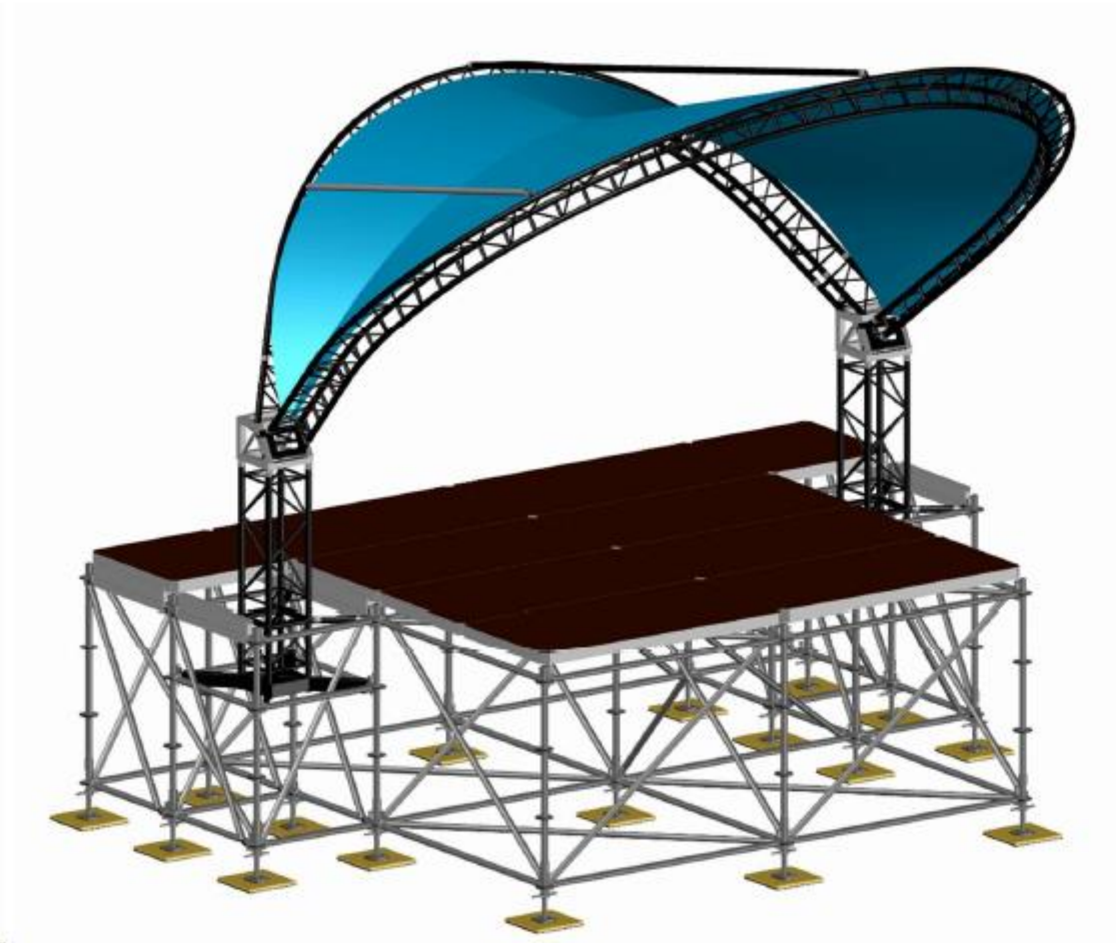
PODIUM – BOEK LEAF

Eekels Verhuur 112023-03



Inhoudsopgave

Voorwoord

Opdrachtgevers en organisatoren, alsmede gemeentelijke diensten hebben behoefte aan handvatten voor de beoordeling van kwaliteit en specificaties van overdekte podia die tijdelijk geplaatst worden. Met als doel het inzichtelijk krijgen van waar gehuurde overdekte podia aan moeten voldoen op gebied van onder meer brandveiligheid- en constructieve veiligheid. Een van de is om een podium-boek op te stellen waarin deze zaken overzichtelijk en begrijpelijk worden weergeven, dit op een vergelijkbare manier hoe een tentboek wordt samengesteld.

In het veld worden diverse termen gebruikt voor het overdekken van een podium; kap, dak, stage, overkapping. In essentie betreft het in dit bouwboek een podium wat voorzien is van een constructie welke zorgdraagt voor (gedeeltelijke) beschutting van de elementen.

In de bijlagen komen zaken aan de orde als tekeningen, kwaliteitsverklaringen, constructieve berekenen en andere informatie welke verder relevant is.
In de normen welke gaan over de overdekte podia worden kwaliteitsverklaringen, constructieve berekeningen en andere relevante stukken genoemd. Hierin staat gesteld dat deze stukken niet in de Nederlandse taal opgesteld hoeven te zijn, eventuele aanvullende toelichtingen en handleidingen wel. Het voorwoord en handleidingen die minimaal in het podium-boek moeten staan worden gezien als toelichting. Andere zaken dan de toelichting(en) in het podium-boek mogen in het Duits, Frans of Engels aangeleverd worden.

Het gebruik van het overdekte podium is geen onderwerp van het podium-boek.

Binnen het NEN lopen nog een aantal andere trajecten die te maken hebben met evenementen, allemaal beginnende met: 8020-

Een aantal, al dan niet Europese, algemeen gehanteerde normen en richtlijnen die te maken hebben met overdekte podia welke tijdelijk geplaatst worden zijn o.a.:

NPR 8020-50	Evenementen – Podiumconstructies – Verantwoordelijkheden
NPR 8020-51	Evenementen – Podiumconstructies – Belastingen en constructieve uitgangspunten

NEN-EN 13814	Machines en constructies op kermisterreinen en amusementsparken – Veiligheid
NEN-EN 1990	Grondslagen van het constructief ontwerp
NEN-EN 1991	Belastingen op constructies
NEN-EN 1993	Staalconstructies

Bovenstaande normen- en richtlijnen refereren o.a. aan de Eurocodes NEN-EN 1991-1-4/NB;

Deel 1: Belastingen op constructies
Deel 1-4: Algemene belastingen – Windbelasting.

Een tijdelijk geplaatst overdekt podium is in beginsel geen bouwwerk in de zin van het bouwbesluit. Hieruit voortvloeiende kan er daarom niet automatisch naar het bouwbesluit of andere zaken worden gekeken als het gaat om beoordeling van een tijdelijk geplaatst overdekt podium. Hier moeten dus ook de eerder genoemde normen- en richtlijnen naast gehouden worden.

Keuringsrapporten voor zeil, bijvoorbeeld bepaald volgens B1 of M1, zijn doorgaans voorzien van een geldigheidsdatum. Deze datum heeft alleen betrekking op het productieproces van het zeil en niet op het product. Het zegt niets over het (brand)verloop van de kwaliteit van het materiaal. Zeil dat voldoet aan de gestelde eisen blijft zelfdovend. Dit gegeven is mede onderschreven door het LNB, cluster brandveilig gebruik.

Overdekte podia zijn onder te verdelen in:

- (gedeeltelijk) met zijwanden van harde panelen of zeil
- zonder zijwanden
- voorzien van meer bouwlagen

Het gebruik van dit podium-boek is slechts voorbehouden aan Eekels Verhuur B.V..
Hallenstraat 20
P.O. Box 175
5530 AB Bladel
T: +31 0 73 6136867
E: info@eekelsverhuur.nl
I: www.eekelsverhuur.nl

NOODNUMMER: +31 0 467 870 112

1. Algemene informatie

In dit hoofdstuk worden alle gegevens van de fabrikant en algemene gegevens overdekte podia indien deze buiten Europa is geproduceerd, tevens naam van importeur.

1.1 Algemene gegevens fabrikant(en);

Zeil	**POLYMAR – FR COLOR 700**
Constructie	LEAF
Type zeil	PVC; artikel 8509 5240

1.2 Algemene gegevens;

Naam	**LEAF**
Type	DJ Covering
Configuratie(s)	6.21x4.14 meter

2 Gegevens verhuurder of leverancier

Hieronder wordt alle huidige en relevante informatie weergegeven van de verhuurder/leverancier.

Rechtsvorm	Besloten Vennootschap
Handelsnaam	Eekels Verhuur B.V.
Bezoekadres	Hallenstraat 20 5531 AB BLADEL
Postadres	P.O. Box 175 5530 AD BLADEL
Telefoonnummer	0031 73 6136867
Website	www.eekelsverhuur.nl
Mailadres	info@eekelsverhuur.nl
K.v.K. nummer	84151722
Omzetbelasting nummer	NL863114192B01
Bank	Rabobank de Kempen
IBAN Rekening nummer	NL43RABO0374476608
BIC	RABONL2U

3 Algemene technische gegevens van de overdekte podia
Waar dient de huurder ten alle tijden rekening mee te houden bij de ingebruikname van het overdekte podium.

3.1 Algemeen
- Geen sneeuw- en/of hagelbelasting gerekend
- Podiumvloer is geschikt voor een belasting tot 750 kg/m2
- Obstakels moeten ten minste 0,5 meter van het doek verwijderd zijn (zowel binnen als buiten).

3.2 Bijzonderheden
Voor de berekeningen is aangehouden:
- Onbebouwde omgeving;
- Tekeningen volgens het bouwboek;
- Toetsing volgens NEN-EN 13814;
- Afmeting van de constructie: 6.21x4.14 meter

4 Basis instandhouding- en ontruimingsprotocol

Er zijn zaken welke in basis ten alle tijden van toepassing zijn bij een overdekt podium.

- De constructie van de overdekte podia mogen na oplevering nooit zo worden aangetast dat de constructieve veiligheid in het geding komt.
- Organisator moet grondankers, ballast, windverbanden, spanbanden, palen, wandpanelen, zeilen of andere zaken na losmaken voor welk doel dan ook direct weer terugplaatsen/vastmaken.
- Bij het verlaten van het terrein en/of afsluiten van dagelijkse werkzaamheden en/of na afloop van het evenement moet organisator waar mogelijk de toegang tot het overdekte podia sluiten of niet toegankelijk maken.
- Het overdekte podia moet(en) te allen tijde door organisator sneeuw- en of hagelvrij gehouden worden.
- Cumulatie van water, z.g. waterzakken, moeten door organisator direct verwijderd worden, indien dit niet lukt moet verhuurder meteen verwittigd worden.
- Eventuele loskomende grondverankering of verschuivende ballast moet door organisator direct gemeld worden aan verhuurder.
- Voor opgave gemiddelde wind in Bft. en windstoten. (piekwind) in relatie tot de grenswaarden, het sluiten of buiten gebruik stellen van het overdekte podium zie windtabel(len) elders in dit stuk. Daarbij dienen de beheersmaatregelen uit bijlage 4 in acht genomen te worden.
- Equipotentiaalverbinding. Al het blootliggende metaalwerk binnen een structuur dat in contact zou kunnen komen met een bron van elektrische stroom moet op adequate wijze geaard zijn. Er moet rekening worden gehouden met de mate van blootstelling en het risico op blikseminslag en, waar van toepassing, moet de constructie voldoende worden beschermd. Advies over verlichtingsniveaus voor normaal en noodgebruik valt buiten het toepassingsgebied van deze norm en is elders beschikbaar.
- Blikseminslag in de constructie die voldoet aan gestelde (brandveiligheidseisen levert geen schade op aan de overdekte podia).
- Bij acute dreiging van zwaar onweer gepaard gaande met z.g. valwind en/of hagel moet het overdekte podium en directe omgeving ontruimd-, en indien mogelijk gesloten worden. Het overdekte podium is hierin van ondergeschikt belang.
- Organisator moet het lokale weer tijdens het evenement adequaat bewaken en actie ondernemen waar eigen organisatieprotocollen of overdekte podiumspecificaties dit aangeven.

5 Verklaring weeromstandigheden

Met welke weersomstandigheden dient de huurder rekening te houden.

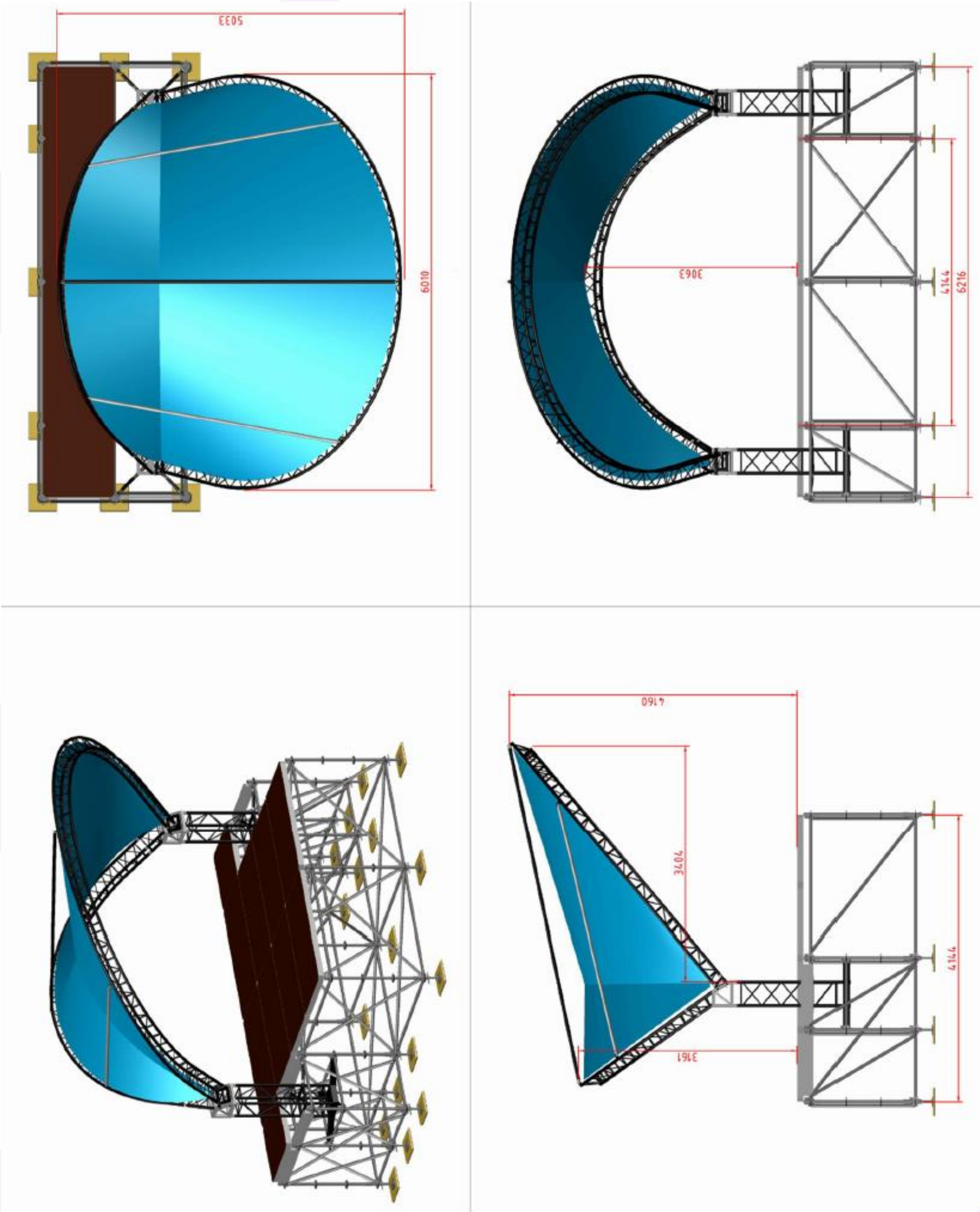
- Een constructie wordt berekend op een stuwdruk (de windbelasting per m2). De stuwdruk ontstaat door de windsnelheid. De windsnelheid is opgebouwd uit een stationair deel en een turbulent deel. Hierdoor ontstaan er pieken in de windsnelheid.
- Windsnelheid wordt standaard gemeten op 10 meter hoogte in het vrije veld, zonder obstakels. Er kan gesproken worden over een piekwindsnelheid, een 10-minuten gemiddelde windsnelheid of een uurgemiddelde windsnelheid. Hoe langer de tijd is, hoe lager het gemiddelde.
- De in de berekeningen gehanteerde beaufort-windschaal wordt in Nederland weergegeven in een 10-minuten **gemiddelde windsnelheid** op 10 meter hoogte in het vrije veld.
- **De stuwdruk waarop een overkapping berekend is, is bepalend voor de sterkte van de overkapping. Het gaat er dus om dat op de juiste manier wordt vastgesteld welke windsnelheid moet worden aangehouden om te kunnen bepalen of de stuwdruk overschreden wordt.**
- Als er niet op locatie gemeten wordt, moet gebruik worden gemaakt van de dichtstbijzijnde meteostation en moet de 10-minuten-gemiddelde windsnelheid op 10 meter hoogte worden opgevraagd. Als de grens-10 minutengemiddelde snelheid wordt bereikt, is de grens-stuwdruk bereikt. De opgegeven waarden gelden voor onbebouwd terrein (buiten de bebouwde kom) en niet voor het strand.
- Onderscheid tussen gemiddelde- en piekwindsnelheid in acht nemen.

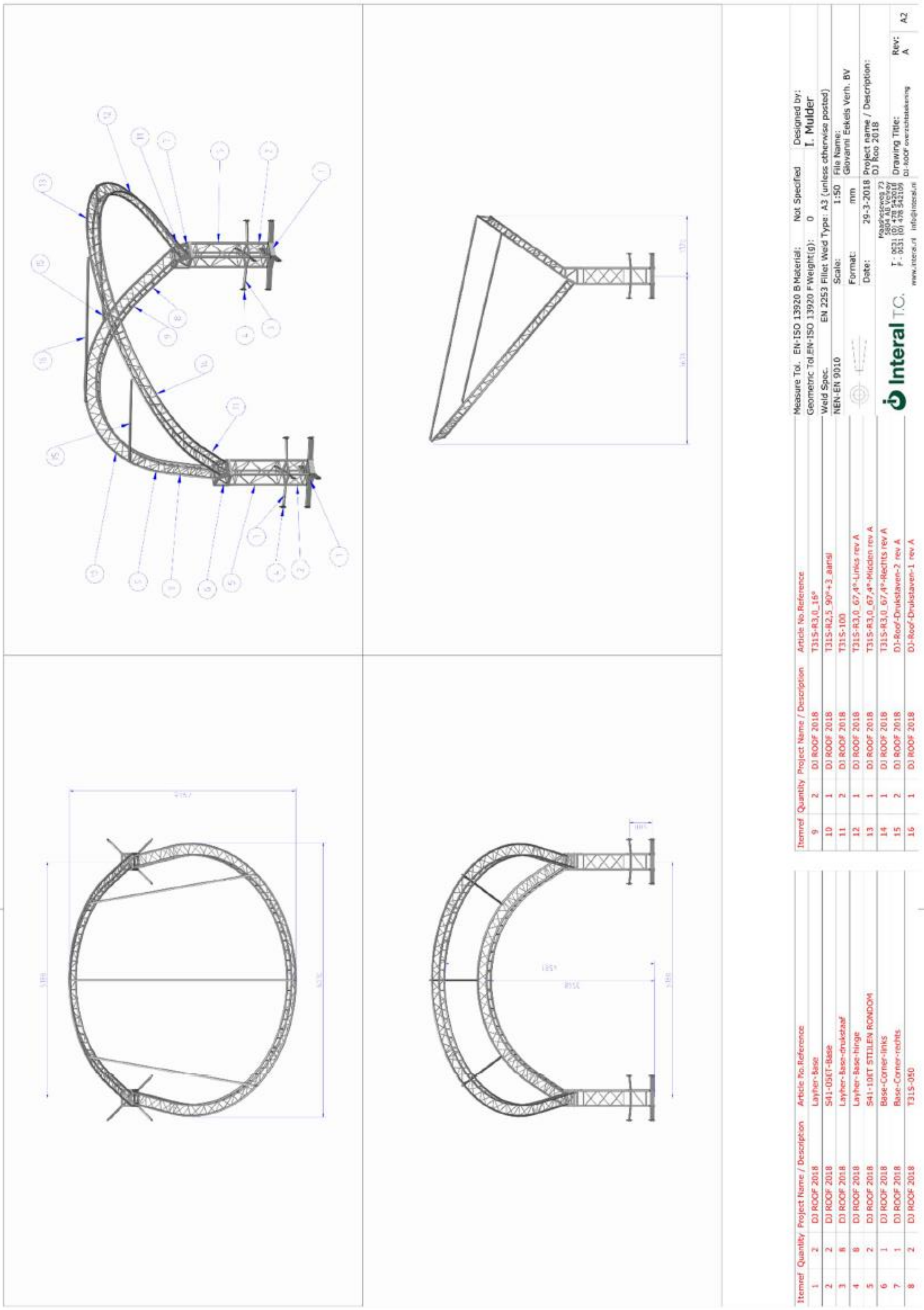
De windkracht volgens de Schaal van Beaufort (bron: KNMI). De schaal van Beaufort wordt gebruikt voor de gemiddelde windsnelheid, over minstens 10 minuten gemeten, níet voor de snelheid van rukwinden/windstoten(piekwind).

Kracht	Benaming van KNMI	Benaming in Zeevaart	Snelheid in km/h*	Snelheid in m/s*	Snelheid in knopen
0	Stil	Windstil	0-1	0-0,2	0-1
1	Zwak	Flauw en stil	1-5	0,3-1,5	1-3
2	Zwak	Flauwe koelte	6-11	1,6-3,3	4-6
3	Matig	Lichte koelte	12-19	3,4-5,4	7-10
4	Matig	Matige koelte	20-28	5,5-7,9	11-16
5	Vrij krachtig	Frisse bries	29-38	8,0-10,7	17-21
6	Vrij krachtig	Stijve bries	39-49	10,8-13,8	22-27
7	Hard	Harde wind	50-61	13,9-17,1	28-33
8	Stormachtig		62-74	17,2-20,7	34-40
9	Storm		75-88	20,8-24,4	41-47
10	Zware storm		89-102	24,5-28,4	48-55
11	Zeer zware storm / orkaanachtig		103-117	28,5-32,6	56-63
12	Orkaan		>117	>32,7	>63

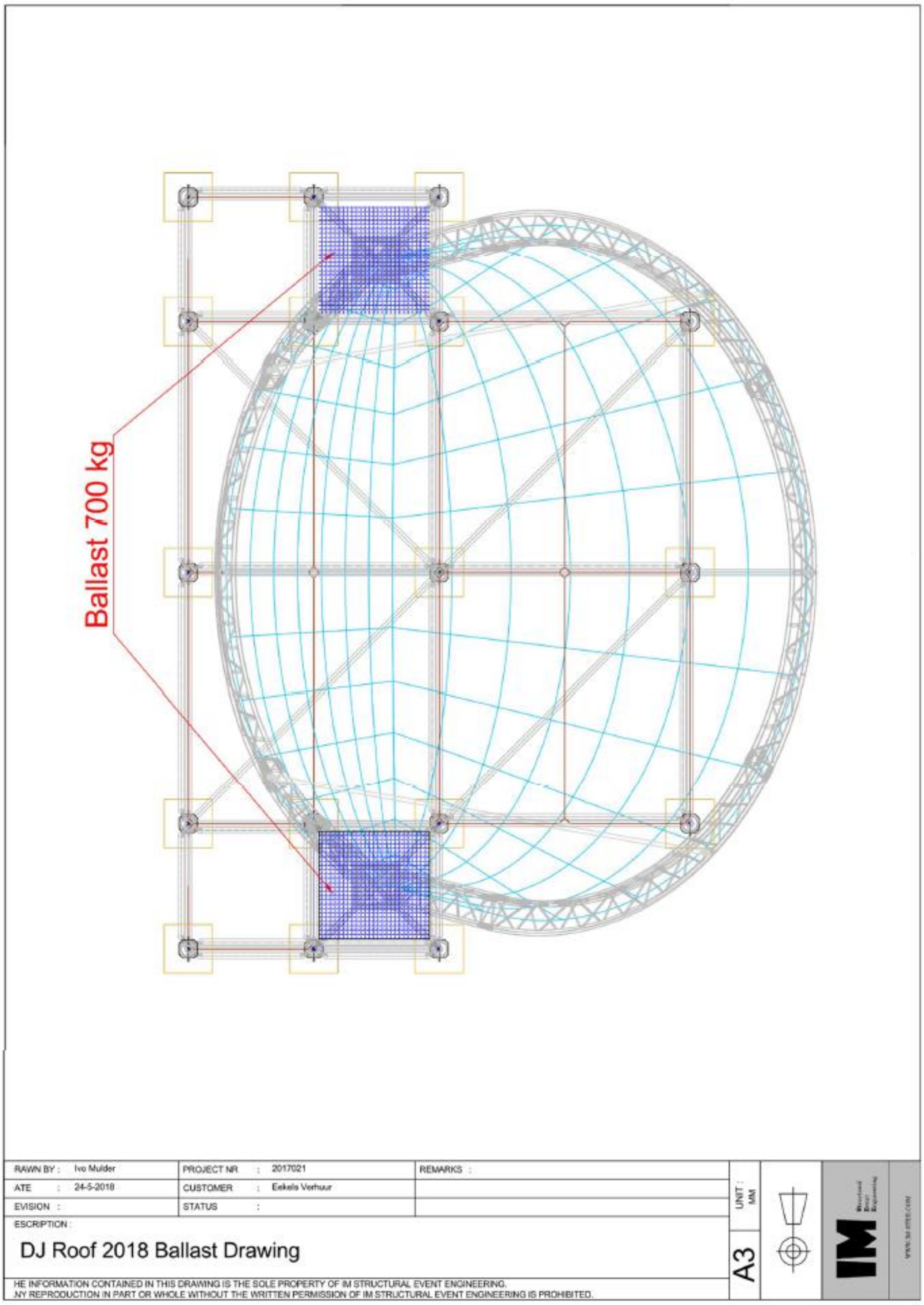
De Nederlandse weerstations onder andere vinden op: www.meteovista.nl, www.knmi.nl, www.meteoconsult.nl en www.meteostation.nl.
Organisator kan ook bij onder andere Meteovista en Meteoconsult gedurende de duur van het evenement een weerbewakingscontract aangaan om nog beter op de hoogte te zijn van de lokale weersomstandigheden.

6 Bijlage I: Tekening(en)




Designed by:
I. Mulder
File Name:
Giovanni Eekels Verh. BV
Project name / Description:
DJ Roof 2018
29-3-2018
Interal T.C.

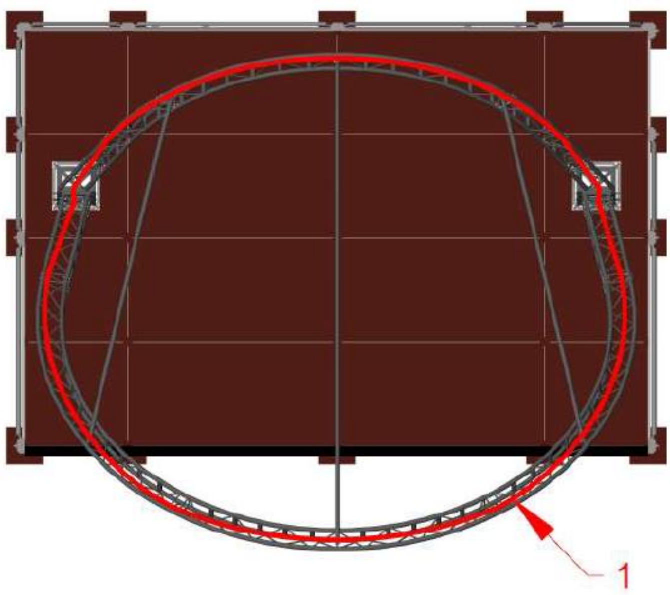
7 Bijlage II: Ballastplan



8 Bijlage III: Riggingscapaciteit

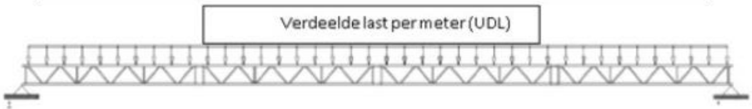
Riggingscapaciteit Leaf 24

Rear



Front

Naam	Waarde	Maximale Gebruiksbelasting per punt
		1
A. Verdeelde last per meter (UDL)	kg/m	25



Figuur 1

Let op:
Bij Dynamische lasten dient een extra veiligheidsfactor gehanteerd te worden in overleg met constructeur Eekels verhuur!

+31 497 870 136 sales@eekelsverhuur.nl www.eekelsverhuur.nl Eekels Verhuur BV
Hallenstraat 20
5531 AB Bladel

9 Bijlage IV: Beheersmaatregelen (WMP; Wind Management Plan)

In dit Beheersplan wordt kort omschreven welke stappen bij welke windsnelheid gezet dienen te worden. De waarde waarbij deze stappen gezet dienen te worden verschillen per windgebied.

Hieronder een opsomming van de 10-minuten gemiddelde windsnelheid per locatie (omschreven in de NEN-EN 1991-1-4:2005)

In de bovenstaande hoofdstukken is uitgelegd hoe de berekening is opgebouwd. Conform de Geldende normen dient dan het onderstaande Beheersingsplan toegepast te worden.

1. Zij- en achterzeilen dienen verwijderd te zijn bij het bereiken van onderstaande waarde;

Gebied	10 minuten gemiddelde windsnelheid (m/s)	Beaufort (Bft)	Piekwindsnelheid (m/s)	Stuwdruk (kN/m^2)
Kust	10.58	5	17.89	0.20 kN/m^2
Onbebouwd	12.03	6	17.89	0.20 kN/m^2
Bebouwd	17.57	7	17.89	0.20 kN/m^2

2. Het podium dient UIT-SERVICE (out-service) gesteld te zijn bij het bereiken van onderstaande waarde;
   - Tevens dient de directe omgeving ontruimd te zijn

Gebied	10 minuten gemiddelde windsnelheid (m/s)	Beaufort (Bft)	Piekwindsnelheid (m/s)	Stuwdruk (kN/m^2)
Kust	15.65	7	26.46	0.4375 kN/m^2
Onbebouwd	17.79	8	26.46	0.4375 kN/m^2
Bebouwd	25.99	9	26.46	0.4375 kN/m^2

3. Bij acute dreiging van zwaar onweer gepaard gaande met z.g. valwind en/of hagel moet de constructie en directe omgeving ontruimd-, en indien mogelijk, gesloten worden. De overkapping is hierin van ondergeschikt belang.

NOTE; de 10-minuten gemiddelde windsnelheid wordt alleen weergegeven als referentie windsnelheid. Acties omtrent de constructie dienen ondernomen te worden aan de hand van de piekwindsnelheid.

Bij vragen of twijfel over dit plan kunt u altijd contact opnemen met Eekels Verhuur B.V.

10 Bijlage V: Zeilcertificaat

Technisches Datenblatt Nr.: **1017.14**

Produkt: POLYMAR® FR COLOR 700

Artikel Nr.: 8509 5240

Beschichtung und Ausrüstung				
Beschichtungsart	**PVC**			
Ausrüstung	**beidseitig mit Acryllack, mikrobiozid, UV-geschützt**			
Brennverhalten	**BS 7837, D.M. 26.06.84 (UNI 9177): CL. 2, DIN 4102: B1, NFP 92507: M2, GOST: G1, NFPA 701 Test 2, EN 13501-1: B-s2-d0**			
zu Brennverhalten	**stets die Aktualität der FR-Zulassung, sowie länderspezifische Gültigkeit prüfen**			
Gesamtgewicht		**680**	g/m²	DIN EN ISO 2286-2
Reißkraft Kette/Schuss		**3000 / 3000**	N/50 mm	DIN EN ISO 1421/V1
Weiterreißfestigkeit Kette/Schuss		**300 / 300**	N	DIN 53363
Haftfestigkeit		**20**	N/cm	PA 09.03 (intern)
Kältebeständigkeit.		**-40**	°C	DIN EN 1876-1
Wärmebeständigkeit		**+70**	°C	PA 07.04 (intern)
Lichtechtheit		**>6**	Note, Value	DIN EN ISO 105 B02
Knickfestigkeit	keine Risse	**100000 x**		DIN 53359 A
Trägergewebe				
Material		**PES**		DIN EN ISO 2076
Fadenstärke		**1100**	dtex	DIN EN ISO 2060
Bindung		**L 1/1**		ISO 3572

Bei den technischen Daten handelt es sich um ca. Werte, die auf Basis von ermittelten Durchschnittswerten erstellt wurden. Aus fertigungstechnischen Gründen sind Abweichungen bis zu -5% möglich. Diese technischen Angaben entsprechen dem heutigen Stand der Kenntnisse und sollen über unsere Produkte ohne Rechtsverbindlichkeit informieren. Diese Daten gelten für neue Ware. Einsatzvorschläge entbinden den Käufer nicht, selbst zu prüfen, ob das Material für den von ihm gewünschten Einsatz geeignet ist.

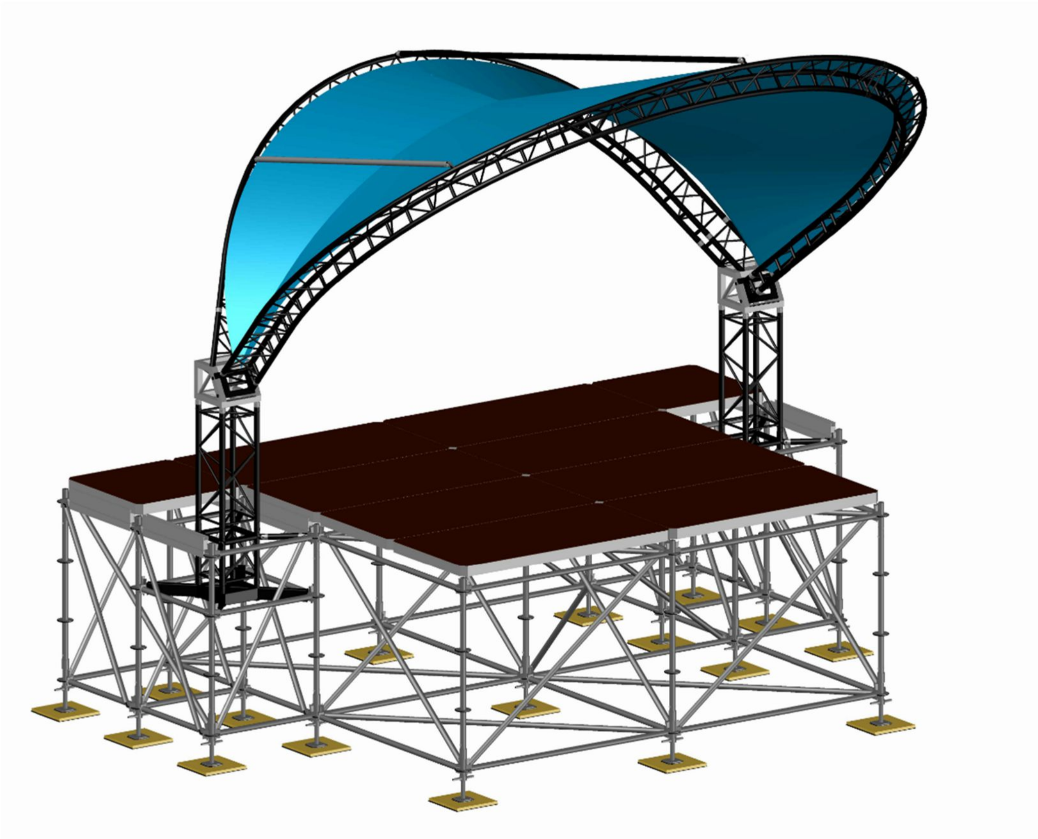
VL/LB:

QM-071/3-08/00 EA/007-06/98 Datum 17.05.2019

11 Bijlage VI: Berekening

IM Structural Event Engineering

WWW.IM-STEE.COM



Project number: 2017021

Structural calculation Report

DJ Roof 2018

Eekels verhuur

This calculation report has been specific prepared for the company Eekels verhuur based at Gruttostraat 9 5212 VM ’s-Hertogenbosch. It is not allowed to copy or print any part of this calculation other than for the intern use at Eekels verhuur. The first chapter of this calculation report can be passed on as annex to a permit application. In all other situations it is obligated to obtain a written permission from the company IM Structural Event Engineering.

Date: 27-05-2018

Ivo Mulder BCs

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8603 DK, Sneek
The Netherlands
+31 (0) 646597297
imulder@im-stee.com

Index

1 General Preliminary notes.

1.1 Project description.

This project concerns the structural calculation of a special DJ roof designed for Eekels Verhuur.
The DJ Roof has been calculated to withstand maximum wind gusts of 20m/s when the Roof canopy is attached.
The construction without the roof canopy attached can withstand wind gusts of 28 m/s.

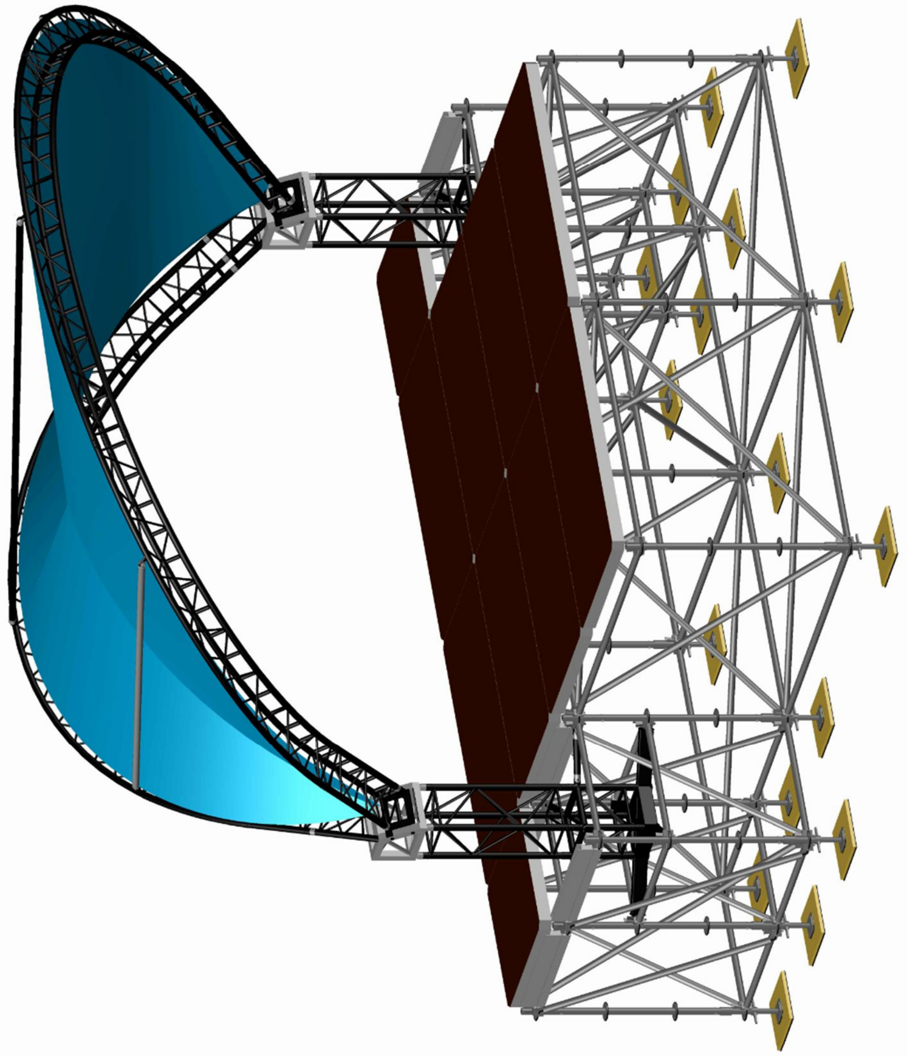
The DJ roof exist of two S41 truss uprights with a special corner on the top. To this special corner, an arch on the front side and an arch on the back side are attached. The front arch can hinge to the front for easy assembling. The arches are constructed from special designed triangular truss. The roof fabric is a membrane which is attached with bungies to the front and back arch.
On the front and back arch there is the possibilities to suspend lightning with a maximum load of 25 kg/m.

The base of the DJ roof need to be integrated in a Layher stage which secures the stability of the system. The small Layher stage is part of the stability calculation of the construction.

The DJ roof can also be integrated in other Layher stages.
Other Layher construction are not part of this calculation and need to be calculated separately!! This because the size will always be different.

1.2 Construction drawing

1.2.1 Impression drawing DJ Roof on small stage



DRAWN BY : Ivo Mulder	PROJECT NR : 2017021	REMARKS :	UNIT : MM
DATE : 24-5-2018	CUSTOMER : Eekels Verhuur		
REVISION :	STATUS :		
DESCRIPTION : DJ Roof 2018 On small stage			A3

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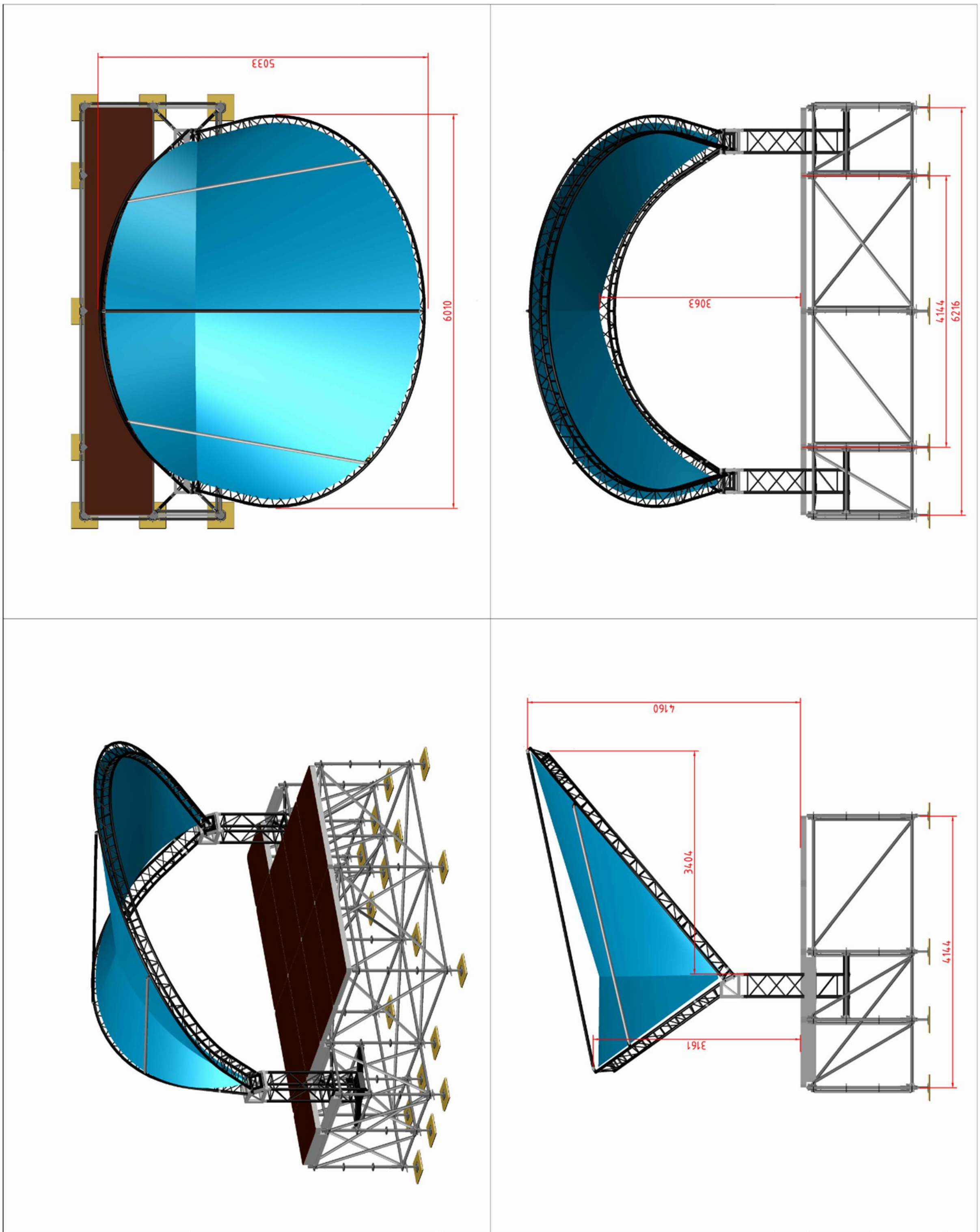

DRAWN BY : Ivo Mulder	PROJECT NR : 2017021	REMARKS :
DATE : 24-5-2018	CUSTOMER : Eekels Verhuur	
REVISION :	STATUS :	

DESCRIPTION :

DJ Roof 2018 On small stage

UNIT : MM

A3

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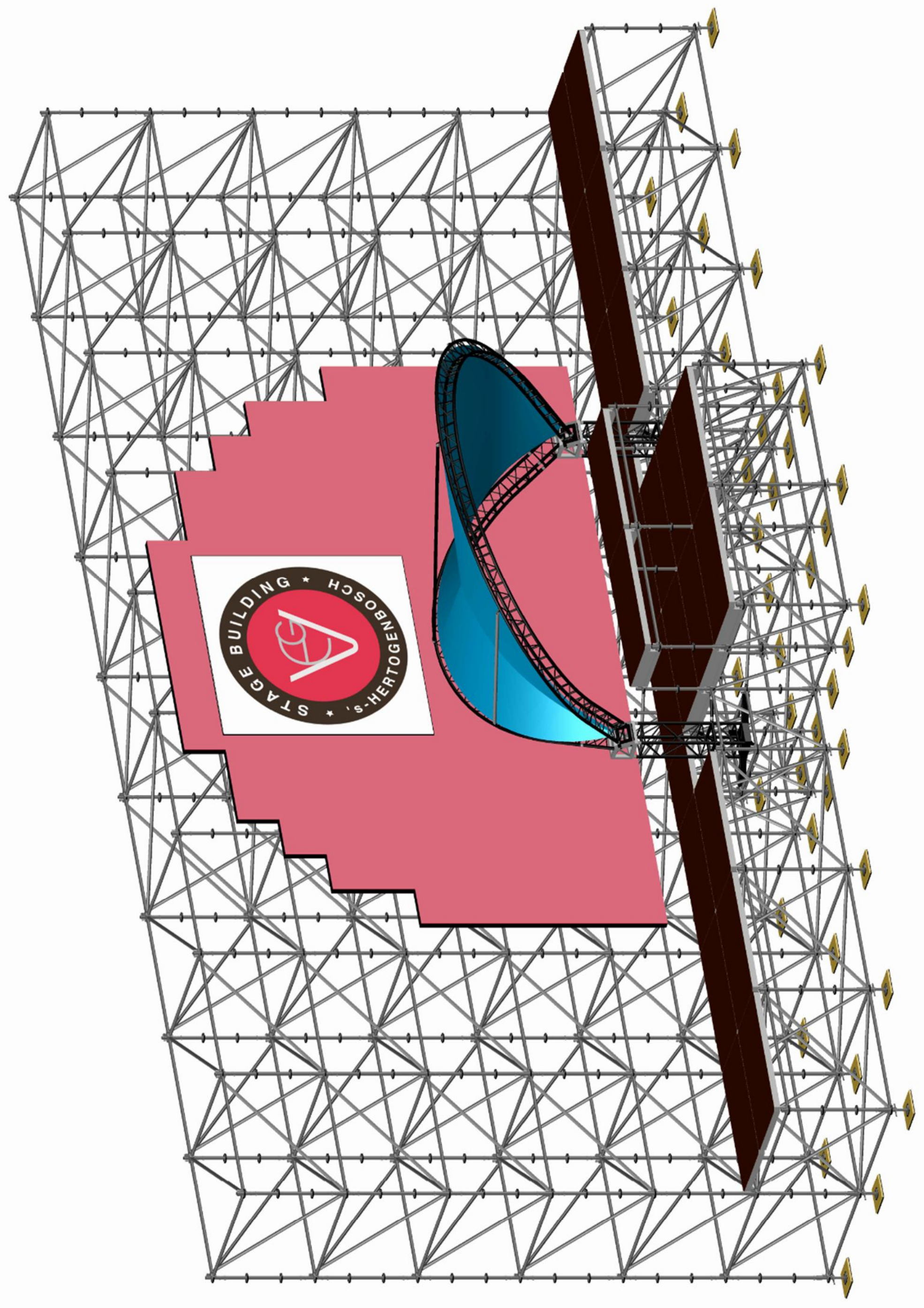
1.2.2 Impression drawing DJ Roof in front of Layher wall.



DRAWN BY : Ivo Mulder	PROJECT NR : 2017021	REMARKS :	UNIT : MM
DATE : 24-5-2018	CUSTOMER : Eekels Verhuur		
REVISION :	STATUS :		
DESCRIPTION : DJ Roof 2018 In front of Layher wall			A3

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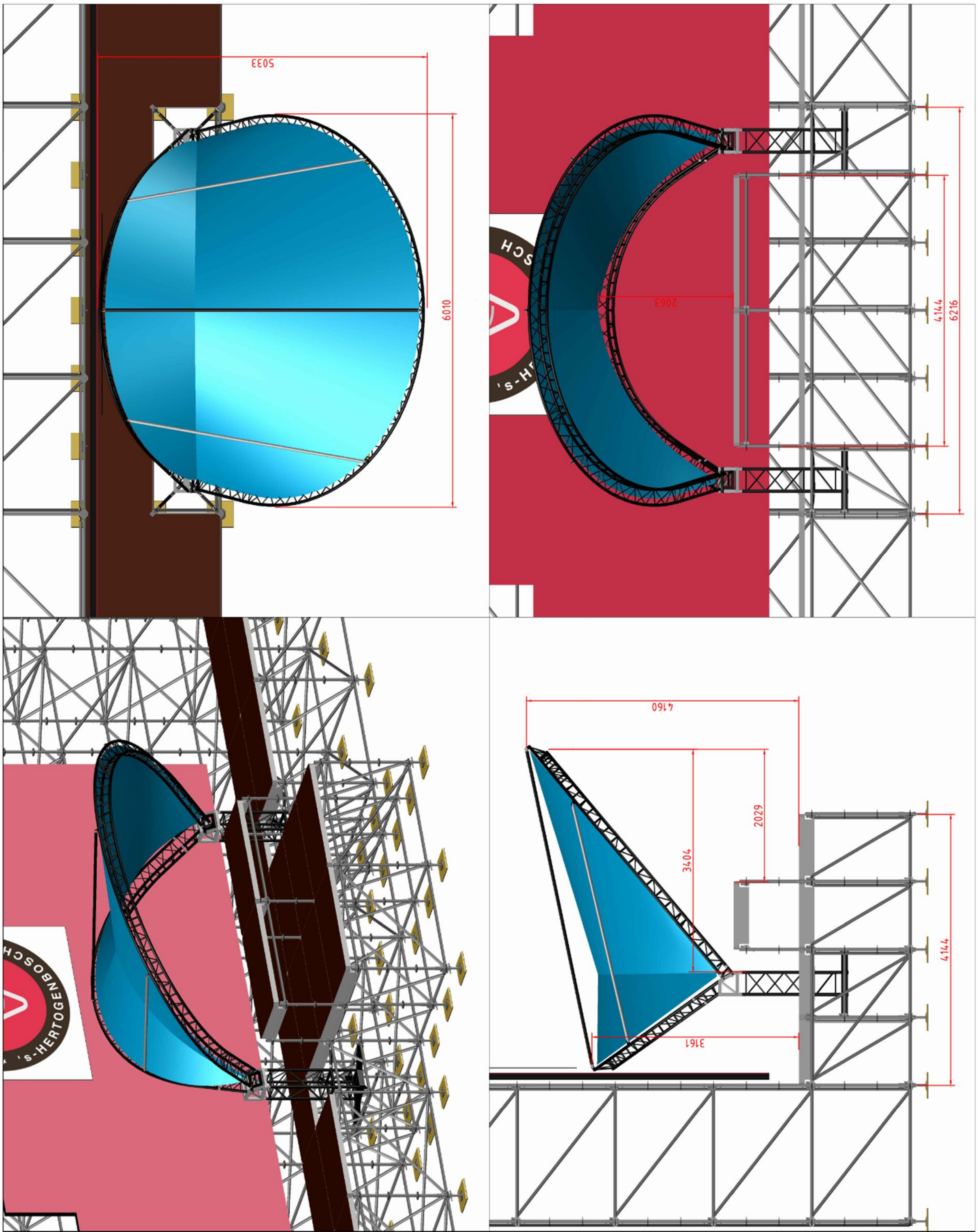

DRAWN BY : Ivo Mulder	PROJECT NR : 2017021	REMARKS :	UNIT : MM	
DATE : 24-5-2018	CUSTOMER : Eekels Verhuur			
REVISION :	STATUS :			
DESCRIPTION : DJ Roof 2018 In front of Layher wall			A3	

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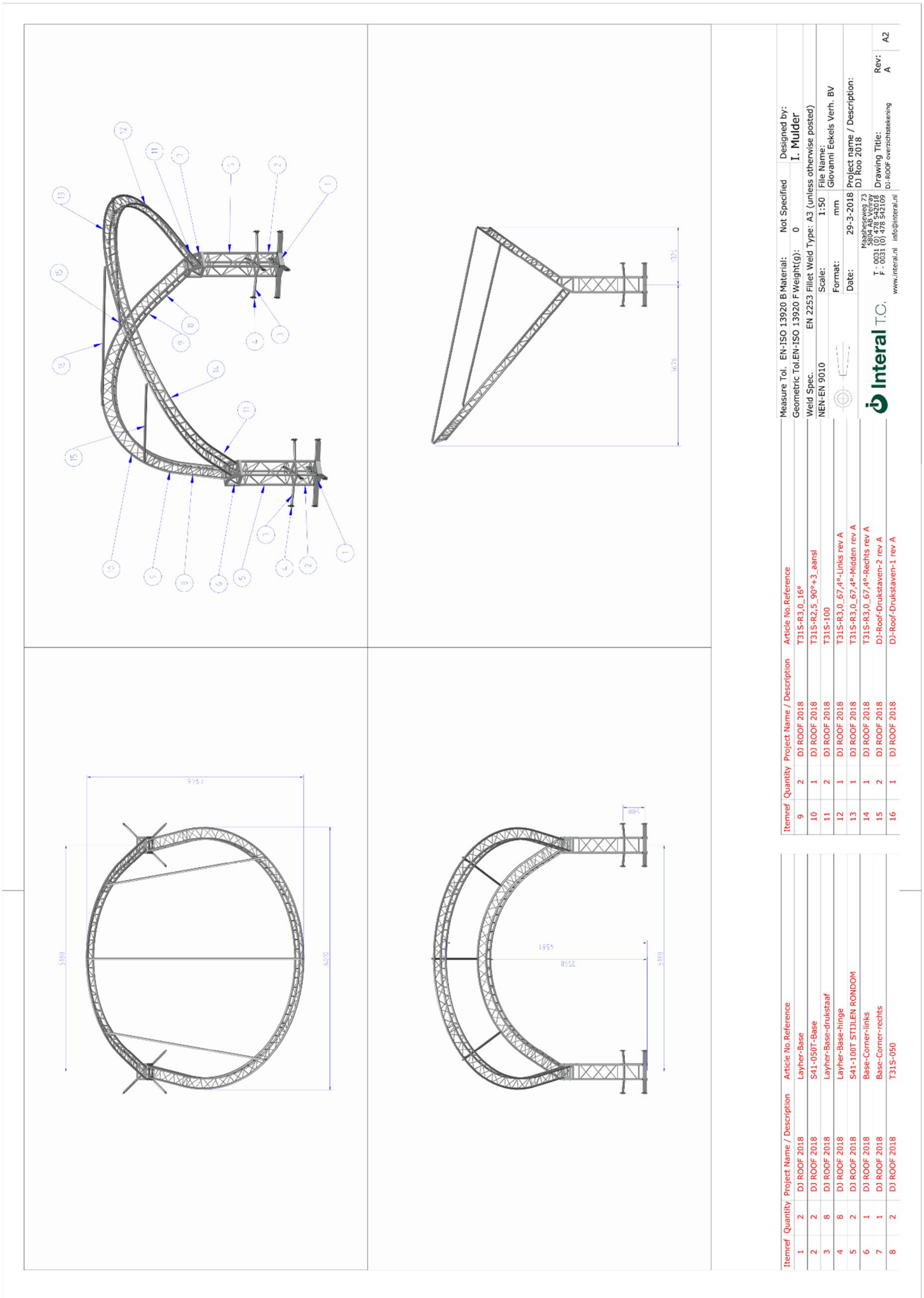
1.2.3 Production overview drawing



1.3 Used normalisation.

This calculation is based on the next parts of the Eurocodes.

NEN-EN 1990	(Eurocode 0) Basis of structural design.
NEN-EN 1991	(Eurocode 1) Action on structures.
NEN-EN 1993	(Eurocode 3) Design of steel structures.
NEN-EN 1999	(Eurocode 9) Design of Aluminium structures.
NEN-EN 13814	Fair ground and amusement park machinery and structures
NEN-EN 13782	Temporary Structures-Tents-Safety.
NEN-EN 12385	Steel wire ropes.

1.4 General load assumption explanation.

The loads which are taken into account in this calculation are based on the information gattered from the different parts of the Eurocodes. Some of the loading information's from the Eurocode are based on permanent building constructions which makes it not feasible to use this information for a temporary demountable construction. In these specific cases there will be an explanation of a well weighted decision why the calculation deviates from the information presented in the Eurocode.

1.5 Used materials.

The roof construction is built from special aluminium truss Produced by Interal T.C..

The stage floor and uprights are constructed from the Layher scaffolding system.

1.6 Load assumptions

1.6.1 Wind loading

According to the Eurocode NEN-EN 13814, two wind situation calculations can be made for a temporary demountable structure. The first situation has a wind speed from 0 to 20 m/s and is called the in-service situation and the second situation has a wind speed from 20 m/s to 28 m/s and is called the out-service situation. These maximum wind speeds are the maximum wind gust measured at 10 meters high in a free environment. The In-service situation is the situation where the construction can be used for events. In this situation the roof canopy and scenery objects can be mounted to the construction. There is no danger concerning the structural integrity of the temporary demountable structure. Before the wind gust exceeds the maximum in-service wind speed of 20 m/s the roof canopy and all big scenery objects need to be removed, so the wind can pass through the construction. All these actions, and how they are executed need to be written in a method statement. When all the actions are finished the out-service situation is in place. In the out-service situation the only people who can be in the neighbourhood of the stage are professionals who know and understand the risk involved in temporary demountable structures and are well aware of the method statement. When there are wind gusts higher than the 28 m/s the construction side need to be completely cleared from all people.

The values of the extreme thrust are based on area's which have a reference wind speed of $V_{b,o}$, less or equal to 28 m/s with a return period of 5 years according to the NEN-EN 13814. If the construction will be used in an area which requires a higher extreme thrust, the user need to be aware that using the same extreme thrust value the return period will be less than 5 years.

In the NEN-EN 1991 there are 4 different terrain categories determined. In the tables on the next pages the maximum wind gust is presented which the construction can withstand in the in-service and the out-service situations, in conjunction with the height and the terrain category. The figure in the column with the head V_b in m/s is the mean wind velocity measured on 10m height in the concerning terrain category, it is recommended to use a professional weather station near to the place where the construction is build. The column with the head Max. wind gust is the maximum peak wind which is determined from the peak wind velocity by the law of Bernoulli.

Because the maximum height of the construction with a stage of 2-meter floor level is below 8 meter, only the table from 0 < 8 m is presented on the next page.

1.6.2 In-service situation.

The 20 m/s which is mentioned as the maximum wind gust for the in-service situation is based on an average between the wind gust of 17.89 m/s for 0 < 8 m and the wind gust 21.91 m/s for 8 < 20 m.

0 < 8 meter 0.20 kN/m²

Terrain category	V_b in m/s (1)	Max. wind gust (2)
Sea or coastal area exposed to open sea	10.58	17.89
Lakes or flat and horizontal area with negligible vegetation and without obstacles	11.02	17.89
Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	12.03	17.89
Area with regular cover of vegetation or buildings with isolated obstacles with separations of maximum 20 obstacles heights (such as villages, suburban terrain permanent forest)	14.29	17.89
Area in which at least 15% of the surface is covered with buildings and their average heights exceeds 15 m.	17.57	17.89

1.6.3 Out-service situation.

The 28m m/s which is mentioned as the maximum wind gust for the out-service situation is based on an average between the wind gust 26.46 m/s for 0 < 8 m and the wind gust 31.62 m/s for 8 < 20 m.

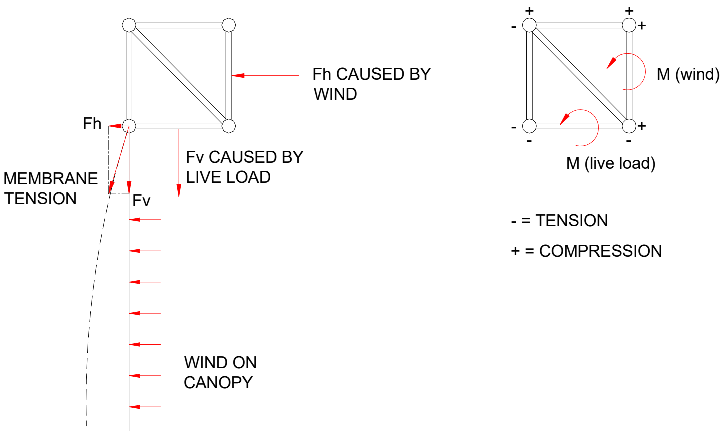
The wind pressure which is mentioned in the table below is increased with 20 % in comparison to the Eurocode 13814. This because the factor C_{tem}, which is 0.80 is taken out of the wind pressure values. Intentionally the factor C_{tem} is applied due to the fact that protection, reinforcement and sheltering is possible. In the case of these kind of structure’s this is not possible to do.

0 < 8 meter 0.4375 kN/m²

Terrain category	V_b in m/s (1)	Max. wind gust (2)
Sea or coastal area exposed to open sea	15.65	26.46
Lakes or flat and horizontal area with negligible vegetation and without obstacles	16.3	26.46
Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	17.79	26.46
Area with regular cover of vegetation or buildings with isolated obstacles with separations of maximum 20 obstacles heights (such as villages, suburban terrain permanent forest)	21.14	26.46
Area in which at least 15% of the surface is covered with buildings and their average heights exceeds 15 m.	25.99	26.46

1.6.4 Membrane tension of the canopy due to wind influences.

If there is a wind pressure applied to a membrane this membrane will have reaction forces in two directions on the connection to the construction. This phenomenon is called membrane tension. And in some cases, this extra loading need to be applied.



With a dynamic loading q=0.50 kN/m^2 applying an aerodynamic coefficient C_f =0.40 and a span of l=5.00 m a resulting membrane tension of Z=0.80 kN/m is derived.

$Z=(Zy^2+Zz^2)^{1/2}$ =0.80 kN/m with

Zz =0.5*0.4*5.0/2=0.50 kN/m
$Zy=(Z^2-Zz^2)^{1/2} =(0.80^2-0.50^2)^{1/2}$ =0.624
Zy/Zz=0.624/0.50=1.25 = 1 / 0.8

This force will be generated by the program itself because the wind loading is set to a membrane.

1.6.5 Snow Loads.

Snow loads are not taken into account in this calculation. Erection of the construction is initially intended to be in appropriate weather conditions. If the construction should be built in winter season, the construction need to be reinforced or kept free from snow, the method how the structure will be kept free from snow need to be written in the method statement.

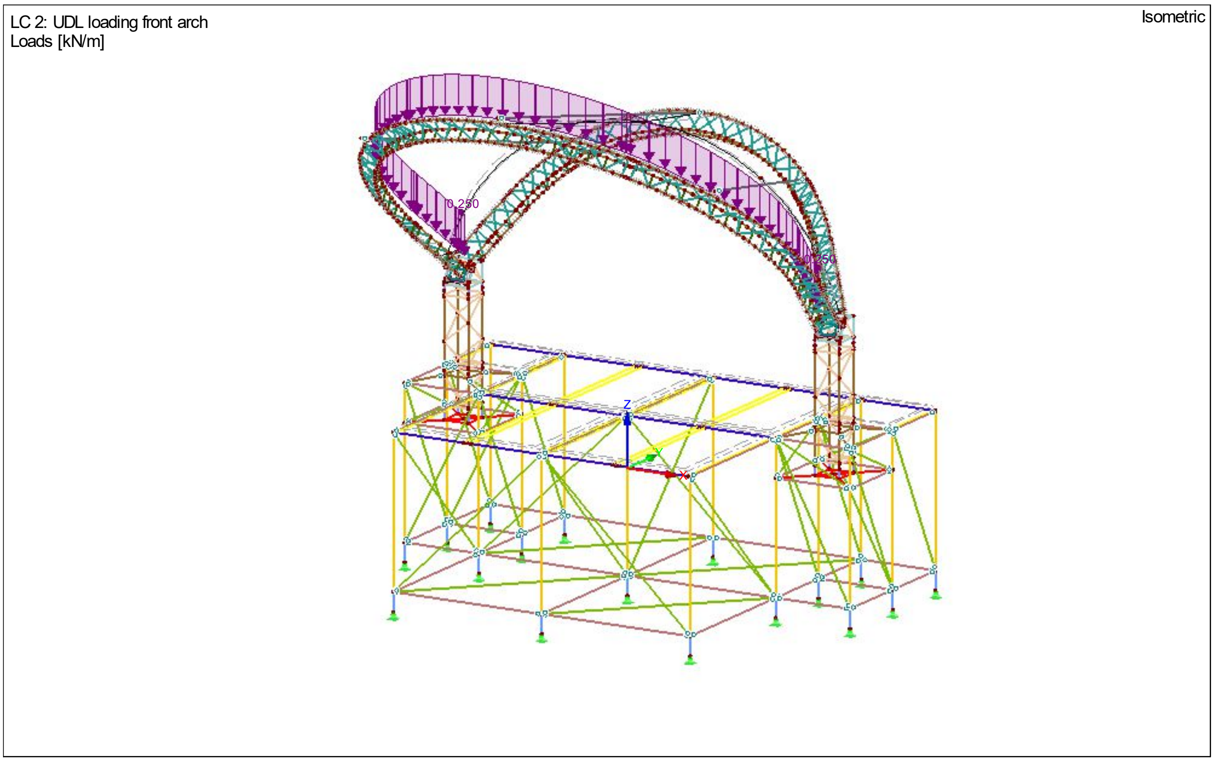
1.6.6 Live load.

In this report the maximum loading on the front and back arch of the construction is presented. These are intended to give an indication of the loading possibilities in the construction. If the actual loading of the construction deviates from these, for example when there is only 1 larger point load in the middle of the arch, an additional calculation need to be made.

1.7 Loading Configurations.

In the next chapters the live loads of the front and back arch is presented.

1.7.1 UDL Loading front arch

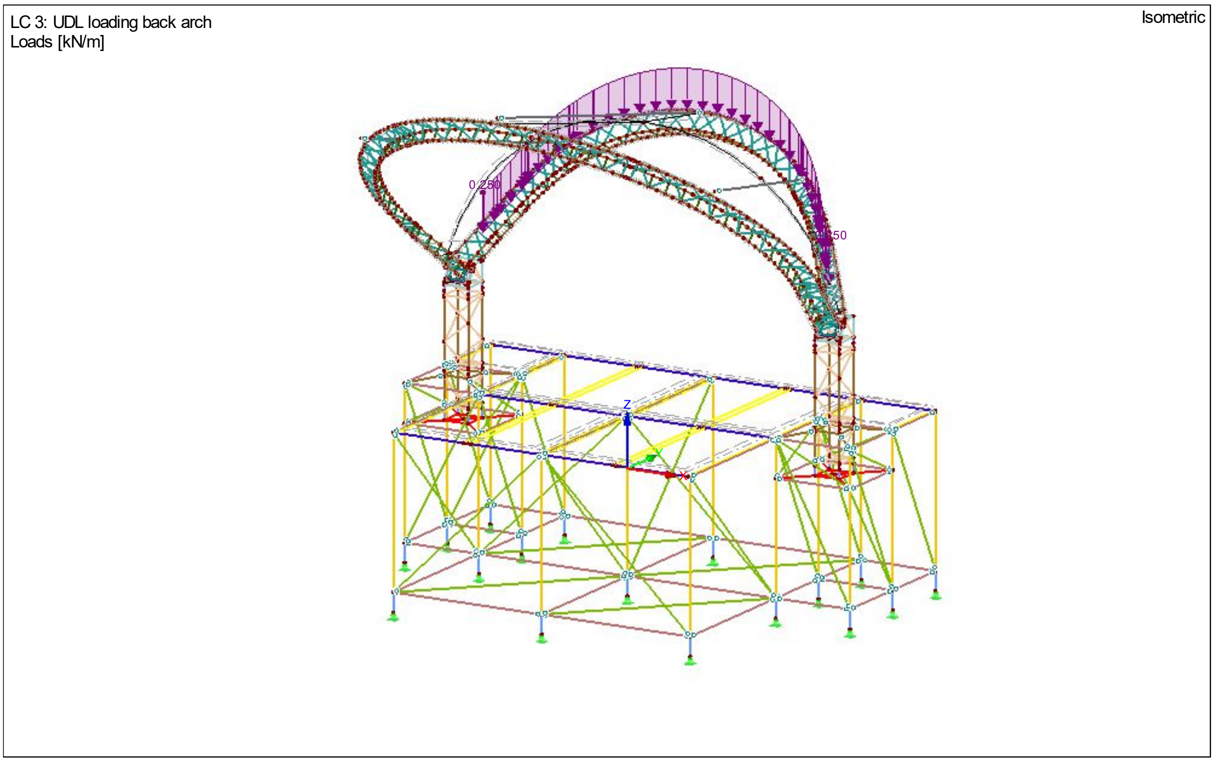


The loading which is taken into account in the UDL Loading setup are:

Front arch = 25 kg/m^{-1}

The total UDL loading on the front arch ~ 300 Kg

1.7.2 UDL Loading Back arch

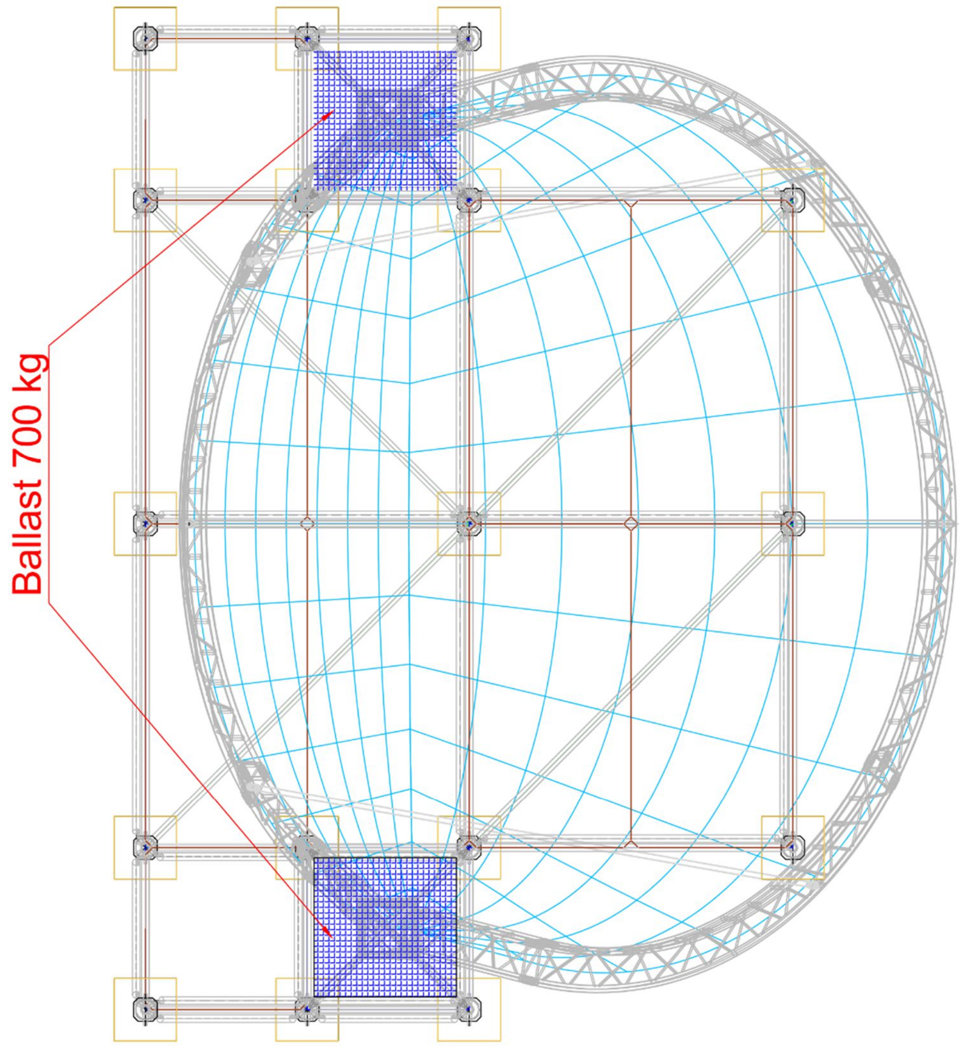


The loading which is taken into account in the UDL Loading setup are:

Front arch = 25 kg/m^{-1}

The total UDL loading on the front arch ~ 165 Kg

1.8 Necessary Ballast loading.



RAWN BY :	Ivo Mulder	PROJECT NR	: 2017021	REMARKS :	UNIT : MM
ATE :	24-5-2018	CUSTOMER	: Eekels Verhuur		
EVISION :		STATUS	:		

ESCRIPTION :

DJ Roof 2018 Ballast Drawing

A3

Structural Event Engineering

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The ballast is checked for uplift, overturning and sliding. The Layher stage which is designed as a ridged stage has been taken into account.

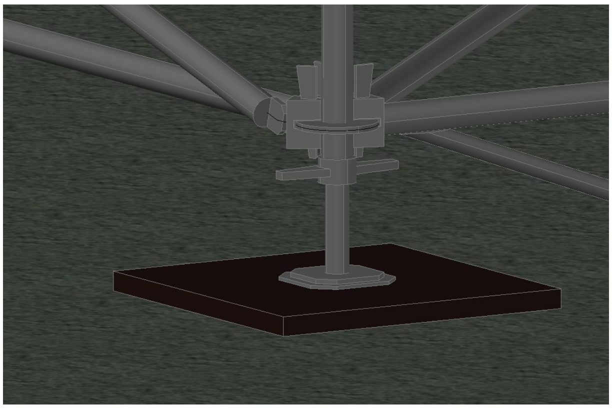
All permanent installed loading can be subtracted from the nearest Ballast position

The safety factor for the ballast calculation against slipping is set to 1.2 according to the NEN-EN 13814. This is based on a horizontal load which is relying on friction.
For the friction coefficient the factor of 0.4 has been taken into account.

