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08

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SUBJECT	PRCD
SEMESTER	6th
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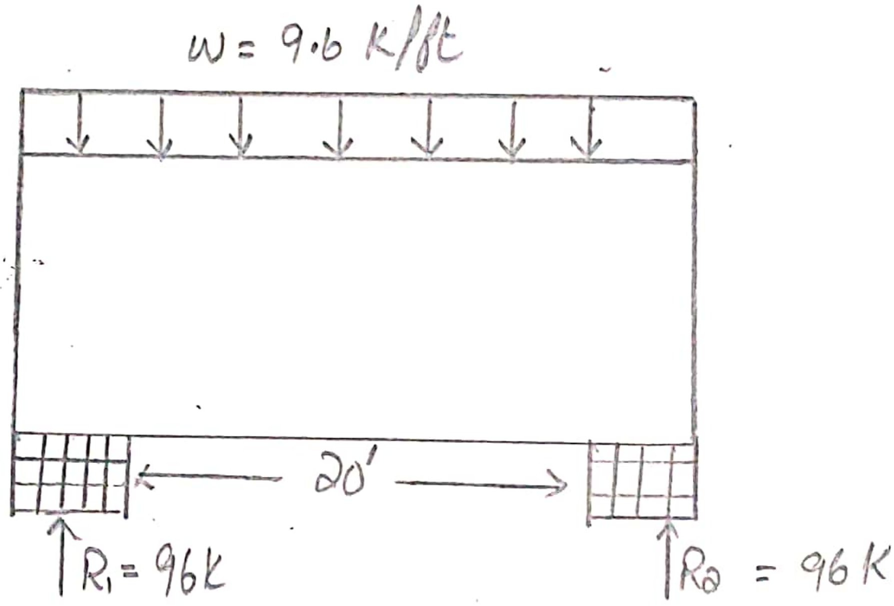
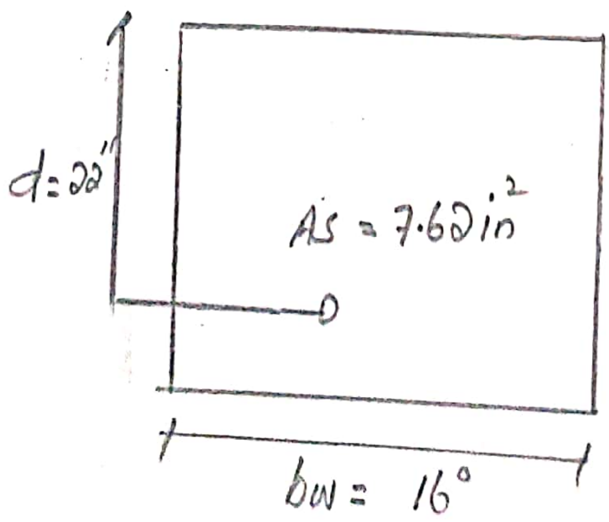
Q2:-

