NAME : Syed Ghayur Shah

ID : 7801

Semester : 6th

Section : A

paper : PRCD-1

Exam : Mid Term

Q#01

A Rectangular Beam that - - - - - -

- - - - - - - - - - final design.

→ **Given Data:**

→ Beam live load (L.L) = 2.47 kips/ft

→ Beam Dead load (D.L) = 1.05 kips/ft

→ Span of Beam = 18ft

→ Depth of Beam = 20"

→ Width Of Beam = 10"

→ Fy = 60000psi = 60 ksi   ∴ 1000 = 1k

→ f'c = 40000psi = 4ki

→ **Required:**

→ Area of the Steel and also provide the draw sketch of final design.

→ **Solution:**

This question we solve in the following steps.

SOLUTION:

* The effective depth (d) = h-3
  = 20 - 3 = 17"

* Assume d' = 2.5"

* **Step#01**

  First of all to Check the Capacity of Section as Singly Reinforcement Beam.

  We know that

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

putting value, we get

∵ $\varepsilon_u = 0.003$
$\varepsilon_y = 0.005$

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

$$\Rightarrow \rho_{max} = 0.018062$$

* **Step#02**

  Area of the Steel

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

putting values

$$\Rightarrow A(st) = 0.018062 \times 10 \times 17 = 3.07062 \text{ in}^2$$

* Step # 03

→ Moment for Area of Steel

We know that

$$M_{u2} = \phi \times A_{(st)} \times f_y (d - a/2) \rightarrow (i)$$

→ Find the value of a

$$\Rightarrow a = \frac{A_{(st)} \times f_y}{0.85 \times f'_c \times b} = \frac{3.07062 \times 60}{0.85 \times 4 \times 10} = \underline{5.42''}$$

→ put value of a in Eq (i)

$$\Rightarrow M_{u2} = 0.90 \times 3.07062 \times 60 \left(17 - \frac{5.42}{2}\right) = \underline{2368.99 \text{ kips-inch}}$$

* Step # 04

① Moment due to given load

$$\Rightarrow \text{weight of Beam} = b \times t \times \gamma_c$$

$$= \frac{10}{12} \times \frac{20}{12} \times 15 = \underline{208.33 \text{ lb/ft}^3}$$

② Total factored load

$$\Rightarrow W_T = 1.2\,D.L + 1.6\,L.L$$

$$\Rightarrow W_T = 1.2(1050 + 208.33) + 1.6(2470) = \underline{5.46 \text{ kips/ft}}$$

* Step # 05

→ To Calculate the ultimate factored moment

$$\Rightarrow M_U = \frac{W \times L^3}{8} \times 12 = \frac{5.46 \times 18^2}{8} \times 12 = \underline{2653.56}$$

→ It is clear that

$$M_U > M_{U2}$$

$$2653.56 > 2368.99$$

→ Design of a Section is Doubly Reinforcement

Step#06

Find the M_{U1}

$\Rightarrow M_U = M_{U1} + M_{U2}$

or

$\Rightarrow M_{U1} = M_U - M_{U2} = 2653.56 - 2368.99 = \underline{284.57 \text{ kip-inch}}$

Step# 07

$M_{U1} = \phi \times A_s' \times f_y \times (d - d')$

$\Rightarrow A_s' = \dfrac{M_{U1}}{\phi \times f_y \times (d-d')} = \dfrac{284.57}{0.90 \times 60(17-2.5)} = \underline{0.36 \text{ in}^2}$

→ Area of Steel in Compression zone

$\Rightarrow$ Total Steel Area $A_{st} = A_{st} + A_s' = 3.07 + 0.36 = \underline{3.43 \text{ in}}$

Step# 08

Selection of Bars.

