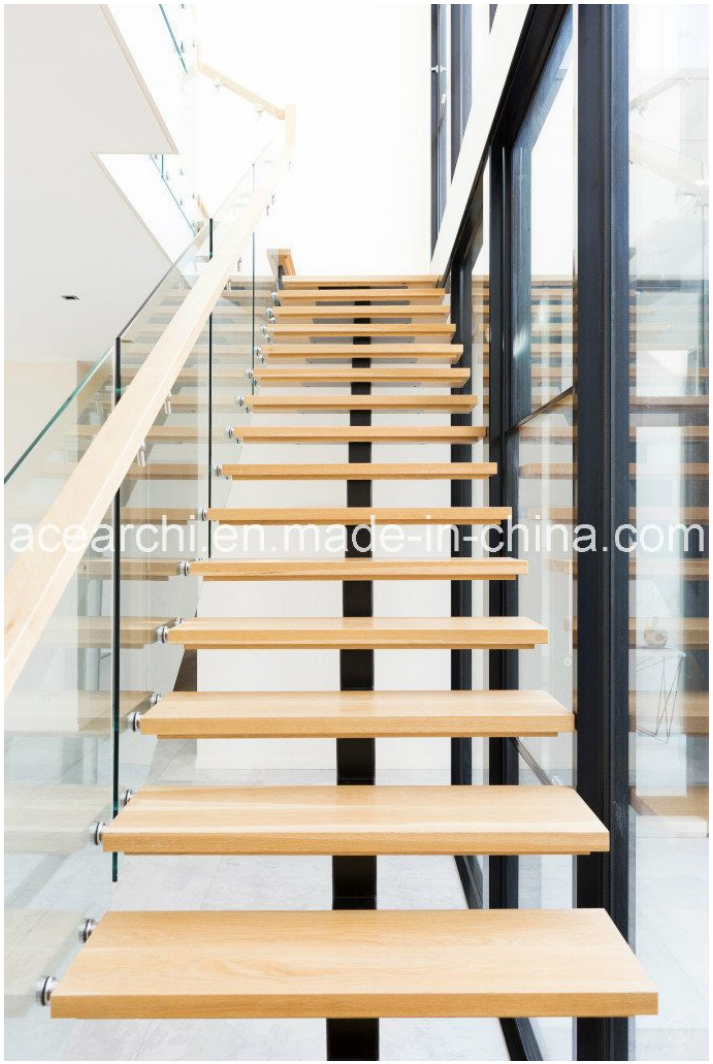
ZÁKLADY STAVEBNÍ MECHANIKY

BDA001

Rovinný šikmý nosník, rozklad šikmého spojitého zatížení, reakce a diagramy vnitřních sil a momentů.

Zdeněk Kala

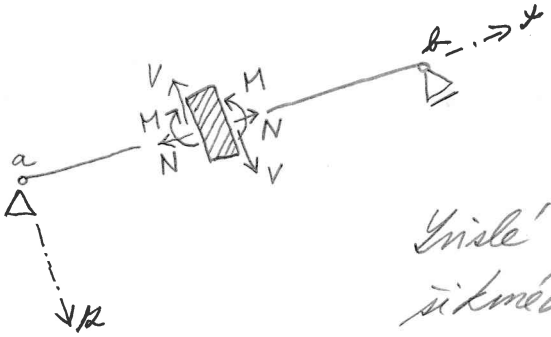
Šikmý nosník

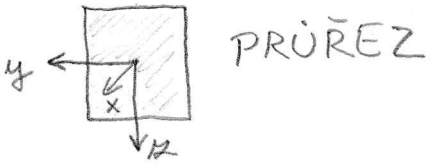


https://onlineschool.cz/statika/vnitrni-sily-v-sikmych-nosnicich/
http://fast10.vsb.cz/michalcova/Statika13/prr_06_13_sikmy.pdf
http://www.zbynekvlk.cz/vyuka/rocnik1/priklady/p8_1/p8_1.html
http://www.kitnarf.cz/education/zidekrostislav/index.php

Šikmý nosník

Šikmým nosníkem rozumíme nosník, jehož střednice je odklopena od vodorovné osy o úhel α.

