

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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WYTRZYMAŁOŚĆ MATERIAŁÓW I

"ZŁOŻONY STAN NAPRĘŻEŃ"

PROJEKT

Oblicz:

- reakcje podporowe
- siłę w cięgnie
- długość spoiny
- naprężenia ścinające, zginające, zastępcze

dla układu ustroju nośnego belkowego.

DANE:

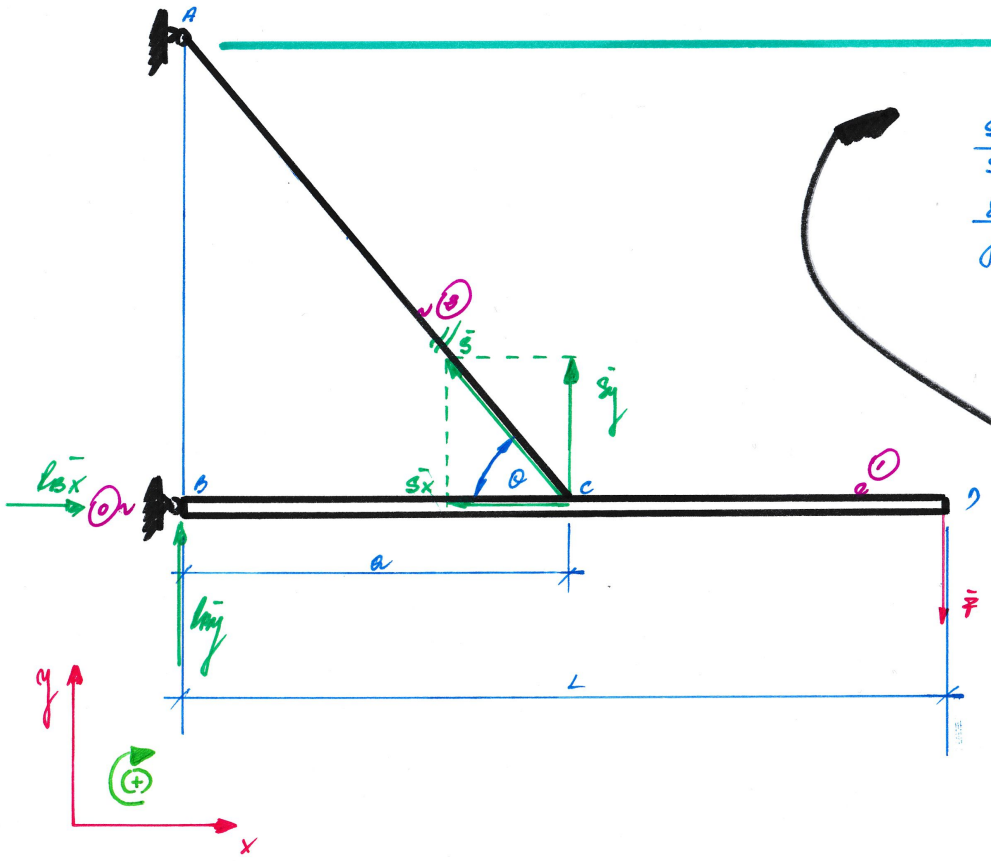
$L, l, H, h, \Theta, F = OK$

SZUKAM:

$R, S, l, \tau_t, \sigma_g, \sigma_z = ?$

8) $\alpha = 60^\circ$ $\quad L = 190$ [cm] $\quad H = 12$ [cm]

$l = 97$ [cm] $\quad h = 15$ [cm] $\quad F = 800$ [kg]



$\frac{S_x}{S} = \cos\alpha \rightarrow S_x = S\cos\alpha$

$\frac{S_y}{S} = \sin\alpha \rightarrow S_y = S\sin\alpha$

I) $R_{Bx} - S\cos\alpha = 0$

II) $R_{By} + S\sin\alpha - F = 0$

III) $-S\,a\sin\alpha + F\cdot L = 0$

II) $S = \dfrac{F\cdot L}{a\sin\alpha}$

$S = \dfrac{8000\cdot 1{,}9}{0{,}97\cdot\sin 60^\circ} = \dfrac{9800}{0{,}8400} =$

$= 11\,309{,}52$ [N]

I) $R_{Bx} = S\cos\alpha$

$R_{Bx} = 11\,309{,}52\cdot\cos 60^\circ = 5654{,}76$ [N]

b) EQUILIBRIO.

