Name : Malak Miraj Qadir
ID : 7829
Section: A
Semester: 6th
Paper : PRCD-1
Instructor : Engr. Fawad Khan

(Question-01)

**Givendata:-**

⇒ 3 equal spans Concrete slab.

⇒ $f'c = 4000$ psi

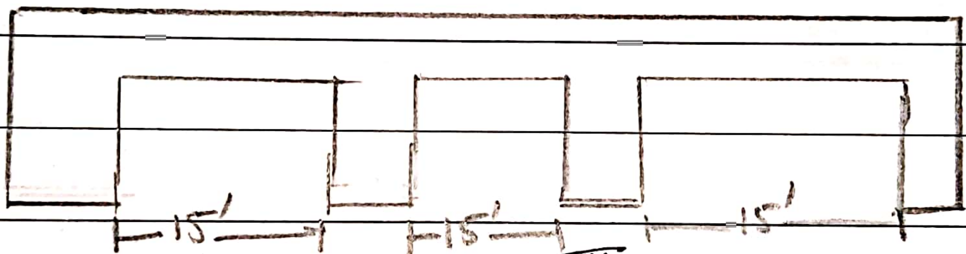
⇒ $fy = 40$ ksi

⇒ Clear span b/w supports = 15ft

⇒ Factored Live load = 160 lb/ft²

⇒ Service Floor finish load = 20lb/ft²

Solution:-




Step#1 (Minimum Thickness):-

By using formula

$t_{min} = L/28$

⇒ 15/28

⇒ 6.4 ≈ 6.5"

As $fy \rightarrow 40$ ksi

So we will multiply a factor with this thickness.

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

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

$$= 0.8$$

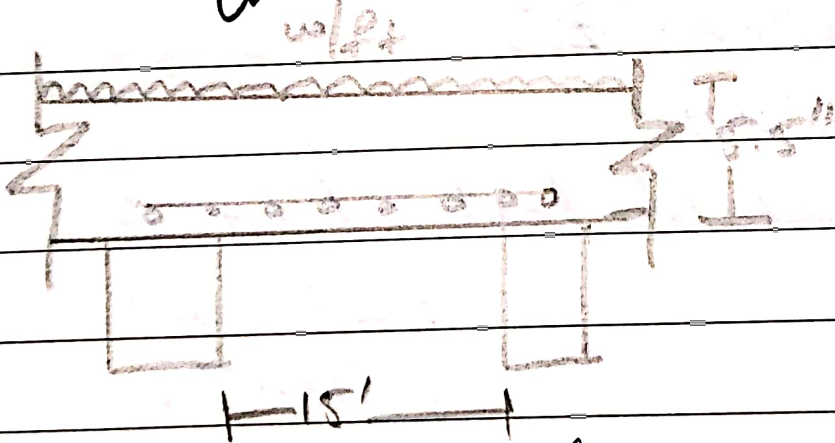
Hence the minimum thickness will be

$6.5 \times 0.8$

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

Step#2:-

(Effective Depth)




By using formula

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

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

$$\boxed{d \cong 4.5''}$$

## Step # 03: (Self wt. of Slab)

By using formula

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

$$= \frac{5.5}{12} \times 150$$

$$\Rightarrow 68.75 \text{ lb/ft}^2$$

## Step # 04:- (Total Factored Load)

Factored live load = $160 \text{ lb/ft}^2$

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

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

$$= 89.94 \text{ Kip\_inches.}$$

Scanned with CamScanner

$$Ast = \frac{89.94}{0.90 \times 40 \times \left(45 - \frac{0.5}{2}\right)} = 0.59\ in^2$$

So we will use $A_{ST} = 0.59 in^2$

"Step # 07":-

Area of Steel for distribution reinforcement:

By using formula

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

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

Step # 08:-

Spacing for main bars.

By formula

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

we use #6 bars dia $= (6/8)''$

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

"Step # 09":-

Spacing for distribution bars.

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

We use #5 bars so

dia $= (5/8)''$; Area $= \frac{\pi}{4}(5/8)^2 = 0.31\ in^2$

Spacing $= \frac{0.31 \times 12}{0.132}$

$= 2.81'' \Rightarrow 28''$ c/c

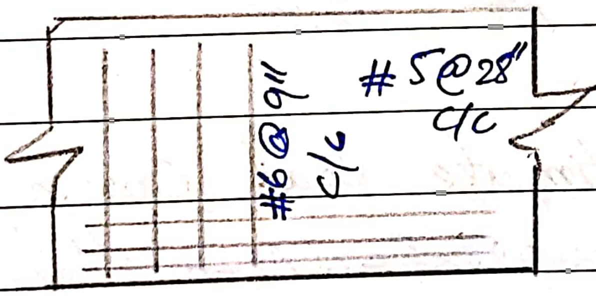
Step #10:-

Find Sketch

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

Main steel #6 at 9" c/c

Distribution steel #5 at 28.1" c/c



Q. No (02)

**Sol:-**

First of all find the unit load of beam.

