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IAT 1 – SEP 2017

Sub:	Design Of RCC Structural Elements						Code:	15CV51
Date:	18/09/17	Duration:	90 mins	Max Marks:	50	Sem: 5	Branch:	CV

Note: **Use of IS 456:2000 and SP 16 code is permitted. Assume the missing data suitably.**

	Answer Two full questions	Marks	OBE CO	OBE BTL
1.	a) What are the different types of loads and classification of loads to be considered in the design of an reinforced concrete elements? b) Derive the stress block parameter of Singly reinforced concrete beam.	7 18	CO1 CO2	L2 L4
2.	a) Explain under reinforced, over reinforced and balanced section with neat sketch. b) A singly RC beam of 250 X450mm deep upto centre of reinforcement provided with 3-16mmdia at an effective cover 50mm, with an effective span 6m, use M20 grade concrete and Fe415 steel. Determine the central point load that can be supported in addition to the self weigh.	7 18	CO1 CO2	L3 L4
3.	a)Explain briefly Design philosophy and Design principle b) Determine the moment of resistance of a T- beam for the following data, breadth of flange = 740mm, effective depth= 400mm, breadth of web= 240mm, Ast= 5-20 dia, depth of flange =110mm, adopt M20 grade concrete and Fe 415 grade steel.	7 18	CO1 CO2	L2 L4

CI **CCI** **HOD**

1)

SOLUTION - IAT-1

DESIGN OF RCC STRUCTURAL ELEMENTS

5th Sem. — 15CV51 VIBHA .N. DALAWAI

Q.1.(a) What are the different loads to be considered in the design of an reinforced concrete element? (6 marks)

(i) Live loads - Live loads on floors and roofs consists of all the loads which are temporarily placed on the structure. For example, loads of people, furniture, machines etc.. These loads keep on changing from time to time. They are also called Imposed loads. — 2 marks

(ii) Dead loads - Dead loads are due to self weight of the structure. These are the permanent loads which are always present. Dead load depends upon the unit weight of the material. Dead load includes, the self weight of walls, floors beams, columns etc.. — 2 marks.

(iii) Wind loads :- The force exerted by the horizontal component of wind is to be considered in the design of buildings. — 1 mark

(iv) Snow loads :- The buildings which are located in the regions where snowfall is very common are to be designed for snow load. — 1 mark

(v) Earthquake load :- Earthquake loads depend upon the place where the buildings is located. — 1 mark

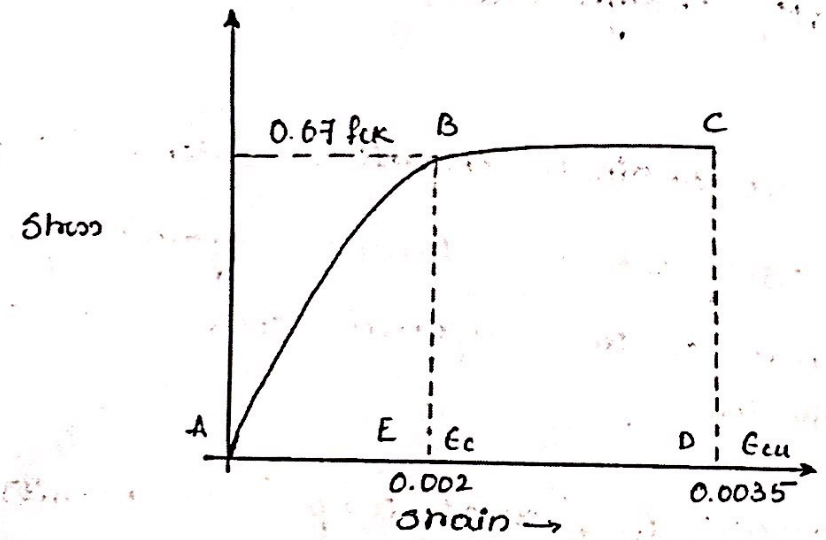
Q.1(b) Stress Block parameter: (18 marks)

The stress strain behaviour of concrete under compression are generally obtained from cylinder or cube of concrete subjected to compression test or loading.

Where as the stress and strain are uniform for a cube, they vary across the depth of Bending members.

