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Subject = P.R.C. Design 1

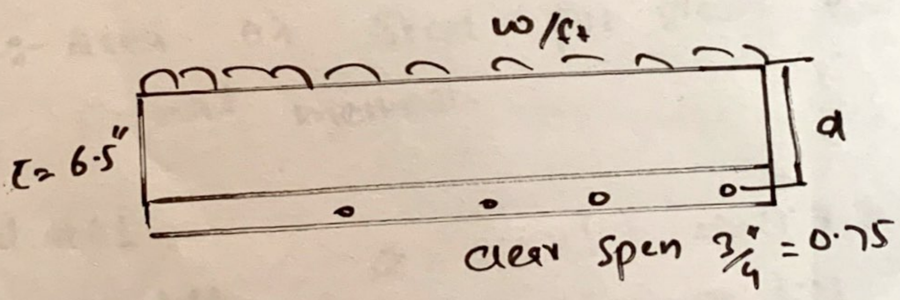
QNO1 → Given data:-

→ 3 equal Span Concrete Slab
→ clear Span b/w Supports = 15ft
→ factored Live load = 160 lb/ft²
→ Service floor finish load = 20 lb/ft²
⇒ $F_c' = 4000$ psi
⇒ $F_y = 40$ ksi

Solution:-

STEP # 01:- $t_{min} = \frac{L}{28} = \frac{15}{28} \times 12 = 6.5''$

STEP # 02:- Effective depth



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

$= 6.5 - (0.75 - \frac{1}{2}(4/8))$

$= 6''$

STEP# 03:- Self weight of Slab

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

$$= \frac{6.5}{12} \times 150 = 81.25 \text{ PSF}$$

STEP# 04:- Total Factored load.

$$W_U = 1.2(81.25 + 20) + 160$$

$$= 281.5 = 0.281 \text{ KSF}$$

STEP# 05:- Ultimate Moment

$$M_U = \frac{W_U \times L^2}{8} = \frac{0.281 \times 15^2}{8} \times 12 = 94.8 \text{ k''}$$

STEP# 06:- Area of Steel for Main Bars By Trial and Repeat method.

Trial # 01

Let $a = 0.2 \times t \Rightarrow 0.2 \times 6.5$
$= 1.3$

$$A_s = \frac{M_U}{\phi \times f_y \times (d - a/2)} = \frac{94.8}{0.90 \times 60 \times (6 - \frac{1.3}{2})}$$

$$= 0.32 \text{ in}^2/\text{ft}$$

Trial #02:- $a = \frac{As \times Fy}{0.85 \times f'c \times b} = \frac{0.32 \times 60}{0.85 \times 4 \times 15} = 0.37''$

$As = \frac{MU}{\phi \times fy \times (d - \frac{a}{2})} = \frac{94.8}{0.90 \times 60 (6 - \frac{0.37}{2})}$

$= 0.30 \, in^2/ft$

$a = 0.35$ $AS = 0.30 \, in^2/ft$

STEP #07:- Area of the Steel for distribution bar

$As_{min} = 0.0018 \times b \times T = 0.0018 \times 15 \times 6.5$

$= 0.17 \, in^2/ft$

STEP # 08:- Spacing bar Main Bar

$S = \frac{Ab}{AS} \times 12 = \frac{0.20}{0.30} \times 12 = 8 \approx 8.\frac{1}{2}$ c/c