Sol:- First of all find the unit load of beam so $b \times \gamma_c$

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

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

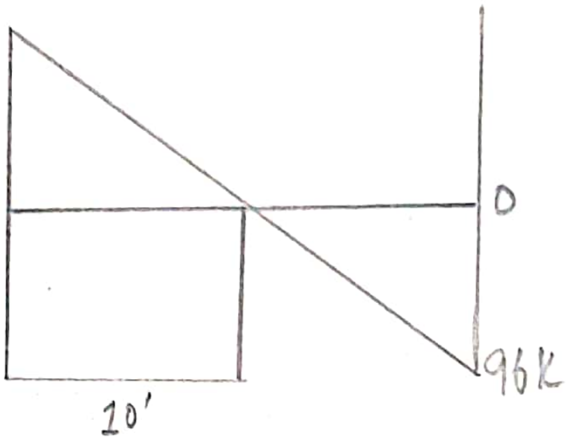




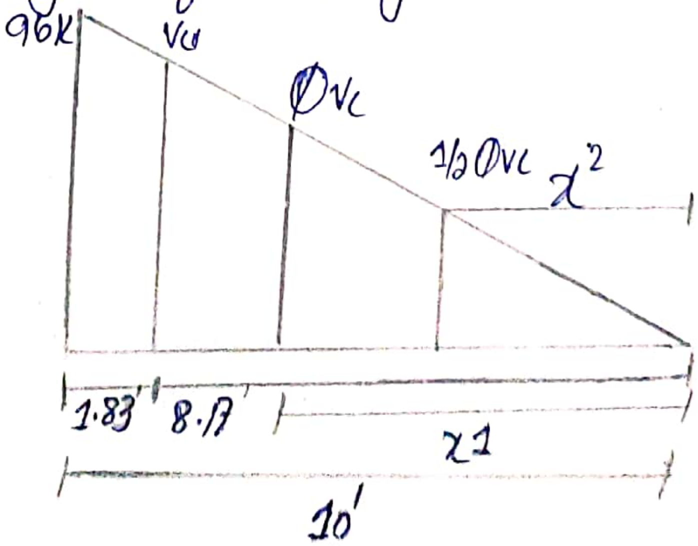
"Step 01":-
Find the value of R_1 & R_2
total load $= 9.6 \times \frac{20}{2} = 96K$

"Step 02:-"
Draw it's shear force diagram.

S.F.D
(Kips)



"Step 03"
Find The value of critical stress "Vu"
and it's location:-
As we know that critical section is located at distance "d" from face of support $= 9 = 22'' = 1.83'$
value of critical shear at distance "d" by similarity of triangles.



From similar Δ's

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

$V_u = 78.43K$

"Step 4" Find the value of "ϕV_c" & "$\frac{1}{2}\phi V_c$" & also it's distance from zero shear to right side.

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

$\phi V_c = 33.40K$

location of ϕV_c by similarity of Δ's.

$$\frac{96}{10} = \frac{33.40}{x_1}$$

$x_1 = 3.48'$

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

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

$x_2 = 1.74'$

"Step 5:-" value of ϕV_s ($V_u = \phi V_s + \phi V_c$)

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

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03K$

"Step 6" check on section Adequancy:-

$$\Rightarrow \phi \times 8 \times \sqrt{f'c} \times bw \times d = \frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$$

$$= 133.57k$$

As $\phi \times 8\sqrt{f'c} \times bw \times d > \phi V_s \rightarrow$ It means section is Adequate.

"Step 7" Check on minimum spacing for stirrups:-

$$\phi \times 4 \times \sqrt{f'c} \times bw \times d = \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000} = 66.79\,k$$

As $\phi 4\sqrt{f'c} \times bw \times d > \phi V_s = 45.03k$

thus max spacing will be selected from the following four condition

(i) $S_{max} = 24''$

(ii) $\frac{d}{2} = \frac{22}{2} = 11''$

(iii) $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'c} \times bw}$

$\because A_v = \frac{\pi}{4}(3/8)^2 = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 16}$ $A_v = 0.11 \times 2$, $A_v = 0.22$

$$= 17.40$$

(iv) $S_{max} = \frac{A_v \times f_y}{50 \times bw}$

$$\Rightarrow \frac{0.22 \times 60000}{50 \times 16}$$

$= 16.50$

From the above four condition, least value of spacing from #3, U shaped will be selected so
$S_{max} = 11''$ c/c

