Szymon Boguś

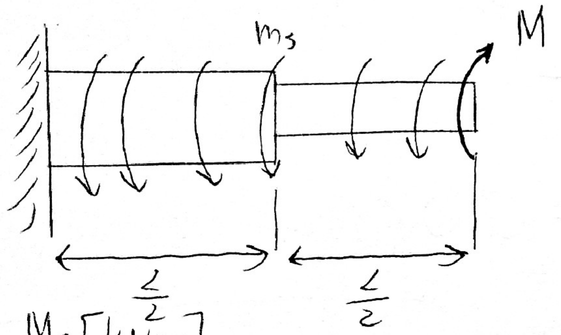
KOLOKWIUM 2, 6.05.2020

$I = 6$

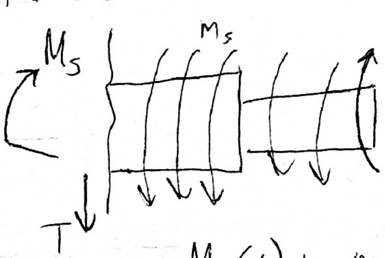
$N = 5$

$m_s = 1{,}05\ \frac{kNm}{m} \quad L = 2m$

$M = 0{,}56\ kNm$



Rozkład $M_s(x)$:



$$-M_s(x) + m_s(L-x) - M = 0$$

$$M_s(x) = m_s(L-x) - M$$

$$M_s(0) = 1{,}05 \cdot 2 - 0{,}56 = 1{,}54\ kNm$$

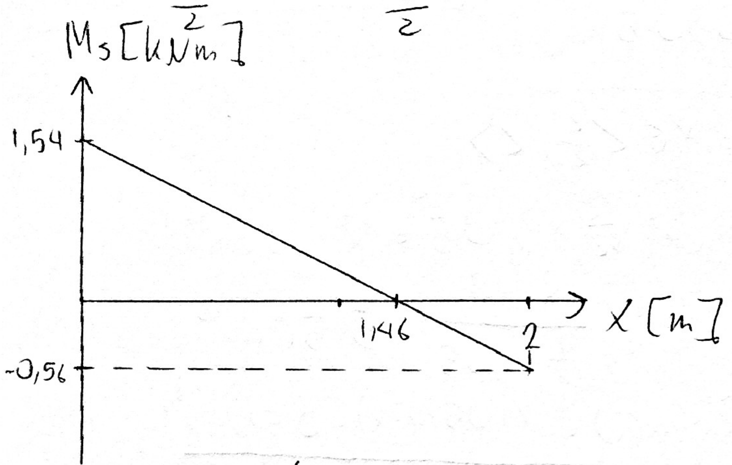
$$M_s(L) = -M = -0{,}56\ kNm$$

miejsce zerowe:

$$0 = m_s L - m_s x - M$$

$$-\frac{M - m_s L}{m_s} = x$$

$$x = -\frac{0{,}56 - 1{,}05 \cdot 2}{1{,}05} \cong 1{,}46\,m$$



Dla $x \in \langle 0, \frac{L}{2} \rangle$

$$J_0 = \frac{12}{32} D^4$$

$$W_0 = \frac{\frac{12}{32} D^4}{\frac{1}{2} D} = \frac{12}{16} D^3$$

$$\tau_{max} = \frac{1{,}05(2-x) - 0{,}56}{\frac{12}{16} D^3} = (1{,}05(2-x) - 0{,}56) \cdot \frac{16}{12 D^3} \cdot 10^3$$

$$\tau_{max}(0) = \frac{(2 \cdot 1{,}05 - 0{,}56)\, 16 \cdot 10^3}{12 D^3} = 7843\ \frac{1}{D^3}$$

Dla $x \in \langle \frac{L}{2}, L \rangle$

$$J_0 = \frac{12}{32} \cdot \frac{D^4}{16} = \frac{D^4 12}{512}$$

$$W_0 = \frac{\frac{D^4 12}{512}}{\frac{1}{4} D} = \frac{D^3 12}{128}$$

$$\tau_{max} = (1{,}05(2-x) - 0{,}56) \cdot \frac{128}{D^3 12} \cdot 10^3$$

$$\tau_{max}(L) = \frac{-0{,}56 \cdot 128 \cdot 10^3}{12 D^3} = -22816\ \frac{1}{D^3}\ [Pa]$$

$|M_s(\frac{L}{2})| = 0{,}49\ kNm$

$|M_s(L)| = 0{,}56\ kNm$

Nie trzeba liczyć τ_{max} w $\frac{L}{2}$, ponieważ wartość bezwzględna w L jest większa

