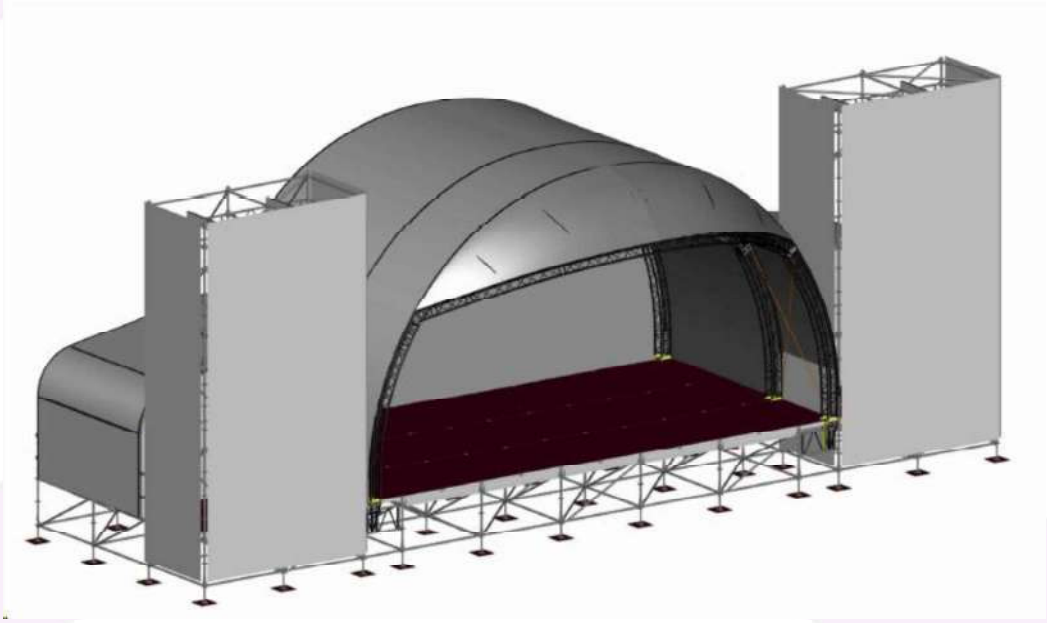
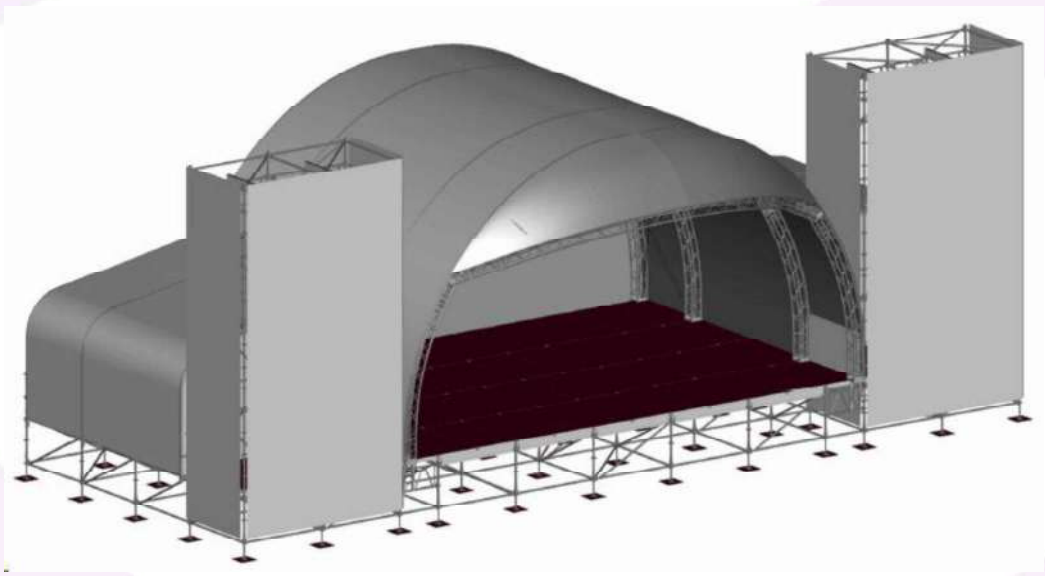
PODIUM - BOEK

HERA

Eekels Verhuur 072026-14





Inhoudsopgave

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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	Interal Protruss Medium Tunnel – S31
Type zeil	PVC; artikel 8509 5240

1.2 Algemene gegevens;

Naam	**HERA**
Type	Medium tunnel
Configuratie(s)	72 - 96

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: 10x6 – 10x8 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.

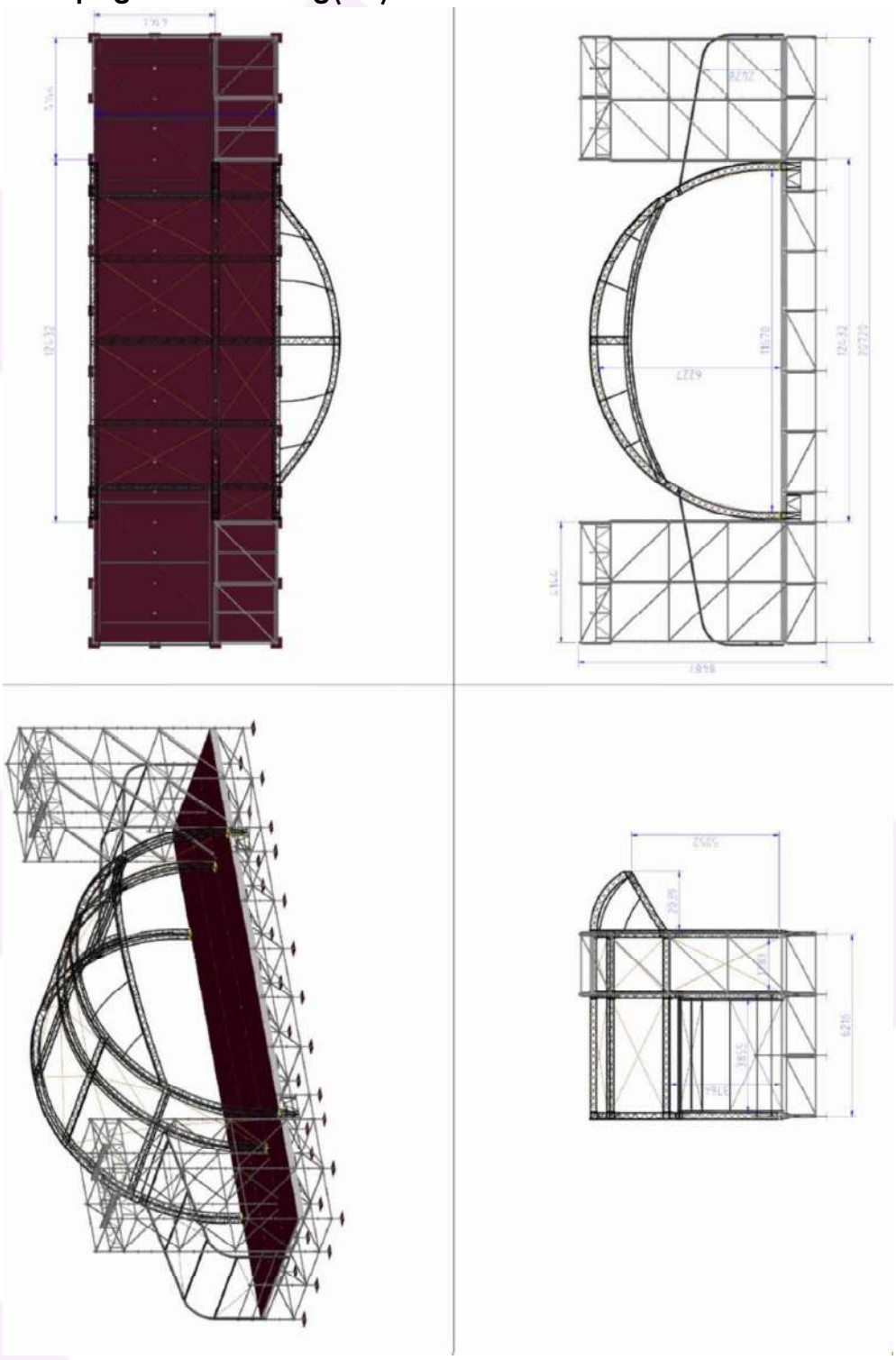
- Een constructie wordt berekend op een stuwdruk (de windbelasting per m2). De stuwdruk ontstaat door de windsnelheid. De windsnelheid is opgebouwd uit een stationair deel en een turbulent deel. Hierdoor ontstaan er pieken in de windsnelheid.
- Windsnelheid wordt standaard gemeten op 10 meter hoogte 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.

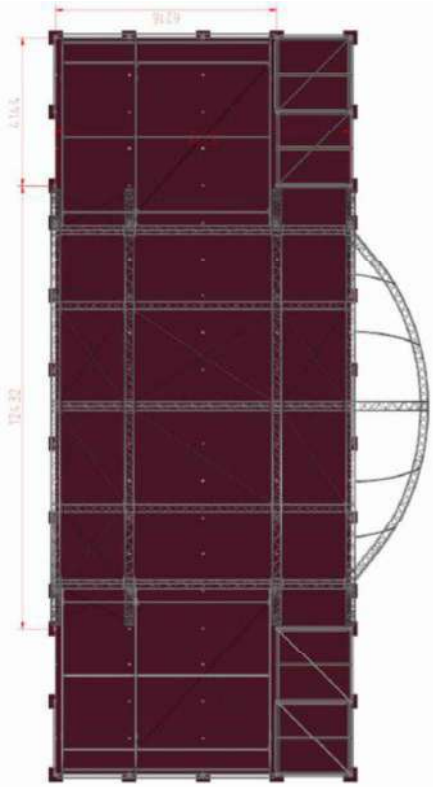
De windkracht volgens de Schaal van Beaufort (bron: KNMI). De schaal van Beaufort wordt gebruikt voor de gemiddelde windsnelheid, over minstens 10 minuten gemeten, níet voor de snelheid van rukwinden/windstoten(piekwind).

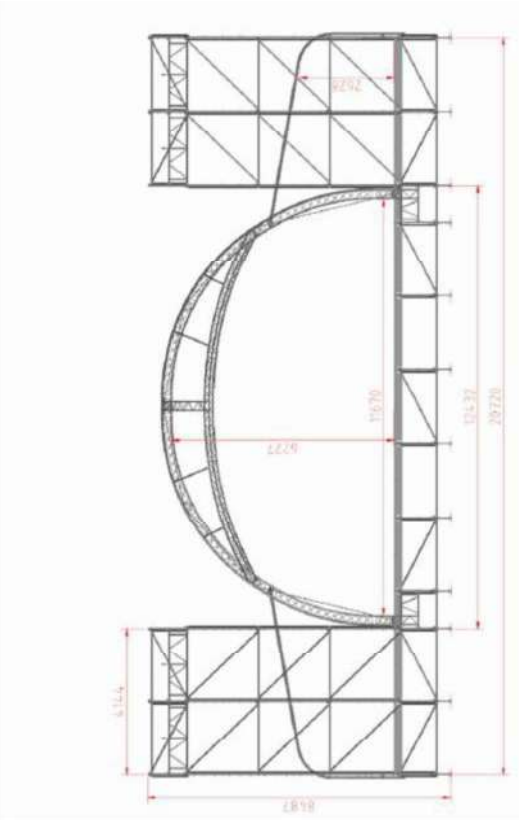
Kracht	Benaming van KNMI	Benaming in Zeevaart	Snelheid in km/h*	Snelheid in m/s*	Snelheid in knopen
0	Stil	Windstil	0-1	0-0,2	0-1
1	Zwak	Flauw en stil	1-5	0,3-1,5	1-3
2	Zwak	Flauwe koelte	6-11	1,6-3,3	4-6
3	Matig	Lichte koelte	12-19	3,4-5,4	7-10
4	Matig	Matige koelte	20-28	5,5-7,9	11-16
5	Vrij krachtig	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

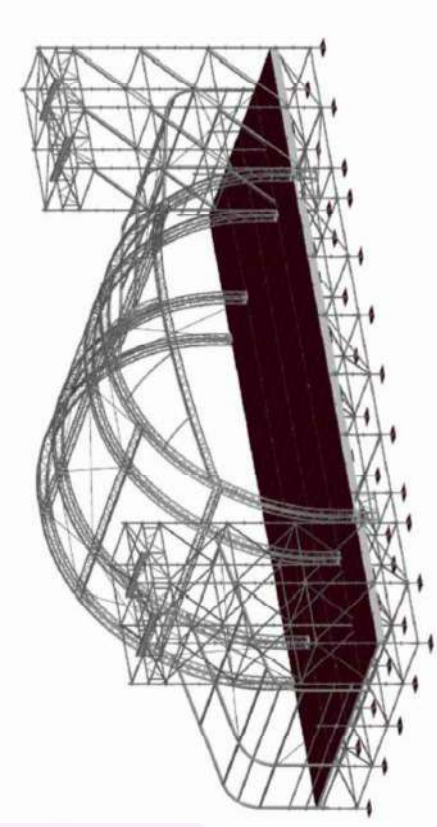
De Nederlandse weerstations onder andere vinden op: www.meteovista.nl, www.knmi.nl, www.meteoconsult.nl en www.meteostation.nl.
Organisator kan ook bij onder andere Meteovista en Meteoconsult gedurende de duur van het evenement een weerbewakingscontract aangaan om nog beter op de hoogte te zijn van de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

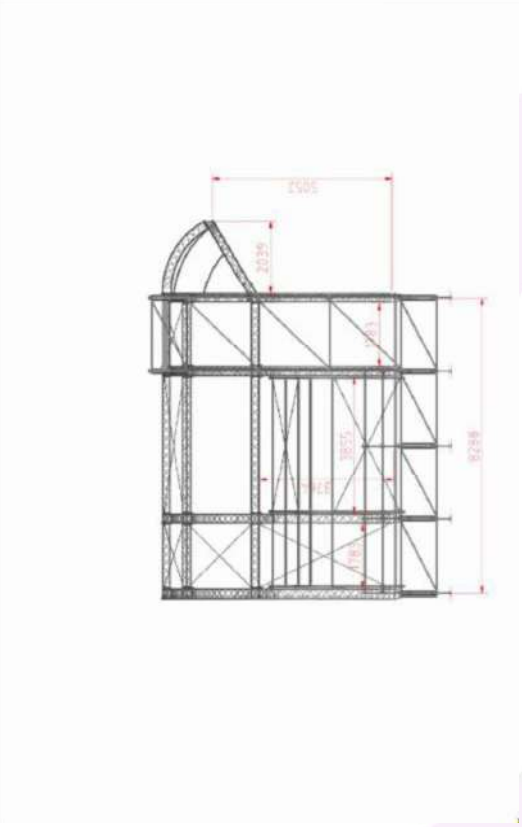
6 Bijlage I: Tekening(en)



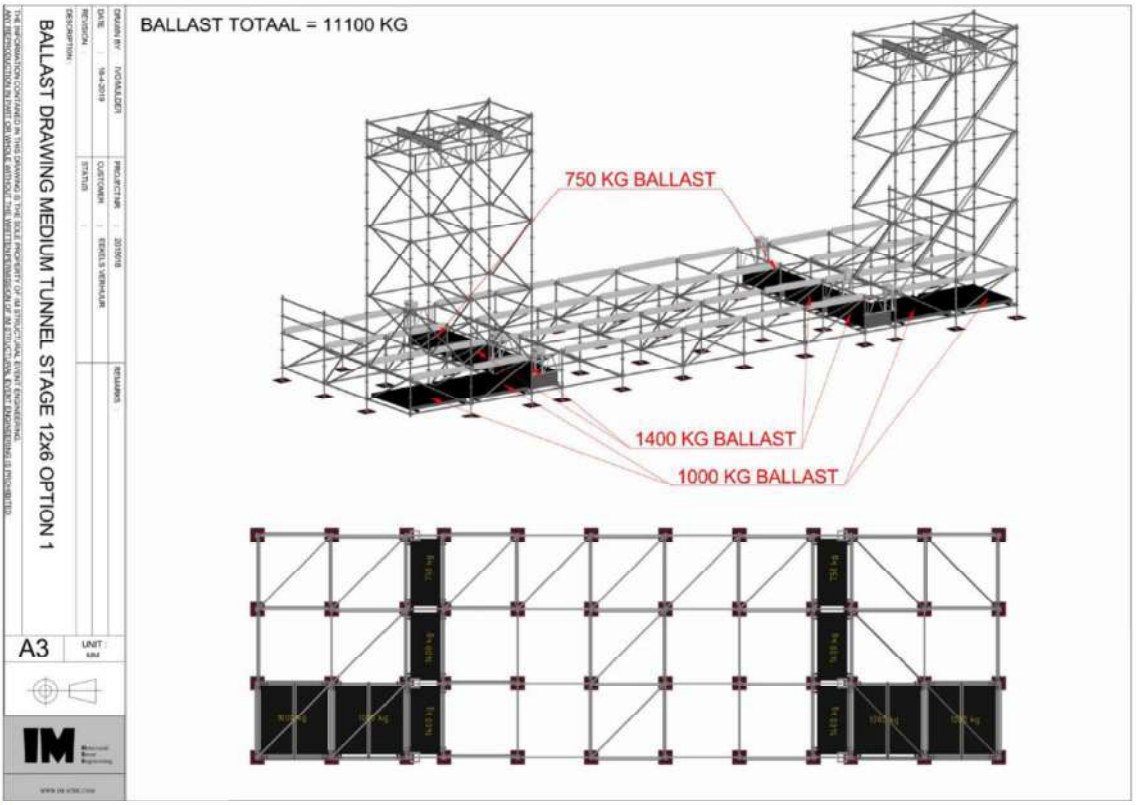




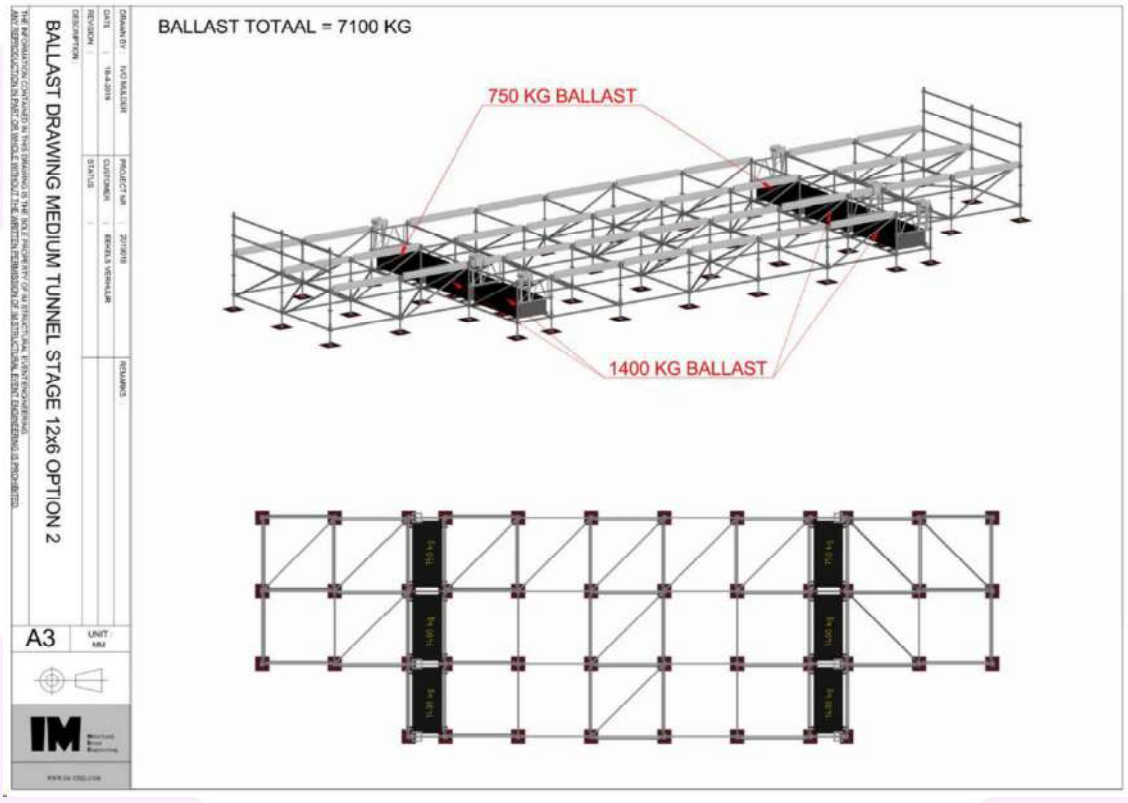




7 Bijlage II: Ballastplan

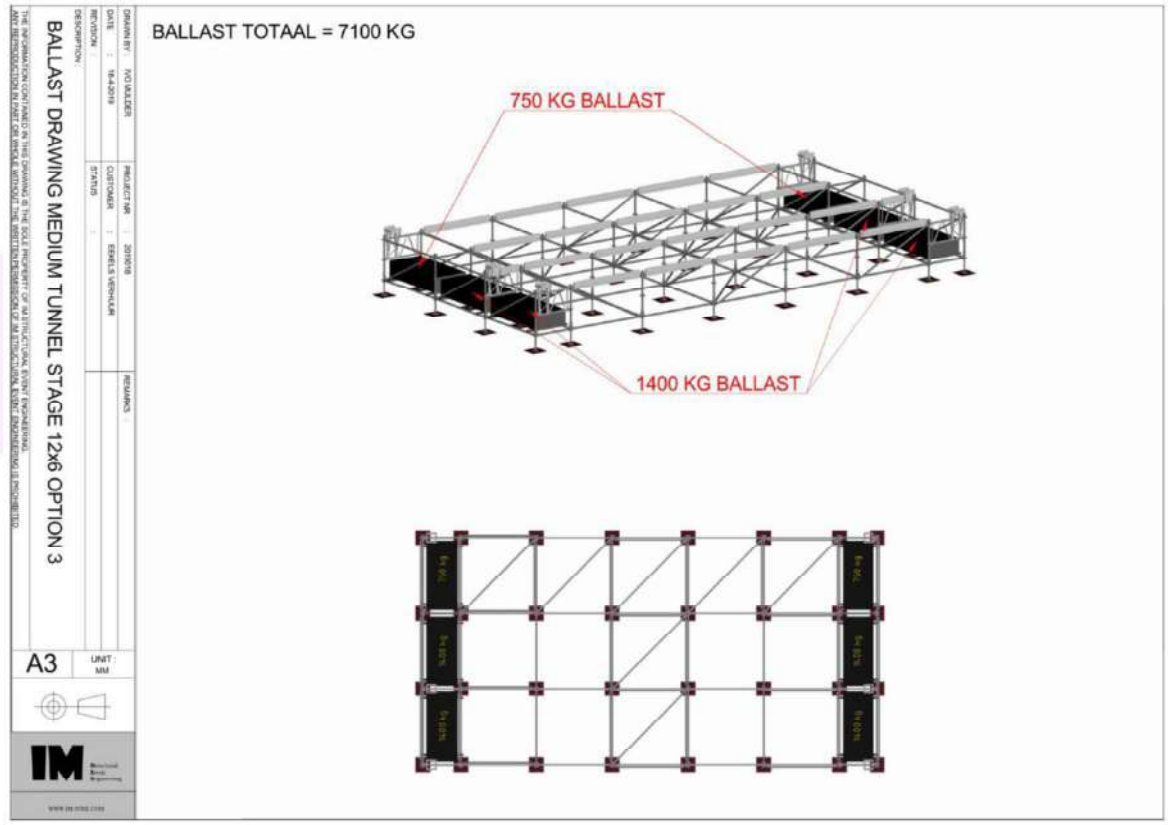


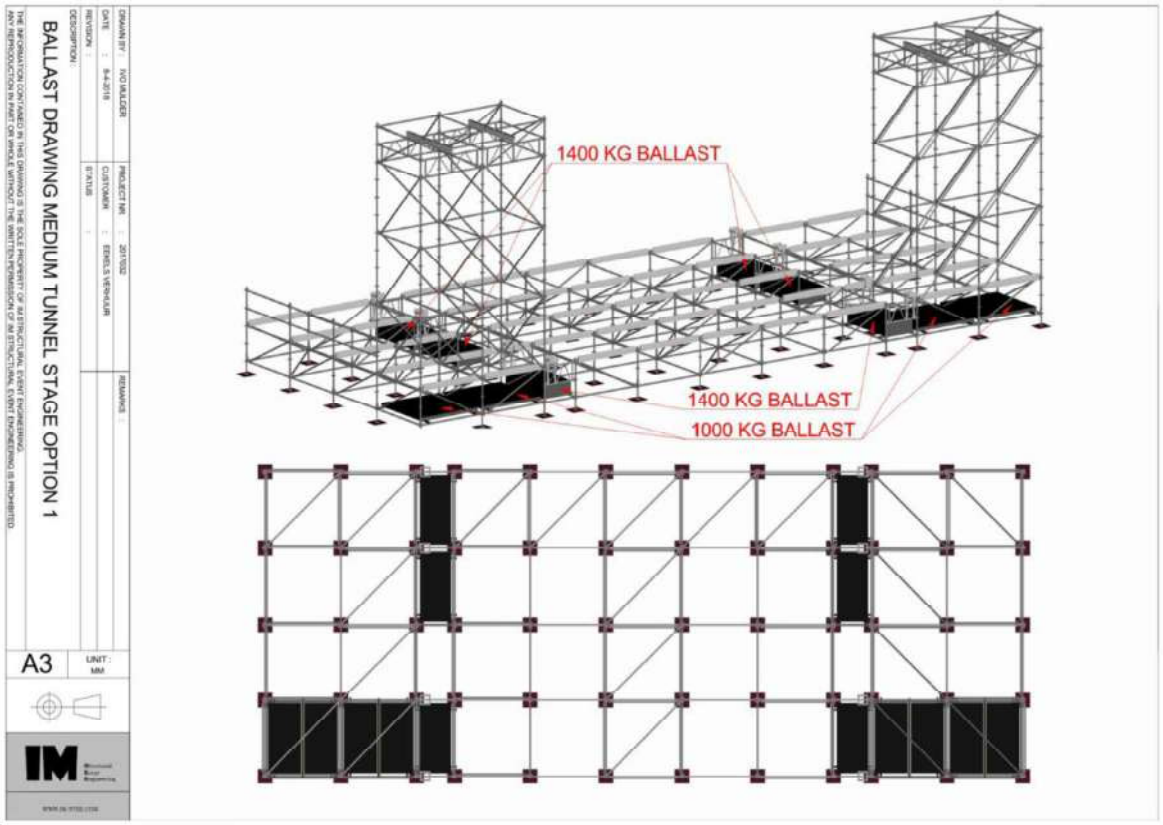
Ballast drawing Medium tunnel stage 12x6 Option 1.



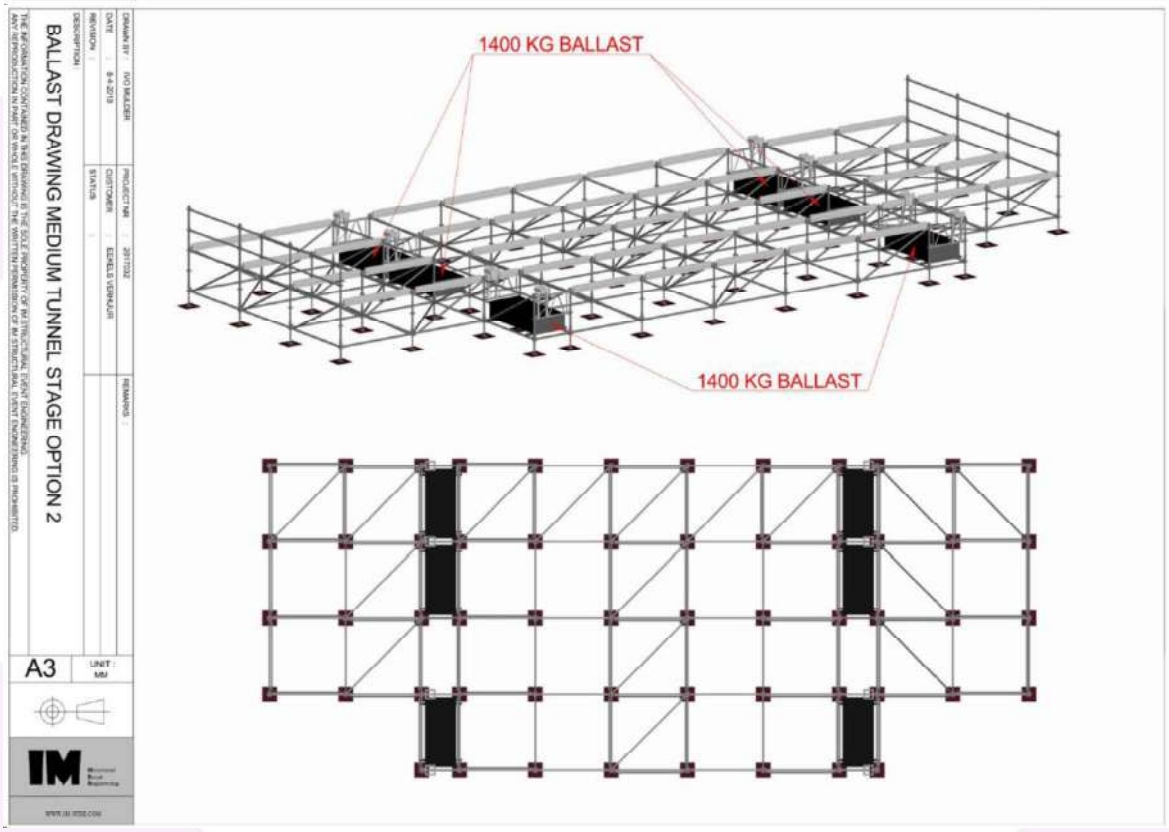
Ballast drawing Medium tunnel stage 12x6 Option 2.

Ballast drawing Medium tunnel stage 12x6 Option 3.

