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Question No: 1

Given data:-

Clear Span = 15ft

factored live load = 160 PSF

Service floor finish load = 20 PSF

F_c = 4000 Psi or 4 Ksi

F_y = 40 Ksi

Solution:-

Step : 01

Minimum thickness :

$$\text{Factor} = \left(0.4 + \frac{f_y}{100}\right) \Rightarrow = \left(0.4 + \frac{40}{100}\right)$$

Factor = 0.8

$$t_{min} = \frac{l}{28} \times 12$$

$$= \frac{15}{28} \times 12$$

t_{min} = 6.428"

Actual t_{min} = factor × t_{min}

$t_{min} = 0.8 \times 6.428$

$t_{min} = 5.5''$

Step : 02

Effective depth

$d = t - \text{clear cover} - \frac{1}{2}(d\ \text{mainbar})$

$d = 5.5 - 0.75 - (4/8)\,0.5$

$d = 4.5''$ using bar #4 for main reinforcement.

Step : 03

Self weight of Slab:

$= \frac{t}{12} \times \gamma\ \text{concrete}$

$= \frac{55}{12} \times 150$

$= 68.75\ \text{PSF}$

Step : 04

Total factored load

$w_u = (1.2 \times D.L) + (1.6 \times L.L)$

* we are neglecting 1.6 because we already have factored live load.

$$w_u = (1.2 \times (68.75 + 20) + (160)$$

$w_u =$ ~~1.2 x~~ 266.5 PSF or $w_u = 0.2665$ KSF

Step : 05: Ultimate moment.

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

$M_u = 89.94$ Kip"

Step : 06

Area of steel of main bar by trial and repeat method.

Trial : 1

let $a = 0.2 \times t \Rightarrow a = 0.2 \times 5.5$

$a = 1.1"$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)} \Rightarrow = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{1.1}{2}\right)}$$

$A_s = 0.632$ in²/ft

Trial : 2

$$a = \frac{As \times fy}{0.85 \times fc' \times b}$$

$$a = \frac{0.632 \times 40}{0.85 \times 4 \times 12}$$

$a = 0.62''$

$As = 0.596 \text{ in}^2/\text{ft}$

Trial : 3

$a = 0.58''$

$As = 0.59 \text{ in}^2/\text{ft}$

Trial : 4

$a = 0.58''$

$As = 0.59 \text{ in}^2/\text{ft}$

Step : 07

Area of steel for distribution Reinforcement :

$As_{min} = 0.002 \times b \times t$

$As_{min} = 0.002 \times 12 \times 5.5$

$As_{min} = 0.132 \text{ in}^2/\text{ft}$

Step : 08

Spacing of main bar

$$S = \frac{Ab}{As} \times 12$$ * using #4 bar

$$S = \frac{0.2}{0.59} \times 12$$ * Area of one bar $= 0.2 in^2$

Step : 09

Spacing for distribution bars:

$$S = \frac{Ab}{As} \times 12$$ * lets using #4 bar

* Area of one bar # $0.2 in^2$

$$S = \frac{0.2}{0.132} \times 12$$

$$S = 18.18'' \approx 18'' \ c/c$$

Step : 10 :-

Final Summary

$f_c' = 4ksi$

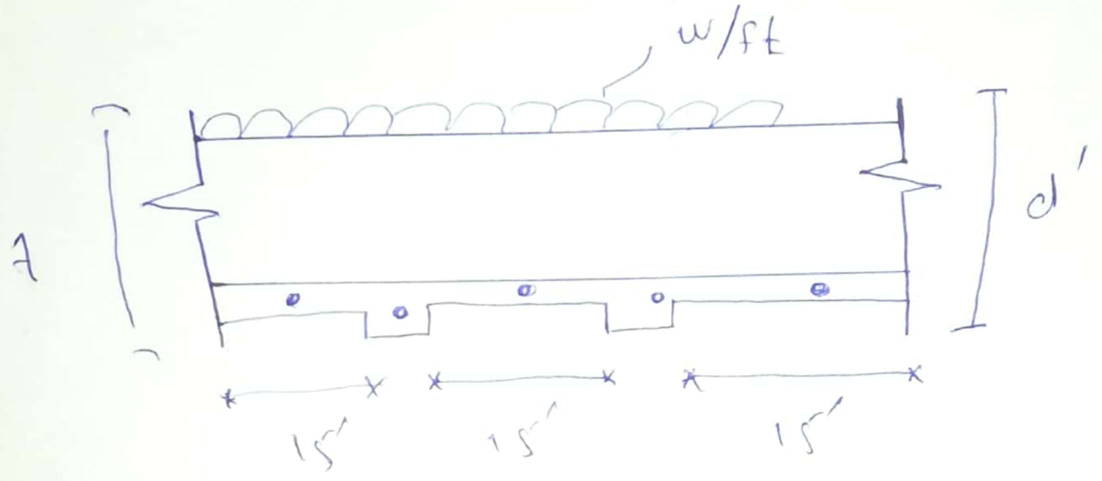
$f_y = 40ksi$

$t = 5.5''$

main steel #4 at 4'' c/c

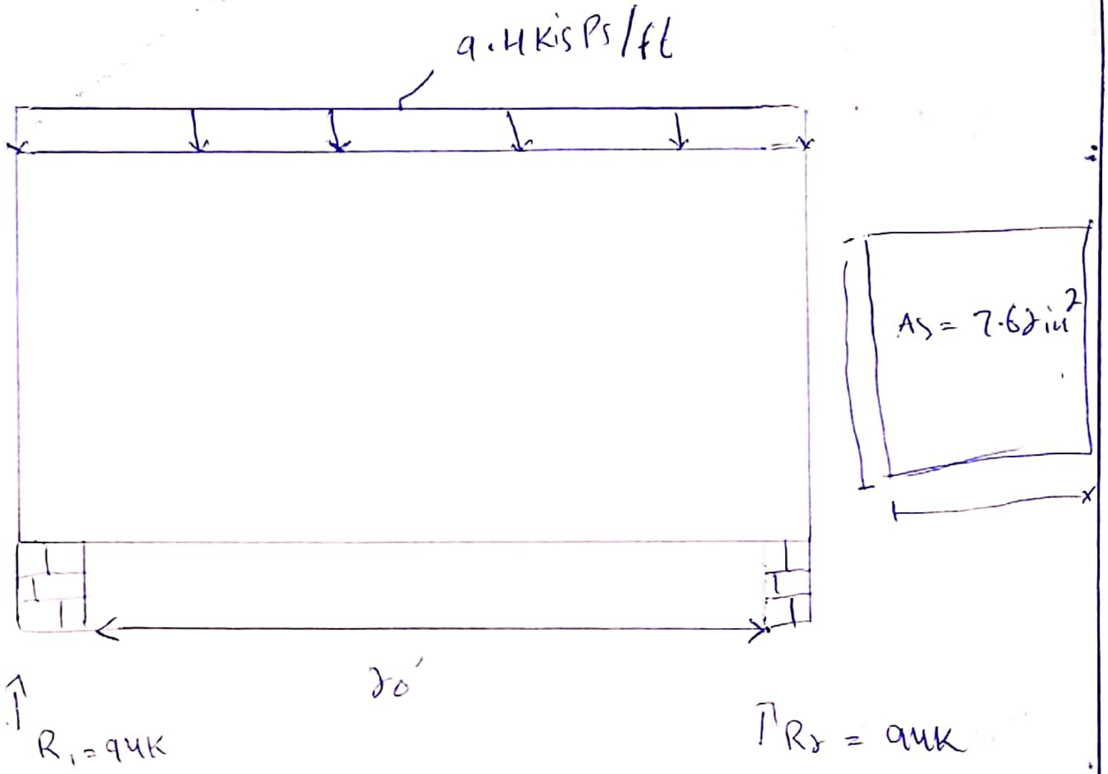
Distribution steel #4 at 18'' c/c.

Question one diagrm :



Question No 2

Given data:-



First we have to find Beam self weight:-

By formula:

$$w = b \times t \times \gamma_c \Rightarrow w = \frac{16}{12} \times \frac{22}{12} \times 150$$

$w = 366.67$ lb/ft or $w = 0.3666$ K/ft

So the factored load will be

$= 1.2(0.3666) = 0.44$ kips/ft

so total applied factored load will be

$= 9.4 + 0.44$

$= 9.84$ kips/ft

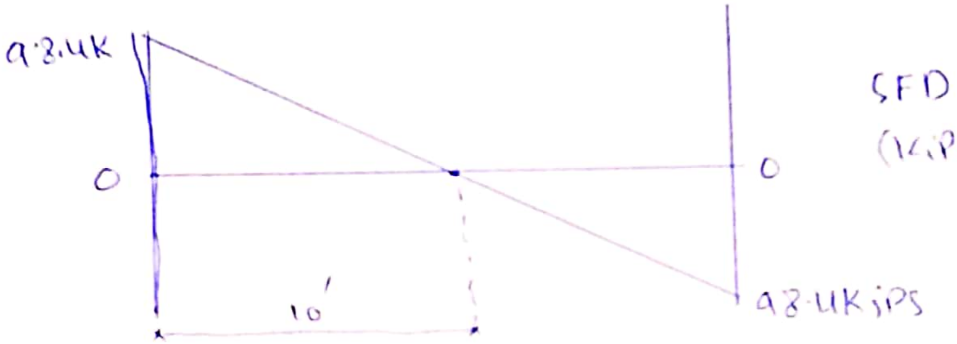
Step : 01

R_1 and R_2 value :

