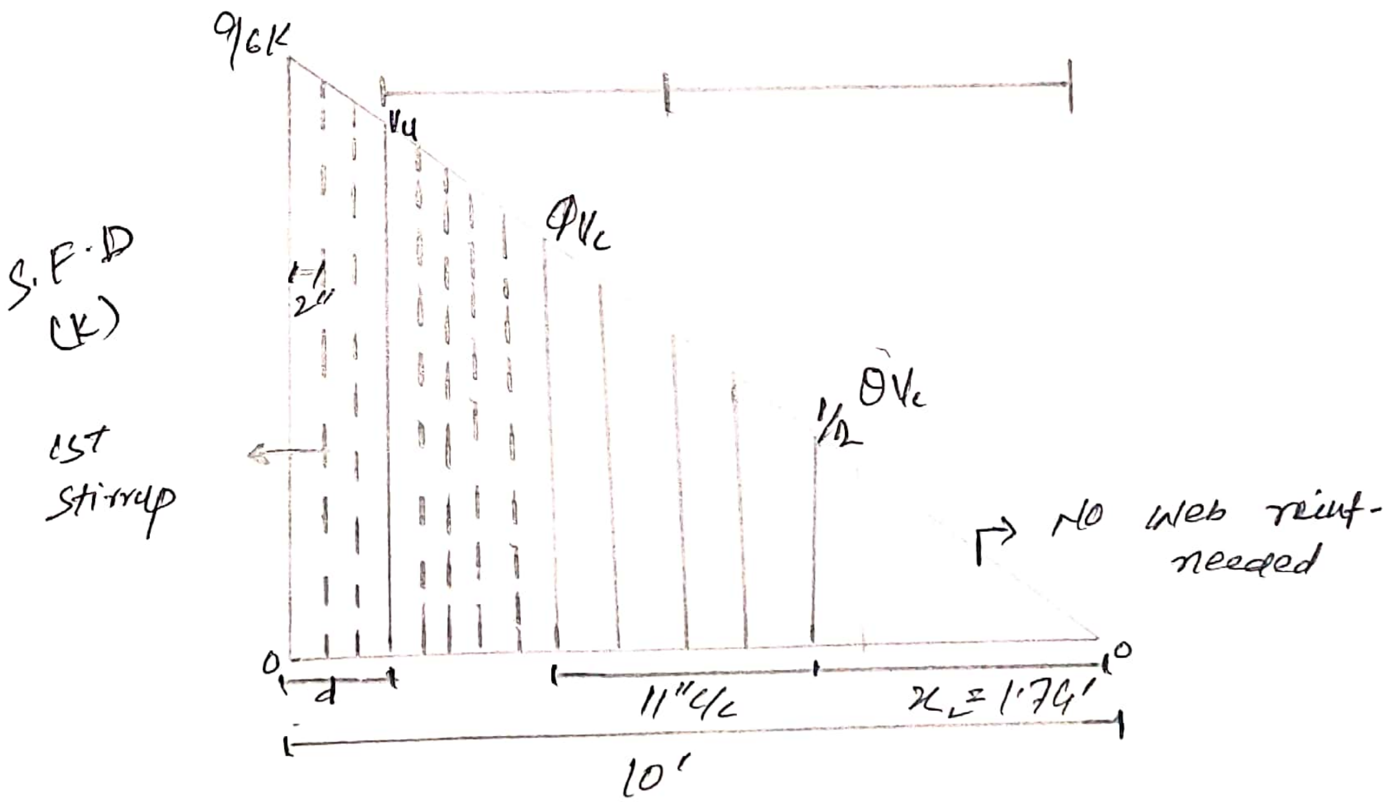
$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c}$$

$$= \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$$

$$= 4.84'' \approx 5'' \ c/c.$$

STEP # 09:

FINAL SKETCH.



