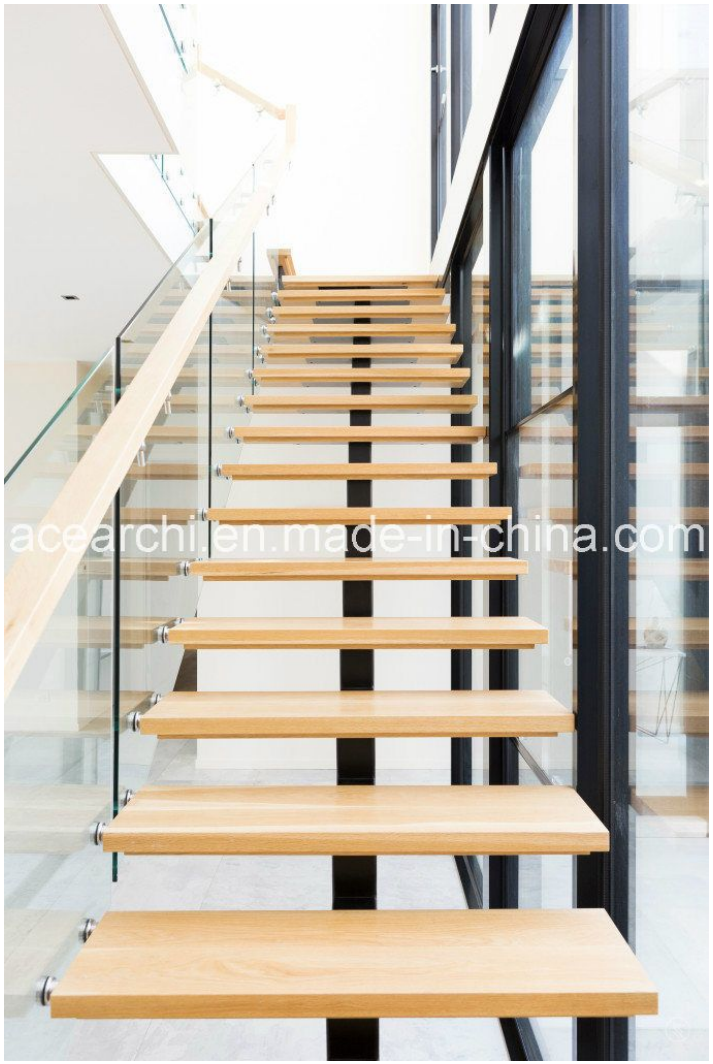
ZÁKLADY STAVEBNÍ MECHANIKY

BDA001

Rovinný šikmý nosník, spojité zatížení šikmého prutu, rozklad šikmého spojitého zatížení, rovinný lomený nosník se šikmými pruty, reakce a diagramy vnitřních sil a momentů. Aplikace na mimostyčníková zatížení rovinných příhradových konstrukcí.

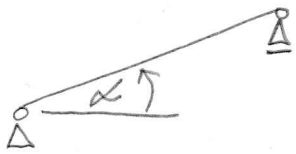
Zdeněk Kala

Šikmý nosník

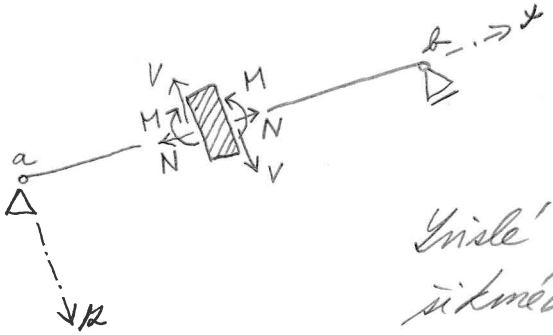


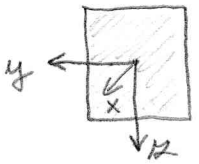
https://onlineschool.cz/statika/vnitrni-sily-v-sikmych-nosnicich/
http://fast10.vsb.cz/michalcova/Statika13/prr_06_13_sikmy.pdf
http://www.zbynekvlk.cz/vyuka/rocnik1/priklady/p8_1/p8_1.html
http://www.kitnarf.cz/education/zidekrostislav/index.php