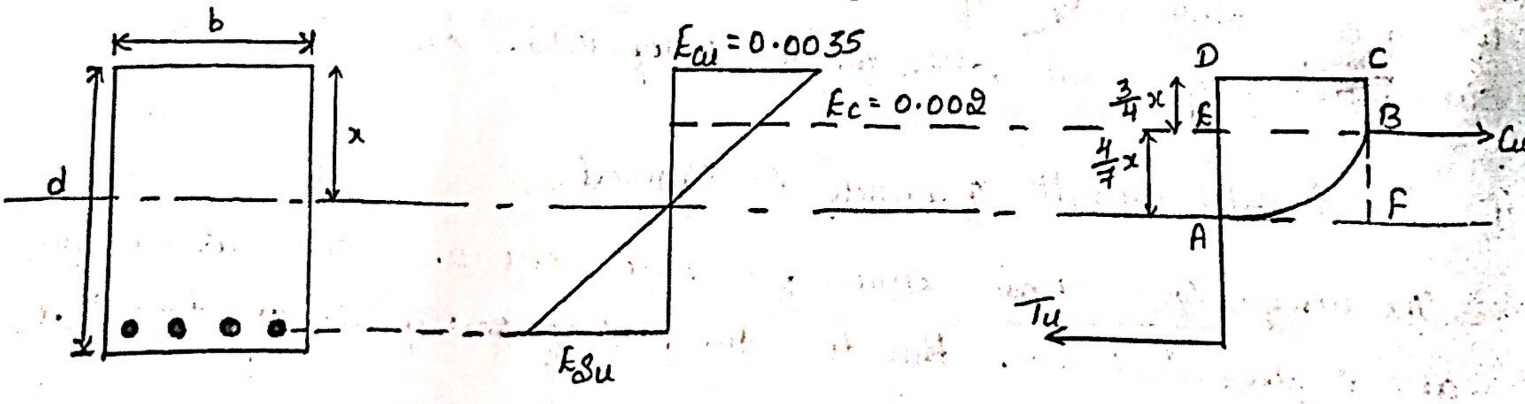
The IS code recommends the compressive strength of concrete in structure = 0.67 fck

The stress strain diagram is as shown in fig.



Stress Strain curve for concrete.

3 marks



Strain and Stress Variation across Section fig (b) shows strain diagram.

fig.(c) shows stress diagram across the section.

The stress block ABCDEA has parabolic part same as stress-strain curve from fig ①. i.e AB part, & then CB linear part B. from CB part of graph = stress of 0.67fck constant.

The total compressive force = C_u which is below the top fiber & can be expressed in stress block parameter K_1, K_2, K_3.

were K_1 = Shape factor = $\dfrac{\text{Area of stress block}}{\text{Area of Rectangle}} = \dfrac{ABCD}{AFCD}$

$K_1 = \dfrac{\text{area of } ABCD}{\text{area of } x \times CD}$ —— ①

— 2 marks

Ultimate strain in concrete = 0.0035 = ϵ_{cu} = AD

Strain after yeilding in concrete = 0.002 = ϵ_c = AE @ stress of 0.67 fck.

The ratio of $\dfrac{\epsilon_{c}}{\epsilon_{cu}} = \dfrac{AE}{AD} = \dfrac{0.002}{0.0035} = \dfrac{4}{7}$

$\therefore$ $AE = 4/7\, AD$

Ily $\dfrac{ED}{AD} = \dfrac{0.0035 - 0.002}{0.0035} = \dfrac{3}{7}$ $\therefore$ $ED = 3/7\, AD$

} 3 marks.

Now area ABCD = Area of ABE + Area BCDE.

$= (2/3\, AE \times BE) + (ED \times CD)$

$= (2/3 \times 4/7\, AD \times CD) + (3/7\, AD \times CD)$

$= 8/21\, (AD \times CD) + 3/7\, AD \times CD$

$= AD \times CD\, (8/21 + 3/7) = 17/21\, AD \times CD.$

— 5 marks

Substuting in eq ①

$K_1 = \dfrac{ABCD}{x \times CD} = \dfrac{AD \times CD \times 17/21}{AD \times CD} = \boxed{17/21 = K_1}$

5 marks

Resultant compressive force is located @ depth of $K_2 x$

$$K_2 x = K_2 AD = \frac{\text{Area of parabola} \times \bar{x}_1 + \text{Area of Rectangle } \bar{x}_2}{\text{Area of } ABCD}$$

$$= \frac{(8/21)(ED + 3/8 AE) + (3/7)(1/2 ED)}{17/21} \quad \frac{AD \times CD}{AD \times CD}$$