I) $\sum F_{ix} = 0$

II) $\sum F_{iy} = 0$

III) $\sum M_{iB} = 0$

$\rightarrow$

I) $R_{Bx} - S_x = 0$

II) $R_{By} + S_y - F = 0$

III) $-S_y\cdot a + F\cdot L = 0$

II) $R_{My} = T - S \sin\alpha$

$R_{My} = 8000 - 11309{,}62 \cdot \sin 60° =$

$= 8000 - 9794{,}53 = -4484{,}33 \ [N]$

$\Rightarrow$

$R_{Ox} = 6854{,}46 \ [N]$

$R_{My} = -4484{,}33$

$S = 11309{,}52$

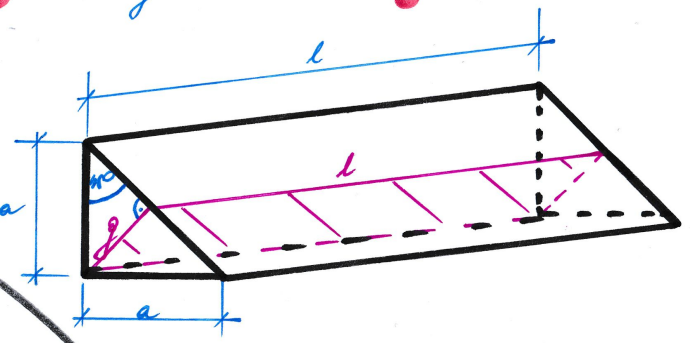
"D"

$T = 6000 \ [N]$

$\tau_t = \frac{T_t}{A_t} \leq \tilde{\imath}_{dop}^{(t)}$

$T_t = T = 6000 \ [N]$

$A_t = 2 \cdot g \cdot l = 2 \cdot 0{,}41a \cdot l$



$\frac{g}{a} = \cos 60° \Rightarrow g = 0{,}41a$

$a = 10 \ [mm] = 0{,}01 \ [m]$

$\tilde{\imath}_{dop}^{(t)} = \gamma \cdot Re \cdot \alpha =$

$= 0{,}21 \cdot 380 \cdot 10^6 \cdot 0{,}8 =$

$= 44{,}1 \cdot 10^6 \ [Pa]$

SPR

$\sum M_c = 0 \Rightarrow R_{My} \cdot a + T \cdot (L - a) \stackrel{?}{=} 0$

$-4484 \cdot 0{,}84 + 6000 \cdot (1{,}8 - 0{,}84) = 0$

$-4680{,}18 + 4680 = 0$

$L = P$ ✓

$$\tau_t = \frac{T_t}{A_t} \leq \tau_{dop}^{(t)}$$

$$\frac{T}{1{,}42\,al} \leq \tau_{dop}^{(t)}$$

$$l \geq \frac{T}{1{,}42 \cdot a \cdot \tau_{dop}^{(t)}} =$$

$$= \frac{6000}{1{,}42 \cdot 0{,}01 \cdot 44{,}1} \cdot 10^{-6} = \frac{5 \cdot 10^{-3}}{0{,}626622} = 7{,}98 \cdot 10^{-3}\ [m] =$$

$$= 7{,}98\ [mm] \quad \Rightarrow \quad l \geq 7{,}98\ [mm]$$

$$\Rightarrow \quad l = 10\ [cm]$$

$$\tau_t = \frac{T}{1{,}42\,al} = \frac{6000}{1{,}42 \cdot 0{,}01 \cdot 0{,}1} =$$

$$= \frac{6000}{1{,}42 \cdot 10^{-3}} = 3{,}52 \cdot 10^6\ [Pa] = 3{,}52\ [MPa]$$

$$44{,}1\ [MPa] = 100\ \%$$

$$3{,}52\ [MPa] = x\ \%$$

$$\Rightarrow \quad x = \frac{3{,}52 \cdot 100}{44{,}1} = 7{,}98\ \%$$

"c"

