TEN TECH
DESIGN AND ENGINEERING OF LIGHTWEIGHT STRUCTURES

Inhoud:	**Tentbook (according to NEN-EN 8020-41:2012)**
Eigenaar Tentboek:	**Qtents**
Tentsysteem:	**10x20m stretch tent - HQ8**
Fabrikant:	**Qtents**
Documentcode:	**18.03.00344.1**
Auteur:	**ir. Nikie van Veen**
Datum:	**21.03.2018**

Tentsysteem:	10x20m stretch tent - HQ8
Documentcode:	18.03.00344.1
Eigenaar tentboek:	Qtents
Fabrikant:	Qtents De Beverspijken 13 5211 EE 's-Hertogenbosch T: +31 (0)73 2032590
Opsteller tentboek / berekening:	Tentech BV Ontwerp en advies voor lichtgewicht bouwen Postbus 85190 3508 AD Utrecht t +31 (0)30 252 1869 f +31 (0)30 254 1239 www.tentech.nl
Datum:	21.03.2018
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Geldig tot:	21.03.2023

1 Inleiding

Qtents is een bedrijf dat tenten produceert gemaakt van rekbaar tentdoek, zogenaamde stretchtenten. De rekbare eigenschap van het doek creëert een grote vormvrijheid. Afhankelijk van de locatie, kunnen er varianten gemaakt worden met een ander aantal / lengte van / plaatsing van masten en afspanningen. Dit resulteert in een op maat gemaakte tent voor elke locatie.

De constructieve berekeningen in dit rapport omvat de statische analyse van de 10x20m stretchtent voor een “geheel open” configuratie. Het is mogelijk om te variëren in afmeting, indien de kleinere tentafmeting wordt afgeleid van de geanalyseerde 10x20m configuratie. In dat geval is het van belang dat de opstelling van masten en afspanningen is gebaseerd op gelijke of kleinere afstanden, waarbij de 10x20m opstelling als startpunt wordt gebruikt. Zie hoofdstuk H.1 voor meer toelichting.

In dit document worden de benodigde gegevens voor een tentboek volgens de NEN 8020-41:2012 gebundeld en gepresenteerd voor de 10x20m stretchtent van Qtents.

Dit tentboek bevat:

- Eigendomsgegevens;
- Tekeningen van tent inclusief maatvoering, onderdelenaanduiding en benodigde verankering;
- Toelaatbare nuttige belasting;
- Maximaal toelaatbare windsnelheden (conform EN 1991-1-4:2005);
- Constructieve berekening (conform NEN-EN 13782:2015);
- Materiaalcertificaten (sterkte eigenschappen en brandeigenschappen).

Utrecht, ir. Nikie van Veen, 21.03.2018

2 Inhoudsopgave

3 Samenvatting

Eigenaar / Fabrikant:	Qtents De Beverspijken 13 5211 EE 's-Hertogenbosch T: +31 (0)73 2032590

Gegevens:		
Hoofd afmetingen:		**10 x 20m stretchtent**
	Breedte:	10.5m
	Lengte:	20m
	Zijkant hoogte doek:	2.5 - 3.0m
	Max. hoogte doek:	4.5m
	Membraan	HQ8
	Midden masten – 4.5m:	Ø94mm [Eucalyptus D35 / Kastanje D24] of ≥ Ø70x3mm [EN-AW 6060 T66 of hoger]
	Midden masten – 4.0m:	Ø90mm [Eucalyptus D35 / Kastanje D24] of Ø63x3mm [EN-AW 6060 T66 of hoger]
	Rand masten – 3.0m:	Ø73mm [Eucalyptus D35 / Kastanje D24] of ≥ Ø51x3mm [EN-AW 6060 T66 of hoger]
	Hoek masten – 2.5m:	Ø73mm [Eucalyptus D35 / Kastanje D24] of ≥ Ø51x3mm [EN-AW 6060 T66 of hoger]
	Stormband:	47mm PES, BL = 2800 kg
	Afspanning – lange zijde:	Band: 25mm PES, BL = 1200 kg, 3 snedes Touw: Ø8mm, BL = 1200 kg, 5 snedes
	Afspanning – korte zijde:	Band: 25mm PES, BL = 1200 kg, 3 snedes Touw: Ø8mm, BL = 1200 kg, 6 snedes
	Afspanning - driehoek:	Band: 25mm PES, BL = 1200 kg, 1 snede Touw: Ø8mm, BL = 1200 kg, 2 snedes
	Afspanning – hoek (2x):	Band: 25mm PES, BL = 1200 kg, 2 snedes Touw: Ø8mm, BL = 1200 kg, 4 snedes
	Verbindingsmiddelden	Minimaal benodigde breeksterkte:
	- Afspanning naar grond:	BL ≥ 3189 kg
	- Afspanning aan doek:	Midden BL ≥ 2272 kg, zijkant BL ≥ 1136 kg
	- Afspanning hoek:	BL ≥ 2035 kg
	Membraan Rand	Afwerking middels lussen of keder met klem.

Belastingen:	
Gebruikersbelasting:	Per kolom mag er maximaal 10 kg centrisch aangebracht worden.
Conventionele belasting:	0.1 kN/m^2 (gelijk aan 4cm sneeuw, overeenkomstig met de Franse CTS)
Windbelasting:	De berekening is gebaseerd op een winddruk van p_w = 500 N/m^2 ,EN 13782, par. 7.4.2.2. Het is mogelijk de winddruk te reduceren ($p_{w,red}$) door deze met een factor te vermenigvuldigen. Zo is er berekend vanaf welke windsnelheid de tent stormbanden nodig heeft. Er is tevens onderzocht bij welke windreductie maximaal 2 ankerpennen Ø25 x 936mm of 3 haringen т 25 x 50mm benodigd zijn. Er moeten dan wel stormbanden aangebracht zijn. $p_{w,basis}$ = 1.0 x 500 = 500 N/m^2 $p_{w,red,stormband}$ = 0.60 x 500 = 300 N/m^2 $p_{w,red,verankering}$ = 0.38 x 500 = 190 N/m^2 Deze stuwdrukken zijn omgerekend naar toelaatbare windsnelheden(1) voor Nederland en worden per opbouwsituatie weergegeven.

Veiligheid tegen verschuiven, opwaaien en omwaaien:	
Ankerkrachten:	Uitgangspunt: hoek ≥ 45 graden voor de afspanningen en stormbanden Per opbouwsituatie wordt de rekenwaarde van de ankerkrachten* opgegeven. ** zie paragraaf H.8.4 voor een toelichting op het berekenen van het benodigd aantal ankers wanneer ankertesten zijn uitgevoerd.*
Verankering middels grondpennen: (diameter x effectieve lengte)	Gebaseerd op dichte, niet samenhangende grond (zand grond) De benodigde aantallen zijn bepaald voor 3 verschillende ankers: - ankerpen **Ø35 x 1200mm** - ankerpen **Ø25 x 936mm** - T-haring **т 25 x 500mm** Op de volgende pagina's worden de aantallen per opbouwsituatie weergegeven.

Situatie 1: HQ8 – 500 N/m²

	Rekenwaarde ankerkracht
Afspanning – lange zijde	10.99 kN
Afspanning – korte zijde	12.76 kN
Afspanning hoek (2x)	8.14 kN
Stormband (per grondpunt)	7.60 kN

	Ø35 x 1200mm	**Ø25 x 936mm**	**т 25 x 500mm**
Afspanning – lange zijde	2x	3x	5x
Afspanning – korte zijde	3x	4x	6x
Afspanning hoek (2x)	2x	2x	4x
Stormband (per grondpunt)	2x	2x	4x

Stormbanden zijn noodzakelijk vanaf een stuwdruk van 300 N/m².

Stuwdruk	Windvlaag	Bebouwd	Onbebouwd	Kust
300 N/m²	87 km/u	> 7 BFT 19.46 m/s	> 7 BFT 18.25 m/s	> 6 BFT 13.82 m/s

Boven de hieronder gegeven windsnelheden dient de structuur ontruimd zijn.

HQ8: p_w = 500 N/m²

	Bebouwd NL cat: III	Onbebouwd NL cat: II	Kust NL cat: I
A. Beaufort (indicatief)	> 9 BFT	> 8 BFT	> 7 BFT
B. 10 min. gemiddelde windsnelheid	25.12 m/s 90.43 km/u	23.56 m/s 84.82 km/u	17.84 m/s 64.22 km/u
C. Piekwindsnelheid (windvlaag)	113 km/u	113 km/u	113 km/u

Gegeven waardes zijn bovengrenswaardes, m/s waardes(B) zijn 10min gemiddelde op 10m hoogte gemeten op het dichtstbijzijnde weerstations; windkracht in Beaufort (BFT) waardes ter indicatie gegeven

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Situatie 2: HQ8 – 190 N/m^2 – gereduceerde verankering

	Rekenwaarde ankerkracht
Afspanning – lange zijde	4.18 kN
Afspanning – korte zijde	4.85 kN
Afspanning hoek (2x)	3.10 kN
Stormband (per grondpunt)	2.89 kN

	Ø25 x 936mm	**т 25 x 500mm**
Afspanning – lange zijde	1x	2x
Afspanning – korte zijde	2x	3x
Afspanning hoek (2x)	1x	2x
Stormband (per grondpunt)	1x	2x

Stormbanden zijn noodzakelijk vanaf een stuwdruk van 125 N/m^2.

Stuwdruk	Windvlaag	Bebouwd	Onbebouwd	Kust
125 N/m^2	57 km/u	> 5 BFT 12.56 m/s	> 5 BFT 11.78 m/s	> 4 BFT 8.92 m/s

Boven de hieronder gegeven windsnelheden dient de structuur ontruimd te zijn.

Gereduceerde verankering: p_w = 190 N/m^2

	Bebouwd NL cat: III	Onbebouwd NL cat: II	Kust NL cat: I
A. Beaufort (indicatief)	> 6 BFT	> 6BFT	> 5 BFT
B. 10 min. gemiddelde windsnelheid	15.49 m/s 55.76 km/u	14.52 m/s 52.27 km/u	11.00 m/s 39.60 km/u
C. Piekwindsnelheid (windvlaag)	70 km/u	70 km/u	70 km/u

Gegeven waardes zijn bovengrenswaardes, m/s waardes(B) zijn 10min gemiddelde op 10m hoogte gemeten op het dichtstbijzijnde weerstations; windkracht in Beaufort (BFT) waardes ter indicatie gegeven

4 Tekening: Hoofdmaatvoering en verankering

Zie hoofdstuk E, Drawings: main dimensions and anchoring op pagina 10 van het berekeningsrapport.

5 Uitgangspunten en randvoorwaarden

Dit document geldt voor de gebouwde constructie wanneer de volgende uitgangspunten en randvoorwaarden zijn aangehouden:

- De gebruikte materialen, onderdelen en doorsneden (membraan, aluminium of houten masten, afspanningen, stormbanden, verankering) zijn zoals in dit document beschreven;
- De afmetingen van de opgebouwde constructie komen overeen met de maten in dit document OF the constructie voldoet aan de voorwaarden voor variatie in afmeting, zoals beschreven in paragraaf H.1;
- Er mogen geen onderdelen (masten, afspanningen, verankering) verwijdert worden;
- Obstakels dienen op ten minste 0,5m afstand van het membraan geplaatst te worden. (gemeten loodrecht op het doek) Het doek moet namelijk voldoende vervormingsvrijheid in alle richtingen krijgen om zo mogelijke beschadigingen door het aanstoten van een object te voorkomen;
- Boven de opgegeven windsnelheden (zie tabel in 3 Samenvatting en 6.1 Toelaatbare windsnelheden) dient de structuur ontruimd te zijn en toegang voor het publiek ontzegd;
- Er mogen alleen decoratie elementen, licht- en/of geluids-installaties van minder dan 10kg per paal worden opgehangen aan de constructie. (centrisch belast);
- Er is rekening gehouden met een conventionele belasting van 0.1 kN/m^2 zoals voorgeschreven wordt in de NEN 13782. Dit komt tevens overeen met een sneeuwbelasting (4cm) volgens de Franse CTS.

6 Toelichting

6.1 Toelaatbare windsnelheden

Wind kan op verschillende manieren uit gedrukt worden:

- 10 minuten gemiddelde windsnelheid – een gemiddelde windsnelheid over 10minuten gemeten op 10m hoogte in een open terrein (NEN-EN 1991-1-4 NB NL terreincategorie II).
- Piekwindsnelheid – een kortstondige maximale windstoot met een bepaalde snelheid, afhankelijk van de hoogte. Vaak gegeven in km/u.

De stuwdruk waarop een tent berekend is, is bepalend voor de sterkte van de tent. Het gaat er dus om dat op de juiste manier wordt vastgesteld welke windsnelheid moet worden aangehouden om te kunnen bepalen of de stuwdruk overschreden wordt.

In de constructieve berekening is gebaseerd op een stuwdruk van **500 N/m^2 tot 5m hoogte.** Vanaf een stuwdruk gelijk aan **300 N/m^2 tot 5m hoogte** zijn stormbanden noodzakelijk. Daarnaast is onderzocht bij welke stuwdruk maximaal 2 ankerpennen Ø25 x 936mm of 3 haringen т 25 x 50mm benodigd zijn. Dit is bij **190 N/m^2 tot 5m hoogte**. Voorgaande stuwdrukken zijn omgerekend naar windsnelheden (zie volgende pagina). Boven de hieronder gegeven windsnelheden dient de structuur ontruimd te zijn.

p_w = 500 N/m^2

	Bebouwd[1] NL cat: III	Onbebouwd[2] NL cat: II	Kust[3] NL cat: I
A. Beaufort (indicatief)	> 9 BFT	> 8 BFT	> 7 BFT
B. 10 min. gemiddelde windsnelheid	25.12 m/s 90.43 km/u	23.56 m/s 84.82 km/u	17.84 m/s 64.22 km/u
C. Piekwindsnelheid (windvlaag)	113 km/u	113 km/u	113 km/u

Gereduceerde verankering : p_w = 190 N/m^2

	Bebouwd[1] NL cat: III	Onbebouwd[2] NL cat: II	Kust[3] NL cat: I
A. Beaufort (indicatief)	> 6 BFT	> 6BFT	> 5 BFT
B. 10 min. gemiddelde windsnelheid	15.49 m/s 55.76 km/u	14.52 m/s 52.27 km/u	11.00 m/s 39.60 km/u
C. Piekwindsnelheid (windvlaag)	70 km/u	70 km/u	70 km/u

1. *Met een bebouwde omgeving wordt bedoeld: binnen de bebouwde kom met voldoende beschutting in Nederland.*
2. *Met een onbebouwde omgeving wordt bedoeld: buiten de bebouwde kom, of binnen de bebouwde kom met weinig beschutting in Nederland.*
3. *Met kust wordt bedoeld: de kortste afstand van de constructie tot aan het water bedraagt minder dan 50m en het betreffende water is 2km lang vrij van obstakels.*

Bovenstaande waardes (A, B en C) kunnen op verschillende manieren gemeten worden en kunnen alle drie onafhankelijk van elkaar gebruikt worden:

A. Dit is een indicatieve Beaufort schaal welke hoort bij de 10 minuten gemiddelde windsnelheid, deze waarde moet afkomstig zijn van het dichtstbijzijnde meteostation.
B. 10 min gemiddelde windsnelheid op 10 meter hoogte in een open terrein, deze waarde moet afkomstig zijn van het dichtstbijzijnde meteostation.
C. Windvlaagsnelheid, deze waarde moet gemeten zijn ter plaatse van de tent op 10m hoogte.

6.2 Windsnelheid berekening

De stuwdrukken worden middels de NEN-EN 1991-1-4 omgerekend naar windsnelheden voor een bebouwde omgeving (categorie III), onbebouwde (categorie II) en kust omgeving (categorie I), uitgaande van een terreinruwheid volgens de Nederlandse NB.

	Met stormbanden	**Gereduceerde verankering**	
Factor	**α = 1.00**	**α = 0.38**	
Stuwdruk p_w	500 N/m^2	190 N/m^2	Op 5**m** hoogte
Bijbehorende stuwdruk voor piekwind $p_{w,peak}$	605 N/m^2	230 N/m^2	Op **10m** hoogte

Het HQ8 doek heeft stormbanden nodig vanaf een stuwdruk van 300 N/m^2 (α = 0.60).
Bij een gereduceerde verankering moeten stormbanden ingezet worden vanaf 125 N/m^2 (α = 0.25).

Piekwindsnelheid op 10m hoogte

$605 \times {}^1/_2 \times \rho \times v^2 = {}^1/_2 \times 1.25 \times v^2 \rightarrow v = 31.1\ {}^m/_s \rightarrow 113\ {}^{km}/_u$	**Verg. 4.10 NEN-EN 1991-1-4 Basisstuwdruk**
$230 \times {}^1/_2 \times \rho \times v^2 = {}^1/_2 \times 1.25 \times v^2 \rightarrow v = 19.2\ {}^m/_s \rightarrow 70\ {}^{km}/_u$	**Verg. 4.10 NEN-EN 1991-1-4 Basisstuwdruk**

Windsnelheid bebouwd gebied op 10m hoogte

$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0.5}{0.05}\right)^{0.07} = 0.22$	**Verg. 4.5 NEN-EN 1991-1-4 Terreinfactor**
$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.22 \times ln\left(\frac{7}{0.5}\right) = 0.59$	**Verg. 4.4 NEN-EN 1991-1-4 Ruwheidsfactor**
$V_m = C_r \times V_b = 0.59 \times V_b$	**Verg. 4.3 NEN-EN 1991-1-4 Gemiddelde windsnelheid op hoogte**
$\sigma_v = K_r \times V_b = 0.22 \times V_b$	**Verg. 4.6 NEN-EN 1991-1-4 Standaardafwijking van de turbulentie**
$L_v = \frac{\sigma_v}{V_m} = \frac{0.22 \times V_b}{0.59 \times V_b} = 0.33$	**Verg. 4.7 NEN-EN 1991-1-4 Turbulentie intensiteit**
$Q_p = (1 + 7 \times L_v) \times {}^1/_2 \times \rho \times {V_m}^2 = 0.79 \times {V_b}^2$	**Verg. 4.8 NEN-EN 1991-1-4 Extreme stuwdruk**
$500 = 0.79 \times {V_b}^2 \rightarrow V_b = 25.12\ {}^m/_s$	**Karakteristieke windsnelheid**
$190 = 0.79 \times {V_b}^2 \rightarrow V_b = 15.49\ {}^m/_s$	**Karakteristieke windsnelheid**

Windsnelheid onbebouwd gebied op 10m hoogte

$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0.2}{0.05}\right)^{0.07} = 0.21$	**Verg. 4.5 NEN-EN 1991-1-4** **Terreinfactor**
$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.21 \times ln\left(\frac{5}{0.2}\right) = 0.67$	**Verg. 4.4 NEN-EN 1991-1-4** **Ruwheidsfactor**
$V_m = C_r \times V_b = 0.67 \times V_b$	**Verg. 4.3 NEN-EN 1991-1-4** **Gemiddelde windsnelheid op hoogte**
$\sigma_v = K_r \times V_b = 0.21 \times V_b$	**Verg. 4.6 NEN-EN 1991-1-4** **Standaardafwijking van de turbulentie**
$L_v = \frac{\sigma_v}{V_m} = \frac{0.21 \times V_b}{0.67 \times V_b} = 0.31$	**Verg. 4.7 NEN-EN 1991-1-4** **Turbulentie intensiteit**
$Q_p = (1 + 7 \times L_v) \times {}^1/_2 \times \rho \times {V_m}^2 = 0.90 \times {V_b}^2$	**Verg. 4.8 NEN-EN 1991-1-4** **Extreme stuwdruk**
$500 = 0.79 \times {V_b}^2 \rightarrow V_b = 23.56\, {}^m/_s$	**Karakteristieke windsnelheid**
$190 = 0.79 \times {V_b}^2 \rightarrow V_b = 14.52\, {}^m/_s$	**Karakteristieke windsnelheid**

Windsnelheid kust gebied op 10m hoogte

$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0{,}005}{0.05}\right)^{0.07} = 0{,}16$	**Verg. 4.5 NEN-EN 1991-1-4** **Terreinfactor**
$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0{,}16 \times ln\left(\frac{5}{0{,}005}\right) = 1{,}12$	**Verg. 4.4 NEN-EN 1991-1-4** **Ruwheidsfactor**
$V_m = C_r \times V_b = 1{,}12 \times V_b$	**Verg. 4.3 NEN-EN 1991-1-4** **Gemiddelde windsnelheid op hoogte**
$\sigma_v = K_r \times V_b = 0{,}16 \times V_b$	**Verg. 4.6 NEN-EN 1991-1-4** **Standaardafwijking van de turbulentie**
$L_v = \frac{\sigma_v}{V_m} = \frac{0{,}16 \times V_b}{1{,}12 \times V_b} = 0{,}14$	**Verg. 4.7 NEN-EN 1991-1-4** **Turbulentie intensiteit**
$Q_p = (1 + 7 \times L_v) \times {}^1/_2 \times \rho \times {V_m}^2 = 1{,}57 \times {V_b}^2$	**Verg. 4.8 NEN-EN 1991-1-4** **Extreme stuwdruk**
$500 = 0.79 \times {V_b}^2 \rightarrow V_b = 17.84\, {}^m/_s$	**Karakteristieke windsnelheid**
$190 = 0.79 \times {V_b}^2 \rightarrow V_b = 11.00\, {}^m/_s$	**Karakteristieke windsnelheid**

6.3 Index / toelichting constructieve berekening

Toelichting	Paginanummer
<u>Geometrie</u> Een 10.5x20m tentafmeting is berekend. De commerciële naam betreft 10x20m. Het is tevens mogelijk om kleinere tentafmetingen te bouwen, zie regels H.1	10 en 18
<u>Belastingaannames en combinaties</u> De berekening is gebaseerd op een winddruk van p_w = 500 N/m², volgens de EN 13782, par. 7.4.2.2. Voor een alternatieve verankering is vervolgens de wind gereduceerd door deze met een factor te vermenigvuldigen. Met stormbanden: geen reductie → stuwdruk $p_{w,}$ = 500 N/m² Gereduceerde verankering: factor 0.38 → stuwdruk $p_{w,red,verankering}$ = 190 N/m² Stormbanden zijn noodzakelijk vanaf 300 N/m². Indien wordt uitgegaan van de gereduceerde verankering, dienen stormbanden geïnstalleerd te zijn vanaf 125 N/m². 2 verschillende windbelastingen zijn beschouwd: Wind opwaarts – 'floating' structuur cp factor = -0.7 Wind neerwaarts – 'floating' structuur cp factor = 0.3 Een conventionele belasting van 0.1 kN/m² (gelijk aan 4cm sneeuw, volgens de Franse CTS) is meegenomen. Gebruiksbelasting: Per kolom mag er maximaal een belasting van 10 kg centrisch aangebracht worden. Belasting combinaties volgens NEN-EN13782	23 t/m 26
<u>Membraanspanningen, kabel- en elementkrachten</u> 3D berekening uitgevoerd middels geometrisch niet-lineair rekenpakket: EASY Een overzicht van de resulterende krachten wordt hier gegeven.	27 t/m 38
<u>Toetsing elementen</u> Sterktecontrole van de masten uitgevoerd conform NEN-EN 1999-1-1 en NEN-EN 1995-1-1; Sterktecontrole van de touwen, banden en het membraan uitgevoerd conform NEN-EN 13782	39 t/m 46
<u>Veiligheid tegen verschuiven, opwaaien en omwaaien</u> Anker bepaling volgens NEN-EN 13782	47 t/m 49
<u>Materiaal certificaten</u>	51
<u>Bijlagen</u> Software input en output wordt weergegeven, waaronder reactiekrachten en optredende interne krachten per element, per belastingcombinatie.	Vanaf 52

7 Materiaalcertificaten

Zie hoofdstuk I, Material vanaf pagina 51 van het berekeningsrapport.

8 Constructieve berekening

De volgende pagina’s bevatten de rapportage van de constructieve berekening van de tent.

Content:	**Static Analysis (according to EN 13782)**
Owner Tentbook:	**Qtents**
Tent system:	**10x20m stretch tent - HQ8**
Manufacturer:	**Qtents**
Document code:	**18.03.00344.1**
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A. **Introduction**

Qtents is a company that creates tent structures of flexible membrane, the so called Stretch Tents. The stretchable characteristic allows a freedom of form as there is not a pre-described shape necessary. Depending on the location, variations can be made with the number, length and placement of poles and ties. This results in a custom made cover at each new location.

The structural analysis within this report covers the static analysis of the 10x20m stretch tents in a floating configuration. It is possible to vary in dimensions when the smaller tent sizes are derived from the analysed 10x20m configuration. In that case, it is of significant importance to use similar (or more favourable) arrangements of poles and guy ropes based on spacing, using the 10x20m arrangement as a starting point.

This document contains the data required for a tent book, according to EN 13782, for the 10x20m stretchtent of Qtents.

This tent book includes

- Ownership data;
- Drawings of the tent, including dimensions, indications of elements and required anchoring.
- Permitted live load;
- Maximum wind speeds (according to EN 1991-1-4:2005);
- Structural analysis (according to EN 13782:2015);
- Material certificates (strength properties and fire properties).

Utrecht, ir. Nikie van Veen, 21.03.2018

B. Contents

C. Codes and standards

▪	EN 1990	Eurocode, Basis of structural Design
▪	EN 1991	Eurocode 1, Part 1-4: General actions - wind actions.
▪	EN 1993	Eurocode 3, Design of steel structures
▪	EN 1995	Eurocode 5, Design of timber structures
▪	EN 1999	Eurocode 9, Design of Aluminium structures
▪	EN 13782	Temporary Structures – Tents - Safety
▪	EN 10204	Products of steel –inspections documents
▪	EN 12195-2	Belts
▪	ISO 1141	Synthetic fiber ropes Polyester
▪	ISO 1346	Synthetic fiber ropes Polypropylene
▪	ISO 1969	Synthetic fiber ropes Polyethylene

D. Summary

Owner / Manufacturer:	Qtents De Beverspijken 13 5211 EE 's-Hertogenbosch T: +31 (0)73 2032590

General information

Main Dimensions		**10 x 20m stretchtent**
	Width:	10.5m
	Length:	20m
	Side height membrane:	2.5 - 3.0m
	Max. heigth:	4.5m
	Membrane	HQ8
	Center poles – 4.5m:	Ø94mm [Eucalyptus D35 / Chestnut D24] of ≥ Ø70x3mm [EN-AW 6060 T66 or higher]
	Center poles – 4.0m:	Ø90mm [Eucalyptus D35 / Chestnut D24] of Ø63x3mm [EN-AW 6060 T66 or higher]
	Side poles – 3.0m:	Ø73mm [Eucalyptus D35 / Chestnut D24] of ≥ Ø51x3mm [EN-AW 6060 T66 or higher]
	Corner poles – 2.5m:	Ø73mm [Eucalyptus D35 / Chestnut D24] of ≥ Ø51x3mm [EN-AW 6060 T66 or higher]
	Storm belt:	47mm PES, BL = 2800 kg
	Guy rope – long side:	Belt: 25mm PES, BL = 1200 kg, 3 sections Rope: Ø8mm, BL = 1200 kg, 5 sections
	Guy rope – short side:	Belt: 25mm PES, BL = 1200 kg, 3 sections Rope: Ø8mm, BL = 1200 kg, 6 sections
	Guy rope - window:	Belt: 25mm PES, BL = 1200 kg, 1 section Rope: Ø8mm, BL = 1200 kg, 2 sections
	Guy rope – corner (2x):	Belt: 25mm PES, BL = 1200 kg, 2 sections Rope: Ø8mm, BL = 1200 kg, 4 sections
	Connection elements:	Minimum required breaking load:
	- Guy rope at ground:	BL ≥ 3189 kg
	- Guy rope at fabric:	Middle BL ≥ 2272 kg, sides BL ≥ 1136 kg
	- Guy rope corner:	BL ≥ 2035 kg
	Membrane edge	Either lugs or keder reinforcement with clamps.

Loads:	
User load:	Max. additional load of 10 kg per column is allowed, if the load is applied centric.
Conventional load:	0.1 kN/m² (equal to 4cm of snow according to the French CTS).
Wind load:	The calculation is based on a wind pressure of p_w = 500 N/m² , according to EN 13782, par. 7.4.2.2. It is possible to reduce the wind pressure by multiplying with a factor ($p_{w,red}$). The reduced wind pressure with which the tent can be built without storm belts has been calculated. Also, reduced anchoring has been researched, so that a maximum of 2 anchors Ø25 x 936mm or 3 stakes т 25 x 50mm are required. $p_{w,}$ = 1.0 x 500 = 500 N/m² $p_{w,red,stormbelt}$ = 0.60 x 500 = 300 N/m² $p_{w,red,anchoring}$ = 0.38 x 500 = 190 N/m² The wind pressure is converted to the corresponding wind speeds, for Europe (not country specific), shown in the following tables:

Safety against sliding, overturning and uplifting:	
Anchor forces:	Assumption: angle ≥ 45 degrees for guy ropes and storm belts. For the different situations the design resistance of the anchor forces* is provided. ** see H.8.4 for anchor tests according to EN 13782.*
Anchoring: (diameter x effective length)	Based on dense, non-cohesive soil (e.g. sandy soils). The required anchoring is determined for 3 different anchors: - Anchor pin **Ø35 x 1200mm** - Anchor pin **Ø25 x 936mm** - Stake **т 25 x 500mm** On the following pages the required amount of anchors is provided for each situation.

