Egzamin pisemny z Mechaniki Konstrukcji II, 11 IX 2023 r.

<table>
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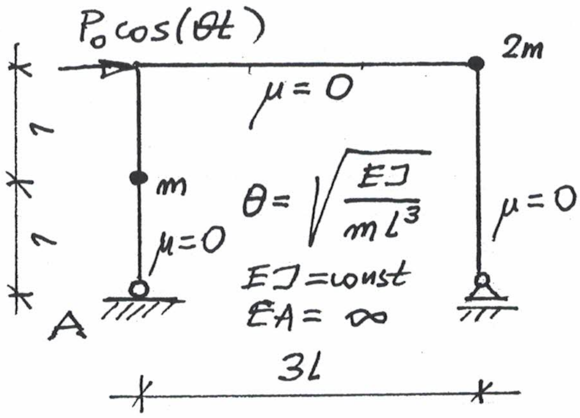
(po egz. ustnym)</td><td>Ocena łączna

Data</td></tr>
</table>

Zadanie 1

Masa danej ramy jest skoncentrowana w dwu węzłach. Rama jest poddana obciążeniu harmonicznemu jak na rysunku. Zapisać równania określające amplitudę reakcji poziomej w podporze A.

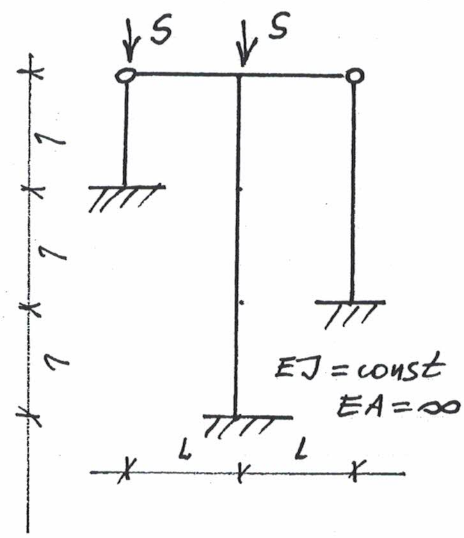
(The mass of the given frame is concentrated at two nodes. The frame is subject to the harmonic load, see the figure. Write down the equations which make it possible to compute the amplitude of the horizontal reaction at the support A.)



Zadanie 2

Dana jest rama płaska obciążona Dużymi siłami osiowymi jak na rys. Zapisać równania utraty stateczności całej ramy.

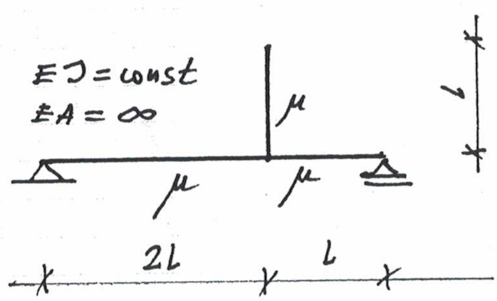
(Given is the frame subject to big axial forces, see the figure. Write down the equations expressing the loss of stability of equilibrium of the whole frame).



Zadanie 3

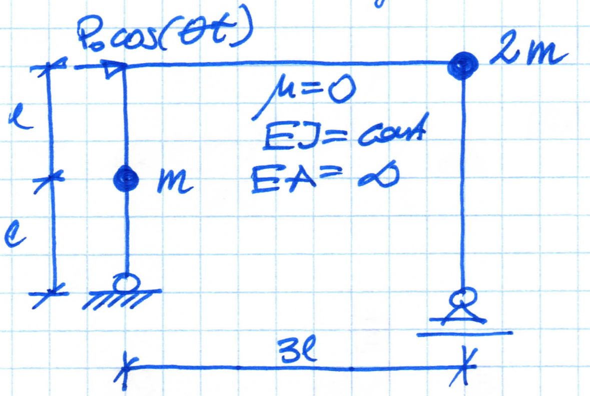
Dana jest rama jak na rysunku. Zapisać równania określające pierwszą częstość drgań własnych.

