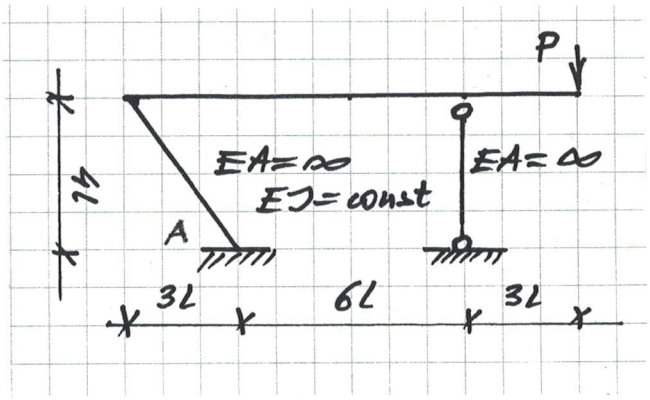
Egzamin pisemny z Mechaniki Konstrukcji I, 16 IV 2019 r.

Imię i NAZWISKO				
Prowadzący ćwiczenia, nr grupy				Nr albumu
ocena zadania 1	ocena zadania 2	ocena zadania 3	Ocena: wykład	Ocena łączna Data, podpis

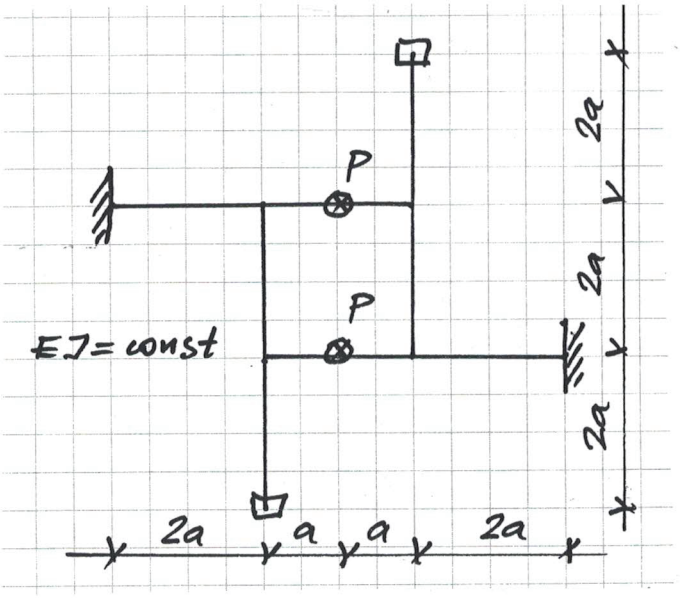
Zadanie 1
Dana jest rama
[EJ=const, $EA=\infty$]
obciążona siłą P.
Znaleźć moment
w utwierdzeniu A
metodą przemieszczeń.

(For the given frame
loaded by the force P
find the bending moment
at the clamped edge A
using the
displacement method)



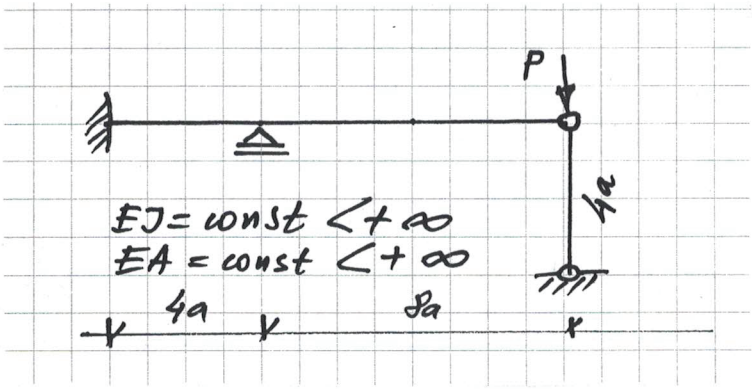
Zadanie 2
Dany jest ruszt przegubowy
obciążony jak na rys.
Znaleźć wykres
momentów zginających.

