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Subject: PRCD-I

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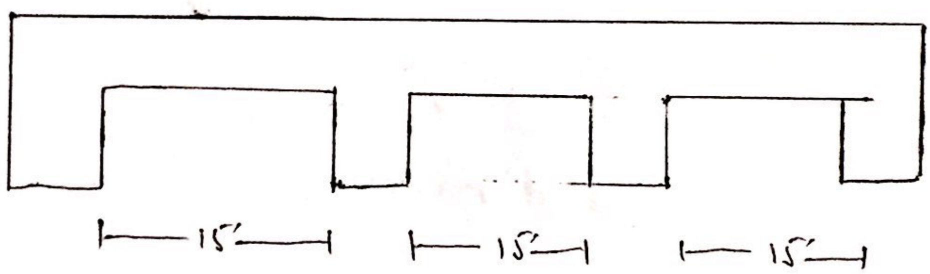
(Question - 01)

Given Data:-

- 3 equal spans concrete slab
- clear span b/w supports = 15 ft
- Factored line load = 160 lb/ ft²
- Service Floor finish load = 20 lb/ft²
- $f_c' = 4000$ Psi
- $f_y = 40$ 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 this thickness

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

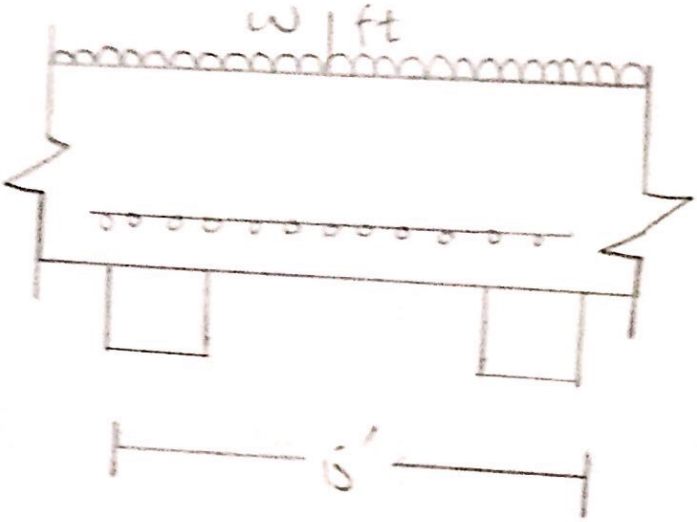
$$= \left(0.4 \times \frac{40}{100}\right) = 0.8$$

Hence the minimum thickness will be

6.5×0.8

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

STEP # 2:- (Effective Depth)



By formula

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

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

$d \cong 4.5''$

STEP # 03:- (Self wt of slab)

By formula

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

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

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 lb/ft^2

Total Factored Load = D.L + L.L

= 106.5 + 160

= 266.5 Lb/ft^2 = 0.2665 k/ft^2

STEP # 5 :- (Ultimate Moment)

By using formula

$$Mu = \frac{wu \times \ell^2}{8} = \frac{0.2665 \times (15)^2 \times 12}{8}$$

= 89.94 kip-inches

STEP # 6 :- Area of steel For main Bars By Trial and Repeat Method.

Trial # 01

Let depth of compression block

$a = 0.2 \times t$

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

$$Ast = \frac{MV}{\phi \times fy \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{1.1}{2})}$$

"Trial # 02:-"

$$as \quad \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} \Rightarrow 0.62 in^2$$

$$Ast = \frac{MV}{\phi \times fy \times (d - \frac{a}{2})} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.6}{2})}$$

$AST = 0.59 in^2$

"Trail # 03:-"

$$a = \frac{0.59 \times 40}{0.85 \times 4 \times 12} = 0.57''$$

$$AST = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.57}{2})} = 0.59 in^2$$

So we will use $AST = 0.59 in^2$

STEP # 07:- Area of steel for distribution reinfrecent

By formula

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

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

STEP # 08:-

Spacing for main bars

By formula

$\text{Spacing} \ \frac{Ab}{AsT} \times 12$

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

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

STEP # 09:-

Spacing for distribution bars.

