Rekenkundige Controle Hoofddraagconstructie

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Nieuwbouw Ligboxenstal

- Constructieve tekening
- Berekening
- Bijlagen

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Inhoudsopgave

A. Algemene uitgangspunten:

Het betreft nieuwbouw van een bedrijfsruimte, opgebouwd uit stalen
vakwerkspanten op betonfunderingen, afgedicht met gaas en kunsstof folie op bogen.
De spantpoten worden op de betonfundering bevestigd.
De kappen bestaan uit bogen, die per 2.0 tot 2.5 meter op de goot gemonteerd worden.
De stabiliteit wordt verzorgd door de spanten zelf in de dwarsrichting, in de langsrichting door windverbanden. Het gebouw wodt gerealiseerd in 2 fasen, die beide berekend zijn.
De globale afmetingen van het totale gebouw bedragen:

lengte $L := 45.8 \cdot m$

breedte $B := 36.34 \cdot m$

hoogte $h := 7.129 \cdot m$

De statische berekeningen zijn gebaseerd op de tekeningen: **Bijlage 1.**

Van toepassing zijnde voorschriften:

NEN-EN 1990	Ontwerpgrondslagen
NEN-EN 1991	Belastingen op constructies.
NEN-EN 1993	Ontwerp en berekening van staalconstructies
NEN-EN 1993-1-8	Ontwerp en berekening van verbindingen

Gebouwgegevens:

Gevolgklasse: CC1 (bedrijfsgebouwen voor de landbouw)

Betrouwbaarheidsindex: $K_{Fl} := 0.9$

Ontwerplevensduur: 15 jaar.

Reductiefactor voor de extreme waarde van de veranderlijke belasting: (krachtswerking 2, pag 11, geeft hogere waarden dan 1991-1-3, Bijlage D)

$\psi_0 := 0$ $t := 15$ jaar $t_0 := 50$ jaar $\psi_t := 1 + \left(\frac{1 - \psi_0}{9}\right) \cdot \ln\left(\frac{t}{t_0}\right)$ $\psi_t = 0.87$

Staalwaarden: S 235: $f_{td} := 360 \cdot N \cdot mm^{-2}$ $f_y := 235 \cdot N \cdot mm^{-2}$ $E_y := 210000 \cdot N \cdot mm^{-2}$

S 275: $f_{td1} := 410 \cdot N \cdot mm^{-2}$ $f_{y1} := 275 \cdot N \cdot mm^{-2}$

Aluminium 6005A T6 $f_{0.2} := 200 \cdot N \cdot mm^{-2}$ $E_d := 70000 \cdot N \cdot mm^{-2}$ **(zie bijlage 2, 3)**

Bouten 8.8 $f_{tbd} := 800 \cdot N \cdot mm^{-2}$

B. Belastingen, algemene gegevens:

B.1. Blijvende belastingen:

B.1.1 Folie + nokken en goten: $p_f := 0.10 \cdot kN \cdot m^{-2}$

B.2 Veranderlijke belastingen:

B.2.1 Veranderlijke belasting door sneeuw: $s_k := 0.70 \cdot kN \cdot m^{-2}$

$C_e := 1 \quad C_t := 1 \quad s := C_e \cdot C_t \cdot s_k \quad s = 0.7 \cdot kN \cdot m^{-2}$

boogbreedte: $s_1 := 7.075 \cdot m$ Booghoogte: $h_1 := 1.629 \cdot m \quad \alpha_1 := \operatorname{atan}\left(\frac{h_1}{0.5 \cdot s_1}\right) \quad \alpha_1 = 24.726 \cdot deg$ <30

$\mu_1 := 0.8 \quad \mu_2 := 1.6$ bovenwaarde 160991-1-3/NB:2007

B.2.2 Veranderlijke windbelasting : Gebied III, onbebouwd. **(prov. Gelderland)**

$v_b := 24.5 \quad \rho := 1.25 \quad k_1 := 1 \quad h = 7.129\,m \quad z_0 := 0.2 \quad f_{red} := 0.85$ (4 stijve goten in de lengterichting)

$z_v := h \cdot m^{-1} \quad z_v = 7.129 \quad z_{min} := 4 \quad z := \text{if}\left(z_v \le z_{min}, z_{min}, z_v\right) \quad z = 7.129$

$k_r := 0.19\left(\frac{z_0}{0.05}\right)^{0.07} \quad k_r = 0.209 \quad c_r(z) := k_r \cdot \ln\left(\frac{z}{z_0}\right) \quad c_r(z) = 0.748 \quad c_0(z) := 1$

$v_m(z) := c_r(z) \cdot c_0(z) \cdot v_b \quad v_m(z) = 18.33$

$I(z) := \frac{k_1}{c_0(z) \cdot \ln\left(\frac{z}{z_0}\right)} \quad I(z) = 0.28$

$q_p(z) := (1 + 7 \cdot I(z)) \cdot \frac{1}{2} \cdot \rho \cdot v_m(z)^2 \cdot Pa \quad q_p(z) = 0.621 \cdot kN \cdot m^{-2}$

B.2.3 Gebouwfactor: $CsCd := 1$

B.2.4 Windvormfactoren: Gevels: winddruk op de gevel: $C_{pe.D} := 0.8$

windzuiging op de gevel: $C_{pe.E} := -0.5$ 1991-1-3/NB:2007 tabel 7.1

Voor meerdere bogen achter elkaar geeft NEN EN 1991-1-4 geen waarden, daarom NEN EN 13031 Tab B.12 aangehouden.

$h_1 = 1629 \cdot mm \quad s_1 = 7.075\,m \quad \frac{h_1}{s_1} = 0.23$ > 0.2

1e kap: $C_{peA} := 0.3 \quad C_{peB} := -1 \quad C_{peC} := -1.2 \quad C_{peD} := -0.4$

2e kap: $C_{peE} := -0.2 \quad C_{peF} := -0.9 \quad C_{peG} := -0.3$

3e ev kap: $C_{peH} := -0.12 \quad C_{peI} := -0.54 \quad C_{peJ} := -0.18$

Maximale overdruk: $C_{pi} := 0.2$

B.2.5 Veranderlijke dakbelasting tbv reparatie en onderhoud: $F_v := 1.5kN$ op de goten

C. Belastingen, (punt/lijnlasten op de spanten/ bogen):

Bogengeometrie zie bijl 4, 5, 6.

C.1 Blijvende belasting:

Spanten maximaal veld in m: $V_1 := 5.2\cdot m$

Op de spanten $V_1 = 5.2\,m$ $p_f = 100\,Pa$ $G_{b1} := V_1\cdot p_f$ $G_{b1} = 0.52\cdot kN\cdot m^{-1}$ **(zie bijlage 7)**

C.2 Veranderlijke belasting:

C.2.1 Veranderlijke belasting door sneeuw:

Op de spanten: $Q_{s.rep1} := V_1\cdot\mu_1\cdot s\cdot\psi_t$ $Q_{s.rep1} = 2.522\cdot kN\cdot m^{-1}$

$Q_{s.rep2} := V_1\cdot\mu_2\cdot s\cdot\psi_t$ $Q_{s.rep2} = 5.045\cdot kN\cdot m^{-1}$ **(zie bijlage 8)**

excentriciteit: $F_{ex2} := \frac{Q_{s.rep2}}{2}\cdot s_1\cdot\frac{1}{50}$ $F_{ex2} = 356.926\,N$ (tbv boogberekening vlgs NEN EN 13031)

C.2.2 Veranderlijke windbelasting:

C.2.2.1 Zijwind, wanden, per spant:

zijwind, druk: $F_{z.d.rep} := V_1\cdot q_p(z)\cdot C_{pe.D}\cdot\psi_t\cdot CsCd\cdot f_{red}$ $F_{z.d.rep} = 1.903\cdot kN\cdot m^{-1}$ **(zie bijl. 9)**

zijwind, zuiging: $F_{z.z.rep} := V_1\cdot q_p(z)\cdot C_{pe.E}\cdot\psi_t\cdot CsCd\cdot f_{red}$ $F_{z.z.rep} = -1.189\cdot kN\cdot m^{-1}$

C.2.2.2. Windzuiging, dak: (zie bijlage 9)

$C_{pi} = 0.2$ $V_1 = 5.2\,m$

eerste boog:

$Q_{wz.d.rep1} := V_1\,q_p(z)\cdot(C_{peA} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep1} = 0.28\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep2} := V_1\,q_p(z)\cdot(C_{peB} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep2} = -3.359\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep3} := V_1\,q_p(z)\cdot(C_{peC} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep3} = -3.918\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep4} := V_1\,q_p(z)\cdot(C_{peD} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep4} = -1.679\cdot kN\cdot m^{-1}$

tweede boog:

$Q_{wz.d.rep5} := V_1\,q_p(z)\cdot(C_{peE} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep4} = -1.679\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep6} := V_1\,q_p(z)\cdot(C_{peF} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep6} = -3.079\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep7} := V_1\,q_p(z)\cdot(C_{peG} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep7} = -1.399\cdot kN\cdot m^{-1}$

derde boog ev:

$Q_{wz.d.rep8} := V_1\,q_p(z)\cdot(C_{peH} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep8} = -0.896\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep9} := V_1\,q_p(z)\cdot(C_{peI} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep9} = -2.071\cdot kN\cdot m^{-1}$

$Q_{wz.d.rep10} := V_1\,q_p(z)\cdot(C_{peJ} - C_{pi})\cdot CsCd\cdot\psi_t$ $Q_{wz.d.rep10} = -1.064\cdot kN\cdot m^{-1}$

C.2.3 Veranderlijke dakbelasting tbv reparatie en onderhoud:

$F_{ro} := 1.5\cdot kN$ **(zie bijlage 10)**

D. Belastigscombinaties:

Belastingscombinaties

	Label	Omschrijving	Fu.C.1	Fu.C.2	Fu.C.3	Fu.C.4	Fu.C.5	Fu.C.6
	B.G.1	Permanent	1.10	1.10	0.90	1.10	1.00	1.00
	B.G.2	Sneeuwbelasting	1.35				1.00	
	B.G.3	Windbelasting		1.35	1.35			1.00
▶	B.G.4	Geconcentreerde veranderlijk				1.35		

E. Controleberekeningen bogen: **(bogen geometrie zie bijlage 4, 5, 6)**

Bogen op knik: ***Rond 60.3 x 2.9 S235***

$F_{sd.b} := -10.16kN$ **(zie bijlage 11)** $N_0 := -6.73 \cdot kN$ $M := -0.40 \cdot kN \cdot m$ **(zie bijlage 12)**

$d_{max} := 60.3 \cdot mm$ $t := 2.9 \cdot mm$ $d_{min} := d_{max} - 2t$ $d_{min} = 54.5 \cdot mm$ boog: $L_{boog} := 8036 \cdot mm$ **(zie bijlage 5)**

Kniklengte van goot tot nok: $l_{sys} := 0.5 \cdot L_{boog} + 840 \cdot mm$ $l_{sys} = 4858 \cdot mm$

ingeklemd bij N.1, scharnier bij N0: $l_{buc.boog} := l_{sys} \cdot \sqrt{\frac{1 + 1.65 \cdot \frac{F_{sd.b}}{N_0}}{5.42}}$ $l_{buc.boog} = 3.899\,m$

$A_{boog} := .25 \cdot \pi \cdot \left(d_{max}^{\ 2} - d_{min}^{\ 2}\right)$ $A_{boog} = 522.95 \cdot mm^2$ $W_{pl.boog} := \left(d_{max} - t\right)^2 \cdot t$ $W_{pl.boog} = 9554.804 \cdot mm^3$

$i_{boog} := .25 \cdot \sqrt{d_{max}^{\ 2} + d_{min}^{\ 2}}$ $i_{boog} = 20.32 \cdot mm$ $\varepsilon := \sqrt{\frac{235 \cdot N \cdot mm^{-2}}{f_y}}$ $\varepsilon = 1$ (Krachtswerking 3, p 14)

$\frac{d_{max}}{t} = 20.793$ dus d.max/t is kleiner dan 25 x ε2, en kleiner dan 50 x ε2

$25 \cdot \varepsilon^2 = 25$ $E_{equ} := E_y$ $f_{y.equ} := f_y$

$\lambda_s := \pi \cdot \sqrt{\frac{E_{equ}}{f_{y.equ}}}$ $\lambda_s = 93.913$ $\alpha_{k.b} := 0.34$ $\lambda_0 := 0.2$ $\lambda_{boog} := \frac{l_{buc.boog}}{i_{boog}}$ $\lambda_{boog} = 191.871$

$\lambda_{rel.b} := \frac{\lambda_{boog}}{\lambda_s}$ $\lambda_{rel.b} = 2.043$ $\omega_{b.buc} := \omega_{buc}\left(\alpha_{k.b}, \lambda_{rel.b}\right)$ $\omega_{b.buc} = 0.202$

$uc_0 := \frac{|F_{sd.b}|}{\omega_{b.buc} \cdot A_{boog} \cdot f_{y.equ}} + \frac{|M|}{W_{pl.boog} \cdot f_{y.equ}}$ $uc_0 = 0.588$

F. Vervormingen:

$u := 29 \cdot mm$ zeeg min 30mm **(zie bijlage 13)**

G. Controleberekeningen traliespant en kolommen:

G.1. Traliespanten bovenregel fase 1:

Spanthoogte 650mm hoh

G.1.1. Traliespanten bovenregel in het vlak van het spant:

Koudgevormde rechthoekkoker 80 x 50 x 3.0mm S235 $h_{b1} := 80\cdot mm$ $b_{b1} := 50\cdot mm$ $t_{b1} := 3.0\cdot mm$

$A_{b1} := A(h_{b1}, b_{b1}, t_{b1}, r)$ $A_{b1} = 728.549\cdot mm^2$ $i_{zb1} := i_z(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{zb1} = 20.249\cdot mm$

$l_{k.zb1} := 1179\cdot mm$ $N_{sd.b1} := -92.32\cdot kN$ **(zie bijlage 14)**

$\lambda_s := \pi\cdot\sqrt{\frac{E_y}{f_y}}$ $\lambda_s = 93.913$ $\alpha_k := 0.49$ $\lambda_0 = 0.2$ $\lambda_z := \frac{l_{k.zb1}}{i_{zb1}}$ $\lambda_{rel} := \frac{\lambda_z}{\lambda_s}$ $\lambda_{rel} = 0.62$

$\omega_{z.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{z.b.buc} = 0.773$ $uc_1 := \frac{|N_{sd.b1}|}{\omega_{z.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_1 = 0.697$

G.1.2. Traliespant bovenregel uit het vlak van het spant:

$A_{b1} = 728.549\cdot mm^2$ $i_{yb1} := i_y(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{yb1} = 29.253\cdot mm$

$N_{sd.b1} = -92.32\cdot kN$ $N_0 := 15.60\cdot kN$ **(zie bijlage 14)** $l_{sysy} := 7075\cdot mm$

$T1 := \frac{N_0}{N_{sd.b1}}$ $T1 = -0.169$ $T := \text{if}(T1 < -0.2, -0.2, T1)$ $T = -0.169$

Kniklengte voor zijwaarts uitwijken volgens gemeten waarden van TNO Bouw:

		Bovenregel	Onderregel
Gemeten Inspanningsfaktor k:	Eindkolom:	0.7	0.8
	Tpv zwevende goot	0.8	0.5
	Middenkolom	0.5	0.8

$L_{k1} := l_{sysy}\cdot\sqrt{\frac{1 + 0.88\cdot T}{1.88}}$ $L_{k2} := l_{sysy}\cdot\sqrt{\frac{1 + 0.51\cdot T}{3.09}}$ $L_{k3} := l_{sysy}\cdot\sqrt{\frac{1 + 1.65\cdot T}{5.42}}$ $L_{k4} := l_{sysy}\cdot\sqrt{\frac{1 + 0.93\cdot T}{7.72}}$

$k_0 := 0.7$ $k_1 := 0.8$ (k0 bij N0, k1 bij Nsdo1)

$l_{buc.b.y} := (1 - k_0)\cdot(1 - k_1)\cdot L_{k1} + k_0\cdot(1 - k_1)\cdot L_{k2} + (1 - k_0)\cdot k_1\cdot L_{k3} + k_0\cdot k_1\cdot L_{k4}$ $l_{buc.b.y} = 2.753\,m$

$\lambda_y := \frac{l_{buc.b.y}}{i_{yb1}}$ $\lambda_y = 94.103$ $\lambda_s = 93.913$ $\lambda_{rel} := \frac{\lambda_y}{\lambda_s}$ $\lambda_{rel} = 1.002$ $\alpha_k = 0.49$

$\omega_{y.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{y.b.buc} = 0.539$ $uc_2 := \frac{|N_{sd.b1}|}{\omega_{y.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_2 = 1$

G.1.3. Traliespanten bovenregel Str 3 (5.4m hoh ipv 5.2): *Koudgevormde rechthoekkoker 80 x 50 x 4.0mm S235*

G.2. Traliespanten onderregel fase 1: Spanthoogte 650mm hoh

G.2.1. Traliespanten onderregel in het vlak van het spant:

Koudgevormde rechthoekkoker 80 x 50 x 2.5mm S235 $h_{b1} := 80\cdot mm \quad b_{b1} := 50\cdot mm \quad t_{b1} := 2.5\cdot mm$

