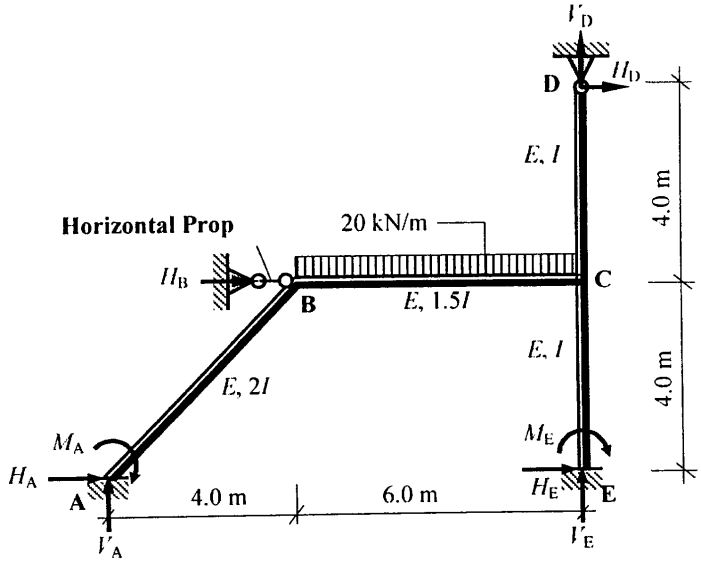
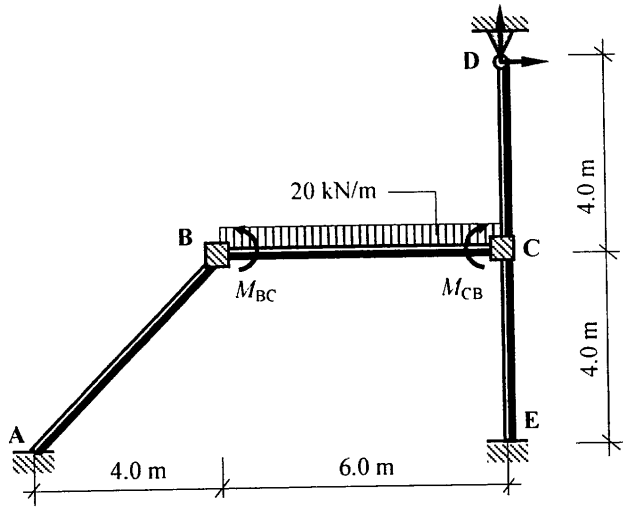
Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.10 **Page No. 1**



Fixed-end Moments:



Member BC

$$M_{BC} = -\frac{wL^2}{12} = -\frac{20.0 \times 6^2}{12} = -60.0 \text{ kNm}$$

$$M_{CB} = +\frac{wL^2}{12} = +\frac{20.0 \times 6^2}{12} = +60.0 \text{ kNm}$$

Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.10 **Page No. 2**

Length of member AB = $\sqrt{\left(4.0^2 + 4.0^2\right)} = 5.657$ m

Distribution Factors : Joint B

$k_{BA} = \left(\frac{2.0I}{5.657}\right) = 0.35I$ $\qquad DF_{BA} = \frac{k_{BA}}{k_{Total}} = \frac{0.35}{0.6} = \mathbf{0.58}$

$\mathbf{k_{total} = 0.6I}$

$k_{BC} = \left(\frac{1.5I}{6.0}\right) = 0.25I$ $\qquad DF_{BC} = \frac{k_{BC}}{k_{Total}} = \frac{0.25}{0.6} = \mathbf{0.42}$

Distribution Factors : Joint C

$k_{CB} = \left(\frac{1.5I}{6.0}\right) = 0.25I$ $\qquad DF_{CB} = \frac{k_{CB}}{k_{Total}} = \frac{0.25}{0.69} = \mathbf{0.36}$

$k_{CD} = \frac{3}{4} \times \left(\frac{I}{4.0}\right) = 0.19I$ $\qquad \mathbf{k_{total} = 0.69I}$ $\qquad DF_{CD} = \frac{k_{CD}}{k_{Total}} = \frac{0.19}{0.69} = \mathbf{0.28}$

$k_{CE} = \left(\frac{I}{4.0}\right) = 0.25I$ $\qquad DF_{CE} = \frac{k_{CE}}{k_{Total}} = \frac{0.25}{0.69} = \mathbf{0.36}$

