Name: Ayub Khan
ID # : 7881
SEC: B
DEPT: BE CIVIL
Semester : 6th
Subject : PRCD 1
Instr: Engr: Fawad Khan
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Q no 1,

Q, (1)

Given data

Clear Span = 15 ft.

Step-1 Minimum thickness

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

$$\Rightarrow \frac{15}{28} \times 12 = 6.428.$$

Factored = $0.4 + \frac{40}{100} = \boxed{0.8}$

Actual $t_{min} = 6.428 \times 0.8$

$= 5.1424.$

Step-2 Effective depth.

$D = t -$ Clear Cover $- \frac{1}{2}$ (d main bar)

$= 5.5 \times 0.25 - \frac{1}{2}(4/8)$

$d = 4.5''$

Step-3: Self weight ~~of load~~ of Slab:

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

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

$= 68.75.$

Step-4: Total factor load

$W_u = 1.2(D.L) + L.L.$

$= 1.2(68.75) + 1.0\,(150).$

$= \underline{242.5}$ or $\underline{0.242\ ksi}$

Step-5: Ultimate moment

$M_u = \frac{W_u \times t^2}{8} = \frac{0.242 \times (1.5)^2}{8}$

$= 7.48 \times 12$

$29.778\ k''$

Step-6:

Area of Steel for main bar by trial method.

Trial 01:

Let $a = 0.2 \times t = 0.2 \times 5.5 = 1.1$

As, $\frac{M_u}{\phi \times f_y \times (d - \frac{a}{2})} = \frac{29.735}{0.90 \times 40 (4.5 - \frac{1.1}{2})}$

$= 0.631$

Trial 02:

$a = \frac{A_s \times f_y}{0.85 \times f'_c \times b} = \frac{0.631 \times 40}{0.25 \times 40 \times 12}$

$a = 0.618$

As $\frac{89.725}{0.90 \times 40 (4.5) - \frac{0.681}{2}} = 0.594$

Q1 (4)

Trail 03:

$$a = \frac{0.824 \times 40}{0.23 \times 4 \times 12} = 0.582$$

$$A_s = \frac{29.735}{0.90 \times 40 \times (4.5 - \frac{0.581}{2})}$$

$$= \boxed{0.582}$$

$$A_s = \frac{29.735}{0.90 \times 40 \times (4.5 - \frac{0.582}{2})} = \boxed{0.599}$$

Trial 04

$$a = \frac{0.549 \times 40}{0.25 \times 4 \times 17} = 0.587.$$

$$A_s = \frac{29.735}{0.90 \times 40 \times (4.5 - \frac{0.587}{2})}$$

$$= \boxed{0.592}$$

Q. 8

Trail 05 :

$$\frac{0.592 \times 40}{0.25 \times 40 \times 12} = \boxed{0.580}$$

$$As = \frac{29.735}{0.90 \times 40 \times \left(4.5 - \frac{0.580}{2}\right)} = 0.592$$

Step - 7 : Area of Steel for distribution.

$$As_{min} = 0.0018 \times b \times t$$

$$0.002 \times 12 \times 5.5 = 0.132 \text{ in}^2/\text{ft}$$

Step - 08 : Spacing for main bars.

$$S = \frac{A\phi}{As} \times 12 = \frac{0.2 \times 12}{0.392} = 4.05 \text{ c/c}$$

Step- 9 : Spacing for distribution bars

4 bar.

$$S = \frac{A_b}{A_s} \times 12 = \frac{0.2}{0.132} \times 12 = 18.18 \approx 18'' \; c/c.$$

Step-10 : Final Summary

$f'c$ = 40 ksi, f_y = 48 ksi

C = 5.5"

main Steel #4 at 4.5 c/c.

Disc Steel #4 at 5 c/c.

