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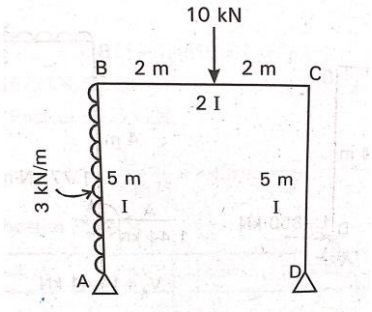
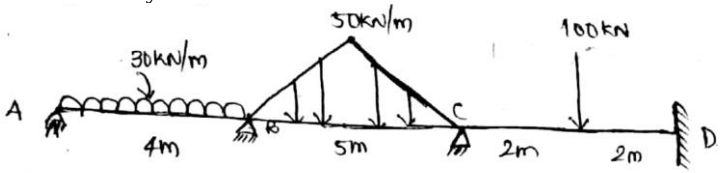
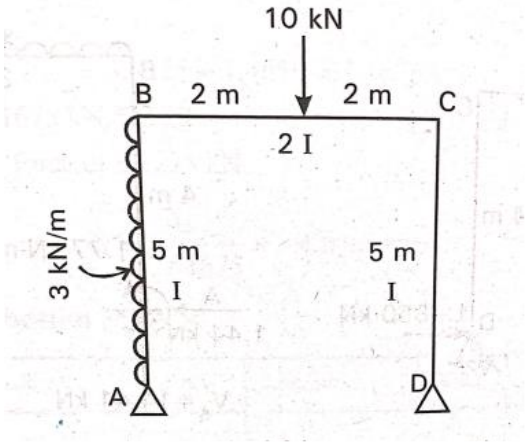
Internal Assessment Test 2

Sub:	Analysis of Indeterminate Structures					Sub Code:	18CV52	Branch:	Civil
Date:	16/12/2021	Duration:	90 min's	Max Marks:	50	Sem / Sec:	5A and 5B		OBE

	Answer TWO FULL Questions **Assume any missing data**	MARKS	CO	RBT
1.	Problem 1: Analyze the portal frame shown in Fig 1. using the MD method. Sketch BMD and SFD 	[25]	CO2	L4
2.	Analyze the continuous beam shown in Fig 2. using the Kani's matrix method. Sketch BMD and SFD and SFD when the Support B is setteling by 8mm, D is rotating in anticlockwise by 0.002 radians and EI=21000kN.m^2 	[25]	CO4	L4

Problem 1: Analyse the given beam using MDM. Draw SFD and BMD



1. Non-Sway analysis:

Steps

I. Fixed end moments

Mfab= -6.25, Mfba= 6.25, Mfbc= -5,Mfcb= 5, Mfcd= 0, Mfdc=0

II. Distribution factor

Joint	*Member*	Relative Stiffness factor (K)	$\sum K$	Distribution factor DF= $\frac{K}{\sum K}$
B	BA	3EI/5=0.6	2.6	0.23
	BC	4E2I/4=2		0.77
C	CB	4E2I/4=2	2.6	0.77
	CD	3EI/5=0.6		0.23

III. Moment distribution table

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	-	0.23	0.77	0.77	0.23	-
FEM	-6.25	6.25	-5	5	0	0
Release jt A	6.25					
		3.13				
Initial moments	0	9.38	-5	5	0	0
\Balance		-1.01	-3.37	-3.85	-1.15	
Carry over factor			-1.93	-1.69		
Balance		0.44	1.48	1.30	0.38	
Carry over factor			0.65	0.74		
Balance		-0.14	-0.5	-0.56	-0.17	
Carry over factor			-0.28	-0.25		
Balance		0.06	0.21	0.19	0.05	
Non sway moment	0	8.73	-8.74	0.89	-0.89	0

IV. Finding sway force with non sway moments

$S= H_A+ H_D$

$H_A= \frac{M_{AB}+M_{BA}}{L_1} = \frac{0+8.73-3*5*2.5}{5}$= -5.75 or 5.75

$H_D= \frac{M_{CD}+M_{DC}}{L_2} = \frac{-0.89+0}{5}$ =-0.178 or 0.178

S= -0.17-5.75= -5.98 or 5.98 which is bcz of non sway moments

2. Sway analysis:

1. Ratios

Let M_{F1} and M_{F2} be the fixed end moments in the member AB and CD respectively and δ *be the sawy*.

