MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

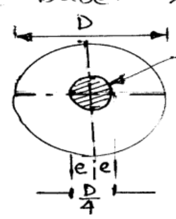
(Autonomous)
(ISO/IEC-27001-2005 Certified)

WINTER-12 EXAMINATION

Subject Code: 12138 Model Answer Page No: 01/

Q.1

a) The range within which the load can be applied so as not to produce any tensile stress, is within the middle third of the base. → Two marks



→ Figure of core of circular cross section Two marks

$e \leq Z/A = \frac{\pi D^3}{32} \Big/ \frac{\pi}{4} D^2 = D/8$ on both sides of centroidal axis — one mark

b) Advantages - i] Fixed beam is subjected to lesser maximum bending moment than the simply supported beam carrying same loading.

ii] For the same loading the maximum deflection for a fixed beam is less than that of the simply supported beam

iii] Fixed beam more stiff and stable than simply supported beam.

Disadvantages -

i] It is practically difficult to maintain the two ends of the beam at exactly same level so sinking of supports, however small will set up considerable stresses

ii] Temperature variations also produce large stresses in fixed beam

iii] When subjected to wheel load due to frequent variation in bending moment, due to vibrations degree of fixity affected.

(Any five points — five marks)

c) If AB and BC are two consecutive spans of continuous beam subjected to an external loading the support moments Ma, Mb and Mc are given by

1/1

$$M_a l_1 + 2M_b(l_1+l_2) + M_c l_2 = \frac{6\bar{a_1 x_1}}{l_1} + \frac{6\bar{a_2 x_2}}{l_2}$$

a_1 = area of the free B.M. diagram for the span AB

a_2 = area of the free B.M. diagram for the span BC

$\bar{x}_1$ = Centroidal distance of the free B.M. diagram on AB from A

$\bar{x}_2$ = Centroidal distance of the free B.M. diagram on BC from C

l_1 = span length AB

l_2 = span length CD

→ Correct statement — one mark

correct expression — Two marks

correct meaning — Two marks.

d) Maximum deflection occurs where slope equal to zero — one mark
for simply supported beam at $x = l/2$ i.e at midspan when load on beam is symmetric.
deflection (y) is maximum — four marks

e) (i) Stiffness factor → It is the moment required to produce unit rotation of the member, which is simply supported end. — Two & half marks

(ii) distribution factor → Distribution factor for a member at a joint is the ratio of stiffness factor for that member and the total stiffness of all the members meeting at a joint. — Two & half marks

f) Column - Vertical compression structural member. — Two marks

Classification - i] Short column — A column whose failure occurs due to crushing (direct compressive stress)

ii] Medium column - A column whose failure occurs due to both direct and bending stress

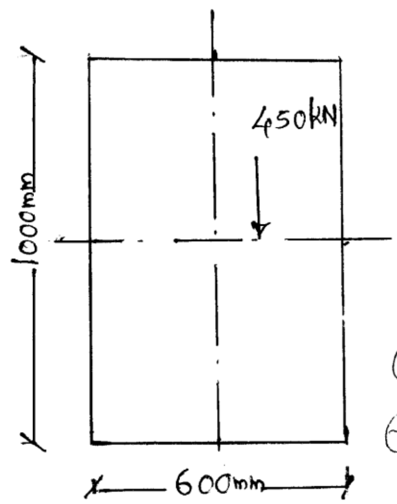
iii] Long column - A column in which failure occurs due to buckling only.

(One mark each)

g) Slenderness ratio indicates degree of slenderness of the column. When value is large means column is

Long column and design of such column is governed by buckling only. When slenderness ratio small column is short column whose failure occurs by crushing only — Five marks

Q.No.2(a)



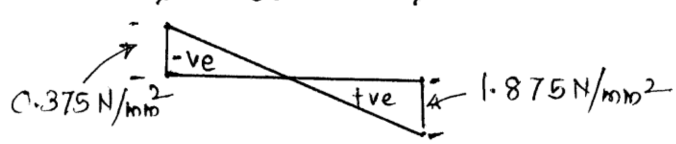
$\sigma_c = \frac{P}{A} = \frac{450\times10^3}{600\times1000} = 0.75\,N/mm^2$ — Two marks

$\sigma_b = \frac{M}{Z} = \frac{450\times10^3\times150}{\frac{1000\times600^2}{6}}$

$= 1.125\,N/mm^2$ — Two marks

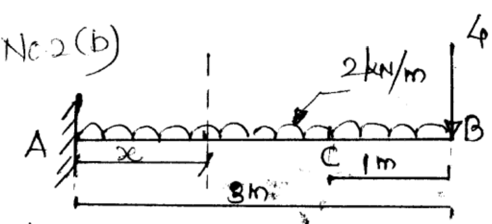
$\sigma_{max} = \sigma_c + \sigma_b = 1.875\,N/mm^2$ — One & half mark

$\sigma_{min} = \sigma_c - \sigma_b = -0.375\,N/mm^2$ — One & half mark



Distribution of stress at base of pillar — One mark

Q.No.2(b)



Consider section at x from fixed end bending moment is given by

Slope at C = ? Deflection at C = ?

