FINAL EXAM

NAME # Basit Khan

ID # 7812

SEC # 'A'

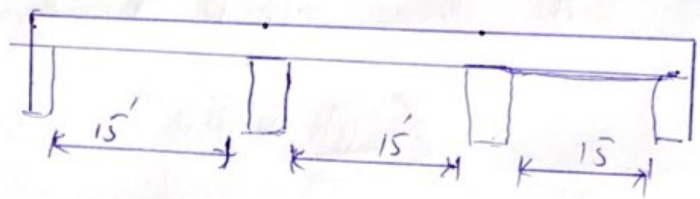
Subject # PRCD-I

Teacher # Sir, Fawad Khan

ID : 7812

Q no : 01

Given data



Given data

Three Span Reinforced Concrete slab

Clear span = 15 ft

live load = 160 psf

Service Floor Finished Load = 20 psf

f'_c = 4000 psi

F_y = 40 ksi

Solution

Step # 01 Minimum Thickness of Slab

$t_{min} = \frac{L}{28} = \frac{15}{28}$ (by formula)

= 6.4

Say,

6.5"

ID: 7812

f_y = 40ksi

So xing a factor with this Thickness

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

$$= 0.4 + \frac{40}{100}$$

$$= 0.8$$

Hence The minimum thickness we have 6.5×0.8

$$t_{min} = 5.2''$$

Say, $5.5''$

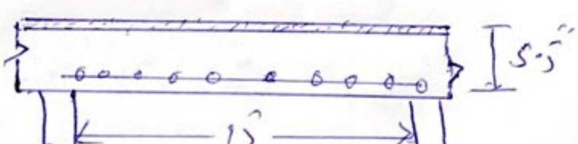
Step # 02

Effective Depth

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

$$d = 5.5 - 0.75 - \frac{1}{2}\left(\frac{5}{8}\right)$$

$$d = 4.5 in$$



ID: 78121

Step # 03 Self weight of Slab

$= t/12 \times \gamma_{concrete}$

$= \frac{5.5}{12} \times 150$

$\Rightarrow 68.75\ lb/ft^2$

Step # 04 Total Factored Load

Factore Live Load = $160\ lb/ft^2$

So The factore dead Load

$D.L = 1.2(20 + 68.75)$

$= 106.5\ lb/ft^2$

Total Factored Load = D.L + L.L

$= 106.5 + 160$

$= 266.5\ lb/ft^2$

$= \frac{266.5}{1000} \Rightarrow 0.2665\ k/ft^2$

Step # 05 Ultimate moment

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

$= 89.94$ kips-inches

ID: 17812

Step # 06

Area of Steel for main by trial and Repeat Method

Trial # 01

Let depth of Compression block

$a = 0.2t = 0.2 \times 5.5 \Rightarrow 1.1$ inch

Now

$$A_{st} = \frac{M_u}{\phi \times F_y \times (d - \frac{a}{2})}$$

$$= \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{1.1}{2})} \Rightarrow 0.63 \text{ in}^2$$

Trial # 02

$$a = \frac{A_{st} \times F_y}{0.85 \times f'_c \times b}$$

$$= \frac{0.63 \times 40}{0.85 \times 4 \times 12} \Rightarrow 0.62 \text{ in}^2$$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - \frac{a}{2})} = \frac{89.94}{0.90 \times 40 \times (4.5 - \frac{0.62}{2})}$$

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

Trial # 03

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

ID: 7812

$$A_{st} = \frac{89.94}{0.90 \times 40 \times \left(4.5 - \frac{0.75}{2}\right)}$$

$$= 0.59\ in^2$$

So Area of steel will be used

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

Step # 07

Area of Steel for distribution Reinforcement

$$A_{min} = 0.002 \times b \times t \quad \text{(For grade 40 steel)}$$

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

$$A_{min} = 0.132\ in^2$$

Step # 08 Spacing for main bar

$$Spacing = \frac{A_b}{A_{st}} \times 12$$

use #6 bar $\left(\frac{6}{8}\right)$

$$Area = \frac{\pi}{4}\left(\frac{6}{8}\right)^2 \quad \left(Area = \frac{\pi}{4}d^2\right)$$

$$= 0.442\ in^2$$

ID: 7812

Step #09

Spacing for Distribution bar

$$\text{Spacing} = \frac{A_b}{A_{st}}$$

Use #5 bar

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

$$\text{Spacing} = \frac{0.31}{0.132} \times 12$$

$$= ~~2.81~~\ 28.1$$

Say, 28"

