NAME = QASIM ZEB

ID NO = 7823

SECTION = A

PAPER = PRCD I

QUESTION NO = 01

GIVEN DATA:-

Width (b) = 10'
Height (h) = 20"
live load (L.L) = 2.47 Kips/ft

Dead load = 1.05 Kips/ft
span = 18'
$f'c$ = 4000 psi = 4 ksi
fy = 60000 psi = 60 ksi

SOLUTION:-

STEP#01:-

Finding Effective depth (d)

$d = h - 3 \Rightarrow 20 - 3 = 17''$

$(d) = 17''$

Effective cover = 2.5"

REINFORCEMENT RATIO:-

We have

$$\rho_{max} = 0.85 \times B \times \frac{f'c}{fy} \times \left(\frac{\varepsilon u}{\varepsilon u + \varepsilon y}\right)$$

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

$$\rho_{max} = 0.04816\,(0.375)$$

$$\boxed{\rho_{max} = 0.0180}$$

STEP#02

Now we have to find Area of steel

We know that

$$\rho_{max} = \frac{Ast}{b \times d} \Rightarrow Ast = \rho_{max}\,(b \times d)$$

$$Ast = 0.0180\,(10 \times 17) \Rightarrow 0.0180\,(170)$$

$$\boxed{Ast = 3.06\,in^2}$$

Scanned with CamScanner

 ID NO# 7823

Step#03:-

Design Moment formula

We know that

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

Where $a = \dfrac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \dfrac{3.06 \times 60}{0.85 \times 4 \times 10} = 5.4''$

$a = 5.4''$

$M_{u2} = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$

$M_{u2} = 2362.93$ Kip-inch

$M_{u2} = 2362.93$ Kip-in

MOMENT DUE TO GIVEN LOAD:-

Beam self weight $= 10/12 \times 20/12 \times 150$

$= 208.33$ lb/ft

Total factored load $= 1.2(1050 + 208.33)$

$+ 1.6(2470) \Rightarrow 5461.99$ lb/ft

$\Rightarrow 5.46$ Kips/ft

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ultimate factored Moment

We have

$$Wl^2/8 \Rightarrow \frac{5.46 \times (18)^2}{8} \times 12 = 2653.56$$

MU = 2653.56

Now as;, $MU_2 < MU$

$2362.92 < 2653.56$ (Doubly Reinforcement Required).

STEP # 04:-

$$MU_1 = MU - MU_2$$

$$MU_1 = 2653.56 - 2362.92$$

$$MU_1 = 290.64 \text{ Kip-inch}$$

STEP # 05:-

Steel Area in compression Zone is;

$$MU_1 = \phi \times Ast \times fy \times (d - d_1)$$

So;

$$Ast = \frac{MU_1}{\phi \times fy \times (d - d_1)}$$

$$= \frac{290.64}{0.90 \times 60 \times (17 - 2.5)} = 0.37 \text{ in}^2$$

Ast = 0.37 in²

STEP # 06:-

$$As = Ast + As' \Rightarrow 3.06 + 0.37 = 3.43 \text{ in}^2$$

As = 3.43 in²

STEP # 07:-

We can use #08 bar (Dia = 8/8 = 1")

Area = 0.785 in^2

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

$= 3.43/0.785 \Rightarrow 4.36 \approx 5$ bars

5 # 8 bars (Tensile Zone)

For compression steel:

use # 6 bars (dia 6/8 = 0.75)

Area = 0.44 in^2

$$\text{No. of bars} = \frac{A_{st}'}{\text{Area of 1 bar}} = \frac{0.377}{0.44} = 0.84$$

$\Rightarrow 0.84 \approx 1$ bar

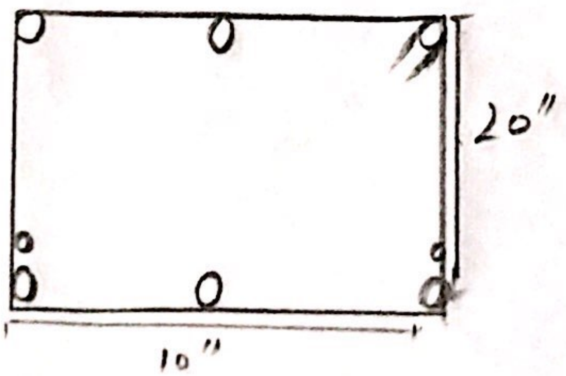
1 # 6 bars (Compression Zone)

