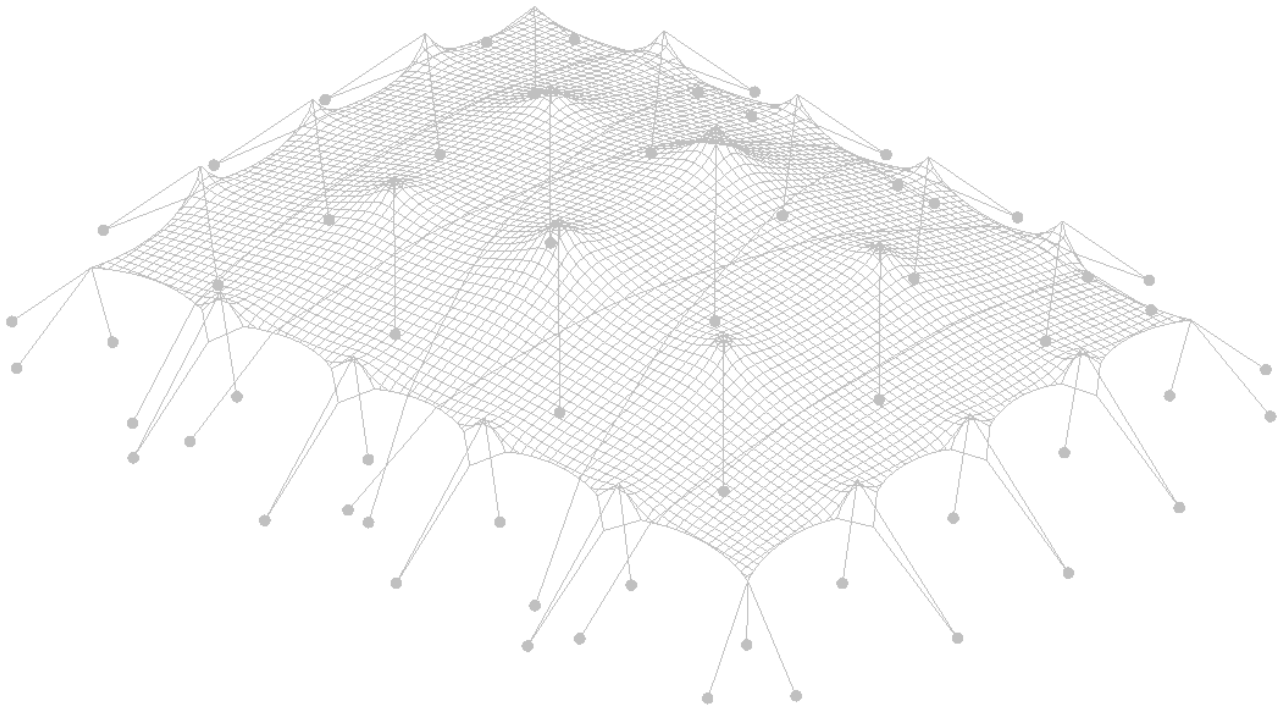
TEN TECH

DESIGN AND ENGINEERING OF LIGHTWEIGHT STRUCTURES



Content:	**Tentbook (according to EN 13782)**
Object:	**15x20m stretchtent**
Owner object:	**Eurostretch B.V.**
Document code:	**26.03.00008.2**
Author:	**S. Banga**
Date:	**10.08.2026**

Rotsoord 9A
NL-3523 CL Utrecht

Postbus 85190
NL-3508 AD Utrecht

T +31 30 252 18 69
F +31 30 254 12 39

E office@tentech.nl
www.tentech.nl

IBAN NL05ABNA0603051022
BIC ABNANL2A

VAT NL 8093.40.562.B01
CC 27162791

Object:	15x20m stretchtent
Document code:	26.03.00008.2
Owner object:	Eurostretch B.V. Akkermansbeekweg 15A 7061 ZA Terborg Nederland info@eurostretch.com
Author tentbook:	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
Date:	10.08.2026
Valid date:	10.08.2031
Author:	S. Banga
Authorized by:	ir. R. Houtman

A. Introduction

Eurostretch B.V. has commissioned Tentech B.V. to perform a static analysis of a stretch tent. Eurostretch B.V. is a Dutch company that specializes in rental and selling of tent structures made of a stretchable membrane, so called Stretch Tents or Bedouin tents. The stretchable membrane enables a freedom of form as there is not a pre-described shape necessary. Depending on the location, the number of poles, length of the poles, and the placement of the poles, number and type of ties can be varied. This results in a custom canopy at each location.

This report presents the static analysis of a 15x20m stretchtent in a “floating” set-up – membrane corners and sides are connected above ground, primarily to poles. This document contains the data required for a tent book, according to EN 13782, for the 15x20m stretchtent of Eurostretch B.V., including:

- Ownership data;
- Drawings of the tent, including dimensions, indications of elements and required anchoring/ballast;
- 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, S. Banga, 10.08.2026

B. Contents

A. Introduction ... 3
B. Contents ... 4
C. Codes and standards ... 5
D. Summary ... 6
E. Drawings: main dimensions and anchoring ... 9
F. Important terms and conditions ... 11
G. Allowed wind speeds ... 12
H. Static analysis ... 15
H.1. Project description ... 18
H.2. Materials ... 19
H.3. Cross sections ... 20
H.4. Calculation method ... 21
H.5. Load cases ... 25
H.6. Calculation results ... 27
H.7. Element check ... 35
H.8. Safety against overturning, sliding and uplifting ... 46
I. Addition 1 – element check for reduced wind speeds [NL] ... 50
I.1. Summary of results – low wind in Netherlands ... 50
I.2. Summary of forces ... 52
I.3. Element check - low wind in Netherlands ... 53
I.4. Safety against overturning, sliding and uplifting - low wind in Netherlands ... 56
J. Addition 2 – element check for combined wind and snow load [FR] ... 58
J.1. Summary of results – snow+wind in France ... 58
J.2. Cross sections ... 61
J.3. Summary of forces ... 61
J.4. Element check – snow + wind in France ... 62
J.5. Safety against overturning, sliding and uplifting – snow + wind in France ... 69
K. Material certificates ... 70
K.1. Fabric specifications ... 70
K.2. Fabric fire certificate ... 71
K.3. Capacity of Eye bolts ... 73
K.4. Capacity of Orange Pin 1 Ton D-sluiting, DIN EN 13889 ... 73
K.5. Carabine, DIN 5299C ... 74
K.6. Rope ratchet ... 74

C. Codes and standards

- EN 1990 Eurocode, Basis of structural Design
- EN 1991 Eurocode 1, Part 1-4: General actions - wind actions.
- EN 1995 Eurocode 5, Design of timber structures
- EN 13782 Temporary Structures – Tents - Safety
- EN 12195-2 Belts made from synthetic fibres
- ISO 1141 Fibre ropes – Polyester
- CTS French standard - Chapiteaux, Tentes, Structures

D. Summary

Manufacturer:	Eurostretch B.V. Akkermansbeekweg 15A 7061 ZA Terborg Nederland info@eurostretch.com

General information:		
Main dimensions:		**15 x 20m**
	Width:	15m
	Length:	20m
	Side height of membrane:	3m
	Max. height:	5m
	Main poles 5m: *	5.0m Ø 110 mm [Spruce, C18]
	Main poles 4m: *	4.0m Ø 95 mm [Spruce, C18]
	Side poles: *	3.0m Ø 75 mm [Spruce, C18]
	Corner poles: *	2.5m Ø 75 mm [Spruce, C18]
	Stormbelts:	50mm PES [EN 12195-2], LC=1000 daN
	Guy ropes:	Ø 8mm polyester, breaking strength ≥ 900 daN **
	Long side – combined:	4 sections
	Long side - V-ropes:	3 sections
	Short side – combined:	5 sections
	Short side - V-ropes:	3 sections
	Belts:	50mm PES [EN 12195-2], LC=1000 daN
	Fasteners:	Carbine 200x15

		M16 & M12 Eye bolt Ratchet, BL = 3.5 kN
	Side & corner pole base plate	30x30cm
	Main pole base plate	30x30cm
User load:	A maximum of 25 kg per main mast may be used for decorations, sound or lighting installations. The load must be applied centrally.	
Snow load:	A snow load of 0.1 kN/m² (4 cm) has been considered in accordance with the French CTS standard.	
Wind load:	**According to EN 13782** The following pressure values have been used: h < 5m: 0.50kN/m² This value corresponds to wind force 8 on the Beaufort scale. Above this wind force (starting at wind force 9), the safety of the structure can no longer be guaranteed, and it must be evacuated.	

* The average diameter, as a minimum required at the middle of the pole.

** The required breaking load (BL_{tot}) may be achieved by using multiple rope sections (n): $BL_{rope} = BL_{tot} / n$, see page 40

Wind speeds for default European terrain categories (not Country specific)

	Out of service (1)				
	Coast	Flattened, open area	Rural area	Village	City
10 min. average wind speed (2)	> 17.94 m/s > 64.57 km/h	> 18.89 m/s > 67.99 km/h	> 21.08 m/s > 75.88 km/h	> 24.99 m/s > 89.97 km/h	> 26.08 m/s > 93.89 km/h
Beaufort (3)	> 7 BFT	> 7 BFT	> 8 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 service' 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 Beaufort (BFT) are indicative values.

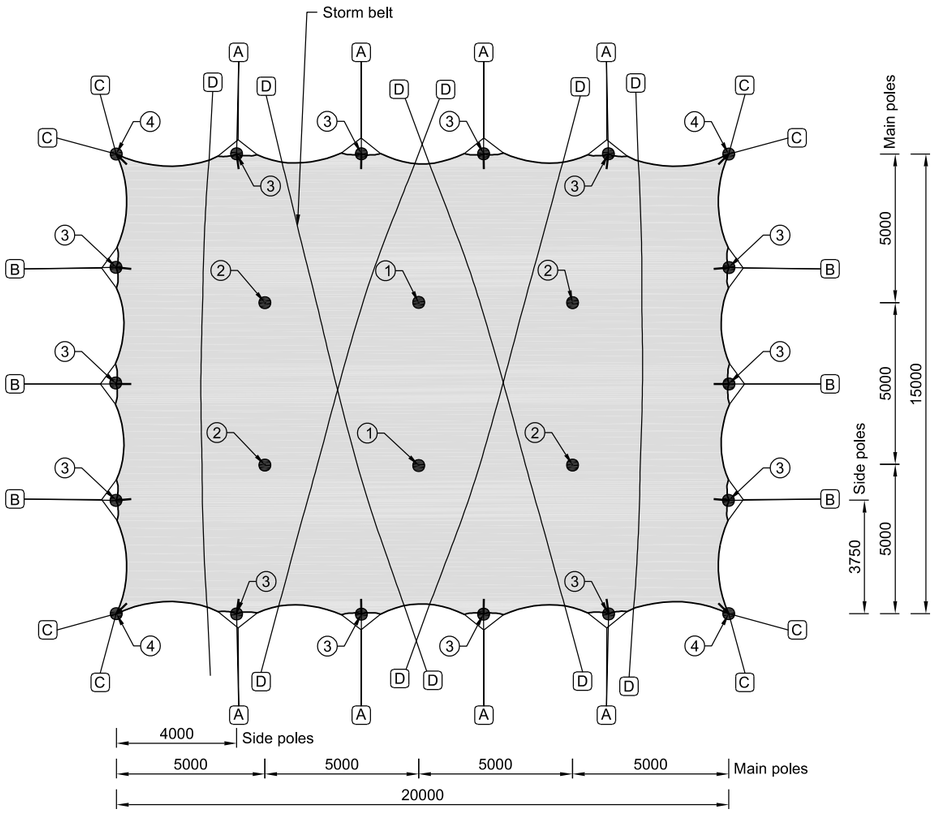
(4) 3 second peak wind speed measured on site at 10m height.

Safety against sliding, overturning and uplifting:		
Anchor forces:	Assumptions: angle of 45 degrees The following design resistance of the anchor forces is required: (See H.8.3, page 48 for Anchor tests according to EN 13782)	
	Long side guy ropes: Short side guy ropes: Corner ties: Stormbelt:	6.82 kN (γ = 1.2) 7.96 kN (γ = 1.2) 5.34 kN (γ = 1.2) 10.66 kN (γ = 1.2)
Required anchors:	Based on dense, non-cohesive soil (e.g. sandy soils). In the case anchors **Ø30mm x 1000mm** (effective length) are being used:	
	Long side guy ropes: Short side guy ropes: Corner ties: Stormbelt:	2 anchors 2 anchors 1 anchor 3 anchors
Required ballast:	Ballast calculation is performed for 2 different situations: - Concrete on concrete – concrete ballasts are placed on concrete - Concrete on wood or rubber – concrete ballasts are placed on wood, or an anti-slip mat is placed underneath the ballast	
		Concrete on concrete / Concrete on wood or rubber
	Long side guy ropes: Short side guy ropes: Corner ties: Stormbelt:	1450 kg / 1290 kg 1690 kg / 1500 kg 1130 kg / 1010 kg 2260 kg / 2010 kg

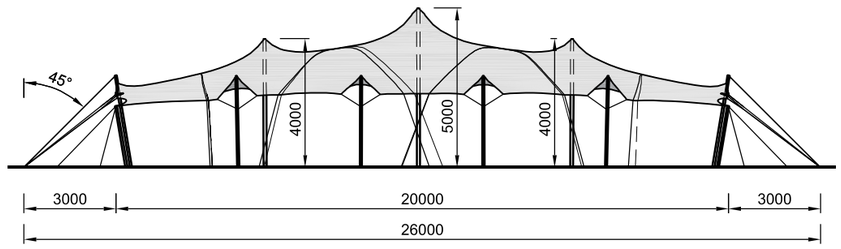
E. Drawings: main dimensions and anchoring

Drawings for the following sizes are presented in this chapter:

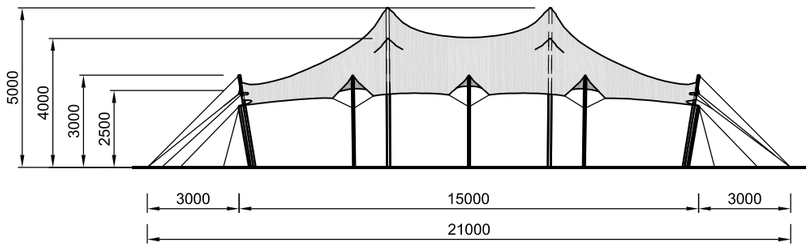
- 15x20m model



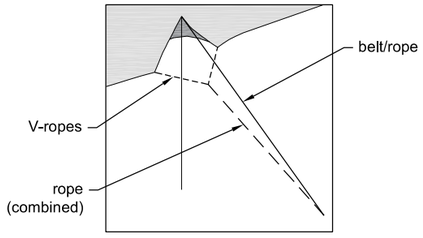
TOP VIEW
[1:200]



FRONT VIEW
[1:200]



SIDE VIEW
[1:200]



GUYING DIAGRAM
[1:100]

Safety against sliding, overturning and uplifting

Based on dense, non-cohesive soil (e.g. sandy soils).

		Anchors (Ø30x1000mm)	Ballast (concrete on concrete)	Ballast (concrete on wood or rubber)
A	Guying - long side	2x anchors	1450 kg	1290 kg
B	Guying - short side	2x anchors	1690 kg	1500 kg
C	Guying - corner	1x anchors	1130 kg	1010 kg
D	Storm belt *(per end)*	3x anchors	2260 kg	2010 kg

All belts/ropes and storm belts of the membrane must be placed under a 45° angle of ≥ 45° be attached to the anchors.

Poles

Main poles 5.0m:
(1) - Ø110mm [C18, Spruce]
Main poles 4.0m:
(2) - Ø95mm [C18, Spruce]
Side poles 3.0m:
(3) - Ø75mm [C18, Spruce]
Corner poles 2.5m:
(4) - Ø75mm [C18, Spruce]

Guying

Storm belt: [PES] BL 3000 daN = LC 1000 daN

Guying belt: [PES] BL 3000 daN = LC 1000 daN
Guying rope: rope: Ø 8mm polyester, breaking strength ≥ 900 daN

Combined & v-ropes:	Rope
n - number of sections	n
Guying - long side (combined)	4x
Guying - long side (v-ropes)	3x
Guying - short side (combined)	5x
Guying - short side (v-ropes)	3x

Belts (alternative rope):	Belt	Rope
n - number of sections	(number)	n
Guying - long side	1x	1x
Guying - short side	1x	1x
Guying - corner	1x	3x

EDITOR:	DATE:	FILENAME:
CH	05.04.2026	TTP20260008_15x20m_EN_01_REV_00

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.
- 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 D) the structure should be evacuated and access for the public must be denied.
- Only decorations, music- and light installations of less than 25 kg per pole, can be attached to the structure. They must be attached centrically.
- A conventional load of 0.1 kN/m^2 is considered according to EN 13782, which corresponds with the required snow load (4cm) according to the French CTS.
- Anchoring is based on dense, non-cohesive soil. When soil differs, additional anchoring might be necessary, or anchor tests need to be performed.
- Poles must be stored dry. If they become wet, there needs to be a possibility for them to dry.
- All water accumulation must be removed as soon as possible.
- Main poles must be secured on the ground to prevent them from falling over

G. Allowed 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 on page 14.

	Full wind load	
Wind pressure p_w	500 N/m²	At **5m** height
Corresponding peak wind pressure $p_{w,peak}$	605 N/m²	At **10m** height

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

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

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.156 \times \ln\left(\frac{4.0}{0.003}\right) = 1.123$$

Eq. 4.4 EN 1991-1-4
Roughness factor
Z = 4.0 > Z_{min} = 1

$$V_m = C_r \times V_b = 1.123 \times V_b$$

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

$$\sigma_v = K_r \times V_b = 0.141 \times V_b$$

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

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.156 \times V_b}{1.158 \times V_b} = 0.139$$

Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^{1}/_{2} \times \rho \times {V_m}^2 = 1.554 \times {V_b}^2$$

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

Equation:

$$500 = 1.554 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 17.94\ m/s$$

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

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.170 \times \ln\left(\frac{4.0}{0.01}\right) = 1.017$$

Eq. 4.4 EN 1991-1-4
Roughness factor at 3.5m height
Z = 4.0 > Z_{min} = 1

$$V_m = C_r \times V_b = 1.017 \times V_b$$

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

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.170 \times V_b}{1.017 \times V_b} = 0.167$$

Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^{1}/_{2} \times \rho \times {V_m}^2 = 1.402 \times {V_b}^2$$

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

Equation:

$$500 = 1.402 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 18.89\ m/s$$

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

$$C_r = K_r \times \ln\left(\frac{z}{z_0}\right) = 0.190 \times \ln\left(\frac{4.0}{0.05}\right) = 0.833$$

Eq. 4.4 EN 1991-1-4
Roughness factor at 4m height
Z = 4.0 > Z_{min} = 2

$$V_m = C_r \times V_b = 0.833 \times V_b$$

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

$$L_v = \frac{\sigma_v}{V_m} = \frac{0.190 \times V_b}{0.833 \times V_b} = 0.228$$

Eq. 4.7 EN 1991-1-4
Turbulence intensity

$$Q_p = (1 + 7 \times L_v) \times {}^1/_2 \times \rho \times {V_m}^2 = 1.125 \times {V_b}^2$$

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

Equation:

$$500 = 1.125 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 21.08\ m/s$$

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

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:

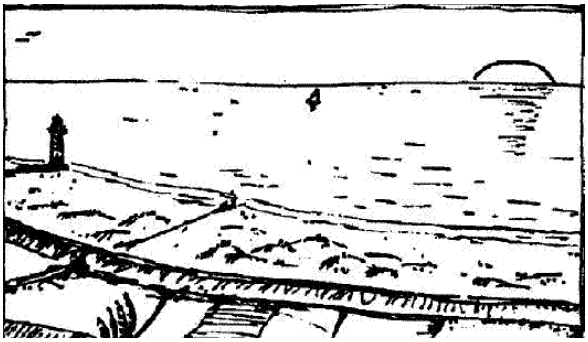
$$500 = 0.735 \times {V_b}^2 \rightarrow solving\ gives \rightarrow V_b = 26.08\ m/s$$

Characteristic wind speed

Terrain categories

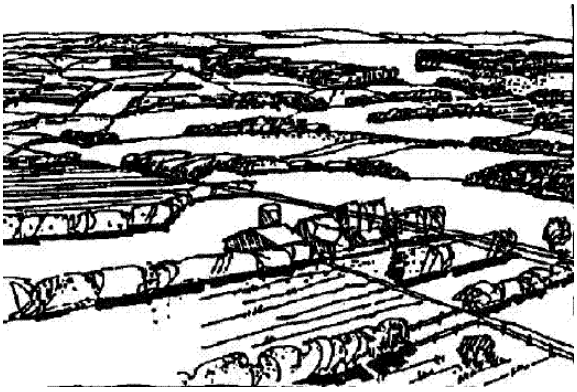
Default European terrain categories (not Country specific)

0: Coastal area:

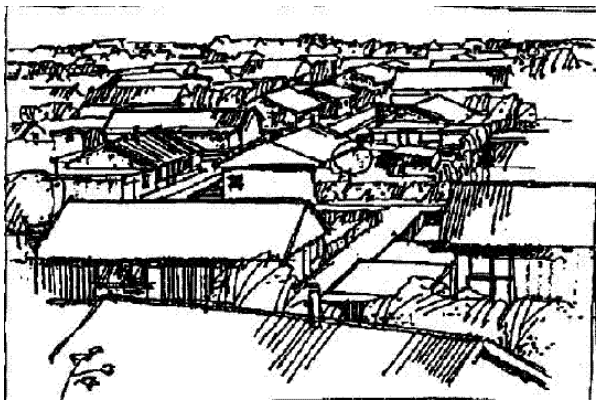


I: Flattened, open area:

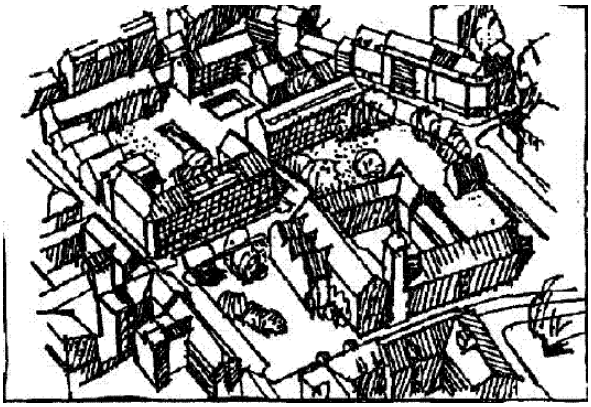
II: Rural area



III: Village



IV: City



H. Static analysis

H.1. Project description ... 18
H.2. Materials ... 19
H.2.1 Fabric ... 19
H.2.2 Guy ropes ... 19
H.2.3 Belts ... 19
H.2.4 Wood ... 20
H.3. Cross sections ... 20
H.4. Calculation method ... 21
H.4.1 Modelling ... 21
H.4.2 Structural behaviour of membrane structures ... 23
H.4.3 Load combinations ... 24
H.5. Load cases ... 25
H.5.1 Own weight ... 25
H.5.2 Pretension ... 25
H.5.3 Conventional / snow load ... 25
H.5.4 User load ... 25
H.5.5 Wind load ... 25
H.6. Calculation results ... 27
H.6.1 Listing of calculated load combinations ... 27
H.6.2 Overview: Global results of static analysis ... 28
H.6.3 Summary of forces ... 34
H.7. Element check ... 35
H.7.1 Membrane ... 35
H.7.2 Main poles 4m ... 36
H.7.3 Main poles 5m ... 37
H.7.4 Side poles ... 38
H.7.5 Corner poles ... 39
H.7.6 Guy ropes ... 40
H.7.7 Belts ... 41
H.7.8 Stormbelts ... 42
H.7.9 Fasteners ... 43
H.8. Safety against overturning, sliding and uplifting ... 46
H.8.1 Anchor capacity ... 46
H.8.2 Required anchor pins ... 47
H.8.3 Anchor tests according to BS-EN 13782 ... 48

H.8.4 Required ballast ... 49
I.1. Summary of results – low wind in Netherlands ... 50
I.2. Summary of forces ... 52
I.3. Element check - low wind in Netherlands ... 53
I.3.1 Membrane ... 53
I.3.2 Guy ropes ... 54
I.3.3 Fasteners ... 55
I.4. Safety against overturning, sliding and uplifting - low wind in Netherlands ... 56
I.4.1 Required anchor pins ... 56
I.4.2 Required ballast ... 57
J.1. Summary of results – snow+wind in France ... 58
J.2. Cross sections ... 61
J.3. Summary of forces ... 61
J.4. Element check – snow + wind in France ... 62
J.4.1 Membrane ... 62
J.4.2 Main poles 4m ... 63
J.4.3 Main poles 5m ... 64
J.4.4 Side poles ... 65
J.4.5 Corner poles ... 66
J.4.6 Belts ... 67
J.4.7 Fasteners ... 68
J.5. Safety against overturning, sliding and uplifting – snow + wind in France ... 69
J.5.1 Required anchor pins ... 69
J.5.2 Required ballast ... 69
K.1. Fabric specifications ... 70
K.2. Fabric fire certificate ... 71
K.3. Capacity of Eye bolts ... 73
K.4. Capacity of Orange Pin 1 Ton D-sluiting, DIN EN 13889 ... 73
K.5. Carabine, DIN 5299C ... 74
K.6. Rope ratchet ... 74
Annex A. Software input (load combination) ... 76
Annex A.1. CO1. Own weight + pretension ... 76
Annex A.2. CO2. Own weight + pretension + conventional / snow ... 77
Annex A.3. CO3. Own weight + pretension + wind pressure ... 78
Annex A.4. CO4. Own weight + pretension + wind suction ... 79
Annex A.5. CO5. Own weight + pretension + wind suction reduced [NL] ... 80
Annex A.6. CO6. Own weight + pretension + wind pressure + snow [FR] ... 81
Annex B. Results per load combination ... 83
Annex B.1. CO1. Own weight + pretension ... 83
Annex B.2. CO2. Own weight + pretension + snow ... 87

Annex B.3. CO3. Own weight + pretension + wind pressure 91
Annex B.4. CO4. Own weight + pretension + wind suction 95
Annex B.5. CO5. Own weight + pretension + wind suction reduced [NL] 99
Annex B.6. CO6. Own weight + pretension + wind pressure + snow [FR] 103
Annex C. Member checks 107
Annex C.1. Main pole 4.0m – Wood, Spruce C18 107
Annex C.2. Main pole 5.0m – Wood, Spruce C18 108
Annex C.3. Side pole 3m – Wood, Spruce C18 109
Annex C.4. Corner pole 2.5m - Wood, C18 110
Annex C.5. Main pole 4.0m – Wood, Spruce C18 – for snow and wind combination [FR] 111
Annex C.6. Main pole 5.0m – Wood, Spruce C18 – for snow and wind combination [FR] 112
Annex C.7. Side pole 3.0m – Wood, Spruce C18 – for snow and wind combination [FR] 113
Annex C.8. Corner pole 2.5m – Wood, Spruce C18 – for snow and wind combination [FR] 114
Annex D. Reaction forces model 115
Annex D.1. Point numbers 115
Annex D.2. Reaction forces 116

H.1. Project description

The principle of a stretchtent is based on a rectangular piece of stretchable membrane with a reinforcement along the boundary. The membrane is supported by poles, both at the edge and under the membrane. The side poles are stabilized by guy ropes and belts. The poles do not require a fixed position which ensures a freedom of shape.

Tentech B.V. has performed a static analysis of a 15x20m stretchtent always assumed to have stormbelts. Further chapters include material and cross-section description, calculation method, load cases and combinations, results, element checks, anchor and ballast calculations. These chapters present calculation results valid for Europe according to EN 13782.

As an exception, two additions to the static analysis are made (see I and J on pages 50 and 58 respectively):

1. For use only in Netherlands – element check for reduced wind speeds.

2. For use in France or countries following French CTS – element check for combined wind and snow loads

For use in other countries than Netherlands or France, the statical analysis must be considered without its additions. When relevant information is mentioned for these specific cases either [NL] or [FR] immediately follows this information. This information is not considered while making the base calculations. Addition J on page 58 must always be considered for use in France.

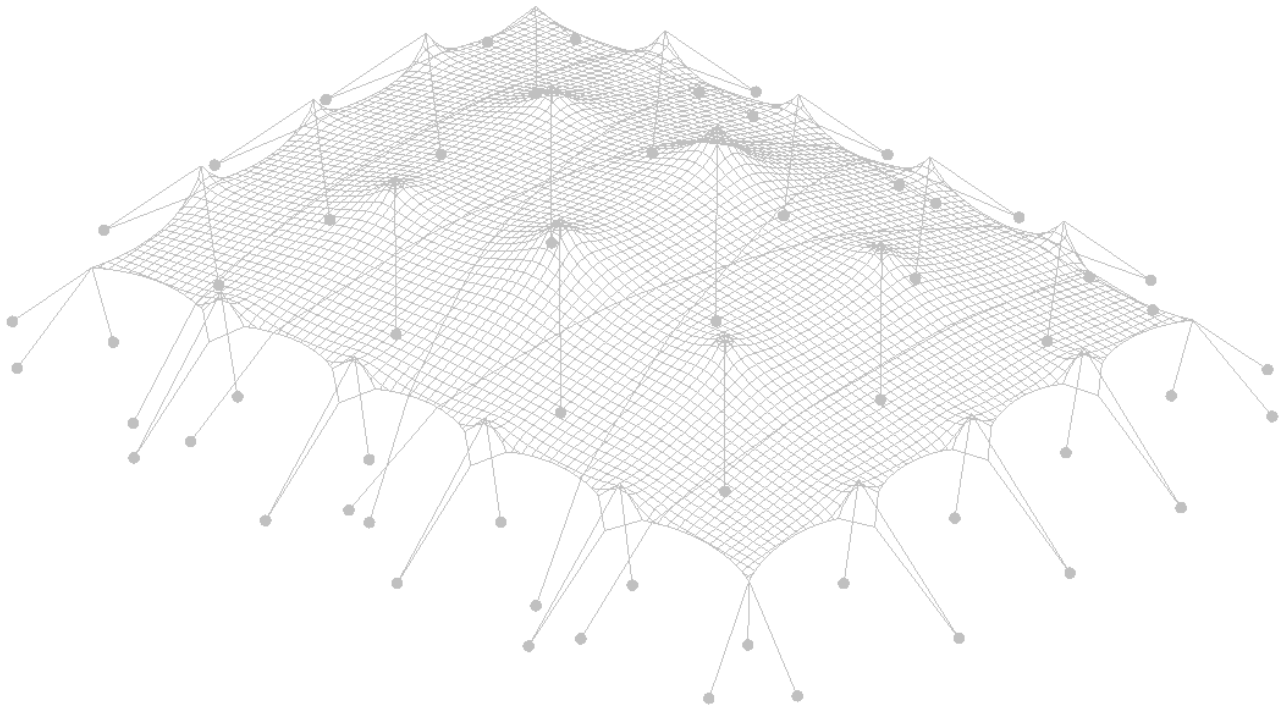


Figure 1. 15x20m model

H.2. Materials

H.2.1 Fabric

Design tensile strength	f_d	f_{tk} / γ_m	art 8.6 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. EN13782
Material factor – global, short duration load	γ_m	2.0	tbl 4. EN13782

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

Material	Type	Weight	$f_{rd;warp;perm}$	$f_{rd;\ weft;perm}$	$f_{rd;\ warp;short}$	$f_{rd:\ weft;short}$
Sioen RP5639	-	≈ 730 gr/m^2	9.6 kN/m	7.2 kN/m	12.0 kN/m	9.0 kN/m

Table 2. Used fabrics

H.2.2 Guy ropes

Design resistance	F_{rd}	R_m / γ_{m1}	art 10.2. EN13782
Characteristic tensile strength	R_m		art 10.2. EN13782
Material factor	$\gamma_{m1 < 12mm}$ $\gamma_{m1 > 12mm}$	4.0 3.3	art 10.3. EN13782 art 10.3. EN13782

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

Material	Cross section	Breaking strength	Rm	F_{rd}
8mm Polyester Braid rope	ø 8 mm	≥ 900 daN	9.0 kN	2.25 kN

Table 4. Used guy ropes

H.2.3 Belts

Design resistance	F_{rd}	R_m / γ_{m1}	art 10.2. EN13782
Characteristic breaking strength	R_m	LC x γ_{m2}	art 10.2. EN13782
Lashing capacity	LC		Conform EN 12195-2
Material factor	γ_{m1}	2.0	art 10.2. EN13782
Material factor	γ_{m2}	3.0	EN1492-1

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

Material	LC	Rm	F_{rd}
Belt [PES] EN 12195-2, 50mm	1000 daN 10 kN	3000 daN 30 kN	15 kN

Table 6. Used belts

H.2.4 Wood

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

Table 7. Used material factors

Material	Weight	$E_{0.05}$	F_{c0k}	F_{mk}
Wood, Spruce, C18	320 kg/m^3	6.0 kN/m^2	18 N/mm^2	18 N/mm^2

Table 8. Used wooden materials

H.3. Cross sections

Profile	Material	Ø mm	G kg/m	A mm^2	I_y mm^4	$W_{el;y}$ mm^3
Ø ≈ 110 mm *	Wood C18	110	3.04	9503	7186884	130671
Ø ≈ 95 mm *	Wood C18	95	2.26	7088	3998198	84173
Ø ≈ 75 mm *	Wood C18	75	1.41	4418	1553156	41417

Table 9. Used cross sections

* the average diameter, as a minimum required at the middle of the pole.

H.4. Calculation method

H.4.1 Modelling

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 modelled in 3D. The membrane is modelled as a cable net structure and is supported by poles. These centre poles will be stabilized by the tensioned membrane. The side poles are stabilized and tied down by tension belts or ropes, which are attached to ground anchors or ballast.

The membrane edges are reinforced. They consist of multiple layers of fabric about 10cm wide with additional patches where the lugs are placed. Storm belts are required constantly and placed in the valleys between the centre poles.

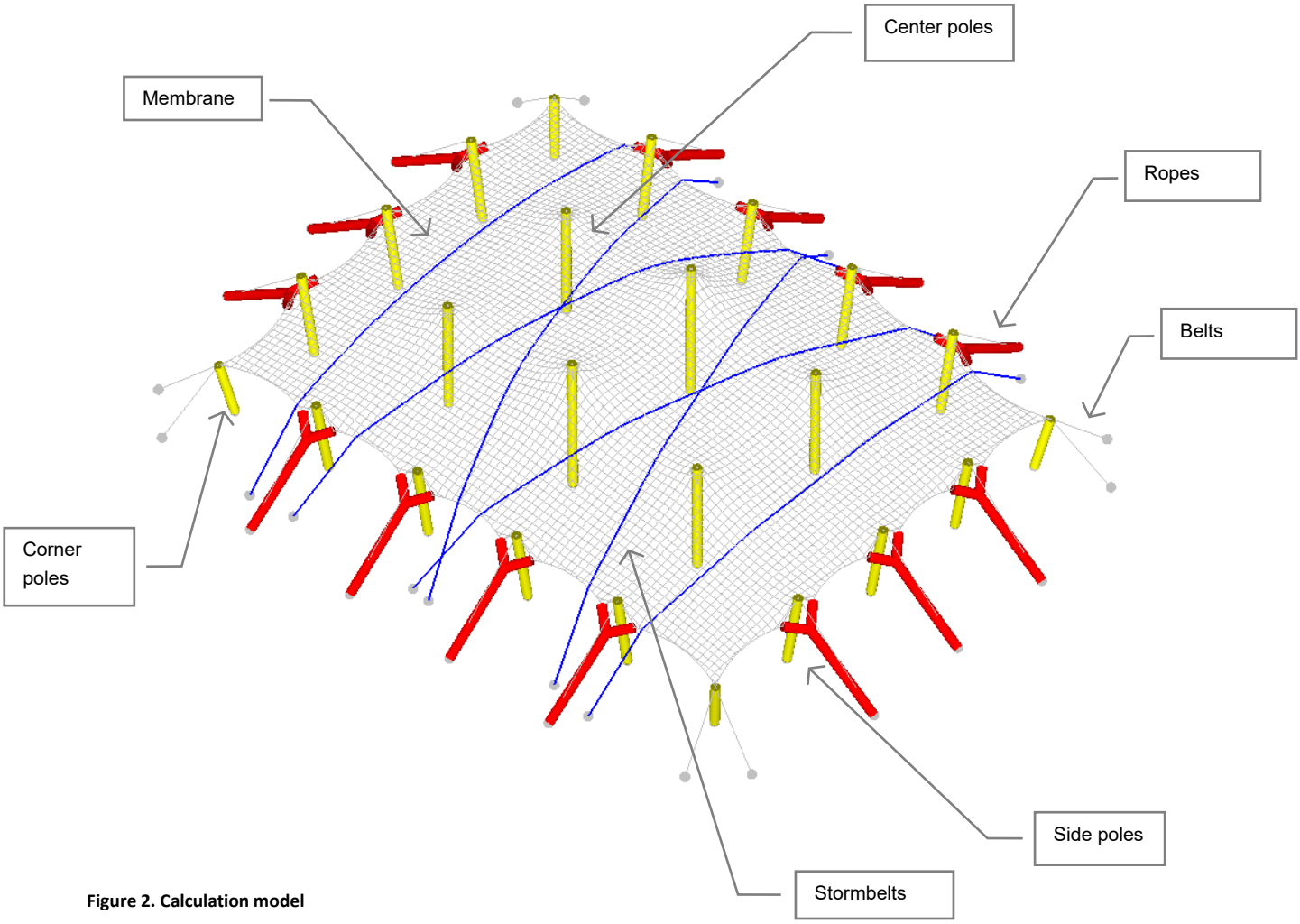


Figure 2. Calculation model

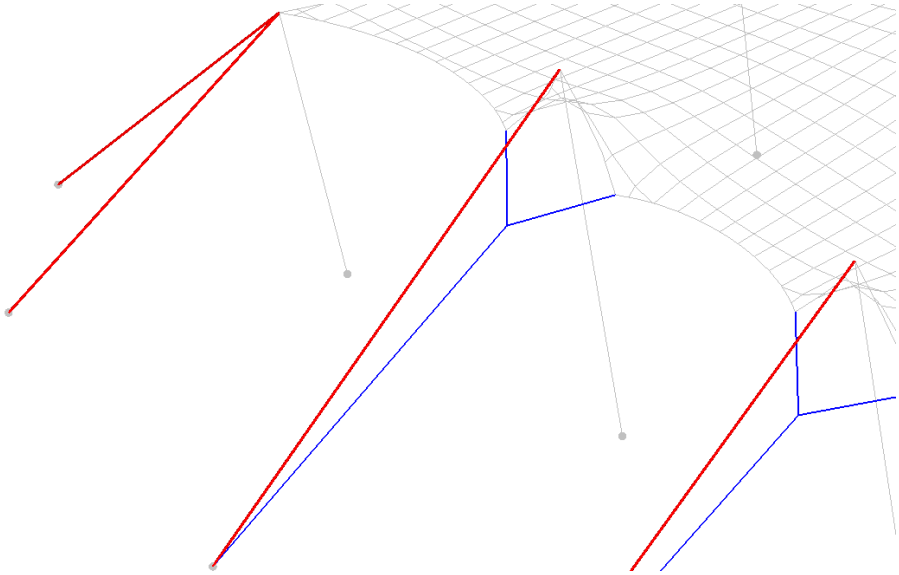


Figure 3. Principle of ties

Ties stabilize the tent and create the shape of the stretchable membrane. Guy ropes (see blue above) transfer the forces to the ground when wind suction is present. Belts (see red above) help transfer the pressure forces.

