KP
ZT

Static analysis

Project . Strohboid tent with reinforcement snow load

Project number . 18-025-15

Client . STROHBOID GmbH
Kasernenstraße 2, 8350 Fehring

Scope . Static analysis

Date . 09.03.2023

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9.3.2023

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Report on the structural analysis STROHBOID

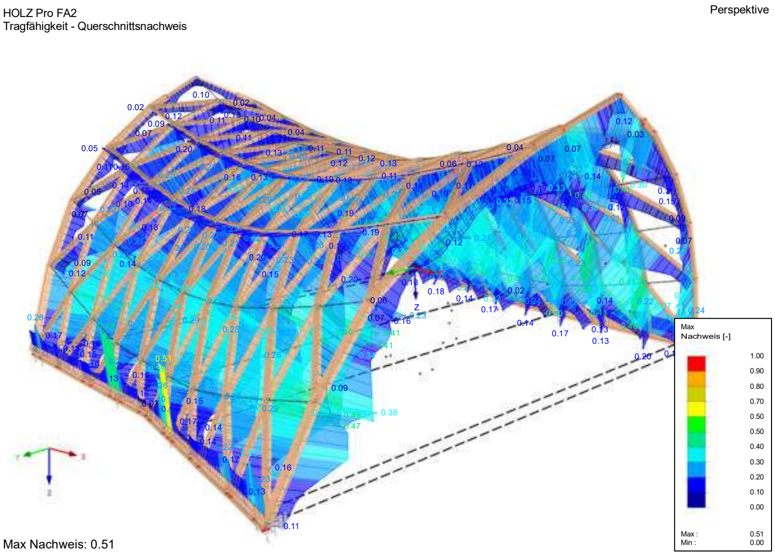
The attached structural analysis is based on the European codes EN.
The most relevant codes are:

EN 1990	Basis of structural design
EN 1991-1-1	Actions of structures – densities, self-weight, imposed loads for buildings
EN 1991-1-3	Actions of structures – snow loads
EN 1991-1-3	Actions of structures – wind actions

To enable you to compare the used loads to us standards we present you the numbers of design loads, wind and snow that are the basis of the calculations and were subsequently modified according to the properties of the object.

Wind load design:	$q_{p(z),d}$ =	**0,9** kN/m²	(0,6 kN/m² * 1,5) ($q_{p(z)}$ = peak velocity pressure)
Snow load design:	S_d =	**1,5** kN/m²	(1,0 kN/m² * 1,5) (snow on the ground)

The maximum utilization of the wooden structure is 51%.



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STATIC CALCULATION

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1 GENERAL INFORMATIN

1.1 Content

1.1.1 Scope and purpose

Definition of loads, determination of internal forces on the spatial model, as well as proof in the limit state of the load-bearing capacity.

1.1.2 Results oft the calculation fort the model Strohboid Snow load reinforcement

Taking into account the approaches in EC0, EC1 and EC5, the present structure can be used for a snow load of up to 1.0 kN/m² and a maximum base speed pressure (wind) of 0.6 kN/m².

1.2 Basics

1.2.1 Planning documents

Drawings are included in the attachment.

1.2.2 Safety concept

The calculation of timber construction is essentially made according to ÖN EN/B 1995-1-1 [3] and the corresponding product approval for ‘Baubuche‘ (construction beech) ETA 14-0354 – European technical assessment.

1.3 Decription of the structure

1.3.1 General description

The building is constructed in wood lattice shell construction as a thin-shell structure. The supporting structure of the STROHBOID event tent is made of a wooden scissor grid, in which wooden slats (73x33 mm) are connected in a uniform grid of 1.25 m in a variable rhombic angle with uniaxially movable joints by M12 threaded bolts. The curved tapered edges of the structure are reinforced by edge beams connected at the top with a metal hinge. The edge beams are made with an upper wooden slat (43x90 mm) and a lower wooden slat (43x90 mm) that are connected with profiles made of aluminum. The grids, that are not fixed in their form during the setup become stable by adding the lower beam.

After the tent has been set up, an inner layer is connected to the outer shell in a shear-resistant manner as snow load reinforcement and for permanent use.
This results in curved composite beams, which were investigated in laboratory tests at the Graz University of Technology (Austria- Europe) with regard to load-bearing capacity and serviceability. Characteristic values of strength and average values of stiffness are used for this calculation according to EC (Eurocode).

The stress-free bending of the slats is the case with a maximum high of 3,2m. This is ensured by the fact that the wood is appropriately treated with moisture before the first bending into shape. After the lattice is brought into the final position, there is a slight pre-tension in the slats resulting out of the force that is needed to bring the structure to a high point of 4.5m.

The wooden lattice is made of hardwood laminated veneer lumber made from beech 'Pollmeier Baubuche S', glued in the direction of the grain. The wooden beams are provided with oblong holes at regular, always equal intervals. The resulting nodes are connected with metric threaded screws and double washers between the battens.

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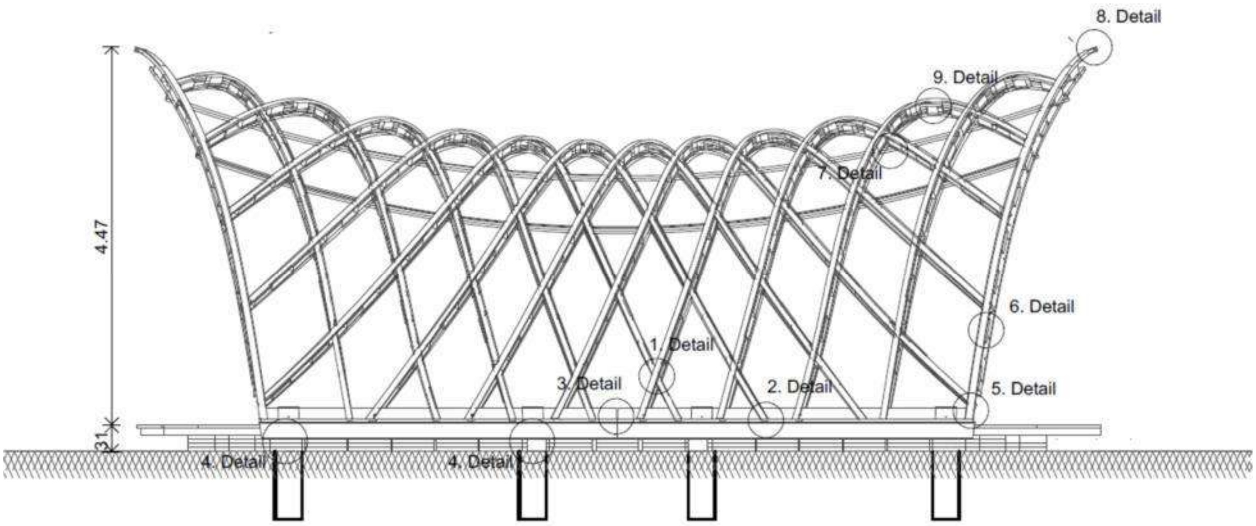
1.3.2 Detailed description

The structure itself essentially consists of 4 structural parts:

1. the reinforced LATTICE SHELL (wooden lattice) incl. ridge beam,
2. the 4 EDGE BEAMS which form two three-joint arches connected by the ridge joint,
3. the FOOT SLEEPERS, which hold the grid shell on the ground in shape and form the connection to the ground, and
4. of the MEMBRANE, which spans this structure.

Below are the detail points with dimensions, materials and construction:



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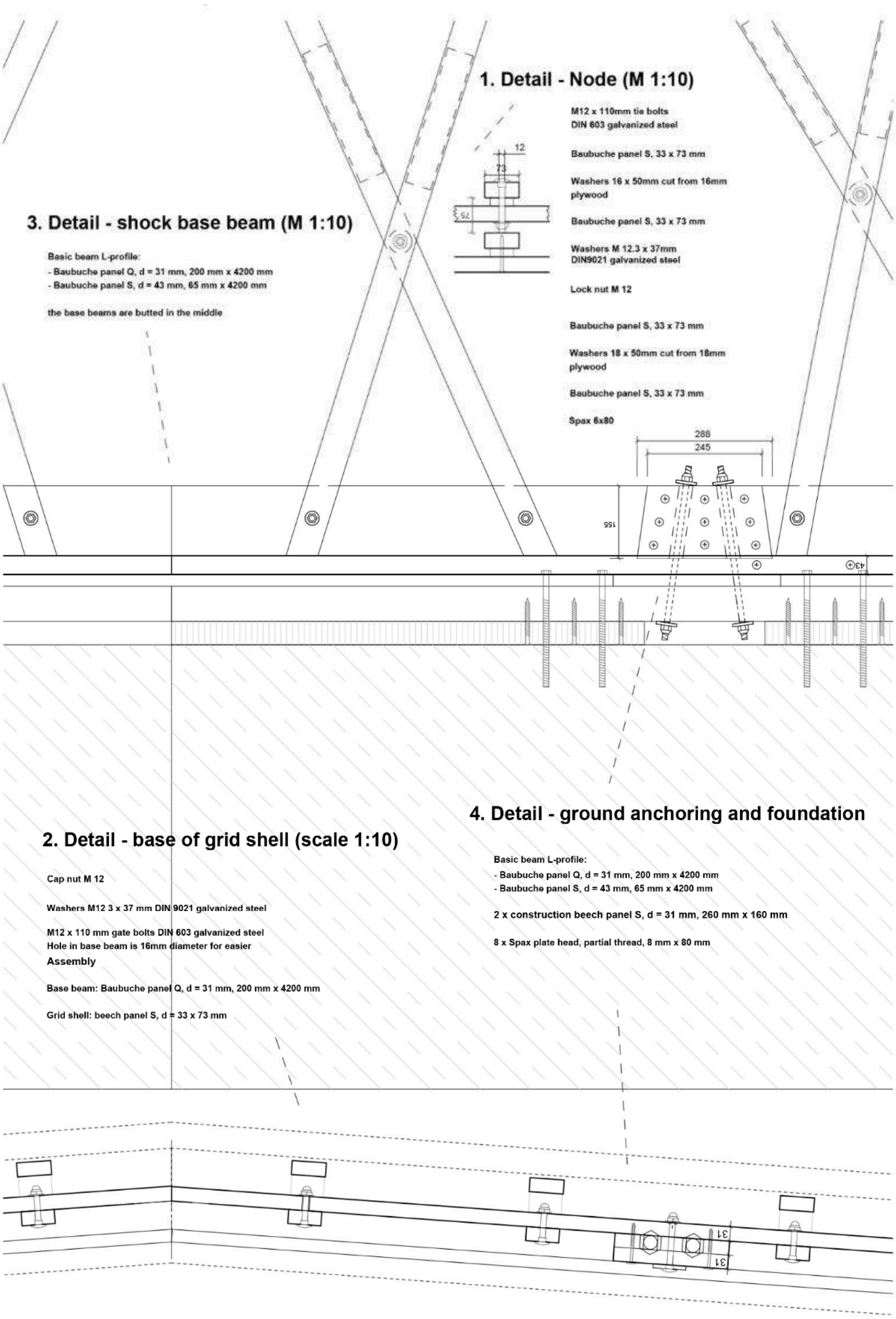
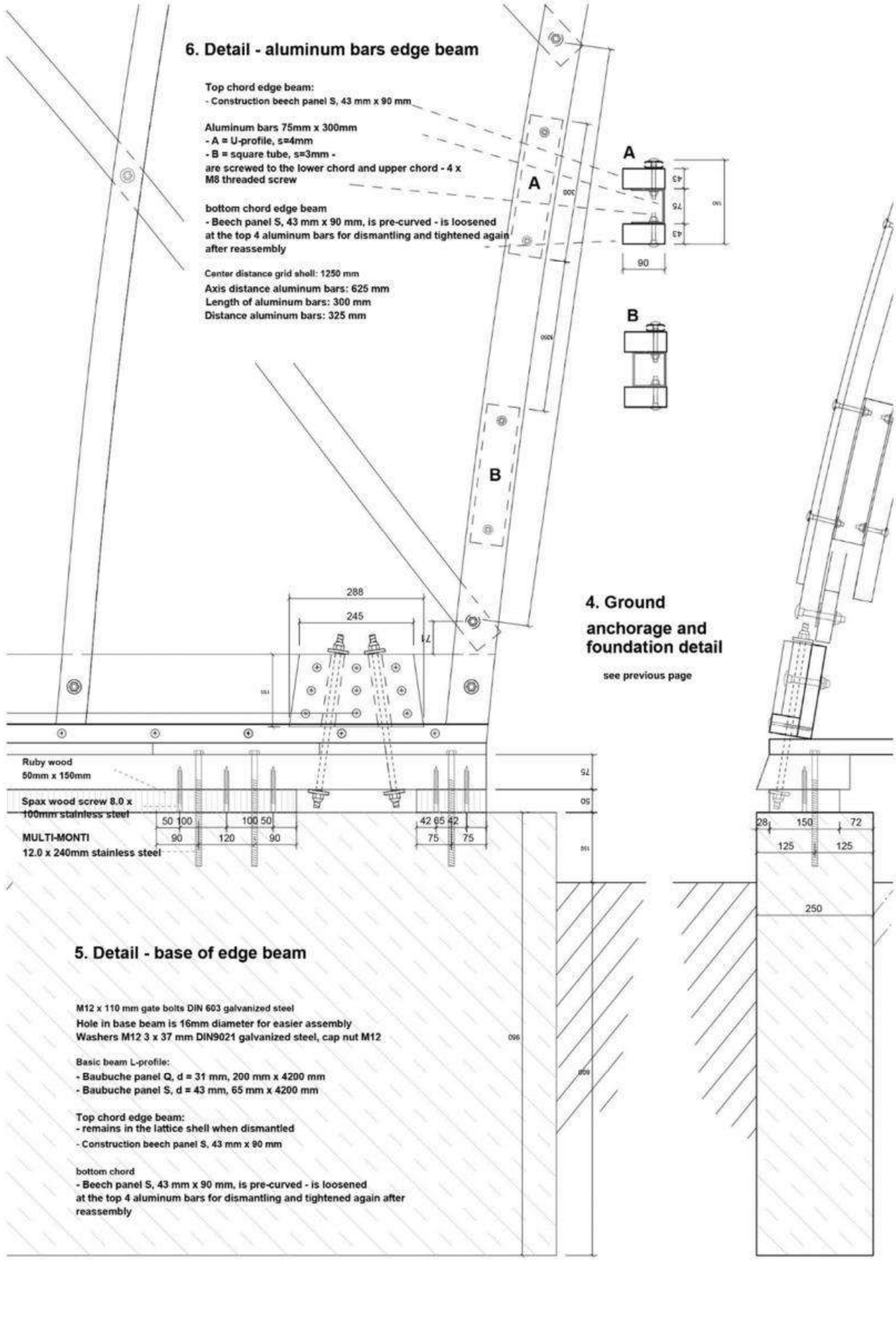


1. Detail - Node (M 1:10)
M12 x 110mm tie bolts
DIN 603 galvanized steel
Baubuche panel S, 33 x 73 mm
Washers 16 x 50mm cut from 16mm plywood
Baubuche panel S, 33 x 73 mm
Washers M 12.3 x 37mm
DIN9021 galvanized steel
Lock nut M 12
Baubuche panel S, 33 x 73 mm
Washers 18 x 50mm cut from 18mm plywood
Baubuche panel S, 33 x 73 mm
Spax 6x80
12
73
75
288
245
155
43
3. Detail - shock base beam (M 1:10)
Basic beam L-profile:
- Baubuche panel Q, d = 31 mm, 200 mm x 4200 mm
- Baubuche panel S, d = 43 mm, 65 mm x 4200 mm
the base beams are butted in the middle
4. Detail - ground anchoring and foundation
Basic beam L-profile:
- Baubuche panel Q, d = 31 mm, 200 mm x 4200 mm
- Baubuche panel S, d = 43 mm, 65 mm x 4200 mm
2 x construction beech panel S, d = 31 mm, 260 mm x 160 mm
8 x Spax plate head, partial thread, 8 mm x 80 mm
2. Detail - base of grid shell (scale 1:10)
Cap nut M 12
Washers M12 3 x 37 mm DIN 9021 galvanized steel
M12 x 110 mm gate bolts DIN 603 galvanized steel
Hole in base beam is 16mm diameter for easier
Assembly
Base beam: Baubuche panel Q, d = 31 mm, 200 mm x 4200 mm
Grid shell: beech panel S, d = 33 x 73 mm
31
31



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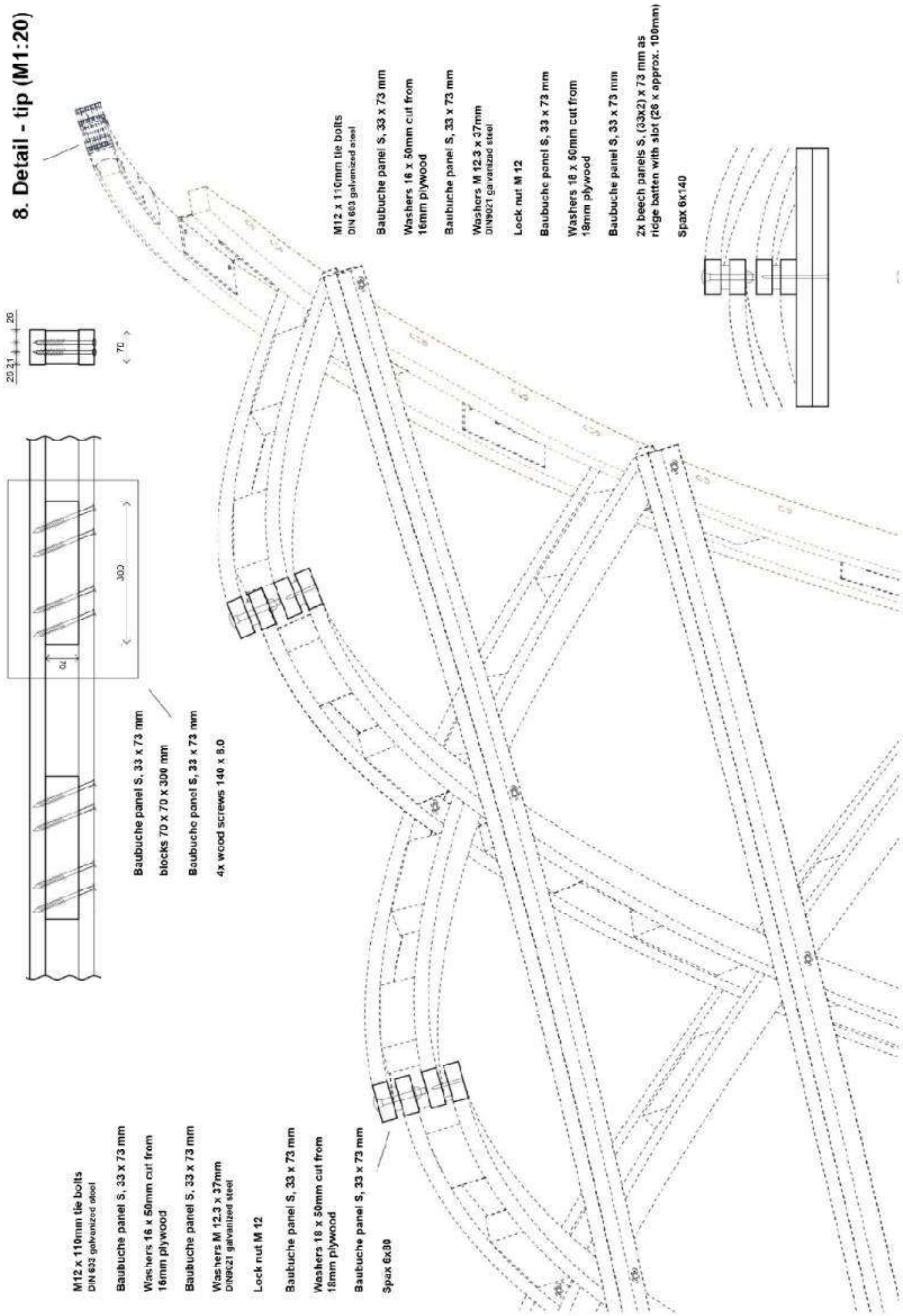
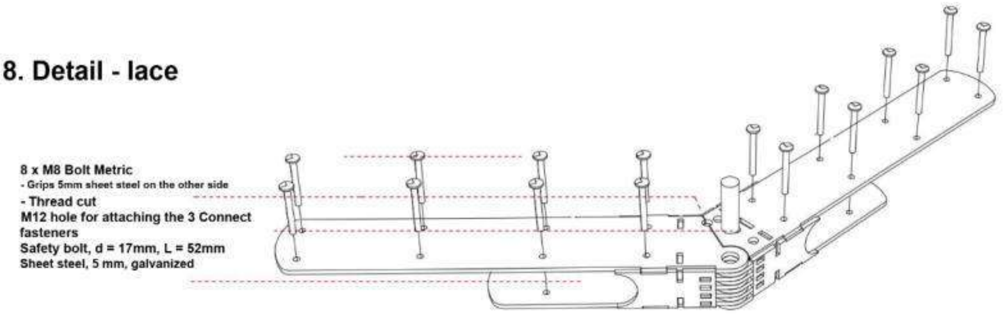
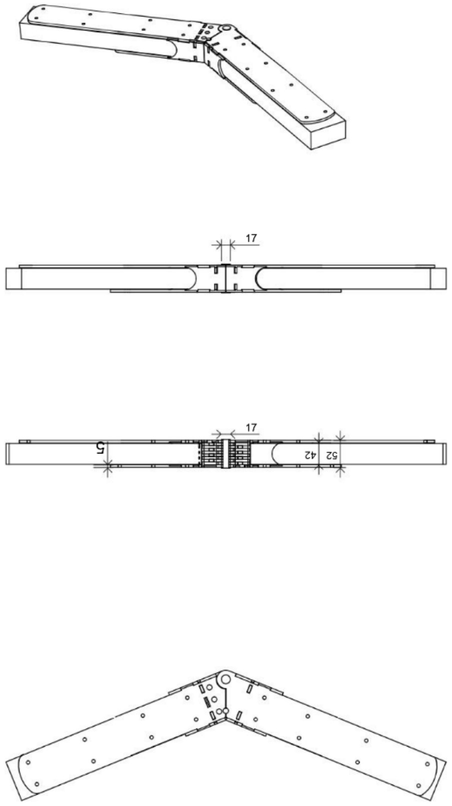

8. Detail - tip (M1:20)
20 21 20
70
300
70
M12 x 110mm tie bolts
DIN 603 galvanized steel
Baubuche panel S, 33 x 73 mm
Washers 16 x 50mm cut from 16mm plywood
Baubuche panel S, 33 x 73 mm
Washers M 12.3 x 37mm
DIN9021 galvanized steel
Lock nut M 12
Baubuche panel S, 33 x 73 mm
Washers 18 x 50mm cut from 18mm plywood
Baubuche panel S, 33 x 73 mm
2x beech panels S, (33x2) x 73 mm as ridge batten with slot (26 x approx. 100mm)
Spax 6x140
Baubuche panel S, 33 x 73 mm
blocks 70 x 70 x 300 mm
Baubuche panel S, 33 x 73 mm
4x wood screws 140 x 8.0
M12 x 110mm tie bolts
DIN 603 galvanized steel
Baubuche panel S, 33 x 73 mm
Washers 16 x 50mm cut from 16mm plywood
Baubuche panel S, 33 x 73 mm
Washers M 12.3 x 37mm
DIN9021 galvanized steel
Lock nut M 12
Baubuche panel S, 33 x 73 mm
Washers 18 x 50mm cut from 18mm plywood
Baubuche panel S, 33 x 73 mm
Spax 6x30

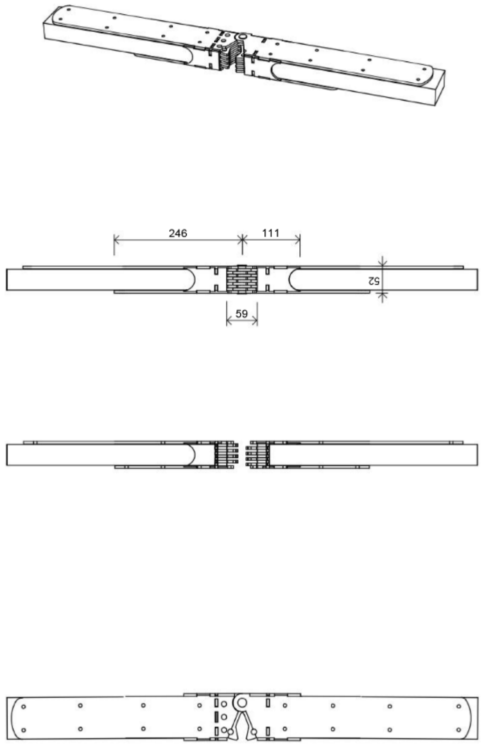
8. Detail - lace



when assembled, the joint is closed



when dismantled, the joint is open



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11. Detail - connector tarpaulin 3
Connect M 1:20

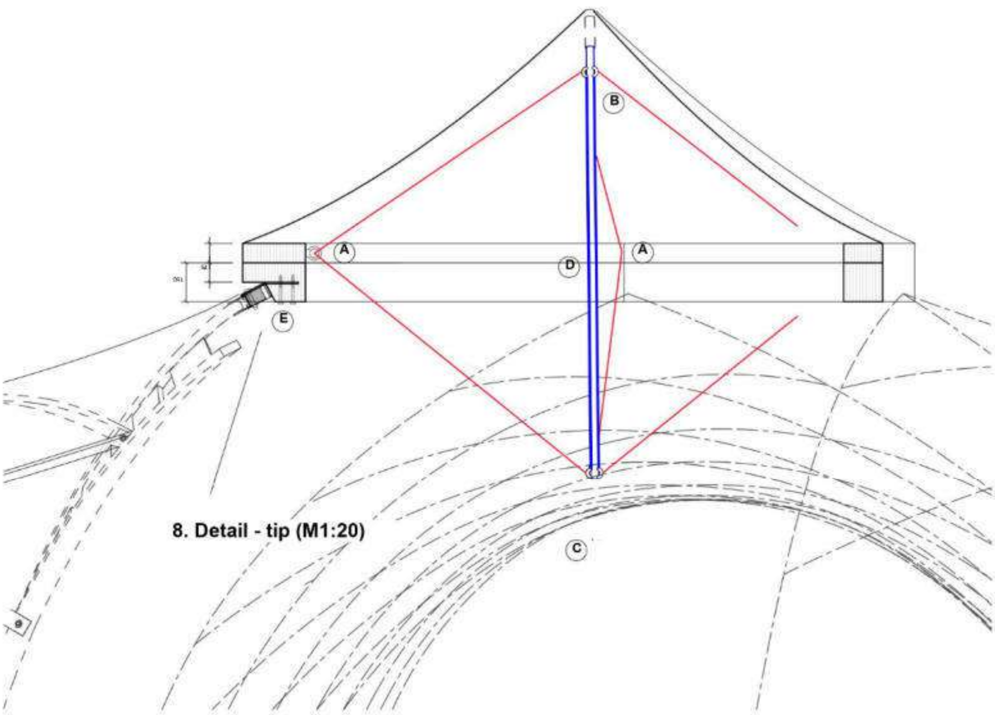
A: M12 x 130 mm Torstock screws DIN 603 Galvanized steel Ring nut M12, load capacity max. 3 KN Screw carabiner with thimble and wire rope 6mm with 3 pcs. Wire rope clamp to ring nut

B: Thimble with wire rope 6mm with 3 pcs. Wire rope clamp and turnbuckle M12 welded to a steel tube with a screw carabiner through an eyelet

C: Thimble with wire rope 6mm with 3 pcs. Wire rope clamp and turnbuckle M12 using shackle through eyelet on steel tube

D: Round steel tube, zinc-plated as a pressure rod; 38mm, wall thickness 2.6mm with eyelets welded on to accommodate carabiners and shackles

E: Beam spruce LVL-S x 150mm x 75mm
Angle sheet steel 8mm
M12 x 70mm tie bolts



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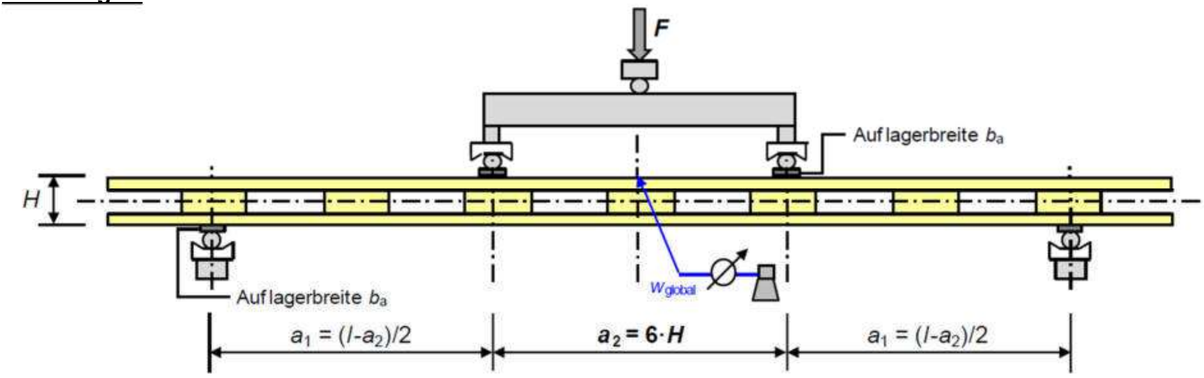
1.3.3 Load-bearing capacity

Normal forces, shear forces and bending moments occur in grid shell. The design is carried out using the general stress analysis. The edge beams, together with the foot beams, form the end of the grid shell and are components at risk of stability. The analysis includes the buckling risk of these composite cross-sections.

1.2.5 Modeling grid bars and edge bars.

The load-bearing capacity and effectiv.e bending stiffness of the two composite beam types were tested in laboratory tests. The results are presented in detail in the attached documents.

Gitterträger:



Result of the component test:

Bezeichnung	F_{max} [kN]	M_{max} [kNm]	$(EI)_{eff}$ [kNm²]
Anzahl	10	10	8
Mittelwert	**7,43**	**5,12**	**48,4**
Standardabweichung	0,33	0,23	10,65
CoV [%]	4,50	4,50	22,0
charakteristischer Wert nach ON EN 14358 [5]		**4,61**	

According to EN 14358:2016, the average value (chapter 4.3) is used for stiffness values for calibration and the characteristic value for resistance calibration, determined by standard deviation and coefficient of variance (5% fractile).

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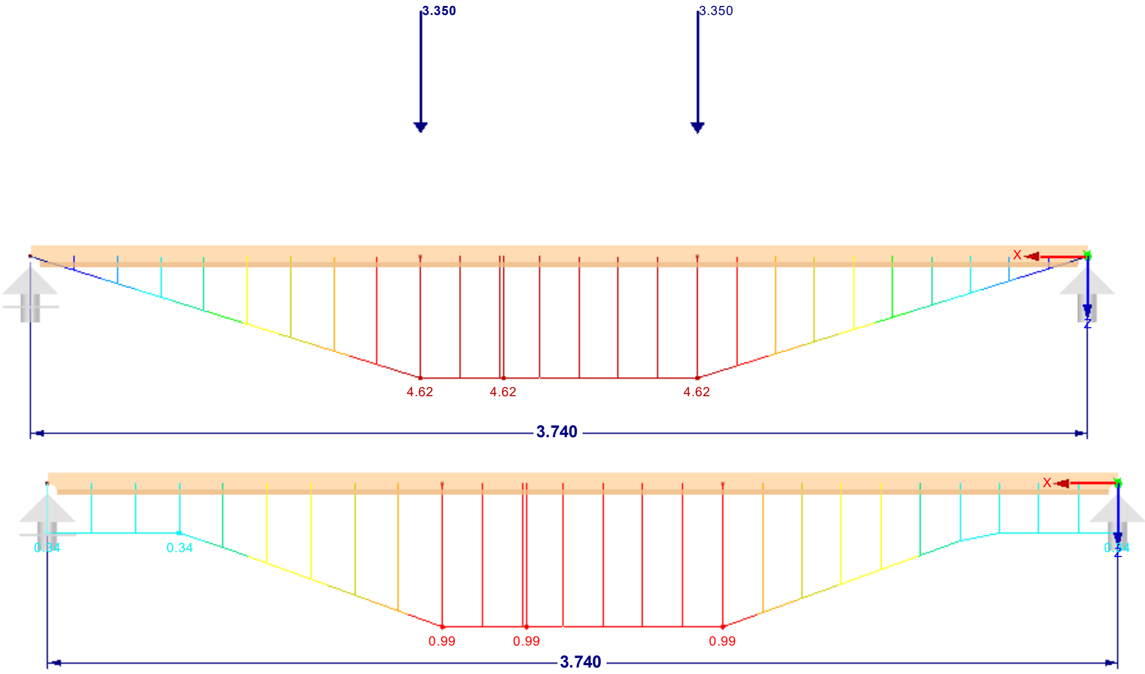
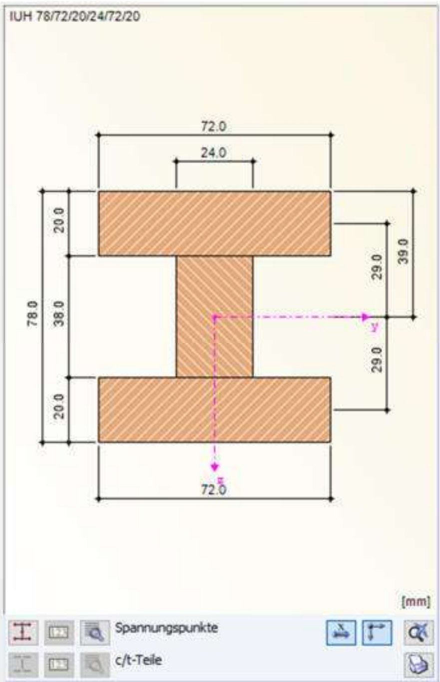
Composite beam – Stiffness framework program



The calibration is carried out without material safety coefficients, so that the correct cross-section is determined lying on the safe side. Values of the equivalent beam:

Querschnittswert	Symbol	Wert	Einheit
Höhe	h	78.0	mm
Breite	b_1	72.0	mm
Höhe	h_1	20.0	mm
Breite	b_2	24.0	mm
Höhe	h_2	38.0	mm
Breite	b_3	72.0	mm
Höhe	h_3	20.0	mm
Nachgiebigkeit	γ_1	1.000	
Nachgiebigkeit	γ_2	1.000	
Lage des Schwerpunktes	z_S	39.0	mm
Abstand der Spannungsnullinie	z_0	39.0	mm
Abstand der Spannungsnullinie	a_1	-29.0	mm
Abstand der Spannungsnullinie	a_2	0.0	mm
Abstand der Spannungsnullinie	a_3	29.0	mm
Querschnittsfläche	A_{tot}	37.92	cm^2
Flächenmoment 2. Grades um y-Achse	$I_{y,eff}$	262.78	cm^4
Flächenmoment 2. Grades um z-Achse	$I_{z,eff}$	128.79	cm^4
Trägheitsradius	$i_{y,eff}$	26.3	mm
Trägheitsradius	$i_{z,eff}$	18.4	mm
Querschnittsgewicht	G	3.0	kg/m
Mantelfläche	A_{Mantel}	0.396	m^2/m
Torsionsträgheitsmoment	I_t	63.30	cm^4
Widerstandsmoment	$W_{y,max,eff}$	67.38	cm^3
Widerstandsmoment	$W_{y,min,eff}$	-67.38	cm^3
Widerstandsmoment	$W_{z,max,eff}$	35.78	cm^3
Widerstandsmoment	$W_{z,min,eff}$	-35.78	cm^3
Statisches Moment	$S_{y,max,eff}$	46.09	cm^3
Statisches Moment	$S_{z,max,eff}$	28.66	cm^3



This follows: Modulus of elasticity of the equivalent material: E = 1830 kN/cm² to achieve the effective bending stiffness according to the test.

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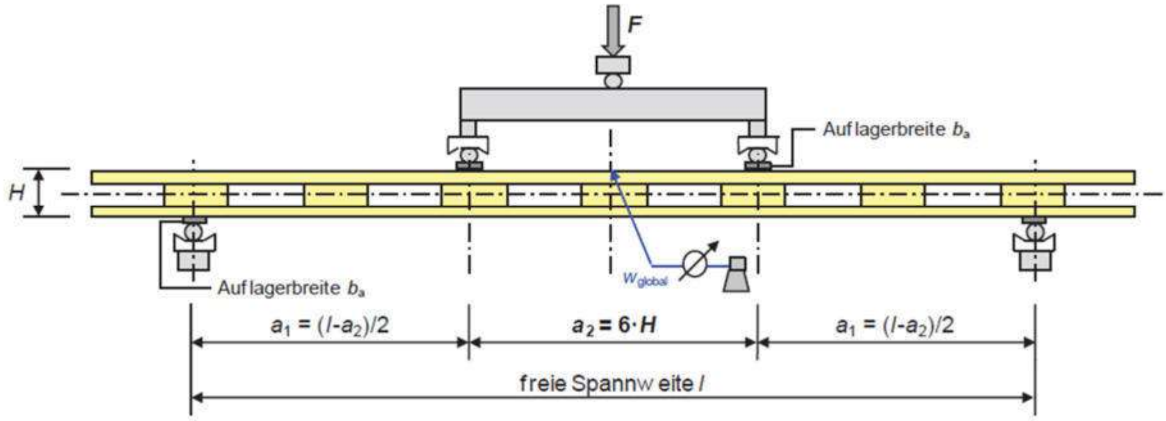
Edge beam:

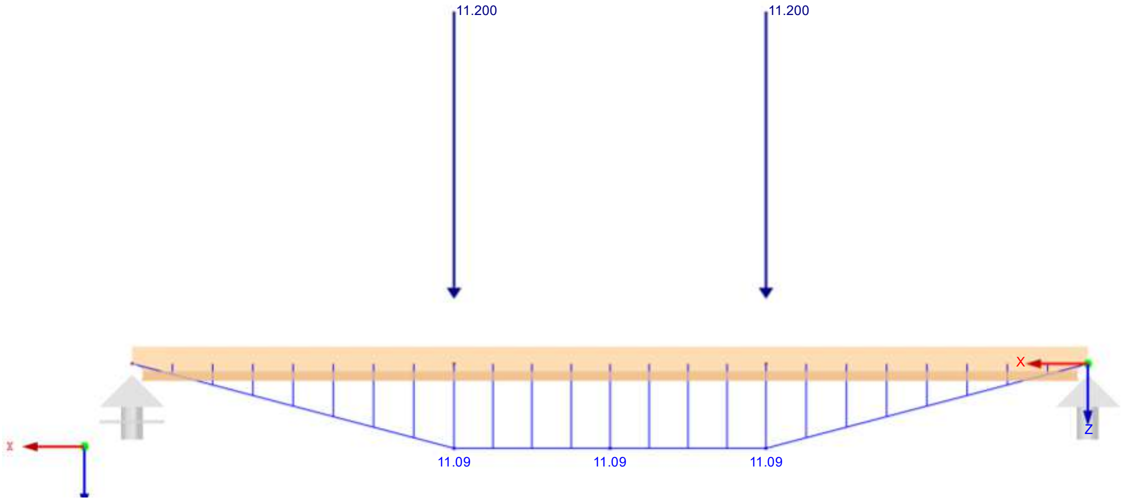


Result of the component test:

Bezeichnung	F_{max} [kN]	M_{max} [kNm]	$(EI)_{eff}$ [kNm²]	m [g]	u [%]
Anzahl	5	5	4	5	5
Mittelwert	**25,54**	**12,64**	**54,2**	**30070**	**5,89**
Standardabweichung	1,37	0,68	5,55	185	0,09
CoV [%]	5,34	5,34	10,2	0,62	1,47
charakteristischer Wert nach ON EN 14358 [4]		**11,07**			

According to EN 14358:2016, the average value (chapter 4.3) is used for stiffness values for calibration and the characteristic value for resistance calibration, determined by standard deviation and coefficient of variance (5% fractile).