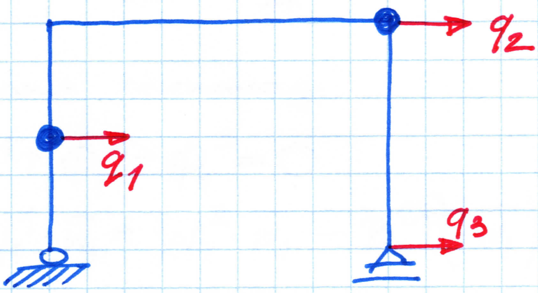
(Given is a frame, cf. the figure. Write down the equations which determine the first circular frequency)

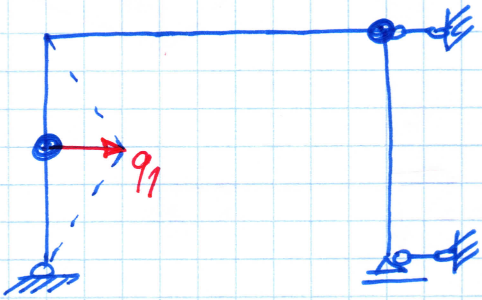


Egzamin MK2 11 IX 2023 Zadanie 1

$$\theta = \sqrt{\frac{EJ}{ml^3}}$$



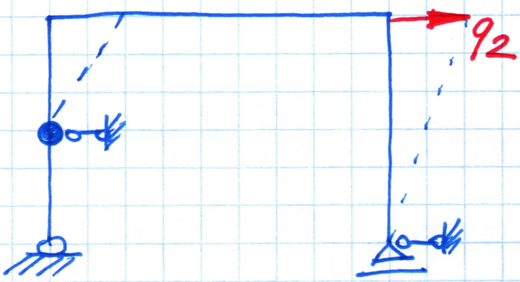




q_1, q_2 – dynamiczne stopnie swobody

q_3 – statyczny stopień swobody

$$\mathbb{q} = \begin{bmatrix} q_1 \\ q_2 \end{bmatrix}$$

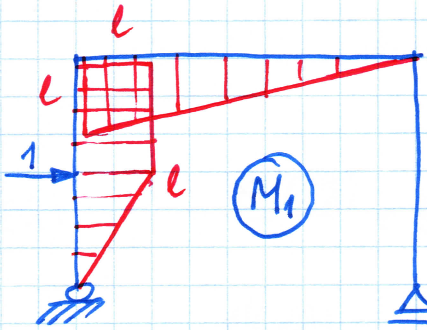


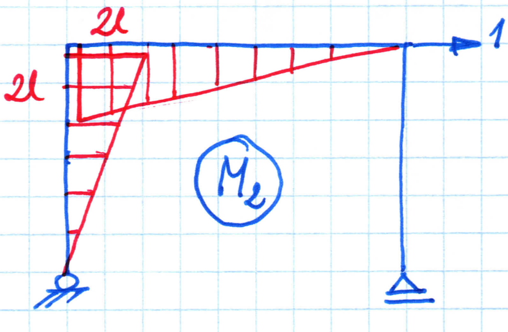
$$E_k = \frac{1}{2}\left(m\dot{q}_1^{\,2} + 2m \cdot \dot{q}_2^{\,2}\right)$$

$$\mathbb{M} = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} m$$

$$\mathbb{D} = \begin{bmatrix} \frac{7}{3} & \frac{23}{6} \\ \frac{23}{6} & \frac{20}{3} \end{bmatrix} \frac{l^3}{EJ}$$

$$\mathbb{d}_0 = \begin{bmatrix} \frac{23}{6} \\ \frac{20}{3} \end{bmatrix} \frac{l^3}{EJ}$$

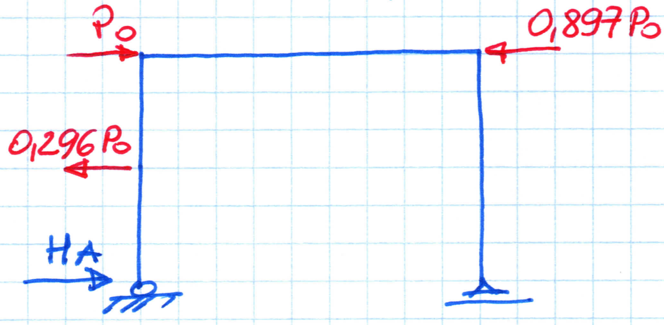




$$(\mathbb{I} - \theta^2 \mathbb{D}\,\mathbb{M})\,\mathbb{q} = \mathbb{d}_0 P_0$$