STEP #09:- Spacing for Distribution bar

let Try #4 bar

$S = \frac{Ab}{AS} \times 12$

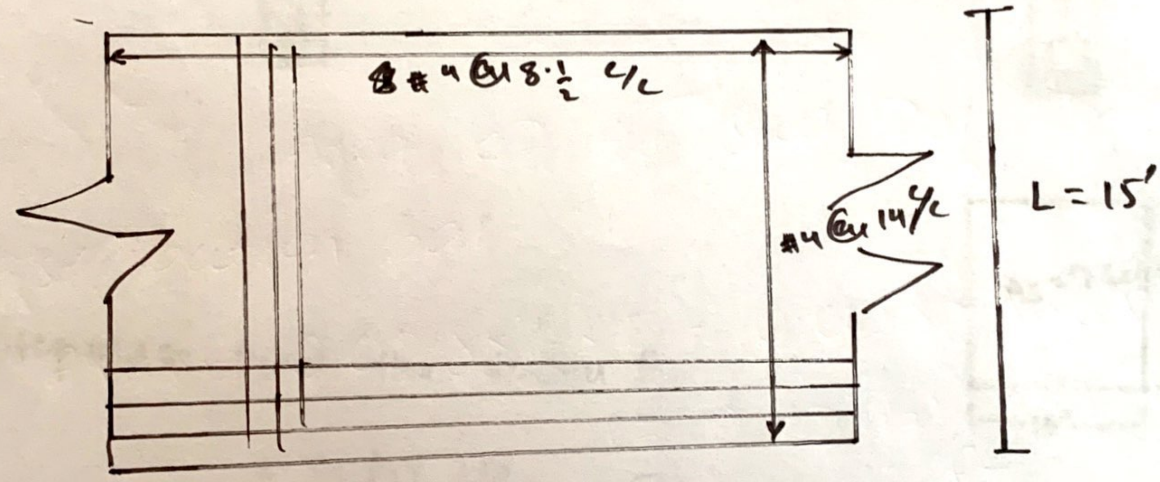
$= \frac{0.20}{0.175} \times 12 = 13.71 \approx 14$

STEP # 10 Final Summary:-

$f'c = 4ksi$ $fy = 40ksi$ $\tau = 6.5$

Main Steel bar #4 = at $8\frac{1}{2}$ c/c

Distribution Steel bar #4 at 14 c/c



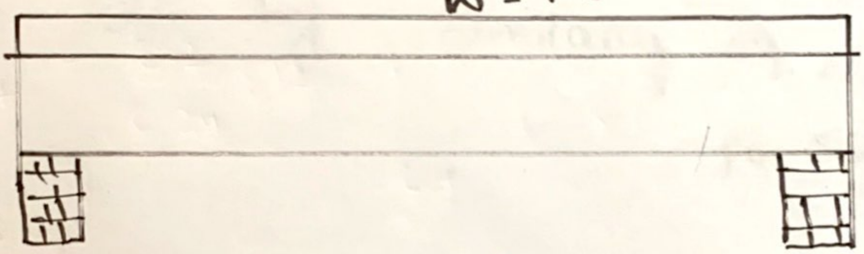
Q.No.2

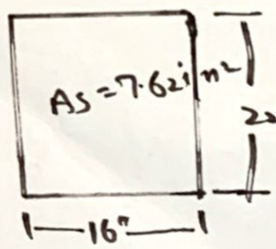
QNO2:- A Simply Rectangular Beam:

Given data:- Width = 16"

