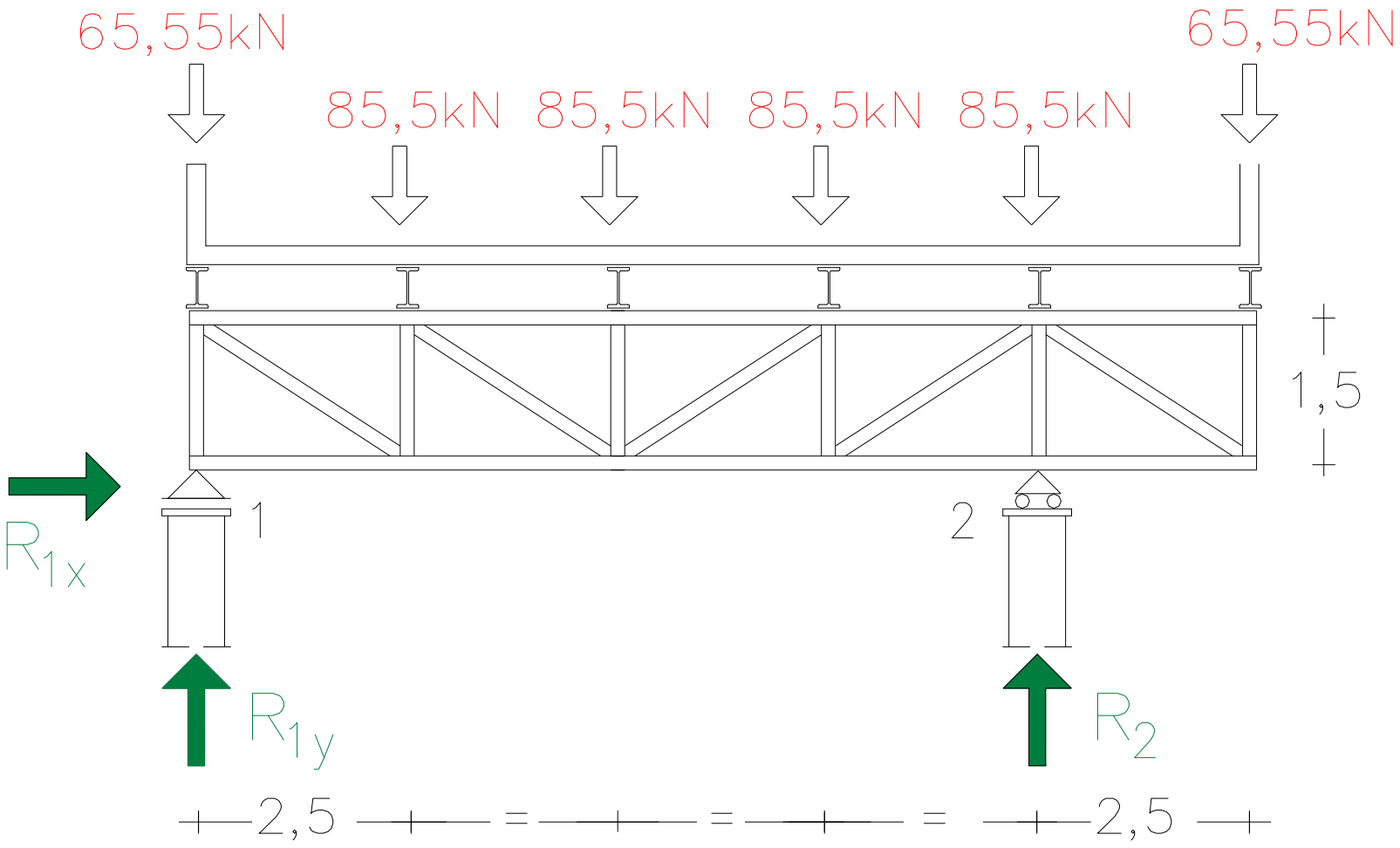
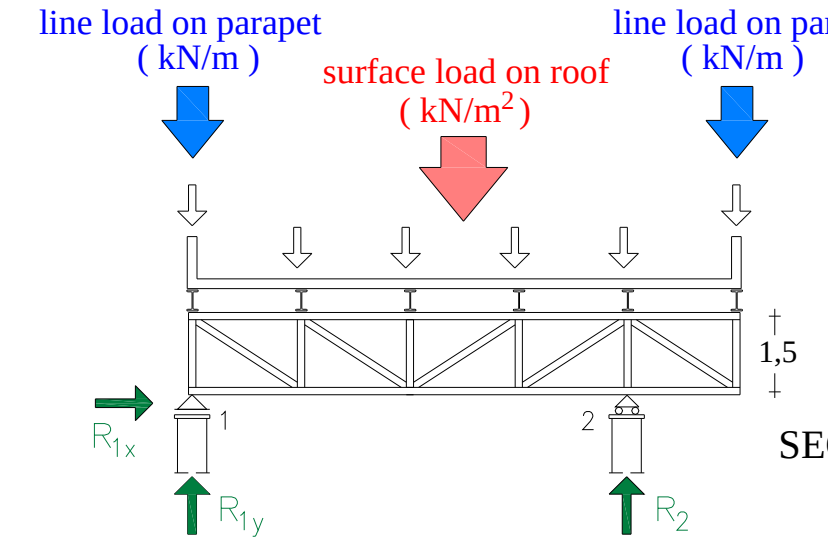
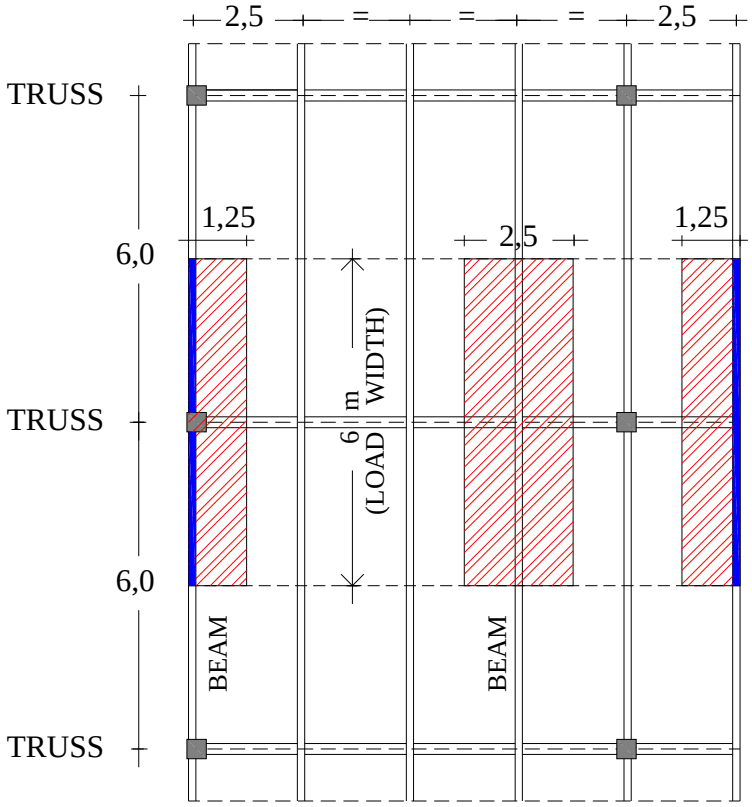
statically determinate trusses: elementary pararell-chords truss





