IF-Ingenieure für Flächentragwerke GmbH
Tel.: 0049-(0)-7531-9270 80 - Fax: 81

if_group

STATICAL CALCULATION

Revision F

project no:	**1153-Crossover L**
job title:	**CROSSOVER L**
client:	**Creative Structures B.V.** Gewenten 43 A NL - 4704 RE Roosendaal Tel.: +31 (0) 16 551 0777 Fax: +31 (0) 16 551 1727 www.creativestructures.nl
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CONTENT:

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1. GENERAL REMARKS

content:

1.1 Materials

		material	name	name	name	tensile strength	yield strength	corrosion protection	DIN EN
X	pipes	aluminium	EN-AW 6082 T6	ALMgSi1		310	260		1999-1-1
X	connectors	steel	S355J0	Fe 360 B	1.0553	470-630	355	hot dip galvanized	1993
X	cables	stainless steel	AISI 316	X2CrNiMo 17132	1.4401				1993
X	plates	stainless steel	AISI 304	X5CrNi18-10	1.4301	500	190-220		
X	fundation	anchors or ballast system see therefore chapter 6 and chapter 7							
X	concrete	allowable soil stress min p = 200 KN/m² dieser Wert ist vom verantwortlichen Bauleiter zu prüfen							
X	membrane	PVC coated fabric				Mehler 1200/1200 Mehler 4000/4000	Typ I [N/5cm] Typ II [N/5cm]		

X used in this building

Attached data sheets

1.2 Construction

This light-weight structure consists of a mechanically prestressed membrane which is fixed at a primary structure.

-form of membrane surface	**Dome-shaped**
-primary structure	**Aluminium arches, braced through cables**
-use	**Shadowing**

1.3 Formfinding / Geometry

The geometry of the membrane structure will be found by computer (formfinding process) in accordance with structural and architectural views. The membrane is reduced to a cablenet computer model (EASY)

1.4 Structural Analysis

membrane structure	The calculation is based on the data of the formfinding analysis. The geometry of the cablenet computer model will be frozen and supplied with stiffness data and loadings. All deformations are included in the nonlinear analysis. Results are all forces in the cables, elongations and the deformed geometry
primary construction/ foundations	analysis follows usual standards

subject of this calculation is the ananlysis of

membrane + cables	x
primary structure	x
foundations	X

1.5 Software

used in calculation:

software-package EASY	form finding and structural analysis of cablenet - and membrane structures	x
EASY BEAM	framework program	x
RST	Querschnittsnachweise (Viewer für EASY BEAM)	x

1.6 Standards

DIN	Deutsche Norm
DIN EN	Europäische Norm / Eurocode

Load assumption			Year:
- DIN EN	1990	Basis of structural design	2010
- DIN EN	13782	Temporary structures - Tents - Safety	2012
- DIN EN	1991-1-1	Actions on structures - Densities, self-weight	2010
- DIN EN	1991-1-4	Actions on structures - Wind actions	2010
Aluminium			
- DIN EN	1999	Design of aluminium structures	2010
Stahl			
- DIN EN	1993	Design of steel structures	2010
Ropes-cables			
- DIN EN	1993-1-11	Design of steel structures	2010
Membrane			
- DIN	53354	Tensile strength of fabrics	1981
- DIN	53357	Adhesion	1982
- DIN	53363	Tear restistance	2003
- DIN	60001	support cloth	2001

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2. GENERAL ARRANGEMENT + MEASUREMENTS:

Content:

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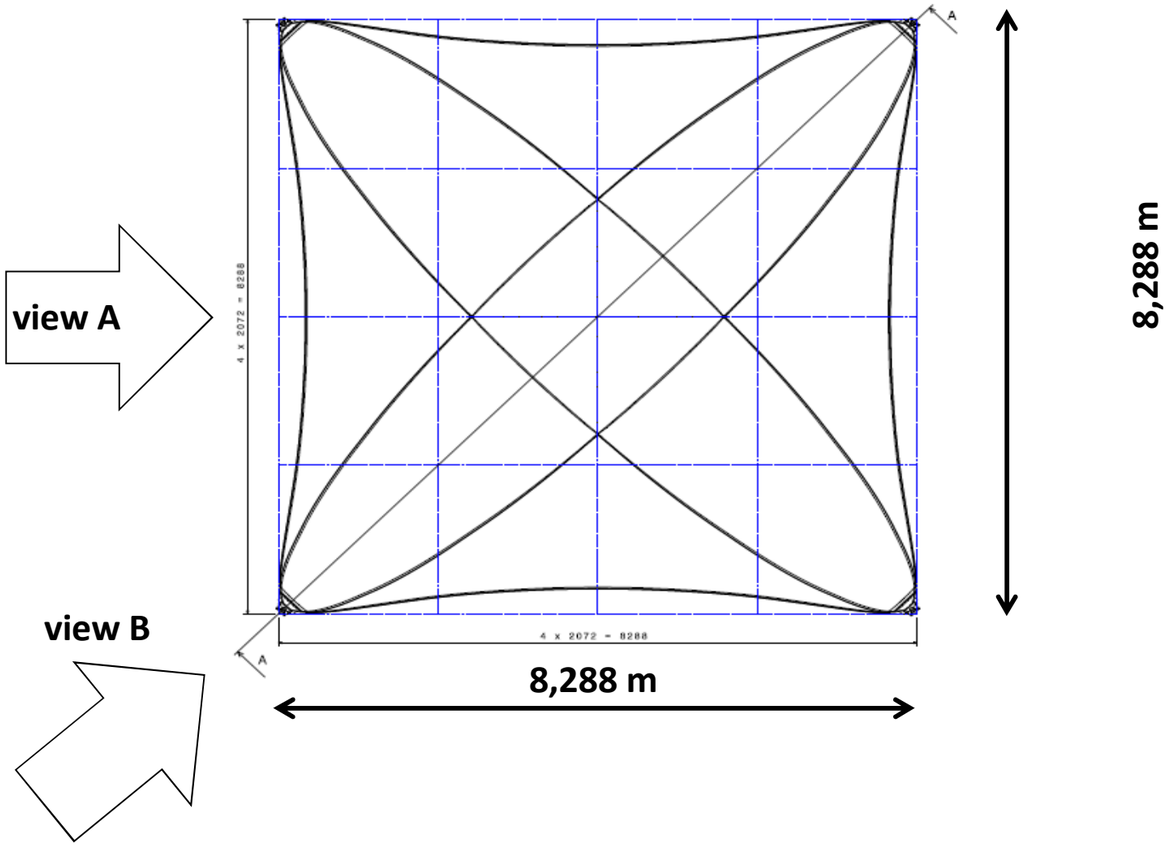
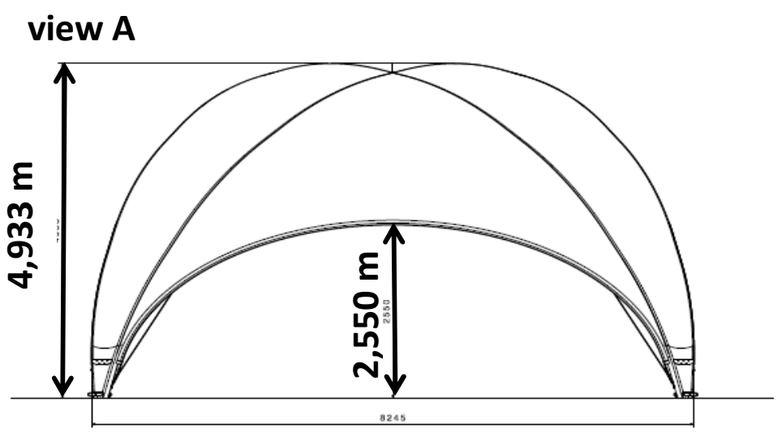
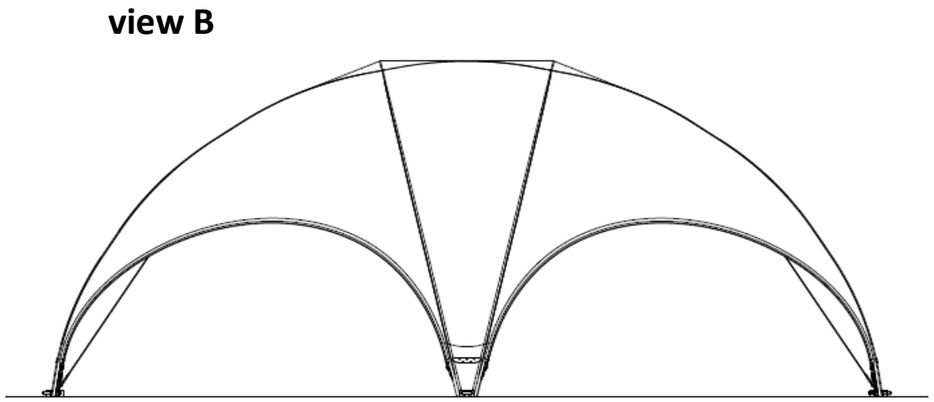
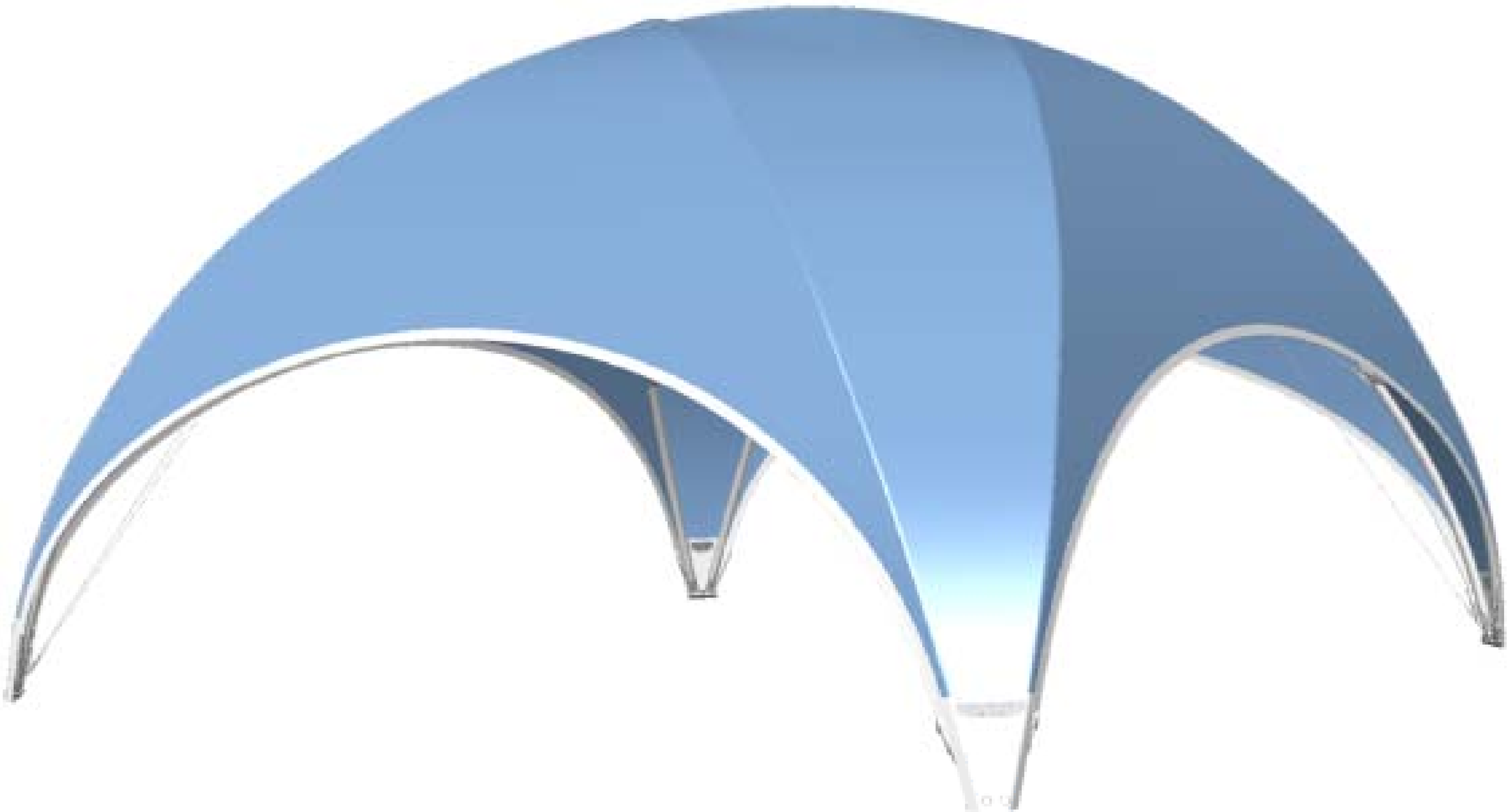
2.1 General Arrangement, Side Views, Sections:







2.2 3D - Views



3. LOAD DESIGN:

content:

3.1 Dead load:

Membrane (incl. Cables):	g_{mem} =	**0,010**	kN/m²

Primary structure: according to DIN EN 1991-1 (disregarded, if not relevant)

3.2 Pretension:

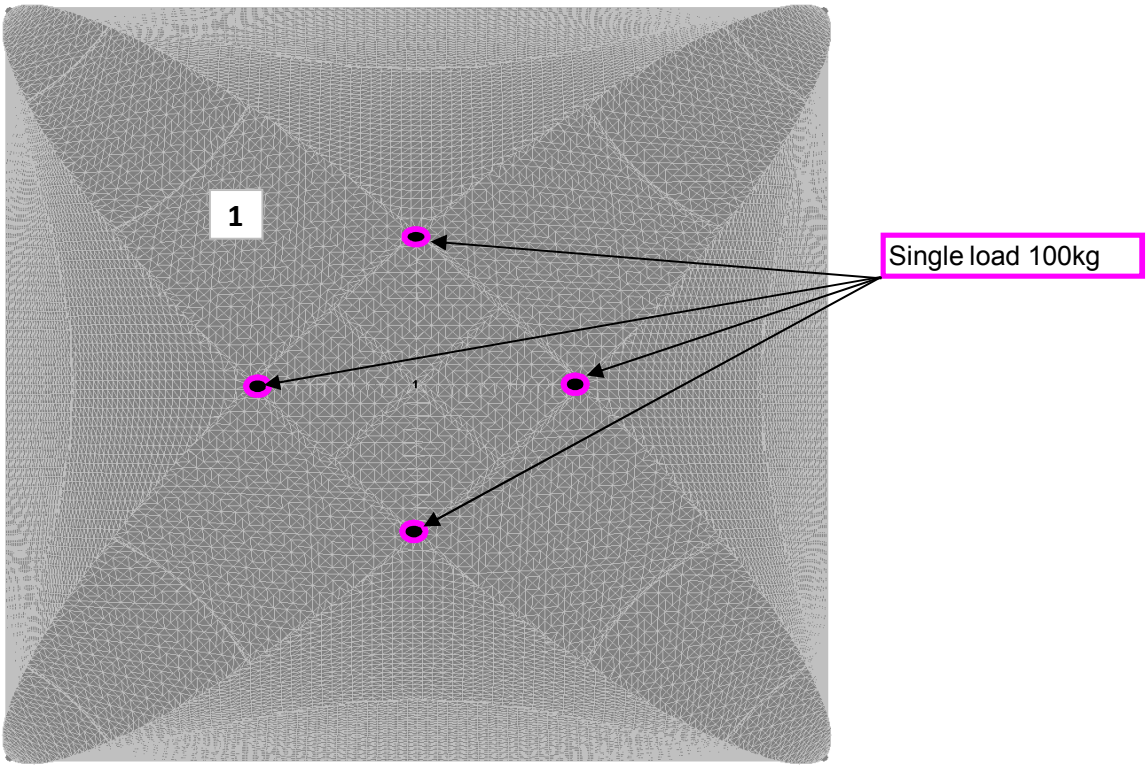
warp direction:	n,wa	**0,25**	kN/m
weft direction:	n,we	**0,25**	kN/m

3.3 Substitutional loading according to DIN EN 13782:

The stability is proven according to passage 6.3 of DIN EN 13782 with a vertical replacement loading of 0,1 kN/m². This loading is not combined with any other loadings except dead load and pretension.

3.4 Technics / Installations:

Technics: Installations:	Loading on each of the 4 arch-crossings:	**1,00** kN



The loading is spread equally on all 4 points. Unequal induction of the loading is impossible.

3.5 WINDLOAD:

DIN EN 13782 states that the wind load can be determined according to DIN EN 1991-1-4 if vref ≤ 28 m/s:

c_{TEM} = 0,8
T_r = 10 Jahre
c_d = 1
c_{ALT} = 1

Tabelle 1 — Windlasten

Höhe: h m	**Staudruck:** q N/m²
h ≤ 5	500
5 < h ≤ 10	600
10 < h ≤ 15	660
15 < h ≤ 20	710
20 < h ≤ 25	760

Vereinfachend können die Werte aus Tabelle 1 mit der Verteilung aus Bild 1 angesetzt werden.

Abweichend von den Standarddrücken aus Tabelle 1 kann für Zelte mit einer Spannweite von weniger oder gleich 10 m und einer Höhe von weniger oder gleich 5 m ein reduzierter Staudruck von 300 N/m² angewandt werden.

Building height **h =** **5** **[m]**
Dynamic pressure **q =** **0,3** **[kN/m²]** **for normal setup**
Dynamic pressure **q =** **0,6** **[kN/m²]** **for a setup on a stage with a max hight of 5m**

Drag coefficients for walls and domes according to DIN EN 1991-1-4:

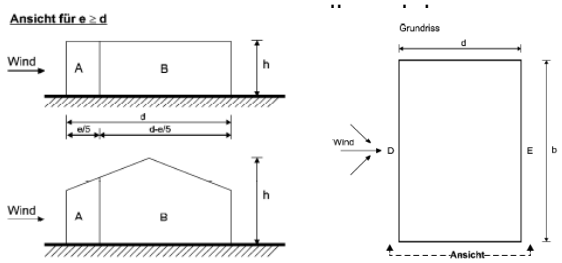
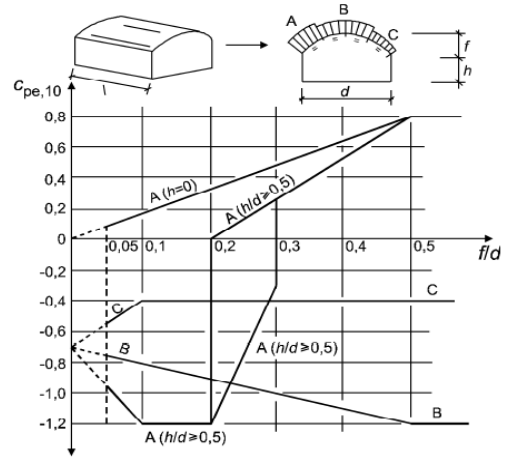
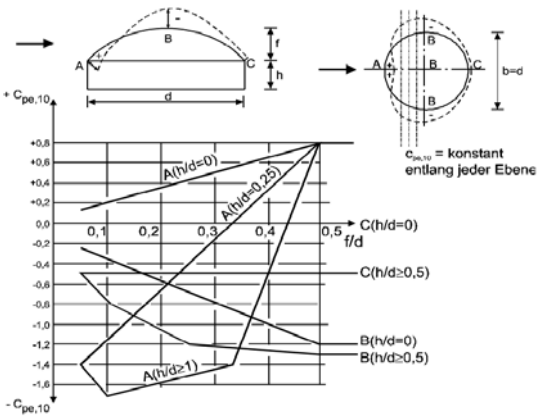


Tabelle 7.1 — Empfohlene Außendruckbeiwerte für vertikale Wände rechteckiger Gebäude

Bereich	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	





The following coefficients were determined on the basis of these drawings, taken from the standards. They were then applied to the shape in a reasonable way.

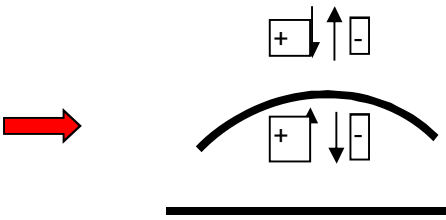
3.5.1 Wind 0°

Assuption for wind load: Tent closed from all sides

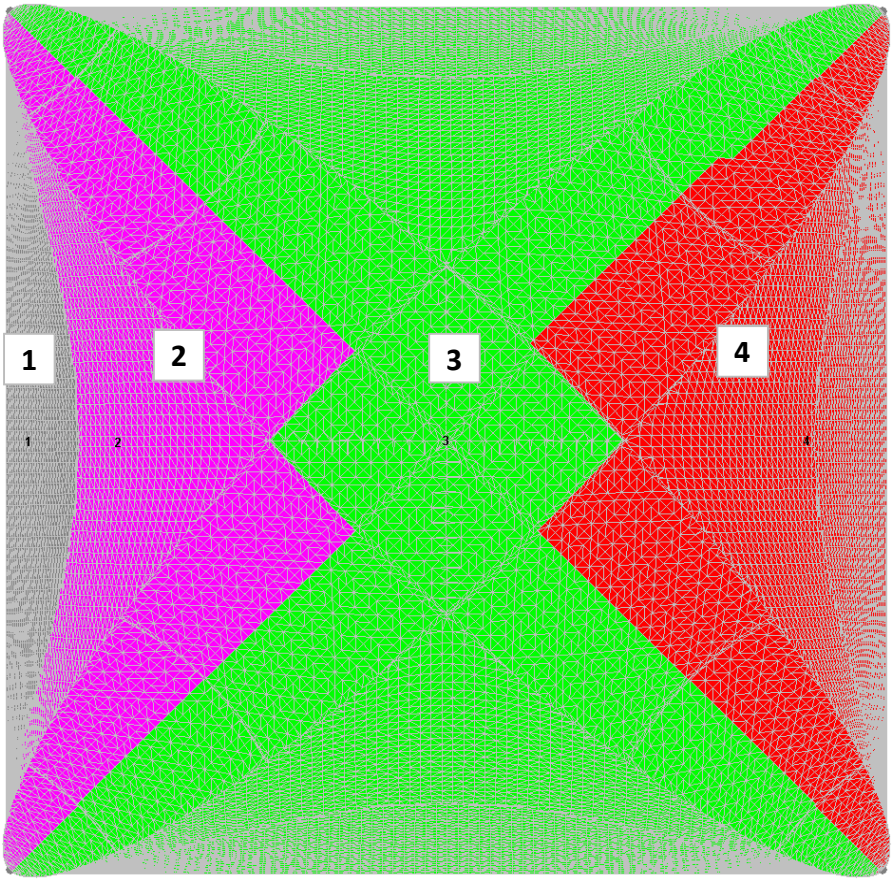
Drag coefficients + wind load:				Wind load	Wind load
	outside	inside	total	q = 0,3	q = 0,6
Zone:	cp ob:	cp un:	cp ges:	w [KN/m²]:	w [KN/m²]:
1	0,80	0,00	0,80	**0,24**	**0,48**
2	0,47	0,00	0,47	**0,14**	**0,28**
3	-0,80	0,00	-0,80	**-0,24**	**-0,48**
4	-0,40	0,00	-0,40	**-0,12**	**-0,24**

The given coefficients (cp tot) take into account the sum of outside (cp out) and inside (cp in) factors.

wind



Areas of loading:
LF D 1 - 7 1,35 x EG + V + 1,5 x Wind 0° (dyn. pressure 0,6)
LF G 1 - 7 EG + V + Wind 0° (dynamic pressure 0,3)

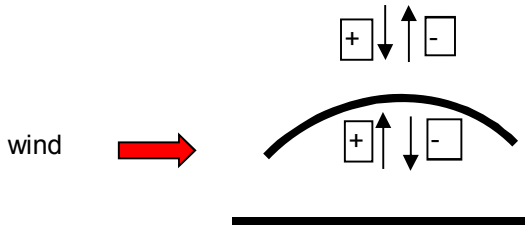


3.5.2 Wind 45°

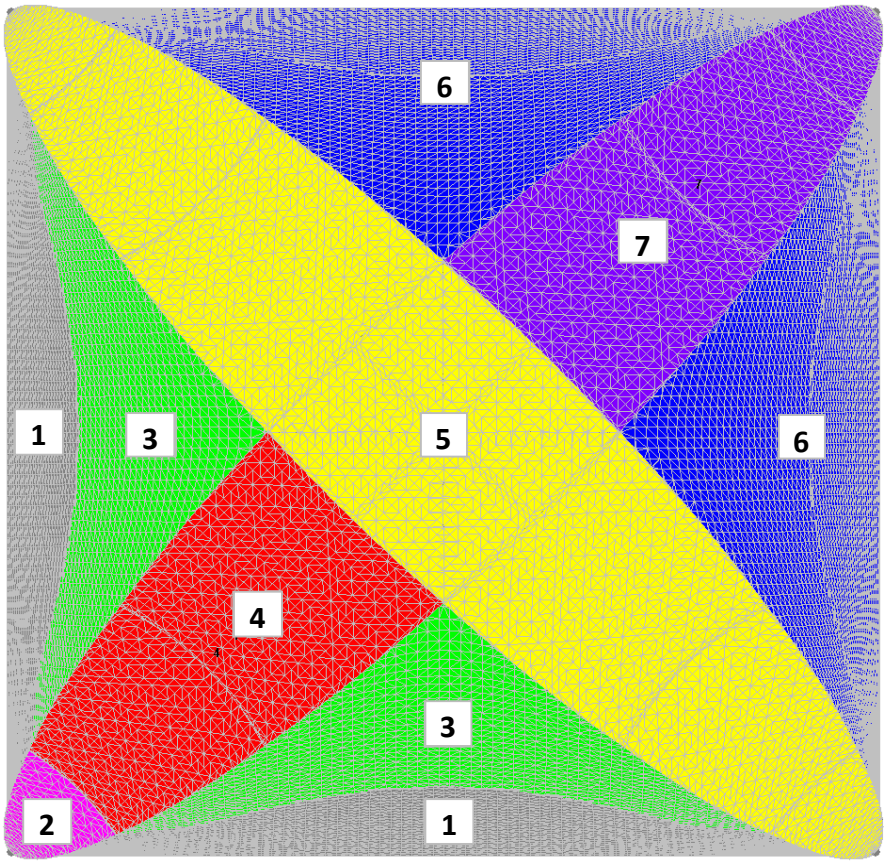
Assuption for wind load: Tent closed from all sides

Drag coefficients + wind load:	outside	inside	total	Wind load q = 0,3	Wind load q = 0,6
Zone:	cp ob:	cp un:	cp ges:	w [KN/m²]:	w [KN/m²]:
1	0,56	0,00	0,56	**0,17**	**0,34**
2	0,80	0,00	0,80	**0,24**	**0,48**
3	0,33	0,00	0,33	**0,10**	**0,20**
4	0,47	0,00	0,47	**0,14**	**0,28**
5	-0,80	0,00	-0,80	**-0,24**	**-0,48**
6	-0,28	0,00	-0,28	**-0,08**	**-0,17**
7	-0,40	0,00	-0,40	**-0,12**	**-0,24**

The given coefficients (cp tot) take into account the sum of outside (cp out) and inside (cp in) factors.



Areas of loading:
LF D 1 - 7 1,35 x EG + V + 1,5 x Wind 45° (dyn. pressure 0,6)
LF G 1 - 7 EG + V + Wind 45° (dynamic pressure 0,3)



3.6 loadcase combinations:

Basically for surface structures it is important to superpose the loads and not the section forces. The loadcase pretension ist automatically superposed. Otherwise the extremals must be found by plausible combinations of load cases.

LF A	1,35 x EG + V
LF B	1,35 x EG + V + 1,5 x Substitutional loading
LF C	1,35 x EG + V + 1,5 x Installations
LF D	1,00 x EG + V + 1,5 x Wind 0° (dyn.press.0,6)
LF E	1,00 x EG + V + 1,5 x Wind 45° (dyn.press.0,6)
LF F	EG + V
LF G	EG + V + 1,2 x Wind 0° (dyn.press.0,3)
LF H	EG + V + 1,2 x Wind 45° (dyn.press.0,3)
LF I	EG + V + 1,2 x Wind 0° (dyn.press.0,6)
LF J	EG + V + 1,2 x Wind 45° (dyn.press.0,6)

The following safety factors are used for the structural calculation of membrane and aluminium parts.

Dead load	**1,35**	**(1,00 if acting beneficial)**
Pretension	**1,00**	
Live load	**1,50**	

The following safety factors are used for the structural calculation of ballast and anchors.

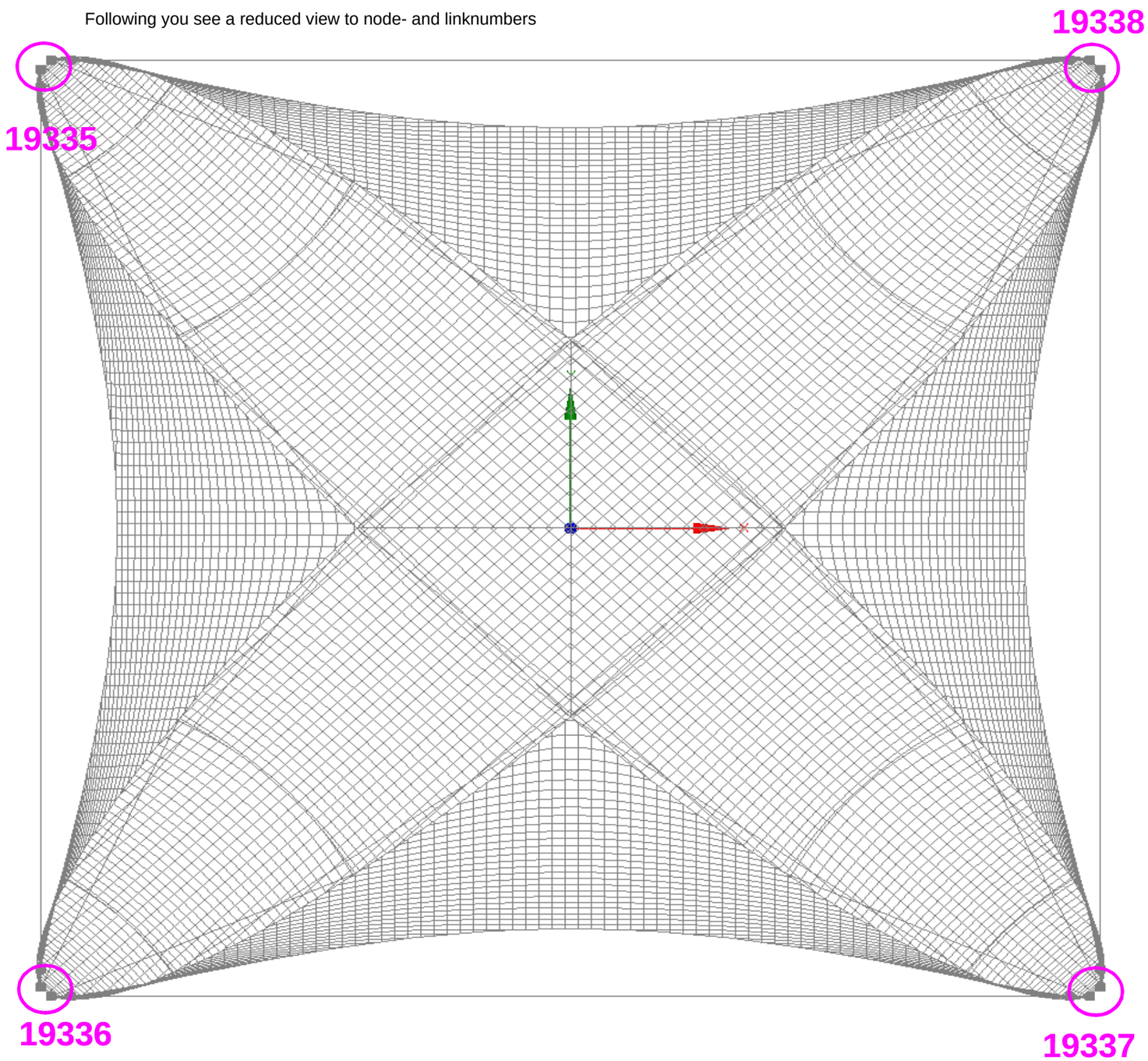
Dead load	**1,00**
Pretension	**1,00**
Live load	**1,20**

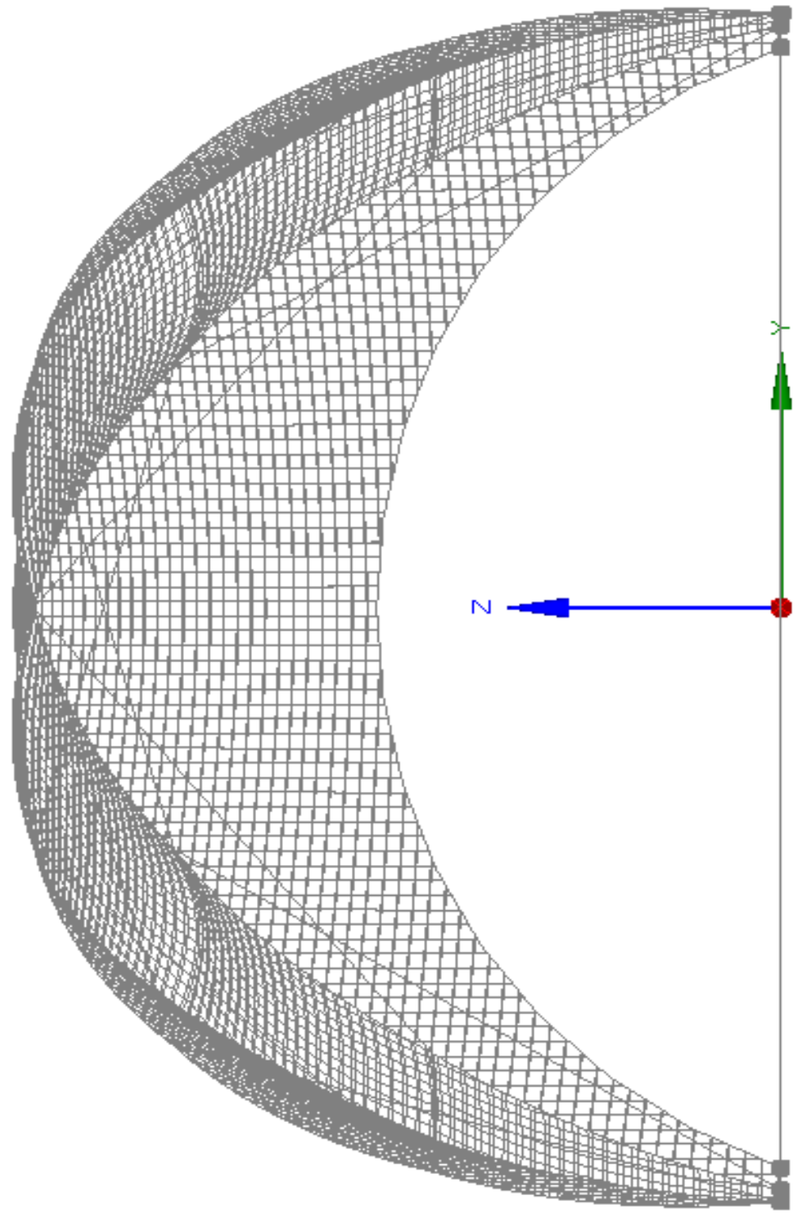
4. ANALYSIS BASICS:

Content:

4.1 Numbering of nodes and links:

Following you see a reduced view to node- and linknumbers





4.2 Stiffness:

SPIRAL STRAND (SS): DIN 3053 E= 130000 N/mm2
stainless steel A4 bulk factor: f = 0,76

MEMBER:	∅	EF (KN)
cable	5	1.940
cable	6	2.794
	0	0
	0	0
	0	0
	0	0

STRAND ROPE (RS): DIN 3060 E= 90000 N/mm2
stainless steel A4 bulk factor: f = 0,528

MEMBER:	∅	EA (KN)
boundary cable:	5	933
	0	0
	0	0
	0	0
	0	0
	0	0

TUBES: E = 70000 N/mm2
Material: AL EN AW 6082 T6

MEMBER:	∅	s	EF (KN)
main profile	90	3	57.397
subprofile	70	3	44.202
	0	0	0
	0	0	0

MEMBRANE

MEMBER:	material:	company:	Typ	EA (KN) Kette	EA (KN) Schuss	
roof-membrane:	PVC/PES	Mehler	I	400	300	**X**
		Mehler	II	1000	600	**X**

5 LOAD CASE ANALYSIS:

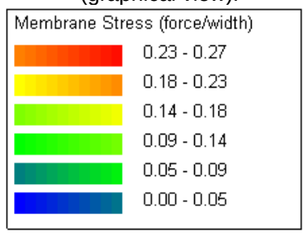
content:

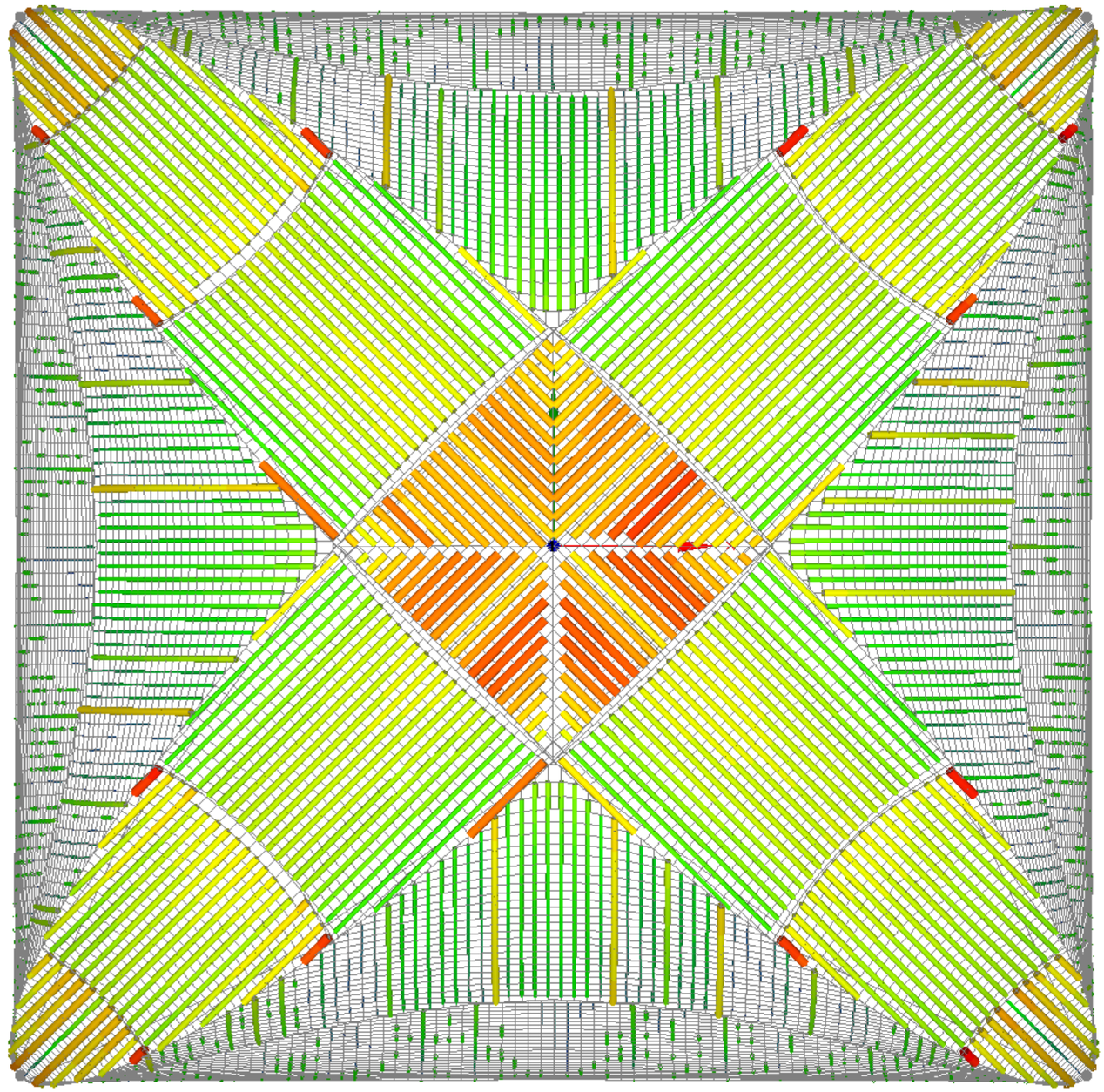
5.1 load combination A 1,35xEG+V

WEFT DIRECTION

5.1.1 STRESSES:

(graphical view):



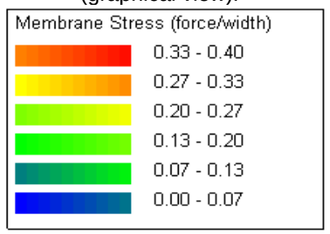


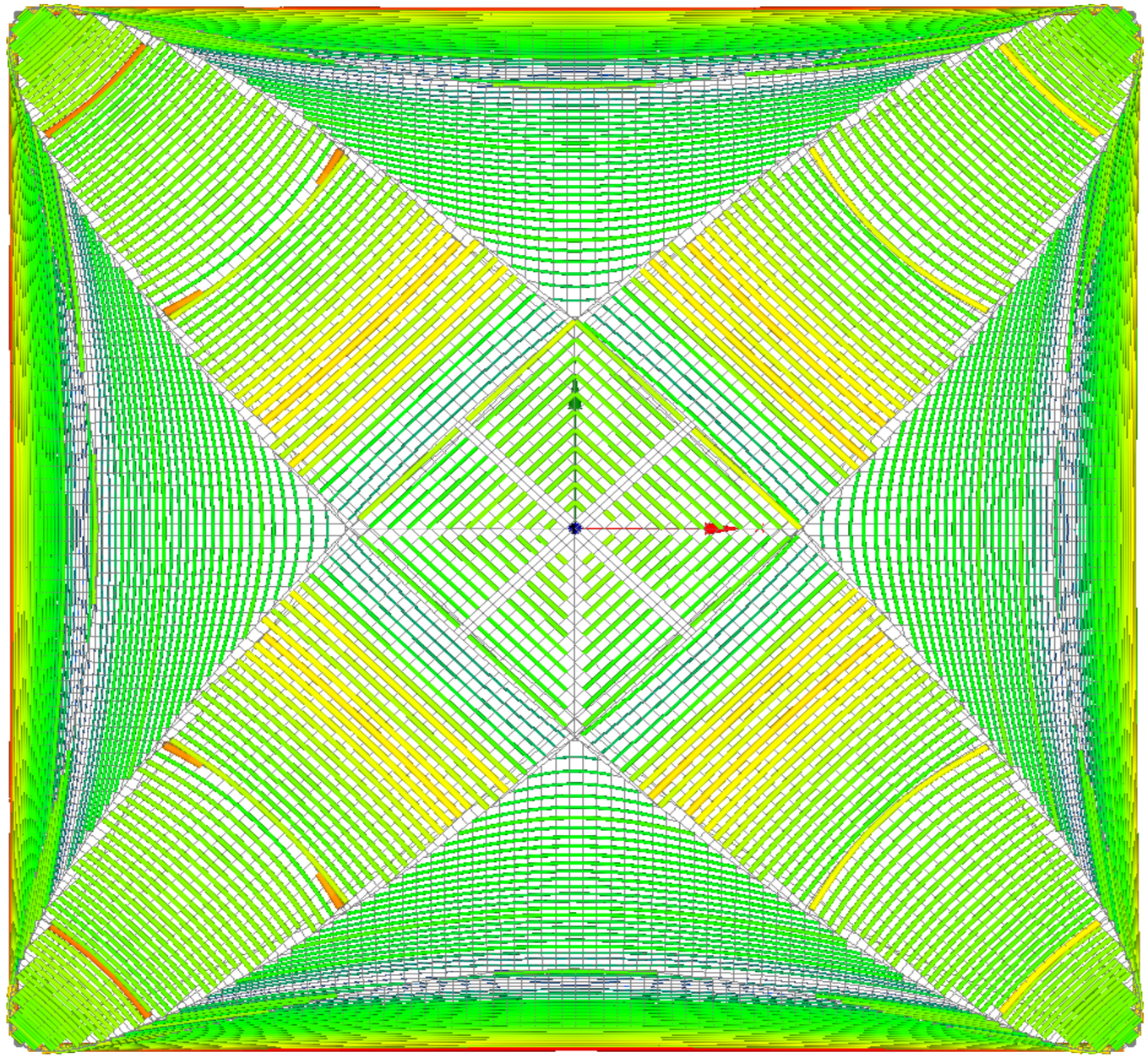
5.1 load combination A 1,35xEG+V

FILL DIRECTION

5.1.2 STRESSES:

(graphical view):

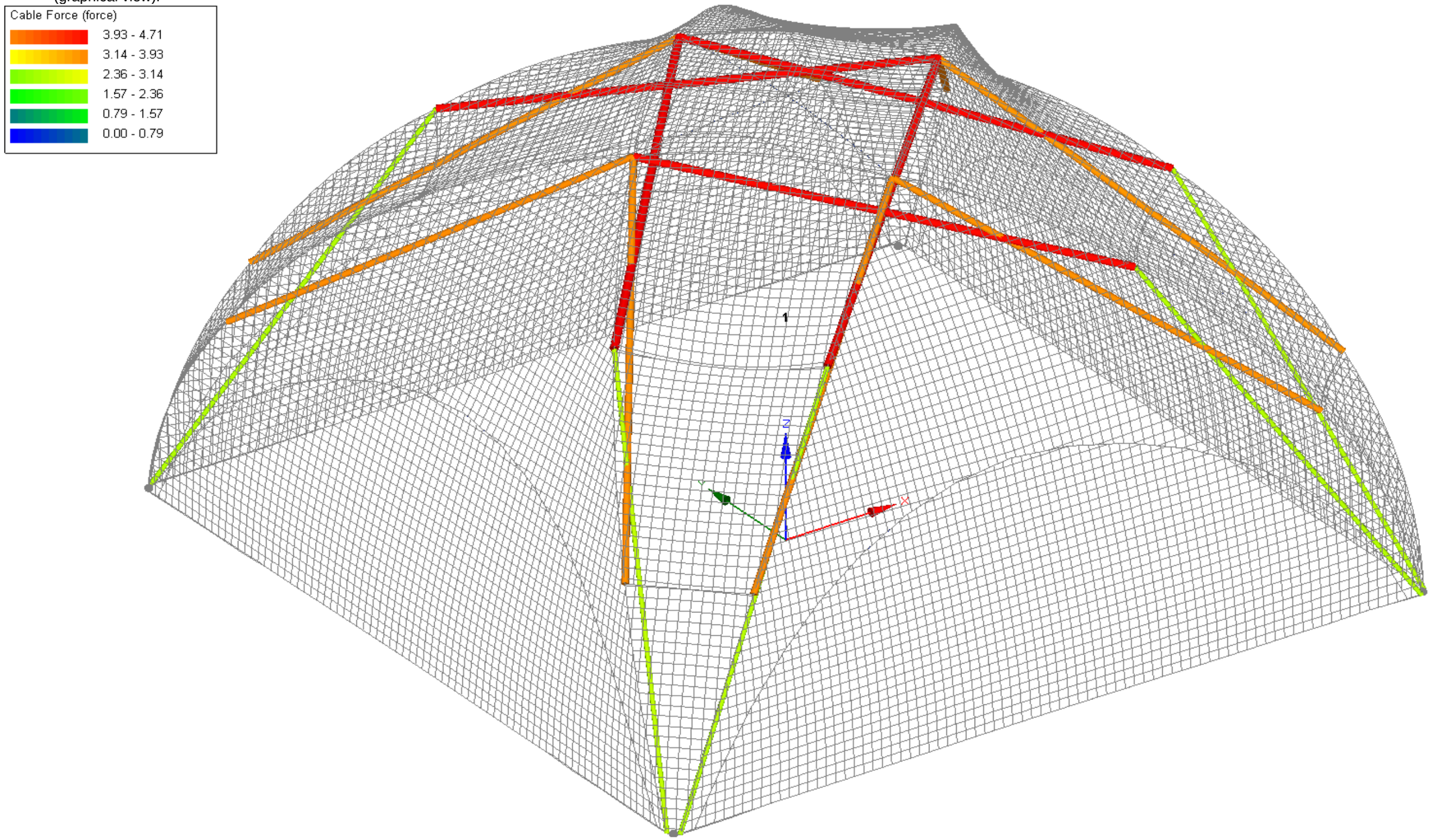




5.1 load combination A 1,35xEG+V cableforce

5.1.3 STRESSES:

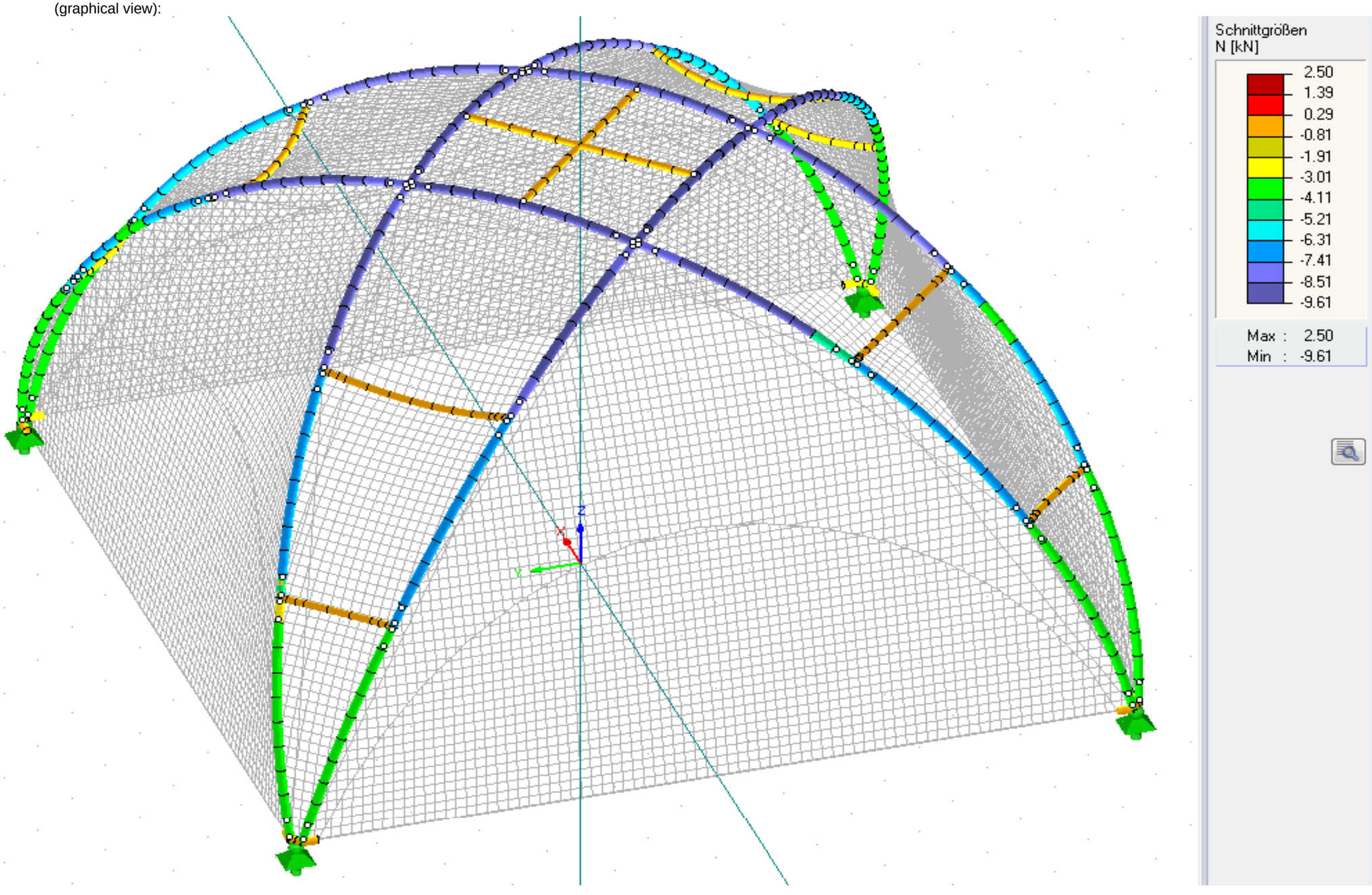
(graphical view):



5.1 load combination A 1,35xEG+V COLLUMN FORCES

5.1.4 STRESSES:

(graphical view):

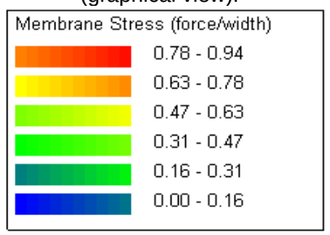


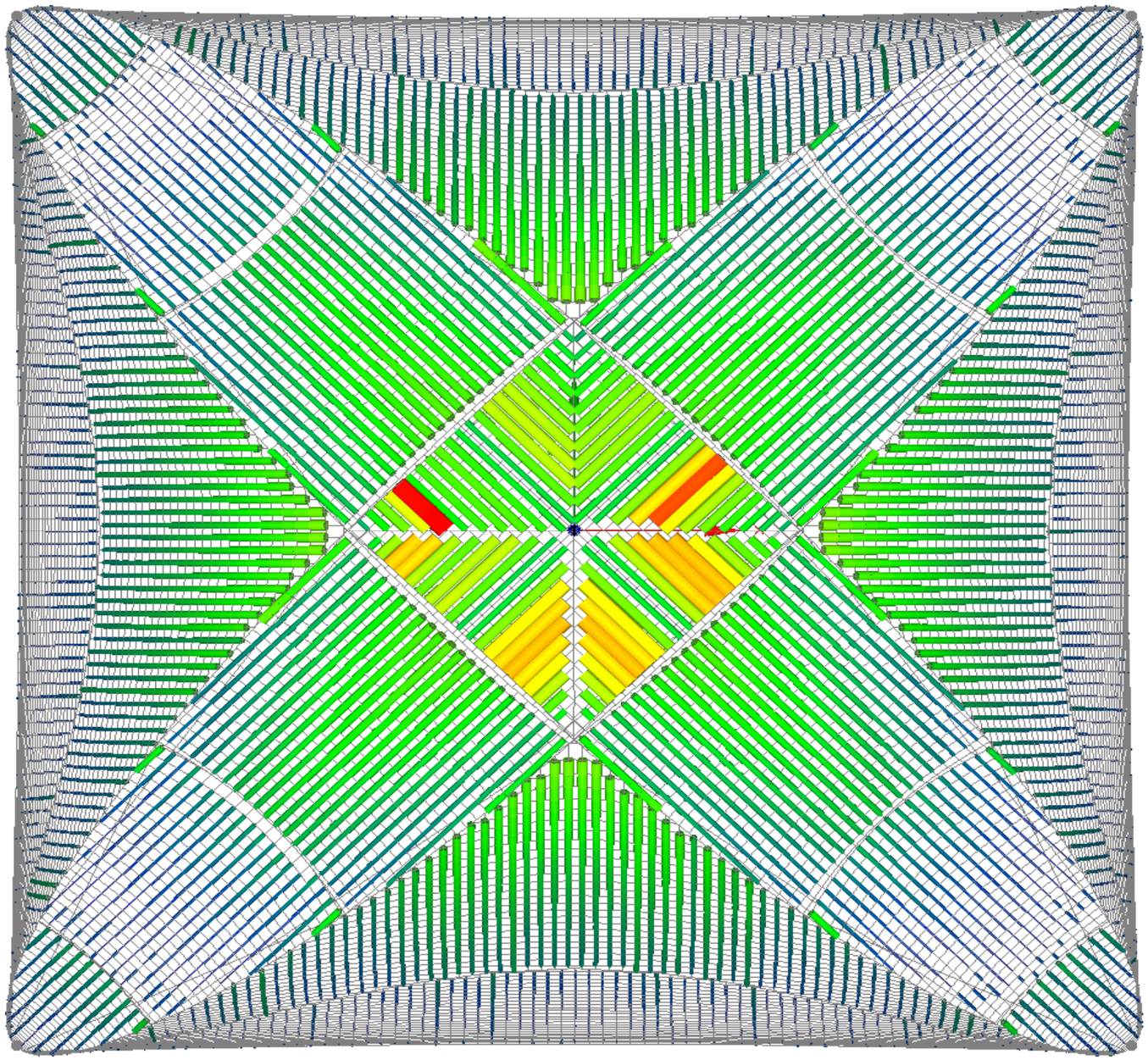
Weiter Schnittgrößen sind im R-Stab Ausdruck in Listenform dargestellt

5,2 load combination B 1,35xEG+V+1,5xSubstitutional load WEFT DIRECTION

5.2.1 STRESSES:

(graphical view):

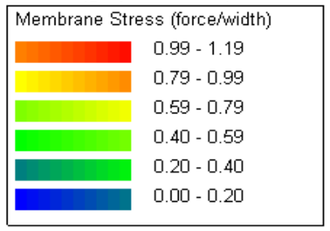


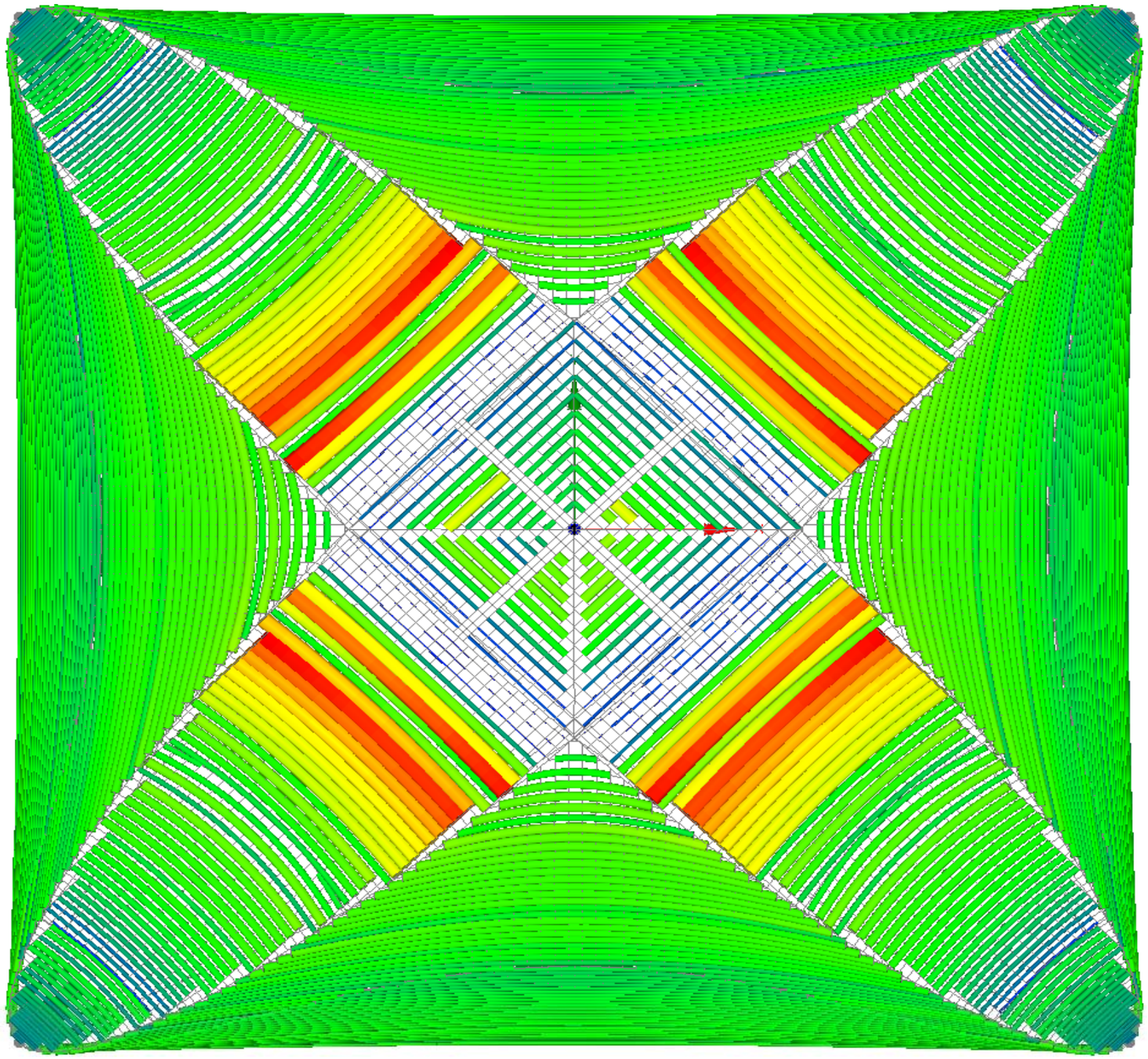


5.2 load combination B 1,35xEG+V+1,5xSubstitutional load FILL DIRECTION

5.2.2 STRESSES:

(graphical view):

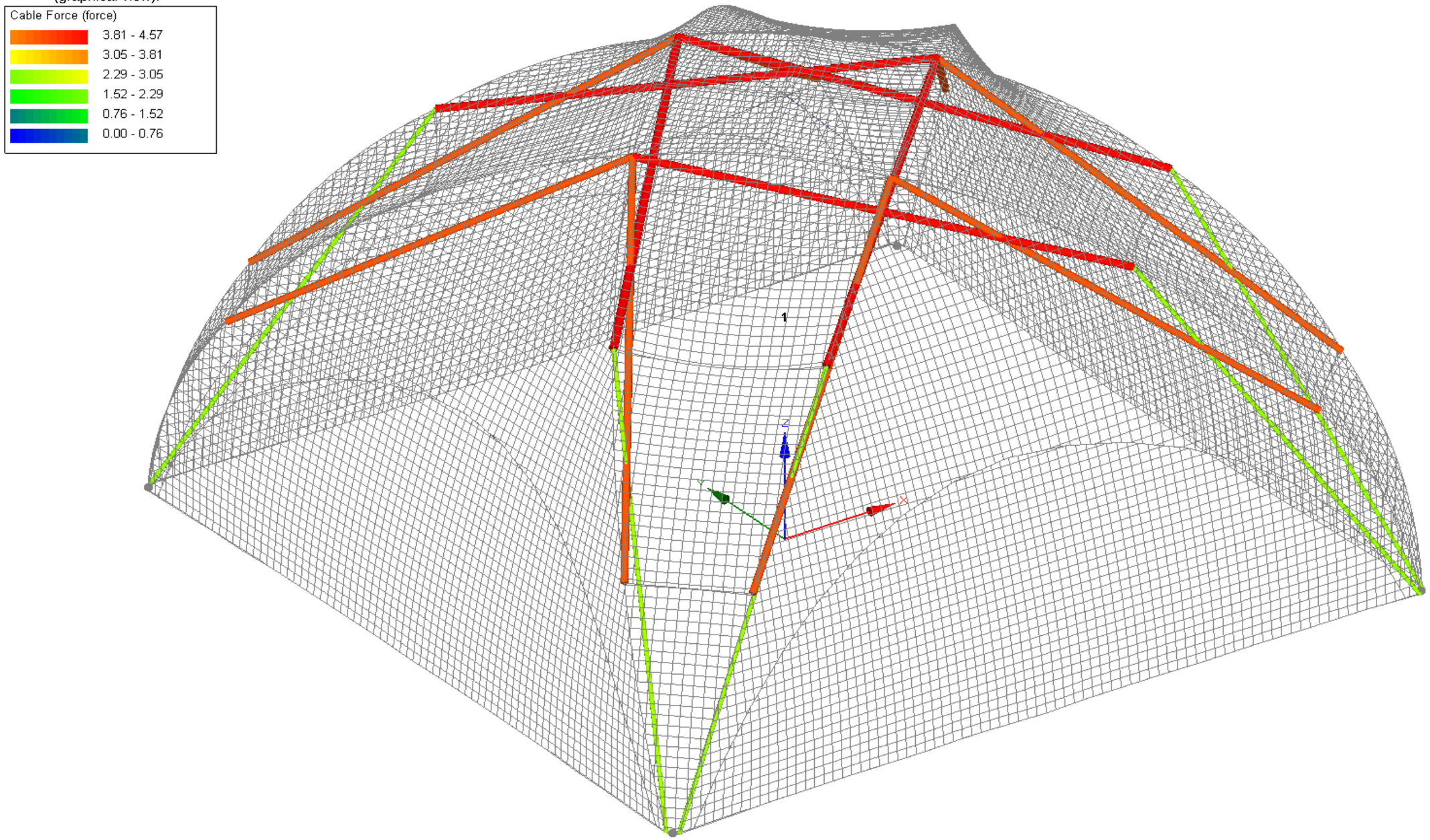




5.2 load combination B 1,35xEG+V+1,5xSubstitutional load cableforce

5.2.3 STRESSES:

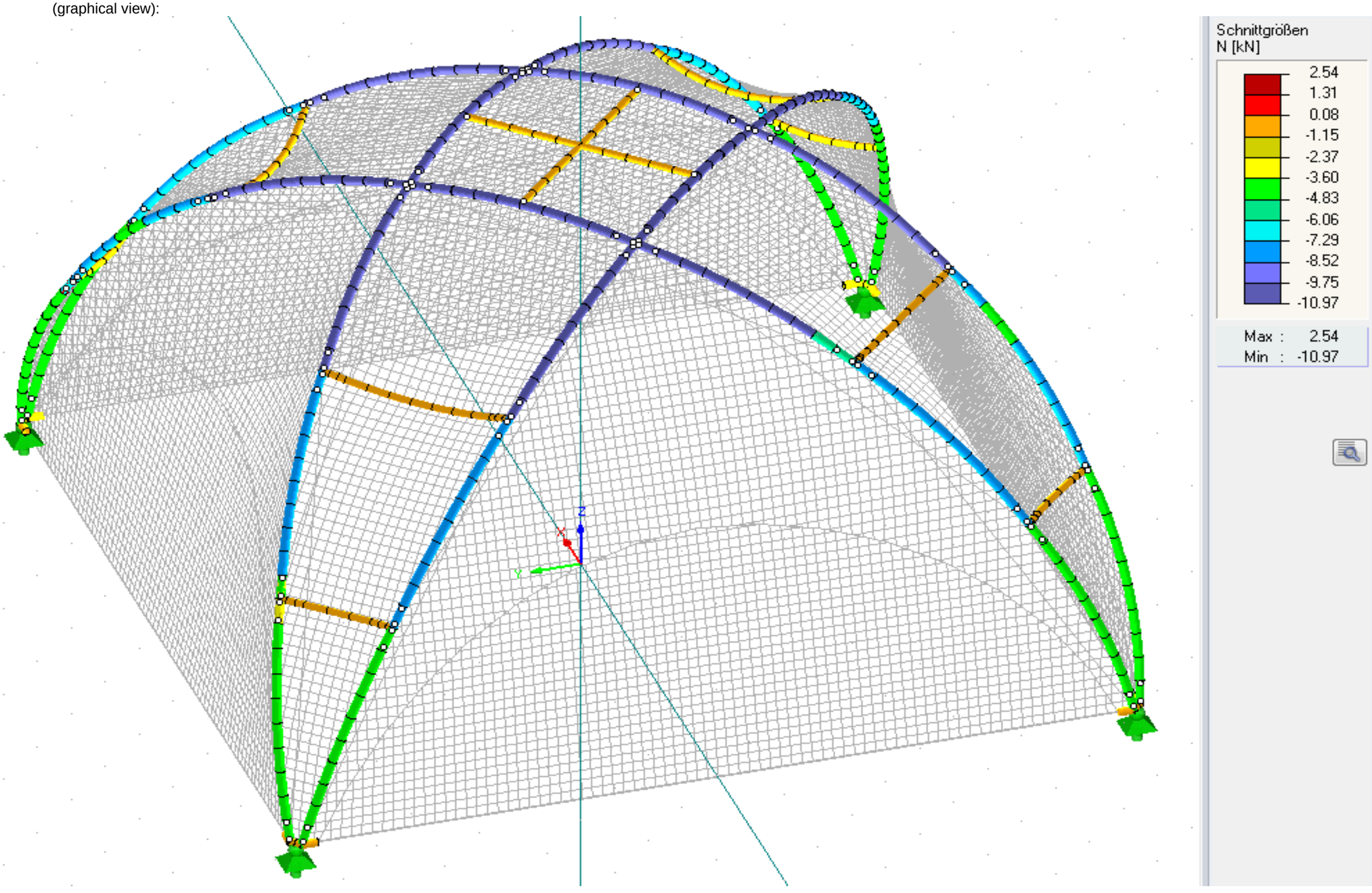
(graphical view):



