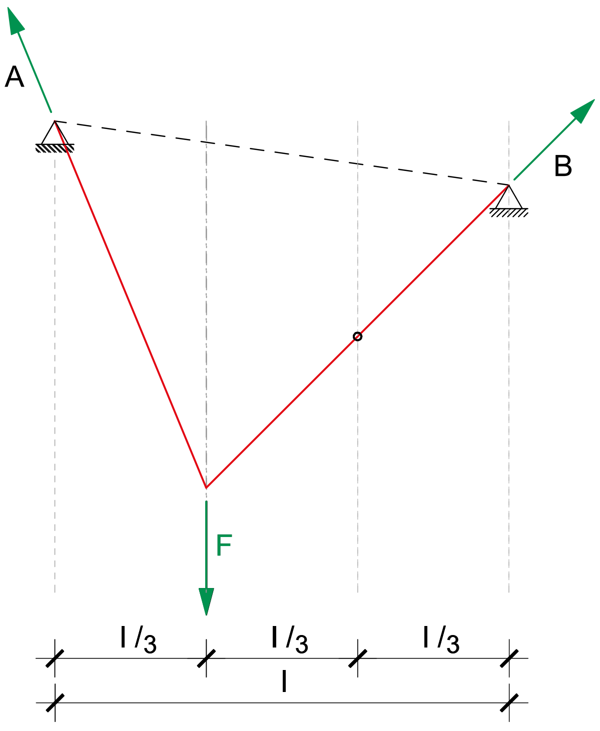
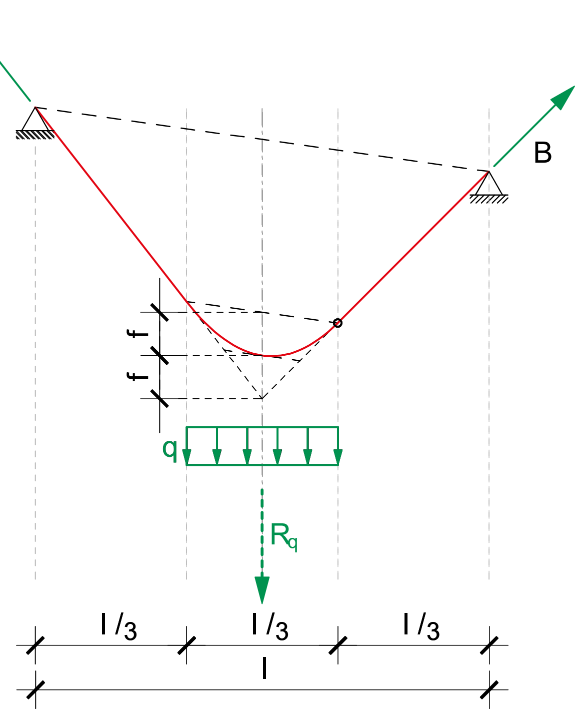
Task 1 Funicular form

For scenarios a) to d), find the funicular form through the given point and draw it in the respective form diagram. Draw the direction of the reaction force in the form diagram.