$\frac{M_{F1}}{M_{F2}}: \frac{3EI\delta/l^2}{3EI\delta/l^2} = \frac{I}{L^2}: \frac{I}{L^2} = = \frac{I}{5^2}: \frac{I}{5^2}$ = 1:1

LET US TAKE -10: -10 (assuming it to be negative)

M_{F1}= -10 is for AB member AND M_{F2}= -10 for CD member

$M`_{FAB}$=-0, $M`_{FBA}$=-10

$M`_{FCD}$=-10, $M`_{FDC}$=-0

2. Moment distribution table

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	-	0.23	0.77	0.77	0.23	-
FEM	0	-10	0	0	-10	0
Balance		2.3	7.7	7.7	2.3	
Carry over factor			3.85	3.85		
Balance		-0.88	-2.96	-2.96	-0.88	
Carry over factor			-1.48	-1.48		
Balance		0.34	1.13	1.13	0.34	
Carry over factor			0.56	0.56		
Balance		-0.12	-0.43	-0.12	-0.43	
Moment due to sway	0	-8.36	+8.37	8.37	-8.36	0

3. The sway force for sway analysis on application of arbitrary moment is worked out. This sway force will be S`

$S`= H`_A + H`_D$

$H`_A = \frac{M`_{AB}+M`_{BA}}{L_1} = \frac{0-8.36}{5}$= -1.66 or 1.66kN

$H`_D = \frac{M`_{CD}+M`_{DC}}{L_2} = \frac{-8.33+0}{5}$ =-1.66 or 1.66kN

S`= -1.66-1.66

S`=-3.32 or 3.32

Total Sway force = P = S+S` = -5.92-3.32 = -9.24 or 9.24

3. Neutralizing

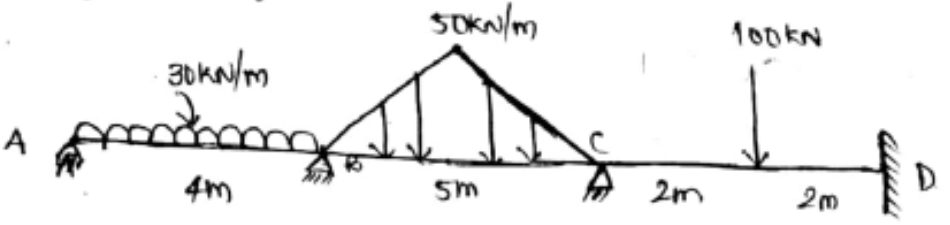
$X = \frac{total\ sway\ force}{sway\ force\ \ due\ to\ sway\ moment} = \frac{9.24}{3.32}$= 2.78

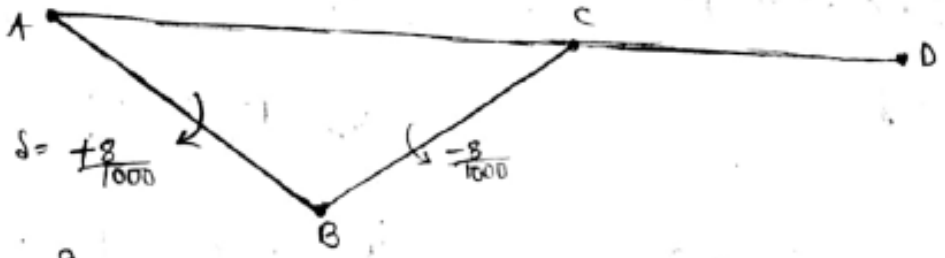
moment due to sway	0	-8.36	+8.37	8.37	-8.36	0
$X *$ Final moment due to sway	0	-22.67	22.67	22.67	-22.67	0
Non sway moment	0	8.73	-8.73	0.89	-0.89	0
Final moments	0	-13.94	13.94	23.56	-23.56	0

Support B sinks by 8mm

NE = $\frac{4EI\theta}{l}$

FE = $\frac{2EI\theta}{l}$





$EI = \frac{210\times10^9}{1000} \times \frac{N}{m^2} \times 0.1\times10^9\times10^{-12}\ m^4$

