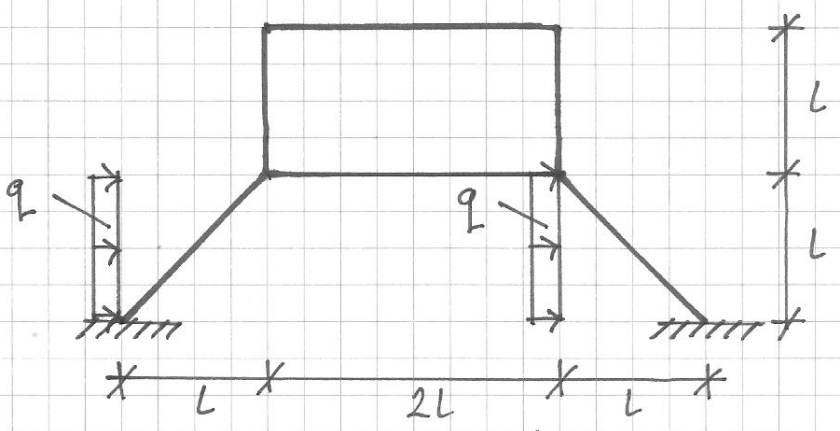
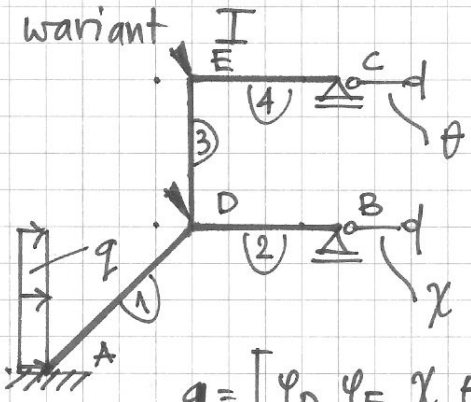
Kolokwium z MK1, 2.2a, r.ak. 2015/16

Zapisać układ równań Metody Przemieszczeń $EJ = const.$

$\varepsilon_e = 0$ $(EA = \infty)$

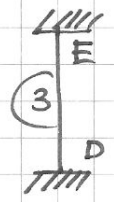


Schemat zredukowany geometrycznie wyznaczalny wariant I

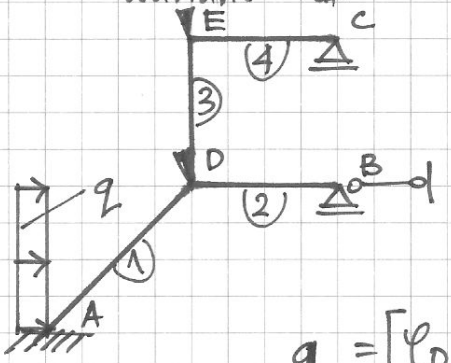


$$q = [\varphi_D \; \varphi_E \; \chi \; \theta]^T$$

Uwaga: schemat pręta 3 w wariancie I:

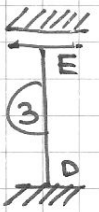


Schemat zredukowany geometrycznie wyznaczalny wariant II



$$q = [\varphi_D \; \varphi_E \; \chi]^T$$

Uwaga: schemat pręta 3 w wariancie II:

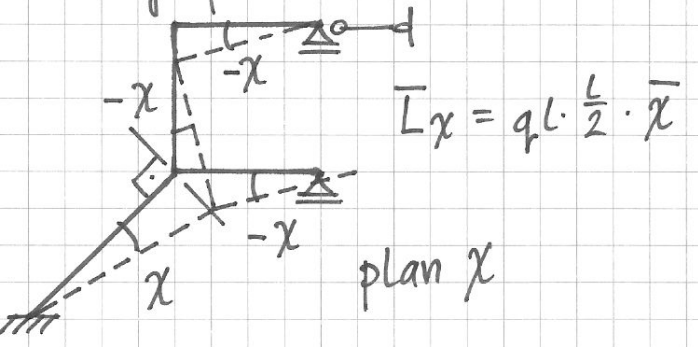


Równania równowagi węzłów (obowiązują w obu wariantach)

$$\Phi_D^{(1)} + \Phi_D^{(2)} + \Phi_D^{(3)} = 0 \qquad (1)$$

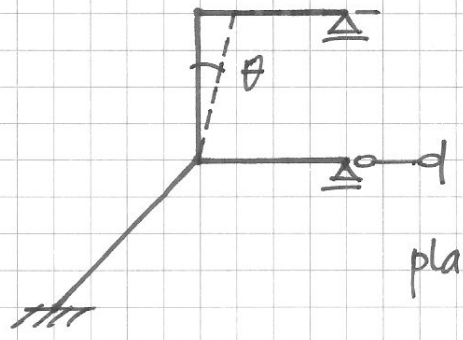
$$\Phi_E^{(3)} + \Phi_E^{(4)} = 0 \qquad (2)$$