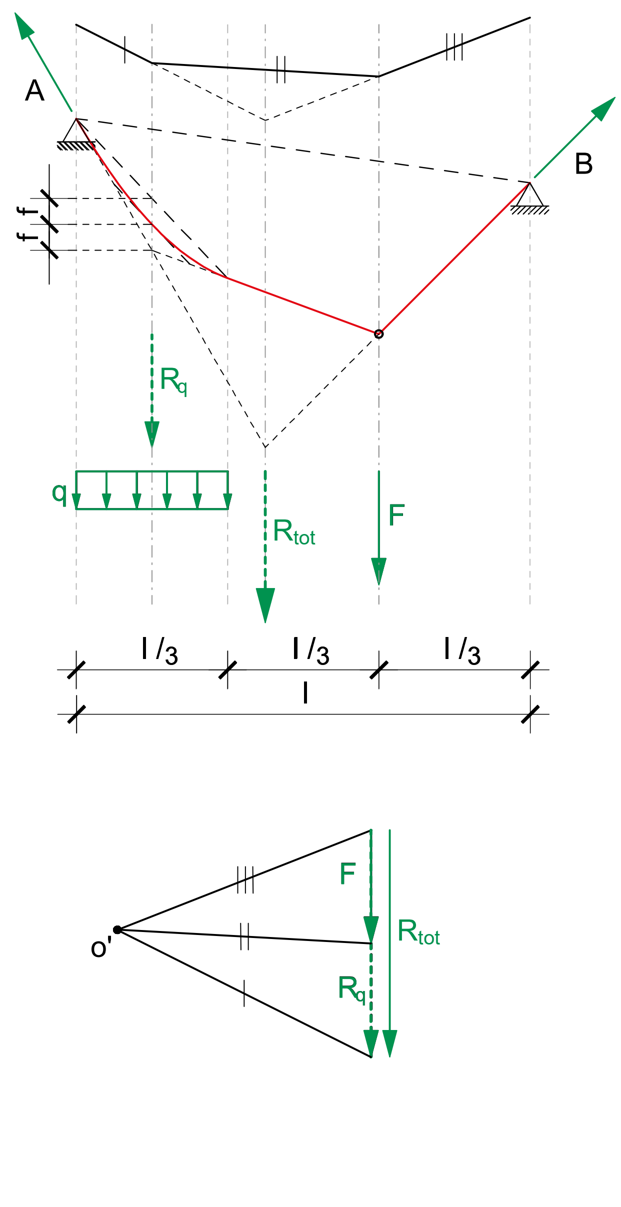
a)



b)

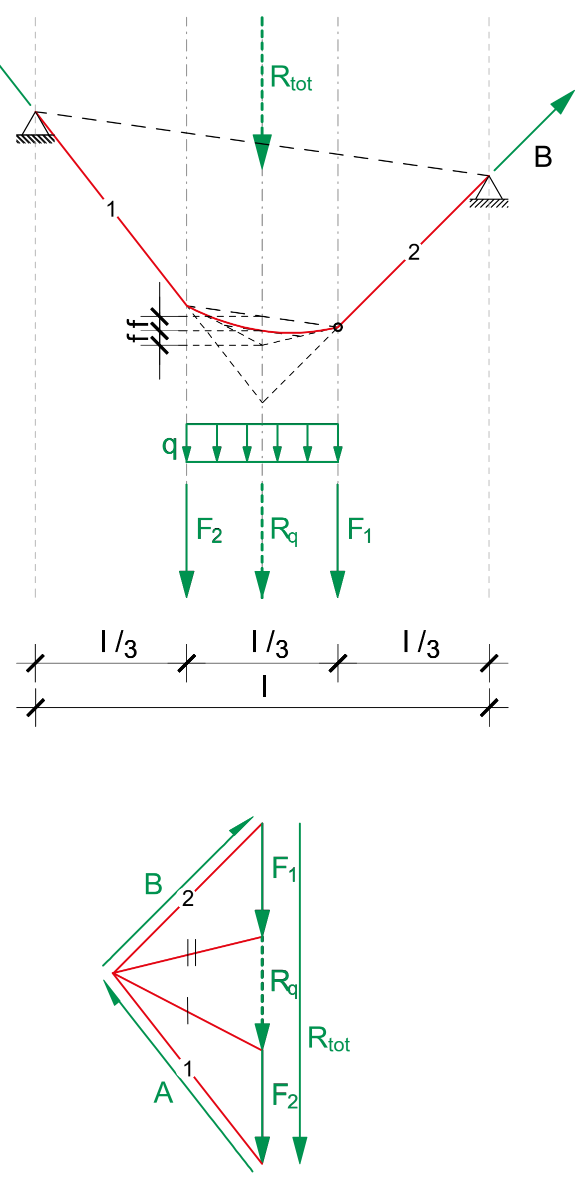


c)



trial funicular

d)



force diagram

Task 2.1 Calculate Loads

a) Find the designed area load $\overline{s}_d$ [kN/m2] according to the example below.
b) Find the designed line load s_d [kN/m]. The suport walls have a distance from 5m.
c) Calculate the point load (Resultant).

