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| Exam | Mid Exam. |
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# * Q.No #2 :-

## * Part A :-

## * Bond Stress :-

### * Defenition :-

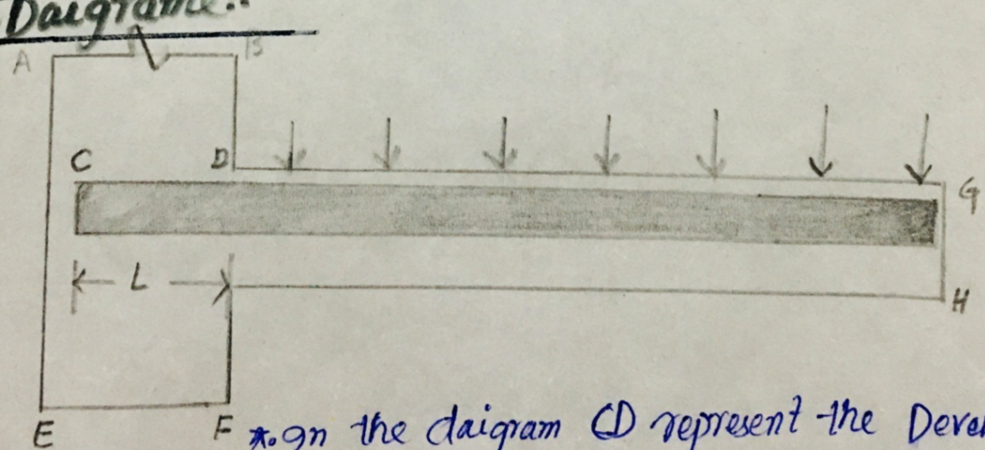
* Bond Stress is the stress produced because of the bond b/w concrete surface and the reinforcement steel. It various depending upon the type of the concrete and reinforcement used.

*. It is like a grip, if surface is rough and less grip and if the surface is smoth and rounded.

## * Develpment Lenght :-

*. Develpment lenght is certain minimum lenght of the bar required on either side of a point of maximum steel stress in order to transfer the load bar to the sourounding concrete through bond without slip so to prevent bar from pulling out under tension.

## * Daigrame :-




*. In the daigram CD represent the Develpment lenght.

# part B

## Doubly Reinforced Beam:-

Doubly reinforced beam is used due to the following reason.

**No #1:-** When the dimension of the beam (breth, depth) are limited for Architectual or Structural purpose.

**No # 2:-** when the Section Such as, braces in water towers etc Such as subjected to reversal of bending movement.

**No #3:-** Due to high demand of load (that Causes movement) and due to restriction in dimension, section is designed as doubly reinforced.

**No # 4:-** In Condition T-beam the portion of the beam over middle Support has to be designed as doubly reinforced Section.

# part C

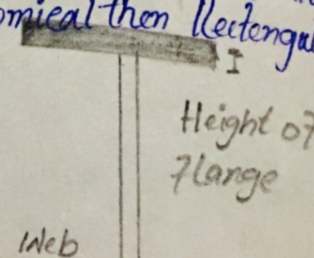
## T-Beam Analysis:-

T-beam Consist of T-Shaped Structure. The top of T-shaped Cross-Section Serves as a flange or Compression member in resisting Compression Stresses. The lower Section web Service to resist the Shear stresses. It is economical then Rectangular beam and is Cast monolithically with the slab.

$\therefore a > h_f$

→ a = depth of compression block

→ $h_f$ = slab thickness / flange height.



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# Rectangular Beam Analysis:.

★ A rectengular beam is one which is generaly used as compresion in top fiber and tension in bottom fiber.

★ Rectangular beam is more used in office/commercial buildings. These can be cast in-stiu using standard reinforcement or precast.

