EX 1 Equilibrium

Structural Design I – HS 17

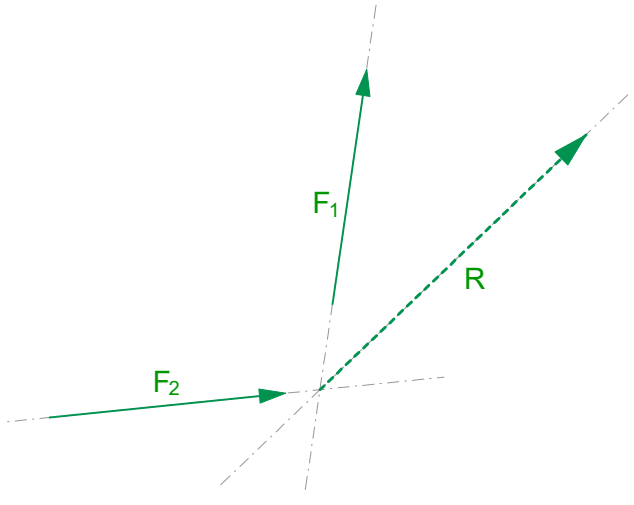
Lösungsvorschlag

Proposal for solution

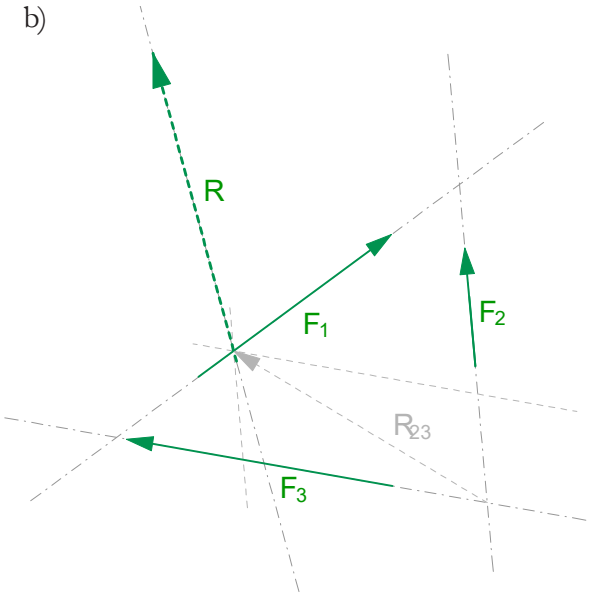
Task 1 Adding and Decomposing Forces

Find the position and magnitude of the resultant force R in a) and b) by means of graphic statics. Decompose the force R given in c) in horizontal and vertical force components F_H and F_V.

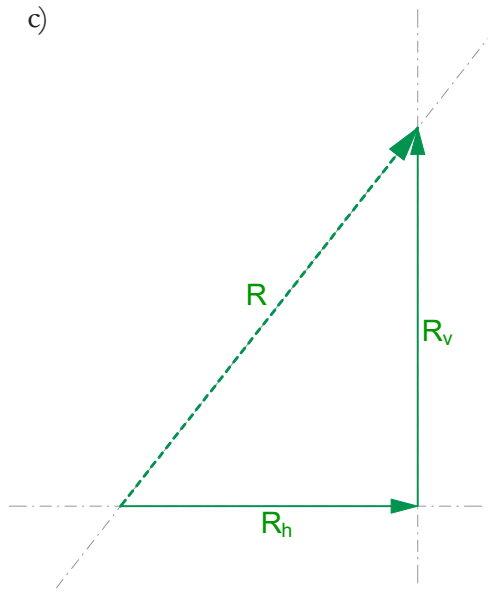
a)



b)

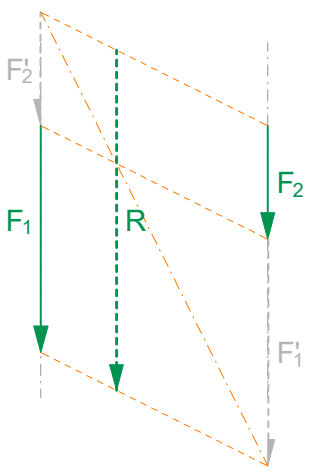


c)