~~Wartość $\tau_{max}(L)$~~ Wartość ~~τ_{max}~~ bezwzględna $\tau_{max}(L)$ jest największa, dlatego to ją przyjmę do obliczeń do hipotezy Treski

$$\sigma^{T}_{RED} = 2 \cdot 22816 \cdot \frac{1}{D^3} = 45632 \frac{1}{D^3} \; [Pa]$$

$$\sigma^{T}_{RED} \leq \frac{Re}{ne} \Rightarrow 45632 \frac{1}{D^3} = \frac{\cancel{6}^{2} \cdot 10^8}{\cancel{3}_{1}}$$

$$D^3 = \frac{45632}{2 \cdot 10^8}$$

$$D = \sqrt[3]{\frac{45632}{2 \cdot 10^8}} = 0{,}0611 m$$

$$\frac{D}{2} = 0{,}0305 m$$

$x \in \langle 0, \frac{L}{2} \rangle$

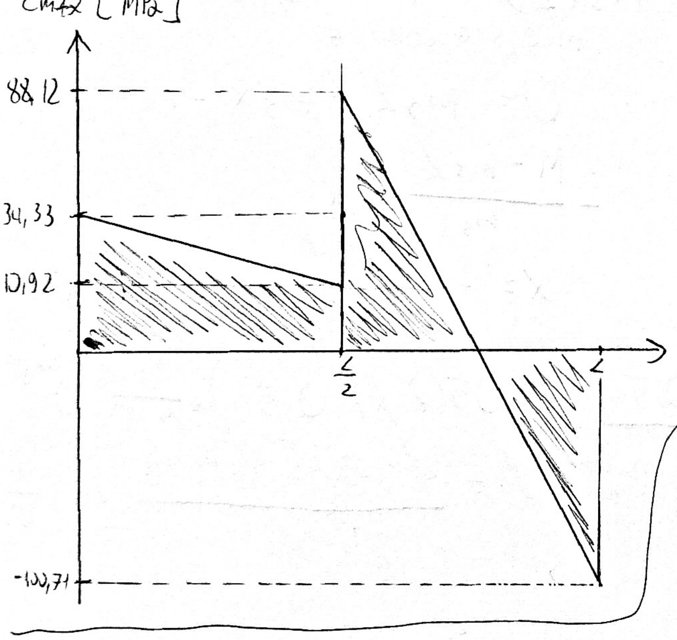
$$J_0 = \frac{\pi}{32} \cdot 6{,}11^4 = 136{,}82 cm^4$$

$$\omega_0 = \frac{136{,}82}{\cancel{3{,}03}\; 3{,}05} = 44{,}85 cm^3$$

$$\tau_{MAX}(x) = \frac{(1{,}05(2-x) - 0{,}56) \cdot 10^3}{44{,}85}$$

$$\tau_{MAX}(0) = 34{,}33 MPa$$

$$\tau_{MAX}\left(\frac{L}{2}\right) = 10{,}92 MPa$$



$x \in \langle \frac{L}{2}, L \rangle$

$$J_0 = \frac{\pi}{32} \cdot 3{,}05^4 = 8{,}49 cm^4$$

$$\omega_0 = \frac{8{,}49}{\frac{1}{2} \cdot 3{,}05} = 5{,}56 cm^3$$

$$\tau_{MAX}(x) = \frac{(1{,}05(2-x) - 0{,}56) \cdot 10^3}{5{,}56}$$

$$\tau_{MAX}(L) = -100{,}71 MPa$$

$$\tau_{MAX}\left(\frac{L}{2}\right) = 88{,}12 MPa$$

Funkcja skręcenia i kąt skręcenia

$$G = \frac{2 \cdot 10^5}{2(1 + 0{,}3)} = 7{,}69 \cdot 10^4 MPa$$

$x \in \langle 0, \frac{L}{2} \rangle$

$$\theta(x) = \frac{(1{,}05(2-x) - 0{,}56) \cdot 10^3}{7{,}69 \cdot 10^{10} \cdot 136{,}82 \cdot 10^{-8}}$$

$$\theta(0) = 0{,}0146 \frac{rad}{m}$$

$$\theta\left(\frac{L}{2}\right) = 0{,}004657 \frac{rad}{m}$$

$$\varphi_1(x) = \int_0^x \frac{(1{,}05(2-x) - 0{,}56) \cdot 10^3}{7{,}69 \cdot 10^{10} \cdot 136{,}82 \cdot 10^{-8}} dx =$$

$$= \frac{10}{7{,}69 \cdot 136{,}82} \cdot \int_0^x (2{,}1 - 1{,}05x - 0{,}5) dx =$$

$$= \frac{10}{7{,}69 \cdot 136{,}82} \left[1{,}54x - \frac{1{,}05}{2} x^2 \right]_0^x$$

