Name Owais Humayoun

ID 7869

Section: 'B'

Subject: P.R.C.D(1)

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Q NO 1 :.

Given :.

⇒ 3 equal spans Concrete Slab

⇒ Clear span b/w Supports = 15 ft

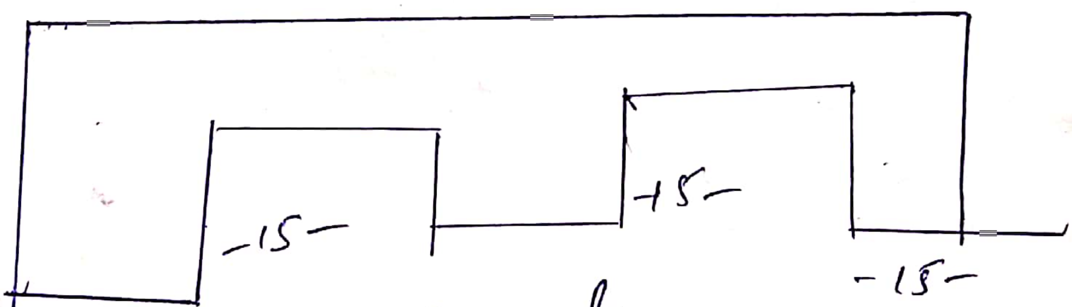
⇒ factored Live load = 160 lb/ft²

⇒ Service floor Finish load ⇒

⇒ f'c = 4000 psi

⇒ fy = 40 ksi

STEP#1 (Minimum thickness)



By using formula

$$t_{main} = L/22 = \frac{15}{22} = 6.4 \cong 6.5''$$

As fy → 40 ksi we will multiply a factor with this thickness

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

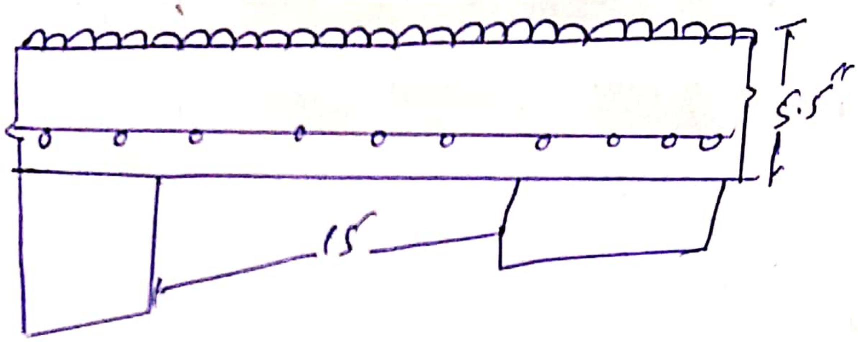
Hence the minimum Thickness will be 6.5 x 0.8

$T_{min} = 5.2 \cong 5.5''$

2)

Step 2 Effective Depth

w/ft



By Formula

d = t - Clear Covers - 1/2 (dia of main bars)

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

d ≅ 4.5

Step 3 Self wt of Slab

By Formula:

t/12 + γ concrete

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

STEP # 4 Total factored load:- 3)

Factored load = 160 lb/ft²

So factored dead load will be

D.L = 1.2 (20 + 68.75) = 106.5 lb/ft²

total factored load = D.L + L.L

=> 166.5 + 160

=> 266.5 lb/ft²

=> 0.2605 k/ft²

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 kip. inches**

STEP #6 Area of steel for main Bars By by trial and Repeat method.

Trial# 01

let depth of compression block

$a = 0.2 \times t$

$= 0.2 \times 5.5$

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

Trial# 02

$$a = \frac{AST \times Fy}{0.85 \times f'c \times b} = \frac{0.63 \times 46}{0.85 \times 4 \times 12}$$

$= 0.62 \text{ inch}^2$

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

$AST = 0.59$

Trail# 03

$$a = \frac{0.59 \times 40}{0.83 \times 4 \times 12} = 0.574$$

$$AST = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.6}{2})} \Rightarrow 0.59 in^2$$

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STEP #07 Area of steel for distribution reinforcement

By Formula::

$A_{min} = 0.002 \times b\,l \rightarrow$ (for Grade 60 steel)

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

STEP #08 Spacing for main bars.

