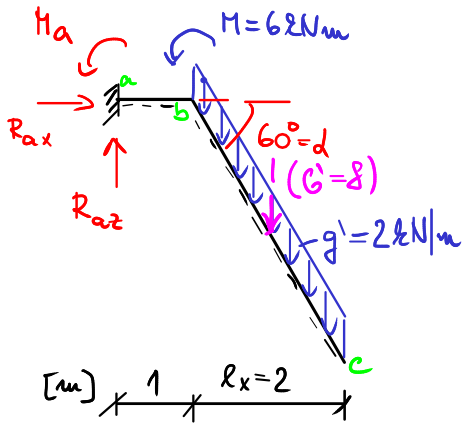
Lomený nosník se šikmými pruty



1) rozklad zatížení

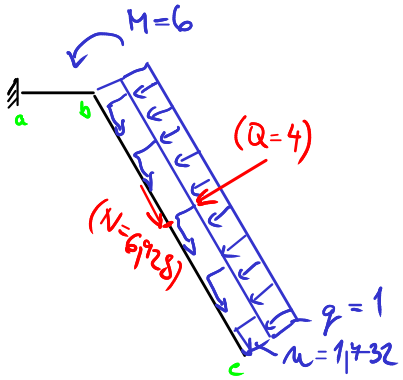
$q = g' \cos\alpha = 2 \cdot \cos 60° = 1 \text{ kN/m}$

$n = g' \sin\alpha = 2 \cdot \sin 60° = 1{,}732 \text{ kN/m}$

$Q = q \cdot l = 1 \cdot 4 = 4 \text{ kN}$ $\qquad G' = g' \cdot 4 = 8 \text{ kN}$

$N = n \cdot l = 1{,}732 \cdot 4 = 6{,}928 \text{ kN}$

$l = \frac{l_x}{\cos 60°} = 4 \text{ m}$



2) reakce

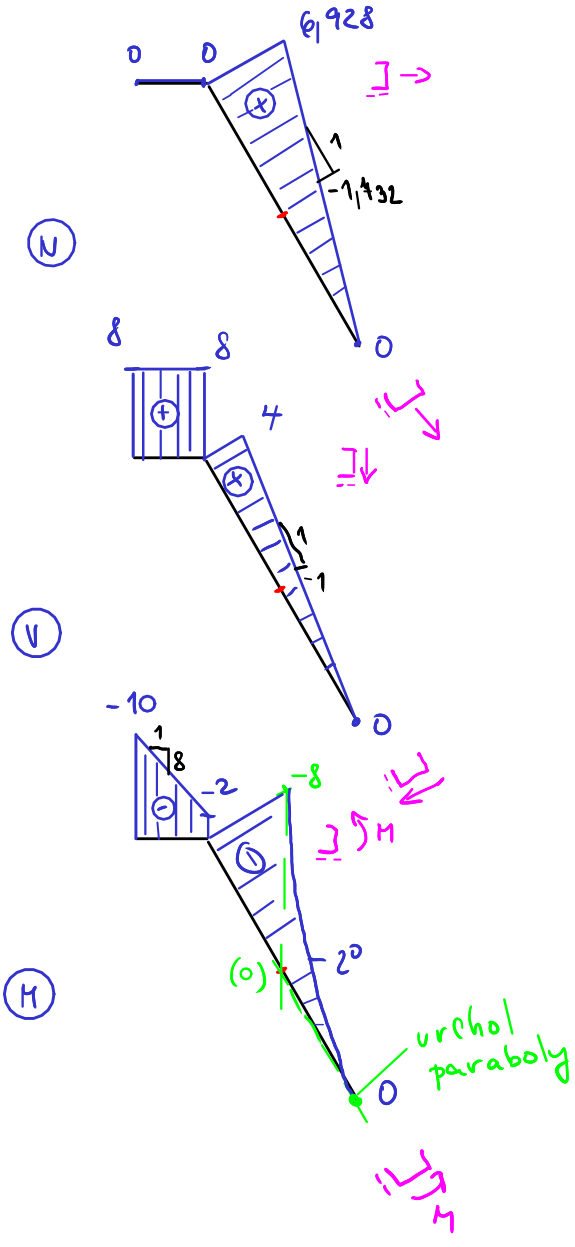
$\Sigma F_{xi} = 0 \Rightarrow R_{ax} = 0$