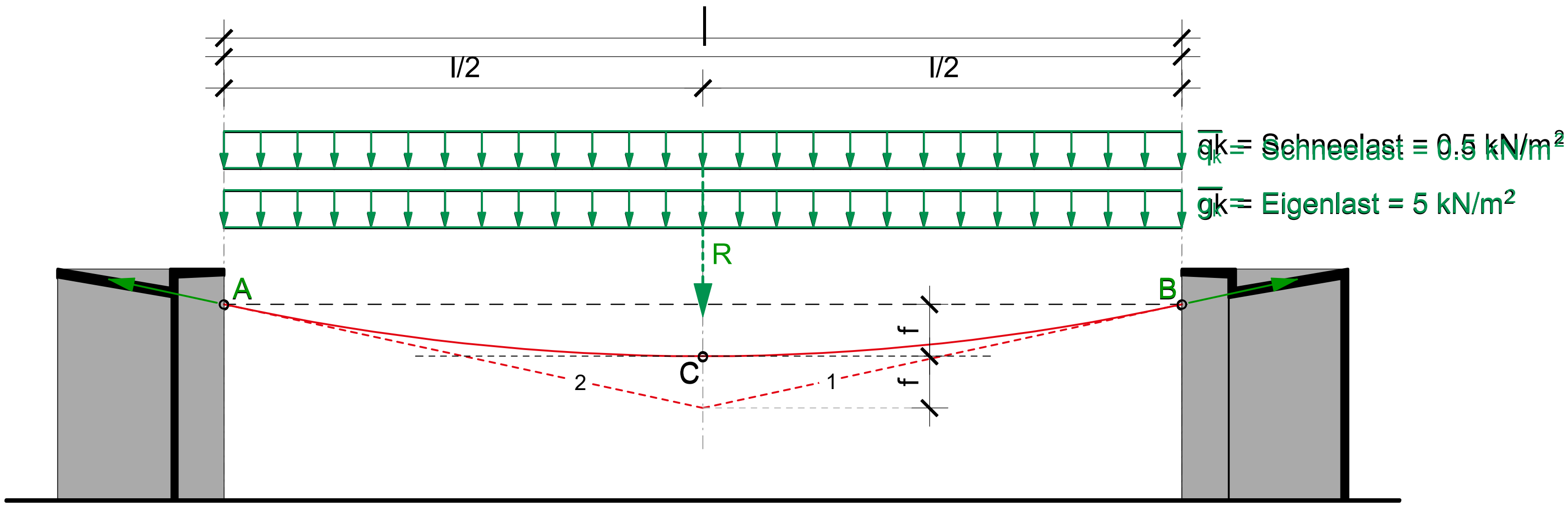
a) $\overline{s}_d = \overline{g}_k \cdot \gamma_G + \overline{q}_k \cdot \gamma_Q$
$\overline{s}_d = 5\ kN/m^2 \cdot 1.35 + 0.5\ kN/m^2 \cdot 1.5 = \mathbf{7.5\ kN/m^2}$

b) $s_d = \overline{s}_d \cdot b$
$s_d = 7.5\ kN/m^2 \cdot 5\ m = \mathbf{37.5\ kN/m}$

c) $R = s_d \cdot l$
$R = 37.5\ kN/m \cdot 65\ m = \mathbf{2437.5\ kN}$

Task 2.2 Designing and Detailing a Suspended Roof

a) Find the roof form (cable) through points A, B and C and the maximum inner forces for the hanging roof. Draw the related form and force diagrams. Draw the direction and determine the magnitude of the reaction force. Indicate tension forces with red and compression forces with blue.
b) How do the stresses in the cable change for the same form but the duplicate load? Draw the new force diagram and indicate the stresses.