Spacing for main bars

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

we use #6 bars dia = (6/8)"

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

STEP #09

Spacing for distribution bars.

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

we use #5 bar so

dia = (5/8)", Area = $\pi/4\,(5/8)^2$

~~= 0.125 in~~

~~Spacing = (5/8)^2 Area = π/4 (5/8)~~

$= 0.31\ in^2$

6)

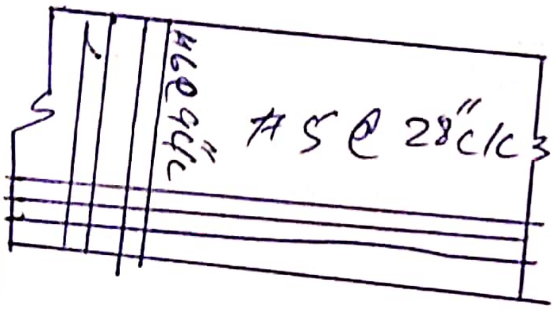
Spacing $= \frac{0.31}{0.132} \times 12 = 2.81 \approx 28''$ c/c

Step #10" Find Sketch

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

main Steel #6 at 9" c/c

Distribution Steel #5 at 28" c/c



Q.No2

Answer:: Given

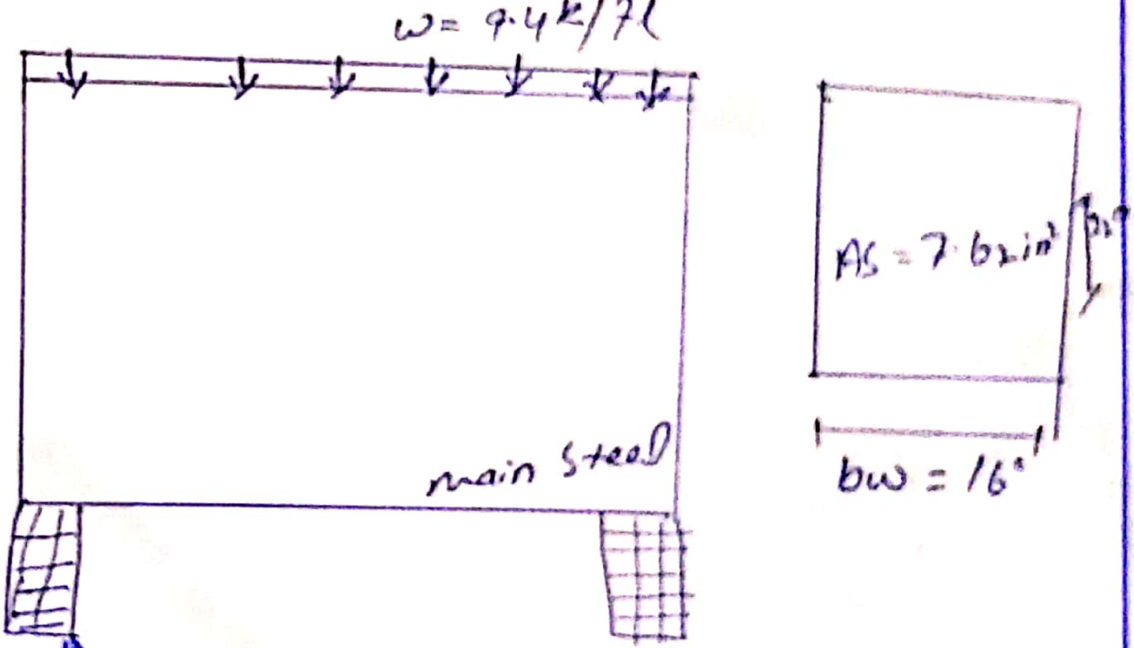
width = 16"

dc = 22"

Factored load = 9.4 k/ft

Clear span = 20'

