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Subject: PRC 2
Instructor:
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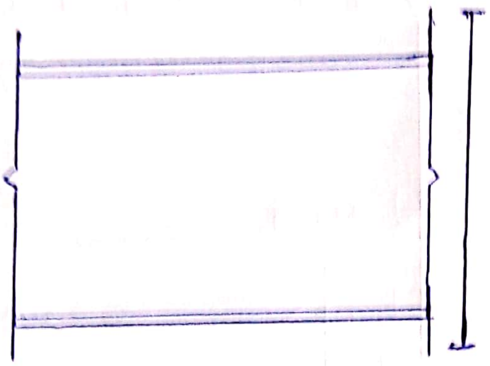
Q1 A reinforced concrete slab is build integrally with it support and consist of three equal spans each will clear span of 15ft. The factor live Load is 160 psf and service floor finish Load is 20 psf design the slab using $f'_c = 4000$ psi and $f_y = 40$ ksi draw sketch of your final design.

Solution:



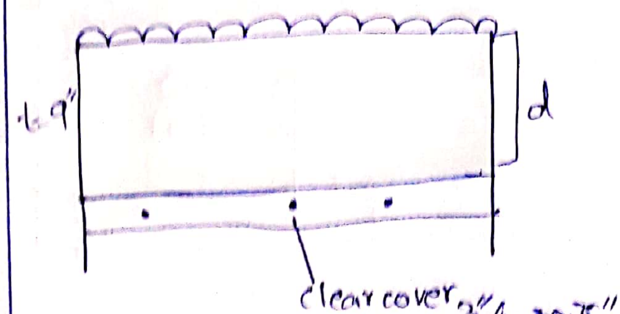
Step 01:-

Minimum thickness = tmin

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

Step 2:-

Effective depth (Distance from top of slab to centre of main base)



$d = t - \left(\text{clearcover} - \frac{1}{2}(d\ m.s)\right)$

$= 9 - \left(0.75 - \frac{1}{2}\left(\frac{4}{3}\right)\right)$

let say we are using 4 bars

$d = 8.0''$

Step:3:- Sel weight of slab $= \frac{t}{12} \times \gamma$ concrete

$$= \frac{9}{12} \times 150$$

$$= 112.5 \text{ Psf}$$

Step:4:-

$$W_u = 1.2 D.L + 1.6 L.L$$

$$= 1.2(2.0)(20+112.5) + 1.6(160) =$$

$$415 \text{ Psf} = 0.415 \text{ ksf}.$$

Step:5:-

Ultimate moment.

$$M_u = \frac{W_u \times l^2}{8} = \frac{0.415 \times (10.5)^2}{8}$$

$$140.06 k'$$

Step:6:- Area of steel for Main Bar by ~~Trial~~ Trial and repeat method.

TRIAL # 1:

$$\text{let } a = 0.2t$$

$$= 0.2 \times 9$$

$$= 1.8''$$

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

$$= \frac{140.06}{0.90 \times 40 (8 - \frac{1.3}{2})} \Rightarrow 0.54 \text{ in}^2/\text{ft}.$$

TRIAL#2:-

$$a = \frac{As \times fy}{0.85 \times f'c \times 6} \Rightarrow \frac{0.54 \times 40}{0.85 \times 4 \times 15} = 0.42''$$

As,

$$\frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{140.06}{0.90 \times 40 \left(8 - \frac{0.42}{2}\right)}$$

$$= 0.50 \ in^2/ft.$$

Step:7:-

Area of steel for distribution Reinforcement

$$As_{min} = 0.0018 \times 6 \times t = 0.0018 \times 15 \times 9$$

$$= 0.24 \ in^2/ft$$

Step:8:-

Spacing for Main Bars

$$S = \frac{Ab}{As} \times 12$$

$$= \frac{0.196 \times 12}{0.50} = 4.70 \approx 5 \ c/c$$

0.2

4.42.

