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Subject	prcd-1

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Q No 1

Given Data

3 equal Spans concrete Slab

clear Span b/w Supports = 15 ft

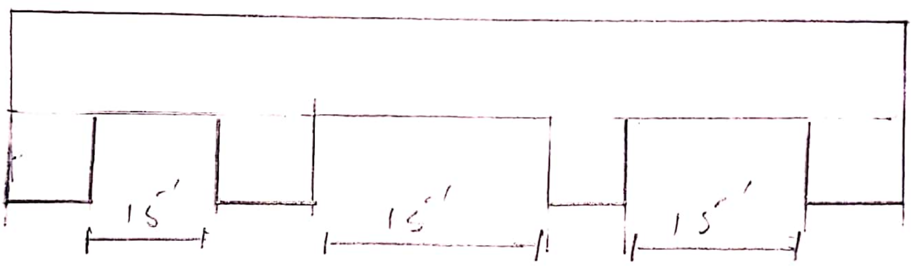
Factored live load = 160 lb/ft^3

Service Floor Finish load = 20 lb/ft^2

f'_c = 4000 psi

f_y = 40 ksi

Solution:-



Step #1 minimum Thickness

By using formula.

$t_{min} = L/28 = 15/123 = 6.4 \simeq 6.5''$

As $f_y \to 40$ ksi

So we will multiply a factor with this Thickness

$Factor = (0.4 + f_y/100)$

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

Hence the minimum thickness will be

$6.5'' \times 0.8$

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

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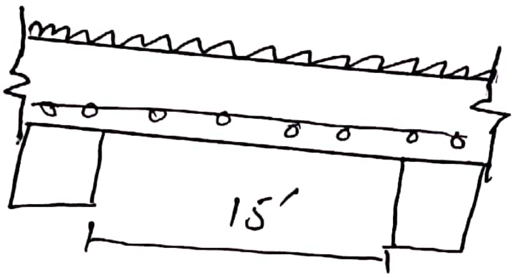
Step # 2

effective Depth



By formula

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

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

$d = 4.5''$

Step # 03

Self weight of Slab

By formula

$\frac{t}{12} + \gamma$ concrete

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

Step # 04 :-

total factor load

Factored live load = 160 lb/ft²

So the factored dead load will be.

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$D.L = 1.2(20+68.75) = 106.5\ lb/ft^2$

Total factored = $D.L + L.L$

$= 106.5 + 160$

$= 266.5\ lb/ft^3 \approx 0.2665\ k/ft^2$

Step # 05 ultimat moment.

By using formula

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

$$\boxed{Mu = 89.94\ kip\ inch}$$

Step # 6 Area of Steel for main bar by Trail and repeat method.

"Traial # 01"

let depth of compression block

$a = 0.2 \times t$

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

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

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

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Trail # 02:

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

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

$$Ast = 0.59 in^2$$

Trail # 03:

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

$$Ast = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.507}{20})} = 0.59 in^2$$

So will use $Ast = 0.59 in^2$

Step # 07:

Area of Steel for distribution reinforcement.

By formula.

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

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

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Step # 08

Spacing for main bars

By formula

$Spacing \frac{Ab}{As_1} \times 12$

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

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

Step # 09..

Spacing for distribution bar..

$Spacing \frac{Ab}{As_1}$

we use # 5 bar So

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

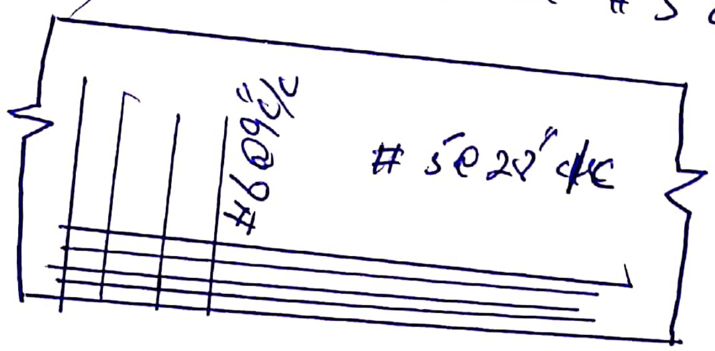
$Spacing = \frac{0.31}{0.132} \times 12 = 2.81 \simeq 28'' c/c$