SECTION



PLAN

ACTIONS (EUROCODE 1 & CTE)

SURFACE LOAD ON ROOF, kN/m^2

PERMANENT LOADS

- SELF WEIGHT OF COMPOSITE SLAB
- STEEEL STRUCTURE CONTRIBUTION
- ROOF SLOPES
- WATERPROOFING
- PAVEMENT

VARAIABLE LOADS

- IMPOSED LOAD
- SNOW LOAD

LINE LOAD ON ROOF PARAPET, kN/m

PERMANENT LOAD

- SELF WEIGHT

Actions on roof structure (Eurocode 1 & Spanish CTE-DB-SE-AE)

PERMANENT LOADS:

Self-weight of structure	
- composite slab (7 + 7 cm) ……....	**2,25 kN/m²**
- steel structure contribution ……..	**0,25 kN/m²**
Self-weight of construction works	
- roof slopes (light weight concrete 10 cm).....	**0,75 kN/m²**
- waterproofing (double asphalt membrane) …..	**0,15 kN/m²**
- pavement (tiles, 5 cm total thickness) …....	**0,80 kN/m²**

VARIABLE LOADS:

Imposed load (maintenance/repair accessible)..	**1,00 kN/m²**
Snow load (h<1000m) …. 0,5·1,0 kN/m² ……...	**0,50 kN/m²**

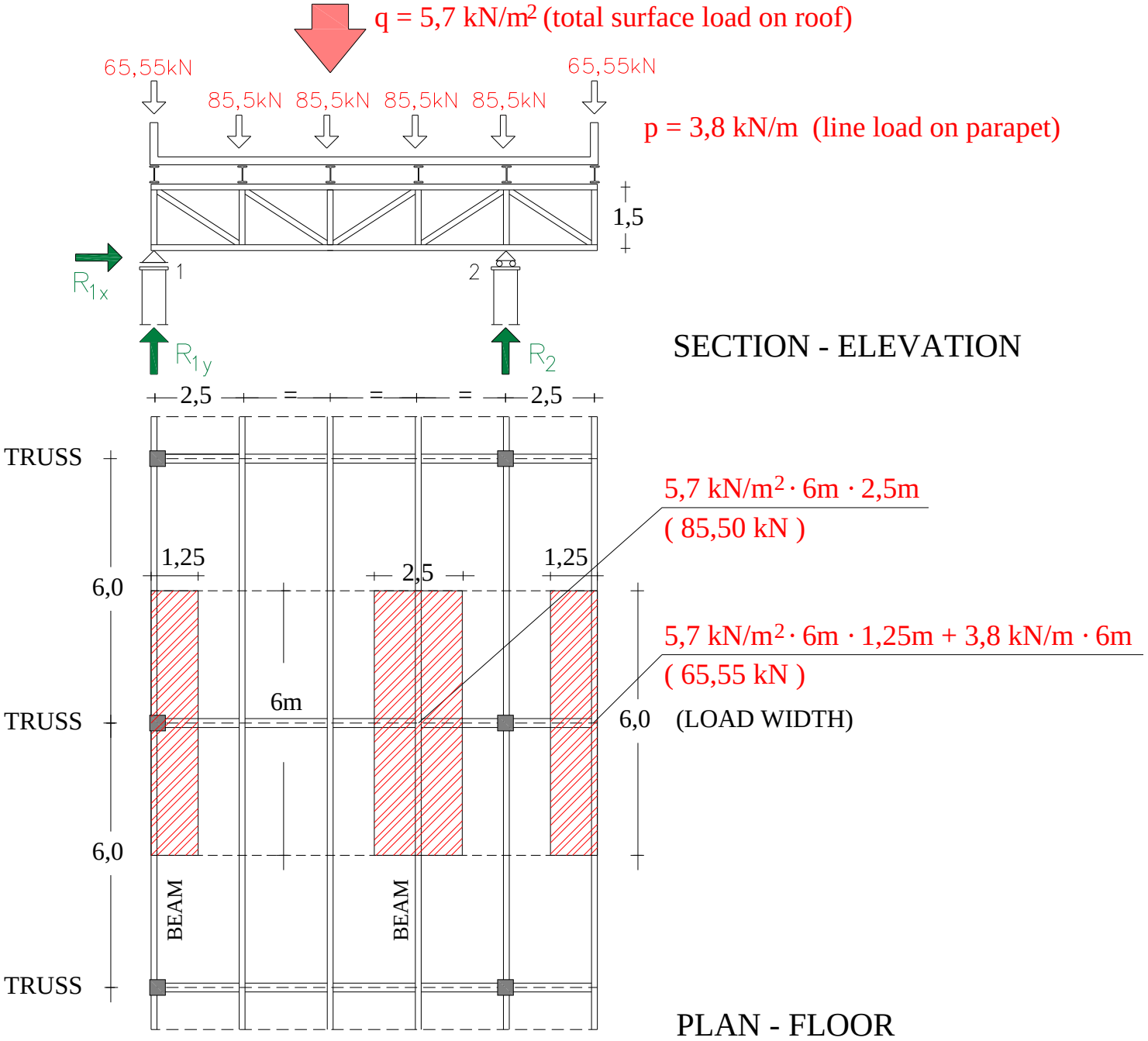
TOTAL SURFACE LOAD ON THE ROOF…..... 5,70 kN/m²

Actions on roof parapets (Eurocode 1 & Spanish CTE-DB-SE-AE)

