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Sec # B

Subject # PRCD - I

Submitted to # Engr. Fawad Khan.

"MID TERM"

Q NO-1

⇒ NUMERICAL :-

Solution :-

⇒ GIVEN DATA :-

$f_y = 60{,}000$ Psi , $w = 10''$

$f'_c = 4000$ Psi , $h = 20''$

$d = h - 3$, D.L $= 1.05$ K/Ft

$= 20 - 3 = 17''$, L.L $= 2.47$ K/Ft

, $d' = 2.5''$

⇒ Step-01 :-

$$\rho_{max} = 0.85 \times \beta \times \frac{f_c}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y} \right)$$

$$= 0.85 \times 0.85 \times \frac{4}{60} \times \left(\frac{0.003}{0.003 + 0.005} \right)$$

$$\rho_{max} = 0.018$$

⇒ Step # 02 :-

Area of Steal

$$\rho_{max} = \frac{A_{ST}}{b \times d}$$

$$A_{ST} = \rho_{max} \times b \times d$$

$$= 0.0181 \times 10 \times 17$$

$$A_{ST} = 3.07 \ in^2$$

⇒ Step # 03 :-

Design Factor moment

$$M_{U_2} = \phi \times A_{ST} \times f_y \times \left(d - \frac{a}{2}\right)$$

$$a = \frac{A_{ST} \times f_y}{0.85 f_c' b}$$

$$= \frac{3.08 \times 60}{0.85 \times 4 \times 10}$$

$$a = 5.4''$$

$$M_{U_2} = 0.90 \times 3.08 \times 60 \times \left(17 - \frac{5.4}{2}\right)$$

$$M_{U_2} = 23783 \ k''$$

NOW;

Moment of a given Load:

Beam self weight $= b \times \gamma_c \times t$

$= 10/12 \times 150 \times \frac{30}{12}$

$= 208.3\ lb/ft$

Total factored load $= 1.2\ D.L + 1.6\ L.L$.

$= 1.2\,(1050 + 208.33) + 1.6\,(2470)$

$= 5.5\ k/ft$

Ultimate factored moment $= \frac{WL^2}{8}$

$M_u = \frac{5.5\,(18)^2 \times 12}{8}$

$= 2653.6\ k''$

Thus $2378.3 < 2653.6$

It should be doubly designed beam.

Step # 04 :-

$$M_{u_1} = M_u - M_{u_2}$$

$$= 2653.6 - 2378.3$$

$$M_{u_1} = 275.2 \; k''$$

Step # 05 :-

$$M_{u_1} = \phi \times As' \times f_y \times (d - d')$$

$$As' = \frac{M_{u_1}}{\phi \times f_y \times (d - d')}$$

$$= \frac{275.2}{0.90 \times 60 (17 - 2.5)}$$

$$As' = 0.35 \; in^2$$

Step # 06 :-

$$As = A_{ST} + As^-$$

$$= 3.08 + 0.35$$

$$= 3.43 \; in^2$$

⇒ This lies in tension zone of steel.

