01

7802

NAME	MUHAMMAD FURQAN
ID	7802
SEMESTER	6th
SECTION	"A"
SUBJECT	RRCD-I
INSTRUCTOR:	Engr. FAWAD KHAN
EXAM	FINAL TERM EXAM SPRING SEMESTER 2026

QUESTION: 01

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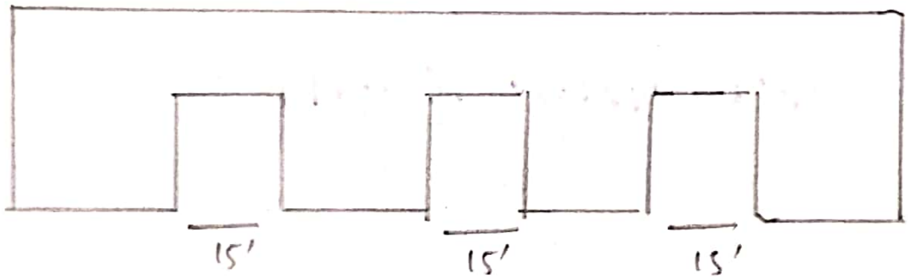
Given Data:

3 equal span concrete slabs
clear span b/w supports = 15 ft
Factored live load = 160 lb/ft²
$f_c' = 4000$ psi
$f_y = 40$ ksi
Service floor finish load = 20 lb/ft².

Solution:



Step: 01 Minimum Thickness:

We know by formula

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

As we know $f_y = 40$ ksi

So we will multiply a factor with this thickness.

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

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

Hence Minimum thickness will be

$$= 6.5 \times 0.8$$

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

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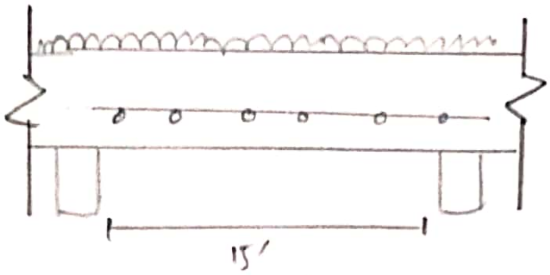
Step:02 Effective Depth:



We know by formula

d = t - clear cover - 1/2 (dia of main bars)

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

$d = 4.5''$

Step:03 Self weight of slab:

We know by formula

$t/12 + \gamma_{concrete}$

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

Step: 04 Total factored load:

Factored live load = $160\ lb/ft^2$

So factored Dead load (D.L) = 1.2 (20+68.75)

$= 106.5\ lb/ft^2$

Total factored load = D.L + L.L

= 106.5 + 160

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

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: 06

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Area of steel for main bars By Trial and Repeat Method.

Trial : 01.

let the depth of compression block

$a = 0.2 \times t$

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

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - 1.1/2)}$$

Trial : 02

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{0.63 \times 40}{0.85 \times 4 \times 12} = 0.62\ in^2$$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{89.94}{0.90 \times 40 \times (4.5 - 0.6/2)}$$

$A_{st} = 0.59\ in^2$

Trial: 03

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

So we use $A_{st} = 0.59''$

Step: 07 Area of steel for distribution Reinforcement.

We know

$A_{min} = 0.002 \times b \times t$ (Grade 40 steel)

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

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Step: 08 Spacing for main bars.

We know

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

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

$$\text{Area} = \frac{\pi}{4}\left(\frac{6}{8}\right)^2 = 0.442\ in^2$$

Step: 09 Spacing for distribution bar

$\text{spacing} = \frac{A_b}{A_{st}}$, we use #5 bars so

$\text{dia} = (5/8)''$

$$\text{Area} = \frac{\pi}{4}\left(\frac{5}{8}\right)^2 = 0.31\ in^2$$

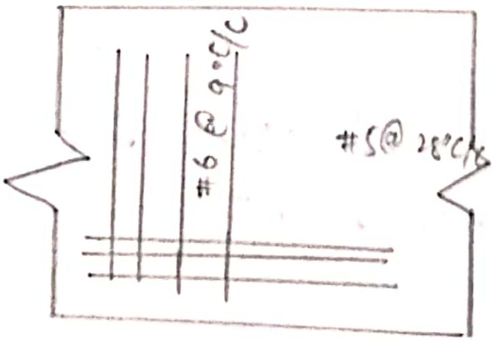
$$\text{spacing} = \frac{0.31}{0.132} \times 12 = 28.1'' \approx 28''\ c/c$$

