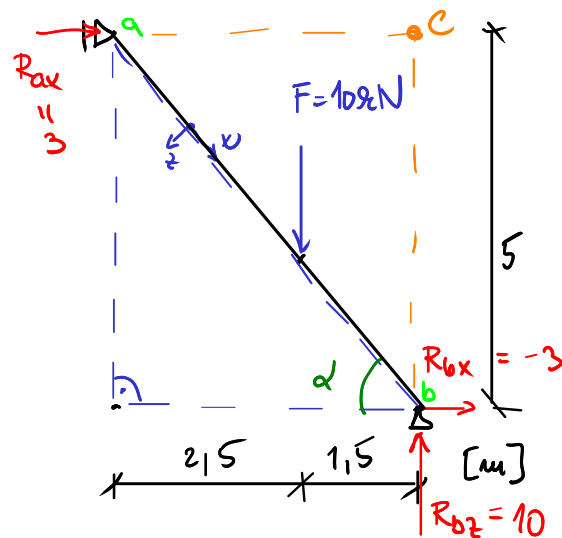


ŠIKMÝ NOSNÍK



1) Reakce:

$$\sum F_{zi} = 0 \quad \oplus \uparrow$$

$$R_{bz} - F = 0 \Rightarrow R_{bz} = F = \underline{\underline{10 \text{ kN}}}$$

$$\sum M_{bi} = 0 \quad \oplus \downarrow$$

$$R_{ax} \cdot 5 - F \cdot 1.5 = 0 \Rightarrow R_{ax} = \frac{1.5F}{5} = \underline{\underline{3 \text{ kN}}}$$

$$\sum M_{ci} = 0 \quad \oplus \uparrow$$

$$R_{bx} \cdot 5 + F \cdot 1.5 = 0 \Rightarrow R_{bx} = -\frac{1.5F}{5} = \underline{\underline{-3 \text{ kN}}}$$

$$\text{kontrola: } \sum F_{xi} = 0 \quad \oplus \rightarrow$$

$$R_{ax} + R_{bx} = 0 \quad 3 + (-3) = 0 \quad \checkmark$$

2) rozklad síl do složek rovnoběžných a kolmých k ose prutu

$$\text{délka } l = \sqrt{4^2 + 5^2} = \sqrt{41} \text{ m}$$

$$\sin d = \frac{5}{\sqrt{41}} = 0,780869$$

$$\cos d = \frac{4}{\sqrt{41}} = 0,624695$$

$$\frac{F^\perp}{F} = \cos d \Rightarrow F^\perp = F \cos d = 6,247 \text{ kN}$$

$$F'' = F \sin d = 7,809 \text{ kN}$$

$$\frac{R_{bz}^\perp}{R_{bz}} = \cos d \Rightarrow R_{bz}^\perp = R_{bz} \cos d = (F^\perp) = 6,247 \text{ kN}$$

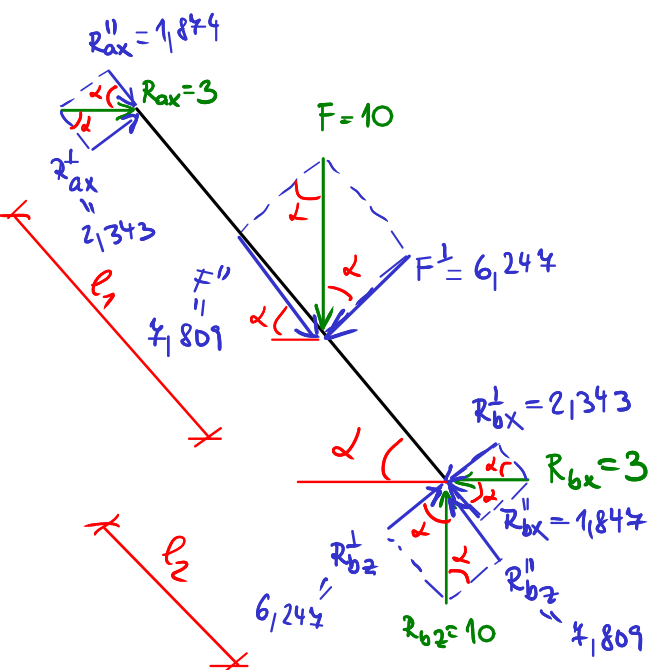
$$R_{bz}'' = R_{bz} \sin d = 7,809 \text{ kN} \quad (= F'')$$

