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Section	B
Semister	6th
Subject	Plain and reinforced Concrete Design 1
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QNo1:

Given Data:

3 equal spans concrete slab

clear span b/w supports = 15ft

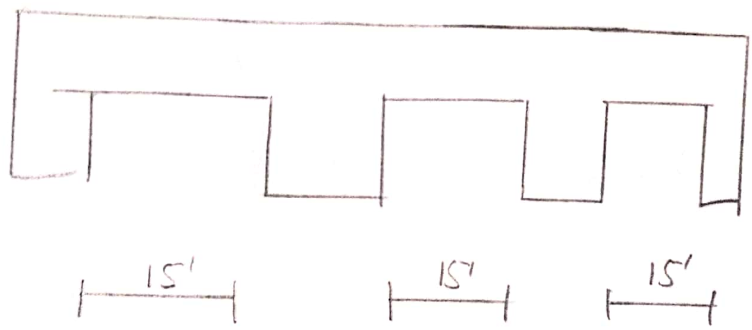
Factored live load = 1600 Lb/ft²

Service floor finish load = 20 lb/ft

f'c = 4000 Psi

fy = 40 ksi

Solution



Step #1 (Minimum Thickness)

By using formula

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

As fy → 40 ksi

So we will multiply a factor with thickness

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

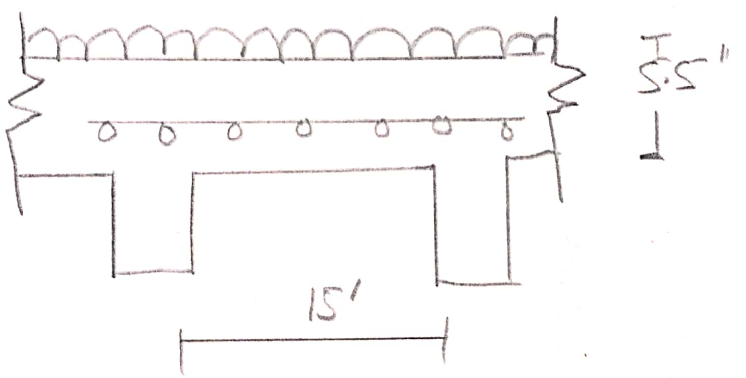
$= \left(0.4 + \frac{40}{100}\right) = 0.8$

Hence the minimum thickness will be

6.5×0.8

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

Step # 2 : (Effective Depth)



By formula

$d = t - \text{Clear cover} - \frac{1}{2}(\text{dia of main ba}$

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

$d \approx 4.5''$

Step# 3:- (self wt. of slab)

By formula

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

$= \frac{5.5}{12} \times 150 = 68.75 \text{ lb/ft}^2$

Step # 04:- (Total Factored Load)

Factored Live Load = 160 lb/ft^2

So the Factored Dead Load will be

$D.L = 1.2 (20 + 68.75)$

$= 106.5 \text{ lb/ft}^2$

Total factored Load = D.L + L.L

$= 106.5 + 160$

$= 266.5 \text{ lb/ft}^2$

$= 0.2665 \text{ k/ft}^2$

Step #5 :- (Ultimate Moment)

By Using formula

$$Mu = \frac{Wu \times L^2}{8}$$

$$= \frac{0.26665 \times (15)^2 \times 12}{8}$$

$$= \boxed{89.94 \text{ Kip-inches}}$$

Step #6 Area of steel for Main Bar

By Trial and Repeat method

Trial #01

Let depth of compression block

$$a = 0.2 \times t$$

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

$$Ast = \frac{Mu}{\phi \times fy \times (d - \frac{a}{2})}$$

$$\frac{89.94}{0.90 \times 40 \times (4.5 - \frac{1.1}{2})}$$

$$\boxed{Ast = 0.63\ in^2}$$

Trail # 02 :

$$a = \frac{As \times fy}{0.55 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12}$$