Composite beams - stiffnesses framework program



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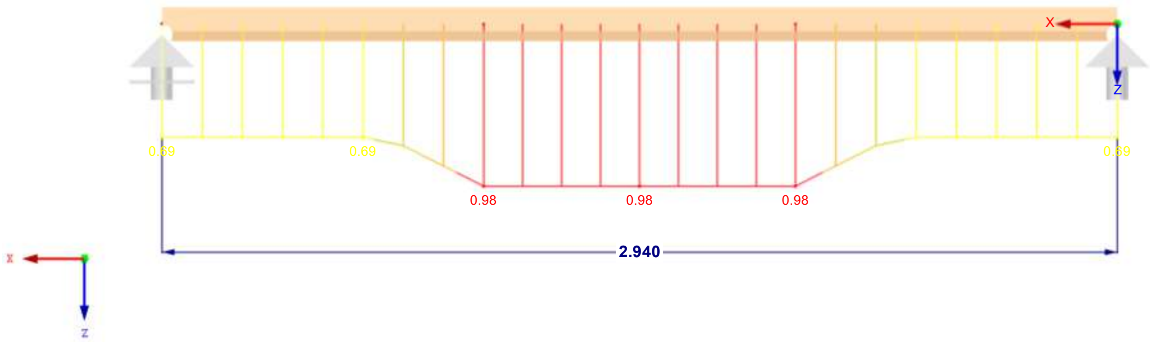
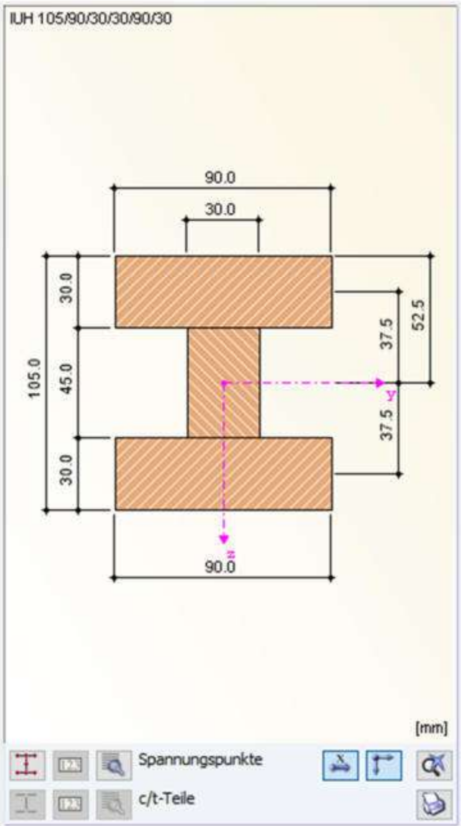


Max Nachweis: 0.98

The calibration is carried out without material safety coefficients, so that the correct cross-section is determined lying on the safe side.

Values of the equivalent beam:

Querschnittswert	Symbol	Wert	Einheit
Höhe	h	105.0	mm
Breite	b_1	90.0	mm
Höhe	h_1	30.0	mm
Breite	b_2	30.0	mm
Höhe	h_2	45.0	mm
Breite	b_3	90.0	mm
Höhe	h_3	30.0	mm
Nachgiebigkeit	γ_1	1.000	
Nachgiebigkeit	γ_2	1.000	
Lage des Schwerpunktes	z_S	52.5	mm
Abstand der Spannungsnullinie	z_0	52.5	mm
Abstand der Spannungsnullinie	a_1	-37.5	mm
Abstand der Spannungsnullinie	a_2	0.0	mm
Abstand der Spannungsnullinie	a_3	37.5	mm
Querschnittsfläche	A_{tot}	67.50	cm^2
Flächenmoment 2. Grades um y-Achse	$I_{y,eff}$	822.66	cm^4
Flächenmoment 2. Grades um z-Achse	$I_{z,eff}$	374.63	cm^4
Trägheitsradius	$i_{y,eff}$	34.9	mm
Trägheitsradius	$i_{z,eff}$	23.6	mm
Querschnittsgewicht	G	5.4	kg/m
Mantelfläche	A_{Mantel}	0.510	m^2/m
Torsionsträgheitsmoment	I_t	215.65	cm^4
Widerstandsmoment	$W_{y,max,eff}$	156.70	cm^3
Widerstandsmoment	$W_{y,min,eff}$	-156.70	cm^3
Widerstandsmoment	$W_{z,max,eff}$	83.25	cm^3
Widerstandsmoment	$W_{z,min,eff}$	-83.25	cm^3
Statisches Moment	$S_{y,max,eff}$	108.84	cm^3
Statisches Moment	$S_{z,max,eff}$	65.81	cm^3



It follows that:
Modulus of elasticity of the equivalent material: E = 660 kN/cm² to achieve the effective bending stiffness according to the test. Modulus of elasticity of the equivalent material: E = 660 kN/cm² to achieve the effective bending stiffness according to the test.

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1.4 Material

1.4.1 Baubuche

The material characteristics of Material 1, Pollmeier Baubuche come from the approval of Pollmeier Furnierwerkstoffe GmbH Z-9.1-838. It also sets the material safety factor for Pollmeier Platte Bau-Buche S at γ_M = 1.2.

Art der Beanspruchung		Furnierschichtholz "Platte BauBuche S"	Furnierschichtholz "Platte BauBuche Q"	
Nenndicke in mm		20 ≤ B ≤ 80	20	30 ≤ B ≤ 80
Festigkeitskennwerte				
Plattenbeanspruchung				
Biegung	$f_{m,0,flat,k}$	80	70	75
Druck	$f_{c,90,flatk}$	10	13	13
Scheibenbeanspruchung				
Biegung a)	$f_{m,0,edge,k}$	75	54	60
Zug ‖ zur Faser	$f_{t,0,k}$	60	45	51
Zug ⊥ zur Faser	$f_{t,90,edge,k}$	1,5	16	8
Druck ‖ zur Faser	$f_{c,0,k}$	57,5	45,6	53,3
Druck ⊥ zur Faser	$f_{c,90,edge,k}$	14	37	19
Schub	$f_{v,0,edge,k}$	8	7,8	7,8
Steifigkeitskennwerte				
Elastizitätsmodul	$E_{0,mean}$	16800	11800	13200
Elastizitätsmodul	$E_{0,05}$	14900	10900	12200
Elastizitätsmodul	$E_{90,mean}$	470	3900	2200
Schubmodul hochkant	$G_{v,0,edge,mean}$	760	820	820
Schubmodul flachkant	$G_{v,0,flat,mean}$	850	430	430
Rohdichte	ρ_k		730	

a) Werte gelten für h ≤ 300 mm. Für 300 < h ≤ 1000 mm ist der charakteristische Festigkeitswert mit dem Beiwert $k_h = (300/h)^{0,12}$ zu multiplizieren. h ist die für die Biegebeanspruchung maßgebende Abmessung des Gesamtquerschnitts in mm.

Rohdichte

mittlere Rohdichte	ρ_{mean}	800 kg/m³	800 kg/m³
charakteristische Rohdichte	ρ_k	730 kg/m³	730 kg/m³

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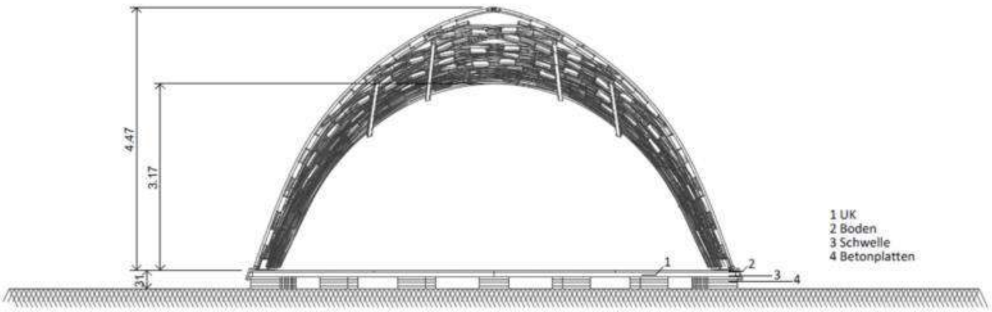
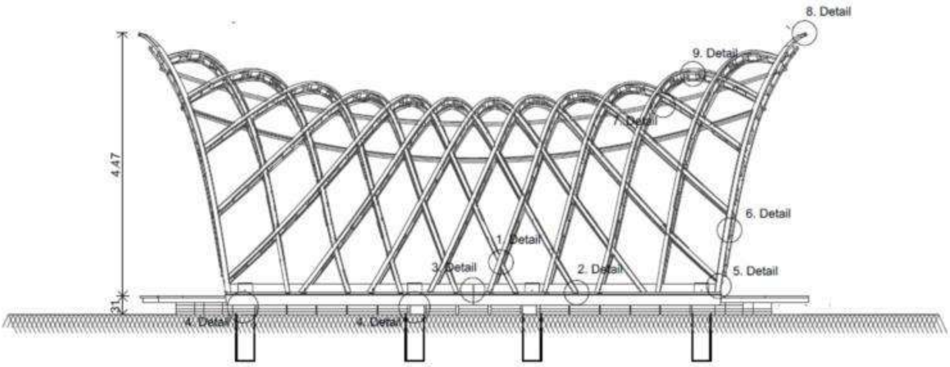
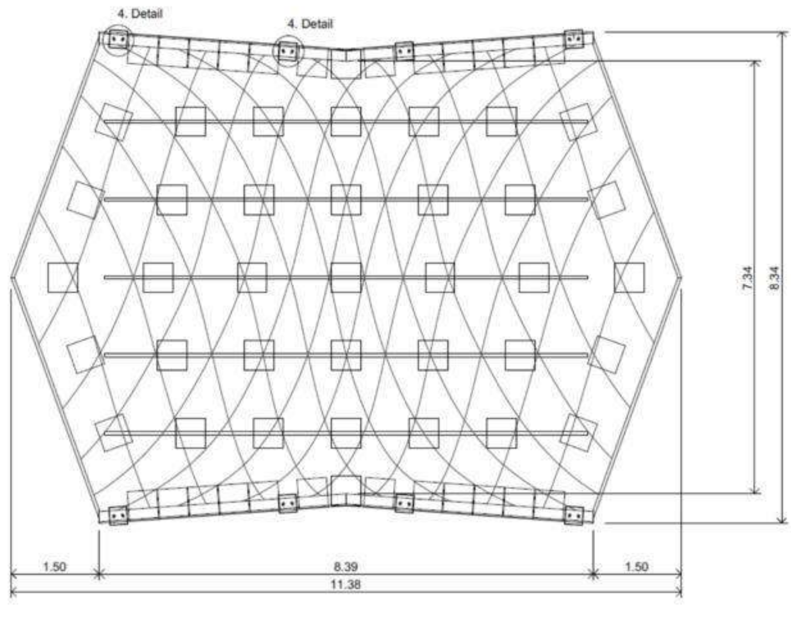
2 DESCRIPTION

2.1 Planning documents

The general dimensions are as follows:

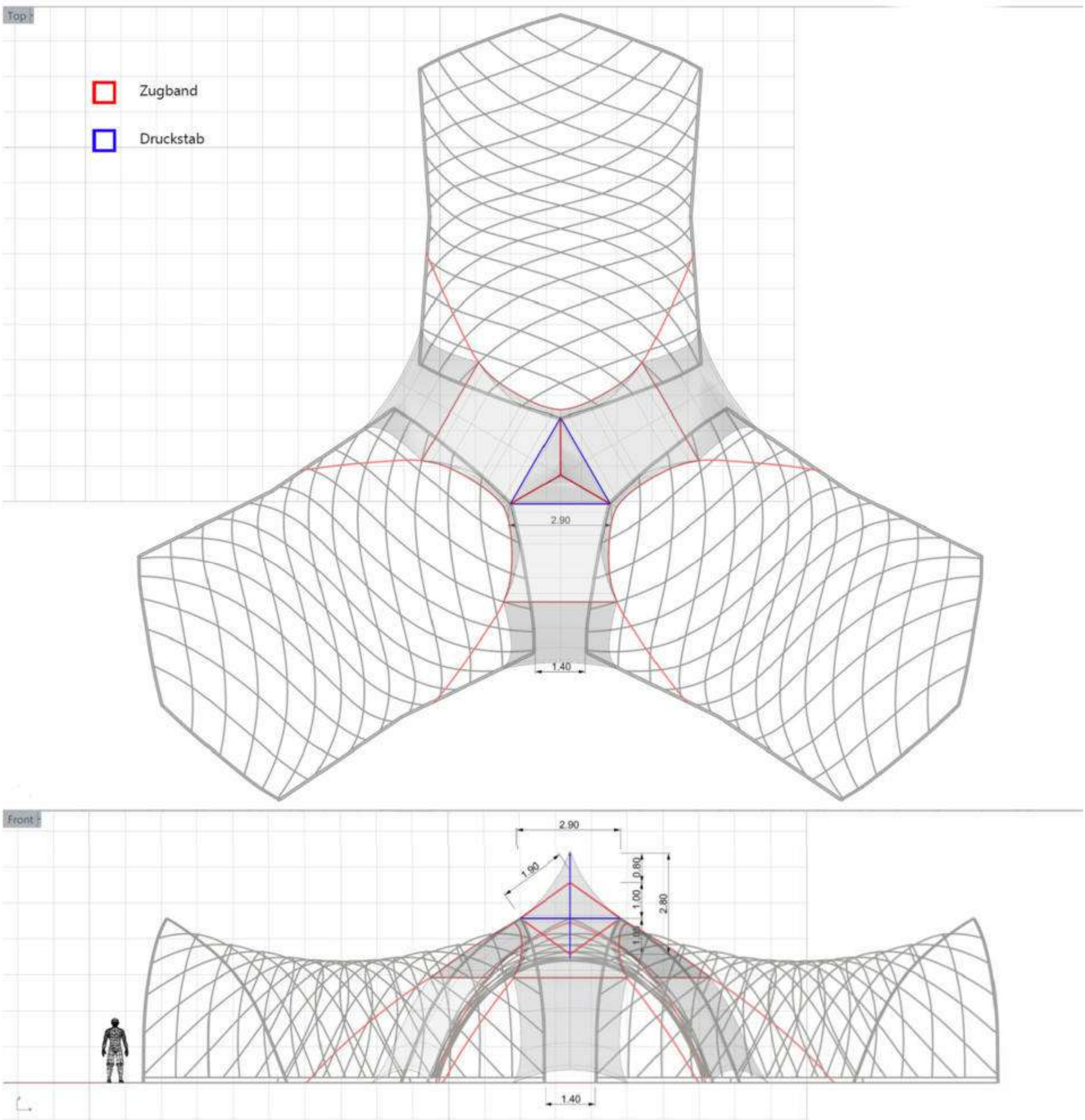






The Connect tent variant consists of tents set up together, which are connected to each other via tarpaulins.

Connect 3:



Lying on the safe side, a catchment area of 2.90 / 2 meters from the Connect superstructure variant is added for snow load determination.

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3 LOADS

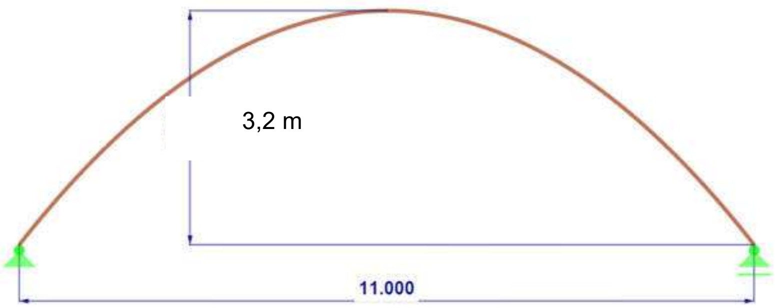
3.1 Constant loads

3.1.1 Dead weight of supporting structure

The dead weight of the structure is automatically determined by the FE program.

γ_{Baubuche} = 8,00 kN/m³

Due to the pretreatment of the individual bars of the grid shell, a parabell-shaped, stress-free geometry of the grid bars is to be expected. The stitch is fixed at 3.2 meters with a maximum bar length of 13.5 meters, 11 meters projected length in the floor plan.



This state is tension-free.This state is tension-free.

3.1.2 Expansion load

In the load case expansion load, the dead weight of the tent tarpaulin as well as the fasteners are taken into account.
$g_{\text{Expansion}}$ = 0.05 kN/m²

3.2 Variable loads

3.2.1 Walking loads

The tent roof is not accessible, so no traffic load is taken into account.

3.2.2 Snow loads

A snow load of sk = 1.0 kN/m² is assumed.
This applies mutatis mutandis to heavy rain and hail events.

Two snow load scenarios according to ÖNORM EN 1991-1-3 chapter 5.3.5 are considered:

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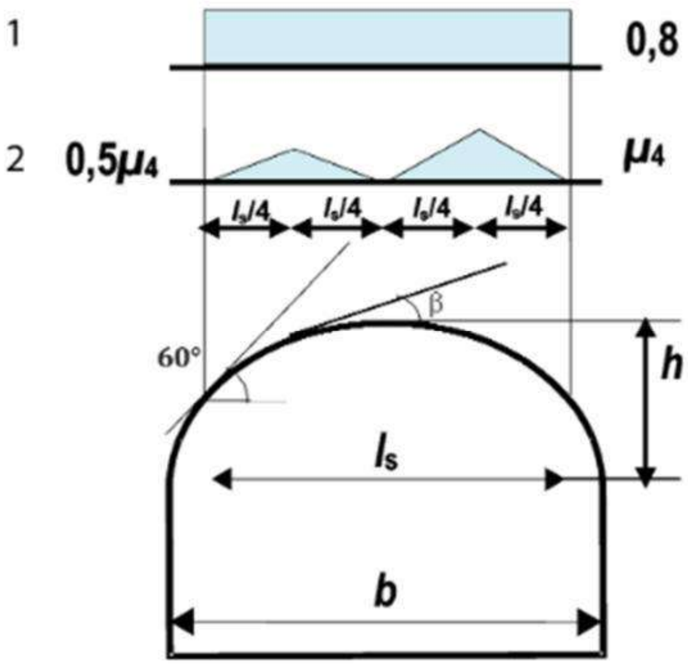
Scenario 1: Unblown snow => µ4 = 0.8

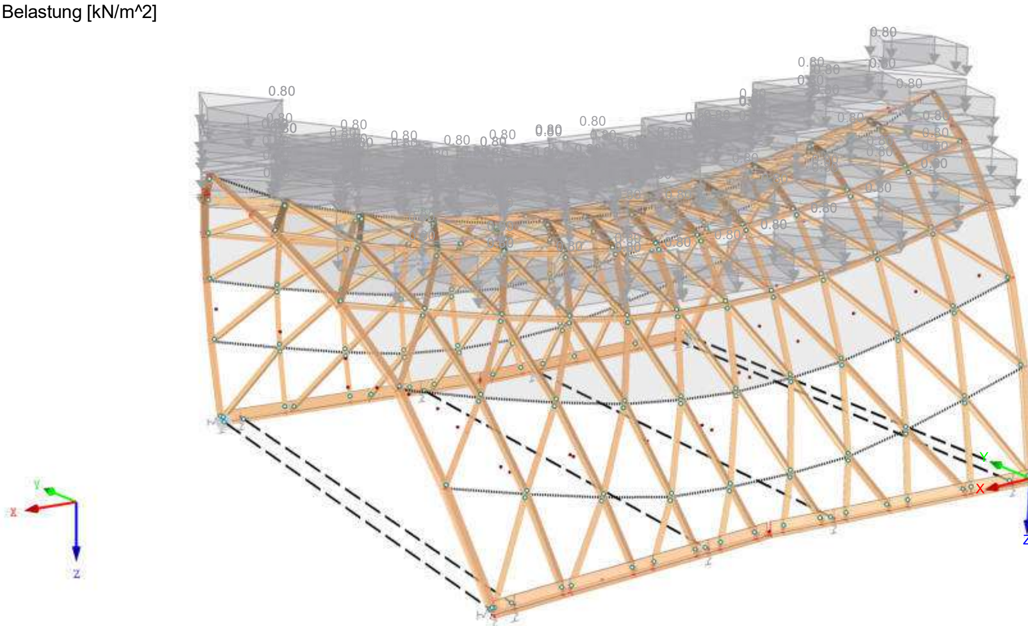
Scenario 2: Drifted snow => µ4 = 2.0



Scenario 1:

LF6 : Schneelast Großräschen
Belastung [kN/m^2]

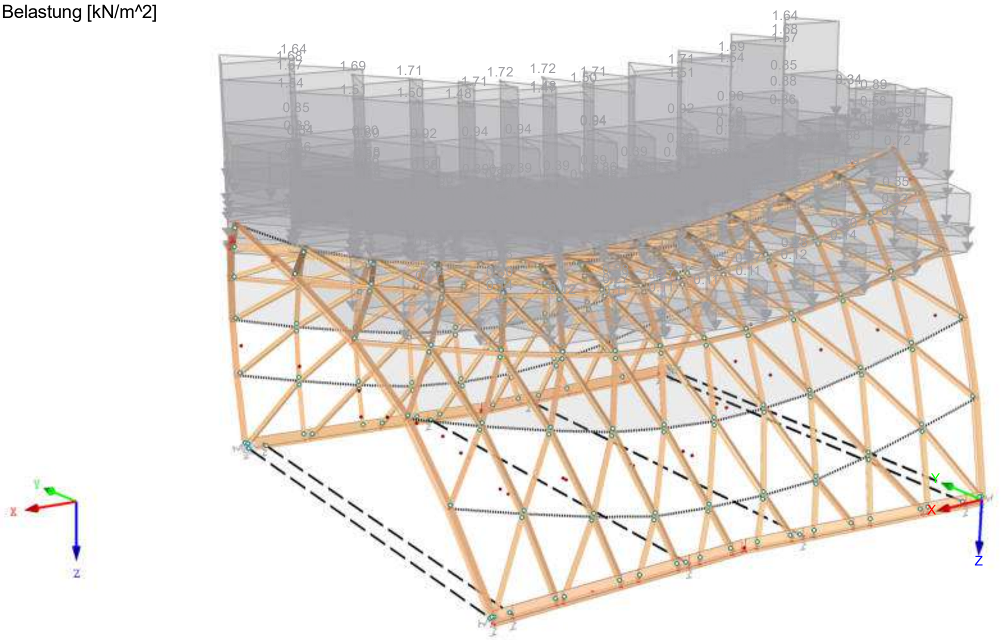
Perspektive



Scenario 2:

LF7 : Schneelast verweht Großräschen
Belastung [kN/m^2]

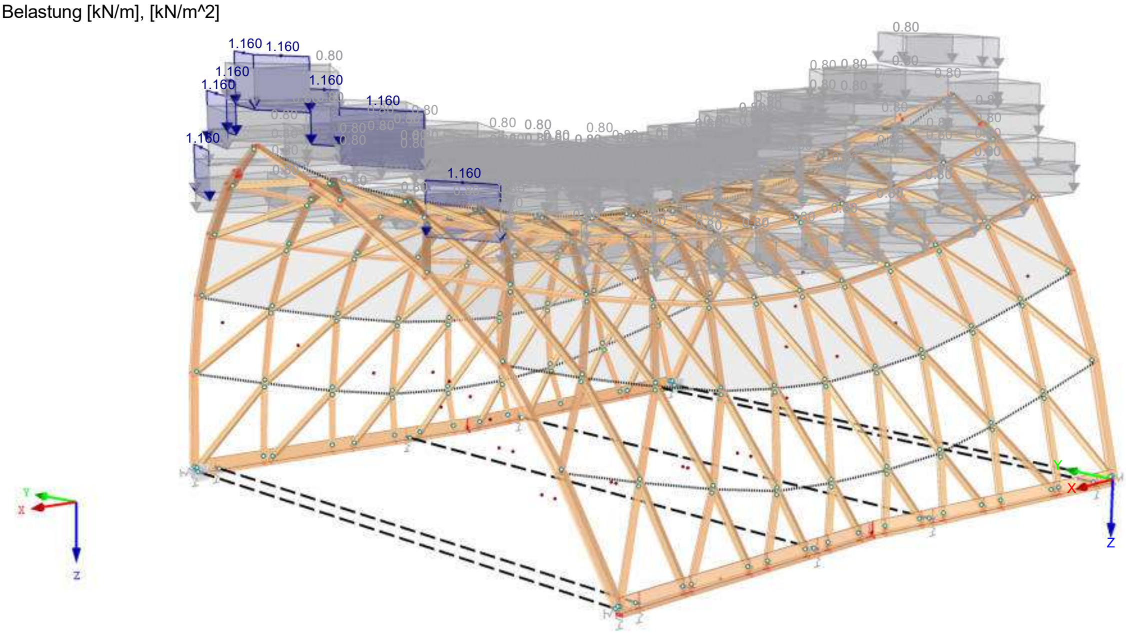
Perspektive



Scenario 3 – Connect variant

LF8 : Schneelast Connect Großräschen
Belastung [kN/m], [kN/m^2]

Perspektive



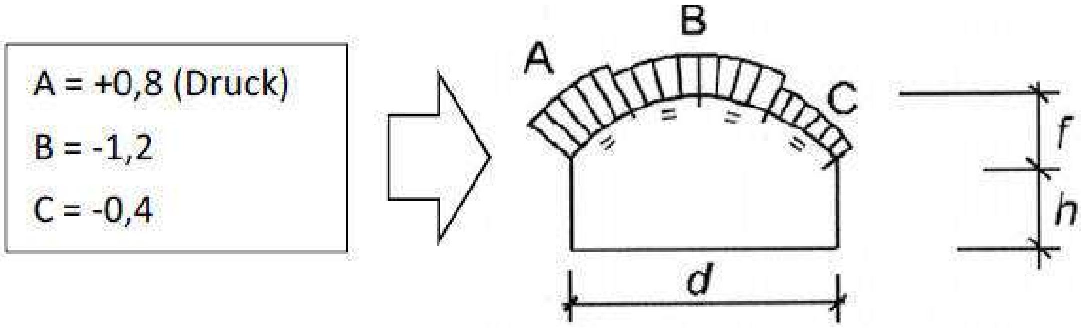
3.2.3 Wind loads

The dynamic pressure of qp,z = 0.6 kN/m² is assumed.

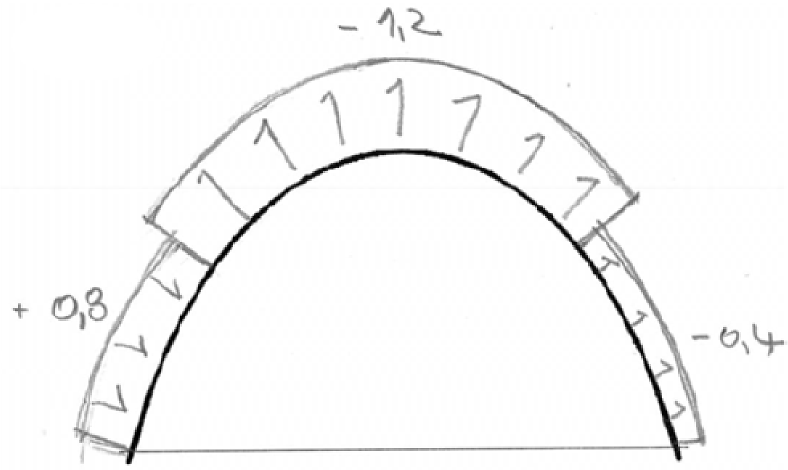
The aerodynamic coefficients in the transverse direction of the tent are applied according to EN 1991-1-4:

3.2.3.1 External pressure coefficients: Wind in Y-direction

Chapter 7.2.8 Curved roofs and domes



Applied to this structure, this means the following external pressure coefficients c_{pe}:



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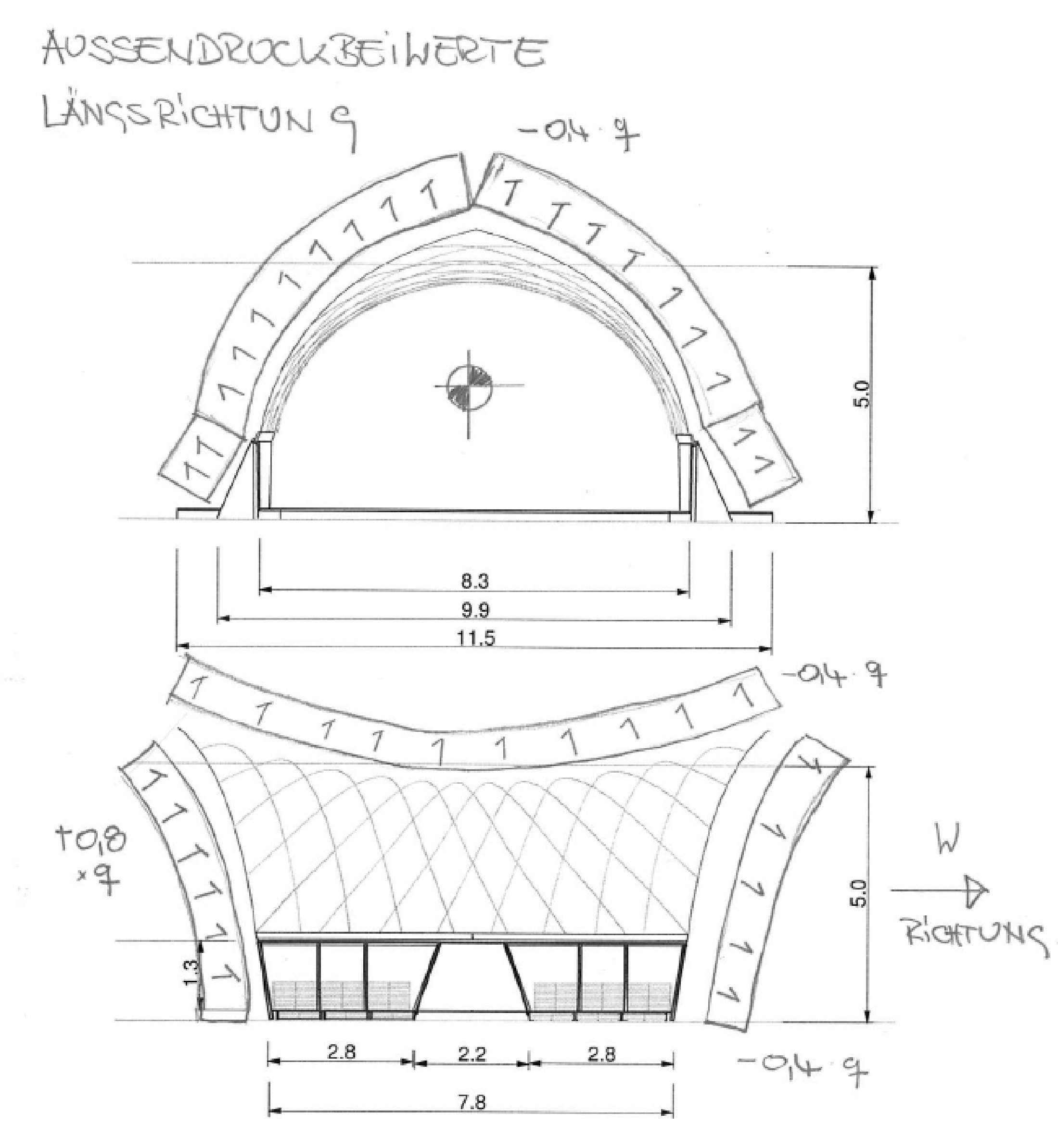
3.2.3.2 External pressure coefficients wind in X direction



Note: The external pressure coefficients shown here (range -0.4) are also assumed to be (-0.4) in the part of the tent facing away from the wind. A wind pressure with a factor of 0.17 * q was investigated and proved not to be decisive.

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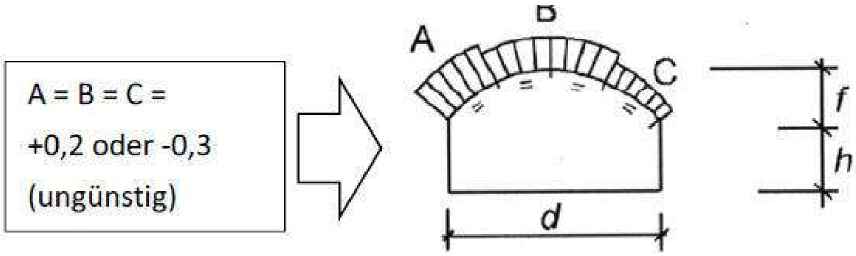
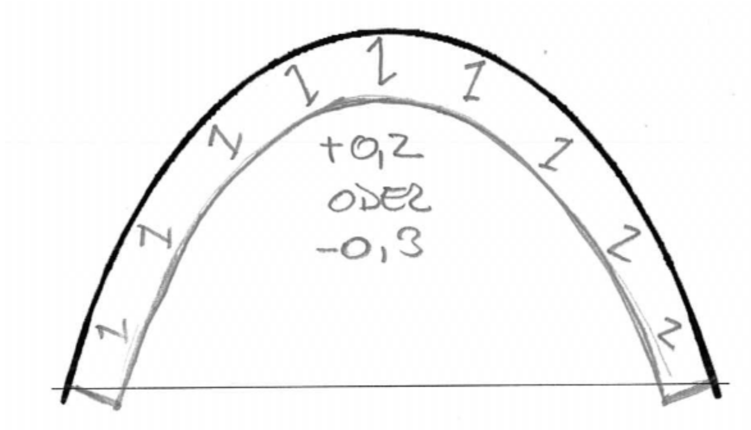
3.2.3.3 Internal pressure coefficients according to chapter 7.2.9 Internal pressure



Applied to this structure, this means the following internal pressure coefficients c_{pi}:



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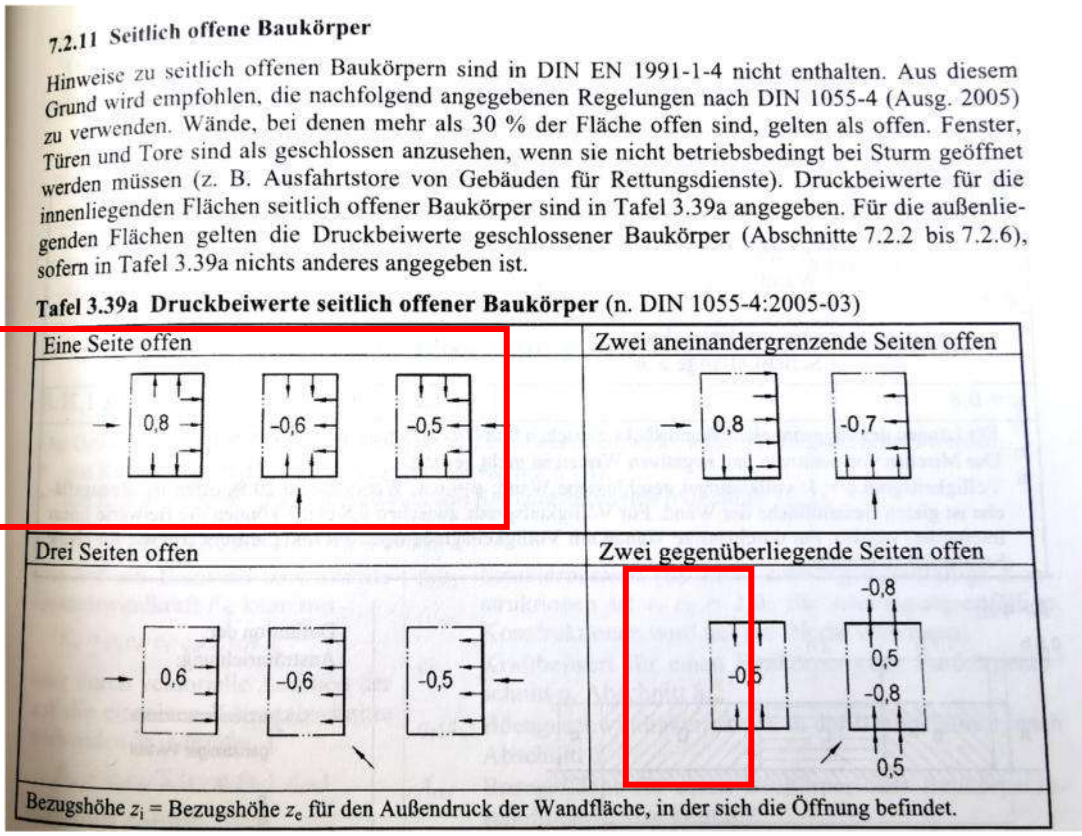
3.2.3.4 Pressure coefficients for lateral opening

Cf. Schneider Bautabellen für Ingenieure: 22nd edition:



7.2.11 Seitlich offene Baukörper

Hinweise zu seitlich offenen Baukörpern sind in DIN EN 1991-1-4 nicht enthalten. Aus diesem Grund wird empfohlen, die nachfolgend angegebenen Regelungen nach DIN 1055-4 (Ausg. 2005) zu verwenden. Wände, bei denen mehr als 30 % der Fläche offen sind, gelten als offen. Fenster, Türen und Tore sind als geschlossen anzusehen, wenn sie nicht betriebsbedingt bei Sturm geöffnet werden müssen (z. B. Ausfahrtstore von Gebäuden für Rettungsdienste). Druckbeiwerte für die innenliegenden Flächen seitlich offener Baukörper sind in Tafel 3.39a angegeben. Für die außenliegenden Flächen gelten die Druckbeiwerte geschlossener Baukörper (Abschnitte 7.2.2 bis 7.2.6), sofern in Tafel 3.39a nichts anderes angegeben ist.

Tafel 3.39a Druckbeiwerte seitlich offener Baukörper (n. DIN 1055-4:2005-03)

Eine Seite offen	Zwei aneinandergrenzende Seiten offen
0,8 / -0,6 / -0,5	0,8 / -0,7
Drei Seiten offen	**Zwei gegenüberliegende Seiten offen**
0,6 / -0,6 / -0,5	-0,8 / -0,5 / 0,5 / -0,8 / 0,5

Bezugshöhe z_i = Bezugshöhe z_e für den Außendruck der Wandfläche, in der sich die Öffnung befindet.

