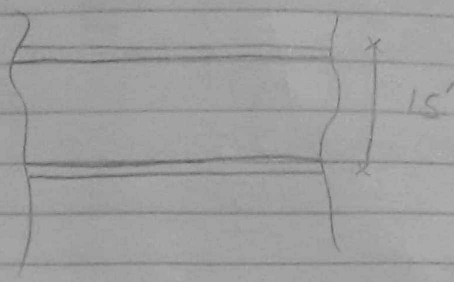
ID 7550 PRCD(I)

Answer # (1):



Step-01:

Minimum thickness

$$t_{min} = \frac{L}{20} = \frac{15 \times 12}{20} = 9''$$

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

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

$$t_{min} = 9 \times 0.8 = 7.2 \cong 7.5''$$

Step #02:

Effective depth:

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

$$d = 7.5 - 0.75 - \frac{1}{2}\left(\frac{4}{8}\right)$$

Using #4 bar for main Reinforcement.

$$d = 6.5''$$

Step #03:

Self wt of slab

$= \frac{t}{12} \times \gamma_{concrete}$

$= \frac{7.5}{15} \times 150 = 75\ psf$

Step #04:

Total factored load

$W_u = 75 + 20 + 160 = 255_{psf} = 0.255\ k$

Step #5

Ultimate Moment:

$M_u = \frac{W_u \times l^2}{8} = \frac{0.255 \times (15)^2}{8} \times 12 = 86.12$

Step #6

Area of steel: for Main Bars by Trail and Repeat Method.

Trail #1:

Let $a = 0.2 \times t = 0.2 \times 7.5 = 1.5$

$A_s = \frac{M_u}{\phi \times f_y \times (d - \frac{a}{2})} = \frac{86.12}{0.90 \times 40 \times (6.5 - \frac{1.5}{2})} = 0.4$ in

Trail #02:

$a = \frac{A_s \times f_y}{0.85 \times f_c \times b} = \frac{0.42 \times 60}{0.85 \times 4 \times 15} =$

$a = 0.3294''$

$$A_s = \frac{M_u}{\phi \times f_y \times \left(d - \frac{a}{2}\right)} = \frac{86.12}{0.90 \times 40\left(6.5 - \frac{0.2991}{2}\right)} = [illegible]3 \ \text{in}^2/\text{ft}$$

$$\boxed{A_s = 0.3776 \ \text{in}^2/\text{ft}}$$

<u>Trail #3:</u>

$$a = \frac{A_s \times f_y}{0.85 \times f'_c \times b}$$

$$a = \frac{0.3776 \times 40}{0.85 \times 4 \times 15} = 0.2961''$$

$$A_s = \frac{M_u}{\phi \times f_y \times \left(d - \frac{a}{2}\right)}$$

$$A_s = \frac{86.12}{0.90 \times 40 \times \left(6.5 - \frac{0.2961}{2}\right)}$$

$$\boxed{A_s = 0.3776 \ \text{in}^2/\text{ft}}$$

<u>Step # 7:</u>

Area of steel for distribution Reinforcement

$$A_{s_{min}} = 0.0018 \times b \times t = 0.0018 \times 15 \times 7.5$$

$$A_{s_{min}} = 0.202 \ \text{in}^2/\text{ft}$$

Scanned with CamScanner

Spacing for Main bars:

$$S = \frac{A_b \times 12}{A_s} = \frac{0.2}{0.3776} \times 12 = 6.4'' \approx 6.5'' \text{ c/c}$$