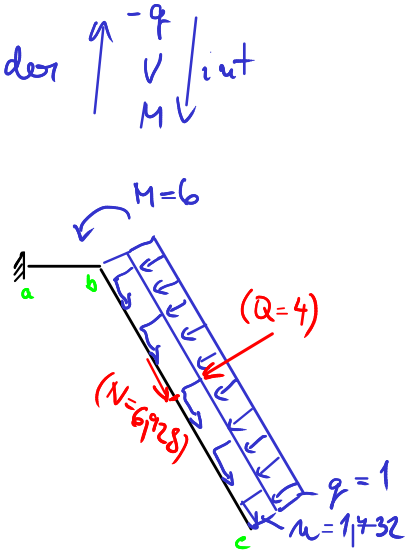
$\Sigma F_{zi} = 0 \Rightarrow R_{az} = G' = 8 \text{ kN}$

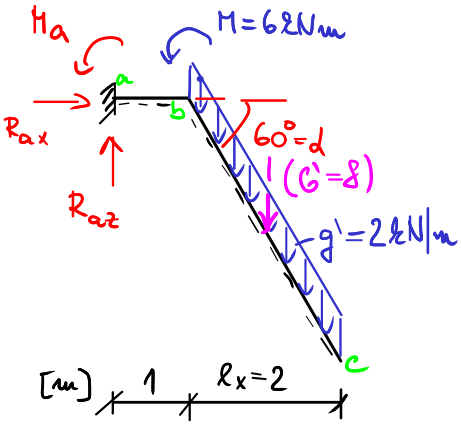
$\Sigma M_{ai} = 0 \Rightarrow H_a = 10 \text{ kNm}$

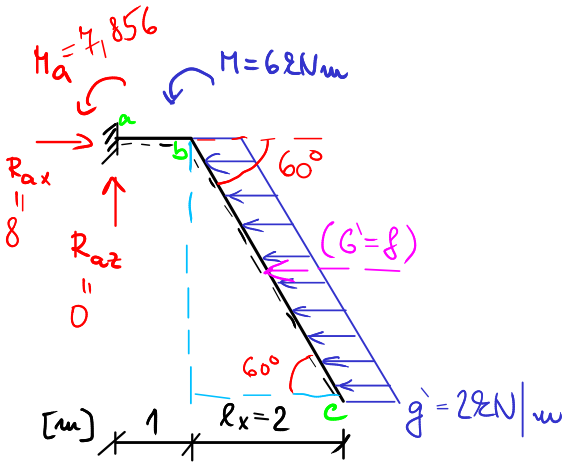
kontrola $\Sigma M_{ci} = 0$

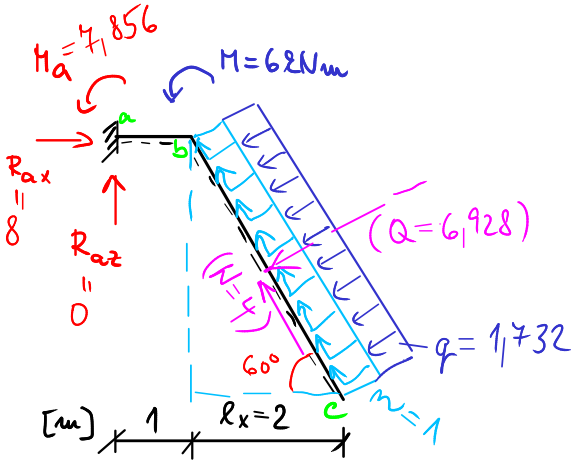
3) vykreslení vnitřních sil









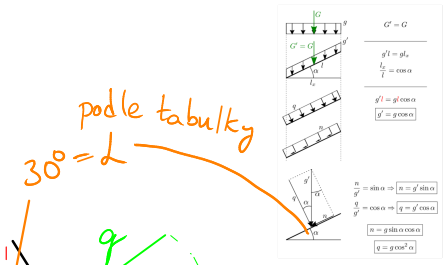


$$\frac{l_x}{l_{bc}} = \cos 60°$$

$$l_{bc} = \frac{l_x}{\cos 60°} = 4\,m$$

$$G' = g' \cdot l_{bc} = 8\,kN$$

rozklad g':



$$n = g' \sin\alpha = g' \cos 60° = 1\,kN/m$$

$$q = g' \cos\alpha = g' \sin 60° = 1{,}732\,kN/m$$

$$Q = q \cdot l_{bc} = 6{,}928\,kN \qquad N = n \cdot l_{bc} = 4\,kN$$

reakce:

$$\Sigma F_{xi} = 0 \oplus \rightarrow$$

$$R_{ax} - G' = 0 \Rightarrow R_{ax} = G' = 8\,kN$$

$$\Sigma F_{zi} = 0 \oplus \uparrow$$

$$R_{az} = 0\,kN$$

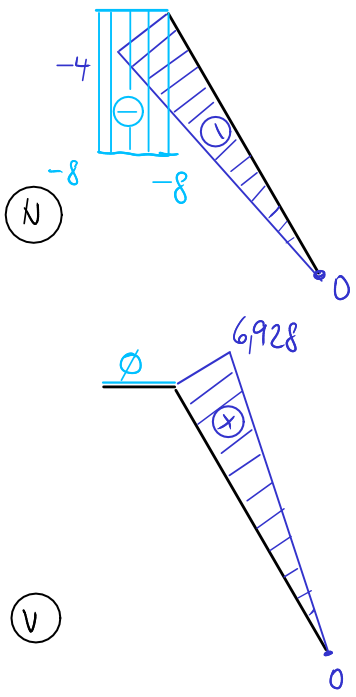
$$\Sigma M_{ai} = 0 \oplus \circlearrowleft$$

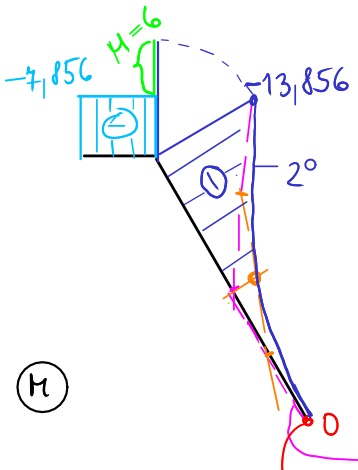
$$\left(M_a + M - G' \cdot \frac{l_y}{2} = 0\right)$$

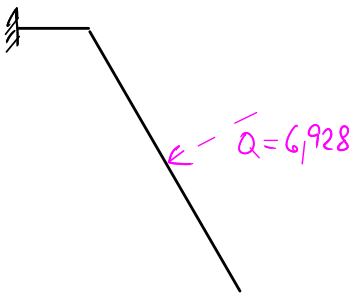
$$M_a + M - Q \cdot \frac{l_{bc}}{2} = 0$$

$$M_a = 7{,}856\,kNm$$

(vykreslení provedeme z volného konce)



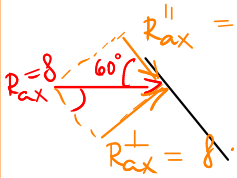


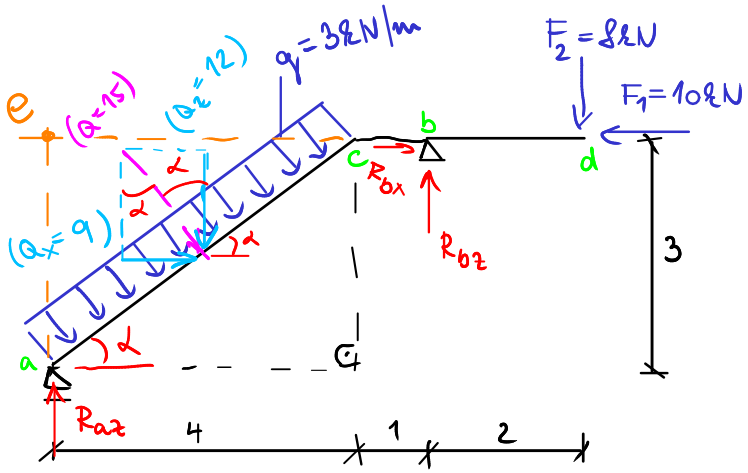


Mod Q tvoří hlavní tečny paraboly

přechodový průřez, vrchol paraboly, vodorovná tečna

kontrola šikmého prutu zleva:





$l_{ac} = 5\,m$

$Q = l_{ac} \cdot q = 5 \cdot 3 = 15\,kN$

$\sin\alpha = \frac{3}{5}$ | $Q_z = Q\cos\alpha = 12\,kN$

$\cos\alpha = \frac{4}{5}$ | $Q_x = Q\sin\alpha = 9\,kN$

1) reakce

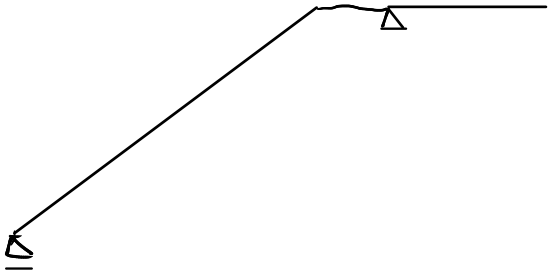
$\Sigma F_{xi} = 0 \quad \oplus\rightarrow$