5.2 load combination B 1,35xEG+V+1,5xSubstitutional load COLLUMN FORCES

5.2.4 STRESSES:

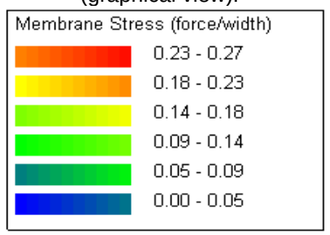
(graphical view):

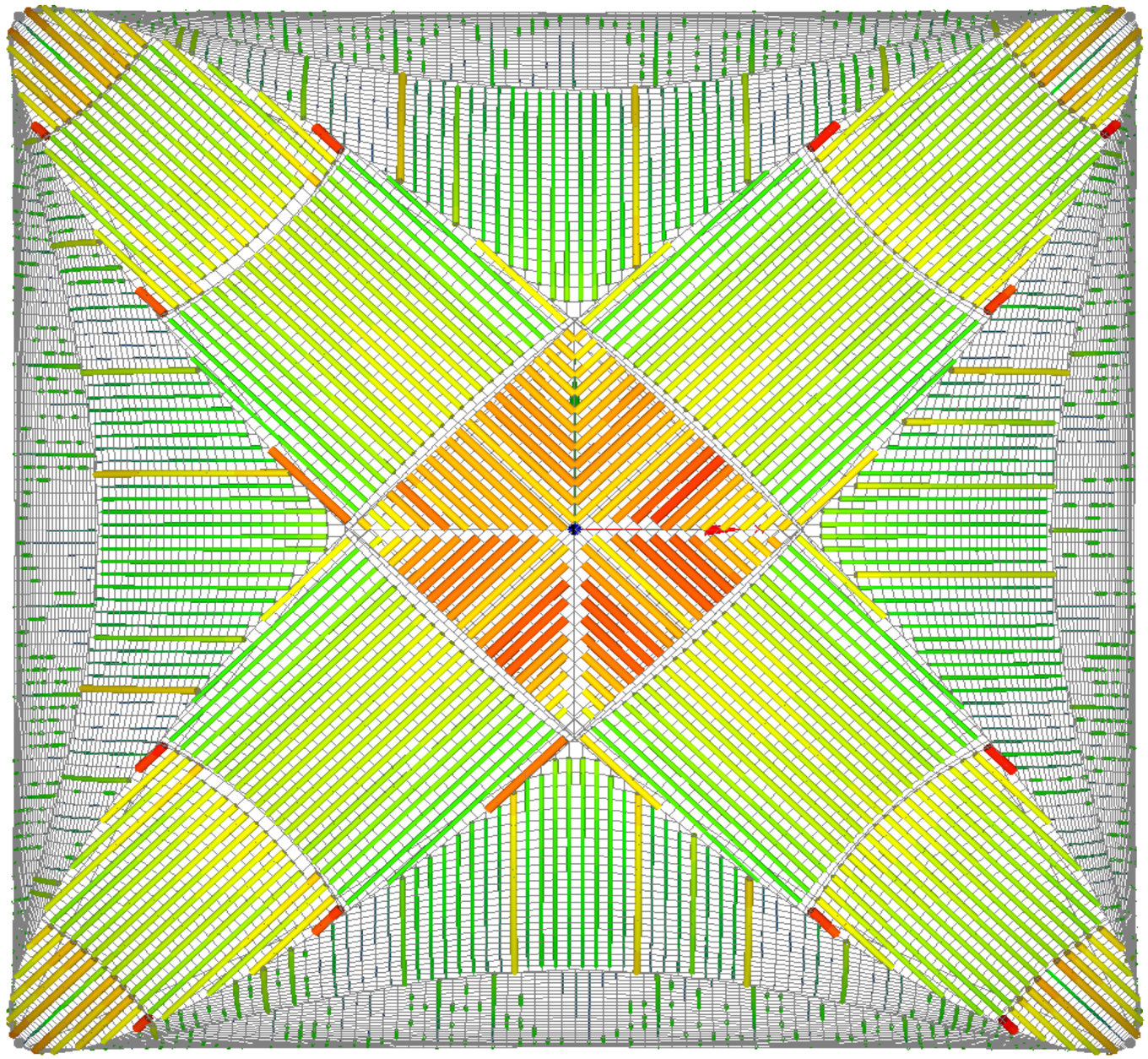


5.3 load combination C 1,35xEG+V+1,5xInstallations WEFT DIRECTION

5.3.1 STRESSES:

(graphical view):

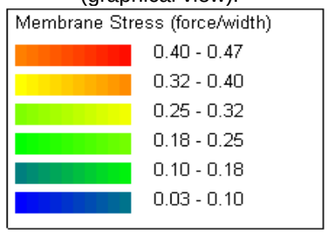


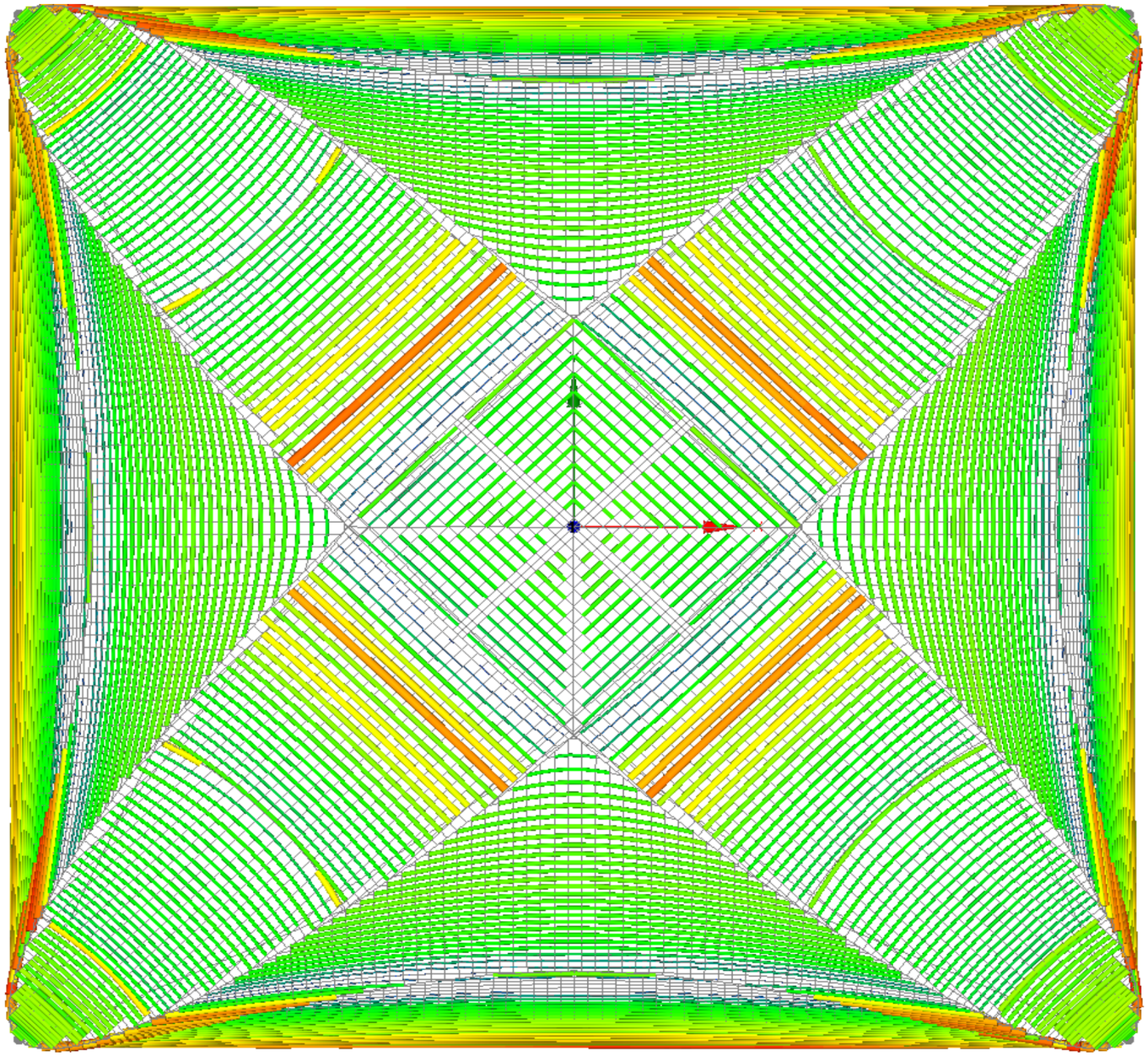


5.3 load combination C 1,35xEG+V+1,5xInstallations FILL DIRECTION

5.3.2 STRESSES:

(graphical view):

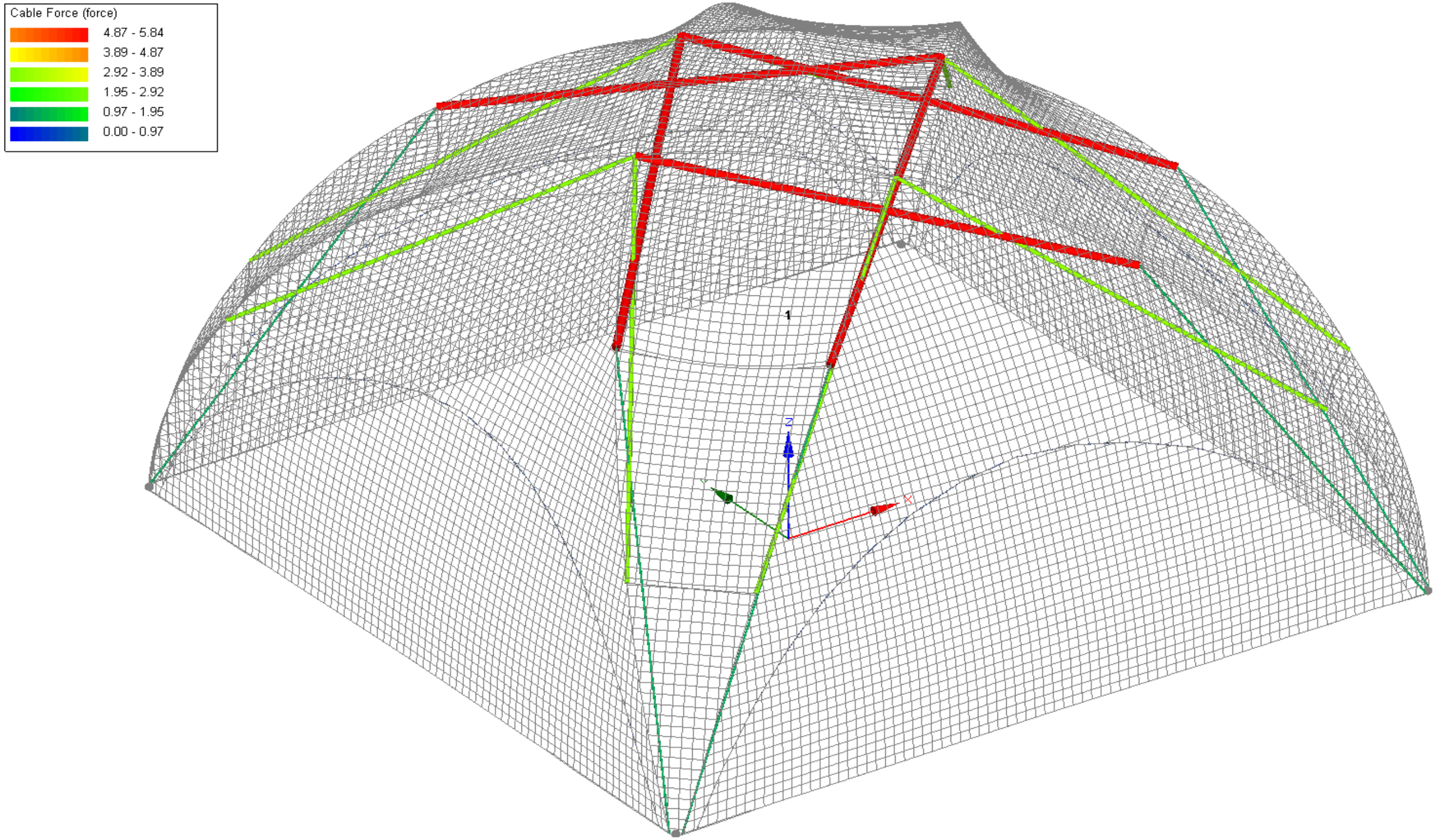




5.3 load combination C 1,35xEG+V+1,5xInstallations cableforce

5.3.3 STRESSES:

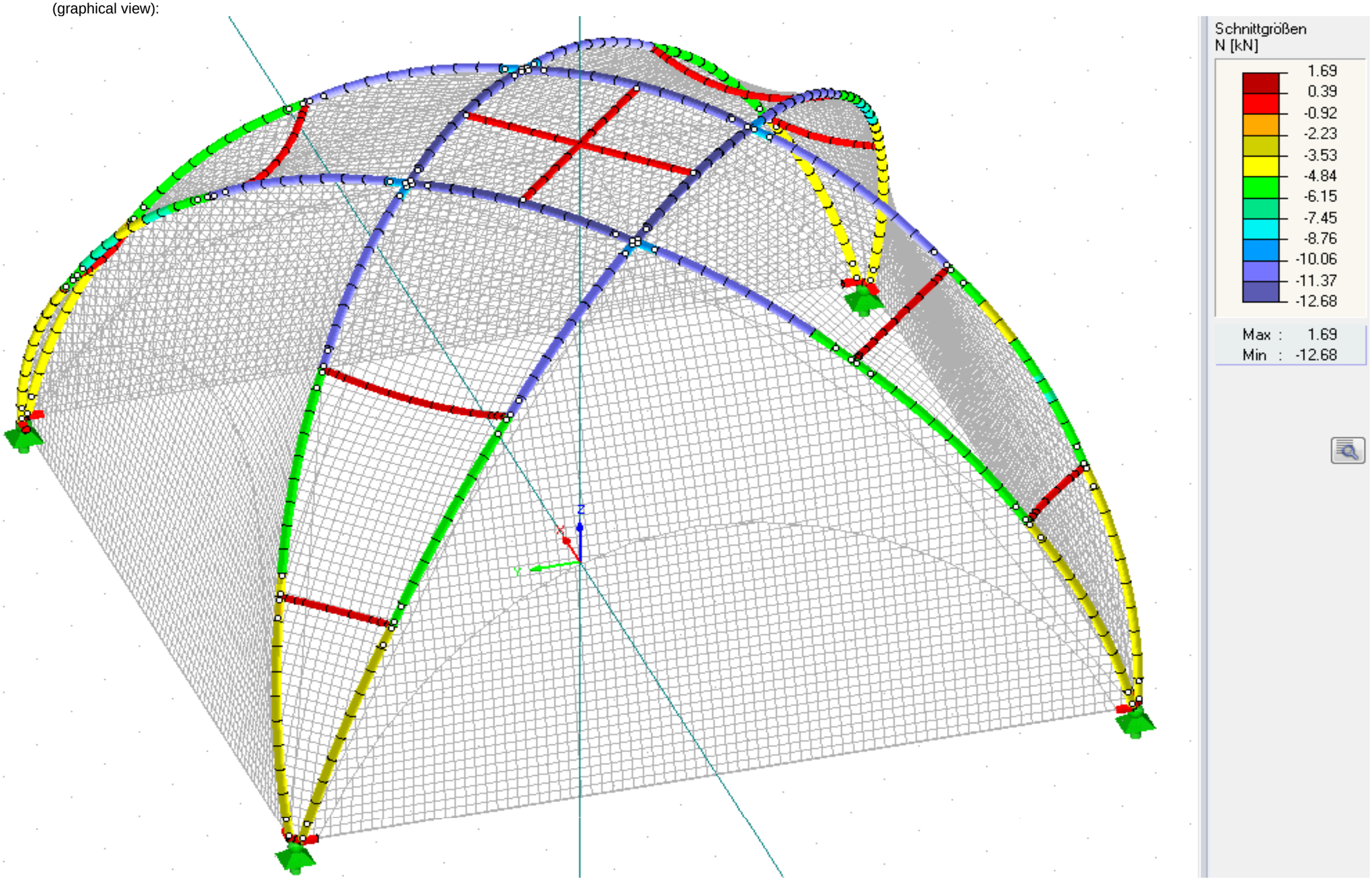
(graphical view):



5.3 load combination C 1,35xEG+V+1,5xInstallations COLLUMN FORCES

5.3.4 STRESSES:

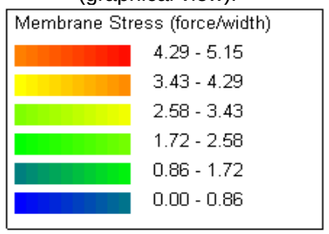
(graphical view):

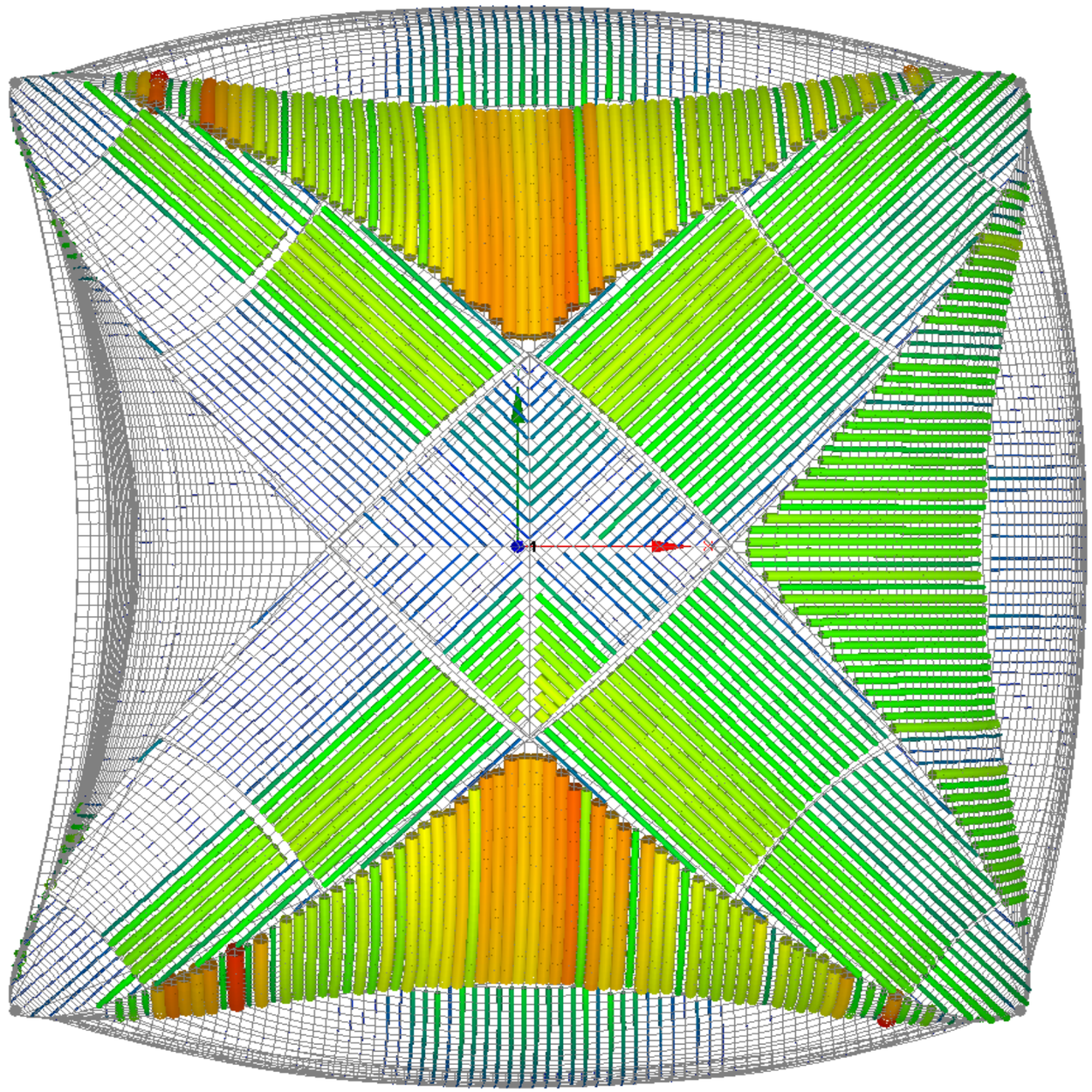


5.4 load combination D 1,00xEG+V+1,5xWind0 (0,6) WEFT DIRECTION

5.4.1 STRESSES:

(graphical view):

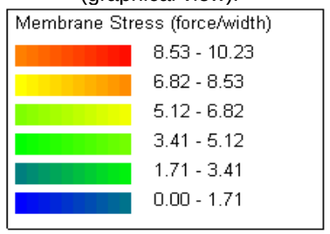


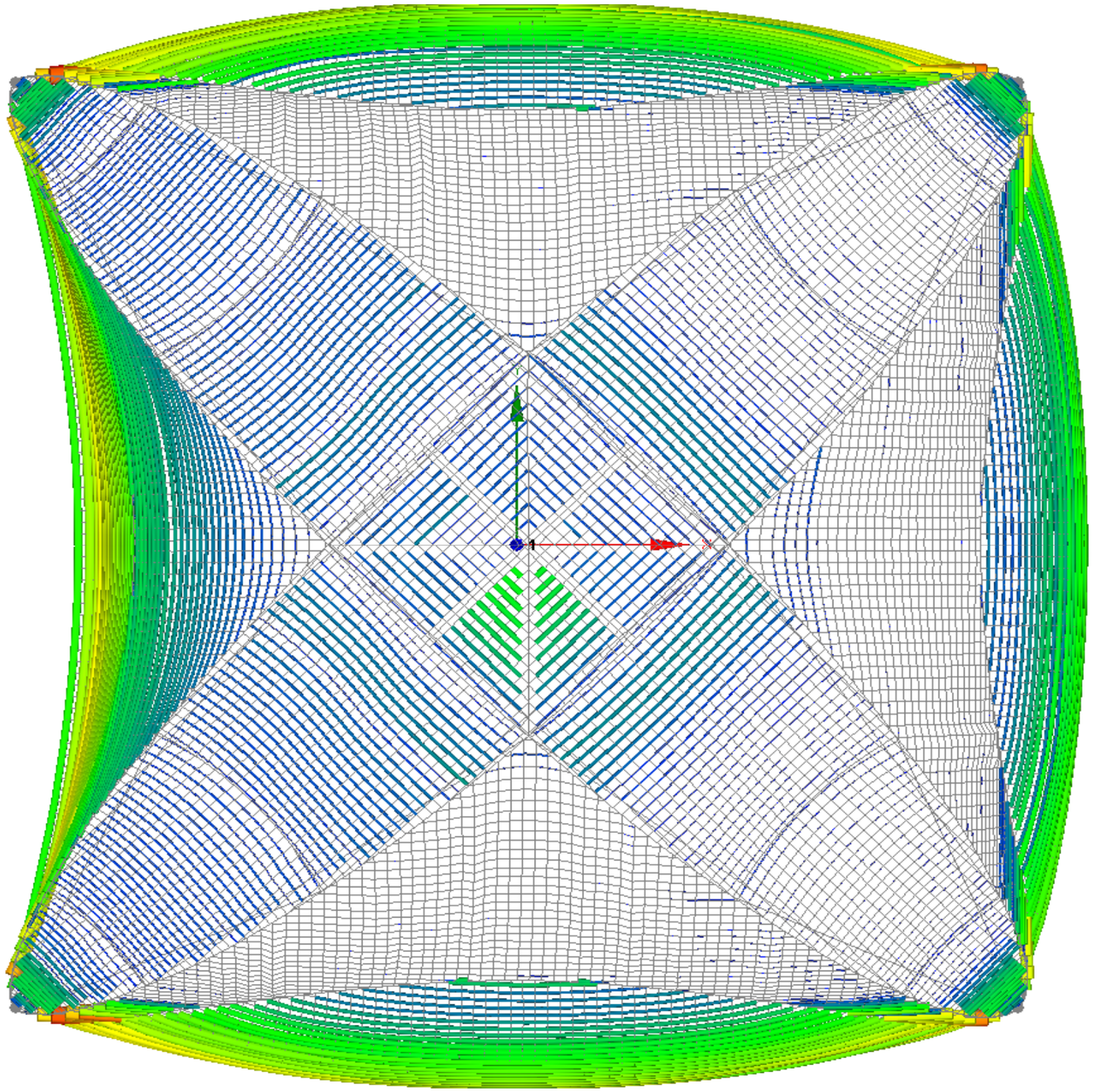


5.4 load combination D 1,00xEG+V+1,5xWind0 (0,6) FILL DIRECTION

5.4.2 STRESSES:

(graphical view):

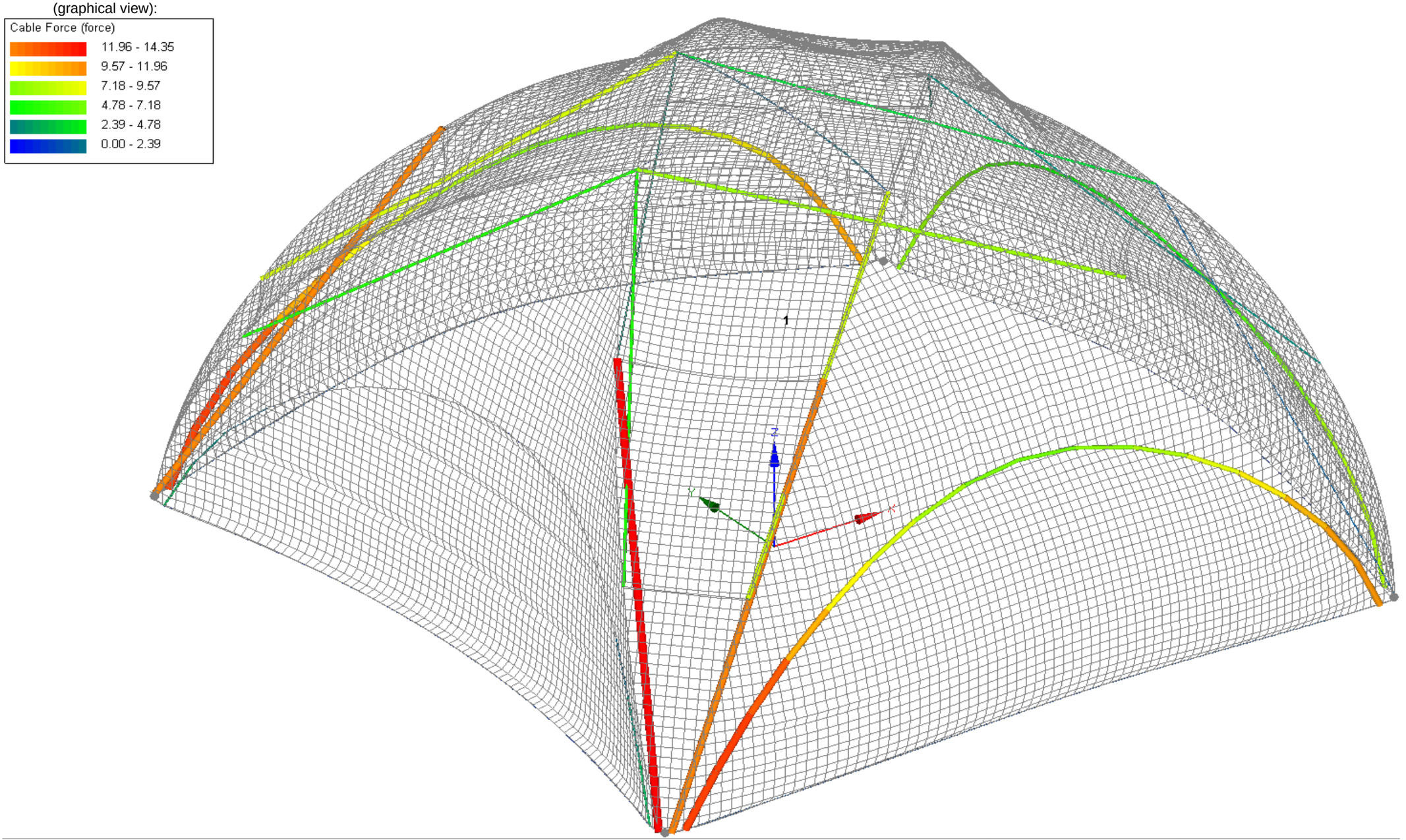




5.4 load combination D 1,00xEG+V+1,5xWind0 (0,6) cableforce

5.4.3 STRESSES:

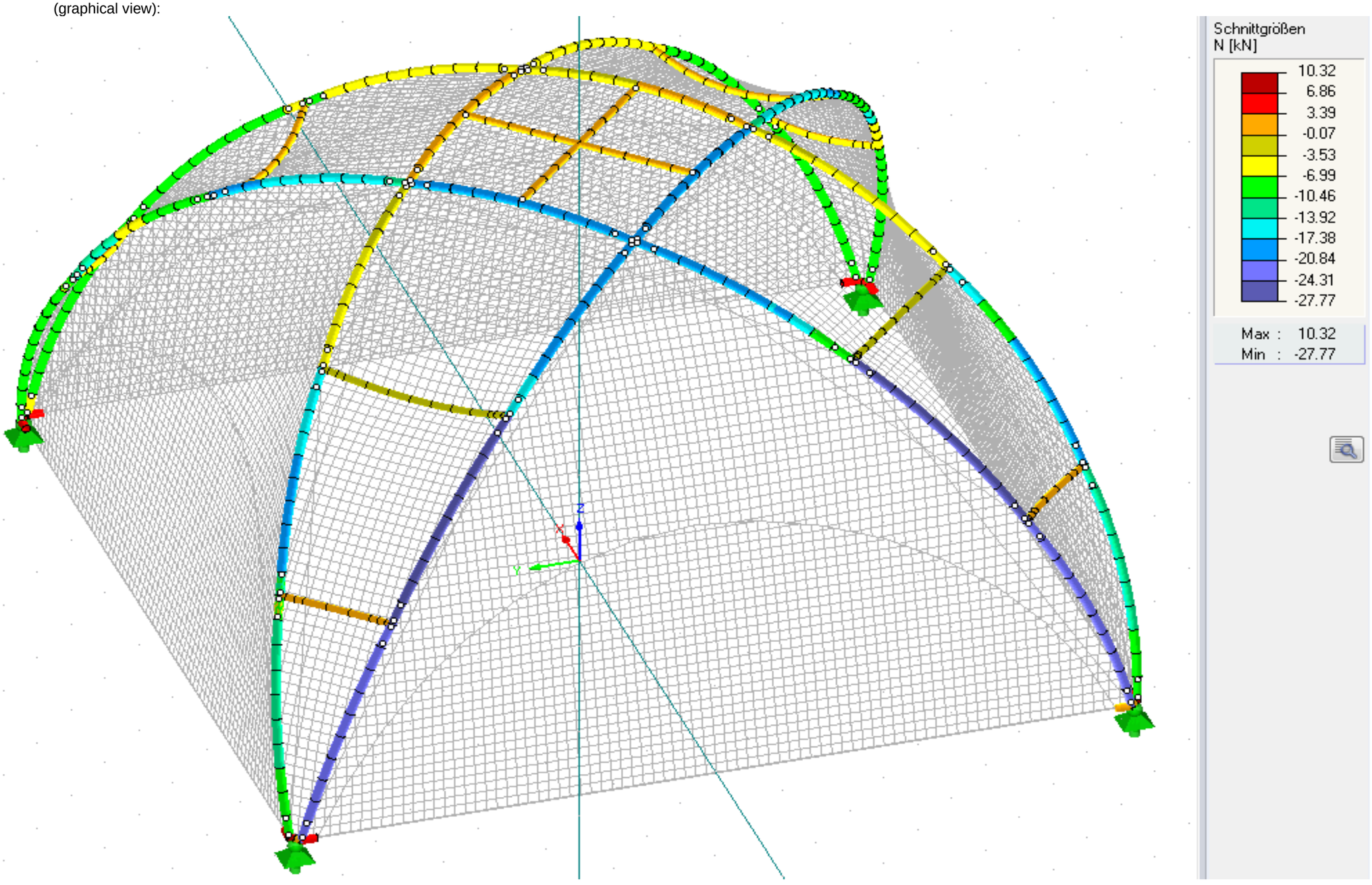
(graphical view):



5.4 load combination D 1,00xEG+V+1,5xWind0 (0,6) COLLUMN FORCES

5.4.4 STRESSES:

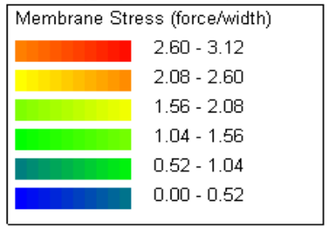
(graphical view):



5.5 load combination E 1,00xEG+V+1,5xWind45 (0,6) WEFT DIRECTION

5.5.1 STRESSES:

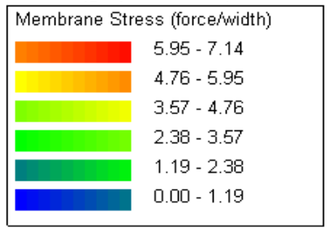
(graphical view):