H.4.2 Structural behaviour 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.

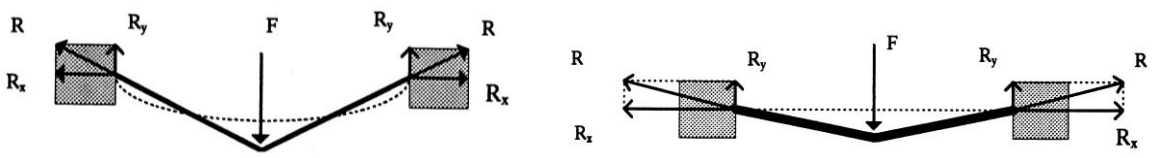


Figure 4. Membrane behavior

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.4.3 Load combinations

H.4.3.1 Fundamental - Ultimate limit state

For determination of strength and to check elements and connections ultimate limit state is used.

	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 10. Load combinations according to EN 13782

This means that the following load combinations will be checked/calculated:

1. 1.35 x Own weight + 1.5 x Wind load
2. 1.35 x Own weight + 1.5 x Snow load
3. 1.35 x Own weight + 1.35 x Wind load + 1.35 x Snow load [FR]

H.4.3.2 Safety against overturning, sliding and uplifting - Ultimate limit state

For determination and check of the needed ballast weight and/or anchors ultimate limit state is used

	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 11. Load combinations according to EN 13782

This means the following load combinations will be checked/calculated:

1. 1.0 x Own weight + 1.2 x Wind load
2. 1.0 x Own weight + 1.2 x Wind load + 1.3 x Snow load [FR]

H.5. Load cases

H.5.1 Own weight

The own weight of the fabric is 730 g/m^2 = 0.0073 kN/m^2 and is considered automatically within EASY software.

H.5.2 Pretension

The structure will be pretensioned with guy ropes and belts. With a ratchet it is possible to achieve 2-3 kN force in corner belts. Approximately 2kN force is achieved in side ropes. The tensile force in ropes and belts results in a membrane stress of approximately 0.50 kN/m^2. Higher membrane forces can be present near connection points due to the stretchable nature of the fabric.

H.5.3 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 can be seen as a snow load of 0.1 kN/m^2 (4cm) according to the French CTS, where snow load must be combined with wind load. This condition is tackled in J. Addition 2 – element check for combined wind and snow load on page 58.

H.5.4 User load

A user defined load (for light, sound and/or decoration purposes) is 25 kg per pole and is added after the analysis while performing element checks.

H.5.5 Wind load

H.5.5.1 Wind pressure

Wind load according to EN 13782, 7.4.2.2:
q_p (z_e) of 0.50 kN/m^2 if the height of the structure does not exceed 5m.

Wind load can be reduced for use in the Netherlands. A reduction factor α=0.6 is applied, which leads to **q_p (z_e) of 0.30 kN/m^2 [NL],** this is tackled in I. Addition 1 – element check for reduced wind speeds [NL]

H.5.5.2 Wind shape values (Cp-factors)

Two different wind situations are reviewed for the membrane:

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

<u>Wind suction</u>

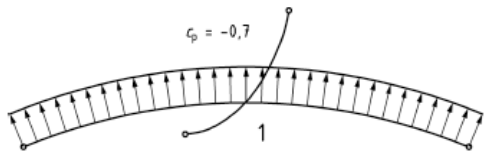


Figure 5. C_p values for rectangle structures EN 13782

P_w	$p_{w,rep}$	
500 N/m^2	-0.7 x 0.500 = **-0.350 kN/m^2**	
300 N/m^2	-0.7 x 0.300 = **-0.210 kN/m^2**	[NL]

<u>Wind pressure</u>

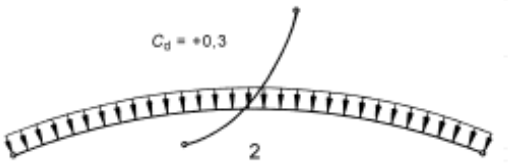


Figure 6. C_p values for rectangle structures EN 13782

P_w	$p_{w,rep}$
500 N/m^2	0.3 x 0.500 = **0.150 kN/m^2**

H.6. Calculation results

H.6.1 Listing of calculated load combinations

LC1 = Pretension
LC2 = Own weight
LC3 = Snow load
LC4 = Wind pressure
LC5 = Wind suction
LC6 = Wind suction reduced

The following load combinations are considered:
partial safety factors are added after the static analysis (see H.4.2).

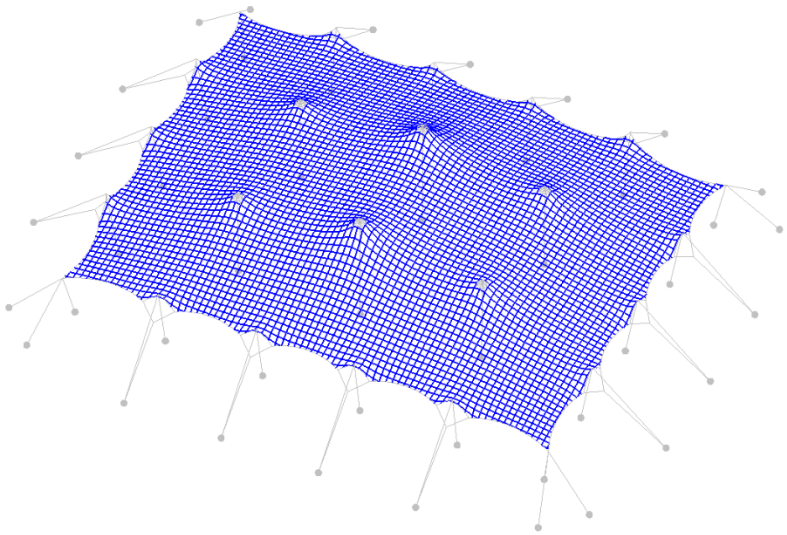
	LC1	LC2	LC3	LC4	LC5	LC6 [NL]
CO1	1 x	1 x				
CO2	1 x	1 x	1 x			
CO3	1 x	1 x		1 x		
CO4	1 x	1 x			1 x	
CO5 [NL]	1 x	1 x				1 x
CO6 [FR]	1 x	1 x	1 x	1 x		

Table 12. Combinations (CO)

The results for load combinations CO5 and CO6 are mentioned in the upcoming chapter but considered in calculations only in chapters I and J on pages 50 and 58 respectively.

H.6.2 Overview: Global results of static analysis

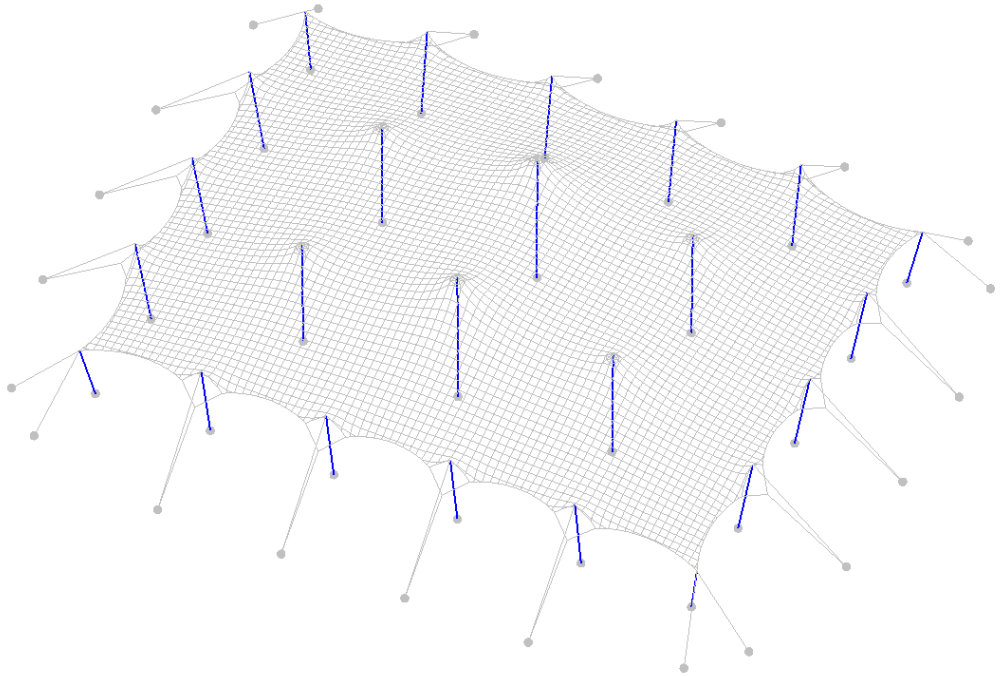
H.6.2.1 Membrane



		Load combination	F_{rep}	Pag.
Warp		CO1. Own weight + pretension	0.93 kN/m	83
		CO2. Own weight + pretension + snow	2.75 kN/m	87
		CO3. Own weight + pretension + wind pressure	3.60 kN/m	91
	Max	CO4. Own weight + pretension + wind suction	4.22 kN/m	95
		CO5. Own weight + pretension + wind suction reduced [NL]	4.09 kN/m	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	5.37 kN/m	103
Weft		CO1. Own weight + pretension	1.01 kN/m	83
		CO2. Own weight + pretension + conventional / snow	2.46 kN/m	87
	Max	CO3. Own weight + pretension + wind pressure	3.14 kN/m	91
		CO4. Own weight + pretension + wind suction	1.92 kN/m	95
		CO5. Own weight + pretension + wind suction reduced [NL]	3.36 kN/m	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	4.49 kN/m	103
Edge		CO1. Own weight + pretension	1.98 kN	83
		CO2. Own weight + pretension + conventional / snow	2.50 kN	87
		CO3. Own weight + pretension + wind pressure	3.06 kN	91
	Max	CO4. Own weight + pretension + wind suction	4.11 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	4.18 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	3.61 kN	103

Table 13. Leading forces in membrane

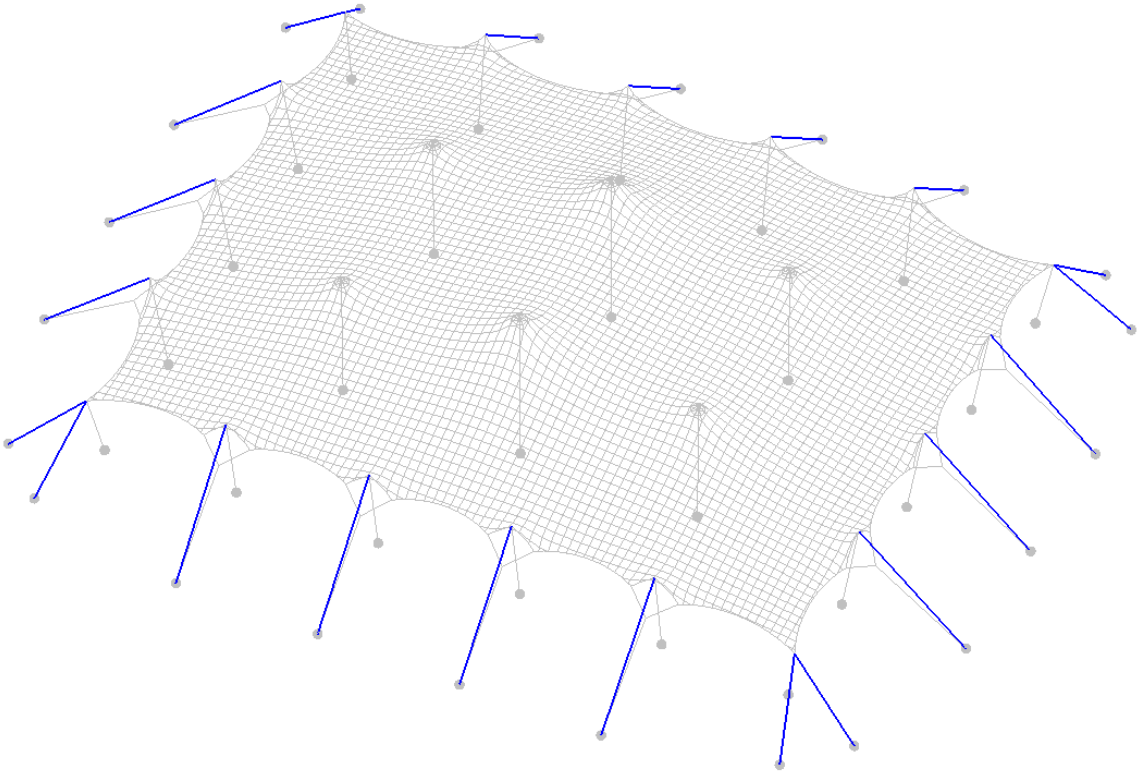
H.6.2.2 Poles



		Load combination	F_{rep}	Pag.
Main poles 4m		CO1. Own weight + pretension	-1.22 kN	83
		CO2. Own weight + pretension + snow	-4.08 kN	87
	Max	CO3. Own weight + pretension + wind pressure	-5.59 kN	91
		CO4. Own weight + pretension + wind suction	0.48 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	1.00 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	-8.55 kN	103
Main poles 5m		CO1. Own weight + pretension	-2.07 kN	83
		CO2. Own weight + pretension + snow	-5.19 kN	87
	Max	CO3. Own weight + pretension + wind pressure	-7.40 kN	91
		CO4. Own weight + pretension + wind suction	-0.06 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	-0.01 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	-11.07 kN	103
Side poles		CO1. Own weight + pretension	-1.35 kN	83
		CO2. Own weight + pretension + conventional / snow	-2.78 kN	87
	Max	CO3. Own weight + pretension + wind pressure	-3.86 kN	91
		CO4. Own weight + pretension + wind suction	-3.80 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	-0.57 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	-5.33 kN	103
Corner poles		CO1. Own weight + pretension	-3.02 kN	83
		CO2. Own weight + pretension + conventional / snow	-4.08 kN	87
	Max	CO3. Own weight + pretension + wind pressure	-5.09 kN	91
		CO4. Own weight + pretension + wind suction	-4.87 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	-4.44 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	-6.19 kN	103

Table 14. Leading forces in poles

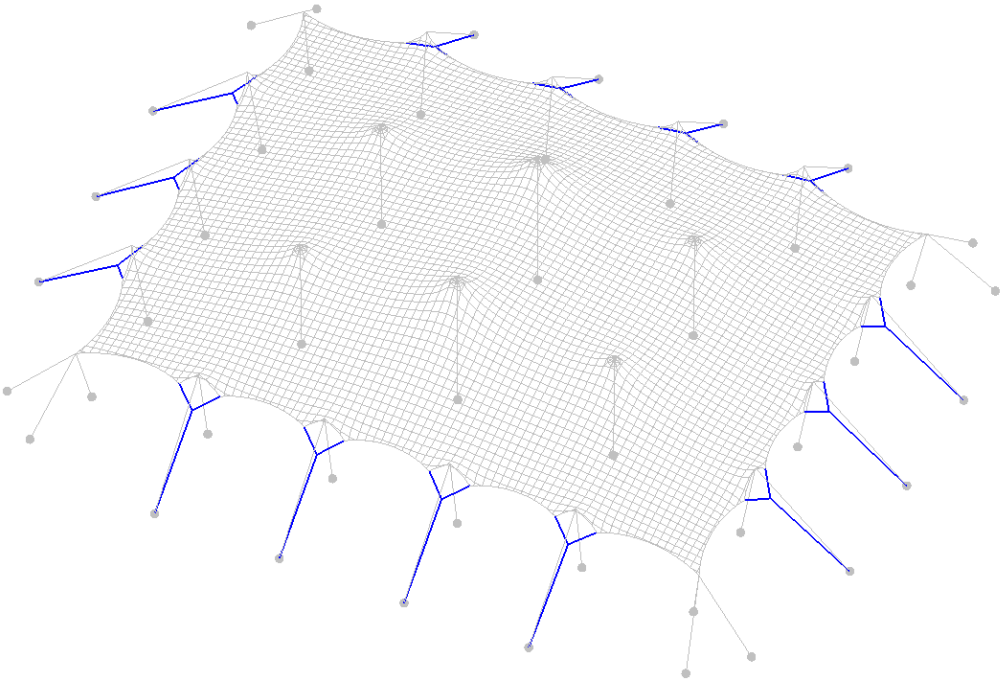
H.6.2.3 Belts



		Load combination	F_{rep}	Pag.
Corner belts		CO1. Own weight + pretension	2.45 kN	83
		CO2. Own weight + pretension + snow	3.11 kN	87
		CO3. Own weight + pretension + wind pressure	3.78 kN	91
	Max	CO4. Own weight + pretension + wind suction	4.45 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	4.21 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	4.41 kN	103
Belts – long side		CO1. Own weight + pretension	0.15 kN	83
		CO2. Own weight + pretension + conventional / snow	0.62 kN	87
	Max	CO3. Own weight + pretension + wind pressure	1.00 kN	91
		CO4. Own weight + pretension + wind suction	0.85 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	0.14 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	1.52 kN	103
Belts – short side		CO1. Own weight + pretension	0.14 kN	83
		CO2. Own weight + pretension + conventional / snow	0.68 kN	87
	Max	CO3. Own weight + pretension + wind pressure	1.12 kN	91
		CO4. Own weight + pretension + wind suction	0.09 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	0.21 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	1.74 kN	103

Table 15. Leading forces in belts

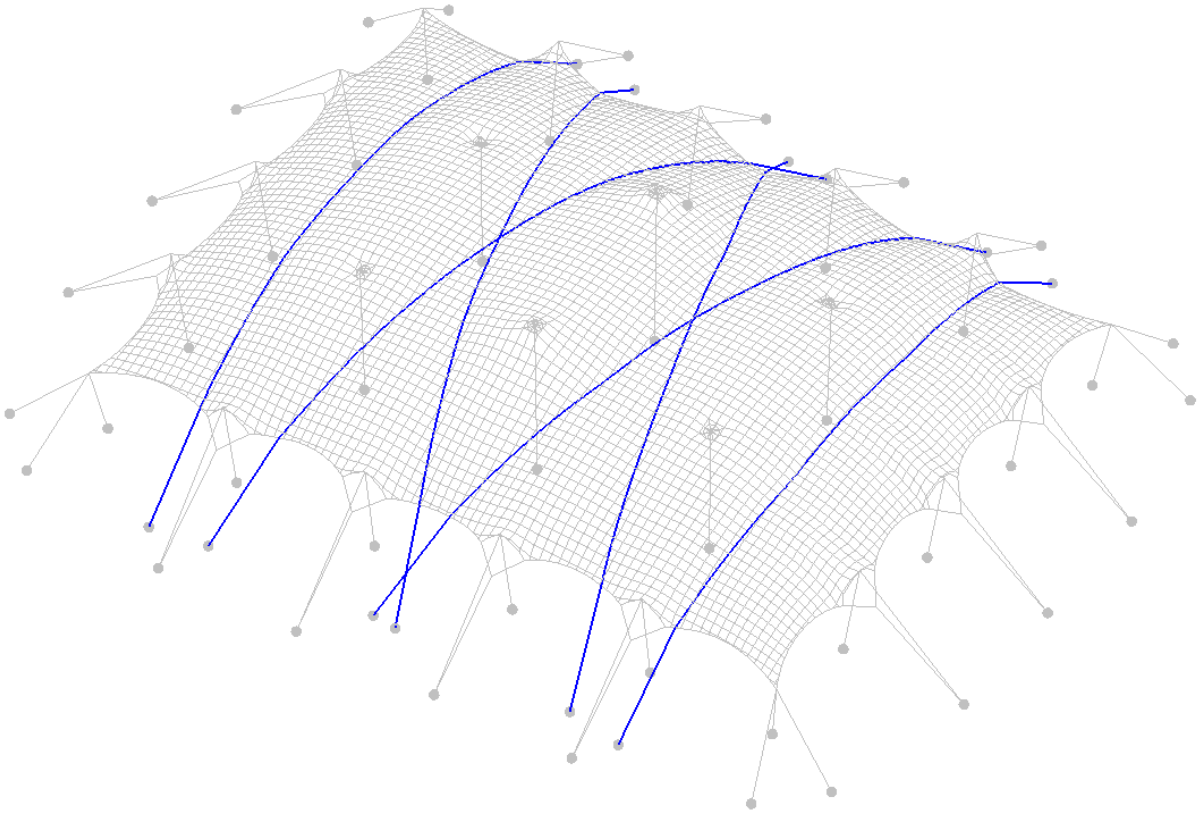
H.6.2.4 Guy ropes



		Load combination	F_{rep}	Pag.
Combined rope – long side		CO1. Own weight + pretension	2.33 kN	83
		CO2. Own weight + pretension + snow	2.78 kN	87
		CO3. Own weight + pretension + wind pressure	3.51 kN	91
	Max	CO4. Own weight + pretension + wind suction	4.85 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	6.61 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	4.02 kN	103
V-ropes – long side		CO1. Own weight + pretension	1.67 kN	83
		CO2. Own weight + pretension + conventional / snow	2.01 kN	87
		CO3. Own weight + pretension + wind pressure	2.50 kN	91
	Max	CO4. Own weight + pretension + wind suction	3.29 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	4.57 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	2.84 kN	103
Combined rope – short side		CO1. Own weight + pretension	2.14 kN	83
		CO2. Own weight + pretension + conventional / snow	2.77 kN	87
		CO3. Own weight + pretension + wind pressure	3.46 kN	91
	Max	CO4. Own weight + pretension + wind suction	6.55 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	6.49 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	4.05 kN	103
V-ropes – short side		CO1. Own weight + pretension	1.58 kN	83
		CO2. Own weight + pretension + conventional / snow	2.05 kN	87
		CO3. Own weight + pretension + wind pressure	2.60 kN	91
	Max	CO4. Own weight + pretension + wind suction	4.51 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	4.42 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	3.03 kN	103

Table 16. Leading forces in ropes

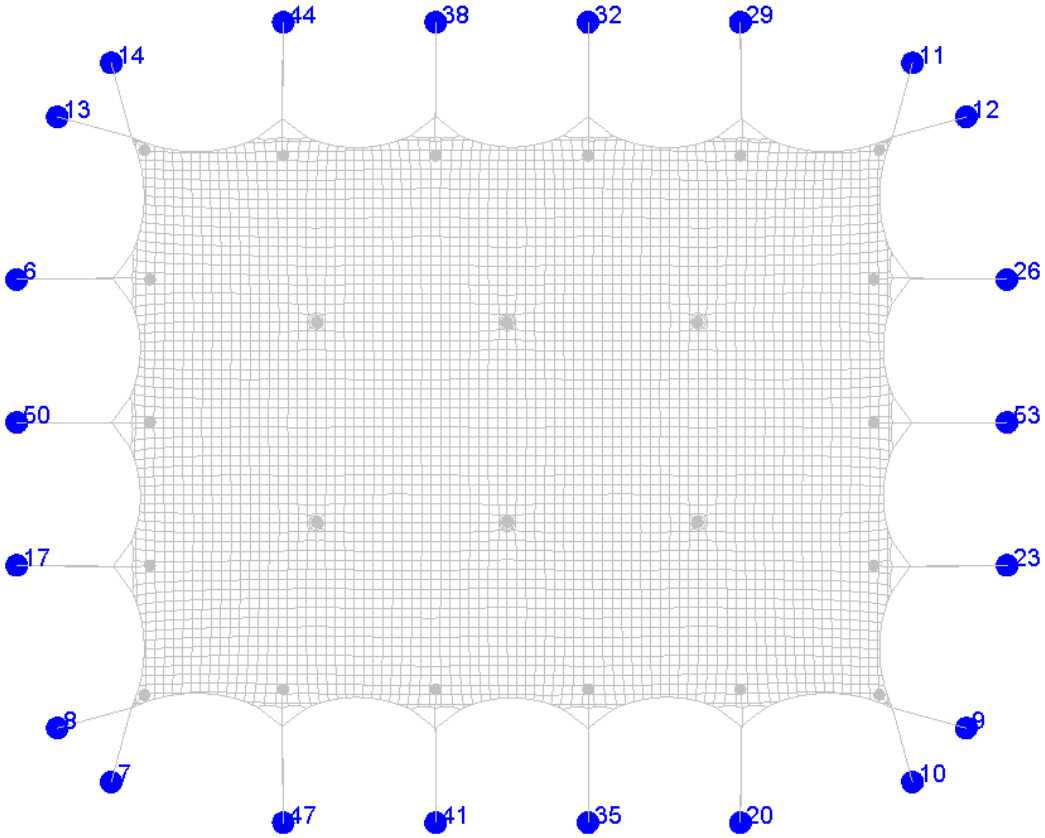
H.6.2.5 Stormbelts



		Load combination	F_{rep}	Pag.
Stormbelts		CO1. Own weight + pretension	0.00 kN	83
		CO2. Own weight + pretension + snow	0.00 kN	87
		CO3. Own weight + pretension + wind pressure	0.00 kN	91
	Max	CO4. Own weight + pretension + wind suction	8.88 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	0.00 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	0.00 kN	103

Table 17. Leading forces in stormbelts

H.6.2.6 Reaction forces



		Load combination	F_{rep}	Pag.
Long side		CO1. Own weight + pretension	2.40 kN	83
		CO2. Own weight + pretension + snow	3.27 kN	87
		CO3. Own weight + pretension + wind pressure	4.31 kN	91
	Max	CO4. Own weight + pretension + wind suction	5.68 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	6.73 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	5.38 kN	103
Short side		CO1. Own weight + pretension	2.24 kN	83
		CO2. Own weight + pretension + conventional / snow	3.42 kN	87
		CO3. Own weight + pretension + wind pressure	4.55 kN	91
	Max	CO4. Own weight + pretension + wind suction	6.63 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	6.70 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	5.85 kN	103
Corner		CO1. Own weight + pretension	2.45 kN	83
		CO2. Own weight + pretension + conventional / snow	3.11 kN	87
		CO3. Own weight + pretension + wind pressure	3.78 kN	91
	Max	CO4. Own weight + pretension + wind suction	4.45 kN	95
		CO5. Own weight + pretension + wind suction reduced [NL]	4.21 kN	99
		CO6. Own weight + pretension + wind pressure + snow [FR]	4.46 kN	103

Table 18. Leading reaction forces

H.6.3 Summary of forces

kN or kN/m	CO1	CO2	CO3	CO4	CO5 [NL]	CO6 [FR]
Warp	0.93	2.75	3.60	4.22	4.09	5.37
Weft	1.01	2.46	3.14	1.92	3.36	4.49
Edge	1.98	2.50	3.06	4.11	4.18	3.61
Main pole 4m	-1.22	-4.08	-5.59	0.48	1.00	-8.55
Main pole 5m	-2.07	-5.19	-7.40	-0.06	-0.01	-11.07
Side pole	-1.35	-2.78	-3.86	-3.80	-0.57	-5.33
Corner pole	-3.02	-4.08	-5.09	-4.87	-4.44	-6.19
Corner belt	2.45	3.11	3.78	4.45	4.21	4.41
Belts - long side	0.15	0.62	1.00	0.85	0.14	1.52
Belts - short side	0.14	0.68	1.12	0.09	0.21	1.74
Stormbelts	0.00	0.00	0.00	8.88	0.00	0.00
Combined rope - long side	2.33	2.78	3.51	4.85	6.61	4.02
V-ropes - long side	1.67	2.01	2.50	3.29	4.57	2.84
Combined rope - short side	2.14	2.77	3.46	6.55	6.49	4.05
V-ropes short side	1.58	2.05	2.60	4.51	4.42	3.03
Anchor - long side	2.40	3.27	4.31	5.68	6.73	5.38
Anchor - short side	2.24	3.42	4.55	6.63	6.70	5.85
Anchor - corner	2.45	3.11	3.78	4.45	4.21	4.46

Table 19. Summary of forces

H.7. Element check

H.7.1 Membrane

Load combination	Element	Representative stress	Design value stress	Pag.
CO1. Own weight + pretension	Long term warp	0.93 kN/m	1.26 kN/m (γ = 1.35)	34
CO1. Own weight + pretension	Long term weft	1.01 kN/m	1.36 kN/m (γ = 1.35)	34
CO3. Own weight + pretension + wind pressure	Short term warp	4.22 kN/m	6.33 kN/m (γ = 1.5)	34
CO4. Own weight + pretension + wind suction	Short term weft	3.14 kN/m	4.71 kN/m (γ = 1.5)	34

Sioen RP5639 fabric is being used.

UC.1a	Long term warp	S_{Ed} / S_{rd} < 1	1.26 / 9.6 = 0.13 < 1	OK
UC.1b	Long term weft	S_{Ed} / S_{rd} < 1	1.36 / 7.2 = 0.19 < 1	OK
UC.1c	Short term warp	S_{Ed} / S_{rd} < 1	6.33 / 12.0 = 0.53 < 1	OK
UC.1d	Short term weft	S_{Ed} / S_{rd} < 1	4.71 / 9.0 = 0.52 < 1	OK

For capacity of membrane see H.2.1, page 19

H.7.2 Main poles 4m

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure	Main pole 4.0m	-5.59 kN	-8.39 kN (γ = 1.5)	34

User load of max. 25 kg is applied, loaded centrically.

4.0m pole Ned = -5.59 x 1.50 + (-0.25 x 1.35) = -8.72 kN

H.7.2.1 4.0m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 95 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 4.00m
Quality = C18

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

UC.2	4.0m	$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.23 / (12.46 x 0.109) = 0.91 ≤ 1	OK

See Annex C.1 Main pole 4.0m – Wood, on page 107 for the elaborate check

H.7.3 Main poles 5m

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure	Main pole 5.0m	-7.40 kN	-11.1 kN (γ = 1.5)	34

User load of max. 25 kg is applied, loaded centrically.

5.0m pole Ned = -7.40 x 1.50 + (-0.25 x 1.35) = -11.44 kN

H.7.3.1 5.0m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 110 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 5.00m
Quality = C18

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

UC.3	5.0m	$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.20 / (12.46 x 0.094) = 1.03 ~ 1	Acceptable

See Annex C.2 Main pole 5.0m – Wood, Spruce C18, on page 108 for the elaborate check

H.7.4 Side poles

Load combinations	Element	Representative force	Design value force	Pag.
CO3. Own weight + pretension + wind pressure	Side pole 3.0m	-3.86 kN	-5.79 kN (γ = 1.5)	34

User load of max. 25 kg is applied, loaded centrically.
3m pole Ned = -3.86 x 1.50 + (-0.25 x 1.35) = -6.13 kN

H.7.4.1 3m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 75 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 3.0m
Quality = C18

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

UC.4	3m	$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.39 / (12.46 x 0.12) = 0.93 < 1	OK

See Annex C.3 Side pole 3m – Wood, Spruce C18, on page 109 for the elaborate check

H.7.5 Corner poles

Load combinations	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	Corner pole 2.5m	-5.09 kN	-7.64 kN (γ = 1.5)	34

User load of max. 25 kg is applied, loaded centrically.

2.5m corner pole Ned = -5.09 x 1.50 + (-0.25 x 1.35) = -7.97 kN

H.7.5.1 2.5m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 75 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 2.5m
Quality = C18

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

UC.5	2.5m	$\sigma_{c,0,d} / (f_{c,0,d} \times k_{cy})$ = 1.80 / (12.46 x 0.170) = 0.85 < 1	OK

See Annex C.4 Corner pole 2.5m - Wood, C18, on page 110 for the elaborate check

H.7.6 Guy ropes

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	long side - combined	4.85 kN	7.28 kN (γ = 1.5)	34
CO4. Own weight + pretension + wind suction	long side – V-ropes	3.29 kN	4.94 kN (γ = 1.5)	34
CO4. Own weight + pretension + wind suction	short side - combined	6.55 kN	9.83 kN (γ = 1.5)	34
CO4. Own weight + pretension + wind suction	short side – V-ropes	4.51 kN	6.77 kN (γ = 1.5)	34

Synthetic rope Ø8mm, BL 900 daN. Is being used → $F_{rd,8mm}$ = 2.25 kN.

In a case of using individual guy ropes made of multiple sections, the ropes need to be tied back, creating multiple rope sections that together will take the load.

UC.6a	long side - combined	1 individual rope made of 4 sections Ø8mm	F_d / F_{rd} < 1	7.28 / (1 x 4 x 2.25) = 0.81 < 1	OK
UC.6b	long side – V-ropes	1 individual rope made of 3 sections Ø8mm	F_d / F_{rd} < 1	4.94 / (1 x 3 x 2.25) = 0.73 < 1	OK
UC.6c	short side - combined	1 individual rope made of 5 sections Ø8mm	F_d / F_{rd} < 1	9.83 / (1 x 5 x 2.25) = 0.87 < 1	OK
UC.6d	short side – V-ropes	1 individual rope made of 3 sections Ø8mm	F_d / F_{rd} < 1	6.77 / (1 x 3 x 2.25) = 1.00 ≤ 1	OK

For capacity of ropes see H.2.2, page 19

It is also possible to use alternative **ropes** with a higher breaking strength (BL_{rope}) and less rope sections (n), as long as $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq BL_{required}}$

Required breaking loads for ropes:

Long side - combined: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 2912}$ **kg**
Long side – V-ropes: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 1976}$ **kg**
Short side - combined: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 3932}$ **kg**
Short side – V-ropes: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 2708}$ **kg**

H.7.7 Belts

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	Corner belt	4.45 kN	6.68 kN (γ = 1.5)	34
CO3. Own weight + pretension + wind pressure	Belt – long side	1.00 kN	1.50 kN (γ = 1.5)	34
CO3. Own weight + pretension + wind pressure	Belt – short side	1.12 kN	1.68 kN (γ = 1.5)	34

H.7.7.1 Belt capacity check

PES belt with a breaking strength of 3000kg is being used.

UC.7a	Corner belt	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	6.68 / (1 x 15) = 0.45 < 1	OK
UC.7b	Belt – long side	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	1.50 / (1 x 15) = 0.10 < 1	OK
UC.7c	Belt – short side	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	1.68 / (1 x 15) = 0.11 < 1	OK

For capacity of ropes see H.2.3, page 19

H.7.7.2 Alternative – rope capacity check

It is possible to use either a rope or a belt. Synthetic rope Ø8mm, BL 900 daN. Is being used → $F_{rd,8mm}$ = 2.25 kN.

In a case of using individual guy ropes, the ropes need to be tied back, creating multiple rope sections that together will take the load.

