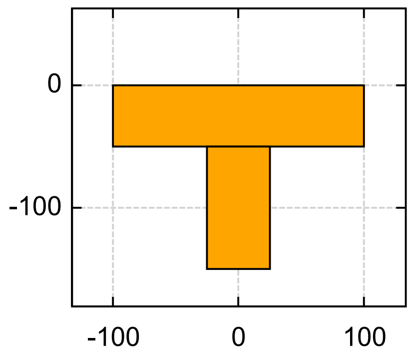
SHEAR FACTOR CALCULATIONS

Section geometry	Width	Height	
Top subsection	$b_1 := 200$	$h_1 := 50$	[mm]
Bottom subsection	$b_2 := 50$	$h_2 := 100$	[mm]
Total section height	$h := h_1 + h_2 = 150$		

Material properties	Elastic modulus	Shear modulus	(typical timber properties)
Top subsection	$E_1 := 11000$	$G_1 := 600$	[N/mm²]
Bottom subsection	$E_2 := 11000$	$G_2 := 600$	[N/mm²]
Shear stiffness	$GA := G_1 \cdot h_1 \cdot b_1 + G_2 \cdot h_2 \cdot b_2 = 9 \cdot 10^6$		[N]

SECTION VIEW

Section view



Position of neutral axis from the top edge [mm] $y_n := \dfrac{b_2 \cdot h_2 \cdot E_2 \cdot \left(h_1 + \dfrac{h_2}{2}\right) + b_1 \cdot h_1 \cdot E_1 \cdot \dfrac{h_1}{2}}{b_1 \cdot h_1 \cdot E_1 + b_2 \cdot h_2 \cdot E_2} = 50$

Position of neutral axis from center [mm] $y_c := y_n - \dfrac{h}{2} = -25$

General expressions

Approximation for step function $H(z) := \dfrac{1}{2} \cdot (1 + \operatorname{sign}(z))$

Elastic modulus expression for the whole cross-section depending on the distance from the top edge

$$E(z) := E_1 \cdot H(z + y_c + h) - (E_1 - E_2) \cdot H\left(z + y_c + \frac{h}{2} - h_1\right)$$

Shear modulus expression for the whole cross-section depending on the distance from the top edge

$$G(z) := G_1 \cdot H(z + y_c + h) - (G_1 - G_2) \cdot H\left(z + y_c + \frac{h}{2} - h_1\right)$$

Cross sectional width depending on the distance from the top edge

$$b(z) := b_1 \cdot H(z + y_c + h) - (b_1 - b_2) \cdot H\left(z + y_c + \frac{h}{2} - h_1\right)$$

Balance of energy of the beam for linear elasticity

Properties for the simply supported beam (useful for the further calculations):

- Linear distributed load	[kN/m]	$q := 1$
- Span length	[m]	$L := 1$

Bending stiffness $\quad EI := \mathrm{Int}\left(E(z) \cdot b(z) \cdot z^2 ; z ; -\frac{h}{2} - y_c ; \frac{h}{2} - y_c \right)$

Shear flow expression $\quad T(z) := (-q) \cdot \frac{L}{2 \cdot EI} \cdot \mathrm{Int}\left(E(z) \cdot b(z) \cdot z ; z ; -\frac{h}{2} - y_c ; z \right)$

Internal energy $\quad U := \mathrm{eval}\left(\frac{1}{2} \cdot \mathrm{Int}\left(\frac{(T(z))^2}{G(z) \cdot b(z)} ; z ; -\frac{h}{2} - y_c ; \frac{h}{2} - y_c \right) \right)$

External energy $\quad W(k_s) := \frac{1}{2} \cdot \frac{k_s}{GA} \cdot \left(\frac{q \cdot L}{2} \right)^2 = \frac{k_s}{72000000}$

Shear correction factor $\quad k_s := \mathrm{solve}\left(U - W(k_s) ; k_s \right) = 1,8$

Bending stiffness	[Nmm²]	$\boxed{EI = 2,75 \cdot 10^{11}}$
Shear correction factor	[-]	$\boxed{k_s = 1,8}$
Corrected shear stiffness	[N]	$\boxed{GAc := \frac{GA}{k_s} = 5 \cdot 10^{6}}$