$\text{spacing} = \frac{Ab}{AsT}$

we use # 5 bars so

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

$Spacing = \frac{0.31}{0.132} \times 12 = 28.1'' \approx 28'' \, c/c$

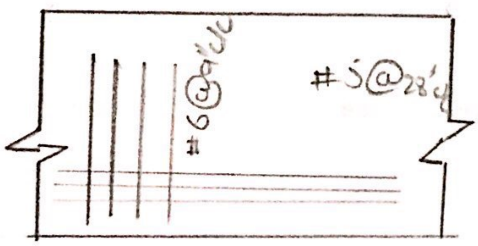
Step # 19-

Find sketch

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

Main steel # 6 at 9'' c/c

Distribution steel # 5 at 28'' c/c



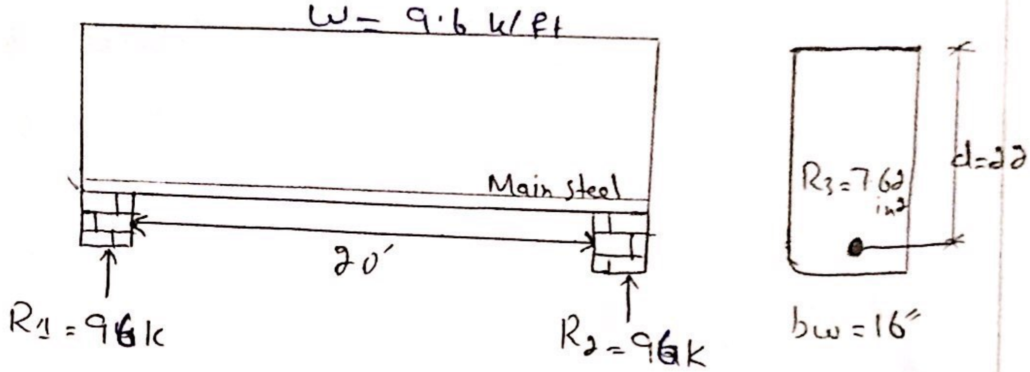
Question No: 02

Ans **Solution:-**

First of all Find the unit load of beam

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

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



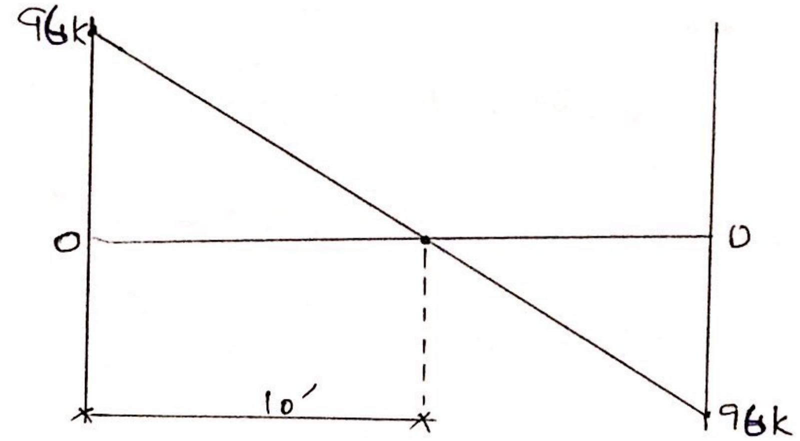
Step-01:-

Find the values of 'R1' and 'R2'

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

Step-02:-

Draw its shear force diagram



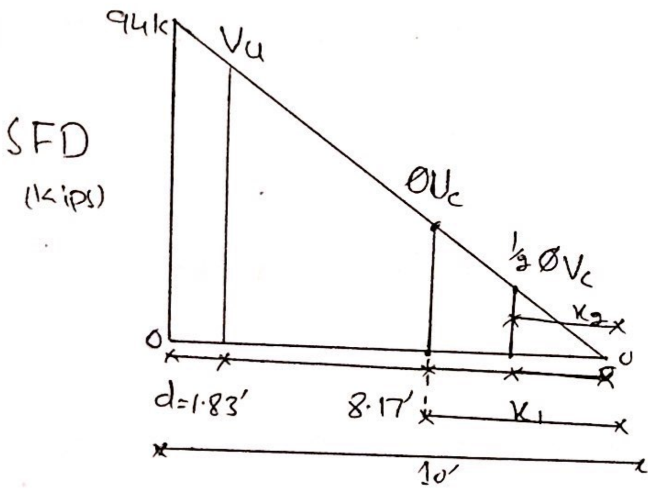
From similar Δ's

$\frac{96}{10} = \frac{V_u}{8.17}$ $V_u = 78.43k$

Step-03:- Find the value of critical shear 'Vu' and its locatio.

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

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



From similar Δ's

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

$$V_u = 78.80 \text{ kips}$$

Step-04! Find value of 'ØVc' and '1/2 ØVc' and also its distances from zero shear to right side

$$\emptyset V_c = \emptyset \times 2 \times \sqrt{f'_c} \times b_w \times d = \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000} = 33.40\,k$$

Location of ØVc by similarity of Δ's

$$\frac{96}{10} = \frac{33.40}{x_1} \Rightarrow x_1 = 3.55'$$

Now

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

Location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x_2} = x_2 = 1.78'$

Step-05: value of ϕV_s. $(V_u = \phi V_s + \phi V_c)$

So, $\phi V_s = V_u - \phi V_c = 78.80 - 33.40 = 45.40k$

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

Step-07: check on Maximum Spacing for stirrups

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

As, $\phi 4 \sqrt{f'_c}\, b_w d > \phi V_s = 45.40k$

So, Max. Spacing will be from following four conditions

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

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

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

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

4. $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 6000}{50 \times 16}$

$= 16.50''$

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

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

Step-08:

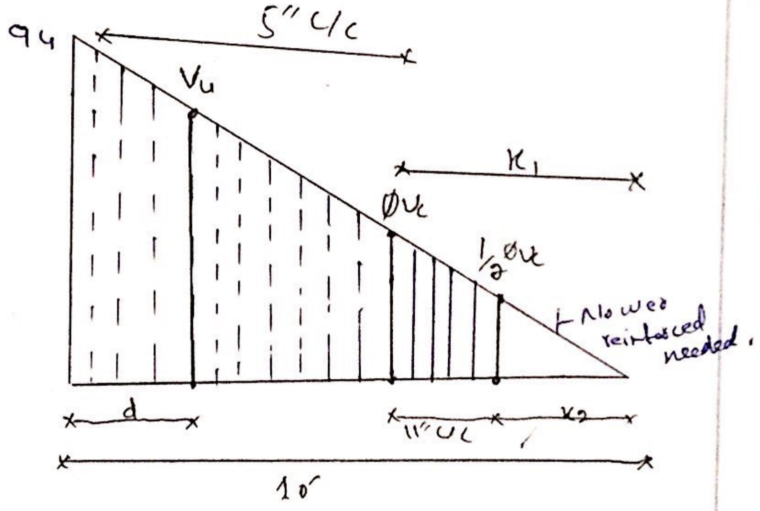
Spacing of stirrup from/at critical section

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

$S = 5'' \, c/c$

Step-09 Final sketch

SFD (kips)



★ As we know that first stirrup from face of support $= S/2 = 2.5'' \approx 2''$

Question No 03:-

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

STEP # 01:-

Find grass area of concrete

$A_g = b \times b$ (Since it is squre tied 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

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

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

$$P_U = 466.50\,K$$

"STEP #04":-

Sketch & design of Ties (c/c to distan

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

Question No 04:-

Design a squre footing ---- sketch. of your final design.

"STEP # 01":-

Let $h = 24''$

"STEP # 02":-

Total weight = wt of soil + wt of RC

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

$= 660$ Psf $= 0.660$ Ksf

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

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

$$= 119.57 \, ft^2$$

"STEP # 05"

Since foundation is square

$$A_{req} = b \times b = 119.57 \Rightarrow B \cong 11'$$

"STEP # 06"

Upward bearing capacity of soil

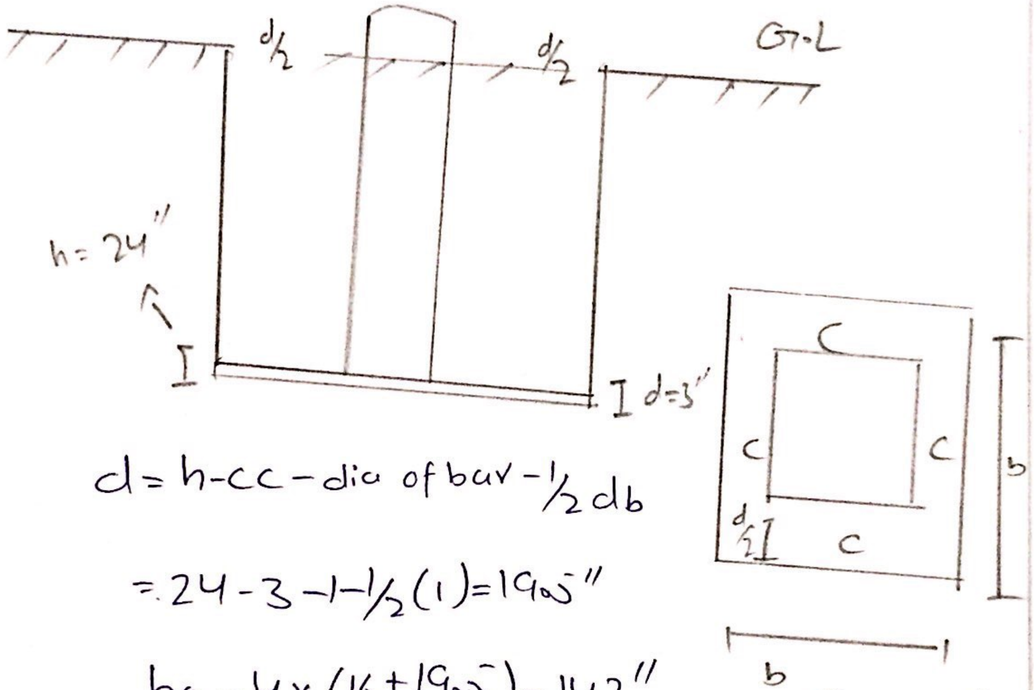
$$q_{up} = \frac{\text{Factored load}}{(B)^2} = \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$$

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

"STEP # 07:"

'Punching' shear:

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



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

$= 24 - 3 - 1 - \frac{1}{2}(1) = 19.5"$

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

∵ Take # 8 bar

dia $= 8/8" = 1"$

"STEP # 08":-

$V_{u2} = q_{up} \times [13^2 - (c+d)^2]$

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

$V_{u2} = 289.60K$

STEP # 09:-

$\phi V_{up} = \phi \times 4\sqrt{f_c'} \times b \times d$

$= \dfrac{0.75 \times 0.1 \times \sqrt{4000} \times 142 \times 19.5}{100}$

$\boxed{\phi V_{up} = 525.38\ K}$

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