



AKADEMIA EDUKACYJNO - INŻYNIERSKA

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MATURA STUDIA PRAKTYKA STAŻ PRACA BIZNES PRZEMYSŁ STEAM

KOMPLEKSOWE WSPARCIE EDUKACYJNE ON – LINE NA KAŻDYM ETAPIE KSZTAŁCENIA INŻYNIERSKIEGO

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PODSTAWY KONSTRUKCJI MASZYN I

"STATYKA – WYTRZYMAŁOŚĆ BELKI STATYCZNIE WYZNACZALNEJ"

PROJEKT

Oblicz:

- minimalne parametry geometryczne

dla układu ustroju nośnego belkowego jakie należy dobrać, aby na pewno przeniósł on zadane obciążenie zewnętrzne.

DANE:

$L, m, g, E, R_e = OK$

SZUKAM:

$a, D = ?$

1)

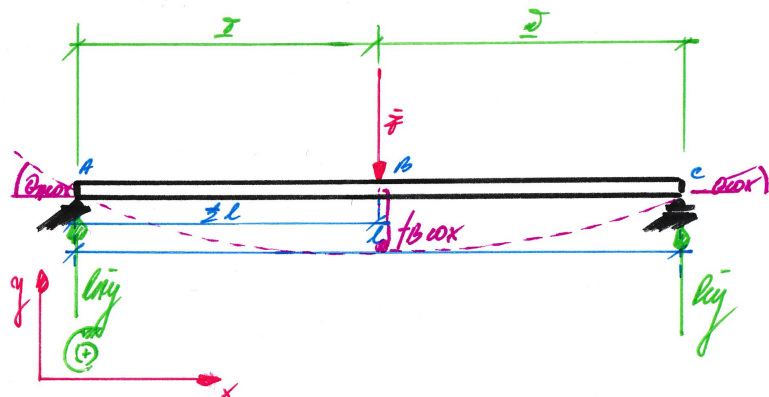
$$m, l = \checkmark$$

$$E = 210 \cdot 10^9 \text{ (Pa)}$$

$$m = 100 \text{ (kg)}$$

$$l = 3 \text{ (m)}$$

$$E_{\text{elox}} = 255 \cdot 10^6 \text{ (Pa)} \quad \text{3) } \sigma_{\text{elox}}$$



$$\sigma_g = \left(\frac{M_{g \text{ elox}}}{W_z} \right) \leq \sigma_{\text{elox}}^{(g)}$$

1) DEPENDS.

$$m = 100 \text{ (kg)}$$

$$g = 9,81 \text{ (m/s}^2\text{)}$$

$$F = m \cdot g = 100 \cdot 9,81 = 981 \text{ (N)}$$

$$\begin{cases} M_{gy} = \frac{1}{2} F \\ R_{gy} = \frac{1}{2} F \end{cases} \quad \begin{cases} M_{gy} = \frac{1}{2} \cdot 981 = 490,5 \text{ (N)} \\ R_{gy} = \frac{1}{2} \cdot 981 = 490,5 \end{cases}$$

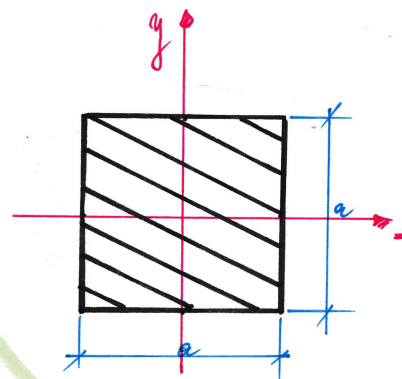
2) $M_{g \text{ elox}}(x) \dots$

$$M_{g \text{ elox}} = \frac{1}{4} F l$$

$$\sigma_{\text{elox}} = \frac{1}{2} F$$

$$M_{g \text{ elox}} = \frac{1}{4} \cdot 981 \cdot 3 = 735,75 \text{ (Nm)}$$

$$\sigma_{\text{elox}} = \frac{1}{2} \cdot 981 = 490,5 \text{ (N)}$$



$$M_{g \text{ elox}} = \checkmark$$

$$W_z = \frac{I_z}{y_{\text{elox}}} = \frac{\frac{a^4}{12}}{\frac{1}{2}a} = \frac{1}{6}a^3$$

$$\sigma_{g \text{ elox}}^{(g)} = \sigma_{\text{elox}}$$

$$\begin{cases} \sigma = 0,60 = 60 \\ E_{\text{elox}} = 255 \cdot 10^6 \text{ (Pa)} \end{cases}$$

$$\sigma_{g \text{ elox}} = \sigma_{\text{elox}} = 0,60 \cdot 255 \cdot 10^6 = 153 \cdot 10^6 \text{ (Pa)}$$

$$\frac{M_{g \text{ elox}}}{W_z} \leq \sigma_{g \text{ elox}}^{(g)}$$

$$W_z \geq \frac{M_{g \text{ elox}}}{\sigma_{g \text{ elox}}^{(g)}}$$

$$\frac{1}{6}a^3 \geq \frac{\frac{1}{4}mgl}{\sigma_{\text{elox}}} \Rightarrow a \geq \sqrt[3]{\frac{3mgl}{2\sigma_{\text{elox}}}}$$