$EI = 200\times3\times10^8 = 600\times10^8\times10^{-6}$

$= 6\times10^4\ kN\text{-}m^2$

$EI\frac{d^2y}{dx^2} = -4(3-x) - \frac{2}{2}(3-x)^2$

$EI\frac{dy}{dx} = -4\left(3x - \frac{x^2}{2}\right) + \frac{2}{6}(3-x)^3 + C_1$

at $x=0 \quad \frac{dy}{dx}=0$

$$0 = 0 + \frac{2}{6}(3-0)^3 + C_1$$

$$\therefore C_1 = -\frac{2}{6}(3)^3 = -9$$

$$EI\frac{dy}{dx} = -4\left(3x - \frac{x^2}{2}\right) + \frac{2}{6}(3-x)^3 - 9$$

$\frac{dy}{dx}$ at $x=2$ $= -4(6-2) + \frac{2}{6}(1)^3 - 9 / EI = -\frac{24.61}{EI} = -4.11 \times 10^{-4}$ ← Four marks

$$EIy = -4\left(\frac{3x^2}{2} - \frac{x^3}{6}\right) - \frac{2}{24}(3-x)^4 - 9x + C_2$$

at $x=0,\ y=0$

$$0 = 0 - \frac{2}{24}(3)^4 - 0 + C_2$$

$$\therefore C_2 = \frac{2}{24} \times 81 = \frac{81}{12}$$

$$\therefore EIy = -4\left(\frac{3x^2}{2} - \frac{x^3}{6}\right) - \frac{2}{24}(3-x)^4 - 9x + \frac{81}{12}$$

at $x = 2m$

$$\therefore EIy = -4\left(\frac{3 \times 4}{2} - \frac{8}{6}\right) - \frac{2}{24}(3-2)^4 - 9 \times 2 + \frac{81}{12}$$

$$= -4\left(\frac{36-8}{6}\right) - \frac{1}{12} - 18 + \frac{81}{12}$$

$$= -4\left(\frac{28}{6}\right) + \frac{80}{12} - 18$$

$$= \frac{-112}{6} + \frac{80}{12} - 18$$

$$= \frac{-2 \times 112 - 18 \times 12 + 80}{12}$$

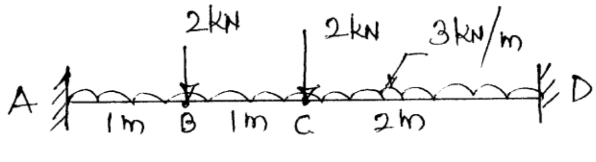
$$= \frac{-224 - 216 + 80}{12} = \frac{-360}{12} = -30$$

$$\therefore y = \frac{-30}{EI} = \frac{-30}{6 \times 10^4} = -5 \times 10^{-4} \times 10^3 = -5 \times 10^{-1} = -0.5$$

← Four marks

Sign

Q No 2(c)

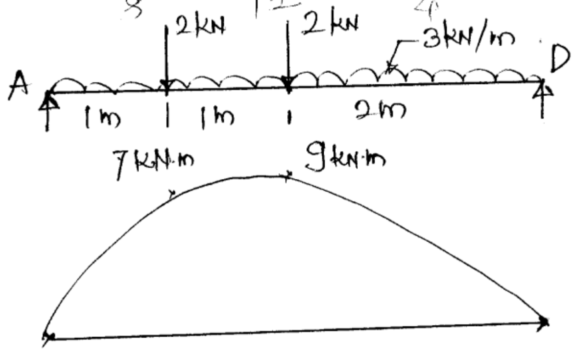


Fixed end moments due to loading

$$M_A = -\frac{WL}{8} - \frac{wl^2}{12} - \frac{wab^2}{l^2}$$

$$= -\frac{2\times 4}{8} - \frac{3\times 4^2}{12} - \frac{2\times 1\times 3^2}{4^2} = -6.125 \text{ kN·m}$$

$$M_B = \frac{2\times 4}{8} + \frac{3\times 4^2}{12} + \frac{2\times 1^2\times 3}{4^2} = +5.375 \text{ kN·m}$$



