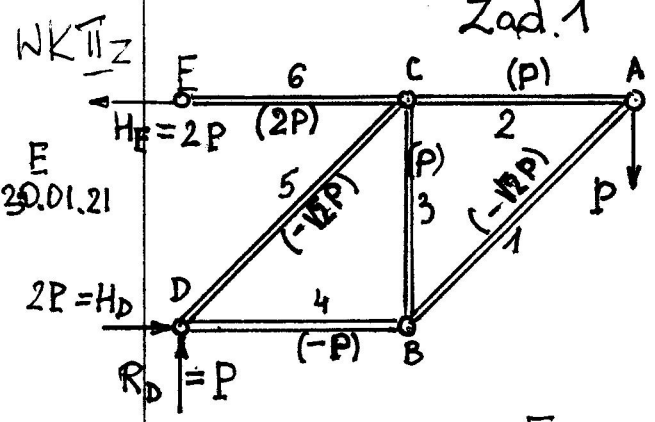
WKTiZ

E

29.01.21

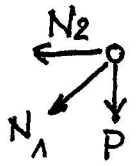
Zad. 1



$l = 1\,m$, $P = 3.2\,kN$, $E = 2\cdot 10^5\,MPa$,

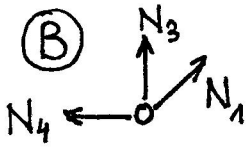
$\sigma_{prop} \cong R_e = 240\,MPa$, $n_{kr} = 2.4$

Wyznaczyć średnicę kołowego przekroju pełnego aby zabezpieczyć się pred wyboczeniem.

(A) 

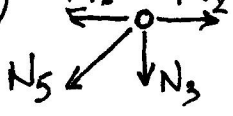
$N_1\frac{\sqrt{2}}{2} + P = 0 \rightarrow N_1 = -\sqrt{2}\cdot P$, $N_1\frac{\sqrt{2}}{2} + N_2 = 0$

$\rightarrow N_2 = -\frac{\sqrt{2}}{2}\cdot N_1 = \frac{-\sqrt{2}}{2}\cdot(-\sqrt{2})P = P \rightarrow N_2 = P$

(B) 

$N_3 + N_1\frac{\sqrt{2}}{2} = 0 \rightarrow N_3 = -\frac{\sqrt{2}}{2}\cdot N_1 = -\frac{\sqrt{2}}{2}\cdot(-\sqrt{2})\cdot P \rightarrow N_3 = P$

$N_4 - N_1\frac{\sqrt{2}}{2} = 0 \rightarrow N_4 = N_1\frac{\sqrt{2}}{2} = -\sqrt{2}P\frac{\sqrt{2}}{2} \rightarrow N_4 = -P$

(C) 

$N_5\frac{\sqrt{2}}{2} + N_3 = 0 \rightarrow N_5 = -\sqrt{2}\cdot N_3 = -\sqrt{2}\cdot P \rightarrow N_5 = -\sqrt{2}P$

$N_6 - N_2 + N_5\frac{\sqrt{2}}{2} = 0 \rightarrow N_6 = N_2 - \frac{\sqrt{2}}{2}\cdot N_5$

$N_6 = P - \frac{\sqrt{2}}{2}\cdot(-\sqrt{2})\cdot P = 2P$

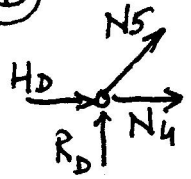
sprawdzenie r-gi na podporach: $N_5\frac{\sqrt{2}}{2} + R_D = 0$

(E) 

$H_E - N_6 = 0$

$H_E = N_6$

$2P = 2P$ (O.K.)

(D) 

$-\sqrt{2}P\frac{\sqrt{2}}{2} + P = 0$ (O.K.)

$N_4 + N_5\frac{\sqrt{2}}{2} + H_D = 0$

$-P - \sqrt{2}P\frac{\sqrt{2}}{2} + 2P = 0$ (O.K.)

Wyboczenie: $\lambda_{gr} = \pi\sqrt{\frac{E}{\sigma_{prop}}} = \pi\sqrt{\frac{200000}{240}} = 90.7$, $(l_i)_s = l_i$

1° pręt 4 $\rightarrow N_4 = -P$, $l_4 = l$, 2° pręt 1 (5) $\rightarrow N_1 = N_5 = -\sqrt{2}P$, $l_1 = l_5 = \sqrt{2}l$

dobranie i_y wspólnego dla wszystkich prętów

$$i_y = \sqrt{\frac{J_y}{A}} = \sqrt{\frac{\pi d^4\cdot 4}{64\cdot\pi d^2}} = \frac{d}{4}$$

pręt 4: $\lambda_4 = \frac{(l_4)_s}{i_y} = \frac{4l}{d}$ pręt 5: $\lambda_5 = \frac{(l_5)_s}{i_y} = \frac{4\sqrt{2}l}{d}$

$$(\sigma_{kr})_4 = \frac{\pi^2 E}{\left(\frac{4l}{d}\right)^2} = \frac{\pi^2 E}{\frac{16l^2}{d^2}} = \frac{\pi^2 E d^2}{16l^2}, \quad (\sigma_{kr})_5 = \frac{\pi^2 E}{\left(\frac{4\sqrt{2}l}{d}\right)^2} = \frac{\pi^2 E d^2}{32l^2}$$

$$(N_{kr})_4 = \frac{\pi^2 E d^2}{16l^2}\cdot\frac{\pi d^2}{4} = \frac{\pi^3 E d^4}{64l^2}, \quad (N_{kr})_5 = \frac{\pi^2 E d^2}{32l^2}\cdot\frac{\pi d^2}{4} = \frac{\pi^3 E d^4}{128l^2}$$

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Z.1 c.d

Warunki bezpieczeństwa ze względu na wyboczenie ogólnie : $|N_i| \leq \frac{(N_{kr})_i}{m_{kr}}$

pręt 4 :

$$P \leq \frac{\pi^3 E d^4}{64 l^2 \cdot m_{kr}} \quad \vee \quad d \geqslant \sqrt[4]{\frac{64 l^2 \cdot m_{kr} P}{\pi^3 E}}$$

pręt 5 :

$$\sqrt{2} \cdot P \leq \frac{\pi^3 E d^4}{128 l^2 \cdot m_{kr}} \quad \vee \quad d \geqslant \sqrt[4]{\frac{128 l^2 m_{kr} \cdot P\sqrt{2}}{\pi^3 E}}$$

Limitujący jest warunek dla pręta 5 :

$$d \geqslant \sqrt[4]{\frac{128 \cdot 1m^2 \cdot 2.4 \cdot 3.2 \cdot 10^3 N \cdot \sqrt{2}}{\pi^3 \cdot 200 \cdot 10^3 N/m^2 \cdot 10^6}} = 2.176 \cdot 10^{-2} m \approx 22 mm$$

sprawdzenie smukłości pręta :

$$i_y = \frac{d}{4} = \frac{22}{4} mm = 5,5 mm$$

$$\lambda_5 = \frac{\sqrt{2} \cdot 1m}{5.5 mm} = \frac{1414}{5.5} = 257 >> \lambda_{gr} = 90.7$$

$$\left(J_y = \frac{\pi}{64} \cdot 22^4 mm^4 = 1,15 \cdot 10^4 mm^4 \right)$$