$$\frac{R_{bx}''}{R_{bx}} = \cos d \Rightarrow R_{bx}'' = R_{bx} \cos d = 1,847 \text{ kN}$$

$$R_{bx}^\perp = R_{bx} \sin d = 2,343 \text{ kN}$$

$$\frac{R_{ax}''}{R_{ax}} = \cos d \Rightarrow R_{ax}'' = R_{ax} \cos d = 1,847 \text{ kN} \quad (R_{bx}'')$$

$$R_{ax}^\perp = R_{ax} \sin d = 2,343 \text{ kN} \quad (R_{bx}^\perp)$$



Rozn: opět musí platit rovnováha

$$\sum F_i'' = 0 \quad \oplus \downarrow$$

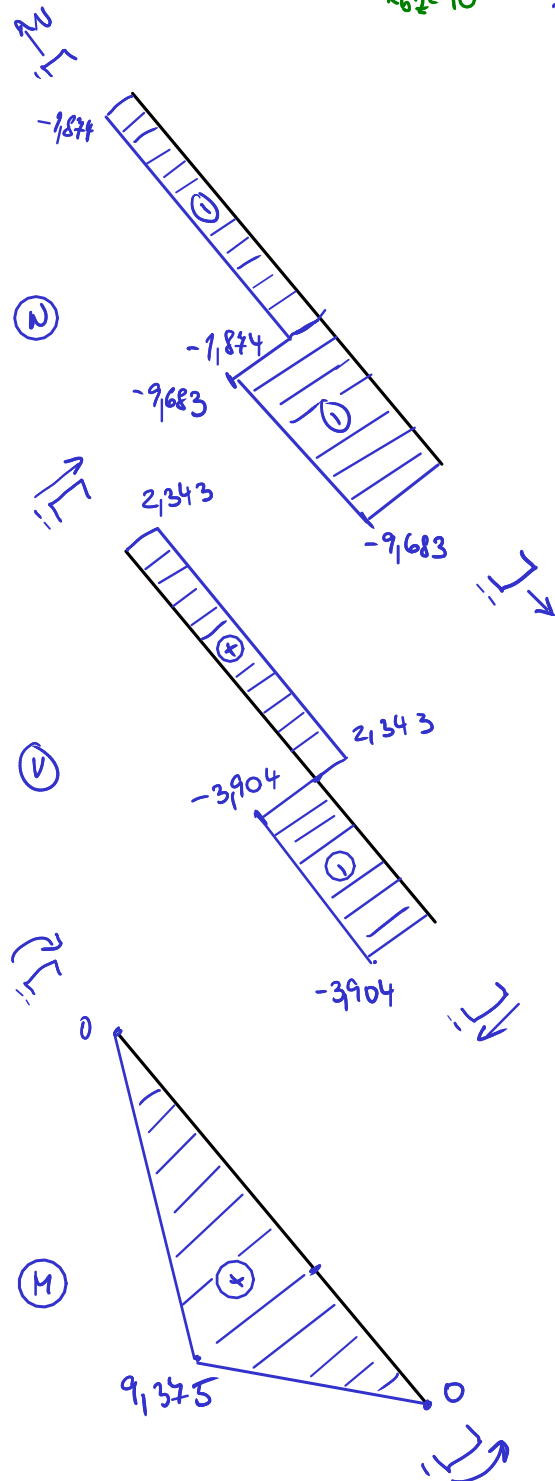
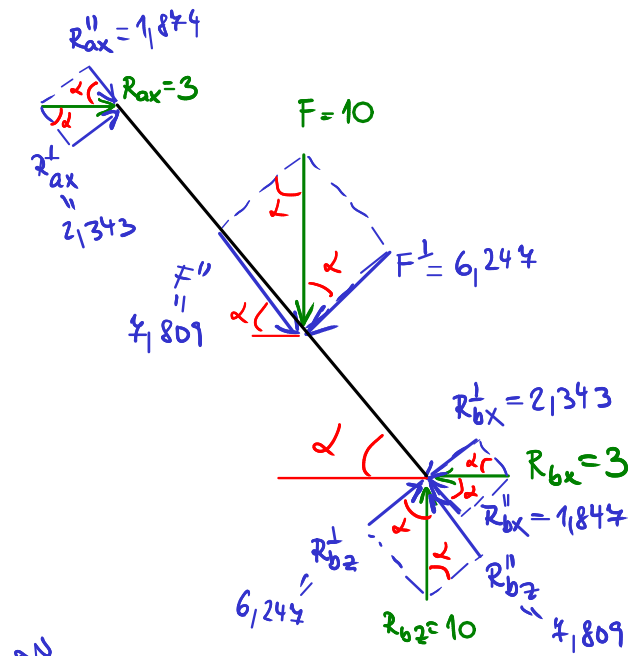
$$R_{ax}'' + F'' - R_{bz}'' - R_{bx}'' = 0 \quad 0 = 0 \quad \checkmark$$