$Q_x + R_{Bx} - F_1 = 0 \Rightarrow \underline{R_{Bx} = 1\,kN}$

$\Sigma M_{bi} = 0 \quad \oplus\circlearrowleft$

$R_{Az} \cdot 5 - Q_z \cdot 3 - Q_x \cdot 1{,}5 + F_2 \cdot 2 = 0$

$\underline{R_{Az} = 6{,}7\,kN}$



$\Sigma M_{ei} = 0 \quad \oplus\circlearrowright$

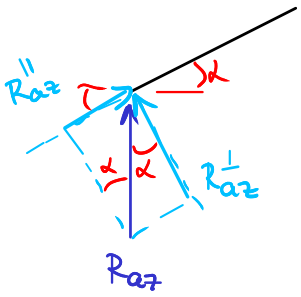
$-Q_z \cdot 2 + Q_x \cdot 1{,}5 + R_{Bz} \cdot 5 - F_2 \cdot 7 = 0$

$\underline{R_{Bz} = 13{,}3\,kN}$

kontrola $\Sigma F_{zi} = 0$ $\quad \underline{0 = 0\ \checkmark}$

$\Sigma M_{ai} = 0$ $\quad 0 = 0\ \checkmark$

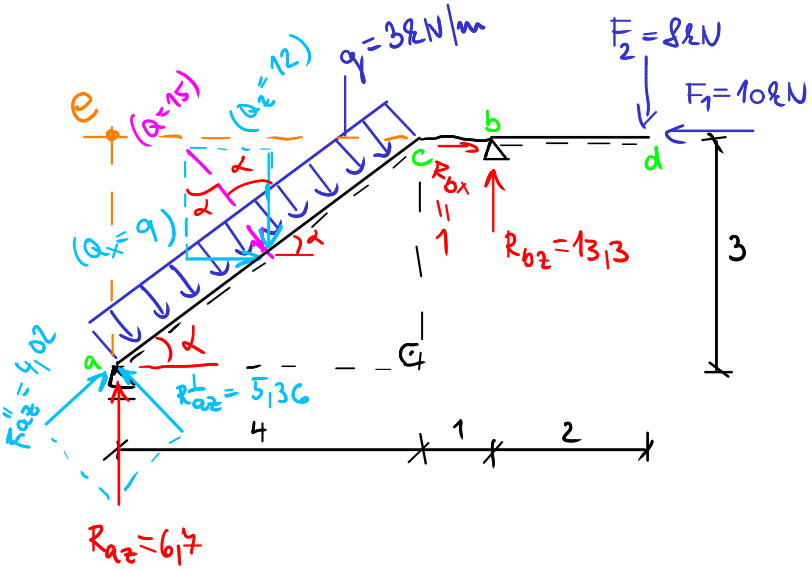
2) rozklad R_{Az} do složek $\perp$ a $\parallel$ s prutem a-c → pro vykreslení zleva