UC.7d	Corner rope	1 individual rope made of 3 sections Ø8mm	F_d / F_{rd} < 1	6.68 / (1 x 3 x 2.25) = 0.99 < 1	OK
UC.7e	Rope – long side	1 individual rope made of 1 section Ø8mm	F_d / F_{rd} < 1	1.50 / (1 x 1 x 2.25) = 0.67 < 1	OK
UC.7f	Rope – short side	1 individual rope made of 1 section Ø8mm	F_d / F_{rd} < 1	1.68 / (1 x 1 x 2.25) = 0.75 < 1	OK

For capacity of ropes see H.2.2, page 19

It is also possible to use alternative **ropes** with a higher breaking strength (BL_{rope}) and less rope sections (n), as long as $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq BL_{required}}$

Required breaking loads for ropes:

Corner rope: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 2672}$ **kg**

Rope – long side: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 600}$ **kg**

Rope – long side: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 672}$ **kg**

H.7.8 Stormbelts

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	Stormbelt	8.88 kN	13.32 kN (γ = 1.5)	34

PES belt with a breaking strength of 3000kg is being used.

UC.8	Storm belt	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	13.32 / (1 x 15) = 0.89 < 1.0	OK

For capacity of ropes see H.2.3, page 19

H.7.9 Fasteners

Force acting on fasteners is equal to the force in belts or ropes. See these values in chapters H.7.7 and H.7.6.

H.7.9.1 Corner belt connection

H.7.9.1.1. M16 Eye bolt, DIN580

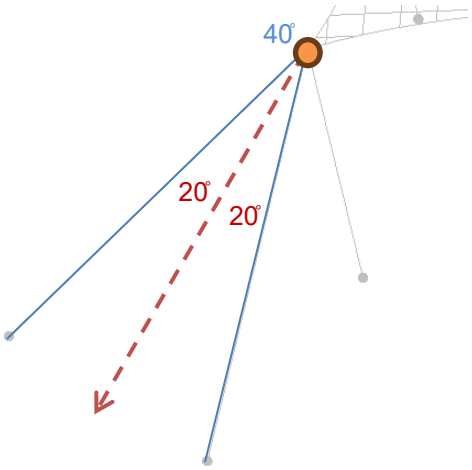
For ≤45°:

M16, WLL 700kg → BL = 6 x 7 kN = 42 kN → Frd = BL / γ_m = 42 / 2 =21 kN

$F_d = 2 \times F_{corner\ belt} \times \cos 20° = 2 \times 6.68 \times \cos 20° = 12.71\ kN$

UC.9a	Corner eye bolt	F_d / F_{rd} < 1	12.71 / 21 = 0.61 < 1.0	OK

For capacity of eye bolts see K.3 Capacity of Eye bolts on page 73.



H.7.9.1.2. Corner belt connection

A similar connection can be used if the capacity of it is at least 12.7 kN.

Orange Pin D-sluiting, WLL 1.0 t → BL = 6 x 10 kN = 60 kN → Frd = BL / γm = 60 kN / 2 = 30 kN

UC.9b	D-sluiting	F_d / F_{rd} < 1	12.71 / 30 = 0.42 < 1.0	OK

For capacity of D-sluiting see K.4 Capacity of Orange Pin 1 Ton D-sluiting, DIN EN 13889 on page 73.

H.7.9.1.3. Rope ratchet – for alternative corner connection with ropes

Ratchet, BL = 3.5 kN → Frd = BL / γm = 3.5 kN / 1.5 = 2.33 kN

F_d=6.68 kN (Instead of corner belts corner ropes are used)

UC.9c	Corner ropes (alternative)	**F_d / F_{rd} < 1**	**6.68 / 3*x2.33= 0.95 < 1**	**OK**

For capacity of rope ratchet see K.6 Rope ratchet, page 74

* Number of cross sections making a rope. Ratchet is applied only on one cross-section.

H.7.9.2 Side belt connection

H.7.9.2.1. M12 Eye bolt, DIN580

For ≤45°:

M12, WLL 340kg → BL = 6 x 3.4 kN = 20.4 kN → Frd = BL / γ_m = 20.4 / 2 = 4.2 kN

F_d=1.68 kN

UC.9d	Corner eye bolt	F_d / F_{rd} < 1	1.68 / 10.2 = 0.416 < 1.0	OK

For capacity of eye bolts see K.3 Capacity of Eye bolts on page 73.

H.7.9.2.2. Carbine, DIN5299C

Carbine 180x14, WLL 580kg → BL = 2 x 5.8 kN = 11.6 kN → Frd = BL / γm = 11.6 kN / 2 = 5.8 kN

F_d=1.68 kN

UC.9e	**F_d / F_{rd} < 1**	**1.68 / 5.8 = 0.29 < 1**	**OK**

For capacity of carabines see K.5 Carabine, DIN 5299C, page 74

H.7.9.3 Side rope connection

H.7.9.3.1. Carbine, DIN5299C

Carbine 200x15, WLL 700kg → BL = 2 x 7 kN = 14 kN → Frd = BL / γm = 14 kN / 2 = 7 kN

F_d=6.77 kN

UC.9f	**F_d / F_{rd} < 1**	**6.77 / 7 = 0.97 < 1**	**OK**

For capacity of carabines see K.5 Carabine, DIN 5299C, page 74

H.7.9.3.2. Rope ratchet

Ratchet, BL = 3.5 kN → Frd = BL / γm = 3.5 kN / 1.5 = 2.33 kN

F_d=7.28 kN (long side), F_d=9.83 kN (short side)

UC.9g	Long side – combined rope	**F_d / F_{rd} < 1**	**7.28 / 4*x2.33= 0.78 < 1**	**OK**
UC.9h	Short side – combined rope	**F_d / F_{rd} < 1**	**9.83 / 5*x2.33= 0.84 < 1**	**OK**

For capacity of rope ratchet see K.6 Rope ratchet, page 74

* Number of cross sections making a rope. Ratchet is applied only on one cross-section.

H.7.9.4 Base plate

H.7.9.4.1. Side pole & corner pole

See H.6.3 for the highest design pressure force. Poles are subjected only to compressive force.

The worst case is assumed – pole is located on soil:

1. Soil (base plate size 30x30 cm, p_{soil} = 150 kN/m^2)

UC.8k	Soil	$\frac{F_d}{A}/p \leq 1$	**7.97 / (0.30*0.30) / 150 = 0.90 < 1**	**OK**

H.7.9.4.2. Main pole

See H.6.3 for the highest design pressure force. Poles are subjected only to compressive force.

The worst case is assumed – pole is located on soil:

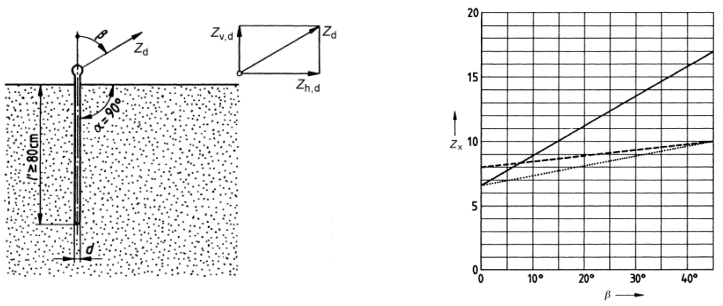
1. Soil (base plate size 30x30 cm, p_{soil} = 150 kN/m^2)

UC.8l	Soil	$\frac{F_d}{A}/p \leq 1$	**8.72 / (0.30*0.30) / 150 = 0.65 < 1**	**OK**

H.8. Safety against overturning, sliding and uplifting

The calculations in this chapter provide a guideline for dense cohesionless soil, in case no anchor tests have been performed. Anchor tests on location can show that a different number of anchors or different size of anchors have sufficient capacity for the specific soil conditions. (see paragraph H.8.3)

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 7. Taken from EN 13782: Figures 4 & 5, table 5

Anchors **of Ø30mm** are used, considering an **effective length of at least 1000 mm.** If multiple anchors are placed at the same location, the anchors need to be at least 5xØ apart to use the full capacity of the anchors.

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

		Ø30 x 1000 mm
Angle	β	≥ 45
Effective length anchor	l'	100 cm
Diameter anchor	d	3.0 cm
Anchor capacity*	Z_d	5.10 kN

H.8.2 Required anchor pins

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	Long side anchor point	5.68 kN	6.82 kN (γ = 1.2)	34
CO4. Own weight + pretension + wind suction	Short side anchor point	6.63 kN	7.96 kN (γ = 1.2)	34
CO4. Own weight + pretension + wind suction	Corner anchor point	4.45 kN	5.34 kN (γ = 1.2)	34
CO4. Own weight + pretension + wind suction	Stormbelt	8.88 kN	10.66 kN (γ = 1.2)	34

Required anchor amount for dense cohesionless soil

Long side guy ropes	2x	Ø30 x 1000 mm	F_d / F_{rd} = 6.82 / (2 x 5.10) = 0.67 ≤ 1	OK
Short side guy ropes	2x	Ø30 x 1000 mm	F_d / F_{rd} = 7.96 / (2 x 5.10) = 0.78 ≤ 1	OK
Corner ties	1x	Ø30 x 1000 mm	F_d / F_{rd} = 5.34 / (1 x 5.10) = 1.04 ~ 1	Acceptable
Stormbelt	3x	Ø30 x 1000 mm	F_d / F_{rd} = 10.66 / (3 x 5.10) = 0.70 ≤ 1	OK

H.8.3 Anchor tests according to BS-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 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 = 4.45 kN
Fsd_{belt} = 1.2 x Frep = 1.2 x 4.45 = 5.34 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 5.34 = 8.54 kN

If for example the anchor test point has a minimal anchor capacity of 5 kN (500 kg), then 2 anchors are needed: 2x5 = 10 kN > $Z_{u,d,test}$

H.8.4 Required ballast

The safety against sliding shall be calculated from:

$\sum \mu * \gamma * N_k \geq \sum \gamma * H_k$ (eq. 5. NEN-EN 13782)

where

μ the coefficient of friction according to table 3

γ The safety factor according to Table 2, γ = 1.2 (unfavorable wind load)

N the vertical load components (characteristic value), corresponds to the required ballast

H the horizontal load components (characteristic value).

The safety against lifting shall be calculated from:

$\sum \gamma * N_{Rk,stb} \geq \sum \gamma * N_{Ek,dst}$ (eq. 7. NEN-EN 13782)

where

$N_{Rk,stb}$ are the vertical stabilizing load components (characteristic value);

$N_{Ek,dst}$ are the vertical lifting destabilizing load components (characteristic value).

For load calculations against sliding and lifting, Frep is split into the horizontal (Fh) and vertical (Fv) forces. If the separate reaction force factors are not known:

$F_h = F_{rep} \times \cos \alpha$ and $F_v = F_{rep} \times \sin \alpha$

Where α is equal to the angle between F_{rep} and the ground plane.

It follows from the above equation:

Required load (against sliding): $B_h = (\gamma F_h) / \mu$

Required load (against lifting): $B_v = \gamma F_v$

$B_{tot} = B_h + B_v$

B_{tot} = total required load

B_h = required load due to horizontal forces

B_v = required load due to vertical forces

Location	F_{rep} (γ = 1.2)	F_H	F_V	α	Ballast for μ = 0.5 (concrete on concrete)	Ballast for μ = 0.6 (concrete on rubber or wood)
	(kN)	(kN)	(kN)	°	(KG)	(KG)
Long side guy ropes	6.82	4.82	4.82	*45*	*1450*	*1290*
Short side guy ropes	7.96	5.63	5.63	*45*	*1690*	*1500*
Corner ties	5.34	3.78	3.78	*45*	*1130*	*1010*
Stormbelts	10.66	7.53	7.53	45	*2260*	*2010*

I. Addition 1 – element check for reduced wind speeds [NL]

For stretchtent use in the Netherlands, a reduction of maximal allowable wind speeds is specified. As a result, the stretchtent is calculated for two wind scenarios – full wind and reduced wind. Maximal wind speeds are specified and if the structure exceeds them, the tent must be evacuated and access must be denied. For these wind speeds no stormbelts are necessary.

A reduction factor α=0.6 is applied, which leads to **q_p (z_e) of 0.30 kN/m² [NL]. No stormbelts are required.**

I.1. Summary of results – low wind in Netherlands

Changes that come from lower wind and no stormbelts are highlighted in orange.

General information:		
Main dimensions:		**15 x 20m**
	Width:	15m
	Length:	20m
	Side height of membrane:	3m
	Max. height:	5m
	Main poles 5m: *	5.0m Ø 110 mm [Spruce, C18]
	Main poles 4m: *	4.0m Ø 95 mm [Spruce, C18]
	Side poles: *	3.0m Ø 75 mm [Spruce, C18]
	Corner poles: *	2.5m Ø 75 mm [Spruce, C18]
	Stormbelts:	50mm PES [EN 12195-2], LC=1000 daN
	Guy ropes:	Ø 8mm polyester, breaking strength ≥ 900 daN **
	Long side – combined:	**5 sections**
	Long side - V-ropes:	3 sections
	Short side – combined:	5 sections
	Short side - V-ropes:	3 sections

	Belts: Fasteners: Side & corner pole base plate Main pole base plate	50mm PES [EN 12195-2], LC=1000 daN Carbine 200x15 M16 & M12 Eye bolt Ratchet, BL = 3.5 kN 30x30cm 30x30cm
User load:	A maximum of 25 kg per main mast may be used for decorations, sound or lighting installations. The load must be applied centrally.	
Snow load:	A snow load of 0.1 kN/m² (4 cm) has been considered in accordance with the French CTS standard.	
Wind load:	**According to EN 13782** The following pressure values have been used: h < 5m: 0.30kN/m²	

* The average diameter, as a minimum required at the middle of the pole.

** The required breaking load (BL_{tot}) may be achieved by using multiple rope sections (n): $BL_{rope} = BL_{tot} / n$, see page 54

Safety against sliding, overturning and uplifting:		
Anchor forces:	Assumptions: angle of 45 degrees The following design resistance of the anchor forces is required: (See H.8.3, page 48 for Anchor tests according to EN 13782)	
	Long side guy ropes: Short side guy ropes: Corner ties:	**8.08 kN** (γ = 1.2) **8.04 kN** (γ = 1.2) **5.05 kN** (γ = 1.2)
Required anchors:	Based on dense, non-cohesive soil (e.g. sandy soils). In the case anchors **Ø30mm x 1000mm** (effective length) are being used:	
	Long side guy ropes: Short side guy ropes: Corner ties:	2 anchors 2 anchors 1 anchor
Required ballast:	Ballast calculation is performed for 2 different situations: - Concrete on concrete – concrete ballasts are placed on concrete - Concrete on wood or rubber – concrete ballasts are placed on wood, or an anti-slip mat is placed underneath the ballast	
		Concrete on concrete / Concrete on wood or rubber

	Long side guy ropes:	1710 kg	1520 kg
	Short side guy ropes:	1710 kg	1520 kg
	Corner ties:	1070 kg	950 kg

I.2. Summary of forces

Further chapters include the calculation only for highlighted elements in the CO5 [NL] column if they show higher values than calculated in the previous chapters or if recalculating them show a clear difference in results. Other element checks can be looked up in H.7.

	Summary					
kN or kN/m	CO1	CO2	CO3	CO4	CO5 [NL]	CO6 [FR]
Warp	0.93	2.75	3.60	4.22	4.09	5.37
Weft	1.01	2.46	3.14	1.92	3.36	4.49
Edge	1.98	2.50	3.06	4.11	4.18	3.61
Main pole 4m	-1.22	-4.08	-5.59	0.48	1.00	-8.55
Main pole 5m	-2.07	-5.19	-7.40	-0.06	-0.01	-11.07
Side pole	-1.35	-2.78	-3.86	-3.80	-0.57	-5.33
Corner pole	-3.02	-4.08	-5.09	-4.87	-4.44	-6.19
Corner belt	2.45	3.11	3.78	4.45	4.21	4.41
Belts - long side	0.15	0.62	1.00	0.85	0.14	1.52
Belts - short side	0.14	0.68	1.12	0.09	0.21	1.74
Stormbelts	0.00	0.00	0.00	8.88	0.00	0.00
Combined rope - long side	2.33	2.78	3.51	4.85	6.61	4.02
V-ropes - long side	1.67	2.01	2.50	3.29	4.57	2.84
Combined rope - short side	2.14	2.77	3.46	6.55	6.49	4.05
V-ropes short side	1.58	2.05	2.60	4.51	4.42	3.03
Anchor - long side	2.40	3.27	4.31	5.68	6.73	5.38
Anchor - short side	2.24	3.42	4.55	6.63	6.70	5.85
Anchor - corner	2.45	3.11	3.78	4.45	4.21	4.46

Table 20. Summary of forces

I.3. Element check - low wind in Netherlands

I.3.1 Membrane

Load combination	Element	Representative stress	Design value stress	Pag.
CO1. Own weight + pretension	Long term warp	0.93 kN/m	1.26 kN/m (γ = 1.35)	52
CO1. Own weight + pretension	Long term weft	1.01 kN/m	1.36 kN/m (γ = 1.35)	52
CO5. Own weight + pretension + wind suction reduced	Short term warp	4.09 kN/m	6.14 kN/m (γ = 1.5)	52
CO5. Own weight + pretension + wind suction reduced	Short term weft	3.13 kN/m	5.04 kN/m (γ = 1.5)	52

Sioen RP5639 fabric is being used.

UC.1a	Long term warp	S_{Ed} / S_{rd} < 1	1.26 / 9.6 = 0.13 < 1	OK
UC.1b	Long term weft	S_{Ed} / S_{rd} < 1	1.36 / 7.2 = 0.19 < 1	OK
UC.1c	Short term warp	S_{Ed} / S_{rd} < 1	6.14 / 12.0 = 0.51 < 1	OK
UC.1d	Short term weft	S_{Ed} / S_{rd} < 1	5.04 / 9.0 = 0.56 < 1	OK

For capacity of membrane see H.2.1, page 19

I.3.2 Guy ropes

Load combination	Element	Representative force	Design value force	Pag.
CO5. Own weight + pretension + wind suction reduced	long side - combined	6.61 kN	9.92 kN (γ = 1.5)	52
CO5. Own weight + pretension + wind suction reduced	long side – V-ropes	4.57 kN	6.86 kN (γ = 1.5)	52
CO5. Own weight + pretension + wind suction reduced	short side - combined	6.49 kN	9.74 kN (γ = 1.5)	52
CO5. Own weight + pretension + wind suction reduced	short side – V-ropes	4.42 kN	6.63 kN (γ = 1.5)	52

Synthetic rope Ø8mm, BL 900 daN. Is being used → $F_{rd,8mm}$ = 2.25 kN.

In a case of using individual guy ropes made of multiple sections, the ropes need to be tied back, creating multiple rope sections that together will take the load.

UC.2a	long side - combined	1 individual rope made of 5 sections Ø8mm	F_d / F_{rd} < 1	9.92 / (1 x 5 x 2.25) = 0.88 < 1	OK
UC.2b	long side – V-ropes	1 individual rope made of 3 sections Ø8mm	F_d / F_{rd} < 1	6.86 / (1 x 3 x 2.25) = 1.02 ~ 1	OK
UC.2c	short side - combined	1 individual rope made of 5 sections Ø8mm	F_d / F_{rd} < 1	9.74 / (1 x 5 x 2.25) = 0.87 < 1	OK
UC.2d	short side – V-ropes	1 individual rope made of 3 sections Ø8mm	F_d / F_{rd} < 1	6.63 / (1 x 3 x 2.25) = 0.98 < 1	OK

For capacity of ropes see H.2.2, page 19

It is also possible to use alternative **ropes** with a higher breaking strength (BL_{rope}) and less rope sections (n), as long as $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq BL_{required}}$

Required breaking loads for ropes:

Long side - combined: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 3968}$ **kg**
Long side – V-ropes: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 2672}$ **kg**
Short side - combined: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 3896}$ **kg**
Short side – V-ropes: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 2652}$ **kg**

I.3.3 Fasteners

Force acting on fasteners is equal to the force in belts or ropes. See these values in chapter I.3.2.

I.3.3.1 Side rope connection

I.3.3.1.1. Carbine, DIN5299C

Carbine 200x15, WLL 700kg → BL = 2 x 7 kN = 14 kN → Frd = BL / ɣm = 14 kN / 2 = 7 kN
F_d=6.86 kN

UC.3a	**F_d / F_{rd} < 1**	**6.86 / 7 = 0.98 < 1**	**OK**

For capacity of carabines see K.5 Carabine, DIN 5299C, page 74

I.3.3.1.2. Rope ratchet

Ratchet, BL = 3.5 kN → Frd = BL / ɣm = 3.5 kN / 1.5 = 2.33 kN
F_d=9.92 kN (long side), F_d=9.74 kN (short side)

UC.3b	Long side – combined rope	**F_d / F_{rd} < 1**	**9.92 / 5*x2.33= 0.85 < 1**	**OK**
UC.3c	Short side – combined rope	**F_d / F_{rd} < 1**	**9.74 / 5*x2.33= 0.84 < 1**	**OK**

For capacity of rope ratchet see K.6 Rope ratchet, page 74

* Number of cross sections making a rope. Ratchet is applied only on one cross-section.

I.4. Safety against overturning, sliding and uplifting - low wind in Netherlands

The calculation in this chapter provides a guideline for dense cohesion less soil, in case no anchor tests have been performed. Anchor tests on location can show that a different number of anchors or different size of anchors have sufficient capacity for the specific soil conditions. (see paragraph H.8.3)

Assumed anchor capacity Frd=5.1 kN (see H.8.1)

I.4.1 Required anchor pins

Load combination	Element	Representative force	Design value force	Pag.
CO5. Own weight + pretension + wind suction reduced	Long side anchor point	6.73 kN	8.08 kN (γ = 1.2)	52
CO5. Own weight + pretension + wind suction reduced	Short side anchor point	6.70 kN	8.04 kN (γ = 1.2)	52
CO5. Own weight + pretension + wind suction reduced	Corner anchor point	4.21 kN	5.05 kN (γ = 1.2)	52

Long side guy ropes	2x	Ø30 x 1000 mm	F_d / F_{rd} = 8.08 / (2 x 5.10) = 0.79 ≤ 1	OK
Short side guy ropes	2x	Ø30 x 1000 mm	F_d / F_{rd} = 8.04 / (2 x 5.10) = 0.79 < 1	OK
Corner ties	1x	Ø30 x 1000 mm	F_d / F_{rd} = 5.05 / (1 x 5.10) = 0.99 < 1	OK

I.4.2 Required ballast

For calculation method see H.8.4.

Location	F_{rep} (γ = 1.2)	F_H	F_V	α	Ballast for μ = 0.5 (concrete on concrete)	Ballast for μ = 0.6 (concrete on rubber or wood)
	(kN)	(kN)	(kN)	°	(KG)	(KG)
Long side guy ropes	8.08	5.71	5.71	*45*	*1710*	*1520*
Short side guy ropes	8.04	5.69	5.69	*45*	*1710*	*1520*
Corner ties	5.05	3.57	3.57	*45*	*1070*	*950*

J. Addition 2 – element check for combined wind and snow load [FR]

For stretchtent use in France, the static analysis must include a load combination including snow and wind loads, corresponding to article 7 of CTS. This addition represents changes in element checks and anchor and ballast determination if this load combination is considered. Stormbelts are always required.

J.1. Summary of results – snow+wind in France

Changes that come from snow and wind combination are highlighted in orange.

General information:		
Main dimensions:		**15 x 20m**
	Width:	15m
	Length:	20m
	Side height of membrane:	3m
	Max. height:	5m
	Main poles 5m: *	5.0m **Ø 120 mm [Spruce, C18]**
	Main poles 4m: *	4.0m **Ø 100 mm [Spruce, C18]**
	Side poles: *	3.0m **Ø 80 mm [Spruce, C18]**
	Corner poles: *	2.5m Ø 75 mm [Spruce, C18]
	Stormbelts:	50mm PES [EN 12195-2], LC=1000 daN
	Guy ropes:	Ø 8mm polyester, breaking strength ≥ 900 daN **
	Long side – combined:	4 sections
	Long side - V-ropes:	3 sections
	Short side – combined:	5 sections
	Short side - V-ropes:	3 sections
	Belts:	50mm PES [EN 12195-2], LC=1000 daN
	Fasteners:	Carbine 200x15

		M16 & M12 Eye bolt Ratchet, BL = 3.5 kN
	Side & corner pole base plate	30x30cm
	Main pole base plate	30x30cm
User load:	A maximum of 25 kg per main mast may be used for decorations, sound or lighting installations. The load must be applied centrally.	
Snow load:	A snow load of 0.1 kN/m² (4 cm) has been considered in accordance with the French CTS standard.	
Wind load:	**According to EN 13782** The following pressure values have been used: h < 5m: 0.50kN/m² This value corresponds to wind force 8 on the Beaufort scale. Above this wind force (starting at wind force 9), the safety of the structure can no longer be guaranteed, and it must be evacuated.	

* The average diameter, as a minimum required at the middle of the pole.

** The required breaking load (BL_{tot}) may be achieved by using multiple rope sections (n): $BL_{rope} = BL_{tot} / n$, see page 40

Safety against sliding, overturning and uplifting:			
Anchor forces:	Assumptions: angle of 45 degrees The following design resistance of the anchor forces is required: (See H.8.3, page 48 for Anchor tests according to EN 13782)		
	Long side guy ropes: Short side guy ropes: Corner ties: Stormbelt:	6.82 kN (γ = 1.2) 7.96 kN (γ = 1.2) **5.35 kN** (γ = 1.2) 10.66 kN (γ = 1.2)	
Required anchors:	Based on dense, non-cohesive soil (e.g. sandy soils). In the case anchors **Ø30mm x 1000mm** (effective length) are being used:		
	Long side guy ropes: Short side guy ropes: Corner ties: Stormbelt:	2 anchors 2 anchors **2 anchors** 3 anchors	
Required ballast:	Ballast calculation is performed for 2 different situations: - Concrete on concrete – concrete ballasts are placed on concrete - Concrete on wood or rubber – concrete ballasts are placed on wood, or an anti-slip mat is placed underneath the ballast		
		Concrete on concrete	Concrete on wood or rubber

	Long side guy ropes:	1450 kg	1290 kg
	Short side guy ropes:	1690 kg	1500 kg
	Corner ties:	**1140 kg**	1010 kg
	Stormbelt:	2260 kg	2010 kg

J.2. Cross sections

Profile	Material	Ø mm	G kg/m	A mm^2	I_y mm^4	$W_{el;y}$ mm^3
Ø ≈ 100 mm *	Wood C18	100	2.51	7853	4908739	98175
Ø ≈ 120 mm *	Wood C18	120	3.62	11310	10178760	169646
Ø ≈ 80 mm *	Wood C18	80	1.61	5026	2010619	50265
Ø ≈ 75 mm *	Wood C18	75	1.41	4418	1553156	41417

Table 21. Used cross sections

* The average diameter, as a minimum required at the middle of the pole.

J.3. Summary of forces

Further chapters include the calculation only for highlighted elements in the CO6 [FR] column if they show higher values than calculated in the previous chapters or if recalculating them show a clear difference in results. Other element checks can be looked up in H.7.

	Summary					
kN or kN/m	CO1	CO2	CO3	CO4	CO5 [NL]	CO6 [FR]
Warp	0.93	2.75	3.60	4.22	4.09	5.37
Weft	1.01	2.46	3.14	1.92	3.36	4.49
Edge	1.98	2.50	3.06	4.11	4.18	3.61
Main pole 4m	-1.22	-4.08	-5.59	0.48	1.00	-8.55
Main pole 5m	-2.07	-5.19	-7.40	-0.06	-0.01	-11.07
Side pole	-1.35	-2.78	-3.86	-3.80	-0.57	-5.33
Corner pole	-3.02	-4.08	-5.09	-4.87	-4.44	-6.19
Corner belt	2.45	3.11	3.78	4.45	4.21	4.41
Belts - long side	0.15	0.62	1.00	0.85	0.14	1.52
Belts - short side	0.14	0.68	1.12	0.09	0.21	1.74
Stormbelts	0.00	0.00	0.00	8.88	0.00	0.00
Combined rope - long side	2.33	2.78	3.51	4.85	6.61	4.02
V-ropes - long side	1.67	2.01	2.50	3.29	4.57	2.84
Combined rope - short side	2.14	2.77	3.46	6.55	6.49	4.05
V-ropes short side	1.58	2.05	2.60	4.51	4.42	3.03
Anchor - long side	2.40	3.27	4.31	5.68	6.73	5.38
Anchor - short side	2.24	3.42	4.55	6.63	6.70	5.85
Anchor - corner	2.45	3.11	3.78	4.45	4.21	4.46

Table 22. Summary of forces

J.4. Element check – snow + wind in France

J.4.1 Membrane

Load combination	Element	Representative stress	Design value stress	Pag.
CO1. Own weight + pretension	Long term warp	0.93 kN/m	1.26 kN/m (γ = 1.35)	61
CO1. Own weight + pretension	Long term weft	1.01 kN/m	1.36 kN/m (γ = 1.35)	61
CO6. Own weight + pretension + wind pressure + snow	Short term warp	5.37 kN/m	7.25 kN/m (γ = 1.35)	61
CO6. Own weight + pretension + wind pressure + snow	Short term weft	4.49 kN/m	6.06 kN/m (γ = 1.35)	61

Sioen RP5639 fabric is being used.

UC.1a	Long term warp	S_{Ed} / S_{rd} < 1	1.26 / 9.6 = 0.13 < 1	OK
UC.1b	Long term weft	S_{Ed} / S_{rd} < 1	1.36 / 7.2 = 0.19 < 1	OK
UC.1c	Short term warp	S_{Ed} / S_{rd} < 1	7.25 / 12.0 = 0.60 < 1	OK
UC.1d	Short term weft	S_{Ed} / S_{rd} < 1	6.06 / 9.0 = 0.67 < 1	OK

For capacity of membrane see H.2.1, page 19

J.4.2 Main poles 4m

Load combinations	Element	Representative force	Design value force	Pag.
CO6. Own weight + pretension + wind pressure + snow	Main pole 4.0m	-8.55 kN	-11.54 kN (γ = 1.35)	61

User load of max. 25 kg is applied, loaded centrically.

4.0m pole Ned = -8.55 x 1.35 + (-0.25 x 1.35) = -11.88 kN

J.4.2.1 4.0m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 100 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 4.00m
Quality = C18

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

UC.2	4.0m	$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.51 / (12.46 x 0.120) = 0.88 ≤ 1	OK

See Annex C.5 Main pole 4.0m – Wood, Spruce C18 – for snow and wind combination [FR], on page 111 for the elaborate check

J.4.3 Main poles 5m

Load combinations	Element	Representative force	Design value force	Pag.
CO6. Own weight + pretension + wind pressure + snow	Main pole 5.0m	-11.07 kN	-14.94 kN (γ = 1.35)	61

User load of max. 25 kg is applied, loaded centrically.

5.0m pole Ned = -11.07 x 1.35 + (-0.25 x 1.35) = -15.28 kN

J.4.3.1 5.0m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 120 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 5.00m
Quality = C18

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

UC.3	5.0m	$\sigma_{c,0,d} / (f_{c,0,d} \times k_{cy})$ = 1.35 / (12.46 x 0.111) = 0.98 ≤ 1	OK

See Annex C.6 Main pole 5.0m – Wood, Spruce C18 – for snow and wind combination [FR], on page 112 for the elaborate check

J.4.4 Side poles

Load combinations	Element	Representative force	Design value force	Pag.
CO6. Own weight + pretension + wind pressure + snow	Side pole 3.0m	-5.33 kN	-7.20 kN (γ = 1.35)	61

User load of max. 25 kg is applied, loaded centrically.

3m pole Ned = -5.33 x 1.35 + (-0.25 x 1.35) = -7.53 kN

J.4.4.1 3m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 80 mm
average diameter, as a minimum required at the middle of the pole

Length = max. 3.0m

Quality = C18

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

UC.4	3m	$\sigma_{c,0,d}$ / ($f_{c,0,d}$ x k_{cy}) = 1.50 / (12.46 x 0.136) = 0.89 < 1	OK

See Annex C.7 Side pole 3.0m – Wood, Spruce C18 – for snow and wind combination [FR], on page 113 for the elaborate check

J.4.5 Corner poles

Load combinations	Element	Representative force	Design value force	Pag.
CO6. Own weight + pretension + wind pressure + snow	Corner pole 2.5m	-6.19 kN	-8.36 kN (γ = 1.35)	61

User load of max. 25 kg is applied, loaded centrically.

2.5m corner pole Ned = -6.19 x 1.35 + (-0.25 x 1.35) = -8.69 kN

J.4.5.1 2.5m pole - Wood, Spruce C18

Profile = Pole, Ø ≈ 75 mm
average diameter, as a minimum required at the middle of the pole
Length = max. 2.5m
Quality = C18

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

UC.5	2.5m	$\sigma_{c,0,d} / (f_{c,0,d} \times k_{cy})$ = 1.97 / (12.46 x 0.170) = 0.93 < 1	OK

See Annex C.8 Corner pole 2.5m – Wood, Spruce C18 – for snow and wind combination [FR], on page 114 for the elaborate check

J.4.6 Belts

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	Corner belt	4.45 kN	6.68 kN (γ = 1.5)	61
CO6. Own weight + pretension + wind pressure + snow	Belt – long side	1.52 kN	2.05 kN (γ = 1.35)	61
CO6. Own weight + pretension + wind pressure + snow	Belt – short side	1.74 kN	2.35 kN (γ = 1.35)	61

J.4.6.1 Belt capacity check

PES belt with a breaking strength of 3000kg is being used.

UC.6a	Corner belt	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	6.68 / (1 x 15) = 0.45 < 1	OK
UC.6b	Belt – long side	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	2.05 / (1 x 15) = 0.14 < 1	OK
UC.6c	Belt – short side	1 PES belt with minimum BL = 3000 kg	F_d / F_{rd} < 1	2.35 / (1 x 15) = 0.16 < 1	OK

For capacity of ropes see H.2.3, page 19

J.4.6.2 Alternative – rope capacity check

It is possible to use either a rope or a belt. Synthetic rope Ø8mm, BL 900 daN. Is being used → $F_{rd,8mm}$ = 2.25 kN.
In a case of using individual guy ropes, the ropes need to be tied back, creating multiple rope sections that together will take the load.

UC.6d	Corner rope	1 individual rope made of 3 sections Ø8mm	F_d / F_{rd} < 1	6.68 / (1 x 3 x 2.25) = 0.99 < 1	OK
UC.6e	Rope – long side	1 individual rope made of 1 section Ø8mm	F_d / F_{rd} < 1	2.05 / (1 x 1 x 2.25) = 0.91 < 1	OK
UC.6f	Rope – short side	1 individual rope made of 1 section Ø8mm	F_d / F_{rd} < 1	2.35 / (1 x 1 x 2.25) = 1.04 ~ 1	OK

For capacity of ropes see H.2.2, page 19

It is also possible to use alternative **ropes** with a higher breaking strength (BL_{rope}) and less rope sections (n), as long as $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq BL_{required}}$
Required breaking loads for ropes:
Corner rope: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 2672}$ **kg**
Rope – long side: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 820}$ **kg**
Rope – long side: $\mathbf{BL_{rope} \times n_{sections} \times n_{ropes} \geq 940}$ **kg**

J.4.7 Fasteners

Force acting on fasteners is equal to the force in belts or ropes. See these values in chapters H.7.7 and H.7.6.

J.4.7.1 Side belt connection

J.4.7.1.1. M12 Eye bolt, DIN580

For ≤45°:

M12, WLL 340kg → BL = 6 x 3.4 kN = 20.4 kN → Frd = BL / γ_m = 20.4 / 2 = 10.2 kN

F_d=2.35 kN

UC.7a	Corner eye bolt	F_d / F_{rd} < 1	2.35 / 10.2 = 0.23 < 1.0	OK

For capacity of eye bolts see K.3 Capacity of Eye bolts on page 73.

J.4.7.1.2. Carbine, DIN5299C

Carbine 180x14, WLL 580kg → BL = 2 x 5.8 kN = 11.6 kN → Frd = BL / γm = 11.6 kN / 2 = 5.8 kN

F_d=2.35 kN

UC.9e	**F_d / F_{rd} < 1**	**2.35 / 5.8 = 0.41 < 1**	**OK**

For capacity of carabines see K.5 Carabine, DIN 5299C, page 74

J.4.7.2 Base plate

J.4.7.2.1. Side pole & corner pole

See J.3 for the highest design pressure force. Poles are subjected only to compressive force.

The worst case is assumed – pole is located on soil:

- Soil (base plate size 30x30 cm, p_{soil} = 150 kN/m^2)

UC.6c	Soil	$\frac{F_d}{A}/p \leq 1$	**8.69 / (0.30*0.30) / 150 = 0.77 < 1**	**OK**

J.4.7.2.2. Main pole

See J.3 for the highest design pressure force. Poles are subjected only to compressive force.

