

TIMOSHENKO BEAM - Uniformly distributed load, Cantilevers and Load fieldwise

+

$$L1 := 1000 \text{ mm}$$

$$L2 := 5000 \text{ mm}$$

$$L3 := 5000 \text{ mm}$$

$$L4 := 1000 \text{ mm}$$

$$h := 100 \text{ mm}$$

$$b := 100 \text{ mm}$$

$$E := 11000 \frac{\text{N}}{\text{mm}^2}$$

$$I := \frac{b \cdot h^3}{12} = \frac{25000000}{3} \text{ mm}^4$$

$$G := 690 \frac{\text{N}}{\text{mm}^2}$$

$$EI := E \cdot I = 9,1667 \cdot 10^{10} \text{ N mm}^2$$

$$A := b \cdot h = 0,01 \text{ m}^2$$

$$GA := G \cdot A = 6,9 \cdot 10^6 \text{ N}$$

$$kS := 1,2$$

$$GAC := \frac{G \cdot A}{kS} = 5,75 \cdot 10^6 \text{ N}$$

$$u1(x; q1; q2; q3; q4) := \left(v1(x) - \frac{EI}{GAC} \cdot v1''(x) \right)$$

$$u2(x; q1; q2; q3; q4) := v2(x) - \frac{EI}{GAC} \cdot v2''(x)$$

$$u3(x; q1; q2; q3; q4) := \left(v3(x) - \frac{EI}{GAC} \cdot v3''(x) \right)$$

$$u4(x; q1; q2; q3; q4) := v4(x) - \frac{EI}{GAC} \cdot v4''(x)$$

$$M1(x; q1; q2; q3; q4) := -(v1''(x) \cdot EI)$$

$$M2(x; q1; q2; q3; q4) := -(v2''(x) \cdot EI)$$

$$M3(x; q1; q2; q3; q4) := -(v3''(x) \cdot EI)$$

$$M4(x; q1; q2; q3; q4) := -(v4''(x) \cdot EI)$$

$$V1(x; q1; q2; q3; q4) := -(v1'''(x) \cdot EI)$$

$$V2(x; q1; q2; q3; q4) := -(v2'''(x) \cdot EI)$$

$$V3(x; q1; q2; q3; q4) := -(v3'''(x) \cdot EI)$$

$$V4(x; q1; q2; q3; q4) := -(v4'''(x) \cdot EI)$$

Reactions

$$R1(q1; q2; q3; q4) := (V1(L1; q1; q2; q3; q4) - V2(0; q1; q2; q3; q4))$$

$$R2(q1; q2; q3; q4) := (V2(L2; q1; q2; q3; q4) - V3(0; q1; q2; q3; q4))$$

$$R3(q1; q2; q3; q4) := V3(L3; q1; q2; q3; q4) - V4(0; q1; q2; q3; q4)$$

$$L := L1 + L2 + L3 + L4 = 12 \text{ m}$$

Beam length

$$L_A := 0 \text{ m}$$

$$L_B := L1 = 1 \text{ m}$$

$$L_C := L1 + L2 = 6 \text{ m}$$

$$L_D := L1 + L2 + L3 = 11 \text{ m}$$

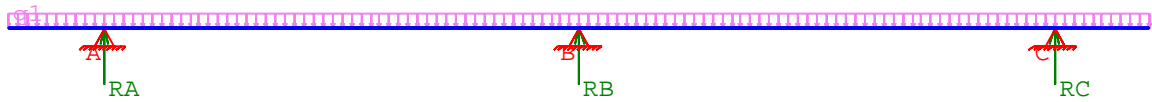
$$L_E := L1 + L2 + L3 + L4 = 12 \text{ m}$$

$$q q := (-1) \frac{\text{kN}}{\text{m}}$$

Uniform distributed load - fieldwise

+

Beam diagram:



$$V_{min}(x) := \begin{cases} \min(V1(x; q q; 0; q q; 0); V1(x; 0; q q; 0; q q); V1(x; q q; q q; 0; q q); V1(x; 0; q q; q q; 0); V1(x; q q; 0; q q; 0)) \\ \min(V2(x - L1; q q; 0; q q; 0); V2(x - L1; 0; q q; 0; q q); V2(x - L1; q q; q q; 0; q q); V2(x - L1; 0; q q; q q; 0)) \\ \min(V3(x - L1 - L2; q q; 0; q q; 0); V3(x - L1 - L2; 0; q q; 0; q q); V3(x - L1 - L2; q q; q q; 0; q q); V3(x - L1 - L2; 0; q q; q q; 0)) \\ \min(V4(x - L1 - L2 - L3; q q; 0; q q; 0); V4(x - L1 - L2 - L3; 0; q q; 0; q q); V4(x - L1 - L2 - L3; q q; q q; 0; q q); V4(x - L1 - L2 - L3; 0; q q; q q; 0)) \\ 0 \end{cases}$$

