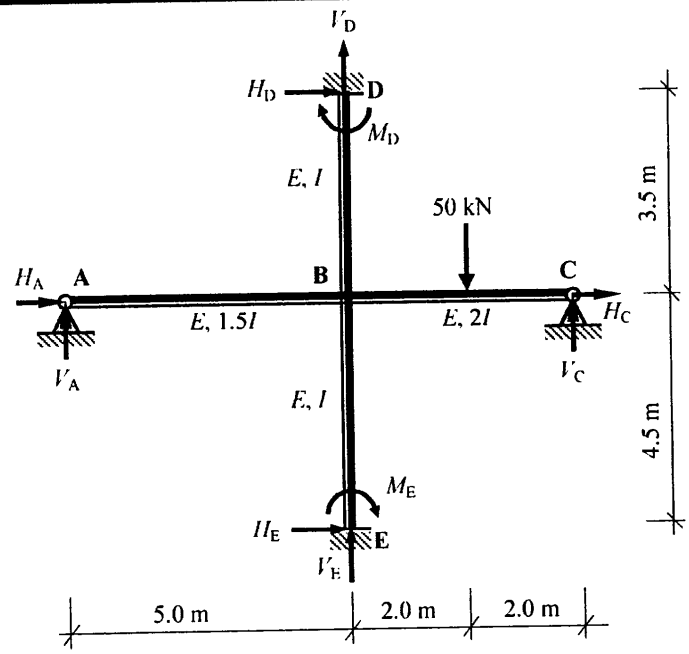
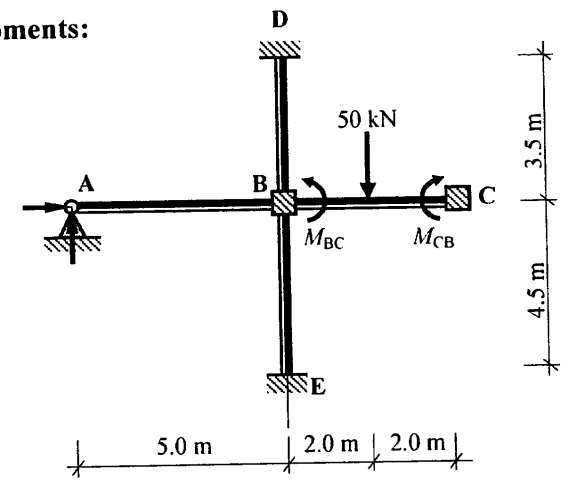
Solution

Topic: Moment Distribution – No-Sway Rigid-Jointed Frames
Problem Number: 5.11 **Page No. 1**



Fixed-end Moments:



Member BC *

$$M_{BC} = -\frac{PL}{8} = -\frac{50.0 \times 4}{8} = -25.0 \text{ kNm}$$

$$M_{CB} = +\frac{PL}{8} = +\frac{50.0 \times 4}{8} = +25.0 \text{ kNm}$$

* Since support C is pinned, the fixed-end moments are ($M_{BC} - 0.5M_{CB}$) at B and zero at C.

($M_{BC} - 0.5M_{CB}$) = [– 25.0 – (0.5 × 25.0)] = – 37.5 kNm.

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Distribution Factors : Joint B