$$\Rightarrow 0.62\ in^2$$

$$Ast = \frac{Mu}{\phi \times fy \times (d - \frac{a}{2})}$$

$$= \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.6}{2})}$$

$$Ast = 0.59\ in^2$$

Trial # 03 /

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

$$= 0.57''$$

$$Ast = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{0.57}{2}\right)}$$

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

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

Step #07: Area of steel for distribution reinforcement

By formula

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

$= 0.002 \times 12 \times 5.5 \Rightarrow \boxed{0.132 \text{ in}^2}$

Step # 08 Spacing for main bars

By formula

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

We use #6 bar dia $= \left(\frac{6}{8}\right)''$

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

Step#09 Spacing for distribution bars

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

We use # 5 bars so

$$\text{dia} = \left(\frac{5}{8}\right)'' \quad \text{Area} = \frac{\pi}{4}\left(\frac{5}{8}\right)^2$$

$$= 0.31 \text{ in}^2$$

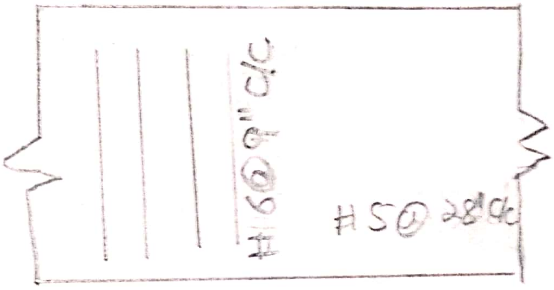
$$\text{Spacing} = \frac{0.31}{0.132} \times 12 = 2.81'' \approx 28'' \text{ c/c}$$

Step # 10 Find Sketch

$f'c = 4 ksi$, $fy = 40 ksi$

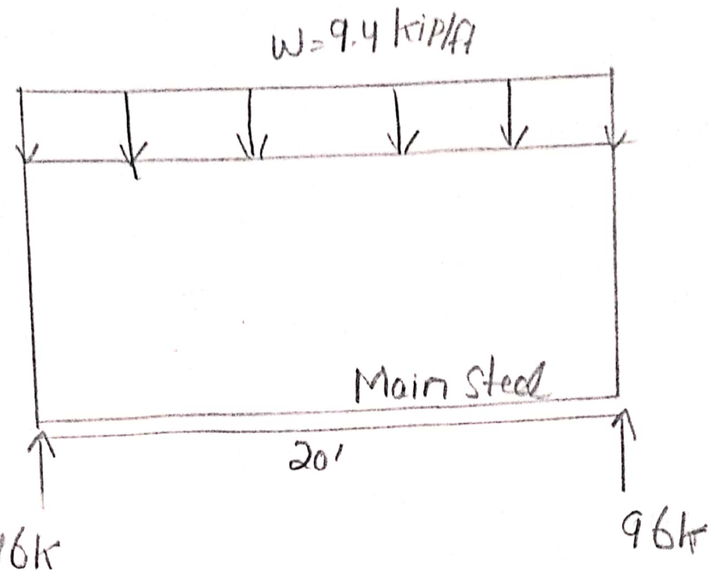
Main Steel # 6 at 9" c/c

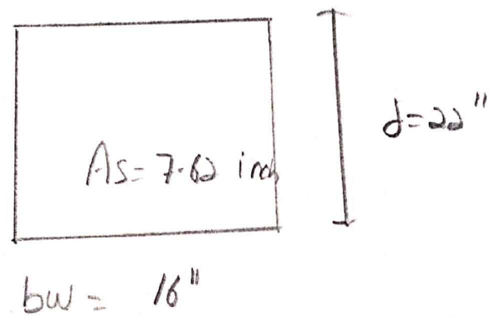
Distribution steel #5 at 28" c/c



QNo2:

Sol:-



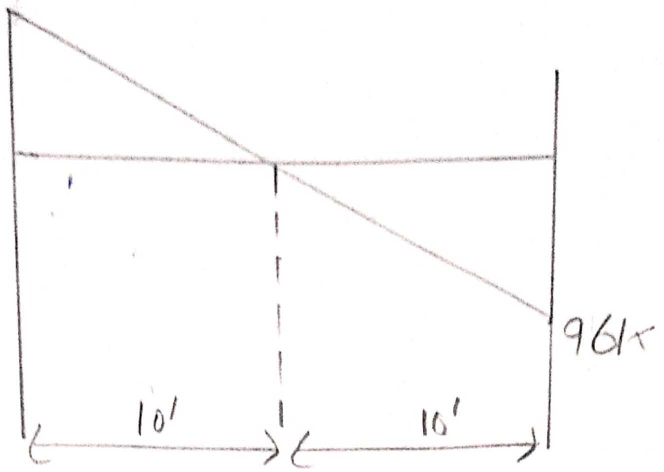


<u>Step #01</u> find values of R_1 and R_2

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

<u>Step# 02</u>

Draw its shear force diagram

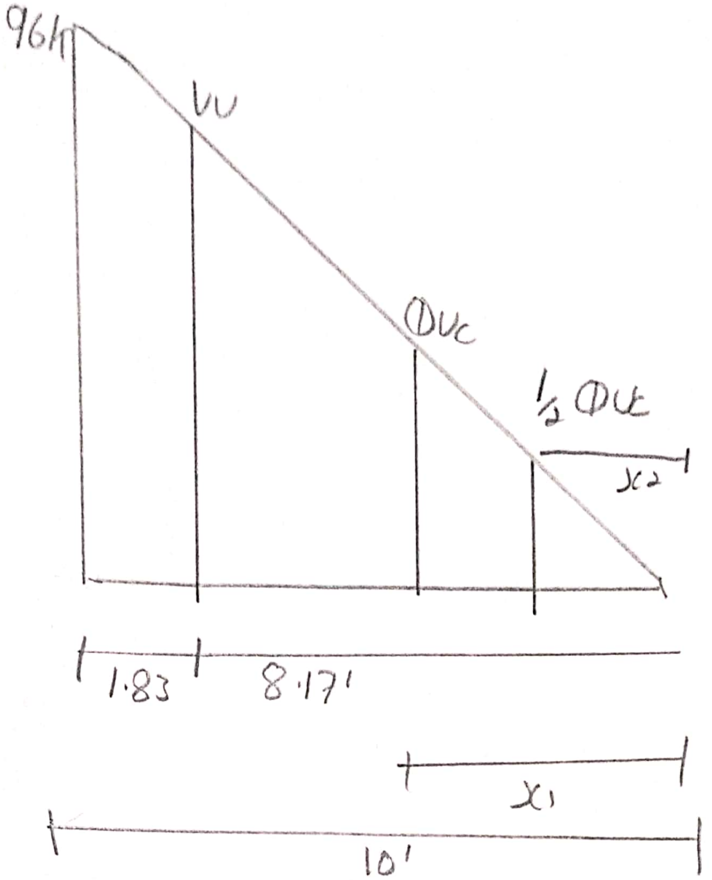


Step #03

Find the value of Critical shear 'Vu' and its location; As we know that critical Section is located at distance "d" from face of = d = 22" = 1.83'

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

P.t.o



From Similar Δ's $\frac{96}{10} = \frac{Vu}{8.17}$

$Vu = 78.43k$

Step # 4 Find the value of ΦVc "{ 1/2 "ΦVc" and also its distance from zero shear to right side

$\Phi Vc = \Phi \times 2 \times \sqrt{f'c} \times bw \times d$

$\Rightarrow \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000}$

$\phi V_c = 33.40\,k$

Location of ϕV_c by similarity of Δs,

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

$x_1 = 3.48'$

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

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

$x_2 = 1.74'$

Step #05: Value of ϕV_s ($V_u = \phi V_s + \phi V_c$)

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

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03\,k$

Step #6 Check on section adequacy.

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

$= 133.57\ k$

As $\phi \times 8\sqrt{f'c} \times bw \times d > \phi Us \rightarrow$ It means Section is adequate.

Step 07#: Check on min spacing for Stirrups.

