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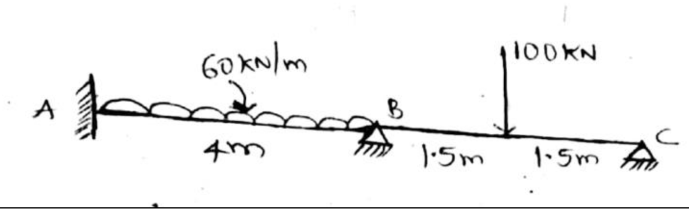
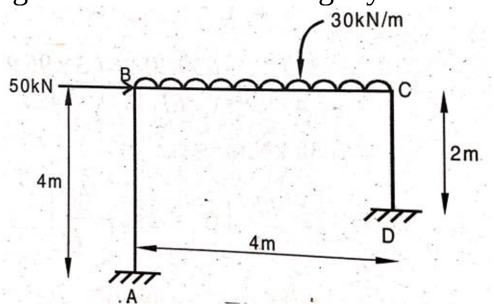
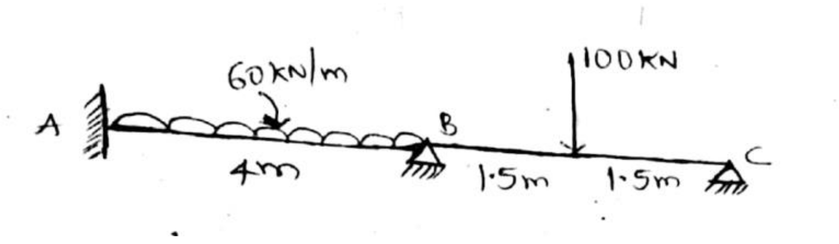
Internal Assessment Test 4 –Feb. 2022

Sub:	Analysis of Indeterminate Structures				Sub Code:	18CV52	Branch:	Civil
Date:	1/2/2022	Duration:	90 min's	Max Marks: 50	Sem / Sec:	5A		OBE

	Answer TWO FULL Questions	MARKS	CO	RBT
1.	Analyze the Frame show in fig 1. Using Stiffness matrix method. Draw **BMD and SFD** 	[25]	CO1	L3
2.	Analyze the given frame shown in fig. by Stiffness matrix method.  fig 2	[25]	CO 2	L3

Solution

1. Analyze the given continuous beam using stiffness matrix method of analysis



Steps

1. Fixed end moments

   M_{FAB}= -80

   Mfba= 80

   Mfbc= -37.5

   Mfcb= 37.5

2. [Δ], [P], [P_L]

   a. $[\Delta] = unknown\ displacment\ matix = \begin{bmatrix}\theta_B \\ \theta_c\end{bmatrix}$

      [P]= moments acting in unit directions $=\begin{bmatrix}0 \\ 0\end{bmatrix}$

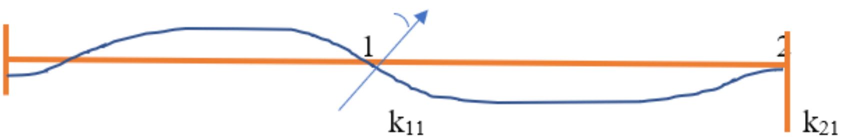
      [P_L]= joint moments $=\begin{bmatrix}M_{FBA} + M_{FBC} \\ M_{FCB}\end{bmatrix} = \begin{bmatrix}80 - 37.5 \\ 37.5\end{bmatrix} =$