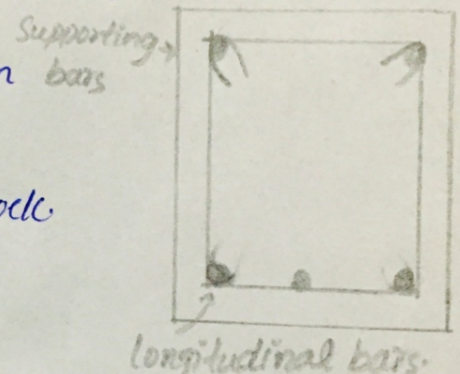
★. In rectengular beam, the stress block daigrame shows the top fibers are subjected to maximum compression & linierly reduces till the neutral axis.

★. Its Analysis is required when

$$a \leq hf$$

a = depth of compression block.

hf = height of flange.




## (part D):.

## Strenght Reduction factors:-

★. It is defined as the ratio of elastic strenght to yeild strenght.

**Denoted by:-** Ø.

**EFFECT ON STRENGHT:.** Strenght reduction factors shows the strenght in terms of percentage while designing a section to resist the moment caused by load.

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*· Basically it represent the uncertanity in determining the members behaviour to the type of stress as to which it is subjected.

*· For Example, during the design process of a beam usually we take 0.75 for shear loads. It shows that 75% of its strenght is considered here and the rest of 25% is for future accidental process.

## (part E):

### Designing methods:

Two methods are used for the designing of concrete and different structural members.

1- ASD (Allowble Stress Design method):

2- USD (ultimate Strenght Design method):

**(1) Allowble Stress Design method:** → ASD method is also known as working stress Design method. It is based on the principle that stresses develped in the structural members should not exceed a certain limit / fraction of elastic limit.

→ In this method, all loads are taken as service loads and no factor is applied to increase these service loads.

**(2) ultimate Strenght Design method:** *· ultimate strenght Design method is also know as load factor method or ultimate load factor method.

*· For structural subjected to large external loads, the ultimate strenght is determined by the inelastic (non-linear analysis).

*· ultimate strenght Design method is best for designing different structural members because of the following.

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**NO # 1:** As the ultimate strenght of the material is considered we will get much slender sections for colums and beams Campared to other methods.

**NO #2:** ultimate design method results is more economical design for a building with fewer special needs for customized areas of reinforcement.

**NO #3:** ASD better determines design for higher safety factor needs where a building is more prone to enviromental pressures or must behvier loads that stress a specific portion of a building.

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## (Question 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'

$f'_c = 4000psi \Rightarrow 4Ksi$

$f_y = 60,000 psi \Rightarrow 6Ksi$

**Solution:-**

**Step No#1:**

Effective depth (d) = h-3 $\Rightarrow$ 20-3 = 17"

Effective Cover = d' = 2.5"

**Reinforcement ratio:**

$$\rho_{max} = 0.85 \times \beta \times \frac{f'_c}{f_y} \times \frac{\varepsilon_y}{\varepsilon_x + \varepsilon_y}$$

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

$$\rho_{max} = 0.0180$$

**Step No#2:**

Finding area of steel

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

$$= 0.0180 \times (10 \times 17)$$

$$= 3.06\ inch^2$$

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## Step NO# 3:-

By formula of design moment.

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

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

$$M_{u2} = 0.90 \times 3.06 \times 60 \times (17 - 5.4/12)$$

$$= 2362.93 \text{ kip-inch}$$

Moment due to given loads:-

$$\text{Beam Self weight} = 10/12 \times \frac{20}{12} \times 150$$

$$= 208.33 \text{ lb/ft}$$

$$\text{Total factored load} = 1.2(1050 + 208.33) + 1.6(2470)$$

$$= 5461.99 \text{ lb/ft}$$

$$= 5.46 \text{ kips/ft.}$$

$$\text{ultimate factored moment} = wL^2/8$$

$$\Rightarrow \frac{5.46 \times 18^2}{8} \times 12$$

$$M_u = 2653.56$$

Now As, $M_{u2} < M_u$

$$\Rightarrow 2362.92 < 2653.56$$

* Doubly reinforcement required.

