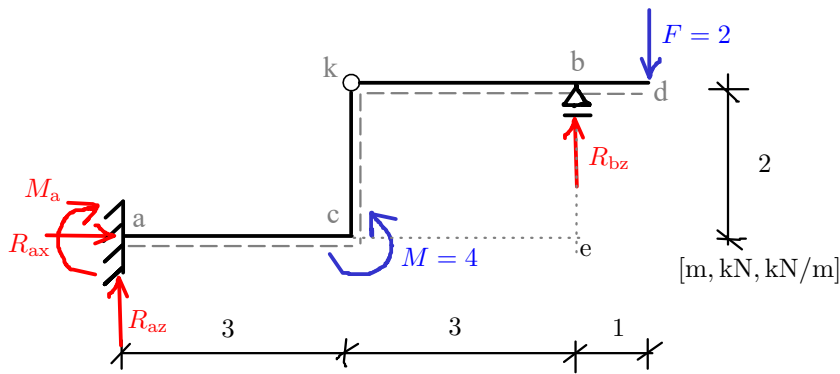


OPAKOVÁNÍ

Př.: Vykreslete průběhy vnitřních sil.



$$\sum M_{ik}^P = 0 : \quad -F \cdot 4 + R_{bz} \cdot 3 = 0$$

$$R_{bz} = \frac{F \cdot 4}{3}$$

$$R_{bz} = \frac{2 \cdot 4}{3} = \frac{8}{3} \text{ kN}$$

$$\sum F_{ix} = 0 : \quad R_{ax} = 0$$

$$\sum M_{ia} = 0 : \quad -F \cdot 7 + R_{bz} \cdot 6 + M - M_a = 0$$

$$M_a = -F \cdot 7 + R_{bz} \cdot 6 + M$$

$$M_a = -2 \cdot 7 + \frac{8}{3} \cdot 6 + 4 = 6 \text{ kNm}$$

$$\sum M_{ie} = 0 : \quad -F \cdot 1 + M - R_{az} \cdot 6 - M_a = 0$$

$$R_{az} = \frac{-F \cdot 1 + M - M_a}{6}$$

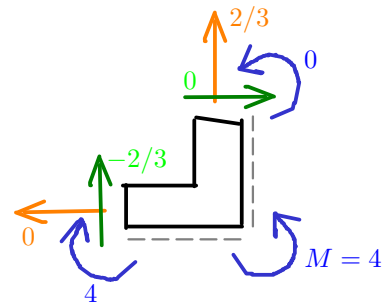
$$R_{az} = \frac{-2 \cdot 1 + 4 - 6}{6} = -\frac{2}{3} \text{ kN}$$

KONTROLA:

$$\sum F_{iz} = 0 : \quad R_{az} + R_{bz} - F = 0$$

$$-\frac{2}{3} + \frac{8}{3} - 2 = 0$$

Kontrola rovnováhy např. ve styčnicku "c":



$$\sum F_{ix} = 0 :$$

$$-0 + 0 = 0$$

$$\sum F_{iz} = 0 :$$

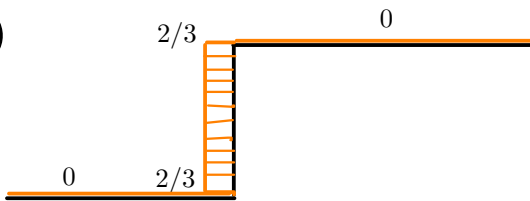
$$-2/3 + 2/3 = 0$$

$$\sum M_i = 0 :$$

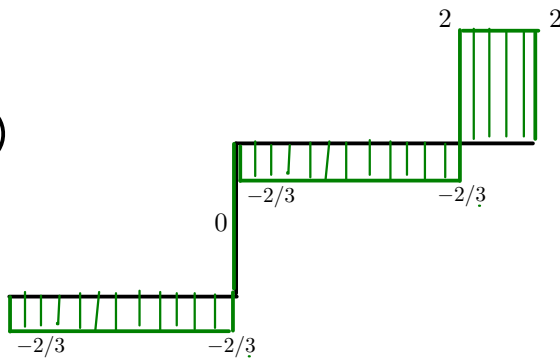
$$-4 + M + 0 = 0$$

$$-4 + 4 + 0 = 0$$

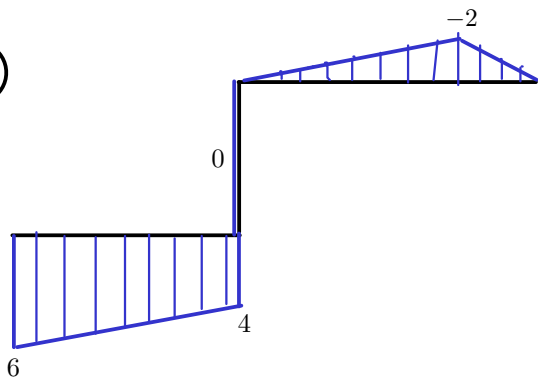
(N)



(V)

