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Section:-

A

Subject:-

Plain & Reinforced Concrete Design-I

Question No. 2

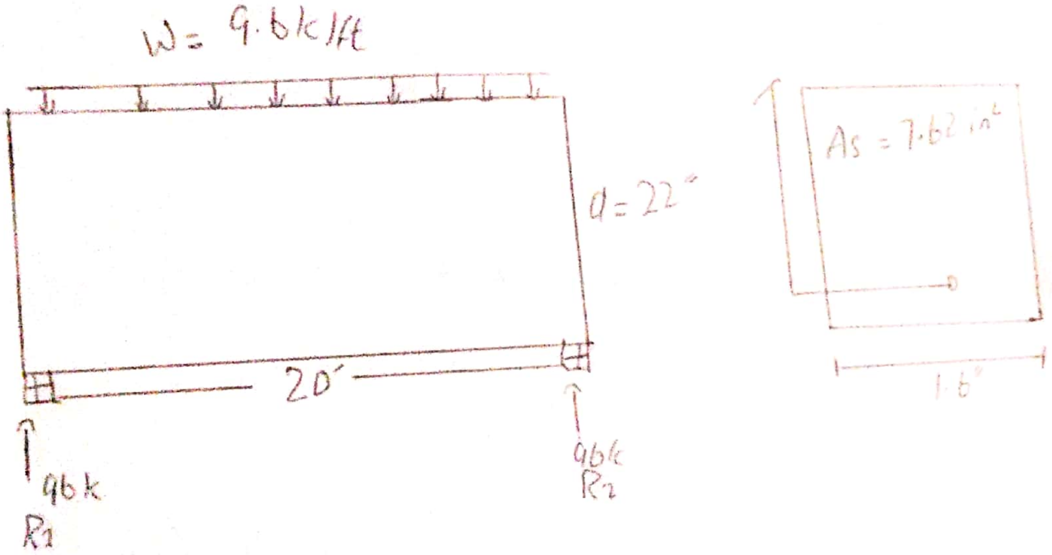
Solution:-

At first find the unit load of beam so

b × γc

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

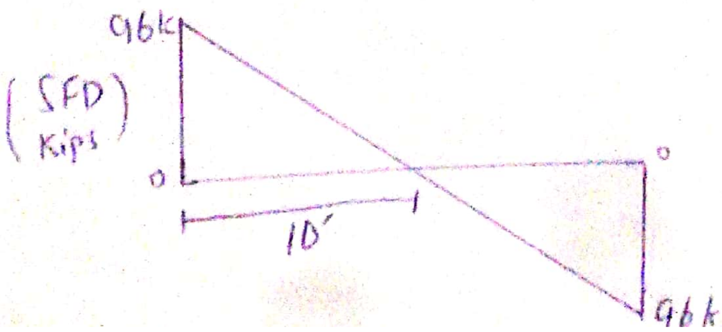
Total factored load = 9.4 + 0.2
= 9.6 k/ft



Step # 01: Find value of 'R1' & 'R2'

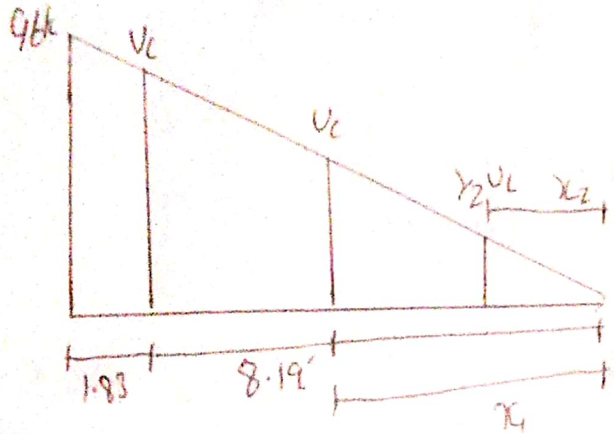
Total load = $9.6 \times \frac{20}{2} = 96k$

Step # 02 Draw its shear force diagram



Step#03:- Finding value of Critical stress "Vu" & its location.