Šikmý nosník



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



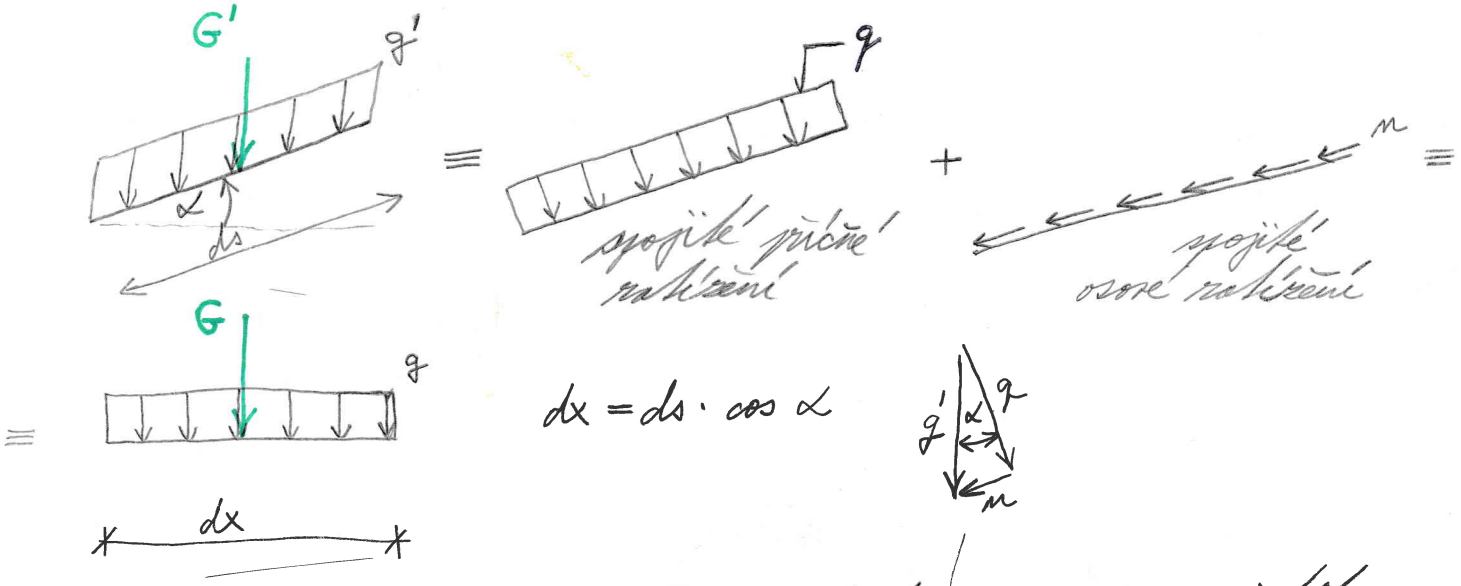


PRŮŘEZ

Šikmé 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.)



$$dx = ds \cdot \cos\alpha$$

$$G = G'$$

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

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

z (1) a (2) (pravé strany)

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

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

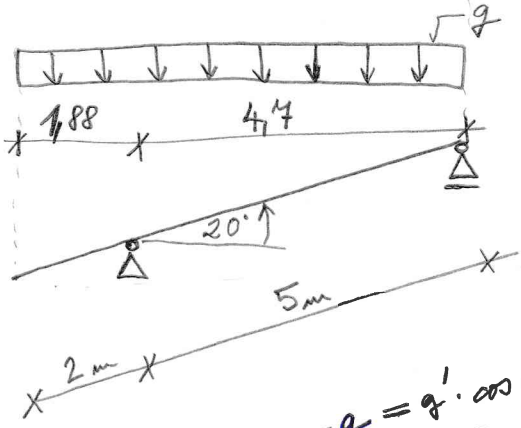
Rozklad svislého spojitého zatížení q' do složky příčné q a osové n

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

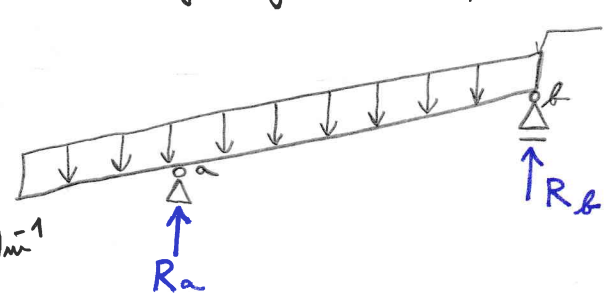
$$n = q' \cdot \sin\alpha = q \cdot \cos\alpha \cdot \sin\alpha$$

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

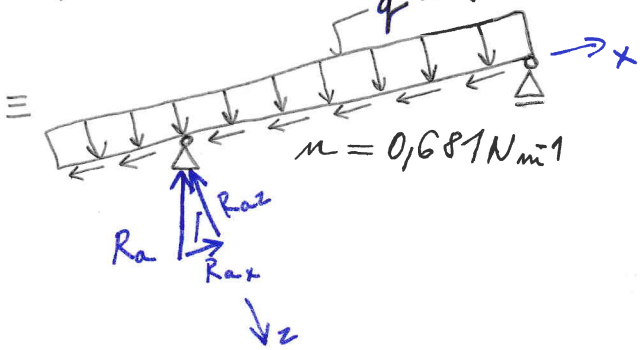
$g = 2{,}12\ kN\,m^{-1}$



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



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



$n = 0{,}681\ N\,m^{-1}$

Reakce:

$\Sigma M_{ib} = 0$

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

$R_a = 3{,}8\ kN$

$\Sigma M_{ia} = a$

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

$R_b = 4{,}2\ kN$

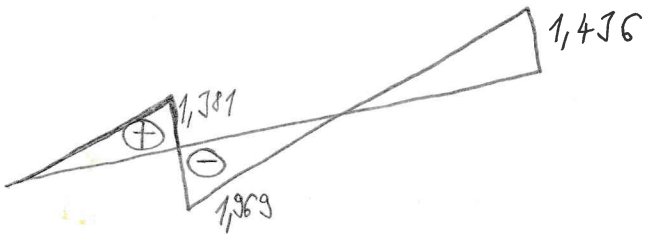
$R_{ax} = R_a \cdot \sin\alpha = 3{,}35\ kN$

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

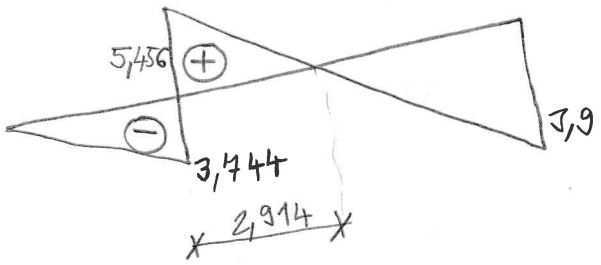
$R_{bx} = R_b \cdot \sin\alpha = 1{,}436\ kN$

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

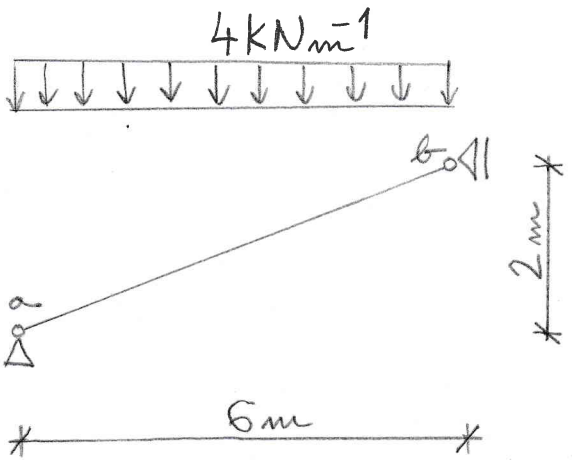
(N)



(V)



