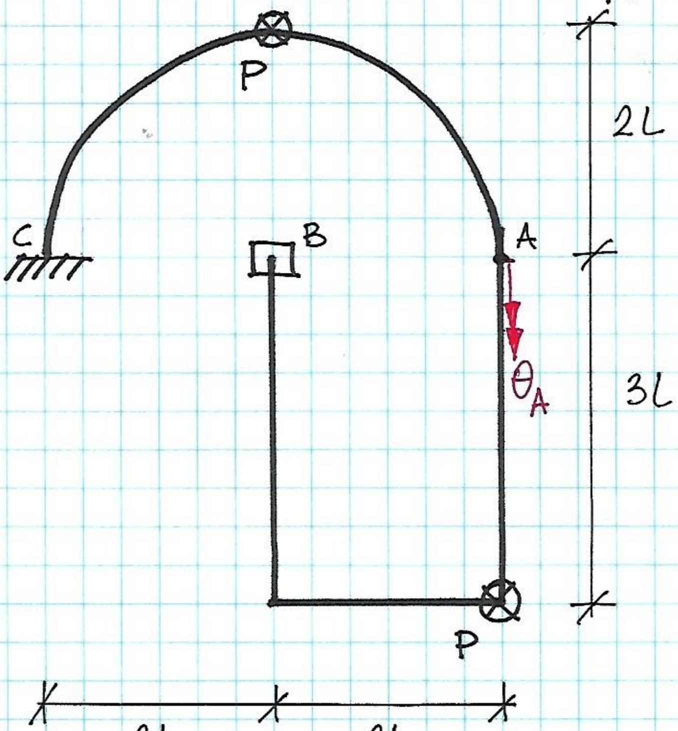
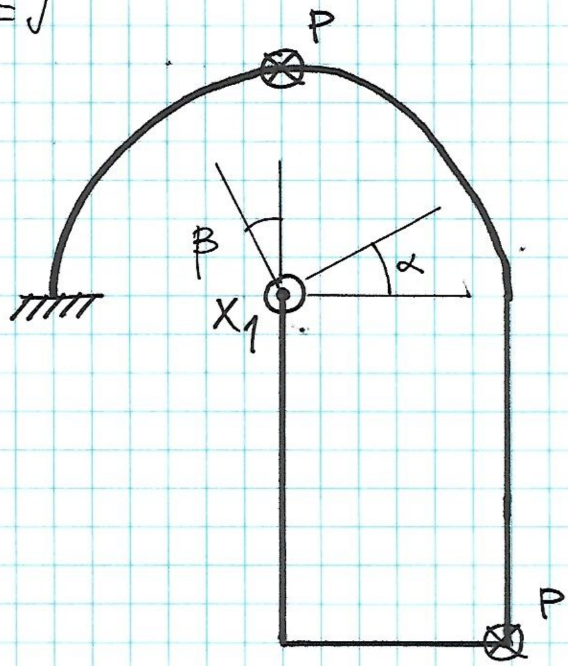
Kolokwium IPB/BZ 12 IV 2018 r.

Oblicz kąt obrotu Θ_A. $GJ_s = EJ$



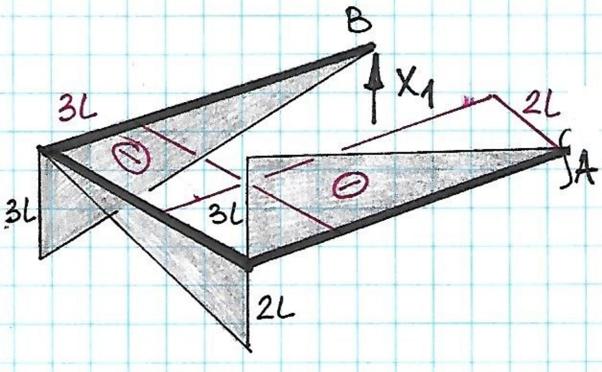
Schemat zastępczy



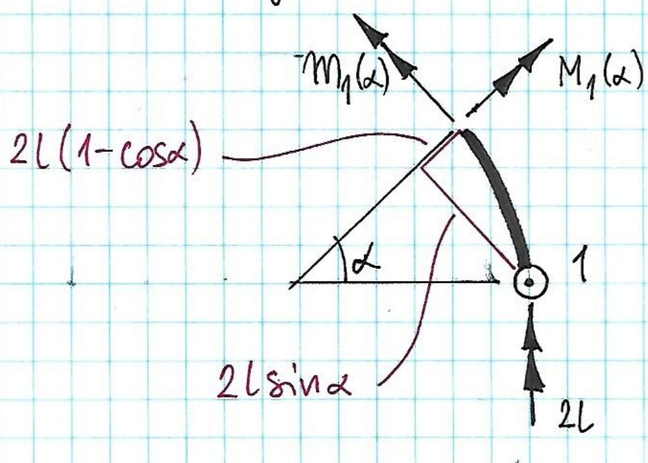
$X_1 = 1$

pręty proste (część A-B)

