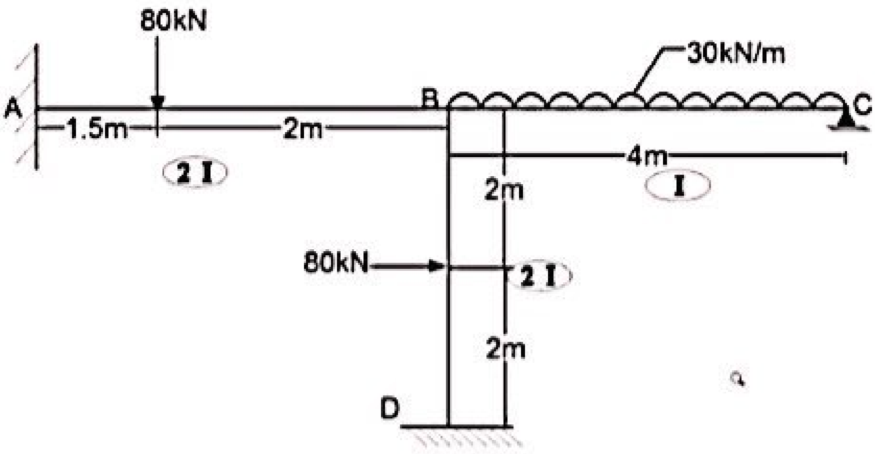
USN

CMRIT

Internal Assessment Test 3

Sub:	Analysis of Indeterminate Structures					Sub Code:	18CV52	Branch:	Civil
Date:	14/12/2020	Duration:	90 min's	Max Marks:	42	Sem / Sec:	5A and 5B		OBE

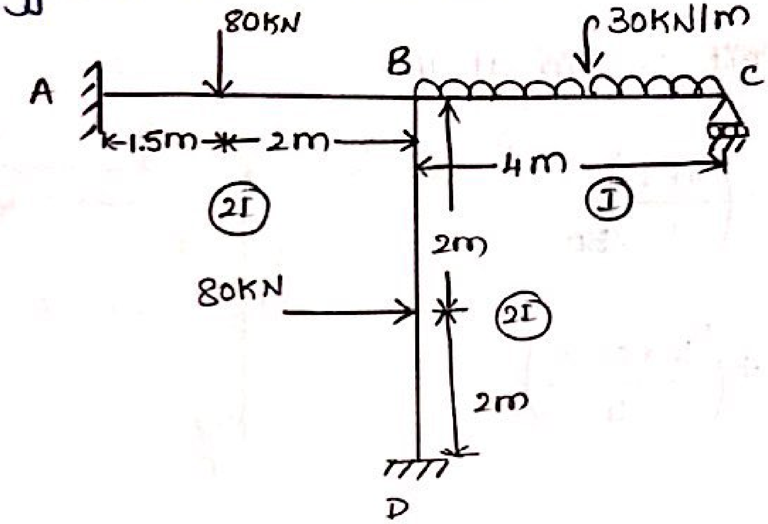
	Answer TWO FULL Questions	MARKS	CO	RBT
1.	Problem 1: Analyze the portal frame shown in Fig 1. using the Stiffness matrix method. Sketch BMD and SFD BMD and SFD 	[21]	CO1	L3
2.	Problem 2: Analyze the continuous beam shown in Fig 2. using the Flexibility matrix method. Sketch BMD and SFD 	[21]	CO1	L2

IAT-03

Sec: "B"

Date: 14/12/2020

01 Analyse the portal frame shown in fig 1. Using the Stiffness matrix method Sketch BMD and SFD



Fixed End moments:

$$M_{FAB} = \frac{-wab^2}{l^2} = \frac{-80\times 1.5\times 2^2}{(3.5)^2} = -39.18\ KNm$$

$$M_{FBA} = \frac{wa^2b}{l^2} = \frac{80\times(1.5)^2\times 2}{(3.5)^2} = 29.38\ KNm$$

$$M_{FBC} = \frac{-wL^2}{12} = \frac{-30\times 4^2}{12} = -40KNm$$

$$M_{FCB} = \frac{wL^2}{12} = \frac{30\times 4^2}{12} = 40KN/m$$

$$M_{FDB} = \frac{+wL}{8} = \frac{-80\times 4}{8_2} = -40KNm$$

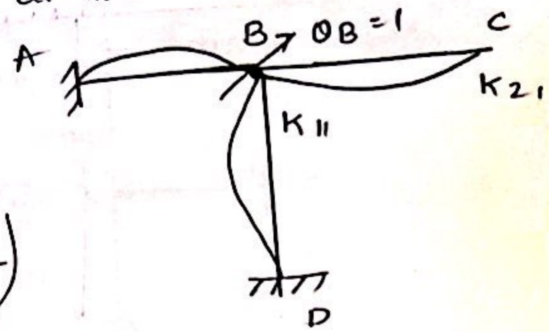
$$M_{FBD} = \frac{wL}{8} = \frac{80\times 4}{8} = 40KNm$$