Step # 9

Spacing for distribution bars

$$S = \frac{A_b}{A_s} \times 12$$ Try # 04 bar

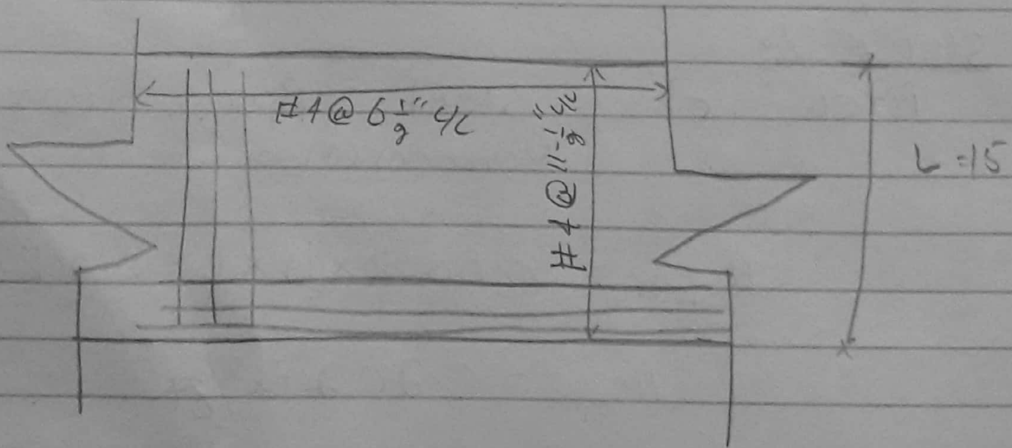
$$S = \frac{0.2}{0.202} \times 12 = 11.88'' \approx 11\tfrac{1}{2}'' \text{ c/c}$$

Step # 10: Final summary

$f_c = 4$ ksi, $f_y = 40$ ksi, $t = 7\frac{1}{2}''$

Main steel = #04 at $6.5\frac{1}{2}''$ c/c

Distribution - steel #04 at $11\text{-}\frac{1}{5}''$ c

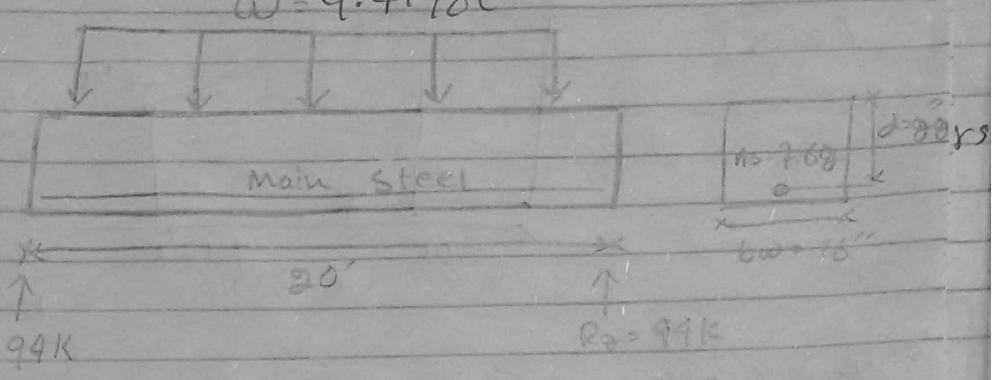


PLAN view of slab

x ~~~~~ x ~~~~~

Answer # 02

Sol:

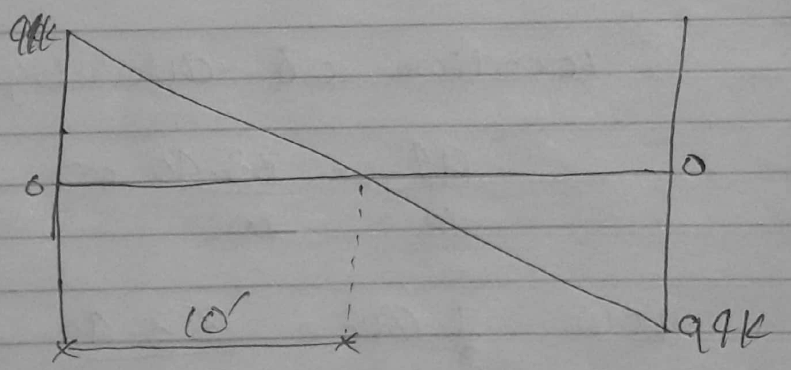


Step # 1:

Find values of R_1 and R_2

Total load = $9.4 \times 20 = 188/2 = 94K$

Step # 02:



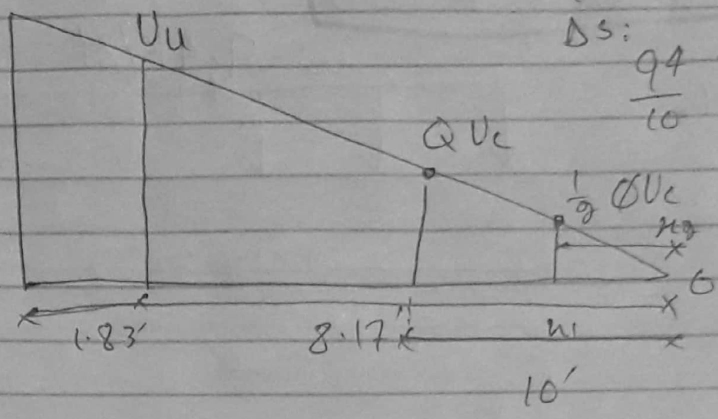
Step # 3

Find the value of critical shear "V_u"

$= d = 22'' = 1.83'$

Value of d of critical shear at distance 'd' by similarity of triangles.

SFD
(kips)



From similar Δs:

$\frac{94}{10} = \frac{Vu}{8.17}$

$Vu = 76.8$

ep # 04:

Find the Value of ΦVc and $\frac{1}{2}$ ΦVc

$\phi Vc = \phi * 2 * \sqrt{f'c} \times bw \times d = \frac{0.75 \times 2 * \sqrt{4000} \times 16 \times 3}{1000}$

$= 33.40k.$

location of ΦVc by similarity of Δs

$\frac{94}{10} = \frac{33.40}{x_1} \Rightarrow x_1 = 3.55'$

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

location of $\frac{1}{2}$ ΦVc $\Rightarrow \frac{94}{10} = \frac{16.70}{x_2}$

$x_2 = 1.78'$

Step # 5

Value of ΦVs

$Vu = (\phi Vs + \phi Vc)$

So. $\phi V_s = V_u - \phi V_c = 76.80 - 33.40$

$= 43.40k.$

.80kips.

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 = $\phi V_s < \phi 8 \sqrt{f'_c}\, b_w d$ => It means section is adequate.

Step # 07:

check on Max spacing for stirrups.

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

As, $\phi 4 \sqrt{f'_c}\, b_w d > \phi V_s = 43.40k$

So Max. spacing will be selected from the following for condition.

① $S_{max} = 24''$

② $\frac{d}{2} = \frac{22}{2} = 11''$

③ $S_{max} = \frac{A_v \times f_y}{0.7 \times \sqrt{f'_c} \times b_w}$

$= \frac{0.22 \times 6000}{0.75 \times \sqrt{4000} \times 16} = 17.40''$

④ $\frac{A_v \times f_y}{50 \times b_w}$

$\frac{0.22 \times 6000}{50 \times 16} = 16.50''$

From the above conditions least value will be selected

Smax= 11" c/c

Step 08:

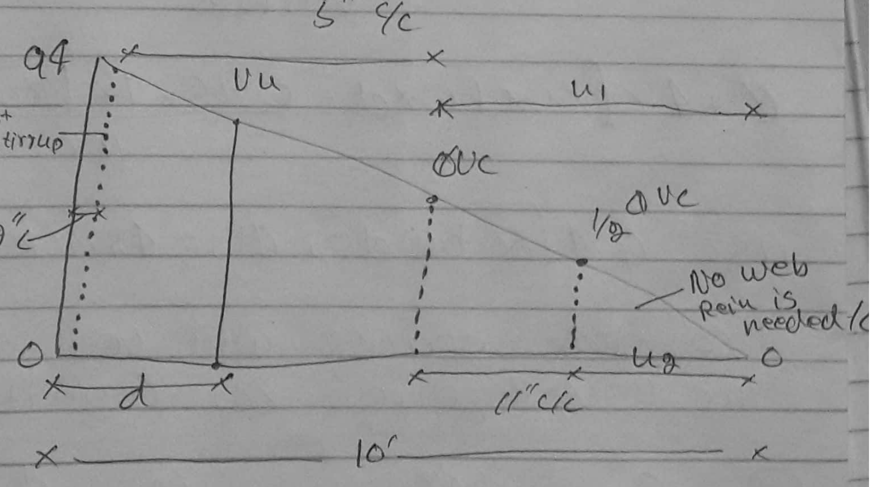
Spacing of stirrups from/at critical section

$$S = \frac{\phi * A_v * f_y * d}{V_u - \phi V_c} = \frac{0.75*0.22*60*22}{76.80 - 33.44}$$

S= 5" c/c.