Qno 2:

Given

Width = 16"

d_e = 22"

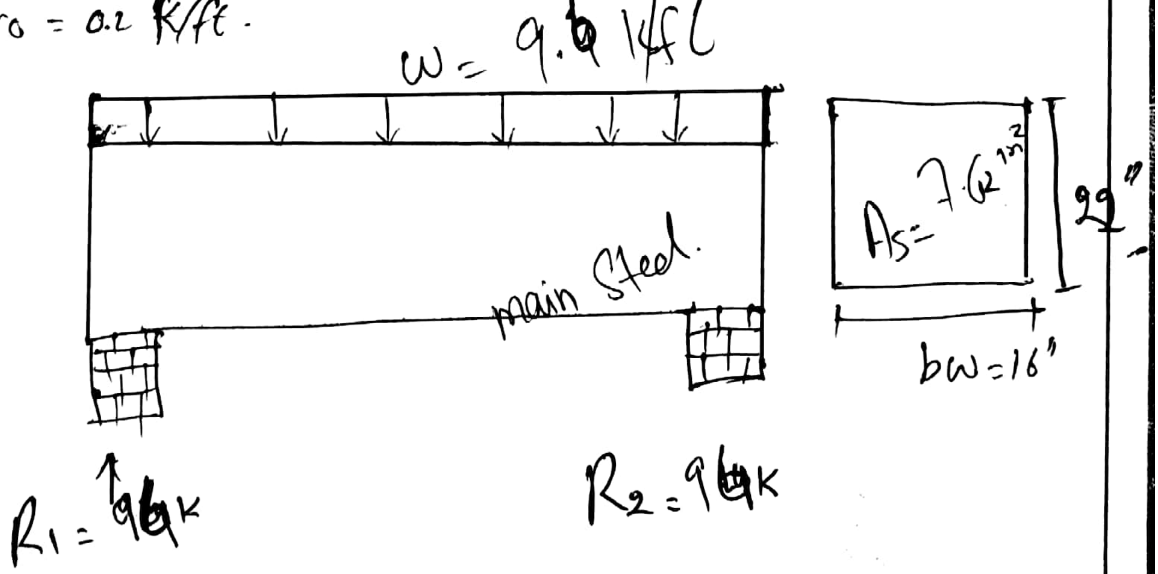
factored load = 9.4 k/ft.

Clear span = 20'

Tensile Steel Area = 7.62 in²

find Self weigh

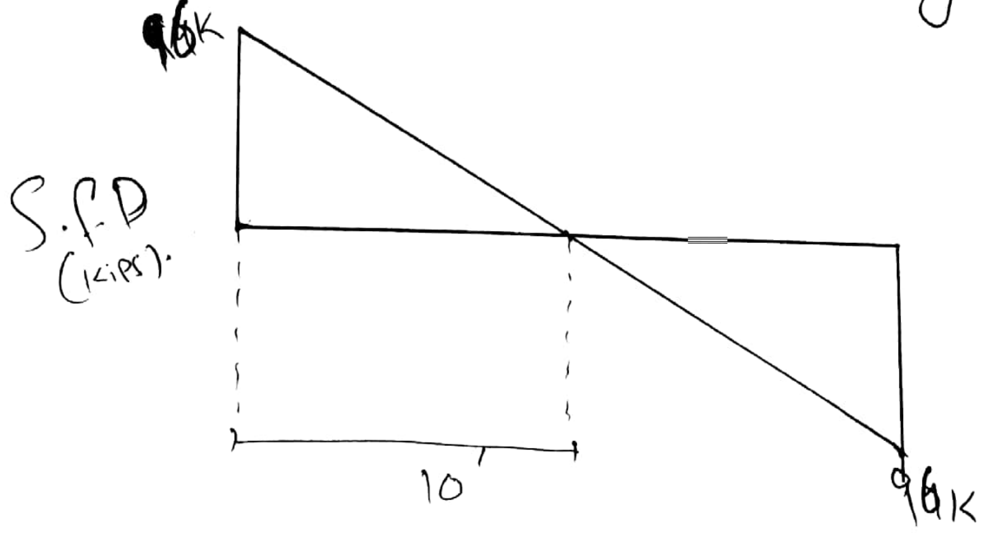
$b \times \gamma_c = \frac{16}{12} \times 150 = 0.2$ K/ft.



Step-1: Find the Value of R_1 & R_2.