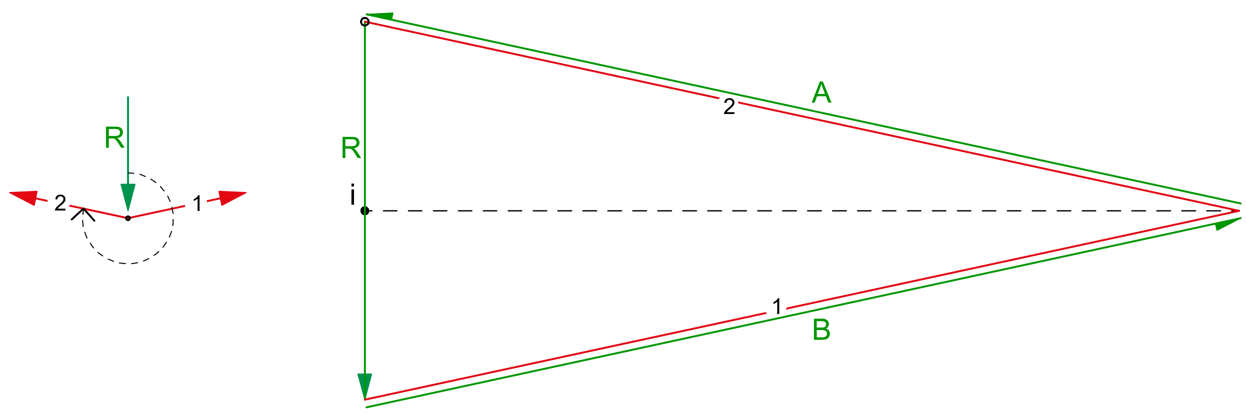
Form Diagram 1:500

Wall every 5 m

a)

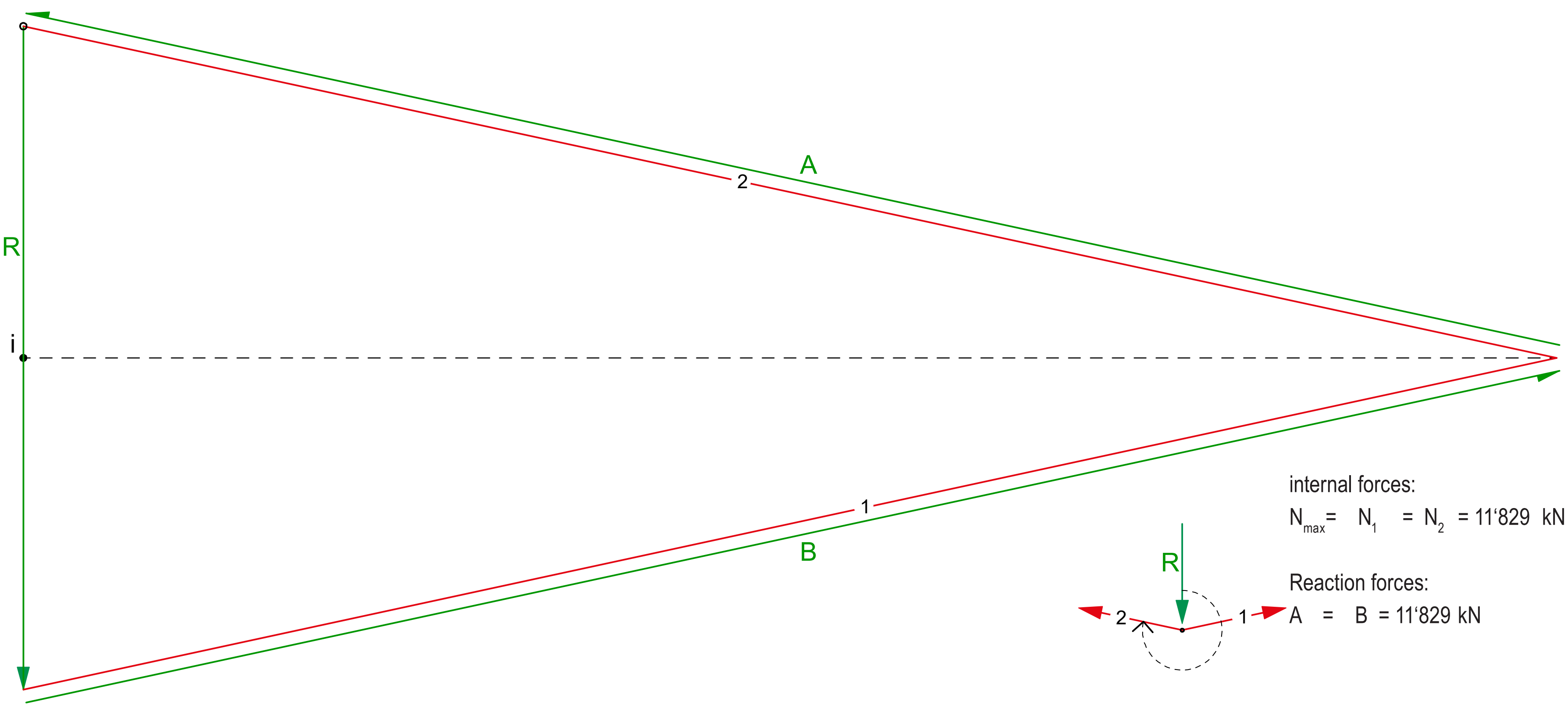
internal forces:
$N_{max} = N_1 = N_2 =$ 5915 kN

