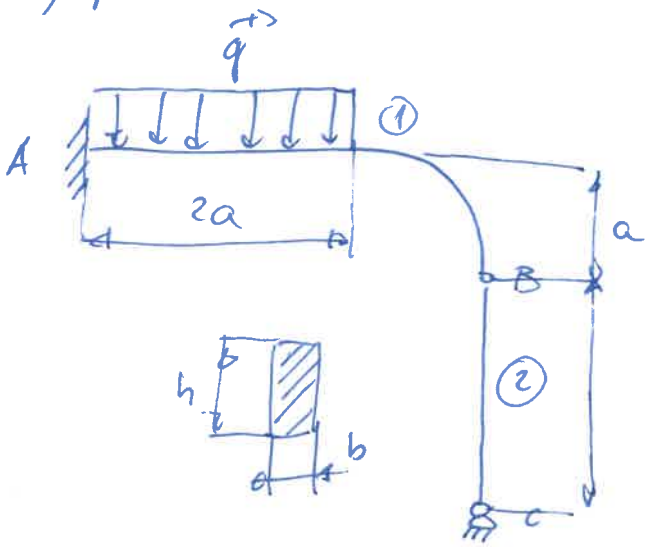
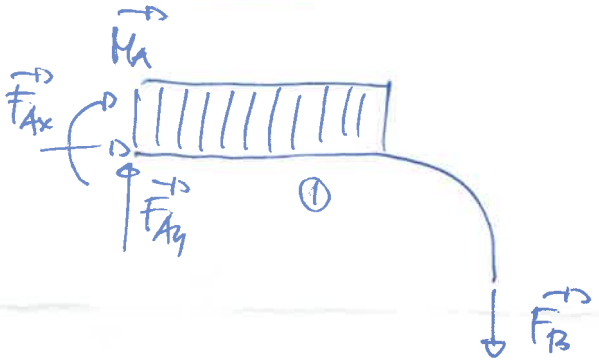
Př: U soustavy pruhů určete bezpečnost vzhledem k MS pružnosti




## 1. Úplné uvolnění



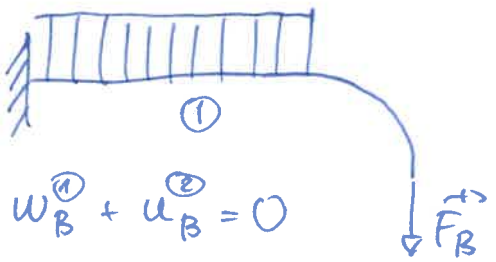


## 2. statický rozbor

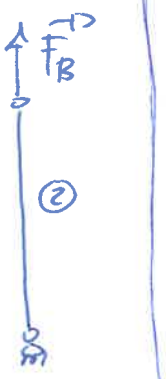
$NP = \{F_{Ax}, F_{Ay}, F_B, M_A, F_C\}$

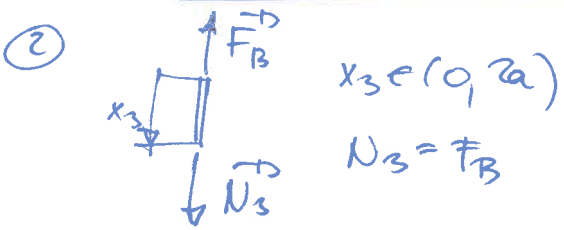
$\left.\begin{matrix} \mu = 5 \\ v = 3+1 \end{matrix}\right\} s = \mu - v = 1$

## 3. Částečné uvolnění




$w_B^{(1)} + u_B^{(2)} = 0$



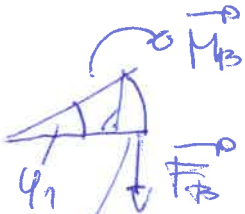




$x_3 \in (0, 2a)$

$N_3 = F_B$

## 4. VVÚ

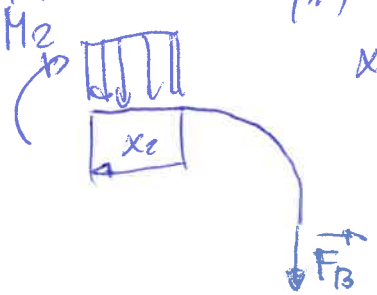
①




$\varphi_1 \in (0, \frac{\pi}{2})$

$M_1 = F_B \cdot a(1 - \cos\varphi_1)$

$a(1-\cos\varphi_1)$




$x_2 \in (0, 2a)$

$M_2 = -F_B(a + x_2) - \frac{q x_2^2}{2}$

## 5. Odstranění stat. neurčitosti

$$w_B^{(1)} + u_B^{(2)} = 0$$

$$\underbrace{\frac{1}{EJ}\int_0^{\frac{\pi}{2}} M_1 \frac{\partial M_1}{\partial F_B} a\,d\varphi_1 + \frac{1}{EJ}\int_0^{2a} M_2 \frac{\partial M_2}{\partial F_B} dx_2}_{w_B^{(1)}} + \underbrace{\frac{N_3 \cdot 2a}{ES}\frac{\partial N_3}{\partial F_B}}_{u_B^{(2)}} = 0$$