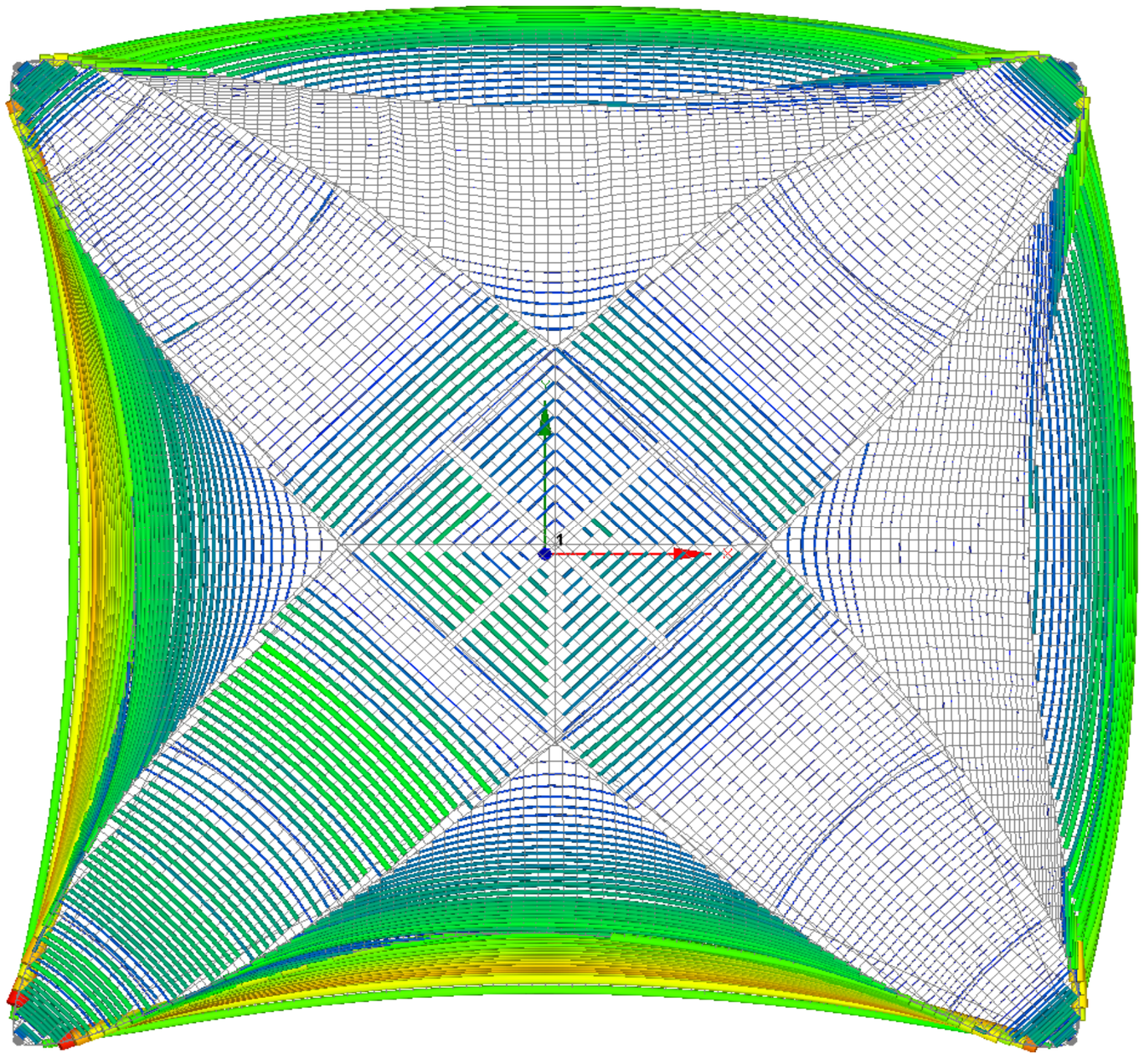


5.5 load combination E 1,00xEG+V+1,5xWind45 (0,6) FILL DIRECTION

5.5.2 STRESSES:

(graphical view):

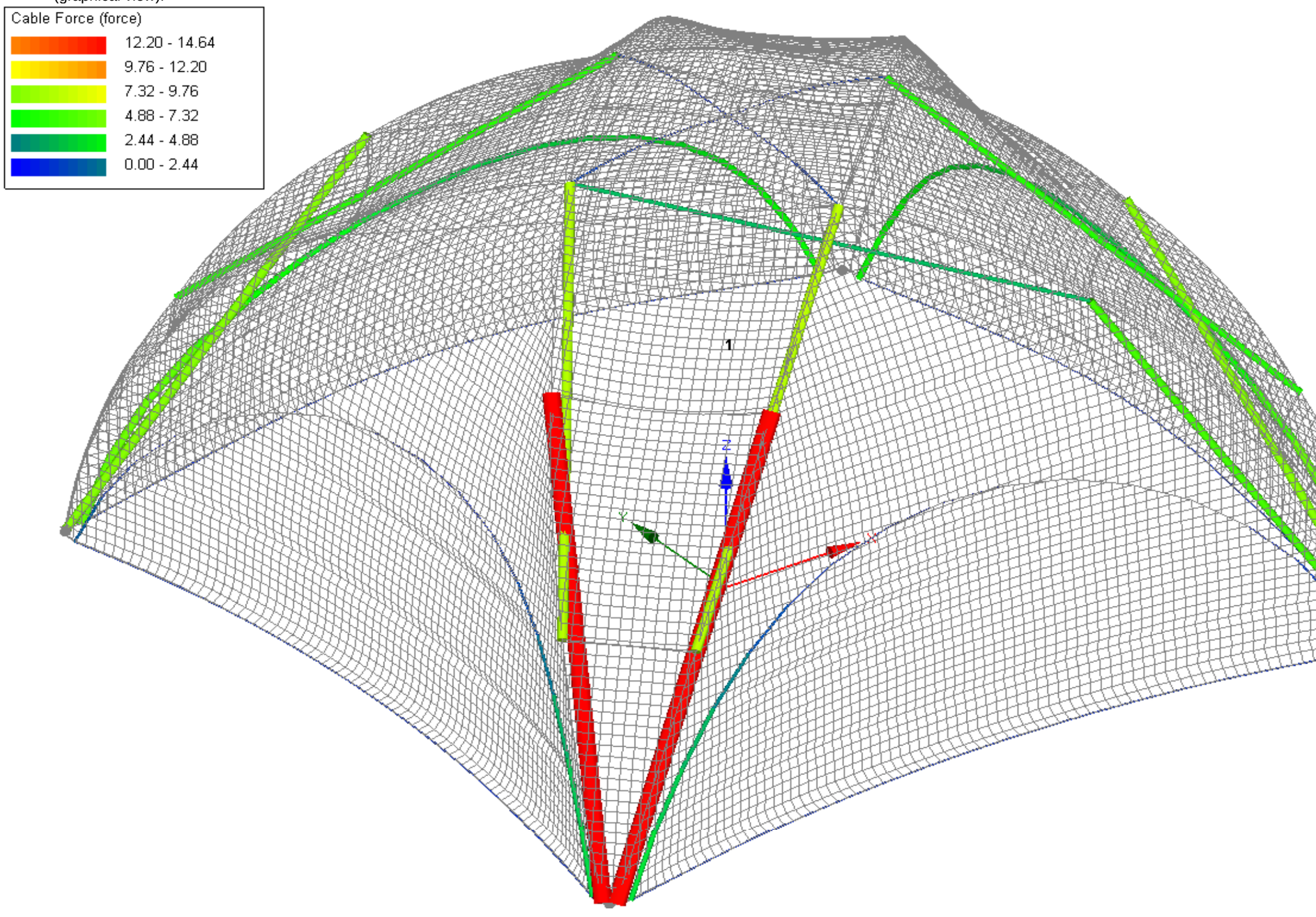




5.5 load combination E 1,00xEG+V+1,5xWind45 (0,6) cableforce

5.5.3 STRESSES:

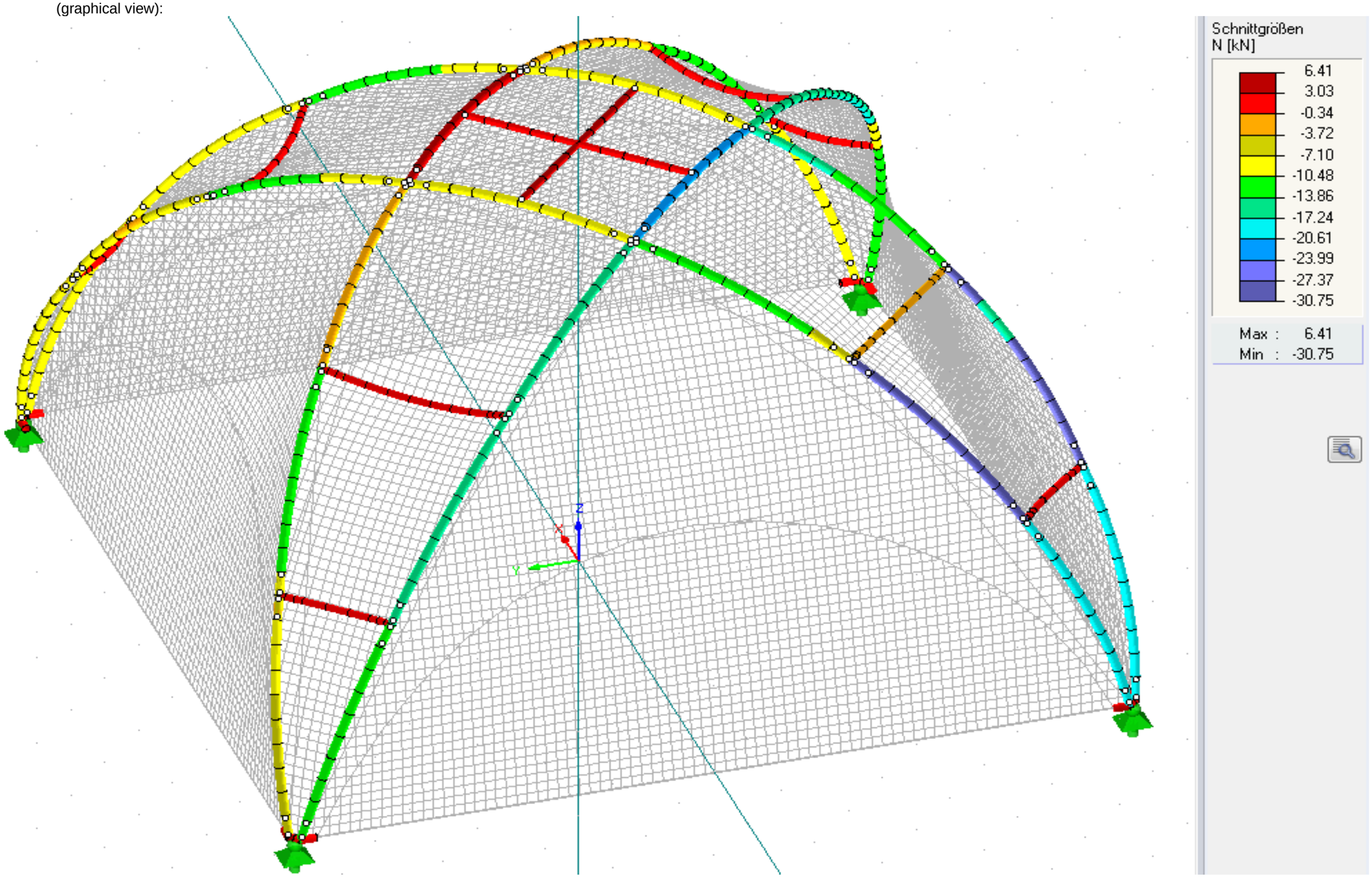
(graphical view):



5.5 load combination E 1,00xEG+V+1,5xWind45 (0,6) COLLUMN FORCES

5.5.4 STRESSES:

(graphical view):



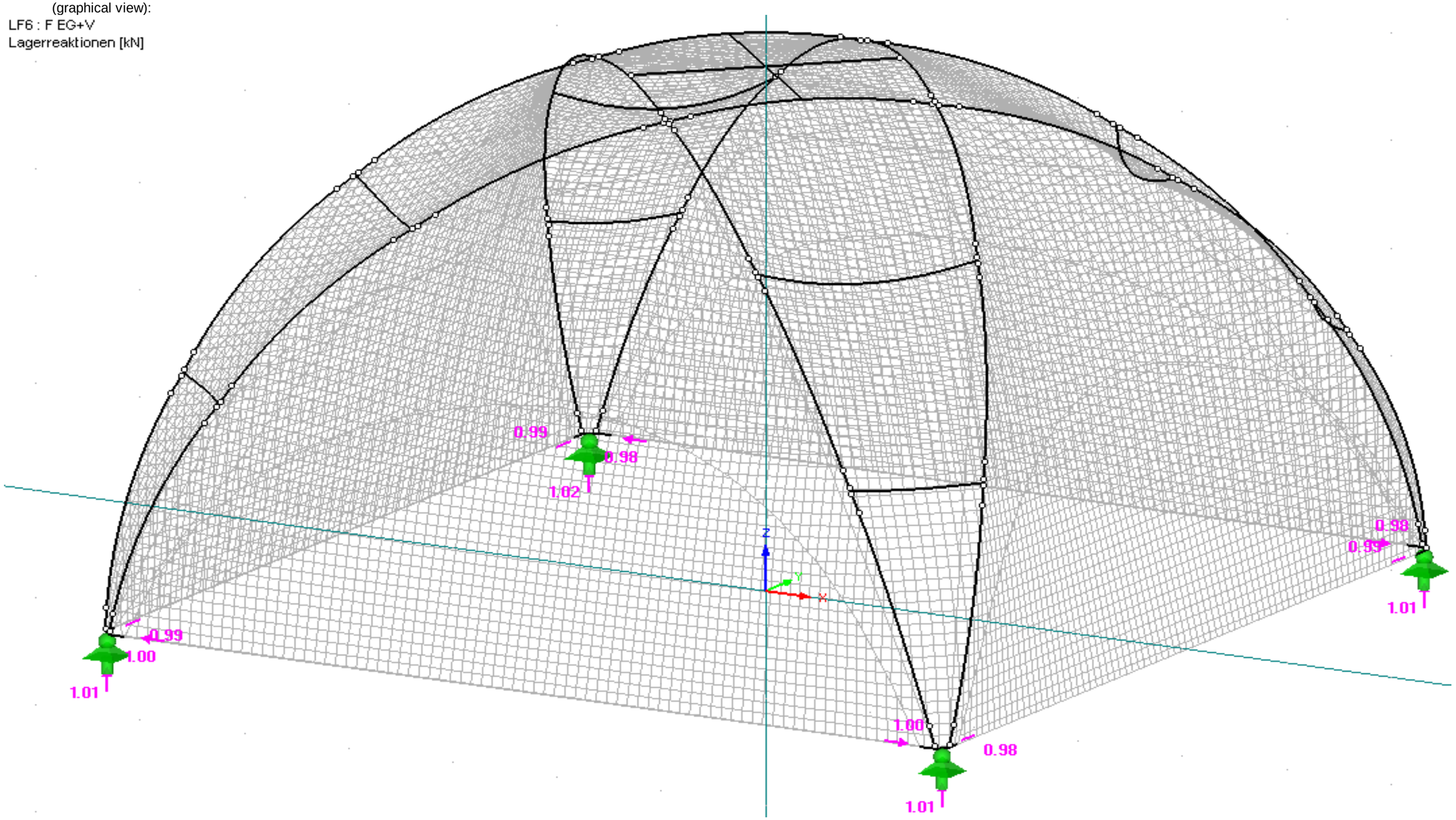
5.6 load combination F EG+V

SUPPORTFORCES

5.6.1 STRESSES:

(graphical view):

LF6 : F EG+V
Lagerreaktionen [kN]



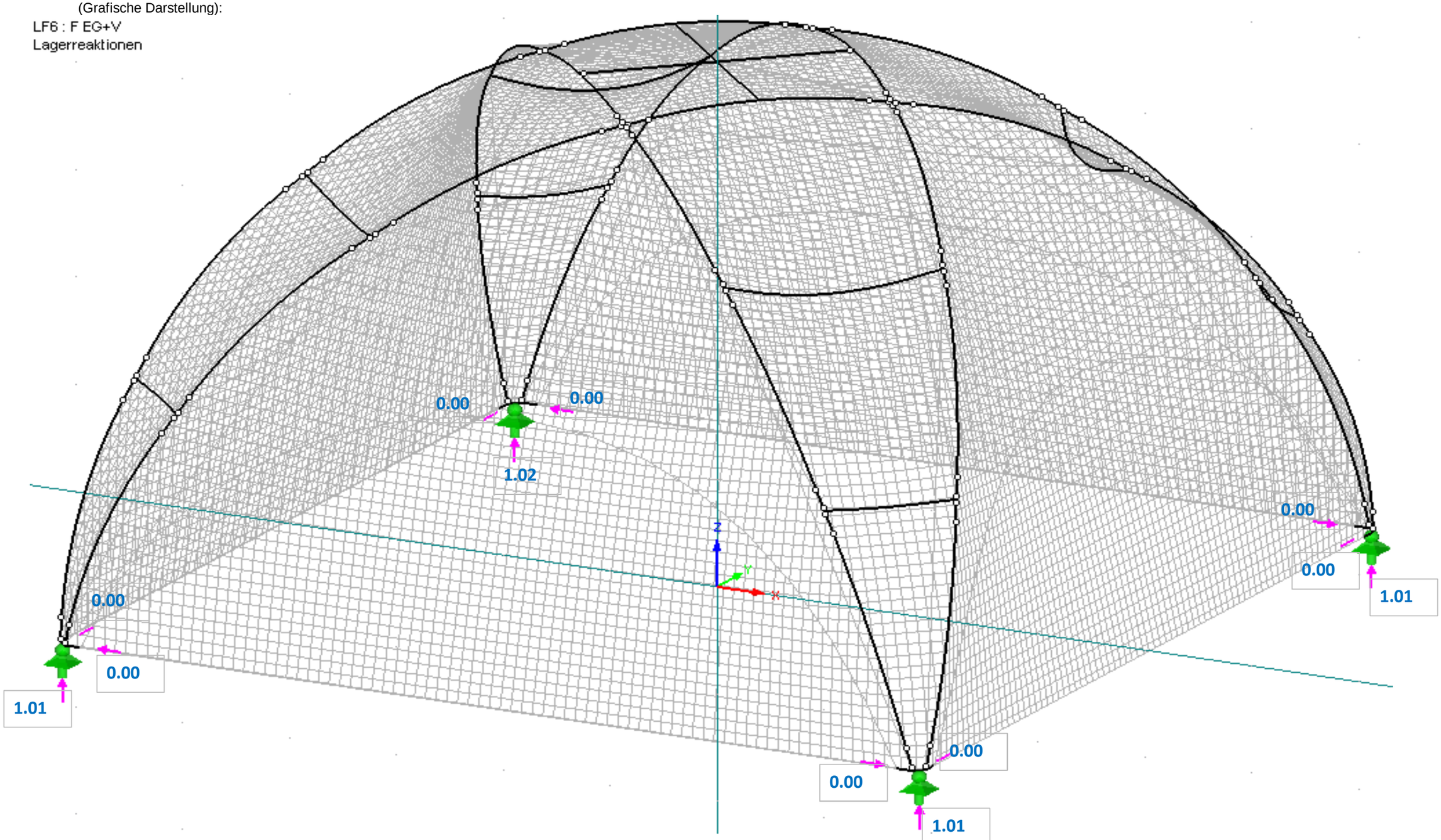
5.6 Lastkombination F EG+V

In the following part are shown the outer supportforces without inner supportforces, which partially are not relevant if a small support displacement is allowed.

5.6.2 "Äussere" Auflagerkrä

(Grafische Darstellung):

LF6 : F EG+V
Lagerreaktionen

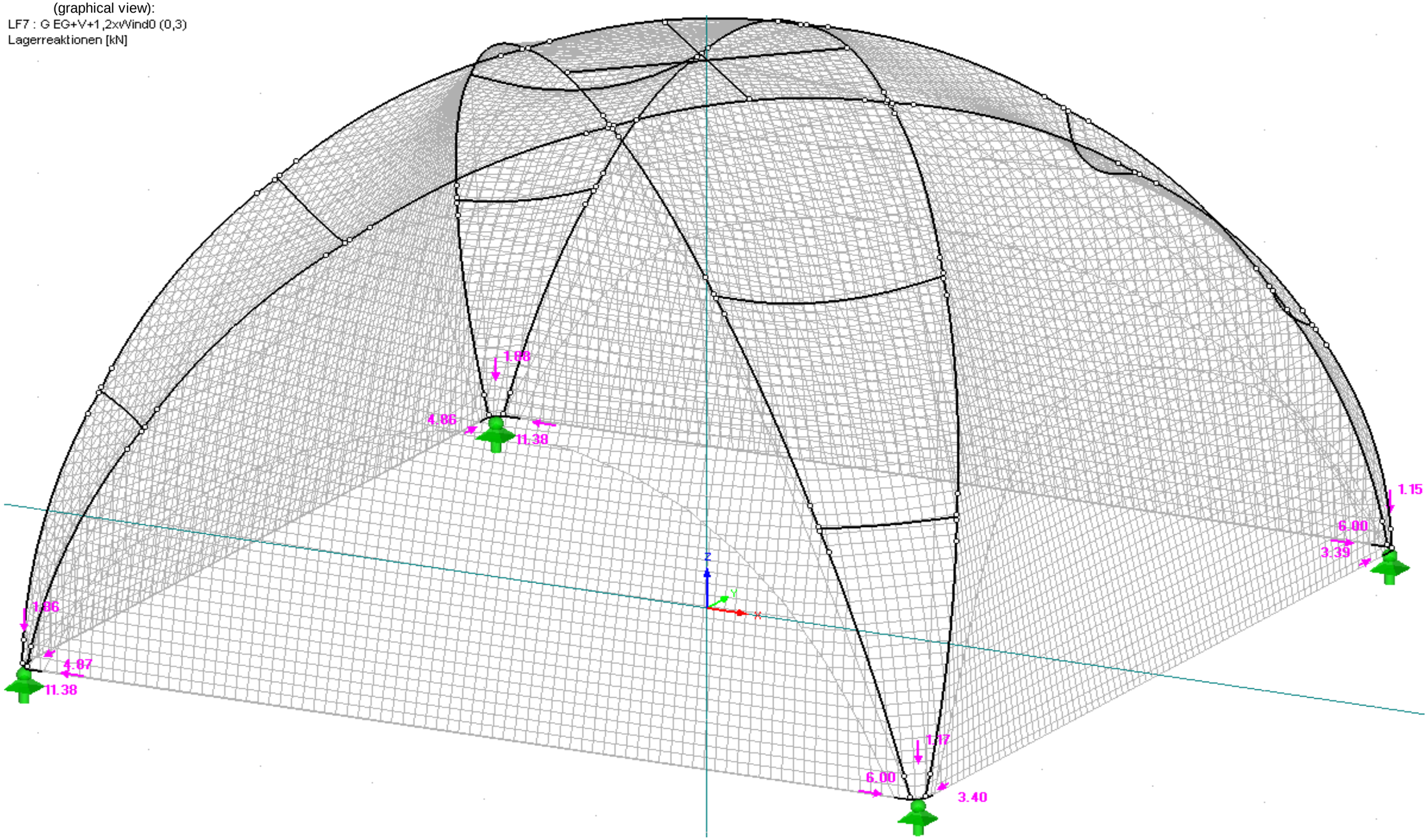


5.7 load combination G EG+V+1,2xWind0 (0,3) SUPPORTFORCES

5.7.1 STRESSES:

(graphical view):

LF7 : G EG+V+1,2xWind0 (0,3)
Lagerreaktionen [kN]



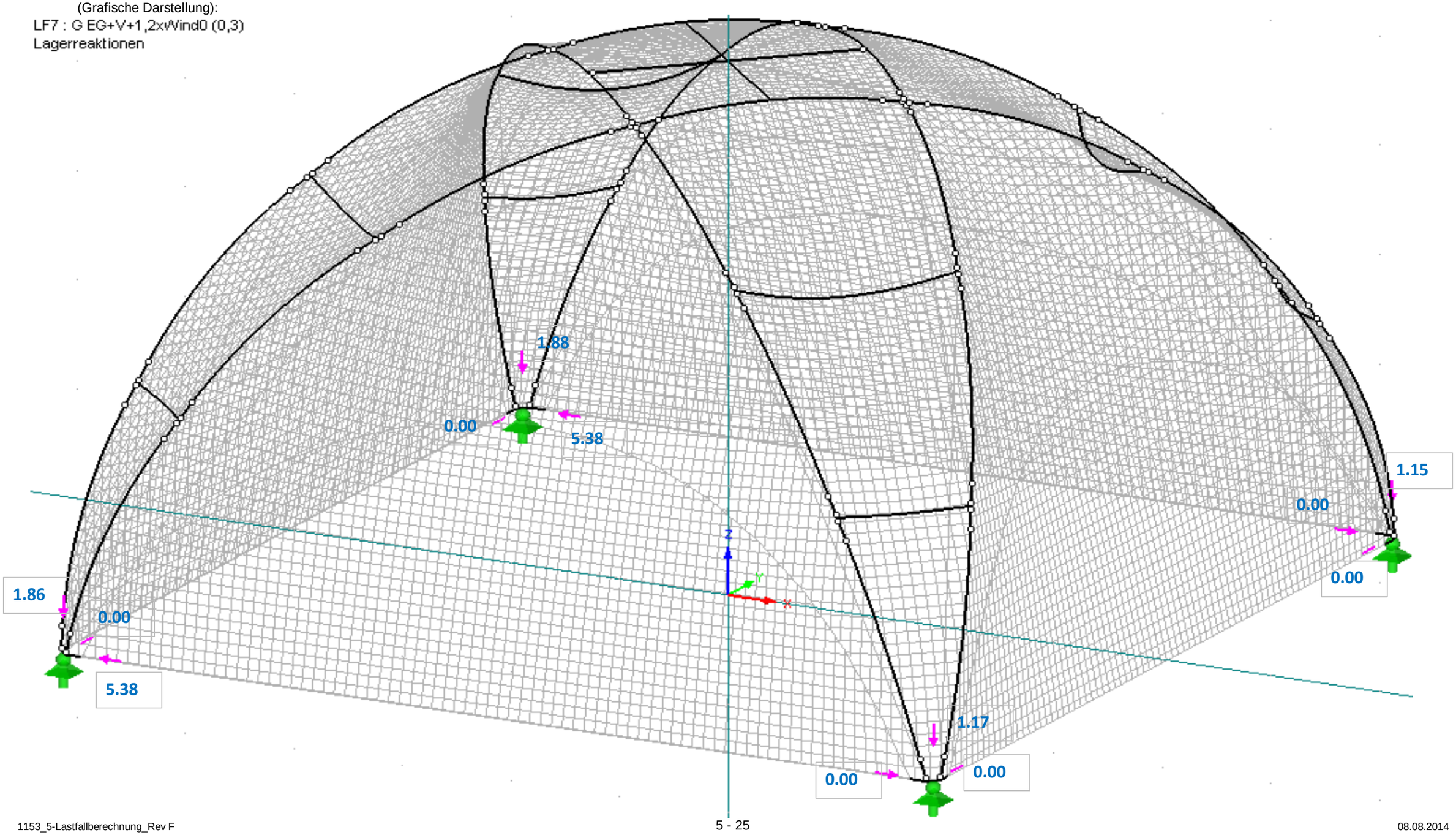
5.7 Lastkombination G EG+V+1,2xWind0 (0,3)

In the following part are shown the outer supportforces without inner supportforces, which partially are not relevant if a small support displacement is allowed.

5.7.2 "Äussere" Auflagerkrä

(Grafische Darstellung):

LF7 : G EG+V+1,2xWind0 (0,3)
Lagerreaktionen

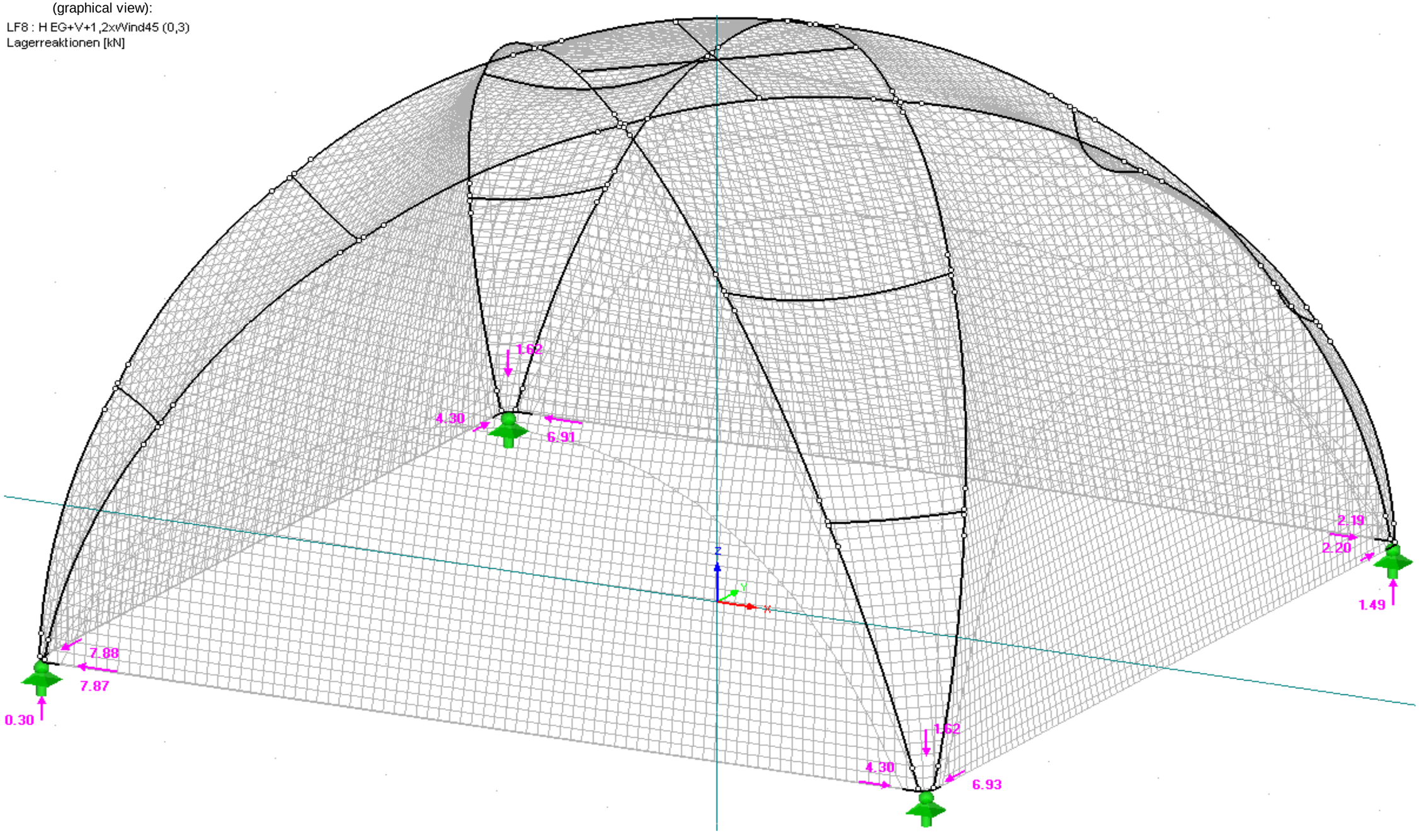


5.8 load combination H EG+V+1,2xWind45 (0,3) SUPPORTFORCES

5.8.1 STRESSES:

(graphical view):

LF8 : H EG+V+1,2xWind45 (0,3)
Lagerreaktionen [kN]

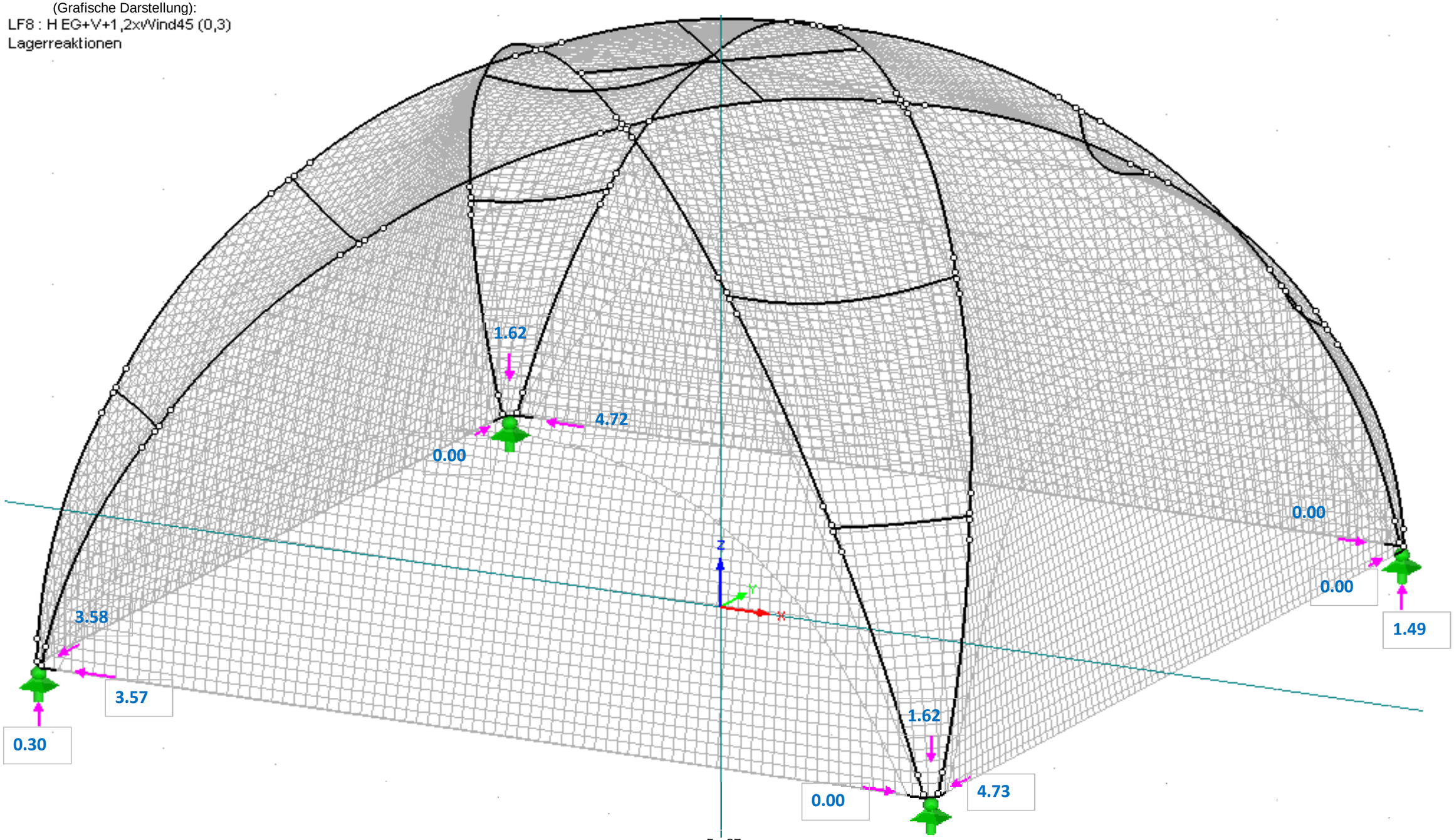


5.8 Lastkombination H EG+V+1,2xWind45 (0,3)

In the following part are shown the outer supportforces without inner supportforces, which partially are not relevant if a small support displacement is allowed.