Step #10 ~~Final~~ Sketch

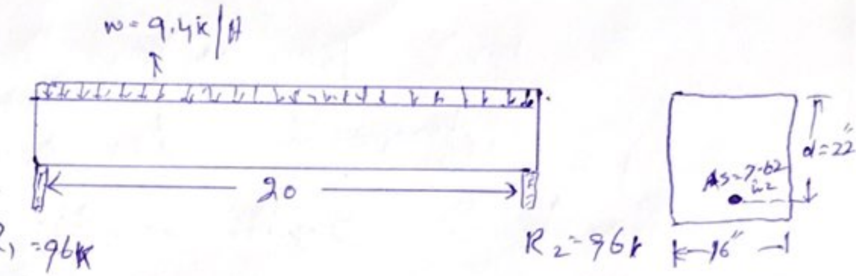
$f'_c = 4ksi$, $f_y = 40ksi$

Main Steel #6 at 9" c/c

Distribution Steel # 5 at 28" c/c

Q: 02 :

Sol:-



First Find the unit Load of beam So $b \times \gamma_c$

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

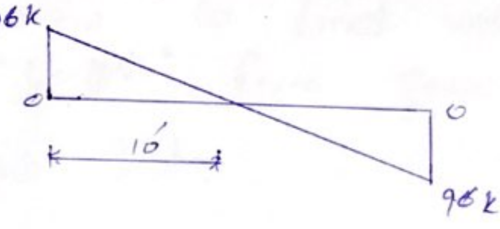
total Factored Load = 9.4 + 0.2
= 9.6 K/ft

Step: 01

Find the Reactions "R_1" & "R_2"

total Load = $9.6 \times \frac{20}{2} = 96K$ ($R_1 = R_2$)

Step: 02 Draw its Shear force diagram

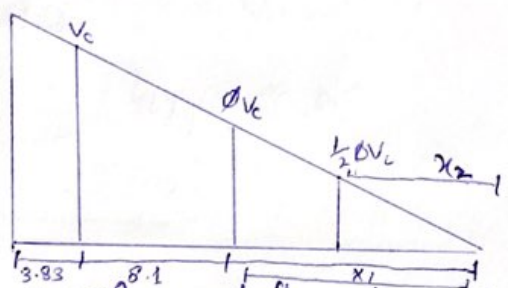


P.T.O

ID: 7812

Step : 03 find value of Critical Stress "V_u" & its Location

As we Know That Critical Location is Located distance "d" from Face of Support $d = \frac{22''}{12} = 1.83'$ value of Critical Shear at distance "d" by Similarly triangles.



From Similar triangles (Δ's)

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

By Cross xing

~~$V_u = 788.43$~~

$V_u = 78.43$

Step : 04 Now to find value of "ϕV_c" & "$\frac{1}{2}\phi V_c$" from zero Shear of Right Side.

