**Bureau ir. M. Klijnstra**

civiel ingenieursbureau

Deventerweg 9
7245 AW Laren

tel: (0573) 40 20 46
fax: (0573) 40 23 58

Laren: 21 februari 2017

Project: **Wagenschuur**
**te Hummelo**

Architect: Warc architectuur & ontwikkeling
te Steenderen

Berekening Restauratie

tekening:

constructeur: M. Klijnstra projectnr: **17017**

**Bureau Ir M. Klijnstra**
civiel ingenieursbureau

Deventerweg 9
7245 AW Laren

tel: (0573) 40 20 46
fax (0573) 40 23 58

## Inhoudsopgave

# 1 Inleiding

De onderstaande berekening betreft de statische berekening voor de restauratie van het bovenvermelde project.
De statische berekening wordt uitgevoerd aan de hand van de eurocode met de bijbehorende nationale bijlagen. Bij het uitvoeren van de berekening wordt gebruik gemaakt van software. De software is deels van eigenhand en van struct4u.

# 2 Uitgangspunten

## 2.1 Bouwkundig

De statische berekening is uitgevoerd aan de hand van de bouwkundige tekeningen van Warc (architectuur en ontwikkeling) te Steenderen. Het betreft de tekeningen

| | |
|---|---|
| werk | Restauratie wagenschuur |
| werknr | 1611 |
| tekeningen | bladen SO-03,14,15 en 25 d.d. 15-02-2017 |

## 2.2 Constructief

*Gevolgklasse en belastingcategorie*
(volgens NEN-EN 1990)

Betrouwbaarheidsniveau
Het bouwwerk valt in het betrouwbaarheidsniveau welk behoort bij gevolgklasse **CC2** en heeft een ontwerplevens-duurklasse van **50** jaar.

*Partiële belastingsfactoren*
De belastingsfactoren volgens de gevolgklasse CC1 zijn in de uiterste grenstoestand (UGT)

| CC | Blijvende en tijdelijke ontwerpsituaties | Blijvende belastingen | | Overheersende veranderlijke belasting | Veranderlijke belastingen gelijktijdig met de overheersende | |
|---|---|---|---|---|---|---|
| | | Ongunstig | Gunstig | | Belangrijkste (indien aanwezig) | Andere |
| 1 | (Vgl. 6.10a) | 1,2 $G_{k,j,sup}$ [a] | 0,9 $G_{k,j,inf}$ | | 1,35 $\psi_{0,1}$ $Q_{k,1}$ | 1,35 $\psi_{0,i}$ $Q_{k,i}$ ($i$ >1) |
| | (Vgl. 6.10b) | 1,1 $G_{k,j,sup}$ [b] | 0,9 $G_{k,j,inf}$ | 1,35 $Q_{k,1}$ | | 1,35 $\psi_{0,i}$ $Q_{k,i}$ ($i$ >1) |

In de bruikbaarheidsgrenstoestand (BGT) zijn de waarden van de belastingsfactoren gelijk 1

## 2.3 Materialen

Tenzij in de berekening anders is vermeld zijn het materiaal kwaliteiten

| | | | |
|---|---|---|---|
| beton | sterkteklasse | C20/25 | milieuklasse XC 2. |
| wapening | ,, | FeB500-A | |
| staal | S235 | | |
| bouten/ankers | 8.8/4.6 | | |
| hout | C24 | | |
| grond | zand grond met tenminste een sondeerwaarde van 4 MN/m$^2$ (ter controle) | | |

# 3 Werkzaamheden

De wagenberging met een grondoppervlak van L x B = ca. 38.00 x 11.00 heeft een goot/nok hoogte van ca. 4.50 resp. 8.70 m. De berging is op 4.00 m hoogte voorzien van een houten verdiepingsvloer
De onderstaande berekening omvat het dak, verdiepingsvloer en de houten gebinten

# 4 Belastingen

## 4.1 Belasting

**Algemeen**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nokhoogte | 8.70 | m | | | | | |
| sneeuw | | | $p_{sn;rep}$ | = | 0.70 | kN/m² | grondvlak |
| Wind gebied III | | | | | | | |
| bebouwd | stuwdruk | | $p_{w.50\ jr}$ | = | 0.66 | kN/m² | |
| gesloten | | | | | | | |
| | overdr | 0.3 | $w_3$ | = | 0.20 | ,, | |
| | onderdr | -0.2 | $w_4$ | = | -0.13 | ,, | |

**Dak**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| helling | | | | | | 35° | 42° | |
| Permanent | | | | | | | | |
| - pannen | 0.50 | kN/m² | | | | | | |
| - isolerende plaat | 0.15 | | | | | | | |
| - sporenkap | 0.10 | ,, | | | | | | |
| - beschot | 0.10 | ,, | | | | | | |
| | 0.85 | kN/m² | dakvlak | | | | | |
| | | | $g_1$ | = | | 1.04 | 1.14 | kN/m² |
| | 35° | 42° | | | | | | |
| **sneeuw** μ = | 0.67 | 0.48 | s | = | | 0.47 | 0.34 | kN/m² |
| | druk | zuiging | | | | druk | zuiging | |
| **wind** μ druk = | 0.70 | -0.24 | w | = | | 0.46 | -0.16 | kN/m² |
| 42° μ druk = | 0.56 | -0.34 | w | = | | 0.37 | -0.22 | |
| a-maat = | 1.74 | m | | | | | | |
| 35° μ druk = | 0.70 | -0.33 | w | = | | 0.46 | -0.22 | kN/m² |
| μ druk = | 0.47 | -0.43 | w | = | | 0.31 | -0.28 | |
| a-maat = | 1.74 | m | | | | | | |

**Vloeren**

| | | | | | | |
|---|---|---|---|---|---|---|
| verd.vloer | beplating | 0.15 | kN/m² | | | |
| | balklaag | 0.10 | | $g_2$ | = | 0.25 kN/m² |
| | veranderlijk | verdeeld | | $p_2$ | = | 5.00 kN/m² |

# 5 Vloeren

## 5.1 Verhoogde begane grondvloer

De balklaag van de verdiepingsvloer is enkelvelds met een overspanning L = 3.40 m

overspaning L = 3.40 m

$\delta_{eind}$ = 13.6 mm
$\delta_{bij}$ = 10.2 mm
$\delta_{trill}$ = 12 mm

balklaag **C24**
**b x h = 100 x 171 mm2**
**hoh = 600 mm**

| hout | | | | | |
|---|---|---|---|---|---|
| $f_{m,o,u,d}$ = | 14.77 | N/mm² | M = | 12.00 | kNm/m |
| $f_{v,o,u,d}$ = | 1.54 | ,, | D = | 29.23 | kN/m |
| $E_{0,ser,d}$ = | 11000 | ,, | $EI_d$ = | 1528 | kNm²/m |
| $E_{kr,ser,d}$ = | 11000 | ,, | $EI_{kr,d}$ = | 1528 | kNm²/m |

| belasting | | | | |
|---|---|---|---|---|
| | perm. | 0.30 | kN/m² | e.g. balklaag wordt numeriek in rekening gebracht |
| (rep.) | verand | 5.00 | ,, | momt ψ = 0.40 |

| belastingen | | | |
|---|---|---|---|
| t.a.v. uiterste grenstoestand | 7.98 | kN/m² |
| t.a.v. bruikbaarheids grenstoestand | 5.30 | ,, |
| t.a.v. kruip | 1.50 | ,, |
| t.a.v. permanent | 0.30 | ,, |
| t.a.v. bepaling laagste eigenfreq. | 2.30 | ,, |

| uiterste grenstoestand | | | |
|---|---|---|---|
| M = | 11.53 | kNm/m |
| D = | 13.57 | kN/m |

u.c = **0.96** **< 1 akkoord**

bruikbaarheids grenstoestand

| | | |
|---|---|---|
| $w_{el}$ = | 6.0 | mm |
| $w_{kr}$ = | 1.7 | ,, |
| $w_{ser,tot}$ = | 8 | mm |
| $w_{on}$ = | 0.3 | ,, |
| $w_{ser,tot}$ = | 7 | mm |

u.c = **0.73** **< 1 akkoord**

trilling eis $\delta_{tril}$ = 12 mm $w_{trl}$ = 2.6 mm

u.c = **0.22** **< 1 akkoord**

## 5.2 Verdiepingsvloer

De balklaag van de verdiepingsvloer is enkelvelds met een overspanning L = 4.15 m

belastingsduurklasse I
klimaatklasse I
kruip 1
overspaning L = 4.15 m

$\delta_{eind}$ = 16.6 mm
$\delta_{bij}$ = 12.45 mm
$\delta_{trill}$ = 12 mm

balklaag **C24**
**b x h = 120 x 196 mm2**
**hoh = 600 mm**

| | | | | | |
|---|---|---|---|---|---|
| hout | $f_{m,o,u,d}$ = | 14.77 N/mm$^2$ | M = | 18.91 | kNm/m |
| | $f_{v,o,u,d}$ = | 1.54 ,, | D = | 40.21 | kN/m |
| | $E_{0,ser,d}$ = | 11000 ,, | $EI_d$ = | 2761 | kNm$^2$/m |
| | $E_{kr,ser,d}$ = | 11000 ,, | $EI_{kr,d}$ = | 2761 | kNm$^2$/m |

belasting perm. 0.30 kN/m$^2$ e.g. balklaag wordt numeriek in rekening gebracht
(rep.) verand 5.00 ,, momt $\psi$ = 0.40

| belastingen | | |
|---|---|---|
| t.a.v. uiterste grenstoestand | 8.02 | kN/m$^2$ |
| t.a.v. bruikbaarheids grenstoestand | 5.30 | ,, |
| t.a.v. kruip | 1.50 | ,, |
| t.a.v. permanent | 0.30 | ,, |
| t.a.v. bepaling laagste eigenfreq. | 2.30 | ,, |

uiterste grenstoestand

| | | |
|---|---|---|
| M = | 17.28 | kNm/m |
| D = | 16.65 | kN/m |

u.c = **0.91** **< 1 akkoord**

bruikbaarheids grenstoestand

| | | |
|---|---|---|
| $w_{el}$ = | 7.4 | mm |
| $w_{kr}$ = | 2.1 | ,, |
| $w_{ser,tot}$ = | 10 | mm |
| $w_{on}$ = | 0.4 | ,, |
| $w_{ser,tot}$ = | 9 | mm |

u.c = **0.73** **< 1 akkoord**

trilling eis $\delta_{tril}$ = 12 mm $w_{trl}$ = 3.2 mm

u.c = **0.27** **< 1 akkoord**

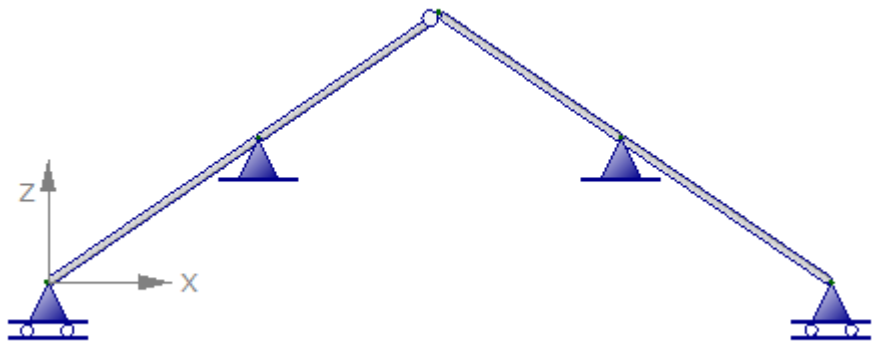
# 6 Sporen

## 6.1 Sporen dakhelling 35°

| | | | |
|---|---|---|---|
| permanent dak | 1.04 x 0.60 = | 0.62 | kN/m |
| sneeuw | 0.47 x 0.60 = | 0.28 | kN/m |

| | | | | | a-waarde |
|---|---|---|---|---|---|
| wind | loef druk | 0.46 x 0.60 = | 0.28 | kN/m | 1.74 |
| | | 0.37 x 0.60 = | 0.22 | kN/m | |
| | lei | -0.22 x 0.60 = | -0.13 | kN/m | 1.74 |
| | | -0.16 x 0.60 = | -0.10 | kN/m | |
| | overdruk | 0.20 x 0.60 = | 0.12 | kN/m | |
| | onderdruk | -0.13 x 0.60 = | -0.08 | ,, | |

## *1 Invoergegevens*




### 1.1 KNOPEN

| Knoop-nummer | Coördinaten | | Opleggingen | | |
|---|---|---|---|---|---|
| | X [mm] | Z [mm] | Tx | Tz | Ry |
| 1 | 0 | 0 | | A | |
| 2 | 2800 | 1910 | A | A | |
| 3 | 5220 | 3560 | | | |
| 4 | 7640 | 1910 | A | A | |
| 5 | 10440 | 0 | | A | |

### 1.2 STAVEN

| Staaf-nummer | Knoop | | Staaf-type | Profiel | Lengte [mm] |
|---|---|---|---|---|---|
| | van | naar | | | |
| 1 | 1 | 2 | | 42 x 171 | 3389 |
| 2 | 2 | 3 | | 42 x 171 | 2929 |
| 3 | 3 | 4 | | 42 x 171 | 2929 |
| 4 | 4 | 5 | | 42 x 171 | 3389 |

**Sporen b x h = 42 x 171 mm hoh 600 mm**

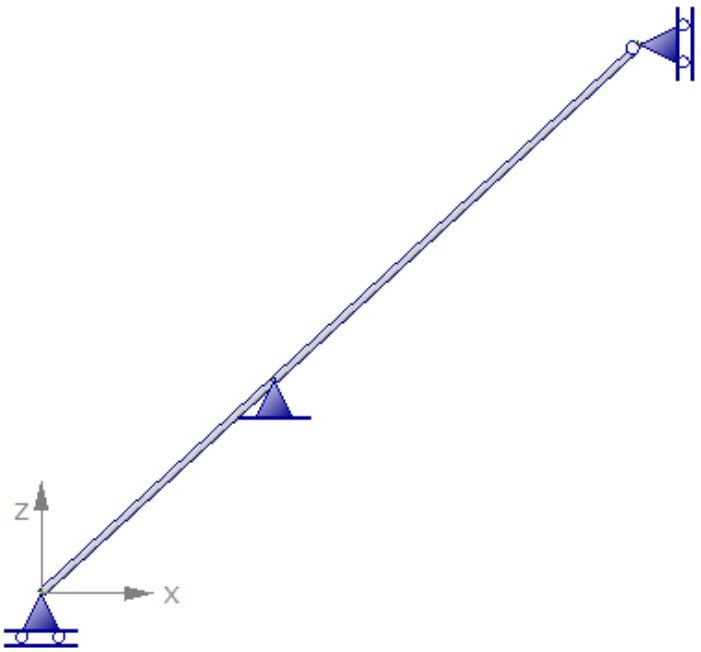
N.B. De sporen zijn “doorgaand” met een rekenkundige lengte L = ca 6.30 m

## 6.2 Sporen dakhelling 42°

| | | | | |
|---|---|---|---|---|
| permanent | dak | 1.14 x 0.60 = | 0.68 | kN/m |
| sneeuw | | 0.34 x 0.60 = | 0.20 | kN/m |
| wind | loef druk | 0.46 x 0.60 = | 0.28 | kN/m |
| | | 0.37 x 0.60 = | 0.22 | kN/m |
| | lei | -0.22 x 0.60 = | -0.13 | kN/m |
| | | -0.16 x 0.60 = | -0.10 | kN/m |

| | | | |
|---|---|---|---|
| overdruk | 0.20 x 0.60 = | 0.12 | kN/m |
| onderdruk | -0.13 x 0.60 = | -0.08 | ,, |

***1 Invoergegevens***




**1.1 KNOPEN**

| Knoop-nummer | Coördinaten | | Opleggingen | | |
|---|---|---|---|---|---|
| | X [mm] | Z [mm] | Tx | Tz | Ry |
| 1 | 0 | 0 | | A | |
| 2 | 1096 | 1000 | A | A | |
| 3 | 2820 | 2580 | A | | |

**1.2 STAVEN**

| Staaf-nummer | Knoop | | Staaf-type | Profiel | Lengte [mm] |
|---|---|---|---|---|---|
| | van | naar | | | |
| 1 | 1 | 2 | | 42 x 171 | 1484 |
| 2 | 2 | 3 | | 42 x 171 | 2338 |

**Sporen b x h = 42 x 171 mm hoh 600 mm**

N.B. De sporen zijn “doorgaand” met een rekenkundige lengte L = ca 3.85 m

## 7 Gordingen en kepers

**Kap 35°**

belasting (de resp. belasting / 0.60 bijlage A)

| | perm | | sneeuw | | wind | |
|---|---|---|---|---|---|---|
| | Fh | Fv | Fh | Fv | Fh | Fv |
| dak | 1.37 | 4.52 | 0.58 | 2.00 | -1.08 | 1.75 |

I.v.m. de spreidband wordt de horizontale overspanning gereduceerd van 4.15 m naar 3.50 m
De gording is als doorgaand gedimensioneerd (als gerberligger of moment vast bij oplegging)

Belastingsfactoren

| *belasting* | $f_y$ | $f_z$ | | $\sigma$ | $\delta$ |
|---|---|---|---|---|---|
| -permanent | 1.37 | 4.52 | kN/m | 1.20 | 1.60 |
| -sneeuw | 0.58 | 2.00 | ,, | 1.50 | 1.00 |
| -wind | 1.08 | 1.75 | ,, | 1.50 | 1.00 |

| | $L_y$ | $L_z$ | |
|---|---|---|---|
| *geometrie* | 3.15 | 4.15 | m |

| *belastingen* | $f_\sigma$ | | $f_\delta$ | | |
|---|---|---|---|---|---|
| *lijnlasten* | y.as | z.as | y.as | z.as | |
| -permanent | 1.64 | 5.42 | 2.19 | 7.23 | kN/m |
| -sneeuw | 0.87 | 3.00 | 0.58 | 2.00 | kN |
| -wind | 1.62 | 2.63 | 1.08 | 1.75 | kN/m |

| *Berekening* | momenten | | doorbuiging | |
|---|---|---|---|---|
| | $M_y$ | $M_z$ | $\delta EI_y$ | $\delta EI_z$ |
| -permanent | 1.63 | 9.34 | 1.41 | 13.97 |
| -sneeuw | 0.86 | 1.25 | 0.37 | 3.86 |
| -wind | 1.61 | 4.52 | 0.69 | 3.38 |

| | momenten | | $\delta$.EI | |
|---|---|---|---|---|
| Combinatie | $M_y$ | $M_z$ | $\delta EI_y$ | $\delta EI_z$ |
| I+II | 2.49 | 10.59 | 1.8 | 17.83 |
| I+III | 3.24 | 13.86 | 2.1 | 17.34 |

*Controle*

Afmeting

| b | h | | C24 | | |
|---|---|---|---|---|---|
| **200** | **200** | **mm²** | $f_{m,o,u,d}$ = | 14.77 | N/mm² |
| | | ,, | $E_{0,ser,d}$ = | 11000 | ,, |

stuks = 1

$\delta_{toel.}$ = 17 mm

| | Y-ri. | Z-ri. | |
|---|---|---|---|
| $M_{toel.}$ = | 19.7 | 19.7 | kNm |
| EI = | 1466.7 | 1466.7 | kNm² |

| | $\sigma_{.rel}$ | | | $\delta$ | | |
|---|---|---|---|---|---|---|
| Combinatie | $\sigma_y$ | $\sigma_z$ | comb. | $\delta_y$ | $\delta_z$ | $\lvert\delta\rvert_{.rel}$ |
| I+II | 0.13 | 0.54 | 0.66 | 1.2 | 12.2 | 0.74 |
| I+III | 0.16 | 0.70 | 0.87 | 1.4 | 5.9 | 0.37 |
| I+IV | 0.08 | 0.47 | 0.56 | 1.0 | 9.5 | 0.58 |

| <u>resultaat</u> | | | |
|---|---|---|---|
| | $\sigma_{rel}$ = | 0.87 | < 1 akkoord |
| | $\delta_{rel}$ = | 0.74 | < 1 akkoord |

## **Kap 42°**

belasting (de reps belasting / 0.60 bijlage B)

| | perm | | sneeuw | | wind | |
|---|---|---|---|---|---|---|
| | Fh | Fv | Fh | Fv | Fh | Fv |
| dak | 0.90 | 3.02 | 0.25 | 0.85 | -0.70 | 1.18 |

| | | | | Belastingsfactoren | |
|---|---|---|---|---|---|
| *belasting* | $f_y$ | $f_z$ | | $\sigma$ | $\delta$ |
| -permanent | 3.05 | 0.90 | kN/m | 1.20 | 1.60 |
| -sneeuw | 0.85 | 0.25 | ,, | 1.50 | 1.00 |
| -wind | 1.18 | 0.70 | ,, | 1.50 | 1.00 |

| | $L_y$ | $L_z$ | |
|---|---|---|---|
| *geometrie* | 5.00 | 5.00 | m |

| *belastingen* | $f_\sigma$ | | $f_\delta$ | | |
|---|---|---|---|---|---|

| *lijnlasten* | y.as | z.as | y.as | z.as | |
|---|---|---|---|---|---|
| -permanent | 3.66 | 1.08 | 4.88 | 1.44 | kN/m |
| -sneeuw | 1.28 | 0.38 | 0.85 | 0.25 | kN |
| -wind | 1.77 | 1.05 | 1.18 | 0.70 | kN/m |

| *Berekening* | momenten | | doorbuiging | |
|---|---|---|---|---|
| | $M_y$ | $M_z$ | $\delta EI_y$ | $\delta EI_z$ |
| -permanent | 11.44 | 3.38 | 39.71 | 11.72 |
| -sneeuw | 3.98 | 0.23 | 6.92 | 2.03 |
| -wind | 5.53 | 3.28 | 9.60 | 5.70 |

| | momenten | | $\delta$.EI | |
|---|---|---|---|---|
| Combinatie | $M_y$ | $M_z$ | $\delta EI_y$ | $\delta EI_z$ |
| I+II | 15.42 | 3.61 | 46.6 | 13.75 |
| I+III | 16.97 | 6.66 | 49.3 | 17.42 |

*Controle*

| Afmeting b | h | | C24 | | |
|---|---|---|---|---|---|
| **230** | **230** | **mm²** | $f_{m,o,u,d}$ = | 14.77 | N/mm² |
| | | ,, | $E_{0,ser,d}$ = | 11000 | ,, |
| stuks = | 1 | | | | |
| $\delta_{toel.}$= | 20 | mm | | | |

| | Y-ri. | Z-ri. | |
|---|---|---|---|
| $M_{toel.}$ = | 29.9 | 29.9 | kNm |
| EI = | 2565.2 | 2565.2 | kNm² |

| | $\sigma_{.rel}$ | | | $\delta$ | | |
|---|---|---|---|---|---|---|
| Combinatie | $\sigma_y$ | $\sigma_z$ | comb. | $\delta_y$ | $\delta_z$ | $\lvert\delta\rvert_{.rel}$ |
| I+II | 0.51 | 0.12 | 0.64 | 18.2 | 5.4 | 0.95 |
| I+III | 0.57 | 0.22 | 0.79 | 19.2 | 3.4 | 0.98 |
| I+IV | 0.38 | 0.11 | 0.49 | 15.5 | 4.6 | 0.81 |

| resultaat | | | |
|---|---|---|---|
| | $\sigma_{rel}$ = | 0.79 | < 1 akkoord |
| | $\delta_{rel}$ = | 0.98 | < 1 akkoord |

## Hoek- Kilkepers

Hieronder zijn de kilkepers gedimensioneerd.

| | | | | |
|---|---|---|---|---|
| permanent | dak | 1.14 x 2 = | 2.28 | kN/m |
| sneeuw | | 0.34 x 2 = | 0.68 | kN/m |
| wind | loef druk | 0.59 x 2 = | 1.18 | kN/m |

| *belasting* | *verdeeld (rep)* kN/m² | aandeel m |
|---|---|---|
| -perm. | 2.28 | 1.00 |
| -sneeuw | 0.68 | 1.00 |
| -wind | 1.18 | 1.00 |

*belasting*
Bepalende belasting is

| | | | |
|---|---|---|---|
| -uiterste grenstoestand | $f\sigma$ = | 4.51 | kN/m |
| -bruikbaarheids grenstoestand | $f\delta$ = | 4.83 | ,, |

*geometrie* $L_x$ = 3.00 m

| *Berekening* | D kN | M kNm | $\delta$.EI kNm³ | N kN |
|---|---|---|---|---|
| *verdeelde* | 6.76 | 5.07 | 5.09 | 0.00 |

| *Controle* | Afmeting b | h | | Kwaliteit C24 | Klimaat I | |
|---|---|---|---|---|---|---|
| | **71** | **196** | **mm²** | $f_{m,o,u,d}$ = | 14.77 | N/mm² |

| | | | | | | |
|---|---|---|---|---|---|---|
| stuks | **1** | **st.** | $f_{v,o,u,d}$ = | 1.54 | ,, |
| $k_h$ = | 1.0 | | $E_{0,ser,d}$ = | 11000 | ,, |
| $M_{toel.}$ = | 6.7 | kNm | $\delta_{toel.}$ = | 12 | mm |
| $Q_{toel.}$ = | 14.3 | kN | EI = | 490 | $kNm^2$ |
| $N_{toel.}$ = | 205.5 | kN | EA = | 153076 | kN |

1-orde

| | | | |
|---|---|---|---|
| $\tau_{rel}$ = | 0.47 | | |
| $\sigma_{rel,c}$ = | 0.00 | | |
| $\sigma_{rel,m}$ = | 0.76 | | |
| $\delta_{rel}$ = | 0.87 | < 1 | akkoord |

## 8 Gebint

| | perm | | verand | | sneeuw | | wind | |
|---|---|---|---|---|---|---|---|---|
| | Fh | Fv | Fh | Fv | Fh | Fv | Fh | Fv |
| Vloer | 1.25 | | 20.75 | | | | | |
| Dak | 6.37 | 21.01 | | | 2.70 | 9.30 | 7.53 | 8.13 |

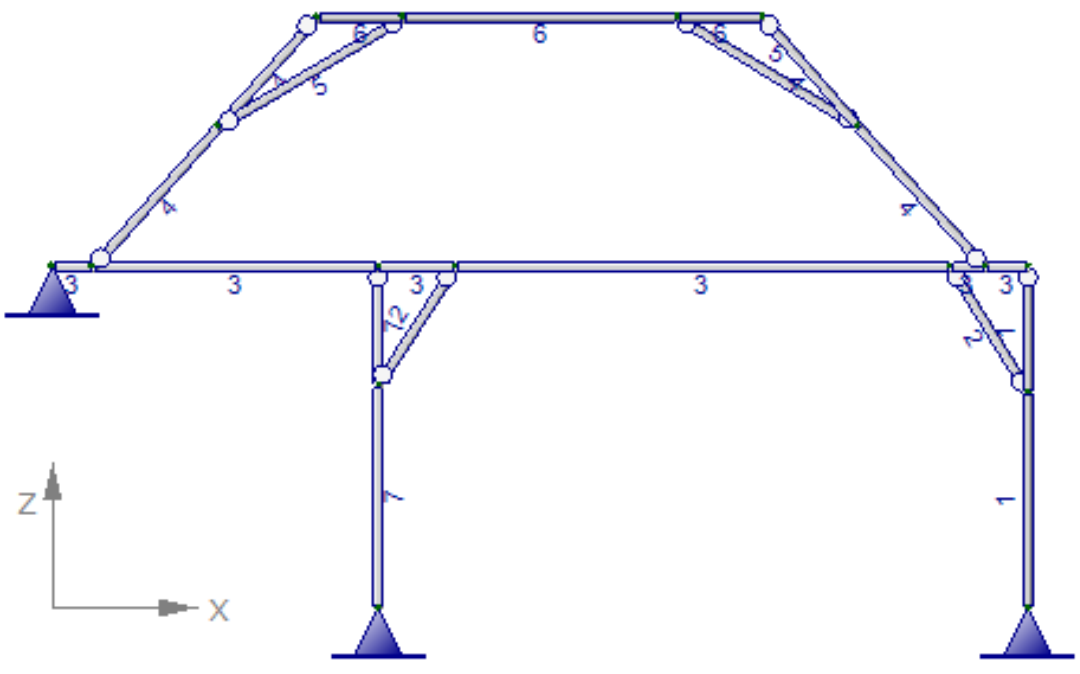
De nummering in de schets **1 invoergegevens** komen overeen met de nummering
In de onderstaande profieltabel en verwijzen naar de houtdoorsneden (C24)

**1.3 PROFIELEN**

| Profiel-nummer | Naam | Gewicht [kg/m] |
|---|---|---|
| 1 | 300x390 | 49.1 |
| 2 | 230x200 | 19.3 |
| 3 | 310x340 | 44.3 |
| 4 | 125 x 200 | 10.5 |
| 5 | 75x125 | 3.9 |
| 6 | 125x200 | 10.5 |
| 7 | 310x300 | 39.1 |

N.B. de doorsnede van de kolom aan het metselwerk is voor de berekening gereduceerd in de breedte i.v.m. de gevelinkeping 240 x120 mm. De bruto doorsnede **b x h = 310 x 400 mm** waar ca. 35 x120 mm t.b.v. de nis in de muur wordt uitgekeept.

***1 Invoergegevens***



## 9 Muurplaat

De “vaste” muurplaat voor de sporen kap is de gording op ca. 6.50 m hoogte. De muurplaat op het metselwerk wordt belast door verticaal omhoog gerichte belasting.

