6. Přednáška

Šikmé nosníky, lomené nosníky se šikmými pruty

a) Zatížení šikmých nosníků

způsoby zadání spojitého zatížení

- ve směru globálních os
  - na délku vodorovného či svislého průmětu prutu - g (x), $\overline{g}$ (z)
  - na délku prutu - g* (x´) ,$\overline{g}$* (x´)
- ve směru lokálních souřadných os
  - pomocí q (x´) , n (x´)

Pro účely vykreslování vnitřních sil je třeba zatížení g a g* převést na q a n.

Základní podmínka převodu je, aby výslednice (náhradní břemeno) zatížení definovaných ve všech variantách zůstávala stejná

$G = G^*$

$g\,dx = g^*\,dx'$

$$g^* = g\frac{dx}{dx'} = g\cos\alpha$$

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

$$n = g^*\sin\alpha$$

$\overline{G} = \overline{G}^*$

$\overline{g}\,dz = \overline{g}^*\,dx'$

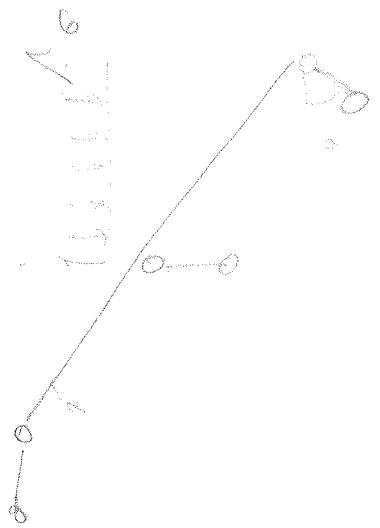
$$\overline{g}^* = \overline{g}\frac{dz}{dx'} = \overline{g}\sin\alpha$$

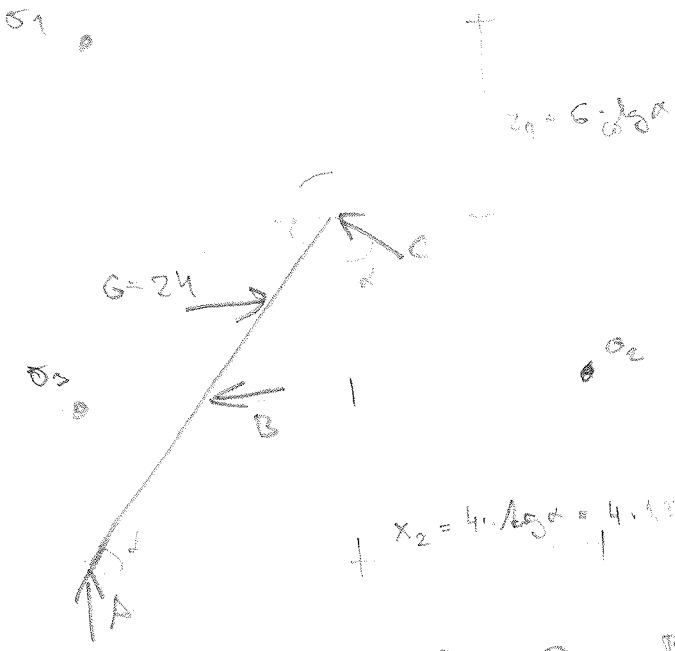
$$q = \overline{g}^*\sin\alpha$$

$$n = \overline{g}^*\cos\alpha$$

b) výpočty vnitřních sil

Pro výpočet vnitřních sil na šikmých nosnících platí stejná pravidla jako byla popsána pro lomené nosníky.