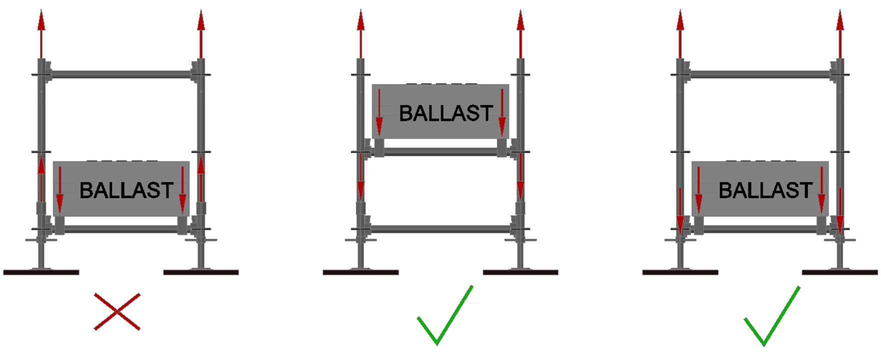
Table 3 — Coefficients of friction μ

	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay[a]	0,25	0,2	0,25
Loam[a]	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65

[a] At least of stiff consistency in accordance with ENV 1997-1.



The ballast need to be placed in such a way that it will be activated when lifting forces are applied. If the ballast is placed on the bottom level the use of Layher uprights with connected base collar is necessary.



2.0 General calculation input.

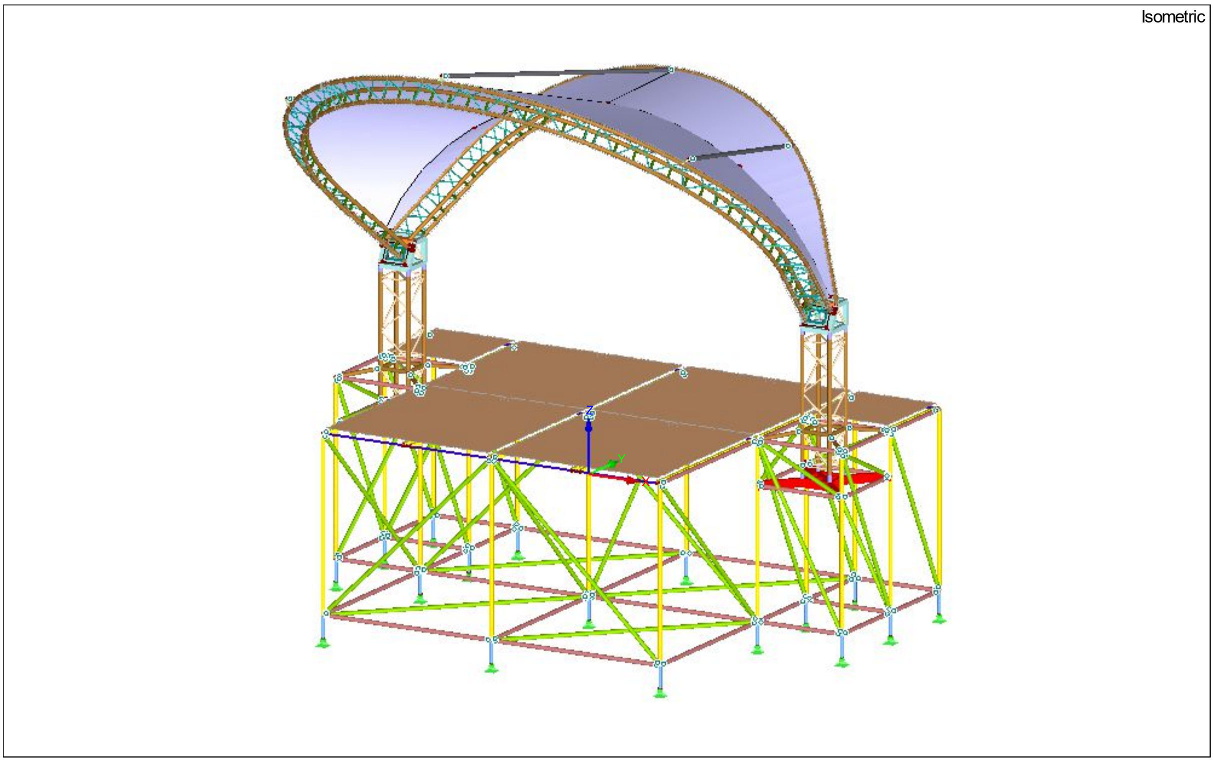
2.1 Information About the calculation program.

For the calculation of the construction the program RFem from Dlubal software GmbH has been used. The calculation of the Load cases has been made according to the Geometrically Linear analyses principle. The calculation of the Load combinations has been made according to the Large deformation analyse principle.

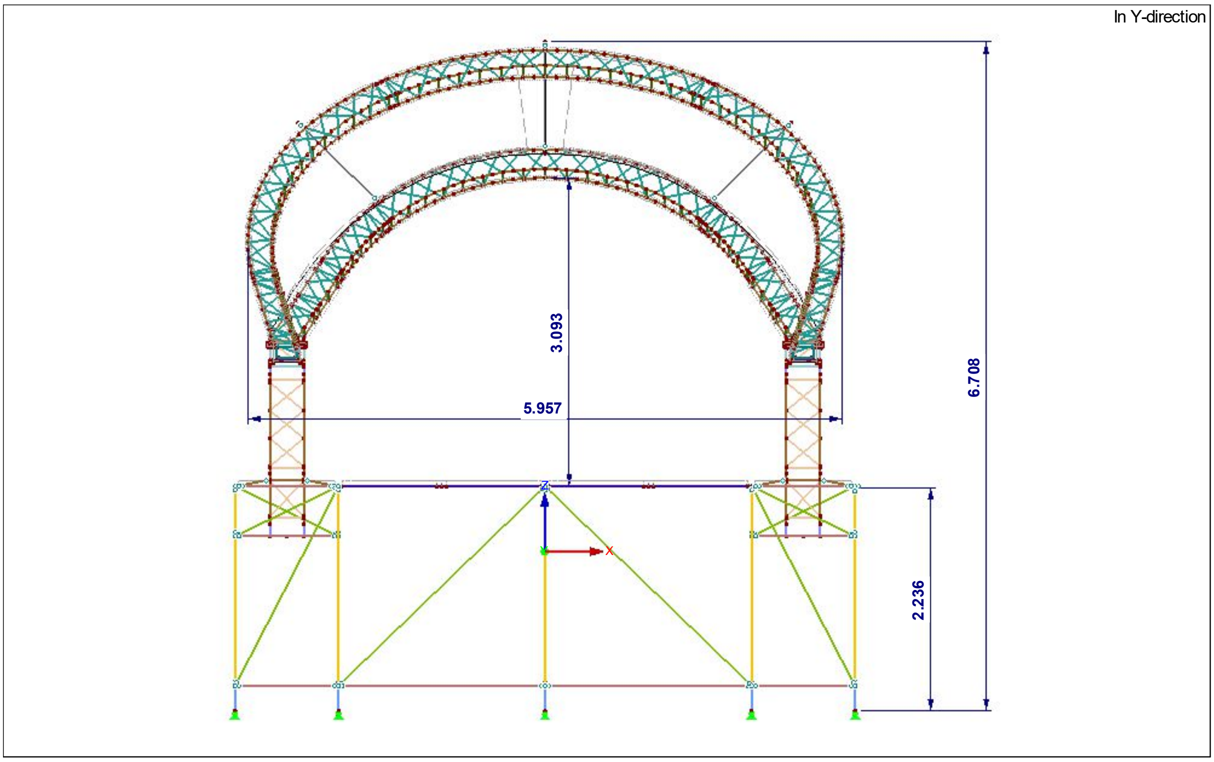
2.2 Construction model of the DJ roof 2018.

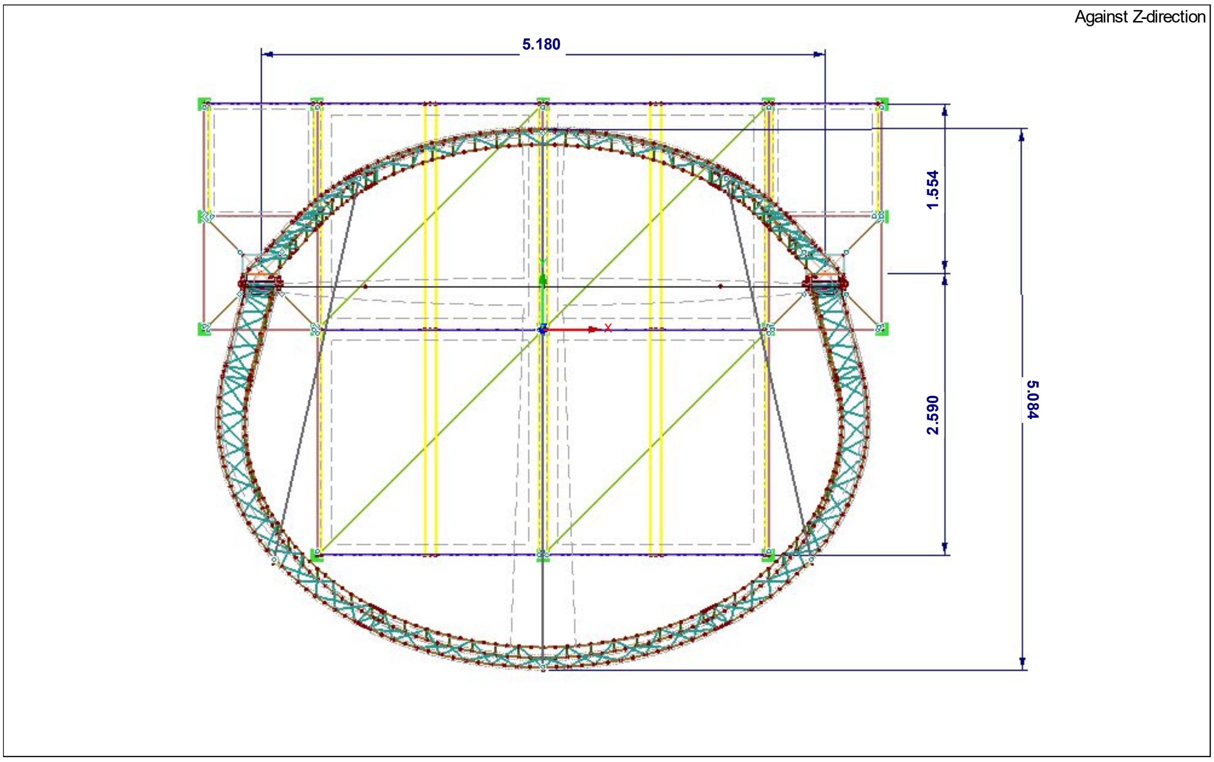
For the construction two models have been entered the program. The first model is for the In service situation, the second model is for the Out service situation in which the canopy has been removed.

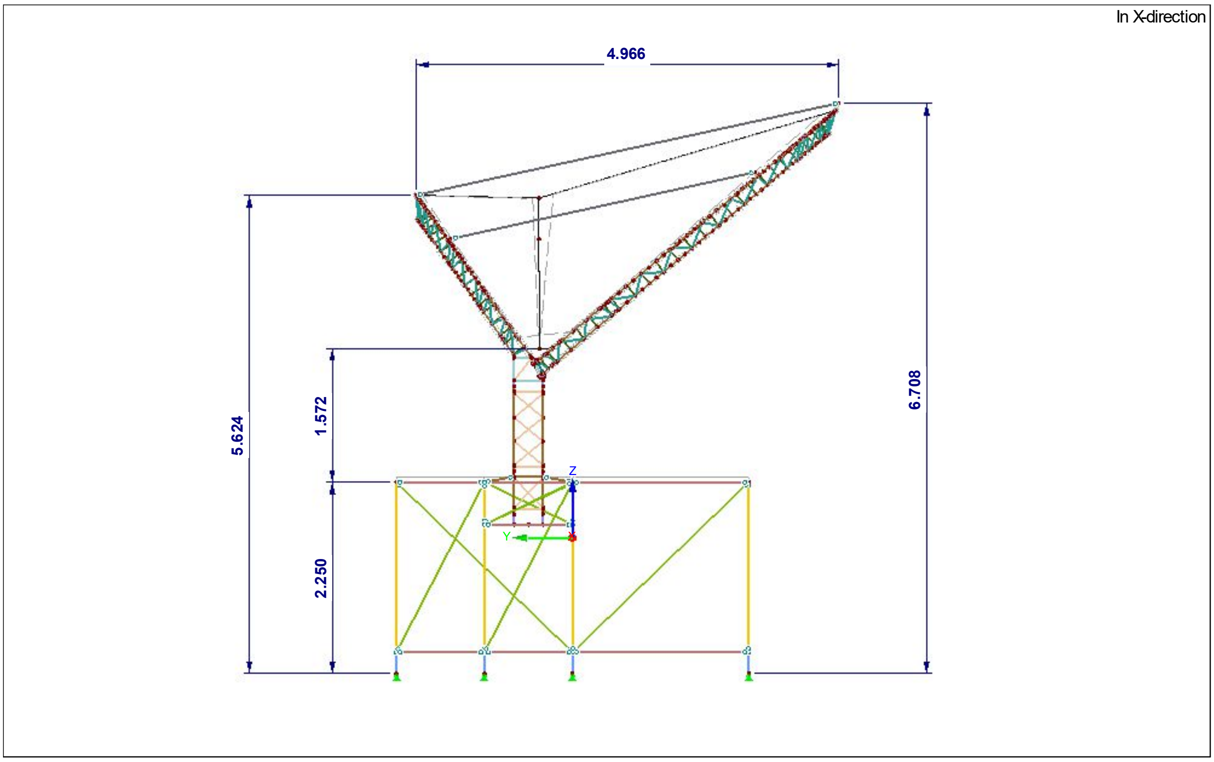
In service model



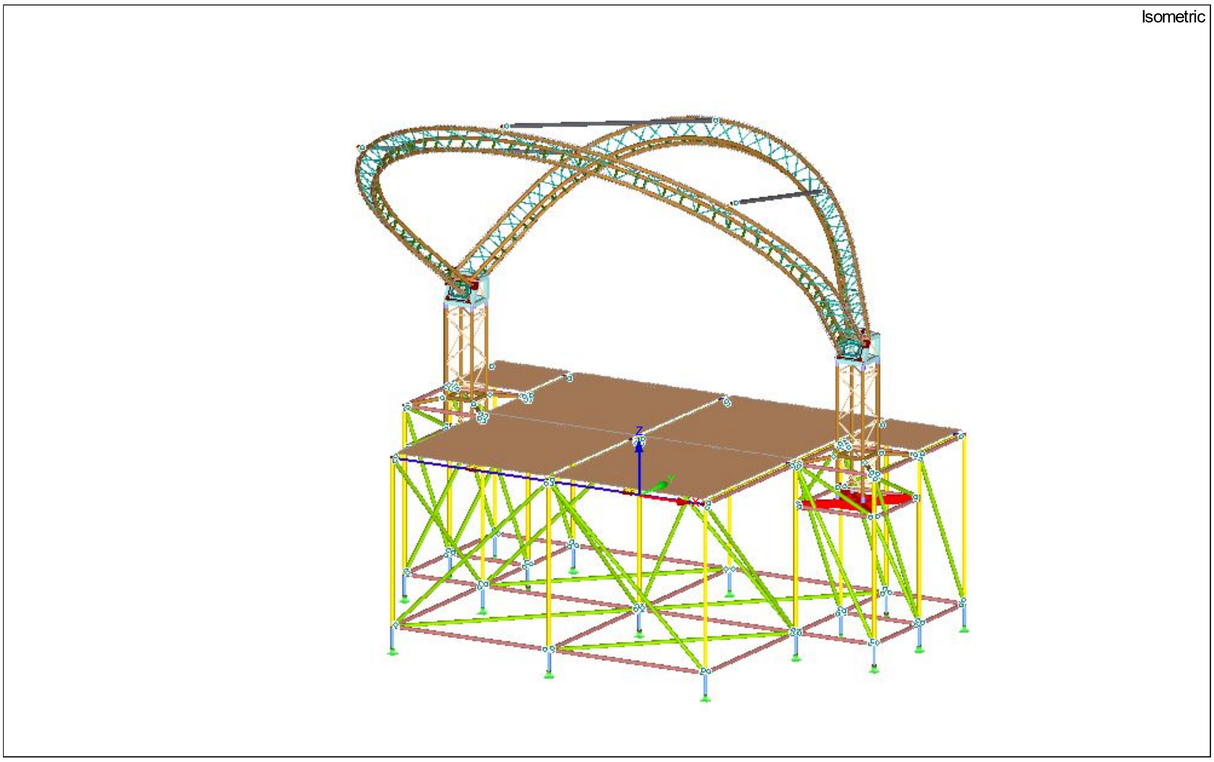
Cross-Sections
1: Ring 38/4.5; S320GD 1.0250
2: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
3: RO 48.3x3.2 (Hot Formed); Steel S 235 JR
4: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
5: RRO 100x50x3.2 (Hot Formed); Steel S 235 JR
6: Ring 50/6; Aluminum EN-AW 6082 (EP,ET) T6
7: Ring 48/3; Aluminum EN-AW 6082 (EP,ET) T6
8: Ring 30/3; Aluminum EN-AW 6082 (EP,ET) T6
9: Ring 20/2; Aluminum EN-AW 6082 (EP,ET) T6
10: HK 50/50/5/5/5/5; Aluminum EN-AW 6082 (EP,ET) T6
11: TO 50/100/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
12: Ring 16/2; Aluminum EN-AW 6082 (EP,ET) T6
13: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
14: Rectangle 15/60; Aluminum EN-AW 6082 (EP,ET) T6
15: RD 20; steel 8.8 kw aliteit
16: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
17: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6


In Y-direction
3.093
5.957
6.708
2.236


Against Z-direction
5.180
1.554
2.590
5.084



Out service model



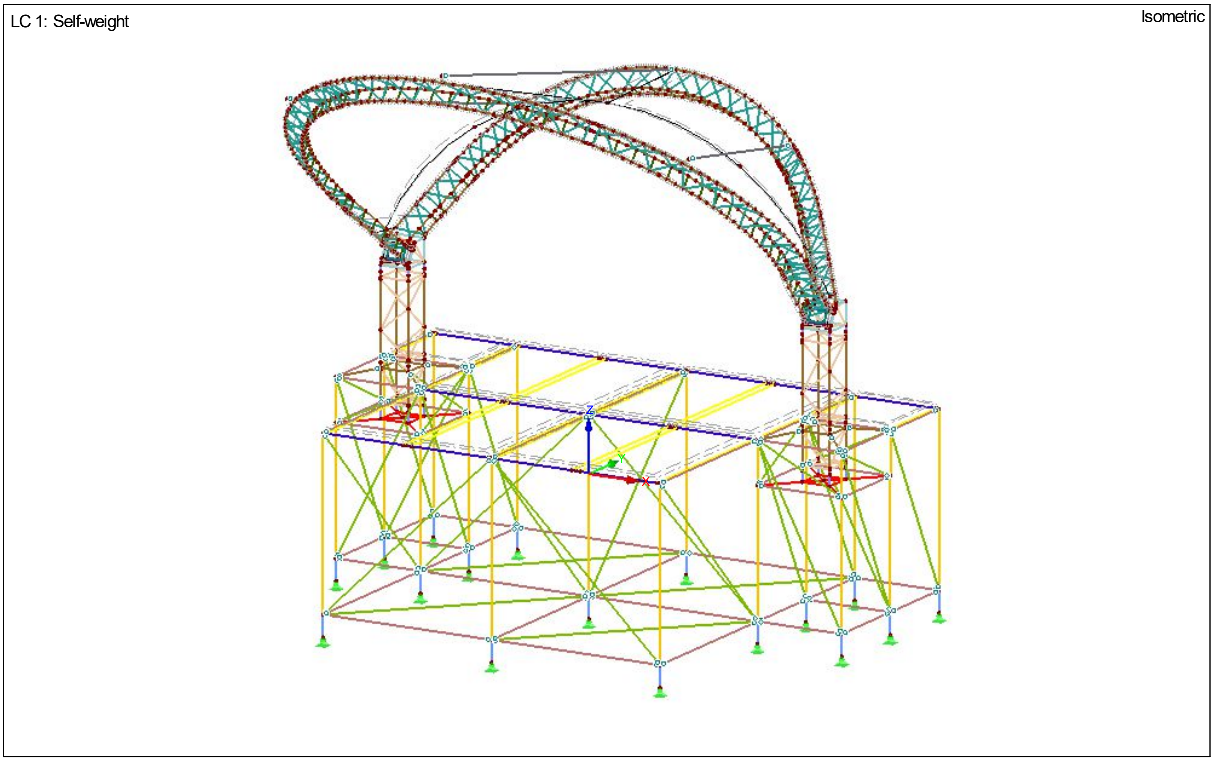
2.3 Different load cases.

For the calculation different load cases have been constructed in the program.

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Active	Self-Weight - Factor in Direction X	Y	Z
LC1	Self-weight	+	Permanent	+	0,000	0,000	-1,000
LC2	UDL loading front arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC3	UDL loading back arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC100	wind direction 0° In service	+	Wind	-	0,000	0,000	0,000
LC101	wind direction 90° In service	+	Wind	-	0,000	0,000	0,000
LC200	wind direction 0° Out service	+	Wind	-	0,000	0,000	0,000
LC201	wind direction 90° Out service	+	Wind	-	0,000	0,000	0,000

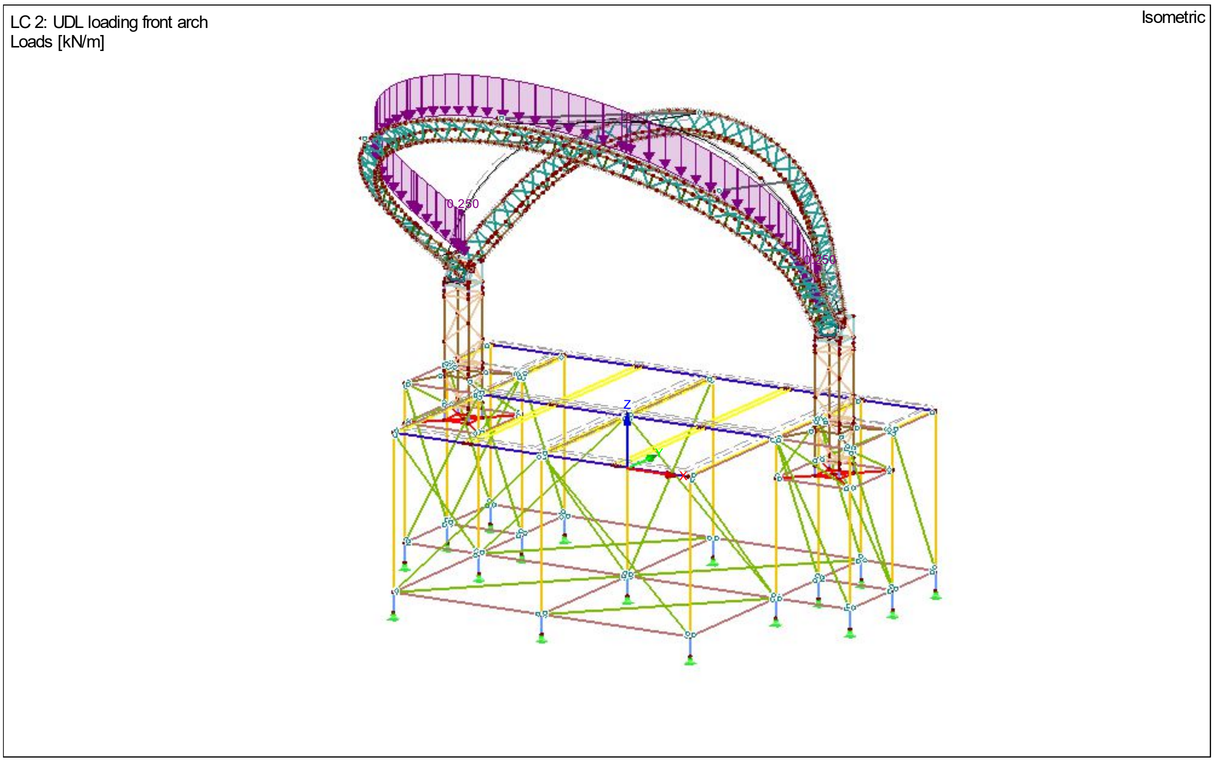
2.4 load case input

2.4.1 LC1 Self-Weight



Self-weight of the system is calculated by the program itself.

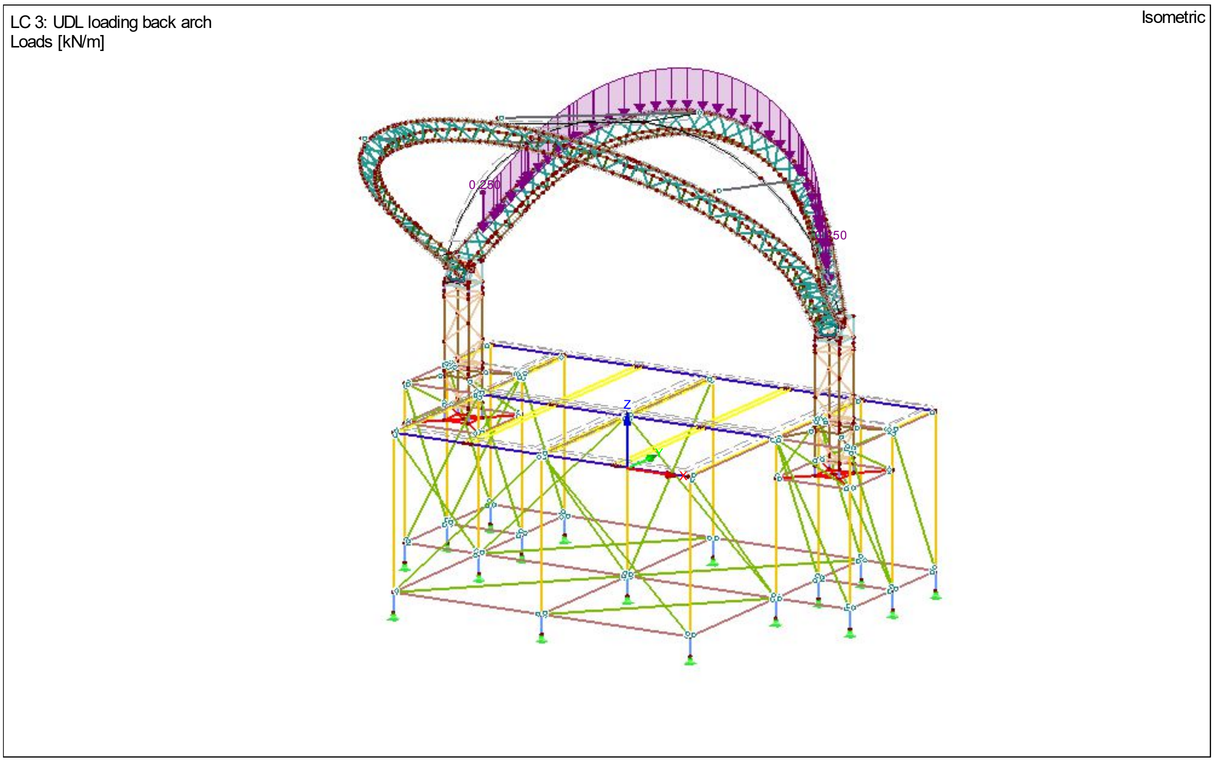
1.4.2 LC2 UDL Loading front arch



The loading which is taken into account in the UDL Loading setup are:

Front arch = 0.25 kN/m^{-1}

1.4.3 LC3 UDL Loading Back arch



The loading which is taken into account in the UDL Loading setup are:

Front arch = 0.25 kN/m^{-1}

2.5 Load cases concerning wing loading.

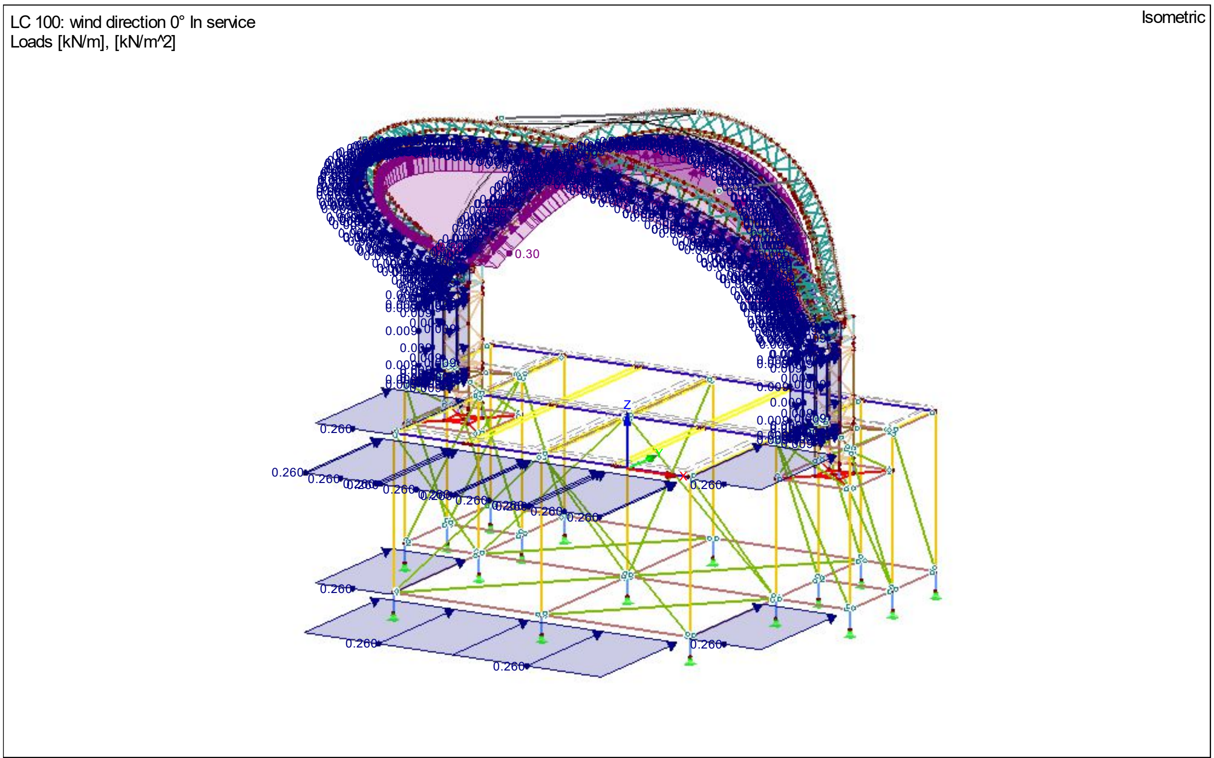
For the calculation of the wind loading the next wind coefficient are used. These factors are subtracted from the Eurocode NEN-EN 1991-1 1-4: general actions – wind actions and EN-AW-13814: Fairground and amusement park machinery and structures safety

Wind from the front Cf = 1.5 for the roof

Wind from the side Cf = 1.3 for the roof

Wind on the stage for both directions Cf = 1.3

2.5.1 LC100 wind direction 0° In service.



Wind calculations Roof Membrane

$q_{w,\,roof}$ = 1.5 * 0.2 * 1 = 0.30 kN/m

Wind on stage.

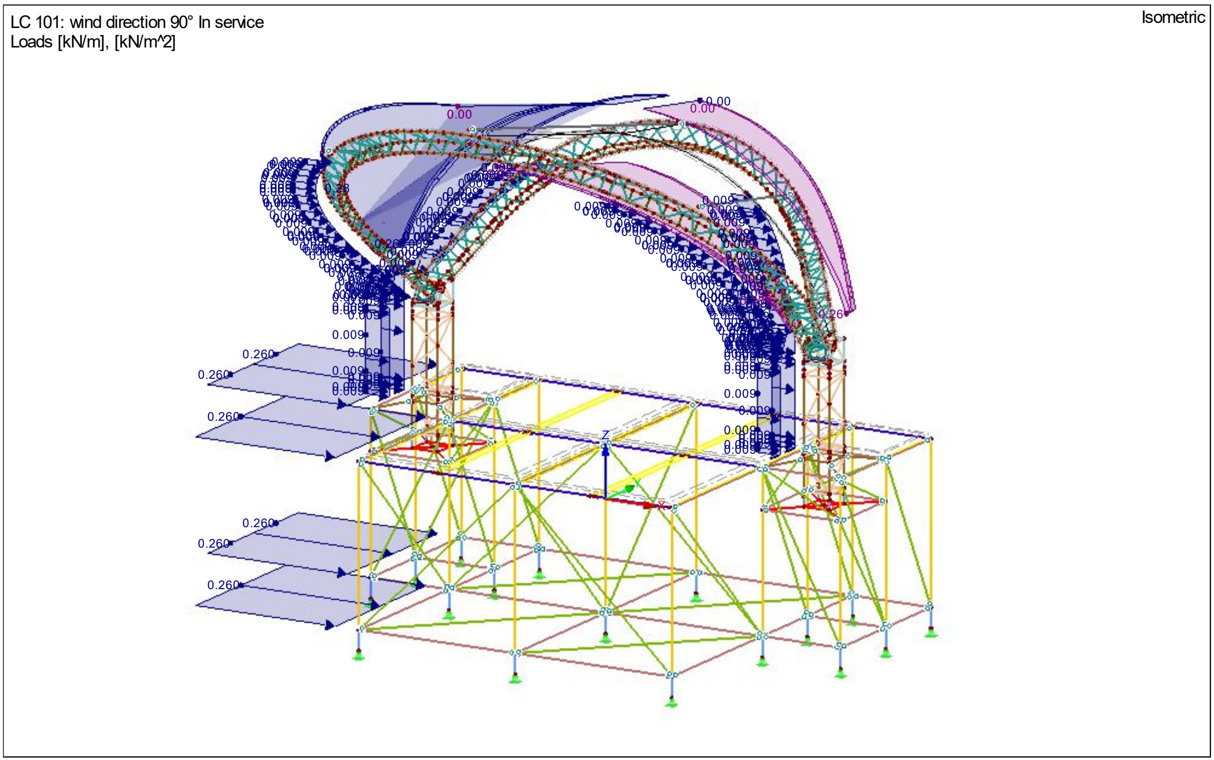
$q_{w,\,stage}$ = 1.3 * 0.2 * 2 / 2 = 0.26 kN/m
These loads have been set on the top and the bottom ledger in the direction of the wind.

wind on truss Tubes.

On all tubes with measurement of 48mm which are exposed to the wind a loading has been set

$q_{w,\,profile\ 48\ mm}$ = 1 * 0.2 * 0.048 = 0.009 kN/m

2.5.2 LC101 wind direction 90° In service.



Wind calculations Roof Membrane

$q_{w,\ roof} = 1.3 * 0.2 * 1 = 0.26$ kN/m

Wind on stage.

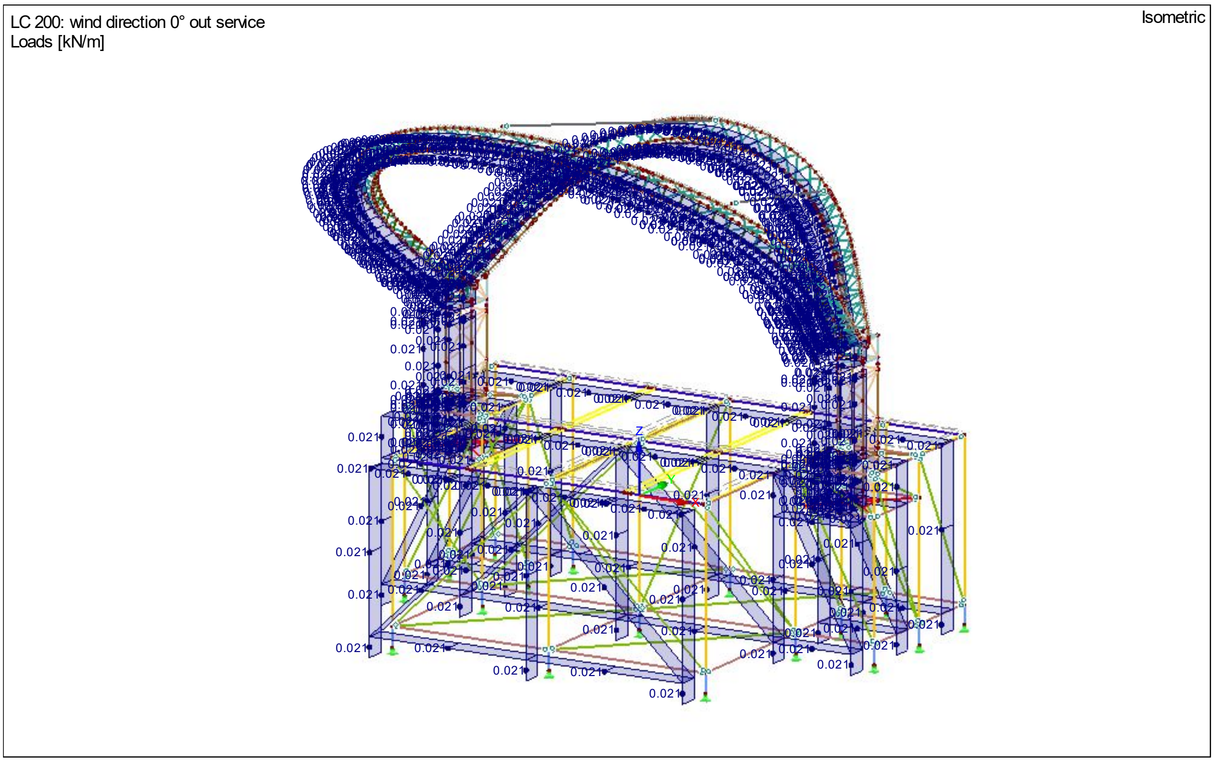
$q_{w,\ stage} = 1.3 * 0.2 * 2 / 2 = 0.26$ kN/m
These loads have been set on the top and the bottom ledger in the direction of the wind.

wind on truss Tubes.

On all tubes with measurement of 48mm which are exposed to the wind a loading has been set

$q_{w,\ profile\ 48\ mm} = 1 * 0.2 * 0.048 = 0.009$ kN/m

2.5.3 LC200 wind direction 0° Out service.

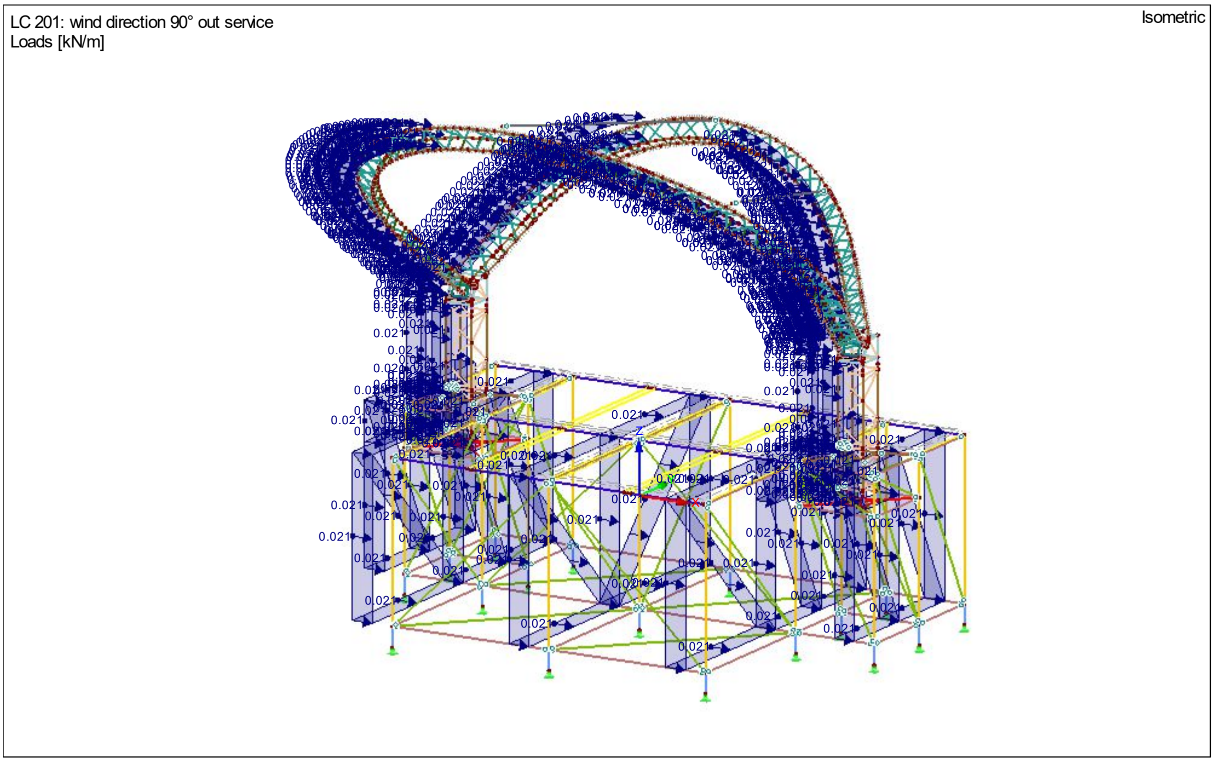


wind on truss and Layher.

On all tubes with measurement of 48mm which are exposed to the wind a loading has been set

$q_{w,\text{ profile 48 mm}}$ = 1 * 0.4375 * 0.048 = 0.021 kN/m

2.5.4 LC201 wind direction 90° Out service.



wind on truss and Layher.

On all tubes with measurement of 48mm which are exposed to the wind a loading has been set

$q_{w,\ profile\ 48\ mm}$ = 1 * 0.4375 * 0.048 = 0.021 kN/m

2.6 Load combinations and result combinations

Different load combinations have been generated in the program.

The calculation has been done according to the stress capacity calculation.

The partial safety factors are According to the EN 13814:2004 chapter 5.3.6.1

γ_G = 1.1 or 1.35	Partial safety factors for permanent actions
$\gamma_{k,i}$ = 1.35	Partial safety factors for variable actions

The fundamental combinations are

$\Sigma\ \gamma_G\ G_k$	$(= \Sigma\ 1.35 * G_k)$
$\Sigma\ \gamma_G\ G_k + \Sigma\ \gamma_{k,i}\ Q_{k,I}$	$(= \Sigma\ 1.1 * G_k + \Sigma\ 1.35 * Q_{k,i})$
G_k	Characteristic value of permanent actions
$Q_{k,i}$	Characteristic value of one of the variable actions

The γ_G is set to 1.15 as an extra safety for all the small extra material which are used in the construction and which are not specific inserted in the Self-weight load case. These extra materials are for example retched straps, steel wire's, clamps….

2.6.1 load combinations.

CO1-CO2 General load combinations

CO50-CO51 Characteristic calculation General load combinations

CO100-CO105 Design calculation In-service wind

CO150-CO155 Characteristic calculation In-service wind

CO200-CO205 Design calculation Out-service wind

CO250-CO255 Characteristic calculation Out-service wind

Load combinations In service model

Load	Load Combination		To	LC.1		LC.2		LC.3		LC.4	
Combin.	DS	Description	Solve	Factor	No.	Factor	No.	Factor	No.	Factor	No.
CO1	0	1.15*LC1 + 1.35*LC2	+	1,150	LC1	1,350	LC2				
CO2	0	1.15*LC1 + 1.35*LC2 + 1.35*LC3	+	1,150	LC1	1,350	LC2	1,350	LC3		
CO50	0	LC1 + LC2	+	1,000	LC1	1,000	LC2				
CO51	0	LC1 + LC2 + LC3	+	1,000	LC1	1,000	LC2	1,000	LC3		
CO100	0	1.15*LC1 + 1.35*LC100	+	1,150	LC1	1,350	LC100				
CO101	0	1.15*LC1 + 1.35*LC2 + 1.35*LC100	+	1,150	LC1	1,350	LC2	1,350	LC100		
CO102	0	1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC100	+	1,150	LC1	1,350	LC2	1,350	LC3	1,350	LC100
CO103	0	1.15*LC1 + 1.35*LC101	+	1,150	LC1	1,350	LC101				
CO104	0	1.15*LC1 + 1.35*LC2 + 1.35*LC101	+	1,150	LC1	1,350	LC2	1,350	LC101		
CO105	0	1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC101	+	1,150	LC1	1,350	LC2	1,350	LC3	1,350	LC101
CO150	0	LC1 + LC100	+	1,000	LC1	1,000	LC100				
CO151	0	LC1 + LC2 + LC100	+	1,000	LC1	1,000	LC2	1,000	LC100		
CO152	0	LC1 + LC2 + LC3 + LC100	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC100
CO153	0	LC1 + LC101	+	1,000	LC1	1,000	LC101				
CO154	0	LC1 + LC2 + LC101	+	1,000	LC1	1,000	LC2	1,000	LC101		
CO155	0	LC1 + LC2 + LC3 + LC101	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC101

Load combinations Out service model

Load	Load Combination		To	LC.1		LC.2		LC.3		LC.4	
Combin.	DS	Description	Solve	Factor	No.	Factor	No.	Factor	No.	Factor	No.
CO1	0	1.15*LC1 + 1.35*LC2	+	1,150	LC1	1,350	LC2				
CO2	0	1.15*LC1 + 1.35*LC2 + 1.35*LC3	+	1,150	LC1	1,350	LC2	1,350	LC3		
CO50	0	LC1 + LC2	+	1,000	LC1	1,000	LC2				
CO51	0	LC1 + LC2 + LC3	+	1,000	LC1	1,000	LC2	1,000	LC3		
CO200	0	1.15*LC1 + 1.35*LC200	+	1,150	LC1	1,350	LC200				
CO201	0	1.15*LC1 + 1.35*LC2 + 1.35*LC200	+	1,150	LC1	1,350	LC2	1,350	LC200		
CO202	0	1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC200	+	1,150	LC1	1,350	LC2	1,350	LC3	1,350	LC200
CO203	0	1.15*LC1 + 1.35*LC201	+	1,150	LC1	1,350	LC201				
CO204	0	1.15*LC1 + 1.35*LC2 + 1.35*LC201	+	1,150	LC1	1,350	LC2	1,350	LC201		
CO205	0	1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC201	+	1,150	LC1	1,350	LC2	1,350	LC3	1,350	LC201
CO250	0	LC1 + LC200	+	1,000	LC1	1,000	LC200				
CO251	0	LC1 + LC2 + LC200	+	1,000	LC1	1,000	LC2	1,000	LC200		
CO252	0	LC1 + LC2 + LC3 + LC200	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC200
CO253	0	LC1 + LC201	+	1,000	LC1	1,000	LC201				
CO254	0	LC1 + LC2 + LC201	+	1,000	LC1	1,000	LC2	1,000	LC201		
CO255	0	LC1 + LC2 + LC3 + LC201	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC201

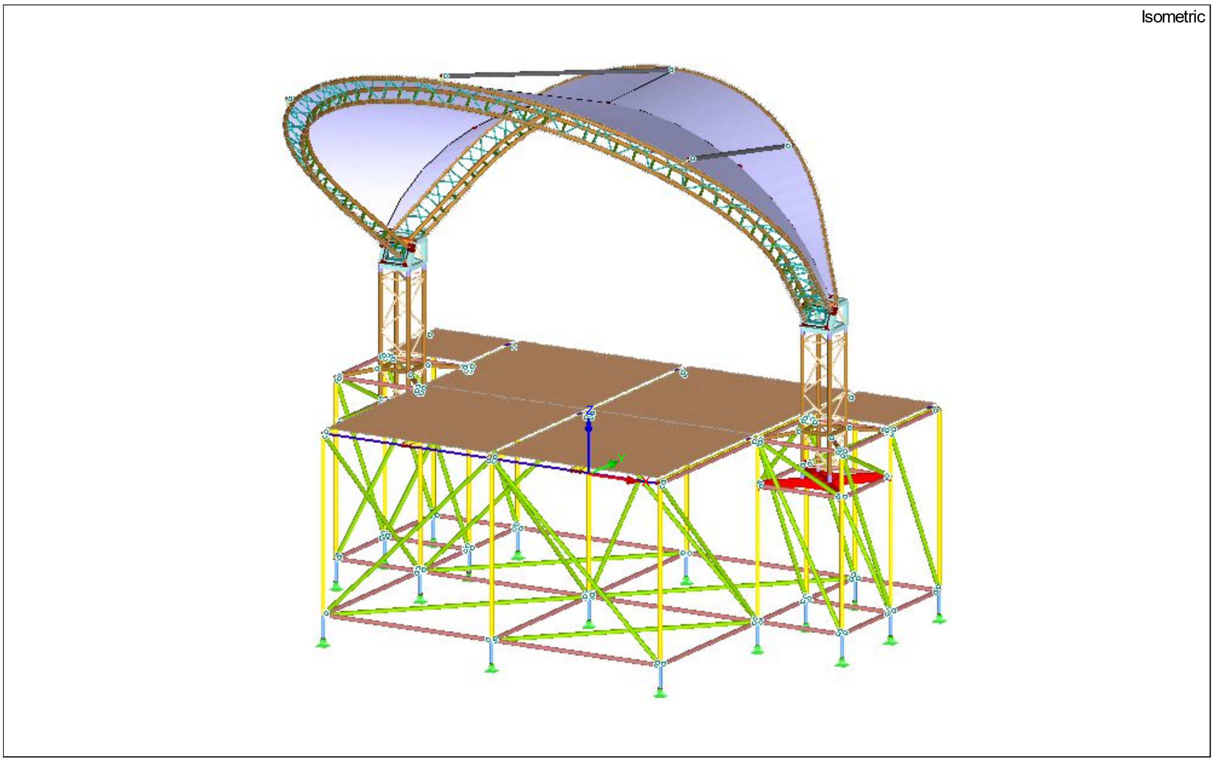
2.6.2 result combinations

Different Result calculation have been generated in the program.

RC1 - General loading without wind	: 1 * (CO1 or to CO2)
RC2 - Characteristic values General loading without wind	: 1 * (CO50 or to CO51)
RC3 - Design values In-service	: 1 * (CO100 or to CO105)
RC4 - Characteristic values In-service	: 1 * (CO150 or to CO155)
RC5 - Design values Out-service	: 1 * (CO200 or to CO205)
RC6 - Characteristic values Out-service	: 1 * (CO250 or to CO255)

2.7 Calculation results for the In service situation

Construction scheme In service Model



Cross-Sections
- 1: Ring 38/4.5; S320GD 1.0250
- 2: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 3: RO 48.3x3.2 (Hot Formed); Steel S 235 JR
- 4: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 5: RRO 100x50x3.2 (Hot Formed); Steel S 235 JR
- 6: Ring 50/6; Aluminum EN-AW 6082 (EP,ET) T6
- 7: Ring 48/3; Aluminum EN-AW 6082 (EP,ET) T6
- 8: Ring 30/3; Aluminum EN-AW 6082 (EP,ET) T6
- 9: Ring 20/2; Aluminum EN-AW 6082 (EP,ET) T6
- 10: HK 50/50/5/5/5/5; Aluminum EN-AW 6082 (EP,ET) T6
- 11: TO 50/100/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 12: Ring 16/2; Aluminum EN-AW 6082 (EP,ET) T6
- 13: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 14: Rectangle 15/60; Aluminum EN-AW 6082 (EP,ET) T6
- 15: RD 20; steel 8.8 kw aliteit
- 16: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 17: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6

2.7.1 Used Materials

Material No.	Material Description	Modulus of Elasticity E [kN/cm²]	Shear Modulus G [kN/cm²]	Poisson's Ratio ν [-]	Specific Weight γ [kN/m³]	Coeff. of Th. Exp. α [1/°C]	Partial Factor γ_M [-]	Material Model
1	S320GD 1.0250 | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
2	Steel S 235 JR | EN 10025:1994-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,100	Isotropic Linear Elastic
3	Aluminum EN-AW 6082 (EP,ET) T6 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic
4	Aluminum EN-AW 5083 O/H111 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic
5	canopy | No code	60,00	20,00	0,500	0,65	1,00E-05	1,000	Isotropic Linear Elastic
6	steel 8.8 kwaliteit | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
7	Plywood, Class F20/10 E40/20, Plate Stress, Perpendicular | EN 12369-2:2011-06	200,00	3,50	3,286	5,00	5,00E-06	1,200	Orthotropic Elastic 2D...
8	Aluminum EN-AW 6005A (EP/O,ER/B) T6 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic

2.7.2 Used cross sections

Section	Cross-Section	Material	Moments of inertia [cm⁴]			Cross-Sectional Areas [cm²]			Principal Axes	Rotation	Overall Dimensions [mm]	
			Torsion	Bending	Bending		Shear	Shear			Width	Depth
No.	Description [mm]	No.	J	I_y	I_z	Axial A	A_y	A_z	α [°]	α' [°]	b	h
1	Ring 38/4.5	1	13,53	6,76	6,76	4,74	2,44	2,44	0,00	0,00	38,0	38,0
2	RO 48.3x3.2 (Hot Formed)	1	23,20	11,60	11,60	4,53	2,26	2,26	0,00	0,00	48,3	48,3
3	RO 48.3x3.2 (Hot Formed)	2	23,20	11,60	11,60	4,53	2,26	2,26	0,00	0,00	48,3	48,3
4	RO 48.3x2.6 (Hot Formed)	2	19,60	9,78	9,78	3,73	1,85	1,85	0,00	0,00	48,3	48,3
5	RRO 100x50x3.2 (Hot Formed)	2	93,40	116,00	38,80	9,08	2,01	5,71	0,00	0,00	50,0	100,0
6	Ring 50/6	3	40,89	20,44	20,44	8,29	4,27	4,27	0,00	0,00	50,0	50,0
7	Ring 48/3	3	21,57	10,78	10,78	4,24	2,14	2,14	0,00	0,00	48,0	48,0
8	Ring 30/3	3	4,69	2,35	2,35	2,54	1,30	1,30	0,00	0,00	30,0	30,0
9	Ring 20/2	3	0,93	0,46	0,46	1,13	0,58	0,58	0,00	0,00	20,0	20,0
10	HK 50/50/5/5/5/5	3	48,28	30,75	30,75	9,00	4,00	4,00	0,00	0,00	50,0	50,0
11	TO 50/100/4/4/4/4	3	110,47	47,37	144,13	11,36	7,07	2,44	0,00	0,00	100,0	50,0
12	Ring 16/2	3	0,44	0,22	0,22	0,88	0,45	0,45	0,00	0,00	16,0	16,0
13	Ring 50/4	3	30,81	15,41	15,41	5,78	2,93	2,93	0,00	0,00	50,0	50,0
14	Rectangle 15/60	3	5,69	27,00	1,69	9,00	7,50	7,50	0,00	0,00	15,0	60,0
15	RD 20	6	1,57	0,79	0,79	3,14	2,64	2,64	0,00	0,00	20,0	20,0
16	EV transom	8	50,00	554,00	70,00	18,78	18,00	18,00	0,00	0,00	49,0	172,5
17	HK 50/30/4/4/4/4	8	16,87	17,67	7,52	5,76	1,62	3,48	0,00	0,00	30,0	50,0

2.7.3 Calculation summary for the In service situation

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	78,1	mm	CO103, FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-78,3	mm	CO104, FE Mesh Node No. 6003 (X: -1.640, Y: -1.229, Z: 4.299 m)
	Maximum displacement in Z-direction	-179,8	mm	CO104, FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum vectorial displacement	204,3	mm	CO104, FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum rotation about X-axis	-32,9	mrad	CO100, Member No. 481, x: 0.000 m
	Maximum rotation about Y-axis	-32,1	mrad	CO1, Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	16,9	mrad	CO104, Member No. 412, x: 0.135 m
	Number of 1D finite elements (member elements)	3413		
	Number of 2D finite elements (surface elements)	12431		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	8980		
	Number of equations	53880		
	Matrix solver method	Direct		
	Maximum number of iterations	100		
	Number of divisions for member results	10		
	Number of divisions of members with cable, elastic foundation, taper, or plastic characteristic	10		
	Activate shear stiffness of members (A-y, A-z)	+		
	Plate bending theory	Mindlin		
	Precision of convergence criteria of nonlinear calculation	1		

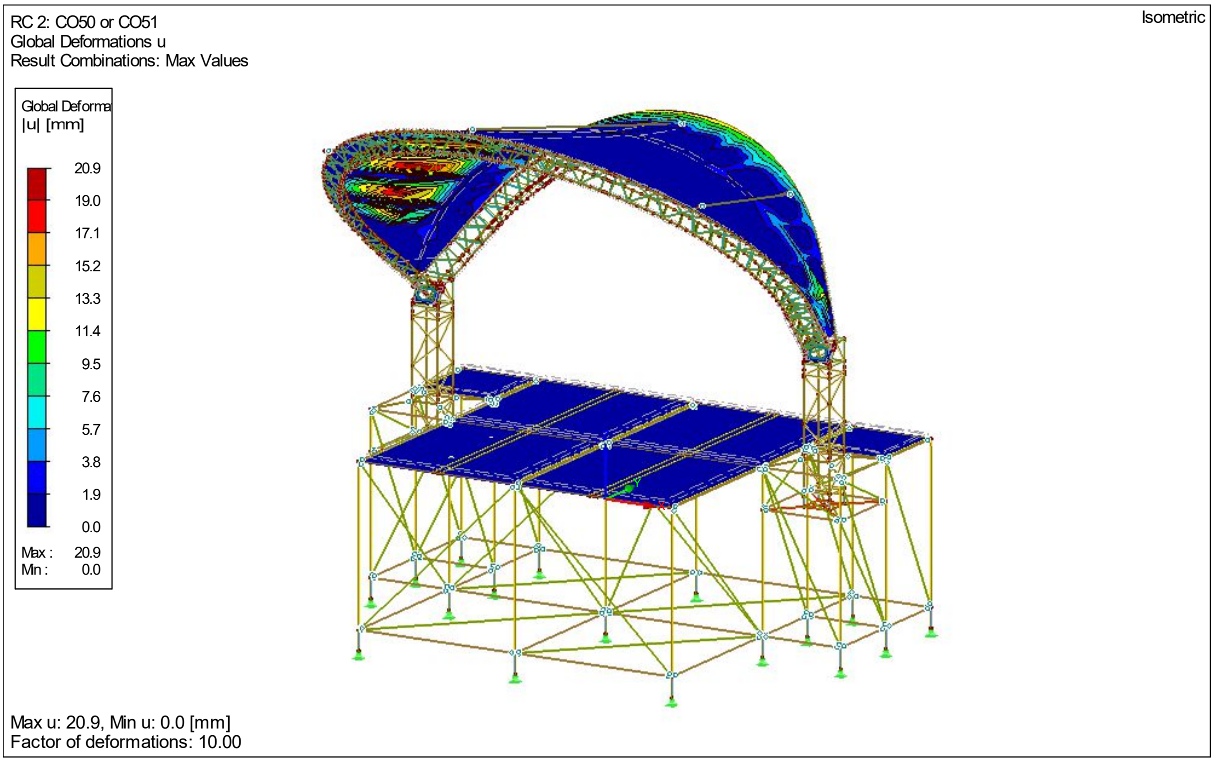
2.7.4 Calculation result of the separate load cases.

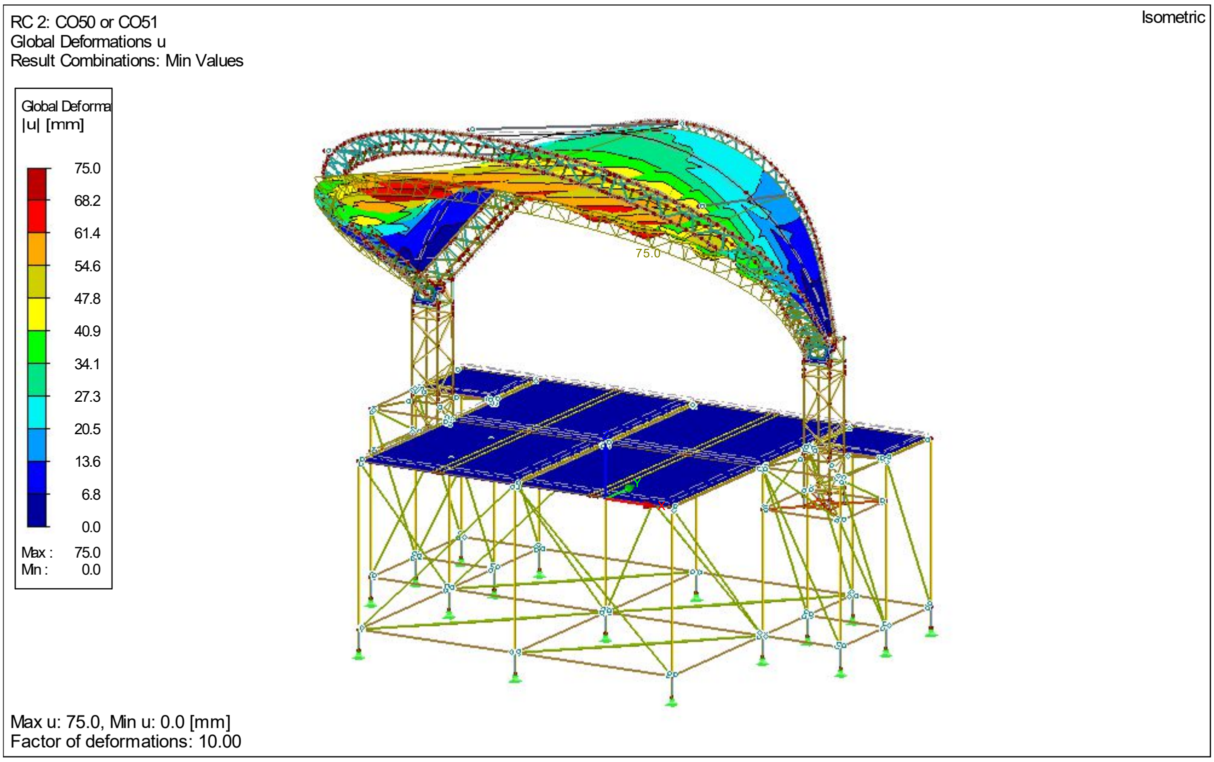
	Description	Value	Unit	Comment
	LC1 - Self-weight			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-11,27	kN	
	Sum of support forces in Z	-11,27	kN	Deviation: 0.00 %
	Resultant of reactions about X	0,004	kNm	At center of gravity of model (X: 0.003, Y: 0.209, Z: 0.417 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,000	kNm	At center of gravity of model
	Maximum displacement in X-direction	-2,0	mm	FE Mesh Node No. 5903 (X: -2.678, Y: 0.104, Z: 2.749 m)
	Maximum displacement in Y-direction	-7,4	mm	Member No. 481, x: 2.034 m
	Maximum displacement in Z-direction	-14,7	mm	Member No. 481, x: 2.034 m
	Maximum vectorial displacement	16,4	mm	Member No. 481, x: 2.034 m
	Maximum rotation about X-axis	9,3	mrad	Member No. 481, x: 5.084 m
	Maximum rotation about Y-axis	-15,4	mrad	Member No. 4, x: 0.027 m
	Maximum rotation about Z-axis	-0,9	mrad	Member No. 476, x: 0.180 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC2 - UDL loading front arch			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-2,99	kN	
	Sum of support forces in Z	-2,99	kN	Deviation: 0.00 %
	Resultant of reactions about X	5,753	kNm	At center of gravity of model (X: 0.003, Y: 0.209, Z: 0.417 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,000	kNm	At center of gravity of model
	Maximum displacement in X-direction	18,1	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-32,5	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-51,2	mm	FE Mesh Node No. 6001 (X: -1.714, Y: -1.548, Z: 4.363 m)
	Maximum vectorial displacement	61,7	mm	FE Mesh Node No. 4014 (X: 1.665, Y: -1.235, Z: 4.293 m)
	Maximum rotation about X-axis	15,8	mrad	Member No. 591, x: 0.000 m
	Maximum rotation about Y-axis	6,8	mrad	Member No. 478, x: 0.135 m
	Maximum rotation about Z-axis	-5,8	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC3 - UDL loading back arch			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-1,65	kN	
	Sum of support forces in Z	-1,65	kN	Deviation: 0.00 %
	Resultant of reactions about X	-1,981	kNm	At center of gravity of model (X: 0.003, Y: 0.209, Z: 0.417 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,000	kNm	At center of gravity of model
	Maximum displacement in X-direction	-1,5	mm	FE Mesh Node No. 3885 (X: 2.701, Y: 0.229, Z: 2.542 m)
	Maximum displacement in Y-direction	6,2	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	6,7	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	9,1	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	-2,6	mrad	Member No. 483, x: 0.000 m
	Maximum rotation about Y-axis	-2,0	mrad	Member No. 21, x: 0.000 m
	Maximum rotation about Z-axis	0,8	mrad	Member No. 299, x: 0.161 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC100 - wind direction 0° In service			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,93	kN	
	Sum of support forces in Y	5,93	kN	Deviation: 0.00 %
	Sum of loads in Z	6,99	kN	
	Sum of support forces in Z	6,99	kN	Deviation: 0.00 %
	Resultant of reactions about X	-	kNm	At center of gravity of model (X: 0.003, Y: 0.209, Z: 0.417 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	-0,001	kNm	At center of gravity of model
	Maximum displacement in X-direction	-12,0	mm	FE Mesh Node No. 3894 (X: 2.766, Y: 0.200, Z: 2.357 m)
	Maximum displacement in Y-direction	58,4	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	70,1	mm	FE Mesh Node No. 3489 (X: 0.072, Y: -2.842, Z: 4.968 m)
	Maximum vectorial displacement	90,4	mm	FE Mesh Node No. 3489 (X: 0.072, Y: -2.842, Z: 4.968 m)
	Maximum rotation about X-axis	-25,5	mrad	Member No. 558, x: 0.000 m
	Maximum rotation about Y-axis	-10,7	mrad	Member No. 612, x: 0.087 m
	Maximum rotation about Z-axis	-6,7	mrad	FE Mesh Node No. 6101 (X: 2.455, Y: 0.349, Z: 1.941 m)
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC101 - wind direction 90° In service			
	Sum of loads in X	4,20	kN	
	Sum of support forces in X	4,20	kN	Deviation: 0.00 %
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-0,03	kN	
	Sum of support forces in Z	-0,03	kN	Deviation: 0.00 %
	Resultant of reactions about X	0,019	kNm	At center of gravity of model (X: 0.003, Y: 0.209, Z: 0.417 m)
	Resultant of reactions about Y	-0,520	kNm	At center of gravity of model
	Resultant of reactions about Z	3,636	kNm	At center of gravity of model
	Maximum displacement in X-direction	69,2	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-44,1	mm	FE Mesh Node No. 5962 (X: -2.319, Y: -1.099, Z: 3.897 m)
	Maximum displacement in Z-direction	-139,6	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum vectorial displacement	153,9	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum rotation about X-axis	13,4	mrad	Member No. 488, x: 0.000 m
	Maximum rotation about Y-axis	-8,3	mrad	Member No. 612, x: 0.087 m
	Maximum rotation about Z-axis	11,3	mrad	Member No. 609, x: 0.117 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)

2.7.5 Calculation result of RC1 - General loading without wind 1 * (CO1 – CO2)

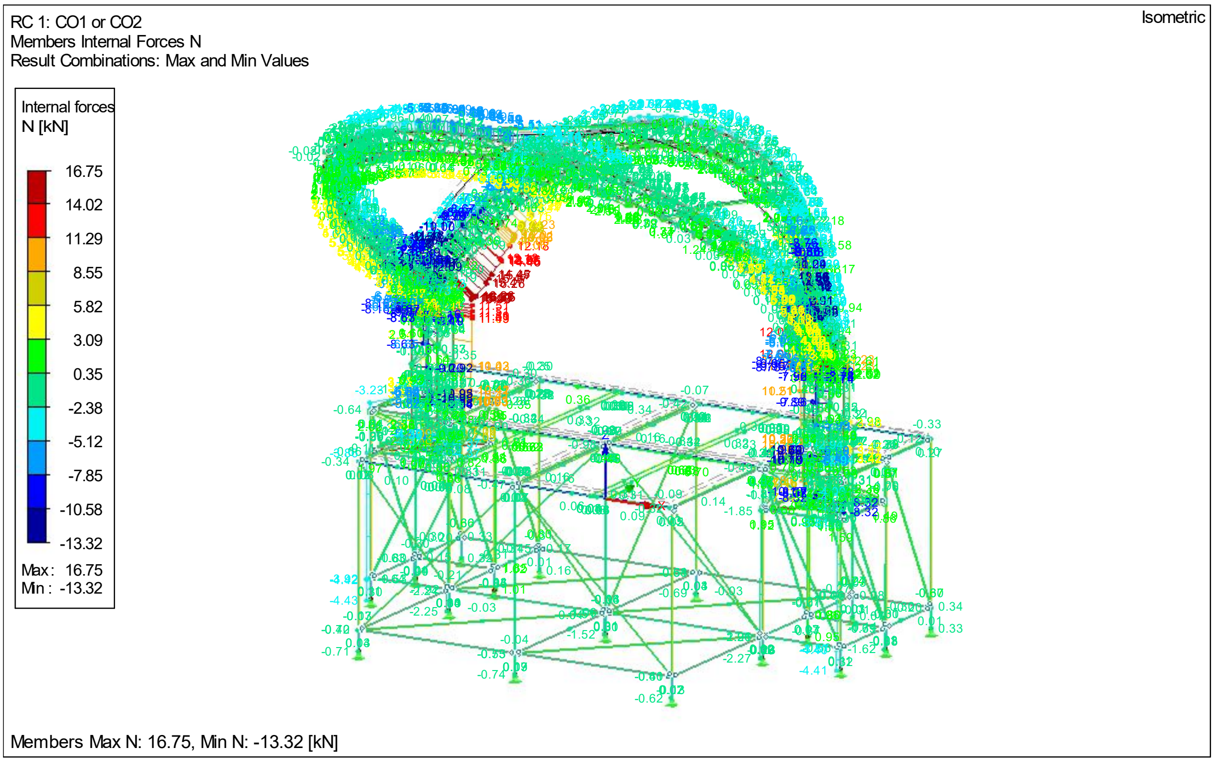
	Description	Value	Unit	Comment
	CO1 - 1.15*LC1 + 1.35*LC2			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-16,99	kN	
	Sum of support forces in Z	-16,99	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	22,9	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-50,7	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-76,6	mm	FE Mesh Node No. 4039 (X: 1.265, Y: -1.742, Z: 4.563 m)
	Maximum vectorial displacement	92,2	mm	FE Mesh Node No. 4039 (X: 1.265, Y: -1.742, Z: 4.563 m)
	Maximum rotation about X-axis	24,9	mrad	Member No. 591, x: 0.000 m
	Maximum rotation about Y-axis	-32,1	mrad	Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	-9,1	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO2 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-19,23	kN	
	Sum of support forces in Z	-19,23	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	18,8	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-41,5	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-64,5	mm	FE Mesh Node No. 4014 (X: 1.665, Y: -1.235, Z: 4.293 m)
	Maximum vectorial displacement	77,8	mm	FE Mesh Node No. 4014 (X: 1.665, Y: -1.235, Z: 4.293 m)
	Maximum rotation about X-axis	20,9	mrad	Member No. 481, x: 5.084 m
	Maximum rotation about Y-axis	-28,8	mrad	Member No. 4, x: 0.032 m
	Maximum rotation about Z-axis	-7,7	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)

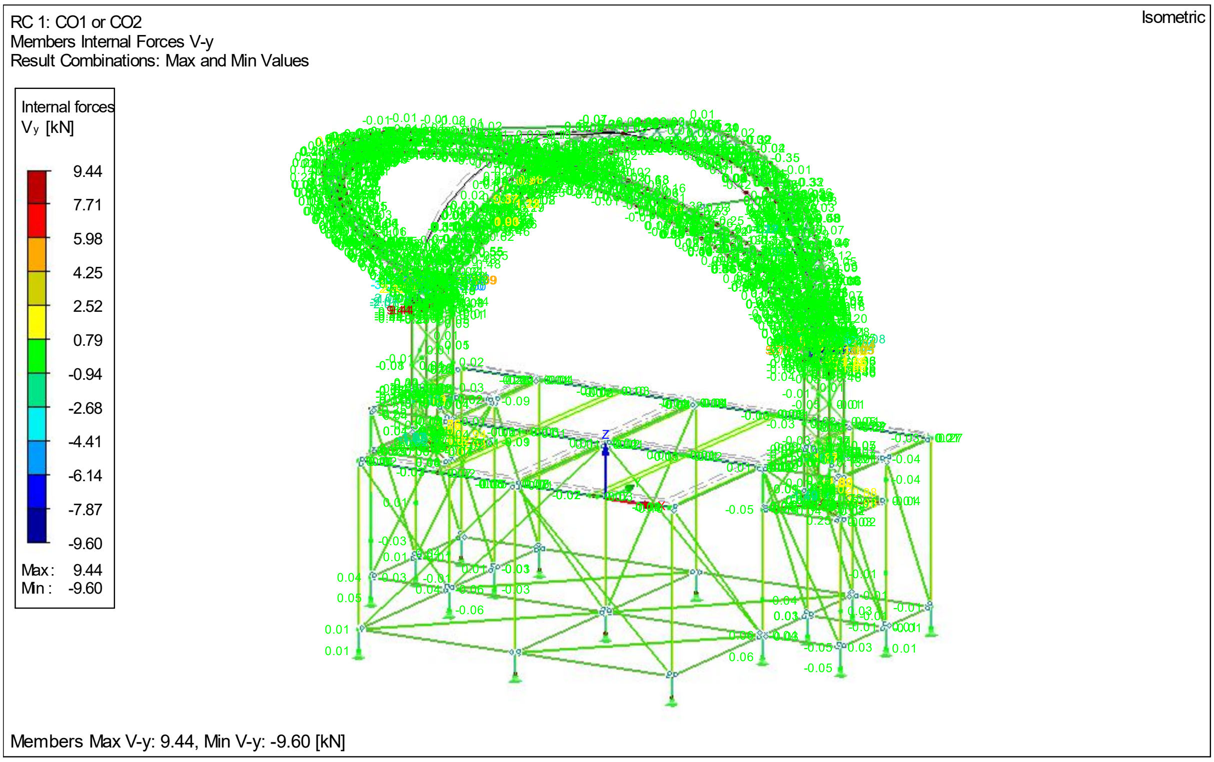
2.7.5.1 Deformation of the RC2: General load combinations characteristic values.





