Mid term paper

Name Rizwan ullah khan

ID 2807

Section 'A'

Subject PRCD -I

Submitted to Engr. Fawad khan.

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Section : "A"

Q:1/ Given data :-

Live load (L.L) = 2.47 kips/ft

Dead load (D.L) = 1.05 kips/ft.

height (h) = 20"

width (b) = 10"

full span = 18'

f'_c = 4000 psi = 4 ksi

f_y = 60 000 psi = 60 ksi

Solution :-

⇒ Step # 01 :-

Effective depth = d = h - 3
= 20 - 3 = 17"

Effective cover = d' = 2.5"

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

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

Name: Rizwan ullah khan ID # 7807

Section: 'A'

$\rho_{max} = 0.0180$

⇒ **Step # 02 :-**

Find the area of Steel :-

$\rho_{max} = \frac{A_{st}}{b \times d} \Rightarrow A_{st} = \rho_{max} \times (b \times d)$

$A_{st} = 0.0180 \times (10 \times 17)$

$A_{st} = 3.06 \text{ in}^2$

⇒ **Step # 03 :-**

Design moment:

$Mu_2 = \phi \times A_{st} \times f_y \times (d - a/2)$

$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{3.06 \times 60}{0.85 \times 40 \times 10} = 5.4''$

$Mu_2 = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$

$Mu_2 = 2362.9 \text{ kip-inch}$

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Section :- 'A'

moment Produced by given load.

Self weight of beam = $\frac{10}{12} \times \frac{20}{12} \times 150$

= 208.3 lb/ft

Factored load = 1.2 (1050 + 208.3) + 1.6 (2470)

= 5.46 kips/ft.

Ultimate factored load = ~~1.2 (1050 + 208.3) + 1.6 (2470)~~

$\frac{wL^2}{8}$

= $\frac{5.46 \times (18)^2}{8} \times 12$

$M_u = 2653.5$

As

$M_{u_2} < M_u$

2362.9 < 2653.5

↓

Required double Reinforcement.

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Section: A'

⇒ Step # 04:-

$$M_{u_1} = 2653.56 - 2362.9$$

$$= 290.64 \text{ kip-inch}$$

⇒ Step # 05:-

Steel Area in Compression:

$$M_{u_1} = \phi \times A'_{st} \times f_y \times (d - d')$$

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

$$= \frac{290.64}{0.90 \times 60 \times (17 - 2.5)}$$

$$A'_{st} = 0.37 \text{ in}^2$$

⇒ Step # 06:-

$$A_s = A_{st} + A'_{st}$$

$$A_s = 3.06 + 0.37$$

$$A_s = 3.43 \text{ in}^2$$

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Section: 'A'

⇒ Step # 07:-

As we use #8 bar which dia is 1"

Area = 0.785 in^2

Calculate No. of bars:-

$$\text{No. of bars} = \frac{A_{st}}{\text{Area of 1 bar}}$$

$$= \frac{3.43}{0.785} = 4.36$$

No. of bars = 5 bars → Tensile zone.

For Compression:-

use #6 bar ⇒ dia 0.75"

Area = 0.44 in^2

$$\text{No. of bars} = \frac{A'_{st}}{\text{Area of 1 bar}} = \frac{0.37}{0.44} = 0.84$$

No. of bars = 1 bar → Compression zone.

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Section:- 'A'

Step # 08:-

Minimum width of beam:-

$$b_{min} = 2(1.5) + 2\left(\frac{3''}{8}\right) + 5(1'') + 4(1'')$$

$$= 12.75 > 10'' \Rightarrow \text{Multiple Layers.}$$

Effective depth (d) $= 20 - 1.5 - \frac{3}{8} - \frac{8}{8} - \frac{1}{2}\left(\frac{6}{8}\right)$

$$\boxed{d = 16.62}$$

Effective Cover $= (d') \; 1.5 + \frac{3}{8} + \frac{1}{2}\left(\frac{6}{8}\right)$

$$\boxed{d' = 2.25''}$$

Moment of design is given by,

$$M_d = \phi \times \left[A_{st}' \times f_y \times (d - d') + (A_{st} - A_{st}') \times f_y \times (d - a/2)\right]$$

$$a = \frac{(A_{st} - A_{st}') \times f_y}{0.85 \times f_c' \times b}$$

$$= \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10} = 6.15''$$

Name: Rizwan ullah khan   ID # 7807

Section:: "A"