$M_{max} = 4{,}16\ kN\,m$



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

$R_b = 36\ kN$

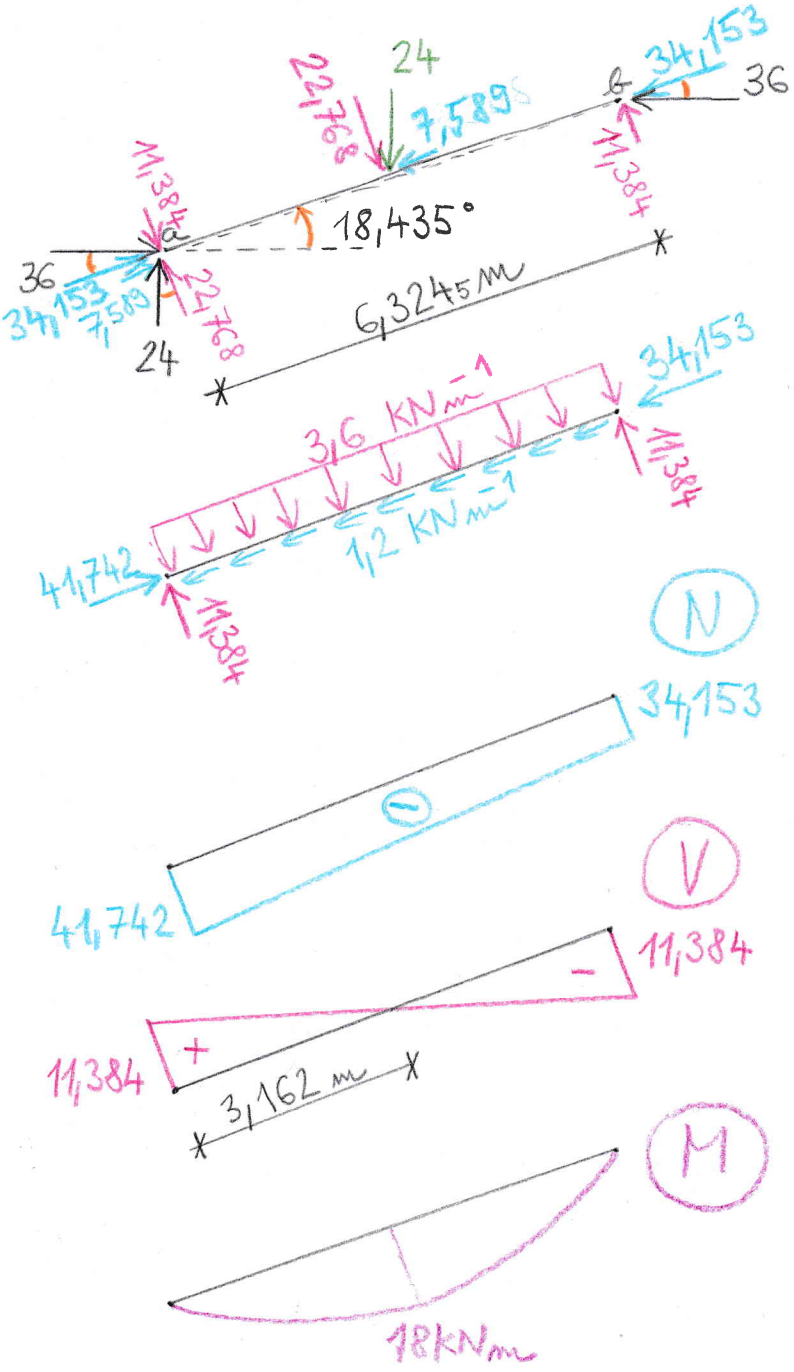
$\Sigma F_x = 0 : H_a - R_b = 0$

$H_a = 36\ kN$

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

$R_a = 24\ kN$

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



$4 \cdot 6 = 24$

$24 \cdot \cos 18{,}435° = 22{,}768$

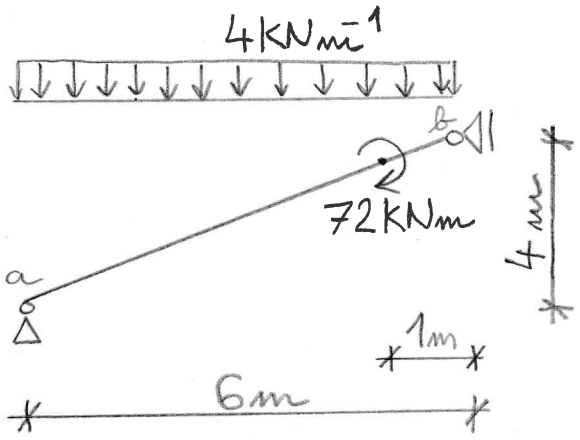
$36 \cdot \sin 18{,}435 = 11{,}384$

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

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

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

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



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

$R_b = 36$

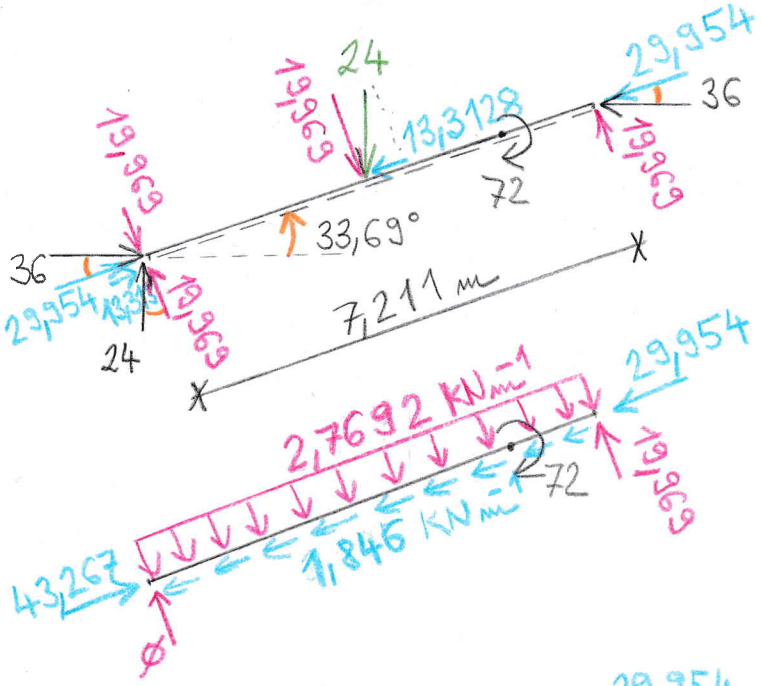
$\Sigma F_x = 0: H_a - R_b = 0$

$H_a = 36\ kN$

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