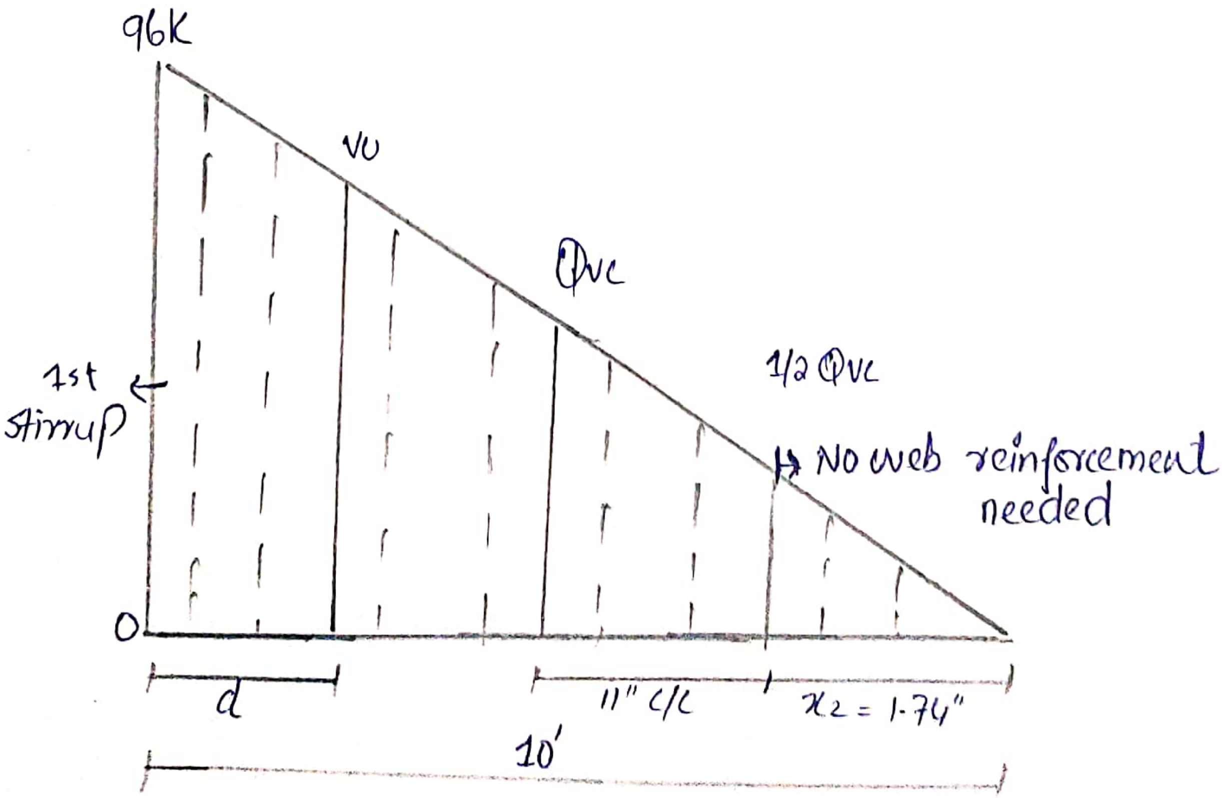
"Step 08" spacing of stirrup from/at critical section.

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

$= 48.4''$

$\approx 5''$ c/c

"Step 9" Find sketch

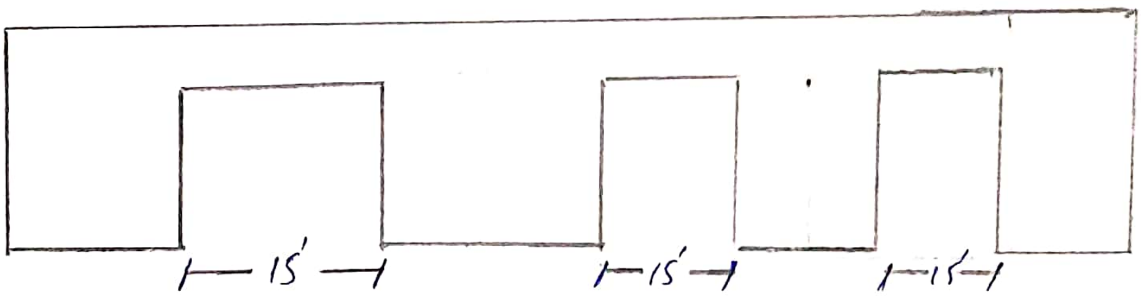


As we know that first stirrup from face of support ⇒ $5/2 = 2.5 \approx 2''$

Q NO 2:-

Given DATA:-

- clear span b/w support = 15'
- Factored live load = 160 lb/ft²
- Service floor finish load = 20 lb/ft²
- $f'c$ = 4000 psi
- fy = 40 ksi



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 with multiply a factor with this thickness

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

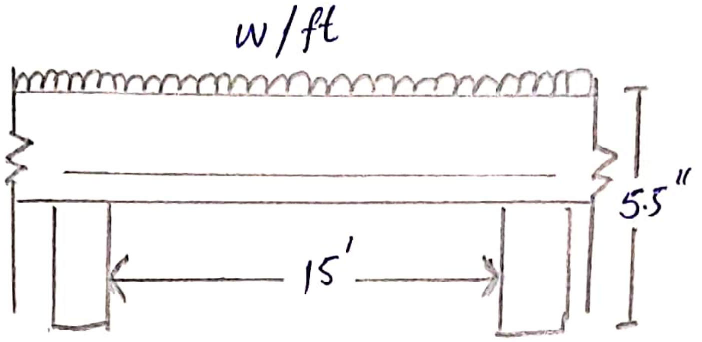
$$= \left(0.4 + \frac{40}{100}\right) = 0.8$$

Hence the minimum thickness will be

6.5×0.8

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

"Step 2" Effective Depth.



By 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 3" Self weight of slab.

