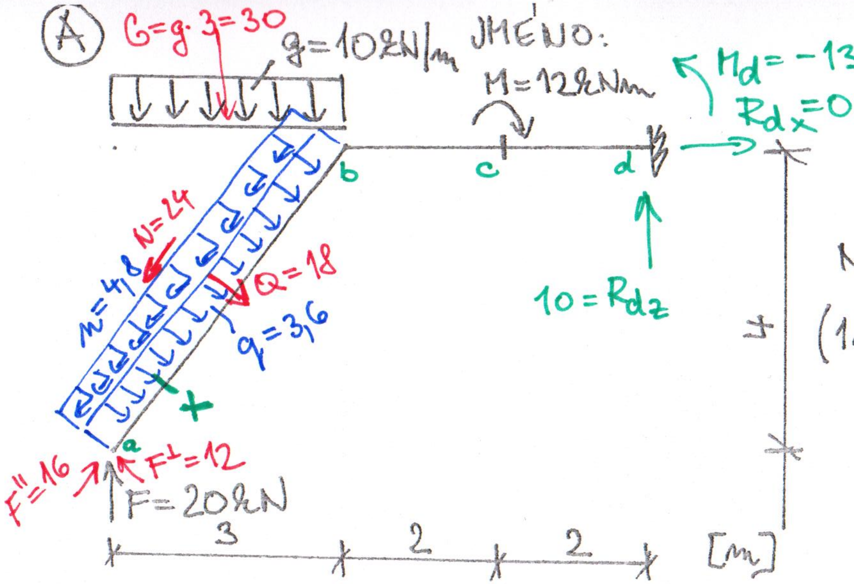
Ⓐ JMÉNO:



REAKCE = ?

N, V, M = ?

(1 mm = 1 kN)

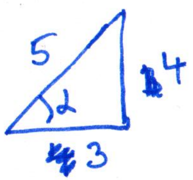
REAKCE: $\oplus\!\rightarrow\ \Sigma F_{xi} = 0 \Rightarrow \underline{R_{dx} = 0}$

$\oplus\!\uparrow\ \Sigma F_{zi} = 0 \Rightarrow F - G + R_{dz} = 0 \Rightarrow \underline{R_{dz} = 10\,kN}$

$\oplus\!\uparrow\ \Sigma M_{di} = 0 \Rightarrow M_d - M + G \cdot 5{,}5 - F \cdot 7 = 0 \Rightarrow \underline{M_d = -13\,kNm}$

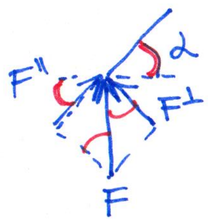
KONTROLA: $\Sigma M_{bi} = 0$

$-F \cdot 3 + G \cdot 1{,}5 - M + M_d + R_{dz} \cdot 4 = 0 \Rightarrow \underline{0 = 0}$ ✓