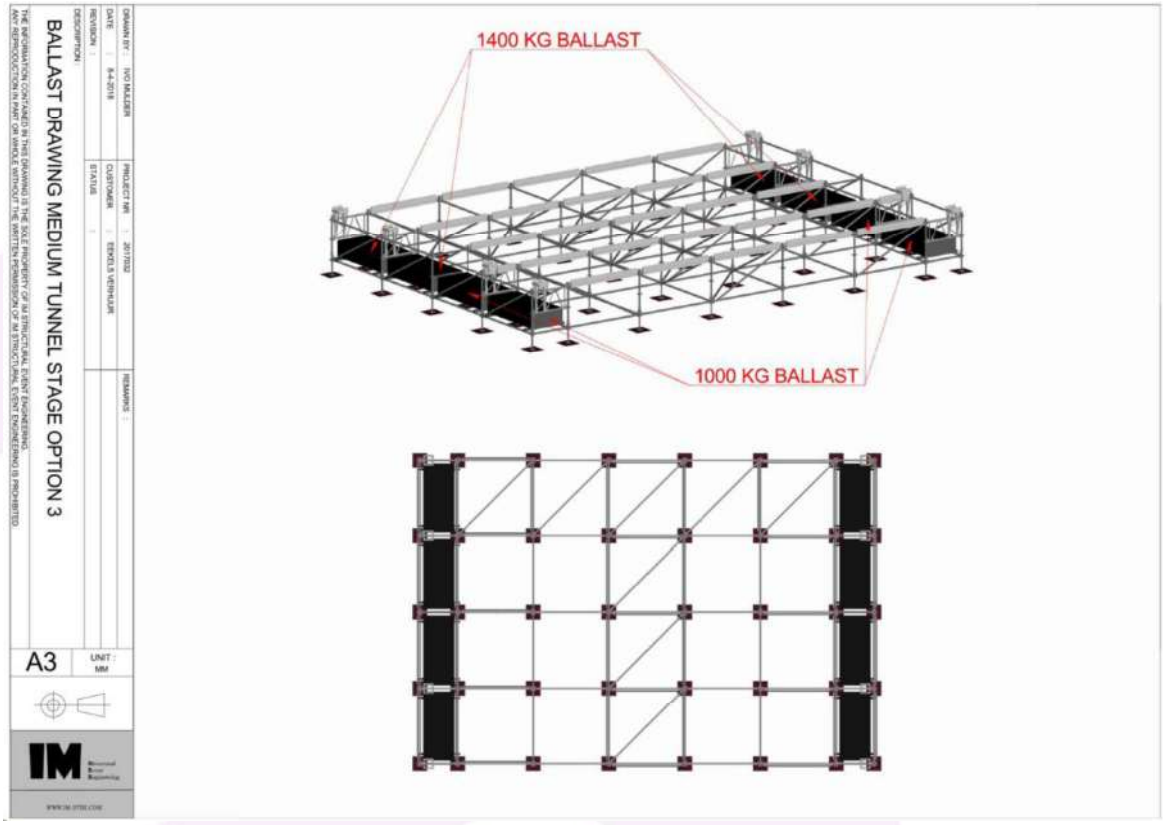




Ballast drawing Medium tunnel stage 10x8 Option 1.



Ballast drawing Medium tunnel stage 10x8 Option 2.



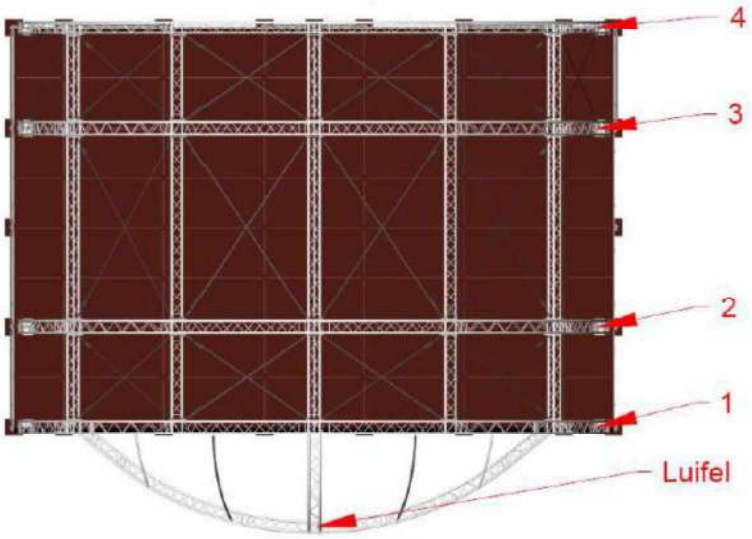
Ballast drawing Medium tunnel stage 10x8 Option 3.

8 Bijlage III: Riggingscapaciteit

Riggingscapaciteit Hera 96/72

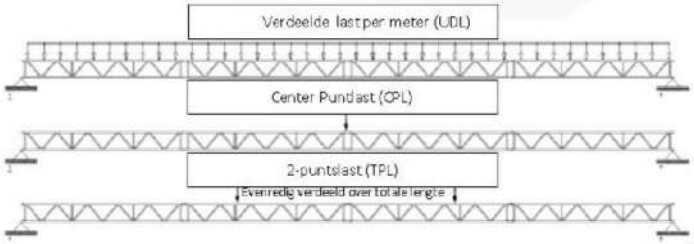
Bij uitvoering in opstelling Hera 72 vervalt de truss 3

Rear



Front

Naam	Waarde	Maximale Gebruiksbelasting per punt				
		1	2	3	4	Luifel
A. Verdeelde last per meter (UDL)	kg/m	75	75	75	50	40
B. Center puntlast (CPL)	kg	750	750	750	750	Zie A
C. 2-puntslast (TPL) 1.6 meter uit de mast	kg	750	750	750	500	Zie A
D. 4-puntslast (FPL)	kg	500	500	500	300	Zie A



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. Achterzeilen dienen verwijderd te zijn bij het bereiken van onderstaande waarde, tevens dienen alle doorgangen in het dakzeil geopend te worden, opgerold en zo hoog mogelijk te worden vastgezet;
    a. Aanvullend; bij sidestages de kopzeilen verwijderen;

Gebied	**10 minuten gemiddelde windsnelheid (m/s)**	**Beaufort (Bft)**	**Piekwindsnelheid (m/s)**	**Stuwdruk (kN/m²)**
Kust	10.58	5	17.89	0.20 kN/m²
Onbebouwd	12.03	6	17.89	0.20 kN/m²
Bebouwd	17.57	7	17.89	0.20 kN/m²

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 en alle windvangers dienen uit de kap.

Gebied	**10 minuten gemiddelde windsnelheid (m/s)**	**Beaufort (Bft)**	**Piekwindsnelheid (m/s)**	**Stuwdruk (kN/m²)**
Kust	15.65	7	26.46	0.4375 kN/m²
Onbebouwd	17.79	8	26.46	0.4375 kN/m²
Bebouwd	25.99	9	26.46	0.4375 kN/m²

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.

- Kantoordagen ma-vrij 0800-1700 uur +31 497 870136
- In geval van nood +31 497 870112

10 Bijlage V: Zeilcertificaat

MEHLER TEXNOLOGIES
A Low & Bonar solution

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.

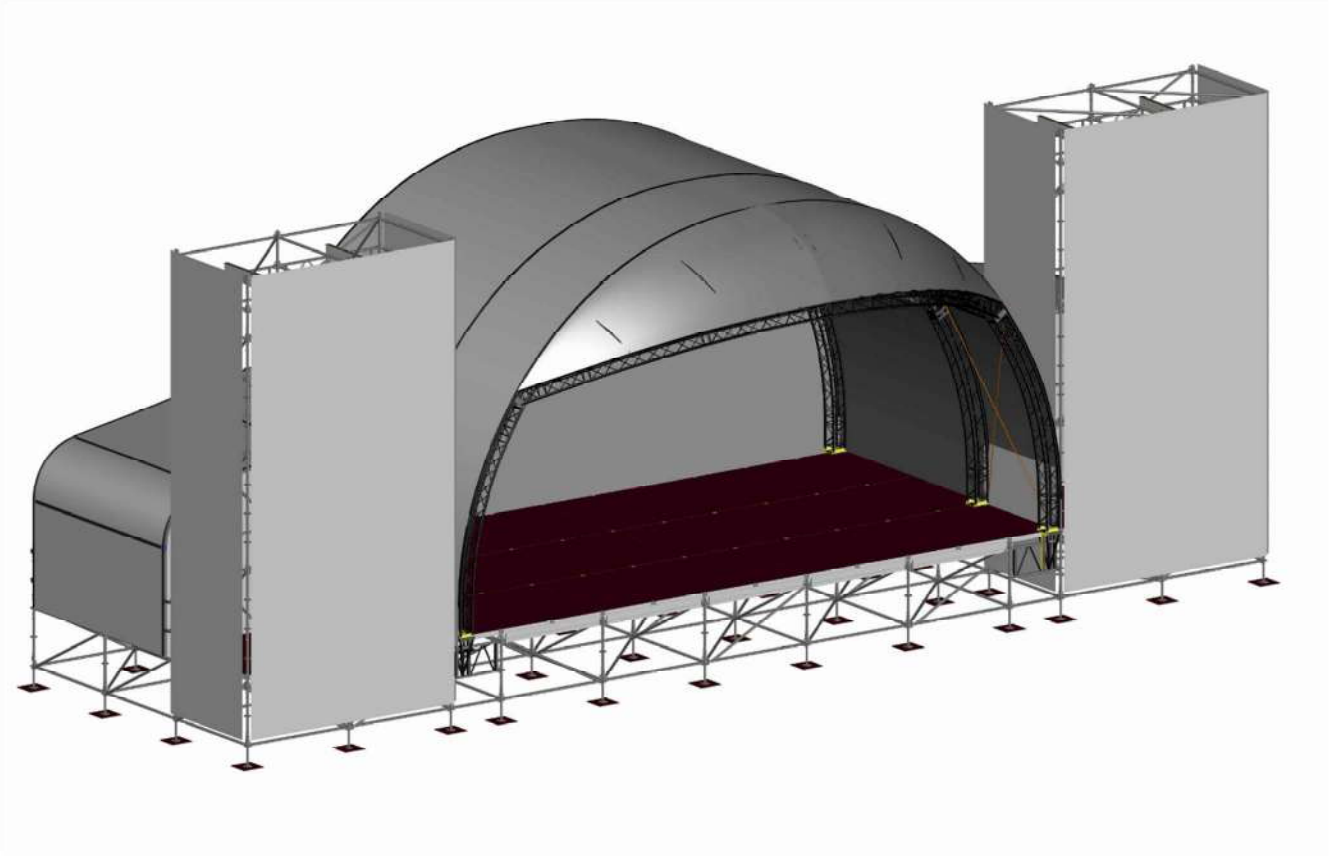
VL/LB:

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

11 Bijlage VI: Berekening

Structural
Event
Engineering

WWW.IM-STEE.COM



Project number: 2019018
Structural calculation Report
Medium Tunnel Roof 12x6
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: 18-4-2019

Ivo Mulder BCs



IM Structural Event Engineering
Jellen 4
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Truss information

1 General Preliminary notes.

1.1 Project description.

This project concerns the calculation of a Medium Tunnel Roof dimensions 12 x 6 m with a height of 8 meter.

The Medium Tunnel Roof is constructed from Interal Protruss. The main arches are square Protruss S31 with dimensions 0.29 x 0.29m and the truss between the main arches is Protruss T31 with dimensions 0.29 x 0.257m. The cantilever on the front is constructed from Protruss T31 which is supported by an arched Protruss S31 and 4 additional tubes which are mainly used to support the canopy.

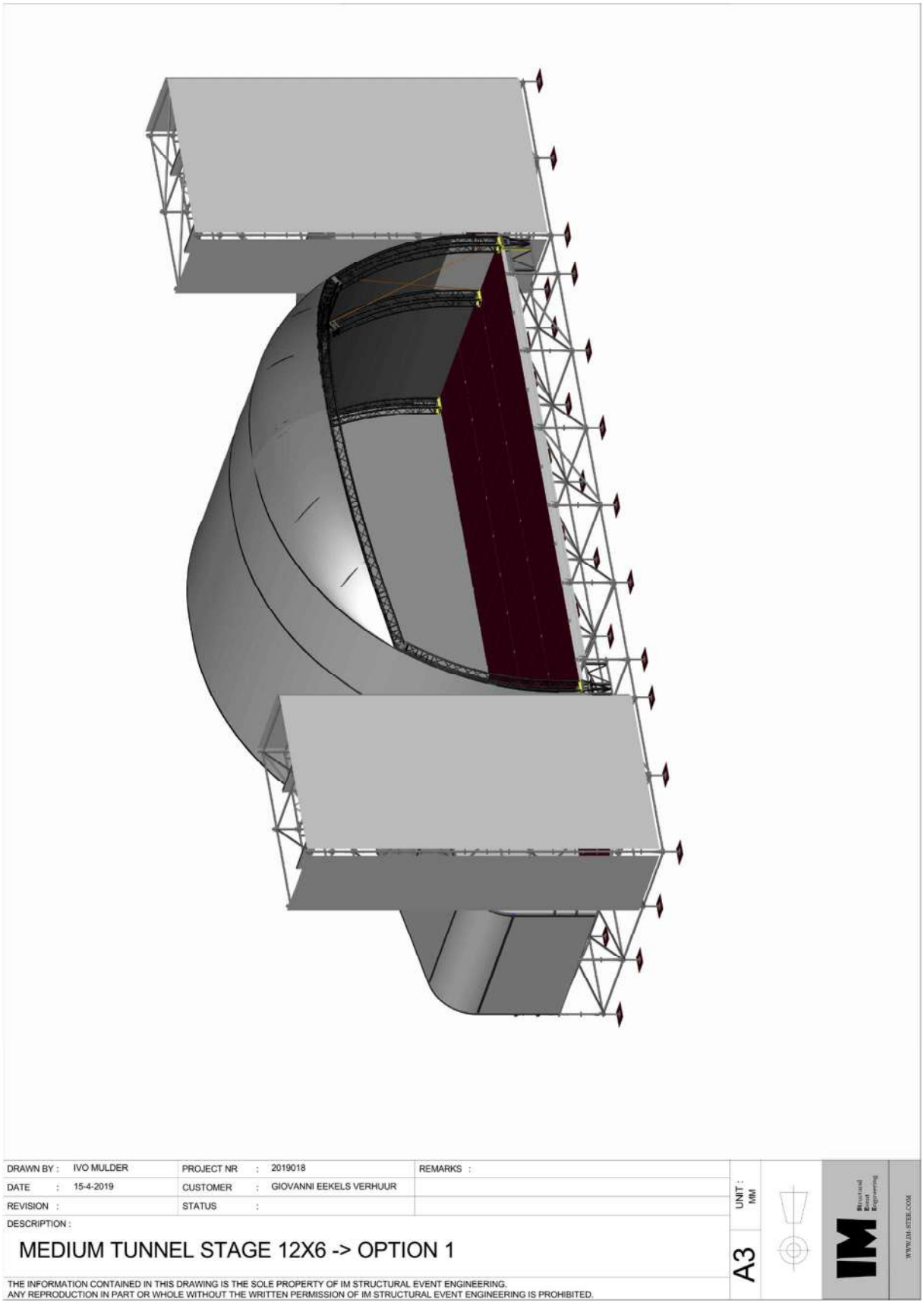
The System is built on a Layher staging floor which is part of this calculation. The height of the Layher stage which is taken into account in this calculation is 1.5 meter.

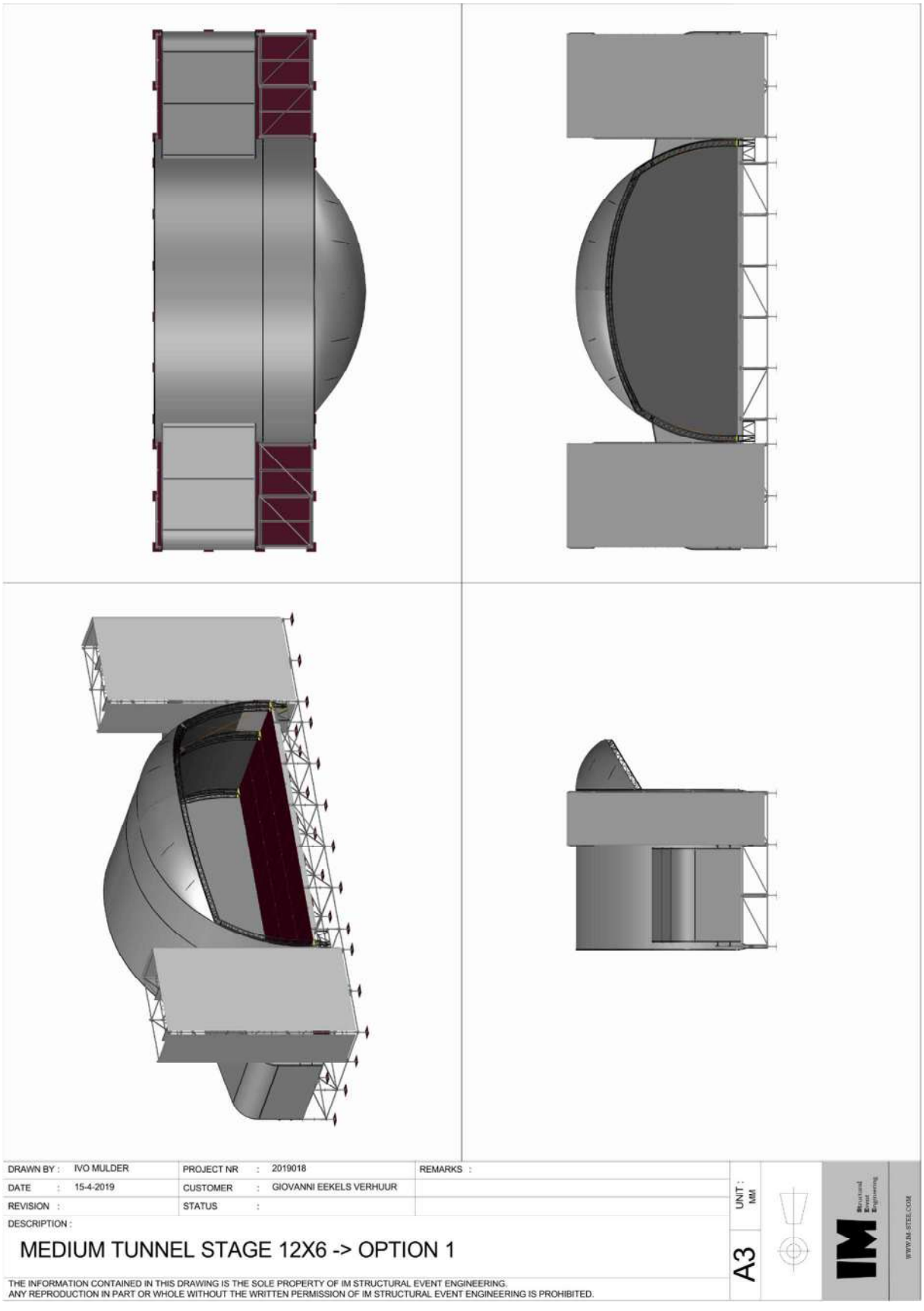
The Medium tunnel stage can be built in two different depths, 6 or 8 meter.
Optional the Medium tunnel stage can be built with Side stage areas of 6x4 and 4x4 meter on the left and the right side and two PA towers on the front next to the roof. These PA Towers are constructed from Layher and are fully integrated into the Layher stage.

When only the Medium tunnel stage option 3 is build, it is necessary to install cross wires in the front and the back of the system in the Out-service wind conditions. This for the structural integrity and stability of the system.

1.2 Construction drawing of the Medium tunnel stage 12x6.

1.2.1 Medium tunnel stage 12x6 Option 1.





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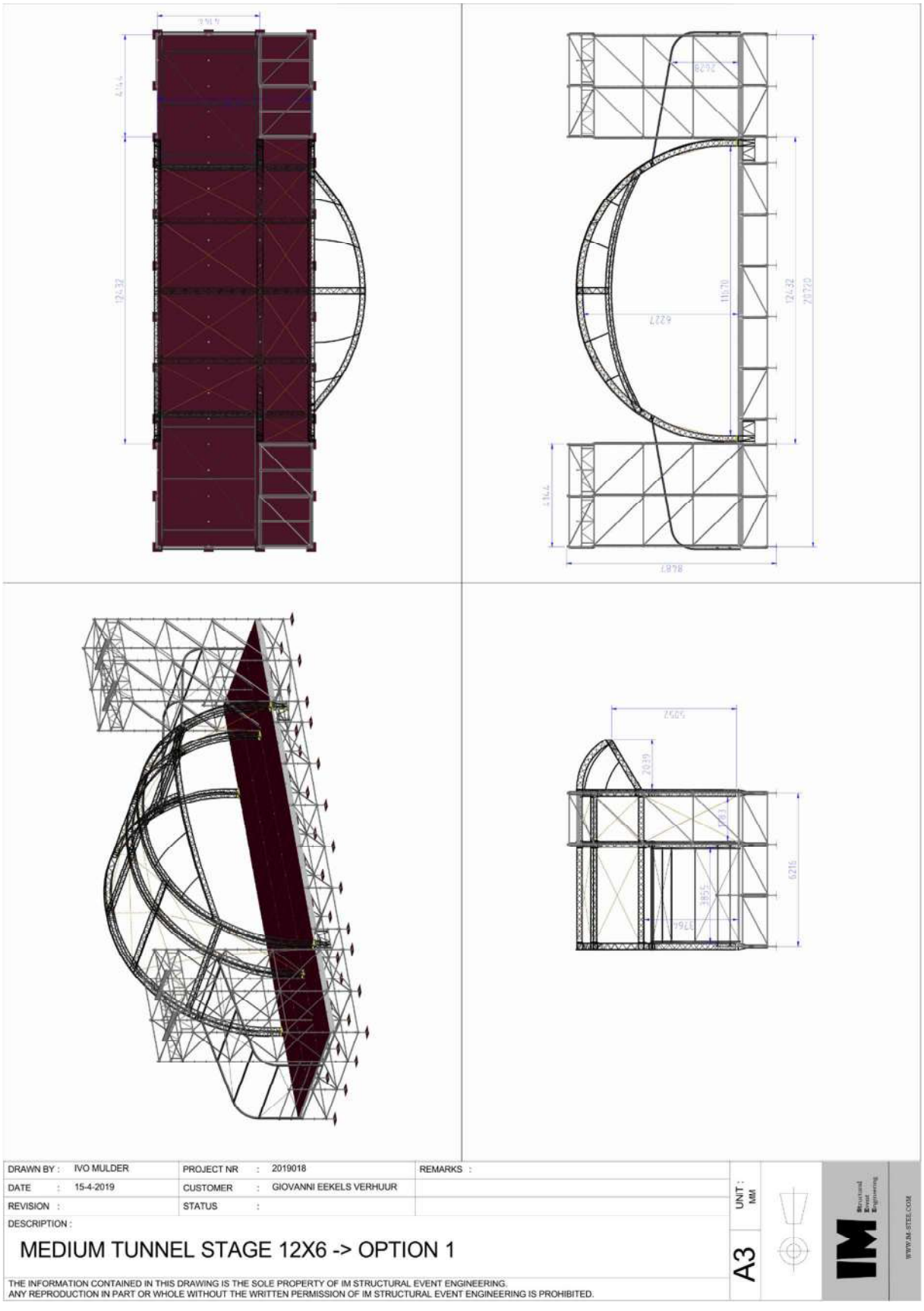
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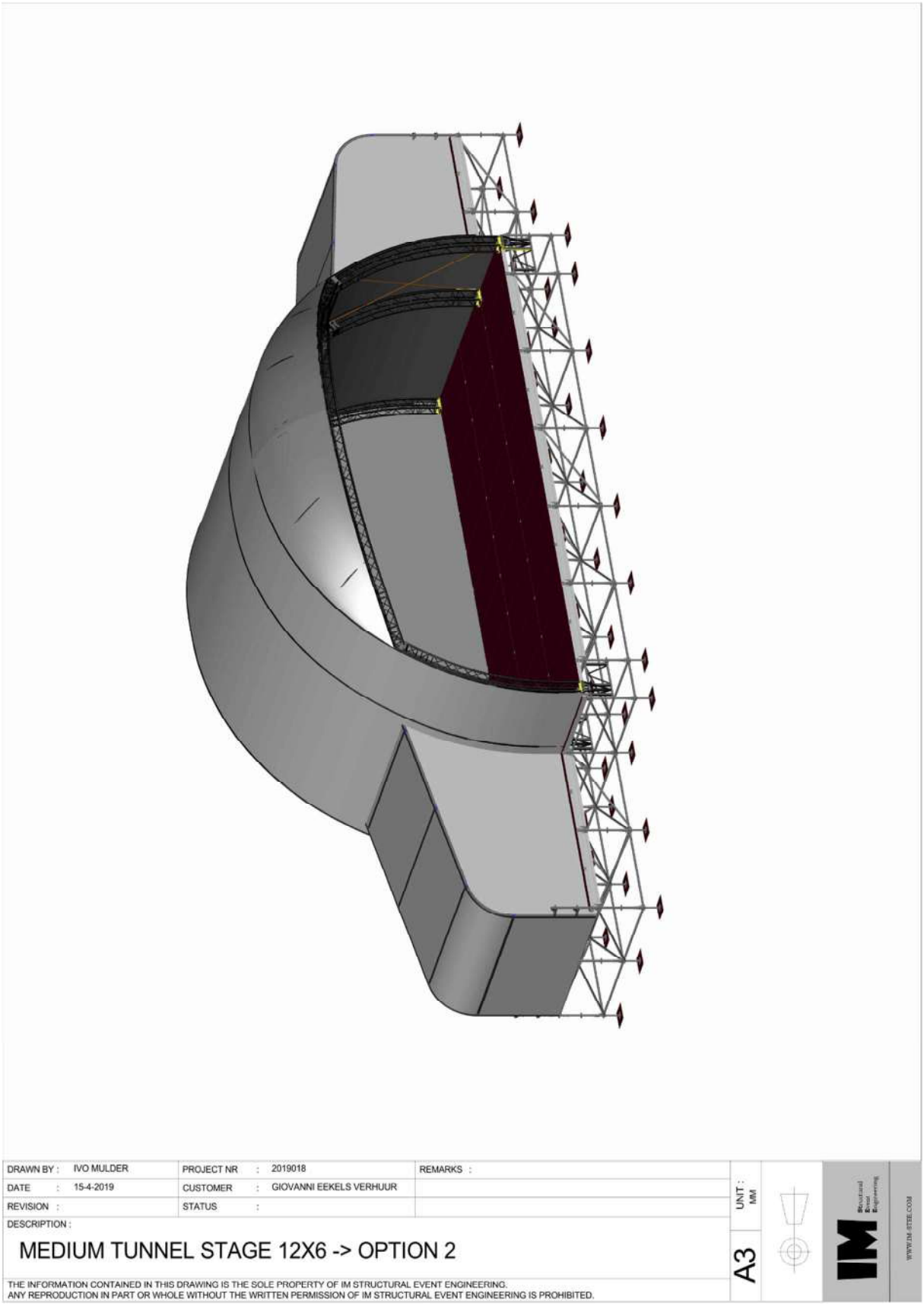
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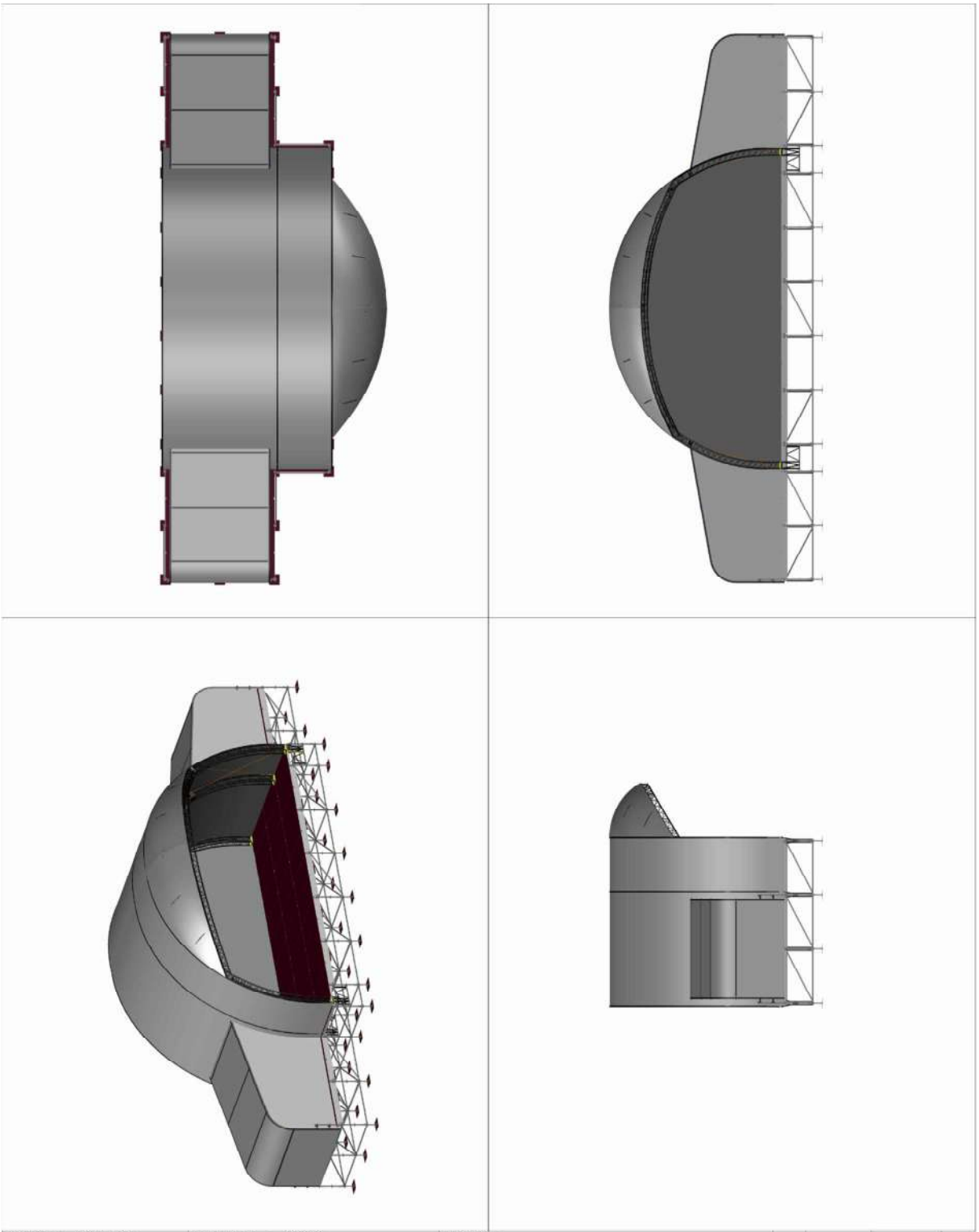
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1.2.2 Medium tunnel stage 12x6 Option 2.