$A_{b1} := A(h_{b1}, b_{b1}, t_{b1}, r)$ $A_{b1} = 619.635\cdot mm^2$ $i_{zb1} := i_z(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{zb1} = 20.507\cdot mm$

$l_{k.zb1} := 1157\cdot mm$ $N_{sd.b1} := -57.70\cdot kN$ **(zie bijlage 15)**

$\lambda_s := \pi\cdot\sqrt{\frac{E_y}{f_y}}$ $\lambda_s = 93.913$ $\alpha_k := 0.49$ $\lambda_0 = 0.2$ $\lambda_z := \frac{l_{k.zb1}}{i_{zb1}}$ $\lambda_{rel} := \frac{\lambda_z}{\lambda_s}$ $\lambda_{rel} = 0.601$

$\omega_{z.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{z.b.buc} = 0.785$ $uc_3 := \frac{|N_{sd.b1}|}{\omega_{z.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_3 = 0.505$

G.2.2. Traliespant onderregel uit het vlak van het spant:

$A_{b1} = 619.635\cdot mm^2$ $i_{yb1} := i_y(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{yb1} = 29.601\cdot mm$

$N_{sd.b1} = -57.7\cdot kN$ $N_0 := 90.71\cdot kN$ **(zie bijlage 15)** $l_{sysy} := 5255\cdot mm$

$T1 := \frac{N_0}{N_{sd.b1}}$ $T1 = -1.572$ $T := if(T1 < -0.2, -0.2, T1)$ $T = -0.2$

Kniklengte voor zijwaarts uitwijken volgens gemeten waarden van TNO Bouw:

		Bovenregel	Onderregel
Gemeten Inspanningsfaktor k:	Eindkolom:	0.7	0.8
	Tpv zwevende goot	0.8	0.5
	Middenkolom	0.5	0.8

$L_{k1} := l_{sysy}\cdot\sqrt{\frac{1 + 0.88\cdot T}{1.88}}$ $L_{k2} := l_{sysy}\cdot\sqrt{\frac{1 + 0.51\cdot T}{3.09}}$ $L_{k3} := l_{sysy}\cdot\sqrt{\frac{1 + 1.65\cdot T}{5.42}}$ $L_{k4} := l_{sysy}\cdot\sqrt{\frac{1 + 0.93\cdot T}{7.72}}$

$k_0 := 0.5$ $k_1 := 0.8$ (k0 bij N0, k1 bij Nsdo1)

$l_{buc.b.y} := (1 - k_0)\cdot(1 - k_1)\cdot L_{k1} + k_0\cdot(1 - k_1)\cdot L_{k2} + (1 - k_0)\cdot k_1\cdot L_{k3} + k_0\cdot k_1\cdot L_{k4}$ $l_{buc.b.y} = 2.053\,m$

$\lambda_y := \frac{l_{buc.b.y}}{i_{yb1}}$ $\lambda_y = 69.349$ $\lambda_s = 93.913$ $\lambda_{rel} := \frac{\lambda_y}{\lambda_s}$ $\lambda_{rel} = 0.738$ $\alpha_k = 0.49$

$\omega_{y.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{y.b.buc} = 0.701$ $uc_4 := \frac{|N_{sd.b1}|}{\omega_{y.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_4 = 0.57$

Op trek: $F_{sd.b2} := 96.48\cdot kN$ $uc_5 := \frac{|F_{sd.b2}|}{A_{b1}\cdot f_y}$ $uc_5 = 0.66$

G.2.3. Traliespant onderregel Str 3: ***Koudgevormde rechthoekkoker 80 x 50 x 3mm S235 Zie H. 2.3.***

G.3. Diagonalen en gootvertikalen fase 1: Diagonalen en gootvertikalen

G.3.1. 2 Diagonalen links van de middenkolom, zie ook indeling bijl 16.

Koudgevormde rechthoekkoker 40 x 40 x 2.0mm S235

$h_{d1} := 40\cdot mm$ $b_{d1} := 40\cdot mm$ $t_{d1} := 2.0\cdot mm$ $A_{d1} := A(h_{d1}, b_{d1}, t_{d1}, r)$ $A_{d1} = 300.566\cdot mm^2$

$i_{d1} := i_z(h_{d1}, b_{d1}, t_{d1}, r)$ $i_{d1} = 15.482\cdot mm$ $N_{max.d1} := -40.36\cdot kN$ **(Bijlage 16)** $l_{k.d1} := 915\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d1} := \frac{l_{k.d1}}{i_{d1}}$ $\lambda_{rel.d1} := \frac{\lambda_{d1}}{\lambda_s}$ $\lambda_{rel.d1} = 0.629$

$\omega_{d1.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d1})$ $\omega_{d1.buc} = 0.768$ $uc_6 := \frac{|N_{max.d1}|}{\omega_{d1.buc}\cdot A_{d1}\cdot f_y}$ $uc_6 = 0.744$

G.3.2. 10 Diagonalen rechts van de middenkolom.

Koudgevormde rechthoekkoker 30 x 30 x 2.0mm S235

$h_{d2} := 30\cdot mm$ $b_{d2} := 30\cdot mm$ $t_{d2} := 2.0\cdot mm$ $A_{d2} := A(h_{d2}, b_{d2}, t_{d2}, r)$ $A_{d2} = 220.566\cdot mm^2$

$i_{d2} := i_z(h_{d2}, b_{d2}, t_{d2}, r)$ $i_{d2} = 11.404\cdot mm$ $N_{max.d2} := -28.32\cdot kN$ **(Bijlage 16)** $l_{k.d2} := 870\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d2} := \frac{l_{k.d2}}{i_{d2}}$ $\lambda_{rel.d2} := \frac{\lambda_{d2}}{\lambda_s}$ $\lambda_{rel.d2} = 0.812$

$\omega_{d2.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d2})$ $\omega_{d2.buc} = 0.654$ $uc_7 := \frac{|N_{max.d2}|}{\omega_{d2.buc}\cdot A_{d2}\cdot f_y}$ $uc_7 = 0.835$

G.3.3. Andere diagonalen.

Koudgevormde rechthoekkoker 25 x 25 x 2.5mm S235

$h_{d3} := 25\cdot mm$ $b_{d3} := 25\cdot mm$ $t_{d3} := 2.5\cdot mm$ $A_{d3} := A(h_{d3}, b_{d3}, t_{d3}, r)$ $A_{d3} = 219.635\cdot mm^2$

$i_{d3} := i_z(h_{d3}, b_{d3}, t_{d3}, r)$ $i_{d3} = 9.161\cdot mm$ $N_{max.d3} := -13.89\cdot kN$ **(Bijlage 16)** $l_{k.d3} := 878\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d3} := \frac{l_{k.d3}}{i_{d3}}$ $\lambda_{rel.d3} := \frac{\lambda_{d3}}{\lambda_s}$ $\lambda_{rel.d3} = 1.021$

$\omega_{d3.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d3})$ $\omega_{d3.buc} = 0.528$ $uc_8 := \frac{|N_{max.d3}|}{\omega_{d3.buc}\cdot A_{d3}\cdot f_y}$ $uc_8 = 0.51$

G.3.4. Diagonalen Str 3: als diagonalen andere stramienen.

G.3.5. Gootvertikalen:

Koudgevormde rechthoekkoker, minimaal 80 breed x 30 of meer x 2.0 mm S235

$h_{v1} := 80\cdot mm \quad b_{v1} := 30\cdot mm \quad t_{v1} := 2.0\cdot mm$

$A_{v1} := A(h_{v1}, b_{v1}, t_{v1}, r) \quad A_{v1} = 420.566\cdot mm^2 \quad i_{v1} := i_z(h_{v1}, b_{v1}, t_{v1}, r) \quad i_{v1} = 12.711\cdot mm$

$N_{max.v1} := -28.57\cdot kN$ **(Bijlage 17)** $\quad l_{k.v1} := 650\cdot mm$

$\lambda_s = 93.913 \quad \alpha_k = 0.49 \quad \lambda_0 := 0.2 \quad \lambda_{v1} := \frac{l_{k.v1}}{i_{v1}} \quad \lambda_{v1} = 51.137 \quad \lambda_{rel.v1} := \frac{\lambda_{v1}}{\lambda_s} \quad \lambda_{rel.v1} = 0.545$

$\omega_{v1.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.v1}) \quad \omega_{v1.buc} = 0.818 \quad uc_9 := \frac{|N_{max.v1}|}{\omega_{v1.buc}\cdot A_{v1}\cdot f_y} \quad uc_9 = 0.353$

G.4. Kolommen.

CF RHS 140-80-5 S275: $h_{k1} := 140\cdot mm \quad b_{k1} := 80\cdot mm \quad t_{k1} := 5.0\cdot mm$

$A_{k1} := A(h_{k1}, b_{k1}, t_{k1}, r) \quad A_{k1} = 20.356\cdot cm^2 \quad W_{yplk1} := W_{ypl}(h_{k1}, b_{k1}, t_{k1}, r) \quad W_{yplk1} = 91.804\cdot cm^3$

$i_{z.k1} := i_z(h_{k1}, b_{k1}, t_{k1}, r) \quad i_{z.k1} = 32.534\cdot mm \quad l_{yk1} := 4850\cdot mm \quad l_{zk1} := 5300\cdot mm$

$N_{csd_0} := -52.79\cdot kN \quad M_{y_0} := -2.1\cdot kN\cdot m$ **(Bijl 17, 18)** $\quad uc_{10} := \frac{|N_{csd_0}|}{A_{k1}\cdot f_{y1}} + \frac{|M_{y_0}|}{W_{yplk1}\cdot f_{y1}} \quad uc_{10} = 0.177$

$N_{csd_1} := 13.37\cdot kN \quad M_{y_1} := \frac{19.4 + 27.7 + 19.6}{3}\cdot kN\cdot m \quad M_{y_1} = 22.233\cdot kN\cdot m$ **(Bijlage 17, 18)**

(EEM 2e orde berekend) $\quad uc_{11} := \frac{|N_{csd_1}|}{A_{k1}\cdot f_{y1}} + \frac{|M_{y_1}|}{W_{yplk1}\cdot f_{y1}} \quad uc_{11} = 0.905$

in de z richting, geschoord raamwerk:

$l_{zk1} = 5300 \cdot mm$ $\alpha_k = 0.49$ $\lambda_0 = 0.2$

$C_A := 5$ (Onder scharnier) $C_B := 5$ (Boven scharnier in de z richting)

$\lambda_g := \pi$ Given

$$C_A \cdot C_B \cdot \lambda_g^2 \cdot \sin(\lambda_g) = (C_A + C_B) \cdot \lambda_g \cdot \cos(\lambda_g) + (1 - C_A - C_B) \cdot \sin(\lambda_g) - 2 \cdot \frac{1 - \cos(\lambda_g)}{\lambda_g}$$

$\lambda_g \geq \pi$ $\lambda_g \leq 2 \cdot \pi$ $\lambda := \text{Find}(\lambda_g)$ $\lambda = 3.264$

$l_{ef} := \pi \cdot \frac{l_{zk1}}{\lambda}$ $l_{ef} = 5101.255 \cdot mm$ $\frac{l_{ef}}{l_{zk1}} = 0.963$

$\lambda_{zk1} := \frac{l_{ef}}{i_{z.k1}}$ $\lambda_s = 93.913$ $\lambda_{zk1rel} := \frac{\lambda_{zk1}}{\lambda_s}$ $\lambda_{zk1rel} = 1.67$ $M_z := 0 \cdot kN \cdot m$

$\omega_{z.k1.buc} := \omega_{buc}(\alpha_k, \lambda_{zk1rel})$ $\omega_{z.k1.buc} = 0.265$ $uc_{12} := \frac{|N_{csd_0}|}{\omega_{z.k1.buc} \cdot A_{k1} \cdot f_y}$ $uc_{12} = 0.416$

G.4.2. Kolommen Str 3. *CF RHS 140-80-5 S275:*

G.5. Overstek.

G.5.1. Schuine staaf:

Koudgevormde rechthoekkoker, 80 x 50 x 2.5 mm S235

$h_{v1} := 80 \cdot mm$ $b_{v1} := 50 \cdot mm$ $t_{v1} := 2.5 \cdot mm$

$A_{v1} := A(h_{v1}, b_{v1}, t_{v1}, r)$ $A_{v1} = 619.635 \cdot mm^2$ $i_{v1} := i_z(h_{v1}, b_{v1}, t_{v1}, r)$ $i_{v1} = 20.507 \cdot mm$

$W_{z.v1} := W_z(h_{v1}, b_{v1}, t_{v1}, r)$ $W_{z.v1} = 10423.026 \cdot mm^3$

$N_{max.v1} := -19.77 \cdot kN$ $M_{max.v1} := 1.5 \cdot kN \cdot m$ **(Bijlage 19)** $l_{k.v1} := 840 \cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{v1} := \frac{l_{k.v1}}{i_{v1}}$ $\lambda_{rel.v1} := \frac{\lambda_{v1}}{\lambda_s}$ $\lambda_{rel.v1} = 0.436$

$\omega_{v1.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.v1})$ $\omega_{v1.buc} = 0.878$ $uc_{13} := \frac{|N_{max.v1}|}{\omega_{v1.buc} \cdot A_{v1} \cdot f_y} + \frac{M_{max.v1}}{W_{z.v1} \cdot f_y}$ $uc_{13} = 0.767$

G.5.2. Horizontale staaf:

Koudgevormde rechthoekkoker, 70 x 70 x 3.0 mm S235

$h_{h1} := 70\cdot mm \quad b_{h1} := 70\cdot mm \quad t_{h1} := 3\cdot mm$

$A_{h1} := A(h_{h1}, b_{h1}, t_{h1}, r) \quad A_{h1} = 788.549\cdot mm^2 \quad i_{h1} := i_z(h_{h1}, b_{h1}, t_{h1}, r) \quad i_{h1} = 27.222\cdot mm$

$W_{pl.h1} := W_{zpl}(h_{h1}, b_{h1}, t_{h1}, r) \quad W_{pl.h1} = 19684.234\cdot mm^3$

$N_{max.h1} := -8.18\cdot kN \quad M_{max.h1} := 3.6\cdot kN\cdot m$ **(Bijlage 19)** $l_{k.h1} := 777\cdot mm$

$\lambda_s = 93.913 \quad \alpha_k = 0.49 \quad \lambda_0 := 0.2 \quad \lambda_{h1} := \frac{l_{k.h1}}{i_{h1}} \quad \lambda_{rel.h1} := \frac{\lambda_{h1}}{\lambda_s} \quad \lambda_{rel.h1} = 0.304$

$\omega_{h1.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.h1}) \quad \omega_{h1.buc} = 0.947 \quad uc_{14} := \frac{|N_{max.h1}|}{\omega_{h1.buc}\cdot A_{h1}\cdot f_y} + \frac{M_{max.h1}}{W_{pl.h1}\cdot f_y} \quad uc_{14} = 0.825$

G.6. Kopplaat traliespant en bouten:

G.6.1. Bouten: $F_{vsd} := |N_{csd_0}| \quad F_{vsd} = 52.79\cdot kN \quad F_{tsd} := 86.49\cdot kN$ **(Bijlage 20)**

M16 8.8, Minimaal twee bouten bij de bovenregel, twee bouten bij de onderregel, dus totaal 4 bouten, binnen 30 mm van de boven- en onderregel:

$A_{bs} := 157\cdot mm^2 \quad f_{tbd} := 800\cdot N\cdot mm^{-2}$

$\alpha_{red1} := 1$ afschuifvlak door de draad van de bout $\alpha_{red2} := 1$ gerolde draad

$F_{vud} := 0.48\cdot\alpha_{red1}\cdot f_{tbd}\cdot A_{bs} \quad F_{vud} = 60.288\cdot kN \quad F_{tud} := 0.72\cdot\alpha_{red2}\cdot f_{tbd}\cdot A_{bs} \quad F_{tud} = 90.432\cdot kN$

$uc_{15} := \frac{|F_{vsd}|}{4F_{vud}}$ 4 bouten op afsch. $uc_{15} = 0.219 \quad uc_{16} := \frac{F_{tsd}}{2F_{tud}} \quad uc_{16} = 0.478$ 2 bouten op trek

$uc_{17} := \frac{F_{vsd}}{4F_{vud}} + \frac{F_{tsd}}{1.4\cdot 2F_{tud}} \quad uc_{17} = 0.56$

G.6.2. Kopplaat: ***kopplaat: minimaal 80 x 20mm.*** $b_{koppl} := 80 \cdot mm$

maximale boutafstand tot de regel: $a_{bout} := 30 \cdot mm$

Maximale gatdiameter voor de bout: $d_g := 18 \cdot mm$

kopplaat rondom gelast aan de boven- en onderregel a=3.0mm.

$$d_p := \sqrt{\frac{4 \cdot F_{tsd} \cdot a_{bout}}{\left(2b_{koppl} - 2d_g\right) \cdot f_y}} \qquad d_p = 18.872 \cdot mm$$

keuze: 20mm

H. Controleberekeningen traliespant en kolommen fase 2:

H.1. Traliespanten rechter bovenregel fase 2:

Spanthoogte 850mm hoh

H.1.1. Traliespanten bovenregel in het vlak van het spant:

Koudgevormde rechthoekkoker 100 x 50 x 3.0mm S235 $h_{b1} := 100\cdot mm$ $b_{b1} := 50\cdot mm$ $t_{b1} := 3.0\cdot mm$