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



QUESTION: 02

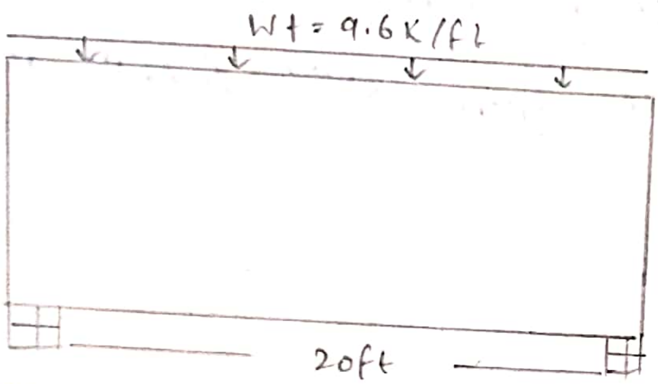
Solution:-

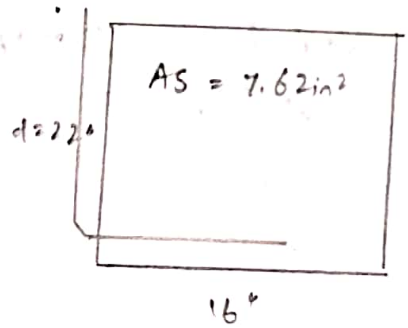
First find unit load of beam
b x γ_c

So

$16/12 \times 150 = 200$ lb/ft $= 0.2$ K/ft.

Now finding total factored load $= 9.4 + 0.2$
$= 9.6$ K/ft.



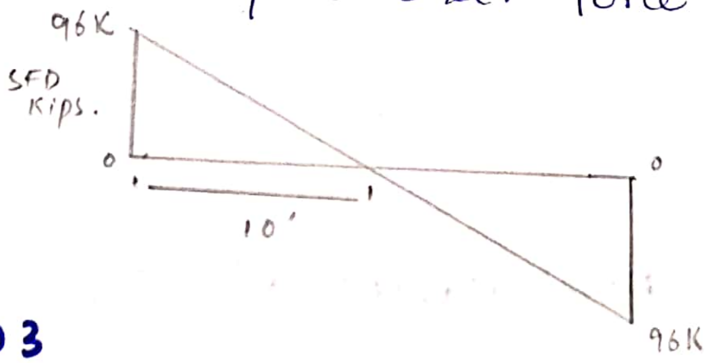


Step: 01. Finding value of R_1 and R_2

Total load $= 9.6 \times 20/2 = 96$K

Step: 02

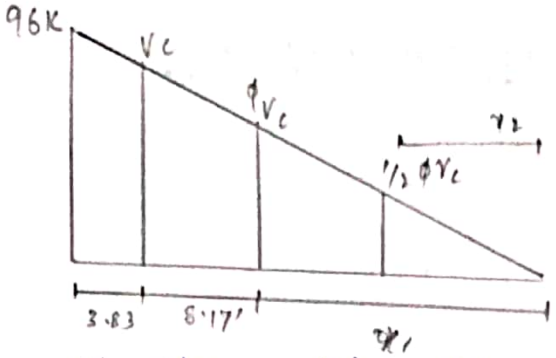
Drawing it sheer force diagram.



Step: 03

Finding value of critical stress "Vu" and its location

→ Critical location is located distance "d" from face of support $d = 22" = 1.83'$ value of critical shear at distance 'd' by Similarity Triangles.



From similar Δ's. $96/10 = V_u/8.17$

$V_u = 78.43K.$

Step: 04 Finding value of "ϕV_c", "$1/2 \phi V_c$" and distance from zero shear to right side.

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

$\phi V_c = 33.40K$

location of ϕV_c by similarity of Δ's

$96/100 = 33.40/x_1$

$x_1 = 3.48'$

Now $1/2 \phi V_c = 33.40/2 = 16.70K$

location of $1/2 \phi V_c$ = $96/10 = 16.70/x_2$

$x_2 = 1.74'$

Step: 05 Find value of ϕV_s ($V_u = \phi V_s + \phi V_c$)

We have

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03K$

Step: 06 Check section adequacy.