Tensile Steel Area = 7.62 in²



$R_1 = 94K$ $R_2 = 94K$

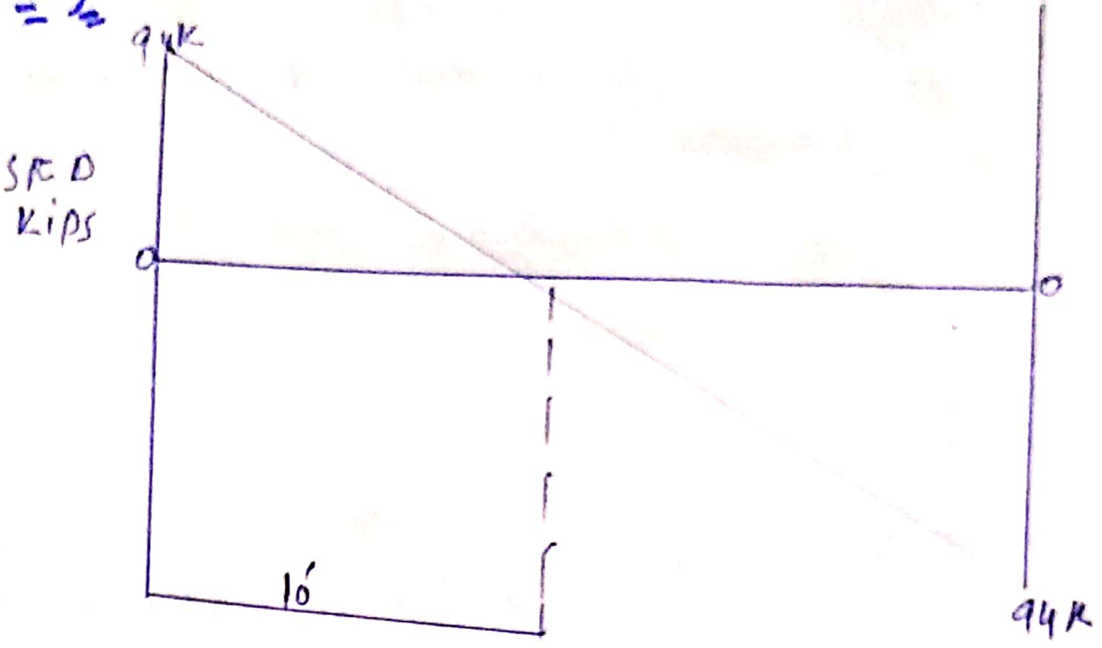
Step-1:: Find the value of R_1 and R_2.

Total load = ~~9.4×20~~/2 = 94

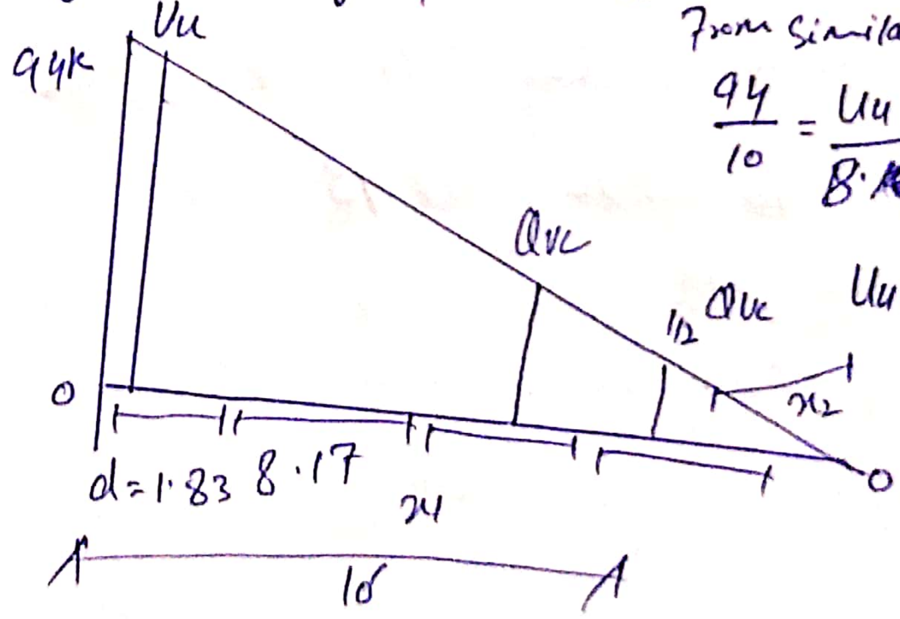
9.6 k/f ⇒ $\frac{9.6 \times 20}{2}$

⇒ 96K

Step:-2 Draw its Shear force diagram



Step#3:- Find value of critical shear V_u and its location, As we know that critical section is located at distance "d" from force of support = d = 22" = 1.83'
value of critical shear at distance "d" by similarity of triangles



From Similar Δ's

$$\frac{94}{10} = \frac{V_u}{8.17}$$

$V_u = 76.80$ kips

Step: 4 Find the value of ϕV_c and $1/2\, \phi V_c$ and also its distance from zero shear to right side.