Step # 10" find Sketch

$f_c' = 4 ksi \quad f_y = 40 ksi$

Main Steel # 6 at 9 c/c

Distribution Steel # 5 at 28 c/c



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QNo 2

Solution:-

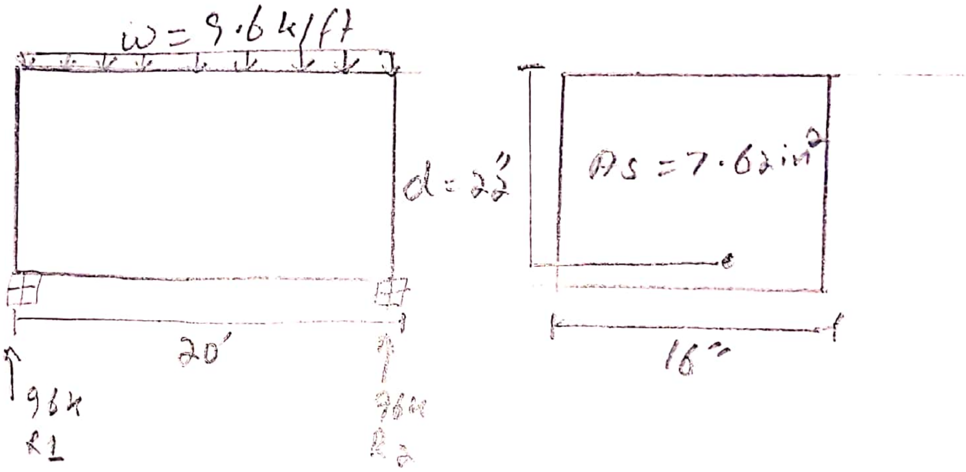
At first find the unit load of beam

So $b \times Y_c$

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

total factored load $= 9.4 + 0.2$

$= 9.6 k/ft$



Step 01 # Find value of "R_1" &

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

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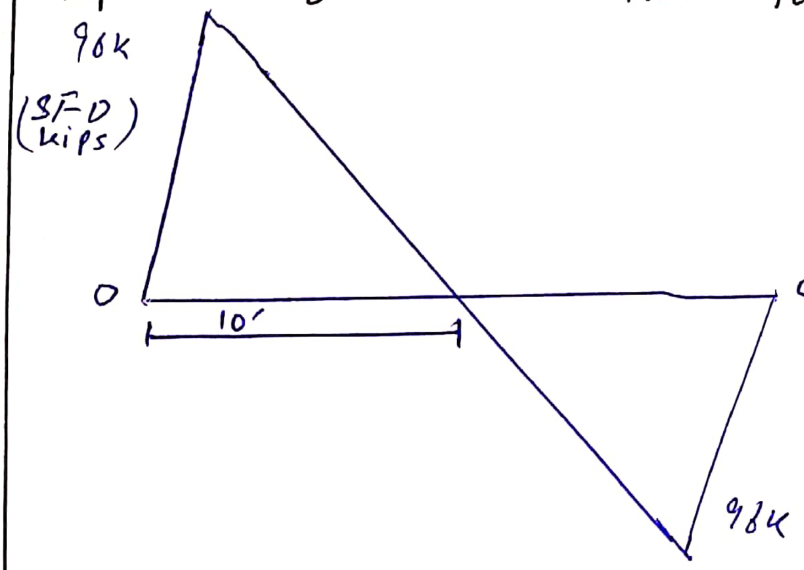
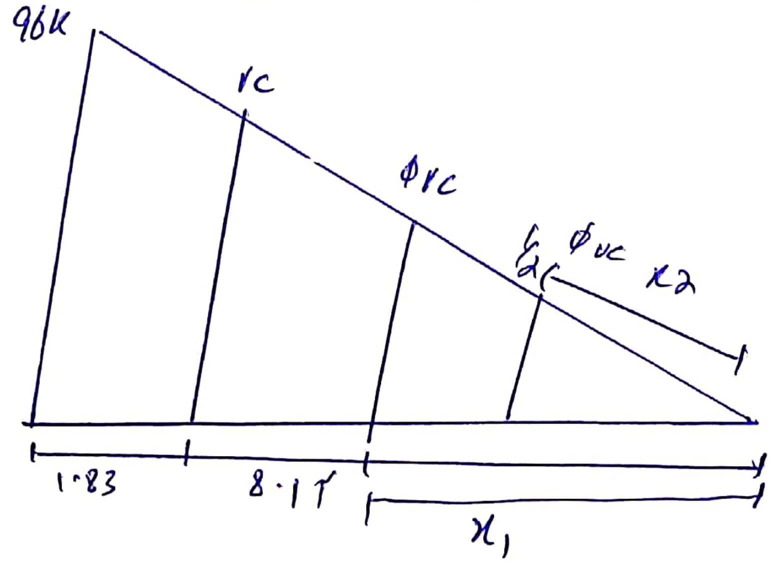
Step #02 Draw its Shear force diagram



Step #03 Finding value of critical stress "Vu" & its location.