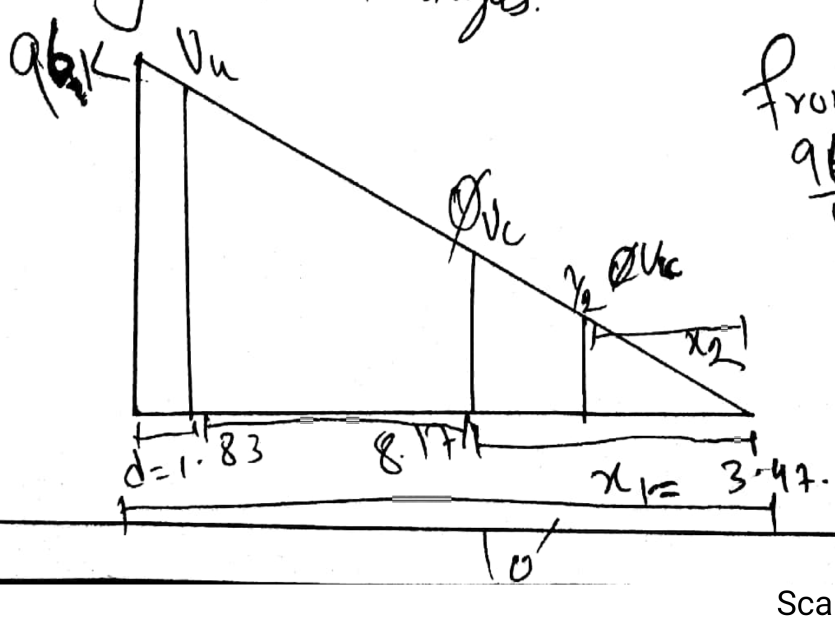
Total load = 9.6 × 20 = 192/2 = 96

Step-2: Draw its Shear force diagram.



Step-3: Find the Value of Critical Shear "V_u" and its location, As we know that, Critical Section is located at the distance "d" from face of Support, d = 22" = 1.83'.

Value of Critical Shear at distance "d" by Similarity of triangles.



from Similar Δs

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

$V_u = 78.42$ Kips.

Step-4: Find the value of "ϕV_c" and $\frac{1}{2}\phi V_c$ And also it's distance from zero Shear to right Side.

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

$$= \frac{0.75 \times 2 \times \sqrt{4000} \times 16 \times 22}{1000} = 33.40k$$

location of ϕV_c by Similarities of Δ'S

$$\frac{96}{10} = \frac{33.40}{x_1} \Rightarrow x_1 = 3.47$$

Now

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

location of $\frac{1}{2}\phi V_c \Rightarrow \frac{96}{10} = \frac{16.70}{x_2} \Rightarrow x_2 = 1.73$

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

So,

$$\phi V_s = V_u - \phi V_c = 78.42 - 33.40 = 45.02K.$$

Scanned with CamScanner

Step-6: Check on Section adequacy

$\phi \times 8 \times \sqrt{f'c} \times b_w \times d = \dfrac{0.75 \times 8 \times \sqrt{4000} \times 16 \times 22}{1000}$

$= 133.57k.$

As, $\phi V_s < \phi 8\sqrt{f'c}\, b_w d \Rightarrow$ It mean Section is adequate.

Step-07: Check on maximum Spacing for Stirrups $\phi \times 4 \times \sqrt{f'c} \times b_w \times d$

$= \dfrac{0.75 \times 4 \times \sqrt{4000} \times 22 \times 16}{1000} = 66.79$ Kip.

As, $\phi 4\sqrt{f'c} \times b_w \times d > \phi V_s = 43.40$ K.

So, Max-Spacing will be Selected from following four Conditions.

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

2- $\dfrac{d}{2} = \dfrac{22}{2} = 11$,

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

4- $S_{max} = \dfrac{A_v \times f_y}{50 \times b_w} = 16.50.$

from above four Condition, least Value of Spacing for #3, 2 legged Stirrups will be Selected.