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

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

$$= 33.40\,k.$$

Location of ϕV_c by Similarity of Δ's.

$$\frac{94}{10} = \frac{33.40}{x_1} \Rightarrow \boxed{x_1 = 3.48'}$$

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

Location of $1/2\, \phi V_c \Rightarrow \frac{94}{10} = \frac{16.70}{x_2}$

$$\Rightarrow \boxed{x_2 = 1.78'}$$

Step. 5: Value of ϕV_s. ($V_u = \phi V_s + \phi V_c$)

$$\phi V_s = V_u - \phi V_c = 78.43 - 33.40$$

$$= \boxed{45.03K}$$

Step: 6 Check on section adequacy.

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

$$= 133.57\,k.$$

As $\phi V_s < \phi\, 8\sqrt{f'_c}\, b_w\, d$ ⇒ It means section is adequal.

Step:: 7 check on maximum spacing for Stirrups

$$\phi \times 4 \times \sqrt{f'_c} \times b_w \times d = \frac{0.75 \times 4 \times .16 \times d}{1000}$$

$\Rightarrow$ 66.79 Kip

As $\phi 4\sqrt{f'_c}\, b_w\, d > \phi V_s = 45.03K$

So max spacing will be selected from following four conditions.

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

2- $d/2 = 11''$

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

$= 17.40''$

4- $S_{max} = \dfrac{A_v \times f_y}{50 \times b_w}$

$\dfrac{0.22 \times 6000}{50 \times 16}$

$= 16.50$

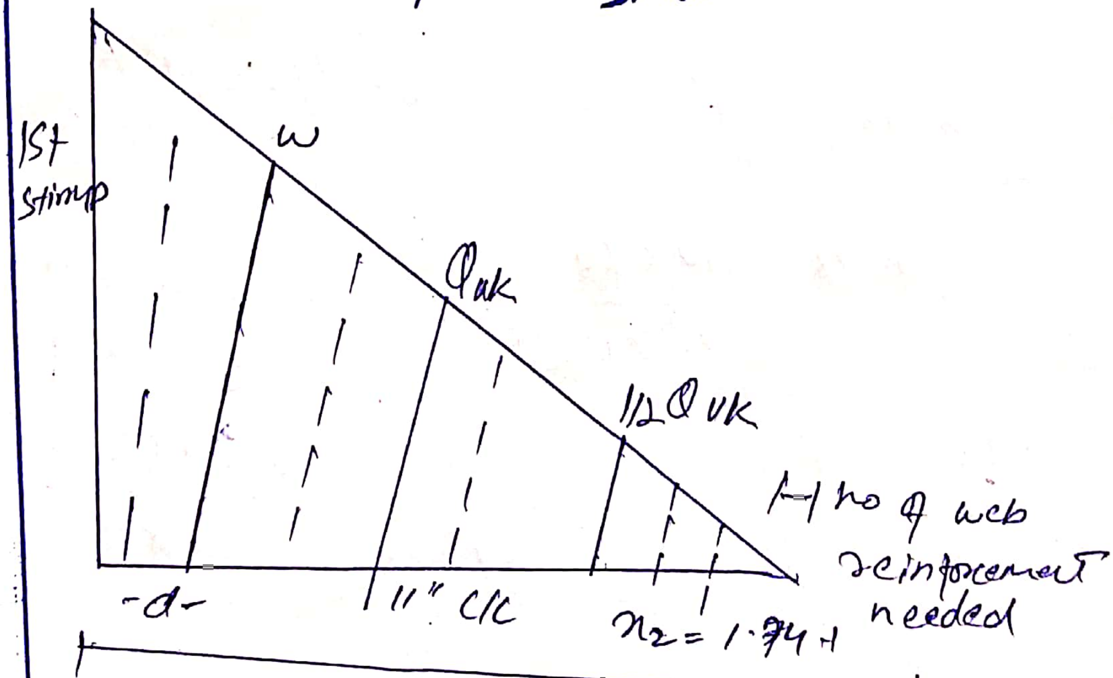
From the above four condition least value of spacing from #3 U shaped will be selected.

