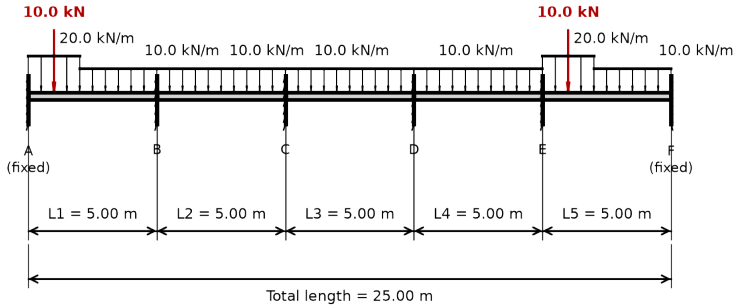
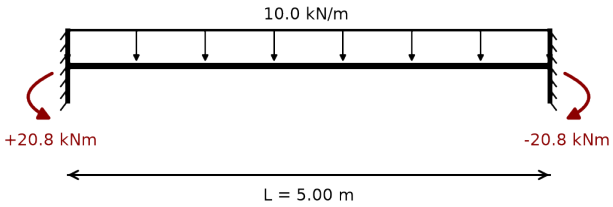
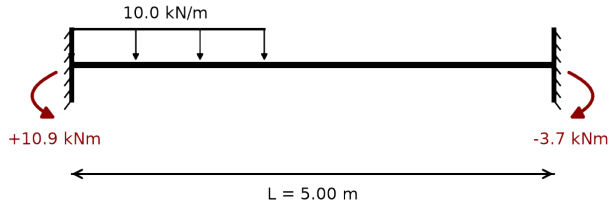
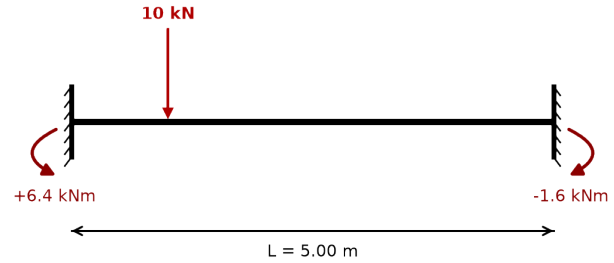
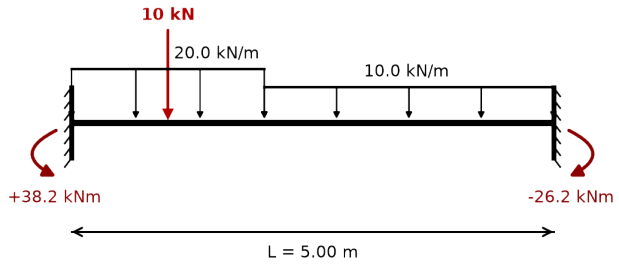
BEAM ANALYSIS REPORT

Element: Beam Analysis 001

Design Code: EN 1992-1-1:2004 | Date: 28 October 2026

REFERENCE	CALCULATIONS	OUTPUT
§Input Parameters	**BEAM CONFIGURATION** Number of spans: **5** Span 1: L = 5.00 m, b = 300 mm, h = 600 mm, UDL = 10 kN/m • Partial UDL 10 kN/m from 0 to 2000 mm • Point load 10 kN @ 1000 mm Span 2: L = 5.00 m, b = 300 mm, h = 600 mm, UDL = 10 kN/m Span 3: L = 5.00 m, b = 300 mm, h = 600 mm, UDL = 10 kN/m Span 4: L = 5.00 m, b = 300 mm, h = 600 mm, UDL = 10 kN/m Span 5: L = 5.00 m, b = 300 mm, h = 600 mm, UDL = 10 kN/m • Partial UDL 10 kN/m from 0 to 2000 mm • Point load 10 kN @ 1000 mm **Free Body Diagram** Free Body Diagram  	
§Step 1 Fixed-End Moments	**FIXED-END MOMENTS** **Span AB** (L = 5.00 m, b = 300 mm, h = 600 mm) • UDL, 10.00 kN/m $FEM_{AB} = +\frac{wL^2}{12} \qquad FEM_{BA} = -\frac{wL^2}{12}$ $FEM_{AB} = +\frac{10.00 \times 5.00^2}{12} = +20.83 kNm$ $FEM_{BA} = -\frac{10.00 \times 5.00^2}{12} = -20.83 kNm$ Span AB – locked (fixed-fixed): UDL, 10.00 kN/m  	

REFERENCE	CALCULATIONS	OUTPUT
	Span AB — next load: • Partial UDL, 10.00 kN/m from 0.00 m to 2.00 m $FEM_{AB} = +\frac{w}{L^2}\int_a^e x(L-x)^2 dx$ $FEM_{BA} = -\frac{w}{L^2}\int_a^e x^2(L-x) dx$ $F_A(x) = \frac{L^2x^2}{2} - \frac{2Lx^3}{3} + \frac{x^4}{4} \qquad F_B(x) = \frac{Lx^3}{3} - \frac{x^4}{4}$ $FEM_{AB} = +\frac{10.00}{5.00^2} \times (27.333 - 0.000) = +10.93 kNm$ $FEM_{BA} = -\frac{10.00}{5.00^2} \times (9.333 - 0.000) = -3.73 kNm$ Span AB – locked (fixed-fixed): Partial UDL, 10.00 kN/m from 0.00 m to 2.00 m 	