$\sin\alpha = \frac{4}{5}$

$\cos\alpha = \frac{3}{5}$



$g' = g \cdot \cos\alpha = 10 \cdot \frac{3}{5} = 6\,kN/m$

$q = g' \cdot \cos\alpha = 6 \cdot \frac{3}{5} = 3{,}6\,kN/m$

$m = g' \cdot \sin\alpha = 6 \cdot \frac{4}{5} = 4{,}8\,kN/m$

$Q = q \cdot 5 = 18\,kN$

$N = m \cdot 5 = 24\,kN$

$F^{\perp} = F \cdot \cos\alpha = 20 \cdot \frac{3}{5} = 12\,kN$

$F^{\parallel} = F \cdot \sin\alpha = 20 \cdot \frac{4}{5} = 16\,kN$

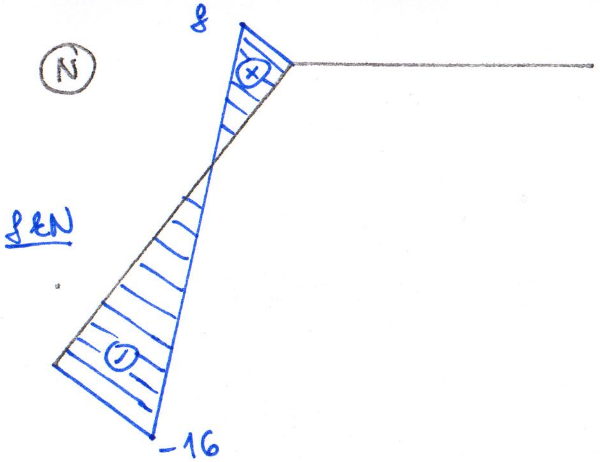
$N(x) = -16 + N_x =$

$= -16 + m \cdot x =$

$= -16 + 4{,}8 \cdot x$

$N(x=5) = -16 + 4{,}8 \cdot 5 = \underline{8\,kN}$

$N(x=0) = -16\,kN$



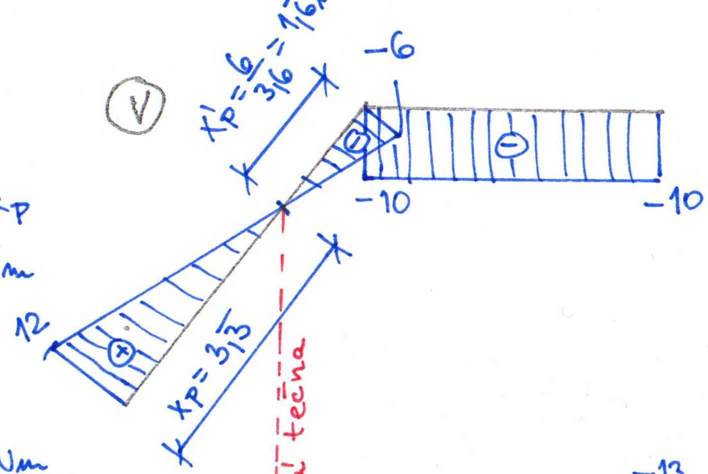
$V(x) = 12 - Q_x =$

$= 12 - q \cdot x =$

$= 12 - 3{,}6 \cdot x$

$V(x_p) = 0 = 12 - 3{,}6\, x_p$

$x_p = \frac{12}{3{,}6} = 3{,}\overline{3}\,m$



${}^{L}M_Q^{bez\ q} = F \cdot 1{,}5 = \underline{30\,kNm}$

$M(x) = F^{\perp} \cdot x - q\,\frac{x^2}{2} =$

$= 12 \cdot x - 1{,}8 \cdot x^2$

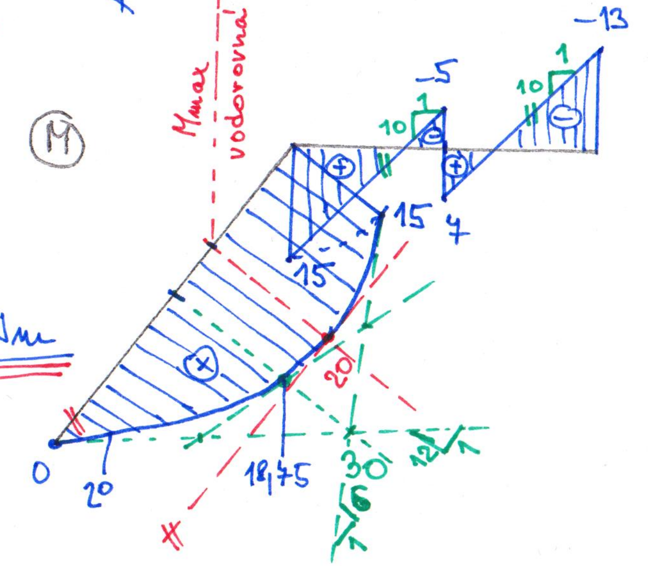
$M(x=0) = 0$ ✓

$M(x=5) = \underline{15\,kNm}$

$M_{max} = M(x = x_p) = \underline{\underline{20\,kNm}}$

$M_Q = M(x = 2{,}5) =$

$= \underline{18{,}75\,kNm}$

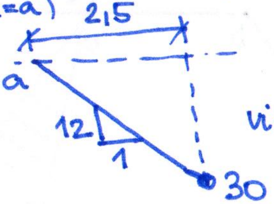


KONTROLA:

$-q$
$\downarrow$ int $\quad V \quad \uparrow$ der
M

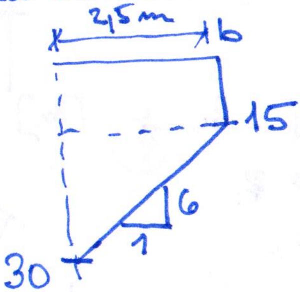
sklon tečny v bodě ⓐ je derivace $M'(x=a)$
což je $V(x=a)$

$V_a = 12$



viz obr. Ⓜ

$V_b = -6$ na šikmém nosníku

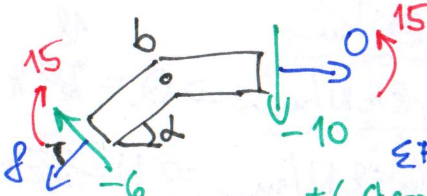


- vodorovný prut
derivace M mezi b-c a c-d je stejná -10
$\Rightarrow$ (konstantní Ⓥ b-d)
$\Rightarrow$ integrál konstanty je lineární fce
$\Rightarrow$ rovnoběžné na obou částech
b-c i c-d

$$-\; M^L_{max} = M_a + \int V dx = 0 + \underbrace{12}_{x_p} = \frac{1}{2} x_p \cdot 12 = \underline{20\,kNm}$$

$$M^P_{max} = M_{ba} - \int V dx = 15 - \underbrace{-6}_{x_p} = \cancel{\ldots}$$

$$= 15 - \frac{1}{2} x_p (-6) = \underline{20\,kNm}$$

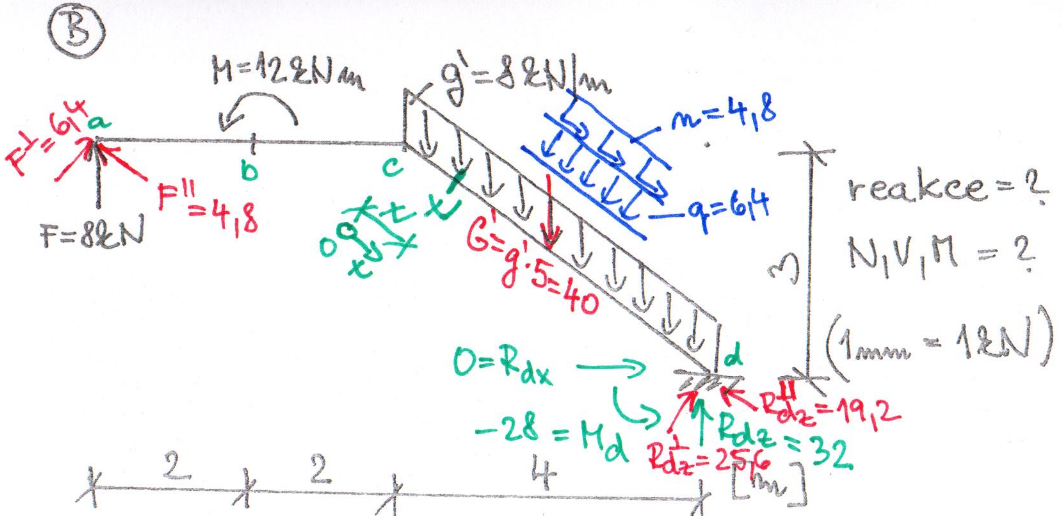


$\Sigma M_i = 0 \Rightarrow 15 - 15 = 0$ ✓

$\Sigma F_{xi} = 0 \Rightarrow$
$0 - 8 \cdot \cos\alpha - (-6) \cdot \sin\alpha = 0$ ✓

$\Sigma F_{zi} = 0 \Rightarrow$
$+(-6)\cos\alpha - (-10) - 8\sin\alpha = 0$ ✓

(B)



REAKCE:

$\oplus\rightarrow$ $\sum F_{xi}=0 \Rightarrow \underline{R_{dx}=0}$

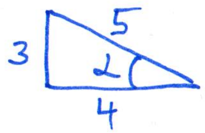
$\oplus\uparrow$ $\sum F_{zi}=0 \Rightarrow F-G'+R_{dz}=0 \Rightarrow \underline{R_{dz}=32\,kN}$

$\oplus\circlearrowleft$ $\sum M_{di}=0 \Rightarrow -F\cdot 8+M+G'\cdot 2+M_d=0 \Rightarrow \underline{M_d=-28\,kNm}$

KONTROLA: $\sum M_{ci}=0$ $\oplus\circlearrowleft$

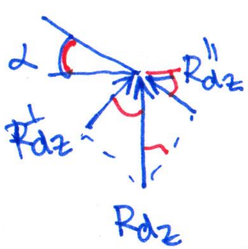
$-F\cdot 4+M-G'\cdot 2+M_d+R_{dz}\cdot 4+R_{dx}\cdot 3=0$

$\underline{0=0}$ ✓



$\sin\alpha=\frac{3}{5}$

$\cos\alpha=\frac{4}{5}$



$q=g'\cdot\cos\alpha=8\cdot\frac{4}{5}=6,4\,kN/m$

$m=g'\cdot\sin\alpha=8\cdot\frac{3}{5}=4,8\,kN/m$

$Q=q\cdot 5=32\,kN$

$N=m\cdot 5=24\,kN$

$R_{dz}^{\perp}=R_{dz}\cdot\cos\alpha=32\cdot\frac{4}{5}=25,6\,kN$

$R_{dz}^{\parallel}=R_{dz}\cdot\sin\alpha=32\cdot\frac{3}{5}=19,2\,kN$

– pro vykreslování z volného konce:

$F^{\perp}=F\cdot\cos\alpha=8\cdot\frac{4}{5}=6,4\,kN$

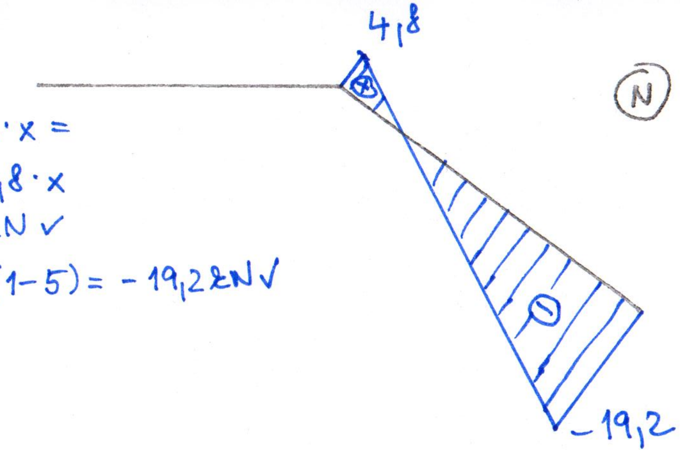
$F^{\parallel}=F\sin\alpha=8\cdot\frac{3}{5}=4,8\,kN$