(For the given
system of beams
loaded as shown
in the figure
find the diagram
of the bending moments)



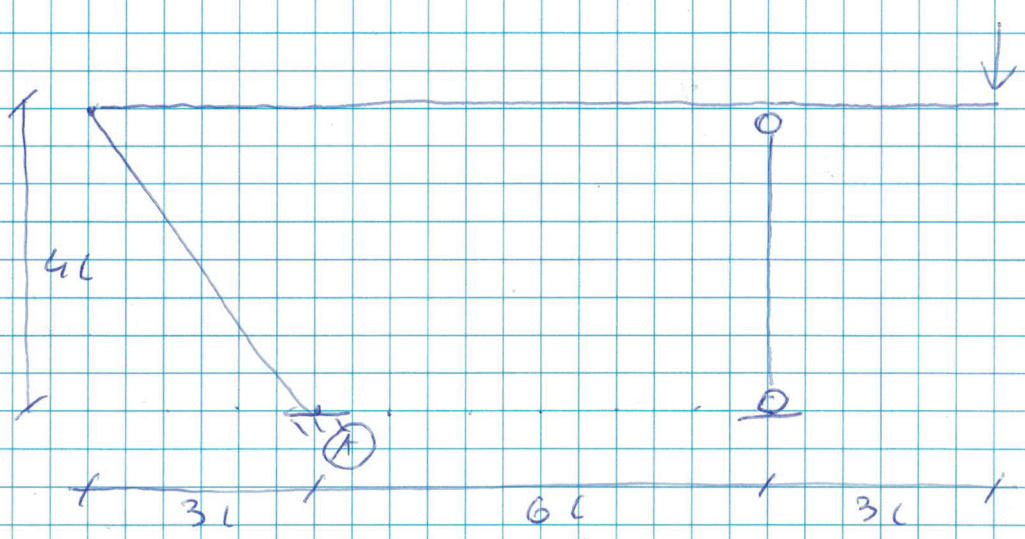
Zadanie 3
Dana jest rama
jak na rysunku.
Zapisać równania macierzowe
metody przemieszczeń

(For the given frame
write down the matrix equations
of the displacement method.)

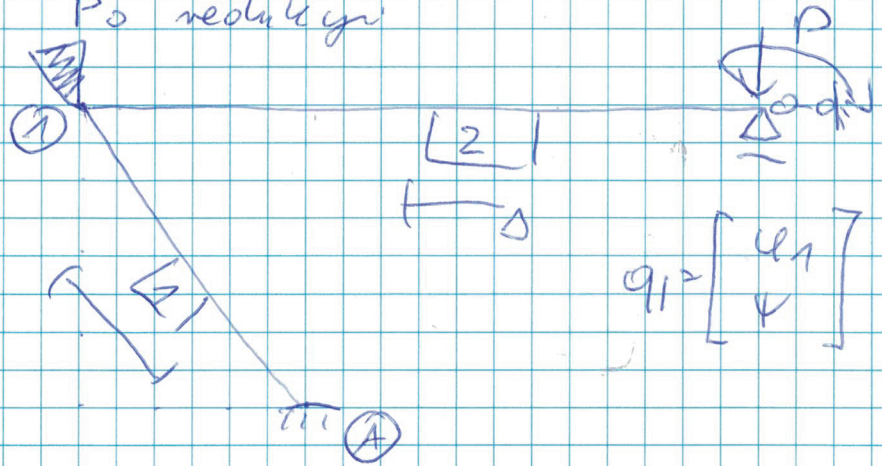


Egzamin MK1 16.04.2019

Zad. 1



Po redukcji



$$q_1 = \begin{bmatrix} \varphi_1 \\ \psi \end{bmatrix}$$

RR:

$$\underline{\Phi}_1^1 + \underline{\Phi}_1^2 = 0$$

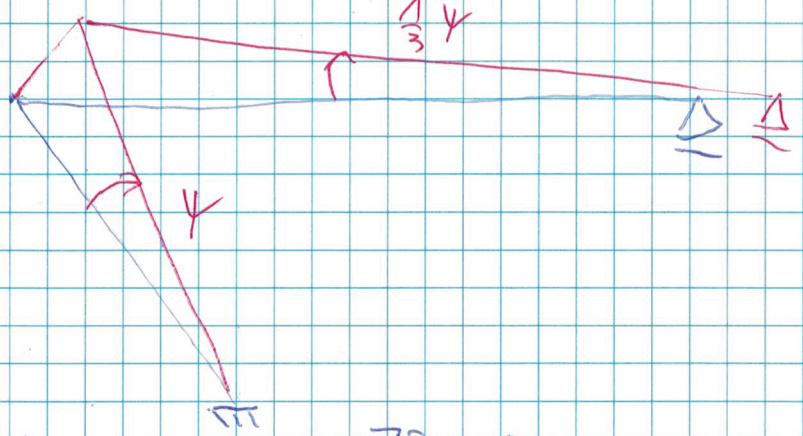
$$\left(\underline{\Phi}_A^1 + \underline{\Phi}_1^1\right)\bar{\psi} + \left(\underline{\Phi}_1^2 + 3Pl\right)\tfrac{1}{3}\bar{\psi} =$$