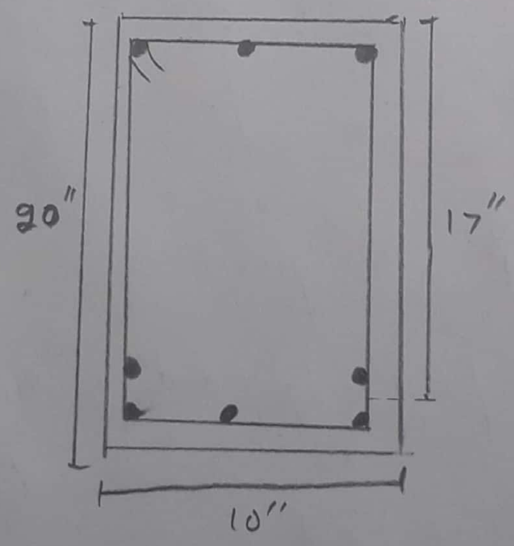
$$M_d = 0.90 \times \left[(1 \times 0.44) \times 60 \times (16.62 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times \left(16.62 - \frac{6.15}{2}\right) \right]$$

$$M_d = 2890.46$$

So

$$M_d = 2890.46 > 2653.56$$

and design is Correct.



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Section: "A"

Q:- 2/

A) Bond stress:-

The stress which is acting on the outer interface of steel to the surrounding concret is called Bond stress.

OR

Bond stress is the result of the bonding between the concrete surface and reinforcement steel. Bond stress resist any force that treies to pull out the rods from the concrete.

Development Length:-

Development length can be defined as the length of the bar required for transferring the stress into the concrete.

OR

The quantity of the reber length that ~~quantity~~ is actually required to be enclosed into the concrete to make desired bond strength between two materials.

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Section: 'A'

Q:- 2/ b)

Condition for using doubly reinforced beam:-

Conditions:-

⇒ when the Cross section of the beam is fixed.

⇒ when moment to be carried by the beam is more then the balanced moment.

⇒ In Case of a Continous beam.

⇒ The portion of the beam over middle support in Continous T beams has to be designed as doubly reinforced section.

⇒ when dimensions of the beam are restricted for architectural or Structural purposes.

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Section. "A"

Q:2/ part "C"

T- beam:-

⇒ T- beam is more economical then rectangular beam.

⇒ In case of t- beam slab & beam are connected with one another and act as a one member.

⇒ It consist of T-shaped structure.

⇒ Analysis is required when

$$a > h_f.$$

a = depth

h_f = slab thickness.

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Section: "A"

Rectangular beam:-

⇒ Rectangular beam is less economically than T- beam.

⇒ In case of rectangular beam slab has been placed on the beam and there is no connection b/w slab & beams.

⇒ It is generally used as compression in top fiber and tension in bottom fibre.

⇒ It is most commenly used in office/ commercial buildings.

⇒ Analysis is required when

$$a \leq h_f$$

a = depth

h_f = height of flange.

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section: "A"

Q: 21 Part - d

Effect of Strength Reduction factor on flexural Strength:-

In design of flexural Strength the Strength reduction factor decrease from tension ~~tens~~ Controlled Section to Compression Controlled Section to indrease safety.

Basically It represent the uncertainly in determine the member behavior to the type of stresses to which it is Subjected.

Strength Reduction factor is denoted by "ϕ"

Q: 21 Part "E"

Designing Method:-

Two methods are used to design Concret & differtnt Structures.