ID: 7812

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

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

$$\phi V_c = 33.40k$$

Location of ϕV_c by Similarity of triangles

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

by C.M

$$x_1 = 3.48'$$

Now $\frac{1}{2}\phi V_c$

$$= \frac{33.40}{2} \Rightarrow 16.70k$$

It's Location by Similarity triangles

$$\frac{96}{10} = \frac{16.70}{x_2}$$

By C.M

$$x_2 = 1.74'$$

PTO

ID: 7812

Step # 05

Find the value of ϕV_s as from formula ($V_u = \phi V_s + \phi V_c$)

$\phi V_s = V_u - \phi V_c$

$\phi V_s = 78.43 - 33.40$

$\phi V_s = 45.03\ K$

Step # 06 Check for accuracy

$\phi \times 8 \times \sqrt{F'c} \times b_w \times d$

$= \dfrac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 133.57K$

As $133.57 > \phi V_s$ (mean section is adaquate)

Step # 07 Checking For minimum Spacing For stirrup

$\phi \times 4 \times \sqrt{F'c} \times b_w \times d$

$= \dfrac{0.75 \times 4 \sqrt{4000} \times 16 \times 22}{1000}$

$= 66.79k$

So,- $66.79k > \phi V_s = 44.83\ K$

PTO

ID: 7812

→ According to ACI Cod

Maximum Spacing will be selected from following Four Conditions

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

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

(3) $S_{max} = \frac{A_v \times F_y}{0.75 \times \sqrt{F'_c} \times b_w}$

$= \frac{0.22 \times 6000}{0.75 \times \sqrt{4000} \times 16}$

$= 17.40''$

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

$= \frac{0.22 \times 6000}{50 \times 16}$

$= 16.50''$

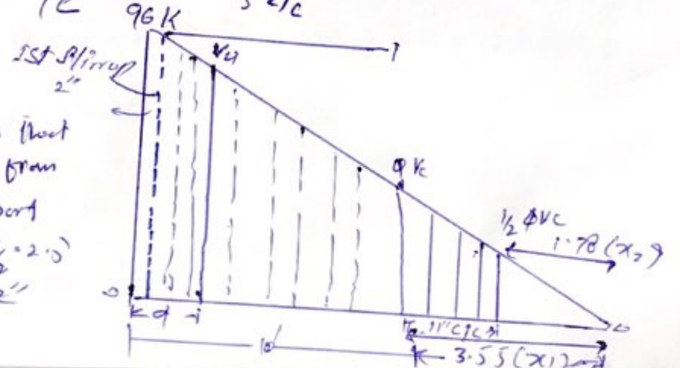
From above four Condition value of Spacing #3 bar as

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

Step #08 Spacing of Stirrup at Critical Section

$S = \frac{\phi \times A_v \times F_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.93 - 33.40} = 4.84$

say, $S = 5''$ c/c



We know that 1st stirrup from face of Support $= \frac{S}{2} = \frac{5}{2} = 2.5$

⇒ 2"

ID : 7812

Q NO: 03

Given data

12 inch^2 Square Coloumn

Steel = 4 #9 Ties # 3@12"

$F'c$ = 4000psi f_y = 60ksi

Sol:

Step # 01 gross area of Concrete

$A_g = b \times b$

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

Step # 02 Area of Steel

A_s,

$A_s = 5\%$ of A_g

$= 0.05 \times 144$

$A_s = 7.2 \, in^2$

Step # 03 Ultimate Load Carrying Capacity

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

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

$P_u = 466.50 k$

Step # 04

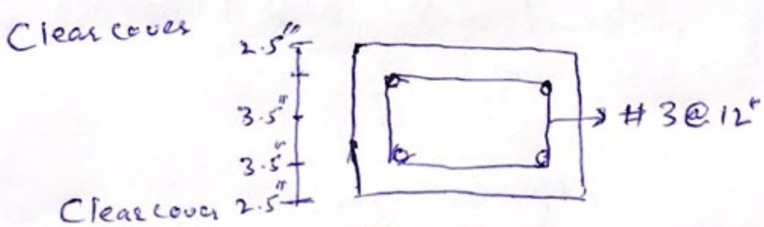
Sketch & design of ties

From the following value we Choose the Least value of all

1. $16 \times$ dia of Long bars $= 16 \times 9/8$
$= 18''$

2. $48 \times$ dia of Tie bars
$= 48 \times 3/8$
$= 18''$

3. Least Column dimension $= 12''$
So c/c distance between ties
$= 12''$



Since This is a tie Square Column so here is no spiral stirrup used The Stirrup used in This rectangular Shape due to the given Specification of The Structure Therefore we will use tie stirrup instead of spiral stirrup.