The worst case is assumed – pole is located on soil:

- Soil (base plate size 30x30 cm, p_{soil} = 150 kN/m^2)

UC.6d	Soil	$\frac{F_d}{A}/p \leq 1$	**11.41 / (0.30*0.30) / 150 = 0.88 < 1**	**OK**

J.5. Safety against overturning, sliding and uplifting – snow + wind in France

The calculation in this chapter provides a guideline for dense cohesion less soil, in case no anchor tests have been performed. Anchor tests on location can show that a different number of anchors or different size of anchors have sufficient capacity for the specific soil conditions. (see paragraph H.8.3)

Assumed anchor capacity Frd=5.1 kN (see H.8.1)

J.5.1 Required anchor pins

Load combination	Element	Representative force	Design value force	Pag.
CO4. Own weight + pretension + wind suction	Corner anchor point	4.46 kN	5.35 kN (γ = 1.2)	61

Corner anchor point	2x	Ø30 x 1000 mm	F_d / F_{rd} = 5.35 / (2 x 5.10) = 0.52 < 1	OK

J.5.2 Required ballast

For calculation method see H.8.4.

Location	F_{rep} (γ = 1.2)	F_H	F_V	α	Ballast for μ = 0.5 (concrete on concrete)	Ballast for μ = 0.6 (concrete on rubber or wood)
	(kN)	(kN)	(kN)	°	(KG)	(KG)
Corner belts	5.35	3.78	3.78	*45*	*1140*	*1010*

K. Material certificates

K.1. Fabric specifications

SIOEN FABRICS

Z.I. du Blanc Ballot, Avenue Urbino 6, B-7700 Mouscron - Tel +32(0)56 85 68 80 - Fax +32(0)56 34 61 31
sioenfabrics@sioen.be - http://www.sioen.com

Technical Data Sheet

RP5639

FLEXITENT SINGLE M2 (fiche provisoire) - Width 153 cm

Total weight / Poids total	730 [+/-10%] g/m²	ISO 3801/5 1977
Weight of fabric [PES] / Poids tissu [PES]	280 [+/-10] g/m²	ISO 3801/5 1977
Weight of coating [PU/PVC] / Poids enduction [PU/PVC]	450 [+/-10%] g/m²	ISO 3801/5 1977
Breaking strength warp Force de rupture chaîne	1200 N/5cm	ISO 13934 1999
Breaking strength weft Force de rupture trame	900 N/5cm	ISO 13934 1999
Breaking extension warp Allongement à la rupture chaîne	110 %	ISO 13934 1999
Breaking extension weft Allongement à la rupture trame	110 %	ISO 13934 1999
Tear strenght warp Résistance à la déchirure chaîne	100 N	ISO 4674A1 1977
Tear strenght weft Résistance à la déchirure trame	180 N	ISO 4674A1 1977
Adhesion warp / Adhérence chaîne	23 N/5cm	D41 1015
Adhesion weft / Adhérence trame	23 N/5cm	D41 1015
Waterproofness before washing Imperméabilité avant lavage	OK:2000 G M D mm	ISO 811 1981
Waterproofness after washing Imperméabilité après lavage	OK:2000 G M D mm	ISO 811 1981
Flammability / Inflammabilité	OK:M2 -	NF P 92-507 (2004)

May be cleaned with mild, PH neutral, non-ionogenic detergents. Certainly avoid solvent containing cleaning agents (alcohols, polar solvents,etc.). Testing is always advised before using cleaning agents.
After surface cleaning, please let air dry.

All our technical characteristics are indicative
Rev. 10/2012

K.2. Fabric fire certificate

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

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 - 21 - P - 096

et 1 annexe de 4 pages.

Valable 5 ans à compter du mardi 13 juillet 2021

Matériau présenté par : **SIOEN FABRICS SA**
Avenue Urbino 6

7700 MOUSCRON

Marque commerciale : **F5639**

Description sommaire:

Type de textile enduit tricot polyester enduit de PVC ignifugé

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

Masse surfacique 730 g/m²

Epaisseur 0,75 mm

Coloris tous coloris/ all colors

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

Classement : **M2**

Observations : /

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

Usage : Revêtement de murs tendus, voilages, rideaux,… **Conditions d'entretien :** selon préconisations du client

Compte tenu des critères résultant des essais annexés décrits dans le(s) rapport(s) d'essais N° : *FE 21-0216-1182*

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 vendredi 23 juillet 2021

Technicien d'essais du Laboratoire Feu
Bilel HAMILA

Responsable Technique du laboratoire Feu du Pôle Ameublement
Clotilde ETIEMVRE

INSTITUT TECHNOLOGIQUE FCBA · LABORATOIRE ESSAIS ET MESURES · CHAMPS-SUR-MARNE

Siège social
10 rue Galilée
77420 Champs-sur-Marne
Tél + 33 (0)1 72 84 97 84
www.fcba.fr
Siret 775 680 903 00132
APE 7219 Z
Code TVA CEE : FR 14 775 680 903

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

TEN TECH

FCBA
INSTITUT TECHNOLOGIQUE

INSTITUT TECHNOLOGIQUE
FCBA
Fire Laboratory
10 rue Galilée - 77420 Champs-sur-Marne

Laboratory approved by the Ministry for the Interior
JO of February 10, 2007
OFFICIAL REPORT OF CLASSIFICATION OF FIRE PERFORMANCE
Of A MATERIAL ENVISAGED IN ARTICLE 5
DECREE OF November 21, 2002

N° CM - 21 - P - 096

et 1 annexe de 4 pages.

Valid 5 years as from mardi 13 juillet 2021

Material presents by : **SIOEN FABRICS SA**
Avenue Urbino 6
7700 MOUSCRON

Trade mark: **F5639**

Summary description

Kind of coating fabric tricot polyester enduit de PVC ignifugé
Composition support textile/ fabric 100% polyester (280 g/m²) + enduction/ coating PVC ignifugé (450 g/m²)

Mass per unit area 730 g/m²
Tickness 0,75 mm
Color tous coloris/ all colors

Nature of the test : Electrical burner test
Flame persistence
Dripping test

Classification : **M2**

Observations : /

Durability of the classification (Article 5 de l'annexe 2) Not limited

Usual term Walls hung covering, sheers, curtains,… **Cleaning conditions** Recommendation of Customer

Taking into account the criteria resulting from the tests annexed described in the test report N° *FE 21-0216-1182*

This official report attests only characteristics of the sample submitted for testing and does not prejudge similar characteristics of products. It thus does not constitute a certification of products within the meaning of the L.115-27 article of the code of the consumption and the law of June 3rd, 1994.
NOTE: The integral reproductions and by photocopy of this official report of classification are only authorized or the official report unit of classification and report of annexed test. These conclusions relate only to the resistance / reaction to fire performance of the element that is the subject of the present classification report. They do not prejudge, in any case, other performances related to its incorporation to a work *

"Not legally acceptable for any use under the pretence of the article AM 18 (Decree of March 6th, 2006) for upholstered seat"

Champs-sur-Marne, le vendredi 23 juillet 2021

Technicien d'essais du Laboratoire Feu
Bilel HAMILA

Responsable Technique du laboratoire Feu du Pôle Ameublement
Clotilde ETIEMVRE

INSTITUT TECHNOLOGIQUE FCBA LABORATOIRE ESSAIS ET MESURES CHAMPS-SUR-MARNE

Siège social
10 rue Galilée
77420 Champs-sur-Marne
Tél + 33 (0)1 72 84 97 84
www.fcba.fr
Siret 775 680 903 00132
APE 7219 Z
Code TVA CEE : FR 14 775 680 903

Only the french version remains valid
Institut technologique FCBA : Forêt, Cellulose, Bois - construction, Ameublement

K.3. Capacity of Eye bolts

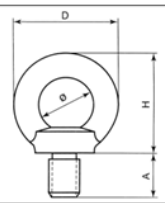
Karta techniczna Nr 2GM/KAR

1. Nazwa dostawcy: **„GÓRALMET" M. i J. Góral Sp. J.** Adres dostawcy: **ul. Krakowska 68, 32-860 Czchów, tel/fax 014 6635260**

2. Nazwa wyrobu: **GM580 Śruba z uchem**

3. Opis i przeznaczenie: Śruba stalowa kuta z uchem, z gwintem metrycznym zwykłym prawym, do wykorzystania jako punkt mocujący do podnoszenia przedmiotów, materiałów i towarów, a także do innych zastosowań, w zakresie parametrów technicznych podanych w punkcie 5 i wymagań Dyrektywy 2006/42/WE

4. Dopuszczalne obciążenia robocze w kolumnie 11 i punkcie 6 podano dla normalnych warunków użytkowania. Przy zastosowaniu wyrobu w wyjątkowo niebezpiecznych warunkach, zakres zastosowania i redukcję dopuszczalnego obciążenia roboczego należy uzgodnić z dostawcą. Przechowywanie i montaż - zgodnie z instrukcją montażu i stosowania elementów osprzętu do podnoszenia.



5. Parametry techniczne wyrobu:

LP.	Rozmiar	Wymiary nominalne [mm]							Masa [kg/szt]	WLL Obciążenie robocze [t]*	MPF Siła próby [kN]	BF Siła niszcząca [min. kN]	Materiał	Powłoki
		D	Ø	H	A	-	-	-						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**M6**	36	20	36	13	-	-	-	0,052	0,09	1,77	5,3	C15	Ocynk elektrolityczny
2	**M8**	36	20	36	13	-	-	-	0,054	0,14	2,75	8,2		
3	**M10**	45	25	45	17	-	-	-	0,099	0,23	4,51	13,5		
4	**M12**	54	30	53	20,5	-	-	-	0,164	0,34	6,67	20,0		
5	**M14**	54	30	53	20,5	-	-	-	0,171	0,50	9,81	29,4		
6	**M16**	63	35	62	27	-	-	-	0,288	0,70	13,73	41,2		
7	**M18**	63	35	62	27	-	-	-	0,300	0,93	18,24	54,7		
8	**M20**	72	40	71	30	-	-	-	0,457	1,20	23,54	70,6		
9	**M22**	72	40	71	30	-	-	-	0,463	1,50	29,42	88,3		
10	**M24**	90	50	90	36	-	-	-	0,874	1,80	35,30	105,9		
11	**M27**	90	50	90	36	-	-	-	0,936	2,50	49,03	147,1		
12	**M30**	108	60	109	45	-	-	-	1,626	3,60	70,61	211,8		

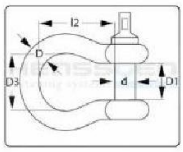
6. Informacje dodatkowe:

- Współczynnik bezpieczeństwa – 6 (*dla obciążenia wzdłuż osi gwintu). Dopuszczalne obciążanie siłą równoległą do płaszczyzny ucha pod kątem do 45° od osi gwintu pod warunkiem redukcji WLL o 30%, lub pod kątem 45° do 90° przy redukcji WLL o 50%. Zabrania się obciążania śruby prostopadle do płaszczyzny ucha. Podane obciążenia są ważne tylko dla prawidłowo zamontowanego wyrobu, tj. gdy gwint śruby jest całkowicie wkręcony w otwór montażowy, a kołnierz śruby spoczywa na powierzchni nośnej
- MPF=2,0 x g x WLL, BF =6,0 x g x WLL gdzie g - przyspieszenie ziemskie w m/s^2 (tj. 9,80665)
- Kod identyfikacyjny producenta i produktu: GM580
- Cechowanie: symbol producenta – GMG; CE ; kod materiału – C15; rozmiar; WLL....T
- Informacje dodatkowe – etykieta: CE ; nazwa wyrobu; rozmiar; ilość szt.; numer dostawy; dane producenta i adres strony internetowej.

K.4. Capacity of Orange Pin 1 Ton D-sluiting, DIN EN 13889

Orange Pin®

50001



DIN EN 13889
U.S. Fed. Spec. RR-C-271
Quality class = 6

	name	Ident Nr.	materiaal	kleur	oppervlakte	d in mm	D in mm	D inch	D1 in mm	D3 in mm	l2 in mm	SWL /WLL daN	gewicht g	VE			
	50001-00,50	933729	HS	orange pin	fe	8	6,5	1/4	11	19	28	500	48	25	1.00	stuks	aanvragen
	50001-00,75	933730	HS	orange pin	fe	10	8	5/16	12	21	31	750	78	25	1.00	stuks	aanvragen
	50001-01,00	933731	HS	orange pin	fe	11	10	3/8	17	26	35	1000	136	1	1.00	stuks	aanvragen
	50001-01,50	933732	HS	orange pin	fe	12	13	7/16	18	30	42	1500	178	1	1.00	stuks	aanvragen
	50001-02,00	933733	HS	orange pin	fe	16	13,5	1/2	20	32	47	2000	300	1	1.00	stuks	aanvragen

K.5. Carabine, DIN 5299C

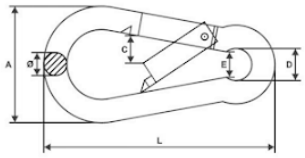
Karta Techniczna Nr 10GM/KAR

1. Nazwa dostawcy: **„GÓRALMET" M. i J. Góral Sp. J.** | Adres dostawcy: **ul. Krakowska 68, 32-860 Czchów, tel/fax 014 6635260**

2. Nazwa wyrobu: **Karabińczyk do lin 5299C**

3. Opis i przeznaczenie: Zatrzaśniki stalowe, służące jako elementy łączące w zakończeniach lin, łańcuchów gospodarczych, oraz do innych zastosowań ogólnych. Do stosowania w zakresie parametrów technicznych podanych w punkcie 5.

4. Karabińczyki do lin nie mogą być użyte w zastosowaniach posiadających inne - uregulowane prawem czy normami wymagania bezpieczeństwa, np. do podnoszenia ładunków, jako środek do ochrony indywidualnej przed upadkiem z wysokości, lub osprzęt alpinistyczny. Nie przeciążać ponad wartość WLL (kG) podaną w kolumnie 13.



5. Parametry techniczne wyrobu:

LP.	Rozmiar [mm]	Wymiary nominalne [mm]									Masa [kg/szt]	WLL Obciążenie robocze [kG]	BF Siła niszcząca [min. kG]	Materiał	Powłoki
		A [mm]	C min [mm]	D [mm]	E min [mm]	Ø [mm]	L [mm]	---	---	---					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**4**	19,5	4,5	6	4,5	3,9	40	---	---	---	0,008	70	140	C10 ~ C15	Ocynk elektrolityczny
2	**5**	24	5,5	7,5	5,5	4,8	50	---	---	---	0,015	100	200		
3	**6**	29	8	8,5	6	5,5	60	---	---	---	0,023	120	240		
4	**7**	34	9	10,5	8,5	6,7	70	---	---	---	0,040	180	360		
5	**8**	39	10	11,5	9	7,4	80	---	---	---	0,056	230	460		
6	**9**	44	11	13,5	10	8,4	90	---	---	---	0,083	250	500		
7	**10**	48	11,5	14,5	11	9,4	100	---	---	---	0,115	350	700		
8	**11**	57	17	17,5	13	10,7	120	---	---	---	0,179	400	800		
9	**12**	67	22	20	15	11,5	140	---	---	---	0,246	450	900		
10	**13**	80	26	21	17	12,6	160	---	---	---	0,343	530	1060		
11	**14**	87	28	24	20	13,6	180	---	---	---	0,443	580	1160		
12	**15**	98	32	24	20	14,7	200	---	---	---	0,563	700	1400		

6. Informacje dodatkowe:

- Współczynnik bezpieczeństwa - 2
- BF =2,0 x WLL
- Cechowanie: symbol producenta – GM lub GMG; kod rozmiaru
- Informacje dodatkowe – etykieta: nazwa wyrobu; rozmiar; ilość szt.; numer dostawy; dane producenta i adres strony internetowej.

K.6. Rope ratchet

3/8" Rope Ratchet

Carolina North Manufacturing

10022

$10.89 ~~$12.89~~

Maximum load limit 250 lbs. Outer casings are made from #6-33% glass filled nylon with interior mechanisms of die cast zinc. Perfect for large jobs:

- heavy loads for transport
- hoisting items
- straightening items
- securing objects under tension
- product weight 0.16 lbs

Product is compatible with our 3/8" S-hooks and 3/8" solid braided rope.

Bulk purchasing options available.

ADD TO CART | BUY IT NOW

Share:

Collections: Bulk Rope Ratchets

Type: Bulk Ratchet

Annex

Annex A. Software input (load combination) ... 76
Annex A.1. CO1. Own weight + pretension ... 76
Annex A.2. CO2. Own weight + pretension + conventional / snow ... 77
Annex A.3. CO3. Own weight + pretension + wind pressure ... 78
Annex A.4. CO4. Own weight + pretension + wind suction ... 79
Annex A.5. CO5. Own weight + pretension + wind suction reduced [NL] ... 80
Annex A.6. CO6. Own weight + pretension + wind pressure + snow [FR] ... 81
Annex B. Results per load combination ... 83
Annex B.1. CO1. Own weight + pretension ... 83
Annex B.2. CO2. Own weight + pretension + snow ... 87
Annex B.3. CO3. Own weight + pretension + wind pressure ... 91
Annex B.4. CO4. Own weight + pretension + wind suction ... 95
Annex B.5. CO5. Own weight + pretension + wind suction reduced [NL] ... 99
Annex B.6. CO6. Own weight + pretension + wind pressure + snow [FR] ... 103
Annex C. Member checks ... 107
Annex C.1. Main pole 4.0m – Wood, Spruce C18 ... 107
Annex C.2. Main pole 5.0m – Wood, Spruce C18 ... 108
Annex C.3. Side pole 3m – Wood, Spruce C18 ... 109
Annex C.4. Corner pole 2.5m - Wood, C18 ... 110
Annex C.5. Main pole 4.0m – Wood, Spruce C18 – for snow and wind combination [FR] 111
Annex C.6. Main pole 5.0m – Wood, Spruce C18 – for snow and wind combination [FR] 112
Annex C.7. Side pole 3.0m – Wood, Spruce C18 – for snow and wind combination [FR] 113
Annex C.8. Corner pole 2.5m – Wood, Spruce C18 – for snow and wind combination [FR] 114
Annex D. Reaction forces model ... 115
Annex D.1. Point numbers ... 115
Annex D.2. Reaction forces ... 116

Annex A. Software input (load combination)

Annex A.1. CO1. Own weight + pretension

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.0714        0.000910
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.7683
-----------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------
 LOADGROUP       LOADMODE      LOAD    FACTOR          SUM_X          SUM_Y          SUM_Z    LOADED AREA
-----------------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------------
       SUM                                            0.0000         0.0000         0.0000
-----------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-----------------------------------------------------------------------------
                LOADMODE                  SUM_X          SUM_Y          SUM_Z
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
       SUM     AREA-LOADS                0.0000         0.0000         0.0000
-----------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
=============================================================================
                                          SUM_X          SUM_Y          SUM_Z
=============================================================================
                                         0.0000         0.0000        -4.7683
=============================================================================
```

```
StatikD:  Sum of external loads:       0.000000       0.000000      -4.768237
StatikD:  Sum of support forces:       0.002626       0.000001       4.768603
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO1_OW+VO
StatikD: Time of calculation:       1.39s
StatikD: Version 2025.38 done.
```

Annex A.2. CO2. Own weight + pretension + conventional / snow

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.0714        0.000910
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.7683
-----------------------------------------------------------------------------------------------------------------------


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       -28.8177         288.18
-----------------------------------------------------------------------------------------------------------------
       SUM                                            0.0000         0.0000       -28.8177
-----------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-----------------------------------------------------------------------------------
                LOADMODE                    SUM_X          SUM_Y          SUM_Z
-----------------------------------------------------------------------------------
       SUM         SCHNEE                  0.0000         0.0000       -28.8177
-----------------------------------------------------------------------------------
-----------------------------------------------------------------------------------
       SUM     AREA-LOADS                  0.0000         0.0000       -28.8177
-----------------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
===================================================================================
                                            SUM_X          SUM_Y          SUM_Z
===================================================================================
                                           0.0000         0.0000       -33.5860
===================================================================================
```

```
Inner Energy=            7.444526


StatikD:  Sum of external loads:       0.000000       0.000000     -33.585988
StatikD:  Sum of support forces:       0.005090      -0.000003      33.586317
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO2_OW+VO+SNOW
StatikD: Time of calculation:       2.02s
StatikD: Version 2025.38 done.
```

Annex A.3. CO3. Own weight + pretension + wind pressure

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.0714        0.000910
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.7683
-----------------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------------
 LOADGROUP       LOADMODE      LOAD    FACTOR          SUM_X          SUM_Y          SUM_Z    LOADED AREA
-----------------------------------------------------------------------------------------------------------------------
         1           WIND   -0.1500      1.00        -0.0095        -0.0005       -43.2265         302.53
-----------------------------------------------------------------------------------------------------------------------
       SUM                                           -0.0095        -0.0005       -43.2265
-----------------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-----------------------------------------------------------------------------------
                LOADMODE                    SUM_X          SUM_Y          SUM_Z
-----------------------------------------------------------------------------------
       SUM          WIND                   -0.0095        -0.0005       -43.2265
-----------------------------------------------------------------------------------
-----------------------------------------------------------------------------------
       SUM     AREA-LOADS                  -0.0095        -0.0005       -43.2265
-----------------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
===================================================================================
                                            SUM_X          SUM_Y          SUM_Z
===================================================================================
                                         -0.0095        -0.0005       -47.9948
===================================================================================
```

```
Inner Energy=           11.143369


StatikD:  Sum of external loads:      -0.009522      -0.000567     -47.994804
StatikD:  Sum of support forces:       0.011108       0.000564      47.995402
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO3_OW+VO+WD
StatikD: Time of calculation:       2.19s
StatikD: Version 2025.38 done.
```

Annex A.4. CO4. Own weight + pretension + wind suction

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.1092        0.001391
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.8060
-----------------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS
-------------------------------------------------------------------------------------------------------------------
 LOADGROUP       LOADMODE      LOAD    FACTOR          SUM_X          SUM_Y          SUM_Z    LOADED AREA
-------------------------------------------------------------------------------------------------------------------
         1           WIND    0.3500      1.00         0.0227         0.0143       100.5501         302.33
-------------------------------------------------------------------------------------------------------------------
       SUM                                            0.0227         0.0143       100.5501
-------------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-------------------------------------------------------------------------------
                LOADMODE                  SUM_X          SUM_Y          SUM_Z
-------------------------------------------------------------------------------
       SUM          WIND                 0.0227         0.0143       100.5501
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
       SUM     AREA-LOADS                0.0227         0.0143       100.5501
-------------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
===============================================================================
                                          SUM_X          SUM_Y          SUM_Z
===============================================================================
                                         0.0227         0.0143        95.7441
===============================================================================
```

```
Inner Energy=           22.999275


StatikD:  Sum of external loads:       0.022646       0.014248      95.744113
StatikD:  Sum of support forces:      -0.013681      -0.011041     -95.772756
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO4_OW+VO+WU
StatikD: Time of calculation:       3.49s
StatikD: Version 2025.38 done.
```

Annex A.5. CO5. Own weight + pretension + wind suction reduced [NL]

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.0714        0.000910
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.7683
-----------------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS
-------------------------------------------------------------------------------------------------------------
 LOADGROUP       LOADMODE      LOAD    FACTOR          SUM_X          SUM_Y          SUM_Z    LOADED AREA
-------------------------------------------------------------------------------------------------------------
         1           WIND    0.2100      1.00         0.0134         0.0007        60.5171         302.53
-------------------------------------------------------------------------------------------------------------
       SUM                                            0.0134         0.0007        60.5171
-------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-------------------------------------------------------------------------------
                LOADMODE                  SUM_X          SUM_Y          SUM_Z
-------------------------------------------------------------------------------
       SUM          WIND                 0.0134         0.0007        60.5171
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
       SUM     AREA-LOADS                0.0134         0.0007        60.5171
-------------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
===============================================================================
                                          SUM_X          SUM_Y          SUM_Z
===============================================================================
                                         0.0134         0.0007        55.7488
===============================================================================
```

```
Inner Energy=           20.031599


StatikD:  Sum of external loads:       0.013347       0.000764      55.748847
StatikD:  Sum of support forces:      -0.013847      -0.000937     -55.746290
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO5_OW+VO+WU_red
StatikD: Time of calculation:       4.47s
StatikD: Version 2025.38 done.
```

Annex A.6. CO6. Own weight + pretension + wind pressure + snow [FR]

Annex A.6.1. For element check

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.0714        0.000910
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.7683
-----------------------------------------------------------------------------------------------------------------------


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       -28.8177         288.18
         1           WIND   -0.1500      1.00        -0.0095        -0.0005       -43.2265         302.53
-----------------------------------------------------------------------------------------------------------------
       SUM                                           -0.0095        -0.0005       -72.0442
-----------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-----------------------------------------------------------------------------------
                 LOADMODE                  SUM_X          SUM_Y          SUM_Z
-----------------------------------------------------------------------------------
       SUM         SCHNEE                 0.0000         0.0000       -28.8177
-----------------------------------------------------------------------------------
       SUM           WIND                -0.0095        -0.0005       -43.2265
-----------------------------------------------------------------------------------
-----------------------------------------------------------------------------------
       SUM     AREA-LOADS                -0.0095        -0.0005       -72.0442
-----------------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
===================================================================================
                                          SUM_X          SUM_Y          SUM_Z
===================================================================================
                                        -0.0095        -0.0005       -76.8125
===================================================================================
```

```
Inner Energy=           17.283677


StatikD:  Sum of external loads:      -0.009522      -0.000567     -76.812500
StatikD:  Sum of support forces:       0.014342       0.000565      76.813748
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO6_OW+VO+WD+SNOW
StatikD: Time of calculation:       2.15s
StatikD: Version 2025.38 done.
```

Annex A.6.2. For anchor and ballast calculation

```
EXTERNAL LOADS (AUTOMATIC SELFWEIGHT)
ORDERED BY LOADGROUPS
-----------------------------------------------------------------------------------------------------------------
     LOADGROUP       LOADMODE    FACTOR  VOLUME/AREA(P.U)          SUM_X          SUM_Y          SUM_Z     VOLUME/AREA
-----------------------------------------------------------------------------------------------------------------
        STRUTS     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -1.7011        0.021671
        CABLES     SELFWEIGHT      1.00         78.500000         0.0000         0.0000        -0.0714        0.000910
 MEM-LINKS1000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.5023      300.458936
 MEM-LINKS2000     SELFWEIGHT      1.00          0.005000         0.0000         0.0000        -1.4934      298.680768
-----------------------------------------------------------------------------------------------------------------
           SUM                                                   0.0000         0.0000        -4.7683
-----------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADGROUPS
-------------------------------------------------------------------------------------------------------------
 LOADGROUP       LOADMODE      LOAD    FACTOR          SUM_X          SUM_Y          SUM_Z    LOADED AREA
-------------------------------------------------------------------------------------------------------------
         1         SCHNEE    0.1083      1.00         0.0000         0.0000       -31.2182         288.18
         1           WIND   -0.1500      1.00        -0.0095        -0.0005       -43.2265         302.53
-------------------------------------------------------------------------------------------------------------
       SUM                                            -0.0095        -0.0005       -74.4447
-------------------------------------------------------------------------------------------------------------


EXTERNAL LOADS (AREA-DEPENDENT)
ORDERED BY LOADMODES
-------------------------------------------------------------------------------
                LOADMODE                  SUM_X          SUM_Y          SUM_Z
-------------------------------------------------------------------------------
       SUM         SCHNEE                 0.0000         0.0000       -31.2182
-------------------------------------------------------------------------------
       SUM           WIND                -0.0095        -0.0005       -43.2265
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
       SUM     AREA-LOADS                -0.0095        -0.0005       -74.4447
-------------------------------------------------------------------------------


EXTERNAL LOADS: SUM OF ALL EXTERNAL LOADS
===============================================================================
                                          SUM_X          SUM_Y          SUM_Z
===============================================================================
                                        -0.0095        -0.0005       -79.2130
===============================================================================
```

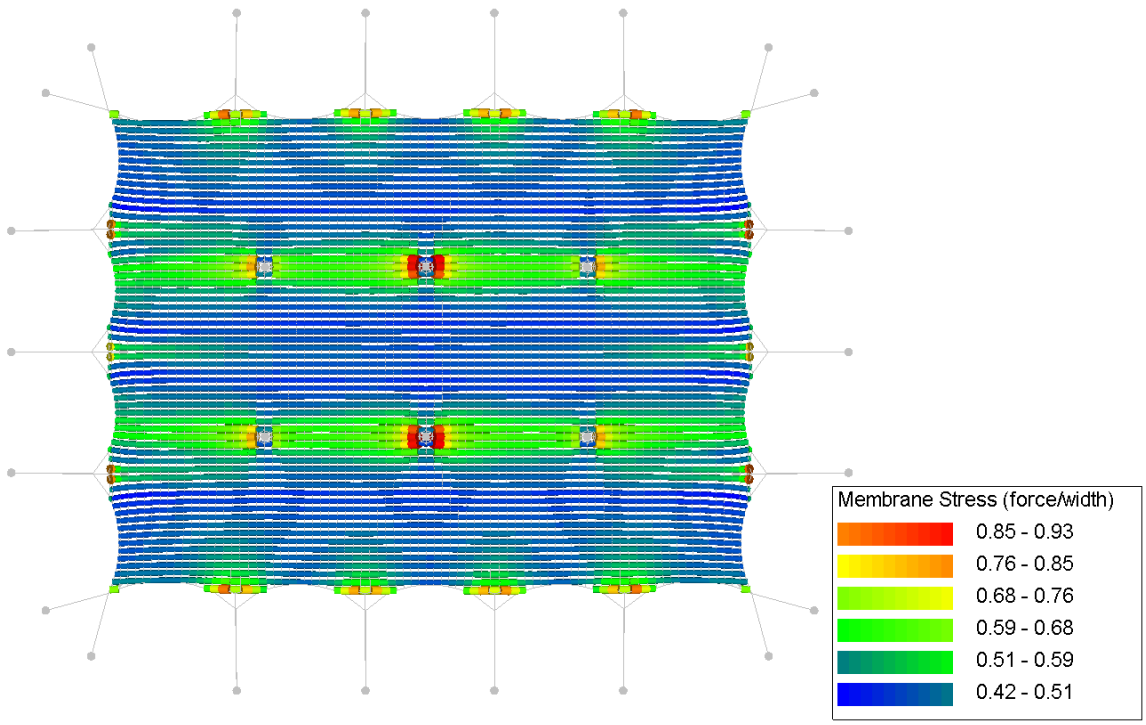
```
Inner Energy=           17.827848


StatikD:  Sum of external loads:      -0.009522      -0.000567     -79.212978
StatikD:  Sum of support forces:       0.014430       0.000563      79.213125
StatikD:  P:\2026\TTP20260008\06. Constructie - hoofdberekeningen\Boek3\15x20\CO6a_OW+VO+WD+SNOW_anchors
StatikD: Time of calculation:       2.12s
StatikD: Version 2025.38 done.
```

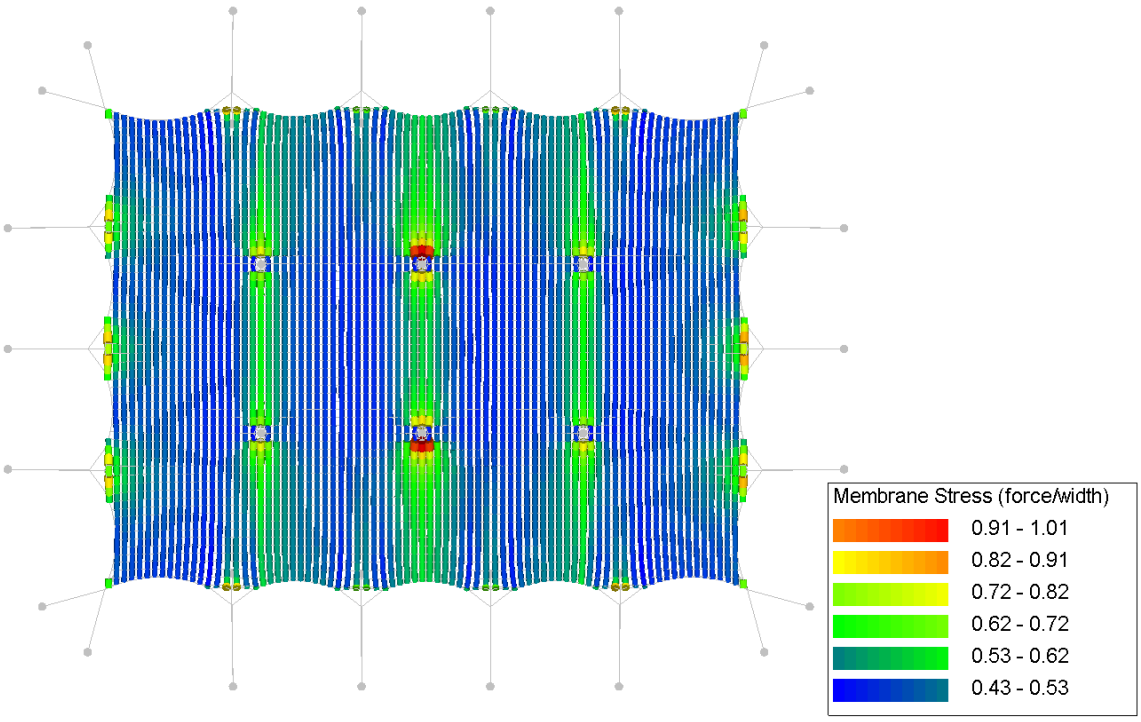
Annex B. Results per load combination

Annex B.1. CO1. Own weight + pretension

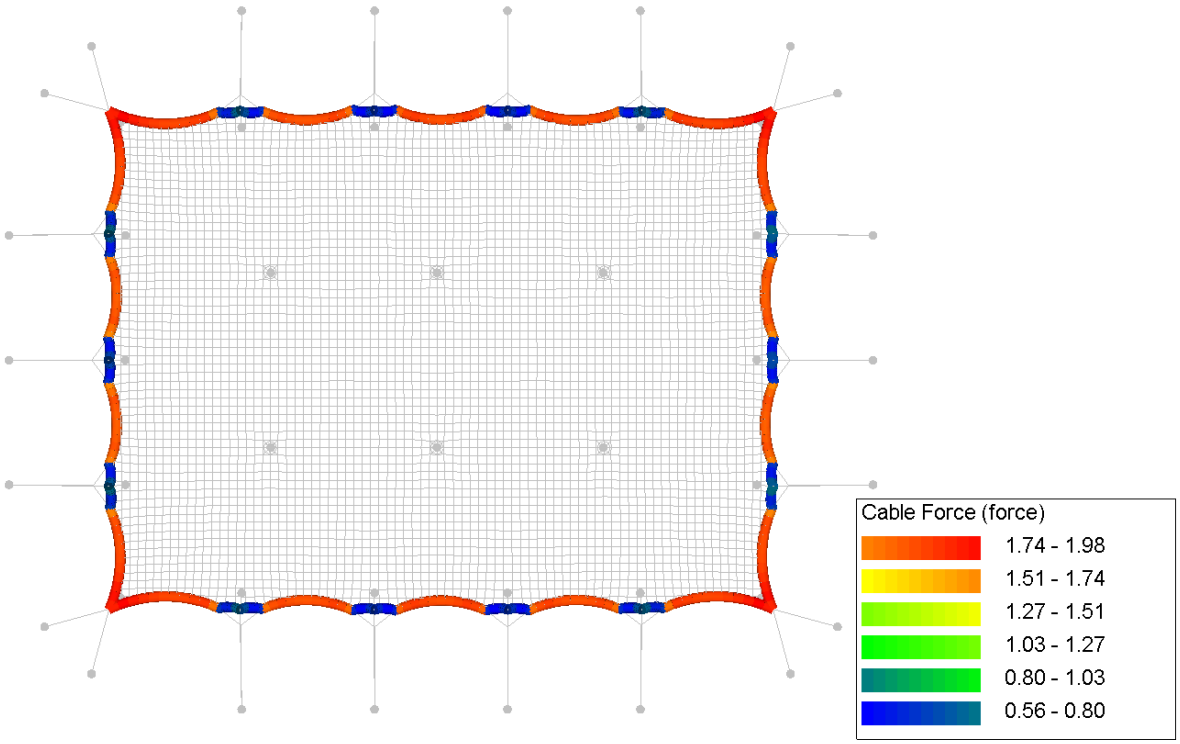
Annex B.1.1. Membrane stress (warp)