$$\underline{\Phi}_A^1 = \frac{EJ}{L}\left[\frac{2}{5}\varphi_1 \ominus \frac{6}{5}\psi\right]$$

$$\underline{\Phi}_1^1 = \frac{EJ}{L}\left[\frac{4}{5}\varphi_1 \ominus \frac{6}{5}\psi\right]$$

$$\underline{\Phi}_1^2 = \frac{EJ}{L}\left[\frac{1}{3}\varphi_1 \ominus \frac{1}{3}\psi\right] + \frac{3}{2}Pl$$

Plan Przemieszczeń



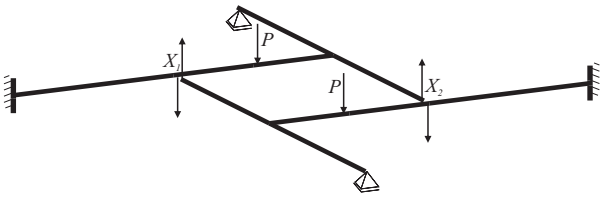
$$\frac{EJ}{L}\begin{bmatrix} \frac{17}{15} & \ominus\frac{59}{45} \\ \ominus\frac{59}{45} & \frac{329}{135} \end{bmatrix}\begin{bmatrix} \varphi_1 \\ \psi \end{bmatrix} = \begin{bmatrix} \ominus\frac{3}{2} \\ \frac{3}{2} \end{bmatrix} Pl \Rightarrow$$

$$\varphi_1 = \ominus 1{,}62\,\frac{Pl^2}{EJ}$$

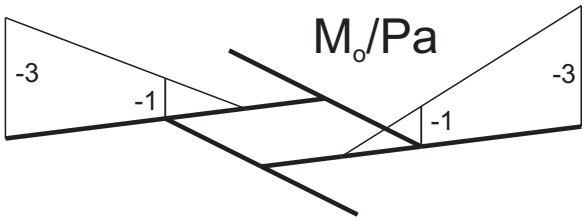
$$\psi = \ominus 0{,}256\,\frac{Pl^2}{EJ}$$

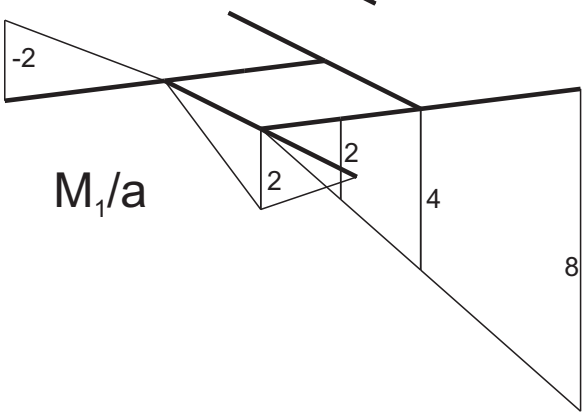
$$M_A = \underline{\Phi}_A^1 = \ominus\frac{15}{44}Pl \simeq \ominus 0{,}34\,Pl$$

Schemat zastępczy zad. 2:



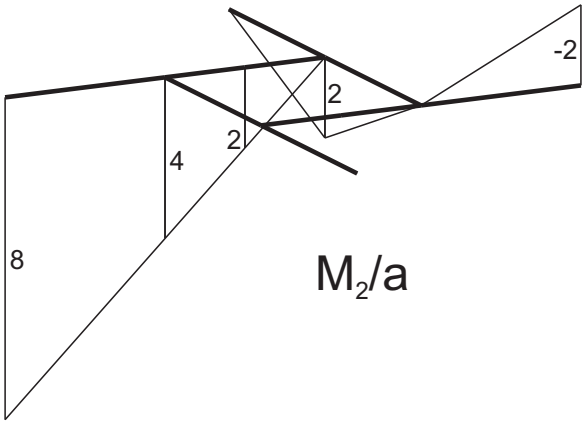
! Należy zauważyć, że $X_2=X_1$.
Bez tego jest dużo obliczeń :) jak niżej.