Step:9:-

Spacing for distribution bar.

$$= \frac{Ab}{Ast}$$

let try #4 bar for distribution steel also.

$$= \frac{0.2}{0.24} \times 12$$

$$= 10'' \; c/c$$

Main-steel #4 at 5 c/c

Distribution-steel #4 at 10" c/c

Q NO:# 2:-

Answer:-

A simply supported rectangular beam 16" wide ----- Draw a sketch of your final diagram.

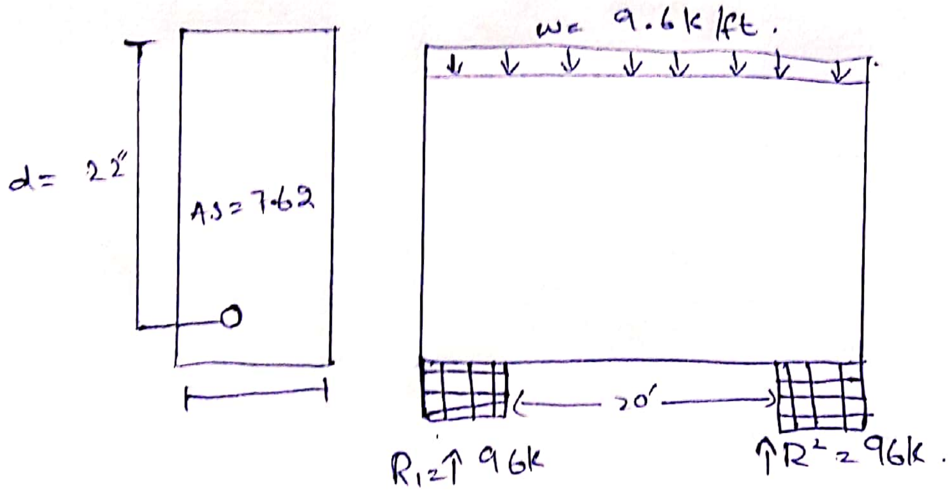
Solution:-

first we find the emil load of Beam.

So, $b \times \gamma_c$.

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

So total factored load $= 9.4 + 0.2 = 9.6\ k/ft$.



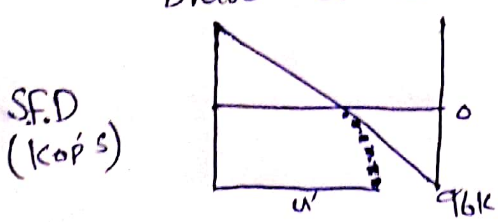
Step# 1:-

find the value of R_1 and R_2

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

Step# 2:-

Draw a clear force diagram.

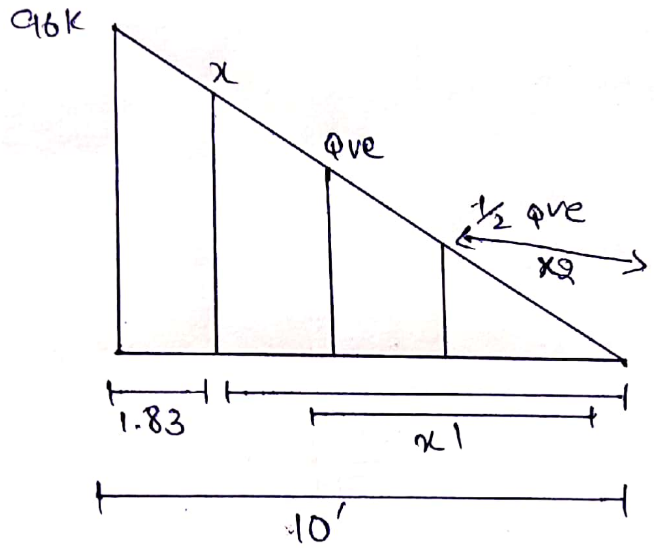


Step#3:

find the value of critical stress "V_u" on its location.

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

value of critical shear of distance "d" by similarity of triangles



from similar Δ's $\frac{96}{10} = \frac{V_u}{8.17} = 78.432$ kips.

Step#4:

find the value of (Q'v c) and ½ Qvc and also its distances from zero shear to rightside.

$$Qvc = Q \times 2 \times \sqrt{fc'} \times bw \times d = \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000}$$

$\Rightarrow$ 33.40k.