$A_{b1} := A(h_{b1}, b_{b1}, t_{b1}, r)$ $A_{b1} = 848.549\cdot mm^2$ $i_{zb1} := i_z(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{zb1} = 20.742\cdot mm$

$l_{k.zb1} := 1547\cdot mm$ $N_{sd.b1} := -104.60\cdot kN$ **(zie bijlage 21)**

$\lambda_s := \pi\cdot\sqrt{\frac{E_y}{f_y}}$ $\lambda_s = 93.913$ $\alpha_k := 0.49$ $\lambda_0 = 0.2$ $\lambda_z := \frac{l_{k.zb1}}{i_{zb1}}$ $\lambda_{rel} := \frac{\lambda_z}{\lambda_s}$ $\lambda_{rel} = 0.794$

$\omega_{z.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{z.b.buc} = 0.666$ $uc_{18} := \frac{|N_{sd.b1}|}{\omega_{z.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_{18} = 0.788$

H.1.2. Traliespant bovenregel uit het vlak van het spant:

$A_{b1} = 848.549\cdot mm^2$ $i_{yb1} := i_y(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{yb1} = 35.733\cdot mm$

$N_{sd.b1} = -104.6\cdot kN$ $N_0 := 83.35\cdot kN$ **(zie bijlage 21)** $l_{sysy} := 7735\cdot mm$

$T1 := \frac{N_0}{N_{sd.b1}}$ $T1 = -0.797$ $T := \text{if}(T1 < -0.2, -0.2, T1)$ $T = -0.2$

Kniklengte voor zijwaarts uitwijken volgens gemeten waarden van TNO Bouw:

		Bovenregel	Onderregel
Gemeten Inspanningsfaktor k:	Eindkolom:	0.7	0.8
	Tpv zwevende goot	0.8	0.5
	Middenkolom	0.5	0.8

$L_{k1} := l_{sysy}\cdot\sqrt{\frac{1 + 0.88\cdot T}{1.88}}$ $L_{k2} := l_{sysy}\cdot\sqrt{\frac{1 + 0.51\cdot T}{3.09}}$ $L_{k3} := l_{sysy}\cdot\sqrt{\frac{1 + 1.65\cdot T}{5.42}}$ $L_{k4} := l_{sysy}\cdot\sqrt{\frac{1 + 0.93\cdot T}{7.72}}$

$k_0 := 0.5$ $k_1 := 0.8$ (k0 bij N0, k1 bij Nsdo1)

$l_{buc.b.y} := (1 - k_0)\cdot(1 - k_1)\cdot L_{k1} + k_0\cdot(1 - k_1)\cdot L_{k2} + (1 - k_0)\cdot k_1\cdot L_{k3} + k_0\cdot k_1\cdot L_{k4}$ $l_{buc.b.y} = 3.022\,m$

$\lambda_y := \frac{l_{buc.b.y}}{i_{yb1}}$ $\lambda_y = 84.56$ $\lambda_s = 93.913$ $\lambda_{rel} := \frac{\lambda_y}{\lambda_s}$ $\lambda_{rel} = 0.9$ $\alpha_k = 0.49$

$\omega_{y.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{y.b.buc} = 0.6$ $uc_{19} := \frac{|N_{sd.b1}|}{\omega_{y.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_{19} = 0.87$

H.1.3. Traliespanten rechter bovenregel Str 3:

Koudgevormde rechthoekkoker 100 x 50 x 3.0mm S235

H.2. Traliespanten onderregel fase 2:

H.2.1. Traliespanten onderregel linker deel in het vlak van het spant: Spanthoogte 650mm hoh

Koudgevormde rechthoekkoker 80 x 50 x 2.5mm S235 $h_{b1} := 80\cdot mm \quad b_{b1} := 50\cdot mm \quad t_{b1} := 2.5\cdot mm$

$A_{b1} := A(h_{b1}, b_{b1}, t_{b1}, r) \quad A_{b1} = 619.635\cdot mm^2 \quad i_{zb1} := i_z(h_{b1}, b_{b1}, t_{b1}, r) \quad i_{zb1} = 20.507\cdot mm$

$l_{k.zb1} := 1157\cdot mm \quad N_{sd.b1} := -77.42\cdot kN$ **(zie bijlage 22)**

$\lambda_s := \pi\cdot\sqrt{\frac{E_y}{f_y}} \quad \lambda_s = 93.913 \quad \alpha_k := 0.49 \quad \lambda_0 = 0.2 \quad \lambda_z := \frac{l_{k.zb1}}{i_{zb1}} \quad \lambda_{rel} := \frac{\lambda_z}{\lambda_s} \quad \lambda_{rel} = 0.601$

$\omega_{z.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel}) \quad \omega_{z.b.buc} = 0.785 \quad uc_{20} := \frac{|N_{sd.b1}|}{\omega_{z.b.buc}\cdot A_{b1}\cdot f_y} \quad uc_{20} = 0.677$

H.2.2. Traliespant onderregel uit het vlak van het spant:

$A_{b1} = 619.635\cdot mm^2 \quad i_{yb1} := i_y(h_{b1}, b_{b1}, t_{b1}, r) \quad i_{yb1} = 29.601\cdot mm$

$N_{sd.b1} = -77.42\cdot kN \quad N_0 := 63.61\cdot kN$ **(zie bijlage 22)** $l_{sysy} := 7075\cdot mm$

$T1 := \frac{N_0}{N_{sd.b1}} \quad T1 = -0.822 \quad T := \text{if}(T1 < -0.2, -0.2, T1) \quad T = -0.2$

Kniklengte voor zijwaarts uitwijken volgens gemeten waarden van TNO Bouw:

		Bovenregel	Onderregel
Gemeten Inspanningsfaktor k:	Eindkolom:	0.7	0.8
	Tpv zwevende goot	0.8	0.5
	Middenkolom	0.5	0.8

$L_{k1} := l_{sysy}\cdot\sqrt{\frac{1 + 0.88\cdot T}{1.88}} \quad L_{k2} := l_{sysy}\cdot\sqrt{\frac{1 + 0.51\cdot T}{3.09}} \quad L_{k3} := l_{sysy}\cdot\sqrt{\frac{1 + 1.65\cdot T}{5.42}} \quad L_{k4} := l_{sysy}\cdot\sqrt{\frac{1 + 0.93\cdot T}{7.72}}$

$k_0 := 0.5 \quad k_1 := 0.8$ (k0 bij N0, k1 bij Nsdo1)

$l_{buc.b.y} := (1 - k_0)\cdot(1 - k_1)\cdot L_{k1} + k_0\cdot(1 - k_1)\cdot L_{k2} + (1 - k_0)\cdot k_1\cdot L_{k3} + k_0\cdot k_1\cdot L_{k4} \quad l_{buc.b.y} = 2.764\,m$

$\lambda_y := \frac{l_{buc.b.y}}{i_{yb1}} \quad \lambda_y = 93.367 \quad \lambda_s = 93.913 \quad \lambda_{rel} := \frac{\lambda_y}{\lambda_s} \quad \lambda_{rel} = 0.994 \quad \alpha_k = 0.49$

$\omega_{y.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel}) \quad \omega_{y.b.buc} = 0.543 \quad uc_{21} := \frac{|N_{sd.b1}|}{\omega_{y.b.buc}\cdot A_{b1}\cdot f_y} \quad uc_{21} = 0.98$

H.2.3. Traliespant linker onderregel Str 3:
Koudgevormde rechthoekkoker 80 x 50 x 2.5mm S275

H.3. Traliespanten onderregel fase 2: Spanthoogte 850mm hoh

H.3.1. Traliespanten onderregel rechter deel in het vlak van het spant:

Koudgevormde rechthoekkoker 100 x 50 x 3.0mm S235 $h_{b1} := 100\cdot mm$ $b_{b1} := 50\cdot mm$ $t_{b1} := 3.0\cdot mm$

$A_{b1} := A(h_{b1}, b_{b1}, t_{b1}, r)$ $A_{b1} = 848.549\cdot mm^2$ $i_{zb1} := i_z(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{zb1} = 20.742\cdot mm$

$l_{k.zb1} := 1547\cdot mm$ $N_{sd.b1} := -51.83\cdot kN$ **(zie bijlage 22)**

$\lambda_s := \pi\cdot\sqrt{\frac{E_y}{f_y}}$ $\lambda_s = 93.913$ $\alpha_k := 0.49$ $\lambda_0 = 0.2$ $\lambda_z := \frac{l_{k.zb1}}{i_{zb1}}$ $\lambda_{rel} := \frac{\lambda_z}{\lambda_s}$ $\lambda_{rel} = 0.794$

$\omega_{z.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{z.b.buc} = 0.666$ $uc_{22} := \frac{|N_{sd.b1}|}{\omega_{z.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_{22} = 0.39$

H.3.2. Traliespant onderregel uit het vlak van het spant:

$A_{b1} = 848.549\cdot mm^2$ $i_{yb1} := i_y(h_{b1}, b_{b1}, t_{b1}, r)$ $i_{yb1} = 35.733\cdot mm$

$N_{sd.b1} = -51.83\cdot kN$ $N_0 := 99.88\cdot kN$ **(zie bijlage 22)** $l_{sysy} := 7735\cdot mm$

$T1 := \frac{N_0}{N_{sd.b1}}$ $T1 = -1.927$ $T := if(T1 < -0.2, -0.2, T1)$ $T = -0.2$

Kniklengte voor zijwaarts uitwijken volgens gemeten waarden van TNO Bouw:

		Bovenregel	Onderregel
Gemeten Inspanningsfaktor k:	Eindkolom:	0.7	0.8
	Tpv zwevende goot	0.8	0.5
	Middenkolom	0.5	0.8

$L_{k1} := l_{sysy}\cdot\sqrt{\frac{1 + 0.88\cdot T}{1.88}}$ $L_{k2} := l_{sysy}\cdot\sqrt{\frac{1 + 0.51\cdot T}{3.09}}$ $L_{k3} := l_{sysy}\cdot\sqrt{\frac{1 + 1.65\cdot T}{5.42}}$ $L_{k4} := l_{sysy}\cdot\sqrt{\frac{1 + 0.93\cdot T}{7.72}}$

$k_0 := 0.5$ $k_1 := 0.8$ (k0 bij N0, k1 bij Nsdo1)

$l_{buc.b.y} := (1 - k_0)\cdot(1 - k_1)\cdot L_{k1} + k_0\cdot(1 - k_1)\cdot L_{k2} + (1 - k_0)\cdot k_1\cdot L_{k3} + k_0\cdot k_1\cdot L_{k4}$ $l_{buc.b.y} = 3.022\,m$

$\lambda_y := \frac{l_{buc.b.y}}{i_{yb1}}$ $\lambda_y = 84.56$ $\lambda_s = 93.913$ $\lambda_{rel} := \frac{\lambda_y}{\lambda_s}$ $\lambda_{rel} = 0.9$ $\alpha_k = 0.49$

$\omega_{y.b.buc} := \omega_{buc}(\alpha_k, \lambda_{rel})$ $\omega_{y.b.buc} = 0.6$ $uc_{23} := \frac{|N_{sd.b1}|}{\omega_{y.b.buc}\cdot A_{b1}\cdot f_y}$ $uc_{23} = 0.43$

H.3.3. Traliespant onderregel Str 3: ***Koudgevormde rechthoekkoker 100 x 50 x 3.0mm S235***

H.4. Diagonalen en gootvertikalen fase 2, in het lage traliespant:

H.4.1. 2 Diagonalen links van de middenkolom, zie ook indeling bijl 16.

Koudgevormde rechthoekkoker 40 x 40 x 2.0mm S235

$h_{d1} := 40\cdot mm$ $b_{d1} := 40\cdot mm$ $t_{d1} := 2.0\cdot mm$ $A_{d1} := A(h_{d1}, b_{d1}, t_{d1}, r)$ $A_{d1} = 300.566\cdot mm^2$

$i_{d1} := i_z(h_{d1}, b_{d1}, t_{d1}, r)$ $i_{d1} = 15.482\cdot mm$ $N_{max.d1} := -37.90\cdot kN$ <40.36 **(Bijlage 16, 23)** $l_{k.d1} := 915\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d1} := \frac{l_{k.d1}}{i_{d1}}$ $\lambda_{rel.d1} := \frac{\lambda_{d1}}{\lambda_s}$ $\lambda_{rel.d1} = 0.629$

$\omega_{d1.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d1})$ $\omega_{d1.buc} = 0.768$ $uc_{24} := \frac{|N_{max.d1}|}{\omega_{d1.buc}\cdot A_{d1}\cdot f_y}$ $uc_{24} = 0.699$

H.4.2. 10 Diagonalen rechts van de middenkolom.

Koudgevormde rechthoekkoker 30 x 30 x 2.0mm S235

$h_{d2} := 30\cdot mm$ $b_{d2} := 30\cdot mm$ $t_{d2} := 2.0\cdot mm$ $A_{d2} := A(h_{d2}, b_{d2}, t_{d2}, r)$ $A_{d2} = 220.566\cdot mm^2$

$i_{d2} := i_z(h_{d2}, b_{d2}, t_{d2}, r)$ $i_{d2} = 11.404\cdot mm$ $N_{max.d2} := -20.25\cdot kN$ <28.32 **(Bijlage 16, 23)** $l_{k.d2} := 870\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d2} := \frac{l_{k.d2}}{i_{d2}}$ $\lambda_{rel.d2} := \frac{\lambda_{d2}}{\lambda_s}$ $\lambda_{rel.d2} = 0.812$

$\omega_{d2.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d2})$ $\omega_{d2.buc} = 0.654$ $uc_{25} := \frac{|N_{max.d2}|}{\omega_{d2.buc}\cdot A_{d2}\cdot f_y}$ $uc_{25} = 0.597$

H.4.3. Andere diagonalen in het lage traliespant.

Koudgevormde rechthoekkoker 25 x 25 x 2.5mm S235

$h_{d3} := 25\cdot mm$ $b_{d3} := 25\cdot mm$ $t_{d3} := 2.5\cdot mm$ $A_{d3} := A(h_{d3}, b_{d3}, t_{d3}, r)$ $A_{d3} = 219.635\cdot mm^2$

$i_{d3} := i_z(h_{d3}, b_{d3}, t_{d3}, r)$ $i_{d3} = 9.161\cdot mm$ $N_{max.d3} := -21.11\cdot kN$ **>13.89** **(Bijlage 16, 23)** $l_{k.d3} := 878\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d3} := \frac{l_{k.d3}}{i_{d3}}$ $\lambda_{rel.d3} := \frac{\lambda_{d3}}{\lambda_s}$ $\lambda_{rel.d3} = 1.021$

$\omega_{d3.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d3})$ $\omega_{d3.buc} = 0.528$ $uc_{26} := \frac{|N_{max.d3}|}{\omega_{d3.buc}\cdot A_{d3}\cdot f_y}$ $uc_{26} = 0.774$

H.5. Diagonalen in het hoge traliespant.

H.5.1. Diagonalen.

Koudgevormde rechthoekkoker 40 x 40 x 2.0mm S235

$h_{d4} := 40\cdot mm$ $b_{d4} := 40\cdot mm$ $t_{d4} := 2.0\cdot mm$ $A_{d4} := A(h_{d4}, b_{d4}, t_{d4}, r)$ $A_{d4} = 300.566\cdot mm^2$

$i_{d4} := i_z(h_{d4}, b_{d4}, t_{d4}, r)$ $i_{d4} = 15.482\cdot mm$ $N_{max.d4} := -28.57\cdot kN$ **(Bijlage 23)** $l_{k.d4} := 1149\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{d4} := \frac{l_{k.d4}}{i_{d4}}$ $\lambda_{rel.d4} := \frac{\lambda_{d4}}{\lambda_s}$ $\lambda_{rel.d4} = 0.79$

$\omega_{d4.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.d4})$ $\omega_{d4.buc} = 0.668$ $uc_{27} := \frac{|N_{max.d4}|}{\omega_{d4.buc}\cdot A_{d4}\cdot f_y}$ $uc_{27} = 0.605$

H.5.2. Diagonalen Str 3: als diagonalen andere stramienen.

H.5.3. Gootvertikaal hoog traliespant:

Koudgevormde rechthoekkoker, minimaal 100 breed x 30 of meer x 2.0 mm S235

$h_{v2} := 100\cdot mm$ $b_{v2} := 30\cdot mm$ $t_{v2} := 2.0\cdot mm$

$A_{v2} := A(h_{v2}, b_{v2}, t_{v2}, r)$ $A_{v2} = 500.566\cdot mm^2$ $i_{v2} := i_z(h_{v2}, b_{v2}, t_{v2}, r)$ $i_{v2} = 12.928\cdot mm$

$N_{max.v2} := -33.04\cdot kN$ **(Bijlage 24)** $l_{k.v2} := 850\cdot mm$

$\lambda_s = 93.913$ $\alpha_k = 0.49$ $\lambda_0 := 0.2$ $\lambda_{v2} := \frac{l_{k.v2}}{i_{v2}}$ $\lambda_{v2} = 65.751$ $\lambda_{rel.v2} := \frac{\lambda_{v2}}{\lambda_s}$ $\lambda_{rel.v2} = 0.7$

$\omega_{v2.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.v2})$ $\omega_{v2.buc} = 0.725$ $uc_{28} := \frac{|N_{max.v2}|}{\omega_{v2.buc}\cdot A_{v2}\cdot f_y}$ $uc_{28} = 0.388$

H.6. Kolommen.