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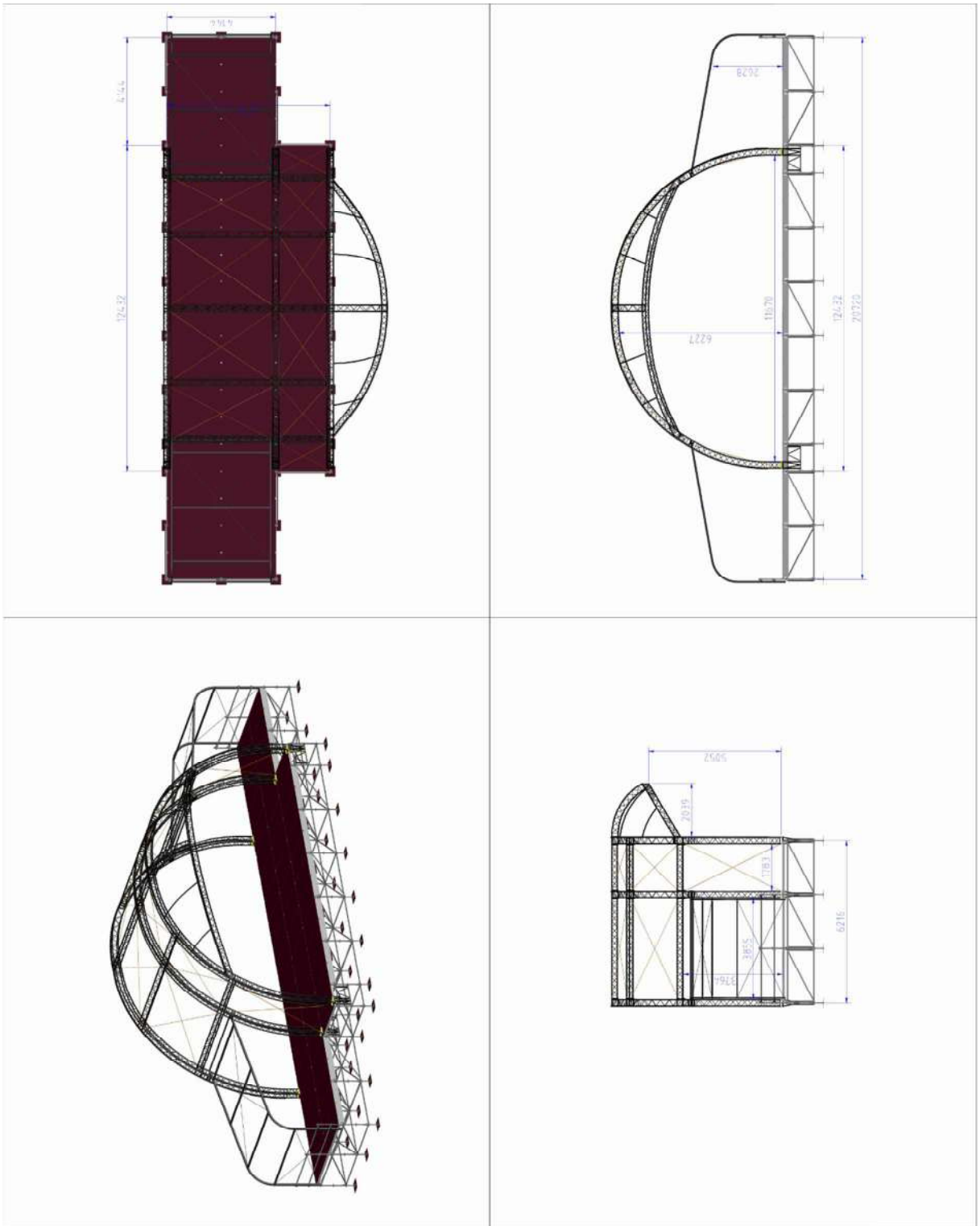
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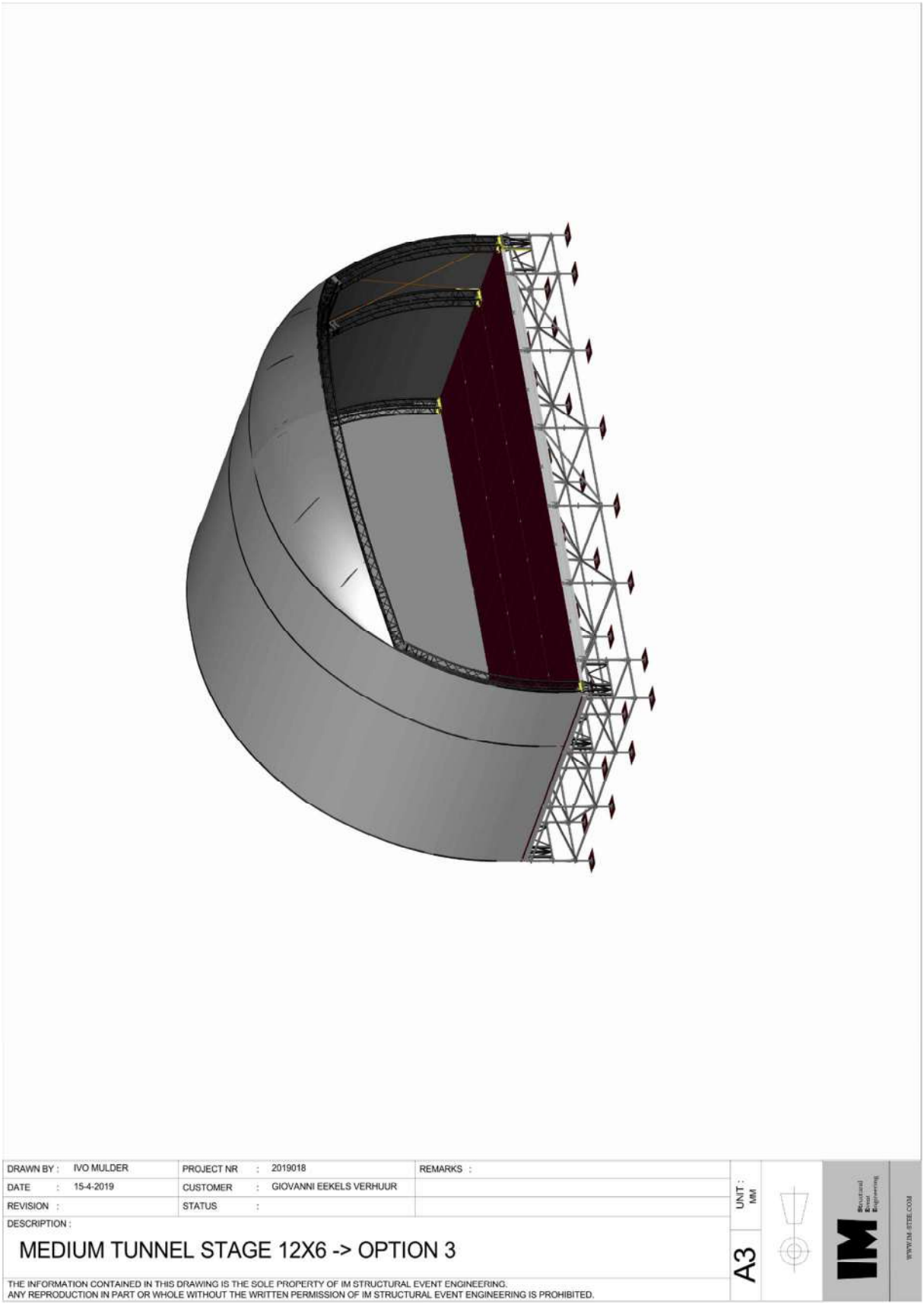
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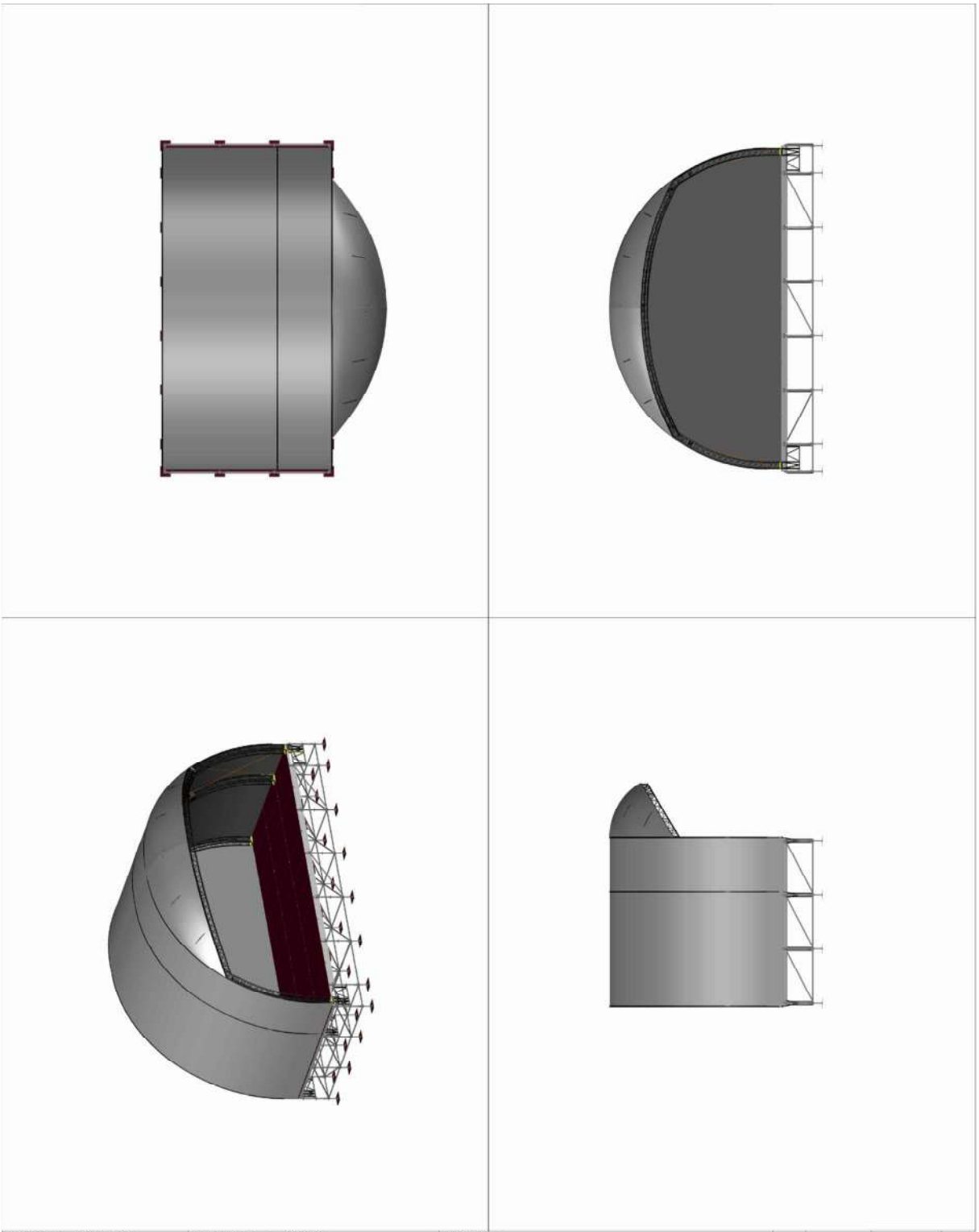
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1.2.3 Medium tunnel stage 12x6 Option 3.





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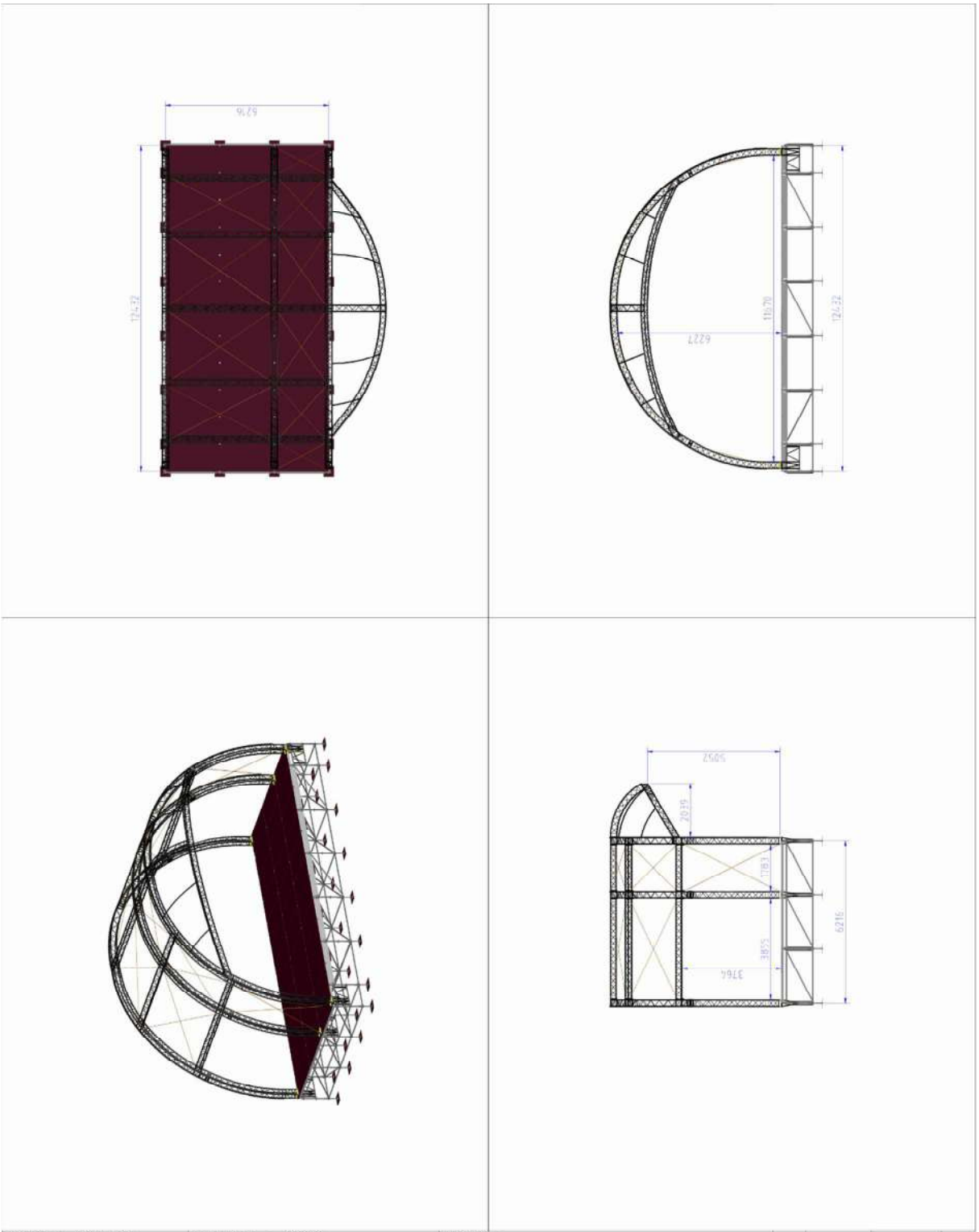
MEDIUM TUNNEL STAGE 12X6 -> OPTION 3

UNIT : MM

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DESCRIPTION :

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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 these 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.

Truss	Interal Protruss S31
Stage	Layher Event system K2000

Connection between roof and stage is made by special steel adapters.

The cross wires are made from ratchet straps with a Load capacity of 25 Kn.

1.6 Load assumptions.

1.6.1 Wind loading.

According to the Eurocode 13814, two wind situation calculations have to be made for a temporary demountable structure. The first situation has a wind speed from 0 to 21 m/s and is called the In-service situation and the second situation has a wind speed from 21 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 back wall is mounted. 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 21 m/s the back wall and big scenery objects need to be removed, so the wind can pass underneath the roof. 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 site 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 5 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 1.5-meter floor level is just below 8 meters, only the table from 0 < 8 m is presented on the next page.

When only the Medium tunnel stage option 3 is build, it is necessary to install cross wires in the front and the back of the system in the Out-service wind conditions. This for the structural integrity and stability of the system.

1.6.2 In-service situation.

The 21 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	Vb 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.

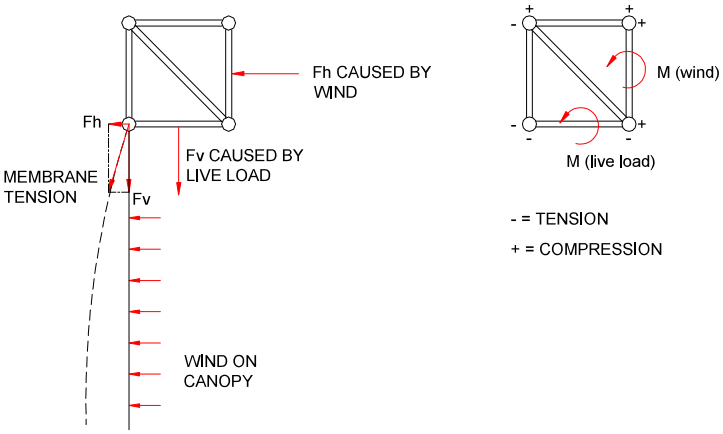
The 28m m/s which is mentioned as the maximum wind gust for the Out-service situation is based on an average between the wind gust 26.46 m/s for 0 < 8 m and the wind gust 31.62 m/s for 8 < 20 m. The wind pressure which is mentioned in the table below is increased with 20 % in comparison to the Eurocode 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	Vb 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

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.

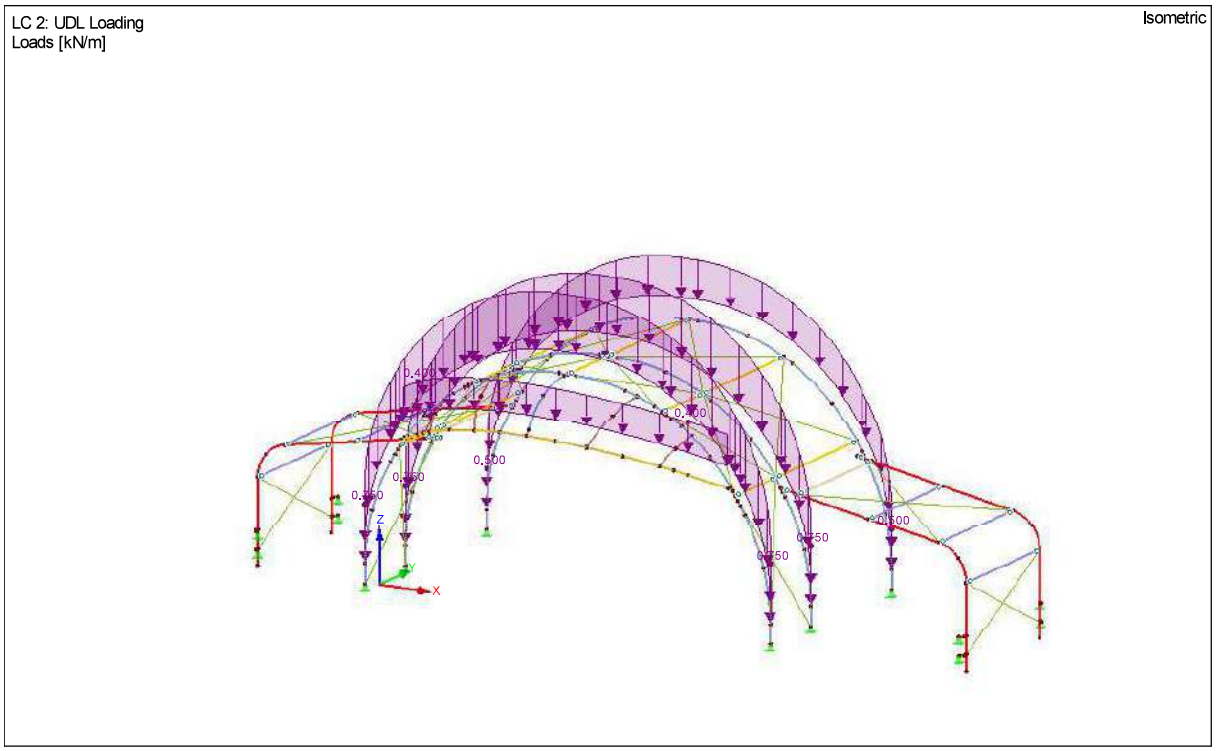
1.6.6 Live load.

In this structural report there are Live load configurations presented. These are intended to give an indication of the Rigging possibilities in the construction. If the actual loading of the construction deviates from these Rigging plots an additional calculation need to be made.
The shifting of Rigging point can influence the maximum loading of the construction.
Each Rigging point need to be attached to the node point of the truss.

1.7 Loading Configurations.

In the next 4 paragraphs the different live load configurations are presented. These loads are possible in all the roof setup options. Additional two PA wing could be installed with each PA wing two point loads of 800 kg

1.7.1 UDL Loading setup.

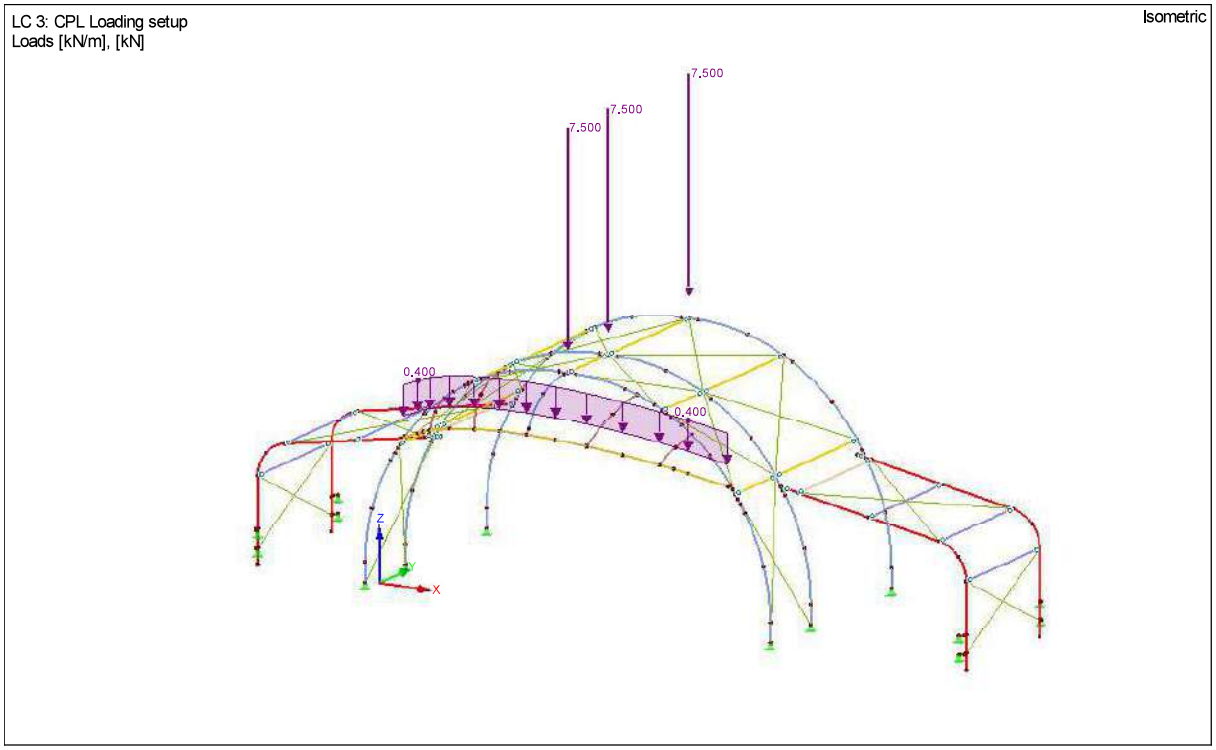


The loading which is taken into account in the UDL Loading setup are:
Truss 1 = 75 kg/m
Truss 2 = 75 kg/m
Truss 3 = 50 kg/m

Cantilever truss 40 kg/m

The total load on the main system is ~ 4350 Kg

1.7.2 Center point load per truss arch.

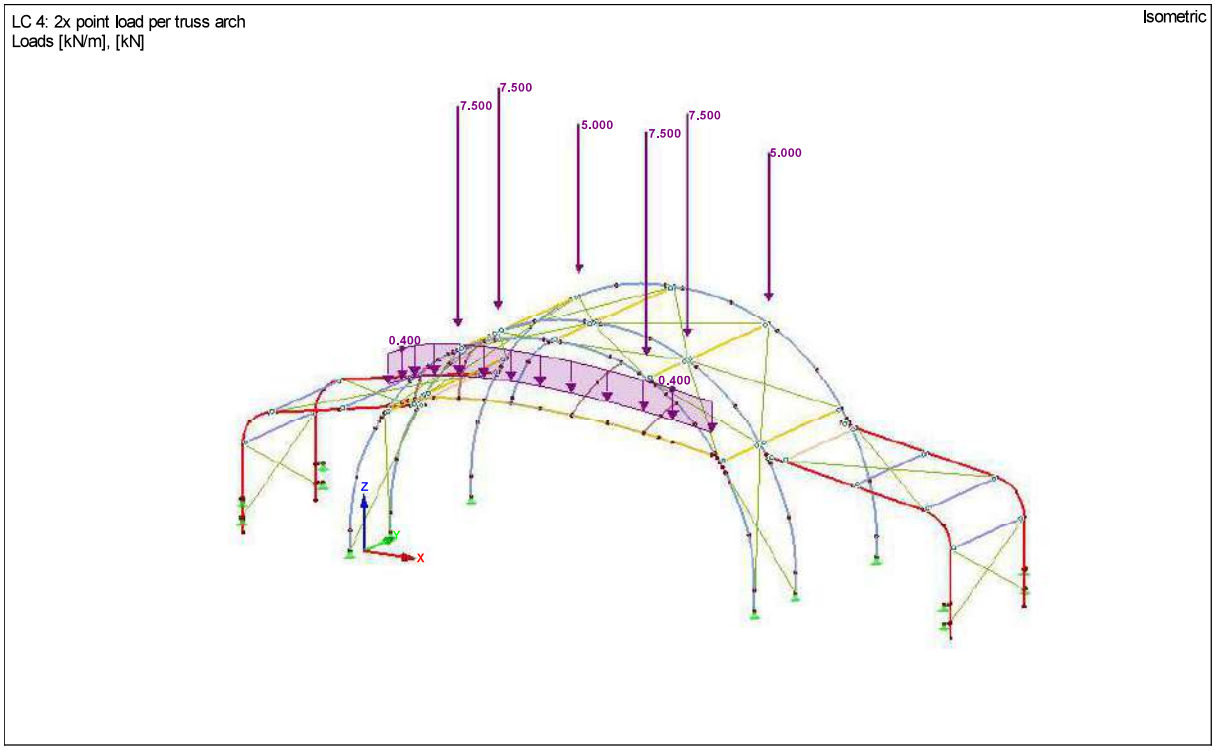


The loading which is taken into account in the Centre point Load setup are:
Truss 1 = 750 kg
Truss 2 = 750 kg
Truss 3 = 750 kg

Cantilever truss 40 kg/m

The total load on the main system is ~ 2675 Kg

1.7.3 2x Point loads per truss arch.

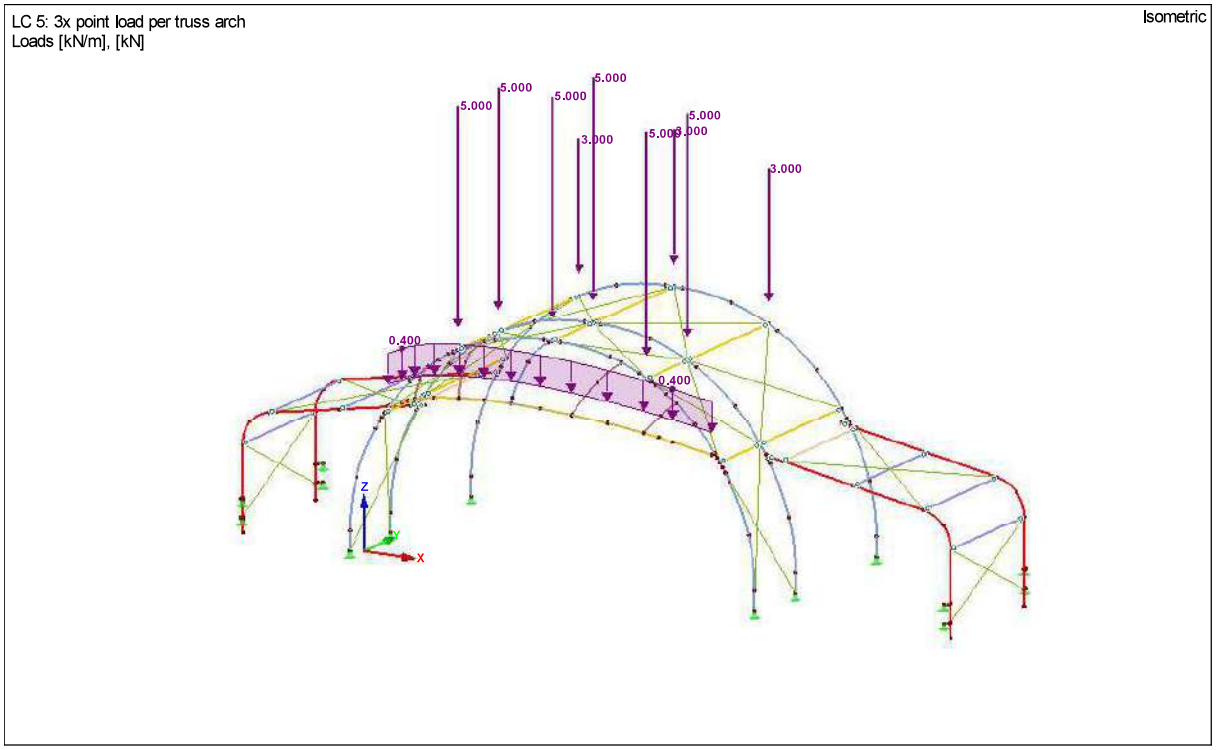


The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 2 x 750 kg
Truss 2 = 2 x 750 kg
Truss 3 = 2 x 500 kg

Cantilever truss 40 kg/m

The total load on the main system is ~ 4400 Kg

1.7.4 3x Point loads per truss arch.



The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 3 x 500 kg
Truss 2 = 3 x 500 kg
Truss 3 = 3 x 300 kg

Cantilever truss 40 kg/m

The total load on the main system is ~ 4300 Kg

1.8 Necessary Ballast loading.

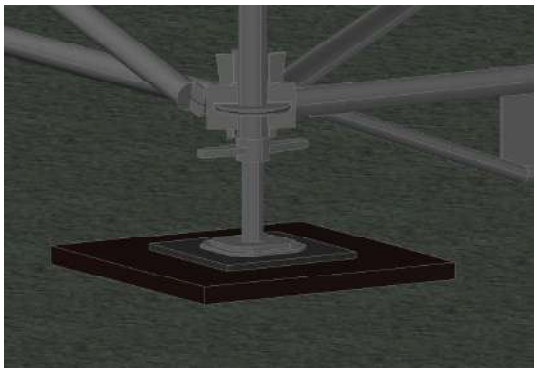
The ballast will be checked for uplift, overturning and sliding. The Layher stage which is designed as a ridged stage will be taken into account.