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Section. A'

1- ASD Method (Allowable stress design)

2- USD Method (ultimate strength design)

1- ASD Method:-

It is also known as working stress design method.

⇒ In this method, all Loads are taken as Service loads and no facters is applied to increase the Service load.

⇒ It is based on principle that Stress developed in structural members should not exceed a certain limit of elastic limit.

2- USD Methods:-

This method is best for designing diffrent structural members. because of following reasons.

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Section: 'A'

★– USD method result in more economical designed for a building with fewer special needs for Customized area.

★ – The ultimate Strength of material is Considered we can get much Slender Section for Column and beam Compared to other method.

⇒ This method is also known as Load factor method.

Q: 3/

Given data:

height of flange = h_f = 6"

C/C distance b/w beams = 10'

width of web = 14"

Span = 32'

Total depth = 28"

D.L = 50 p.s.f

L.L = 225 p.s.f

f_y = 60,000 psi

f'_c = 4000 psi

(15)

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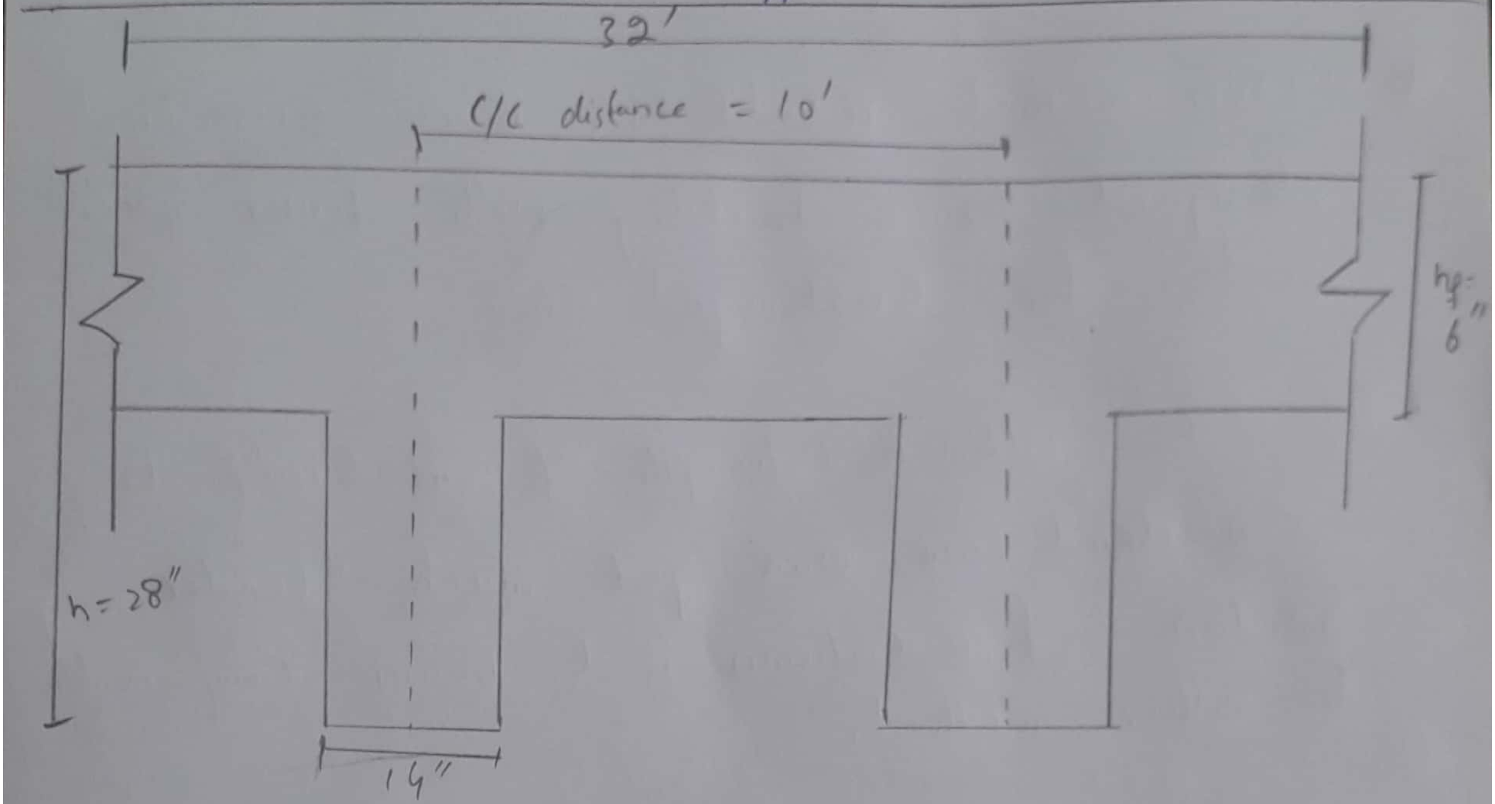
Section: "A"