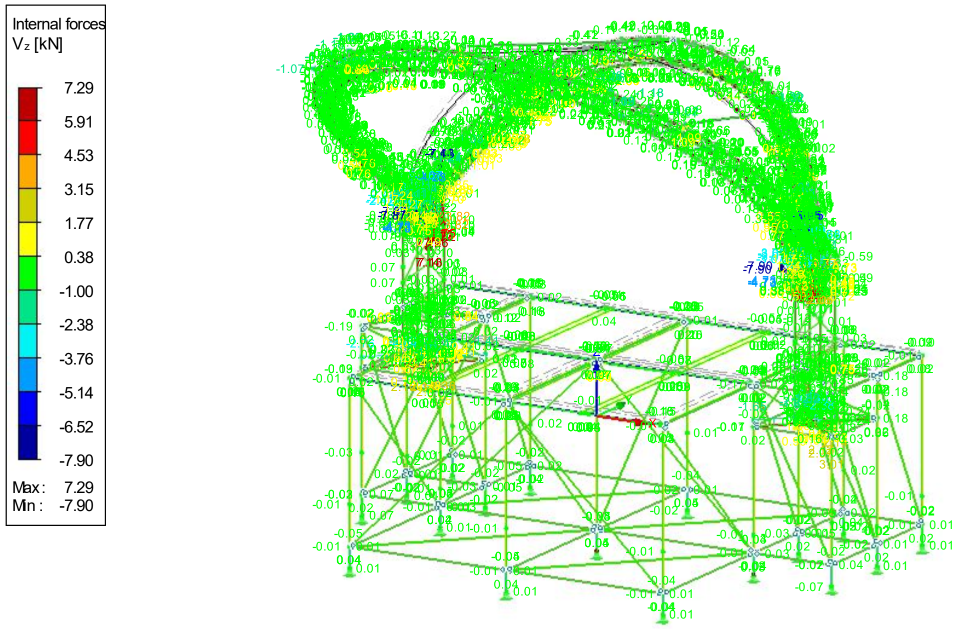
2.7.5.2 Internal force diagram RC1 Design calculation general load combinations





RC 1: CO1 or CO2
Members Internal Forces V-z
Result Combinations: Max and Min Values

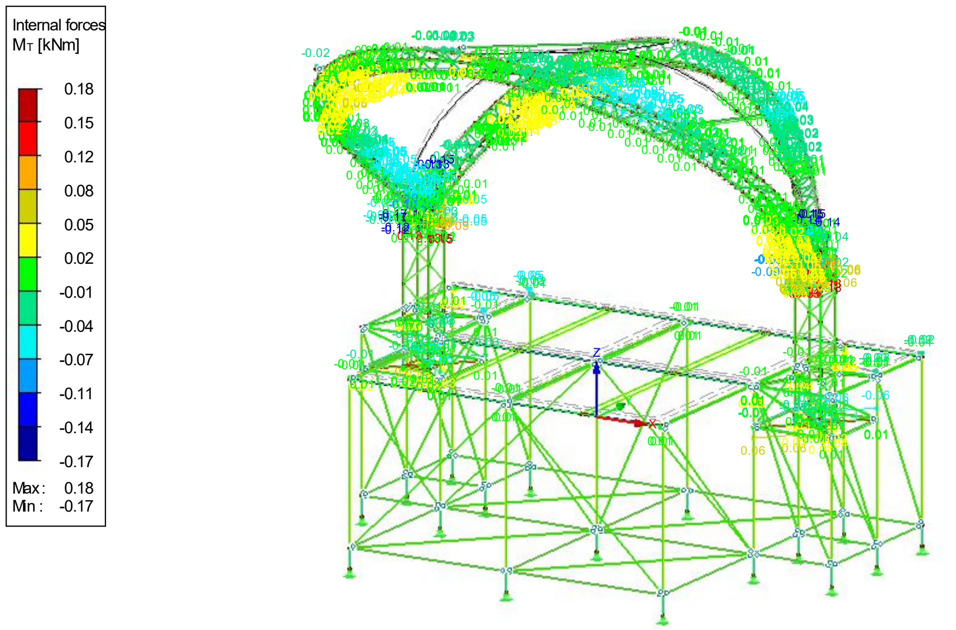
Isometric



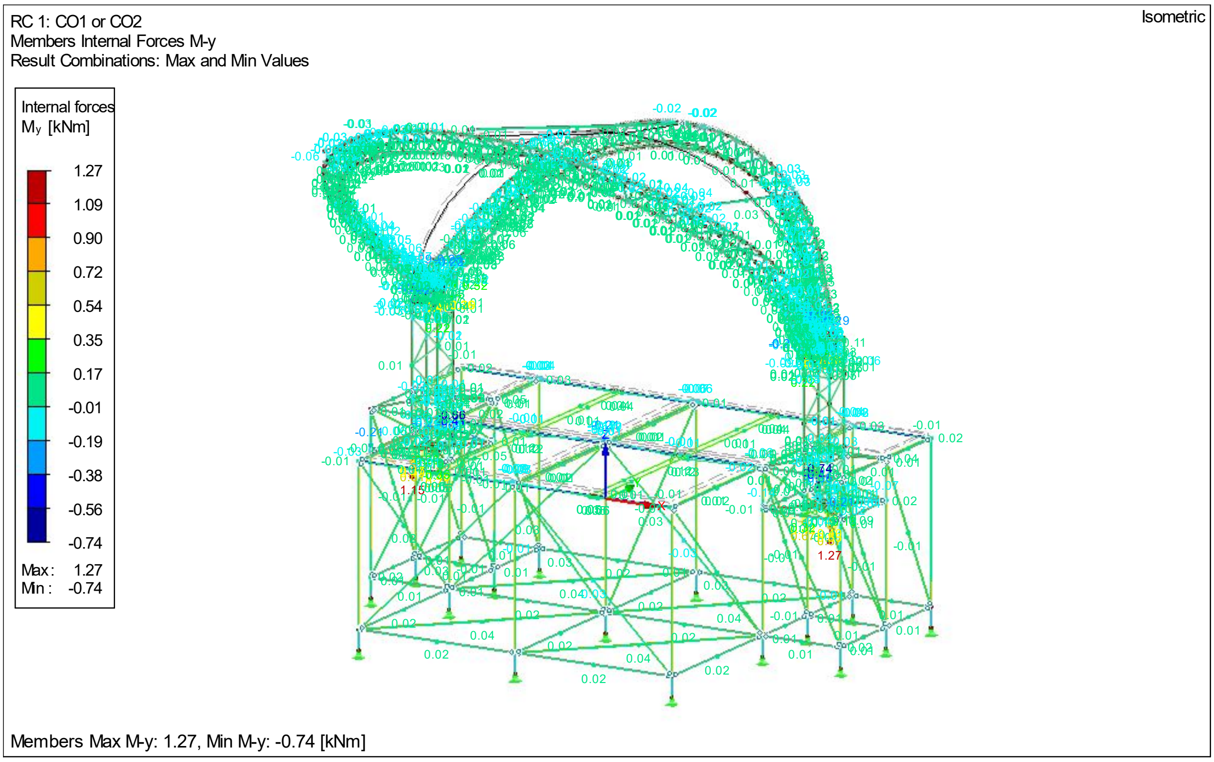
Members Max V-z: 7.29, Min V-z: -7.90 [kN]

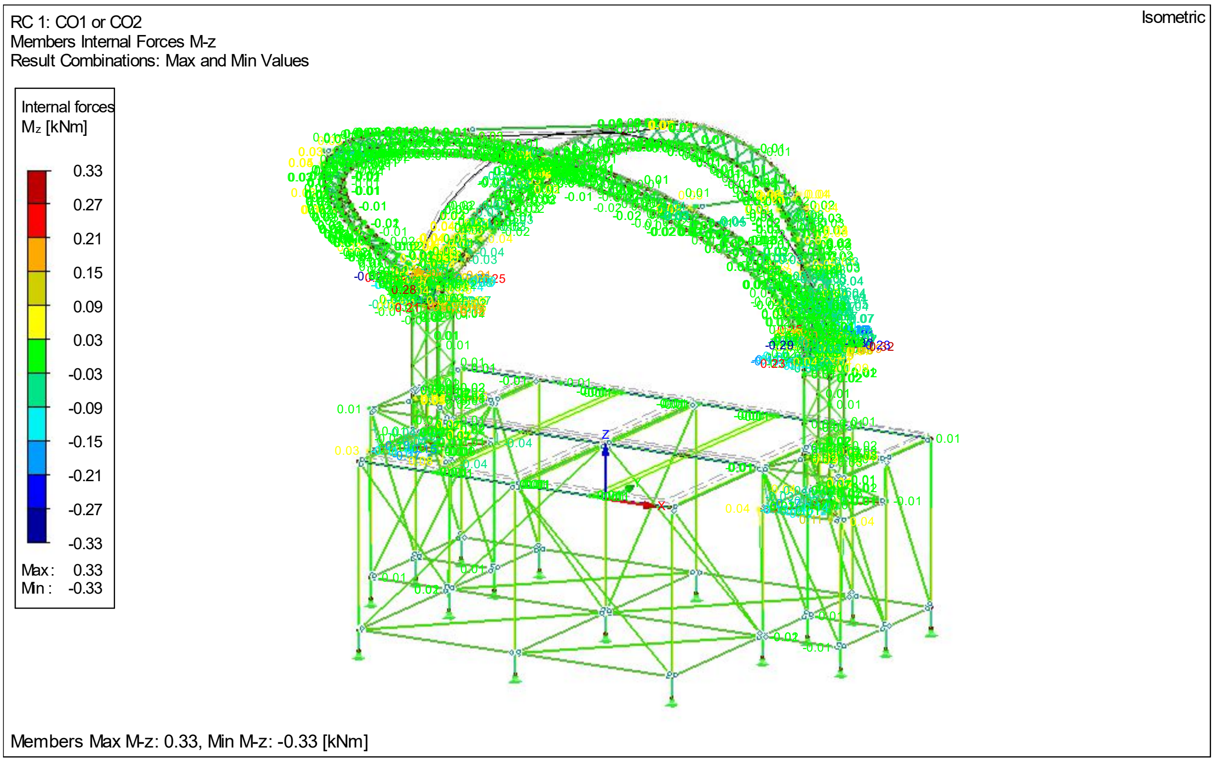
RC 1: CO1 or CO2
Members Internal Forces M-T
Result Combinations: Max and Min Values

Isometric



Members Max M-T: 0.18, Min M-T: -0.17 [kNm]


RC 1: CO1 or CO2
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
M_y [kNm]
1.27
1.09
0.90
0.72
0.54
0.35
0.17
-0.01
-0.19
-0.38
-0.56
-0.74
Max : 1.27
Min : -0.74
Members Max M-y: 1.27, Min M-y: -0.74 [kNm]

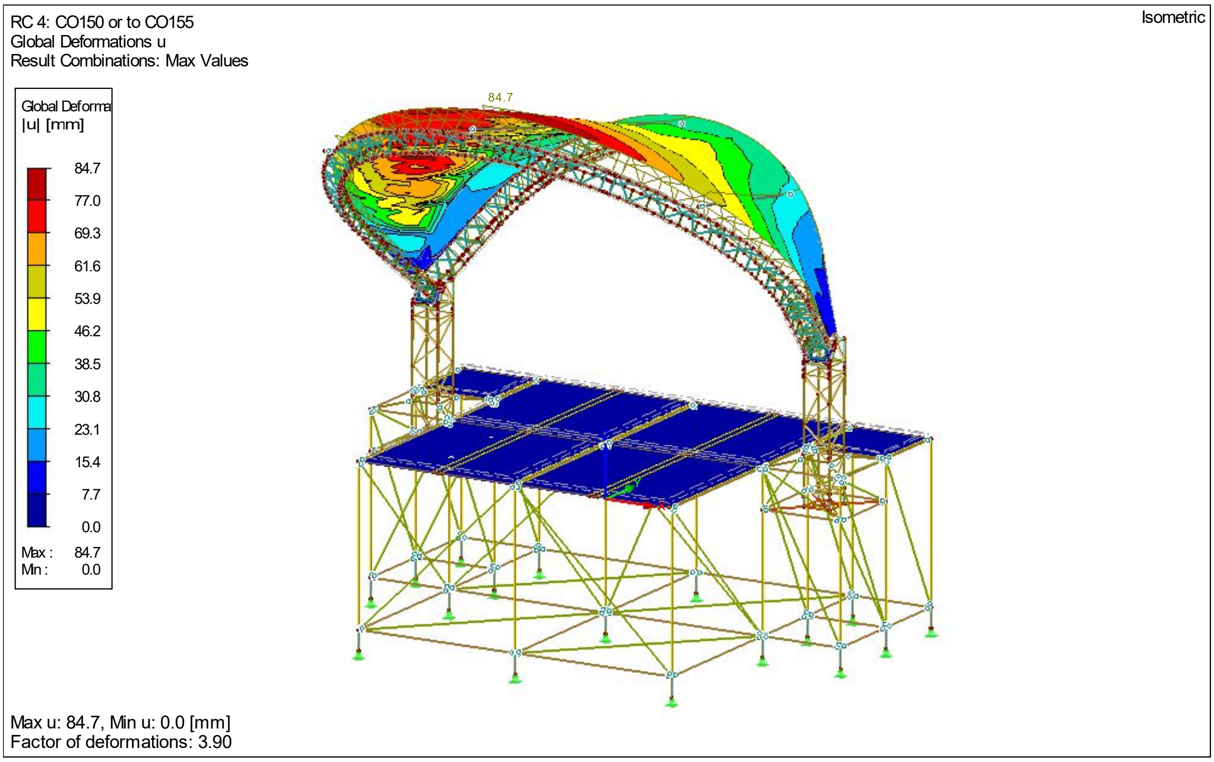

RC 1: CO1 or CO2
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
M_z [kNm]
0.33
0.27
0.21
0.15
0.09
0.03
-0.03
-0.09
-0.15
-0.21
-0.27
-0.33
Max : 0.33
Min : -0.33
Members Max M-z: 0.33, Min M-z: -0.33 [kNm]

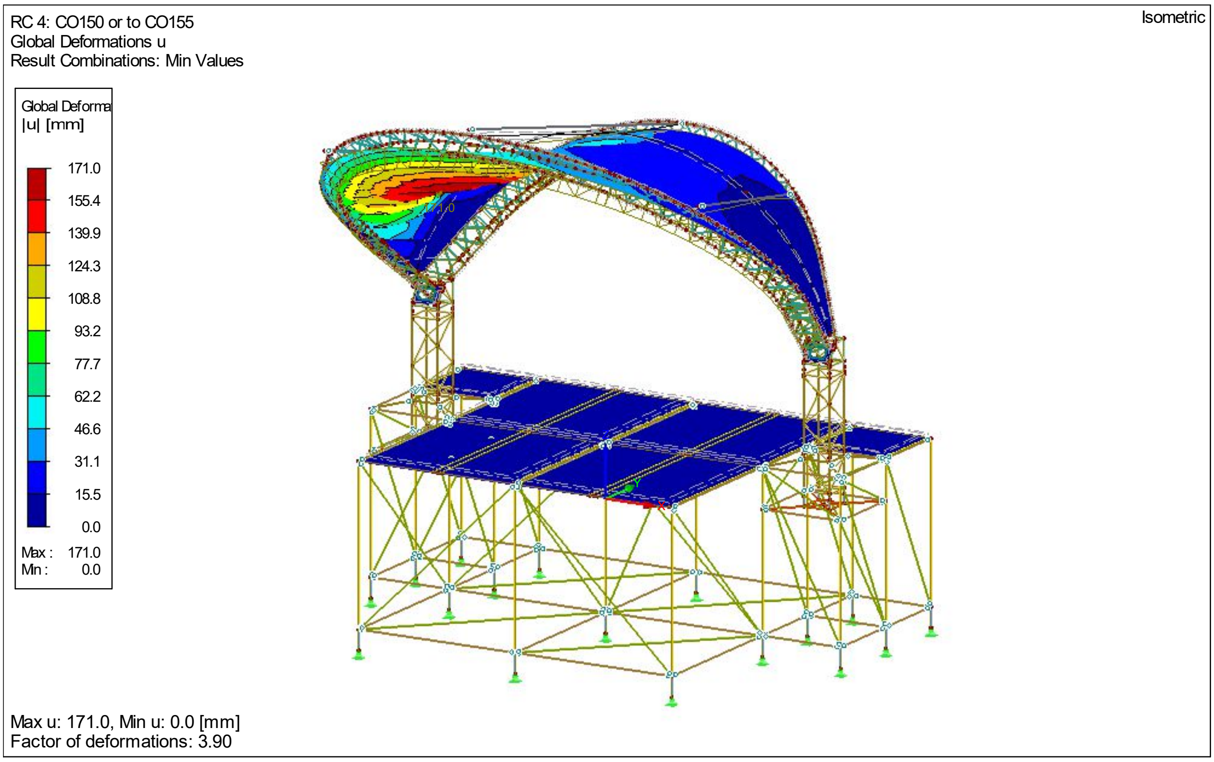
2.7.6 Calculation result of RC3 - Design values In-service: 1 * (CO100 – CO105)

	Description	Value	Unit	Comment
	CO100 - 1.15*LC1 + 1.35*LC100			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	8,05	kN	
	Sum of support forces in Y	8,05	kN	Deviation: 0.00 %
	Sum of loads in Z	-3,53	kN	
	Sum of support forces in Z	-3,53	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-15,2	mm	FE Mesh Node No. 3894 (X: 2.766, Y: 0.200, Z: 2.357 m)
	Maximum displacement in Y-direction	73,4	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	86,9	mm	FE Mesh Node No. 3489 (X: 0.072, Y: -2.842, Z: 4.968 m)
	Maximum vectorial displacement	112,8	mm	FE Mesh Node No. 3489 (X: 0.072, Y: -2.842, Z: 4.968 m)
	Maximum rotation about X-axis	-32,9	mrad	Member No. 481, x: 0.000 m
	Maximum rotation about Y-axis	-22,4	mrad	Member No. 6, x: 0.032 m
	Maximum rotation about Z-axis	-8,2	mrad	FE Mesh Node No. 6101 (X: 2.455, Y: 0.349, Z: 1.941 m)
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO101 - 1.15*LC1 + 1.35*LC2 + 1.35*LC100			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	7,94	kN	
	Sum of support forces in Y	7,94	kN	Deviation: 0.00 %
	Sum of loads in Z	-7,53	kN	
	Sum of support forces in Z	-7,53	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-11,2	mm	FE Mesh Node No. 3894 (X: 2.766, Y: 0.200, Z: 2.357 m)
	Maximum displacement in Y-direction	35,7	mm	FE Mesh Node No. 5414 (X: -0.015, Y: -2.649, Z: 4.925 m)
	Maximum displacement in Z-direction	45,9	mm	FE Mesh Node No. 5414 (X: -0.015, Y: -2.649, Z: 4.925 m)
	Maximum vectorial displacement	58,1	mm	FE Mesh Node No. 5414 (X: -0.015, Y: -2.649, Z: 4.925 m)
	Maximum rotation about X-axis	-19,7	mrad	Member No. 481, x: 0.000 m
	Maximum rotation about Y-axis	-23,1	mrad	Member No. 6, x: 0.036 m
	Maximum rotation about Z-axis	5,9	mrad	Member No. 1346, x: 0.000 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO102 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC100			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	7,97	kN	
	Sum of support forces in Y	7,97	kN	Deviation: 0.00 %
	Sum of loads in Z	-9,77	kN	
	Sum of support forces in Z	-9,77	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	11,2	mm	FE Mesh Node No. 5879 (X: -2.761, Y: 0.204, Z: 2.355 m)
	Maximum displacement in Y-direction	43,1	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	52,9	mm	FE Mesh Node No. 3362 (X: 0.054, Y: -2.826, Z: 4.965 m)
	Maximum vectorial displacement	68,2	mm	FE Mesh Node No. 3362 (X: 0.054, Y: -2.826, Z: 4.965 m)
	Maximum rotation about X-axis	-21,8	mrad	Member No. 481, x: 0.000 m
	Maximum rotation about Y-axis	-19,7	mrad	Member No. 6, x: 0.036 m
	Maximum rotation about Z-axis	5,9	mrad	Member No. 1346, x: 0.000 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO103 - 1.15*LC1 + 1.35*LC101			
	Sum of loads in X	5,65	kN	
	Sum of support forces in X	5,65	kN	Deviation: 0.00 %
	Sum of loads in Y	0,01	kN	
	Sum of support forces in Y	0,01	kN	Deviation: 0.00 %
	Sum of loads in Z	-13,00	kN	
	Sum of support forces in Z	-13,00	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	78,1	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-53,3	mm	FE Mesh Node No. 5962 (X: -2.319, Y: -1.099, Z: 3.897 m)
	Maximum displacement in Z-direction	-157,0	mm	FE Mesh Node No. 6030 (X: -1.181, Y: -1.374, Z: 4.491 m)
	Maximum vectorial displacement	174,2	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum rotation about X-axis	18,5	mrad	Member No. 488, x: 0.000 m
	Maximum rotation about Y-axis	-19,9	mrad	Member No. 6, x: 0.036 m
	Maximum rotation about Z-axis	14,0	mrad	Member No. 609, x: 0.117 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO104 - 1.15*LC1 + 1.35*LC2 + 1.35*LC101			
	Sum of loads in X	5,64	kN	
	Sum of support forces in X	5,64	kN	Deviation: 0.00 %
	Sum of loads in Y	0,01	kN	
	Sum of support forces in Y	0,01	kN	Deviation: 0.00 %
	Sum of loads in Z	-17,03	kN	
	Sum of support forces in Z	-17,03	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	77,1	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-78,3	mm	FE Mesh Node No. 6003 (X: -1.640, Y: -1.229, Z: 4.299 m)
	Maximum displacement in Z-direction	-179,8	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum vectorial displacement	204,3	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum rotation about X-axis	28,6	mrad	Member No. 483, x: 0.000 m
	Maximum rotation about Y-axis	-30,7	mrad	Member No. 4, x: 0.036 m

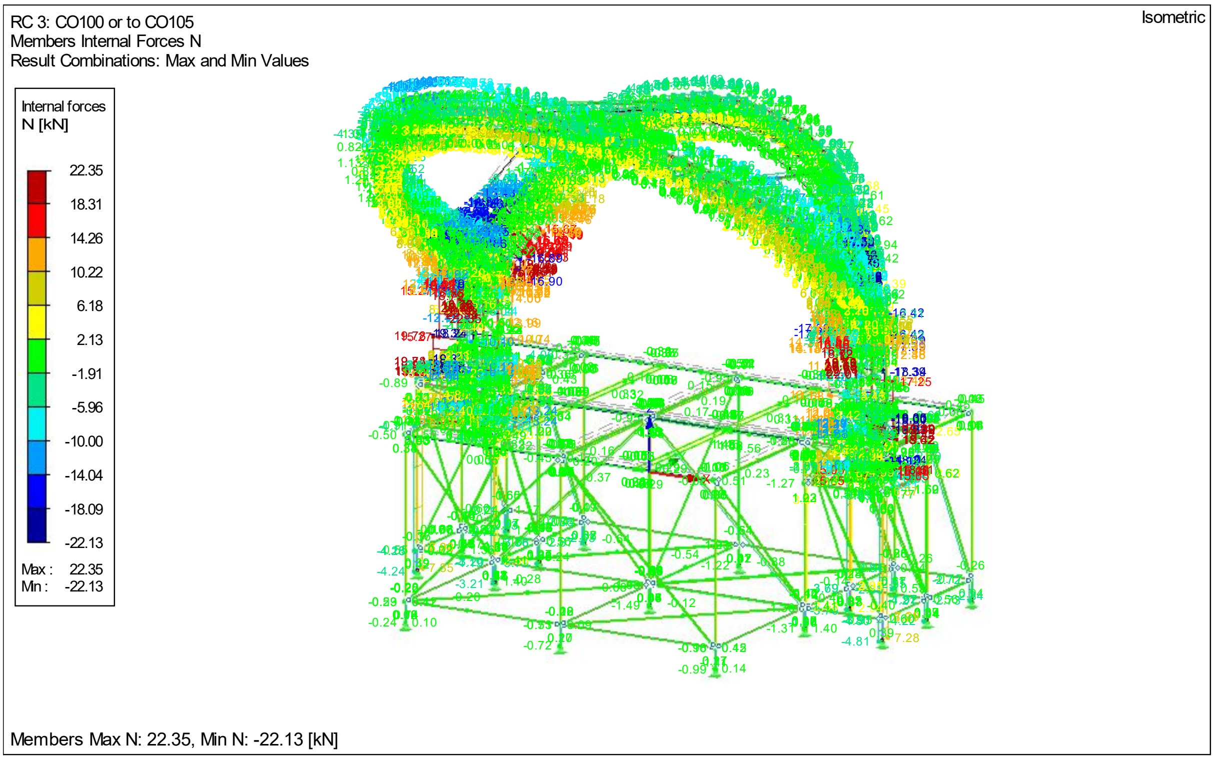
	Maximum rotation about Z-axis	16,9	mrad	Member No. 412, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO105 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC101			
	Sum of loads in X	5,64	kN	
	Sum of support forces in X	5,64	kN	Deviation: 0.00 %
	Sum of loads in Y	0,01	kN	
	Sum of support forces in Y	0,01	kN	Deviation: 0.00 %
	Sum of loads in Z	-19,27	kN	
	Sum of support forces in Z	-19,27	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	76,6	mm	FE Mesh Node No. 5964 (X: -2.213, Y: -0.823, Z: 3.856 m)
	Maximum displacement in Y-direction	-72,6	mm	FE Mesh Node No. 6003 (X: -1.640, Y: -1.229, Z: 4.299 m)
	Maximum displacement in Z-direction	-174,9	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum vectorial displacement	197,6	mm	FE Mesh Node No. 6019 (X: -1.321, Y: -1.264, Z: 4.423 m)
	Maximum rotation about X-axis	24,9	mrad	Member No. 483, x: 0.000 m
	Maximum rotation about Y-axis	-27,5	mrad	Member No. 4, x: 0.032 m
	Maximum rotation about Z-axis	16,2	mrad	Member No. 412, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)

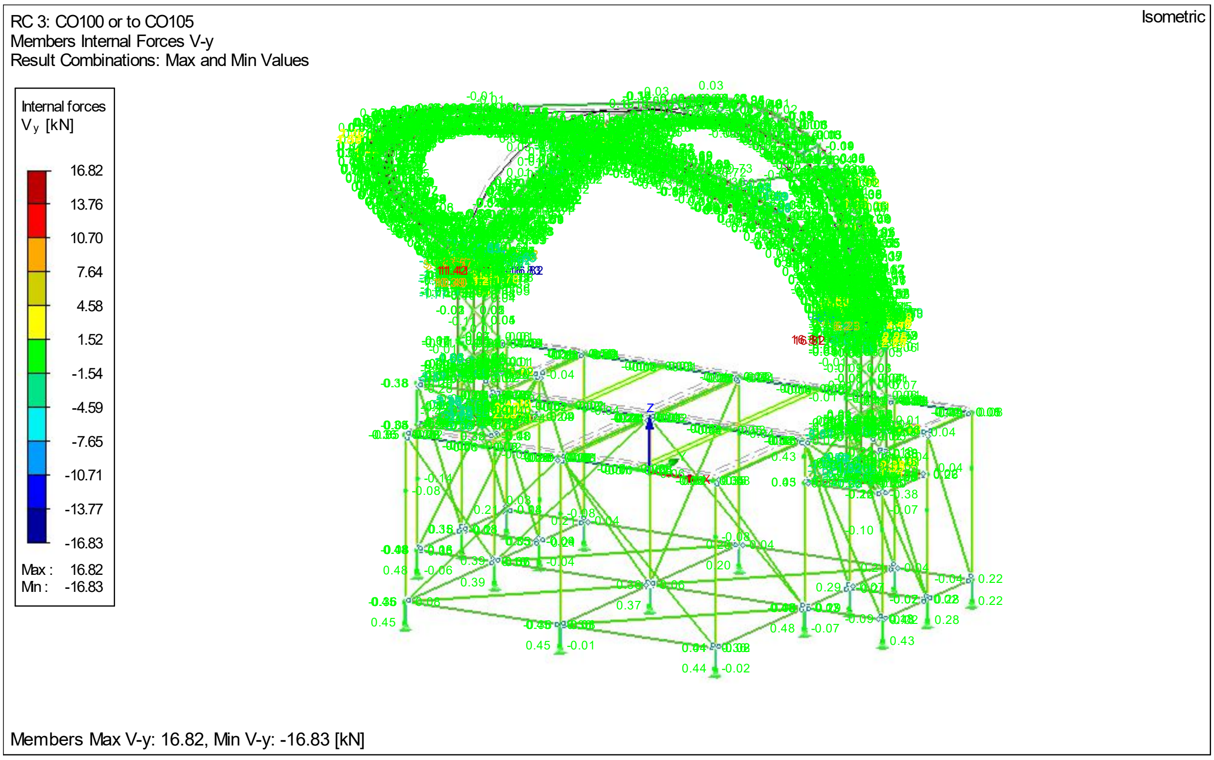
2.7.6.1 Deformation of the RC4: Out-service load combinations characteristic values.





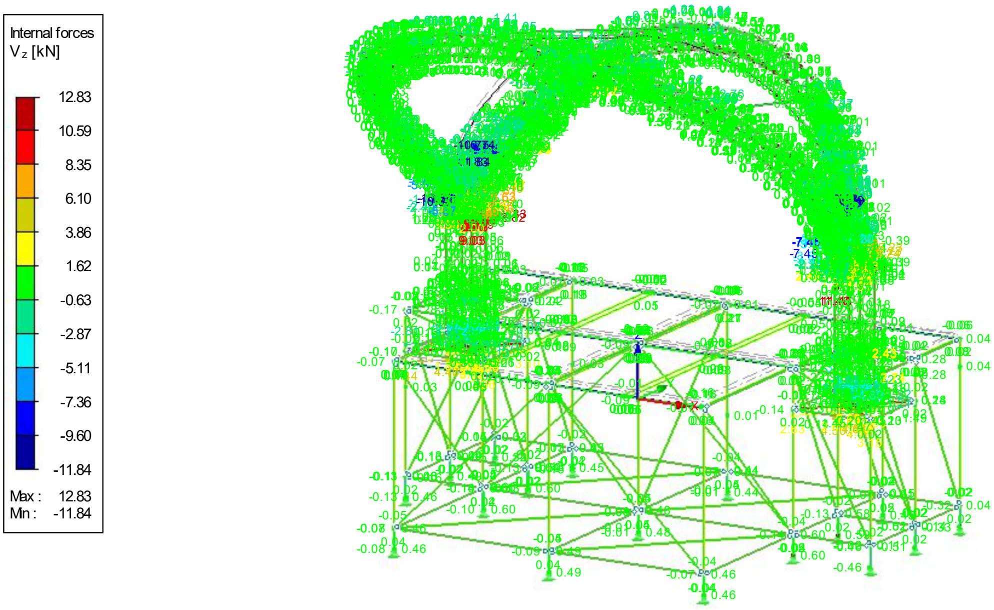
2.7.6.2 Internal force diagram RC3 Design calculation In service wind





RC 3: CO100 or to CO105
Members Internal Forces V-z
Result Combinations: Max and Min Values

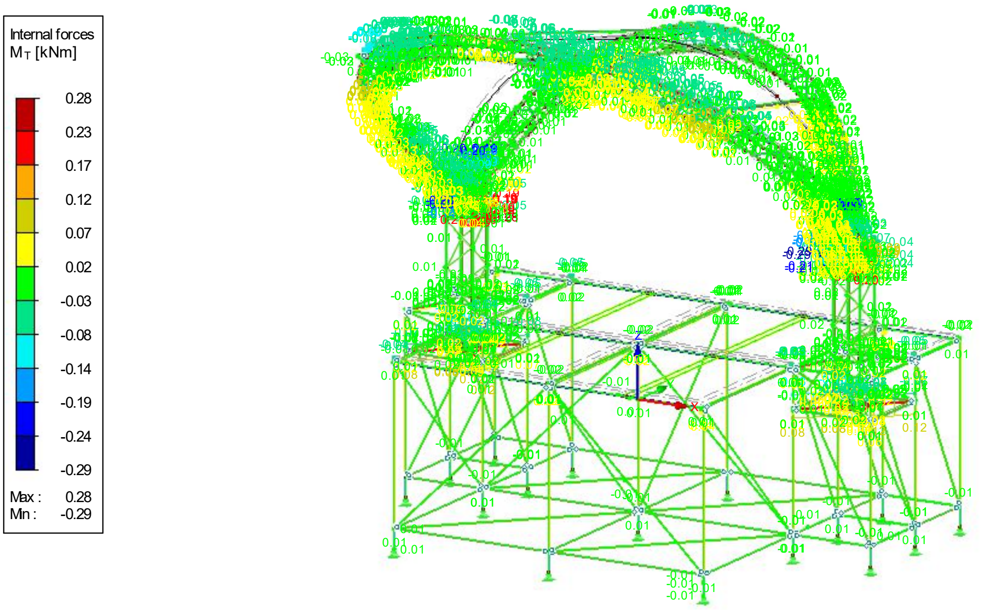
Isometric



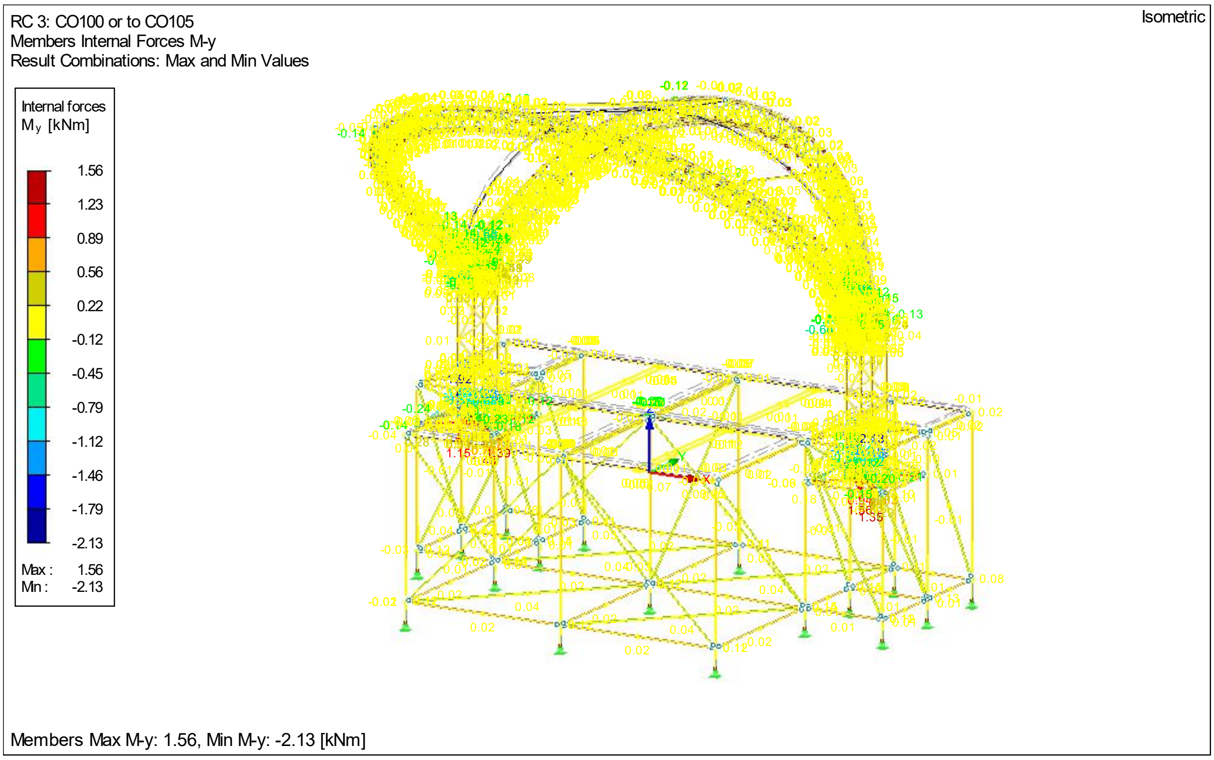
Members Max V-z: 12.83, Min V-z: -11.84 [kN]

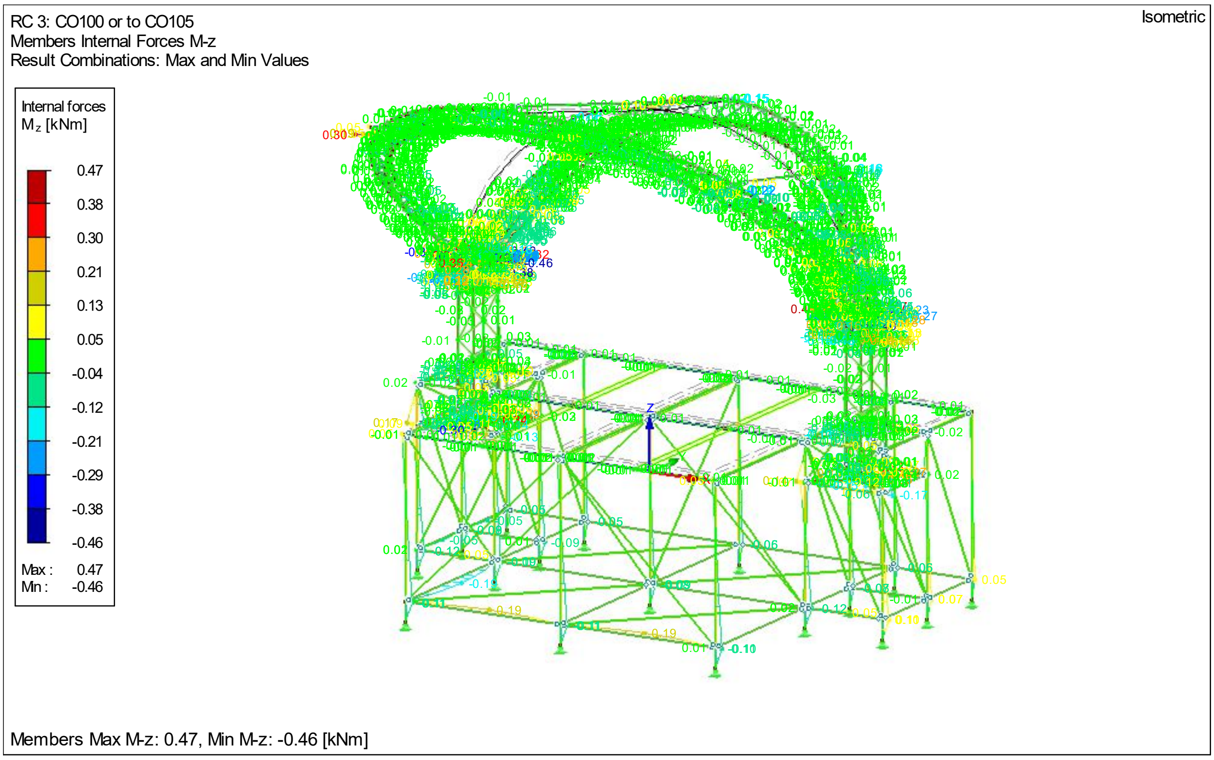
RC 3: CO100 or to CO105
Members Internal Forces M-T
Result Combinations: Max and Min Values

Isometric



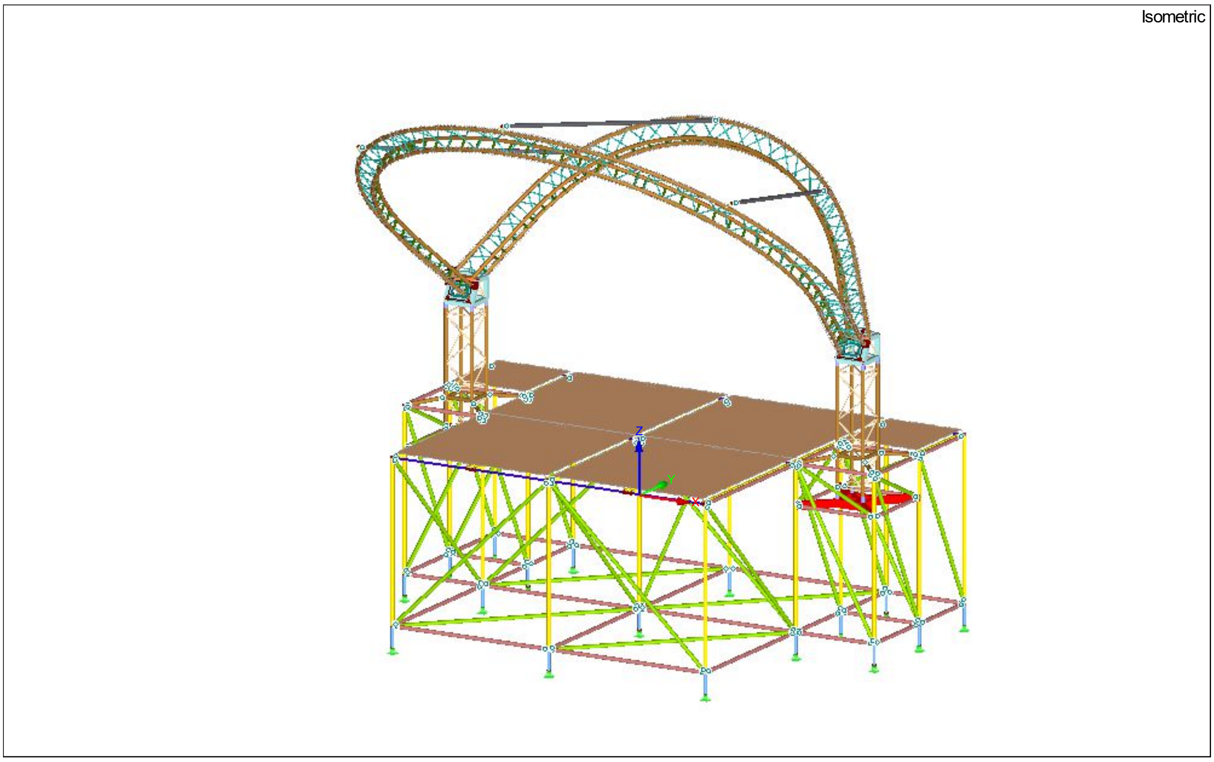
Members Max M-T: 0.28, Min M-T: -0.29 [kNm]


RC 3: CO100 or to CO105
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
M_y [kNm]
1.56
1.23
0.89
0.56
0.22
-0.12
-0.45
-0.79
-1.12
-1.46
-1.79
-2.13
Max : 1.56
Min : -2.13
Members Max M-y: 1.56, Min M-y: -2.13 [kNm]


RC 3: CO100 or to CO105
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
M_z [kNm]
0.47
0.38
0.30
0.21
0.13
0.05
-0.04
-0.12
-0.21
-0.29
-0.38
-0.46
Max : 0.47
Min : -0.46
Members Max M-z: 0.47, Min M-z: -0.46 [kNm]

2.8 Calculation results for the Out service situation

Construction scheme Out service Model



Cross-Sections
- 1: Ring 38/4.5; S320GD 1.0250
- 2: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 3: RO 48.3x3.2 (Hot Formed); Steel S 235 JR
- 4: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 5: RRO 100x50x3.2 (Hot Formed); Steel S 235 JR
- 6: Ring 50/6; Aluminum EN-AW 6082 (EP,ET) T6
- 7: Ring 48/3; Aluminum EN-AW 6082 (EP,ET) T6
- 8: Ring 30/3; Aluminum EN-AW 6082 (EP,ET) T6
- 9: Ring 20/2; Aluminum EN-AW 6082 (EP,ET) T6
- 10: HK 50/50/5/5/5/5; Aluminum EN-AW 6082 (EP,ET) T6
- 11: TO 50/100/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 12: Ring 16/2; Aluminum EN-AW 6082 (EP,ET) T6
- 13: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 14: Rectangle 15/60; Aluminum EN-AW 6082 (EP,ET) T6
- 15: RD 20; steel 8.8 kw aliteit
- 16: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 17: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6

2.8.1 Used Materials

Material No.	Material Description	Modulus of Elasticity E [kN/cm²]	Shear Modulus G [kN/cm²]	Poisson's Ratio ν [-]	Specific Weight γ [kN/m³]	Coeff. of Th. Exp. α [1/°C]	Partial Factor γ_M [-]	Material Model
1	S320GD 1.0250 | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
2	Steel S 235 JR | EN 10025:1994-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,100	Isotropic Linear Elastic
3	Aluminum EN-AW 6082 (EP,ET) T6 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic
4	Aluminum EN-AW 5083 O/H111 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic
5	canopy | No code	60,00	20,00	0,500	0,65	1,00E-05	1,000	Isotropic Linear Elastic
6	steel 8.8 kwaliteit | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
7	Plywood, Class F20/10 E40/20, Plate Stress, Perpendicular | EN 12369-2:2011-06	200,00	3,50	3,286	5,00	5,00E-06	1,200	Orthotropic Elastic 2D...
8	Aluminum EN-AW 6005A (EP/O,ER/B) T6 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic

2.8.2 Used cross sections

Section	Cross-Section	Material	Moments of inertia [cm⁴]			Cross-Sectional Areas [cm²]			Principal Axes	Rotation	Overall Dimensions [mm]	
			Torsion	Bending	Bending		Shear	Shear			Width	Depth
No.	Description [mm]	No.	J	I_y	I_z	Axial A	A_y	A_z	α [°]	α' [°]	b	h
1	Ring 38/4.5	1	13,53	6,76	6,76	4,74	2,44	2,44	0,00	0,00	38,0	38,0
2	RO 48.3x3.2 (Hot Formed)	1	23,20	11,60	11,60	4,53	2,26	2,26	0,00	0,00	48,3	48,3
3	RO 48.3x3.2 (Hot Formed)	2	23,20	11,60	11,60	4,53	2,26	2,26	0,00	0,00	48,3	48,3
4	RO 48.3x2.6 (Hot Formed)	2	19,60	9,78	9,78	3,73	1,85	1,85	0,00	0,00	48,3	48,3
5	RRO 100x50x3.2 (Hot Formed)	2	93,40	116,00	38,80	9,08	2,01	5,71	0,00	0,00	50,0	100,0
6	Ring 50/6	3	40,89	20,44	20,44	8,29	4,27	4,27	0,00	0,00	50,0	50,0
7	Ring 48/3	3	21,57	10,78	10,78	4,24	2,14	2,14	0,00	0,00	48,0	48,0
8	Ring 30/3	3	4,69	2,35	2,35	2,54	1,30	1,30	0,00	0,00	30,0	30,0
9	Ring 20/2	3	0,93	0,46	0,46	1,13	0,58	0,58	0,00	0,00	20,0	20,0
10	HK 50/50/5/5/5/5	3	48,28	30,75	30,75	9,00	4,00	4,00	0,00	0,00	50,0	50,0
11	TO 50/100/4/4/4/4	3	110,47	47,37	144,13	11,36	7,07	2,44	0,00	0,00	100,0	50,0
12	Ring 16/2	3	0,44	0,22	0,22	0,88	0,45	0,45	0,00	0,00	16,0	16,0
13	Ring 50/4	3	30,81	15,41	15,41	5,78	2,93	2,93	0,00	0,00	50,0	50,0
14	Rectangle 15/60	3	5,69	27,00	1,69	9,00	7,50	7,50	0,00	0,00	15,0	60,0
15	RD 20	6	1,57	0,79	0,79	3,14	2,64	2,64	0,00	0,00	20,0	20,0
16	EV transom	8	50,00	554,00	70,00	18,78	18,00	18,00	0,00	0,00	49,0	172,5
17	HK 50/30/4/4/4/4	8	16,87	17,67	7,52	5,76	1,62	3,48	0,00	0,00	30,0	50,0

2.8.3 Calculation summary for the Out service situation

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	11,3	mm	CO204, Member No. 822, x: 0.027 m
	Maximum displacement in Y-direction	-53,3	mm	CO204, Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-64,6	mm	CO204, Member No. 483, x: 0.000 m
	Maximum vectorial displacement	84,1	mm	CO204, Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	26,4	mrad	CO204, Member No. 525, x: 0.000 m
	Maximum rotation about Y-axis	-32,7	mrad	CO204, Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	11,4	mrad	CO204, Member No. 412, x: 0.135 m
	Number of 1D finite elements (member elements)	2520		
	Number of 2D finite elements (surface elements)	1580		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	3281		
	Number of equations	19686		
	Matrix solver method	Direct		
	Maximum number of iterations	100		
	Number of divisions for member results	10		
	Number of divisions of members with cable, elastic foundation, taper, or plastic characteristic	10		
	Activate shear stiffness of members (A-y, A-z)	+		
	Plate bending theory	Mindlin		
	Precision of convergence criteria of nonlinear calculation	1		

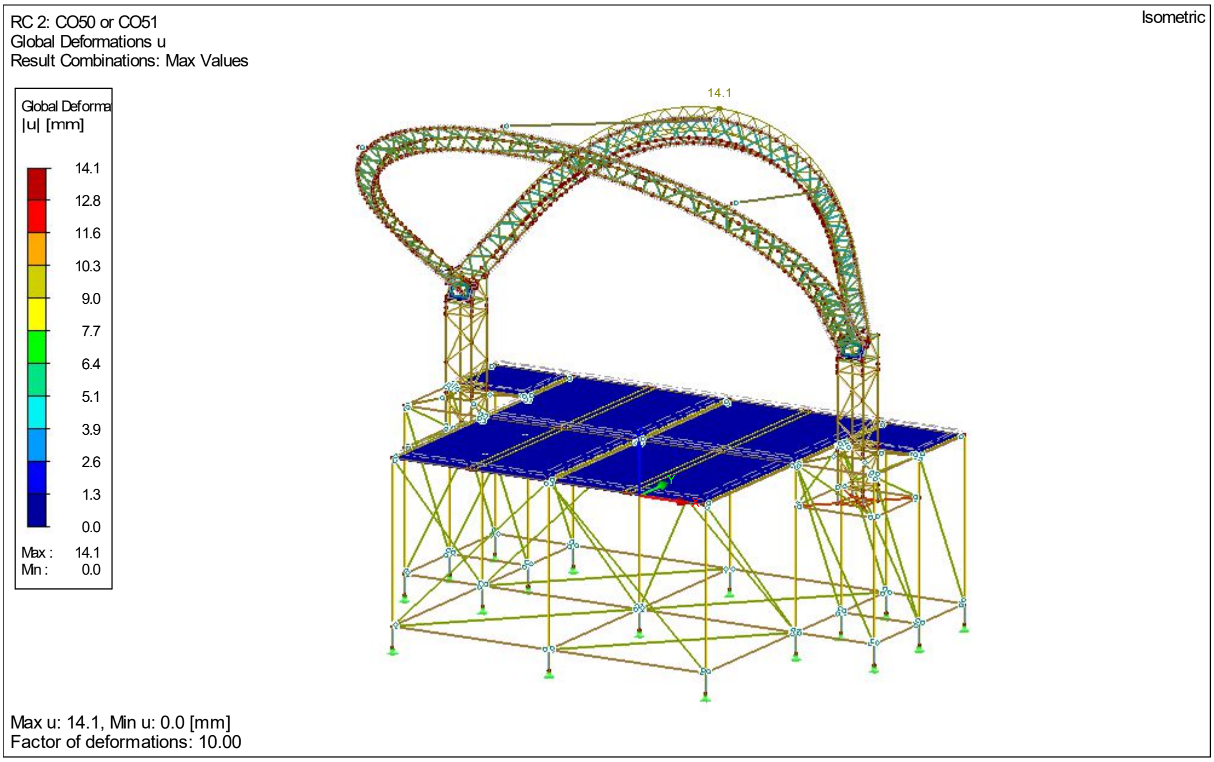
2.8.4 Calculation result of the separate load cases.

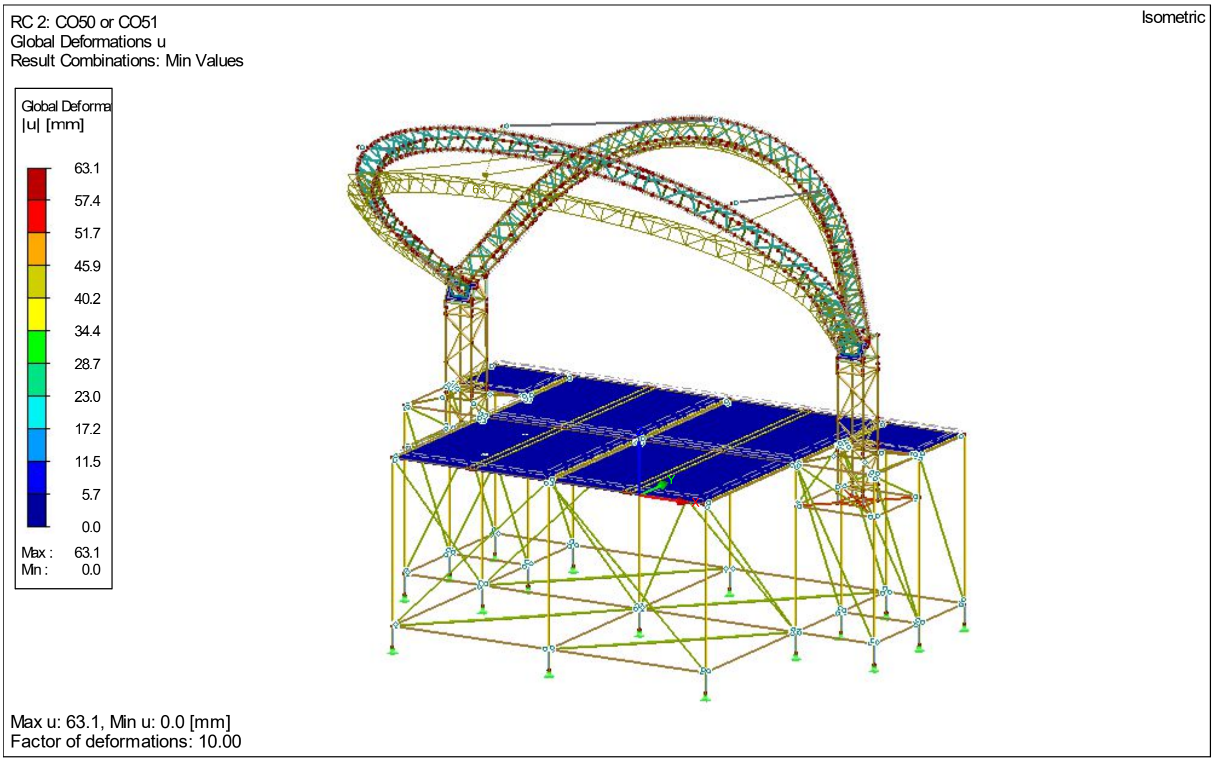
	Description	Value	Unit	Comment
	LC1 - Self-weight			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-11,23	kN	
	Sum of support forces in Z	-11,23	kN	Deviation: 0.00 %
	Resultant of reactions about X	0,004	kNm	At center of gravity of model (X: 0.003, Y: 0.211, Z: 0.406 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,000	kNm	At center of gravity of model
	Maximum displacement in X-direction	0,7	mm	Member No. 829, x: 0.027 m
	Maximum displacement in Y-direction	-7,6	mm	Member No. 481, x: 2.034 m
	Maximum displacement in Z-direction	-14,7	mm	Member No. 481, x: 2.034 m
	Maximum vectorial displacement	16,6	mm	Member No. 481, x: 2.034 m
	Maximum rotation about X-axis	9,4	mrad	Member No. 481, x: 5.084 m
	Maximum rotation about Y-axis	-15,4	mrad	Member No. 4, x: 0.027 m
	Maximum rotation about Z-axis	-1,1	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC2 - UDL loading front arch			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-2,99	kN	
	Sum of support forces in Z	-2,99	kN	Deviation: 0.00 %
	Resultant of reactions about X	5,763	kNm	At center of gravity of model (X: 0.003, Y: 0.211, Z: 0.406 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,000	kNm	At center of gravity of model
	Maximum displacement in X-direction	3,1	mm	Member No. 829, x: 0.027 m
	Maximum displacement in Y-direction	-33,9	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-40,7	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	52,9	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	16,6	mrad	Member No. 570, x: 0.000 m
	Maximum rotation about Y-axis	7,3	mrad	Member No. 612, x: 0.146 m
	Maximum rotation about Z-axis	-6,0	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC3 - UDL loading back arch			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-1,65	kN	
	Sum of support forces in Z	-1,65	kN	Deviation: 0.00 %
	Resultant of reactions about X	-1,977	kNm	At center of gravity of model (X: 0.003, Y: 0.211, Z: 0.406 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,000	kNm	At center of gravity of model
	Maximum displacement in X-direction	-0,2	mm	Member No. 624, x: 0.175 m
	Maximum displacement in Y-direction	7,6	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	7,9	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	10,9	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	-3,7	mrad	Member No. 483, x: 0.000 m
	Maximum rotation about Y-axis	-1,9	mrad	Member No. 21, x: 0.000 m
	Maximum rotation about Z-axis	1,3	mrad	Member No. 299, x: 0.121 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC200 - wind direction 0° out service			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,88	kN	
	Sum of support forces in Y	3,88	kN	Deviation: 0.00 %
	Sum of loads in Z	0,00	kN	
	Sum of support forces in Z	0,00	kN	
	Resultant of reactions about X	-2,461	kNm	At center of gravity of model (X: 0.003, Y: 0.211, Z: 0.406 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	-0,002	kNm	At center of gravity of model
	Maximum displacement in X-direction	-0,4	mm	Member No. 829, x: 0.189 m
	Maximum displacement in Y-direction	12,0	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	12,0	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	17,0	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	-4,7	mrad	Member No. 592, x: 0.006 m
	Maximum rotation about Y-axis	-5,9	mrad	Member No. 6, x: 0.032 m
	Maximum rotation about Z-axis	1,4	mrad	Member No. 299, x: 0.161 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	LC201 - wind direction 90° out service			
	Sum of loads in X	3,70	kN	
	Sum of support forces in X	3,70	kN	Deviation: 0.00 %
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	0,00	kN	
	Sum of support forces in Z	0,00	kN	
	Resultant of reactions about X	0,000	kNm	At center of gravity of model (X: 0.003, Y: 0.211, Z: 0.406 m)
	Resultant of reactions about Y	1,858	kNm	At center of gravity of model
	Resultant of reactions about Z	0,249	kNm	At center of gravity of model
	Maximum displacement in X-direction	5,7	mm	Member No. 513, x: 0.178 m
	Maximum displacement in Y-direction	-0,7	mm	Member No. 626, x: 0.117 m
	Maximum displacement in Z-direction	-0,4	mm	Member No. 527, x: 0.087 m
	Maximum vectorial displacement	5,7	mm	Member No. 513, x: 0.149 m
	Maximum rotation about X-axis	0,9	mrad	Member No. 488, x: 0.000 m
	Maximum rotation about Y-axis	1,8	mrad	Member No. 1359, x: 0.000 m
	Maximum rotation about Z-axis	1,6	mrad	Member No. 870, x: 0.060 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)

2.8.5 Calculation result of RC1 - General loading without wind 1 * (CO1 – CO2)

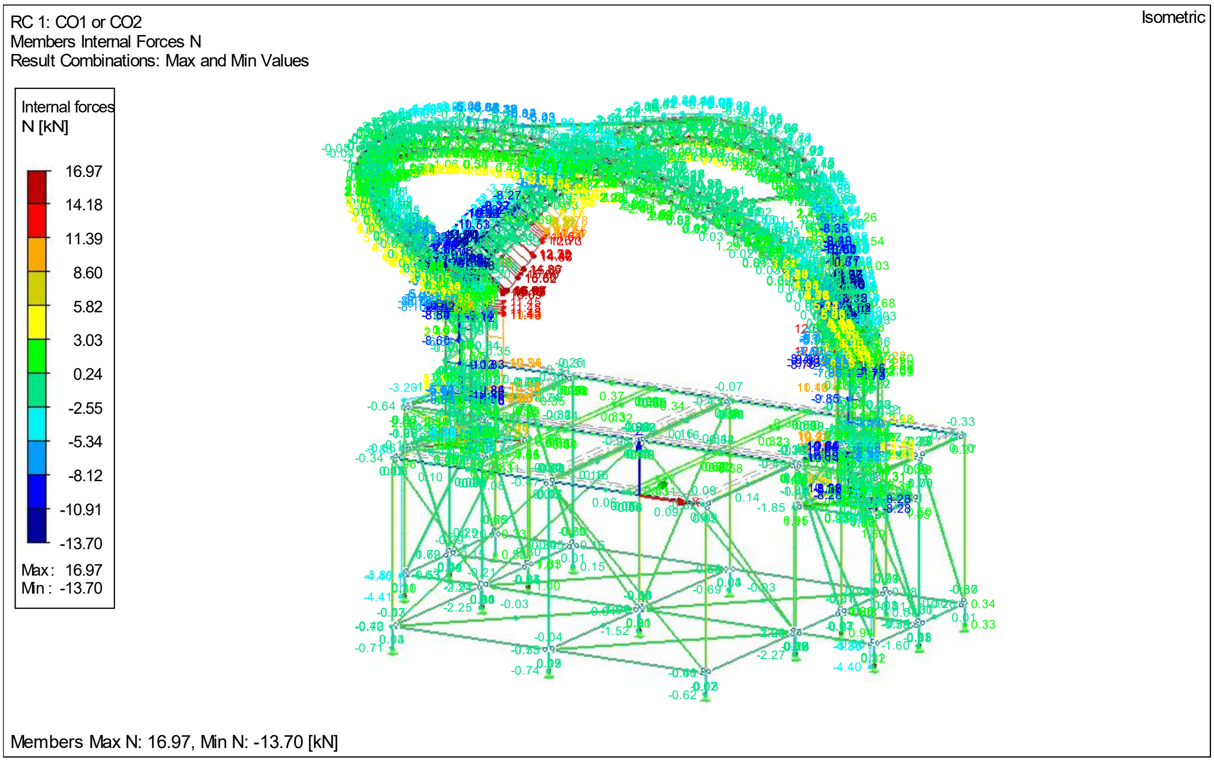
	Description	Value	Unit	Comment
	CO1 - 1.15*LC1 + 1.35*LC2			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-16,95	kN	
	Sum of support forces in Z	-16,95	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	5,0	mm	Member No. 829, x: 0.027 m
	Maximum displacement in Y-direction	-53,2	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-64,5	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	83,6	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	26,2	mrad	Member No. 570, x: 0.000 m
	Maximum rotation about Y-axis	-32,1	mrad	Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	-9,4	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO2 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-19,18	kN	
	Sum of support forces in Z	-19,18	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	4,9	mm	Member No. 829, x: 0.027 m
	Maximum displacement in Y-direction	-43,1	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-53,7	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	68,9	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	21,4	mrad	Member No. 570, x: 0.000 m
	Maximum rotation about Y-axis	-28,7	mrad	Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	-7,9	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)

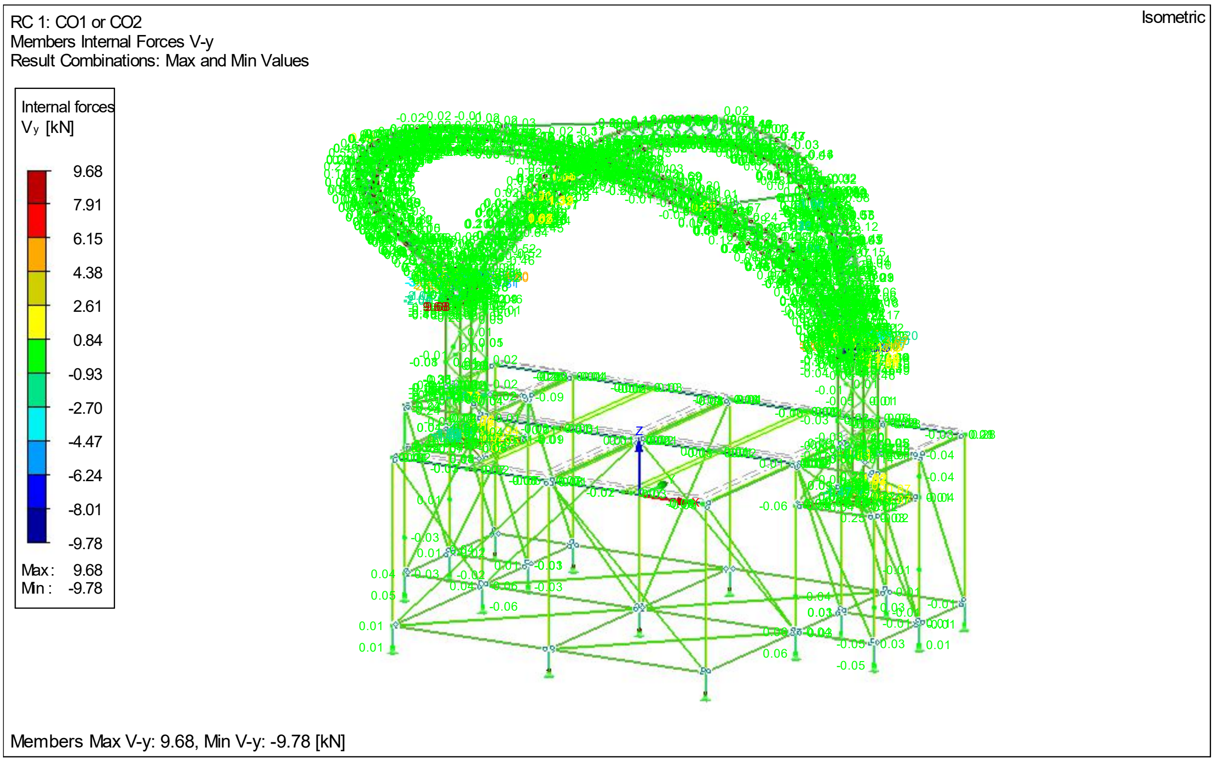
2.8.5.1 Deformation of the RC2: General load combinations characteristic values.