Consider the beam as simply supported beam

$R_A + R_D = 2+2+12 = 16$

$R_D\times 4 - 2\times 1 - 2\times 2 - 3\times 4\times 2 = 0$

$R_D = 7.5$ kN, $R_A = 8.5$ kN

$M_A = 0$ & $M_D = 0$

$M_C = 7.5\times 2 - 3\times 2\times 1 = 15-6 = 9$ kN·m

$M_B = 8.5\times 1 - 3\times 1\times 0.5 = 7$ kN·m

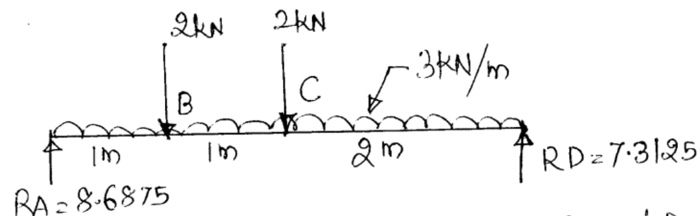
Reactions considering fixed end moments

$= -6.125 + 2\times 1 + 2\times 2 + 3\times 4\times 2 - R_D\times 4 + 5.375 = 0$

$-6.125 + 6 + 24 - 4RD + 5.375 = 0$

$RD = 7.3125 \uparrow$

$RA = 8.5 + \frac{7.5}{4} = 8.6875 \uparrow$



↓ +ve

S.F at D = RD = 7.3125

S.F at C = -7.3125 + 3×2 + 2

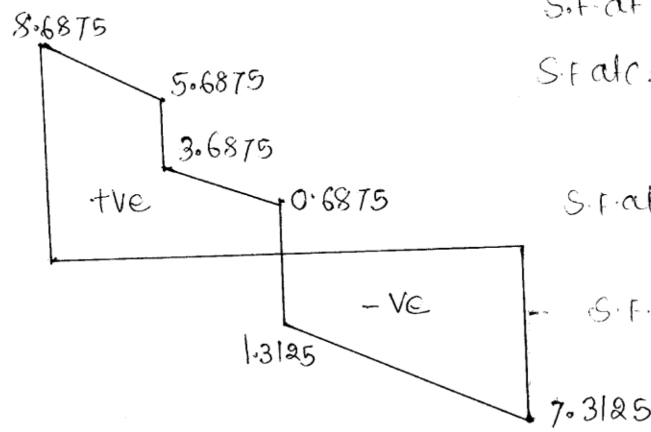
= 0.6875

S.F at B = 0.6875 + 2 + 3×1

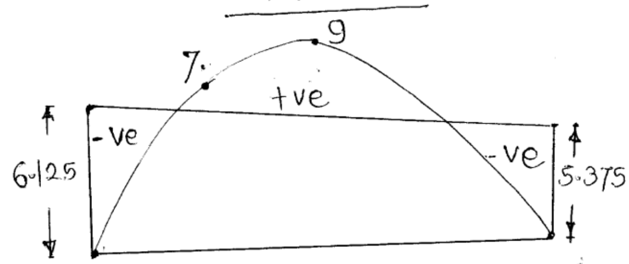
= 5.6875

S.F at A = 5.6875 + 3×1

= 8.6875



S.F DIAGRAM

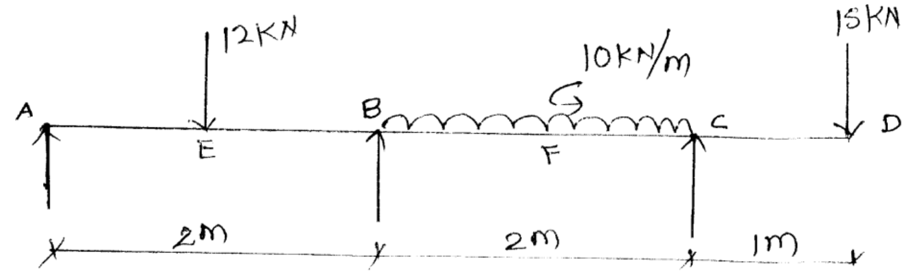


B.M. DIAGRAM

(Correct fixed end moments → Four marks, SFD - Two marks
BMD — Two marks)

Q. 3

a)



Given :— $E = 210 GPa$

$I = 2.8 \times 10^8 \, mm^4$

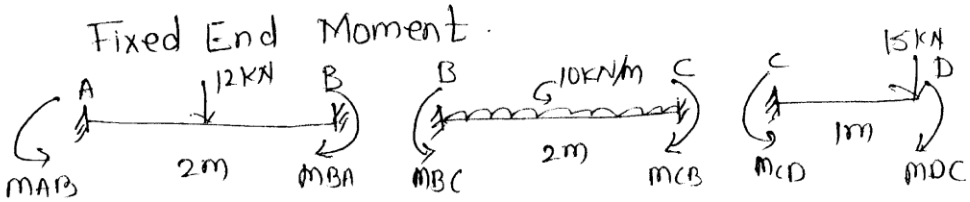
$MA = 0$

Find = MB and MC

Solution ;—

Step ~~0~~ 1

Fixed End Moment.



$$MAB = MBA = \frac{-W_1 L_1}{8} = \frac{-12 \times 2}{8} = -3 \, KNm$$

$$MBC = MCB = \frac{-W_2 L_2^2}{12} = \frac{-10 \times 2^2}{12} = -3.33 \, KNm$$

$$MCD = -15 \times 1 = -15 \, KNm$$

(01)

$$MDC = 0$$

Step 2

Stiffness factor.

Joint B

$$K_{BA} = \frac{3EI}{L_1} = \frac{3EI}{2} = 1.5 EI$$

②

$$K_{BC} = \frac{3EI}{L_2} = \frac{3EI}{2} = 1.5EI.$$

$$\Sigma K = K_{BA} + K_{BC} = 1.5EI + 1.5EI$$

$$\Sigma K = 3EI$$

Joint C

$$K_{CB} = \frac{4EI}{L_2} = \frac{4EI}{2} = 2EI.$$

$$K_{CD} = 0$$

$$\Sigma K = 2EI.$$

(02)

Step 3

Distribution factor.

Joint B

$$DF_{BA} = \frac{K_{BA}}{\Sigma K} = \frac{1.5EI}{3EI} = 0.5EI$$

$$DF_{BC} = \frac{K_{BC}}{\Sigma K} = \frac{1.5EI}{3EI} = 0.5EI.$$

Joint C

$$DF_{CB} = \frac{K_{CB}}{\Sigma K} = \frac{2EI}{2EI} = 1$$

$$DF_{CD} = \frac{K_{CD}}{\Sigma K} = \frac{0}{2EI} = 0$$

(02)

(3)

Step 4

Moment Distribution Table

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF		0.5	0.5	1	0	
FEM	-3.0	+3.0	-3.33	+3.33	-15	0
Release Moment	3			+11.67		
carry over		1.5	5.835			
Initial moment	0	4.5	2.5	15	-15	
		7.0				
		-3.5	-3.5			
Final moment	0	1	-1	15	-15	

Ans.

