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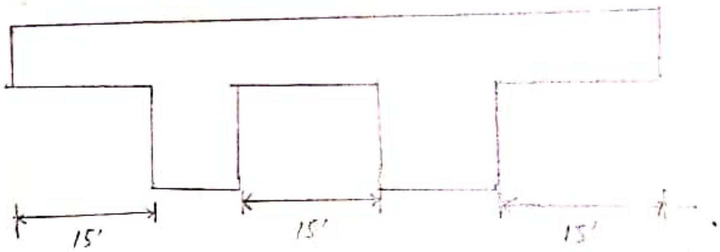
QNo1

Give data

* 3 equal spans Concrete slab
* Clear spains between Supports = 15ft
* Factored live load = 160 lb/ft^2
* f'_c = 4000 psi
* f_y = 40ksi

Solution



Step 1

(Minimum Thickness)

By using Formula

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

As $f_y \rightarrow$ 40 ksi

So we will multiply a factor with this thickness factor

$$= (0.4 + f_y/100)$$

$$= (0.4 + 40/100) = 0.8$$

Hence the minimum thickness will be 6.5×0.8

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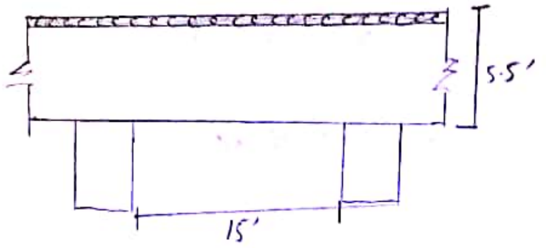
t_{min} = 5.2 = 5.5"

Step#2 (Effective Depth)



By Formula

d= t - Clear cover - ½ (dia of main bars)

= 5.5 - 0.75 - ½ (⅜)

d= 4.5"

Step#3 (Self wt. of Slab)

By Formula

t/12 + Yconcrete

$= \frac{5.5}{12} \times 150$ = 68.75 lb/ft²

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

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Total Factored load = D.L + L.L

$= 106.5 + 160$

$= 266.5 \ lb/ft^2$

Step # 5 (Ultimate Moment)

By using formula

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

$$\boxed{= 89.94 \ \text{kip-in}}$$

Step # 6 Area of Steel for Main Bars by trial and repeat Method

Trial # 1 let depth of compression block

$a = 0.2 \times t$

$= 0.2 \times 5.5 = 1.1''$

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

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

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Trial # 2

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

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

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

Trial # 3

$$a = \frac{0.59 \times 40}{0.85 \times 4 \times 12} = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} =$$

$$= 0.57''$$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.5}{2})} = 0.59 \text{ in}^2$$

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

Step no 7 ⇒ Area of Steel for distribution reinforced

By formula

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

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

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

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Step#7 ⇒ Area of Steel for distribution reinforced

By formula

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

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

Step#8 Spacing for main bars:

By formula

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

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

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

Step#9 Spacing for distribution bars:

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

We use #5 bar so

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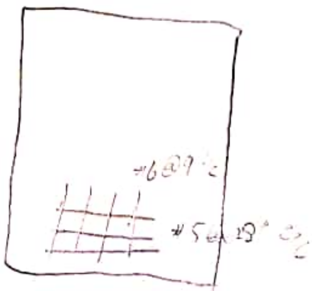
Step#10 Draw Sketch

$f_c' = 4ksi$, $f_y = 40ksi$

Main Steel #6 at c/c

Distribution Steel #5 c/c



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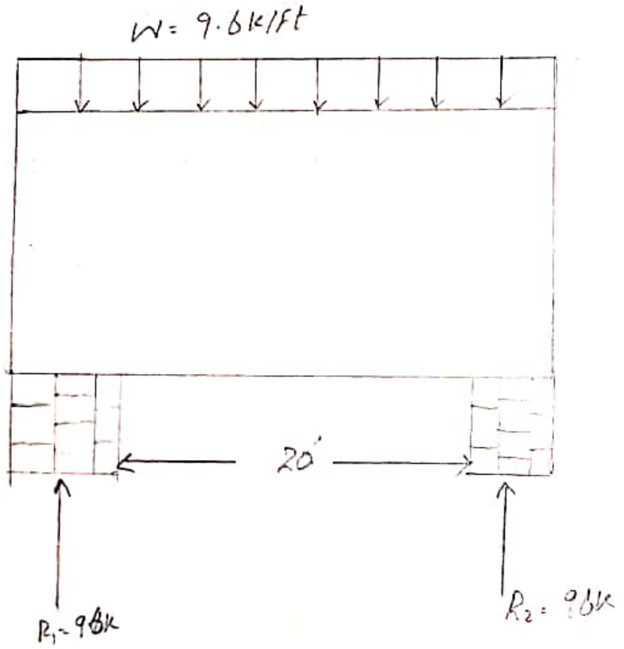
QNo2