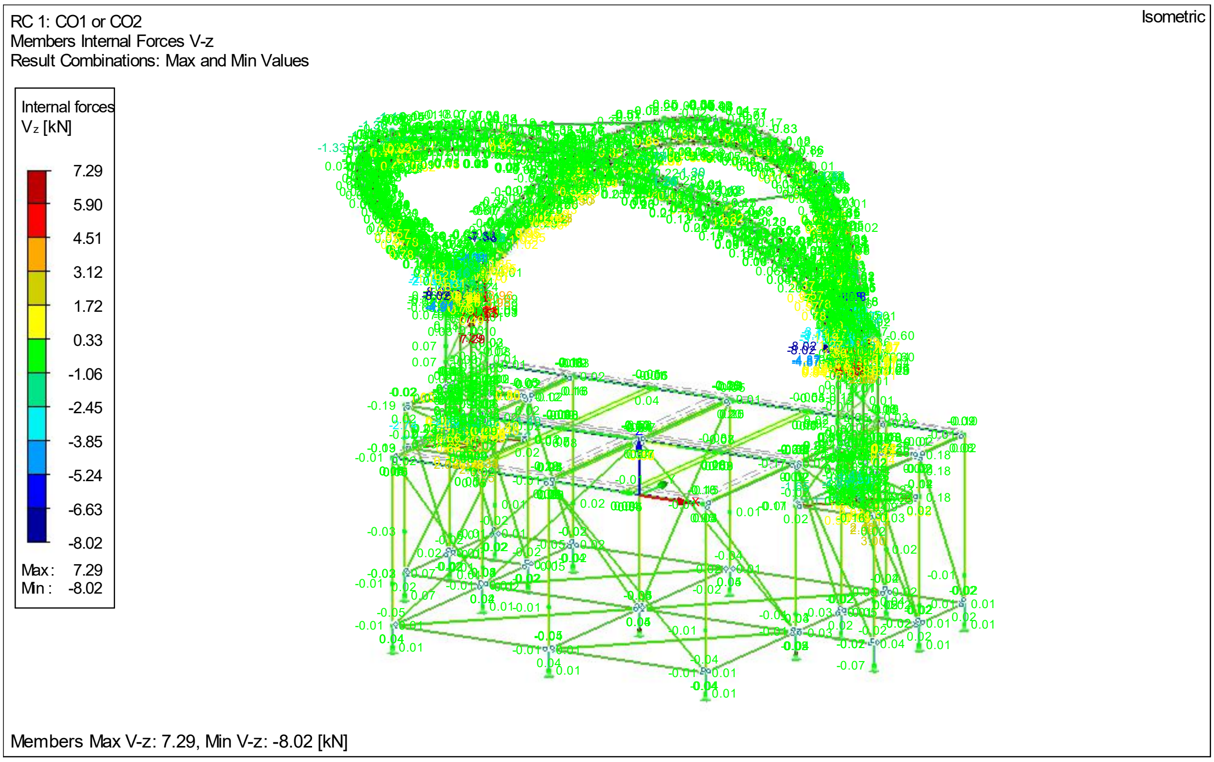


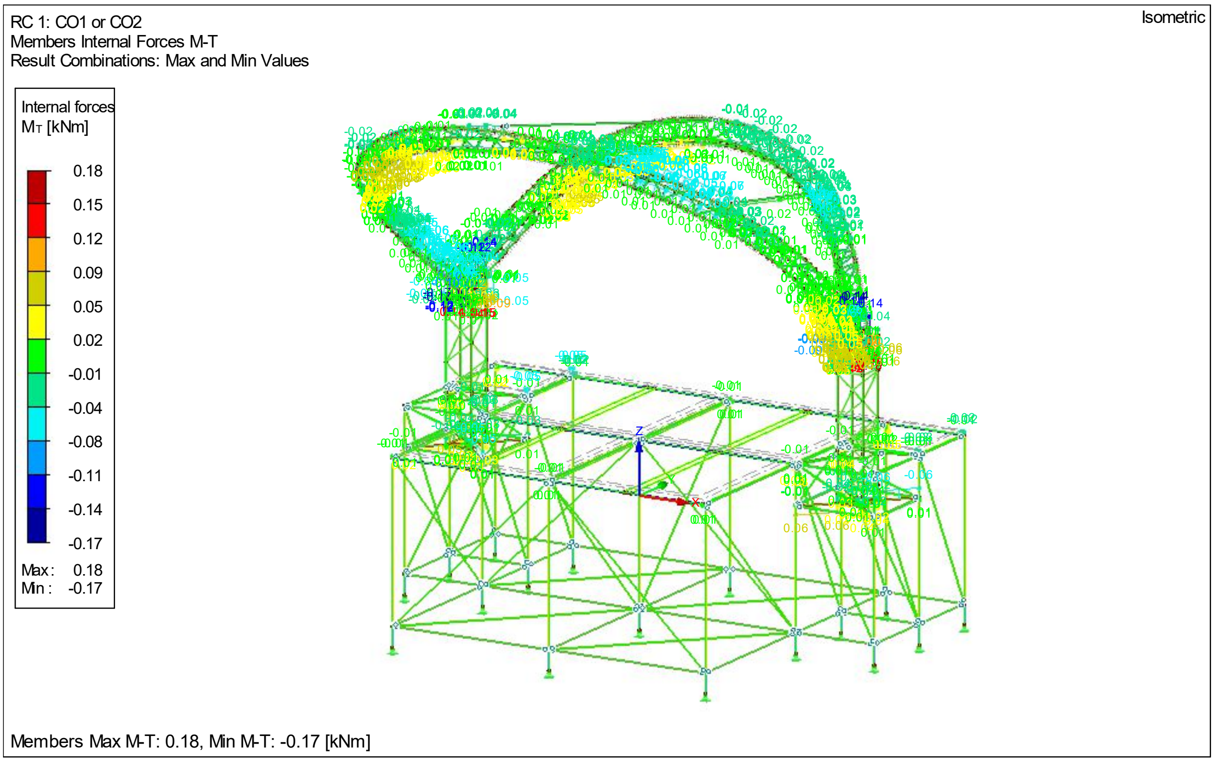


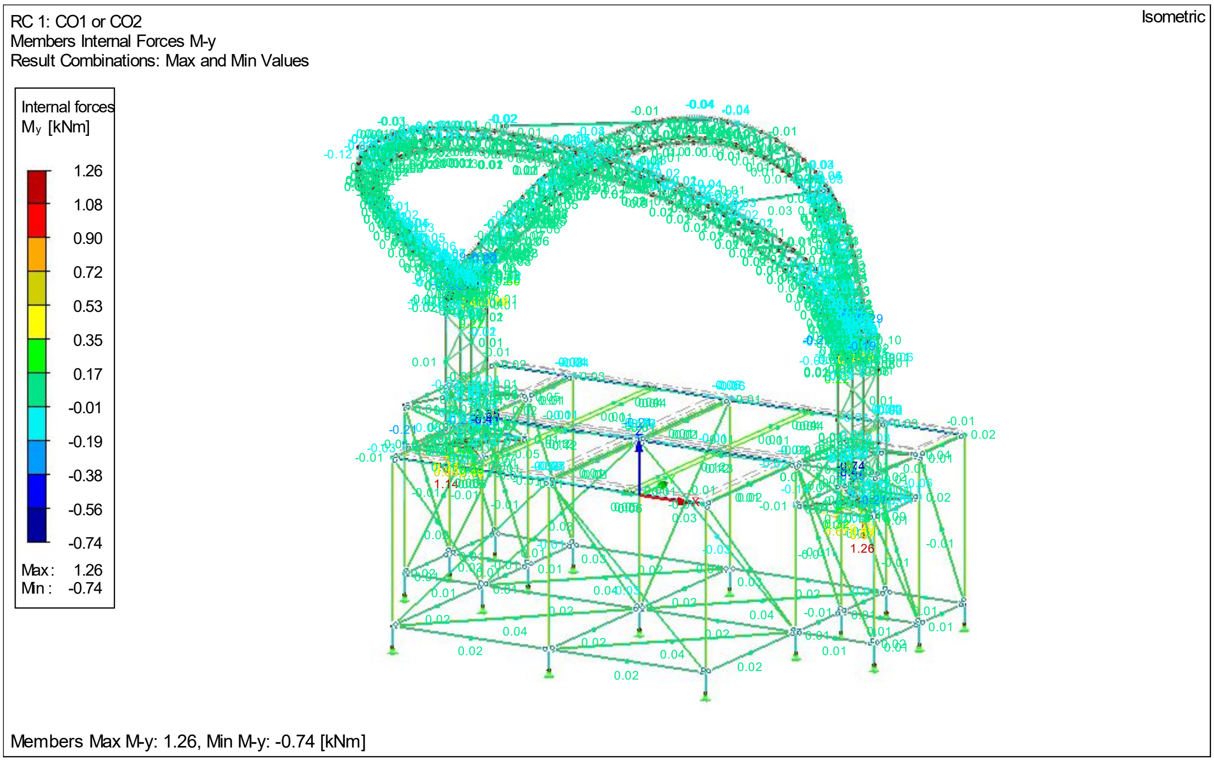
2.8.5.2 Internal force diagram RC1 Design calculation general load combinations

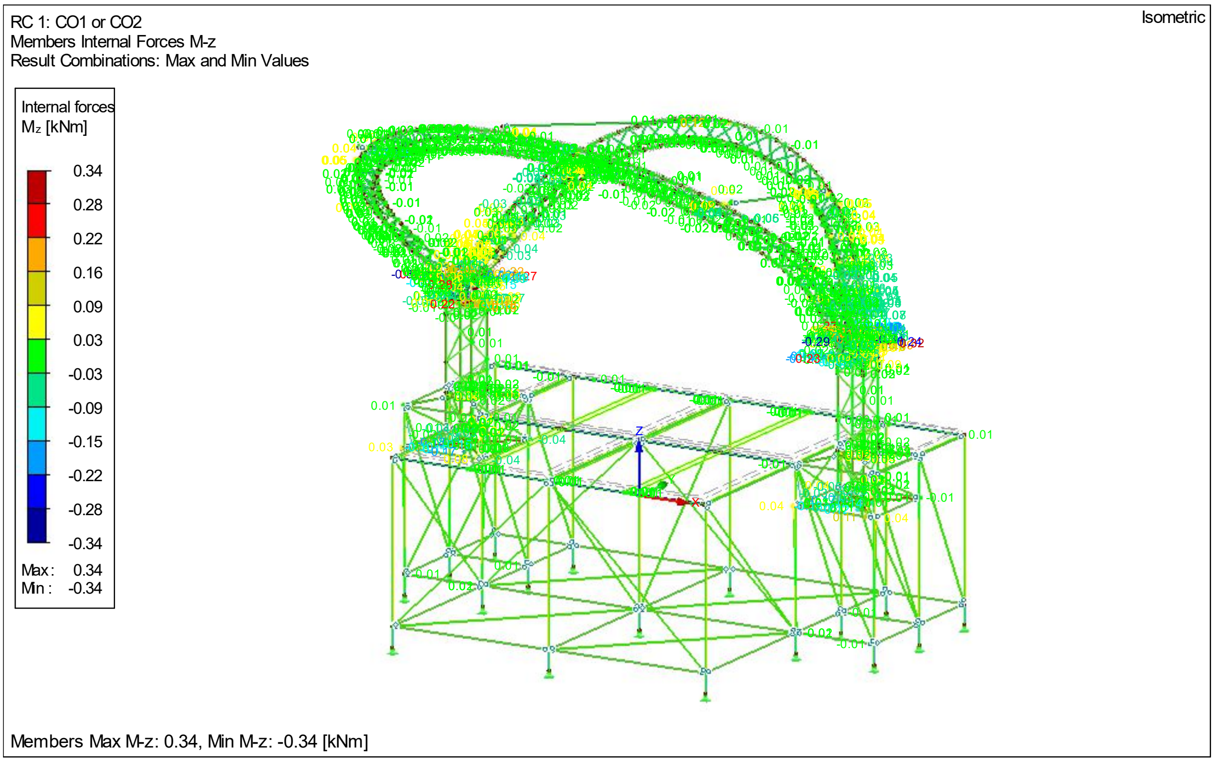





RC 1: CO1 or CO2
Members Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
7.29
5.90
4.51
3.12
1.72
0.33
-1.06
-2.45
-3.85
-5.24
-6.63
-8.02
Max : 7.29
Min : -8.02
Members Max V-z: 7.29, Min V-z: -8.02 [kN]


RC 1: CO1 or CO2
Members Internal Forces M-T
Result Combinations: Max and Min Values
Isometric
Internal forces
MT [kNm]
0.18
0.15
0.12
0.09
0.05
0.02
-0.01
-0.04
-0.08
-0.11
-0.14
-0.17
Max : 0.18
Min : -0.17
Members Max M-T: 0.18, Min M-T: -0.17 [kNm]


RC 1: CO1 or CO2
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
1.26
1.08
0.90
0.72
0.53
0.35
0.17
-0.01
-0.19
-0.38
-0.56
-0.74
Max : 1.26
Min : -0.74
Members Max M-y: 1.26, Min M-y: -0.74 [kNm]

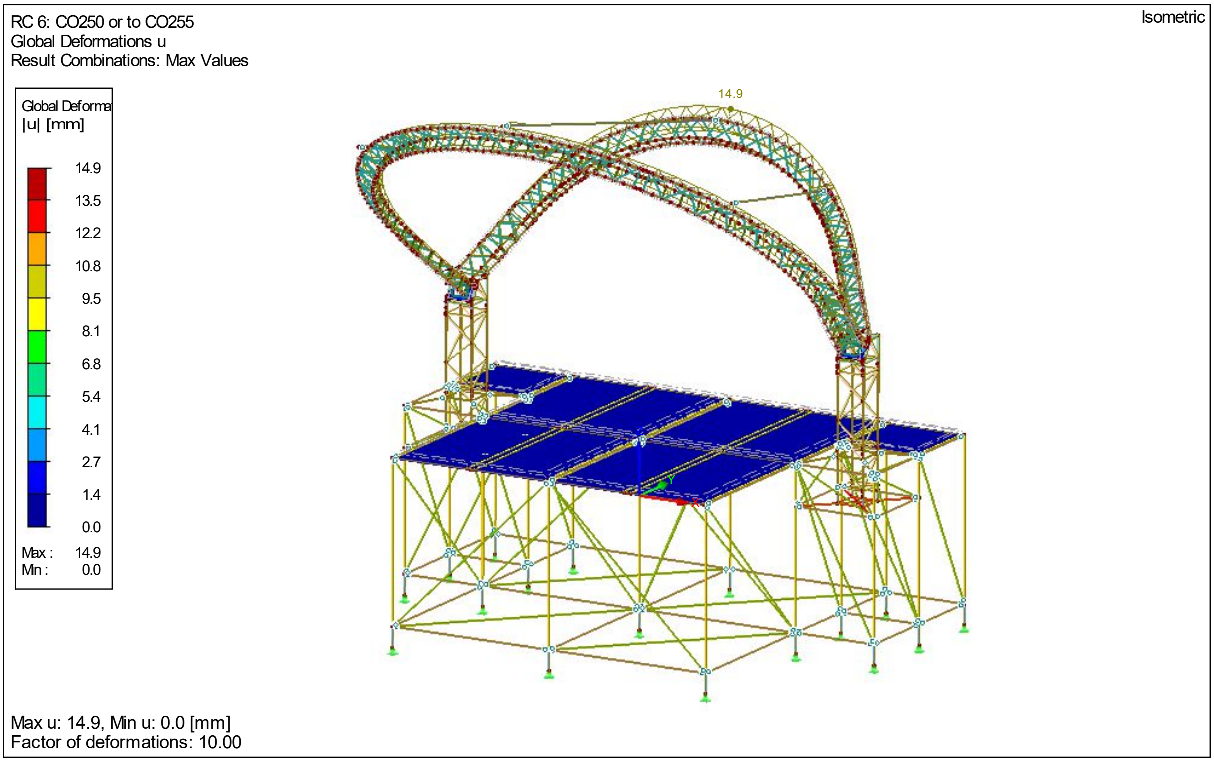

RC 1: CO1 or CO2
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
0.34
0.28
0.22
0.16
0.09
0.03
-0.03
-0.09
-0.15
-0.22
-0.28
-0.34
Max : 0.34
Min : -0.34
Members Max M-z: 0.34, Min M-z: -0.34 [kNm]

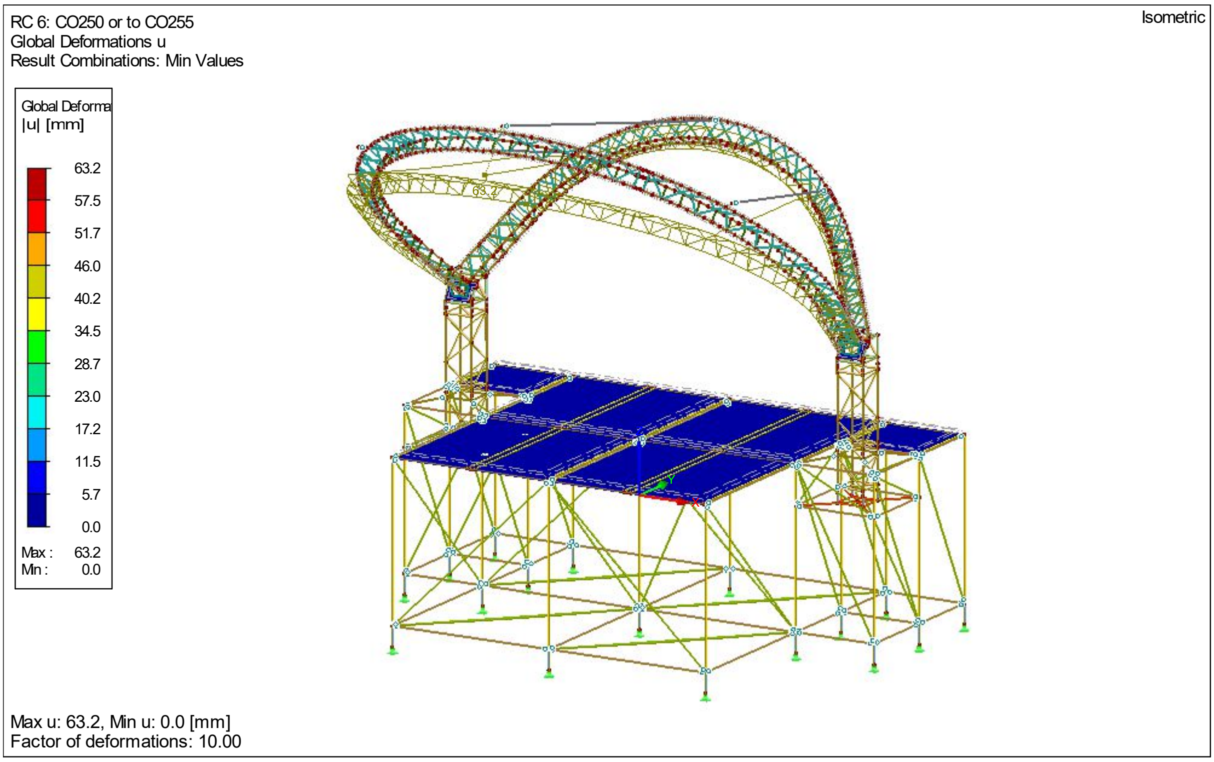
2.8.6 Calculation result of RC5 - Design values Out-service: 1 * (CO200 – CO205)

	Description	Value	Unit	Comment
	CO200 - 1.15*LC1 + 1.35*LC200			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,23	kN	
	Sum of support forces in Y	5,23	kN	Deviation: 0.00 %
	Sum of loads in Z	-12,91	kN	
	Sum of support forces in Z	-12,91	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-0,8	mm	Member No. 1385, x: 1.440 m
	Maximum displacement in Y-direction	9,3	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-12,0	mm	Member No. 481, x: 3.050 m
	Maximum vectorial displacement	13,0	mm	Member No. 481, x: 3.050 m
	Maximum rotation about X-axis	-11,1	mrad	Member No. 481, x: 0.000 m
	Maximum rotation about Y-axis	-21,6	mrad	Member No. 6, x: 0.036 m
	Maximum rotation about Z-axis	-1,1	mrad	Member No. 1333, x: 2.880 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO201 - 1.15*LC1 + 1.35*LC2 + 1.35*LC200			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,23	kN	
	Sum of support forces in Y	5,23	kN	Deviation: 0.00 %
	Sum of loads in Z	-16,95	kN	
	Sum of support forces in Z	-16,95	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	4,5	mm	Member No. 826, x: 0.189 m
	Maximum displacement in Y-direction	-37,0	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-47,8	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	60,4	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	19,7	mrad	Member No. 570, x: 0.000 m
	Maximum rotation about Y-axis	-28,7	mrad	Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	-7,6	mrad	Member No. 476, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO202 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC200			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,23	kN	
	Sum of support forces in Y	5,23	kN	Deviation: 0.00 %
	Sum of loads in Z	-19,18	kN	
	Sum of support forces in Z	-19,18	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	4,4	mm	Member No. 829, x: 0.000 m
	Maximum displacement in Y-direction	-26,8	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-36,9	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	45,6	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	16,5	mrad	Member No. 481, x: 5.084 m
	Maximum rotation about Y-axis	-26,1	mrad	Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	-6,1	mrad	Member No. 476, x: 0.180 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO203 - 1.15*LC1 + 1.35*LC201			
	Sum of loads in X	5,00	kN	
	Sum of support forces in X	5,00	kN	Deviation: 0.00 %
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-12,91	kN	
	Sum of support forces in Z	-12,91	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	8,0	mm	Member No. 760, x: 0.162 m
	Maximum displacement in Y-direction	-8,9	mm	Member No. 481, x: 2.034 m
	Maximum displacement in Z-direction	-16,9	mm	Member No. 481, x: 2.034 m
	Maximum vectorial displacement	19,8	mm	FE Mesh Node No. 2159 (X: 0.003, Y: -1.144, Z: 4.678 m)
	Maximum rotation about X-axis	10,8	mrad	Member No. 481, x: 5.084 m
	Maximum rotation about Y-axis	19,5	mrad	Member No. 21, x: 0.000 m
	Maximum rotation about Z-axis	3,2	mrad	Member No. 412, x: 0.180 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO204 - 1.15*LC1 + 1.35*LC2 + 1.35*LC201			
	Sum of loads in X	5,00	kN	
	Sum of support forces in X	5,00	kN	Deviation: 0.00 %
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-16,95	kN	
	Sum of support forces in Z	-16,95	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	11,3	mm	Member No. 822, x: 0.027 m
	Maximum displacement in Y-direction	-53,3	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-64,6	mm	Member No. 483, x: 0.000 m
	Maximum vectorial displacement	84,1	mm	Member No. 483, x: 0.000 m
	Maximum rotation about X-axis	26,4	mrad	Member No. 525, x: 0.000 m
	Maximum rotation about Y-axis	-32,7	mrad	Member No. 4, x: 0.036 m

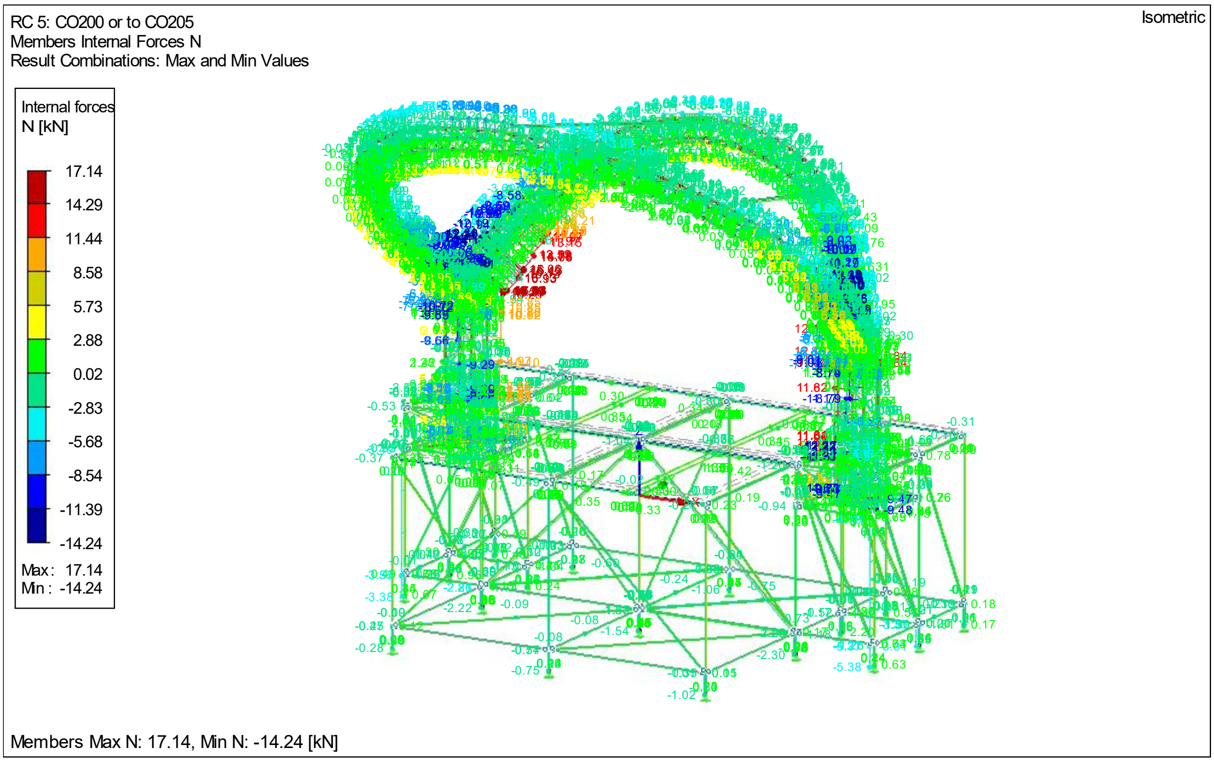
	Maximum rotation about Z-axis	11,4	mrad	Member No. 412, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)
	CO205 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3 + 1.35*LC201			
	Sum of loads in X	5,00	kN	
	Sum of support forces in X	5,00	kN	Deviation: 0.00 %
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-19,18	kN	
	Sum of support forces in Z	-19,18	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	11,1	mm	Member No. 822, x: 0.000 m
	Maximum displacement in Y-direction	-43,2	mm	Member No. 483, x: 0.000 m
	Maximum displacement in Z-direction	-53,8	mm	Member No. 481, x: 0.000 m
	Maximum vectorial displacement	69,4	mm	Member No. 481, x: 0.000 m
	Maximum rotation about X-axis	21,7	mrad	Member No. 524, x: 0.000 m
	Maximum rotation about Y-axis	-29,0	mrad	Member No. 4, x: 0.036 m
	Maximum rotation about Z-axis	9,9	mrad	Member No. 412, x: 0.135 m
	Method of analysis	Large		Large Deformation Analysis (Newton-Raphson)

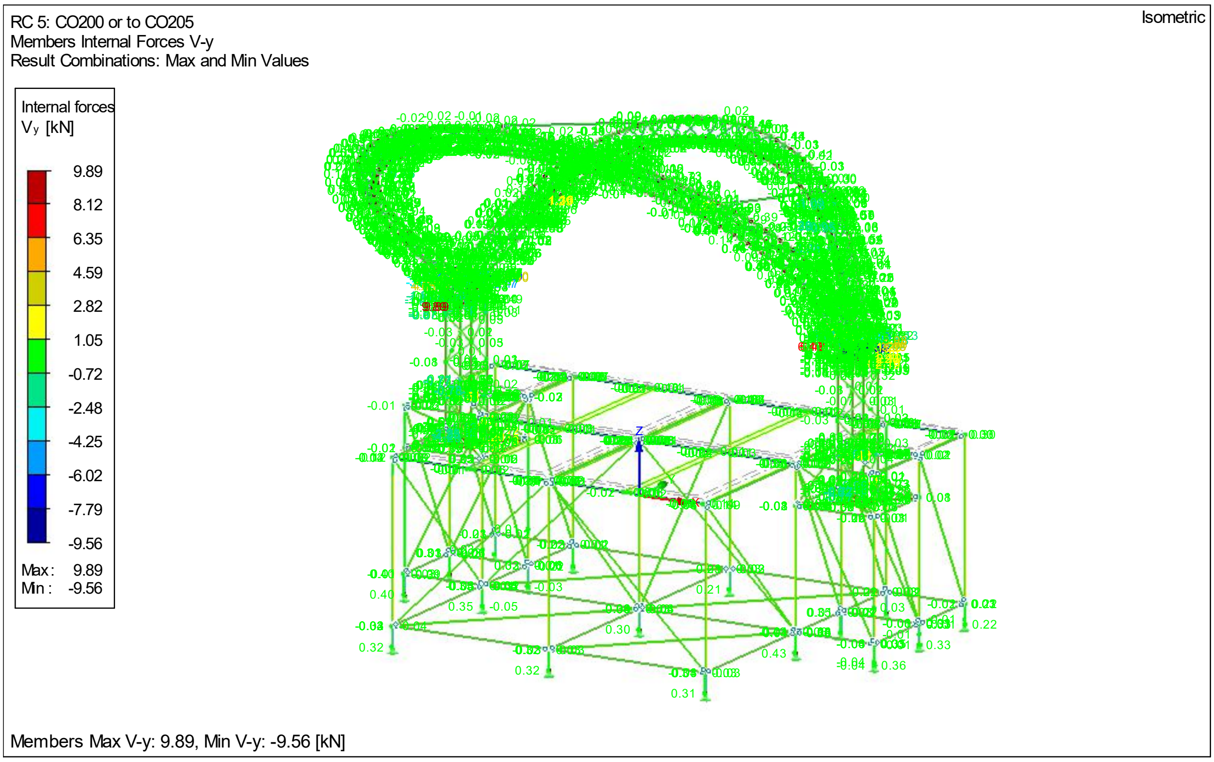
2.8.6.1 Deformation of the RC6: Out-service load combinations characteristic values.

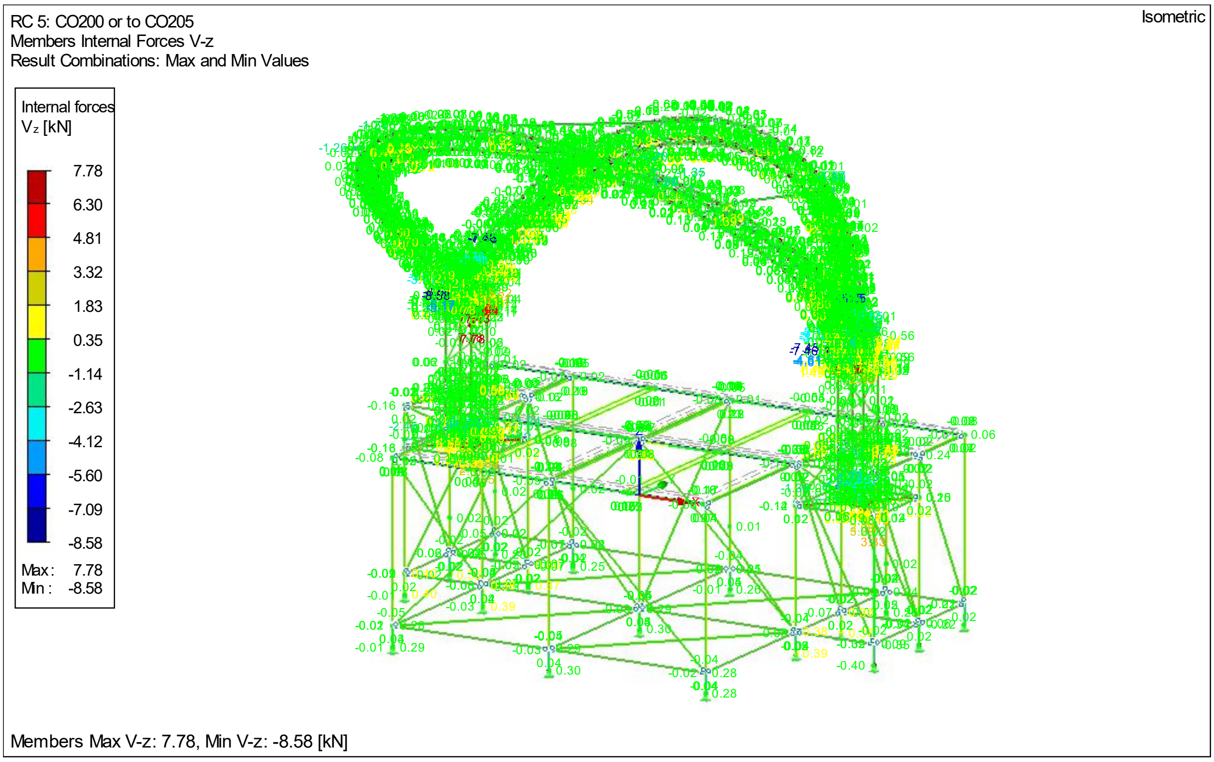


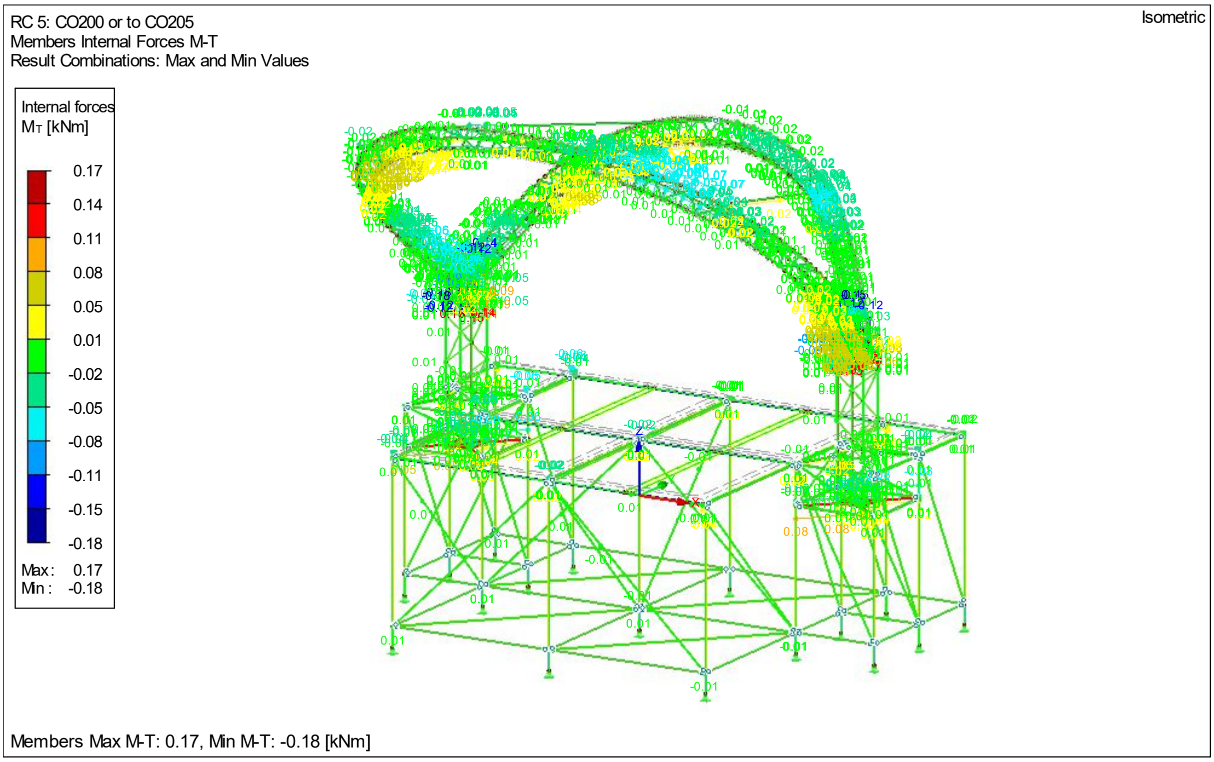


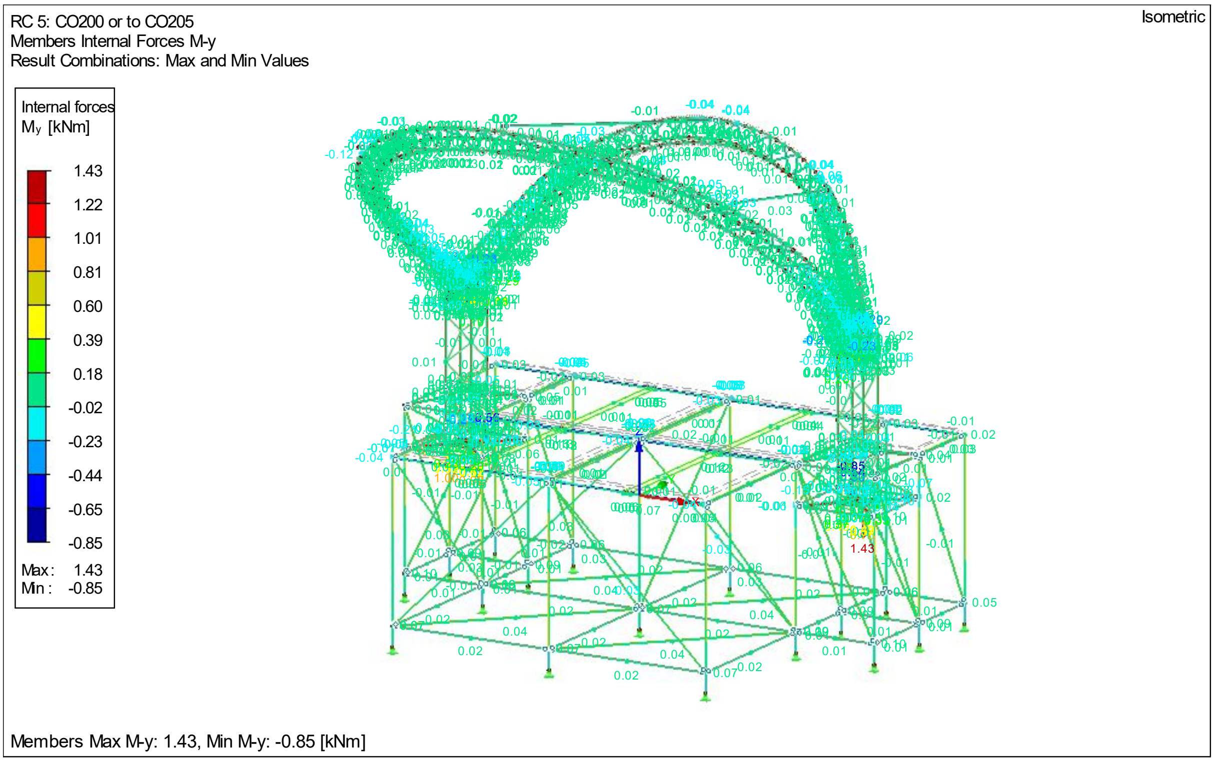
2.8.6.2 Internal force diagram RC5 Design calculation Out service wind

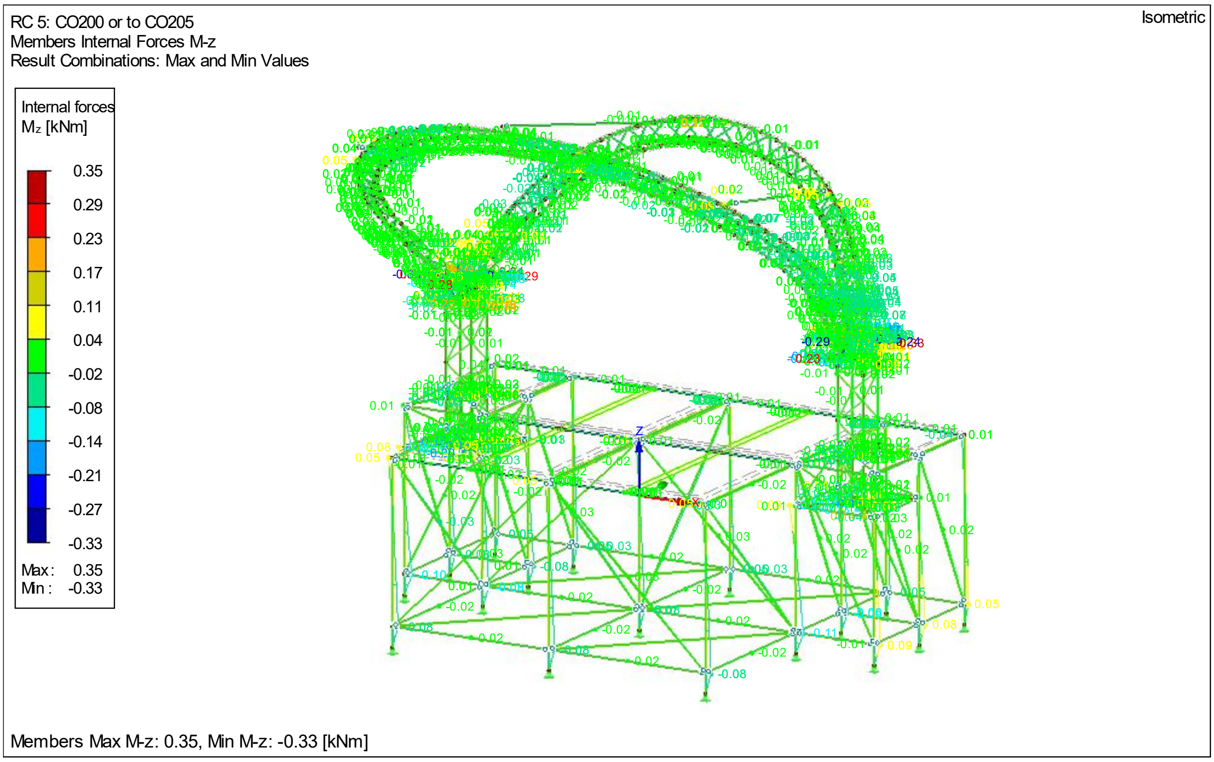





RC 5: CO200 or to CO205
Members Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
7.78
6.30
4.81
3.32
1.83
0.35
-1.14
-2.63
-4.12
-5.60
-7.09
-8.58
Max : 7.78
Min : -8.58
Members Max V-z: 7.78, Min V-z: -8.58 [kN]


RC 5: CO200 or to CO205
Members Internal Forces M-T
Result Combinations: Max and Min Values
Isometric
Internal forces
MT [kNm]
0.17
0.14
0.11
0.08
0.05
0.01
-0.02
-0.05
-0.08
-0.11
-0.15
-0.18
Max : 0.17
Min : -0.18
Members Max M-T: 0.17, Min M-T: -0.18 [kNm]

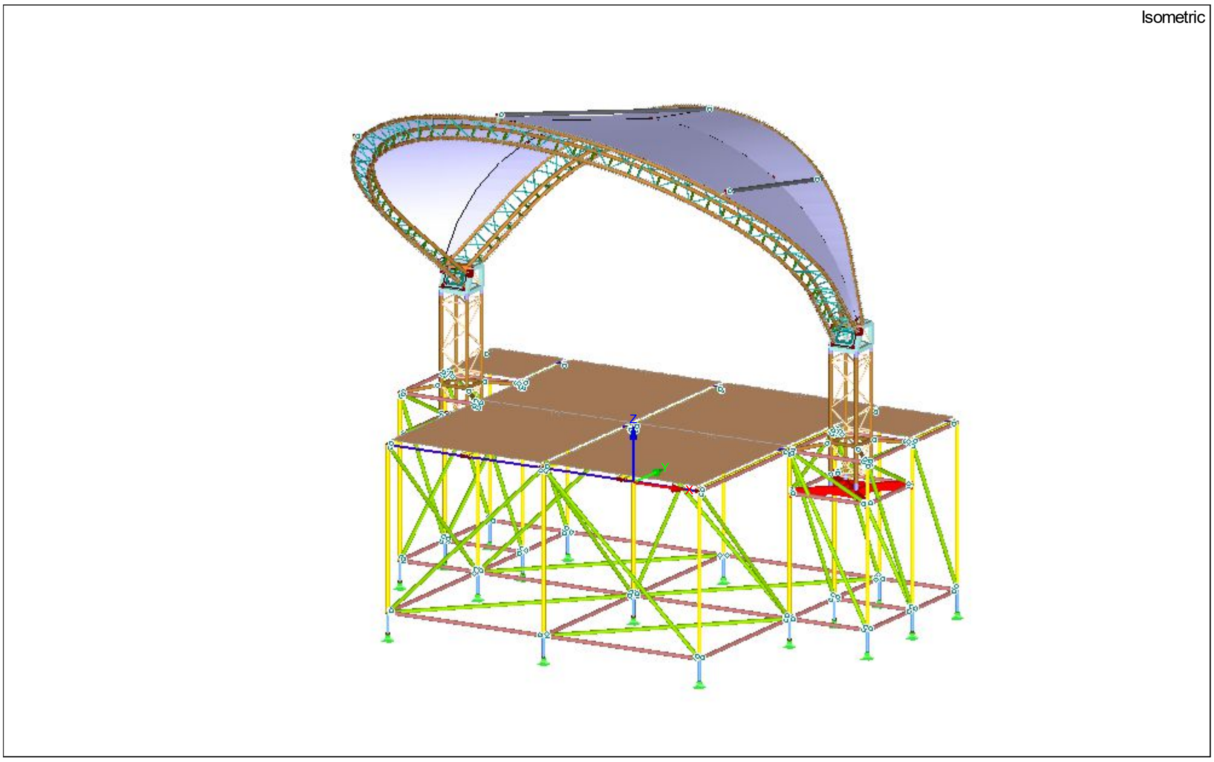

RC 5: CO200 or to CO205
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
1.43
1.22
1.01
0.81
0.60
0.39
0.18
-0.02
-0.23
-0.44
-0.65
-0.85
Max : 1.43
Min : -0.85
Members Max M-y: 1.43, Min M-y: -0.85 [kNm]


RC 5: CO200 or to CO205
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
0.35
0.29
0.23
0.17
0.11
0.04
-0.02
-0.08
-0.14
-0.21
-0.27
-0.33
Max : 0.35
Min : -0.33
Members Max M-z: 0.35, Min M-z: -0.33 [kNm]

2.9 Stress analyse calculation for the In service situation.

There are three stress analyse calculation made for the In service situation

CA1 - General loading without wind	: 1 * (CO1 or to CO2)
CA2 – Load cases wind direction 0°	: 1 * (CO100 or to CO102)
CA3 – Load cases wind direction 90°	: 1 * (CO103 or to CO105)



Cross-Sections
- 1: Ring 38/4.5; S320GD 1.0250
- 2: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 3: RO 48.3x3.2 (Hot Formed); Steel S 235 JR
- 4: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 5: RRO 100x50x3.2 (Hot Formed); Steel S 235 JR
- 6: Ring 50/6; Aluminum EN-AW 6082 (EP,ET) T6
- 7: Ring 48/3; Aluminum EN-AW 6082 (EP,ET) T6
- 8: Ring 30/3; Aluminum EN-AW 6082 (EP,ET) T6
- 9: Ring 20/2; Aluminum EN-AW 6082 (EP,ET) T6
- 10: HK 50/50/5/5/5/5; Aluminum EN-AW 6082 (EP,ET) T6
- 11: TO 50/100/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 12: Ring 16/2; Aluminum EN-AW 6082 (EP,ET) T6
- 13: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 14: Rectangle 15/60; Aluminum EN-AW 6082 (EP,ET) T6
- 15: RD 20; steel 8.8 kw aliteit
- 16: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 17: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6

2.9.1 stress analyse Cross sections description

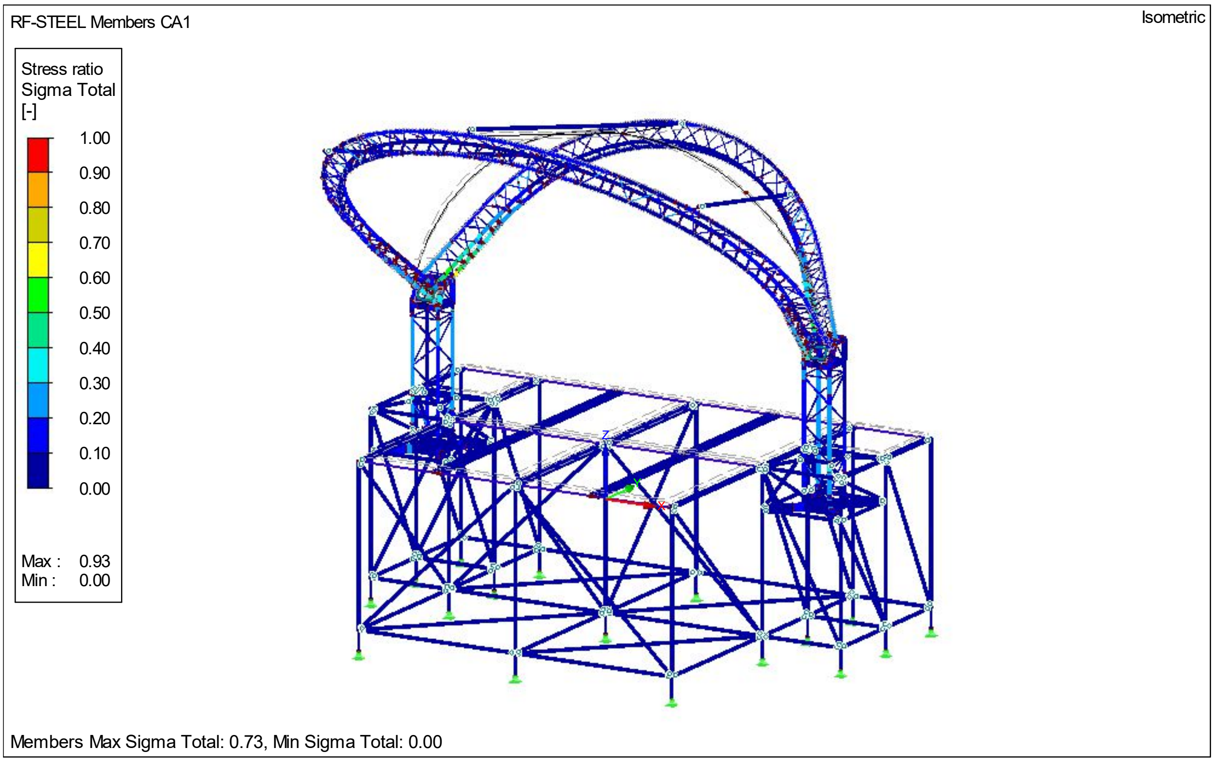
Section No.	Material No.	Cross-Section Description	Max. Design Ratio	Opti-mize
1	1	Ring 38/4.5	0,03	No
2	1	RO 48.3x3.2 (Hot Formed)	0,07	No
3	2	RO 48.3x3.2 (Hot Formed)	0,03	No
4	2	RO 48.3x2.6 (Hot Formed)	0,04	No
5	2	RRO 100x50x3.2 (Hot Formed)	0,12	No
6	3	Ring 50/6	0,03	No
7	3	Ring 48/3	0,15	No
8	3	Ring 30/3	0,18	No
9	3	Ring 20/2	0,06	No
10	3	HK 50/50/5/5/5/5	0,10	No
11	3	TO 50/100/4/4/4/4	0,05	No
12	3	Ring 16/2	0,10	No
13	3	Ring 50/4	0,08	No
14	3	Rectangle 15/60	0,05	No
15	6	RD 20	0,11	No
16	8	EV transom		No
17	8	HK 50/30/4/4/4/4	0,02	No

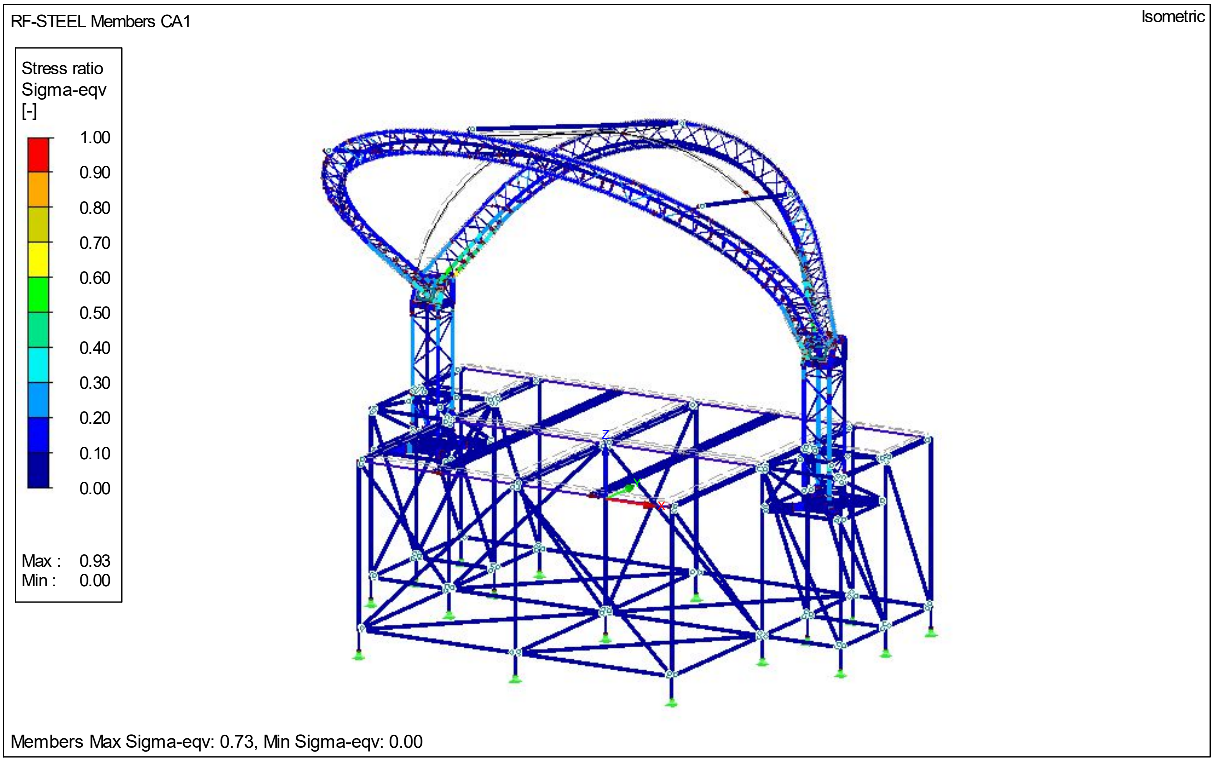
2.9.2 Used materials

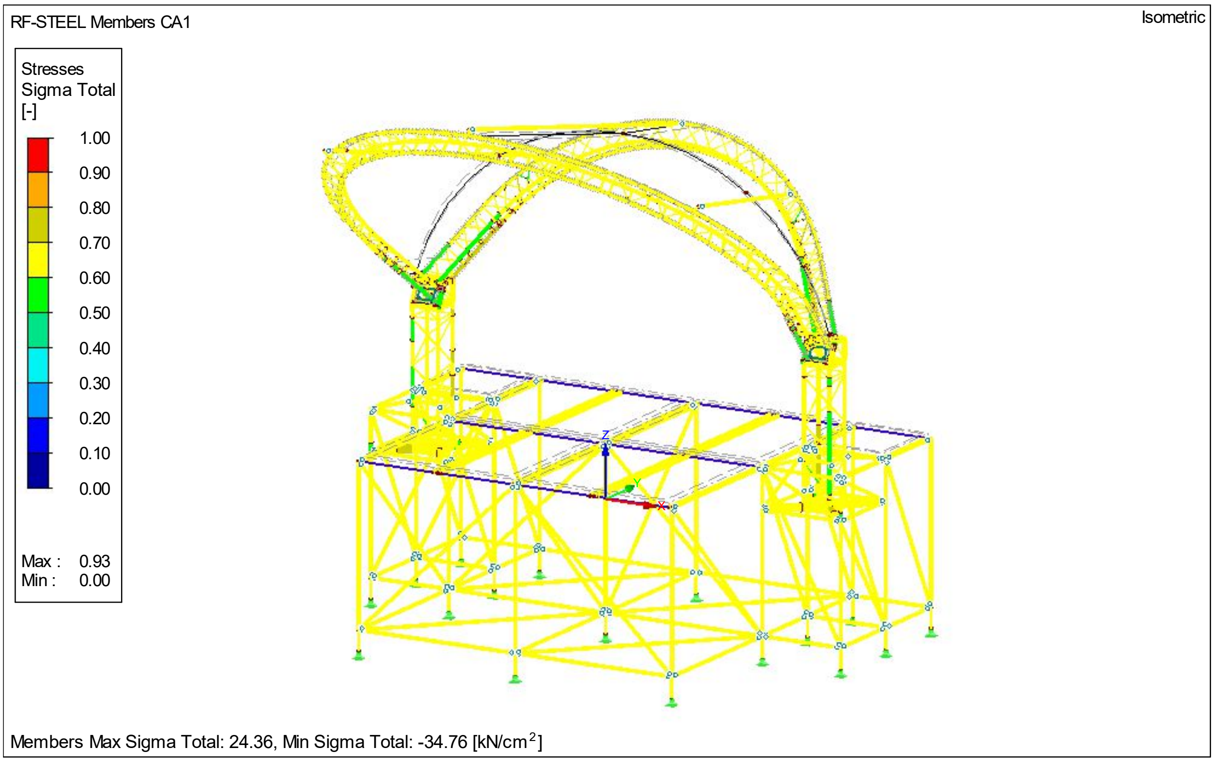
Material No.	Material Description	Safety Factor γ_M [-]	Yield Strength f_{yk} [kN/cm²]	Limit Stresses [kN/cm²] Manually	Limit σ_x	Limit τ	Limit σ_{eqv}
1	S320GD 1.0250* | EN 10346:2009-03	1,10	32,00	-	29,09	16,80	29,09
2	Steel S 235 JR | EN 10025:1994-03	1,10	23,50	-	21,36	12,33	21,36
3	Aluminum EN-AW 6082 (EP,ET) T6* | EN 1999-1-1:2007	1,10	12,50	-	11,36	6,56	11,36
4	Aluminum EN-AW 5083 O/H111 | EN 1999-1-1:2007	1,00	12,50	-	12,50	7,22	12,50
5	canopy | No code	1,10	0,00	-	0,00	0,00	0,00
6	steel 8.8 kwaliteit | EN 10346:2009-03	1,00	64,00	-	64,00	36,95	64,00
7	Plywood, Class F20/10 E40/20, Plate Stress, Perpendicular | EN 12369-2:2011-06	1,20	0,00	-	0,00	0,00	0,00
8	Aluminum EN-AW 6005A (EP/O,ER/B) T6 | EN 1999-1-1:2007	1,00	22,50	-	22,50	12,99	22,50

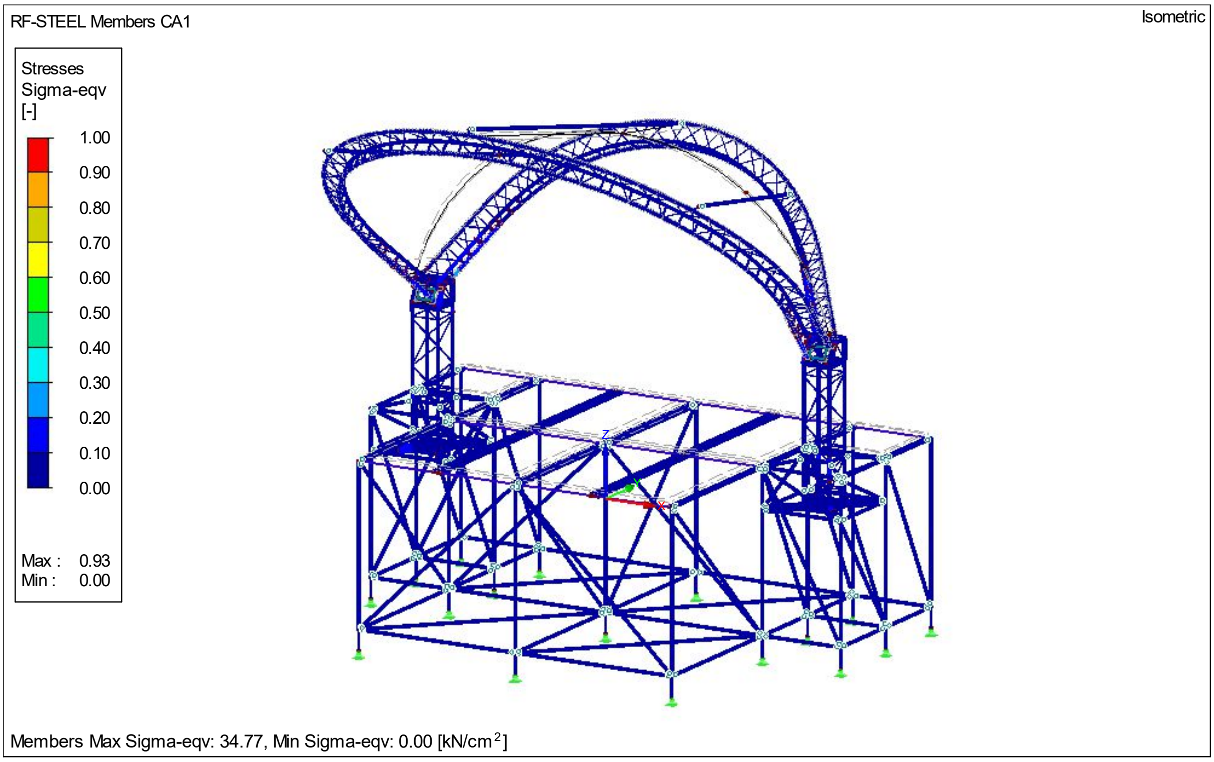
The Yield strength of material 3 has been manually changed. This is according to the Eurocode NEN-EN 1999-1-1 Table 3.2 the $f_{o,haz}$ for the heat affective zone. This check is concerning a welded construction with heat affective zones in the main elements, there for the choice to check the construction according to the lower $f_{o\ haz}$.

2.9.3 Results stress analyse calculation CA1 = General loading without wind





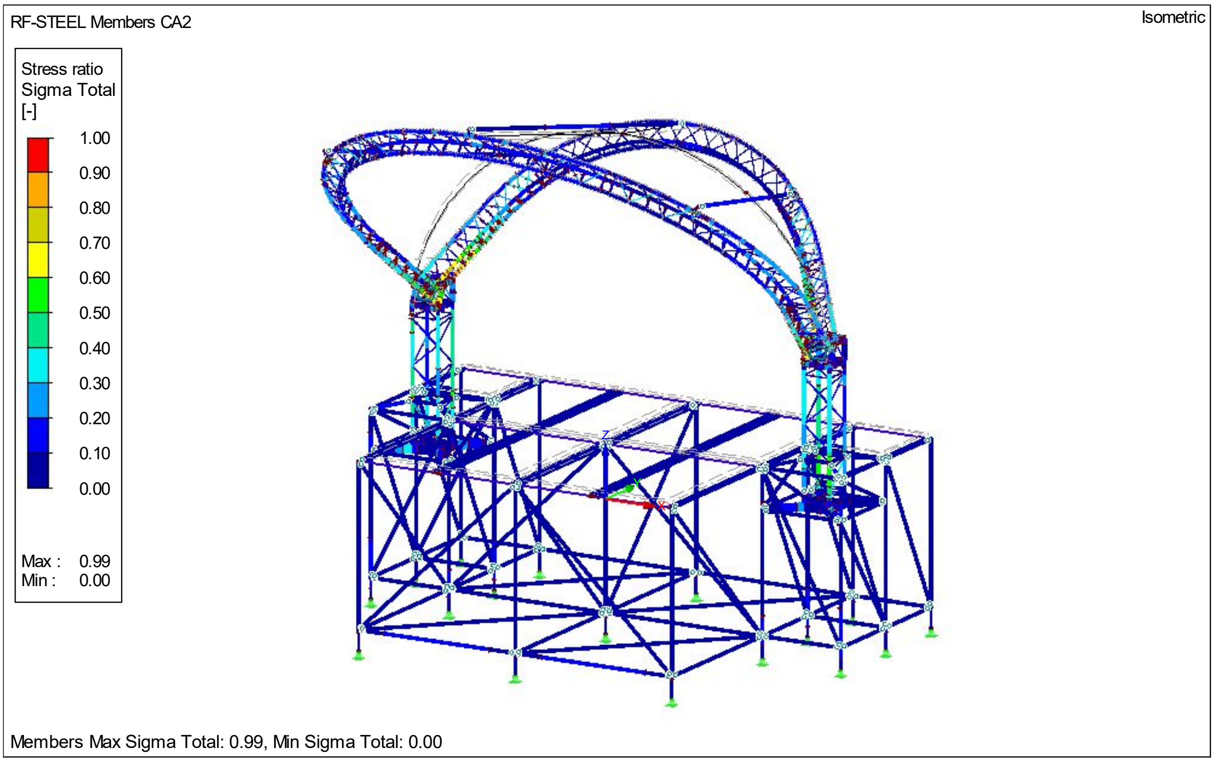

RF-STEEL Members CA1
Isometric
Stresses
Sigma Total
[-]
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Max : 0.93
Min : 0.00
Members Max Sigma Total: 24.36, Min Sigma Total: -34.76 [kN/cm2]

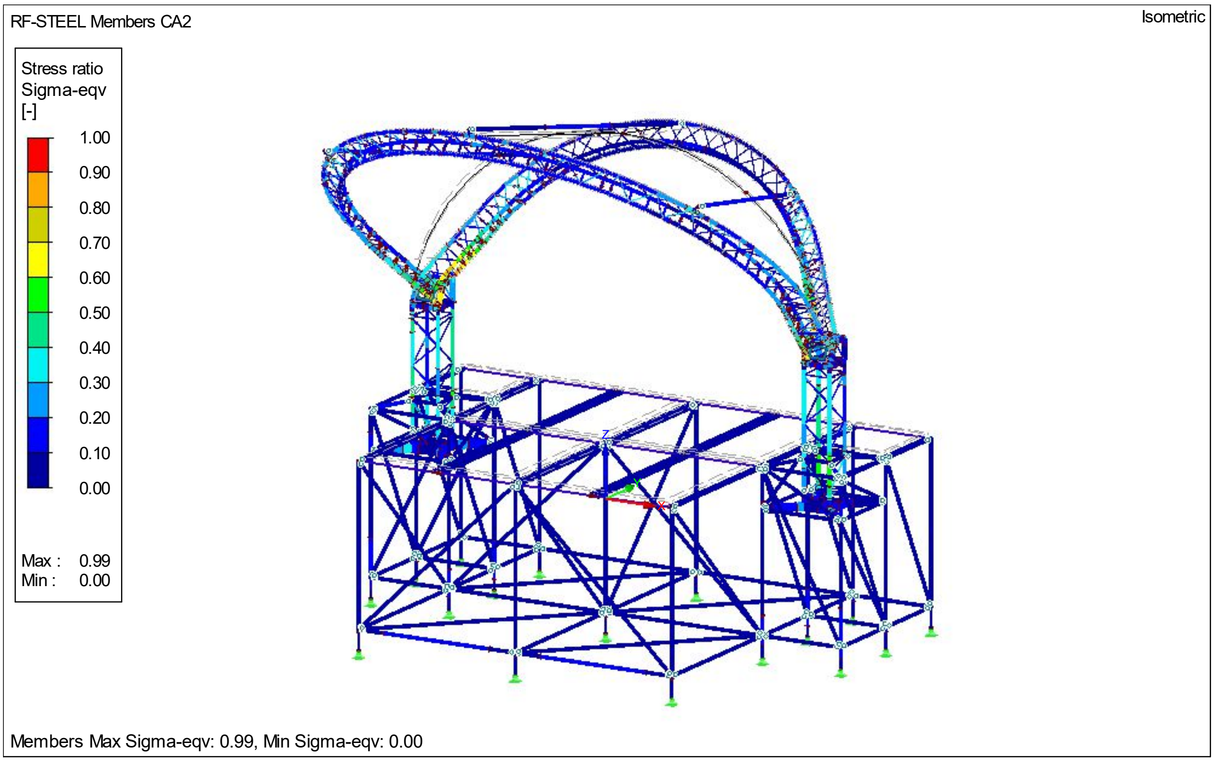

RF-STEEL Members CA1
Isometric
Stresses
Sigma-eqv
[-]
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Max : 0.93
Min : 0.00
Members Max Sigma-eqv: 34.77, Min Sigma-eqv: 0.00 [kN/cm2]

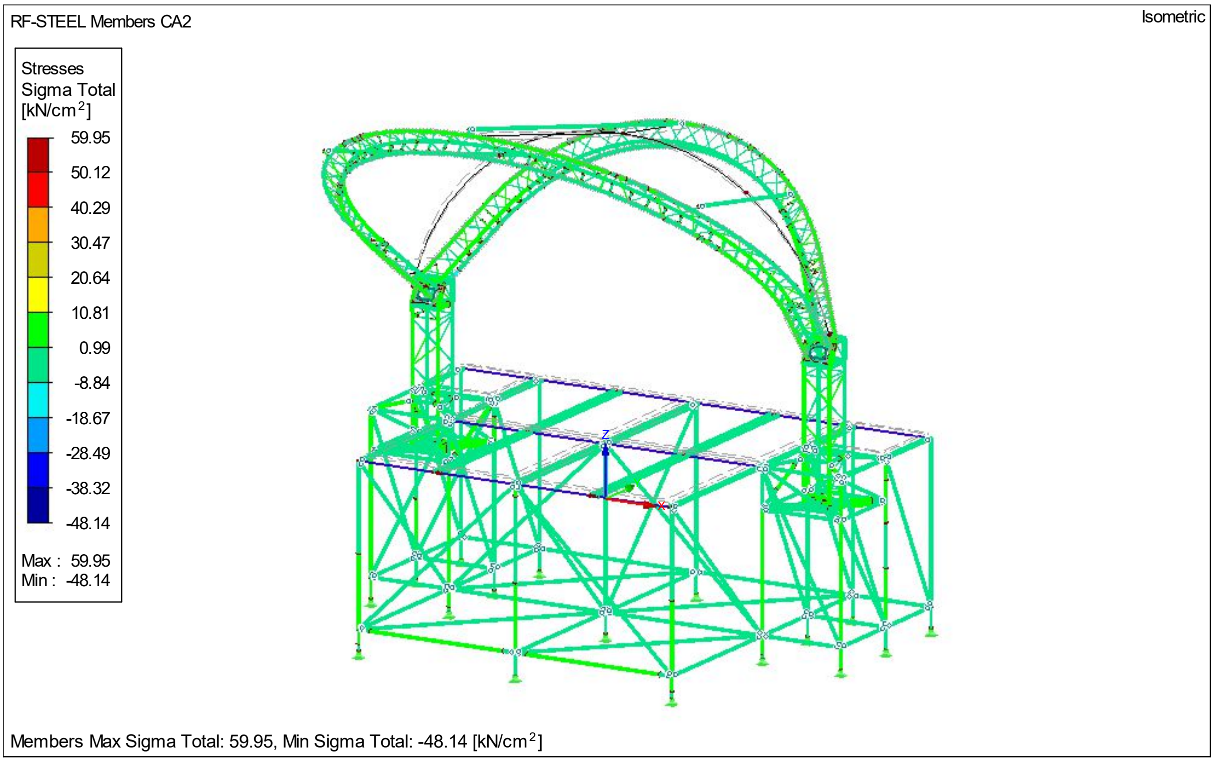
2.9.3.1 Results stress analyse calculation CA1 - Utilisation per cross section

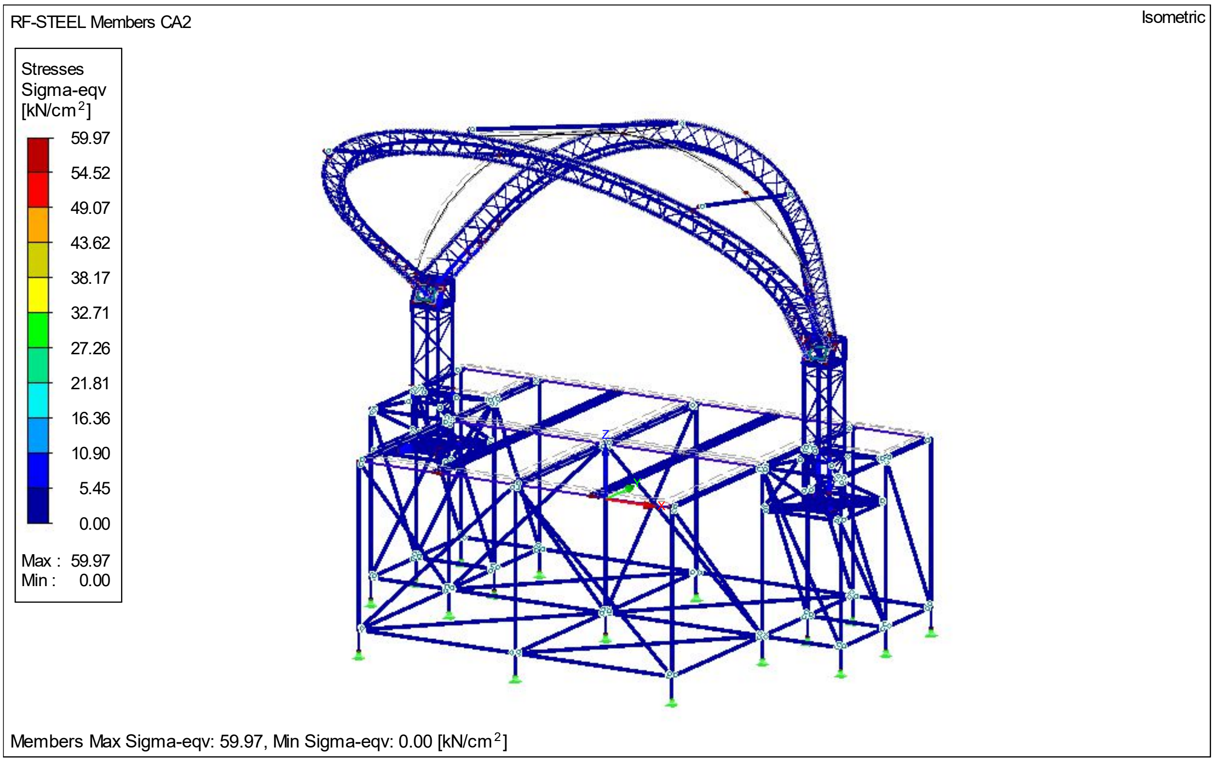
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 38/4.5							
	1180	0,250	25	CO2	Sigma Total	-1,53	29,09	0,05
	1180	0,000	34	CO2	Tau Total	0,05	16,80	0,00
	1180	0,250	25	CO2	Sigma-eqv	1,53	29,09	0,05
2	RO 48.3x3.2 (Hot Formed)							
	1223	0,000	5	CO2	Sigma Total	-3,20	29,09	0,11
	1243	0,000	18	CO1	Tau Total	0,80	16,80	0,05
	1223	0,000	5	CO2	Sigma-eqv	3,20	29,09	0,11
3	RO 48.3x3.2 (Hot Formed)							
	1299	0,691	28	CO2	Sigma Total	0,55	21,36	0,03
	4	0,036	1	CO1	Tau Total	-0,54	12,33	0,04
	4	0,000	19	CO1	Sigma-eqv	0,96	21,36	0,04
4	RO 48.3x2.6 (Hot Formed)							
	1417	1,465	28	CO2	Sigma Total	0,91	21,36	0,04
	36	0,000	19	CO2	Tau Total	-0,12	12,33	0,01
	1417	1,465	28	CO2	Sigma-eqv	0,91	21,36	0,04
5	RRO 100x50x3.2 (Hot Formed)							
	56	0,493	11	CO1	Sigma Total	5,68	21,36	0,27
	56	0,000	8	CO1	Tau Total	-0,66	12,33	0,05
	56	0,493	11	CO1	Sigma-eqv	5,71	21,36	0,27
6	Ring 50/6							
	68	0,125	35	CO1	Sigma Total	3,08	23,64	0,13
	61	0,000	31	CO1	Tau Total	0,30	13,65	0,02
	68	0,125	35	CO1	Sigma-eqv	3,08	23,64	0,13
7	Ring 48/3							
	267	0,000	15	CO1	Sigma Total	8,29	11,36	0,73
	976	0,000	2	CO1	Tau Total	1,31	6,56	0,20
	267	0,000	15	CO1	Sigma-eqv	8,33	11,36	0,73
8	Ring 30/3							
	682	0,000	27	CO1	Sigma Total	6,27	11,36	0,55
	876	0,150	18	CO1	Tau Total	1,46	6,56	0,22
	682	0,000	27	CO1	Sigma-eqv	6,32	11,36	0,56
9	Ring 20/2							
	114	0,000	9	CO1	Sigma Total	3,08	11,36	0,27
	113	0,169	1	CO1	Tau Total	-0,09	6,56	0,01
	114	0,000	9	CO1	Sigma-eqv	3,08	11,36	0,27
10	HK 50/50/5/5/5/5							
	1446	0,000	10	CO1	Sigma Total	6,01	11,36	0,53
	247	0,044	8	CO1	Tau Total	2,21	6,56	0,34
	1446	0,000	10	CO1	Sigma-eqv	6,09	11,36	0,54
11	TO 50/100/4/4/4/4							
	245	0,084	14	CO1	Sigma Total	3,76	11,36	0,33
	261	0,081	7	CO1	Tau Total	-2,60	6,56	0,40
	245	0,084	14	CO1	Sigma-eqv	4,72	11,36	0,42
12	Ring 16/2							
	301	0,322	3	CO1	Sigma Total	4,02	11,36	0,35
	878	0,239	13	CO1	Tau Total	0,37	6,56	0,06
	301	0,322	3	CO1	Sigma-eqv	4,02	11,36	0,35
13	Ring 50/4							
	14	0,000	14	CO1	Sigma Total	7,63	11,36	0,67
	14	0,000	20	CO1	Tau Total	1,32	6,56	0,20
	14	0,000	14	CO1	Sigma-eqv	7,74	11,36	0,68
14	Rectangle 15/60							
	486	0,090	4	CO2	Sigma Total	-2,23	23,64	0,09
	486	0,000	1	CO1	Tau Total	0,69	13,65	0,05
	486	0,090	4	CO2	Sigma-eqv	2,48	23,64	0,11
15	RD 20							
	239	0,032	34	CO1	Sigma Total	-34,76	64,00	0,54
	887	0,016	37	CO1	Tau Total	5,25	36,95	0,14
	239	0,032	34	CO1	Sigma-eqv	34,77	64,00	0,54
17	HK 50/30/4/4/4/4							
	783	0,000	10	CO1	Sigma Total	0,44	22,50	0,02
	783	0,000	8	CO2	Tau Total	0,06	12,99	0,00
	783	0,000	10	CO1	Sigma-eqv	0,45	22,50	0,02

2.9.4 Results stress analyse calculation CA2 = Load cases wind direction 0°.





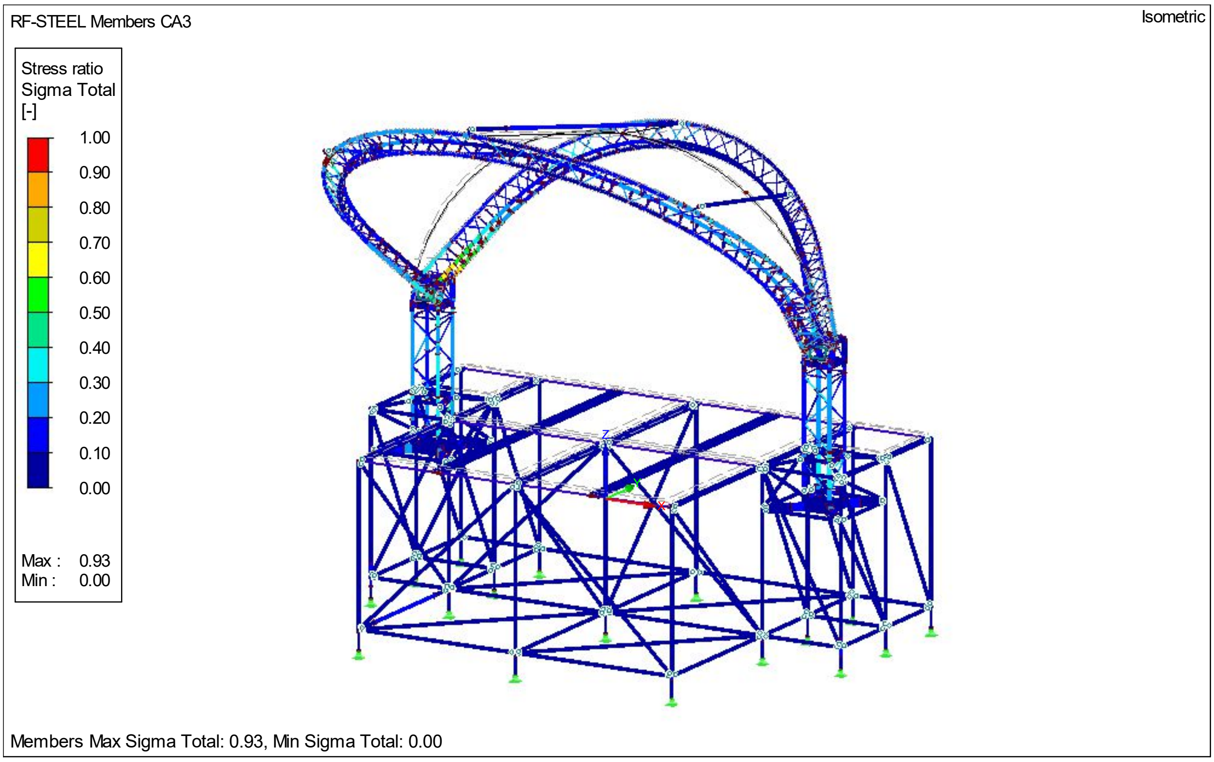

RF-STEEL Members CA2
Isometric
Stresses
Sigma Total
[kN/cm²]
59.95
50.12
40.29
30.47
20.64
10.81
0.99
-8.84
-18.67
-28.49
-38.32
-48.14
Max : 59.95
Min : -48.14
Members Max Sigma Total: 59.95, Min Sigma Total: -48.14 [kN/cm²]

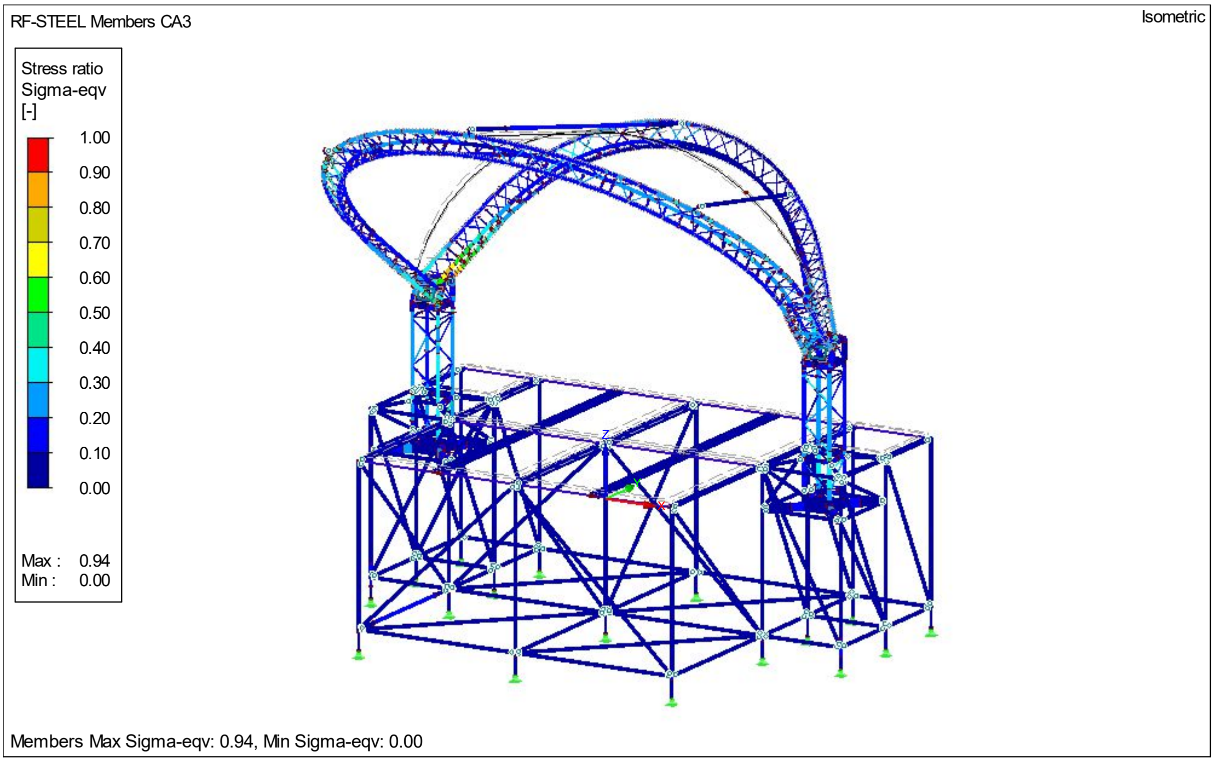

RF-STEEL Members CA2
Isometric
Stresses
Sigma-eqv
[kN/cm²]
59.97
54.52
49.07
43.62
38.17
32.71
27.26
21.81
16.36
10.90
5.45
0.00
Max : 59.97
Min : 0.00
Members Max Sigma-eqv: 59.97, Min Sigma-eqv: 0.00 [kN/cm²]

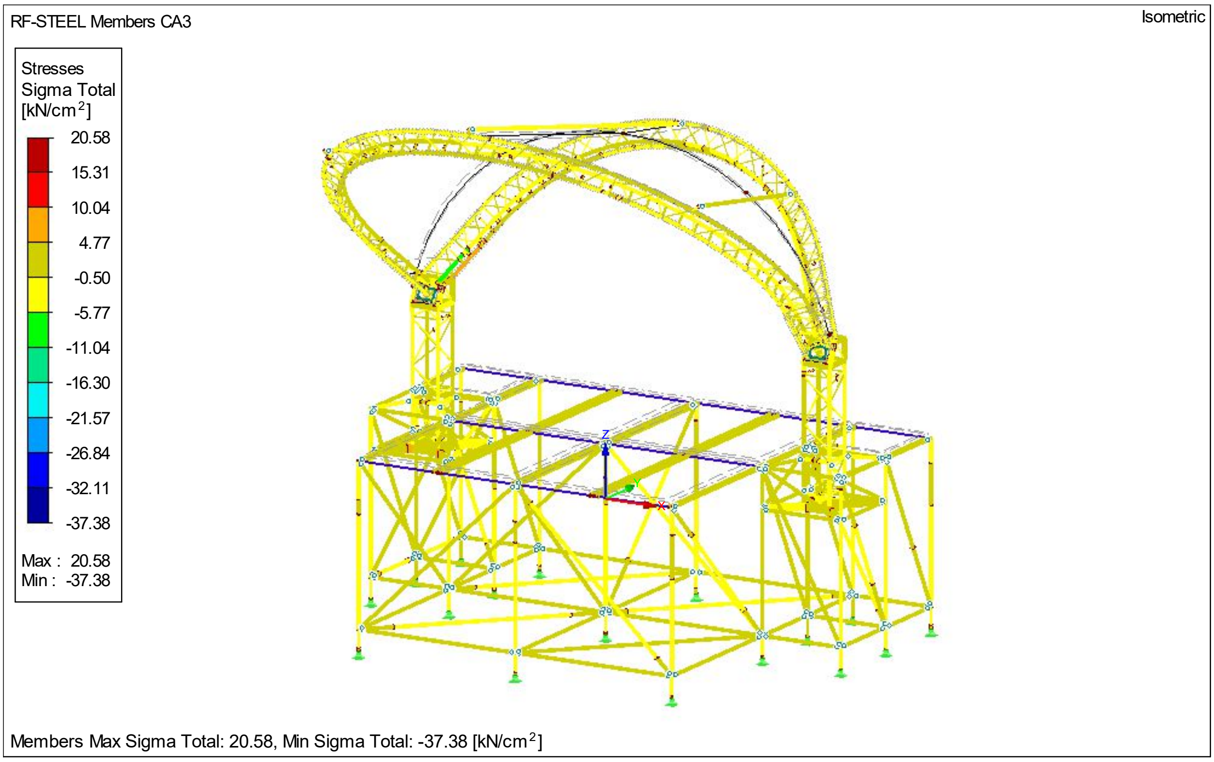
2.9.4.1 Results stress analyse calculation CA2 - Utilisation per cross section.