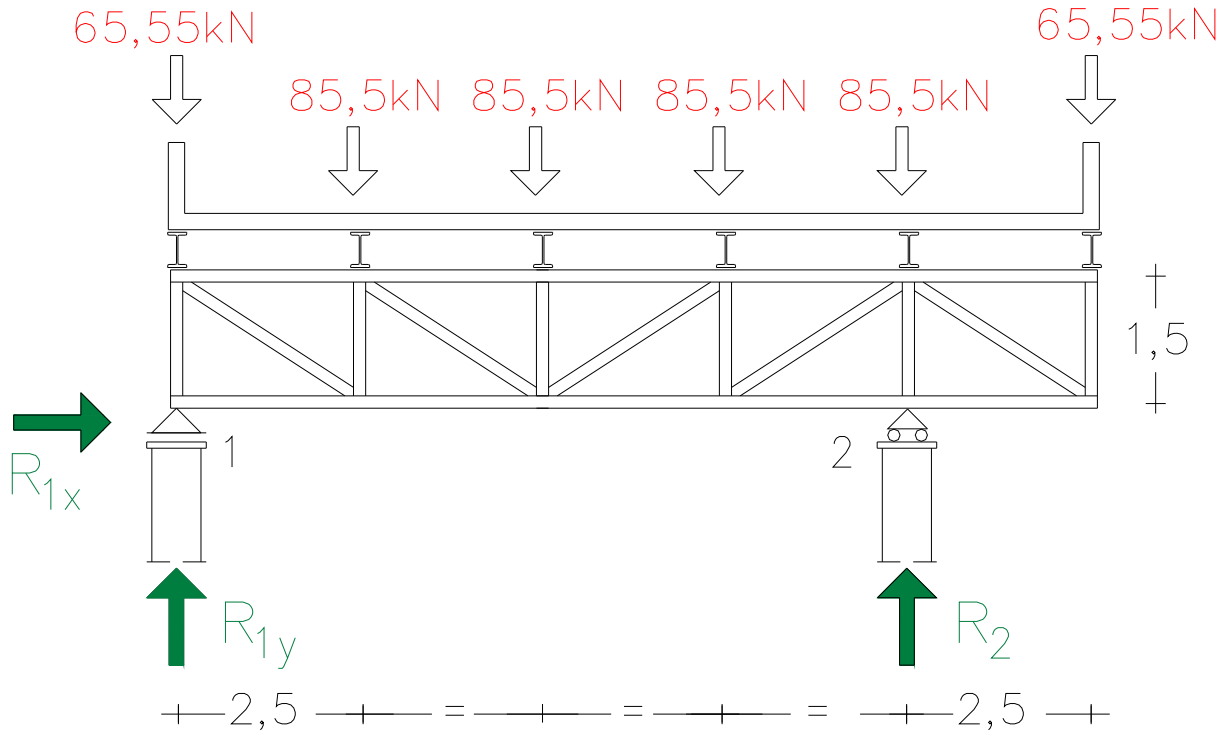
PERMANENT LOAD

- Self-weight (one foot brick; h=1m) …….. 3,80 kN/m

TOTAL LINE LOAD ON THE ROOF PARAPET……. 3,80 kN/m


q = 5,7 kN/m2 (total surface load on roof)
65,55kN
85,5kN
85,5kN
85,5kN
85,5kN
65,55kN
p = 3,8 kN/m (line load on parapet)
1,5
1
2
R1x
R1y
R2
SECTION - ELEVATION
2,5
=
=
=
2,5
TRUSS
TRUSS
TRUSS
6,0
6,0
1,25
2,5
1,25
6m
BEAM
BEAM
5,7 kN/m2 · 6m · 2,5m
(85,50 kN)
5,7 kN/m2 · 6m · 1,25m + 3,8 kN/m · 6m
(65,55 kN)
6,0 (LOAD WIDTH)
PLAN - FLOOR

discussion of static determinacy

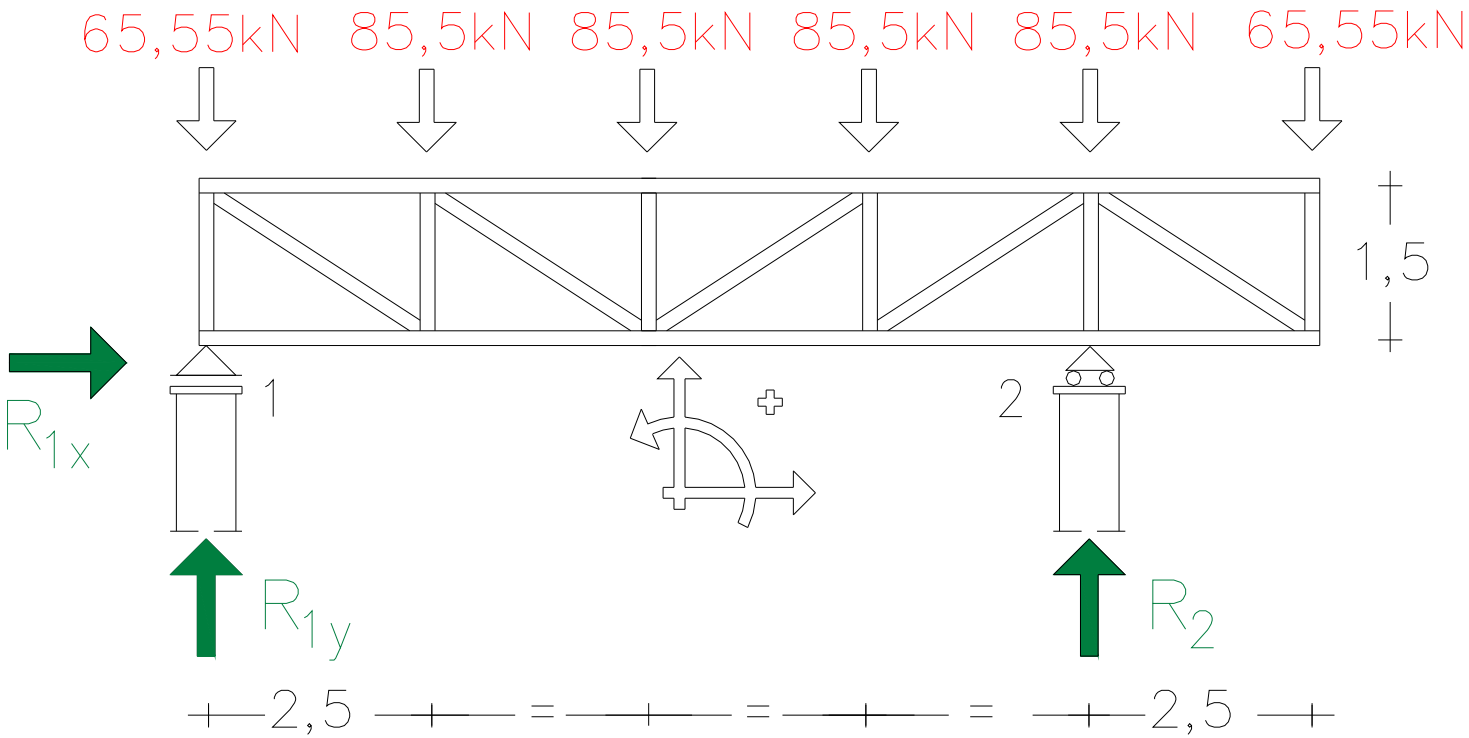


Unknowns: 3 reactions + 21 internal forces = 24

Equations : 12 joints x 2 equations / joint = 24

necessary but not sufficient condition !!!