$\phi \times 4 \times \sqrt{f'c} \times bw \times d = \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 66.79\ k$

As $\phi 4\sqrt{f'c}\ bw\ d > \phi Us = 45.03\ k$

Thus max spacing will be selected from the following four condition

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

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

3) $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'c} \times b_w}$

$= 0$

$\therefore A_v = \frac{\pi}{4}\left(\frac{3}{8}\right)^2$

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

$= 17.40$

④ $S_{max} = \frac{0.22 \times 60{,}000}{50 \times 16} = 16.50''$

From above four condition least value of spacing for #3, 2 legged stirrup will be selected

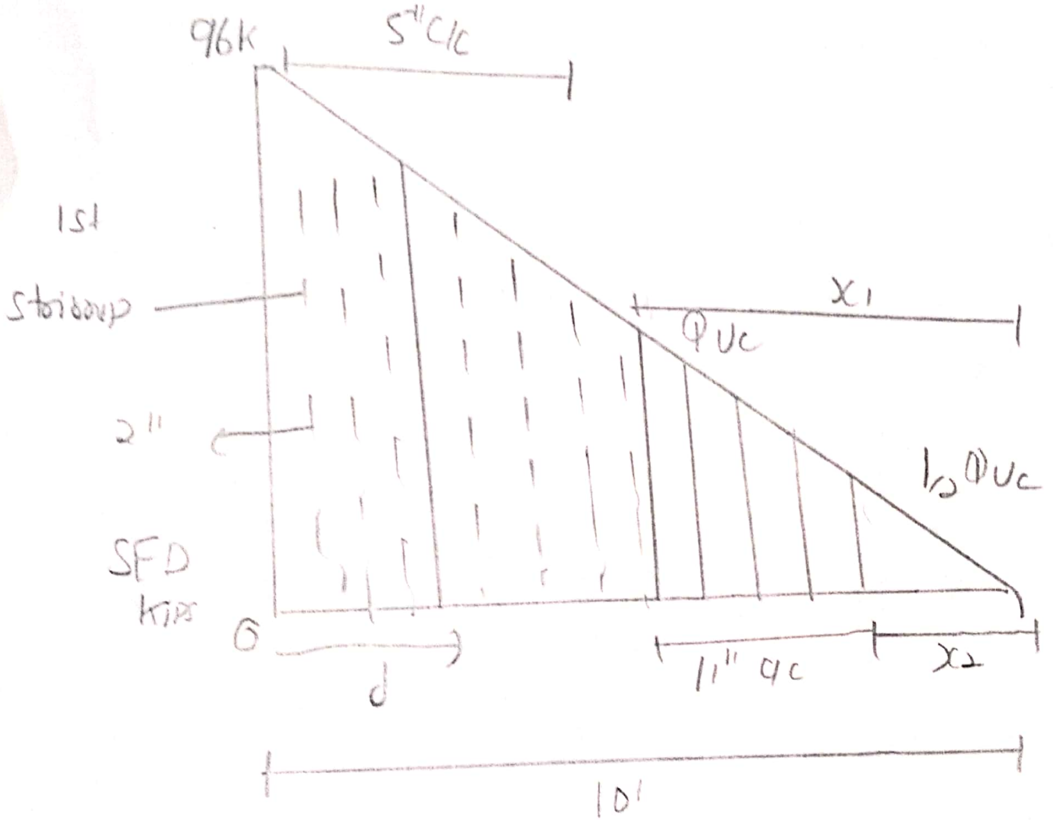
So $S_{max} = 11''$ c/c

<u>Step#08</u> Spacing of Stirrup from 1at critical Section

$S = \frac{0.75 \times 0.22 \times 60 \times 22}{76.80 - 33.44}$

$S = 5''$ c/c

Step # 9



As we know that first stirrup from face of support

$$= \frac{S}{2} = \frac{5}{2} \approx 2''$$

QNO3:

Given Data

Column = 12 inch square

reinforced = 4 #9

Ties are #3 spaced @ 12 inches

$f_c' = 4000$ psi

$f_y = 6$ ksi

Solution.

