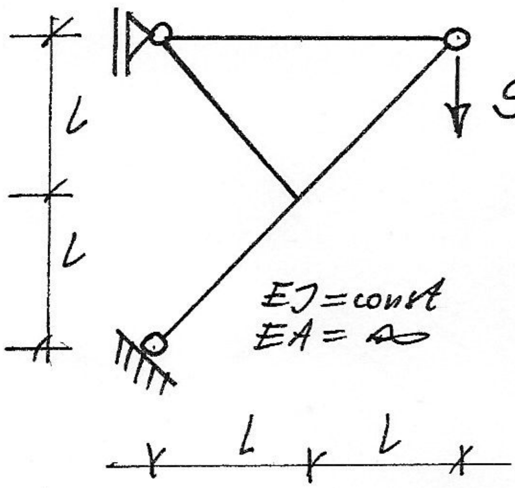
Egzamin z Mechaniki Konstrukcji II, 28 XI 2016 r.
Wydział Inżynierii Lądowej, studia stacjonarne

NAZWISKO imię				
Grupa	Data zaliczenia ćwiczeń		Numer albumu	
Ocena zadania 1	Ocena zadania 2	Ocena zadania 3	Ocena z egzaminu	Ocena łączna Data

Zadanie 1

Zapisz równania określające wartość siły krytycznej. Sprawdzić ponadto wyboczenie lokalne..

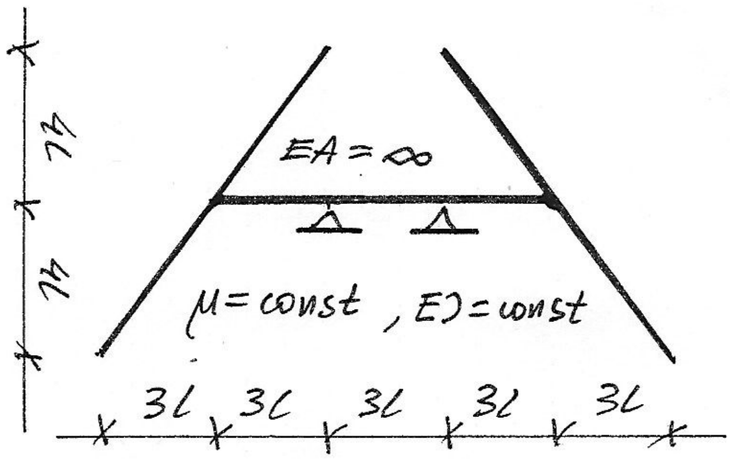
(Write down the equations determining the value of the critical force. Check the conditions of local buckling)



Zadanie 2

Zapisz równania określające częstości drgań własnych antysymetrycznych.

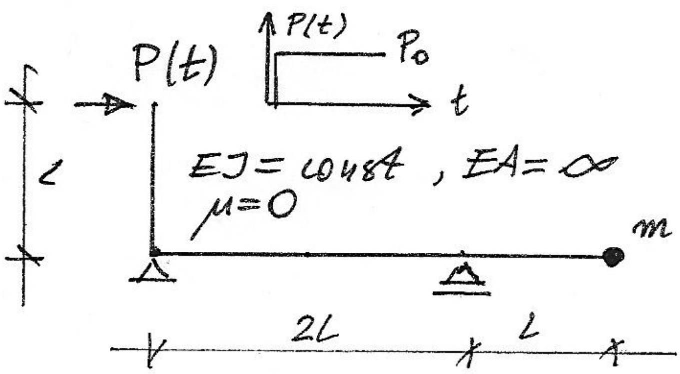
(Write down the equations determining the eigenfrequencies of antisymmetric vibration)



Zadanie 3

Dana rama jest obciążona nagle przyłożonym obciążeniem o wartości P_o.
Przyjąć jednorodne warunki początkowe.
Znaleźć przemieszczenie masy w dowolnej chwili czasu

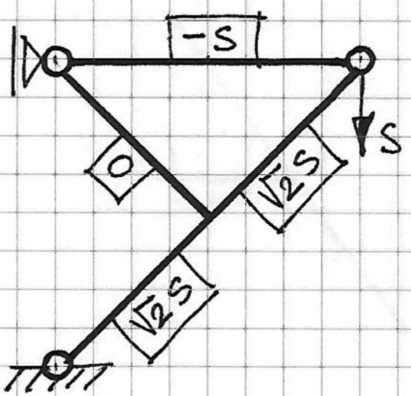
(The force P_o is abruptly applied to the given frame. Find the displacement of the mass at arbitrary time instant. The initial conditions are homogeneous)