	Span AB — next load: • Point load, P = 10.00 kN @ 1.00 m from left $FEM_{AB} = +\frac{Pab^2}{L^2} \qquad FEM_{BA} = -\frac{Pa^2b}{L^2}$ $FEM_{AB} = +\frac{10.00 \times 1.00 \times 4.00^2}{5.00^2} = +6.40 kNm$ $FEM_{BA} = -\frac{10.00 \times 1.00^2 \times 4.00}{5.00^2} = -1.60 kNm$ Span AB – locked (fixed-fixed): Point load, P = 10.00 kN @ 1.00 m from left 	
	Span AB — combined FEM (sum of the loads above): $FEM_{AB} = (+20.83) + (+10.93) + (+6.40) = +38.17 kNm$ $FEM_{BA} = (-20.83) + (-3.73) + (-1.60) = -26.17 kNm$ Span AB – locked (fixed-fixed) 	**FEM_{AB} = +38.17 kNm** **FEM_{BA} = -26.17 kNm**

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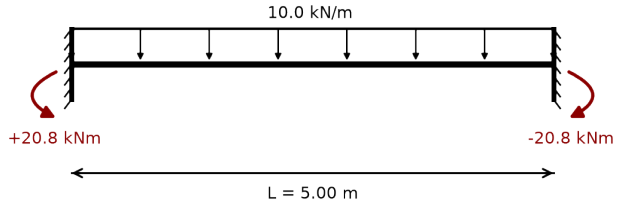
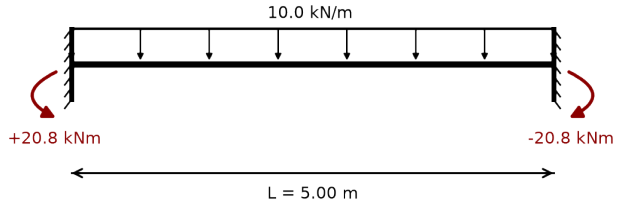
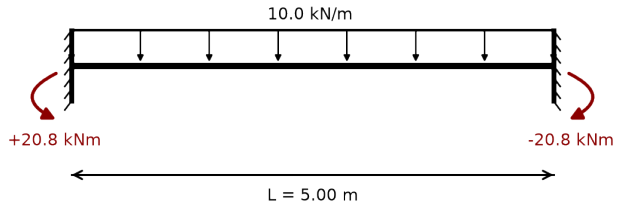
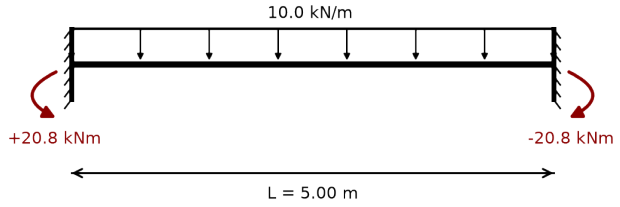
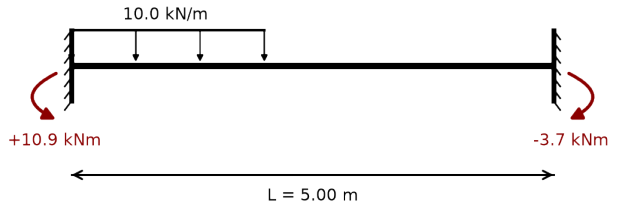
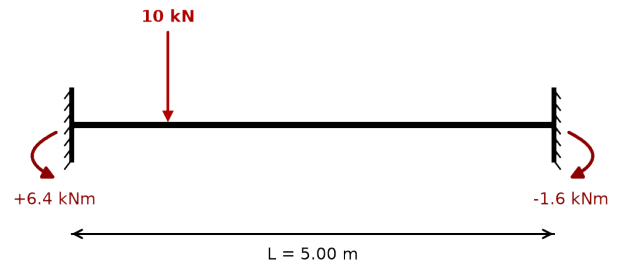
	Span BC (L = 5.00 m, b = 300 mm, h = 600 mm) • UDL, 10.00 kN/m $FEM_{BC} = +\frac{wL^2}{12} \qquad FEM_{CB} = -\frac{wL^2}{12}$ $FEM_{BC} = +\frac{10.00 \times 5.00^2}{12} = +20.83 kNm$ $FEM_{CB} = -\frac{10.00 \times 5.00^2}{12} = -20.83 kNm$ Span BC – locked (fixed-fixed): UDL, 10.00 kN/m  	**FEM_{BC} = +20.83 kNm** **FEM_{CB} = -20.83 kNm**
	Span CD (L = 5.00 m, b = 300 mm, h = 600 mm) • UDL, 10.00 kN/m $FEM_{CD} = +\frac{wL^2}{12} \qquad FEM_{DC} = -\frac{wL^2}{12}$ $FEM_{CD} = +\frac{10.00 \times 5.00^2}{12} = +20.83 kNm$ $FEM_{DC} = -\frac{10.00 \times 5.00^2}{12} = -20.83 kNm$ Span CD – locked (fixed-fixed): UDL, 10.00 kN/m  	**FEM_{CD} = +20.83 kNm** **FEM_{DC} = -20.83 kNm**
