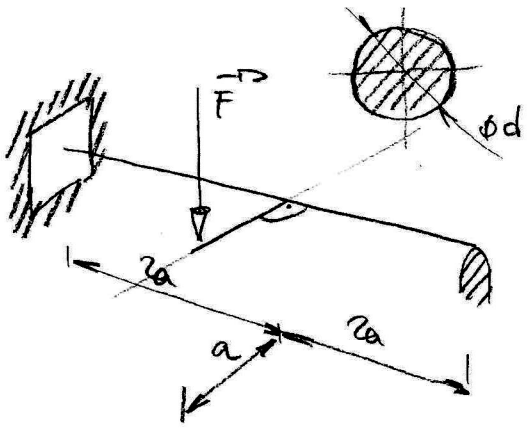
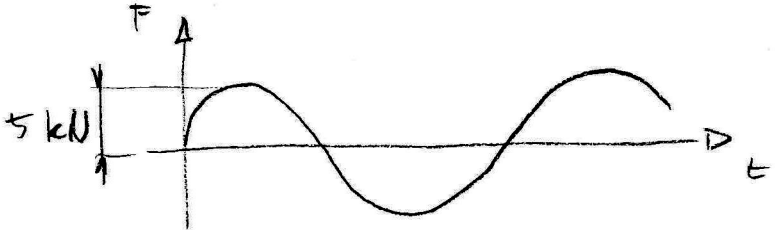


Př: U pultu stanovte bezpečnost vzhledem k MS neomezené životnosti u součásti podle obrázku.



materiál ocel, broušený povrch, válečkování

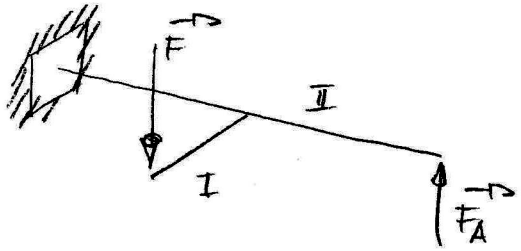
$\sigma_{pt} = 500\ MPa$ $\quad h_1 = 10\ mm$

$\sigma_c = 175\ MPa$ $\quad d = 65\ mm$

$\sigma_{cov} = 150\ MPa$ $\quad a = 500\ mm$

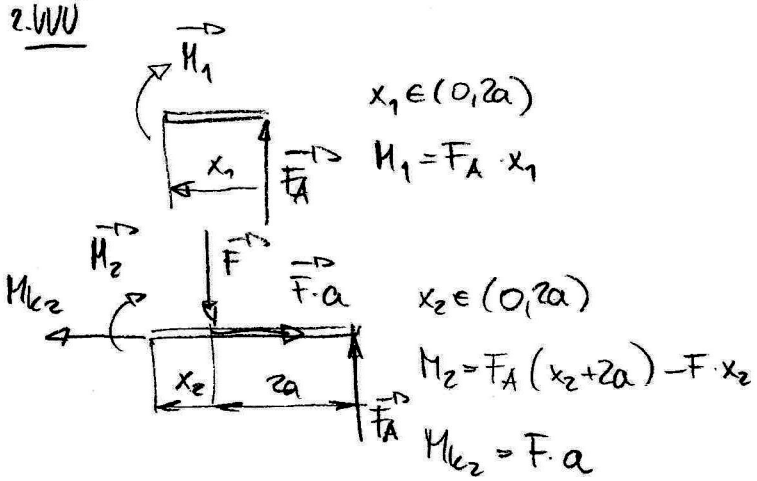
$\tau_c = 125\ MPa$

1. částečné uvolnění



$W_A = 0$

2. VVÚ



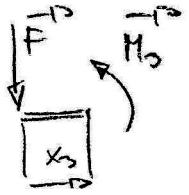
$x_1 \in (0, 2a)$

$M_1 = F_A \cdot x_1$

$x_2 \in (0, 2a)$

$M_2 = F_A(x_2 + 2a) - F \cdot x_2$

$M_{k2} = F \cdot a$



$x_3 \in (0, a)$

$M_3 = -F \cdot x_3$

3. Odstranění stat. neurčitosti

$$W_A = \frac{\partial W}{\partial F_A}$$

$$0 = \int_0^{2a} \frac{M_1}{EJ} \frac{\partial M_1}{\partial F_A} dx_1 + \int_0^{2a} \frac{M_2}{EJ} \frac{\partial M_2}{\partial F_A} dx_2 + \int_0^{a} \frac{M_3}{EJ} \frac{\partial M_3}{\partial F_A} dx_3$$

$$0 = \int_0^{2a} F_A \cdot x_1 \cdot x_1 dx_1 + \int_0^{2a} \left[F_A(x_2 + 2a) - F \cdot x_2 \right] \cdot (x_2 + 2a) dx_2 + \int_0^{a} (-F \cdot x_3) \cdot 0 \, dx_3$$