$$M_{min}(x) := \begin{cases} \min(M1(x; q q; 0; q q; 0); M1(x; 0; q q; 0; q q); M1(x; q q; q q; 0; q q); M1(x; 0; q q; q q; 0); M1(x; q q; 0; q q; 0)) \\ \min(M2(x - L1; q q; 0; q q; 0); M2(x - L1; 0; q q; 0; q q); M2(x - L1; q q; q q; 0; q q); M2(x - L1; 0; q q; q q; 0)) \\ \min(M3(x - L1 - L2; q q; 0; q q; 0); M3(x - L1 - L2; 0; q q; 0; q q); M3(x - L1 - L2; q q; q q; 0; q q); M3(x - L1 - L2; 0; q q; q q; 0)) \\ \min(M4(x - L1 - L2 - L3; q q; 0; q q; 0); M4(x - L1 - L2 - L3; 0; q q; 0; q q); M4(x - L1 - L2 - L3; q q; q q; 0; q q); M4(x - L1 - L2 - L3; 0; q q; q q; 0)) \\ 0 \end{cases}$$

$$u_{min}(x) := \begin{cases} \min(u1(x; q q; 0; q q; 0); u1(x; 0; q q; 0; q q); u1(x; q q; q q; 0; q q); u1(x; 0; q q; q q; 0); u1(x; q q; 0; q q; 0)) \\ \min(u2(x - L1; q q; 0; q q; 0); u2(x - L1; 0; q q; 0; q q); u2(x - L1; q q; q q; 0; q q); u2(x - L1; 0; q q; q q; 0)) \\ \min(u3(x - L1 - L2; q q; 0; q q; 0); u3(x - L1 - L2; 0; q q; 0; q q); u3(x - L1 - L2; q q; q q; 0; q q); u3(x - L1 - L2; 0; q q; q q; 0)) \\ \min(u4(x - L1 - L2 - L3; q q; 0; q q; 0); u4(x - L1 - L2 - L3; 0; q q; 0; q q); u4(x - L1 - L2 - L3; q q; q q; 0; q q); u4(x - L1 - L2 - L3; 0; q q; q q; 0)) \\ 0 \end{cases}$$

$$V_{max}(x) := \begin{cases} \max(V1(x; q q; 0; q q; 0); V1(x; 0; q q; 0; q q); V1(x; q q; q q; 0; q q); V1(x; 0; q q; q q; 0); V1(x; q q; 0; q q; 0)) \\ \max(V2(x - L1; q q; 0; q q; 0); V2(x - L1; 0; q q; 0; q q); V2(x - L1; q q; q q; 0; q q); V2(x - L1; 0; q q; q q; 0)) \\ \max(V3(x - L1 - L2; q q; 0; q q; 0); V3(x - L1 - L2; 0; q q; 0; q q); V3(x - L1 - L2; q q; q q; 0; q q); V3(x - L1 - L2; 0; q q; q q; 0)) \\ \max(V4(x - L1 - L2 - L3; q q; 0; q q; 0); V4(x - L1 - L2 - L3; 0; q q; 0; q q); V4(x - L1 - L2 - L3; q q; q q; 0; q q); V4(x - L1 - L2 - L3; 0; q q; q q; 0)) \\ 0 \end{cases}$$