Egzamin z MK 2, 28.11.2016, zadanie 1

Exam on MoS 2, problem 1

Rozkład dużych sił osiowych
Big axial force distribution



$$\sigma = L\sqrt{\frac{S}{EJ}}$$

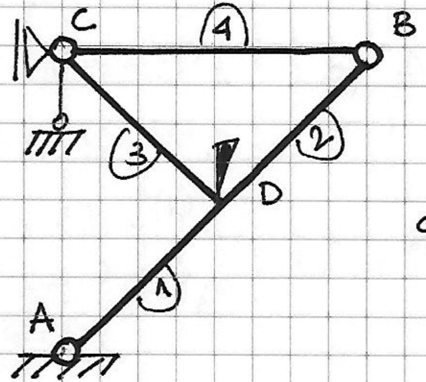
$$\sigma^{(1)} = 1{,}68\,\sigma$$

$$\sigma^{(2)} = 1{,}68\,\sigma$$

$$\sigma^{(3)} = 0$$

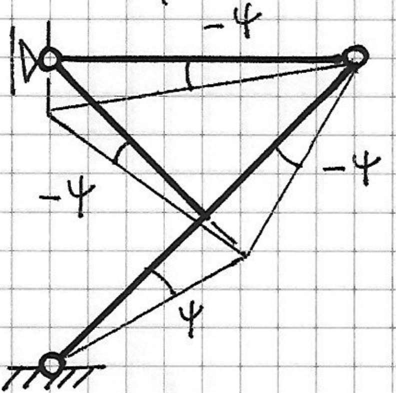
$$\sigma^{(4)} = 2\sigma i$$

Układ zastępczy
The primary system



$$\mathbf{q} = \begin{bmatrix} \varphi_D \\ \psi \end{bmatrix}$$

Plan przesunięć
Translation plan



Równania równowagi
Equilibrium equations

$$1)\quad \phi_D^{(1)} + \phi_D^{(2)} + \phi_D^{(3)} = 0$$

$$2)\quad \phi_D^{(1)} \cdot \bar{\psi} + \phi_D^{(2)} \cdot (-\bar{\psi}) + \phi_D^{(3)} \cdot (-\bar{\psi})$$
$$+ \sqrt{2}S \cdot \sqrt{2}L \cdot \psi \cdot \bar{\psi} + \sqrt{2}S \cdot \sqrt{2}L \cdot (-\psi)(-\bar{\psi})$$
$$+ (-S) \cdot 2L \cdot (-\psi) \cdot (-\bar{\psi}) = 0$$

Wzory transformacyjne
Slope-deflection equations

$$\phi_D^{(1)} = \frac{EJ}{L}\left[\frac{1}{\sqrt{2}}\alpha'(1{,}68\sigma)(\varphi_D - \psi)\right]$$

$$\phi_D^{(2)} = \frac{EJ}{L}\left[\frac{1}{\sqrt{2}}\alpha'(1{,}68\sigma)(\varphi_D + \psi)\right]$$

$$\phi_D^{(3)} = \frac{3EJ}{L}\left[\frac{1}{\sqrt{2}}(\varphi_D + \psi)\right]$$

Równania równowagi cd. / Equilibrium equations cont.

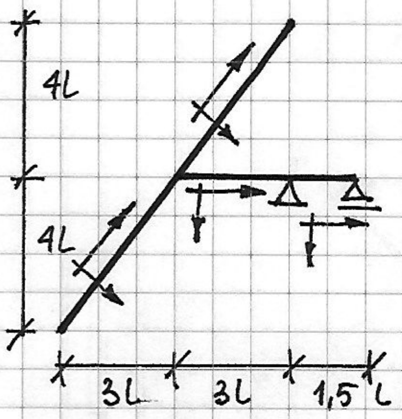
$$\begin{bmatrix} \frac{3}{\sqrt{2}} + \sqrt{2}\alpha'(1{,}68\sigma) & \frac{3}{\sqrt{2}} \\ \frac{3}{\sqrt{2}} & \frac{3}{\sqrt{2}} + \sqrt{2}\alpha'(1{,}68\sigma) - 2\sigma^2 \end{bmatrix} \begin{bmatrix} \varphi_D \\ \psi \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Wyboczenie lokalne / Local buckling (pręty 1, 2) / (bars 1 or 2)

$$\sqrt{2}\,S_{kr} = \left(\frac{\pi}{0{,}7}\right)^2 \frac{EJ}{(\sqrt{2}L)^2} \rightarrow S_{kr} = 7{,}12\,\frac{EJ}{L^2}$$