	Span DE (L = 5.00 m, b = 300 mm, h = 600 mm) • UDL, 10.00 kN/m $FEM_{DE} = +\frac{wL^2}{12} \qquad FEM_{ED} = -\frac{wL^2}{12}$ $FEM_{DE} = +\frac{10.00 \times 5.00^2}{12} = +20.83 kNm$ $FEM_{ED} = -\frac{10.00 \times 5.00^2}{12} = -20.83 kNm$ Span DE – locked (fixed-fixed): UDL, 10.00 kN/m  	**FEM_{DE} = +20.83 kNm** **FEM_{ED} = -20.83 kNm**

REFERENCE	CALCULATIONS	OUTPUT
	Span EF (L = 5.00 m, b = 300 mm, h = 600 mm) • UDL, 10.00 kN/m $FEM_{EF} = +\frac{wL^2}{12} \qquad FEM_{FE} = -\frac{wL^2}{12}$ $FEM_{EF} = +\frac{10.00 \times 5.00^2}{12} = +20.83 kNm$ $FEM_{FE} = -\frac{10.00 \times 5.00^2}{12} = -20.83 kNm$ Span EF – locked (fixed-fixed): UDL, 10.00 kN/m  	
	Span EF — next load: • Partial UDL, 10.00 kN/m from 0.00 m to 2.00 m $FEM_{EF} = +\frac{w}{L^2}\int_a^e x(L-x)^2 dx$ $FEM_{FE} = -\frac{w}{L^2}\int_a^e x^2(L-x) dx$ $F_A(x) = \frac{L^2x^2}{2} - \frac{2Lx^3}{3} + \frac{x^4}{4} \qquad F_B(x) = \frac{Lx^3}{3} - \frac{x^4}{4}$ $FEM_{EF} = +\frac{10.00}{5.00^2} \times (27.333 - 0.000) = +10.93 kNm$ $FEM_{FE} = -\frac{10.00}{5.00^2} \times (9.333 - 0.000) = -3.73 kNm$ Span EF – locked (fixed-fixed): Partial UDL, 10.00 kN/m from 0.00 m to 2.00 m  	
	Span EF — next load: • Point load, P = 10.00 kN @ 1.00 m from left $FEM_{EF} = +\frac{Pab^2}{L^2} \qquad FEM_{FE} = -\frac{Pa^2b}{L^2}$ $FEM_{EF} = +\frac{10.00 \times 1.00 \times 4.00^2}{5.00^2} = +6.40 kNm$ $FEM_{FE} = -\frac{10.00 \times 1.00^2 \times 4.00}{5.00^2} = -1.60 kNm$ Span EF – locked (fixed-fixed): Point load, P = 10.00 kN @ 1.00 m from left  	

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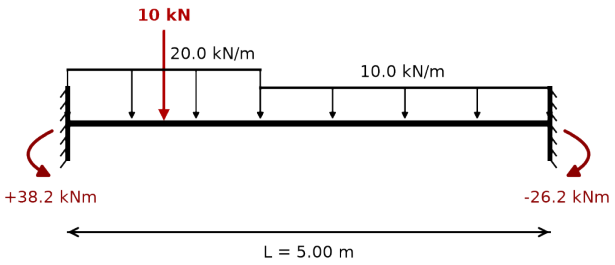
	Span EF — combined FEM (sum of the loads above): $FEM_{EF} = (+20.83) + (+10.93) + (+6.40) = +38.17 kNm$ $FEM_{FE} = (-20.83) + (-3.73) + (-1.60) = -26.17 kNm$ Span EF – locked (fixed-fixed)  	**FEM_{EF} = +38.17 kNm** **FEM_{FE} = -26.17 kNm**