Step # 07 :-

Bars Selections

→ For tensile steel; let's the take #8 having an area of 0.785 in2

No. of bars = $\frac{A_s}{A_b}$ = $\frac{3.43}{0.785}$ = 4.36 ≈ 5 bars

→ For compression steel; lets take #6 having an area of 0.442 in2

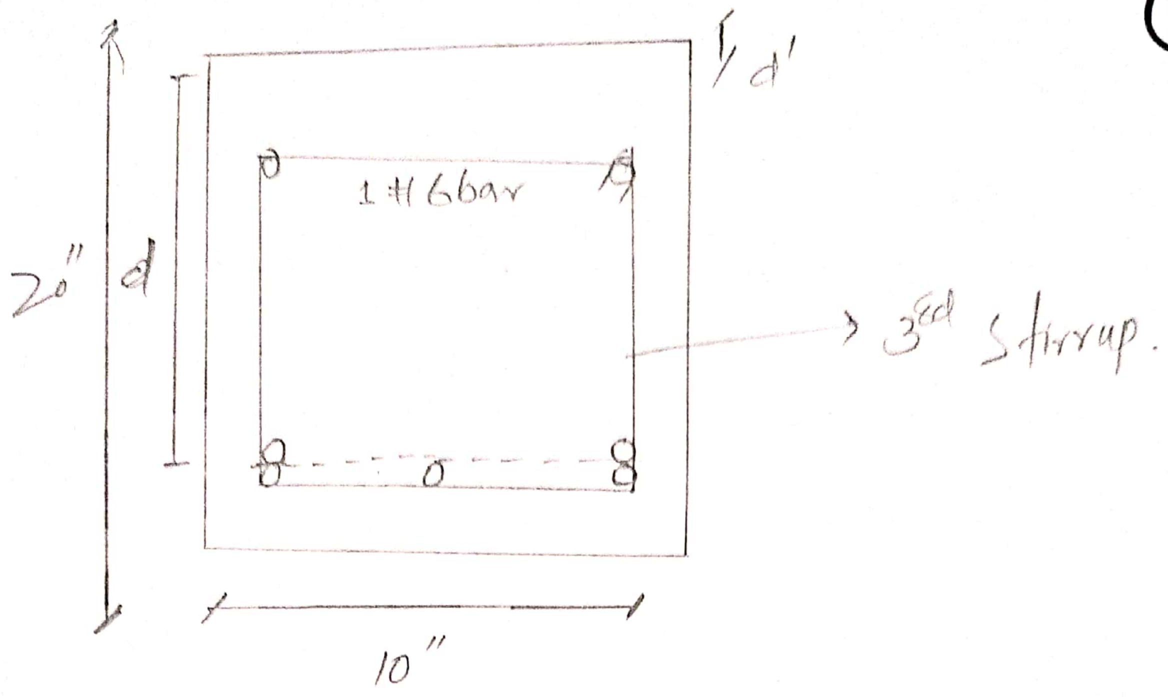
No. of bars = $\frac{A_s'}{A_b}$ = $\frac{0.35}{0.442}$ = 0.79 bars ≈ 1 bar

Step # 08 :-

Beam Minimum Width

$b_{min} = (2 \times 1.5) + 2(3/8) + (5 \times 8/8) + (4 \times 8/8)$

It should be in multipals layers.



$d = 20 - 1.5 - 3/8 - 8/8 - 1/2\,(8/8)$

$d = 16.62''$

$d' = 1.5 + \frac{3}{8} + 1/2\,(6/8) = 2.25''$

Step #09:

Design Moment

$$Md = \phi \times [As' \times fy \times (d - d') + (As - As') \times fy \times (d - a/2)]$$

$$a = \frac{(As - As') \times fy}{0.85 fc \times b} = \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10}$$

$a = 6.15''$

$$= 0.90 \times [1 \times 0.44 \times 60 \times (16.62 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times (16.25 - \frac{6.15}{2})]$$

$Md = 2891.52$

$Md = 2891.5 > 2653.56\,k''$ "DESIGN is OK."

Q No. 2

⇒ Briefly Describe Bond Stress and Develop Length.

⇒ "BOND STRESS"

The stress which is acting on the outer interface of steel to surrounding concrete is called Bond stress. This stress help in keeping bond b/w reinforced and concrete together. Bond resist any force that tries to pull out the rods from the concrete.

⇒ Development length:

The length of a bar required on the either side of the section to develop the required stress in steel at the section through bond. In other words we can say the development length of the bar required to develop the design stress in reinforcement all the critical section.

Q no. 2

PART. B :-

⇒ In which condition doubly reinforced beam can be used ?

ANSWER :-

This type of beam is provided when the depth of the beam is restricted. If the beam with limited depth is reinforced on the tension side. It might not have sufficient resistance to oppose the bending moment. Major reason for providing doubly reinforced beam is to ensure there is increase in moment carrying capacity. ensure safety against reversel of stress in the structure due to wind forces, sesmic force and temperature stress.

⇒ "PART.C"

→ Diff. B/w T-Beam & Rectangular Beam.

T-BEAM	Rectangular BEAM :-
→ In beam, slab and beams are connected with eachother and acts as one member.	→ In R-Beam, slab is placed on the Beam so that there is no connect. b/w slab and beam.
→ Flexual capacity of T-Beam varies base on the sign of moment.	→ Flexual capacity depends on location of reinforcement to the yield.
→ Design procedure depends on the location of ...	→ Simple design with no complextion.

PART: D :-

⇒ Write Short Note On effect of Strength reduction factor on flexural Strength -

ANSWER :- In the design of flexural strength, the strength reduction factor decrease from tension - controlled section to compression controlled section to increase the safety with decreasing ductility. The tension controlled sections are desirable for their ductile behaviour for giving sufficient warning to failure. Depending on the failure structure compression controlled section have less ductility thus they act simultaneously to hold together the structure.

PART. E :-

⇒ ~~Following~~ Briefly describe methods, which one of them can be used for design of different member and why?