P.T.O

location of ΦVc by similarity of Δ's

$96/10 = \frac{33.40}{x_1} = 3.47'$ $x_1 = 3.47'$

Now ½ ΦVc $= \frac{33.40}{2} = 16.70k$

location of ½ ΦVc $= 96/10 = 16.70/x_2 \Rightarrow x_2 = 1.73'$

Step#5:-

value of ΦVs = (V_u = ΦVc + ΦVc)

ΦVc = V_u − ΦVc = 76.80 − 33.40 = 743.40k.

Step#6:-

check on section adegdeny.

$\phi \times 8 \times \sqrt{Fc'} \times bw \times d = \frac{0.75 \times 8 \times 4000 \times 16 \times 22}{1000}$

$\Rightarrow 133.57k$

As $\phi Vs < \phi 8 \sqrt{fc} \times bw \times d \Rightarrow$ it means section of adegdate.

Step#7:-

check on maximum spacing for ~~stirrup~~ stirrups.

$\phi \times 4 \times \sqrt{Fc'} \times bw \times d \Rightarrow \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$

$\Rightarrow 66.79$ kip.

As $\phi 4 \sqrt{Fc'} \times bw \times d > \phi Vs = 43.40k$.

so max-spacing will be selected from following four conditions.

P.T.O

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

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

3) $S_{max} = \dfrac{A_v \times f_y}{0.75 \times \sqrt{f_c'} \times b_w} = 17.40''$

4) $S_{max} = \dfrac{A_v \times f_y}{50 \times b_w} = 16.50''$

from above four conditions - test value of spacing for # 3, 2 legged stirrups will be selected

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

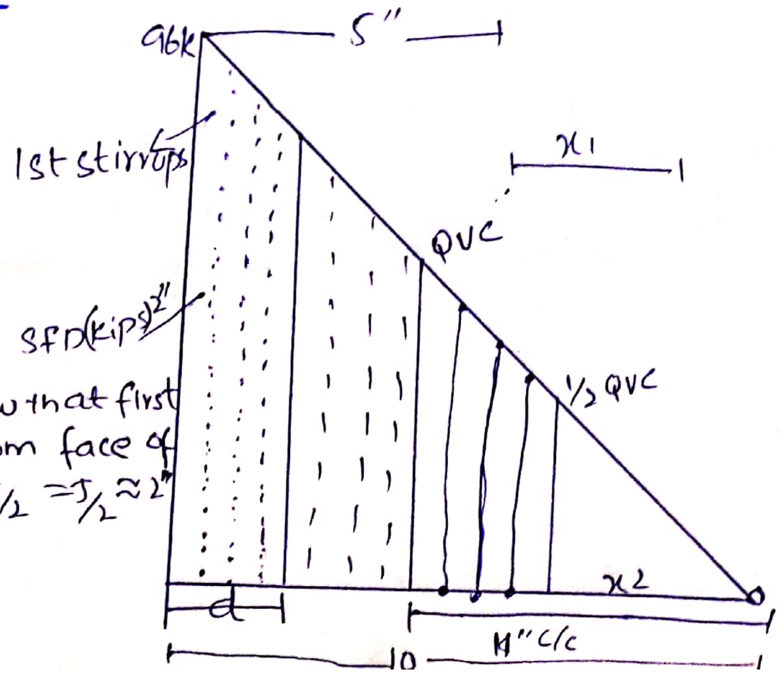
Step# 8:-

spacing of stirrups from at critical section

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

$S = 5'' c/c$

Step# 9: Final sketch.



As we know that first stirrups from face of support = $S/2 = 5/2 \approx 2''$

QNO:3:-

Calculate the axial ultimate ------ design & necessary spirals.

Step#1:-

Find gross area of concrete.

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

$A_g = 12 \times 12 = 144\ in^2$ (Acutal).

Step#2:-

Find area of steel.

Since $A_s = 5\%$ of A_g

$= 0.05 \times 144$

$A_s = 7.2\ in^2$

Step#3:-

Ultimate load carrying capacity.

