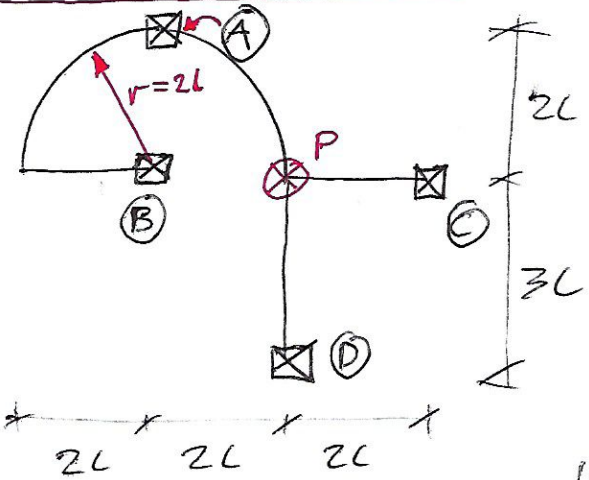
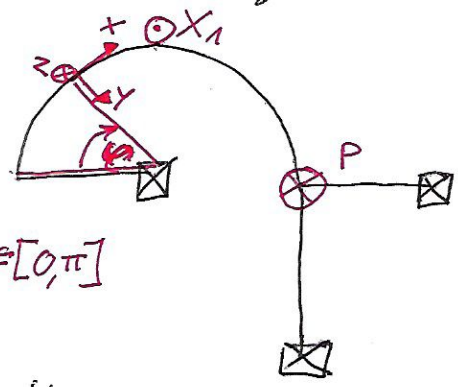
KOLOKWIUM MK IPB 9.04.18:

Znaleźć reakcję R_A; $EJ = const$, $GJ_s = \frac{1}{2}EJ$.



Układ zastępczy stat. wyzn.:



$\varphi_1 \in [0, \pi]$

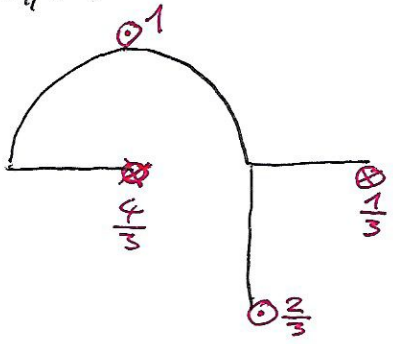
Układ biegunowy φ wraz z lokalnym układem współrzędnych (bazą) na pręcie zakrzywionym.

Reakcje, siły:

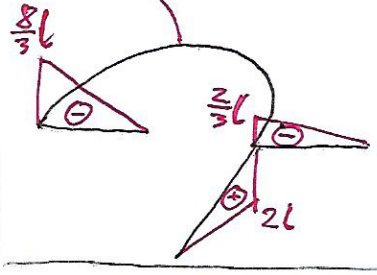
M:

N:

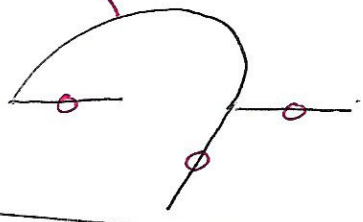
Stan „1":



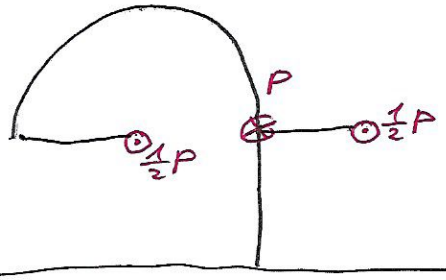
M_1: $M_{gr,1}(\varphi) = \begin{cases} 0 & \text{dla } \varphi \in [0, \frac{\pi}{2}] \\ 2l \cdot \sin(\varphi - \frac{\pi}{2}), & \varphi \in [\frac{\pi}{2}, \pi] \end{cases}$



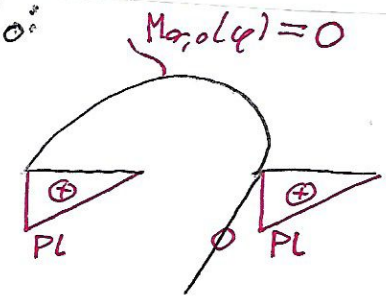
N_1: $N_{gr,1}(\varphi) = \begin{cases} -\frac{8}{3}l & , \varphi \in [0, \frac{\pi}{2}] \\ -\frac{2}{3}l - 2l \cdot \cos(\varphi - \frac{\pi}{2}) & , \varphi \in [\frac{\pi}{2}, \pi] \end{cases}$



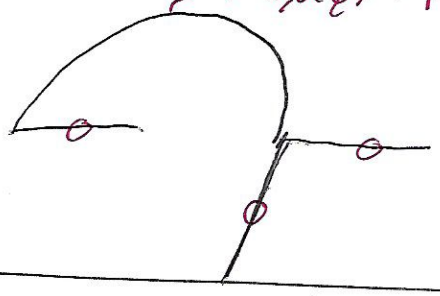
Stan „0":



M_0: $M_{gr,0}(\varphi) = 0$



N_0: $N_{gr,0}(\varphi) = P \cdot l$



$$\delta_{11} = \frac{1}{EJ}\left[\left(\frac{1}{2}\cdot\frac{8}{3}l\cdot 2l\right)\left(\frac{2}{3}\cdot\frac{8}{3}l\right) + \left(\frac{1}{2}\cdot\frac{2}{3}l\cdot 2l\right)\left(\frac{2}{3}\cdot\frac{2}{3}l\right) + \left(\frac{1}{2}\cdot 2l\cdot 3l\right)\left(-\frac{2}{3}\cdot 2l\right)\right] +$$

$$+ \frac{1}{EJ}\int_{\frac{\pi}{2}}^{\pi}\left[2l\cdot\sin(\varphi-\tfrac{\pi}{2})\right]^2 \cdot \overset{2l}{\overset{//}{r}}\, d\varphi + \frac{1}{\underset{\frac{1}{2}EJ}{GJ_s}}\left[\int_0^{\frac{\pi}{2}}\left[-\tfrac{8}{3}l\right]^2 \cdot \overset{2l}{\overset{//}{r}}\, d\varphi + \int_{\frac{\pi}{2}}^{\pi}\left[-\tfrac{2}{3}l - 2l\cdot\cos(\varphi-\tfrac{\pi}{2})\right]^2 \cdot \overset{2l}{\overset{//}{r}}\, d\varphi\right]$$

$$= 86.026\,\frac{l^3}{EJ}$$

$$\delta_{10} = \frac{1}{EJ}\left[\left(\frac{1}{2}\cdot\frac{8}{3}l\cdot 2l\right)\left(-\frac{2}{3}Pl\right) + \left(\frac{1}{2}\cdot\frac{2}{3}l\cdot 2l\right)\left(-\frac{2}{3}Pl\right)\right] +$$

$$+ \frac{1}{\underset{\frac{1}{2}EJ}{GJ_s}}\left[\int_0^{\frac{\pi}{2}}\left(-\tfrac{8}{3}l\right)(Pl)\cdot \overset{2l}{\overset{//}{r}}\, d\varphi + \int_{\frac{\pi}{2}}^{\pi}\left[-\tfrac{2}{3}l - 2l\cdot\cos(\varphi-\tfrac{\pi}{2})\right]\cdot(Pl)\cdot \overset{2l}{\overset{//}{r}}\, d\varphi\right] = -31.167\,\frac{Pl^2}{EJ}$$

$$R_A = X_1 = -\frac{\delta_{10}}{\delta_{11}} = 0.362P$$