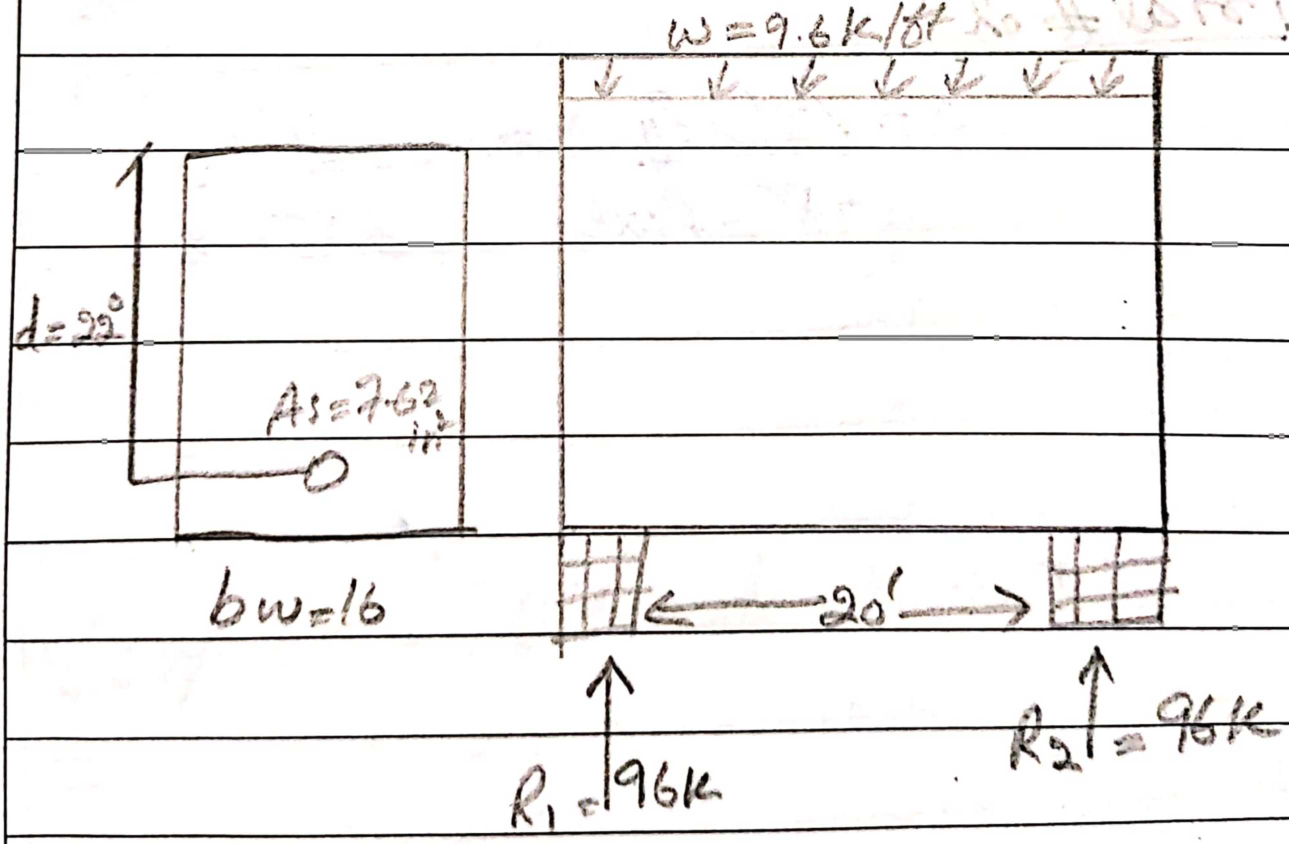
So $b \times \gamma_c$

$= \frac{16}{12} \times 150$

$\Rightarrow 200\ lb/ft = 0.2\ k/ft$

So total factored load $= 9.4 + 0.2$

$= 9.6\ k/ft$

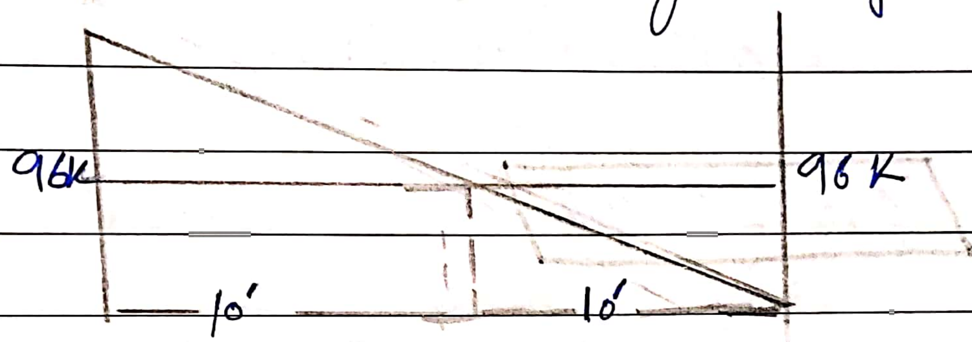


Step#01: find values of $R_1$ and $R_2$

Total loads = $9.6 \times 20 = \frac{188}{2} = 96K$

Step#02:-

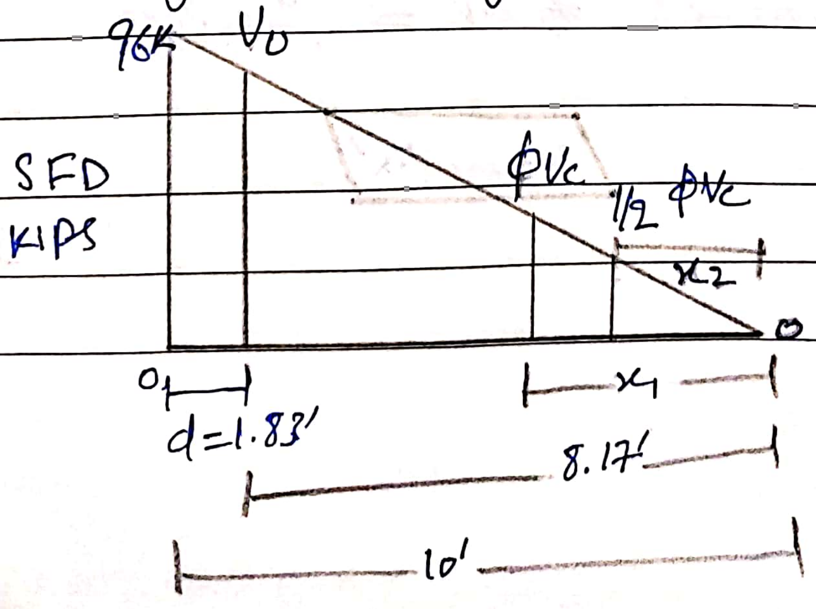
Draw its shear force diagram




Step#03:-

find the value of critical shear "$V_u$" 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 traingles



Step# 04:-

find the value of '$\phi V_c$' and $\frac{1}{2}$ '$\phi V_c$' and also its distance from zero shear to right side.

$$\phi V_c = \phi \times 2 \times \sqrt{f'_c} \times b_w \times d$$

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

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

Location of $\phi V_c$ by Similarity of '$\Delta s$'

$$\frac{96}{10} = \frac{33.40}{x_1} \Rightarrow \boxed{x_1 = 3.4'}$$

Now

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{9}{10} = \frac{16.70}{x_2}$

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

## Step # 05:

Value of $\phi V_s$

$(V_u = \phi V_s + \phi V_c)$

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

$= 78.80 - 33.40$

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

## Step # 06:

Check on Section adequacy

$$\phi . 8 \sqrt{f'c}\, b_w . d = \frac{0.75 . 8 \sqrt{4000} . 16.22}{1000}$$

$= 133.57K$

As

$\phi V_s < \phi 8 \sqrt{f'c} . b_w d$

$\Rightarrow$ It means section is adequate.

## Step # 7

Check on Maximum Spacing for stirrups $\phi . 4 \sqrt{f'c} . b_w . d = \frac{0.75 . 4 \sqrt{4000} . 16.22}{1000}$

$= 66.79 Kip$

As $\phi 4\sqrt{f'c}\, b_w d > \phi V_s = 43.40k$
So Max spacing will be selected from following four conditions