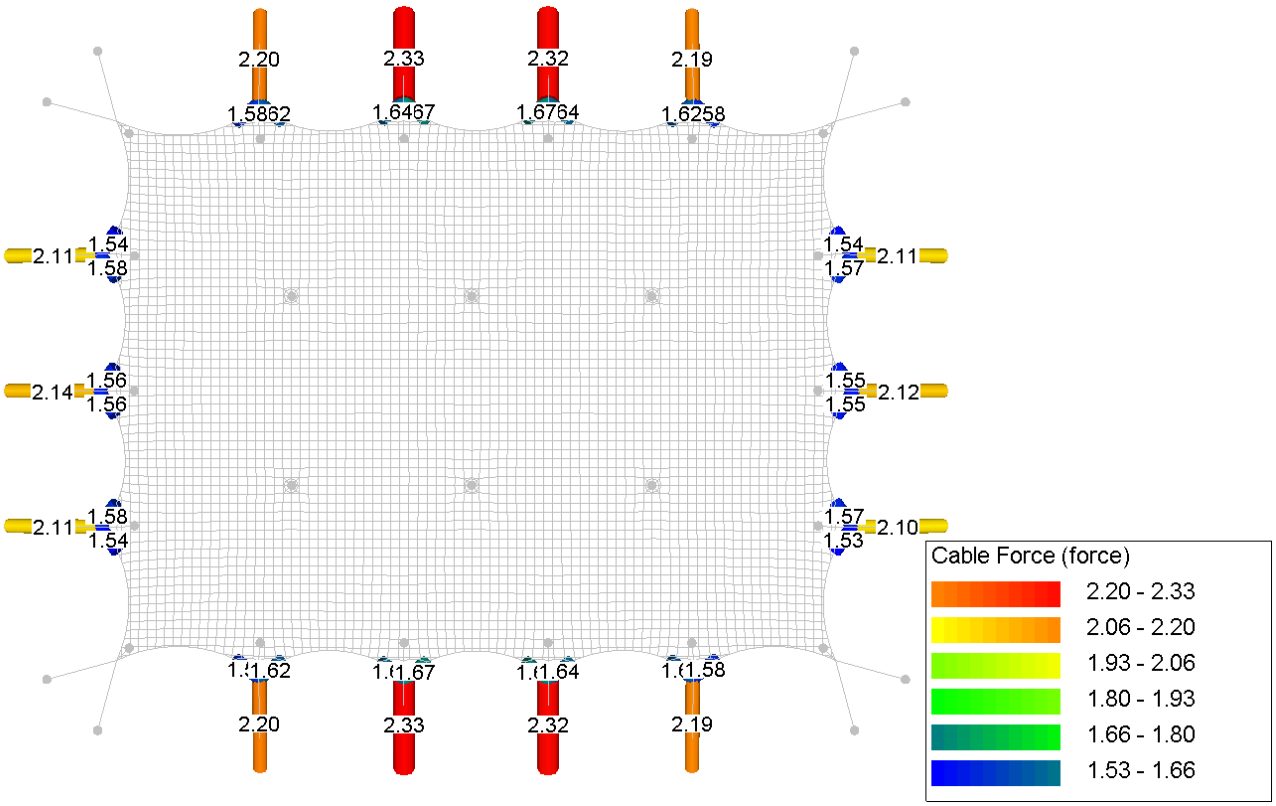
Annex B.1.2. Membrane stress (weft)



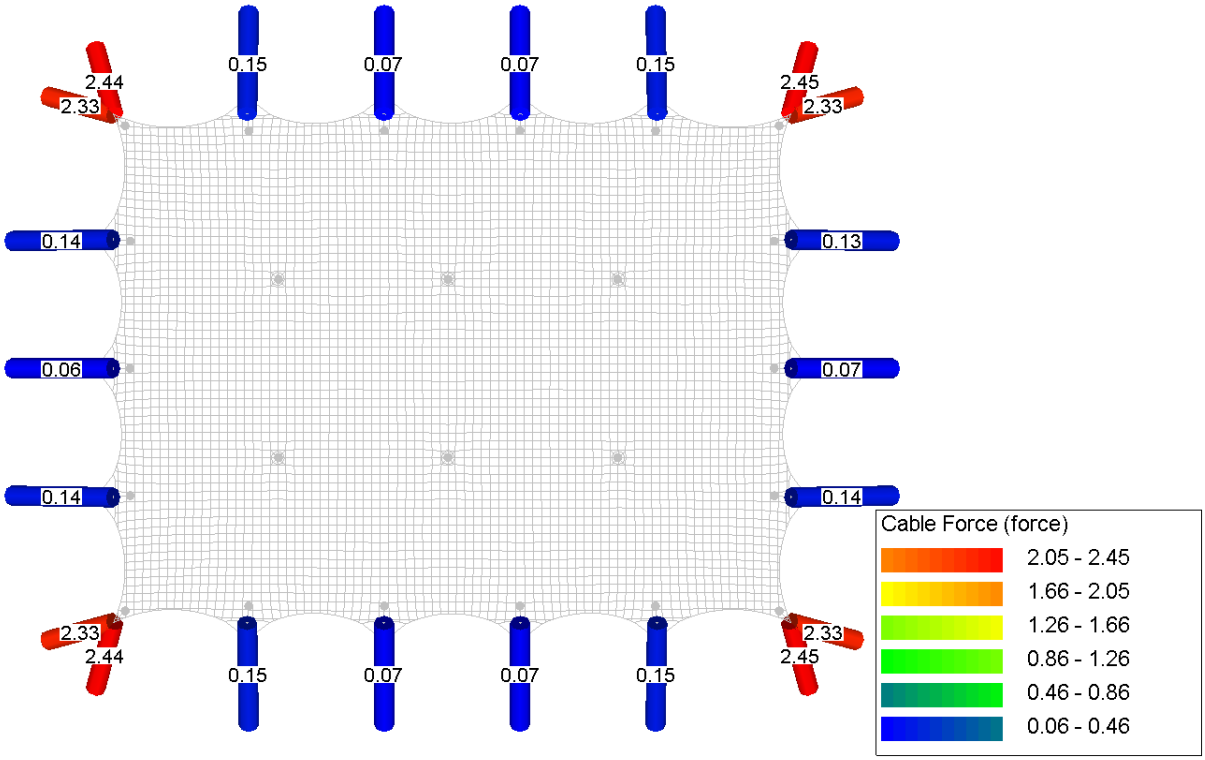
Annex B.1.3. Circumference rope forces



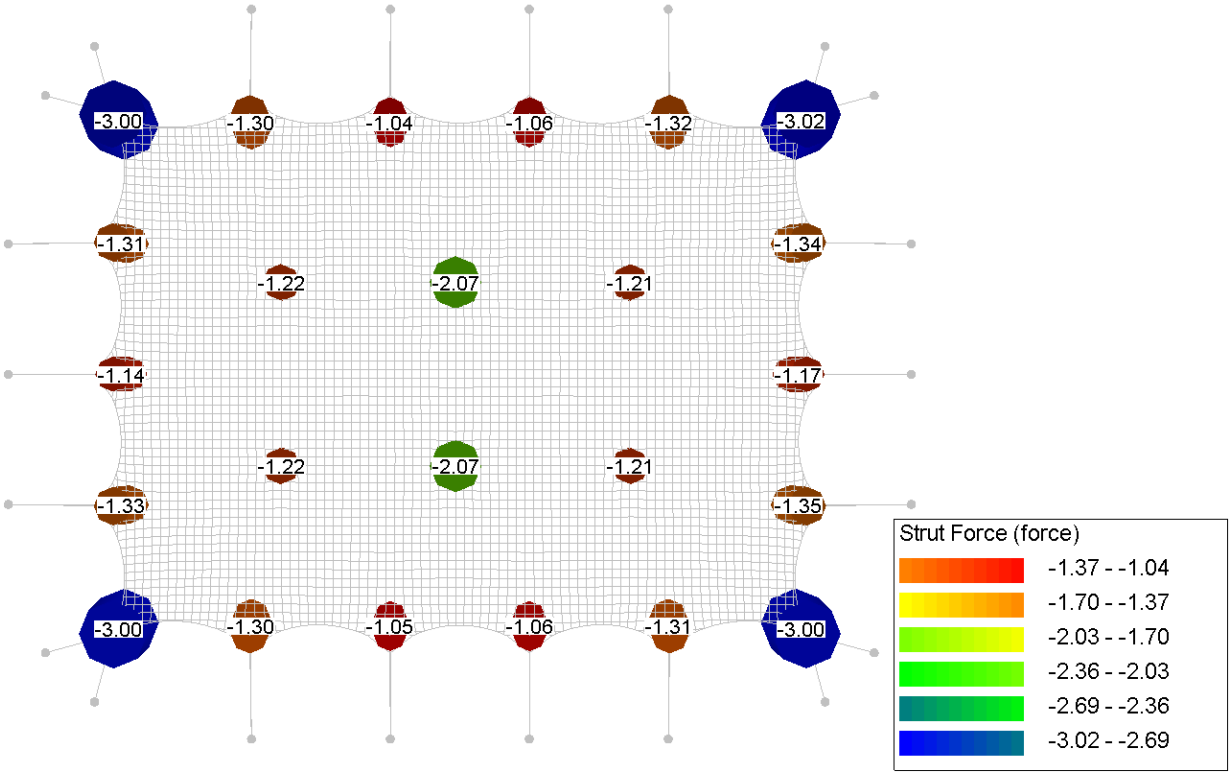
Annex B.1.4. Rope forces



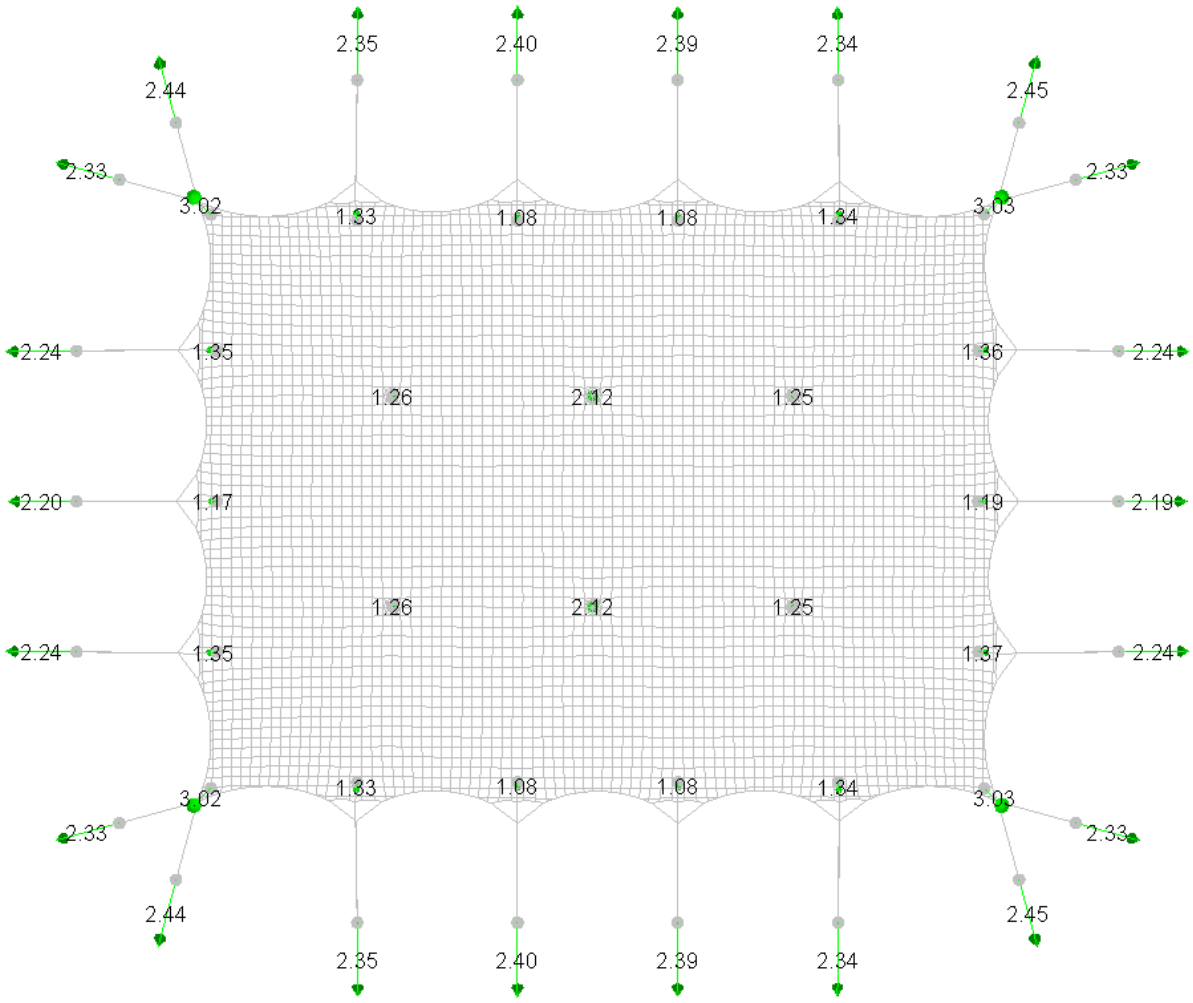
Annex B.1.5. Belt forces



Annex B.1.6. Pole forces

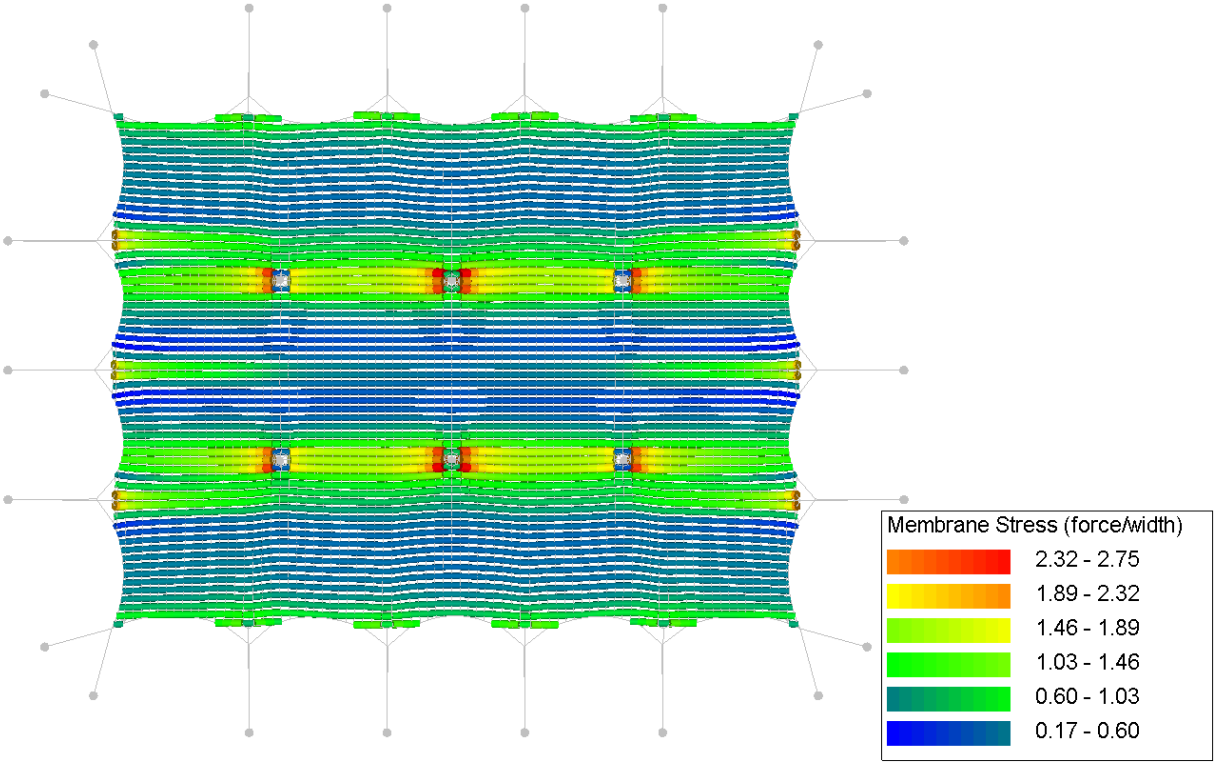


Annex B.1.7. Reaction forces

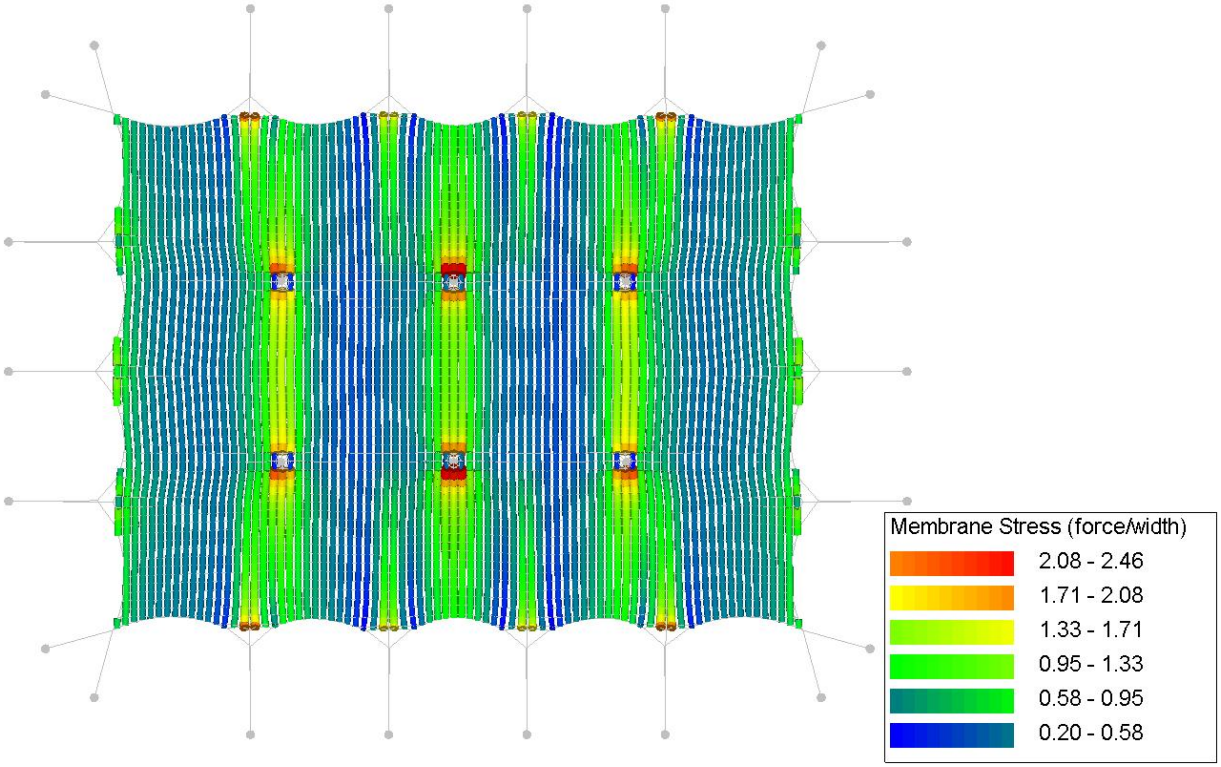


Annex B.2. CO2. Own weight + pretension + snow

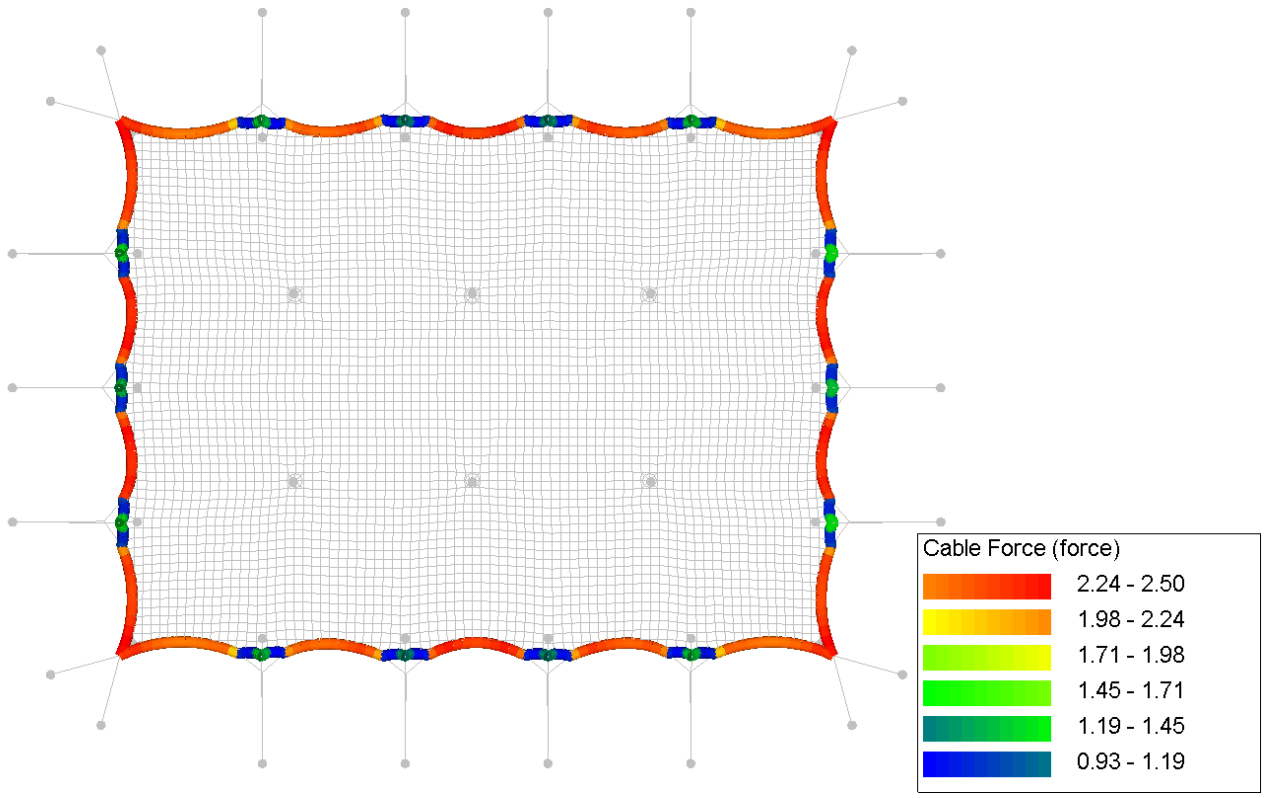
Annex B.2.1. Membrane stress (warp)



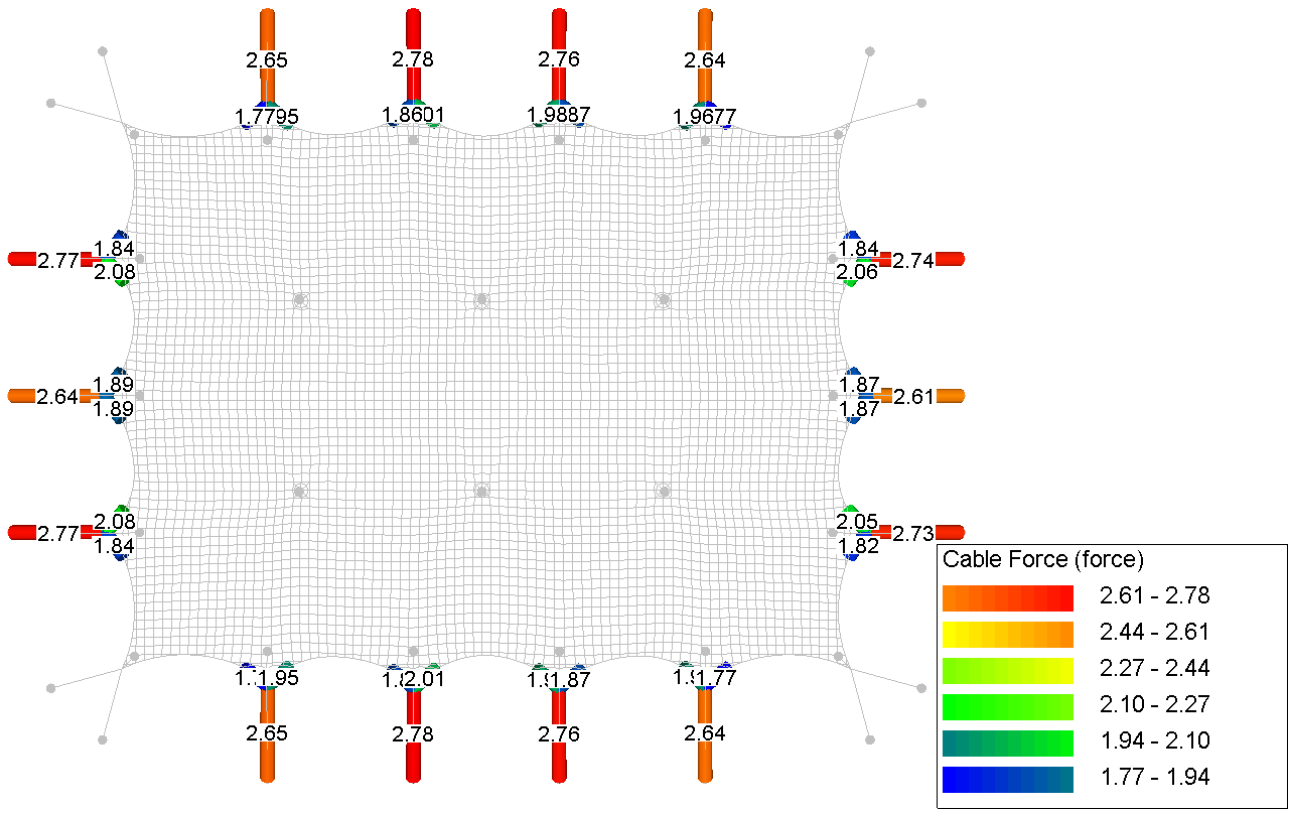
Annex B.2.2. Membrane stress (weft)



