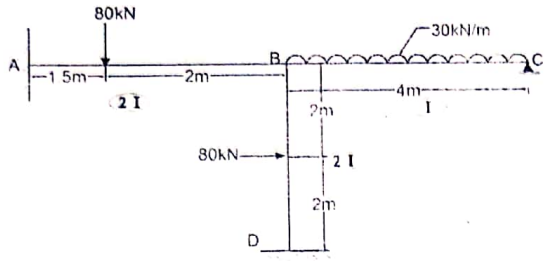
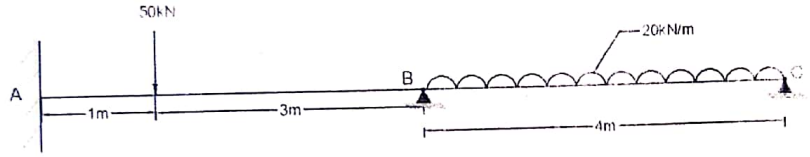
USN

Solution of Internal Assessment Test 3 –Nov. 2019

Sub:	Analysis of Indeterminate Structures			Sub Code:	17CV52	Branch:	Civil	
Date:	16/11/2019	Duration:	90 min's	Max Marks: 50	Sem / Sec:	5A and 5B		OBE

Answer TWO FULL Questions

		MARKS	CO	RBT
1.	Analyze the Frame show in fig 1. Using Stiffness matrix method. Draw **BMD and SFD**  fig 1	[25]	CO1	L3
2.	Analyze the Continuous beam show in fig 2. Using Flexibility matrix method. Draw **BMD and SFD**  fig 2	[25]	CO2	L3

Q.1

Step 1: FEM

$$M_{FAB} = \frac{-wab^2}{l^2} = \frac{-80\times1.5\times2^2}{3.5^2} = 39.18 \text{ kN-m}$$

$$M_{FBA} = \frac{wa^2b}{l^2} = \frac{80\times1.5^2\times2}{3.5^2} = 29.39 \text{ kN-m}$$

$$M_{FBC} = \frac{-wl^2}{12} = \frac{-30\times4^2}{12} = -40 \text{ kN-m}$$

$$M_{FCB} = \frac{wl^2}{12} = \frac{30\times4^2}{12} = 40 \text{ kN-m}$$

$$M_{FBD} = \frac{wl}{8} = \frac{80\times4}{8} = 40 \text{ kN-m}$$

$$M_{FDB} = \frac{-wl}{8} = \frac{-80\times4}{8} = -40 \text{ kN-m}$$

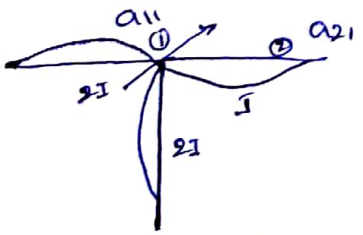
Step:2 Stiffness factor

$$\begin{bmatrix} \theta_B \\ \theta_C \end{bmatrix} = \begin{bmatrix} P - P_L \\ P - P_L \end{bmatrix}$$

$$\begin{bmatrix} 0 - M_{FBA} + M_{FBC} + M_{FBD} \\ 0 - M_{FCB} \end{bmatrix}$$

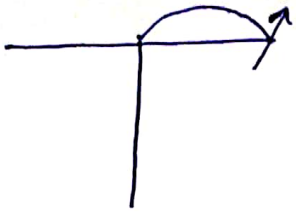
$$\frac{1}{EI}\begin{bmatrix} 5.28 & 0.5 \\ 0.5 & 1 \end{bmatrix}^{-1}\begin{bmatrix} -29.39 \\ -40 \end{bmatrix}$$

Step:3 Stiffness matrix



$$a_{11} = \frac{4E\times2I}{3.5} + \frac{4E\times I}{4} + \frac{4\times2IE}{4} = 5.26$$

$$a_{21} = \frac{2EI}{4} = 0.5EI$$



$a_{12} = \frac{2EI}{4} = 0.5EI$

$a_{22} = \frac{4EI}{4} = 1EI$

$\theta_B = \frac{-1.86}{EI}$

$\theta_C = \frac{-39.06}{EI}$

Step:4 Slope Deflection equation

$M_{AB} = M_{FAB} + \frac{2EI}{l}\left(2\theta_A + \theta_B - \frac{3\delta}{l}\right)$