M_1 m_1



łuk kołowy (część A-C)



$$M_1(\alpha) - 1\cdot 2L\sin\alpha + 2L\cdot\sin\alpha = 0$$

$$M_1(\alpha) = 0$$

$$m_1(\alpha) + 1\cdot 2L(1-\cos\alpha) + 2L\cdot\cos\alpha = 0$$

$$m_1(\alpha) = -2L$$

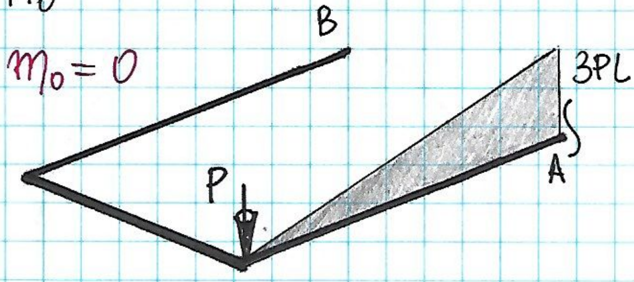
$$\delta_{11} = \frac{1}{EJ}\left[20{,}67\,L^3\right] + \frac{1}{GJ_s}\left[55{,}13\,L^3\right] = 75{,}80\,\frac{L^3}{EJ}$$

Stan "0"

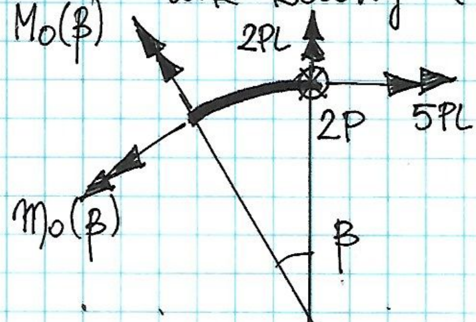
pręty proste (część A-B)

M_0

$\mathfrak{M}_0 = 0$

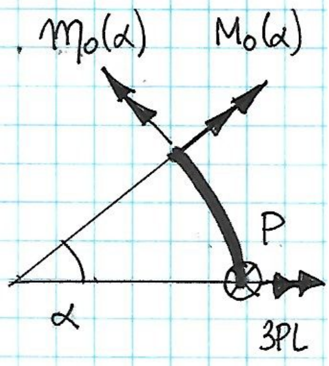


Łuk kołowy (część A-C)



$\beta = \alpha - \frac{1}{2}\pi$

$\beta \in (0, \frac{1}{2}\pi)$



$\alpha \in (0, \frac{1}{2}\pi)$

α : $M_0(\alpha) + P \cdot 2L\sin\alpha + 3PL\cos\alpha = 0 \longrightarrow M_0(\alpha) = -2PL\sin\alpha - 3PL\cos\alpha$

$\mathfrak{M}_0(\alpha) - P \cdot 2L(1-\cos\alpha) - 3PL\sin\alpha = 0 \longrightarrow \mathfrak{M}_0(\alpha) = 2PL + 3PL\sin\alpha - 2PL\cos\alpha$

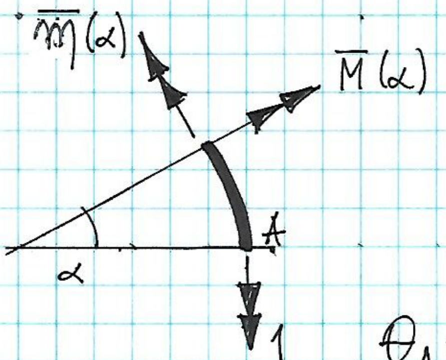
β : $M_0(\beta) + 2P \cdot 2L\sin\beta + 2PL\cos\beta - 5PL\sin\beta = 0 \rightarrow M_0(\beta) = PL\sin\beta - 2PL\cos\beta$

$\mathfrak{M}_0(\beta) - 2P \cdot 2L(1-\cos\beta) - 2PL\sin\beta - 5PL\cos\beta = 0 \rightarrow \mathfrak{M}_0(\beta) = 4PL + 2PL\sin\beta + PL\cos\beta$

$$\delta_{10} = \frac{1}{EJ}\left[4{,}5PL^3\right] + \frac{1}{GJs}\left[-53{,}70PL^3\right] = -49{,}20\frac{PL^3}{EJ}$$

$$X_1 = 0{,}65\,P$$

Obciążenie jednostkowe "w kierunku" θ_A w schemacie statycznie wyznaczalnym nie wywołuje sił wewnętrznych w prętach prostych.



$\overline{M}(\alpha) - 1 \cdot \sin\alpha = 0 \longrightarrow \overline{M}(\alpha) = \sin\alpha$

$\overline{\mathfrak{M}}(\alpha) - 1 \cdot \cos\alpha = 0 \longrightarrow \overline{\mathfrak{M}}(\alpha) = \cos\alpha$

$\overline{M}(\beta) = \overline{M}(\alpha - \frac{1}{2}\pi)$, $\overline{\mathfrak{M}}(\beta) = \overline{\mathfrak{M}}(\alpha - \frac{1}{2}\pi)$

$$\theta_A = \frac{1}{EJ}\int_{A-C} M\overline{M}\,ds + \frac{1}{GJs}\int_{A-C} \mathfrak{M}\overline{\mathfrak{M}}\,ds =$$

$$= \frac{1}{EJ}\int_{A-C}(M_1X_1 + M_0)\overline{M}\,ds + \frac{1}{GJs}\int_{A-C}(\mathfrak{M}_1X_1 + \mathfrak{M}_0)\overline{\mathfrak{M}}\,ds$$

$$= -16{,}57\frac{PL^3}{EJ}$$

Opracował Szymon Spodzieja