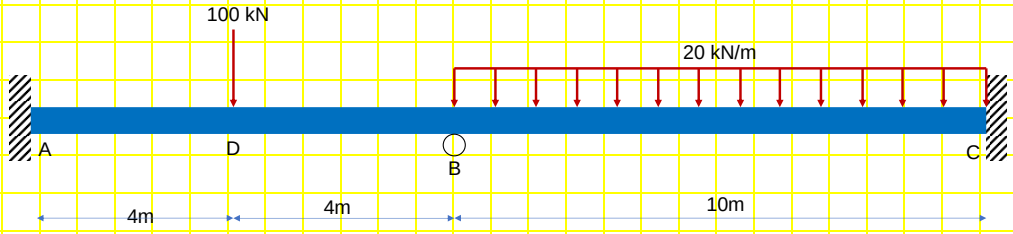
Teesside University **School of Science, Engineering and Design**	Module: Structural Analysis and Design	Sheet No: 1
	Produced by: S3018735	Checked by: S3018735
	Date: December 12, 2024	

Project: ICA – Multi-storey building project

Part 2:



Stiffness Factors:

$$K_{BA} = \frac{4EI}{L} = \frac{4EI}{8} = 0.50EI$$

$$K_{BC} = \frac{4EI}{L} = \frac{4EI}{10} = 0.40EI$$

$$K_B = K_{BA} + K_{BC} = 0.50EI + 0.40EI$$

$$K_B = 0.90EI$$

Distribution Factor:

$$DF_{AB} = 0 \text{ (Fixed End)}$$

$$DF_{BA} = \frac{K_{BA}}{K_{BA} + K_{BC}}$$

$$DF_{BA} = \frac{0.50EI}{0.90EI} = 0.556$$

$$DF_{BC} = \frac{K_{BC}}{K_{BA} + K_{BC}}$$

$$DF_{BC} = \frac{0.40EI}{0.90EI}$$

$$DF_{BC} = 0.444$$

$$DF_{CB} = 0 \text{ (Fixed End)}$$

Fixed End Moments:

$$(FEM)_{AB} = -\frac{PL}{8}$$

$$(FEM)_{AB} = -\frac{(100kN \times 8m)}{8}$$

$$(FEM)_{AB} = -100kN$$

$$(FEM)_{AB} = \frac{PL}{8}$$

$$(FEM)_{AB} = \frac{(100kN \times 8m)}{8}$$

$$(FEM)_{AB} = 100kN$$

$$(FEM)_{BC} = -\frac{wL^2}{12} \qquad (FEM)_{AB} = \frac{wL^2}{12}$$

$$(FEM)_{AB} = -\frac{\left(\frac{20kN}{m}\right)(10m)^2}{12} \qquad (FEM)_{AB} = \frac{\left(\frac{20kN}{m}\right)(10m)^2}{12}$$

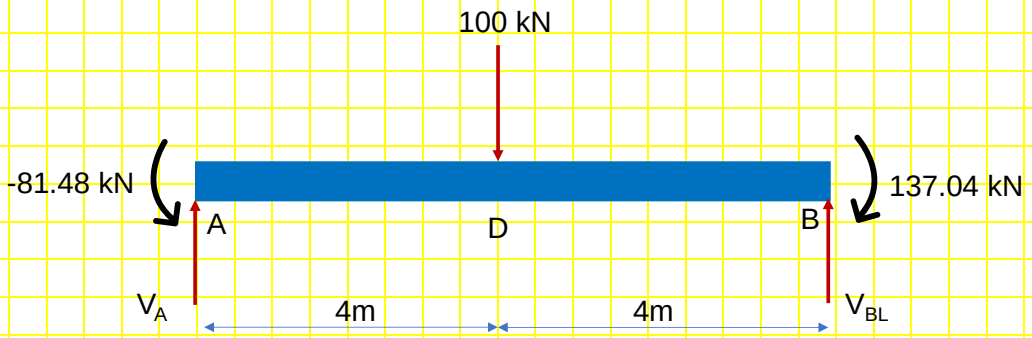
$$(FEM)_{AB} = -166.67kN \qquad (FEM)_{AB} = 166.67kN$$