$EI = 21000\ kNm^2$

Step 1:- Fixed end moments

$M_{FAB} = \frac{-\omega l^2}{12} - \frac{6EI\delta}{l^2} = \frac{-30\times4^2}{12} - \frac{6\times21000}{4^2}\left(\frac{8}{1000}\right)$

$M_{FAB} = -103\ kNm$

$M_{FBA} = \frac{\omega l^2}{12} - \frac{6EI\delta}{l^2} = \frac{30\times4^2}{12} - \frac{6\times21000\times8}{4^2\times1000} = +23\ kNm$

$M_{FBC} = \frac{-5}{96}\omega l^2 - \frac{6EI\delta}{l^2} \Rightarrow \frac{-5\times50\times5^2}{96} - \frac{6\times21000\times(-8)}{5^2\times1000} = -24.78\ kNm$

$M_{FCB} = \frac{5}{96}\omega l^2 - \frac{6\times21000\times-8}{5^2\times1000} = \frac{5\times50\times5^2}{96} - \frac{6\times21000\times-8}{5^2\times1000} = 105.4\ kNm$

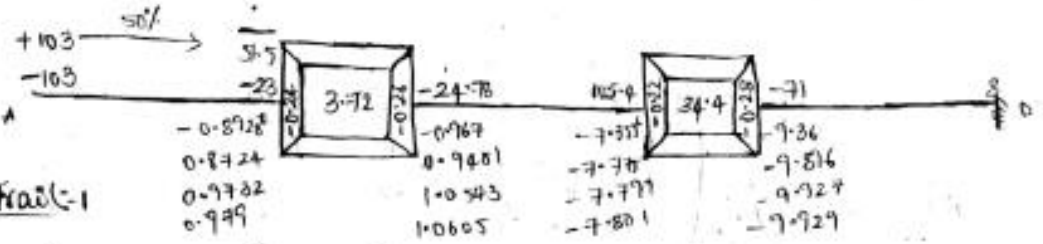
$M_{FCD} = \frac{-\omega l}{8} + \frac{2EI\theta}{l} \Rightarrow \frac{-100\times4}{8} + \frac{2\times21000\times(-0.002)}{4} = -71\ kNm$

$M_{FDC} = \frac{\omega l}{8} + \frac{4EI\theta}{l} \Rightarrow \frac{100\times4}{8} + \frac{4\times21000}{4}\left(-0.002\right) = 8\ kNm$

Step 2:- Rotational factor

Joint	member	k	Σk	$U = \frac{-1}{2}\frac{k}{\Sigma k}$
B	BA	$\frac{3}{4}\times\frac{I}{L} = 0.1875I$	$0.3875I$	-0.24
	BC	$\frac{I}{L} = 0.2I$		-0.26
C	CB	$\frac{I}{L} = 0.2I$	$0.45I$	-0.22
	CD	$\frac{I}{L} = 0.25I$		-0.28

Step 3:- Rotational moments ($m' = U(\Sigma M_F + FERM)$)



Trail-1

$m'_{ba} = -0.24(3.72+0) = -0.8928$

$m'_{ba} = -0.26(3.72+0) = -0.967$

$m'_{cb} = -0.22(34.4 - 0.967) = -7.355$

$m'_{cd} = -0.28(34.4 - 0.967) = -9.36$

Trail ii:-

$m'_{ba} = -0.24(3.72 - 7.355) = 0.8724$

$m'_{bc} = -0.26(3.72 - 7.355) = 0.9451$

$m'_{cb} = -0.22(34.4 + 0.9451) = -7.775$

$m'_{cd} = -0.28(34.4 + 0.9451) = -9.876$

Trail iii:-

$m'_{ba} = -0.24(3.72 - 7.775) = 0.9732$

$m'_{bc} = -0.26(3.72 - 7.775) = 1.0543$

$m'_{cb} = -0.22(34.4 + 1.0543) = -7.799$

$m'_{cd} = -0.28(34.4 + 1.0543) = -9.927$

Trail iv:-

$m'_{ba} = -0.24(3.72 - 7.799) = 0.979$

$m'_{bc} = -0.26(3.72 - 7.799) = 1.0605$

$m'_{cb} = -0.22(34.4 + 1.0605) = -7.801$

$m'_{cd} = -0.28(34.4 + 1.0605) = -9.929$

Step 4 :- End moments :- ($M_F + 2$ NERM $+ 1$ FERM)