$$R_1 = R_2 = \frac{9.84 \times 20}{2}$$

Step : 02

Shear force diagrm

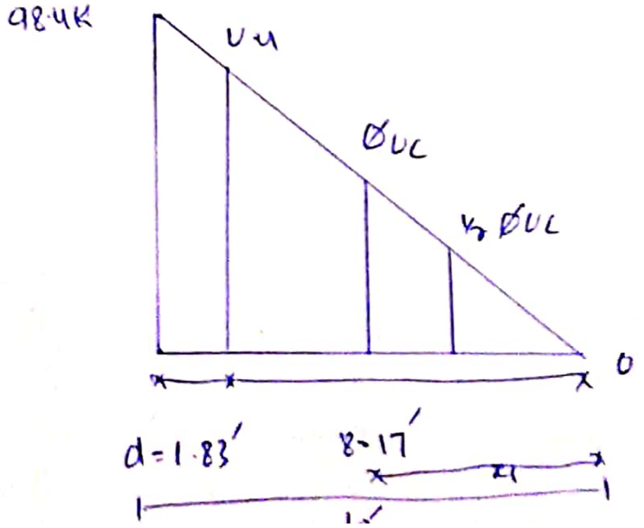


Step : 03

Critical shear value and its location

=> location from support face => d = 22" = 1.83'

=> value of critical shear at "d" by similarily of triangles



From similar Δ's :

$$\frac{98.4}{10} = \frac{V_u}{8.17}$$

$V_u = 80.39$ kips.

Step : 04

value of ϕV_c and $\frac{1}{2}\phi V_c$ and its distances from zero shear to right side.

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

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

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

$\Rightarrow$ location of ϕV_c by similairty of Δs:

$\dfrac{98.4}{10} = \dfrac{33.40}{x_1}$

$\boxed{x_1 = 3.39'}$

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

$\Rightarrow$ location of $\frac{1}{2}\phi V_c = \dfrac{98.4}{10} = \dfrac{16.70}{x_2}$

$\boxed{x_2 = 1.697'}$

Step : 5

Value of ϕV_s

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 80.39 - 33.40$

$\boxed{\phi V_s = 46.99k}$

Step : 06

Section Adequacy:-

$$\phi \times 8 \times \sqrt{f_c'} \times b_w \times d$$

$$\frac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000} = \boxed{133.57k}$$

=> As $\phi V_s < (\phi \times 8 \times \sqrt{f_c'} \times b_w \times d)$, it means Section is adequate.

Step : 07

Chek max. Spacing for stirrup

$$\Rightarrow \phi \times 4 \times \sqrt{f_c'} \times b_w \times d$$

$$\Rightarrow \frac{0.75 \times 4 \times \sqrt{4000} \times 16 \times 22}{1000}$$

$$\Rightarrow \boxed{66.79 \text{ Kips}}$$

* As $\boxed{\phi . 4 . \sqrt{f_c'} . b_w . d} > \boxed{\phi V_s = 46.99}$

=> So max. spacing will be selected from following four conditions.