Situation 1: PremiumStretch – 500 N/m²

	Design resistance of anchor force
Guy ropes – long side	10.99 kN
Guy ropes – short side	12.76 kN
Guy ropes – corner (2x)	8.14 kN
Storm belt (per ground point)	7.60 kN

	Ø35 x 1200mm	**Ø25 x 936mm**	**ᴛ 25 x 500mm**
Guy ropes – long side	2x	3x	5x
Guy ropes – short side	3x	4x	6x
Guy ropes – corner (2x)	2x	2x	4x
Storm belt (per ground point)	2x	2x	4x

Storm belts needs to be installed, starting from a wind pressure of 300 N/m²

Wind pressure	Peak	Coast	Flattened, open area	Rural area	Village	City
300 N/m²	87 km/u	> 5 BFT 13.58 m/s	> 6 BFT 14.24 m/s	> 6 BFT 15.77 m/s	> 7 BFT 19.36 m/s	> 7 BFT 20.20 m/s

Above the wind speeds as shown in the table below, the structure has to be out of order.

HQ8: p_w = 500 N/m²

	Out of order (1)				
	Coast	Flattened, open area	Rural area	Village	City
10 min. average wind speed (2)	> 17.53 m/s > 63.1 km/h	> 18.39 m/s > 66.20 km/h	> 20.36 m/s > 73.30 km/h	> 24.99 m/s > 89.96 km/h	> 26.08 m/s > 93.89 km/h
Beaufort (3)	> 7 BFT	> 7 BFT	> 7 BFT	> 9 BFT	> 9 BFT
Peak wind speed (4)	> 113 km/h	> 113 km/h	> 113 km/h	> 113 km/h	> 113 km/h

(1) *'Out of order' means: above the given wind speed the structure is no longer guaranteed regarding strength and/or stability.*
(2) *10min average wind speed at 10m height measured at the nearest weather stations.*
(3) *wind data in Beauford (BFT) are indicative values*
(4) *peak wind speed (gust), measured on site at 10m height.*

Situation 3: HQ8 – 190 N/m^2 – reduced anchoring

	Design resistance of anchor force
Guy ropes – long side	4.18 kN
Guy ropes – short side	4.85 kN
Guy ropes – corner (2x)	3.10 kN
Storm belt (per ground point)	2.89 kN

	Ø25 x 936mm	**T 25 x 500mm**
Guy ropes – long side	1x	2x
Guy ropes – short side	2x	3x
Guy ropes – corner (2x)	1x	2x
Storm belt (per ground point)	1x	2x

Storm belts needs to be installed, starting from a wind pressure of 125 N/m^2

Wind pressure	Peak	Coast	Flattened, open area	Rural area	Village	City
125 N/m^2	57 km/u	> 4 BFT 8.76 m/s	> 4 BFT 9.19 m/s	> 4 BFT 10.18 m/s	> 5 BFT 12.50 m/s	> 5 BFT 13.04 m/s

<u>Above</u> the wind speeds as shown in the table below, the structure has to be out of order.

Reduced anchoring: p_w = 190 N/m^2

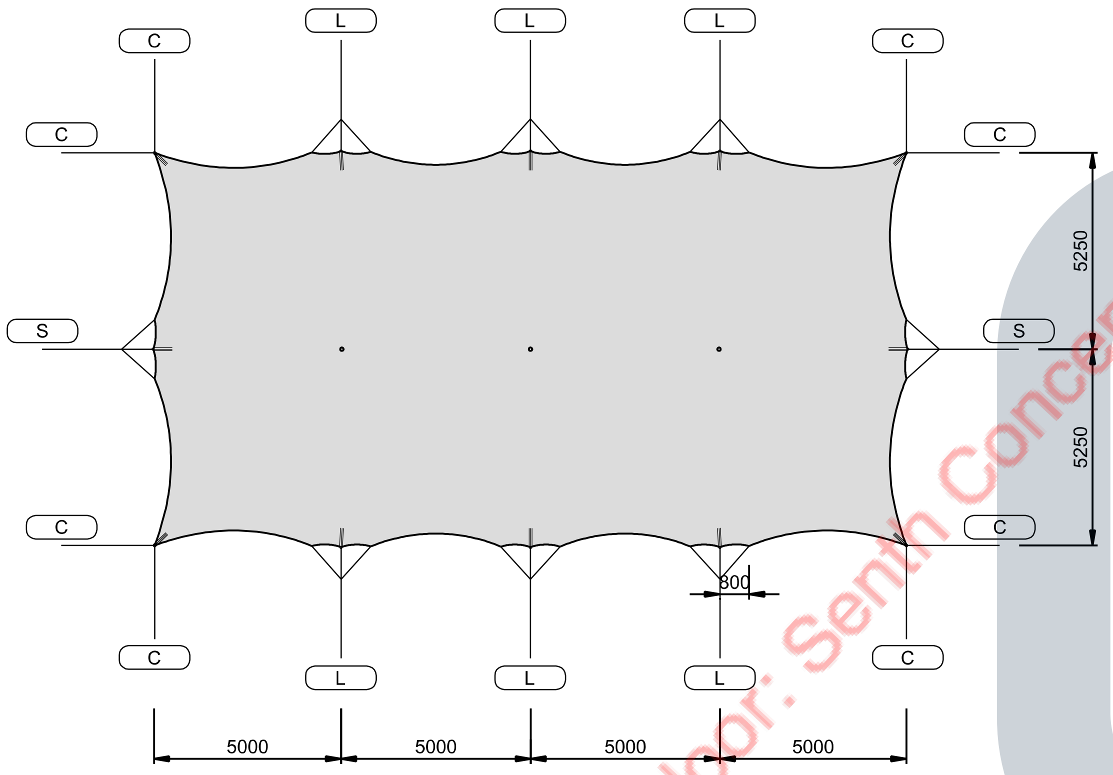
	Out of order (1)				
	Coast	Flattened, open area	Rural area	Village	City
10 min. average wind speed (2)	> 10.80 m/s > 38.88 km/h	> 11.33 m/s > 40.79 km/h	> 12.55 m/s > 45.18 km/h	> 15.41 m/s > 55.48 km/h	> 16.08 m/s > 57.89 km/h
Beaufort (3)	> 5 BFT	> 5 BFT	> 5 BFT	> 6 BFT	> 6 BFT
Peak wind speed (4)	> 70 km/h	> 70 km/h	> 70 km/h	> 70 km/h	> 70 km/h

(1) 'Out of order' means: above the given wind speed the structure is no longer guaranteed regarding strength and/or stability.
(2) 10min average wind speed at 10m height measured at the nearest weather stations.
(3) *wind data in Beauford (BFT) are indicative values*
(4) *peak wind speed (gust), measured on site at 10m height.*

TEN TECH

E. Drawings: main dimensions and anchoring

HQ8



TOP VIEW
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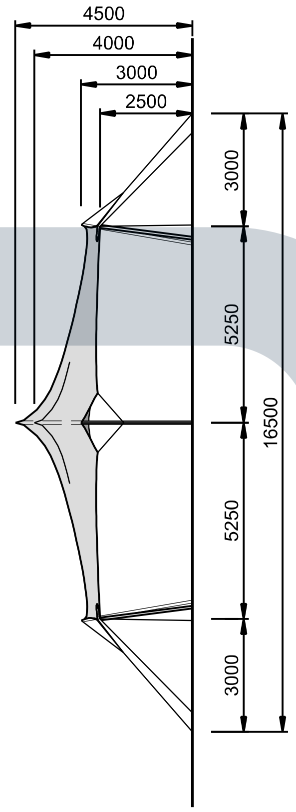

SIDE VIEW
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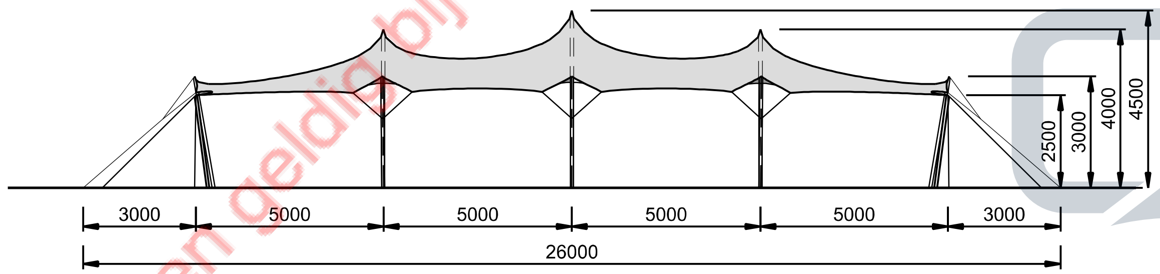

SIDE VIEW
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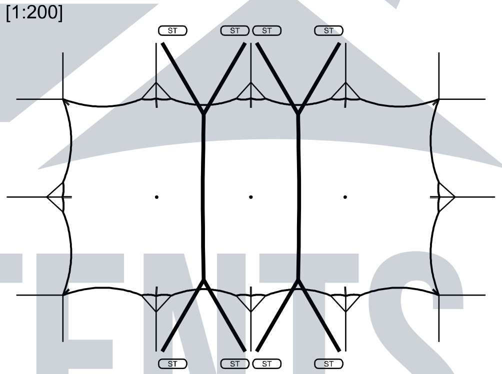

CONFIGURATION WITH STORMBELTS
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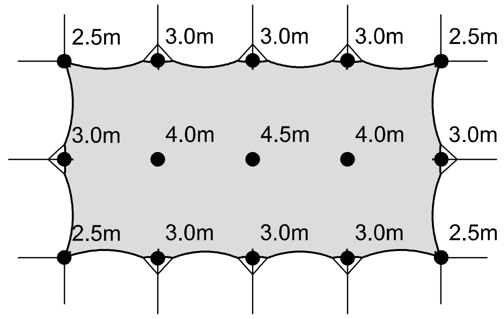
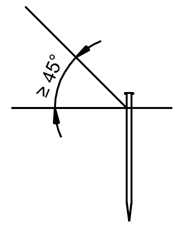


POLE HEIGHT DIAGRAM
[1:400]



For The Netherlands

HQStretch: p_w = 500 N/m²

	Out of order		
	Built area NL cat: **III**	Rural area NL cat: **II**	Coast NL cat: **I**
10 min. average wind speed	>25.12 m/s >90.43 km/h	>23.56 m/s >84.82 km/h	>17.84 m/s >64.22 km/h
Beaufort	> 9 BFT	> 8 BFT	> 7 BFT
Peak wind speed	>113 km/h	>113 km/h	>113 km/h

Storm belts needs to be installed, starting from a wind pressure of 300 N/m²

Wind pressure	Peak	Built area	Rural area	Coast
300 N/m²	87 km/u	> 7 BFT 19.46 m/s	> 7 BFT 18.25 m/s	> 6 BFT 13.82 m/s

For Europe, not country specific

HQStretch: p_w = 500 N/m²

	Out of order				
	Coast	Flattened, open area	Rural area	Village	City
10 min. average wind speed	> 17.53 m/s > 63.1 km/h	> 18.39 m/s > 66.20 km/h	> 20.36 m/s > 73.30 km/h	> 24.99 m/s > 89.96 km/h	> 26.08 m/s > 93.89 km/h
Beaufort	> 7 BFT	> 7 BFT	> 7 BFT	> 9 BFT	> 9 BFT
Peak wind speed	> 113 km/h	> 113 km/h	> 113 km/h	> 113 km/h	> 113 km/h

Storm belts needs to be installed, starting from a wind pressure of 300 N/m²

Wind pressure	Peak	Coast	Flattened, open area	Rural area	Village	City
300 N/m²	87 km/u	> 5 BFT 13.58 m/s	> 6 BFT 14.24 m/s	> 6 BFT 15.77 m/s	> 7 BFT 19.36 m/s	> 7 BFT 20.20 m/s

POLES

Center poles (4.5m)	Ø70 x 3mm [EN AW-6060 T66]	Ø94 [D24 Chestnut]/[D35 Eucalyptus]
Center poles (4.0m)	Ø63 x 3mm [EN AW-6060 T66]	Ø90 [D24 Chestnut]/[D35 Eucalyptus]
Side poles (3.0m)	Ø51 x 3mm [EN AW-6060 T66]	Ø73 [D24 Chestnut]/[D35 Eucalyptus]
Corner poles (2.5m)	Ø51 x 3mm [EN AW-6060 T66]	Ø73 [D24 Chestnut]/[D35 Eucalyptus]

TIES

Guy rope – long side:	Belt: 25mm PES, BL = 1200 kg, 3 sections Rope: Ø8mm, BL = 1200 kg, 5 sections
Guy rope – short side:	Belt: 25mm PES, BL = 1200 kg, 3 sections Rope: Ø8mm, BL = 1200 kg, 6 sections
Guy rope - window:	Belt: 25mm PES, BL = 1200 kg, 1 section Rope: Ø8mm, BL = 1200 kg, 2 sections
Guy rope – corner (2x):	Belt: 25mm PES, BL = 1200 kg, 2 sections Rope: Ø8mm, BL = 1200 kg, 4 sections

Therefore, all ropes and belts must be tied back and forth the amount of sections required.

STORM BELTS

Storm belts: 47mm PES, BL = 2800 kg

HQ8 requires no storm belts up to a wind pressure of 300 N/m²

ANCHORS

500 N/m²	Ø35 x 1200mm	Ø25 x 936mm	⊤ 25 x 500mm
Long side	2	3	5
Short side	3	4	6
Corner 2x	2	2	4
Storm belt (per ground point)	2	2	4

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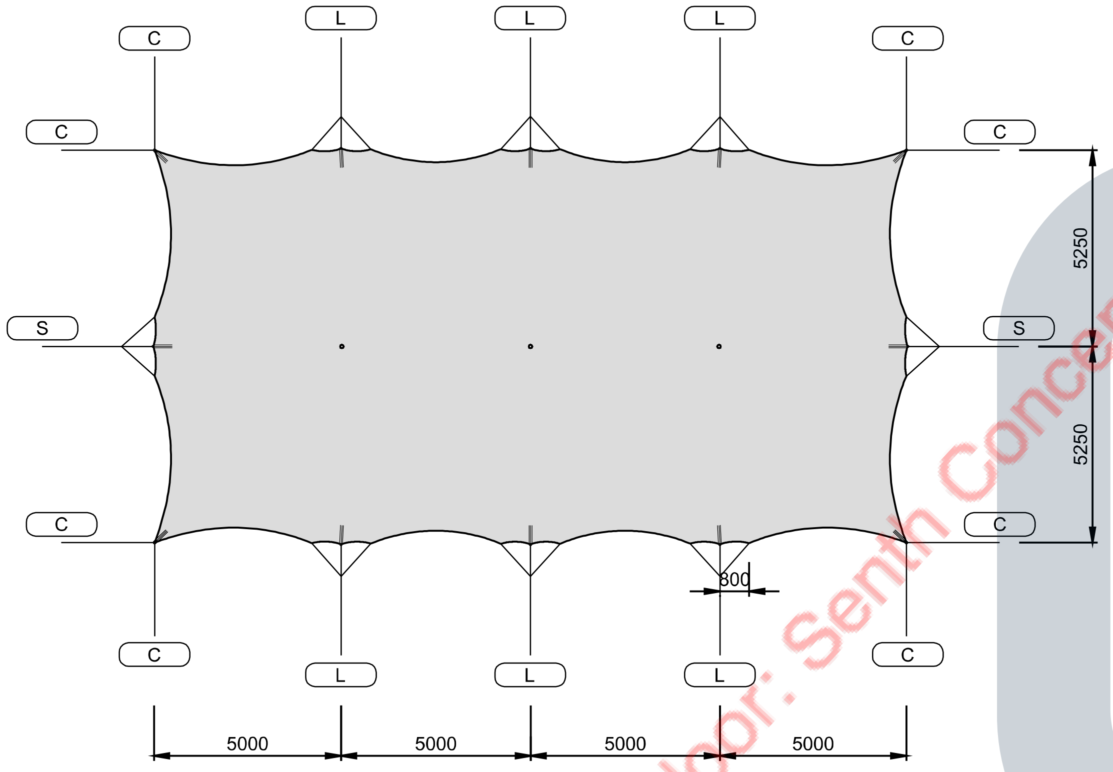
Reduced anchoring



TOP VIEW
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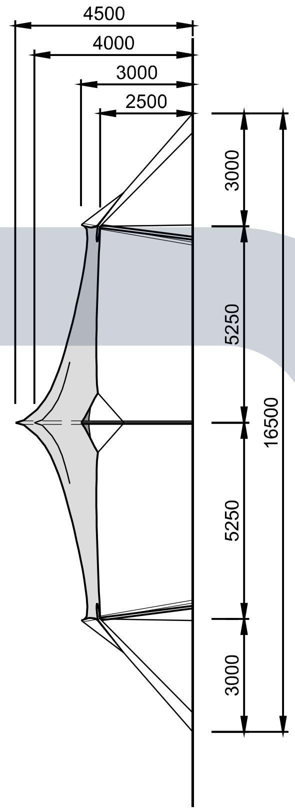
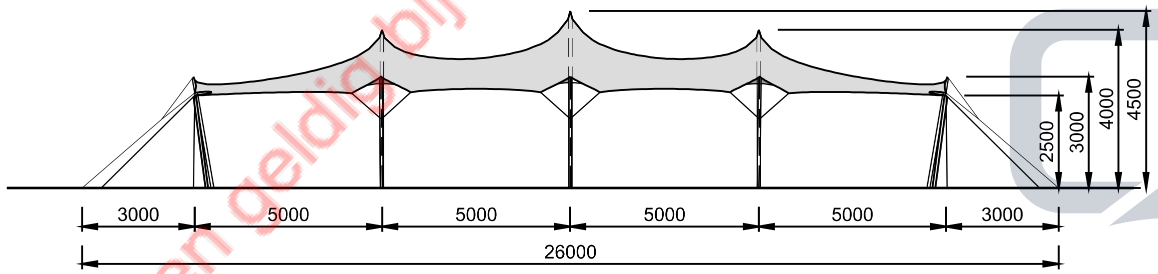
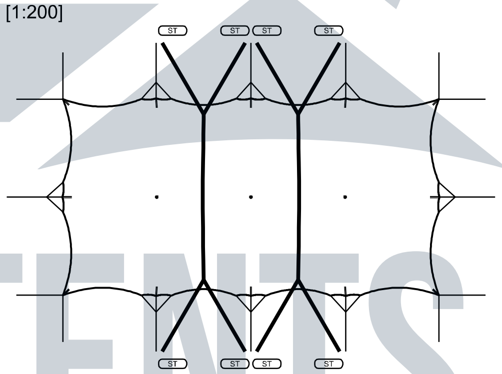
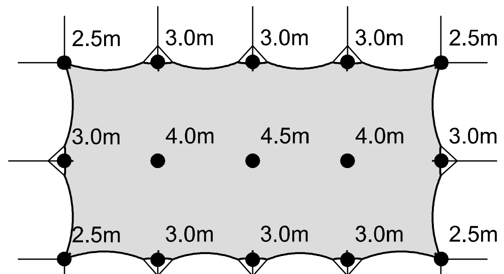


SIDE VIEW
[1:200]

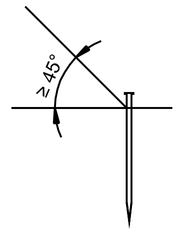


SIDE VIEW
[1:200]


CONFIGURATION WITH STORMBELTS
[1:400]



POLE HEIGHT DIAGRAM
[1:400]



For The Netherlands

Reduced anchoring: p_w = 190 N/m²

	Out of order		
	Built area NL cat: **III**	Rural area NL cat: **II**	Coast NL cat: **I**
10 min. average wind speed	>15.49 m/s >55.76 km/h	>14.52 m/s >52.27 km/h	>11.00 m/s >39.60 km/h
Beaufort	> 6 BFT	> 6 BFT	> 5 BFT
Peak wind speed	>70 km/h	>70 km/h	>70 km/h

Storm belts needs to be installed, starting from a wind pressure of 125 N/m²

Wind pressure	Peak	Built area	Rural area	Coast
125 N/m²	57 km/u	> 5 BFT 12.56 m/s	> 5 BFT 11.78 m/s	> 4 BFT 8.92 m/s

For Europe, not country specific

Reduced anchoring: p_w = 190 N/m²

	Out of order				
	Coast	Flattened, open area	Rural area	Village	City
10 min. average wind speed	> 10.80 m/s > 38.88 km/h	> 11.33 m/s > 40.79 km/h	> 12.55 m/s > 45.18 km/h	> 15.41 m/s > 55.48 km/h	> 16.08 m/s > 57.89 km/h
Beaufort	> 5 BFT	> 5 BFT	> 5 BFT	> 6 BFT	> 6 BFT
Peak wind speed	> 70 km/h	> 70 km/h	> 70 km/h	> 70 km/h	> 70 km/h

Storm belts needs to be installed, starting from a wind pressure of 125 N/m²

Wind pressure	Peak	Coast	Flattened, open area	Rural area	Village	City
125 N/m²	57 km/u	> 4 BFT 8.76 m/s	> 4 BFT 9.19 m/s	> 4 BFT 10.18 m/s	> 5 BFT 12.50 m/s	> 5 BFT 13.04 m/s

POLES

Center poles (4.5m)	Ø70 x 3mm [EN AW-6060 T66]	Ø94 [D24 Chestnut]/[D35 Eucalyptus]
Center poles (4.0m)	Ø63 x 3mm [EN AW-6060 T66]	Ø90 [D24 Chestnut]/[D35 Eucalyptus]
Side poles (3.0m)	Ø51 x 3mm [EN AW-6060 T66]	Ø73 [D24 Chestnut]/[D35 Eucalyptus]
Corner poles (2.5m)	Ø51 x 3mm [EN AW-6060 T66]	Ø73 [D24 Chestnut]/[D35 Eucalyptus]

TIES

Guy rope – long side:	Belt: 25mm PES, BL = 1200 kg, 3 sections
	Rope: Ø8mm, BL = 1200 kg, 5 sections
Guy rope – short side:	Belt: 25mm PES, BL = 1200 kg, 3 sections
	Rope: Ø8mm, BL = 1200 kg, 6 sections
Guy rope - window:	Belt: 25mm PES, BL = 1200 kg, 1 section
	Rope: Ø8mm, BL = 1200 kg, 2 sections
Guy rope – corner (2x):	Belt: 25mm PES, BL = 1200 kg, 2 sections
	Rope: Ø8mm, BL = 1200 kg, 4 sections

Therefore, all ropes and belts must be tied back and forth the amount of sections required.

STORM BELTS

Storm belts: 47mm PES, BL = 2800 kg

Reduced anchoring requires no storm belts up to a wind pressure of 125 N/m²

ANCHORS

190 N/m²	Ø25 x 936mm	т 25 x 500mm
Long side	1	2
Short side	2	3
Corner 2x	1	2
Storm belt (per ground point)	1	2

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TEN TECH

F. Important terms and conditions

This document applies to the built structure if the following principles and conditions are met:

- The used materials, parts and sections (membrane, poles, ties, anchoring) are in accordance with this document;
- The dimensions of the built structure match the dimensions stated in this document OR the structure satisfies the requirements for variations in size, as described in chapter H.1 ;
- Parts (poles, ties, anchors) may not be removed;
- Obstacles should be placed at least 0.5m from the membrane (measured perpendicular to the fabric); The fabric needs a certain freedom to deform in all directions to prevent damages caused by collision with objects located closely to the fabric (see also EN 13782, article 8.7);
- Above the maximum allowable wind speeds (see summary, part wind load) the structure should have been evacuated and access for the public must be denied;
- Only decorations, music- and light installations of less than 10 kg per pole, can be attached to the structure;
- A conventional load of 0.1 kN/m^2 is taken into account according to EN 13782, which corresponds with the required snowload (4cm) according to the French CTS.

G. Allowable wind speeds

The maximum wind speed is converted into a basic wind speed for a coastal area, flattened/open area, rural area, village and city according to EN 1991-1-4. Terrain roughness is taken according to the recommended general values for the different terrain categories for Europe. (not country specific) Illustrations of these terrain categories are presented at page 16.

	With storm belts	Without storm belts	Reduced anchoring	
Factor	**α = 1.00**	**α = 0.60**	**α = 0.38**	
Wind pressure p_w	500 N/m²	300 N/m²	190 N/m²	At **5m** height
Corresponding wind pressure for peak $p_{w,peak}$	605 N/m²	363 N/m²	230 N/m²	At **10m** height

The HQ8 fabric requires storm belts from 300 N/m² (α=0.60).
For the reduced anchoring, storm belts are required from 125 N/m² (α=0.39).

