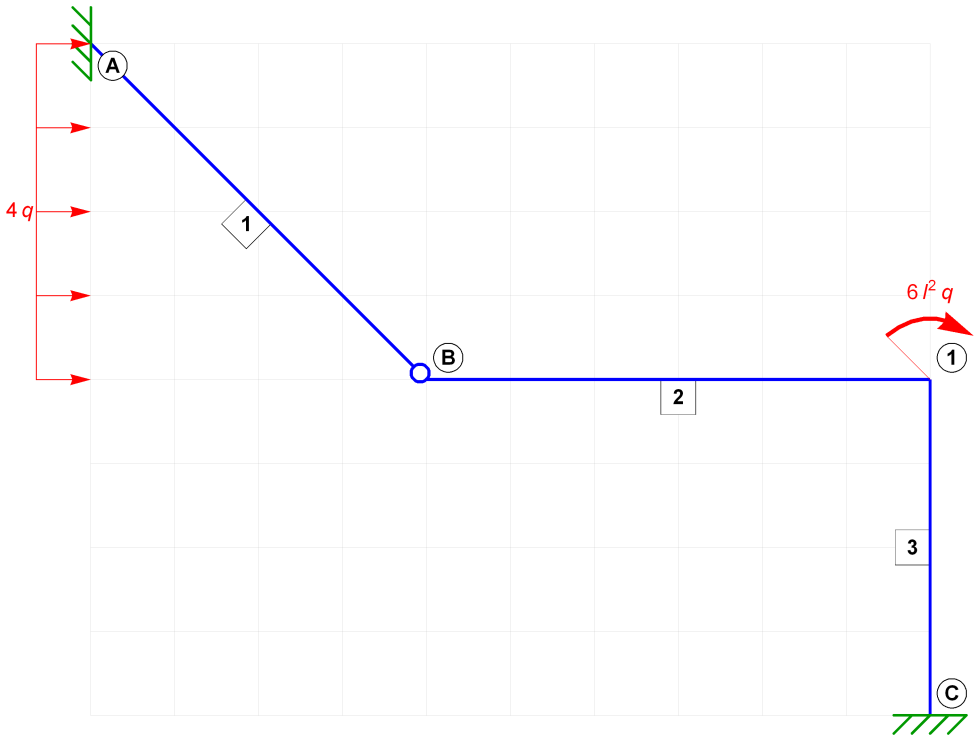
Kol. 2.3.

r.a. 2024/2025

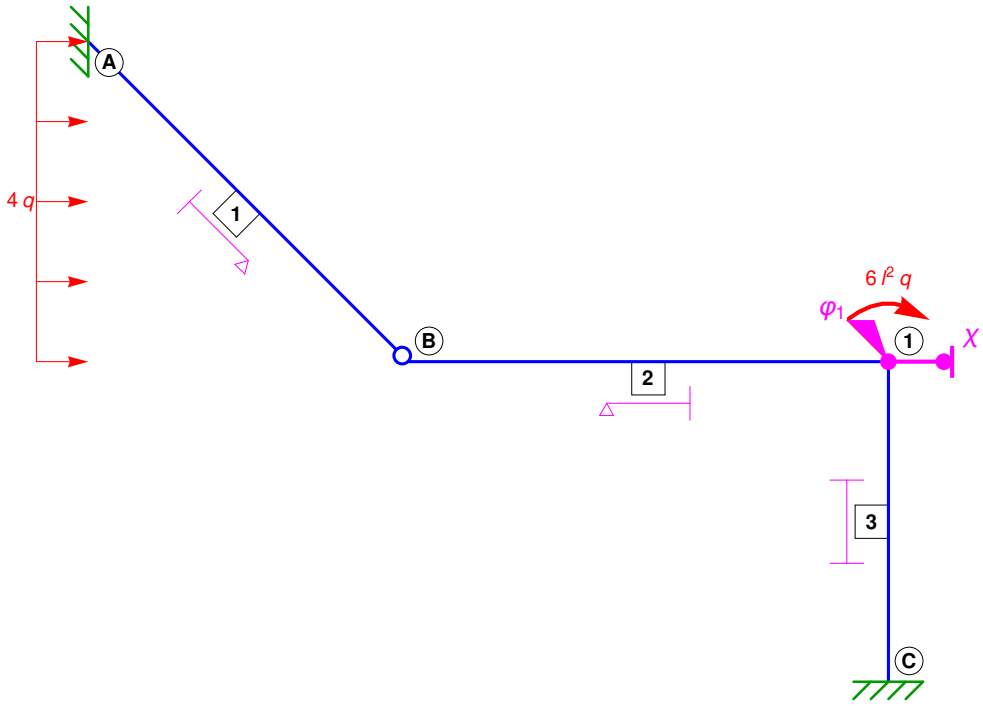
Geometria oraz obciążenia konstrukcji (wymiar oczka siatki - l):