Moment Distribution Table

Joint	A	B		C
Member	AB	BA	BC	CB
DF	0	0.556	0.444	0
FEM	-100	100	-166.667	166.6667
	0	37.03704	29.62963	0
	18.51852	0	0	14.81481
ΣM	**-81.4815**	**137.037**	**-137.037**	**181.4815**

Shear Force and Bending Moment Diagram Calculations:

Segment AB:



$\Sigma M_A = 0$ (C. W + ve)

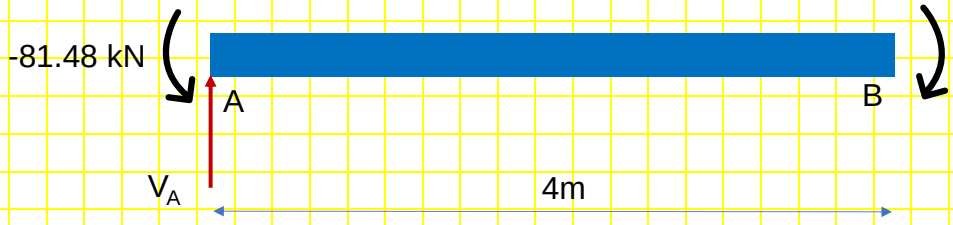
$$-81.48 + 137.04 + 4(100) - 8V_{BL} = 0$$

$$V_{BL} = 56.945 \text{ kN}$$

$\Sigma F_y = 0$ (↑ +ve)

$$V_A = 100 - 56.945$$

$$V_A = 43.055 \text{ kN}$$

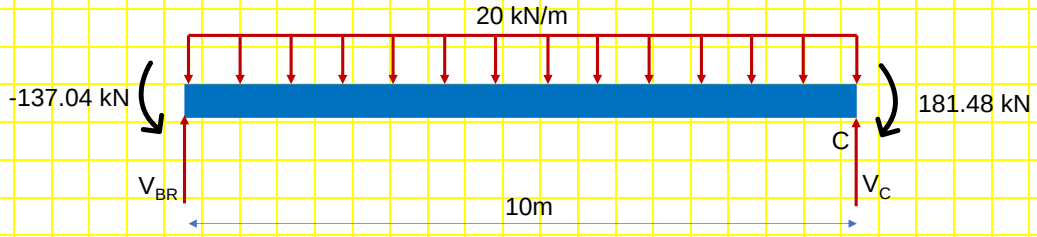


$\Sigma M_D = 0$ (C. W + ve)

$$-M_D - 81.48 + 4(56.945) = 0$$

$$M_D = 90.74\ \text{kN.m}$$

Segment BC:



$\Sigma M_B = 0\ (C.W + ve)$

$$-137.04 + 181.48 - 20(10)(5) - 10V_C = 0$$

$$V_C = 104.44\ \text{kN}$$

$\Sigma F_y = 0\ (\uparrow + ve)$

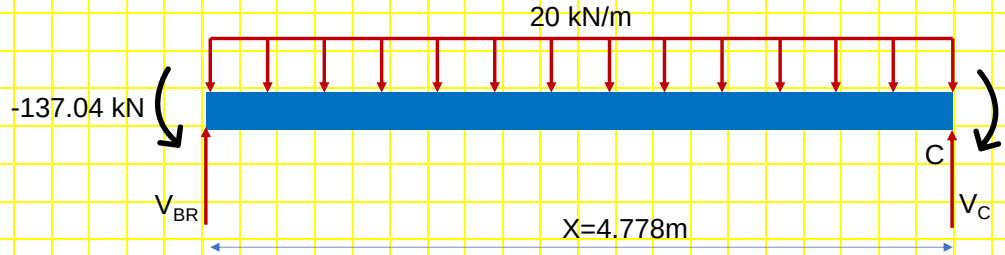
$$V_{BR} = 104.44 - 200$$

$$V_{BR} = 95.56\ \text{kN}$$

Location of Maximum Moment is Where Shear Force is Zero. Therefore;

$$x = \frac{95.56\ \text{kN}}{20} = 4.778\text{m}$$

$$BMD_{Max} = 8\text{m} + 4.778\text{m} = 12.778\text{m}$$



$\Sigma M_x = 0\ (C.W + ve)$

$$-M_x - 137.04 + 95.56(4.778) - \left(20 \times \frac{(4.778)^2}{2}\right) = 0$$

$$M_x = 91.23\ \text{kN.m}$$

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Shear Force and Bending Moment Diagrams