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

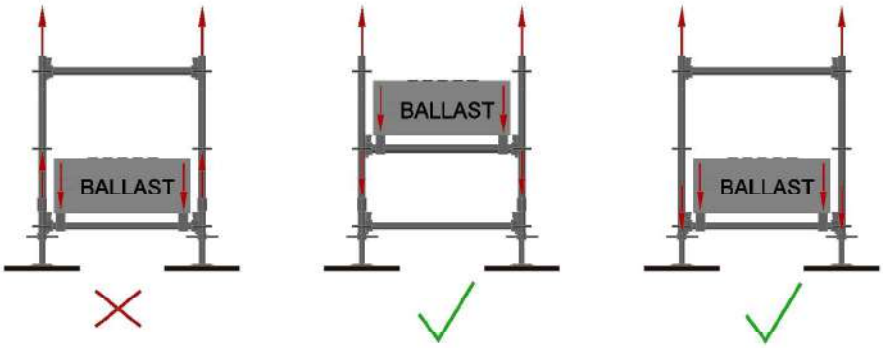
The safety factor for the ballast calculation against slipping is set to 1.2 according to the NEN-EN 13814. This is based on a horizontal load which is relying on friction.
For the friction coefficient the factor of 0.6 has been taken into account.
The Ballast calculation with factor 0.6 can be justified because rubber underlayment plate is used.

Table 3 — Coefficients of friction μ

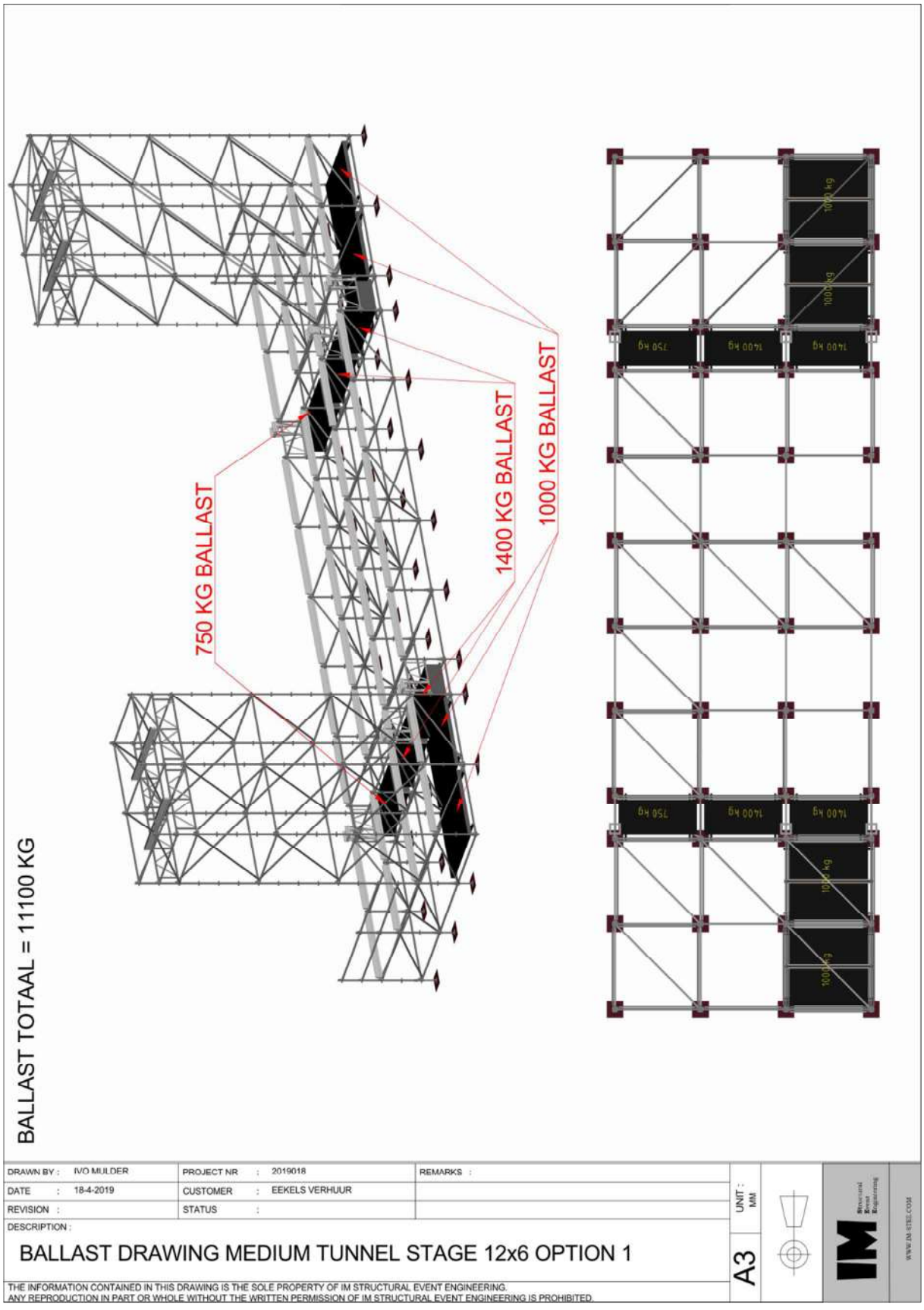
	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay[a]	0,25	0,2	0,25
Loam[a]	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65
[a] At least of stiff consistency in accordance with ENV 1997-1.			



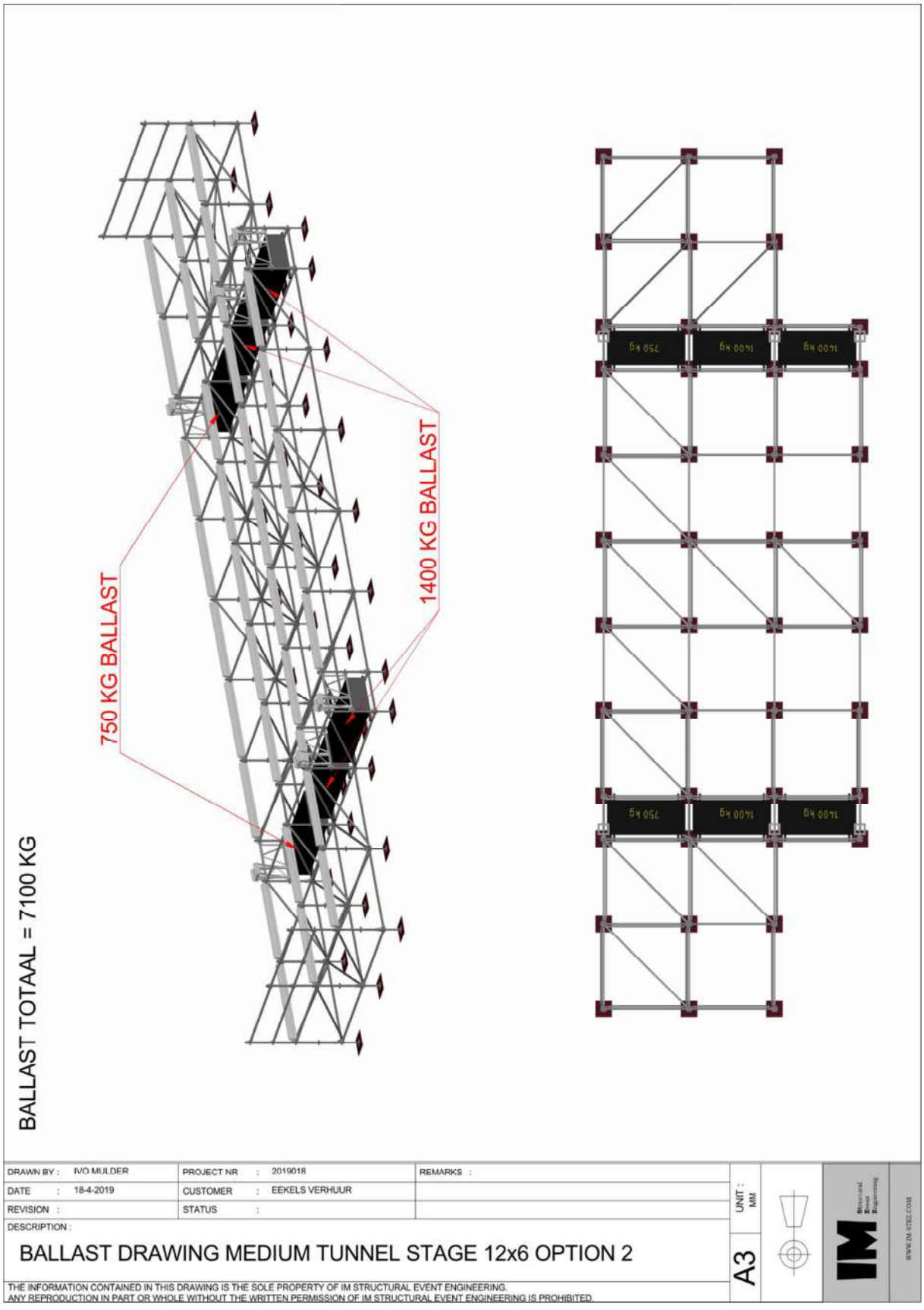
The ballast need to be placed in such a way that it will be activated when lifting forces are applied. If the ballast is placed on the bottom level the use of Layher uprights with connected base collar is necessary.



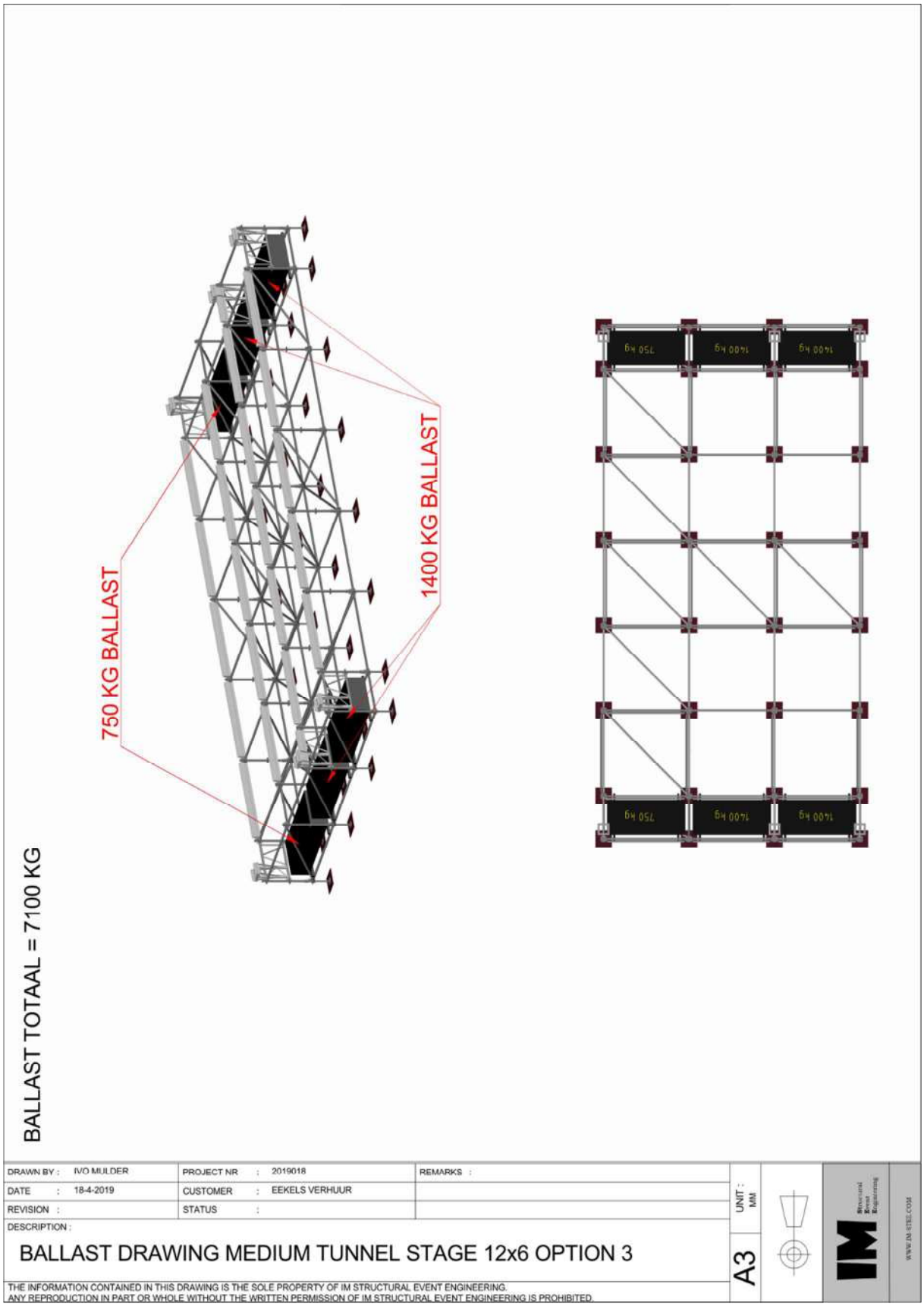
Ballast drawing Medium tunnel stage 12x6 Option 1.



Ballast drawing Medium tunnel stage 12x6 Option 2.



Ballast drawing Medium tunnel stage 12x6 Option 3.

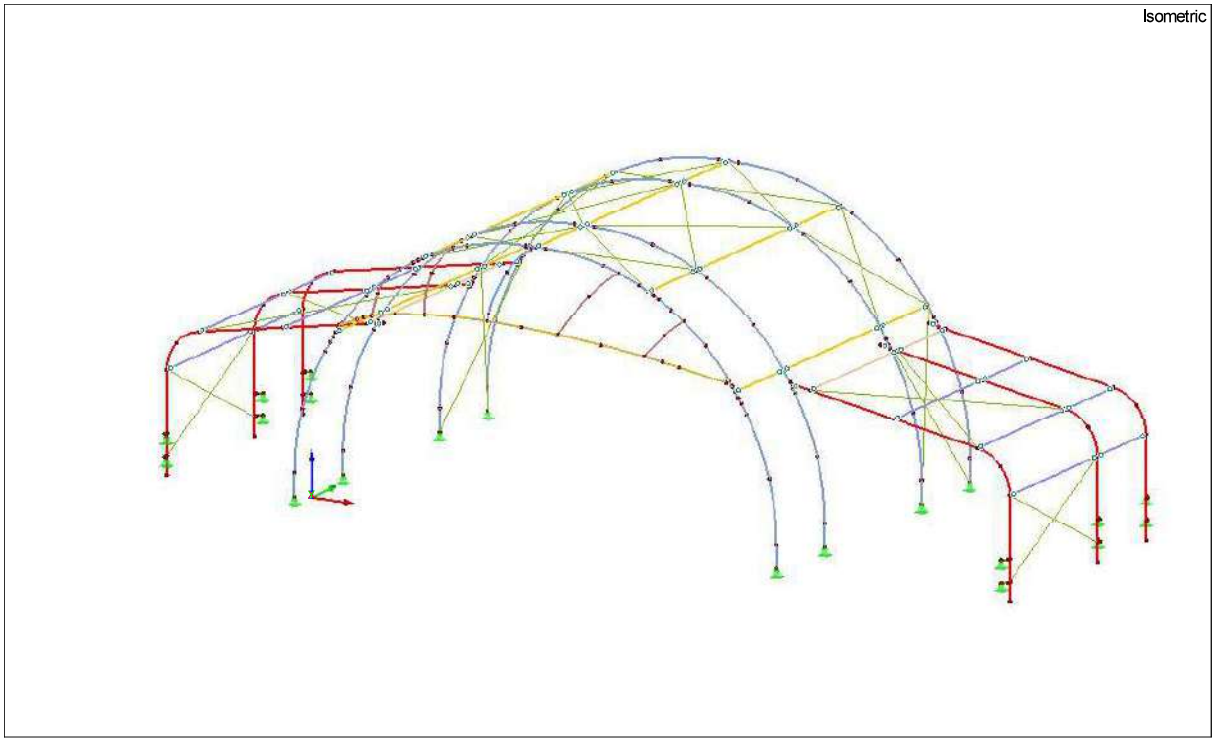


2.0 General calculation input.

2.1 Information About the calculation program.

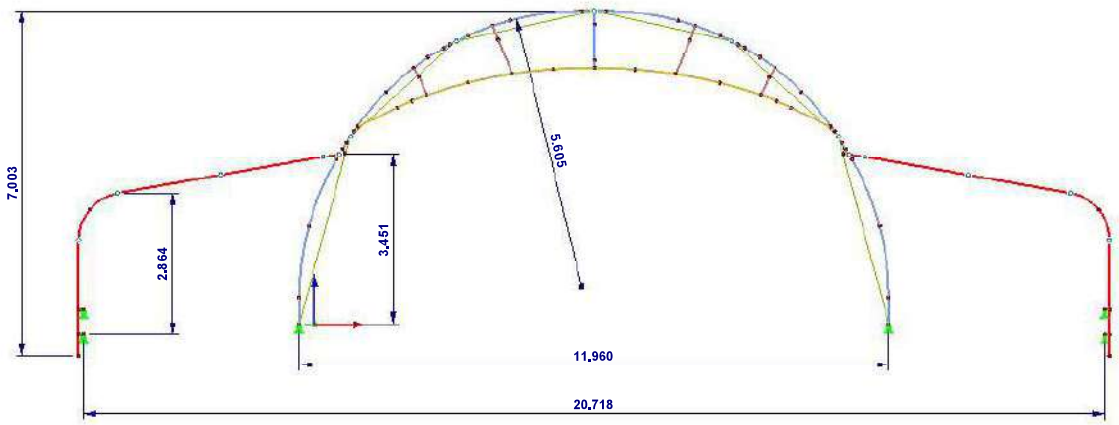
For the calculation of the construction the program RFem from Dlubal software GmbH has been used. The calculation of the Load cases has been made according to the Geometrically Linear analyses principle. The calculation of the Load combinations has been made according to the second order analysis (nonlinear) principle.

2.2 Construction model of the Medium Tunnel Roof 12x6 setup option 1 and 2.

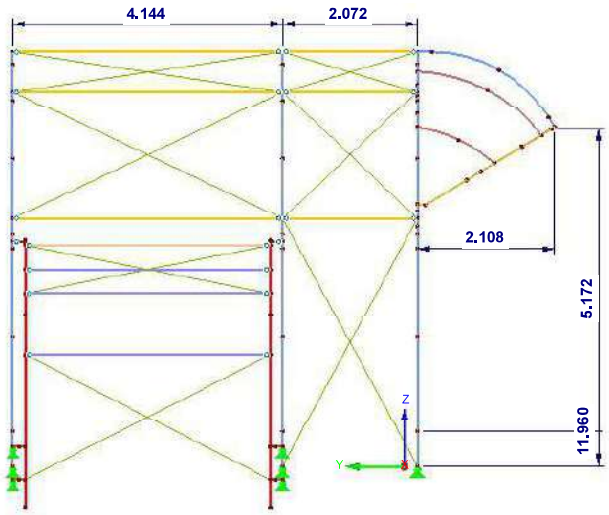


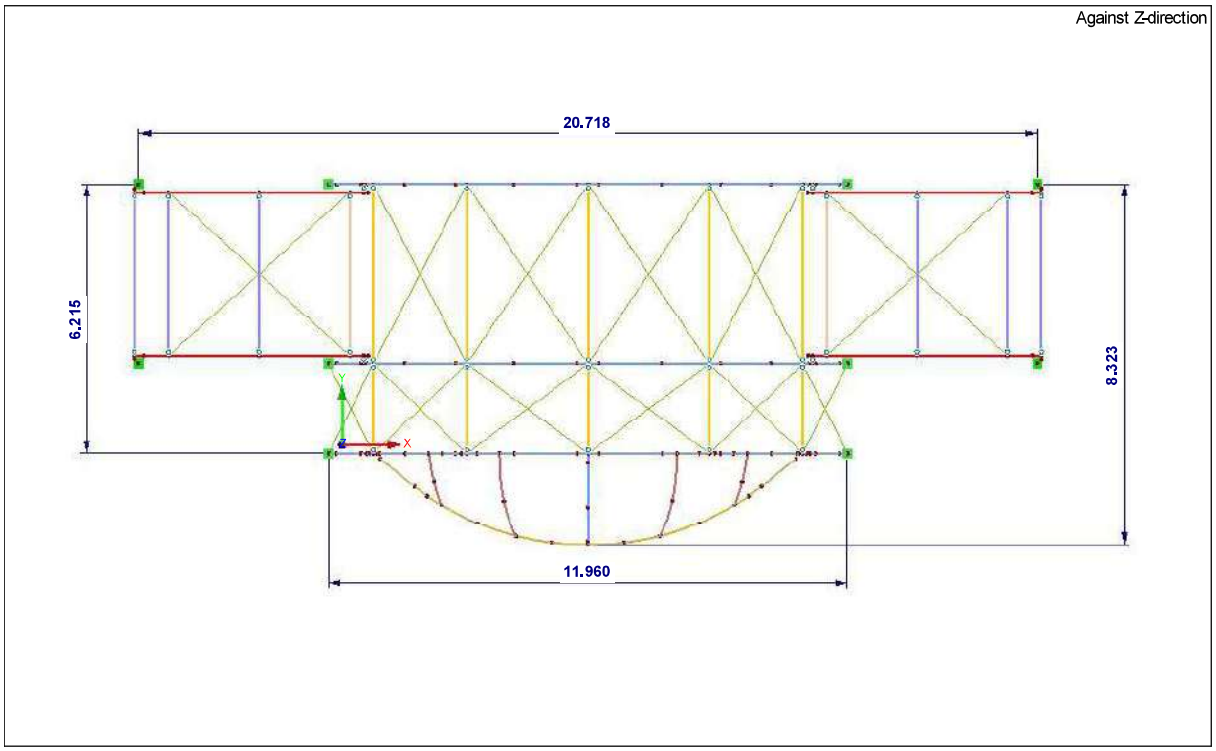
Cross-Sections
- 1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
- 2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
- 3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 4: RD 10; steel 8.8 kw aliteit
- 5: roder keder profiel 80x61x3; Aluminum EN-AW 6061 (ET,EP,ER/B) T6
- 6: HK 50/50/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 7: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 8: RD 20; steel 8.8 kw aliteit
- 9: Ring 60/5; Aluminum EN-AW 6082 (EP,ET) T6

In Y-direction



In X-direction




Against Z-direction
20.718
6.215
8.323
11.960
Y
X

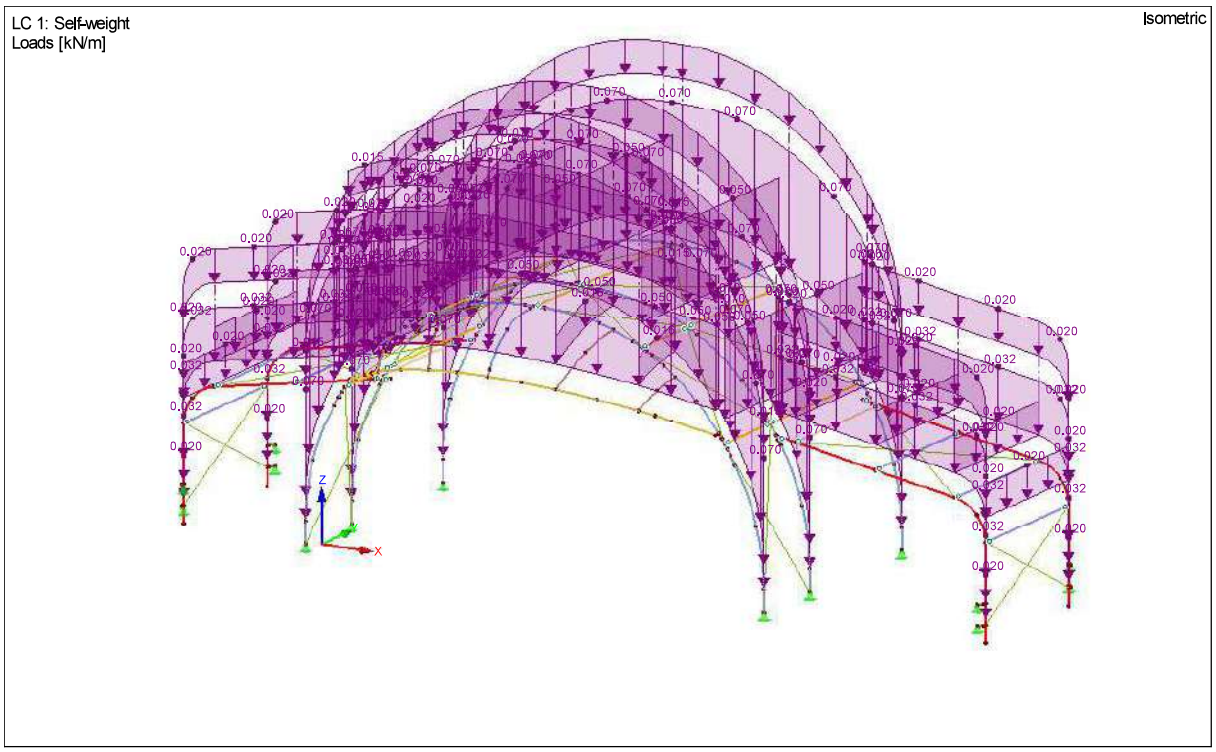
2.3 Single Load cases model option 1 and 2.

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

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self-weight	+	Permanent	-	0,000	0,000	-1,000
LC2	UDL Loading	+	Permanent/Imposed	-	0,000	0,000	0,000
LC3	CPL Loading setup	+	Permanent/Imposed	-	0,000	0,000	0,000
LC4	2x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC5	3x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC10	In-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC11	In-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC12	In-service wind 180°	+	Wind	-	0,000	0,000	0,000
LC13	Out-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC14	Out-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC15	Out-service wind 180°	+	Wind	-	0,000	0,000	0,000

2.4 load case input model option 1 and 2.

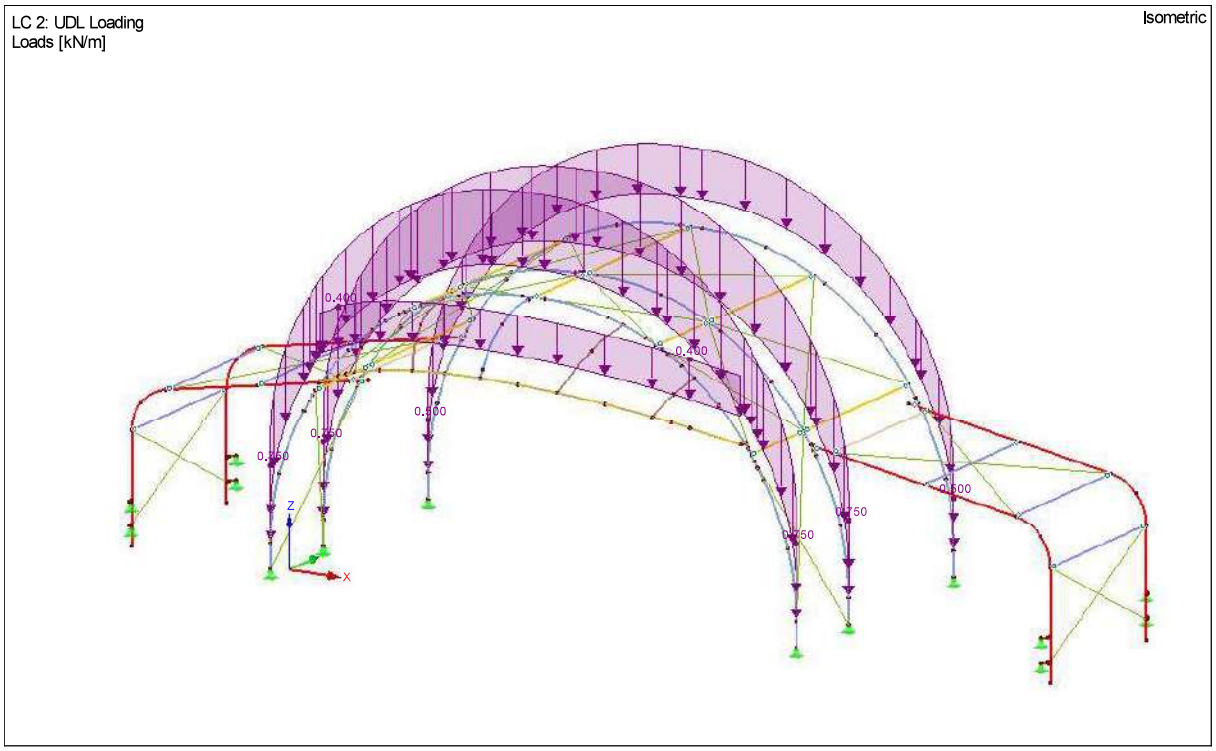
2.4.1 LC1 Self-Weight.



Interal Protruss S31 = 0.07 kN/m^{-1}
Interal Protruss T31 = 0.05 kN/m^{-1}
Keder Profile 80x61 = 0.032 kN/m^{-1}
Tube 50x4 = 0.016 kN/m^{-1}
Tube 60x5 = 0.02 kN/m^{-1}

Canopy truss1 + cantilever truss = 0.015 kN/m^{-1}
Canopy truss2 + truss3 = 0.02 kN/m^{-1}
Canopy keder profile side stage = 0.02 kN/m^{-1}

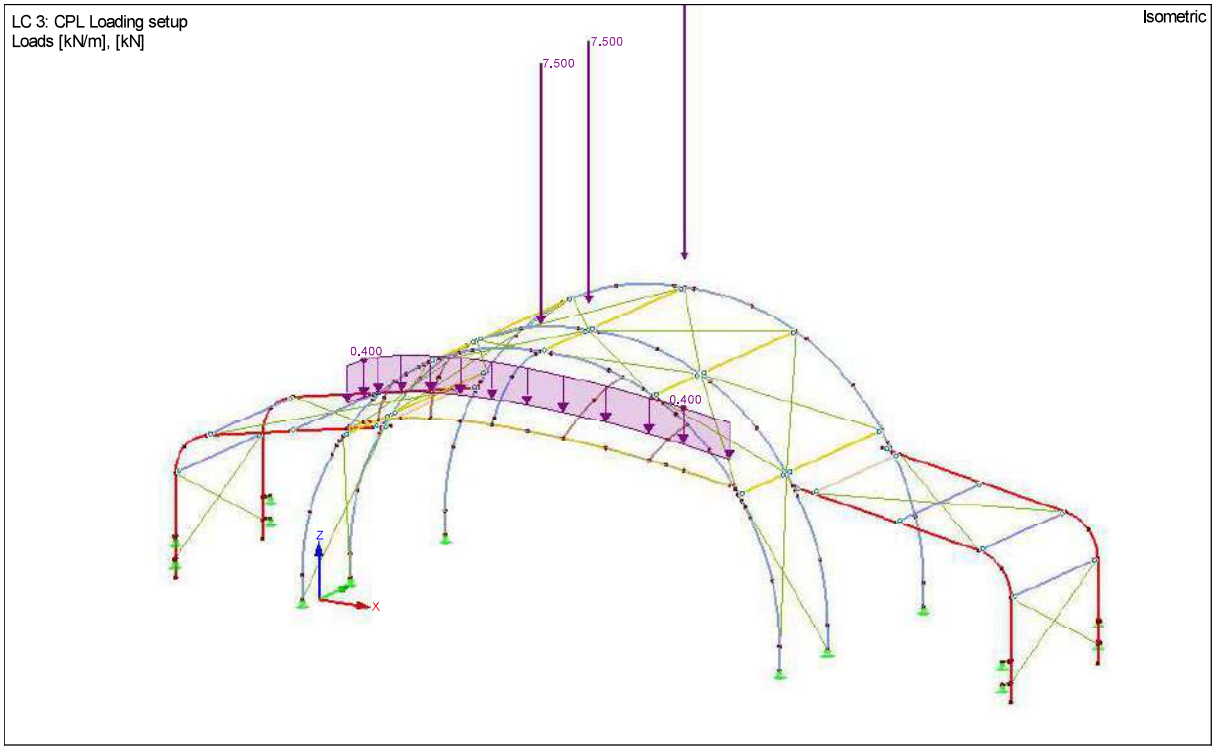
2.4.2 LC2 UDL Loading setup.