Reaction forces:
A = B = 5915 kN



Force Diagram 1cm ≙ 500kN

b)



internal forces:
$N_{max} = N_1 = N_2 =$ 11'829 kN

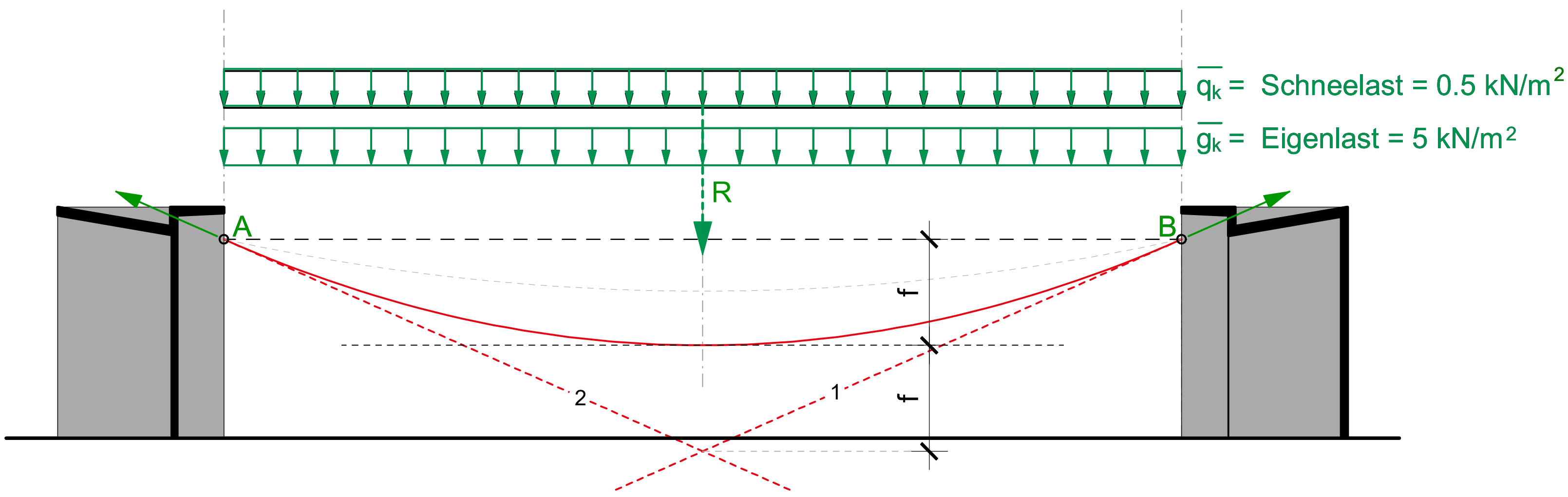
Reaction forces:
A = B = 11'829 kN

Force Diagram 1cm ≙ 500kN

Task 2.3 Designing and Detailing a Suspended Roof by means of the Maximum Stress in the Structure