$$\sum F_i^\perp = 0 \quad \checkmark$$

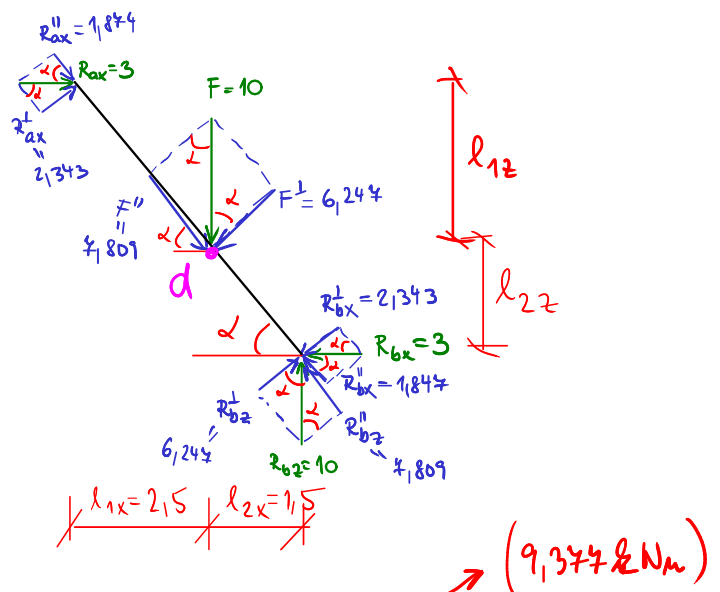
$$\sum M_{ai} = 0 \quad \oplus \downarrow$$

$$\left. \begin{aligned} F \cdot 2.5 + R_{bx} \cdot 5 - R_{bz} \cdot 4 = 0 \\ \text{nebo } F^\perp \cdot l_1 + R_{bx}^\perp \cdot l - R_{bz}^\perp \cdot l = 0 \end{aligned} \right\} l_1 = \frac{l}{4} \cdot 2.5$$

3, vykreslení vnitřních sil N, V, M



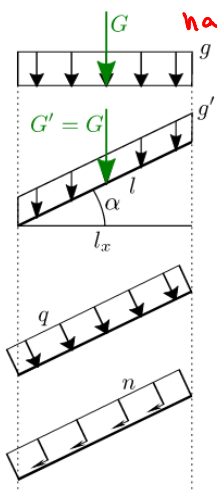
$$\frac{l_{2z}}{l_{2x}} = \frac{5}{4} \Rightarrow l_{2z} = 1,875 \text{ m} \quad l_{1z} = 3,125 \text{ m}$$