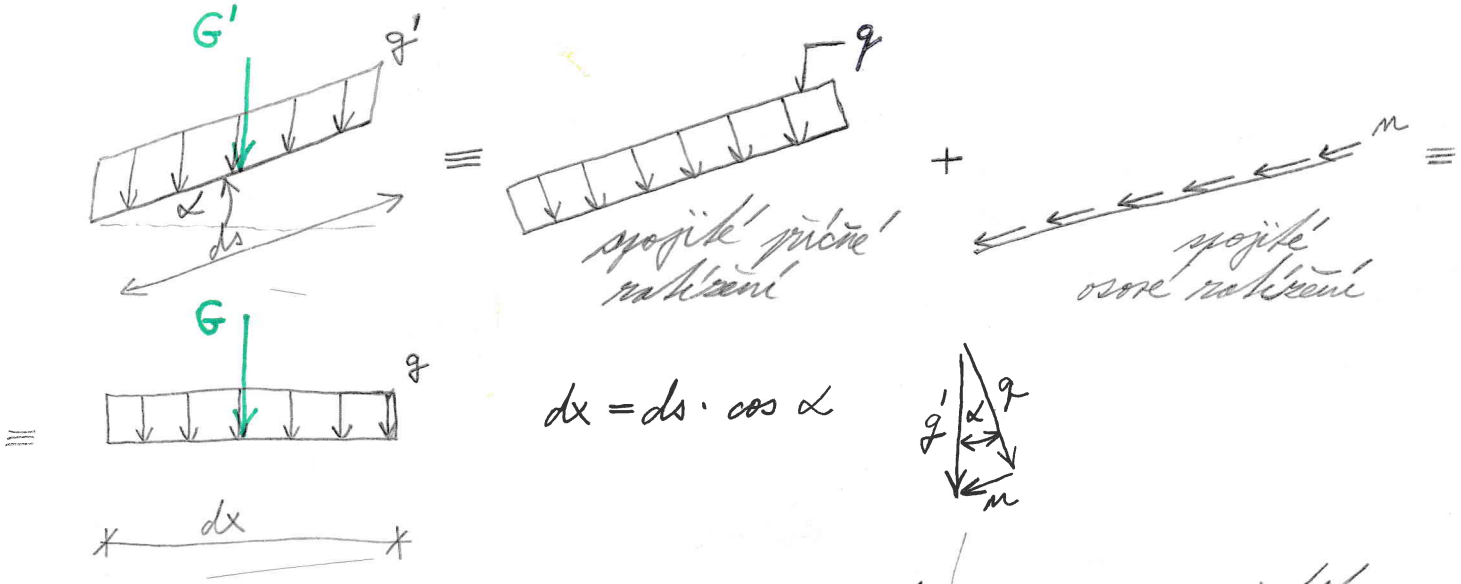




Vnitřní spojité zatížení může být u šikmého nosníku zadáno dvěma způsoby

a) podél střednice o intenzitě q' (vlastní tíha)

b) po svislém průmětu o intenzitě q (sněhové zatížení, zatížení větrem apod.)



$G = G'$

(1) $q \cdot dx = q' \cdot ds$

(2) $q \cdot dx = q \cdot ds \cdot \cos\alpha$

z (1) a (2) (pravé strany)

$q' \cdot ds = q \cdot ds \cdot \cos\alpha$

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

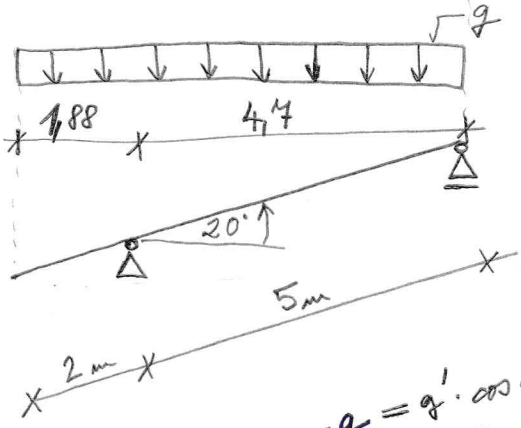
Rozklad svislého spojitého zatížení q' do složky příčné q a osové n

$q = q' \cdot \cos\alpha = q \cdot \cos^2\alpha$

$n = q' \cdot \sin\alpha = q \cdot \cos\alpha \cdot \sin\alpha$

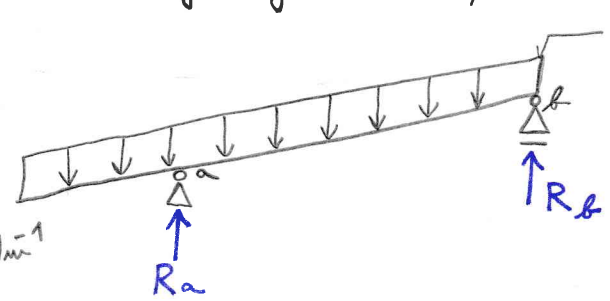
Příklad: Určete průběh vnitřních sil N, V, M na šikmém prostém nosníku s levým převislým koncem a úhlem sklonu $\alpha = 20°$ pro spojité rovnoměrné svislé zatížení