Peak wind speed at 10m height

Equation:

$$605 = {}^{1}/_{2} \times \rho \times v^2 = {}^{1}/_{2} \times 1.25 \times v^2 \rightarrow v = 31.1\ m/s \rightarrow \pm 113\ km/h$$
Eq. 4.10 EN 1991-1-4 Basic wind pressure

$$363 = {}^{1}/_{2} \times \rho \times v^2 = {}^{1}/_{2} \times 1.25 \times v^2 \rightarrow v = 24.1\ m/s \rightarrow \pm 87\ km/h$$
Eq. 4.10 EN 1991-1-4 Basic wind pressure

$$230 = {}^{1}/_{2} \times \rho \times v^2 = {}^{1}/_{2} \times 1.25 \times v^2 \rightarrow v = 19.2\ m/s \rightarrow \pm 70\ km/h$$
Eq. 4.10 EN 1991-1-4 Basic wind pressure

Wind speed coastal area at 10m height

$$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0.003}{0.05}\right)^{0.07} = 0.156$$
Eq. 4.5 EN 1991-1-4 Terrain factor for coastal area

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.156 \times \ln\left(\frac{5.0}{0.003}\right) = 1.158$$
Eq. 4.4 EN 1991-1-4 Roughness factor at 4m height Z = 5.0 > Z_{min} = 1

$$V_m = C_r \times V_b = 1.158 \times V_b$$
Eq. 4.3 EN 1991-1-4 Average wind speed at height

$$\sigma_v = K_r \times V_b = 0.156 \times V_b$$
Eq. 4.6 EN 1991-1-4 Standard deviation of turbulence

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.156 \times V_b}{1.158 \times V_b} = 0.135$$
Eq. 4.7 EN 1991-1-4 Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^{1}/_{2} \times \rho \times {V_m}^2 = 1.628 \times {V_b}^2$$
Eq. 4.8 EN 1991-1-4 Extreme wind pressure

Equation:

$$500 = 1.628 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 17.53\ m/s$$
Characteristic wind speed

$$300 = 1.628 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 13.58\ m/s$$
Characteristic wind speed

$$190 = 1.628 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 10.80\ m/s$$
Characteristic wind speed

Wind speed flattened, open area at 10m height

$$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0.01}{0.05}\right)^{0.07} = 0.170$$

Eq. 4.5 EN 1991-1-4
Terrain factor for coastal area

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.170 \times \ln\left(\frac{5.0}{0.01}\right) = 1.055$$

Eq. 4.4 EN 1991-1-4
Roughness factor at 3.5m height
Z = 5.0 > Z_{min} = 1

$$V_m = C_r \times V_b = 1.055 \times V_b$$

Eq. 4.3 EN 1991-1-4
Average wind speed at height

$$\sigma_v = K_r \times V_b = 0.170 \times V_b$$

Eq. 4.6 EN 1991-1-4
Standard deviation of turbulence

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.170 \times V_b}{1.055 \times V_b} = 0.161$$

Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^{1}/_{2} \times \rho \times {V_m}^2 = 1.479 \times {V_b}^2$$

Eq. 4.8 EN 1991-1-4
Extreme wind pressure

Equation:

$$500 = 1.479 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 18.39\ m/s$$ **Characteristic wind speed**

$$300 = 1.479 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 14.24\ m/s$$ **Characteristic wind speed**

$$190 = 1.479 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 11.33\ m/s$$ **Characteristic wind speed**

Wind speed rural area at 10m height

$$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0.05}{0.05}\right)^{0.07} = 0.190$$

Eq. 4.5 EN 1991-1-4
Terrain factor for unbuilt area

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.190 \times \ln\left(\frac{5.0}{0.05}\right) = 0.875$$

Eq. 4.4 EN 1991-1-4
Roughness factor at 4m height
Z = 5.0 > Z_{min} = 2

$$V_m = C_r \times V_b = 0.875 \times V_b$$

Eq. 4.3 EN 1991-1-4
Average wind speed at height

$$\sigma_v = K_r \times V_b = 0.190 \times V_b$$

Eq. 4.6 EN 1991-1-4
Standard deviation of turbulence

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.190 \times V_b}{0.875 \times V_b} = 0.217$$

Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^{1}/_{2} \times \rho \times {V_m}^2 = 1.206 \times {V_b}^2$$

Eq. 4.8 EN 1991-1-4
Extreme wind pressure

Equation:

$$500 = 1.206 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 20.36\ m/s$$ **Characteristic wind speed**

$$300 = 1.206 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 15.77\ m/s$$ **Characteristic wind speed**

$$190 = 1.206 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 12.55\ m/s$$ **Characteristic wind speed**

Wind speed village at 10m height

$$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{0.3}{0.05}\right)^{0.07} = 0.215$$
Eq. 4.5 EN 1991-1-4
Terrain factor for unbuilt area

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.215 \times \ln\left(\frac{5}{0.3}\right) = 0.606$$
Eq. 4.4 EN 1991-1-4
Roughness factor at 7m height
Z = Z_{min} = 5

$$V_m = C_r \times V_b = 0.606 \times V_b$$
Eq. 4.3 EN 1991-1-4
Average wind speed at height

$$\sigma_v = K_r \times V_b = 0.215 \times V_b$$
Eq. 4.6 EN 1991-1-4
Standard deviation of turbulence

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.215 \times V_b}{0.606 \times V_b} = 0.355$$
Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^1/_2 \times \rho \times V_m{}^2 = 0.801 \times V_b{}^2$$
Eq. 4.8 EN 1991-1-4
Extreme wind pressure

Equation:

$500 = 0.801 \times V_b{}^2 \rightarrow solving\ gives \rightarrow V_b = 24.99\ m/s$ **Characteristic wind speed**

$300 = 0.801 \times V_b{}^2 \rightarrow solving\ gives \rightarrow V_b = 19.36\ m/s$ **Characteristic wind speed**

$190 = 0.801 \times V_b{}^2 \rightarrow solving\ gives \rightarrow V_b = 15.41\ m/s$ **Characteristic wind speed**

Wind speed city at 10m height

$$K_r = 0.19 \times \left(\frac{z_0}{0.05}\right)^{0.07} = 0.19 \times \left(\frac{1}{0.05}\right)^{0.07} = 0.234$$
Eq. 4.5 EN 1991-1-4
Terrain factor for unbuilt area

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.234 \times \ln\left(\frac{10}{1}\right) = 0.540$$
Eq. 4.4 EN 1991-1-4
Roughness factor at 7m height
Z = Z_{min} =10

$$V_m = C_r \times V_b = 0.540 \times V_b$$
Eq. 4.3 EN 1991-1-4
Average wind speed at height

$$\sigma_v = K_r \times V_b = 0.234 \times V_b$$
Eq. 4.6 EN 1991-1-4
Standard deviation of turbulence

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.234 \times V_b}{0.540 \times V_b} = 0.434$$
Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^1/_2 \times \rho \times V_m{}^2 = 0.735 \times V_b{}^2$$
Eq. 4.8 EN 1991-1-4
Extreme wind pressure

Equation:

$500 = 0.735 \times V_b{}^2 \rightarrow solving\ gives \rightarrow V_b = 26.08\ m/s$ **Characteristic wind speed**

$300 = 0.735 \times V_b{}^2 \rightarrow solving\ gives \rightarrow V_b = 20.20\ m/s$ **Characteristic wind speed**

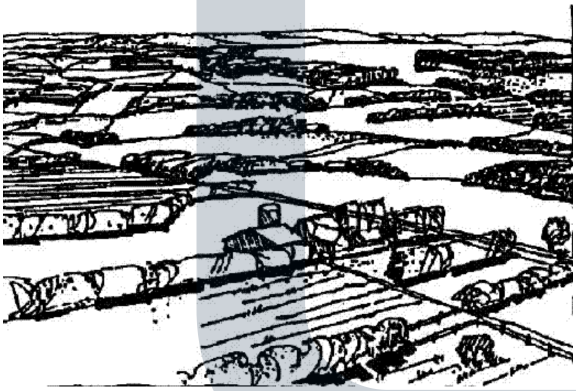
$190 = 0.735 \times V_b{}^2 \rightarrow solving\ gives \rightarrow V_b = 16.08\ m/s$ **Characteristic wind speed**

Terrain categories

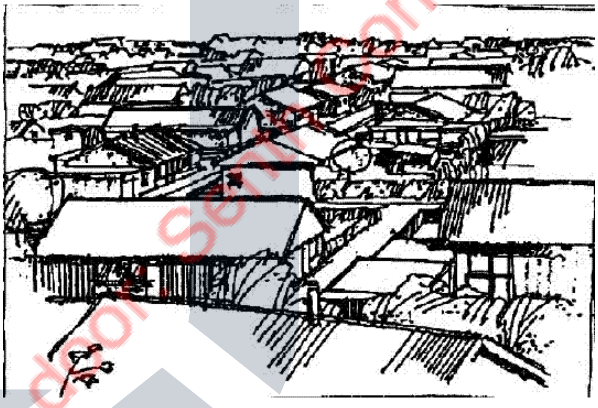
0: Coastal area:

I: Flattened, open area:

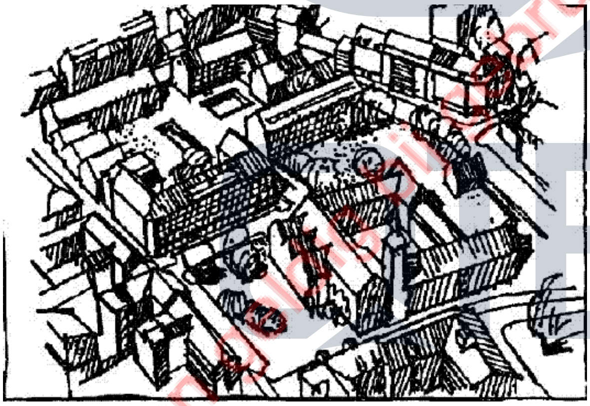
II: Rural area



III: Village



IV: City



H. Static analysis

H.1. Project description

The principle of a stretchtent is based on a rectangular piece of stretchable membrane. The membrane is supported by poles, both at the edge and in the field. The side poles are stabilized by ties. The poles do not require a fixed position which ensures a freedom of shape.

Tentech has performed a static analysis of the “10x20m” stretchtent for the floating configuration. The actual fabric size is 10.5x20m and it is supported by 3 main poles in the field. Around the edges side poles are placed every 5m.

The main dimensions, position of poles, ties and anchoring can be found in Chapter E, Drawings: main dimensions and anchoring on page 10.

<u>Smaller tent sizes</u>
It is possible to vary in dimensions when smaller tent sizes are derived from the analysed 10x20m configuration. The principle of scaling is being used for the verification of the strength and stability of different sizes.

Principe of scaling: a tent with a similar arrangement of poles and ties but smaller in size is automatically verified when the calculation of the less favourable or bigger tent has been approved, provided that the spacing between the poles and ties of the scaled tent is similar or smaller than the original tent.

While constructing smaller tent sizes, it is of significant importance to use similar (or more favourable*) arrangements of poles and guy ropes based on spacing – to ensure correct pole and guy rope placement - using the 10x20m arrangement as a starting point.

* with ‘more favourable is meant: more safe, which implies relatively more poles and/or guy ropes than the 10x20m for arrangements.

The reaction forces of the 10x20m should be used for anchoring. Therefore, the same amount of anchoring should be places at each specified location / element unless additional calculations show otherwise.

Storm belts should be placed in each valley (between center poles) in width direction, which means: (X-1) storm belts, with X = number of rows of center poles in length direction.

H.2. Materials and cross sections

H.2.1 Fabric

Design tensile strength	f_d	f_{tk} / γ_m	art 8.6 NEN-EN 13782
Characteristic tensile strength (warp)	$f_{tk,\ warp}$		
Characteristic tensile strength (weft)	$f_{tk,\ weft}$		
Material factor – global, permanent load	γ_m	2.5	tbl 4. NEN-EN13782
Material factor – global, short duration load	γ_m	2.0	tbl 4. NEN-EN13782

Table 1. Used symbols, codes and standard for fabric materials

Material	Type	Weight	$f_{rd;warp;perm}$	$f_{rd;\ weft;perm}$	$f_{rd;\ warp;short}$	$f_{rd:\ weft;short}$
HQ8	-	730 gr/m^2	9.6 kN/m	7.2 kN/m	12.0 kN	9.0 kN/m

Table 2. Used fabrics

H.2.2 Belts

Design resistance	F_{rd}	R_m / γ_{m1}	art 10.2. NEN-EN13782
Characteristic tensile strength	R_m		art 10.2. NEN-EN13782
Material factor	γ_{m1}	2.0	art 10.2. NEN-EN13782

Table 3. Used symbols, codes and standard for belt materials

Material	Width	Breaking strength	Rm	F_{rd}
Storm belt [PES] EN 12195-2	47 mm	≥ 2800 daN	28 kN	14 kN
Tension belt [PES] EN 12195-2	25mm	≥ 1200 daN	12 kN	6 kN

Table 4. Used belts

H.2.3 Ropes

Design resistance	F_{rd}	R_m / γ_{m1}	art 10.2. NEN-EN13782
Characteristic tensile strength	R_m		art 10.2. NEN-EN13782
Material factor	γ_{m1}	4.0	art 10.3. NEN-EN13782

Table 5. Used symbols, codes and standard for belt materials

Material	Cross section	Breaking strength	Rm	F_{rd}
Polyester rope	Ø 8 mm	≥ 1200 daN	12 kN	3 kN

Table 6. Used ropes

H.2.4 Aluminium

Material factor (strength)	γ_{m1}	1.1	tbl. 6.1. NEN-EN 1999-1-1
Material factor (stability)	γ_{m1}	1.1	tbl 6.1. NEN-EN 1999-1-1
Material factor (tension to fracture/connections)	γ_{m2}	1.25	tbl 2.1. NEN-EN 1999-1-1

Table 7. Used material factors

Material	Weight	E-modulus	f_y	f_u
EN AW-6060 T66	2700 kg/m^3	70000 N/mm^2	150 N/mm^2	195 N/mm^2

Table 8. Used Aluminium materials

H.2.5 Wood

Material factor	γ_{m1}	1.3	tbl. 2.3. NEN-EN 1995-1-1

Table 9. Used material factors

Material	Weight	$E_{0.05}$	$F_{c,0,k}$	$F_{m,k}$
Wood, Eucalyptus strength class D35	540 kg/m^3	8.7 kN/m^2	25 N/mm^2	35 N/mm^2
Wood, Chestnut strength class D24	485 kg/m^3	8.5 kN/m^2	21 N/mm^2	24 N/mm^2

Table 10. Used Aluminium materials

H.3. Cross sections

Profile	Material	w mm	t mm	G kg/m^1	A mm^2	I_y mm^4	$W_{el;y}$ mm^3	$W_{pl;y}$ mm^3
Ø 70 x 3 mm	6060 T66	70	3	1.70	631	355038	10144	13476
Ø 63 x 3 mm	6060 T66	63	3	1.53	565	255105	8099	10809
Ø 51 x 3 mm	6060 T66	51	3	1.22	452	130797	5129	6921
Ø ≥ 94mm	Wood D35 / D24	94	n/a	3.37 3.75	6940	3832492	81542	
Ø ≥ 90mm	Wood D35 / D24	90	n/a	3.09 3.44	6362	3220623	71569	
Ø ≥ 73mm	Wood D35 / D24	73	n/a	2.03 2.26	4185	1393995	38192	

Table 11. Used cross sections

H.4. Calculation method

The analysis of the structure is performed with the software package EASY FCS supplied by TECHNET GmbH, Berlin. This software is specially developed for structures with large deformability, such as membrane structures. The performed analysis is a full non-linear second order analysis.

The membrane structure is modeled in 3D. The membrane is modeled as a cable net structure and supported by poles. These center poles will be stabilized by the tensioned membrane. The side poles are stabilized and tied down by guy ropes, which are attached to ground anchors.

H.4.1 Structural behavior of membrane structures

Since the fabric is a highly deformable material, it is only possible to calculate stresses and deformations with a non-linear method. FEM-software EASY is used to perform these calculations. Because of the non-linearity of the calculations the partial safety factors are not applied beforehand, since the deformations will be greater due to these safety factors, resulting in lower stresses in the fabric. See figure below.

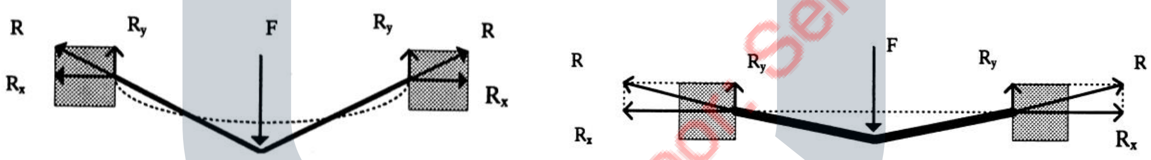


Figure 1. membrane behavior

As a membrane structure is a form-active structure, article 6.3 (4) b) of the EN-1990:2002 applies:

> *When the action effect increases less than the action, the partial factor γ_F should be applied to the action effect of the representative value of the action.*

This means that no load factors are applied on the load beforehand, but afterwards.

H.4.2 Structural behaviour of stretch membrane

The stretchtent is a form active structure based on the curvature principle. When the membrane is loaded, the curvature in the structure is increasing or decreasing, depending on the direction of the curvature. This change in curvature is proportional to the stresses in the fabric. The change of curvature, and thereby also the deformations, is substantial due to the flexible nature of the membrane.

The poles are supporting the fabric. The application of rounded caps at the top of the poles reduces the peak loads in the fabric. Vice versa, the fabric supports the poles in transverse direction, enabling the assumption of a 2-sided hinged pole (in combination with the stabilising effect of the belts).

H.4.3 Structural system

The modelled membrane structure is composed out of an initially flat membrane. By supporting the membrane at multiple points, a smooth curved surface can be created.

The membrane edges are reinforced. There are two different options: 1) edge with lugs, 2) edge with continuous keder using clamps for the connection. Both edges, reinsure that point loads are introduced gradually into the fabric.

From a certain wind load, storm belts are required, which are placed along the width of the tent.

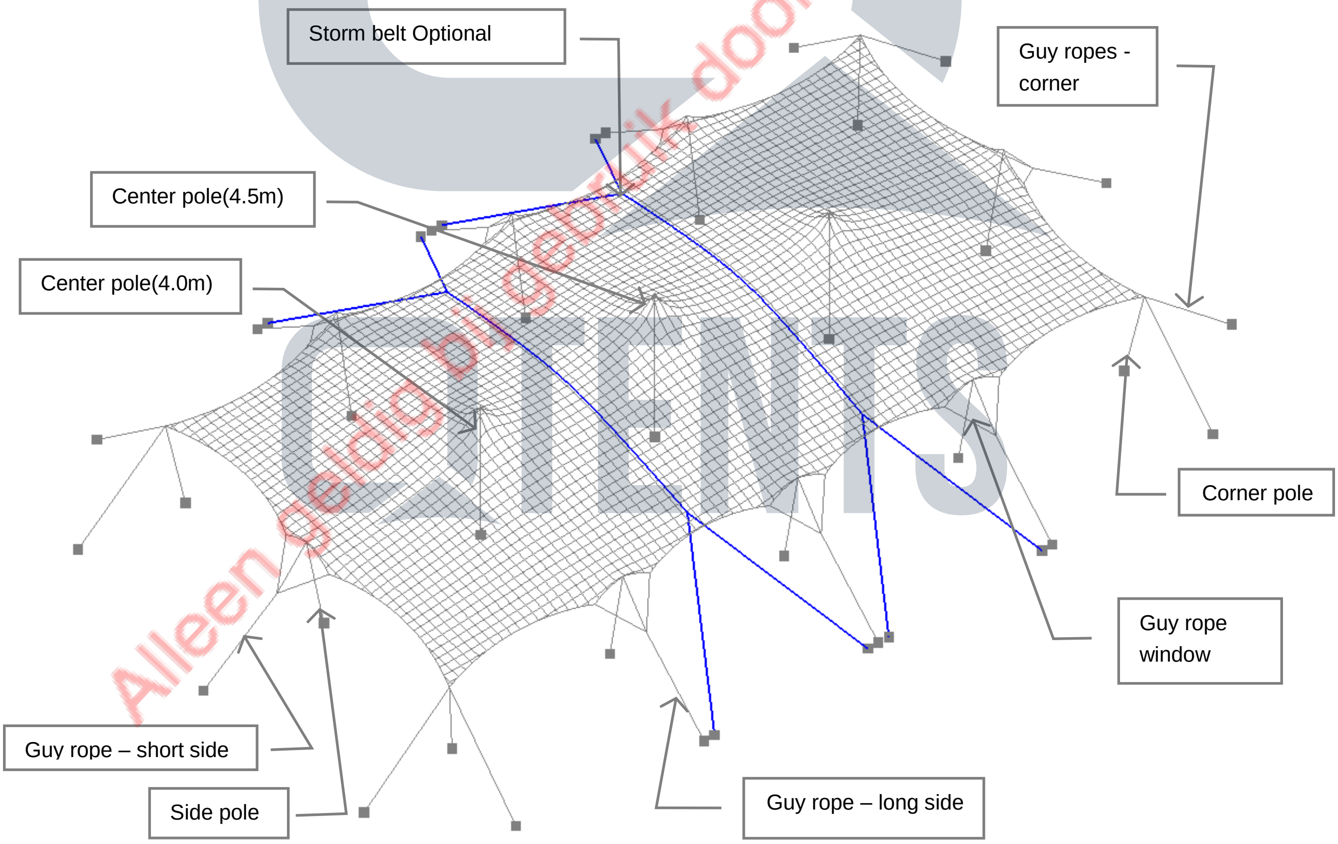


Figure 2. Calculation model 10x20m

H.4.4 Load combinations

H.4.4.1 Strength - Ultimate limit state

For the purpose of determination of strength and check of elements and connections.

	One variable load	Multiple variable loads
Unfavorable permanent load	$1.35 \times G + 1.5 \times Q$	$1.35 \times G + \sum 1.35 \times Q_i$
Favorable permanent load	$1.0 \times G + 1.5 \times Q$	$1.0 \times G + \sum 1.35 \times Q_i$

Table 12. Load combinations according to NEN-EN 13782

This means the following load combinations will be checked/calculated

1. 1.0 x Own weight + 1.5 x Wind load
2. 1.35 x Own weight + 1.35 x Conventional load
3. 1.35 x Own weight + 1.5 x Snow load

H.4.4.2 Safety against overturning, sliding and uplifting - Ultimate limit state

For the purpose of determination and check of needed anchor pins.

	One or multiple variable loads
Unfavorable permanent load	$1.1 \times G + 1.2 \times Q_{wind} + \sum 1.3 \times Q_i$
Favorable permanent load	$1.0 \times G + 1.2 \times Q_{wind} + \sum 1.3 \times Q_i$

Table 13. Load combinations according to NEN-EN 13782

This means the following load combinations will be checked/calculated

1. 1.0 x Own weight + 1.2 x Wind load

H.5. Load cases

H.5.1 Own weight

The own weight of the fabric is ±0.730 kg/m² = ca. 0.0073 kN/m² and is added as separate load case.

H.5.2 Pretension

The structure will be pretensioned with guy ropes. The pretension is approximately 1.50 kN pressure in center poles.

H.5.3 User load

A user defined load (for light, sound and/or decoration purposes) is set on 10 kg per pole and is added after the analysis while performing element checks.

H.5.4 Wind

H.5.4.1 Wind pressure

Wind load according to EN 13782, 6.4.2.2:
For any other location where v_{ref} > 28 m/s*, calculations shall be provided for the tent verifying the stability and resistance with the local conditions. Special measures have to be taken. In the design calculations the necessary means shall be verified through calculation.

For v_{ref} < 28 m/s*, the wind load per unit may be evaluated applying the following minimum values given in EN 1991-1-4 with:
$C_{TEM} = 0.8$
$T_r = 10$ years
$C_d = 1$
$C_{alt} = 1$

** The stated value for wind speed is a 10-minute average, measured at 10m height.*

According to table 1 of article 6.4.2.2. of EN 13782, this results in a wind pressure of 500 N/m² in case of tents with a height equal or less to 5m. The tent may also be calculated with a reduced wind pressure. However, in this case the structural system is guaranteed regarding strength and/or stability at lower wind speeds than given in the Eurocode. This influences the maximum allowable wind speed.

It has been researched until which reduced wind pressures the tent can be built without storm belts. (added as separate load cases):

- HQ8 requires no storm belts up to 300 N/m² (α=0.60)

H.5.4.2 Wind shape values (Cp-factors)

Two different wind situations are reviewed for the membrane:

1. The whole tent is subjected to wind suction (conform Cp values given in EN 13782)
2. The whole tent is subjected to wind pressure (conform Cp values given in EN 13782)

H.5.4.2.1. Wind suction

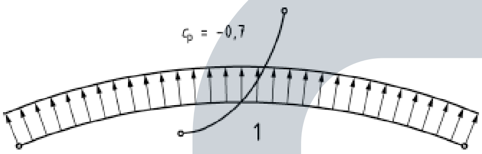


figure 3. C_p values for rectangle structures EN 13782 – wind suction

$P_{w,reduced}$	$p_{w,representative,reduced}$
300 N/m²	-0.7 x 0.300 = **-0.210 kN/m²**
500 N/m²	-0.7 x 0.500 = **-0.350 kN/m²**

H.5.4.2.2. Wind pressure

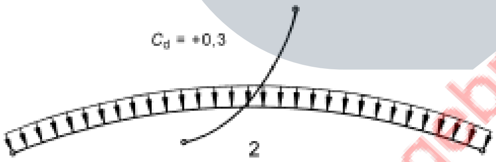


figure 4. C_p values for rectangle structures EN 13782 – wind pressure

$P_{w,reduced}$	$p_{w,representative,reduced}$
300 N/m²	0.3 x 0.300 = **0.090 kN/m²**
500 N/m²	0.3 x 0.500 = **0.150 kN/m²**

H.5.5 Conventional / snow load

Conventional load according to EN 13782: The stability shall be checked with a conventional vertical load of 0,1 kN/m2. This load shall not be combined with other load cases, except self-weight.

H.5.6 Snow load

Snow loads are not considered in the strength- and stability analysis. This means that the following conditions have to be met (according to EN 13782, article 7.4.3):

- the tent is erected in areas, where there is no likelihood of snow, or
- the tent operates at a time of the year, where the likelihood of snow can be discounted or;
- where by design or operating conditions snow settling on the tent is prevented;
- where pre-planned operation action prevents snow settling on the tent.

This last condition may be achieved by:

- Sufficient heating equipment is installed and is ready for use and;
- heating is started prior to snow fall and;
- tent is heated in such a way, that the whole roof cladding has an outside air temperature of more than + 2 °C;
- Cladding is made and tensioned in such a way, that pounding of water or any other deformations of the cladding cannot take place.

However, for France it is required to regard the structure with a snow load of 0.1 kN/m^2 (4cm) according to the CTS. This load corresponds to the conventional load and is lower than the downward wind load. Therefore, the snow load is not taken into account as a separate load case in the calculations.

H.6. Calculation results

H.6.1 Listing of calculated load combinations

LC1 = Pretension
LC2 = Own weight
LC3 = Conventional load / Snow load
LC4 = Wind pressure – full wind load
LC5 = Wind suction – full wind load – with storm belts
LC6 = Wind suction – reduction 0.60 – without storm belts

The following load combinations are taken into account:
partial safety factors are added after the static analysis (see H.4.1).

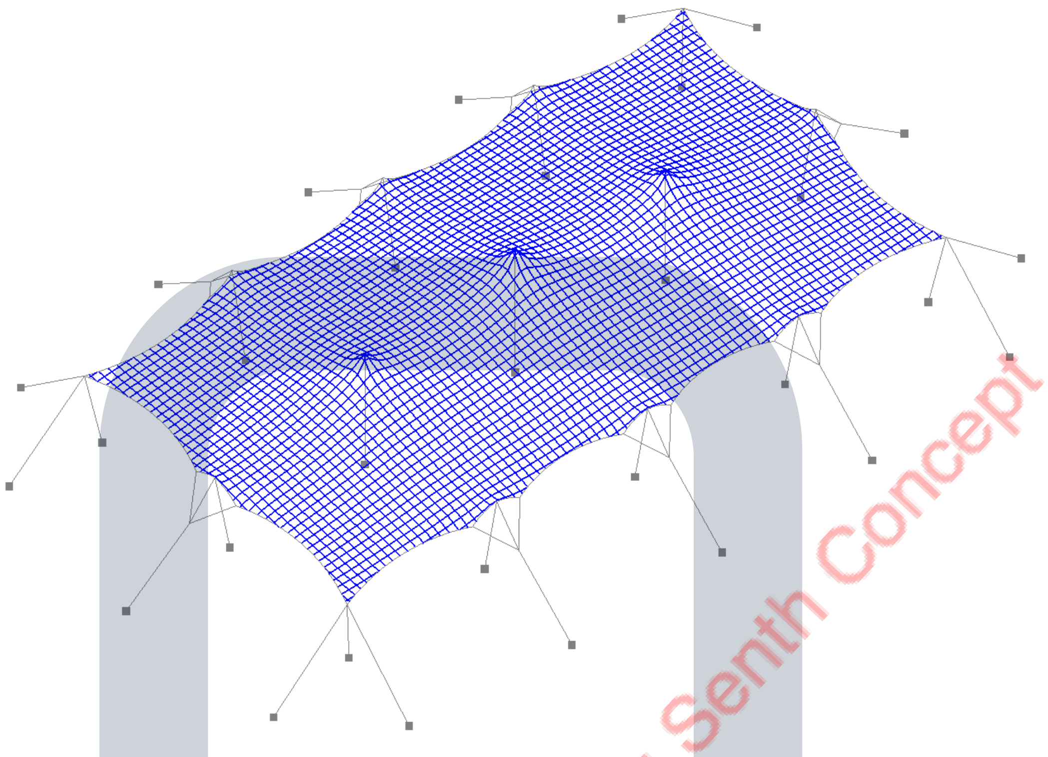
	LC 1	LC2	LC 3	LC 4	LC 5	LC6
CO 1	1 x	1 x				
CO 2	1 x	1 x	1 x			
CO 3	1 x	1 x		1 x		
CO 4	1 x	1 x			1 x	
CO 5	1 x	1 x				1 x

table 14. Combinations (CO)

Storm belts are only necessary above a certain wind pressure / speed. Only when required, storm belts are added to the calculation model. In H.6.2 Overview: Global results of static analysis, it is explicitly mentioned when a storm belt is added.