$$M_d^L = R_{ax}^L \cdot l_1 = R_{ax} \cdot l_{1z} = 9,375 \text{ kNm}$$

$$M_d^P = R_{bz}^L \cdot l_2 - R_{bx}^L \cdot l_{2z} = R_{bz} \cdot 1,5 - R_{bx} \cdot l_{2z} = 9,375 \text{ kNm}$$

na průběh



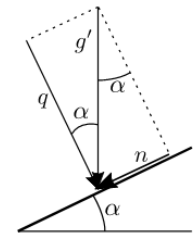
$$G' = G$$

$$g' l = g l_x$$

$$\frac{l_x}{l} = \cos \alpha$$

$$g' l = g l \cos \alpha$$

$$g' = g \cos \alpha$$

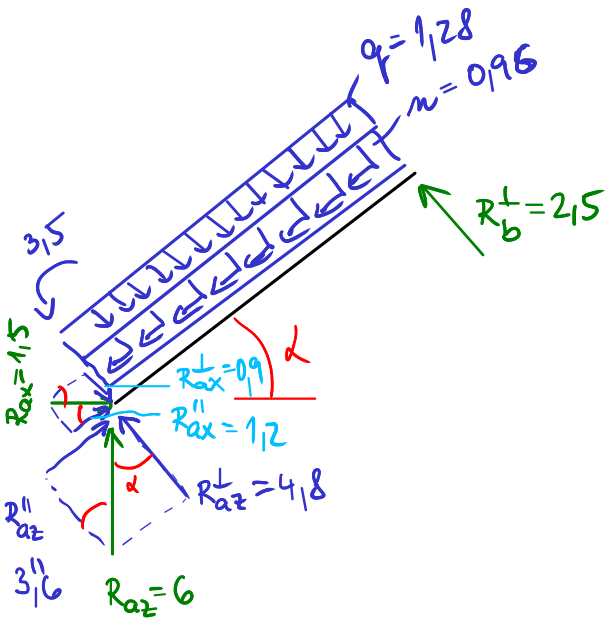
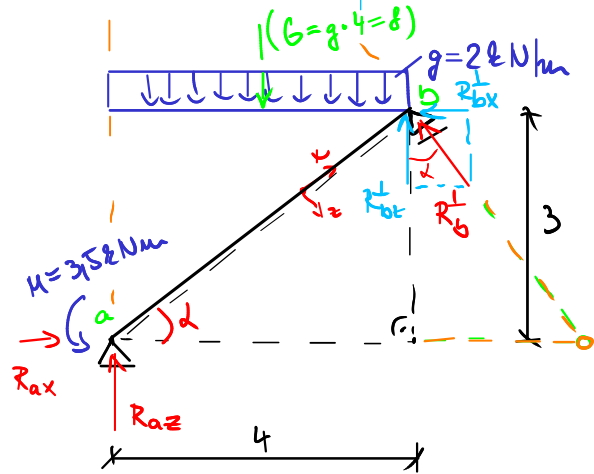


$$\frac{n}{g'} = \sin \alpha \Rightarrow n = g' \sin \alpha$$

$$\frac{q}{g'} = \cos \alpha \Rightarrow q = g' \cos \alpha$$

$$n = g \sin \alpha \cos \alpha$$

$$q = g \cos^2 \alpha$$



$$l = 5 \text{ m}$$

$$\sin \alpha = \frac{3}{5} \quad \cos \alpha = \frac{4}{5}$$

1) reakce

$$\sum M_{ai} = 0 \quad (+ \curvearrowright)$$

$$R_b^{\perp} \cdot 5 + M - G \cdot 2 = 0 \Rightarrow R_b^{\perp} = 2.5 \text{ kN}$$

$$\sum F_{xi} = 0 \quad (+ \rightarrow)$$

$$R_{ax} - R_{bx}^{\perp} = 0 \Rightarrow R_{ax} = 1.5 \text{ kN}$$

$$R_{bx}^{\perp} = R_b^{\perp} \cdot \sin \alpha = 2.5 \cdot \frac{3}{5} = 1.5 \text{ kN}$$

