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CMR INSTITUTE OF TECHNOLOGY, BENGALURU.
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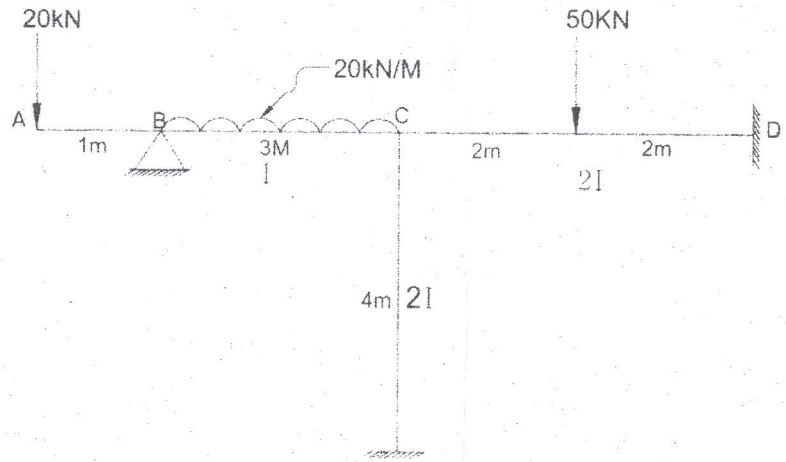
Internal Assessment Test 1 – Sept. 2018

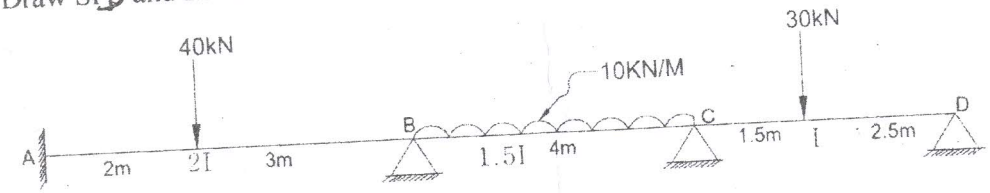
Sub:	Analysis of indeterminate Structures			Sub Code:	15CV52	Branch:	CV
Date:	07.09.2018	Duration:	90 min`s	Max Marks:	50	Sem / Sec:	Vth A &B

All questions are compulsory

1 (a) Analyse the frame shown in Fig by slope deflection method. Draw BMD [25]



2 (a) Analyse the continuous beam shown in Fig by moment distribution method. Draw SFD and BMD [25] CO 2 L3



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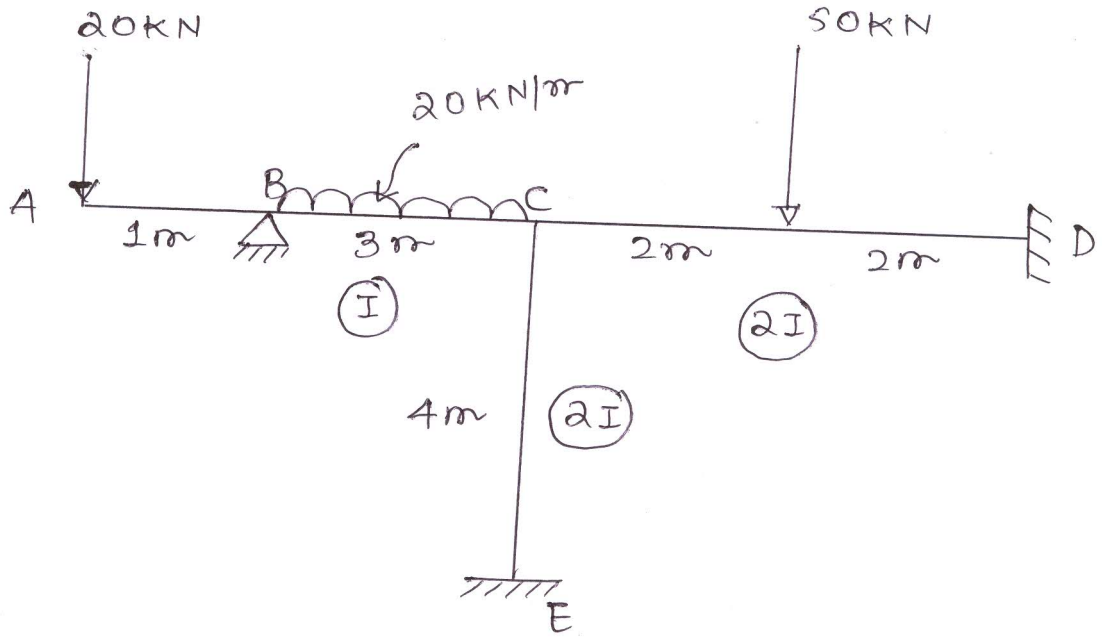
Q-1.(a) Slope-deflection method :-



