

# TIMOSHENKO BEAM - Single supported beam with 2 concentrated forces

## Beam spans

Span length [mm]  $L := 6000$

## Rectangular cross-section

Section height  $h := 200$

Section width  $b := 100$

Shear factor  $k_s := 1,2$

Moment of inertia  $I := \frac{b \cdot h^3}{12}$

Cross - sectional area  $A := b \cdot h$

## Beam material

Elastic modulus  $E := 11000$

Shear modulus  $G := 690$

Bending stiffness  $EI := E \cdot I$

Shear stiffness  $GA := G \cdot A = 1,38 \cdot 10^7$

Corrected shear stiffness  $GAC := \frac{G \cdot A}{k_s} = 1,15 \cdot 10^7$

## Beam load

Load start  $x_s := \frac{L}{8} = 750$

Load length  $x_l := \frac{7 \cdot L}{8} = 5250$

Blocklast [N/mm]  $q := 1$

Approximation step-function  $H(x) := \frac{1}{2} \cdot (1 + \text{sign}(x))$

Blocklast  $p(x) := q \cdot H(x - x_s) - q \cdot H(x - x_l)$

$$I_4(x) := \frac{\text{Int}\left(\text{Int}\left(\text{Int}\left(\text{Int}(p(x); x); x\right); x\right); x\right); x}{EI}$$

$$I_3(x) := \frac{\text{Int}\left(\text{Int}\left(\text{Int}(p(x); x); x\right); x\right)}{EI}$$

$$I_2(x) := \frac{\text{Int}\left(\text{Int}(p(x); x)\right)}{EI}$$

$$v(x) := \left( a_0 + a_1 \cdot x + a_2 \cdot x^2 + a_3 \cdot x^3 \right) + I_4(x)$$

$$v'(x) := \left( a_1 + 2 \cdot a_2 \cdot x + 3 \cdot a_3 \cdot x^2 \right) + I_3(x)$$

$$v''(x) := 2 \cdot a_2 + 6 \cdot a_3 \cdot x + I_2(x)$$

$$\text{Assign} \left( \text{Algsys} \left( \begin{bmatrix} v(0) = 0 \\ v''(0) = 0 \\ v(L) = 0 \\ v''(L) = 0 \end{bmatrix}; \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \end{bmatrix} \right) \right) = \begin{cases} -21,5732 \\ 0,0276 \\ -4,6023 \cdot 10^{-6} \\ 0 \end{cases}$$

$$u(x) := \left( v(x) - \frac{EI}{GAC} \cdot v''(x) \right)$$

$$M(x) := (-EI) \cdot v''(x)$$

$$\text{eval} \left( u \left( \frac{L}{2} \right) \right) = 21,6703$$

Deflection - midspan

$$w_m := \frac{5}{384} \cdot \frac{q \cdot L^4}{EI} + \frac{q \cdot L^2}{8 \cdot GAC} = 23,4027$$

$$\text{eval} \left( M \left( \frac{L}{2} \right) \right) = 4,2188 \cdot 10^6$$

Moment - midspan

$$M_w := \frac{q \cdot L^2}{8} = 4,5 \cdot 10^6$$