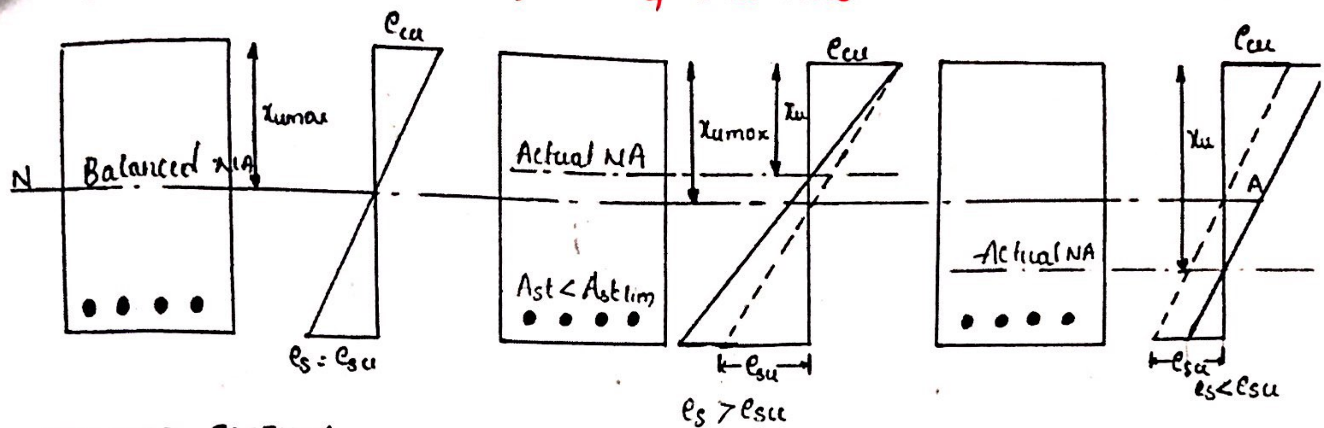
$$= \frac{(8/21)(3/7 + (3/8 \times 4/7) AD) + (3/7 (1/2 \times 3/7) AD)}{17/21}$$

$$= \frac{99}{238} = 0.416 \text{ or } 0.42.$$

$K_2 x = 0.42 AD$

$\boxed{K_2 = 0.42}$

Q.2.(a) Explain Under, Over & Balanced Sections — (7 marks)



BALANCED SECTION

UNDER REINFORCED SECTION

OVER REINFORCED SECTION. (1 mark

2 marks

<u>Balanced Section</u>: The strain in steel and strain in concrete reach their maximum value simultaneously. the $e_c = e_{cu}$ & $e_s = e_{su}$. The % of steel in this section is known as critical or limiting steel percentage (P_t lim). The depth of neutral axis $x_u = x_{umax}$.

<u>Under Reinforced section</u>: is one in which P_t is less than critical or limiting percentage. Due to this the actual NA is above the balanced NA & $x_u < x_{umax}$. Hence stress in steel required reaches first than Concrete.

∴ Beam fails by excess yielding of steel. 2 marks

Before beam fails it gives sufficient warning.

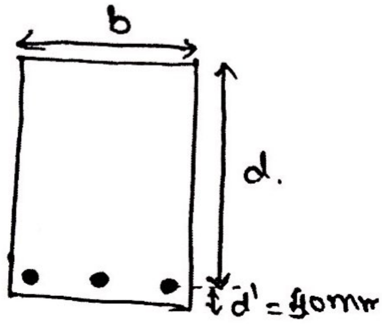
<u>Over Reinforced Section</u>: In this type of beam cls, the % of steel is greater than what is required for balanced section. Hence stress in Concrete reaches first than steel ∴ Beam fails by crushing of Concrete in compression zone. Hence this type of failure is Sudden & it won't give warning before it fail.

∴ IS 456: is not permitting over Reinforced design. 2 marks

8.

2.b) A single reinforced concrete beam 250 × 450 mm deep upto the centre of reinforcement is reinforced with 3-16 mm dia at an effective cover 50 mm, effective span 6 m, M20 concrete and Fe 415 steel. Determine the central point load that can be supported in addition to the self weight.

Given :- 2 marks.