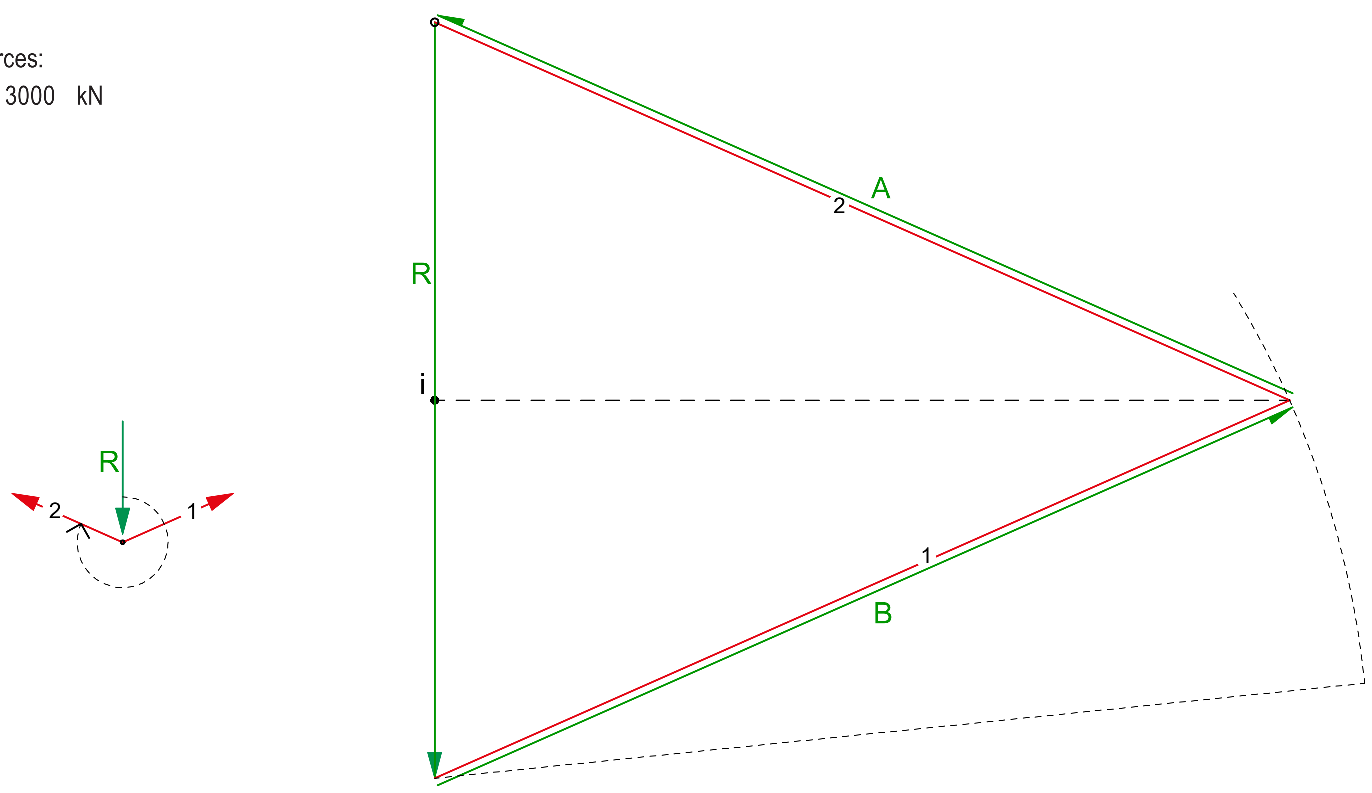
a) How does the form from 2.2 a) change if the maximum cable force is $N_{d,max}$ = 3000 kN ? Draw the corresponding form and force diagrams. Draw the direction and determine the magnitude of the reaction force. Indicate tension forces with red and compression forces with blue.

b) Calculate the rope diameter due to the maximum cable force made of steel S235.



Form Diagram 1:500

Reaction forces:
A = B = 3000 kN



Force Diagram 1cm ≙ 250kN

b) $N_{d,max}$ = 3'000'000 N
f_{td} = 223.8 N/mm²

A_{req} = N_d / f_{td} = 13'404.8 mm²
D = $\sqrt{4 \cdot A / \pi}$ = 131 mm

The smaller the axial force N_{max}, the bigger the sag of the cable.