$$\tau_t = \frac{T_t}{A_t} \leq \sigma_{dop}^{(t)}$$

$T_t = S_y = S \sin\Theta$

$A_t = 1{,}42\, a\, l$

$\sigma_{dop}^{(t)} = 44{,}1 \cdot 10^6$ [Pa]

$$\frac{S \sin\Theta}{1{,}42\, a\, l} \leq \sigma_{dop}^{(t)}$$

$$l \geq \frac{S \sin\Theta}{1{,}42\, a \cdot \sigma_{dop}^{(t)}} =$$

$$= \frac{11\,309{,}52 \cdot \sin 60^\circ}{1{,}42 \cdot 0{,}01 \cdot 44{,}1} \cdot 10^{-6} = \frac{9794{,}33}{0{,}62622} \cdot 10^{-6} =$$

$= 15\,640{,}38 \cdot 10^{-6}$ [m] $= 15{,}64$ [mm]

$\Rightarrow \quad l \geq 15{,}64$ [mm]

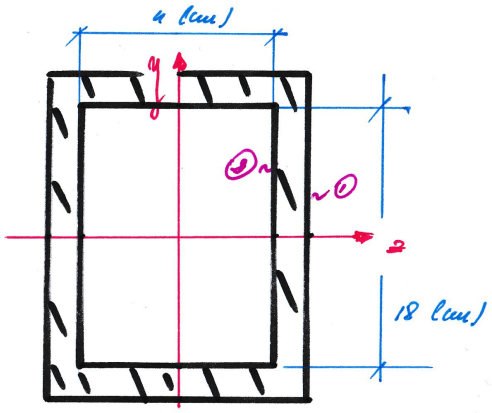
$\Rightarrow \quad l = 18$ [mm]

$$\sigma_g = \frac{M_c}{W_z} \leq \sigma_{dop}^{(g)}$$

$M_c = S_x \cdot h = S \cos\Theta \cdot h = 11\,309{,}62 \cdot \cos 60^\circ \cdot 0{,}15 =$

$= 848{,}21$ [Nm]

$$W_z = \frac{J_z}{y_{max}}$$



$$J_z^{①} = \frac{(4{,}2) \cdot (18{,}2)^3}{12} = 2103{,}88 \text{ [cm}^4\text{]} =$$

$= 2103{,}88 \cdot 10^{-8}$ [m^4]

$$J_z^{②} = \frac{4 \cdot (18)^3}{12} = 1944 \text{ [cm}^4\text{]} =$$

$= 1944 \cdot 10^{-8}$ [m^4]

$$J_z = J_z^{①} - J_z^{②}$$

$\Rightarrow \quad J_z = 2103{,}88 \cdot 10^{-8} - 1944 \cdot 10^{-8} = 166 \cdot 10^{-8}$ [m^4]

$y_{max} = 9,1 \ [cm] = 0,091 \ [m]$

$\sigma_{dop}^{(g)} = \gamma \cdot k_e = 0,35 \cdot 300 \cdot 10^6 = 122,5 \ [MPa]$

$W_z = \frac{I_z}{y_{max}} = \frac{166 \cdot 10^{-8}}{0,091} = 18,24 \cdot 10^{-6} \ [m^3]$

$\sigma_g = \frac{M_c}{W_z} \leq \sigma_{dop}^{(g)}$

$\sigma_g = \frac{M_c}{W_z} = \frac{848,21}{18,24} \cdot 10^6 = 46,5 \ [MPa]$

$\sigma_z = \sqrt{\sigma_g^2 + 3\tilde{\tau}_t^2}$

$\sigma_z = \sqrt{(46,5)^2 + 3 \cdot (3,83)^2} = 46,87 \ [MPa]$

$\tilde{\tau}_t = \frac{3 m_s c \Theta}{1,42 \, a l} = \frac{8494,33}{1,42 \cdot 0,01 \cdot 0,18} \cdot [redacted] =$

$= \frac{8494,33}{2,556 \cdot [redacted] \cdot 10^{-3}} \cdot [redacted] = 3831,88 \cdot 10^{+3} = 3,83 \cdot 10^6 \ [Pa] = 3,83 \ [MPa]$


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