‘external’ forces equilibrium: applied forces → reaction forces



$\Sigma F_x = 0 \;:\; \boxed{R_{1x} = 0}$

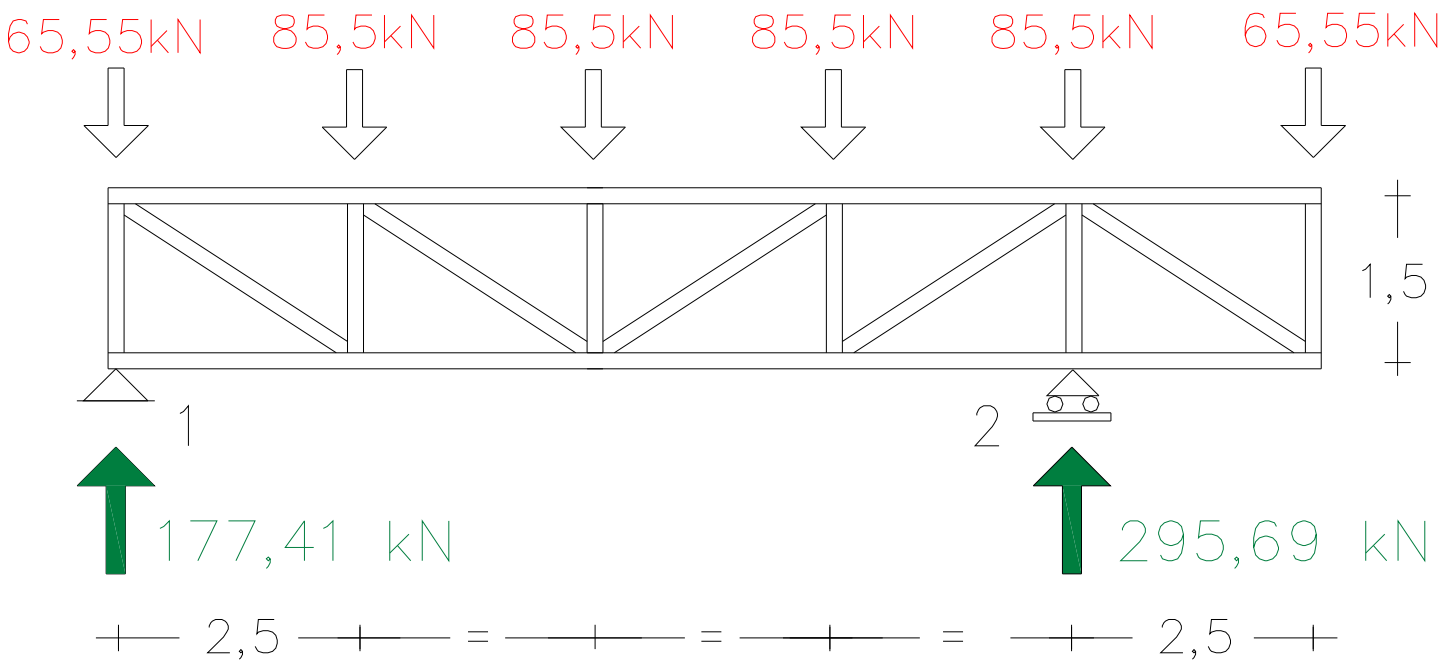
$\Sigma F_y = 0 \;:\; -2 \cdot 65,55 - 4 \cdot 85,5 + R_{1y} + R_2 = 0 \;:\; R_{1y} + R_2 = 476,1\text{kN}$

$\Sigma M_2 = 0 \;:\; 65,55 \cdot 10 + 85,5 \cdot (7,5 + 5 + 2,5) - 65,55 \cdot 2,5 - R_{1y} \cdot 10 = 0$

$\boxed{R_{1y} = 177,41\text{kN}}$

$\boxed{R_2 = 295,69\text{kN}}$

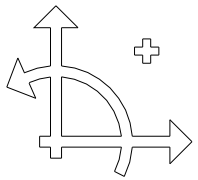
‘external’ equilibrium → reaction forces