The loading which is taken into account in the UDL Loading setup are:
Truss 1 = 0.75 kN/m^{-1}
Truss 2 = 0.75 kN/m^{-1}
Truss 3 = 0.50 kN/m^{-1}

Cantilever truss 0.40 kN/m^{-1}

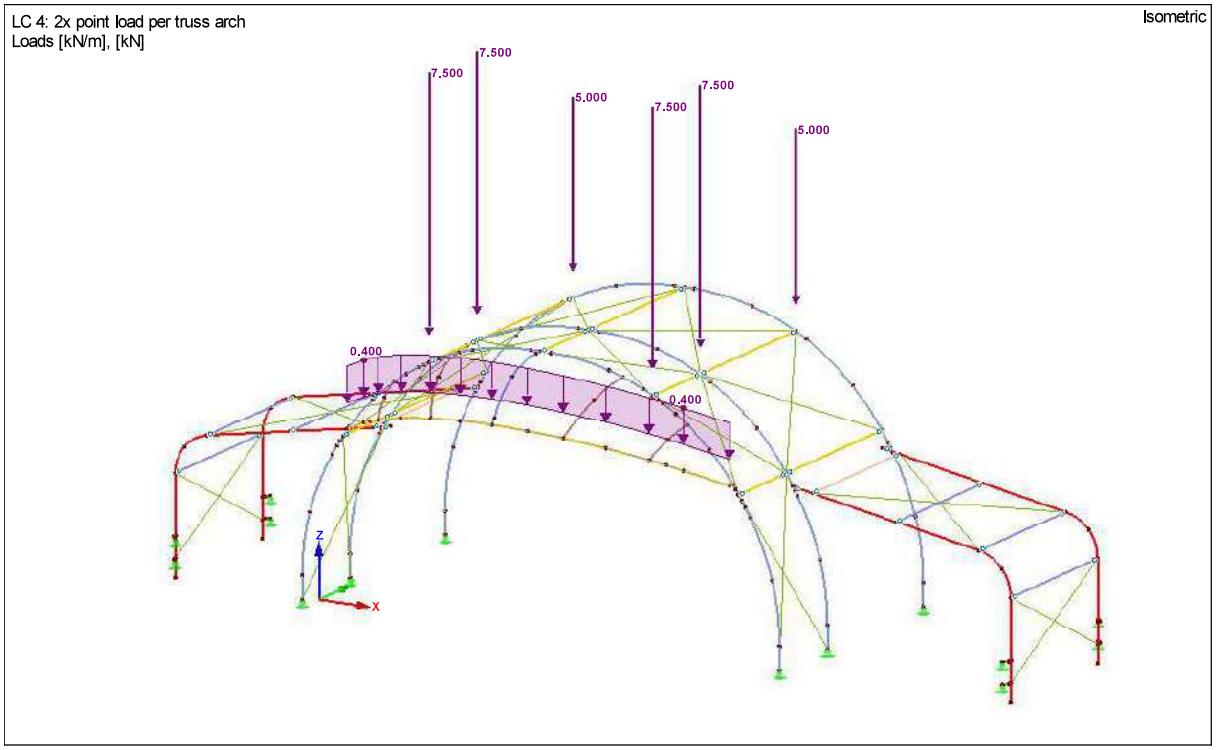
2.4.3 LC3 Center point load per truss arch.



The loading which is taken into account in the Centre point Load setup are:
Truss 1 = 7.50 kN
Truss 2 = 7.50 kN
Truss 3 = 7.50 kN

Cantilever truss 0.40 kN/m^{-1}

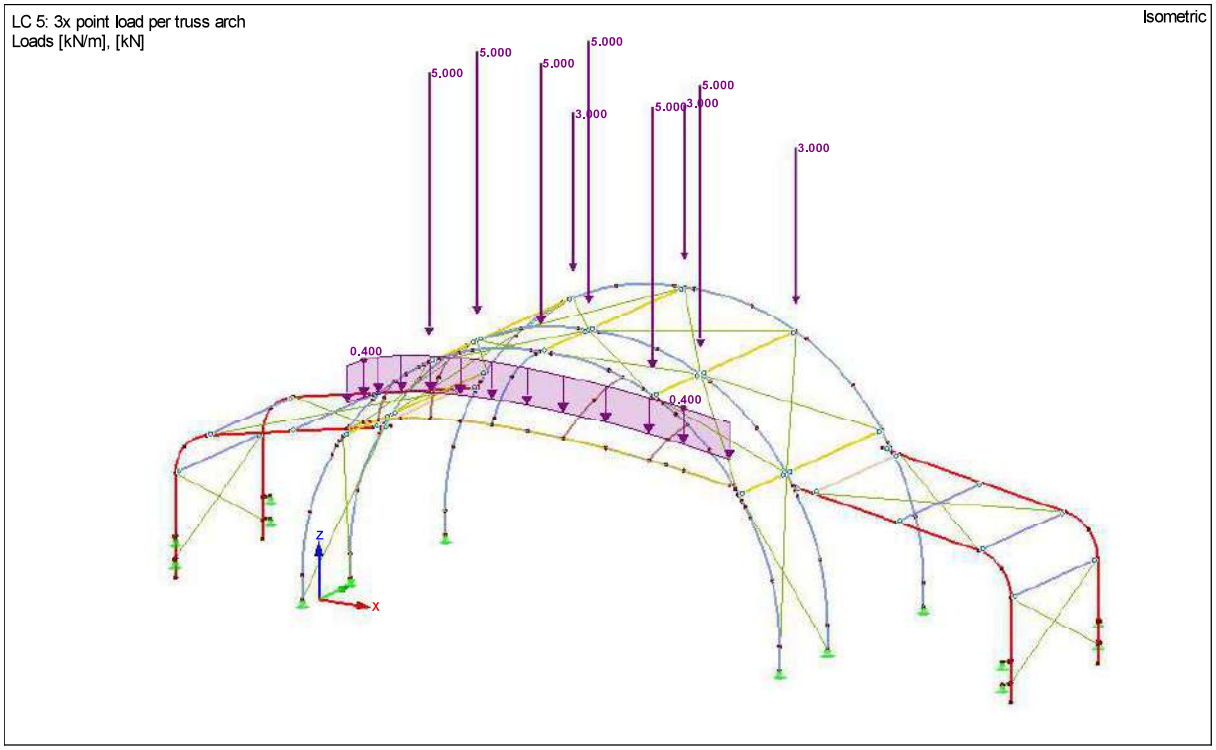
2.4.4 LC4 2x Point loads per truss arch.



The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 2 x 7.50 kN
Truss 2 = 2 x 7.50 kN
Truss 3 = 2 x 5.00 kN

Cantilever truss 0.40 kN/m^{-1}

2.4.5 LC5 3x Point loads per truss arch.

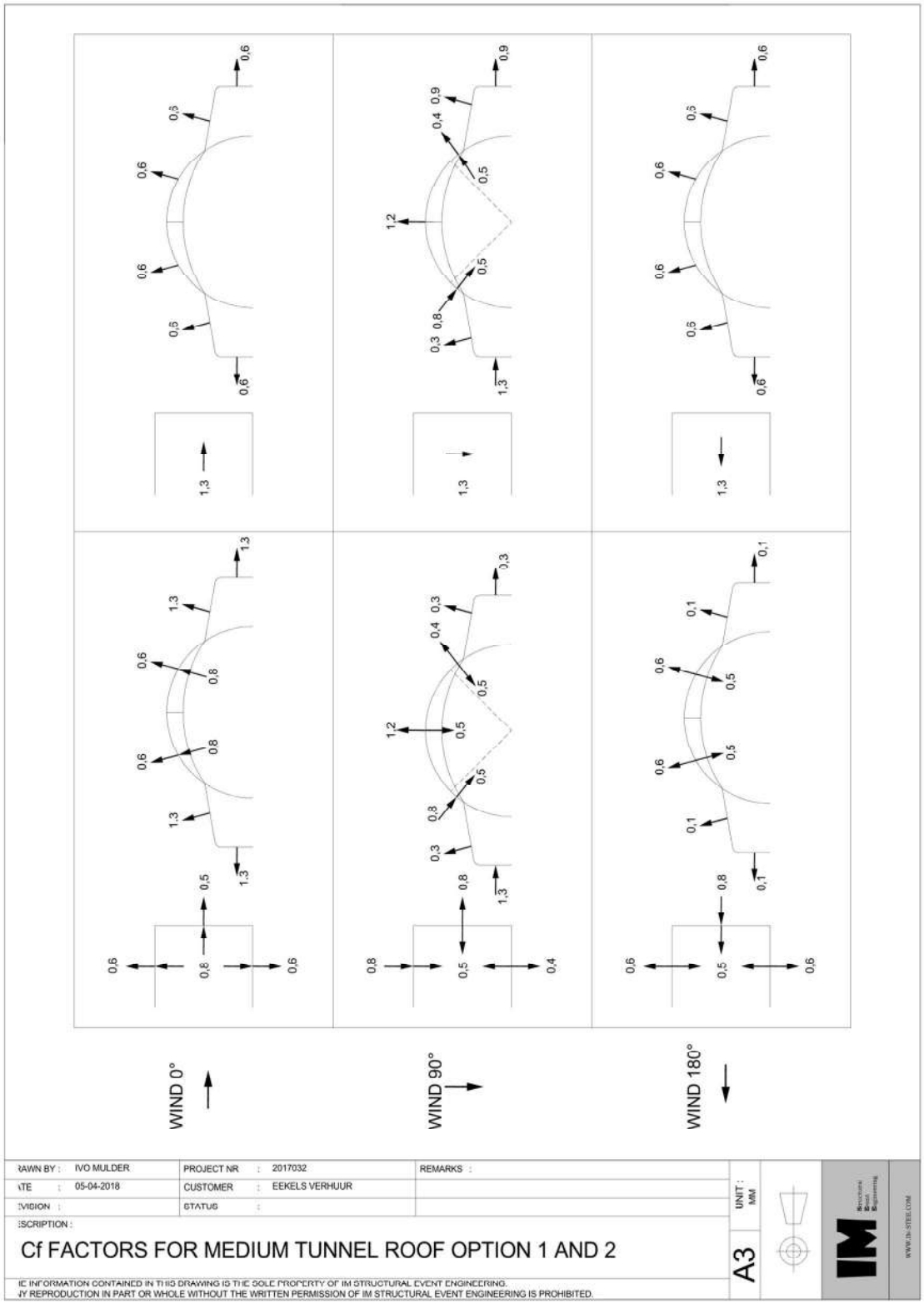


The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 3 x 5.00 kN
Truss 2 = 3 x 5.00 kN
Truss 3 = 3 x 3.00 kN

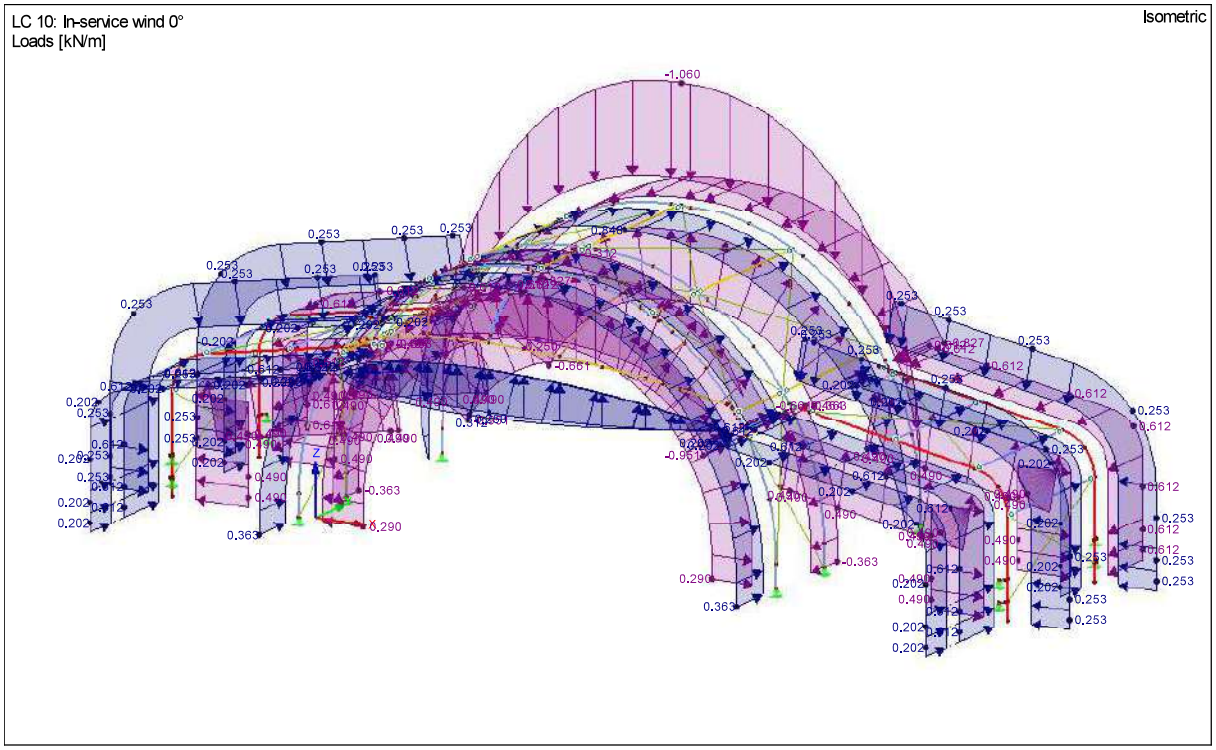
Cantilever truss 0.40 kN/m^{-1}

2.5 Load cases concerning wing loading model option 1 and 2.

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 NEN-EN 13814: Fairground and amusement park machinery and structures safety.



2.5.1 load case 10 In-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 1.4 * 0.2 * 1.036 = 0.290$ kN/m
$q_{w,\ roof\ truss\ 2} = 1.4 * 0.2 * 3.398 = 0.951$ kN/m
$q_{w,\ roof\ truss\ 3} = 1.4 * 0.2 * 2.072 = 0.661$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.290 / 0.8 = 0.363$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.951/0.8) - (0.290 / 0.8) = 0.464$ kN/m
$q_{mt,\ roof\ truss\ 3} = 0.661 / 0.8 = 0.827$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.2 * 2.5 * 0.5 = 0.25 kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.2 * 0 = 0 kN/m

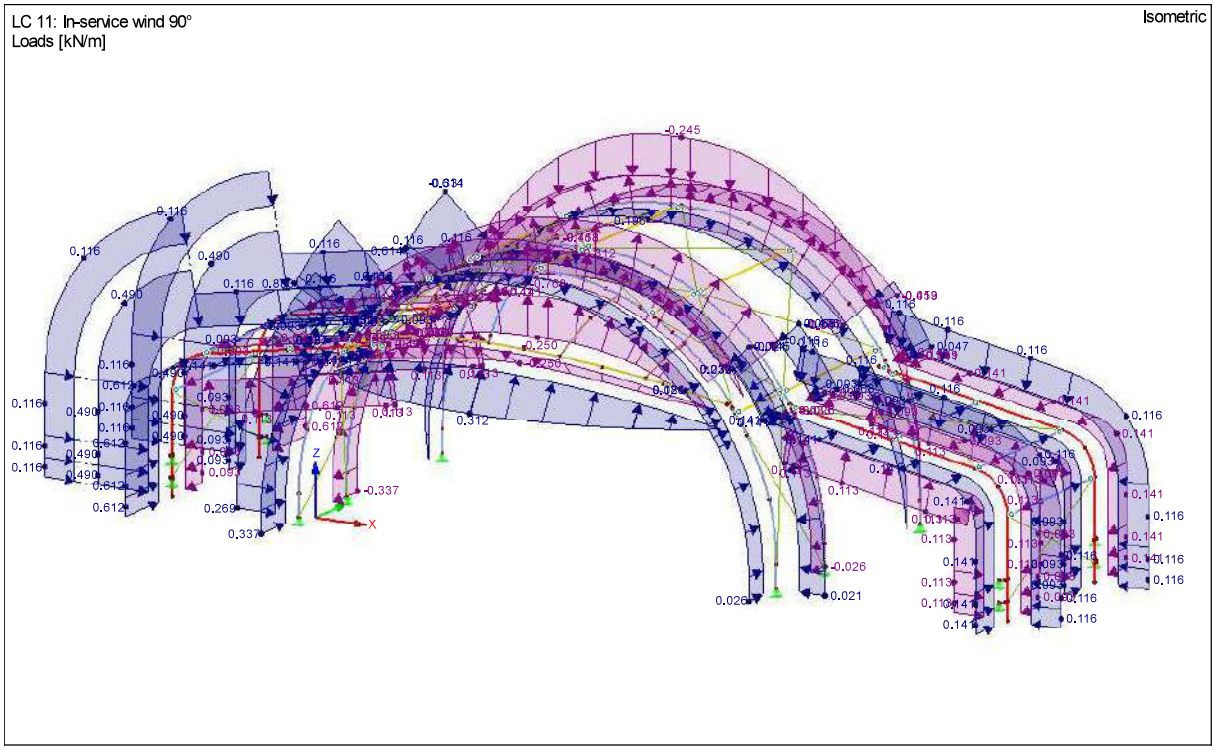
Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.25 / 0.8 = 0.312 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1}$ = 1.3 * 0.2 * 1.883 = 0.490 kN/m
$q_{w,\ profile\ 2}$ = 1.3 * 0.2 * 1883 = 0.490 kN/m

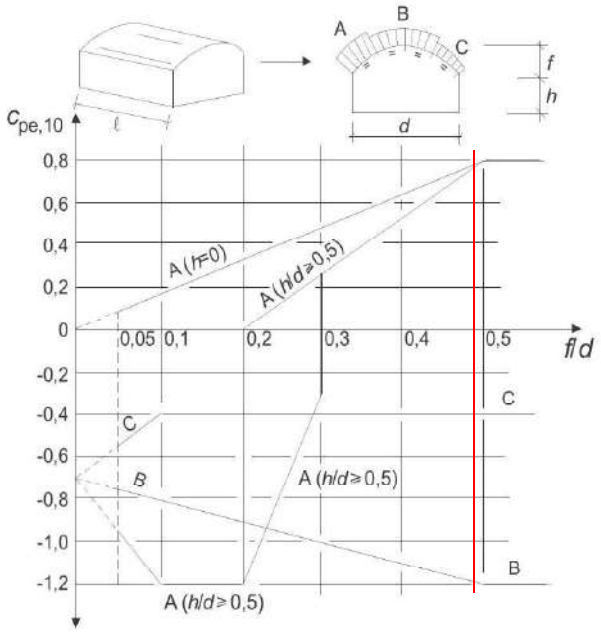
Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1}$ = 0.490 / 0.8 = 0.612 kN/m
$q_{mt,\ profile\ 2}$ = 0.490 / 0.8 = 0.612 kN/m

Side stage front and back canopy
The front and back Canopy are attached to Profile and Layher.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 1.3 * 0.2 * 12.13 = 3.154 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 3.154 / 2 / 7.81= 0.202 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.202 / 0.8 = 0.253 kN/m

2.5.2 load case 11 In-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling the structure down.
The result of these two forces are
A = -1.3 B = 0.7 C = -0.1

Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.2 * 1.036 = 0.269$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 0.7 * 0.2 * 1.036 = 0.145$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.2 * 3.398 = 0.883$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 0.7 * 0.2 * 3.398 = 0.476$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.2 * 2.072 = 0.614$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 0.7 * 0.2 * 2.072 = 0.331$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.1 * 0.2 * 2.072 = 0.047$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.269 / 0{,}8 = 0.337$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.145 / 0.8 = 0.181$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.020 / 0.8 = 0.026$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (0.614 / 0.8) - (0.269 / 0.8) = 0.431$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (0.331 / 0.8) - (0.145 / 0.8) = 0.232$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.047 / 0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\text{ roof truss 3 section A}} = 0.614 / 0{,}8 = 0.768$ kN/m
$q_{mt,\text{ roof truss 3 section B}} = 0.331 / 0.8 = 0.413$ kN/m
$q_{mt,\text{ roof truss 3 section C}} = 0.047 / 0.8 = 0.059$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\text{ back wall mid}} = 0.3 * 0.2 * 6.525 * 0.5 = 0.196$ kN/m
$q_{w,\text{ back wall side}} = 0.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\text{ back wall mid}} = 0.196 / 0.8 = 0.245$ kN/m
$q_{mt,\text{ back wall side}} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\text{ cantilever mid}} = 1 * 0.2 * 2.5 * 0.5 = 0.25$kN/m
$q_{w,\text{ cantilever side}} = 1 * 0.2 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.25 / 0.8 = 0.312 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on side stage area's
Wind calculations of the side stage canopy windward side.
$q_{w,\ profile\ 1\ side}$ = 1.3 * 0.2 * 1.883 = 0.490 kN/m
$q_{w,\ profile\ 1\ roof}$ = 0.3 * 0.2 * 1.883 = 0.113 kN/m
$q_{w,\ profile\ 2\ side}$ = 1.3 * 0.2 * 1.883 = 0.490 kN/m
$q_{w,\ profile\ 2\ roof}$ = 0.3 * 0.2 * 1.883 = 0.113 kN/m

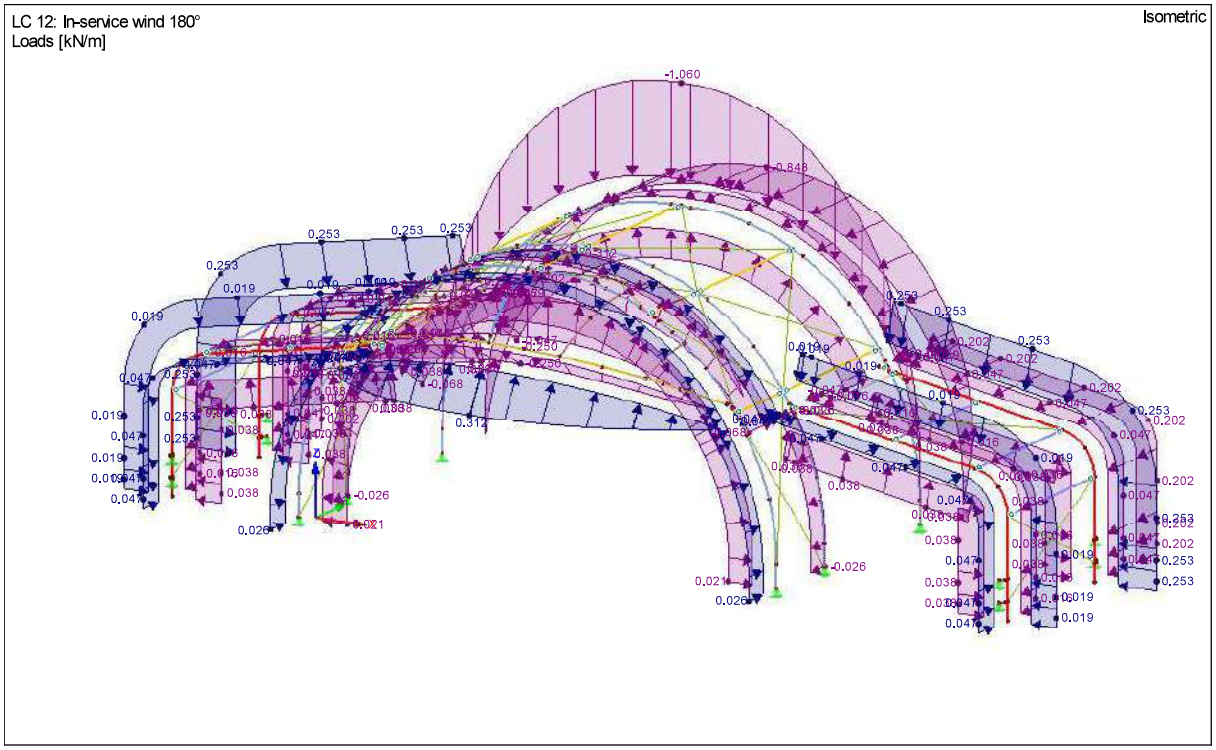
Membrane tension of the side stage canopy windward side.
$q_{mt,\ profile\ 1\ side}$ = 0.490 / 0.8 = 0.612 kN/m
$q_{mt,\ profile\ 1\ roof}$ = 0.113 / 0.8 = 0.141 kN/m
$q_{mt,\ profile\ 2\ side}$ = 0.490 / 0.8 = 0.612 kN/m
$q_{mt,\ profile\ 2\ roof}$ = 0.113 / 0.8 = 0.141 kN/m

Wind calculations of the side stage canopy lee side.
$q_{w,\ profile\ 1}$ = 0.3 * 0.2 * 1.883 = 0.113 kN/m
$q_{w,\ profile\ 2}$ = 0.3 * 0.2 * 1.883 = 0.113 kN/m

Membrane tension of the side stage canopy lee side.
$q_{mt,\ profile\ 1}$ = 0.113 / 0.8 = 0.141 kN/m
$q_{mt,\ profile\ 2}$ = 0.113 / 0.8 = 0.141 kN/m

Side stage front and back canopy
The front and back Canopy are attached to Profile and Layher.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 0.3 * 0.2 * 12.13 = 0.728 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 0.728 / 2 / 7.81= 0.093 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.093 / 0.8 = 0.116 kN/m

2.5.3 load case 12 In-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.1 * 0.2 * 2.072 = 0.047$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.021 / 0.8 = 0.026$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.047/0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.047 / 0.8 = 0.059$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.2 * 2.5 * 0.5 = 0.25kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.2 * 0 = 0 kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.25 / 0.8 = 0.312 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

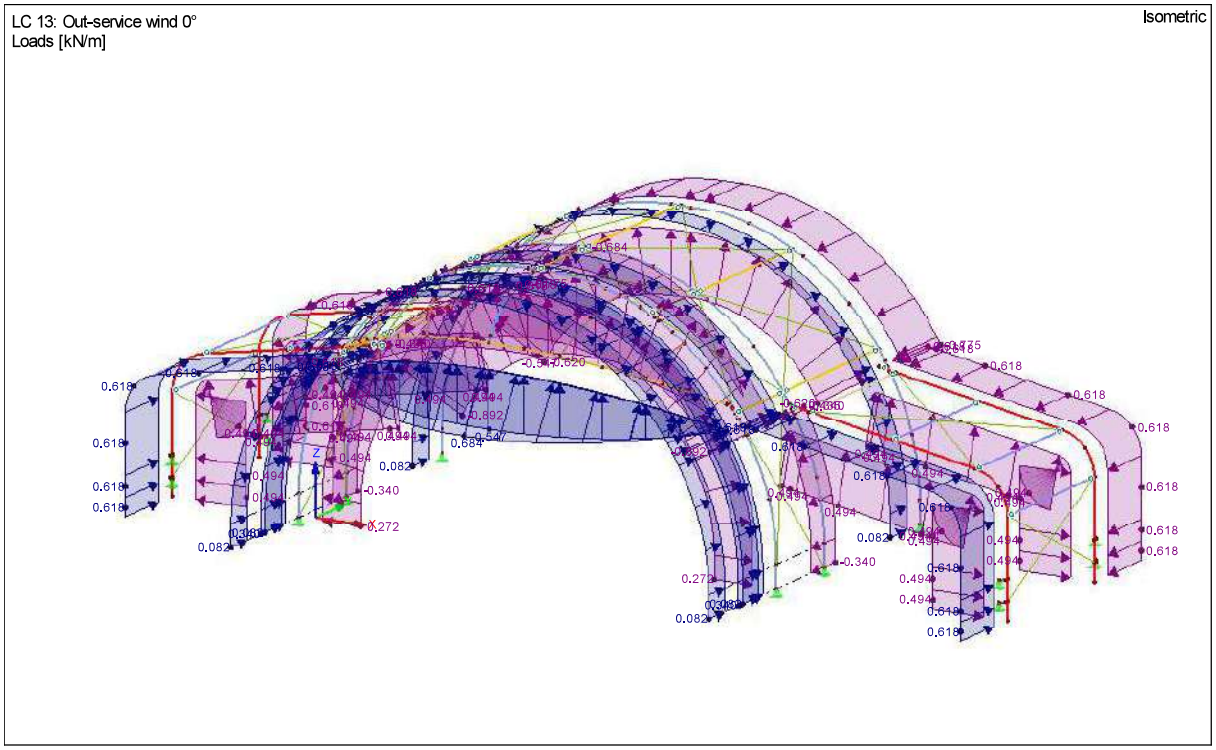
Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1}$ = 0.1 * 0.2 * 1.883 = 0.038 kN/m
$q_{w,\ profile\ 2}$ = 0.1 * 0.2 * 1.883 = 0.038 kN/m

Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1}$ = 0.038 / 0.8 = 0.047 kN/m
$q_{mt,\ profile\ 2}$ = 0.038 / 0.8 = 0.047 kN/m

Side stage front canopy
The front Canopy is attached to the Profile and Layher stage.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 0.1 * 0.2 * 12.13 = 0.243 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 0.243 / 2 / 7.81 = 0.016 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.016 / 0.8 = 0.019 kN/m

Side stage Back canopy
The Back Canopy is attached to the Profile and Layher stage.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 1.3 * 0.2 * 12.13 = 3.154 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 3.154 / 2 / 7.81 = 0.202 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.202 / 0.8 = 0.252 kN/m

2.5.4 load case 13 Out-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.6 * 0.4375 * 3.398 = 0.892$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.6 * 0.4375 * 2.072 = 0.620$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.272 / 0.8 = 0.340$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.620/0.8) - (0.272 / 0.8) = 0.435$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.620 / 0.8 = 0.775$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$kN/m
$q_{w,\ cantilever\ side} = 1 * 0.4375 * 0 = 0$ kN/m