§Step 2 Member Stiffness	**MEMBER STIFFNESS** NOTE: Relative stiffness k = I / L (E common to all spans, since spans have the same material grade). A span whose outer end is pinned/roller offers only 3/4 of its stiffness at the joint it frames into. **Span AB:** I = 5.400e+09 mm^4, L = 5.00 m $k_{AB} = \frac{I}{L}$ $k_{AB} = \frac{5.400e+09}{5.00 \times 1000} = 1080.000 \times 10^6 mm^3$ **Span BC:** I = 5.400e+09 mm^4, L = 5.00 m $k_{BC} = \frac{I}{L}$ $k_{BC} = \frac{5.400e+09}{5.00 \times 1000} = 1080.000 \times 10^6 mm^3$ **Span CD:** I = 5.400e+09 mm^4, L = 5.00 m $k_{CD} = \frac{I}{L}$ $k_{CD} = \frac{5.400e+09}{5.00 \times 1000} = 1080.000 \times 10^6 mm^3$ **Span DE:** I = 5.400e+09 mm^4, L = 5.00 m $k_{DE} = \frac{I}{L}$ $k_{DE} = \frac{5.400e+09}{5.00 \times 1000} = 1080.000 \times 10^6 mm^3$ **Span EF:** I = 5.400e+09 mm^4, L = 5.00 m $k_{EF} = \frac{I}{L}$ $k_{EF} = \frac{5.400e+09}{5.00 \times 1000} = 1080.000 \times 10^6 mm^3$	**k_{AB} = 1080.000** **k_{BC} = 1080.000** **k_{CD} = 1080.000** **k_{DE} = 1080.000** **k_{EF} = 1080.000**

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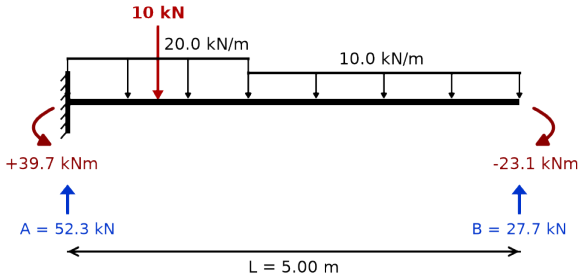
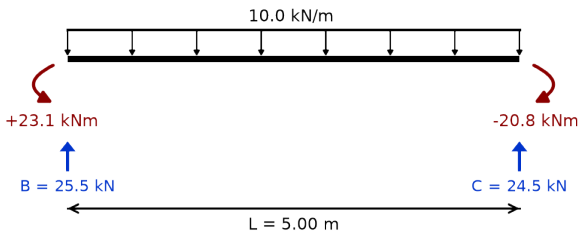
§Step 3 Distribution Factors	**DISTRIBUTION FACTORS** At each interior joint: DF = k / Σk **Joint B:** $\Sigma k = k_{BA} + k_{BC}$ $\Sigma k = 1080.000 + 1080.000 = 2160.000 \times 10^6$ $DF_{BA} = \frac{k_{BA}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ $DF_{BC} = \frac{k_{BC}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ **Joint C:** $\Sigma k = k_{CB} + k_{CD}$ $\Sigma k = 1080.000 + 1080.000 = 2160.000 \times 10^6$ $DF_{CB} = \frac{k_{CB}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ $DF_{CD} = \frac{k_{CD}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ **Joint D:** $\Sigma k = k_{DC} + k_{DE}$ $\Sigma k = 1080.000 + 1080.000 = 2160.000 \times 10^6$ $DF_{DC} = \frac{k_{DC}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ $DF_{DE} = \frac{k_{DE}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ **Joint E:** $\Sigma k = k_{ED} + k_{EF}$ $\Sigma k = 1080.000 + 1080.000 = 2160.000 \times 10^6$ $DF_{ED} = \frac{k_{ED}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$ $DF_{EF} = \frac{k_{EF}}{\Sigma k} = \frac{1080.000}{2160.000} = 0.500$	**Joint B:** **DF_{BA} = 0.500** **DF_{BC} = 0.500** **Joint C:** **DF_{CB} = 0.500** **DF_{CD} = 0.500** **Joint D:** **DF_{DC} = 0.500** **DF_{DE} = 0.500** **Joint E:** **DF_{ED} = 0.500** **DF_{EF} = 0.500**
§Step 4 Moment Distribution	**MOMENT DISTRIBUTION** Each interior joint is balanced by its DFs; half of each distributed moment is carried over to the far end. Repeats until the carried-over moments are negligible.	**M_A = 39.674 kNm** **M_B = 23.152 kNm** **M_C = 20.764 kNm** **M_D = 18.864 kNm** **M_E = 28.833 kNm** **M_F = 30.838 kNm**

Joint	A	B		C		D		E		F
Member	**AB**	**BA**	**BC**	**CB**	**CD**	**DC**	**DE**	**ED**	**EF**	**FE**
D.F.	**-**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**-**
F.E.M.	**+38.17**	**-26.17**	**+20.83**	**-20.83**	**+20.83**	**-20.83**	**+20.83**	**-20.83**	**+38.17**	**-26.17**
Dist.		+2.67	+2.67					-8.67	-8.67	
C.O.	+1.33			+1.33			-4.33			-4.33
Dist.				-0.67	-0.67	+2.17	+2.17			
C.O.			-0.33		+1.08	-0.33		+1.08		