$\operatorname{tg}\alpha = \frac{4}{3}$ $\operatorname{ctg}\alpha = \frac{3}{4}$

$C_y = 0,8\,C = 5,053$

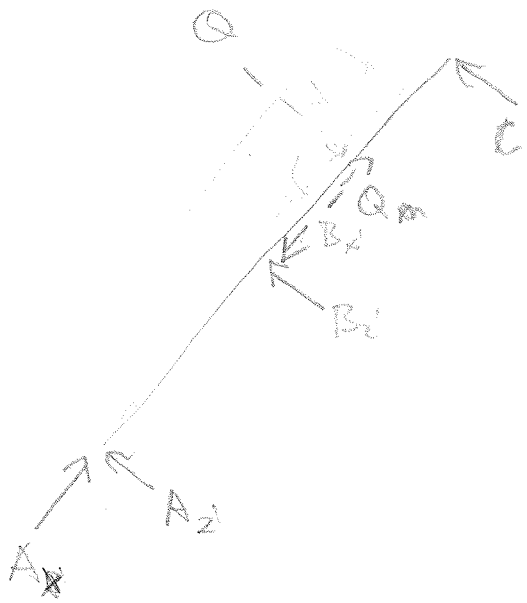
$C_x = 0,6\,C = 4,236$

$\Sigma M_{O1} = 0 \qquad G \cdot 6,5 - B \cdot 8,5 = 0 \qquad B = \frac{24 \cdot 6,5}{8,5} = 18,353$

$\Sigma M_{O2} = 0 \qquad A \cdot 11,33 + G \cdot 2 = 0 \qquad A = -\frac{24 \cdot 2}{11,33} = -4,237$

$\Sigma M_{O3} = 0 \qquad G \cdot 2 - C\cos\alpha \cdot 6 - C\sin\alpha \cdot 4 = 0$

$C = \frac{24 \cdot 2}{6 \cdot 0,6 + 4 \cdot 0,8} = 7,059$



$Q = G \cdot \sin\alpha = 24 \cdot 0{,}8 = 19{,}2$

$Q_{\parallel} = G \cdot \cos\alpha = 24 \cdot 0{,}6 = 14{,}4$

$B_{x'} = B \cos\alpha = 18{,}353 \cdot 0{,}6 = 11{,}01$

$B_{z'} = B \sin\alpha = 18{,}353 \cdot 0{,}8 = 14{,}68$

$A_{x'} = A \sin\alpha = -4{,}237 \cdot 0{,}8 = -3{,}39$

$A_{z'} = A \cos\alpha = -4{,}237 \cdot 0{,}6 = -2{,}54$

$q = Q/5 = 3{,}84$

$N_a = -A_{x'} = 3{,}39$

$V_a = A_{z'} = -2{,}54$

$N_{bP} = -A_{x'} + B_{x'} = 3{,}39 + 11{,}01 = 14{,}4$

$V_{bP} = A_{z'} + B_{z'} = -2{,}54 + 14{,}68 = 12{,}14$

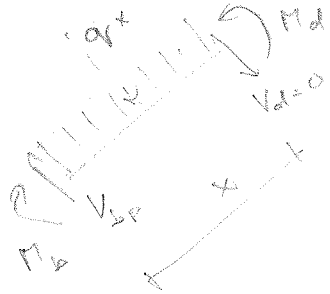
$V_c = -C = -7{,}06$

$M_b = A \cdot 3 = -4{,}237 \cdot 3 = -12{,}711$

$x = \frac{12{,}14}{3{,}84} = 3{,}16$

$\Theta = -V_{bP} = 0$

$qx = V_{bP}$



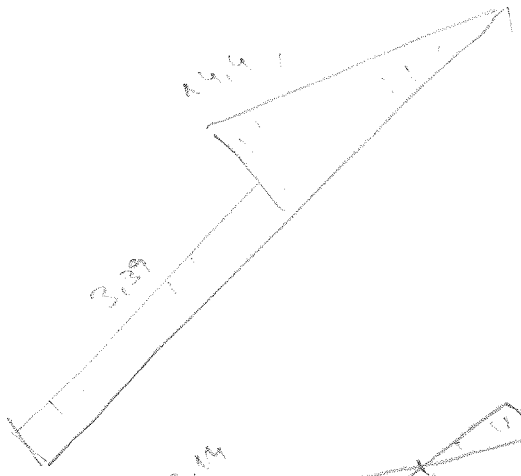
$M_a = M_b + V_{bP}\frac{x}{2} - Q\frac{x}{2}$