H.6.1. Kolommen normale stramienen. *CF RHS 140-80-5 S275:* $h_{k1} := 140\cdot mr$ $b_{k1} := 80\cdot mm$ $t_{k1} := 5.0\cdot mr$

$A_{k1} := A(h_{k1}, b_{k1}, t_{k1}, r)$ $A_{k1} = 20.356\cdot cm^2$ $W_{yplk1} := W_{ypl}(h_{k1}, b_{k1}, t_{k1}, r)$ $W_{yplk1} = 91.804\cdot cm^3$

$i_{z.k1} := i_z(h_{k1}, b_{k1}, t_{k1}, r)$ $i_{z.k1} = 32.534\cdot mm$ $l_{yk1} := 4650\cdot mm$ $l_{zk1} := 5500\cdot mm$

$N_{csd_2} := -69.02\cdot kN$ $M_{y_2} := -2.7\cdot kN\cdot m$ **(Bijl 25, 26)**

$$uc_{29} := \frac{\left|N_{csd_2}\right|}{A_{k1}\cdot f_{y1}} + \frac{\left|M_{y_2}\right|}{W_{yplk1}\cdot f_{y1}} \qquad uc_{29} = 0.23$$

$N_{csd_3} := 11.39\cdot kN$ $M_{y_3} := 20.6\cdot kN\cdot m$ **(Bijlage 17, 18)**

(EEM 2e orde berekend)

$$uc_{30} := \frac{\left|N_{csd_3}\right|}{A_{k1}\cdot f_{y1}} + \frac{\left|M_{y_3}\right|}{W_{yplk1}\cdot f_{y1}} \qquad uc_{30} = 0.836$$

in de z richting, geschoord raamwerk:

$l_{zk1} = 5500\cdot mm$ $\alpha_k = 0.49$ $\lambda_0 = 0.2$

$C_A := 5$ (Onder scharnier) $C_B := 5$ (Boven scharnier in de z richting)

$\lambda_g := \pi$ Given

$$C_A\cdot C_B\cdot \lambda_g^{\,2}\cdot\sin(\lambda_g) = (C_A + C_B)\cdot\lambda_g\cdot\cos(\lambda_g) + (1 - C_A - C_B)\cdot\sin(\lambda_g) - 2\cdot\frac{1-\cos(\lambda_g)}{\lambda_g}$$

$\lambda_g \ge \pi$ $\lambda_g \le 2\cdot\pi$ $\lambda := \text{Find}(\lambda_g)$ $\lambda = 3.264$

$$l_{ef} := \pi\cdot\frac{l_{zk1}}{\lambda} \qquad l_{ef} = 5293.755\cdot mm \qquad \frac{l_{ef}}{l_{zk1}} = 0.963$$

$\lambda_{zk1} := \frac{l_{ef}}{i_{z.k1}}$ $\lambda_s = 93.913$ $\lambda_{zk1rel} := \frac{\lambda_{zk1}}{\lambda_s}$ $\lambda_{zk1rel} = 1.733$ $M_z := 0\cdot kN\cdot m$

$\omega_{z.k1.buc} := \omega_{buc}(\alpha_k, \lambda_{zk1rel})$ $\omega_{z.k1.buc} = 0.25$ $uc_{31} := \frac{\left|N_{csd_2}\right|}{\omega_{z.k1.buc}\cdot A_{k1}\cdot f_y}$ $uc_{31} = 0.578$

H.6.2. Kolommen Str 3. *CF RHS 140-80-5 S275*

H.7. Overstek.

H.7.1. Schuine staaf:

Koudgevormde rechthoekkoker, 80 x 50 x 2.5 mm S235

$h_{v2} := 80\cdot mm \quad b_{v2} := 50\cdot mm \quad t_{v2} := 2.5\cdot mm$

$A_{v2} := A(h_{v2}, b_{v2}, t_{v2}, r) \quad A_{v2} = 619.635\cdot mm^2 \quad i_{v2} := i_z(h_{v2}, b_{v2}, t_{v2}, r) \quad i_{v2} = 20.507\cdot mm$

$W_{v2} := W_z(h_{v2}, b_{v2}, t_{v2}, r) \quad W_{v2} = 10423.026\cdot mm^3$

$N_{max.v2} := 39.44\cdot kN \quad M_{max.v2} := 2.7\cdot kN\cdot m$ **(Bijlage 26)**

$$uc_{32} := \frac{|N_{max.v2}|}{A_{v2}\cdot f_y}\cdot\frac{M_{max.v2}}{W_{v2}\cdot f_y} \qquad uc_{32} = 0.299$$

H.7.2. Horizontale staaf:

Koudgevormde rechthoekkoker, 80 x 80 x 5.0 mm S235

$h_{h1} := 80\cdot mm \quad b_{h1} := 80\cdot mm \quad t_{h1} := 5\cdot mm$

$A_{h1} := A(h_{h1}, b_{h1}, t_{h1}, r) \quad A_{h1} = 1435.619\cdot mm^2 \quad i_{h1} := i_z(h_{h1}, b_{h1}, t_{h1}, r) \quad i_{h1} = 30.203\cdot mm$

$W_{pl.h1} := W_{zpl}(h_{h1}, b_{h1}, t_{h1}, r) \quad W_{pl.h1} = 39735.25\cdot mm^3$

$N_{max.h1} := -8.47\cdot kN \quad M_{max.h1} := 7.7\cdot kN\cdot m$ **(Bijlage 26)** $l_{k.h1} := 777\cdot mm$

$\lambda_s = 93.913 \quad \alpha_k = 0.49 \quad \lambda_0 := 0.2 \quad \lambda_{h1} := \frac{l_{k.h1}}{i_{h1}} \quad \lambda_{rel.h1} := \frac{\lambda_{h1}}{\lambda_s} \quad \lambda_{rel.h1} = 0.274$

$\omega_{h1.buc} := \omega_{buc}(\alpha_k, \lambda_{rel.h1}) \quad \omega_{h1.buc} = 0.962 \quad uc_{33} := \frac{|N_{max.h1}|}{\omega_{h1.buc}\cdot A_{h1}\cdot f_y} + \frac{M_{max.h1}}{W_{pl.h1}\cdot f_y} \quad uc_{33} = 0.851$

H.8. Kopplaat traliespant en bouten:

H.8.1. Bouten: $F_{vsd} := \left|N_{csd_2}\right|$ $F_{vsd} = 69.02\cdot kN$ $F_{tsd} := 98.25\cdot kN$ **(Bijlage 27)**

M16 8.8, Minimaal twee bouten bij de bovenregel, twee bouten bij de onderregel, dus totaal 4 bouten, binnen 30 mm van de boven- en onderregel:

$A_{bs} := 157\cdot mm^2$ $f_{tbd} := 800\cdot N\cdot mm^{-2}$

$\alpha_{red1} := 1$ afschuifvlak door de draad van de bout $\alpha_{red2} := 1$ gerolde draad

$F_{vud} := 0.48\cdot\alpha_{red1}\cdot f_{tbd}\cdot A_{bs}$ $F_{vud} = 60.288\cdot kN$ $F_{tud} := 0.72\cdot\alpha_{red2}\cdot f_{tbd}\cdot A_{bs}$ $F_{tud} = 90.432\cdot kN$

$uc_{34} := \frac{\left|F_{vsd}\right|}{4F_{vud}}$ 4 bouten op afsch. $uc_{34} = 0.286$ $uc_{35} := \frac{F_{tsd}}{2F_{tud}}$ $uc_{35} = 0.543$ 2 bouten op trek

$uc_{36} := \frac{F_{vsd}}{4F_{vud}} + \frac{F_{tsd}}{1.4\cdot 2F_{tud}}$ $uc_{36} = 0.674$

H.8.2. Kopplaat: ***kopplaat: minimaal 100 x 20mm.*** $b_{koppl} := 100\cdot mm$

maximale boutafstand tot de regel: $a_{bout} := 30\cdot mm$

Maximale gatdiameter voor de bout: $d_g := 18\cdot mm$

kopplaat rondom gelast aan de boven- en onderregel a=3.0mm.

$d_p := \sqrt{\frac{4\cdot F_{tsd}\cdot a_{bout}}{\left(2b_{koppl} - 2d_g\right)\cdot f_y}}$ $d_p = 17.49\cdot mm$ **keuze: 20mm**

I. Windverbanden:

Let wel: De goot is onderdeel van het windverband, zie ook gootberekening, met normaalkracht tgv wind. Ngoot = 18.8 kN.

Bruto kolomhoogte: $h_{kol} := 5500 \cdot mm$ maximum lengte $L = 45.8\,m$

winddruk: $q_p(z) = 621.352\,Pa$ $C_{pe.D} = 0.8$ $C_{pe.E} = -0.5$ $C_f := 0.01$

Bepalend veld: $veld := 0.5 \cdot (15.193 + 12.33) \cdot m$ $veld = 13.761\,m$

Rechthoekige kopwand: $F_r := veld \cdot h_{kol} \cdot q_p(z) \cdot \left(C_{pe.D} - C_{pe.E}\right) \cdot \psi_t$ $F_r = 52.959 \cdot kN$

Rond gedeelte: oppervlakte bogen: $A_1 := 8.691 \cdot m^2$ **Bijlage 6**

$F_b := 2A_1 \cdot q_p(z) \cdot \left(C_{pe.D} + C_{pe.E}\right) \cdot \psi_t$ $F_b = 2.807 \cdot kN$

zwaartepunten boven de goten: $x_z := 661 \cdot mm$ **Bijlage 6**

Boogomtrek: $boog_1 := 8.204 \cdot m$

Windwrijving: Boog: $F_w := 2boog_1 \cdot L \cdot q_p(z) \cdot C_f \cdot \psi_t \cdot K_{Fl}$ $F_w = 3.64 \cdot kN$

$$N_{hor} := \frac{F_r \cdot 0.5h_{kol} + F_b \cdot \left(x_z + h_{kol}\right) + F_w \cdot \left(x_z + h_{kol}\right)}{h_{kol}} \quad N_{hor} = 33.701 \cdot kN \quad N_{goot} := 0.5 \cdot N_{hor}$$

I.1. Horizontaal windverband:

Horizontaal verband (2 stel per gebouwlengte):

$N_h := \frac{\sqrt{{s_1}^2 + {V_1}^2}}{V_1} \cdot N_{hor}$ $N_h = 56.906 \cdot kN$ $n := 2$ $V_1 = 5.2\,m$ $\gamma_3 := 1.35$

schoren plat: $t_s := 5 \cdot mm$ $b_s := 50 \cdot mm$

$A_s := t_s \cdot b_s$ $A_s = 250 \cdot mm^2$ $uc_{37} := \frac{N_h \cdot \gamma_3}{n \cdot A_s \cdot f_y}$ $uc_{37} = 0.654$

I.2. Vertikaal windverband in de lengterichting (minimaal 2 stel per gebouwlengte).

$N_v := \frac{\sqrt{{h_{kol}}^2 + {V_1}^2}}{V_1} \cdot N_{hor}$ $N_v = 49.055 \cdot kN$ $n := 2$ $V_1 = 5.2\,m$

schoren plat: $t_s := 5 \cdot mm$ $b_s := 50 \cdot mm$ $A_s := t_s \cdot b_s$ $A_s = 250 \cdot mm^2$ $uc_{38} := \frac{N_v \cdot \gamma_3}{n \cdot A_s \cdot f_y}$ $uc_{38} = 0.564$

J. Reakties op de schoorvakkolommen:

Reakties op de schoorvakkolommen bij kopwind: kolomhoogte: $h_{kol} := 5.50\cdot m$

afstand tussen de kolommen: $V_{nom} := 5.2\cdot m$ aantal schoorvakken: $n = 2$

Vertikale reaktie: $R_{Vsls} := \frac{N_{hor}\cdot h_{kol}}{n\cdot V_{nom}}$ $R_{Vsls} = 17.823\cdot kN$ **SLS, trek en druk**

(bruikbaarheidsgrenstoestand)

$R_{Vuls} := \frac{N_{hor}\cdot h_{kol}\cdot \gamma_3}{n\cdot V_{nom}}$ $R_{Vuls} = 24.061\cdot kN$ **ULS, trek en druk**

(uiterste grenstoestand)

Horizontale reaktie: $R_{Hsls} := \frac{N_{hor}}{n}$ $R_{Hsls} = 16.851\cdot kN$ **SLS, trek en druk**

(bruikbaarheidsgrenstoestand)

$R_{Huls} := \frac{N_{hor}\cdot \gamma_3}{n}$ $R_{Huls} = 22.748\cdot kN$ **ULS, trek en druk**

(uiterste grenstoestand)

K. Aluminium goot.

K.1. Aluminium goot op Windlast.

$V_b := 2.5\cdot m$

Gekoppeld op de momentennulpunten (0.25 x V), over de steunpunten doorlopend.

Boogreakties: $F_{boog} := 6.4\cdot kN$ **(Bijlage 27, Fu.C.3)** $V_1 = 5.2\,m$ $q_w := \frac{F_{boog}}{V_b}$ $q_w = 2.56\cdot kN\cdot m^{-1}$

moment: $M_g := \frac{1}{12}\cdot q_w\cdot V_1^{\,2}$ $M_g = 5.769\cdot kN\cdot m$ $f_{0.2} = 200\cdot N\cdot mm^{-2}$

Aluminium goot **(Bijlage 2)**

$N_{goot} = 16.851\cdot kN$ $W_{yg} := 74638\cdot mm^3$ $W_{yplg} := 1.35W_{yg}$ $W_{yplg} = 100761.3\cdot mm^3$ $A_g := 2681\cdot mm^2$

$I_{y.g} := 5879857\cdot mm^4$ $i_g := \sqrt{\frac{I_{y.g}}{A_g}}$ $i_g = 46.831\cdot mm$ $\lambda_s := \pi\cdot\sqrt{\frac{E_d}{f_{0.2}}}$ $\lambda_s = 58.774$

$l_{k.g} := 0.7V_1$ $l_{k.g} = 3640\cdot mm$ $\alpha_{k.g} := 0.526$ $\lambda_0 := 0.2$ $\lambda_g := \frac{l_{k.g}}{i_g}$

$\lambda_{grel} := \frac{\lambda_g}{\lambda_s}$ $\lambda_{grel} = 1.322$ $\chi_{g.buc} := \omega_{buc}(\alpha_{k.g}, \lambda_{grel})$ $\chi_{g.buc} = 0.372$

$uc_{39} := \frac{|N_{goot}|}{\chi_{g.buc}\cdot A_g\cdot f_{0.2}} + \frac{|M_g|}{W_{yplg}\cdot f_{0.2}}$ $uc_{39} = 0.371$

K.2. Aluminium goot op Sneeuwlast.

moment: $F_{boog} := 16.2 \cdot kN$ **(Bijlage 27, Fu.C.1)** $V_b := 2.5 \cdot m$ $q_s := \frac{F_{boog}}{V_b}$ $q_s = 6.48 \cdot kN \cdot m^{-1}$

moment: $M_g := \frac{1}{12} \cdot q_s \cdot V_1^{\,2}$ $M_g = 14.602 \cdot kN \cdot m$ $uc_{40} := \frac{|M_g|}{W_{yplg} \cdot f_{0.2}}$ $uc_{40} = 0.725$

L. Kolommen kopwanden:

maximaal veld: $veld := 6.0 \cdot m$ lengte: $h_{kop} := 5.5 \cdot m$

$q_{kolom} := (C_{pe.D} - C_{pe.E}) \cdot veld \cdot q_p(z)$ $q_{kolom} = 4.847 \cdot kN \cdot m^{-1}$

$M_{kolom} := .125 \cdot q_{kolom} \cdot h_{kop}^{\,2}$ $M_{kolom} = 18.326 \cdot kN \cdot m$

Kolommen *CF RHS 140-80-5 S235:*

$h_{k3} := 140 \cdot mm$ $b_{k3} := 80 \cdot mm$ $t_{k3} := 5 \cdot mm$

$A_{k3} := A(h_{k3}, b_{k3}, t_{k3}, r)$ $A_{k3} = 20.356 \cdot cm^2$ $W_{yplk3} := W_{ypl}(h_{k3}, b_{k3}, t_{k3}, r)$ $W_{yplk3} = 91.804 \cdot cm^3$

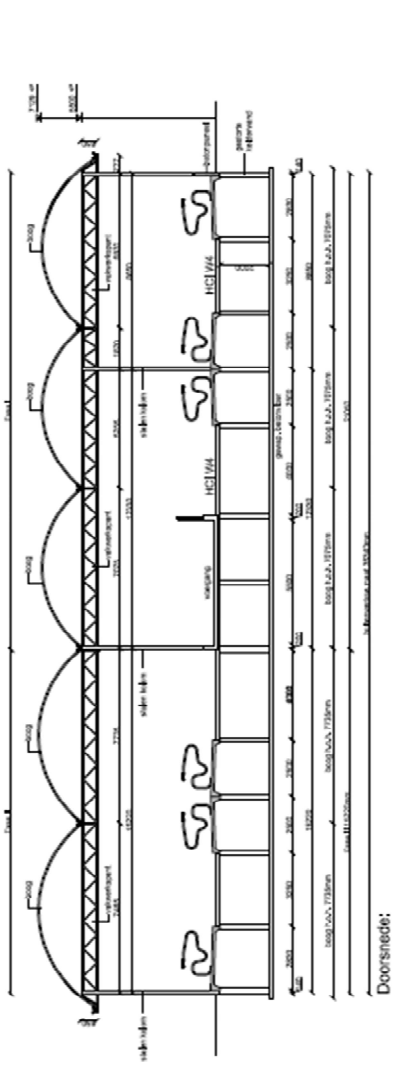
$uc_{41} := \frac{M_{kolom}}{W_{yplk3} \cdot f_y}$ $uc_{41} = 0.849$