Egzamin z MK2, 28.11.2016, zadanie 2

Exam on MoS2, problem 2

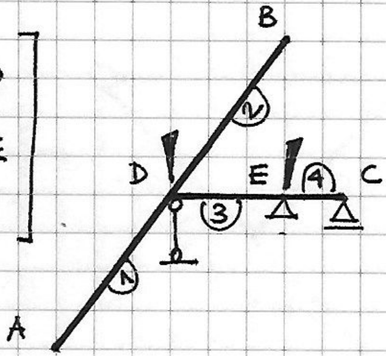


Schemat zredukowany
The reduced scheme

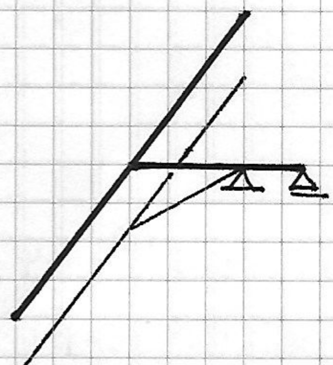
$$\lambda^{(1)} = 5\lambda$$
$$\lambda^{(2)} = 5\lambda$$
$$\lambda^{(3)} = 3\lambda$$
$$\lambda^{(4)} = 1{,}5\lambda$$
$$\lambda^4 = L^4 \cdot \frac{\mu\omega^2}{EJ}$$

Schemat zastępczy
The primary scheme

$$q = \begin{bmatrix} \varphi_D \\ \varphi_E \\ \frac{V}{L} \end{bmatrix}$$



Plan przesunięć / Translation plan



$$W_D^{(1)} = \frac{3}{5}V \qquad u^{(1)} = -\frac{4}{5}V$$
$$W_D^{(2)} = \frac{3}{5}V \qquad u^{(2)} = -\frac{4}{5}V$$
$$W_D^{(3)} = V$$

Równania równowagi / Equations of equilibrium

$$\Phi_D^{(1)} + \Phi_D^{(2)} + \Phi_D^{(3)} = 0$$
$$\Phi_E^{(3)} + \Phi_E^{(4)} = 0$$
$$-W_D^{(1)} \cdot \frac{3}{5}\bar{V} - W_D^{(2)} \cdot \frac{3}{5}\bar{V} - W_1^{(3)} \cdot \bar{V} + B_{\parallel}^{(1)} \cdot \left(-\frac{4}{5}\bar{V}\right) + B_{\parallel}^{(2)} \cdot \left(-\frac{4}{5}\bar{V}\right) = 0$$

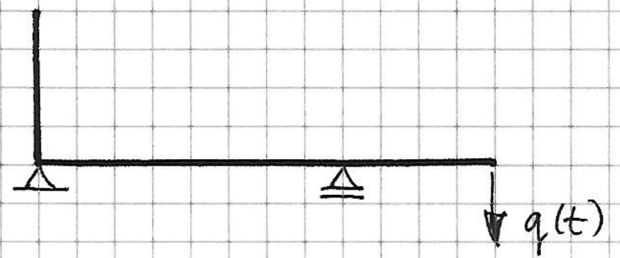
Wzory transformacyjne i siły bezwładności
Slope-deflection equations and inertia forces