de = 22" Factorured Load = 9.4 k/ft

Clear Span = 20' Tensile Steel Area = 7.62 in²

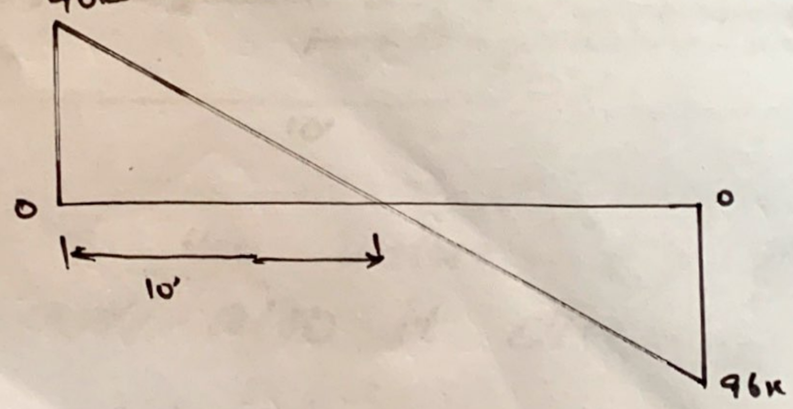




Step #01:- find the R_1 and R_2

$$= 9.6 \times \frac{20}{2} = 96k$$

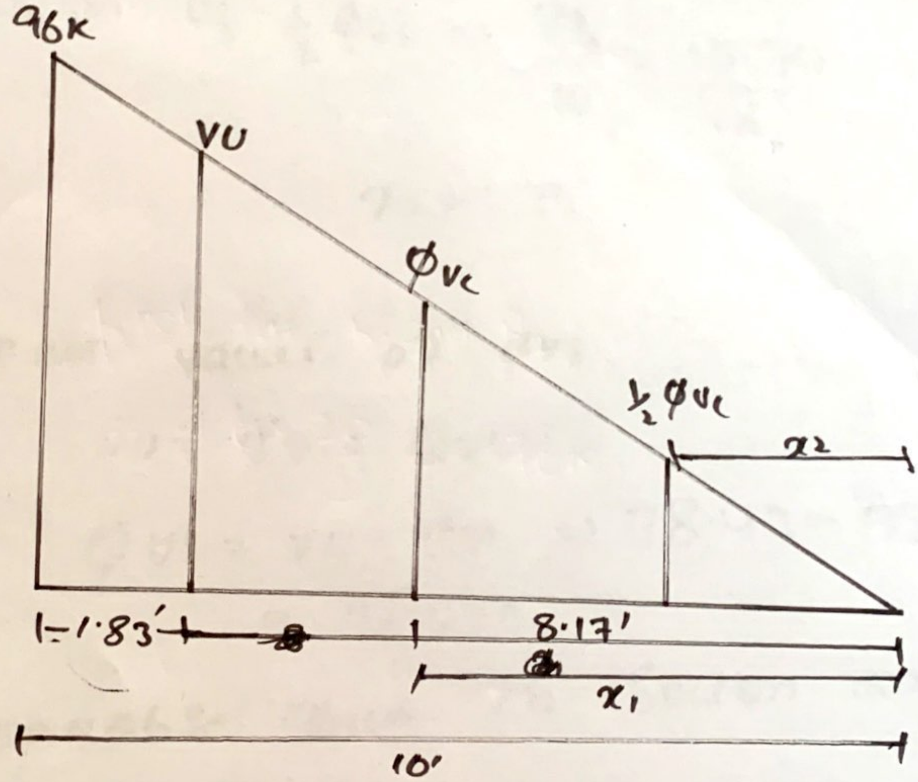
Step #02:-



Step #03 find the value of Critical Stress Vu and its location-

As we know that Critical Section is Located at distance "d" from face of Support = 1.83' value of Critical Shear at distance "d" by Similarity of Δs

for Similar Δs



Step # 04 Find the value of ϕVc and ½ ϕVc and also it distance from Zero Shear to right side.

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

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

Location of ϕV_c by similar Δs

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

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

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

$$x_2 = 1.73$$

STEP #05 values of ϕV_s

$$V_u = \phi V_s + \phi V_c$$

$$\phi V_s = V_u - \phi V_c \Rightarrow 78.43 - 33.40$$

$$= 45.03K$$

STEP #06:- Check on Section adequacy

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

$$= 133.57K$$

As $\phi V_s < \phi 8\sqrt{f_c'} b_w \times d$ Section is adequ.

STEP# 07:- Check on Maximum Spacing For Stirrups-

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

$= 66.79$ kip

As $\phi 4\sqrt{f'c}\, bwd > \phi Us = 45.03$ k,

So ~~Max~~ Mini Spacing will be Selected from the following four condition-

① $S_{max} = 24''$ ② $\frac{d}{2} = \frac{22}{2} = 11''$

③ $S_{max} = \frac{Av \times Fy}{0.75 \times \sqrt{f'c} \times bw}$
$= 17.40''$

④ $\frac{Av \times Fy}{50 \times bw} = \frac{0.22 \times 60000}{50 \times 16}$
$= 16.50''$

From above four Condition Least value of Spacing for #3, 2 Legged Stirrup will Selected