STEP #08:- Spacing of Stirrup from 2nd critical Section.

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

$\Rightarrow 48.4'' \approx S/c$

STEP #08:- Find sketch



As we know that 1st stirrup from face of support

$S/2 \Rightarrow 2.5 \cong 2''$

QNo3: Calculate the axial ultimate load carring capacity of a 12 inch. $f'c = 4000$ psi $fy = 60$ ksi.

(12)

Ans:-

STEP#1:. Find grass area of concrete.

$Ag = b \times b$ (since it is squal ... column)

$Ag = 12 \times 12 = 144$ inch2 (Actual)

STEP#2:. Find the area of steel:.

Since $As = 5\%$ of Ag

$= 0.05 \times 144$

$As = 7.2$ inch2

STEP#3:. Ultimate load Carring Capacity.

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

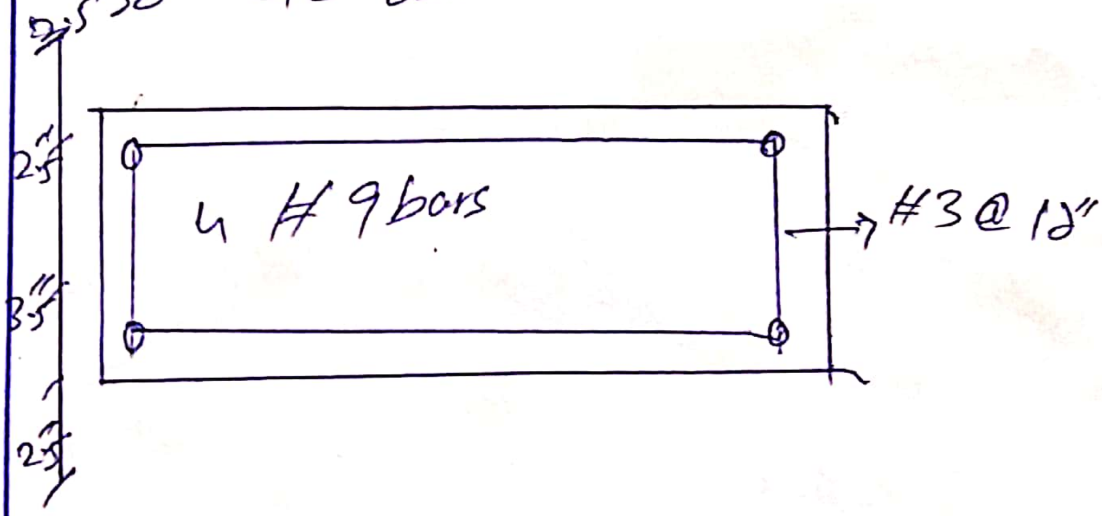
$= 0.65 \times 0.80 \times [0.85 \times 4(144 - 7.2) + 7.2 \times 60]$

$PU = 466.50k$

STEP#4:. Sketch and design of Ties (c/c) to distance.

From the below value we used the least value of all thus.

16 x dia of long bars = 16 x 9/8
= 18"
48 x dia of the bars = 48 x 3/8
= 18"
3) least column dimension = 12"
So c/c distance b/w ties = 12"



Since Tial a that Squance column So there is no spiral strup 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) Design a square single footing (14) Sketch of your final design.