3. Stiffness matrix= to find the θ_B, θ_c

   a. Applying the unit rotation along the 1 co-ordinate directions

      $[\Delta] = [k]^{-1} [P-P_L]$

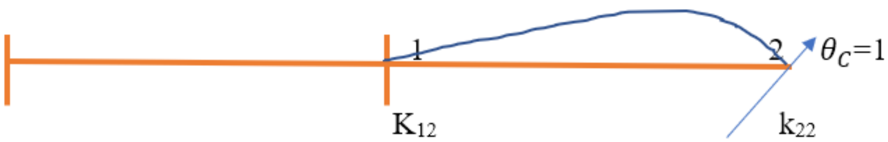
For coordinate 1 θ_B=1



$k_{11} = \frac{4EI}{4} + \frac{4EI}{3} = 2.33EI$

$k_{21} = \frac{2EI}{L} = 0.67EI$

applying the unit rotation at co-ordinate 2



$K_{12} = \frac{2EI}{L} = 0.67EI$

$K_{22} = \frac{4EI}{L} = 1.33EI$

$[k] = \begin{bmatrix}k_{11} & k_{12} \\ k_{21} & k_{22}\end{bmatrix}$

$[k]=EI\begin{bmatrix}2.33 & 0.67\\0.67 & 1.33\end{bmatrix}$

$[k]^{-1}=\frac{1}{EI}\begin{bmatrix}2.33 & 0.66\\0.67 & 1.33\end{bmatrix}^{-1}$

$[\Delta] = [k]^{-1}\,[P-P_L]$

$\begin{bmatrix}\theta_B\\\theta_c\end{bmatrix}=\frac{1}{EI}\begin{bmatrix}2.33 & 0.66\\0.67 & 1.33\end{bmatrix}^{-1}\begin{bmatrix}0-(80-37.5) & .\\0-(37.5) & .\end{bmatrix}$

$\begin{bmatrix}\theta_B\\\theta_c\end{bmatrix}=\frac{1}{EI}\begin{bmatrix}-11.89 & .\\-22.36 & .\end{bmatrix}$

θ_B= -11.89/EI, θ_C= -22.36/EI

4. Slope deflection equation:

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

= -80+2EI/4(0-11.89/EI-0)= -85.94KN.M

$M_{BA}= M_{FBA}+\frac{2EI}{l}(2\theta_B+\theta_A-\frac{3\partial}{l})$

= 80+2EI/4(2/(-11.89/EI))= 68.11kN.m

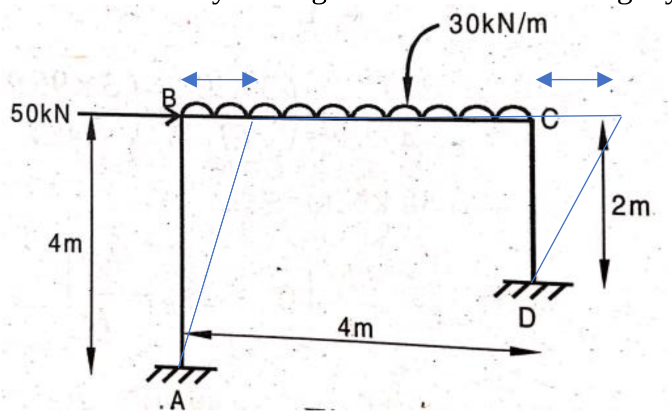
$M_{BC}= M_{FBC}+\frac{2EI}{l}(2\theta_B+\theta_C-\frac{3\partial}{l})$

=-37.5+2EI/3(2*-11.89/EI-22.36/EI)= -68.16Kn.M

$M_{CB}= M_{FCB}+\frac{2EI}{l}(2\theta_C+\theta_B-\frac{3\partial}{l})$

= 37.5+2EI/3(2*-22.36/EI-11.89/EI)= -0.05kN.m

Problem 2: Analyze the given frame shown in fig. by Stiffness matrix method.



Unknows = 3

1. Fixed end moment:
   Mfbc= -40
   Mfcb= 40

2. [Δ], [P], [P_L]

$[\Delta] = unknown\ displacment\ matix = \begin{bmatrix} \delta \\ \theta_B \\ \theta_C \end{bmatrix}$

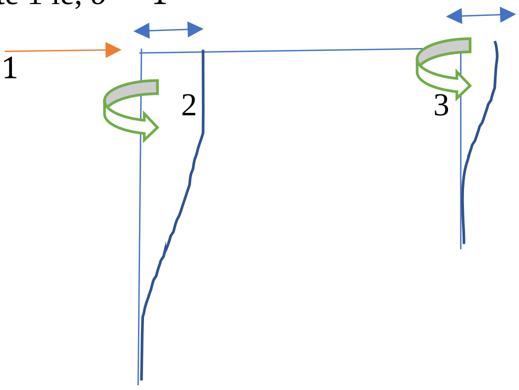
[P]= External forces $= \begin{bmatrix} 50 \\ 0 \\ 0 \end{bmatrix}$

