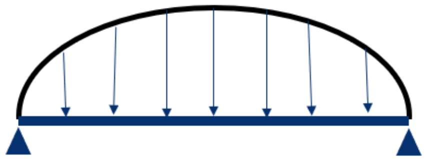
DESIGN OF BEAM UNDER SEMI-ELLIPSE LOAD, BEAM END SUPPORTS ARE PINNED

Length of beam $L_{beam} := 3\ m$

Maximum load on beam $q_{max} := 10\ \frac{kN}{m}$

Elastic modulus of steel $E_{steel} := 210\ GPa$

Moment of inertia of beam $I_{beam} := 25170\ cm^4$



Calculatiotions for determination of shear, moment, slope and deflection graphs

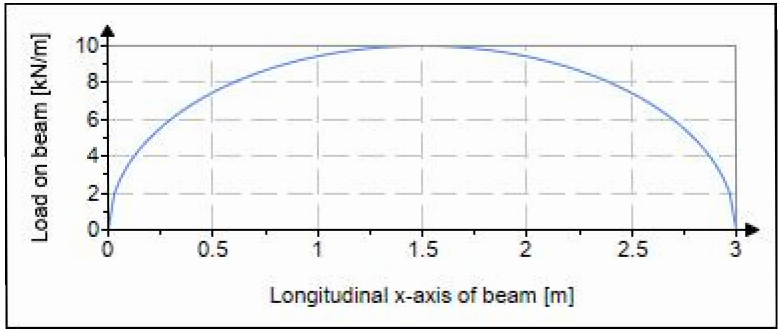
Amount of points in following graphs $Amount\_of\_steps := 100$

$$Step\_length := \frac{L_{beam}}{Amount\_of\_steps} \qquad Step\_length = 0.03\ m$$

All values in x-axis

$$x_{all} := \left\| \begin{array}{l} \text{for } i \in 0..Amount\_of\_steps \\ \quad \| \; x_{all_i} \leftarrow Step\_length \cdot i \\ x_{all} \end{array} \right.$$

$$q_{load} := \left\| \begin{array}{l} \text{for } i \in 0..Amount\_of\_steps \\ \quad \| \; q_{load_i} \leftarrow \dfrac{\sqrt{-\left(4 \cdot L_{beam}^{2} \cdot q_{max}^{2} \cdot x_{all_i}^{2}\right) + 4 \cdot L_{beam}^{3} \cdot q_{max}^{2} \cdot x_{all_i}}}{L_{beam}^{2}} \\ q_{load} \end{array} \right.$$



Load function $q(x) = \frac{\sqrt{-(4 \cdot L^2 \cdot q^2 \cdot x^2) + 4 \cdot L^3 \cdot q^2 \cdot x}}{L^2}$

L = length of beam
q = maximum load
x = longitudinal axix of beam

Shear function is integral of load function

Shear at center of beam is zero, thus integration constant C can be computed with

$$\int q\left(\frac{L}{2}\right) \mathrm{d}x + C = 0 \xrightarrow{solve, C} -\left(x \cdot q\left(\frac{L}{2}\right)\right)$$

Shear function $V(x) = \int q(x)\, \mathrm{d}x - \left(x \cdot q\left(\frac{L}{2}\right)\right)$

Moment function is integral of shear function

Moment at end of beam is zero, thus integration constant C can be computed with

$$\int V(0\ m)\, \mathrm{d}x + C = 0 \xrightarrow{solve, C} -(V(0) \cdot x)$$

Moment function $M(x) = \int V(x)\, \mathrm{d}x - (V(0\ m) \cdot x)$

Slope function is integral of moment function, divided by bending stiffness

Slope at center of beam is zero, thus integration constant is

$$\int M\left(\frac{L}{2}\right) \mathrm{d}x + C = 0 \xrightarrow{solve\,,C} -\left(x \cdot M\left(\frac{L}{2}\right)\right)$$

Slope function $$\theta(x) = \frac{1}{E \cdot I} \cdot \left(\int M(x)\, \mathrm{d}x - \left(x \cdot M\left(\frac{L}{2}\right)\right)\right)$$

Deflection function is integral of slope function

Deflection at end of beam is zero, thus integration constant is

$$\int \theta(0\ m)\, \mathrm{d}x + C = 0 \xrightarrow{solve\,,C} -(\theta(0) \cdot x)$$

Deflection function

$$y(x) = \int \theta(x)\, \mathrm{d}x - (\theta(0) \cdot x)$$