So,

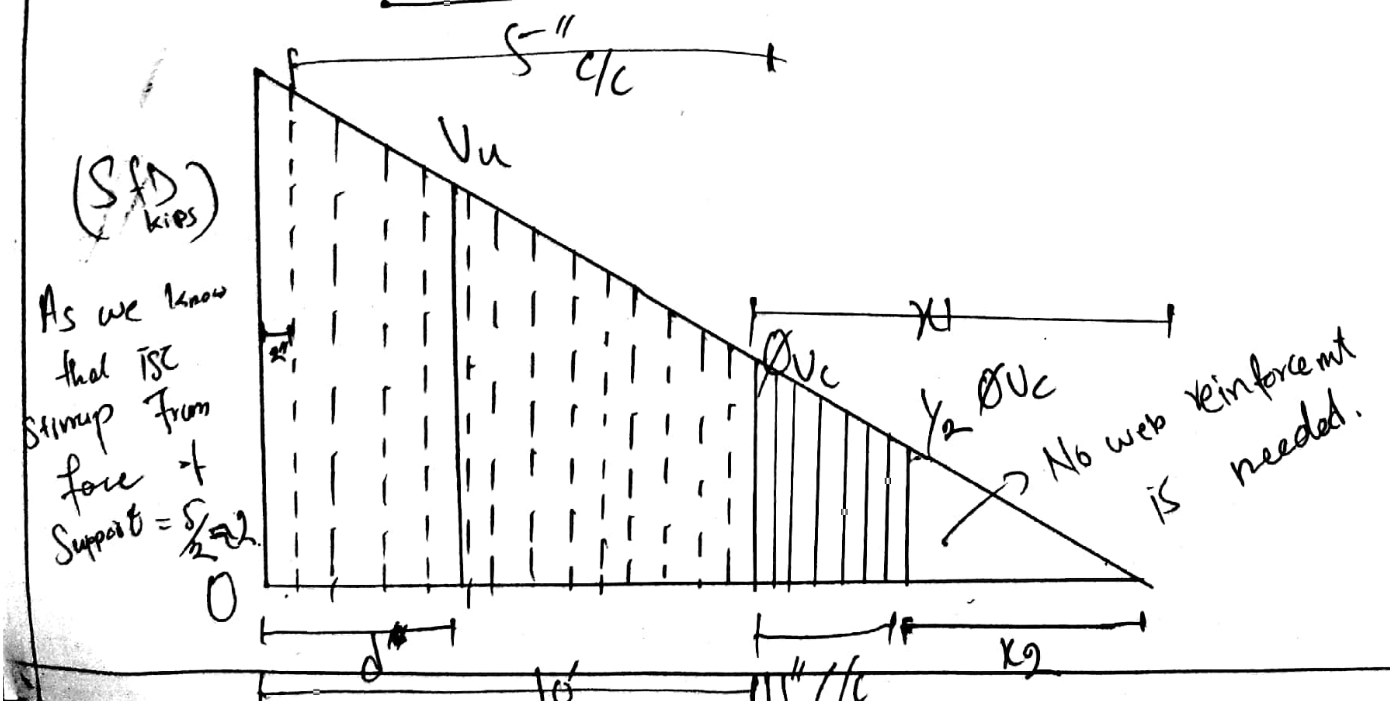
$$S_{max} = 11'' \; c/c.$$

Step-8: Spacing of Stirrups from Critical Section.

$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.42 - 33.44}$$

$S = 4.84 \approx S = 5'' \; c/s$

Step-9: Sketch the final Sketch.



Question # 03.

→ Calculate the axial ultimate load carrying capacity of a 12 inch-square tied column reinforced with 4 # 9. Ties are # 3 spaced @ 12 inches. Use $f_c' = 4000$ psi and $f_y = 60$ ksi, Also design necessary spirals.

Solution; **Given.**

Step-1: Find gross area of concrete.

$A_g = b \times b$ (Since it is square tied column.

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

Step – 2 : Find the area of Steal.

Since $As = 5\%$ of Ag.

$= 0.05 \times 144$.

$As = 7.2 in^2$

Step-3: ultimat load Carrying Capacity.

$Pu = \emptyset \times 0.80 \times [0.85 \times f'c \times (Ag - As)$

$+ As \times fy]$.

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

$Pu = 466.50k$

Step -4 : Sketch and design of ties (c/c to distance).

From the below value ~~use~~ we choses the least value of all, thus;

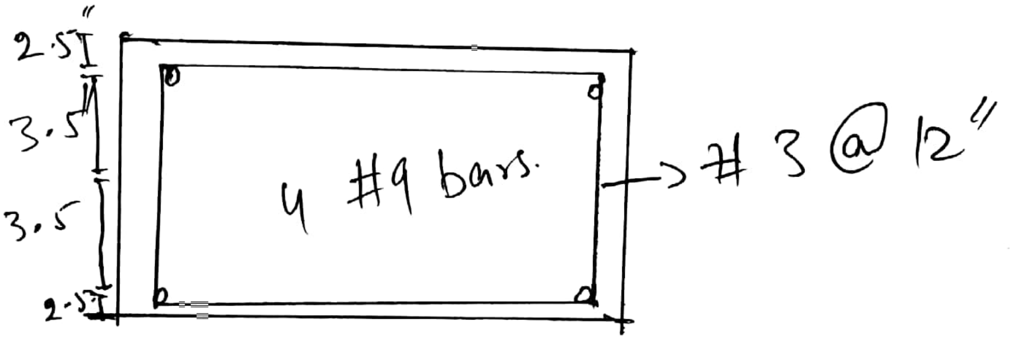
Q3, Q3 (3)