ANSWER :- Following are the Design method of PRC

1) "Ultimate Design"

It is defined as the method which limit the structural usefulness material of the structure upto ultimate load.

(11) "LIMIT STATE METHOD":-

It is defined as the method which limit the structural usefulness of material of structure upto certain load at which acceptable limit of surface ability and safety are applied so that the failure of the structure does not happens.

(III) 'Elastic Method Of Design':-

It is defined as the method which limits the structural usefulness of the material of the structure upto certain load at which minimum stress to extreme fiber reaches the characteristics strength of material in bending.

QNo.3

Numerical:

Solution:

⇒ **Given Data:**

C/C Distance = 10'

h_f = 6"

b_w = 10"

h = 28"

Span = 32'

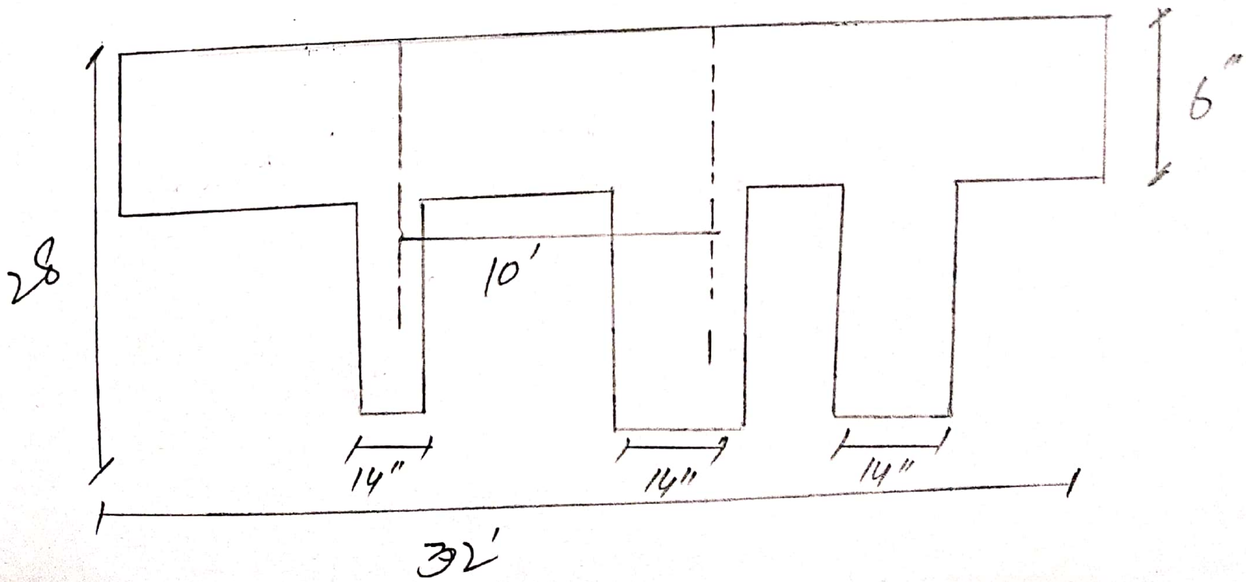
d = sufficient depth = h − 3 = 28 − 3 = 25"

D.L = 50 Lb/Ft²

L.L = 225 Lb/Ft²

f_y = 60,000 psi = 60 ksi

f'_c = 4000 psi = 4 ksi



"Step-01":

Ultimate factored moment

$$M_u = \frac{WL^2}{8}$$

1) Self weight of Beam.

$W_t = b \times l \times \gamma_c$

$= 14/12 \times 28/12 \times 150$

$= 408.3 \text{ lb/ft}$

(2) Total factored load;

$= 1.2 D.L + 1.6 L.L$

$= 1.2 (50 + 408.3) + 1.6 (225)$

$= 909.99 \text{ lb/ft}$

$= 0.909 \text{ k/ft}$

$M_u = \frac{0.909 \times (32)^2}{8} = 116.35 \times 12$

$= 1396.22 \text{ k/ft}$

"Step #02":

Determine "be"

(1) $16 \times h_f + b_w = 16 \times 6 \times 14 = 110$ "

(2) c/c distance $= 10 \times 12 = 120$ "

(3) span /4 $= 32/4 \times 12 = 96$ "

Select the least value of "be" i-e 96.

"Step-03"

Check Whether Rectangular or T-Beam analysis is required.