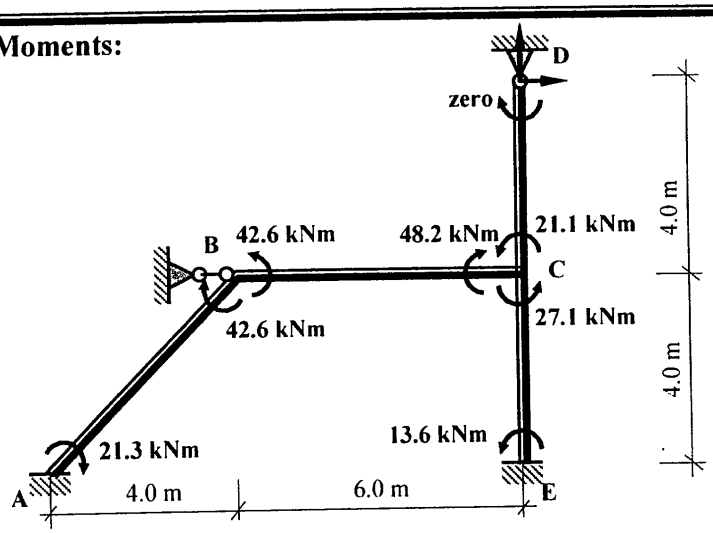
Moment Distribution Table:

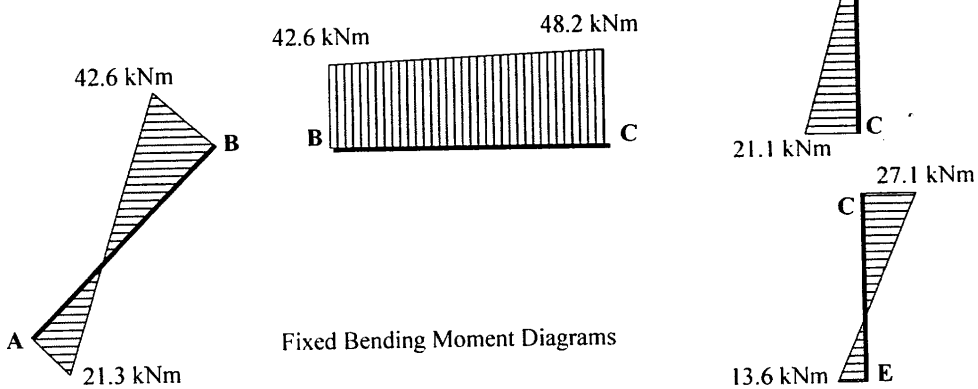
Joint	A	B		C			E	D
	AB	BA	BC	CB	CD	CE	EC	DC
Distribution Factors	**0**	**0.58**	**0.42**	**0.36**	**0.28**	**0.36**	**0**	**1.0**
Fixed-end Moments			− 60.0	+ 60.0				
Balance		+ 34.8	+ 25.2	− 21.6	− 16.8	− 21.6		
Carry-over	+ 17.4		− 10.8	+ 12.6			− 10.8	
Balance		+ 6.26	+ 4.54	− 4.54	− 3.52	− 4.54		
Carry-over	+ 3.13		− 2.27	+ 2.27			− 2.27	
Balance		+ 1.32	+ 0.95	− 0.82	− 0.63	− 0.82		
Carry-over	+ 0.66		− 0.41	+ 0.48			− 0.41	
Balance		+ 0.24	+ 0.17	− 0.17	− 0.14	− 0.17		
Carry-over	+ 0.12						− 0.09	
Total	**+ 21.3**	**+ 42.6**	**− 42.6**	**+ 48.2**	**− 21.1**	**− 27.1**	**− 13.6**	**0**

Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.10 **Page No. 3**

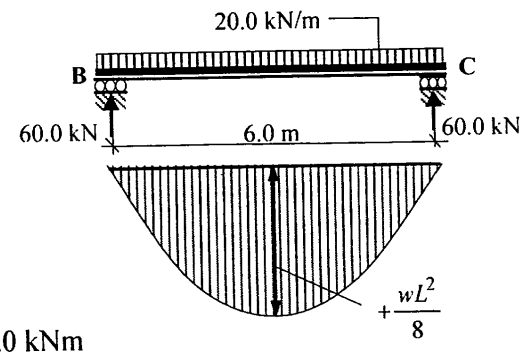
Continuity Moments:





Fixed Bending Moment Diagrams

Free bending moments:

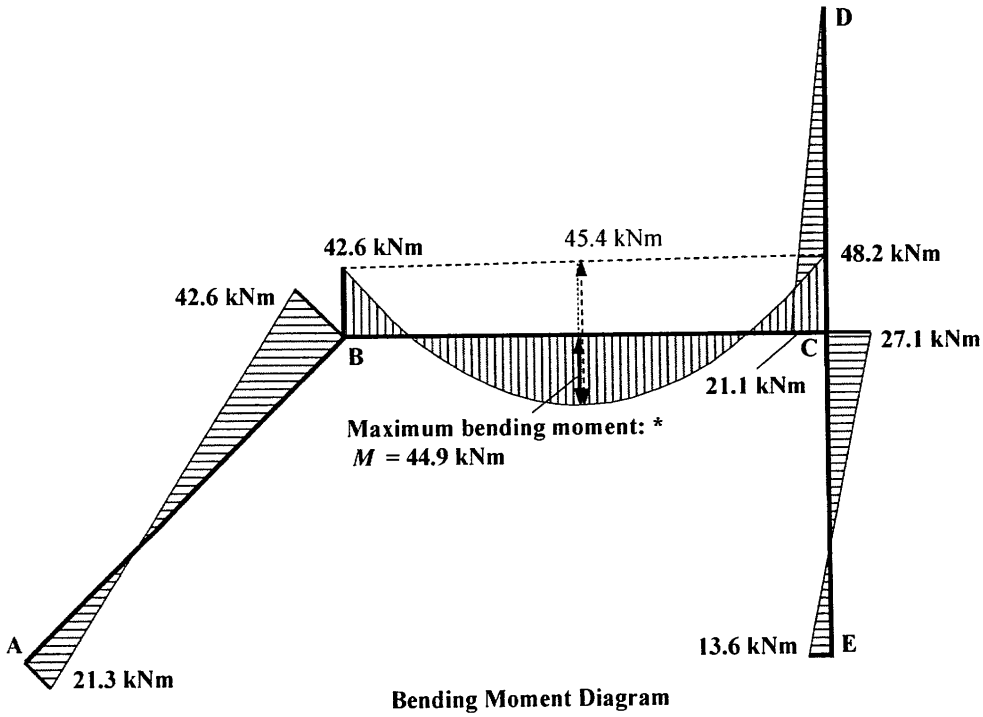


Member BC: $M_{free} = (20.0 \times 6^2)/8 = 90.0$ kNm

Free Bending Moment Diagram

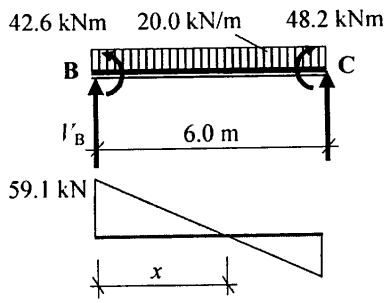
Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.10 **Page No. 4**



Bending Moment Diagram

* **The maximum value along the length of member BC can be found by identifying the point of zero shear as follows:**



Shear Force Diagram

+ve $\circlearrowright$ $\Sigma M_C = 0$

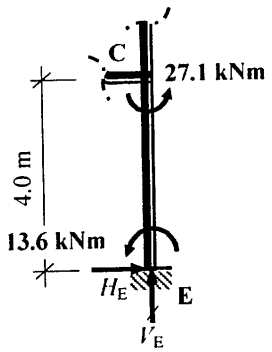
$-42.6 - (20.0 \times 6.0 \times 3.0) + 48.2 + (V_B \times 6.0) = 0$ $\quad \therefore V_B = +59.1$ **kN** ↑

$x = (59.1/20.0) = 2.96$ m

$M_{maximum} = (0.5 \times 2.96 \times 59.1) - 42.6 =$ **44.9 kNm**

Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.10 **Page No. 4**

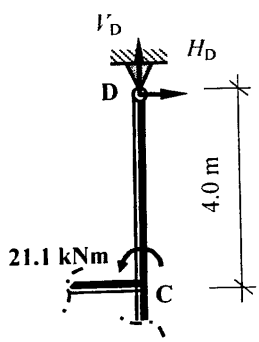


Consider Member CE:

+ve $\circlearrowright \Sigma M_C = 0$

$-27.1 - 13.6 - (H_E \times 4.0) = 0$

$\therefore$ **$H_E = -10.18$ kN** ←

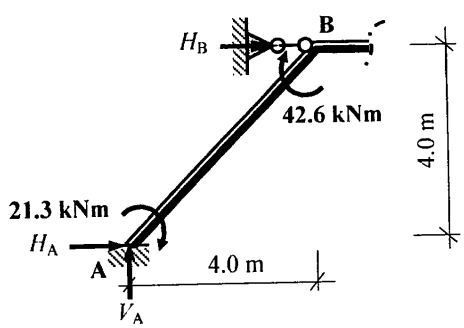


Consider Member CD:

+ve $\circlearrowright \Sigma M_C = 0$

$-21.1 + (H_D \times 4.0) = 0$

$\therefore$ **$H_D = +5.28$ kN** →



Consider Member AB:

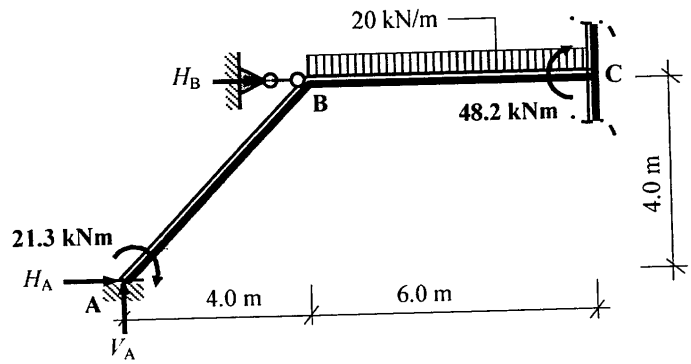
+ve $\circlearrowright \Sigma M_B = 0$

$+42.6 + 21.3 - (H_A \times 4.0) + (V_A \times 4.0) = 0$

$\therefore H_A = V_A + 15.98$

Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.10 **Page No. 5**



Consider a section at C:

+ve $\curvearrowright \Sigma M_C = 0$

$+ 48.2 - (20.0 \times 6.0 \times 3.0) + 21.3 - (H_A \times 4.0) + (V_A \times 10.0) = 0$

$\therefore H_A = 2.5V_A - 72.63$

$\therefore V_A + 15.98 = 2.5V_A - 72.63$

$\therefore \boldsymbol{V_A = 59.1\ kN} \uparrow$

$\therefore \boldsymbol{H_A = 75.1\ kN} \rightarrow$

For the complete frame:

+ve $\rightarrow \Sigma F_x = 0$

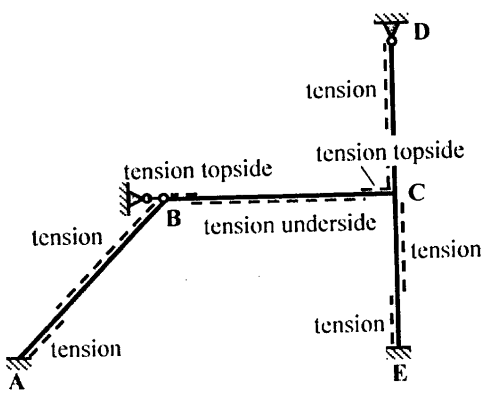
$+ 75.1 + 5.28 - 10.18 + H_B = 0$

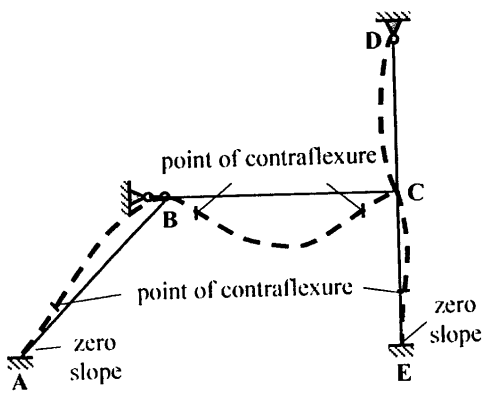
$\therefore \boldsymbol{H_B = +70.2\ kN} \leftarrow$

There is insufficient information from the moment distribution analysis to determine the values of V_D and V_E separately; i.e.

+ve $\uparrow \Sigma F_y = 0$

$-(20.0 \times 6.0) + 59.1 + V_D + V_E = 0$ $\quad \therefore \boldsymbol{V_D + V_E = +(120.0 - 59.1) = +60.9\ kN}$





Deflected Shape