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

$= 133.57\,K$

$133.57K > \phi V_s$ (means section adequate)

Step: 07 Check Min status for stirrup:

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

$= \boxed{66.79K} > \phi V_c = 44.03K$

Maximum spacing selected from following 04 conditions.

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

(ii) $d/2 = 22/2 = 11''$

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

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

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

(4) $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 60000}{50 \times 16} = 16.50$

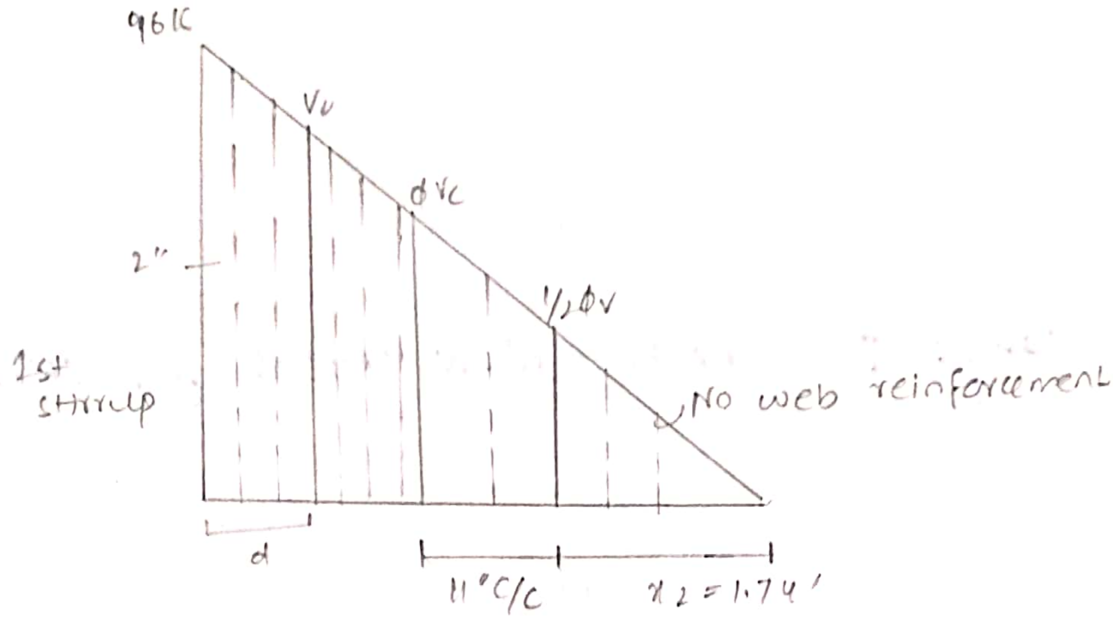
From above four conditions least value of spacing for #3 U stirrup will be selected so $S_{max} = 11''$ c/c

Step: 08 Spacing of stirrup from 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

Step:09 Final Sketch.



We know first stirrup from face of support = 5/2 = 2.5 ≃ 2".

QUESTION:03

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Step: 01

Finding gross area of concrete

$Ag = b \times b$ (since square tied column)

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

Step: 02

Area of steel

since $As = 5\%$ of Ag

$= 0.05 \times 144$

$= 7.2 in^2$

Step: 03

Ultimate load carrying capacity

$Pu = \phi \times 0.80 \, [0.85 \times fc' \times (Ag - As) + As + fy)$

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

$Pu = 466.50 \, K$

Step: 04

Sketch Design and title

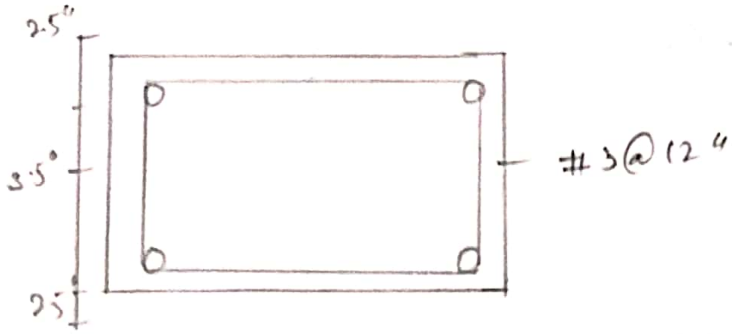
From the values we choose the least value

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

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

least column dimension = 12"

so c/c distance b/w ties = 12"



Since its tied square column

→ no spiral stirrup used.