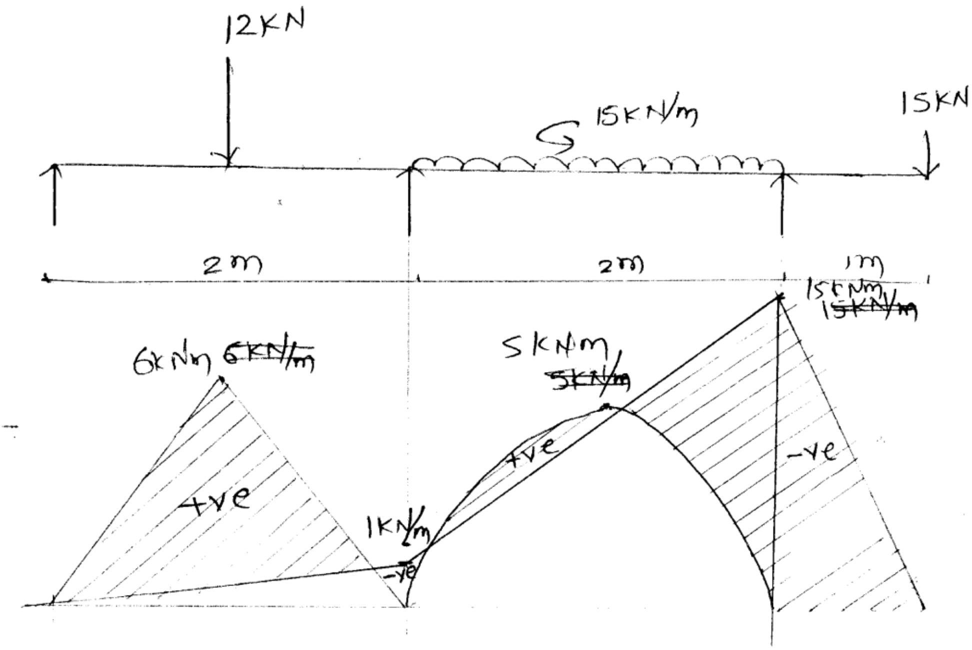
(02)

MA = 0

MB = ~~1KN/m~~ -1 KNm

MC = - 15KNm

(+)


12KN
15KN/m
15KN
2m
2m
1m
15KNm
~~15KN/m~~
6KNm ~~6KN/m~~
5KNm
~~5KN/m~~
+ve
+ve
-ve
1KN/m
-ve

(01)

BMD.

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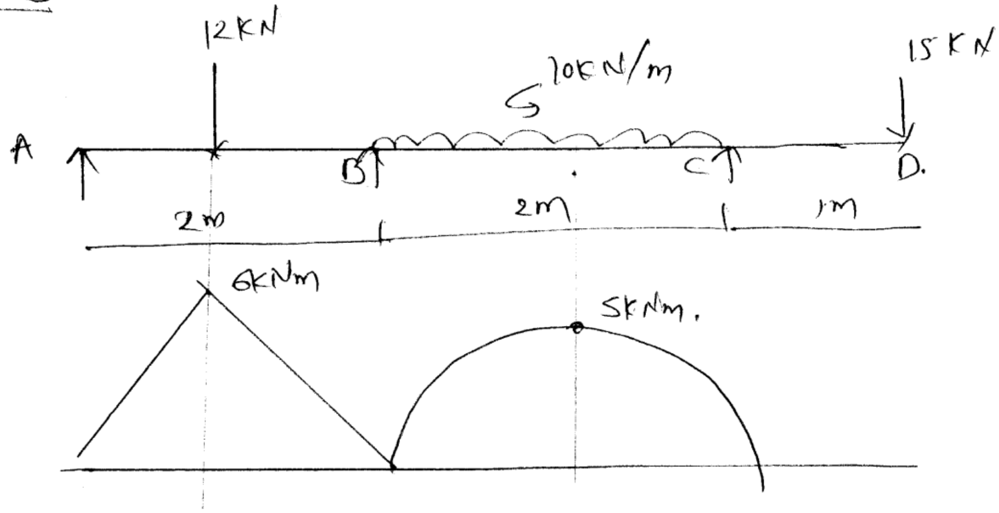
Q3 B



Known,

$MA = 0$, $MC = -15KNm$

Step I

Free moments

① span AB

$$ME = \frac{W_1 L_1}{4} = \frac{12 \times 2}{4} = 6 \, \cancel{KN/m} \, KNm$$

② Span BC

$$MF = \frac{\omega_2 L_2^2}{8} = \frac{10 \times 2^2}{8} = 5KNm$$

Step 2 Evaluate $\frac{6a\bar{x}}{L}$

For span AB

$$\frac{6a_1\bar{x}_1}{L_1} = 6 \times \left(\tfrac{1}{2} \times 2 \times 6\right) \times \tfrac{1}{2}$$
$$= 18$$

For span BC

$$\frac{6a_2\bar{x}_2}{L_2} = 6 \times \left(\tfrac{2}{3} \times 2 \times 5\right) \times \tfrac{1}{2}$$
$$= 20$$

Step 3

Use of three moment equation

$$M_A L_1 + 2M_B(L_1+L_2) + M_C L_2 = -\left[\frac{6a_1\bar{x}_1}{L_1} + \frac{6a_2\bar{x}_2}{L_2}\right]$$

$$0 + 2M_B(2+2) - 15 \times 2 = -[18+20]$$

$$8M_B - 30 = -38$$

$$8M_B = -38 + 30$$

$$8M_B = -8$$

$$\underline{M_B = -1\,\text{KNm}}$$

Answer

$M_A = 0$

$M_B = -1\,\text{kNm}$

$M_C = -15\,\text{kNm}$

Q. 3 C.

c) Assumptions used in the theory of long columns (ie ~~Euler as~~ Assumptions made in Euler's Theory of Long column)

1) The compressive load is exactly axial ie it passes through the centroid of the column section.