$\Rightarrow$ ① for Tensile Steel

Let, Try #8 bars, having Area $= 0.785 \text{ in}^2$

→ Number of bars $= \dfrac{A_s}{A_b} = \dfrac{3.43}{0.785}$

$= 4.369 \approx 5$ bars (#08)

| #8 $= \frac{8}{8} = 1$ (dia)
| Area $= \frac{\pi}{4} d^2$
| $= \frac{3.14}{4}(1)^2$
| $= 0.785 \text{ in}^2$

② For Compression Steel

Let, Try #6 bars having Area $= 0.44 \text{ in}^2$

Number of bar $= \dfrac{A_s'}{A_b} = \dfrac{0.36}{0.44}$

$= 0.81 \approx 1$ bar (#06)

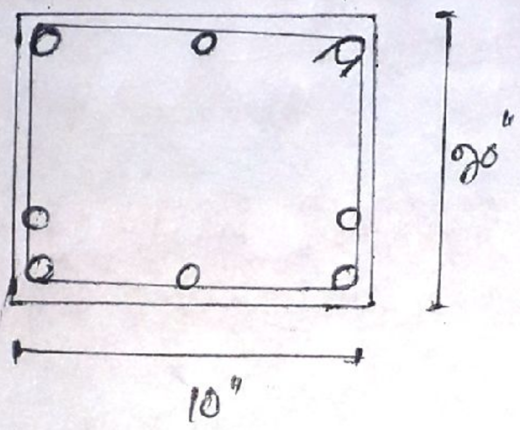
| #6 $= \frac{6}{8} = 0.75$
| Area $= \frac{\pi}{4}(0.75)^2$
| $= 0.44 \text{ in}^2$

Step # 09

→ Check the Minimum Width of Beam.

$$b_{min} = 2(1.5) + 2(3/8) + 5(8/8) + 4(8/8)$$
$$= 12.75'' > 10''$$

⇒ On one layer its not good.



⇒ Effective Cover $(d') = 1.5 + 3/8 + 1/2(8/8) = 2.25''$

⇒ Effective depth $(d) = 20 - 1.5 - 3/8 - 8/8 - 1/2(8/8) = 16.62''$

Step # 10

Design the moment

$$\Rightarrow M_d = \phi \times [A_s' \times f_y \times (d - d') + (A_{st} - A_{st}') \times f_y \times (d - a/2)] \rightarrow (x)$$

Find value of a

$$\Rightarrow a = \frac{(A_{st} - A_{st}') f_y}{0.85 \times f_c' \times b} = \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10} = 6.15$$

put value of a in Eq (x)

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

$\Rightarrow M_d = 2890.46$

As $M_d = 2890.46 > 2053.56$ k" **(Design is Ok)**

Q02

→ a) Briefly describe Bond Stress and develo-pment length.

Ans: → BOND STRESS:

It is defined as " The Stress which is acting on The outer interface of steel To The surrounding concrete is called bond Stress"

→ Explaination:

* Bond Stress also called The Resulting Stress.
* Bond Stress help in keeping bond between Reinforcement and concrete together
* This Stress result any force That Tries To pull out The rods from The concrete.

* When Try To pull out the Reinforcement bar from hardened Concrete Then bond Stress Resist The bar To come out.

→ **Development length:**

* It is defined as " The length of bar required To Transfer The force in The bar To Surrounding Concrete Through bond is called development length".

↳ Development length to develop a safe bond between the bar Surface and Concrete. So Their no failure due To Slippage of bar occure during The ultimate loading Condition.

↳ Also provide The extra length of The bar.

b) On which Condition doubly Reinforced beam Can be used.

ANS: On Their Condition, used The doubly Reinforced beam, when The

Restriction occure in the size of beam

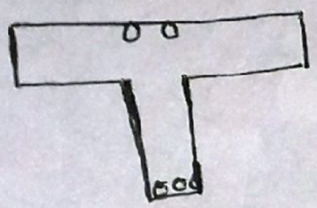
for Example:

↳ when the depth of beam should not be greater than 18" and the External load on beam is very much, which can not resist the load a beam of Singly Reinforcement in that condition then the used the doubly Reinforced Beam.

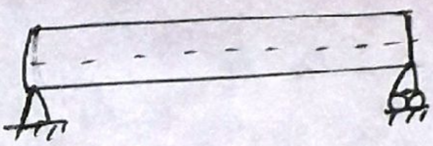
C) Differentiate between T-Beam analysis and Rectangular Beam Analysis.