$x \in \langle \frac{L}{2}, L \rangle$

$$\theta(x) = \frac{(1{,}05(2-x) - 0{,}56) \cdot 10^3}{7{,}69 \cdot 10^{10} \cdot 8{,}49 \cdot 10^{-8}}$$

$$\cancel{\theta(x)} \; \theta\left(\frac{L}{2}\right) = 0{,}075 \frac{rad}{m}$$

$$\theta(L) = -0{,}0857 \frac{rad}{m}$$

Szymon Boguś

KOLOKWIUM 2

Ciąg dalszy

Funkcja skręcenia i kąt skręcenia

$x \in \langle 0, \frac{L}{2} \rangle$

$$\varphi_1(x) = \frac{10}{7{,}69 \cdot 136{,}82}\left(1{,}54x - \frac{1{,}05}{2}x^2\right)$$

$$\varphi_1(0) = 0$$

$$\varphi_1\left(\frac{L}{2}\right) = 9{,}64 \cdot 10^{-3}\ \text{rad}$$

$x \in \langle \frac{L}{2}, L \rangle$

$$\varphi_2(x) = \int_{\frac{L}{2}}^{x} \frac{(1{,}05(L-x) - 0{,}56)\cdot 10^3}{7{,}69 \cdot 10^{10} \cdot 8{,}49 \cdot 10^{-9}}\,dx =$$

$$= \frac{10}{7{,}69 \cdot 8{,}49}\int_{\frac{L}{2}}^{x}(1{,}54 - 1{,}05x)\,dx =$$

$$= \frac{10}{7{,}69 \cdot 8{,}49}\cdot\left[1{,}54x - \frac{1{,}05}{2}x^2\right]_{\frac{L}{2}}^{x}$$

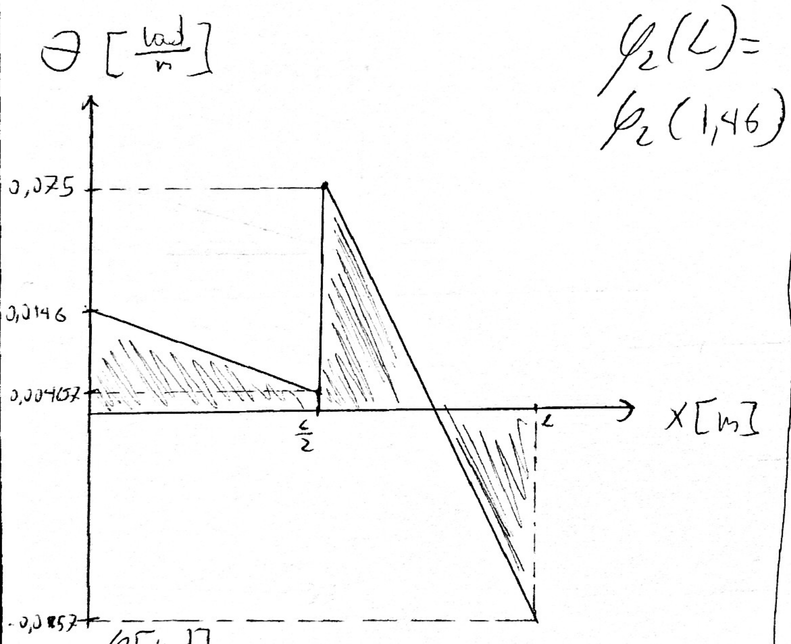
$$\varphi_2(x) = \varphi_1\left(\frac{L}{2}\right) + \frac{10}{7{,}69 \cdot 8{,}49}\left(1{,}54x - \frac{1{,}05}{2}x^2 - \left(1{,}54 - \frac{1{,}05}{2}\right)\right)$$

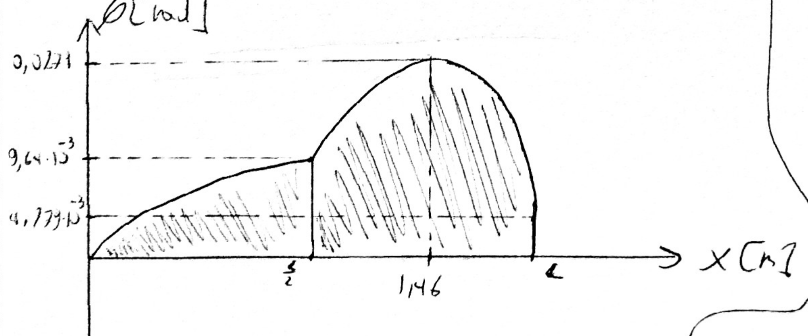
$$\varphi_2\left(\frac{L}{2}\right) = \varphi_1\left(\frac{L}{2}\right) = 9{,}64 \cdot 10^{-3}\ \text{rad}$$

$$\varphi_2(L) = \varphi_1\left(\frac{L}{2}\right) + \frac{10}{7{,}69 \cdot 8{,}49}\left(1{,}54 \cdot 2 - \frac{1{,}05}{2}\cdot 4 - \left(1{,}54 - \frac{1{,}05}{2}\right)\right)$$

$$\varphi_2(L) = 4{,}279 \cdot 10^{-3}\ \text{rad}$$

$$\varphi_2(1{,}46) = 0{,}0271\ \text{rad}$$





$$\tau(D) = \frac{M_s(L)\cdot\frac{D}{4}\cdot 10^3}{8{,}49 \cdot 10^{-8}} = \frac{-0{,}56 \cdot 10^3 \cdot \frac{D}{4}}{8{,}49 \cdot 10^{-8}}$$

~~$\tau(1) = -3297 \cdot 10^6\ \text{Pa}$~~

~~$\tau(2)$~~

$$\tau(0) = 0$$

$$\tau(0{,}0611) = -100{,}75\ \text{MPa}$$