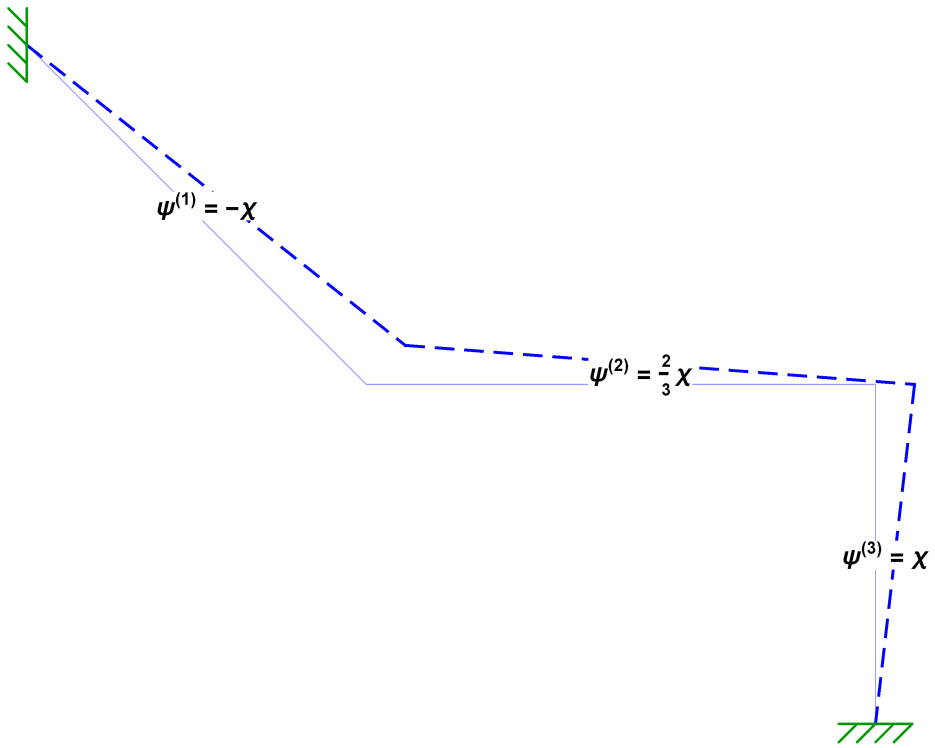
Wektor niewiadomych:

$$\mathbf{q} = \begin{pmatrix} \varphi_1 \\ \chi \end{pmatrix}$$

Układ geometrycznie wyznaczalny:



Plan przemieszczeń:



$\psi^{(1)} = -\chi$

$\psi^{(2)} = \frac{2}{3}\chi$

$\psi^{(3)} = \chi$

Momenty wyjściowe:

$\Phi_A^{01} = 8.000\, l^2\, q$

Wzory transformacyjne:

$\Phi_A^1 = \frac{EJ}{l}[\, 0.530\,\chi\,] + 8.000\, l^2\, q$

$\Phi_1^2 = \frac{EJ}{l}[\, 0.500\,\varphi_1 - 0.333\,\chi\,]$

$\Phi_1^3 = \frac{EJ}{l}[\, \varphi_1 - 1.500\,\chi\,]$

$\Phi_C^3 = \frac{EJ}{l}[\, 0.500\,\varphi_1 - 1.500\,\chi\,]$

Równania równowagi:

$\Phi_1^2 + \Phi_1^3 - 6.000\, l^2\, q = 0$

$\Phi_A^1 \cdot (-\overline{\chi}) + \Phi_1^2 \cdot \frac{2}{3}\overline{\chi} + (\Phi_1^3 + \Phi_C^3)\,\overline{\chi} + 16\, l\, q \cdot 2.000\, l\,\overline{\chi} = \overline{0}$

$$\frac{EJ}{l}\begin{pmatrix} 1.500 & -1.833 \\ -1.833 & 3.753 \end{pmatrix}\begin{pmatrix} \varphi_1 \\ \chi \end{pmatrix} = l^2\, q \begin{pmatrix} 6.000 \\ 24.000 \end{pmatrix}$$

Rozwiązanie metody przemieszczeń:

$$\mathbf{q} = \begin{pmatrix} \varphi_1 \\ \chi \end{pmatrix} = \frac{l^3\, q}{EJ}\begin{pmatrix} 29.331 \\ 20.726 \end{pmatrix}$$

Momenty brzegowe:

$\Phi_A^1 = 18.991\, l^2\, q$

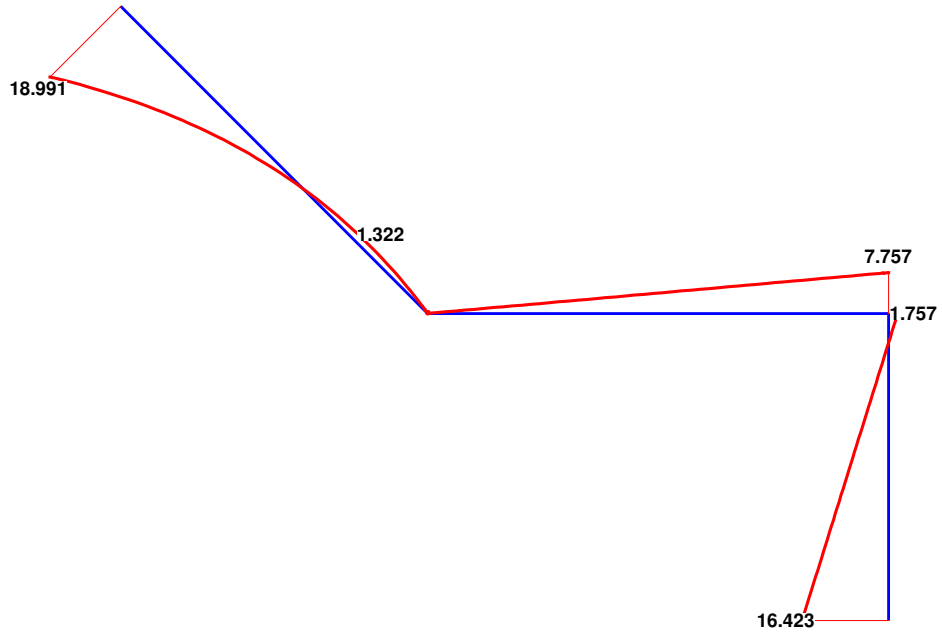
$\Phi_1^2 = 7.757\, l^2\, q$

$\Phi_1^3 = -1.757\, l^2\, q$

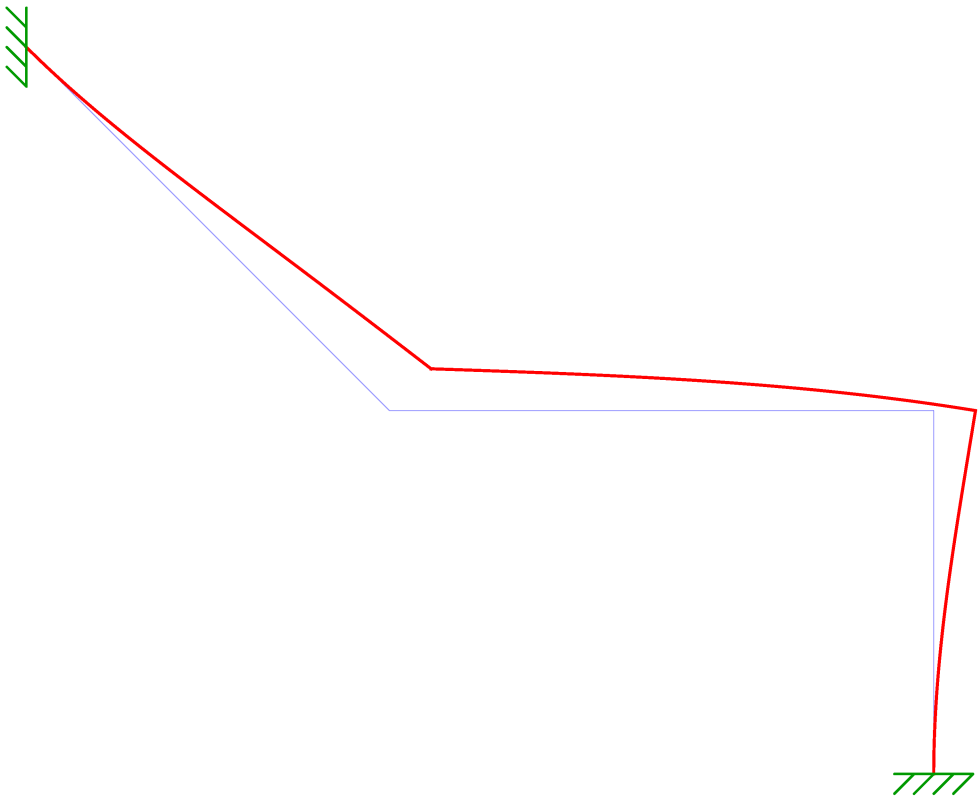
$\Phi_C^3 = -16.423\, l^2\, q$

Wykres momentów zginających:

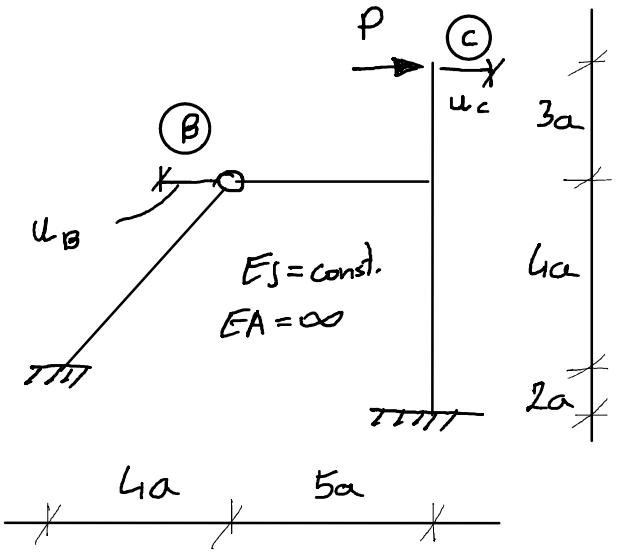
M[l^2 q]:



Deformacja konstrukcji:

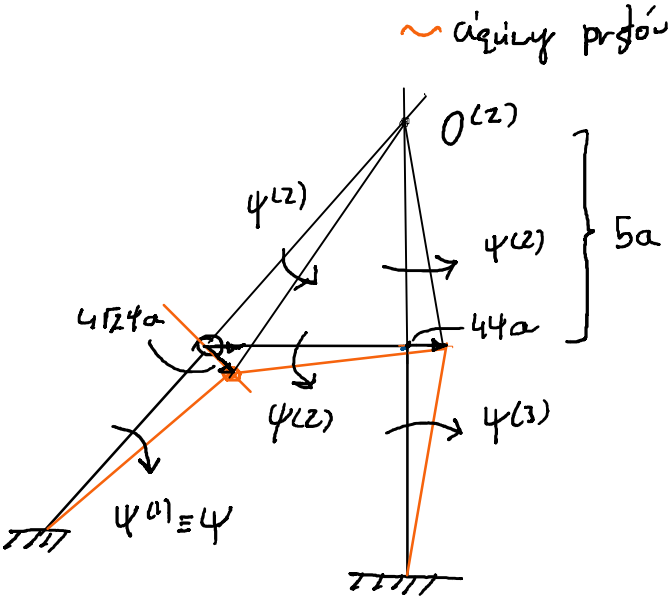


K2.3 22 I 2025

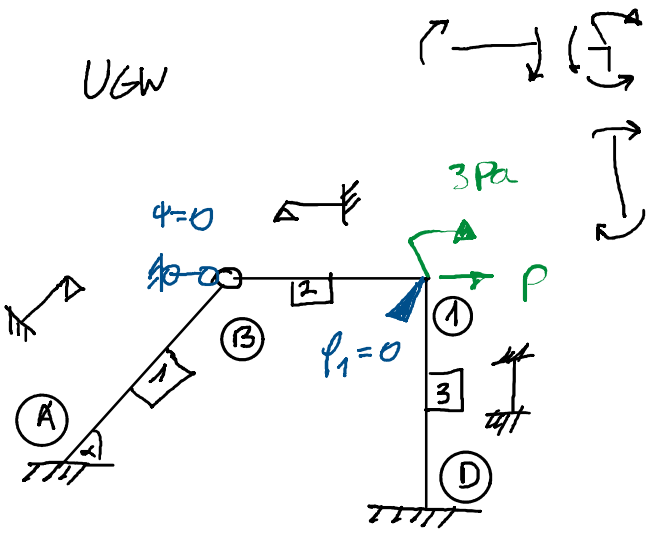


1. $M = ?$
2. $u_B = ?$
3. $u_C = ?$

PLAN PRZEMIESZCZEŃ



UGW



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

$\psi^{(1)} \equiv \psi \quad \psi^{(2)} = -\frac{4}{5}\psi \quad \psi^{(3)} = \frac{2}{3}\psi$

RRMP:

1) $\phi_1^{(2)} + \phi_1^{(3)} - 3Pa = 0$

2) $\phi_A^{(1)} \cdot \bar{\psi} + \phi_1^{(2)} \cdot (-\frac{4}{5}\bar{\psi}) + (\phi_D^{(3)} + \phi_1^{(3)}) \cdot (\frac{2}{3}\bar{\psi}) + L_{\substack{\text{obc} \\ \text{zew}}} = 0$

$L_{\substack{\text{obc} \\ \text{zew}}} = P \cdot 4\bar{\psi}a$

WZORY TRANSFORMACYJNE

$$\phi_A^{(1)} = \frac{3EJ}{4\sqrt{2}a}[-\psi] \qquad \phi_1^{(2)} = \frac{3EJ}{5a}\left[\varphi_1 + \frac{4}{5}\psi\right]$$

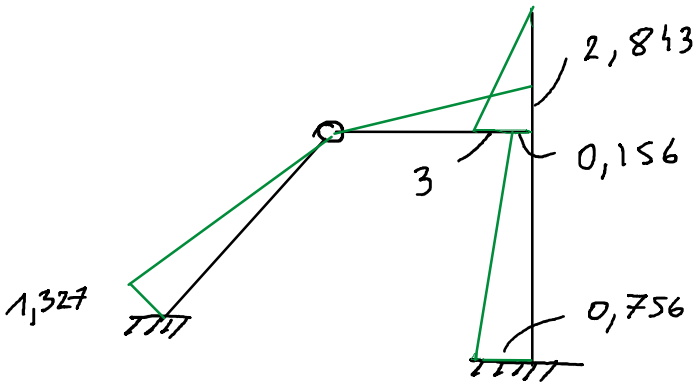
$$\phi_D^{(3)} = \frac{2EJ}{6a}\left[\varphi_1 - 3\cdot\frac{2}{3}\psi\right] \qquad \phi_1^{(3)} = \frac{2EJ}{6a}\left[2\varphi_1 - 3\cdot\frac{2}{3}\psi\right]$$

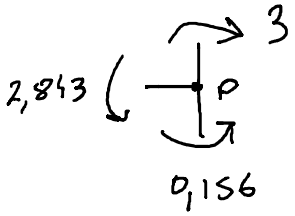
po podstawieniu w 2) $\bar{\psi} = -1$, po podstawieniu reszty wielkości do równań, otrzymamy:

$$\frac{EJ}{a}\begin{bmatrix} 19/15 & -14/75 \\ -14/75 & 1{,}803 \end{bmatrix}\begin{bmatrix}\varphi_1 \\ \psi\end{bmatrix} = Pa\begin{bmatrix}3\\4\end{bmatrix}$$

$$\varphi_1 \cong 2{,}737\ \frac{Pa^2}{EJ} \qquad \psi \cong 2{,}502\ \frac{Pa^2}{EJ}$$

(M) [Pa]





$\Sigma M_P \cong 0$

$$u_B = 4\cdot 2{,}502\ \frac{Pa^3}{EJ} = 8{,}502\ \frac{Pa^3}{EJ}$$