$g = 2{,}12\ kN\,m^{-1}$



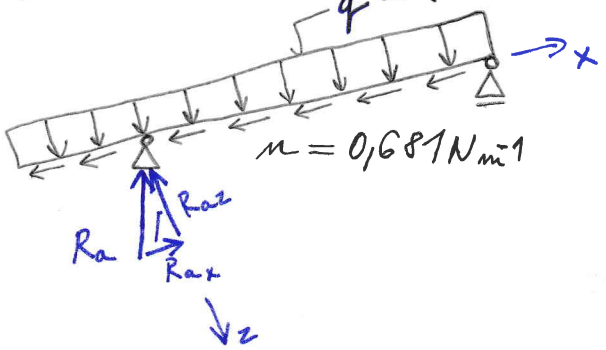
$\equiv$

$g' = g \cdot \cos\alpha = 2{,}12 \cdot \cos 20° = 2\ kN\,m^{-1}$



$q = g' \cdot \cos\alpha = 1{,}872\ kN\,m^{-1}$

$\equiv$



Reakce:

$\sum M_{ib} = 0$

$-R_a \cdot 4{,}7 + 2 \cdot 4{,}0 \cdot \frac{6{,}58}{2} = 0$

$R_a = 9{,}8\ kN$

$\sum M_{ia} = a$

$R_b \cdot 4{,}7 + 2 \cdot 2 \cdot \frac{1{,}88}{2} - 2 \cdot 5 \cdot \frac{4{,}7}{2} = 0$

$R_b = 4{,}2\ kN$

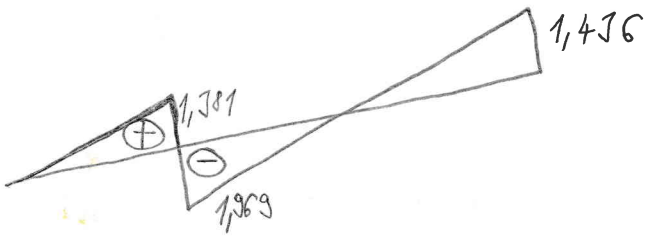
$R_{ax} = R_a \cdot \sin\alpha = 3{,}35\ kN$

$R_{az} = R_a \cdot \cos\alpha = 9{,}2\ kN$

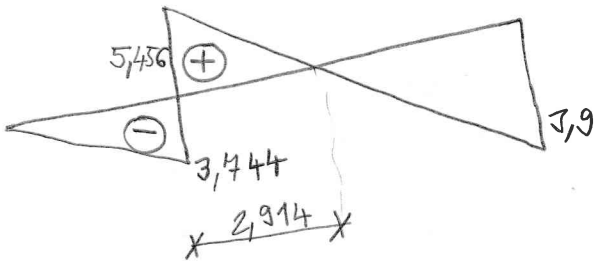
$R_{bx} = R_b \cdot \sin\alpha = 1{,}436\ kN$

$R_{bz} = R_b \cdot \cos\alpha = 3{,}9467\ kN$

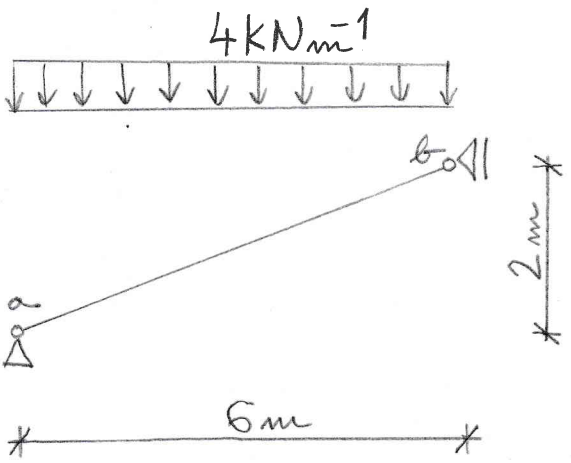
(N)



(V)