Soln:-

Effective depth (d) = h - 3

= 28 - 3

$$d = 25''$$

Step # 01:-

We know that

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

Find "w"

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Section 'A'

$W_t = b \times t \times \gamma_c$

$= \frac{14}{12} \times \frac{28}{12} \times 150$

$W_t = 408.34$ lb/ft

Total Facter Load:-

$= 1.2\,DL + 1.6\,LL$

$= 1.2(50 + 408.34) + 1.6(225)$

$= 910.1$ lb/ft

$= 0.9101$ kip/ft

Total Factered moment:-

$M_U = \frac{wL^2}{8} = \frac{0.910 \times (32)^2}{8} \times 12$

$M_U = 1397.76$ kip-inch

Step # 02:-

Analysis for T-beam or rectangular:

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'Section 'A''

⇒ $a = h_f = 6''$

Area of steel

$$A_{st} = \frac{M_U}{\phi \times f_y \times (d - a/2)}$$

$$= \frac{1397.76}{0.90 \times 60 \times (25 - 6/2)} = 1.17 \text{ in}^2$$

⇒ By formula of "a"

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{1.17 \times 60}{0.85 \times 4 \times 96} = 0.226''$$

if a is less then height of flange
So we have to design Ractangular beam.

$$A_{st} = \frac{M_U}{\phi \times f_y \times (d - a/2)} = \frac{1397.76}{0.90 \times 60 \times (25 - \frac{0.2}{2})}$$

$$\boxed{A_{st} = 1.03 \text{ in}^2}$$

Name: Rizwan ullah khan ID # 7807

Section: "A"

⇒ Now

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{1.03 \times 60}{0.85 \times 4 \times 96} = 0.19''$$

So

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1397.6}{0.90 \times 60 \times (25 - \frac{0.19}{2})}$$

$$\boxed{A_{st} = 1.03 \text{ in}^2}$$

So Area of steel of both is same.

Step # 03:-

Reinforcement Ratio:-

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

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

$$\boxed{\rho_{max} = 0.018}$$

$$\Rightarrow \rho_{min} = 200/f_y = \frac{200}{60,000}$$

$$\boxed{\rho_{min} = 0.003}$$

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Section: 'A'

$\Rightarrow \rho = \frac{A_{st}}{b \times d} = \frac{1.03}{14 \times 25} = 0.002$

$\boxed{\rho = 0.002}$

Check the order

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

$0.003 < 0.002 < 0.018$

if ρ is less then ρ_{min}, so find A_{st} on ρ_{min} then

$\rho_{min} = \frac{A_{st}}{b \times d} \Rightarrow A_{st} = \rho_{min} \times b \times d$

$A_{st} = 0.003 \times 14 \times 25$

$\boxed{A_{st} = 1.05 \, in^2}$

Step # 04

No: of Bar required:

We use # 8 bar,   Dia = (8/8) = 1"

Area = $\frac{\pi}{4}\left(\frac{8}{8}\right)^2 = 0.785 \, in^2$

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Section "A"