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★ Step NO #4:-

$M_{u1} = 2653.56 - 2362.96$

$M_{u1} = 290.64$ Kip-inch

Step NO #5:

Steel area in Compression zone will be

$M_{u1} = \phi \times A'_{st} \times f_y \times (d - d')$

$$A'_{steel} = \frac{M_{u1}}{\phi \times f_y \times (d - d')} \Rightarrow \frac{290.64}{0.90 \times 60 \times (17 - 2.5)}$$

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

Step NO # 6:

$A_s = A_{st} + A'_{st} \Rightarrow 3.06 + 0.37 = 3.43\ in^2$

$A_{s1} = 3.43\ inch^2$

Step NO #7:

We used bar no #8 (dia = 8/8 = 1")

Area = 0.785 $inch^2$

$$\text{No. of bars} = \frac{A_{st}}{\text{Area of one bar}} \rightarrow \frac{3.43}{0.785}$$

$\rightarrow 4.36 \Rightarrow 5$ bar

So 5 #8 bars: its for tensile zone.

(a)

## Compression Steel:-

use #6 bars.

dia (6/8) = $0.75''$, Area = $0.44\ inch^2$

No. of bars = $\frac{A_s'}{\text{Area of one bar}} = \frac{0.37}{0.44} \Rightarrow 0.84$

No. of bars = $0.84 \simeq 1$ bar

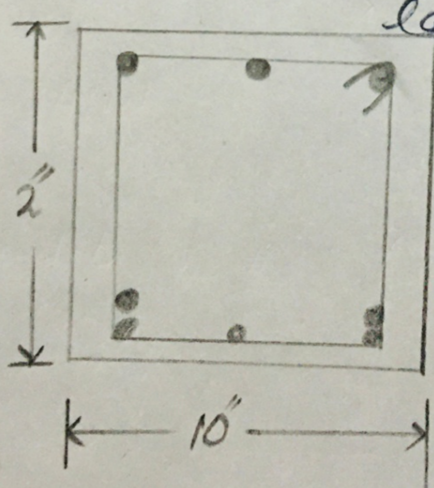
So 1 #6 bar in Compression Zone.

## Step No # 8

Beam minimum width:

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

$= 12.75 > 10'' \rightarrow$ These are used in multiple layers.



Effective Depth:-

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

$d = 16.62''$

Effective Cover:- $(d')$

$\Rightarrow 1.5 + 3/8 + 1/2(6/8)$

$d' = 2.25''$

Step No # 9:-

Design movement is

$Md = \phi \times [Ast' \times fy \times (d - d') + (Ast - A'st) \times fy \times (d - \frac{a}{2})]$

$a = \frac{(Ast - A'st) \times fy}{0.85 \times f'c \times b} \Rightarrow \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10}$

$a = 6.15''$

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

$Md = 2890.46$

$Md = 2890.46 > 2653.56$

* The Given Designed is right.

# Q.NO#3

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## Given Data:

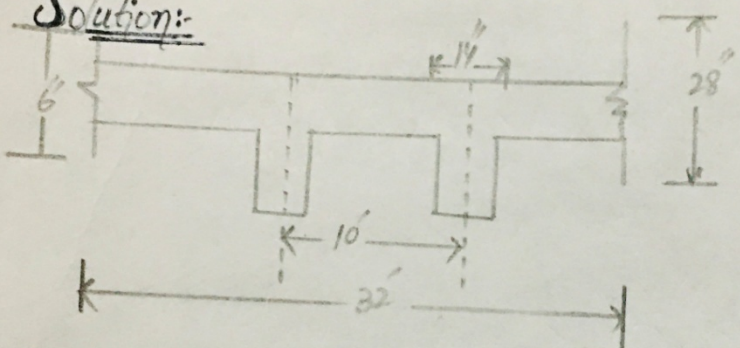
Clear Cover = 10', Span = 32', Slab Thickness = 6"

Web width = 14", Total depth = h = 28", (effective depth = 28-3 = 25")

Dead load = 50 lb/ft², S.S = 225 lb/ft²

$f_y$ = 60,000 psi , $f'c$ = 4000 psi

## Solution:




**Step No #1:**

$$M_u = \frac{W_u \times L^2}{8}$$

*Beam Self weight per feet.