H.6.2 Overview: Global results of static analysis

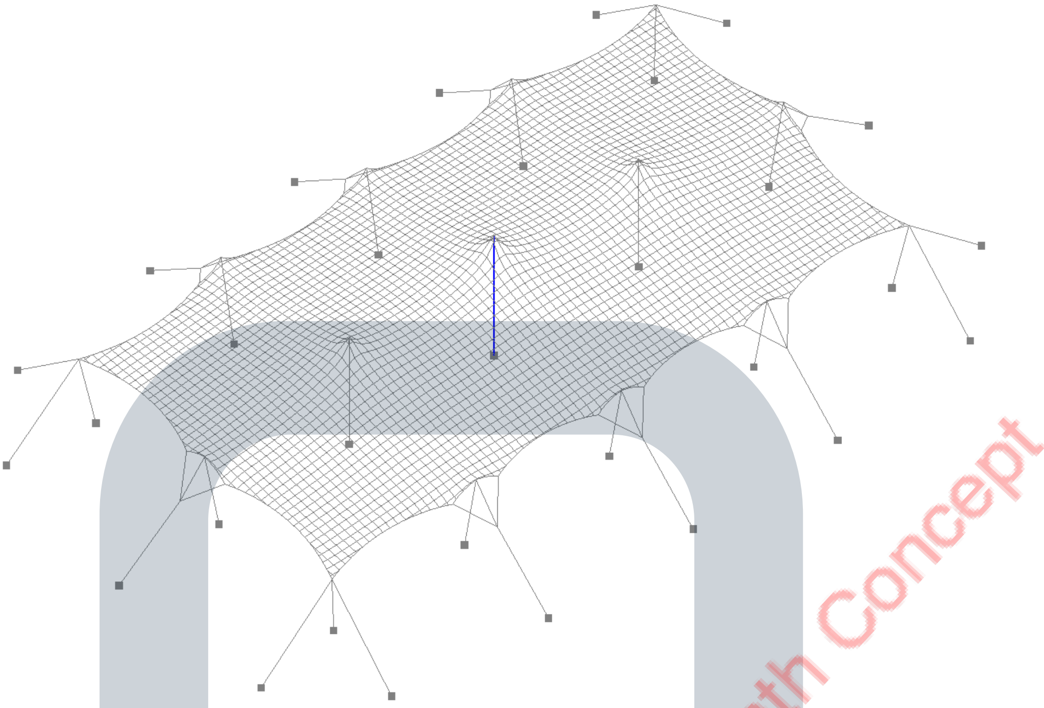
H.6.2.1 Membrane



10x20m		Load combination	F_{rep}	Pag.
Warp		CO1. Own weight + pretension	1.71 kN/m	56
		CO2. Own weight + pretension + conventional	3.14 kN/m	58
		CO3. Own weight + pretension + wind pressure full wind load	4.18 kN/m	60
	Max	CO4. Own weight + pretension + wind suction full wind load – with storm belts	4.41 kN/m	62
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	2.69 kN/m	65
Weft		CO1. Own weight + pretension	2.00 kN/m	56
		CO2. Own weight + pretension + conventional	3.65 kN/m	58
	Max	CO3. Own weight + pretension + wind pressure full wind load	4.81 kN/m	60
		CO4. Own weight + pretension + wind suction full wind load – with storm belts	4.43 kN/m	62
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	3.81 kN/m	65

Table 15. Leading forces membrane

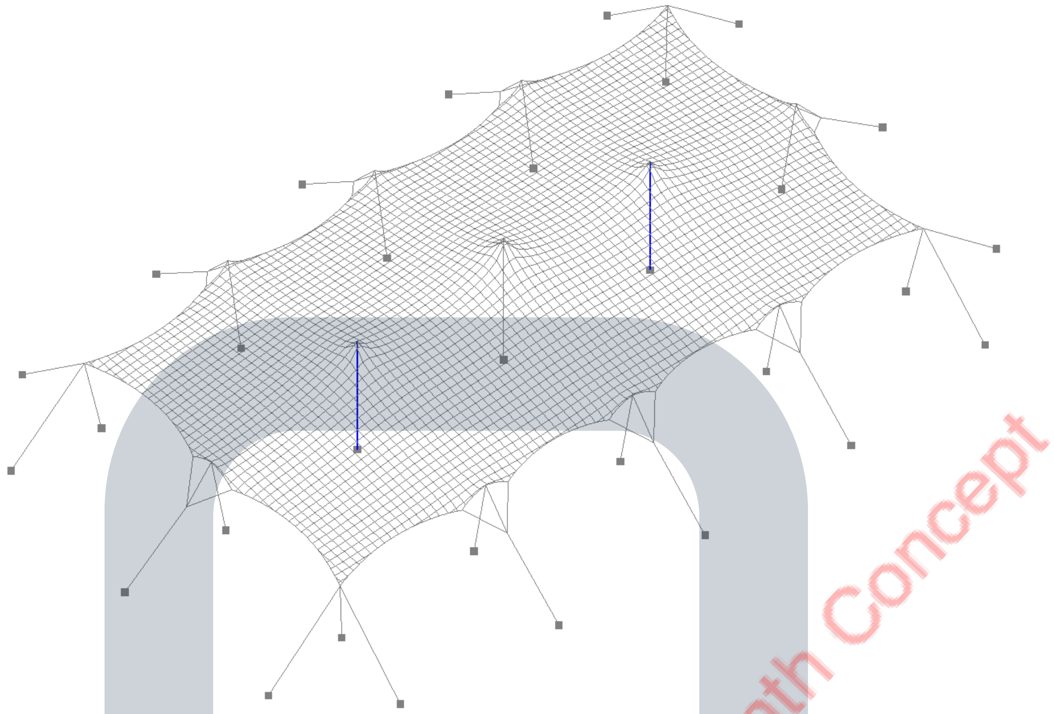
H.6.2.2 Center pole 4.5m



10x20m		Load combination	F_{rep}	Pag.
		CO1. Own weight + pretension	-1.50 kN	57
		CO2. Own weight + pretension + conventional	-5.27 kN	59
Center pole 4.5m	**Max**	CO3. Own weight + pretension + wind pressure full wind load	-7.01 kN	61
		CO4. Own weight + pretension + wind suction full wind load – with storm belts	-	64
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	-	66

Table 16. Leading forces Center pole

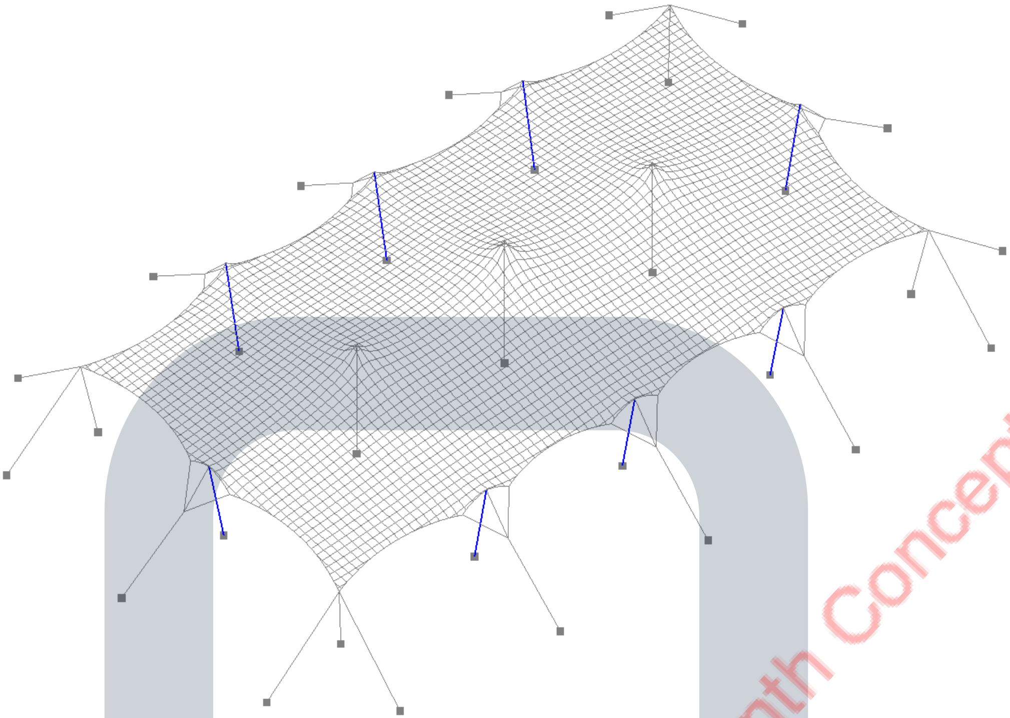
H.6.2.3 Center pole 4.0m



10x20m		Load combination	F_{rep}	Pag.
		CO1. Own weight + pretension	-1.17 kN	57
		CO2. Own weight + pretension + conventional	-4.56 kN	59
Center pole	**Max**	CO3. Own weight + pretension + wind pressure full wind load	-6.22 kN	61
4.0m		CO4. Own weight + pretension + wind suction full wind load – with storm belts	-	64
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	-	66

Table 17. Leading forces Center pole

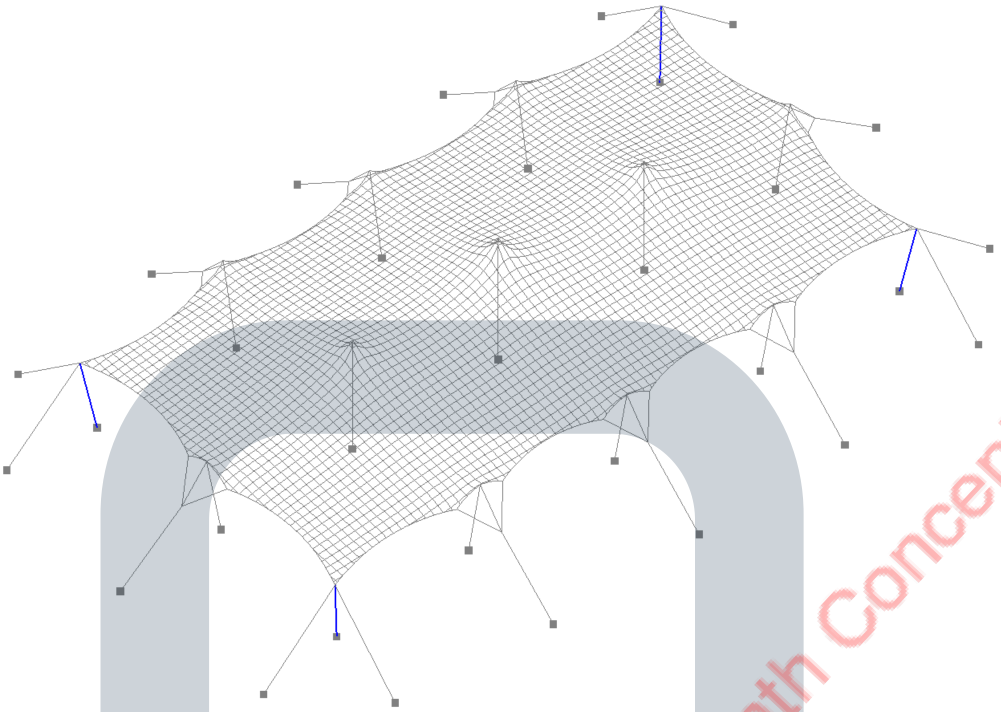
H.6.2.4 Side Pole 3m



10x20m		Load combination	F_{rep}	Pag.
Side poles 3.0m		CO1. Own weight + pretension	-1.93 kN	57
		CO2. Own weight + pretension + conventional	-4.16 kN	59
	Max	CO3. Own weight + pretension + wind pressure full wind load	-5.56 kN	61
		CO4. Own weight + pretension + wind suction full wind load – with storm belts	-1.39 kN	64
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	-1.39 kN	66

Table 18. Leading forces side poles 3m

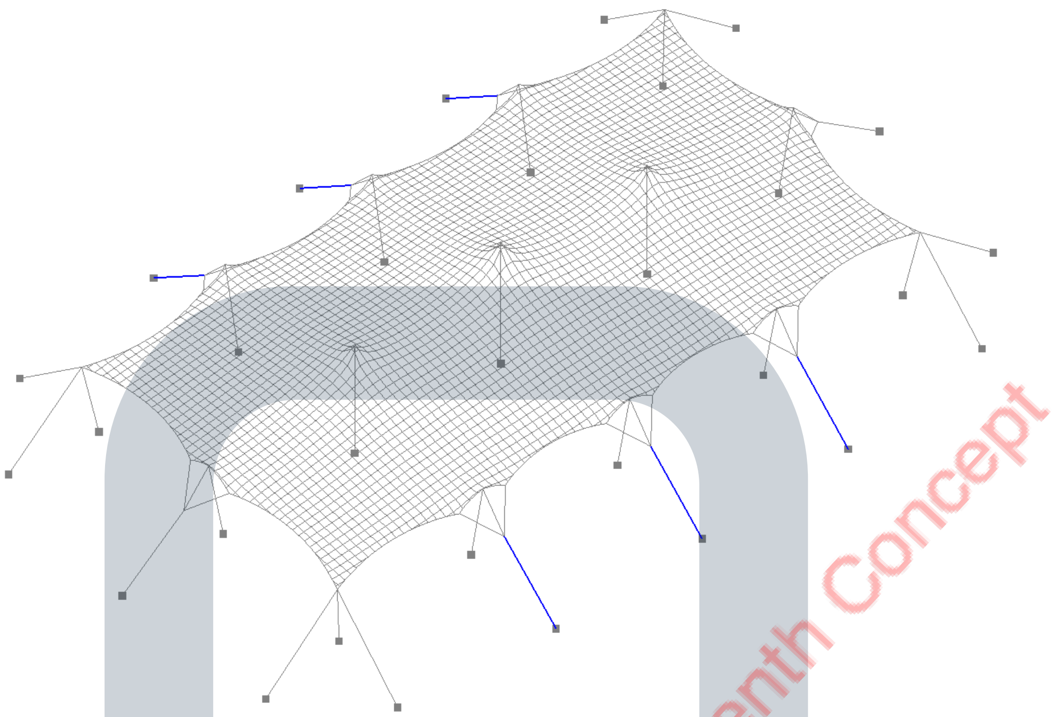
H.6.2.5 Corner pole 2.5m



10x20m		Load combination	F_{rep}	Pag.
Corner poles 2.5m		CO1. Own weight + pretension	-4.83 kN	57
		CO2. Own weight + pretension + conventional	-6.50 kN	59
	Max	CO3. Own weight + pretension + wind pressure full wind load	-7.75 kN	61
		CO4. Own weight + pretension + wind suction full wind load – with storm belts	-7.36 kN	64
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	-6.54 kN	66

Table 19. Leading forces corner poles 2.5m

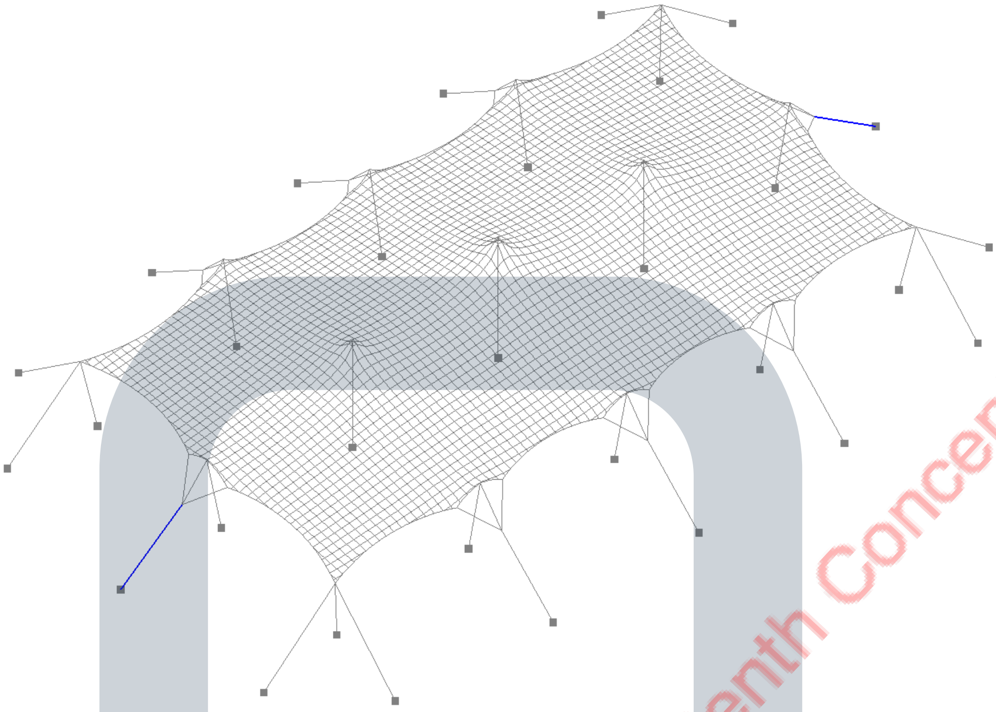
H.6.2.6 Guy ropes – long sides



10x20m		Load combination	F_{rep}	Pag.
Ties		CO1. Own weight + pretension	2.74 kN	57
		CO2. Own weight + pretension + conventional	4.30 kN	59
		CO3. Own weight + pretension + wind pressure full wind load	5.45 kN	61
		CO4. Own weight + pretension + wind suction full wind load – with storm belts	8.86 kN	63
	Max	CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	9.16 kN	66

Table 20. Leading forces ties

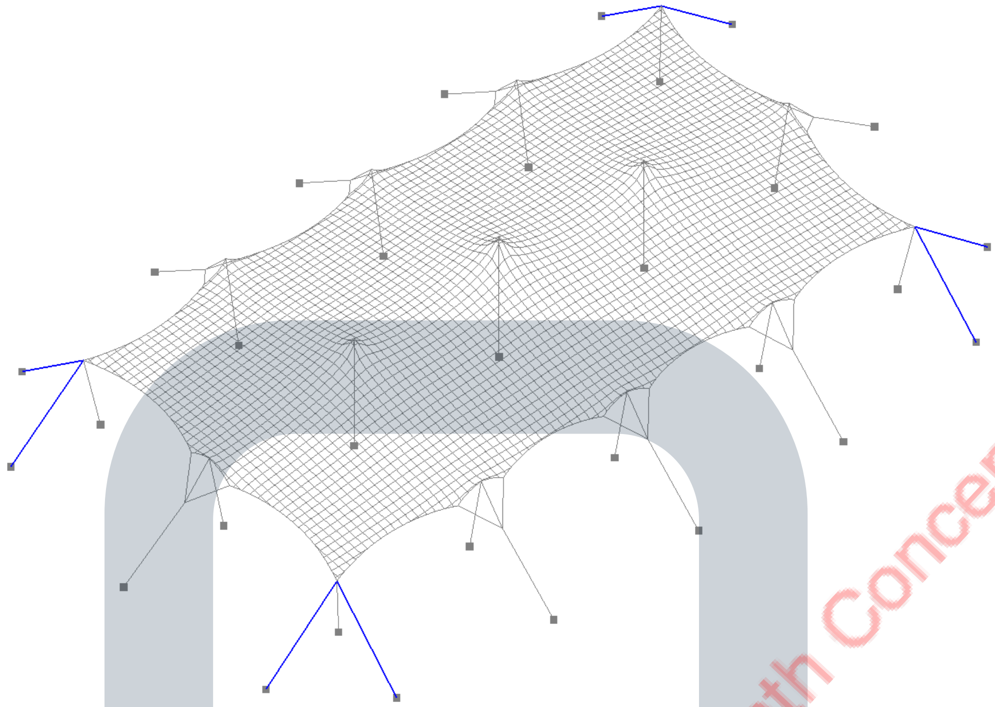
H.6.2.7 Guy ropes – short sides



10x20m		Load combination	F_{rep}	Pag.
Ties		CO1. Own weight + pretension	3.03 kN	57
		CO2. Own weight + pretension + conventional	4.98 kN	59
		CO3. Own weight + pretension + wind pressure full wind load	6.41 kN	61
	Max	CO4. Own weight + pretension + wind suction full wind load – with storm belts	10.63 kN	63
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	7.19 kN	66

Table 21. Leading forces ties

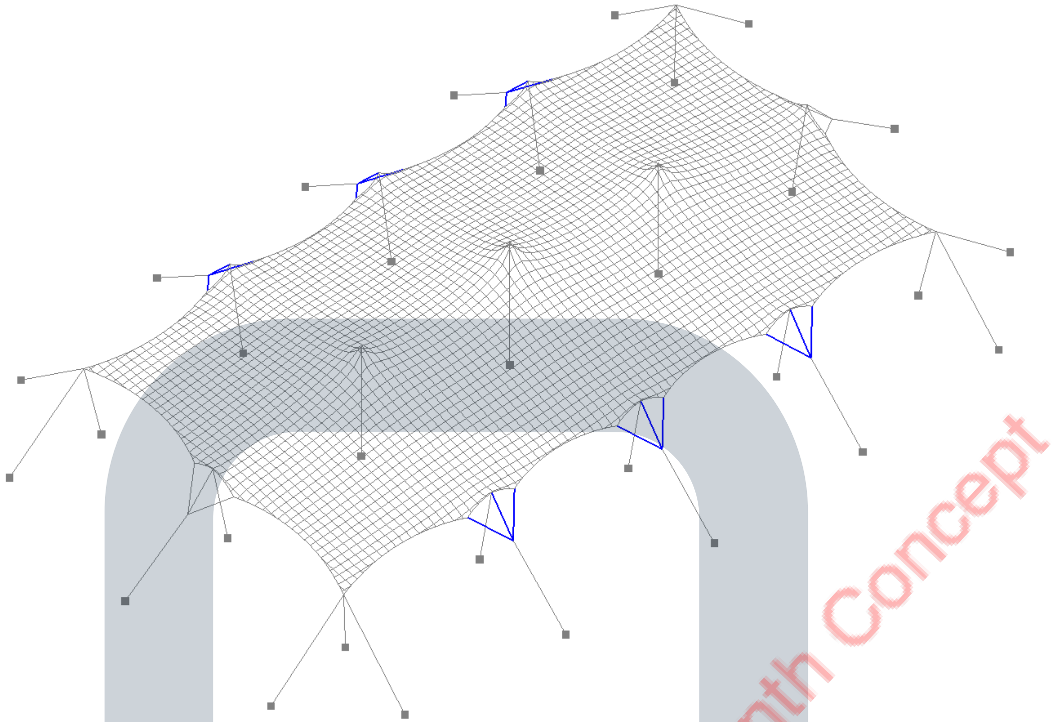
H.6.2.8 Guy ropes - corner



10x20m		Load combination	F_{rep}	Pag.
Corner Ties		CO1. Own weight + pretension	3.65 kN	57
		CO2. Own weight + pretension + conventional	4.43 kN	59
		CO3. Own weight + pretension + wind pressure full wind load	5.09 kN	61
	Max	CO4. Own weight + pretension + wind suction full wind load – with storm belts	6.78 kN	63
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	5.79 kN	66

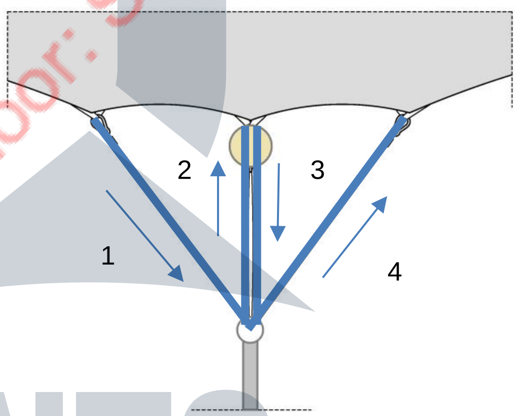
Table 22. Leading forces corner ties

H.6.2.9 Guy ropes – windows – long sides



A window consists of one continuous rope.
Forces are divided over 4 rope cross sections as shown.
Therefore, the average force is calculated as:

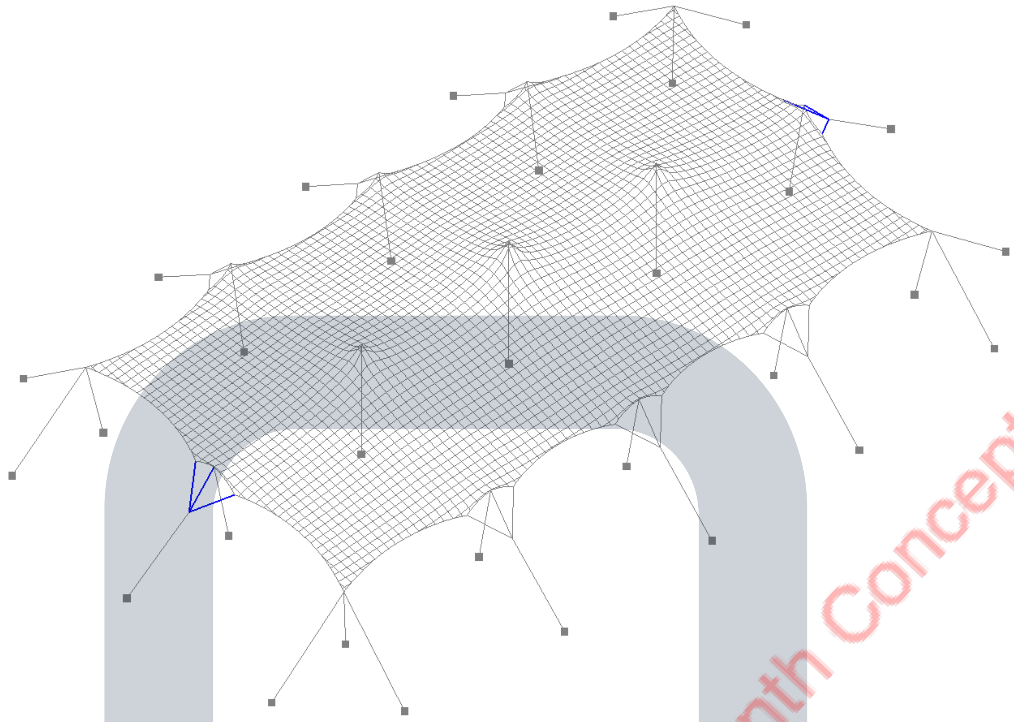
(2 x Tie Side + 1 x Tie Middle) / 4



10x20m		Load combination	F_{rep}	Pag.
		CO1. Own weight + pretension	0.82 kN	57
		CO2. Own weight + pretension + conventional	1.22 kN	59
Guy ropes		CO3. Own weight + pretension + wind pressure full wind load	1.53 kN	61
Windows		CO4. Own weight + pretension + wind suction full wind load – with storm belts	2.79 kN	63
	Max	CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	2.83 kN	66

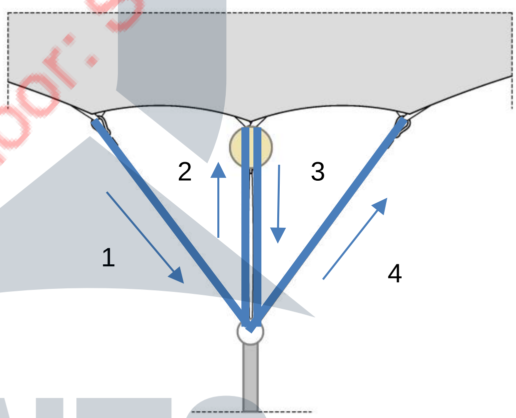
Table 23. Leading forces guy ropes windows

H.6.2.10 Guy ropes – windows – short sides



A window consists of one continuous rope.
Forces are divided over 4 rope cross sections as shown.
Therefore, the average force is calculated as:

(2 x Tie Side + 1 x Tie Middle) / 4



10x20m		Load combination	F_{rep}	Pag.
Guy ropes Windows		CO1. Own weight + pretension	0.90 kN	57
		CO2. Own weight + pretension + conventional	1.41 kN	59
		CO3. Own weight + pretension + wind pressure full wind load	1.79 kN	61
		CO4. Own weight + pretension + wind suction full wind load – with storm belts	2.17 kN	63
	Max	CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	3.19 kN	66

Table 24. Leading forces guy ropes windows

H.6.2.11 Storm belts

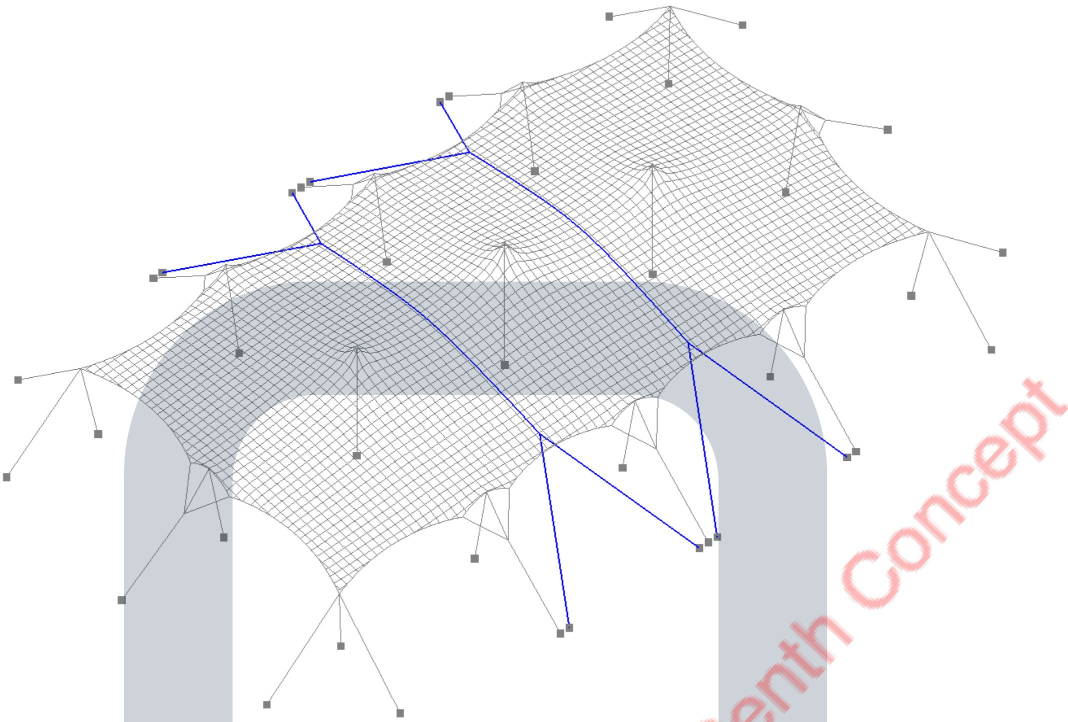


Figure 5. 10x20m with 2 stormbelts

10x20m		Load combination	F_{rep}	Pag.
Storm Belts		CO1. Own weight + pretension	No stormbelt	-
		CO2. Own weight + pretension + conventional	No stormbelt	-
		CO3. Own weight + pretension + wind pressure full wind load	No stormbelt	-
	Max	CO4. Own weight + pretension + wind suction full wind load – with storm belts	8.32 kN	63
		CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	No stormbelt	-

Table 25. Leading forces storm belts

H.7. Check elements

H.7.1.1 Membrane

Load combination		Element	Representative stress	Design value stress	Pag.
CO1. Own weight + pretension	Warp	Membrane Permanent load	1.71 kN/m	2.56 kN/m (γ = 1.5)	56
CO4. Own weight + pretension + wind suction full wind load – with storm belts	Warp	Membrane Short term load	4.41 kN/m	6.62 kN/m (γ = 1.5)	62
CO1. Own weight + pretension	Weft	Membrane Permanent load	2.00 kN/m	3.00 kN/m (γ = 1.5)	56
CO3. Own weight + pretension + wind pressure full wind load	Weft	Membrane Short term load	4.81 kN/m	7.22 kN/m (γ = 1.5)	62