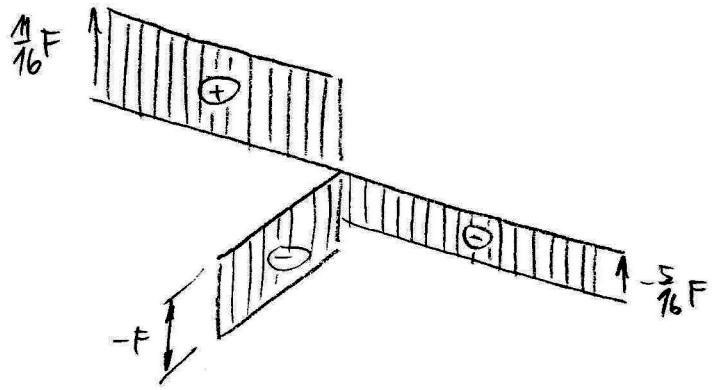
$$0 = F_A \cdot \frac{(2a)^3}{3} + F_A \left[\frac{(2a)^3}{3} + 4a \frac{(2a)^2}{2} + 4a^2 \cdot 2a \right] -$$

$$-F\cdot\left[\frac{(2a)^3}{3}+2a\frac{(2a)^2}{2}\right]$$

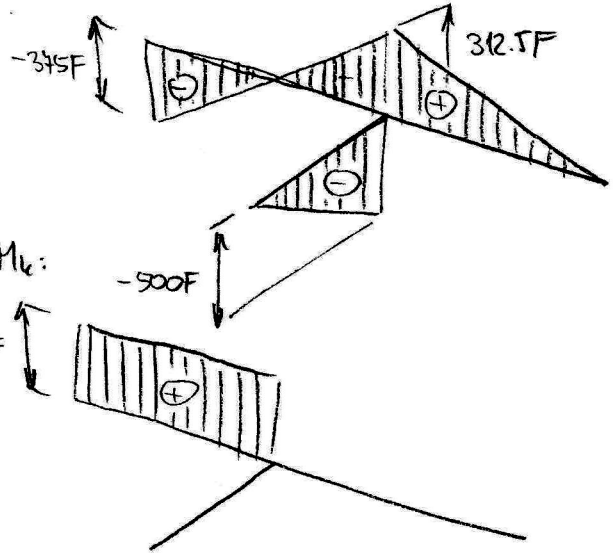
$$0=F_A\left(\frac{8}{3}+\frac{8}{3}+8+8\right)-F\left(\frac{8}{2}+4\right)$$

$$F_A=F\cdot\frac{20}{3}\,\frac{3}{16+48}=F\cdot\frac{20}{64}=F\frac{5}{16}$$

T:



M_o:



4. Řešení

I: $$\sigma_{I\,max}=\frac{M_{I\,max}}{W_o}=\frac{500\cdot5000}{\frac{\pi\cdot65^3}{32}}=93\ MPa$$

$$\sigma_c^*=\frac{\vartheta_\sigma\eta_\sigma}{\beta_\sigma}\sigma_c=\frac{0.82\cdot1.08}{1}\cdot145=155\ MPa$$

součinitel velikosti

$$\vartheta_\sigma=\vartheta_1\vartheta_2=0.87\cdot0.94=0.82$$

$$\vartheta_1=1-\sqrt{k\cdot\log\frac{h}{h_1}}=1-\sqrt{2\cdot10^{-2}\cdot\log\frac{65}{10}}=0.87$$

$$\vartheta_2=1+\left(\frac{\sigma_{cov}}{\sigma_c}-1\right)\sqrt{\frac{h_1}{h}}=1+\left(\frac{150}{145}-1\right)\cdot\sqrt{\frac{10}{65}}=0.94$$

součinitel vrubu

$$\beta_\sigma=1$$

součinitel povrchu

$$\eta_\sigma=\eta_1\eta_2=0.9\cdot1.2=1.08$$

$$\eta_1=0.9$$

$$\eta_2=1.2$$

$$k_I=\frac{\sigma_c^*}{\sigma_{I\,max}}=\frac{155}{93}=1.67$$

II:

$$\sigma_{II\,max} = \frac{M_{II\,max}}{W_o} = \frac{395 \cdot F}{\frac{\pi \cdot d^3}{32}} = \frac{32 \cdot 395 \cdot 5000}{\pi \cdot 65^3} = 40\,MPa$$

$$\tau^k_{II\,max} = \frac{M_{kII\,max}}{W_k} = \frac{500F}{\frac{\pi \cdot d^3}{16}} = \frac{16 \cdot 500 \cdot 5000}{\pi \cdot 65^3} = 46\,MPa$$

$$\tau^*_c = \frac{\vartheta_x \eta_\tau}{\beta_\tau} \sigma_c = \frac{0.77 \cdot 1.08}{1} \cdot 175 = 146\,MPa$$

součinitel velikosti

$$\vartheta_\tau = \vartheta_1 \vartheta_{2\tau} = 0.84 \cdot 0.89 = 0.77$$

$$\vartheta_{2\tau} = 1 + \left(\frac{\tau_c}{\sigma_c} - 1\right)\sqrt{\frac{h_1}{h}} = 1 + \left(\frac{125}{175} - 1\right) \cdot \sqrt{\frac{10}{65}} = 0.89$$

součinitel vrubu

$$\beta_\tau = 1$$

součinitel povrchu

$$\eta_\tau = \eta_1 \eta_2 = 0.9 \cdot 1.2 = 1.08$$

$$\left.\begin{aligned} k_{II\sigma} &= \frac{\sigma_c^*}{\sigma_{II\,max}} = \frac{155}{40} = 2.21 \\ k_{II\tau} &= \frac{\tau_c^*}{\tau^k_{II\,max}} = \frac{146}{46} = 3.14 \end{aligned}\right\} \Rightarrow k_{II} = \frac{k_{II\sigma} \cdot k_{II\tau}}{\sqrt{k_{II\sigma}^2 + k_{II\tau}^2}} = \frac{2.21 \cdot 3.14}{\sqrt{2.21^2 + 3.14^2}} = 1.81$$

$$k = \min\{k_I, k_{II}\} = \underline{\underline{1.67}}$$