As we know that critical location is located distance "d" from face of support d = 22" = 1.83' value of critical Short at distance "d" by Similarity triangler.



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from Similar = Δ's $\frac{96}{10} = \frac{V_u}{8.17}$

$V_u = 78.43k$

Step 04:- Finding value of "ϕV_c" & $\frac{1}{2}\phi V_c$"
& its distance form Shear to right side.

$\phi V_c = \phi \times 2 \times \sqrt{F'_c} \times b_w \times d = \frac{0.75 \times 2 \times \sqrt{4+0} \times 16 \times 22}{1000}$

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

location of ϕV_c by Similarity of Δs

$\frac{96}{100} = \frac{33.40}{w}$

$\boxed{x_1 = 3.48'}$

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

location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x}$

$x_2 = 1.74'$

step # 05 Find value of ϕV_s ($V_u = \phi V_s + \phi V_c$)
So we have

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 78.43 - 33.40$

$\phi V_c = 45.03k$

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Step# 06 Check Section Adequacy

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

$\boxed{133.57k}$

$133.57k > \phi V_c$ (mean Section adequate

Step# 07 Chee mini Spacing for Stirrups

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

$\boxed{= 66.79k} > \phi V_s = 44.03k$

Thus max Spacing will be selected from the following 4 Condition

① $S_{max} = 24''$

② $\frac{d}{2} = \frac{22}{2} = 11''$

③ $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{F_c} \times b_w}$

$A_v = \frac{\pi}{4} (3/8)^2 \therefore A_v = 0.11 \times 2 = 0.22$

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

(4) $S_{max} = \frac{A_v \times f_y}{50 \times b_w}$

$$S_{max} = \frac{0.22 \times 60000}{50 \times 16}$$

from the above 4 condition least value of Spacing for #3 U Spyed will be Selected So $S_{max} = 11'' c/c$

Step#08 Spacing of Stirrup from at Critical Section

$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$$

$$S = 4.84 \approx 5'' \; c/c$$

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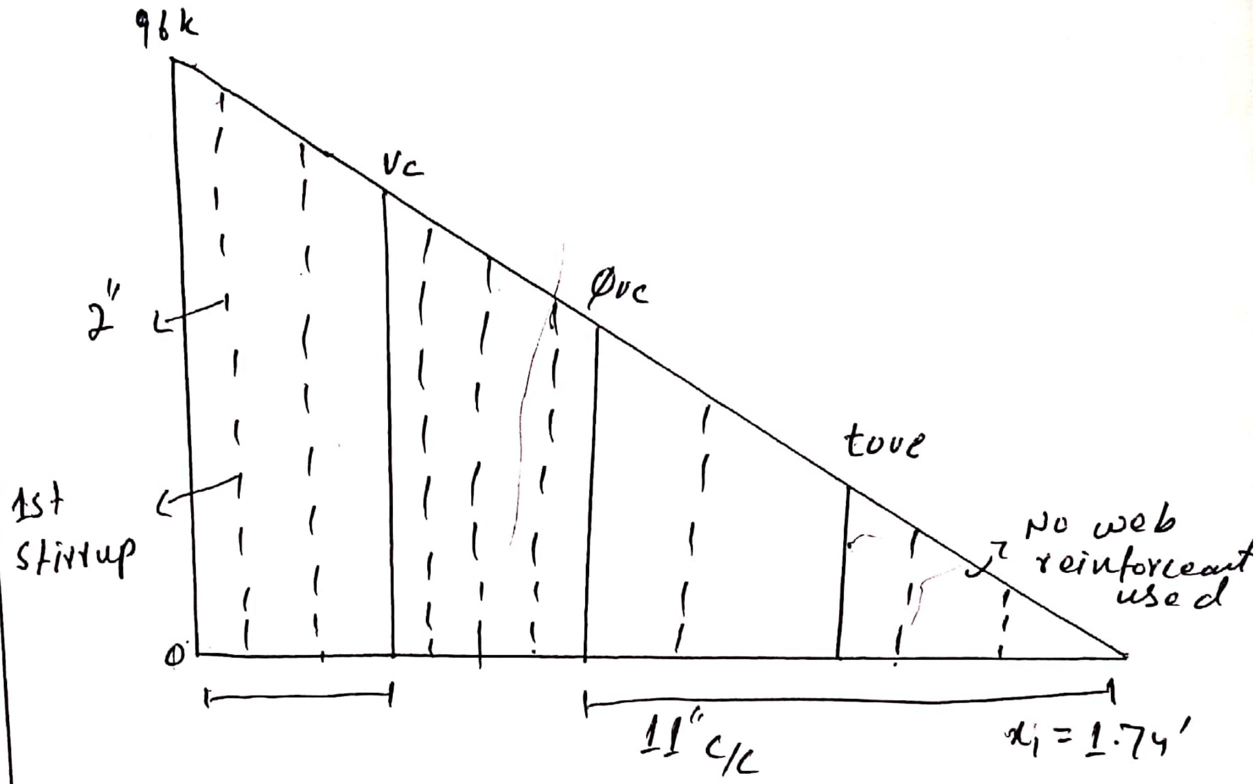
Step # 09 Final Sketch.