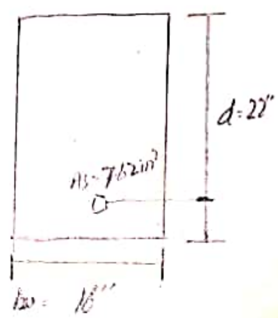
Sol ⇒ First of all find the unit load of beam

So $b \times \gamma_c$

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

So total Factored load $= 9.4 + 0.2 = 9.6 \, k/ft$





Step#01 ⇒ Find the values of R_1 and R_2

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

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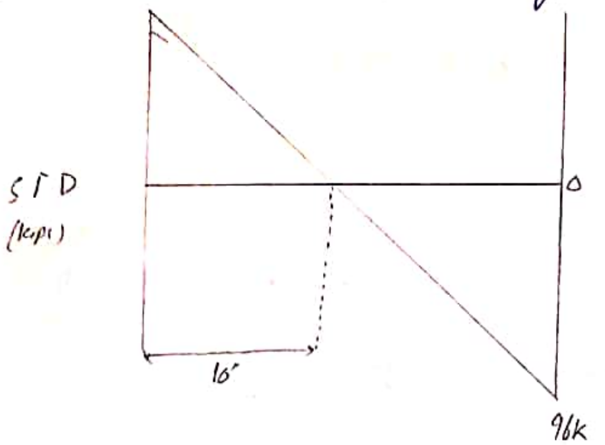
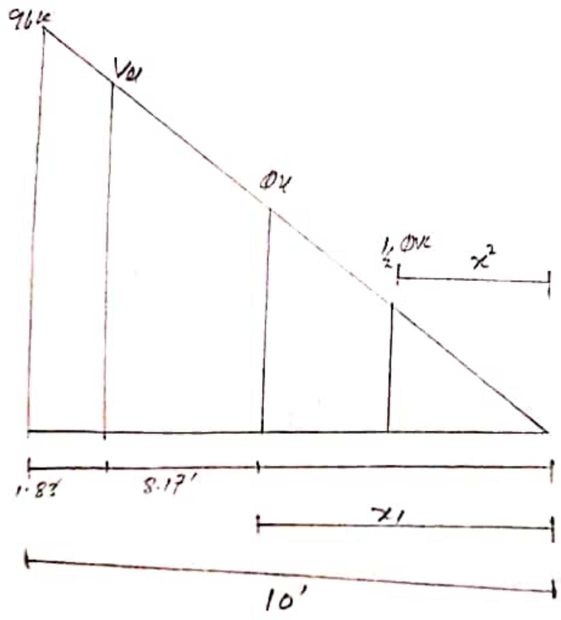
Step # 02 Draw its Shear Force diagram.



Step # 3 Find the value of Critical Stress "V_u" and its Location–

As we know that critical section is located at distance 'd' from face of support = a = 22" = 1.83'

Value of Critical Shear at distance "d" by Similarity of triangles.



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From Similar Δ's

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

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

Step#3: Find the value of "ϕV_c" & "$\frac{1}{2}\phi V_c$" and also it's distance from zero shear to right side

$$\phi V_c = \phi \times 2 \times \sqrt{f'_c} \times b_w \times d = \frac{0.75 \times 2 \times \sqrt{1000 \times 16 \times 28} \times L}{1000}$$

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

location ϕV_c by Similarity of Δ's

$$\frac{96}{10} = \frac{33.40}{0.5 \times x_1}$$

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

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

location of $\frac{1}{2}\phi V_c = \frac{96}{10} = \frac{16.70}{x_2}$

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

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Step#05 " Value of Vs ($V_u = \phi V_s + \phi V_c$)

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

$\phi V_s = 78.43 - 33.40$

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

Step#06 ⇒ " Check on Section adequacy

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

$= 133.57k$

As $\phi \times 8\sqrt{f'_c} \times b_w \times d > \phi V_s$ → It means Section is adequate

Step#07 " Check on min spacing for Stirrups.