3.2.3.5 Overview of wind load cases

LF 11:	Wind in +X direction closed in combination with cpi +0.2
LF 12:	Wind in -X direction closed in combination with cpi +0.2
LF 13:	Wind in +X direction closed in combination with cpi -0.3
LF 14:	Wind in -X direction closed in combination with cpi -0.3
LF 15:	Wind open in +X direction
LF 16:	Wind in +X direction windward closed
LF 17:	Wind in -X direction windward closed
LF 18:	Wind in +X direction turned away from the wind closed
LF 19:	Wind closed in -X direction facing away from the wind

Four wind load cases are defined in the transverse direction of the building:

LF 21:	Wind in +Y direction in combination with cpi +0.2
LF 22:	Wind in -Y direction in combination with cpi +0.2
LF 23:	Wind in +Y direction in combination with cpi -0.5 (-0.3 standard, -0.5 lt Schneider)
LF 24:	Wind in -Y direction in combination with cpi -0.5 (-0.3 norm, **-0.5** lt cutter)

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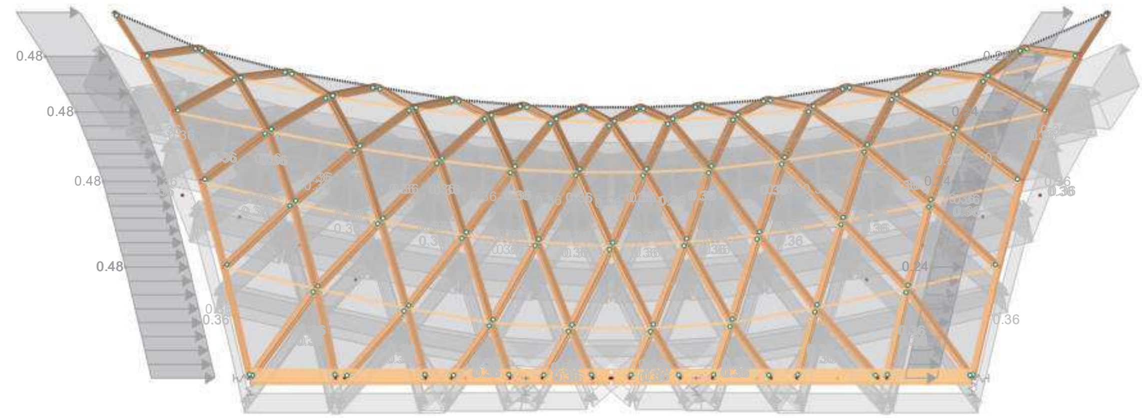
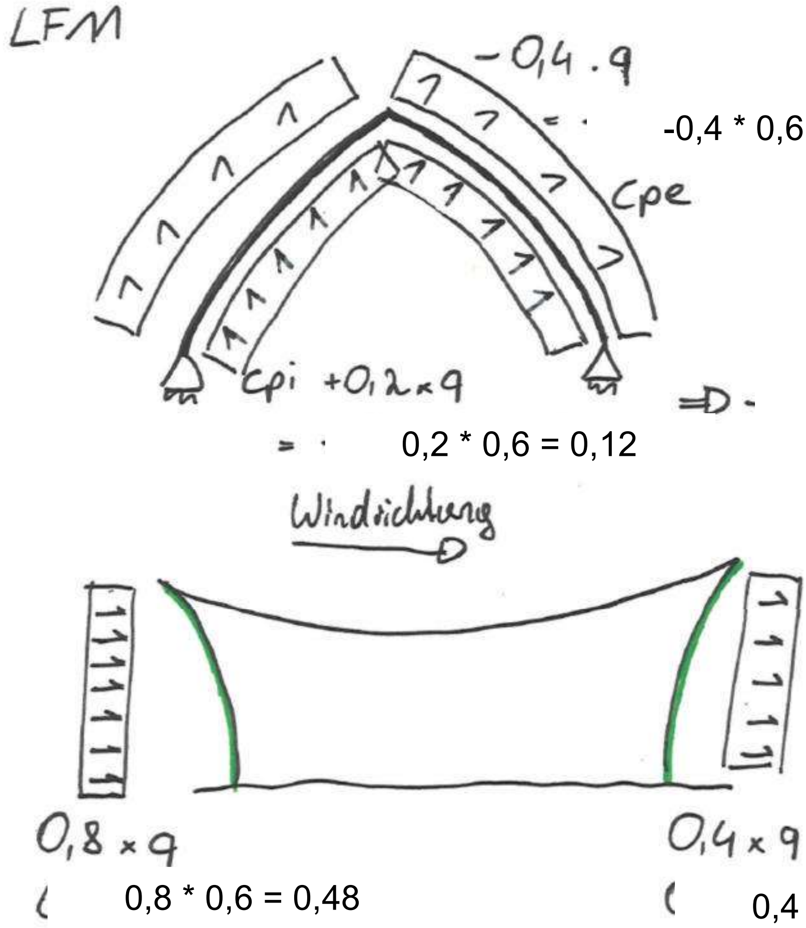
3.2.3.6 Load application in the longitudinal direction of the building

LF 11: Wind in +X closed cpi +0.2

LF11 : Wind in +X geschlossen cpi +
Belastung [kN/m^2]

Entgegen der Y-Richtung





-0,4 * 0,6 = -0,24

0,2 * 0,6 = 0,12

-0,24 – (+0,12) =
-0,36 kN/m²

0,8 * 0,6 = 0,48

0,4 * 0,6 = 0,24

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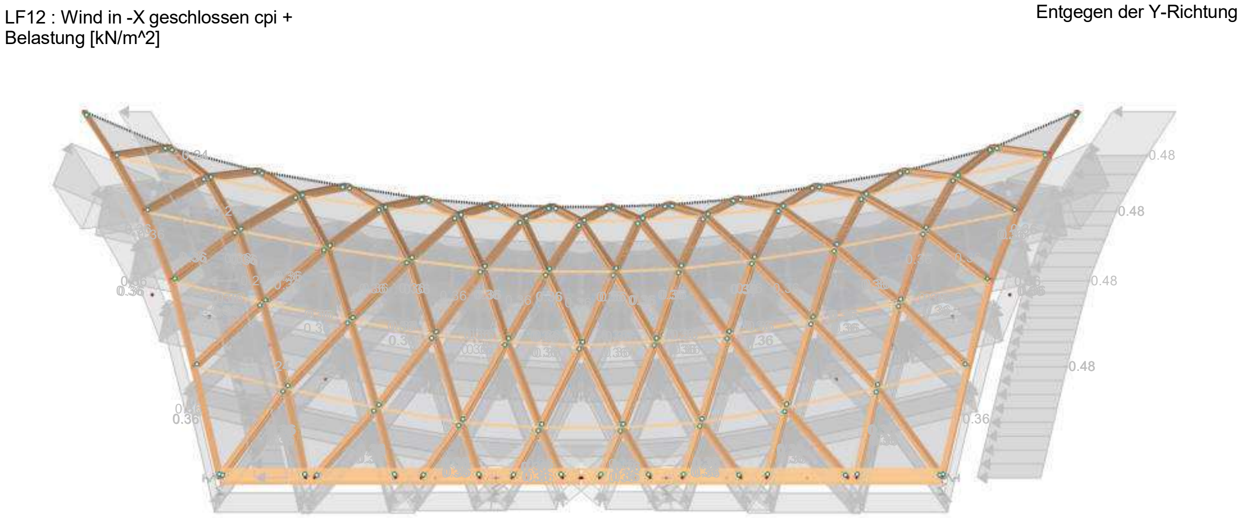
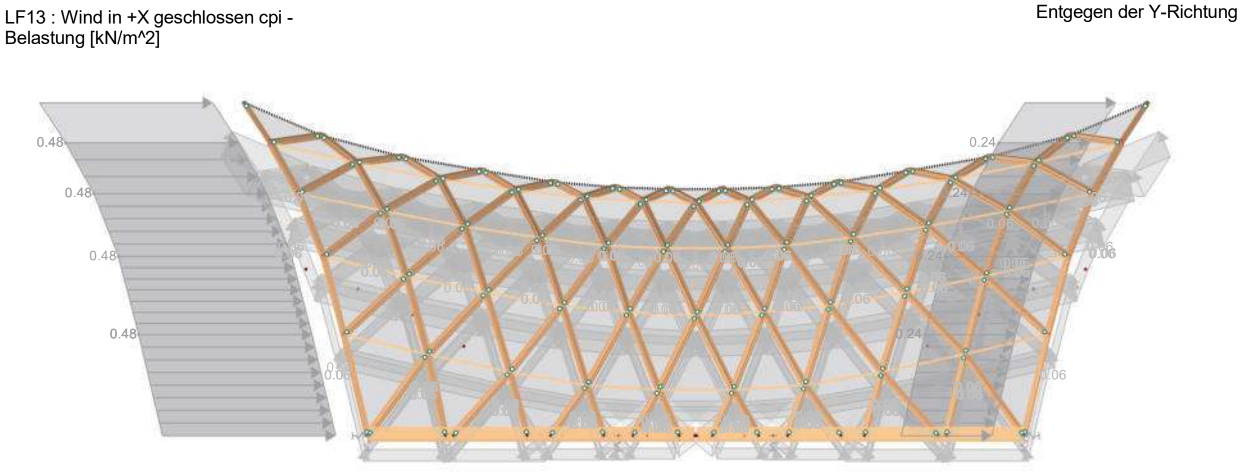
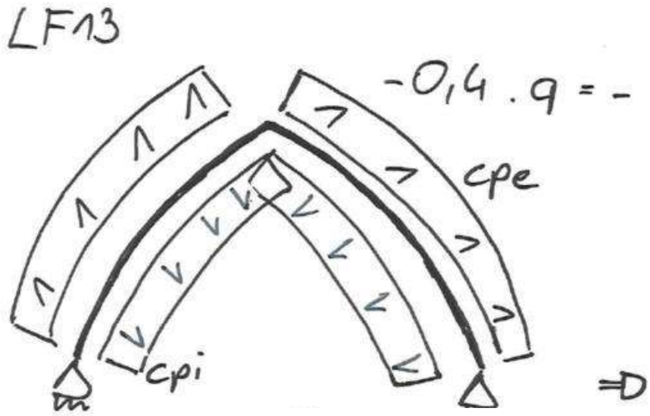
LF 12: Wind in -X closed cpi +0.2

LF11 mirrored



LF 13: Wind in +X closed cpi -0.3

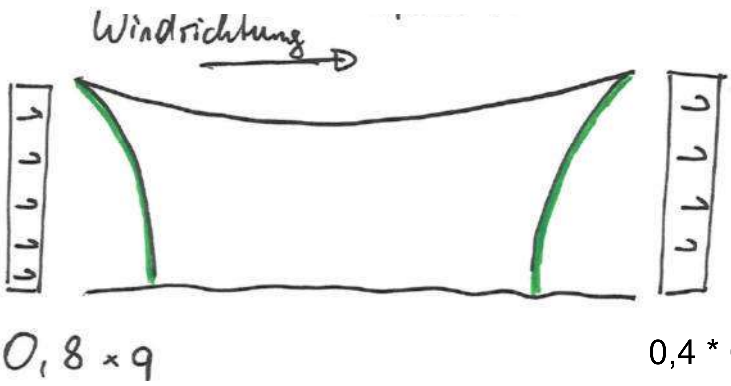




-0,4 * 0,6 = -0,24

-0,24 – (-0,18) =
-0,6 kN/m²

-0,3 * 0,6 = -0,18 kN/m²



0,4 * 0,6 = 0,24 kN/m²

0,8 * 0,6 = 0,48 kN/m²

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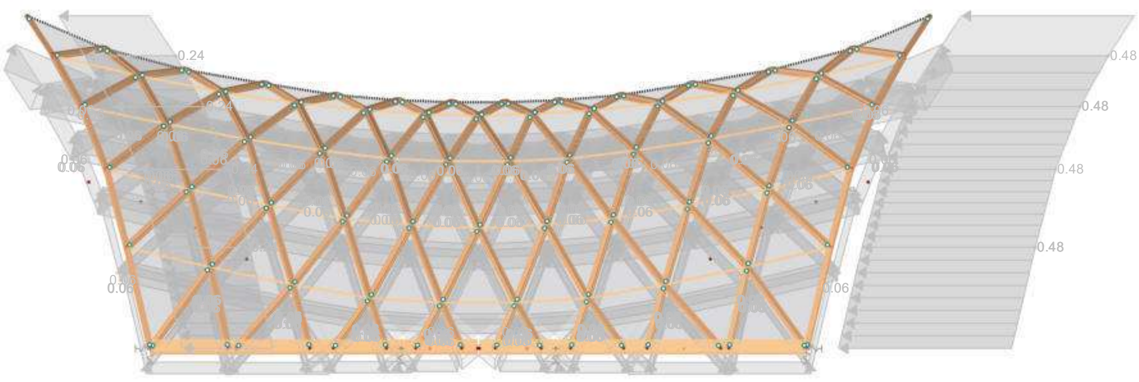
LF 14: Wind in -X closed cpi -0.3

LF 13 gespiegel

LF14 : Wind in -X geschlossen cpi -
Belastung [kN/m^2]

Entgegen der Y-Richtung



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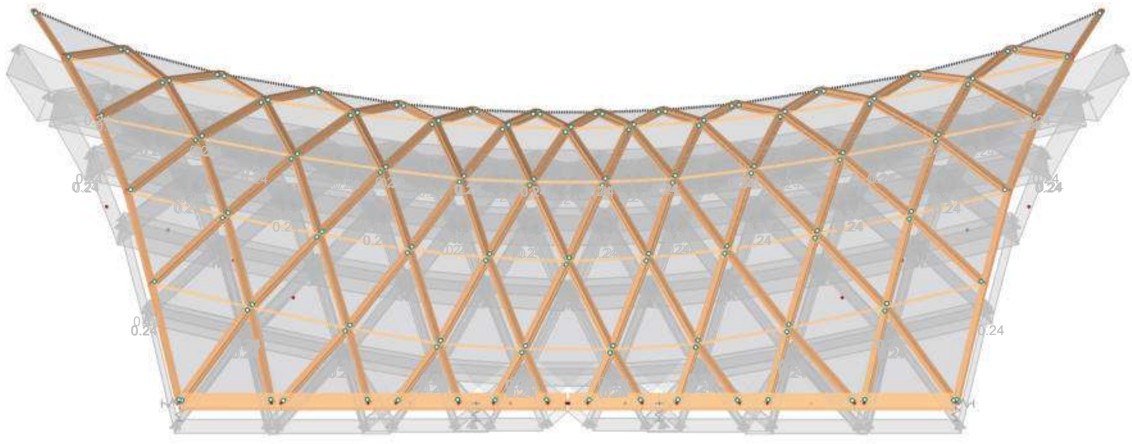
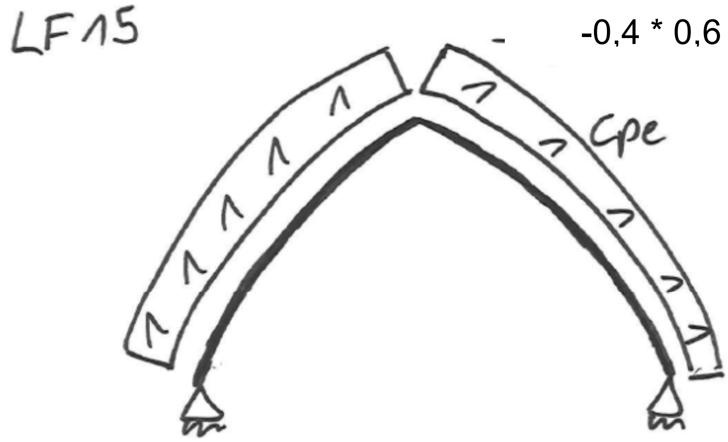
LF 15: Wind open in +X direction

LF15 : Wind in +X offen
Belastung [kN/m^2]

Entgegen der Y-Richtung





-0,4 * 0,6 = -0,24 kN/m²

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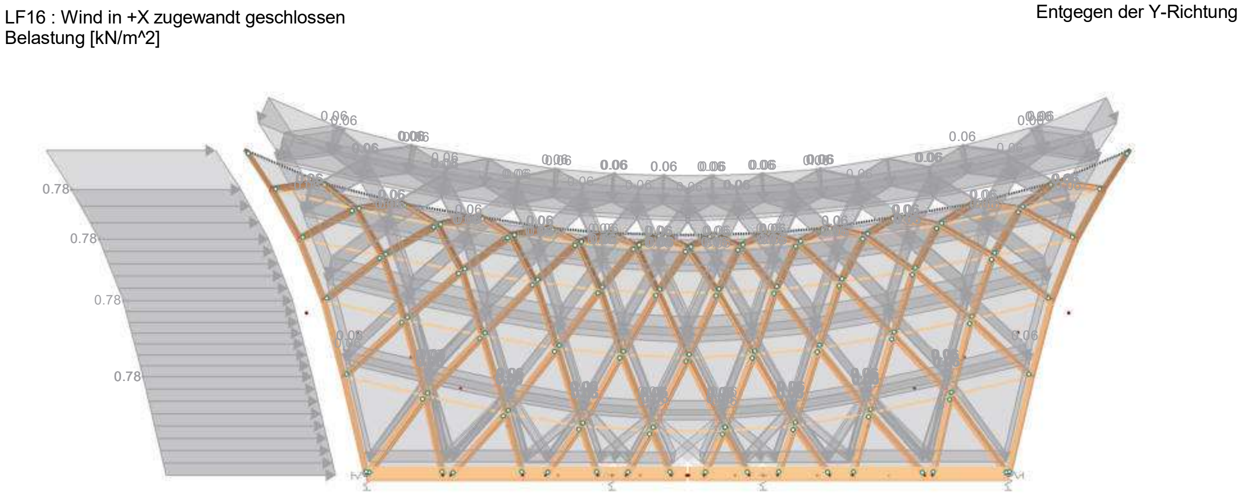
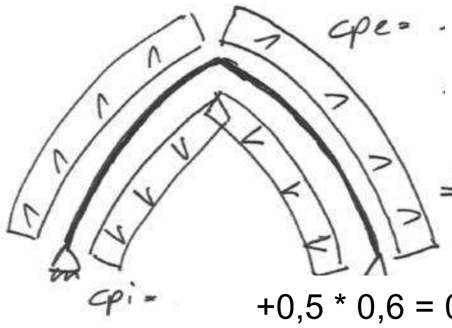
LF 16: Wind in +X direction windward closed

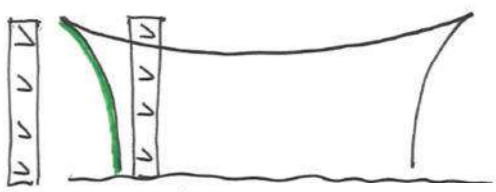




-0,4 * 0,6 = -0,24 kN/m²

⇒ -0,24 + 0,30 = 0,6 kN/m²

+0,5 * 0,6 = 0,30 kN/m²



cpi = +0,5 * 0,6 = 0,30 kN/m²

cpe = +0,8 * 0,6 = 0,48 kN/m²

⇒ 0,30 + 0,48 = 0,78 kN/m²

cpi = + 0,5 vgl. Schneider Bautabellen

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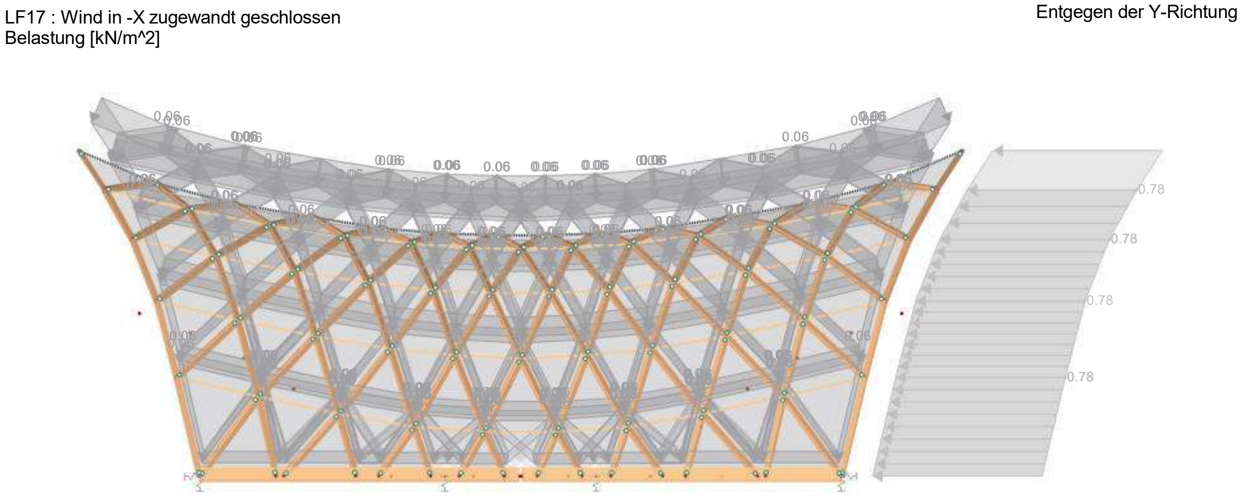
LF 17: Wind in -X direction windward closed

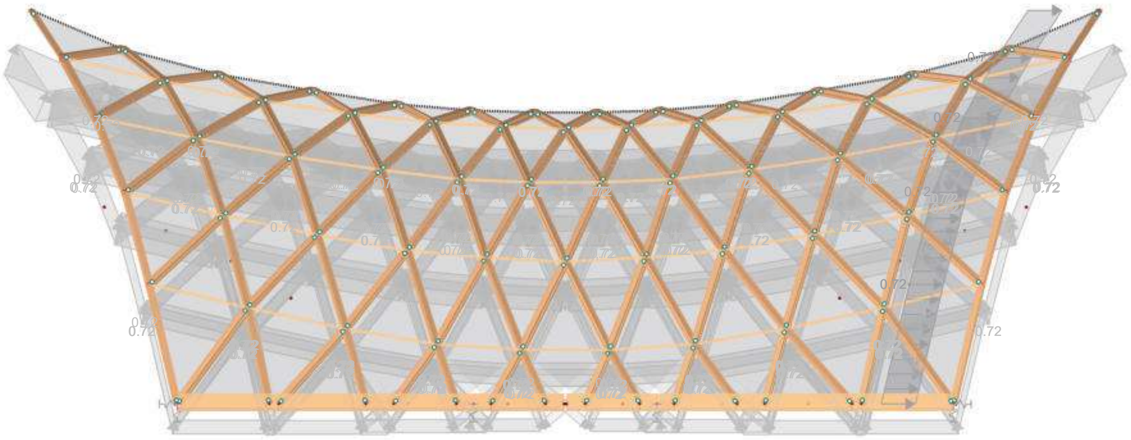
LF 16 mirrored



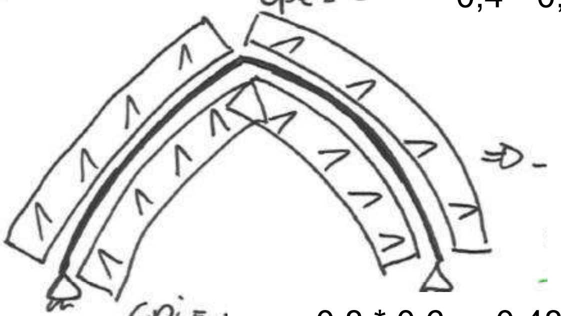
LF 18: Wind in +X direction facing away from the wind closed

LF18 : Wind in +X abgewandt geschlossen
Belastung [kN/m^2]

Entgegen der Y-Richtung



LF18

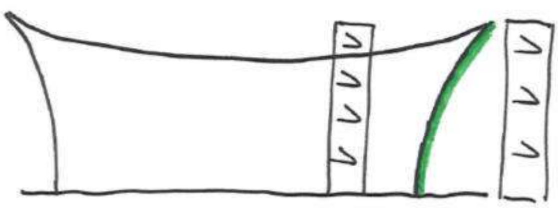


cpe = - -0,4 * 0,6 = -0,24 kN/m²

-0,24 - 0,48 =
-0,72 kN/m²

cpi = - -0,8 * 0,6 = -0,48 kN/m²

Windrichtung



cpi = - -0,8 * 0,6 = 0,48 kN/m²

cpe = - -0,4 * 0,6 = 0,24 kN/m²

-0,48 - 0,24 = 0,72 kN/m²

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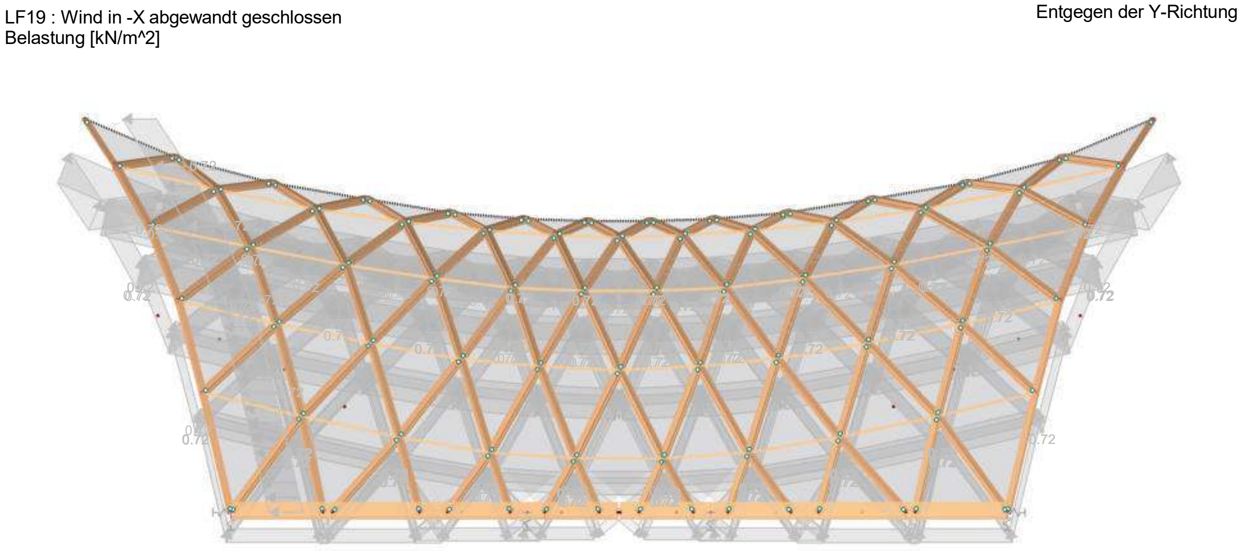
LF 19: Wind in -X direction facing away from the wind closed

LF 18 mirrored



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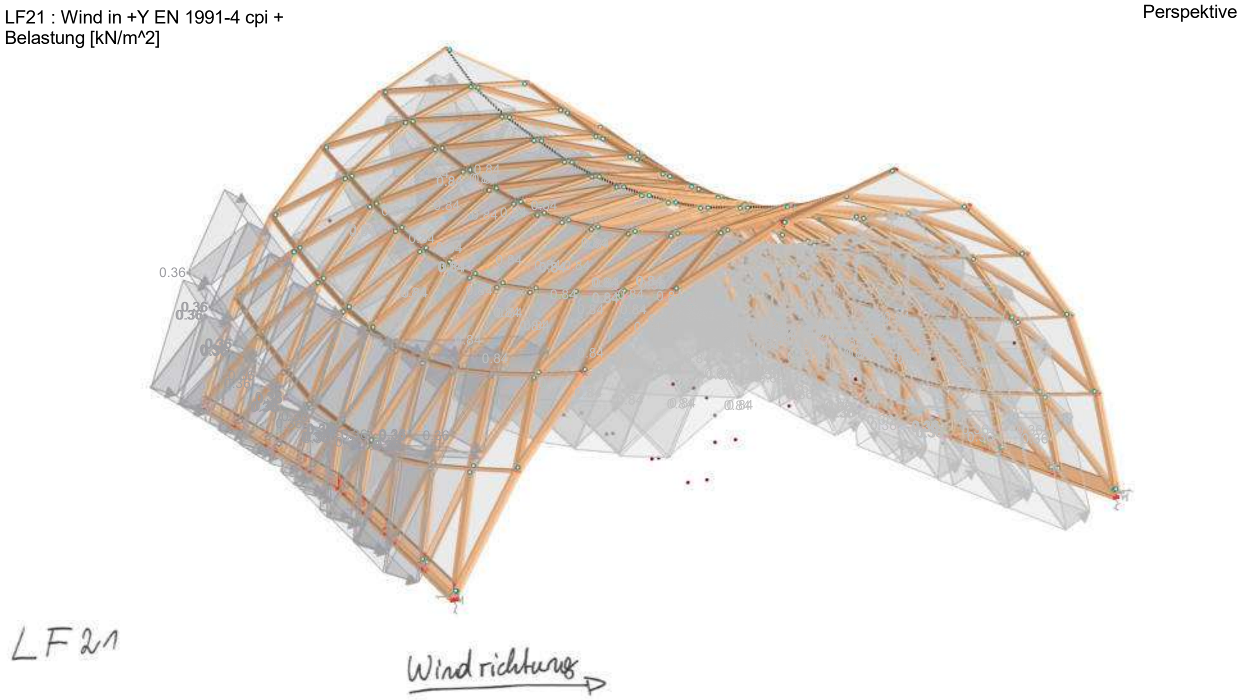
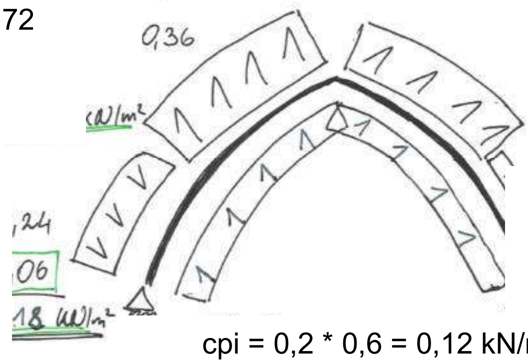
LF 21: Wind in +Y direction in combination with cpi +0.2





cpe = -1,2 * 0,6 = -0,72 kN/m²
-0,72 – 0,12 = -0,84 kN/m²

cpe = +0,8 * 0,6 = 0,48 kN/m²
+0,48 – 0,12 = +0,36 kN/m²

cpe = -0,4 * 0,6 = -0,24 kN/m²
-0,24 – 0,12 = -0,36 kN/m²

cpi = 0,2 * 0,6 = 0,12 kN/m²
(entgegenwirkend => * (-0,1)

1)

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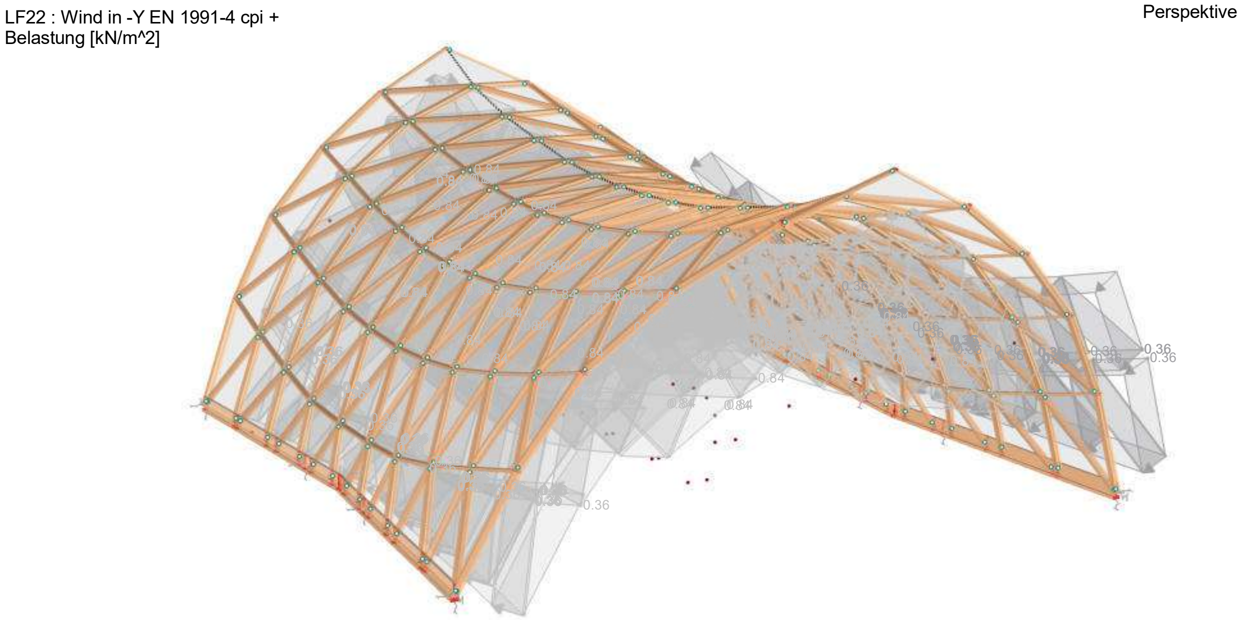
LF 22: Wind in -Y direction in combination with cpi +0.2

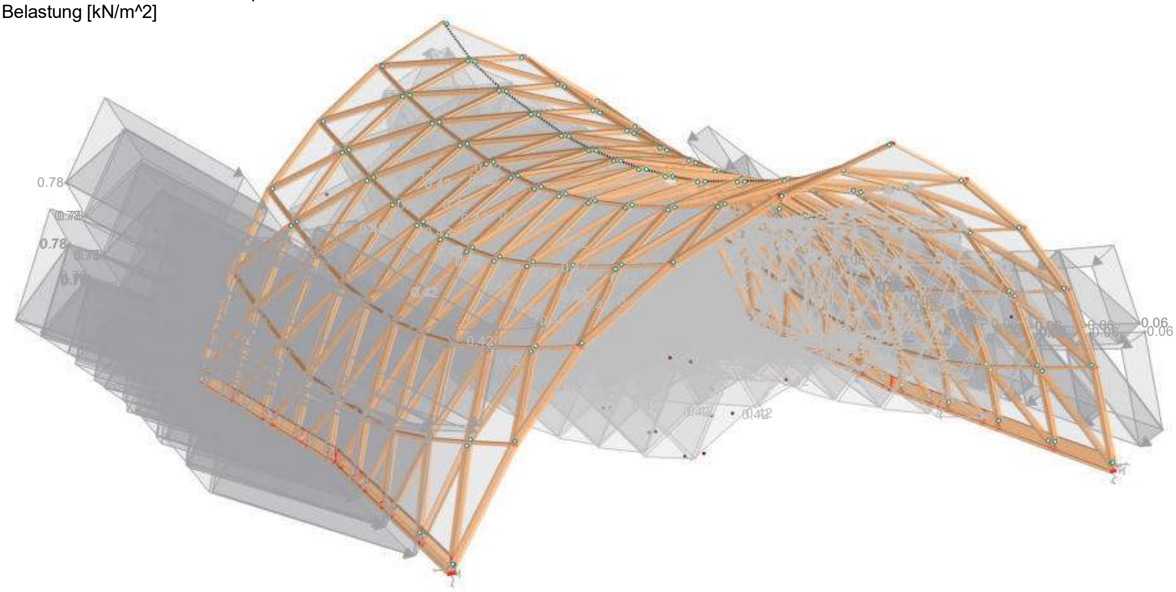
LF 21 mirrored



LF 23: Wind in +Y direction in combination with cpi -0.5 (-0.3 standard, -0.5 lt Schneider)

LF23 : Wind in +Y EN 1991-4 cpi -
Belastung [kN/m^2]

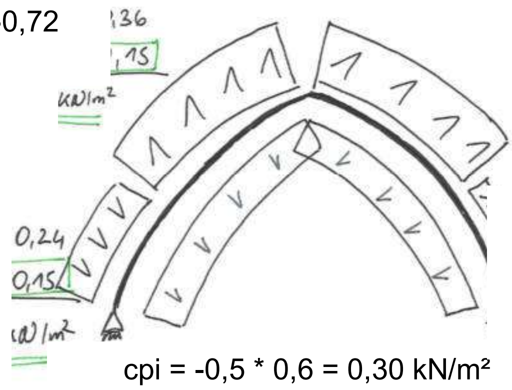
Perspektive



LF 23

Windrichtung

cpe = -1,2 * 0,6 = -0,72 kN/m²



cpe = -0,4 * 0,6 = -0,24 kN/m²
-0,24 +0,30 = + 0,06 kN/m²

cpe = +0,8 * 0,6 = 0,48 kN/m²
+0,48 +0,30 = +0,78 kN/m²

cpi = -0,5 * 0,6 = 0,30 kN/m²
(entgegenwirkend => * (-0,1)

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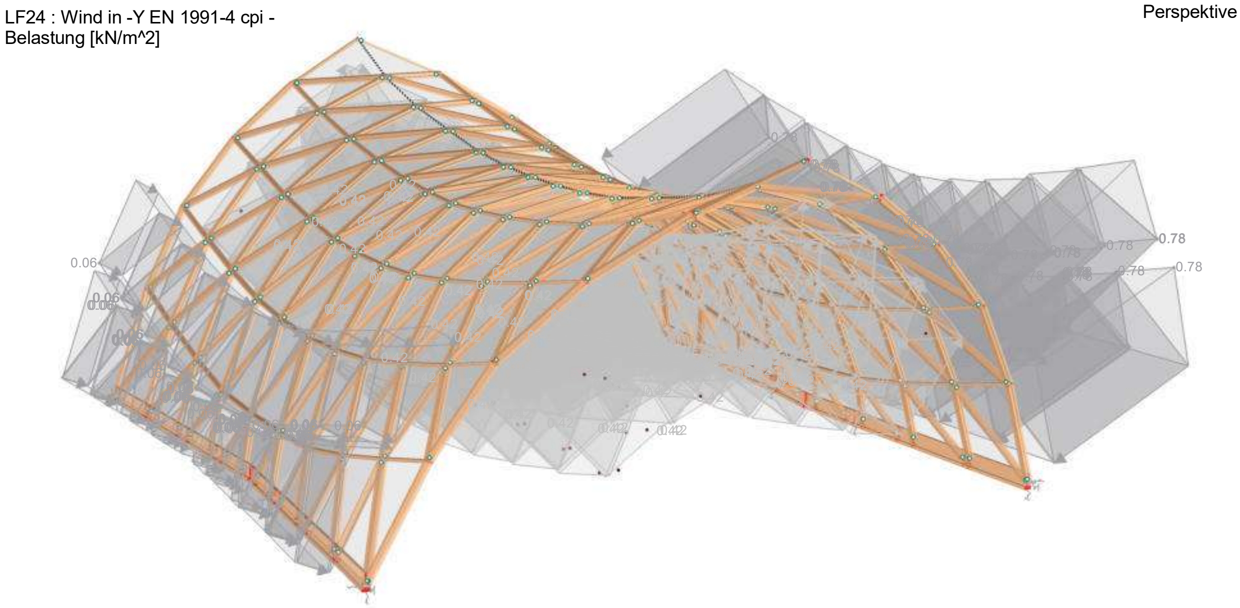
LF 24: Wind in -Y direction in combination with cpi -0.5 (-0.3 norm, -0.5 lt cutter)

LF 23 mirrored



3.3 Exceptional Loads

3.3.1 Seismic loads

Seismic loads are not to be taken into account due to their flexibility and low dead weight.

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3.4 LOAD CASE COMBINATIONS

3.4.1 ULS Combination

The ULS combinations are created according to the following scheme:

$$E_d = \max \begin{Bmatrix} \gamma_G\ G_k + \gamma_{Q,1}\ Q_{k,1} \\ \gamma_G\ G_k + \sum \gamma_{Q,i}\ Q_{k,i} \\ \gamma_G\ G_k + \gamma_{Q,el}\ Q_{k,el} \end{Bmatrix}$$

Dabei ist

E_d	der Bemessungswert der Beanspruchungen;
$\gamma_G = 1{,}35$	der Teilsicherheitsbeiwert für ungünstig wirkende ständige Einwirkungen;
$\gamma_G = 1{,}00$	der Teilsicherheitsbeiwert für günstig wirkende ständige Einwirkungen;
$\gamma_{Q,1} = 1{,}50$	der Teilsicherheitsbeiwert für nur eine veränderliche Einwirkung;
$\gamma_{Q,i} = 1{,}35$	der Teilsicherheitsbeiwert für mehrere veränderliche Einwirkungen;
$\gamma_{Q,el} = 1{,}35$	der Teilsicherheitsbeiwert für die Ersatzlast;
G_k	der charakteristische Wert für die ständige Einwirkung;
$Q_{k,1}$	der charakteristische Wert für eine der veränderlichen Einwirkungen;
$Q_{k,i}$	der charakteristische Wert für mehrere veränderliche Einwirkungen;
$Q_{k,el}$	der charakteristische Wert für die vertikale Ersatzlast nach 7.3.