Step E09:

Final sketch



As we know that first stirrups from face of support = 5/2 = 5/2 ≈ 2"

PLAN view of slab

Sol:

Step-01: Let depth of foundation OR, thickness of foundation

$$= h = 12''$$

$$\text{Effective depth} = d = 12 - 3.5 = 8.5''.$$

Step-02: $\text{Total Weight} = W_{concrete} + W_{soil}$

$$= \frac{12}{12} * 150 + 4 * 100 = 550 \text{ psf}$$

$$\simeq 0.55 \text{ ksf}.$$

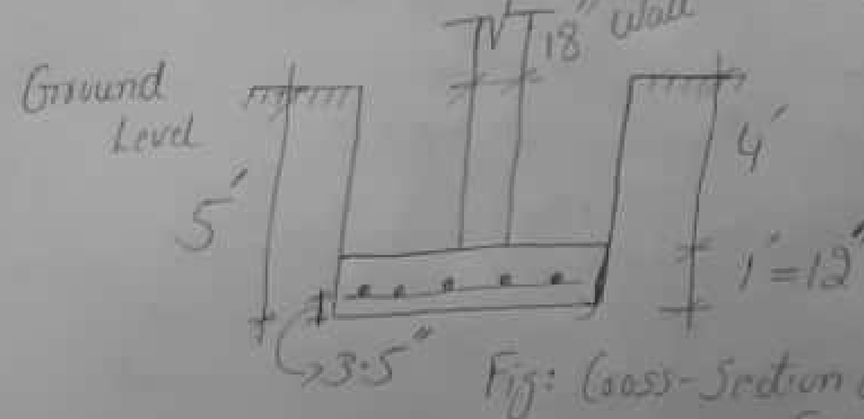


Fig: Cross-Section of Wall Foundation.

Scanned with CamScanner

Step-03: Effective Bearing Capacity

$$q_e = q_a - W = 5 - 0.55 = 4.45 \text{ ksf}$$

Step-04: Bearing Area:

$$A = \frac{\text{Service load}}{q_e} = \frac{15+10}{4.45} = 5.62 \text{ ft}^2.$$

$$\approx 5.62 * 1' \text{ or, } 5.75 * 1'$$

$$\approx 5'\text{-}9'' * 1'$$

Step-05: Design Pressure on the base of footing due to factored loads.

$$q_{up} = \frac{\text{Factored load}}{\text{Footing Area}} = \frac{1.2*15+1.6*10}{5.75' * 1'}$$