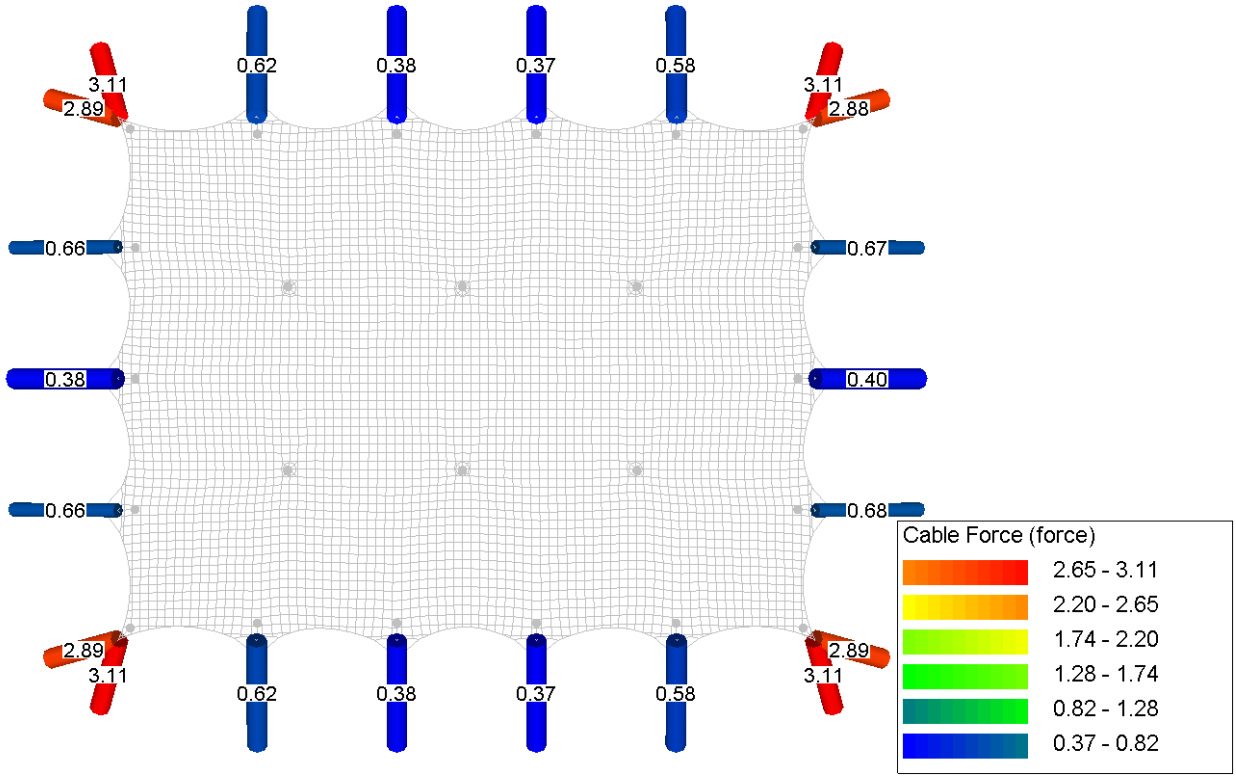
Annex B.2.3. Circumference rope forces



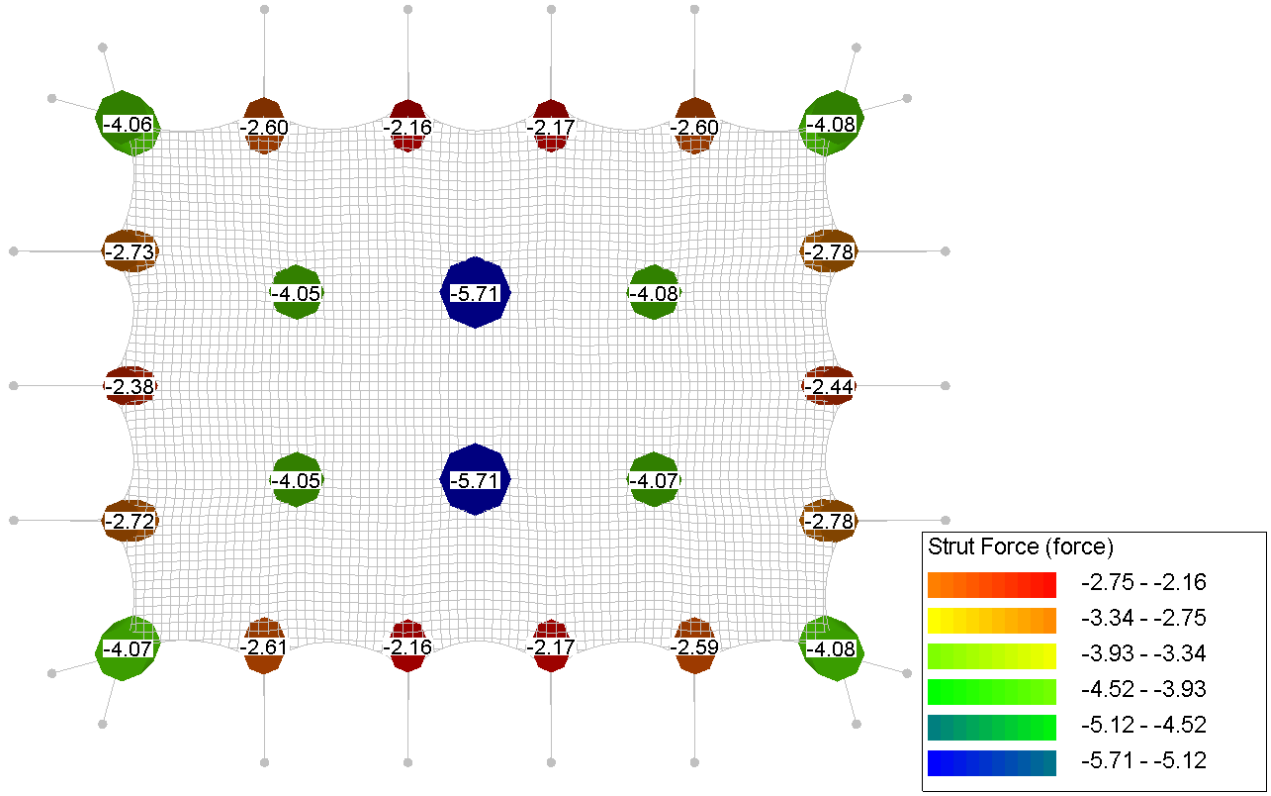
Annex B.2.4. Rope forces



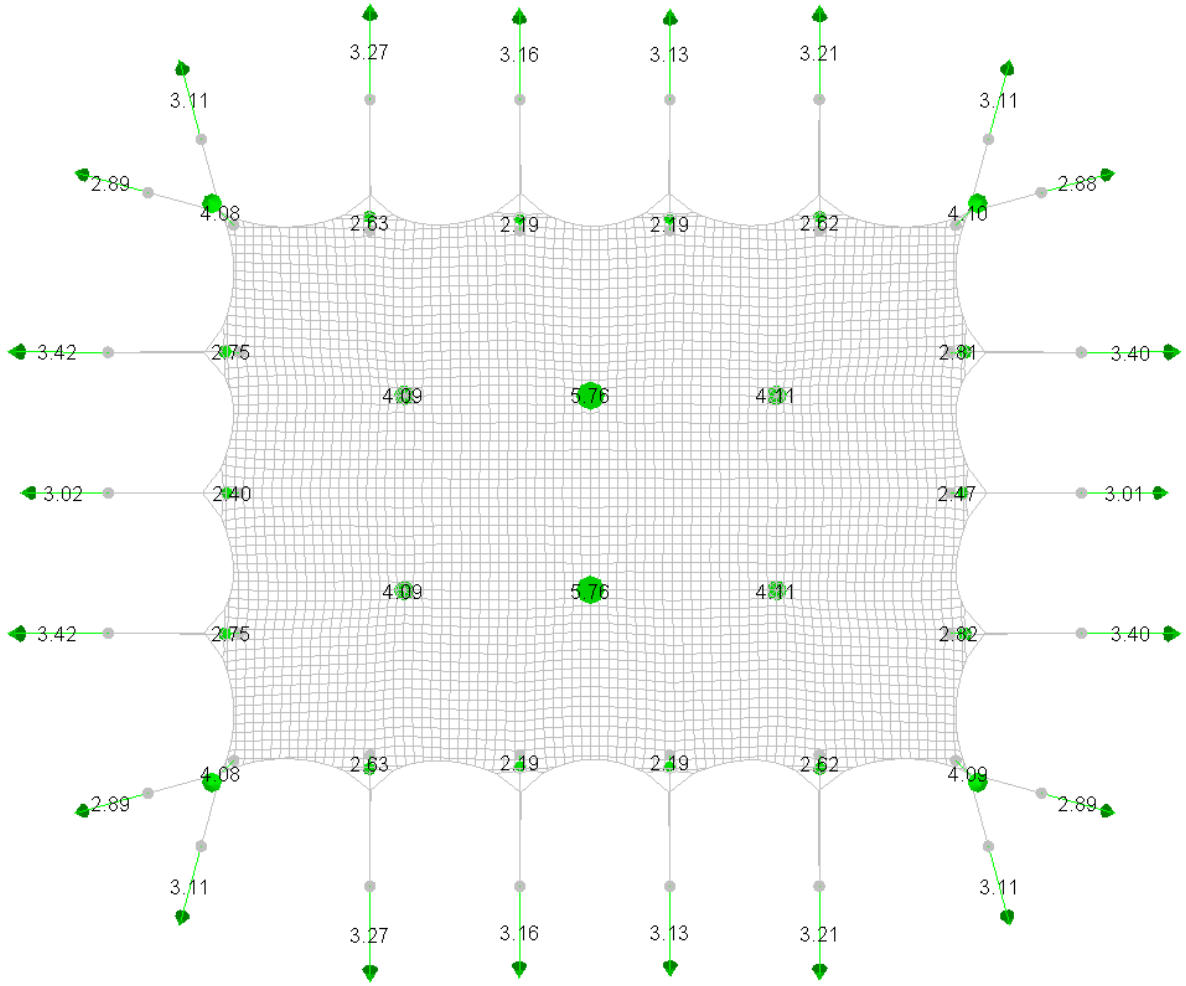
Annex B.2.5. Belt forces



Annex B.2.6. Pole forces

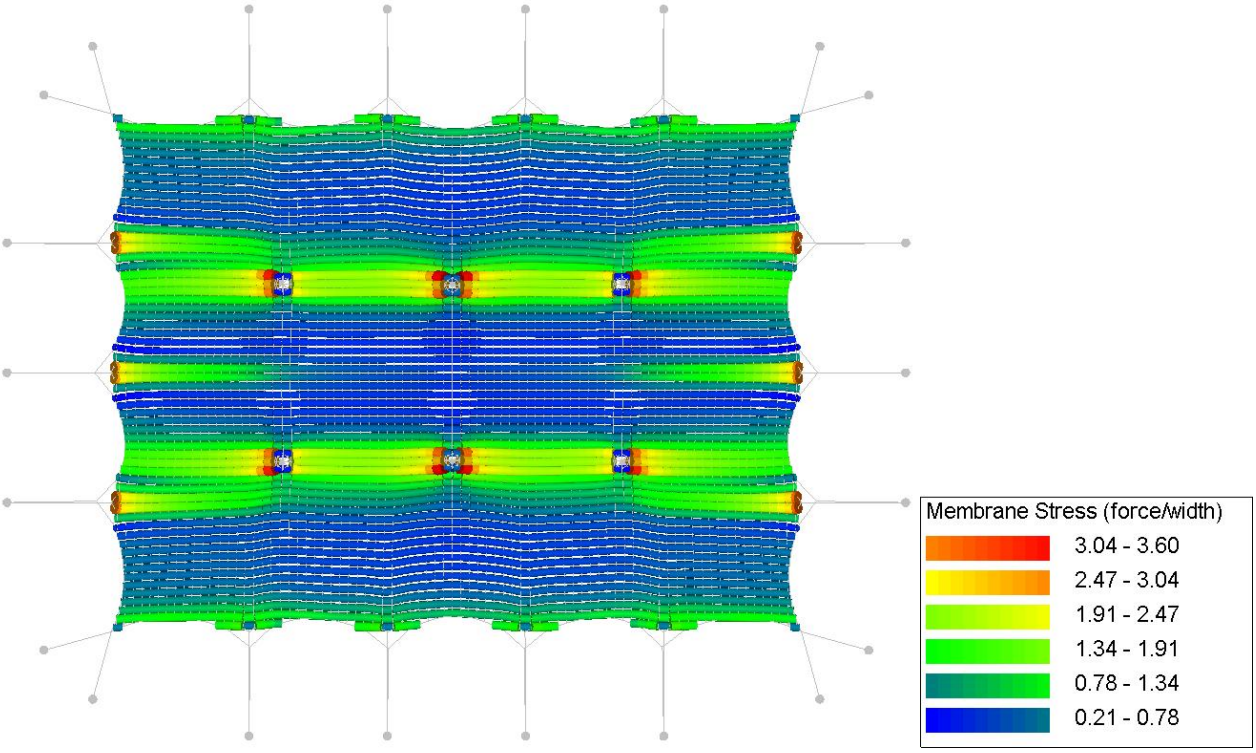


Annex B.2.7. Anchor forces

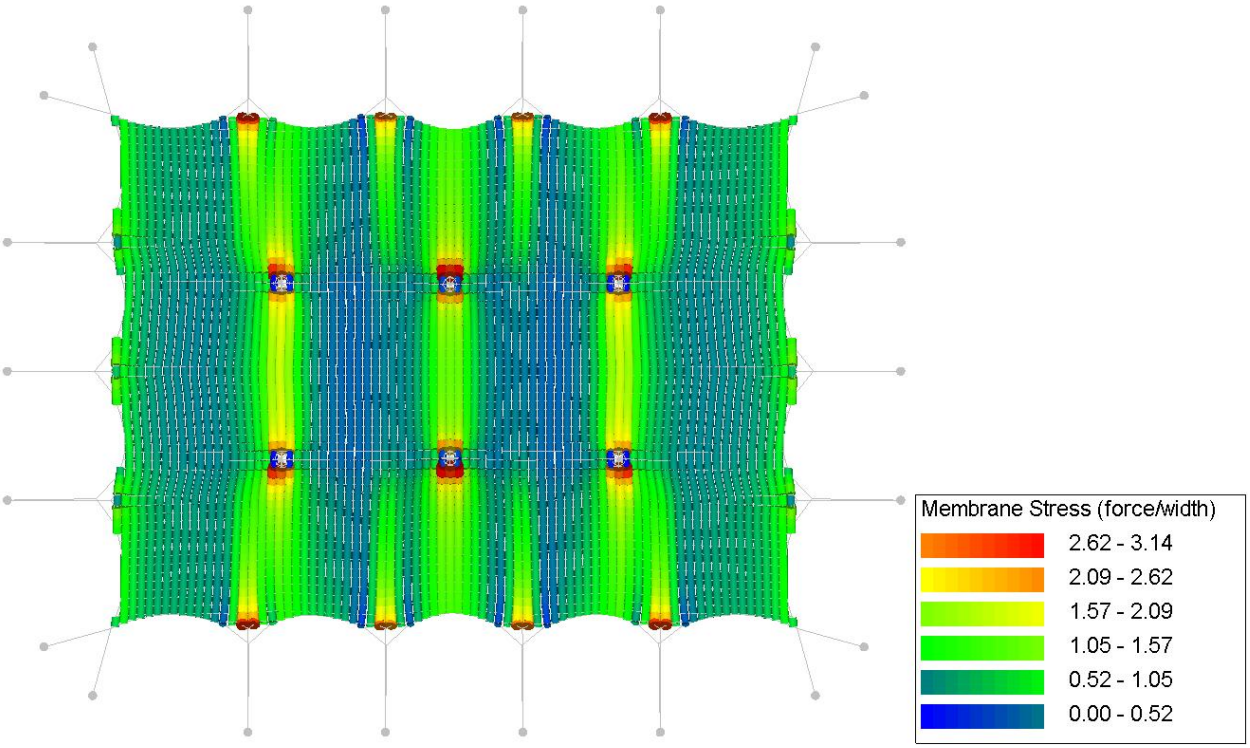


Annex B.3. CO3. Own weight + pretension + wind pressure

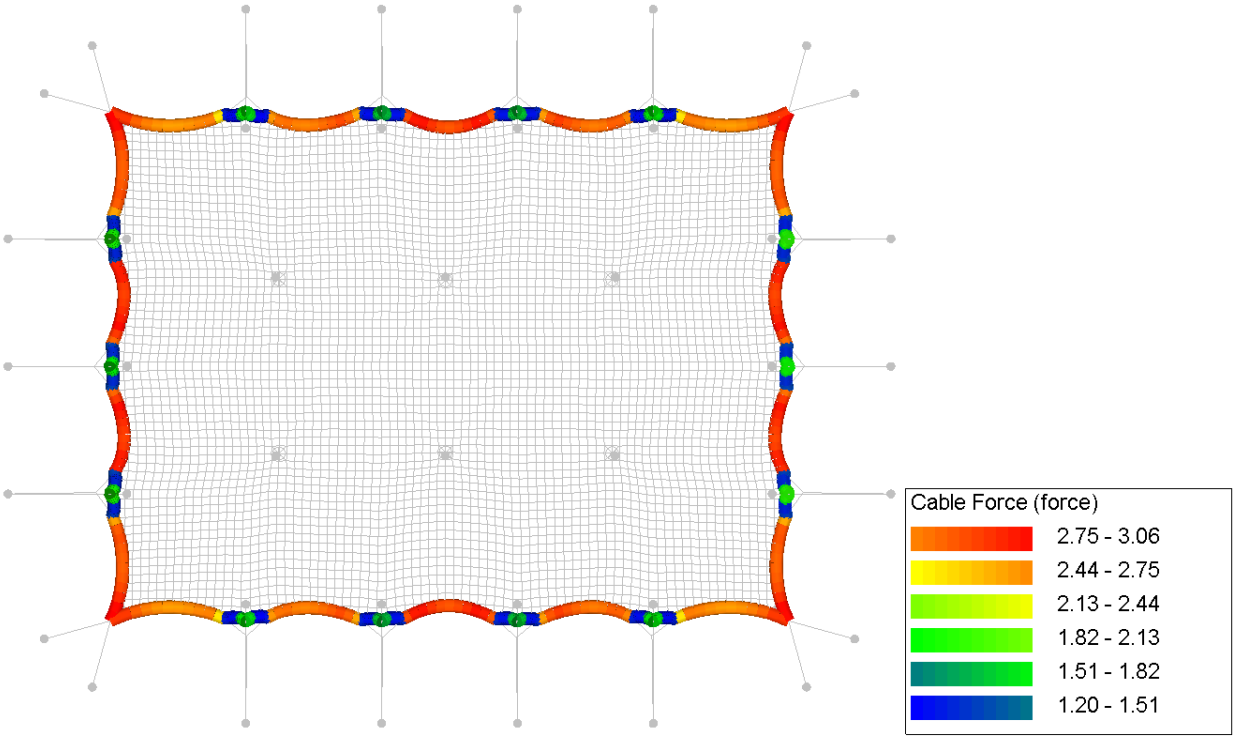
Annex B.3.1. Membrane stress (warp)



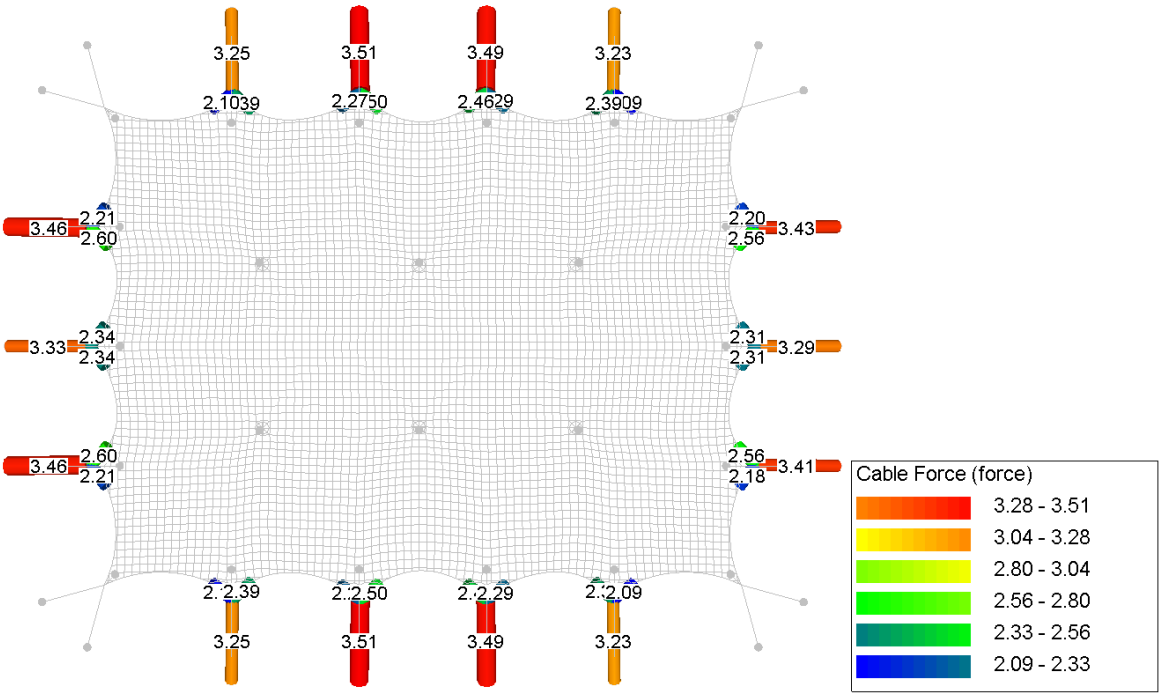
Annex B.3.2. Membrane stress (weft)



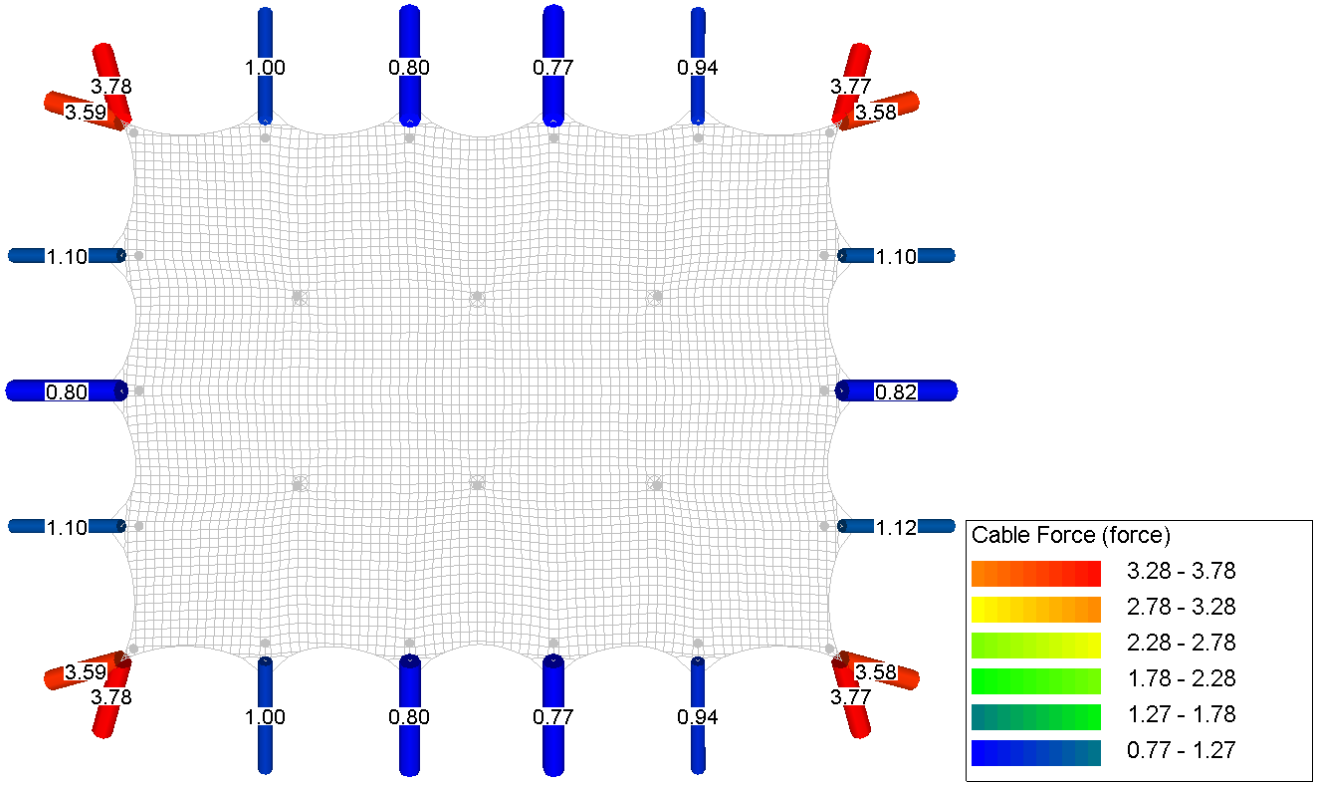
Annex B.3.3. Circumference rope forces



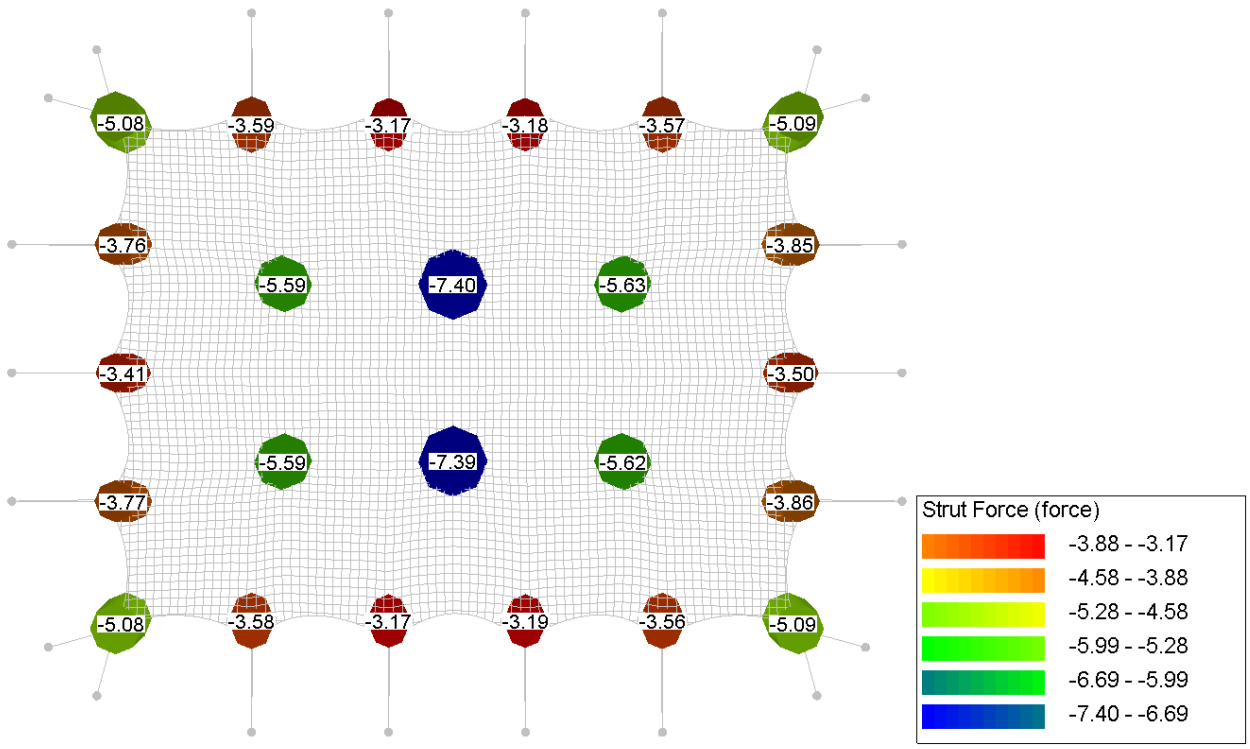
Annex B.3.4. Rope forces



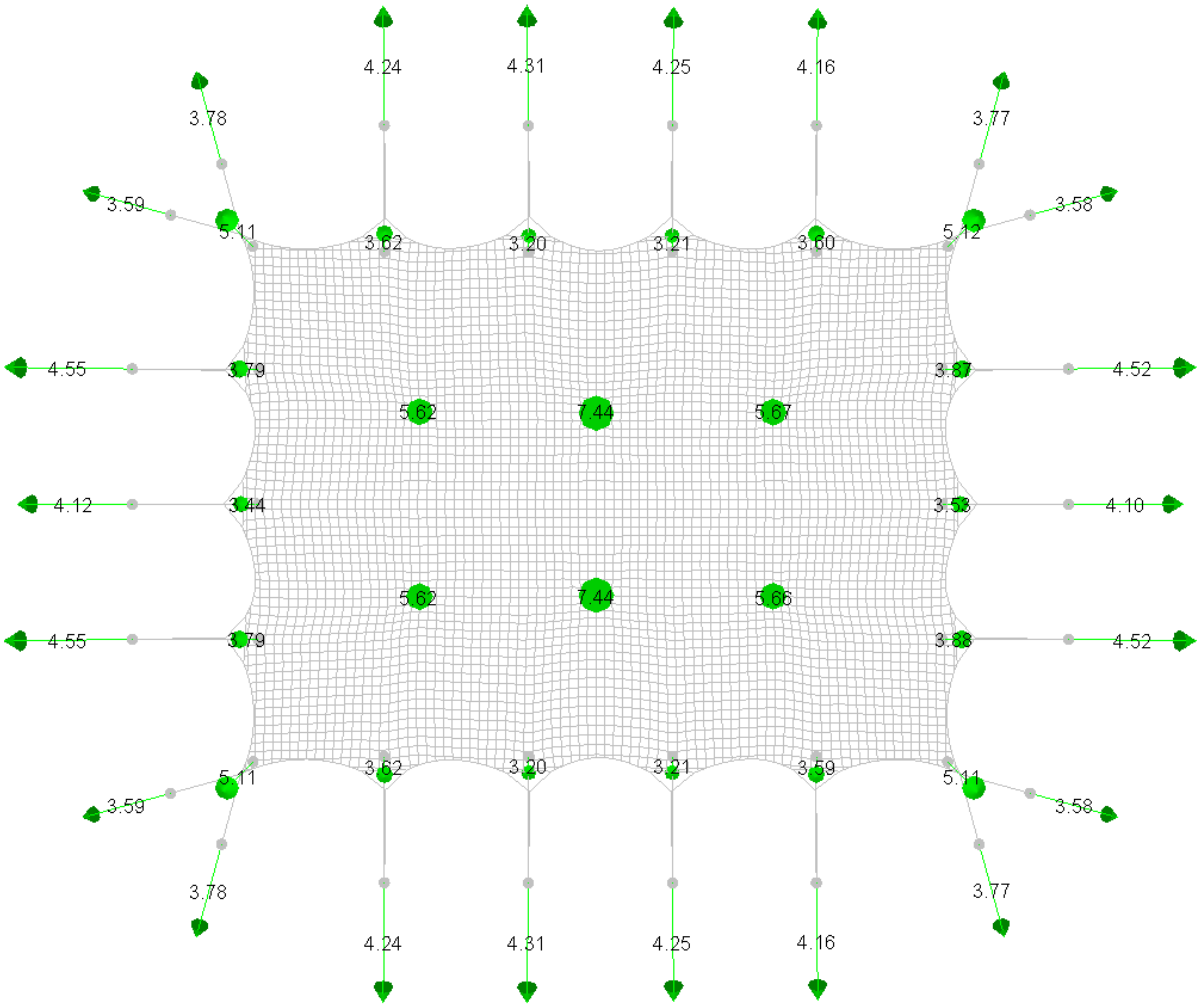
Annex B.3.5. Belt forces



Annex B.3.6. Poles forces

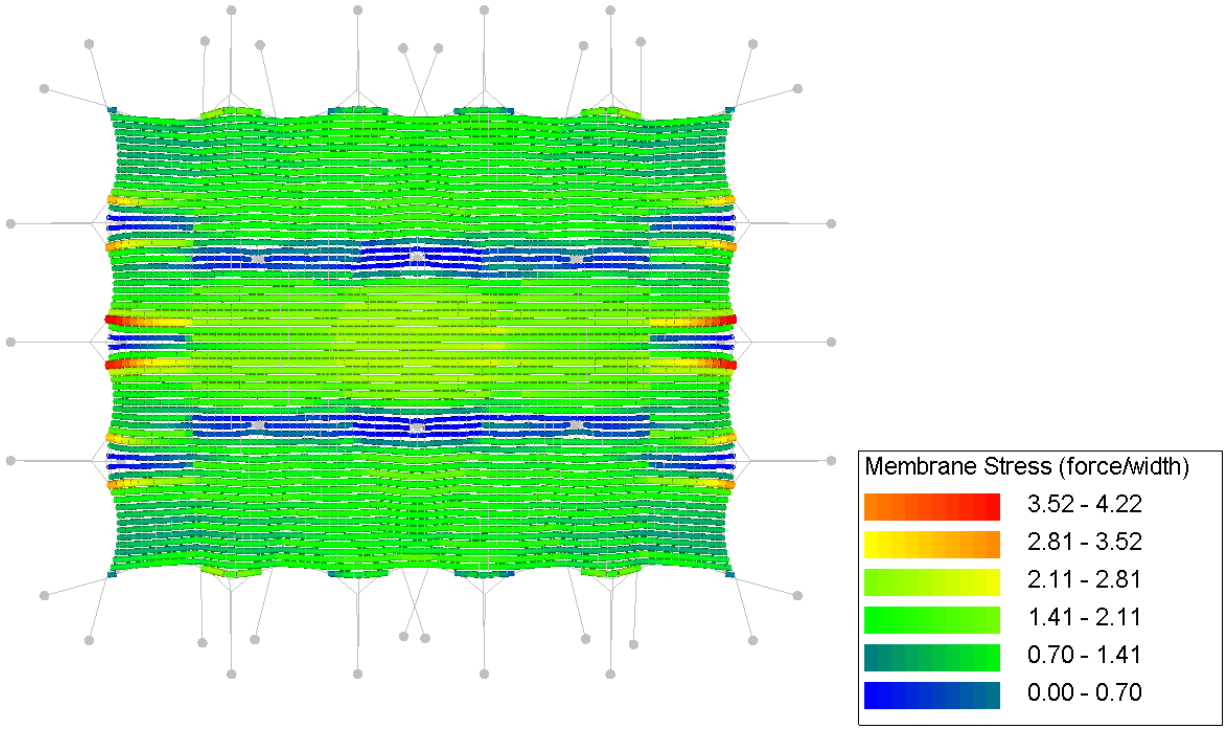


Annex B.3.7. Reaction forces

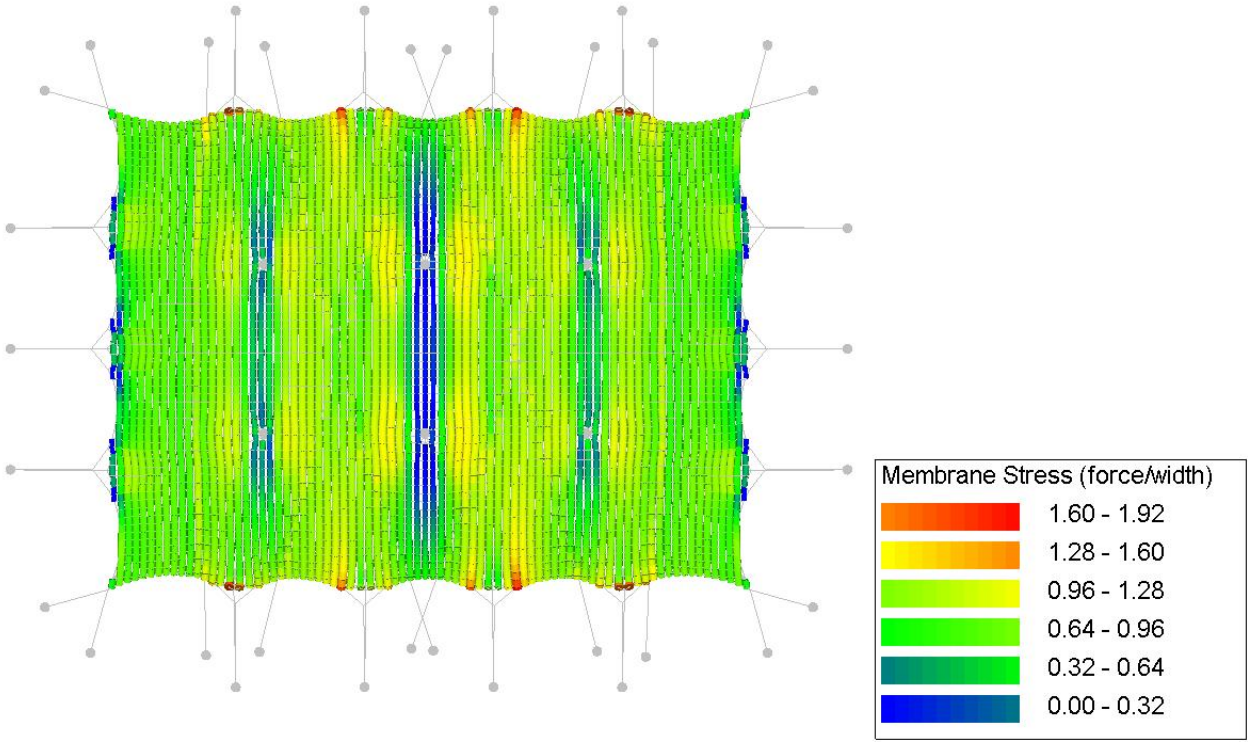


Annex B.4. CO4. Own weight + pretension + wind suction

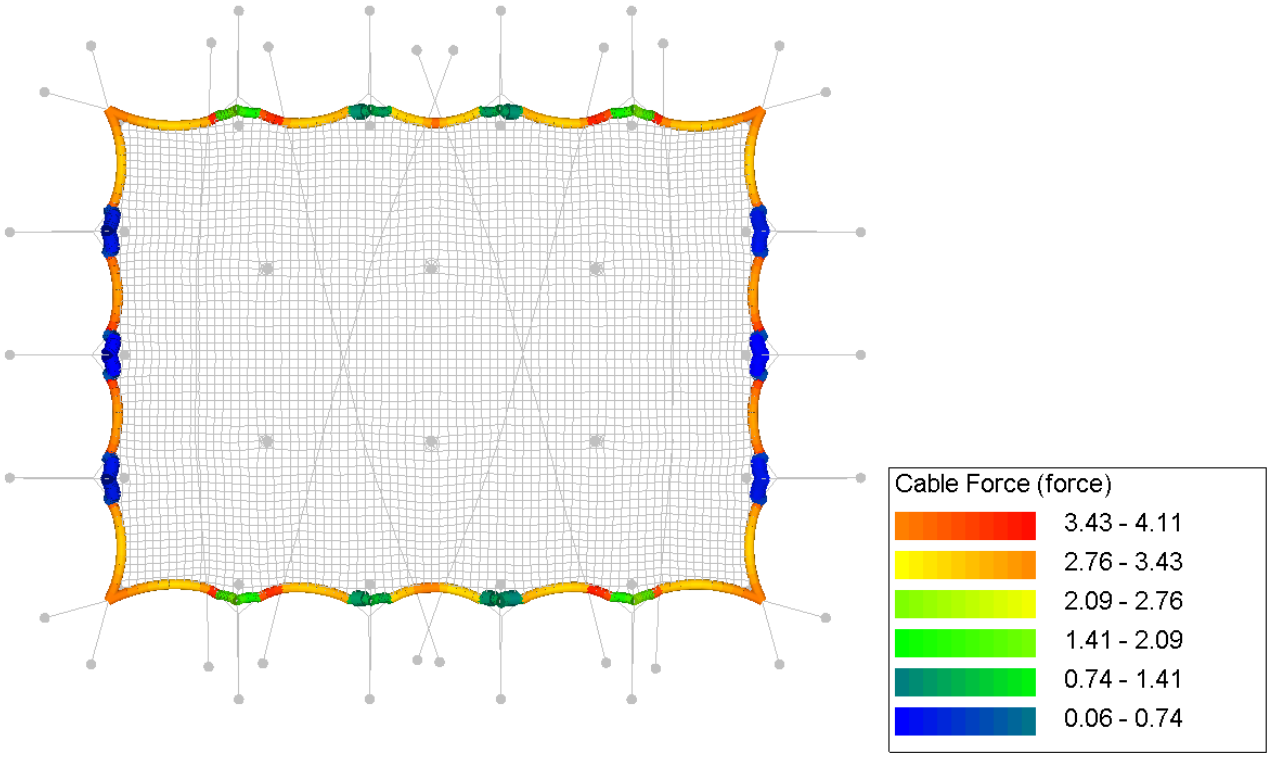
Annex B.4.1. Membrane stress (warp)



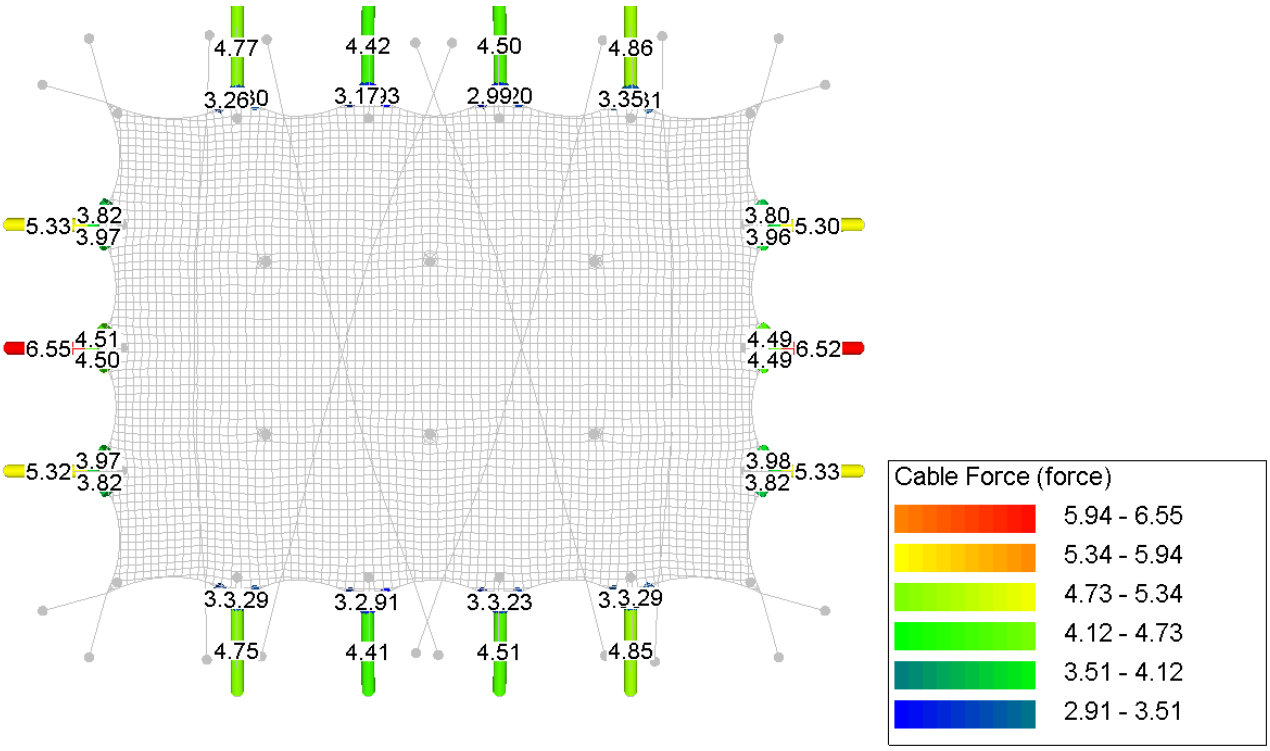
Annex B.4.2. Membrane stress (weft)