$= M_b + V_{bP}\frac{x}{2}$

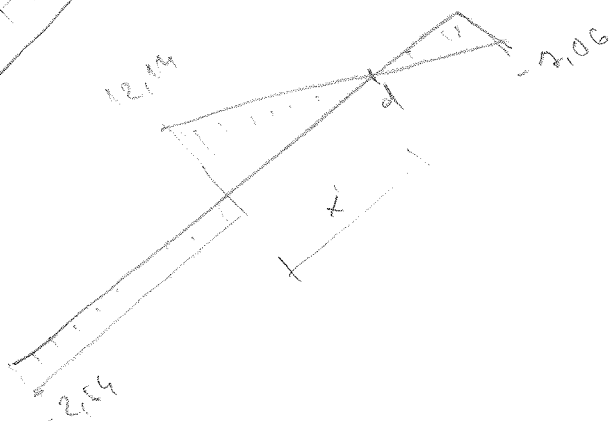
$= -12{,}711 + 12{,}14\frac{3{,}16}{2}$

$= 6{,}47$

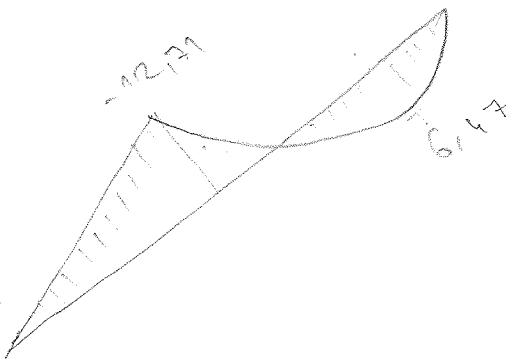
(N)