(I) Fixed end moments :- [FEM's]

$$M_{FBC} = \frac{-wl^2}{12} = \frac{-20 \times 3^2}{12} = -15\ KNm$$

$$M_{FCB} = \frac{wl^2}{12} = \frac{20 \times 3^2}{12} = 15\ KNm$$

$$M_{FCD} = \frac{-wl}{8} = -\frac{50 \times 4}{8} = -25\ KNm$$

$$M_{FDC} = \frac{wl}{8} = \frac{50 \times 4}{8} = 25\ KNm$$

$$M_{FCE} = M_{FEC} = 0$$

(II) Slope-deflection equations

$$M_{BC} = M_{FBC} + \frac{2EI}{l}\left[2\theta_B + \theta_C - \frac{3\delta}{l}\right]$$

~~$= -15 + 2$~~

span BC, $l = 3m$

$I = I$

$\delta = 0$

$$M_{BC} = -15 + \frac{2EI}{3}\left[2\theta_B + \theta_C\right]$$

$$M_{BC} = -15 + 1.33EI\theta_B + 0.66EI\theta_C \quad \text{—— (1)}$$

$$M_{CB} = M_{FCB} + \frac{2EI}{l}\left[2\theta_C + \theta_B - \frac{3\delta}{l}\right]$$

$$M_{CB} = 15 + \frac{2EI}{3}\left[2\theta_C + \theta_B\right]$$

$$M_{CB} = 15 + 1.33EI\theta_C + 0.66EI\theta_B \quad \text{— (2)}$$

span CD, $l = 4m$

$I = 2I$

$\theta_D = 0$

$\delta = 0$

$$M_{CD} = M_{FCD} + \frac{2EI}{l}\left[2\theta_C + \theta_D - \frac{3\delta}{l}\right]$$

$$M_{CD} = -25 + \frac{4EI}{4}\left[2\theta_C\right]$$

$$M_{CD} = -25 + 2EI\theta_C \quad \text{—— (3)}$$

$$M_{DC} = M_{FDC} + \frac{2EI}{l}\left[2\cancel{\theta_D}^{0} + \theta_C - \frac{3\cancel{\delta}^{0}}{l}\right]$$

$$M_{DC} = 25 + \frac{4EI}{4}[\theta_C]$$

$$M_{DC} = 25 + EI\theta_C \quad \text{---} \quad (4)$$

span, CE, $I = 2I$

$l = 4m$

$\theta_E = 0$

$$M_{CE} = M_{FCE} + \frac{2EI}{l}\left[2\theta_C + \cancel{\theta_E}^{0} - \frac{3\cancel{\delta}^{0}}{l}\right]$$

$$M_{CE} = 0 + \frac{4EI}{4}[2\theta_C]$$

$$M_{CE} = 2EI\theta_C \quad \text{---} \quad (5)$$

$$M_{EC} = M_{FEC} + \frac{2EI}{l}\left[2\cancel{\theta_E}^{0} + \theta_C - \frac{3\cancel{\delta}^{0}}{l}\right]$$

$$M_{EC} = 0 + \frac{4EI}{4}[\theta_C]$$

$$M_{EC} = EI\theta_C \quad \text{---} \quad (6)$$

(III) Joint equilibrium condition-

@ Joint B,

$$\cancel{M_{AB}}\ M_{BA} + M_{BC} = 0$$

$$M_{BA} = 20\ KNm$$

$\Rightarrow \quad 20 - 15 + 1.33\,EI\theta_B + 0.66\,EI\theta_C = 0$

$\Rightarrow \quad 1.33\,EI\theta_B + 0.66\,EI\theta_C = -5 \quad \text{—— (A)}$

@ Joint C, $M_{CB} + M_{Ce} + M_{CD} = 0$

$\Rightarrow 15 + 1.33\,EI\theta_C + 0.66\,EI\theta_B + 2EI\theta_C + (-25) + 2EI\theta_C = 0$