Task 2 The Resultant of Parallel Forces

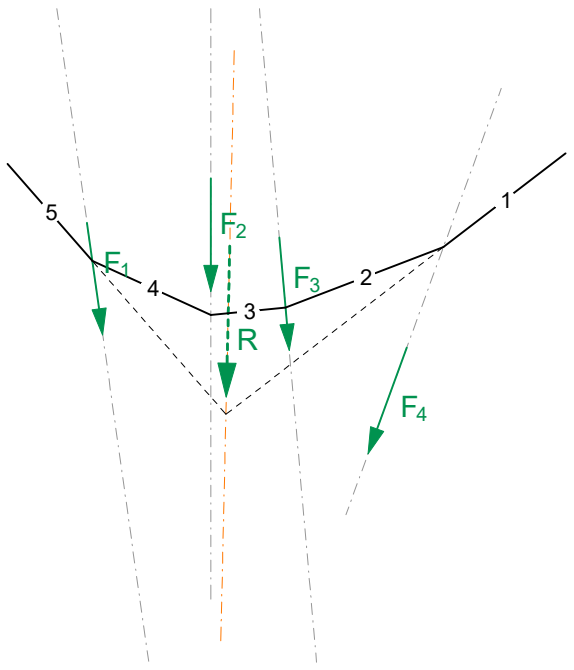
Find the position and magnitude of the resultant with the help of the proportion rule and draw it in the given case.



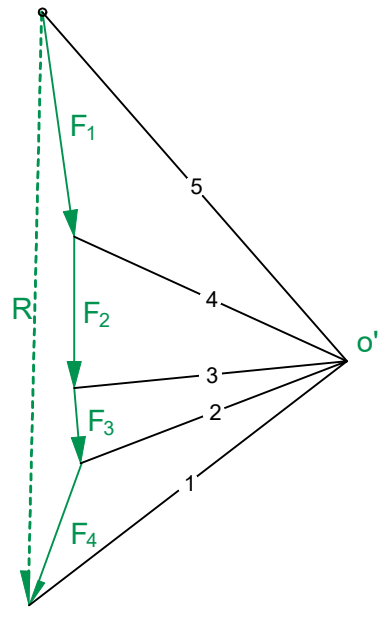
Task 3 The Resultant of a set of Forces Acting in Any Direction

Find the resultant with the help of the trial funicular polygon.

F_1 = 45 kN
F_2 = 30 kN
F_3 = 15 kN
F_4 = 30 kN



form diagram
1:50



force diagram
1cm ≙ 15kN

EX 1

Structural Design I – HS 17

Equilibrium

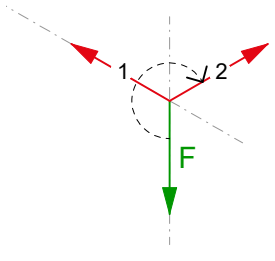
Lösungsvorschlag

Proposal for solution

Task 4 Drawing the Subsystems

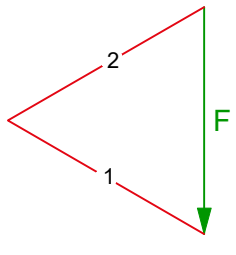
Draw a corresponding force diagram for each subsystem (a-f). Determine the magnitude [kN] for each force and draw its direction in subsystem. Indicate tension forces with red and compression forces with blue colour. Explain the solution in situation e).

a)



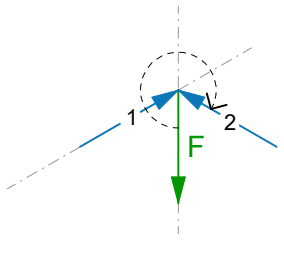
subsystem

F = 30 kN
N_1 = 30 kN
N_2 = 30 kN



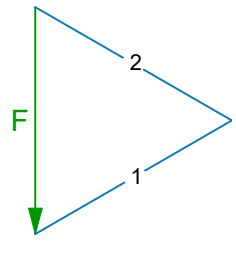
force diagram
1cm ≙ 10kN

b)



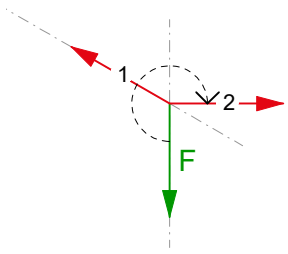
subsystem

F = 30 kN
N_1 = -30 kN
N_2 = -30 kN



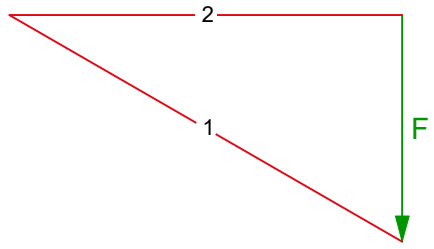
force diagram
1cm ≙ 10kN

c)



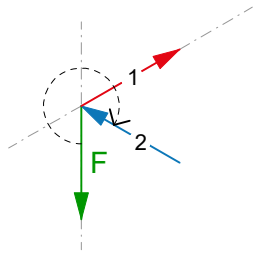
subsystem

F = 30 kN
N_1 = 60 kN
N_2 = 52 kN



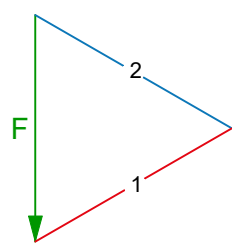
force diagram
1cm ≙ 10kN

d)