$^{L}N(x)=F^{\parallel}-m\cdot x=$

$=4,8-4,8\cdot x$

$N(x=0)=4,8\,kN$ ✓

$N(x=5)=4,8\cdot(1-5)=-19,2\,kN$ ✓



$^{L}V(x)=F^{\perp}-qx=$

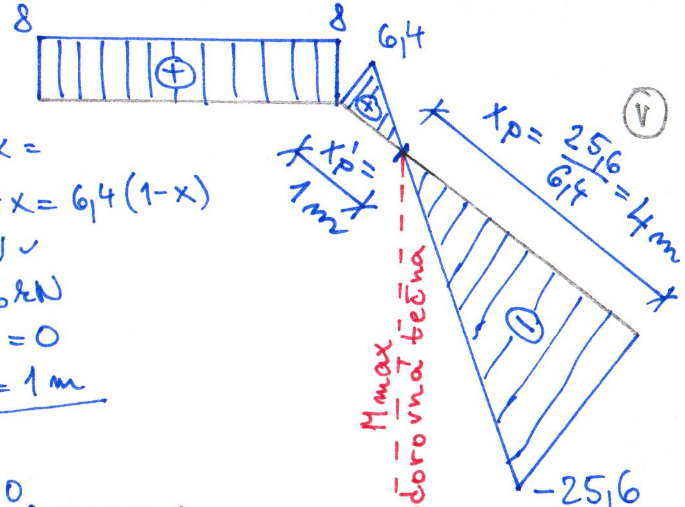
$=6,4-6,4x=6,4(1-x)$

$V(x=0)=6,4\,kN$ ✓

$V(x=5)=-25,6\,kN$

x_p': $6,4\cdot(1-x_p')=0$

$\underline{x_p'=1\,m}$



$^{L}M_Q^{bez\,q}=F\cdot 6-M=$

$\underline{=36\,kNm}$

$^{L}M(x)=F\cdot(4+x\cdot\cos\alpha)-$

$-M-q\frac{x^2}{2}=$

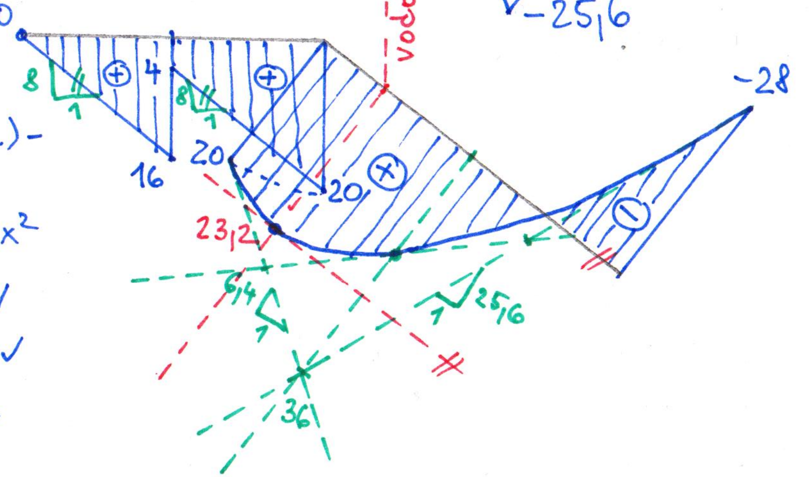
$=20+\cancel{3,2}\,6,4x-3,2x^2$

$M(x=0)=20\,kNm$ ✓

$M(x=5)=-28\,kNm$ ✓

$M_{max}=M(x=x_p')=$

$\underline{\underline{=23,2\,kNm}}$



rychlá kontrola momentů

- zleva

$$M^{L}_{max} = M_c + \int V\,dx = 20 + \ldots =$$

6,4

x_p'

$$= 20 + \frac{1}{2}\,6{,}4 \cdot 1 = \underline{23{,}2\ kNm}\ ✓$$

- zprava

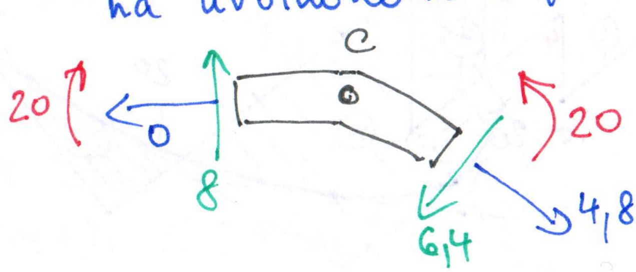
$$M^{P}_{max} = M_d - \int V\,dx = -28 - \ldots =$$

$-25{,}6$

x_p

$$= -28 - \frac{1}{2}(-25{,}6) \cdot 4 = \underline{23{,}2\ kNm}\ ✓$$

- jelikož mám rozklad ~~sil~~ všech sil do směrů x a z a do směrů ⊥ a ∥ mohu provést kontrolu zleva/zprava pomocí těchto sil
- nebo bych mohl provést kontrolu na uvolněném styčníku c



$\Sigma M_c = 0$

$\Sigma F_x = 0$

$\Sigma F_z = 0$