① $S_{max} = \boxed{24''}$

② $d/2 = \frac{22}{2} = \boxed{11''}$

③ $S_{max} = \frac{0.22 \times 60{,}000}{0.75 \times \sqrt{4000} \times 16}$

$\boxed{S_{max} = 17.40''}$

④ $S_{max} = \frac{0.22 \times 60{,}000}{50 \times 16}$

$\boxed{S_{max} = 16.50''}$

least value of spacing for #.3 legged Stirrup will be

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

Step : 08

Spacing of Stirrup at critical section

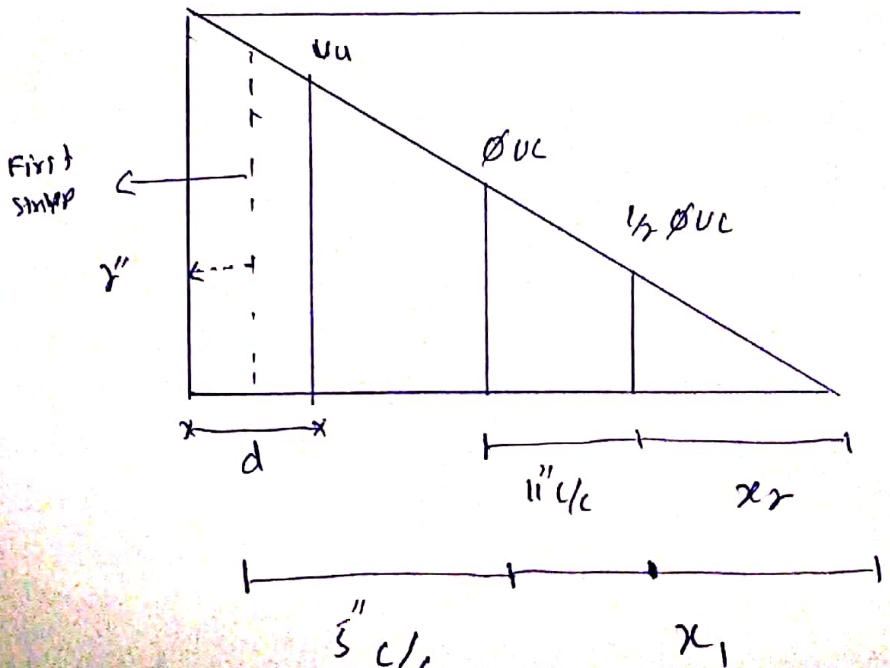
$$S = \frac{\phi \times (A_v \text{ of } \# 3, 2 \text{ legged}) \times f_y \times d}{V_u - \phi V_c}$$

$$S = \frac{0.75 \times 0.22 \times 60 \times 22}{80.39 - 33.40}$$

$S = 4.64 \approx 5'' \ c/c$

Step 9:

Final sketch:-



first stirrup from support face $s/2 = 5/2 = 2''$

Question No 03

Given data:

capacity = ?

Breadth = 12"

Depth = 12"

Bar number = 9

* Spacing @ 12"
* $f_c' = 4000\,psi$
* $f_y = 60\,ksi$

Step 1 :-

Find grass of concrete

$A_g = b \times b$ (since it is square tied column)

$A_g = 12 \times 12 = 144\ in^2$

Step : 2

Find area of steel

Since $A_s = 5\ \%$ of A_g

$= 0.05 \times 144$

$A_s = 7.2\ in^2$

Step : 3

Ultimate load carrying capacity

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

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

$P_u = 466.50\,K$

Step 04:-

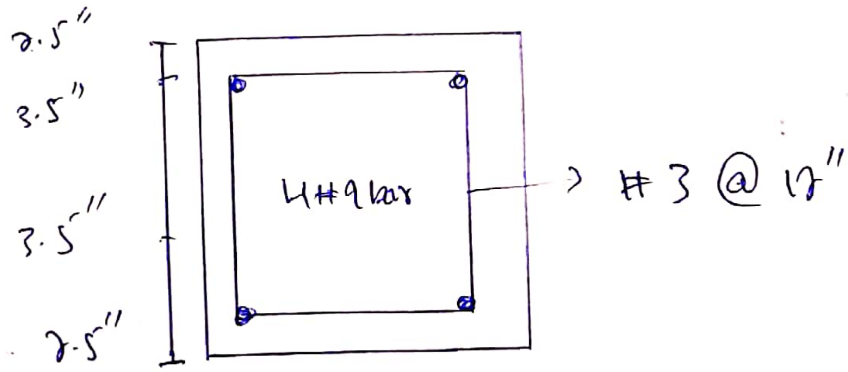
Stectch and Design of this (c/c to distance

From the below values we choose the least value of all this:-

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 colume dimension = 12"



* Since it is a tied sauare colum so there is no spiral stirup used. the stirrup used is of rectangular shape due to the specifiction of the structure this we will use the stirrups instead.