$R_a = 24$

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



$4 \cdot 6 = 24$

$24 \cdot \cos 33{,}69° = 19{,}969$

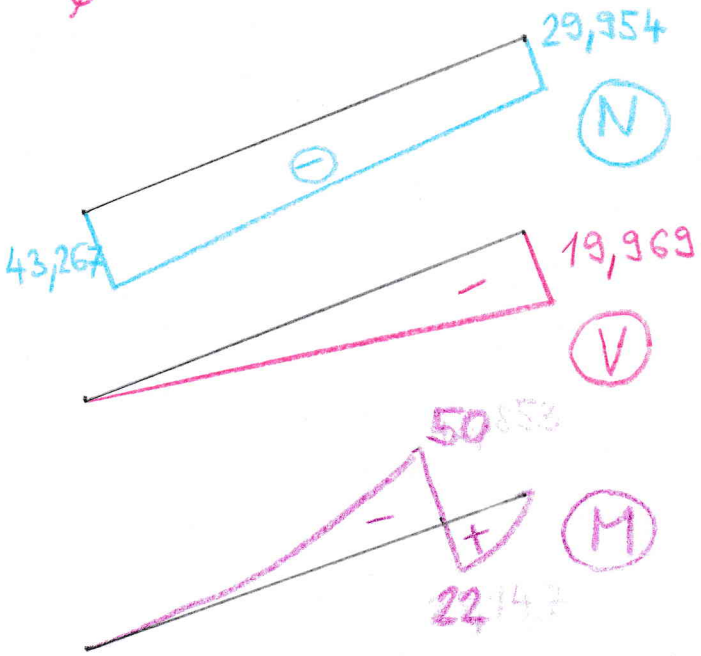
$36 \cdot \sin 33{,}69° = 19{,}969$

$24 \cdot \sin 33{,}69° = 13{,}313$

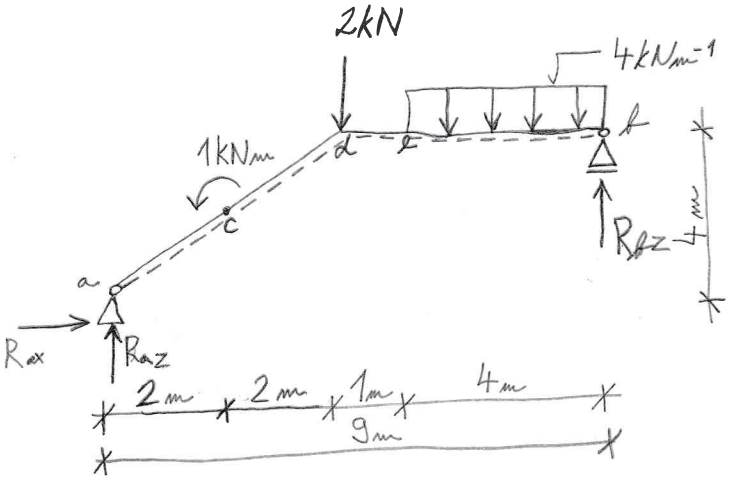
$36 \cdot \cos 33{,}69 = 29{,}954$

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

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



Příklad: Stanovte průběh N, V, M na prostém lomeném nosníku se šikmým prutem o sklonu $\alpha = 45°$



$\Sigma M_a = 0$

$R_b \cdot 9 - 4 \cdot 4 \cdot 7 - 2 \cdot 4 + 1 = 0$

$R_{bz} = 13{,}22\ kN$

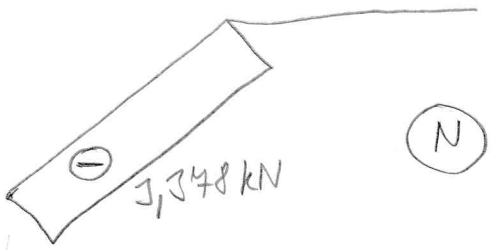
$\Sigma F_z = 0$

$2 + 4 \cdot 4 = R_{az} + R_{bz} \Rightarrow R_{az} = 4{,}77\ kN$

$\Sigma M_b = 0$

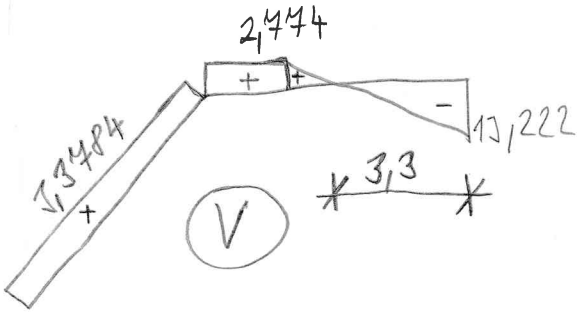
$R_{ax} \cdot 4 + 1 + 2 \cdot 5 + 4 \cdot 4 \cdot 2 - R_{az} \cdot 9 = 0$