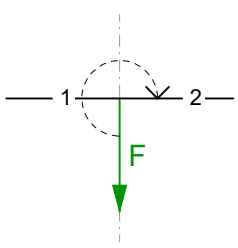
subsystem

F = 30 kN
N_1 = 30 kN
N_2 = -30 kN



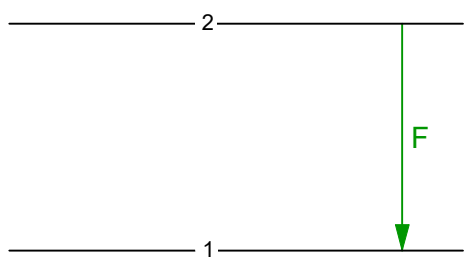
force diagram
1cm ≙ 10kN

e)



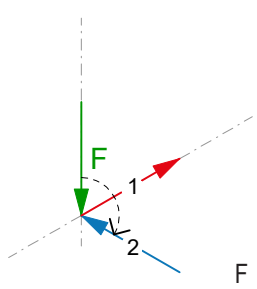
subsystem

F = 30 kN
N_1 = ∞ kN
N_2 = ∞ kN



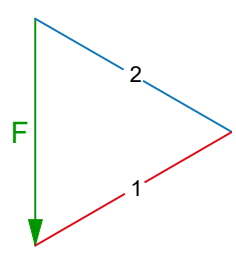
force diagram
1cm ≙ 10kN

f)



subsystem

F = 30 kN
N_1 = 30 kN
N_2 = -30 kN



force diagram
1cm ≙ 10kN

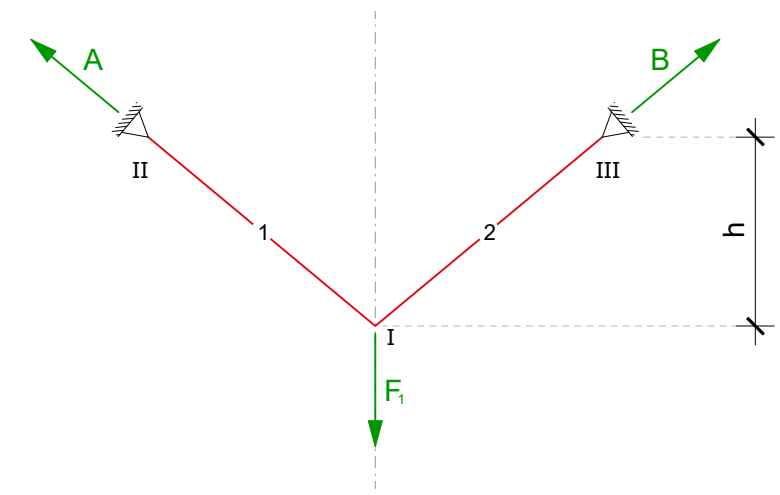
Explanation for e):

The solution is not possible. The parallel lines cross at infinite, which means the forces are also infinitely big.

Additional Task 1 Drawing the Force Diagrams

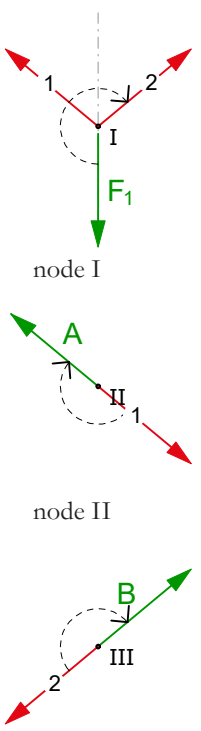
Draw a corresponding subsystem and a force diagram for each case (a-c). Determine the magnitude of the reaction forces and the maximum force in kN.

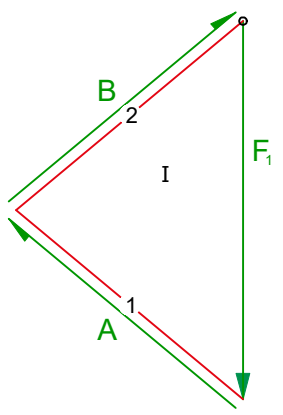
a)



