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Subject :- PRCD-I

program :- BEC

Exam :- Final terms

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Q #02:-

Ans:-

A simply supported rectangular beam 16" wide---

Draw a sketch of your final diagram:-

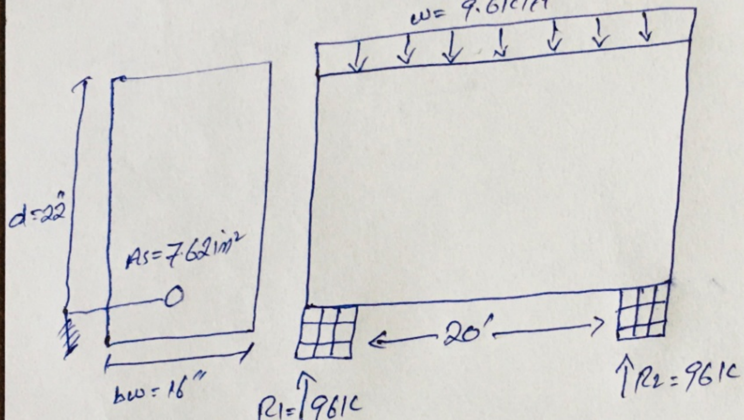
Sol:-

First we find the unit load of Beam.

so b×rc

= 16/12 × 150 = 200 lb/ft = 0.2 k/ft

so total factored load = 9.4 + 0.2 = 9.6 k/ft

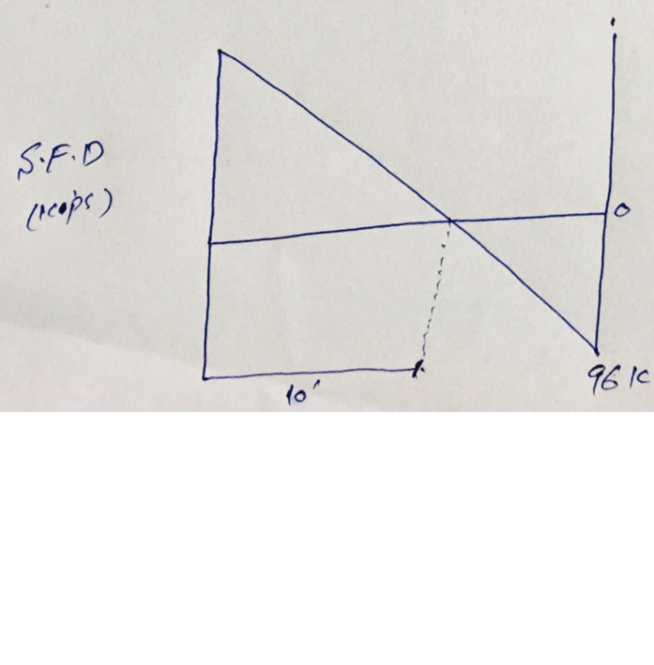


step #01:-

Find the value of R1 & R2

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

step #02 Draw a shear force diagram:-

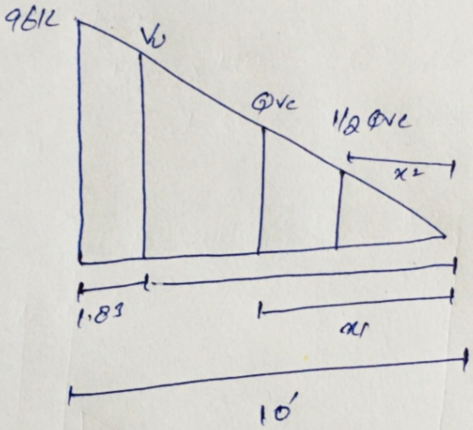


step #03

Find the value of critical stress "Vu" on its location.

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

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



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

step #4

Find the value of (ϕV_c) and 1/2 ϕV_c and also its distances from zero shear to right side

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

$\Rightarrow 33.40k$

location of ϕV_c by similarity of Δ's

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

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

location of 1/2 ϕV_c = 96/10 = 16.70/x_2 = x_2 = 1.73′

step#05

value of ϕV_s ($V_u = \phi V_s + \phi V_c$)

$\phi V_s = V_u - \phi V_c = 76.80 - 33.40 \Rightarrow 43.40k$

step#6:

check on section adequacy

(a) $\phi \times 8 \times \sqrt{f_c'} \times b_w \times d = \frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$\Rightarrow 133.57k$

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

step#7

Check on maximum spacing for stirrups

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

$\Rightarrow 66.79$ kip

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

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

1) $S_{max} = 24''$ 2) $d/2 = 22/2 = 11''$

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

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

From above four condition - lest value of spacing for #3, 2 legged stirrups will be selected.