All possible combinations are created automatically after EC0:

Limit state of load-bearing capacity
Limit state of serviceability – characteristic
Limit state of serviceability – common
Limit state of usability – quasi-constant

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3.4.2 Overview of load case combinations

GZT:

Last-kombin.	Beschreibung	LF.1		LF.2		LF.3		LF.4	
		Faktor	Nr.	Faktor	Nr.	Faktor	Nr.	Faktor	Nr.
LK1	1.35*LF1 + 1.35*LF2	1.350	LF1	1.350	LF2				
LK2	1.35*LF1 + 1.35*LF2 + 1.5*LF11	1.350	LF1	1.350	LF2	1.500	LF11		
LK3	1.35*LF1 + 1.35*LF2 + 1.5*LF12	1.350	LF1	1.350	LF2	1.500	LF12		
LK4	1.35*LF1 + 1.35*LF2 + 1.5*LF13	1.350	LF1	1.350	LF2	1.500	LF13		
LK5	1.35*LF1 + 1.35*LF2 + 1.5*LF14	1.350	LF1	1.350	LF2	1.500	LF14		
LK6	1.35*LF1 + 1.35*LF2 + 1.5*LF15	1.350	LF1	1.350	LF2	1.500	LF15		
LK7	1.35*LF1 + 1.35*LF2 + 1.5*LF16	1.350	LF1	1.350	LF2	1.500	LF16		
LK8	1.35*LF1 + 1.35*LF2 + 1.5*LF17	1.350	LF1	1.350	LF2	1.500	LF17		
LK9	1.35*LF1 + 1.35*LF2 + 1.5*LF18	1.350	LF1	1.350	LF2	1.500	LF18		
LK10	1.35*LF1 + 1.35*LF2 + 1.5*LF19	1.350	LF1	1.350	LF2	1.500	LF19		
LK11	1.35*LF1 + 1.35*LF2 + 1.5*LF21	1.350	LF1	1.350	LF2	1.500	LF21		
LK12	1.35*LF1 + 1.35*LF2 + 1.5*LF22	1.350	LF1	1.350	LF2	1.500	LF22		
LK	1.35*LF1 + 1.35*LF2 + 1.5*LF23	1.350	LF1	1.350	LF2	1.500	LF		

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13							23		
LK14	1.35*LF1 + 1.35*LF2 + 1.5*LF24	1.350	LF1	1.350	LF2	1.500	LF24		
LK15	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF11	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF11
LK16	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF11	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF11
LK17	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF11	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF11
LK18	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF12	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF12
LK19	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF12	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF12
LK20	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF12	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF12
LK21	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF13	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF13
LK22	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF13	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF13
LK23	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF13	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF13
LK24	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF14	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF14
LK25	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF14	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF14
LK26	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF14	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF14
LK27	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF15	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF15
LK28	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF15	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF15

LK29	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF15	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF15
LK30	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF16	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF16
LK31	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF16	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF16
LK32	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF16	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF16
LK33	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF17	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF17
LK34	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF17	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF17
LK35	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF17	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF17
LK36	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF18	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF18
LK37	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF18	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF18
LK38	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF18	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF18
LK39	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF19	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF19
LK40	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF19	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF19
LK41	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF19	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF19
LK42	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF21	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF21
LK43	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF21	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF21

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LK44	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF21	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF21
LK45	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF22	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF22
LK46	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF22	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF22
LK47	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF22	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF22
LK48	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF23	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF23
LK49	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF23	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF23
LK50	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF23	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF23
LK51	1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF24	1.350	LF1	1.350	LF2	0.750	LF6	1.500	LF24
LK52	1.35*LF1 + 1.35*LF2 + 0.75*LF7 + 1.5*LF24	1.350	LF1	1.350	LF2	0.750	LF7	1.500	LF24
LK53	1.35*LF1 + 1.35*LF2 + 0.75*LF8 + 1.5*LF24	1.350	LF1	1.350	LF2	0.750	LF8	1.500	LF24
LK54	1.35*LF1 + 1.35*LF2 + 1.5*LF6	1.350	LF1	1.350	LF2	1.500	LF6		
LK55	1.35*LF1 + 1.35*LF2 + 1.5*LF7	1.350	LF1	1.350	LF2	1.500	LF7		
LK56	1.35*LF1 + 1.35*LF2 + 1.5*LF8	1.350	LF1	1.350	LF2	1.500	LF8		
LK57	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF11	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF11
LK58	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF11	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF11

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LK59	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF11	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF11
LK60	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF12	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF12
LK61	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF12	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF12
LK62	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF12	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF12
LK63	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF13	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF13
LK64	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF13	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF13
LK65	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF13	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF13
LK66	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF14	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF14
LK67	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF14	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF14
LK68	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF14	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF14
LK69	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF15	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF15
LK70	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF15	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF15
LK71	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF15	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF15
LK72	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF16	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF16
LK73	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF16	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF16

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LK74	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF16	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF16
LK75	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF17	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF17
LK76	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF17	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF17
LK77	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF17	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF17
LK78	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF18	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF18
LK79	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF18	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF18
LK80	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF18	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF18
LK81	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF19	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF19
LK82	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF19	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF19
LK83	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF19	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF19
LK84	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF21	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF21
LK85	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF21	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF21
LK86	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF21	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF21
LK87	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF22	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF22
LK88	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF22	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF22

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LK89	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF22	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF22
LK90	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF23	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF23
LK91	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF23	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF23
LK92	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF23	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF23
LK93	1.35*LF1 + 1.35*LF2 + 1.5*LF6 + 0.9*LF24	1.350	LF1	1.350	LF2	1.500	LF6	0.900	LF24
LK94	1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF24	1.350	LF1	1.350	LF2	1.500	LF7	0.900	LF24
LK95	1.35*LF1 + 1.35*LF2 + 1.5*LF8 + 0.9*LF24	1.350	LF1	1.350	LF2	1.500	LF8	0.900	LF24

GZG –Characteristic

LK96	LF1 + LF2	1.000	LF1	1.000	LF2				
LK97	LF1 + LF2 + LF11	1.000	LF1	1.000	LF2	1.000	LF11		
LK98	LF1 + LF2 + LF12	1.000	LF1	1.000	LF2	1.000	LF12		
LK99	LF1 + LF2 + LF13	1.000	LF1	1.000	LF2	1.000	LF13		
LK100	LF1 + LF2 + LF14	1.000	LF1	1.000	LF2	1.000	LF14		
LK101	LF1 + LF2 + LF15	1.000	LF1	1.000	LF2	1.000	LF15		
LK102	LF1 + LF2 + LF16	1.000	LF1	1.000	LF2	1.000	LF16		

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LK103	LF1 + LF2 + LF17	1.000	LF1	1.000	LF2	1.000	LF17		
LK104	LF1 + LF2 + LF18	1.000	LF1	1.000	LF2	1.000	LF18		
LK105	LF1 + LF2 + LF19	1.000	LF1	1.000	LF2	1.000	LF19		
LK106	LF1 + LF2 + LF21	1.000	LF1	1.000	LF2	1.000	LF21		
LK107	LF1 + LF2 + LF22	1.000	LF1	1.000	LF2	1.000	LF22		
LK108	LF1 + LF2 + LF23	1.000	LF1	1.000	LF2	1.000	LF23		
LK109	LF1 + LF2 + LF24	1.000	LF1	1.000	LF2	1.000	LF24		
LK110	LF1 + LF2 + 0.5*LF6 + LF11	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF11
LK111	LF1 + LF2 + 0.5*LF7 + LF11	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF11
LK112	LF1 + LF2 + 0.5*LF8 + LF11	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF11
LK113	LF1 + LF2 + 0.5*LF6 + LF12	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF12
LK114	LF1 + LF2 + 0.5*LF7 + LF12	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF12
LK115	LF1 + LF2 + 0.5*LF8 + LF12	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF12
LK116	LF1 + LF2 + 0.5*LF6 + LF13	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF13
LK117	LF1 + LF2 + 0.5*LF7 + LF13	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF13

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LK118	LF1 + LF2 + 0.5*LF8 + LF13	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF13
LK119	LF1 + LF2 + 0.5*LF6 + LF14	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF14
LK120	LF1 + LF2 + 0.5*LF7 + LF14	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF14
LK121	LF1 + LF2 + 0.5*LF8 + LF14	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF14
LK122	LF1 + LF2 + 0.5*LF6 + LF15	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF15
LK123	LF1 + LF2 + 0.5*LF7 + LF15	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF15
LK124	LF1 + LF2 + 0.5*LF8 + LF15	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF15
LK125	LF1 + LF2 + 0.5*LF6 + LF16	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF16
LK126	LF1 + LF2 + 0.5*LF7 + LF16	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF16
LK127	LF1 + LF2 + 0.5*LF8 + LF16	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF16
LK128	LF1 + LF2 + 0.5*LF6 + LF17	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF17
LK129	LF1 + LF2 + 0.5*LF7 + LF17	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF17
LK130	LF1 + LF2 + 0.5*LF8 + LF17	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF17
LK131	LF1 + LF2 + 0.5*LF6 + LF18	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF18
LK132	LF1 + LF2 + 0.5*LF7 + LF18	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF18

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LK133	LF1 + LF2 + 0.5*LF8 + LF18	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF18
LK134	LF1 + LF2 + 0.5*LF6 + LF19	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF19
LK135	LF1 + LF2 + 0.5*LF7 + LF19	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF19
LK136	LF1 + LF2 + 0.5*LF8 + LF19	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF19
LK137	LF1 + LF2 + 0.5*LF6 + LF21	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF21
LK138	LF1 + LF2 + 0.5*LF7 + LF21	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF21
LK139	LF1 + LF2 + 0.5*LF8 + LF21	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF21
LK140	LF1 + LF2 + 0.5*LF6 + LF22	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF22
LK141	LF1 + LF2 + 0.5*LF7 + LF22	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF22
LK142	LF1 + LF2 + 0.5*LF8 + LF22	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF22
LK143	LF1 + LF2 + 0.5*LF6 + LF23	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF23
LK144	LF1 + LF2 + 0.5*LF7 + LF23	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF23
LK145	LF1 + LF2 + 0.5*LF8 + LF23	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF23
LK146	LF1 + LF2 + 0.5*LF6 + LF24	1.000	LF1	1.000	LF2	0.500	LF6	1.000	LF24
LK147	LF1 + LF2 + 0.5*LF7 + LF24	1.000	LF1	1.000	LF2	0.500	LF7	1.000	LF24

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LK 148	LF1 + LF2 + 0.5*LF8 + LF24	1.000	LF1	1.000	LF2	0.500	LF8	1.000	LF24
LK 149	LF1 + LF2 + LF6	1.000	LF1	1.000	LF2	1.000	LF6		
LK 150	LF1 + LF2 + LF7	1.000	LF1	1.000	LF2	1.000	LF7		
LK 151	LF1 + LF2 + LF8	1.000	LF1	1.000	LF2	1.000	LF8		
LK 152	LF1 + LF2 + LF6 + 0.6*LF11	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF11
LK 153	LF1 + LF2 + LF7 + 0.6*LF11	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF11
LK 154	LF1 + LF2 + LF8 + 0.6*LF11	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF11
LK 155	LF1 + LF2 + LF6 + 0.6*LF12	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF12
LK 156	LF1 + LF2 + LF7 + 0.6*LF12	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF12
LK 157	LF1 + LF2 + LF8 + 0.6*LF12	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF12
LK 158	LF1 + LF2 + LF6 + 0.6*LF13	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF13
LK 159	LF1 + LF2 + LF7 + 0.6*LF13	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF13
LK 160	LF1 + LF2 + LF8 + 0.6*LF13	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF13
LK 161	LF1 + LF2 + LF6 + 0.6*LF14	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF14
LK 162	LF1 + LF2 + LF7 + 0.6*LF14	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF14
LK 163	LF1 + LF2 + LF8 + 0.6*LF14	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF14

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LK164	LF1 + LF2 + LF6 + 0.6*LF15	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF15
LK165	LF1 + LF2 + LF7 + 0.6*LF15	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF15
LK166	LF1 + LF2 + LF8 + 0.6*LF15	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF15
LK167	LF1 + LF2 + LF6 + 0.6*LF16	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF16
LK168	LF1 + LF2 + LF7 + 0.6*LF16	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF16
LK169	LF1 + LF2 + LF8 + 0.6*LF16	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF16
LK170	LF1 + LF2 + LF6 + 0.6*LF17	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF17
LK171	LF1 + LF2 + LF7 + 0.6*LF17	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF17
LK172	LF1 + LF2 + LF8 + 0.6*LF17	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF17
LK173	LF1 + LF2 + LF6 + 0.6*LF18	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF18
LK174	LF1 + LF2 + LF7 + 0.6*LF18	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF18
LK175	LF1 + LF2 + LF8 + 0.6*LF18	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF18
LK176	LF1 + LF2 + LF6 + 0.6*LF19	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF19
LK177	LF1 + LF2 + LF7 + 0.6*LF19	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF19
LK178	LF1 + LF2 + LF8 + 0.6*LF19	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF19

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LK 179	LF1 + LF2 + LF6 + 0.6*LF21	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF21
LK 180	LF1 + LF2 + LF7 + 0.6*LF21	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF21
LK 181	LF1 + LF2 + LF8 + 0.6*LF21	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF21
LK 182	LF1 + LF2 + LF6 + 0.6*LF22	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF22
LK 183	LF1 + LF2 + LF7 + 0.6*LF22	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF22
LK 184	LF1 + LF2 + LF8 + 0.6*LF22	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF22
LK 185	LF1 + LF2 + LF6 + 0.6*LF23	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF23
LK 186	LF1 + LF2 + LF7 + 0.6*LF23	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF23
LK 187	LF1 + LF2 + LF8 + 0.6*LF23	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF23
LK 188	LF1 + LF2 + LF6 + 0.6*LF24	1.000	LF1	1.000	LF2	1.000	LF6	0.600	LF24
LK 189	LF1 + LF2 + LF7 + 0.6*LF24	1.000	LF1	1.000	LF2	1.000	LF7	0.600	LF24
LK 190	LF1 + LF2 + LF8 + 0.6*LF24	1.000	LF1	1.000	LF2	1.000	LF8	0.600	LF24

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GZG – Rare and quasi constant

LK 191	LF1 + LF2	1.000	LF1	1.000	LF2				
LK 192	LF1 + LF2 + 0.2*LF11	1.000	LF1	1.000	LF2	0.200	LF11		
LK 193	LF1 + LF2 + 0.2*LF12	1.000	LF1	1.000	LF2	0.200	LF12		
LK 194	LF1 + LF2 + 0.2*LF13	1.000	LF1	1.000	LF2	0.200	LF13		
LK 195	LF1 + LF2 + 0.2*LF14	1.000	LF1	1.000	LF2	0.200	LF14		
LK 196	LF1 + LF2 + 0.2*LF15	1.000	LF1	1.000	LF2	0.200	LF15		
LK 197	LF1 + LF2 + 0.2*LF16	1.000	LF1	1.000	LF2	0.200	LF16		
LK 198	LF1 + LF2 + 0.2*LF17	1.000	LF1	1.000	LF2	0.200	LF17		
LK 199	LF1 + LF2 + 0.2*LF18	1.000	LF1	1.000	LF2	0.200	LF18		
LK 200	LF1 + LF2 + 0.2*LF19	1.000	LF1	1.000	LF2	0.200	LF19		
LK 201	LF1 + LF2 + 0.2*LF21	1.000	LF1	1.000	LF2	0.200	LF21		
LK 202	LF1 + LF2 + 0.2*LF22	1.000	LF1	1.000	LF2	0.200	LF22		
LK 203	LF1 + LF2 + 0.2*LF23	1.000	LF1	1.000	LF2	0.200	LF23		
LK 204	LF1 + LF2 + 0.2*LF24	1.000	LF1	1.000	LF2	0.200	LF24		
LK 205	LF1 + LF2 + 0.2*LF6	1.000	LF1	1.000	LF2	0.200	LF6		
LK 206	LF1 + LF2 + 0.2*LF7	1.000	LF1	1.000	LF2	0.200	LF7		
LK 207	LF1 + LF2 + 0.2*LF8	1.000	LF1	1.000	LF2	0.200	LF8		
LK 208	LF1 + LF2	1.000	LF1	1.000	LF2				

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4 COMPONENTS

4.1 GENERAL DETERMINATION OF CUTTING FORCE

The cutting forces are determined on the three-dimensional framework model.

In the following, the verification-relevant cutting forces are summarized in the individual paragraphs.

The cutting forces are calculated according to 2nd order theory. This in turn means that any stability failure due to the large pre-curvature of the lattice shell is also taken into account. A separate stability check is not kept.

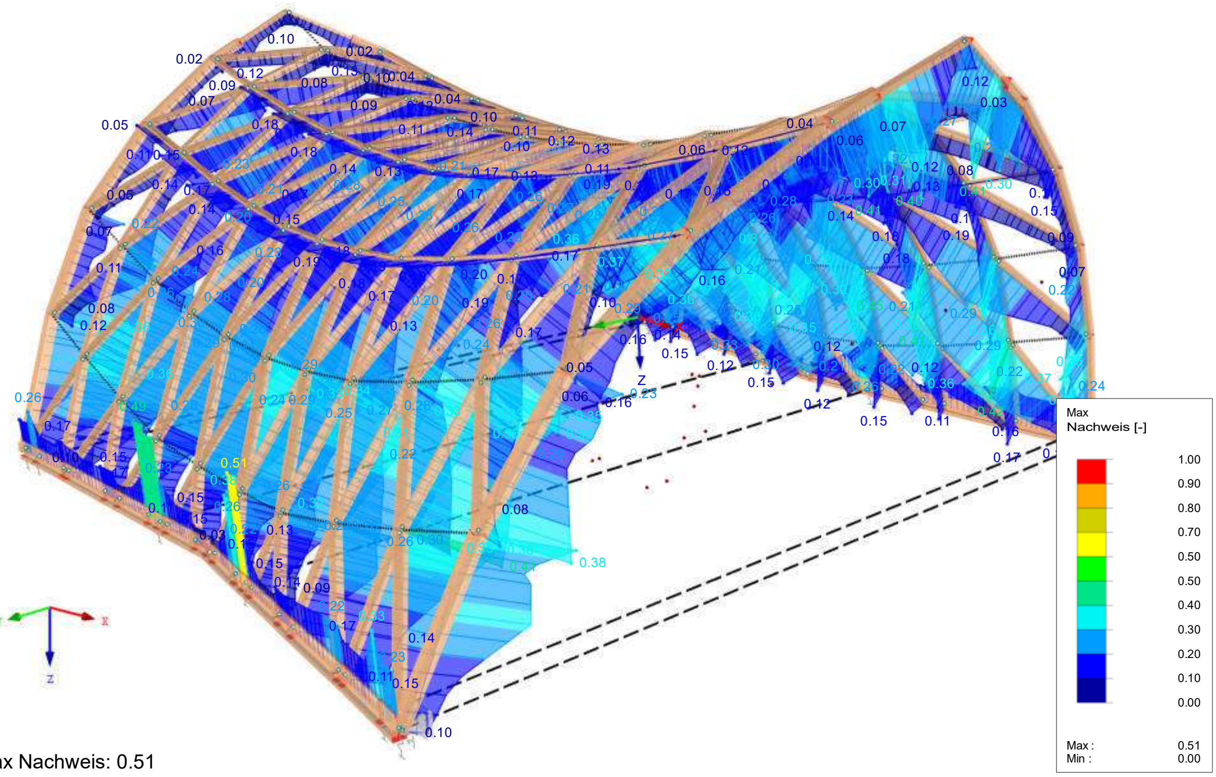
The cross-sections were modelled realistically.

4.2 Proof

4.2.1 Proof of the grid shell | gross cross-sections ULS

HOLZ Pro FA1
Tragfähigkeit - Querschnittsnachweis

Perspektive



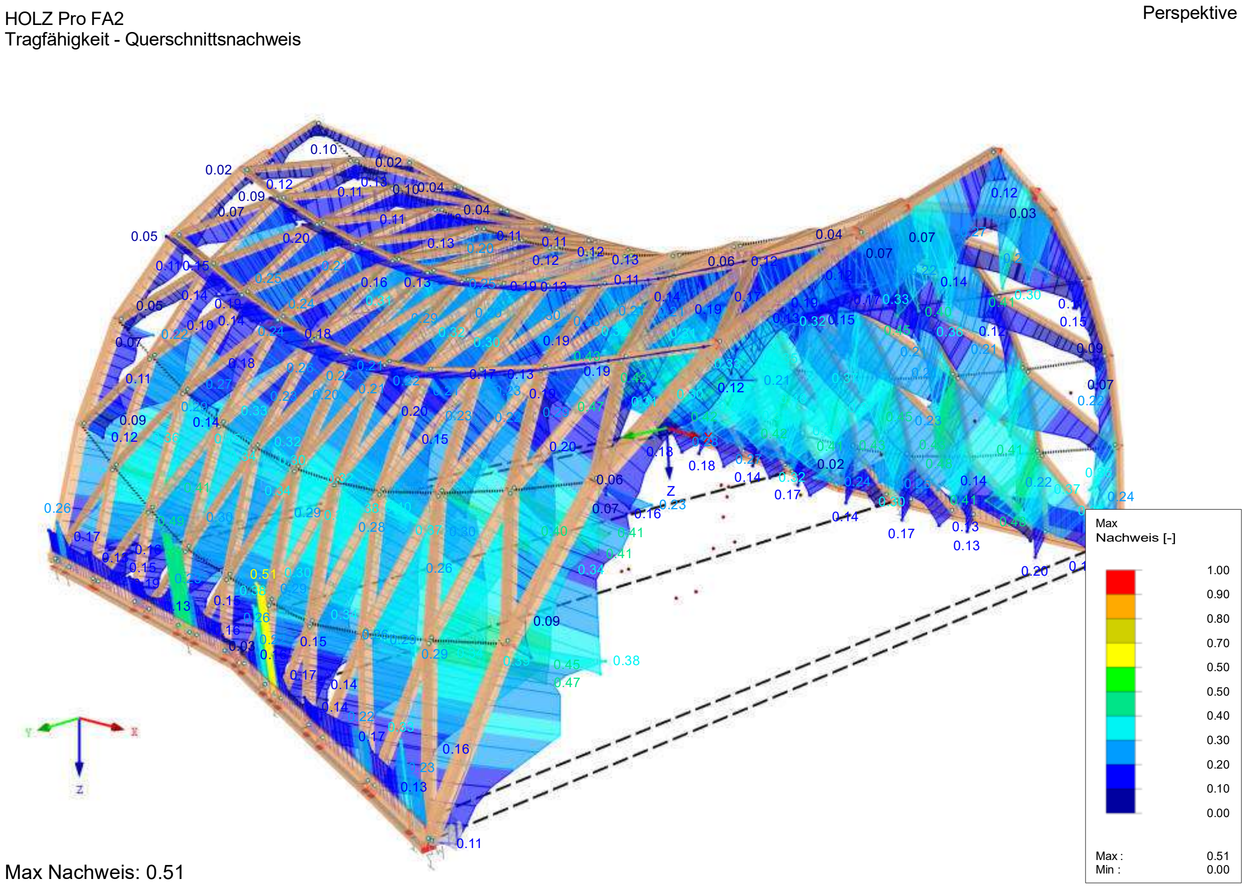
Max Nachweis: 0.51

The maximum cross-section utilization in the base beam is **51 %.**

4.2.2 Proof of the grid shell | Netto cross-sections ULS

The verification is carried out on cross-sections with dimensions reduced by the borehole. Thus, the locally weakened cross-sectional areas at the crossing points of the grid shell bars are recorded.

The bore of 12 mm is taken into account for all cross-sections. This means that the resistance moment Wy of the grid shell cross-section is reduced by the proportion of the borehole.



The maximum cross-section load in the edge beam and base beam does not change.

The maximum utilization **of the edge beam and the base beam is 51%.**

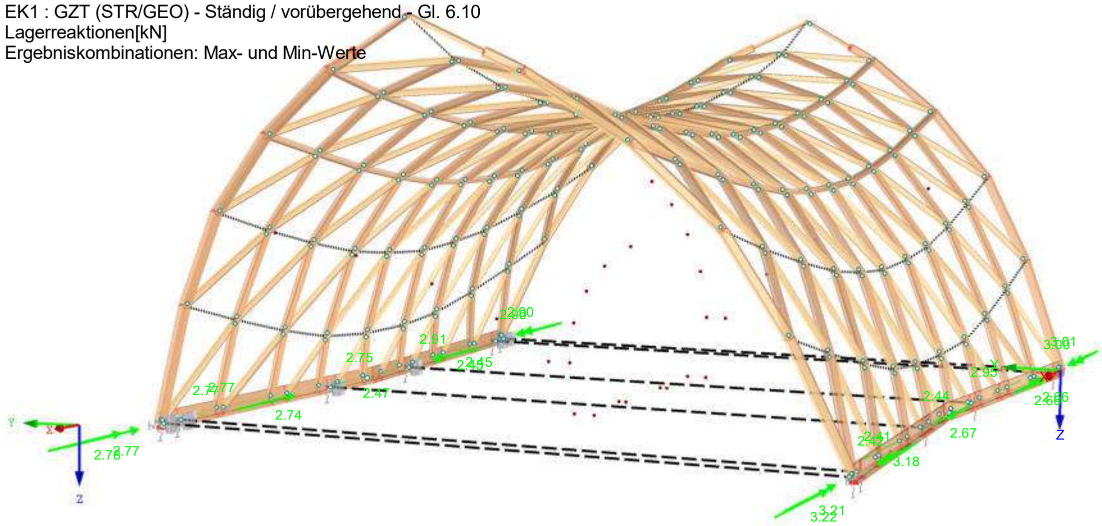
4.3 Bearing Situation

4.3.1 Bearing reactions design values

The design values of the bearing reactions are shown, enveloping from all combinations to be considered..

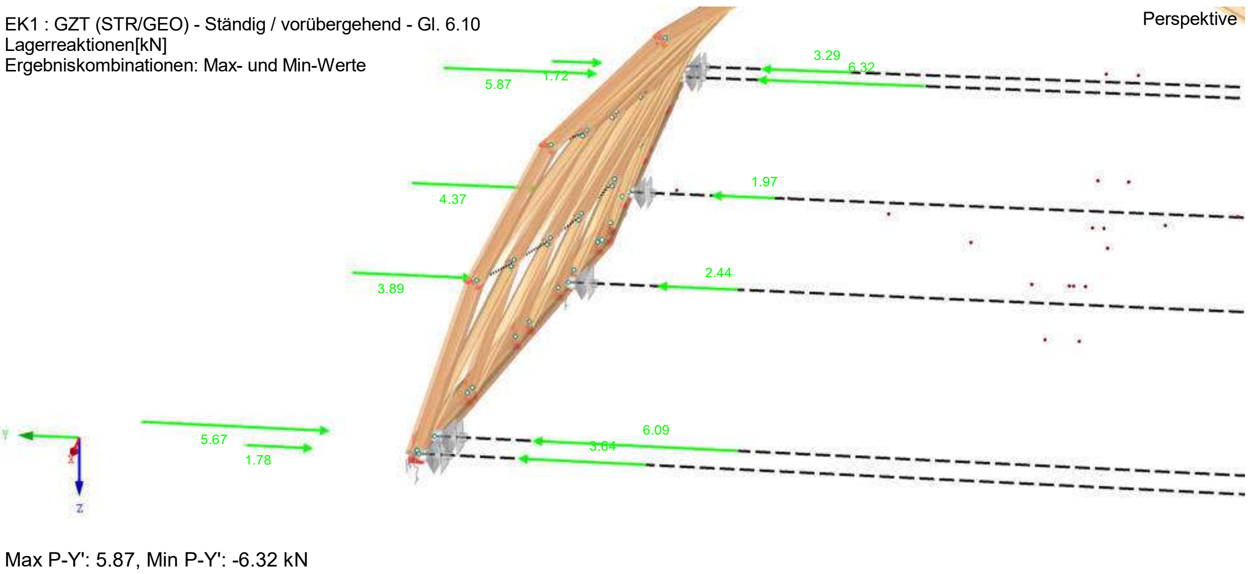
Bearing loads in X-direction

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Lagerreaktionen[kN]
Ergebniskombinationen: Max- und Min-Werte

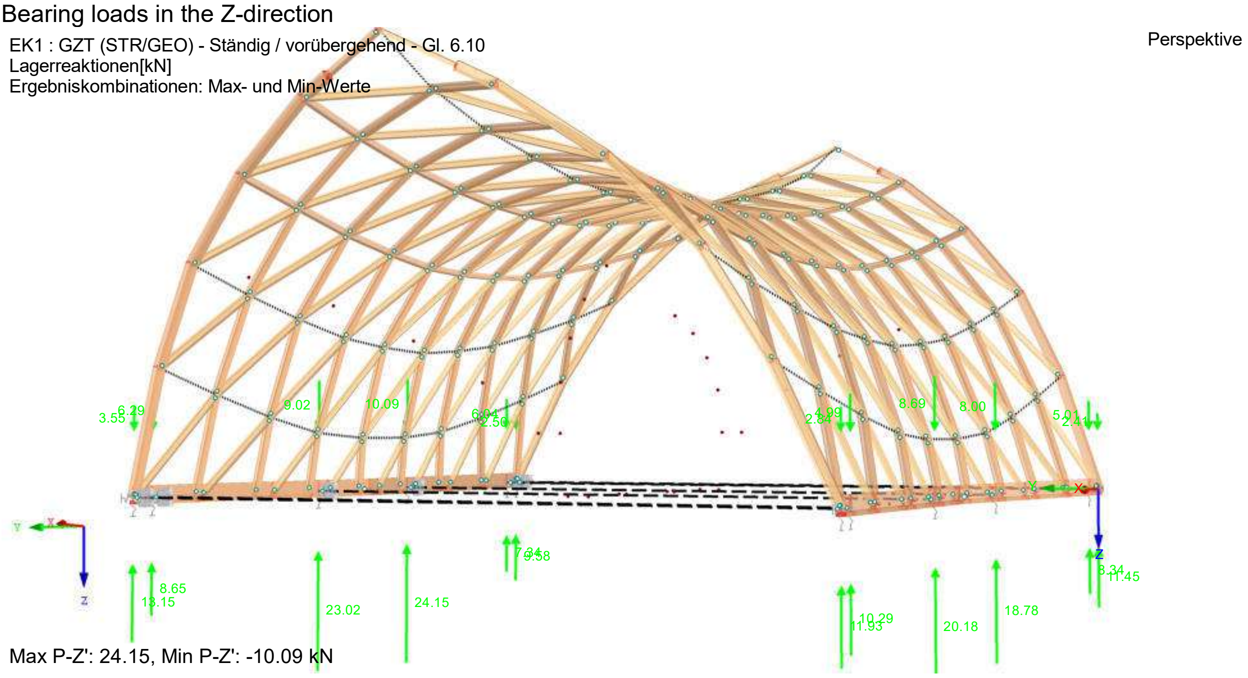


Max P-X': 3.22, Min P-X': -3.01 kN

Bearing loads in the Y-direction
Global support loads in the Y-direction because the two sides are shorted via tension-compression couplings.



Bearing loads in the Z-direction



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4.3.2 Bearing reactions related loads

Knoten Nr.		Lagerkräfte [kN] $P_{X'}$	$P_{Y'}$	$P_{Z'}$	Zugehörige Lastfälle
16	Max $P_{X'}$	**2.78**	0.27	6.00	LK 36
	Min $P_{X'}$	**-2.77**	-1.54	1.70	LK 34
	Max $P_{Y'}$	0.44	**1.78**	6.12	LK 11
	Min $P_{Y'}$	-0.62	**-3.64**	-0.73	LK 94
	Max $P_{Z'}$	0.77	0.71	**13.15**	LK 92
	Min $P_{Z'}$	-0.77	-2.59	**-3.55**	LK 46
19	Max $P_{X'}$	**2.66**	0.00	1.76	LK 7
	Min $P_{X'}$	**-3.01**	0.00	5.02	LK 40
	Max $P_{Z'}$	-2.56	0.00	**11.45**	LK 76
	Min $P_{Z'}$	0.71	0.00	**-2.41**	LK 11
43	Max $P_{X'}$	**3.22**	0.00	9.71	LK 31
	Min $P_{X'}$	**-2.42**	0.00	-2.84	LK 10
	Max $P_{Z'}$	2.05	0.00	**11.93**	LK 74
	Min $P_{Z'}$	-2.42	0.00	**-2.84**	LK 10
64	Max $P_{X'}$	**2.45**	-0.80	-1.09	LK 37
	Min $P_{X'}$	**-2.90**	0.31	9.55	LK 33
	Max $P_{Y'}$	-0.43	**1.72**	5.04	LK 11
	Min $P_{Y'}$	0.60	**-3.29**	1.06	LK 94
	Max $P_{Z'}$	-2.12	0.19	**9.58**	LK 75
	Min $P_{Z'}$	0.66	-1.13	**-2.50**	LK 12
326	Max $P_{X'}$	**3.18**	0.00	10.14	LK 31
	Min $P_{X'}$	**-2.44**	0.00	-4.96	LK 10
	Max $P_{Z'}$	2.02	0.00	**20.18**	LK 74
	Min $P_{Z'}$	0.35	0.00	**-8.69**	LK 12
327	Max $P_{X'}$	**2.67**	0.00	7.36	LK 7
	Min $P_{X'}$	**-2.95**	0.00	-1.43	LK 40
	Max $P_{Z'}$	-1.83	0.00	**18.78**	LK 77
	Min $P_{Z'}$	-0.35	0.00	**-8.00**	LK 12

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Knoten Nr.		Lagerkräfte [kN] $P_{X'}$	$P_{Y'}$	$P_{Z'}$	Zugehörige Lastfälle
328	Max $P_{X'}$	**2.47**	1.40	2.26	LK 37
	Min $P_{X'}$	**-2.91**	0.36	14.23	LK 33
	Max $P_{Y'}$	-0.30	**4.37**	15.73	LK 91
	Min $P_{Y'}$	0.57	**-1.97**	-0.21	LK 12
	Max $P_{Z'}$	-1.55	3.86	**24.15**	LK 76
	Min $P_{Z'}$	-0.35	2.06	**-10.09**	LK 11
329	Max $P_{X'}$	**2.74**	-0.12	1.09	LK 36
	Min $P_{X'}$	**-2.75**	1.86	15.51	LK 34
	Max $P_{Y'}$	0.28	**3.89**	15.59	LK 91
	Min $P_{Y'}$	-0.57	**-2.44**	-0.81	LK 12
	Max $P_{Z'}$	1.34	3.50	**23.02**	LK 73
	Min $P_{Z'}$	0.35	1.68	**-9.02**	LK 11
338	Max $P_{X'}$	**2.66**	0.00	0.44	LK 7
	Min $P_{X'}$	**-3.00**	0.00	0.83	LK 40
	Max $P_{Z'}$	-2.02	0.00	**8.34**	LK 75
	Min $P_{Z'}$	2.08	0.00	**-5.01**	LK 9
339	Max $P_{X'}$	**2.77**	0.07	-0.75	LK 36
	Min $P_{X'}$	**-2.77**	-0.77	1.57	LK 34
	Max $P_{Y'}$	0.80	**5.67**	2.29	LK 48
	Min $P_{Y'}$	-0.79	**-6.09**	4.89	LK 52
	Max $P_{Z'}$	1.79	-0.40	**8.65**	LK 74
	Min $P_{Z'}$	-2.07	0.04	**-6.29**	LK 10
340	Max $P_{X'}$	**3.21**	0.00	7.32	LK 31
	Min $P_{X'}$	**-2.41**	0.00	-4.99	LK 10
	Max $P_{Z'}$	2.04	0.00	**10.29**	LK 74
	Min $P_{Z'}$	-2.41	0.00	**-4.99**	LK 10
341	Max $P_{X'}$	**2.45**	-0.86	-4.47	LK 37
	Min $P_{X'}$	**-2.90**	-0.33	5.60	LK 33
	Max $P_{Y'}$	-0.79	**5.87**	3.58	LK 50
	Min $P_{Y'}$	0.76	**-6.32**	2.93	LK 52
	Max $P_{Z'}$	-2.12	-0.42	**7.34**	LK 75
	Min $P_{Z'}$	2.41	-0.43	**-6.04**	LK 9