ANY 04 4 MARKS

2) The material of the column is perfectly homogeneous and isotropic.

3) The column is initially straight and of uniform lateral dimensions.

4) The column is long and fails due to buckling only.

5) Shortening of the column due to direct compression is neglected.

6) The self weight of the column is neglected.

7) The stresses do not exceed the limit of proportionality.

Solution ~~for~~ of a problem —

Given $l_{eff} = 4.2m$ (effective length).

~~axia~~ radious of colum $(r) = 90mm$

$\sigma_c = 500 Mpa$; $a = 1/1700$

Find Out;

axial load (P).

Solution: assume $E = 2\times10^5\ N/mm^2$; $l_e = 4200mm$

$r = 90mm$; $d = 180mm$.

01 $A = \pi r^2 = 25.446 \times 10^3\ mm^2$

01 $I_{yy} = I_{xx} = \frac{\pi}{64} d^4 = 51.5299 \times 10^6\ mm^4$

Euler's formula for long column.

$$P = \frac{\pi^2 E I_{min}}{(L_e)^2} \quad (01)$$

$$P = \frac{\pi^2 \times 2\times10^5 \times 51.53\times10^6}{(4200)^2}$$

$$= \cancel{5.766\times10^6 N}.\ 5766.22\times10^3 N$$

ie

$$\boxed{P = 5766.22\ KN} \quad (01)$$

Q4. Attempt any Four of the following. (4x4) (8)

a) Given.

d = diometer of chimney = 4m

h = height of chimney = 50m

p = horizontal wind pressure = 1.4 kpa

= 1400 pa.

Solution :—

Wind force (P) = c × p × projected area.
acting at h/2

where C = 0.67 for circular c/s.

~~Win~~. P = c × p × projected area.

= 0.67 × 1400 × 4 × 50

= 187600 N

$$M = P \times \frac{h}{2} = 187600 \times \frac{50}{2}$$

$$= 4.69 \times 10^6 \text{ Nm.}$$

$$Z = \frac{\pi}{32} \times D^3$$

$$= \frac{\pi}{32} \times 4^3$$

$$= 6.283 \text{ m}^3$$

$\therefore$ bending stress $(\sigma b) = \frac{M}{Z}$

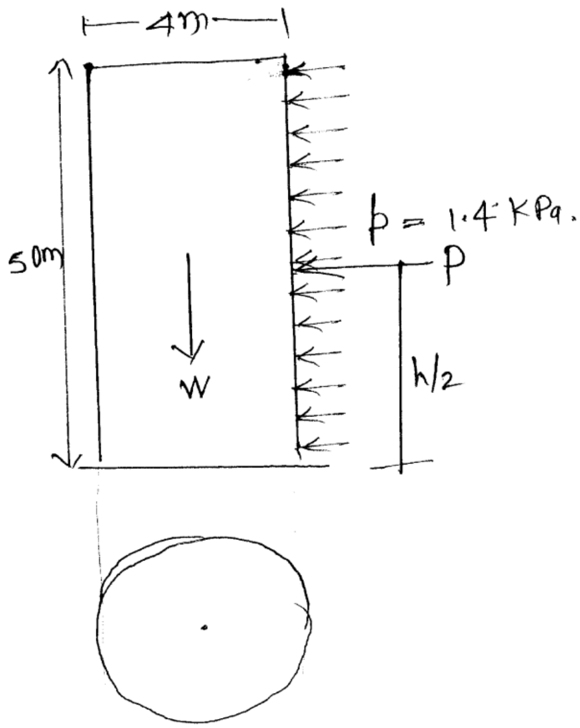
$= \frac{4.69 \times 10^6}{6.283}$

$= 746.45 \times 10^3 \; N/m^2$

$$\boxed{\sigma_b = 746.45 \; kN/m^2}$$

Ans :-

$\sigma b = 746.45 \; kN/m^2$



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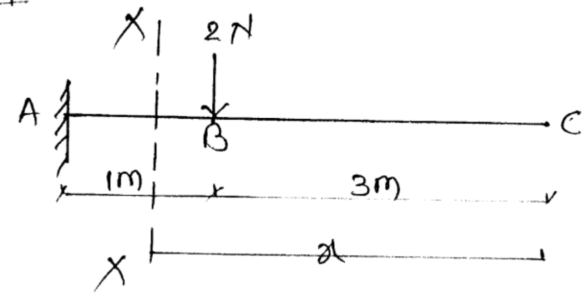
Q.4] ~~At~~
b)



Consider a section XX at a distance x from C

$$M_x = -2(x-3)$$

$$EI \frac{d^2y}{dx^2} = M_x$$

$$= -2(x-3)$$

$$EI \frac{dy}{dx} = -2\frac{(x-3)^2}{2} + C_1$$

$$\boxed{EI\,\theta = -(x-3)^2 + C_1} \rightarrow eq\ (1)$$

$$\boxed{EI\,y = -\frac{(x-3)^3}{3} + C_1 x + C_2} \rightarrow eq\ (2)$$

in equation (1) at $x = 4$, $\theta = 0$

$$EI \cancel{\phi}_{0} = -(4-3)^2 + C_1$$

$$0 = -(1)^2 + C_1$$

$$\therefore \underline{\underline{C_1 = 1}}$$

In equation (2) at $x = 4$, $y = 0$

$$0 = -\frac{(4-3)^3}{3} + 1 \times 4 + C_2$$

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$$0 = -\frac{1}{3} + 4 + C_2$$

$$C_2 = -4 + \frac{1}{3}$$

$$C_2 = -3.67$$

∴ Slope equation;

$$\boxed{EI\,\theta = -(x-3)^2 + 1} \longrightarrow eq\ 3$$

∴ Deflection equation;

$$EIy = -\frac{(x-3)^3}{3} + \overset{1x}{\cancel{C_1}} - 3.67 \longrightarrow eq\ 4$$