$$\begin{aligned}
M_{\max}(x) &:= \begin{cases} \text{Max}(M1(x; qq; 0; qq; 0); M1(x; 0; qq; 0; qq); M1(x; qq; qq; 0; qq); M1(x; 0; qq; qq; 0); M1(x; \\ \text{Max}(M2(x-L1; qq; 0; qq; 0); M2(x-L1; 0; qq; 0; qq); M2(x-L1; qq; qq; 0; qq); M2(x-L1; 0; \\ \text{Max}(M3(x-L1-L2; qq; 0; qq; 0); M3(x-L1-L2; 0; qq; 0; qq); M3(x-L1-L2; qq; qq; 0; qq); \\ \text{Max}(M4(x-L1-L2-L3; qq; 0; qq; 0); M4(x-L1-L2-L3; 0; qq; 0; qq); M4(x-L1-L2-L3; qq; \\ 0 \end{cases} \\
u_{\max}(x) &:= \begin{cases} \text{Max}(u1(x; qq; 0; qq; 0); u1(x; 0; qq; 0; qq); u1(x; qq; qq; 0; qq); u1(x; 0; qq; qq; 0); u1(x; \\ \text{Max}(u2(x-L1; qq; 0; qq; 0); u2(x-L1; 0; qq; 0; qq); u2(x-L1; qq; qq; 0; qq); u2(x-L1; 0; \\ \text{Max}(u3(x-L1-L2; qq; 0; qq; 0); u3(x-L1-L2; 0; qq; 0; qq); u3(x-L1-L2; qq; qq; 0; qq); \\ \text{Max}(u4(x-L1-L2-L3; qq; 0; qq; 0); u4(x-L1-L2-L3; 0; qq; 0; qq); u4(x-L1-L2-L3; qq; \\ 0 \end{cases}
\end{aligned}$$

$$R1_{\min} := \text{Min}(R1(qq; 0; qq; 0); R1(0; qq; 0; qq); R1(qq; qq; 0; qq); R1(0; qq; qq; 0); R1(qq; 0; qq; qq);$$

$$R1_{\max} := \text{Max}(R1(qq; 0; qq; 0); R1(0; qq; 0; qq); R1(qq; qq; 0; qq); R1(0; qq; qq; 0); R1(qq; 0; qq; qq);$$

$$R2_{\min} := \text{Min}(R2(qq; 0; qq; 0); R2(0; qq; 0; qq); R2(qq; qq; 0; qq); R2(0; qq; qq; 0); R2(qq; 0; qq; qq);$$

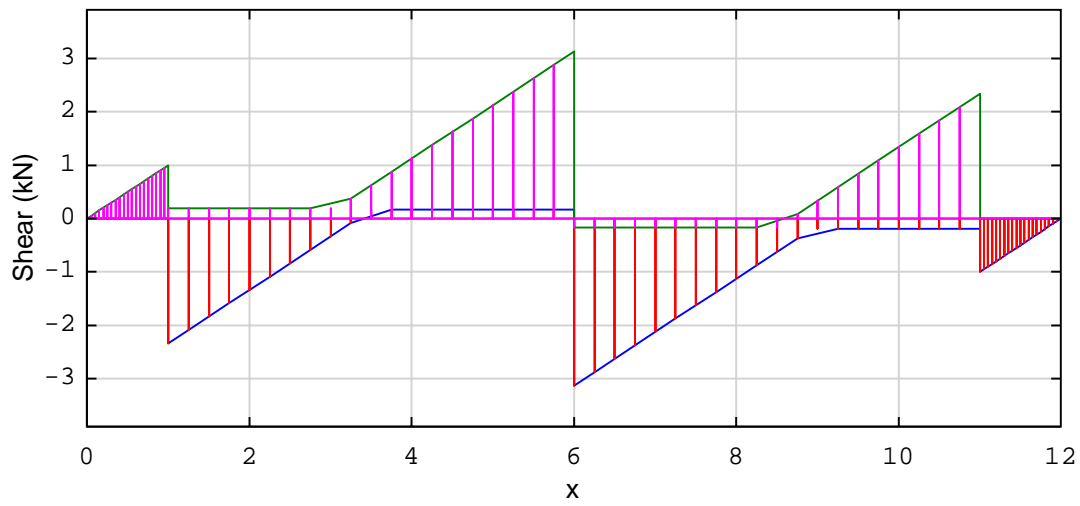
$$R2_{\max} := \text{Max}(R2(qq; 0; qq; 0); R2(0; qq; 0; qq); R2(qq; qq; 0; qq); R2(0; qq; qq; 0); R2(qq; 0; qq; qq);$$

$$R3_{\min} := \text{Min}(R3(qq; 0; qq; 0); R3(0; qq; 0; qq); R3(qq; qq; 0; qq); R3(0; qq; qq; 0); R3(qq; 0; qq; qq);$$