→ T-Beam	→ Rectangular Beam
* T-Beam are mostly used and heavy duty and the large space i-e bridge.	* Rectangular beam mostly used in commercial building.
* T-Beam are more ecomical than R-beam	* Rectangular beam are not more econmical than T-beam

* On T-beam, the slab and beam are connected with one another and acts as a one member



* On Rectangular beam, slab has been placed on the beam so there is no connection between slab and beam.



d) write short ------ ..flexural strength.

Ans: On the design of flexural strength The strength reduction factor decrease from Tension control section to compression controlled section to increase safety with decreasing ductility this show to determine the reduction factor for flexural strength of Reinforcement concrete.

e) which one of the ------ and why?

Ans: **Designing Methods:**

In designing method mostly in the world two method are used

1. ASD method
2. USD method.

① → ASD Method:

Its also called stress design method. Its based on the principle that stresses developed in the structural member should not be exceed a certain limit friction of Elastic limit. In this method all load are taken as service load and no factor is applied to increase these service load.

② → USD method:

→ USD mean ultimate strength design method and also called load factor method

→ For the structure subjected to large External load the ultimate strength is determine by the inelastic analysis.

→ USD method is more Correct and good For the designing of different Structural Method i-e.

↳ USD method Result is more economical design for a building with fewer a Special need for Customized Area and requirment.

↳ For beam and colum. The USD method is good as compare to other method.

Q03: A Concrete floor System.....

- - - - - - - - - - of Final Design.

Given Data:

→ Length = 30'

→ Center to Centre distance = 10'

→ Thickness of Slab (h_f) = 6"

→ Beam web width (b_w) = 14"

→ Total depth (h) = 28"

→ Effective depth = 28" − 3" = 25"

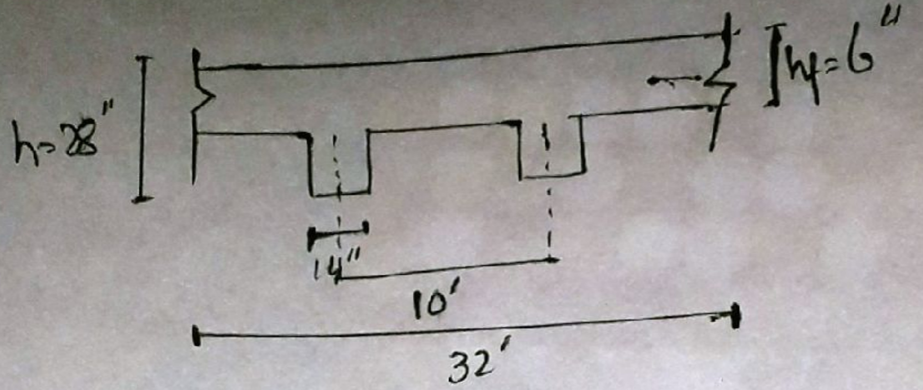
→ Dead load (DL) = 50 lb/ft²

→ Live load (LL) = 225 lb/ft²

→ f_y = 60000 psi = 60 ksi

→ f_c' = 4000 psi = 4 ksi

SOLUTION:



→ **Step#01**

Calculate ultimate factored moment

$$\Rightarrow M_u = \frac{W_u \times l^2}{8} \rightarrow (A)$$

find W_u

$$\Rightarrow W_t = b \times t \times \gamma_c = \frac{14}{12} \times \frac{28}{12} \times 150 = 408.33 \text{ lb/ft}$$

now

$$W_u = 1.2 D.L + 1.6 L.L = 1.2(50 + 408.33) + 1.6(225)$$

$$\Rightarrow W_u = 909.96 \text{ lb/ft or } 0.909 \text{ kips/ft}$$

→ put "W_u" in Eq (A), we get

$$\Rightarrow M_u = \frac{0.909 \times (32)^2}{8} \times 12 = 1396.22 \text{ kip-inch.}$$

→ **Step#02**

Effective width (be)

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

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

3- $\frac{span}{4} = 32/4 \times 12 = 96"$

$\Rightarrow be = 96"$

→ **Step#03**

Check whether Rectangular or T-Beam.