$$\sum M_{bi} = 0 : R_{az} \cdot 4 - R_{ax} \cdot 3 - G \cdot 2 - M = 0 \quad R_{az} = 6 \text{ kN}$$

$$\text{kontrola : } \sum F_{xi} = 0$$

2) rozklad do $\perp$ a $\parallel$

$$n = q \cos \alpha \sin \alpha = 2 \cdot \frac{4}{5} \cdot \frac{3}{5} = 0.96 \text{ kN/m}$$

$$q_{\parallel} = q \cos^2 \alpha = 2 \cdot \frac{4^2}{5^2} = 1.28 \text{ kN/m}$$

náhradní břemeno

$$Q = q_{\parallel} \cdot l = 1.28 \cdot 5 = 6.4 \text{ kN}$$

$$N = n \cdot l = 0.96 \cdot 5 = 4.8 \text{ kN}$$

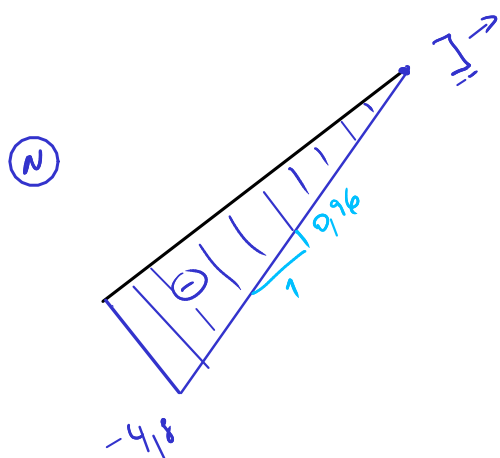
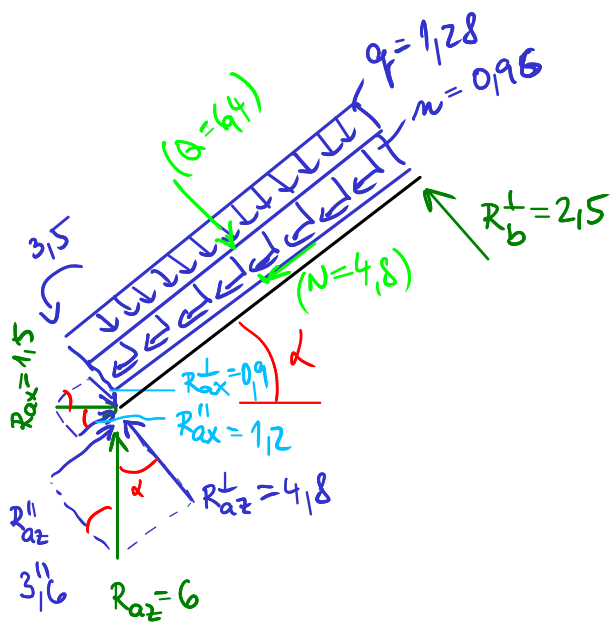
$$\frac{R_{az}^{\perp}}{R_{az}} = \cos \alpha \Rightarrow R_{az}^{\perp} = R_{az} \cos \alpha = 4.8 \text{ kN}$$