$w_t = b \times t \times \gamma_c \Rightarrow \frac{14}{12} \times \frac{28}{12} \times 150 \Rightarrow$ **408.33 lb/ft.**

**Total Factored load:**

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

$\Rightarrow 909.99$ lb/ft $\Rightarrow$ **0.909 Kip/ft**

**Moment:** $\Rightarrow wl^2/8 \Rightarrow \frac{0.909 \times (32)^2 \times 12}{8}$ = **1396.23 Kip.inch**

**Effective Breadth:**

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

2) c/c distance = 10(12) = 120"

3) Span/4 = 32/4 × 12 = 96" ∴ $b_e$ = 96"

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## Step NO#3:
(Rectengular or T beam):

### Trail No# 1:
Let a = hf = 6"

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

$A_{steel} = 1.17\ in^2$.

### Trail No#2:

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

$= 0.2" < 6"$

So Rectengular Beam is designed:

$$A_{st} = \frac{1396.23}{0.90 \times 60 \times (25 - 0.2/2)} \Rightarrow 1.03\ inch^2$$

### Trail NO#3:

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

$$A_{steel} = \frac{1396.23}{0.90 \times 60(25 - \frac{0.18}{2})} \rightarrow 1.03\ inch^2$$

## Step NO#4: Check $\rho_{max}$ And $\rho_{mini}$

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

$$\rho_{min} = \frac{200}{f_y} \Rightarrow \frac{200}{60,000} \Rightarrow \rho_{min} = 0.003$$

$$\rho = \frac{A_{st}}{b \times d} = \frac{1.03}{14 \times 25} \Rightarrow 0.0029$$

→ $\rho_{min} < \rho < \rho_{max}$

→ $0.003 < 0.002 < 0.018$

→ As $\rho$ is less then $\rho_{min}$

So,

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

$A_{steel} = 0.003 \times 14 \times 25 \Rightarrow$ **$1.05 in^2$**

* **Step NO 5:** No. and Salection of bars. Let use #8 bar, then

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

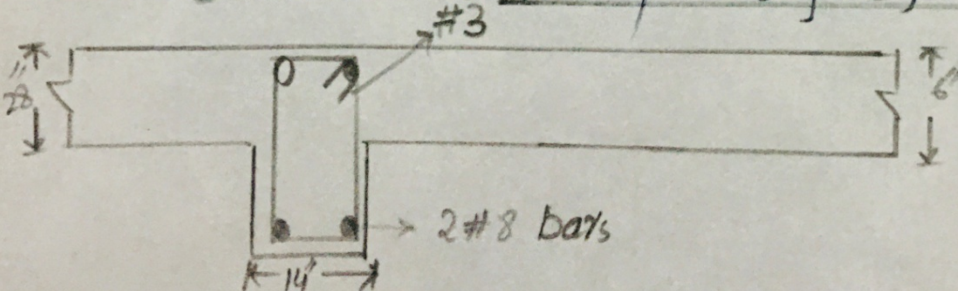
$No. of\ bars = \frac{1.05}{0.785} = 1.3 \approx 2$

* We use 2#8 bars.

* **Step NO# 6:** Minimum width

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

$= 6.75" < 14"$ → It is Good in Single Layer or one.



## Step NO# 7:-

Design moment

$Md = \phi \times fy \times Ast \times (d - a/2)$

Area Steel = Area of 1 bar × No of bars

$= 0.785 \times 2$ $= 1.57 in^2$

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

$Md = 0.90 \times 60 \times 1.57 \times (25 - \frac{0.2}{2})$

$= 2111.02$ Kip-inch

As, 2111.02 > 1396.23

**Result:-** The Designed is ok.