⇒ As we know that First Stirrup from face of Support =

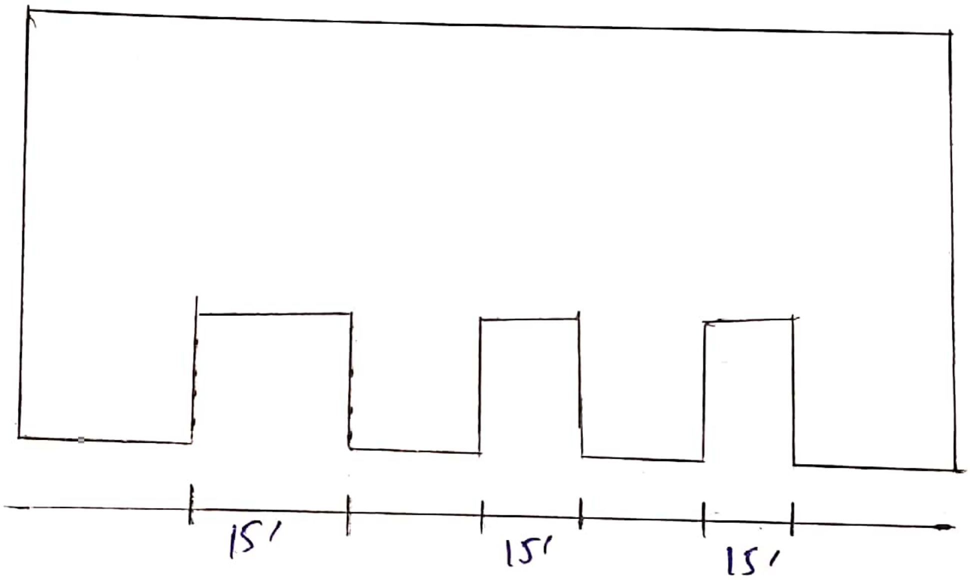
$$\Rightarrow S/2 = 2.5 \approx 2''$$

Q No. 2

SOLUTION:-

⇒ **Given DATA:-**

- → Clear span b/w supports = 15'
- → Factored Live load = 160 Lb/ft²
- ⇒ Service floor finish load = 20 Lb/ft²
- → $f'_c = 4000\ psi$
- → $f_y = 40\ ksi$



⇒ **Step: 01>** "Minimum thickness"

Using formula

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

As $f_y = 40ksi$; So we will multiply a factor with this thickness.

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

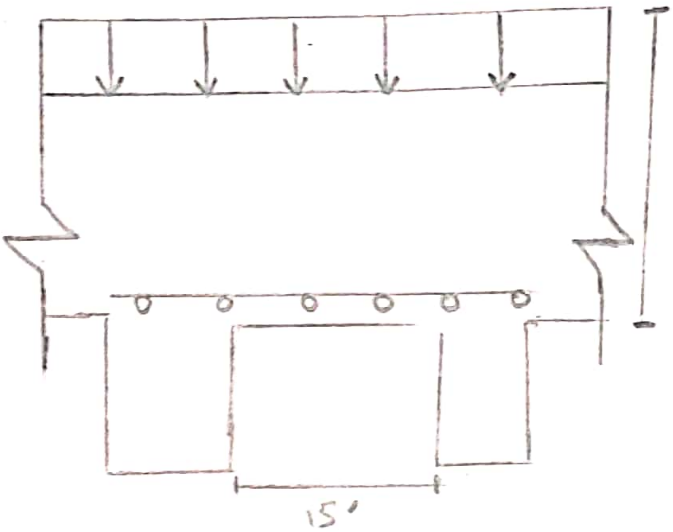
$= \left(0.4 + \frac{40}{100}\right) = 0.8.$

Thus the main thickness will be

$= 6.5 \times 0.8$

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

Step: 02 :- EFFECTIVE DEPTH :-



BY Formula :-

$d = t - c.c - \frac{1}{2}(\text{dia of M.B})$

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

$\boxed{d = 4.5''}$

Step 03 :- Self weigh of Slab :-

By formula $\Rightarrow \frac{t}{12} \times \gamma_c = \frac{5.5}{12} \times 150$

$= 68.75 \ lb/ft^2$

Step 04:- Total Factore Load:-

Factored Live load $= 160\ Lb/ft^2$
So Factored dead load will be

$D.L = 1.2(20 \times 68.75) = 106.5\ lb/ft^2$
Total factored load $= D.L + L.L$
$= 106.5 + 160$
$= 266.5\ Lb/ft^2 = 0.2665\ K/ft^2$

Step 05:-

Ultimate moment
By Formula

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

$M_u = 89.94\ k\text{-}in$

Step 06:- Area of steel for main Bar
by trail and Repeat method.

Trail #01:-

Let $a = 0.2 \times t$
$= 0.2 \times 5.5$
$= 1.1''$

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

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

Trial #02:-

$$a = \frac{A_{ST} \times F_y}{0.85 \times f_c' \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} = 0.62 \text{ in}^2$$

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.62}{2})}$$

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

Trial #03:-

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

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

So. we will use $A_{ST} = 0.59 \text{ in}^2$

STEP 07:- Area of Steel for distribution reinforcement
By Formula.

$$A_{min} = 0.002 \times b \times t \quad \rightarrow \text{(For Grad 40 steel)}$$
$$= 0.002 \times 12 \times 5.5 = 0.13 \text{ in}^2$$

Step #08 Spacing For main bars.
By Formula;

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

We use #6 bar dia = $(6/8)''$

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

$$S = \frac{0.442}{0.59} \times 12 = 8.98 \approx 9'' \ c/c$$

Step # 09

Spacing For distribution Bar.