Question No 4"

Step 1 :-

let h = 24"

Step : 02 :-

Total weight = Wt of soil + Wt of R.C

= 3 x 120 + 2 x 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

Reauried Area for foundation

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

$\text{area} = 119.57 \, ft^2$

Step # 05

Since foundation is square

$$\text{Area} = b \times b = 119.57$$

$$\Rightarrow B \cong 11'$$

Step 06 :-

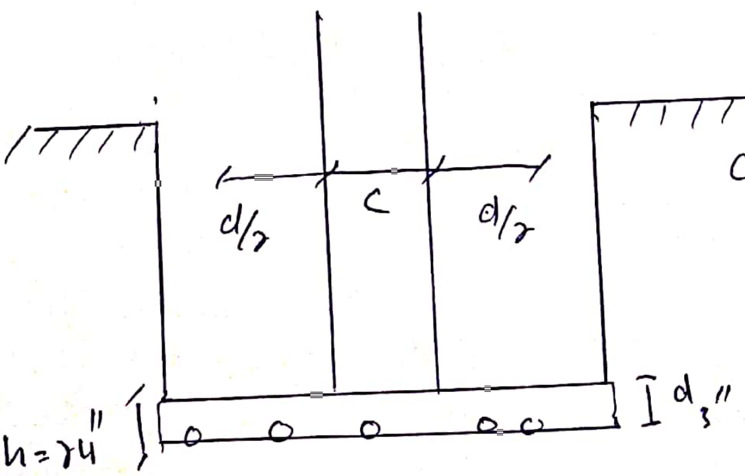
upward bearing capacity of soil

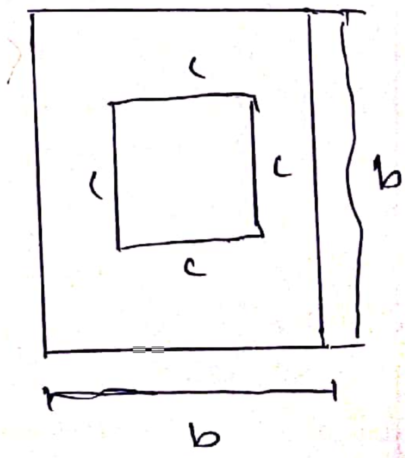
$$q_{up} = \frac{\text{Factored load}}{(B)^2} = \frac{1.2 \times 100 + 1.6 \times 120}{11^2}$$

$$\boxed{q_{up} = 2.58\ K/ft^2}$$

Step : 07 Punching shear

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





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

Take bar #8 bar

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

dia $= 8''/8 = 1''$

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

Step 08 :- value of V_{o2}

$V_{o2} = q_{up} \times \left[B^2 - (c+d)^2 \right]$

$= 2.58 \times \left[(41)^2 - (16 + 19.5)^2 \right]$

$V_{o2} = 289.60$ KiPS

Step 19 :-

value of $\phi V_{c/p}$

$= \phi \times 4 \times \sqrt{f'c} \times b_o \times d$

$= \dfrac{0.75 \times 4 \times \sqrt{3000} \times 142 \times 19.5}{100}$

$= 454.99k$

Step 10 :-

Beam shear check

By formula

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

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

$$\boxed{V_{u1} = 91.05 \text{ Kips}}$$

Step 11 :-

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

$$= 0.75 \times 2 \times \sqrt{3000} \times (10.934 \times 12) \times 19.5$$

$$\boxed{\phi V_c = 105.10 > V_{u1}}$$ Hence ok

Step 12 :-

ultimate moment:

$$M_u = \frac{q_{up} \times B}{8} \times \left(10.934 - \frac{16}{12}\right)^2$$

Step 13

Area of steel for main bar

by trials

Trial 1 :-

$a = 0.2 \times h \quad = 0.2 \times 24 \quad = \boxed{4.8''}$

$$A_s = \frac{M_u}{\phi \times f_y \times (d - a/2)}$$

$$= \frac{3944.09}{0.9 \times 60 \times \left(19.5 - \frac{4.8}{2}\right)}$$

$A_s = 8.56 \text{ in}^2$

Trial 2 :-

$\boxed{a = 1.53''}$

$A_s = 7.192 \text{ in}^2$

Trial 3 :-

$a = 1.28$

$\boxed{A_s = 7.1}$

Step 14 :- As. main reinforcement

$A_{s\,min} = 0.0018 \times B \times h$

$= 5.70 \text{ in}^2$

$$A_{s\,min} = \frac{200}{f_y} \times B \times d$$

$= 8.58\ in^2$

$$A_{s\,min} = \frac{3 \times \sqrt{f_c'}}{f_y}$$

$= 7.05\ in^2$

∆ greater value selection

Step 15 using # 8 bar

$$\text{No of bar} = \frac{A_s}{A_b} = \frac{8.58}{0.785}$$

$= 10.92 \simeq 11$ bars in each direction.