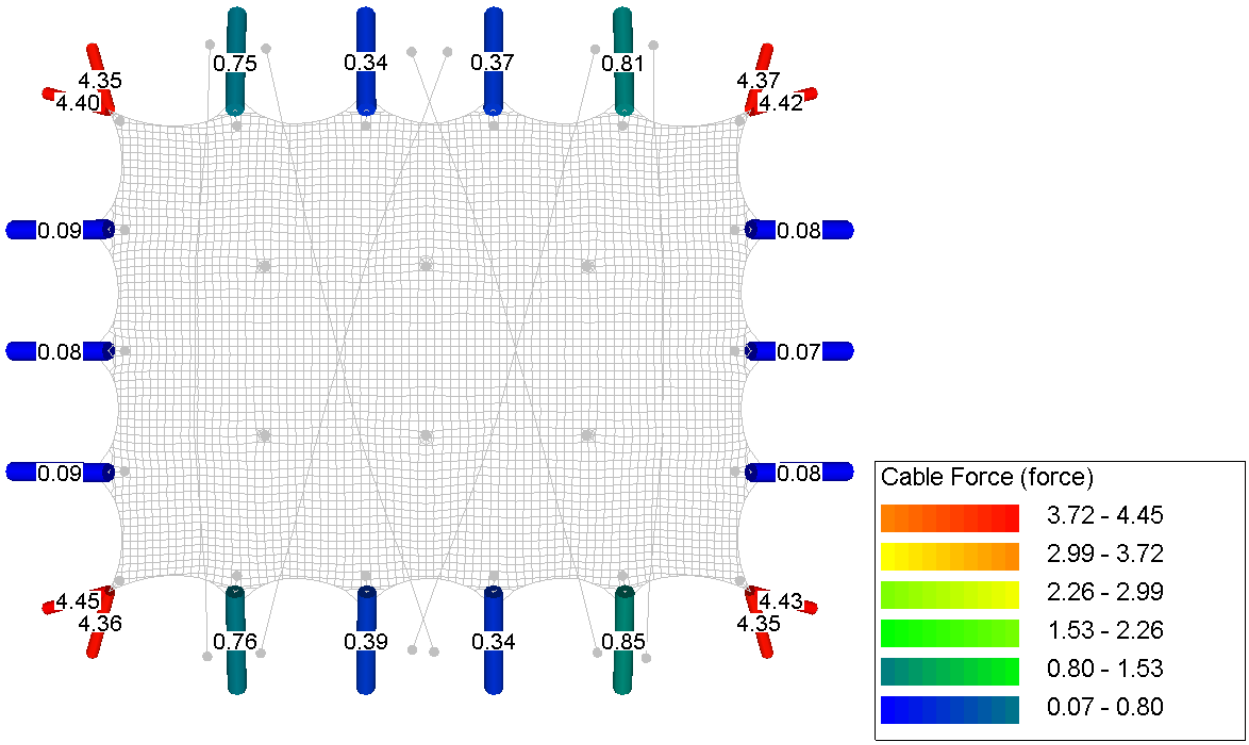
Annex B.4.3. Circumference rope forces



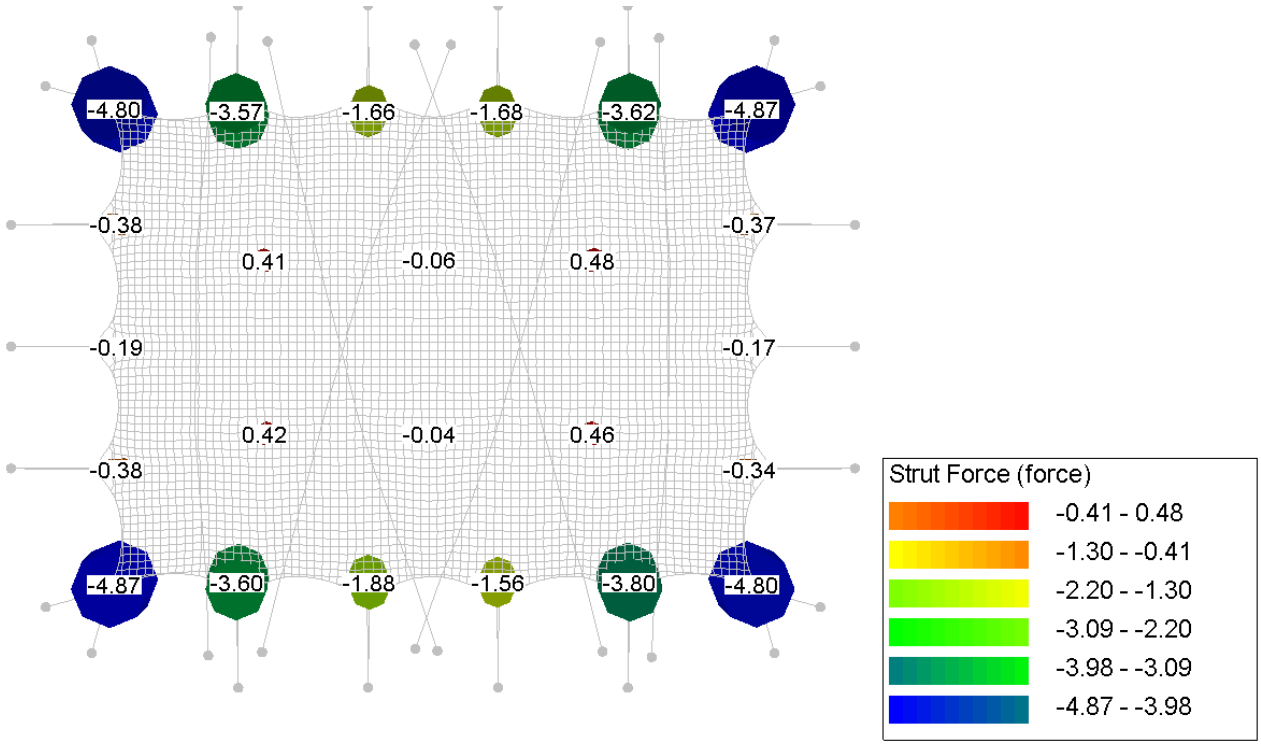
Annex B.4.4. Guy rope forces



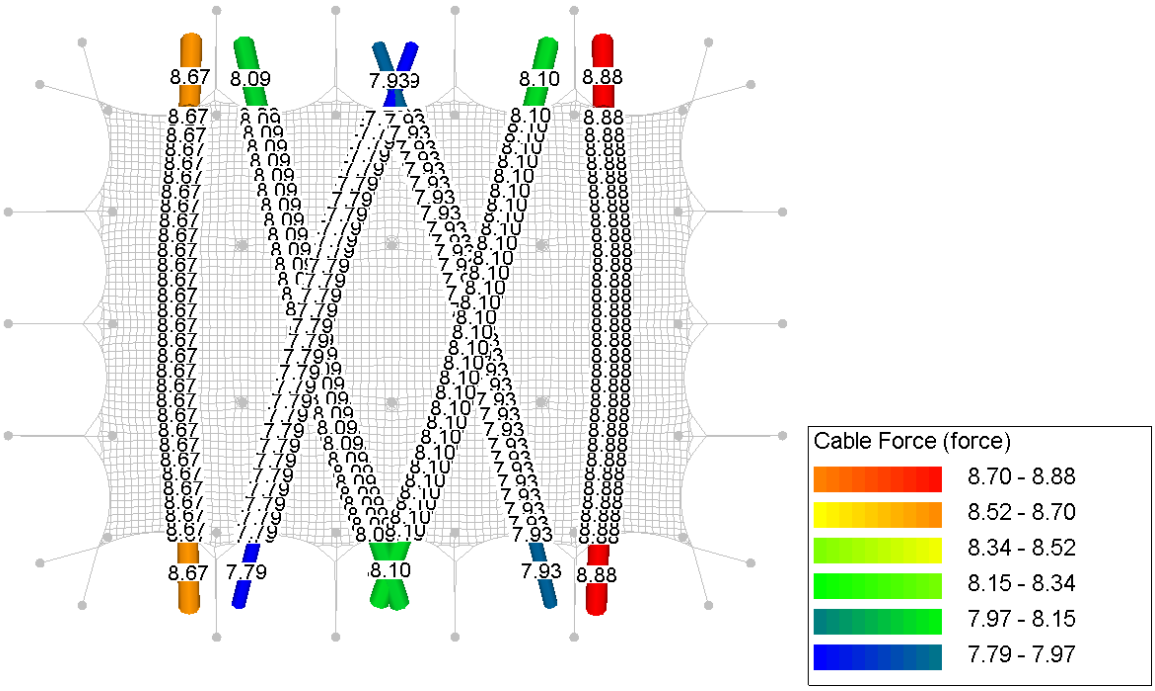
Annex B.4.5. Belt forces



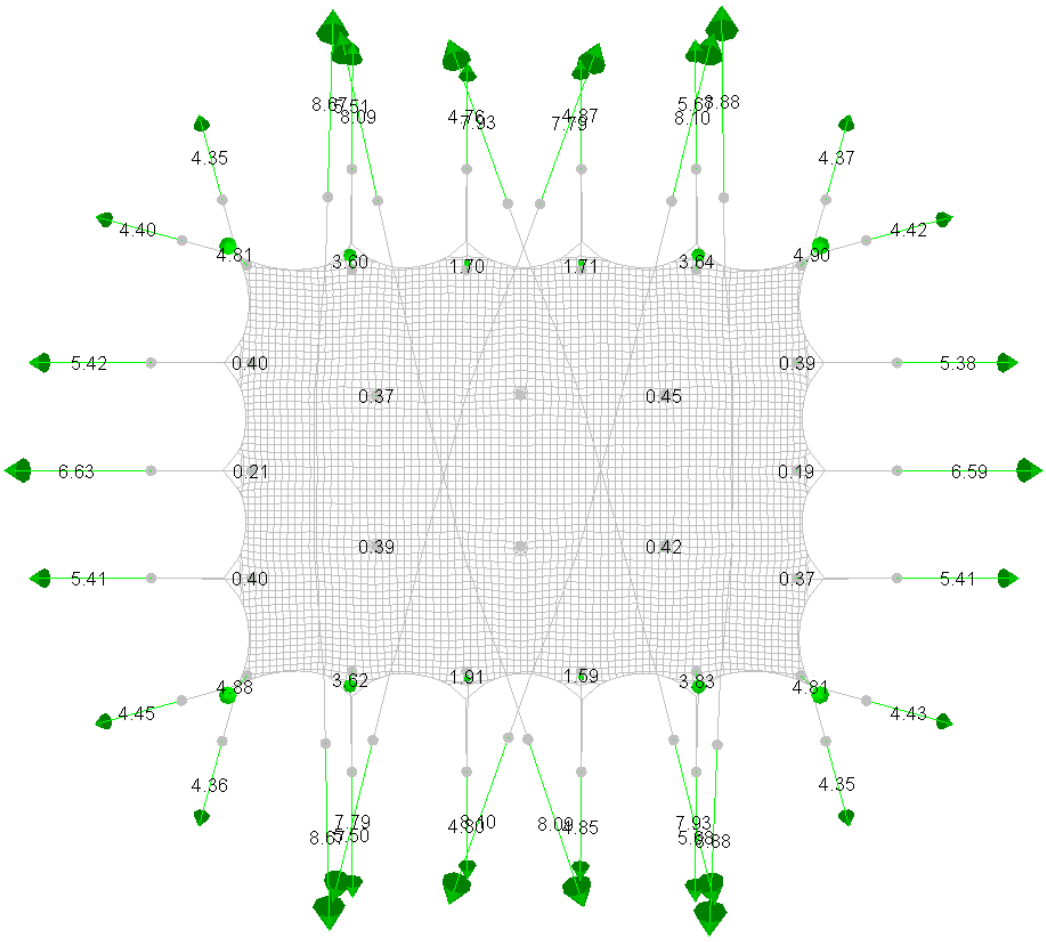
Annex B.4.6. Poles forces



Annex B.4.7. Storm belt forces

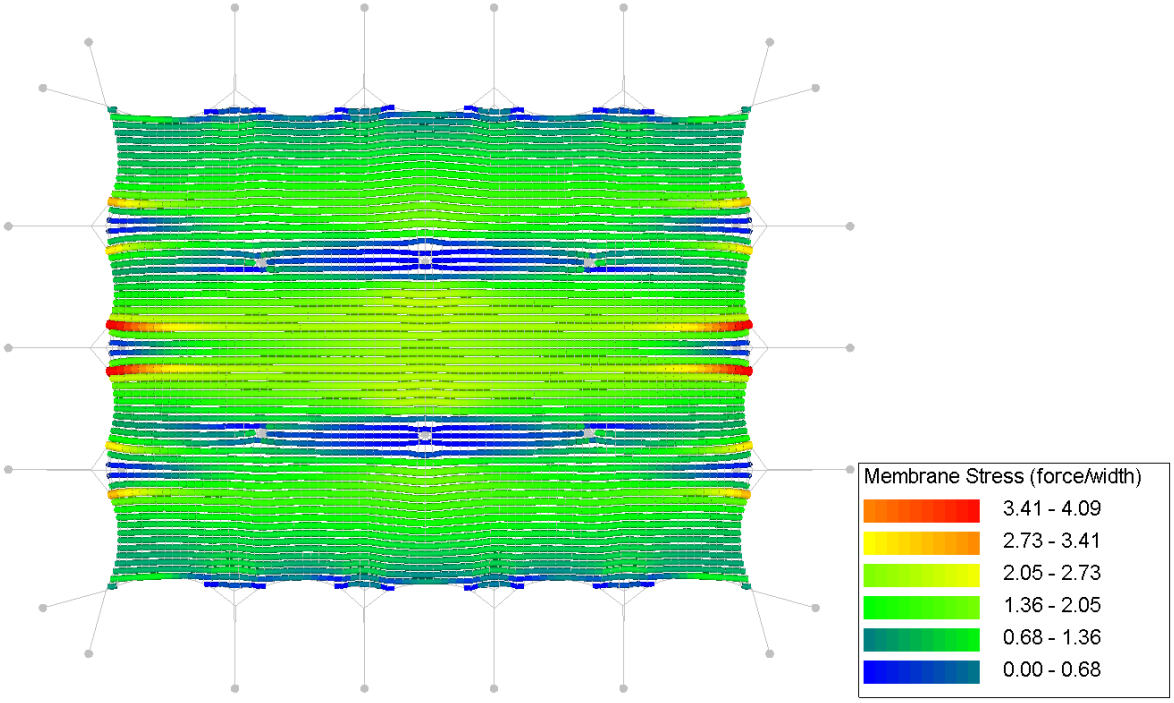


Annex B.4.8. Reaction forces

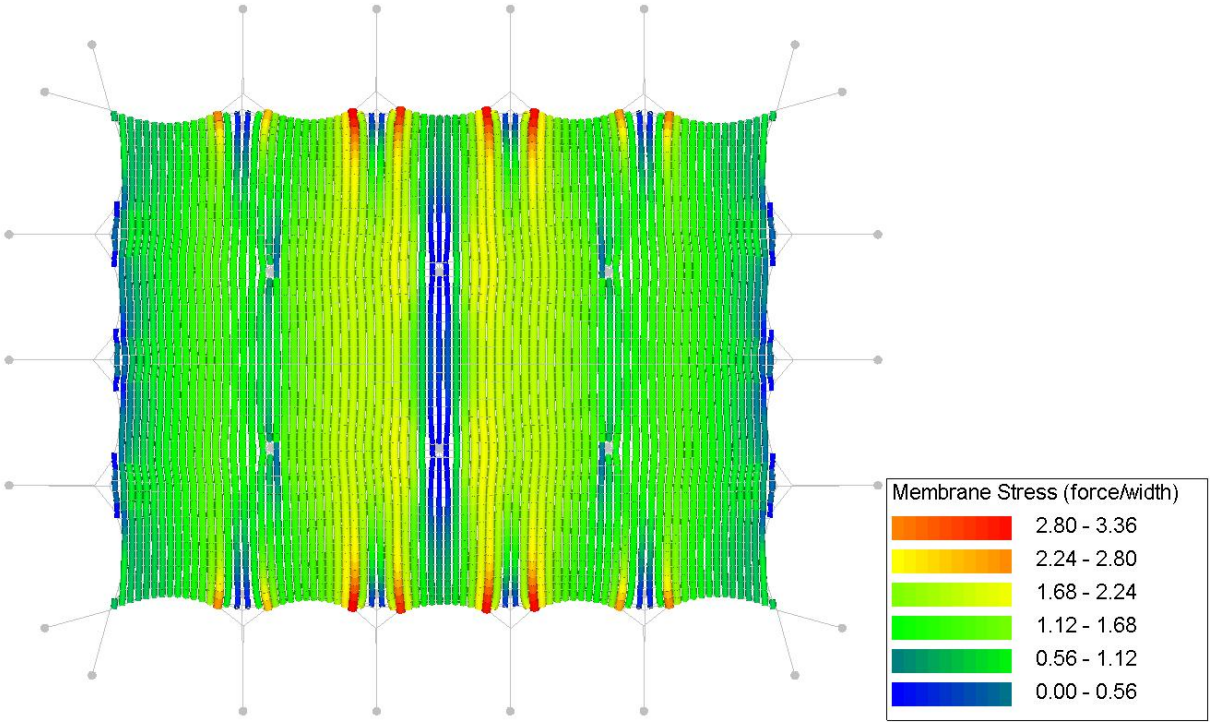


Annex B.5. CO5. Own weight + pretension + wind suction reduced [NL]

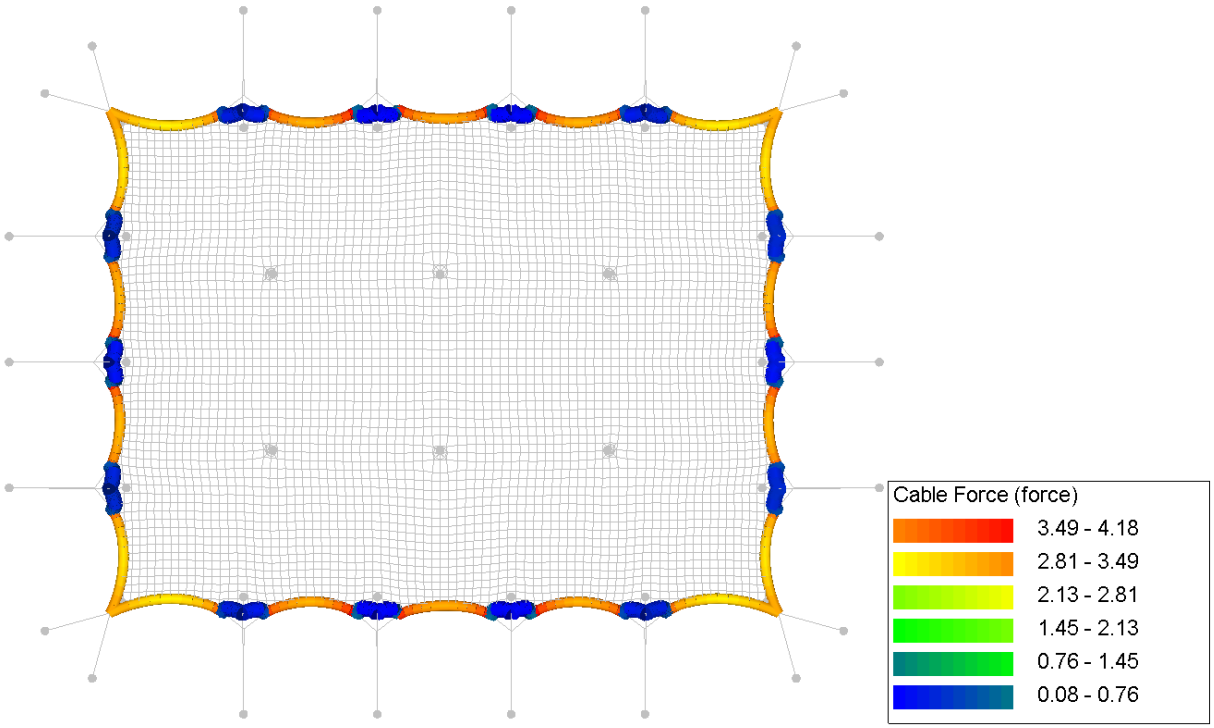
Annex B.5.1. Membrane stress (warp)



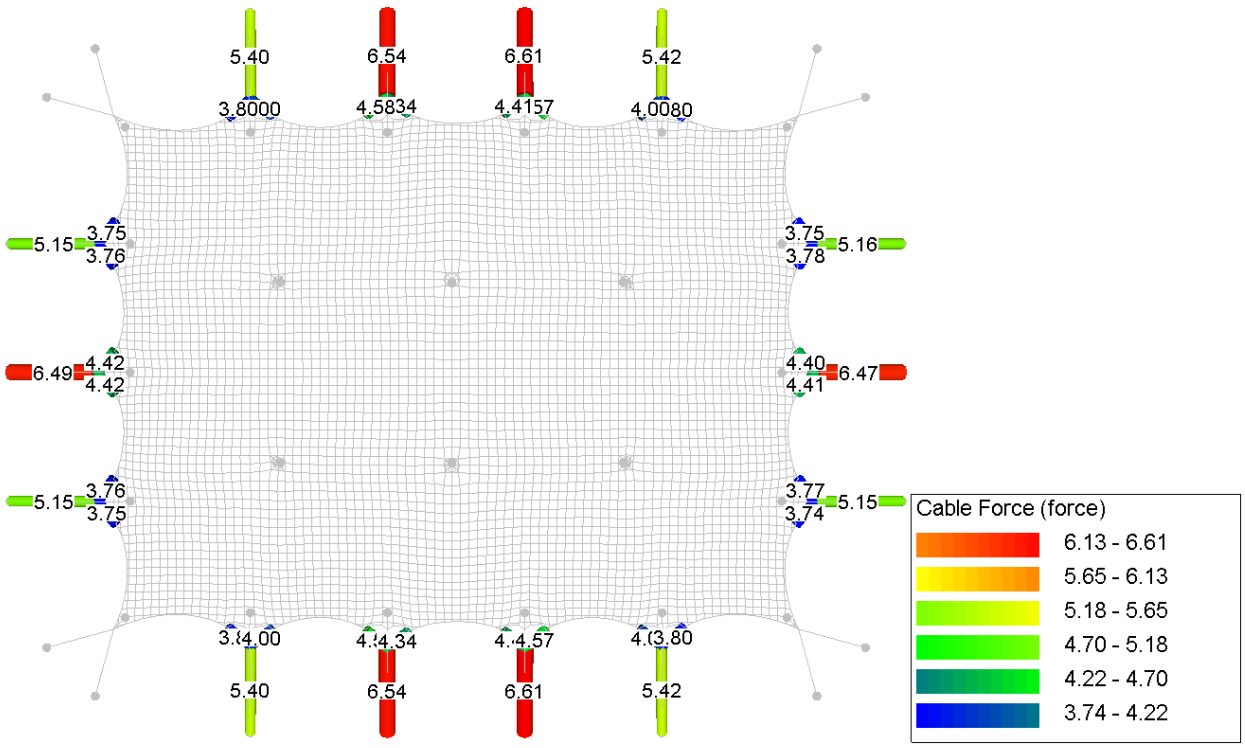
Annex B.5.2. Membrane stress (weft)



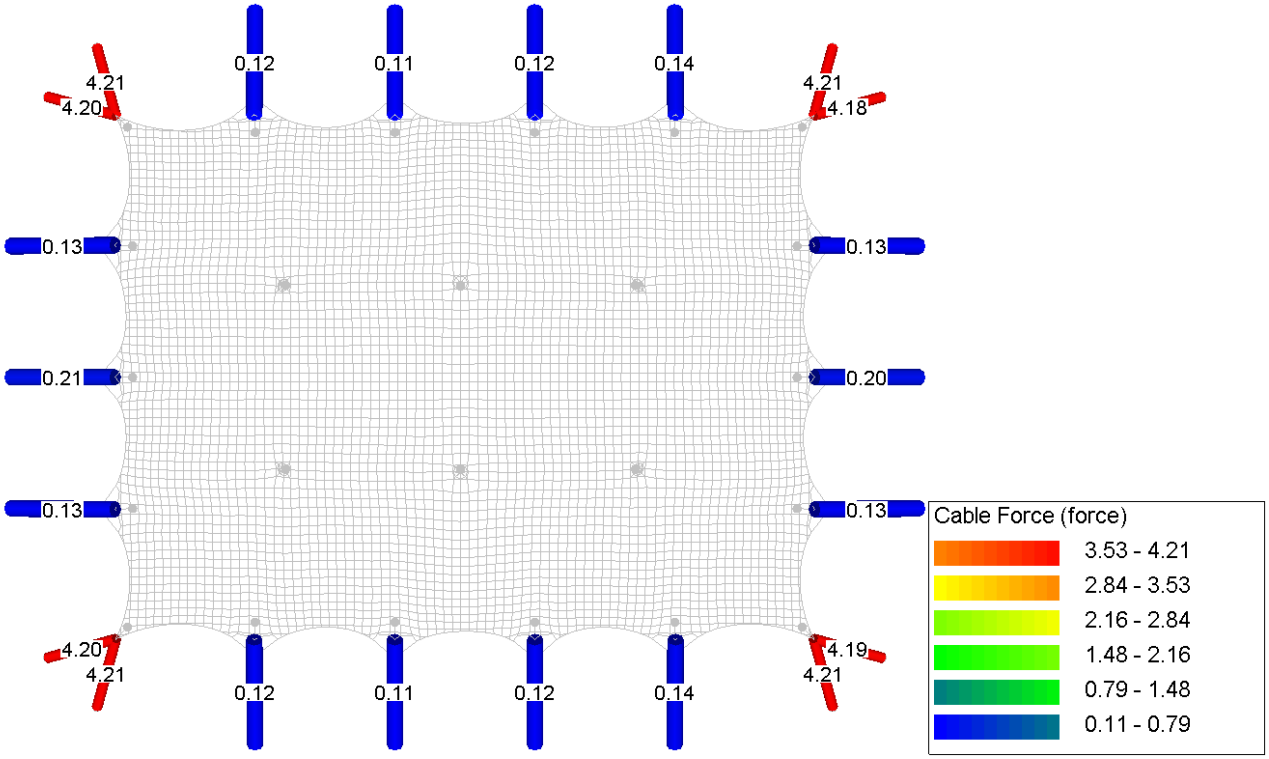
Annex B.5.3. Circumference rope forces



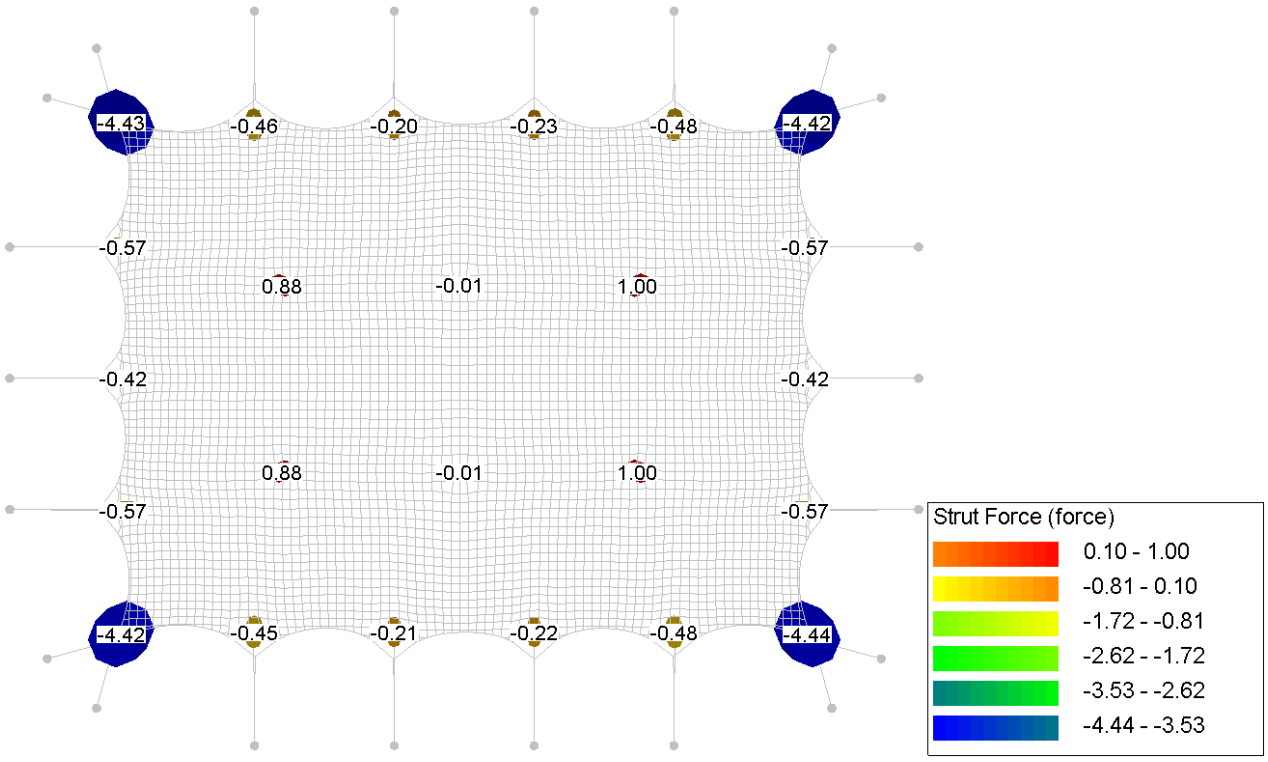
Annex B.5.4. Rope forces



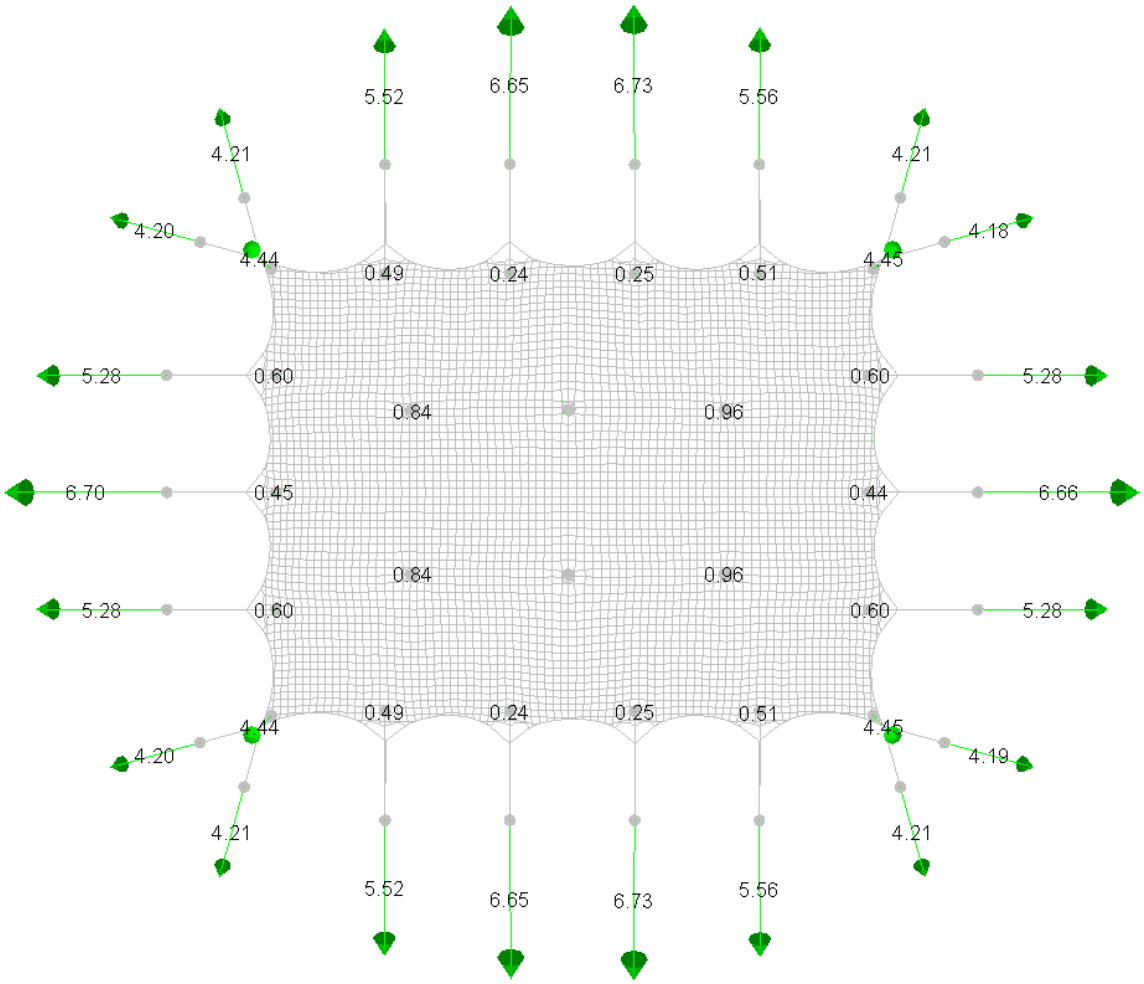
Annex B.5.5. Belt forces



Annex B.5.6. Poles forces

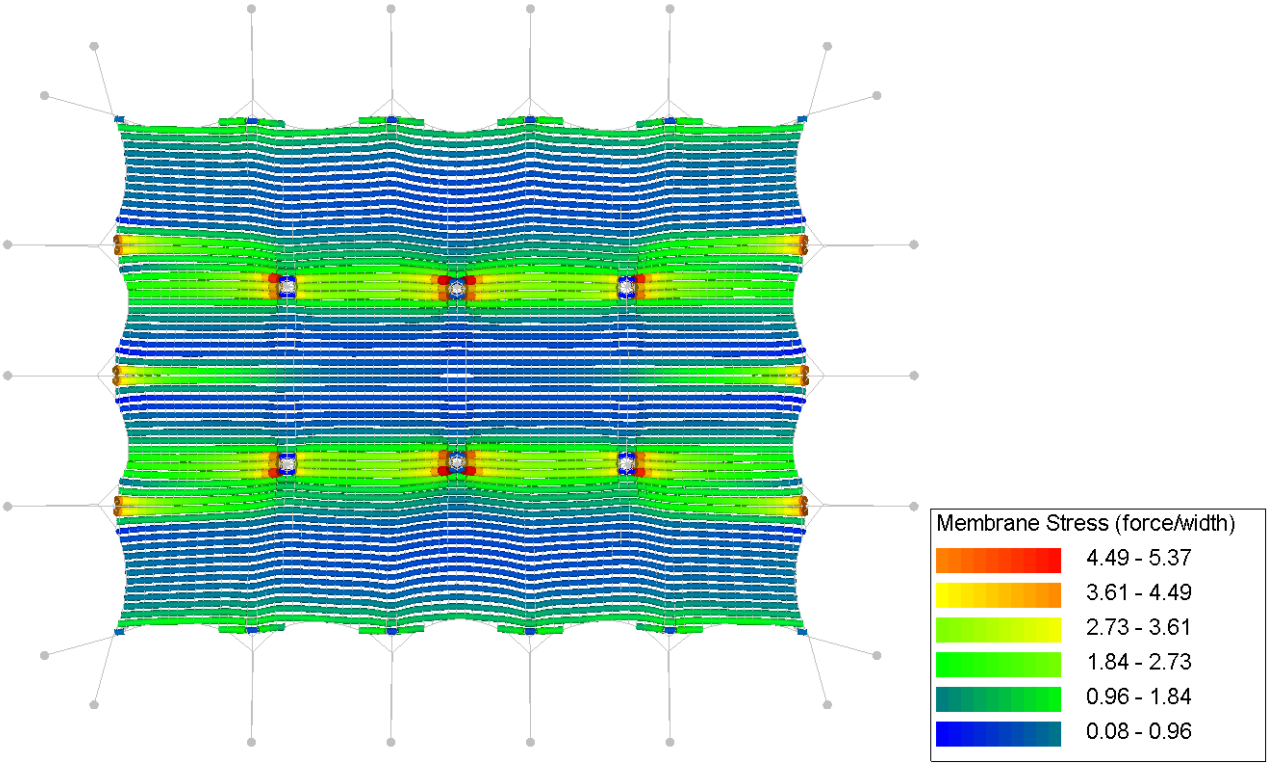


Annex B.5.7. Reaction forces

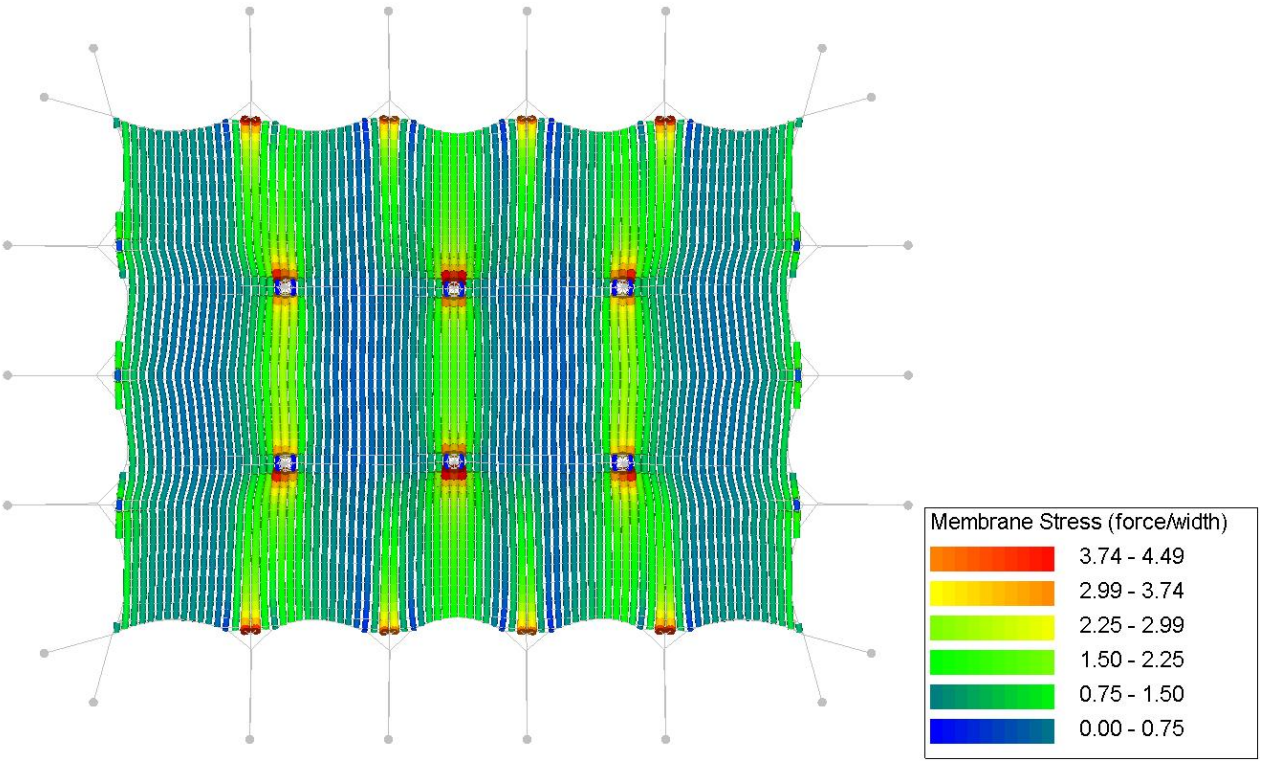


Annex B.6. CO6. Own weight + pretension + wind pressure + snow [FR]

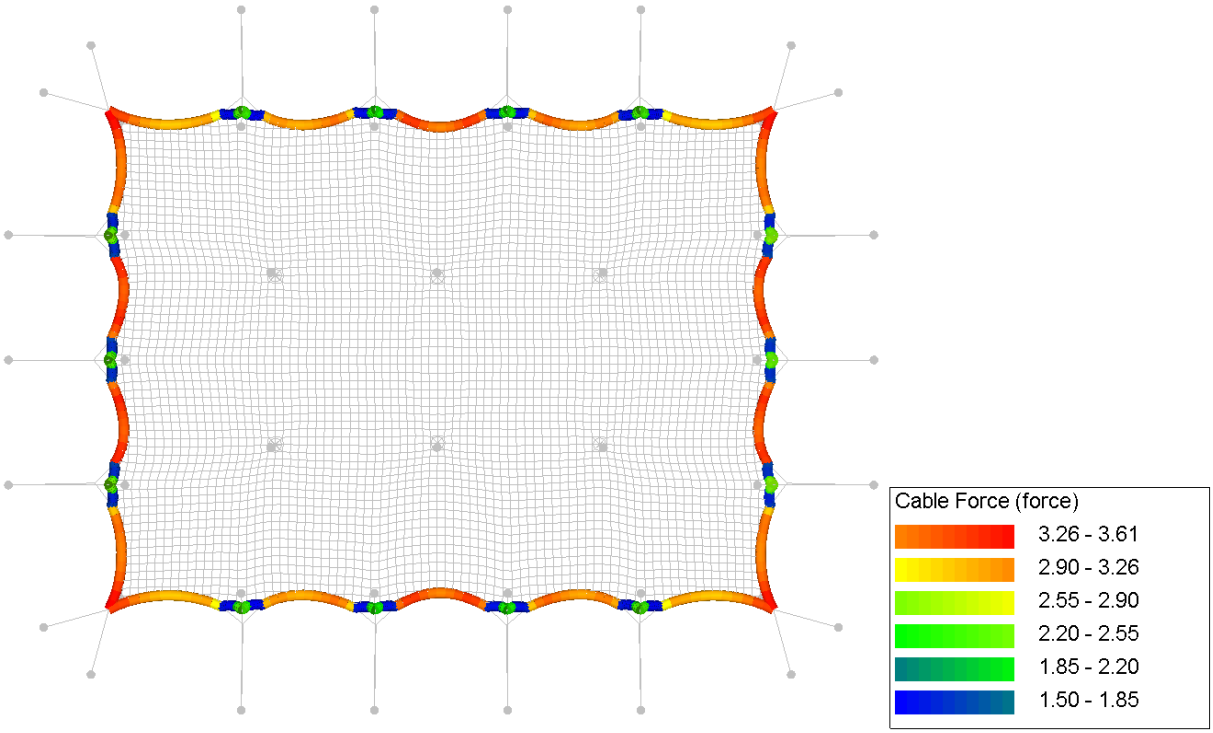
Annex B.6.1. Membrane stress (warp)