$M_{max} = 4{,}16\ kNm$



$\Sigma M_a = 0 : -4 \cdot 6 \cdot 3 + R_b \cdot 2 = 0$

$R_b = 36\ kN$

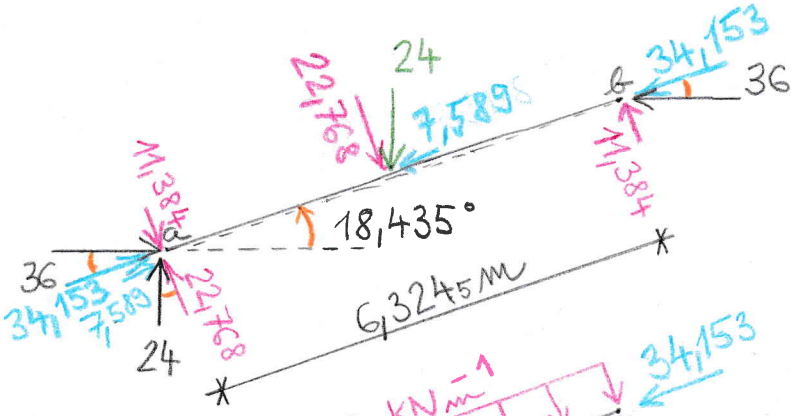
$\Sigma F_x = 0 : H_a - R_b = 0$

$H_a = 36\ kN$

$\Sigma M_b = 0 : -R_a \cdot 6 + 36 \cdot 2 + 4 \cdot 6 \cdot 3 = 0$

$R_a = 24\ kN$

$\Sigma F_y = 0 : 24 - 4 \cdot 6 = 0$ ✓



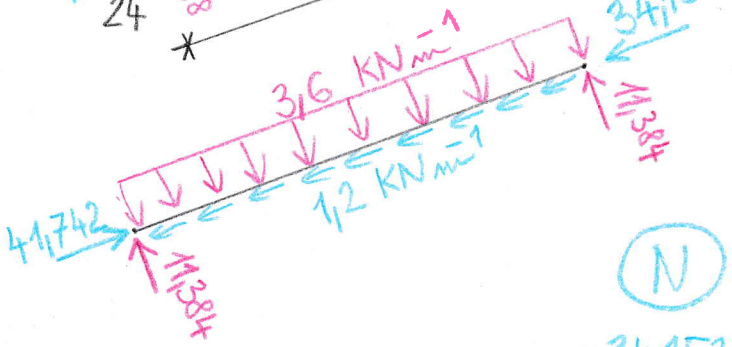
$4 \cdot 6 = 24$

$24 \cdot \cos 18{,}435° = 22{,}768$

$36 \cdot \sin 18{,}435 = 11{,}384$