By formula

$t/12 + \gamma\,\text{concrete}$

$= 5.5/12 \times 150$

$= 68.75\ lb/ft^2$

"Step 4" 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 $= D.L + L.L$

$= 106.5 + 160$

$= 266.5\ lb/ft^2 \Rightarrow 0.2665\ k/ft^2$

"Step 05"

Ultimate Moment:-

By using formula

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

$Mu = 89.94$ kips-inches.

"Step 6" Area of steel for main bars by trail and repeat method.

"Trial 01:-

Let depth of compression block

$a = 0.2 \times t$

$= 0.2 \times 5.5$

$= 1.1''$

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

$Ast = 0.63\ in^2$

"Strial 02"

$$a = \frac{Ast \times fy}{0.55 \times f'c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} \Rightarrow 0.62 in^2$$

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

$$Ast = 0.59 in^2$$

"trial 3"

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

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

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

"step 7"

Area of steel for distribution reinforcement

By formula

$$A_{min} = 0.002 \times b \times L \Rightarrow \text{(Grade 40 steel)}$$
$$= 0.002 \times 12 \times 5.5 = 0.132 in^2$$

"step 8" "spacing for main bars"

By formula

spacing $\frac{A_b}{A_{st}} \times 12$

we use #6 bar 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 $= \pi/4\,(5/8)^2 = 0.31\ in^2$

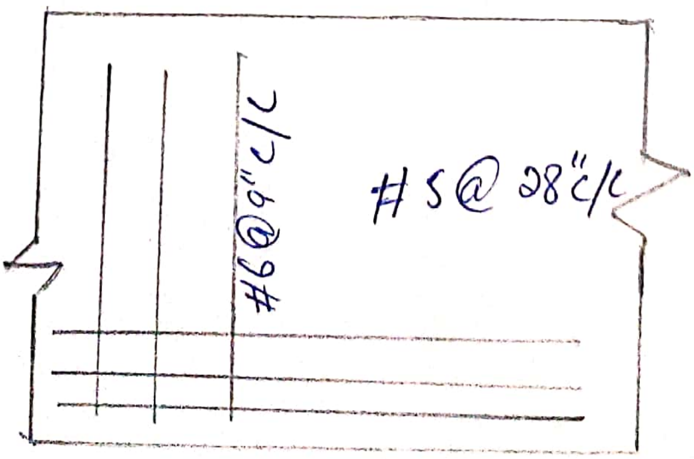
spacing $= \frac{0.31}{0.132} \times 12 = 28.1'' \approx 28''$ c/c

"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



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Q3

Sol:-

"Step 01:-" "Find gross area of concrete"

$A_g = b \times b$ (since it is squaretied 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

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

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

$P_u = 466.50K$

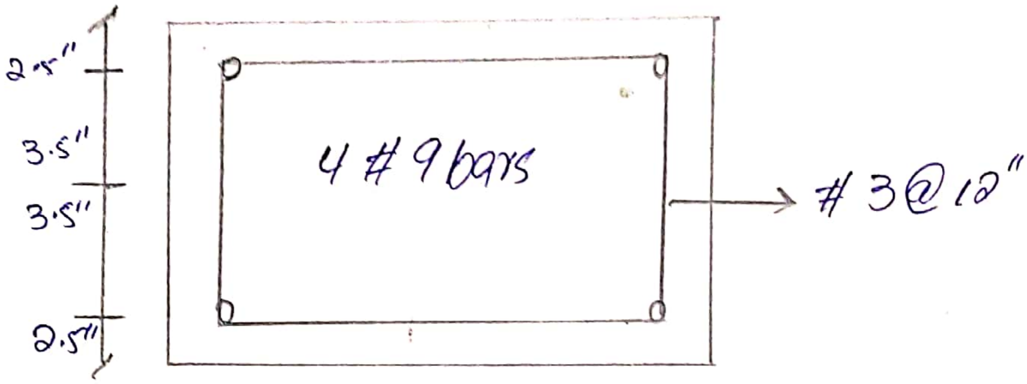
"Step 4" sketch and design of ties (c/c distance)

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

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

ii) 48 x dia of tie bar = 48x 3/8 = 18"

iii) least dimension of column = 12"
so c/c distance b/w ties = 12"



Since it is a tied square colume 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.