De bepalende belasting bedraagt F = 0.20 kN ofwel f = 0.20 / 0.60 = 0.35 kN/m

De muurplaat verticaal gekoppeld aan de gebinten (L=4.20 m) geeft als snedekracht
$M = ⅛.0.35.4.20^2 = 0.8$ kNm  h x b = 100 x 200 mm (C18) is $M_u$ = 3 kNm
u.c. << 1 voldoet

koppeling gebint  F = 0.35 x 4.20 x 1.20 = 2 kN
draadend  ø 12 (praktisch)

## 10 Stabiliteit

De stabiliteit van de wagenberging is in de richting loodrecht op de nok gewaarborgd door de stijfheid van de gebinten, in het bijzonder door de schoren 230x200 mm.
Deze verbinding dan ook uitvoeren met deuvels (trek/druk verbinding)

De stabiliteit evenwijdig aan de nok wordt gewaarborgd door de spreidbanden 100 x 125 mm En de schijfwerking van de verdiepingsvloer welke **schuif vast** aan het metselwerk wordt verbonden.

Controle spreidbanden  F = ½ 0.66 x (0.8+0.5) x 11.50 x 2.25 x 1.35 = 15 kN per zijde
aantal spreidbanden 8 x 2 = 16 stuks
per windrichting functioneren 8 stuk (druk-kracht wordt overgebracht)

F per spreidband = 15/8 = 2 kN  numeriek is vast geteld dat de u.c. waarde << 1 is voldoet

## 11 Verbindingen

De verbindingen tussen de vloerligger (b x h = 310 x 340) en de kolommen uitvoeren in een blinde pen en gat verbinding.
Bij de tussenkolom de pen aan de kolom. Bij de kolom in het metselwerk de pen aan de ligger met schuine borstrand.

## 12 Fundatie

Aanname  De fundatie is een gemetselde fundatie waarvan de aanlegbreedte wordt opgemeten.

In de onderstaande berekening is de vereiste aanlegbreedte aangegeven bij een grondslag van  schoonzand met een vaste consistentie (in het werk te controleren) met een toelaatbare grondspanning $\sigma_{gr}$ = 175 kN/m$^2$ (voorbelast)

| | | | | |
|---|---|---|---|---|
| Belasting | t.g.v. gebint | kolom in gevel | vert./hor. | F = 125 / 32 kN |
| | | kolom midden | | F = 210 / 32 ,, |
| | | oplegging muur | | F = 60 ,, |

Kanteling
De verticale en horizontale belasting wordt in verhouding 1 : 4 en 1 : 7 naar de ondergrond overgebracht. Indien de gemetselde fundatie in 1: 2 getrapt is uitgevoerd treedt er geen kanteling op (u.c. = 2/4 < 1 voldoet), dit ter controle.

Oppervlak aanleg  t.p.v. **kolom in gevel**  A = 125/175 = 1.20 m$^2$
i.v.m. Fh = 32 kN wordt **L x B = 1.00 x 1.00 m**

t.p.v. **kolom midden**  A = 210/175 = 1.20 m$^2$
i.v.m. Fh = 32 kN wordt **L x B = 1.25 x 1.25 m**

| | | |
|---|---|---|
| t.p.v. **oplegging gevel** | f = 60 / 4 = 15 kN/m | (gesloten gevel) |
| | f = 10 x 4.5 = 45 ,, | (incl. 1.35 ) |
| | Σf = 60 kN/m | |

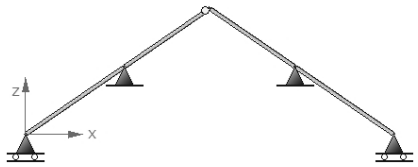
vereiste strookbreedte **B = 0.50 m**

## 13 Bijlagen

Bestand :C:\2017projecten\17017\sporen35.xfr2

Gehanteerde normen: : NEN-EN 1995-1-1 + C1 + A1:2011/NB:2013 (nl)
Gevolgklasse : CC2

## *1 Invoergegevens*




### 1.1 KNOPEN

| Knoop-nummer | Coördinaten X [mm] | Coördinaten Z [mm] | Opleggingen Tx | Opleggingen Tz | Opleggingen Ry |
|---|---|---|---|---|---|
| 1 | 0 | 0 | | A | |
| 2 | 2800 | 1910 | A | A | |
| 3 | 5220 | 3560 | | | |
| 4 | 7640 | 1910 | A | A | |
| 5 | 10440 | 0 | | A | |

### 1.2 STAVEN

| Staaf-nummer | Knoop van | Knoop naar | Staaf-type | Profiel | Lengte [mm] |
|---|---|---|---|---|---|
| 1 | 1 | 2 | | 42 x 171 | 3389 |
| 2 | 2 | 3 | | 42 x 171 | 2929 |
| 3 | 3 | 4 | | 42 x 171 | 2929 |
| 4 | 4 | 5 | | 42 x 171 | 3389 |

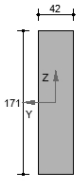
### 1.3 PROFIELEN

| Profiel-nummer | Naam | Gewicht [kg/m] | E [N/mm²] | A [mm²] | Iy [mm4] | Wy;el_1 [mm³] | Wy;el_2 [mm³] |
|---|---|---|---|---|---|---|---|
| 1 | 42 x 171 | 3.0 | 11000 | 7182 | 17500738 | 204687 | 204687 |





**42 x 171**




**Materiaalgegevens**

| | | |
|---|---|---|
| Sterkteklasse | | C24 |
| Klimaatklasse | | 1 |
| Materiaaltype | | Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60 |
| Elasticiteitsmodulus | E = | 11000 N/mm² |

| | | $f_{m,k}$ | $f_{t,0,k}$ | $f_{t,90,k}$ | $f_{c,0,k}$ | $f_{c,90,k}$ | $f_{v,k}$ |
|---|---|---|---|---|---|---|---|
| | | 24.00 | 14.00 | 0.40 | 21.00 | 2.50 | 4.00 N/mm² |
| Belastingsduurklasse | $k_{mod}$ | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.08 | 6.46 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 14.77 | 8.62 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 16.62 | 9.69 | 0.25 | 14.54 | 1.73 | 2.77 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ | = | 420 kg/m³ | $\rho_k$ | = | 350 kg/m³ |
| Elasticiteitsmodulus | $E_{0,mean}$ | = | 11000 N/mm² | $E_{90,mean}$ | = | 370 N/mm² |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ | = | 6875 N/mm² | $E_{90,fin}$ | = | 231 N/mm² |
| Elasticiteitsmodulus | $E_{0,05}$ | = | 7400 N/mm² | $E_{0,d}$ | = | 8462 N/mm² |
| Afschuifmodulus | $G_{mean}$ | = | 690 N/mm² | $G_{0,05}$ | = | 460 N/mm² |

**Doorsnedegegevens**

| | | | | | | |
|---|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ | = | 21.0 mm | $z_{max}$ | = | 85.5 mm |
| Minimale coördinaat | $y_{min}$ | = | -21.0 mm | $z_{min}$ | = | -85.5 mm |
| Zwaartelijn | $z_s$ | = | 0.0 mm | $y_s$ | = | 0.0 mm |
| Oppervlak / Gewicht | A | = | 7182.0 mm² | G | = | 3.0 kg/m |
| Statisch moment | $S_y$ | = | 153515 mm³ | $S_z$ | = | 37706 mm³ |
| Traagheidsmoment | $I_y$ | = | 17500739 mm⁴ | $I_z$ | = | 1055754 mm⁴ |
| Traagheidsstraal | $i_y$ | = | 49.4 mm | $i_z$ | = | 12.1 mm |
| Elastisch weerstandsmoment | $W_{y,el}$ | = | 204687 mm³ | $W_{z,el}$ | = | 50274 mm³ |
| Centrifugaalmoment | $C_{yz}$ | = | 0 mm³ | hoek | = | 0.00 graden |
| Traagheidsmoment | $I_{max}$ | = | 17500739 mm⁴ | $I_{min}$ | = | 1055754 mm⁴ |
| Traagheidsstraal | $i_{max}$ | = | 49.4 mm | $i_{min}$ | = | 12.1 mm |

### 1.4 BELASTINGSGEVALLEN

| Nr. | Omschrijving | Type | ψ0 | ψ1 | ψ2 |
|---|---|---|---|---|---|
| 1 | Permanent | Permanent incl. eigen gewicht | 1.00 | 1.00 | 1.00 |
| 2 | sneeuw links | Sneeuw | 0.00 | 0.20 | 0.00 |
| 3 | sneeuw rechts | Sneeuw | 0.00 | 0.20 | 0.00 |
| 4 | wind | Wind | 0.00 | 0.20 | 0.00 |
| 5 | onderdruk | Wind | 0.00 | 0.20 | 0.00 |
| 6 | overdruk | Wind | 0.00 | 0.20 | 0.00 |

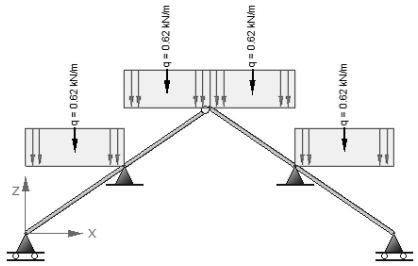




**1.5 BELASTINGSGEVAL 1 Permanent INCL. eigen gewicht**
**Totaal eigen gewicht: : 38 kg.**

#### 1.5.1 Staafbelastingen

| Staaf-nummer | Belasting Type | q1 | q2 | Hoek | Afstand van Knoop | a [mm] | L [mm] |
|---|---|---|---|---|---|---|---|
| 1 | | -0.620 kN/m | -0.620 kN/m | -34.3 | 1 | 0 | 3389 |
| 1 | q | -0.030 kN/m | -0.030 kN/m | -34.3 | 1 | 0 | 3389 |
| 2 | | -0.620 kN/m | -0.620 kN/m | -34.3 | 2 | 0 | 2929 |
| 2 | q | -0.030 kN/m | -0.030 kN/m | -34.3 | 2 | 0 | 2929 |
| 3 | | -0.620 kN/m | -0.620 kN/m | 34.3 | 3 | 0 | 2929 |
| 3 | q | -0.030 kN/m | -0.030 kN/m | 34.3 | 3 | 0 | 2929 |
| 4 | | -0.620 kN/m | -0.620 kN/m | 34.3 | 4 | 0 | 3389 |
| 4 | q | -0.030 kN/m | -0.030 kN/m | 34.3 | 4 | 0 | 3389 |




*) Belastingen a.g.v. eigen gewicht worden niet getekend!

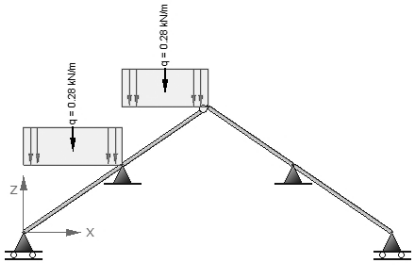
### 1.6 BELASTINGSGEVAL 2 sneeuw links

#### 1.6.1 Staafbelastingen

| Staaf-nummer | Belasting Type | q1 | q2 | Hoek | Afstand van Knoop | a [mm] | L [mm] |
|---|---|---|---|---|---|---|---|
| 1 | | -0.280 kN/m | -0.280 kN/m | -34.3 | 1 | 0 | 3389 |
| 2 | | -0.280 kN/m | -0.280 kN/m | -34.3 | 2 | 0 | 2929 |



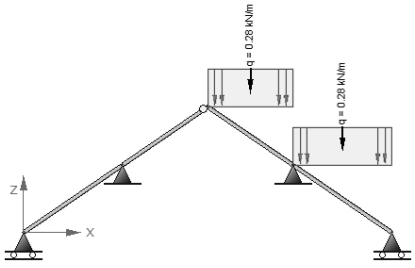





### 1.7 BELASTINGSGEVAL 3 sneeuw rechts

#### 1.7.1 Staafbelastingen

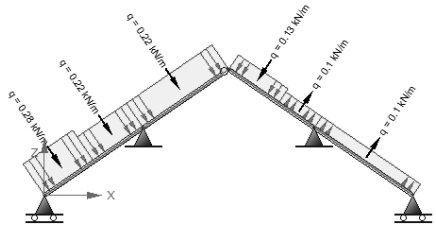
| Staaf-nummer | Belasting Type | q1 | q2 | Hoek | Afstand van Knoop | a [mm] | L [mm] |
|---|---|---|---|---|---|---|---|
| 3 | | -0.280 kN/m | -0.280 kN/m | 34.3 | 3 | 0 | 2929 |
| 4 | | -0.280 kN/m | -0.280 kN/m | 34.3 | 4 | 0 | 3389 |



**1.8 BELASTINGSGEVAL 4 wind**

**1.8.1 Staafbelastingen**

| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 1 | q | -0.220 kN/m | -0.220 kN/m | 0.0 | 1 | 1700 | 1689 |
| 1 | q | -0.280 kN/m | -0.280 kN/m | 0.0 | 1 | 0 | 1700 |
| 2 | q | -0.220 kN/m | -0.220 kN/m | 0.0 | 2 | 0 | 2929 |
| 3 | q | 0.100 kN/m | 0.100 kN/m | 0.0 | 3 | 1700 | 1229 |
| 3 | q | -0.130 kN/m | -0.130 kN/m | 0.0 | 3 | 0 | 1700 |
| 4 | q | 0.100 kN/m | 0.100 kN/m | 0.0 | 4 | 0 | 3389 |



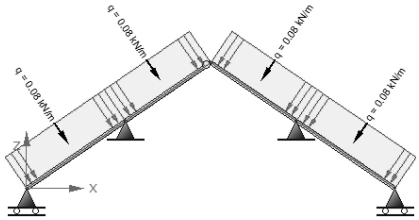

**1.9 BELASTINGSGEVAL 5 onderdruk**

**1.9.1 Staafbelastingen**

| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 1 | q | -0.080 kN/m | -0.080 kN/m | 0.0 | 1 | 0 | 3389 |
| 2 | q | -0.080 kN/m | -0.080 kN/m | 0.0 | 2 | 0 | 2929 |
| 3 | q | -0.080 kN/m | -0.080 kN/m | 0.0 | 3 | 0 | 2929 |
| 4 | q | -0.080 kN/m | -0.080 kN/m | 0.0 | 4 | 0 | 3389 |



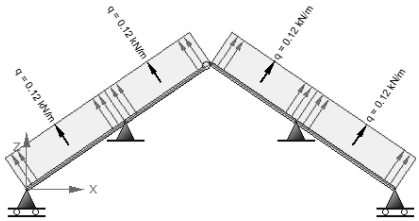





**1.10 BELASTINGSGEVAL 6 overdruk**

**1.10.1 Staafbelastingen**

| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 1 | q | 0.120 kN/m | 0.120 kN/m | 0.0 | 1 | 0 | 3389 |
| 2 | q | 0.120 kN/m | 0.120 kN/m | 0.0 | 2 | 0 | 2929 |
| 3 | q | 0.120 kN/m | 0.120 kN/m | 0.0 | 3 | 0 | 2929 |
| 4 | q | 0.120 kN/m | 0.120 kN/m | 0.0 | 4 | 0 | 3389 |








***2 Berekeningsresultaten***

**2.1 BELASTINGSGEVALLEN**

**(GL) Geometrisch lineaire krachtsverdeling**

**2.1.1 Reactiekrachten**

| Knoop-nummer | Belastings geval | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|---|
| 1 | 1 | | 0.716 | |
| | 2 | | 0.305 | |
| | 3 | | 0.000 | |
| | 4 | | 0.437 | |
| | 5 | | 0.128 | |
| | 6 | | -0.192 | |
| 2 | 1 | 0.820 | 2.711 | |
| | 2 | 0.175 | 1.037 | |
| | 3 | 0.175 | 0.120 | |
| | 4 | -0.510 | 0.755 | |
| | 5 | -0.138 | 0.290 | |
| | 6 | 0.208 | -0.435 | |
| 4 | 1 | -0.820 | 2.711 | |
| | 2 | -0.175 | 0.119 | |
| | 3 | -0.175 | 1.037 | |
| | 4 | -0.466 | 0.025 | |
| | 5 | 0.138 | 0.290 | |
| | 6 | -0.208 | -0.435 | |
| 5 | 1 | | 0.716 | |
| | 2 | | 0.000 | |
| | 3 | | 0.305 | |
| | 4 | | -0.183 | |
| | 5 | | 0.128 | |
| | 6 | | -0.192 | |

**2.2 UITERSTE GRENSTOESTANDEN (UGT)**

**2.2.1 Belastingscombinaties**

**(GNL) Geometrisch niet-lineaire krachtsverdeling**

| Combinatie nummer | Omschrijving | Type |
|---|---|---|
| 1 | permanent | UGT |
| 2 | sneeuw 1/1 | UGT |
| 3 | sneeuw 1/0.5 | UGT |
| 4 | wind + onderdruk | UGT |
| 5 | wind + overdruk | UGT |





| Combinatie nummer | Belasting (ψ x γ) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| 1 | 1.00x1.20 | | | | | | | | | |
| 2 | 1.00x1.20 | 1.00x1.50 | 1.00x1.50 | | | | | | | |
| 3 | 1.00x1.20 | 0.50x1.50 | 1.00x1.50 | | | | | | | |
| 4 | 1.00x1.20 | | | 1.00x1.50 | 1.00x1.50 | | | | | |
| 5 | 1.00x1.20 | | | 1.00x1.50 | | 1.00x1.50 | | | | |

**2.2.2 Reactiekrachten**

| Knoop-nummer | Combinatie nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|---|
| 1 | 1 | | 0.859 | |
| | 2 | | 1.317 | |
| | 3 | | 1.088 | |
| | 4 | | 1.705 | |
| | 5 | | 1.226 | |
| 2 | 1 | 0.984 | 3.254 | |
| | 2 | 1.509 | 4.988 | |
| | 3 | 1.378 | 4.211 | |
| | 4 | 0.011 | 4.821 | |
| | 5 | 0.530 | 3.734 | |
| 4 | 1 | -0.984 | 3.253 | |
| | 2 | -1.509 | 4.988 | |
| | 3 | -1.378 | 4.898 | |
| | 4 | -1.475 | 3.725 | |
| | 5 | -1.994 | 2.639 | |
| 5 | 1 | | 0.859 | |
| | 2 | | 1.317 | |
| | 3 | | 1.317 | |
| | 4 | | 0.776 | |
| | 5 | | 0.297 | |

**2.2.3 Staafreactiekrachten**

| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 0.484 | 0.709 | |
| | | 2 | 0.759 | 1.113 | -0.684 |
| | 2 | 1 | 0.742 | 1.088 | |
| | | 2 | 1.164 | 1.706 | -1.048 |
| | 3 | 1 | 0.613 | 0.898 | |
| | | 2 | 0.962 | 1.410 | -0.866 |
| | 4 | 1 | 0.961 | 1.409 | |
| | | 2 | 0.282 | 2.092 | -1.286 |
| | 5 | 1 | 0.691 | 1.013 | |
| | | 2 | 0.552 | 1.471 | -0.905 |
| 2 | 1 | 2 | 1.887 | 1.021 | 0.684 |
| | | 3 | -0.813 | 0.554 | |
| | 2 | 2 | 2.893 | 1.565 | 1.048 |
| | | 3 | -1.247 | 0.850 | |
| | 3 | 2 | 2.549 | 1.293 | 0.866 |
| | | 3 | -1.189 | 0.702 | |
| | 4 | 2 | 2.443 | 1.886 | 1.286 |
| | | 3 | -1.369 | 1.007 | |
| | 5 | 2 | 1.990 | 1.316 | 0.905 |
| | | 3 | -0.916 | 0.698 | |

| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 3 | 1 | 3 | 0.813 | 0.554 | |
| | | 4 | -1.887 | 1.021 | -0.683 |
| | 2 | 3 | 1.246 | 0.850 | |
| | | 4 | -2.893 | 1.565 | -1.047 |
| | 3 | 3 | 1.088 | 0.850 | |
| | | 4 | -2.734 | 1.565 | -1.047 |
| | 4 | 3 | 1.438 | 0.906 | |
| | | 4 | -2.512 | 1.167 | -0.743 |
| | 5 | 3 | 0.985 | 0.597 | |
| | | 4 | -2.059 | 0.598 | -0.362 |
| 4 | 1 | 4 | -0.759 | 1.113 | 0.683 |
| | | 5 | -0.484 | 0.710 | |
| | 2 | 4 | -1.164 | 1.706 | 1.047 |
| | | 5 | -0.742 | 1.088 | |
| | 3 | 4 | -1.164 | 1.706 | 1.047 |
| | | 5 | -0.742 | 1.088 | |
| | 4 | 4 | -0.806 | 1.079 | 0.743 |
| | | 5 | -0.437 | 0.641 | |
| | 5 | 4 | -1.076 | 0.459 | 0.362 |
| | | 5 | -0.167 | 0.245 | |

**2.2.4 Snedekrachten en vervormingen**

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | -0.484 | 0.709 | **0.000** | 0.0 |
| | | | 1320 | 0.000 | 0.000 | **0.468** | 2.3 |
| | | | 1479 | 0.058 | -0.085 | 0.461 | **2.3** |
| | | | 3389 | 0.759 | -1.113 | -0.684 | 0.0 |
| 1 | 2 | 1 | 0 | -0.742 | 1.088 | 0.000 | 0.0 |
| | | | 1320 | 0.000 | 0.000 | **0.718** | 3.5 |
| | | | 1479 | 0.089 | -0.131 | 0.707 | **3.5** |
| | | | 3389 | 1.164 | -1.706 | -1.048 | 0.0 |
| 1 | 3 | 1 | 0 | -0.613 | 0.898 | 0.000 | 0.0 |
| | | | 1319 | 0.000 | 0.000 | **0.593** | 2.9 |
| | | | 1479 | 0.074 | -0.108 | 0.584 | **2.9** |
| | | | 3389 | 0.962 | -1.410 | -0.866 | 0.0 |
| 1 | 4 | 1 | 0 | -0.961 | 1.409 | 0.000 | 0.0 |
| | | | 1307 | -0.482 | 0.000 | **0.921** | 4.5 |
| | | | 1477 | -0.419 | -0.182 | 0.906 | **4.5** |
| | | | 1700 | -0.338 | -0.423 | 0.838 | 4.4 |
| | | | 2643 | 0.008 | -1.354 | **0.000** | 2.0 |
| | | | 3389 | 0.282 | -2.092 | -1.286 | 0.0 |
| 1 | 5 | 1 | 0 | -0.691 | 1.013 | **0.000** | 0.0 |
| | | | 1303 | -0.213 | 0.000 | **0.660** | 3.2 |
| | | | 1477 | -0.149 | -0.135 | 0.648 | **3.2** |
| | | | 1700 | -0.068 | -0.309 | 0.598 | 3.2 |
| | | | 3389 | 0.552 | -1.471 | -0.905 | 0.0 |
| 2 | 1 | 2 | 0 | -1.887 | 1.021 | -0.684 | 0.0 |
| | | | 868 | -1.569 | 0.554 | **0.000** | 0.4 |
| | | | 1899 | -1.191 | 0.000 | **0.286** | 0.8 |
| | | | 2929 | -0.813 | -0.554 | 0.000 | 0.0 |
| 2 | 2 | 2 | 0 | -2.893 | 1.565 | -1.048 | 0.0 |
| | | | 868 | -2.405 | 0.850 | **0.000** | 0.5 |

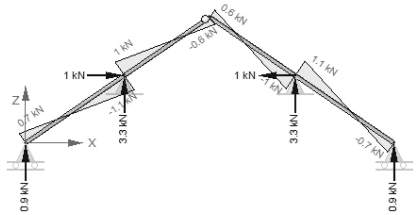




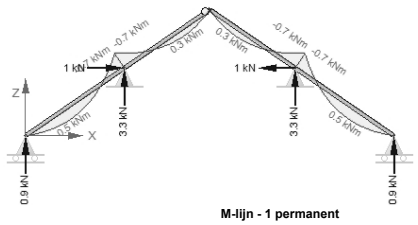
| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 2 | 2 | 2 | 1899 | -1.826 | 0.000 | **0.438** | 1.3 |
| | | | 2929 | -1.247 | -0.850 | 0.000 | 0.0 |
| 2 | 3 | 2 | 0 | -2.549 | 1.293 | -0.866 | 0.0 |
| | | | 868 | -2.146 | 0.702 | **0.000** | 0.4 |
| | | | 1899 | -1.667 | 0.000 | **0.362** | 1.1 |
| | | | 2929 | -1.189 | -0.702 | 0.000 | 0.0 |
| 2 | 4 | 2 | 0 | -2.443 | 1.886 | -1.286 | 0.0 |
| | | | 1909 | -1.743 | 0.000 | **0.514** | 1.5 |
| | | | 2929 | -1.369 | -1.007 | 0.000 | 0.0 |
| 2 | 5 | 2 | 0 | -1.990 | 1.316 | -0.905 | 0.0 |
| | | | 1914 | -1.288 | 0.000 | **0.355** | 1.0 |
| | | | 2929 | -0.916 | -0.698 | 0.000 | 0.0 |
| 3 | 1 | 3 | 0 | -0.813 | 0.554 | 0.000 | 0.0 |
| | | | 1031 | -1.191 | 0.000 | **0.286** | 0.8 |
| | | | 2929 | -1.887 | -1.021 | -0.683 | 0.0 |
| 3 | 2 | 3 | 0 | -1.246 | 0.850 | 0.000 | 0.0 |
| | | | 1031 | -1.826 | 0.000 | **0.438** | 1.3 |
| | | | 2929 | -2.893 | -1.565 | -1.047 | 0.0 |
| 3 | 3 | 3 | 0 | -1.088 | 0.850 | 0.000 | 0.0 |
| | | | 1031 | -1.667 | 0.000 | **0.438** | 1.3 |
| | | | 2929 | -2.734 | -1.565 | -1.047 | 0.0 |
| 3 | 4 | 3 | 0 | -1.438 | 0.906 | 0.000 | 0.0 |
| | | | 1063 | -1.828 | 0.000 | **0.482** | 1.6 |
| | | | 1216 | -1.884 | -0.131 | 0.472 | **1.6** |
| | | | 1700 | -2.061 | -0.543 | 0.309 | 1.3 |
| | | | 2929 | -2.512 | -1.167 | -0.743 | 0.0 |
| 3 | 5 | 3 | 0 | -0.985 | 0.597 | 0.000 | 0.0 |
| | | | 1080 | -1.381 | 0.000 | **0.323** | 1.1 |
| | | | 1249 | -1.443 | -0.093 | 0.315 | **1.1** |
| | | | 1700 | -1.608 | -0.343 | 0.216 | 1.0 |
| | | | 2929 | -2.059 | -0.598 | -0.362 | 0.0 |
| 4 | 1 | 4 | 0 | 0.759 | 1.113 | -0.683 | 0.0 |
| | | | 750 | 0.484 | 0.710 | **0.000** | 1.0 |
| | | | 1910 | 0.058 | 0.086 | 0.461 | **2.3** |
| | | | 2070 | 0.000 | 0.000 | **0.468** | 2.3 |
| | | | 3389 | -0.484 | -0.710 | 0.000 | 0.0 |
| 4 | 2 | 4 | 0 | 1.164 | 1.706 | -1.047 | 0.0 |
| | | | 750 | 0.742 | 1.088 | **0.000** | 1.6 |
| | | | 1910 | 0.089 | 0.131 | 0.708 | **3.5** |
| | | | 2069 | 0.000 | 0.000 | **0.718** | 3.5 |
| | | | 3389 | -0.742 | -1.088 | 0.000 | 0.0 |
| 4 | 3 | 4 | 0 | 1.164 | 1.706 | -1.047 | 0.0 |
| | | | 749 | 0.742 | 1.088 | **0.000** | 1.6 |
| | | | 1910 | 0.089 | 0.131 | 0.708 | **3.5** |
| | | | 2069 | 0.000 | 0.000 | **0.718** | 3.5 |
| | | | 3389 | -0.742 | -1.088 | 0.000 | 0.0 |
| 4 | 4 | 4 | 0 | 0.806 | 1.079 | -0.743 | 0.0 |
| | | | 863 | 0.489 | 0.641 | **0.000** | 0.8 |
| | | | 2126 | 0.026 | 0.000 | **0.405** | 1.8 |
| | | | 3389 | -0.437 | -0.641 | 0.000 | 0.0 |
| 4 | 5 | 4 | 0 | 1.076 | 0.459 | -0.362 | 0.0 |
| | | | 1028 | 0.699 | 0.245 | **0.000** | 0.2 |
| | | | 2208 | 0.266 | 0.000 | **0.145** | 0.6 |
| | | | 3389 | -0.167 | -0.245 | 0.000 | 0.0 |