Given data :

$F_c' = 3ksi$

$F_y = 60ksi$

$q_a = 2.50ksf$

$\gamma_{soil} = 120 psf$

$D.L = 100 kips$

$L.L = 120 kips$

$Z = 5$

Sol: Thickness of footing

Step# 01

Assume

$h = 22 in$

Step# 02 Overburden pressure, w

$Z = 5'$

Total weight = $W_{con} + W_{fill}$

$W = \gamma_c h + \gamma_f (Z-h)$

$= (1.25 \times 150) + 120(5-1.25)$

$W = 187.5 + 450$

$W = 637.5 psf$ ∴ ÷ing by 1000

$W = 0.6735 \ Ksf$

Step # 03 Effective bearing Capacity

$q = q_a - W$

$= 2.5 - 0.6375$

$q = 1.8625 \ Ksf$

Step # 04 Bearing Area

$A_{req} = \frac{\text{Service Load}}{q_e}$ — (1)

$A_{req} = \frac{100 + 120}{1.8625}$

$A_{req} = \frac{220}{1.8625}$

$A_{req} = 118.120 \ ft^2$

$A_{req} = B \times B$

$= 118.120$

$B = 10.86 \cong 11 \ ft$

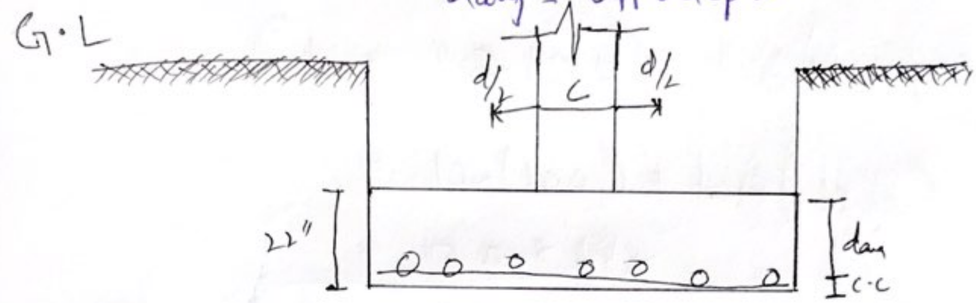
$B = 11 \ ft$

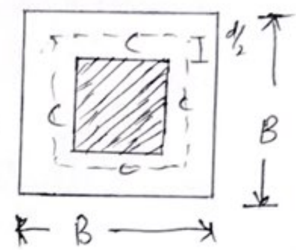
Step # 5 Critical Shear parameter

$b_o = 4 \times (C + d_{avg})$ — (1)

∵ C = colum dia

d_{avg} = Eff. depth





use #8 bar

$d = h - (C.C - \text{dia of bar} - \frac{1}{2} \text{dia of bar})$

$= 22 - (3 + 1 + 0.5)$

$= 22 - (4.5$

$= 17.5$

put in eq (1)

$b_o = 4 \times (16 \times 17.5)$

$b_o = 134$ inch

ID : 7812

Step # 06 Design pressure due to Factor Load

$$q_u = \frac{F.L}{A_{req}} \quad — (2)$$

$$F.L = 1.2(D.L) + 1.6(L.L)$$

$$= 1.2(100) + 1.6(120)$$

$$= 120 + 192$$

$$F.L = 312 \text{ kips}$$

$$q_u = \frac{312}{121}$$

$$q_u = 2.57 \text{ kcf}$$

Step # 07 punching Shear V_{up}

$$V_{up} = q_u \{B^2 - (c + d_{avg})^2\}$$

$$= 2.57 \{11^2 - \left(\frac{16 + 17.5}{12}\right)\}$$

$$V_{up} = 290.94 \text{ kips}$$

Step #8 punching Shear Capacity:

$V_{up} = 290.94$

$\phi V_{cp} = \phi 4\sqrt{f_c'}\, b_o \times d$

$= \dfrac{0.75 \times 4 \times \sqrt{3000} \times 134 \times 17.5}{1000}$

$\phi V_{cp} = 385.32 > 290.94$

so it's okay

Step #09

Beam Shear (one way slab

$V_{u1} = q_{uf} \times B \times \left(\frac{B}{2} - \frac{C}{2} - d\right)$

$= 2.57 \times 11 \times \left(\frac{11}{2} - \frac{16/12}{2} - \frac{17.5}{12}\right)$

$V_{u1} = 95.45K$

Step # 10 Self Shearing Capacity

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

$$= \frac{0.75 \times 2 \times \sqrt{3000} \times (11 \times 12) \times 17.5}{1000}$$

$\phi V_c = 189.785 > V_{u1} \rightarrow$ okay

Step # 11 Ultimate Moment

$$M_u = q_u B K^2/2 \quad \text{— (3)}$$

$$K = \left(\frac{B-c}{2}\right) = \frac{\left(11 - \frac{16}{12}\right)}{2}$$

$$K = 4.83$$

putt in eq (3)

$$M_u = \frac{2.57 \times 11 \times 4.83^2}{2}$$

$M_u = 329.75$ Kft

$M_u = 3957$ in-kips

Step # 12 Area of for main bar by trail & error Method

where,

$M_u = 3957$ in-kip

Let Suppose

$a = 0.2h \Rightarrow 0.2 \times 22 = 4.4''$

Tria # 1 $a = 4.4''$

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

$$A_s = \frac{3957}{0.9 \times 60 \times \left(17.5 - \frac{4.4}{2}\right)}$$

$$A_s = \frac{3957}{780.3}$$

$$\boxed{A_s = 4.789}$$

Trial # 02

$$a = \frac{A_s f_y}{0.85 \times f'_c \times B}$$

$$= \frac{4.79 \times 60}{0.85 \times 3 \times (11 \times 12)}$$

ID: 7812

$a = 0.852$

$$A_s = \frac{M_u}{\phi \times F_y (d - \frac{a}{2})} = \frac{3957}{0.9 \times 60 (17.5 - \frac{0.852}{2})}$$

$A_s = 4.29 in^2$

Trial # 03

$$a = \frac{A_s f_y}{0.85 \times f'_c \times B}$$

$$= \frac{4.29 \times 60}{0.85 \times 3 \times (11 \times 12)}$$

$a = 0.7602$

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

$$= \frac{3957}{0.9 \times 60 \times (17.5 - \frac{0.7602}{2})}$$

$A_s = 4.28$

Step # B Check minimum Requirement of Steel.

ID : 7812

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

$= 0.0018 \times (11 \times 12) \times 22$

$A_{s\,min} = 5.2272 \text{ in}^2$

(ii) $A_{s\,min} = \frac{200}{f_y} \times B \times d_{av}$

$= \frac{200}{60000} \times (11 \times 12) \times (17.5$

$A_{s\,min} = 7.7 \text{ in}^2$

(iii) $A_{s\,min} = \frac{3 \times \sqrt{f'_c} \times B \times d}{f_y}$

$= \frac{3 \times \sqrt{3000} \times (11 \times 12) \times (17.5)}{60000}$

$A_{s\,min} = 6.32 \text{ in}^2$

greater will be selected

$(A_{s\,min} = 7.7 \text{ in}^2)$

S

ID : 7812

Step # 14 No of bars

Using # 8 bar

$$A_b = \frac{\pi}{4} d^2$$

$$= \frac{3.14}{4}(1)^2 \Rightarrow 0.785 \text{ in}^2$$

$$\text{No of bars} = \frac{A_s}{A_b} = \frac{7.7}{0.785}$$

$$= 9.8 \cong 10 \text{ bars}$$

Spacing :

$$\frac{10.5 \times 12}{9}$$

Spacing = 14 in c/c