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

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

$P_u = 466.50k$

Step#4:-

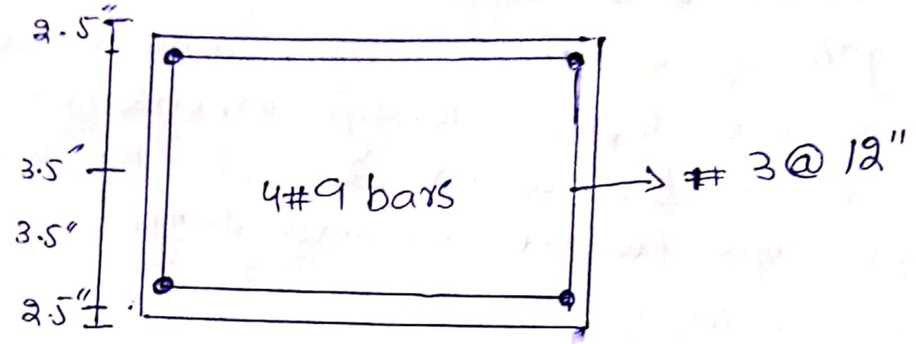
Sketch and design of ties (c/c todistance).

From the below value we choose the least value of all thus;

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 $= 12''$

P.T.O. →

So c/c distance b/w the 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 specification of structure thus we will use Tie stirrup instead.

QNO:4
Answer:-

Solution:-

Step # 1:-
let $h = 24''$

Step # 2:-
Total weight = wt of soil + wt of Rc
$3 \times 120 + 2 \times 150 = 660$ psf $= 0.660$

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

$$Area = \frac{S.L}{q_e} = \frac{100 + 120}{1.84} \Rightarrow Area = 119.56 ft^2$$

Step # 5:-
Since foundation is square

Area $= B \times B = 119.56$ $B \Rightarrow 119'-56''$

Step # 6:-
$$q_{up} = \frac{\text{factored load}}{(B)^2}$$

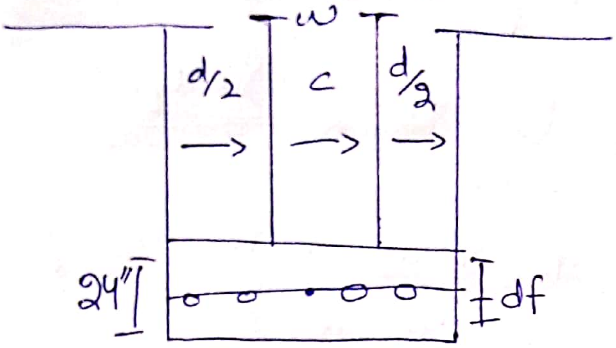
$$= \frac{1.2 \times 100 + 1.6 \times 120}{(119.56)^2} \Rightarrow q_{up} = 0.021 \ k/ft^2$$

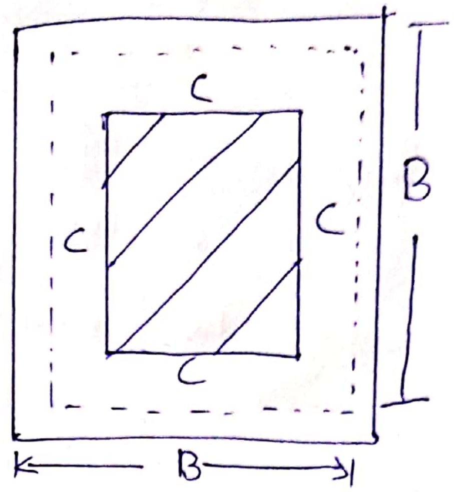
P.T.O

Step # 7:-

Ponching shear

$b = 4+(c+d)$





$d = h - \text{clearcover} - \text{dia of bar} - \frac{1}{2} \times db$

$d = 24-3-1-\frac{1}{2}+1 = 19.5"$

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

Step # 8

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

$\Rightarrow 0.021 \left[(119.56)^2 - \left(\frac{16+19.5}{12}\right)^2\right]$

$V_{u_2} = 300.$

THE END.