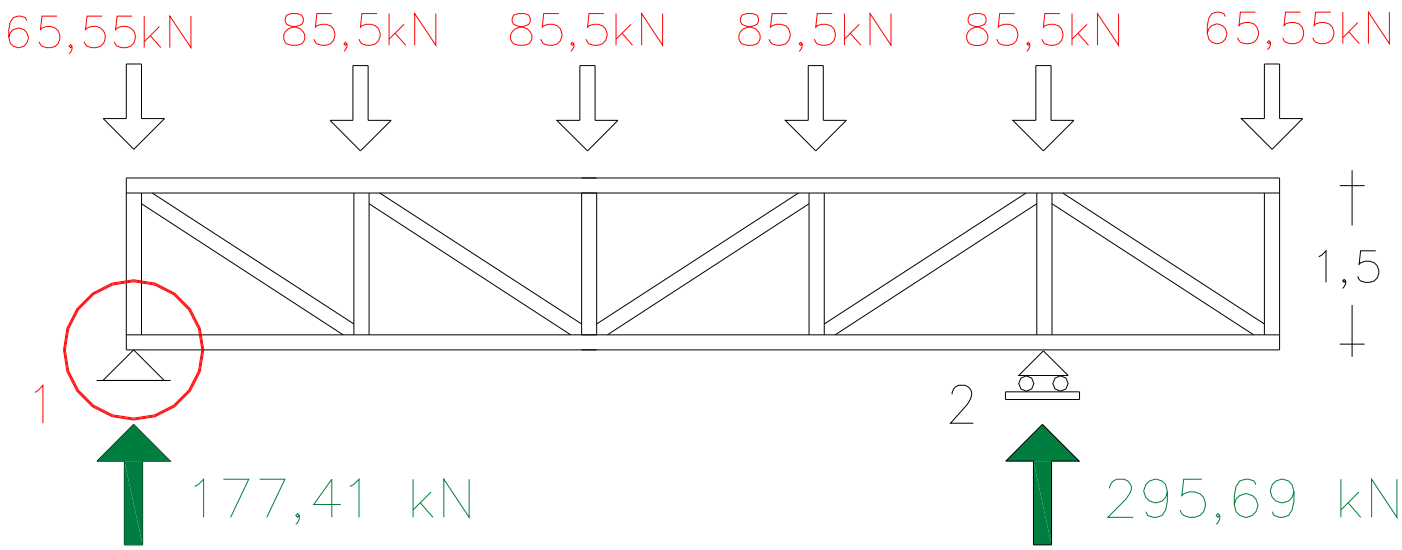
$$R_{1x} = 0$$

$$R_{1y} = 177,41\text{kN}$$

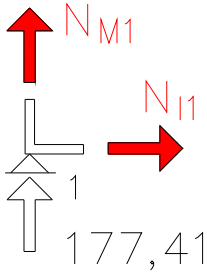
$$R_2 = 295,69\text{kN}$$

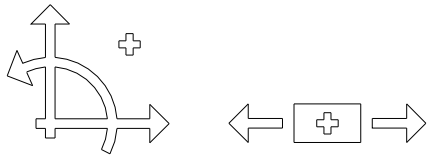


‘internal’ equilibrium → axial forces
method of joints



JOINT A

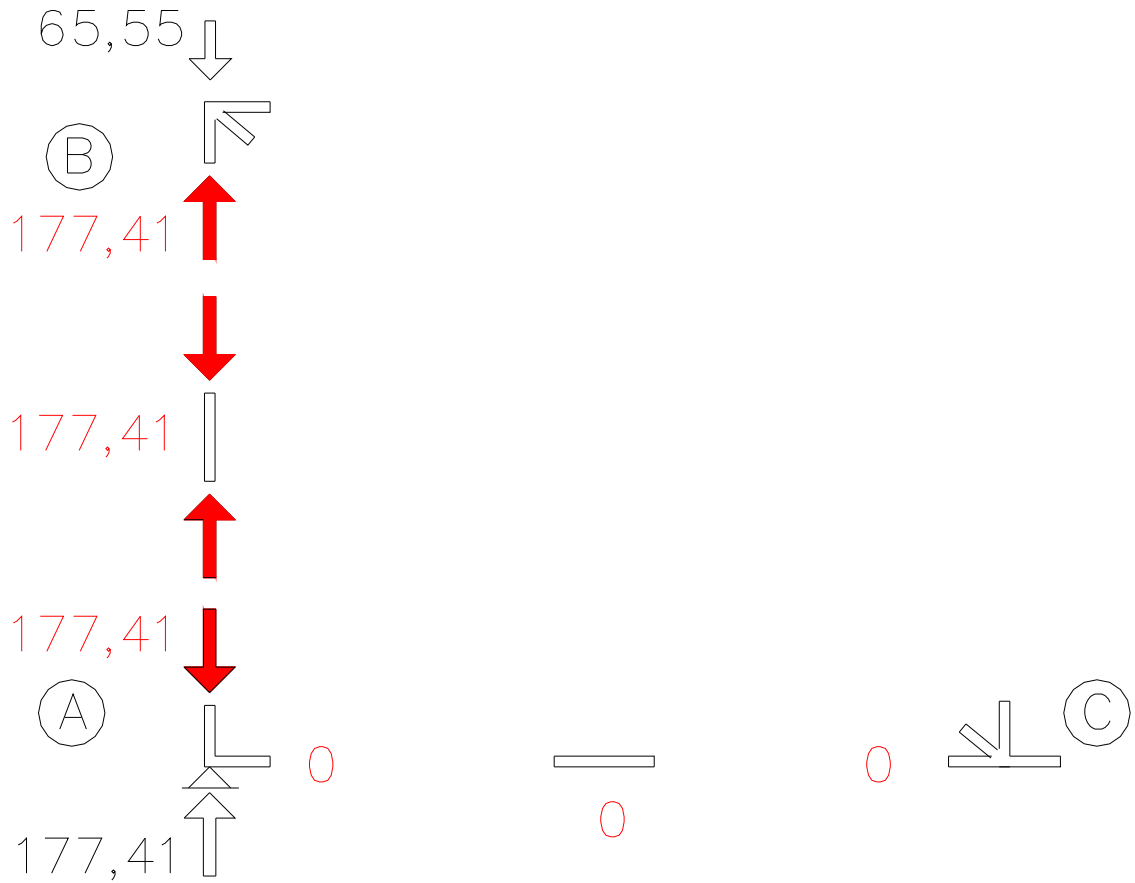




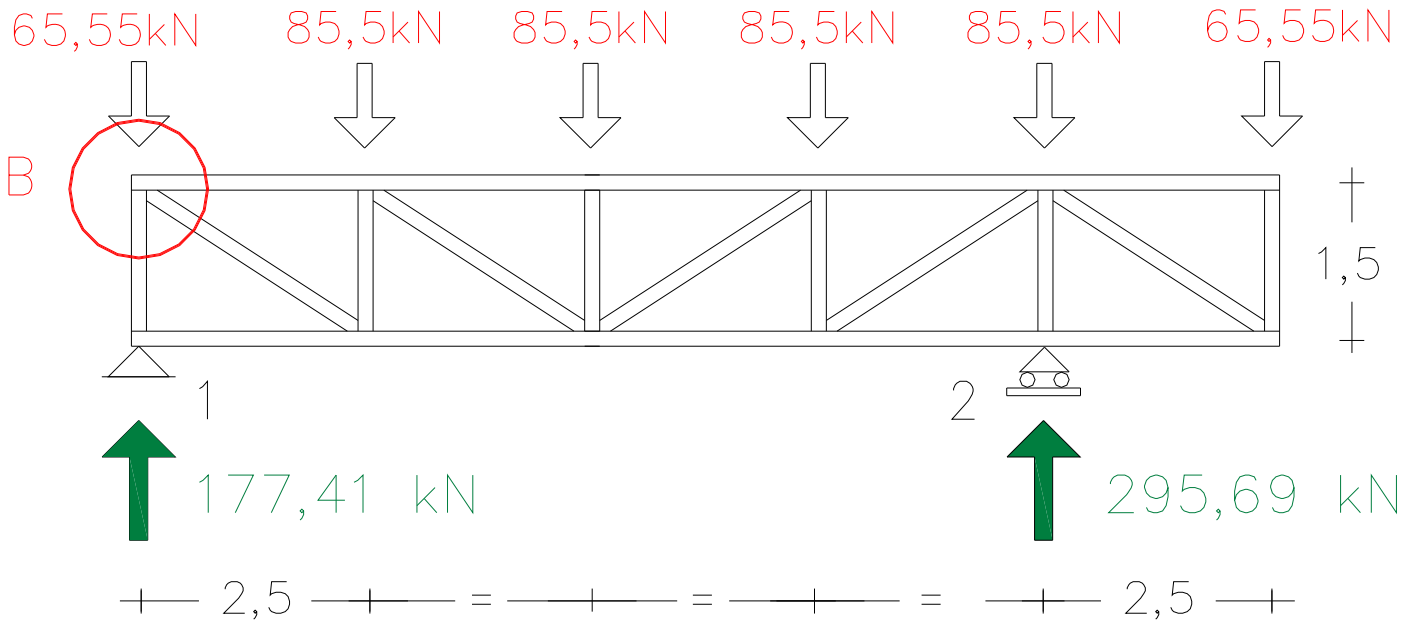
$$\Sigma F_x = 0 : \boxed{N_{I1} = 0}$$