5.8.2 "Äussere" Auflagerkrä

(Grafische Darstellung):
LF8 : H EG+V+1,2xWind45 (0,3)
Lagerreaktionen

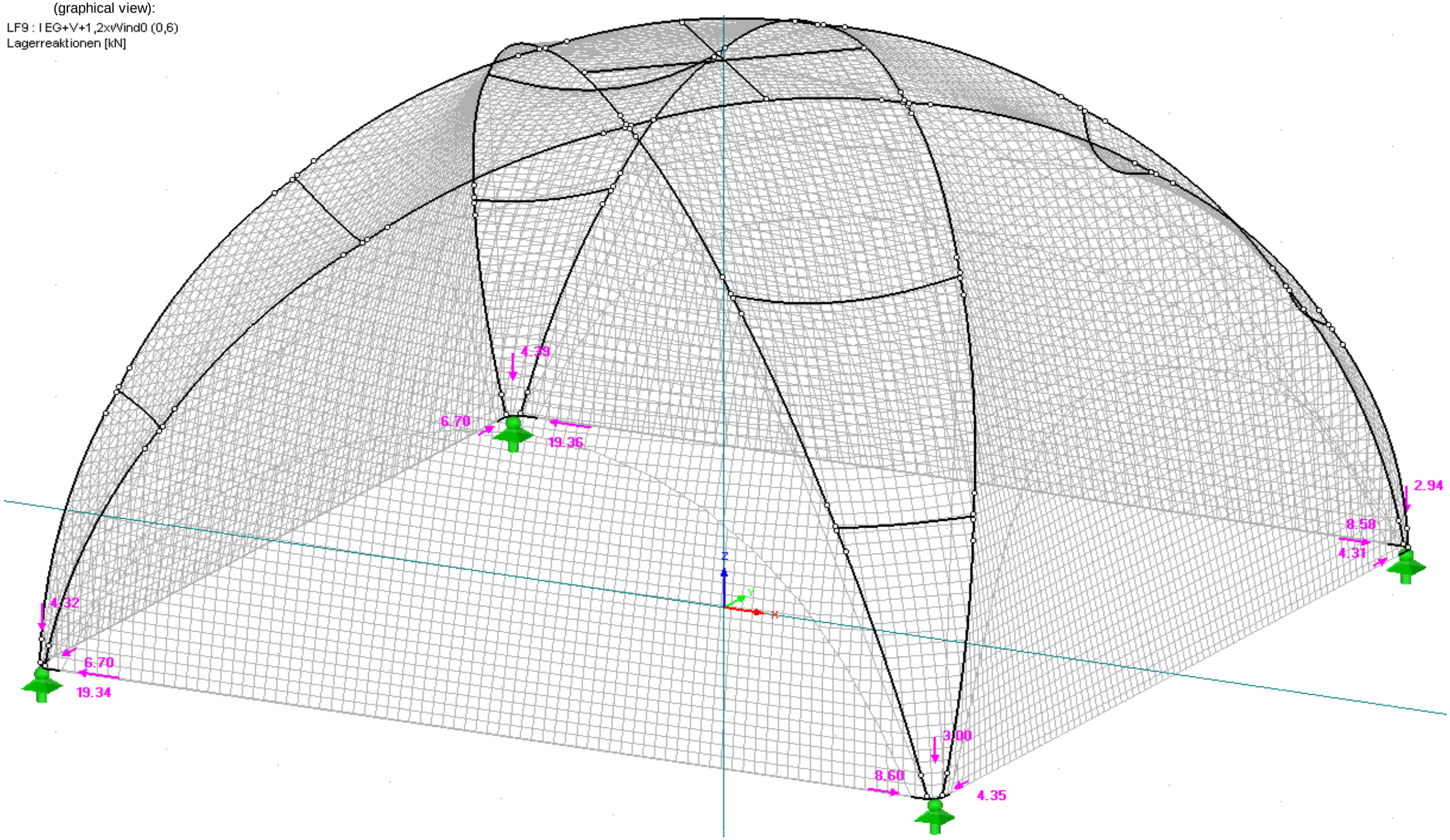


5.9 load combination I EG+V+1,2xWind0 (0,6) SUPPORTFORCES

5.9.1 STRESSES:

(graphical view):

LF9 : I EG+V+1,2xWind0 (0,6)
Lagerreaktionen [kN]



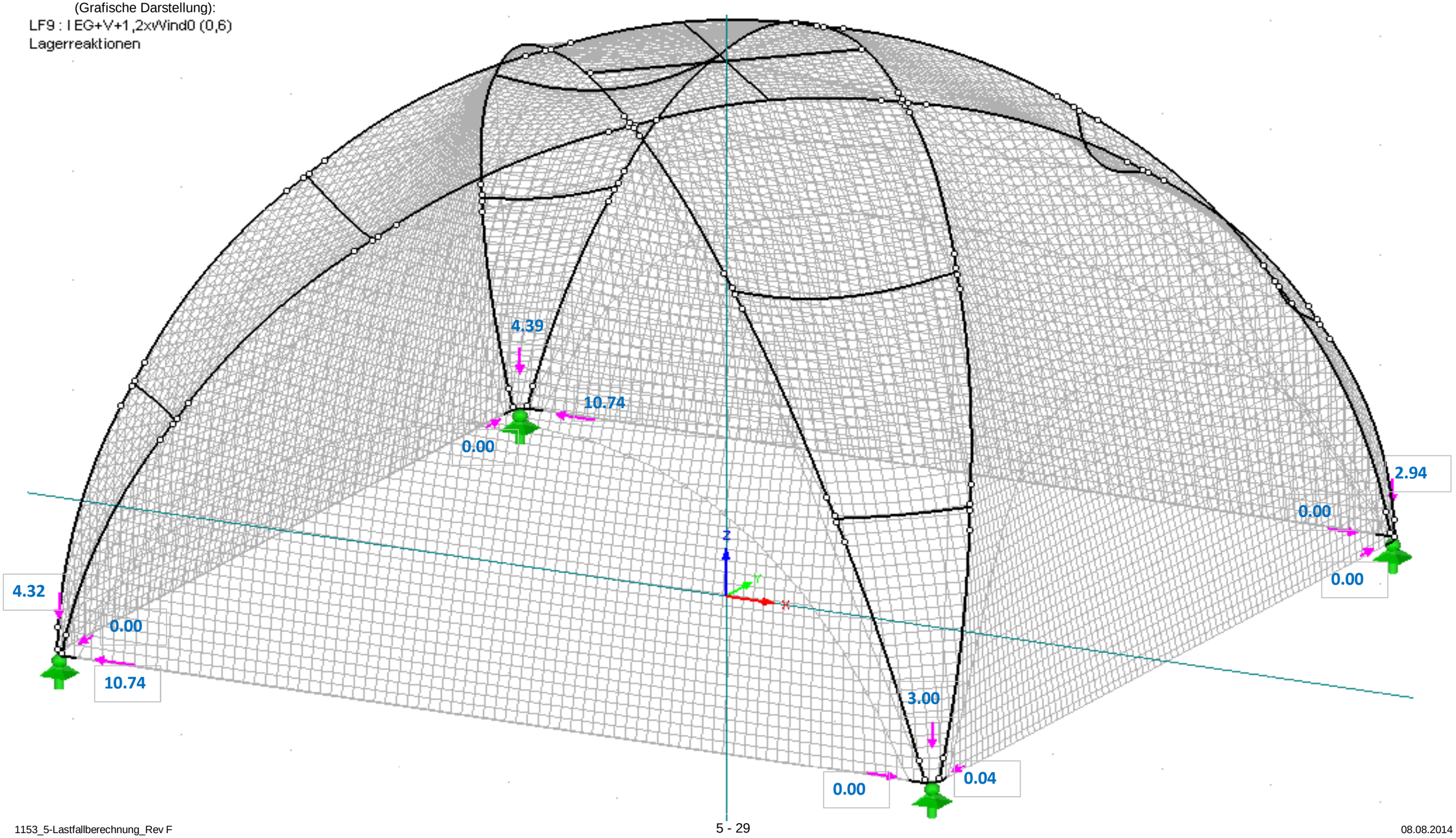
5.9 Lastkombination I EG+V+1,2xWind0 (0,6)

In the following part are shown the outer supportforces without inner supportforces, which partially are not relevant if a small support displacement is allowed.

5.9.2 "Äussere" Auflagerkrä

(Grafische Darstellung):

LF9 : I EG+V+1,2xWind0 (0,6)
Lagerreaktionen

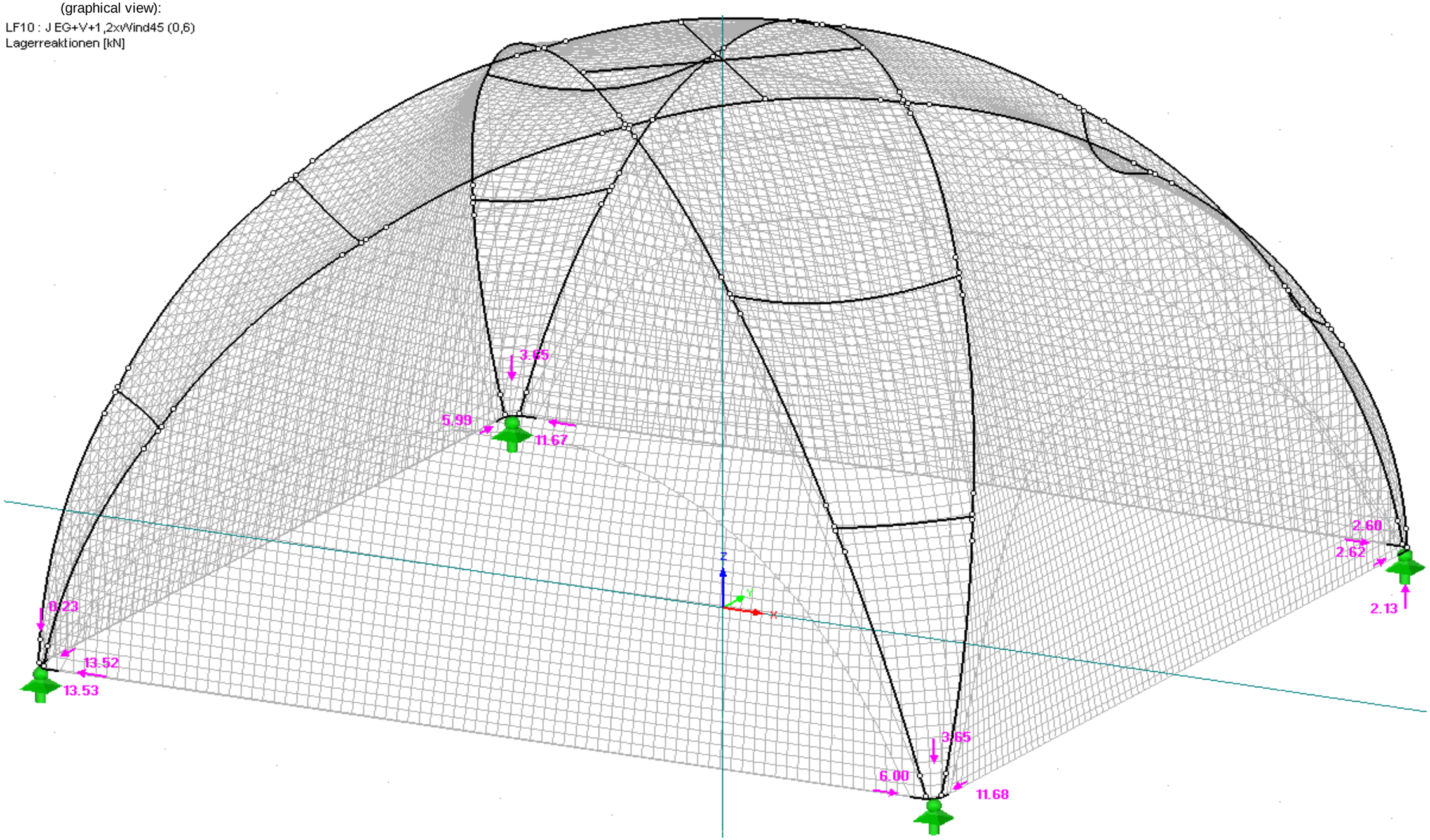


5.10 load combination J EG+V+1,2xWind45 (0,6) SUPPORTFORCES

5.10.1 STRESSES:

(graphical view):

LF10 : J EG+V+1,2xWind45 (0,6)
Lagerreaktionen [kN]



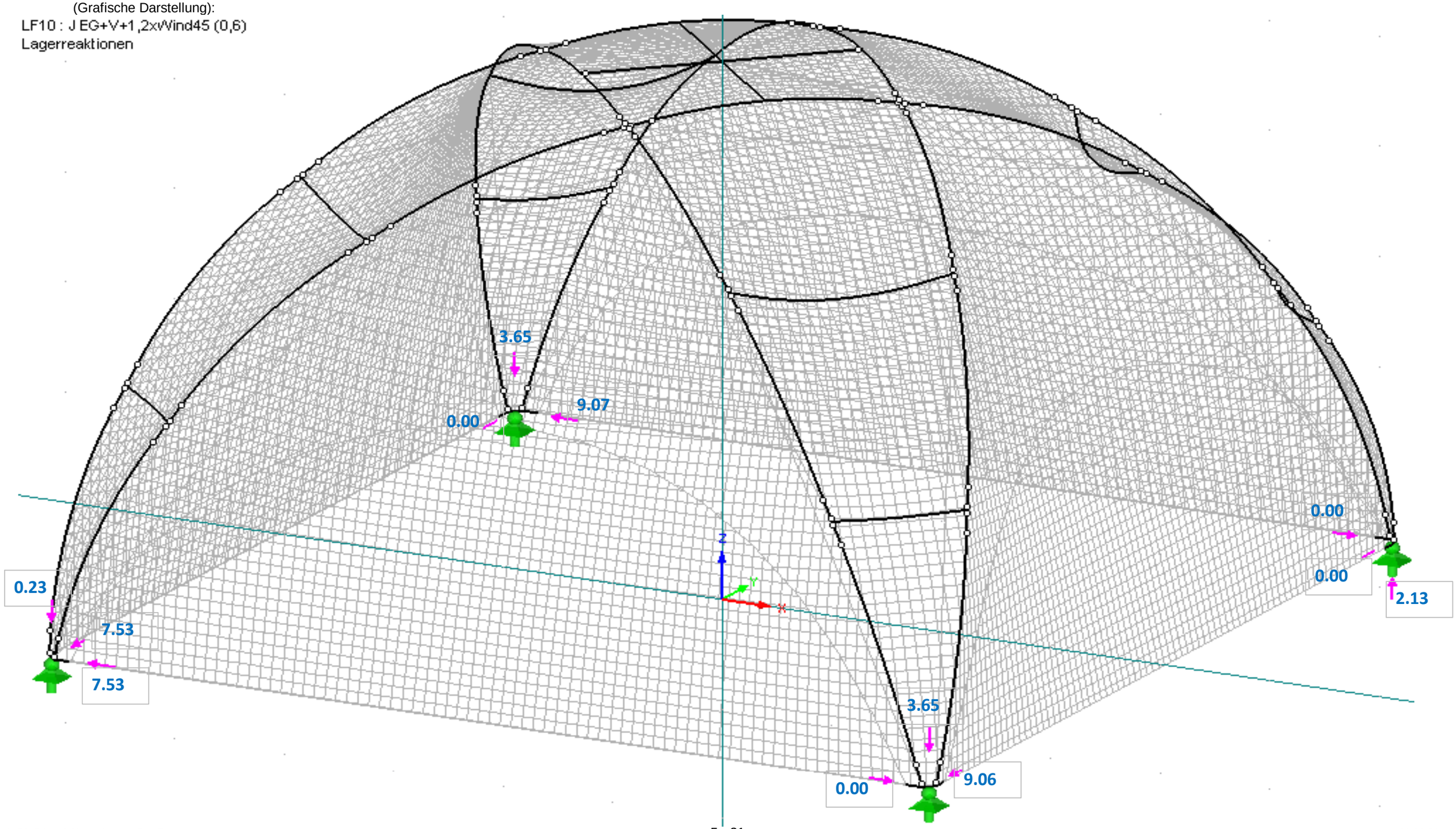
5.10 Lastkombination J EG+V+1,2xWind45 (0,6)

In the following part are shown the outer supportforces without inner supportforces, which partially are not relevant if a small support displacement is allowed.

5.10.2 "Äussere" Auflagerkr

(Grafische Darstellung):

LF10 : J EG+V+1,2xWind45 (0,6)
Lagerreaktionen



Comment: Kommentar

Project:

Structure: **Ergebnissfile aktuell**

Date: 08/08/2014

STRUCTURAL ANALYSIS

PROJECT

Crossover L

Spannungsnachweise / Bemessung
Stahlrohrknoten
Aluminiumrohre

CLIENT

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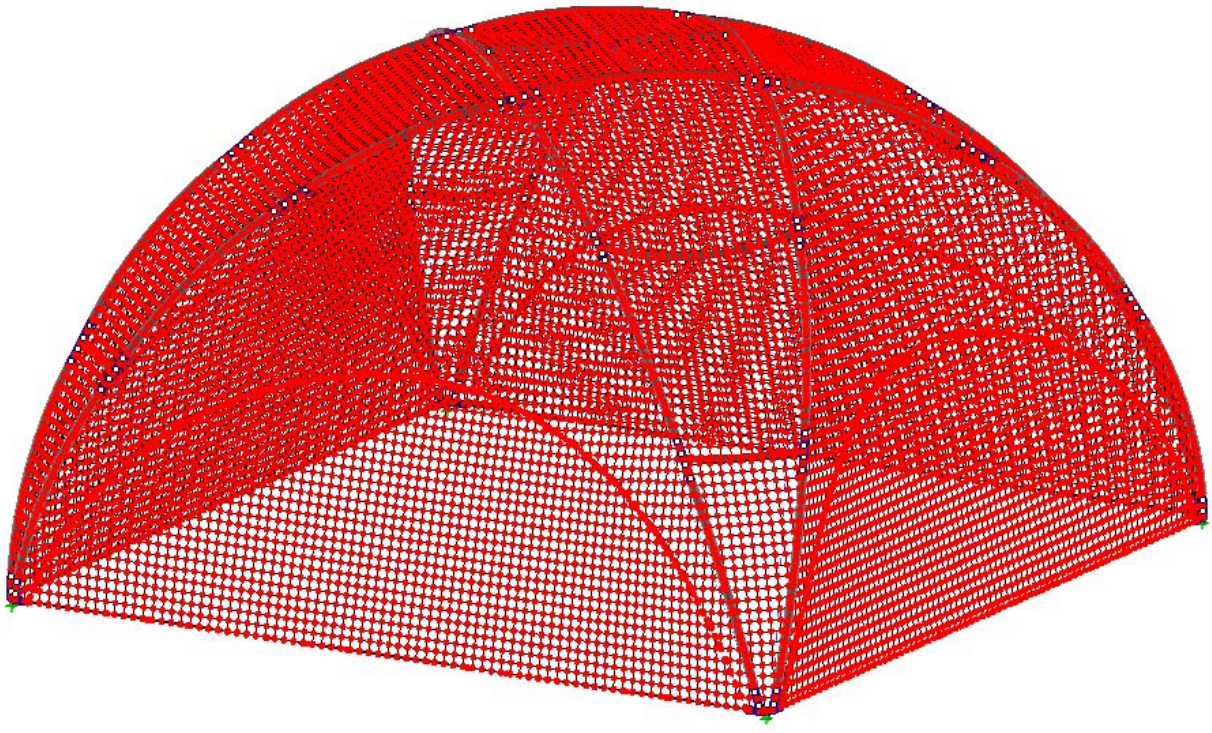

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- ☐ Load Groups
- ☐ Load Combinations
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STRUCTURAL DATA PARAMETERS

- ☐ 1D Continuous Beam
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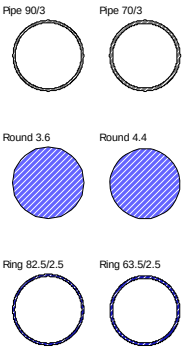
- ☒ 3D Construction Type
- ☐ Grid

19338	Nodes	32941	Elements
6	Materials	0	Cables
10	Sections	0	Tapered Elements
2	Element Hinges	0	Elastic Foundations
9	Element Partitions	0	Sets of Elements

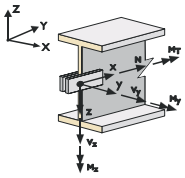
MATERIALS

Material No.	Material Description	E-Modulus E [kN/cm²]	G-Modulus G [kN/cm²]	Sp. Weight γ [kN/m³]	Coeff. Thermal α [1/°C]	Saf. Factor γ_M [-]
1	Aluminium EN-AW 6082 (EP,ET) T6 | EN 1999-1-1:2007	7000.00	2700.00	27.00	2.3000E-05	1.100
2	Spiralseil	13000.00	5000.00	78.50	1.6000E-05	1.100
3	Membrane 1000	0.04	0.00	0.00	0.00	1.100
4	Membrane 2000	0.03	0.00	0.00	0.00	1.100
5	Rundlitzenseil	9000.00	3500.00	78.50	1.6000E-05	1.100
6	Baustahl S 355 | DIN EN 1993-1-1:2010-12	21000.00	8100.00	78.50	1.2000E-05	1.000



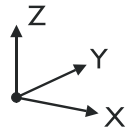
CROSS-SECTIONS

Section No.	Cross-section Description	Mater. No.	I_T [cm⁴] A [cm²]	I_y [cm⁴] A_y [cm²]	I_z [cm⁴] A_z [cm²]
1	Pipe 90/3	1	155.59 8.20	77.67 4.07	77.67 4.07
2	Pipe 70/3	1	71.20 6.31	35.50 3.13	35.50 3.13
3	Pipe 70/3	1	71.20 6.31	35.50 3.13	35.50 3.13
4	Cross Section 4	4	0.00	0.00	0.00
5	Cross Section 5	3	0.00	0.00	0.00
6	Round 3.6	5	0.00 0.10	0.00 0.09	0.00 0.09
7	Cross Section 7	2	0.00 0.01	0.00	0.00
8	Round 4.4	2	0.00 0.15	0.00 0.13	0.00 0.13
9	Ring 82.5/2.5	6	100.63 6.28	50.31 3.12	50.31 3.12
10	Ring 63.5/2.5	6	44.64 4.79	22.32 2.38	22.32 2.38



MEMBER RELEASES

Release No.	Reference System	Force Release or Spring [kN/m] N	V_y	V_z	Moment Release or Spring [kNm/rad] M_T	M_y	M_z
1	Local x,y,z Gelenk	☐	☐	☐	☒	☐	☐
2	Local x,y,z Gelenk	☐	☐	☐	☐	☒	☒



NODAL SUPPORTS

Support No.	Nodes No.	Rotation [°] Sequen.	about X	about Y	about Z	Support Conditions $u_{X'}$	$u_{Y'}$	$u_{Z'}$	$\varphi_{X'}$	$\varphi_{Y'}$	$\varphi_{Z'}$
1	19335 68000001	ZYX	0.00	0.00	0.00	☒	☒	☒	☐	☐	☐
2	19336 68000002	ZYX	0.00	0.00	0.00	☒	☒	☒	☐	☐	☐
3	19337 68000003	ZYX	0.00	0.00	0.00	☒	☒	☒	☐	☐	☐
4	19338 68000004	ZYX	0.00	0.00	0.00	☒	☒	☒	☐	☐	☐

RESULTS - SUMMARY

	Description	Value	Unit	Comment
	LC1 - A 1,35xEG+V			
	Sum of Loads in X	0.00	kN	
	Sum of Support Reactions in X	0.00	kN	
	Sum of Loads in Y	0.00	kN	
	Sum of Support Reactions in Y	0.00	kN	
	Sum of Loads in Z	-5.47	kN	
	Sum of Support Reactions in Z	-5.47	kN	Deviation 0.00%
	Max Displacement in X	57.9	mm	Member No. 23885, x: 0.097 m
	Max Displacement in Y	-57.3	mm	Member No. 17138, x: 0.099 m
	Max Displacement in Z	25.6	mm	Member No. 23937, x: 0.000 m
	Max Vectorial Displacement	62.6	mm	Member No. 22467, x: 0.099 m
	Max rotation about X	-5.8	mrad	
	Max Rotation about Y	-6.1	mrad	
	Max Rotation about Z	6.0	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC2 - B 1,35xEG+V+1,5xErsatzlast			
	Sum of Loads in X	0.00	kN	
	Sum of Support Reactions in X	0.00	kN	
	Sum of Loads in Y	0.00	kN	
	Sum of Support Reactions in Y	0.00	kN	
	Sum of Loads in Z	-15.55	kN	
	Sum of Support Reactions in Z	-15.55	kN	Deviation 0.00%
	Max Displacement in X	-65.5	mm	Member No. 24623, x: 0.424 m
	Max Displacement in Y	-60.1	mm	Member No. 30267, x: 0.424 m
	Max Displacement in Z	-55.6	mm	Member No. 3557, x: 0.100 m
	Max Vectorial Displacement	66.7	mm	Member No. 24623, x: 0.424 m
	Max rotation about X	5.5	mrad	
	Max Rotation about Y	-5.6	mrad	
	Max Rotation about Z	2.0	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC3 - C 1,35xEG+V+1,5xInstallation			
	Sum of Loads in X	0.00	kN	
	Sum of Support Reactions in X	0.00	kN	
	Sum of Loads in Y	0.00	kN	
	Sum of Support Reactions in Y	0.00	kN	
	Sum of Loads in Z	-14.70	kN	
	Sum of Support Reactions in Z	-14.70	kN	Deviation 0.00%
	Max Displacement in X	-93.8	mm	Member No. 11599, x: 0.099 m
	Max Displacement in Y	-94.4	mm	Member No. 17195, x: 0.000 m
	Max Displacement in Z	39.1	mm	Member No. 32754, x: 0.000 m
	Max Vectorial Displacement	101.9	mm	Member No. 17193, x: 0.099 m
	Max rotation about X	11.8	mrad	
	Max Rotation about Y	11.5	mrad	
	Max Rotation about Z	-6.3	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC4 - D 1,35xEG+V+1,5xWind0 (0,6)			
	Sum of Loads in X	26.90	kN	
	Sum of Support Reactions in X	26.90	kN	Deviation 0.00%
	Sum of Loads in Y	0.07	kN	
	Sum of Support Reactions in Y	0.07	kN	Deviation 0.00%
	Sum of Loads in Z	18.07	kN	
	Sum of Support Reactions in Z	18.07	kN	Deviation 0.00%
	Max Displacement in X	689.9	mm	Member No. 12824, x: 0.098 m
	Max Displacement in Y	770.7	mm	Member No. 28136, x: 0.099 m
	Max Displacement in Z	447.3	mm	Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	886.4	mm	Member No. 18428, x: 0.097 m
	Max rotation about X	-42.6	mrad	
	Max Rotation about Y	40.4	mrad	
	Max Rotation about Z	67.2	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC5 - E 1,35xEG+V+1,5xWind45 (0,6)			
	Sum of Loads in X	20.75	kN	
	Sum of Support Reactions in X	20.75	kN	Deviation 0.00%
	Sum of Loads in Y	20.75	kN	
	Sum of Support Reactions in Y	20.75	kN	Deviation 0.00%
	Sum of Loads in Z	6.52	kN	
	Sum of Support Reactions in Z	6.52	kN	Deviation 0.00%
	Max Displacement in X	607.1	mm	Member No. 22468, x: 0.000 m
	Max Displacement in Y	603.0	mm	Member No. 28200, x: 0.000 m
	Max Displacement in Z	313.5	mm	Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	679.8	mm	Member No. 22468, x: 0.099 m
	Max rotation about X	-59.2	mrad	

RESULTS - SUMMARY

	Description	Value	Unit	Comment
	Max Rotation about Y	61.7	mrad	Member No. 22468, x: 0.099 m
	Max Rotation about Z	-44.3	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC6 - F EG+V			
	Sum of Loads in X	0.00	kN	
	Sum of Support Reactions in X	0.00	kN	
	Sum of Loads in Y	0.00	kN	
	Sum of Support Reactions in Y	0.00	kN	
	Sum of Loads in Z	-4.05	kN	
	Sum of Support Reactions in Z	-4.05	kN	Deviation 0.00%
	Max Displacement in X	66.3	mm	Member No. 23861, x: 0.000 m
	Max Displacement in Y	-65.3	mm	Member No. 18507, x: 0.097 m
	Max Displacement in Z	29.5	mm	Member No. 23937, x: 0.000 m
	Max Vectorial Displacement	71.4	mm	Member No. 22466, x: 0.099 m
	Max rotation about X	5.8	mrad	
	Max Rotation about Y	-6.1	mrad	
	Max Rotation about Z	6.9	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC7 - G EG+V+1,2xWind0 (0,3)			
	Sum of Loads in X	10.76	kN	
	Sum of Support Reactions in X	10.76	kN	Deviation 0.00%
	Sum of Loads in Y	0.03	kN	
	Sum of Support Reactions in Y	0.03	kN	Deviation 0.00%
	Sum of Loads in Z	6.08	kN	
	Sum of Support Reactions in Z	6.08	kN	Deviation 0.00%
	Max Displacement in X	526.0	mm	Member No. 23937, x: 0.000 m
	Max Displacement in Y	619.1	mm	Member No. 28200, x: 0.000 m
	Max Displacement in Z	350.7	mm	Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	707.7	mm	Member No. 29552, x: 0.097 m
	Max rotation about X	-20.4	mrad	
	Max Rotation about Y	17.4	mrad	
	Max Rotation about Z	-37.4	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC8 - H EG+V+1,2xWind45 (0,3)			
	Sum of Loads in X	8.30	kN	
	Sum of Support Reactions in X	8.30	kN	Deviation 0.00%
	Sum of Loads in Y	8.30	kN	
	Sum of Support Reactions in Y	8.30	kN	Deviation 0.00%
	Sum of Loads in Z	1.46	kN	
	Sum of Support Reactions in Z	1.46	kN	Deviation 0.00%
	Max Displacement in X	489.2	mm	Member No. 22408, x: 0.000 m
	Max Displacement in Y	487.2	mm	Member No. 28260, x: 0.099 m
	Max Displacement in Z	250.6	mm	Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	548.3	mm	Member No. 23936, x: 0.000 m
	Max rotation about X	-22.8	mrad	
	Max Rotation about Y	23.7	mrad	
	Max Rotation about Z	-30.1	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC9 - I EG+V+1,2xWind0 (0,6)			
	Sum of Loads in X	21.52	kN	
	Sum of Support Reactions in X	21.52	kN	Deviation 0.00%
	Sum of Loads in Y	0.06	kN	
	Sum of Support Reactions in Y	0.06	kN	Deviation 0.00%
	Sum of Loads in Z	14.65	kN	
	Sum of Support Reactions in Z	14.65	kN	Deviation 0.00%
	Max Displacement in X	631.0	mm	Member No. 12824, x: 0.098 m
	Max Displacement in Y	728.3	mm	Member No. 28137, x: 0.000 m
	Max Displacement in Z	422.3	mm	Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	837.2	mm	Member No. 29551, x: 0.097 m
	Max rotation about X	-36.0	mrad	
	Max Rotation about Y	30.2	mrad	
	Max Rotation about Z	-58.4	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	LC10 - J EG+V+1,2xWind45 (0,6)			
	Sum of Loads in X	16.60	kN	
	Sum of Support Reactions in X	16.60	kN	Deviation 0.00%
	Sum of Loads in Y	16.60	kN	
	Sum of Support Reactions in Y	16.60	kN	Deviation 0.00%