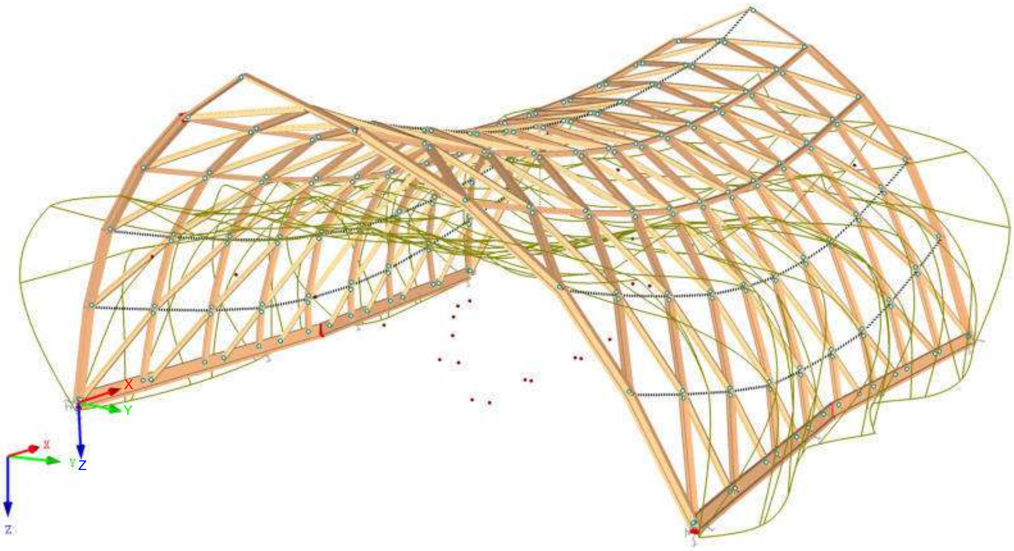
4.4 Merchantability

4.4.1 Deformation

4.4.1.1 Dead load

LF1 : Eigengewicht

Perspektive

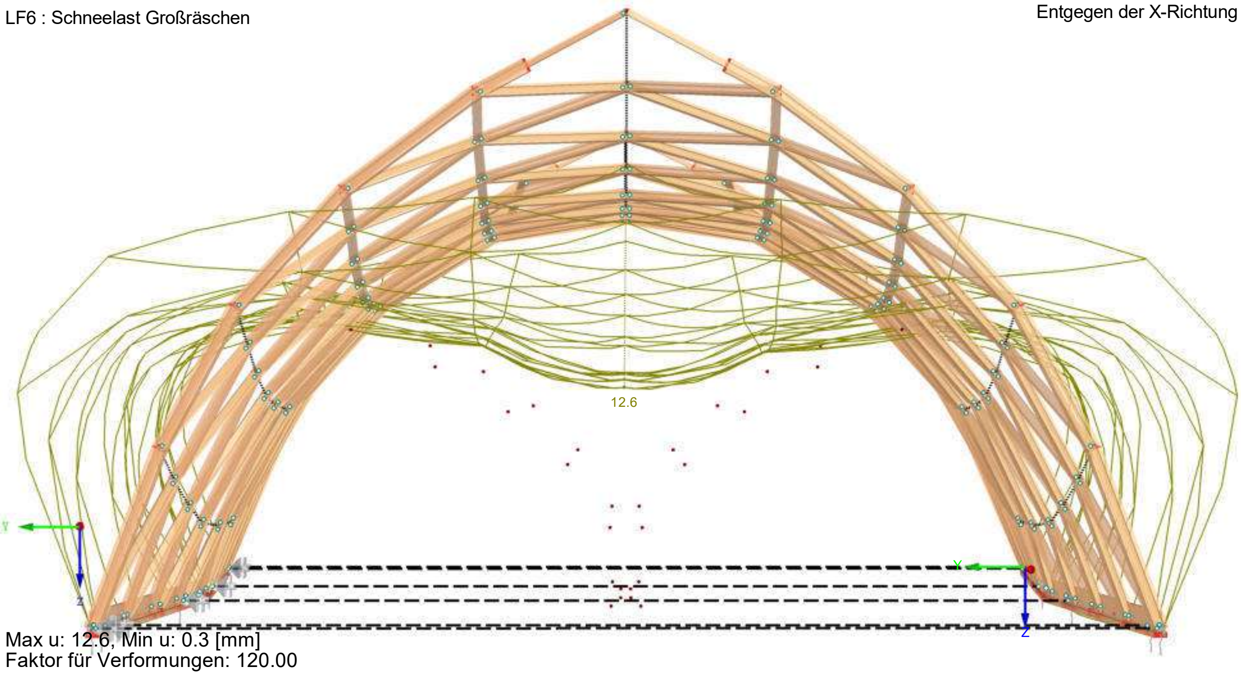


Max u: 1.8, Min u: 0.1 [mm]
Faktor für Verformungen: 820.00

4.4.1.2 Snow Scenario 1

LF6 : Schneelast Großräschen

Entgegen der X-Richtung



Max u: 12.6, Min u: 0.3 [mm]
Faktor für Verformungen: 120.00

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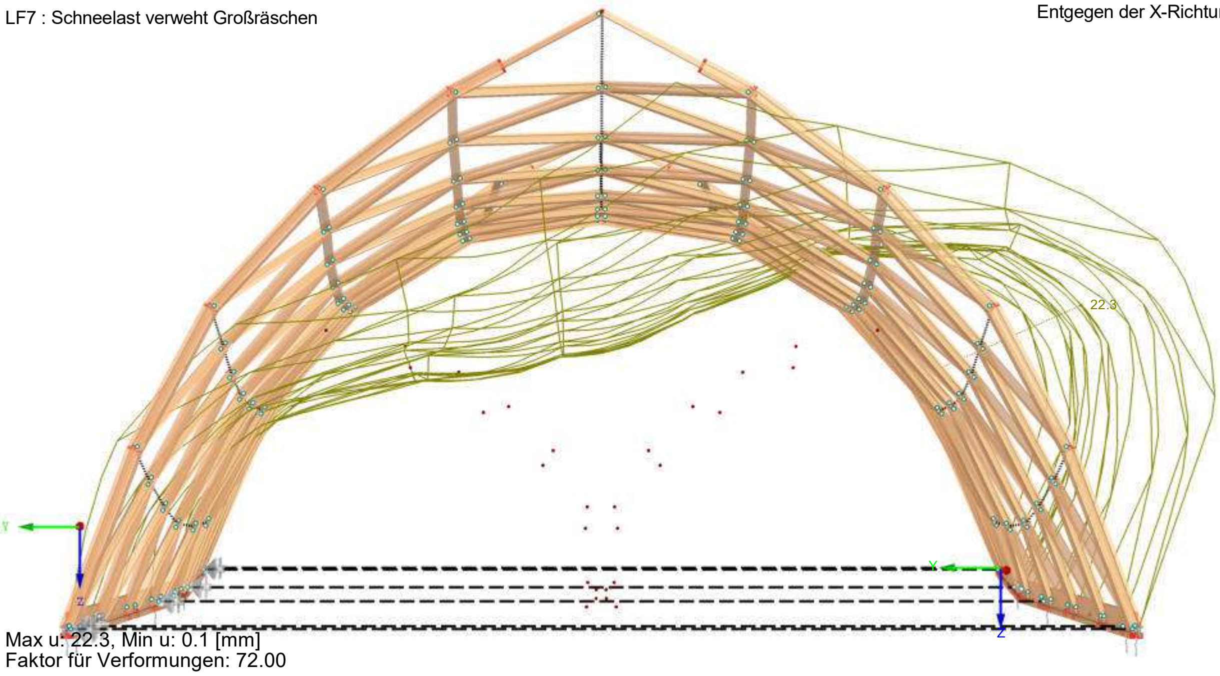
4.4.1.3 Snow Scenario 2

LF7 : Schneelast verweht Großräschen

Entgegen der X-Richtung

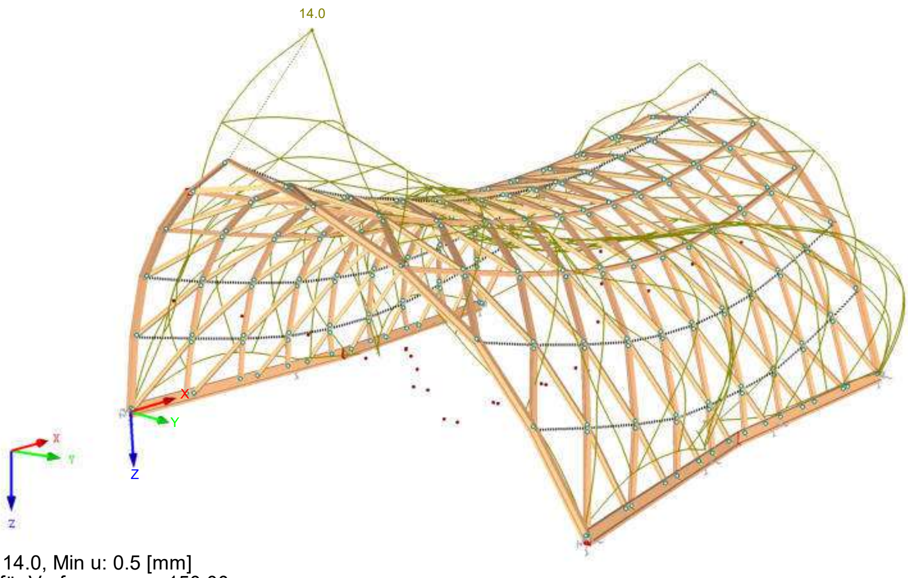


Max u: 22.3, Min u: 0.1 [mm]
Faktor für Verformungen: 72.00

4.4.1.4 Wind in X-direction LF 18

LF18 : Wind in +X abgewandt geschlossen

Perspektive



Max u: 14.0, Min u: 0.5 [mm]
Faktor für Verformungen: 150.00

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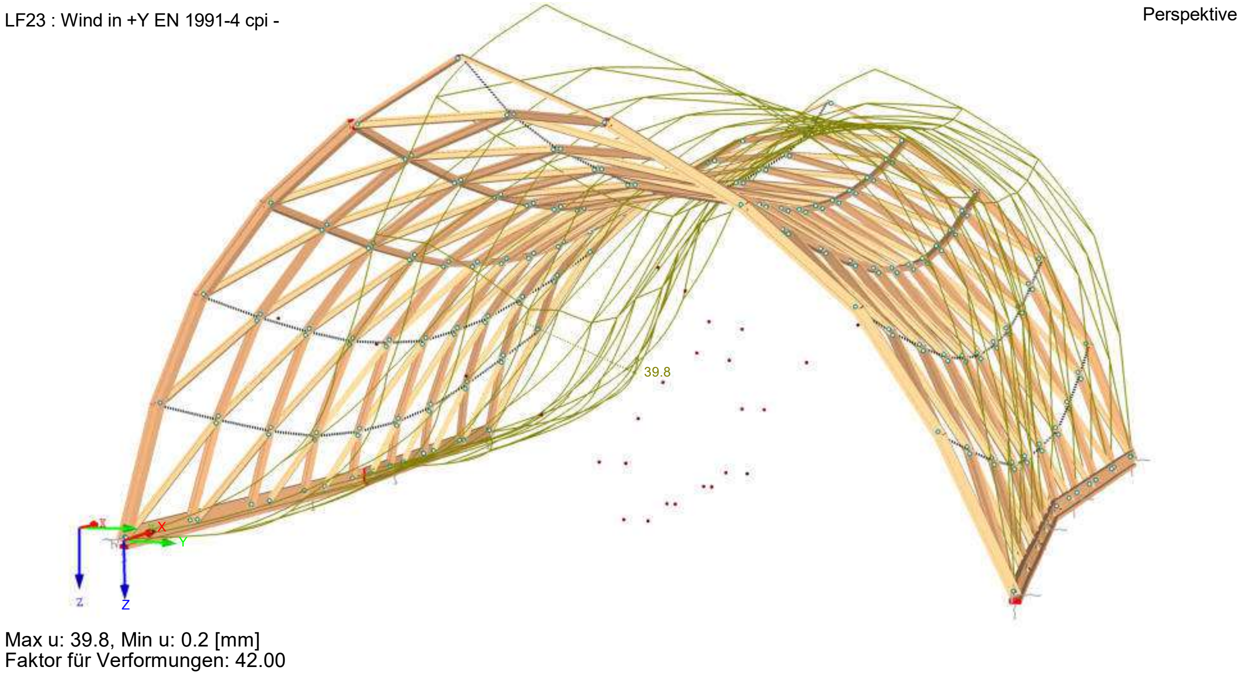
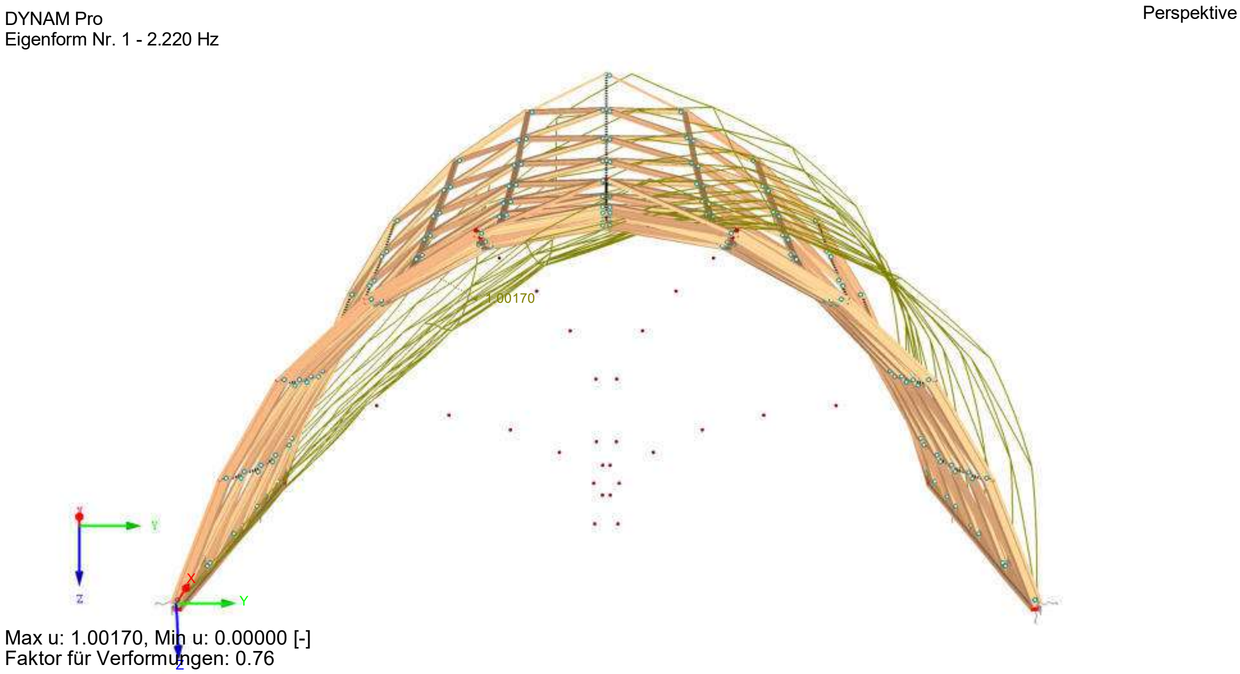
4.4.1.5 Wind in Y-direction



4.4.2 Oscillation



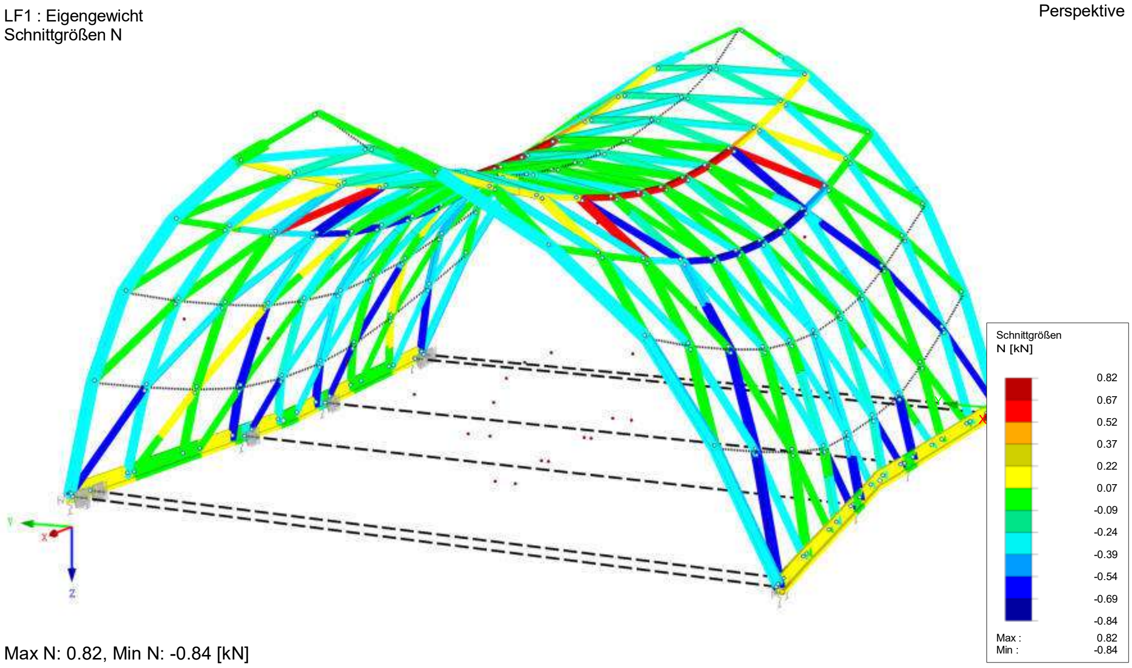
Natural frequency: 2.20 Hz

4.5 Internal Forces | Compilation

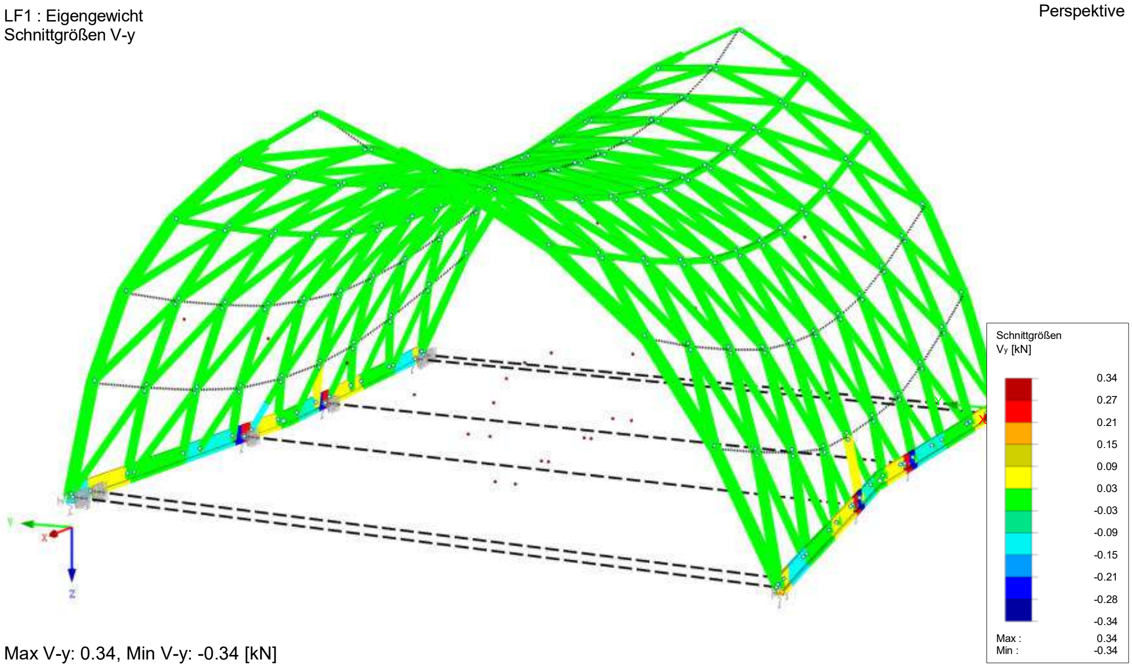
Furthermore, only representative load cases are shown. All other load cases and load combinations are included in the result combination.

4.5.1 Dead load

4.5.1.1 Normal forces



4.5.1.2 Shear forces in y-direction



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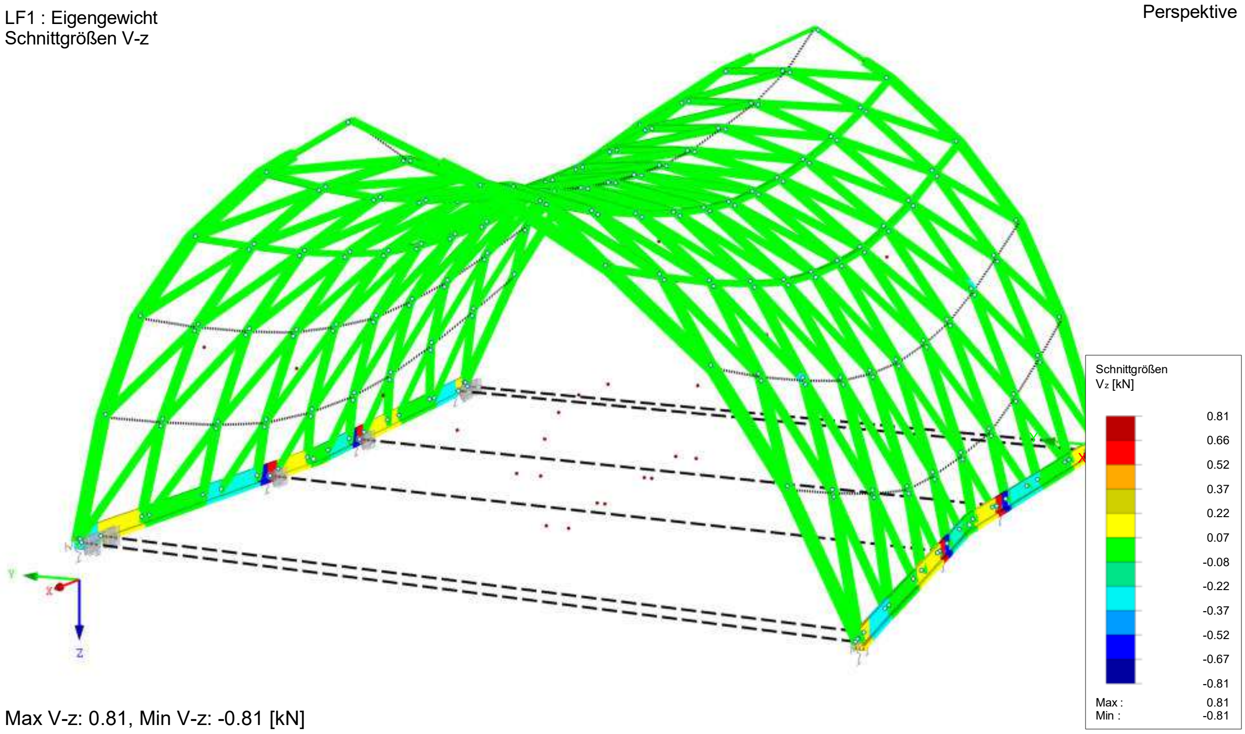
4.5.1.3 Shear forces in the z-direction

LF1 : Eigengewicht
Schnittgrößen V-z

Perspektive

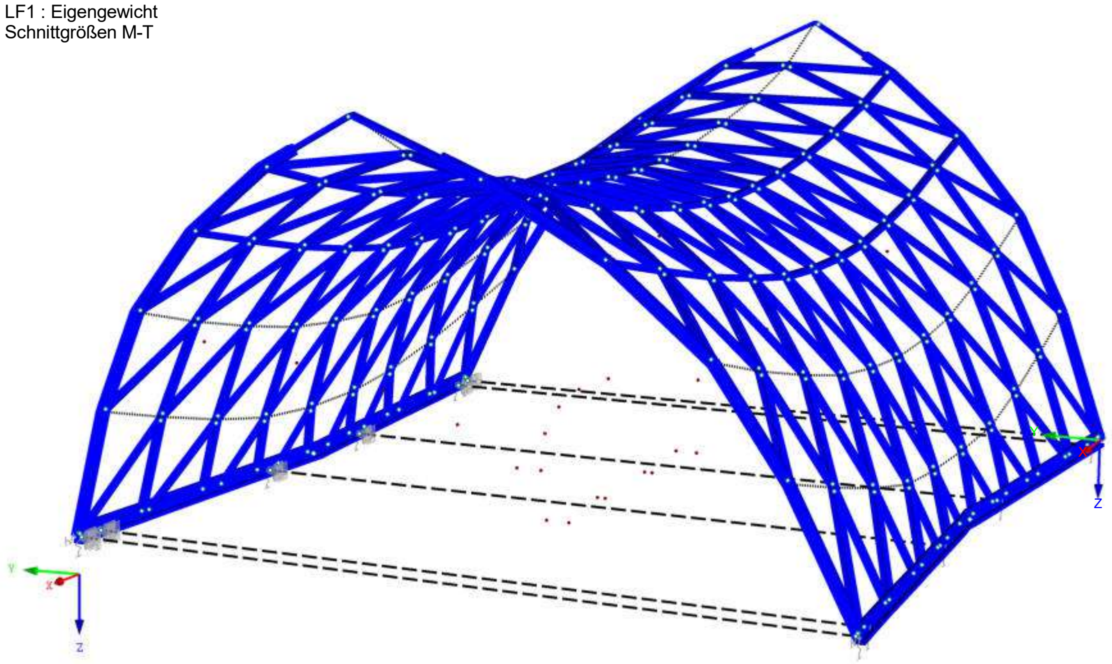


Max V-z: 0.81, Min V-z: -0.81 [kN]

4.5.1.4 Torsional moments

LF1 : Eigengewicht
Schnittgrößen M-T

Perspektive



Max M-T: 0.00, Min M-T: 0.00 [kNm]

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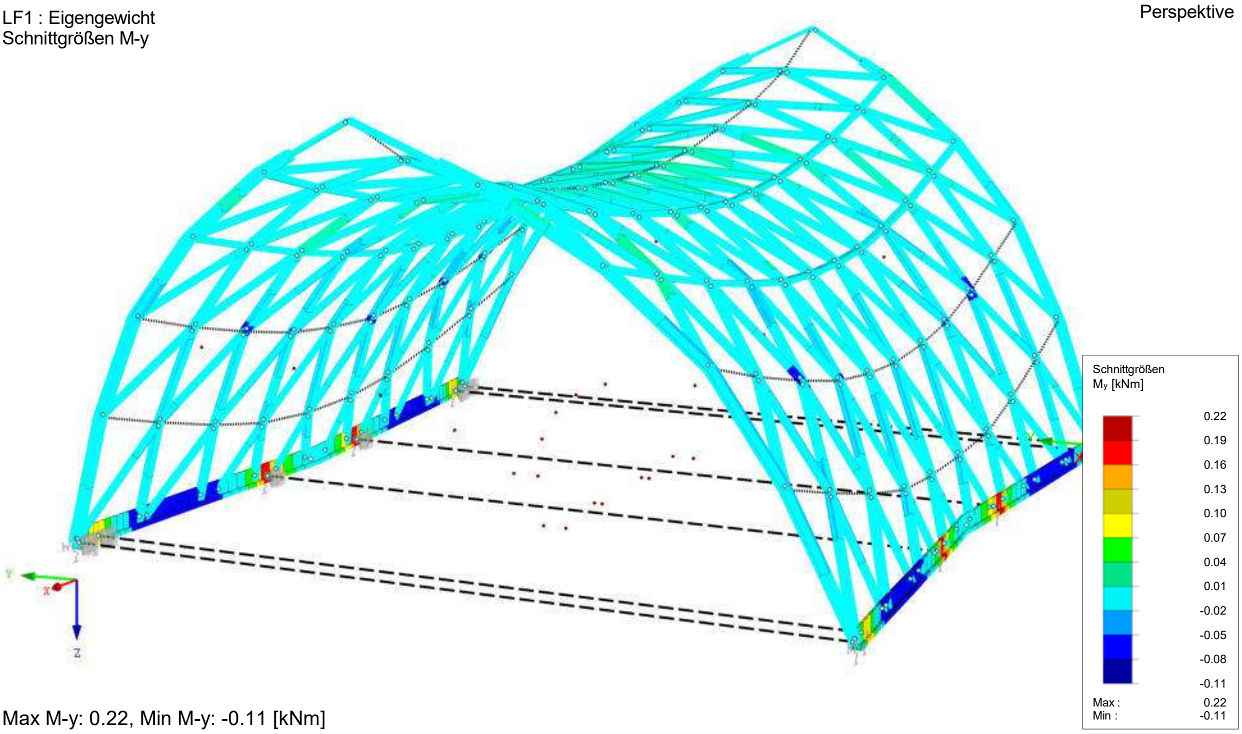
KP
ZT

4.5.1.5 Bending moments around the y-axis

LF1 : Eigengewicht
Schnittgrößen M-y

Perspektive

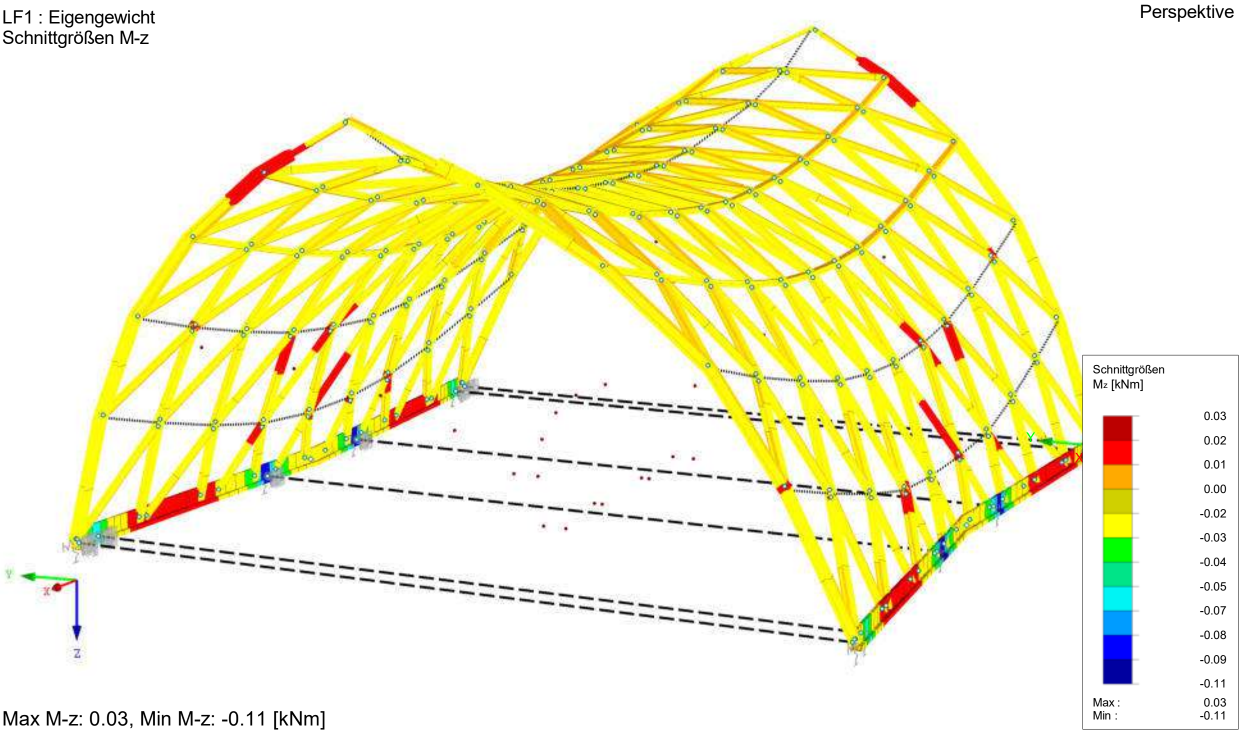


Max M-y: 0.22, Min M-y: -0.11 [kNm]

4.5.1.6 Bending moments around the z-axis

LF1 : Eigengewicht
Schnittgrößen M-z

Perspektive



Max M-z: 0.03, Min M-z: -0.11 [kNm]

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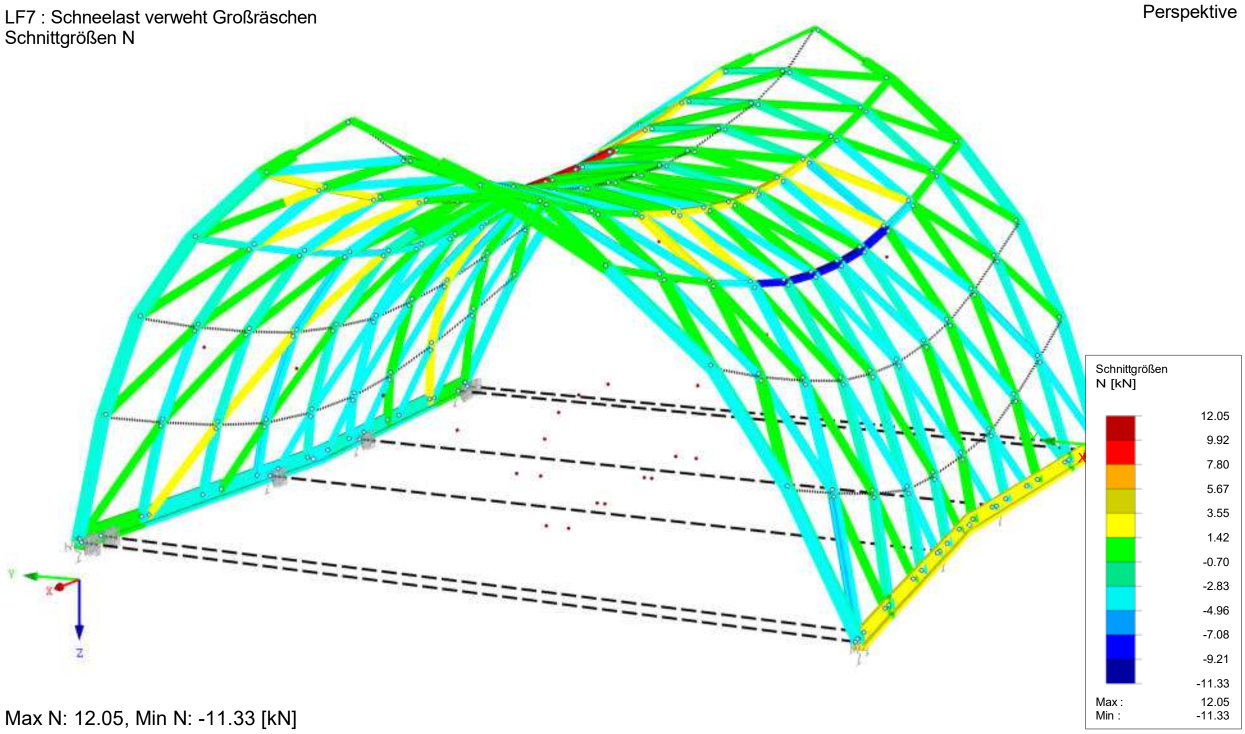
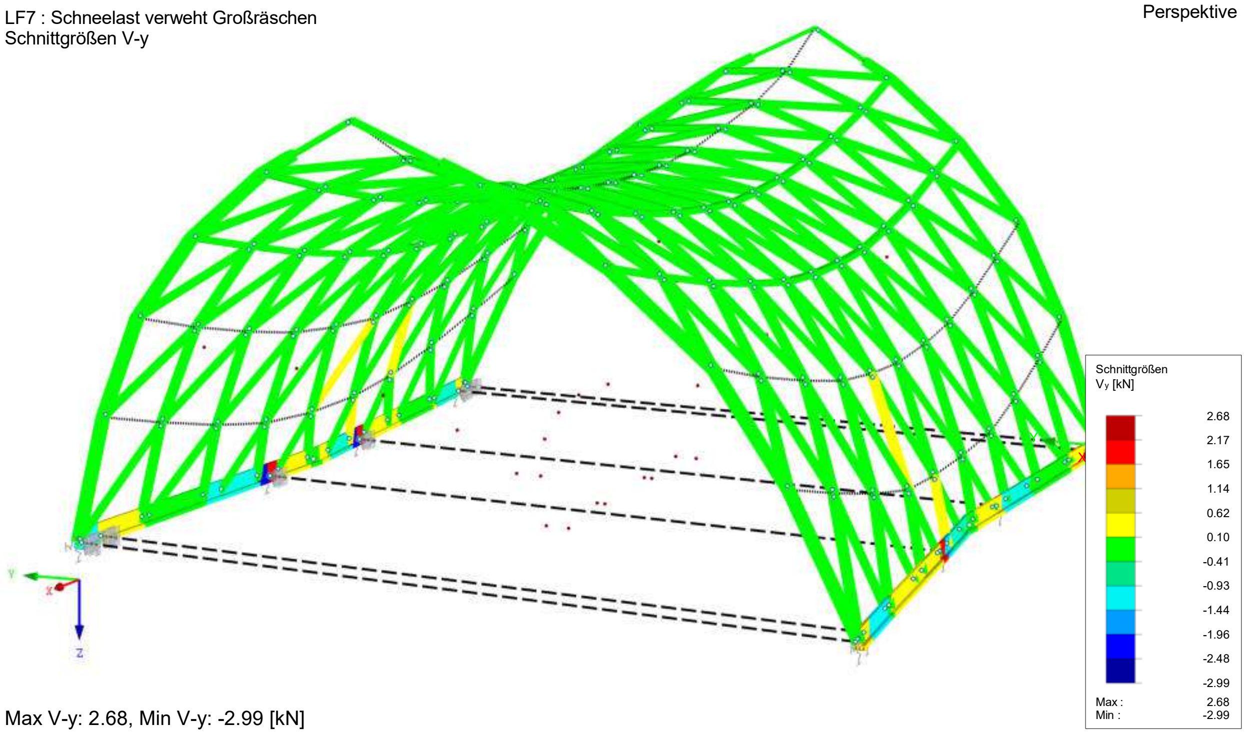
4.5.2 Load Case 7: Snow Blown

4.5.2.1 Normal force



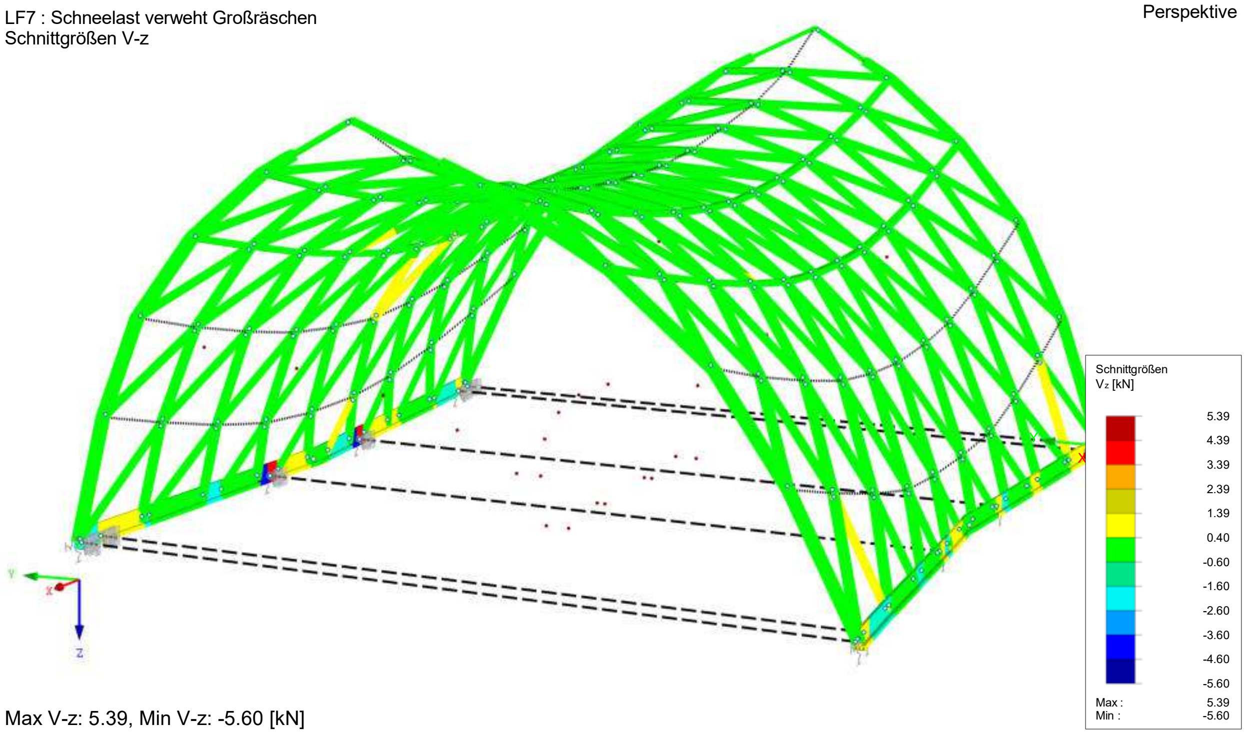
Max N: 12.05, Min N: -11.33 [kN]