$$k_{BA} = \frac{3}{4} \times \left(\frac{1.5I}{5.0}\right) = 0.23I$$

$$k_{BC} = \frac{3}{4} \times \left(\frac{2I}{4.0}\right) = 0.38I$$

$$k_{BD} = \left(\frac{I}{3.5}\right) = 0.29I$$

$$k_{BE} = \left(\frac{I}{4.5}\right) = 0.22I$$

$$k_{total} = \mathbf{1.12}I$$

$$DF_{BA} = \frac{k_{BA}}{k_{Total}} = \frac{0.23}{1.12} = \mathbf{0.21}$$

$$DF_{BC} = \frac{k_{BC}}{k_{Total}} = \frac{0.38}{1.12} = \mathbf{0.33}$$

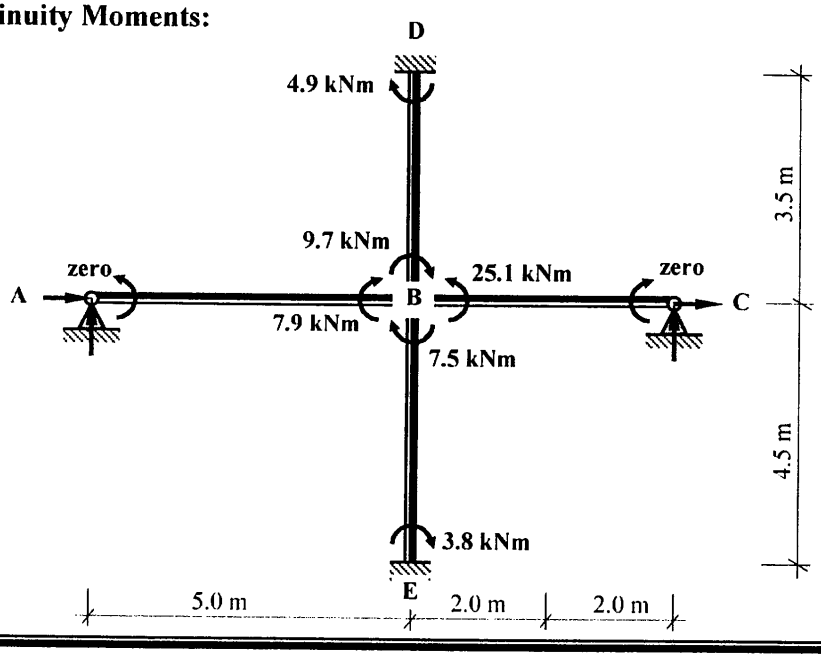
$$DF_{BD} = \frac{k_{BD}}{k_{Total}} = \frac{0.29}{1.12} = \mathbf{0.26}$$

$$DF_{BE} = \frac{k_{BE}}{k_{Total}} = \frac{0.22}{1.12} = \mathbf{0.20}$$

Moment Distribution Table:

Joint	A	D			B				E	C
	AB	DB		BD	BA	BC	BE		EB	CB
Distribution Factors	1.0	0		0.26	0.21	0.33	0.2		0	1.0
Fixed-end Moments						− 37.5				
Balance				+ 9.7	+ 7.9	+ 12.4	+ 7.5			
Carry-over		+ 4.9							+ 3.8	
Total	0	+ 4.9		+ 9.7	+ 7.9	− 25.1	+ 7.5		+ 3.8	0

Continuity Moments:



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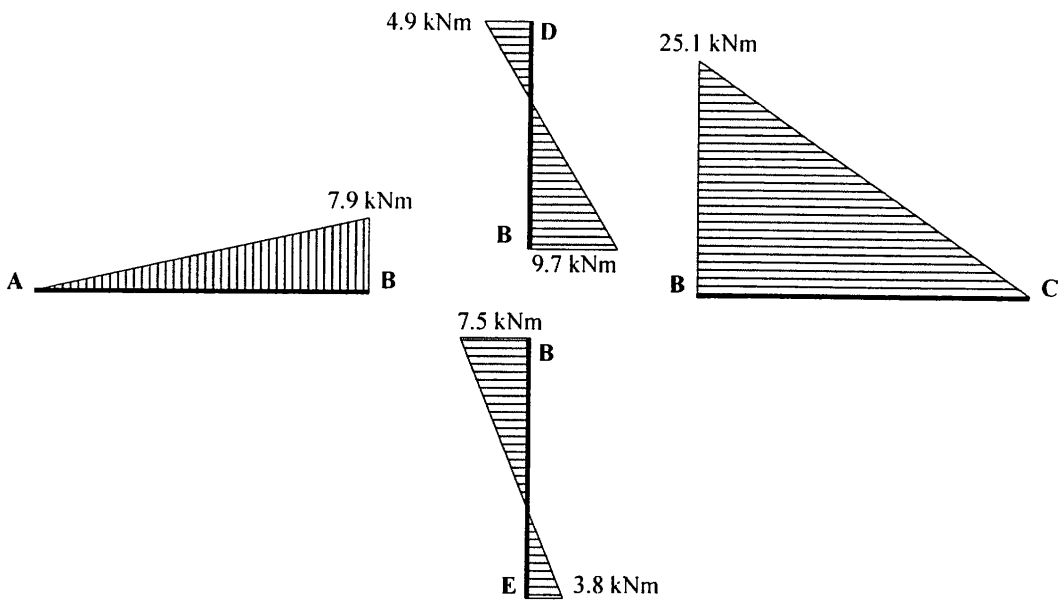
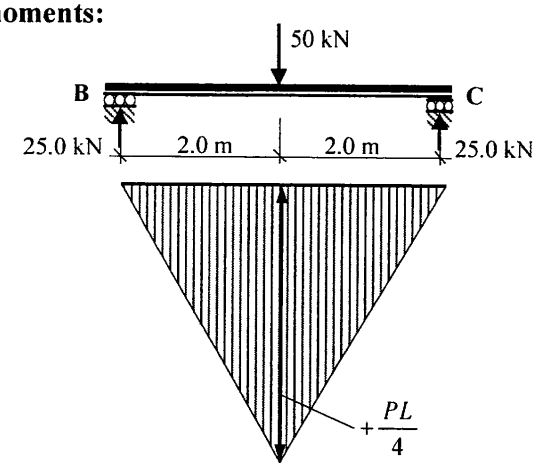