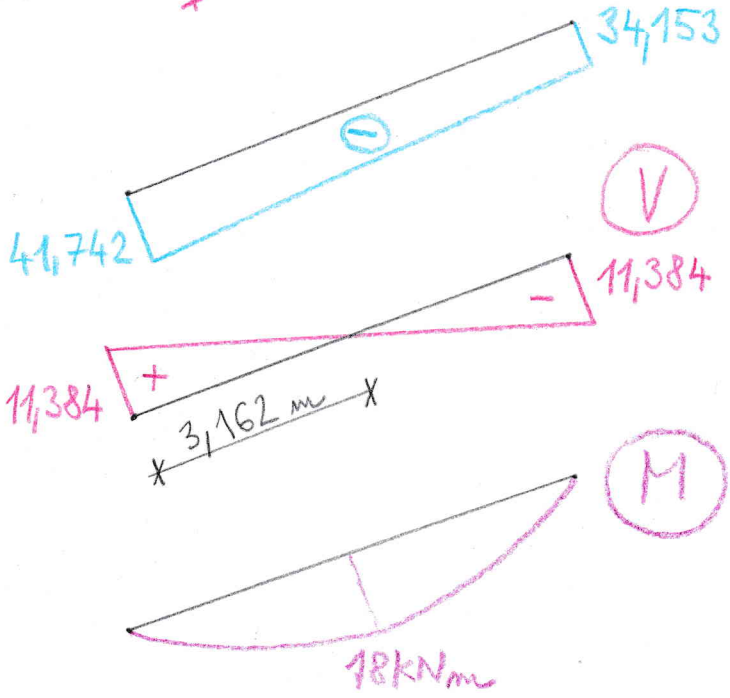
$24 \cdot \sin 18{,}435 = 7{,}589$

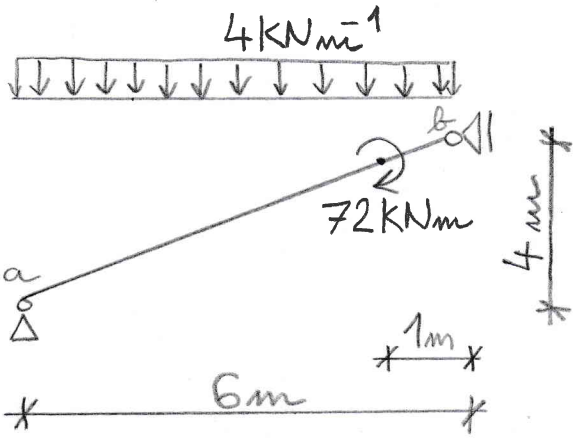
$36 \cdot \cos 18{,}435 = 34{,}153$



$\frac{22{,}768\ kN}{6{,}324\ m} = 3{,}6\ kN\,m^{-1}$

$\frac{7{,}589\ kN}{6{,}324\ m} = 1{,}2\ kN\,m^{-1}$





$\Sigma M_a = 0: -4 \cdot 6 \cdot 3 - 72 + R_b \cdot 4 = 0$

$R_b = 36$

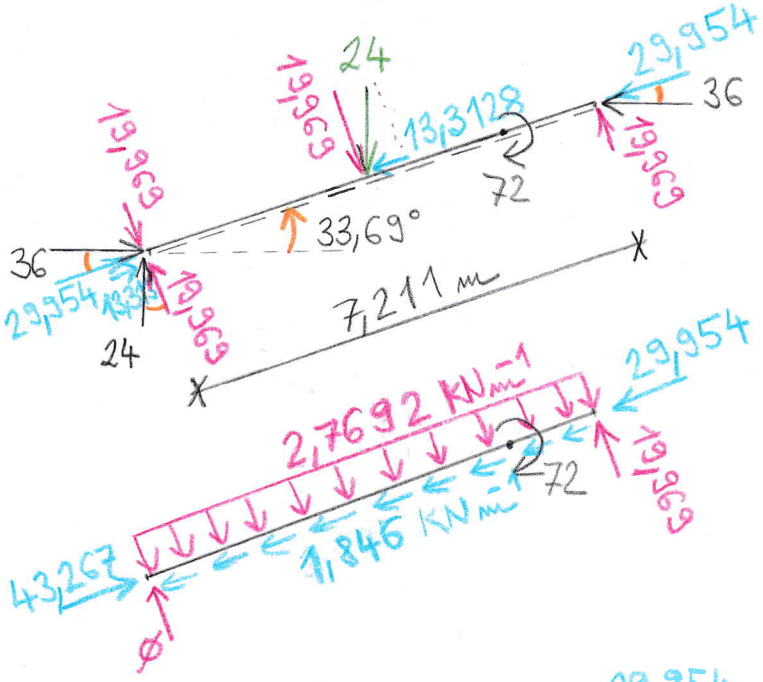
$\Sigma F_x = 0: H_a - R_b = 0$

$H_a = 36\ kN$

$\Sigma M_b = 0: -R_a \cdot 6 + 36 \cdot 4 + 4 \cdot 6 \cdot 3 - 72 = 0$