4.5.2.2 Shear forces in y-direction



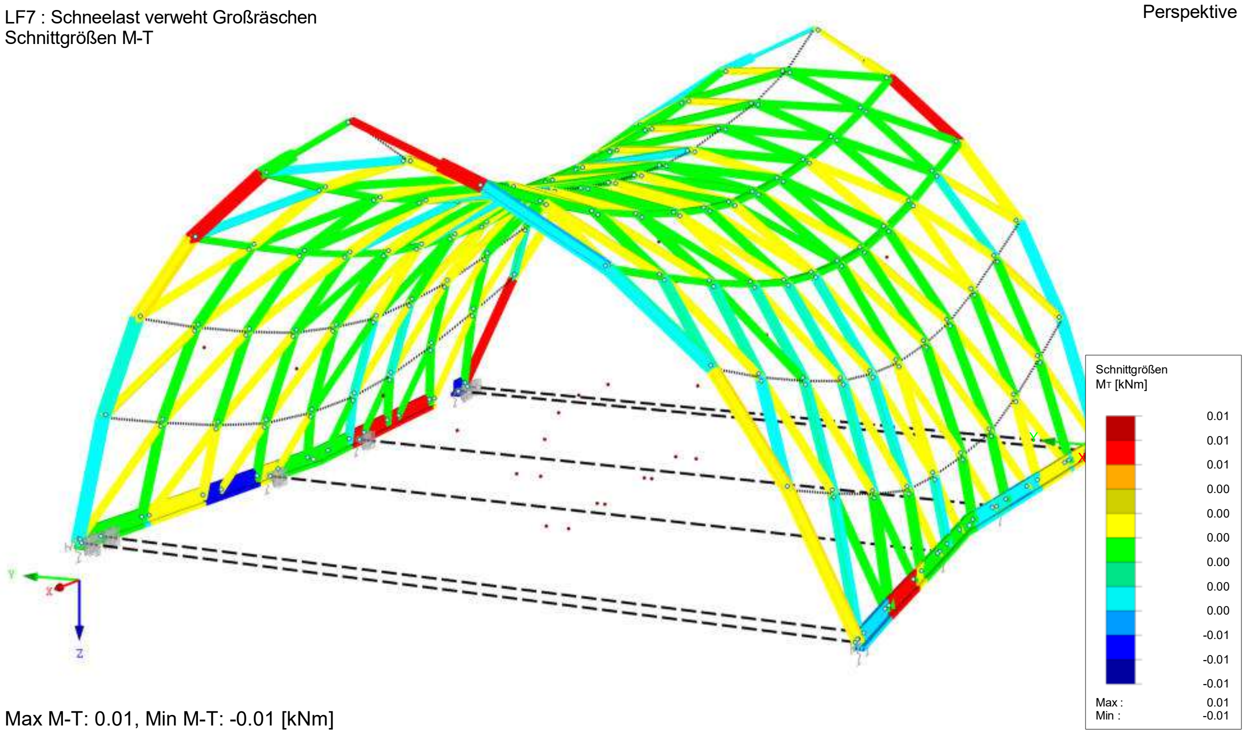
Max V-y: 2.68, Min V-y: -2.99 [kN]

4.5.2.3 Shear forces in z-direction



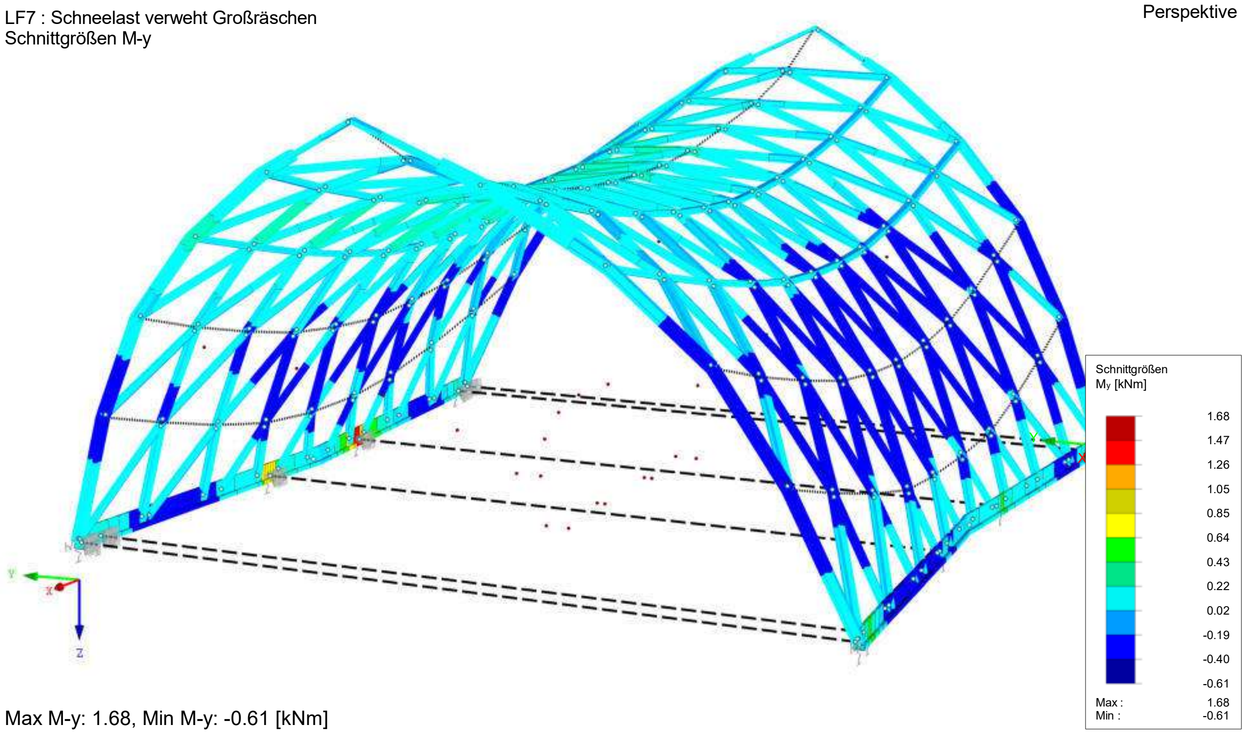
Max V-z: 5.39, Min V-z: -5.60 [kN]

4.5.2.4 Torsional moments



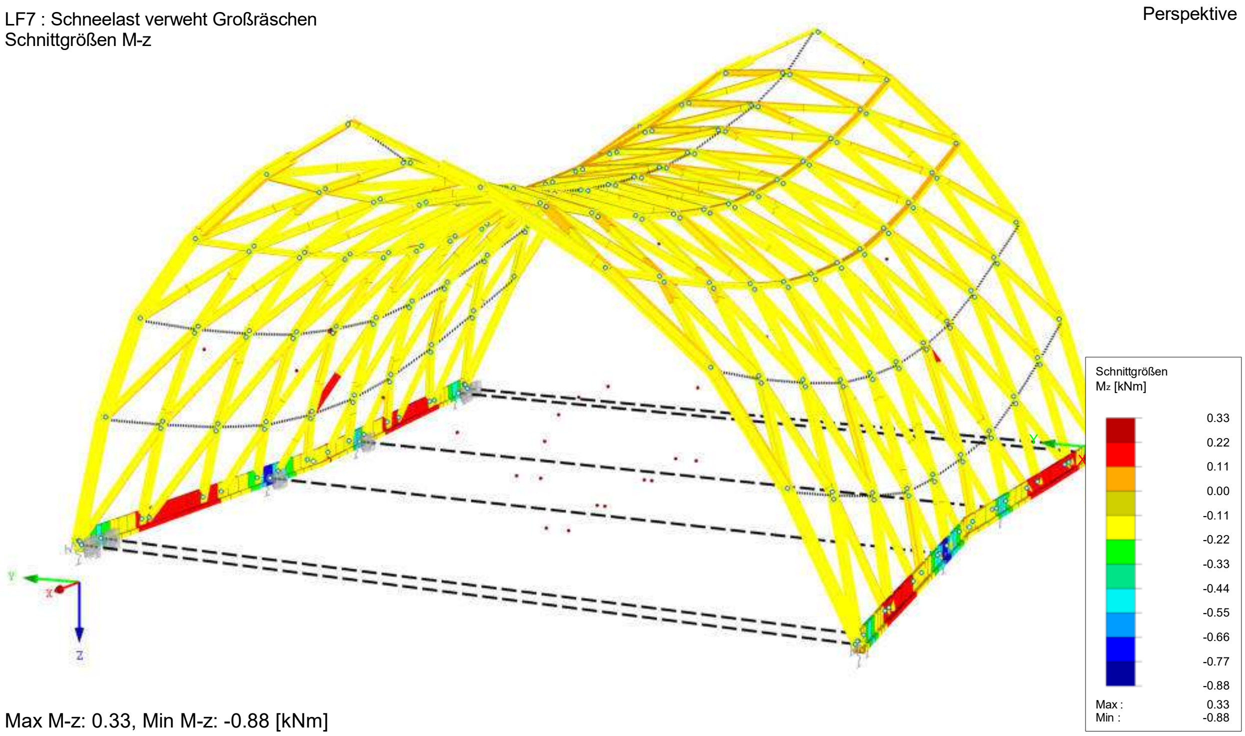
Max M-T: 0.01, Min M-T: -0.01 [kNm]

4.5.2.5 Bending moments around the y-axis



Max M-y: 1.68, Min M-y: -0.61 [kNm]

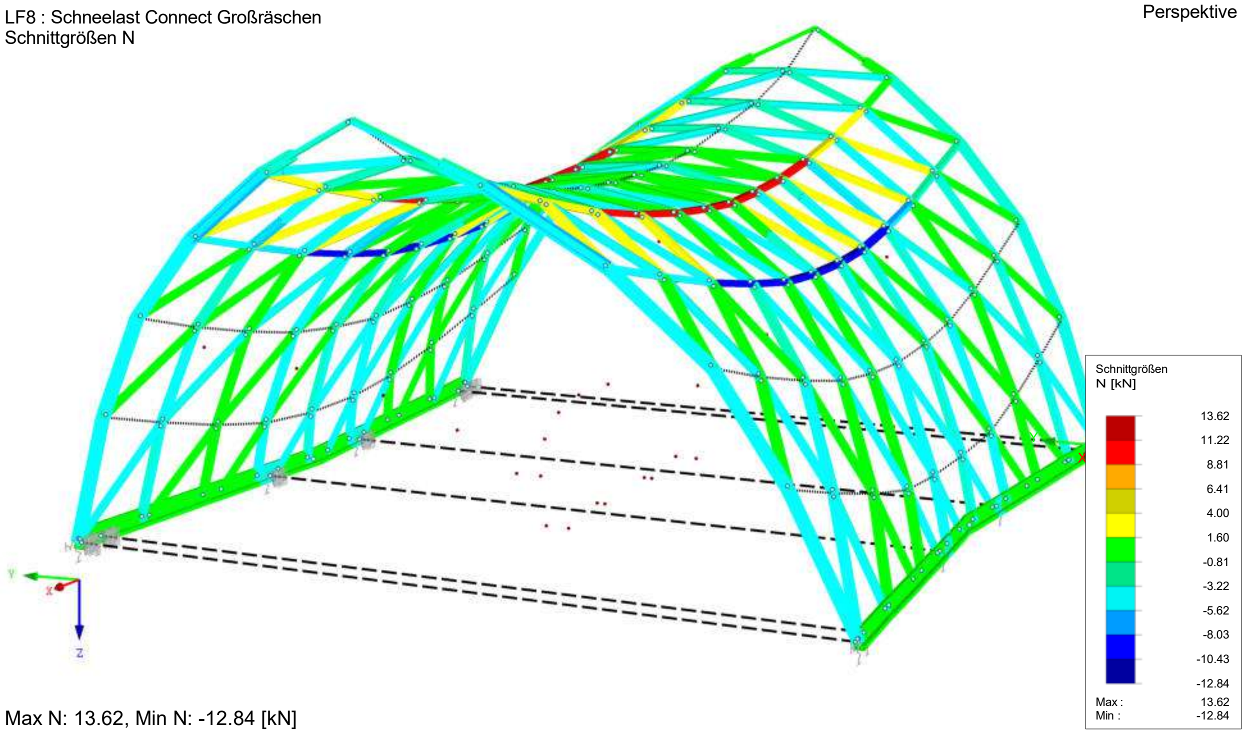
4.5.2.6 Bending moments around the z-axis



Max M-z: 0.33, Min M-z: -0.88 [kNm]

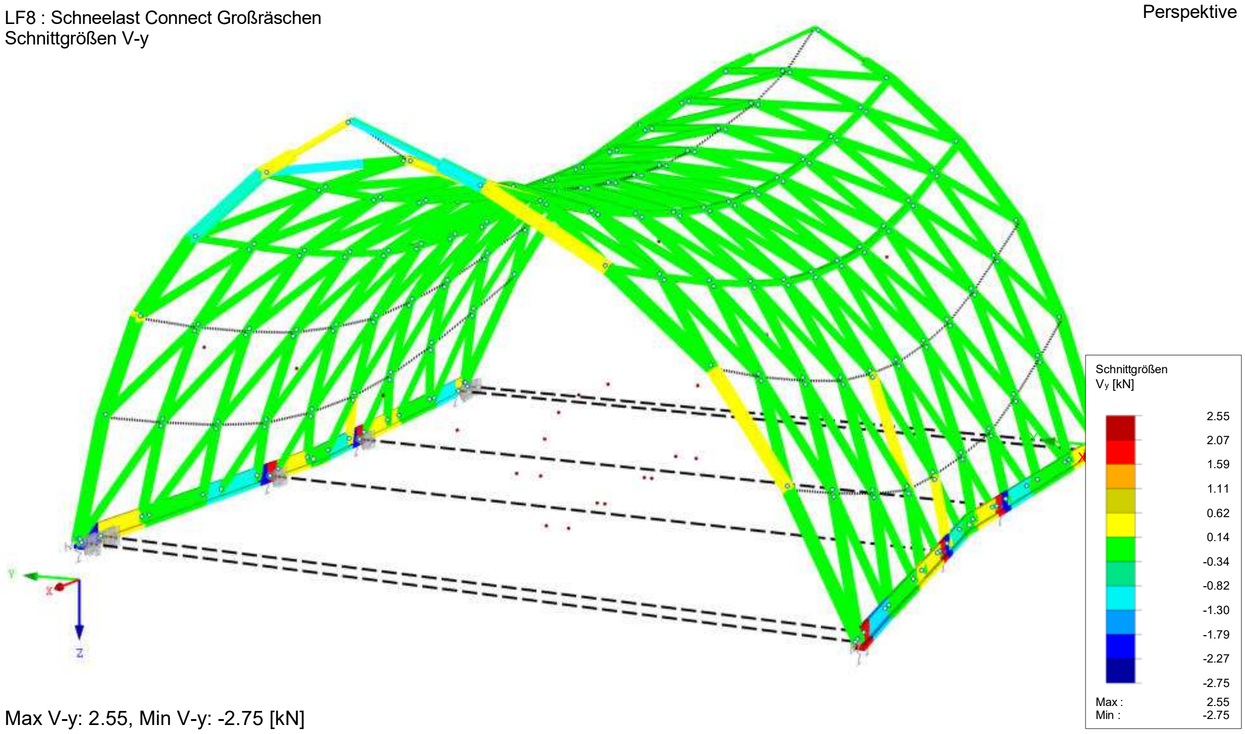
4.5.3 Load case 8: Snow Connect variant

4.5.3.1 Normal forces



Max N: 13.62, Min N: -12.84 [kN]

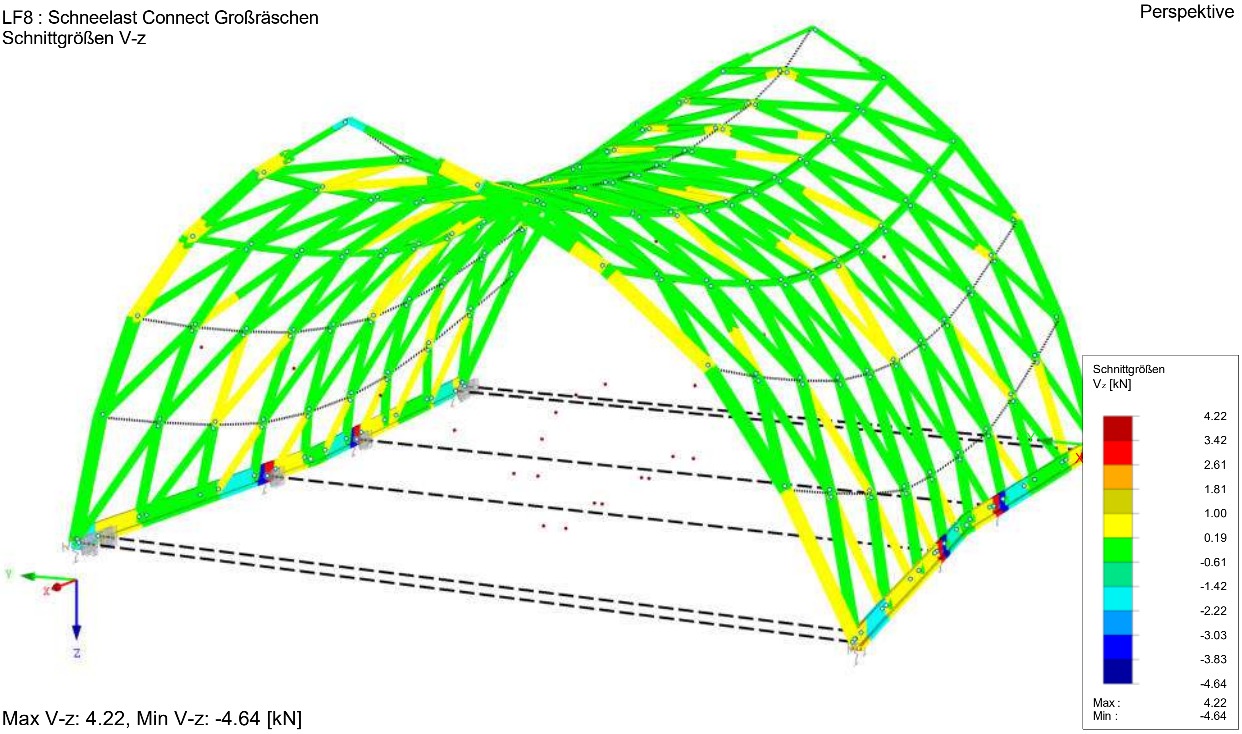
4.5.3.2 Shear forces in y-direction



Max V-y: 2.55, Min V-y: -2.75 [kN]

4.5.3.3 Shear forces in z-direction

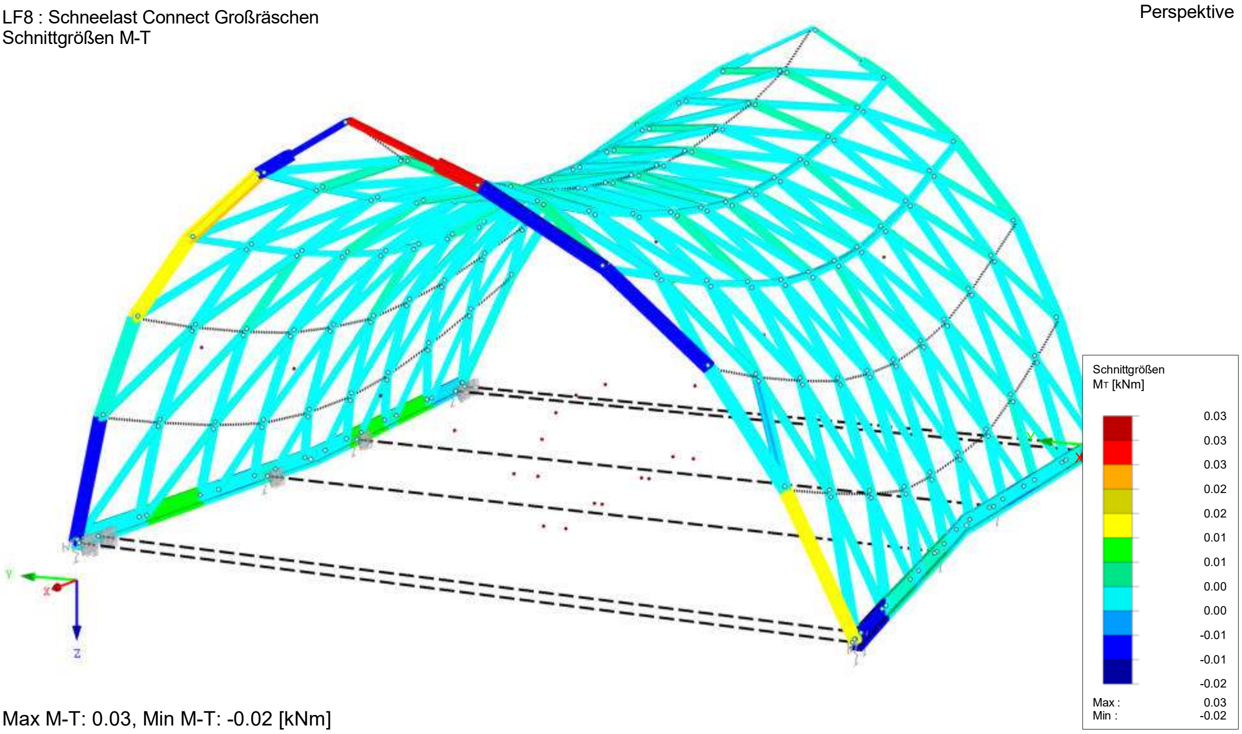
LF8 : Schneelast Connect Großräschen
Schnittgrößen V-z



Max V-z: 4.22, Min V-z: -4.64 [kN]

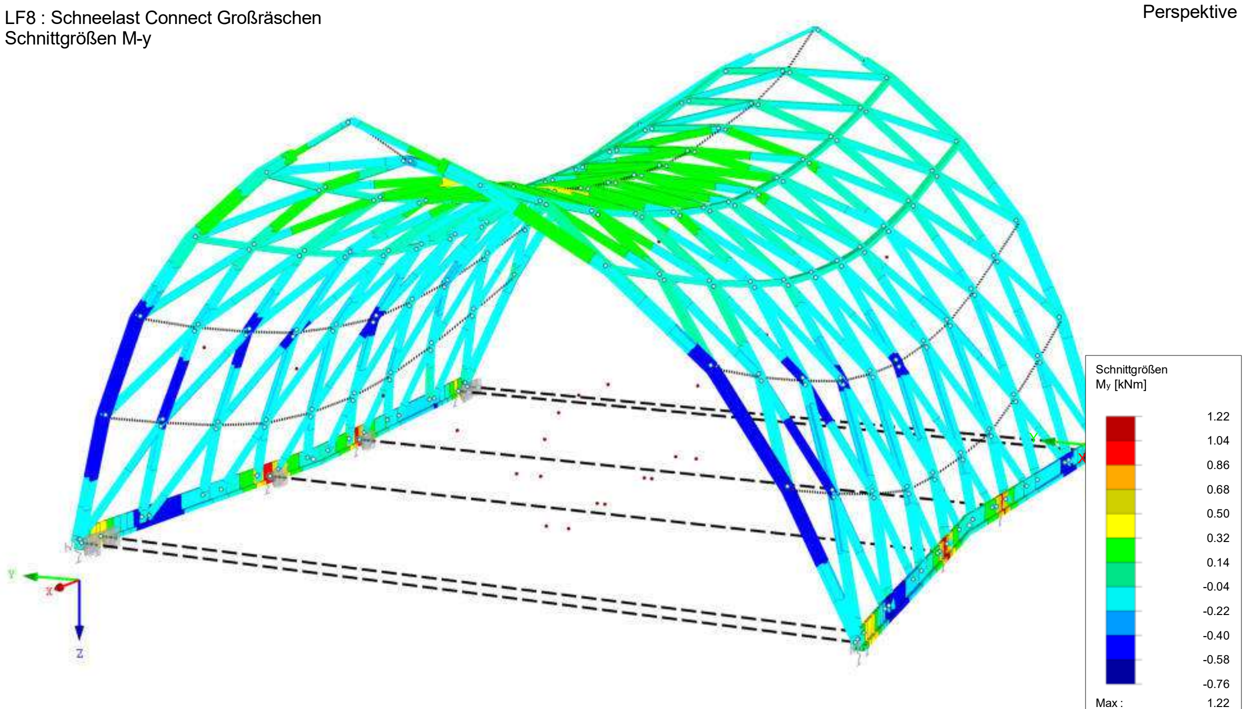
4.5.3.4 Torsional moments

LF8 : Schneelast Connect Großräschen
Schnittgrößen M-T



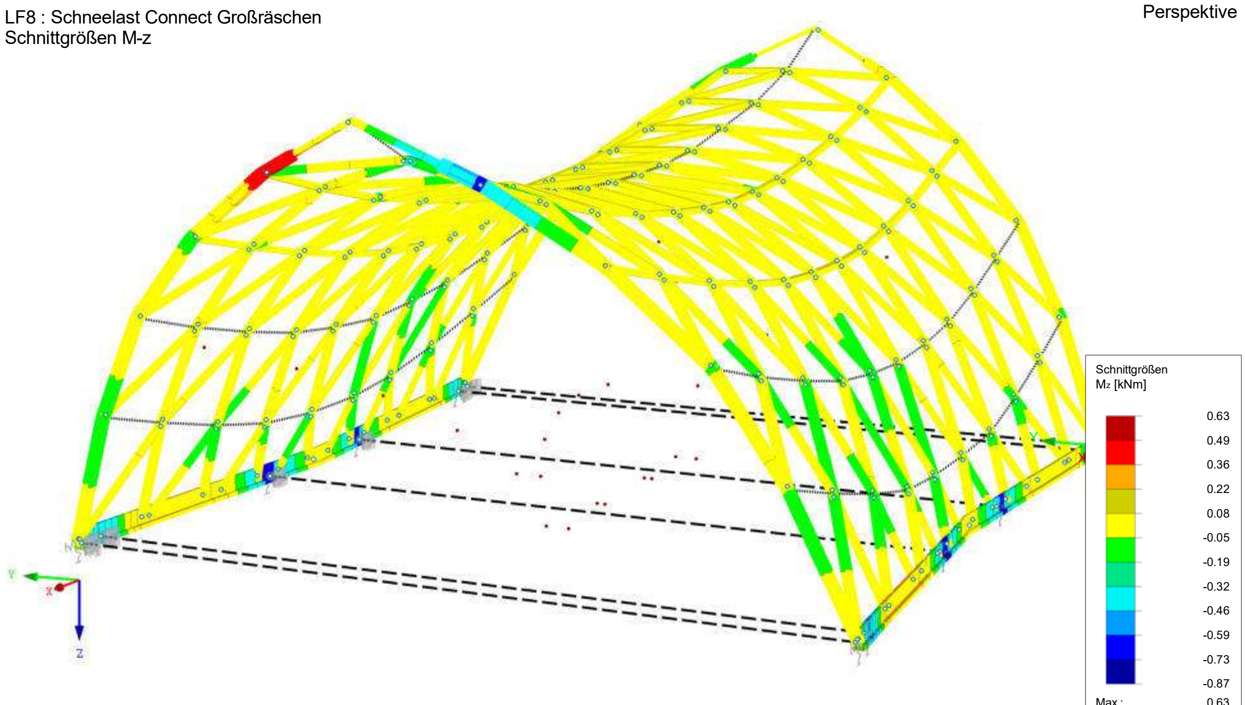
Max M-T: 0.03, Min M-T: -0.02 [kNm]

4.5.3.5 Bending moments around the y-axis



Max M-y: 1.22, Min M-y: -0.76 [kNm]

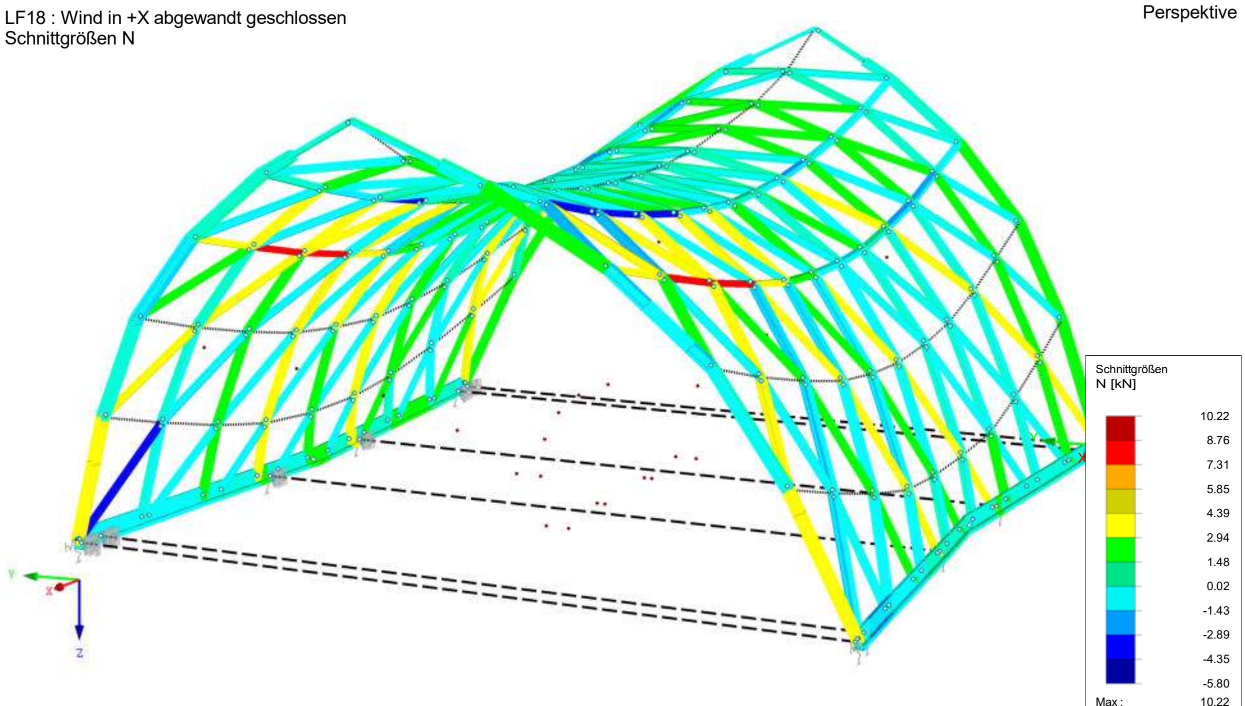
4.5.3.6 Bending moments around the z-axis



Max M-z: 0.63, Min M-z: -0.87 [kNm]

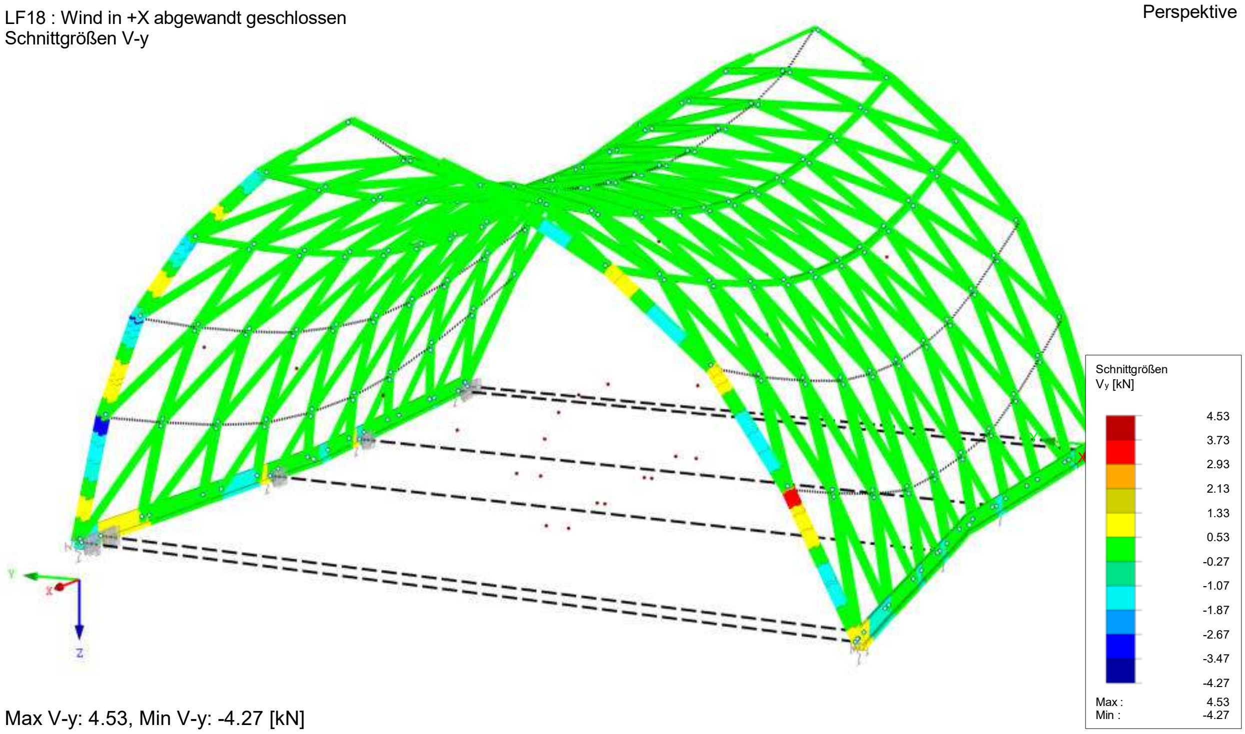
4.5.4 Load case 18: Wind facing away in +X direction closed

4.5.4.1 Normal force



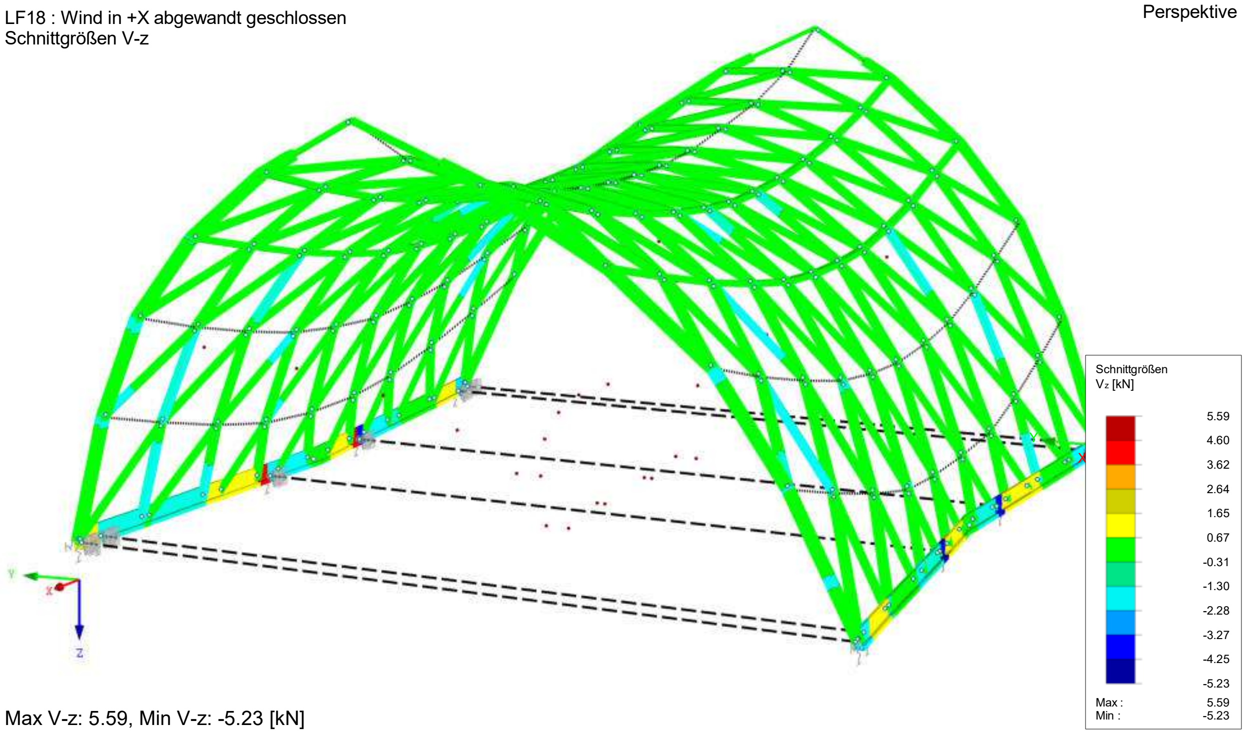
Max N: 10.22, Min N: -5.80 [kN]

4.5.4.2 Shear forces in y-direction

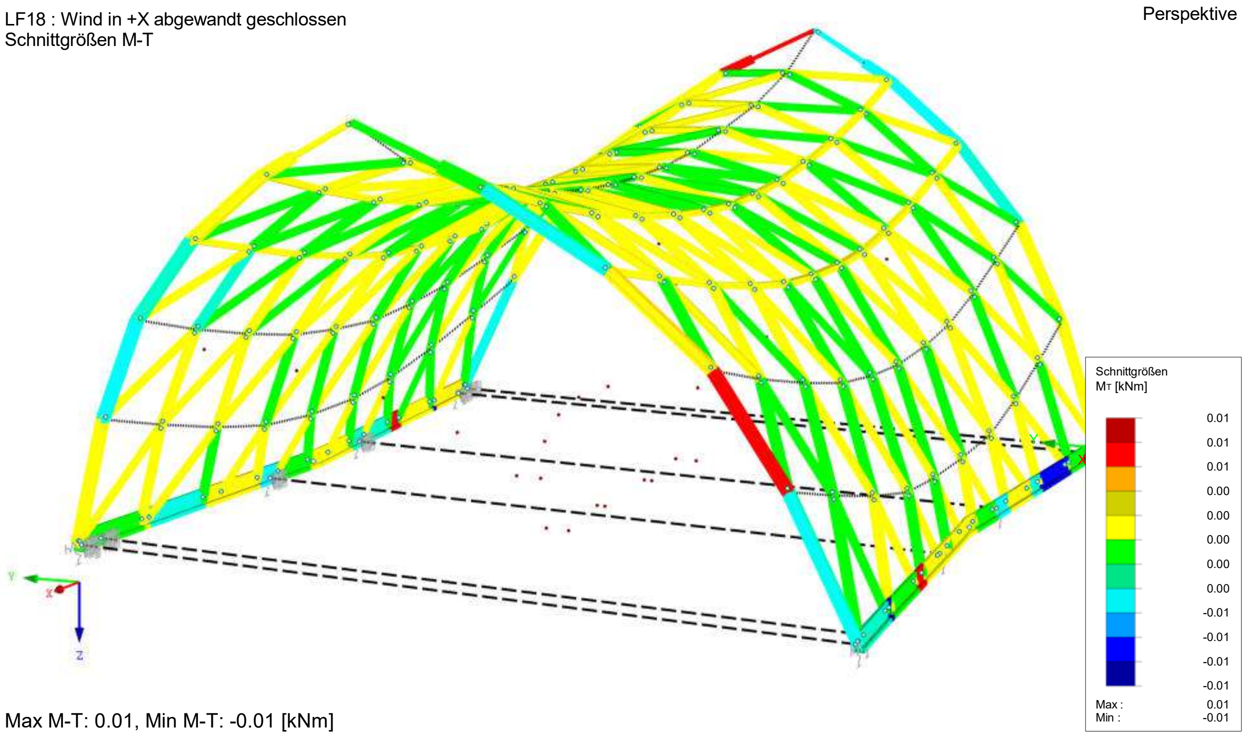


Max V-y: 4.53, Min V-y: -4.27 [kN]