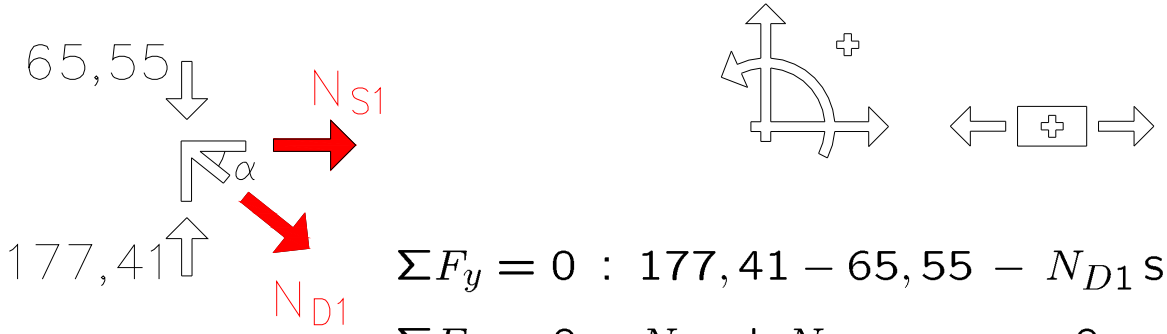
$$\Sigma F_y = 0 : 177,41 + N_{M1} = 0 : \boxed{N_{M1} = -177,41\text{kN}}$$

<u>sequential</u> equilibrium of joints
(less than 2 unknown axial forces per joint)



‘internal’ equilibrium of joints

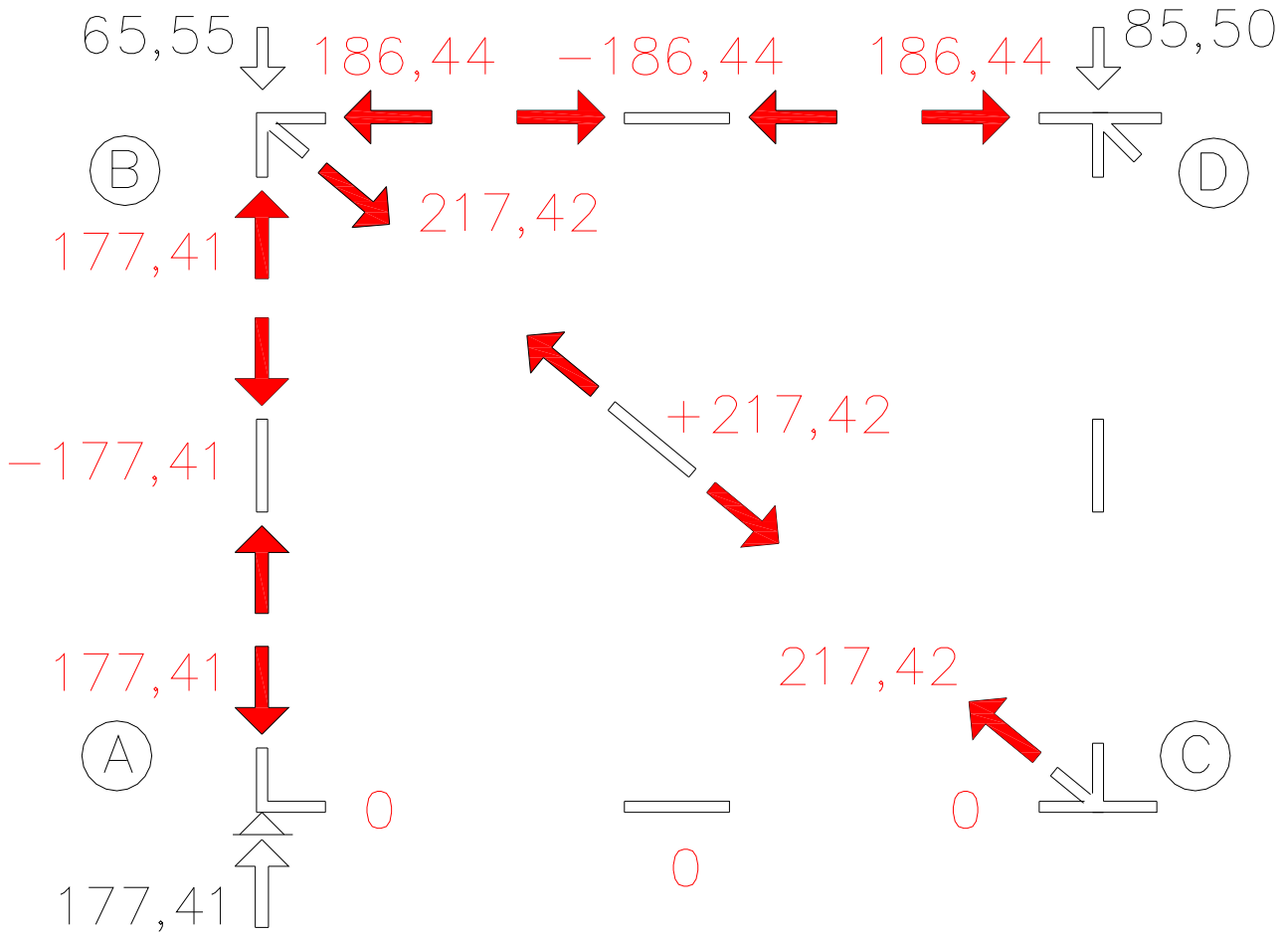




$\Sigma F_y = 0 : 177,41 - 65,55 - N_{D1} \sin\alpha = 0 : \boxed{N_{D1} = 217,42\text{kN}}$