[P_L]= joint force(moments) $= \begin{bmatrix} 0 \\ M_{FBA} + M_{FBC} \\ M_{FCB} + M_{FCD} \end{bmatrix} = = \begin{bmatrix} 0 \\ -40 \\ 40 \end{bmatrix}$

3. Stiffness matrix= to find the $\delta, \theta_B, \theta_c$

Applying the unit rotation along the co-ordinate 1 ie, $\delta = 1$

$\delta = 1$



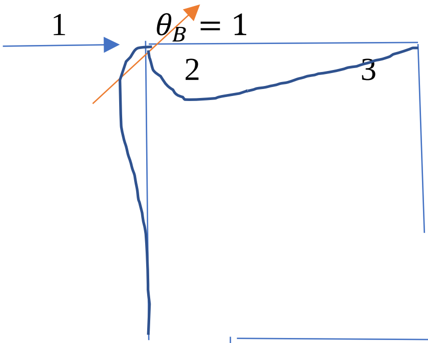
$k_{11} = \frac{12EI}{4^3} + \frac{12EI}{2^3} = 1.68EI$

$k_{21} = -\frac{6EI}{4^2} = -0.37EI$

$k_{31} = -\frac{6EI}{2^2} = -1.5\ EI$

Applying the unit rotation along the co-ordinate 2, ie =

$k_{12} = -\frac{6EI}{L^2} = -0.37EI$

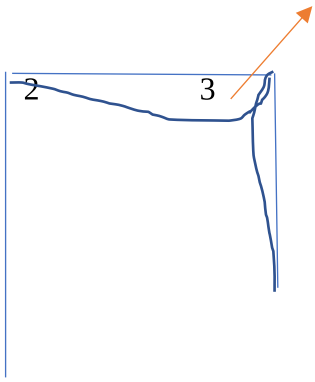


$k_{22} = \frac{4EI}{L} + \frac{4EI}{L} = 2EI$

$k_{23} = \frac{2EI}{L} = 0.5EI$

$\theta_C = 1$

Applying the unit rotation along the co-ordinate 3



$K_{13} = -\frac{6EI}{L^2} = -1.5EI$

$K_{23} = \frac{2EI}{L} = 0.5EI$

$k_{33} = \frac{4EI}{L} + \frac{4EI}{L} = 3EI$

$$\begin{bmatrix} k_{11} & k_{12} & k_{13} \\ k_{21} & k_{22} & k_{23} \\ k_{31} & k_{32} & k_{33} \end{bmatrix} = [EI] \begin{bmatrix} 1.68 & -0.37 & -1.5 \\ -0.37 & 2 & 0.5 \\ -1.5 & 0.5 & 3 \end{bmatrix}$$

$[\Delta] = [k]^{-1}\ [P-P_L]$

$$\begin{bmatrix}\theta_B\\\theta_C\\\theta_D\end{bmatrix}=\frac{1}{EI}\begin{bmatrix}1.68 & -0.37 & -1.5\\-0.37 & 2 & 0.5\\-1.5 & 0.5 & 3\end{bmatrix}^{-1}\begin{bmatrix}50\\40\\-40\end{bmatrix}$$

$$\delta = 35.68/EI, \theta_B = 26.6/EI \ , \theta_C = 0.1/EI$$

4. Substitute the above values in the slope deflection equation

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

$M_{AB} = -0.3$

$M_{BA} = M_{FBA} + \frac{2EI}{l}(\theta_A+2\theta_B - \frac{3\partial}{l})$

$M_{BA} = 13.33$

For Span BC , l=

$M_{BC} = M_{FBC} + \frac{2EI}{l}(2\theta_B+\theta_c - \frac{3\partial}{l})$

$M_{BC} = -13.33$

$M_{CB} = M_{FCB} + \frac{2EI}{l}(\theta_B+2\theta_c - \frac{3\partial}{l})$

$M_{CB} = 53.33$

For Span CD , l=

$M_{CD} = M_{FCD} + \frac{2EI}{l}(2\theta_C+\theta_D - \frac{3\partial}{l})$

$M_{CD} = -53.33$

$M_{DC} = M_{FDC} + \frac{2EI}{l}(2\theta_D+\theta_C - \frac{3\partial}{l})$

$M_{DC} = -53.33$