F_1 = 100 kN
A = 78 kN
B = 78 kN
$N_{max} = N_2 = N_1$ = 78 kN

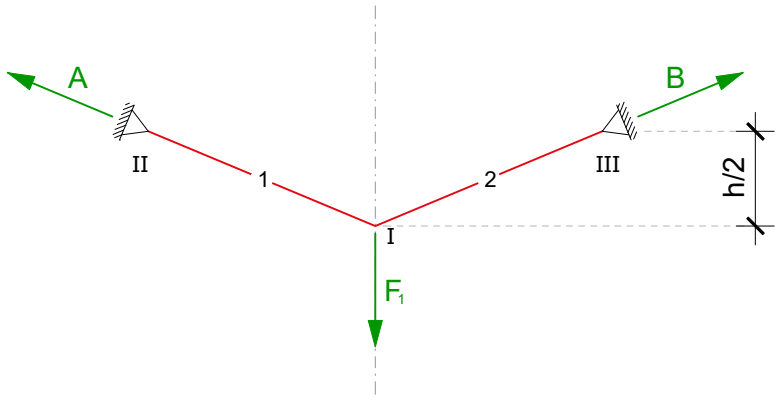
form diagram
1:50





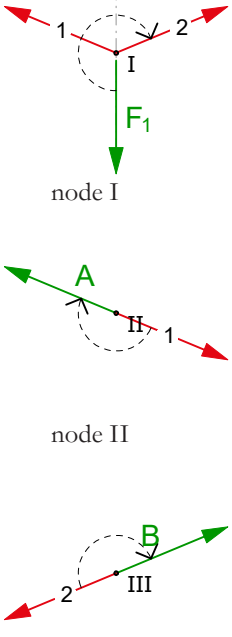
force diagram
1cm ≙ 20kN

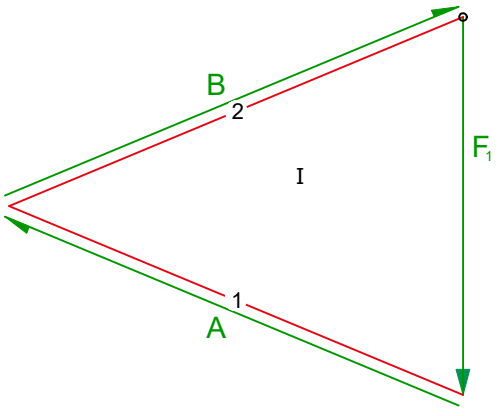
b)



F_1 = 100 kN
A = 130 kN
B = 130 kN
$N_{max} = N_2 = N_1$ = 130 kN

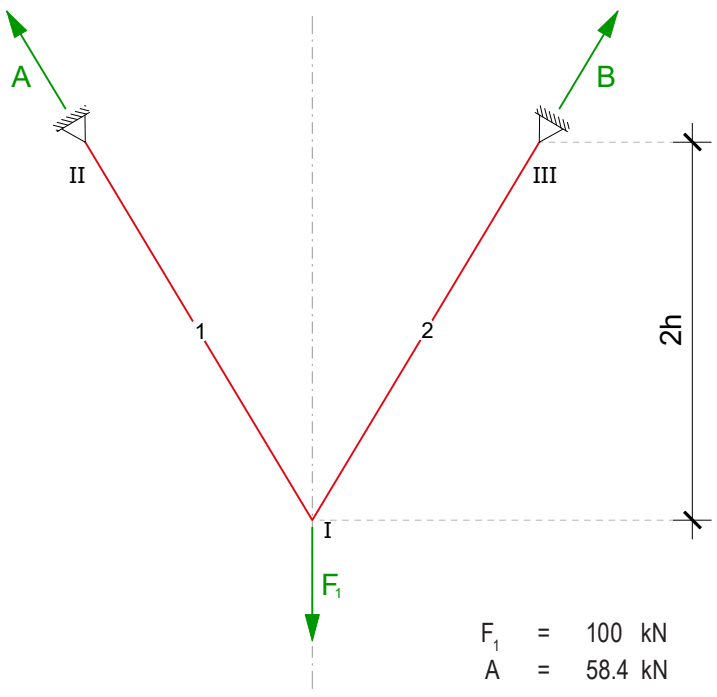
form diagram
1:50





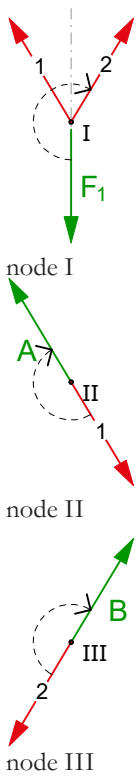
force diagram
1cm ≙ 20kN

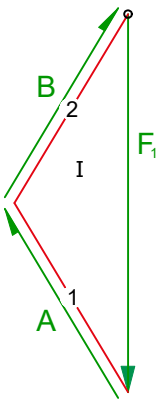
c)



F_1 = 100 kN
A = 58.4 kN
B = 58.4 kN
$N_{max} = N_2 = N_1$ = 58.4 kN

form diagram
1:50





force diagram
1cm ≙ 20kN

d) How does the geometry of the structural system correspond with the magnitude of the force?

The shallower the structural system (h), the bigger the forces.