* Trial #01

let $a = h_f = 6$

$$A_{st} = \frac{M_U}{\phi \times f_y (d - a/2)} = \frac{1396.23}{0.90 \times 60 \times (25 - 6/2)} = 1.175\ in^2$$

* Trial #02

$$a = \frac{A_s \times f_y}{0.85 \times f_c' \times b_e} = \frac{1.75 \times 60}{0.85 \times 4 \times 96} = 0.31'' < 6''$$

Rectangular Beam design

$$\Rightarrow A_{st} = \frac{1396.23}{0.90 \times 60 \times (25 - \frac{0.21}{2})} = 1.03\ in^2$$

* Trial #03

$$a = \frac{A_s \times f_y}{0.85 \times f_c' \times b_e} = \frac{1.03 \times 60}{0.85 \times 4 \times 96} = 0.18''$$

$$\Rightarrow A_{st} = \frac{1396.23}{0.90 \times 60 (25 - \frac{0.18}{2})} = 1.03\ in^2$$

→ **Step#04** Check ρ_{max} & ρ_{min}

$$\rho_{max} = 0.85 \times \beta \times \frac{f_c'}{F_y} \times \left(\frac{\varepsilon_U}{\varepsilon_U + \varepsilon_t}\right)$$

putting values, we get

$\Rightarrow \rho_{max} = 0.85 \times 0.85 \times 4/60 \times \left(\frac{0.003}{0.003+0.005}\right) = \underline{0.018}$

$\Rightarrow \rho_{min} = \frac{200}{fy} = \frac{200}{60000} = \underline{0.003}$

$\Rightarrow \rho = \frac{Ast}{b \times d} = \frac{1.03}{14 \times 25} = \underline{0.00294}$

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

$0.003 > 0.00294 < 0.018$

* when $\rho < \rho_{min}$

$\rho = \frac{Ast}{b \times d} \Rightarrow Ast = \rho \times b \times d = 0.003 \times 14 \times 25 = \underline{1.05 \, in^2}$

Step#05

→ No of Bars Selection.

Let Try ~~#08~~ main bar, having Area OF OF one #08 bar = ~~1.27~~ 0.785 in^2

| dia = 8/8 = 1"
| Area = $\pi/4 (1)^2$
| = 0.785

No of bars = $\frac{Ast}{Ab} = \frac{1.05}{0.785} = 1.3 \approx 2$

So, Take 2(#08) main bars

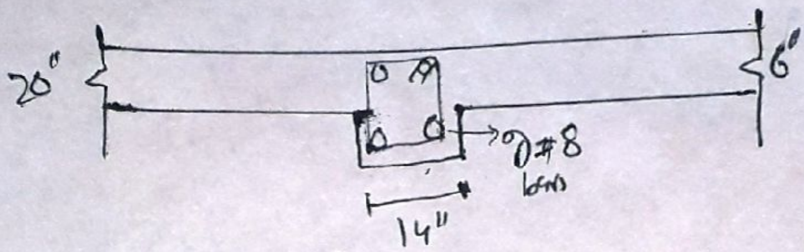
Step#06

Check on minimum width.

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

$= \underline{6.75'' < 14''}$

So good in one layer



Step#7

Design Moment

$\Rightarrow M_d = \phi \times f_y \times A_{st} \times (d - a/2) \rightarrow (1)$

$* \hookrightarrow A_{st} =$ Area of one bar × No of bars

$= 0.785 \times 2 = \underline{1.57 \text{ in}^2}$

$* \hookrightarrow a = \dfrac{A_{st} \times f_y}{0.85 \times f'_c \times b_e} = \dfrac{1.57 \times 60}{0.85 \times 4 \times 96} = \underline{0.2''}$

put these value in Eq(1)

$M_d = 0.90 \times 60 \times 1.57 \times \left(105 - \dfrac{0.2}{2}\right)$

$\Rightarrow M_d = \underline{9111.02 \text{ kip-in}}$

$M_d > M_u$

$9111.02 k'' > 1390.2 k''$

The design is OK