$b = 250\ mm$

$d = 450\ mm$

$A_{st} = 3 \times \frac{\pi}{4} \times 16^2 = 603.18 mm^2$

$d' = 50\ mm$

$L = 6 m$

$f_{ck} = 20\ N/mm^2$

$f_y = 415\ N/mm^2$.

$D = 450 + 50 = 500 mm$.

$M_u = M_D + M_L$. — 01 mark

$$\frac{w_D L^2}{8} + \frac{W_L L}{4} = M_u \quad \text{— (i)}$$

— 01 mark

$w_D = \gamma \times b \times D$.

$w_D = 25 \times 250 \times 500$

$w_D = 3.125\ kN/m$

} 3 mark

From IS·456: 2000, Page 96, Clause — 01 mark

$$\frac{x_u}{d} = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b d}$$

01 mark

$$\frac{x_u}{d} = \frac{0.87 \times 415 \times 603.18}{0.36 \times 20 \times 250 \times 450} = 0.268$$ 01 mark

$$\left.\frac{x_{u.max}}{d}\right]_{415} = 0.48$$ 02 marks

$$\therefore \frac{x_u}{d} < \frac{x_{u.max}}{d}$$

From IS 456: 2000, page 96, clause G

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{A_{st} f_y}{f_{ck} b d}\right]$$ 01 mark

$$M_u = 0.87 \times 415 \times 603.18 \times 450 \left[1 - \frac{603.18 \times 415}{20 \times 250 \times 450}\right]$$

$$M_u = 87097380.87 \text{ N-mm}$$

$$M_u = 87.09 \text{ kN-m}$$

} 03 ma

From ⑥ :-

$$\frac{87.09}{1.5} = \frac{3.125 \times 6^2}{2} + \frac{w_L \times 6^2}{2}$$

~~$w_L = 0.1$ kN/m~~ //

$$\frac{87.09}{1.5} = \frac{3.125 \times 6^2}{8} + \frac{w_L \times 6}{4}$$

$$58.06 = 14.06 + 1.5 w_L$$

$$w_L = 29.33 \text{ kN/m}$$

} 02 marks.

Q.3.(a)

Q. Explain the philosophy and principals of limit's state method of design.

* Built on fundamental Consumption - way of thinking.
* Earliest was WSM (working stress method). & established. 100 years old & It is depend on linear elastic theory. It is only ~~based~~ concentrate on serviceability.
* Followed by ULM - ultimate load method in 1950's : It is only concentrate on strength.
* LMS Com - limit state method is come to existance to over come there drawbacks
* It concentrate on both serviceability and safety.
* Relaibibility based method is come to the picture.

Design philosophy - 03

Design principle - 04

(b) Determine the moment of resistance of a T-beam for the following data.
Breadth of the flange = 740mm, Effective depth = 400mm
Breadth of the web = 240mm, Area of steel = 5-20,
Depth of flange = 110mm. Adopt M20 grade concrete & Fe-415 grade steel.

Given:-

$b_f = 740$ mm.
$b_w = 240$ mm
$d = 400$ mm.
$d_f = 110$ mm.
$A_{st} = 5 \times \pi/4 \times 20^2 = 1570.79\ mm^2$.
$f_{ck} = 20\ N/mm^2$
$f_y = 415\ N/mm^2$. ——— 2-marks

Assuming $x_u < D_f$.

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b_f}$$ 02 mark

$$x_u = \frac{0.87 \times 415 \times 1570.79}{0.36 \times 20 \times 740} = 106.44\ mm$$ 02 mark

$\therefore x_u < D_f$. → Rectangular Section — 01 mark.

Compare x_u & $x_{u.max}$. — 01 mark

$x_{u.max} = 0.48 \times d$

$x_{u.max} = 0.48 \times 400 = 192\ mm$. } 02 mark —01 mark

$\therefore x_u < x_{u.max}$ ∴ under reinforced section — 01 mark

From IS:456:2000, Page 96, clause G (1.1) b Eqn. — 01 mark

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{A_{st} f_y}{b d f_{ck}}\right]$$ — 02 mark

$$M_u = 0.87 \times 415 \times 1570.79 \times 400 \left[1 - \frac{1570.79 \times 415}{400 \times 240 \times 20}\right]$$

— 02 mark

$M_u = 149.83$ KN-m // — 01 mark