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



From similar Δ's $\frac{96}{10} = \frac{V_u}{8.17}$

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

Step#04:- Finding value of "ØVc" & "½ ØVc" & its distance from zero shear to right side.

$$ØV_c = Ø \times 2\sqrt{F'_c} \times b_w \times d = \frac{0.75 \times 2 \times \sqrt{5400} \times 16 \times 22}{1000}$$

$$\boxed{ØV_c = 33.40\,k}$$

Location of ØVc by similarity of Δ's

$$\frac{96}{100} = \frac{33.40}{x_1}$$

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

Now,

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{70} = \frac{16.70}{x_2}$

$\boxed{x_2 = 1.74}$

Step#05

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

So we have

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 78.43 - 33.40$

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

Step#06

Check section Adequacy

$\phi \times 8 \times \sqrt{f'_c} \times b_w \times d = \frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$\boxed{= 133.57k}$

$133.57k > \phi V_s$ (mean section is adequate)

Step#07

Check mini spacing for stirrups

$\phi \times 4 \times \sqrt{f'_c} \times b_w \times d \Rightarrow \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= \boxed{66.79k} > \phi V_s = 44.03k$

thus max spacing will be selected from the following 4 conditions.

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

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

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

: $A_v = \frac{\pi}{4} (\frac{3}{8})^2$; $A_v = 0.11 \times 2 = 0.22$

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

(4) $S_{max} = \dfrac{A_v \times f_y}{50 \times b_w}$

$= \dfrac{0.22 \times 60000}{50 \times 16} = 16.50$

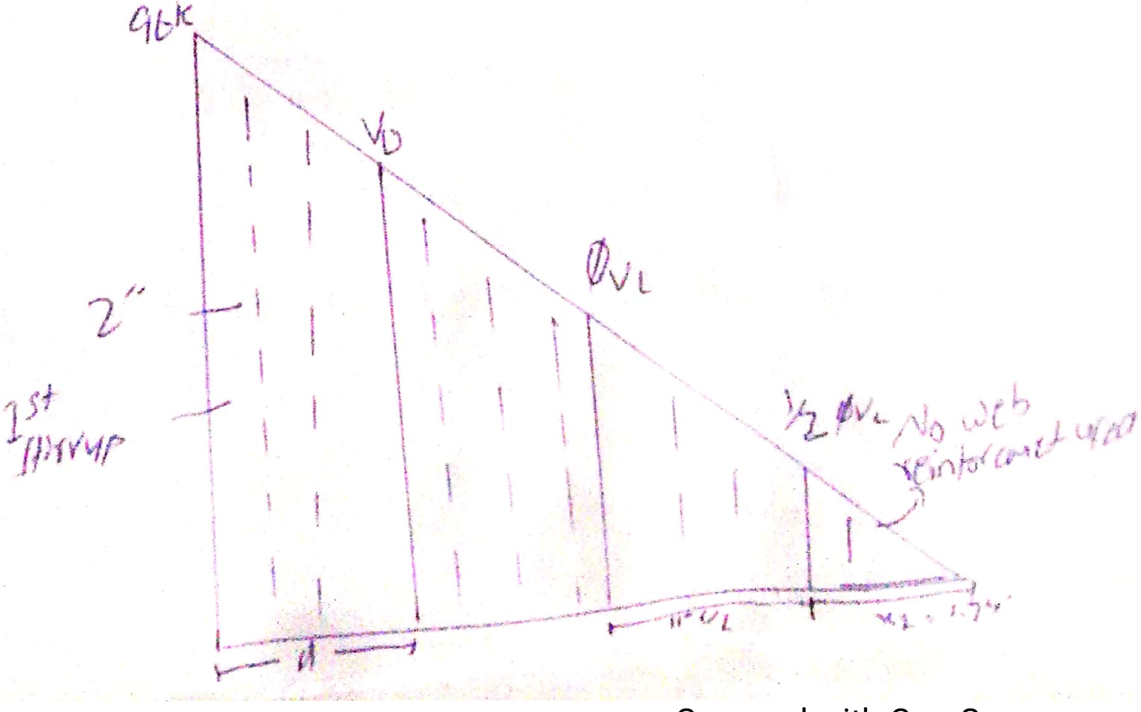
From the above 4 conditions, least value of spacing for #3 U shaped will be selected so $S_{max} = 11''$ c/c

Step # 08 Spacing of stirrup at critical section.