Additional Task

Suspension bridge Sigriswil

a) Calculate the total line load s_d on the dimensioning level for the main cable considering the safety factors. Then calculate the total resultant point load R. Assume the constant area load is $\overline{g}_k$ = 1.0 kN/m², while the live load makes $\overline{q}_k$ = 0.7 kN/m².

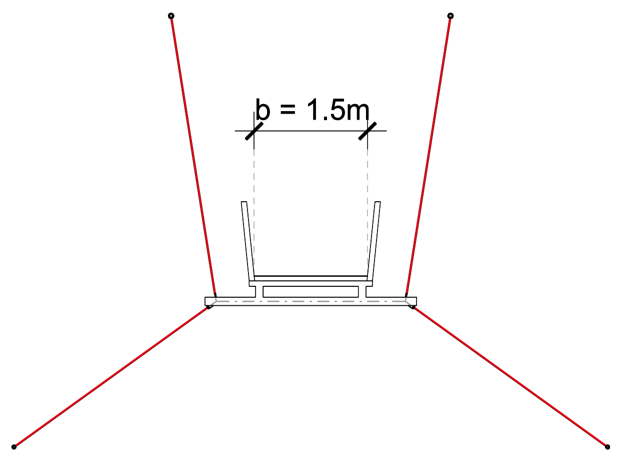
$\overline{s}_d = \overline{g}_k \cdot \gamma_G + \overline{q}_k \cdot \gamma_Q$

$\overline{s}_d = 1.0\ \text{kN/m}^2 \cdot 1.35 + 0.7\ \text{kN/m}^2 \cdot 1.5 = \mathbf{2.4\ kN/m^2}$

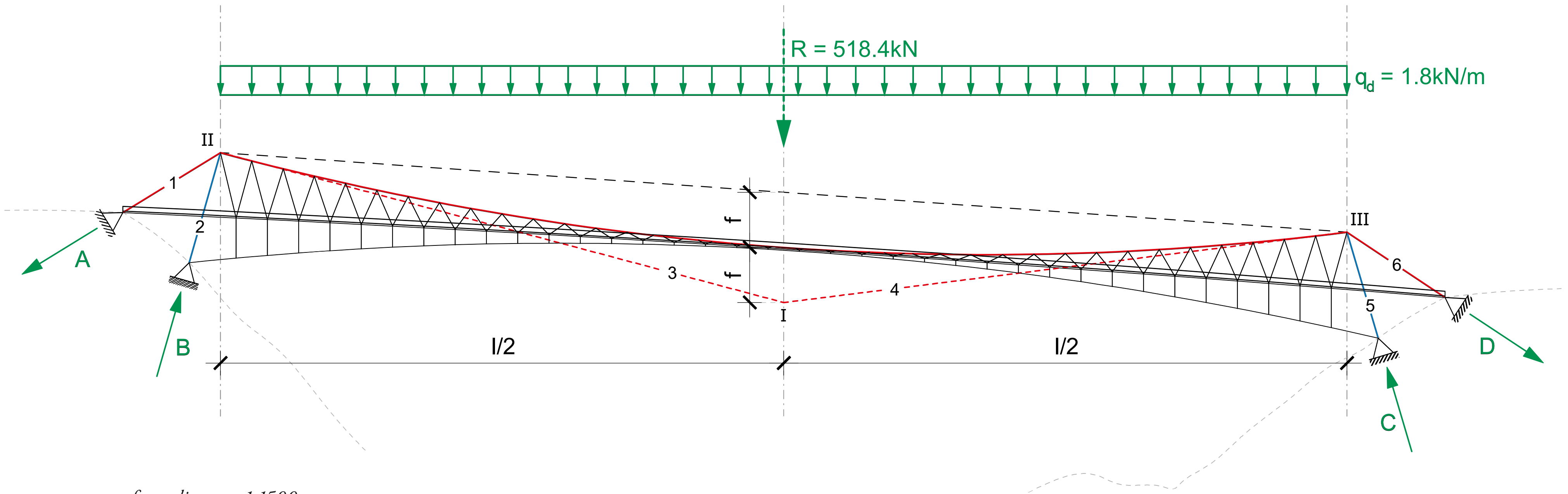
$s_d = \overline{s}_d \cdot b = 2.4\ \text{kN/m}^2 \cdot 0.75\ \text{m} = \mathbf{1.8\ kN/m}$