Scanned with CamScanner

Step (2) $[\Delta] = \begin{bmatrix} \theta_B \\ \theta_C \end{bmatrix}$: $P = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

$$[P_L] = \begin{bmatrix} M_{FBA} + M_{FBC} + M_{FBD} \\ M_{FCB} \end{bmatrix} = \begin{bmatrix} 29.38 + (-40) + 40 \\ 40 \end{bmatrix} = \begin{bmatrix} 29.38 \\ 40 \end{bmatrix}$$

Step 3: Apply the Unit rotatin at the coordinate



$$K_{11} = \left(\frac{4EI}{L}\right)_{BA} + \left(\frac{4EI}{L}\right)_{BC} + \left(\frac{4EI}{L}\right)_{BD}$$

$$= \left(\frac{4 \times 2EI}{3.5}\right) + \left(\frac{4 \times EI}{4}\right) + \left(\frac{4 \times 2EI}{4}\right)$$

$$= 5.28EI$$

$$K_{21} = \frac{2EI}{L} = \frac{2EI}{4_2} = 0.5EI$$

Apply the Unit rotation at the coordinate 2 - joint C

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

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

$$\begin{bmatrix} K_{11} & K_{12} \\ K_{21} & K_{22} \end{bmatrix} = EI \begin{bmatrix} 5.28 & 0.5 \\ 0.5 & 1 \end{bmatrix}$$

$$\theta = [K]^{-1} [P - P_L]$$

$$\begin{bmatrix} \theta_B \\ \theta_C \end{bmatrix} = \frac{1}{EI} \begin{bmatrix} 5.28 & 0.5 \\ 0.5 & 1 \end{bmatrix}^{-1} \begin{bmatrix} -29.38 \\ -40 \end{bmatrix}$$

$\theta_B = -1.86/EI$

$\theta_C = -39.06/EI$

Substute the θ_B and θ_C in Slope deflection Equation

$$M_{AB} = M_{FAB} + \frac{2EI}{l}\left\{2\cancel{\theta_A}^{0} + \theta_B - \cancel{\frac{3\delta}{l}}^{0}\right\}$$

$$= -39.18 + \frac{2\times 2EI}{3.5}\left\{\theta_B\right\} = -39.18 + \frac{4EI}{3.5}\left\{\frac{-1.86}{EI}\right\}$$

$$= -41.305 KNm$$

$$M_{BA} = M_{FBA} + \frac{2\times 2EI}{3.5}\left\{2\theta_B\right\}$$

$$= 29.38 + \frac{4EI}{3.5}\left\{2(-1.86/EI\right\}$$

$$= 25.12 KNm$$

$$M_{BC} = M_{FBC} + \frac{2EI}{L}\left\{2\theta_B + \theta_C - \cancel{\frac{3\delta}{L}}^{0}\right\}$$

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

$$= -61.39 KNm$$

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

$$= 0 KNm$$

$$M_{BD} = M_{FBD} + \frac{2\times 2EI}{L}\left\{2\theta_B + \cancel{\theta_D}^{0} - \cancel{\frac{3\delta}{L}}^{0}\right\}$$

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

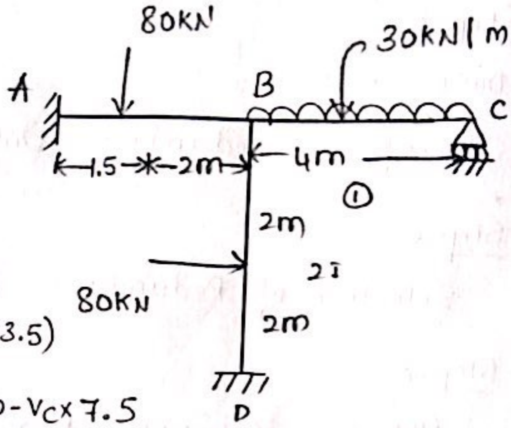
$$= 36.28 KNm$$

$$M_{DB} = M_{FDB} + \frac{2\times 2EI}{4}\left\{\theta_B + 2\cancel{\theta_D}^{0} - \frac{3\delta}{L}\right\}$$