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

$S = 4.84 \approx 5$ c/c

Step # 9 Final Design



Question No. 8

Solution:

Step # 01:

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 # 02:

Find area of steel

Since, $A_s = 5\%$ of A_g

$= 0.05 \times 144$

$A_s = 7.2\ in^2$

Step # 03:

Ultimate load carrying capacity.

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

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

$P_u = 466.50\ k$

Step # 04:

Sketch & design of Ties (c/c distance)

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

1) $16 \times$ dia of long bar $= 16 \times 9/8$

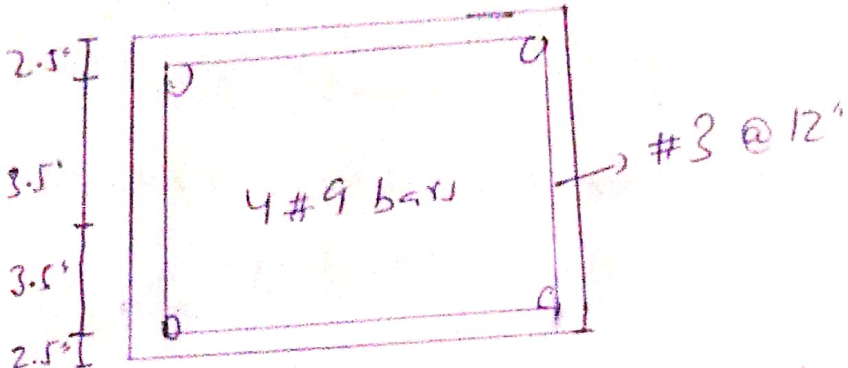
$= 18''$

2) $48 \times$ dia of Tie bar $= 48 \times 3/8$

$= 18''$

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 tie stirrups instead.

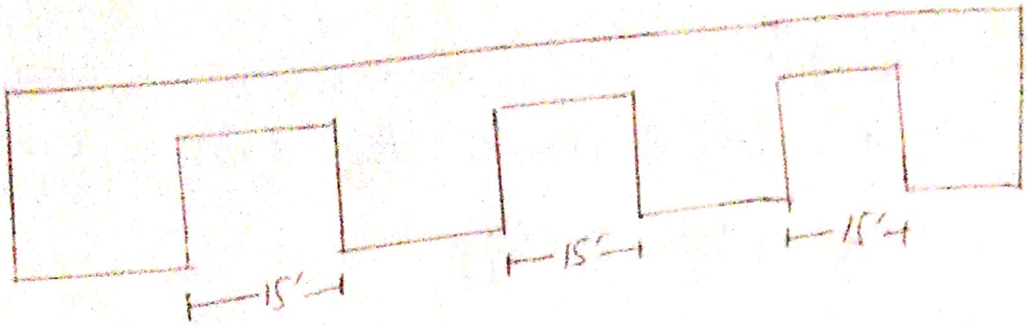
Question No. 1

Given Data:

- Clear span b/w support = 15'
- Factored live load = 160 lb/ft
- Service floor finish load = 20 lb/ft
- f'_c = 4000 psi
- f_y = 40 ksi

Solution:

P.T.O



Step#01:- Minimum Thickness

By using formula,

$t_{min} = L/28 = \frac{15}{28} = 6.4 \cong 6.5"$

As $f_y \rightarrow 40$ ksi

So we will multiply a factor with this thickness

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

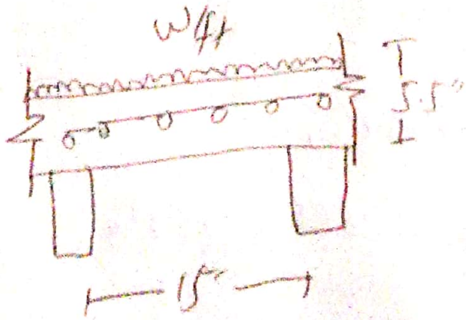
$= (0.4 + \frac{40}{100}) = 0.8$

Hence the minimum thickness will be,

6.5×0.8

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

Step#02:- Effective depth



By formula,

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

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

$d = 4.5''$

Step # 03:

Self weight of 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 $= 160\ lb/ft^3$

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,

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

$M_u = 29.94$ kips-inches

Step# 06:- Area of Steel for Main bars by Trail & Repeat Method

'Trial # 01':

Let depth of compression block

$a = 0.2 \times t$

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

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times [45 - \frac{1.1}{2})}$$

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

'Trial # 02'

$$a = \frac{A_{st} \times f_y}{0.55 \times f'_c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} \Rightarrow 0.62 \text{ in}^2$$

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

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

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

Step#07:- Area of steel for distribution reinforcement

By formula,

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

$= 0.002 \times 12 \times 5.5 = 0.132\ in^2$

Step#08:-

Spacing for main bars

By formula,

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

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

Area $= \pi/4\,(6/8)^2 = 0.442\ in^2$

Step#09:- Spacing for distribution bars

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

We use #5 bars so

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

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

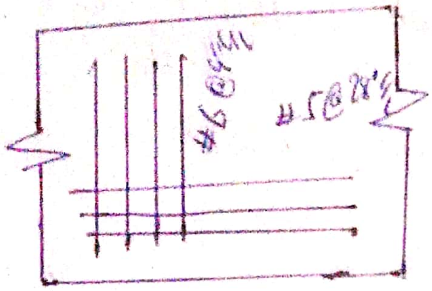
Step # 10:

Find Sketch

$f'_c = 4ksi$, $f_y = 40ksi$

Main steel #6 at 9" c/c

Distribution steel #5 at 28" c/c



Question No. 4

Solution:-

Step# 01:-

$h = 24"$

Step# 02:

Total weight = Wt of soil + Wt of RC

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

$= 660\ psf = 0.660\ ksf$

Step# 03:- Effective bearing capacity.

$q_e = q_a - \omega$

$= 250 - 0.660$

$q_e = 2.84$ ksf

Step# 04:- Required Area for foundation

$\text{Area} = \dfrac{\text{Service load}}{q_e} = \dfrac{100+120}{1.84}$

$= 119.57\ ft^2$

Step# 05: Foundation is square

$\text{Area} = b \times b$

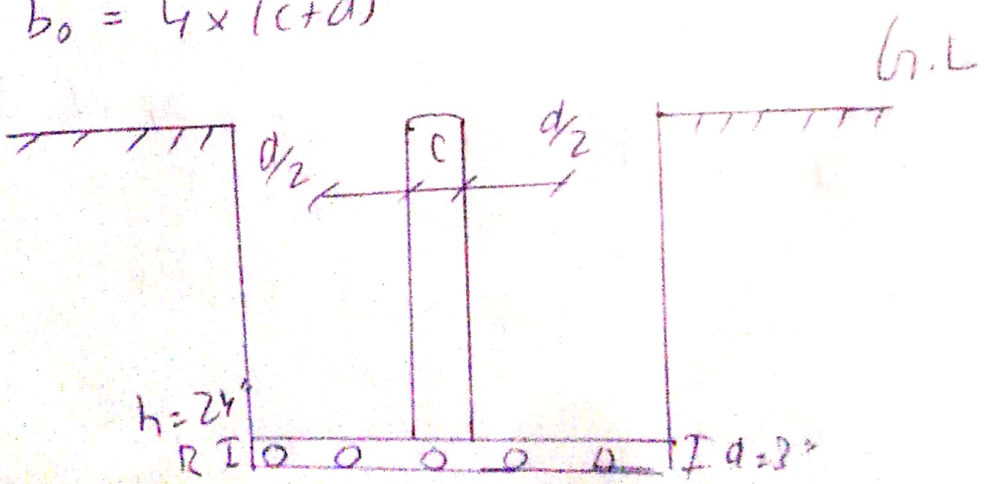
Step# 06: upward bearing capacity of soil

$q_{up} = \dfrac{\text{Factored load}}{(B)^2} = \dfrac{1.2 \times 100 * 1.6 \times 120}{11^2}$

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

Step# 07: Punching shear

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



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

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

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

Step # 08 :-

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

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