HQStretch

UC.1a	**Warp, permanent**	**S_{Ed} / S_{rd} < 1**	**2.56 / 9.6 = 0.27 < 1**	**OK**
UC.1b	**Warp, short term**	**S_{Ed} / S_{rd} < 1**	**6.62 / 12.0 = 0.55 < 1**	**OK**
UC.1c	**Weft, permanent**	**S_{Ed} / S_{rd} < 1**	**3.00 / 7.2 = 0.42 < 1**	**OK**
UC.1d	**Weft, short term**	**S_{Ed} / S_{rd} < 1**	**7.22 / 9.0 = 0.80 < 1**	**OK**

For capacity of membrane see H.2.1, page 19

H.7.1.2 Center pole 4.5m

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure full wind load	Center pole 4.5m	-7.01 kN	-10.52 kN (γ = 1.5)	61

User load of max. 10 kg is applied, loaded centrically.
Ned = (-7.01 x 1.5) + (1.35 x -0.1) = -10.65 kN

H.7.1.2.1. Aluminium

Profile = tube Ø70 x 3mm
Length = max. 4.5m
Quality = EN AW-6060 T66

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.3a	**Interaction (NM)**	**4.5m**	$\left(\frac{N_{ed}}{\chi\omega N_{rd}}\right)^{0.8} = \left(\frac{10.65}{0.1115 \cdot 1 \cdot 91.85}\right)^{0.8} = 1.04 \approx 1$	**Acceptable**

See Annex C.1, on page 67 for elaborate check

H.7.1.2.2. Chestnut

Profile = ≥ Ø94mm
Length = max. 4.5m
Quality = D24

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.3b	**4.5m**	**$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.52 / (14.54 x 0.1032) = 1.01**	**Acceptable**

See Annex C.2, on page 68 for elaborate check

H.7.1.2.3. Eucalyptus

Profile = ≥ Ø94mm
Length = max. 4.5m
Quality = D35

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.3c	**4.5m**	**$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.53 / (17.31 x 0.0883) = 1.00**	**OK**

See Annex C.3, on page 69 for elaborate check

H.7.1.3 Center pole 4.0m

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure full wind load	Center pole 4.0m	-6.22 kN	-9.33 kN (γ = 1.5)	61

User load of max. 10 kg is applied, loaded centrically.
Ned = (-6.22 x 1.5) + (1.35 x -0.1) = -9.47 kN

H.7.1.3.1. Aluminium

Profile = tube Ø63 x 3mm
Length = max. 4.0m
Quality = EN AW-6060 T66

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.4a	**Interaction (NM)**	**4.0m**	$\left(\frac{N_{ed}}{\chi\omega N_{rd}}\right)^{0.8} = \left(\frac{9.47}{0.1132 \cdot 1 \cdot 9.47}\right)^{0.8} = 1.02 \approx 1$	**Acceptable**

See Annex C.4 on page 70 for elaborate check

H.7.1.3.2. Chestnut

Profile = ≥ Ø90mm
Length = max. 4.0m
Quality = D24

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.4b	**4.0m**	$\sigma_{c,0,d}$ **/ ($f_{c,0,d}$ x k_{cy}) = 1.49 / (14.54 x 0.1179) = 0.87**	**OK**

See Annex C.5 on page 71 for elaborate check

H.7.1.3.3. Eucalyptus

Profile = ≥ Ø90mm
Length = max. 4.0m
Quality = D35

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.4c	**4.0m**	**$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.49 / (17.31 x 0.1019) = 0.84**	**OK**

See Annex C.6, on page 72 for elaborate check

H.7.1.4 Side pole 3.0m

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure full wind load	side pole 3.0m	-5.56 kN	-8.34 kN (γ = 1.5)	61

User load of max. 10 kg is applied, loaded centrically.
Ned = (-5.56 x 1.5) + (1.35 x -0.1) = -8.48 kN

H.7.1.4.1. Aluminium

Profile = tube Ø51 x 3mm
Length = max. 3.0m
Quality = EN AW-6060 T66

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.5a	**Interaction (NM)**	**3.0m**	$\left(\frac{N_{ed}}{\chi\omega N_{rd}}\right)^{0.8} = \left(\frac{8.48}{0.1282 \cdot 1 \cdot 65.80}\right)^{0.8} = 1.00 = 1$	**OK**

See Annex C.7 on page 73 for elaborate check

H.7.1.4.2. Chestnut

Profile = ≥ Ø73mm
Length = max. 3.0m
Quality = D24

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.5b	**3.0m**	**$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 2.02 / (14.54 x 0.1370) = 1.02**	**Acceptable**

See Annex C.8, on page 74 for elaborate check

H.7.1.4.3. Eucalyptus

Profile = ≥ Ø73mm
Length = max. 3.0m
Quality = D35

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.5c	**3.0m**	**$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 2.02 / (17.31 x 0.1185) = 0.99**	**OK**

See Annex C.9, on page 75 for elaborate check

H.7.1.5 Corner pole 2.5m

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure full wind load	side pole 2.5m	-7.75 kN	-11.63 kN (γ = 1.5)	61

User load of max. 10 kg is applied, loaded centrically.
Ned = (-7.75 x 1.5) + (1.35 x -0.1) = -11.76 kN

H.7.1.5.1. Aluminium

Profile = tube Ø51 x 3mm
Length = max. 2.5m
Quality = EN AW-6060 T66

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.6a	**Interaction (NM)**	**2.5m**	$\left(\frac{N_{ed}}{\chi\omega N_{rd}}\right)^{0.8} = \left(\frac{11.76}{0.1809 \cdot 1 \cdot 65.80}\right)^{0.8} = 0.99 < 1$	**OK**

See Annex C.10 on page 76 for elaborate check

H.7.1.5.2. Chestnut

Profile = ≥ Ø73mm
Length = max. 2.5m
Quality = D24

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.6b	**2.5m**	**$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 2.81 / (14.54 x 0.1938) = 1.00**	**OK**

See Annex C.11, on page 77 for elaborate check

H.7.1.5.3. Eucalyptus

Profile = ≥ Ø73mm
Length = max. 2.5m
Quality = D35

The poles are considered as hinged poles; the buckling length is equivalent to the pole length.

UC.6c	**2.5m**	$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 2.81 / (17.31 x 0.1680) = 0.97	**OK**

See Annex C.12, on page 78 for elaborate check

H.7.1.6 Guy ropes

Load combination	Element	Representative force	Design value force	Pag.
CO5. Own weight + pretension + wind suction reduction 0.60 - without storm belts	Long sides	9.16 kN	13.74 kN (γ = 1.5)	66
CO4. Own weight + pretension + wind suction full wind load –with storm belts	Short sides	10.63 kN	15.95 kN (γ = 1.5)	63
CO4. Own weight + pretension + wind suction full wind load –with storm belts	Corner (2x)	6.78 kN	10.17 kN (γ = 1.5)	63

Either ropes or belts are being used:
- Polyester ropes Ø8mm with a minimum breaking strength of **1200kg.** (F_{rd} = 3kN)
- PES belts with a minimum breaking strength of **1200kg.** (F_{rd} = 6 kN)

UC.7a	Guy rope	**5 sections**	**F_d / F_{rd} < 1**	**13.74 / (5 x 3) = 0.92 < 1**	**OK**
UC.7b	Tension belt	**3 sections**	**F_d / F_{rd} < 1**	**13.74 / (3 x 6) = 0.76 < 1**	**OK**

For capacity of ropes and belts see H.2.3 and H.2.2 , page 19

UC.8a	Guy rope	**6 sections**	**F_d / F_{rd} < 1**	**15.95 / (6 x 3) = 0.89 < 1**	**OK**
UC.8b	Tension belt	**3 sections**	**F_d / F_{rd} < 1**	**15.95 / (3 x 6) = 0.89 < 1**	**OK**

For capacity of ropes and belts see H.2.3 and H.2.2 , page 19

UC.9a	Guy rope	**4 sections**	**F_d / F_{rd} < 1**	**10.17 / (4 x 3) = 0.85 < 1**	**OK**
UC.9b	Tension belt	**2 sections**	**F_d / F_{rd} < 1**	**10.17 / (2 x 6) = 0.85 < 1**	**OK**

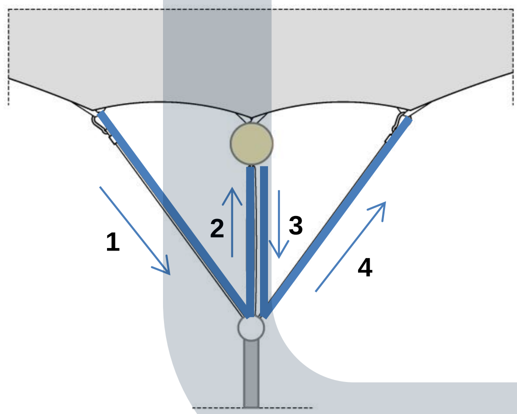
For capacity of ropes and belts see H.2.3 and H.2.2 , page 19

H.7.1.7 Guy ropes windows

Load combination	Element	Representative force	Design value force	Pag.
CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	Long sides - windows total sum value	2.83 kN	4.25 kN (γ = 1.5)	66
CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	Short sides - windows total sum value	3.19 kN	4.79 kN (γ = 1.5)	66

One continuous rope is used to create the window. Therefore the total of the forces can be equally divided over the amount of rope sections and branches used to create a window.
When three branches are used, such as in the case of the Qtents Stretchtent, a configuration with 4 rope cross sections is used (see image below)

Continuous - 4 rope sections



Either ropes or belts are being used:
- Polyester rope Ø8mm with a minimum breaking strength of **1200kg.** (F_{rd} = 3 kN)
- PES belts with a minimum breaking strength of **1200kg.** (F_{rd} = 6 kN)

UC.10a	Guy rope window Long sides	**2 sections**	**F_d / F_{rd} < 1**	**4.25 / (2 x 3)= 0.71 < 1**	**OK**
UC.10b	Tension belt window Long sides	**1 section**	**F_d / F_{rd} < 1**	**4.25 / 6 = 0.71 < 1**	**OK**

For capacity of ropes and belts see H.2.3 and H.2.2 , page 19

UC.11a	Guy rope window Short sides	**2 sections**	**F_d / F_{rd} < 1**	**4.79 / (2 x 3) = 0.80 < 1**	**OK**
UC.11b	Tension belt window Short sides	**1 section**	**F_d / F_{rd} < 1**	**4.79 / 6 = 0.80 < 1**	**OK**

For capacity of ropes and belts see H.2.3 and H.2.2 , page 19

H.7.1.8 Storm belts

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction full wind load – with storm belts	Storm belts	8.32 kN	12.48 kN (γ = 1.5)	63

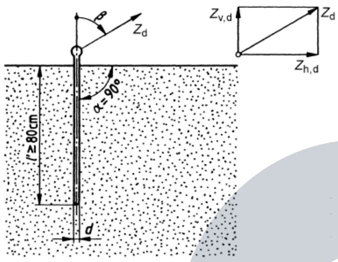
Belts are PES belts with a minimum breaking strength of **2800kg.** (F_{rd} = 14 kN)

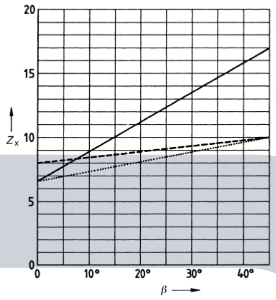
UC.12	Storm belt	**F_d / F_{rd} < 1**	**12.48 / 14 = 0.89 < 1.0**	**OK**

For capacity of belts see H.2.2, page 19

H.8. Safety against overturning, sliding and uplifting

H.8.1 Anchor capacity





Angle of pull	Load bearing capacity *N*
$\beta = 0$	Z_d = 6,5 dl' for stiff cohesive and for dense cohesion less soils
$\beta = 0$	Z_d = 8 dl' for very stiff cohesive soils
$\beta \geq 45$	Z_d = 10 dl' for cohesive soils of at least medium to stiff consistency
$\beta \geq 45$	Z_d = 17 dl' for dense cohesion less soils
$0 < \beta < 45$	The load bearing capacity for the soil types shall be determined by interpolation

Z_d is the anchor service load (service load), in N;
$Z_{h,d}$ is the horizontal anchor service load, in N;
$Z_{v,d}$ is the vertical anchor service load, in N;
d is the anchor diameter, in cm;
l' is the depth of penetration in cm;
α is the angle of penetration;
ß is the angle of acting tensile force to the vertical

figure 6. Taken from from NEN-EN 13782: Figures 4 & 5, table 5

3 different type of anchors have been regarded:

- Anchor pin Ø30 with effective length L_{eff} of 1200mm.
- Anchor pin Ø25 with effective length L_{eff} of 936mm.
- Anchor stake т 25 with effective length L_{eff} of 500mm.

If multiple anchors are placed at the same location, the anchors need to be at least 5x Ø apart to exploit the full capacity of the anchors.

<u>Anchor capacity for anchors based in dense cohesion less soil (sandy soil)</u>

		Ø35 x 1200mm	**Ø25 x 936mm**	**т 25 x 500mm**	
Angle	β	≥ 45	≥ 45	≥ 45	°
Effective length anchor	l'	120	93.3	50	cm
Diameter anchor	d	3.5	2.5	2.5	cm
Anchor capacity*	Z_d	7.14	3.98	2.13	kN

*Calculated under the assumption the anchor is based in dense cohesion less soil.

H.8.2 Required anchors

Load combination	Element	Representative force	Design value force	Pag.
CO5. Own weight + pretension + wind suction reduction 0.60 – without storm belts	Guy rope - Long side	9.16 kN	10.99 kN (γ = 1.2)	66
CO4. Own weight + pretension + wind suction full wind load – with storm belts	Guy rope - Short side	10.63 kN	12.76 kN (γ = 1.2)	63
CO4. Own weight + pretension + wind suction full wind load – with storm belts	Guy rope – Corner (2x)	6.78 kN	8.14 kN (γ = 1.2)	63
CO4. Own weight + pretension + wind suction full wind load – with storm belts	Storm belt (per ground point)	6.33 kN	7.60 kN (γ = 1.2)	63

UC.13a	Guy rope – Long side	**Ø35 x 1200mm**	**2x**	$F_d / F_{rd} < 1$	**10.99 / (2 x 7.14) = 0.77 < 1**	**OK**
UC.13b		**Ø25 x 936mm**	**3x**	$F_d / F_{rd} < 1$	**10.99 / (3 x 3.98) = 0.92 < 1**	**OK**
UC.13c		**т 25 x 500mm**	**5x**	$F_d / F_{rd} < 1$	**10.99 / (5 x 2.13) = 1.03 ≈ 1**	**OK**

UC.14a	Guy rope – Short side	**Ø35 x 1200mm**	**3x**	$F_d / F_{rd} < 1$	**12.76 / (3 x 7.14) = 0.60 < 1**	**OK**
UC.14b		**Ø25 x 936mm**	**4x**	$F_d / F_{rd} < 1$	**12.76 / (4 x 3.98) = 0.80 < 1**	**OK**
UC.14c		**т 25 x 500mm**	**6x**	$F_d / F_{rd} < 1$	**12.76 / (6 x 2.13) = 1.00 = 1**	**OK**

UC.15a	Guy rope – Corner (2x)	**Ø35 x 1200mm**	**2x**	$F_d / F_{rd} < 1$	**8.14 / (2 x 7.14) = 0.57 < 1**	**OK**
UC.15b		**Ø25 x 936mm**	**2x**	$F_d / F_{rd} < 1$	**8.14 / (2 x 3.98) = 1.02 ≈ 1**	**OK**
UC.15c		**т 25 x 500mm**	**4x**	$F_d / F_{rd} < 1$	**8.14 / (4 x 2.13) = 0.96 < 1**	**OK**

UC.16a	Storm belt (per ground point)*	**Ø35 x 1200mm**	**2x**	$F_d / F_{rd} < 1$	**7.60 / (2 x 7.14) = 0.53 < 1**	**OK**
UC.16b		**Ø25 x 936mm**	**2x**	$F_d / F_{rd} < 1$	**7.60 / (2 x 3.98) = 0.95 < 1**	**OK**
UC.16c		**т 25 x 500mm**	**4x**	$F_d / F_{rd} < 1$	**7.60 / (4 x 2.13) = 0.89 < 1**	**OK**

* Storm belts and their anchoring are only required from a wind pressure of 300 N/m².

H.8.3 Reduced anchoring

Load combination	Element	Representative force	Design value force	Pag.
Reduction 0.38	Guy rope – Long side	0.38 x 9.16 = 3.48 kN	4.18 kN (γ = 1.2)	66
Reduction 0.38	Guy rope – Short side	0.38 x 10.63 = 4.04 kN	4.85 kN (γ = 1.2)	63
Reduction 0.38	Guy rope – Corner (2x)	0.38 x 6.78 = 2.58 kN	3.10 kN (γ = 1.2)	63
Reduction 0.38	Storm belt (per ground point)	0.38 x 6.33 = 2.41 kN	2.89 kN (γ = 1.2)	63

UC.17b	Guy rope – Long side	**Ø25 x 936mm**	**1x**	**$F_d / F_{rd} < 1$**	**4.18 / (1 x 3.98) = 1.05 ≈ 1**	**OK**
UC.17c		**T 25 x 500mm**	**2x**	**$F_d / F_{rd} < 1$**	**4.18 / (2 x 2.13) = 0.98 < 1**	**OK**
UC.18b	Guy rope – Short side	**Ø25 x 936mm**	**2x**	**$F_d / F_{rd} < 1$**	**4.85 / (2 x 3.98) = 0.61 < 1**	**OK**
UC.18c		**T 25 x 500mm**	**3x**	**$F_d / F_{rd} < 1$**	**4.85 / (3 x 2.13) = 0.76 < 1**	**OK**
UC.19b	Guy rope – Corner (2x)	**Ø25 x 936mm**	**1x**	**$F_d / F_{rd} < 1$**	**3.10 / (1 x 3.98) = 0.78 < 1**	**OK**
UC.19c		**T 25 x 500mm**	**2x**	**$F_d / F_{rd} < 1$**	**3.10 / (2 x 2.13) = 0.73 < 1**	**OK**
UC.20b	Storm belt (per ground point)*	**Ø25 x 936mm**	**1x**	**$F_d / F_{rd} < 1$**	**2.89 / (1 x 3.98) = 0.73 < 1**	**OK**
UC.20c		**T 25 x 500mm**	**2x**	**$F_d / F_{rd} < 1$**	**2.89 / (2 x 2.13) = 0.68 < 1**	**OK**

* Storm belts and their anchoring are required from a reduction factor of α = (0.38/0.60)*0.39 ≈ 0.25, which corresponds to a wind pressure of 125 N/m^2..

H.8.4 Anchor tests according to EN 13782

It is advised to perform anchor test on location when there is a reason to doubt the “pull-out force” of the anchors, which could be when ground conditions differ from dense, non-cohesive soil.

Anchor tests should be carried out according to the following procedure:
Three anchors spread throughout the terrain should be put perpendicular into the ground. The anchors should be pulled out with the aid of a spring balance in the direction of the force acting on the anchor. The lowest of the three measured values should be used.

A safety factor of v = 1.6 regarding ultimate limit load is to apply for the lowest test value in order to determine the load bearing capacity in subsequent calculation. The load bearing capacity determined in this manner shall not result in anchor movement which would result in stresses, deformations or instability inadmissible for the structure.
If the foundation conditions are comparable, test loadings carried out in another location may be adduced for substantiation purposes.

<u>For example:</u>
Force in belts: Frep = 16.2 kN
Fsd_{belt} = 1.2 x Frep = 1.2 x 16.2 = 19.4 kN

The partial safety factor γ = 1.6 is applied on the ultimate limit load:
$Z_{u,d,test}$ > 1.6 x Fsd = 1.6 x 19.4 =31.1 kN

If for example the anchor test point outs that there has to be a minimal anchor capacity of 16 kN (1600 kg), then 2 anchors are needed: 2x16 = 32 kN > $Z_{u,d,test}$

I. Material certificates

Fire certificate HQ8

INSTITUT TECHNOLOGIQUE
FCBA
Laboratoire d'essais feu
10 rue Galilée - 77420 Champs-sur-Marne

FCBA INSTITUT TECHNOLOGIQUE

Laboratoire agréé par le Ministère de l'Intérieur et de l'Aménagement du Territoire
JO du 10 février 2007
PROCES-VERBAL DE CLASSEMENT DE REACTION AU FEU
D'UN MATERIAU PREVU A L'ARTICLE 5
DE L'ARRETE DU 21 NOVEMBRE 2002

Page 1

N° CM - 16 - P - 076 / D / 1

et 1 annexe de 4 pages.

Valable 5 ans à compter du mercredi 18 mai 2016

Matériau présenté par :

Marque commerciale : QTENTS HQ8 (13567345)

Description sommaire:

Type de support support textile polyester enduit de PVC/ polyster fabric with PVC coating

Composition support textile/ fabric 100% polyester (280 g/m²) + enduction/ coating PVC ignifugé (450 g/m²)

Masse surfacique 730 g/m²

Coloris tous coloris/ all colors

Nature de l'essai : Essai au brûleur électrique
Essai de persistance de flamme
Essai de gouttes

Classement : M2

Observations : Ce Procès Verbal numéro CM - 16 - P - 076 / D / 1 est une extension du Procès Verbal numéro CM - 16 - P - 076 du produit F5639

Durabilité du classement (l'annexe 22) : Non limitée a priori

Usage : Revêtement de murs tendus, voilages, rideaux,… **Conditions d'entretien :** Non lavable à l'eau et non nettoyable

Compte tenu des critères résultant des essais annexés décrits dans le(s) rapport(s) d'essais N° : *367160335 et 367160687*

Ce procès-verbal atteste uniquement des caractéristiques de l'échantillon soumis aux essais et ne préjuge pas des caractéristiques de produits similaires. Il ne constitue donc pas une certification de produits au sens de l'article L.115-27 du code de la consommation et de la loi du 3 juin 1994.
NOTA : Seules sont autorisées les reproductions intégrales et par photocopies du présent procès-verbal de classement ou de l'ensemble du procès-verbal de classement et rapport(s) d'essais annexé(s).Ces conclusions ne portent que sur les performances de résistance / réaction au feu de l'élément objet du présent procès verbal de classement. Elles ne préjugent, en aucun cas, des autres performances liées à son incorporation à un ouvrage"

"Non valable pour toute application couverte par l'article AM 18 (Arrêté du 6 mars 2006) concernant les sièges rembourrés"

Champs-sur-Marne, le jeudi 11 janvier 2018

Technicienne d'essais du Laboratoire Feu

Clotilde ETIEMVRE

Responsable Technique du Laboratoire Feu du Pôle Ameublement

INSTITUT TECHNOLOGIQUE LABORATOIRE ESSAIS ET MESURES CHAMPS-SUR-MARNE

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Institut technologique FCBA : Forêt, Cellulose, Bois - construction, Ameublement

J. Annexes

Annex A. Software input (load cases)

Annex A.1. Own weight + pretension

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS

LOADGROUP	LOADMODE	LOAD	FACTOR	SUM_X	SUM_Y	SUM_Z	LOADED AREA
1	EIGENGEWICHT	0.0073	1.00	0.0000	0.0000	-1.4659	200.81
SUM				0.0000	0.0000	-1.4659	

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES

	LOADMODE	SUM_X	SUM_Y	SUM_Z
SUM	EIGENGEWICHT	0.0000	0.0000	-1.4659
SUM	AREA-LOADS	0.0000	0.0000	-1.4659

EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS

SUM_X	SUM_Y	SUM_Z
0.0000	0.0000	-1.4659

Annex A.2. Own weight + pretension + conventional

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS

LOADGROUP	LOADMODE	LOAD	FACTOR	SUM_X	SUM_Y	SUM_Z	LOADED AREA
1	SCHNEE	0.1000	1.00	0.0000	0.0000	-19.5435	195.44
1	EIGENGEWICHT	0.0073	1.00	0.0000	0.0000	-1.4659	200.81
SUM				0.0000	0.0000	-21.0094	

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES

	LOADMODE	SUM_X	SUM_Y	SUM_Z
SUM	SCHNEE	0.0000	0.0000	-19.5435
SUM	EIGENGEWICHT	0.0000	0.0000	-1.4659
SUM	AREA-LOADS	0.0000	0.0000	-21.0094

EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS

SUM_X	SUM_Y	SUM_Z
0.0000	0.0000	-21.0094

Annex A.3. Own weight + pretension + wind pressure – full wind load

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS

LOADGROUP	LOADMODE	LOAD	FACTOR	SUM_X	SUM_Y	SUM_Z	LOADED AREA
1	EIGENGEWICHT	0.0073	1.00	0.0000	0.0000	-1.4659	200.81
1	WIND	-0.1500	1.00	0.0000	0.0000	-29.3141	200.81
SUM				0.0000	0.0000	-30.7800	

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES

	LOADMODE	SUM_X	SUM_Y	SUM_Z
SUM	EIGENGEWICHT	0.0000	0.0000	-1.4659
SUM	WIND	0.0000	0.0000	-29.3141
SUM	AREA-LOADS	0.0000	0.0000	-30.7800

EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS

SUM_X	SUM_Y	SUM_Z
0.0000	0.0000	-30.7800

Annex A.4. Own weight + pretension + wind suction – full wind load, storm belts

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS

LOADGROUP	LOADMODE	LOAD	FACTOR	SUM_X	SUM_Y	SUM_Z	LOADED AREA
1	EIGENGEWICHT	0.0073	1.00	0.0000	0.0000	-1.4658	200.80
1	WIND	0.3500	1.00	0.0000	0.0000	68.3910	200.80
SUM				0.0000	0.0000	66.9252	

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES

	LOADMODE	SUM_X	SUM_Y	SUM_Z
SUM	EIGENGEWICHT	0.0000	0.0000	-1.4658
SUM	WIND	0.0000	0.0000	68.3910
SUM	AREA-LOADS	0.0000	0.0000	66.9252

EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS

SUM_X	SUM_Y	SUM_Z
0.0000	0.0000	66.9252

Annex A.5. Own weight + pretension + wind suction – reduction 0.60

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS

LOADGROUP	LOADMODE	LOAD	FACTOR	SUM_X	SUM_Y	SUM_Z	LOADED AREA
1	EIGENGEWICHT	0.0073	1.00	0.0000	0.0000	-1.4659	200.81
1	WIND	0.3500	0.60	0.0000	0.0000	41.0397	200.81
SUM				0.0000	0.0000	39.5738	

EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES

	LOADMODE	SUM_X	SUM_Y	SUM_Z
SUM	EIGENGEWICHT	0.0000	0.0000	-1.4659
SUM	WIND	0.0000	0.0000	41.0397
SUM	AREA-LOADS	0.0000	0.0000	39.5738

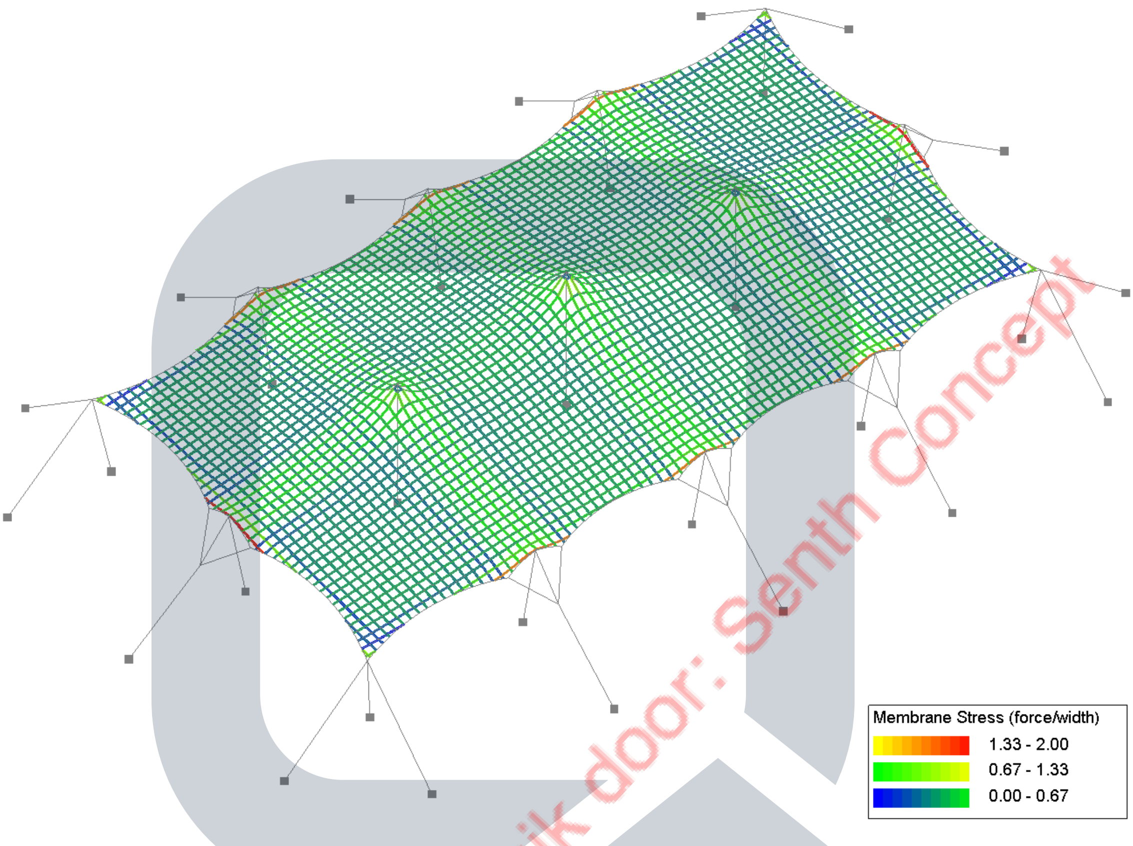
EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS

SUM_X	SUM_Y	SUM_Z
0.0000	0.0000	39.5738

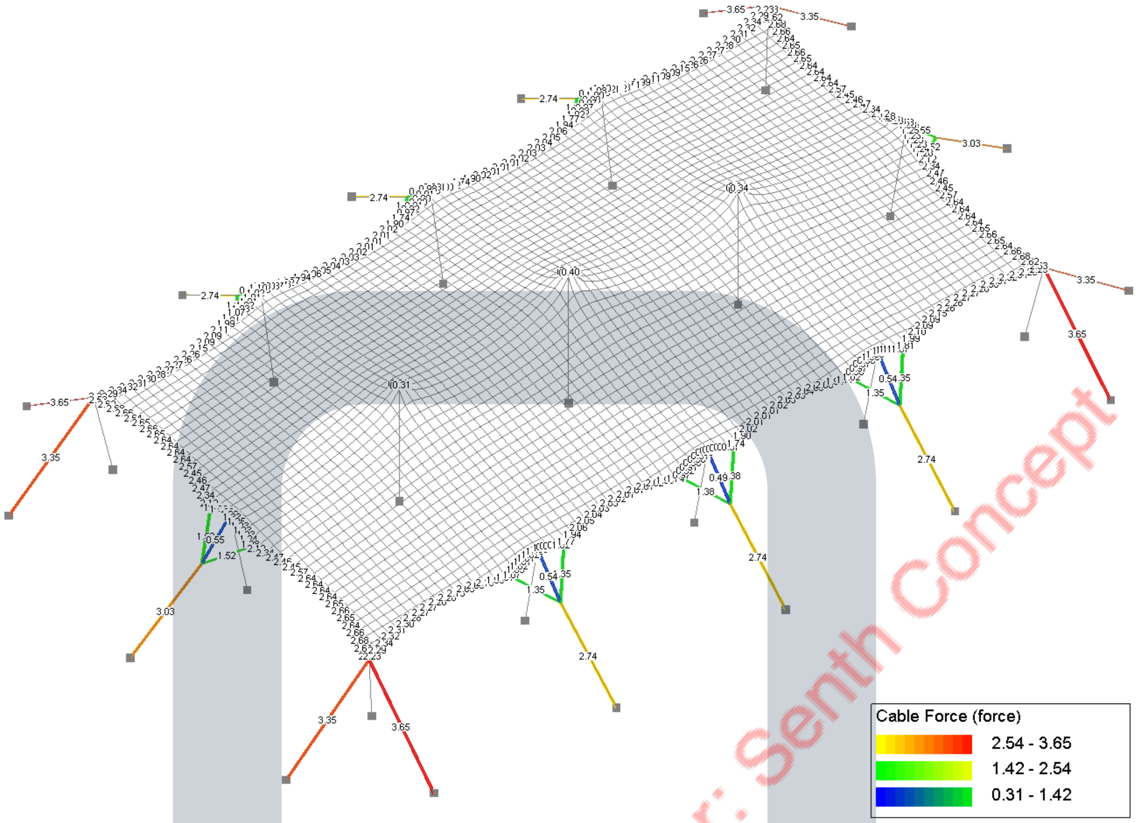
Annex B. Results per load combination

Annex B.1. Own weight + pretension

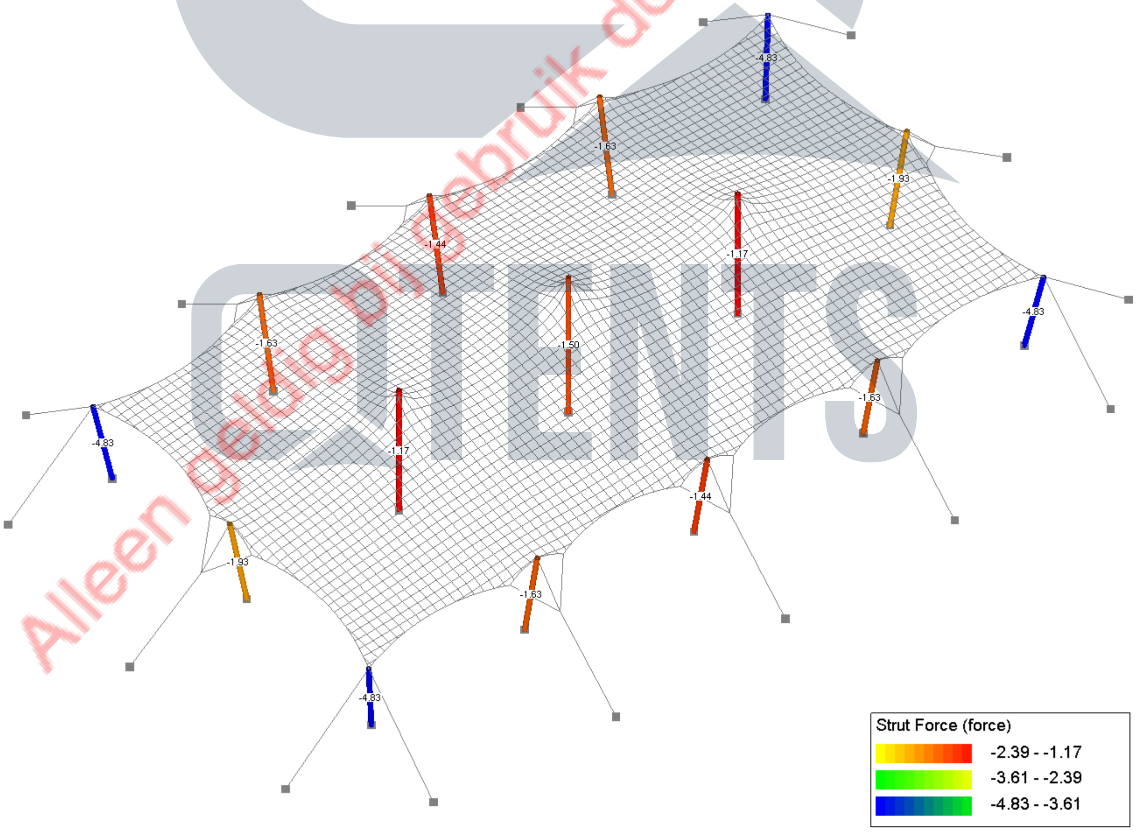
Annex B.1.1. Membrane stress



Annex B.1.2. Cable forces

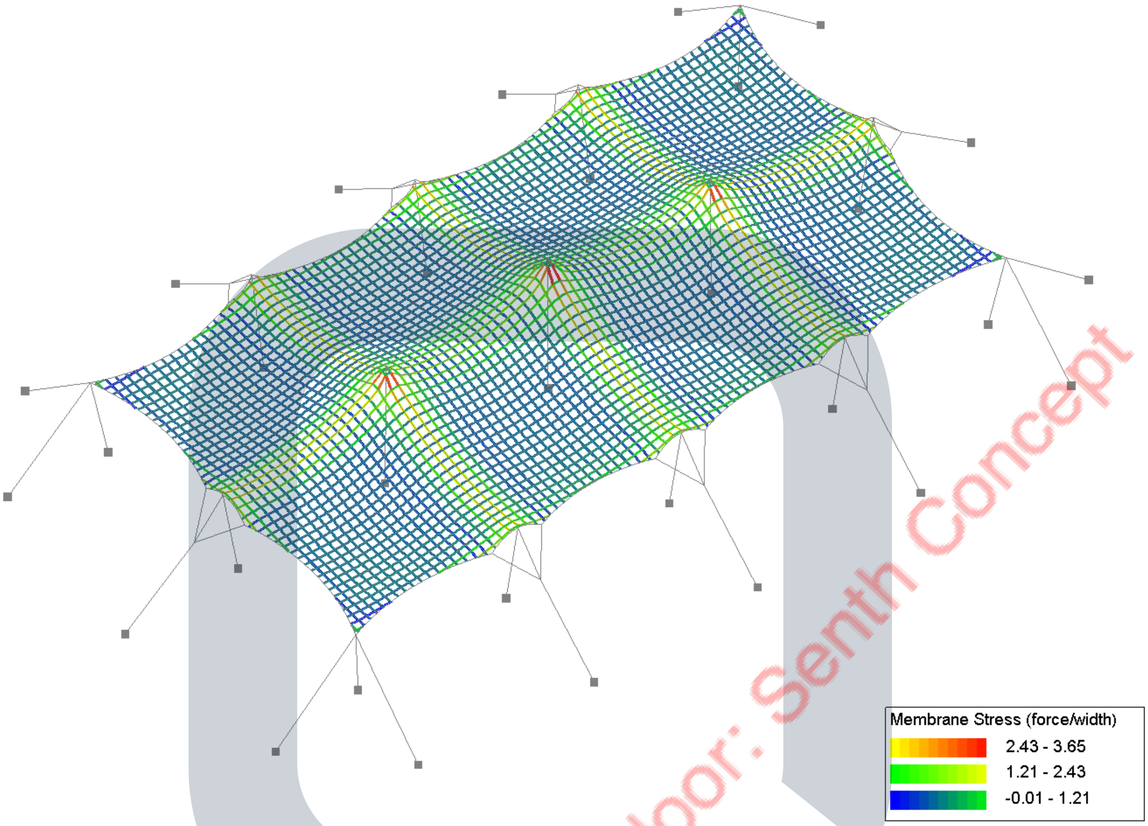


Annex B.1.3. Strut forces

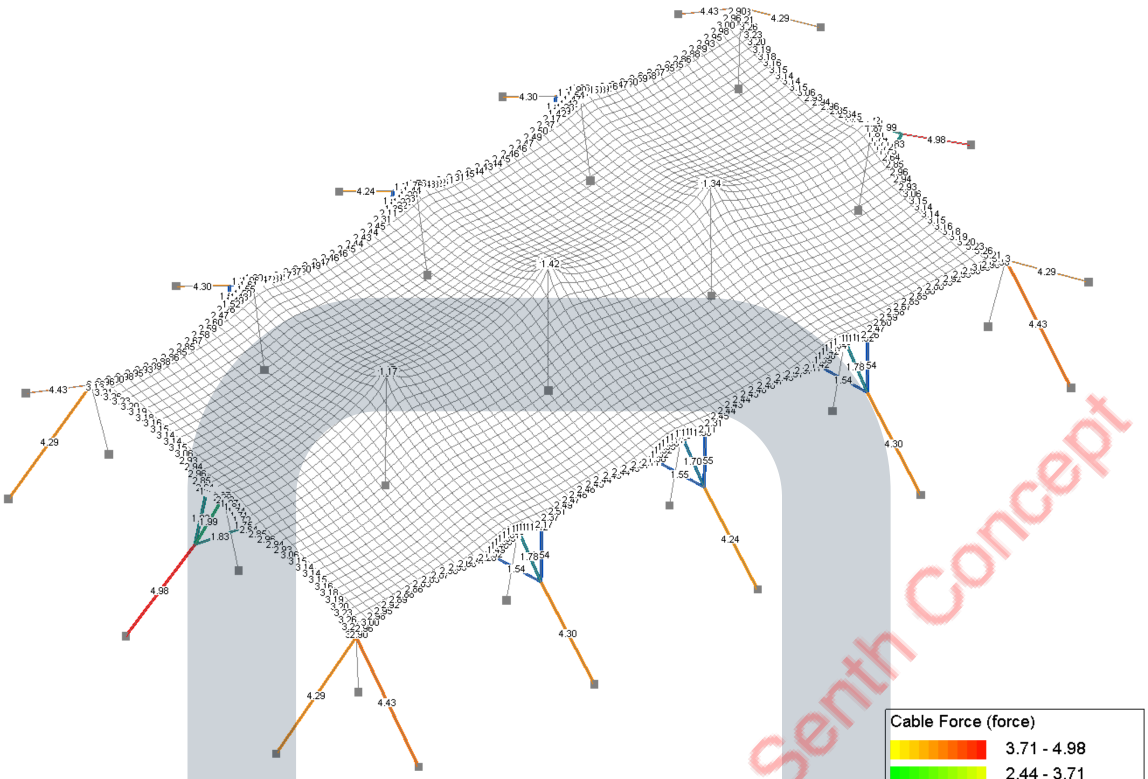


Annex B.2. Own weight + pretension + conventional

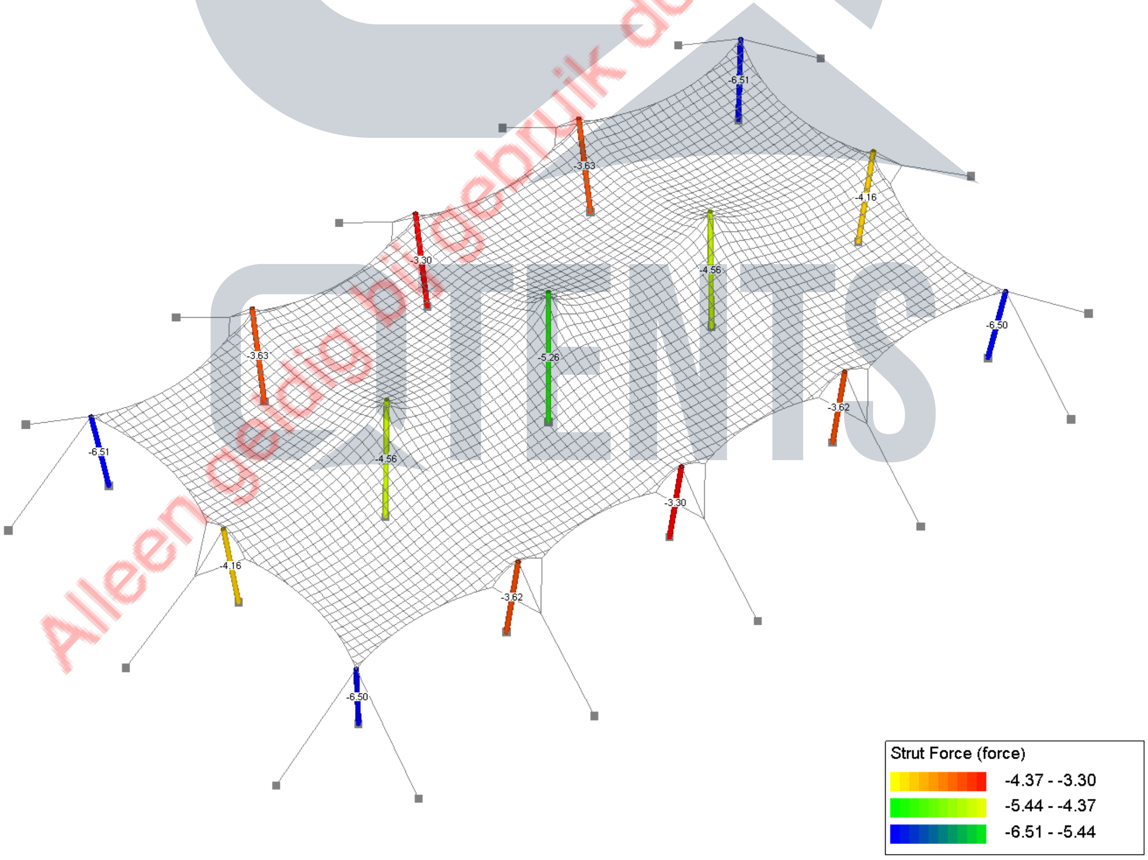
Annex B.2.1. Membrane stress



Annex B.2.2. Cable forces

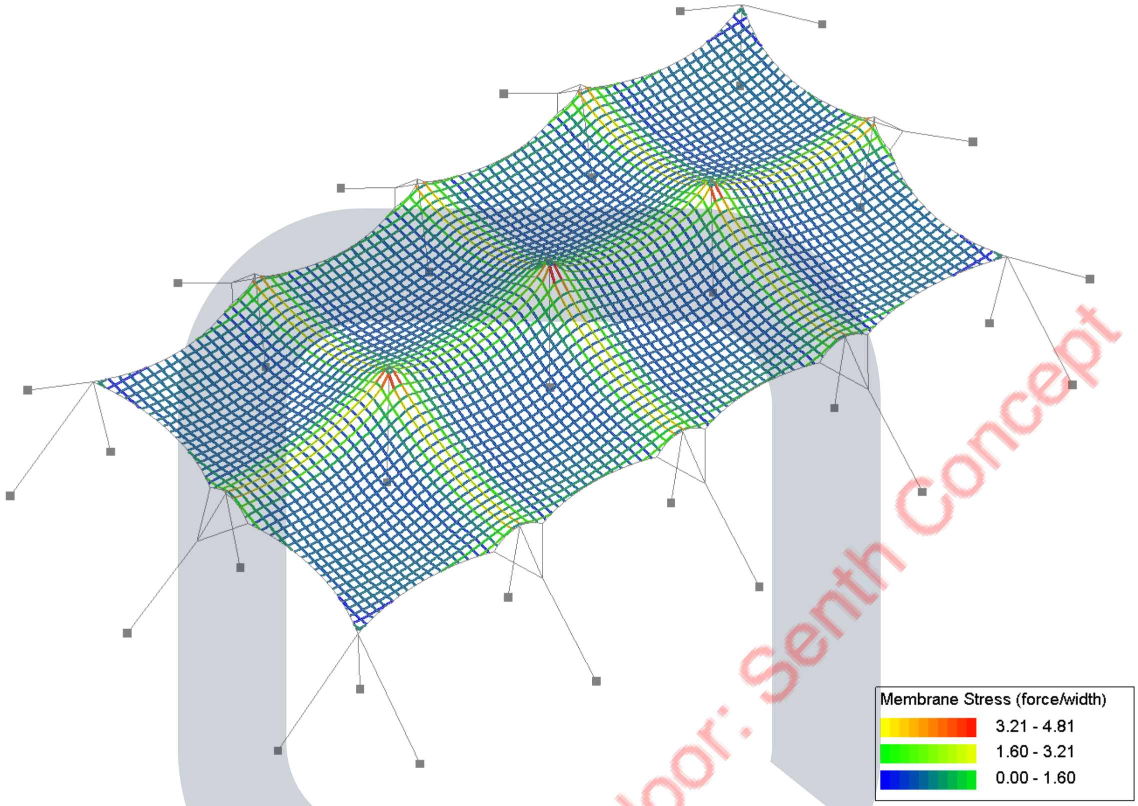


Annex B.2.3. Strut forces

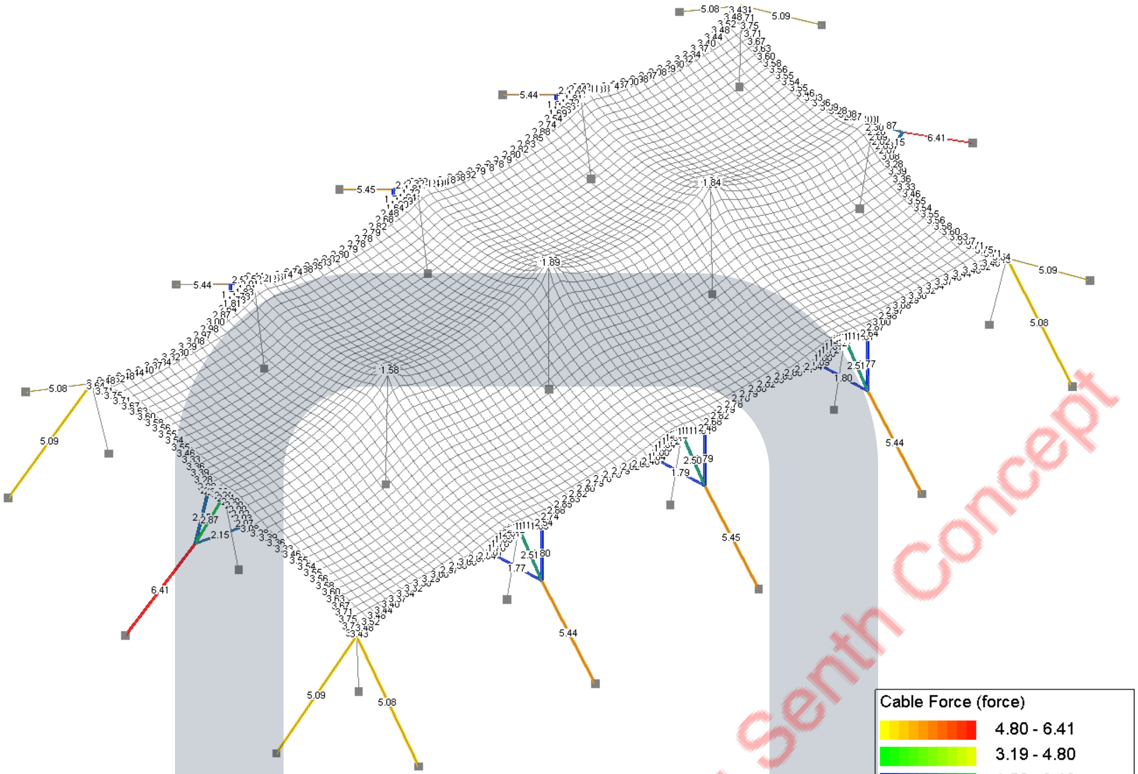


Annex B.3. Own weight + pretension + wind pressure – full wind load

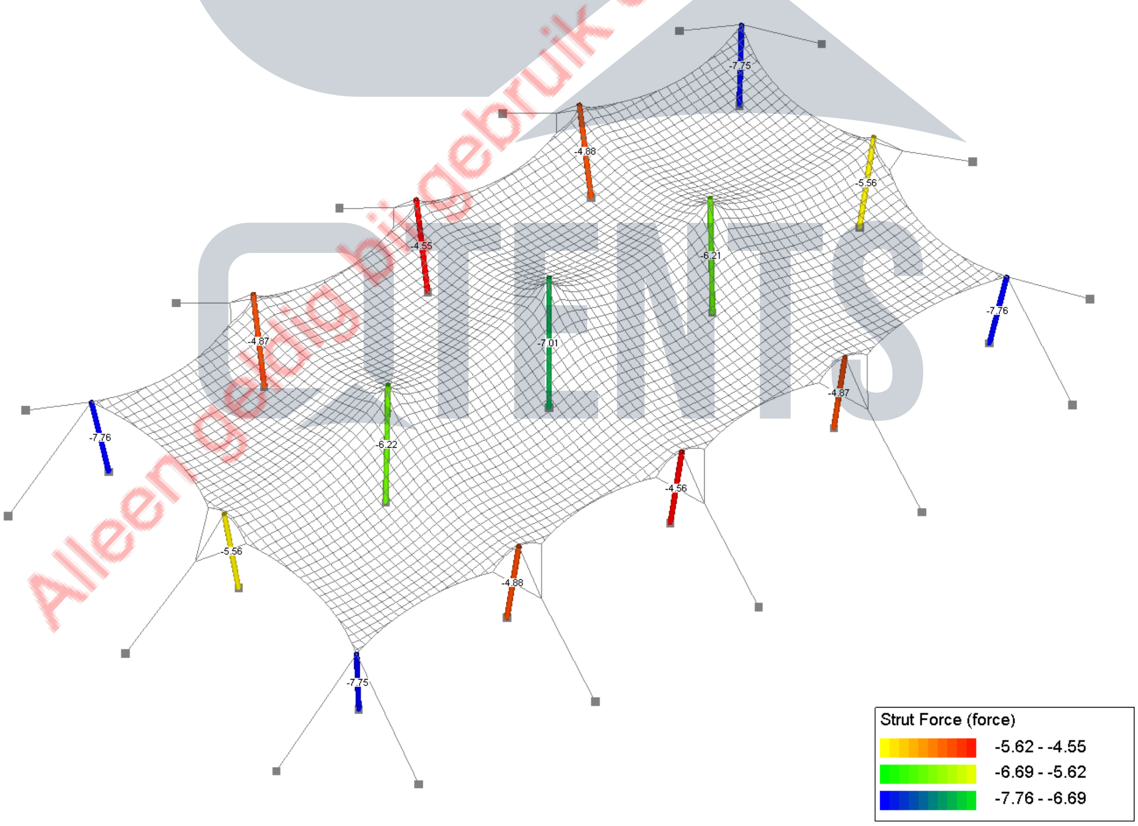
Annex B.3.1. Membrane stress



Annex B.3.2. Cable forces

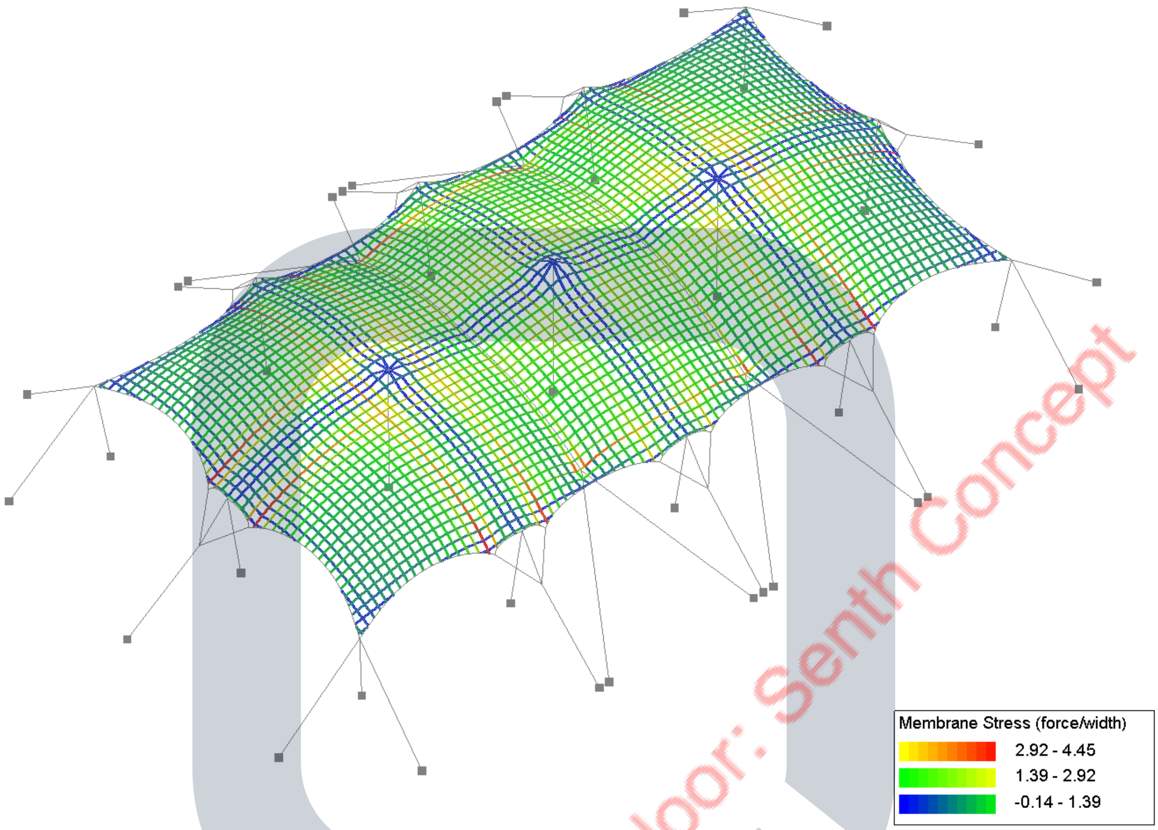


Annex B.3.3. Strut forces

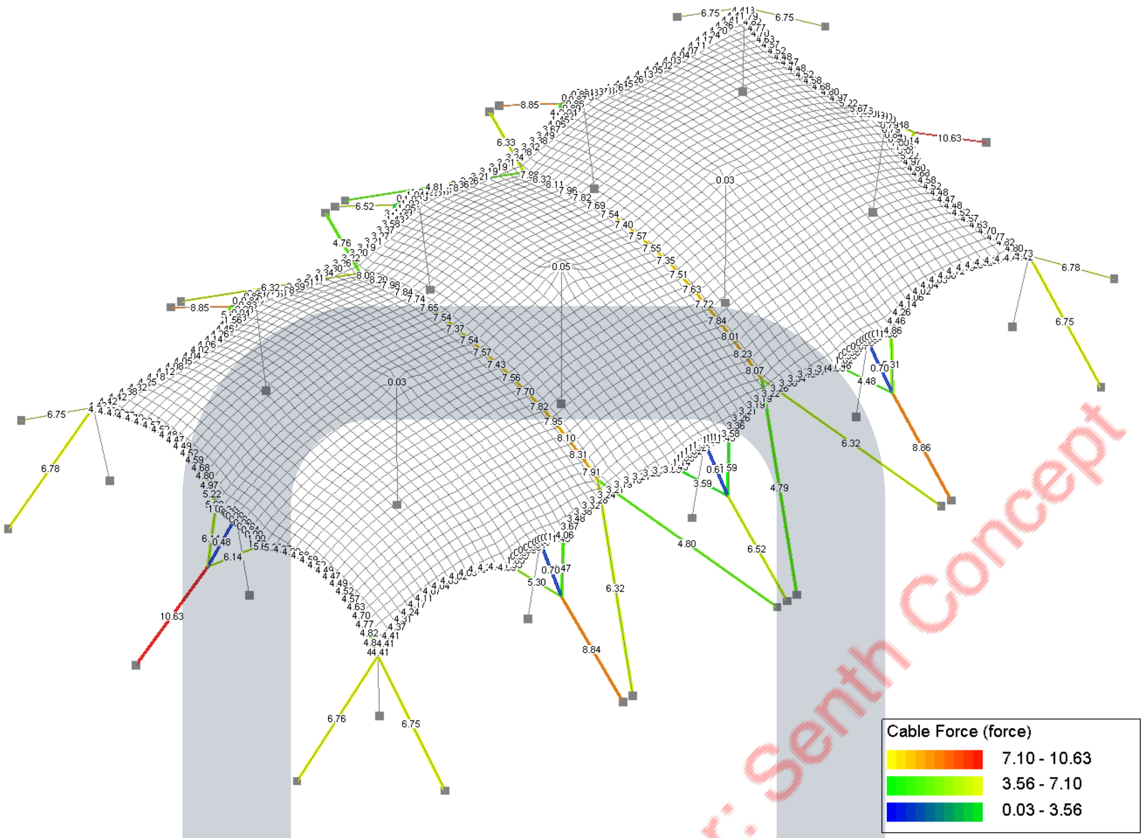


Annex B.4. Own weight + pretension + wind suction – full wind load, storm belts

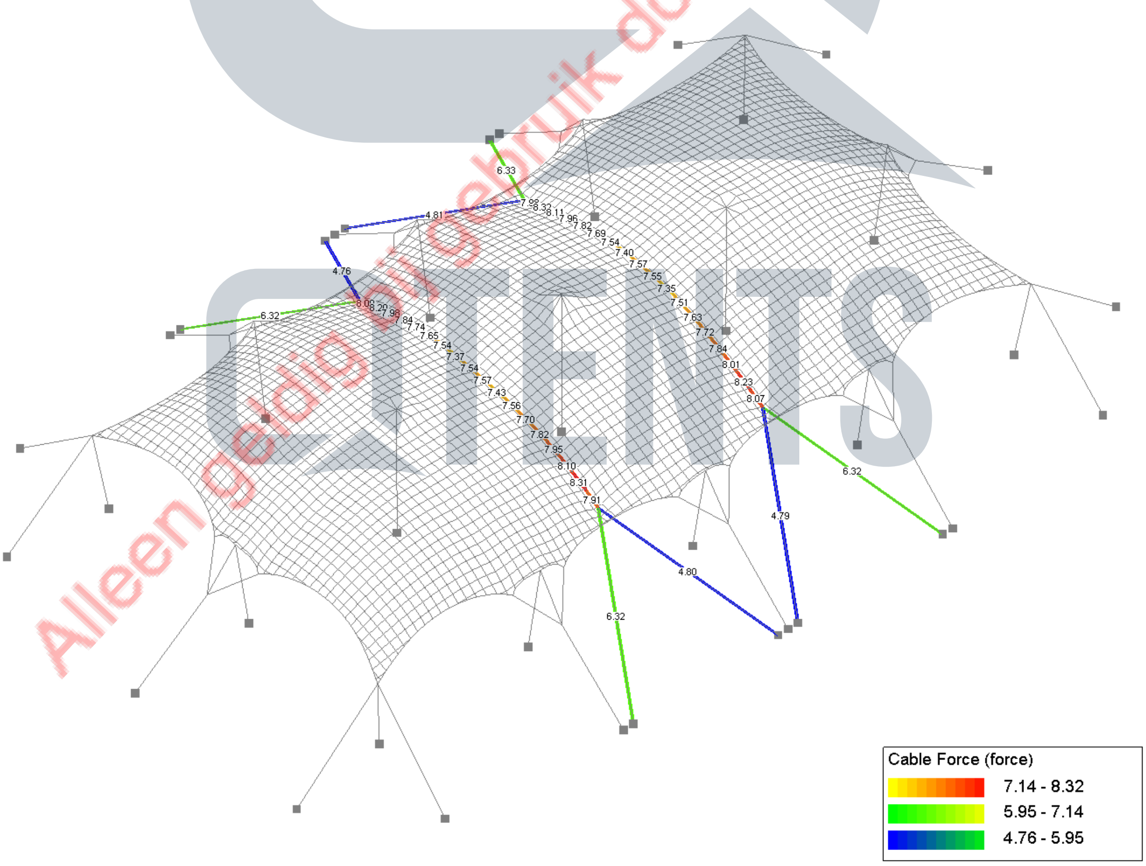
Annex B.4.1. Membrane stress



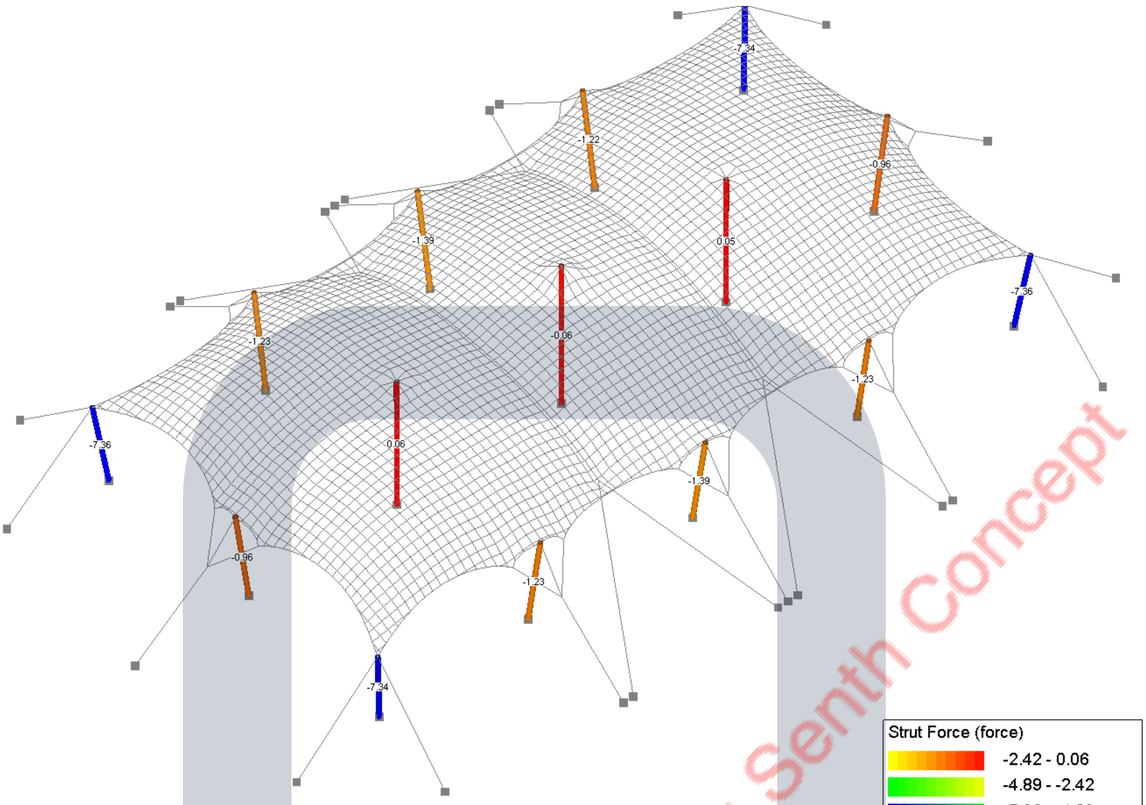
Annex B.4.2. Cable forces



Annex B.4.3. Storm belts

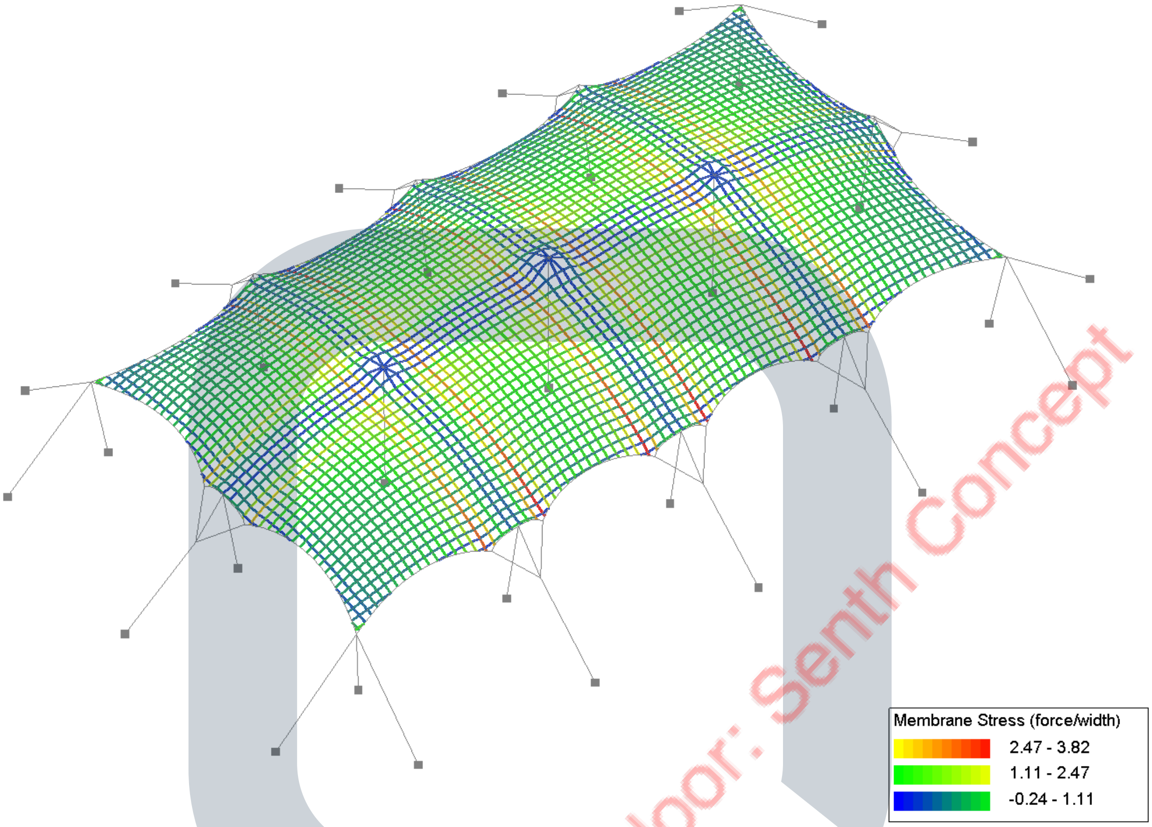


Annex B.4.4. Strut forces

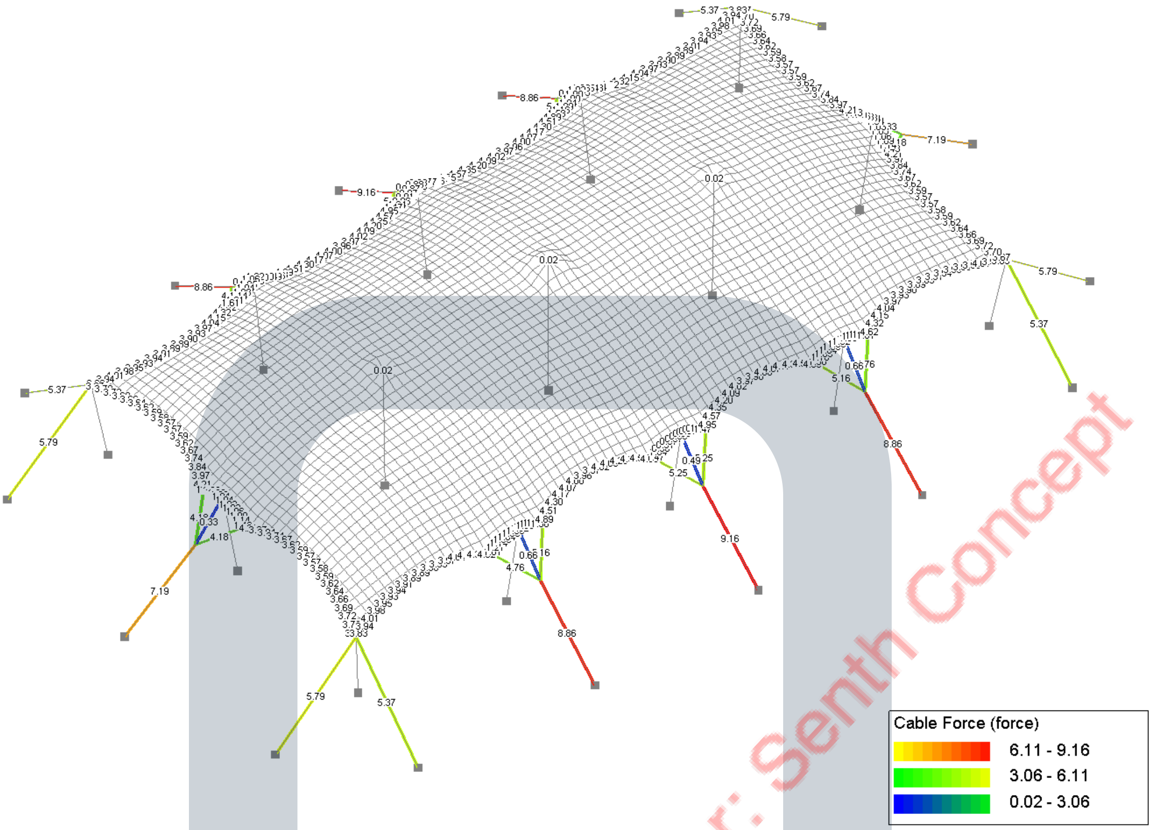


Annex B.5. Own weight + pretension + wind suction – reduction 0.60

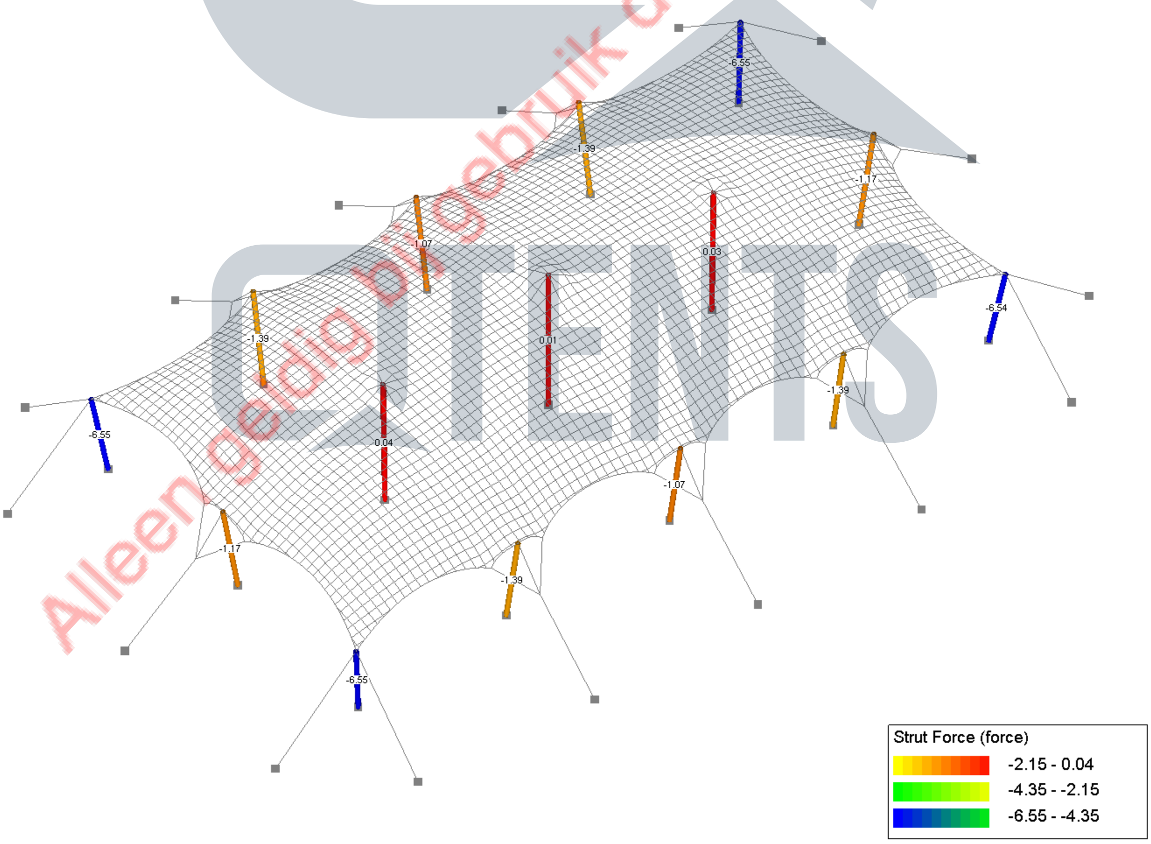
Annex B.5.1. Membrane stress



Annex B.5.2. Cable forces



Annex B.5.3. Strut forces



Annex C. Member checks

Annex C.1. Center pole 4.5m – Aluminium

Project:	17.09.0553	Element:	Center pole 4.5m	Member:	-	Combination:	wind pressure

Parameters

fo	160	N/mm^2				
fu	215	N/mm^2				
E	70000	N/mm^2				
N	10.65	kN (druk)				
My	0.00	kNm				
Mz	0.00	kNm				
Lcr;y	4500	mm				
Lcr;z	4500	mm				
Iy	355038	mm^4				
Iz	355038	mm^4				
ey	35	mm				
ex	35	mm				
Wyel	10144	mm^3				
Wypl	13476	mm^3				
Wzel	10144	mm^3				
Wzpl	13476	mm^3				
Aeff	631	mm^2				
γm1	1.1					
γm2	1.25					

classification by thickness of round tube

t	3	mm	
D	70	mm	
ß	14.49		eq (6.10)
ε	1.25		
class	2		table (6.2)
class overide			*Off*

classification conditions - Table 6.2 - Slenderness parameters

	ß1	ß2	ß3
Class A	13.75	20.00	27.50
class 1		False	ß < ß1
class 2		True	ß1 < ß < ß2
class 3		False	ß2 < ß < ß3
class 4		False	ß3 < ß

Compression art. (6.2.4)

1 Ned / Nc,Rd < 1		eq (6.22)
2 Ned / Nu,Rd < 1		eq (6.21)
Ned	10.65 kN	
Nc,Rd	91.85 kN	
Nu,Rd	108.61 kN	
UC1 ✓	0.12	
UC2 ✓	0.10	

Bending Moment art. (6.2.5)

1 Myed / Myc,Rd < 1		eq (6.25)
2 Myed / Myu,Rd < 1		eq (6.24)
3 Mzed / Mzc,Rd < 1		eq (6.25)
4 Mzed / Mzu,Rd < 1		eq (6.24)
Myed	0.00 kN	
Mzed	0.00 kN	
α;y	1.33	table (6.4)
α;z	1.33	table (6.4)
Myc,Rd	1.96 kNm	
Myu,Rd	1.74 kNm	
Mzc,Rd	1.96 kNm	
Mzu,Rd	1.74 kNm	
UC1-y	-	
UC2-y	-	
UC3-z	-	
UC4-z	-	

Checks not necessary, no bending moment

Bending and Axial Force art. (6.2.9)

$$\left(\frac{N_{Ed}}{\omega_0 N_{Rd}}\right)^{\psi}+\left[\left(\frac{M_{y,Ed}}{\omega_0 M_{y,Rd}}\right)^{1.7}+\left(\frac{M_{z,Ed}}{\omega_0 M_{z,Rd}}\right)^{1.7}\right]^{0.6}\le 1.00$$

eq. (6.43) - (ω0 = 1) - (ψ = 1.3)

UC	-

Check not necessary, no bending moments

Buckling (compression) art. (6.3.1.1)

Ned / Nb,Rd < 1		eq. (6.48)
Ned	10.65 kN	
BC	A	
α	0.20	table (6.6)
λ_0	0.10	table (6.6)
χ	0.11	eq. (6.50)
Φ	4.95 N	
λ	2.89	eq. (6.51)
Ncr	12112.90 (z-axis)	
Nb,Rd	10.24 kN	
UC	1.04	

Buckling (Bending and Axial Force) art. (6.3.3.1)

$$\left(\frac{N_{Ed}}{\chi_{min}\,\omega_x N_{Rd}}\right)^{\psi_c}+\frac{1}{\omega_0}\left[\left(\frac{M_{y,Ed}}{M_{y,Rd}}\right)^{1.7}+\left(\frac{M_{z,Ed}}{M_{z,Rd}}\right)^{1.7}\right]^{0.6}\le 1.00$$

eq. (6.62) - (ω0 = 1) - (ωx = 1) - (ψ = 0.8)

UC	1.03

Annex C.2. Center pole 4.5m – Chestnut

Material

Woodtype		Chestnut (European)		
Strenght type		D24		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	94.5	mm	
Length (buckling)	$l_{buc;y}$	4.5	m	
Effective area	A	7013.801949	mm^2	
Moment of innertia	I_y	3914687.803	mm^4	
Elastic modules	$W_{el;y}$	82850.53552	mm^3	
Charistic pressure strenght	f_{c0k}	21	N/mm^2	
Charistic bending strenght	f_{c0k}	24	N/mm^2	
Modules of elasticity	$E_{0.05}$	8.5	kN/m^2	
	i_y	23.6	mm	
Slenderness	λ_y	190.5		
Relative slenderness	λ_{rely}	3.01		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	5.31		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.10		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	10.65	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.52	N/mm^2	
Bending stress	σ_{c0d}	0.00	N/mm^2	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	14.54	N/mm^2	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	16.62	N/mm^2	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**1.01**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.3. Center pole 4.5m – Eucalyptus

Material

Woodtype		Eucalyptus (African)		
Strenght type		D35		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	94	mm	
Length (buckling)	$l_{buc;y}$	4.5	m	
Effective area	A	6939.778172	mm²	
Moment of innertia	I_y	3832492.495	mm⁴	
Elastic modules	$W_{el;y}$	81542.39352	mm³	
Charistic pressure strenght	f_{c0k}	25	N/mm²	
Charistic bending strenght	f_{c0k}	35	N/mm²	
Modules of elasticity	$E_{0.05}$	8.7	kN/m²	
	i_y	23.5	mm	
Slenderness	λ_y	191.5		