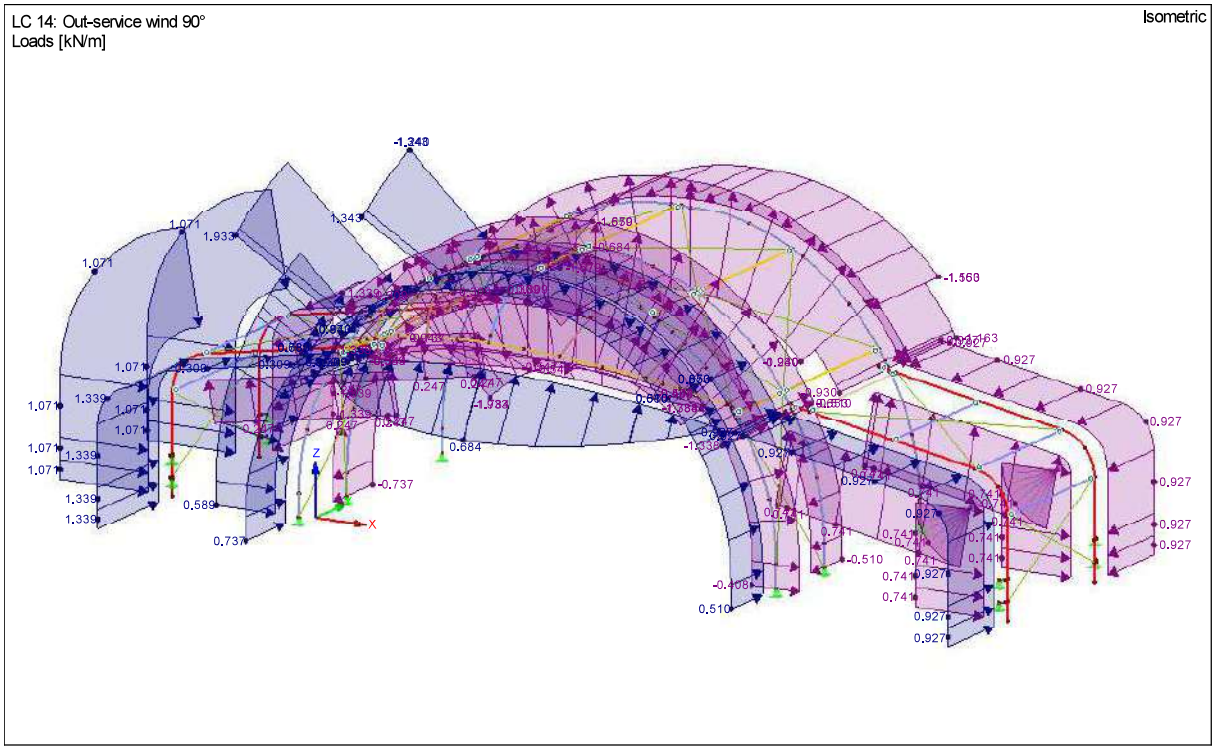
Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1} = 0.6 * 0.4375 * 1.883 = 0.494$ kN/m
$q_{w,\ profile\ 2} = 0.6 * 0.4375 * 1.883 = 0.494$ kN/m

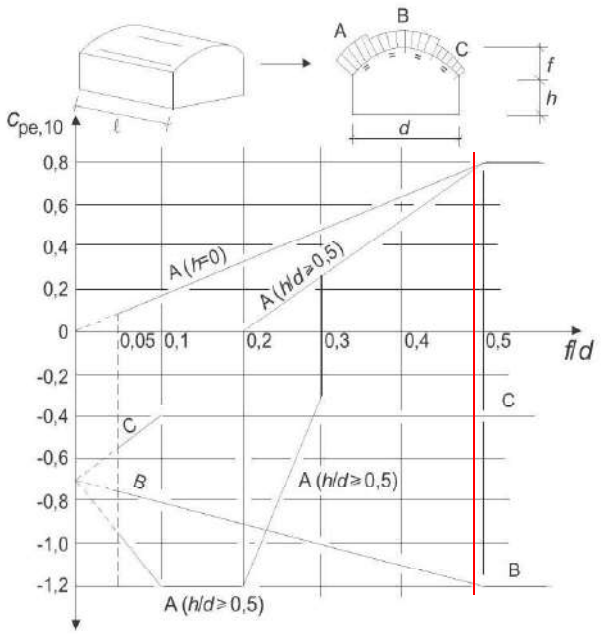
Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1} = 0.494 / 0.8 = 0.618$ kN/m
$q_{mt,\ profile\ 2} = 0.494 / 0.8 = 0.618$ kN/m

Wind on truss
$q_{w,\ truss} = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082$ kN/m

2.5.5 load case 14 Out-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling and pushing the structure.
The result of these two forces are
A = -1.3 B = 1.2 C = 0.9

Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.4375 * 1.036 = 0.589$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 1.2 * 0.4375 * 1.036 = 0.544$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.9 * 0.4375 * 1.036 = 0.408$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.4375 * 3.398 = 1.933$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 1.2 * 0.4375 * 3.398 = 1.784$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.9 * 0.4375 * 3.398 = 1.338$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.4375 * 2.072 = 1.343$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 1.2 * 0.4375 * 2.072 = 1.240$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.9 * 0.4375 * 2.072 = 0.930$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.589 / 0.8 = 0.737$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.544 / 0.8 = 0.680$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.408 / 0.8 = 0.510$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (1.343 / 0.8) - (0.589 / 0.8) = 0.943$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (1.240 / 0.8) - (0.544 / 0.8) = 0.870$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.930 / 0.8) - (0.408 / 0.8) = 0.653$ kN/m
$q_{mt,\text{ roof truss 3 section A}} = 1.343 / 0{,}8 = 1.679$ kN/m
$q_{mt,\text{ roof truss 3 section B}} = 1.240 / 0.8 = 1.550$ kN/m
$q_{mt,\text{ roof truss 3 section C}} = 0.930 / 0.8 = 1.163$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$ kN/m
$q_{w,\ cantilever\ side} = 1 * 0.4375 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

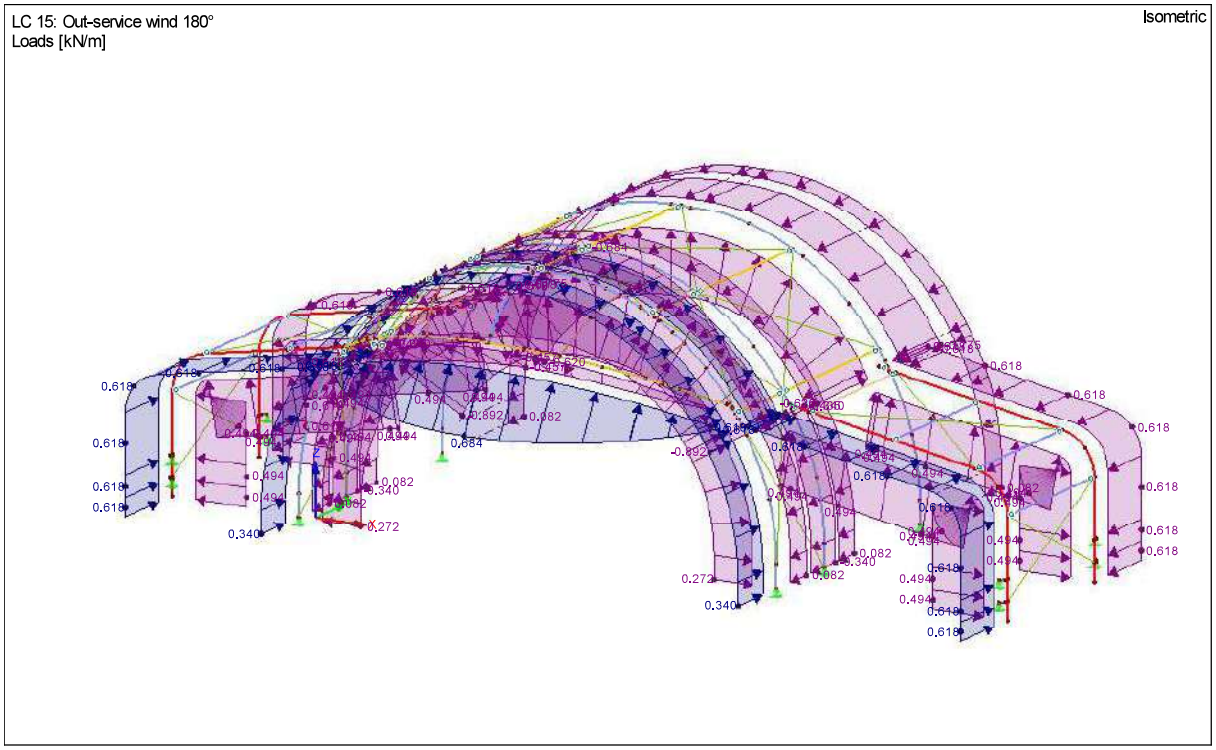
Wind on side stage area's
Wind calculations of the side stage canopy windward side.
$q_{w,\ profile\ 1\ side} = 1.3 * 0.4375 * 1.883 = 1.071$ kN/m
$q_{w,\ profile\ 1\ roof} = 0.3 * 0.4375 * 1.883 = 0.247$ kN/m
$q_{w,\ profile\ 2\ side} = 1.3 * 0.4375 * 1.883 = 1.071$ kN/m
$q_{w,\ profile\ 2\ roof} = 0.3 * 0.4375 * 1.883 = 0.247$ kN/m

Membrane tension of the side stage canopy windward side.
$q_{mt,\ profile\ 1\ side} = 1.071 / 0.8 = 1.339$ kN/m
$q_{mt,\ profile\ 1\ roof} = 0.247 / 0.8 = 0.309$ kN/m
$q_{mt,\ profile\ 2\ side} = 1.071 / 0.8 = 1.339$ kN/m
$q_{mt,\ profile\ 2\ roof} = 0.247 / 0.8 = 0.309$ kN/m

Wind calculations of the side stage canopy lee side.
$q_{w,\ profile\ 1} = 0.9 * 0.4375 * 1.883 = 0.741$ kN/m
$q_{w,\ profile\ 2} = 0.9 * 0.4375 * 1.883 = 0.741$ kN/m

Membrane tension of the side stage canopy lee side.
$q_{mt,\ profile\ 1} = 0.741 / 0.8 = 0.927$ kN/m
$q_{mt,\ profile\ 2} = 0.741 / 0.8 = 0.927$ kN/m

2.5.6 load case 15 Out-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m
$q_{w,\ roof\ truss\ 2}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 2.072 = 0.620 kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1}$ = 0.272 / 0.8 = 0.340 kN/m
$q_{mt,\ roof\ truss\ 2}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 3}$ = 0.620 / 0.8 = 0.775 kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.4375 * 2.5 * 0.5 = 0.547kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.4375 * 0 = 0 kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.547 / 0.8 = 0.684 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

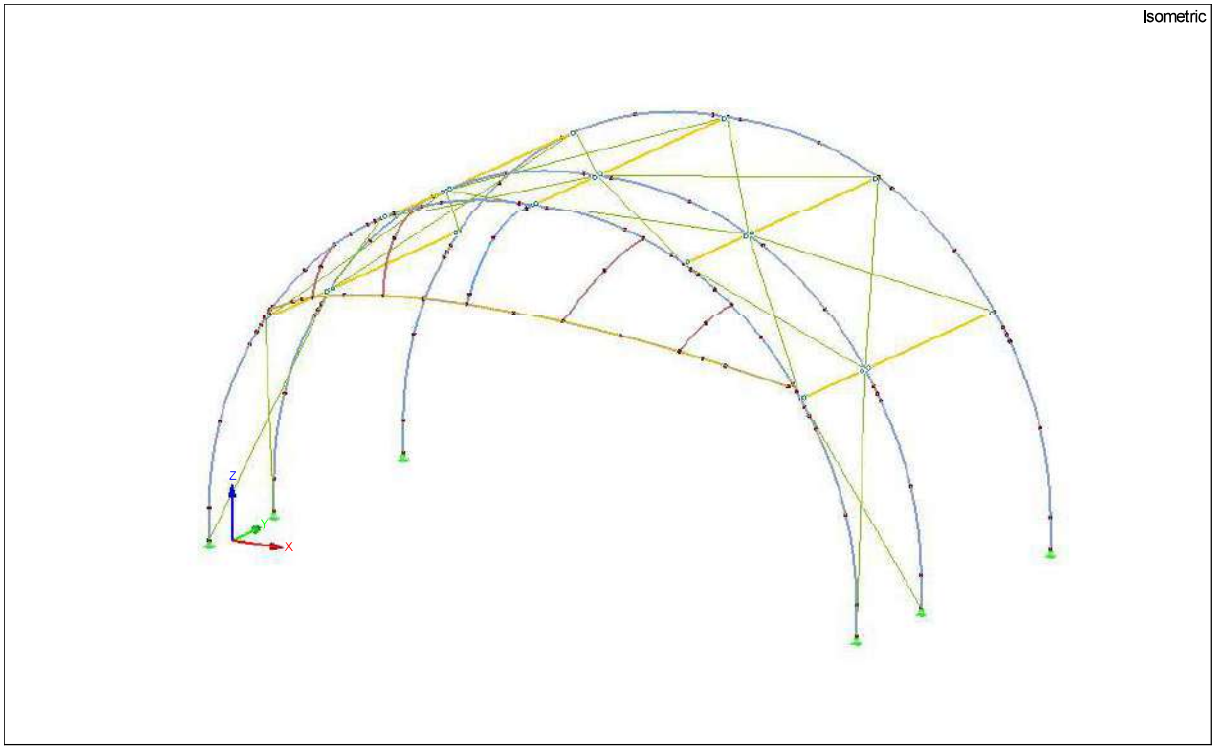
Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1} = 0.6 * 0.4375 * 1.883 = 0.494$ kN/m
$q_{w,\ profile\ 2} = 0.6 * 0.4375 * 1.883 = 0.494$ kN/m

Membrane tension of the side stage roof canopy.
$q_{mt,\ Profile\ 1} = 0.494 / 0.8 = 0.618$ kN/m
$q_{mt,\ Profile\ 2} = 0.494 / 0.8 = 0.618$ kN/m

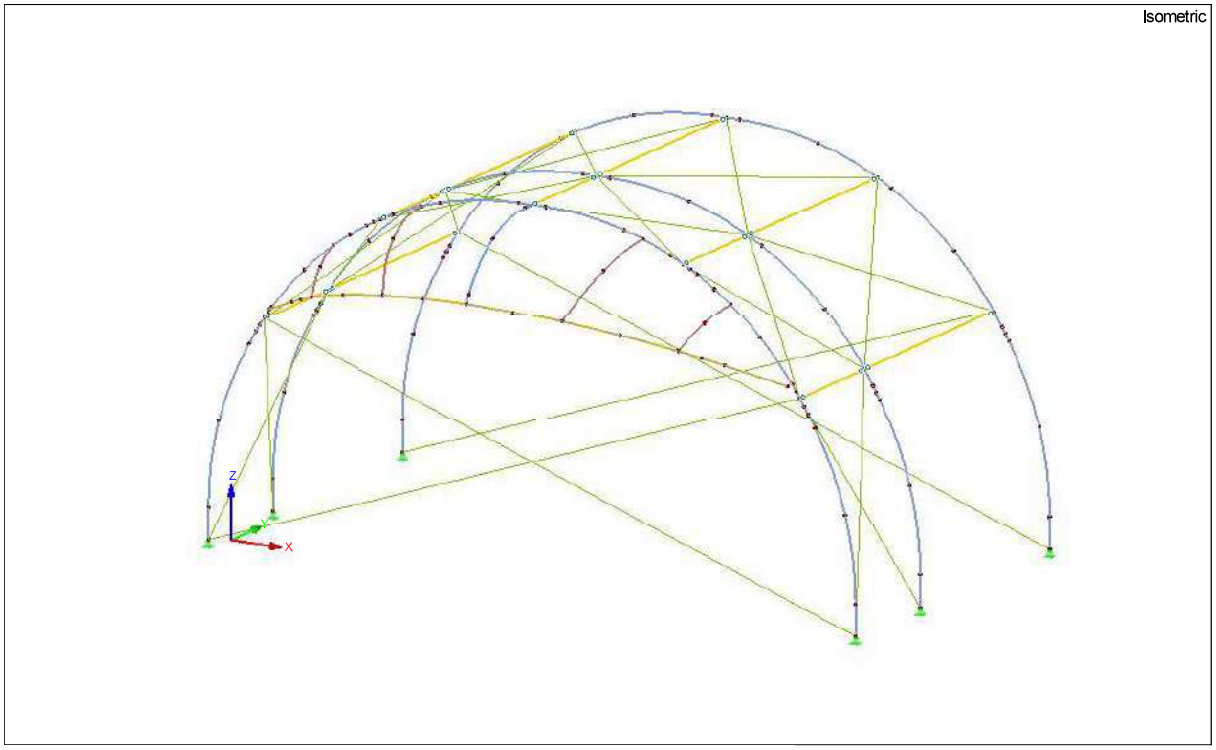
Wind on truss
$q_{w,\ truss} = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082$ kN/m

2.6 Construction model of the Medium Tunnel Roof 12x9 setup option 3.

In service model.

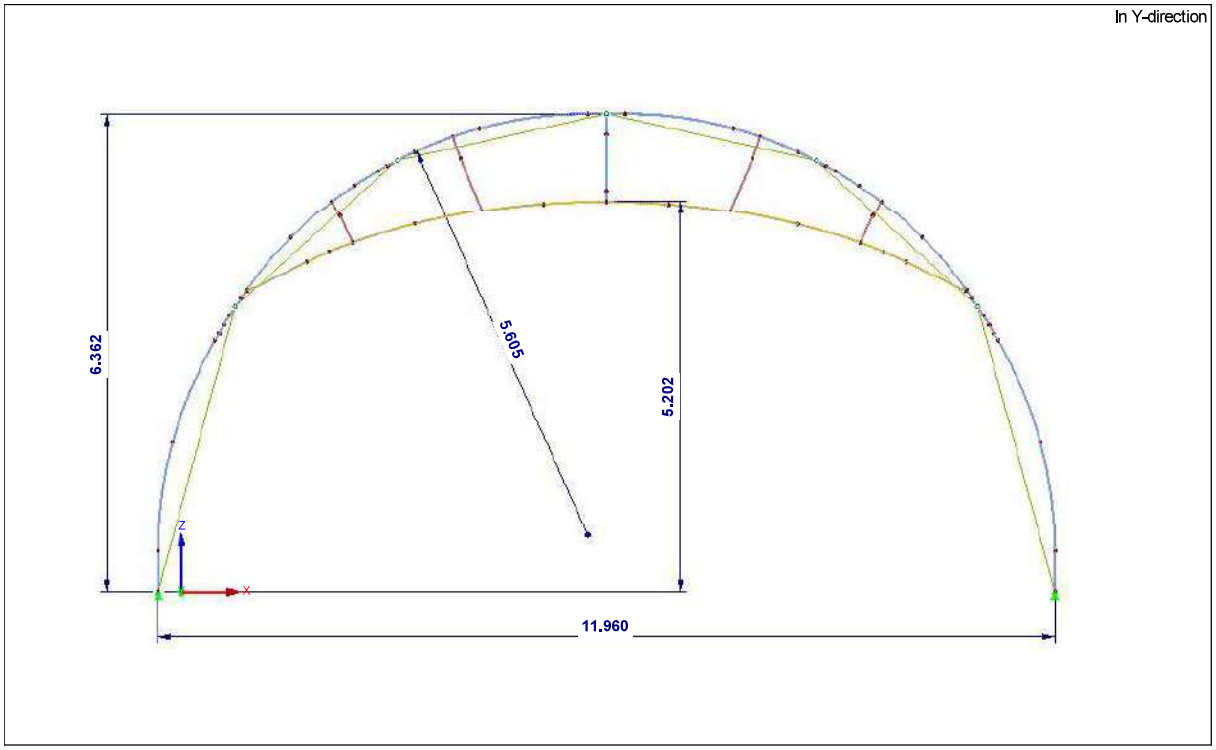


Out service model.

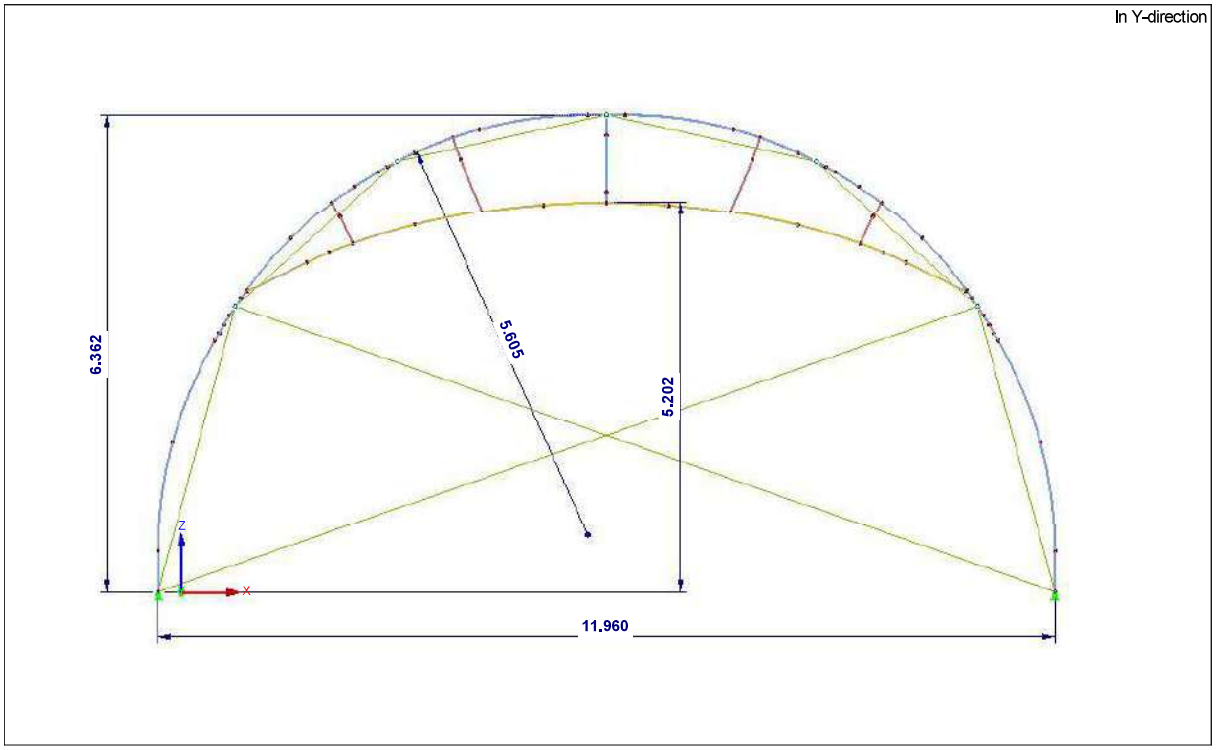


Cross-Sections
1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
4: RD 10; steel 8.8 kw aliteit

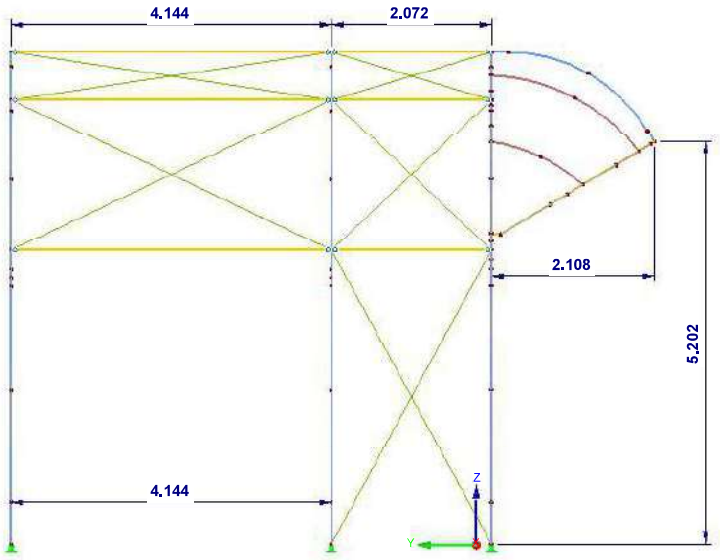
In service front view.



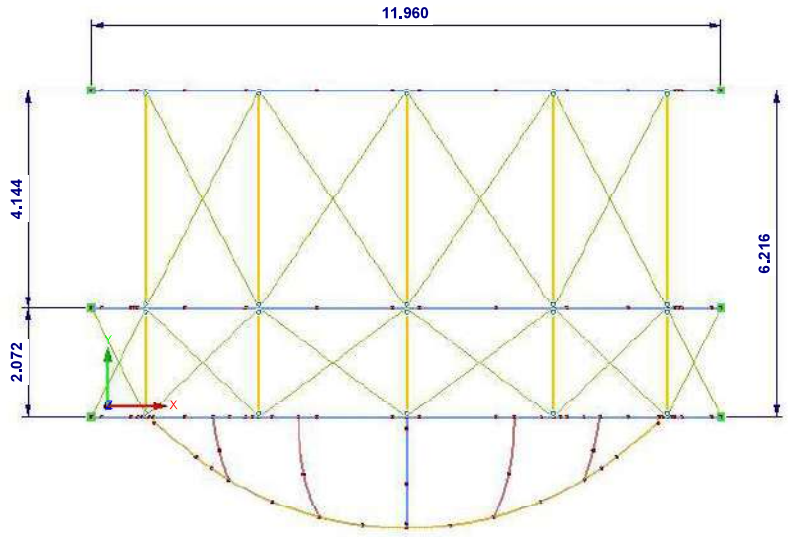
Out service front view.



In X-direction



Against Z-direction



For the structural integrity and stability of the system it is necessary to ad cross wires in the front and the back of the system in the out-service situation for Medium tunnel stage option 3.

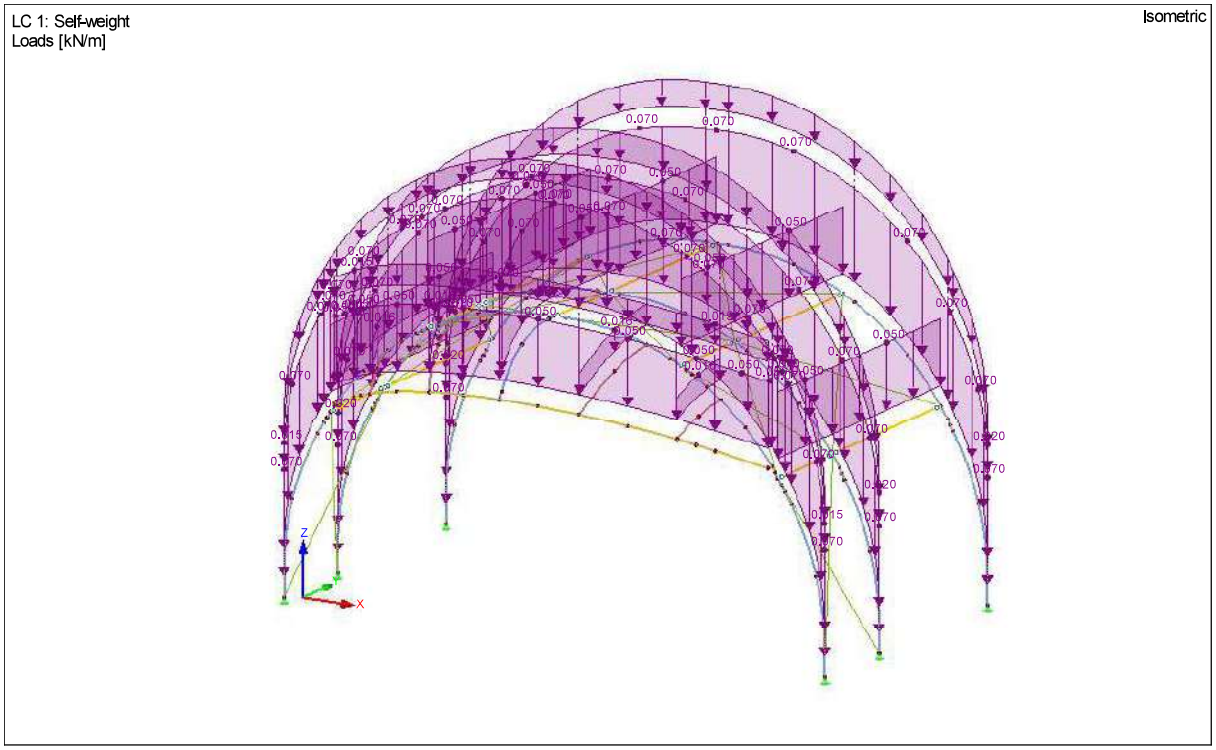
2.7 Single Load cases model option 3.

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

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self-weight	+	Permanent	-	0,000	0,000	-1,000
LC2	UDL Loading	+	Permanent/Imposed	-	0,000	0,000	0,000
LC3	CPL Loading setup	+	Permanent/Imposed	-	0,000	0,000	0,000
LC4	2x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC5	3x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC10	In-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC11	In-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC12	In-service wind 180°	+	Wind	-	0,000	0,000	0,000
LC13	Out-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC14	Out-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC15	Out-service wind 180°	+	Wind	-	0,000	0,000	0,000

2.8 Load case input Model option 3.

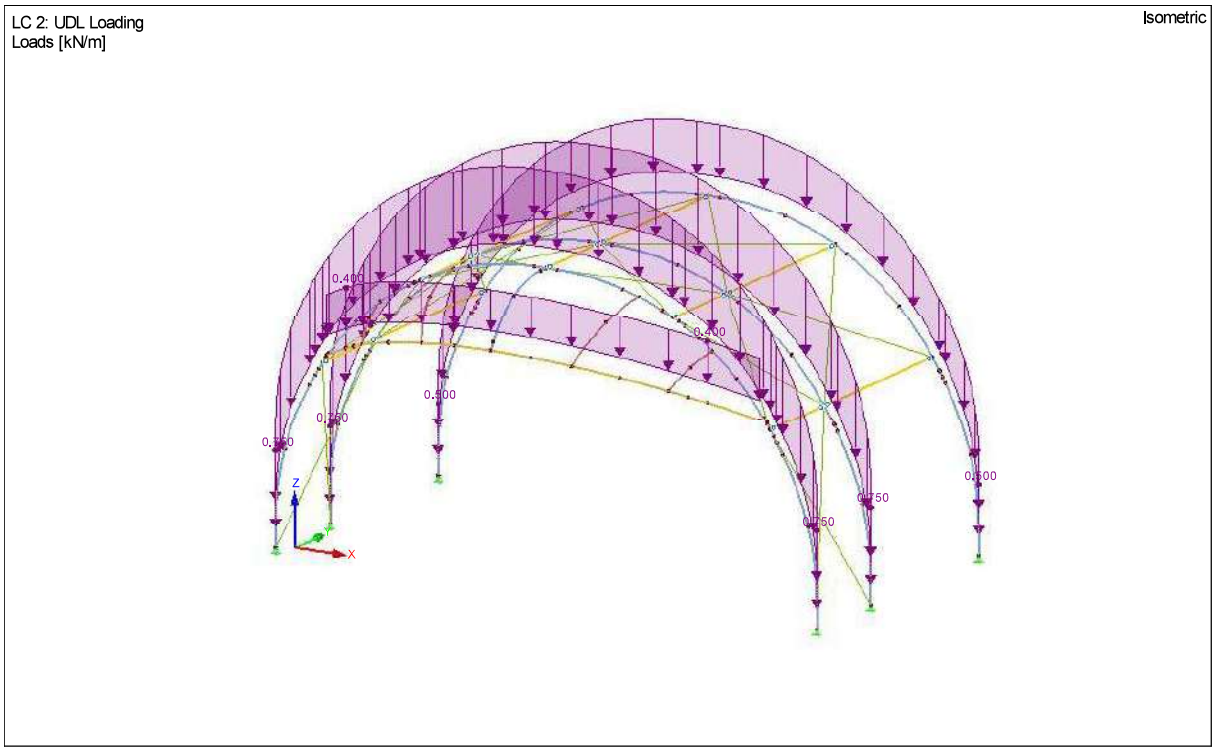
2.8.1 LC1 Self-Weight.