No. of Bars = $\frac{\text{Area of Steel}}{\text{Area of Single Bar}} = \frac{1.05}{0.785} = 1.3$

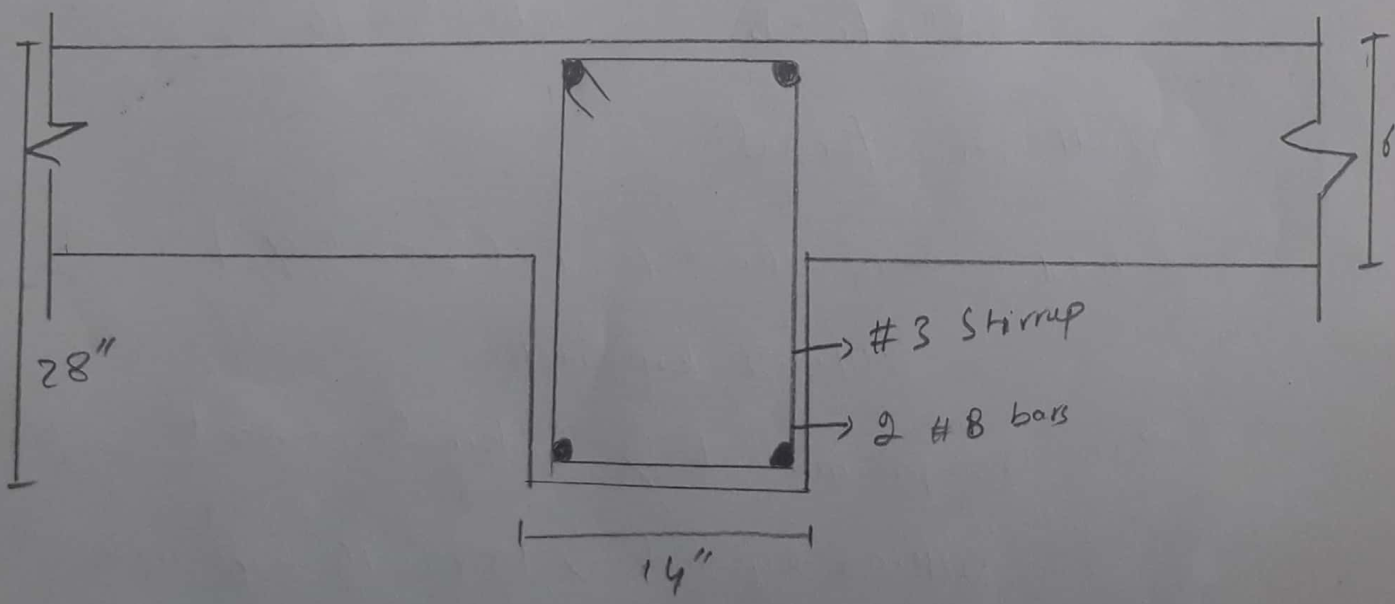
No: of Bars = 2 ⇒ # 8 bars.

Step # 05

Width of Accomodation of Bars:

$b_{min} = 2(1.5) + 2(3/8) + 2(8/8) + 1(8/8)$

$= 6.75'' < 14''$ ⇒ we will used Single Layer of bar.



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Section: 'A'

Step # 6 :-

Moment Design:

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

$$\text{No: of bars} = \frac{\text{Area of steel}}{\text{Area of Single bars}}$$

A_{st} = No. of bars × Area of ~~steel~~ Single bar.

$$A_{st} = 2 \times 0.785$$

$$\boxed{A_{st} = 1.57 \text{ in}^2}$$

Now

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{1.57 \times 60}{0.85 \times 4 \times 96} = 0.2''$$

putt in formula

$$Md = 0.90 \times 60 \times 1.57 \times (25 - 0.2/2)$$

$$= 2111.02 \text{ kip-inch}$$

So

Design moment > External moment

2111.02 kip-inch > 1397.76 kip-inch

Disign is correct.