(1) 16 x dia of long bar = 16x 9/8.
= 18"

(2). 48 x dia of the bar = 48 x dia of tie bar = 48x 3/8
= 18"

(3) = least Coloumn dimension = 12"

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



• Since it is a tied Square Coloum So there is no Spiral Stirrup ~~on~~ used, the Stirrup used it of Rectegular Shape due to the Specification of the Stracture thus We will use tie Stirrups instead.

Q4 (1) (Q4) Q12

Q4: Design a Square footing --- Sketch of your final design.

Step-1:

Let $h = 24''$

Step-2:

Total weight = wt of Soil + wt of RC.

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

$= 660$ psf $= 0.660$ ksf.

Step-3: Effective beam Capacity:

$q_e = q_a - w$

$= 2.50 - 0.660$

$q_e = 1.84$ ksf.

Step-4: Require Area for foundation.

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

119.57 ft².

Step-5: Since ~~forward~~ foundation is Square

$A_{req} = b \times b =$

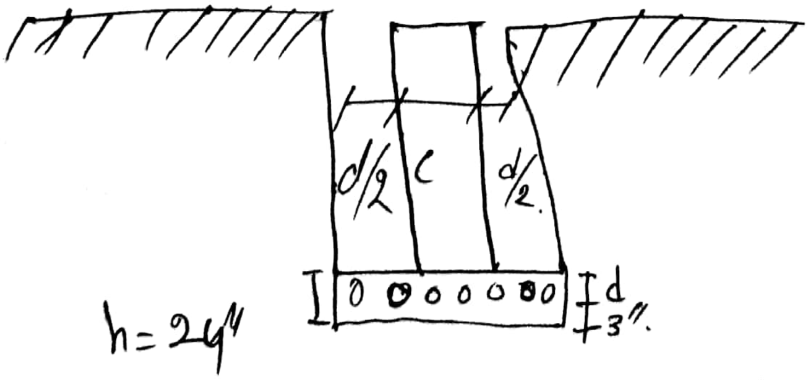
Step-6: Upward bearing Capacity.

$$q_{up} = \frac{\text{factored load}}{(B)^2} = \frac{1.2 \times 160 + 1.6 \times 120}{11^2}$$

$$q_{up} = 2.58\ k/ft^3$$

Step-07: Punching Shear.

$$b_0 = 4 \times (c + d)$$



$d = h - c.c - \text{dia of bar} - \frac{1}{2} d_b$ ∴ take #8 bar, dia = 8/8 = 1"

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

$b_0 = 4 \times (16 + 19.5) = 142"$

Step-8.

$$V_u = q_{up} \times (B^2 - (c \times d)^2)$$

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

$V_u = 289.60k.$

Step-9 :

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

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

$\Rightarrow 525.38k.$

Step-10: Beam Shear / one way Shear Check.

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

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

$V_u = 90.95k.$

Step - 11: Self Shear Capacity.

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

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

$$\Rightarrow 110.04k > V_{u}, \Rightarrow ok.$$

Step 12. <u>ultimate moment</u>

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

$$M_w = 331.49k' = 3977.93k''.$$

Step - 13: Area of Steel for members by trial and Repeat method.

Trial 1:

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

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

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

Trial 2:

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

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

Trial 3:

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

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

So thus area $= 7.1 \text{ in}^2$.

Step-14: Check the min reinforcement by the following as method.

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

$As_{min} = 5.70 \text{ in}^2$

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

$= 8.58 \text{ in}^2$

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

$= 7.05 \text{ in}^2$

from above value greater value will be selected thus $As_{min} = 8.58 \text{ in}^2$.

Step-15: Using # 8 bar

$Ab = 0.785 \text{ in}^2$

No. of bars $= \frac{As}{Ab} = \frac{8.58}{0.785} = 10.92$

$\approx$ 11 bars in each direction.