STEP # 08:-

Minimum beam width

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

$= 12.75 > 10"$ (Multiple layer)



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

$$d = 16.62''$$

Effective cover $(d') = 1.5 + 3/8 + 1/2\,(6/8)$

$$(d') = 2.25$$

STEP # 09:-

We have to given Design Moment

$$Md = \phi \times \left[A's_t \times f_y \times (d - d') + (As_t - A's_t) \times f_y \times (d - a/2) \right]$$

$$a = \frac{(As_t - A's_t) \times f_y}{0.85 \times f'_c \times b}$$

$$= \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 16} = 6.15''$$

$$a = 6.15''$$

$$Md = 0.90 \times \left[(1 \times 0.44) \times 60 \times (16.62 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times (16.62 - 6.15/2) \right]$$

$$Md = 2890.46$$

$$Md = 2890.46 > 2653.56$$

(Design is OK)

QUESTION NO=02 (Part=A)

⇒ **BOND STRESS:-**

The Stress which is acting on the Outer interface of Steel to the Surrounding Concrete is called bond Stress. This stress help in Keeping the bond b/w Reinforcement and Concrete together. Bond Stress Resist any force that tries to pull out the Rods from the Concrete. When we try to Pull Out the Reinforcement bar from hardened concrete, then this bond Stress Resists the bar to come out.

DEVELOPMENT LENGHT:-

The development lenght can be defined as the amount of Reinforcement (bar) lenght needed to be embedded OR Projected into the Column to established the desired bond stress between the concrete and steel.

To develop a safe bond between the bar surface and the concrete so that no failure due to slippage of bar occure during the ultimate load condition.

QUESTION NO=2 (part=B)

We provided doubly Reinforced beam due to the following. Which are given below.

1) When the cross sectional of the beam is fixed.
2) When there is a torsion on the beam.
3) When Moment to be carried by the beam is more than the balanced Moment.
4) Doubly Reinforced beam is always used for safety Reason, To counter wind force and temperature stresses.

QUESTION NO = 02 (Part = C)

T- BEAM:-

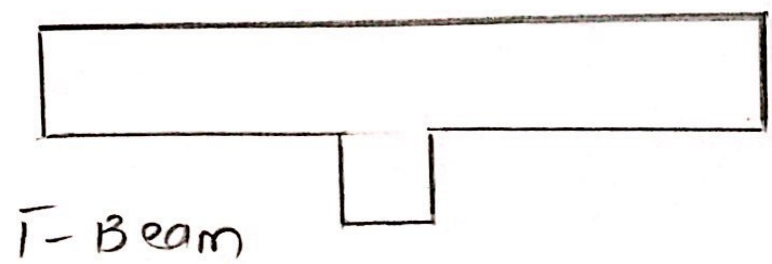
⇒ When slab are Monolithically casted with beams in a positive Moment Zone, part of the slab act as a part of the beam and Resists the longitudnal compression.

⇒ T- Beam are Mostly used in heavy duty and large space such as bridges.

⇒ T- Beam are more economical than Rectangular beam.

⇒ The design procedure of T-beam as depend on the location of Moment as the case of it's flexural strenght

⇒ Shape of the T-beam is;



RECTANGULAR BEAM:-

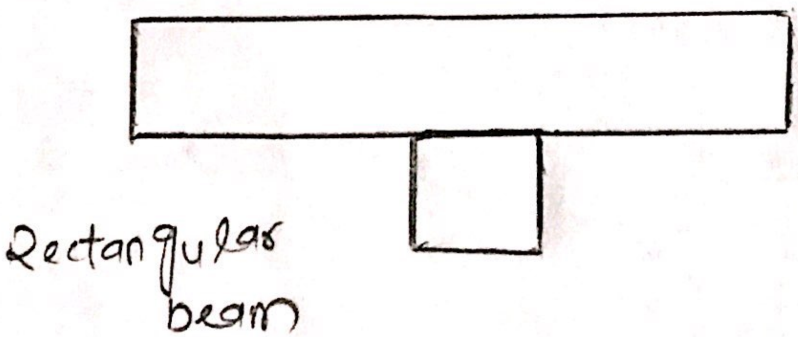
⇒ The Rectangular beam is generally used as compression in top fibre and tension in bottom fibre of that beam.

⇒ Rectangular beams are Mostly used in commercial building.

⇒ Rectangular beam are less economical as compared to T-beam.

⇒ In case of Rectangular beam, slab has been placed on the beam, so there is no connection b/w slab and beam.