① $S_{max} = 24''$

② $\frac{d}{2} = \frac{22}{2} = 11''$

③ $S_{max} = \frac{0.22 \times 60000}{0.75\sqrt{4000} \times 16} = 17.40$

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

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

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

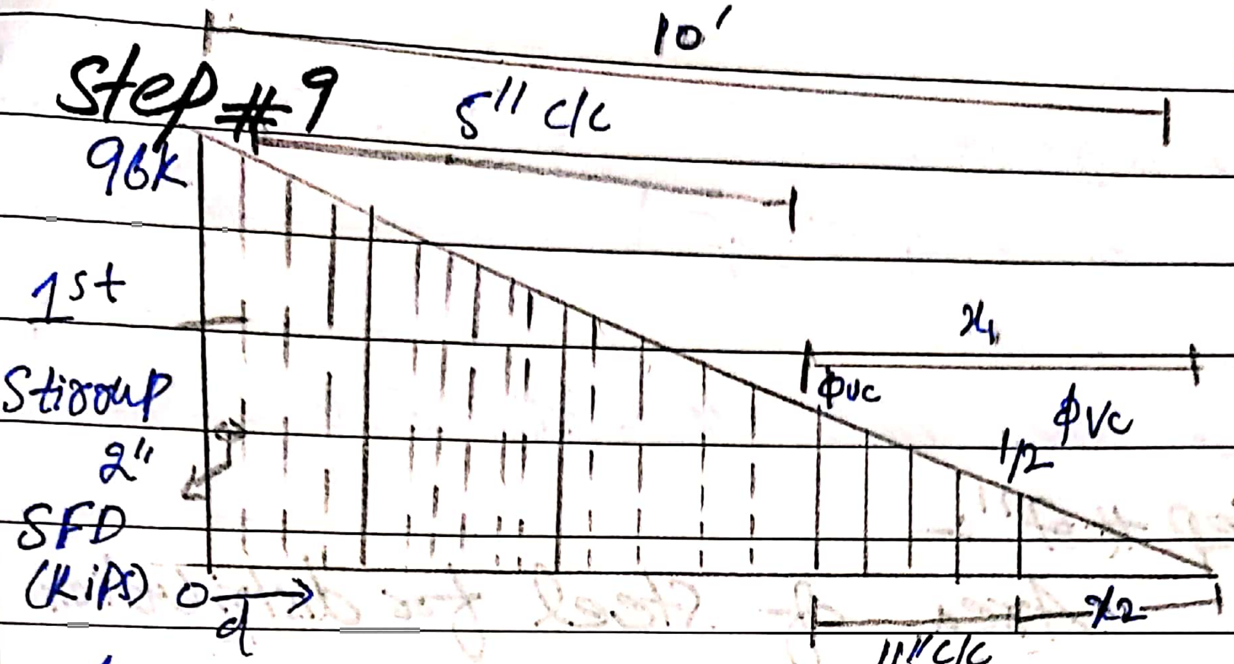
**Step #03**

Spacing of stirrup from/at 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

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

Q.No(03)

Ans:-

Step#01

Finding gross area of concrete.

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

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

"Step#02"

Find the 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

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

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

$P_u = 466.58K$

"Step#04:-

Sketch and design of Ties (c/c to distance)

From the below value we choose

the last value of all thus.

1)- 16 x dia of long bar = 16 x 9/8
= 18"

(2) 48 x dia of Tie bar = 48 x 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 use tie stirrups instead.

Q.No # 4

Solution:-

Step # 1

let $h = 24''$

Step # 02:

Total weight = wt of soil + wt of fte

$= 3 \times 120 + 2 \times 150 = 660$ 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

$$\text{Area} = \frac{\text{Service load}}{q_e}$$

$$= \frac{100 + 120}{1.84}$$

**Area = 119.59 ft²**

## Step#05

Since foundation is square

$A_{req} = B \times B$

$= 119.56 \Rightarrow B \simeq 11'$

## Step#06: Upward bearing Capacity of Soil

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

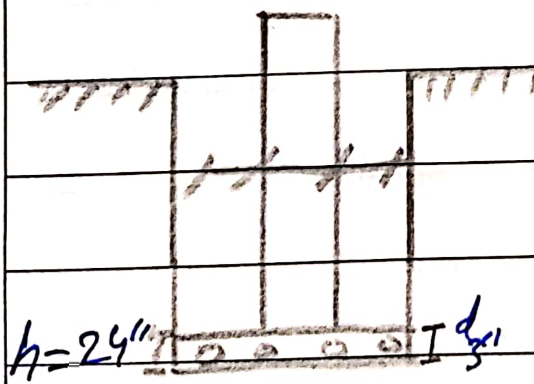
$$q_{up} = \frac{1.2 \times 150 + 1.6 \times 120}{11^2}$$

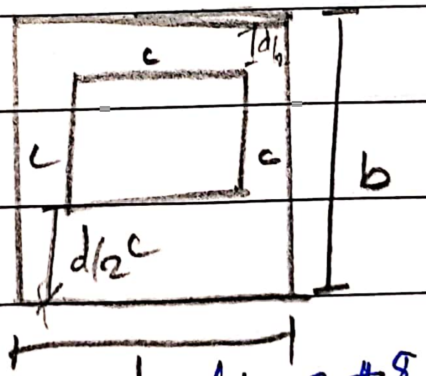
$q_{up} = 2.58\ K/ft^2$

## Step 07:-

Punching Shear:

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




(take #8 bar dia = $\left(\frac{8}{8}\right)'' = 1''$)

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

$= 24 - 3 - 1 - 1/2(1) = 19.5''$

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

$= 142''$

Step #08

$V_{v2} = q_{up} \times \left[ B^2 - (c+d)^2 \right]$

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

$V_{v2} = 300$