Trail # 1 :-

let $a = h_f = 6$

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.24}{0.90 \times 60 \times (25 - 6/2)}$$

$$A_{St} = 1.175 \; in^2$$

Trail # 2 :

$$a = \frac{A_{ST} \times f_y}{0.85 f_c' \times b_e} = \frac{1.175 \times 60}{0.85 \times 4 \times 96}$$

$$= 0.22'' < 6''$$

Thus rectangular beam analysis is require

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.24}{0.90 \times 60 \times (25 - 0.2/2)}$$

Trail # 3 :-

$$a = \frac{1.04 \times 60}{0.85 \times 4 \times 96} = 0.19''$$

$$A_{ST} = \frac{1396.24}{0.90 \times 60 \times (25 - 0.19/2)} = 1.04 \; in^2$$

→ Area is Same.

"Step-04:"

ρ_{max} and ρ_{min}

- $\rho_{max} = 0.85 \times \beta \times \frac{f'_c}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_t}\right)$

$= 0.85 \times 0.85 \times \frac{4}{60} \times \left(\frac{0.003}{0.003 + 0.005}\right)$

$\rho_{max} = 0.018$

- $\rho_{min} = \frac{200}{f_y} = \frac{200}{6000} = 0.003$

- $\rho_{min} = \frac{A_{ST}}{b \times d} = \frac{1.03}{14 \times 25} = 0.0029$

$\rho_{min} < \rho < \rho_{max}$

As ρ is less then ρ_{min} Thus;

$\rho = \frac{A_{ST}}{b \times d} = A_{ST} = \rho_{min} \times b \times d$

$= 0.003 \times 14 \times 25$

$= 1.05\ in^2$

"Step#05":

Selection and No. of Bars

let use #10 Bar having area of 1.27 in².

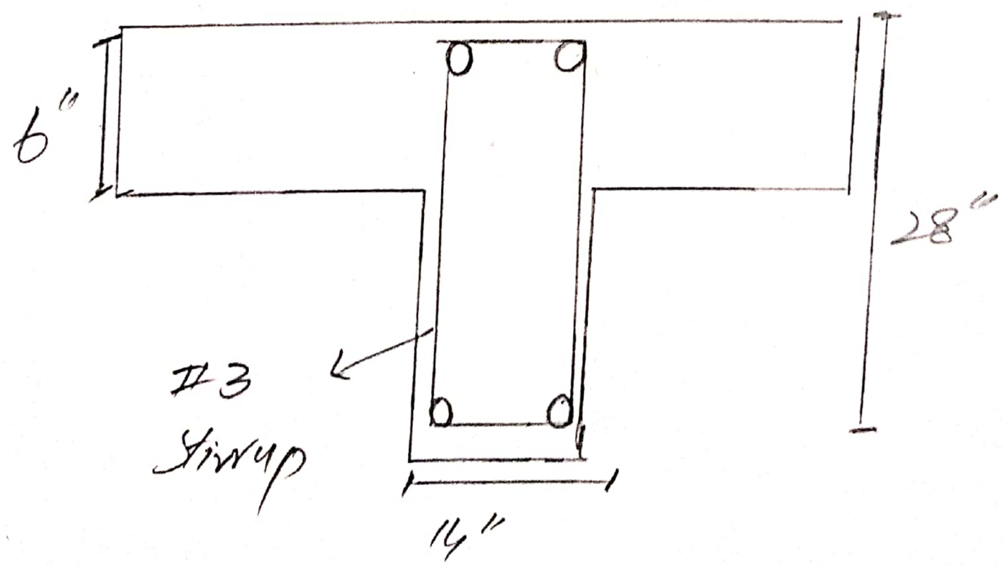
$$\text{No. of Bars} = \frac{A_{ST}}{A_s} = \frac{1.05}{1.27} \approx 2 \text{ Bars}$$

"Step #06":

Check on minimum width

$$b_{min} = (2\times1.5)+(2\times3/8)+(2\times10/8)+1(10/8)$$
$$= 7.5'' < 14''$$

It is good in one layer.



"Step-07":

Design moment

$$M_d = \phi \times f_y \times A_{ST} \times (d - a/2)$$

- $A_{ST} = 1.27 \times 2 = 2.54 \text{ in}^2$
- $a = \dfrac{A_{ST} \times f_y}{0.85 f'_c \times b_e} = \dfrac{2.54 \times 60}{0.85 \times 4 \times 96} = 0.46$ "

$\rightarrow M_d = 0.90 \times 60 \times 2.54 \times (25 - \frac{0.46}{2}) = 3396.97$

$\Rightarrow 3396.97 > 1396.24$

$\Rightarrow$ "Design is OK"

"THE END"