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

We use #5 bar, so

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

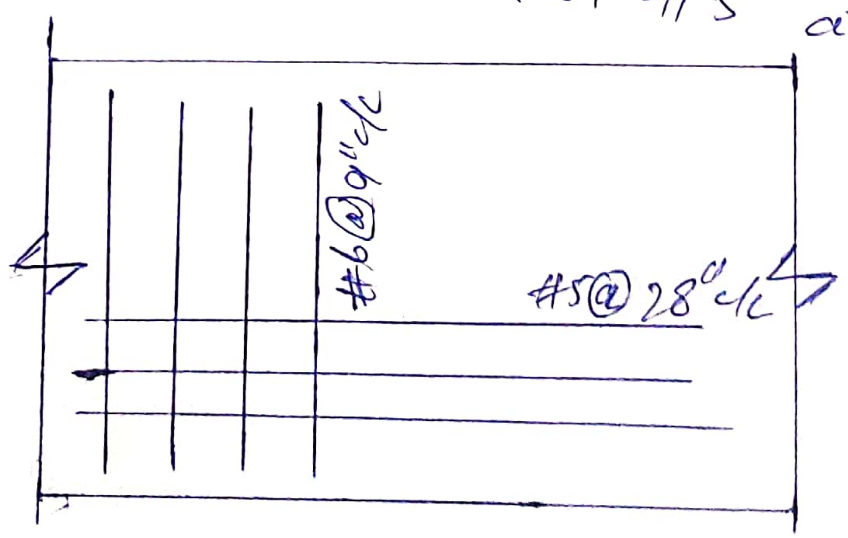
$$Spacing = \frac{0.31}{0.132} \times 12 = 28.1'' \approx 28'' \ c/c$$

Step #10 FINAL SKETCHED

$f'_c = 4ksi \quad f_y = 40ksi$

Main Steel #6 at 9" c/c

Distribution Steel #5 at 28" c/c



Q No.3

Solutions:

Step 01: Find grass area of concrete.

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

$A_g = 12 \times 12 = 144\ in^2$ (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: Ultimat load carrying capacity.

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

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

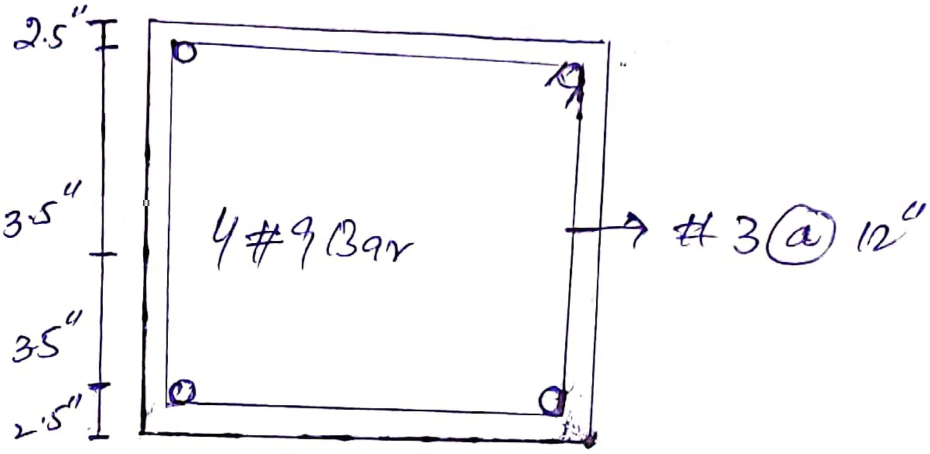
$P_u = 466.50\ K$

Step #04 Sketch and Design of Ties (c/c to distance)

From the below values 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 not spiral Stirrup used is of rectangular shape due to the Specification of the structure thus we will use tie stirrups instead.

Q No. 4

Solution:

Step-01

Let $h = 24''$

Step-02

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

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

$= 660\ psf = 0.660\ ksf$

Step-03

Effective Bearing capacity.