⇒ Shape of Rectangular beam is;



QUESTION NO# 02 (part# D)

EFFECT OF STRENGHT REDUCTION FACTOR ON FLEXURAL STRENGHT:-

In the design of flexural strenght, the strenght Reduction factor decreases from tension controlled section to compression.
controlled section to increase safety with decreasing ductility. This shows that to determined the Reduction factor for flexural strenght of Reinforced Concrete beam according to ACI. in The reliability based design the Reliabl prediction of the "str" flexural strenght of Reinforced concrete member is assured by the use of the Reduction factor corresponding to different target Reliability index.

QUESTION NO # 02 (Part # F)

DESIGNING METHOD:-

There are two Methods of designing of concrete.

1) ALLOWABLE STRESS DESIGN:-

Allowable stress design is reffered as the Service load design or working stress design.

The basic concept of this Method is that the Maximum stress in a structural member is always smaller than a certain allowable stress in bridge working.

The allowable stress of a Materal determined according to it's normal strenght over the safety factor.

2) ULTIMATE STRENGHT DESIGN METHOD:-

Ultimate Strenght design Method is also known as factor Method OR ultimate load factor.

Ultimate Strenght design method produces a more Rational and economical design compared to working stress design metho

The ultimate strenght design method utilize a more Realistic factor of safety.

In this Method, the Reinforced concrete structure is design beyond the elastic Region.

QUESTION NO = 03

GIVEN DATA:-

c/c Distance = 10'

Span = 32'

Web width = 14"

Effective depth = 28" - 3" = 25"

Total depth = 28"

Slab thickness = 6"

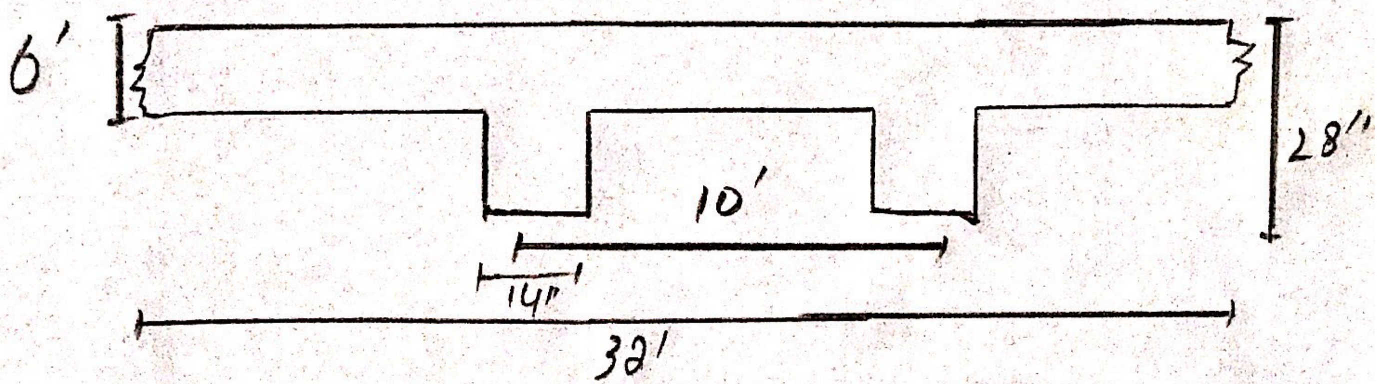
D.L = 50 lb/ft^2

S.S = 225 lb/ft^2

f_y = 60000 psi

f'_c = 4000 psi

SOLUTION:-



STEP#01:- We know that

$$MU = \frac{wu \times L^2}{8}$$

Beam self weight per feet

$Wt = b \times t \times \gamma c = 14/12 \times 28/12 \times 150$

$Wt = 1.666 \times 2.333 \times 150 \Rightarrow 408.33$

$Wt = 408.33\ lb/ft$

Total factored load:-

$\Rightarrow 1.2(50 + 408.33) + 1.6(225)$

$= 909.99\ lb/ft = 0.909\ Kip/ft$

MOMENT:-

We have to given that

$WL^2/8 \Rightarrow \frac{0.909(32)^2 \times 12}{8} = 1396.23$ Kip-in

Effective Breadth:-

1) $16(hf) + bw = (16)(6) + 14 = 110''$
2) c/c distance $= 10(12) = 120''$
3) span/4 $= 32/4 \times 12 \Rightarrow 96''$

so $be = 96''$

STEP # 03:- (Rectangular OR T-beam)