$R_{ax} = -0{,}0\ kN$



$N_{ac} = N_{cd} = R_{az} \cdot \sin 45° = 3{,}3729\ kN$

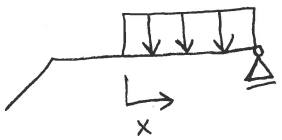
$N_{de} = N_{eb} = 0$

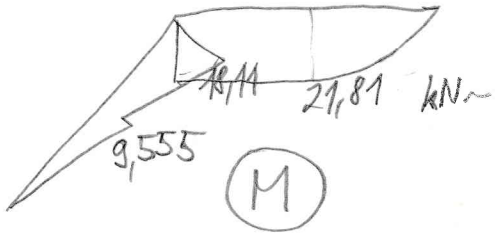


$V_{ac} = V_{cd} = R_{az} \cdot \cos 45° = 3{,}3729\ kN$

$V_{de} = R_{az} - 2kN = 2{,}774\ kN$

$V_{eb} = R_{az} - 2kN - 4 \cdot x$





${}^{L}M_c = R_{az} \cdot \cos 45° \cdot 2{,}828 = 9{,}555\ kNm$

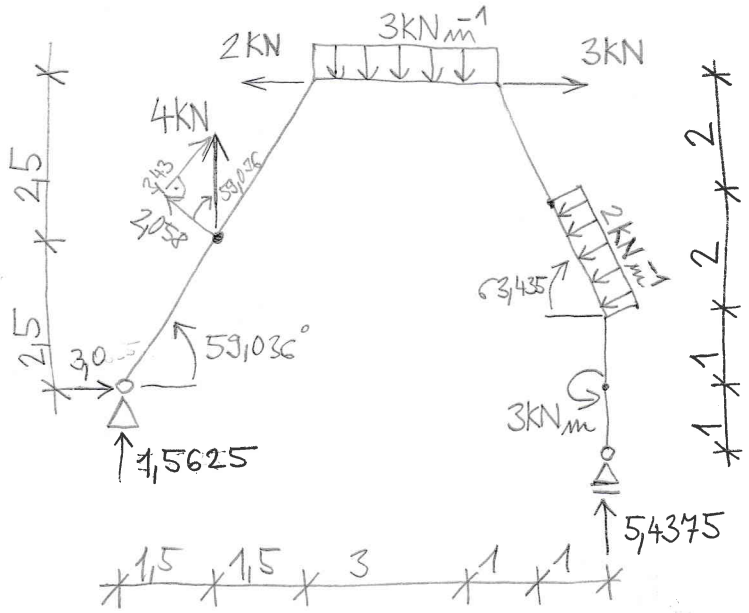
${}^{P}M_c = {}^{L}M_c - 1 = 8{,}555\ kNm$

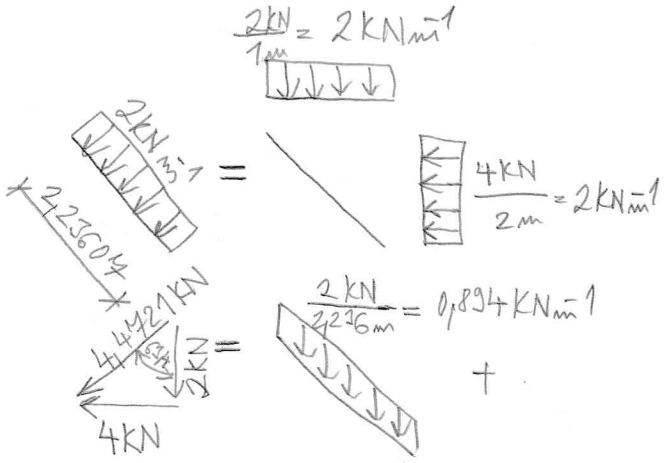
$M_d = R_{az} \cdot \cos 45 \cdot 5{,}656 - 1 = 18{,}11\ kNm$

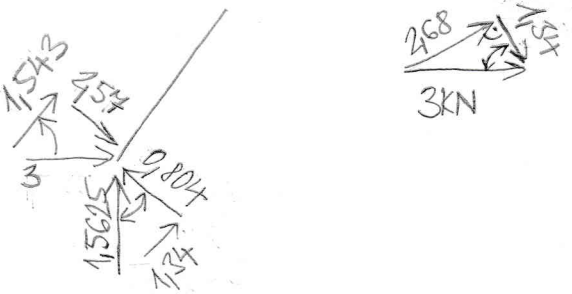
$M_e = 4{,}77 \cdot 5 - 1 - 2 \cdot 1 = 20{,}85\ kNm$

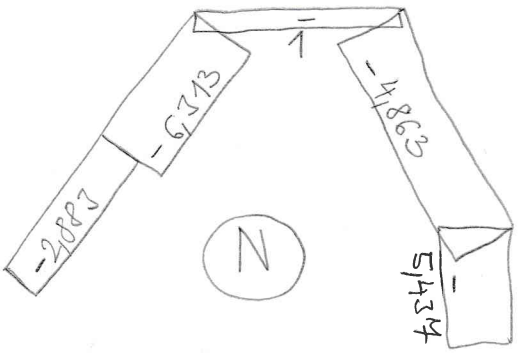
$M_{max} = 4{,}77 \cdot 5{,}7 - 1 - 2 \cdot 1{,}7 - 4 \cdot 0{,}7 \cdot \frac{0{,}7}{2} =$