RESULTS - SUMMARY

	Description	Value	Unit	Comment
	Sum of Loads in Z	5.41	kN	Deviation 0.00%
	Sum of Support Reactions in Z	5.41	kN	Deviation 0.00%
	Max Displacement in X	573.1	mm	Member No. 22467, x: 0.099 m
	Max Displacement in Y	569.4	mm	
	Max Displacement in Z	297.4	mm	Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	642.6	mm	Member No. 23936, x: 0.097 m
	Max rotation about X	-46.5	mrad	
	Max Rotation about Y	48.6	mrad	
	Max Rotation about Z	-39.1	mrad	
	Method of Analysis	3rd Order		Large Deformation Analysis (Non-linear, Newton-Raphson)
	Consider favorable effects of tensile forces of membe	No		
	Divide results back by LG factor	No		
	Stiffness Reduction by Gamma-M	No		
	Number of Iterations	1		
	Summary			
	Max Displacement in X	689.9	mm	LC4, Member No. 12824, x: 0.098 m
	Max Displacement in Y	770.7	mm	LC4, Member No. 28136, x: 0.099 m
	Max Displacement in Z	447.3	mm	LC4, Member No. 30267, x: 0.424 m
	Max Vectorial Displacement	886.4	mm	LC4, Member No. 18428, x: 0.097 m
	Max rotation about X	-59.2	mrad	LC5,
	Max Rotation about Y	61.7	mrad	LC5,
	Max Rotation about Z	67.2	mrad	LC4,
	Number of 1D Finite Elements (member elements)	32941		
	Number of FE nodes	19338		
	Number of Equations	116028		
	Matrix Solver Method	Direct		
	Max Number of Iterations	100		
	Number of Load Increments	1		
	Divisions of members for member results	10		
	Divisions of cable, foundation or tapered members	10		
	Refer Internal Forces to Deformed Structure	Yes		
	Activate shear rigidity (A-y, A-z) of members	No		
	Activate Failed Members	Yes		

NODES - SUPPORT FORCES

Node No.	LC/LG	Support forces [kN] $P_{X'}$	$P_{Y'}$	$P_{Z'}$	Support moments [kNm] $M_{X'}$	$M_{Y'}$	$M_{Z'}$
19335	LC1	0.92	-0.93	-1.37	0.00	0.00	0.00
	LC2	0.42	-0.43	-3.89	0.00	0.00	0.00
	LC3	-0.04	0.03	-3.68	0.00	0.00	0.00
	LC4	23.09	-7.33	5.43	0.00	0.00	0.00
	LC5	13.90	-6.60	4.33	0.00	0.00	0.00
	LC6	0.98	-0.99	-1.02	0.00	0.00	0.00
	LC7	11.38	-4.86	1.88	0.00	0.00	0.00
	LC8	6.91	-4.30	1.62	0.00	0.00	0.00
	LC9	19.36	-6.70	4.39	0.00	0.00	0.00
	LC10	11.67	-5.99	3.65	0.00	0.00	0.00
19336	LC1	0.94	0.93	-1.36	0.00	0.00	0.00
	LC2	0.45	0.43	-3.88	0.00	0.00	0.00
	LC3	-0.02	-0.03	-3.67	0.00	0.00	0.00
	LC4	23.05	7.33	5.30	0.00	0.00	0.00
	LC5	16.29	16.29	0.40	0.00	0.00	0.00
	LC6	1.00	0.99	-1.01	0.00	0.00	0.00
	LC7	11.38	4.87	1.86	0.00	0.00	0.00
	LC8	7.87	7.88	-0.30	0.00	0.00	0.00
	LC9	19.34	6.70	4.32	0.00	0.00	0.00
	LC10	13.53	13.52	0.23	0.00	0.00	0.00
19337	LC1	-0.94	0.93	-1.36	0.00	0.00	0.00
	LC2	-0.45	0.43	-3.88	0.00	0.00	0.00
	LC3	0.03	-0.03	-3.67	0.00	0.00	0.00
	LC4	-9.64	4.64	3.72	0.00	0.00	0.00
	LC5	-6.60	13.92	4.33	0.00	0.00	0.00
	LC6	-1.00	0.98	-1.01	0.00	0.00	0.00
	LC7	-6.00	3.40	1.17	0.00	0.00	0.00
	LC8	-4.30	6.93	1.62	0.00	0.00	0.00
	LC9	-8.60	4.35	3.00	0.00	0.00	0.00
	LC10	-6.00	11.68	3.65	0.00	0.00	0.00
19338	LC1	-0.92	-0.93	-1.37	0.00	0.00	0.00
	LC2	-0.42	-0.43	-3.89	0.00	0.00	0.00
	LC3	0.04	0.03	-3.67	0.00	0.00	0.00
	LC4	-9.61	-4.58	3.61	0.00	0.00	0.00
	LC5	-2.83	-2.86	-2.54	0.00	0.00	0.00
	LC6	-0.98	-0.99	-1.01	0.00	0.00	0.00
	LC7	-6.00	-3.39	1.15	0.00	0.00	0.00
	LC8	-2.19	-2.20	-1.49	0.00	0.00	0.00
	LC9	-8.58	-4.31	2.94	0.00	0.00	0.00
	LC10	-2.60	-2.62	-2.13	0.00	0.00	0.00
Σ Suppo	LC1	0.00	0.00	-5.47			
Σ Loads		0.00	0.00	-5.47			
Σ Suppo	LC2	0.00	0.00	-15.55			
Σ Loads		0.00	0.00	-15.55			
Σ Suppo	LC3	0.00	0.00	-14.70			
Σ Loads		0.00	0.00	-14.70			
Σ Suppo	LC4	26.90	0.06	18.07			
Σ Loads		26.90	0.07	18.07			
Σ Suppo	LC5	20.75	20.75	6.51			
Σ Loads		20.75	20.75	6.52			
Σ Suppo	LC6	0.00	0.00	-4.05			
Σ Loads		0.00	0.00	-4.05			
Σ Suppo	LC7	10.76	0.03	6.07			
Σ Loads		10.76	0.03	6.08			
Σ Suppo	LC8	8.30	8.30	1.45			
Σ Loads		8.30	8.30	1.46			
Σ Suppo	LC9	21.52	0.05	14.65			
Σ Loads		21.52	0.06	14.65			
Σ Suppo	LC10	16.60	16.60	5.41			
Σ Loads		16.60	16.60	5.41			

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GENERAL DATA

Members to design:	1,2,11,12,20,21,30,39,40,49,50,59,60,72-74,83,84,92,93,102,103,112,113,125,126,135,136,145,146,155,156,165-167,176,177,185,186,195-197,206,207,219,220,229,237,238,247,248,257,258,260,269,270,288-290,299,300,312,313,322,323,332,333,342,343,352-356,358,367-370,375-380,389,392,397,402,407,412-417	
Ultimate Limit State Design		
Load cases to design:	LC1	A 1,35xEG+V
	LC2	B 1,35xEG+V+1,5xErsatzlast
	LC3	C 1,35xEG+V+1,5xInstallation
	LC4	D 1,35xEG+V+1,5xWind0 (0,6)
	LC5	E 1,35xEG+V+1,5xWind45 (0,6)

DETAILS

Stability Analysis	
Stability Check	☐
Determination of elastic critical moment for lateral-torsional buckling	
For members:	Automatically by Eigenvalue Method
Load application of positive transverse loads:	On cross-section edge directed to shear center (e.g. top flange, destabilizing effect)
Limit Load for Special Cases	
Unsymmetric cross-sections with compression and bending	
$M_{y,Ed} / M_{pl,y,Rd} \leq$	0.01
$M_{z,Ed} / M_{pl,z,Rd} \leq$	0.01
$N_{c,Ed} / N_{pl} \leq$	0.01
Non-Symmetrical Cross-Sections, Tapered Members or Sets of Members	
$M_{z,Ed} / M_{pl,z,Rd} \leq$	0.05
Cross-Sections with Torsion	
$\tau_{t,Ed} / \tau_{t,Rd} \leq$	0.05
Stability analysis method of sets of members acc. to	6.3.4 General Method
Options	
Elastic Design (also for cross-sections of Class 1 or 2)	☐
Cross section check for M+N	
Use linear interaction acc. to 6.2.1(7)	☐
Member Slendernesses	
Members with	λ_{limit}
Tension only:	300
Compression / flexure:	200
Design of Welds	
Allow Design of Welds	☐
Fire Design Settings	
$t_{fi, requ}$ [min]	15.00
Unprotected Members Δt [s]	5.00
Protected Members Δt [s]	30.00
Temperature Curve for Determination of Temperature of Gases	
Nominal temperature curves	Standard temperature-time curve
αc [W/m²K]	25.00
Thermal Actions for Temperature Analysis	
Φ	1.00
ε_m	0.70
ε_f	1.00
Fire Properties	
$\gamma_{M,fi}$	1.00

NATIONAL ANNEX - DIN

Partial Factors acc. to 6.1, Note 2B	
For resistance of cross-sections γ_{M0} :	1.00
For resistance of members to buckling (assessed for checks in Clause 6.3) γ_{M1} :	1.10
For resistance of cross-sections in tension to fracture γ_{M2} :	1.25
Shear acc. to 6.2.6(3) and shear buckling acc. to EN 1993-1-5	
Factor η :	1.20
Parameters for Lateral-Torsional Buckling	
Imperfection coefficients of lateral-torsional buckling curves acc. to Table 6.3	
Buckling Curve a :	0.21
Buckling Curve b :	0.34
Buckling Curve c :	0.49
Buckling Curve d :	0.76
Use factor f for modification of χ_{LT} according to 6.3.2.3(2)	☒
Parameters for Φ_{LT} acc. to 6.3.2.3(1):	
Rolled I-sections	
$\lambda_{LT,0}$:	0.40
β :	0.75
Welded I-Sections	
$\lambda_{LT,0}$:	0.40
β :	0.75
Determine lateral-torsional buckling curves:	If possible, acc. to 6.3.2.3, Eq. (6.57), otherwise acc. to 6.3.2.2, Eq. (6.56)
Determine interaction factors for 6.3.3(4) according to Method:	2 according to Annex B
Serviceability Limits (Deflections) acc. to 7.2	
Combination of actions (Table A1.4 of EN 1990):	Cantilevers
CH : Characteristic L / 300	L_c / 150
FR : Frequent L / 200	L_c / 100
QP : Quasi-permanent L / 200	L_c / 100
General Method according to 6.3.4	
Use General Method also for non-I-sections	☐
Always use General Method for stability design according to 6.3.4	☐
Use Europan lateral-torsional buckling curve according to [5]	☐
Use the method of Johannes Caspar Naumes for assessing the out-of-plane stability	☐
Stainless Steel (EN 1993-1-4) Parameters	
Partial Factors acc. to 5.1	
For resistance of cross-sections γ_{M0}	1.100
For resistance of members to buckling (assessed for proofs in Clause 6.3) γ_{M1}	1.100
For resistance of cross-sections to fracture due to tension γ_{M2}	1.250
Shear According to 5.6(2) and Shear Buckling η	1.200
Parameters for Stability Design	
Imperfection Coefficient Buckling	α
Cold formed open sections	0.490
Hollow sections (welded or seamless)	0.490
Welded open sections (about the major axis)	0.490
Welded open sections (about the minor axis)	0.760
Torsional and Lateral-Torsional Buckling	
All structural members	0.340
Parameter for Φ Buckling	λ_0
Cold formed open sections	0.400
Hollow sections (welded or seamless)	0.400
Welded open sections (about the major axis)	0.200

NATIONAL ANNEX - DIN

Welded open sections (about the minor axis)	0.200
Torsional and Lateral-Torsional Buckling	
All structural members	0.200
Imperfection Coefficient	α_{LT}
Cold formed sections and hollow sections (welded and seamless)	0.340
Welded open sections and other sections	0.760

MATERIALS

Material No	Material Description	Comment
6	Baustahl S 355	

CROSS-SECTIONS

Ring 82.5/2.5 Ring 63.5/2.5

Cross-s. No	Material No	Cross-section Description [mm]	Comment
9	6	Ring 82.5/2.5	
	Type General - only Class 3 and Class 4 possible		
10	6	Ring 63.5/2.5	
	Type General - only Class 3 and Class 4 possible		

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
9	**Ring 82.5/2.5 -**						
	1	0.000	LF4	0.05	≤ 1	101)	Cross-section check - Tension acc. to 6.2.3
	Design Internal Forces						
	N_{Ed}	10.32 kN		$V_{z,Ed}$	11.02 kN	$M_{y,Ed}$	-0.78 kNm
	$V_{y,Ed}$	12.84 kN		T_{Ed}	0.24 kNm	$M_{z,Ed}$	0.11 kNm
	Design Ratio						
	$N_{t,Ed}$	10.32 kN		$N_{pl,Rd}$	223.05 kN	$N_{u,Rd}$	221.67 kN
	A	6.28 cm^2		A_{net}	6.28 cm^2	$N_{t,Rd}$	221.67 kN
	f_y	35.50 kN/cm^2		f_u	49.00 kN/cm^2	η	0.05
	γ_{M0}	1.000		γ_{M2}	1.250		
	136	0.000	LF5	0.14	≤ 1	102)	Cross-section check - Compression acc. to 6.2.4
	Design Internal Forces						
	N_{Ed}	-30.68 kN		$V_{z,Ed}$	-3.70 kN	$M_{y,Ed}$	2.65 kNm
	$V_{y,Ed}$	1.45 kN		T_{Ed}	0.00 kNm	$M_{z,Ed}$	1.33 kNm
	Design Ratio						
	$N_{c,Ed}$	30.68 kN		f_y	35.50 kN/cm^2	$N_{c,Rd}$	223.05 kN
	A	6.28 cm^2		γ_{M0}	1.000	η	0.14
	196	0.058	LF3	0.02	≤ 1	112)	Cross-section check - Bending about y-axis acc. to 6.2.5 - Class 3
	Design Internal Forces						
	N_{Ed}	-0.41 kN		$V_{z,Ed}$	-1.85 kN	$M_{y,Ed}$	-0.09 kNm
	$V_{y,Ed}$	-0.04 kN		T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm
	Design Ratio						
	$M_{y,Ed}$	0.09 kNm		γ_{M0}	1.000	η	0.02
	$S_{el,y,min}$	12.20 cm^3		$M_{el,y,Rd}$	4.33 kNm		
	f_y	35.50 kN/cm^2		$M_{c,y,Rd}$	4.33 kNm		
	103	0.058	LF1	0.01	≤ 1	117)	Cross-section check - Bending about z-axis acc. to 6.2.5 - Class 3
	Design Internal Forces						
	N_{Ed}	-0.19 kN		$V_{z,Ed}$	-0.68 kN	$M_{y,Ed}$	0.00 kNm
	$V_{y,Ed}$	0.66 kN		T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.04 kNm
	Design Ratio						
	$M_{z,Ed}$	0.04 kNm		γ_{M0}	1.000	η	0.01
	$S_{el,z,min}$	12.20 cm^3		$M_{el,z,Rd}$	4.33 kNm		
	f_y	35.50 kN/cm^2		$M_{c,z,Rd}$	4.33 kNm		
	369	0.000	LF4	0.11	≤ 1	122)	Cross-section check - Shear force in z-axis acc. to 6.2.6(4) - Class 3 or 4
	Design Internal Forces						
	N_{Ed}	7.11 kN		$V_{z,Ed}$	11.00 kN	$M_{y,Ed}$	-0.03 kNm
	$V_{y,Ed}$	-1.15 kN		T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.02 kNm
	Design Ratio						
	$V_{z,Ed}$	11.00 kN		t	2.5 mm	γ_{M0}	1.000
	Q_y	2.54 cm^3		$\tau_{V,z,Ed}$	2.22 kN/cm^2	τ_{Rd}	20.50 kN/cm^2
	I_y	50.31 cm^4		f_y	35.50 kN/cm^2	η	0.11
	415	0.029	LF5	0.18	≤ 1	124)	Cross-section check - Shear force in y-axis acc. to 6.2.6(4) - Class 3 or 4
	Design Internal Forces						
	N_{Ed}	1.60 kN		$V_{z,Ed}$	-1.15 kN	$M_{y,Ed}$	0.04 kNm
	$V_{y,Ed}$	-11.48 kN		T_{Ed}	0.01 kNm	$M_{z,Ed}$	-0.50 kNm
	Design Ratio						
	$V_{y,Ed}$	11.48 kN		t	2.5 mm	γ_{M0}	1.000
	Q_z	3.97 cm^3		$\tau_{V,y,Ed}$	3.62 kN/cm^2	τ_{Rd}	20.50 kN/cm^2
	I_z	50.31 cm^4		f_y	35.50 kN/cm^2	η	0.18
	1	0.000	LF4	0.05	≤ 1	131)	Cross-section check - Torsion acc. to 6.2.7
	Design Internal Forces						
	N_{Ed}	10.32 kN		$V_{z,Ed}$	11.02 kN	$M_{y,Ed}$	-0.78 kNm
	$V_{y,Ed}$	12.84 kN		T_{Ed}	0.24 kNm	$M_{z,Ed}$	0.11 kNm
	Design Ratio						
	T_{Ed}	0.24 kNm		$\tau_{t,Ed}$	0.97 kN/cm^2	τ_{Rd}	20.50 kN/cm^2
	A_c	50.27 cm^2		f_y	35.50 kN/cm^2	η	0.05
	t_{min}	2.5 mm		γ_{M0}	1.000		

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	1	0.000	LF4	0.22	≤ 1	133)	Cross-section check - Torsion and shear force acc. to 6.2.7(5)

Design Internal Forces

N_{Ed}	10.32 kN	$V_{z,Ed}$	11.02 kN	$M_{y,Ed}$	-0.78 kNm		
$V_{y,Ed}$	12.84 kN	T_{Ed}	0.24 kNm	$M_{z,Ed}$	0.11 kNm		

Design Ratio

$V_{z,Ed}$	11.02 kN	T_{Ed}	0.24 kNm	f_y	35.50 kN/cm²		
Q_y	3.97 cm³	A_c	50.27 cm²	γ_{M0}	1.000		
I_y	50.31 cm⁴	t	2.5 mm	τ_{Rd}	20.50 kN/cm²		
t	2.5 mm	$\tau_{t,Ed}$	0.97 kN/cm²	η	0.22		
$\tau_{V,z,Ed}$	3.47 kN/cm²	$\tau_{V,z,t,Ed}$	4.44 kN/cm²				

	1	0.058	LF4	0.24	≤ 1	138)	Cross-section check - Torsion and shear force acc. to 6.2.7(5)

Design Internal Forces

N_{Ed}	10.32 kN	$V_{z,Ed}$	11.01 kN	$M_{y,Ed}$	-0.15 kNm		
$V_{y,Ed}$	12.84 kN	T_{Ed}	0.24 kNm	$M_{z,Ed}$	-0.63 kNm		

Design Ratio

$V_{y,Ed}$	12.84 kN	T_{Ed}	0.24 kNm	f_y	35.50 kN/cm²		
Q_z	3.97 cm³	A_c	25.00 cm²	γ_{M0}	1.000		
I_z	50.31 cm⁴	t	5.0 mm	τ_{Rd}	20.50 kN/cm²		
t	2.5 mm	$\tau_{t,Ed}$	0.97 kN/cm²	η	0.24		
$\tau_{V,y,Ed}$	4.05 kN/cm²	$\tau_{V,y,t,Ed}$	5.02 kN/cm²				

	196	0.058	LF3	0.02	≤ 1	143)	Cross-section check - Bending and shear force acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-0.41 kN	$V_{z,Ed}$	-1.85 kN	$M_{y,Ed}$	-0.09 kNm		
$V_{y,Ed}$	-0.04 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

$M_{y,Ed}$	-0.09 kNm	Q_y	0.00 cm³	$V_{pl,z,Rd}$	63.88 kN		
I_y	50.31 cm⁴	t	2.5 mm	v_z	0.029		
z_{SP}	41.3 mm	$\tau_{V,z,Ed}$	0.00 kN/cm²	$\sigma_{x,Rd}$	35.50 kN/cm²		
$\sigma_{x,Ed}$	-0.73 kN/cm²	f_y	35.50 kN/cm²	η	0.02		
$V_{z,Ed}$	1.85 kN	γ_{M0}	1.000				

	103	0.058	LF1	0.01	≤ 1	153)	Cross-section check - Bending about z-axis and shear force acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-0.19 kN	$V_{z,Ed}$	-0.68 kN	$M_{y,Ed}$	0.00 kNm		
$V_{y,Ed}$	0.66 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.04 kNm		

Design Ratio

$M_{z,Ed}$	-0.04 kNm	Q_z	0.00 cm³	v_y	0.010		
I_z	50.31 cm⁴	$\tau_{V,y,Ed}$	0.00 kN/cm²	$\sigma_{x,Rd}$	35.50 kN/cm²		
y_{SP}	-41.3 mm	f_y	35.50 kN/cm²	η	0.01		
$\sigma_{x,Ed}$	-0.35 kN/cm²	γ_{M0}	1.000				
$V_{y,Ed}$	0.66 kN	$V_{pl,y,Rd}$	63.88 kN				

	196	0.058	LF5	0.11	≤ 1	158)	Cross-section check - Bending about z-axis, shear force and torsion acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	0.10 kN	$V_{z,Ed}$	-2.97 kN	$M_{y,Ed}$	0.00 kNm		
$V_{y,Ed}$	6.05 kN	T_{Ed}	-0.15 kNm	$M_{z,Ed}$	-0.46 kNm		

Design Ratio

$M_{z,Ed}$	-0.46 kNm	t	2.5 mm	γ_{M0}	1.000		
I_z	50.31 cm⁴	$\tau_{t,Ed}$	0.59 kN/cm²	$V_{pl,y,Rd}$	63.88 kN		
y_{SP}	41.3 mm	$V_{y,Ed}$	6.05 kN	$V_{pl,y,T,Rd}$	62.05 kN		
$\sigma_{x,Ed}$	3.75 kN/cm²	Q_z	0.00 cm³	v_y	0.097		
T_{Ed}	0.15 kNm	$\tau_{V,y,Ed}$	0.00 kN/cm²	$\sigma_{x,Rd}$	35.50 kN/cm²		
A_c	50.27 cm²	f_y	35.50 kN/cm²	η	0.11		

	238	0.000	LF4	0.83	≤ 1	163)	Cross-section check - Biaxial bending and shear force acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-0.22 kN	$V_{z,Ed}$	0.13 kN	$M_{y,Ed}$	-0.43 kNm		

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	414	0.000	LF4	0.15	≤ 1	168)	Cross-section check - Biaxial bending, shear force and torsion acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section
	333	0.058	LF5	0.34	≤ 1	183)	Cross-section check - Bending, shear and axial force acc. to 6.2.9.2 - Class 3 - General cross-section
	416	0.043	LF4	0.08	≤ 1	188)	Cross-section check - Bending, shear, torsion and axial force acc. to 6.2.9.2 - Class 3 - General cross-section
	195	0.184	LF5	0.06	≤ 1	203)	Cross-section check - Bending about z-axis, shear and axial force acc. to 6.2.9.2 - Class 3 - General cross-section

$V_{y,Ed}$	-3.66	kN	T_{Ed}	0.00	kNm	$M_{z,Ed}$	-3.60	kNm	
Design Ratio									
$M_{y,Ed}$	-0.43	kNm	$\sigma_{x,Ed}$	-29.64	kN/cm²	f_y	35.50	kN/cm²	
I_y	50.31	cm⁴	$V_{z,Ed}$	0.13	kN	γ_{M0}	1.000		
z_{SP}	7.2	mm	Q_y	3.91	cm³	$V_{pl,z,Rd}$	63.88	kN	
$\sigma_{x,My,Ed}$	-0.61	kN/cm²	t	2.5	mm	$V_{pl,y,Rd}$	63.88	kN	
$M_{z,Ed}$	-3.60	kNm	$\tau_{V,z,Ed}$	0.04	kN/cm²	v_z	0.002		
I_z	50.31	cm⁴	$V_{y,Ed}$	3.66	kN	v_y	0.057		
y_{SP}	-40.6	mm	Q_z	0.67	cm³	$\sigma_{x,Rd}$	35.50	kN/cm²	
$\sigma_{x,Mz,Ed}$	-29.03	kN/cm²	$\tau_{V,y,Ed}$	0.20	kN/cm²	η	0.83		
Design Internal Forces									
N_{Ed}	0.22	kN	$V_{z,Ed}$	4.53	kN	$M_{y,Ed}$	-0.11	kNm	
$V_{y,Ed}$	-8.88	kN	T_{Ed}	0.24	kNm	$M_{z,Ed}$	-0.64	kNm	
Design Ratio									
$M_{y,Ed}$	-0.11	kNm	A_c	50.27	cm²	γ_{M0}	1.000		
I_y	50.31	cm⁴	t	2.5	mm	$V_{pl,z,Rd}$	63.88	kN	
z_{SP}	-7.2	mm	$\tau_{t,Ed}$	0.97	kN/cm²	$V_{pl,y,Rd}$	63.88	kN	
$\sigma_{x,My,Ed}$	0.16	kN/cm²	$V_{z,Ed}$	4.53	kN	$V_{pl,z,T,Rd}$	60.87	kN	
$M_{z,Ed}$	-0.64	kNm	Q_y	3.91	cm³	$V_{pl,y,T,Rd}$	60.87	kN	
I_z	50.31	cm⁴	$\tau_{V,z,Ed}$	1.41	kN/cm²	v_z	0.074		
y_{SP}	40.6	mm	$V_{y,Ed}$	8.88	kN	v_y	0.146		
$\sigma_{x,Mz,Ed}$	5.17	kN/cm²	Q_z	0.67	cm³	$\sigma_{x,Rd}$	35.50	kN/cm²	
$\sigma_{x,Ed}$	5.33	kN/cm²	$\tau_{V,y,Ed}$	0.47	kN/cm²	η	0.15		
T_{Ed}	0.24	kNm	f_y	35.50	kN/cm²				
Design Internal Forces									
N_{Ed}	6.23	kN	$V_{z,Ed}$	1.59	kN	$M_{y,Ed}$	-1.35	kNm	
$V_{y,Ed}$	0.44	kN	T_{Ed}	0.00	kNm	$M_{z,Ed}$	0.00	kNm	
Design Ratio									
N_{Ed}	6.23	kN	$\sigma_{x,My,Ed}$	11.03	kN/cm²	f_y	35.50	kN/cm²	
A	6.28	cm²	$\sigma_{x,Ed}$	12.03	kN/cm²	γ_{M0}	1.000		
$\sigma_{x,N,Ed}$	0.99	kN/cm²	$V_{z,Ed}$	1.59	kN	$V_{pl,z,Rd}$	63.88	kN	
$M_{y,Ed}$	-1.35	kNm	Q_y	0.00	cm³	v_z	0.025		
I_y	50.31	cm⁴	t	2.5	mm	$\sigma_{x,Rd}$	35.50	kN/cm²	
z_{SP}	-41.3	mm	$\tau_{V,z,Ed}$	0.00	kN/cm²	η	0.34		
Design Internal Forces									
N_{Ed}	4.17	kN	$V_{z,Ed}$	-0.51	kN	$M_{y,Ed}$	-0.26	kNm	
$V_{y,Ed}$	-3.94	kN	T_{Ed}	-0.13	kNm	$M_{z,Ed}$	-0.01	kNm	
Design Ratio									
N_{Ed}	4.17	kN	T_{Ed}	0.13	kNm	γ_{M0}	1.000		
A	6.28	cm²	A_c	50.27	cm²	$V_{pl,z,Rd}$	63.88	kN	
$\sigma_{x,N,Ed}$	0.66	kN/cm²	t	2.5	mm	$V_{pl,z,T,Rd}$	62.32	kN	
$M_{y,Ed}$	-0.26	kNm	$\tau_{t,Ed}$	0.50	kN/cm²	v_z	0.008		
I_y	50.31	cm⁴	$V_{z,Ed}$	0.51	kN	$\sigma_{x,Rd}$	35.50	kN/cm²	
z_{SP}	-41.3	mm	Q_y	0.00	cm³	η	0.08		
$\sigma_{x,My,Ed}$	2.11	kN/cm²	$\tau_{V,z,Ed}$	0.00	kN/cm²				
$\sigma_{x,Ed}$	2.77	kN/cm²	f_y	35.50	kN/cm²				
Design Internal Forces									
N_{Ed}	-12.17	kN	$V_{z,Ed}$	-0.73	kN	$M_{y,Ed}$	0.00	kNm	
$V_{y,Ed}$	0.96	kN	T_{Ed}	0.00	kNm	$M_{z,Ed}$	0.02	kNm	
Design Ratio									
N_{Ed}	-12.17	kN	$\sigma_{x,Mz,Ed}$	-0.19	kN/cm²	γ_{M0}	1.000		
A	6.28	cm²	$\sigma_{x,Ed}$	-2.13	kN/cm²	$V_{pl,y,Rd}$	63.88	kN	
$\sigma_{x,N,Ed}$	-1.94	kN/cm²	$V_{y,Ed}$	0.96	kN	v_y	0.015		
$M_{z,Ed}$	0.02	kNm	Q_z	0.00	cm³	$\sigma_{x,Rd}$	35.50	kN/cm²	

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x [m]	LC/LG/ CO	Design		Acc. to Formula	

I_z 50.31 cm⁴ $\tau_{V,y,Ed}$ 0.00 kN/cm² η 0.06
y_{SP} 41.3 mm f_y 35.50 kN/cm²

	416	0.000	LF5	0.13	≤ 1	208)	Cross-section check - Bending about z-axis, shear, torsion and axial force acc. to 6.2.9.2 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	5.16 kN	$V_{z,Ed}$	-7.64 kN	$M_{y,Ed}$	0.00 kNm	
$V_{y,Ed}$	-8.40 kN	T_{Ed}	-0.15 kNm	$M_{z,Ed}$	-0.46 kNm	

Design Ratio

N_{Ed}	5.16 kN	T_{Ed}	0.15 kNm	γ_{M0}	1.000	
A	6.28 cm²	A_c	50.27 cm²	$V_{pl,y,Rd}$	63.88 kN	
$\sigma_{x,N,Ed}$	0.82 kN/cm²	t	2.5 mm	$V_{pl,y,T,Rd}$	62.05 kN	
$M_{z,Ed}$	-0.46 kNm	$\tau_{t,Ed}$	0.59 kN/cm²	v_y	0.135	
I_z	50.31 cm⁴	$V_{y,Ed}$	8.40 kN	$\sigma_{x,Rd}$	35.50 kN/cm²	
y_{SP}	41.3 mm	Q_z	0.00 cm³	η	0.13	
$\sigma_{x,Mz,Ed}$	3.77 kN/cm²	$\tau_{V,y,Ed}$	0.00 kN/cm²			
$\sigma_{x,Ed}$	4.59 kN/cm²	f_y	35.50 kN/cm²			

	49	0.233	LF4	1.09	> 1	223)	Cross-section check - Biaxial bending, shear and axial force acc. to 6.2.10 and 6.2.9 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-17.74 kN	$V_{z,Ed}$	5.05 kN	$M_{y,Ed}$	3.87 kNm	
$V_{y,Ed}$	-0.46 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	2.02 kNm	

Design Ratio

N_{Ed}	-17.74 kN	y_{SP}	20.6 mm	$\tau_{V,y,Ed}$	0.13 kN/cm²	
A	6.28 cm²	$\sigma_{x,Mz,Ed}$	-8.27 kN/cm²	f_y	35.50 kN/cm²	
$\sigma_{x,N,Ed}$	-2.82 kN/cm²	$\sigma_{x,Ed}$	-38.59 kN/cm²	γ_{M0}	1.000	
$M_{y,Ed}$	3.87 kNm	$V_{z,Ed}$	5.05 kN	$V_{pl,z,Rd}$	63.88 kN	
I_y	50.31 cm⁴	Q_y	1.99 cm³	$V_{pl,y,Rd}$	63.88 kN	
z_{SP}	-35.7 mm	t	2.5 mm	v_z	0.079	
$\sigma_{x,My,Ed}$	-27.49 kN/cm²	$\tau_{V,z,Ed}$	0.80 kN/cm²	v_y	0.007	
$M_{z,Ed}$	2.02 kNm	$V_{y,Ed}$	0.46 kN	$\sigma_{x,Rd}$	35.50 kN/cm²	
I_z	50.31 cm⁴	Q_z	3.43 cm³	η	1.09	

	356	0.000	LF5	0.39	≤ 1	228)	Cross-section check - Biaxial bending, shear, torsion and axial force acc. to 6.2.10 and 6.2.9 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-6.20 kN	$V_{z,Ed}$	-1.80 kN	$M_{y,Ed}$	1.57 kNm	
$V_{y,Ed}$	0.06 kN	T_{Ed}	0.06 kNm	$M_{z,Ed}$	-0.12 kNm	

Design Ratio

N_{Ed}	-6.20 kN	$\sigma_{x,Ed}$	-13.86 kN/cm²	f_y	35.50 kN/cm²	
A	6.28 cm²	T_{Ed}	0.06 kNm	γ_{M0}	1.000	
$\sigma_{x,N,Ed}$	-0.99 kN/cm²	A_c	50.27 cm²	$V_{pl,z,Rd}$	63.88 kN	
$M_{y,Ed}$	1.57 kNm	t	2.5 mm	$V_{pl,y,Rd}$	63.88 kN	
I_y	50.31 cm⁴	$\tau_{t,Ed}$	0.25 kN/cm²	$V_{pl,z,T,Rd}$	63.11 kN	
z_{SP}	-41.3 mm	$V_{z,Ed}$	1.80 kN	$V_{pl,y,T,Rd}$	63.11 kN	
$\sigma_{x,My,Ed}$	-12.87 kN/cm²	Q_y	0.00 cm³	v_z	0.028	
$M_{z,Ed}$	-0.12 kNm	$\tau_{V,z,Ed}$	0.00 kN/cm²	v_y	0.001	
I_z	50.31 cm⁴	$V_{y,Ed}$	0.06 kN	$\sigma_{x,Rd}$	35.50 kN/cm²	
y_{SP}	0.0 mm	Q_z	3.97 cm³	η	0.39	
$\sigma_{x,Mz,Ed}$	0.00 kN/cm²	$\tau_{V,y,Ed}$	0.02 kN/cm²			

10	**Ring 63.5/2.5 -**						
	12	0.000	LF3	0.00	≤ 1	100)	Negligible internal forces