$$q_1 = -0{,}296 \frac{Pl^3}{EJ} \qquad q_2 = -0{,}448 \frac{Pl^3}{EJ}$$

$M_3 = M_2$

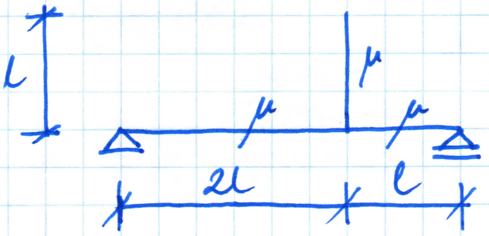


$$H_A = P_0 - 0{,}296 P_0 - 0{,}897 P_0 = 0$$

$$H_A = +0{,}193 P_0$$

Rozwiązanie opracował – Jan Pełczyński

Egzamin MK2 11 IX 2023 Zadanie 3

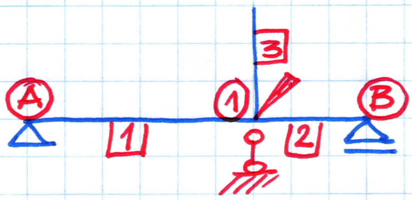


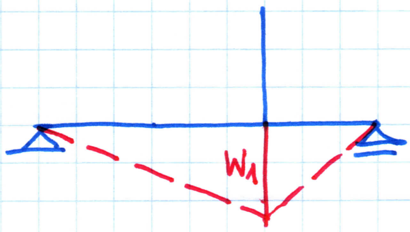
$EJ = const$

$EA = \infty$

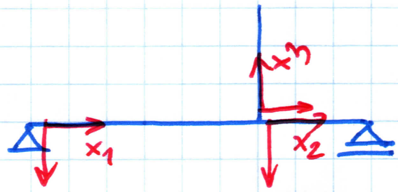
$\lambda_1 = 2\lambda \quad \lambda_3 = \lambda$

$\lambda_2 = \lambda$





$$q = \begin{bmatrix} \varphi_1 \\ \frac{W_1}{l} \end{bmatrix}$$



Równania równowagi

1) $\phi_1^1 + \phi_1^2 + \phi_1^3 = 0$

2) $W_1^1 \cdot \bar{w}_1 + W_1^2 \cdot \bar{w}_1 - B_{11}^{(3)}(-\bar{w}_1) = 0$

$$B_{11}^{(3)} = -\mu l \cdot \omega^2 w_1$$

$$\phi_1^1 = \frac{EJ}{2l}\left(\alpha'(2\lambda)\varphi_1 - \frac{1}{2}\theta'(2\lambda)\frac{w}{l}\right) \qquad W_1^1 = \frac{EJ}{4l^2}\left(-\theta'(2\lambda)\varphi_1 + \gamma'(2\lambda)\frac{w}{2l}\right)$$

$$\phi_1^2 = \frac{EJ}{l}\left(\alpha'(\lambda)\varphi_1 + \theta'(\lambda)\frac{w}{l}\right) \qquad W_1^2 = \frac{EJ}{l^2}\left(\theta'(\lambda)\varphi_1 + \gamma'(\lambda)\frac{w}{l}\right)$$

$$\phi_1^3 = \frac{EJ}{l}\left(\alpha''(\lambda)\varphi_1\right)$$

$$\mathbb{K}(\lambda) = \frac{EJ}{l}\begin{bmatrix} \frac{1}{2}\alpha'(2\lambda) + \alpha''(\lambda) + \alpha'(\lambda) & -\frac{\theta'(2\lambda)}{4} + \theta'(\lambda) \\ -\frac{\theta'(2\lambda)}{4} + \theta'(\lambda) & \frac{\gamma'(2\lambda)}{8} + \gamma'(\lambda) - \lambda^4 \end{bmatrix}$$

$$\det(\mathbb{K}(\lambda)) = 0 \rightarrow \omega_1$$

Opracował Jan Pełczyński