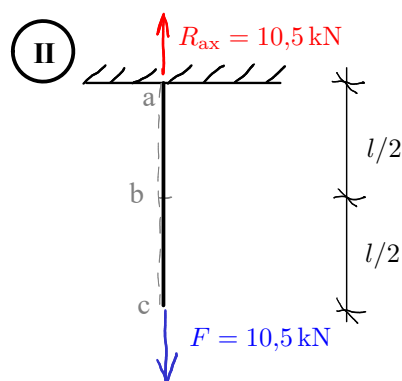
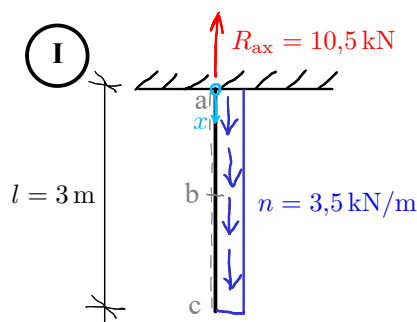


(M)

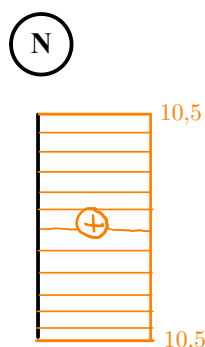
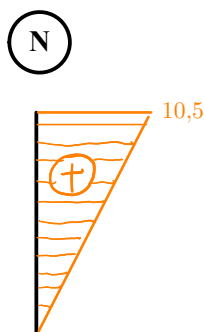
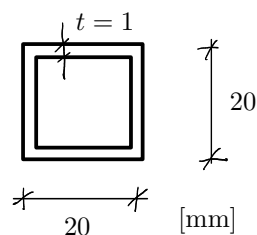


PROSTÝ TAH/TLAK

Př.: Určete maximální napětí v prutu, posuďte, zda vyhovuje, a určete posuny bodů "b" a "c" pro oba zatěžovací případy.



Hliník:
 $E = 70 \text{ GPa}$
 $f_d = 150 \text{ MPa}$



$$A = (20 \cdot 20) - (18 \cdot 18) = 76 \text{ mm}^2 = 76 \cdot 10^{-6} \text{ m}^2$$

$$\max \sigma_I = \max \sigma_{II} = \frac{N_{\max}}{A_{\min}}$$

$$\max \sigma_I = \max \sigma_{II} = \frac{10,5 \cdot 10^3}{76} = 138,158 \text{ MPa}$$

POSUDEK:

$$\sigma_{\max} \leq f_d$$

$$138,2 \text{ MPa} \leq 150 \text{ MPa} \quad \checkmark \text{ VYHOVUJE}$$

POSUNY BODŮ: $u(x) = \int \frac{N(x)}{EA} dx$

I

$$N(x) = R_{ax} - n \cdot x = 10,5 - 3x$$

$$u(x) = \frac{1}{EA} \int N(x) dx = \frac{1}{EA} \int [10,5 - 3x] dx$$

$$u(x) = \frac{1}{EA} [10,5x - 3 \frac{x^2}{2} + C] \rightarrow \text{konstantu } C \text{ určíme z okrajových podmínek: } u_a = u(x=0) = 0$$

$$u_a = \frac{1}{EA} [10,5 \cdot 0 - 3 \frac{0^2}{2} + C] = 0$$

$$10,5 \cdot 0 - 3 \frac{0^2}{2} + C = 0$$

$$C = 0$$

$$u(x) = \frac{1}{EA} [10,5x - 3 \frac{x^2}{2}]$$

$$u_b = u(x = 1,5 \text{ m}) = \frac{1}{70 \cdot 10^3 \cdot 76 \cdot 10^{-6}} \cdot [10,5 \cdot 10^{-3} \cdot 1,5 - 3,5 \cdot 10^{-3} \cdot \frac{1,5^2}{2}] = 2,22 \cdot 10^{-3} \text{ m} \quad [\text{dosazeno v MN a m}]$$

$$u_c = u(x = 3 \text{ m}) = \frac{1}{70 \cdot 10^6 \cdot 76 \cdot 10^{-6}} \cdot [10,5 \cdot 3 - 3,5 \cdot \frac{3^2}{2}] = 2,96 \cdot 10^{-3} \text{ m} \quad [\text{dosazeno v kN a m}]$$

II

$$N(x) = 10,5$$

$$u(x) = \frac{1}{EA} \int N(x) dx = \frac{1}{EA} \int [10,5] dx \rightarrow \Delta l = \frac{Nl}{EA} \quad \text{pro konstantní } N, E, A$$

$$u(x) = \frac{1}{EA} [10,5x + C] \rightarrow \text{konstantu } C \text{ určíme z okrajových podmínek: } u_a = u(x=0) = 0$$

$$u_a = \frac{1}{EA} [10,5 \cdot 0 + C] = 0$$

$$10,5 \cdot 0 + C = 0$$

$$C = 0$$

$$u(x) = \frac{1}{EA} [10,5x]$$

$$u_b = u(x = 1,5 \text{ m}) = \frac{1}{70 \cdot 10^3 \cdot 76 \cdot 10^{-6}} \cdot [10,5 \cdot 10^{-3} \cdot 1,5] = 2,96 \cdot 10^{-3} \text{ m} \quad [\text{dosazeno v MN a m}]$$

$$u_c = u(x = 3 \text{ m}) = \frac{1}{70 \cdot 10^6 \cdot 76 \cdot 10^{-6}} \cdot [10,5 \cdot 3] = 5,92 \cdot 10^{-3} \text{ m} \quad [\text{dosazeno v kN a m}]$$