$= -39.18 + \frac{2 \times 2}{3.5}\left[0 + \left(\frac{-1.86}{EI}\right)\right]$

$M_{AB} = -41.03$

$M_{BA} = 29.39 + \frac{2 \times 2EI}{3.5}\left(\frac{2 \times -1.86}{EI}\right)$

$M_{BA} = 25.13$

$M_{BC} = -40 \times \frac{2 \times EI}{4}\left(\frac{-1.86 \times 2}{EI} + \left(\frac{-39.06}{EI}\right)\right)$

$M_{BC} = 61.44$

$M_{CB} = 0$

$M_{BD} = 40 + \frac{2EI \times 2}{4}\left(2 \times \frac{-1.86}{EI}\right)$

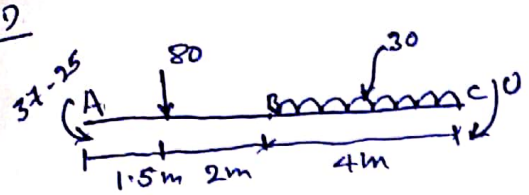
$= 36.28$

$M_{DB} = -40 + \frac{2EI \times 2}{4}\left(\frac{-1.86}{EI}\right)$

$= -41.86$

Step:5 BMD & S.FD

S.F.D



$M_B = V_A \times 3.5 - 80 \times 2 - 41.03 + 25.13$

$V_A = 50\ kN$

$M_B = -V_C \times 4 + 30 \times 4 \times \frac{4}{2} - 61.44$

$V_C = 44.64\ kN$

$V_A + V_B + V_C = 80 + 30 \times 4$

$50 + V_B + 44.64 = 200$

$V_B = 105.36$

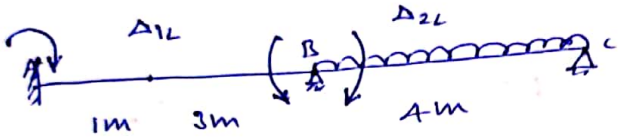
Q2.

Step:1 Determine Static Indeterminancy

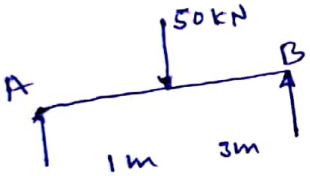
$$DOSI = r - 3 - h = 5 - 3 - 0 = 2$$

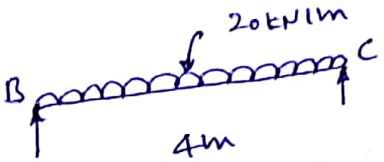
Step:2 Selection of Redundant

$$\text{Redundant} = \begin{bmatrix} M_A \\ M_B \end{bmatrix}$$



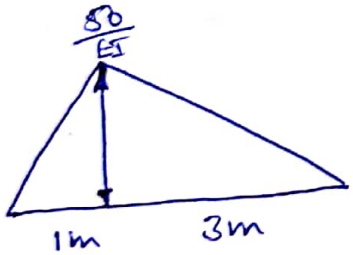
Step:3 Applying conjugate beam method

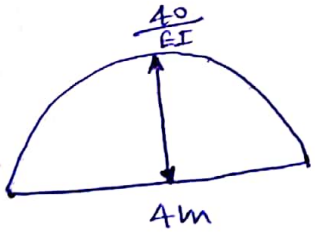




$$AB = M = \frac{PL}{4} = \frac{50 \times 4}{4EI} = \frac{50}{EI}$$

$$BC = M = \frac{wl^2}{8} = \frac{20 \times 4^2}{8EI} = \frac{40}{EI}$$





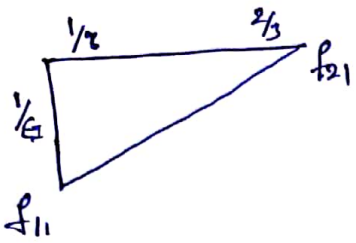
$$\Delta_{1L} = \frac{1}{2}\left[\frac{1}{2} \times 4 \times \frac{50}{EI}\right]$$