Interal Protruss S31 = 0.07 kN/m^{-1}
Interal Protruss T31 = 0.05 kN/m^{-1}
Tube 50x4 = 0.016 kN/m^{-1}

Canopy truss1 + cantilever truss = 0.015 kN/m^{-1}
Canopy truss2 + truss3 = 0.02 kN/m^{-1}

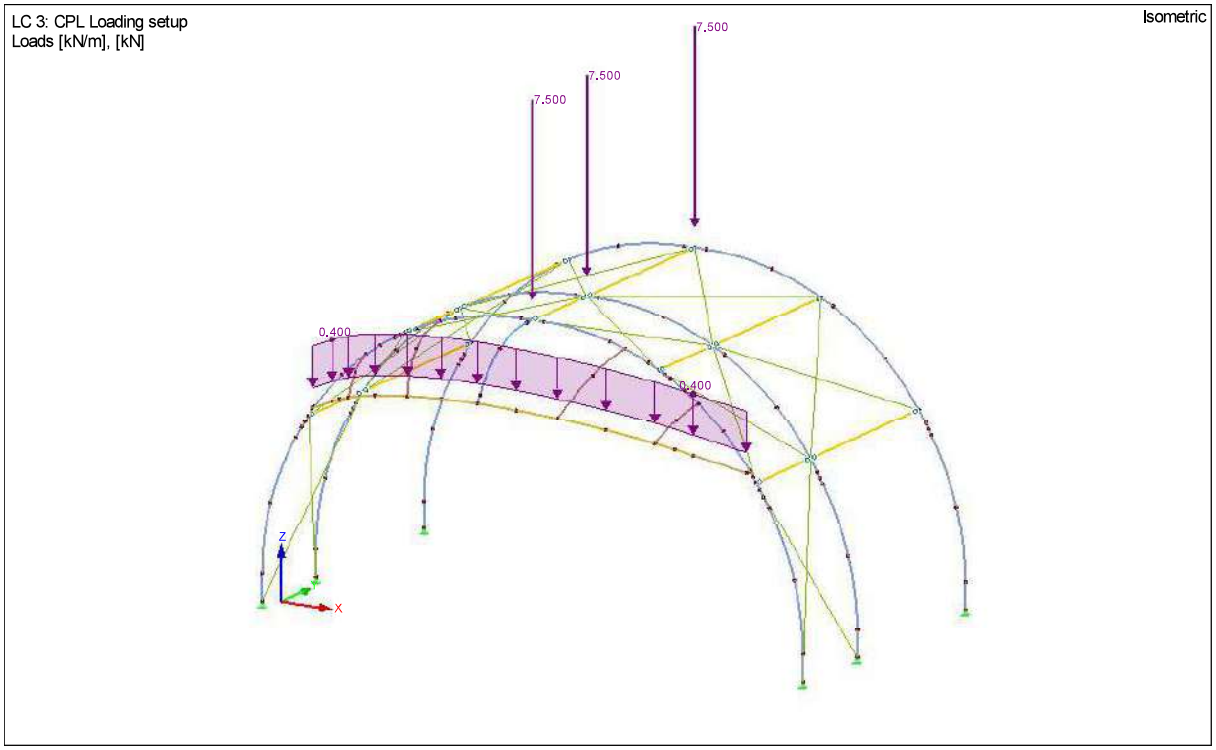
2.8.2 LC2 UDL Loading setup.



The loading which is taken into account in the UDL Loading setup are:
Truss 1 = 0.75 kN/m^{-1}
Truss 2 = 0.75 kN/m^{-1}
Truss 3 = 0.50 kN/m^{-1}

Cantilever truss 0.40 kN/m^{-1}

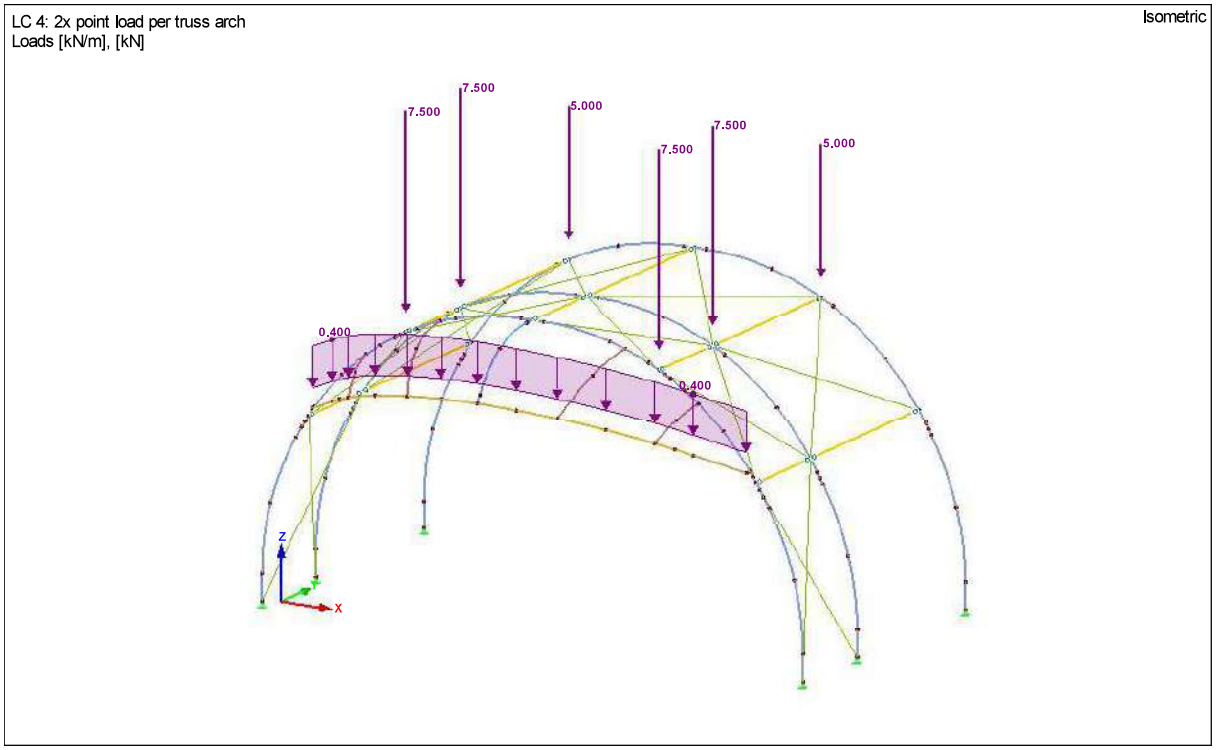
2.8.3 LC3 Center point load per truss arch.



The loading which is taken into account in the Centre point Load setup are:
Truss 1 = 7.50 kN
Truss 2 = 7.50 kN
Truss 3 = 7.50 kN

Cantilever truss 0.40 kN/m^{-1}

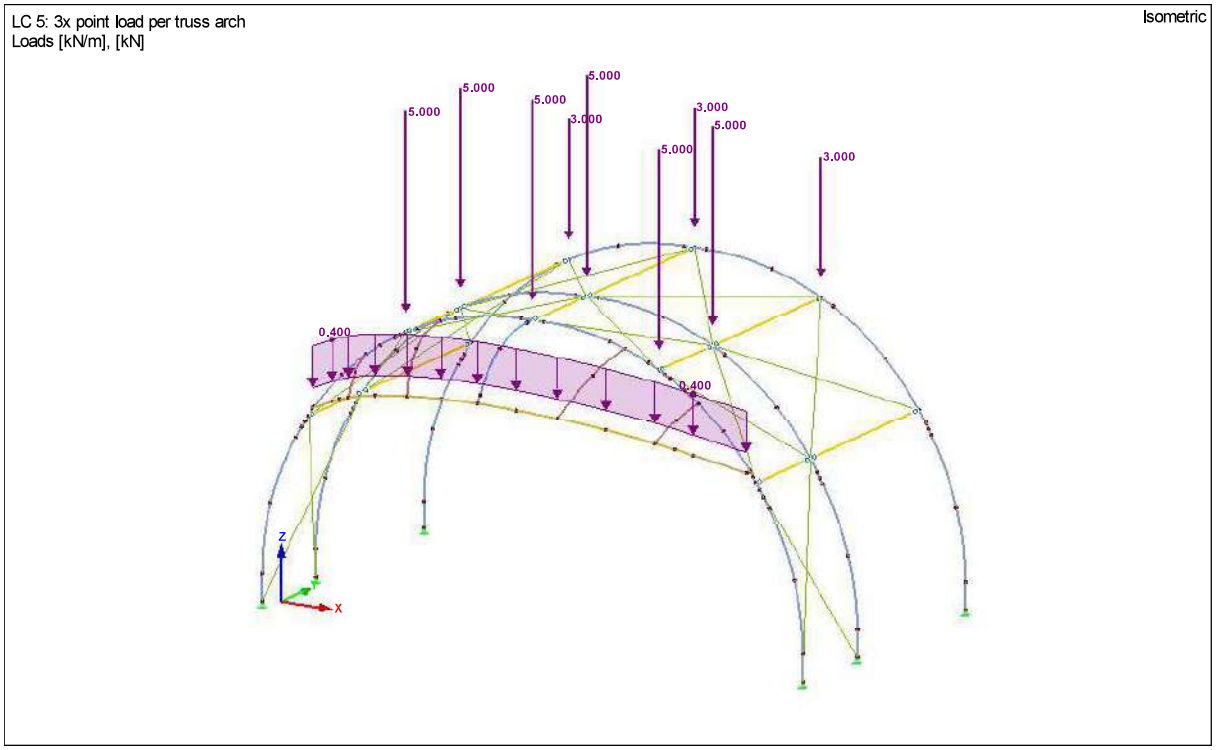
2.8.4 LC4 2x Point loads per truss arch.



The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 2 x 7.50 kN
Truss 2 = 2 x 7.50 kN
Truss 3 = 2 x 5.00 kN

Cantilever truss 0.40 kN/m^{-1}

2.8.5 LC5 3x Point loads per truss arch.

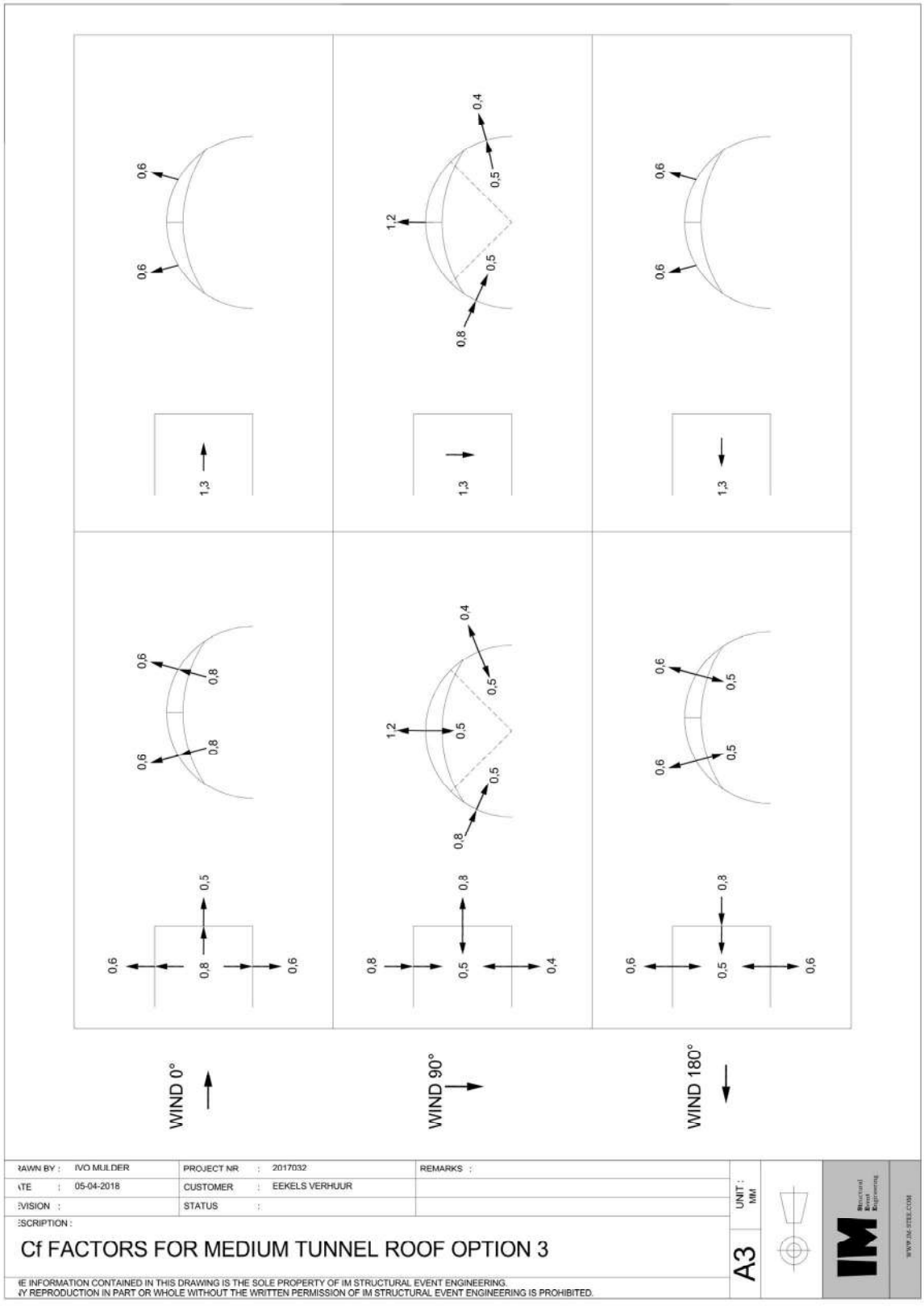


The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 3 x 5.00 kN
Truss 2 = 3 x 5.00 kN
Truss 3 = 3 x 3.00 kN

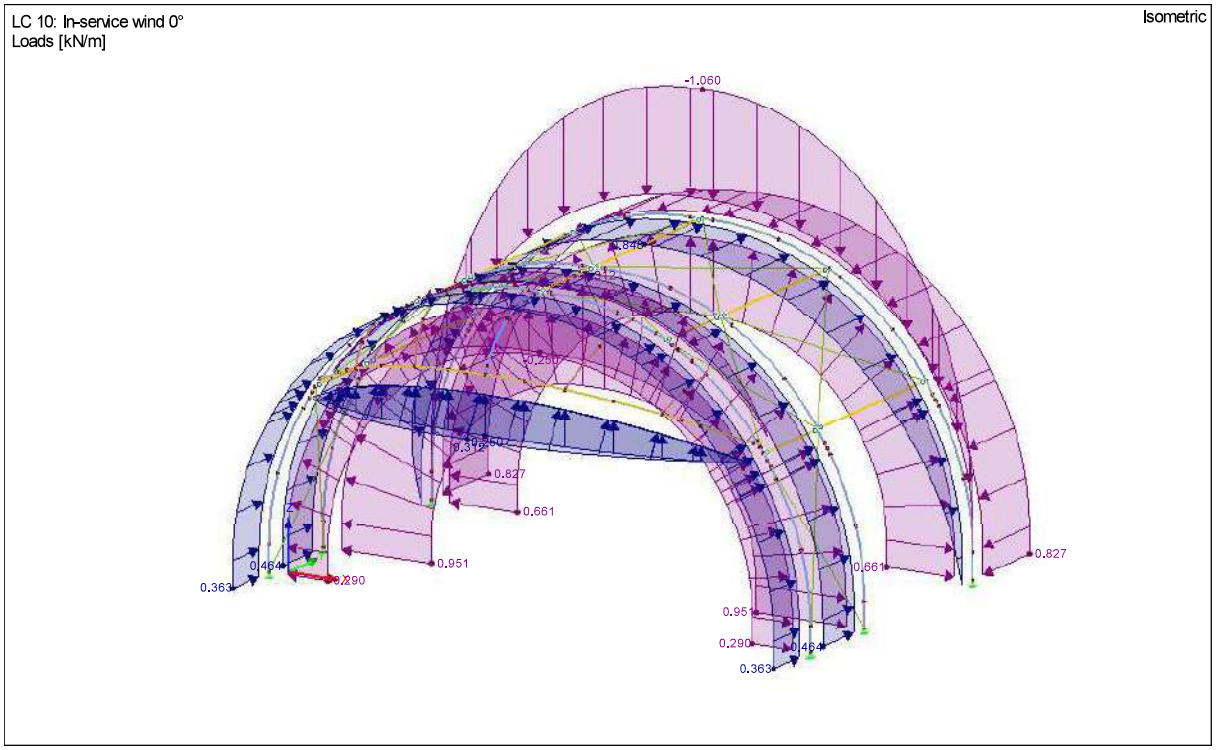
Cantilever truss 0.40 kN/m^{-1}

2.9 Load cases concerning wing loading model option 3.

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 NEN-EN 13814: Fairground and amusement park machinery and structures safety.



2.9.1 load case 10 In-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 1.4 * 0.2 * 1.036 = 0.290$ kN/m
$q_{w,\ roof\ truss\ 2} = 1.4 * 0.2 * 3.398 = 0.951$ kN/m
$q_{w,\ roof\ truss\ 3} = 1.4 * 0.2 * 2.072 = 0.661$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.290 / 0.8 = 0.363$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.661/0.8) - (0.290 / 0.8) = 0.464$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.661 / 0.8 = 0.827$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.

$q_{w,\ cantilever\ mid} = 1 * 0.2 * 2.5 * 0.5 = 0.25$ kN/m

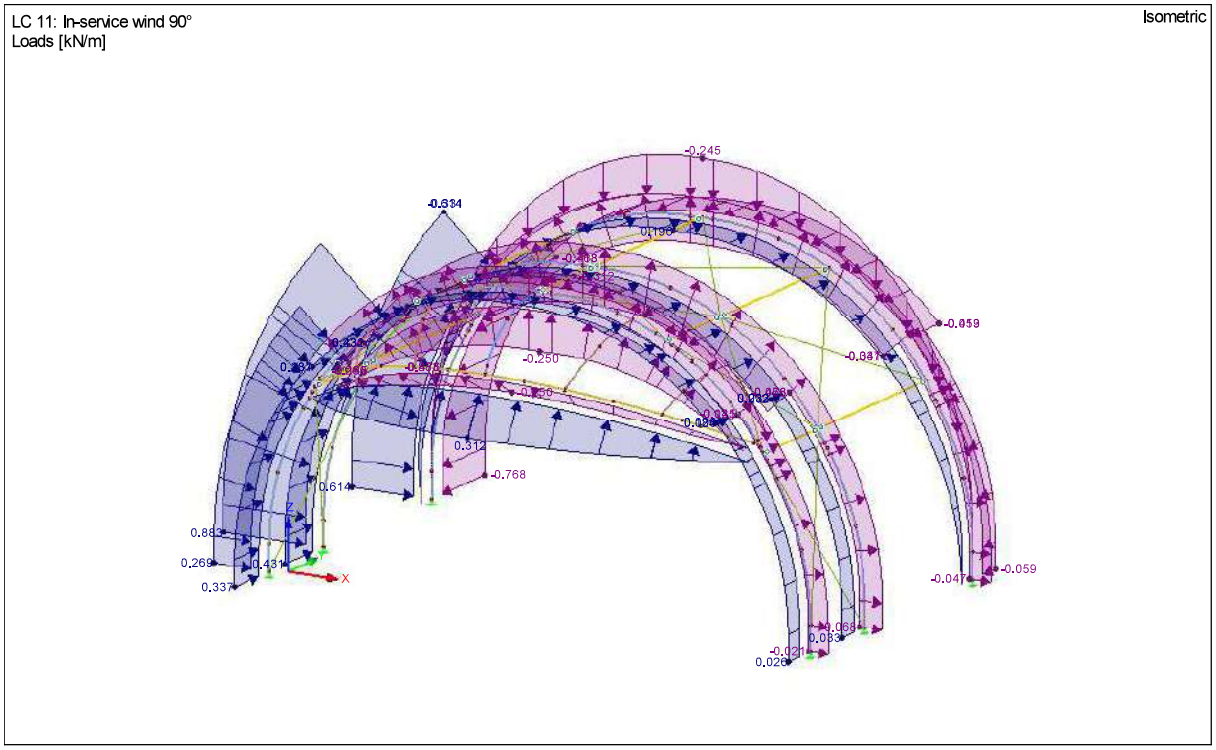
$q_{w,\ cantilever\ side} = 1 * 0.2 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.

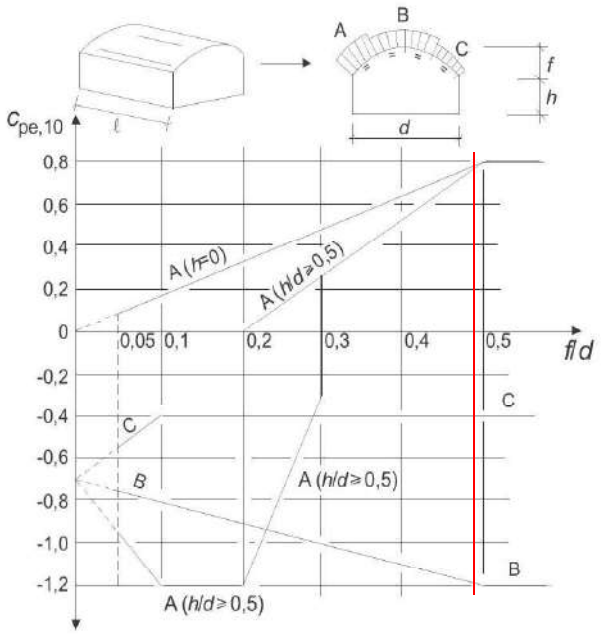
$q_{mt,\ cantilever\ mid} = 0.25 / 0.8 = 0.312$ kN/m

$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

2.9.2 load case 11 In-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling the structure down.
The result of these two forces are
A = -1.3 B = 0.7 C = -0.1

Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.2 * 1.036 = 0.269$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 0.7 * 0.2 * 1.036 = 0.145$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.2 * 3.398 = 0.883$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 0.7 * 0.2 * 3.398 = 0.476$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.2 * 2.072 = 0.614$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 0.7 * 0.2 * 2.072 = 0.331$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.1 * 0.2 * 2.072 = 0.047$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.269 / 0{,}8 = 0.337$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.145 / 0.8 = 0.181$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.020 / 0.8 = 0.026$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (0.614 / 0.8) - (0.269 / 0.8) = 0.431$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (0.331 / 0.8) - (0.145 / 0.8) = 0.232$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.047 / 0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\text{ roof truss 3 section A}} = 0.614 / 0.8 = 0.768$ kN/m
$q_{mt,\text{ roof truss 3 section B}} = 0.331 / 0.8 = 0.413$ kN/m
$q_{mt,\text{ roof truss 3 section C}} = 0.047 / 0.8 = 0.059$ kN/m

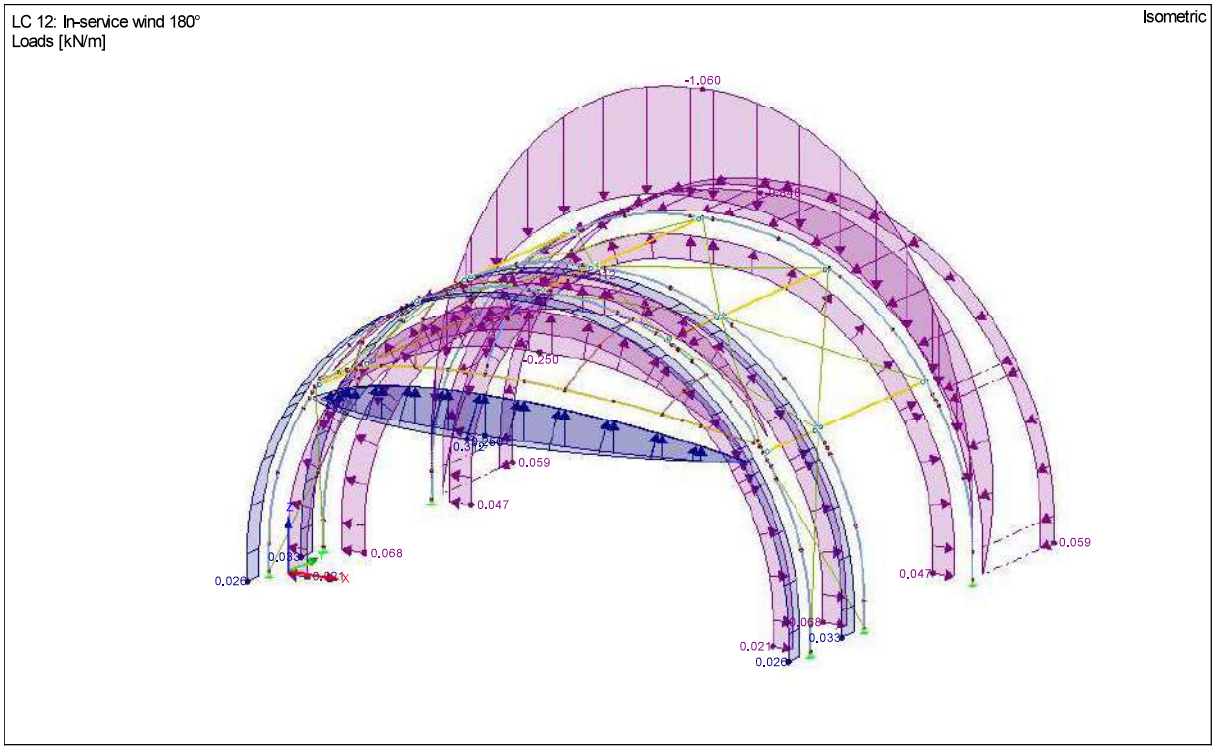
Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\text{ back wall mid}} = 0.3 * 0.2 * 6.525 * 0.5 = 0.196$ kN/m
$q_{w,\text{ back wall side}} = 0.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\text{ back wall mid}} = 0.196 / 0.8 = 0.245$ kN/m
$q_{mt,\text{ back wall side}} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\text{ cantilever mid}} = 1 * 0.2 * 2.5 * 0.5 = 0.25$kN/m
$q_{w,\text{ cantilever side}} = 1 * 0.2 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.25 / 0.8 = 0.312$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

2.9.3 load case 12 In-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.1 * 0.2 * 3.398 = 0.047$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.021 / 0.8 = 0.026$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.047/0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\ roof\ truss\ 3} = 0.047 / 0.8 = 0.0059$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.

$q_{w,\ cantilever\ mid} = 1 * 0.2 * 2.5 * 0.5 = 0.25 kN/m$

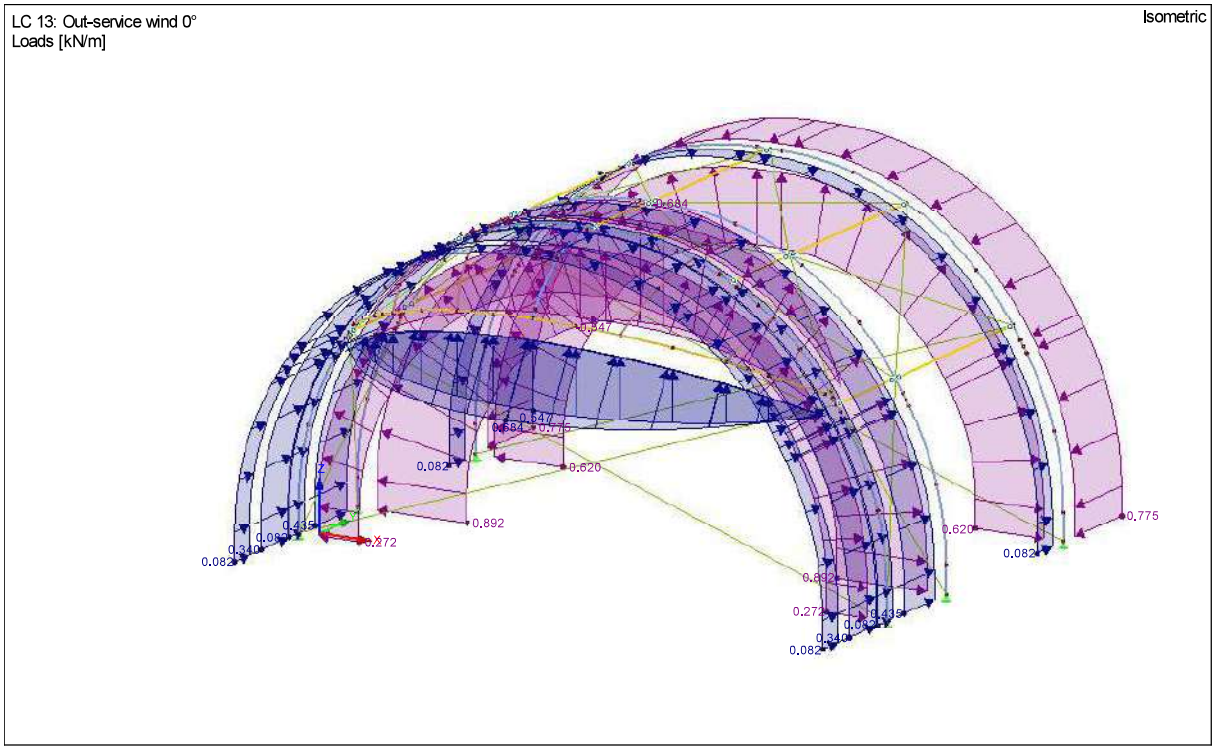
$q_{w,\ cantilever\ side} = 1 * 0.2 * 0 = 0\ kN/m$

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.