Relative slenderness	λ_{rely}	3.27		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	6.13		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.09		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	10.65	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.53	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	17.31	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	24.23	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**1.00**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.4. Center pole 4.0m – Aluminium

Project:	17.09.0553 - Qtents	Element:	Center pole 4m	Member:	-	Combination:	wind pressure

Parameters

fo	160	N/mm²
fu	215	N/mm²
E	70000	N/mm²
N	9.47	kN (druk)
My	0.00	kNm
Mz	0.00	kNm
Lcr;y	4000	mm
Lcr;z	4000	mm
Iy	255105	mm⁴
Iz	255105	mm⁴
ey	31.5	mm
ex	31.5	mm
Wyel	8099	mm³
Wypl	10809	mm³
Wzel	8099	mm³
Wzpl	10809	mm³
Aeff	565	mm²
γm1	1.1	
γm2	1.25	

classification by thickness of round tube

t	3	mm	
D	63	mm	
ß	13.75		eq (6.10)
ε	1.25		
class	1		table (6.2)
class overide			Off

classification conditions - Table 6.2 - Slenderness parameters

	ß1	ß2	ß3
Class A	13.75	20.00	27.50
class 1		True	ß < ß1
class 2		False	ß1 < ß < ß2
class 3		False	ß2 < ß < ß3
class 4		False	ß3 < ß

Compression art. (6.2.4)

1 **Ned / Nc,Rd < 1** — eq (6.22)
2 **Ned / Nu,Rd < 1** — eq (6.21)

Ned	9.47	kN
Nc,Rd	82.25	kN
Nu,Rd	97.26	kN
UC1	✓	**0.12**
UC2	✓	**0.10**

Bending Moment art. (6.2.5)

1 **Myed / Myc,Rd < 1** — eq (6.25)
2 **Myed / Myu,Rd < 1** — eq (6.24)
3 **Mzed / Mzc,Rd < 1** — eq (6.25)
4 **Mzed / Mzu,Rd < 1** — eq (6.24)

Myed	0.00	kN	
Mzed	0.00	kN	
α;y	1.33		table (6.4)
α;z	1.33		table (6.4)
Myc,Rd	1.57	kNm	
Myu,Rd	1.39	kNm	
Mzc,Rd	1.57	kNm	
Mzu,Rd	1.39	kNm	
UC1-y	-		
UC2-y	-		
UC3-z	-		
UC4-z	-		

Checks not necessary, no bending moments

Bending and Axial Force art. (6.2.9)

$$\left(\frac{N_{Ed}}{\omega_0 N_{Rd}}\right)^{\psi} + \left[\left(\frac{M_{y,Ed}}{\omega_0 M_{y,Rd}}\right)^{1.7} + \left(\frac{M_{z,Ed}}{\omega_0 M_{z,Rd}}\right)^{1.7}\right]^{0.6} \leq 1.00$$

eq. (6.43) - (ω0 = 1) - (ψ = 1.3)

UC	-

Check not necessary, no bending moments

Buckling (compression) art. (6.3.1.1)

Ned / Nb,Rd < 1 — eq. (6.48)

Ned	9.47	kN	
BC	A		
α	0.20		table (6.6)
λ_0	0.10		table (6.6)
χ	0.11		eq. (6.50)
Φ	4.88	N	
λ	2.87		eq. (6.51)
Ncr	11015.32	(z-axis)	
Nb,Rd	9.31	kN	
UC	!	**1.02**	

Buckling (Bending and Axial Force) art. (6.3.3.1)

$$\left(\frac{N_{Ed}}{\chi_{min}\,\omega_x N_{Rd}}\right)^{\psi_c} + \frac{1}{\omega_0}\left[\left(\frac{M_{y,Ed}}{M_{y,Rd}}\right)^{1.7} + \left(\frac{M_{z,Ed}}{M_{z,Rd}}\right)^{1.7}\right]^{0.6} \leq 1.00$$

eq. (6.62) - (ω0 = 1) - (ωx = 1) - (ψ = 0.8)

UC	!	**1.01**

Annex C.5. Center pole 4.0m – Chestnut

Material

Woodtype		Chestnut (European)		
Strenght type		D24		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	90	mm	
Length (buckling)	$l_{buc;y}$	4	m	
Effective area	A	6361.725124	mm²	
Moment of innertia	I_y	3220623.344	mm⁴	
Elastic modules	$W_{el;y}$	71569.40764	mm³	
Charistic pressure strenght	f_{c0k}	21	N/mm²	
Charistic bending strenght	f_{c0k}	24	N/mm²	
Modules of elasticity	$E_{0.05}$	8.5	kN/m²	
	i_y	22.5	mm	
Slenderness	λ_y	177.8		
Relative slenderness	λ_{rely}	2.81		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.71		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.12		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	9.47	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.49	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	14.54	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	16.62	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**0.87**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.6. Center pole 4.0m – Eucalyptus

Material

Woodtype		Eucalyptus (African)		
Strenght type		D35		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	90	mm	
Length (buckling)	$l_{buc;y}$	4	m	
Effective area	A	6361.725124	mm²	
Moment of innertia	I_y	3220623.344	mm⁴	
Elastic modules	$W_{el;y}$	71569.40764	mm³	
Charistic pressure strenght	f_{c0k}	25	N/mm²	
Charistic bending strenght	f_{c0k}	35	N/mm²	
Modules of elasticity	$E_{0.05}$	8.7	kN/m²	
	i_y	22.5	mm	
Slenderness	λ_y	177.8		
Relative slenderness	λ_{rely}	3.03		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	5.37		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.10		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	9.47	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.49	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	17.31	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	24.23	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**0.84**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.7. Side pole 3.0m - Aluminium

Project:	17.09.0553 - Qtents	Element:	Side pole 3m	Member:	-	Combination:	wind pressure

Parameters

fo	160	N/mm^2
fu	215	N/mm^2
E	70000	N/mm^2
N	8.48	kN (druk)
My	0.00	kNm
Mz	0.00	kNm
Lcr;y	3000	mm
Lcr;z	3000	mm
Iy	130797	mm^4
Iz	130797	mm^4
ey	25.5	mm
ex	25.5	mm
Wyel	5129	mm^3
Wypl	6921	mm^3
Wzel	5129	mm^3
Wzpl	6921	mm^3
Aeff	452	mm^2
γm1	1.1	
γm2	1.25	

classification by thickness of round tube

t	3	mm	
D	51	mm	
ß	12.37		eq (6.10)
ε	1.25		
class	1		table (6.2)
class overide			*Off*

classification conditions - Table 6.2 - Slenderness parameters

	ß1	ß2	ß3
Class A	13.75	20.00	27.50
class 1		True	ß < ß1
class 2		False	ß1 < ß < ß2
class 3		False	ß2 < ß < ß3
class 4		False	ß3 < ß