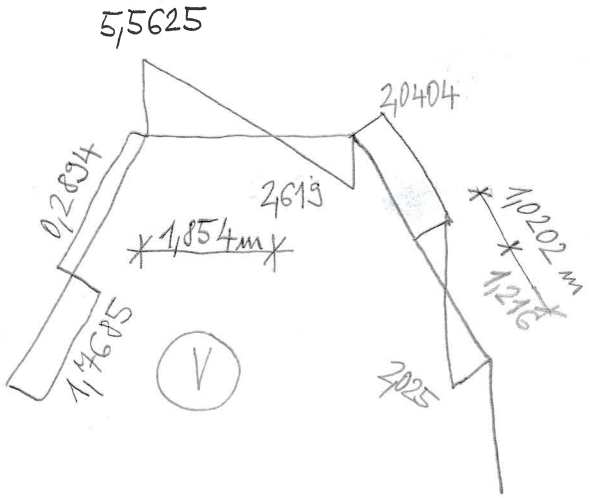
$= 21{,}81\ kNm$

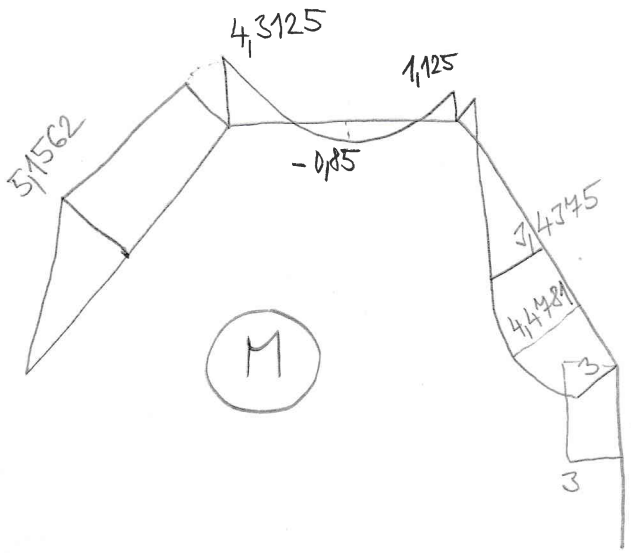

2KN
3KN m⁻¹
3KN
4KN
2,5
2,5
2
2
1
1
59,036°
3KN m
1,5625
5,4375
1,5
1,5
3
1
1

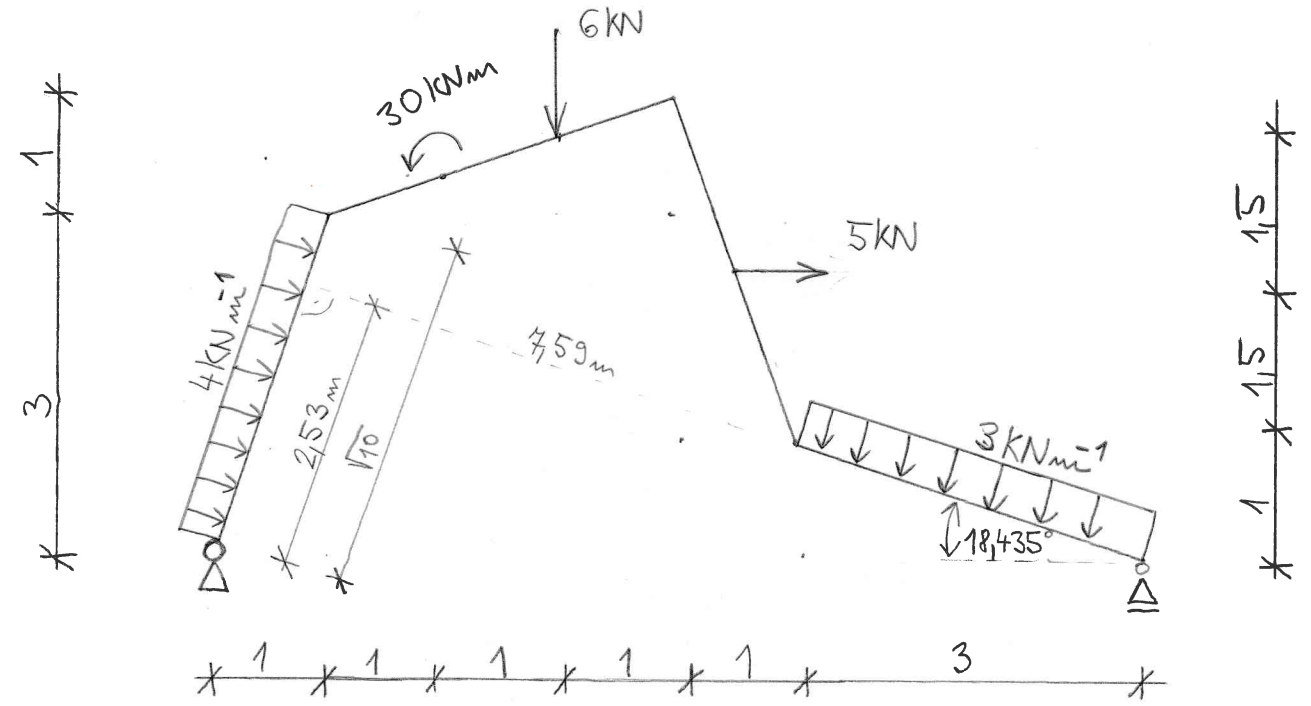

2KN = 2 KN m⁻¹
1m
4KN
2m
= 2KN m⁻¹
4,23604
4,4721KN
2KN
4KN
2 KN
2,236m
= 0,894 KN m⁻¹
+
+
4KN
2,236m
= 1,789 KN m⁻¹