$R_a = 24$

$\Sigma F_y = 0: 24 - 4 \cdot 6 = 0$ ✓



$4 \cdot 6 = 24$

$24 \cdot \cos 33{,}69° = 19{,}969$

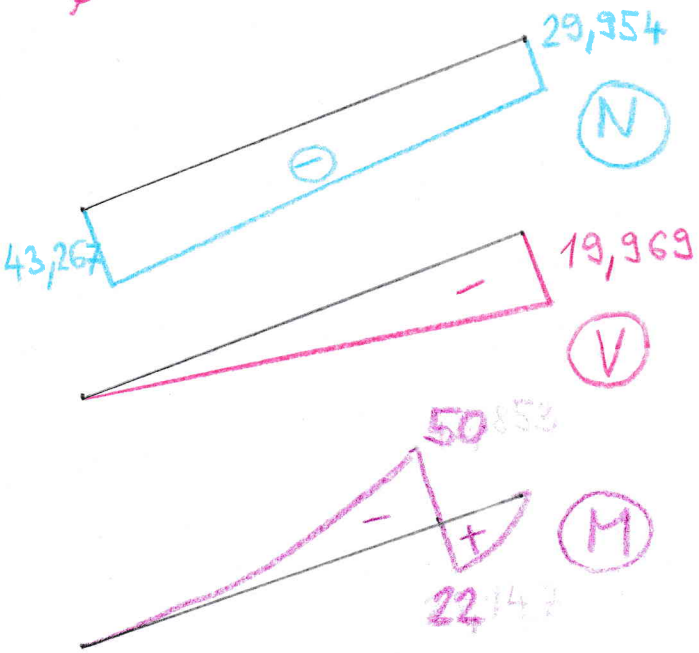
$36 \cdot \sin 33{,}69° = 19{,}969$

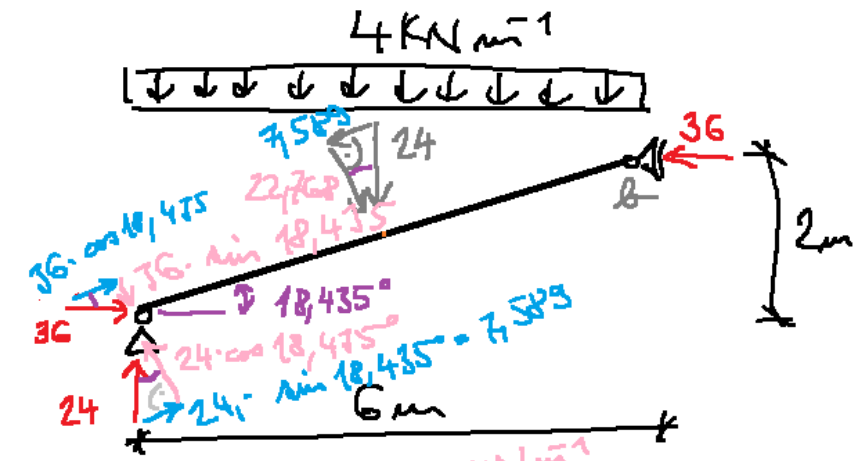
$24 \cdot \sin 33{,}69° = 13{,}313$

$36 \cdot \cos 33{,}69 = 29{,}954$

$\frac{19{,}969\ kN}{7{,}211} = 2{,}7694\ kNm^{-1}$

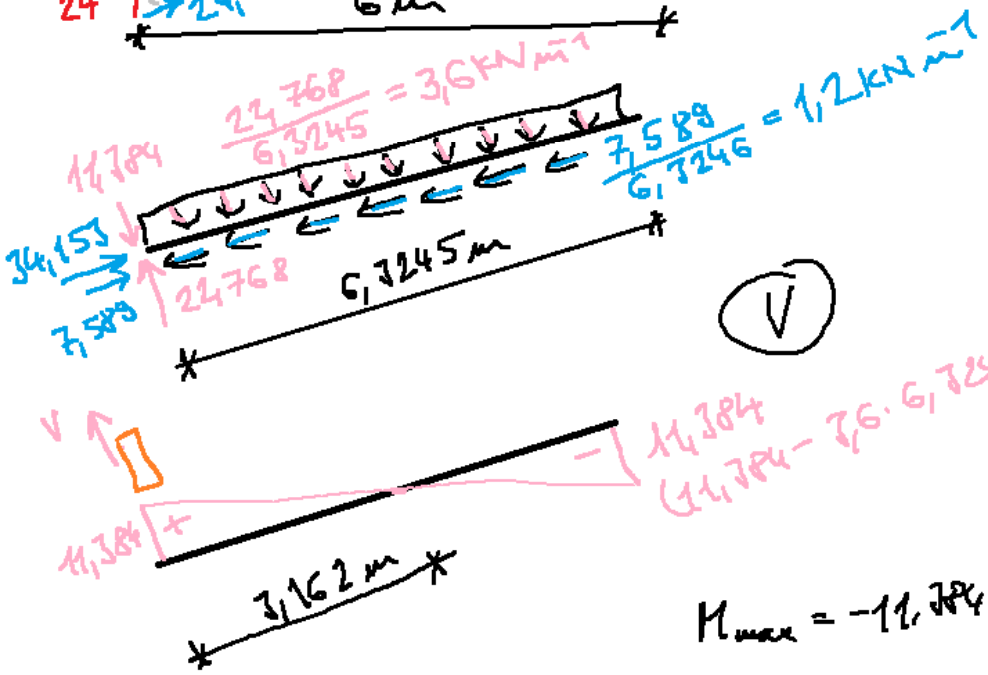
$\frac{13{,}3128\ kN}{7{,}211} = 1{,}846\ kNm^{-1}$