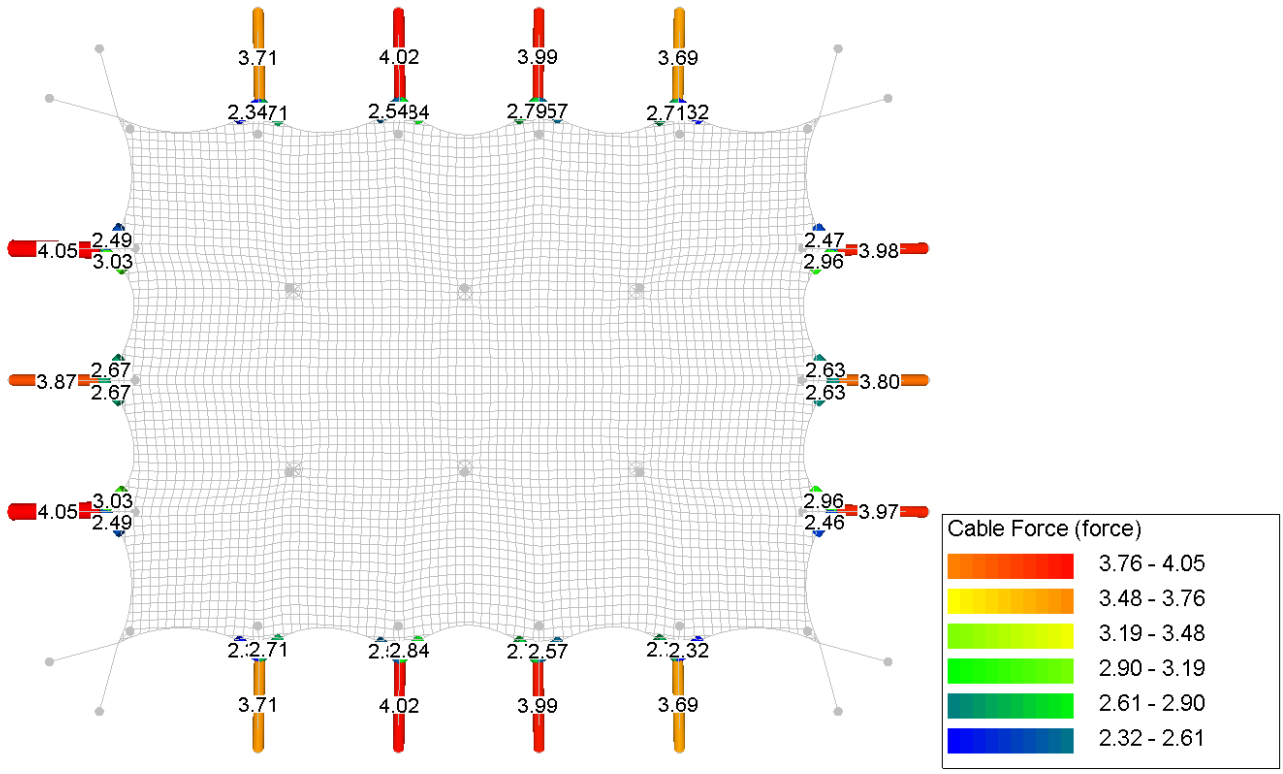
Annex B.6.2. Membrane stress (weft)



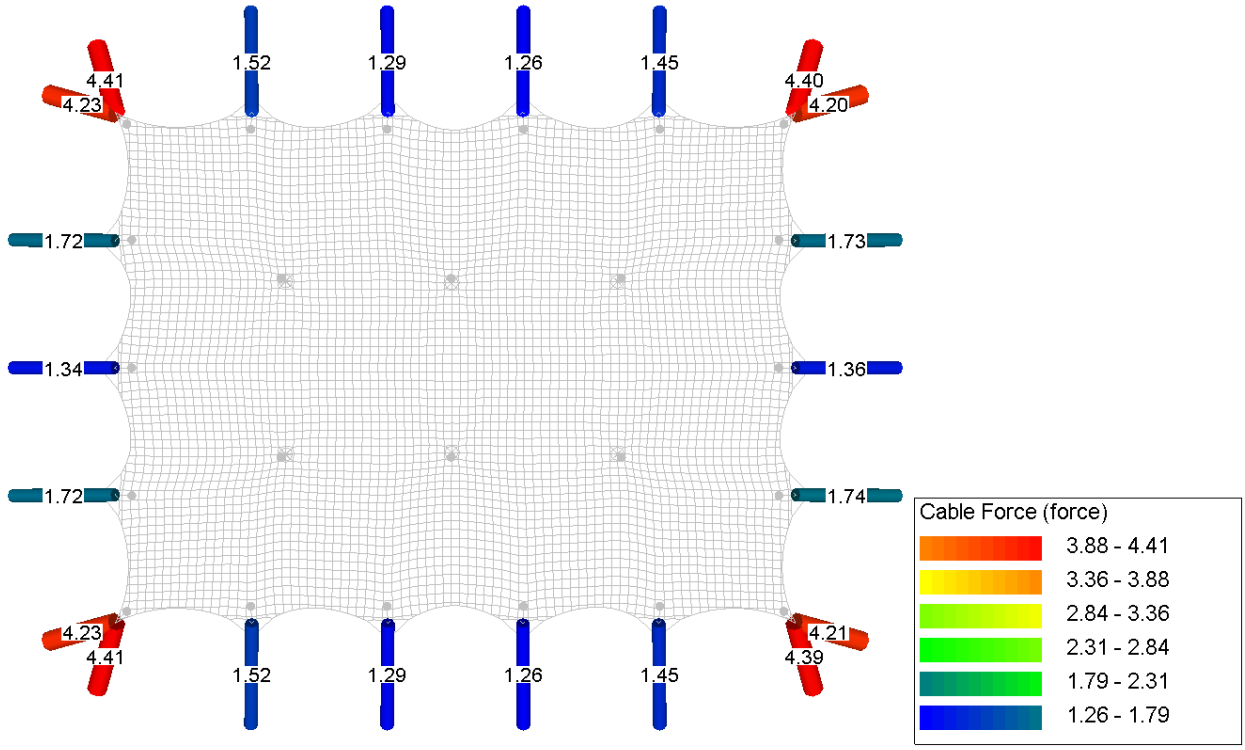
Annex B.6.3. Circumference rope forces



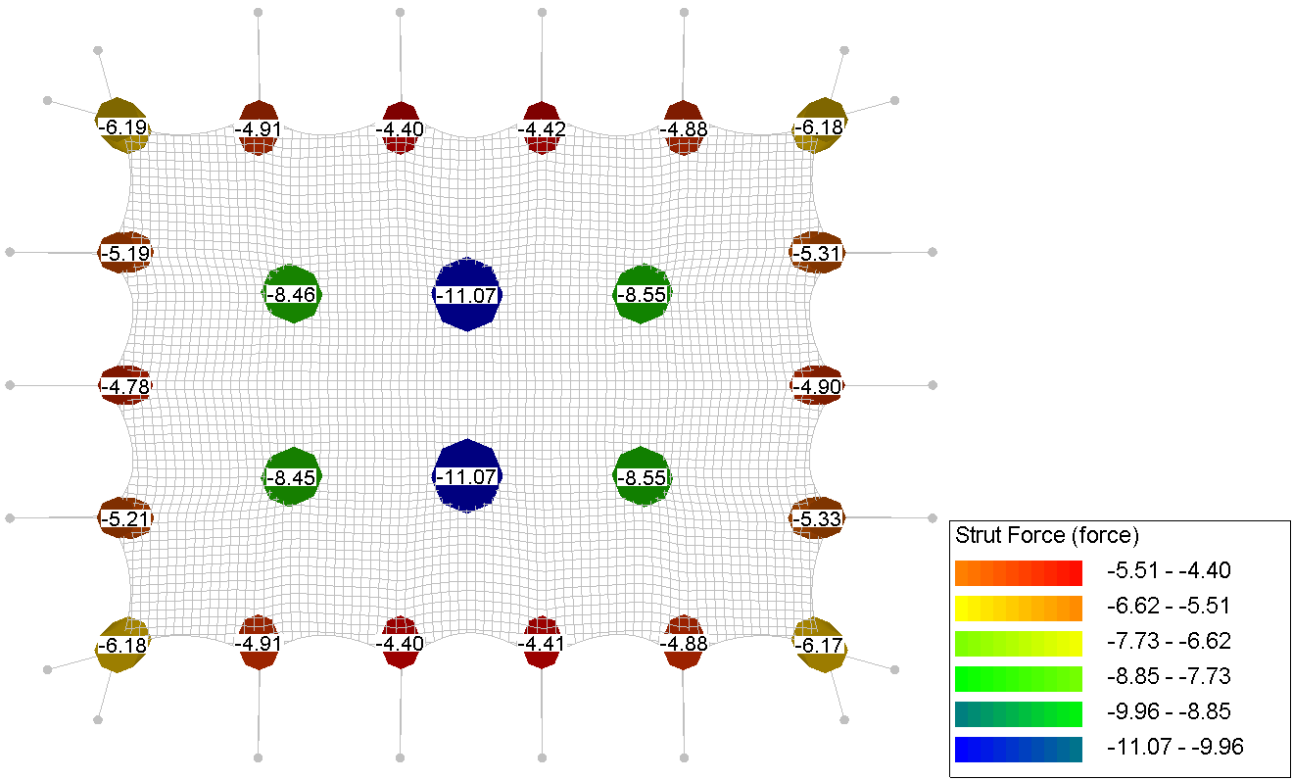
Annex B.6.4. Guy rope forces



Annex B.6.5. Belt forces

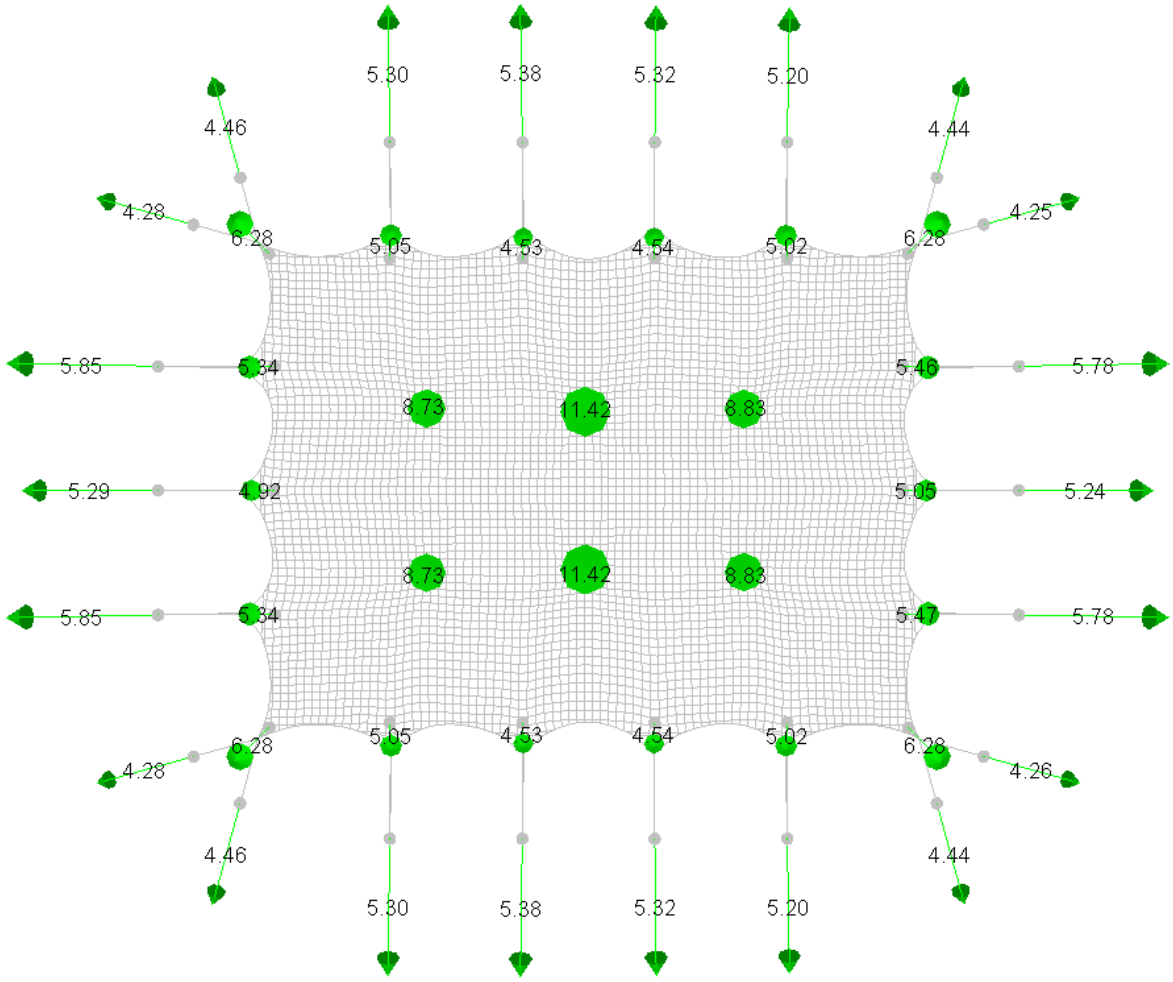


Annex B.6.6. Poles forces



Annex B.6.7. Reaction forces

Increased snow load of 0.1 x 1.5/1.35=0.1083 kN/m2 is applied for ballast and anchor calculation



Annex C. Member checks

Annex C.1. Main pole 4.0m – Wood, Spruce C18

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	95	mm	
Length (buckling)	$l_{buc,y}$	4	m	
Effective area	A	7088.218425	mm^2	
Moment of innertia	I_y	3998198.205	mm^4	
Elastic modules	$W_{el,y}$	84172.59379	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	23.8	mm	
Slenderness	λ_y	168.4		
Relative slenderness	λ_{rely}	2.94		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	5.07		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.109		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	8.72	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.23	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**0.91**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.2. Main pole 5.0m – Wood, Spruce C18

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	110	mm	
Length (buckling)	l_{bucy}	5	m	
Effective area	A	9503.317777	mm^2	
Moment of innertia	I_y	7186884.069	mm^4	
Elastic modules	W_{ely}	130670.6194	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	27.5	mm	
Slenderness	λ_y	181.8		
Relative slenderness	λ_{rely}	3.17		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	5.81		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.094		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	11.44	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.20	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**1.03**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.3. Side pole 3m – Wood, Spruce C18

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	75	mm	
Length (buckling)	l_{bucy}	3	m	
Effective area	A	4417.864669	mm^2	
Moment of innertia	I_y	1553155.548	mm^4	
Elastic modules	$W_{el,y}$	41417.48127	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	18.8	mm	
Slenderness	λ_y	160.0		
Relative slenderness	λ_{rely}	2.79		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.64		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.120		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	6.13	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.39	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**0.93**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.4. Corner pole 2.5m - Wood, C18

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	75	mm	
Length (buckling)	$l_{buc,y}$	2.5	m	
Effective area	A	4417.864669	mm^2	
Moment of innertia	I_y	1553155.548	mm^4	
Elastic modules	$W_{el,y}$	41417.48127	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	18.8	mm	
Slenderness	λ_y	133.3		
Relative slenderness	λ_{rely}	2.32		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	3.40		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.170		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	7.97	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.80	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**0.85**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.5. Main pole 4.0m – Wood, Spruce C18 – for snow and wind combination [FR]

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	100	mm	
Length (buckling)	l_{bucy}	4	m	
Effective area	A	7853.981634	mm^2	
Moment of innertia	I_y	4908738.521	mm^4	
Elastic modules	$W_{el,y}$	98174.77042	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	25.0	mm	
Slenderness	λ_y	160.0		
Relative slenderness	λ_{rely}	2.79		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.64		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.120		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	11.88	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.51	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**1.01**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.6. Main pole 5.0m – Wood, Spruce C18 – for snow and wind combination [FR]

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	120	mm	
Length (buckling)	l_{bucy}	5	m	
Effective area	A	11309.73355	mm^2	
Moment of innertia	I_y	10178760.2	mm^4	
Elastic modules	$W_{el,y}$	169646.0033	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	30.0	mm	
Slenderness	λ_y	166.7		
Relative slenderness	λ_{rely}	2.91		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.98		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.111		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	15.28	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.35	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**0.98**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.7. Side pole 3.0m – Wood, Spruce C18 – for snow and wind combination [FR]

Woodtype		Spruce		
Strenght type		C18		
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
Height	D	80	mm	
Length (buckling)	l_{bucy}	3	m	
Effective area	A	5026.548246	mm^2	
Moment of innertia	I_y	2010619.298	mm^4	
Elastic modules	$W_{el,y}$	50265.48246	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	20.0	mm	
Slenderness	λ_y	150.0		
Relative slenderness	λ_{rely}	2.62		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	4.15		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.136		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	7.53	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.50	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**0.89**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex C.8. Corner pole 2.5m – Wood, Spruce C18 – for snow and wind combination [FR]

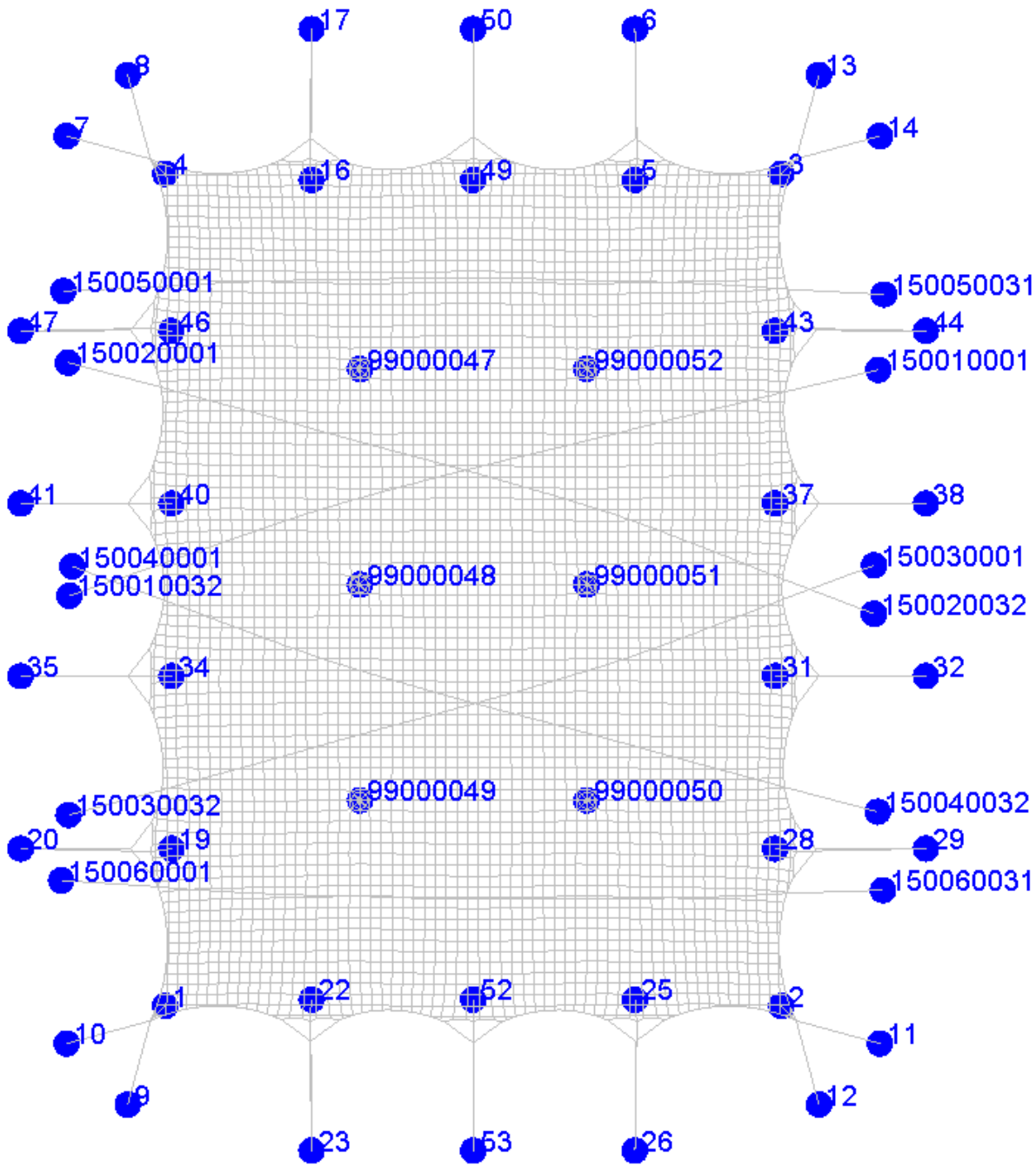
Woodtype		Spruce		
Strenght type		C18		
Material factor	γ_M	1.3		NEN-EN 1995-1-1:2005 table 2.3
Climate class		2		NEN-EN 1995-1-1:2005 article 2.3.1.3
Straightness factor	β_c	0.2		NEN-EN 1995-1-1:2005 equ. 6.29
Height	D	75	mm	
Length (buckling)	$l_{buc,y}$	2.5	m	
Effective area	A	4417.864669	mm^2	
Moment of innertia	I_y	1553155.548	mm^4	
Elastic modules	$W_{el,y}$	41417.48127	mm^3	
Charistic pressure strenght	f_{c0k}	18	N/mm²	
Charistic bending strenght	f_{c0k}	18	N/mm²	
Modules of elasticity	$E_{0.05}$	6	kN/m²	
	i_y	18.8	mm	
Slenderness	λ_y	133.3		
Relative slenderness	$\lambda_{rel,y}$	2.32		NEN-EN 1995-1-1:2005 equ. 6.21
	k_y	3.40		NEN-EN 1995-1-1:2005 equ. 6.21
Buckling factor	k_{cy}	0.170		NEN-EN 1995-1-1:2005 equ. 6.25

Strength check

Pressure force	F_d	8.69	kN	
Bending moment	M_d	0.00	kNm	
Pressure stress	σ_{c0d}	1.97	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}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Design bending strenght	f_{m0d}	12.46	N/mm²	NEN-EN 1995-1-1:2005 equ. 2.14
Strength check		**0.93**		NEN-EN 1995-1-1:2005 equ. 6.23

Annex D. Reaction forces model

Annex D.1. Point numbers



Annex D.2. Reaction forces

Reaction forces are shown in kilonewtons [kN] without any safety factor (1.35, 1.5, 1.2). A load combination especially for anchors and ballast calculation for snow and wind combined is CO6a.

				CO1			CO2			CO3			CO4			CO5			CO6			CO6a		
Att	Node	Koor X	Koor Y	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
Tie	6	-8.00	6.75	-1.77	-0.02	-1.37	-2.69	0.01	-2.11	-3.58	0.04	-2.81	-4.29	0.01	-3.31	-4.19	-0.01	-3.21	-4.51	0.08	-3.57	-4.59	0.08	-3.63
Tie	17	-8.00	-0.75	-1.77	0.02	-1.37	-2.69	-0.01	-2.11	-3.58	-0.04	-2.81	-4.29	-0.01	-3.31	-4.19	0.01	-3.21	-4.52	-0.08	-3.57	-4.59	-0.08	-3.63
Tie	20	11.00	-7.50	-0.02	-1.85	-1.43	0.01	-2.53	-1.98	0.04	-3.27	-2.57	-0.03	-4.55	-3.41	0.02	-4.39	-3.41	0.07	-4.02	-3.18	0.07	-4.08	-3.22
Tie	23	18.00	-0.75	1.77	0.02	-1.36	2.68	-0.01	-2.10	3.55	-0.04	-2.79	4.28	-0.01	-3.30	4.19	0.01	-3.20	4.46	-0.08	-3.53	4.53	-0.08	-3.59
Tie	26	18.00	6.75	1.77	-0.02	-1.37	2.68	0.01	-2.10	3.56	0.04	-2.79	4.26	0.01	-3.28	4.20	-0.01	-3.21	4.46	0.08	-3.53	4.53	0.08	-3.59
Tie	29	11.00	13.50	-0.02	1.85	-1.43	0.01	2.53	-1.98	0.04	3.27	-2.57	-0.03	4.54	-3.40	0.02	4.39	-3.41	0.07	4.02	-3.18	0.07	4.08	-3.23
Tie	32	7.00	13.50	0.00	1.86	-1.51	0.01	2.43	-1.97	0.03	3.31	-2.68	-0.03	3.81	-3.03	-0.03	5.14	-4.35	0.05	4.07	-3.30	0.05	4.13	-3.35
Tie	35	7.00	-7.50	0.00	-1.86	-1.51	0.01	-2.43	-1.97	0.03	-3.31	-2.68	-0.04	-3.80	-3.02	-0.03	-5.14	-4.35	0.05	-4.07	-3.30	0.05	-4.13	-3.35
Tie	38	3.00	13.50	0.00	1.86	-1.51	-0.02	2.46	-1.99	-0.04	3.35	-2.71	0.03	3.72	-2.96	0.04	5.07	-4.30	-0.06	4.12	-3.34	-0.06	4.18	-3.39
Tie	41	3.00	-7.50	0.00	-1.86	-1.51	-0.02	-2.46	-1.99	-0.04	-3.35	-2.71	0.03	-3.76	-2.99	0.04	-5.07	-4.30	-0.06	-4.12	-3.34	-0.06	-4.18	-3.39
Tie	44	-1.00	13.50	0.02	1.86	-1.44	0.00	2.57	-2.02	-0.03	3.33	-2.63	0.03	4.41	-3.30	-0.02	4.36	-3.39	-0.06	4.09	-3.25	-0.06	4.15	-3.29
Tie	47	-1.00	-7.50	0.02	-1.86	-1.44	0.00	-2.57	-2.02	-0.03	-3.33	-2.63	0.02	-4.40	-3.30	-0.02	-4.36	-3.39	-0.06	-4.09	-3.25	-0.07	-4.15	-3.29
Tie	50	-8.00	3.00	-1.72	0.00	-1.37	-2.36	0.00	-1.89	-3.22	0.00	-2.58	-5.14	0.00	-4.19	-5.22	0.00	-4.20	-4.05	0.00	-3.27	-4.12	0.00	-3.32
Tie	53	18.00	3.00	1.72	0.00	-1.36	2.34	0.00	-1.88	3.20	0.00	-2.57	5.10	0.00	-4.16	5.20	0.00	-4.17	4.01	0.00	-3.24	4.08	0.00	-3.29
Tie	7	-5.52	-6.43	-0.45	-1.67	-1.72	-0.58	-2.13	-2.19	-0.71	-2.58	-2.66	-0.82	-2.98	-3.07	-0.79	-2.88	-2.96	-0.83	-3.02	-3.10	-0.84	-3.05	-3.14
Tie	8	-6.93	-5.02	-1.60	-0.43	-1.65	-1.98	-0.54	-2.04	-2.46	-0.67	-2.53	-3.05	-0.84	-3.13	-2.87	-0.79	-2.96	-2.90	-0.80	-2.98	-2.93	-0.81	-3.01
Tie	9	16.93	-5.02	1.60	-0.43	-1.65	1.97	-0.54	-2.04	2.45	-0.67	-2.52	3.03	-0.83	-3.12	2.87	-0.79	-2.95	2.88	-0.79	-2.96	2.91	-0.80	-3.00
Tie	10	15.52	-6.43	0.45	-1.67	-1.73	0.58	-2.13	-2.19	0.70	-2.58	-2.65	0.82	-2.98	-3.06	0.79	-2.88	-2.96	0.82	-3.01	-3.09	0.83	-3.04	-3.12
Tie	11	15.52	12.43	0.46	1.68	-1.73	0.58	2.13	-2.19	0.71	2.58	-2.66	0.82	2.99	-3.08	0.79	2.88	-2.97	0.83	3.01	-3.10	0.84	3.04	-3.13
Tie	12	16.93	11.02	1.59	0.43	-1.64	1.97	0.54	-2.03	2.45	0.67	-2.52	3.03	0.83	-3.11	2.86	0.79	-2.94	2.88	0.79	-2.96	2.91	0.80	-2.99
Tie	13	-6.93	11.02	-1.60	0.43	-1.65	-1.98	0.54	-2.04	-2.46	0.67	-2.53	-3.01	0.83	-3.10	-2.87	0.79	-2.96	-2.90	0.80	-2.98	-2.93	0.81	-3.01
Tie	14	-5.52	12.43	-0.45	1.67	-1.72	-0.58	2.13	-2.19	-0.71	2.59	-2.66	-0.82	2.98	-3.06	-0.79	2.88	-2.96	-0.83	3.02	-3.10	-0.84	3.05	-3.14
Pole	1	14.65	-4.15	0.50	-0.50	2.94	0.68	-0.67	3.98	0.84	-0.83	4.97	0.78	-0.78	4.68	0.72	-0.72	4.33	1.01	-1.00	6.03	1.02	-1.01	6.11
Pole	2	14.65	10.15	0.50	0.50	2.95	0.68	0.67	3.98	0.84	0.83	4.98	0.79	0.79	4.77	0.72	0.72	4.33	1.01	1.00	6.03	1.02	1.02	6.12
Pole	3	-4.65	10.15	-0.50	0.50	2.93	-0.67	0.67	3.97	-0.84	0.83	4.97	-0.78	0.78	4.68	-0.72	0.72	4.32	-1.01	1.00	6.03	-1.02	1.01	6.11
Pole	4	-4.65	-4.15	-0.50	-0.50	2.93	-0.67	-0.67	3.97	-0.84	-0.83	4.97	-0.79	-0.79	4.75	-0.72	-0.72	4.32	-1.01	-1.00	6.03	-1.02	-1.01	6.11
Pole	5	-4.50	6.75	-0.22	0.02	1.33	-0.44	0.02	2.71	-0.61	0.00	3.74	-0.06	0.00	0.39	-0.09	0.00	0.59	-0.83	-0.03	5.16	-0.85	-0.04	5.28
Pole	16	-4.50	-0.75	-0.22	-0.02	1.33	-0.44	-0.02	2.72	-0.61	0.00	3.74	-0.06	0.00	0.40	-0.09	0.00	0.59	-0.83	0.03	5.16	-0.85	0.04	5.28
Pole	19	11.00	-4.00	0.02	-0.21	1.32	0.02	-0.42	2.59	-0.01	-0.58	3.55	0.10	-0.62	3.78	0.00	-0.08	0.51	-0.04	-0.78	4.85	-0.04	-0.80	4.96
Pole	22	14.50	-0.75	0.22	-0.02	1.35	0.45	-0.02	2.78	0.62	0.00	3.83	0.06	0.00	0.37	0.09	0.00	0.59	0.85	0.03	5.28	0.87	0.04	5.40
Pole	25	14.50	6.75	0.22	0.02	1.35	0.45	0.02	2.77	0.62	-0.01	3.82	0.06	0.00	0.38	0.09	0.00	0.59	0.85	-0.04	5.27	0.87	-0.04	5.39
Pole	28	11.00	10.00	0.02	0.21	1.32	0.02	0.42	2.59	-0.01	0.58	3.55	0.08	0.59	3.60	0.00	0.08	0.51	-0.04	0.78	4.85	-0.04	0.80	4.96
Pole	31	7.00	10.00	0.00	0.17	1.07	0.00	0.35	2.16	-0.01	0.52	3.17	-0.02	0.27	1.69	0.00	0.04	0.25	-0.02	0.71	4.38	-0.02	0.72	4.48
Pole	34	7.00	-4.00	0.00	-0.17	1.07	0.00	-0.35	2.16	-0.01	-0.52	3.17	-0.01	-0.26	1.57	0.00	-0.04	0.25	-0.02	-0.71	4.38	-0.02	-0.72	4.48
Pole	37	3.00	10.00	0.00	0.17	1.07	0.00	0.35	2.16	0.01	0.51	3.16	0.02	0.27	1.67	0.00	0.03	0.23	0.03	0.71	4.37	0.03	0.72	4.47
Pole	40	3.00	-4.00	0.00	-0.17	1.07	0.00	-0.35	2.16	0.01	-0.51	3.16	0.03	-0.31	1.88	0.00	-0.03	0.23	0.03	-0.71	4.37	0.03	-0.72	4.47
Pole	43	-1.00	10.00	-0.02	0.21	1.32	-0.02	0.42	2.60	0.00	0.58	3.57	-0.08	0.58	3.55	0.00	0.08	0.48	0.04	0.79	4.88	0.04	0.80	4.98
Pole	46	-1.00	-4.00	-0.02	-0.21	1.32	-0.02	-0.42	2.60	0.00	-0.58	3.57	-0.08	-0.58	3.57	0.00	-0.08	0.48	0.04	-0.79	4.88	0.04	-0.80	4.98
Pole	49	-4.50	3.00	-0.19	0.00	1.15	-0.39	0.00	2.37	-0.55	0.00	3.39	-0.03	0.00	0.21	-0.07	0.00	0.44	-0.77	0.00	4.74	-0.78	0.00	4.85
Pole	52	14.50	3.00	0.19	0.00	1.18	0.40	0.00	2.43	0.57	0.00	3.48	0.03	0.00	0.19	0.07	0.00	0.44	0.79	0.00	4.87	0.80	0.00	4.98
Pole	99000047	-0.12	0.38	-0.01	-0.01	1.26	0.03	0.02	4.09	0.11	0.07	5.62	0.01	0.01	-0.39	0.04	0.01	-0.84	0.26	0.16	8.49	0.27	0.17	8.73

Pole	99000048	4.88	0.38	0.00	-0.01	2.12	0.00	0.04	5.76	0.01	0.12	7.44	0.00	0.00	0.09	0.00	0.00	0.06	0.02	0.27	11.11	0.03	0.29	11.41
Pole	99000049	9.88	0.38	0.01	-0.01	1.25	-0.02	0.03	4.11	-0.09	0.08	5.66	-0.01	0.01	-0.42	-0.04	0.02	-0.96	-0.21	0.18	8.58	-0.22	0.19	8.82
Pole	99000050	9.88	5.63	0.01	0.01	1.25	-0.02	-0.03	4.11	-0.09	-0.08	5.66	-0.01	-0.01	-0.45	-0.04	-0.02	-0.96	-0.21	-0.18	8.58	-0.22	-0.19	8.83
Pole	99000051	4.88	5.63	0.00	0.01	2.12	0.00	-0.04	5.76	0.01	-0.12	7.44	0.00	0.00	0.10	0.00	0.00	0.05	0.02	-0.27	11.11	0.03	-0.29	11.41
Pole	99000052	-0.12	5.63	-0.01	0.01	1.26	0.03	-0.02	4.09	0.11	-0.07	5.62	0.01	-0.01	-0.37	0.04	-0.01	-0.84	0.26	-0.16	8.49	0.27	-0.17	8.73
Stormbelt	150010001	-0.10	12.40										-1.31	5.89	-5.39									
Stormbelt	150010032	5.13	-6.37										1.96	-5.87	-5.21									
Stormbelt	150020001	-0.27	-6.40										-1.40	-5.62	-5.20									
Stormbelt	150020032	5.56	12.29										2.06	5.61	-4.99									
Stormbelt	150030001	4.43	12.30										-2.06	5.73	-5.08									
Stormbelt	150030032	10.22	-6.39										1.43	-5.74	-5.29									
Stormbelt	150040001	4.46	-6.30										-2.08	-5.84	-5.22									
Stormbelt	150040032	10.15	12.38										1.45	5.86	-5.40									
Stormbelt	150050001	-1.92	-6.51										0.15	-6.55	-5.69									
Stormbelt	150050031	-1.85	12.53										0.20	6.56	-5.67									
Stormbelt	150060001	11.74	-6.56										-0.28	-6.70	-5.83									
Stormbelt	150060031	11.96	12.50										-0.08	6.72	-5.80									