To calculate deflection at free end

ie y_c ; $x = 0$ in equation 4

$$EI\,y_c = -\frac{(0-3)^3}{3} + 1 \times 0 - 3.67$$

$$EI\,y_c = 9 - 3.67$$

$$\boxed{y_c = \frac{5.33}{EI}}$$

Pl. cle

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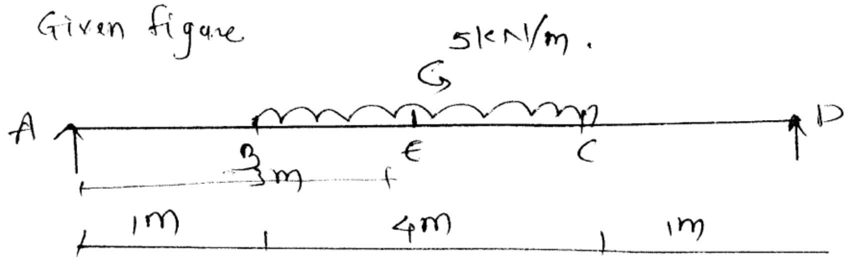
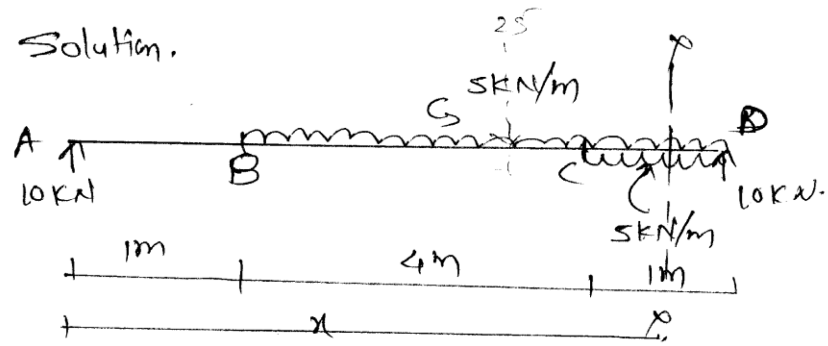
Q4 E Given figure



To find y max.

Solution.



Consider section at X-X at distance x from A.

~~M_x~~ To Calulcate seation of beam

$M_A = 0$

$R_D \times 6 = 25 \times 3.5 - 5 \times 5.5$

$R_D = \frac{60}{6} = 10 KN$

$R_A = 25 - 5 - 10$

$= 10 \text{ KN.}$

$M_x = 10x - 5\frac{(x-1)^2}{2} + 5\frac{(x-5)^2}{2}$

$= 10x - 2.5(x-1)^2 + 2.5(x-5)^2$

$\frac{d^2y}{dx^2} EI = \frac{10x^2}{2} - 2.5(x-1)^2 + 2.5(x-5)^2$

$$\frac{dy}{dx} EI = 10\frac{x^2}{2} - 2.5\frac{(x-1)^3}{3} + 2.5\frac{(x-5)^3}{3}$$

$$\boxed{\frac{dy}{dx} EI = 5x^2 + C_1 - 0.833\frac{(x-1)^3}{\cancel{3}} + 0.833(x-5)^3} \rightarrow \text{eq } (1)$$

$$\cancel{EIy = \frac{5x^3}{3} + C_1x + C_2 - 0.833\frac{(x-1)^4}{4} + \frac{0.833}{4}(x-5)^4}$$

$$\cancel{= 1.67x^3 + C_1x + C_2 - 0.8}$$

$$EIy = \frac{5x^3}{3} + C_1x + C_2 - 0.833\frac{(x-1)^4}{4} + 0.833\frac{(x-5)^4}{4}$$

$$EIy = 1.67x^3 + C_1x + C_2 - 0.208(x-1)^4 + 0.208(x-5)^4 \longrightarrow \text{Eq } (2)$$

~~Slope equation~~

$\cancel{EI\theta = 5x}$

In eq (2) at $x = 0$, $y = 0$

$$\cancel{EIy} = 1.67\cancel{x^3} + C_1\cancel{x} + C_2$$

$$\boxed{C_2 = 0}$$

In eqn (2) at $x = 6m$, $y = 0$

$$EIy = 1.67x^3 + C_1x - 0.208(x-1)^4 + 0.208(x-5)^4$$

$$0 = 1.67 \times 6^3 + 6C_1 - 0.208(6-1)^4 + 0.208(6-5)^4$$

$$0 = 360.72 + 6C_1 - 130 + 0.208$$

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$$6C_1 = -230.928$$

$$\boxed{C_1 = -38.49}$$

Deflection eqn is

$$EIy = 1.67x^3 - 38.49x + 0.208(x-1)^4 + 0.208(x-5)^4$$

Slope eqn is

$$EI\theta = 5x^2 - 38.49 - 0.833(x-1)^3 + 0.83(x-5)^3$$

due to symmetry deflection is maximum at 3m,

$x = 3m$.