4) f_{max}

$$f_{\text{max}} = \frac{\hbar l^3}{48 E \hbar} \leq f_{\text{dep}}$$

$$\hbar - \checkmark$$

$$l - \checkmark$$

$$E = 210 \text{ (GeV)} = 210 \cdot 10^9 \text{ (eV)}$$

$$\frac{a^4}{12}$$

$$f_{\text{dep}} = \frac{1}{800} = \frac{3}{800} = 6 \cdot 10^{-3} \text{ (cm)}$$

$$\frac{\hbar l^3}{48 E \hbar} \leq f_{\text{dep}}$$

$$\hbar \geq \frac{\hbar l^3}{48 E f_{\text{dep}}}$$

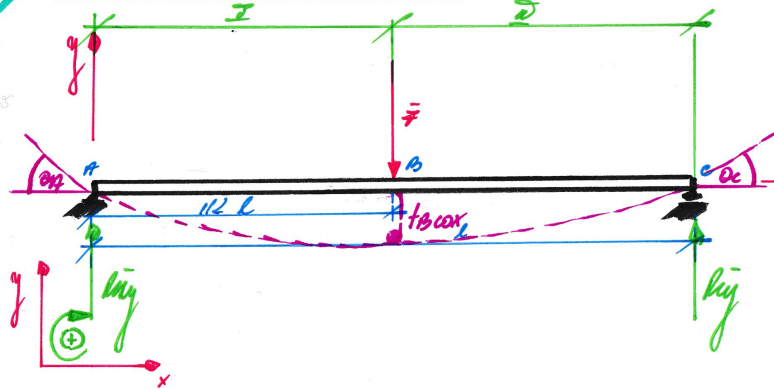
$$\frac{a^4}{12} \geq \frac{\hbar l^3}{48 E f_{\text{dep}}} \quad 1 \cdot 12$$

$$a \geq \sqrt[4]{\frac{\hbar l^3}{4 E f_{\text{dep}}}}$$

$$a \geq \sqrt[3]{\frac{3 \hbar l}{e f_{\text{max}}(g)}} = \sqrt{\frac{3 \hbar l}{e \hbar f_{\text{max}}}}$$

$$a \geq \sqrt[4]{\frac{\hbar l^3}{4 E f_{\text{max}}(dep)}} = \sqrt{\frac{125 \hbar l^2}{E}}$$

11) $D: m, l, Re_{\text{cox}}, E - \checkmark$



1) Re_{cox}

$$\begin{cases} R_{Ay} = \frac{1}{2} \bar{F} = \frac{1}{2} m g \\ R_{By} = \frac{1}{2} \bar{F} = \frac{1}{2} m g \end{cases}$$

2) M_{cox}

$$\begin{cases} M_{\text{cox}} = \frac{1}{4} \bar{F} l = \frac{1}{4} m g l \\ R_{\text{cox}} = \frac{1}{2} \bar{F} = \frac{1}{2} m g \end{cases}$$

3) σ_{cox}

$$\sigma_g = \frac{M_{\text{cox}}}{W_z} \leq \sigma_{\text{cox}}^{(g)}$$

$$M_{\text{cox}} = \frac{1}{4} m g l$$

$$\sigma_{\text{cox}}^{(g)} = \sigma \cdot Re$$

$$W_z = \frac{I_z}{y_{\text{cox}}} = \frac{\frac{\pi D^4}{64}}{\frac{1}{2} D} = \frac{\pi D^3}{32}$$

$$\frac{M_{\text{cox}}}{W_z} \leq \sigma_{\text{cox}}^{(g)}$$

$$W_z \geq \frac{M_{\text{cox}}}{\sigma_{\text{cox}}^{(g)}}$$

$$\frac{\pi D^3}{32} \geq \frac{\frac{1}{4} m g l}{\sigma \cdot Re}$$

$$D \geq \sqrt[3]{\frac{8 m g l}{\pi \sigma \cdot Re}}$$

4) f_{cox}

$$f_{\text{cox}} = \frac{\bar{F} l^3}{48 E I} \leq f_{\text{dep.}}$$

$$\bar{F} = m \cdot g$$

$$l = \checkmark$$

$$E = \checkmark$$

$$I = \frac{\pi D^4}{64}$$

$$f_{\text{dep.}} = \frac{l}{100}$$

$$\frac{\bar{F} l^3}{48 E I} \leq f_{\text{dep.}}$$

$$I \geq \frac{\bar{F} l^3}{48 E f_{\text{dep.}}}$$

$$\frac{\pi D^4}{64} \geq \frac{m g l^3}{48 E f_{\text{dep.}}}$$

$$D \geq \sqrt[4]{\frac{4 m g l^3}{3 \pi E f_{\text{dep.}}}}$$

$$D \geq \sqrt[3]{\frac{8 m g l}{\pi \cdot \sigma_{\text{cox}}^{(g)}}}$$

$$D \geq \sqrt[4]{\frac{4 m g l^3}{3 \pi E f_{\text{dep.}}}}$$

$$D \geq \sqrt[3]{\frac{8 m g l}{\pi \cdot \sigma \cdot Re}}$$

$$D \geq \sqrt[4]{\frac{2000 m g l^2}{3 \pi E}}$$