we know that first Stirrup from face of Support = 5/2 = 2.5 ≈ 2"

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Q No03 Solution

Step#01:

Find gross area of concrete.

Ag = b×b (Since it is squared 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

$Pu = \phi \times 0.80 \times [0.85 \times f_c'(Ag - As) + As \times f_y$

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

$Pu = 466.50k$

Step#04:

Sketch & design of Ties (c/c to distance) from the below values we choose the least value of all these.

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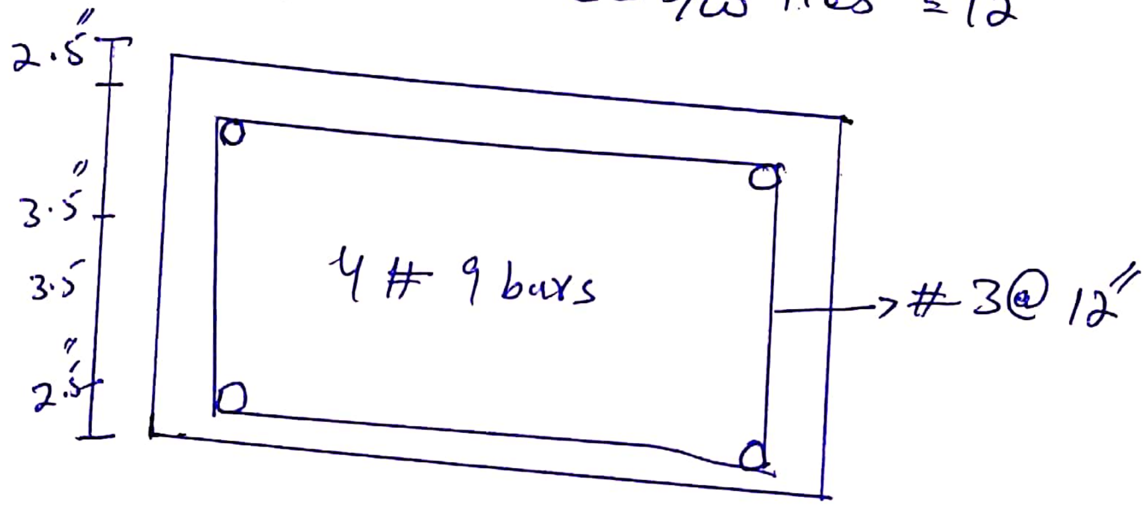
1) 16 x dia of long bar = 16 x 9/8
= 18"

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 it Rectangular Shape
due to the Specification of the structure
the we will use tie Stirraps instead.