$$EIy = 1.67x^3 - 38.49x + 0.208(x-1)^4$$

$$= 1.67 \times 3^3 - 38.49 \times 3 + 0.208(3-1)^4.$$

$$\cancel{= 45.09 - 115.49 - 0.208(}$$

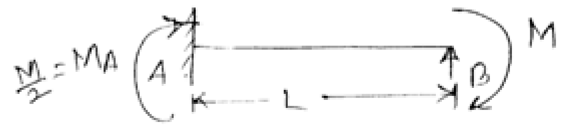
$$= 45.09 - 115.47 + \cancel{0.208(3.} 3.328$$

$$EIy = -67.052$$

$$\boxed{\therefore y_E = \frac{-67.052}{EI}} \rightarrow \text{Ans}$$

-ve sign ~~idnt~~ indicated downward deflection.

Q.4 d - Carry over factor – For one end fixed and other end simply supported — (01)



When the moment applied at A as clockwise moment 'M', then the moment produced at A is (02) half the moment applied at B, but in opposite nature, $M_A = \frac{M}{2}$

Thus here the carryover factor is one-half (01)

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Q.-4

e) Nature of moments induced due to continuity :-

For the usual downward loadings on the continuous beam, hogging moments causing convexity upwards occur at the intermediate supports and sagging moments causing convexity downwards occur at the mid-spans.

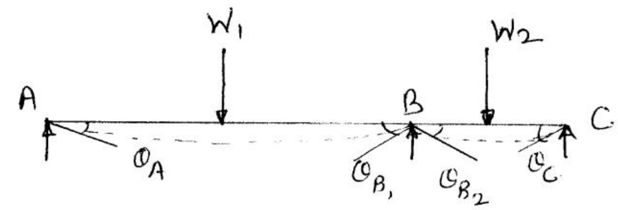

fig:- Continuous beam with simply supported ends

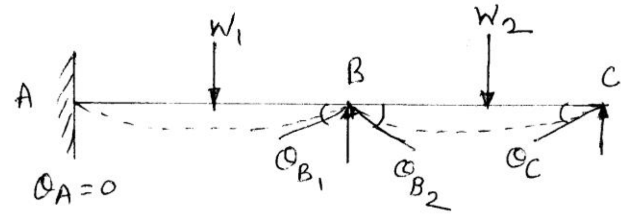

fig:- Continuous beam with one end fixed and other simply supported.

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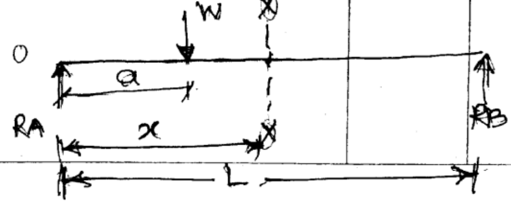
Brief Solution and Structured Marking Scheme

For the subject:- Theory of structures Code No. :- 12138

Name of Brach and Year:- Civil Engg. (III)

Q. NO.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum marks for Question / sub Question	Remark
5	(a)	Macaulay's Method :- Steps :- 1) Find support reactions 2) Take 'O' as origin and take section x-x at a distance 'x' from origin. 3) Prepare bending moment equation at section X-X 'M' 4) Write differential equation i.e. $EI\frac{d^2y}{dx^2} = M$ $= R_A x - W(x-a)$ 5) Integrating above equation w.r.t. x $EI\frac{dy}{dx} = R_A\cdot\frac{x^2}{2} + C_1 - \frac{W(x-a)^2}{2}$ ---- Slope Eq^n 6) Again integrating above equation w.r.t. x $EI\,y = R_A\cdot\frac{x^3}{6} + C_1 x + C_2 - \frac{W(x-a)^3}{6}$ -- $Defl^n$ Eq^n 7) Find C_1 and C_2 by using boundary conditions 8) Substitute values of C_1 & C_2 in slope and deflection equation. With values of x find slope and ~~eq~~ deflection. 			Each step 1 Mark. Cont...

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Brief Solution andStructured Marking Scheme

For the subject:- Theory of structures Code No. :- 12138

Name of Brach and Year:- Civil Engg (III)

Q. NO.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum marks for Question / sub Question	Remark
5	(b)	Fixed end Moment at A is			
		$M_A = -\frac{Wab^2}{L^2}$		$1\frac{1}{2}$ Mark	
		$= -\frac{W x_1 x_2^2}{(x_1+x_2)^2}$		$1\frac{1}{2}$ Mark	
		$= -\frac{W x_1 x_2^2}{x_1^2+x_2^2+2x_1x_2}$		1 Mark	
		~~MB~~ Fixed end moment at B is			
		$M_B = -\frac{Wa^2b}{L^2}$		$1\frac{1}{2}$ Mark	
		$= -\frac{W x_1^2 x_2}{(x_1+x_2)^2}$		$1\frac{1}{2}$ Mark	
		$= -\frac{W x_1^2 x_2}{x_1^2+x_2^2+2x_1x_2}$		1 Mark	
	If above prob solved by 1^{st} principle or if $x_1 = x_2$ assumed & the prob. is solved then for correct ans give marks				

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Brief Solution andStructured Marking Scheme

For the subject:- Theory of structures Code No. :- 12138

Name of Brach and Year:- Civil Engg (III)

Q. NO.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum marks for Question / sub Question	Remark
5	(c)	Moment Distribution Method for Symmetrical Portal Frame Steps:- Each step 1 Mark 1) Open the portal frame and treat it exactly as a three span continuous beam. 2) Assume the span AB, BC and CD as a fixed beam and find the fixed end moments 3) Find stiffness factors at the joints B & C 4) Find distribution factors at the joints B & C 5) Prepare moment distribution table & find the moments at support and joint. 6) Process of moment distribution ~~tab~~ can be stopped at the end of 4^{th} distribution 7) Assume each span of given frame to be simply supported & find free bending moment. 8) Superimpose M'- diagram over the M- diagram & draw net BMD.			