Plany przesunięć (wariant I)



plan χ

$\bar{L}_\chi = ql \cdot \frac{l}{2} \cdot \bar{\chi}$



plan θ

$\bar{L}_\theta = 0$

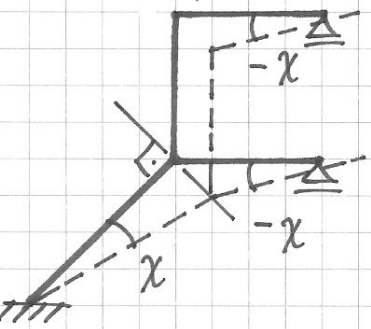
Równania równowagi ramy (wariant I)

$$\left[\Phi_A^{(1)} + \Phi_D^{(1)}\right] \cdot \bar{\chi} + \Phi_D^{(2)} \cdot (-\bar{\chi}) + \left[\Phi_D^{(3)} + \Phi_E^{(3)}\right] \cdot (-\bar{\chi})$$

$$+ \Phi_E^{(4)} \cdot (-\bar{\chi}) + \bar{L}_\chi = 0 \qquad (3)_I$$

$$\left[\Phi_D^{(3)} + \Phi_E^{(3)}\right] \cdot \bar{\theta} + \bar{L}_\theta = 0 \qquad (4)_I$$

Plany przesunięć (wariant II)



$\bar{L}_\chi = ql \cdot \frac{l}{2} \cdot \bar{\chi}$

Równanie równowagi ramy (wariant II)

$$\left[\Phi_A^{(1)} + \Phi_D^{(1)}\right] \cdot \bar{\chi} + \Phi_D^{(2)} \cdot (-\bar{\chi}) + \Phi_E^{(4)} \cdot (-\bar{\chi}) + \bar{L}_\chi = 0 \qquad (3)_{II}$$

Ostatecznie równania równowagi:

- wariant I : $(1) + (2) + (3)_I + (4)_I$
- wariant II : $(1) + (2) + (3)_{II}$

Wzory transformacyjne:

$$\Phi_A^{(1)} = \frac{2EJ}{L\sqrt{2}}\left[\varphi_D - 3\chi\right] - \frac{1}{12}ql^2 \qquad \Phi_E^{(4)} = \frac{3EJ}{L}\left[\varphi_E + \chi\right]$$

$$\Phi_D^{(1)} = \frac{2EJ}{L\sqrt{2}}\left[2\varphi_D - 3\chi\right] + \frac{1}{12}ql^2$$

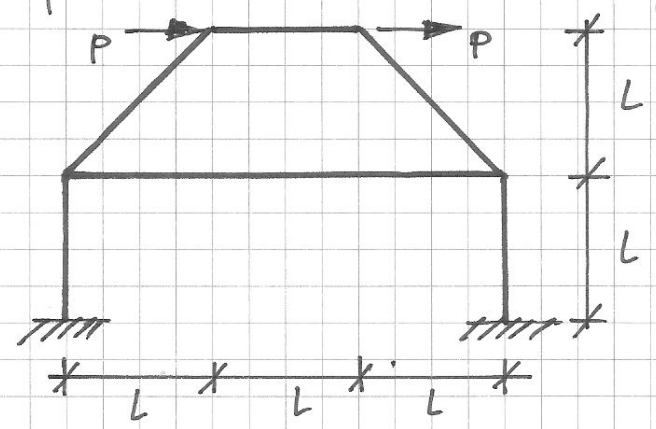
$$\Phi_D^{(2)} = \frac{3EJ}{L}\left[\varphi_D + \chi\right]$$

$$\left.\begin{aligned}\Phi_D^{(3)} &= \frac{2EJ}{L}\left[2\varphi_D + \varphi_E + 3\chi - 3\theta\right] \\ \Phi_E^{(3)} &= \frac{2EJ}{L}\left[\varphi_D + 2\varphi_E + 3\chi - 3\theta\right]\end{aligned}\right\} \text{w. I} \quad \text{lub} \quad \left.\begin{aligned}\Phi_D^{(3)} &= \frac{EJ}{L}\left[\varphi_D - \varphi_E\right] \\ \Phi_E^{(3)} &= -\frac{EJ}{L}\left[\varphi_D - \varphi_E\right]\end{aligned}\right\} \text{w. II}$$

Kolokwium z MK1, 2.2b, r.ak. 2015/16

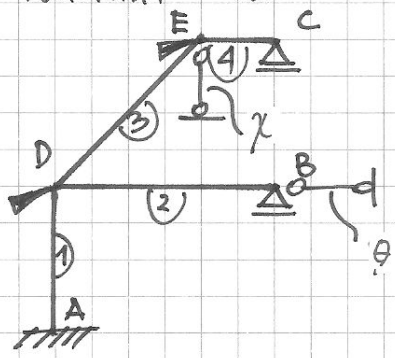
Zapisać układ równań Metody Przemieszczeń $EJ = const.$