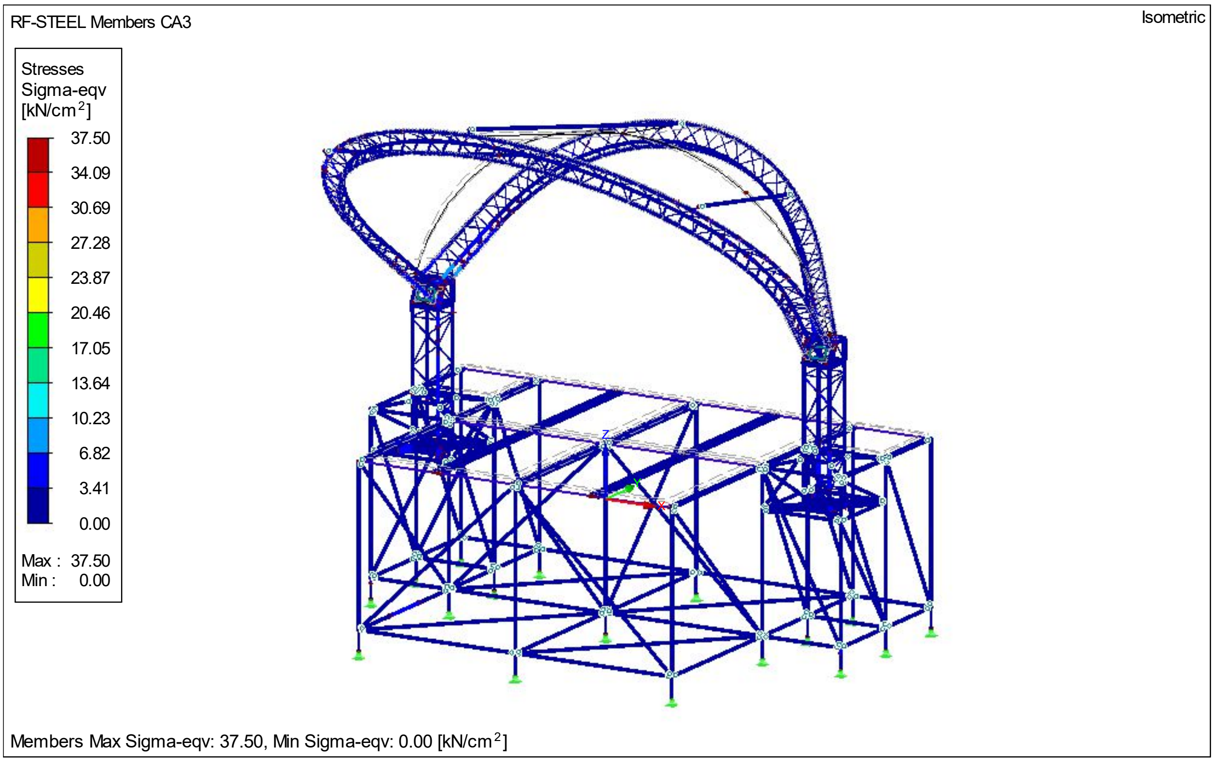
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 38/4.5							
	1192	0,250	28	CO100	Sigma Total	-5,00	29,09	0,17
	1190	0,250	36	CO100	Tau Total	0,32	16,80	0,02
	1192	0,250	28	CO100	Sigma-eqv	5,00	29,09	0,17
2	RO 48.3x3.2 (Hot Formed)							
	1223	0,000	5	CO100	Sigma Total	5,08	29,09	0,17
	1243	0,000	18	CO100	Tau Total	-1,21	16,80	0,07
	1223	0,000	5	CO100	Sigma-eqv	5,08	29,09	0,17
3	RO 48.3x3.2 (Hot Formed)							
	1401	1,243	20	CO100	Sigma Total	3,81	21,36	0,18
	6	0,000	19	CO100	Tau Total	-0,56	12,33	0,05
	1401	0,829	20	CO100	Sigma-eqv	3,81	21,36	0,18
4	RO 48.3x2.6 (Hot Formed)							
	32	0,767	28	CO100	Sigma Total	1,06	21,36	0,05
	36	0,000	1	CO100	Tau Total	0,19	12,33	0,02
	32	0,767	28	CO100	Sigma-eqv	1,06	21,36	0,05
5	RRO 100x50x3.2 (Hot Formed)							
	56	0,493	11	CO100	Sigma Total	-9,53	21,36	0,45
	56	0,493	8	CO100	Tau Total	1,19	12,33	0,10
	56	0,493	11	CO100	Sigma-eqv	9,60	21,36	0,45
6	Ring 50/6							
	68	0,125	36	CO100	Sigma Total	-5,83	23,64	0,25
	61	0,125	31	CO100	Tau Total	-0,58	13,65	0,04
	68	0,125	36	CO100	Sigma-eqv	5,83	23,64	0,25
7	Ring 48/3							
	267	0,000	15	CO100	Sigma Total	-11,21	11,36	0,99
	200	0,000	8	CO100	Tau Total	-1,91	6,56	0,29
	267	0,000	15	CO100	Sigma-eqv	11,29	11,36	0,99
8	Ring 30/3							
	682	0,150	9	CO100	Sigma Total	-9,17	11,36	0,81
	681	0,150	36	CO100	Tau Total	-1,68	6,56	0,26
	682	0,150	9	CO100	Sigma-eqv	9,17	11,36	0,81
9	Ring 20/2							
	114	0,000	9	CO100	Sigma Total	-5,97	11,36	0,53
	113	0,000	1	CO100	Tau Total	0,18	6,56	0,03
	114	0,000	9	CO100	Sigma-eqv	5,97	11,36	0,53
10	HK 50/50/5/5/5/5							
	266	0,000	2	CO100	Sigma Total	8,20	11,36	0,72
	247	0,000	8	CO100	Tau Total	3,57	6,56	0,54
	266	0,000	2	CO100	Sigma-eqv	9,39	11,36	0,83
11	TO 50/100/4/4/4/4							
	245	0,084	14	CO100	Sigma Total	-5,58	11,36	0,49
	261	0,000	7	CO100	Tau Total	3,83	6,56	0,58
	245	0,084	14	CO100	Sigma-eqv	7,02	11,36	0,62
12	Ring 16/2							
	460	0,327	27	CO100	Sigma Total	5,97	11,36	0,53
	472	0,360	20	CO100	Tau Total	0,47	6,56	0,07
	460	0,327	27	CO100	Sigma-eqv	5,99	11,36	0,53
13	Ring 50/4							
	14	0,000	14	CO100	Sigma Total	-10,30	11,36	0,91
	8	0,026	36	CO100	Tau Total	1,83	6,56	0,28
	14	0,000	14	CO100	Sigma-eqv	10,46	11,36	0,92
14	Rectangle 15/60							
	488	0,095	1	CO100	Sigma Total	5,51	23,64	0,23
	486	0,090	1	CO100	Tau Total	0,79	13,65	0,06
	488	0,095	1	CO100	Sigma-eqv	5,67	23,64	0,24
15	RD 20							
	239	0,032	34	CO100	Sigma Total	59,95	64,00	0,94
	887	0,000	37	CO100	Tau Total	9,13	36,95	0,25
	239	0,032	34	CO100	Sigma-eqv	59,97	64,00	0,94
17	HK 50/30/4/4/4/4							
	1163	1,036	14	CO100	Sigma Total	0,53	22,50	0,02
	1422	0,000	8	CO100	Tau Total	0,06	12,99	0,00
	1163	1,036	14	CO100	Sigma-eqv	0,54	22,50	0,02

2.9.5 Results stress analyse calculation CA3 Load cases wind direction 90°.






RF-STEEL Members CA3
Isometric
Stresses
Sigma Total
[kN/cm2]
20.58
15.31
10.04
4.77
-0.50
-5.77
-11.04
-16.30
-21.57
-26.84
-32.11
-37.38
Max : 20.58
Min : -37.38
Members Max Sigma Total: 20.58, Min Sigma Total: -37.38 [kN/cm2]


RF-STEEL Members CA3
Isometric
Stresses
Sigma-eqv
[kN/cm2]
37.50
34.09
30.69
27.28
23.87
20.46
17.05
13.64
10.23
6.82
3.41
0.00
Max : 37.50
Min : 0.00
Members Max Sigma-eqv: 37.50, Min Sigma-eqv: 0.00 [kN/cm2]

2.9.5.1 Results stress analyse calculation CA3 - Utilisation per cross section.

Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 38/4.5							
	1181	0,000	34	CO104	Sigma Total	-4,34	29,09	0,15
	1363	0,000	29	CO104	Tau Total	0,23	16,80	0,01
	1181	0,000	34	CO104	Sigma-eqv	4,34	29,09	0,15
2	RO 48.3x3.2 (Hot Formed)							
	1433	0,000	23	CO105	Sigma Total	4,19	29,09	0,14
	1243	0,014	36	CO104	Tau Total	-0,72	16,80	0,04
	1433	0,000	23	CO105	Sigma-eqv	4,19	29,09	0,14
3	RO 48.3x3.2 (Hot Formed)							
	1289	1,243	36	CO105	Sigma Total	3,80	21,36	0,18
	6	0,036	1	CO104	Tau Total	-0,57	12,33	0,05
	1289	0,829	36	CO105	Sigma-eqv	3,80	21,36	0,18
4	RO 48.3x2.6 (Hot Formed)							
	1385	1,440	28	CO103	Sigma Total	-1,20	21,36	0,06
	33	0,000	1	CO105	Tau Total	0,14	12,33	0,01
	1385	1,440	28	CO103	Sigma-eqv	1,20	21,36	0,06
5	RRO 100x50x3.2 (Hot Formed)							
	50	0,493	13	CO104	Sigma Total	7,10	21,36	0,33
	1211	0,493	8	CO104	Tau Total	0,86	12,33	0,07
	50	0,493	13	CO104	Sigma-eqv	7,10	21,36	0,33
6	Ring 50/6							
	61	0,125	21	CO104	Sigma Total	-5,08	23,64	0,21
	61	0,000	30	CO104	Tau Total	0,58	13,65	0,04
	61	0,125	21	CO104	Sigma-eqv	5,09	23,64	0,22
7	Ring 48/3							
	267	0,000	16	CO104	Sigma Total	10,62	11,36	0,93
	612	0,233	30	CO103	Tau Total	2,04	6,56	0,31
	267	0,000	16	CO104	Sigma-eqv	10,73	11,36	0,94
8	Ring 30/3							
	882	0,000	25	CO104	Sigma Total	-7,68	11,36	0,68
	873	0,150	3	CO104	Tau Total	-1,49	6,56	0,23
	882	0,000	25	CO104	Sigma-eqv	7,68	11,36	0,68
9	Ring 20/2							
	114	0,000	8	CO104	Sigma Total	5,38	11,36	0,47
	113	0,169	1	CO104	Tau Total	-0,22	6,56	0,03
	114	0,000	8	CO104	Sigma-eqv	5,38	11,36	0,47
10	HK 50/50/5/5/5/5							
	1446	0,000	10	CO104	Sigma Total	7,80	11,36	0,69
	266	0,044	8	CO104	Tau Total	2,82	6,56	0,43
	1446	0,000	10	CO104	Sigma-eqv	7,91	11,36	0,70
11	TO 50/100/4/4/4/4							
	261	0,081	10	CO104	Sigma Total	4,90	11,36	0,43
	261	0,081	7	CO104	Tau Total	-3,59	6,56	0,55
	261	0,081	6	CO104	Sigma-eqv	6,47	11,36	0,57
12	Ring 16/2							
	460	0,327	28	CO103	Sigma Total	6,17	11,36	0,54
	462	0,327	34	CO103	Tau Total	-0,58	6,56	0,09
	460	0,327	28	CO103	Sigma-eqv	6,19	11,36	0,54
13	Ring 50/4							
	14	0,000	14	CO104	Sigma Total	9,77	11,36	0,86
	8	0,000	1	CO104	Tau Total	-1,89	6,56	0,29
	14	0,000	15	CO104	Sigma-eqv	9,99	11,36	0,88
14	Rectangle 15/60							
	488	0,095	1	CO103	Sigma Total	5,78	23,64	0,24
	1208	0,000	1	CO104	Tau Total	0,63	13,65	0,05
	488	0,095	1	CO103	Sigma-eqv	5,86	23,64	0,25
15	RD 20							
	887	0,000	33	CO104	Sigma Total	-37,38	64,00	0,58
	887	0,016	37	CO104	Tau Total	6,11	36,95	0,17
	887	0,000	33	CO104	Sigma-eqv	37,50	64,00	0,59
17	HK 50/30/4/4/4/4							
	1163	1,036	14	CO103	Sigma Total	0,44	22,50	0,02
	1429	0,000	8	CO105	Tau Total	0,06	12,99	0,00
	1163	1,036	14	CO103	Sigma-eqv	0,44	22,50	0,02

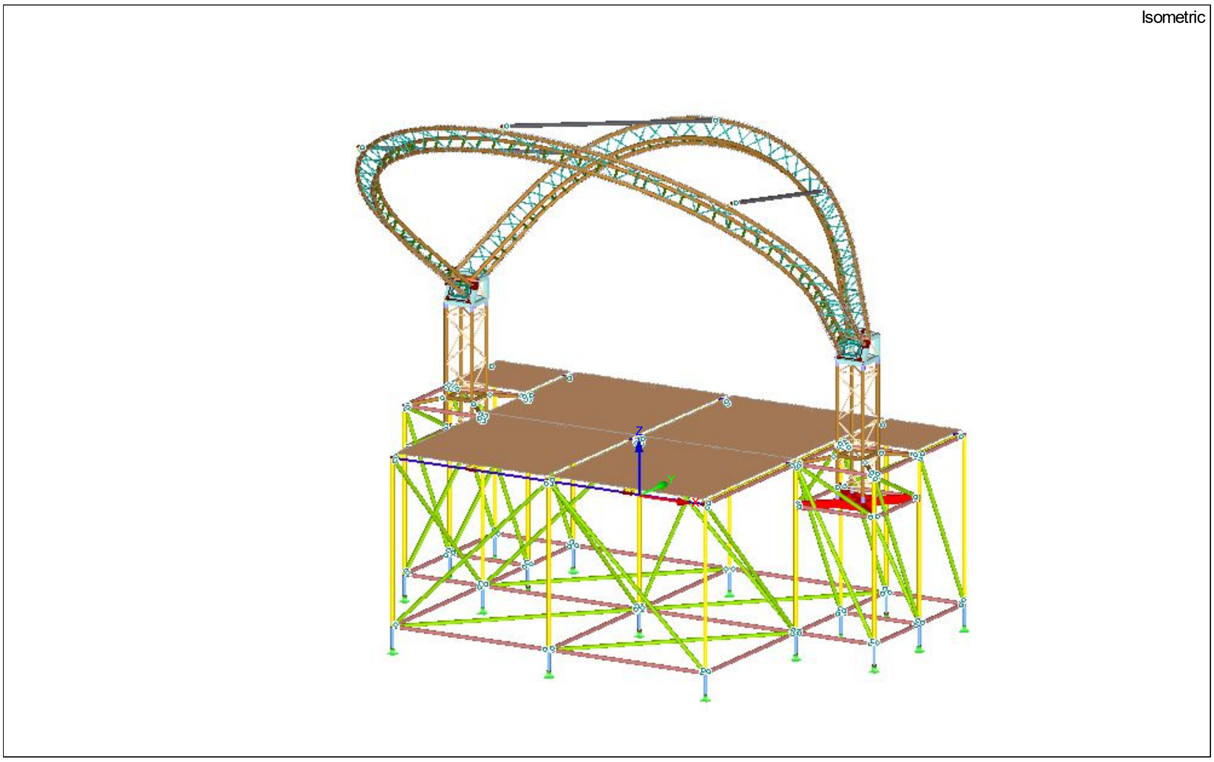
2.10 Stress analyse calculation for the Out service situation.

There are three stress analyse calculation made for the Out service situation

CA1 - General loading without wind : 1 * (CO1 or to CO2)

CA2 – Load cases wind direction 0° : 1 * (CO200 or to CO202)

CA3 – Load cases wind direction 90° : 1 * (CO203 or to CO205)



Cross-Sections
- 1: Ring 38/4.5; S320GD 1.0250
- 2: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 3: RO 48.3x3.2 (Hot Formed); Steel S 235 JR
- 4: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 5: RRO 100x50x3.2 (Hot Formed); Steel S 235 JR
- 6: Ring 50/6; Aluminum EN-AW 6082 (EP,ET) T6
- 7: Ring 48/3; Aluminum EN-AW 6082 (EP,ET) T6
- 8: Ring 30/3; Aluminum EN-AW 6082 (EP,ET) T6
- 9: Ring 20/2; Aluminum EN-AW 6082 (EP,ET) T6
- 10: HK 50/50/5/5/5/5; Aluminum EN-AW 6082 (EP,ET) T6
- 11: TO 50/100/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 12: Ring 16/2; Aluminum EN-AW 6082 (EP,ET) T6
- 13: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 14: Rectangle 15/60; Aluminum EN-AW 6082 (EP,ET) T6
- 15: RD 20; steel 8.8 kw aliteit
- 16: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 17: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6

2.10.1 stress analyse Cross sections description

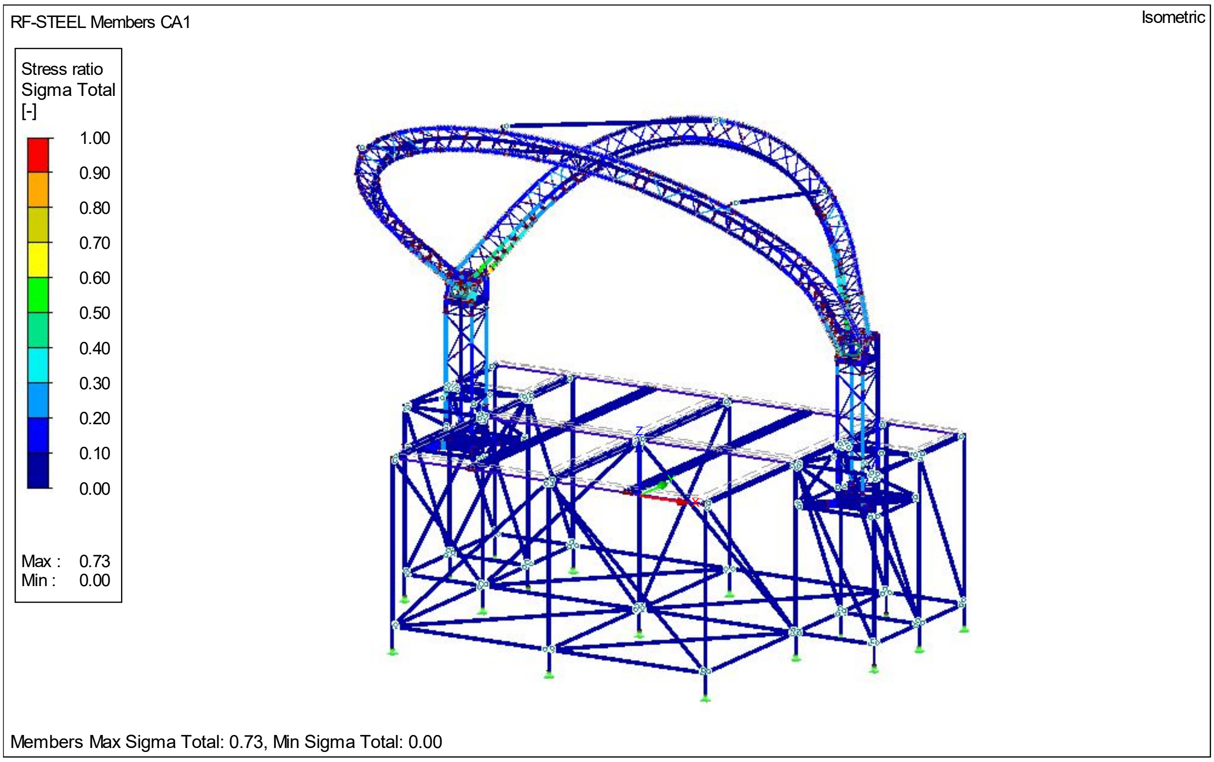
Section No.	Material No.	Cross-Section Description	Max. Design Ratio	Opti-mize
1	1	Ring 38/4.5	0,03	No
2	1	RO 48.3x3.2 (Hot Formed)	0,07	No
3	2	RO 48.3x3.2 (Hot Formed)	0,03	No
4	2	RO 48.3x2.6 (Hot Formed)	0,04	No
5	2	RRO 100x50x3.2 (Hot Formed)	0,12	No
6	3	Ring 50/6	0,03	No
7	3	Ring 48/3	0,15	No
8	3	Ring 30/3	0,18	No
9	3	Ring 20/2	0,06	No
10	3	HK 50/50/5/5/5/5	0,10	No
11	3	TO 50/100/4/4/4/4	0,05	No
12	3	Ring 16/2	0,10	No
13	3	Ring 50/4	0,08	No
14	3	Rectangle 15/60	0,05	No
15	6	RD 20	0,11	No
16	8	EV transom		No
17	8	HK 50/30/4/4/4/4	0,02	No

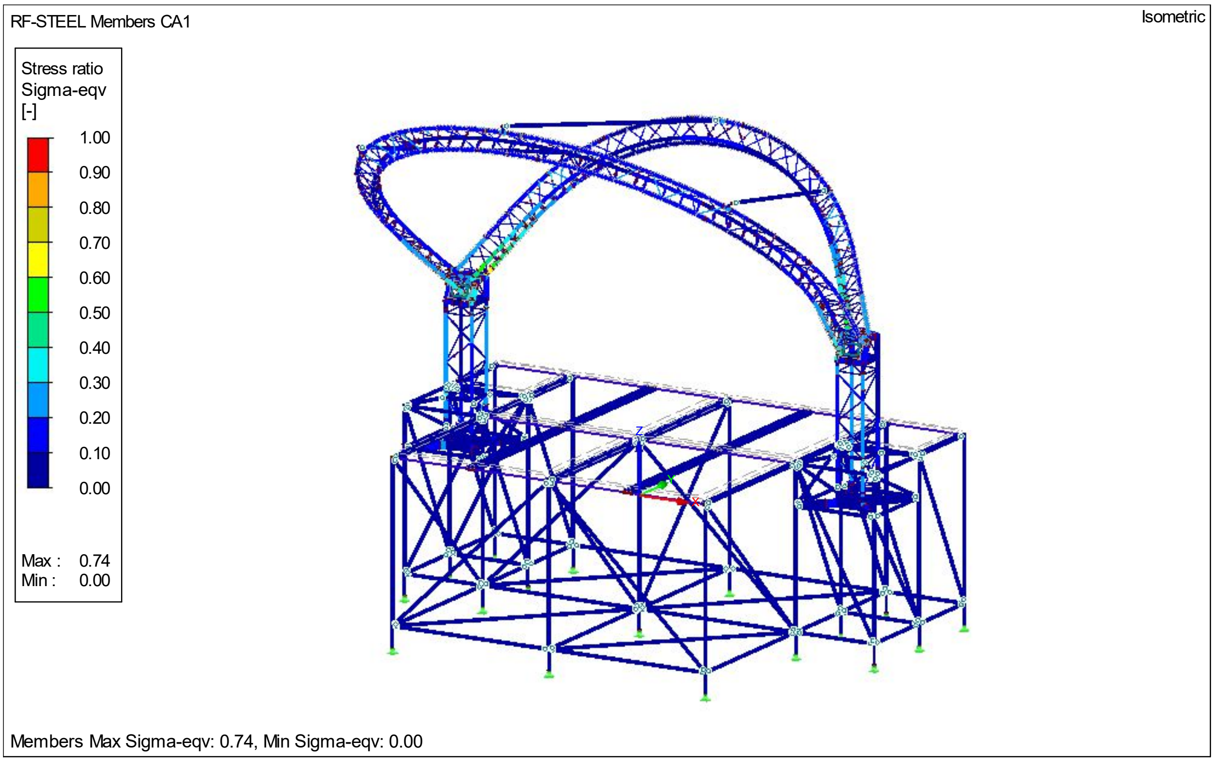
2.10.2 Used materials

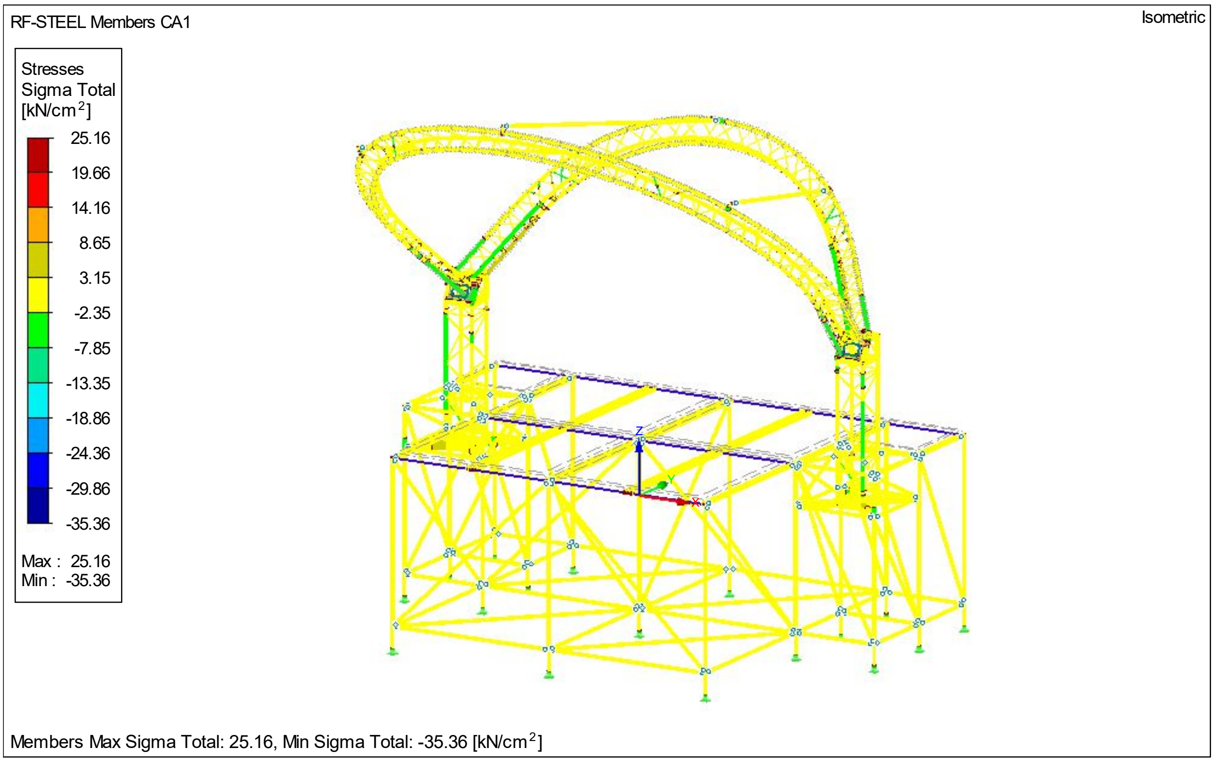
Material No.	Material Description	Safety Factor γ_M [-]	Yield Strength f_{yk} [kN/cm²]	Limit Stresses [kN/cm²] Manually	Limit σ_x	Limit τ	Limit σ_{eqv}
1	S320GD 1.0250* | EN 10346:2009-03	1,10	32,00	-	29,09	16,80	29,09
2	Steel S 235 JR | EN 10025:1994-03	1,10	23,50	-	21,36	12,33	21,36
3	Aluminum EN-AW 6082 (EP,ET) T6* | EN 1999-1-1:2007	1,10	12,50	-	11,36	6,56	11,36
4	Aluminum EN-AW 5083 O/H111 | EN 1999-1-1:2007	1,00	12,50	-	12,50	7,22	12,50
5	canopy | No code	1,10	0,00	-	0,00	0,00	0,00
6	steel 8.8 kwaliteit | EN 10346:2009-03	1,00	64,00	-	64,00	36,95	64,00
7	Plywood, Class F20/10 E40/20, Plate Stress, Perpendicular | EN 12369-2:2011-06	1,20	0,00	-	0,00	0,00	0,00
8	Aluminum EN-AW 6005A (EP/O,ER/B) T6 | EN 1999-1-1:2007	1,00	22,50	-	22,50	12,99	22,50

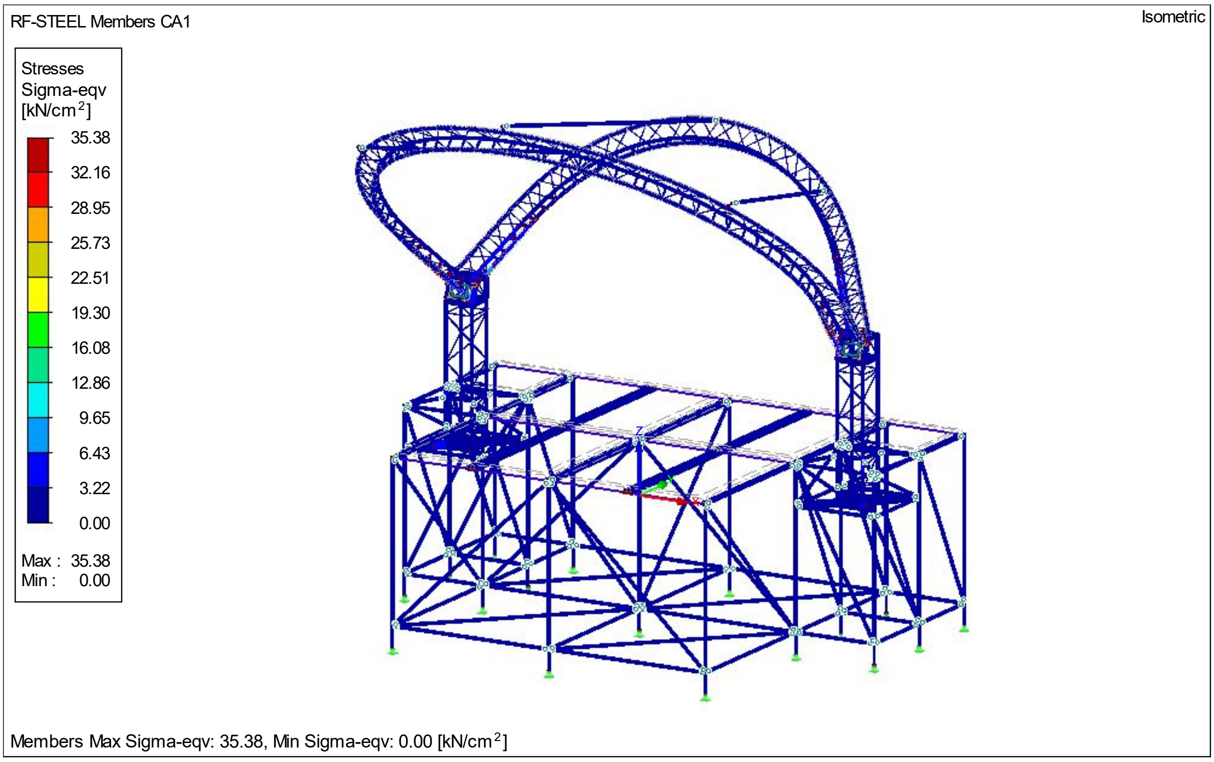
The Yield strength of material 3 has been manually changed. This is according to the Eurocode NEN-EN 1999-1-1 Table 3.2 the $f_{o,haz}$ for the heat affective zone. This check is concerning a welded construction with heat affective zones in the main elements, there for the choice to check the construction according to the lower $f_{o\ haz.}$

2.10.3 Results stress analyse calculation CA1 = General loading without wind





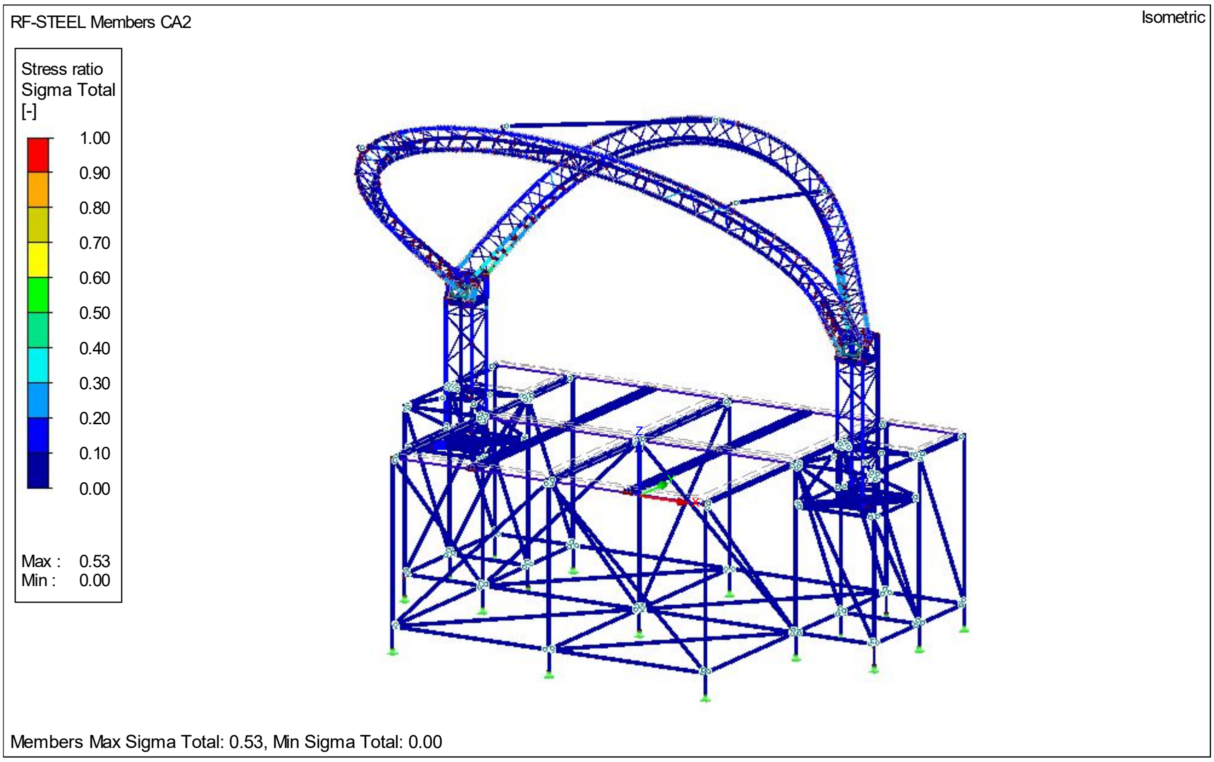

RF-STEEL Members CA1
Isometric
Stresses
Sigma Total
[kN/cm²]
25.16
19.66
14.16
8.65
3.15
-2.35
-7.85
-13.35
-18.86
-24.36
-29.86
-35.36
Max : 25.16
Min : -35.36
Members Max Sigma Total: 25.16, Min Sigma Total: -35.36 [kN/cm²]

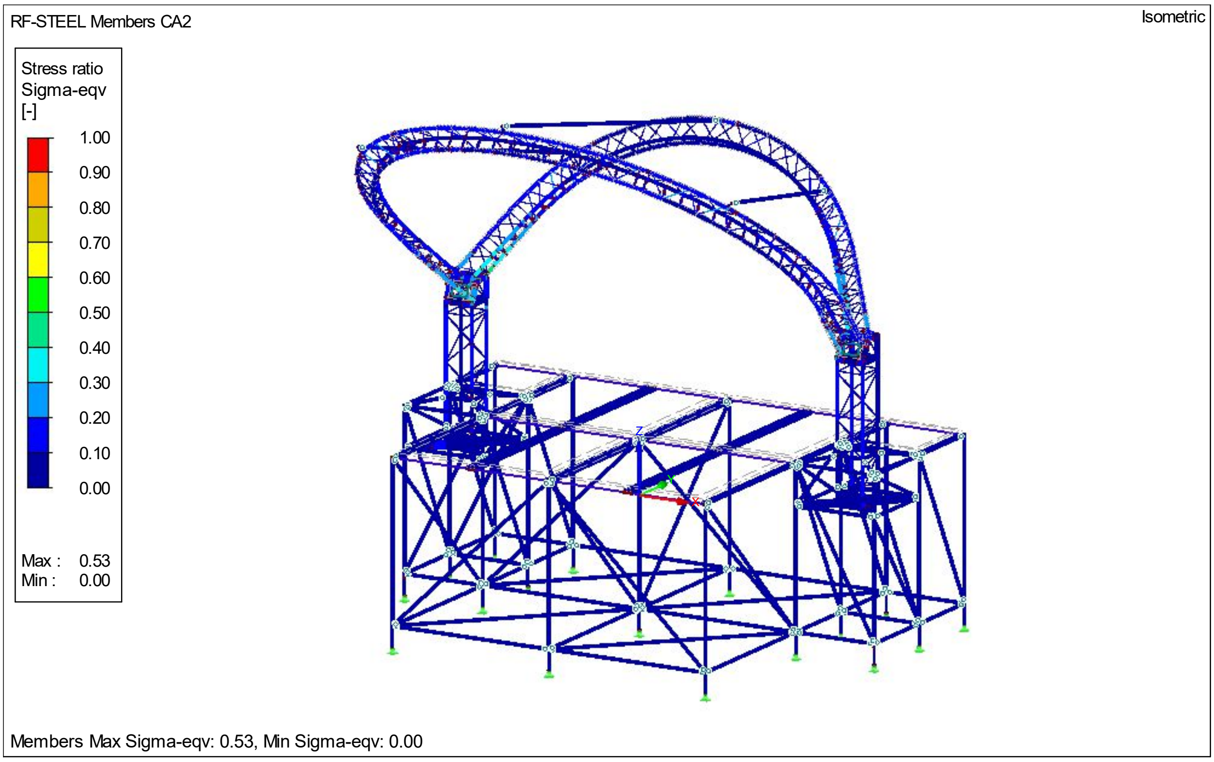

RF-STEEL Members CA1
Isometric
Stresses
Sigma-eqv
[kN/cm²]
35.38
32.16
28.95
25.73
22.51
19.30
16.08
12.86
9.65
6.43
3.22
0.00
Max : 35.38
Min : 0.00
Members Max Sigma-eqv: 35.38, Min Sigma-eqv: 0.00 [kN/cm²]

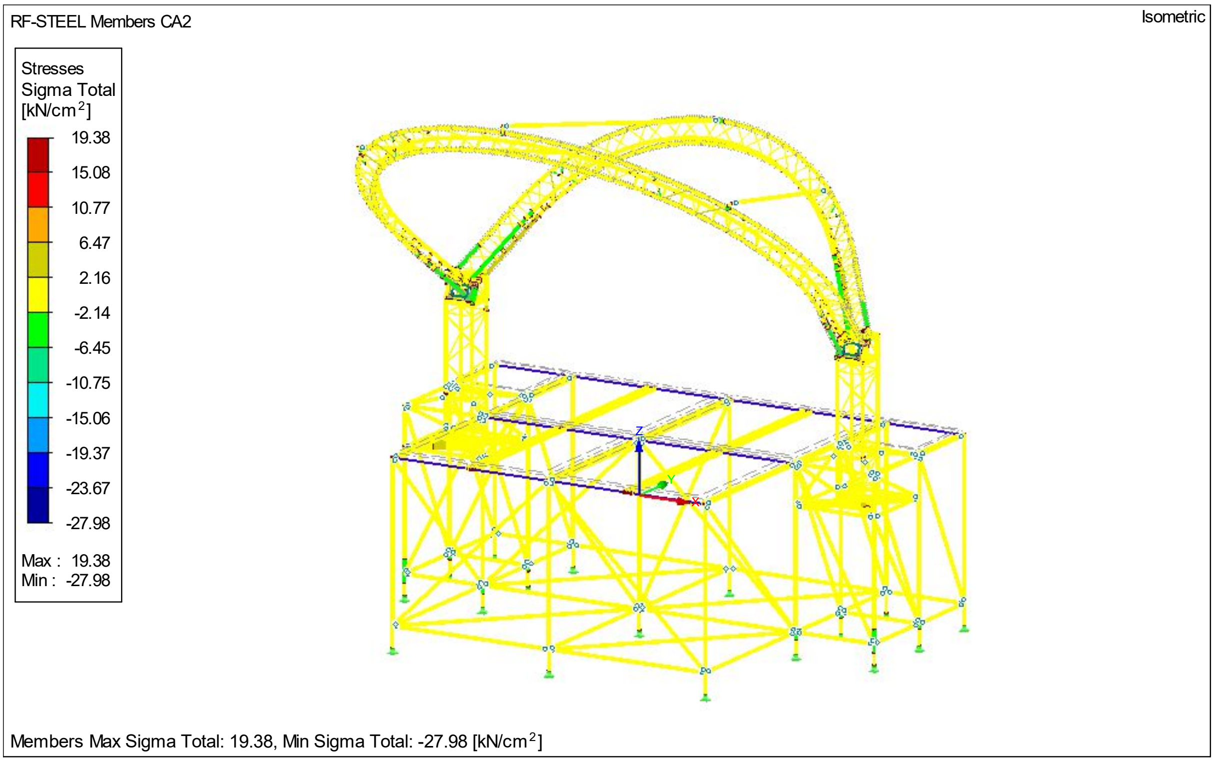
2.10.3.1 Results stress analyse calculation CA1 - Utilisation per cross section

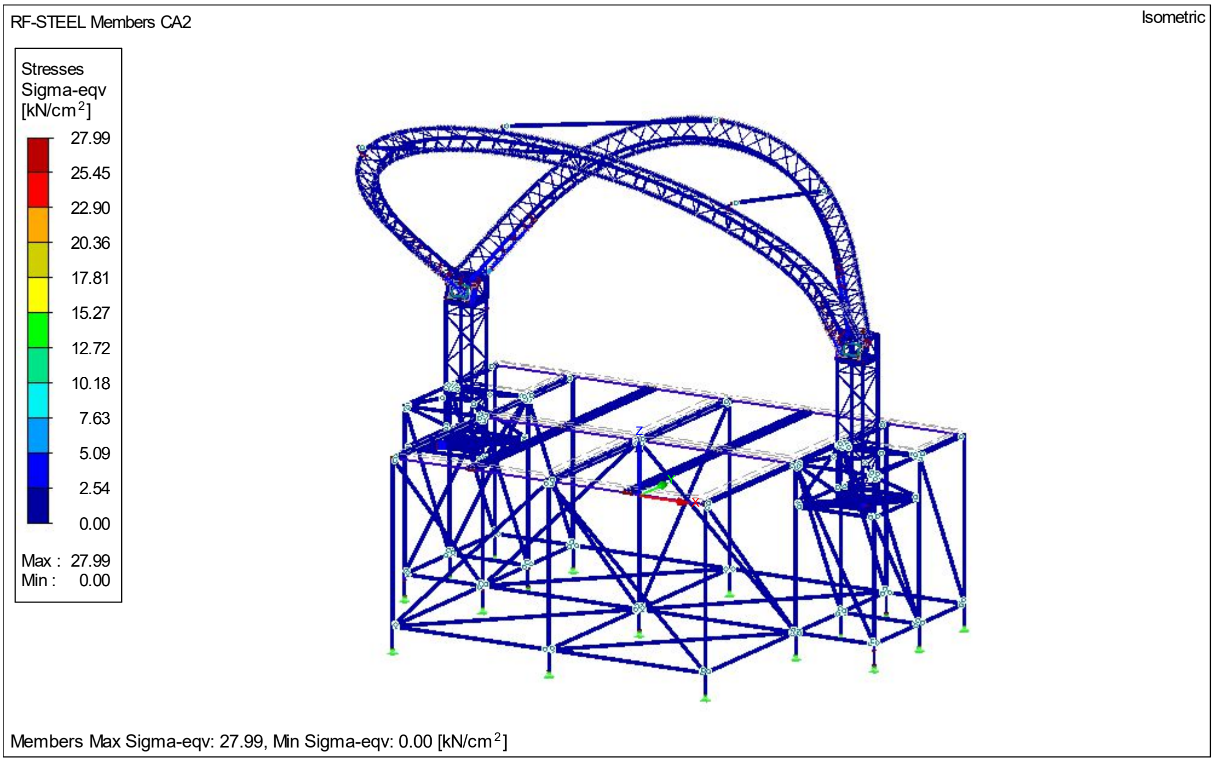
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 38/4.5							
	1181	0,000	25	CO2	Sigma Total	-1,51	29,09	0,05
	1180	0,000	34	CO2	Tau Total	0,05	16,80	0,00
	1181	0,000	25	CO2	Sigma-eqv	1,51	29,09	0,05
2	RO 48.3x3.2 (Hot Formed)							
	1223	0,000	5	CO2	Sigma Total	-3,18	29,09	0,11
	1243	0,000	18	CO1	Tau Total	0,80	16,80	0,05
	1223	0,000	5	CO2	Sigma-eqv	3,18	29,09	0,11
3	RO 48.3x3.2 (Hot Formed)							
	1299	0,691	28	CO2	Sigma Total	0,54	21,36	0,03
	4	0,036	1	CO1	Tau Total	-0,54	12,33	0,04
	4	0,000	19	CO1	Sigma-eqv	0,96	21,36	0,04
4	RO 48.3x2.6 (Hot Formed)							
	1417	1,465	28	CO2	Sigma Total	0,91	21,36	0,04
	36	0,000	19	CO2	Tau Total	-0,12	12,33	0,01
	1417	1,465	28	CO2	Sigma-eqv	0,91	21,36	0,04
5	RRO 100x50x3.2 (Hot Formed)							
	56	0,493	11	CO1	Sigma Total	5,66	21,36	0,27
	56	0,000	8	CO1	Tau Total	-0,66	12,33	0,05
	56	0,493	11	CO1	Sigma-eqv	5,69	21,36	0,27
6	Ring 50/6							
	68	0,125	36	CO1	Sigma Total	3,09	23,64	0,13
	61	0,000	31	CO1	Tau Total	0,31	13,65	0,02
	68	0,125	36	CO1	Sigma-eqv	3,09	23,64	0,13
7	Ring 48/3							
	267	0,000	15	CO1	Sigma Total	8,35	11,36	0,73
	976	0,000	2	CO1	Tau Total	1,47	6,56	0,22
	267	0,000	15	CO1	Sigma-eqv	8,35	11,36	0,74
8	Ring 30/3							
	682	0,000	27	CO1	Sigma Total	6,47	11,36	0,57
	873	0,150	2	CO1	Tau Total	-1,50	6,56	0,23
	682	0,000	27	CO1	Sigma-eqv	6,52	11,36	0,57
9	Ring 20/2							
	114	0,000	9	CO1	Sigma Total	3,11	11,36	0,27
	113	0,169	1	CO1	Tau Total	-0,09	6,56	0,01
	114	0,000	9	CO1	Sigma-eqv	3,11	11,36	0,27
10	HK 50/50/5/5/5/5							
	1446	0,000	10	CO1	Sigma Total	5,97	11,36	0,53
	247	0,044	8	CO1	Tau Total	2,24	6,56	0,34
	1446	0,000	10	CO1	Sigma-eqv	6,04	11,36	0,53
11	TO 50/100/4/4/4/4							
	245	0,084	14	CO1	Sigma Total	3,73	11,36	0,33
	245	0,084	1	CO1	Tau Total	2,54	6,56	0,39
	245	0,084	14	CO1	Sigma-eqv	4,64	11,36	0,41
12	Ring 16/2							
	301	0,322	2	CO1	Sigma Total	4,14	11,36	0,36
	420	0,000	4	CO2	Tau Total	0,39	6,56	0,06
	301	0,322	2	CO1	Sigma-eqv	4,14	11,36	0,36
13	Ring 50/4							
	14	0,000	14	CO1	Sigma Total	7,61	11,36	0,67
	8	0,000	36	CO1	Tau Total	-1,14	6,56	0,17
	14	0,000	14	CO1	Sigma-eqv	7,67	11,36	0,68
14	Rectangle 15/60							
	488	0,095	1	CO2	Sigma Total	-3,59	23,64	0,15
	1207	0,050	1	CO1	Tau Total	0,52	13,65	0,04
	488	0,095	1	CO2	Sigma-eqv	3,59	23,64	0,15
15	RD 20							
	239	0,032	34	CO1	Sigma Total	-35,36	64,00	0,55
	887	0,016	37	CO1	Tau Total	5,38	36,95	0,15
	239	0,032	34	CO1	Sigma-eqv	35,38	64,00	0,55
17	HK 50/30/4/4/4/4							
	783	0,000	10	CO1	Sigma Total	0,44	22,50	0,02
	783	0,000	8	CO2	Tau Total	0,06	12,99	0,00
	783	0,000	10	CO1	Sigma-eqv	0,45	22,50	0,02

2.10.4 Results stress analyse calculation CA2 = Load cases wind direction 0°.





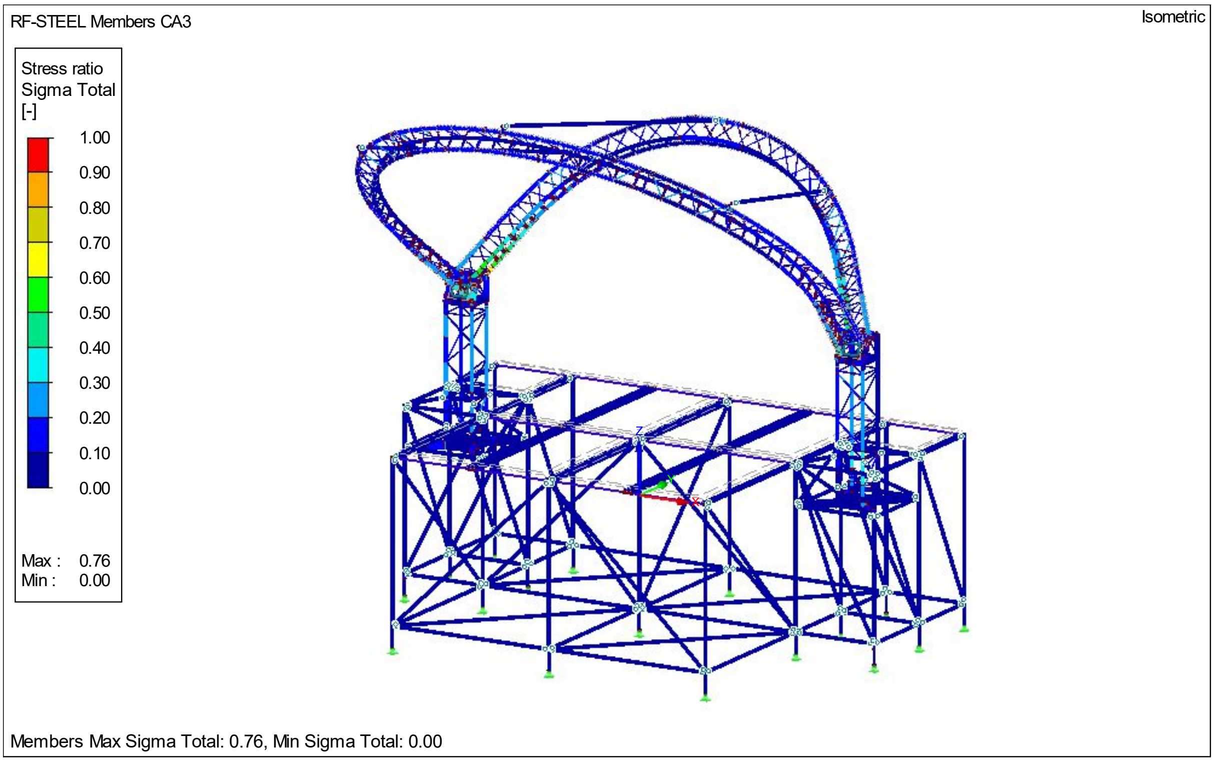

RF-STEEL Members CA2
Isometric
Stresses
Sigma Total
[kN/cm2]
19.38
15.08
10.77
6.47
2.16
-2.14
-6.45
-10.75
-15.06
-19.37
-23.67
-27.98
Max : 19.38
Min : -27.98
Members Max Sigma Total: 19.38, Min Sigma Total: -27.98 [kN/cm2]

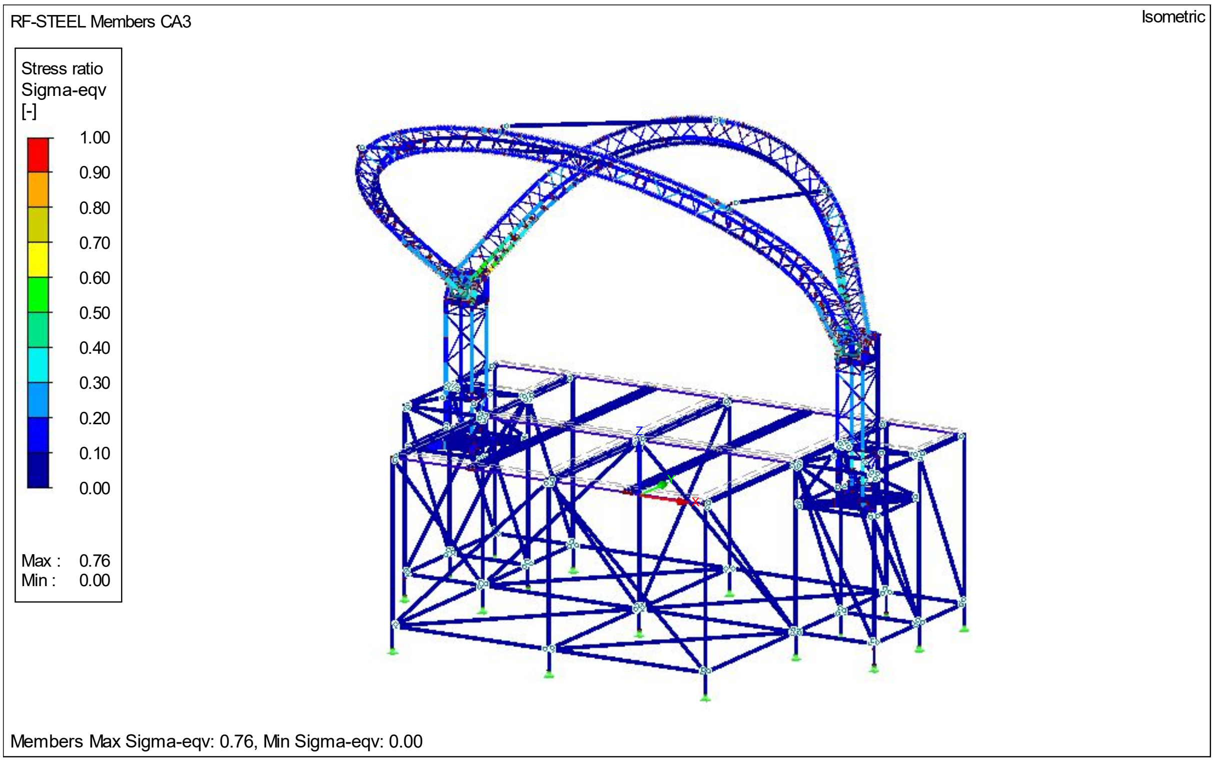

RF-STEEL Members CA2
Isometric
Stresses
Sigma-eqv
[kN/cm2]
27.99
25.45
22.90
20.36
17.81
15.27
12.72
10.18
7.63
5.09
2.54
0.00
Max : 27.99
Min : 0.00
Members Max Sigma-eqv: 27.99, Min Sigma-eqv: 0.00 [kN/cm2]

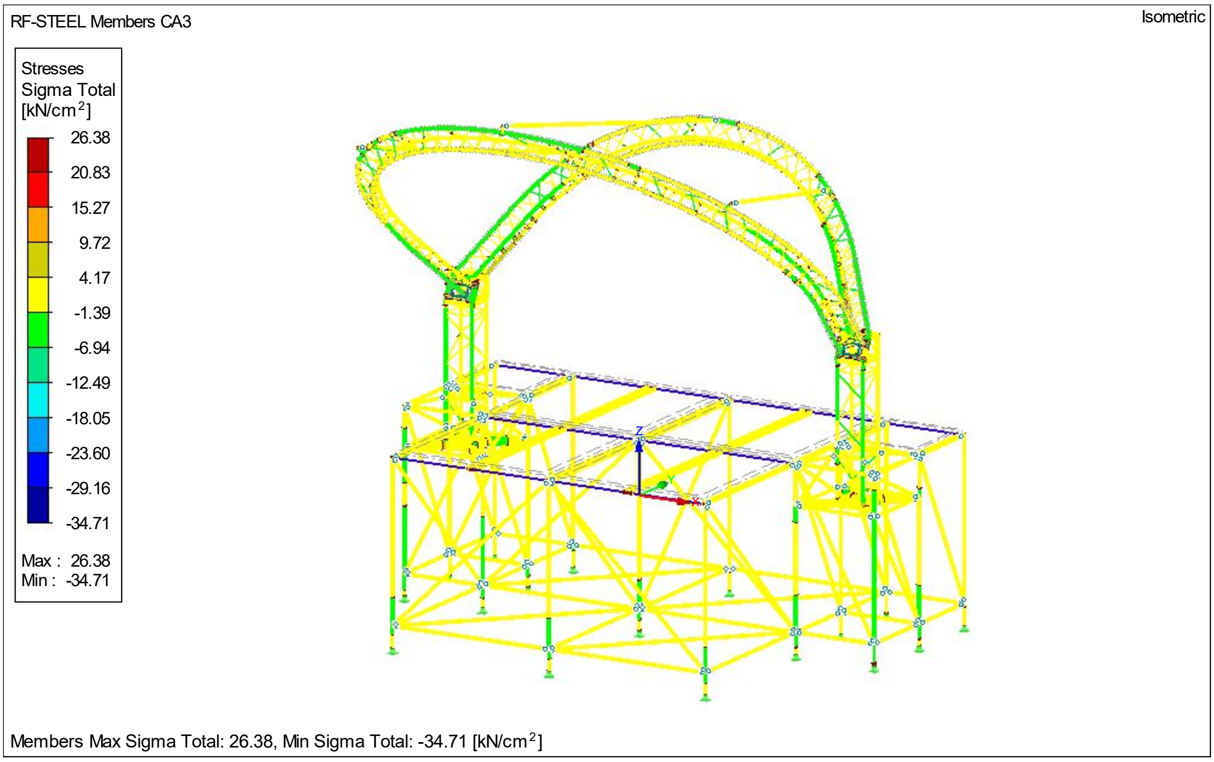
2.10.4.1 Results stress analyse calculation CA2 - Utilisation per cross section.

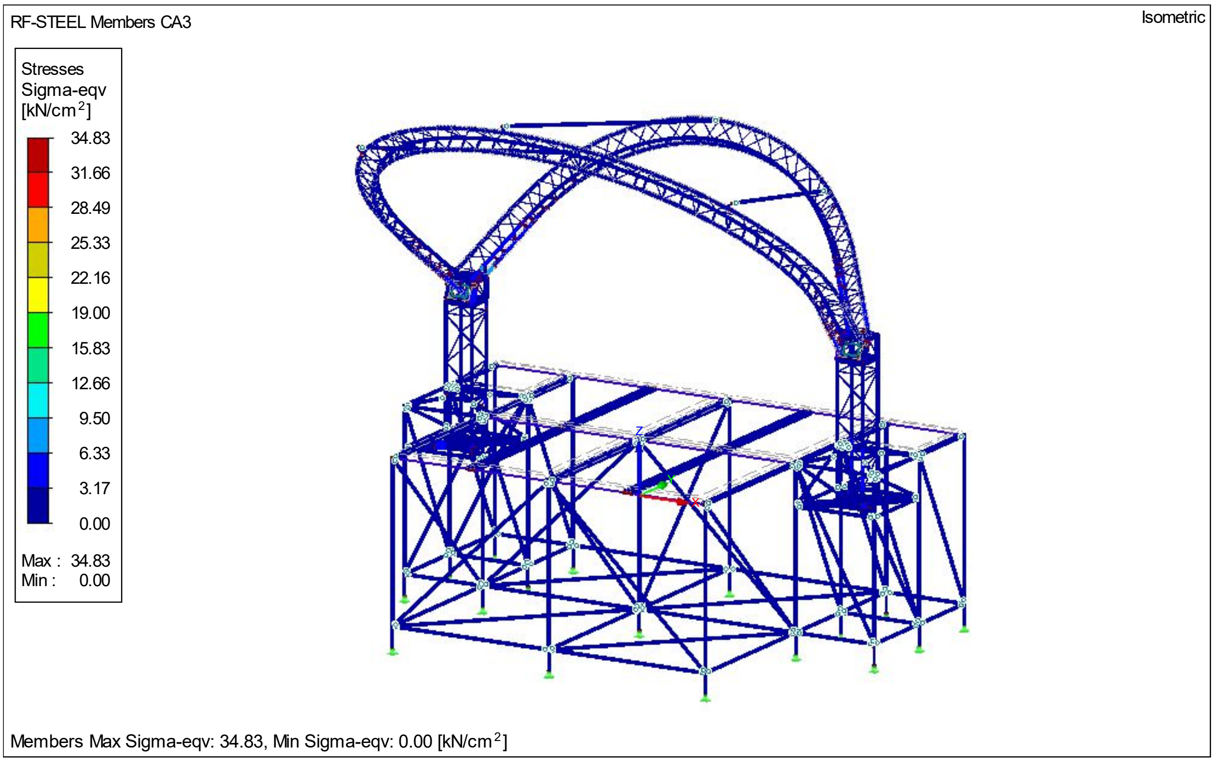
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 38/4.5							
	1180	0,250	27	CO202	Sigma Total	-3,31	29,09	0,11
	1180	0,000	36	CO202	Tau Total	0,22	16,80	0,01
	1180	0,250	27	CO202	Sigma-eqv	3,31	29,09	0,11
2	RO 48.3x3.2 (Hot Formed)							
	1241	0,000	11	CO202	Sigma Total	-2,51	29,09	0,09
	1243	0,014	18	CO201	Tau Total	0,61	16,80	0,04
	1241	0,000	11	CO202	Sigma-eqv	2,51	29,09	0,09
3	RO 48.3x3.2 (Hot Formed)							
	1402	1,243	25	CO202	Sigma Total	0,59	21,36	0,03
	4	0,036	34	CO201	Tau Total	-0,54	12,33	0,04
	4	0,036	34	CO201	Sigma-eqv	0,93	21,36	0,04
4	RO 48.3x2.6 (Hot Formed)							
	1385	1,440	33	CO200	Sigma Total	-1,04	21,36	0,05
	1334	0,000	32	CO200	Tau Total	0,11	12,33	0,01
	1385	1,440	33	CO200	Sigma-eqv	1,04	21,36	0,05
5	RRO 100x50x3.2 (Hot Formed)							
	56	0,493	11	CO201	Sigma Total	3,93	21,36	0,18
	56	0,000	16	CO202	Tau Total	0,45	12,33	0,04
	56	0,493	11	CO201	Sigma-eqv	3,94	21,36	0,18
6	Ring 50/6							
	227	0,073	18	CO201	Sigma Total	2,19	23,64	0,09
	223	0,073	11	CO201	Tau Total	0,18	13,65	0,01
	227	0,073	18	CO201	Sigma-eqv	2,19	23,64	0,09
7	Ring 48/3							
	267	0,000	15	CO201	Sigma Total	5,99	11,36	0,53
	606	0,002	16	CO201	Tau Total	1,19	6,56	0,18
	267	0,000	15	CO201	Sigma-eqv	6,00	11,36	0,53
8	Ring 30/3							
	682	0,000	27	CO201	Sigma Total	5,31	11,36	0,47
	873	0,150	2	CO201	Tau Total	-1,20	6,56	0,18
	682	0,000	27	CO201	Sigma-eqv	5,35	11,36	0,47
9	Ring 20/2							
	114	0,000	8	CO201	Sigma Total	1,68	11,36	0,15
	136	0,000	18	CO201	Tau Total	-0,07	6,56	0,01
	114	0,000	8	CO201	Sigma-eqv	1,68	11,36	0,15
10	HK 50/50/5/5/5/5							
	1446	0,000	10	CO201	Sigma Total	4,27	11,36	0,38
	247	0,044	8	CO201	Tau Total	1,76	6,56	0,27
	266	0,000	2	CO201	Sigma-eqv	4,50	11,36	0,40
11	TO 50/100/4/4/4/4							
	245	0,084	14	CO201	Sigma Total	2,71	11,36	0,24
	261	0,000	7	CO201	Tau Total	-1,83	6,56	0,28
	245	0,084	14	CO201	Sigma-eqv	3,37	11,36	0,30
12	Ring 16/2							
	470	0,360	14	CO201	Sigma Total	3,35	11,36	0,29
	420	0,000	4	CO202	Tau Total	0,32	6,56	0,05
	470	0,360	14	CO201	Sigma-eqv	3,35	11,36	0,29
13	Ring 50/4							
	14	0,000	14	CO201	Sigma Total	5,47	11,36	0,48
	8	0,000	36	CO201	Tau Total	-0,82	6,56	0,13
	14	0,000	14	CO201	Sigma-eqv	5,52	11,36	0,49
14	Rectangle 15/60							
	488	0,095	1	CO202	Sigma Total	-3,08	23,64	0,13
	1207	0,050	1	CO201	Tau Total	0,41	13,65	0,03
	488	0,095	1	CO202	Sigma-eqv	3,08	23,64	0,13
15	RD 20							
	239	0,032	34	CO201	Sigma Total	-27,98	64,00	0,44
	887	0,016	37	CO201	Tau Total	4,25	36,95	0,12
	239	0,032	34	CO201	Sigma-eqv	27,99	64,00	0,44
17	HK 50/30/4/4/4/4							
	783	0,000	10	CO202	Sigma Total	0,44	22,50	0,02
	1422	0,000	8	CO200	Tau Total	0,06	12,99	0,00
	783	0,000	10	CO202	Sigma-eqv	0,44	22,50	0,02

2.10.5 Results stress analyse calculation CA3 Load cases wind direction 90°.






RF-STEEL Members CA3
Isometric
Stresses
Sigma Total
[kN/cm2]
26.38
20.83
15.27
9.72
4.17
-1.39
-6.94
-12.49
-18.05
-23.60
-29.16
-34.71
Max : 26.38
Min : -34.71
Members Max Sigma Total: 26.38, Min Sigma Total: -34.71 [kN/cm2]


RF-STEEL Members CA3
Isometric
Stresses
Sigma-eqv
[kN/cm2]
34.83
31.66
28.49
25.33
22.16
19.00
15.83
12.66
9.50
6.33
3.17
0.00
Max : 34.83
Min : 0.00
Members Max Sigma-eqv: 34.83, Min Sigma-eqv: 0.00 [kN/cm2]

2.10.5.1 Results stress analyse calculation CA3 - Utilisation per cross section.

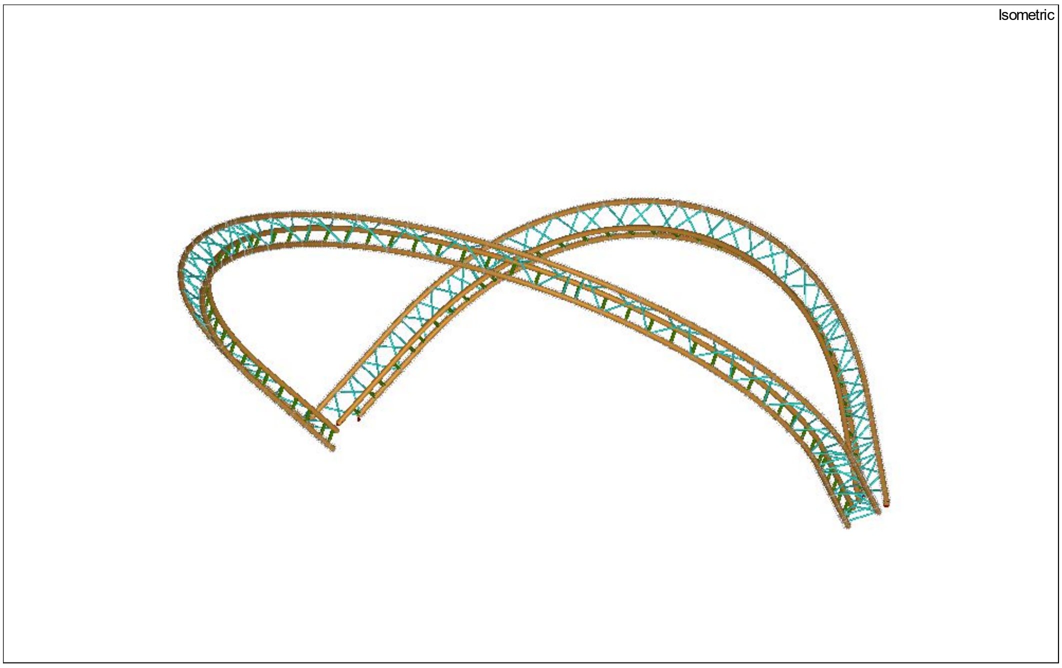
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 38/4.5							
	1180	0,250	20	CO205	Sigma Total	-3,52	29,09	0,12
	1363	0,000	28	CO204	Tau Total	0,22	16,80	0,01
	1180	0,250	20	CO205	Sigma-eqv	3,52	29,09	0,12
2	RO 48.3x3.2 (Hot Formed)							
	1223	0,000	5	CO205	Sigma Total	-3,66	29,09	0,13
	1243	0,000	36	CO204	Tau Total	-0,79	16,80	0,05
	1223	0,000	5	CO205	Sigma-eqv	3,66	29,09	0,13
3	RO 48.3x3.2 (Hot Formed)							
	1341	1,243	31	CO203	Sigma Total	0,62	21,36	0,03
	4	0,036	1	CO204	Tau Total	-0,59	12,33	0,05
	4	0,000	19	CO204	Sigma-eqv	1,05	21,36	0,05
4	RO 48.3x2.6 (Hot Formed)							
	1418	1,465	10	CO204	Sigma Total	-1,13	21,36	0,05
	36	0,000	19	CO205	Tau Total	-0,12	12,33	0,01
	1418	1,465	10	CO204	Sigma-eqv	1,13	21,36	0,05
5	RRO 100x50x3.2 (Hot Formed)							
	56	0,493	13	CO204	Sigma Total	6,48	21,36	0,30
	56	0,000	16	CO205	Tau Total	0,69	12,33	0,06
	56	0,493	13	CO204	Sigma-eqv	6,50	21,36	0,30
6	Ring 50/6							
	61	0,125	22	CO204	Sigma Total	-3,44	23,64	0,15
	61	0,000	31	CO204	Tau Total	0,37	13,65	0,03
	61	0,125	22	CO204	Sigma-eqv	3,45	23,64	0,15
7	Ring 48/3							
	267	0,000	16	CO204	Sigma Total	8,69	11,36	0,76
	1093	0,000	18	CO204	Tau Total	-1,58	6,56	0,24
	267	0,000	16	CO204	Sigma-eqv	8,69	11,36	0,76
8	Ring 30/3							
	839	0,000	29	CO204	Sigma Total	6,75	11,36	0,59
	873	0,150	2	CO204	Tau Total	-1,56	6,56	0,24
	839	0,000	29	CO204	Sigma-eqv	6,79	11,36	0,60
9	Ring 20/2							
	114	0,000	9	CO204	Sigma Total	3,63	11,36	0,32
	113	0,169	1	CO204	Tau Total	-0,13	6,56	0,02
	114	0,000	9	CO204	Sigma-eqv	3,63	11,36	0,32
10	HK 50/50/5/5/5/5							
	1446	0,000	10	CO204	Sigma Total	6,18	11,36	0,54
	266	0,044	8	CO204	Tau Total	2,36	6,56	0,36
	1446	0,000	10	CO204	Sigma-eqv	6,24	11,36	0,55
11	TO 50/100/4/4/4/4							
	245	0,084	14	CO204	Sigma Total	3,66	11,36	0,32
	261	0,081	7	CO204	Tau Total	-2,61	6,56	0,40
	261	0,081	6	CO204	Sigma-eqv	4,67	11,36	0,41
12	Ring 16/2							
	313	0,322	18	CO204	Sigma Total	4,24	11,36	0,37
	874	0,141	8	CO204	Tau Total	-0,41	6,56	0,06
	313	0,322	18	CO204	Sigma-eqv	4,24	11,36	0,37
13	Ring 50/4							
	14	0,000	14	CO204	Sigma Total	7,85	11,36	0,69
	8	0,000	36	CO204	Tau Total	-1,23	6,56	0,19
	14	0,000	15	CO204	Sigma-eqv	7,91	11,36	0,70
14	Rectangle 15/60							
	486	0,090	4	CO205	Sigma Total	-3,66	23,64	0,15
	1208	0,050	1	CO204	Tau Total	0,53	13,65	0,04
	486	0,090	4	CO205	Sigma-eqv	3,66	23,64	0,15
15	RD 20							
	887	0,000	33	CO204	Sigma Total	-34,71	64,00	0,54
	887	0,016	37	CO204	Tau Total	5,59	36,95	0,15
	887	0,000	33	CO204	Sigma-eqv	34,83	64,00	0,54
17	HK 50/30/4/4/4/4							
	783	0,000	10	CO204	Sigma Total	0,46	22,50	0,02
	783	0,000	8	CO205	Tau Total	0,06	12,99	0,00
	783	0,000	10	CO204	Sigma-eqv	0,47	22,50	0,02

3.0 Detail calculations for different parts.

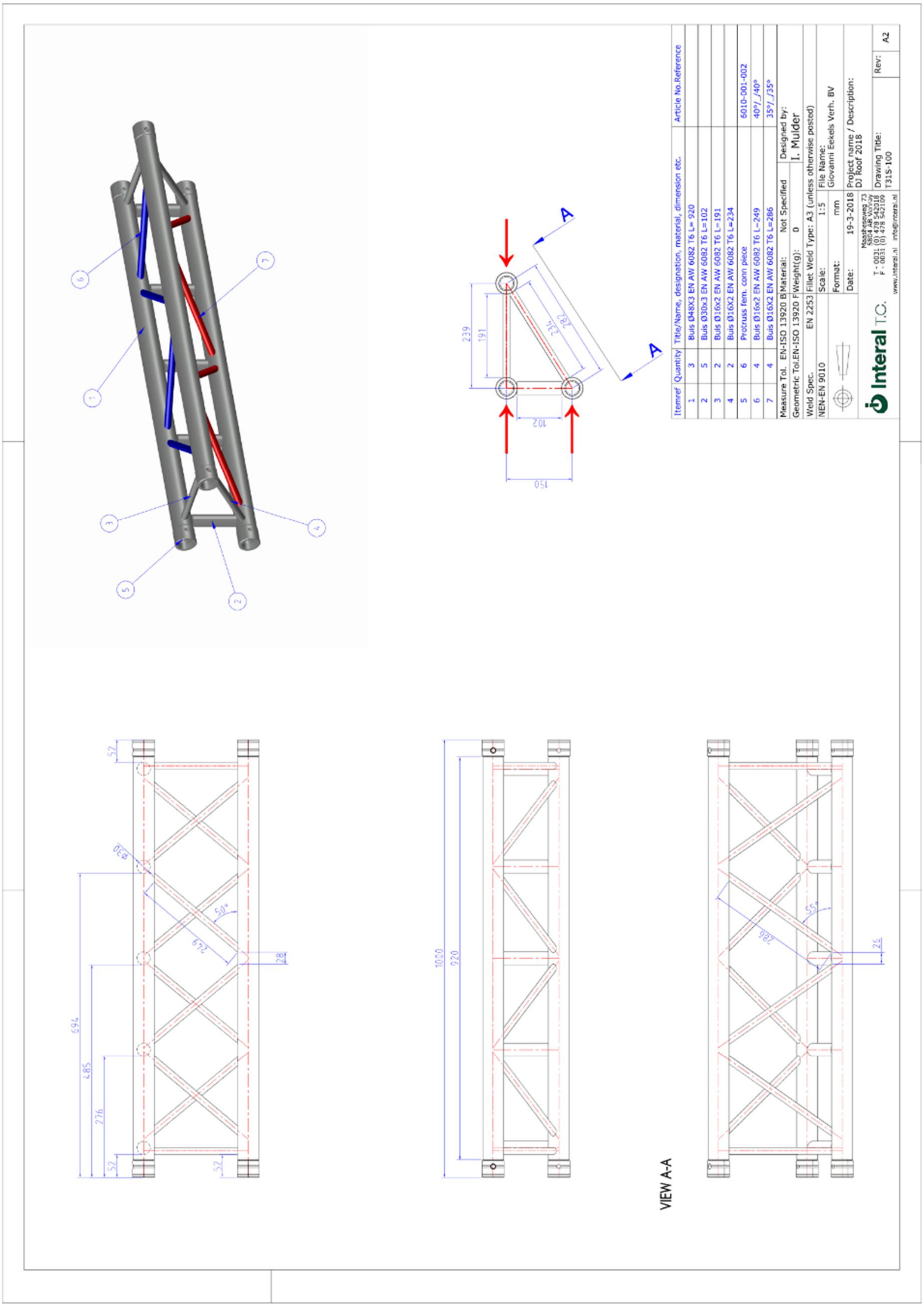
The In service situation contents the decisive load combinations.