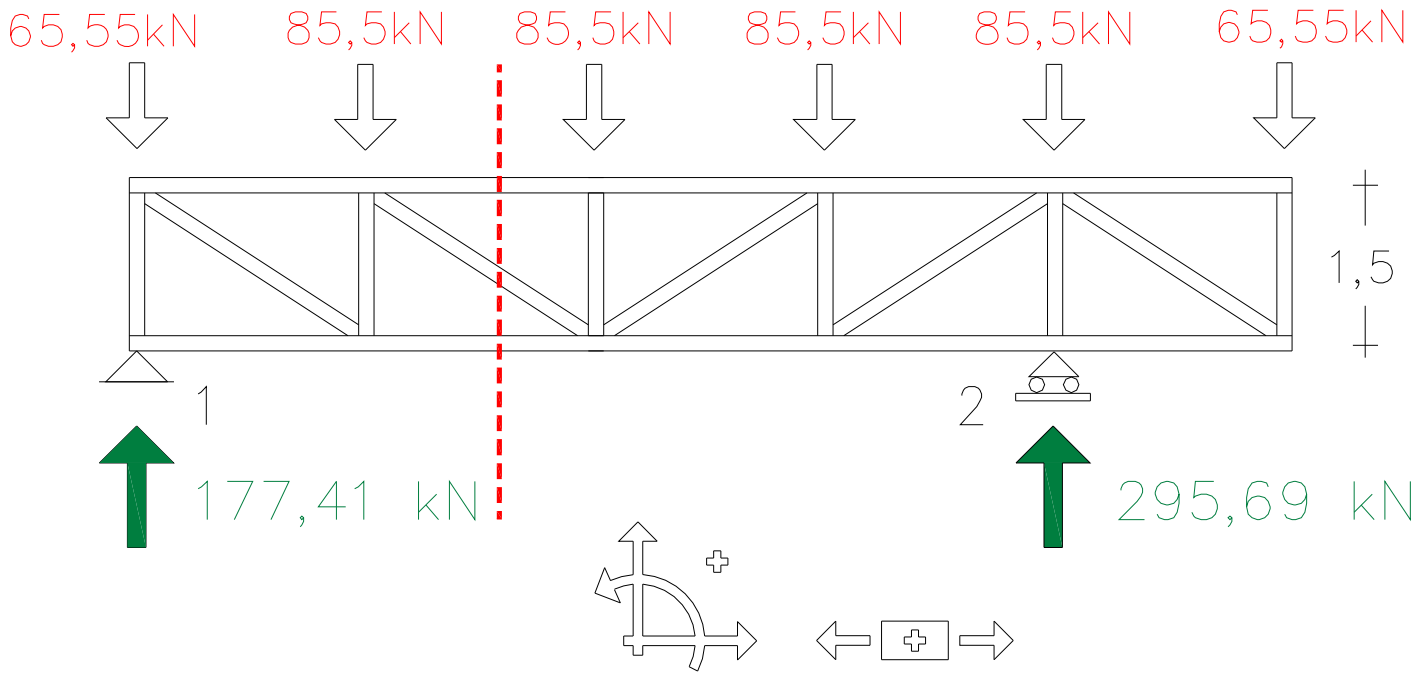
$\Sigma F_x = 0 : N_{S1} + N_{D1} \cos\alpha = 0 : \boxed{N_{S1} = -186,44\text{kN}}$

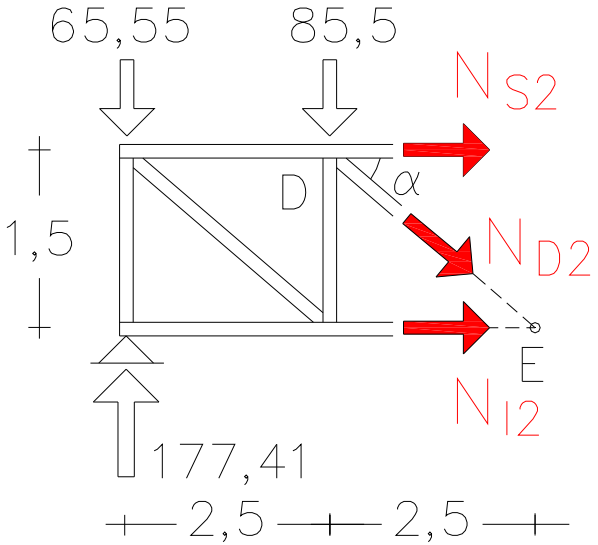
sequential equilibrium of joints (using previous results)



high risk of chaining fails!: unappropriate to calculate large structures by hand:

alternative procedure: method of sections





$\Sigma F_y = 0 \; : \; 177,41 - 65,55 - 85,5 - N_{D2} \sin\alpha \; = \; 0$

$\boxed{N_{D2} = 51,24\text{kN}}$

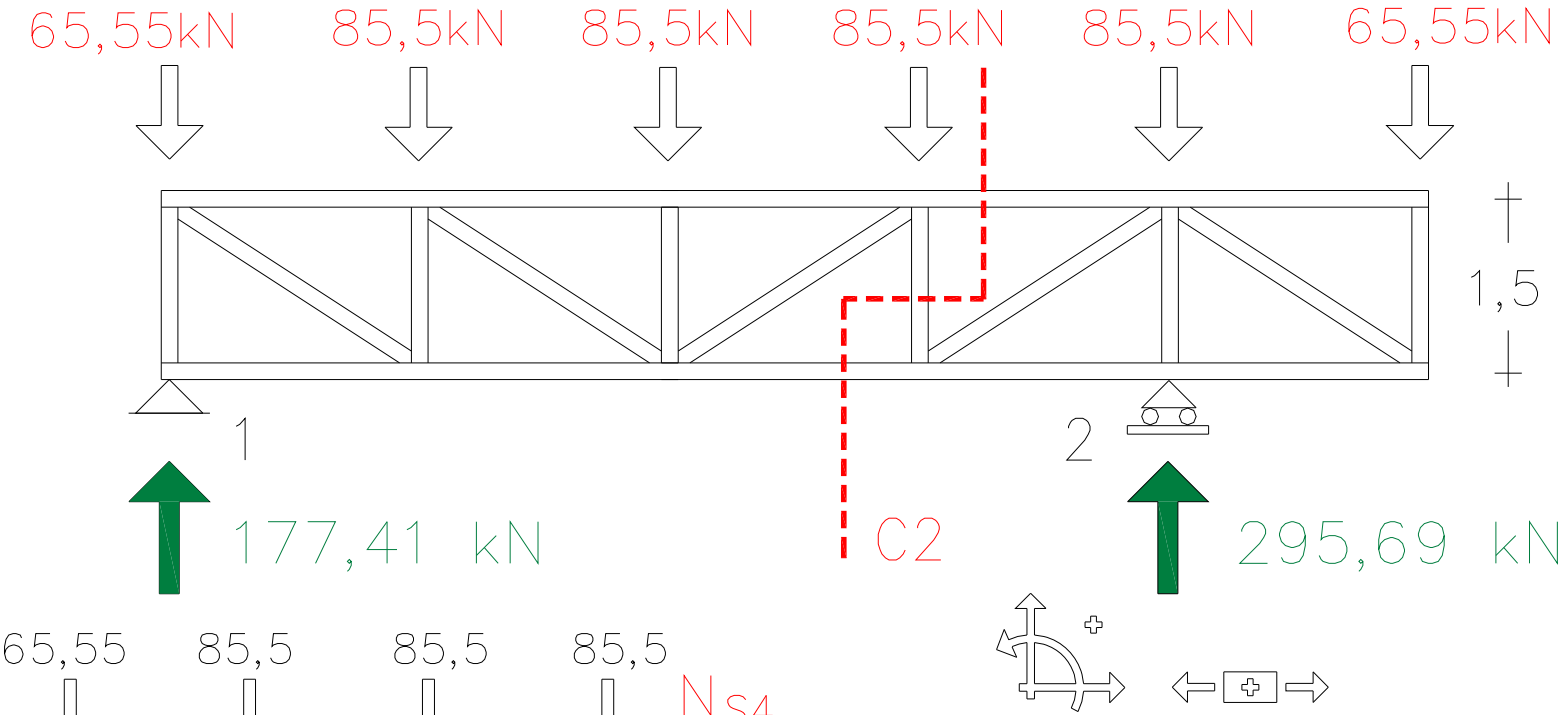
$\Sigma M_D = 0 \; : \; -177,41 \cdot 2,5 + 65,55 \cdot 2,5 + N_{I2} \cdot 1,5 \; = 0$