Dist.		+0.17	+0.17	-0.54	-0.54	+0.17	+0.17	-0.54	-0.54	
C.O.	+0.08		-0.27	+0.08	+0.08	-0.27	-0.27	+0.08		-0.27
Dist.		+0.14	+0.14	-0.08	-0.08	+0.27	+0.27	-0.04	-0.04	
C.O.	+0.07		-0.04	+0.07	+0.14	-0.04	-0.02	+0.14		-0.02
Dist.		+0.02	+0.02	-0.10	-0.10	+0.03	+0.03	-0.07	-0.07	
C.O.	+0.01		-0.05	+0.01	+0.02	-0.05	-0.03	+0.02		-0.03
Dist.		+0.03	+0.03	-0.01	-0.01	+0.04	+0.04			
C.O.	+0.01		-0.01	+0.01	+0.02	-0.01		+0.02		
Dist.				-0.02	-0.02			-0.02	-0.02	
C.O.			-0.01			-0.01	-0.01			-0.01
Dist.						+0.01	+0.01			
C.O.					+0.01			+0.01		
Final	**+39.67**	**-23.15**	**+23.14**	**-20.75**	**+20.76**	**-18.86**	**+18.86**	**-28.82**	**+28.83**	**-30.83**

REFERENCE	CALCULATIONS	OUTPUT
§Step 5 Reactions	**REACTIONS & SPAN ANALYSIS** *Each span is isolated as a free body carrying its own loads together with its FINAL moments.* **Span AB:** Span AB – final moments & reactions  (a) Taking moments about B (ΣM = 0, anticlockwise +ve): $-V_A \times L + 10.0 \times (L - 1.00) + \frac{10.0 \times L^2}{2} + 20.0 \times (L - 1.00) + M_{AB} + M_{BA} = 0$ $-V_A \times 5.00 + 40.00 + 125.00 + 80.00 + (+39.67) + (-23.15) = 0$ $V_A = \frac{261.52}{5.00} = 52.30kN \uparrow$ (b) Vertical force equilibrium (ΣF_y = 0, up = down): $V_A + V_{BL} = 10.00 + 10.00 \times 5.00 + 20.00$ $V_{BL} = 80.00 - 52.30 = 27.70kN \uparrow$ (c) Maximum sagging moment inside the span: $V(x) = V_A - 10.0x - 10.0 \times (x - 0.00)H(x - 0.00) + 10.0 \times (x - 2.00)H(x - 2.00) - 10H(x - 1.00) = 0$ $= > x_{max} = 2.23m$ $M_{max} = (-39.67) + 52.30 \times 2.23 - \frac{10.0 \times 2.23^2}{2} - 10.0 \times 2.00 \times (2.23 - 0.00 - \frac{2.00}{2}) - 10.0 \times (2.23 - 1.00) = 15.20kNm$	