$R = s_d \cdot l = 1.8\ \text{kN/m} \cdot 288.2\ \text{m} = \mathbf{518.4\ kN}$

b) Find the maximum stress in the cable, the support reaction forces and the forces in the pylons and backstays assuming that the bearing cable (top cable) represents a parabola. Determine the stress type (tension/compression) for each case and indicate it (red/blue).

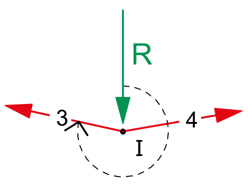


cross section 1:100

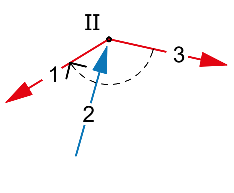


form diagram 1:1500

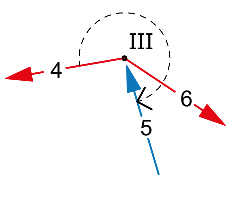
main cable:
N_3 = 1'370 kN
N_4 = 1'334 kN
pylon:
N_2 = -1'465 kN
N_5 = -1'359 kN
grouted anchor:
N_1 = 2'022 kN
N_6 = 2'053 kN
support reaction:
A = 2'022 kN
B = 1'465 kN
C = 1'359 kN
D = 2'053 kN



node I

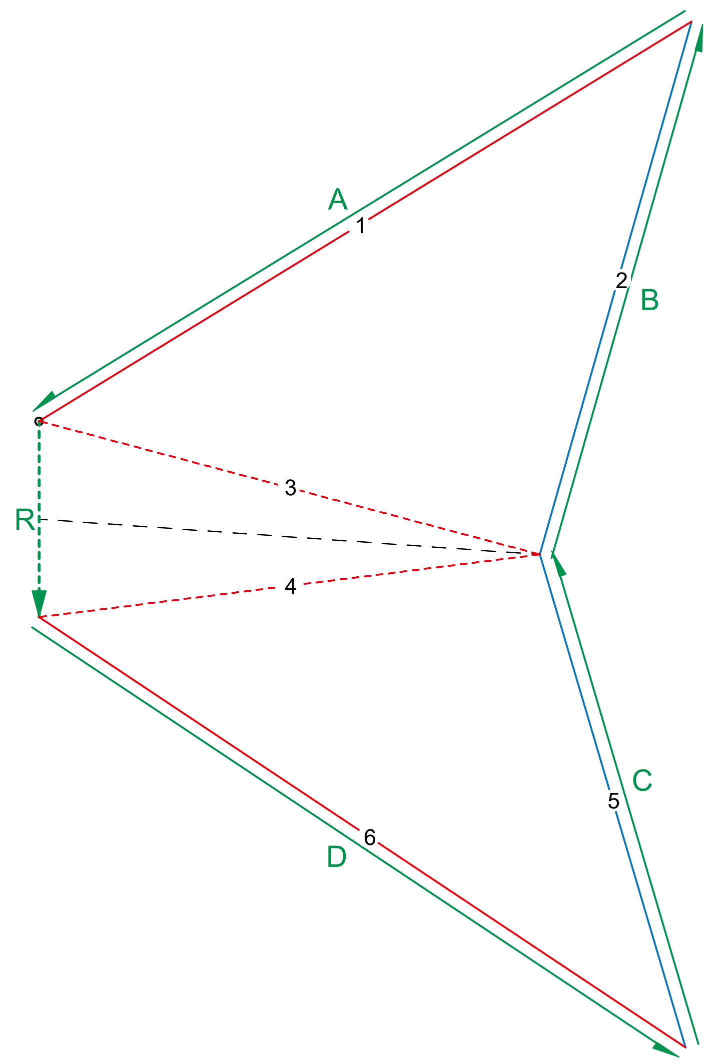


node II



node III

Subsystem



force diagram 1cm ≙ 200kN