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

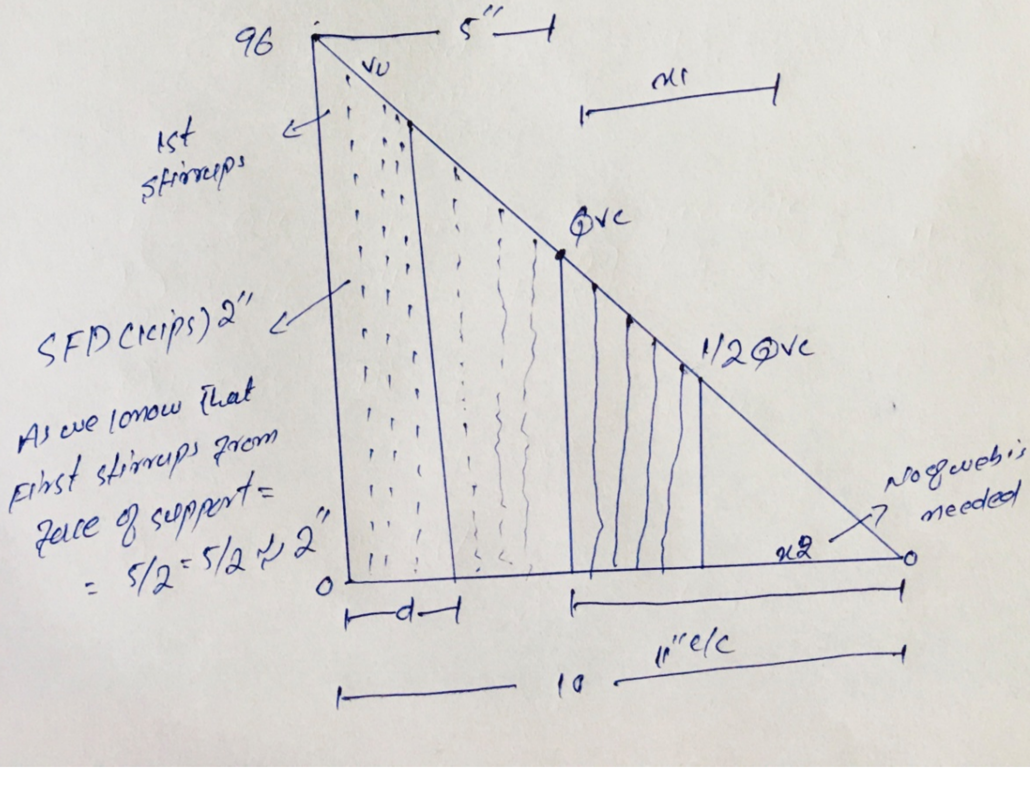
Step#8:

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.



Q#1 page#5

Ans

Given data:

(•) 3 equal spans concrete slab

(•) Clear span b/w supports = 15ft

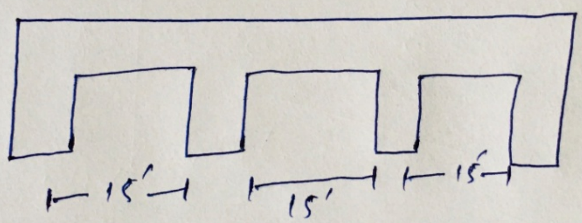
(•) Factored live load = 160 lb/ft²

(•) Service floor finish load = 20 lb/ft²

(•) f'_c = 4000 psi

(•) f_y = 40 ksi

Sol:



Step#01: Minimum Thickness

Formula

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

As $F_y = 40ksi$

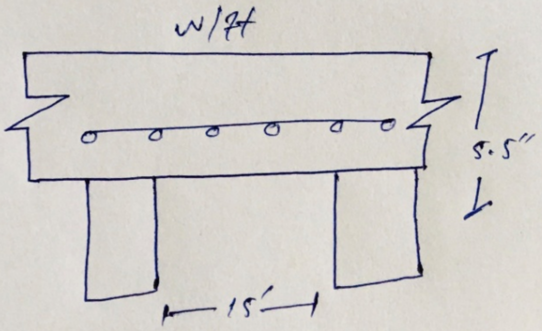
So we will multiply a factor with this thickness