These load combinations show the highest internal forces, besides that are the Utilisations of the stress calculation in the In service situation higher then the Utilisation of the stress in the Out service situation.

3.1 Detail Check of Special Triangular truss.



3.1.1 special triangular truss model.



3.1.2 Truss main tube and coupling system

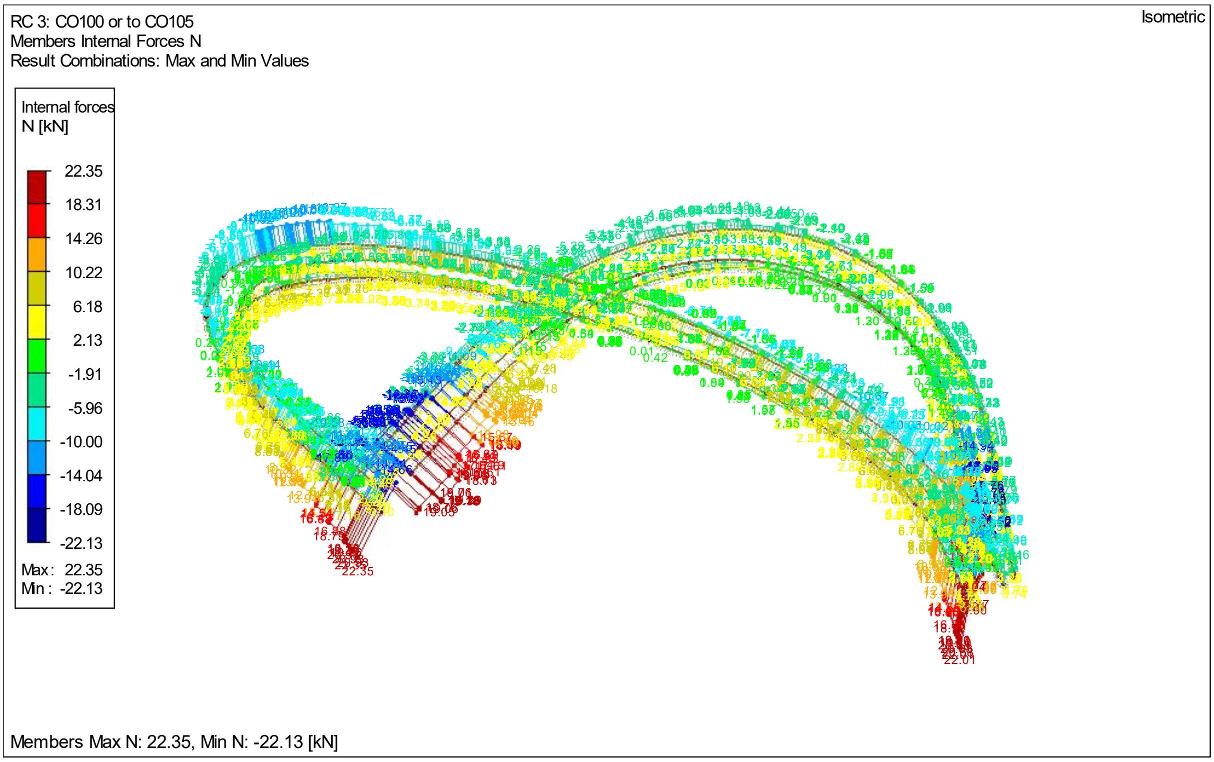
The truss coupling system is the same as the S41 truss of Interal. According to the structural information of the S41 truss, the maximum normal force in the coupling system is 49.24 kN.

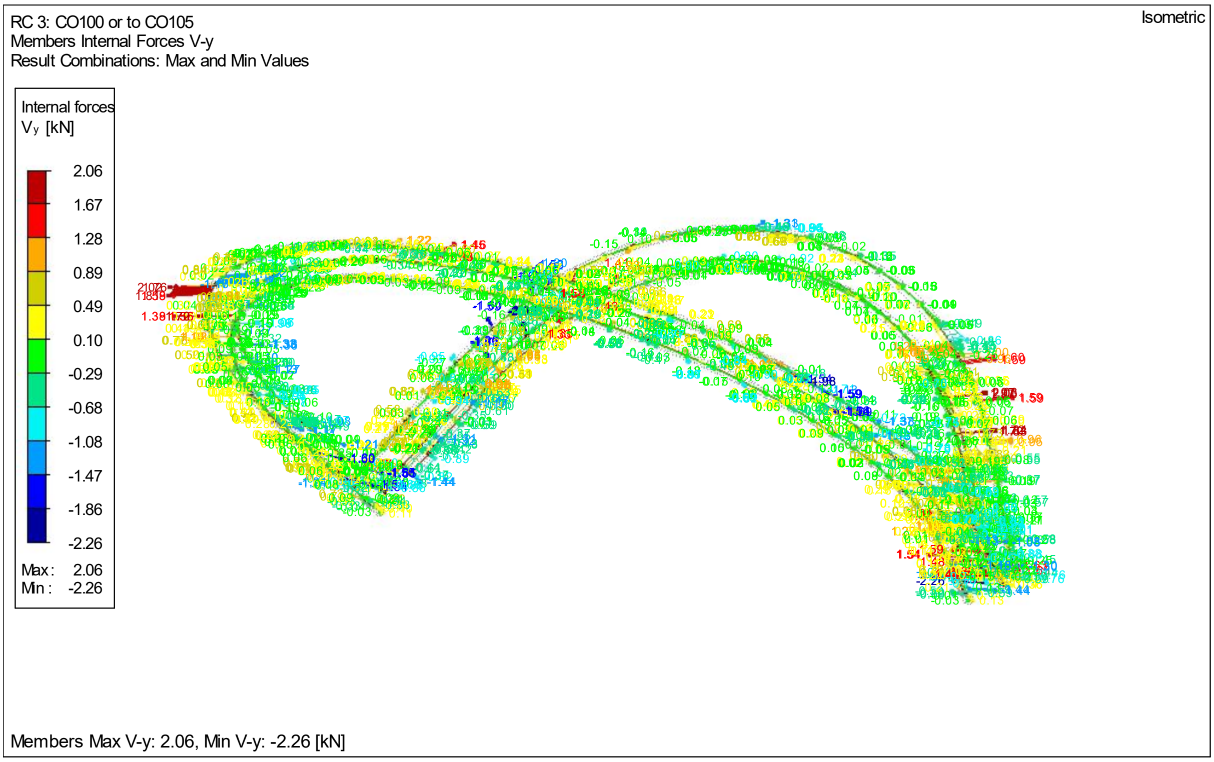
The decisive position is in the heat affective zone in the main tube just behind the weld of the coupler to the main tube.

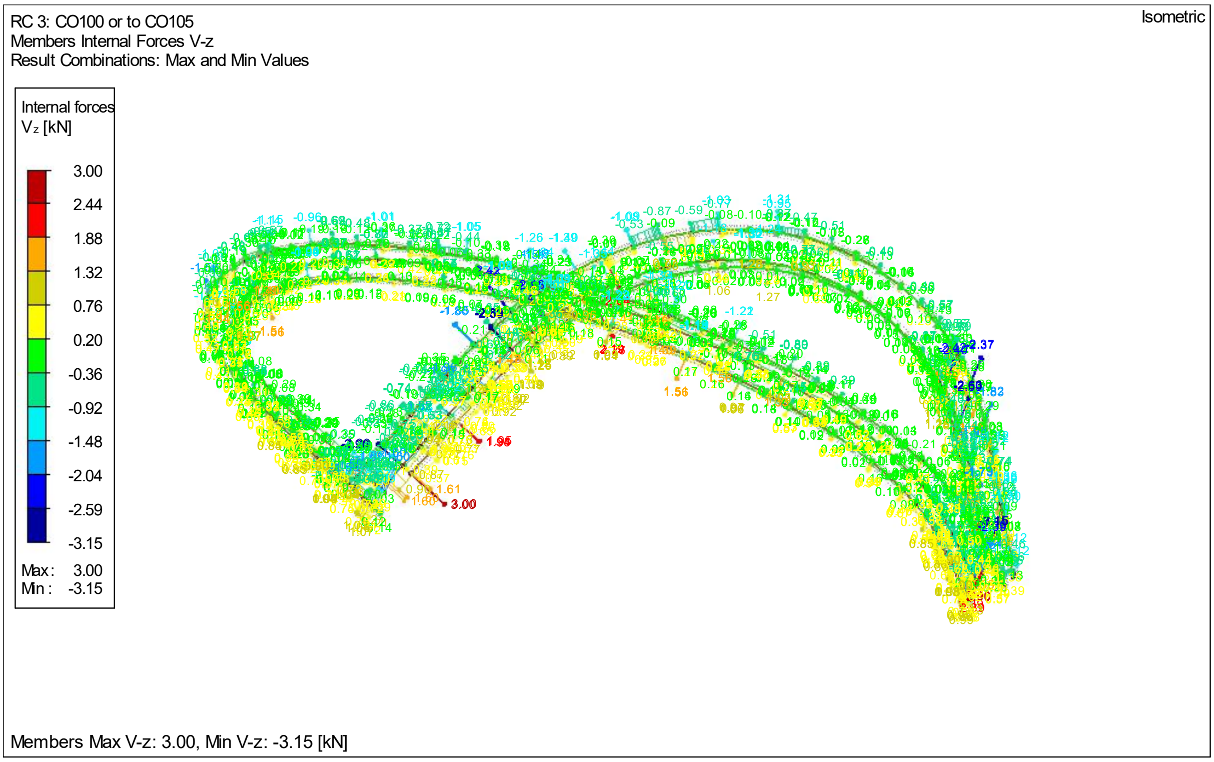
Check of the main tube

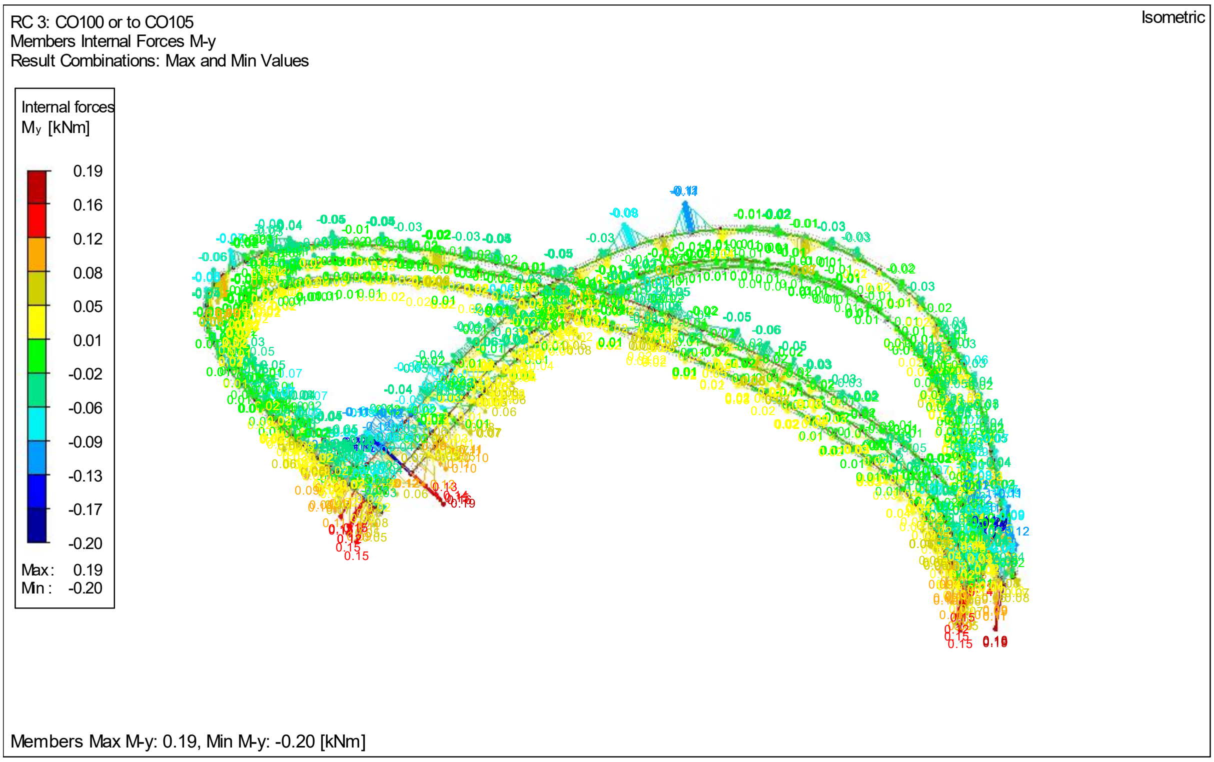
The decisive result combination is RC3 – Design values In service wind

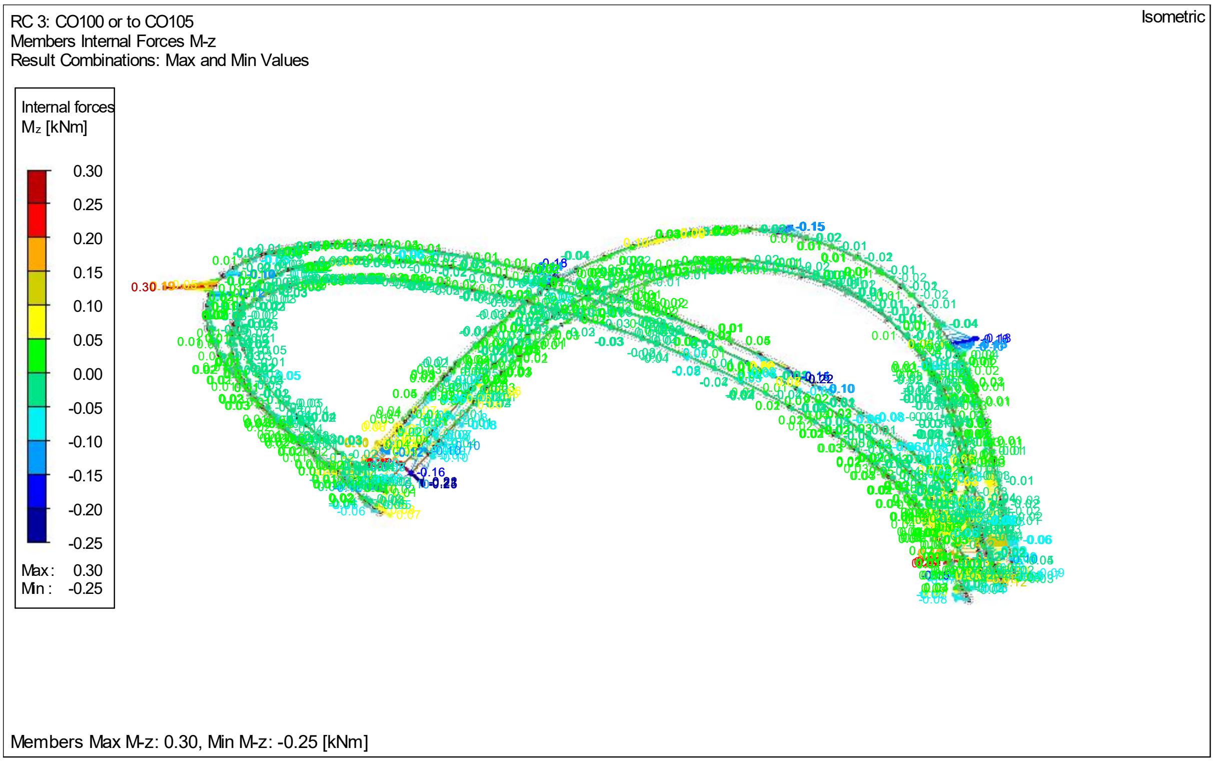
Internal forces diagrams for the complete truss in RC3



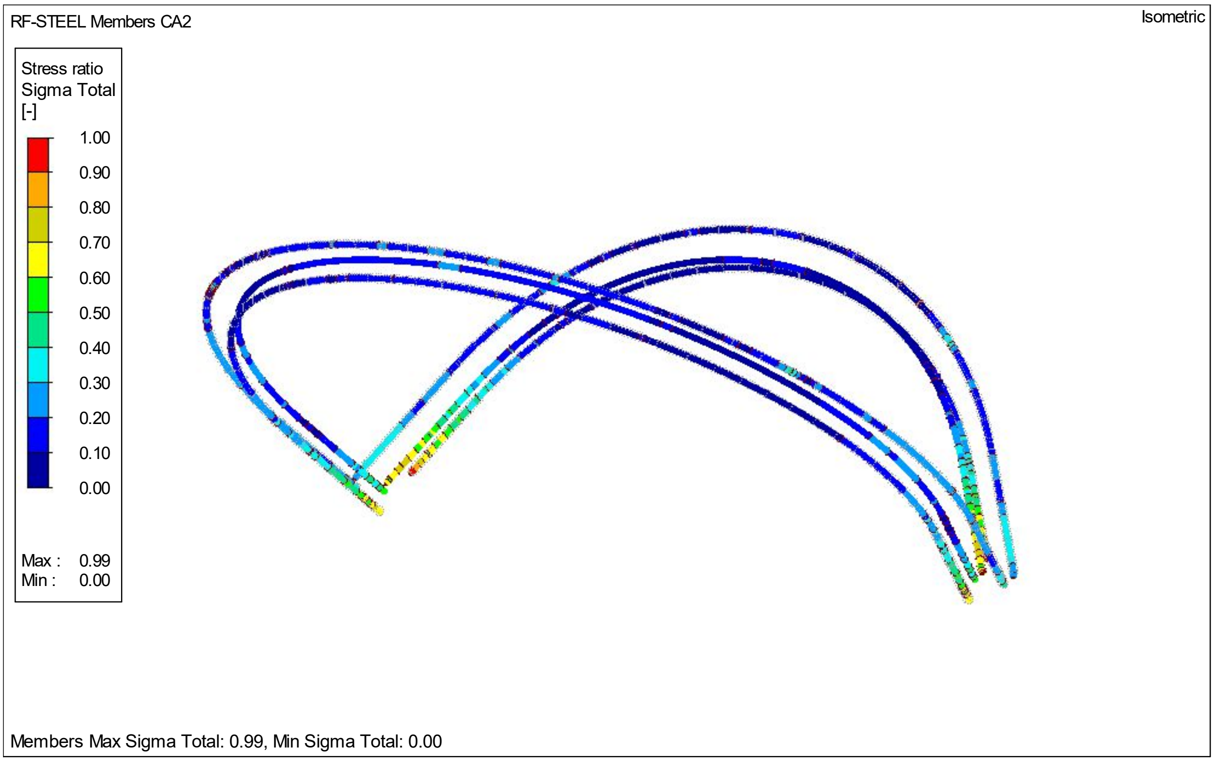

RC 3: CO100 or to CO105
Members Internal Forces V-y
Result Combinations: Max and Min Values
Isometric
Internal forces
Vy [kN]
2.06
1.67
1.28
0.89
0.49
0.10
-0.29
-0.68
-1.08
-1.47
-1.86
-2.26
Max : 2.06
Min : -2.26
Members Max V-y: 2.06, Min V-y: -2.26 [kN]


RC 3: CO100 or to CO105
Members Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
3.00
2.44
1.88
1.32
0.76
0.20
-0.36
-0.92
-1.48
-2.04
-2.59
-3.15
Max : 3.00
Min : -3.15
Members Max V-z: 3.00, Min V-z: -3.15 [kN]

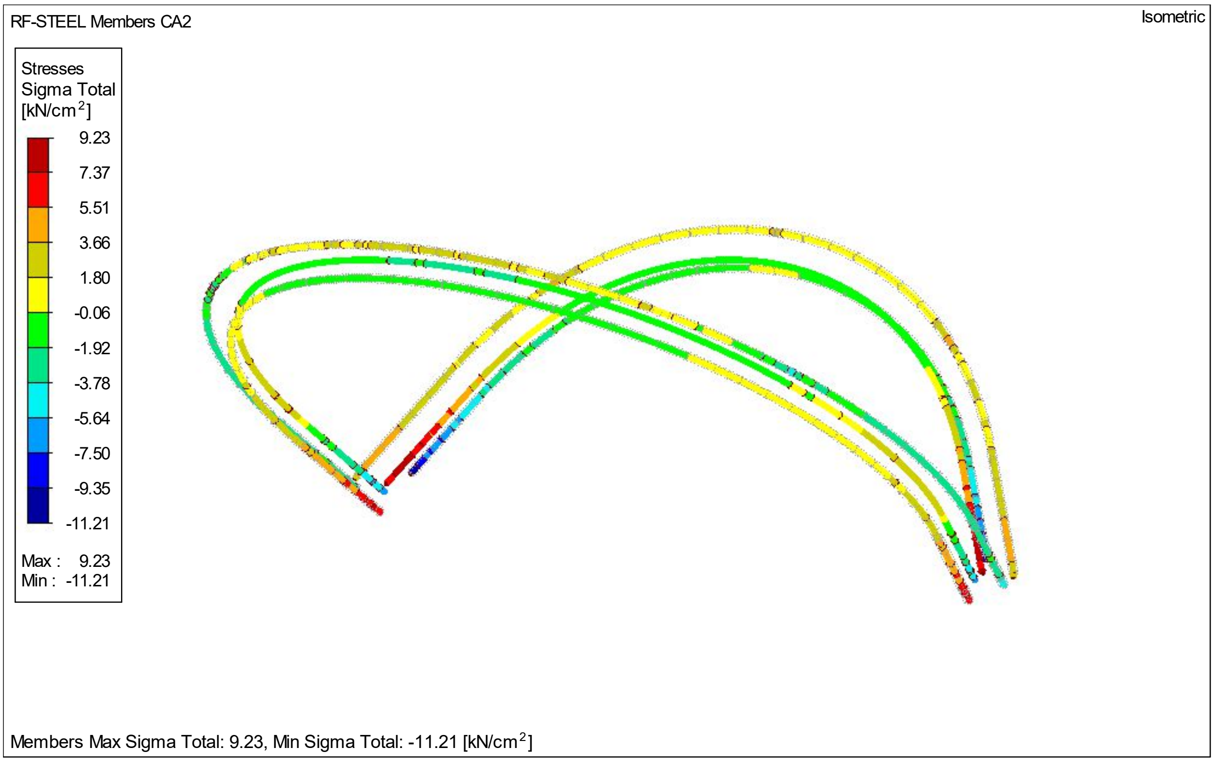

RC 3: CO100 or to CO105
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
0.19
0.16
0.12
0.08
0.05
0.01
-0.02
-0.06
-0.09
-0.13
-0.17
-0.20
Max : 0.19
Min : -0.20
Members Max M-y: 0.19, Min M-y: -0.20 [kNm]


RC 3: CO100 or to CO105
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
Max : 0.30
Min : -0.25
Members Max M-z: 0.30, Min M-z: -0.25 [kNm]

Result of the stress calculation CA2



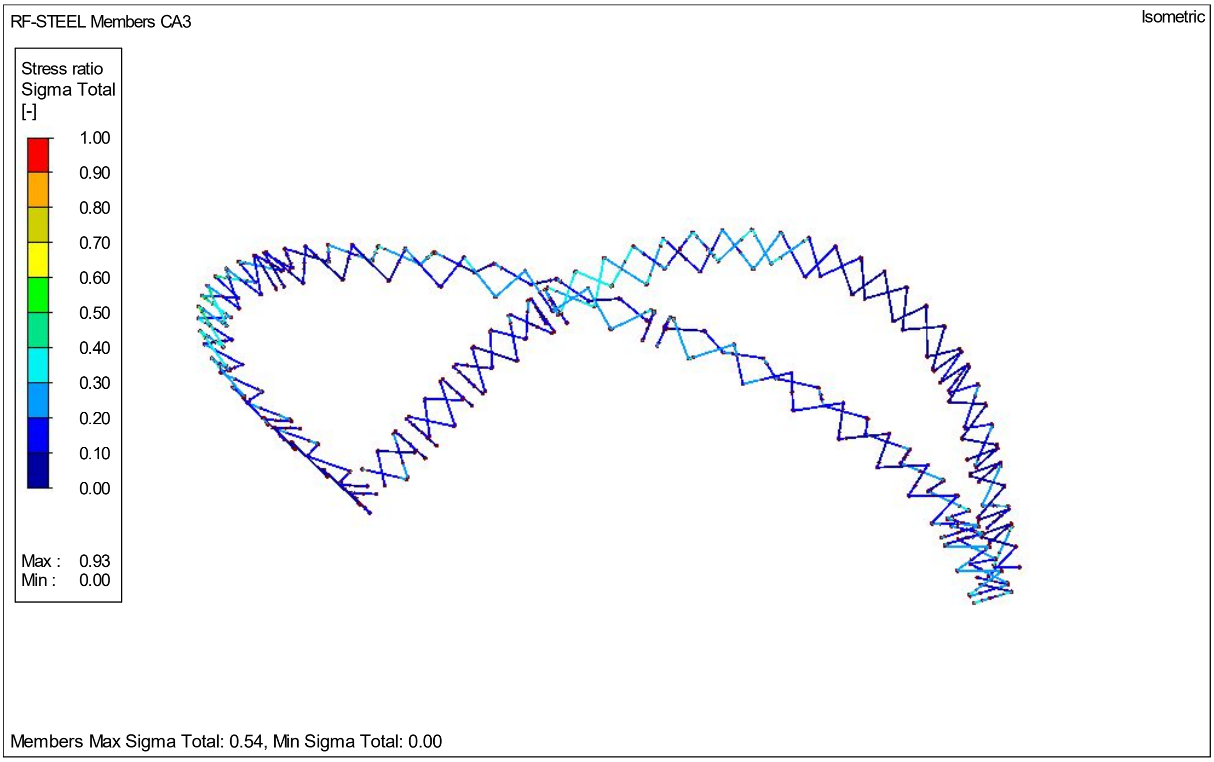
Maximum utilisation = 99%



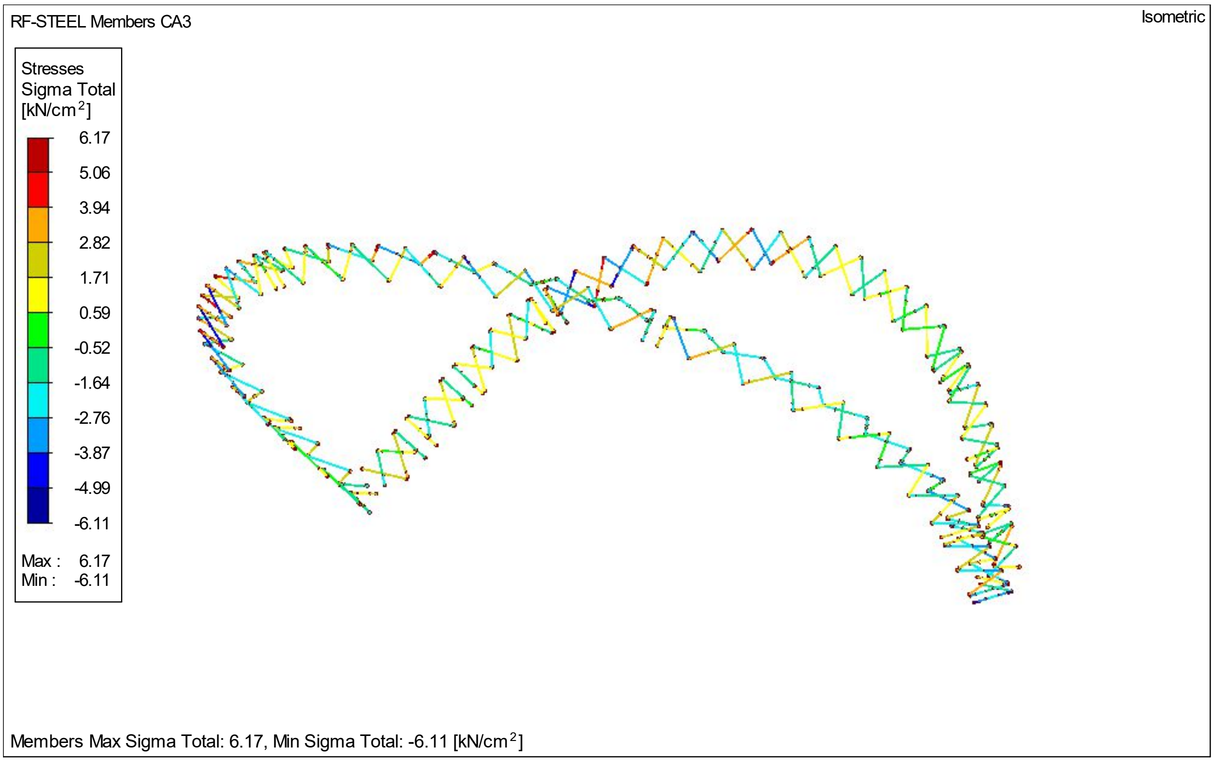
Maximum stress = 11.21 kN/cm² < 12.5 kN/cm²

3.1.3 Check of the Truss diagonals.

Result of the stress calculation CA3



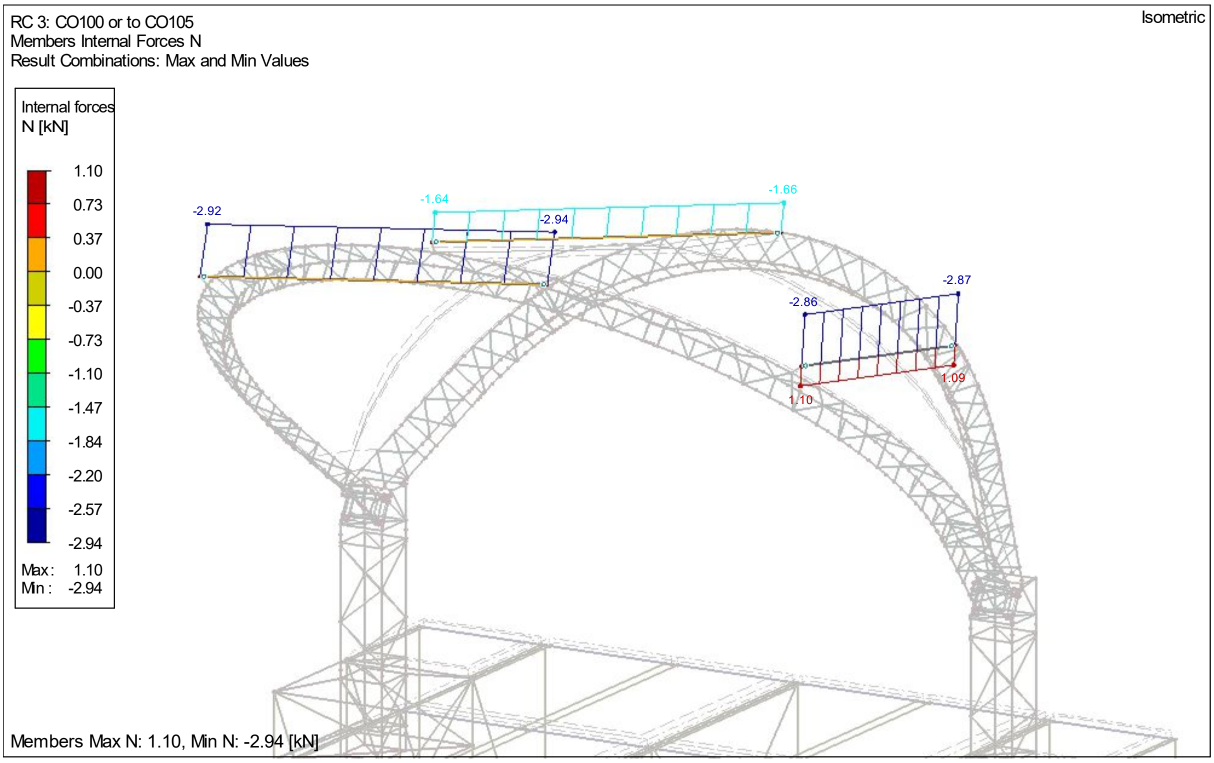
Maximum utilisation = 54%



Maximum stress = 6.17 kN/cm² < 12.5 kN/cm²

3.2 Check of the pressure tube in the top of the roof.

Maximum normal force inside the Pressure tube.



Buckling calculation of the middle tube:

$N_{ed} = 1.65$ kN

Buckling Length factor K = 1.25 table 6,8 NEN-EN 1999-1-1

$L_{cr} = 1.25 * 508.5 = 636$

$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$

$\lambda_z = 636 / (1.63 * \pi) * \sqrt{((5.78 * 25) / (5.78 * 7000))} = 5.24$

$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$

$\Theta_z = 0.5 * (1 + 0.2 * (5.24 - 0.10) + 5.24^2) = 14.74$

$X_z = 1 / (\Theta_z + \sqrt{(\Theta_z^2 - \lambda_z^2)})$

$X_z = 1 / (14.74 + \sqrt{(14.74^2 - 5.24^2)}) = 0.04$

$N_{b,rd} = X_z * A * f_0 / 1.1$

$N_{b,rd} = 0.04 * 5.78 * 12.5 / 1.1 = 2.30$ kN

Check

$N_{b,rd} / N_{ed} < 1$

$2.30 / 1.64 = 0.71 < 1$

Buckling calculation of the side tube:

$N_{ed} = 2.87$ kN

Buckling Length factor K = 1.25 table 6,8 NEN-EN 1999-1-1

$L_{cr} = 1.25 * 375 = 469$

$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{} ((A_{eff} * f_0) / A * E))$

$\lambda_z = 469 / (1.63 * \pi) * \sqrt{} ((5.78 * 25) / (5.78 * 7000)) = 3.86$

$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$

$\Theta_z = 0.5 * (1 + 0.2 * (3.86 - 0.10) + 3.86^2) = 8.34$

$X_z = 1 / (\Theta_z + \sqrt{} (\Theta_z^2 - \lambda_z^2))$

$X_z = 1 / (8.34 + \sqrt{} (8.34^2 - 3.86^2)) = 0.06$

$N_{b,rd} = X_z * A * f_0 / 1.1$

$N_{b,rd} = 0.06 * 5.78 * 12.5 / 1.1 = 4.17$ kN

Check

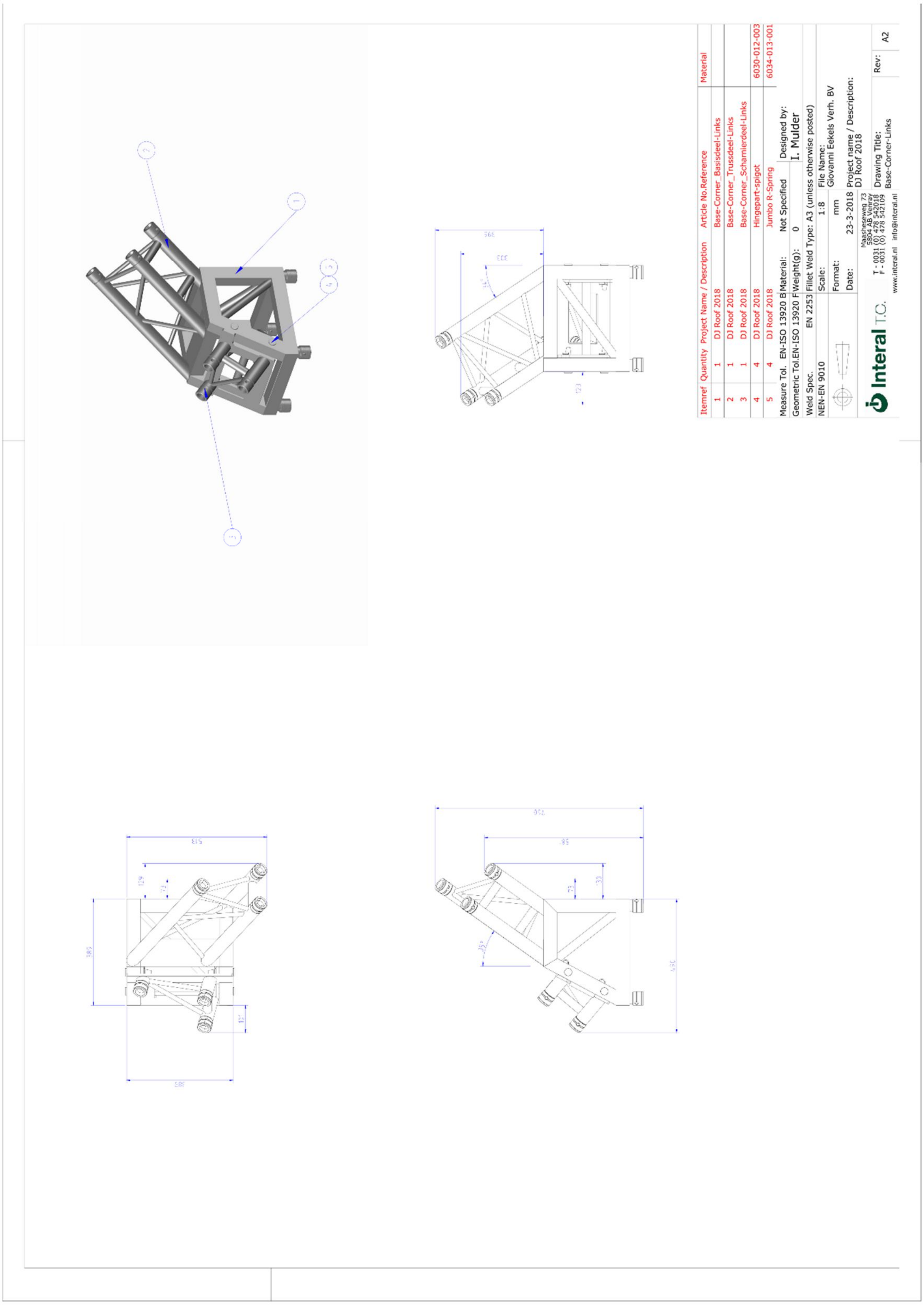
$N_{b,rd} / N_{ed} < 1$

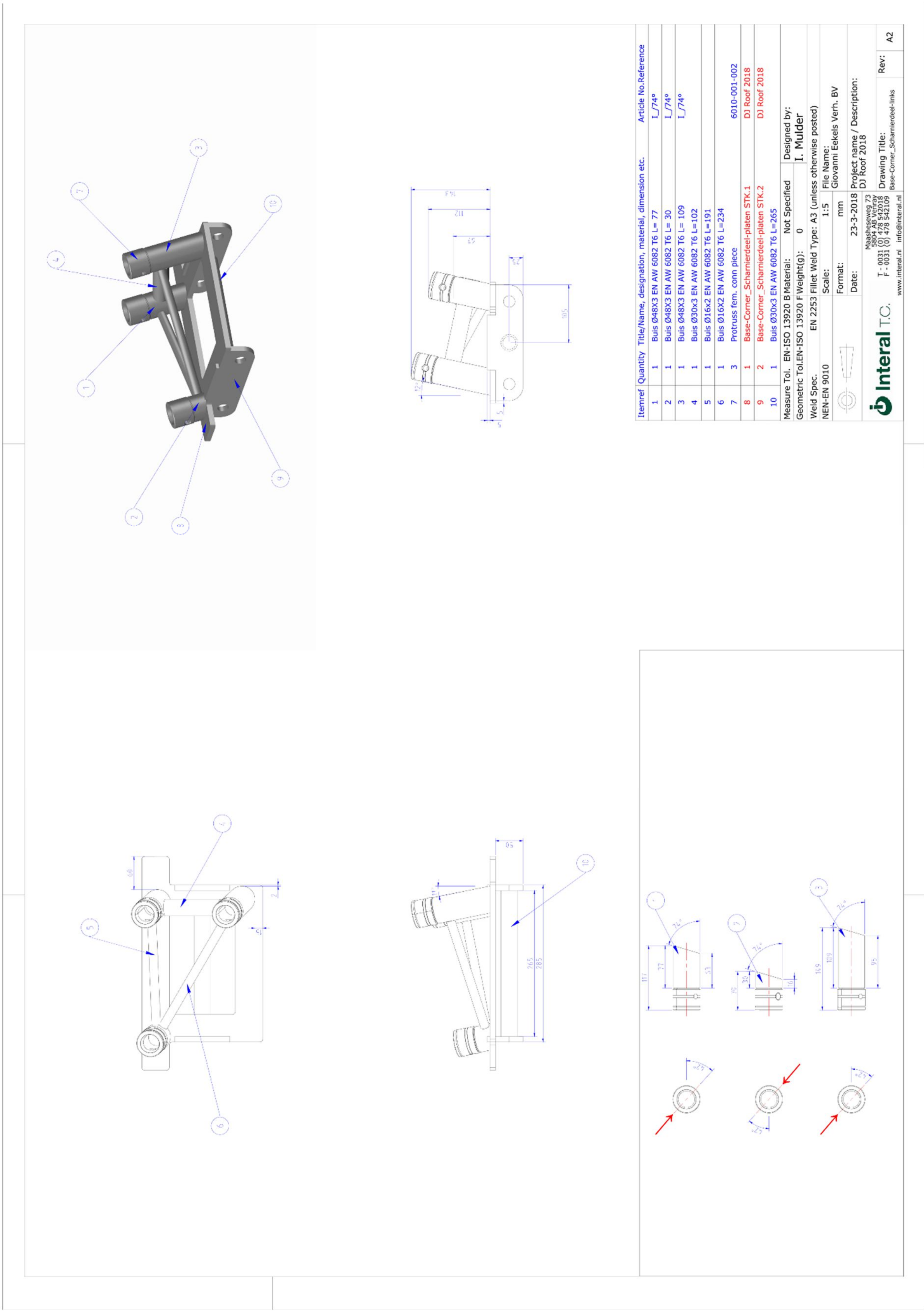
$4.17 / 2.87 = 0.69 < 1$

3.3 Detail check of the hinge corner with arch attachment.

The check of the corner has been done with the stress analyse calculation for the In service situation

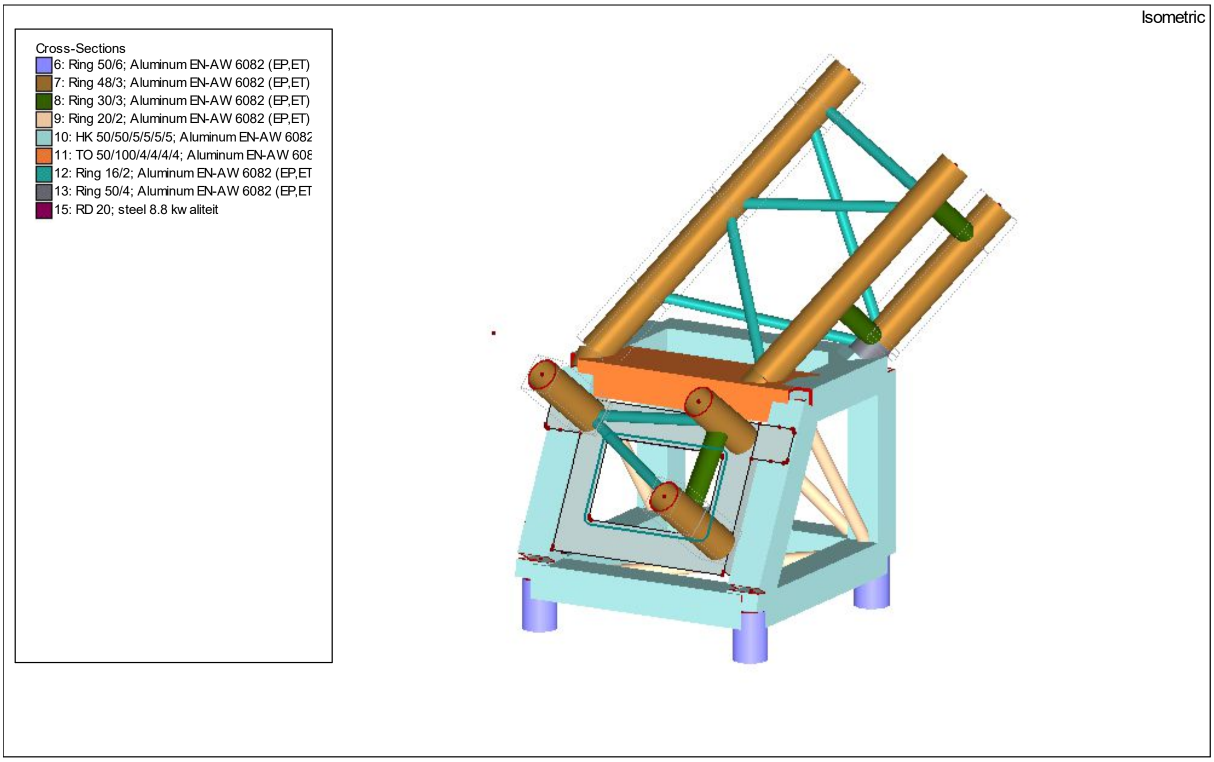
3.3.1 Drawings of the left corner

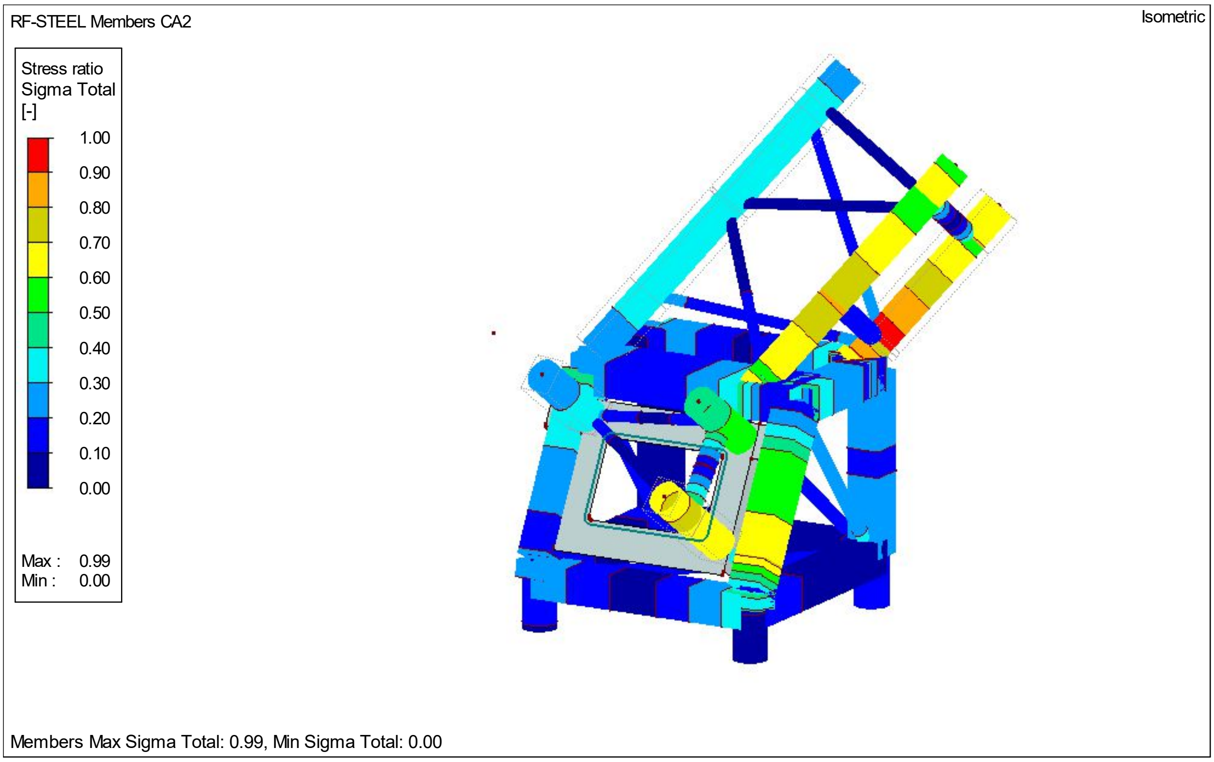


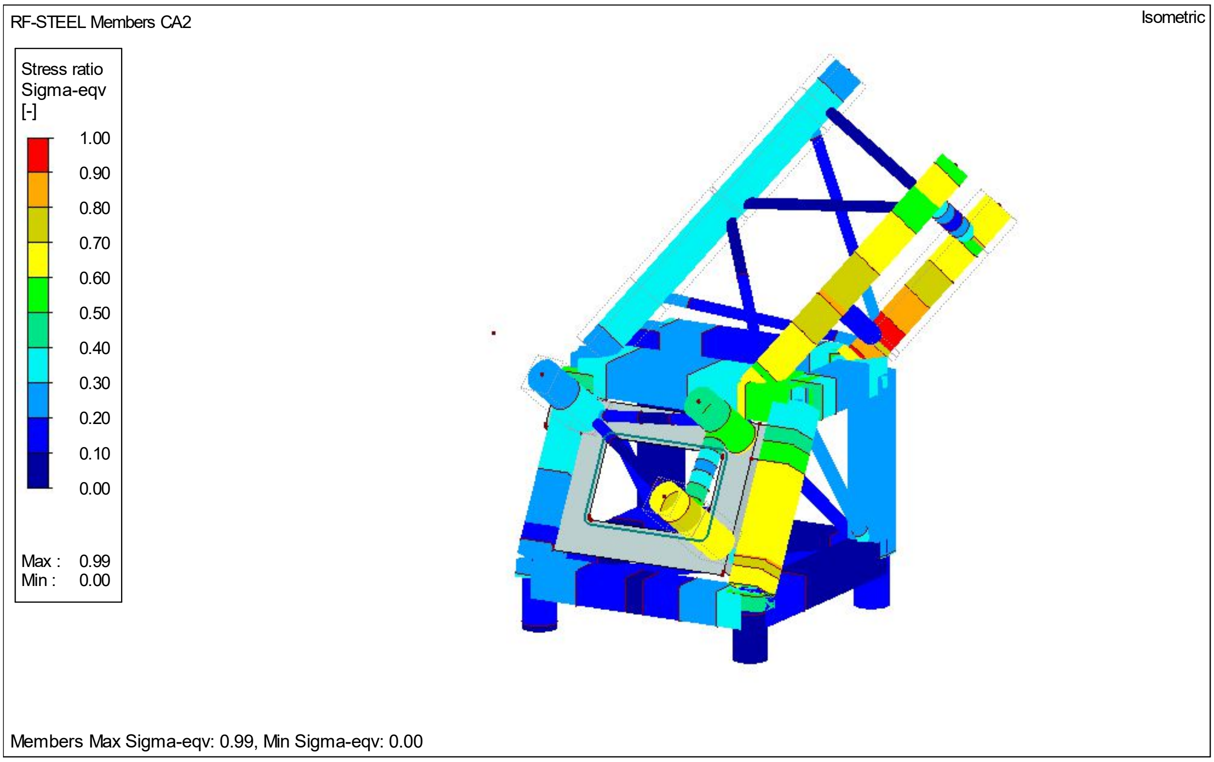


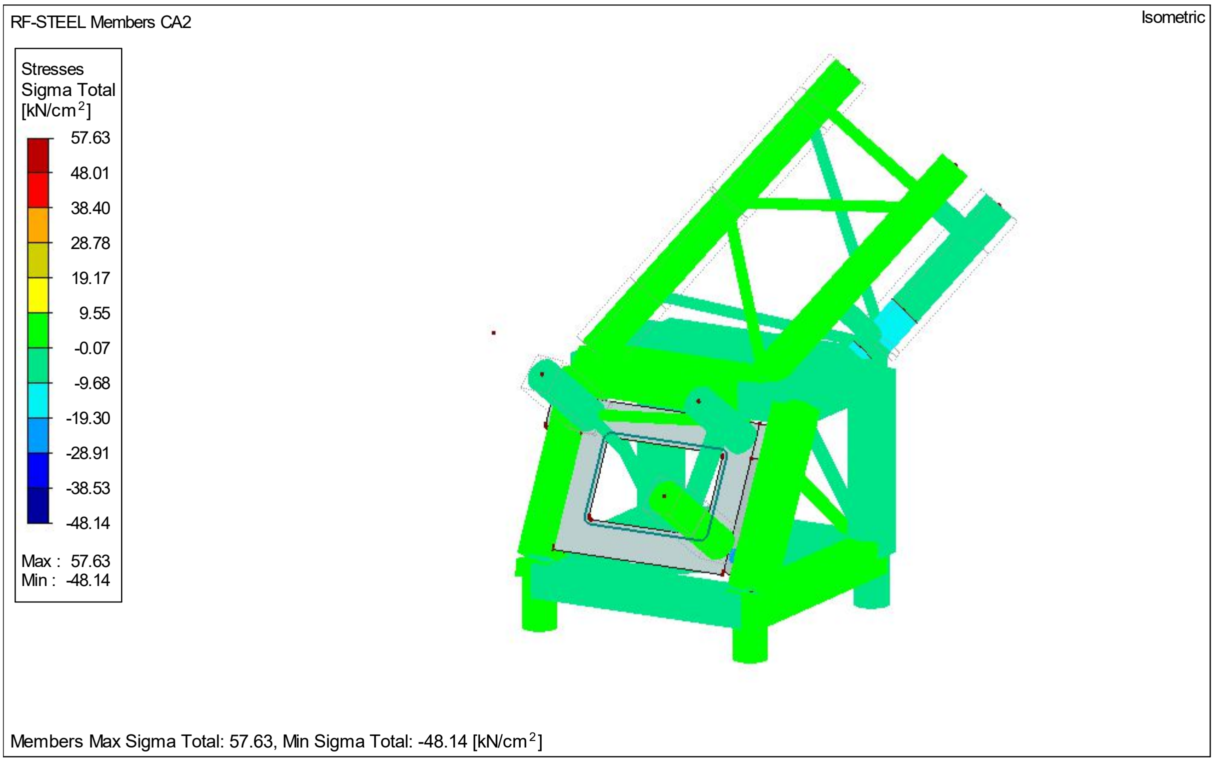
Itemref	Quantity	Title/Name, designation, material, dimension etc.	Article No.	Reference
1	1	Buis Ø48X3 EN AW 6082 T6 L= 77		I_/74°
2	1	Buis Ø48X3 EN AW 6082 T6 L= 30		I_/74°
3	1	Buis Ø48X3 EN AW 6082 T6 L= 109		I_/74°
4	1	Buis Ø30x3 EN AW 6082 T6 L=102		
5	1	Buis Ø16x2 EN AW 6082 T6 L=191		
6	1	Buis Ø16X2 EN AW 6082 T6 L=234		
7	3	Protruss fem. conn piece	6010-001-002	
8	1	Base-Corner_Scharnierdeel-platen STK.1		DJ Roof 2018
9	2	Base-Corner_Scharnierdeel-platen STK.2		DJ Roof 2018
10	1	Buis Ø30x3 EN AW 6082 T6 L=265		

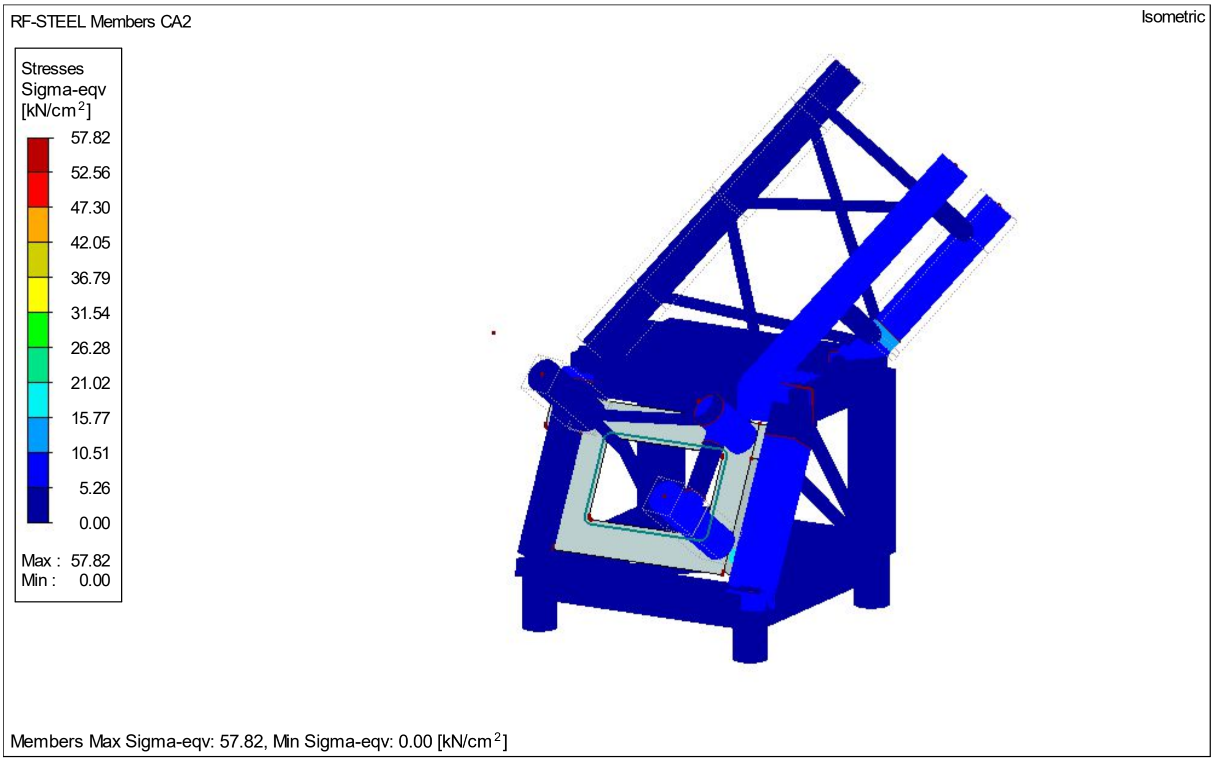
3.3.2 Stress analyse CA2 –design values In-service






RF-STEEL Members CA2
Isometric
Stress ratio
Sigma-eqv
[-]
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Max : 0.99
Min : 0.00
Members Max Sigma-eqv: 0.99, Min Sigma-eqv: 0.00


RF-STEEL Members CA2
Isometric
Stresses
Sigma Total
[kN/cm2]
57.63
48.01
38.40
28.78
19.17
9.55
-0.07
-9.68
-19.30
-28.91
-38.53
-48.14
Max : 57.63
Min : -48.14
Members Max Sigma Total: 57.63, Min Sigma Total: -48.14 [kN/cm2]



Maximum yield strength for different materials

Material = EN-AW-6082 T6
$f_{o,haz}$ = 12.5 kN/cm²

The Yield strength for the material EN-AW-6082 T6, has been manually changed into $f_{o,haz}$,This is according to the Eurocode NEN-EN 1999-1-1 Table 3.2 the $f_{o,haz}$ for the heat affective zone. This check is concerning a welded construction with heat affective zones in the main elements, there for the choice to check the construction according to the lower $f_{o\ haz.}$

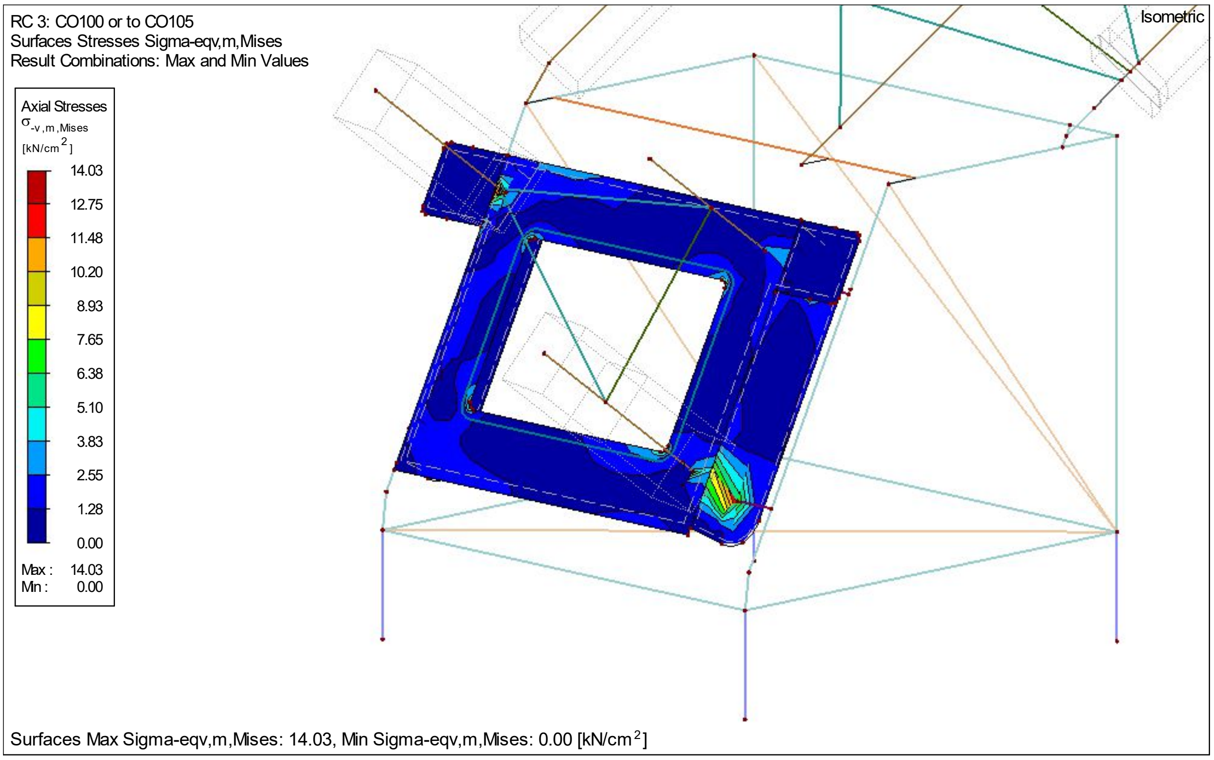
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Stress [kN/cm²] Limit	Stress Ratio
6	Ring 50/6							
	68	0,125	36	CO100	Sigma Total	-5,83	23,64	0,25
	61	0,125	31	CO100	Tau Total	-0,58	13,65	0,04
	68	0,125	36	CO100	Sigma-eqv	5,83	23,64	0,25
7	Ring 48/3							
	267	0,000	15	CO100	Sigma Total	-11,21	11,36	0,99
	200	0,000	8	CO100	Tau Total	-1,91	6,56	0,29
	267	0,000	15	CO100	Sigma-eqv	11,29	11,36	0,99
8	Ring 30/3							
	682	0,150	9	CO100	Sigma Total	-9,17	11,36	0,81
	681	0,150	36	CO100	Tau Total	-1,68	6,56	0,26
	682	0,150	9	CO100	Sigma-eqv	9,17	11,36	0,81
9	Ring 20/2							
	114	0,000	9	CO100	Sigma Total	-5,97	11,36	0,53
	113	0,000	1	CO100	Tau Total	0,18	6,56	0,03
	114	0,000	9	CO100	Sigma-eqv	5,97	11,36	0,53
10	HK 50/50/5/5/5/5							
	266	0,000	2	CO100	Sigma Total	8,20	11,36	0,72
	247	0,000	8	CO100	Tau Total	3,57	6,56	0,54
	266	0,000	2	CO100	Sigma-eqv	9,39	11,36	0,83
11	TO 50/100/4/4/4/4							
	245	0,084	14	CO100	Sigma Total	-5,58	11,36	0,49
	261	0,000	7	CO100	Tau Total	3,83	6,56	0,58
	245	0,084	14	CO100	Sigma-eqv	7,02	11,36	0,62

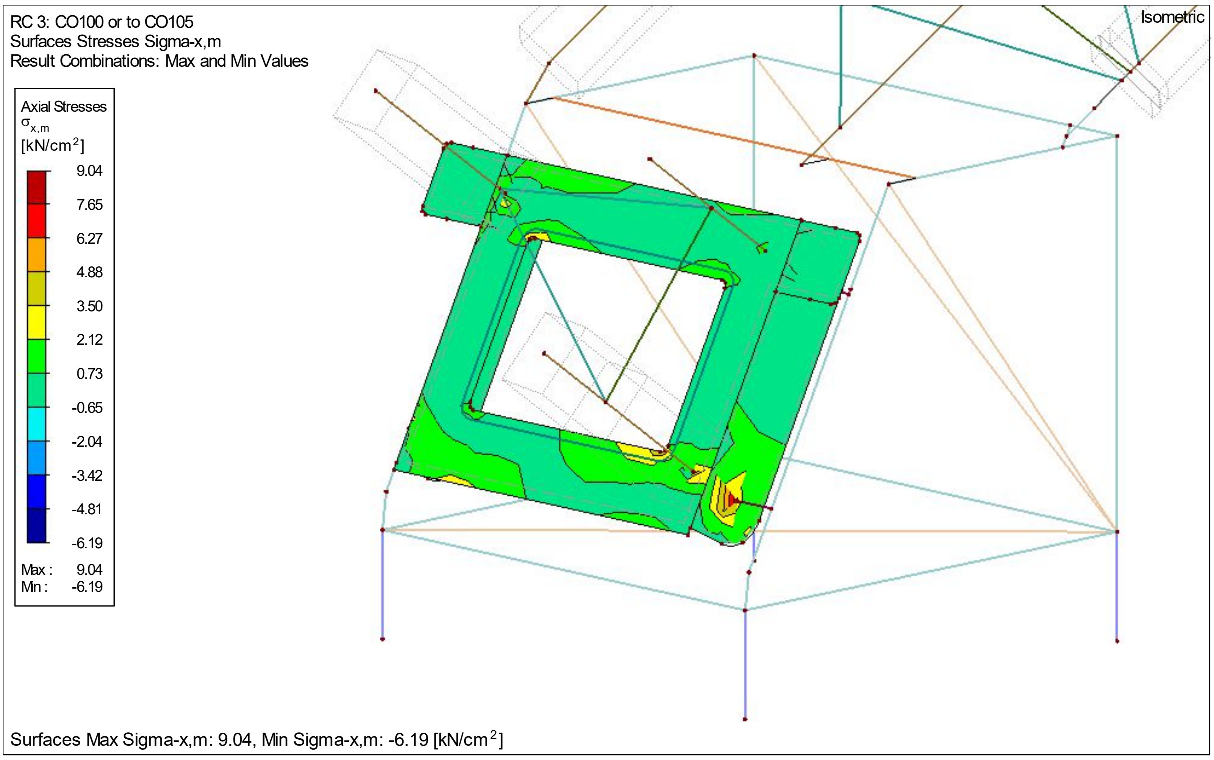
12	Ring 16/2							
	460	0,327	27	CO100	Sigma Total	5,97	11,36	0,53
	472	0,360	20	CO100	Tau Total	0,47	6,56	0,07
	460	0,327	27	CO100	Sigma-eqv	5,99	11,36	0,53
13	Ring 50/4							
	14	0,000	14	CO100	Sigma Total	-10,30	11,36	0,91
	8	0,026	36	CO100	Tau Total	1,83	6,56	0,28
	14	0,000	14	CO100	Sigma-eqv	10,46	11,36	0,92
14	Rectangle 15/60							
	488	0,095	1	CO100	Sigma Total	5,51	23,64	0,23
	486	0,090	1	CO100	Tau Total	0,79	13,65	0,06
	488	0,095	1	CO100	Sigma-eqv	5,67	23,64	0,24
15	RD 20							
	239	0,032	34	CO100	Sigma Total	59,95	64,00	0,94
	887	0,000	37	CO100	Tau Total	9,13	36,95	0,25
	239	0,032	34	CO100	Sigma-eqv	59,97	64,00	0,94
17	HK 50/30/4/4/4/4							
	1163	1,036	14	CO100	Sigma Total	0,53	22,50	0,02
	1422	0,000	8	CO100	Tau Total	0,06	12,99	0,00
	1163	1,036	14	CO100	Sigma-eqv	0,54	22,50	0,02

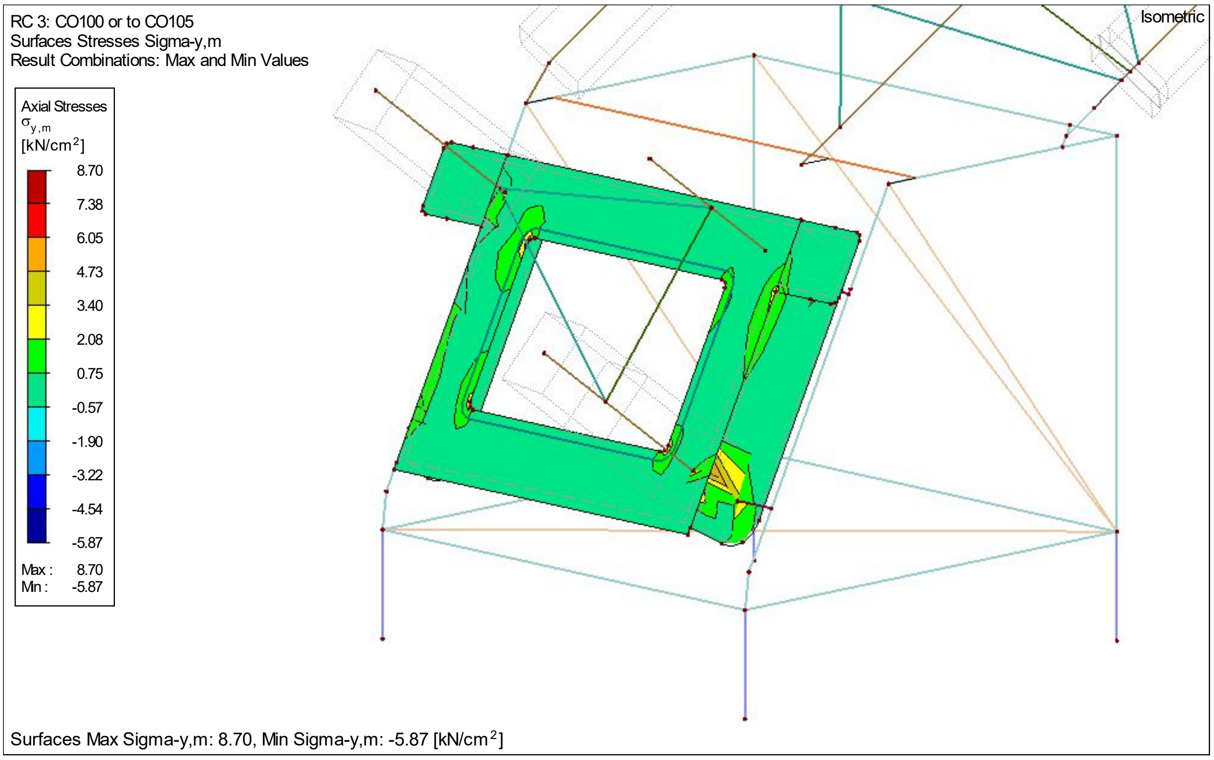
Maximum Utilisation in the heat affected zone beside the weld to the square profile and the Main tube of the back arch.