$$q_{up} = 5.91 \text{ ksf}.$$

Step-06: Check of Beam Shear Capacity

$$V_{ud} = q_{up} * \left[\frac{(B-S)}{2} - d\right]$$

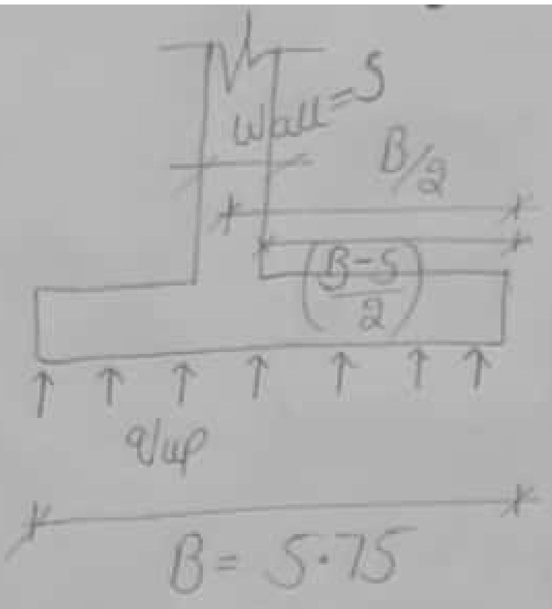
where; B = Breadth of foundation

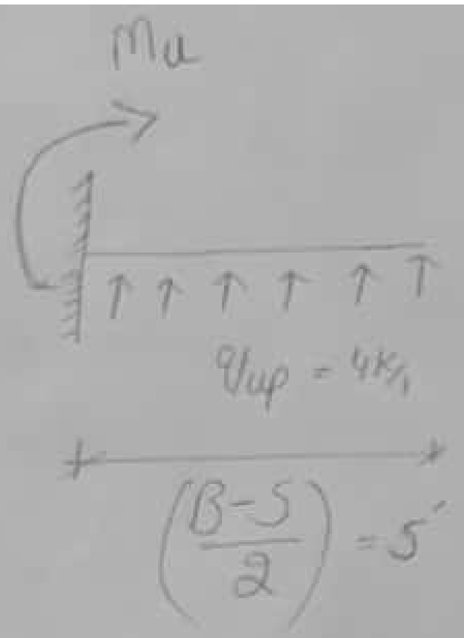
S = Wall thickness

d = Effective depth.

$$V_{ud} = 5.91 * \left[\frac{(5.75 - 18/12)}{2} - \frac{8.5}{12}\right]$$

$$V_{ud} = 8.37 \text{ K}$$





$$+M_u = q_{up} * \left(\frac{B-S}{2}\right) * \frac{1}{2} * \left(\frac{B-S}{2}\right)$$

$$= \frac{q_{up}}{8} * (B-S)^2$$

Step-07: Beam Section Self Shear Capacity.

$$\phi V_c = \phi 2\sqrt{f'_c}\, b\, d = \frac{0.75 * 2 * \sqrt{3500} * 12 * 8.5}{1000}$$

$$\phi V_c = 9.05 \text{ kip}$$

Step-08: Actual Value of Effective depth from 'ϕV_c'.

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

OR, $$d = \frac{\phi V_c * 1000}{2 * \sqrt{f'_c} * b} = \frac{8.37 * 1000}{2 * \sqrt{3500} * 12} = 7.9'' < 8.5'' \text{ (Assumed)}$$

Take $\phi V_c \approx V_{ud} = 8.37K$

O.K

Step-09: $M_u = \frac{q_{up}}{8} * (B-S)^2$

$= \frac{5.91}{8} * \left[5.75 - \frac{18}{12}\right]^2 = 13.34\,K'$

$M_u = 160.08$ K-inch

Step-10: Area of Steel:

By Trial and Repeat Method.

Trial # 01: Let $a = 0.2 * d = 1.6''$

$$A_s = \frac{M_u}{\phi * f_y * (d - \frac{a}{2})} = 0.47\ in^2/ft$$

Trial # 02:

$$a = \frac{A_s * f_y}{0.85 * f_c * b} = 0.65''$$

$$A_s = \frac{160.08}{0.90 * 50 * (8 - \frac{0.65}{2})} = 0.44\ in^2/ft$$

Trial # 03:

$$a = \frac{0.44 * 50}{0.85 * 3.5 * 12} = 0.61''$$

$$A_s = \frac{160.08}{0.90 * 50 * (8 - \frac{0.61}{2})} = 0.44\ in^2/ft$$

Step-11: Code ductility Requirements;

$$As_{min} = 0.002 * b * h = 0.002 * 12 * 12$$
$$= 0.29 \ in^2/ft$$

$$As_{max} = \rho_{max} * b * d$$
$$= 0.85^2 * \frac{f_c'}{f_y} * \left[\frac{\varepsilon_t}{\varepsilon_t + \varepsilon_y}\right] * b * d$$
$$= 0.85^2 * \frac{3.5}{50} * \left[\frac{0.003}{0.003 + 0.005}\right] * 12 * 8.5$$

$$As_{max} = 1.93 \ in^2/ft > 0.44 \ in^2/ft \quad OK$$

Step-12: Spacing b/w Main & Distribution bars

Main Bars: Use #5 having $A_b = 0.31 \ in^2$

$$Spacing = \frac{A_b}{A_s} * 12 = \frac{0.31}{0.44} * 12$$
$$\cong 8\tfrac{1}{2}'' \ c/c$$