$Factor = (0.4 + f_y/100) = (0.4 + 40/100) = 0.8$

The minimum thickness will be 6.5×0.8

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

step #2:



Formula

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

$= 5.5 - 0.75 - 1/2 (5/8)$

$d = 4.5''$

step #03: self wt of slab

$t/12 + \gamma_{concrete}$

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

step #04: 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 = $D.L + L.L \Rightarrow 106.5 + 160$

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

$\Rightarrow 0.265 \text{ k/ft}^2$

step #05: ultimate moment:

$M_u = \frac{w_u \times l^2}{8} = \frac{0.2665 \times (15)^2}{8} \times 12$

$= 89.94$ kip-inches

step # 6 :- Area of steel for main Bars By Trial and repeat method.

Trial # 01 :-

let depth of Compression block

$a = 0.2 \times t \Rightarrow 0.2 \times 5.5 = 1.1''$

$$Ast = \frac{Mv}{\phi \times fy \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - 1.1/2)} \Rightarrow 0.632 in^2$$

Trial # 2 :-

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{0.632 \times 40}{0.85 \times 4 \times 12} = 0.57''$$

step # 07 :- Area of steel distribution reinforced.

Formula $As_{min} = 0.002 \times b \times t$ (for grade 40 steel

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

step # 08 :- spacing for main bars.

spacing $\frac{A_o}{Ast} \times 12$ use #6 bars dia = (6/8)''

$Area = \pi/4\,(6/8)^2 = 0.442 in^2$

step # 09 :- spacing for distribution Bar

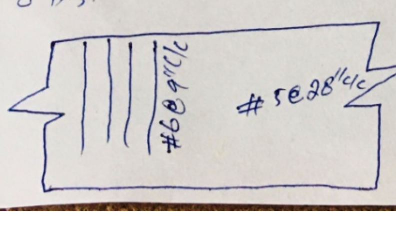
spacing $= \frac{A_o}{Ast}$ = we use #5 bars

dia = 5/8)'' $Area = \pi/4\,(5/8)^2 = 0.31 in^2$

spacing $= \frac{0.31}{0.132} \times 12 = 2.81'' \Rightarrow 28''$ c/c

step # 10 :- Final sketch :- $f'c = 4ksi$, $fy = 40ksi$. main steel #6 at 9'' c/c

o Distribution steel #5 at 28'' c/c



Sol :-

Step #1 :- Find gross area of concrete.

$Ag = b \times b$ (since it is squar tied column)

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

Step #02 :- Find the area of steel.

since $As = 5\%$ of Ag

$= 0.05 \times 144$

$As = 7.2 in^2$

Step #03 :- ultimate load carrying capacity.

$PU = \phi \times 0.80 \times [0.85 \times f'c \times (Ag - Ast) + As \times fy$

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

$PU = 466.50 k$

Step # 4 :-

sketch & design of ties (c/c to distance)

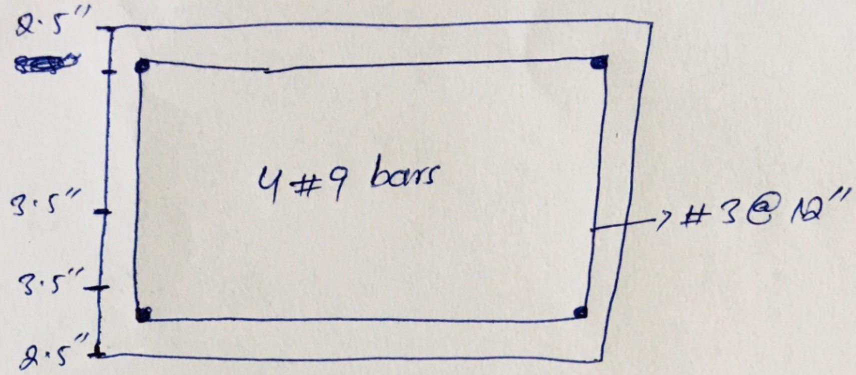
From the below value we chose the least value of all thas

(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 $= 12''$

so c/c distance btw 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 ~~setes7te~~ specification of the structure thus we will use tie stirrups - instead.