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

Scanned with CamScanner

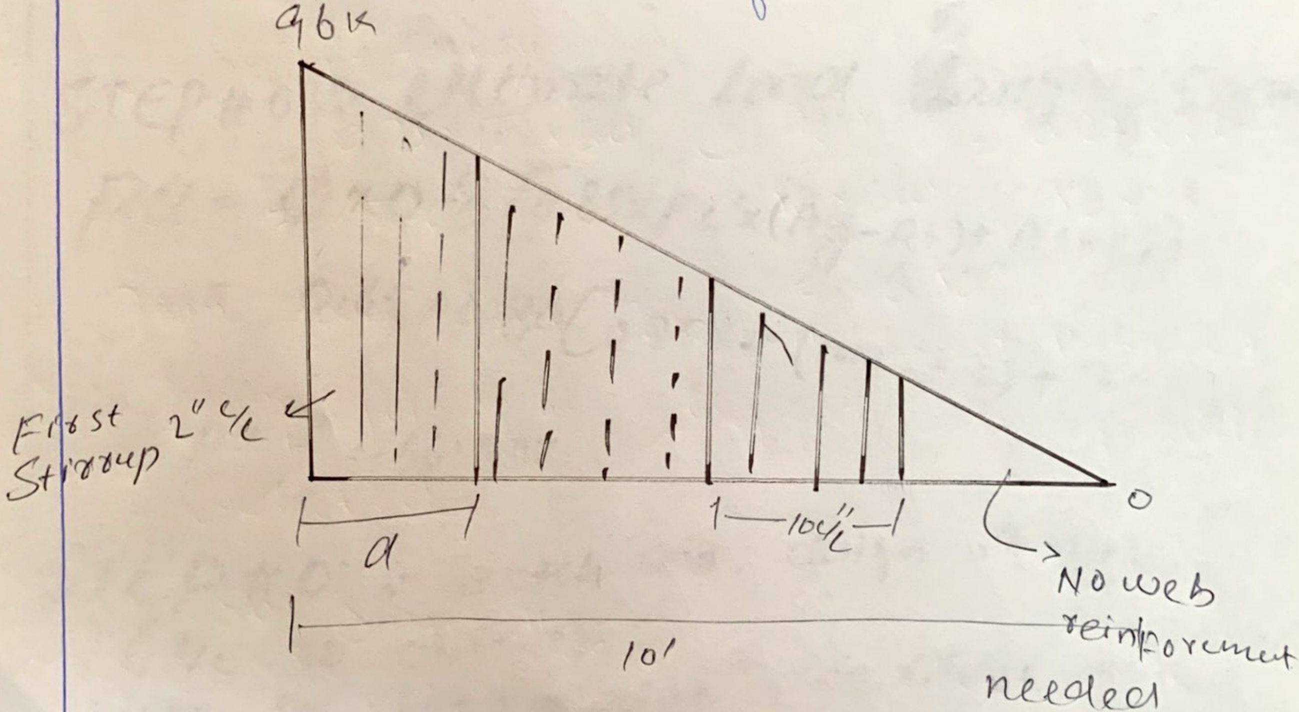
Step # 08:-

$$S = \frac{\phi \times Av \times Fy \times d}{Vu - \phi Vc} = \frac{0.75 \times 0.22 \times 60 \times 22}{78.43 - 33.40}$$

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

First Stirrup from start $= \frac{S}{2} = \frac{5}{2} = 2.5 \approx 2''$

STEP # 09:-



QNO3:- Calculate the axial ultimate----
design necessary Spirals-

STEP#01:- Find groses area of Concrete

$Ag = b \times b$ (since it is Squere tied Column)

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

STEP#02:- Find the area of Steel

Since $As = 5\%$ of Ag
$= 0.05 \times 144 = 7.2\ in^2$

STEP#03:- Ultimate load Barrying Capacity

$Pu = \phi \times 0.8 \{0.85 \times Fc' \times (Ag - As) + As \times Fy\}$
$= 0.65 \times 0.80 [0.85 \times 4 (144 - 7.2) + 7.2 \times 60]$

$Pu = 466.50k$

STEP#04:- Sketch and design of Ties
(C/c TO distance)
From the below value we chose the least value of all thus-