Contd...

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Brief Solution andStructured Marking Scheme

For the subject:- Theory of structures Code No. :- 12138

Name of Brach and Year:- Civil Engg. (III)

Q. NO.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum marks for Question / sub Question	Remark
6	(a)	Direct Load i) When line of action of load coincides with the axis of the member is called as direct load ii) Direct load produces direct stress ($\sigma_0 = P/A$) iii) Direct load produces stress which is compressive in nature & intensity is uniform throughout the c/s ~~section~~ of member iv) Any one correct e.g.	Eccentric Load i) When line of action of load does not coincides with the axis of the member is called eccentric load ii) Eccentric load produces direct stress as well as bending stress $\sigma b = \pm \frac{M}{Z}$ iii) Eccentric load produces bending stress which may be compression or tensile in nature. & intensity is not uniform throughout the c/s ~~of~~ of member. iv) Any one correct e.g.	Each ~~step~~ difference 1 Mark	

Brief Solution & Structured Marking Scheme

Subject Title :- Theory of Structures QP Code No. :- 12138

Name of Course & Year / Sem. :- Civil Engg Third (V)

Q. No.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum Marks for Question / Sub Question	Remark
6	(b)	Differential Equation –			
		i) For deflection			
		$EI\,y = \iint M$	—	$1\frac{1}{2}$	Mark
		ii) For slope			
		$EI\frac{dy}{dx} = \int M$	—	$1\frac{1}{2}$	Mark
		where, EI – Flexural rigidity ($N\text{-}mm^2$)			
		M – Bending moment eq^n			1 Mark
		y – Deflection (mm)			
		$\frac{dy}{dx}$ – slope (rad)			
	(c)	Eulers Formula –			
		$P = \frac{\pi^2 E I_{min}}{(L_e)^2}$	—	1	Mark
		where, P = Safe load carrying capacity (N)			
		E = Young's Modulus of elasticity (MPa)			1 Mark
		I = Minimum moment of Inertia (mm^4)			

L_e = Effective length of column (mm)

Cont - - - -

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Brief Solution & Structured Marking Scheme

Subject Title :- Theory of Structures QP Code No. :- 12138

Name of Course & Year / Sem. :- Civil Engg. 3 (5th Sem)

Q. No.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum Marks for Question / Sub Question	Remark
		Limitations of Eulers formula –			
		Crusing stress $\sigma_c = \frac{\pi^2 E}{\left(\frac{Le}{k}\right)^2} = \frac{\pi^2 E}{\lambda^2}$		1 Mark	
		where $\lambda = \frac{Le}{k}$ - slenderness ratio			
		For mild steel – $\sigma_c = 325$ MPa, $E = 200$ GPa			
		$\therefore 325 = \frac{\pi^2 \times 200 \times 10^3}{\lambda^2}$		1 Mark	
		$\lambda \geq 77.93$ say 80			
		i.e. Eulers formula is only applicable when $\lambda \geq 80$ for mild steel when both ends are hinged.			

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Brief Solution & Structured Marking Scheme

Subject Title :- Theory of structures QP Code No. :- 12138

Name of Course & Year / Sem. :- Civil Engg III (V)

Q. No.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum Marks for Question / Sub Question	Remark
6	(d)	Points to be Considered — i) Tall structures are subjected to horizontal pressure due to wind following points should be considered 1) Height of building — Due to wind pressure, causing bending moment at the base of the structures. ii) Slef weight of the structure — Due to self weight compressive stress will develop. iii) Shape of structure — The wind force acts on the exposed surface of the structure. The shape of exposed surface affects magnitude of the force exerted by wind. $P = C \times p \times A_p$ $C = 1$ — for Flat surface shape, $C = 2/3$ — for circular shape iv) Projected Area (A_p) — If the surface of the structure is vertical, the total force acts at $H/2$ from base. If the surface of the structure is inclined, the total force acts at the C.G. of the projected area.			

— Each Point 1 Mark

Cont...

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Brief Solution & Structured Marking Scheme

Subject Title :- Theory of structures QP Code No. :- 12138

Name of Course & Year / Sem. :- Civil Engg (III) 5th Sem.

Q. No.	Sub Question No.	Key Points / Key Steps / Formula / Step by Solution / Correct Answer etc.	Marking Scheme	Maximum Marks for Question / Sub Question	Remark
6	(e)	Concept of deflected shape of continuous beam.			

i) Def^n. – When the beam is subjected to the downward loading then longitudinal axis of the beam bends or deflects in the form of a curve called elastic curve or deflected shape of the beam.

ii) Fig:

iii) Nature of Moments

Two types of moments –

a) Sagging – It produces convexity in downward direction (+ve)

b) Hogging – It produces convexity in upward direction at intermediate supports (–ve)

iv) Slopes –

At intermediate supports slopes are equal

i.e. $\theta_{B_1} = \theta_{B_2}$ & $\theta_{C_1} = \theta_{C_2}$

Each point @ 1 Mark