Trial # 01:- Let $a = h_f = 6''$

We know that

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

$$\boxed{A_{st} = 1.17 \, in^2}$$

Trial # 02:- Where

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

$\Rightarrow 0.2'' < 6''$ (Rectangular Beam design)

$$A_{st} = \frac{1396.23}{0.90 \times 60 (25 - 0.2/2)}$$

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

Trial # 03:-

$$a = \frac{1.03 \times 60}{0.85 \times 4 \times 96} = 0.18''$$

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

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

STEP#04:-

Finding ρ_{max} And ρ_{min}

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

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

ρ_{min} is given by;

$$200/fy = 200/60000 = 0.003$$

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

$$\rho = \frac{Ast}{b \times d} = 1.03/14 \times 25 = 0.0029$$

$$\boxed{\rho = 0.0029}$$

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

$$0.003 < 0.0029 < 0.018$$

As we know that

ρ is less than ρ_{min}

$$\rho_{min} = Ast/b \times d \Rightarrow Ast = \rho_{min} \times b \times d$$

$$Ast = 0.003 \times 14 \times 25 \Rightarrow 1.05 \text{ in}^2$$

$$\boxed{Ast = 1.05 \text{ in}^2}$$

STEP#05:- SELECTION OF bar

We use #8 bar; then

dia(8/8) = 1" and Area = 0.785 in^2

No. of bars = $\frac{1.05}{0.785}$ = 1.31 ≅ 2

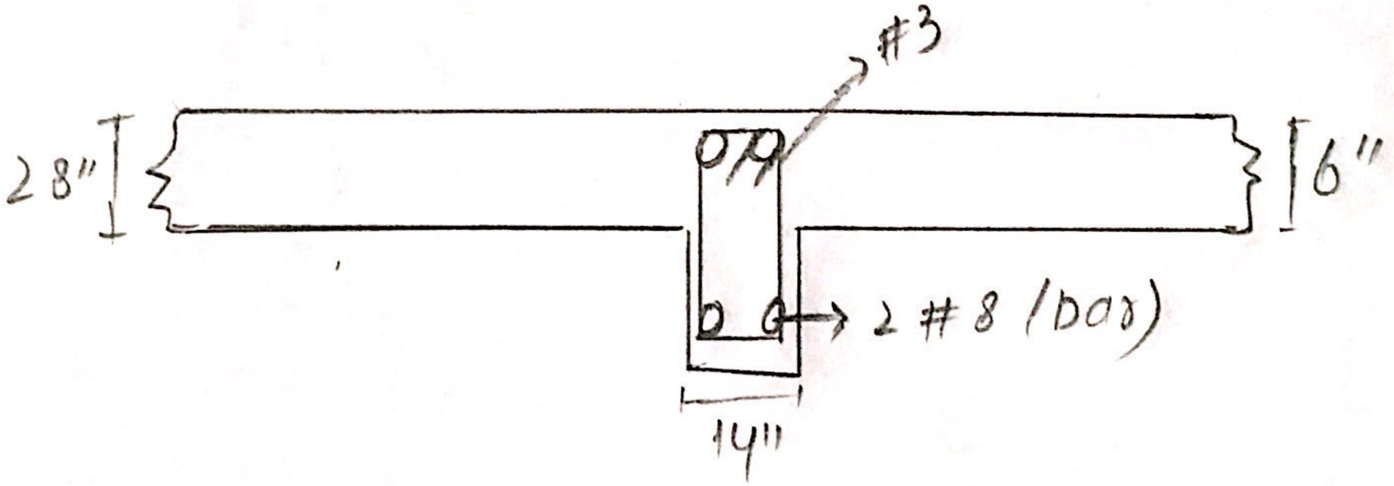
So we use 2 #8 bars.

STEP#06:-

Now we have to find Minimum width

bmin = 2(1.5)+2(3/8) +2(8/8)+1(8/8)

=) 6.75" < 14" (Good in one layer)



STEP#07:- Design Moment

We have

Md = ∅ × fy × Ast × (d − a/2)

Area of steel = Area of 1 bar × No. of bar

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

Where

$$a = \frac{1.57 \times 60}{0.85 \times 4 \times 96} = 0.2''$$

$$\Rightarrow M_d = 0.90 \times 60 \times 1.5 \times (25 - 0.2/2)$$

$= 2111.02$ kip-in

As; $2111.02 > 1396.23$

(Design is ok).