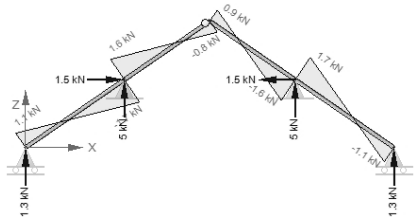





**D-lijn - 1 permanent**



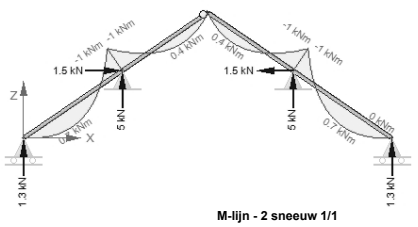

**M-lijn - 1 permanent**



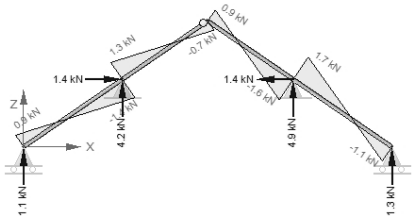

**D-lijn - 2 sneeuw 1/1**



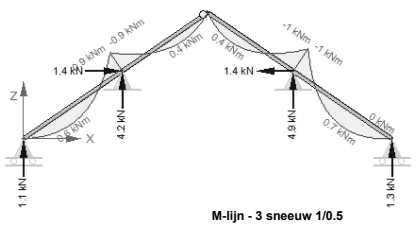




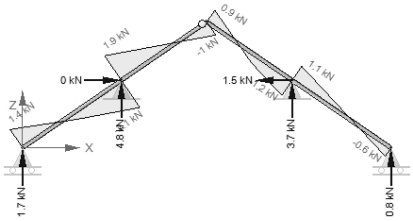

**M-lijn - 2 sneeuw 1/1**



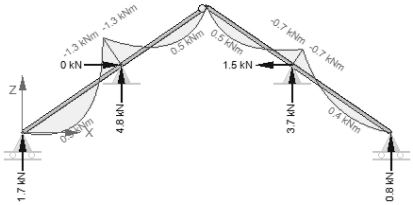

**D-lijn - 3 sneeuw 1/0.5**



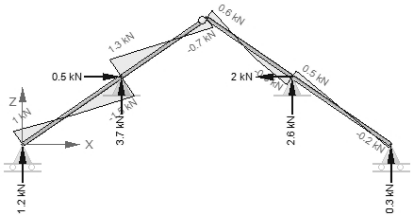

**M-lijn - 3 sneeuw 1/0.5**




**D-lijn - 4 wind + onderdruk**



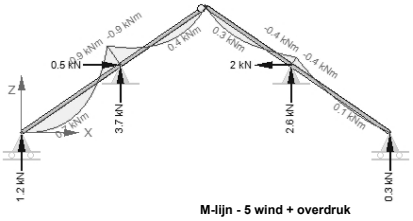

**M-lijn - 4 wind + onderdruk**




**D-lijn - 5 wind + overdruk**








**M-lijn - 5 wind + overdruk**

### 2.3 BRUIKBAARHEIDSGRENSTOESTANDEN (BGT)

#### 2.3.1 Belastingscombinaties

**(GNL) Geometrisch niet-lineaire krachtsverdeling**

| Combinatie nummer | Omschrijving | Type |
|---|---|---|
| 6 | permanent | BGT |
| 7 | sneeuw 1/1 | BGT |
| 8 | sneeuw 1/0.5 | BGT |
| 9 | wind + onderdruk | BGT |
| 10 | wind + overdruk | BGT |

| Combinatie nummer | Belasting (ψ x γ) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| 6 | 1.60x1.00 | | | | | | | | | |
| 7 | 1.60x1.00 | 1.00x1.00 | 1.00x1.00 | | | | | | | |
| 8 | 1.60x1.00 | 0.50x1.00 | 1.00x1.00 | | | | | | | |
| 9 | 1.60x1.00 | | | 1.00x1.00 | 1.00x1.00 | | | | | |
| 10 | 1.60x1.00 | | | 1.00x1.00 | | 1.00x1.00 | | | | |

#### 2.3.2 Knoopverplaatsingen

| Knoop-nummer | Combinatie nummer | dx [mm] | dz [mm] | dr [mrad] |
|---|---|---|---|---|
| 1 | 6 | 0.0 | 0.0 | -3.4 |
| | 7 | 0.0 | 0.0 | -4.3 |
| | 8 | 0.0 | 0.0 | -3.8 |
| | 9 | 0.0 | 0.0 | -5.0 |
| | 10 | 0.0 | 0.0 | -4.1 |
| 2 | 6 | 0.0 | 0.0 | 0.7 |
| | 7 | 0.0 | 0.0 | 0.9 |
| | 8 | 0.0 | 0.0 | 0.8 |
| | 9 | 0.0 | 0.0 | 1.1 |
| | 10 | 0.0 | 0.0 | 0.9 |
| 3 | 6 | 0.0 | -0.1 | -1.6 |
| | 7 | 0.0 | -0.1 | -2.0 |
| | 8 | 0.0 | -0.1 | -2.0 |
| | 9 | 0.0 | -0.1 | -2.2 |





| Knoop-nummer | Combinatie nummer | dx [mm] | dz [mm] | dr [mrad] |
|---|---|---|---|---|
| 3 | 10 | 0.0 | -0.1 | -1.8 |
| 4 | 6 | 0.0 | 0.0 | -0.7 |
| | 7 | 0.0 | 0.0 | -0.9 |
| | 8 | 0.0 | 0.0 | -0.9 |
| | 9 | 0.0 | 0.0 | -0.3 |
| | 10 | 0.0 | 0.0 | -0.1 |
| 5 | 6 | 0.0 | 0.0 | 3.4 |
| | 7 | 0.0 | 0.0 | 4.3 |
| | 8 | 0.0 | 0.0 | 4.3 |
| | 9 | 0.0 | 0.0 | 3.1 |
| | 10 | 0.0 | 0.0 | 2.1 |

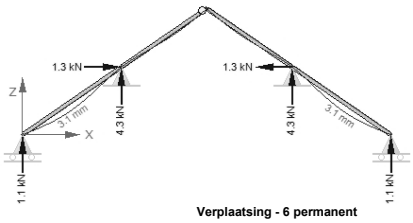
#### 2.3.3 Snedekrachten en vervormingen

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 6 | 1 | 0 | -0.645 | 0.946 | **0.000** | 0.0 |
| | | | 1320 | 0.000 | 0.000 | **0.624** | 3.0 |
| | | | 1479 | 0.078 | -0.114 | 0.615 | **3.1** |
| | | | 3389 | 1.012 | -1.484 | -0.912 | 0.0 |
| 1 | 7 | 1 | 0 | -0.817 | 1.198 | 0.000 | 0.0 |
| | | | 1320 | 0.000 | 0.000 | **0.790** | 3.8 |
| | | | 1479 | 0.098 | -0.144 | 0.779 | **3.9** |
| | | | 2639 | 0.817 | -1.198 | **0.000** | 1.7 |
| | | | 3389 | 1.282 | -1.879 | -1.154 | 0.0 |
| 1 | 8 | 1 | 0 | -0.731 | 1.072 | 0.000 | 0.0 |
| | | | 1320 | 0.000 | 0.000 | **0.707** | 3.4 |
| | | | 1479 | 0.088 | -0.129 | 0.697 | **3.5** |
| | | | 2639 | 0.731 | -1.072 | **0.000** | 1.5 |
| | | | 3389 | 1.147 | -1.682 | -1.033 | 0.0 |
| 1 | 9 | 1 | 0 | -0.963 | 1.412 | 0.000 | 0.0 |
| | | | 1311 | -0.322 | 0.000 | **0.926** | 4.5 |
| | | | 1478 | -0.240 | -0.180 | 0.911 | **4.6** |
| | | | 1700 | -0.132 | -0.418 | 0.845 | 4.4 |
| | | | 2642 | 0.328 | -1.376 | **0.000** | 2.0 |
| | | | 3389 | 0.694 | -2.136 | -1.313 | 0.0 |
| 1 | 10 | 1 | 0 | -0.783 | 1.148 | **0.000** | 0.0 |
| | | | 1310 | -0.143 | 0.000 | **0.752** | 3.6 |
| | | | 1477 | -0.061 | -0.147 | 0.740 | **3.7** |
| | | | 1700 | 0.048 | -0.342 | 0.685 | 3.6 |
| | | | 3389 | 0.874 | -1.722 | -1.059 | 0.0 |
| 2 | 6 | 2 | 0 | -2.516 | 1.361 | -0.912 | 0.0 |
| | | | 868 | -2.092 | 0.739 | **0.000** | 0.5 |
| | | | 1899 | -1.588 | 0.000 | **0.381** | 1.1 |
| | | | 2929 | -1.084 | -0.739 | 0.000 | 0.0 |
| 2 | 7 | 2 | 0 | -3.187 | 1.724 | -1.154 | 0.0 |
| | | | 868 | -2.650 | 0.936 | **0.000** | 0.6 |
| | | | 1899 | -2.011 | 0.000 | **0.482** | 1.4 |
| | | | 2929 | -1.373 | -0.936 | 0.000 | 0.0 |
| 2 | 8 | 2 | 0 | -2.958 | 1.543 | -1.033 | 0.0 |
| | | | 868 | -2.477 | 0.837 | **0.000** | 0.5 |
| | | | 1899 | -1.906 | 0.000 | **0.431** | 1.3 |
| | | | 2929 | -1.335 | -0.837 | 0.000 | 0.0 |
| 2 | 9 | 2 | 0 | -2.887 | 1.938 | -1.313 | 0.0 |

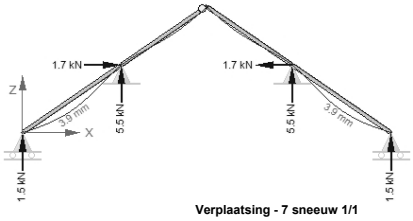




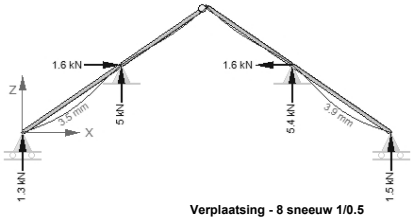
| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 2 | 9 | 2 | 882 | -2.456 | 1.041 | **0.000** | 0.6 |
| | | | 1905 | -1.955 | 0.000 | **0.533** | 1.5 |
| | | | 2929 | -1.455 | -1.041 | 0.000 | 0.0 |
| 2 | 10 | 2 | 0 | -2.585 | 1.558 | -1.059 | 0.0 |
| | | | 885 | -2.152 | 0.835 | **0.000** | 0.5 |
| | | | 1907 | -1.652 | 0.000 | **0.427** | 1.2 |
| | | | 2929 | -1.153 | -0.835 | 0.000 | 0.0 |
| 3 | 6 | 3 | 0 | -1.084 | 0.739 | 0.000 | 0.0 |
| | | | 1031 | -1.588 | 0.000 | **0.381** | 1.1 |
| | | | 2929 | -2.516 | -1.361 | -0.911 | 0.0 |
| 3 | 7 | 3 | 0 | -1.373 | 0.936 | 0.000 | 0.0 |
| | | | 1031 | -2.011 | 0.000 | **0.483** | 1.4 |
| | | | 2929 | -3.187 | -1.724 | -1.153 | 0.0 |
| 3 | 8 | 3 | 0 | -1.267 | 0.936 | 0.000 | 0.0 |
| | | | 1031 | -1.906 | 0.000 | **0.483** | 1.4 |
| | | | 2929 | -3.081 | -1.724 | -1.153 | 0.0 |
| 3 | 9 | 3 | 0 | -1.501 | 0.974 | 0.000 | 0.0 |
| | | | 1051 | -2.014 | 0.000 | **0.512** | 1.6 |
| | | | 1190 | -2.082 | -0.129 | 0.503 | **1.6** |
| | | | 1700 | -2.332 | -0.602 | 0.316 | 1.3 |
| | | | 2929 | -2.933 | -1.459 | -0.950 | 0.0 |
| 3 | 10 | 3 | 0 | -1.198 | 0.768 | 0.000 | 0.0 |
| | | | 1056 | -1.715 | 0.000 | **0.405** | 1.3 |
| | | | 1201 | -1.786 | -0.106 | 0.398 | **1.3** |
| | | | 1700 | -2.030 | -0.468 | 0.255 | 1.1 |
| | | | 2929 | -2.630 | -1.079 | -0.696 | 0.0 |
| 4 | 6 | 4 | 0 | 1.012 | 1.484 | -0.911 | 0.0 |
| | | | 750 | 0.645 | 0.946 | **0.000** | 1.4 |
| | | | 1910 | 0.078 | 0.114 | 0.615 | **3.1** |
| | | | 2070 | 0.000 | 0.000 | **0.624** | 3.0 |
| | | | 3389 | -0.645 | -0.946 | 0.000 | 0.0 |
| 4 | 7 | 4 | 0 | 1.282 | 1.879 | -1.153 | 0.0 |
| | | | 749 | 0.818 | 1.198 | **0.000** | 1.7 |
| | | | 1910 | 0.098 | 0.144 | 0.780 | **3.9** |
| | | | 2069 | 0.000 | 0.000 | **0.791** | 3.8 |
| | | | 3389 | -0.818 | -1.198 | 0.000 | 0.0 |
| 4 | 8 | 4 | 0 | 1.282 | 1.879 | -1.153 | 0.0 |
| | | | 749 | 0.818 | 1.199 | **0.000** | 1.7 |
| | | | 1910 | 0.098 | 0.144 | 0.780 | **3.9** |
| | | | 2069 | 0.000 | 0.000 | **0.791** | 3.8 |
| | | | 3389 | -0.818 | -1.199 | 0.000 | 0.0 |
| 4 | 9 | 4 | 0 | 1.043 | 1.461 | -0.950 | 0.0 |
| | | | 805 | 0.650 | 0.901 | **0.000** | 1.2 |
| | | | 1937 | 0.096 | 0.112 | 0.573 | **2.8** |
| | | | 2097 | 0.018 | 0.000 | **0.582** | 2.7 |
| | | | 3389 | -0.614 | -0.901 | 0.000 | 0.0 |
| 4 | 10 | 4 | 0 | 1.223 | 1.047 | -0.696 | 0.0 |
| | | | 827 | 0.819 | 0.637 | **0.000** | 0.9 |
| | | | 1950 | 0.270 | 0.079 | 0.402 | **1.9** |
| | | | 2108 | 0.192 | 0.000 | **0.408** | 1.9 |
| | | | 3389 | -0.434 | -0.637 | 0.000 | 0.0 |




**Verplaatsing - 6 permanent**



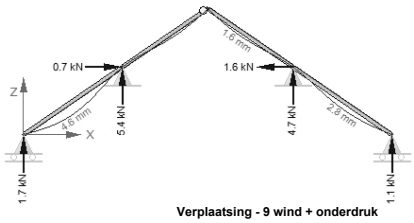

**Verplaatsing - 7 sneeuw 1/1**



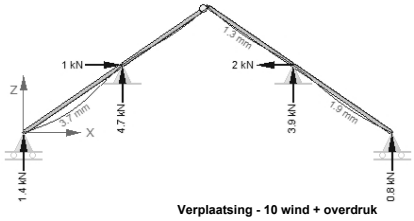

**Verplaatsing - 8 sneeuw 1/0.5**








**Verplaatsing - 9 wind + onderdruk**



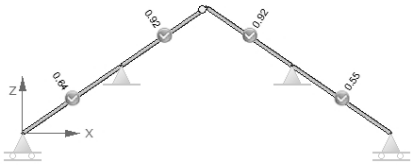

**Verplaatsing - 10 wind + overdruk**

**2.4 EN1995 TOETSINGEN**

De toetsing van de houtprofielen in de uiterste grenstoestand volgens EN 1995-1-1 is gebaseerd op een geometrische niet-lineaire krachtsverdeling (tweede orde analyse) inclusief de gegeven imperfecties volgens art.5.4.4.








| Staaf-nummer | Profiel | Combinatie nummer | Artikel | U.C. |
|---|---|---|---|---|
| 1 | 42 x 171 | 7 | 6.1.2 | 0.01 |
| | | 6 | 6.1.4 | 0.01 |
| | | 6 | 6.1.6 | 0.28 |
| | | 6 | 6.1.7 | 0.17 |
| | | 6 | 6.2.3 | 0.42 |
| | | 9 | 6.2.4 | 0.27 |
| | | 4 | 6.3.2 | 0.30 |
| | | 1 | 6.3.3 | 0.64 |
| 2 | 42 x 171 | 6 | 6.1.4 | 0.03 |
| | | 6 | 6.1.7 | 0.15 |
| | | 6 | 6.2.4 | 0.40 |
| | | 6 | 6.3.2 | 0.92 |
| | | 6 | 6.3.3 | 0.90 |
| 3 | 42 x 171 | 6 | 6.1.4 | 0.04 |
| | | 6 | 6.1.7 | 0.15 |
| | | 6 | 6.2.4 | 0.40 |
| | | 6 | 6.3.2 | 0.92 |
| | | 6 | 6.3.3 | 0.90 |
| 4 | 42 x 171 | 6 | 6.1.2 | 0.01 |
| | | 6 | 6.1.4 | 0.01 |
| | | 1 | 6.1.6 | 0.21 |
| | | 6 | 6.1.7 | 0.17 |
| | | 6 | 6.2.3 | 0.42 |
| | | 6 | 6.2.4 | 0.28 |
| | | 6 | 6.3.2 | 0.28 |
| | | 6 | 6.3.3 | 0.55 |





**2.4.1 BEREKENING VAN UNITY CHECKS**

**Staaf 3 - 42 x 171 (C24 Klimaatklasse:1)**

**Druk evenwijdig aan de vezelrichting** **art. 6.1.4**

Combinatie : 6 x = 2929 mm Nx = -2.516 kN Vz = -1.361 kN My = 0 kNm
Belastingsduurklasse : Blijvend

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{2516.0}{7182} = 0.4 \text{ N/mm}^2 < f_{c,0,d} = 9.7 \text{ N/mm}^2 \quad (6.2)$$

**Afschuiving** **art. 6.1.7**

Combinatie : 6 x = 2929 mm Nx = -2.516 kN Vz = -1.361 kN My = 0 kNm
Belastingsduurklasse : Blijvend

$$\tau_d = \frac{V_{Ed} S}{b\, I_y} = \frac{1361.0 \times 153515}{42 \times 17500739} = 0.3 \text{ N/mm}^2 < f_{v,d} = 1.8 \text{ N/mm}^2 \quad (6.13)$$

**Gecombineerde buig- en axiale drukspanningen** **art. 6.2.4**

Combinatie : 6 x = 2929 mm Nx = -2.516 kN Vz = -1.361 kN My = -0.911 kNm
Belastingsduurklasse : Blijvend

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{2516}{7182} = 0.4 \text{ N/mm}^2 \quad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0.911 \times 10^6}{205 \times 10^3} = 4.4 \text{ N/mm}^2$$

$$\left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \left(\frac{0.4}{9.7}\right)^2 + \frac{4.4}{11.1} = 0.40 < 1.00 \quad (6.19)$$

**Kolommen onderworpen aan druk of aan druk en buiging** **art. 6.3.2**

Combinatie : 6 x = 2929 mm Nx = -2.516 kN Vz = -1.361 kN My = -0.911 kNm
Belastingsduurklasse : Blijvend

$$\lambda_y = \frac{L_{cr,y}}{i_y} = \frac{2929}{49.4} = 59.33 \qquad \lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{59.33}{\pi}\sqrt{\frac{21.0}{7400}} = 1.006 \quad (6.21)$$

$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{2929}{12.1} = 241.58 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{241.58}{\pi}\sqrt{\frac{21.0}{7400}} = 4.096 \quad (6.22)$$

$$k_y = 0{,}5(1 + \beta_c(\lambda_{rel,y} - 0{,}3) + \lambda_{rel,y}^2 = 0{,}5 \times (1 + 0.2 \times (1.006 - 0{,}3) + 1.006^2 = 1.08 \quad (6.27)$$

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} = \frac{1}{1.08 + \sqrt{1.08^2 - 1.01^2}} = 0.68 \quad (6.25)$$

$$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (4.096 - 0{,}3) + 4.096^2 = 9.27 \quad (6.28)$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{9.27 + \sqrt{9.27^2 - 4.10^2}} = 0.06 \quad (6.26)$$

$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{2516}{7182} = 0.4$ N/mm $^2$ $\sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0.911 \times 10^6}{205 \times 10^3} = 4.4$ N/mm $^2$

$$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0.4}{0.68 \times 9.7} + \frac{4.4}{11.1} + 0.7 \times \frac{0.0}{14.3} = 0.45 < 1.00 \quad (6.23)$$

$$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0.4}{0.06 \times 9.7} + 0.7 \times \frac{4.4}{11.1} + \frac{0.0}{14.3} = 0.92 < 1.00 \quad (6.24)$$

**Liggers onderworpen aan druk of aan druk en buiging** **art. 6.3.3**

Combinatie : 6 x = 2929 mm Nx = -2.516 kN Vz = -1.361 kN My = -0.911 kNm
Belastingsduurklasse : Blijvend

Aantal kipsteunen: 0 Op twee steunpunten: Gelijkmatig verdeelde belasting

$\rightarrow l_{ef} = 0.9 \times l = 0.9 \times 2929 = 2636$ mm

$$\sigma_{m,crit} = \frac{0{,}78\, b^2}{h\, l_{ef}} E_{0,05} = \frac{0{,}78 \times 42^2}{171 \times 2636} \times 7400 = 22.6 \text{ N/mm}^2 \quad (6.32)$$

$$\lambda_{rel,m} = \sqrt{\frac{f_{m,k}}{\sigma_{m,crit}}} = \sqrt{\frac{24}{22.6}} = 1.031 \quad (6.30)$$

$0{,}75 < \lambda_{rel,m} < 1{,}4 \rightarrow k_{crit} = 1{,}56 - 0{,}75\ \lambda_{rel,m} = 1{,}56 - 0{,}75 \times 1.031 = 0.787$ (6.34)

$\sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0.911 \times 10^6}{205 \times 10^3} = 4.4$ N/mm $^2$ $\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{2516}{7182} = 0.4$ N/mm $^2$

$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{2929}{12.1} = 241.58$ $\lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{241.58}{\pi}\sqrt{\frac{21.0}{7400}} = 4.096$ (6.22)

$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (4.096 - 0{,}3) + 4.096^2 = 9.27$ (6.28)

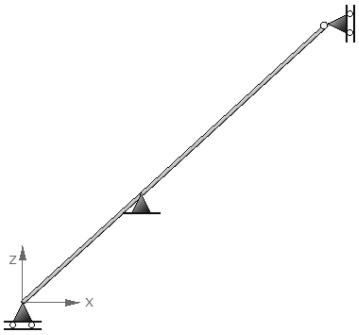
$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{9.27 + \sqrt{9.27^2 - 4.10^2}} = 0.06 \quad (6.26)$$

$$\left(\frac{\sigma_{m,d}}{k_{crit} f_{m,d}}\right)^2 + \frac{\sigma_{c,d}}{k_{c,d} f_{c,0,d}} = \left(\frac{4.4}{0.79 \times 11.1}\right)^2 + \frac{0.4}{0.06 \times 9.7} = 0.90 < 1.00 \quad (6.35)$$

Bestand :C:\2017projecten\17017\sporen42.xfr2

Gehanteerde normen: : NEN-EN 1995-1-1 + C1 + A1:2011/NB:2013 (nl)
Gevolgklasse : CC2

## *1 Invoergegevens*




### 1.1 KNOPEN

| Knoop-nummer | Coördinaten X [mm] | Coördinaten Z [mm] | Opleggingen Tx | Opleggingen Tz | Opleggingen Ry |
|---|---|---|---|---|---|
| 1 | 0 | 0 | | A | |
| 2 | 1096 | 1000 | A | A | |
| 3 | 2820 | 2580 | A | | |

### 1.2 STAVEN

| Staaf-nummer | Knoop van | Knoop naar | Staaf-type | Profiel | Lengte [mm] |
|---|---|---|---|---|---|
| 1 | 1 | 2 | | 42 x 171 | 1484 |
| 2 | 2 | 3 | | 42 x 171 | 2338 |

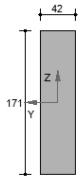
### 1.3 PROFIELEN

| Profiel-nummer | Naam | Gewicht [kg/m] | E [N/mm²] | A [mm²] | Iy [mm4] | Wy;el_1 [mm³] | Wy;el_2 [mm³] |
|---|---|---|---|---|---|---|---|
| 1 | 42 x 171 | 2.5 | 7000 | 7182 | 17500738 | 204687 | 204687 |





**42 x 171**




**Materiaalgegevens**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sterkteklasse | | C14 | | | | | | |
| Klimaatklasse | | 1 | | | | | | |
| Materiaaltype | | Gezaagd hout | $\gamma_M$ = 1.30 | $k_{def}$ = 0.60 | | | | |
| Elasticiteitsmodulus | | E = 7000 N/mm² | | | | | | |
| | | $f_{m,k}$ | $f_{t,0,k}$ | $f_{t,90,k}$ | $f_{c,0,k}$ | $f_{c,90,k}$ | $f_{v,k}$ | |
| | | 14.00 | 8.00 | 0.40 | 16.00 | 2.00 | 3.00 | N/mm² |
| Belastingsduurklasse | $k_{mod}$ | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ | |
| Blijvend | 0.60(0.50) | 6.46 | 3.69 | 0.15 | 7.38 | 0.92 | 1.38 | N/mm² |
| Middellang | 0.80(0.65) | 8.62 | 4.92 | 0.20 | 9.85 | 1.23 | 1.85 | |
| Kort | 0.90(0.80) | 9.69 | 5.54 | 0.25 | 11.08 | 1.38 | 2.08 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = | 350 kg/m³ | $\rho_k$ = | 290 kg/m³ |
| Elasticiteitsmodulus | $E_{0,mean}$ = | 7000 N/mm² | $E_{90,mean}$ = | 230 N/mm² |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = | 4375 N/mm² | $E_{90,fin}$ = | 144 N/mm² |
| Elasticiteitsmodulus | $E_{0,05}$ = | 4700 N/mm² | $E_{0,d}$ = | 5385 N/mm² |
| Afschuifmodulus | $G_{mean}$ = | 440 N/mm² | $G_{0,05}$ = | 290 N/mm² |

**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = | 21.0 mm | $z_{max}$ = | 85.5 mm |
| Minimale coördinaat | $y_{min}$ = | -21.0 mm | $z_{min}$ = | -85.5 mm |
| Zwaartelijn | $z_s$ = | 0.0 mm | $y_s$ = | 0.0 mm |
| Oppervlak / Gewicht | A = | 7182.0 mm² | G = | 2.5 kg/m |
| Statisch moment | $S_y$ = | 153515 mm³ | $S_z$ = | 37706 mm³ |
| Traagheidsmoment | $I_y$ = | 17500739 mm⁴ | $I_z$ = | 1055754 mm⁴ |
| Traagheidsstraal | $i_y$ = | 49.4 mm | $i_z$ = | 12.1 mm |
| Elastisch weerstandsmoment | $W_{y,el}$ = | 204687 mm³ | $W_{z,el}$ = | 50274 mm³ |
| Centrifugaalmoment | $C_{yz}$ = | 0 mm³ | hoek = | 0.00 graden |
| Traagheidsmoment | $I_{max}$ = | 17500739 mm⁴ | $I_{min}$ = | 1055754 mm⁴ |
| Traagheidsstraal | $i_{max}$ = | 49.4 mm | $i_{min}$ = | 12.1 mm |

### 1.4 BELASTINGSGEVALLEN

| Nr. | Omschrijving | Type | ψ0 | ψ1 | ψ2 |
|---|---|---|---|---|---|
| 1 | Permanent | Permanent incl. eigen gewicht | 1.00 | 1.00 | 1.00 |
| 2 | sneeuw | Sneeuw | 0.00 | 0.20 | 0.00 |
| 3 | wind | Wind | 0.00 | 0.20 | 0.00 |
| 4 | overdruk | Wind | 0.00 | 0.20 | 0.00 |
| 5 | onderdruk | Wind | 0.00 | 0.20 | 0.00 |

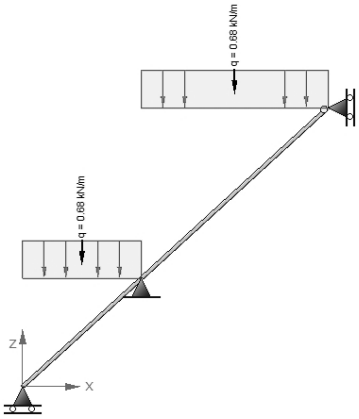




### 1.5 BELASTINGSGEVAL 1 Permanent INCL. eigen gewicht
**Totaal eigen gewicht: : 10 kg.**

#### 1.5.1 Staafbelastingen

| Staaf-nummer | Belasting Type | q1 | q2 | Hoek | Afstand van Knoop | a [mm] | L [mm] |
|---|---|---|---|---|---|---|---|
| 1 | q | -0.680 kN/m | -0.680 kN/m | -42.4 | 1 | 0 | 1484 |
| 1 | q | -0.025 kN/m | -0.025 kN/m | -42.4 | 1 | 0 | 1484 |
| 2 | q | -0.680 kN/m | -0.680 kN/m | -42.5 | 2 | 0 | 2338 |
| 2 | q | -0.025 kN/m | -0.025 kN/m | -42.5 | 2 | 0 | 2338 |




*) Belastingen a.g.v. eigen gewicht worden niet getekend!