$$\frac{1}{J}\int_0^{\frac{\pi}{2}} -F_B a(1-\cos\varphi_1)(-a)(1-\cos\varphi_1)\,a\,d\varphi_1 + \frac{1}{J}\int_0^{2a}\left[-F_B(a+x_2) - \frac{qx_2^2}{2}\right]\cdot(-1)(a+x_2)\,dx_2 + \frac{F_B 2a}{S} = 0$$

$$\frac{1}{J}F_B a^3 \int_0^{\frac{\pi}{2}} (1 - 2\cos\varphi_1 + \cos^2\varphi_1)\,d\varphi_1 + \frac{1}{J}\int_0^{2a}\left[F_B(a^2+2ax_2+x_2^2) + \frac{qa}{2}x_2^2 + \frac{qx_2^3}{2}\right]dx_2 + \frac{F_B 2a}{S} = 0$$

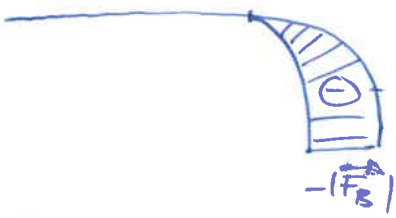
$$\frac{1}{J}F_B a^3\left[\varphi_1 - 2\sin\varphi_1 + \frac{1}{2}\varphi_1 + \frac{1}{4}\sin 2\varphi_1\right]_0^{\frac{\pi}{2}} + \frac{1}{J}F_B\left[a^2x_2 + 2a\frac{x_2^2}{2} + \frac{x_2^3}{3}\right]_0^{2a} + \frac{1}{J}\frac{q}{2}\left[a\frac{x_2^3}{3} + \frac{x_2^4}{4}\right]_0^{2a} + \frac{F_B 2a}{S} = 0$$

$$SF_B\left(\frac{\pi}{2}a^2 - 2a^2 + \frac{\pi}{4}a^2 + 8a^2 + 4a^2 + \frac{8}{3}a^2\right) + JF_B 2a = -S\frac{q}{2}\left(\frac{8}{3}a^3 + 4a^3\right)$$

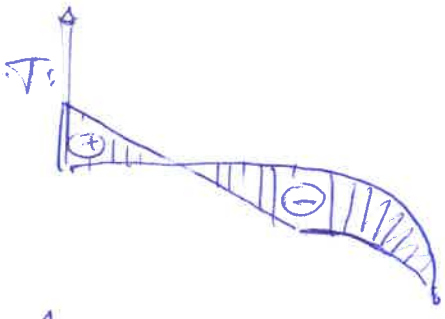
$F_B = \ldots < 0$ Dopočítejte !!

## 6. Řešení

① N:




T:



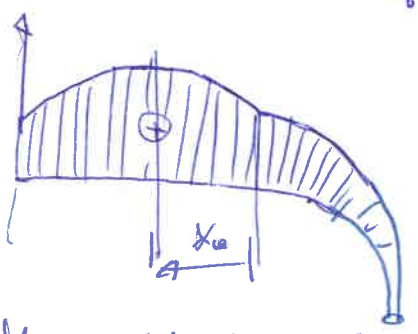
$$-M_2'(x_2)\Big|_{x_2=x_0} = T_2(x_2)\Big|_{x_2=x_0} = 0$$

$$+F_B + qx_0 = 0$$

$$x_0 = -\frac{F_B}{q} = \frac{|F_B|}{q} = \ldots$$

Dopočítejte !!!

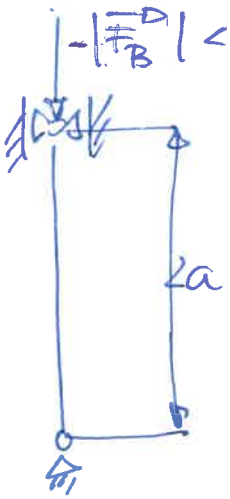
M:




Dopočítejte !!!

$\rightarrow M_{max} = M_2(x_2 = x_0) \Rightarrow k$

(2)




$$i = \sqrt{\frac{J}{S}} = \sqrt{\frac{\frac{1}{12}b^3 h}{b \cdot h}} = \frac{1}{2\sqrt{3}} b = \frac{\sqrt{3}}{6} b$$

$$\lambda = \frac{l}{i} = \frac{2a}{\frac{\sqrt{3}}{6} b} = \sqrt{3}\,\frac{a}{b}$$

$$\lambda_k = \sqrt{\frac{\alpha^2 \sigma_k}{E}} = \sqrt{\frac{\pi^2 \sigma_k}{E}}$$

$$\lambda < \lambda_k \Rightarrow \quad k = \frac{\frac{\sigma_k}{|F_B|}}{b \cdot h} = \frac{\sigma_k b \cdot h}{|F_B|}$$

$$\lambda > \lambda_k \Rightarrow \quad F_{kr} = \frac{\alpha^2 E J}{L^2} = \frac{\pi^2 E \frac{1}{12} b^3 h}{4a^2}$$

$$k = \frac{F_{kr}}{|F_B|}$$