1) 16 x dia of long bar $= 16 \times \frac{9}{8}$

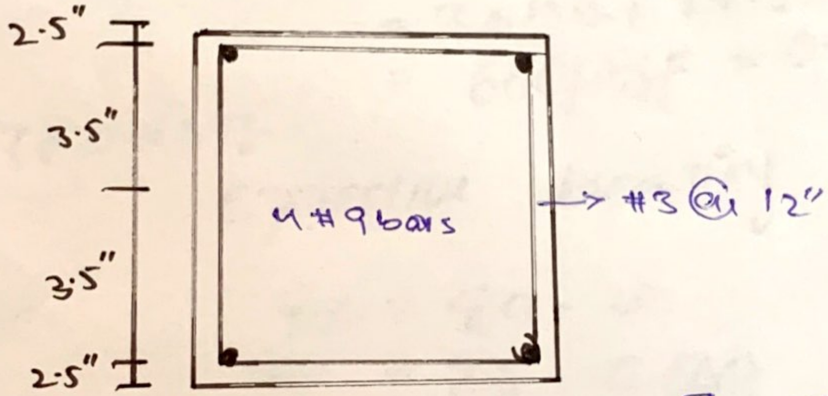
$= 18''$

2) 48 x dia of Tie bar $= 48 \times \frac{3}{8}$

$= 18''$

3) Least column dimension $= 12''$

So c/c distance b/w ties $= 12''$



* Since it is a tied Square Column so there is no Spiral Stirrup used the Stirrup used is of rectangular Shape due to the ~~perpendicular~~ Structure specification of the Structure this we will use Tie Stirrups instead.

QNO4- Design a Square Footing ---- Sketch of your final design-

Step #01:-

let $h = 24''$

STEP # 02:-

Total weight = wt of soil + wt of RC

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

$= 660 PSF = 0.660 KSF$

STEP #03:-

Effective bearing capacity

$q_e = q_a - w$

$q_e = 2.5 - 0.660$

$q_e = 1.84 KSF$

STEP #04:- Required Area for foundation

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

$= 119.57 ft^3$

STEP #05:- Since foundation is square

$Area = b \times b = 119.57 \Rightarrow B \cong 11$

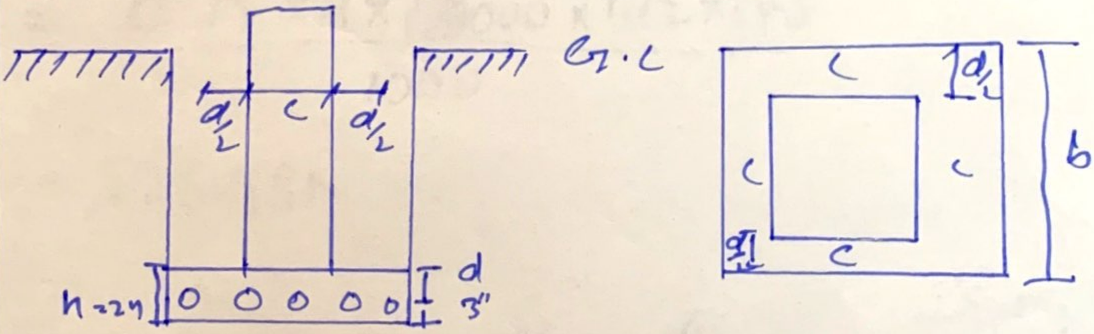
STEP 6: upward bearing Capacity of Soils:-

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

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

STEP # 07 :- punching Shear.

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



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

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

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

Take # 8 bar
dia = 8/8'' = 1

2

STEP #8

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

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

$$V_{u2} = 288.60K$$

STEP # 9-

$$\phi V_{cp} = \frac{\phi \times 4 \times \sqrt{f'c} \times b \times d}{1000}$$

$$= \frac{0.75 \times 4 \times \sqrt{3000} \times 142 \times 19.5}{1000}$$

$$= 525.38K$$

STEP #10:- Beam Shear/one way Shear check

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

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

$$V_{u1} = 90.95K$$

STEP #11:- Self Shear Capacity

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

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

$$= 110.04k > V_{u1} \Rightarrow OK$$

STEP #12:- Ultimate Moment

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

$$M_U = 331.49k' = 3977.93k''$$

STEP #13:- Area of Steel For mainbars by Trial and Repeat Method

Trial 1

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

$$As = \frac{Mu}{\phi \times Fy \times (d - \frac{a}{2})} = 8.56 in^2$$

Trial #2

$$a = \frac{As \times fy}{0.85 \times fc \times b} = 1.53''$$

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

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 main Reinforcement by the following as method-

$A_{smin} = 0.0018 \times B \times h = 5.70 in^2$

$A_{smin} = \frac{200}{fy} \times B \times d = 8.58 in^2$

$$A_{smin} = \frac{3 \times \sqrt{3000}}{60000} \times (11 \times 12) \times 19.5$$

$$= 7.05 \text{ in}^2$$

From above values greeter value will be Selected thus

$$A_{smin} = 8.58 \text{ in}^2$$

STEP #15:-

using Bars #6

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

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

$= 10.92 \approx 11$ bars in each direction