→ stirrup of rectangular shape is used.
due to specification of structure that we will use tie stirrup instead.

QUESTION: 04

Solution:-

Step # 1

let $h = 24''$

Step: 02

Total weight = wt of soil + wt of RC

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

$= 0.660$.

Step: 03

Now Finding Effective bearing capacity

$q_e = q_a - w = 2.50 - 0.660$

$q_e = 1.84$ Ksf

Step: 04

Now finding required area for Foundation

$A_{req} = \dfrac{\text{Service load}}{q_c} = \dfrac{100+120}{1.84}$

$A_{req} = 119.56\ ft^2$

Step: 05

Since foundation is square

Area = $B \times B = 119.56$

$B \Rightarrow$ ~~10.93''~~ – ~~56''~~ 11'

Step: 06

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

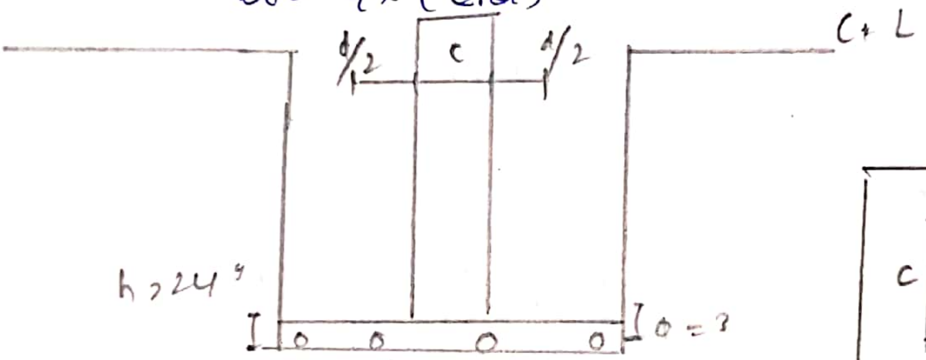
$$= \frac{1.2 \times 100 + 1.6 + 120}{(11)^2}$$

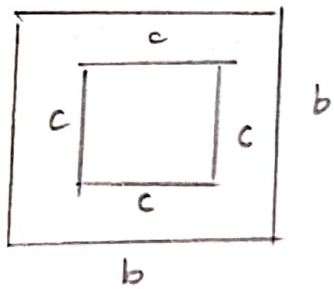
$q_{up} = 2.58\,K/ft^2$

Step: 07

Now finding punching shear

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





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

putting values.

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

Take #8 bar

dia $= 8/8 = 1''$

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

Step: 08

$V_{U2} = q_{up} \times [B^2 - (C+d)^2]$

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

$V_{U2} = 289.60K$.

Step: 09

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

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

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

Step: 10

Now finding beam sheer/ one way sheer check.

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

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

$V_{U1} = 90.95K$

Step: 11

Finding self sheer capacity.

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

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

$= 110.04 K > V_{U1} \Rightarrow OK$

Step: 12

Now finding ultimate moment.

$M_U = \frac{q_{up} \times B}{8} \times (B - C)^2 = \frac{2.58 \times 11}{8} \times (11 - 16/12)^2$

$M_U = 331.49K \simeq 3977.93K.$

Step # 13

Finding area of steel by Trial and Repeat method

Trial 01: let $a = 0.2 \times h = 0.2 \times 2.4 = 4.8''$

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

Trial: 02

$a = \frac{A_s \times f_y}{0.85 \times fc' \times b} = \frac{8.56 \times 60}{0.85 \times 3 \times 11 \times 12} = 1.53''$

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

Trial : 03

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

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

so that area is $7.1 \ in^2$

Step : 14:

Now checking Reinforcement by following three methods.

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

$= 5.70 \ in^2$

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

$= 8.58 \ in^2$

(C) $As_{min} = \frac{3 \times \sqrt{fc'}}{fy} \times B \times d = \frac{3 \times \sqrt{3000} (11 \times 12) \times 19.5}{60000}$

$= 7.05 \ in^2$

From above values greater value will be selected.

$As_{min} = 8.58 \ in^2.$

Step: 15

Now using #8 bars

$A_b = 0.785\ in^2$

$\text{No. of bars} = \frac{A_s}{A_b}$

putting values

$= \frac{8.58}{0.785} = 10.92 \approx 11$ bars in each direction