$q_e = q_a - W$

$= 2.50 - 0.660$

$q_e = 1.84\ ksf$

Step-04

Required Area for foundation.

$$A_{req} = \frac{\text{Service Load}}{q_e} = \frac{\cancel{100}+120}{1.84} = 119.57\ ft^2$$

Step-05

Since foundation is square.

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

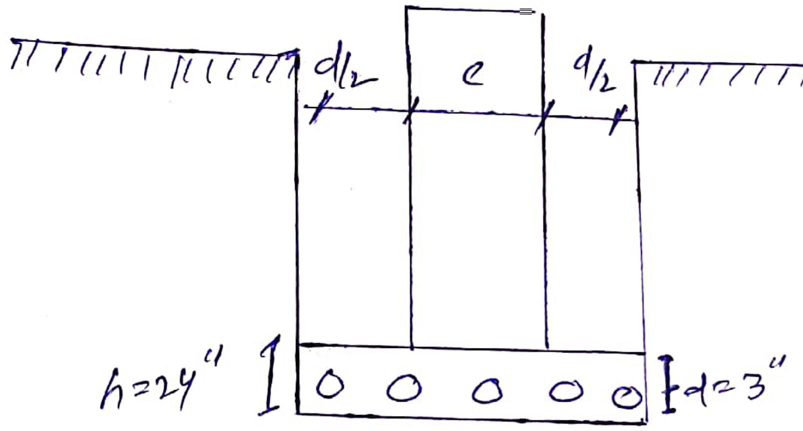
Step #06 Upward Bearing Capacity of Soil. (14)

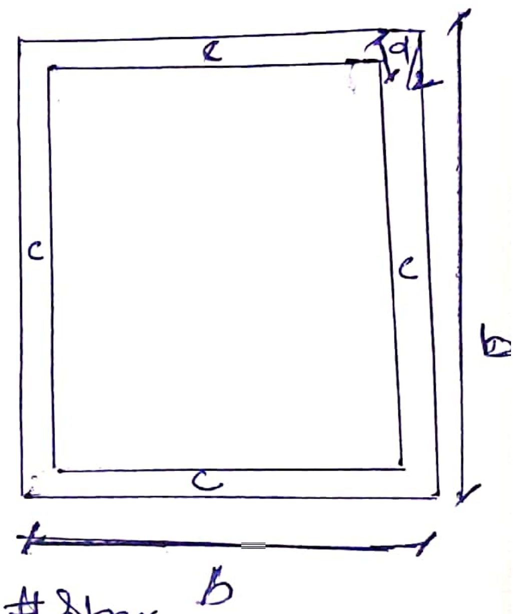
$$q_{up} = \frac{\text{Factored Load}}{(B)^2} = \frac{1.2\times100\times1.6\times120}{11^2}$$

$$\boxed{q_{up} = 2.58\ \text{KIA2}}$$

Step #07 Punching Shear.

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





$$d = h - c.c - \text{dia of bar} - \frac{1}{2} d_b$$

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

∴ Take #8 bar, dia = 8/8 = 1"

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

Step #08:

$$V_{u_2} = q_{up}\times[B^2-(c+d)^2]$$

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

$$V_{u2} = 289.60\ K$$

Step #09

$$\phi V_{cp} = \phi \times 4 \times \sqrt{f'_c} \times b_o \times d$$

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

$$\phi V_{cp} = 525.38$$

Step# 10 Beam shear / one way Shear check.

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

$$V_{u1} = 2.58 \times 11 \times \left[11/2 - 16/12/2 - 19.5 \right]$$

$$\boxed{V_{u1} = 90.95\,K}$$

Step #11 Self shear capacity.

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

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

$$= 110.04\,K > V_{u1} \Rightarrow O.K$$

Step # 12 Ultimate moment.

$$M_u = \frac{q_{up} \times B}{8} \times (B - c)^2 = \frac{9.58 \times 11}{8} \times \left(11 - \frac{16}{12}\right)^2$$

$$M_u = 331.49k' = 3977.93k''$$

Step # 13 Area of steel for main bars by Trail and 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:-

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

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

Trial # 03

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

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

Thus Area $= \boxed{7.1 \text{ in}^2}$

Step # 14 check the min. reinforcement by the following 03 methods;

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

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

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

$$\boxed{= 8.58 \text{ in}^2}$$

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

$$\boxed{= 7.05 \text{ in}^2}$$

From above values the greater value will be selected thus;

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

Step #15

Using #8 Bars.

$A_b = 0.785 \text{ in}^2$

No. of Bars $= \frac{A_s}{A_b} = \frac{858}{0.785}$

$= 10.92 \approx 11$ bars, in each direction.

THE END