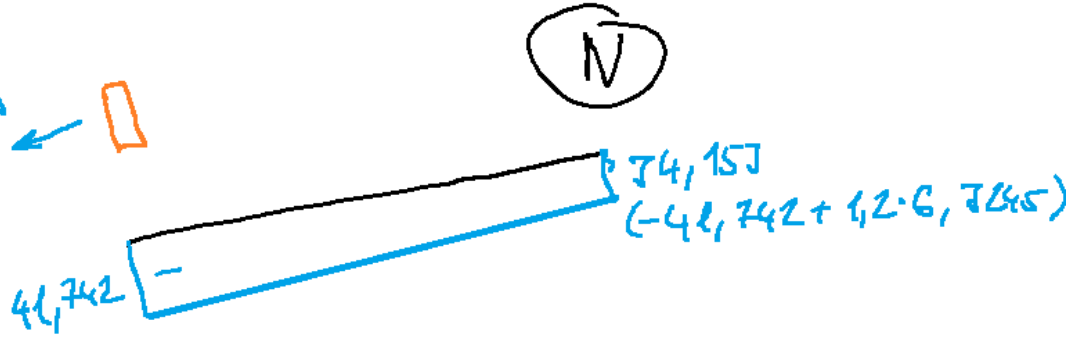


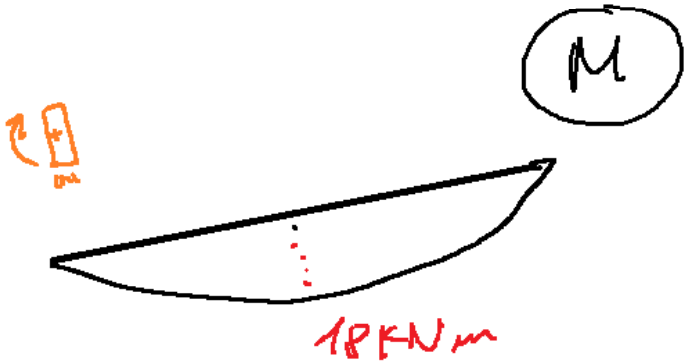


$\Sigma M_A = 0 \quad -24 \cdot 3 + R_B \cdot 2 = 0 \Rightarrow R_B = 36\ kN$

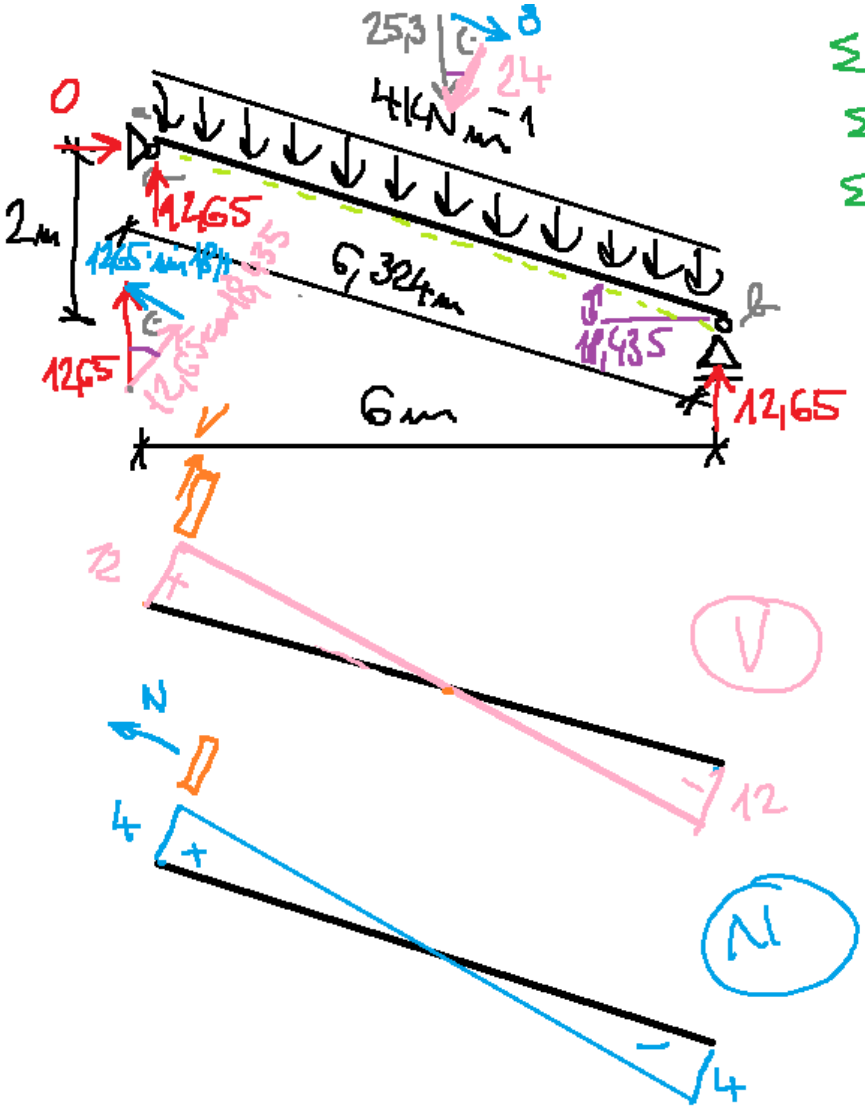
$\Sigma F_x = 0 \quad H_A - 36 = 0 \Rightarrow H_A = 36$







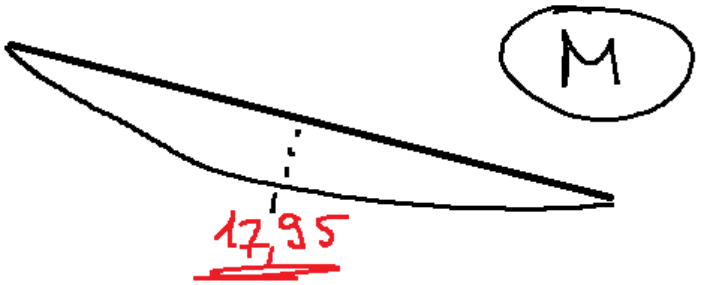
$M_{max} = -11,384 \cdot 3,162 - 3,6 \cdot 3,162 \cdot \frac{3,162}{2} + 22,768 \cdot 3,162 = 18\ kNm$