$\phi \times 4 \times \sqrt{f'_c}\ b_w \times d = \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000} = 66.79k$

As $\phi 4\sqrt{f'_c}\ b_w d > \phi V_s = 45.03k$

Thus max spacing will be Selected from the Thus max Spacing will be Selecte from the following four Condition

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

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

3) $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'_c} \times b_w} = \frac{0.22 \times 60000}{0.75 \times \sqrt{10000} \times 16} = 17.40$

$A_v = \frac{\pi}{4}(\frac{3}{8})^2 = \frac{0.22 \times 60000}{0.75 \times \sqrt{1000} \times 16} = 17.40''$

$A_v = 0.11 \times 2$

$A_v = 0.22$

4) $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 60000}{50 \times 16} = 16.50$

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

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

$= 48.4'' \approx 5''$ c/c

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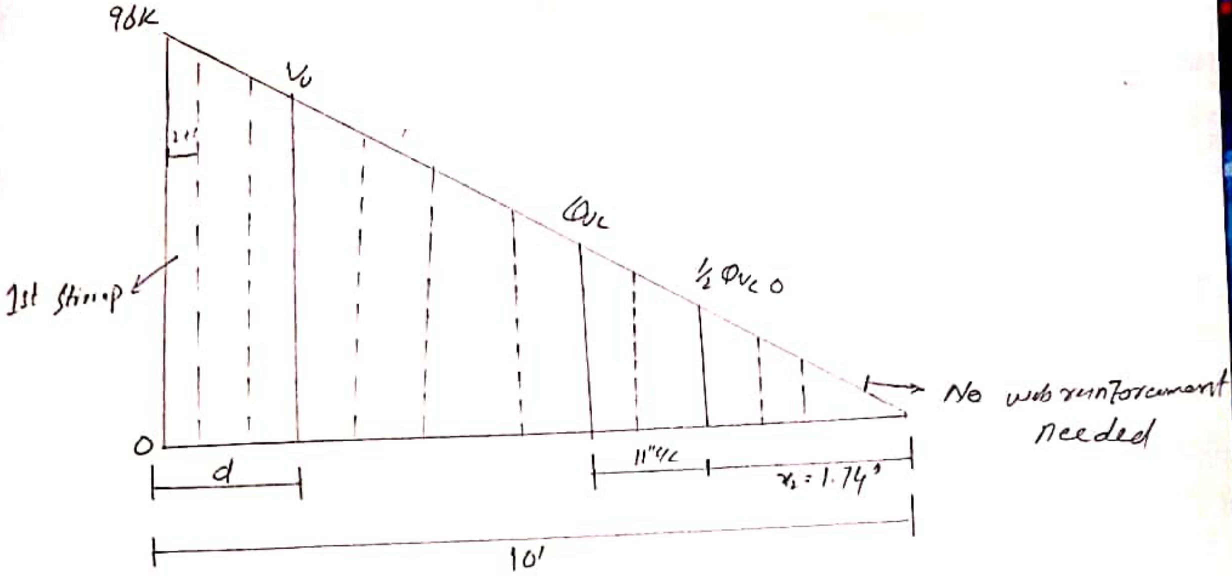
Step#9   Find Sketch



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

$\Rightarrow \frac{5}{2} = 2.5 \approx 2''$

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Q.No 3

Given data ⇒

→ Column = 12 inch - Squre

→ reinforced = 4 # 9

→ Ties are # 3 Spaced 12 inches

→ F'_c = 4000 ksi

→ F_y = 6 ksi

Solution

Step#1 Find gross area of concrete:

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

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

Step#2 Find area of steel

Since A_s = 5% of A_g

$A_s = 0.05 \times 144$

$A_s = 7.2 \, in^2$

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Step#3 Ultimate load carrying capacity

$P_U = \phi \times 0.80 \times \{0.85 \times f'_c \times (A_g - A_s) + A_s \times f_y\}$

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

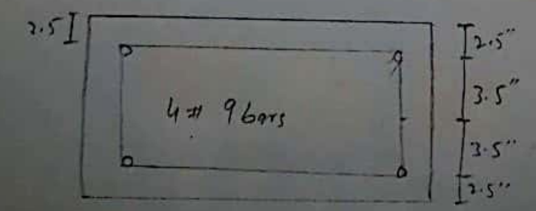
$P_u = 466.50k$

Step#04 Sketch of ties (c/c to distance)

From the below value we choose the last value of all thus.