Utilisation is 99%

3.3.3 Stress analyse calculation of the adapter plate.




RC 3: CO100 or to CO105
Surfaces Stresses Sigma-x,m
Result Combinations: Max and Min Values
Isometric
Axial Stresses
$\sigma_{x,m}$
[kN/cm^2]
9.04
7.65
6.27
4.88
3.50
2.12
0.73
-0.65
-2.04
-3.42
-4.81
-6.19
Max : 9.04
Min : -6.19
Surfaces Max Sigma-x,m: 9.04, Min Sigma-x,m: -6.19 [kN/cm^2]


RC 3: CO100 or to CO105
Surfaces Stresses Sigma-y,m
Result Combinations: Max and Min Values
Isometric
Axial Stresses
$\sigma_{y,m}$
[kN/cm^2]
8.70
7.38
6.05
4.73
3.40
2.08
0.75
-0.57
-1.90
-3.22
-4.54
-5.87
Max : 8.70
Min : -5.87
Surfaces Max Sigma-y,m: 8.70, Min Sigma-y,m: -5.87 [kN/cm^2]

Stress calculation in the head affected zone around the welded tube with maximum Normal force of the main tube from the truss

$N_{ed, max}$ = 22.35 kN

Shear Surface in heat affected zone = π * 4.8 * 1.0 = 15.1 cm²

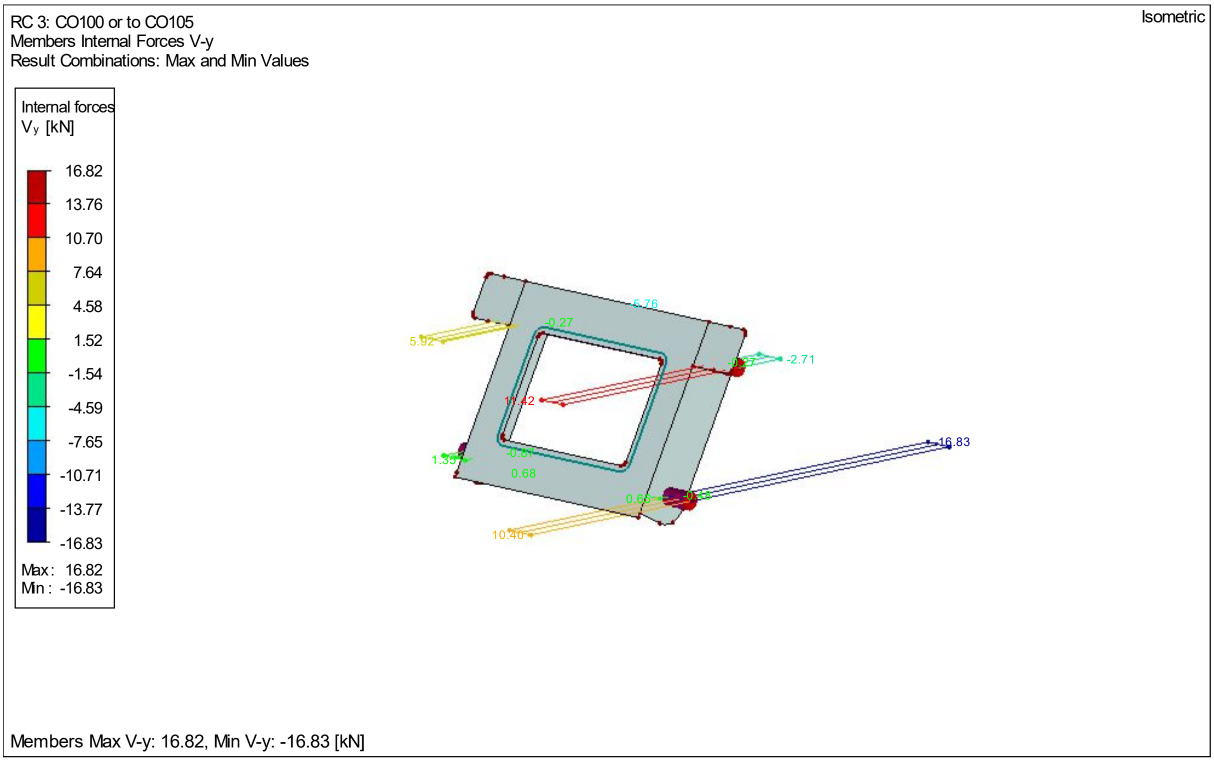
V_{rd} = 0.58 * 15.1 * 12.5 / 1.1 = 99.52 kN

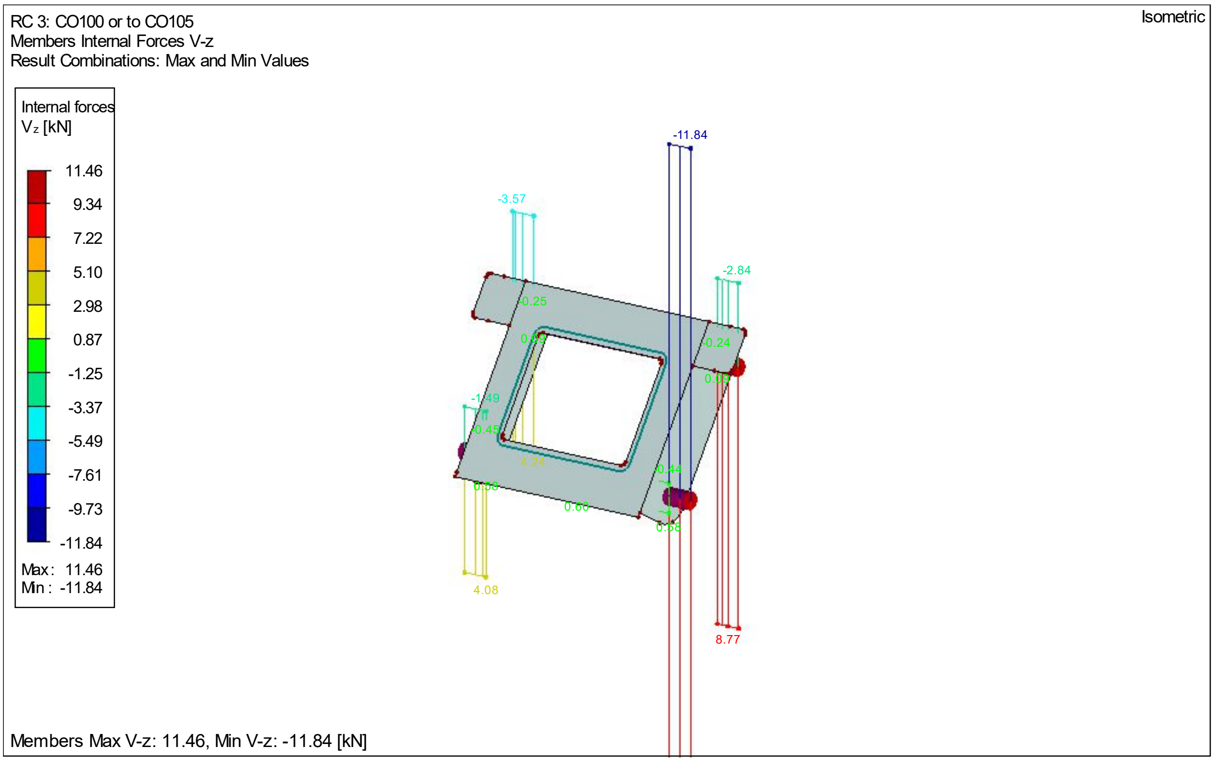
$N_{ed, max} / V_{rd} < 1$

22.35 / 99.52 = 0.22 < 1

3.3.4 calculation of the surface pressure between the hinge construction and the pin

Shear force inside the pin in two directions





Check of the surface pressure in the hinge adapter

Total shear force

$F_{b,Ed} = \sqrt{(Vy^2+Vz^2)} = \sqrt{(16.82^2 + 11.84^2)} = 20.57$ kN

$F_{b,Rd} = 1.5 * f_u * d * t / \gamma_{m2} = 1.5 * 27.5 * 2.0 * 1 / 1.25 = 66$ kN

Check

$F_{b,Ed} / F_{b,Rd} < 1$

$20.57 / 66 = 0.31 < 1$

Check of the surface pressure in the corner square profile

Total shear force

$F_{b,Ed} = \sqrt{(Vy^2+Vz^2)} = \sqrt{(16.82^2 + 11.84^2)} = 20.57$ kN

$F_{b,Rd} = 1.5 * f_u * d * t / \gamma_{m2} = 1.5 * 31 * 2.0 * 0.4 / 1.25 = 29.76$ kN

Check

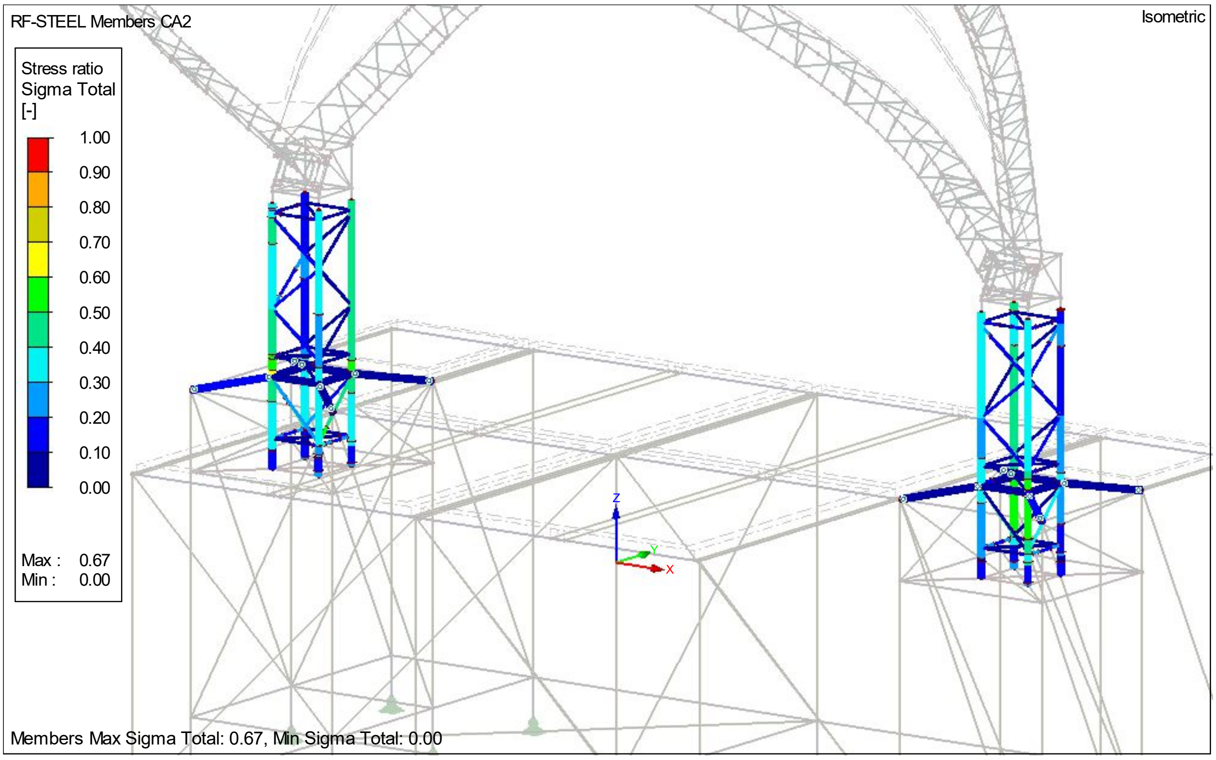
$F_{b,Ed} / F_{b,Rd} < 1$

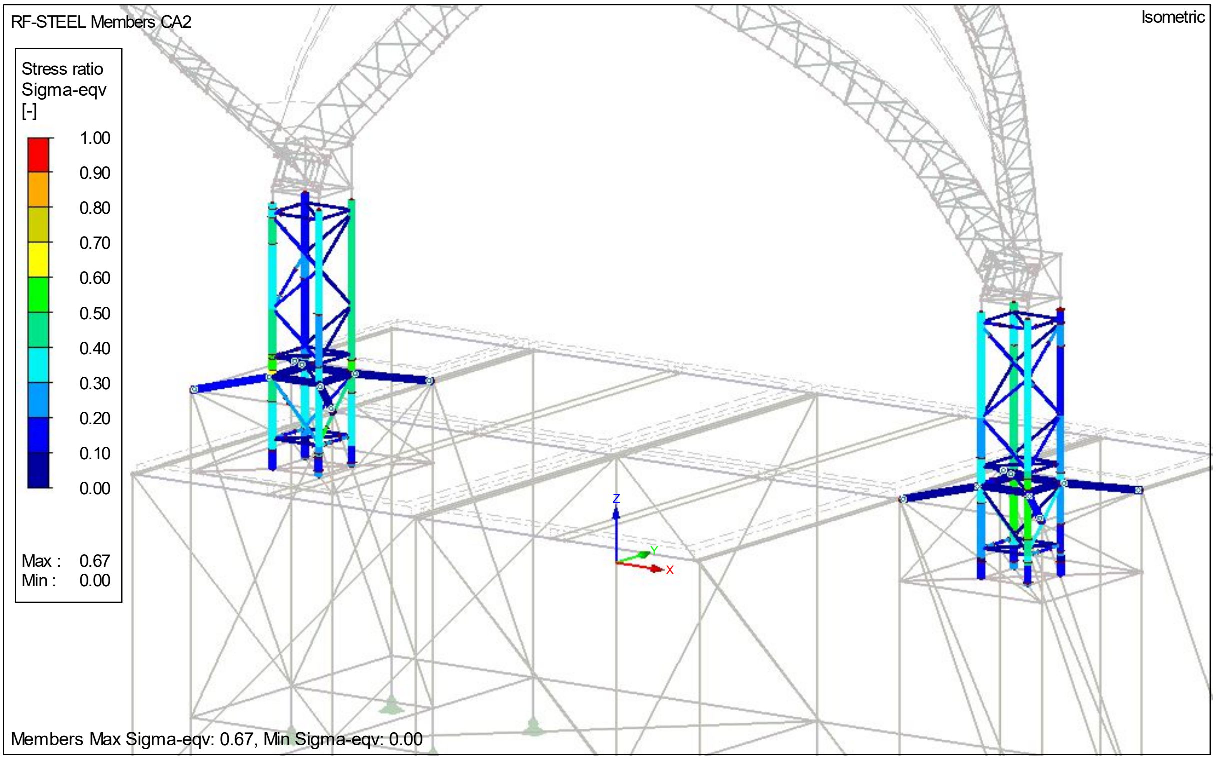
$20.57 / 29.76 = 0.69 < 1$

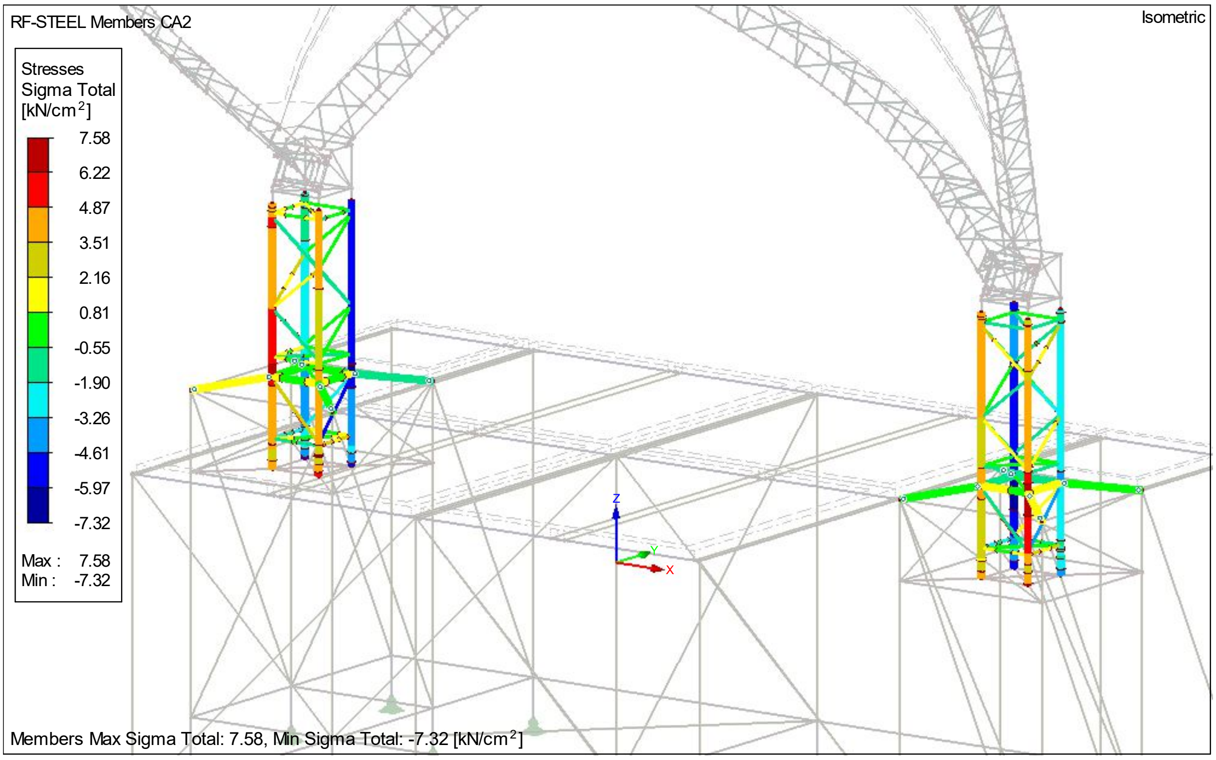
3.4 Check of the S41 truss.

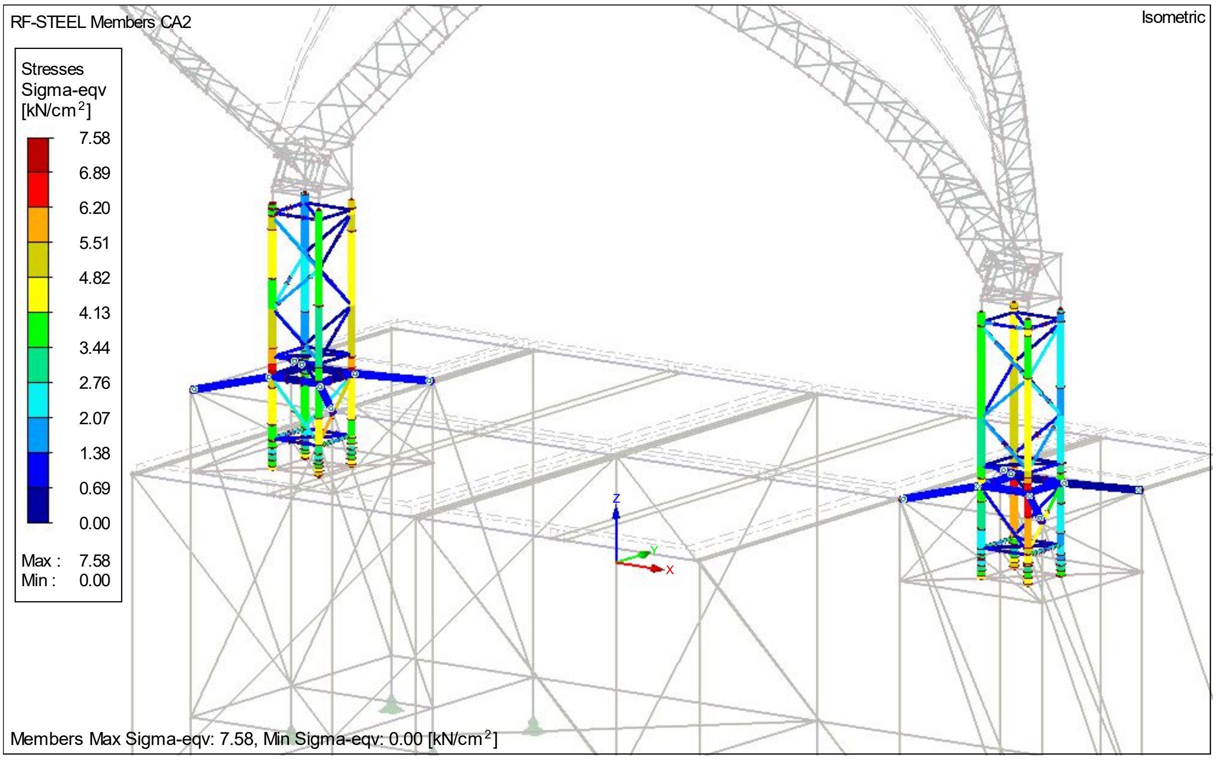
The check of the S41 truss has been done with the stress analyse calculation CA2 for the In service situation.

Stress analyse CA2 –design values In-service






RF-STEEL Members CA2
Isometric
Stresses
Sigma Total
[kN/cm²]
7.58
6.22
4.87
3.51
2.16
0.81
-0.55
-1.90
-3.26
-4.61
-5.97
-7.32
Max : 7.58
Min : -7.32
Members Max Sigma Total: 7.58, Min Sigma Total: -7.32 [kN/cm²]


RF-STEEL Members CA2
Isometric
Stresses
Sigma-eqv
[kN/cm²]
7.58
6.89
6.20
5.51
4.82
4.13
3.44
2.76
2.07
1.38
0.69
0.00
Max : 7.58
Min : 0.00
Members Max Sigma-eqv: 7.58, Min Sigma-eqv: 0.00 [kN/cm²]

Maximum yield strength for different materials

Material = EN-AW-6082 T6
$f_{o,haz}$ = 12.5 kN/cm²

The Yield strength for the material EN-AW-6082 T6, has been manually changed into $f_{o,haz}$,This is according to the Eurocode NEN-EN 1999-1-1 Table 3.2 the $f_{o,haz}$ for the heat affective zone. This check is concerning a welded construction with heat affective zones in the main elements, there for the choice to check the construction according to the lower $f_{o\ haz}$.

Maximum utilisation is 67%

Maximum stress = 7.58 kN/cm² < 12.5 kN/cm²

The S41 truss is stabilized by short aluminium 48x3 tubes which has a length of 0.5 meter and a maximum force of 5.64 kN

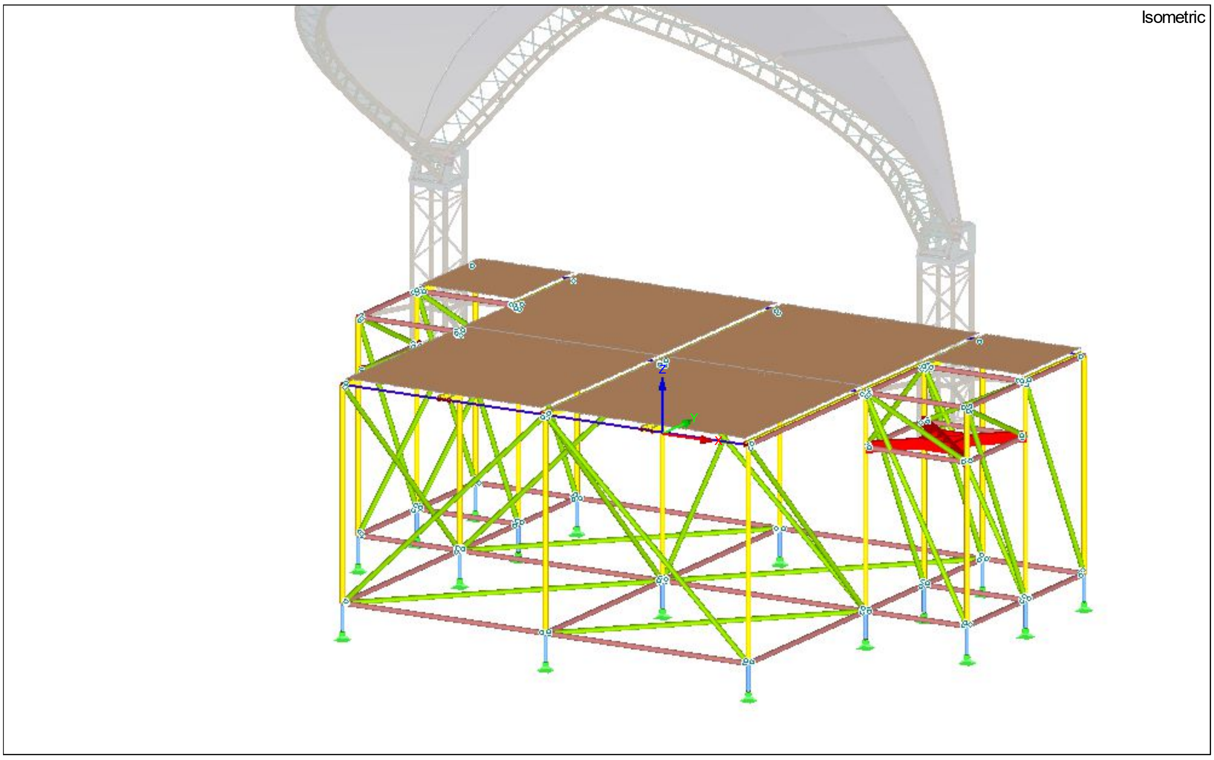
Utilisation on buckling = 9%

4.0 Calculation of the Layher System.

The staging system is built from the Layher scaffolding system. The type of Layher which is used in General is the k2000+ system. All the design figures which are taken into account in this calculation are taken from the k2000+ system.

4.1 RFem Layher stage Model

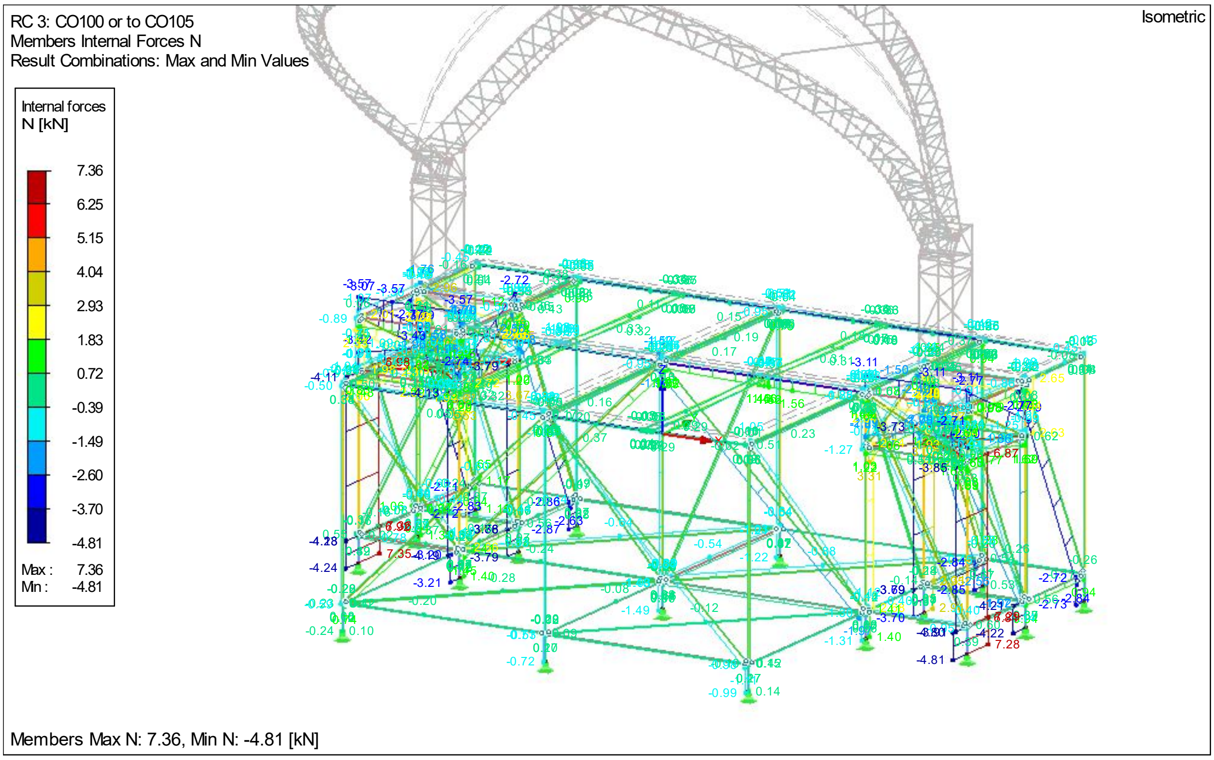
The Layher system is part of the main model and therefor all the reaction forces of the roof system are already in the model

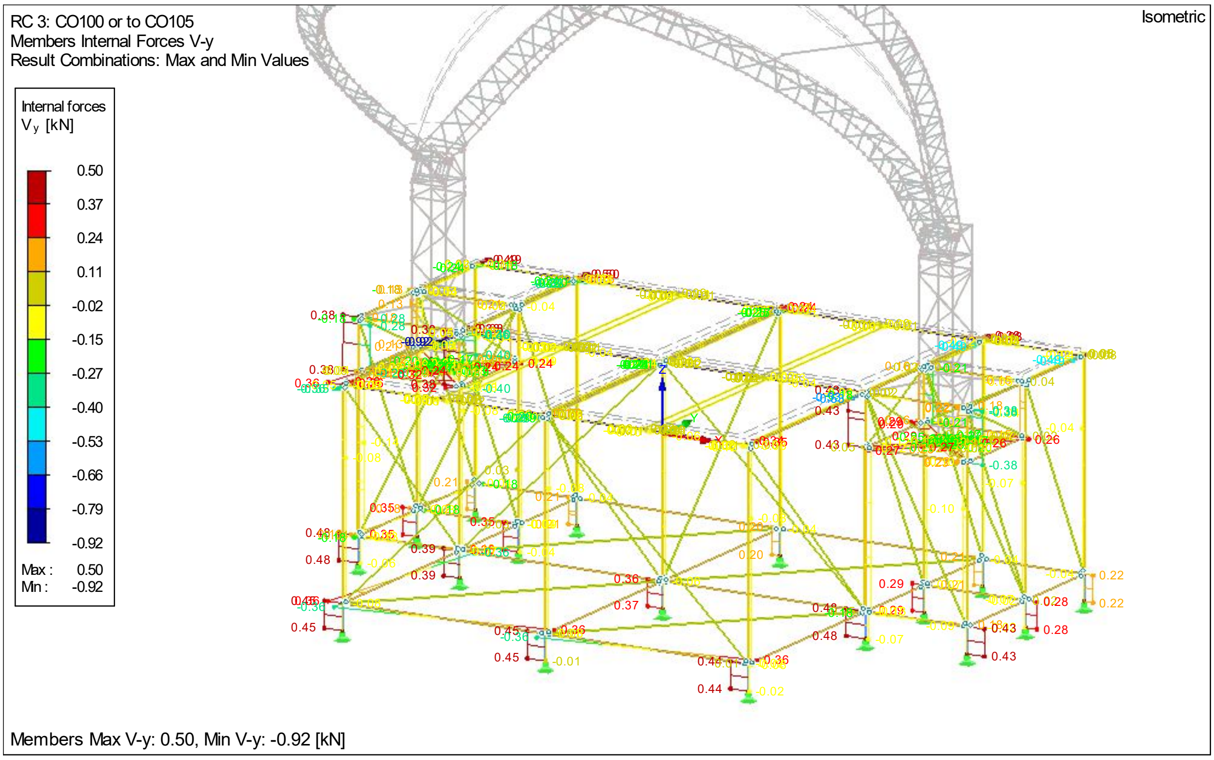


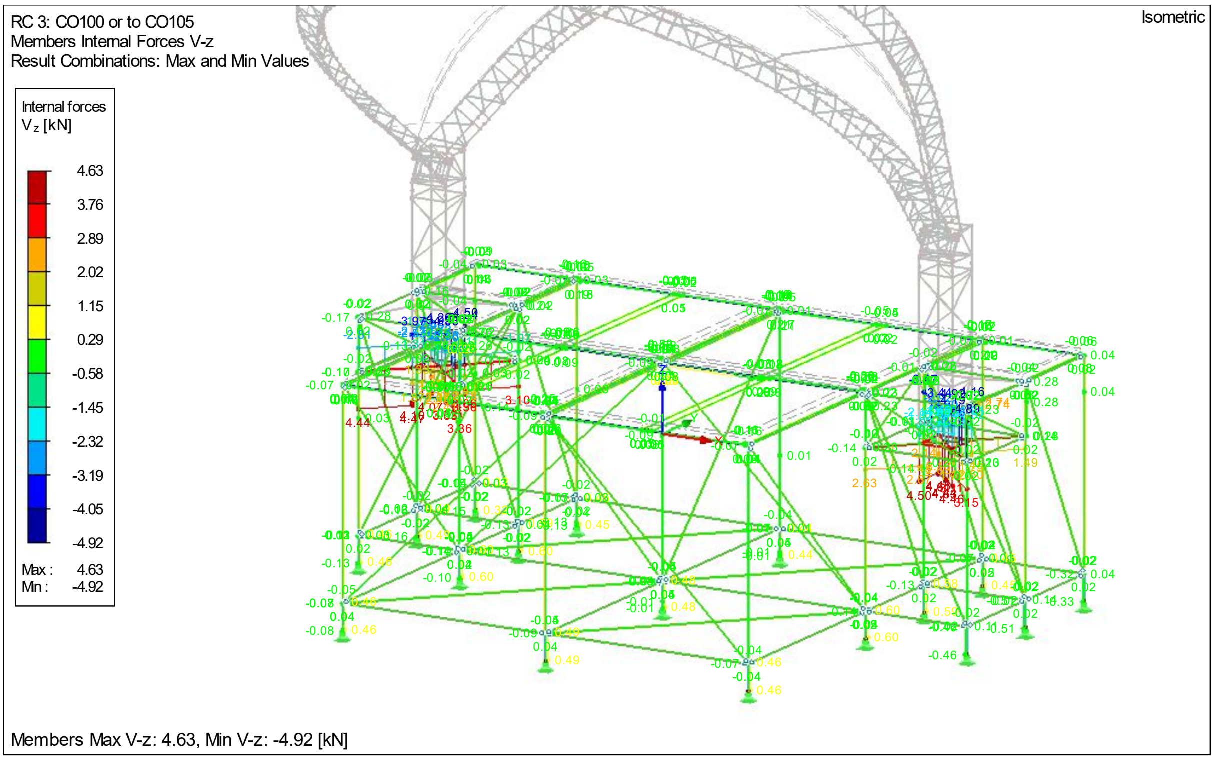
Cross-Sections
- 1: Ring 38/4.5; S320GD 1.0250
- 2: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 3: RO 48.3x3.2 (Hot Formed); Steel S 235 JR
- 4: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 5: RRO 100x50x3.2 (Hot Formed); Steel S 235 JR
- 16: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 17: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6

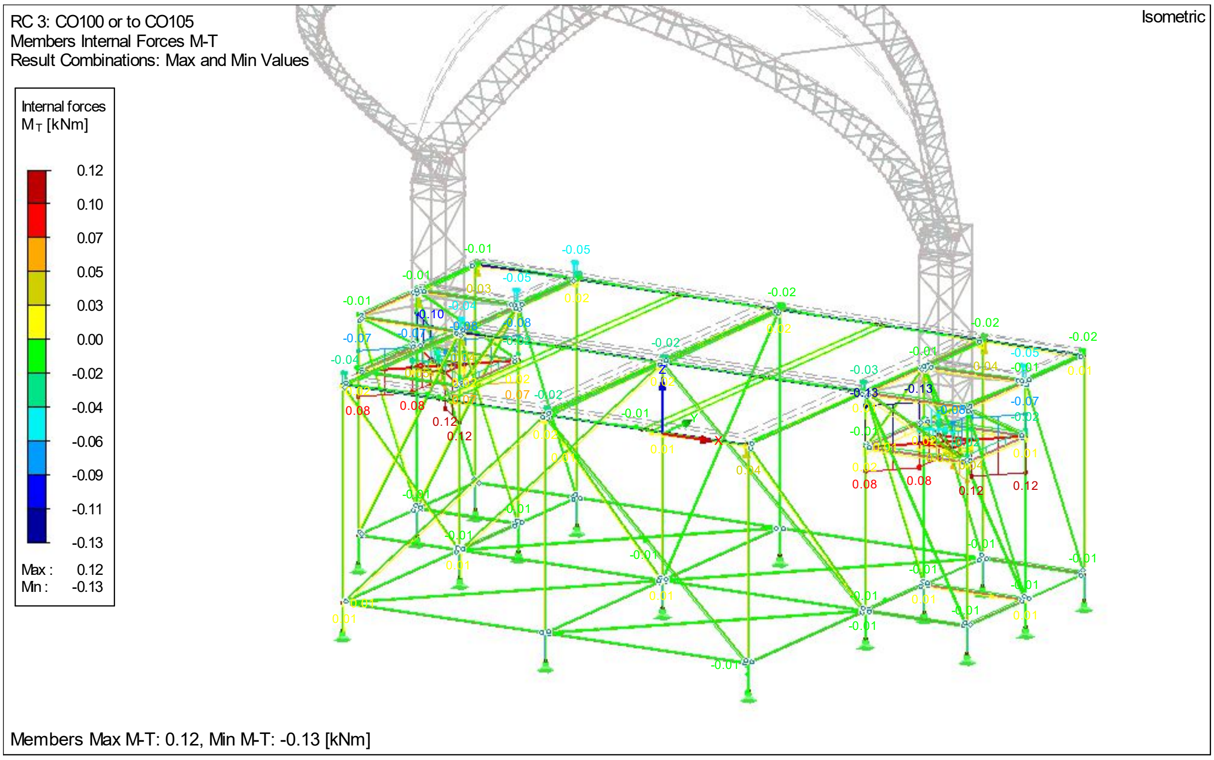
4.2 Internal force diagram result combinations.

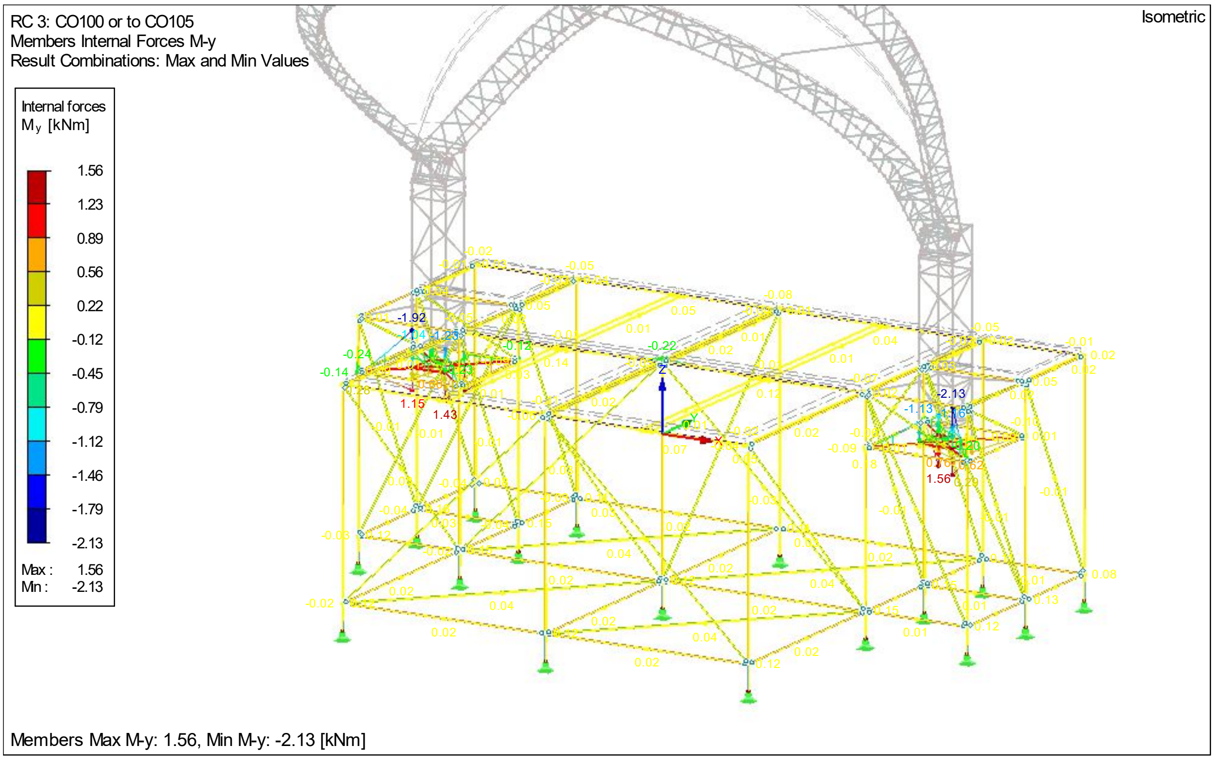
4.2.1 Internal force diagram result combination RC3 Design calculation In-service situation.

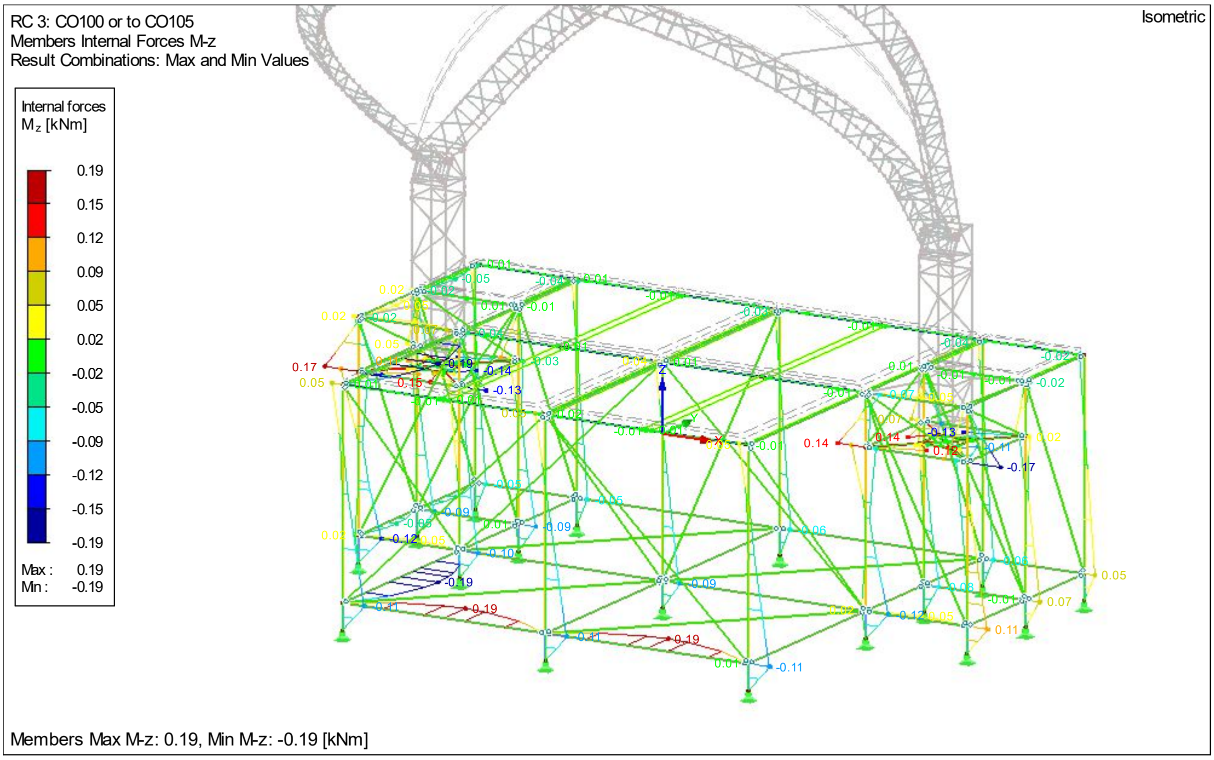




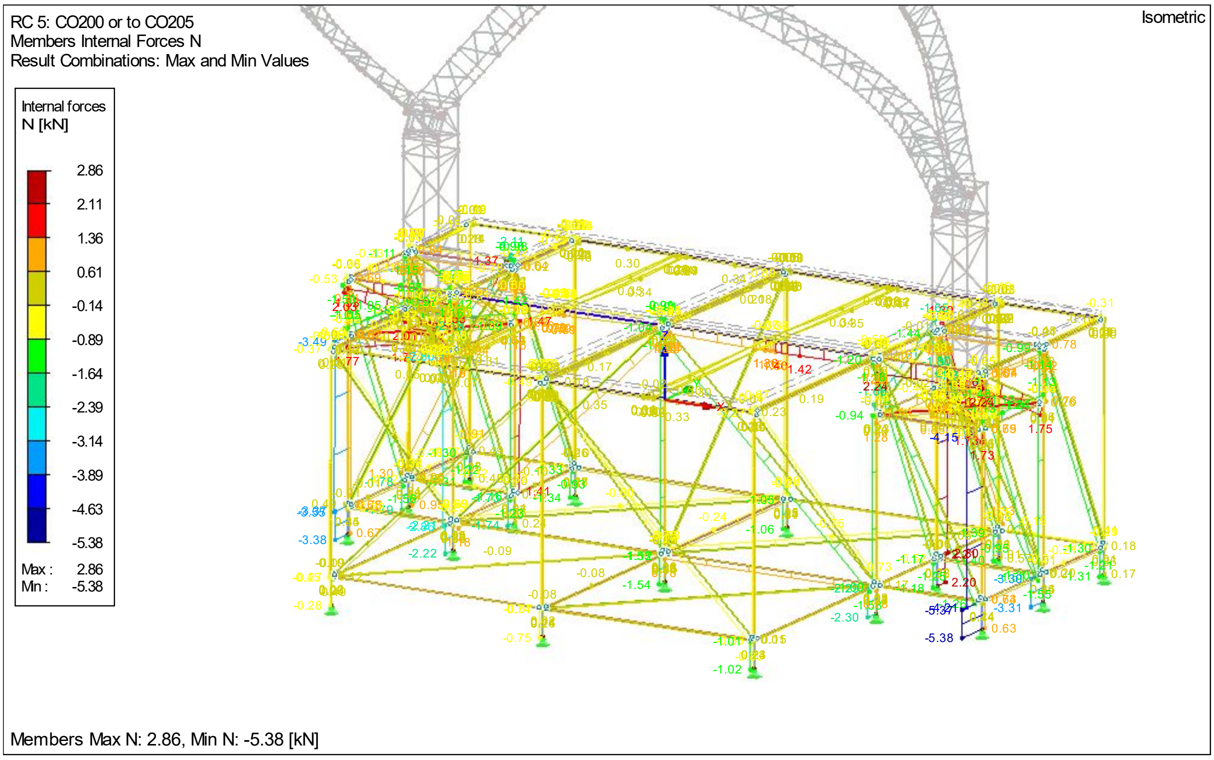

RC 3: CO100 or to CO105
Members Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
V_z [kN]
4.63
3.76
2.89
2.02
1.15
0.29
-0.58
-1.45
-2.32
-3.19
-4.05
-4.92
Max : 4.63
Min : -4.92
Members Max V-z: 4.63, Min V-z: -4.92 [kN]

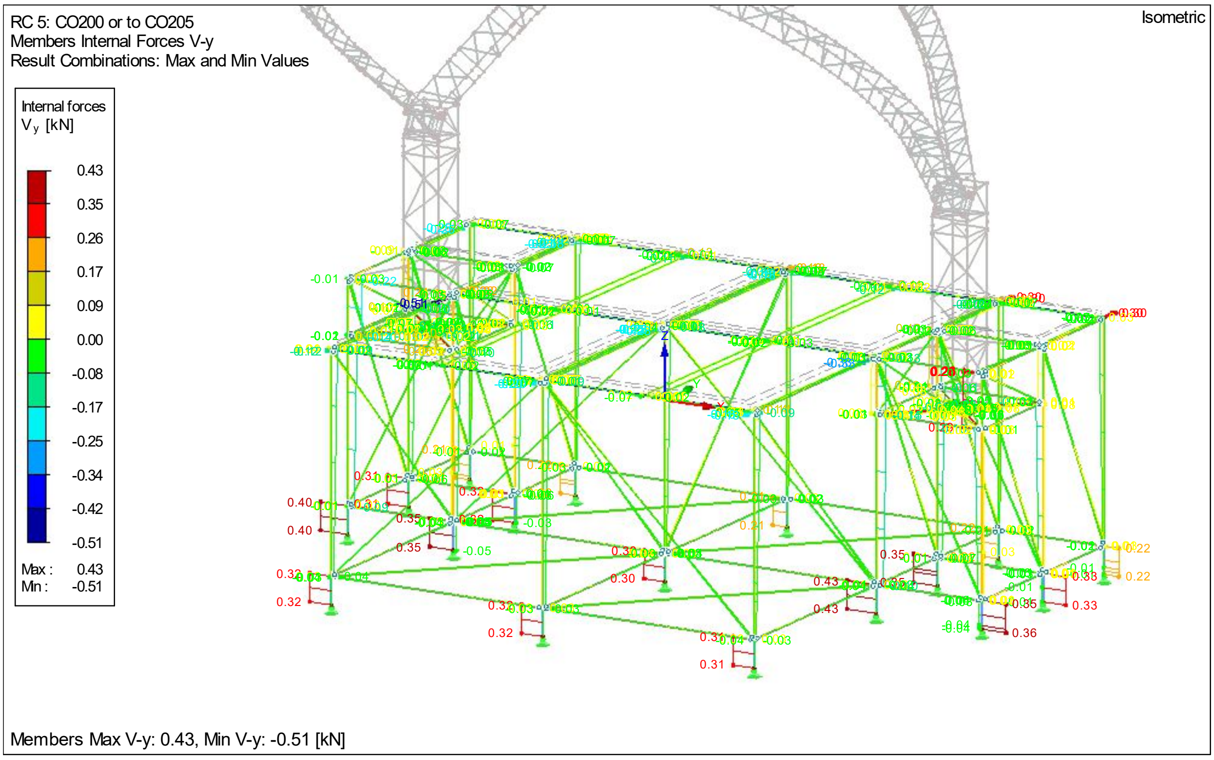

RC 3: CO100 or to CO105
Members Internal Forces M-T
Result Combinations: Max and Min Values
Isometric
Internal forces
M_T [kNm]
0.12
0.10
0.07
0.05
0.03
0.00
-0.02
-0.04
-0.06
-0.09
-0.11
-0.13
Max : 0.12
Min : -0.13
Members Max M-T: 0.12, Min M-T: -0.13 [kNm]

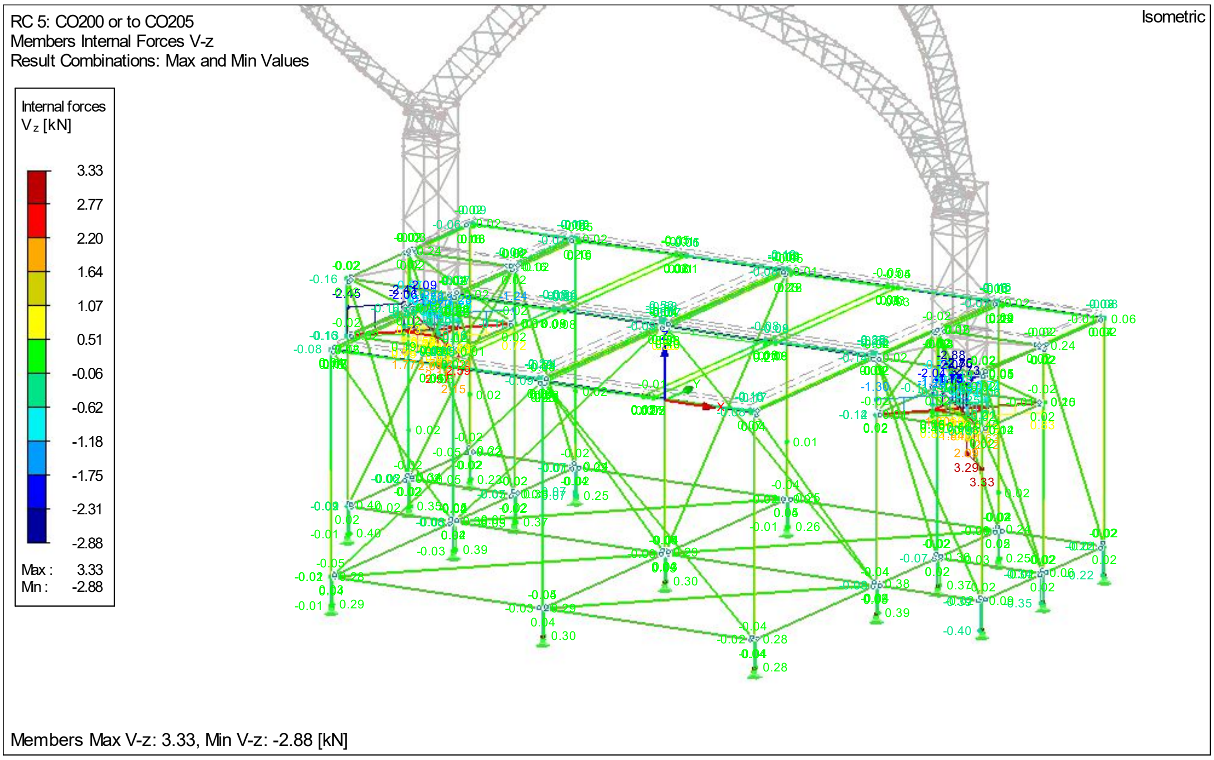

RC 3: CO100 or to CO105
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
M y [kNm]
1.56
1.23
0.89
0.56
0.22
-0.12
-0.45
-0.79
-1.12
-1.46
-1.79
-2.13
Max : 1.56
Min : -2.13
Members Max M-y: 1.56, Min M-y: -2.13 [kNm]

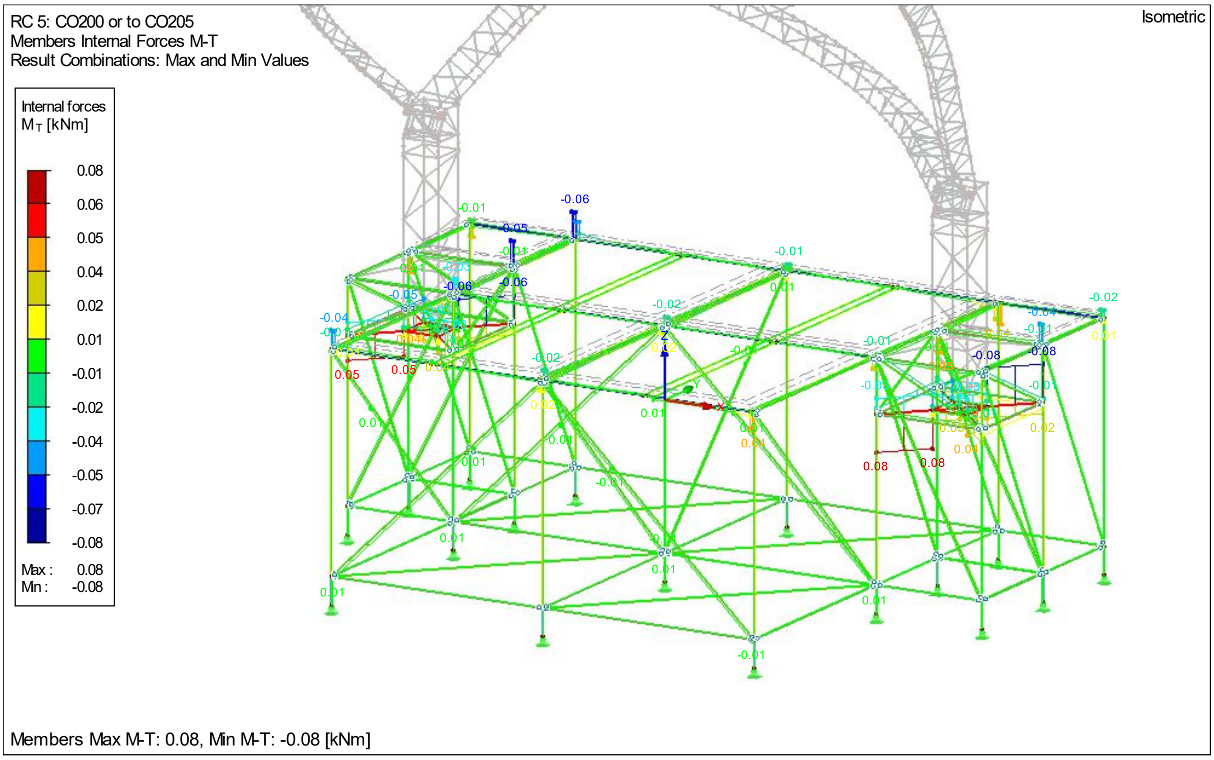

RC 3: CO100 or to CO105
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
M z [kNm]
0.19
0.15
0.12
0.09
0.05
0.02
-0.02
-0.05
-0.09
-0.12
-0.15
-0.19
Max : 0.19
Min : -0.19
Members Max M-z: 0.19, Min M-z: -0.19 [kNm]

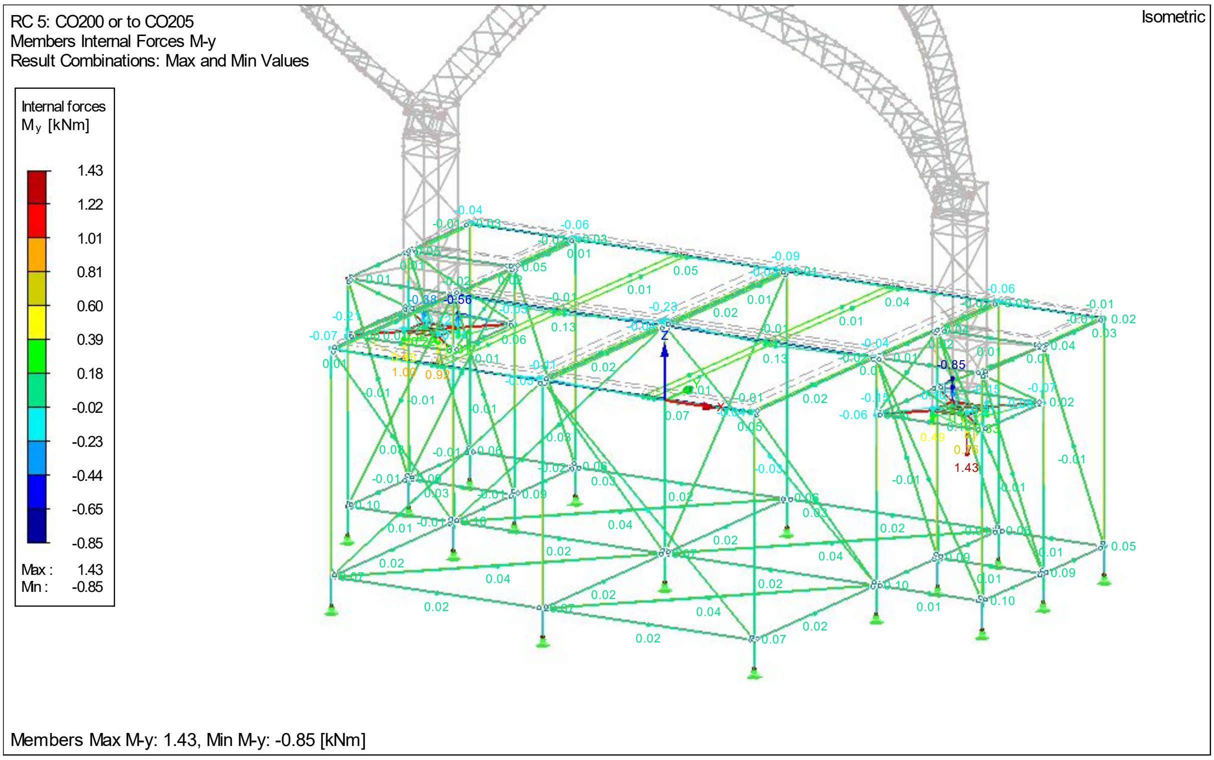
4.2.2 Internal force diagram result combination RC5 Design calculation Out-service situation.

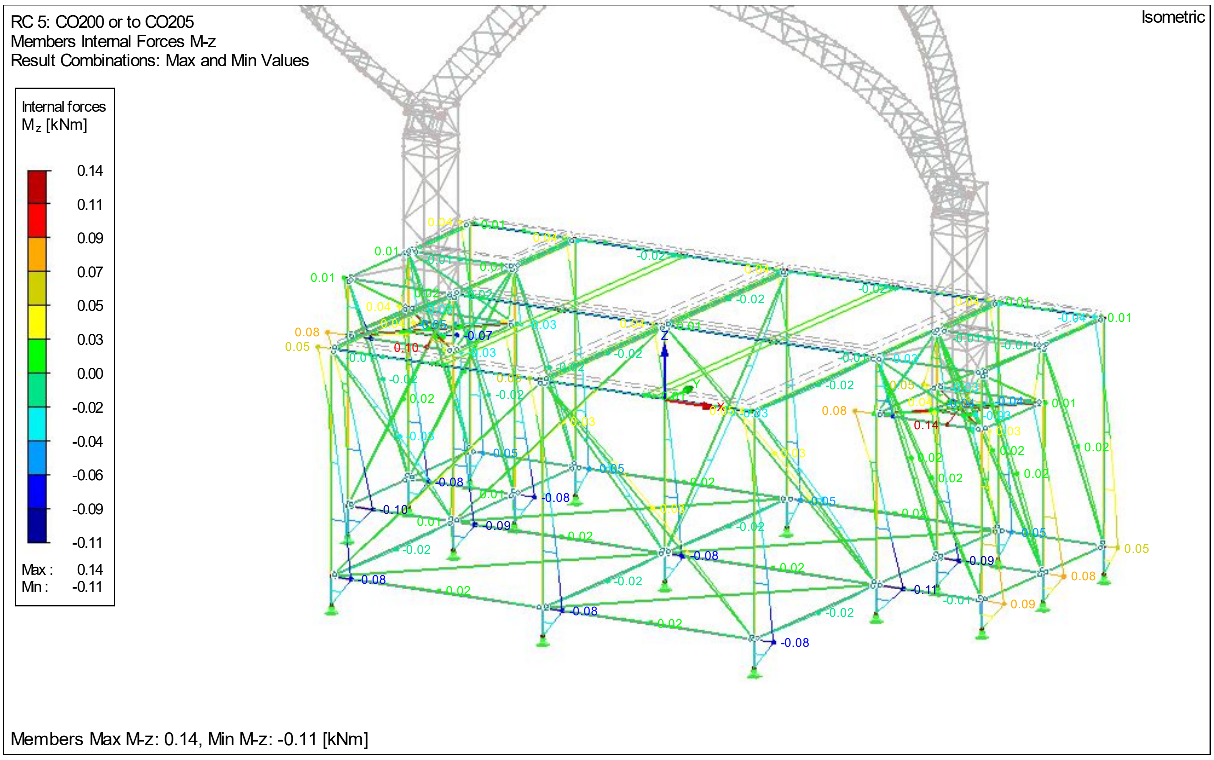





RC 5: CO200 or to CO205
Members Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
V z [kN]
3.33
2.77
2.20
1.64
1.07
0.51
-0.06
-0.62
-1.18
-1.75
-2.31
-2.88
Max : 3.33
Min : -2.88
Members Max V-z: 3.33, Min V-z: -2.88 [kN]


RC 5: CO200 or to CO205
Members Internal Forces M-T
Result Combinations: Max and Min Values
Isometric
Internal forces
M T [kNm]
0.08
0.06
0.05
0.04
0.02
0.01
-0.01
-0.02
-0.04
-0.05
-0.07
-0.08
Max : 0.08
Min : -0.08
Members Max M-T: 0.08, Min M-T: -0.08 [kNm]

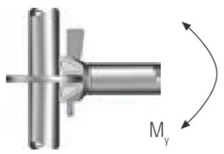

RC 5: CO200 or to CO205
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
M_y [kNm]
1.43
1.22
1.01
0.81
0.60
0.39
0.18
-0.02
-0.23
-0.44
-0.65
-0.85
Max : 1.43
Min : -0.85
Members Max M-y: 1.43, Min M-y: -0.85 [kNm]


RC 5: CO200 or to CO205
Members Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
M_z [kNm]
0.14
0.11
0.09
0.07
0.05
0.03
0.00
-0.02
-0.04
-0.06
-0.09
-0.11
Max : 0.14
Min : -0.11
Members Max M-z: 0.14, Min M-z: -0.11 [kNm]

4.3 Layher information of different connections resistance design values

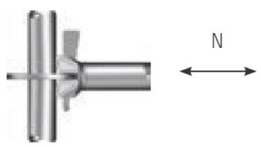
Z-8.22-64: K 2000+

Biegemoment



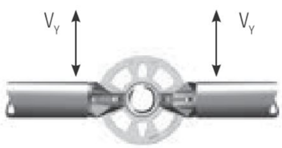
Biegemoment
$M_{y,Rd} = \pm 101{,}0$ kNcm

Normalkraft

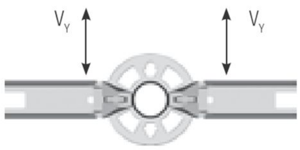


$N_{Rd} = \pm 31{,}0$ kN

Horizontale Querkraft

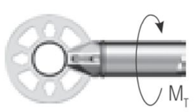


O-Riegel: $V_{y,Rd} = \pm 10{,}0$ kN



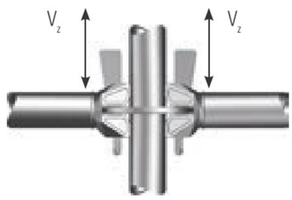
U-Riegel: $V_{y,Rd} = \pm 5{,}9$ kN

Torsionsmoment



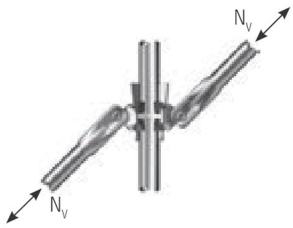
$M_{T,Rd} = \pm 52{,}5$ kNcm

Vertikale Querkraft



Vertikale Querkraft, Einzelanschluss
$V_{z,Rd} = \pm 26{,}4$ kN
Vertikale Querkraft je Lochscheibe
$\sum V_{z,Rd} = \pm 105{,}6$ kN

Normalkraft, Diagonale



Beanspruchbarkeiten der Vertikaldiagonalen für Feldhöhe 2,00 m für **K 2000+**:

	Druck								Zug
Feldlänge [m]	0,73	1,09	1,40	1,57	2,07	2,57	3,07	4,14	alle Feldlängen
N_{VRd} [kN]	-16,1	-16,8	-15,5	-14,8	-12,4	-10,2	-8,3	-5,3	+17,9

K 2000+ Bauteile können mit Bauteilen der Variante LW, Variante II und Variante I vermischt werden. Beanspruchbarkeiten siehe Zulassung Z-8.22-64 und Z-8.22-949.

Rd = Beanspruchbarkeit,
(enthält Teilsicherheitsbeiwert γ_M)

*„Zulässige Lasten" bzw. „Gebrauchslasten" erhält man durch Division der Beanspruchbarkeit durch 1,5 (= γ_F)

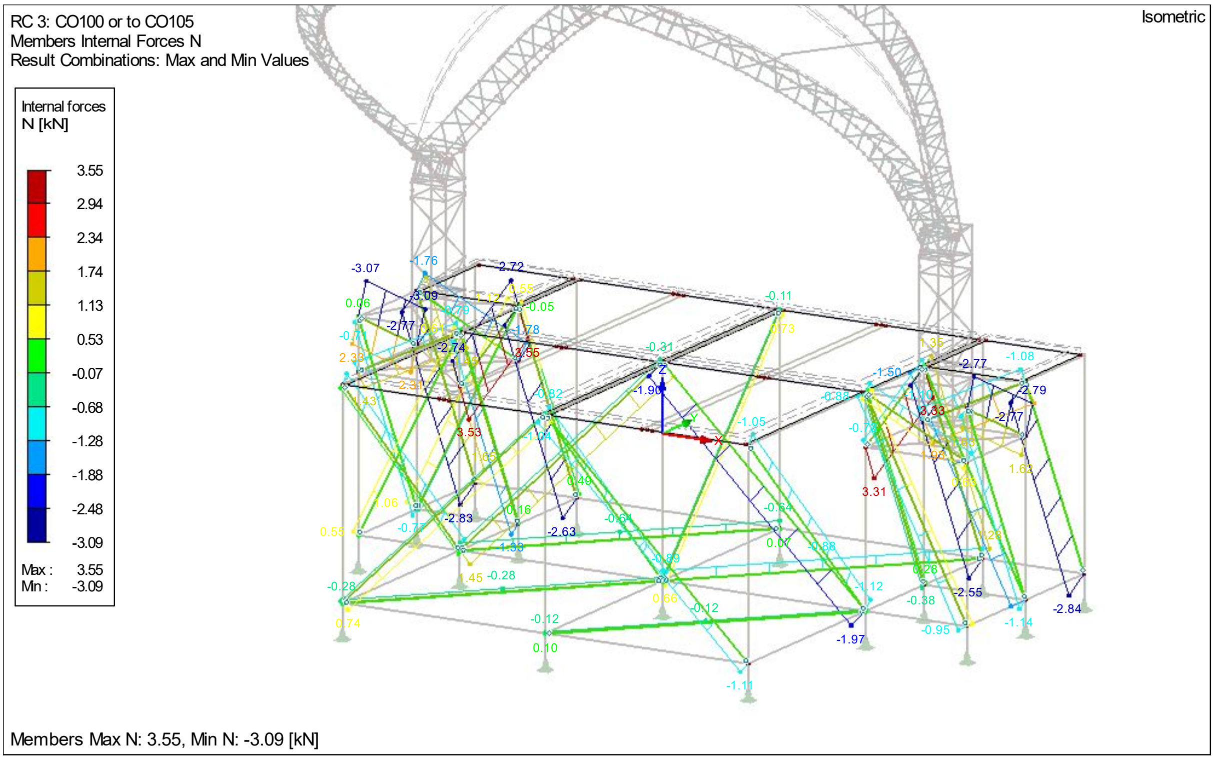
15

•

4.4 Detail check diagonals

Decisive result combination = RC3 design values In-service situation. This due to the fact that in the In service situation the floor loading has been taken into account. This floor loading is not allowed in the Out service situation.

4.4.1 result combination RC3 Design calculation In-service situation.