$EA = \infty$



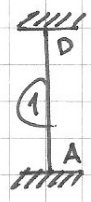
Schemat geometrycznie wyznaczalny (z uwzgl. antysymetrii)

wariant I

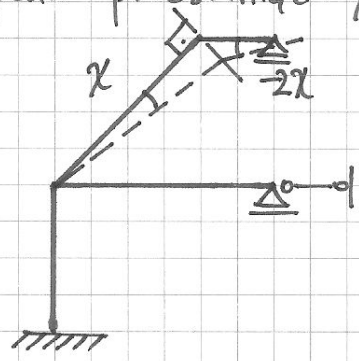


$$q = \begin{bmatrix} \varphi_D \\ \varphi_E \\ \chi \\ \theta \end{bmatrix}$$

Uwaga: schemat pręta 1:

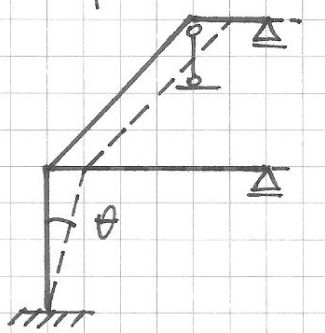


plan przesunięć χ:



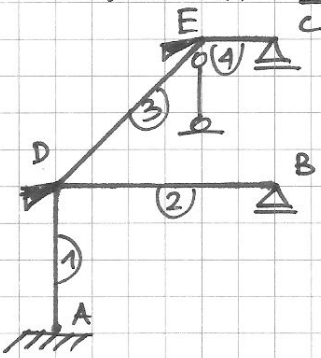
$$\bar{L}_\chi = P \cdot L \cdot \bar{\chi}$$

plan przesunięć θ:



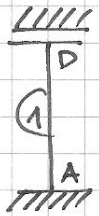
$$\bar{L}_\theta = P \cdot L \cdot \bar{\theta}$$

wariant II

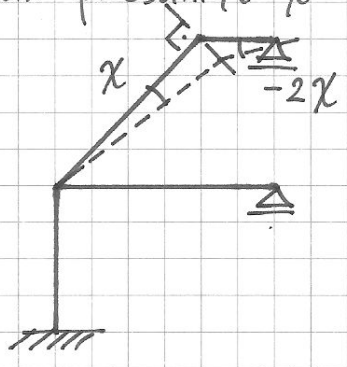


$$q = \begin{bmatrix} \varphi_D \\ \varphi_E \\ \chi \end{bmatrix}$$

Uwaga: schemat pręta 1



plan przesunięć χ:



$$\bar{L}_\chi = P \cdot L \cdot \bar{\chi}$$

Równania równowagi węzłów (obowiązują w obu wariantach)

$$T_D^{(1)} + T_D^{(2)} + T_D^{(3)} = 0 \qquad (1)$$
$$T_E^{(3)} + T_E^{(4)} = 0 \qquad (2)$$

Równania równowagi ramy (wariant I)

$$\left[T_D^{(3)} + T_E^{(3)}\right] \cdot \overline{\chi} + T_E^{(4)} \cdot (-2\overline{\chi}) + \overline{L}\chi = 0 \qquad (3)_I$$
$$\left[T_A^{(1)} + T_D^{(1)}\right] \cdot \overline{\theta} + \overline{L}\theta = 0 \qquad (4)_I$$

Równania równowagi ramy (wariant II)

$$\left[T_D^{(3)} + T_E^{(3)}\right] \cdot \overline{\chi} + T_E^{(4)} \cdot (-2\overline{\chi}) + \overline{L}\chi = 0 \qquad (3)_{II}$$

Ostatecznie równania równowagi:
- wariant I : $(1) + (2) + (3)_I + (4)_I$
- wariant II : $(1) + (2) + (3)_{II}$

Wzory transformacyjne:

$$\left.\begin{aligned} T_A^{(1)} &= \frac{2EJ}{L}\left[\varphi_D - 3\theta\right] \\ T_D^{(1)} &= \frac{2EJ}{L}\left[2\varphi_D - 3\theta\right] \end{aligned}\right\} \text{wariant I}$$

$$\left.\begin{aligned} T_A^{(1)} &= \frac{EJ}{L}\left[\varphi_D\right] - \frac{1}{2}PL \\ T_D^{(1)} &= -\frac{EJ}{L}\left[\varphi_D\right] - \frac{1}{2}PL \end{aligned}\right\} \text{wariant II}$$

$$T_D^{(2)} = \frac{3EJ}{\frac{3}{2}L}\left[\varphi_D\right]$$

$$T_D^{(3)} = \frac{2EJ}{L\sqrt{2}}\left[2\varphi_D + \varphi_E - 3\chi\right]$$
$$T_E^{(3)} = \frac{2EJ}{L\sqrt{2}}\left[\varphi_D + 2\varphi_E - 3\chi\right]$$

$$T_E^{(4)} = \frac{3EJ}{\frac{1}{2}L}\left[\varphi_D + 2\chi\right]$$