Design Internal Forces

N_{Ed}	-0.10 kN	$V_{z,Ed}$	0.06 kN	$M_{y,Ed}$	0.01 kNm	
$V_{y,Ed}$	-0.03 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm	

Design Ratio

η 0.00

	412	0.237	LF5	0.02	≤ 1	101)	Cross-section check - Tension acc. to 6.2.3

Design Internal Forces

N_{Ed}	3.57 kN	$V_{z,Ed}$	0.00 kN	$M_{y,Ed}$	-0.14 kNm	
$V_{y,Ed}$	-0.18 kN	T_{Ed}	0.11 kNm	$M_{z,Ed}$	0.19 kNm	

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	

Design Ratio

$N_{t,Ed}$	3.57 kN	$N_{pl,Rd}$	170.08 kN	$N_{u,Rd}$	169.02 kN
A	4.79 cm²	A_{net}	4.79 cm²	$N_{t,Rd}$	169.02 kN
f_y	35.50 kN/cm²	f_u	49.00 kN/cm²	η	0.02
γ_{M0}	1.000	γ_{M2}	1.250		

125	0.000	LF5	0.01 ≤ 1	102)	Cross-section check - Compression acc. to 6.2.4

Design Internal Forces

N_{Ed}	-2.07 kN	$V_{z,Ed}$	-0.36 kN	$M_{y,Ed}$	0.26 kNm
$V_{y,Ed}$	-0.80 kN	T_{Ed}	-0.06 kNm	$M_{z,Ed}$	0.15 kNm

Design Ratio

$N_{c,Ed}$	2.07 kN	f_y	35.50 kN/cm²	$N_{c,Rd}$	170.08 kN
A	4.79 cm²	γ_{M0}	1.000	η	0.01

397	0.178	LF5	0.15 ≤ 1	112)	Cross-section check - Bending about y-axis acc. to 6.2.5 - Class 3

Design Internal Forces

N_{Ed}	-0.07 kN	$V_{z,Ed}$	-0.19 kN	$M_{y,Ed}$	-0.38 kNm
$V_{y,Ed}$	-0.16 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm

Design Ratio

$M_{y,Ed}$	0.38 kNm	γ_{M0}	1.000	η	0.15
$S_{el,y,min}$	7.03 cm³	$M_{el,y,Rd}$	2.50 kNm		
f_y	35.50 kN/cm²	$M_{c,y,Rd}$	2.50 kNm		

323	0.060	LF3	0.02 ≤ 1	117)	Cross-section check - Bending about z-axis acc. to 6.2.5 - Class 3

Design Internal Forces

N_{Ed}	0.01 kN	$V_{z,Ed}$	-0.42 kN	$M_{y,Ed}$	0.00 kNm
$V_{y,Ed}$	1.24 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.06 kNm

Design Ratio

$M_{z,Ed}$	0.06 kNm	γ_{M0}	1.000	η	0.02
$S_{el,z,min}$	7.03 cm³	$M_{el,z,Rd}$	2.50 kNm		
f_y	35.50 kN/cm²	$M_{c,z,Rd}$	2.50 kNm		

323	0.060	LF3	0.01 ≤ 1	122)	Cross-section check - Shear force in z-axis acc. to 6.2.6(4) - Class 3 or 4

Design Internal Forces

N_{Ed}	0.01 kN	$V_{z,Ed}$	-0.42 kN	$M_{y,Ed}$	0.00 kNm
$V_{y,Ed}$	1.24 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.06 kNm

Design Ratio

$V_{z,Ed}$	0.42 kN	t	2.5 mm	γ_{M0}	1.000
Q_y	2.31 cm³	$\tau_{V,z,Ed}$	0.17 kN/cm²	τ_{Rd}	20.50 kN/cm²
I_y	22.32 cm⁴	f_y	35.50 kN/cm²	η	0.01

323	0.060	LF3	0.02 ≤ 1	124)	Cross-section check - Shear force in y-axis acc. to 6.2.6(4) - Class 3 or 4

Design Internal Forces

N_{Ed}	0.01 kN	$V_{z,Ed}$	-0.42 kN	$M_{y,Ed}$	0.00 kNm
$V_{y,Ed}$	1.24 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.06 kNm

Design Ratio

$V_{y,Ed}$	1.24 kN	t	2.5 mm	γ_{M0}	1.000
Q_z	2.31 cm³	$\tau_{V,y,Ed}$	0.51 kN/cm²	τ_{Rd}	20.50 kN/cm²
I_z	22.32 cm⁴	f_y	35.50 kN/cm²	η	0.02

300	0.000	LF4	0.08 ≤ 1	131)	Cross-section check - Torsion acc. to 6.2.7

Design Internal Forces

N_{Ed}	1.40 kN	$V_{z,Ed}$	-0.03 kN	$M_{y,Ed}$	-1.02 kNm
$V_{y,Ed}$	1.92 kN	T_{Ed}	0.24 kNm	$M_{z,Ed}$	1.48 kNm

Design Ratio

T_{Ed}	0.24 kNm	$\tau_{t,Ed}$	1.67 kN/cm²	τ_{Rd}	20.50 kN/cm²
A_c	29.22 cm²	f_y	35.50 kN/cm²	η	0.08
t_{min}	2.5 mm	γ_{M0}	1.000		

185	0.000	LF5	0.11 ≤ 1	133)	Cross-section check - Torsion and shear force acc. to 6.2.7(5)

Design Internal Forces

N_{Ed}	1.63 kN	$V_{z,Ed}$	1.96 kN	$M_{y,Ed}$	0.65 kNm
$V_{y,Ed}$	-0.55 kN	T_{Ed}	-0.20 kNm	$M_{z,Ed}$	0.44 kNm

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	300	0.060	LF4	0.12	≤ 1	138)	Cross-section check - Torsion and shear force acc. to 6.2.7(5)

Design Ratio

$V_{z,Ed}$	1.96 kN	T_{Ed}	0.20 kNm	f_y	35.50 kN/cm²		
Q_y	2.31 cm³	A_c	29.22 cm²	γ_{M0}	1.000		
I_y	22.32 cm⁴	t	2.5 mm	τ_{Rd}	20.50 kN/cm²		
t	2.5 mm	$\tau_{t,Ed}$	1.40 kN/cm²	η	0.11		
$\tau_{V,z,Ed}$	0.81 kN/cm²	$\tau_{V,z,t,Ed}$	2.21 kN/cm²				

Design Internal Forces

N_{Ed}	1.40 kN	$V_{z,Ed}$	-0.03 kN	$M_{y,Ed}$	-1.02 kNm
$V_{y,Ed}$	1.92 kN	T_{Ed}	0.24 kNm	$M_{z,Ed}$	1.36 kNm

Design Ratio

$V_{y,Ed}$	1.92 kN	T_{Ed}	0.24 kNm	f_y	35.50 kN/cm²
Q_z	2.31 cm³	A_c	25.00 cm²	γ_{M0}	1.000
I_z	22.32 cm⁴	t	2.9 mm	τ_{Rd}	20.50 kN/cm²
t	2.5 mm	$\tau_{t,Ed}$	1.67 kN/cm²	η	0.12
$\tau_{V,y,Ed}$	0.79 kN/cm²	$\tau_{V,y,t,Ed}$	2.46 kN/cm²		

	397	0.178	LF5	0.15	≤ 1	143)	Cross-section check - Bending and shear force acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-0.07 kN	$V_{z,Ed}$	-0.19 kN	$M_{y,Ed}$	-0.38 kNm
$V_{y,Ed}$	-0.16 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm

Design Ratio

$M_{y,Ed}$	-0.38 kNm	Q_y	0.00 cm³	$V_{pl,z,Rd}$	48.73 kN
I_y	22.32 cm⁴	t	2.5 mm	v_z	0.004
z_{SP}	31.8 mm	$\tau_{V,z,Ed}$	0.00 kN/cm²	$\sigma_{x,Rd}$	35.50 kN/cm²
$\sigma_{x,Ed}$	-5.37 kN/cm²	f_y	35.50 kN/cm²	η	0.15
$V_{z,Ed}$	0.19 kN	γ_{M0}	1.000		

	323	0.000	LF1	0.01	≤ 1	148)	Cross-section check - Bending, shear force and torsion acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	0.08 kN	$V_{z,Ed}$	-0.20 kN	$M_{y,Ed}$	0.02 kNm
$V_{y,Ed}$	1.79 kN	T_{Ed}	0.04 kNm	$M_{z,Ed}$	0.01 kNm

Design Ratio

$M_{y,Ed}$	0.02 kNm	t	2.5 mm	γ_{M0}	1.000
I_y	22.32 cm⁴	$\tau_{t,Ed}$	0.26 kN/cm²	$V_{pl,z,Rd}$	48.73 kN
z_{SP}	31.8 mm	$V_{z,Ed}$	0.20 kN	$V_{pl,z,T,Rd}$	48.12 kN
$\sigma_{x,Ed}$	0.32 kN/cm²	Q_y	0.00 cm³	v_z	0.004
T_{Ed}	0.04 kNm	$\tau_{V,z,Ed}$	0.00 kN/cm²	$\sigma_{x,Rd}$	35.50 kN/cm²
A_c	29.22 cm²	f_y	35.50 kN/cm²	η	0.01

	323	0.060	LF3	0.02	≤ 1	153)	Cross-section check - Bending about z-axis and shear force acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	0.01 kN	$V_{z,Ed}$	-0.42 kN	$M_{y,Ed}$	0.00 kNm
$V_{y,Ed}$	1.24 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.06 kNm

Design Ratio

$M_{z,Ed}$	-0.06 kNm	Q_z	0.00 cm³	v_y	0.025
I_z	22.32 cm⁴	$\tau_{V,y,Ed}$	0.00 kN/cm²	$\sigma_{x,Rd}$	35.50 kN/cm²
y_{SP}	31.8 mm	f_y	35.50 kN/cm²	η	0.02
$\sigma_{x,Ed}$	0.79 kN/cm²	γ_{M0}	1.000		
$V_{y,Ed}$	1.24 kN	$V_{pl,y,Rd}$	48.73 kN		

	323	0.060	LF2	0.05	≤ 1	158)	Cross-section check - Bending about z-axis, shear force and torsion acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	0.30 kN	$V_{z,Ed}$	-0.24 kN	$M_{y,Ed}$	-0.01 kNm
$V_{y,Ed}$	1.84 kN	T_{Ed}	0.04 kNm	$M_{z,Ed}$	-0.11 kNm

Design Ratio

$M_{z,Ed}$	-0.11 kNm	t	2.5 mm	γ_{M0}	1.000
I_z	22.32 cm⁴	$\tau_{t,Ed}$	0.28 kN/cm²	$V_{pl,y,Rd}$	48.73 kN
y_{SP}	31.8 mm	$V_{y,Ed}$	1.84 kN	$V_{pl,y,T,Rd}$	48.07 kN

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	

$\sigma_{x,Ed}$	1.63	kN/cm²	Q_z		0.00	cm³	v_y	0.038	
T_{Ed}	0.04	kNm	$\tau_{V,y,Ed}$		0.00	kN/cm²	$\sigma_{x,Rd}$	35.50	kN/cm²
A_c	29.22	cm²	f_y		35.50	kN/cm²	η	0.05	

397	0.237	LF5	0.16	≤ 1	163)	Cross-section check - Biaxial bending and shear force acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section			
Design Internal Forces									
N_{Ed}	-0.07	kN	$V_{z,Ed}$		-0.19	kN	$M_{y,Ed}$	-0.39	kNm
$V_{y,Ed}$	-0.16	kN	T_{Ed}		0.00	kNm	$M_{z,Ed}$	0.01	kNm
Design Ratio									
$M_{y,Ed}$	-0.39	kNm	$\sigma_{x,Ed}$		-5.52	kN/cm²	f_y	35.50	kN/cm²
I_y	22.32	cm⁴	$V_{z,Ed}$		0.19	kN	γ_{M0}	1.000	
z_{SP}	31.8	mm	Q_y		0.00	cm³	$V_{pl,z,Rd}$	48.73	kN
$\sigma_{x,My,Ed}$	-5.52	kN/cm²	t		2.5	mm	$V_{pl,y,Rd}$	48.73	kN
$M_{z,Ed}$	0.01	kNm	$\tau_{V,z,Ed}$		0.00	kN/cm²	v_z	0.004	
I_z	22.32	cm⁴	$V_{y,Ed}$		0.16	kN	v_y	0.003	
y_{SP}	0.0	mm	Q_z		2.31	cm³	$\sigma_{x,Rd}$	35.50	kN/cm²
$\sigma_{x,Mz,Ed}$	0.00	kN/cm²	$\tau_{V,y,Ed}$		0.07	kN/cm²	η	0.16	

219	0.060	LF5	0.50	≤ 1	168)	Cross-section check - Biaxial bending, shear force and torsion acc. to 6.2.9.2 and 6.2.10 - Class 3 - General cross-section			
Design Internal Forces									
N_{Ed}	-0.16	kN	$V_{z,Ed}$		1.80	kN	$M_{y,Ed}$	0.69	kNm
$V_{y,Ed}$	-1.01	kN	T_{Ed}		-0.05	kNm	$M_{z,Ed}$	1.04	kNm
Design Ratio									
$M_{y,Ed}$	0.69	kNm	A_c		29.22	cm²	γ_{M0}	1.000	
I_y	22.32	cm⁴	t		2.5	mm	$V_{pl,z,Rd}$	48.73	kN
z_{SP}	-15.9	mm	$\tau_{t,Ed}$		0.35	kN/cm²	$V_{pl,y,Rd}$	48.73	kN
$\sigma_{x,My,Ed}$	-4.89	kN/cm²	$V_{z,Ed}$		1.80	kN	$V_{pl,z,T,Rd}$	47.89	kN
$M_{z,Ed}$	1.04	kNm	Q_y		2.00	cm³	$V_{pl,y,T,Rd}$	47.89	kN
I_z	22.32	cm⁴	$\tau_{V,z,Ed}$		0.64	kN/cm²	v_z	0.038	
y_{SP}	27.5	mm	$V_{y,Ed}$		1.01	kN	v_y	0.021	
$\sigma_{x,Mz,Ed}$	-12.79	kN/cm²	Q_z		1.15	cm³	$\sigma_{x,Rd}$	35.50	kN/cm²
$\sigma_{x,Ed}$	-17.68	kN/cm²	$\tau_{V,y,Ed}$		0.21	kN/cm²	η	0.50	
T_{Ed}	0.05	kNm	f_y		35.50	kN/cm²			

60	0.060	LF2	0.01	≤ 1	183)	Cross-section check - Bending, shear and axial force acc. to 6.2.9.2 - Class 3 - General cross-section			
Design Internal Forces									
N_{Ed}	-0.48	kN	$V_{z,Ed}$		0.12	kN	$M_{y,Ed}$	0.02	kNm
$V_{y,Ed}$	-0.08	kN	T_{Ed}		0.00	kNm	$M_{z,Ed}$	-0.01	kNm
Design Ratio									
N_{Ed}	-0.48	kN	$\sigma_{x,My,Ed}$		-0.27	kN/cm²	f_y	35.50	kN/cm²
A	4.79	cm²	$\sigma_{x,Ed}$		-0.37	kN/cm²	γ_{M0}	1.000	
$\sigma_{x,N,Ed}$	-0.10	kN/cm²	$V_{z,Ed}$		0.12	kN	$V_{pl,z,Rd}$	48.73	kN
$M_{y,Ed}$	0.02	kNm	Q_y		0.00	cm³	v_z	0.002	
I_y	22.32	cm⁴	t		2.5	mm	$\sigma_{x,Rd}$	35.50	kN/cm²
z_{SP}	-31.8	mm	$\tau_{V,z,Ed}$		0.00	kN/cm²	η	0.01	

323	0.030	LF5	0.05	≤ 1	208)	Cross-section check - Bending about z-axis, shear, torsion and axial force acc. to 6.2.9.2 - Class 3 - General cross-section			
Design Internal Forces									
N_{Ed}	1.10	kN	$V_{z,Ed}$		-1.59	kN	$M_{y,Ed}$	0.00	kNm
$V_{y,Ed}$	-0.78	kN	T_{Ed}		-0.13	kNm	$M_{z,Ed}$	0.10	kNm
Design Ratio									
N_{Ed}	1.10	kN	T_{Ed}		0.13	kNm	γ_{M0}	1.000	
A	4.79	cm²	A_c		29.22	cm²	$V_{pl,y,Rd}$	48.73	kN
$\sigma_{x,N,Ed}$	0.23	kN/cm²	t		2.5	mm	$V_{pl,y,T,Rd}$	46.60	kN
$M_{z,Ed}$	0.10	kNm	$\tau_{t,Ed}$		0.90	kN/cm²	v_y	0.017	
I_z	22.32	cm⁴	$V_{y,Ed}$		0.78	kN	$\sigma_{x,Rd}$	35.50	kN/cm²
y_{SP}	-31.8	mm	Q_z		0.00	cm³	η	0.05	
$\sigma_{x,Mz,Ed}$	1.41	kN/cm²	$\tau_{V,y,Ed}$		0.00	kN/cm²			
$\sigma_{x,Ed}$	1.64	kN/cm²	f_y		35.50	kN/cm²			

60	0.045	LF2	0.01	≤ 1	223)	Cross-section check - Biaxial bending, shear and axial

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	60	0.045	LF2	0.01	≤ 1	223)	force acc. to 6.2.10 and 6.2.9 - Class 3 - General cross-section

Design Internal Forces

N_{Ed}	-0.48 kN	$V_{z,Ed}$	0.12 kN	$M_{y,Ed}$	0.02 kNm		
$V_{y,Ed}$	-0.08 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.01 kNm		

Design Ratio

N_{Ed}	-0.48 kN	y_{SP}	-10.9 mm	$\tau_{V,y,Ed}$	0.03 kN/cm²		
A	4.79 cm²	$\sigma_{x,Mz,Ed}$	-0.03 kN/cm²	f_y	35.50 kN/cm²		
$\sigma_{x,N,Ed}$	-0.10 kN/cm²	$\sigma_{x,Ed}$	-0.36 kN/cm²	γ_{M0}	1.000		
$M_{y,Ed}$	0.02 kNm	$V_{z,Ed}$	0.12 kN	$V_{pl,z,Rd}$	48.73 kN		
I_y	22.32 cm⁴	Q_y	0.78 cm³	$V_{pl,y,Rd}$	48.73 kN		
z_{SP}	-29.8 mm	t	2.5 mm	v_z	0.002		
$\sigma_{x,My,Ed}$	-0.23 kN/cm²	$\tau_{V,z,Ed}$	0.02 kN/cm²	v_y	0.002		
$M_{z,Ed}$	-0.01 kNm	$V_{y,Ed}$	0.08 kN	$\sigma_{x,Rd}$	35.50 kN/cm²		
I_z	22.32 cm⁴	Q_z	2.17 cm³	η	0.01		

312	0.060	LF4	0.80	≤ 1	228)	Cross-section check - Biaxial bending, shear, torsion and axial force acc. to 6.2.10 and 6.2.9 - Class 3 - General cross-section	

Design Internal Forces

N_{Ed}	1.41 kN	$V_{z,Ed}$	2.53 kN	$M_{y,Ed}$	1.10 kNm		
$V_{y,Ed}$	1.44 kN	T_{Ed}	0.17 kNm	$M_{z,Ed}$	-1.64 kNm		

Design Ratio

N_{Ed}	1.41 kN	$\sigma_{x,Ed}$	28.31 kN/cm²	f_y	35.50 kN/cm²		
A	4.79 cm²	T_{Ed}	0.17 kNm	γ_{M0}	1.000		
$\sigma_{x,N,Ed}$	0.30 kN/cm²	A_c	29.22 cm²	$V_{pl,z,Rd}$	48.73 kN		
$M_{y,Ed}$	1.10 kNm	t	2.5 mm	$V_{pl,y,Rd}$	48.73 kN		
I_y	22.32 cm⁴	$\tau_{t,Ed}$	1.16 kN/cm²	$V_{pl,z,T,Rd}$	45.97 kN		
z_{SP}	15.9 mm	$V_{z,Ed}$	2.53 kN	$V_{pl,y,T,Rd}$	45.97 kN		
$\sigma_{x,My,Ed}$	7.81 kN/cm²	Q_y	2.00 cm³	v_z	0.055		
$M_{z,Ed}$	-1.64 kNm	$\tau_{V,z,Ed}$	0.91 kN/cm²	v_y	0.031		
I_z	22.32 cm⁴	$V_{y,Ed}$	1.44 kN	$\sigma_{x,Rd}$	35.50 kN/cm²		
y_{SP}	27.5 mm	Q_z	1.16 cm³	η	0.80		
$\sigma_{x,Mz,Ed}$	20.20 kN/cm²	$\tau_{V,y,Ed}$	0.30 kN/cm²				

PARTS LIST BY MEMBER

Part No	Cross-Section Description	Number Members	Length [m]	Tot. Length [m]	Surf. Area [m²]	Volume [m³]	Unit Weight [kg/m]	Weight [kg]	Tot. Weight [t]
1	9 - Ring 82.5/2.5	8	0.06	0.46	0.12	0.00	4.93	0.28	0.002
2	9 - Ring 82.5/2.5	17	0.24	4.16	1.08	0.00	4.93	1.21	0.021
3	10 - Ring 63.5/2.5	16	0.06	0.96	0.19	0.00	3.76	0.23	0.004
4	9 - Ring 82.5/2.5	43	0.23	10.02	2.60	0.01	4.93	1.15	0.049
5	9 - Ring 82.5/2.5	8	0.15	1.20	0.31	0.00	4.93	0.74	0.006
6	10 - Ring 63.5/2.5	4	0.24	0.95	0.19	0.00	3.76	0.89	0.004
Sum		96		17.75	4.49	0.01			0.085

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GENERAL DATA

Members to design:	3-10,13-19,22-29,31-38,41-48,51-58,61-71,75-82,85-91,94-101,104-111,114-124,12134,137-144,147-154,157-164,168-175,178-184,187-194,198-205,208-218,221-228,230-236,239-246,249-256,259,261-268,271-278,280-287,291-298,301-311,314-321,324-331,334-341,344-351,357,359-366,371-374,381-388,390,391,393-396,398-401,403-406,408-411	
Ultimate Limit State Design		
Load cases to design:	LC1	A 1,35xEG+V
	LC2	B 1,35xEG+V+1,5xErsatzlast
	LC3	C 1,35xEG+V+1,5xInstallation
	LC4	D 1,35xEG+V+1,5xWind0 (0,6)
	LC5	E 1,35xEG+V+1,5xWind45 (0,6)

DETAILS

Alternative Values		
EN 1999-1-1: 6.2.5.1 (2)	$\alpha_{3,u}$	☒
EN 1999-1-1: 6.2.5.1 (2)	$\alpha_{3,w}$	☒
EN 1999-1-1: 6.2.9.1 (1)	η_0	☒
EN 1999-1-1: 6.2.9.1 (1)	γ_0	☒
EN 1999-1-1: 6.2.9.1 (1)	ξ_0	☒
EN 1999-1-1: 6.2.9.2 (1)	ψ	☒
EN 1999-1-1: 6.3.3.1 (1),(2)	η_c	☒
EN 1999-1-1: 6.3.3.1 (1)	ξ_{yc}	☒
EN 1999-1-1: 6.3.3.1 (1),(2)	ξ_{zc}	☒
EN 1999-1-1: 6.3.3.1 (3)	ψ_c	☒
EN 1999-1-1: 6.3.3.2 (1)	η_c	☒
EN 1999-1-1: 6.3.3.2 (1)	$_{zc}$	☒
Options		
Elastic Design (also for cross-sections of Class 1 or 2)		☒
Design of shear acc. to 6.2.1(5), eq. (6.15c)		☒
Design of angles acc. to 6.2.1(5), eq. (6.15a)		☐
Design of Angle Cross-Section acc. to 6.2.1(5)		☐
Design of General Cross-Section acc. to 6.2.1(5), eq. (6.15a)		☒
Design of General Cross-Section acc. to 6.2.1(5)		☒
Design of Plate Girders acc. to 6.7		☐
Shear Design of Solid Bars		☐
Shear Buckling Design of Webs		☐
Stability Analysis		
Stability Check		☐
Determination of elastic critical moment for lateral-torsional buckling		
For members:		Automatically by Eigenvalue Method
Load application of positive transverse loads:		On cross-section edge directed to shear center (e.g. top flange, destabilizing effect)
Determination of distance xs for studied section		
Calculation of x_s for unknown shapes of buckling		Use half of the buckling length
Limit Load for Special Cases		
Unsymmetric cross-sections with compression and bending		
$M_{y,Ed} / M_{pl,y,Rd} \leq$		0.01
$M_{z,Ed} / M_{pl,z,Rd} \leq$		0.01
$N_{c,Ed} / N_{pl} \leq$		0.01
Cross-Sections with Torsion		
$\tau_{t,Ed} / \tau_{t,Rd} \leq$		0.05
Slenderness Determination		
Calculate slenderness for lateral torsional buckling λ_{LT} acc. to Annex I.2 (2) (I-sections and channels covered by Table I.5)		☐
Calculate slenderness for torsional and torsional-flexural buckling λ_T acc. to Annex I.4 (2) (sections covered by Table I.8)		☐
Torsional and Torsional-Flexural Buckling		
Ignore Note 6.3.1.4(1) and perform desig		☒
Member Slendernesses		
Members with		λ_{limit}
Tension only:		300
Compression / flexure:		200

NATIONAL ANNEX - DIN

Partial Factors acc. to 6.1, Note 2B
For resistance of members to buckling (Assessed for Checks in Clause 6.3)
γ_{M1} 1.100
For resistance of cross-sections in tension to fracture
γ_{M2} 1.250

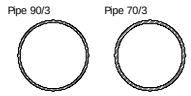
Serviceability Limits (Deflections) acc. to 7.2
Combination of actions (Table A1.4 of EN 1990):

			Cantilevers
CH :	Characteristic	L / 300	L_c / 150
FR :	Frequent	L / 200	L_c / 100
QP :	Quasi-permanent	L / 200	L_c / 100

General Trixial State of Stess in Section
Maximum Ratio for Triaxial State of Stress acc. to 6.15 (ar. 6.2.1 (5))
C 1.200

MATERIALS

Material No	Material Description	Comment
1	Aluminium EN-AW 6082 (EP,ET) T6	



CROSS-SECTIONS

Cross-s. No	Material No	Cross-section Description [mm]	Comment
1	1	Pipe 90/3	
2	1	Pipe 70/3	
3	1	Pipe 70/3	

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
1	**Pipe 90/3 -**						
	335	0.116	LF2	0.06	≤ 1	102)	Cross-section check - Compression acc. to 6.2.4
	Design Internal Forces						
	N_{Ed}	-10.92 kN		$V_{z,Ed}$	-1.05 kN	$M_{y,Ed}$	-0.01 kNm
	$V_{y,Ed}$	0.20 kN		T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.01 kNm
	Design Ratio						
	$N_{c,Ed}$	10.92 kN		f_o	25.00 kN/cm²	$N_{c,Rd}$	186.35 kN
	A_{eff}	8.20 cm²		γ_{M1}	1.100	η	0.06
	154	0.000	LF5	0.07	≤ 1	116)	Cross-section check - Shear force - Elastic - Round tubes and bars
	Design Internal Forces						
	N_{Ed}	-21.57 kN		$V_{z,Ed}$	3.42 kN	$M_{y,Ed}$	0.53 kNm
	$V_{y,Ed}$	1.01 kN		T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.11 kNm
	Design Ratio						
	V_{Ed}	3.57 kN		t	3.0 mm	γ_{M1}	1.100
	Q	5.63 cm³		$\tau_{V,Ed}$	0.86 kN/cm²	τ_{Rd}	13.12 kN/cm²
	I	77.67 cm⁴		f_o	25.00 kN/cm²	η	0.07
	264	0.000	LF4	0.00	≤ 1	131)	Cross-section check - Torsion acc. to 6.2.7.2
	Design Internal Forces						
	N_{Ed}	-7.66 kN		$V_{z,Ed}$	0.08 kN	$M_{y,Ed}$	0.26 kNm
	$V_{y,Ed}$	-0.07 kN		T_{Ed}	-0.02 kNm	$M_{z,Ed}$	-0.02 kNm
	Design Ratio						
	T_{Ed}	0.02 kNm		$\tau_{t,Ed}$	0.05 kN/cm²	τ_{Rd}	13.12 kN/cm²
	A_c	59.45 cm²		f_o	25.00 kN/cm²	η	0.00
	t_{min}	3.0 mm		γ_{M1}	1.100		
	45	0.000	LF4	0.14	≤ 1	137)	Cross-section check - Torsion and shear force acc. to 6.2.7.2(4) - Elastic - Round tubes and bars
	Design Internal Forces						
	N_{Ed}	-18.18 kN		$V_{z,Ed}$	2.64 kN	$M_{y,Ed}$	-0.62 kNm
	$V_{y,Ed}$	-3.02 kN		T_{Ed}	-0.31 kNm	$M_{z,Ed}$	-0.05 kNm
	Design Ratio						
	V_{Ed}	4.01 kN		T_{Ed}	0.31 kNm	γ_{M1}	1.100
	Q	5.63 cm³		A_c	59.45 cm²	τ_{Rd}	13.12 kN/cm²
	I	77.67 cm⁴		$\tau_{t,Ed}$	0.86 kN/cm²	η	0.14
	t	3.0 mm		$\tau_{V,t,Ed}$	1.83 kN/cm²		
	$\tau_{V,Ed}$	0.97 kN/cm²		f_o	25.00 kN/cm²		
	242	0.175	LF4	0.08	≤ 1	146)	Cross-section check - Bending, shear force and torsion acc. to 6.2.5 to 6.2.8
	Design Internal Forces						
	N_{Ed}	-0.25 kN		$V_{z,Ed}$	-0.18 kN	$M_{y,Ed}$	-0.40 kNm
	$V_{y,Ed}$	-2.74 kN		T_{Ed}	-0.31 kNm	$M_{z,Ed}$	0.00 kNm
	Design Ratio						
	$M_{y,Ed}$	0.40 kNm		$V_{z,Ed}$	0.18 kN	$V_{z,Rd}$	64.55 kN
	α_y	1.308		$A_{v,z}$	4.92 cm²	$V_{z,T,Rd}$	60.31 kN
	$W_{el,y}$	17.26 cm³		T_{Ed}	0.31 kNm	v_z	0.003
	f_o	25.00 kN/cm²		A_c	59.45 cm²	$M_{o,y,Rd}$	5.13 kNm
	γ_{M1}	1.100		t	3.0 mm	η	0.08
	γ_{M2}	1.250		$\tau_{t,Ed}$	0.86 kN/cm²		
	239	0.000	LF4	0.54	≤ 1	167)	Cross-section check - Bending, shear force and torsion acc. to 6.2.5 - 6.2.9 - Round tubes and bars
	Design Internal Forces						
	N_{Ed}	-0.22 kN		$V_{z,Ed}$	0.08 kN	$M_{y,Ed}$	-0.40 kNm
	$V_{y,Ed}$	-3.45 kN		T_{Ed}	-0.13 kNm	$M_{z,Ed}$	-2.74 kNm
	Design Ratio						
	M_{Ed}	2.77 kNm		V_{Ed}	3.45 kN	V_{Rd}	64.55 kN
	α	1.308		A_v	4.92 cm²	$V_{T,Rd}$	62.76 kN
	W_{el}	17.26 cm³		T_{Ed}	0.13 kNm	v	0.055
	f_o	25.00 kN/cm²		A_c	59.45 cm²	$M_{o,Rd}$	5.13 kNm
	γ_{M1}	1.100		t	3.0 mm	η	0.54
	γ_{M2}	1.250		$\tau_{t,Ed}$	0.36 kN/cm²		
	142	0.000	LF5	0.21	≤ 1	171)	Cross-section check - Bending, shear and axial force acc. to 6.2.9

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Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	

Design Internal Forces

N_{Ed}	-13.86 kN	$V_{z,Ed}$	-1.36 kN	$M_{y,Ed}$	-0.95 kNm		
$V_{y,Ed}$	0.73 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.01 kNm		

Design Ratio

f_o	25.00 kN/cm²	ψ	1.300	α_y	1.308		
γ_{M1}	1.100	$V_{z,Ed}$	1.36 kN	α_z	1.000		
γ_{M2}	1.250	$A_{v,z}$	4.92 cm²	$M_{o,y,Rd}$	5.13 kNm		
N_{Ed}	-13.86 kN	$V_{z,Rd}$	64.55 kN	$M_{y,Rd}$	5.13 kNm		
A	8.20 cm²	v_z	0.021	η_{Ny}	0.03		
N_{Rd}	186.35 kN	$M_{y,Ed}$	0.95 kNm	η_{My}	0.06		
ω_0	1.000	$W_{el,y}$	17.26 cm³	η	0.21		

388	0.117	LF4	0.23	≤ 1	176)	Cross-section check - Bending, shear, torsion and axial force acc. to 6.2.9	

Design Internal Forces

N_{Ed}	-16.24 kN	$V_{z,Ed}$	2.43 kN	$M_{y,Ed}$	1.00 kNm		
$V_{y,Ed}$	0.59 kN	T_{Ed}	-0.01 kNm	$M_{z,Ed}$	-0.01 kNm		

Design Ratio

f_o	25.00 kN/cm²	$A_{v,z}$	4.92 cm²	$W_{el,y}$	17.26 cm³		
γ_{M1}	1.100	T_{Ed}	0.01 kNm	α_y	1.308		
γ_{M2}	1.250	A_c	59.45 cm²	α_z	1.000		
N_{Ed}	-16.24 kN	t	3.0 mm	$M_{o,y,Rd}$	5.13 kNm		
A	8.20 cm²	$\tau_{t,Ed}$	0.04 kN/cm²	$M_{y,Rd}$	5.13 kNm		
N_{Rd}	186.35 kN	$V_{z,Rd}$	64.55 kN	η_{Ny}	0.04		
ω_0	1.000	$V_{z,T,Rd}$	64.37 kN	η_{My}	0.06		
ψ	1.300	v_z	0.038	η	0.23		
$V_{z,Ed}$	2.43 kN	$M_{y,Ed}$	1.00 kNm				