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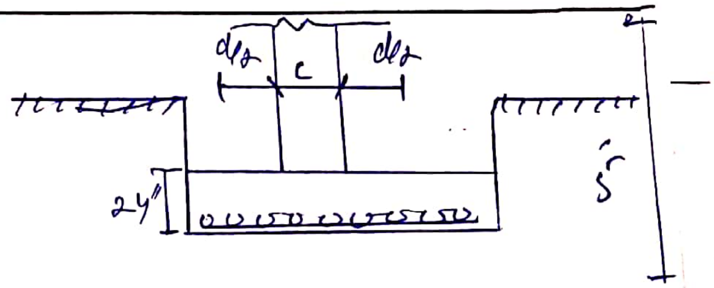
QNo4

Step#01:.

let $h = 24''$



Step # 2:.

Total weight = wt of Soil + wt of RC
$= 3 \times 120 \times 2 \times 150$
$= 660\ psf = 0.660\ kg$

Step #3:.

effective bearing capacity

$q_e = q_a - W$
$= 2.50 - 0.660$
$q_e = 1.84\ kg.$

Step#4:. Required Area for foundation

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

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

$$= 119.57\ ft$$

Step#5

Since foundation is square

Area = $b \times b = 119.57 \Rightarrow B \cong 11'$

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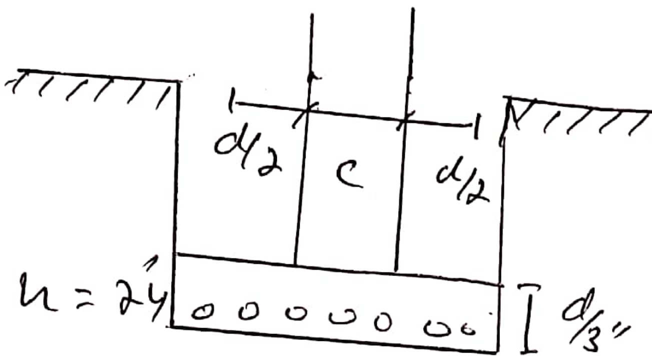
Step#06 :-

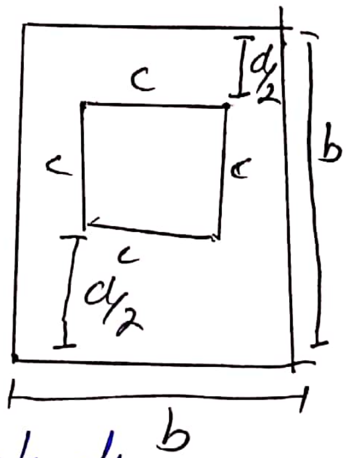
$$q_{up} = \frac{\text{Factored load}}{(B)^2} = \frac{1.2\times100\times1.6\times120}{11^2}$$

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

Step 07 :-

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





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

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

$b_o = 4\times(16\times19.5") = 142"$

Take #8 bar
dia = $8\times\frac{1}{8}$

Step#08 :

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

$= 2.58\times\left[11^2-\left(\frac{16+19.5}{12}\right)^2\right]$

$$\boxed{V_{u2} = 289.60k}$$

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Step 09

$$\phi V_{c/p} = \phi \times 4 \times \sqrt{f'c} \times b \times d$$

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

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

Step # 10

Beam are/one way Shear Check

$$V_{u1} - q_{up} \times B \times \left[B/2 - C/2 - d\right)$$

$$V_{u1} = 2.58 \times 11 \times \left[11/2 - \frac{16/12}{2} - 19.5\right]$$

Step # 11

Self Shear capacity

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

$$= \frac{0.75 \times 2 \times \sqrt{4000} \times [11 \times 12.16]}{1000}$$

$$= 110.04k > V_{u1} \Rightarrow O.K$$

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Step # 12 Ultimate moment

$$Mu = \frac{q_{up} \times B}{8} \times (B-c)^2 = \frac{2.58 \times 11}{8} \times \left(\frac{11-16}{12}\right)^2$$

$$Mu = 331.49k' \approx 3977.93k''$$

Step#13

Area of Steel for main bars by trail & Repeat method.

Trail #01

let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$$As = \frac{Mu}{\phi \times f_y \times (d - a/2)} = \frac{3977.93}{0.90 \times 60 \times (11 - 4.8/2)} = 8.56 \text{ in}^2$$

Trail #2

$$a = \frac{As \times f_y}{0.85 \times f'c \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times 11 \times 1.2} = 1.13''$$

$$As = \frac{3977.93}{0.90 \times 60 \times (11 - 1.113/2)} = 7.197 \text{ in}^2$$

Trail #3

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

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

So that area = 7.1 in²

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