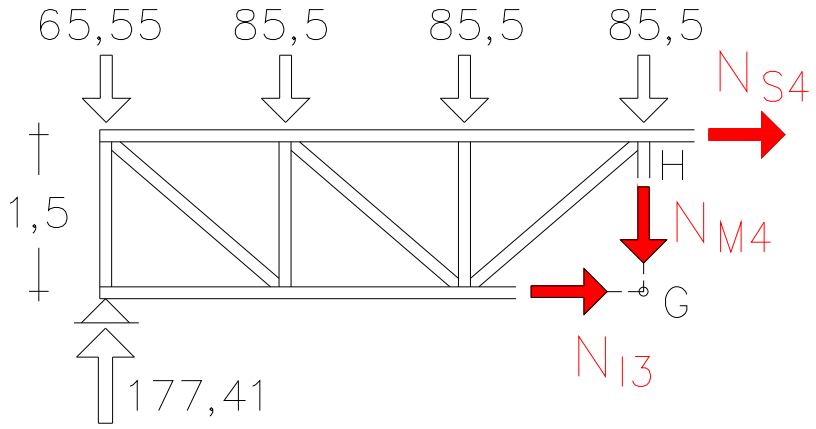
$\boxed{N_{I2} = 186,44\text{kN}}$

$\Sigma M_E = 0 \; : \; -177,41 \cdot 5 + 65,55 \cdot 5 + 85,5 \cdot 2,5 - N_{S2} \cdot 1,5 \; = 0$

$\boxed{N_{S2} = -230,77\text{kN}}$

‘internal’ equilibrium: other sections





$\Sigma F_y = 0 \; : \; \boxed{N_{M4} = -14,46\text{kN}}$

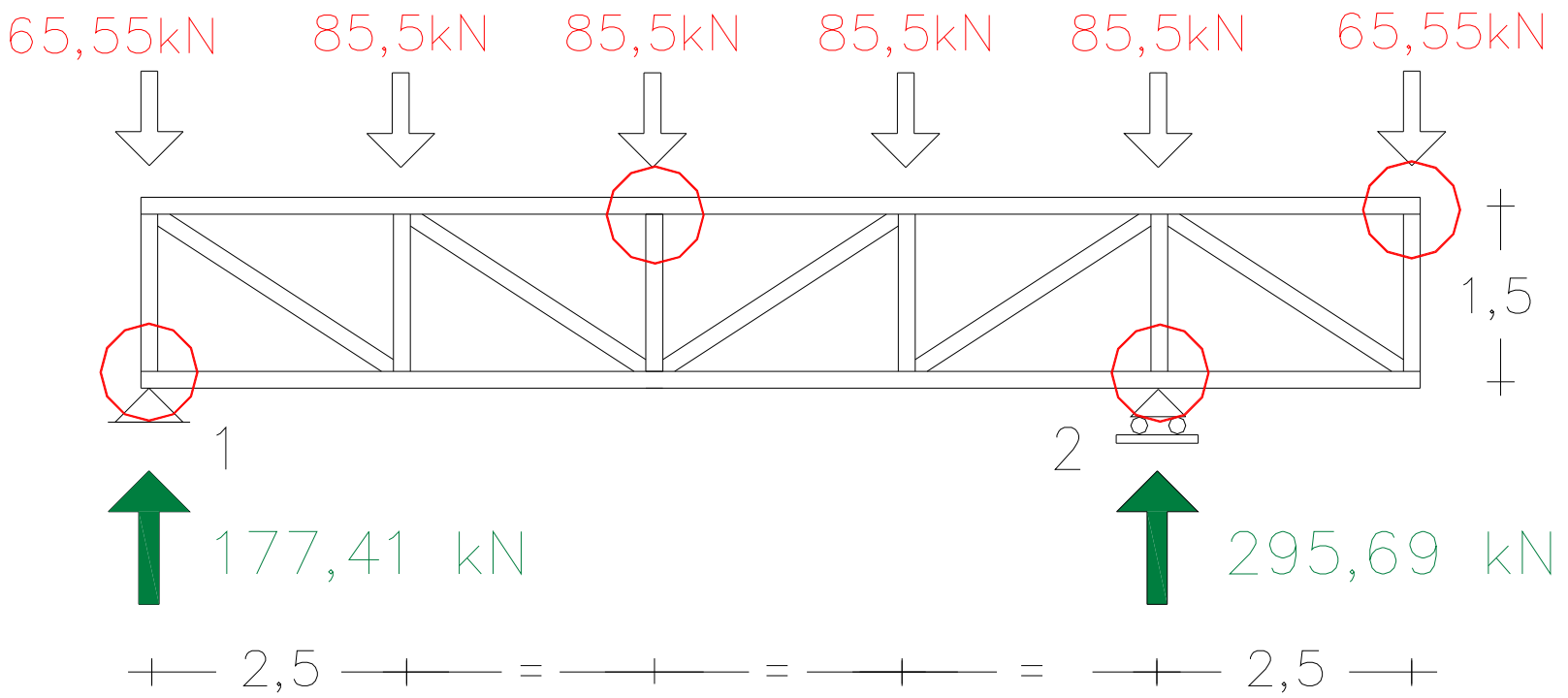
$\Sigma M_C = 0 \; : \; \boxed{N_{I4} = -131,81\text{kN}}$

$\Sigma M_D = 0 \; : \; \boxed{N_{I3} = 131,81\text{kN}}$

previous results not used in new sections

equilibrium: lower risk of chaining fails!

method of joints
(only selected joints)



axial forces in bars (tension and compression)