	Span BC: Span BC – final moments & reactions  (a) Taking moments about C (ΣM = 0, anticlockwise +ve): $-V_{BR} \times L + \frac{10.0 \times L^2}{2} + M_{BC} + M_{CB} = 0$ $-V_{BR} \times 5.00 + 125.00 + (+23.14) + (-20.75) = 0$ $V_{BR} = \frac{127.39}{5.00} = 25.48kN \uparrow$ (b) Vertical force equilibrium (ΣF_y = 0, up = down): $V_{BR} + V_{CL} = 10.00 \times 5.00$ $V_{CL} = 50.00 - 25.48 = 24.52kN \uparrow$ (c) Maximum sagging moment inside the span: $V(x) = V_{BR} - 10.0x = 0$ $= > x_{max} = 2.55m$ $M_{max} = (-23.14) + 25.48 \times 2.55 - \frac{10.0 \times 2.55^2}{2} = 9.32kNm$	

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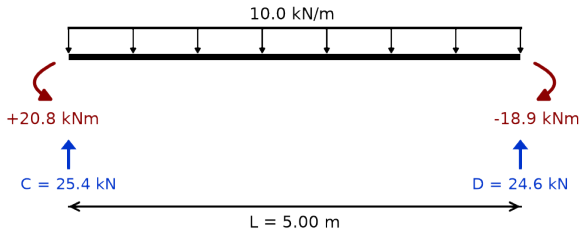
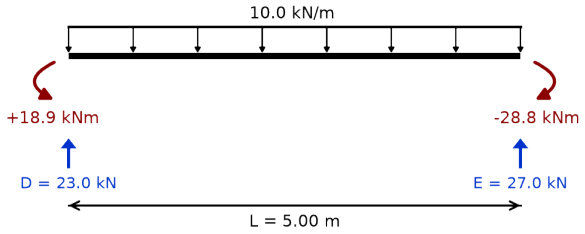
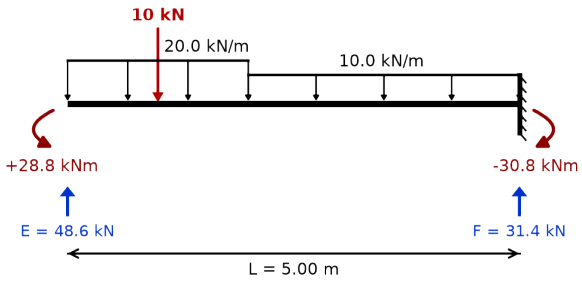
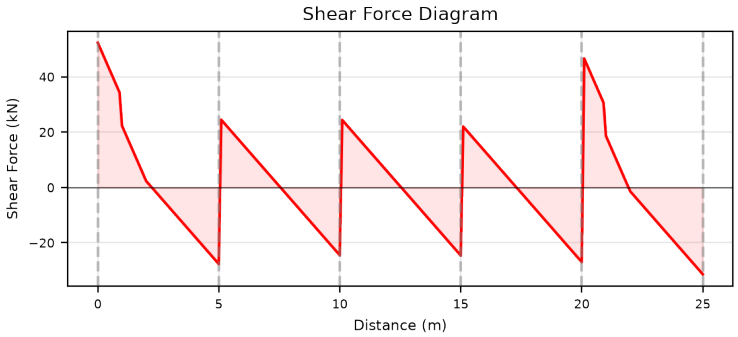
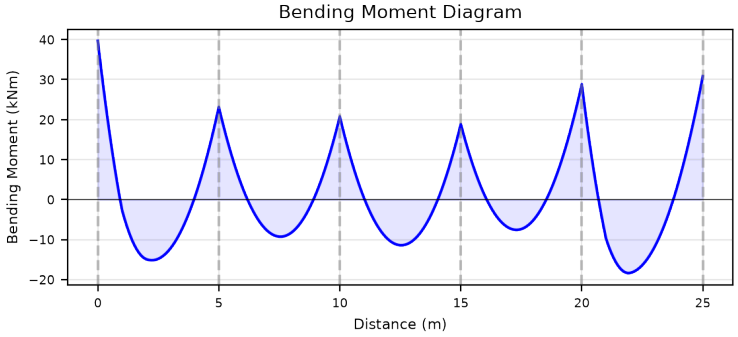
	Span CD: Span CD – final moments & reactions  (a) Taking moments about D (ΣM = 0, anticlockwise +ve): $-V_{CR} \times L + \frac{10.0 \times L^2}{2} + M_{CD} + M_{DC} = 0$ $-V_{CR} \times 5.00 + 125.00 + (+20.76) + (-18.86) = 0$ $V_{CR} = \frac{126.90}{5.00} = 25.38kN \uparrow$ (b) Vertical force equilibrium (ΣF_y = 0, up = down): $V_{CR} + V_{DL} = 10.00 \times 5.00$ $V_{DL} = 50.00 - 25.38 = 24.62kN \uparrow$ (c) Maximum sagging moment inside the span: $V(x) = V_{CR} - 10.0x = 0$ $= > x_{max} = 2.54m$ $M_{max} = (-20.76) + 25.38 \times 2.54 - \frac{10.0 \times 2.54^2}{2} = 11.45kNm$	
	Span DE: Span DE – final moments & reactions  (a) Taking moments about E (ΣM = 0, anticlockwise +ve): $-V_{DR} \times L + \frac{10.0 \times L^2}{2} + M_{DE} + M_{ED} = 0$ $-V_{DR} \times 5.00 + 125.00 + (+18.86) + (-28.82) = 0$ $V_{DR} = \frac{115.04}{5.00} = 23.01kN \uparrow$ (b) Vertical