$\Rightarrow \quad 0.66\,EI\theta_B + 5.33\,EI\theta_C = 10 \quad \text{— (B)}$

Solving (A) and (B), we get:

$$\theta_B = \frac{-5}{EI} \quad \text{and} \quad \theta_C = \frac{2.49}{EI}$$

(IV) End Moments-

substituting θ_B and θ_C in SD eq's

$$M_{BC} = -15 + 1.33\,\cancel{EI}\left(\frac{-5}{\cancel{EI}}\right) + 0.66\,\cancel{EI} \times \left(\frac{2.49}{\cancel{EI}}\right)$$

$$M_{BC} = -20.00\ \text{KNm}$$

$$M_{CB} = 15 + 1.33\,EI \times \left(\frac{2.49}{EI}\right) + 0.66\,EI\left(\frac{-5}{EI}\right)$$

$$M_{CB} = 15.011\ \text{KNm}$$

$$M_{CD} = -25 + 2\cancel{EI}\left(\frac{2.49}{\cancel{EI}}\right)$$

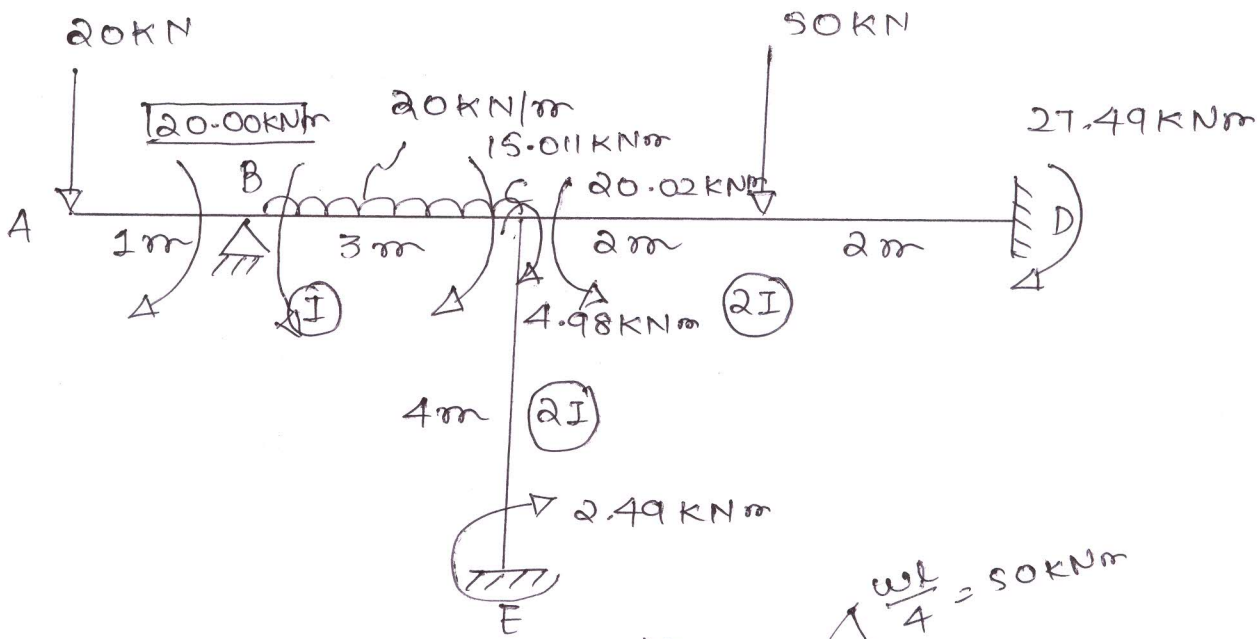
$$M_{CD} = -20.02\ \text{KNm}$$

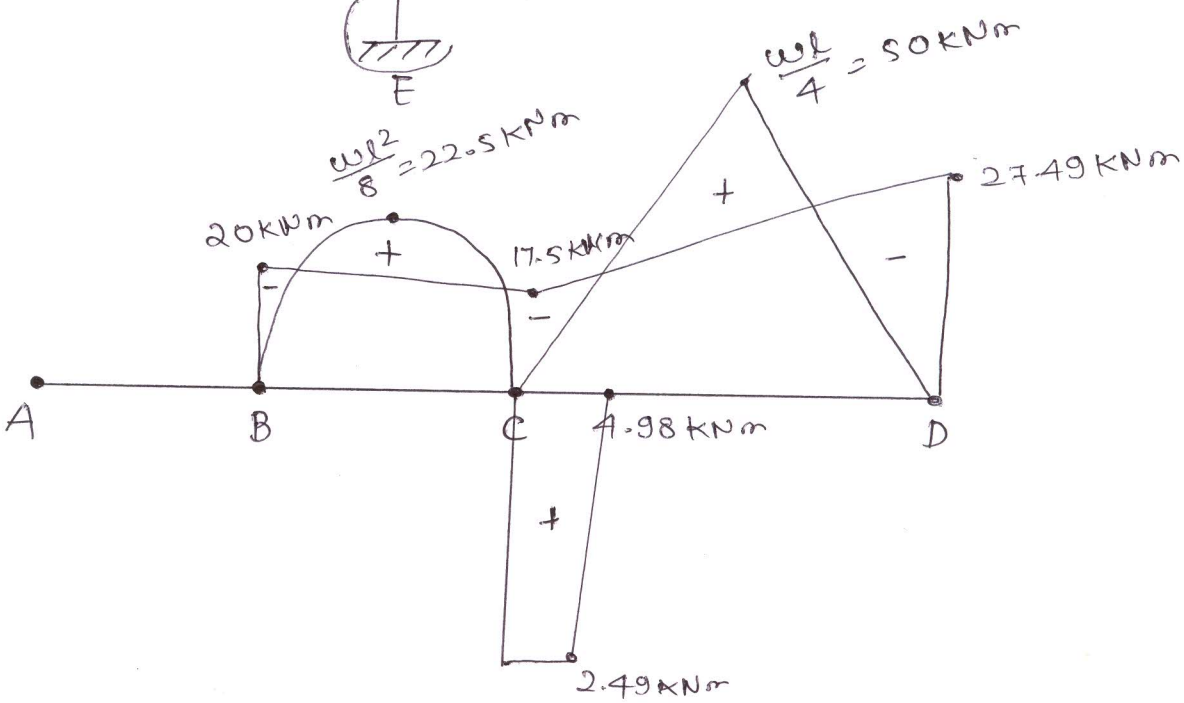
$$M_{DC} = 25 + \cancel{EI} \times \left(\frac{2.49}{\cancel{EI}}\right) = 27.49\ KNm$$

$$M_{CE} = 2\cancel{EI} \times \left(\frac{2.49}{\cancel{EI}}\right) = 4.98\ KNm$$

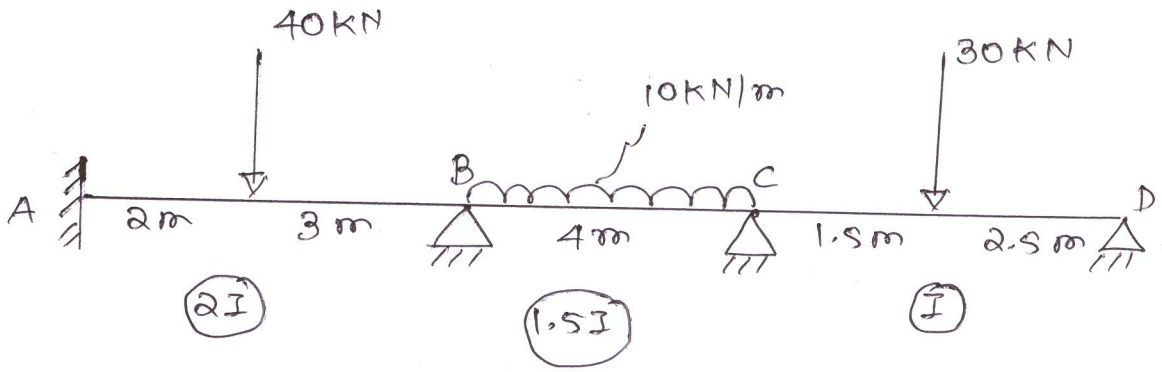
$$M_{EC} = \cancel{EI} \times \left(\frac{2.49}{\cancel{EI}}\right) = 2.49\ KNm$$

(V) Bending moment diagram.