$$R_{az}^{\parallel} = R_{az} \sin \alpha = 3.6 \text{ kN}$$

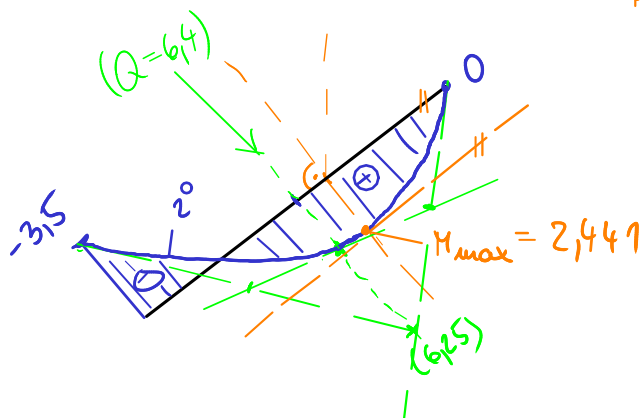
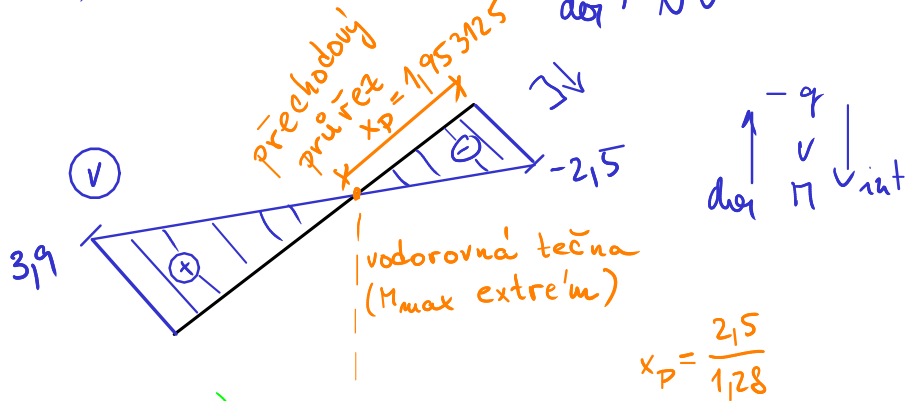
$$\frac{R_{ax}^{\parallel}}{R_{ax}} = \cos \alpha \Rightarrow R_{ax}^{\parallel} = R_{ax} \cos \alpha = 1.2 \text{ kN}$$

$$R_{ax}^{\perp} = 0.9 \text{ kN}$$

$$\text{kontrola : } \sum F_{xi}^{\parallel} = 0 \quad \sum F_{xi}^{\perp} = 0$$



3) vnitřní síly N, V, M



$$M_{max} = R_b^{\perp} \cdot x_p - x_p \cdot q \cdot \frac{x_p}{2} = 2,5 \cdot x_p - 1,28 \cdot \frac{x_p^2}{2} = 2,441 \text{ kNm}$$

$$M_{max} = M_b - \int_b^{x_p} V dx = 0 - \frac{1}{2} x_p \cdot (-2,5) = 2,441 \text{ kNm}$$

DOPLNĚNÍ: výpočet reakcí pomocí 3 nezávislých rovnic

⊕ nemusím dělat rozklad R_b^I , který není potřeba

$$\textcircled{c} \quad \frac{3}{4} = \frac{x}{3} \Rightarrow x = \frac{9}{4} = 2,25 \text{ m}$$

$$\textcircled{d} \quad \frac{z}{5} = \frac{5}{3} \Rightarrow z = \frac{25}{3} = 8,3 \text{ m}$$

$$\sum M_{di} = 0 \quad (\oplus \uparrow)$$

$$R_{ax} \cdot 8,3 + M - G \cdot 2 = 0$$

$$R_{ax} = \frac{-3,5 + 8 \cdot 2}{8,3} = \underline{1,5 \text{ kN}}$$

$$\sum M_{ci} = 0 \quad (\oplus \downarrow)$$

$$R_{az} \cdot (4 + 2,25) - M - G(2 + 2,25) = 0$$

$$R_{az} = \frac{+3,5 + 8 \cdot 4,25}{6,25} = \underline{6 \text{ kN}}$$

$$\sum M_{bi} = 0 \quad (\oplus \rightarrow)$$

$$R_b^I \cdot 5 + M - G \cdot 2 = 0 \Rightarrow R_b^I = \underline{2,5 \text{ kN}}$$

$$\text{kontrola: } \sum M_{bi} = 0 \quad (\oplus \downarrow)$$

$$R_{az} \cdot 4 - R_{ax} \cdot 3 - M - G \cdot 2 = 0$$

$$6 \cdot 4 - 1,5 \cdot 3 - 3,5 - 8 \cdot 2 = 0 \quad \checkmark$$