Fixed Bending Moment Diagrams

Free bending moments:



Free Bending Moment Diagram

Member BC: $M_{free} = (50.0 \times 4)/4 = 50.0$ kNm

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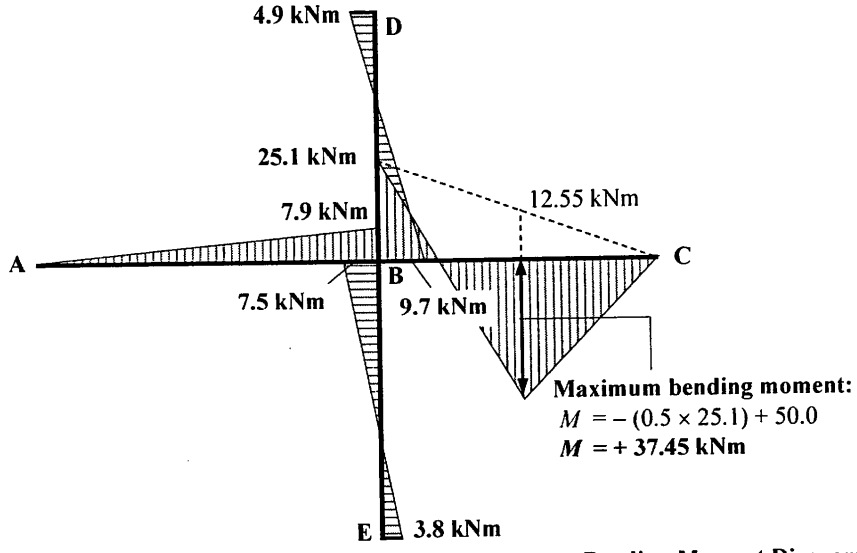
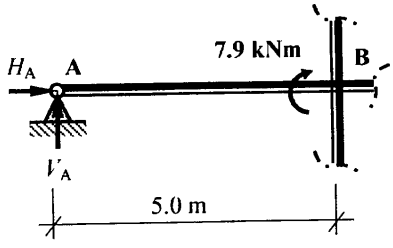
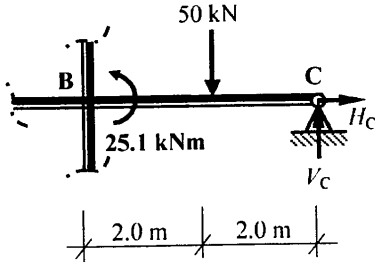