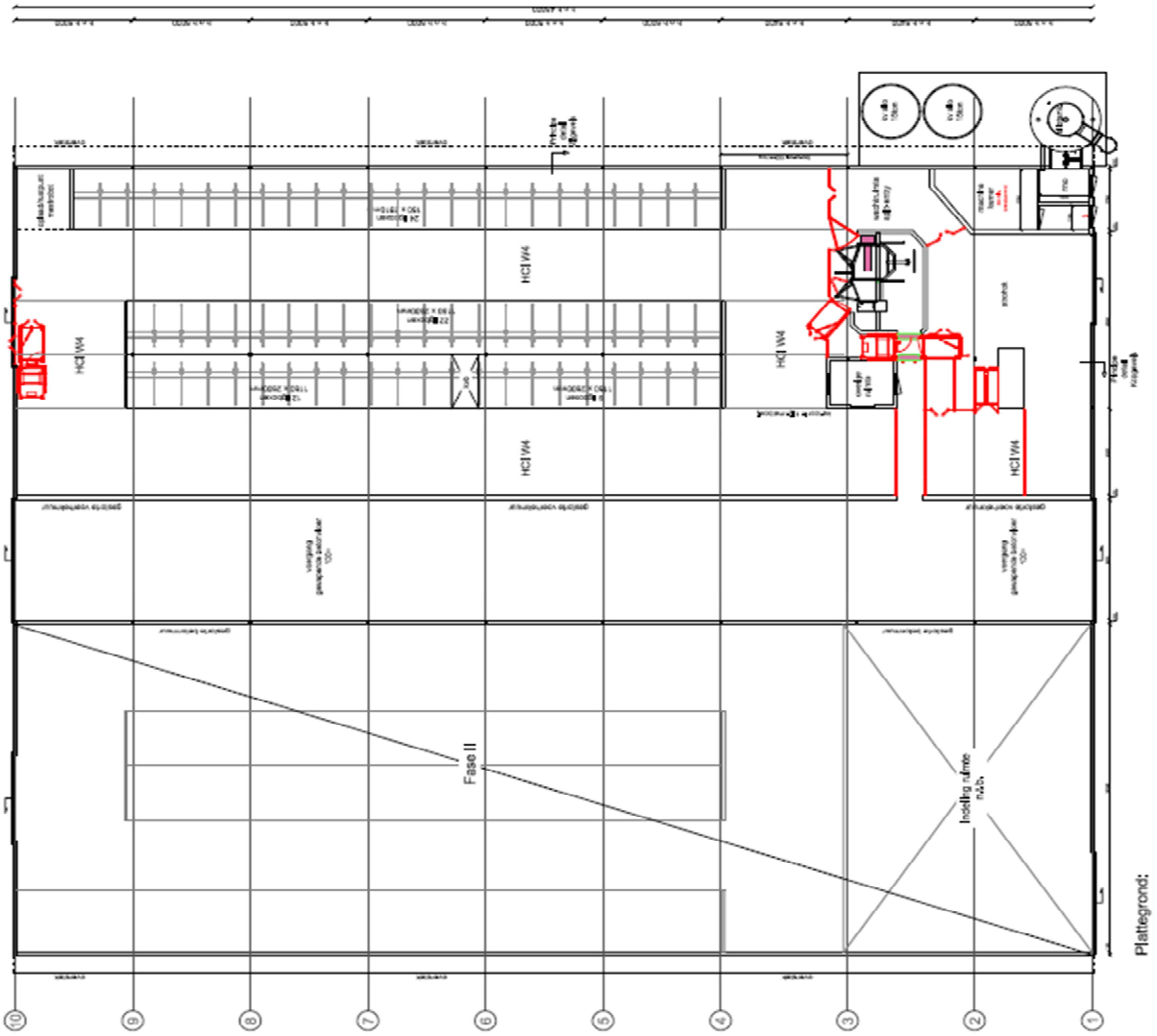
M. UC check:

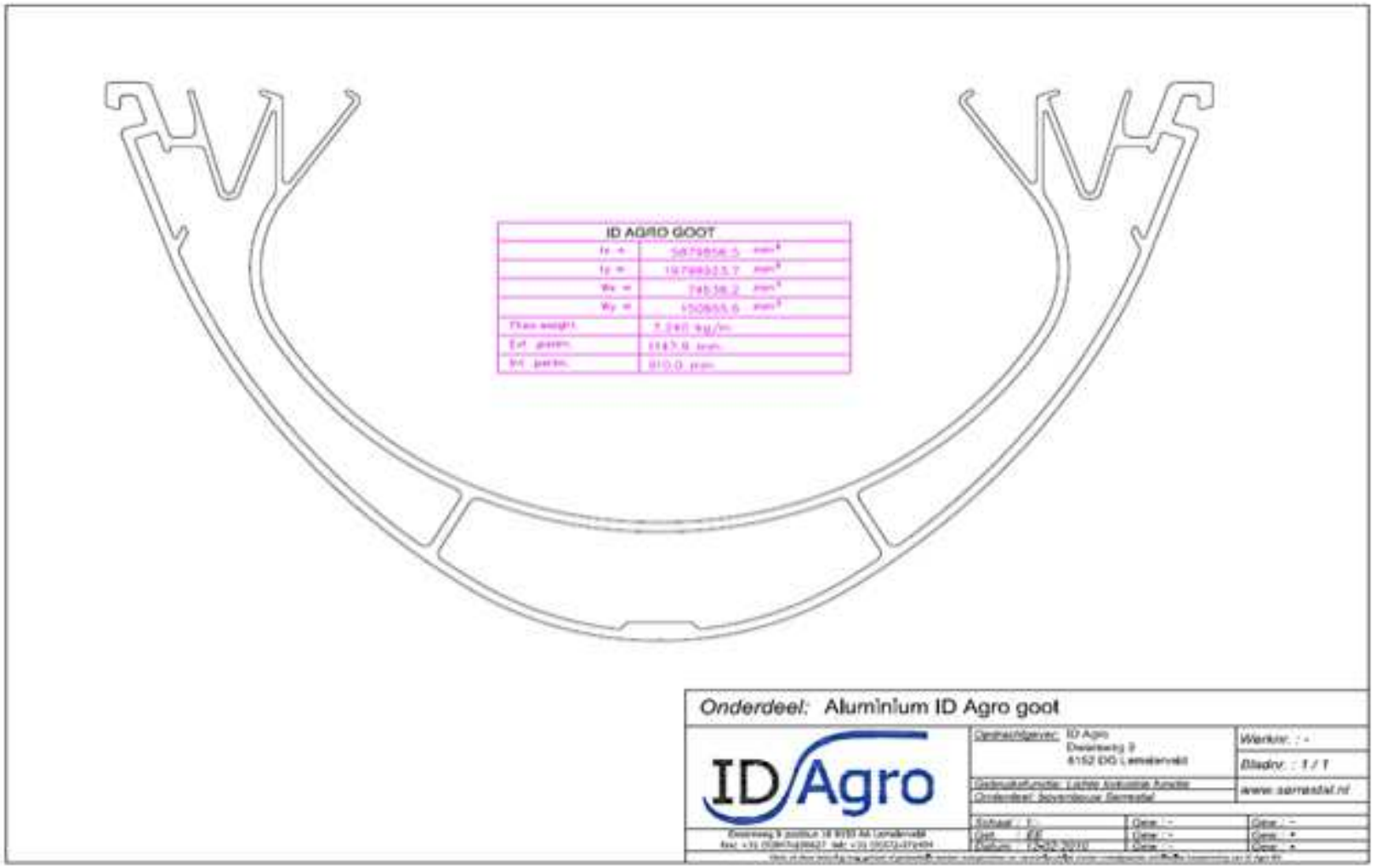
max(uc) = 1

n

Groot Nibbelink Halle Bijlagen.







Aluminium goot

Fabrieksverklaring volgens EN 10204 – 2.1
voor EN AW-6063 T66

Hiermede bevestigt BOAL B.V. dat alle aan u geleverde profielen voldoen aan de specificaties zoals omschreven op onze order bevestigingen.

Deze specificaties omvatten zowel de onderstaande chemische samenstelling van het materiaal, als de mechanische eigenschappen en de maat- en vormtoleranties.

Chemische samenstelling:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Div.	Al
Min.	0,2				0,45					Restant
Max.	0,6	0,35	0,1	0,1	0,9	0,10	0,10	0,1	0,15	Restant

Mechanisch eigenschappen:

	Rp0,2 N/mm²	Rm N/mm²	A50mm %
Min.	200	245	8

$\alpha_k = 0.526$

Berekening statische waarden van een cirkelsegment.
Bron: Wolfram Math World.

Eerste Boog

$h_s := 1629 \cdot mm$ $c_s := 7075 \cdot mm$

$R_s := \frac{c_s^2 + 4 \cdot h_s^2}{8 \cdot h_s}$ $R_s = 4.655\,m$ $\phi := 2 \cdot \operatorname{asin}\left(\frac{c_s}{2 \cdot R_s}\right)$ $\phi = 1.726 \cdot rad$

Oppervlak: $A_s := R_s^2 \cdot \operatorname{acos}\left(\frac{R_s - h_s}{R_s}\right) - (R_s - h_s) \cdot \sqrt{2 \cdot R_s \cdot h_s - h_s^2}$ $A_s = 8\,m^2$

Booglengte: $s_s := R_s \cdot \phi$ $s_s = 8.036\,m$

Zwaartepunt: $y_z := h_s - R_s + \frac{4 \cdot R_s \cdot \sin(0.5 \cdot \phi)^3}{3(\phi - \sin(\phi))}$ $y_z = 0.662\,m$

$a := R_s - h_s$ $a = 3.026\,m$ $b := a^2 - R_s^2$ $b = -12.514\,m^2$

$\theta := 0 \cdot deg$ $x_0 := 0.5 \cdot c_s - \frac{-2a \cdot \tan(\theta) + \sqrt{(2a \cdot \tan(\theta))^2 - 4 \cdot (1 + \tan(\theta)^2) \cdot b}}{2 \cdot (1 + \tan(\theta)^2)}$ $x_0 = 0\,m$

$y_0 := \sqrt{R_s^2 - (0.5 \cdot c_s - x_0)^2} - (R_s - h_s)$ $y_0 = 0 \cdot mm$

$\theta = \begin{matrix} 0, \\ 22.5, \\ 55, \\ 70, \\ 115, \\ 155, \\ 180 \end{matrix}$

$x = \begin{pmatrix} 0 \\ 1.169 \\ 2.482 \\ 2.958 \\ 4.27 \\ 5.787 \\ 7.075 \end{pmatrix} m$ $y = \begin{pmatrix} 0 \\ 0.981 \\ 1.508 \\ 1.593 \\ 1.571 \\ 1.049 \\ 0 \end{pmatrix} m$

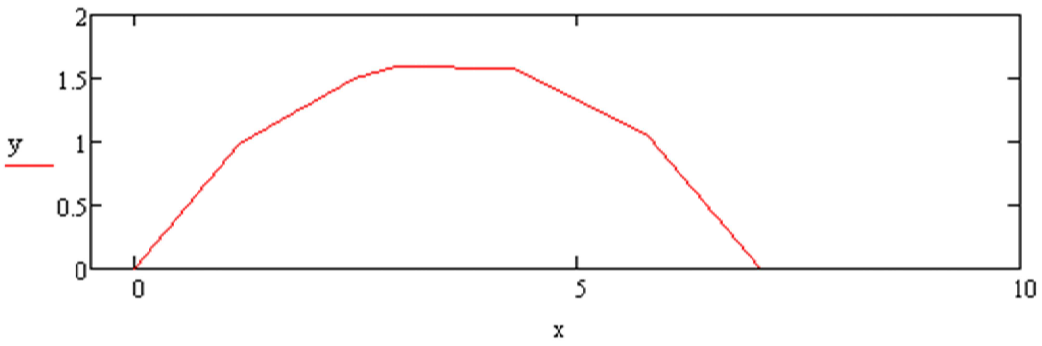
Boogkoorde: $c_s = 7.075\,m$

Booghoogte: $h_s = 1.629\,m$

Oppervlakte : $A_s = 8\,m^2$

Booglengte: $s_s = 8.036\,m$

Zwaartepunt: $y_z = 0.662\,m$



Groot Nibbelink Halle Bijlagen.