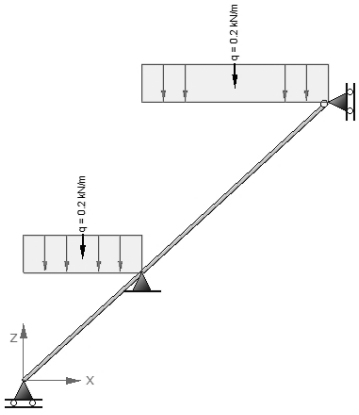
### 1.6 BELASTINGSGEVAL 2 sneeuw

#### 1.6.1 Staafbelastingen

| Staaf-nummer | Belasting Type | q1 | q2 | Hoek | Afstand van Knoop | a [mm] | L [mm] |
|---|---|---|---|---|---|---|---|
| 1 | q | -0.200 kN/m | -0.200 kN/m | -42.4 | 1 | 0 | 1484 |
| 2 | q | -0.200 kN/m | -0.200 kN/m | -42.5 | 2 | 0 | 2338 |



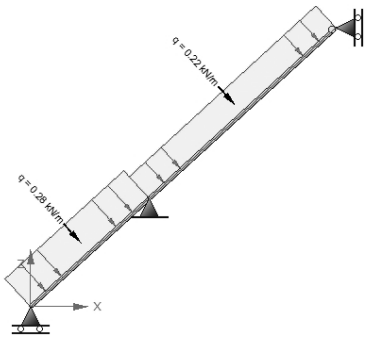





### 1.7 BELASTINGSGEVAL 3 wind

#### 1.7.1 Staafbelastingen

| Staaf-nummer | Belasting Type | q1 | q2 | Hoek | Afstand van Knoop | a [mm] | L [mm] |
|---|---|---|---|---|---|---|---|
| 1 | q | -0.280 kN/m | -0.280 kN/m | 0.0 | 1 | 0 | 1484 |
| 2 | q | -0.220 kN/m | -0.220 kN/m | 0.0 | 2 | 0 | 2338 |



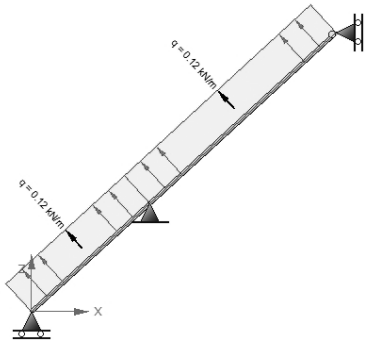

**1.8 BELASTINGSGEVAL 4 overdruk**

**1.8.1 Staafbelastingen**

| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 1 | q | 0.120 kN/m | 0.120 kN/m | 0.0 | 1 | 0 | 1484 |
| 2 | q | 0.120 kN/m | 0.120 kN/m | 0.0 | 2 | 0 | 2338 |







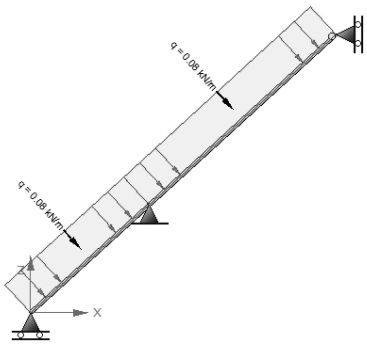

**1.9 BELASTINGSGEVAL 5 onderdruk**

**1.9.1 Staafbelastingen**

| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 1 | q | -0.080 kN/m | -0.080 kN/m | 0.0 | 1 | 0 | 1484 |
| 2 | q | -0.080 kN/m | -0.080 kN/m | 0.0 | 2 | 0 | 2338 |












***2 Berekeningsresultaten***

**2.1 BELASTINGSGEVALLEN**

**(GL) Geometrisch lineaire krachtsverdeling**

**2.1.1 Reactiekrachten**

| Knoop-nummer | Belastings geval | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|---|
| 1 | 1 | | 0.204 | |
| | 2 | | 0.057 | |
| | 3 | | 0.169 | |
| | 4 | | -0.063 | |
| | 5 | | 0.042 | |
| 2 | 1 | 0.542 | 1.810 | |
| | 2 | 0.152 | 0.507 | |
| | 3 | -0.324 | 0.517 | |
| | 4 | 0.142 | -0.276 | |
| | 5 | -0.095 | 0.184 | |
| 3 | 1 | -0.542 | | |
| | 2 | -0.152 | | |
| | 3 | -0.303 | | |
| | 4 | 0.168 | | |
| | 5 | -0.112 | | |

**2.2 UITERSTE GRENSTOESTANDEN (UGT)**

**2.2.1 Belastingscombinaties**

**(GNL) Geometrisch niet-lineaire krachtsverdeling**

| Combinatie nummer | Omschrijving | Type |
|---|---|---|
| 1 | permanent | UGT |
| 2 | sneeuw | UGT |
| 3 | wind + overdruk | UGT |
| 4 | wind + onderdruk | UGT |

| Combinatie nummer | Belasting (ψ x γ) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1 | 1.00x1.20 | | | | |
| 2 | 1.00x1.20 | 1.00x1.50 | | | |
| 3 | 1.00x1.20 | | 1.00x1.50 | 1.00x1.50 | |
| 4 | 1.00x1.20 | | 1.00x1.50 | | 1.00x1.50 |

**2.2.2 Reactiekrachten**

| Knoop-nummer | Combinatie nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|---|
| 1 | 1 | | 0.245 | |
| | 2 | | 0.330 | |
| | 3 | | 0.405 | |
| | 4 | | 0.561 | |
| 2 | 1 | 0.650 | 2.172 | |

| Knoop-nummer | Combinatie nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|---|
| 2 | 2 | 0.878 | 2.932 | |
| | 3 | 0.376 | 2.533 | |
| | 4 | 0.021 | 3.223 | |
| 3 | 1 | -0.650 | | |
| | 2 | -0.878 | | |
| | 3 | -0.853 | | |
| | 4 | -1.272 | | |

**2.2.3 Staafreactiekrachten**

| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 0.165 | 0.181 | |
| | | 2 | 0.468 | 0.513 | -0.246 |
| | 2 | 1 | 0.223 | 0.244 | |
| | | 2 | 0.632 | 0.693 | -0.333 |
| | 3 | 1 | 0.273 | 0.299 | |
| | | 2 | 0.360 | 0.751 | -0.335 |
| | 4 | 1 | 0.378 | 0.415 | |
| | | 2 | 0.255 | 1.080 | -0.494 |
| 2 | 1 | 2 | 1.477 | 0.650 | 0.246 |
| | | 3 | -0.479 | 0.439 | |
| | 2 | 2 | 1.995 | 0.878 | 0.333 |
| | | 3 | -0.647 | 0.593 | |
| | 3 | 2 | 1.627 | 0.863 | 0.335 |
| | | 3 | -0.629 | 0.577 | |
| | 4 | 2 | 1.936 | 1.282 | 0.494 |
| | | 3 | -0.938 | 0.860 | |

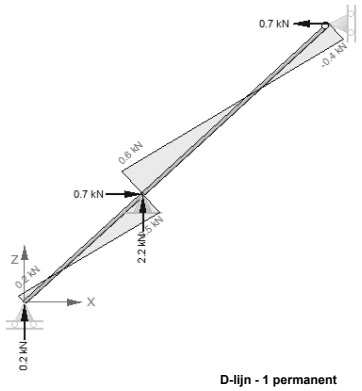
**2.2.4 Snedekrachten en vervormingen**

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | -0.165 | 0.181 | 0.000 | 0.0 |
| | | | 387 | 0.000 | 0.000 | **0.035** | 0.0 |
| | | | 773 | 0.165 | -0.181 | **0.000** | 0.0 |
| | | | 1484 | 0.468 | -0.513 | -0.246 | 0.0 |
| 1 | 2 | 1 | 0 | -0.223 | 0.244 | **0.000** | 0.0 |
| | | | 387 | 0.000 | 0.000 | **0.047** | 0.0 |
| | | | 1484 | 0.632 | -0.693 | -0.333 | 0.0 |
| 1 | 3 | 1 | 0 | -0.273 | 0.299 | 0.000 | 0.0 |
| | | | 422 | -0.092 | 0.000 | **0.063** | 0.0 |
| | | | 1484 | 0.360 | -0.751 | -0.335 | 0.0 |
| 1 | 4 | 1 | 0 | -0.378 | 0.415 | 0.000 | 0.0 |
| | | | 411 | -0.203 | 0.000 | **0.085** | 0.0 |
| | | | 823 | -0.027 | -0.415 | **0.000** | -0.1 |
| | | | 1484 | 0.255 | -1.080 | -0.494 | 0.0 |
| 2 | 1 | 2 | 0 | -1.477 | 0.650 | -0.246 | 0.0 |
| | | | 453 | -1.284 | 0.439 | **0.000** | 0.3 |
| | | | 1289 | -0.927 | 0.049 | 0.204 | **0.8** |
| | | | 1396 | -0.882 | 0.000 | **0.207** | 0.8 |
| | | | 2339 | -0.479 | -0.439 | 0.000 | 0.0 |
| 2 | 2 | 2 | 0 | -1.995 | 0.878 | -0.333 | 0.0 |





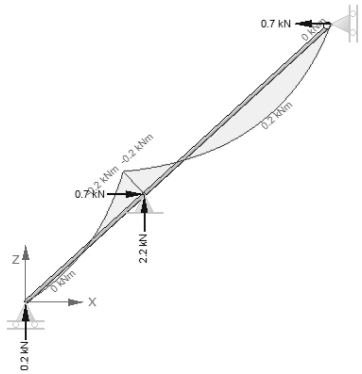
| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 2 | 2 | 2 | 453 | -1.734 | 0.593 | **0.000** | 0.5 |
| | | | 1289 | -1.252 | 0.067 | 0.276 | **1.1** |
| | | | 1396 | -1.190 | 0.000 | **0.280** | 1.1 |
| | | | 2339 | -0.647 | -0.593 | 0.000 | 0.0 |
| 2 | 3 | 2 | 0 | -1.627 | 0.863 | -0.335 | 0.0 |
| | | | 466 | -1.428 | 0.577 | **0.000** | 0.4 |
| | | | 1295 | -1.074 | 0.066 | 0.266 | **1.0** |
| | | | 1402 | -1.029 | 0.000 | **0.270** | 1.0 |
| | | | 2339 | -0.629 | -0.577 | 0.000 | 0.0 |
| 2 | 4 | 2 | 0 | -1.936 | 1.282 | -0.494 | 0.0 |
| | | | 461 | -1.739 | 0.860 | **0.000** | 0.7 |
| | | | 1293 | -1.384 | 0.098 | 0.398 | **1.6** |
| | | | 1400 | -1.339 | 0.000 | **0.403** | 1.5 |
| | | | 2339 | -0.938 | -0.860 | 0.000 | 0.0 |




**D-lijn - 1 permanent**



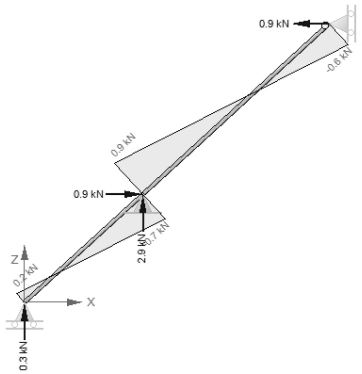




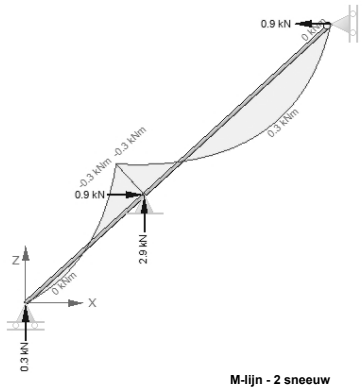

**M-lijn - 1 permanent**







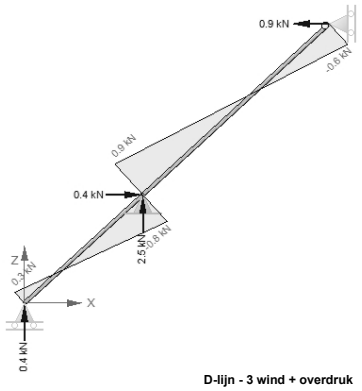

**D-lijn - 2 sneeuw**




**M-lijn - 2 sneeuw**



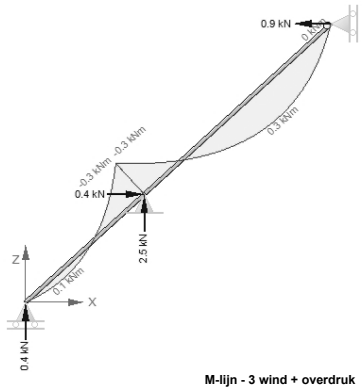





**D-lijn - 3 wind + overdruk**



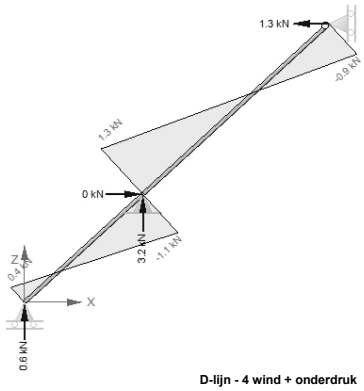




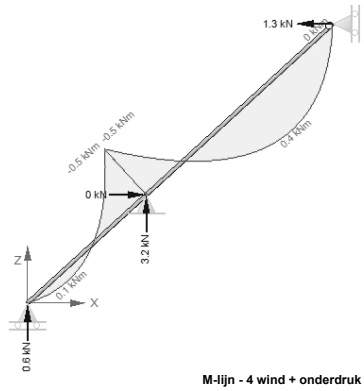

**M-lijn - 3 wind + overdruk**








**D-lijn - 4 wind + onderdruk**




**M-lijn - 4 wind + onderdruk**

**2.3 BRUIKBAARHEIDSGRENSTOESTANDEN (BGT)**

**2.3.1 Belastingscombinaties**

**(GNL) Geometrisch niet-lineaire krachtsverdeling**

| Combinatie nummer | Omschrijving | Type |
|---|---|---|
| 5 | permanent | BGT |
| 6 | sneeuw | BGT |
| 7 | wind + overdruk | BGT |
| 8 | wind + onderdruk | BGT |

| Combinatie nummer | Belasting (ψ x γ) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 5 | 1.60x1.00 | | | | |
| 6 | 1.60x1.00 | 1.00x1.00 | | | |
| 7 | 1.60x1.00 | | 1.00x1.00 | 1.00x1.00 | |
| 8 | 1.60x1.00 | | 1.00x1.00 | | 1.00x1.00 |





**2.3.2 Knoopverplaatsingen**

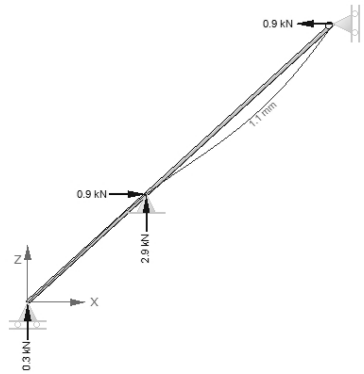
| Knoop-nummer | Combinatie nummer | dx [mm] | dz [mm] | dr [mrad] |
|---|---|---|---|---|
| 1 | 5 | 0.0 | 0.0 | 0.0 |
| | 6 | 0.0 | 0.0 | 0.0 |
| | 7 | 0.0 | 0.0 | -0.1 |
| | 8 | 0.0 | 0.0 | -0.1 |
| 2 | 5 | 0.0 | 0.0 | -0.6 |
| | 6 | 0.0 | 0.0 | -0.8 |
| | 7 | 0.0 | 0.0 | -0.7 |
| | 8 | 0.0 | 0.0 | -0.9 |
| 3 | 5 | 0.0 | -0.1 | 0.0 |
| | 6 | 0.0 | -0.1 | 0.0 |
| | 7 | 0.0 | -0.1 | 0.0 |
| | 8 | 0.0 | -0.1 | 0.0 |

**2.3.3 Snedekrachten en vervormingen**

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 5 | 1 | 0 | -0.220 | 0.241 | **0.000** | 0.0 |
| | | | 387 | 0.000 | 0.000 | **0.047** | 0.0 |
| | | | 1484 | 0.624 | -0.684 | -0.329 | 0.0 |
| 1 | 6 | 1 | 0 | -0.258 | 0.283 | 0.000 | 0.0 |
| | | | 386 | 0.000 | 0.000 | **0.055** | 0.0 |
| | | | 1484 | 0.733 | -0.804 | -0.386 | 0.0 |
| 1 | 7 | 1 | 0 | -0.292 | 0.320 | **0.000** | 0.0 |
| | | | 408 | -0.060 | 0.000 | **0.065** | 0.0 |
| | | | 1484 | 0.552 | -0.843 | -0.388 | 0.0 |
| 1 | 8 | 1 | 0 | -0.362 | 0.397 | 0.000 | 0.0 |
| | | | 404 | -0.133 | 0.000 | **0.080** | 0.0 |
| | | | 1484 | 0.482 | -1.062 | -0.494 | 0.0 |
| 2 | 5 | 2 | 0 | -1.970 | 0.867 | -0.329 | 0.0 |
| | | | 453 | -1.712 | 0.586 | **0.000** | 0.5 |
| | | | 1289 | -1.236 | 0.066 | 0.273 | **1.1** |
| | | | 1396 | -1.176 | 0.000 | **0.276** | 1.1 |
| | | | 2339 | -0.639 | -0.586 | 0.000 | 0.0 |
| 2 | 6 | 2 | 0 | -2.315 | 1.018 | -0.386 | 0.0 |
| | | | 453 | -2.012 | 0.688 | **0.000** | 0.5 |
| | | | 1289 | -1.452 | 0.077 | 0.320 | **1.3** |
| | | | 1396 | -1.381 | 0.000 | **0.324** | 1.2 |
| | | | 2339 | -0.751 | -0.688 | 0.000 | 0.0 |
| 2 | 7 | 2 | 0 | -2.070 | 1.009 | -0.388 | 0.0 |
| | | | 460 | -1.808 | 0.677 | **0.000** | 0.5 |
| | | | 1292 | -1.335 | 0.078 | 0.314 | **1.2** |
| | | | 1399 | -1.273 | 0.000 | **0.318** | 1.2 |
| | | | 2339 | -0.739 | -0.677 | 0.000 | 0.0 |
| 2 | 8 | 2 | 0 | -2.276 | 1.288 | -0.494 | 0.0 |
| | | | 458 | -2.015 | 0.866 | **0.000** | 0.7 |
| | | | 1292 | -1.540 | 0.098 | 0.402 | **1.6** |
| | | | 1399 | -1.480 | 0.000 | **0.407** | 1.6 |
| | | | 2339 | -0.945 | -0.866 | 0.000 | 0.0 |



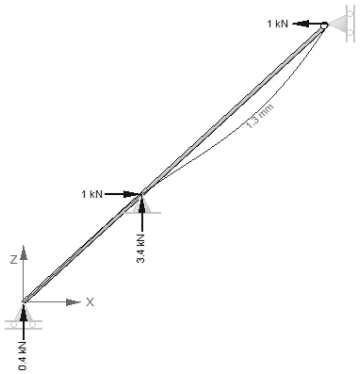




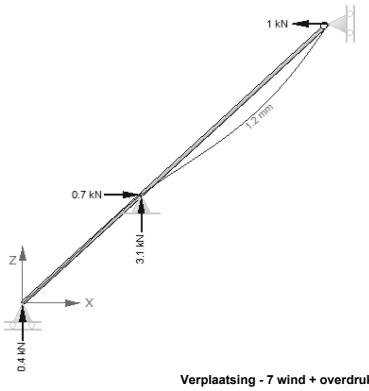

**Verplaatsing - 5 permanent**







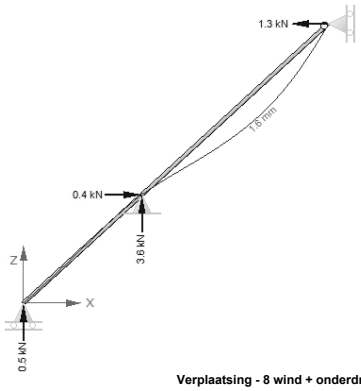

**Verplaatsing - 6 sneeuw**




**Verplaatsing - 7 wind + overdruk**







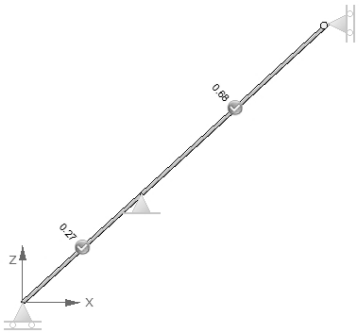

**Verplaatsing - 8 wind + onderdruk**

**2.4 EN1995 TOETSINGEN**

De toetsing van de houtprofielen in de uiterste grenstoestand volgens EN 1995-1-1 is gebaseerd op een geometrische niet-lineaire krachtsverdeling (tweede orde analyse) inclusief de gegeven imperfecties volgens art.5.4.4.








| Staaf-nummer | Profiel | Combinatie nummer | Artikel | U.C. |
|---|---|---|---|---|
| 1 | 42 x 171 | 5 | 6.1.2 | 0.02 |
| | | 4 | 6.1.4 | 0.00 |
| | | 5 | 6.1.6 | 0.04 |
| | | 4 | 6.1.7 | 0.11 |
| | | 5 | 6.2.3 | 0.27 |
| | | 4 | 6.2.4 | 0.04 |
| | | 4 | 6.3.2 | 0.05 |
| | | 8 | 6.3.3 | 0.25 |
| 2 | 42 x 171 | 5 | 6.1.4 | 0.03 |
| | | 5 | 6.1.7 | 0.13 |
| | | 5 | 6.2.4 | 0.25 |
| | | 5 | 6.3.2 | 0.68 |
| | | 5 | 6.3.3 | 0.58 |





**2.4.1 BEREKENING VAN UNITY CHECKS**

**Staaf 2 - 42 x 171 (C14 Klimaatklasse:1)**

**Druk evenwijdig aan de vezelrichting** **art. 6.1.4**

Combinatie : 5 x = 452.6 mm Nx = -1.712 kN Vz = 0.586 kN My = 0 kNm
Belastingsduurklasse : Blijvend

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{1712.2}{7182} = 0.2 \text{ N/mm}^2 < f_{c,0,d} = 7.4 \text{ N/mm}^2 \quad (6.2)$$

**Afschuiving** **art. 6.1.7**

Combinatie : 5 x = 0 mm Nx = -1.97 kN Vz = 0.867 kN My = -0.329 kNm
Belastingsduurklasse : Blijvend

$$\tau_d = \frac{V_{Ed} S}{b\, I_y} = \frac{866.6 \times 153515}{42 \times 17500739} = 0.2 \text{ N/mm}^2 < f_{v,d} = 1.4 \text{ N/mm}^2 \quad (6.13)$$

**Gecombineerde buig- en axiale drukspanningen** **art. 6.2.4**

Combinatie : 5 x = 0 mm Nx = -1.97 kN Vz = 0.867 kN My = -0.329 kNm
Belastingsduurklasse : Blijvend

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{1970}{7182} = 0.3 \text{ N/mm}^2 \quad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0.329 \times 10^6}{205 \times 10^3} = 1.6 \text{ N/mm}^2$$

$$\left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \left(\frac{0.3}{7.4}\right)^2 + \frac{1.6}{6.5} = 0.25 < 1.00 \quad (6.19)$$

**Kolommen onderworpen aan druk of aan druk en buiging** **art. 6.3.2**

Combinatie : 5 x = 0 mm Nx = -1.97 kN Vz = 0.867 kN My = -0.329 kNm
Belastingsduurklasse : Blijvend

$$\lambda_y = \frac{L_{cr,y}}{i_y} = \frac{2338}{49.4} = 47.37 \qquad \lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{47.37}{\pi}\sqrt{\frac{16.0}{4700}} = 0.880 \quad (6.21)$$

$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{2338}{12.1} = 192.83 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{192.83}{\pi}\sqrt{\frac{16.0}{4700}} = 3.581 \quad (6.22)$$

$$k_y = 0{,}5(1 + \beta_c(\lambda_{rel,y} - 0{,}3) + \lambda_{rel,y}^2 = 0{,}5 \times (1 + 0.2 \times (0.880 - 0{,}3) + 0.880^2 = 0.95 \quad (6.27)$$

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} = \frac{1}{0.95 + \sqrt{0.95^2 - 0.88^2}} = 0.78 \quad (6.25)$$

$$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (3.581 - 0{,}3) + 3.581^2 = 7.24 \quad (6.28)$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{7.24 + \sqrt{7.24^2 - 3.58^2}} = 0.07 \quad (6.26)$$

$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{1970}{7182} = 0.3\ N/mm^2$ $\sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0.329 \times 10^6}{205 \times 10^3} = 1.6\ N/mm^2$

$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0.3}{0.78 \times 7.4} + \frac{1.6}{6.5} + 0.7 \times \frac{0.0}{8.3} = 0.30 < 1.00$ (6.23)

$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0.3}{0.07 \times 7.4} + 0.7 \times \frac{1.6}{6.5} + \frac{0.0}{8.3} = 0.68 < 1.00$ (6.24)

**Liggers onderworpen aan druk of aan druk en buiging** **art. 6.3.3**

Combinatie : 5 x = 0 mm Nx = -1.97 kN Vz = -0.586 kN My = -0.329 kNm
Belastingsduurklasse : Blijvend

Aantal kipsteunen: 0 Op twee steunpunten: Gelijkmatig verdeelde belasting

$\rightarrow l_{ef} = 0.9 \times l = 0.9 \times 2338 = 2105$ mm

$\sigma_{m,crit} = \frac{0{,}78\ b^2}{h\ l_{ef}} E_{0,05} = \frac{0{,}78 \times 42^2}{171 \times 2105} \times 4700 = 18\ N/mm^2$ (6.32)

$\lambda_{rel,m} = \sqrt{\frac{f_{m,k}}{\sigma_{m,crit}}} = \sqrt{\frac{14}{18}} = 0.883$ (6.30)

$0{,}75 < \lambda_{rel,m} < 1{,}4 \quad \rightarrow k_{crit} = 1{,}56 - 0{,}75\ \lambda_{rel,m} = 1{,}56 - 0{,}75 \times 0.883 = 0.898$ (6.34)

$\sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0.329 \times 10^6}{205 \times 10^3} = 1.6\ N/mm^2$ $\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{1970}{7182} = 0.3\ N/mm^2$

$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{2338}{12.1} = 192.83$ $\lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{192.83}{\pi}\sqrt{\frac{16.0}{4700}} = 3.581$ (6.22)

$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (3.581 - 0{,}3) + 3.581^2 = 7.24$ (6.28)

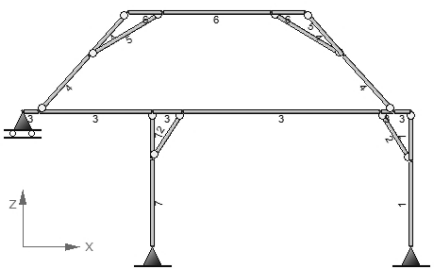
$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{7.24 + \sqrt{7.24^2 - 3.58^2}} = 0.07$ (6.26)

$\left(\frac{\sigma_{m,d}}{k_{crit} f_{m,d}}\right)^2 + \frac{\sigma_{c,d}}{k_{c,d} f_{c,0,d}} = \left(\frac{1.6}{0.90 \times 6.5}\right)^2 + \frac{0.3}{0.07 \times 7.4} = 0.58 < 1.00$ (6.35)

Bestand :C:\2017projecten\17017\gebint.xfr2

Gehanteerde normen: : NEN-EN 1995-1-1 + C1 + A1:2011/NB:2013 (nl)
Gevolgklasse : CC2

## *1 Invoergegevens*




### 1.1 KNOPEN

| Knoop-nummer | Coördinaten X [mm] | Coördinaten Z [mm] | Opleggingen Tx | Opleggingen Tz | Opleggingen Ry |
|---|---|---|---|---|---|
| 1 | 3595 | 0 | A | A | |
| 2 | 10760 | 0 | A | A | |
| 3 | 10760 | 2378 | | | |
| 4 | 3595 | 2448 | | | |
| 5 | 0 | 3750 | | A | |
| 6 | 450 | 3750 | | | |
| 7 | 3595 | 3750 | | | |
| 8 | 4442 | 3750 | | | |
| 9 | 9910 | 3750 | | | |
| 10 | 10290 | 3750 | | | |
| 11 | 10760 | 3750 | | | |
| 12 | 1840 | 5300 | | | |
| 13 | 8885 | 5300 | | | |
| 14 | 2920 | 6500 | | | |
| 15 | 3880 | 6500 | | | |
| 16 | 6890 | 6500 | | | |
| 17 | 7840 | 6500 | | | |

### 1.2 STAVEN

| Staaf-nummer | Knoop van | Knoop naar | Staaf-type | Profiel | Lengte [mm] |
|---|---|---|---|---|---|
| 1 | 3 | 2 | | 300x390 | 2378 |
| 2 | 1 | 4 | | 340x440 | 2448 |
| 3 | 9 | 3 | | 230x200 | 1614 |
| 4 | 11 | 3 | | 300x390 | 1372 |
| 5 | 4 | 7 | | 340x440 | 1302 |
| 6 | 8 | 4 | | 230x200 | 1553 |