Q-2.(a) Moment-distribution Method-



(I) FEM's

$$M_{FAB} = \frac{-wab^2}{l^2} = \frac{-40\times2\times3^2}{5^2} = -28.8\ KNm$$

$$M_{FBA} = \frac{wa^2b}{l^2} = \frac{40\times2^2\times3}{5^2} = 19.2\ KNm$$

$$M_{FBC} = \frac{-wl^2}{12} = \frac{-10\times4^2}{12} = -13.33\ KNm$$

$$M_{FCB} = \frac{wl^2}{12} = \frac{10\times4^2}{12} = 13.33\ KNm$$

$$M_{FCD} = \frac{-wab^2}{l^2} = \frac{-30\times1.5\times2.5^2}{4^2} = -17.57\ KNm$$

$$M_{FDC} = \frac{wa^2b}{l^2} = \frac{30\times1.5^2\times2.5}{4^2} = 10.54\ KNm$$

(II) Distribution factors-

Joint	Member	K	ΣK	Df = K/ΣK
B	BA	I/l = 0.4I	0.775I	0.52
	BC	I/l = 0.375I		0.48
C	CB	I/l = 0.375I	0.5625I	0.67
	CD	$\frac{3}{4}\frac{I}{l}$ = 0.1875I		0.33

(III) Moment distribution Table-

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
D.f	-	0.52	0.48	0.67	0.33	-
FEM	-28.8	19.2	-13.33	13.33	-17.57	10.54
Released						-10.54
					-5.27	
Initial Val.	-28.8	19.2	-13.33	13.33	-22.84	0
Bal.		-3.052	-2.817	6.371	3.138	0
CO	-1.526		3.185	-1.408		0 ~~1.569~~
Bal		-1.656	-1.528	0.943	0.464	
CO	-0.828		0.471	-0.764		0 ~~0.232~~
Bal		-0.244	-0.226	0.511	0.252	
CO	-0.122		0.255	-0.113		0 ~~0.126~~
** Bal		-0.132	-0.122	0.075	0.037	