Step #01

Find gross area of concrete

$A_g = b \times b$ (since it is square field

$A_g = 12 \times 12 = 144 \text{ in}^2$ (Actual)

Step # 02: Find area of steel

Since $A_s = 5\%$ of A_g

$A_s = 0.05 \times 144$

$A_s = 7.2 \text{ in}^2$

Step # 03: Ultimate load carrying capacity

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

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

$P_u = 466.50 \text{ k}$

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

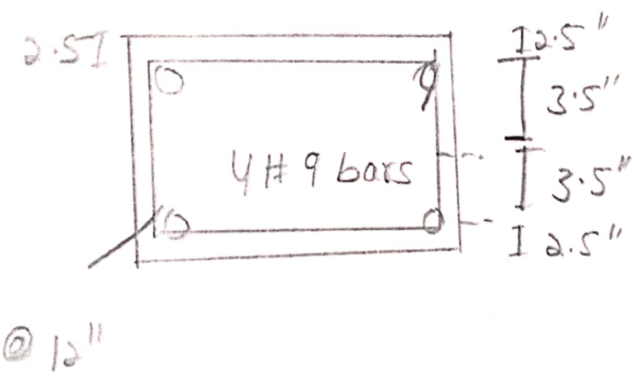
From the below value use chose the least value of all thus

→ 16×dia of long bar = 16× 9/8 = 18"

→ 48× dia of tie bar = 48× 3/8 = 18'

least column dimension = 12"

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



So it is a tied square column so there is no spiral stirrup used, the stirrup used is of rectangular shape due the specification of the structure that we use tie Stirrups instead.

Q No 4.

Sol:-

Step # 1

let h = 24"

Step # 02

Total weight = wt of soil + wt of RC

= 3x120 + 2x150 = 660 Psf

= 0.660

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

$$A_{req} = \frac{\text{Service load}}{q_c} = \frac{100+120}{1.84}$$

$$\boxed{A_{req} = 119.56\ ft^2}$$

Step #5

Since foundation is square

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

$$B \Rightarrow 119' - 56''$$

Step # 6

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

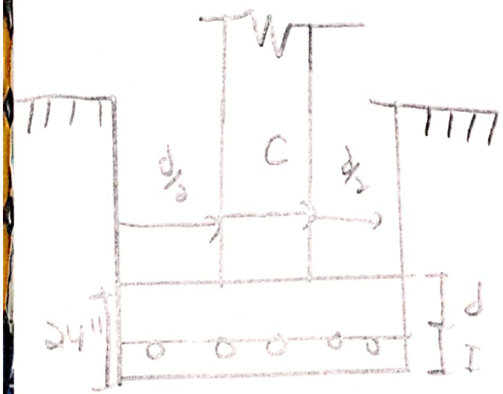
$$q_{up} = \frac{1.2 \times 100 + 1.6 \times 120}{(119.56)^2}$$

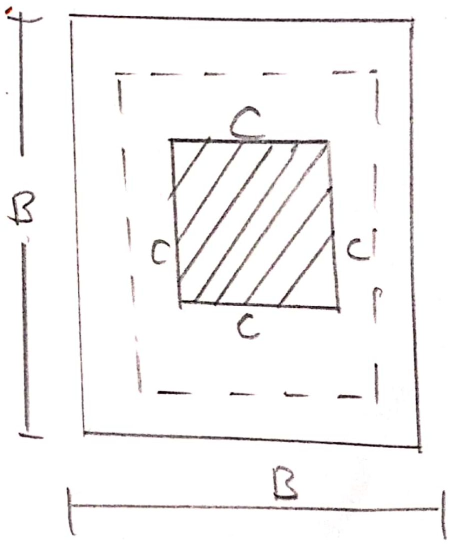
$V_{up} = 0.021 \ k/ft^2$

Step# 07

Punching shear,

$b_o = 4 (c+d)$





$d = h - \text{clear cover} - \text{dia of bar} - \frac{1}{2} \times d_b$

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

$= 19.5''$

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

Step # 08

$$V_{U2} = q_{up} \times \left[B^2 - (c+d)^2 \right]$$

$$= 0.021 \left[(11956)^2 - \left(\frac{16+19.5}{12} \right)^2 \right]$$

$$\boxed{V_{U2} = 300}$$