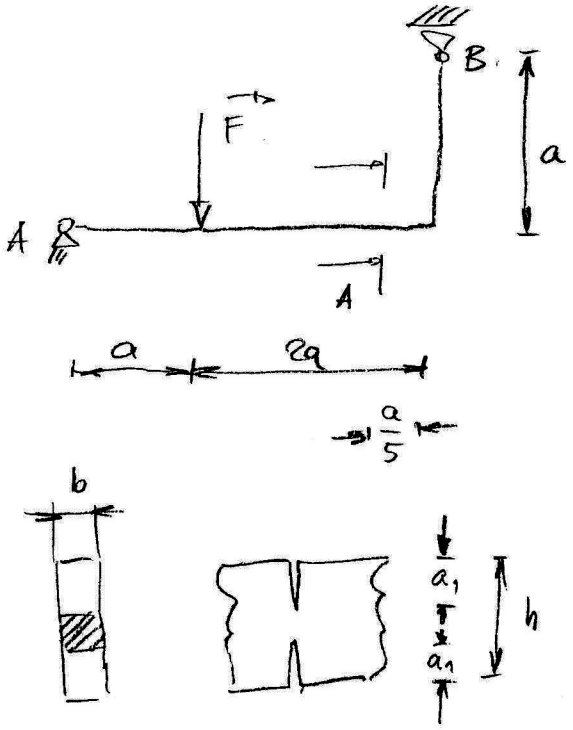
Př: Stanovte zbytkovou životnost pantu a posuďte další chování tohoto pantu v průřezu A.



$K_{Ic} = 40\ MPa\,m^{\frac{1}{2}}$

$\sigma_k = 350\ MPa$

$\sigma_{pt} = 500\ MPa$

$K_{th} = 4{,}3\ MPa \cdot m^{\frac{1}{2}}$

$B = 3$

$A = 5 \cdot 10^{-12}$

$F_a = 15\ kN$

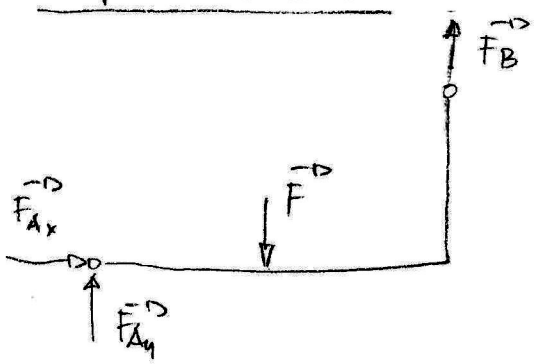
$h = 50\ mm$

$a_1 = 6\ mm$

$a = 200\ mm$

$b = 10\ mm$

1. Úplné uvolnění



2. Statický rozbor

$NP = \{F_{Ax}, F_{Ay}, F_B\}$

$\left.\begin{matrix} \mu = 3 \\ v = 3 \end{matrix}\right\} \Rightarrow$ úloha je stat. uvolitá

3. VVÚ

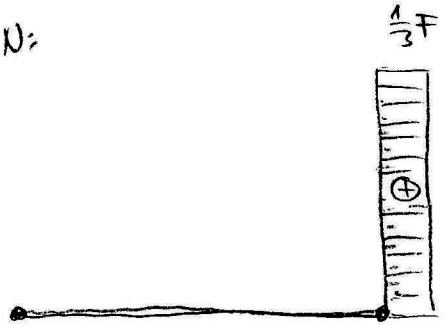
(i) Stanovení reakcí ve vazbách

$$\Sigma M_A: F_B \cdot 3a - F a = 0 \Rightarrow F_B = \frac{F}{3}$$

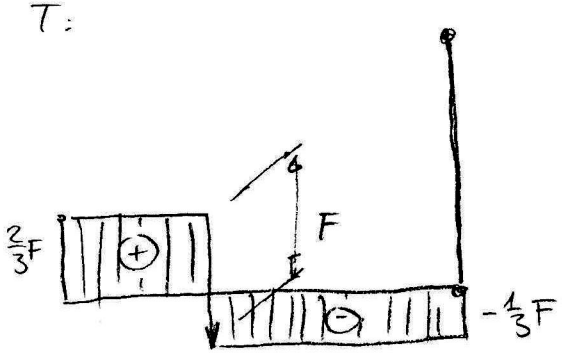
$$\left.\begin{matrix} \Sigma M_B: F_{Ax} \cdot a - F_{Ay} \cdot 3a + F \cdot 2a = 0 \\ \Sigma F_x: F_{Ax} = 0 \end{matrix}\right\} \Rightarrow F_{Ay} = \frac{2F}{3},\ F_{Ax} = 0$$

