

Mid-Term Exam

Question (1): (14 Marks)

Element (1): (nodes 1 & 2)

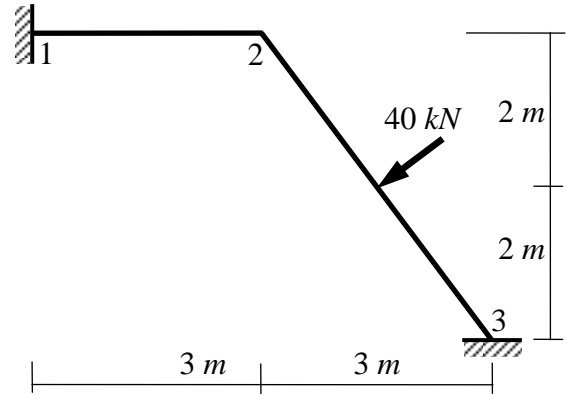
$\alpha = 0 \quad \lambda = \cos \alpha = 1 \quad \text{and} \quad \mu = \sin \alpha = 0$

$6EI/L^2 = 2EI/3$

$4EI/L = 4EI/3$

$2EI/L = 2EI/3$

$$\begin{Bmatrix} F_{x1} \\ F_{y1} \\ M_1 \\ F_{x2} \\ F_{y2} \\ M_2 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & 0 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & 0 \\ - & - & - & - & - & -2EI/3 \\ - & - & - & - & - & 4EI/3 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$



Element (2): (nodes 2 & 3)

$\alpha = -53.13 \quad \lambda = \cos \alpha = 0.6 \quad \text{and} \quad \mu = \sin \alpha = -0.8$

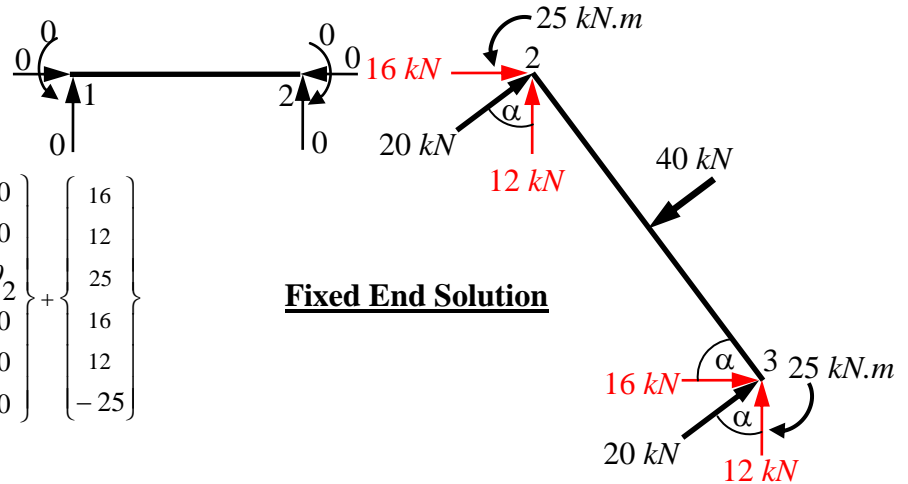
$6\mu EI/L^2 = 6(-0.8)EI/25 = -0.192EI$

$6\lambda EI/L^2 = 6(0.6)EI/25 = 0.144EI$

$4EI/L = 0.8EI$

$2EI/L = 0.4EI$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ M_2 \\ F_{x3} \\ F_{y3} \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & 0.192EI & - & - & - \\ - & - & 0.144EI & - & - & - \\ - & - & 0.8EI & - & - & - \\ - & - & -0.192EI & - & - & - \\ - & - & -0.144EI & - & - & - \\ - & - & 0.4EI & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 16 \\ 12 \\ 25 \\ 16 \\ 12 \\ -25 \end{Bmatrix}$$



Fixed End Solution

Frame equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ 0 \\ 0 \\ 0 \\ X_3 \\ Y_3 \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & 0 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & (0+0.192EI) \\ - & - & - & - & - & (-2EI/3+0.144EI) \\ - & - & - & - & - & (4EI/3+0.8EI) \\ - & - & - & - & - & -0.192EI \\ - & - & - & - & - & -0.144EI \\ - & - & - & - & - & 0.4EI \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 16 \\ 12 \\ 25 \\ 16 \\ 12 \\ -25 \end{Bmatrix}$$

From Row No. 6 $\rightarrow 0 = (4EI/3+0.8EI)(\theta_2) + 25$

$\rightarrow \theta_2 = -11.71875/EI$

From Element 1

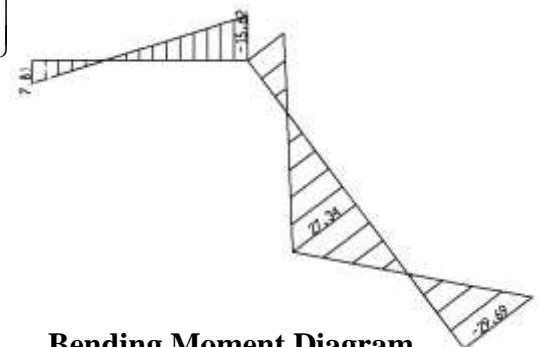
$M_1 = 2EI/3 (-11.71875/EI) + 0 = -7.8125 \text{ kN.m}$

$M_2 = 4EI/3 (-11.71875/EI) + 0 = -15.625 \text{ kN.m}$

From Element 2

$M_2 = 0.8EI (-11.71875/EI) + 25 = +15.625 \text{ kN.m}$

$M_3 = 0.4EI (-11.71875/EI) - 25 = -29.6875 \text{ kN.m}$

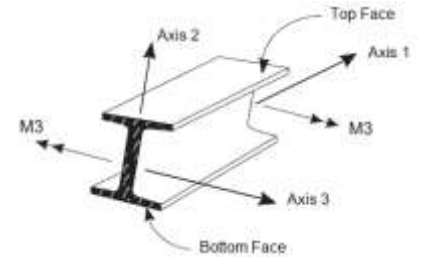


Bending Moment Diagram

Question (2): (6 Marks)

TRUE or FALSE (Put ✓ or ✗ in front of the statement number in your answer sheet).

1. The abbreviation “CAD” means Computer-Aided Design and the abbreviation “SAP” means Structural Analysis Program.
2. The frame element is also called beam-column element.
3. In space frames, there are 6 d.o.f per free node, which are 2 translations and 4 rotations.
4. Bar element used in modeling trusses has two nodes at its ends, every node has 4 d.o.f.
5. Structures that can be modeled with the frame element include: 3-D and planar frames – 3-D and planar trusses – Flat slabs – Raft foundation.
6. The default initial output of SAP2000 is the deformed shape of the structure.
7. In SAP2000, frame sections are defined independently of the frame elements, and are assigned to the elements.
8. If the direction of the moment M_3 is as shown in the figure, the bottom face will be subject to a compression.



1.	✓
2.	✓
3.	✗
4.	✗
5.	✗
6.	✓
7.	✓
8.	✗

With my best wishes
Dr. M. Abdel-Kader