4.5.4.3 Shear forces in z-direction



4.5.4.4 Torsional moments



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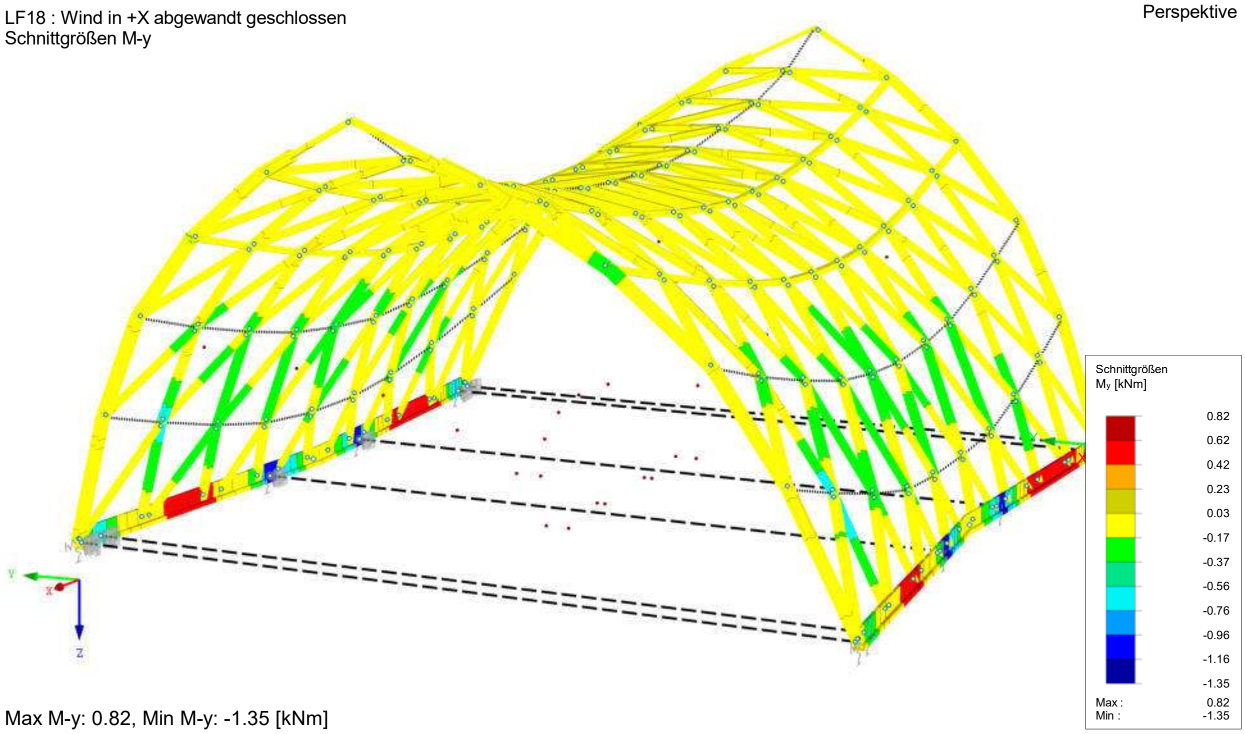
4.5.4.5 Bending moments around the y-axis

LF18 : Wind in +X abgewandt geschlossen
Schnittgrößen M-y

Perspektive

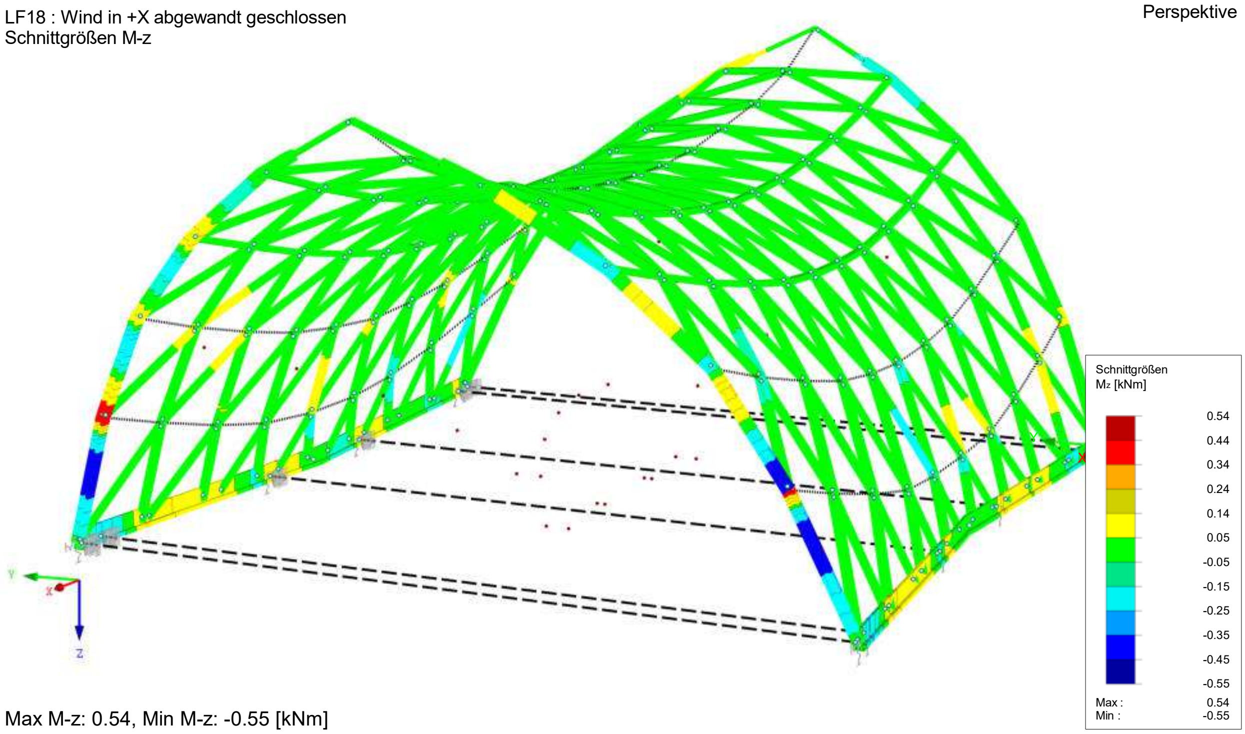


Max M-y: 0.82, Min M-y: -1.35 [kNm]

4.5.4.6 Bending moments around the z-axis

LF18 : Wind in +X abgewandt geschlossen
Schnittgrößen M-z

Perspektive



Max M-z: 0.54, Min M-z: -0.55 [kNm]

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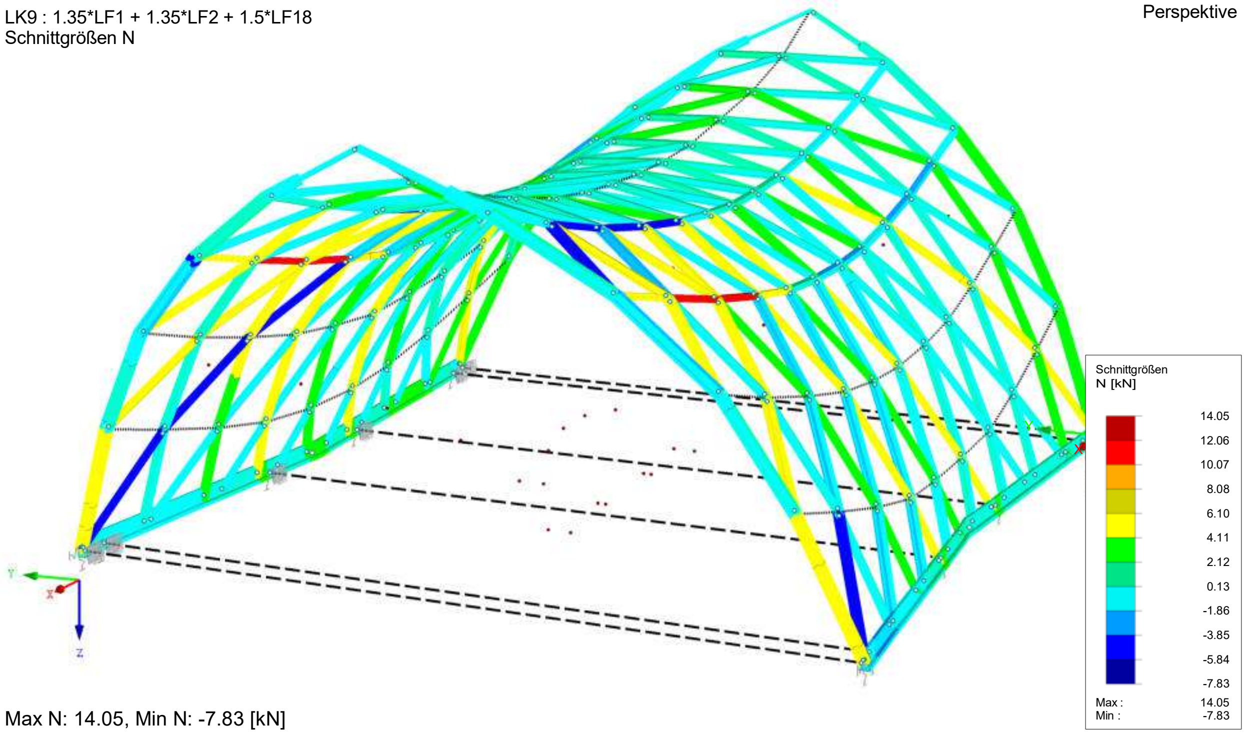
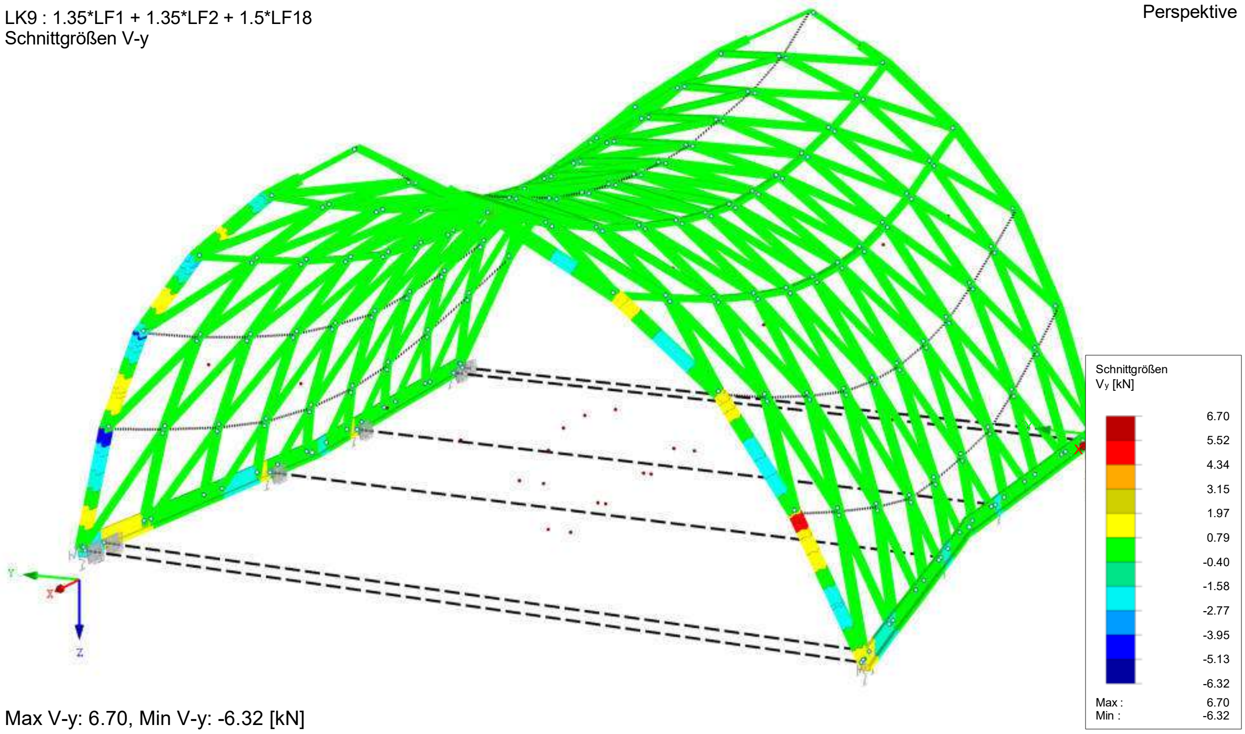
4.5.1 Load combination 9 ULS: (1.35*EG) + (1.50*wind in X + averted closed)

4.5.1.1 Normal forces



4.5.1.2 Shear forces in y-direction



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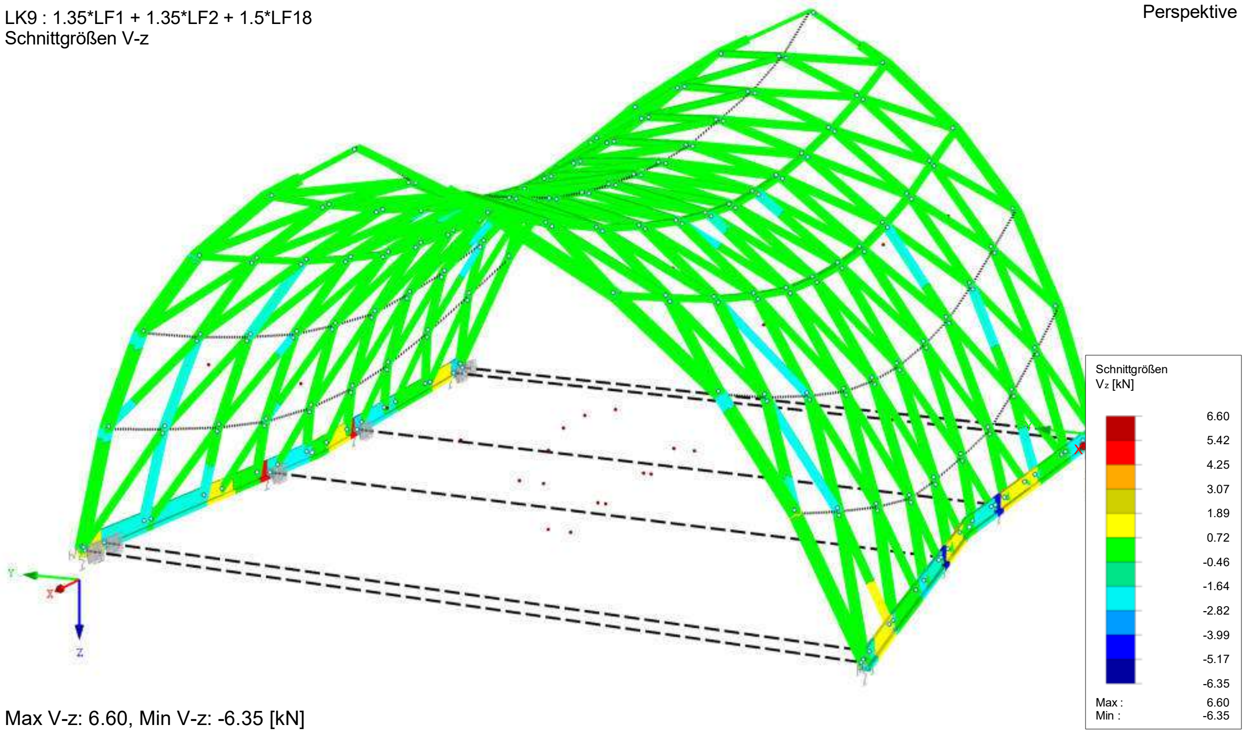
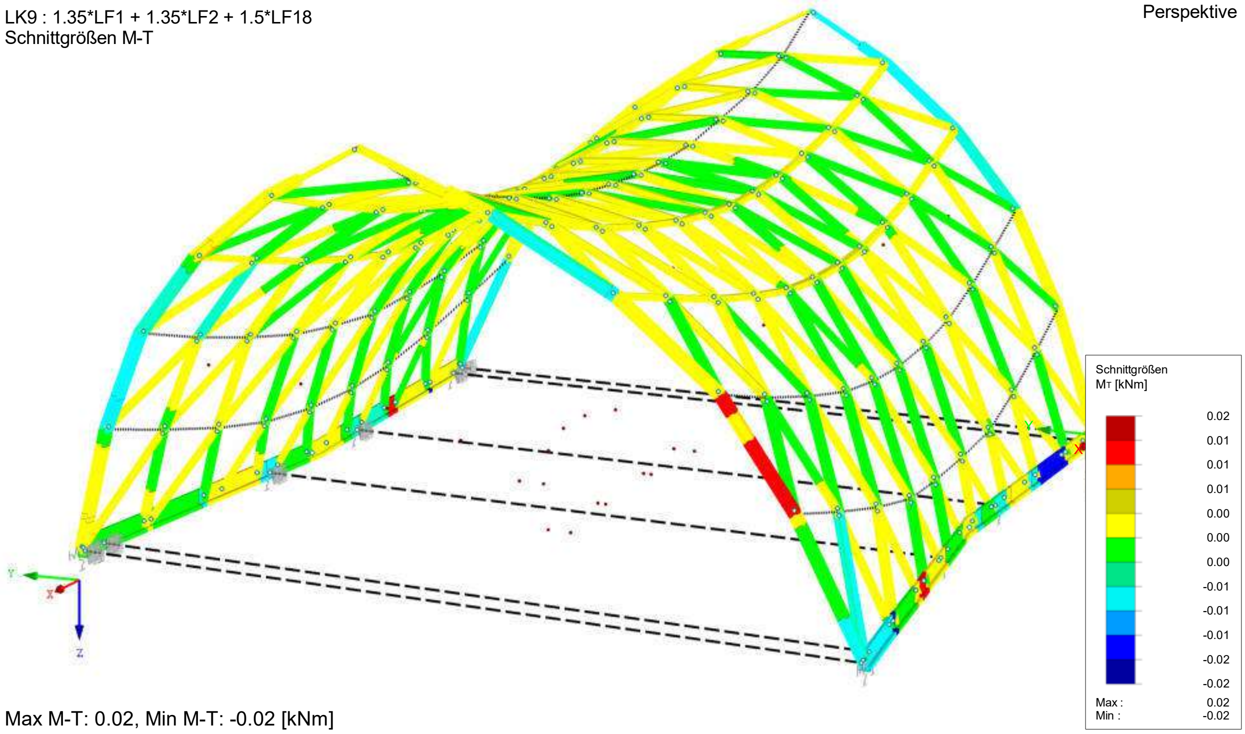
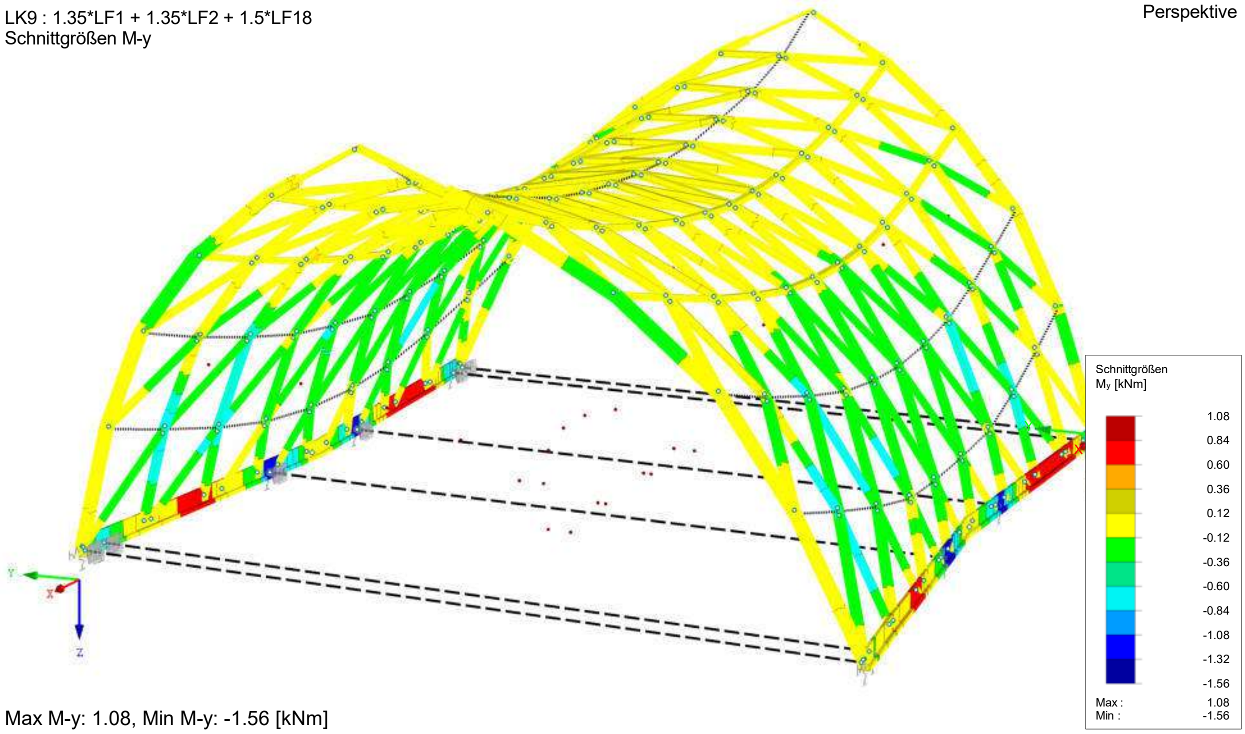
4.5.1.3 Shear forces in z-direction



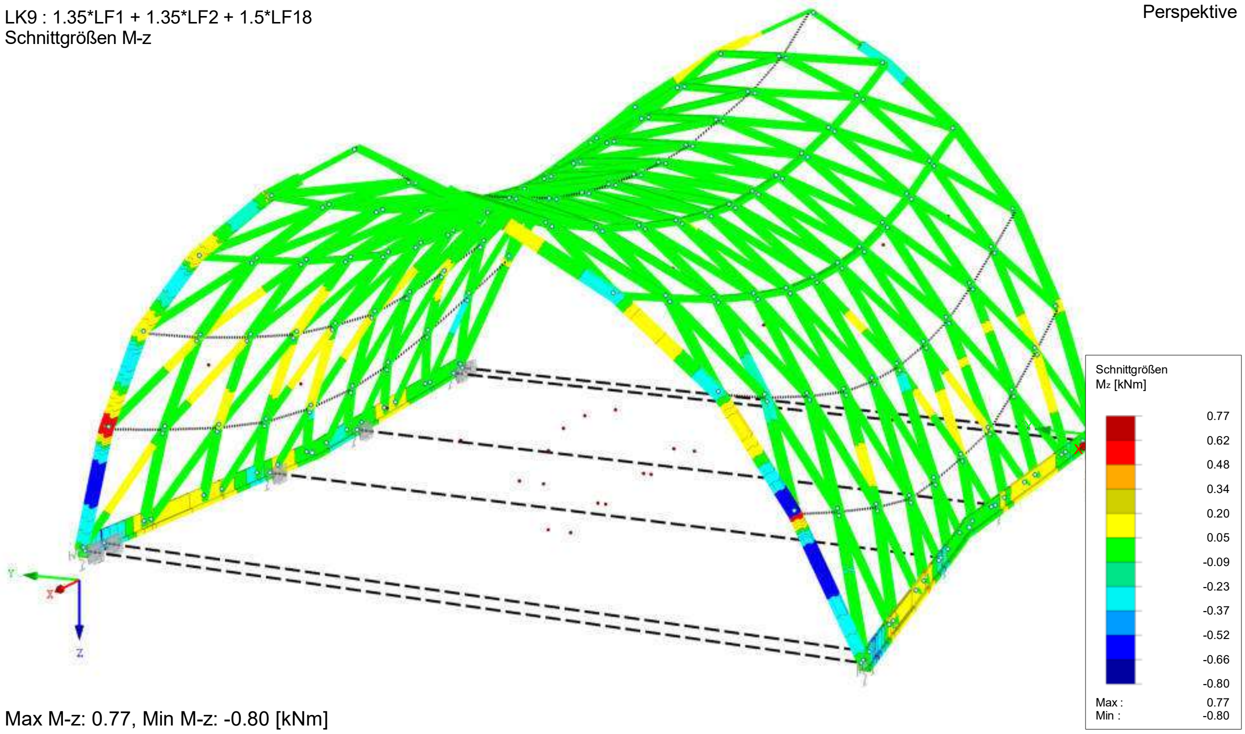
4.5.1.4 Torsional moments



4.5.1.5 Bending moments around the y-axis



4.5.1.6 Bending moments around the z-axis



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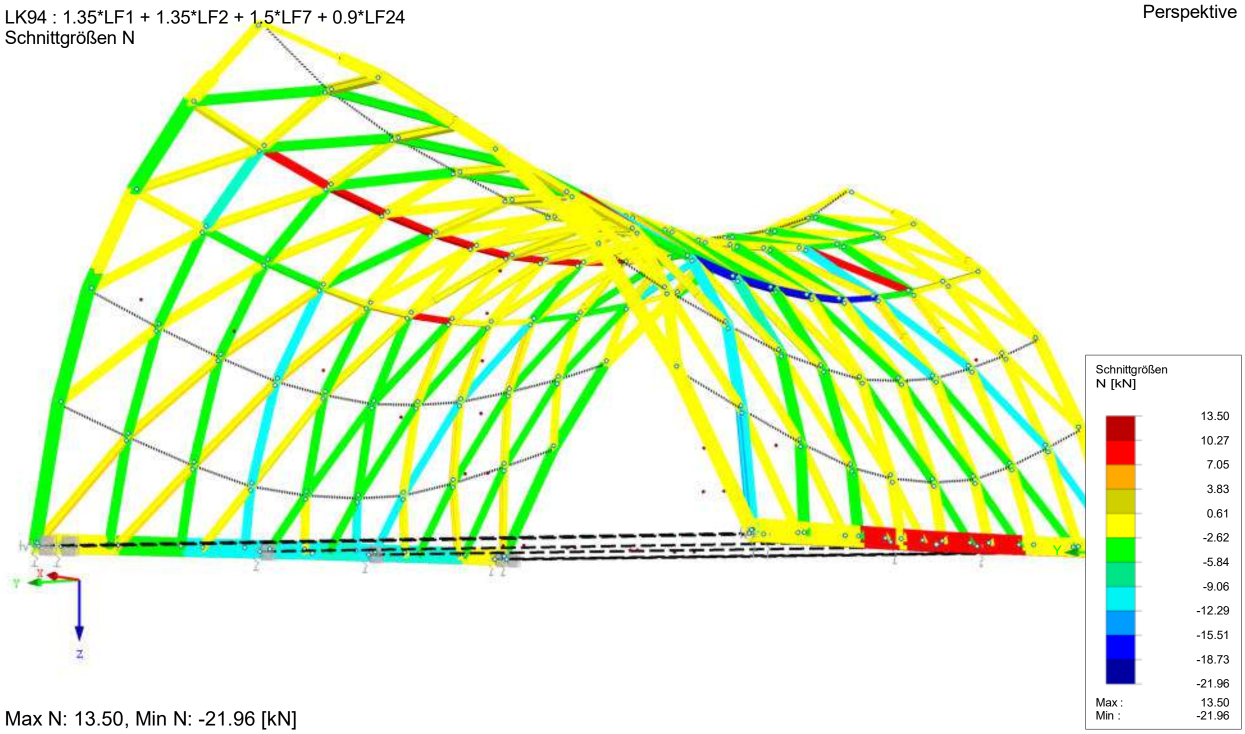
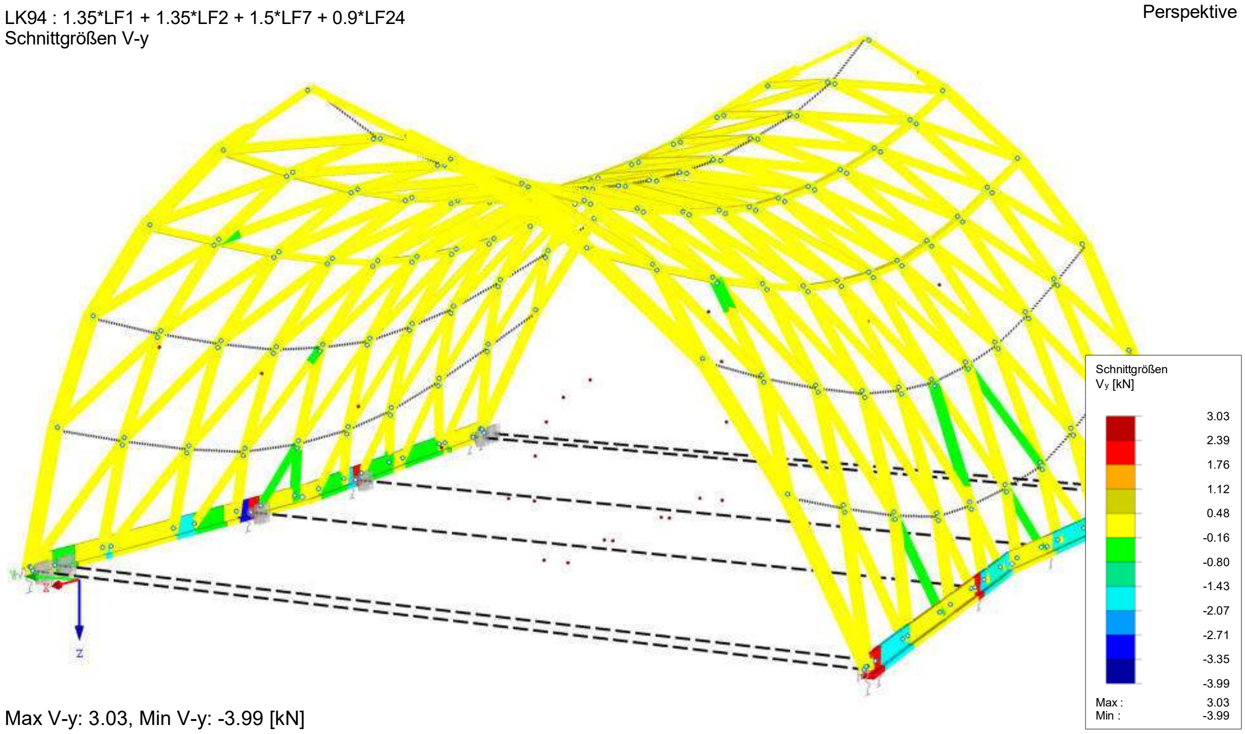
4.5.2 Load combination 94 ULS: (1.35*EG) + (0.90*wind in Y - cpi -) + (1.5* snow blown)

4.5.2.1 Normal forces



4.5.2.2 Shear forces in y-direction



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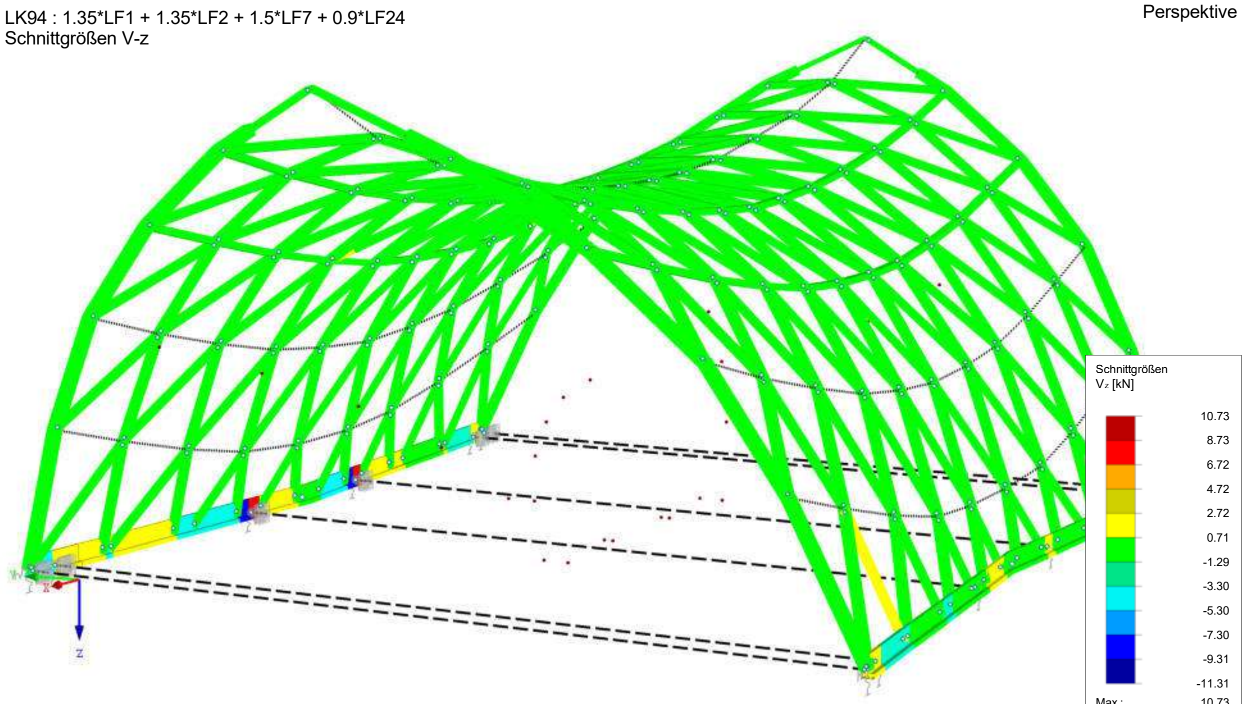
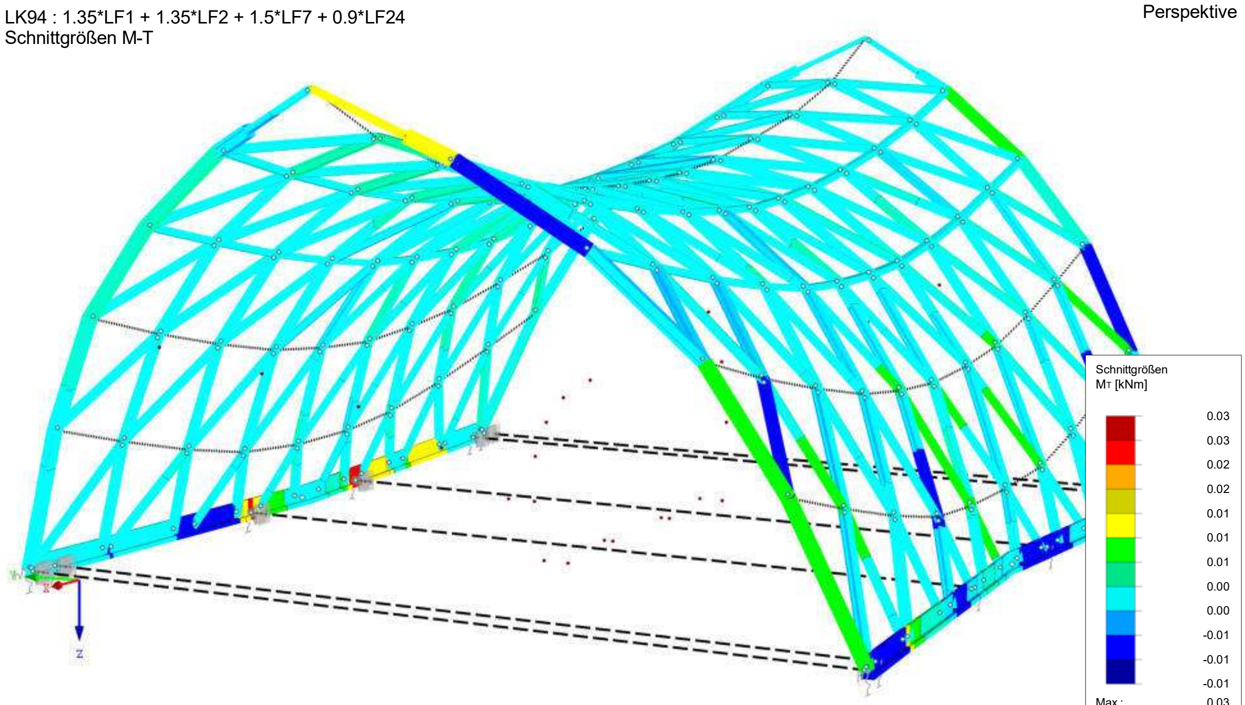
4.5.2.3 Shear forces in z-direction



Max V-z: 10.73, Min V-z: -11.31 [kN]

4.5.2.4 Torsional moments



Max M-T: 0.03, Min M-T: -0.01 [kNm]

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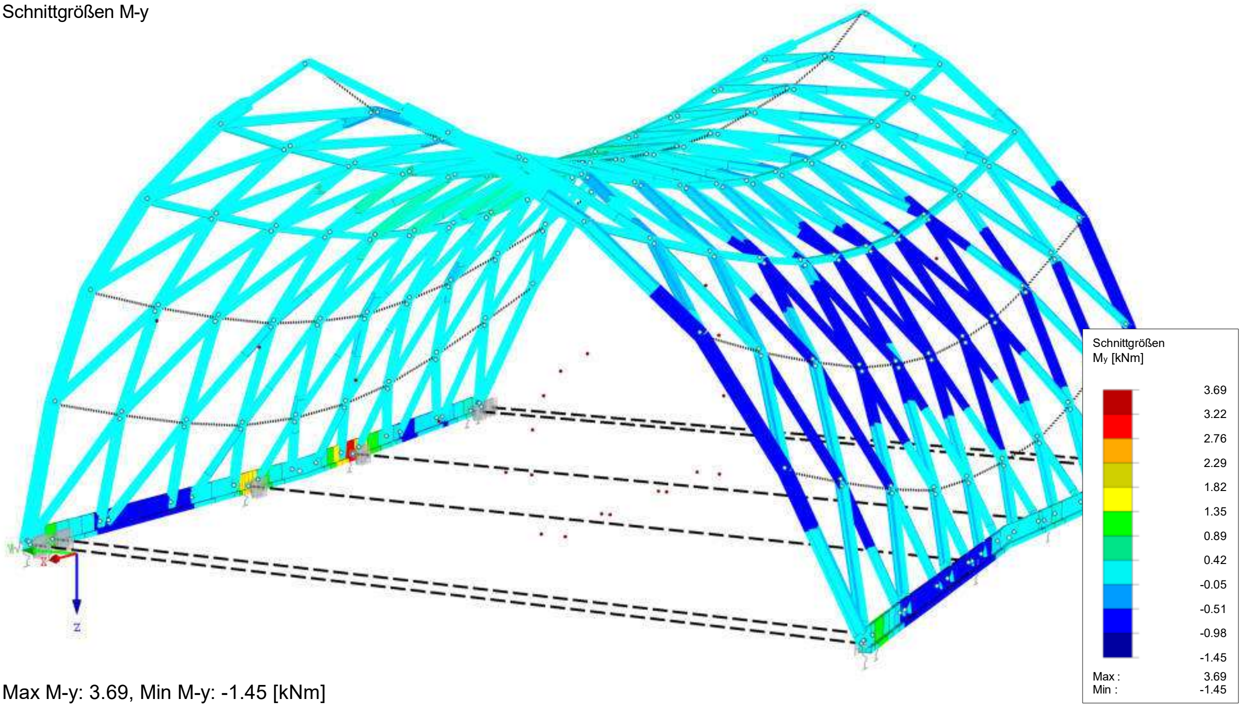
4.5.2.5 Bending moments around the y-axis

LK94 : 1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF24
Schnittgrößen M-y