Solution:: STEP # 1 Let $h = 24''$

STEP # 2:: Total weight = wt of Soil + wt of RC

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

$= 0.660$

STEP # 3

effective bearing capacity

$q_e = q_a - w = 2.50 - 0.660$

$q_e = 1.84 ksf$

STEP # 4:: Required Area for foundation

$$Area = \frac{Service\ load}{q_e} = \frac{100 + 120}{1.84}$$

$$\boxed{Area = 119.56 ft^2}$$

Step # 05

Since foundation is square

$Area = B \times B = 119.56$

$B = \sqrt{119.56}$

Step # 06

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

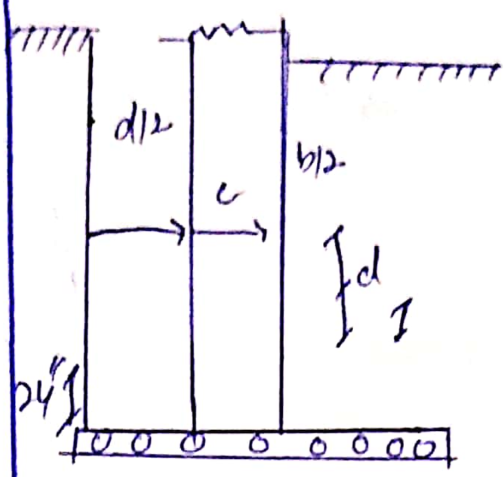
$q_{up} = \dfrac{1.2 \times 100 + 1.6 \times 180}{(119.56)^2}$

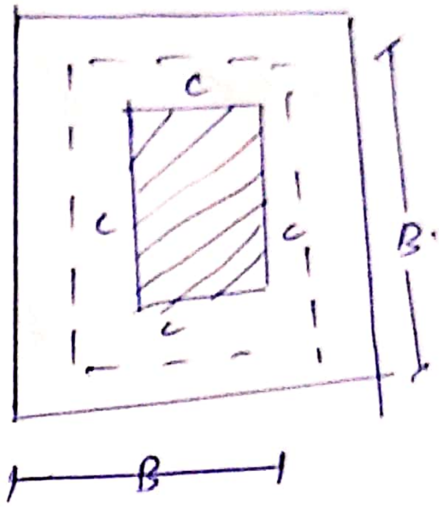
$q_{up} = 0.021\ k/ft^2$

Step # 07

punching shear

$b_o = 4(c+d)$





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

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

$b_o = 4(16 + 19.50) = 142''$

STEP # 08

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

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

$V_{u2} = 289$

Step 9:

$$\phi V_{up} = \frac{\phi \times 4 \times \sqrt{f'c} \times b \times d}{1000}$$

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

$$= 525.38k$$

Step: 10: Beam shear / one avery shear check

$$V_{u1} = q_{up} \times B \times \left[\frac{B}{2} - \frac{c}{2} - d\right]$$

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

$$V_{u1} = 90.95k$$

Step: 11

Self shear capacity

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

$$= \frac{0.75 \times 2 \times \sqrt{4000} \times (11 \times 12 \cdot 16)}{1000}$$

(8)
(9)
(7)

$= 110.04K > V_{u1} \Rightarrow$

STep 12:- Ultimate moment:

$$M_u = \frac{q_{up} \times B}{8} \times (B-C)^2 = \frac{2.58 \times 11}{8} \times \left(\frac{11.16}{12}\right)^2$$

$M_u = 331.49K' = 3977.93K'$

STep 13:- Area of Steel for main bars by trial to Repeat method.

Trial 1:- Let $a = 0.2 \times h = 0.2 \times 24 = 4.8''$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{3977.93}{0.9 \times 60 \times (11.4 \cdot \frac{4.8}{2})}$$

$= 8.56 \text{ in}^2$

Trial 2:-

$$a = \frac{A_s \times f_y}{0.85 \times f_c \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times 11 \times 12}$$

$= 1.53$

$$As = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{1.55}{2}\right)} = 7.197 in^2$$ 19)

Trial 3.

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

$$As = \frac{3977.93}{0.90 \times 60 \times \left(11 - \frac{1.28}{2}\right)} = 7.5 in^2$$

So thus area = $7.1 in^2$

STEP#14 cheak the main reinforcement by the following of method.

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

$$As_{min} = 5.7 in^2$$

$$As_{main} = \frac{200}{fy} \times B \times d = \frac{200}{6000} \times (11 \times 12) \times 19.5$$

$$\Rightarrow 8.58 inch^2$$

Step :: 15

using # 8 bars.

$A_b = 0.785 \, in^2$

No of bars $= \frac{A_s}{A_b} = \frac{8.58}{0.785} = 10.92$

$\approxeq$ 11 bars in

each direction.