* $16 \times$ dia of long bar $= 16 \times 9/8 = 18''$
* $48 \times$ dia of tie bar $= 48 \times 3/8 = 18'$
* Leas column direction $= 12''$

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



#3 @ 12"

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So It is a tied Square Column so there is no Spiral Stirrups used, the Stirrup used is of rectangular Shape due to the Specification of the Structure that we will use tie Stirrups instead.

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QNo 4

Solution

Step # 1 let $h = 24''$

Step # 2 ⇒ Total weight = wt of soil + wt of RC

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

$= 660\ psf = 0.660\ ksf$

Step # 3 ⇒ Effective bearing capacity

$q_e = q_a - w$

$= 2.50 - 0.660$

$q_e = 1.84\ ksf$

Step # 4 ⇒ "Required Area for Foundation"

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

Step # 5 " Since Foundation is square

$A_{req} = b \times b = 119.56$

$B \Rightarrow 119'' — 56''$

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Step#06

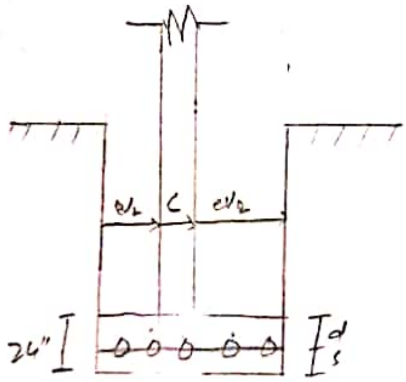
$$q_{up} = \frac{\text{Factored load}}{(B)^2}$$

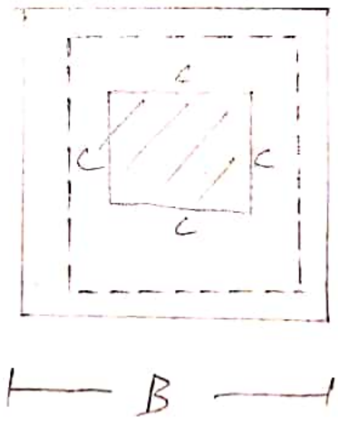
$$q_{up} = \frac{1.2 \times 100 + 1.6 \times 120}{(119.56)^2}$$

$$q_{up} = 0.021\ k/ft^2$$

Step#07 Ponching Shear

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





d = h − Clearcover − dia of bar − 1/2 × d_b

$$d = 24 - 3 - 1 - \tfrac{1}{2} + 1 = 19.5''$$

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

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Step # 8

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

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

$$\boxed{V_{u_2} = 289.60k}$$

Step # 9

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

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

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

Step # 10 ⇒ Beam Shear / one way Shear Check

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

$$V_{u_1} = 2.58 \times 11 \times \left[\frac{11}{2} - \frac{\frac{16}{12}}{2} - 19.5\right]$$

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

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Step #11 Slab 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

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

$$M_u = 331.49\,k' \approx 3977.93\,k''$$

Step #13 Area of Steel for main bars by trail & Repeat method:

Trial 1 let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - \frac{a}{2})} = \frac{3977.93}{0.90 \times 60 (11 - \frac{4.8}{2})} = 8.56\,in^2$$

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Trial #2

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

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

Trial #3

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

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

So that area = $7.1 m^2$

Step No 04 Check the min reinforced by the following 03 method:

a) $Asmin = 0.0018 \times B \times h = 0.0018 (11 \times 12) \times 24$

$= 5.70 \ in$

b) $Asmin = \frac{200}{fy} \times B \times d = \frac{200}{60000} \times (11 \times 12) \times 19.5$

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

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

$= 7.05\ in^2$

From above value greater value will be selected

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

Step#15 Using # 8 bar

$A_b = 0.785\ in$

No. of bars $= \frac{A_s}{A_b} = \frac{8.58}{0.785} = 10.92 \approx 11$ bars in each direction

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