Perspektive

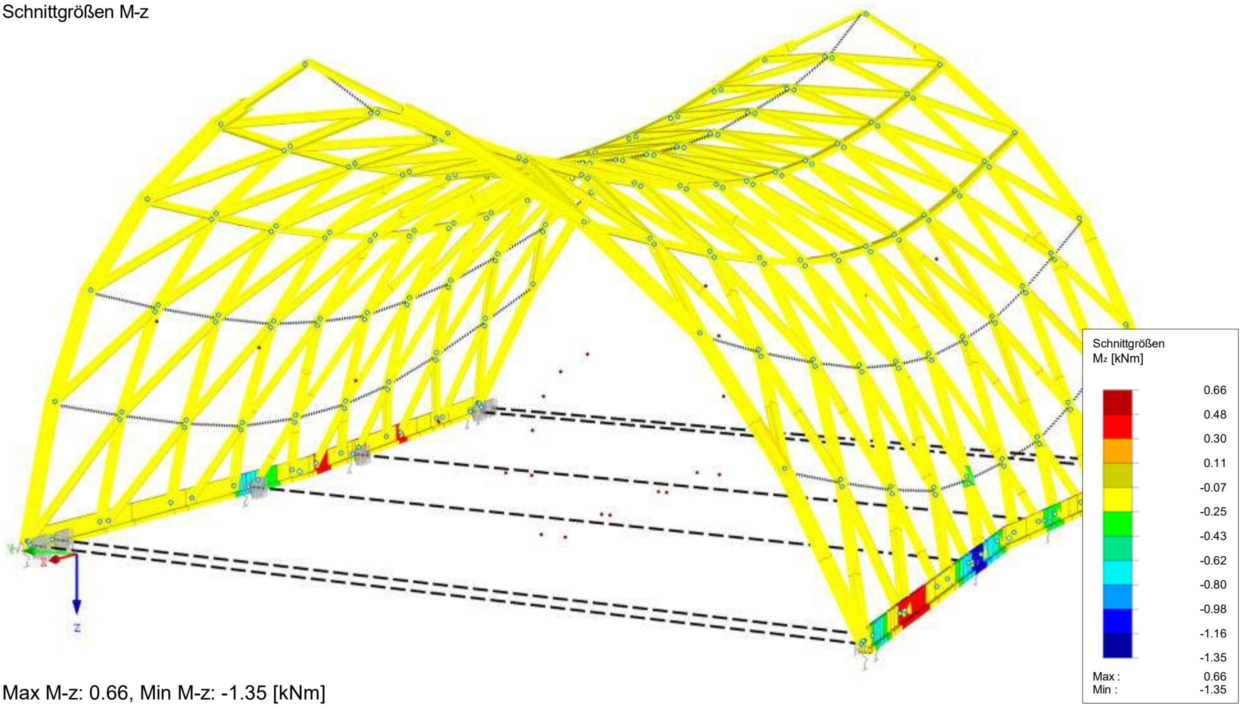


Max M-y: 3.69, Min M-y: -1.45 [kNm]

4.5.2.6 Bending moments around the z-axis

LK94 : 1.35*LF1 + 1.35*LF2 + 1.5*LF7 + 0.9*LF24
Schnittgrößen M-z

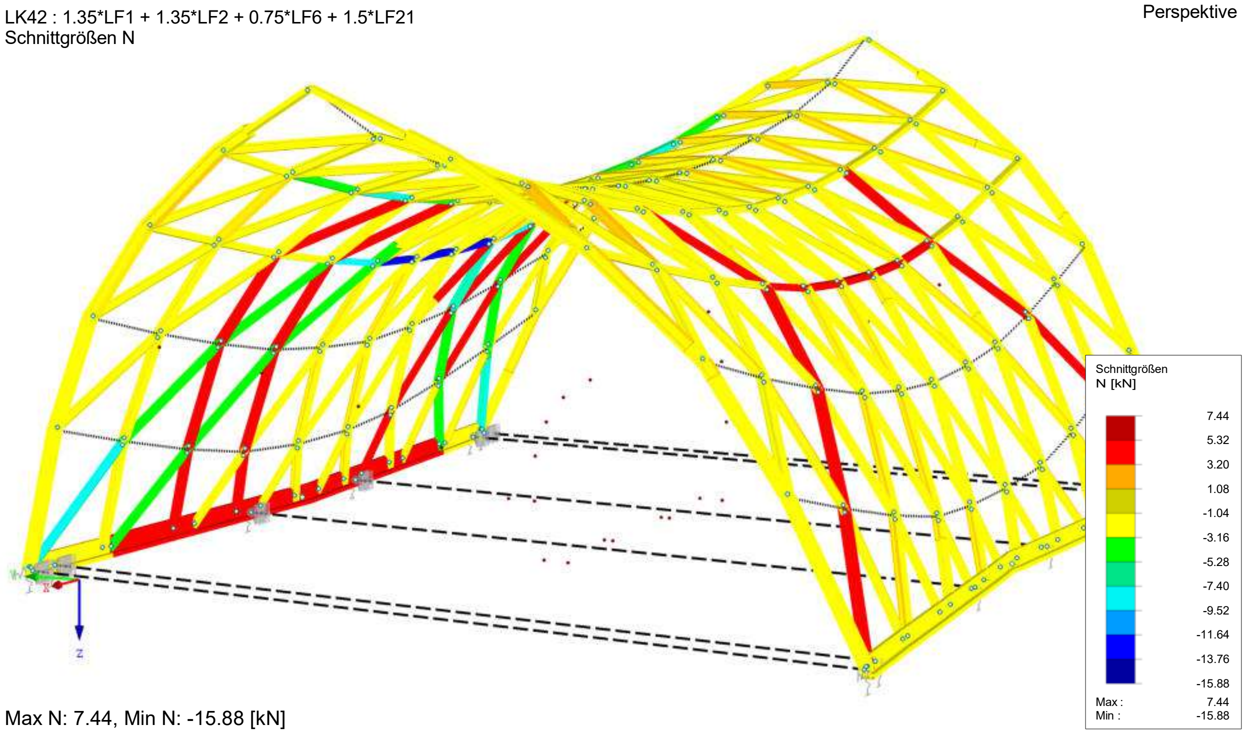
Perspektive



Max M-z: 0.66, Min M-z: -1.35 [kNm]

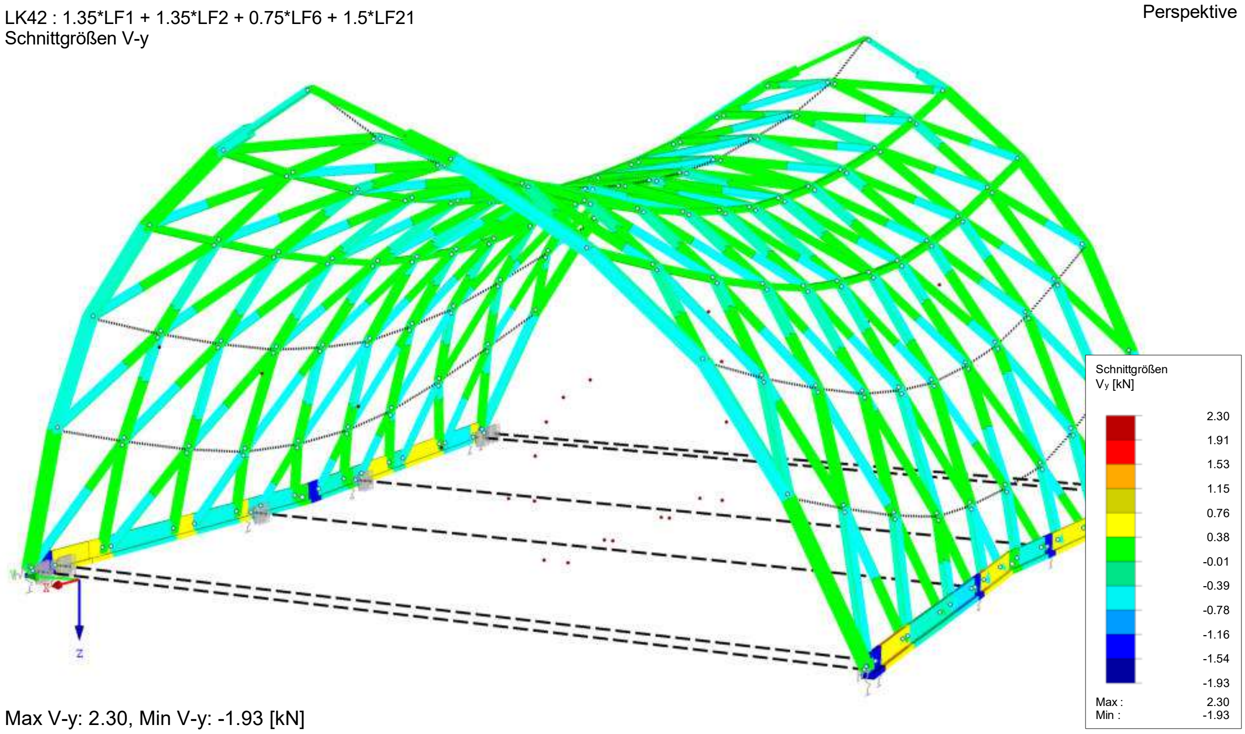
4.5.3 Load combination 42 ULS: (1.35*EG) + (1.50*wind in Y + cpi +) + (0.75* snow)

4.5.3.1 Normal forces



Max N: 7.44, Min N: -15.88 [kN]

4.5.3.2 Shear forces in y-direction

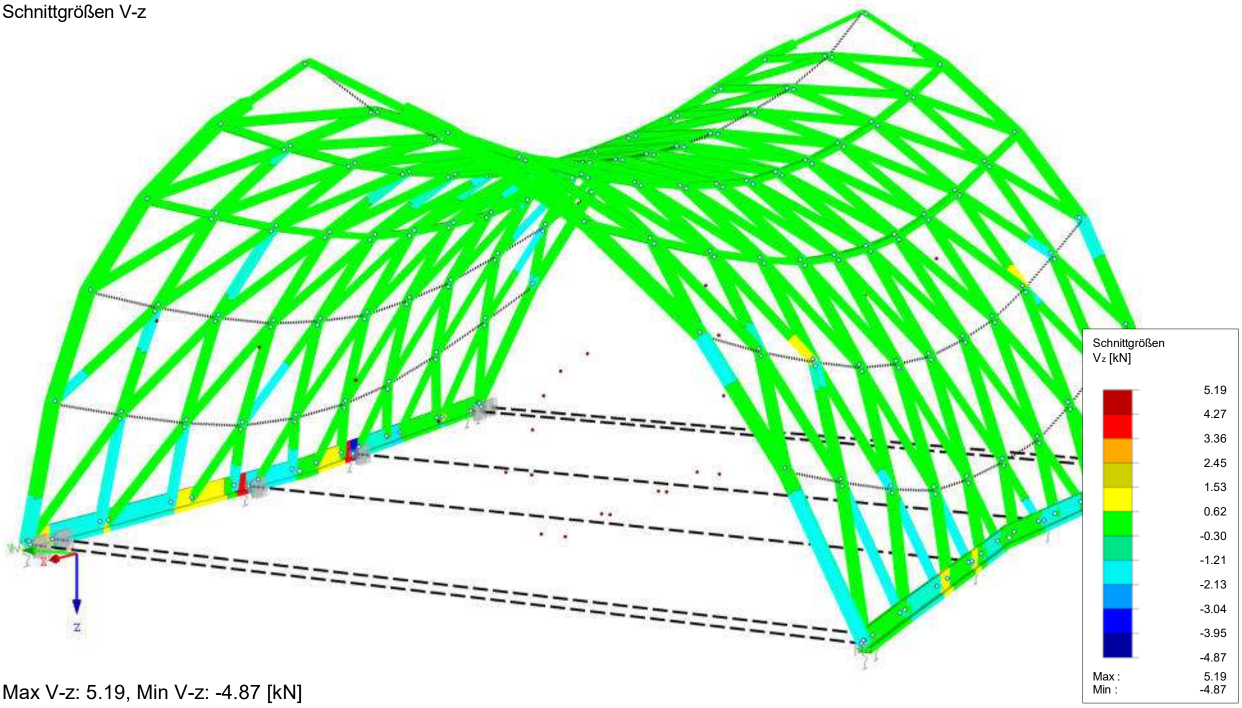


Max V-y: 2.30, Min V-y: -1.93 [kN]

4.5.3.3 Shear forces in z-direction

LK42 : 1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF21
Schnittgrößen V-z

Perspektive

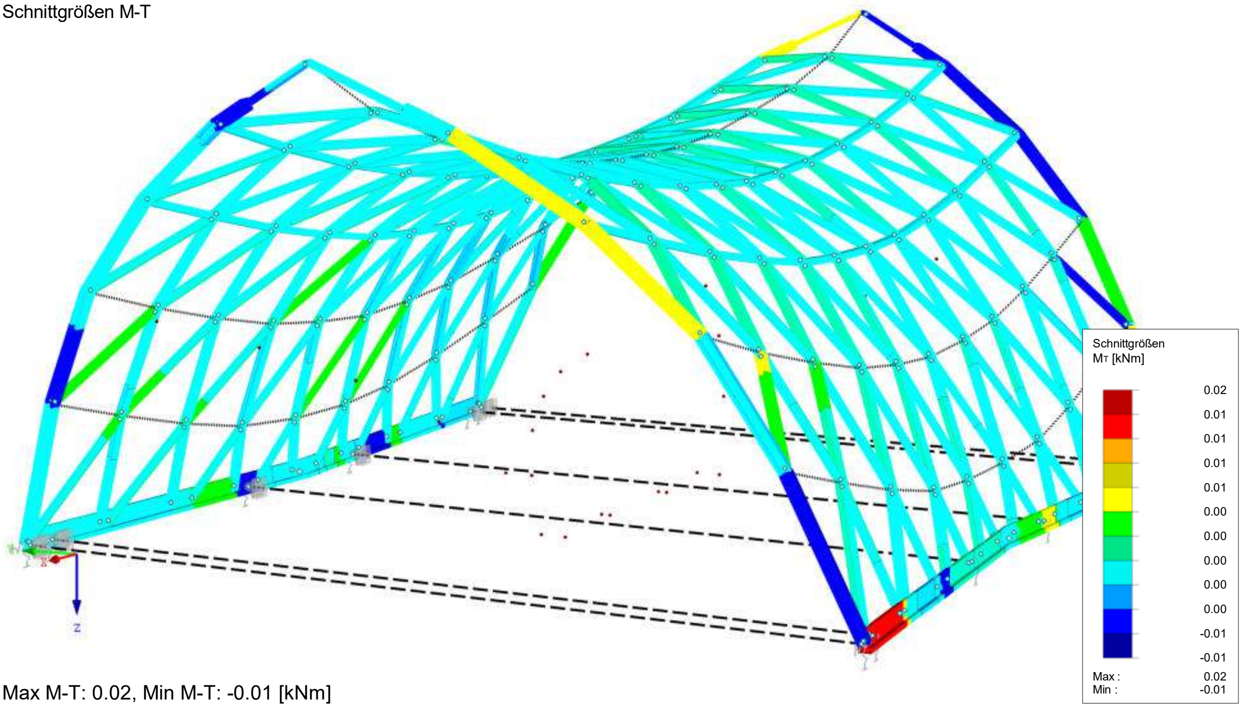


Max V-z: 5.19, Min V-z: -4.87 [kN]

4.5.3.4 Torsional moments

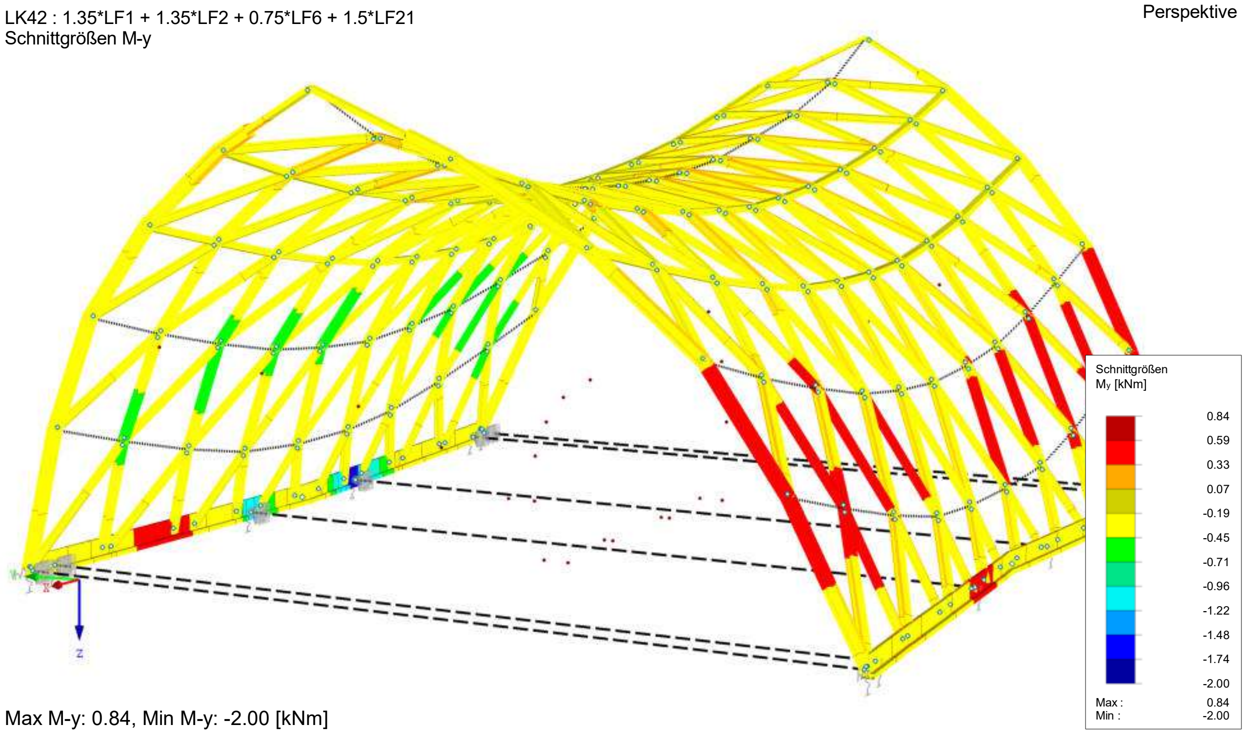
LK42 : 1.35*LF1 + 1.35*LF2 + 0.75*LF6 + 1.5*LF21
Schnittgrößen M-T

Perspektive



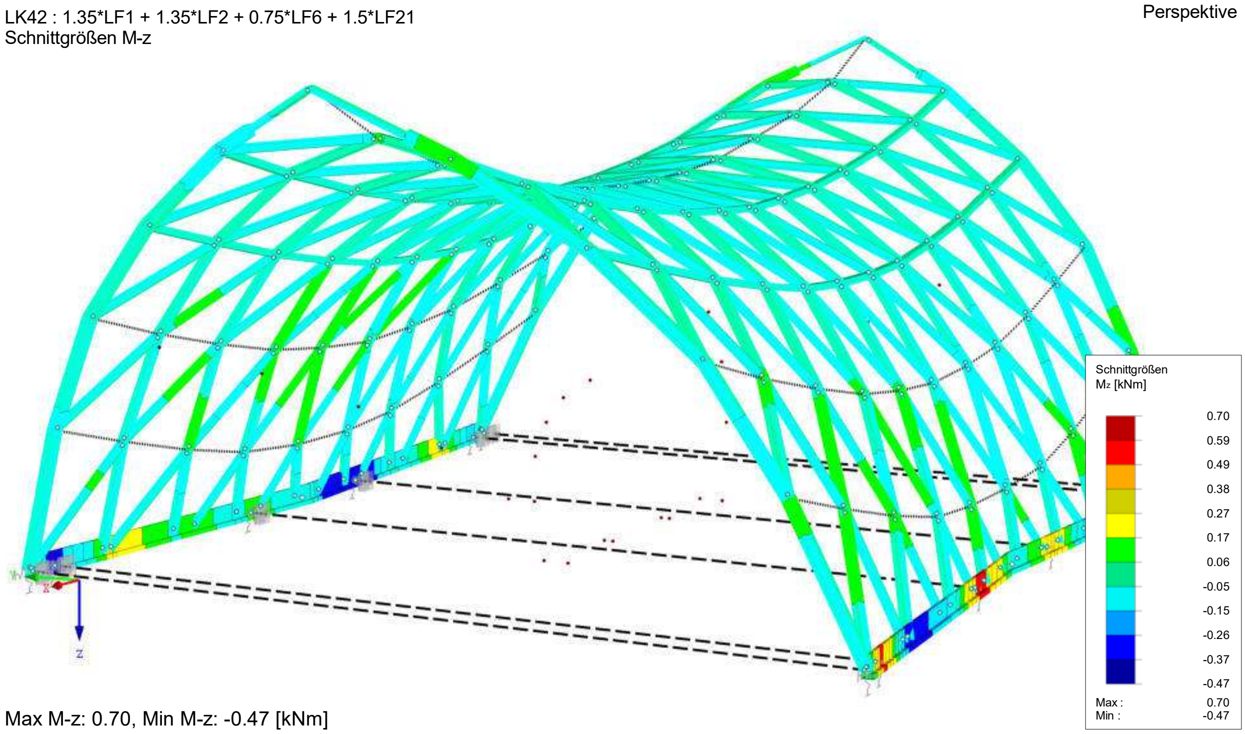
Max M-T: 0.02, Min M-T: -0.01 [kNm]

4.5.3.5 Bending moments around the y-axis



Max M-y: 0.84, Min M-y: -2.00 [kNm]

4.5.3.6 Bending moments around the z-axis



Max M-z: 0.70, Min M-z: -0.47 [kNm]

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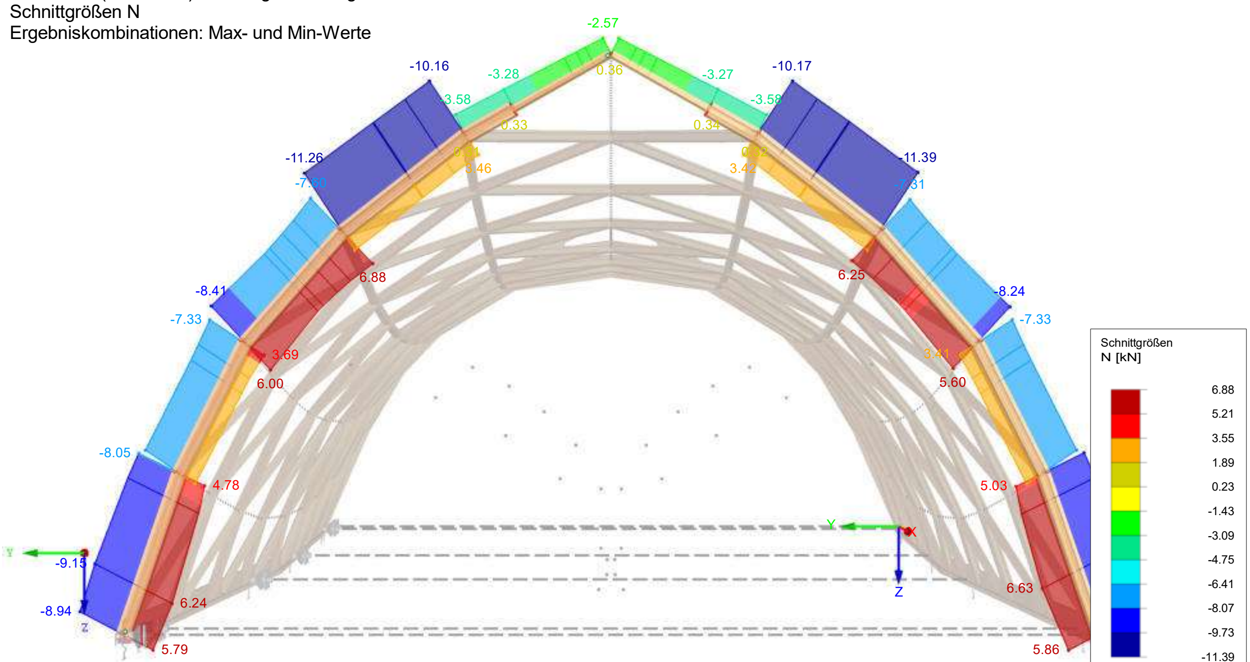
4.5.4 Result combination (only edge beams shown)

4.5.4.1 Normal forces

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Schnittgrößen N
Ergebniskombinationen: Max- und Min-Werte

Entgegen der X-Richtung

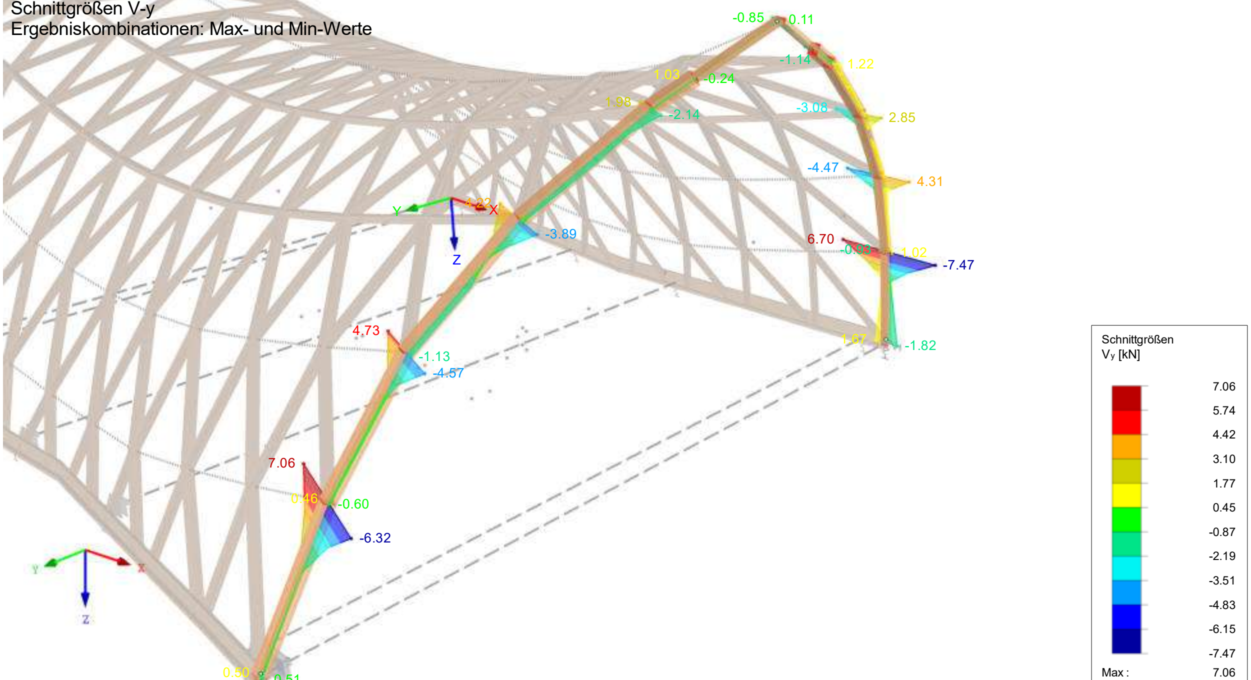


Max N: 6.88, Min N: -11.39 [kN]

4.5.4.2 Shear forces in y- direction

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Schnittgrößen V-y
Ergebniskombinationen: Max- und Min-Werte

Perspektive

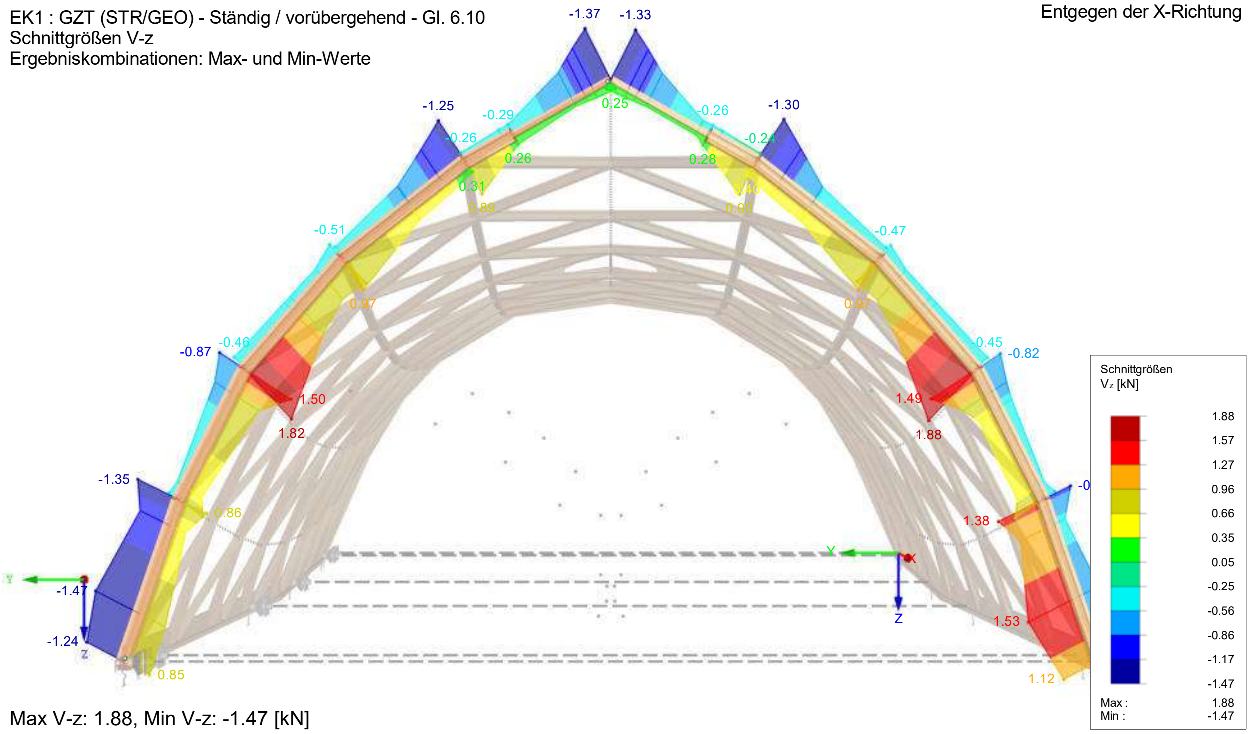


Max V-y: 7.06, Min V-y: -7.47 [kN]

4.5.4.3 Shear forces in z- direction

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Schnittgrößen V-z
Ergebniskombinationen: Max- und Min-Werte

Entgegen der X-Richtung

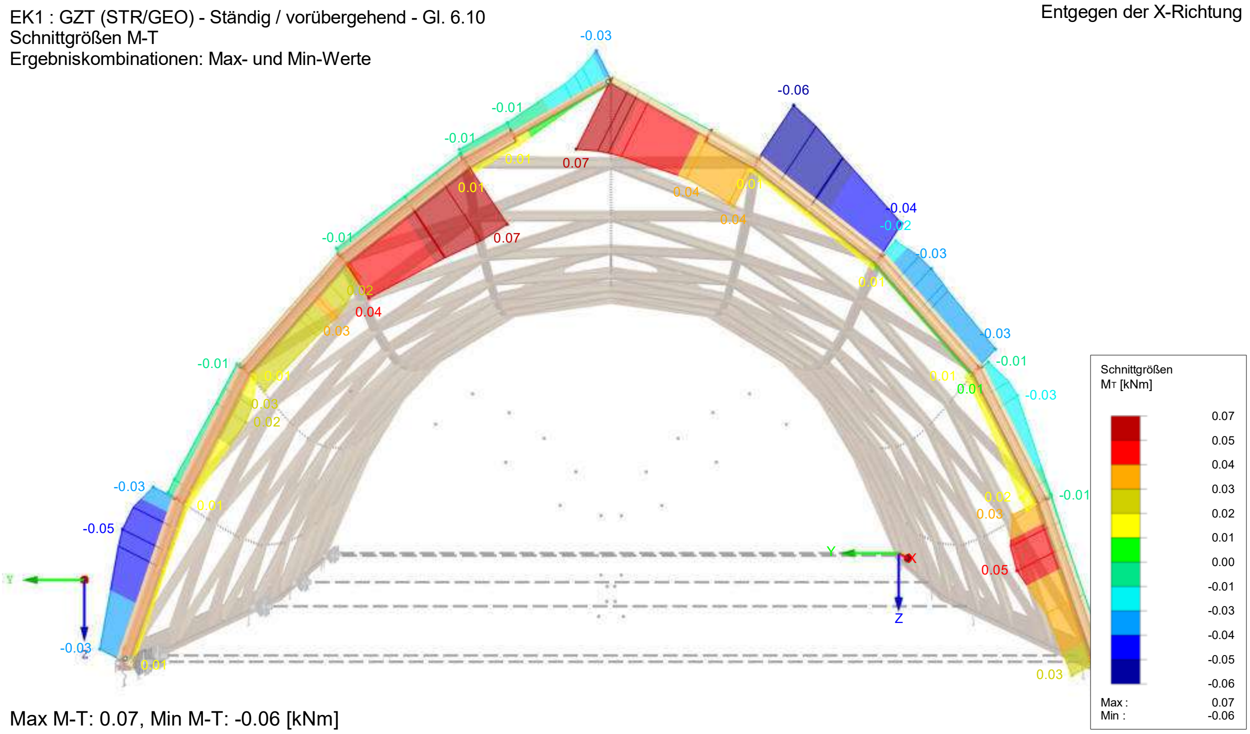


Max V-z: 1.88, Min V-z: -1.47 [kN]

4.5.4.4 Torsional moments

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Schnittgrößen M-T
Ergebniskombinationen: Max- und Min-Werte

Entgegen der X-Richtung

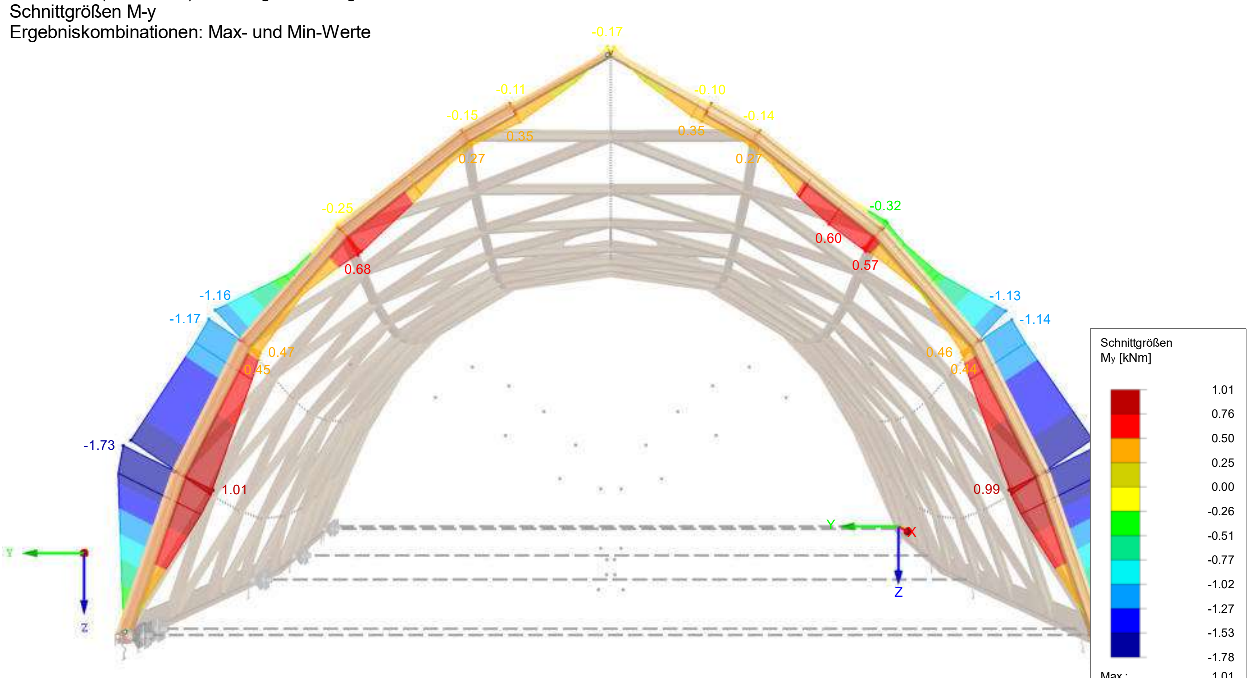


Max M-T: 0.07, Min M-T: -0.06 [kNm]

4.5.4.5 Bending moments around the Y-axis

Entgegen der X-Richtung

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Schnittgrößen M-y
Ergebniskombinationen: Max- und Min-Werte

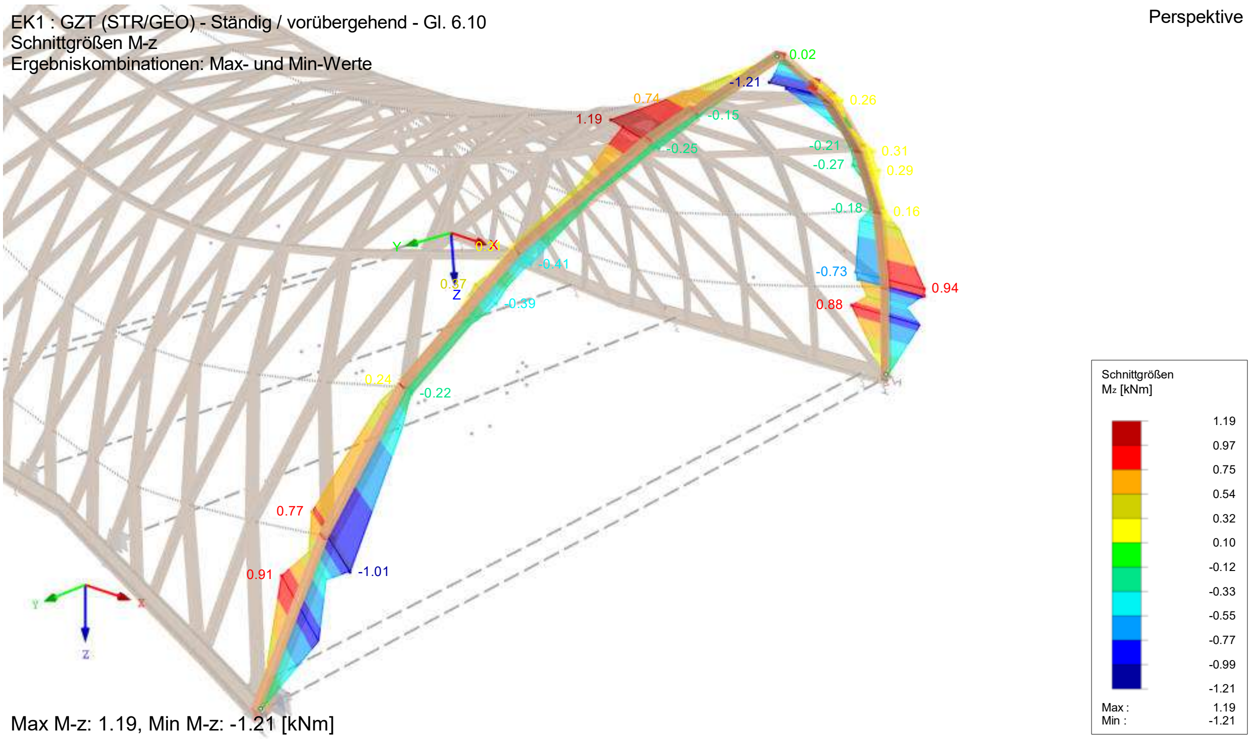


Max M-y: 1.01, Min M-y: -1.78 [kNm]

4.5.4.6 Bending moments around the Z-axis

Perspektive

EK1 : GZT (STR/GEO) - Ständig / vorübergehend - Gl. 6.10
Schnittgrößen M-z
Ergebniskombinationen: Max- und Min-Werte



Max M-z: 1.19, Min M-z: -1.21 [kNm]

5 DETAIL POINTS

According to attachment

6 ATTACHMENTS

All components and connections without separate proof in the present static calculations are carried out by the contractor according to the recognized rules of technology and the state of standardization.

End of document |

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