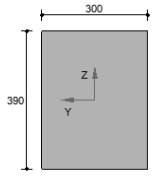


| Staaf-nummer | Knoop van | Knoop naar | Staaf-type | Profiel | Lengte [mm] |
|---|---|---|---|---|---|
| 7 | 5 | 6 | | 340x350 | 450 |
| 8 | 6 | 7 | | 340x350 | 3145 |
| 9 | 7 | 8 | | 340x350 | 847 |
| 10 | 8 | 9 | | 340x350 | 5468 |
| 11 | 9 | 10 | | 340x350 | 380 |
| 12 | 10 | 11 | | 340x350 | 470 |
| 13 | 6 | 12 | | 125 x 200 | 2082 |
| 14 | 13 | 10 | | 125 x 200 | 2092 |
| 15 | 12 | 14 | | 125 x 200 | 1614 |
| 16 | 12 | 15 | | 75x125 | 2367 |
| 17 | 13 | 16 | | 75x125 | 2328 |
| 18 | 17 | 13 | | 125 x 200 | 1591 |
| 19 | 14 | 15 | | 125x200 | 960 |
| 20 | 15 | 16 | | 125x200 | 3010 |
| 21 | 16 | 17 | | 125x200 | 950 |

### 1.3 PROFIELEN

| Profiel-nummer | Naam | Gewicht [kg/m] | E [N/mm²] | A [mm²] | Iy [mm4] | Wy;el_1 [mm³] | Wy;el_2 [mm³] |
|---|---|---|---|---|---|---|---|
| 1 | 300x390 | 49.1 | 11000 | 117000 | 148297500 | 7605000 | 7605000 |
| 2 | 230x200 | 19.3 | 11000 | 46000 | 153333333 | 1533333 | 1533333 |
| 3 | 340x350 | 50.0 | 11000 | 119000 | 121479166 | 6941667 | 6941667 |
| 4 | 125 x 200 | 10.5 | 11000 | 25000 | 83333333 | 833333 | 833333 |
| 5 | 75x125 | 3.9 | 11000 | 9375 | 12207031 | 195312 | 195312 |
| 6 | 125x200 | 10.5 | 11000 | 25000 | 83333333 | 833333 | 833333 |
| 7 | 340x440 | 52.4 | 7000 | 149600 | 241354666 | 10970667 | 10970667 |

**300x390**




**Materiaalgegevens**
Sterkteklasse C24
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60
Elasticiteitsmodulus E = 11000 N/mm²

| Belastingsduurklasse | $k_{mod}$ | $f_{m,k}$ 24.00 | $f_{t,0,k}$ 14.00 | $f_{t,90,k}$ 0.40 | $f_{c,0,k}$ 21.00 | $f_{c,90,k}$ 2.50 | $f_{v,k}$ 4.00 N/mm² |
|---|---|---|---|---|---|---|---|
| | | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.08 | 6.46 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 14.77 | 8.62 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 16.62 | 9.69 | 0.25 | 14.54 | 1.73 | 2.77 |



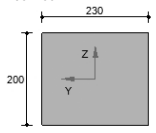


| | | | | | | |
|---|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = | 420 kg/m³ | $\rho_k$ = | 350 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = | 11000 N/mm² | $E_{90,mean}$ = | 370 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = | 6875 N/mm² | $E_{90,fin}$ = | 231 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = | 7400 N/mm² | $E_{0,d}$ = | 8462 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = | 690 N/mm² | $G_{0,05}$ = | 460 N/mm² | | |

**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = | 150.0 mm | $z_{max}$ = | 195.0 mm | |
| Minimale coördinaat | $y_{min}$ = | -150.0 mm | $z_{min}$ = | -195.0 mm | |
| Zwaartelijn | $z_s$ = | 0.0 mm | $y_s$ = | 0.0 mm | |
| Oppervlak / Gewicht | A = | 117000.0 mm² | G = | 49.1 kg/m | |
| Statisch moment | $S_y$ = | 5703750 mm³ | $S_z$ = | 4387500 mm³ | |
| Traagheidsmoment | $I_y$ = | 1482975000 mm⁴ | $I_z$ = | 877500000 mm⁴ | |
| Traagheidsstraal | $i_y$ = | 112.6 mm | $i_z$ = | 86.6 mm | |
| Elastisch weerstandsmoment | $W_{y;el}$ = | 7605000 mm³ | $W_{z;el}$ = | 5850000 mm³ | |
| Centrifugaalmoment | $C_{yz}$ = | 0 mm³ | hoek = | 0.00 graden | |
| Traagheidsmoment | $I_{max}$ = | 1482975000 mm⁴ | $I_{min}$ = | 877500000 mm⁴ | |
| Traagheidsstraal | $i_{max}$ = | 112.6 mm | $i_{min}$ = | 86.6 mm | |

**230x200**




**Materiaalgegevens**
Sterkteklasse C24
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60
Elasticiteitsmodulus E = 11000 N/mm²

| Belastingsduurklasse | $k_{mod}$ | $f_{m,k}$ 24.00 | $f_{t,0,k}$ 14.00 | $f_{t,90,k}$ 0.40 | $f_{c,0,k}$ 21.00 | $f_{c,90,k}$ 2.50 | $f_{v,k}$ 4.00 N/mm² |
|---|---|---|---|---|---|---|---|
| | | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.08 | 6.46 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 14.77 | 8.62 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 16.62 | 9.69 | 0.25 | 14.54 | 1.73 | 2.77 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = | 420 kg/m³ | $\rho_k$ = | 350 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = | 11000 N/mm² | $E_{90,mean}$ = | 370 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = | 6875 N/mm² | $E_{90,fin}$ = | 231 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = | 7400 N/mm² | $E_{0,d}$ = | 8462 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = | 690 N/mm² | $G_{0,05}$ = | 460 N/mm² | | |

**Doorsnedegegevens**

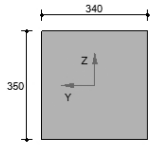
| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = | 115.0 mm | $z_{max}$ = | 100.0 mm | |
| Minimale coördinaat | $y_{min}$ = | -115.0 mm | $z_{min}$ = | -100.0 mm | |
| Zwaartelijn | $z_s$ = | 0.0 mm | $y_s$ = | 0.0 mm | |
| Oppervlak / Gewicht | A = | 46000.0 mm² | G = | 19.3 kg/m | |
| Statisch moment | $S_y$ = | 1150000 mm³ | $S_z$ = | 1322500 mm³ | |
| Traagheidsmoment | $I_y$ = | 153333333 mm⁴ | $I_z$ = | 202783333 mm⁴ | |





| | | | | | | |
|---|---|---|---|---|---|---|
| Traagheidsstraal | $i_y$ = | 57.7 mm | $i_z$ = | 66.4 mm | | |
| Elastisch weerstandsmoment | $W_{y;el}$ = | 1533333 mm³ | $W_{z;el}$ = | 1763333 mm³ | | |
| Centrifugaalmoment | $C_{yz}$ = | 0 mm³ | hoek = | 90.00 graden | | |
| Traagheidsmoment | $I_{max}$ = | 202783333 mm⁴ | $I_{min}$ = | 153333333 mm⁴ | | |
| Traagheidsstraal | $i_{max}$ = | 66.4 mm | $i_{min}$ = | 57.7 mm | | |

**340x350**




**Materiaalgegevens**
Sterkteklasse C24
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60
Elasticiteitsmodulus E = 11000 N/mm²

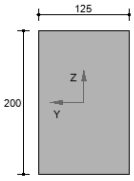
| Belastingsduurklasse | $k_{mod}$ | $f_{m,k}$ 24.00 | $f_{t,0,k}$ 14.00 | $f_{t,90,k}$ 0.40 | $f_{c,0,k}$ 21.00 | $f_{c,90,k}$ 2.50 | $f_{v,k}$ 4.00 N/mm² |
|---|---|---|---|---|---|---|---|
| | | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.08 | 6.46 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 14.77 | 8.62 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 16.62 | 9.69 | 0.25 | 14.54 | 1.73 | 2.77 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = | 420 kg/m³ | $\rho_k$ = | 350 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = | 11000 N/mm² | $E_{90,mean}$ = | 370 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = | 6875 N/mm² | $E_{90,fin}$ = | 231 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = | 7400 N/mm² | $E_{0,d}$ = | 8462 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = | 690 N/mm² | $G_{0,05}$ = | 460 N/mm² | | |

**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = | 170.0 mm | $z_{max}$ = | 175.0 mm | |
| Minimale coördinaat | $y_{min}$ = | -170.0 mm | $z_{min}$ = | -175.0 mm | |
| Zwaartelijn | $z_s$ = | 0.0 mm | $y_s$ = | 0.0 mm | |
| Oppervlak / Gewicht | A = | 119000.0 mm² | G = | 50.0 kg/m | |
| Statisch moment | $S_y$ = | 5206250 mm³ | $S_z$ = | 5057500 mm³ | |
| Traagheidsmoment | $I_y$ = | 1214791667 mm⁴ | $I_z$ = | 1146366667 mm⁴ | |
| Traagheidsstraal | $i_y$ = | 101.0 mm | $i_z$ = | 98.1 mm | |
| Elastisch weerstandsmoment | $W_{y;el}$ = | 6941667 mm³ | $W_{z;el}$ = | 6743333 mm³ | |
| Centrifugaalmoment | $C_{yz}$ = | 0 mm³ | hoek = | 0.00 graden | |
| Traagheidsmoment | $I_{max}$ = | 1214791667 mm⁴ | $I_{min}$ = | 1146366667 mm⁴ | |
| Traagheidsstraal | $i_{max}$ = | 101.0 mm | $i_{min}$ = | 98.1 mm | |

**125 x 200**




**Materiaalgegevens**

Sterkteklasse C24
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60
Elasticiteitsmodulus E = 11000 N/mm²

| | | $f_{m,k}$ | $f_{t,0,k}$ | $f_{t,90,k}$ | $f_{c,0,k}$ | $f_{c,90,k}$ | $f_{v,k}$ |
|---|---|---|---|---|---|---|---|
| | | 24.00 | 14.00 | 0.40 | 21.00 | 2.50 | 4.00 N/mm² |
| Belastingsduurklasse | $k_{mod}$ | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.08 | 6.46 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 14.77 | 8.62 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 16.62 | 9.69 | 0.25 | 14.54 | 1.73 | 2.77 |

| | | | | | |
|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = 420 kg/m³ | $\rho_k$ = | 350 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = 11000 N/mm² | $E_{90,mean}$ = | 370 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = 6875 N/mm² | $E_{90,fin}$ = | 231 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = 7400 N/mm² | $E_{0,d}$ = | 8462 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = 690 N/mm² | $G_{0,05}$ = | 460 N/mm² | | |

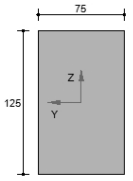
**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = 62.5 mm | $z_{max}$ = | 100.0 mm | | |
| Minimale coördinaat | $y_{min}$ = -62.5 mm | $z_{min}$ = | -100.0 mm | | |
| Zwaartelijn | $z_s$ = 0.0 mm | $y_s$ = | 0.0 mm | | |
| Oppervlak / Gewicht | A = 25000.0 mm² | G = | 10.5 kg/m | | |
| Statisch moment | $S_y$ = 625000 mm³ | $S_z$ = | 390625 mm³ | | |
| Traagheidsmoment | $I_y$ = 83333333 mm⁴ | $I_z$ = | 32552083 mm⁴ | | |
| Traagheidsstraal | $i_y$ = 57.7 mm | $i_z$ = | 36.1 mm | | |
| Elastisch weerstandsmoment | $W_{y,el}$ = 833333 mm³ | $W_{z,el}$ = | 520833 mm³ | | |
| Centrifugaalmoment | $C_{yz}$ = 0 mm³ | hoek = | 0.00 graden | | |
| Traagheidsmoment | $I_{max}$ = 83333333 mm⁴ | $I_{min}$ = | 32552083 mm⁴ | | |
| Traagheidsstraal | $i_{max}$ = 57.7 mm | $i_{min}$ = | 36.1 mm | | |





**75x125**




**Materiaalgegevens**

Sterkteklasse C24
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60 $k_h$ = 1.04
Elasticiteitsmodulus E = 11000 N/mm²

| | | $f_{m,k}$ | $f_{t,0,k}$ | $f_{t,90,k}$ | $f_{c,0,k}$ | $f_{c,90,k}$ | $f_{v,k}$ |
|---|---|---|---|---|---|---|---|
| | | 24.89 | 14.52 | 0.40 | 21.00 | 2.50 | 4.00 N/mm² |
| Belastingsduurklasse | $k_{mod}$ | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.49 | 6.70 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 15.32 | 8.94 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 17.23 | 10.05 | 0.25 | 14.54 | 1.73 | 2.77 |

| | | | | | |
|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = 420 kg/m³ | $\rho_k$ = | 350 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = 11000 N/mm² | $E_{90,mean}$ = | 370 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = 6875 N/mm² | $E_{90,fin}$ = | 231 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = 7400 N/mm² | $E_{0,d}$ = | 8462 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = 690 N/mm² | $G_{0,05}$ = | 460 N/mm² | | |

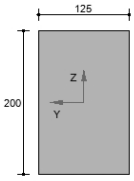
**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = 37.5 mm | $z_{max}$ = | 62.5 mm | | |
| Minimale coördinaat | $y_{min}$ = -37.5 mm | $z_{min}$ = | -62.5 mm | | |
| Zwaartelijn | $z_s$ = 0.0 mm | $y_s$ = | 0.0 mm | | |
| Oppervlak / Gewicht | A = 9375.0 mm² | G = | 3.9 kg/m | | |
| Statisch moment | $S_y$ = 146484 mm³ | $S_z$ = | 87891 mm³ | | |
| Traagheidsmoment | $I_y$ = 12207031 mm⁴ | $I_z$ = | 4394531 mm⁴ | | |
| Traagheidsstraal | $i_y$ = 36.1 mm | $i_z$ = | 21.7 mm | | |
| Elastisch weerstandsmoment | $W_{y,el}$ = 195313 mm³ | $W_{z,el}$ = | 117188 mm³ | | |
| Centrifugaalmoment | $C_{yz}$ = 0 mm³ | hoek = | 0.00 graden | | |
| Traagheidsmoment | $I_{max}$ = 12207031 mm⁴ | $I_{min}$ = | 4394531 mm⁴ | | |
| Traagheidsstraal | $i_{max}$ = 36.1 mm | $i_{min}$ = | 21.7 mm | | |





**125x200**




**Materiaalgegevens**

Sterkteklasse C24
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60
Elasticiteitsmodulus E = 11000 N/mm²

| | | $f_{m,k}$ | $f_{t,0,k}$ | $f_{t,90,k}$ | $f_{c,0,k}$ | $f_{c,90,k}$ | $f_{v,k}$ |
|---|---|---|---|---|---|---|---|
| | | 24.00 | 14.00 | 0.40 | 21.00 | 2.50 | 4.00 N/mm² |
| Belastingsduurklasse | $k_{mod}$ | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 11.08 | 6.46 | 0.15 | 9.69 | 1.15 | 1.85 N/mm² |
| Middellang | 0.80(0.65) | 14.77 | 8.62 | 0.20 | 12.92 | 1.54 | 2.46 |
| Kort | 0.90(0.80) | 16.62 | 9.69 | 0.25 | 14.54 | 1.73 | 2.77 |

| | | | | | |
|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = 420 kg/m³ | $\rho_k$ = | 350 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = 11000 N/mm² | $E_{90,mean}$ = | 370 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = 6875 N/mm² | $E_{90,fin}$ = | 231 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = 7400 N/mm² | $E_{0,d}$ = | 8462 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = 690 N/mm² | $G_{0,05}$ = | 460 N/mm² | | |

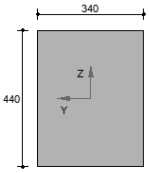
**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = 62.5 mm | $z_{max}$ = | 100.0 mm | | |
| Minimale coördinaat | $y_{min}$ = -62.5 mm | $z_{min}$ = | -100.0 mm | | |
| Zwaartelijn | $z_s$ = 0.0 mm | $y_s$ = | 0.0 mm | | |
| Oppervlak / Gewicht | A = 25000.0 mm² | G = | 10.5 kg/m | | |
| Statisch moment | $S_y$ = 625000 mm³ | $S_z$ = | 390625 mm³ | | |
| Traagheidsmoment | $I_y$ = 83333333 mm⁴ | $I_z$ = | 32552083 mm⁴ | | |
| Traagheidsstraal | $i_y$ = 57.7 mm | $i_z$ = | 36.1 mm | | |
| Elastisch weerstandsmoment | $W_{y,el}$ = 833333 mm³ | $W_{z,el}$ = | 520833 mm³ | | |
| Centrifugaalmoment | $C_{yz}$ = 0 mm³ | hoek = | 0.00 graden | | |
| Traagheidsmoment | $I_{max}$ = 83333333 mm⁴ | $I_{min}$ = | 32552083 mm⁴ | | |
| Traagheidsstraal | $i_{max}$ = 57.7 mm | $i_{min}$ = | 36.1 mm | | |





**340x440**




**Materiaalgegevens**

Sterkteklasse C14
Klimaatklasse 1
Materiaaltype Gezaagd hout $\gamma_M$ = 1.30 $k_{def}$ = 0.60
Elasticiteitsmodulus E = 7000 N/mm²

| | | $f_{m,k}$ | $f_{t,0,k}$ | $f_{t,90,k}$ | $f_{c,0,k}$ | $f_{c,90,k}$ | $f_{v,k}$ |
|---|---|---|---|---|---|---|---|
| | | 14.00 | 8.00 | 0.40 | 16.00 | 2.00 | 3.00 N/mm² |
| Belastingsduurklasse | $k_{mod}$ | $f_{m,d}$ | $f_{t,0,d}$ | $f_{t,90,d}$ | $f_{c,0,d}$ | $f_{c,90,d}$ | $f_{v,d}$ |
| Blijvend | 0.60(0.50) | 6.46 | 3.69 | 0.15 | 7.38 | 0.92 | 1.38 N/mm² |
| Middellang | 0.80(0.65) | 8.62 | 4.92 | 0.20 | 9.85 | 1.23 | 1.85 |
| Kort | 0.90(0.80) | 9.69 | 5.54 | 0.25 | 11.08 | 1.38 | 2.08 |

| | | | | | |
|---|---|---|---|---|---|
| Volumieke massa | $\rho_{mean}$ = 350 kg/m³ | $\rho_k$ = | 290 kg/m³ | | |
| Elasticiteitsmodulus | $E_{0,mean}$ = 7000 N/mm² | $E_{90,mean}$ = | 230 N/mm² | | |
| Elasticiteitsmodulus (kruip) | $E_{0,fin}$ = 4375 N/mm² | $E_{90,fin}$ = | 144 N/mm² | | |
| Elasticiteitsmodulus | $E_{0,05}$ = 4700 N/mm² | $E_{0,d}$ = | 5385 N/mm² | | |
| Afschuifmodulus | $G_{mean}$ = 440 N/mm² | $G_{0,05}$ = | 290 N/mm² | | |

**Doorsnedegegevens**

| | | | | | |
|---|---|---|---|---|---|
| Maximale coördinaat | $y_{max}$ = 170.0 mm | $z_{max}$ = | 220.0 mm | | |
| Minimale coördinaat | $y_{min}$ = -170.0 mm | $z_{min}$ = | -220.0 mm | | |
| Zwaartelijn | $z_s$ = 0.0 mm | $y_s$ = | 0.0 mm | | |
| Oppervlak / Gewicht | A = 149600.0 mm² | G = | 52.4 kg/m | | |
| Statisch moment | $S_y$ = 8228000 mm³ | $S_z$ = | 6358000 mm³ | | |
| Traagheidsmoment | $I_y$ = 2413546667 mm⁴ | $I_z$ = | 1441146667 mm⁴ | | |
| Traagheidsstraal | $i_y$ = 127.0 mm | $i_z$ = | 98.1 mm | | |
| Elastisch weerstandsmoment | $W_{y,el}$ = 10970667 mm³ | $W_{z,el}$ = | 8477333 mm³ | | |
| Centrifugaalmoment | $C_{yz}$ = 0 mm³ | hoek = | 0.00 graden | | |
| Traagheidsmoment | $I_{max}$ = 2413546667 mm⁴ | $I_{min}$ = | 1441146667 mm⁴ | | |
| Traagheidsstraal | $i_{max}$ = 127.0 mm | $i_{min}$ = | 98.1 mm | | |

**1.4 BELASTINGSGEVALLEN**

| Nr. | Omschrijving | Type | ψ0 | ψ1 | ψ2 |
|---|---|---|---|---|---|
| 1 | permanent | Permanent incl. eigen gewicht | 1.00 | 1.00 | 1.00 |
| 2 | veranderlijk | C:Bijeenkomstfunctie | 0.25 | 0.70 | 0.60 |
| 3 | sneeuw | Sneeuw | 0.00 | 0.20 | 0.00 |
| 4 | wind | Wind | 0.00 | 0.20 | 0.00 |

**1.5 BELASTINGSGEVAL 1 permanent INCL. eigen gewicht**
**Totaal eigen gewicht: : 1127 kg.**

**1.5.1 Staafbelastingen**

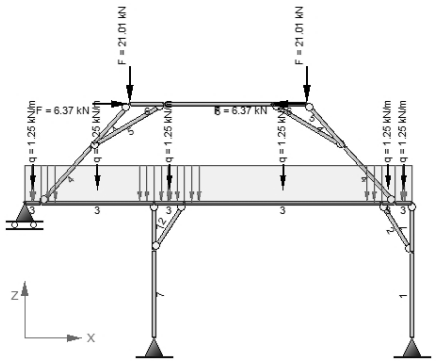
| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 1 | q | -0.491 kN/m | -0.491 kN/m | 90.0 | 3 | 0 | 2378 |
| 2 | q | -0.524 kN/m | -0.524 kN/m | -90.0 | 1 | 0 | 2448 |
| 3 | q | -0.193 kN/m | -0.193 kN/m | 58.2 | 9 | 0 | 1614 |
| 4 | q | -0.491 kN/m | -0.491 kN/m | 90.0 | 11 | 0 | 1372 |
| 5 | q | -0.524 kN/m | -0.524 kN/m | -90.0 | 4 | 0 | 1302 |
| 6 | q | 0.193 kN/m | 0.193 kN/m | -57.0 | 8 | 0 | 1553 |
| 7 | q | -1.250 kN/m | -1.250 kN/m | 0.0 | 5 | 0 | 450 |
| 7 | q | -0.500 kN/m | -0.500 kN/m | 0.0 | 5 | 0 | 450 |
| 8 | q | -0.500 kN/m | -0.500 kN/m | 0.0 | 6 | 0 | 3145 |
| 8 | q | -1.250 kN/m | -1.250 kN/m | 0.0 | 6 | 0 | 3145 |
| 9 | q | -0.500 kN/m | -0.500 kN/m | 0.0 | 7 | 0 | 847 |
| 9 | q | -1.250 kN/m | -1.250 kN/m | 0.0 | 7 | 0 | 847 |
| 10 | q | -1.250 kN/m | -1.250 kN/m | 0.0 | 8 | 0 | 5468 |
| 10 | q | -0.500 kN/m | -0.500 kN/m | 0.0 | 8 | 0 | 5468 |
| 11 | q | -0.500 kN/m | -0.500 kN/m | 0.0 | 9 | 0 | 380 |
| 11 | q | -1.250 kN/m | -1.250 kN/m | 0.0 | 9 | 0 | 380 |
| 12 | q | -0.500 kN/m | -0.500 kN/m | 0.0 | 10 | 0 | 470 |
| 12 | q | -1.250 kN/m | -1.250 kN/m | 0.0 | 10 | 0 | 470 |
| 13 | q | -0.105 kN/m | -0.105 kN/m | -48.1 | 6 | 0 | 2082 |
| 14 | q | -0.105 kN/m | -0.105 kN/m | 47.8 | 13 | 0 | 2092 |
| 15 | q | -0.105 kN/m | -0.105 kN/m | -48.0 | 12 | 0 | 1614 |
| 16 | q | -0.039 kN/m | -0.039 kN/m | -30.5 | 12 | 0 | 2367 |
| 17 | q | 0.039 kN/m | 0.039 kN/m | 31.0 | 13 | 0 | 2328 |
| 18 | q | -0.105 kN/m | -0.105 kN/m | 48.9 | 17 | 0 | 1591 |
| 19 | q | -0.105 kN/m | -0.105 kN/m | 0.0 | 14 | 0 | 960 |
| 20 | q | -0.105 kN/m | -0.105 kN/m | 0.0 | 15 | 0 | 3010 |
| 21 | q | -0.105 kN/m | -0.105 kN/m | 0.0 | 16 | 0 | 950 |

**1.5.2 Knoopbelastingen**

| Knoop-nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|
| 14 | 6.370 | -21.010 | |
| 17 | -6.370 | -21.010 | |








*) Belastingen a.g.v. eigen gewicht worden niet getekend!

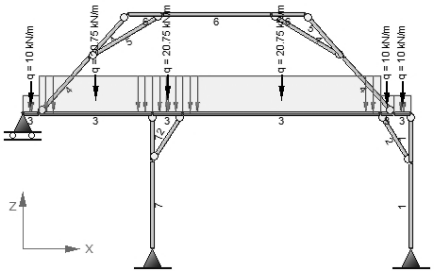
**1.6 BELASTINGSGEVAL 2 veranderlijk**

**1.6.1 Staafbelastingen**

| Staaf-nummer | Belasting | | | | Afstand van | | |
|---|---|---|---|---|---|---|---|
| | Type | q1 | q2 | Hoek | Knoop | a [mm] | L [mm] |
| 7 | q | -10.000 kN/m | -10.000 kN/m | 0.0 | 5 | 0 | 450 |
| 8 | q | -20.750 kN/m | -20.750 kN/m | 0.0 | 6 | 0 | 3145 |
| 9 | q | -20.750 kN/m | -20.750 kN/m | 0.0 | 7 | 0 | 847 |
| 10 | q | -20.750 kN/m | -20.750 kN/m | 0.0 | 8 | 0 | 5468 |
| 11 | q | -10.000 kN/m | -10.000 kN/m | 0.0 | 9 | 0 | 380 |
| 12 | q | -10.000 kN/m | -10.000 kN/m | 0.0 | 10 | 0 | 470 |







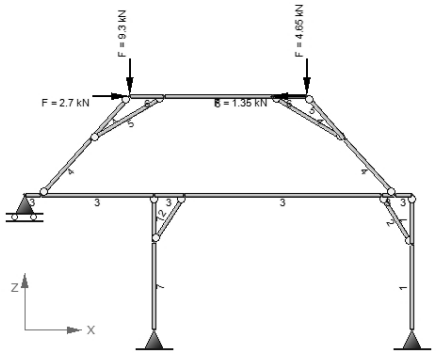

**1.7 BELASTINGSGEVAL 3 sneeuw**

**1.7.1 Knoopbelastingen**

| Knoop-nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|
| 14 | 2.700 | -9.300 | |
| 17 | -1.350 | -4.650 | |



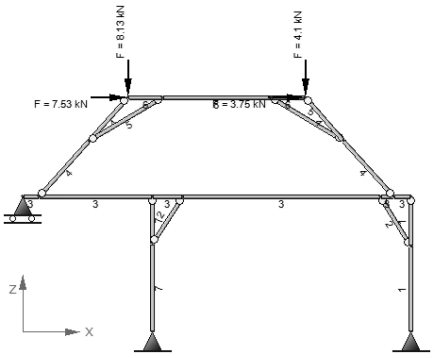





**1.8 BELASTINGSGEVAL 4 wind**

**1.8.1 Knoopbelastingen**

| Knoop-nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|
| 14 | 7.530 | -8.130 | |
| 17 | 3.750 | -4.100 | |








## *2 Berekeningsresultaten*

### 2.1 UITERSTE GRENSTOESTANDEN (UGT)

#### 2.1.1 Belastingscombinaties

**(GNL) Geometrisch niet-lineaire krachtsverdeling**

| Combinatie nummer | Omschrijving | Type |
|---|---|---|
| 1 | permanent | UGT |
| 2 | perm + veranderlijk | UGT |
| 3 | perm + sneeuw | UGT |
| 4 | perm + wind | UGT |

| Combinatie nummer | Belasting (ψ x γ) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| 1 | 1.00x1.35 | 0.40x1.50 | | | |
| 2 | 1.00x1.20 | 1.00x1.50 | | | |
| 3 | 1.00x1.00 | 0.40x1.50 | 1.00x1.20 | | |
| 4 | 1.00x1.00 | 0.40x1.50 | | 1.00x1.50 | |

#### 2.1.2 Reactiekrachten

| Knoop-nummer | Combinatie nummer | Fx [kN] | Fz [kN] | My [kNm] |
|---|---|---|---|---|
| 1 | 1 | 14.813 | 99.602 | |
| | 2 | 31.174 | 210.446 | |
| | 3 | 13.268 | 94.948 | |
| | 4 | 4.739 | 90.821 | |
| 2 | 1 | -14.813 | 74.299 | |
| | 2 | -31.174 | 124.461 | |
| | 3 | -14.888 | 72.045 | |
| | 4 | -21.659 | 83.556 | |
| 5 | 1 | | 41.778 | |
| | 2 | | 59.126 | |
| | 3 | | 42.066 | |
| | 4 | | 36.287 | |