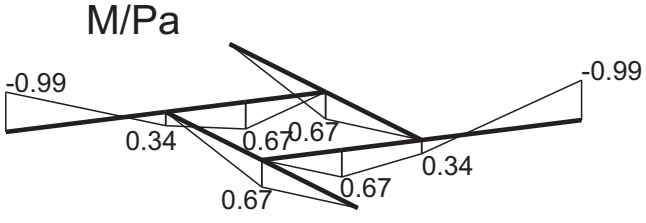




Układ równań i rozwiązanie.

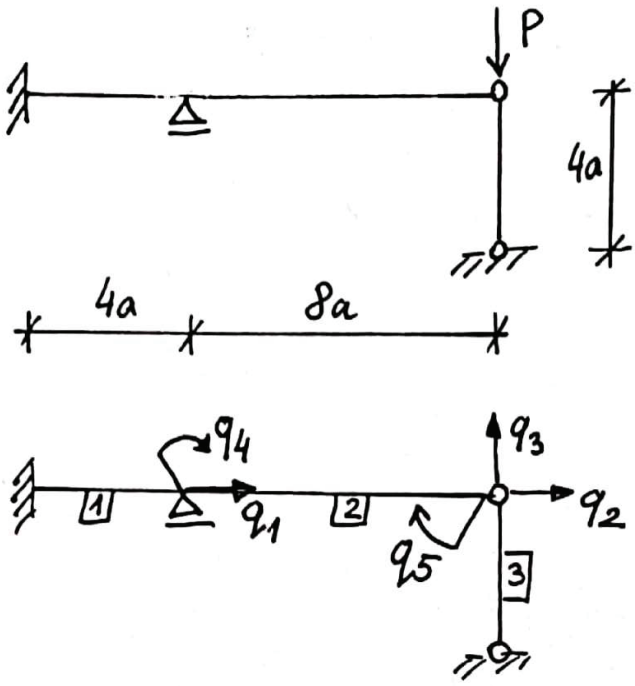
$$\frac{a^3}{EJ}\begin{bmatrix} 93 & 1/3 & -26 & 2/3 \\ -26 & 2/3 & 93 & 1/3 \end{bmatrix}\begin{bmatrix} x1 \\ x2 \end{bmatrix} + \frac{Pa^3}{EJ}\begin{bmatrix} -22 & 1/3 \\ -22 & 1/3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \quad \begin{matrix} \mathbf{x1=} \\ \mathbf{x2=} \end{matrix} \quad \begin{matrix} \mathbf{0.335P} \\ \mathbf{0.335P} \end{matrix}$$





oprac. K. Hetmański

Egzamin z MK1, 16.04.2019 Zadanie 3



$$\Delta = \mathbb{B} q \qquad N = \mathbb{E} \Delta$$
$$^*\varkappa = {}^*\mathbb{B} q \qquad {}^*\Phi = \mathbb{D}(2\,{}^*\varkappa + \varkappa^*)$$
$$\varkappa^* = \mathbb{B}^* q \qquad \Phi^* = \mathbb{D}({}^*\varkappa + 2\varkappa^*)$$

$$\mathbb{K} q = \mathbb{Q}$$
$$\mathbb{K} = \mathbb{B}^T \mathbb{E} \mathbb{B} + 2({}^*\mathbb{B})^T \mathbb{D}\, {}^*\mathbb{B} + ({}^*\mathbb{B})^T \mathbb{D}\, \mathbb{B}^* + (\mathbb{B}^*)^T \mathbb{D}\, {}^*\mathbb{B} + 2(\mathbb{B}^*)^T \mathbb{D}\, \mathbb{B}^*$$

$$q = (q_1, \ldots, q_5)^T$$

$$\mathbb{B} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{pmatrix}$$

$$^*\mathbb{B} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1/8a & 1 & 0 \end{pmatrix}$$

$$\mathbb{B}^* = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1/8a & 0 & 1 \end{pmatrix}$$

$$\mathbb{E} = \begin{pmatrix} \frac{1}{4} & 0 & 0 \\ 0 & \frac{1}{8} & 0 \\ 0 & 0 & \frac{1}{4} \end{pmatrix} \frac{EA}{a}$$

$$\mathbb{D} = \begin{pmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{4} \end{pmatrix} \frac{EI}{a}$$

$$Q = (0 \;\; 0 \;\; -P \;\; 0 \;\; 0)^T$$