$$\Phi_D^{(1)} = \frac{EJ}{L}\left[\frac{1}{5}\alpha''(5\lambda)\varphi_D - \frac{3}{125}\vartheta''(5\lambda)\frac{V}{L}\right] \qquad B_{\parallel}^{(1)} = \frac{EJ}{L^2}\left(-4\lambda^4 \frac{V}{L}\right)$$
$$\Phi_D^{(2)} = \frac{EJ}{L}\left[\frac{1}{5}\alpha''(5\lambda)\varphi_D + \frac{3}{125}\vartheta''(5\lambda)\frac{V}{L}\right] \qquad B_{\parallel}^{(2)} = \frac{EJ}{L^2}\left(-4\lambda^4 \frac{V}{L}\right)$$
$$\Phi_D^{(3)} = \frac{EJ}{L}\left[\frac{1}{3}\alpha(3\lambda)\varphi_D + \frac{1}{3}\beta(3\lambda)\varphi_E + \frac{1}{9}\vartheta(3\lambda)\frac{V}{L}\right]$$
$$\Phi_E^{(3)} = \frac{EJ}{L}\left[\frac{1}{3}\beta(3\lambda)\varphi_D + \frac{1}{3}\alpha(3\lambda)\varphi_E + \frac{1}{9}\delta(3\lambda)\frac{V}{L}\right]$$
$$\Phi_E^{(4)} = \frac{EJ}{L}\left[\frac{2}{3}\alpha'(1{,}5\lambda)\varphi_E\right]$$
$$W_D^{(1)} = \frac{EJ}{L^2}\left[-\frac{1}{25}\vartheta''(5\lambda)\varphi_D + \frac{3}{625}\gamma''(5\lambda)\frac{V}{L}\right]$$
$$W_D^{(2)} = \frac{EJ}{L^2}\left[\frac{1}{25}\vartheta''(5\lambda)\varphi_D + \frac{3}{625}\gamma''(5\lambda)\frac{V}{L}\right]$$
$$W_D^{(3)} = \frac{EJ}{L^2}\left[\frac{1}{9}\vartheta(3\lambda)\varphi_D + \frac{1}{9}\delta(3\lambda)\varphi_E + \frac{1}{27}\gamma(3\lambda)\frac{V}{L}\right]$$

Egzamin z MK2, 28.11.2016, zadanie 3

Exam on MoS2, problem 3

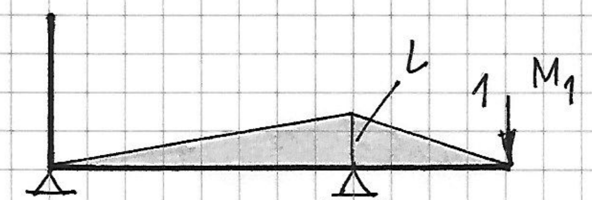
Równanie ruchu / Equation of motion

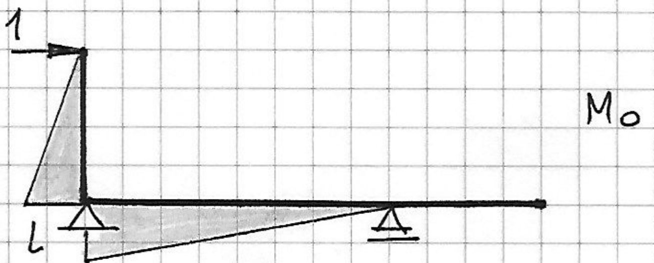


$$d m \ddot{q}(t) + q(t) = d_0 P(t)$$

$$\ddot{q}(t) + \frac{1}{dm} q(t) = \frac{d_0}{d} \cdot \frac{1}{m} P(t)$$

Wyznaczenie d, d_0 / Determining d and d_0.





$$d = \frac{1}{EJ}\left[\frac{1}{2}\cdot L\cdot L\cdot \frac{2}{3}L + \frac{1}{2}\cdot 2L\cdot L\cdot \frac{2}{3}L\right] = \frac{L^3}{EJ}$$

$$d_0 = \frac{1}{EJ}\left[\frac{1}{2}\cdot 2L\cdot L\cdot\left(-\frac{1}{3}L\right)\right] = -\frac{1}{3}\frac{L^3}{EJ}$$

Ostatecznie / Finally

$$\ddot{q}(t) + \frac{EJ}{mL^3} q(t) = -\frac{1}{3m} P_0$$

CORJ / GSHE

$$q_0(t) = A_1 \sin(\omega t) + A_2 \cos(\omega t), \quad \omega = \frac{1}{dm}$$

CSRN / PSNHE

$$q_s(t) = B, \quad q(t) = q_0(t) + q_s(t)$$

Wyznaczamy B / We determine B

$$\frac{EJ}{mL^3} B = -\frac{1}{3m} P_0 \longrightarrow B = -\frac{P_0 L^3}{3EJ}$$

Wyznaczamy A_1 i A_2 / We determine A_1 and A_2

$$q(t) = A_1 \sin(\omega t) + A_2 \cos(\omega t) + B$$

$$q(0) = 0 \longrightarrow A_2 + B = 0 \longrightarrow A_2 = \frac{P_0 L^3}{3EJ}$$

$$\dot{q}(0) = 0 \longrightarrow \omega A_1 = 0 \longrightarrow A_1 = 0$$

$$q(t) = -\frac{P_0 L^3}{3EJ}\left[1 - \cos(\omega t)\right]$$