θ = 15,
35,
55,
80,
90,
100,
135,
165,
180

x =

	0
0	0
1	0.794
2	1.732
3	2.482
4	3.252
5	3.538
6	3.823
7	4.948
8	6.281
9	7.075

m

y =

	0
0	0
1	0.735
2	1.264
3	1.508
4	1.62
5	1.629
6	1.62
7	1.41
8	0.735
9	0

m

Vervolg bogen 7075

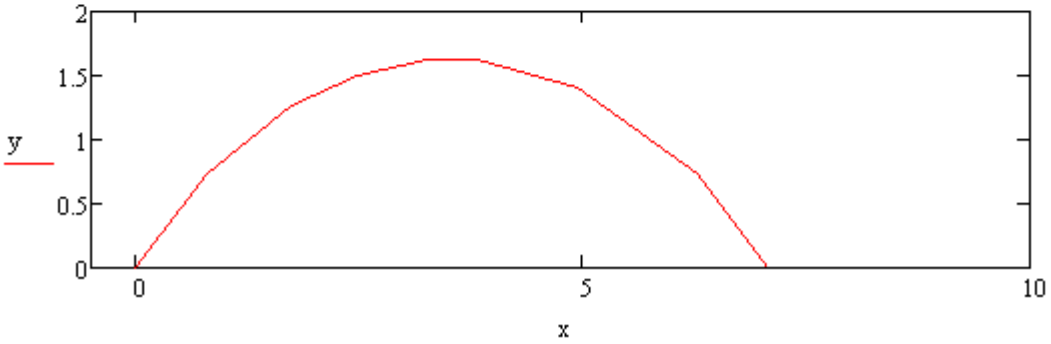
Boogkoorde: $c_s = 7.075\,m$

Booghoogte: $h_s = 1.629\,m$

Oppervlakte : $A_s = 8\,m^2$

Booglengte: $s_s = 8.036\,m$

Zwaartepunt: $y_z = 0.662\,m$



θ = 15,
35,
55,
80,
90,
100,
135,
165,
180

x =

	0
0	0
1	0.958
2	2.011
3	2.801
4	3.582
5	3.868
6	4.153
7	5.303
8	6.777
9	7.735

m

y =

	0
0	0
1	0.779
2	1.3
3	1.523
4	1.621
5	1.629
6	1.621
7	1.435
8	0.779
9	0

m

Vervolg bogen 7735

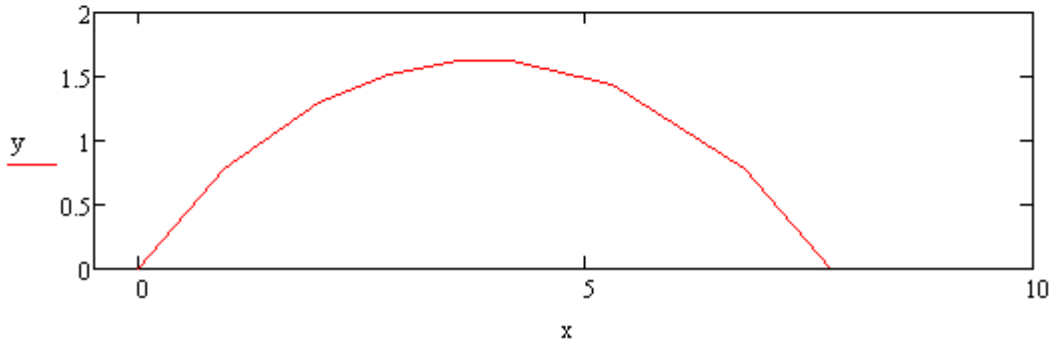
Boogkoorde: $c_s = 7.735\,m$

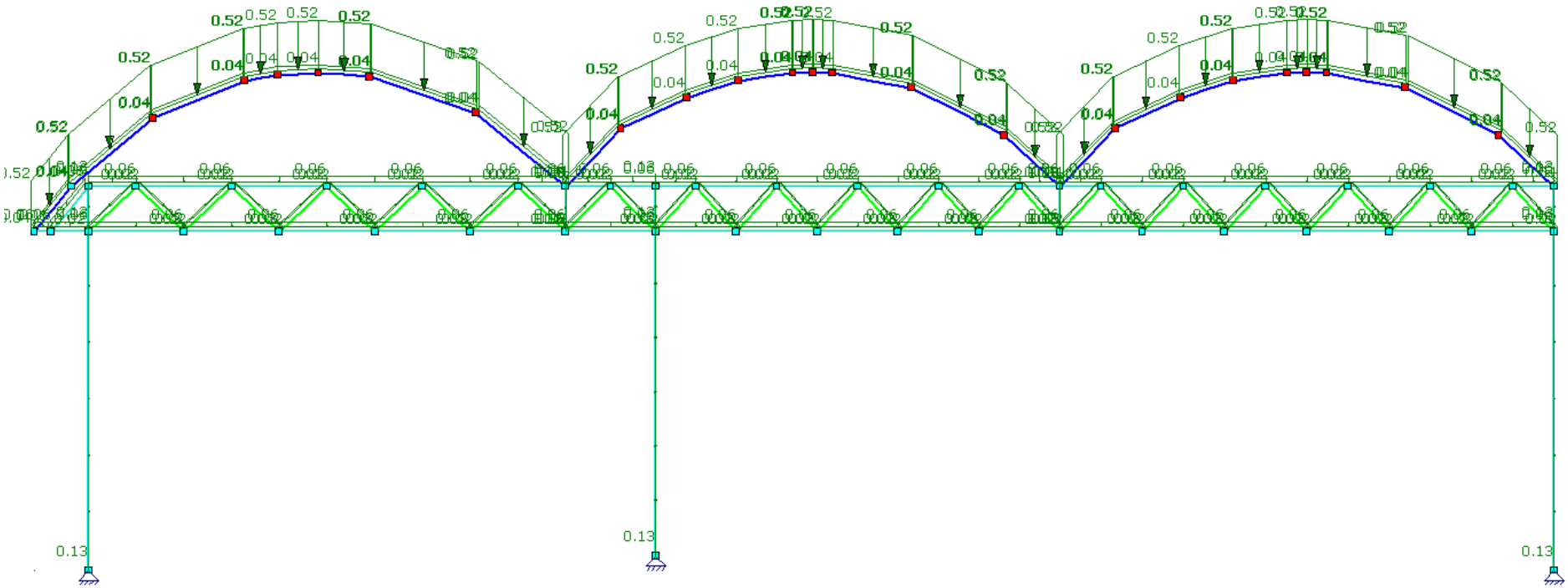
Booghoogte: $h_s = 1.629\,m$

Oppervlakte : $A_s = 8.691\,m^2$

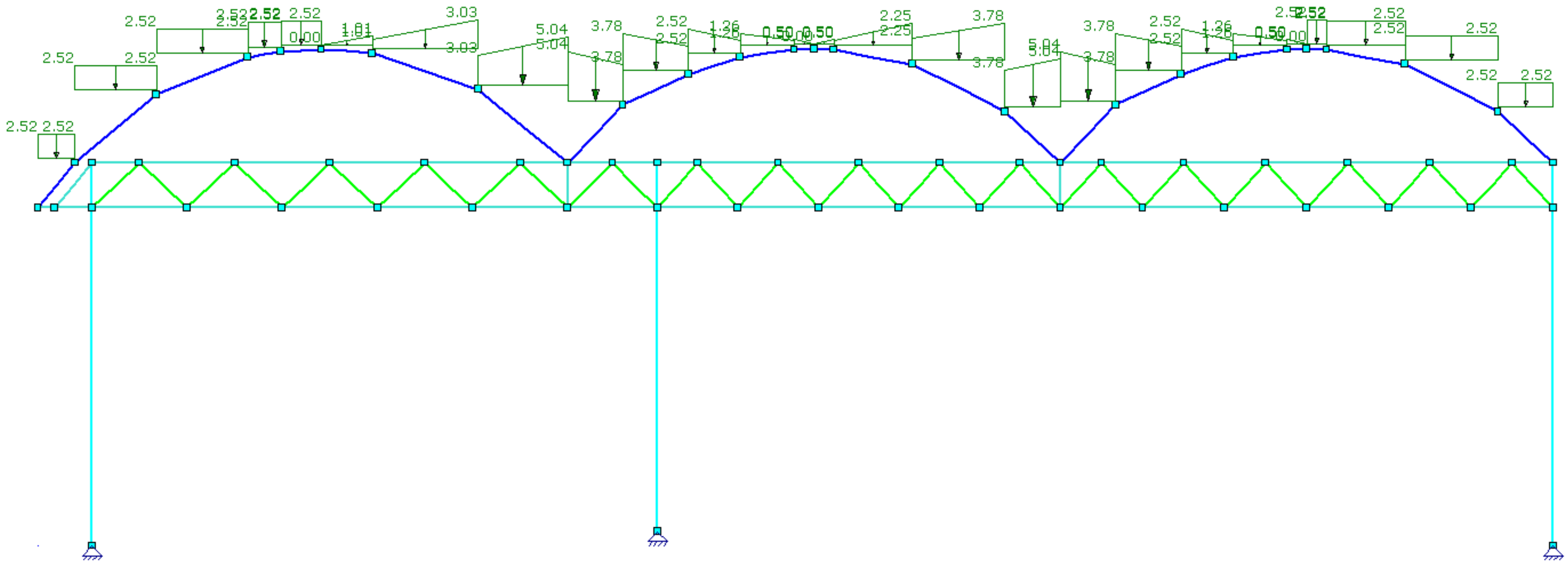
Booglengte: $s_s = 8.62\,m$

Zwaartepunt: $y_z = 0.661\,m$

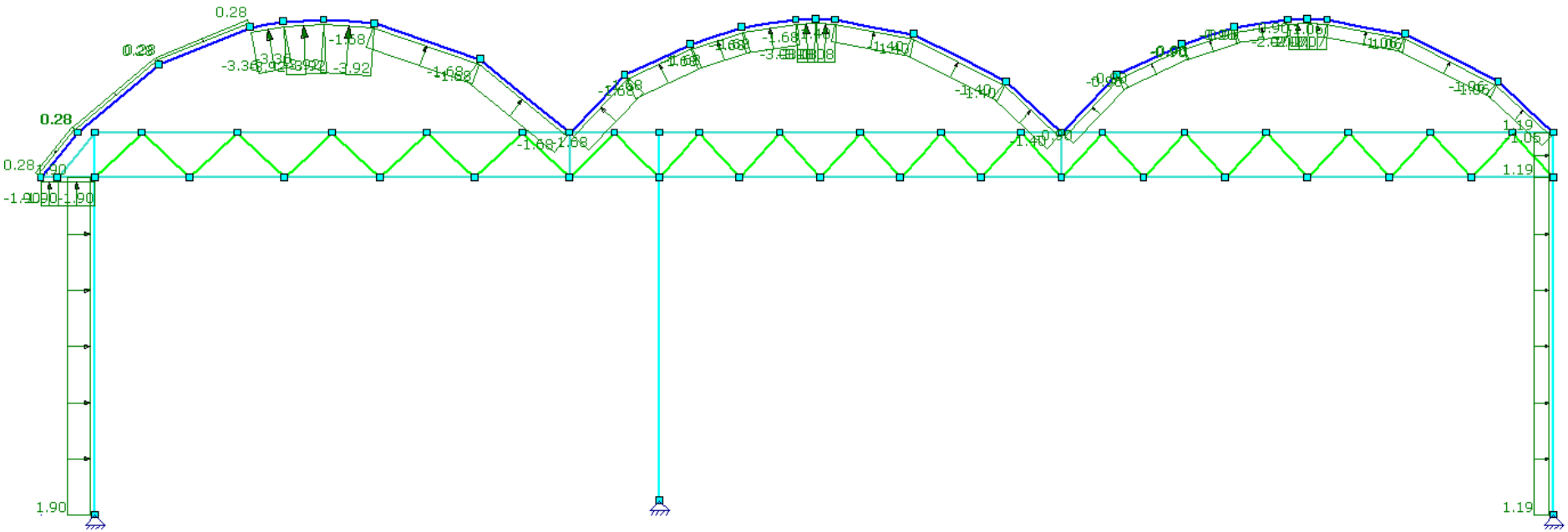




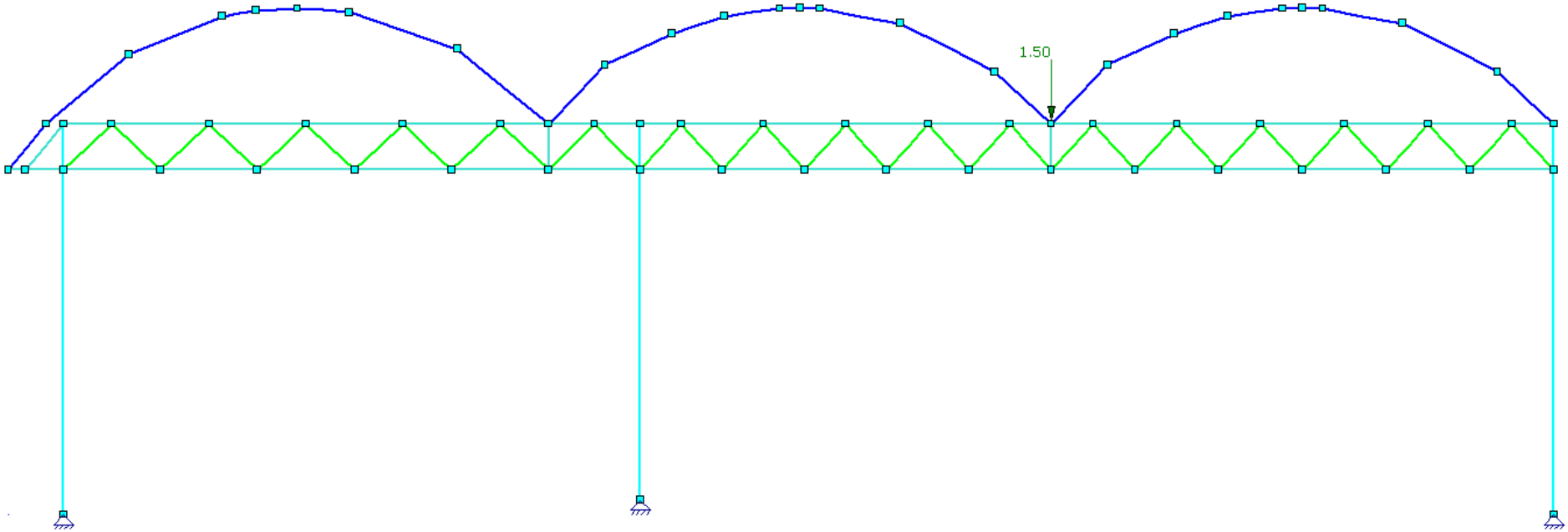
Blijvende belasting



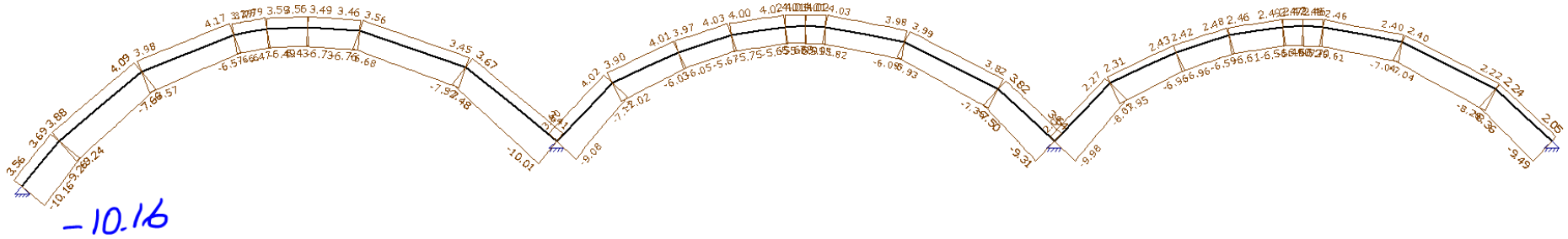
Sneeuw



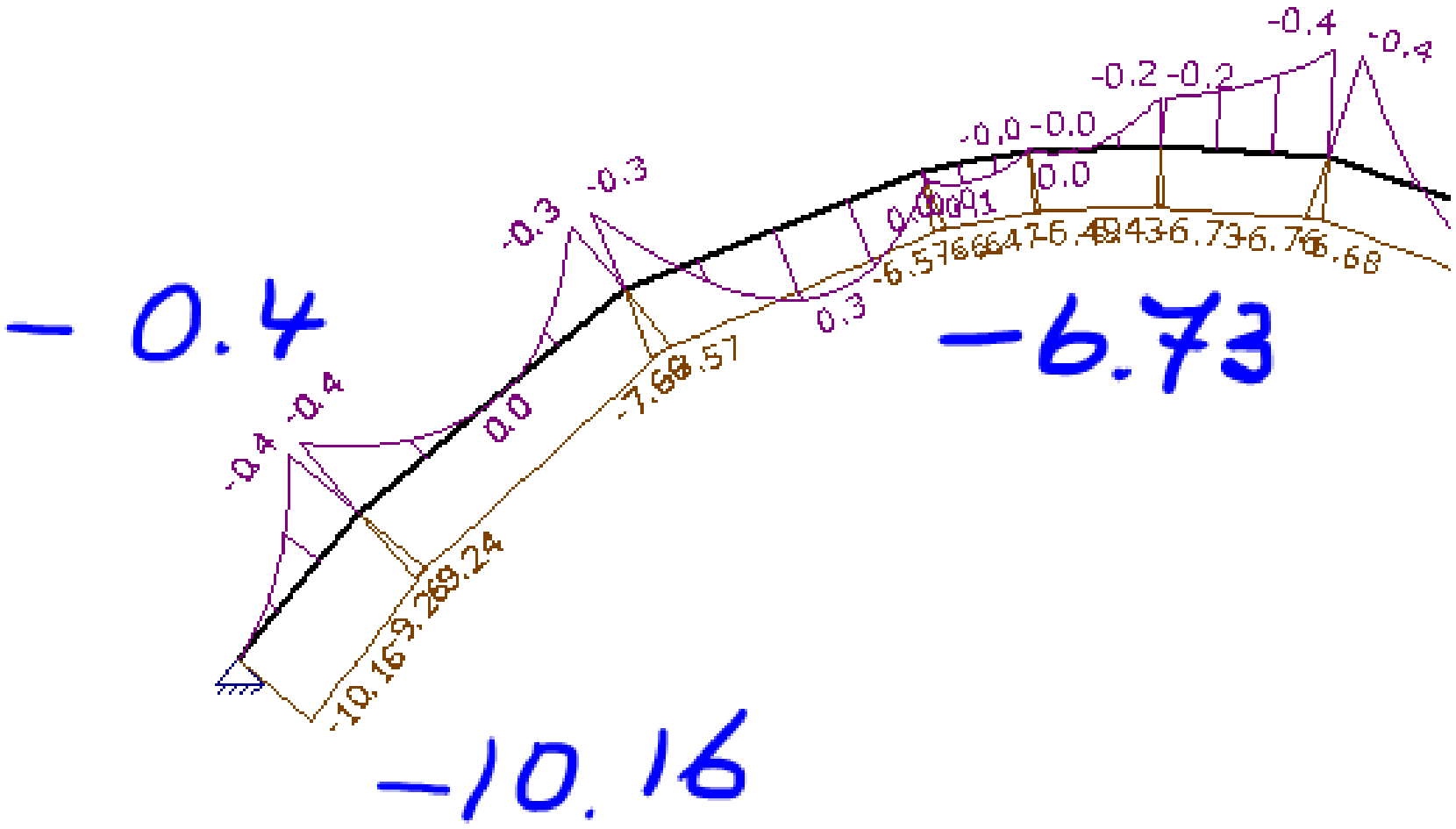
Wind



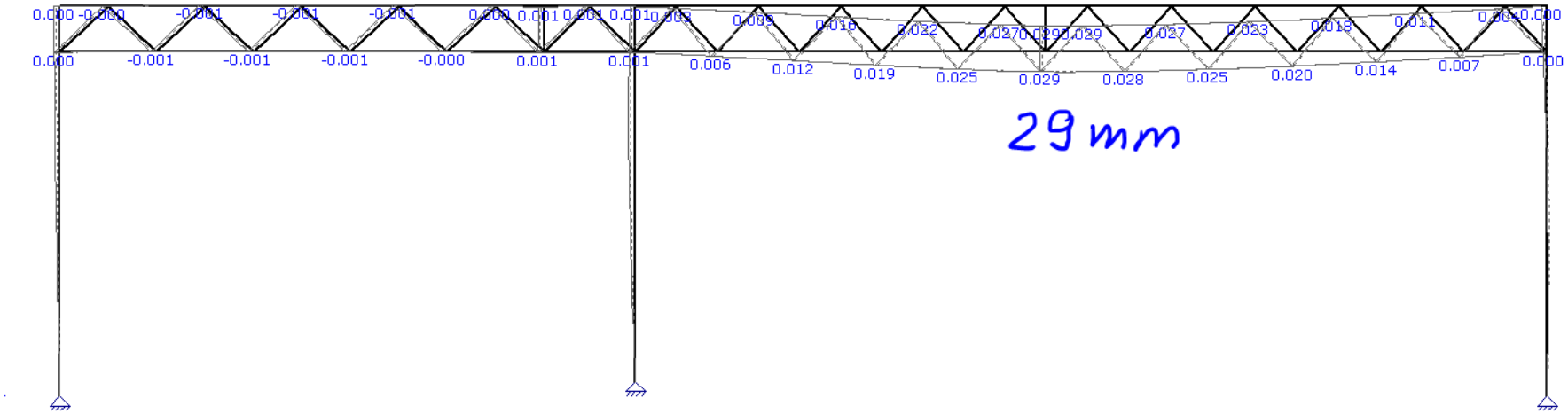
Gec vert belasting



Bogen, omhullende normaalkrachten.