$$= \frac{50}{EI}$$

$$\Delta_{2L} = \frac{1}{2}\left[\frac{1}{2} \times 4 \times \frac{50}{EI}\right] + \frac{1}{2}\left[\frac{2}{3} \times 4 \times \frac{40}{EI}\right]$$

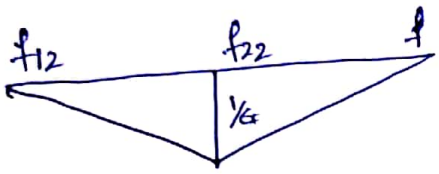
$$= \frac{103.33}{EI}$$

Step:4 Applying Flexibility matrix



$$f_{11} = \frac{1}{4}\left[\frac{2}{3}\times 4 \times \frac{1}{2}\times 4\times \frac{1}{EI}\right] = \frac{1.33}{EI}$$

$$f_{21} = \frac{1}{4}\left[\frac{1}{3}\times 4\times \frac{1}{2}\times 4\times \frac{1}{EI}\right] = \frac{0.66}{EI}$$



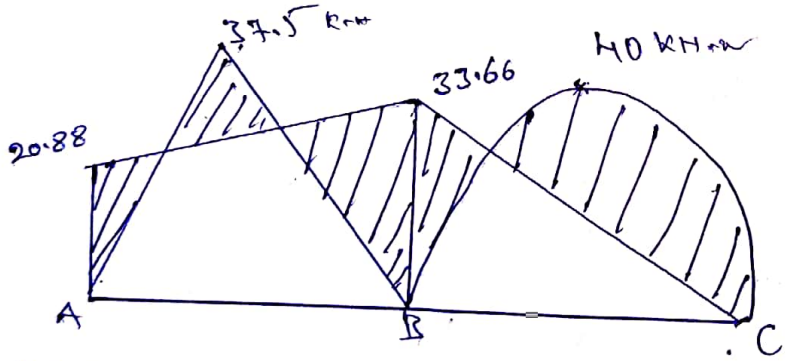
$$f_{12} = \left[\frac{1}{3}\times\frac{1}{2}\times 4\times\frac{1}{EI}\right] = \frac{0.66}{EI}$$

$$f_{22} = \left[\frac{2}{3}\times\frac{1}{2}\times 4\times\frac{1}{EI}\right] + \left[\frac{2}{3}\times\frac{1}{2}\times 4\times\frac{1}{EI}\right] = \frac{2.66}{EI}$$

$$\therefore [F] = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix} = \frac{1}{EI}\begin{bmatrix} 1.33 & 0.66 \\ 0.66 & 2.66 \end{bmatrix}^{-1}\begin{bmatrix} 50 \\ 403.33 \end{bmatrix}$$

$$\begin{bmatrix} M_{AB} \\ M_{BC} \end{bmatrix} = \begin{matrix} 20.88\ kN\text{-}m \\ 33.66\ kN\text{-}m \end{matrix}$$

BMD



$$\frac{Wab}{l} = \frac{50\times 1\times 3}{4} = 37.5\ KNm$$

$$\frac{wl^2}{8} = \frac{20\times 4^2}{8} = 40\ KNm$$

SFD

$$\Sigma M_B = 0$$

$$R_A \times 4 - 50\times 3 + 20.88$$

$$R_A = 32.28\ KN$$

$$\Sigma M_B = 0$$

$R_C \times 4 - 20 \times 4 \times \frac{4}{2} + 33.66$

$R_C = 31.585$

$R_A + R_B + R_C = 50 + 80 \times 4$

$= 130 \text{ kN}$

$32.28 + 31.585 + R_B = 130$

$R_B = 66.135 \text{ kN}$

SFD