228	0.000	LF5	0.04	≤ 1	181)	Cross-section check - Bending about z-axis, shear and axial force acc. to 6.2.9	

Design Internal Forces

N_{Ed}	-7.77 kN	$V_{z,Ed}$	0.67 kN	$M_{y,Ed}$	-0.01 kNm		
$V_{y,Ed}$	-0.34 kN	T_{Ed}	0.01 kNm	$M_{z,Ed}$	-0.14 kNm		

Design Ratio

f_o	25.00 kN/cm²	ψ	1.300	α_y	1.000		
γ_{M1}	1.100	$V_{y,Ed}$	0.34 kN	α_z	1.308		
γ_{M2}	1.250	$A_{v,y}$	4.92 cm²	$M_{o,z,Rd}$	5.13 kNm		
N_{Ed}	-7.77 kN	$V_{y,Rd}$	64.55 kN	$M_{z,Rd}$	5.13 kNm		
A	8.20 cm²	v_y	0.005	η_{Nz}	0.02		
N_{Rd}	186.35 kN	$M_{z,Ed}$	0.14 kNm	η_{Mz}	0.00		
ω_0	1.000	$W_{el,z}$	17.26 cm³	η	0.04		

46	0.000	LF4	0.17	≤ 1	186)	Cross-section check - Bending about z-axis, shear, torsion and axial force acc. to 6.2.9.1(4)	

Design Internal Forces

N_{Ed}	-18.10 kN	$V_{z,Ed}$	3.30 kN	$M_{y,Ed}$	-0.01 kNm		
$V_{y,Ed}$	-2.45 kN	T_{Ed}	-0.28 kNm	$M_{z,Ed}$	0.67 kNm		

Design Ratio

f_o	25.00 kN/cm²	$A_{v,y}$	4.92 cm²	$W_{el,z}$	17.26 cm³		
γ_{M1}	1.100	T_{Ed}	0.28 kNm	α_y	1.000		
γ_{M2}	1.250	A_c	59.45 cm²	α_z	1.308		
N_{Ed}	-18.10 kN	$t_{V,y}$	3.0 mm	$M_{o,z,Rd}$	5.13 kNm		
A	8.20 cm²	$\tau_{t,Ed}$	0.77 kN/cm²	$M_{z,Rd}$	5.13 kNm		
N_{Rd}	186.35 kN	$V_{y,Rd}$	64.55 kN	η_{Nz}	0.05		
ω_0	1.000	$V_{y,T,Rd}$	60.75 kN	η_{Mz}	0.03		
ψ	1.300	v_y	0.040	η	0.17		
$V_{y,Ed}$	2.45 kN	$M_{z,Ed}$	0.67 kNm				

82	0.245	LF5	0.58	≤ 1	191)	Cross-section check - Biaxial bending, shear and axial force acc. to 6.2.10 and 6.2.9	

Design Internal Forces

N_{Ed}	-20.45 kN	$V_{z,Ed}$	0.83 kN	$M_{y,Ed}$	2.31 kNm		
$V_{y,Ed}$	-0.50 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	1.18 kNm		

Design Ratio

f_o	25.00 kN/cm²	$V_{z,Rd}$	64.55 kN	v_y	0.008		
γ_{M1}	1.100	v_z	0.013	$M_{z,Ed}$	1.18 kNm		
γ_{M2}	1.250	$M_{y,Ed}$	2.31 kNm	$W_{el,z}$	17.26 cm³		
N_{Ed}	-20.45 kN	$W_{el,y}$	17.26 cm³	α_z	1.308		

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Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	

	A	8.20	cm²	α_y		1.308		$M_{o,z,Rd}$	5.13 kNm
	N_{Rd}	186.35	kN	$M_{o,y,Rd}$		5.13	kNm	$M_{z,Rd}$	5.13 kNm
	ω_0	1.000		$M_{y,Rd}$		5.13	kNm	η_N	0.06
	ψ	1.300		$V_{y,Ed}$		0.50	kN	η_{My}	0.26
	$V_{z,Ed}$	0.83	kN	$A_{v,y}$		4.92	cm²	η_{Mz}	0.08
	$A_{v,z}$	4.92	cm²	$V_{y,Rd}$		64.55	kN	η	0.58
	48	0.233	LF4	0.72	≤ 1	196)	Cross-section check - Biaxial bending, shear, torsion and axial force acc. to 6.2.10 and 6.2.9		
	Design Internal Forces								
	N_{Ed}	-17.89	kN	$V_{z,Ed}$		4.46	kN	$M_{y,Ed}$	2.70 kNm
	$V_{y,Ed}$	-1.01	kN	T_{Ed}		-0.12	kNm	$M_{z,Ed}$	1.91 kNm
	Design Ratio								
	f_o	25.00	kN/cm²	$\tau_{t,Ed}$		0.33	kN/cm²	$V_{y,Rd}$	64.55 kN
	γ_{M1}	1.100		$V_{z,Rd}$		64.55	kN	$V_{y,T,Rd}$	62.95 kN
	γ_{M2}	1.250		$V_{z,T,Rd}$		62.95	kN	v_y	0.016
	T_{Ed}	0.12	kNm	v_z		0.071		$M_{z,Ed}$	1.91 kNm
	A_c	59.45	cm²	$M_{y,Ed}$		2.70	kNm	$W_{el,z}$	17.26 cm³
	N_{Ed}	-17.89	kN	$W_{el,y}$		17.26	cm³	α_z	1.308
	A	8.20	cm²	α_y		1.308		$M_{o,z,Rd}$	5.13 kNm
	N_{Rd}	186.35	kN	$M_{o,y,Rd}$		5.13	kNm	$M_{z,Rd}$	5.13 kNm
	ω_0	1.000		$M_{y,Rd}$		5.13	kNm	η_N	0.05
	ψ	1.300		$V_{y,Ed}$		1.01	kN	η_{My}	0.34
	$V_{z,Ed}$	4.46	kN	$A_{v,y}$		4.92	cm²	η_{Mz}	0.19
	$A_{v,z}$	4.92	cm²	$t_{V,y}$		3.0	mm	η	0.72
	$t_{V,z}$	3.0	mm	$\tau_{t,f,Ed}$		0.33	kN/cm²		
2	**Pipe 70/3 -**								
	91	0.000	LF2	0.00	≤ 1	100)	Negligible internal forces		
	Design Internal Forces								
	N_{Ed}	-0.04	kN	$V_{z,Ed}$		-0.09	kN	$M_{y,Ed}$	-0.01 kNm
	$V_{y,Ed}$	0.05	kN	T_{Ed}		0.00	kNm	$M_{z,Ed}$	-0.01 kNm
	Design Ratio								
	η	0.00							
	124	0.000	LF3	0.01	≤ 1	106)	Cross-section check - Bending about y-axis acc. to 6.2.5		
	Design Internal Forces								
	N_{Ed}	-0.06	kN	$V_{z,Ed}$		-0.02	kN	$M_{y,Ed}$	-0.03 kNm
	$V_{y,Ed}$	0.03	kN	T_{Ed}		0.00	kNm	$M_{z,Ed}$	-0.01 kNm
	Design Ratio								
	$M_{y,Ed}$	0.03	kNm	γ_{M1}		1.100		$A_{v,z}$	3.79 cm²
	α_y	1.428		γ_{M2}		1.250		$V_{z,Rd}$	49.71 kN
	$W_{el,y}$	10.14	cm³	$M_{o,y,Rd}$		3.29	kNm	v_z	0.000
	f_o	25.00	kN/cm²	$V_{z,Ed}$		0.02	kN	η	0.01
	69	0.163	LF1	0.01	≤ 1	107)	Cross-section check - Bending about z-axis acc. to 6.2.5		
	Design Internal Forces								
	N_{Ed}	-0.25	kN	$V_{z,Ed}$		-0.05	kN	$M_{y,Ed}$	0.00 kNm
	$V_{y,Ed}$	0.00	kN	T_{Ed}		0.00	kNm	$M_{z,Ed}$	0.02 kNm
	Design Ratio								
	$M_{z,Ed}$	0.02	kNm	γ_{M1}		1.100		$A_{v,y}$	3.79 cm²
	α_z	1.428		γ_{M2}		1.250		$V_{y,Rd}$	49.71 kN
	$W_{el,z}$	10.14	cm³	$M_{o,z,Rd}$		3.29	kNm	v_y	0.000
	f_o	25.00	kN/cm²	$V_{y,Ed}$		0.00	kN	η	0.01
	211	0.000	LF5	0.19	≤ 1	108)	Cross-section check - Bending acc. to 6.2.5 - Round tubes and bars		
	Design Internal Forces								
	N_{Ed}	0.01	kN	$V_{z,Ed}$		-0.09	kN	$M_{y,Ed}$	-0.58 kNm
	$V_{y,Ed}$	-0.86	kN	T_{Ed}		0.01	kNm	$M_{z,Ed}$	-0.23 kNm
	Design Ratio								
	M_{Ed}	0.62	kNm	γ_{M1}		1.100		V_{Rd}	49.71 kN
	α	1.428		γ_{M2}		1.250		v	0.017
	W_{pl}	10.14	cm³	$M_{o,Rd}$		3.29	kNm	η	0.19
	W_{el}	10.14	cm³	V_{Ed}		0.87	kN		
	f_o	25.00	kN/cm²	A_v		3.79	cm²		

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	215	0.000	LF4	0.05	≤ 1	116)	Cross-section check - Shear force - Elastic - Round tubes and bars

Design Internal Forces

N_{Ed}	1.76 kN	$V_{z,Ed}$	1.76 kN	$M_{y,Ed}$	-0.32 kNm		
$V_{y,Ed}$	-1.34 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.81 kNm		

Design Ratio

V_{Ed}	2.21 kN	t	3.0 mm	γ_{M1}	1.100		
Q	3.34 cm^3	$\tau_{V,Ed}$	0.69 kN/cm^2	τ_{Rd}	13.12 kN/cm^2		
I	35.50 cm^4	f_o	25.00 kN/cm^2	η	0.05		

	89	0.000	LF5	0.01	≤ 1	131)	Cross-section check - Torsion acc. to 6.2.7.2

Design Internal Forces

N_{Ed}	-0.26 kN	$V_{z,Ed}$	-0.07 kN	$M_{y,Ed}$	-0.07 kNm		
$V_{y,Ed}$	-0.01 kN	T_{Ed}	0.03 kNm	$M_{z,Ed}$	-0.08 kNm		

Design Ratio

T_{Ed}	0.03 kNm	$\tau_{t,Ed}$	0.13 kN/cm^2	τ_{Rd}	13.12 kN/cm^2		
A_c	35.26 cm^2	f_o	25.00 kN/cm^2	η	0.01		
t_{min}	3.0 mm	γ_{M1}	1.100				

	302	0.000	LF4	0.15	≤ 1	137)	Cross-section check - Torsion and shear force acc. to 6.2.7.2(4) - Elastic - Round tubes and bars

Design Internal Forces

N_{Ed}	1.38 kN	$V_{z,Ed}$	0.02 kN	$M_{y,Ed}$	-1.03 kNm		
$V_{y,Ed}$	2.00 kN	T_{Ed}	0.29 kNm	$M_{z,Ed}$	1.18 kNm		

Design Ratio

V_{Ed}	2.01 kN	T_{Ed}	0.29 kNm	γ_{M1}	1.100		
Q	3.34 cm^3	A_c	35.26 cm^2	τ_{Rd}	13.12 kN/cm^2		
I	35.50 cm^4	$\tau_{t,Ed}$	1.39 kN/cm^2	η	0.15		
t	3.0 mm	$\tau_{V,t,Ed}$	2.02 kN/cm^2				
$\tau_{V,Ed}$	0.63 kN/cm^2	f_o	25.00 kN/cm^2				

	212	0.054	LF5	0.18	≤ 1	146)	Cross-section check - Bending, shear force and torsion acc. to 6.2.5 to 6.2.8

Design Internal Forces

N_{Ed}	0.09 kN	$V_{z,Ed}$	0.19 kN	$M_{y,Ed}$	-0.59 kNm		
$V_{y,Ed}$	-0.83 kN	T_{Ed}	0.05 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

$M_{y,Ed}$	0.59 kNm	$V_{z,Ed}$	0.19 kN	$V_{z,Rd}$	49.71 kN		
α_y	1.428	$A_{v,z}$	3.79 cm^2	$V_{z,T,Rd}$	48.90 kN		
$W_{el,y}$	10.14 cm^3	T_{Ed}	0.05 kNm	v_z	0.004		
f_o	25.00 kN/cm^2	A_c	35.26 cm^2	$M_{o,y,Rd}$	3.29 kNm		
γ_{M1}	1.100	t	3.0 mm	η	0.18		
γ_{M2}	1.250	$\tau_{t,Ed}$	0.22 kN/cm^2				

	216	0.000	LF5	0.20	≤ 1	156)	Cross-section check - Bending about z-axis, shear force and torsion acc. to 6.2.5 to 6.2.8

Design Internal Forces

N_{Ed}	-0.09 kN	$V_{z,Ed}$	1.42 kN	$M_{y,Ed}$	0.01 kNm		
$V_{y,Ed}$	-0.78 kN	T_{Ed}	-0.02 kNm	$M_{z,Ed}$	0.67 kNm		

Design Ratio

$M_{z,Ed}$	0.67 kNm	$V_{y,Ed}$	0.78 kN	$V_{y,Rd}$	49.71 kN		
α_z	1.428	$A_{v,y}$	3.79 cm^2	$V_{y,T,Rd}$	49.34 kN		
$W_{el,z}$	10.14 cm^3	T_{Ed}	0.02 kNm	$v_{y,T}$	0.016		
f_o	25.00 kN/cm^2	A_c	35.26 cm^2	$M_{o,z,Rd}$	3.29 kNm		
γ_{M1}	1.100	$t_{V,y}$	3.0 mm	η	0.20		
γ_{M2}	1.250	$\tau_{t,Ed}$	0.10 kN/cm^2				

	211	0.000	LF5	0.19	≤ 1	162)	Cross-section check - Bending and shear force acc. to 6.2.5 - 6.2.9 - Round tubes and bars

Design Internal Forces

N_{Ed}	0.01 kN	$V_{z,Ed}$	-0.09 kN	$M_{y,Ed}$	-0.58 kNm		
$V_{y,Ed}$	-0.86 kN	T_{Ed}	0.01 kNm	$M_{z,Ed}$	-0.23 kNm		

Design Ratio

M_{Ed}	0.62 kNm	γ_{M1}	1.100	V_{Rd}	49.71 kN		
α	1.428	γ_{M2}	1.250	v	0.017		
W_{el}	10.14 cm^3	V_{Ed}	0.87 kN	$M_{o,Rd}$	3.29 kNm		
f_o	25.00 kN/cm^2	A_v	3.79 cm^2	η	0.19		

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	218	0.085	LF5	0.34	≤ 1	167)	Cross-section check - Bending, shear force and torsion acc. to 6.2.5 - 6.2.9 - Round tubes and bars

Design Internal Forces

N_{Ed}	-0.16 kN	$V_{z,Ed}$	1.70 kN	$M_{y,Ed}$	0.58 kNm		
$V_{y,Ed}$	-0.90 kN	T_{Ed}	-0.05 kNm	$M_{z,Ed}$	0.98 kNm		

Design Ratio

M_{Ed}	1.14 kNm	V_{Ed}	1.93 kN	V_{Rd}	49.71 kN		
α	1.428	A_v	3.79 cm^2	$V_{T,Rd}$	48.79 kN		
W_{el}	10.14 cm^3	T_{Ed}	0.05 kNm	v	0.039		
f_o	25.00 kN/cm^2	A_c	35.26 cm^2	$M_{o,Rd}$	3.29 kNm		
γ_{M1}	1.100	t	3.0 mm	η	0.34		
γ_{M2}	1.250	$\tau_{t,Ed}$	0.24 kN/cm^2				

117	0.000	LF5	0.13	≤ 1	171)	Cross-section check - Bending, shear and axial force acc. to 6.2.9	

Design Internal Forces

N_{Ed}	-2.11 kN	$V_{z,Ed}$	0.15 kN	$M_{y,Ed}$	0.42 kNm		
$V_{y,Ed}$	0.64 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

f_o	25.00 kN/cm^2	ψ	1.300	α_y	1.428		
γ_{M1}	1.100	$V_{z,Ed}$	0.15 kN	α_z	1.000		
γ_{M2}	1.250	$A_{v,z}$	3.79 cm^2	$M_{o,y,Rd}$	3.29 kNm		
N_{Ed}	-2.11 kN	$V_{z,Rd}$	49.71 kN	$M_{y,Rd}$	3.29 kNm		
A	6.31 cm^2	v_z	0.003	η_{Ny}	0.00		
N_{Rd}	143.51 kN	$M_{y,Ed}$	0.42 kNm	η_{My}	0.03		
ω_0	1.000	$W_{el,y}$	10.14 cm^3	η	0.13		

67	0.163	LF4	0.03	≤ 1	176)	Cross-section check - Bending, shear, torsion and axial force acc. to 6.2.9	

Design Internal Forces

N_{Ed}	-0.45 kN	$V_{z,Ed}$	0.02 kN	$M_{y,Ed}$	-0.12 kNm		
$V_{y,Ed}$	-0.41 kN	T_{Ed}	-0.01 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

f_o	25.00 kN/cm^2	ω_0	1.000	$M_{o,y,Rd}$	3.29 kNm		
γ_{M1}	1.100	ψ	1.300	$M_{y,Rd}$	3.29 kNm		
γ_{M2}	1.250	$M_{y,Ed}$	0.12 kNm	η_{Ny}	0.00		
N_{Ed}	-0.45 kN	$W_{el,y}$	10.14 cm^3	η_{My}	0.00		
A	6.31 cm^2	α_y	1.428	η	0.03		
N_{Rd}	143.51 kN	α_z	1.000				

274	0.230	LF5	0.05	≤ 1	181)	Cross-section check - Bending about z-axis, shear and axial force acc. to 6.2.9	

Design Internal Forces

N_{Ed}	1.57 kN	$V_{z,Ed}$	0.00 kN	$M_{y,Ed}$	0.00 kNm		
$V_{y,Ed}$	0.00 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.17 kNm		

Design Ratio

f_o	25.00 kN/cm^2	ω_0	1.000	$M_{o,z,Rd}$	3.29 kNm		
γ_{M1}	1.100	ψ	1.300	$M_{z,Rd}$	3.29 kNm		
γ_{M2}	1.250	$M_{z,Ed}$	0.17 kNm	η_{Nz}	0.00		
N_{Ed}	1.57 kN	$W_{el,z}$	10.14 cm^3	η_{Mz}	0.01		
A	6.31 cm^2	α_y	1.000	η	0.05		
N_{Rd}	143.51 kN	α_z	1.428				

308	0.163	LF4	0.31	≤ 1	186)	Cross-section check - Bending about z-axis, shear, torsion and axial force acc. to 6.2.9.1(4)	

Design Internal Forces

N_{Ed}	1.66 kN	$V_{z,Ed}$	1.72 kN	$M_{y,Ed}$	0.00 kNm		
$V_{y,Ed}$	1.36 kN	T_{Ed}	0.02 kNm	$M_{z,Ed}$	-1.03 kNm		

Design Ratio

f_o	25.00 kN/cm^2	$A_{v,y}$	3.79 cm^2	$W_{el,z}$	10.14 cm^3		
γ_{M1}	1.100	T_{Ed}	0.02 kNm	α_y	1.000		
γ_{M2}	1.250	A_c	35.26 cm^2	α_z	1.428		
N_{Ed}	1.66 kN	$t_{V,y}$	3.0 mm	$M_{o,z,Rd}$	3.29 kNm		
A	6.31 cm^2	$\tau_{t,Ed}$	0.08 kN/cm^2	$M_{z,Rd}$	3.29 kNm		
N_{Rd}	143.51 kN	$V_{y,Rd}$	49.71 kN	η_{Nz}	0.00		
ω_0	1.000	$V_{y,T,Rd}$	49.42 kN	η_{Mz}	0.14		
ψ	1.300	v_y	0.027	η	0.31		
$V_{y,Ed}$	1.36 kN	$M_{z,Ed}$	1.03 kNm				

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	215	0.218	LF4	0.33	≤ 1	191)	Cross-section check - Biaxial bending, shear and axial force acc. to 6.2.10 and 6.2.9

Design Internal Forces

N_{Ed}	1.76 kN	$V_{z,Ed}$	1.75 kN	$M_{y,Ed}$	0.07 kNm		
$V_{y,Ed}$	-1.34 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	1.11 kNm		

Design Ratio

f_o	25.00 kN/cm²	$V_{z,Rd}$	49.71 kN	v_y	0.027		
γ_{M1}	1.100	v_z	0.035	$M_{z,Ed}$	1.11 kNm		
γ_{M2}	1.250	$M_{y,Ed}$	0.07 kNm	$W_{el,z}$	10.14 cm³		
N_{Ed}	1.76 kN	$W_{el,y}$	10.14 cm³	α_z	1.428		
A	6.31 cm²	α_y	1.428	$M_{o,z,Rd}$	3.29 kNm		
N_{Rd}	143.51 kN	$M_{o,y,Rd}$	3.29 kNm	$M_{z,Rd}$	3.29 kNm		
ω_0	1.000	$M_{y,Rd}$	3.29 kNm	η_N	0.00		
ψ	1.300	$V_{y,Ed}$	1.34 kN	η_{My}	0.00		
$V_{z,Ed}$	1.75 kN	$A_{v,y}$	3.79 cm²	η_{Mz}	0.16		
$A_{v,z}$	3.79 cm²	$V_{y,Rd}$	49.71 kN	η	0.33		

	311	0.085	LF4	0.58	≤ 1	196)	Cross-section check - Biaxial bending, shear, torsion and axial force acc. to 6.2.10 and 6.2.9

Design Internal Forces

N_{Ed}	1.42 kN	$V_{z,Ed}$	2.41 kN	$M_{y,Ed}$	0.95 kNm		
$V_{y,Ed}$	1.28 kN	T_{Ed}	0.17 kNm	$M_{z,Ed}$	-1.55 kNm		

Design Ratio

f_o	25.00 kN/cm²	$\tau_{t,Ed}$	0.80 kN/cm²	$V_{y,Rd}$	49.71 kN		
γ_{M1}	1.100	$V_{z,Rd}$	49.71 kN	$V_{y,T,Rd}$	46.67 kN		
γ_{M2}	1.250	$V_{z,T,Rd}$	46.67 kN	v_y	0.027		
T_{Ed}	0.17 kNm	v_z	0.052	$M_{z,Ed}$	1.55 kNm		
A_c	35.26 cm²	$M_{y,Ed}$	0.95 kNm	$W_{el,z}$	10.14 cm³		
N_{Ed}	1.42 kN	$W_{el,y}$	10.14 cm³	α_z	1.428		
A	6.31 cm²	α_y	1.428	$M_{o,z,Rd}$	3.29 kNm		
N_{Rd}	143.51 kN	$M_{o,y,Rd}$	3.29 kNm	$M_{z,Rd}$	3.29 kNm		
ω_0	1.000	$M_{y,Rd}$	3.29 kNm	η_N	0.00		
ψ	1.300	$V_{y,Ed}$	1.28 kN	η_{My}	0.12		
$V_{z,Ed}$	2.41 kN	$A_{v,y}$	3.79 cm²	η_{Mz}	0.28		
$A_{v,z}$	3.79 cm²	$t_{V,y}$	3.0 mm	η	0.58		
$t_{V,z}$	3.0 mm	$\tau_{t,f,Ed}$	0.80 kN/cm²				

3	**Pipe 70/3 -**						
	403	0.059	LF3	0.00	≤ 1	100)	Negligible internal forces

Design Internal Forces

N_{Ed}	-0.19 kN	$V_{z,Ed}$	0.08 kN	$M_{y,Ed}$	0.00 kNm		
$V_{y,Ed}$	0.00 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

η	0.00						

	408	0.000	LF5	0.02	≤ 1	101)	Cross-section check - Tension acc. to 6.2.3

Design Internal Forces

N_{Ed}	3.56 kN	$V_{z,Ed}$	-0.26 kN	$M_{y,Ed}$	0.00 kNm		
$V_{y,Ed}$	-0.03 kN	T_{Ed}	0.11 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

$N_{t,Ed}$	3.56 kN	γ_{M1}	1.100	η	0.02		
A_g	6.31 cm²	$N_{o,Rd}$	143.51 kN				
f_o	25.00 kN/cm²	$N_{t,Rd}$	143.51 kN				

	406	0.119	LF5	0.05	≤ 1	106)	Cross-section check - Bending about y-axis acc. to 6.2.5

Design Internal Forces

N_{Ed}	0.12 kN	$V_{z,Ed}$	-0.06 kN	$M_{y,Ed}$	-0.16 kNm		
$V_{y,Ed}$	0.07 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm		

Design Ratio

$M_{y,Ed}$	0.16 kNm	γ_{M1}	1.100	$A_{v,z}$	3.79 cm²		
α_y	1.428	γ_{M2}	1.250	$V_{z,Rd}$	49.71 kN		
$W_{el,y}$	10.14 cm³	$M_{o,y,Rd}$	3.29 kNm	v_z	0.000		
f_o	25.00 kN/cm²	$V_{z,Ed}$	0.06 kN	η	0.05		

	396	0.237	LF5	0.11	≤ 1	108)	Cross-section check - Bending acc. to 6.2.5 - Round tubes and bars

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	

Design Internal Forces

N_{Ed}	-0.07 kN	$V_{z,Ed}$	-0.24 kN	$M_{y,Ed}$	-0.35 kNm
$V_{y,Ed}$	-0.03 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.02 kNm

Design Ratio

M_{Ed}	0.35 kNm	γ_{M1}	1.100	V_{Rd}	49.71 kN
α	1.428	γ_{M2}	1.250	v	0.005
W_{pl}	10.14 cm^3	$M_{o,Rd}$	3.29 kNm	η	0.11
W_{el}	10.14 cm^3	V_{Ed}	0.24 kN		
f_o	25.00 kN/cm^2	A_v	3.79 cm^2		

393	0.237	LF5	0.01	≤ 1	116)	Cross-section check - Shear force - Elastic - Round tubes and bars

Design Internal Forces

N_{Ed}	-0.08 kN	$V_{z,Ed}$	-0.49 kN	$M_{y,Ed}$	-0.12 kNm
$V_{y,Ed}$	0.02 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm

Design Ratio

V_{Ed}	0.49 kN	t	3.0 mm	γ_{M1}	1.100
Q	3.34 cm^3	$\tau_{V,Ed}$	0.15 kN/cm^2	τ_{Rd}	13.12 kN/cm^2
I	35.50 cm^4	f_o	25.00 kN/cm^2	η	0.01

396	0.237	LF4	0.10	≤ 1	137)	Cross-section check - Torsion and shear force acc. to 6.2.7.2(4) - Elastic - Round tubes and bars

Design Internal Forces

N_{Ed}	0.77 kN	$V_{z,Ed}$	-0.13 kN	$M_{y,Ed}$	-0.23 kNm
$V_{y,Ed}$	-1.70 kN	T_{Ed}	-0.16 kNm	$M_{z,Ed}$	1.06 kNm

Design Ratio

V_{Ed}	1.71 kN	T_{Ed}	0.16 kNm	γ_{M1}	1.100
Q	3.34 cm^3	A_c	35.26 cm^2	τ_{Rd}	13.12 kN/cm^2
I	35.50 cm^4	$\tau_{t,Ed}$	0.76 kN/cm^2	η	0.10
t	3.0 mm	$\tau_{V,t,Ed}$	1.29 kN/cm^2		
$\tau_{V,Ed}$	0.53 kN/cm^2	f_o	25.00 kN/cm^2		

405	0.237	LF5	0.05	≤ 1	141)	Cross-section check - Bending and shear force acc. to 6.2.5 and 6.2.8

Design Internal Forces

N_{Ed}	0.12 kN	$V_{z,Ed}$	-0.14 kN	$M_{y,Ed}$	-0.15 kNm
$V_{y,Ed}$	0.01 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	0.00 kNm

Design Ratio

$M_{y,Ed}$	0.15 kNm	γ_{M1}	1.100	$V_{z,Rd}$	49.71 kN
α_y	1.428	γ_{M2}	1.250	v_z	0.003
$W_{el,y}$	10.14 cm^3	$V_{z,Ed}$	0.14 kN	$M_{o,y,Rd}$	3.29 kNm
f_o	25.00 kN/cm^2	$A_{v,z}$	3.79 cm^2	η	0.05

396	0.237	LF5	0.11	≤ 1	162)	Cross-section check - Bending and shear force acc. to 6.2.5 - 6.2.9 - Round tubes and bars

Design Internal Forces

N_{Ed}	-0.07 kN	$V_{z,Ed}$	-0.24 kN	$M_{y,Ed}$	-0.35 kNm
$V_{y,Ed}$	-0.03 kN	T_{Ed}	0.00 kNm	$M_{z,Ed}$	-0.02 kNm

Design Ratio

M_{Ed}	0.35 kNm	γ_{M1}	1.100	V_{Rd}	49.71 kN
α	1.428	γ_{M2}	1.250	v	0.005
W_{el}	10.14 cm^3	V_{Ed}	0.24 kN	$M_{o,Rd}$	3.29 kNm
f_o	25.00 kN/cm^2	A_v	3.79 cm^2	η	0.11

408	0.178	LF5	0.02	≤ 1	176)	Cross-section check - Bending, shear, torsion and axial force acc. to 6.2.9

Design Internal Forces

N_{Ed}	3.56 kN	$V_{z,Ed}$	-0.27 kN	$M_{y,Ed}$	-0.05 kNm
$V_{y,Ed}$	-0.03 kN	T_{Ed}	0.11 kNm	$M_{z,Ed}$	0.01 kNm

Design Ratio

f_o	25.00 kN/cm^2	$A_{v,z}$	3.79 cm^2	$W_{el,y}$	10.14 cm^3
γ_{M1}	1.100	T_{Ed}	0.11 kNm	α_y	1.428
γ_{M2}	1.250	A_c	35.26 cm^2	α_z	1.000
N_{Ed}	3.56 kN	t	3.0 mm	$M_{o,y,Rd}$	3.29 kNm
A	6.31 cm^2	$\tau_{t,Ed}$	0.51 kN/cm^2	$M_{y,Rd}$	3.29 kNm
N_{Rd}	143.51 kN	$V_{z,Rd}$	49.71 kN	η_{Ny}	0.01
ω_0	1.000	$V_{z,T,Rd}$	47.79 kN	η_{My}	0.00
ψ	1.300	v_z	0.006	η	0.02

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DESIGN BY CROSS-SECTION

Cross-s. No	Member No	Location x x [m]	LC/LG/ CO	Design		Acc. to Formula	
	406	0.237	LF4	0.38	≤ 1	196)	Cross-section check - Biaxial bending, shear, torsion and axial force acc. to 6.2.10 and 6.2.9

$V_{z,Ed}$	0.27 kN	$M_{y,Ed}$	0.05 kNm				
Design Internal Forces							
N_{Ed}	1.49 kN	$V_{z,Ed}$	0.00 kN	$M_{y,Ed}$	-0.12 kNm		
$V_{y,Ed}$	-1.34 kN	T_{Ed}	-0.02 kNm	$M_{z,Ed}$	1.25 kNm		
Design Ratio							
f_o	25.00 kN/cm²	$\tau_{t,Ed}$	0.11 kN/cm²	$V_{y,Rd}$	49.71 kN		
γ_{M1}	1.100	$V_{z,Rd}$	49.71 kN	$V_{y,T,Rd}$	49.28 kN		
γ_{M2}	1.250	$V_{z,T,Rd}$	49.28 kN	v_y	0.027		
T_{Ed}	0.02 kNm	v_z	0.000	$M_{z,Ed}$	1.25 kNm		
A_c	35.26 cm²	$M_{y,Ed}$	0.12 kNm	$W_{el,z}$	10.14 cm³		
N_{Ed}	1.49 kN	$W_{el,y}$	10.14 cm³	α_z	1.428		
A	6.31 cm²	α_y	1.428	$M_{o,z,Rd}$	3.29 kNm		
N_{Rd}	143.51 kN	$M_{o,y,Rd}$	3.29 kNm	$M_{z,Rd}$	3.29 kNm		
ω_0	1.000	$M_{y,Rd}$	3.29 kNm	η_N	0.00		
ψ	1.300	$V_{y,Ed}$	1.34 kN	η_{My}	0.00		
$V_{z,Ed}$	0.00 kN	$A_{v,y}$	3.79 cm²	η_{Mz}	0.19		
$A_{v,z}$	3.79 cm²	$t_{V,y}$	3.0 mm	η	0.38		
$t_{V,z}$	3.0 mm	$\tau_{t,f,Ed}$	0.11 kN/cm²				

PARTS LIST BY MEMBER

Part No	Cross-Section Description	Number Members	Length [m]	Tot. Length [m]	Surf. Area [m²]	Volume [m³]	Unit Weight [kg/m]	Weight [kg]	Tot. Weight [t]
1	1 - Pipe 90/3	64	0.24	15.67	4.43	0.01	2.21	0.54	0.035
2	2 - Pipe 70/3	24	0.09	2.04	0.45	0.00	1.70	0.14	0.003
3	2 - Pipe 70/3	12	0.23	2.76	0.61	0.00	1.70	0.39	0.005
4	1 - Pipe 90/3	167	0.23	38.92	11.00	0.03	2.21	0.52	0.086
5	2 - Pipe 70/3	8	0.07	0.58	0.13	0.00	1.70	0.12	0.001
6	2 - Pipe 70/3	28	0.22	6.10	1.34	0.00	1.70	0.37	0.010
7	2 - Pipe 70/3	1	0.06	0.06	0.01	0.00	1.70	0.10	0.000
8	3 - Pipe 70/3	16	0.24	3.79	0.83	0.00	1.70	0.40	0.006
Sum		320		69.93	18.81	0.05			0.147