#### 2.1.3 Staafreactiekrachten

| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 1 | 1 | 3 | 72.721 | 14.796 | 35.185 |
| | | 2 | -74.299 | -14.796 | |
| | 2 | 3 | 123.058 | 31.166 | 74.112 |
| | | 2 | -124.461 | -31.166 | |
| | 3 | 3 | 70.877 | 14.892 | 35.412 |
| | | 2 | -72.045 | -14.892 | |
| | 4 | 3 | 82.388 | 21.892 | 52.060 |
| | | 2 | -83.556 | -21.892 | |
| 2 | 1 | 1 | 99.602 | -15.032 | |
| | | 4 | -97.872 | 15.032 | -36.797 |
| | 2 | 1 | 210.446 | -32.057 | |
| | | 4 | -208.908 | 32.057 | -78.476 |
| | 3 | 1 | 94.948 | -13.440 | |
| | | 4 | -93.667 | 13.440 | -32.901 |





| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 2 | 4 | 1 | 90.821 | -4.644 | |
| | | 4 | -89.539 | 4.644 | -11.368 |
| 3 | 1 | 9 | 76.230 | 0.111 | |
| | | 3 | -76.587 | 0.111 | |
| | 2 | 9 | 160.203 | 0.099 | |
| | | 3 | -160.521 | 0.099 | |
| | 3 | 9 | 76.777 | 0.082 | |
| | | 3 | -77.042 | 0.082 | |
| | 4 | 9 | 112.831 | 0.082 | |
| | | 3 | -113.096 | 0.082 | |
| 4 | 1 | 11 | 6.770 | -25.645 | |
| | | 3 | -7.680 | 25.645 | -35.185 |
| | 2 | 11 | -13.753 | -54.017 | |
| | | 3 | 12.944 | 54.017 | -74.112 |
| | 3 | 11 | 4.780 | -25.811 | |
| | | 3 | -5.454 | 25.811 | -35.412 |
| | 4 | 11 | -14.392 | -37.944 | |
| | | 3 | 13.717 | 37.944 | -52.060 |
| 5 | 1 | 4 | 31.575 | 28.262 | 36.797 |
| | | 7 | -30.655 | -28.262 | |
| | 2 | 4 | 68.906 | 60.273 | 78.476 |
| | | 7 | -68.088 | -60.273 | |
| | 3 | 4 | 34.406 | 25.270 | 32.901 |
| | | 7 | -33.724 | -25.270 | |
| | 4 | 4 | 68.970 | 8.731 | 11.368 |
| | | 7 | -68.288 | -8.731 | |
| 6 | 1 | 8 | 78.712 | -0.110 | |
| | | 4 | -79.052 | -0.110 | |
| | 2 | 8 | 166.859 | -0.098 | |
| | | 4 | -167.160 | -0.098 | |
| | 3 | 8 | 70.426 | -0.082 | |
| | | 4 | -70.677 | -0.082 | |
| | 4 | 8 | 24.265 | -0.082 | |
| | | 4 | -24.517 | -0.082 | |
| 7 | 1 | 5 | | 41.778 | |
| | | 6 | | -38.015 | 17.953 |
| | 2 | 5 | | 59.126 | |
| | | 6 | | -51.431 | 24.875 |
| | 3 | 5 | | 42.066 | |
| | | 6 | | -38.578 | 18.145 |
| | 4 | 5 | | 36.287 | |
| | | 6 | | -32.799 | 15.544 |
| 8 | 1 | 6 | -26.251 | 8.720 | -17.953 |
| | | 7 | 26.251 | 37.865 | -27.876 |
| | 2 | 6 | -23.334 | 25.397 | -24.875 |
| | | 7 | 23.334 | 79.094 | -59.563 |
| | 3 | 6 | -26.153 | 7.611 | -18.145 |
| | | 7 | 26.153 | 37.047 | -28.143 |
| | 4 | 6 | -19.125 | 5.251 | -15.544 |
| | | 7 | 19.125 | 39.408 | -38.168 |
| 9 | 1 | 7 | -54.496 | -7.260 | 27.876 |
| | | 8 | 54.496 | 19.806 | -39.339 |
| | 2 | 7 | -83.495 | -11.203 | 59.563 |
| | | 8 | 83.495 | 39.345 | -80.970 |
| | 3 | 7 | -51.402 | -3.373 | 28.143 |
| | | 8 | 51.402 | 15.401 | -36.094 |





| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 9 | 4 | 7 | -27.726 | 28.826 | 38.168 |
| | | 8 | 27.726 | -16.798 | -18.846 |
| 10 | 1 | 8 | -11.438 | 46.127 | 39.339 |
| | | 9 | 11.438 | 34.866 | -8.551 |
| | 2 | 8 | 7.841 | 100.493 | 80.970 |
| | | 9 | -7.841 | 81.180 | -28.166 |
| | 3 | 8 | -12.886 | 43.602 | 36.094 |
| | | 9 | 12.886 | 34.042 | -9.956 |
| | 4 | 8 | -14.386 | 37.122 | 18.846 |
| | | 9 | 14.386 | 40.523 | -28.144 |
| 11 | 1 | 9 | -51.876 | 29.929 | 8.551 |
| | | 10 | 51.876 | -26.751 | 2.219 |
| | 2 | 9 | -77.430 | 54.962 | 28.166 |
| | | 10 | 77.430 | -48.464 | -8.515 |
| | 3 | 9 | -53.571 | 31.234 | 9.956 |
| | | 10 | 53.571 | -28.290 | 1.354 |
| | 4 | 9 | -74.006 | 55.408 | 28.144 |
| | | 10 | 74.006 | -52.463 | -7.648 |
| 12 | 1 | 10 | -25.625 | -2.755 | -2.219 |
| | | 11 | 25.625 | 6.685 | |
| | 2 | 10 | -54.096 | 22.135 | 8.515 |
| | | 11 | 54.096 | -14.099 | |
| | 3 | 10 | -25.798 | -1.060 | -1.354 |
| | | 11 | 25.798 | 4.702 | |
| | 4 | 10 | -37.961 | 18.094 | 7.648 |
| | | 11 | 37.961 | -14.451 | |
| 13 | 1 | 6 | 39.339 | 0.026 | |
| | | 12 | -39.119 | 0.171 | -0.150 |
| | 2 | 6 | 34.964 | 0.024 | |
| | | 12 | -34.769 | 0.152 | -0.133 |
| | 3 | 6 | 40.519 | 1.373 | |
| | | 12 | -40.356 | -1.227 | 2.706 |
| | 4 | 6 | 33.279 | 4.596 | |
| | | 12 | -33.116 | -4.450 | 9.418 |
| 14 | 1 | 13 | 39.208 | -0.133 | -0.486 |
| | | 10 | -39.428 | 0.332 | |
| | 2 | 13 | 34.855 | -0.114 | -0.425 |
| | | 10 | -35.050 | 0.291 | |
| | 3 | 13 | 40.173 | 1.203 | 2.363 |
| | | 10 | -40.335 | -1.056 | |
| | 4 | 13 | 49.452 | 4.440 | 9.134 |
| | | 10 | -49.614 | -4.292 | |
| 15 | 1 | 12 | 38.101 | 0.170 | 0.150 |
| | | 14 | -37.931 | -0.017 | |
| | 2 | 12 | 33.864 | 0.151 | 0.133 |
| | | 14 | -33.713 | -0.015 | |
| | 3 | 12 | 48.986 | -1.620 | -2.706 |
| | | 14 | -48.860 | 1.733 | |
| | 4 | 12 | 64.252 | -5.777 | -9.418 |
| | | 14 | -64.126 | 5.890 | |
| 16 | 1 | 12 | 1.051 | 0.054 | |
| | | 15 | -0.987 | 0.054 | |
| | 2 | 12 | 0.935 | 0.048 | |
| | | 15 | -0.878 | 0.048 | |
| | 3 | 12 | -9.066 | 0.040 | |
| | | 15 | 9.113 | 0.040 | |

| Staaf-nummer | Combinatie nummer | Knoop-nummer | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] |
|---|---|---|---|---|---|
| 16 | 4 | 12 | -32.669 | 0.040 | |
| | | 15 | 32.717 | 0.040 | |
| 17 | 1 | 13 | 1.608 | -0.053 | |
| | | 16 | -1.545 | -0.053 | |
| | 2 | 13 | 1.446 | -0.047 | |
| | | 16 | -1.389 | -0.047 | |
| | 3 | 13 | 11.221 | -0.039 | |
| | | 16 | -11.174 | -0.039 | |
| | 4 | 13 | 34.544 | -0.039 | |
| | | 16 | -34.497 | -0.039 | |
| 18 | 1 | 17 | 37.486 | 0.380 | |
| | | 13 | -37.656 | -0.231 | 0.486 |
| | 2 | 17 | 33.308 | 0.333 | |
| | | 13 | -33.459 | -0.201 | 0.425 |
| | 3 | 17 | 29.328 | -1.430 | |
| | | 13 | -29.454 | 1.540 | -2.363 |
| | 4 | 17 | 16.364 | -5.685 | |
| | | 13 | -16.490 | 5.795 | -9.134 |
| 19 | 1 | 14 | 33.972 | -0.176 | |
| | | 15 | -33.972 | 0.312 | -0.234 |
| | 2 | 14 | 30.196 | -0.157 | |
| | | 15 | -30.196 | 0.278 | -0.208 |
| | 3 | 14 | 43.597 | 2.937 | |
| | | 15 | -43.597 | -2.836 | 2.771 |
| | 4 | 14 | 64.960 | 10.354 | |
| | | 15 | -64.960 | -10.253 | 9.891 |
| 20 | 1 | 15 | 34.850 | 0.155 | 0.234 |
| | | 16 | -34.850 | 0.271 | -0.409 |
| | 2 | 15 | 30.978 | 0.136 | 0.208 |
| | | 16 | -30.978 | 0.243 | -0.369 |
| | 3 | 15 | 35.763 | -1.894 | -2.771 |
| | | 16 | -35.763 | 2.210 | -3.404 |
| | 4 | 15 | 36.790 | -6.639 | -9.891 |
| | | 16 | -36.790 | 6.956 | -10.569 |
| 21 | 1 | 16 | 33.500 | 0.498 | 0.409 |
| | | 17 | -33.500 | -0.363 | |
| | 2 | 16 | 29.763 | 0.448 | 0.369 |
| | | 17 | -29.763 | -0.328 | |
| | 3 | 16 | 26.169 | 3.634 | 3.404 |
| | | 17 | -26.169 | -3.534 | |
| | 4 | 16 | 7.202 | 11.176 | 10.569 |
| | | 17 | -7.202 | -11.076 | |

#### 2.1.4 Snedekrachten en vervormingen

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | 0 | -72.721 | 14.796 | -35.185 | 0.0 |
| | | | 1005 | -73.388 | 14.796 | -20.315 | **-0.8** |
| | | | 2378 | -74.299 | 14.796 | 0.000 | 0.0 |
| 1 | 2 | 3 | 0 | -123.058 | 31.166 | -74.112 | 0.0 |
| | | | 1005 | -123.651 | 31.166 | -42.791 | **-1.6** |
| | | | 2378 | -124.461 | 31.166 | 0.000 | 0.0 |
| 1 | 3 | 3 | 0 | -70.877 | 14.892 | -35.412 | 0.0 |





| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 1005 | -71.370 | 14.892 | -20.447 | **-0.8** |
| | | | 2378 | -72.045 | 14.892 | 0.000 | 0.0 |
| 1 | 4 | 3 | 0 | -82.388 | 21.892 | -52.060 | 0.0 |
| | | | 1005 | -82.882 | 21.892 | -30.059 | **-1.2** |
| | | | 2378 | -83.556 | 21.892 | 0.000 | 0.0 |
| 2 | 1 | 1 | 0 | -99.602 | -15.032 | 0.000 | 0.0 |
| | | | 1414 | -98.603 | -15.032 | -21.247 | **-0.8** |
| | | | 2448 | -97.872 | -15.032 | -36.797 | 0.0 |
| 2 | 2 | 1 | 0 | -210.446 | -32.057 | 0.000 | 0.0 |
| | | | 1414 | -209.558 | -32.057 | -45.311 | **-1.8** |
| | | | 2448 | -208.908 | -32.057 | -78.476 | 0.0 |
| 2 | 3 | 1 | 0 | -94.948 | -13.440 | 0.000 | 0.0 |
| | | | 1414 | -94.208 | -13.440 | -18.997 | **-0.7** |
| | | | 2448 | -93.667 | -13.440 | -32.901 | 0.0 |
| 2 | 4 | 1 | 0 | -90.821 | -4.644 | 0.000 | 0.0 |
| | | | 1414 | -90.081 | -4.644 | -6.564 | **-0.3** |
| | | | 2448 | -89.539 | -4.644 | -11.368 | 0.0 |
| 3 | 1 | 9 | 0 | -76.230 | 0.111 | 0.000 | 0.0 |
| | | | 806 | -76.408 | 0.000 | 0.045 | **0.0** |
| | | | 807 | -76.409 | 0.000 | **0.045** | 0.0 |
| | | | 1614 | -76.587 | -0.111 | 0.000 | 0.0 |
| 3 | 2 | 9 | 0 | -160.203 | 0.099 | 0.000 | 0.0 |
| | | | 806 | -160.362 | 0.000 | 0.040 | **0.0** |
| | | | 807 | -160.362 | 0.000 | **0.040** | 0.0 |
| | | | 1614 | -160.521 | -0.098 | 0.000 | 0.0 |
| 3 | 3 | 9 | 0 | -76.777 | 0.082 | 0.000 | 0.0 |
| | | | 806 | -76.909 | 0.000 | 0.033 | **0.0** |
| | | | 807 | -76.909 | 0.000 | **0.033** | 0.0 |
| | | | 1614 | -77.042 | -0.082 | 0.000 | 0.0 |
| 3 | 4 | 9 | 0 | -112.831 | 0.082 | 0.000 | 0.0 |
| | | | 807 | -112.964 | 0.000 | **0.033** | 0.0 |
| | | | 808 | -112.964 | 0.000 | 0.033 | **0.0** |
| | | | 1614 | -113.096 | -0.082 | 0.000 | 0.0 |
| 4 | 1 | 11 | 0 | -6.770 | -25.645 | 0.000 | 0.0 |
| | | | 793 | -7.295 | -25.645 | -20.324 | **-0.3** |
| | | | 1372 | -7.680 | -25.645 | -35.185 | 0.0 |
| 4 | 2 | 11 | 0 | 13.753 | -54.017 | 0.000 | 0.0 |
| | | | 793 | 13.286 | -54.017 | -42.810 | **-0.5** |
| | | | 1372 | 12.944 | -54.017 | -74.112 | 0.0 |
| 4 | 3 | 11 | 0 | -4.780 | -25.811 | 0.000 | 0.0 |
| | | | 793 | -5.169 | -25.811 | -20.455 | **-0.3** |
| | | | 1372 | -5.454 | -25.811 | -35.412 | 0.0 |
| 4 | 4 | 11 | 0 | 14.392 | -37.944 | 0.000 | 0.0 |
| | | | 793 | 14.002 | -37.944 | -30.072 | **-0.4** |
| | | | 1372 | 13.717 | -37.944 | -52.060 | 0.0 |
| 5 | 1 | 4 | 0 | -31.575 | 28.262 | -36.797 | 0.0 |
| | | | 550 | -31.187 | 28.262 | -21.256 | **-0.2** |
| | | | 1302 | -30.655 | 28.262 | 0.000 | 0.0 |
| 5 | 2 | 4 | 0 | -68.906 | 60.273 | -78.476 | 0.0 |
| | | | 550 | -68.561 | 60.273 | -45.330 | **-0.5** |
| | | | 1302 | -68.088 | 60.273 | 0.000 | 0.0 |
| 5 | 3 | 4 | 0 | -34.406 | 25.270 | -32.901 | 0.0 |
| | | | 550 | -34.118 | 25.270 | -19.005 | **-0.2** |
| | | | 1302 | -33.724 | 25.270 | 0.000 | 0.0 |
| 5 | 4 | 4 | 0 | -68.970 | 8.731 | -11.368 | 0.0 |





| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 5 | 4 | 4 | 550 | -68.682 | 8.731 | -6.567 | **-0.1** |
| | | | 1302 | -68.288 | 8.731 | 0.000 | 0.0 |
| 6 | 1 | 8 | 0 | -78.712 | -0.110 | 0.000 | 0.0 |
| | | | 777 | -78.882 | 0.000 | **-0.043** | 0.0 |
| | | | 777 | -78.882 | 0.000 | -0.043 | **0.0** |
| | | | 1553 | -79.052 | 0.110 | 0.000 | 0.0 |
| 6 | 2 | 8 | 0 | -166.859 | -0.098 | 0.000 | 0.0 |
| | | | 777 | -167.010 | 0.000 | **-0.038** | 0.0 |
| | | | 777 | -167.010 | 0.000 | -0.038 | **0.0** |
| | | | 1553 | -167.160 | 0.098 | 0.000 | 0.0 |
| 6 | 3 | 8 | 0 | -70.426 | -0.082 | 0.000 | 0.0 |
| | | | 777 | -70.552 | 0.000 | **-0.032** | 0.0 |
| | | | 777 | -70.552 | 0.000 | -0.032 | **0.0** |
| | | | 1553 | -70.677 | 0.082 | 0.000 | 0.0 |
| 6 | 4 | 8 | 0 | -24.265 | -0.082 | 0.000 | 0.0 |
| | | | 777 | -24.391 | 0.000 | **-0.032** | 0.0 |
| | | | 777 | -24.391 | 0.000 | -0.032 | **0.0** |
| | | | 1553 | -24.517 | 0.082 | 0.000 | 0.0 |
| 7 | 1 | 5 | 0 | 0.000 | 41.778 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 39.610 | 10.551 | **0.0** |
| | | | 450 | 0.000 | 38.015 | 17.953 | 0.0 |
| 7 | 2 | 5 | 0 | 0.000 | 59.126 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 54.693 | 14.755 | **0.0** |
| | | | 450 | 0.000 | 51.431 | 24.875 | 0.0 |
| 7 | 3 | 5 | 0 | 0.000 | 42.066 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 40.056 | 10.646 | **0.0** |
| | | | 450 | 0.000 | 38.578 | 18.145 | 0.0 |
| 7 | 4 | 5 | 0 | 0.000 | 36.287 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 34.277 | 9.148 | **0.0** |
| | | | 450 | 0.000 | 32.799 | 15.544 | 0.0 |
| 8 | 1 | 6 | 0 | 26.251 | 8.720 | 17.953 | 0.0 |
| | | | 589 | 26.251 | 0.000 | **20.520** | 0.8 |
| | | | 2253 | 26.251 | -24.656 | **0.000** | 0.5 |
| | | | 3145 | 26.251 | -37.865 | -27.876 | 0.0 |
| 8 | 2 | 6 | 0 | 23.334 | 25.397 | 24.875 | 0.0 |
| | | | 764 | 23.334 | 0.000 | **34.583** | 1.5 |
| | | | 2207 | 23.334 | -47.937 | **0.000** | 0.8 |
| | | | 3145 | 23.334 | -79.094 | -59.563 | 0.0 |
| 8 | 3 | 6 | 0 | 26.153 | 7.611 | 18.145 | 0.0 |
| | | | 536 | 26.153 | 0.000 | **20.185** | 0.7 |
| | | | 2222 | 26.153 | -23.942 | **0.000** | 0.5 |
| | | | 3145 | 26.153 | -37.047 | -28.143 | 0.0 |
| 8 | 4 | 6 | 0 | 19.125 | 5.251 | 15.544 | 0.0 |
| | | | 370 | 19.125 | 0.000 | **16.515** | 0.3 |
| | | | 1895 | 19.125 | -21.657 | **0.000** | 0.1 |
| | | | 3145 | 19.125 | -39.408 | -38.168 | 0.0 |
| 9 | 1 | 7 | 0 | 54.496 | -7.260 | -27.876 | 0.0 |
| | | | 436 | 54.496 | -13.717 | -32.449 | **-0.2** |
| | | | 847 | 54.496 | -19.806 | -39.339 | 0.0 |
| 9 | 2 | 7 | 0 | 83.495 | -11.203 | -59.563 | 0.0 |
| | | | 434 | 83.495 | -25.631 | -67.561 | **-0.5** |
| | | | 847 | 83.495 | -39.345 | -80.970 | 0.0 |
| 9 | 3 | 7 | 0 | 51.402 | -3.373 | -28.143 | 0.0 |
| | | | 433 | 51.402 | -9.516 | -30.931 | **-0.2** |
| | | | 847 | 51.402 | -15.401 | -36.094 | 0.0 |





| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 9 | 4 | 7 | 0 | 27.726 | 28.826 | -38.168 | 0.0 |
| | | | 400 | 27.726 | 23.153 | -27.785 | **-0.2** |
| | | | 847 | 27.726 | 16.798 | -18.846 | 0.0 |
| 10 | 1 | 8 | 0 | 11.438 | 46.127 | -39.339 | 0.0 |
| | | | 2954 | 11.438 | 2.378 | 32.293 | **6.3** |
| | | | 3114 | 11.438 | 0.000 | **32.484** | 6.2 |
| | | | 5468 | 11.438 | -34.866 | -8.551 | 0.0 |
| 10 | 2 | 8 | 0 | -7.841 | 100.493 | -80.970 | 0.0 |
| | | | 2906 | -7.841 | 3.958 | 70.773 | **13.8** |
| | | | 3025 | -7.841 | 0.000 | **71.009** | 13.7 |
| | | | 5468 | -7.841 | -81.179 | -28.166 | 0.0 |
| 10 | 3 | 8 | 0 | 12.886 | 43.602 | -36.094 | 0.0 |
| | | | 2930 | 12.886 | 2.003 | 30.709 | **6.0** |
| | | | 3071 | 12.886 | 0.000 | **30.850** | 6.0 |
| | | | 5468 | 12.886 | -34.042 | -9.955 | 0.0 |
| 10 | 4 | 8 | 0 | 14.386 | 37.122 | -18.846 | 0.0 |
| | | | 2614 | 14.386 | 0.000 | **29.677** | 5.8 |
| | | | 2663 | 14.386 | -0.686 | 29.660 | **5.8** |
| | | | 5468 | 14.386 | -40.523 | -28.144 | 0.0 |
| 11 | 1 | 9 | 0 | 51.876 | 29.929 | -8.551 | 0.0 |
| | | | 143 | 51.876 | 28.731 | -4.349 | **0.0** |
| | | | 298 | 51.876 | 27.436 | **0.000** | 0.0 |
| | | | 380 | 51.876 | 26.751 | 2.219 | 0.0 |
| 11 | 2 | 9 | 0 | 77.430 | 54.962 | -28.166 | 0.0 |
| | | | 173 | 77.430 | 52.005 | -18.917 | **0.0** |
| | | | 380 | 77.430 | 48.464 | -8.515 | 0.0 |
| 11 | 3 | 9 | 0 | 53.571 | 31.234 | -9.956 | 0.0 |
| | | | 152 | 53.571 | 30.055 | -5.293 | **0.0** |
| | | | 332 | 53.571 | 28.658 | **0.000** | 0.0 |
| | | | 380 | 53.571 | 28.290 | 1.354 | 0.0 |
| 11 | 4 | 9 | 0 | 74.006 | 55.408 | -28.144 | 0.0 |
| | | | 173 | 74.006 | 54.068 | -18.678 | **0.0** |
| | | | 380 | 74.006 | 52.463 | -7.648 | 0.0 |
| 12 | 1 | 10 | 0 | 25.625 | -2.755 | 2.219 | 0.0 |
| | | | 205 | 25.625 | -4.467 | 1.479 | **0.0** |
| | | | 470 | 25.625 | -6.685 | 0.000 | 0.0 |
| 12 | 2 | 10 | 0 | 54.096 | 22.135 | -8.515 | 0.0 |
| | | | 196 | 54.096 | 18.792 | -4.514 | **0.0** |
| | | | 470 | 54.096 | 14.099 | 0.000 | 0.0 |
| 12 | 3 | 10 | 0 | 25.798 | -1.060 | 1.354 | 0.0 |
| | | | 207 | 25.798 | -2.660 | 0.970 | **0.0** |
| | | | 470 | 25.798 | -4.702 | 0.000 | 0.0 |
| 12 | 4 | 10 | 0 | 37.961 | 18.094 | -7.648 | 0.0 |
| | | | 197 | 37.961 | 16.564 | -4.228 | **0.0** |
| | | | 470 | 37.961 | 14.451 | 0.000 | 0.0 |
| 13 | 1 | 6 | 0 | -39.339 | 0.026 | 0.000 | 0.0 |
| | | | 278 | -39.310 | 0.000 | **0.004** | 0.0 |
| | | | 555 | -39.280 | -0.026 | **0.000** | 0.0 |
| | | | 1383 | -39.193 | -0.105 | -0.054 | **0.0** |
| | | | 2082 | -39.119 | -0.171 | -0.150 | 0.0 |
| 13 | 2 | 6 | 0 | -34.964 | 0.024 | 0.000 | 0.0 |
| | | | 280 | -34.938 | 0.000 | **0.003** | 0.0 |
| | | | 560 | -34.912 | -0.024 | **0.000** | 0.0 |
| | | | 1384 | -34.835 | -0.093 | -0.048 | **0.0** |
| | | | 2082 | -34.769 | -0.152 | -0.133 | 0.0 |

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 13 | 3 | 6 | 0 | -40.519 | 1.373 | 0.000 | 0.0 |
| | | | 1198 | -40.425 | 1.289 | 1.594 | **0.8** |
| | | | 2082 | -40.356 | 1.227 | 2.706 | 0.0 |
| 13 | 4 | 6 | 0 | -33.279 | 4.596 | 0.000 | 0.0 |
| | | | 1201 | -33.185 | 4.512 | 5.470 | **2.9** |
| | | | 2082 | -33.116 | 4.450 | 9.418 | 0.0 |
| 14 | 1 | 13 | 0 | -39.208 | -0.133 | 0.486 | 0.0 |
| | | | 910 | -39.304 | -0.219 | 0.326 | **0.2** |
| | | | 2092 | -39.428 | -0.332 | 0.000 | 0.0 |
| 14 | 2 | 13 | 0 | -34.855 | -0.114 | 0.425 | 0.0 |
| | | | 910 | -34.940 | -0.191 | 0.285 | **0.2** |
| | | | 2092 | -35.050 | -0.291 | 0.000 | 0.0 |
| 14 | 3 | 13 | 0 | -40.173 | 1.203 | -2.363 | 0.0 |
| | | | 880 | -40.241 | 1.141 | -1.331 | **-0.7** |
| | | | 2092 | -40.335 | 1.056 | 0.000 | 0.0 |
| 14 | 4 | 13 | 0 | -49.452 | 4.440 | -9.134 | 0.0 |
| | | | 883 | -49.520 | 4.377 | -5.241 | **-2.8** |
| | | | 2092 | -49.614 | 4.292 | 0.000 | 0.0 |
| 15 | 1 | 12 | 0 | -38.101 | 0.170 | -0.150 | 0.0 |
| | | | 619 | -38.036 | 0.111 | -0.064 | **0.0** |
| | | | 1614 | -37.931 | 0.017 | 0.000 | 0.0 |
| 15 | 2 | 12 | 0 | -33.864 | 0.151 | -0.133 | 0.0 |
| | | | 619 | -33.806 | 0.098 | -0.056 | **0.0** |
| | | | 1614 | -33.713 | 0.015 | 0.000 | 0.0 |
| 15 | 3 | 12 | 0 | -48.986 | -1.620 | 2.706 | 0.0 |
| | | | 685 | -48.932 | -1.668 | 1.581 | **0.5** |
| | | | 1614 | -48.860 | -1.733 | 0.000 | 0.0 |
| 15 | 4 | 12 | 0 | -64.252 | -5.777 | 9.418 | 0.0 |
| | | | 683 | -64.198 | -5.825 | 5.454 | **1.7** |
| | | | 1614 | -64.126 | -5.890 | 0.000 | 0.0 |
| 16 | 1 | 12 | 0 | -1.051 | 0.054 | 0.000 | 0.0 |
| | | | 1183 | -1.019 | 0.000 | **0.032** | 0.1 |
| | | | 1184 | -1.019 | 0.000 | 0.032 | **0.1** |
| | | | 2367 | -0.987 | -0.054 | 0.000 | 0.0 |
| 16 | 2 | 12 | 0 | -0.935 | 0.048 | 0.000 | 0.0 |
| | | | 1183 | -0.906 | 0.000 | **0.029** | 0.1 |
| | | | 1184 | -0.906 | 0.000 | 0.029 | **0.1** |
| | | | 2367 | -0.878 | -0.048 | 0.000 | 0.0 |
| 16 | 3 | 12 | 0 | 9.066 | 0.040 | 0.000 | 0.0 |
| | | | 1183 | 9.089 | 0.000 | 0.024 | **0.1** |
| | | | 1183 | 9.089 | 0.000 | **0.024** | 0.1 |
| | | | 2367 | 9.113 | -0.040 | 0.000 | 0.0 |
| 16 | 4 | 12 | 0 | 32.669 | 0.040 | 0.000 | 0.0 |
| | | | 1183 | 32.693 | 0.000 | 0.024 | **0.1** |
| | | | 1183 | 32.693 | 0.000 | **0.024** | 0.1 |
| | | | 2367 | 32.717 | -0.040 | 0.000 | 0.0 |
| 17 | 1 | 13 | 0 | -1.608 | -0.053 | 0.000 | 0.0 |
| | | | 1164 | -1.576 | 0.000 | **-0.031** | -0.1 |
| | | | 1165 | -1.576 | 0.000 | -0.031 | **-0.1** |
| | | | 2328 | -1.545 | 0.053 | 0.000 | 0.0 |
| 17 | 2 | 13 | 0 | -1.446 | -0.047 | 0.000 | 0.0 |
| | | | 1164 | -1.418 | 0.000 | **-0.027** | -0.1 |
| | | | 1165 | -1.418 | 0.000 | -0.027 | **-0.1** |
| | | | 2328 | -1.389 | 0.047 | 0.000 | 0.0 |
| 17 | 3 | 13 | 0 | -11.221 | -0.039 | 0.000 | 0.0 |