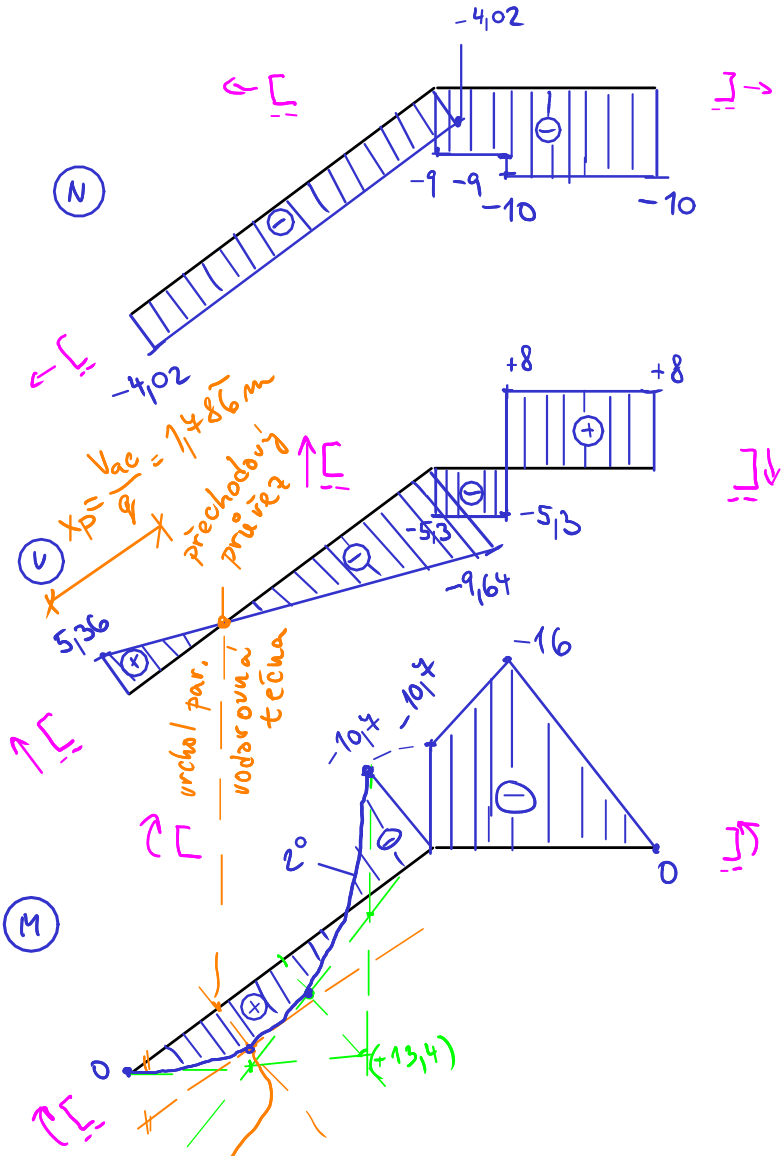


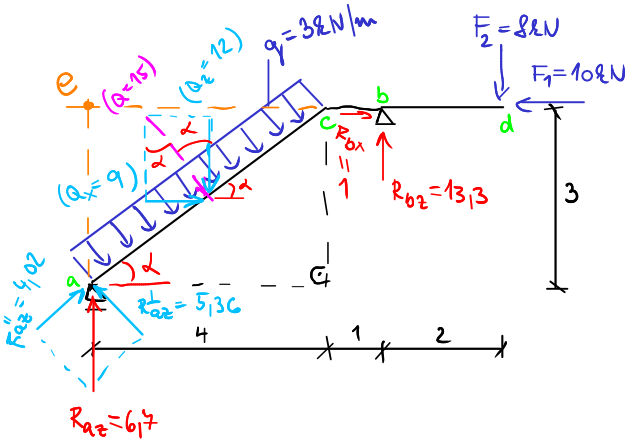
$R_{Az}^{\parallel} = R_{Az}\sin\alpha = \underline{4{,}02\,kN}$

$R_{Az}^{\perp} = R_{Az}\cos\alpha = \underline{5{,}36\,kN}$

(pro vykreslení zprava rozklad R_{Bx}, R_{Bz}, F_1 a F_2)





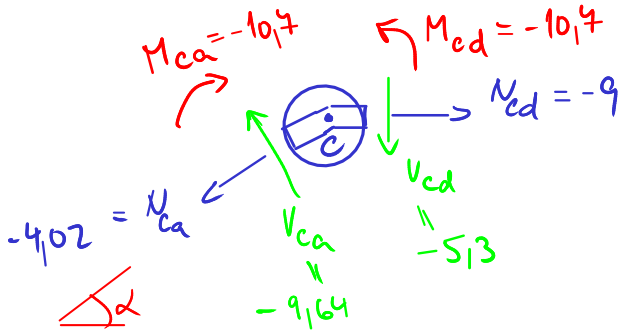


$$M_{max} = R^{\perp}_{Az} \cdot x_p - q \cdot x_p \cdot \frac{x_p}{2} =$$

$$M_{max} = M_a + \int_a^{x_p} V \, dx = 0 + \frac{1}{2} x_p \cdot 5{,}36 = 4{,}788\,kNm$$

$$M_c = R_{Az} \cdot 4 - Q_z \cdot 2 - Q_x \cdot 1{,}5 = -19{,}78\,kNm$$

$$M_Q^{bez\,q} = R_{Az} \cdot 2 = 6{,}7 \cdot 2 = 13{,}4\,kNm$$

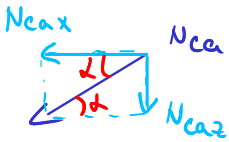


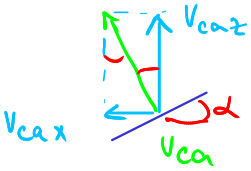
$$\sum M_{ci} = 0$$

$$M_{ca} - M_{cd} = 0 \Rightarrow 0 = 0 \checkmark$$

$$\sum F_{zi} = 0$$

$$\sum F_{xi} = 0$$





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

$$V_{ca,z} - N_{ca,z} - V_{cd} = 0$$