Q#04

Ans :-

Sol :-

step#1 :-

let $h = 24''$

step#2

Total wt = wt of soil + wt of RC

$3 + 120 + 2 \times 150 = 660 psf = 0.660$

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

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

step#05 :-

Since foundation is square

$Area = B \times B = 119.56$

$B \cong 119.56''$

step#6 :-

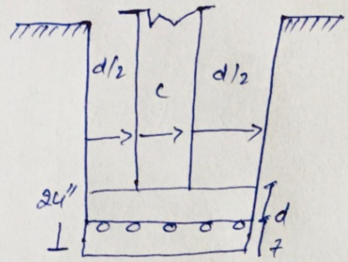
$q_{up} = \frac{\text{factored load}}{(B)^2}$

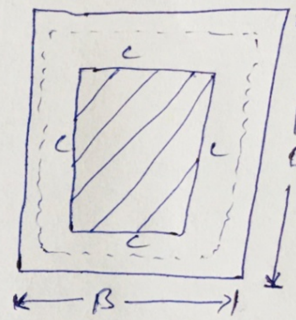
$\Rightarrow \frac{1.2 \times 100 + 1.6 \times 120}{(119.56)^2}$

$q_{up} = 0.0211 k/ft^2$

Step # 7: punching shear

$b_o = 4 + (C+d)$





d = h - clear cover - dia of bar - 1/2 × db

$d = 24 - 3 - 1 - 1/2 + 1 = 19.5''$

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

Step # 08

$\Rightarrow V_{u2} = q_{up} \times \left[(B^2 - (C+d)^2 \right]$

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

$\Rightarrow V_{u2} = 300$

Step # 9:

$\phi V_{c/p} = \phi \times 4 \times \sqrt{f_c'} \times b_w \times d$

$\Rightarrow \frac{0.75 \times 4 \times \sqrt{4000} \times 142 \times 19.5}{1000}$

$\phi V_{c/p} = 525.38$

Step # 10:

Beam shear/are one way shear check

$V_{U1} = q_{up} \times B^2 [B/2 - c/2 - d]$

$V_{U1} = 2.58 \times 11 \times [11/2 - 16/2 - 19.5]$

$V_{U1} = 90.95k$

Step # 11: self shear capacity

$\phi V_c = \phi \times 2 \times \sqrt{f_c} \times b \times d$

$\Rightarrow \frac{0.75 \times 2 \sqrt{4000} \times (11-16)}{1000}$

$\Rightarrow 110.04k > V_{U1} = 70k$

Step #12: ultimate ~~motom~~ moment

$M_U = \frac{q_{up} \times B}{8} \times (B-C)^2 = \frac{258 \times 11}{8} \times \frac{(11-16)^2}{2}$

$M_U = 331.49k' = 3977.93k''$

Step # 13:

Area of steel for main bars by trial and repeat method.

Trial #01 let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$A_s = \frac{M_U}{\phi \times f_y \times (d - a/2)} = \frac{3977.93}{0.90 \times 60 \times (11 - 4.8/2)}$

$= 8.56 \text{ in}^2$

Trial # 02:

$a = As \times fy / 0.85 \times fc \times b = \frac{8.56 \times 60}{0.85 \times 3 \times 12 \times 11} = 1.53''$

$As = \frac{3977.93}{0.90 \times 60 \times (11 - 1.53/2)} = 7.197\ in^2$

Trial # 03

$a = \frac{7.197 \times 60}{0.85 \times 3 \times 11 \times 12} = 1.28''$

$As = \frac{3977.93}{0.90 \times 60\ (11 - 1.28/2)} = 7.1\ in^2$

thus Area = $7.1\ in^2$

Step # 14:

check the min reinforcement by the following 3 method.

$As_{min} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$

$As_{min} = 5.70\ in^2$

$As_{min} = \frac{200}{fy} \times B \times d = \frac{200}{60000} \times (11 \times 12) \times 19.5$

$= 8.58\ in^2$

$As_{min} = 3 \times \frac{\sqrt{fc'}}{fy} \times B \times d = 3 \times \frac{\sqrt{3000}}{60,000} \times 11 \times 12 \times 19.5$

$= 7.05\ in^2$

From the above value greater value will be selected thus

$A_{s\,min} = 8.58\,in^2$

step # 15 :

using #8 bars

$A_b = 0.785\,in^2$

No of bars $= A_s/A_b = 8.58/0.785$

$= 10.92 \approx 11$ bars in each direction

The End