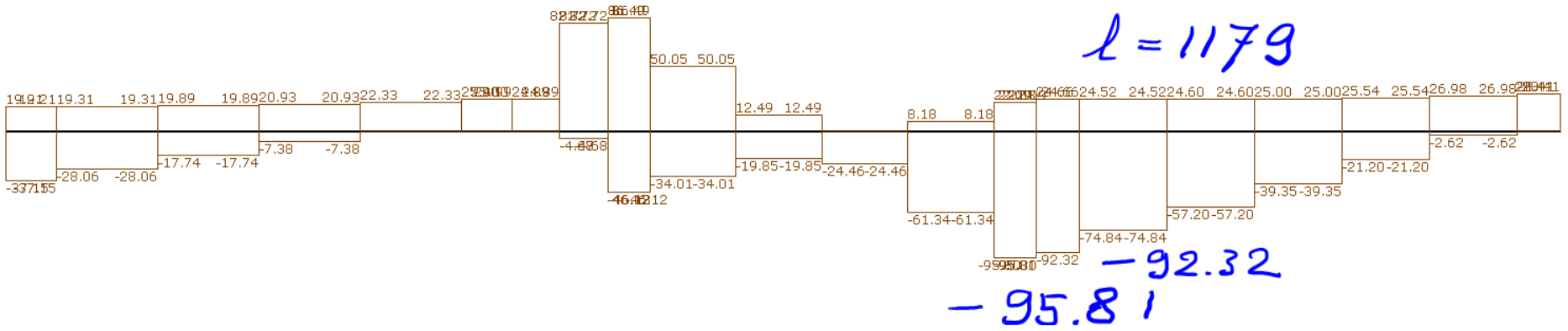


Bogen, omhullende normaalkracht met bijbehorend moment.

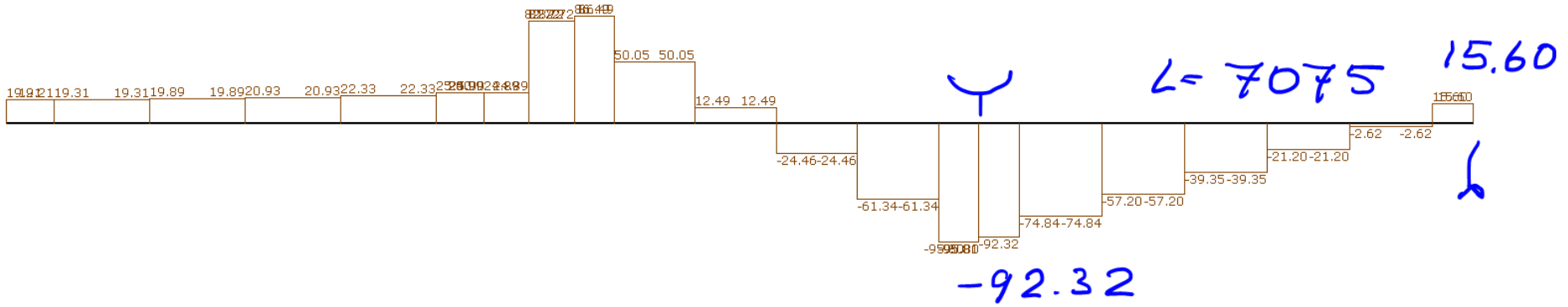


Doorbuiging

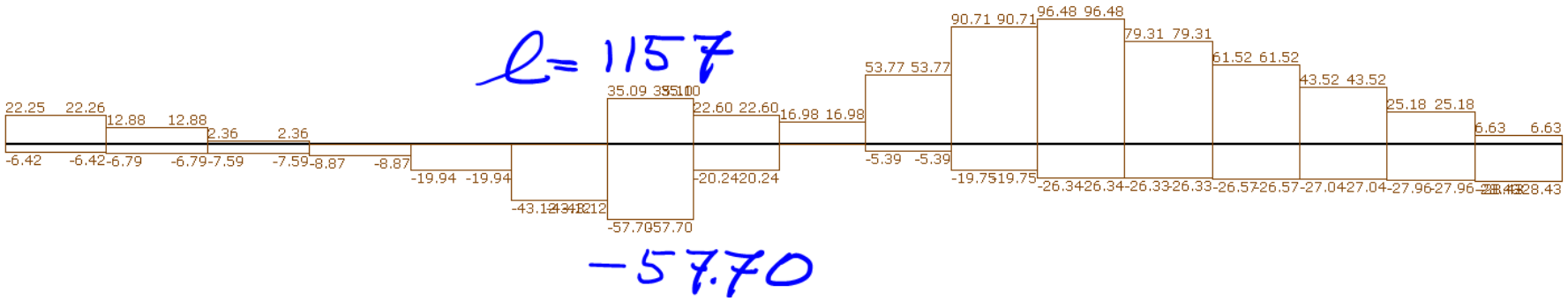
Groot Nibbelink Halle Bijlagen.



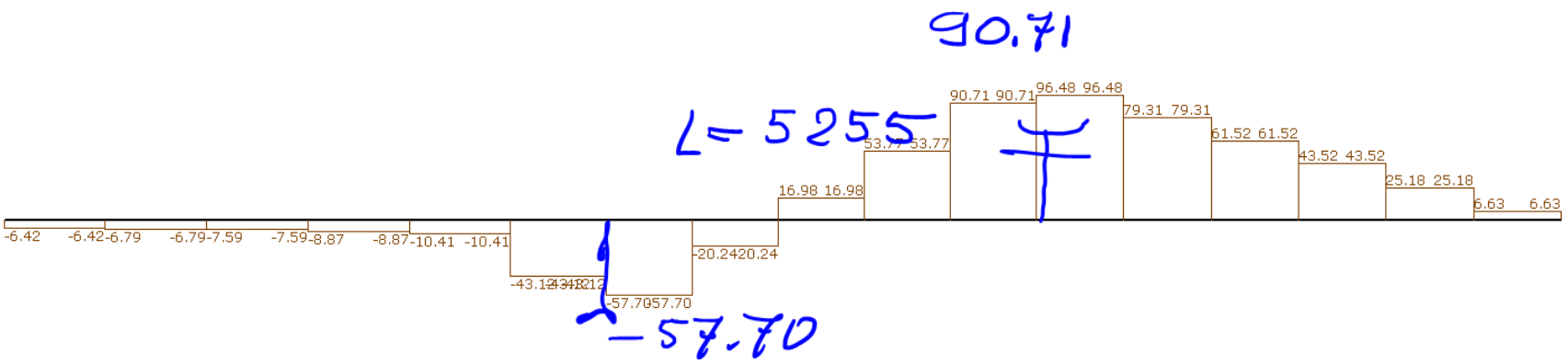
Bovenregel, omhullende normaalkrachten.



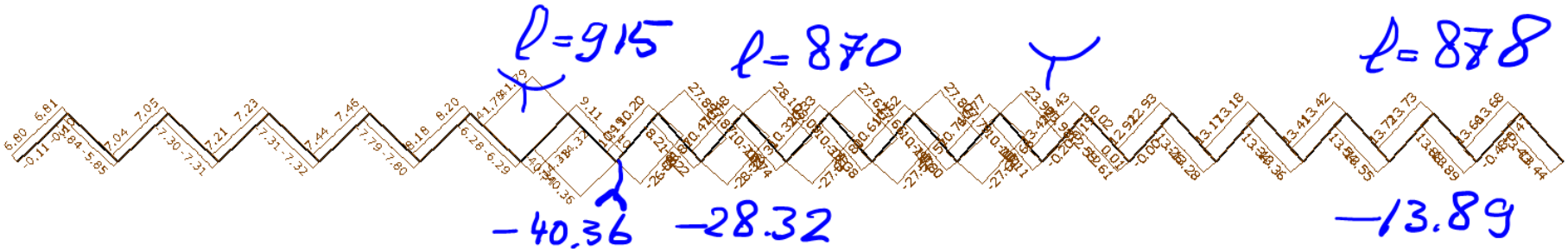
Bovenregel, normaalkrachten.



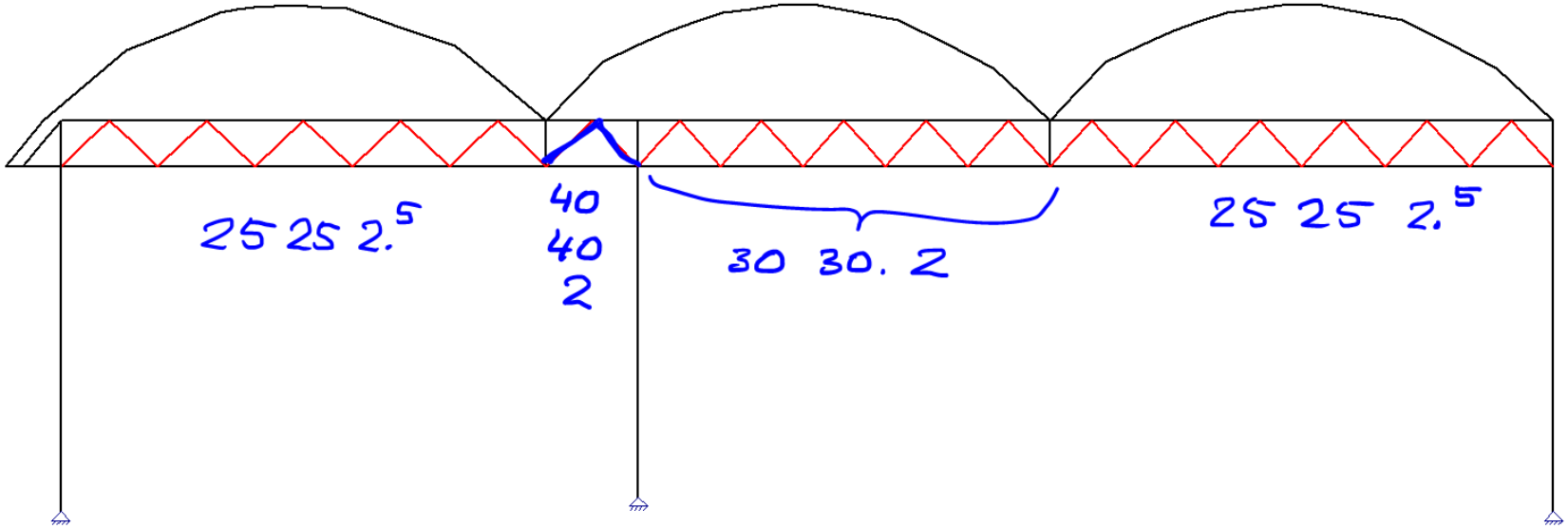
Onderregel, omhullende normaalkrachten.



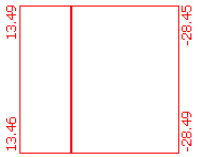
Onderregel, normaalkrachten.

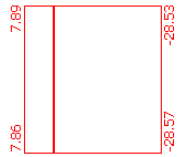


Diagonalen, omhullende normaalkrachten.



Diagonalen, indeling.

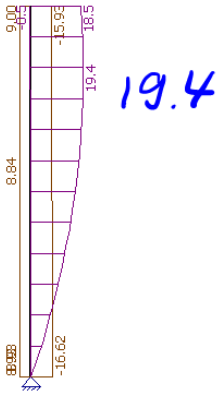




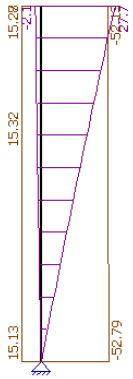
l = 650

−28.57

Gootvertikalen, omhullende normaalkrachten,

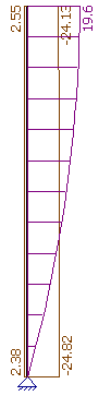


19.4



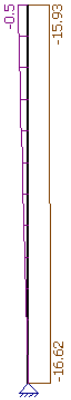
27.7

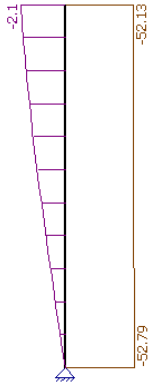
−52.79



19.6

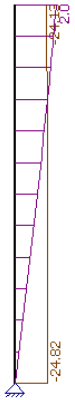
Kolommen, omhullende momenten en normaalkrachten.



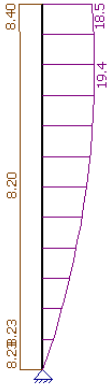


-2.1

-52.79

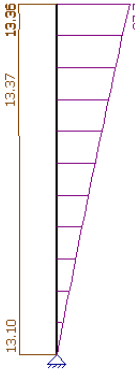


Kolommen, omhullende normaalkrachten en bijbehorende momenten.



8.40

19.4

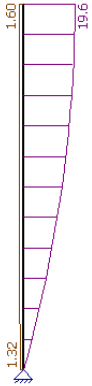


13.37

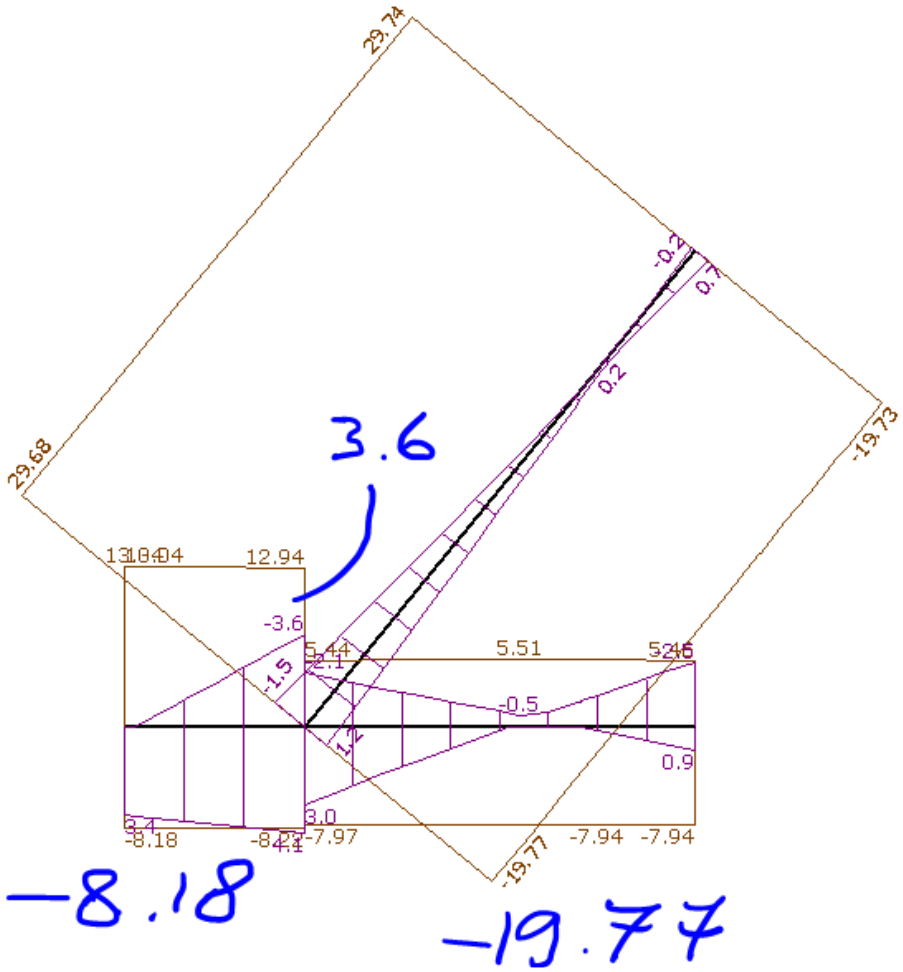
27.7

16.0

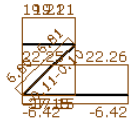
19.6

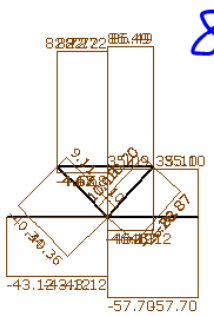


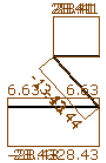
Kolommen, omhullende momenten en bijbehorende normaalkrachten.



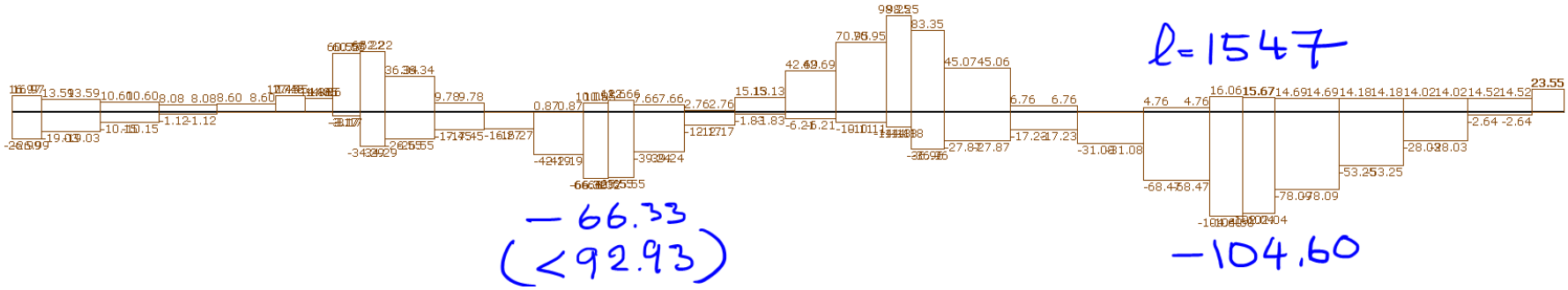
Overstek, omhullende waarden.