$\Sigma M_A = 0 \quad -25{,}3 \cdot 3 + R_B \cdot 6 = 0 \Rightarrow R_B = 12{,}65\,kN$

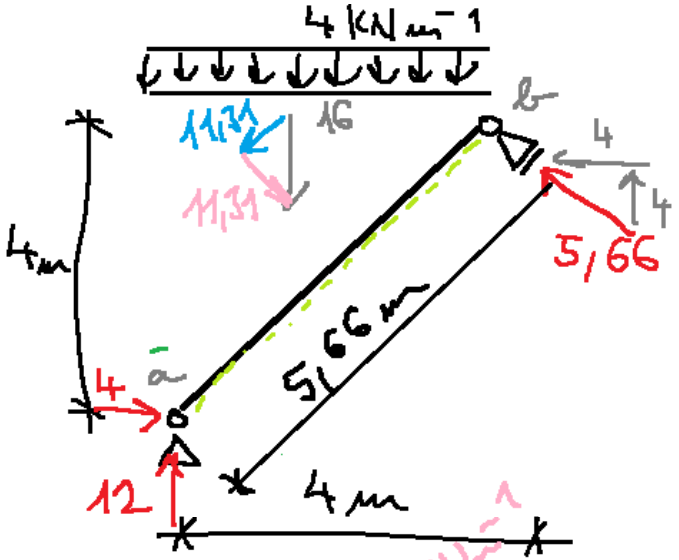
$\Sigma F_y = 0 \quad R_A - 25{,}3 + 12{,}65 = 0 \Rightarrow R_A = 12{,}65\,kN$

$\Sigma F_x = 0 \quad H_A = 0$



$M_{max} = 12 \cdot 3{,}162 - 4 \cdot 3{,}162 \cdot \frac{3{,}162}{2} = 17{,}95\,kNm$

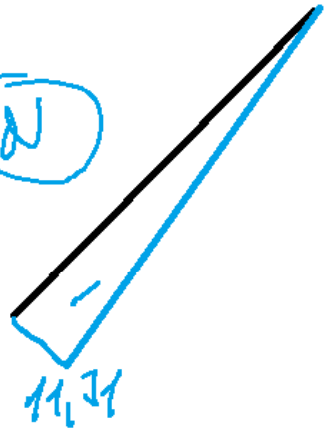
$(12{,}65 \cdot 3 - \quad - 11 - \quad) = 17{,}95$

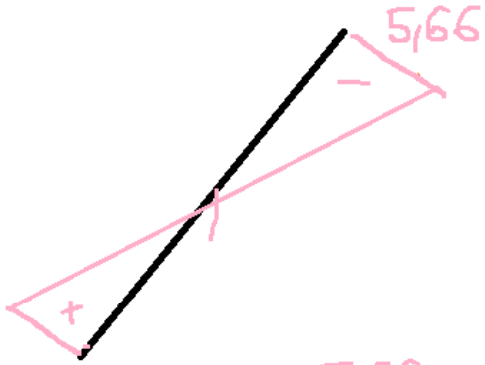


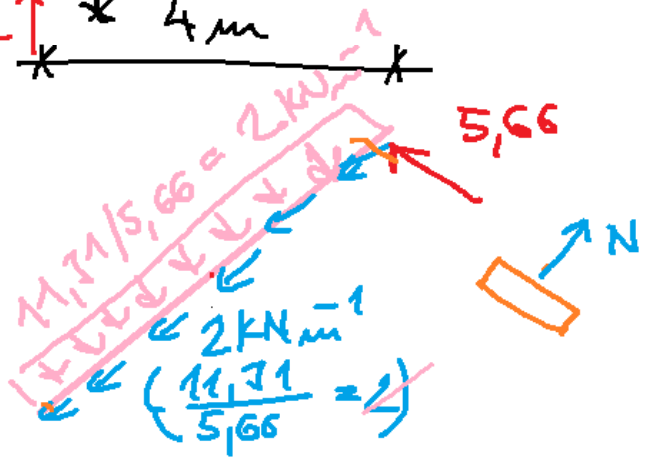
$\Sigma M_a = 0 \quad -16 \cdot 2 + R_b \cdot 5{,}66 = 0 \qquad R_b = 5{,}66\ kN$

$\Sigma F_x = 0 \quad H_a - 4 = 0$

$\Sigma F_y = 0 \quad R_a - 16 + 4 = 0$







$M_{max} = 5{,}66 \cdot 2{,}83 - 2 \cdot 2{,}83 \frac{2{,}83}{2} = 8\,kN$