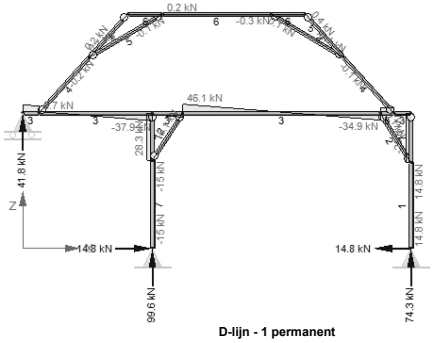


| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 17 | 3 | 13 | 1164 | -11.198 | 0.000 | **-0.023** | -0.1 |
| | | | 1165 | -11.198 | 0.000 | -0.023 | **-0.1** |
| | | | 2328 | -11.174 | 0.039 | 0.000 | 0.0 |
| 17 | 4 | 13 | 0 | -34.544 | -0.039 | 0.000 | 0.0 |
| | | | 1164 | -34.520 | 0.000 | **-0.023** | -0.1 |
| | | | 1165 | -34.520 | 0.000 | -0.023 | **-0.1** |
| | | | 2328 | -34.497 | 0.039 | 0.000 | 0.0 |
| 18 | 1 | 17 | 0 | -37.486 | 0.380 | 0.000 | 0.0 |
| | | | 907 | -37.583 | 0.295 | 0.306 | **0.1** |
| | | | 1591 | -37.656 | 0.231 | 0.486 | 0.0 |
| 18 | 2 | 17 | 0 | -33.308 | 0.333 | 0.000 | 0.0 |
| | | | 907 | -33.394 | 0.258 | 0.268 | **0.1** |
| | | | 1591 | -33.459 | 0.201 | 0.425 | 0.0 |
| 18 | 3 | 17 | 0 | -29.328 | -1.430 | 0.000 | 0.0 |
| | | | 921 | -29.401 | -1.494 | -1.346 | **-0.4** |
| | | | 1591 | -29.454 | -1.540 | -2.363 | 0.0 |
| 18 | 4 | 17 | 0 | -16.364 | -5.685 | 0.000 | 0.0 |
| | | | 919 | -16.436 | -5.748 | -5.254 | **-1.6** |
| | | | 1591 | -16.490 | -5.795 | -9.134 | 0.0 |
| 19 | 1 | 14 | 0 | -33.972 | -0.176 | 0.000 | 0.0 |
| | | | 563 | -33.972 | -0.256 | -0.122 | **0.0** |
| | | | 960 | -33.972 | -0.312 | -0.234 | 0.0 |
| 19 | 2 | 14 | 0 | -30.196 | -0.157 | 0.000 | 0.0 |
| | | | 563 | -30.196 | -0.228 | -0.108 | **0.0** |
| | | | 960 | -30.196 | -0.278 | -0.208 | 0.0 |
| 19 | 3 | 14 | 0 | -43.597 | 2.937 | 0.000 | 0.0 |
| | | | 554 | -43.597 | 2.879 | 1.611 | **0.2** |
| | | | 960 | -43.597 | 2.836 | 2.771 | 0.0 |
| 19 | 4 | 14 | 0 | -64.960 | 10.354 | 0.000 | 0.0 |
| | | | 554 | -64.960 | 10.295 | 5.720 | **0.6** |
| | | | 960 | -64.960 | 10.253 | 9.891 | 0.0 |
| 20 | 1 | 15 | 0 | -34.850 | 0.155 | -0.234 | 0.0 |
| | | | 1095 | -34.850 | 0.000 | **-0.149** | -0.2 |
| | | | 1638 | -34.850 | -0.077 | -0.170 | **-0.2** |
| | | | 3010 | -34.850 | -0.271 | -0.409 | 0.0 |
| 20 | 2 | 15 | 0 | -30.978 | 0.136 | -0.208 | 0.0 |
| | | | 1083 | -30.978 | 0.000 | **-0.135** | -0.2 |
| | | | 1640 | -30.978 | -0.070 | -0.154 | **-0.2** |
| | | | 3010 | -30.978 | -0.243 | -0.369 | 0.0 |
| 20 | 3 | 15 | 0 | -35.763 | -1.894 | 2.771 | 0.0 |
| | | | 1408 | -35.763 | -2.042 | **0.000** | -0.2 |
| | | | 3010 | -35.763 | -2.210 | -3.404 | 0.0 |
| 20 | 4 | 15 | 0 | -36.790 | -6.639 | 9.891 | 0.0 |
| | | | 1473 | -36.790 | -6.794 | **0.000** | -0.2 |
| | | | 3010 | -36.790 | -6.956 | -10.569 | 0.0 |
| 21 | 1 | 16 | 0 | -33.500 | 0.498 | -0.409 | 0.0 |
| | | | 396 | -33.500 | 0.442 | -0.223 | **0.0** |
| | | | 950 | -33.500 | 0.363 | 0.000 | 0.0 |
| 21 | 2 | 16 | 0 | -29.763 | 0.448 | -0.369 | 0.0 |
| | | | 396 | -29.763 | 0.398 | -0.201 | **0.0** |
| | | | 950 | -29.763 | 0.328 | 0.000 | 0.0 |
| 21 | 3 | 16 | 0 | -26.169 | 3.634 | -3.404 | 0.0 |
| | | | 402 | -26.169 | 3.591 | -1.953 | **-0.2** |
| | | | 950 | -26.169 | 3.534 | 0.000 | 0.0 |
| 21 | 4 | 16 | 0 | -7.202 | 11.176 | -10.569 | 0.0 |

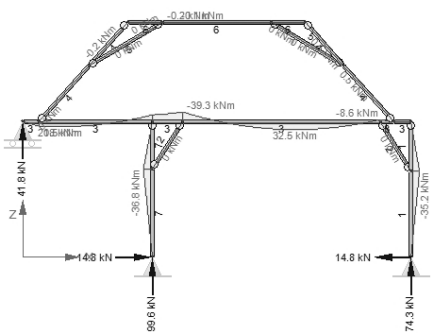




| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 21 | 4 | 16 | 402 | -7.202 | 11.133 | -6.089 | **-0.7** |
| | | | 950 | -7.202 | 11.076 | 0.000 | 0.0 |



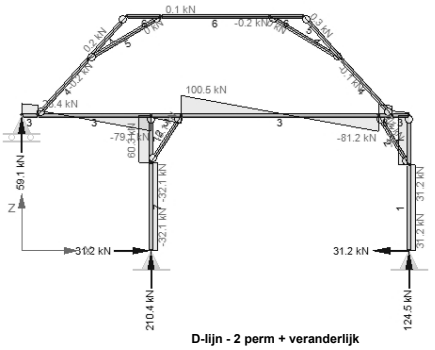

**D-lijn - 1 permanent**



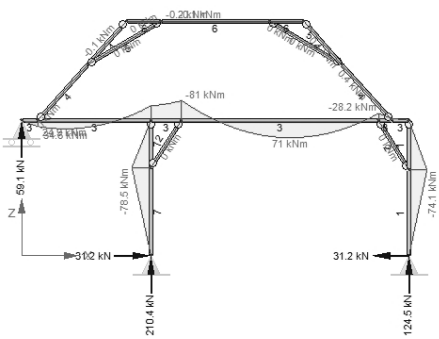

**M-lijn - 1 permanent**



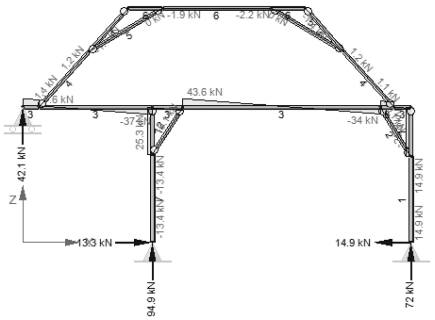




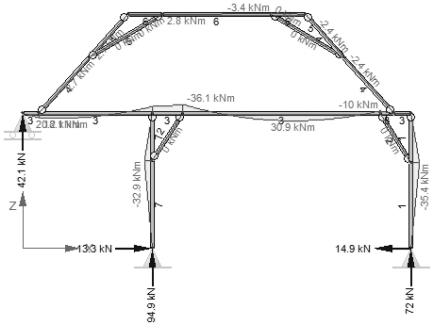

**D-lijn - 2 perm + veranderlijk**




**M-lijn - 2 perm + veranderlijk**



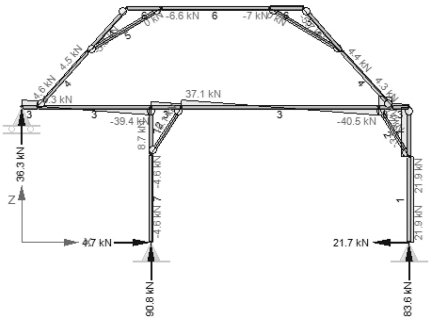

**D-lijn - 3 perm + sneeuw**



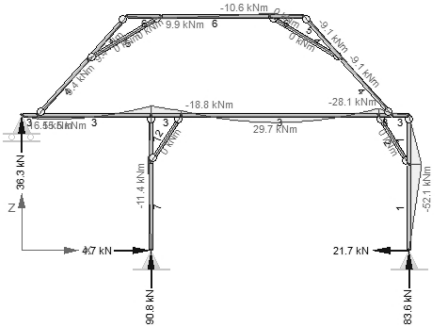

**M-lijn - 3 perm + sneeuw**








**D-lijn - 4 perm + wind**




**M-lijn - 4 perm + wind**





**2.2 BRUIKBAARHEIDSGRENSTOESTANDEN (BGT)**

**2.2.1 Belastingscombinaties**

**(GNL) Geometrisch niet-lineaire krachtsverdeling**

| Combinatie nummer | Omschrijving | Type |
|---|---|---|
| 5 | permanent | BGT |
| 6 | perm + veranderlijk | BGT |
| 7 | perm + sneeuw | BGT |
| 8 | perm + wind | BGT |

| Combinatie nummer | Belasting (ψ x γ) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| 5 | 1.60x1.00 | 0.40x1.00 | | | |
| 6 | 1.60x1.00 | 1.24x1.00 | | | |
| 7 | 1.60x1.00 | 0.40x1.00 | 1.00x1.00 | | |
| 8 | 1.60x1.00 | 0.40x1.00 | | 1.00x1.00 | |

**2.2.2 Knoopverplaatsingen**

| Knoop-nummer | Combinatie nummer | dx [mm] | dz [mm] | dr [mrad] |
|---|---|---|---|---|
| 1 | 5 | 0.0 | 0.0 | 2.6 |
| | 6 | 0.0 | 0.0 | 5.5 |
| | 7 | 0.0 | 0.0 | 2.5 |
| | 8 | 0.0 | 0.0 | 0.2 |
| 2 | 5 | 0.0 | 0.0 | -0.3 |
| | 6 | 0.0 | 0.0 | -1.4 |
| | 7 | 0.0 | 0.0 | -0.6 |
| | 8 | 0.0 | 0.0 | -2.6 |
| 3 | 5 | -0.8 | -0.1 | 1.7 |
| | 6 | -0.5 | -0.2 | 3.4 |
| | 7 | -0.4 | -0.1 | 1.6 |
| | 8 | 3.9 | -0.1 | 0.3 |
| 4 | 5 | -4.7 | -0.2 | 0.5 |
| | 6 | -9.4 | -0.4 | 0.5 |
| | 7 | -4.4 | -0.2 | 0.4 |
| | 8 | 0.2 | -0.2 | -0.8 |
| 5 | 5 | -4.4 | 0.0 | -1.8 |
| | 6 | -7.9 | 0.0 | -3.0 |
| | 7 | -4.1 | 0.0 | -2.0 |
| | 8 | 1.6 | 0.0 | -1.6 |
| 6 | 5 | -4.4 | -0.8 | -1.5 |
| | 6 | -7.9 | -1.3 | -2.5 |
| | 7 | -4.1 | -0.8 | -1.6 |
| | 8 | 1.6 | -0.7 | -1.3 |
| 7 | 5 | -4.3 | -0.2 | 0.3 |
| | 6 | -7.8 | -0.5 | 0.0 |
| | 7 | -4.0 | -0.2 | 0.3 |
| | 8 | 1.7 | -0.2 | -0.4 |
| 8 | 5 | -4.3 | -0.6 | -1.4 |
| | 6 | -7.7 | -2.1 | -3.9 |
| | 7 | -3.9 | -0.7 | -1.4 |
| | 8 | 1.7 | -1.3 | -1.9 |
| 9 | 5 | -4.2 | -2.5 | 2.7 |





| Knoop-nummer | Combinatie nummer | dx [mm] | dz [mm] | dr [mrad] |
|---|---|---|---|---|
| 9 | 6 | -7.7 | -5.2 | 6.2 |
| | 7 | -3.8 | -2.5 | 2.7 |
| | 8 | 1.8 | -1.8 | 2.1 |
| 10 | 5 | -4.2 | -1.5 | 2.7 |
| | 6 | -7.7 | -2.9 | 5.8 |
| | 7 | -3.8 | -1.5 | 2.7 |
| | 8 | 1.9 | -1.0 | 1.8 |
| 11 | 5 | -4.2 | -0.1 | 2.8 |
| | 6 | -7.7 | -0.2 | 5.8 |
| | 7 | -3.8 | -0.2 | 2.9 |
| | 8 | 1.9 | -0.2 | 1.9 |
| 12 | 5 | -4.3 | -1.3 | -0.3 |
| | 6 | -7.6 | -2.0 | -0.4 |
| | 7 | 1.3 | -6.2 | -1.8 |
| | 8 | 15.7 | -13.8 | -4.3 |
| 13 | 5 | -5.1 | -2.7 | 0.2 |
| | 6 | -8.4 | -4.1 | 0.1 |
| | 7 | 0.3 | 1.7 | -1.2 |
| | 8 | 14.8 | 10.1 | -3.6 |
| 14 | 5 | -4.0 | -1.9 | 0.4 |
| | 6 | -7.2 | -2.7 | 0.3 |
| | 7 | 1.6 | -7.0 | 0.6 |
| | 8 | 16.0 | -14.6 | 0.6 |
| 15 | 5 | -4.2 | -1.6 | 0.2 |
| | 6 | -7.4 | -2.4 | 0.1 |
| | 7 | 1.4 | -6.0 | 1.8 |
| | 8 | 15.7 | -12.8 | 4.1 |
| 16 | 5 | -4.6 | -2.0 | -0.6 |
| | 6 | -7.8 | -3.2 | -0.7 |
| | 7 | 0.8 | 2.1 | 0.7 |
| | 8 | 15.2 | 9.7 | 3.0 |
| 17 | 5 | -4.8 | -2.8 | -0.9 |
| | 6 | -7.9 | -4.0 | -1.0 |
| | 7 | 0.7 | 1.7 | -1.0 |
| | 8 | 15.1 | 10.1 | -0.9 |

**2.2.3 Snedekrachten en vervormingen**

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 1 | 5 | 3 | 0 | -67.346 | 11.729 | -27.891 | 0.0 |
| | | | 1005 | -68.136 | 11.729 | -16.104 | **-0.6** |
| | | | 2378 | -69.215 | 11.729 | 0.000 | 0.0 |
| 1 | 6 | 3 | 0 | -118.113 | 27.372 | -65.091 | 0.0 |
| | | | 1005 | -118.903 | 27.372 | -37.583 | **-1.4** |
| | | | 2378 | -119.982 | 27.372 | 0.000 | 0.0 |
| 1 | 7 | 3 | 0 | -73.664 | 12.580 | -29.914 | 0.0 |
| | | | 1005 | -74.454 | 12.580 | -17.272 | **-0.7** |
| | | | 2378 | -75.534 | 12.580 | 0.000 | 0.0 |
| 1 | 8 | 3 | 0 | -80.077 | 17.064 | -40.579 | 0.0 |
| | | | 1005 | -80.867 | 17.064 | -23.430 | **-0.9** |
| | | | 2378 | -81.947 | 17.064 | 0.000 | 0.0 |
| 2 | 5 | 1 | 0 | -78.848 | -11.902 | 0.000 | 0.0 |
| | | | 1414 | -77.664 | -11.902 | -16.822 | **-0.7** |

| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 2 | 5 | 1 | 2448 | -76.797 | -11.902 | -29.135 | 0.0 |
| 2 | 6 | 1 | 0 | -184.777 | -28.109 | 0.000 | 0.0 |
| | | | 1414 | -183.593 | -28.109 | -39.730 | **-1.6** |
| | | | 2448 | -182.726 | -28.109 | -68.810 | 0.0 |
| 2 | 7 | 1 | 0 | -80.165 | -11.385 | 0.000 | 0.0 |
| | | | 1414 | -78.981 | -11.385 | -16.092 | **-0.6** |
| | | | 2448 | -78.115 | -11.385 | -27.871 | 0.0 |
| 2 | 8 | 1 | 0 | -77.154 | -5.646 | 0.000 | 0.0 |
| | | | 1414 | -75.970 | -5.646 | -7.980 | **-0.3** |
| | | | 2448 | -75.103 | -5.646 | -13.821 | 0.0 |
| 3 | 5 | 9 | 0 | -60.382 | 0.131 | 0.000 | 0.0 |
| | | | 806 | -60.594 | 0.000 | 0.053 | **0.0** |
| | | | 807 | -60.594 | 0.000 | **0.053** | 0.0 |
| | | | 1614 | -60.807 | -0.131 | 0.000 | 0.0 |
| 3 | 6 | 9 | 0 | -140.690 | 0.131 | 0.000 | 0.0 |
| | | | 806 | -140.902 | 0.000 | 0.053 | **0.0** |
| | | | 807 | -140.902 | 0.000 | **0.053** | 0.0 |
| | | | 1614 | -141.114 | -0.131 | 0.000 | 0.0 |
| 3 | 7 | 9 | 0 | -64.749 | 0.131 | 0.000 | 0.0 |
| | | | 806 | -64.961 | 0.000 | 0.053 | **0.0** |
| | | | 807 | -64.961 | 0.000 | **0.053** | 0.0 |
| | | | 1614 | -65.173 | -0.131 | 0.000 | 0.0 |
| 3 | 8 | 9 | 0 | -87.861 | 0.131 | 0.000 | 0.0 |
| | | | 806 | -88.073 | 0.000 | 0.053 | **0.0** |
| | | | 807 | -88.073 | 0.000 | **0.053** | 0.0 |
| | | | 1614 | -88.285 | -0.131 | 0.000 | 0.0 |
| 4 | 5 | 11 | 0 | -14.589 | -20.329 | 0.000 | 0.0 |
| | | | 793 | -15.212 | -20.329 | -16.111 | **-0.2** |
| | | | 1372 | -15.668 | -20.329 | -27.891 | 0.0 |
| 4 | 6 | 11 | 0 | 2.592 | -47.443 | 0.000 | 0.0 |
| | | | 793 | 1.969 | -47.443 | -37.599 | **-0.5** |
| | | | 1372 | 1.514 | -47.443 | -65.091 | 0.0 |
| 4 | 7 | 11 | 0 | -17.201 | -21.803 | 0.000 | 0.0 |
| | | | 793 | -17.824 | -21.803 | -17.280 | **-0.2** |
| | | | 1372 | -18.280 | -21.803 | -29.914 | 0.0 |
| 4 | 8 | 11 | 0 | -3.954 | -29.577 | 0.000 | 0.0 |
| | | | 793 | -4.577 | -29.577 | -23.440 | **-0.3** |
| | | | 1372 | -5.033 | -29.577 | -40.579 | 0.0 |
| 5 | 5 | 4 | 0 | -24.146 | 22.377 | -29.135 | 0.0 |
| | | | 550 | -23.685 | 22.377 | -16.829 | **-0.2** |
| | | | 1302 | -23.055 | 22.377 | 0.000 | 0.0 |
| 5 | 6 | 4 | 0 | -59.646 | 52.849 | -68.810 | 0.0 |
| | | | 550 | -59.186 | 52.849 | -39.747 | **-0.4** |
| | | | 1302 | -58.556 | 52.849 | 0.000 | 0.0 |
| 5 | 7 | 4 | 0 | -27.743 | 21.406 | -27.871 | 0.0 |
| | | | 550 | -27.282 | 21.406 | -16.099 | **-0.2** |
| | | | 1302 | -26.652 | 21.406 | 0.000 | 0.0 |
| 5 | 8 | 4 | 0 | -50.005 | 10.615 | -13.821 | 0.0 |
| | | | 550 | -49.545 | 10.615 | -7.983 | **-0.1** |
| | | | 1302 | -48.915 | 10.615 | 0.000 | 0.0 |
| 6 | 5 | 8 | 0 | -62.339 | -0.131 | 0.000 | 0.0 |
| | | | 777 | -62.540 | 0.000 | **-0.051** | 0.0 |
| | | | 777 | -62.540 | 0.000 | -0.051 | **0.0** |
| | | | 1553 | -62.741 | 0.131 | 0.000 | 0.0 |
| 6 | 6 | 8 | 0 | -146.486 | -0.131 | 0.000 | 0.0 |





| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 6 | 6 | 8 | 777 | -146.687 | 0.000 | **-0.051** | 0.0 |
| | | | 777 | -146.687 | 0.000 | -0.051 | **0.0** |
| | | | 1553 | -146.888 | 0.131 | 0.000 | 0.0 |
| 6 | 7 | 8 | 0 | -59.620 | -0.131 | 0.000 | 0.0 |
| | | | 777 | -59.822 | 0.000 | **-0.051** | 0.0 |
| | | | 777 | -59.822 | 0.000 | -0.051 | **0.0** |
| | | | 1553 | -60.023 | 0.131 | 0.000 | 0.0 |
| 6 | 8 | 8 | 0 | -29.476 | -0.131 | 0.000 | 0.0 |
| | | | 777 | -29.677 | 0.000 | **-0.051** | 0.0 |
| | | | 777 | -29.677 | 0.000 | -0.051 | **0.0** |
| | | | 1553 | -29.878 | 0.131 | 0.000 | 0.0 |
| 7 | 5 | 5 | 0 | 0.000 | 42.443 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 40.680 | 10.776 | **0.0** |
| | | | 450 | 0.000 | 39.383 | 18.411 | 0.0 |
| 7 | 6 | 5 | 0 | 0.000 | 61.554 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 57.613 | 15.449 | **0.0** |
| | | | 450 | 0.000 | 54.714 | 26.160 | 0.0 |
| 7 | 7 | 5 | 0 | 0.000 | 48.756 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 46.993 | 12.413 | **0.0** |
| | | | 450 | 0.000 | 45.697 | 21.252 | 0.0 |
| 7 | 8 | 5 | 0 | 0.000 | 43.635 | 0.000 | 0.0 |
| | | | 259 | 0.000 | 41.872 | 11.085 | **0.0** |
| | | | 450 | 0.000 | 40.575 | 18.947 | 0.0 |
| 8 | 5 | 6 | 0 | 31.114 | 4.662 | 18.411 | 0.0 |
| | | | 420 | 31.114 | 0.000 | **19.390** | 0.6 |
| | | | 1200 | 31.114 | -8.659 | 16.012 | **1.0** |
| | | | 2289 | 31.114 | -20.747 | **0.000** | 0.5 |
| | | | 3145 | 31.114 | -30.247 | -21.822 | 0.0 |
| 8 | 6 | 6 | 0 | 31.114 | 20.001 | 26.160 | 0.0 |
| | | | 701 | 31.114 | 0.000 | **33.171** | 1.4 |
| | | | 2226 | 31.114 | -43.506 | **0.000** | 0.8 |
| | | | 3145 | 31.114 | -69.725 | -52.031 | 0.0 |
| 8 | 7 | 6 | 0 | 36.707 | 3.263 | 21.252 | 0.0 |
| | | | 294 | 36.707 | 0.000 | **21.732** | 0.5 |
| | | | 1186 | 36.707 | -9.904 | 17.313 | **1.0** |
| | | | 2273 | 36.707 | -21.964 | **0.000** | 0.5 |
| | | | 3145 | 36.707 | -31.645 | -23.379 | 0.0 |
| 8 | 8 | 6 | 0 | 30.922 | 1.976 | 18.947 | 0.0 |
| | | | 178 | 30.922 | 0.000 | **19.123** | 0.2 |
| | | | 2034 | 30.922 | -20.604 | **0.000** | 0.3 |
| | | | 3145 | 30.922 | -32.932 | -29.731 | 0.0 |
| 9 | 5 | 7 | 0 | 53.485 | -7.225 | -21.822 | 0.0 |
| | | | 438 | 53.485 | -12.082 | -26.046 | **-0.2** |
| | | | 847 | 53.485 | -16.627 | -31.924 | 0.0 |
| 9 | 6 | 7 | 0 | 83.889 | -11.332 | -52.031 | 0.0 |
| | | | 436 | 83.889 | -23.768 | -59.681 | **-0.4** |
| | | | 847 | 83.889 | -35.497 | -71.863 | 0.0 |
| 9 | 7 | 7 | 0 | 58.105 | -5.032 | -23.379 | 0.0 |
| | | | 434 | 58.105 | -9.852 | -26.610 | **-0.2** |
| | | | 847 | 58.105 | -14.433 | -31.622 | 0.0 |
| 9 | 8 | 7 | 0 | 41.480 | 15.929 | -29.731 | 0.0 |
| | | | 409 | 41.480 | 11.384 | -24.139 | **-0.2** |
| | | | 847 | 41.480 | 6.527 | -20.221 | 0.0 |
| 10 | 5 | 8 | 0 | 19.362 | 35.566 | -31.924 | 0.0 |
| | | | 3000 | 19.362 | 2.263 | 24.826 | **4.8** |





| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 10 | 5 | 8 | 3204 | 19.362 | 0.000 | **25.057** | 4.8 |
| | | | 5468 | 19.362 | -25.127 | -3.384 | 0.0 |
| 10 | 6 | 8 | 0 | 3.716 | 87.256 | -71.863 | 0.0 |
| | | | 2924 | 3.716 | 3.828 | 61.313 | **11.9** |
| | | | 3058 | 3.716 | 0.000 | **61.570** | 11.9 |
| | | | 5468 | 3.716 | -68.745 | -21.253 | 0.0 |
| 10 | 7 | 8 | 0 | 25.465 | 35.481 | -31.622 | 0.0 |
| | | | 2996 | 25.465 | 2.223 | 24.866 | **4.8** |
| | | | 3197 | 25.465 | 0.000 | **25.088** | 4.8 |
| | | | 5468 | 25.465 | -25.212 | -3.544 | 0.0 |
| 10 | 8 | 8 | 0 | 25.268 | 31.192 | -20.221 | 0.0 |
| | | | 2779 | 25.268 | 0.349 | 23.601 | **4.7** |
| | | | 2810 | 25.268 | 0.000 | **23.607** | 4.7 |
| | | | 5468 | 25.268 | -29.501 | -15.597 | 0.0 |
| 11 | 5 | 9 | 0 | 51.406 | 26.196 | -3.384 | 0.0 |
| | | | 131 | 51.406 | 25.302 | **0.000** | 0.0 |
| | | | 380 | 51.406 | 23.612 | 6.079 | 0.0 |
| 11 | 6 | 9 | 0 | 78.570 | 50.853 | -21.253 | 0.0 |
| | | | 167 | 78.570 | 48.315 | -12.973 | **0.0** |
| | | | 380 | 78.570 | 45.077 | -3.027 | 0.0 |
| 11 | 7 | 9 | 0 | 59.818 | 29.842 | -3.544 | 0.0 |
| | | | 120 | 59.818 | 29.023 | **0.000** | 0.0 |
| | | | 250 | 59.818 | 28.141 | 3.707 | **0.0** |
| | | | 380 | 59.818 | 27.258 | 7.305 | 0.0 |
| 11 | 8 | 9 | 0 | 71.772 | 45.184 | -15.597 | 0.0 |
| | | | 157 | 71.772 | 44.119 | -8.605 | **0.0** |
| | | | 355 | 71.772 | 42.772 | **0.000** | 0.0 |
| | | | 380 | 71.772 | 42.600 | 1.082 | 0.0 |
| 12 | 5 | 10 | 0 | 20.293 | -11.336 | 6.079 | 0.0 |
| | | | 201 | 20.293 | -12.703 | 3.663 | **0.0** |
| | | | 470 | 20.293 | -14.532 | 0.000 | 0.0 |
| 12 | 6 | 10 | 0 | 47.456 | 10.011 | -3.026 | 0.0 |
| | | | 188 | 47.456 | 7.151 | -1.412 | **0.0** |
| | | | 470 | 47.456 | 2.867 | 0.000 | 0.0 |
| 12 | 7 | 10 | 0 | 21.761 | -13.944 | 7.305 | 0.0 |
| | | | 201 | 21.761 | -15.311 | 4.364 | **0.0** |
| | | | 470 | 21.761 | -17.140 | 0.000 | 0.0 |
| 12 | 8 | 10 | 0 | 29.571 | -0.703 | 1.082 | 0.0 |
| | | | 207 | 29.571 | -2.108 | 0.791 | **0.0** |
| | | | 470 | 29.571 | -3.899 | 0.000 | 0.0 |
| 13 | 5 | 6 | 0 | -46.626 | 0.031 | 0.000 | 0.0 |
| | | | 274 | -46.592 | 0.000 | **0.004** | 0.0 |
| | | | 547 | -46.558 | -0.031 | **0.000** | 0.0 |
| | | | 1382 | -46.453 | -0.124 | -0.065 | **0.0** |
| | | | 2082 | -46.366 | -0.203 | -0.179 | 0.0 |
| 13 | 6 | 6 | 0 | -46.622 | 0.031 | 0.000 | 0.0 |
| | | | 277 | -46.588 | 0.000 | **0.004** | 0.0 |
| | | | 554 | -46.553 | -0.031 | **0.000** | 0.0 |
| | | | 1383 | -46.449 | -0.124 | -0.064 | **0.0** |
| | | | 2082 | -46.362 | -0.202 | -0.178 | 0.0 |
| 13 | 7 | 6 | 0 | -56.104 | 1.210 | 0.000 | 0.0 |
| | | | 1195 | -55.954 | 1.076 | 1.366 | **0.7** |
| | | | 2082 | -55.843 | 0.977 | 2.276 | 0.0 |
| 13 | 8 | 6 | 0 | -49.384 | 3.210 | 0.000 | 0.0 |
| | | | 1199 | -49.234 | 3.075 | 3.768 | **2.0** |