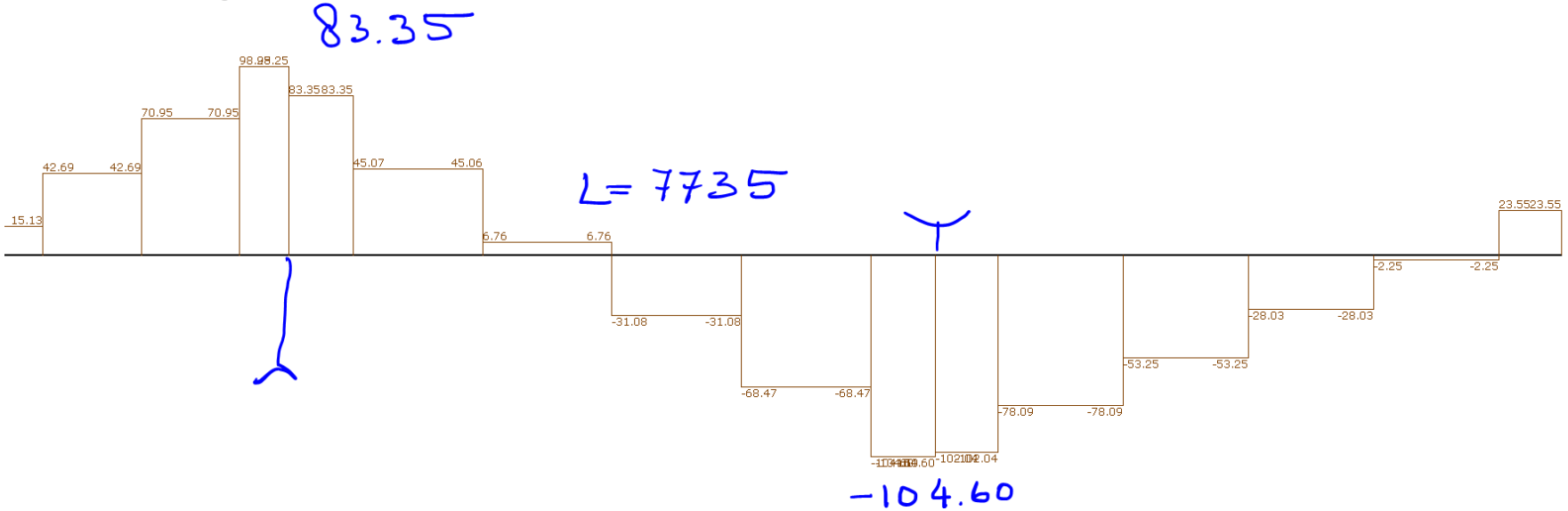




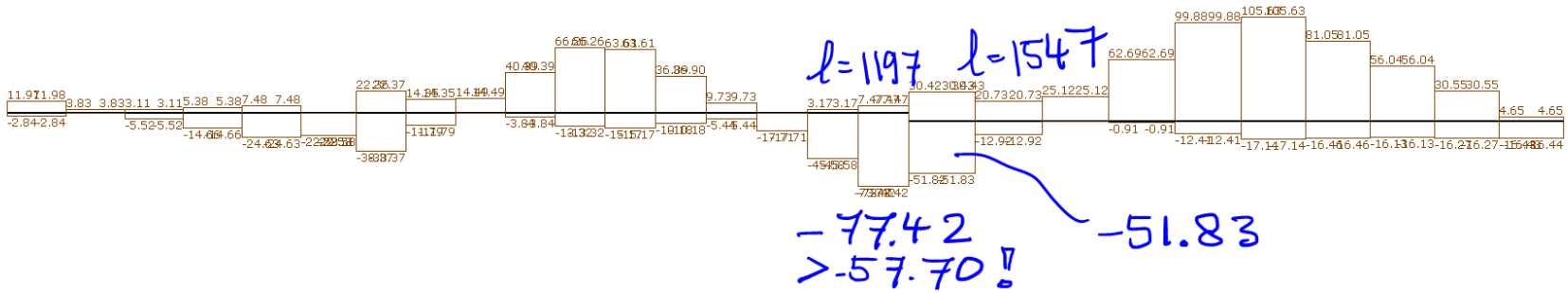
Omhullende knoopkrachten.



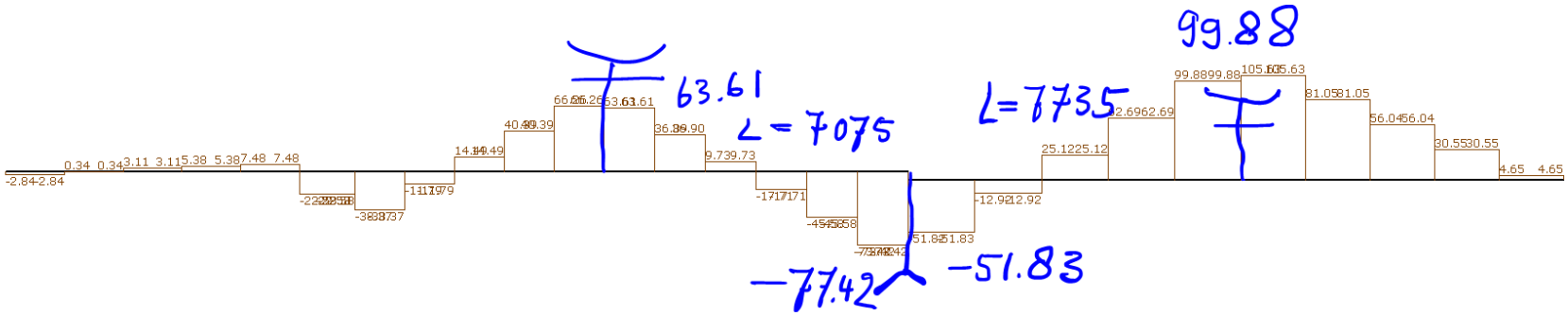
Fase 2, bovenregel, omhullende normaalkrachten



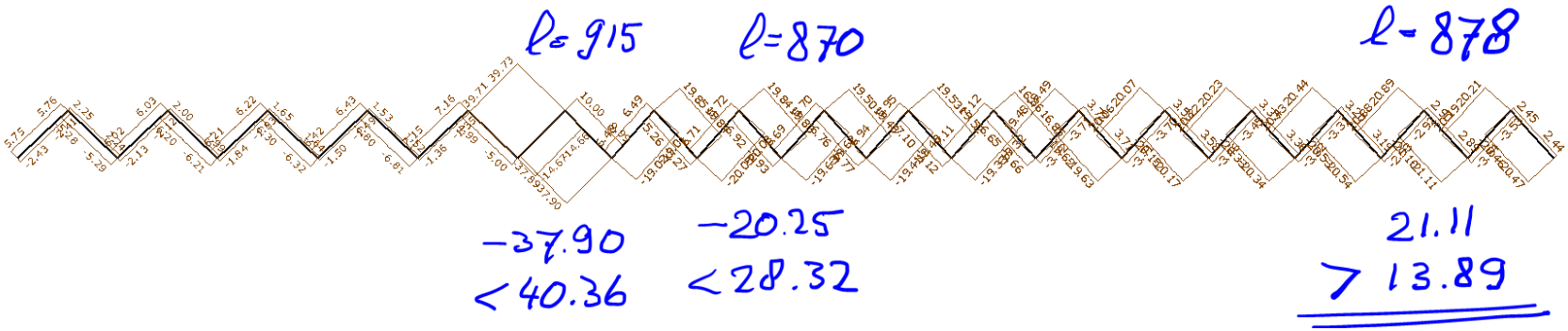
Fase 2, bovenregel, normaalkrachten.



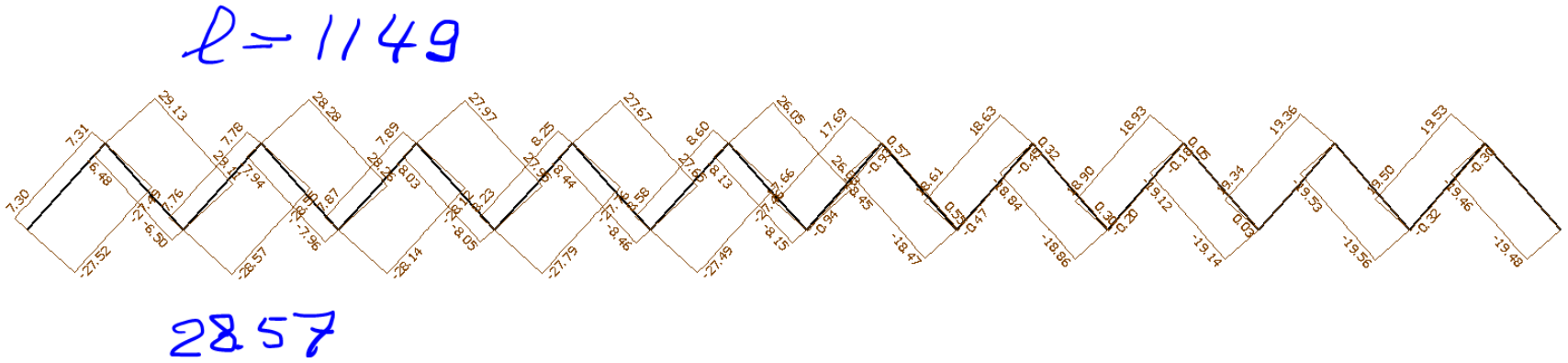
Fase 2, onderregel, omhullende normaalkrachten.



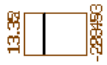
Fase 2, onderregel, normaalkrachten



Diagonalen laag deel, omhullende normaalkrachten en vergelijking met fase 1.



Gootvertikaal fase 2, omhullende normaalkrachten.



ℓ=650

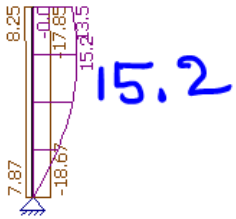
−27.56

<28.57

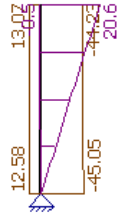
ℓ=850

33.04

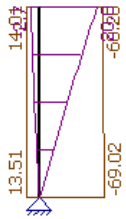
Gootvertikaal fase 2, omhullende normaalkrachten.



15.2

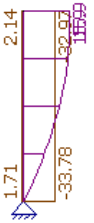


20.6



20.0

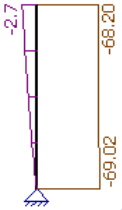
−69.02



15.9

Kolommen, omhullende waarden.

-2.7

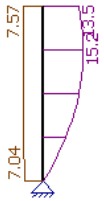


-69.02

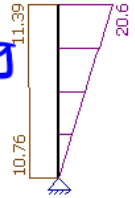
Kolommen, omhullende normaalkrachten en bijbeh momenten.

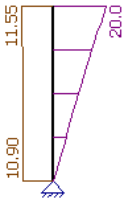
M

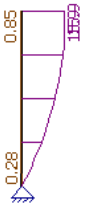
20.6



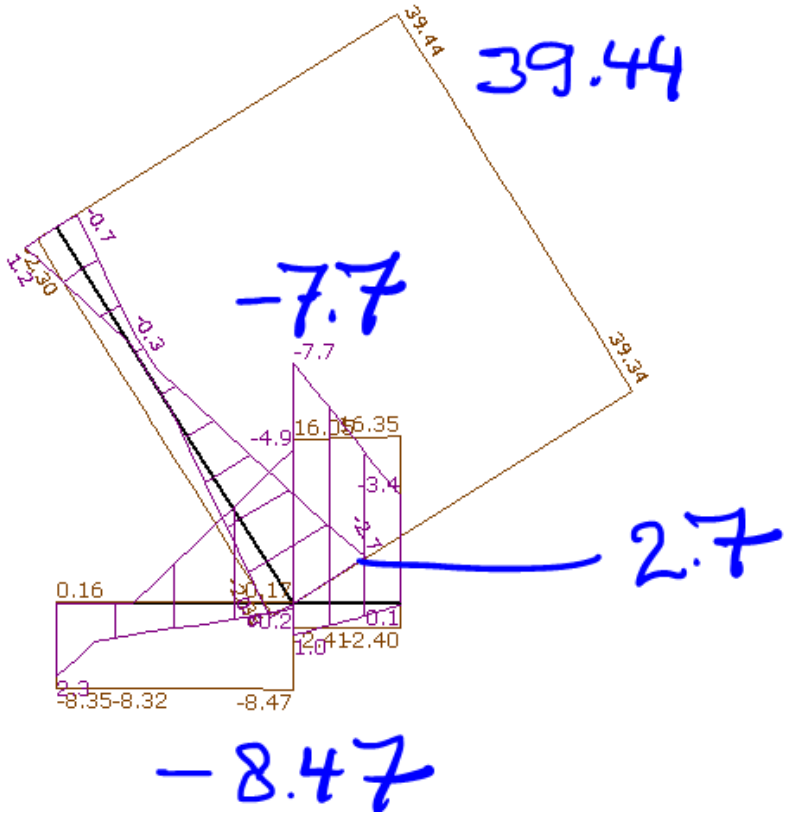
11.39



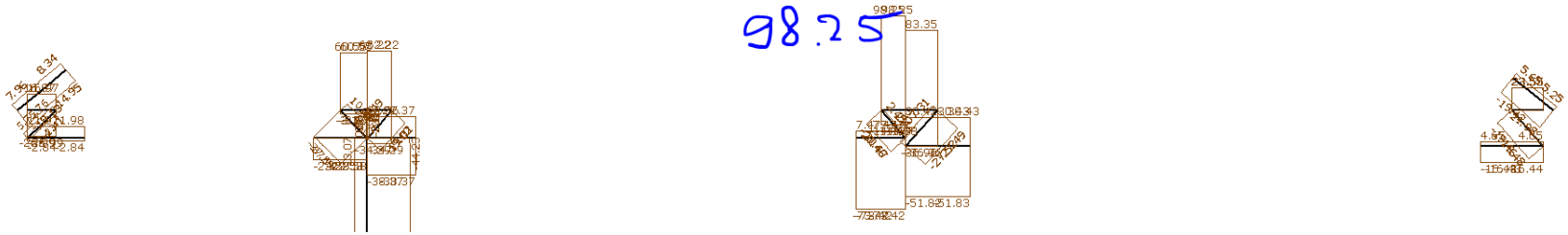




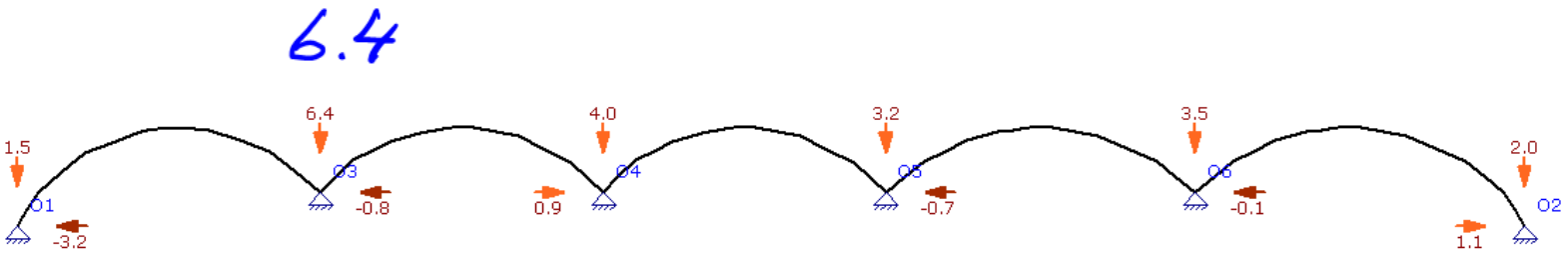
Kolommen, omhullende momenten en bijbeh normaalkrachten.



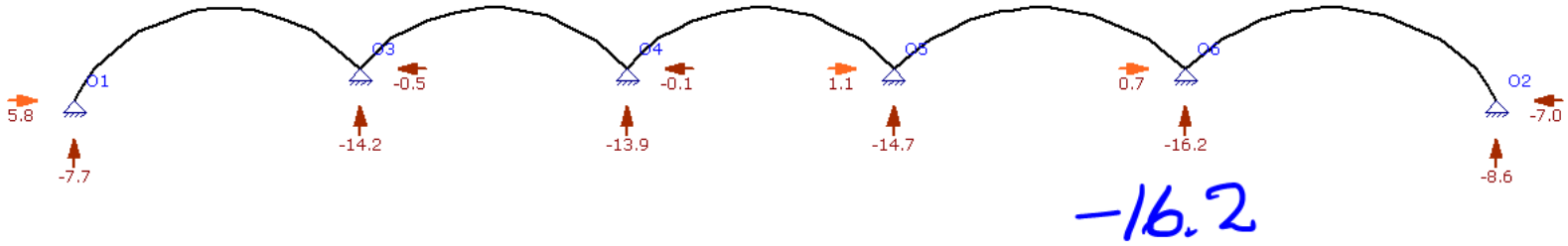
Overstek, omhullende waarden.



Knopen, omhullende normaalkrachten.



Boogreacties, wind.



Boogreacties, sneeuw