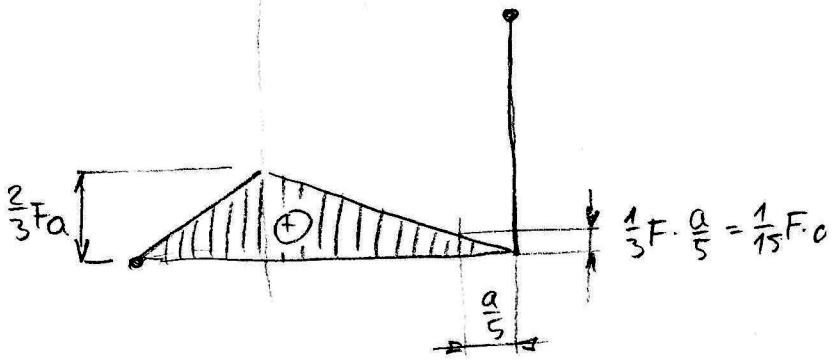
(2i)

N:



T:





4. Řešení

Vztah z T11 str 190 skupina PPII:

$$k_I = \sigma\sqrt{\pi\cdot a}\cdot f_1\left(\frac{a}{b}\right) = \sigma\sqrt{\pi\cdot a_1}\cdot \underbrace{\frac{\frac{4}{3\pi}\left\{1+\frac{1}{2}\left(\frac{2a_1}{h}\right)+\frac{3}{8}\left(\frac{2a_1}{h}\right)^2+\frac{5}{16}\left(\frac{2a_1}{h}\right)^3\right\}-0.47\left(\frac{2a_1}{h}\right)^4+0.663\left(\frac{2a_1}{h}\right)^5}{\sqrt{\left(1-\frac{2a_1}{h}\right)^3}}}_{f_1\left(\frac{2a_1}{h}\right)}$$

$$f_1 = \frac{\frac{4}{3\pi}\left\{1+\frac{1}{2}\left(\frac{2.6}{50}\right)+\frac{3}{8}\left(\frac{2.6}{50}\right)^2+\frac{5}{16}\left(\frac{2.6}{50}\right)^3\right\}-0.47\left(\frac{2.6}{50}\right)^4+0.663\left(\frac{2.6}{50}\right)^5}{\sqrt{\left(1-\frac{2.6}{50}\right)^3}} = 0.48$$

$$\sigma = \frac{3M}{2t\cdot b^2} \equiv \frac{3\cdot\frac{1}{15}\cdot F\cdot a}{2\cdot b\cdot\left(\frac{h}{2}\right)^2} = \frac{3\cdot 15000\,200}{30\cdot 10\cdot(25)^2} = 48\ \text{MPa}$$

$$K_I = 48\cdot\sqrt{\pi\cdot 6}\cdot 0.48 = 162.5\ \text{MPa}\cdot\text{mm}^{\frac{1}{2}}$$

$$r_k = \frac{1}{\pi}\left(\frac{K_I}{\sigma_k}\right)^2 = \frac{1}{\pi}\left(\frac{162.5}{350}\right)^2 = 6.86\cdot 10^{-2}\ \text{mm}$$

$\left.\begin{array}{l} K_I < K_{Ic} \\ r_k \ll a_1 \end{array}\right\}$ => trhlina se šíří stabilně za podmínek LELM.

$\Delta K < K_I > K_{th}$ => únavová trhlina se šíří nenulovou rychlostí

$$a_1^{①} = \frac{1}{\pi}\left(\frac{K_{1c}}{\sigma \cdot f_1}\right)^2 = \frac{1}{\pi}\left(\frac{40\cdot\sqrt{1000}}{48\cdot 0.48}\right)^2 = 1.1\cdot 10^3 \text{ mm}$$

$$\sigma_{pt} = \frac{M}{\frac{b(h-2a_1^{②})^2}{6}} \Rightarrow a_1^{②} = \frac{h}{2} - \frac{1}{2}\sqrt{\frac{6M}{b\cdot\sigma_{pt}}} = \frac{50}{2} - \frac{1}{2}\sqrt{\frac{6\cdot 15000\cdot 1000}{15\cdot 10\cdot 300}} =$$

$$= 17.3 \text{ mm}$$

$$a_c = \min\{a_1^{①}, a_1^{②}\} = 17.3 \text{ mm}$$

$$n = \int_{a_1}^{a_c} \frac{da}{A\cdot(\Delta K)^\beta} \quad \frac{a_c - a_1}{A\cdot(\Delta K)^\beta} = \frac{17.3-6}{5\cdot 10^{-12}(162.5)^3}\cdot\sqrt{1000} = 1.7\cdot 10^4 \text{ cyklů}$$

Odhad zbytkové životnosti součásti je $1.7\cdot 10^4$ cyklů.