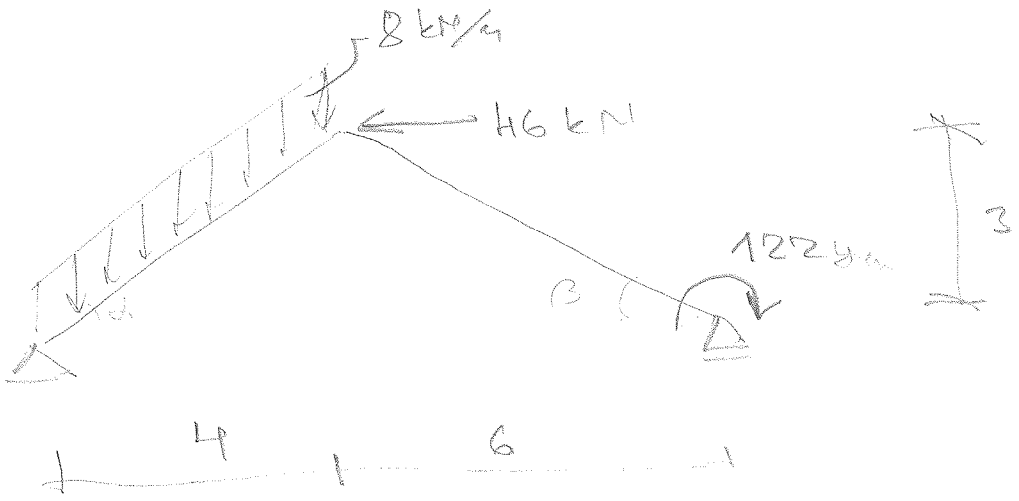


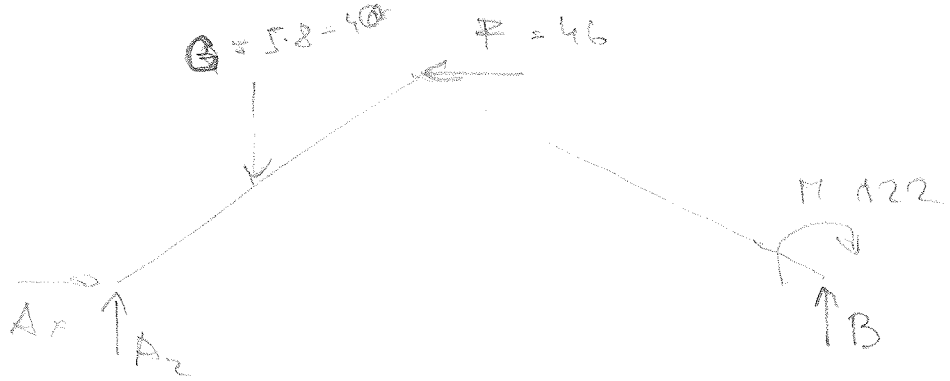
(V)



(M)







$A_x = 46$

$B = \frac{2 \cdot 40 - 46 \cdot 3 + 122}{10} = 6{,}4 \text{ kN}$

$A_z = \frac{40 \cdot 8 + 46 \cdot 3 - 122}{10} = 33{,}6 \text{ kN}$

$\alpha = \arctg\left(\frac{3}{4}\right) = 36{,}87°$

$\cos\alpha = 0{,}8 \quad \sin\alpha = 0{,}6$

$q = g' \cdot \cos\alpha = 6{,}4 \text{ kN}$

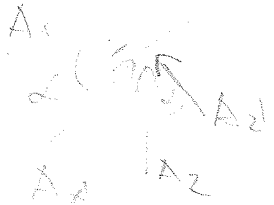
$N = g' \sin\alpha = 4{,}8 \text{ kN}$

$Q = 6{,}4 \cdot 5 = 32$

$Q_N = 4{,}8 \cdot 5 = 24$

$A_{x'} = A_x \cos\alpha + A_z \cdot \sin\alpha = 46 \; 0{,}8 + 33{,}6 \cdot 0{,}6 = 56{,}96$

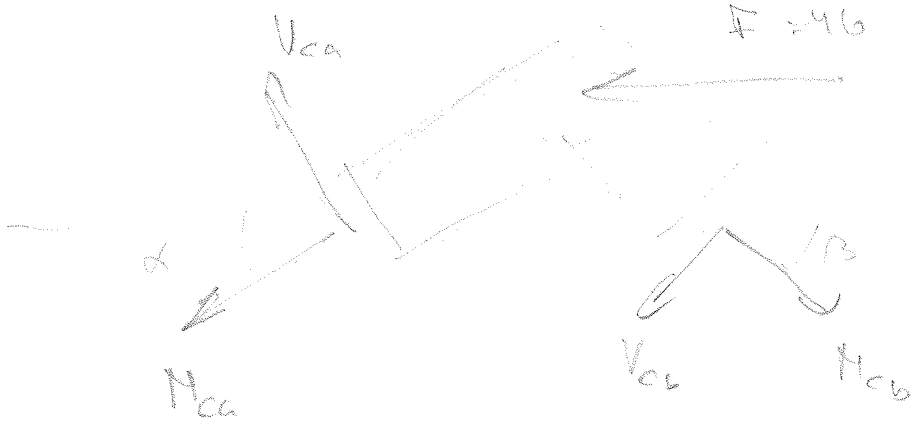
$A_{z'} = A_z \cos\alpha - A_x \sin\alpha = 33{,}6 \cdot 0{,}8 - 46 \cdot 0{,}6 = -0{,}72$