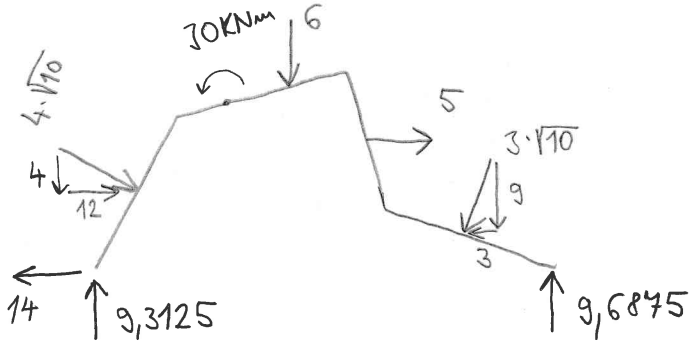

1,5625
0,894
1,34
3KN

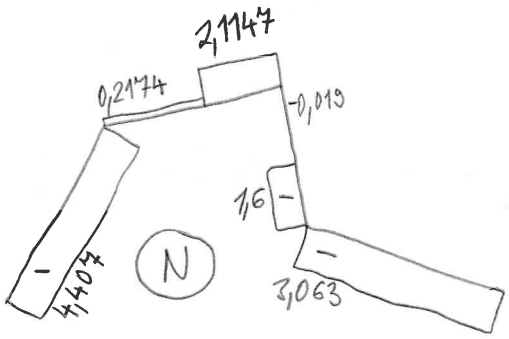

-2,683
-6,313
-4,863
5,4375
N

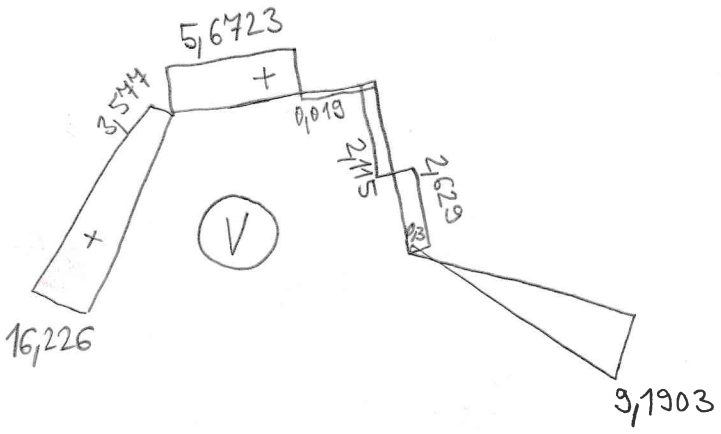

5,5625
2,0404
0,2894
2,619
1,854m
1,0202 m
1,216
1,4685
2,025
V

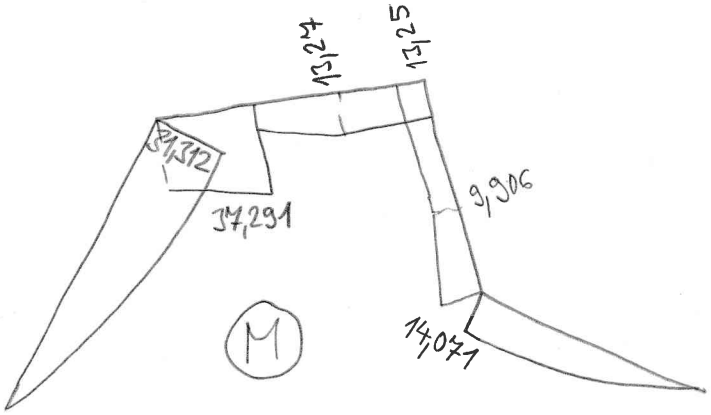

4,3125
1,125
5,1562
-0,85
1,4775
4,4481
3
3
M


6kN
30kNm
5kN
4kNm⁻¹
3kNm⁻¹
2,53m
√10
7,59m
18,435°
1
3
1,5
1,5
1,5
1
1 1 1 1 1 3


30kNm
6
5
4·√10
4
12
3·√10
9
3
14
9,3125
9,6875


2,1147
0,2174
-0,019
1,6
4,407
3,063
N


5,6723
3,544
0,019
2,115
2,629
16,226
9,1903
V


13,24
13,25
9,312
17,291
9,906
14,071
M