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

$$= -41.86\,kNm.$$

Shear force diagram



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

$$\Sigma M_A = 0$$

$$V_A\times 0 + 80\times 1.5 - V_B\times 3.5 + 30\times 4\times\{2+3.5) + (-41.305) + 25.12 - 61.39 + 0 - V_C\times 7.5$$

$$\boxed{V_B = 105.36\,kN}$$

$\Sigma M_B = 0$ (LHS)

$$V_A \times 3.5 - 80\times 2 - 41.30 + 25.12$$

$$\boxed{V_A = 50.3\,kN}$$

$\Sigma M_B = 0$ (RHS

$$= V_C\times 4 + 30\times 4\times 2 + 0 - 61.39$$

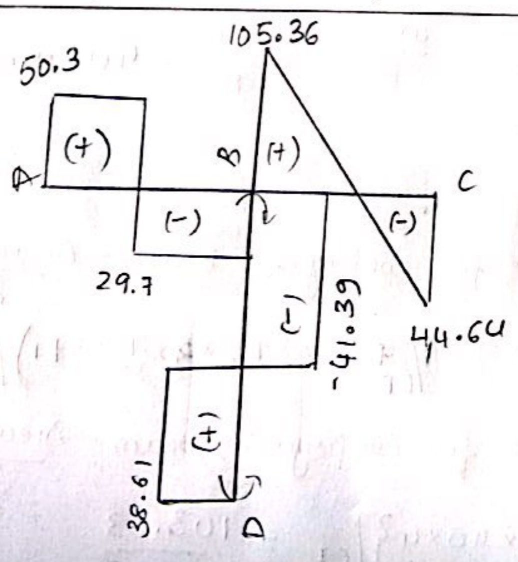
$$\boxed{V_C = 44.65\,kN}$$

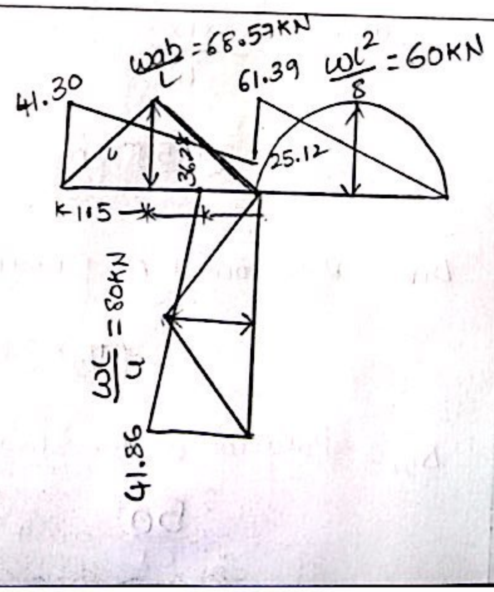
$$H_D + H_B = 80$$

$$\Sigma H_D = 0 \quad -80\times 2 + H_B\times 4 + 36.28 - 41.86$$

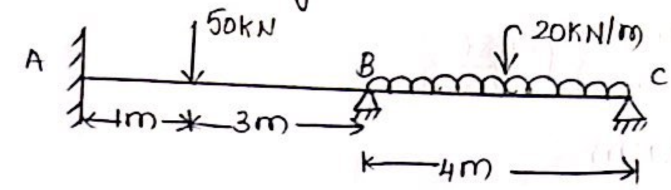
$$\boxed{H_B = 41.38\,kN}$$

$$\boxed{H_D = 38.61\,kN}$$





02 Analyze the Continuous beam Shown in fig 2 Using the Flexibility matrix method. Sketch BMD & SFD



Step-1

DOSI = 5-3 = 2

Therefore 2 Redundant = Unknown M_A and M_B

Step-02

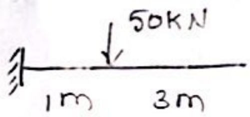
Selection of Redundant = A and B are coordinates 1 and 2

Step-03

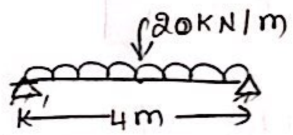
Applying Conjugate beam method

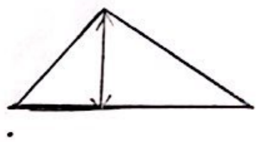
Split the beam as AB and BC

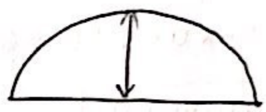
AB Spam



BC Span







$\frac{wab}{L} = \frac{50\times1\times3}{4}$

$= 37.5$ KNm

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

Δ_{1L} = Rotation at A - Shear at A for conjugate beam = $\frac{\text{Area of BMD}}{EI}$ 50/EI