Compression art. (6.2.4)

1 **Ned / Nc,Rd < 1** **eq (6.22)**
2 **Ned / Nu,Rd < 1** **eq (6.21)**

Ned	8.48	kN
Nc,Rd	65.80	kN
Nu,Rd	77.81	kN
UC1 ✔	**0.13**	
UC2 ✔	**0.11**	

Bending Moment art. (6.2.5)

1 **Myed / Myc,Rd < 1** **eq (6.25)**
2 **Myed / Myu,Rd < 1** **eq (6.24)**
3 **Mzed / Mzc,Rd < 1** **eq (6.25)**
4 **Mzed / Mzu,Rd < 1** **eq (6.24)**

Myed	0.00	kN	
Mzed	0.00	kN	
α;y	1.35		table (6.4)
α;z	1.35		table (6.4)
Myc,Rd	1.01	kNm	
Myu,Rd	0.88	kNm	
Mzc,Rd	1.01	kNm	
Mzu,Rd	0.88	kNm	
UC1-y	-		
UC2-y	-		
UC3-z	-		
UC4-z	-		

Checks not necessary, no bending moments

Bending and Axial Force art. (6.2.9)

$$\left(\frac{N_{Ed}}{\omega_0 N_{Rd}}\right)^{\psi} + \left[\left(\frac{M_{y,Ed}}{\omega_0 M_{y,Rd}}\right)^{1.7} + \left(\frac{M_{z,Ed}}{\omega_0 M_{z,Rd}}\right)^{1.7}\right]^{0.6} \le 1.000$$

eq. (6.43) - (ω0 = 1) - (ψ = 1.3)

UC	-

Check not necessary, no bending moments

Buckling (compression) art. (6.3.1.1)

Ned / Nb,Rd < 1 **eq. (6.48)**

Ned	8.48	kN	
BC	A		
α	0.20		table (6.6)
λ_0	0.10		table (6.6)
χ	0.13		eq. (6.50)
Φ	4.36	N	
λ	2.68		eq. (6.51)
Ncr	10040.45	(z-axis)	
Nb,Rd	8.43	kN	
UC	**1.00**		

Buckling (Bending and Axial Force) art. (6.3.3.1)

$$\left(\frac{N_{Ed}}{\chi_{min}\,\omega_x N_{Rd}}\right)^{\psi_c} + \frac{1}{\omega_0}\left[\left(\frac{M_{y,Ed}}{M_{y,Rd}}\right)^{1.7} + \left(\frac{M_{z,Ed}}{M_{z,Rd}}\right)^{1.7}\right]^{0.6} \le 1.00$$

eq. (6.62) - (ω0 = 1) - (ωx = 1) - (ψ = 0.8)

UC	**1.00**

Annex C.8. Side pole 3.0m - Chestnut

Material

Woodtype		Chestnut (European)		
Strenght type		D24		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	73	mm	
Length (buckling)	$l_{buc;y}$	3	m	
Effective area	A	4185.386813	mm²	
Moment of innertia	I_y	1393995.395	mm⁴	
Elastic modules	$W_{el;y}$	38191.65467	mm³	
Charistic pressure strenght	f_{c0k}	21	N/mm²	
Charistic bending strenght	f_{c0k}	24	N/mm²	
Modules of elasticity	$E_{0.05}$	8.5	kN/m²	
	i_y	18.3	mm	
Slenderness	λ_y	164.4		
Relative slenderness	λ_{rely}	2.60		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.11		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.14		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	8.48	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	2.02	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	14.54	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	16.62	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**1.02**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.9. Side pole 3.0m – Eucalyptus

Material

Woodtype		Eucalyptus (African)		
Strenght type		D35		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	73	mm	
Length (buckling)	$l_{buc;y}$	3	m	
Effective area	A	4185.386813	mm²	
Moment of innertia	I_y	1393995.395	mm⁴	
Elastic modules	$W_{el;y}$	38191.65467	mm³	
Charistic pressure strenght	f_{c0k}	25	N/mm²	
Charistic bending strenght	f_{c0k}	35	N/mm²	
Modules of elasticity	$E_{0.05}$	8.7	kN/m²	
	i_y	18.3	mm	
Slenderness	λ_y	164.4		
Relative slenderness	λ_{rely}	2.80		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.68		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.12		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	8.48	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	2.02	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	17.31	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	24.23	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**0.99**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.10. Corner pole 2.5m - Aluminium

Project:	17.09.0553 - Qtents	Element:	Corner pole 2.5m	Member:	-	Combination:	wind pressure

Parameters

fo	160	N/mm²
fu	215	N/mm²
E	70000	N/mm²
N	11.76	kN (druk)
My	0.00	kNm
Mz	0.00	kNm
Lcr;y	2500	mm
Lcr;z	2500	mm
Iy	130797	mm⁴
Iz	130797	mm⁴
ey	25.5	mm
ex	25.5	mm
Wyel	5129	mm³
Wypl	6921	mm³
Wzel	5129	mm³
Wzpl	6921	mm³
Aeff	452	mm²
γm1	1.1	
γm2	1.25	

classification by thickness of round tube

t	3	mm	
D	51	mm	
ß	12.37		eq (6.10)
ε	1.25		
class	1		table (6.2)
class overide	*Off*		

classification conditions - Table 6.2 - Slenderness parameters

	ß1	ß2	ß3
Class A	13.75	20.00	27.50
class 1		True	ß < ß1
class 2		False	ß1 < ß < ß2
class 3		False	ß2 < ß < ß3
class 4		False	ß3 < ß

Compression art. (6.2.4)

1	**Ned / Nc,Rd < 1**	**eq (6.22)**
2	**Ned / Nu,Rd < 1**	**eq (6.21)**

Ned	11.76	kN
Nc,Rd	65.80	kN
Nu,Rd	77.81	kN
UC1 ✓	**0.18**	
UC2 ✓	**0.15**	

Bending Moment art. (6.2.5)

1	**Myed / Myc,Rd < 1**	**eq (6.25)**
2	**Myed / Myu,Rd < 1**	**eq (6.24)**
3	**Mzed / Mzc,Rd < 1**	**eq (6.25)**
4	**Mzed / Mzu,Rd < 1**	**eq (6.24)**

Myed	0.00	kN	
Mzed	0.00	kN	
α;y	1.35		table (6.4)
α;z	1.35		table (6.4)
Myc,Rd	1.01	kNm	
Myu,Rd	0.88	kNm	
Mzc,Rd	1.01	kNm	
Mzu,Rd	0.88	kNm	
UC1-y	-		
UC2-y	-		
UC3-z	-		
UC4-z	-		

Checks not necessary, no bending moments

Bending and Axial Force art. (6.2.9)

$$\left(\frac{N_{Ed}}{\omega_0 N_{Rd}}\right)^{\psi} + \left[\left(\frac{M_{y,Ed}}{\omega_0 M_{y,Rd}}\right)^{1.7} + \left(\frac{M_{z,Ed}}{\omega_0 M_{z,Rd}}\right)^{1.7}\right]^{0.6} \le 1.00$$

eq. (6.43) - (ω0 = 1) - (ψ = 1.3)

UC	-

Check not necessary, no bending moments

Buckling (compression) art. (6.3.1.1)

Ned / Nb,Rd < 1		**eq. (6.48)**
Ned	11.76 kN	
BC	A	
α	0.20	table (6.6)
λ_0	0.10	table (6.6)
χ	0.18	eq. (6.50)
Φ	3.22 N	
λ	2.24	eq. (6.51)
Ncr	14458.25 (z-axis)	
Nb,Rd	11.90 kN	
UC ✓	**0.99**	

Buckling (Bending and Axial Force) art. (6.3.3.1)

$$\left(\frac{N_{Ed}}{\chi_{min}\,\omega_x N_{Rd}}\right)^{\psi_c} + \frac{1}{\omega_0}\left[\left(\frac{M_{y,Ed}}{M_{y,Rd}}\right)^{1.7} + \left(\frac{M_{z,Ed}}{M_{z,Rd}}\right)^{1.7}\right]^{0.6} \le 1.00$$

eq. (6.62) - (ω0 = 1) - (ωx = 1) - (ψ = 0.8)

UC ✓	**0.99**

Annex C.11. Corner pole 2.5m - Chestnut

Material

Woodtype		Chestnut (European)		
Strenght type		D24		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	73	mm	
Length (buckling)	$l_{buc;y}$	2.5	m	
Effective area	A	4185.386813	mm²	
Moment of innertia	I_y	1393995.395	mm⁴	
Elastic modules	$W_{el;y}$	38191.65467	mm³	
Charistic pressure strenght	f_{c0k}	21	N/mm²	
Charistic bending strenght	f_{c0k}	24	N/mm²	
Modules of elasticity	$E_{0.05}$	8.5	kN/m²	
	i_y	18.3	mm	
Slenderness	λ_y	137.0		
Relative slenderness	λ_{rely}	2.17		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	3.04		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.19		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	11.76	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	2.81	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	14.54	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	16.62	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**1.00**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.12. Corner pole 2.5m - Eucalyptus

Material

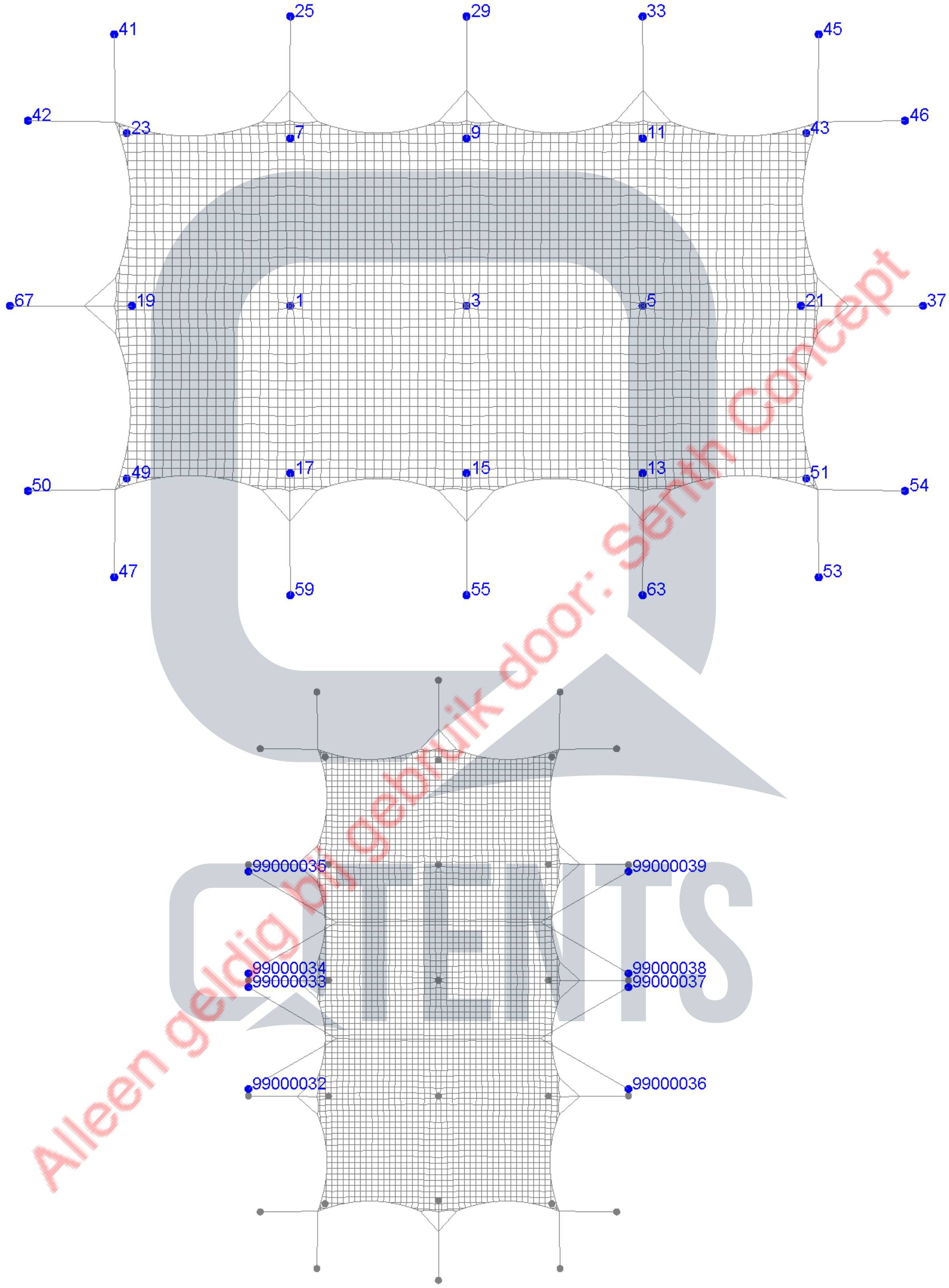
Woodtype		Eucalyptus (African)		
Strenght type		D35		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Diameter	D	73	mm	
Length (buckling)	$l_{buc;y}$	2.5	m	
Effective area	A	4185.386813	mm²	
Moment of innertia	I_y	1393995.395	mm⁴	
Elastic modules	$W_{el;y}$	38191.65467	mm³	
Charistic pressure strenght	f_{c0k}	25	N/mm²	
Charistic bending strenght	f_{c0k}	35	N/mm²	
Modules of elasticity	$E_{0.05}$	8.7	kN/m²	
	i_y	18.3	mm	
Slenderness	λ_y	137.0		
Relative slenderness	λ_{rely}	2.34		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	3.44		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.17		NEN-EN 1995-1-1:2005 equ. 6.25

Strenght check

Pressure force	F_d	11.76	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	2.81	N/mm²	
Bending stress	σ_{c0d}	0.00	N/mm²	
Load duration		short		NEN-EN 1995-1-1:2005 table 2.1
Modificationfactor	k_{mod}	0.90		NEN-EN 1995-1-1:2005 table 3.1
Design pressure strenght	f_{c0d}	17.31	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	24.23	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strenght check		**0.97**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex D. Software output (reaction forces)

Annex D.1. Point numbers



Annex D.2. Reaction forces

Annex D.2.1. Own weight + pretension

Att	Node	Koor X	Koor Y	Koor Z	Fx	Fy	Fz
Side pole 3m	7	-5.00	4.75	0.00	-0.01	0.27	1.61
Side pole 3m	9	0.00	4.75	0.00	0.00	0.24	1.43
Side pole 3m	11	5.00	4.75	0.00	0.01	0.27	1.61
Side pole 3m	13	5.00	-4.75	0.00	0.01	-0.27	1.61
Side pole 3m	15	0.00	-4.75	0.00	0.00	-0.24	1.43
Side pole 3m	17	-5.00	-4.75	0.00	-0.01	-0.27	1.61
Side pole 3m	19	-9.50	0.00	0.00	-0.32	0.00	1.91
Side pole 3m	21	9.50	0.00	0.00	0.32	0.00	1.91
Corner pole 2.5m	23	-9.65	4.90	0.00	-0.63	0.61	4.75
Corner pole 2.5m	43	9.65	4.90	0.00	0.63	0.61	4.75
Corner pole 2.5m	49	-9.65	-4.90	0.00	-0.63	-0.61	4.75
Corner pole 2.5m	51	9.65	-4.90	0.00	0.63	-0.61	4.75
Center pole 4.5m	3	0.00	0.00	0.00	0.00	0.00	1.50
Center pole 4m	1	-5.00	0.00	0.00	0.00	0.00	1.17
Center pole 4m	5	5.00	0.00	0.00	0.00	0.00	1.17
Guy rope - long side	25	-5.00	8.21	0.00	0.01	2.06	-1.80
Guy rope - long side	29	0.00	8.21	0.00	0.00	2.06	-1.80
Guy rope - long side	33	5.00	8.21	0.00	-0.01	2.06	-1.80
Guy rope - long side	55	0.00	-8.21	0.00	0.00	-2.06	-1.80
Guy rope - long side	59	-5.00	-8.21	0.00	0.01	-2.06	-1.80
Guy rope - long side	63	5.00	-8.21	0.00	-0.01	-2.06	-1.80
Guy rope - short side	37	12.96	0.00	0.00	2.29	0.00	-1.98
Guy rope - short side	67	-12.96	0.00	0.00	-2.29	0.00	-1.98
Guy rope - corner	41	-10.00	7.70	0.00	-0.03	2.60	-2.56
Guy rope - corner	42	-12.45	5.25	0.00	-2.38	0.04	-2.36
Guy rope - corner	45	10.00	7.70	0.00	0.03	2.60	-2.56
Guy rope - corner	46	12.45	5.25	0.00	2.38	0.04	-2.36
Guy rope - corner	47	-10.00	-7.70	0.00	-0.03	-2.60	-2.56
Guy rope - corner	50	-12.45	-5.25	0.00	-2.38	-0.04	-2.36
Guy rope - corner	53	10.00	-7.70	0.00	0.03	-2.60	-2.56
Guy rope - corner	54	12.45	-5.25	0.00	2.38	-0.04	-2.36

Annex D.2.2. Own weight + pretension + conventional

Att	Node	Koor X	Koor Y	Koor Z	Fx	Fy	Fz
Side pole 3m	7	-5.00	4.75	0.00	-0.01	0.57	3.58
Side pole 3m	9	0.00	4.75	0.00	0.00	0.52	3.26
Side pole 3m	11	5.00	4.75	0.00	0.01	0.57	3.58
Side pole 3m	13	5.00	-4.75	0.00	0.01	-0.57	3.58
Side pole 3m	15	0.00	-4.75	0.00	0.00	-0.52	3.26
Side pole 3m	17	-5.00	-4.75	0.00	-0.01	-0.57	3.58
Side pole 3m	19	-9.50	0.00	0.00	-0.64	0.00	4.11
Side pole 3m	21	9.50	0.00	0.00	0.64	0.00	4.11
Corner pole 2.5m	23	-9.65	4.90	0.00	-0.81	0.79	6.40
Corner pole 2.5m	43	9.65	4.90	0.00	0.81	0.79	6.40
Corner pole 2.5m	49	-9.65	-4.90	0.00	-0.81	-0.79	6.40
Corner pole 2.5m	51	9.65	-4.90	0.00	0.81	-0.79	6.40
Center pole 4.5m	3	0.00	0.00	0.00	0.00	0.00	5.27
Center pole 4m	1	-5.00	0.00	0.00	0.04	0.00	4.56
Center pole 4m	5	5.00	0.00	0.00	-0.04	0.00	4.56
Guy rope - long side	25	-5.00	8.21	0.00	0.00	3.22	-2.85
Guy rope - long side	29	0.00	8.21	0.00	0.00	3.17	-2.81
Guy rope - long side	33	5.00	8.21	0.00	0.00	3.22	-2.85
Guy rope - long side	55	0.00	-8.21	0.00	0.00	-3.17	-2.81
Guy rope - long side	59	-5.00	-8.21	0.00	0.00	-3.22	-2.85
Guy rope - long side	63	5.00	-8.21	0.00	0.00	-3.22	-2.85
Guy rope - short side	37	12.96	0.00	0.00	3.76	0.00	-3.27
Guy rope - short side	67	-12.96	0.00	0.00	-3.76	0.00	-3.27
Guy rope - corner	41	-10.00	7.70	0.00	-0.05	3.15	-3.11
Guy rope - corner	42	-12.45	5.25	0.00	-3.06	0.06	-3.02
Guy rope - corner	45	10.00	7.70	0.00	0.05	3.15	-3.11
Guy rope - corner	46	12.45	5.25	0.00	3.06	0.06	-3.02
Guy rope - corner	47	-10.00	-7.70	0.00	-0.05	-3.15	-3.11
Guy rope - corner	50	-12.45	-5.25	0.00	-3.06	-0.06	-3.02
Guy rope - corner	53	10.00	-7.70	0.00	0.05	-3.15	-3.11
Guy rope - corner	54	12.45	-5.25	0.00	3.06	-0.06	-3.02

Annex D.2.3. Own weight + pretension + wind pressure – full wind load

Att	Node	Koor X	Koor Y	Koor Z	Fx	Fy	Fz
Side pole 3m	7	-5.00	4.75	0.00	0.02	0.74	4.82
Side pole 3m	9	0.00	4.75	0.00	0.00	0.69	4.50
Side pole 3m	11	5.00	4.75	0.00	-0.02	0.74	4.82
Side pole 3m	13	5.00	-4.75	0.00	-0.02	-0.74	4.82
Side pole 3m	15	0.00	-4.75	0.00	0.00	-0.69	4.50
Side pole 3m	17	-5.00	-4.75	0.00	0.02	-0.74	4.82
Side pole 3m	19	-9.50	0.00	0.00	-0.82	0.00	5.50
Side pole 3m	21	9.50	0.00	0.00	0.82	0.00	5.50
Corner pole 2.5m	23	-9.65	4.90	0.00	-0.93	0.92	7.64
Corner pole 2.5m	43	9.65	4.90	0.00	0.93	0.92	7.64
Corner pole 2.5m	49	-9.65	-4.90	0.00	-0.93	-0.92	7.64
Corner pole 2.5m	51	9.65	-4.90	0.00	0.93	-0.92	7.64
Center pole 4.5m	3	0.00	0.00	0.00	0.00	0.00	7.01
Center pole 4m	1	-5.00	0.00	0.00	0.11	0.00	6.22
Center pole 4m	5	5.00	0.00	0.00	-0.11	0.00	6.22
Guy rope - long side	25	-5.00	8.21	0.00	-0.02	4.08	-3.59
Guy rope - long side	29	0.00	8.21	0.00	0.00	4.09	-3.61
Guy rope - long side	33	5.00	8.21	0.00	0.02	4.08	-3.59
Guy rope - long side	55	0.00	-8.21	0.00	0.00	-4.09	-3.61
Guy rope - long side	59	-5.00	-8.21	0.00	-0.02	-4.08	-3.59
Guy rope - long side	63	5.00	-8.21	0.00	0.02	-4.08	-3.59
Guy rope - short side	37	12.96	0.00	0.00	4.85	0.00	-4.20
Guy rope - short side	67	-12.96	0.00	0.00	-4.85	0.00	-4.20
Guy rope - corner	41	-10.00	7.70	0.00	-0.08	3.62	-3.56
Guy rope - corner	42	-12.45	5.25	0.00	-3.63	0.08	-3.57
Guy rope - corner	45	10.00	7.70	0.00	0.08	3.62	-3.56
Guy rope - corner	46	12.45	5.25	0.00	3.63	0.08	-3.57
Guy rope - corner	47	-10.00	-7.70	0.00	-0.08	-3.62	-3.56
Guy rope - corner	50	-12.45	-5.25	0.00	-3.63	-0.08	-3.57
Guy rope - corner	53	10.00	-7.70	0.00	0.08	-3.62	-3.56
Guy rope - corner	54	12.45	-5.25	0.00	3.63	-0.08	-3.57

Annex D.2.4. Own weight + pretension + wind suction – full wind load, with storm belts

Att	Node	Koor X	Koor Y	Koor Z	Fx	Fy	Fz
Side pole 3m	7	-5.00	4.75	0.00	0.00	0.18	1.21
Side pole 3m	9	0.00	4.75	0.00	0.00	0.22	1.37
Side pole 3m	11	5.00	4.75	0.00	0.00	0.18	1.21
Side pole 3m	13	5.00	-4.75	0.00	0.00	-0.18	1.21
Side pole 3m	15	0.00	-4.75	0.00	0.00	-0.22	1.37
Side pole 3m	17	-5.00	-4.75	0.00	0.00	-0.18	1.21
Side pole 3m	19	-9.50	0.00	0.00	-0.13	0.00	0.95
Side pole 3m	21	9.50	0.00	0.00	0.13	0.00	0.95
Corner pole 2.5m	23	-9.65	4.90	0.00	-0.81	0.80	7.27
Corner pole 2.5m	43	9.65	4.90	0.00	0.81	0.80	7.25
Corner pole 2.5m	49	-9.65	-4.90	0.00	-0.81	-0.80	7.26
Corner pole 2.5m	51	9.65	-4.90	0.00	0.81	-0.80	7.26
Center pole 4.5m	3	0.00	0.00	0.00	0.00	0.00	0.06
Center pole 4m	1	-5.00	0.00	0.00	0.00	0.00	-0.06
Center pole 4m	5	5.00	0.00	0.00	0.00	0.00	-0.06
Guy rope - long side	25	-5.00	8.21	0.00	0.14	6.77	-5.70
Guy rope - long side	29	0.00	8.21	0.00	0.00	4.98	-4.22
Guy rope - long side	33	5.00	8.21	0.00	-0.14	6.77	-5.70
Guy rope - long side	55	0.00	-8.21	0.00	0.00	-4.97	-4.21
Guy rope - long side	59	-5.00	-8.21	0.00	0.14	-6.76	-5.69
Guy rope - long side	63	5.00	-8.21	0.00	-0.14	-6.78	-5.71
Guy rope - short side	37	12.96	0.00	0.00	8.12	0.00	-6.85
Guy rope - short side	67	-12.96	0.00	0.00	-8.12	0.00	-6.86
Guy rope - corner	41	-10.00	7.70	0.00	-0.15	4.83	-4.71
Guy rope - corner	42	-12.45	5.25	0.00	-4.85	0.15	-4.74
Guy rope - corner	45	10.00	7.70	0.00	0.15	4.83	-4.71
Guy rope - corner	46	12.45	5.25	0.00	4.83	0.15	-4.72
Guy rope - corner	47	-10.00	-7.70	0.00	-0.15	-4.83	-4.71
Guy rope - corner	50	-12.45	-5.25	0.00	-4.83	-0.15	-4.72
Guy rope - corner	53	10.00	-7.70	0.00	0.15	-4.83	-4.71
Guy rope - corner	54	12.45	-5.25	0.00	4.85	-0.15	-4.73
Storm belt	99000032				-2.66	4.74	-3.23
Storm belt	99000033				2.02	3.57	-2.43
Storm belt	99000034				-2.02	3.60	-2.46
Storm belt	99000035				2.68	4.73	-3.23
Storm belt	99000036				-2.67	-4.73	-3.23
Storm belt	99000037				2.03	-3.59	-2.45
Storm belt	99000038				-2.03	-3.59	-2.45
Storm belt	99000039				2.67	-4.73	-3.22

TEN TECH

Annex D.2.5. Own weight + pretension + wind suction – reduction 0.60, without storm belts

Att	Node	Koor X	Koor Y	Koor Z	Fx	Fy	Fz
Side pole 3m	7	-5.00	4.75	0.00	0.01	0.20	1.37
Side pole 3m	9	0.00	4.75	0.00	0.00	0.15	1.06
Side pole 3m	11	5.00	4.75	0.00	-0.01	0.20	1.37
Side pole 3m	13	5.00	-4.75	0.00	-0.01	-0.20	1.37
Side pole 3m	15	0.00	-4.75	0.00	0.00	-0.15	1.06
Side pole 3m	17	-5.00	-4.75	0.00	0.01	-0.20	1.37
Side pole 3m	19	-9.50	0.00	0.00	-0.18	0.00	1.16
Side pole 3m	21	9.50	0.00	0.00	0.18	0.00	1.16
Corner pole 2.5m	23	-9.65	4.90	0.00	-0.76	0.77	6.45
Corner pole 2.5m	43	9.65	4.90	0.00	0.76	0.77	6.45
Corner pole 2.5m	49	-9.65	-4.90	0.00	-0.76	-0.77	6.45
Corner pole 2.5m	51	9.65	-4.90	0.00	0.76	-0.77	6.45
Center pole 4.5m	3	0.00	0.00	0.00	0.00	0.00	-0.01
Center pole 4m	1	-5.00	0.00	0.00	0.00	0.00	-0.05
Center pole 4m	5	5.00	0.00	0.00	0.00	0.00	-0.03
Guy rope - long side	25	-5.00	8.21	0.00	-0.12	6.78	-5.71
Guy rope - long side	29	0.00	8.21	0.00	0.00	6.98	-5.93
Guy rope - long side	33	5.00	8.21	0.00	0.12	6.78	-5.71
Guy rope - long side	55	0.00	-8.21	0.00	0.00	-6.98	-5.93
Guy rope - long side	59	-5.00	-8.21	0.00	-0.12	-6.78	-5.71
Guy rope - long side	63	5.00	-8.21	0.00	0.12	-6.78	-5.71
Guy rope - short side	37	12.96	0.00	0.00	5.49	0.00	-4.64
Guy rope - short side	67	-12.96	0.00	0.00	-5.49	0.00	-4.64
Guy rope - corner	41	-10.00	7.70	0.00	-0.10	3.83	-3.77
Guy rope - corner	42	-12.45	5.25	0.00	-4.14	0.10	-4.06
Guy rope - corner	45	10.00	7.70	0.00	0.10	3.83	-3.77
Guy rope - corner	46	12.45	5.25	0.00	4.14	0.10	-4.06
Guy rope - corner	47	-10.00	-7.70	0.00	-0.10	-3.83	-3.77
Guy rope - corner	50	-12.45	-5.25	0.00	-4.14	-0.10	-4.06
Guy rope - corner	53	10.00	-7.70	0.00	0.10	-3.83	-3.77
Guy rope - corner	54	12.45	-5.25	0.00	4.14	-0.10	-4.06