(IV) End moments -

$M_{AB} = -31.276\ KNm$

$M_{BA} = 14.116\ KNm$

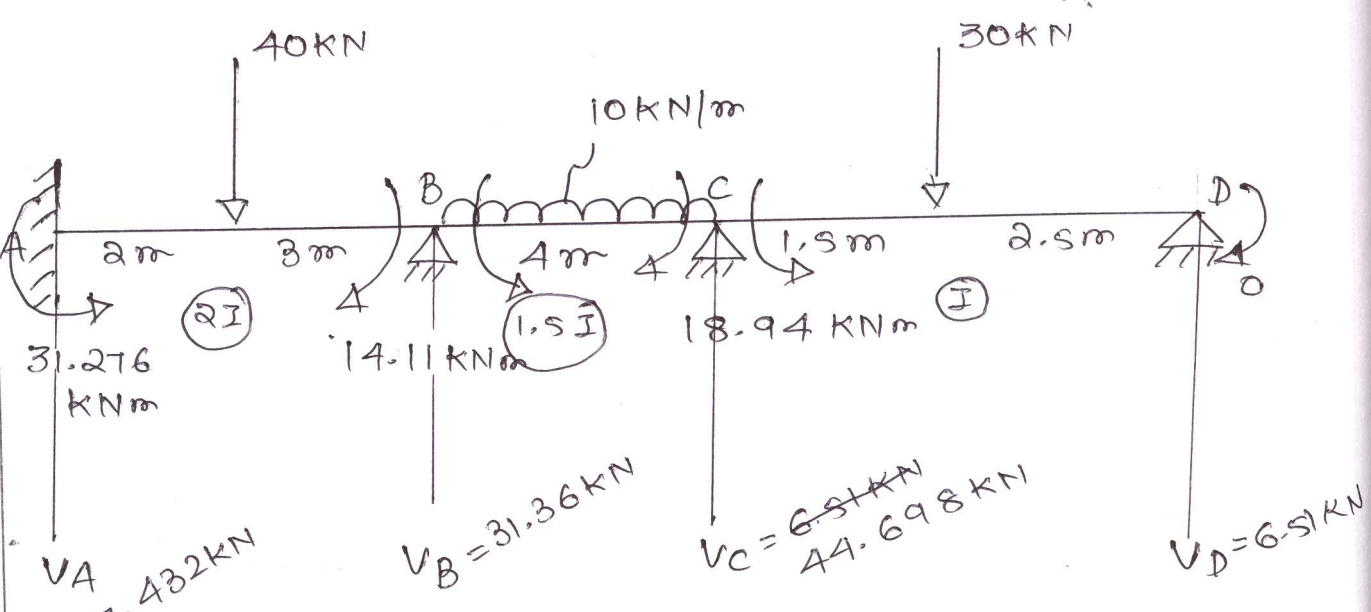
$M_{BC} = -14.112\ KNm$

$M_{CB} = 18.945\ KNm$

$M_{CD} = -18.949\ KNm$

$M_{DC} = 0$

(V) SFD and BMD



$$V_A + V_B + V_C + V_D = 110\ KN$$

$$\Sigma M_B = 0 \quad [LHS]$$

$$V_A \times 5 - 40 \times 3 - 31.276 + 14.116 = 0$$

$$V_A = 27.432\ KN$$

$\Sigma M_C = 0$ [RHS]

$-4V_D + 30 \times 1.5 - 18.949 = 0$

$\boxed{V_D = 6.51 \text{ KN}}$

$\Sigma M_C = 0$ [LHS]

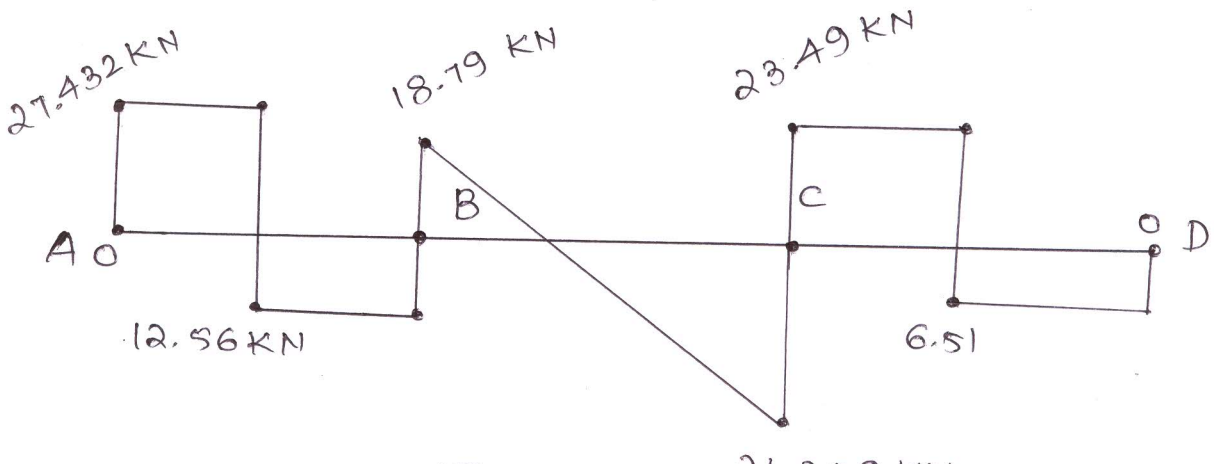
$(27.432 \times 9) + V_B \times 4 - (40 \times 7) - (40 \times 2)$

$-31.276 + 18.945 = 0$

$\boxed{V_B = 31.36 \text{ KN}}$

$\boxed{V_C = 44.698 \text{ KN}}$

SFD >>



BMD >> $\frac{wab}{l} = 48 \text{KNm}$