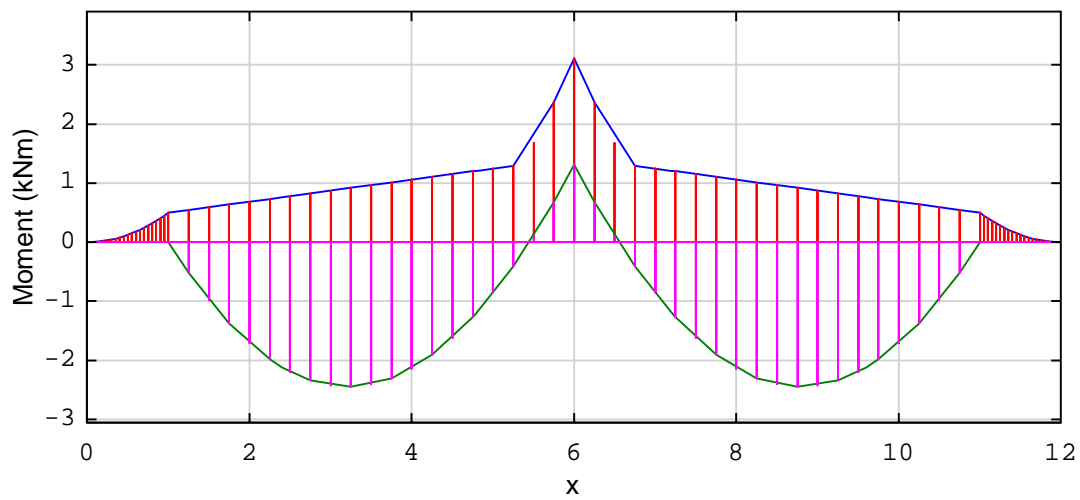
$$R3_{\max} := \text{Max}(R3(qq; 0; qq; 0); R3(0; qq; 0; qq); R3(qq; qq; 0; qq); R3(0; qq; qq; 0); R3(qq; 0; qq; qq);$$



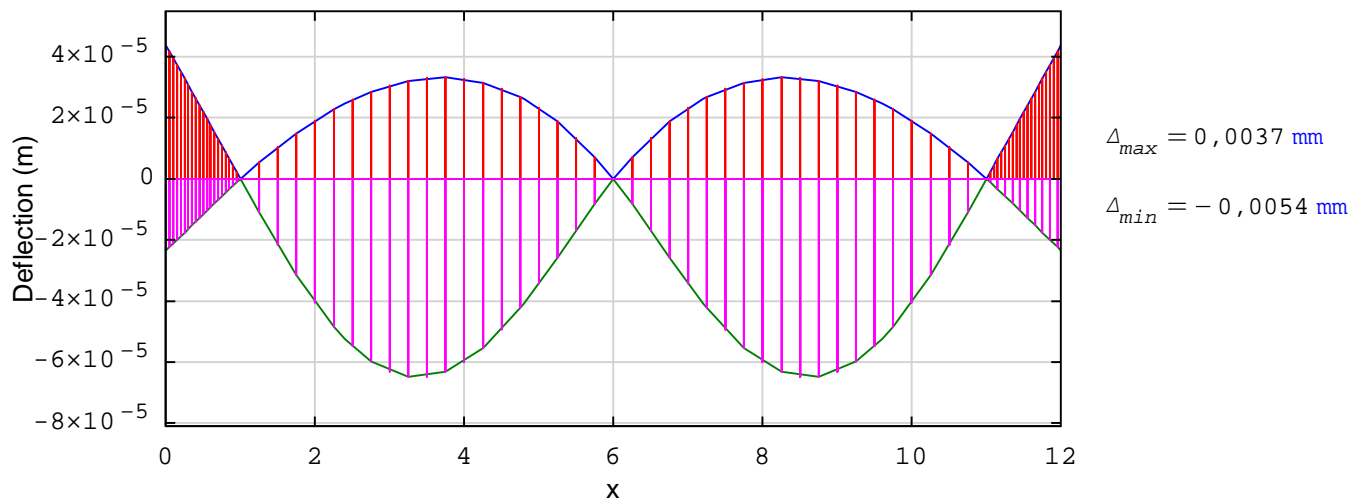
Shear Diagram



Moment Diagram



Deflection Diagram



Reactions

$$R1_{min} = 812,9535 \text{ N}$$

$$R1_{max} = 3337,8103 \text{ N}$$

$$R2_{min} = 2824,3794 \text{ N}$$

$$R2_{max} = 6247,6133 \text{ N}$$

$$R3_{min} = 812,9535 \text{ N}$$

$$R3_{max} = 3337,8103 \text{ N}$$