$\beta = \arctg\left(\frac{4}{2}\right) = 24{,}565°$

$B_{x'} = B \cos\beta = 6{,}4 \cdot \sin\beta = 2{,}86$

$B_{z'} = B \cos\beta = 6{,}4 \cdot \cos\beta = 5{,}724$

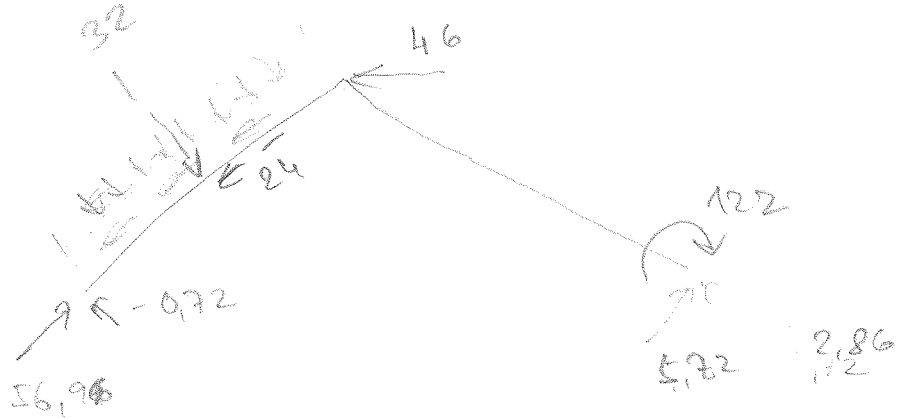


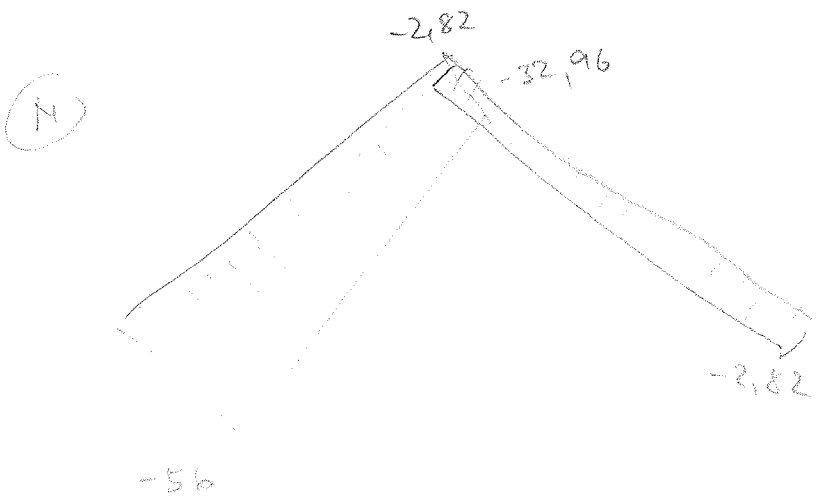
$$N_{CA}\cos\alpha + V_{CA}\sin\alpha + F + V_{CB}\sin\beta - N_{CB}\cdot\cos\beta = 0$$

$$-32{,}96\cdot 0{,}8 + (-32{,}72)\cdot 0{,}6 + 46 + (-5{,}72)\,0{,}4472 - (-2{,}86)\,0{,}8944 = 0 \checkmark$$

$$N_{CA}\sin\alpha - V_{CA}\cos\alpha + V_{CB}\cos\beta + N_{CB}\cdot\sin\beta = 0$$

$$-32{,}96\cdot 0{,}6 - (-32{,}72)\cdot 0{,}8 + (-5{,}72)\,0{,}8944 + (-2{,}86)\,0{,}4472 = 0 \checkmark$$





$N_a = -B_{x'} = -56,96$

$V_a = B_{z'} = -0,72$

$M_a = 0$

$M_{\text{€}a} = -B_x + Q_H = -56,96 + 24$
$= -32,96$

$V_{ca} = B_{z'} - Q = -0,72 - 32$
$= -32,72$

$M_c = -A_x \cdot 3 + A_z \cdot 4 - Q \cdot 2$
$= -46 \cdot 3 + 33,6 \cdot 4 - 40 \cdot 2$
$= -83,6$

$N_b = -B_{x'} = -2,86 = N_{cb}$

$V_b = -B_{z'} = -1,72 = V_{cb}$

$M_b = -122$

$M_c = B \cdot 6 - M$
$= 64 \cdot 6 - 122 = -83,6$ ✓