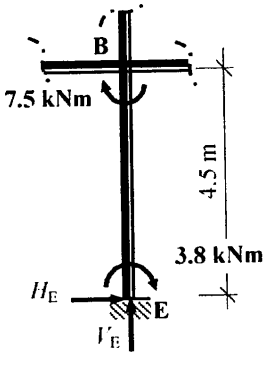
Bending Moment Diagram



Consider Member AB:
+ve $\circlearrowright \Sigma M_B = 0$
$+ 7.9 + (V_A \times 5.0) = 0$
$\therefore V_A = +1.58$ kN ↑



Consider Member BC:
+ve $\circlearrowright \Sigma M_B = 0$
$-25.1 + (50.0 \times 2.0) - (V_C \times 4.0) = 0$
$\therefore V_C = +18.73$ kN ↑



Consider Member BE:
+ve $\circlearrowleft \Sigma M_B = 0$
$+ 7.5 + 3.8 - (H_E \times 4.5) = 0$

$\therefore H_E = +2.51$ kN →

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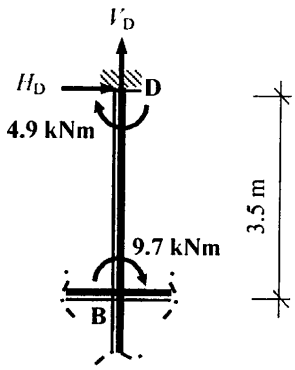


Consider Member BD:

+ve $\circlearrowright \Sigma M_B = 0$

$+ 9.7 + 4.9 + (H_D \times 3.5) = 0$

$\therefore H_D = -4.17$ kN ←

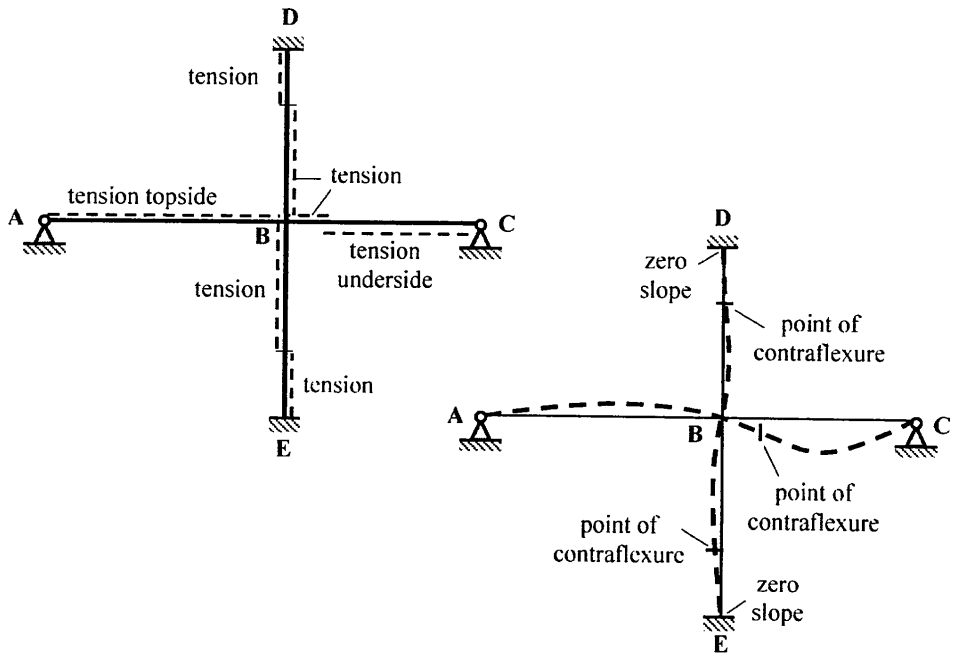
There is insufficient information from the moment distribution analysis to determine the values of H_A, H_C, V_D and V_E separately; i.e.

+ve → $\Sigma F_x = 0$

$H_A + H_C - 4.17 + 2.51 = 0$ $\therefore H_A + H_C = +1.66$ kN

+ve ↑ $\Sigma F_y = 0$

$-50.0 + 1.58 + 18.73 + V_D + V_E = 0$ $\therefore V_D + V_E = +29.69$ kN



Deflected Shape