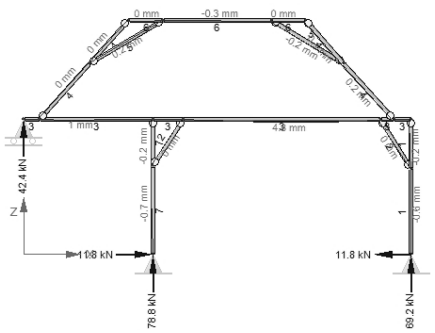


| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 13 | 8 | 6 | 2082 | -49.123 | 2.976 | 6.439 | 0.0 |
| 14 | 5 | 13 | 0 | -46.469 | -0.162 | 0.586 | 0.0 |
| | | | 910 | -46.583 | -0.265 | 0.392 | **0.2** |
| | | | 2092 | -46.730 | -0.398 | 0.000 | 0.0 |
| 14 | 6 | 13 | 0 | -46.474 | -0.160 | 0.583 | 0.0 |
| | | | 910 | -46.587 | -0.263 | 0.390 | **0.2** |
| | | | 2092 | -46.734 | -0.397 | 0.000 | 0.0 |
| 14 | 7 | 13 | 0 | -55.753 | 0.967 | -1.776 | 0.0 |
| | | | 874 | -55.862 | 0.868 | -0.974 | **-0.5** |
| | | | 2092 | -56.013 | 0.731 | 0.000 | 0.0 |
| 14 | 8 | 13 | 0 | -60.105 | 2.967 | -5.959 | 0.0 |
| | | | 881 | -60.215 | 2.867 | -3.389 | **-1.8** |
| | | | 2092 | -60.366 | 2.730 | 0.000 | 0.0 |
| 15 | 5 | 12 | 0 | -45.160 | 0.202 | -0.179 | 0.0 |
| | | | 619 | -45.083 | 0.132 | -0.076 | **0.0** |
| | | | 1614 | -44.958 | 0.020 | 0.000 | 0.0 |
| 15 | 6 | 12 | 0 | -45.159 | 0.201 | -0.178 | 0.0 |
| | | | 619 | -45.081 | 0.132 | -0.075 | **0.0** |
| | | | 1614 | -44.957 | 0.020 | 0.000 | 0.0 |
| 15 | 7 | 12 | 0 | -62.651 | -1.319 | 2.276 | 0.0 |
| | | | 686 | -62.565 | -1.396 | 1.344 | **0.4** |
| | | | 1614 | -62.449 | -1.501 | 0.000 | 0.0 |
| 15 | 8 | 12 | 0 | -69.591 | -3.898 | 6.439 | 0.0 |
| | | | 683 | -69.506 | -3.975 | 3.750 | **1.2** |
| | | | 1614 | -69.390 | -4.079 | 0.000 | 0.0 |
| 16 | 5 | 12 | 0 | -1.245 | 0.064 | 0.000 | 0.0 |
| | | | 1183 | -1.207 | 0.000 | **0.038** | 0.2 |
| | | | 1184 | -1.207 | 0.000 | 0.038 | **0.2** |
| | | | 2367 | -1.169 | -0.064 | 0.000 | 0.0 |
| 16 | 6 | 12 | 0 | -1.242 | 0.064 | 0.000 | 0.0 |
| | | | 1183 | -1.204 | 0.000 | **0.038** | 0.2 |
| | | | 1184 | -1.204 | 0.000 | 0.038 | **0.2** |
| | | | 2367 | -1.167 | -0.064 | 0.000 | 0.0 |
| 16 | 7 | 12 | 0 | 7.162 | 0.064 | 0.000 | 0.0 |
| | | | 1183 | 7.199 | 0.000 | 0.038 | **0.2** |
| | | | 1183 | 7.200 | 0.000 | **0.038** | 0.2 |
| | | | 2367 | 7.237 | -0.064 | 0.000 | 0.0 |
| 16 | 8 | 12 | 0 | 21.490 | 0.064 | 0.000 | 0.0 |
| | | | 1183 | 21.527 | 0.000 | 0.038 | **0.2** |
| | | | 1183 | 21.527 | 0.000 | **0.038** | 0.2 |
| | | | 2367 | 21.565 | -0.064 | 0.000 | 0.0 |
| 17 | 5 | 13 | 0 | -1.892 | -0.063 | 0.000 | 0.0 |
| | | | 1164 | -1.854 | 0.000 | **-0.037** | -0.2 |
| | | | 1165 | -1.854 | 0.000 | -0.037 | **-0.2** |
| | | | 2328 | -1.816 | 0.063 | 0.000 | 0.0 |
| 17 | 6 | 13 | 0 | -1.905 | -0.063 | 0.000 | 0.0 |
| | | | 1164 | -1.867 | 0.000 | **-0.037** | -0.2 |
| | | | 1165 | -1.867 | 0.000 | -0.037 | **-0.2** |
| | | | 2328 | -1.829 | 0.063 | 0.000 | 0.0 |
| 17 | 7 | 13 | 0 | -10.431 | -0.063 | 0.000 | 0.0 |
| | | | 1164 | -10.394 | 0.000 | **-0.037** | -0.2 |
| | | | 1165 | -10.394 | 0.000 | -0.037 | **-0.2** |
| | | | 2328 | -10.356 | 0.063 | 0.000 | 0.0 |
| 17 | 8 | 13 | 0 | -24.592 | -0.063 | 0.000 | 0.0 |
| | | | 1164 | -24.554 | 0.000 | **-0.037** | -0.2 |

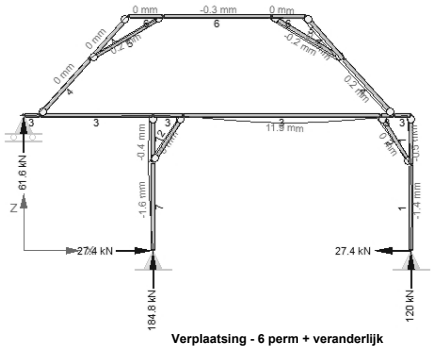
| Staaf-nummer | Comb. nummer | Knoop-nummer | x-lokaal [mm] | Nx-lokaal [kN] | Vz-lokaal [kN] | My-lokaal [kNm] | df-lokaal [mm] |
|---|---|---|---|---|---|---|---|
| 17 | 8 | 13 | 1165 | -24.554 | 0.000 | -0.037 | **-0.2** |
| | | | 2328 | -24.516 | 0.063 | 0.000 | 0.0 |
| 18 | 5 | 17 | 0 | -44.441 | 0.456 | 0.000 | 0.0 |
| | | | 907 | -44.556 | 0.356 | 0.368 | **0.1** |
| | | | 1591 | -44.643 | 0.281 | 0.586 | 0.0 |
| 18 | 6 | 17 | 0 | -44.434 | 0.454 | 0.000 | 0.0 |
| | | | 907 | -44.549 | 0.354 | 0.366 | **0.1** |
| | | | 1591 | -44.636 | 0.278 | 0.583 | 0.0 |
| 18 | 7 | 17 | 0 | -45.579 | -1.028 | 0.000 | 0.0 |
| | | | 924 | -45.696 | -1.130 | -0.997 | **-0.3** |
| | | | 1591 | -45.780 | -1.204 | -1.776 | 0.0 |
| 18 | 8 | 17 | 0 | -36.425 | -3.657 | 0.000 | 0.0 |
| | | | 921 | -36.542 | -3.759 | -3.413 | **-1.0** |
| | | | 1591 | -36.627 | -3.833 | -5.959 | 0.0 |
| 19 | 5 | 14 | 0 | -40.265 | -0.210 | 0.000 | 0.0 |
| | | | 563 | -40.265 | -0.304 | -0.145 | **0.0** |
| | | | 960 | -40.265 | -0.371 | -0.279 | 0.0 |
| 19 | 6 | 14 | 0 | -40.268 | -0.210 | 0.000 | 0.0 |
| | | | 563 | -40.268 | -0.305 | -0.145 | **0.0** |
| | | | 960 | -40.268 | -0.371 | -0.279 | 0.0 |
| 19 | 7 | 14 | 0 | -55.805 | 2.426 | 0.000 | 0.0 |
| | | | 554 | -55.805 | 2.333 | 1.319 | **0.1** |
| | | | 960 | -55.805 | 2.265 | 2.252 | 0.0 |
| 19 | 8 | 14 | 0 | -67.195 | 6.961 | 0.000 | 0.0 |
| | | | 554 | -67.195 | 6.868 | 3.831 | **0.4** |
| | | | 960 | -67.195 | 6.800 | 6.605 | 0.0 |
| 20 | 5 | 15 | 0 | -41.306 | 0.185 | -0.279 | 0.0 |
| | | | 1102 | -41.306 | 0.000 | **-0.177** | -0.2 |
| | | | 1637 | -41.306 | -0.090 | -0.201 | **-0.3** |
| | | | 3010 | -41.306 | -0.321 | -0.483 | 0.0 |
| 20 | 6 | 15 | 0 | -41.306 | 0.184 | -0.279 | 0.0 |
| | | | 1093 | -41.306 | 0.000 | **-0.179** | -0.2 |
| | | | 1637 | -41.306 | -0.091 | -0.204 | **-0.3** |
| | | | 3010 | -41.306 | -0.322 | -0.488 | 0.0 |
| 20 | 7 | 15 | 0 | -49.599 | -1.540 | 2.252 | 0.0 |
| | | | 1361 | -49.599 | -1.769 | **0.000** | -0.2 |
| | | | 3010 | -49.599 | -2.046 | -3.146 | 0.0 |
| 20 | 8 | 15 | 0 | -48.644 | -4.438 | 6.605 | 0.0 |
| | | | 1449 | -48.644 | -4.681 | **0.000** | -0.3 |
| | | | 3010 | -48.644 | -4.944 | -7.514 | 0.0 |
| 21 | 5 | 16 | 0 | -39.717 | 0.588 | -0.483 | 0.0 |
| | | | 396 | -39.717 | 0.521 | -0.263 | **0.0** |
| | | | 950 | -39.717 | 0.428 | 0.000 | 0.0 |
| 21 | 6 | 16 | 0 | -39.707 | 0.593 | -0.488 | 0.0 |
| | | | 396 | -39.707 | 0.527 | -0.266 | **0.0** |
| | | | 950 | -39.707 | 0.434 | 0.000 | 0.0 |
| 21 | 7 | 16 | 0 | -40.694 | 3.391 | -3.146 | 0.0 |
| | | | 400 | -40.694 | 3.324 | -1.803 | **-0.2** |
| | | | 950 | -40.694 | 3.231 | 0.000 | 0.0 |
| 21 | 8 | 16 | 0 | -27.602 | 7.989 | -7.514 | 0.0 |
| | | | 402 | -27.602 | 7.922 | -4.318 | **-0.5** |
| | | | 950 | -27.602 | 7.830 | 0.000 | 0.0 |







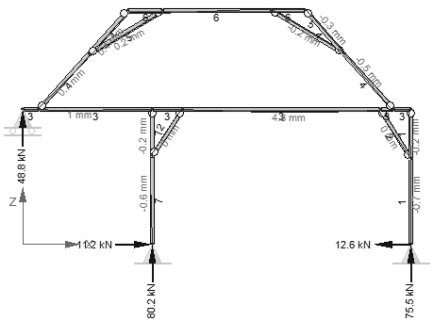

**Verplaatsing - 5 permanent**



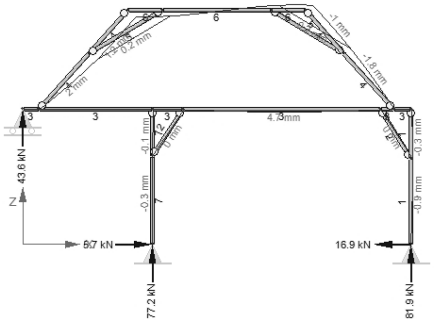

**Verplaatsing - 6 perm + veranderlijk**








**Verplaatsing - 7 perm + sneeuw**



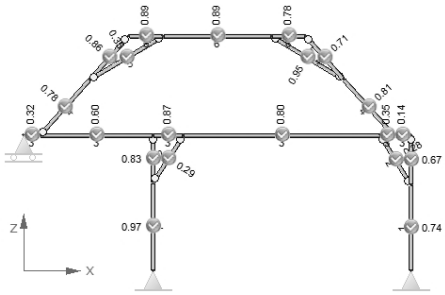

**Verplaatsing - 8 perm + wind**





**2.3 EN1995 TOETSINGEN**

De toetsing van de houtprofielen in de uiterste grenstoestand volgens EN 1995-1-1 is gebaseerd op een geometrische niet-lineaire krachtsverdeling (tweede orde analyse) inclusief de gegeven imperfecties volgens art.5.4.4.




| Staaf-nummer | Profiel | Combinatie nummer | Artikel | U.C. |
|---|---|---|---|---|
| 1 | 300x390 | 2 | 6.1.4 | 0.08 |
| | | 2 | 6.1.7 | 0.16 |
| | | 2 | 6.2.4 | 0.67 |
| | | 2 | 6.3.2 | 0.74 |
| 2 | 340x440 | 2 | 6.1.4 | 0.14 |
| | | 2 | 6.1.7 | 0.17 |
| | | 2 | 6.2.4 | 0.85 |
| | | 2 | 6.3.2 | 0.97 |
| 3 | 230x200 | 2 | 6.1.4 | 0.27 |
| | | 6 | 6.1.7 | 0.00 |
| | | 2 | 6.2.4 | 0.07 |
| | | 2 | 6.3.2 | 0.28 |
| 4 | 300x390 | 2 | 6.1.2 | 0.01 |
| | | 7 | 6.1.4 | 0.01 |
| | | 2 | 6.1.7 | 0.28 |
| | | 2 | 6.2.3 | 0.67 |
| | | 8 | 6.2.4 | 0.32 |
| 5 | 340x440 | 2 | 6.1.4 | 0.05 |
| | | 2 | 6.1.7 | 0.33 |
| | | 2 | 6.2.4 | 0.83 |
| 6 | 230x200 | 2 | 6.1.4 | 0.28 |
| | | 6 | 6.1.7 | 0.00 |
| | | 2 | 6.2.4 | 0.08 |

| Staaf-nummer | Profiel | Combinatie nummer | Artikel | U.C. |
|---|---|---|---|---|
| 6 | 230x200 | 2 | 6.3.2 | 0.29 |
| 7 | 340x350 | 6 | 6.1.6 | 0.26 |
| | | 6 | 6.1.7 | 0.32 |
| 8 | 340x350 | 7 | 6.1.2 | 0.03 |
| | | 2 | 6.1.7 | 0.41 |
| | | 2 | 6.2.3 | 0.60 |
| | | 2 | 6.3.3 | 0.58 |
| 9 | 340x350 | 2 | 6.1.7 | 0.20 |
| | | 2 | 6.2.3 | 0.87 |
| 10 | 340x350 | 2 | 6.1.7 | 0.51 |
| | | 6 | 6.2.3 | 0.70 |
| | | 2 | 6.2.4 | 0.79 |
| | | 2 | 6.3.2 | 0.80 |
| | | 6 | 6.3.3 | 0.70 |
| 11 | 340x350 | 8 | 6.1.2 | 0.06 |
| | | 2 | 6.1.7 | 0.28 |
| | | 2 | 6.2.3 | 0.35 |
| 12 | 340x350 | 4 | 6.1.2 | 0.03 |
| | | 2 | 6.1.7 | 0.11 |
| | | 2 | 6.2.3 | 0.14 |
| 13 | 125 x 200 | 7 | 6.1.4 | 0.15 |
| | | 4 | 6.1.7 | 0.10 |
| | | 4 | 6.2.4 | 0.69 |
| | | 4 | 6.3.2 | 0.78 |
| 14 | 125 x 200 | 8 | 6.1.4 | 0.17 |
| | | 4 | 6.1.7 | 0.10 |
| | | 4 | 6.2.4 | 0.68 |
| | | 4 | 6.3.2 | 0.81 |
| 15 | 125 x 200 | 8 | 6.1.4 | 0.19 |
| | | 4 | 6.1.7 | 0.13 |
| | | 4 | 6.2.4 | 0.71 |
| | | 4 | 6.3.2 | 0.86 |
| 16 | 75x125 | 4 | 6.1.2 | 0.35 |
| | | 5 | 6.1.4 | 0.01 |
| | | 6 | 6.1.7 | 0.00 |
| | | 4 | 6.2.3 | 0.35 |
| | | 5 | 6.2.4 | 0.01 |
| | | 5 | 6.3.2 | 0.05 |
| | | 5 | 6.3.3 | 0.04 |
| 17 | 75x125 | 4 | 6.1.4 | 0.25 |
| | | 6 | 6.1.7 | 0.00 |
| | | 4 | 6.2.4 | 0.07 |
| | | 4 | 6.3.2 | 0.95 |
| 18 | 125 x 200 | 5 | 6.1.4 | 0.14 |
| | | 4 | 6.1.7 | 0.13 |
| | | 4 | 6.2.4 | 0.66 |
| | | 4 | 6.3.2 | 0.71 |
| 19 | 125x200 | 8 | 6.1.4 | 0.18 |
| | | 4 | 6.1.7 | 0.22 |
| | | 4 | 6.2.4 | 0.75 |
| | | 4 | 6.3.2 | 0.89 |
| 20 | 125x200 | 7 | 6.1.4 | 0.14 |
| | | 4 | 6.1.7 | 0.15 |
| | | 4 | 6.2.4 | 0.77 |
| | | 4 | 6.3.2 | 0.89 |
| 21 | 125x200 | 5 | 6.1.4 | 0.12 |





| Staaf-nummer | Profiel | Combinatie nummer | Artikel | U.C. |
|---|---|---|---|---|
| 21 | 125x200 | 4 | 6.1.7 | 0.24 |
| | | 4 | 6.2.4 | 0.76 |
| | | 4 | 6.3.2 | 0.78 |

### 2.3.1 BEREKENING VAN UNITY CHECKS

**Staaf 1 - 300x390 (C24 Klimaatklasse:1)**

**Druk evenwijdig aan de vezelrichting** art. 6.1.4

Combinatie : 2 x = 2378 mm Nx = -124.461 kN Vz = 31.166 kN My = 0 kNm
Belastingsduurklasse : Middellang

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{124460.5}{117000} = 1.1 \text{ N/mm}^2 < f_{c,0,d} = 12.9 \text{ N/mm}^2 \quad (6.2)$$

**Afschuiving** art. 6.1.7

Combinatie : 2 x = 0 mm Nx = -123.058 kN Vz = 31.166 kN My = -74.112 kNm
Belastingsduurklasse : Middellang

$$\tau_d = \frac{V_{Ed} S}{b\, I_y} = \frac{31165.5 \times 5703750}{300 \times 1482975000} = 0.4 \text{ N/mm}^2 < f_{v,d} = 2.5 \text{ N/mm}^2 \quad (6.13)$$

**Gecombineerde buig- en axiale druckspanningen** art. 6.2.4

Combinatie : 2 x = 0 mm Nx = -123.058 kN Vz = 31.166 kN My = -74.112 kNm
Belastingsduurklasse : Middellang

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{123058}{117000} = 1.1 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{74.112 \times 10^6}{7605 \times 10^3} = 9.7 \text{ N/mm}^2$$

$$\left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \left(\frac{1.1}{12.9}\right)^2 + \frac{9.7}{14.8} = 0.67 < 1.00 \quad (6.19)$$

**Kolommen onderworpen aan druk of aan druk en buiging** art. 6.3.2

Combinatie : 2 x = 0 mm Nx = -123.058 kN Vz = 31.166 kN My = -74.112 kNm
Belastingsduurklasse : Middellang

$$\lambda_y = \frac{L_{cr,y}}{i_y} = \frac{2378}{112.6} = 21.12 \qquad \lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{21.12}{\pi}\sqrt{\frac{21.0}{7400}} = 0.358 \quad (6.21)$$

$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{2378}{86.6} = 27.46 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{27.46}{\pi}\sqrt{\frac{21.0}{7400}} = 0.466 \quad (6.22)$$

$$k_y = 0{,}5(1 + \beta_c(\lambda_{rel,y} - 0{,}3) + \lambda_{rel,y}^2 = 0{,}5 \times (1 + 0.2 \times (0.358 - 0{,}3) + 0.358^2 = 0.57 \quad (6.27)$$

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} = \frac{1}{0.57 + \sqrt{0.57^2 - 0.36^2}} = 0.99 \quad (6.25)$$

$$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (0.466 - 0{,}3) + 0.466^2 = 0.62 \quad (6.28)$$





$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{0.62 + \sqrt{0.62^2 - 0.47^2}} = 0.96 \quad (6.26)$$

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{123058}{117000} = 1.1 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{74.112 \times 10^6}{7605 \times 10^3} = 9.7 \text{ N/mm}^2$$

$$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{1.1}{0.99 \times 12.9} + \frac{9.7}{14.8} + 0.7 \times \frac{0.0}{14.8} = 0.74 < 1.00 \quad (6.23)$$

$$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{1.1}{0.96 \times 12.9} + 0.7 \times \frac{9.7}{14.8} + \frac{0.0}{14.8} = 0.55 < 1.00 \quad (6.24)$$

**Staaf 2 - 340x440 (C14 Klimaatklasse:1)**

**Druk evenwijdig aan de vezelrichting** art. 6.1.4

Combinatie : 2 x = 0 mm Nx = -210.446 kN Vz = -32.057 kN My = 0 kNm
Belastingsduurklasse : Middellang

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{210446.3}{149600} = 1.4 \text{ N/mm}^2 < f_{c,0,d} = 9.8 \text{ N/mm}^2 \quad (6.2)$$

**Afschuiving** art. 6.1.7

Combinatie : 2 x = 0 mm Nx = -210.446 kN Vz = -32.057 kN My = 0 kNm
Belastingsduurklasse : Middellang

$$\tau_d = \frac{V_{Ed} S}{b\, I_y} = \frac{32057.1 \times 8228000}{340 \times 2413546667} = 0.3 \text{ N/mm}^2 < f_{v,d} = 1.8 \text{ N/mm}^2 \quad (6.13)$$

**Gecombineerde buig- en axiale drukspanningen** art. 6.2.4

Combinatie : 2 x = 2448 mm Nx = -208.908 kN Vz = -32.057 kN My = -78.476 kNm
Belastingsduurklasse : Middellang

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{208908}{149600} = 1.4 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{78.476 \times 10^6}{10971 \times 10^3} = 7.2 \text{ N/mm}^2$$

$$\left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \left(\frac{1.4}{9.8}\right)^2 + \frac{7.2}{8.6} = 0.85 < 1.00 \quad (6.19)$$

**Kolommen onderworpen aan druk of aan druk en buiging** art. 6.3.2

Combinatie : 2 x = 2448 mm Nx = -208.908 kN Vz = -32.057 kN My = -78.476 kNm
Belastingsduurklasse : Middellang

$$\lambda_y = \frac{L_{cr,y}}{i_y} = \frac{2448}{127.0} = 19.27 \qquad \lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{19.27}{\pi}\sqrt{\frac{16.0}{4700}} = 0.358 \quad (6.21)$$





$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{2448}{98.1} = 24.94 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{24.94}{\pi}\sqrt{\frac{16.0}{4700}} = 0.463 \quad (6.22)$$

$$k_y = 0{,}5(1 + \beta_c(\lambda_{rel,y} - 0{,}3) + \lambda_{rel,y}^2 = 0{,}5 \times (1 + 0.2 \times (0.358 - 0{,}3) + 0.358^2 = 0.57 \quad (6.27)$$

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} = \frac{1}{0.57 + \sqrt{0.57^2 - 0.36^2}} = 0.99 \quad (6.25)$$

$$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (0.463 - 0{,}3) + 0.463^2 = 0.62 \quad (6.28)$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{0.62 + \sqrt{0.62^2 - 0.46^2}} = 0.96 \quad (6.26)$$

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{208908}{149600} = 1.4 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{78.476 \times 10^6}{10971 \times 10^3} = 7.2 \text{ N/mm}^2$$

$$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{1.4}{0.99 \times 9.8} + \frac{7.2}{8.6} + 0.7 \times \frac{0.0}{8.6} = 0.97 < 1.00 \quad (6.23)$$

$$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{1.4}{0.96 \times 9.8} + 0.7 \times \frac{7.2}{8.6} + \frac{0.0}{8.6} = 0.73 < 1.00 \quad (6.24)$$

**Staaf 9 - 340x350 (C24 Klimaatklasse:1)**

**Afschuiving** art. 6.1.7

Combinatie : 2 x = 847 mm Nx = 83.495 kN Vz = -39.345 kN My = -80.97 kNm
Belastingsduurklasse : Middellang

$$\tau_d = \frac{V_{Ed} S}{b\, I_y} = \frac{39344.7 \times 5206250}{340 \times 1214791667} = 0.5 \text{ N/mm}^2 < f_{v,d} = 2.5 \text{ N/mm}^2 \quad (6.13)$$

**Gecombineerde buig- en axiale trekspanningen** art. 6.2.3

Combinatie : 2 x = 847 mm Nx = 83.495 kN Vz = -39.345 kN My = -80.97 kNm
Belastingsduurklasse : Middellang

$$\sigma_{t,0,d} = \frac{N_{c,Ed}}{A} = \frac{83495}{119000} = 0.7 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{80.970 \times 10^6}{6942 \times 10^3} = 11.7 \text{ N/mm}^2$$

$$\frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \frac{0.7}{8.6} + \frac{11.7}{14.8} = 0.87 < 1.00 \quad (6.17)$$

**Staaf 19 - 125x200 (C24 Klimaatklasse:1)**

**Druk evenwijdig aan de vezelrichting** art. 6.1.4

Combinatie : 8 x = 0 mm Nx = -67.195 kN Vz = 6.961 kN My = 0 kNm
Belastingsduurklasse : Middellang

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{67194.8}{25000} = 2.7 \text{ N/mm}^2 < f_{c,0,d} = 14.5 \text{ N/mm}^2 \quad (6.2)$$

**Afschuiving** art. 6.1.7

Combinatie : 4 x = 0 mm Nx = -64.96 kN Vz = 10.354 kN My = 0 kNm
Belastingsduurklasse : Middellang

$$\tau_d = \frac{V_{Ed}\, S}{b\, Iy} = \frac{10353.7 \times 625000}{125 \times 83333333} = 0.6 \text{ N/mm}^2 < f_{v,d} = 2.8 \text{ N/mm}^2 \quad (6.13)$$

**Gecombineerde buig- en axiale drukspanningen** art. 6.2.4

Combinatie : 4 x = 960 mm Nx = -64.96 kN Vz = 10.253 kN My = 9.891 kNm
Belastingsduurklasse : Middellang

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{64960}{25000} = 2.6 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{9.891 \times 10^6}{833 \times 10^3} = 11.9 \text{ N/mm}^2$$

$$\left(\frac{\sigma_{t,0,d}}{f_{t,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \left(\frac{2.6}{14.5}\right)^2 + \frac{11.9}{16.6} = 0.75 < 1.00 \quad (6.19)$$

**Kolommen onderworpen aan druk of aan druk en buiging** art. 6.3.2

Combinatie : 4 x = 960 mm Nx = -64.96 kN Vz = 10.253 kN My = 9.891 kNm
Belastingsduurklasse : Middellang

$$\lambda_y = \frac{L_{cr,y}}{i_y} = \frac{960}{57.7} = 16.63 \qquad \lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{16.63}{\pi}\sqrt{\frac{21.0}{7400}} = 0.282 \quad (6.21)$$

$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{960}{36.1} = 26.60 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{26.60}{\pi}\sqrt{\frac{21.0}{7400}} = 0.451 \quad (6.22)$$

$$k_z = 0{,}5(1 + \beta_c(\lambda_{rel,z} - 0{,}3) + \lambda_{rel,z}^2 = 0{,}5 \times (1 + 0.2 \times (0.451 - 0{,}3) + 0.451^2 = 0.62 \quad (6.28)$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{0.62 + \sqrt{0.62^2 - 0.45^2}} = 0.96 \quad (6.26)$$

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{64960}{25000} = 2.6 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{9.891 \times 10^6}{833 \times 10^3} = 11.9 \text{ N/mm}^2$$

$$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{2.6}{1.00 \times 14.5} + \frac{11.9}{16.6} + 0.7 \times \frac{0.0}{17.2} = 0.89 < 1.00 \quad (6.23)$$

$$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{2.6}{0.96 \times 14.5} + 0.7 \times \frac{11.9}{16.6} + \frac{0.0}{17.2} = 0.69 < 1.00 \quad (6.24)$$