Distribution Bars: Try #4 having $A_b = 0.20 \ in^2$

$$Spacing = \frac{A_b}{As_{min}} * 12 = \frac{0.20}{0.29} * 12$$
$$\approx 8'' \ c/c$$

Sol: $P_d = \phi * 0.80 * [0.85 * f_c' * (A_g - A_s) + A_s * f_y]$

First find design load:

$P_d = 1.2 * D.L + 1.6 * L.L = 1.2 * 400 + 1.6 * 240$

$P_d = 864$ kips.

As, it is given in the question that:

$A_s = 5\%$ of $A_g = 0.05 * A_g$.

So;

$$864 = 0.65 * 0.80 * [0.85 * 5 * (A_g - 0.05 * A_g) + 0.05 * A_g * 60]$$

$A_g = 236.01 \ in^2$

Since, it is a square tied column.

So, $A_g = b * b = 236.01$

$b^2 = 236.01 \Rightarrow b = 15.36'' \approx 16''$

Let $b = 16''$

Now $A_g = b * b = 16 * 16 = 256 \ in^2$.

$$864 = 0.65 * 0.80 * [0.85 * 5 * (256 - A_s) + A_s * 60]$$

$A_s = 10.13 \ in^2$

Next step is to find number of bars;

Let try #10 bar having $A_b = 1.27\ in^2$.

$$\text{No. of bars} = \frac{A_s}{A_b} = \frac{10.13}{1.27} = 7.98 \approx 8\ \#10 \text{ bars}$$

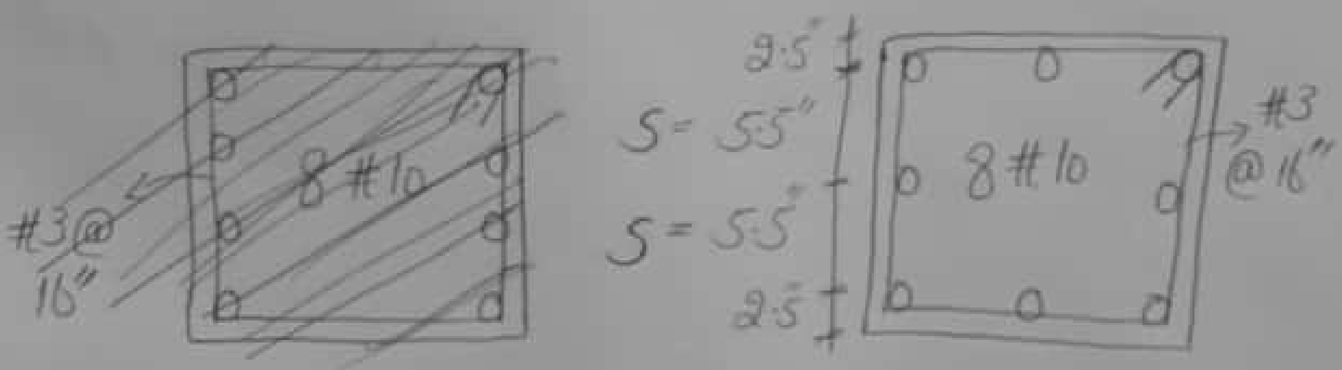
Design of Ties: 1- 16 * dia of longitudinal bar

$$16 * \frac{10}{8} = 20''$$

2- 48 * diameter of Tie bar = $48 * \frac{3}{8} = 18''$

3- Least Column dimension = 16"

⇒ c/c distance b/w Ties = 16"



If S > 6", then More ties will be Provided.

⇒ Check for additional Ties

$S = 5.5 - \frac{10}{8} = 4.25'' < 6''$, therefore no additional ties are required.

Note: S = Clear/Face to face distance b/w two Main bars.

Scanned with CamScanner