Check of the vertical diagonal

Maximum Normal force in a diagonal $N_{y,ed}$ 3.55 kN

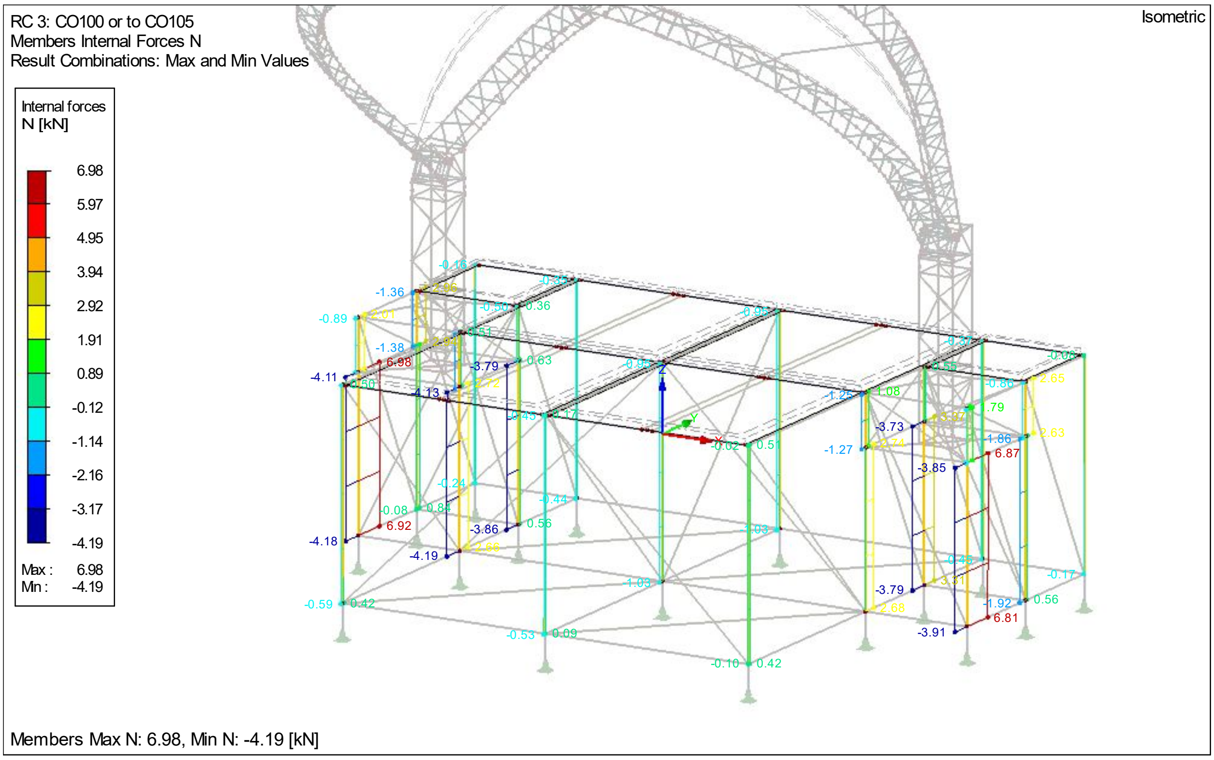
Maximum resistance design of a diagonal $N_{y,rd} = 12.4$ kN

$N_{y,ed} / N_{y,rd} < 1$

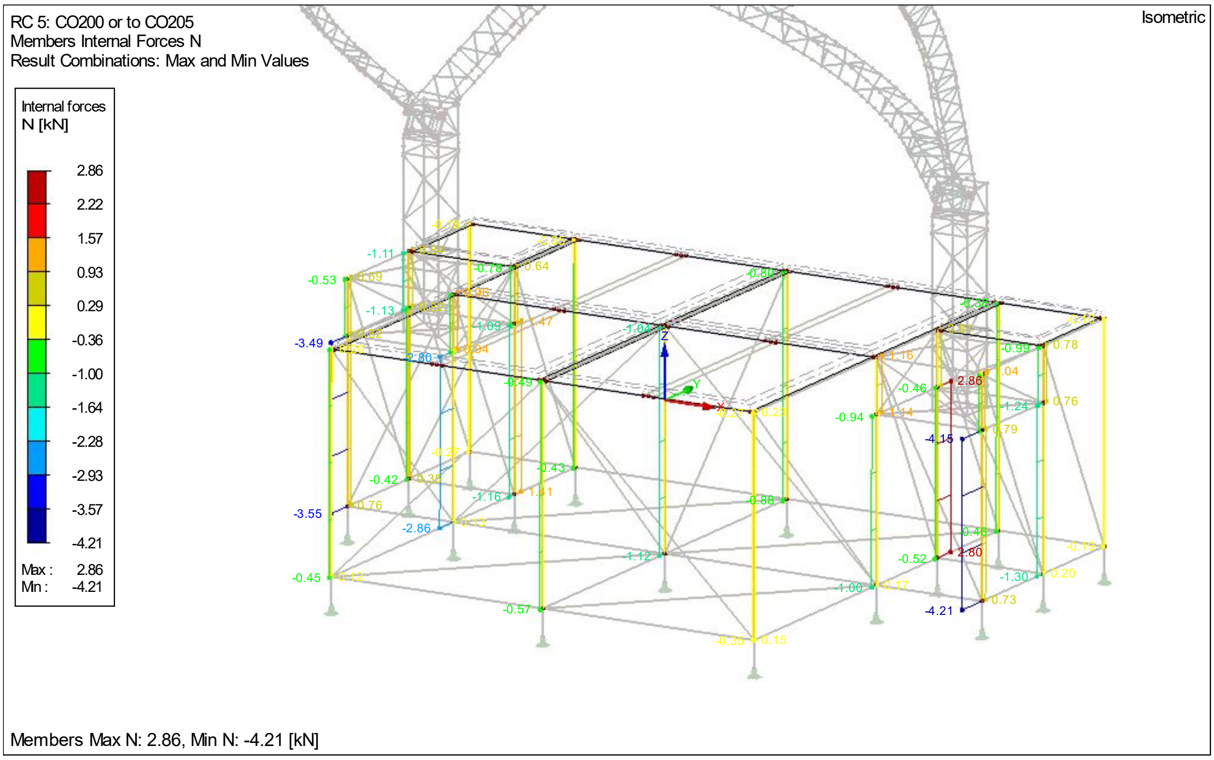
$3.55 / 12.4 = 0.29 < 1$

4.5 Detail check Layher upright underneath the stage.

4.5.1 result combination RC3 Design calculation In-service situation.



4.5.2 result combination RC5 Design calculation Out-service situation.



Buckling calculation Layher pole Maximum Normal force

N_{ed} = 6.98 kN

Buckling Length factor K = 0.9

The factor K is according to table 6,8 NEN-EN 1999-1-1

L = 200 cm

$L_{cr} = 0.9 * 200 = 162$

$I_y = \sqrt{} (I_y / A) = \sqrt{} (11.6 / 4.53) = 1.6$

$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{} ((A_{eff} * f_y) / A * E))$

$\lambda_z = 162 / (1.6 * \pi) * \sqrt{} ((4.27 * 35.5) / (4.27 * 21000)) = 1.32$

$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$

$\Theta_z = 0.5 * (1 + 0.49 * (1.32 - 0.10) + 1.32^2) = 1.65$

$X_z = 1 / (\Theta_z + \sqrt{} (\Theta_z^2 - \lambda_z^2))$

$X_z = 1 / (1.65 + \sqrt{} (1.65^2 - 1.32^2)) = 0.38$

$N_{b, RD} = X_z * A * f_0 / 1.1 = 0.38 * 4.27 * 32 / 1.1 = 47.21$ kN

check

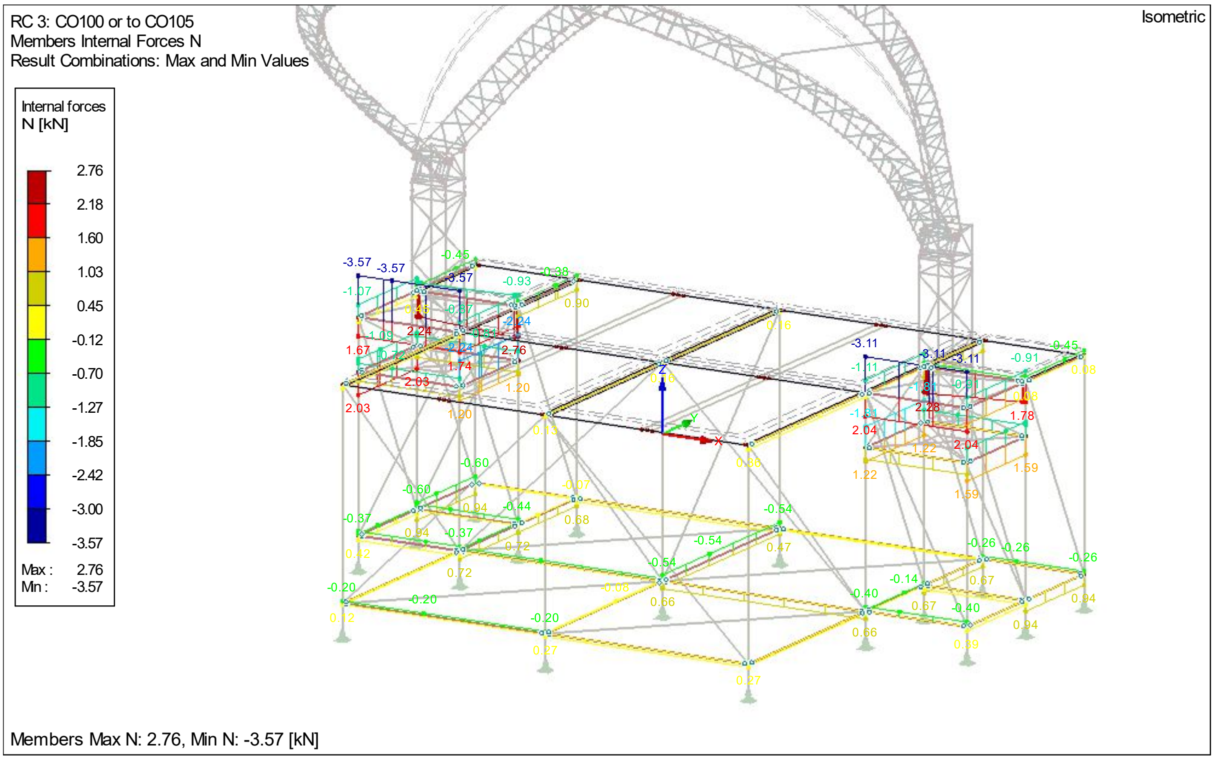
$N_{ed} / N_{b, RD} < 1$

$6.98 / 47.21 = 0.15 < 1$

4.6 Detail check of horizontal ledgers.

Decisive result combination = RC3 design values In-service situation.

4.6.1 result combination RC3 Design calculation In-service situation.



Check of the horizontal ledgers

Maximum Normal force in a horizontal diagonal $N_{y,ed} = 3.57$ kN

Maximum resistance design of a horizontal diagonal $N_{y,rd} = 31.0$ kN

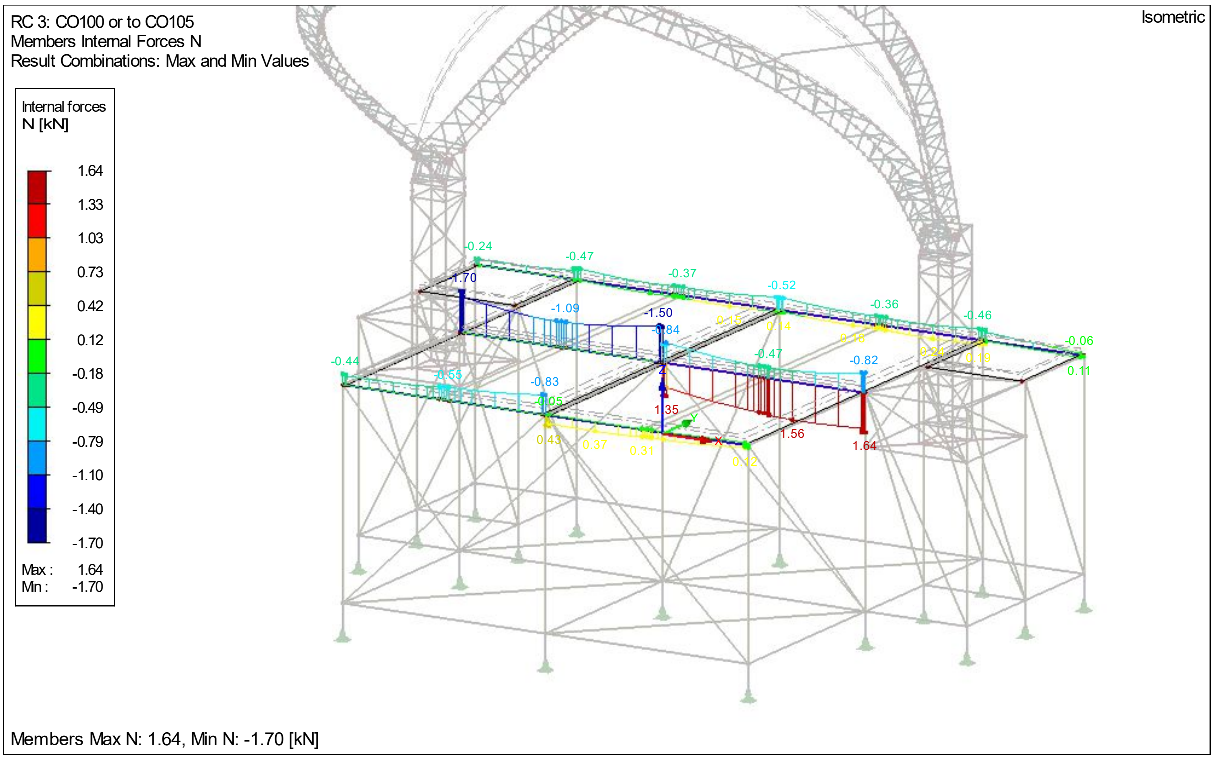
$N_{y,ed} / N_{y,rd} < 1$

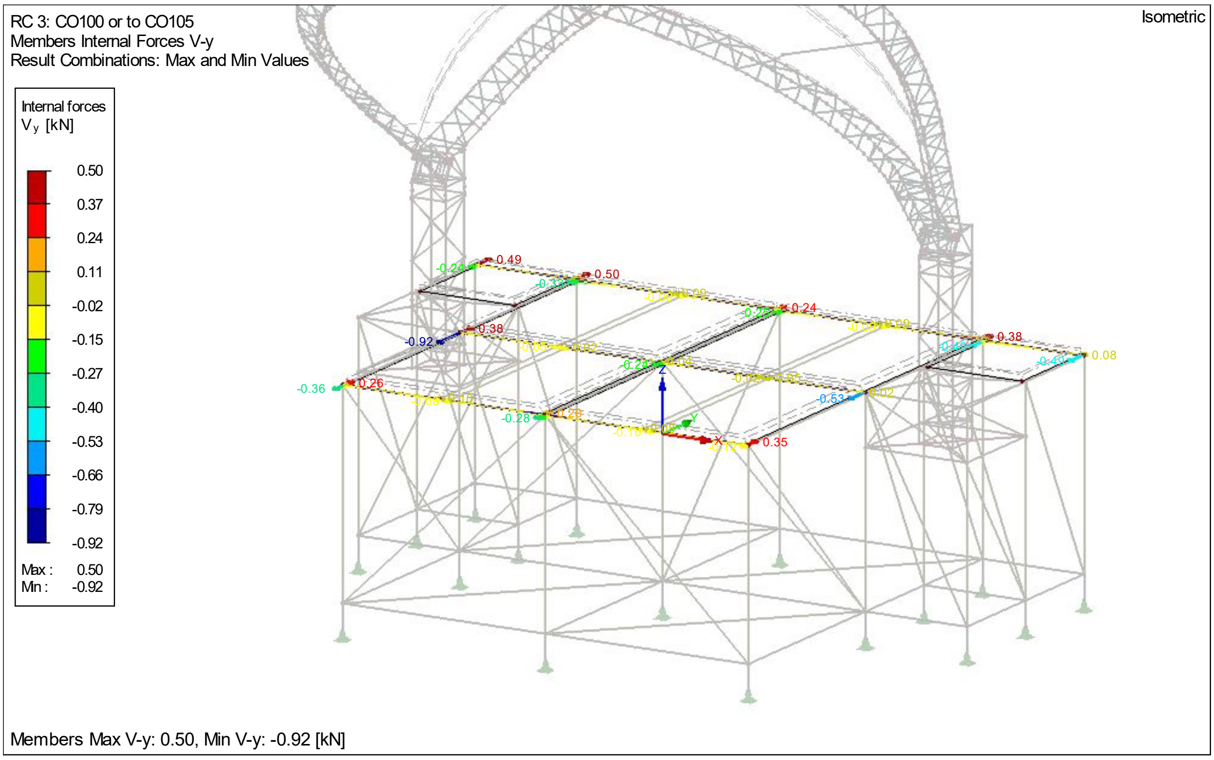
$3.57 / 31.0 = 0.12 < 1$

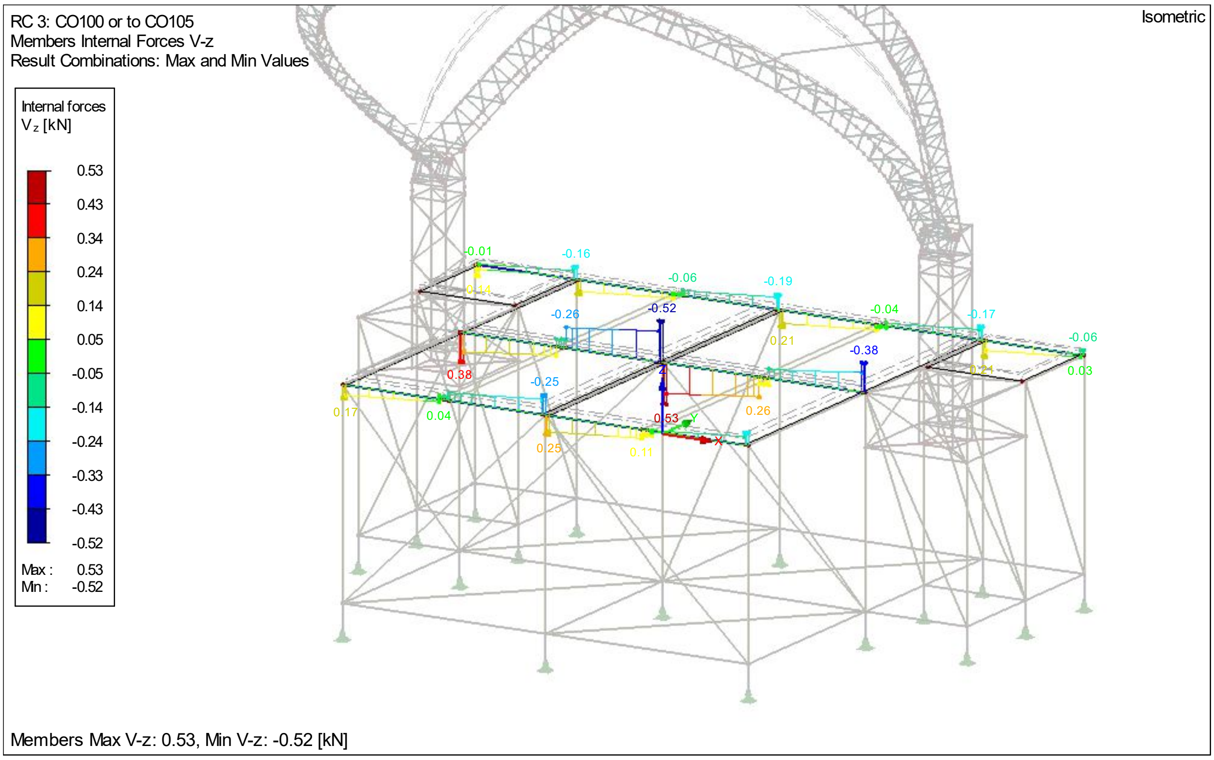
4.7 Detail check of floor beam

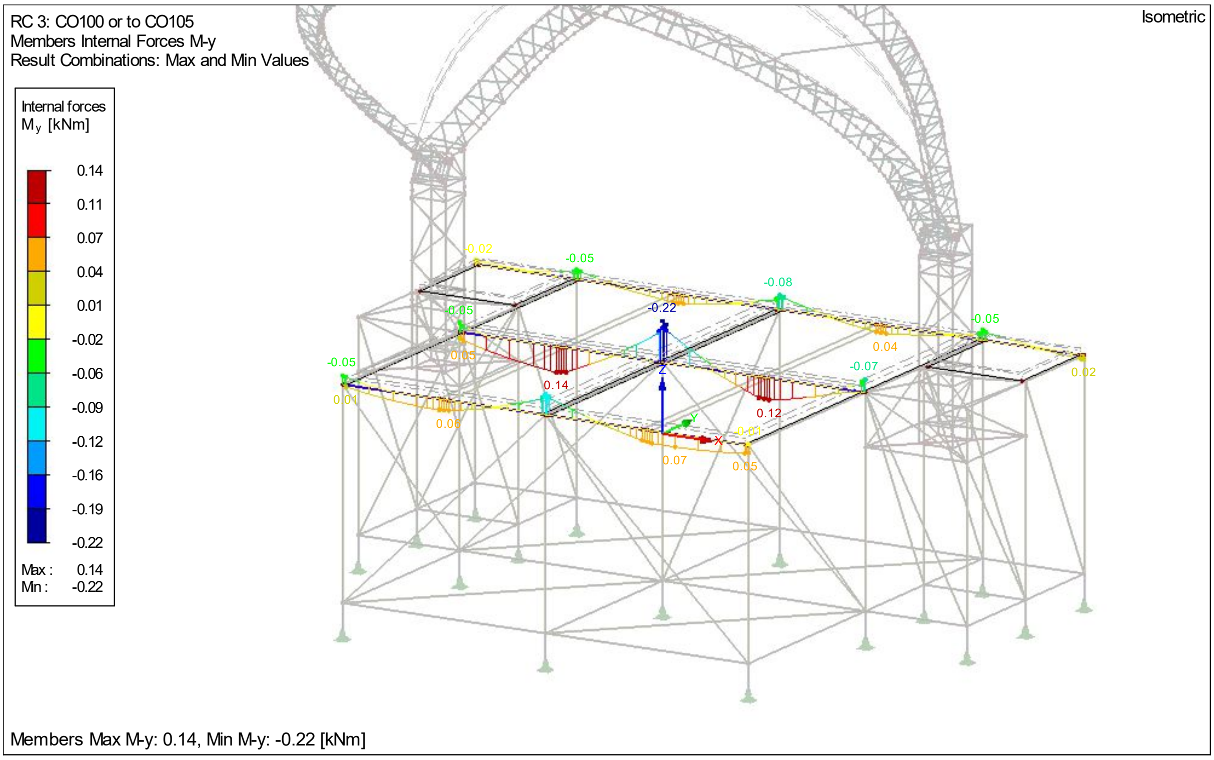
Decisive result combination = RC3 design values In-service situation.

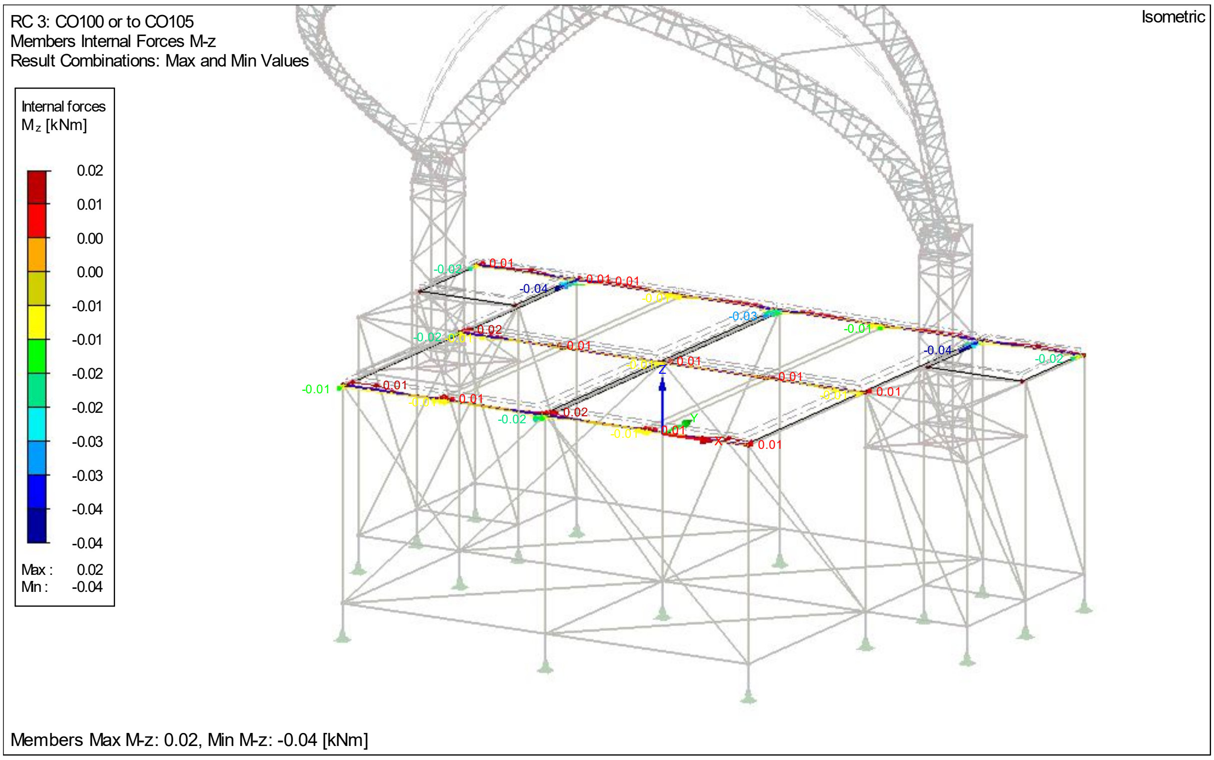
4.7.1 result combination RC3 Design calculation In-service situation.





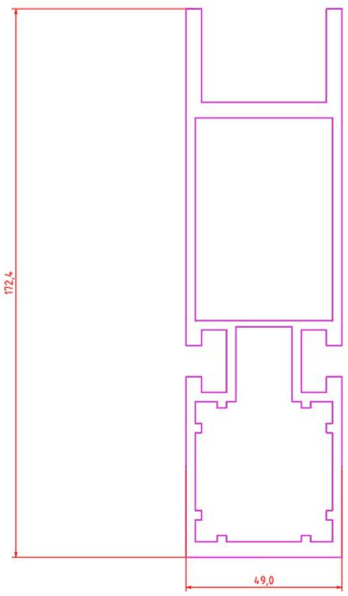

RC 3: CO100 or to CO105
Members Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
V z [kN]
0.53
0.43
0.34
0.24
0.14
0.05
-0.05
-0.14
-0.24
-0.33
-0.43
-0.52
Max : 0.53
Min : -0.52
Members Max V-z: 0.53, Min V-z: -0.52 [kN]


RC 3: CO100 or to CO105
Members Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
0.14
0.11
0.07
0.04
0.01
-0.02
-0.06
-0.09
-0.12
-0.16
-0.19
-0.22
Max : 0.14
Min : -0.22
Members Max M-y: 0.14, Min M-y: -0.22 [kNm]



Profiel berekening.

Layher Event Beam speciaal profiel Aluminium 6005A T6



I_1	[INCH^4]	5542580
I_2	[INCH^4]	701985
S_c	[INCH]	90.03
S_t	[INCH]	82.38
A	[INCH^2]	1878.072

Wy= I_1 / e_y = 554 / 8.25 = 67.15 cm³

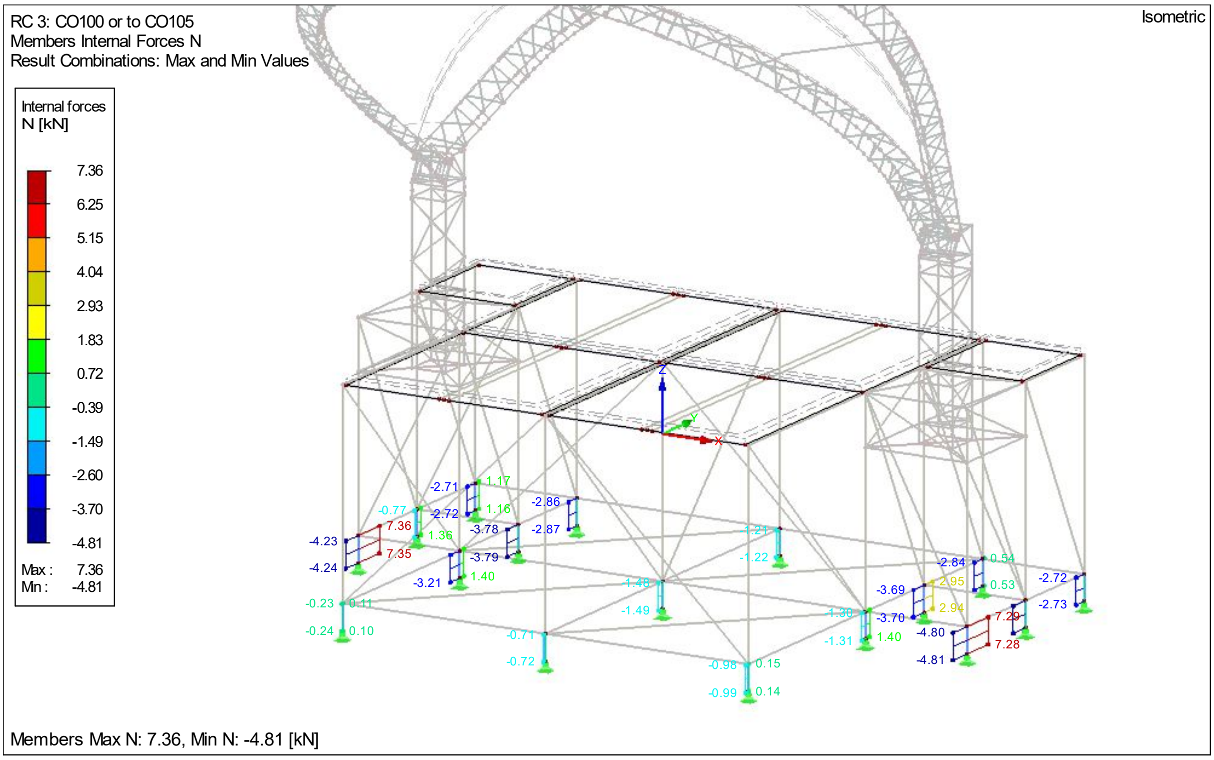
Wz= I_2 / e_z = 70.2 / 2.5 = 28.08 cm³

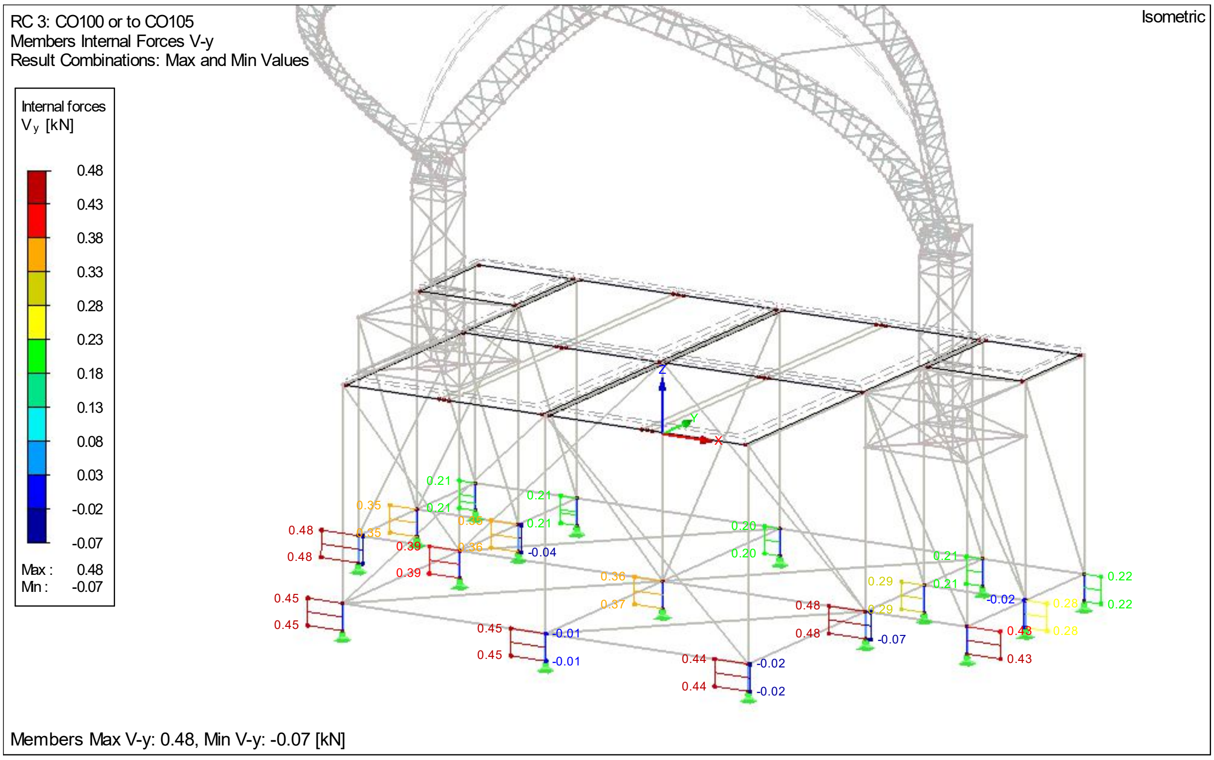
Due to the low internal forces no further proof necessary.

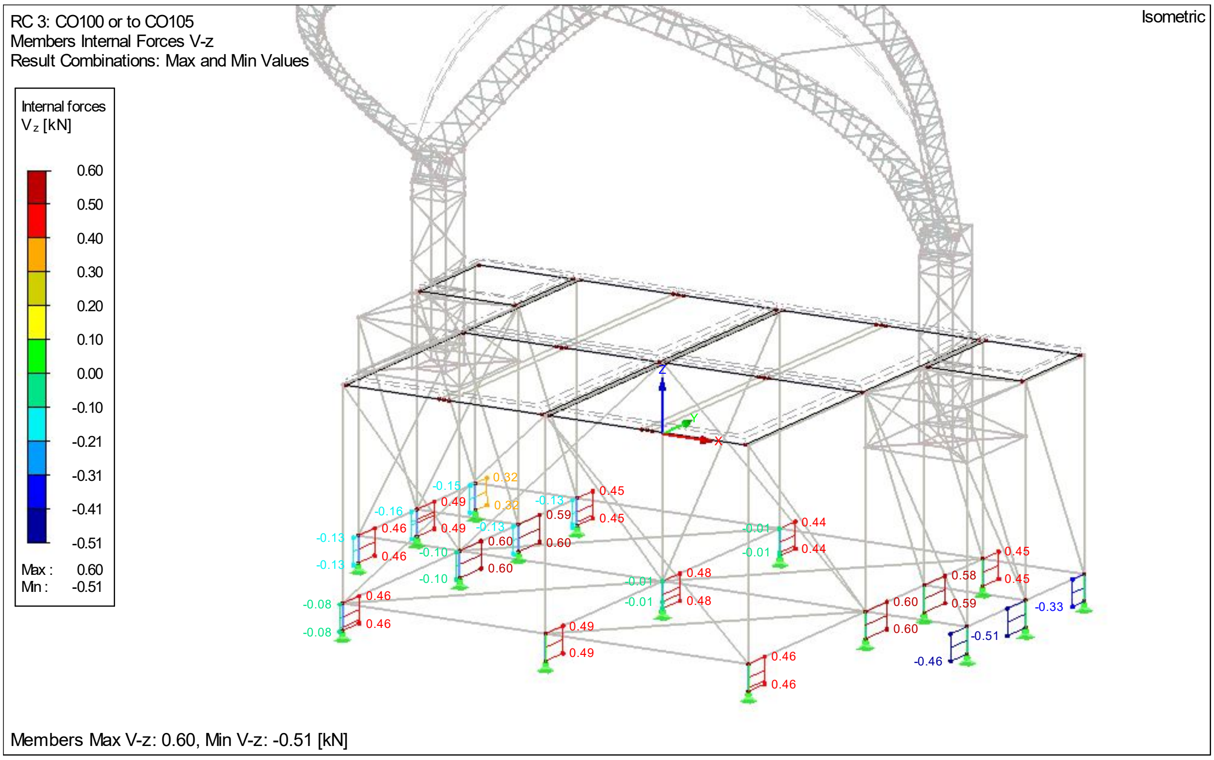
4.8 Detail check of the Layher spindles.

Decisive result combination = RC3 design values In-service situation.

4.8.1 result combination RC3 Design calculation In-service situation.







Check of the Layher screw jack.

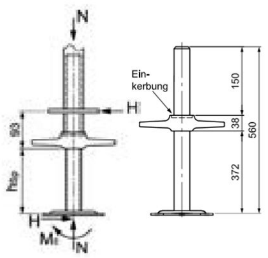
Maximum Normal force in a Layher screw jack $N_{y,ed} = 7.36$ kN

Maximum horizontal force in this Layher screw jack $V_{y,ed} = \sqrt{(0.48^2 + 0.60^2)} = 0.76$ kN

According to the table 12 from the Layher technical information catalogue, a Screw jack with a horizontal load of 0.76 kN and a vertical load of 7.36 kN can have a maximum spindle length of 37cm.

Fußspindeln – Belastungstabellen

FUSSSPINDEL 60



Ersatzquerschnittswerte der Spindel

A = 3,84 cm²
W_{el} = 2,61 cm³
W_{pl} = 3,26 cm³
I = 3,74 cm⁴

Material: EN 10219-S235JRH
→ Rollgewinde: $f_{y,k}$ = 280,0 N/mm²

Tab. 12 Belastung Fußspindeln

Zulässige Vertikallast N [kN]* bei gleichzeitiger Wirkung einer Horizontallast H [kN]

Ausspindellänge h_{Sp} [cm]	H = 0,0		H = 0,5		H = 1,0		H = 1,5		H = 2,0		H = 2,5		H = 3,0		H = 3,5		H = 4,0		H = 4,5		H = 5,0		H = 5,5		H = 6,0		Zul. Horizontallast H [kN] wenn N = 0
	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	
0	39	53	39	51	39	51	39	51	39	50	39	49	39	49	38	–	38	–	37	–	36	–	36	–	35	–	26,3
5	39	52	39	51	39	50	39	48	38	–	37	–	36	–	35	–	34	–	33	–	32	–	31	–	30	–	7,8
10	39	51	39	49	38	–	37	–	36	–	34	–	33	–	30	–	29	–	28	–	26	–	25	–	–	–	4,6
15	39	49	38	–	36	–	35	–	33	–	31	–	29	–	–	–	–	–	–	–	–	–	–	–	–	–	3,2
20	38	–	36	–	34	–	32	–	29	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,5
25	37	–	34	–	31	–	28	–	23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,0
30	35	–	31	–	27	–	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,7
35	32	–	27	–	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,5
37	30	–	25	–	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,4

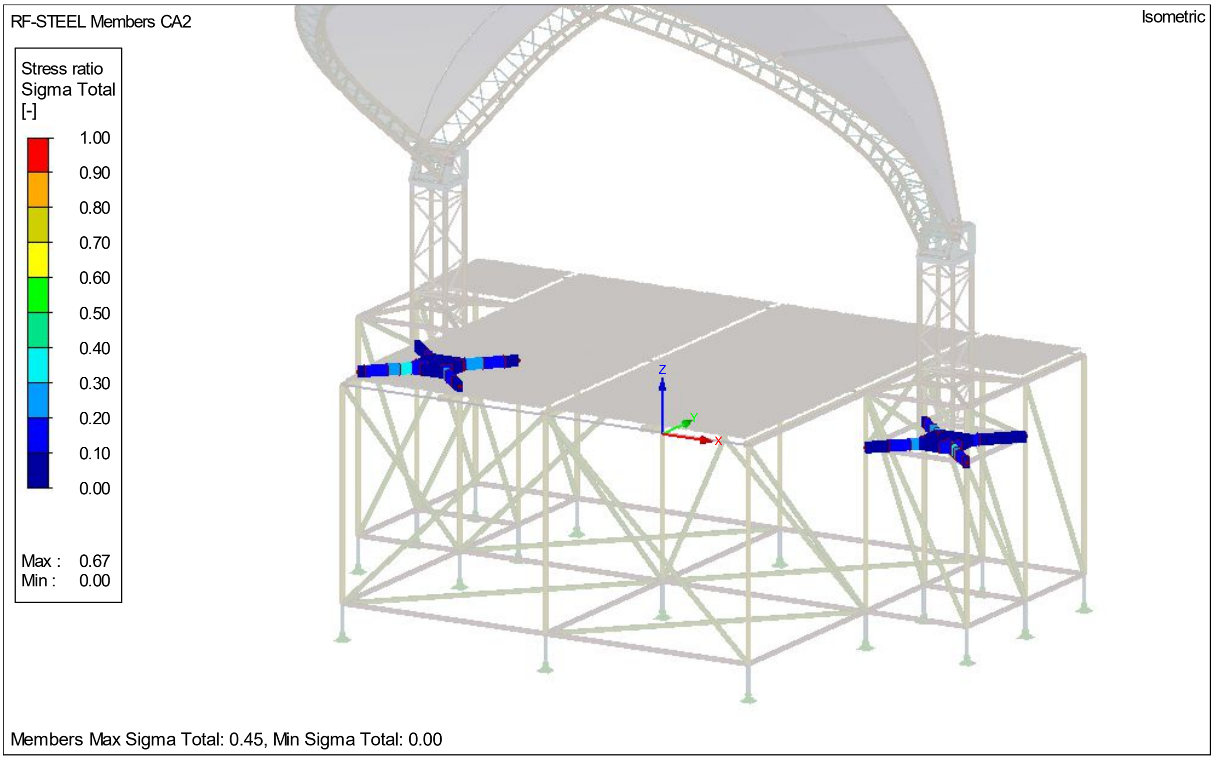
*Die zulässigen Vertikallasten wurden berechnet unter Anwendung des Berechnungsmodells nach DIN EN 12811-1, Abs. 10.2.3.2. Zur Erfassung der Biegesteifigkeit des Ständerrohres, der Schnittgrößenanteile aus Theorie II. Ordnung und der maximalen Beanspruchbarkeit der Ständer wurden folgende Raumgerüste mit Rastermaß 2,57 x 2,57 m berücksichtigt:
2,00 m Lagenhöhe für Stieldruckkräfte $N_1 \leq 39$ kN
1,50 m Lagenhöhe für Stieldruckkräfte 39 kN < $N_2 \leq 54$ kN

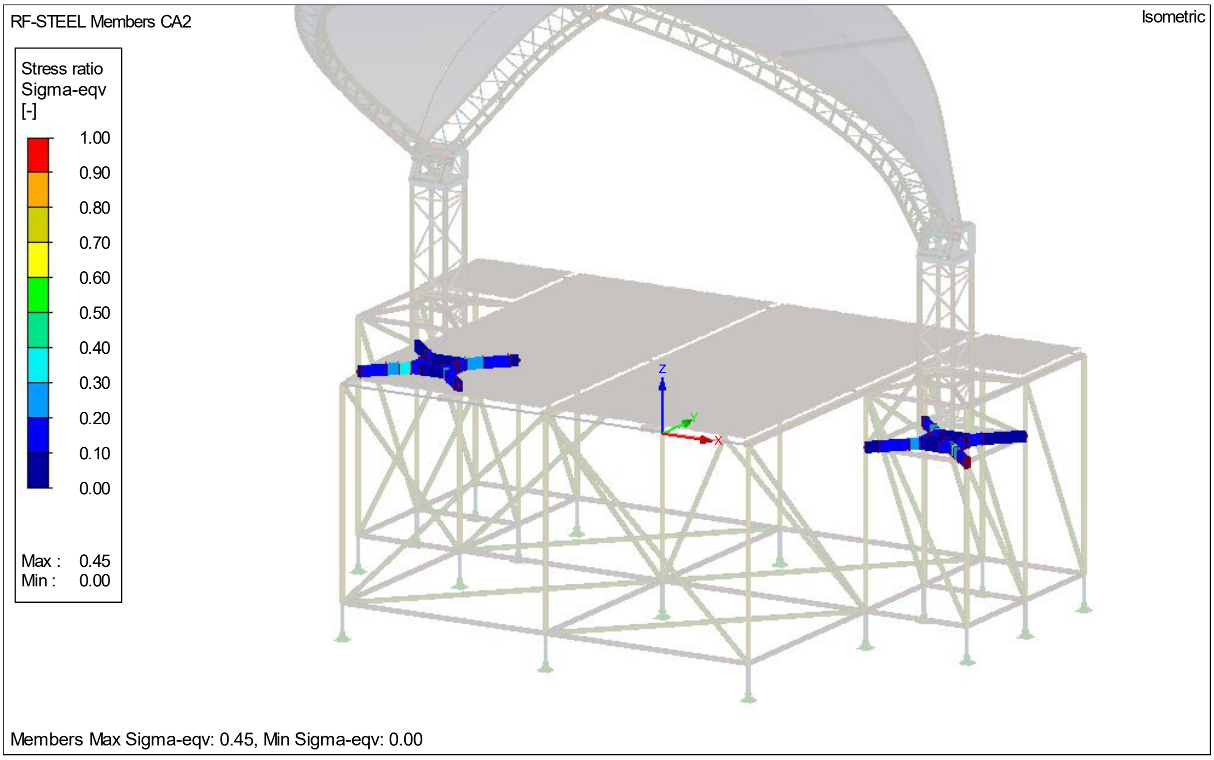
(–) Bei dieser Kombination von Ausspindellänge und Horizontallast ist die Biegebeanspruchbarkeit der Spindel überschritten.

4.9 Detail check of the Layher base adapter.

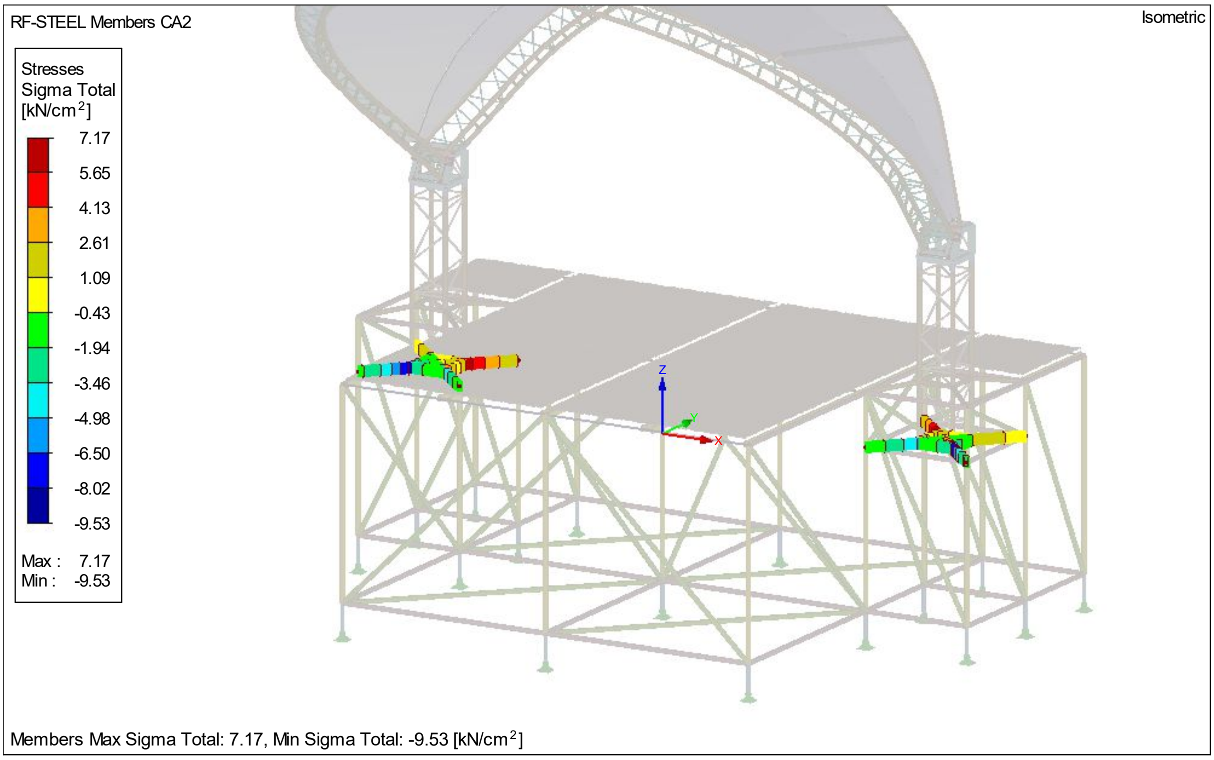
Decisive result combination = RC3 design values In-service situation.

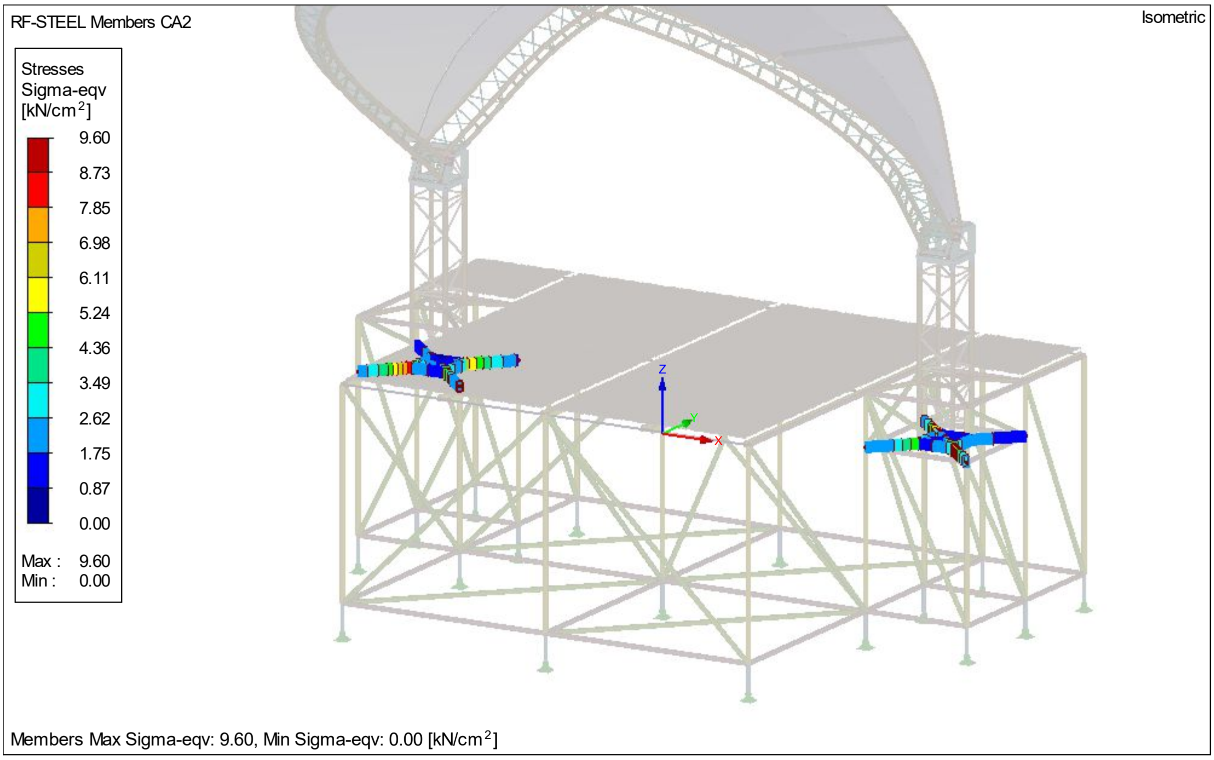
The check of the Layher base has been done with the stress analyse calculation CA2 for the In service situation.





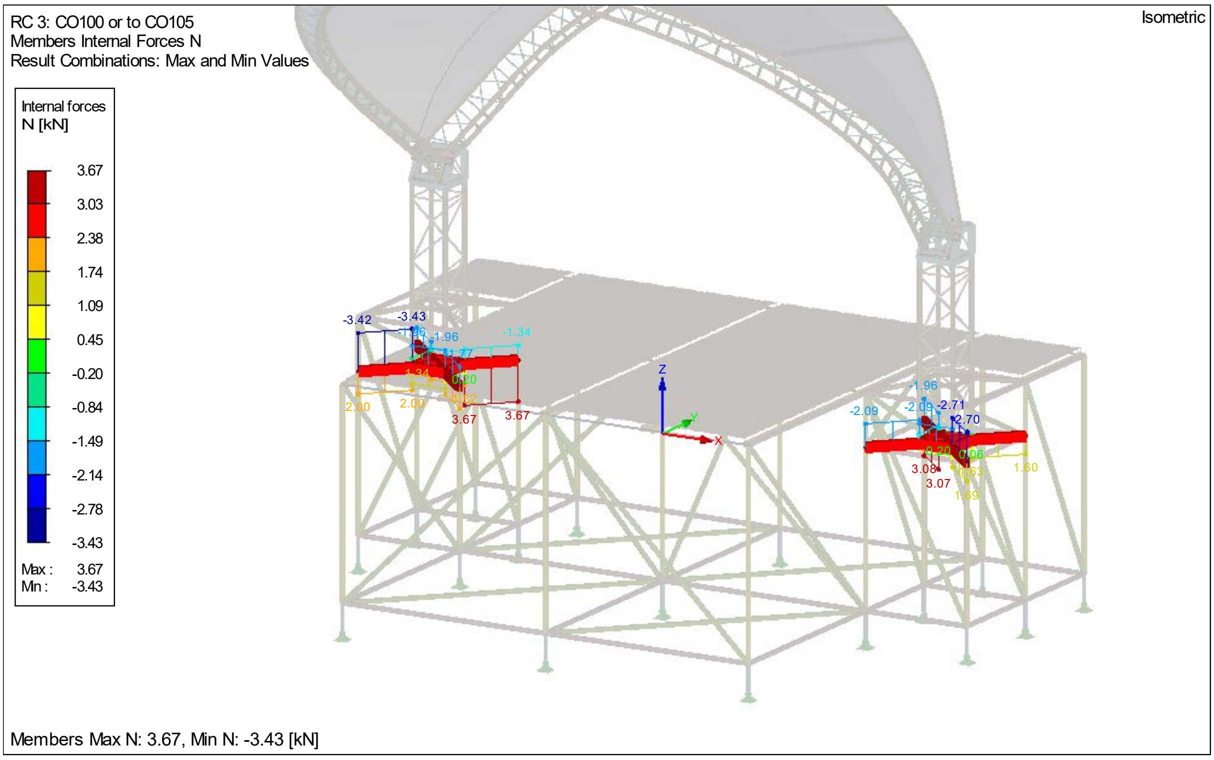
Maximum utilisation = 45%





Maximum stress = 11.21 kN/cm² < 23.5 kN/cm²

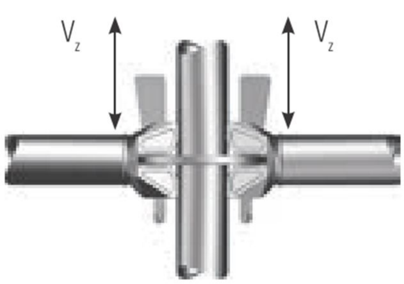
Check of the Layher coupler to the upright.



Maximum transversal force at the coupling = 3.67 kN.

According to the information of the Layher system the maximum transversal force of the coupler is 26.4 kN.

Vertikale Querkraft



Vertikale Querkraft, Einzelanschluss
$V_{z, Rd} = \pm 26{,}4$ kN
Vertikale Querkraft je Lochscheibe
$\sum V_{z, Rd} = \pm 105{,}6$ kN

5.0 Ballast and support load calculations.

5.1 General information Ballast calculation.

The ballast will be checked for uplift, overturning and sliding. The Layher stage which is designed as a ridged stage will be taken into account.

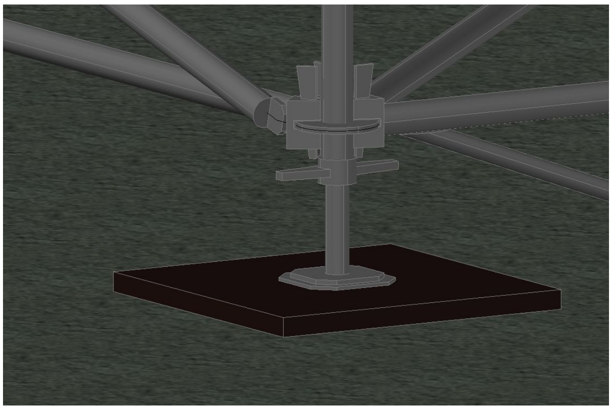
All permanent installed loading can be subtracted from the nearest Ballast position.

The safety factor for the ballast calculation against slipping is set to 1.2 according to the NEN-EN 13814. This is based on a horizontal load which is relying on friction.
For the friction coefficient the factor of 0.4 has been taken into account according to the table below.

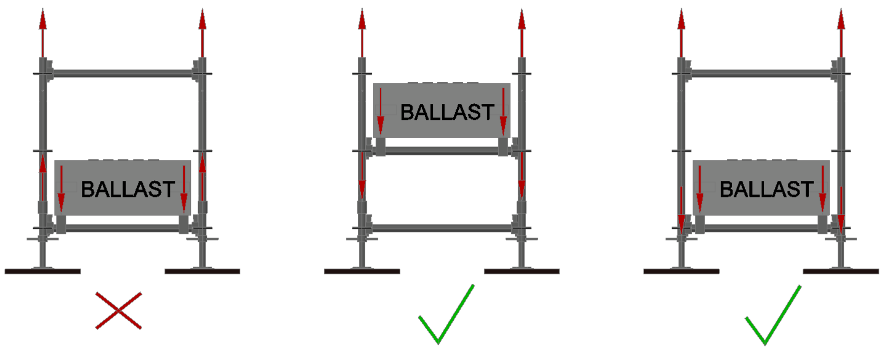
Table 3 — Coefficients of friction μ

	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay[a]	0,25	0,2	0,25
Loam[a]	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65

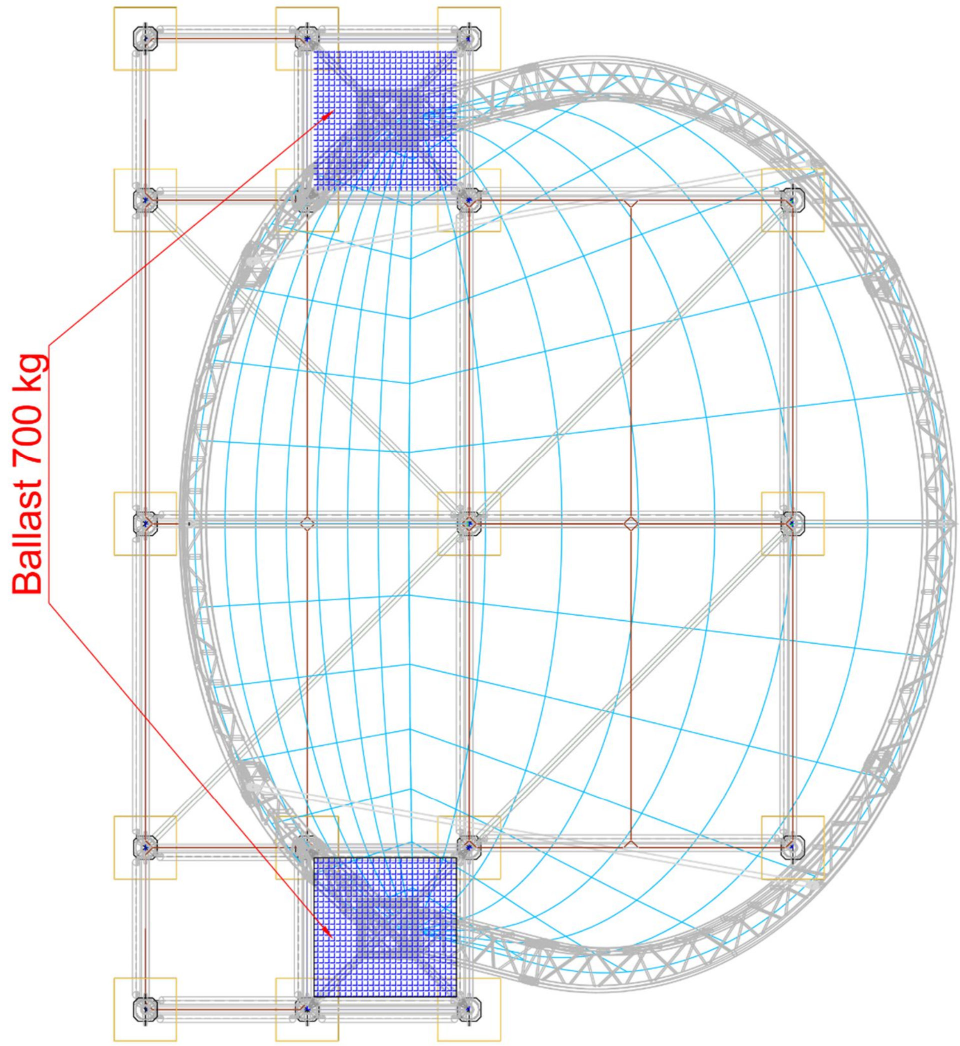
[a] At least of stiff consistency in accordance with ENV 1997-1.



The ballast need to be placed in such a way that it will be activated when lifting forces are applied. If the ballast is placed on the bottom level the use of Layher uprights with connected base collar is necessary.



5.2 Ballast configuration



RAWN BY : Ivo Mulder	PROJECT NR : 2017021	REMARKS :	UNIT : MM
ATE : 24-5-2018	CUSTOMER : Eekels Verhuur		
EVISION :	STATUS :		

ESCRIPTION :

DJ Roof 2018 Ballast Drawing

A3

Structural Event Engineering

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5.3 Ballast calculation against uplift.

For the uplift ballast calculation, the total uplift forces will be taken into account and divide over two positions on each side. The relatively small Layher stage is a structurally stiff system and will work as one system.

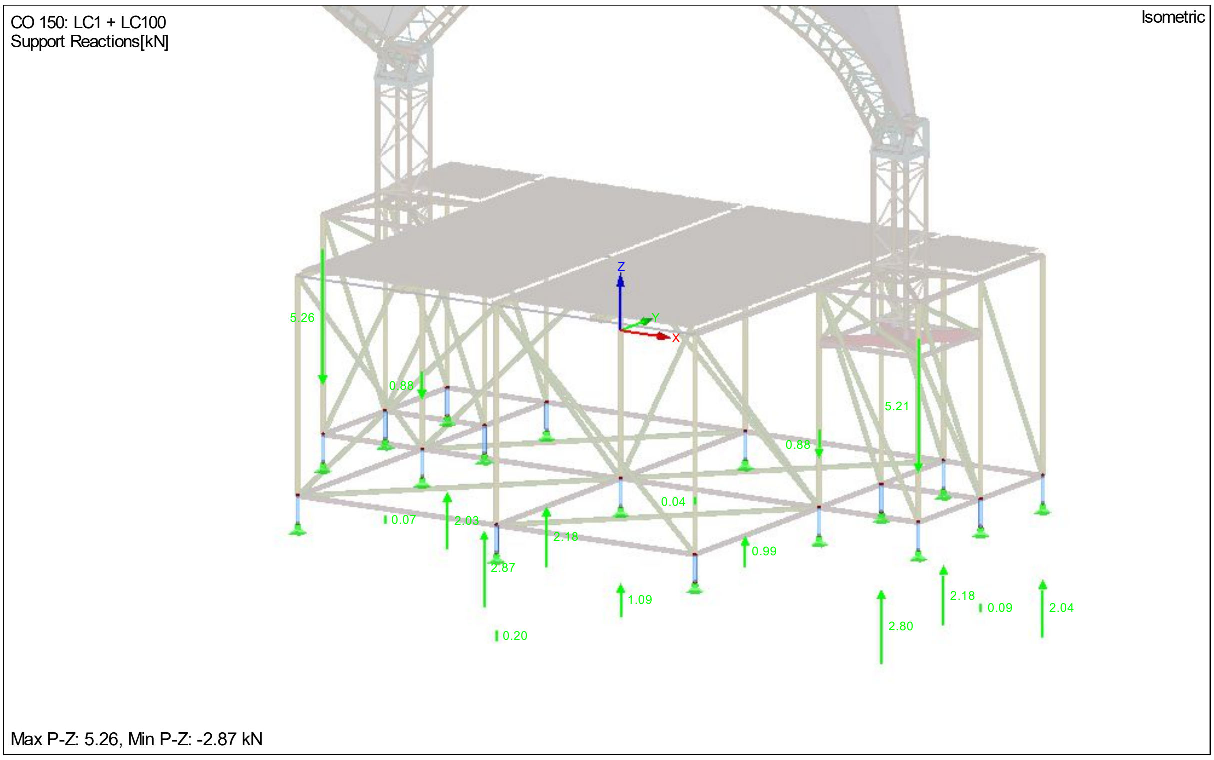
5.3.1 Lifting forces RC3 -characteristic values In-service

The load combinations CO150, CO103 are decisive. These load cases have only self-weight, wind loading and no live load.

The self-weight of the system is already taken into account in the different calculations. The values are the actual values which need to be secured against ballast. The safety factor γ against overturning sliding and lifting are taken from table 2 of the EN-13814

For the uplift the γ = 1.2

Check Load combination CO150



Total amount of uplift force

Sum of loads in Z – Self-Weight = uplift force

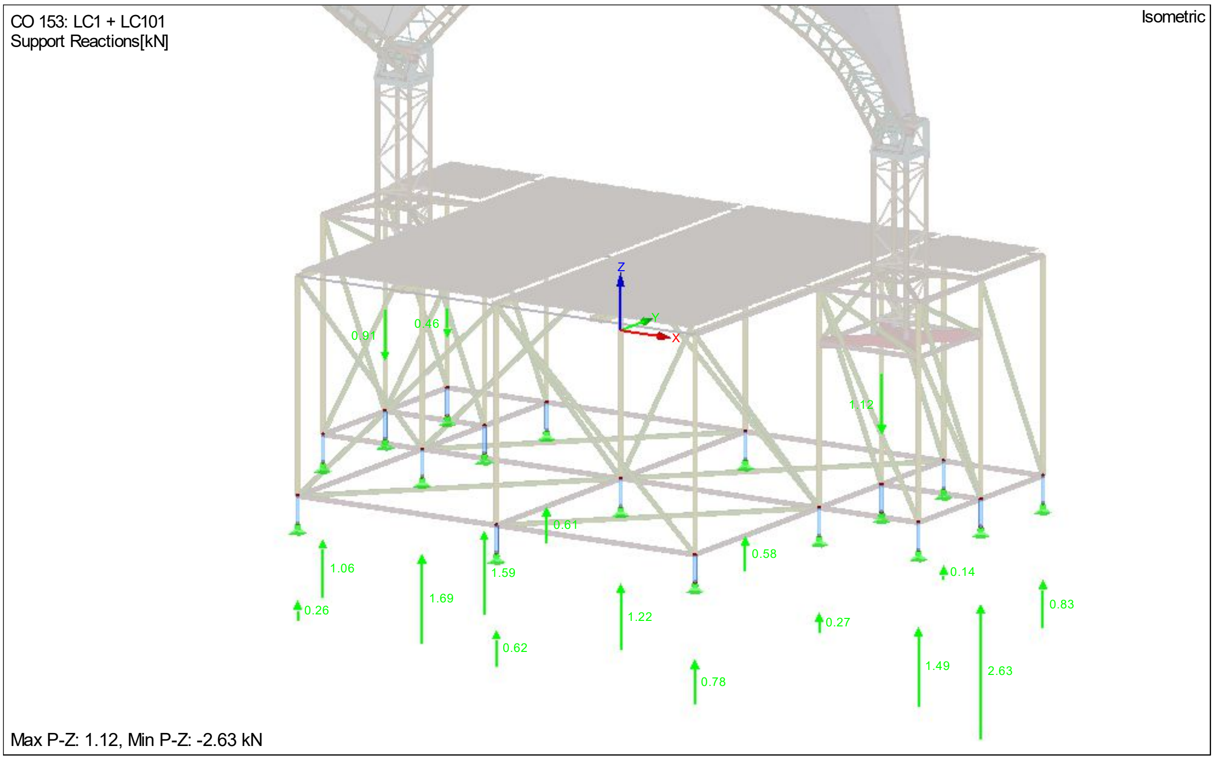
4.27 – 11.27 = 7.00 kN

Ballast check

(self-weight) / Uplift force > 1.2

11.27 / 7.00 = 1.61 > 1.2

Check Load combination CO153



Total amount of uplift force

Sum of loads in Z – Self-Weight = uplift force

11.29 – 11.27 = 0.02 kN

Ballast check

self-weight / Uplift force > 1.2

0.02 / 7.00 > 1.2

5.4 Calculation of the system against overturning.

Results loading from the RFem model of the main construction for the different load combinations.

	Description	Value	Unit		Description	Value	Unit
	CO150 - LC1 + LC100				**CO250 - LC1 + LC200**		
	Sum of loads in X	0,00	kN		Sum of loads in X	0,00	kN
	Sum of loads in Y	5,92	kN		Sum of loads in Y	3,88	kN
	Sum of loads in Z	-4,27	kN		Sum of loads in Z	-11,23	kN
	CO151 - LC1 + LC2 + LC100				**CO251 - LC1 + LC2 + LC200**		
	Sum of loads in X	0,00	kN		Sum of loads in X	0,00	kN
	Sum of loads in Y	5,87	kN		Sum of loads in Y	3,88	kN
	Sum of loads in Z	-7,24	kN		Sum of loads in Z	-14,22	kN
	CO152 - LC1 + LC2 + LC3 + LC100				**CO252 - LC1 + LC2 + LC3 + LC200**		
	Sum of loads in X	0,00	kN		Sum of loads in X	0,00	kN
	Sum of loads in Y	5,88	kN		Sum of loads in Y	3,88	kN
	Sum of loads in Z	-8,89	kN		Sum of loads in Z	-15,87	kN
	CO153 - LC1 + LC101				**CO253 - LC1 + LC201**		
	Sum of loads in X	4,20	kN		Sum of loads in X	3,70	kN
	Sum of loads in Y	0,00	kN		Sum of loads in Y	0,00	kN
	Sum of loads in Z	-11,29	kN		Sum of loads in Z	-11,23	kN
	CO154 - LC1 + LC2 + LC101				**CO254 - LC1 + LC2 + LC201**		
	Sum of loads in X	4,19	kN		Sum of loads in X	3,70	kN
	Sum of loads in Y	0,00	kN		Sum of loads in Y	0,00	kN
	Sum of loads in Z	-14,28	kN		Sum of loads in Z	-14,22	kN
	CO155 - LC1 + LC2 + LC3 + LC101				**CO255 - LC1 + LC2 + LC3 + LC201**		
	Sum of loads in X	4,19	kN		Sum of loads in X	3,70	kN
	Sum of loads in Y	0,00	kN		Sum of loads in Y	0,00	kN
	Sum of loads in Z	-15,94	kN		Sum of loads in Z	-15,87	kN

Decisive load combination CO50

CO50

Sum of load in Y direction = 5.92 kN
Sum of load in Z direction = -4.27 kN
Ballast = 7.00 kN per base unit

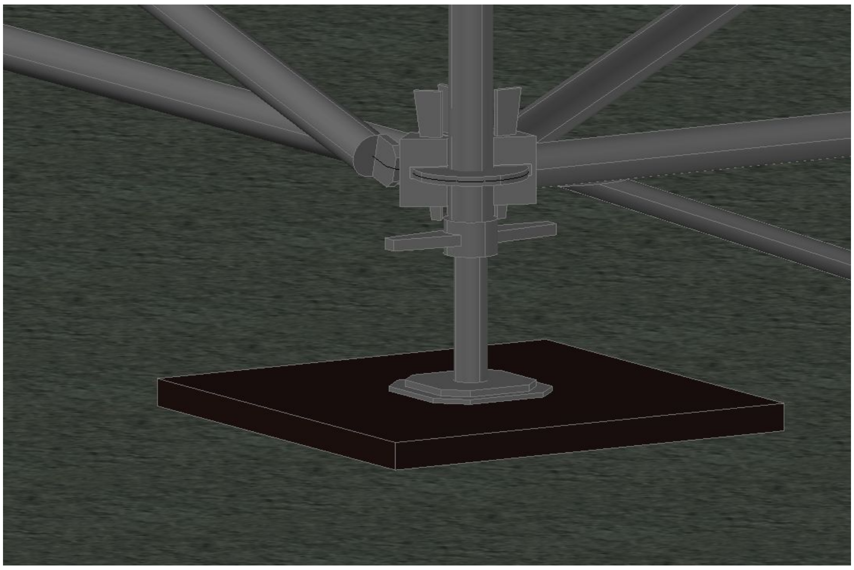
Overturning moment

M_{ov} = (5.92 * 3/) + ((4.27-11.27) * 4.144 / 2) =
M_{ov} = 17.76 + 14.5 = 32.26 kNm
Stabilization moment
M_{stab} = (2 * 7 * 2.072) + (11.27 * 4.144 / 2)
M_{stab} = 29 + 23.35 = 52.36 kNm

M_{stab}/ M_{ov} = 52.36 / 32.26= 1.62 > 1.2

5.5 Ballast calculation against slipping.

Decisive load combination is CO150



Ballast requirement with μ = 0.4 Steel-wood-concrete/sand/gravel

Horizontal force = 5.92 kN

Total vertical force = 4.27 kN

Ballast = 7.00 kN per base unit

Check

(total vertical force + ballast) * friction coefficient / Horizontal Force > 1.2

(4.27 + 14) * 0.4 / 5.92 = 1.23 > 1.2

Interal PROTRUSS S41

Truss series	PROTRUSS S41
Truss manufacturer	Interal T.C. the Netherlands
Truss series calculated by:	MICHEL.ENGINEERE
Structural report number:	2014-0067

Design internal forces for the complete truss

Normal force main chord	+/- 49.24 kN
Normal force coupling system	+/- 60.54 kN
Normal force diagonals	+/- 13.39 kN
Bending moment $M_{yR,d}$	33.39 kNm
Bending moment $M_{zR,d}$	33.39 kNm
Normal Force $N_{R,d}$	196.97 kN
Transversal Force $V_{yr,d}$	18.94 kN
Transversal Force $V_{zr,d}$	18.94 kN

Truss geometry

Main chords	48x3	EN AW-6082T6	
Diagonals	20x2	EN AW-6082T6	
Coupling system	CONICAL COUPLING SYSTEM		
Height	339 mm		Centre to centre distance main chords
Width	339 mm		Centre to centre distance main chords
A	16.96 cm²		
I_y	4917 cm^4		
I_z	4917 cm^4		
i_y	17.25 cm		
i_z	17.25 cm		