Q4:-

Step 01:-
let h = 24"

Step 02:-
total wt = wt of soil + wt of RC
= 3x 120 + 2x 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 4" "Required Area for foundation":

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

$= 119.57 \, ft^2$

"Step 5" "Since foundation is square"

Area = b×b = 119.57

$\Rightarrow B \cong 11'$

"Step 6" "upward bearing capacity of soil"

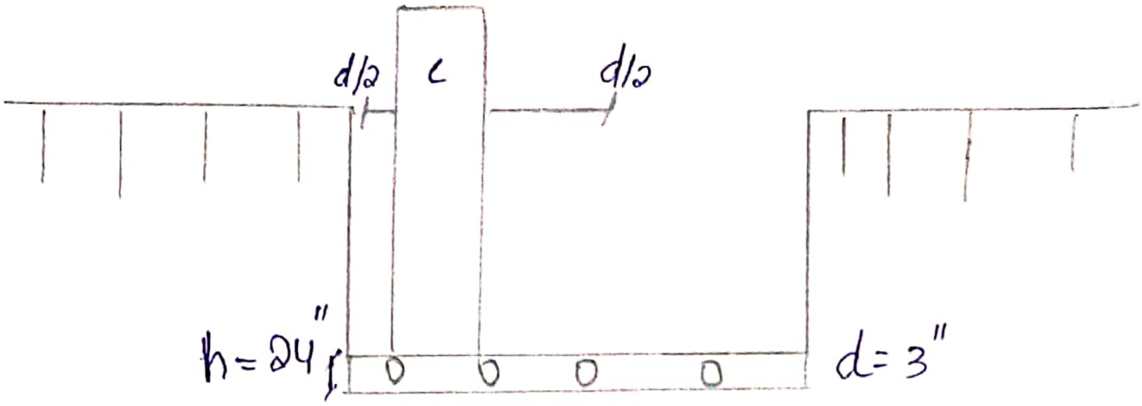
$q_{up} = \frac{\text{factored load}}{(B)^2} = \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$

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

"Step 7" Punching shear

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

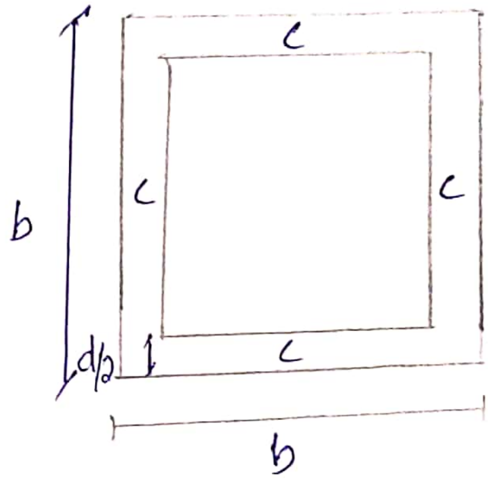
P.T.O



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

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

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



"Step 8":-

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

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

$V_{u2} = 289.60\,K$

"Step 09":-

① $V_{up} = \dfrac{\phi \times 4 \times \sqrt{f'_c} \times b_o d}{1000}$

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

$= 525.38\,K$

"Step 10" "Beam shear / one way shear check:-"

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

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

$V_{u1} = 90.95\,K$

"Step 11":- "self shear capacity:-"

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

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

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

"Step 12" "Ultimate Moment"

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

$M_u = 331.49K' = 3977.93K''$

Step 13:- Area of steel for main bars by trial & Repeat method.

trial 1:-

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

$$As = \frac{Mu}{\phi \times fy \times (d - \frac{a}{2})} = \frac{3977.93}{0.9 \times 60 \times (11 - \frac{4.8}{2})}$$

$$= 8.56 in^2$$

trial 2:-

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

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

"trial 3":-

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

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

So thus area $= 7.1 in^2$

"Step 14"

"Check the min reinforcement by the following as method;

$A_{s\,min} = 0.0018 \times B \times h = 0.0018 \times (11 \times 12) \times 24$

$A_{s\,min} = 5.70 in^2$

$A_{s\,min} = \frac{200}{f_y} \times B \times d = \frac{200}{60000} \times (11 \times 12) \times 19.5$

$= 8.58 in^2$

$A_{s\,min} = \frac{3 \times \sqrt{F'_c}}{f_y} \times B \times d = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$

$= 7.05 in^2$

From above values greater value will be selected thus $A_{s\,min} = 8.58 in^2$

~~from above~~

"Step 15"

using #8 bars

$A_b = 0.785 in^2$

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

$\approx$ 11 bars in each direction.