force equilibrium (ΣF_y = 0, up = down): $V_{DR} + V_{EL} = 10.00 \times 5.00$ $V_{EL} = 50.00 - 23.01 = 26.99kN \uparrow$ (c) Maximum sagging moment inside the span: $V(x) = V_{DR} - 10.0x = 0$ $= > x_{max} = 2.30m$ $M_{max} = (-18.86) + 23.01 \times 2.30 - \frac{10.0 \times 2.30^2}{2} = 7.61kNm$	

REFERENCE	CALCULATIONS	OUTPUT
	Span EF: Span EF – final moments & reactions  (a) Taking moments about F (ΣM = 0, anticlockwise +ve): $-V_{ER} \times L + 10.0 \times (L - 1.00) + \frac{10.0 \times L^2}{2} + 20.0 \times (L - 1.00) + M_{EF} + M_{FE} = 0$ $-V_{ER} \times 5.00 + 40.00 + 125.00 + 80.00 + (+28.83) + (-30.83) = 0$ $V_{ER} = \frac{243.00}{5.00} = 48.60kN \uparrow$ (b) Vertical force equilibrium (ΣF_y = 0, up = down): $V_{ER} + V_F = 10.00 + 10.00 \times 5.00 + 20.00$ $V_F = 80.00 - 48.60 = 31.40kN \uparrow$ (c) Maximum sagging moment inside the span: $V(x) = V_{ER} - 10.0x - 10.0 \times (x - 0.00)H(x - 0.00) + 10.0 \times (x - 2.00)H(x - 2.00) - 10H(x - 1.00) = 0$ $= > x_{max} = 1.93m$ $M_{max} = (-28.83) + 48.60 \times 1.93 - \frac{10.0 \times 1.93^2}{2} - 10.0 \times 1.93 \times (1.93 - 0.00 - \frac{1.93}{2}) - 10.0 \times (1.93 - 1.00) = 18.42kNm$	
	Reactions at the joints: $R_A = 52.30kN$ $R_B = V_{BL} + V_{BR} = 27.70 + 25.48 = 53.17kN$ $R_C = V_{CL} + V_{CR} = 24.52 + 25.38 = 49.90kN$ $R_D = V_{DL} + V_{DR} = 24.62 + 23.01 = 47.63kN$ $R_E = V_{EL} + V_{ER} = 26.99 + 48.60 = 75.59kN$ $R_F = 31.40kN$	**R_A = 52.304 kN** **R_B = 53.173 kN** **R_C = 49.902 kN** **R_D = 47.626 kN** **R_E = 75.593 kN** **R_F = 31.401 kN**

REFERENCE	CALCULATIONS	OUTPUT
§Step 6 SFD & BMD	**Shear Force Diagram**  **Bending Moment Diagram**  	**V_{max} = 52.30 kN** **M_{max} = 39.67 kNm**