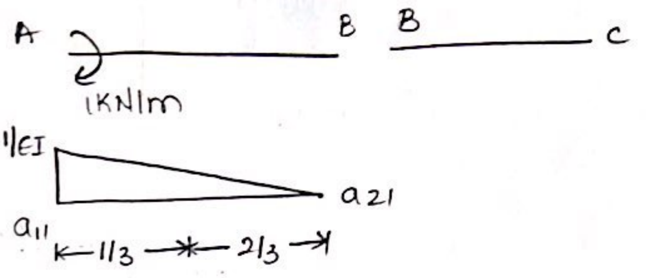
$= \left(\frac{1}{2}\times 37.5\times 1\times \frac{2}{3}\times 1\right)/EI + \left(\frac{1}{2}\times 37.5\times 3\times\left(\frac{1}{3}\times 3+1\right)\right)/EI = \frac{50}{EI}$

Δ_{2L} = Rotation at B - Shear at B for conjugate beam = $\frac{\text{Area of BMD}}{EI}$

$= \frac{50}{EI} + \frac{1}{2}\left\{\frac{2}{3}\times 40\times 4\right\}/EI = \frac{103.33}{EI}$

Step 4 - Getting Flexibility matrix:

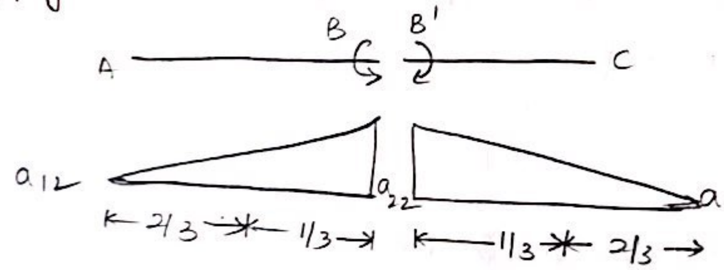
Apply unit moment at coordinate -1



$$a_{11} = \left(1/2 \times 4 \times 1/EI \times 2/3\right) = 1.33/EI$$

$$a_{21} = \left\{1/2 \times 4 \times 1/EI \times 1/3\right) = 0.67/EI$$

Apply Unit moment at coordinate -2



$$a_{12} = \left(1/2 \times 4 \times 1/EI\right) \times 1/3 = 0.67/EI$$

$$a_{22} = \left(1/2 \times 4 \times 1/EI \times 2/3\right) + \left(1/2 \times 4 \times 1/EI \times 2/3\right) = 2.66/EI$$

$$P = [a]^{-1}[\Delta - \Delta_{1L}]$$

$$\begin{bmatrix} M_A \\ M_B \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \Delta - \Delta_{1L} \\ \Delta - \Delta_{2L} \end{bmatrix}$$

$$\begin{bmatrix} M_A \\ M_B \end{bmatrix} = \left[EI \begin{bmatrix} 1.33 & 0.67 \\ 0.67 & 2.66 \end{bmatrix}^{-1} \frac{1}{EI} \begin{Bmatrix} 0 - 50 \\ 0 - 103.33 \end{Bmatrix} \right.$$

$$\begin{bmatrix} M_A \\ M_B \end{bmatrix} = \begin{bmatrix} -20.64 \\ -33.64 \end{bmatrix}$$

Scanned with CamScanner

$M_{AB} = -20.64$

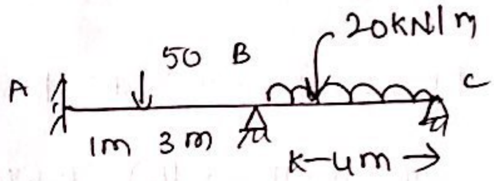
$M_{BA} = 33.64$

$M_{BC} = -33.64$

$M_{CB} = 0$

Shear force diagram

$V_A + V_B + V_C = 50 + 20 \times 4$



$\Sigma M_B = 0$ (LHS)

$V_A \times 4 - 50 \times 3 - 20.64 + 33.64$

$\boxed{V_A = +34.25}$

$\Sigma M_B = 0$ (RHS)

$-V_C \times 4 + 20 \times 4 \times 2 + 0 - 33.64$

$V_C = 31.58\ kN$

$\boxed{V_B = 64.17}$