$M_{AB} = 0$ (due to use release A value)

$M_{BA} = M_{FBA} + 2(0.979) + 1(0) = +28.54\ 2\ (0.979) = +30.492$ kNm

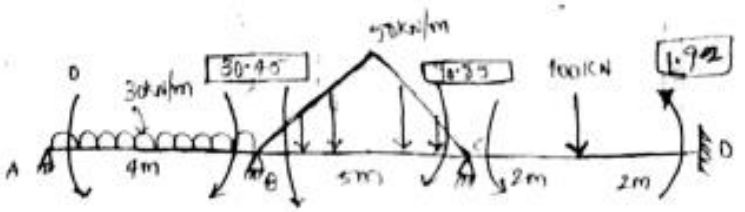
$M_{BC} = M_{FBC} + 2(1.0605) + 1(-7.79) = -30.96$ kNm

$M_{CB} = M_{FCB} + 2(-7.79) + 1(1.05) = 90.87$ kNm

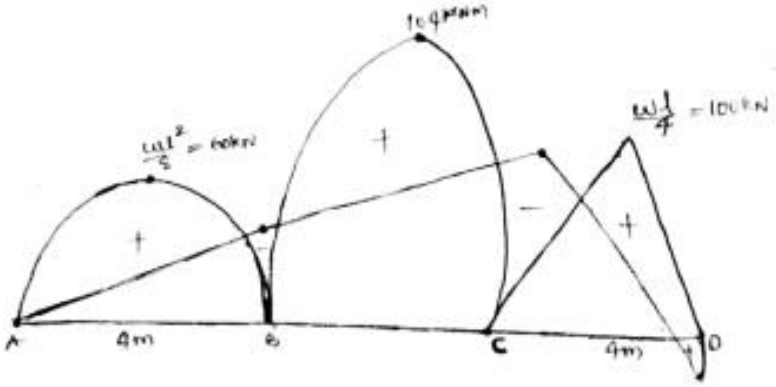
$M_{CD} = -71 + 2(-9.92) + 1(0) = -90.84$ kNm

$M_{DC} = 8 + 2(0) + 1(-9.92) = -1.92$ kNm

Step 5 :- SFD & BMD



BMD :-



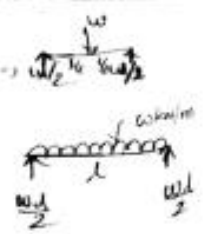
$\Rightarrow \Sigma F_y = 0 \Rightarrow R_1 + R_2 - \frac{1}{2} \times 5 \times 50 = 0 \Rightarrow R_1 + R_2 = 125$

$\Sigma M_B = 0 \Rightarrow -R_2 \times 5 + \frac{1}{2} \times 5 \times 50 \times 2.5 \Rightarrow \boxed{R_2 = 62.5\ kN}$

$\boxed{R_1 = 62.5\ kN}$

$\Rightarrow$ BM @ E $\Rightarrow 62.5 \times 2.5 - \frac{1}{2} \times 2.5 \times 50 \times \left(\frac{1}{3} \times 2.5\right)$

$= 104$ kNm



$\Sigma F_y = 0$

$V_A + V_B + V_C + V_D = 30\times4 + \frac{1}{2}\times5\times50 + 100$

$\Sigma M_B = 0$ (LHS)

$\Rightarrow V_A \times 4 + 30\cdot45 - 30\times4\times\frac{4}{2} = 0$

$\boxed{V_A = 52.38\ kN}$

$\Sigma M_C = 0$ (RHS)

$\Rightarrow -V_D \times 4 + 100\times2 - 90\cdot85 - 1\cdot92 = 0$

$\boxed{V_D = 26\cdot8\ kN}$

$\Sigma M_B = 0$ (RHS)

$-V_D\times9 + 100\times7 - 1\cdot92 - 30\cdot45 - V_C\times5 - \frac{1}{2}\times5\times50\times2\cdot5 = 0$

$\boxed{V_C = 147\cdot78\ kN}$

$\boxed{V_B = 118\cdot04\ kN}$

SFD:-