$q_{mt,\ cantilever\ mid} = 0.25 / 0.8 = 0.312\ kN/m$

$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0\ kN/m$

2.9.4 load case 13 Out-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.6 * 0.4375 * 3.398 = 0.892$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.6 * 0.4375 * 2.072 = 0.620$ kN/m

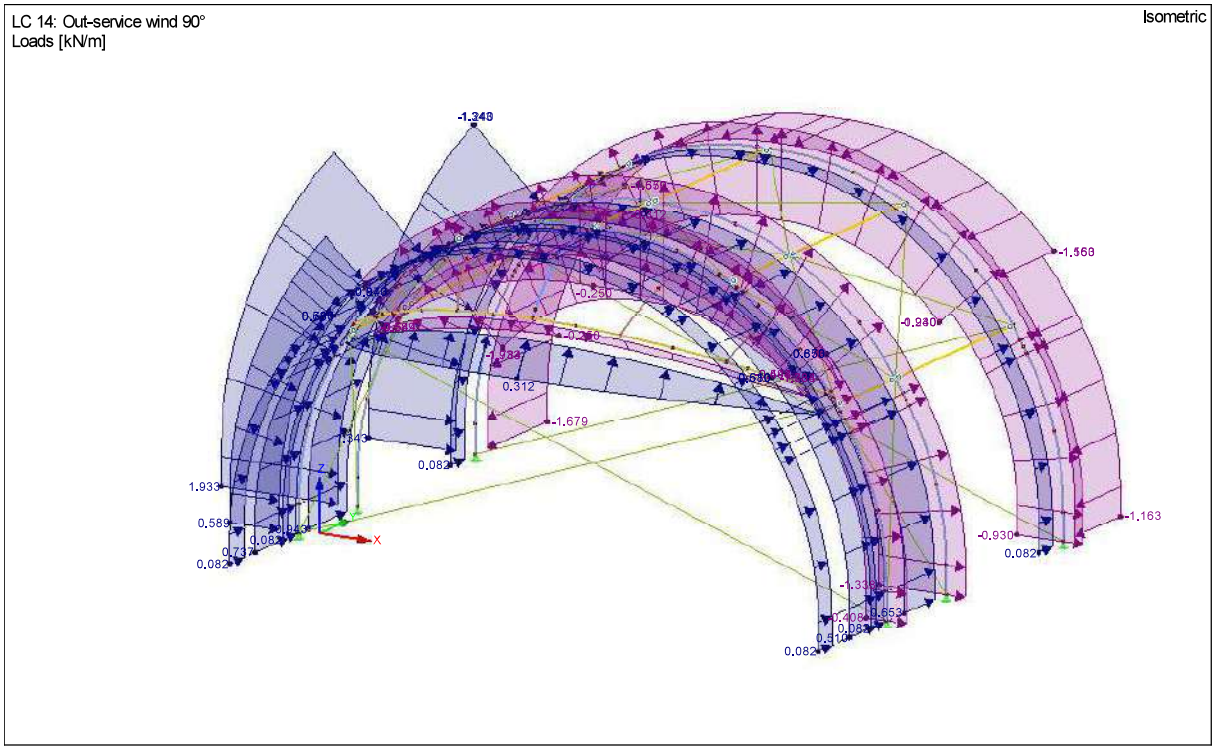
Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.272 / 0.8 = 0.340$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.620/0.8) - (0.272 / 0.8) = 0.435$ kN/m
$q_{mt,\ roof\ truss\ 3} = 0.620 / 0.8 = 0.775$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$kN/m
$q_{w,\ cantilever\ side} = 1 * 0.4375 * 0 = 0$ kN/m

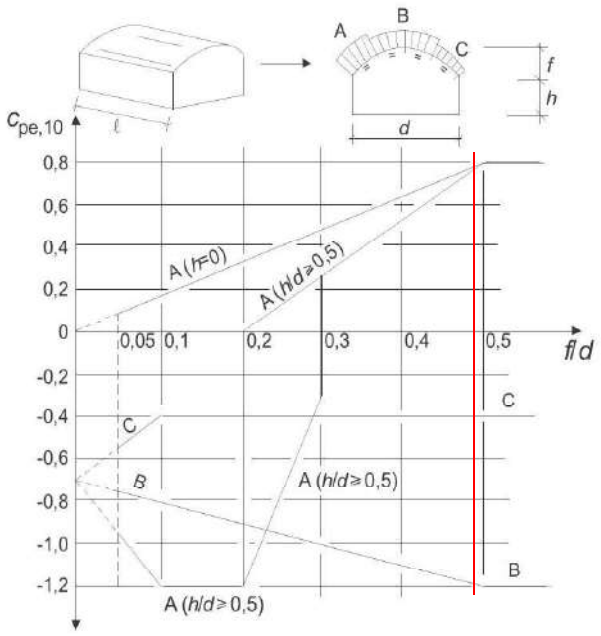
Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

Wind on truss
$q_{w,\ truss} = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082$ kN/m

2.9.5 load case 14 Out-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling and pushing the structure.
The result of these two forces are
A = -1.3 B = 1.2 C = 0.9

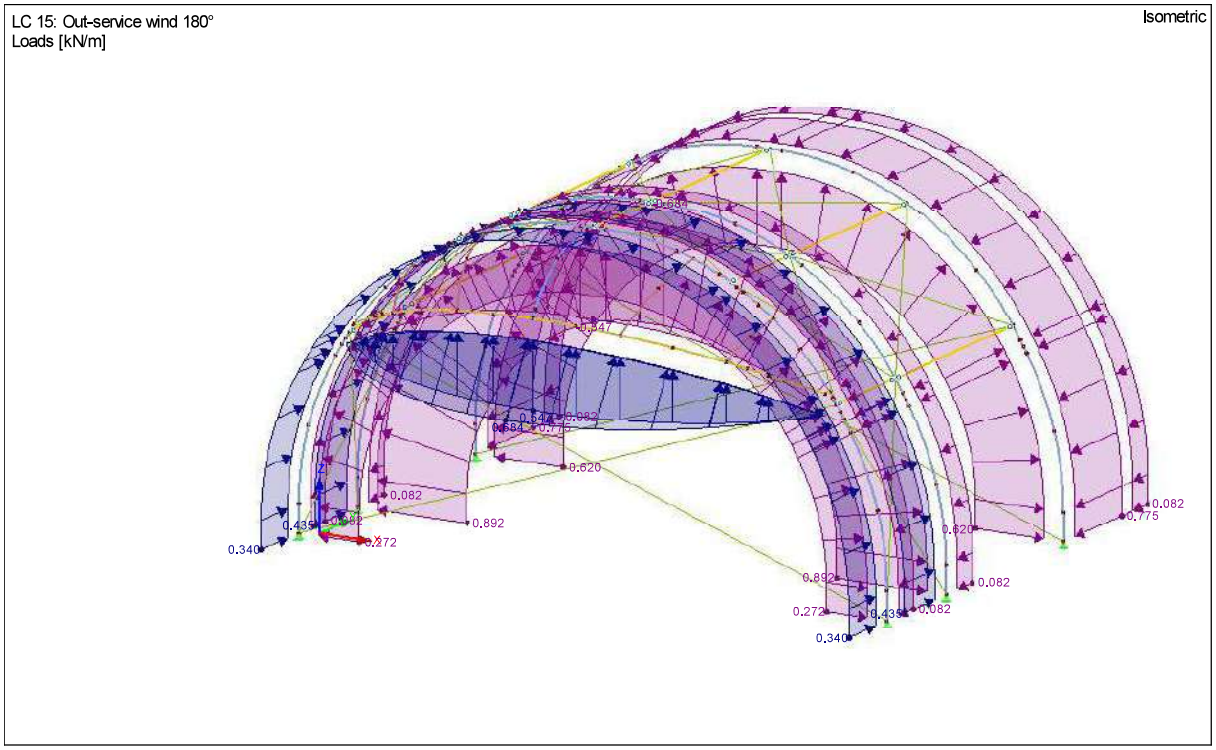
Wind calculations for the Roof spans
$q_{w,\ roof\ truss\ 1\ section\ A} = 1.3 * 0.4375 * 1.036 = 0.589$ kN/m
$q_{w,\ roof\ truss\ 1\ section\ B} = 1.2 * 0.4375 * 1.036 = 0.544$ kN/m
$q_{w,\ roof\ truss\ 1\ section\ C} = 0.9 * 0.4375 * 1.036 = 0.408$ kN/m
$q_{w,\ roof\ truss\ 2\ section\ A} = 1.3 * 0.4375 * 3.398 = 1.933$ kN/m
$q_{w,\ roof\ truss\ 2\ section\ B} = 1.2 * 0.4375 * 3.398 = 1.784$ kN/m
$q_{w,\ roof\ truss\ 2\ section\ C} = 0.9 * 0.4375 * 3.398 = 1.338$ kN/m
$q_{w,\ roof\ truss\ 3\ section\ A} = 1.3 * 0.4375 * 2.072 = 1.343$ kN/m
$q_{w,\ roof\ truss\ 3\ section\ B} = 1.2 * 0.4375 * 2.072 = 1.240$ kN/m
$q_{w,\ roof\ truss\ 3\ section\ C} = 0.9 * 0.4375 * 2.072 = 1.930$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\ roof\ truss\ 1\ section\ A} = 0.589 / 0.8 = 0.737$ kN/m
$q_{mt,\ roof\ truss\ 1\ section\ B} = 0.544 / 0.8 = 0.680$ kN/m
$q_{mt,\ roof\ truss\ 1\ section\ C} = 0.408 / 0.8 = 0.510$ kN/m
$q_{mt,\ roof\ truss\ 2\ section\ A} = (1.343 / 0.8) - (0.589 / 0.8) = 0.943$ kN/m
$q_{mt,\ roof\ truss\ 2\ section\ B} = (1.240 / 0.8) - (0.544 / 0.8) = 0.870$ kN/m
$q_{mt,\ roof\ truss\ 2\ section\ C} = (0.930 / 0.8) - (0.408 / 0.8) = 0.653$ kN/m
$q_{mt,\ roof\ truss\ 3\ section\ A} = 1.343 / 0.8 = 1.679$ kN/m
$q_{mt,\ roof\ truss\ 3\ section\ B} = 1.240 / 0.8 = 1.550$ kN/m
$q_{mt,\ roof\ truss\ 3\ section\ C} = 1.930 / 0.8 = 1.163$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$ kN/m
$q_{w,\ cantilever\ side} = 1 * 0.4375 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

2.9.6 load case 15 Out-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.6 * 0.4375 * 3.398 = 0.892$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.6 * 0.4375 * 2.072 = 0.620$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.272 / 0.8 = 0.340$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.620/0.8) - (0.272 / 0.8) = 0.435$ kN/m
$q_{mt,\ roof\ truss\ 3} = 0.620 / 0.8 = 0.775$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$kN/m
$q_{w,\ cantilever\ side} = 1 * 0.4375 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

Wind on truss
$q_{w,\ truss} = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082$ kN/m

2.10 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 factor for permanent actions
$\gamma_{k,i}$ = 1.35 Partial safety factor 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….

2.10.1 load combinations.

For all the models the same load combinations are generated.

CO1-CO4	Live load without wind
CO10-CO34	Design Values In-service situation
CO50-CO74	Characteristic Values In-service situation
CO100-CO124	Design Values Out-service situation
CO150-CO174	Characteristic Values Out-service situation

Load	Load Combination		To	LC.1		LC.2		LC.3	
Combin.	DS	Description	Solve	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*LC3	+	1,150	LC1	1,350	LC3		
CO3	0	1.15*LC1 + 1.35*LC4	+	1,150	LC1	1,350	LC4		
CO4	0	1.15*LC1 + 1.35*LC5	+	1,150	LC1	1,350	LC5		
CO10	0	1.15*LC1 + 1.35*LC10	+	1,150	LC1	1,350	LC10		
CO11	0	1.15*LC1 + 1.35*LC2 + 1.35*LC10	+	1,150	LC1	1,350	LC2	1,350	LC10
CO12	0	1.15*LC1 + 1.35*LC3 + 1.35*LC10	+	1,150	LC1	1,350	LC3	1,350	LC10
CO13	0	1.15*LC1 + 1.35*LC4 + 1.35*LC10	+	1,150	LC1	1,350	LC4	1,350	LC10
CO14	0	1.15*LC1 + 1.35*LC5 + 1.35*LC10	+	1,150	LC1	1,350	LC5	1,350	LC10
CO20	0	1.15*LC1 + 1.35*LC11	+	1,150	LC1	1,350	LC11		
CO21	0	1.15*LC1 + 1.35*LC2 + 1.35*LC11	+	1,150	LC1	1,350	LC2	1,350	LC11
CO22	0	1.15*LC1 + 1.35*LC3 + 1.35*LC11	+	1,150	LC1	1,350	LC3	1,350	LC11
CO23	0	1.15*LC1 + 1.35*LC4 + 1.35*LC11	+	1,150	LC1	1,350	LC4	1,350	LC11
CO24	0	1.15*LC1 + 1.35*LC5 + 1.35*LC11	+	1,150	LC1	1,350	LC5	1,350	LC11
CO30	0	1.15*LC1 + 1.35*LC12	+	1,150	LC1	1,350	LC12		
CO31	0	1.15*LC1 + 1.35*LC2 + 1.35*LC12	+	1,150	LC1	1,350	LC2	1,350	LC12
CO32	0	1.15*LC1 + 1.35*LC3 + 1.35*LC12	+	1,150	LC1	1,350	LC3	1,350	LC12
CO33	0	1.15*LC1 + 1.35*LC4 + 1.35*LC12	+	1,150	LC1	1,350	LC4	1,350	LC12
CO34	0	1.15*LC1 + 1.35*LC5 + 1.35*LC12	+	1,150	LC1	1,350	LC5	1,350	LC12
CO50	0	LC1 + LC10	+	1,000	LC1	1,000	LC10		
CO51	0	LC1 + LC2 + LC10	+	1,000	LC1	1,000	LC2	1,000	LC10
CO52	0	LC1 + LC3 + LC10	+	1,000	LC1	1,000	LC3	1,000	LC10
CO53	0	LC1 + LC4 + LC10	+	1,000	LC1	1,000	LC4	1,000	LC10
CO54	0	LC1 + LC5 + LC10	+	1,000	LC1	1,000	LC5	1,000	LC10
CO60	0	LC1 + LC11	+	1,000	LC1	1,000	LC11		
CO61	0	LC1 + LC2 + LC11	+	1,000	LC1	1,000	LC2	1,000	LC11
CO62	0	LC1 + LC3 + LC11	+	1,000	LC1	1,000	LC3	1,000	LC11
CO63	0	LC1 + LC4 + LC11	+	1,000	LC1	1,000	LC4	1,000	LC11
CO64	0	LC1 + LC5 + LC11	+	1,000	LC1	1,000	LC5	1,000	LC11
CO70	0	LC1 + LC12	+	1,000	LC1	1,000	LC12		
CO71	0	LC1 + LC2 + LC12	+	1,000	LC1	1,000	LC2	1,000	LC12
CO72	0	LC1 + LC3 + LC12	+	1,000	LC1	1,000	LC3	1,000	LC12
CO73	0	LC1 + LC4 + LC12	+	1,000	LC1	1,000	LC4	1,000	LC12
CO74	0	LC1 + LC5 + LC12	+	1,000	LC1	1,000	LC5	1,000	LC12
CO100	0	1.15*LC1 + 1.35*LC13	+	1,150	LC1	1,350	LC13		
CO101	0	1.15*LC1 + 1.35*LC2 + 1.35*LC13	+	1,150	LC1	1,350	LC2	1,350	LC13
CO102	0	1.15*LC1 + 1.35*LC3 + 1.35*LC13	+	1,150	LC1	1,350	LC3	1,350	LC13
CO103	0	1.15*LC1 + 1.35*LC4 + 1.35*LC13	+	1,150	LC1	1,350	LC4	1,350	LC13
CO104	0	1.15*LC1 + 1.35*LC5 + 1.35*LC13	+	1,150	LC1	1,350	LC5	1,350	LC13
CO110	0	1.15*LC1 + 1.35*LC14	+	1,150	LC1	1,350	LC14		
CO111	0	1.15*LC1 + 1.35*LC2 + 1.35*LC14	+	1,150	LC1	1,350	LC2	1,350	LC14
CO112	0	1.15*LC1 + 1.35*LC3 + 1.35*LC14	+	1,150	LC1	1,350	LC3	1,350	LC14
CO113	0	1.15*LC1 + 1.35*LC4 + 1.35*LC14	+	1,150	LC1	1,350	LC4	1,350	LC14
CO114	0	1.15*LC1 + 1.35*LC5 + 1.35*LC14	+	1,150	LC1	1,350	LC5	1,350	LC14
CO120	0	1.15*LC1 + 1.35*LC15	+	1,150	LC1	1,350	LC15		
CO121	0	1.15*LC1 + 1.35*LC2 + 1.35*LC15	+	1,150	LC1	1,350	LC2	1,350	LC15
CO122	0	1.15*LC1 + 1.35*LC3 + 1.35*LC15	+	1,150	LC1	1,350	LC3	1,350	LC15
CO123	0	1.15*LC1 + 1.35*LC4 + 1.35*LC15	+	1,150	LC1	1,350	LC4	1,350	LC15
CO124	0	1.05*LC1 + 1.35*LC5 + 1.35*LC15	+	1,050	LC1	1,350	LC5	1,350	LC15
CO150	0	LC1 + LC13	+	1,000	LC1	1,000	LC13		
CO151	0	LC1 + LC2 + LC13	+	1,000	LC1	1,000	LC2	1,000	LC13
CO152	0	LC1 + LC3 + LC13	+	1,000	LC1	1,000	LC3	1,000	LC13
CO153	0	LC1 + LC4 + LC13	+	1,000	LC1	1,000	LC4	1,000	LC13
CO154	0	LC1 + LC5 + LC13	+	1,000	LC1	1,000	LC5	1,000	LC13

CO160	0	LC1 + LC14	+	1,000	LC1	1,000	LC14		
CO161	0	LC1 + LC2 + LC14	+	1,000	LC1	1,000	LC2	1,000	LC14
CO162	0	LC1 + LC3 + LC14	+	1,000	LC1	1,000	LC3	1,000	LC14
CO163	0	LC1 + LC4 + LC14	+	1,000	LC1	1,000	LC4	1,000	LC14
CO164	0	LC1 + LC5 + LC14	+	1,000	LC1	1,000	LC5	1,000	LC14
CO170	0	LC1 + LC15	+	1,000	LC1	1,000	LC15		
CO171	0	LC1 + LC2 + LC15	+	1,000	LC1	1,000	LC2	1,000	LC15
CO172	0	LC1 + LC3 + LC15	+	1,000	LC1	1,000	LC3	1,000	LC15
CO173	0	LC1 + LC4 + LC15	+	1,000	LC1	1,000	LC4	1,000	LC15
CO174	0	LC1 + LC5 + LC15	+	1,000	LC1	1,000	LC5	1,000	LC15

2.10.2 result combinations.

Different Result calculation have been generated in the program.

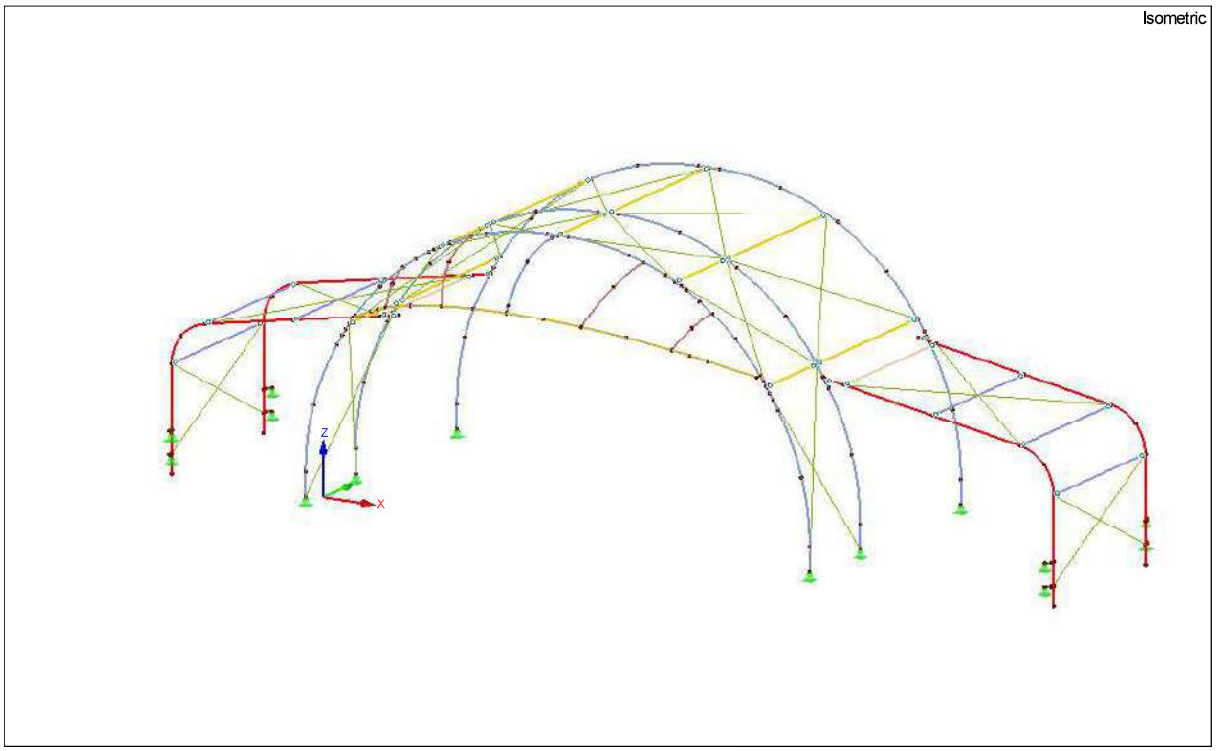
RC1 - Live loading without wind : 1 * (CO1 - CO4)
RC2 - Design Values In-service : 1 * (CO10 – CO34)
RC3 - Characteristic Values In-service : 1 * (CO50 – CO74)
RC4 - Design Values Out-service : 1 * (CO100 – CO124)
RC5 - Characteristic Values Out-service : 1 * (CO150 – CO174)

3 Calculation results for different Load Cases and Load Combinations.

In this chapter the results of the different load cases and load combinations of the medium tunnel stage option 1 and 2 are presented. The design calculations will be used to check the structural integrity of separate parts of the structure. The results for the characteristic calculations will be used to determine the deflection of the system and the steel wires which need to be used. These results will not be presented for each load combination. If the use of these results is necessary, the particular information will be given.

3.1 General calculation of the medium Tunnel Roof 12x6 option 1 and 2.

3.1.1 construction scheme.



Cross-Sections
- 1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
- 2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
- 3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 4: RD 10; steel 8.8 kw aliteit
- 5: roder keder profiel 80x61x3; Aluminum EN-AW 6061 (ET,EP,ER/B) T6
- 6: HK 50/50/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 7: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 8: RD 20; steel 8.8 kw aliteit
- 9: Ring 60/5; Aluminum EN-AW 6082 (EP,ET) T6

3.1.2 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	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
2	Aluminum EN-AW 6061 (ET,EP,ER/B) T6 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic
3	steel 8.8 kwaliteit | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
4	S320GD 1.0250 | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic

3.1.3 Used cross sections.

Section No.	Cross-Section Description [mm]	Material No.	Moments of inertia [cm⁴] Torsion J	Bending I_y	Bending I_z	Cross-Sectional Areas [cm²] Axial A	Shear A_y	Shear A_z	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Depth h
1	Interal truss Protruss S31	1	500,00	2096,00	2096,00	16,97	16,97	16,97	0,00	0,00	290,0	290,0
2	Interal Truss Protruss T31	1	150,00	1057,40	1057,40	12,72	12,72	12,72	0,00	0,00	289,0	257,0
3	Ring 50/4	1	30,81	15,41	15,41	5,78	2,93	2,93	0,00	0,00	50,0	50,0
4	RD 10	3	0,10	0,05	0,05	0,79	0,66	0,66	0,00	0,00	10,0	10,0
5	roder keder profiel 80x61x3	2	10,00	93,40	49,76	11,94	11,50	11,50	0,00	0,00	80,0	61,0
6	HK 50/50/4/4/4/4	1	40,69	26,15	26,15	7,36	3,22	3,22	0,00	0,00	50,0	50,0
7	RO 48.3x3.2 (Hot Formed)	4	23,20	11,60	11,60	4,53	2,26	2,26	0,00	0,00	48,3	48,3
8	RD 20	3	1,57	0,79	0,79	3,14	2,64	2,64	0,00	0,00	20,0	20,0
9	Ring 60/5	1	65,88	32,94	32,94	8,64	4,38	4,38	0,00	0,00	60,0	60,0

3.2 Calculation summary model option 1 and 2.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	95,0	mm	CO114, Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	59,2	mm	CO14, Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	111,2	mm	CO114, Member No. 197, x: 0.000 m
	Maximum vectorial displacement	147,3	mm	CO114, Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	30,0	mrad	CO114, Member No. 195, x: 0.000 m
	Maximum rotation about Y-axis	-61,6	mrad	CO114, Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-30,5	mrad	CO14, Member No. 197, x: 2.112 m
	Number of 1D finite elements (member elements)	342		
	Number of 2D finite elements (surface elements)	0		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	293		
	Number of equations	1758		
	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		
	Allow failing members	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

3.3 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	-10,24	kN	
	Sum of support forces in Z	-10,24	kN	Deviation: 0.00 %
	Resultant of reactions about X	1,677	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 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	-2,4	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-2,0	mm	Member No. 52, x: 0.250 m
	Maximum displacement in Z-direction	-7,8	mm	Member No. 139, x: 1.882 m
	Maximum vectorial displacement	7,8	mm	Member No. 139, x: 1.882 m
	Maximum rotation about X-axis	-2,6	mrad	Member No. 131, x: 0.000 m
	Maximum rotation about Y-axis	3,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-0,9	mrad	Member No. 165, x: 0.119 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC2 - UDL Loading			
	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	-43,75	kN	
	Sum of support forces in Z	-43,75	kN	Deviation: 0.00 %
	Resultant of reactions about X	38,823	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,002	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	-12,3	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-9,7	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-28,3	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	28,5	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	7,3	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-6,7	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-3,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC3 - CPL Loading setup			
	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	-26,89	kN	
	Sum of support forces in Z	-26,89	kN	Deviation: 0.00 %
	Resultant of reactions about X	20,465	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 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	-16,5	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-8,7	mm	Member No. 79, x: 0.000 m
	Maximum displacement in Z-direction	-37,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	37,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	9,1	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-8,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-6,8	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC4 - 2x point load per truss 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	-44,39	kN	
	Sum of support forces in Z	-44,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	39,147	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,002	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	-19,2	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,2	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-41,4	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	41,5	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	10,8	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	10,2	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-5,2	mrad	Member No. 104, x: 0.675 m
	Method of analysis	Linear		Geometrically Linear Analysis

	Description	Value	Unit	Comment
	LC5 - 3x point load per truss 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	-43,39	kN	
	Sum of support forces in Z	-43,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	42,520	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,002	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	-22,3	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-14,9	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-50,2	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	50,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	12,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-11,6	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-7,5	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC10 - In-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	16,73	kN	
	Sum of support forces in Y	16,73	kN	Deviation: 0.00 %
	Sum of loads in Z	16,93	kN	
	Sum of support forces in Z	16,93	kN	Deviation: 0.00 %
	Resultant of reactions about X	-54,130	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,003	kNm	At center of gravity of model
	Maximum displacement in X-direction	14,7	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	32,4	mm	Member No. 193, x: 1.590 m
	Maximum displacement in Z-direction	23,5	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	41,9	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	17,0	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-14,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-21,2	mrad	Member No. 197, x: 1.760 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC11 - In-service wind 90°			
	Sum of loads in X	6,65	kN	
	Sum of support forces in X	6,65	kN	Deviation: 0.00 %
	Sum of loads in Y	0,03	kN	
	Sum of support forces in Y	0,03	kN	Deviation: 0.00 %
	Sum of loads in Z	6,94	kN	
	Sum of support forces in Z	6,94	kN	Deviation: 0.00 %
	Resultant of reactions about X	-24,485	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-29,883	kNm	At center of gravity of model
	Resultant of reactions about Z	-3,414	kNm	At center of gravity of model
	Maximum displacement in X-direction	18,2	mm	Member No. 205, x: 0.000 m
	Maximum displacement in Y-direction	-3,3	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	17,7	mm	Member No. 101, x: 1.129 m
	Maximum vectorial displacement	21,0	mm	Member No. 101, x: 1.129 m
	Maximum rotation about X-axis	-4,8	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	8,2	mrad	Member No. 108, x: 1.013 m
	Maximum rotation about Z-axis	-4,7	mrad	Member No. 124, x: 1.333 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC12 - In-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-17,26	kN	
	Sum of support forces in Y	-17,26	kN	Deviation: 0.00 %
	Sum of loads in Z	-9,99	kN	
	Sum of support forces in Z	-9,99	kN	Deviation: 0.00 %
	Resultant of reactions about X	-60,153	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	4,4	mm	Member No. 76, x: 0.521 m
	Maximum displacement in Y-direction	-32,7	mm	Member No. 178, x: 0.000 m
	Maximum displacement in Z-direction	-14,1	mm	Member No. 176, x: 1.767 m
	Maximum vectorial displacement	35,6	mm	Member No. 178, x: 0.000 m
	Maximum rotation about X-axis	8,8	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-9,5	mrad	Member No. 109, x: 0.000 m
	Maximum rotation about Z-axis	-17,8	mrad	Member No. 124, x: 1.000 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC13 - Out-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	2,41	kN	
	Sum of support forces in Y	2,41	kN	Deviation: 0.00 %
	Sum of loads in Z	41,58	kN	

	Description	Value	Unit	Comment
	Sum of support forces in Z	41,58	kN	Deviation: 0.00 %
	Resultant of reactions about X	-22,209	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,005	kNm	At center of gravity of model
	Resultant of reactions about Z	0,007	kNm	At center of gravity of model
	Maximum displacement in X-direction	11,3	mm	Member No. 38, x: 0.000 m
	Maximum displacement in Y-direction	10,1	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	39,4	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	41,5	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	14,1	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-26,4	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	11,7	mrad	Member No. 165, x: 0.095 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC14 - Out-service wind 90°			
	Sum of loads in X	23,46	kN	
	Sum of support forces in X	23,46	kN	Deviation: 0.00 %
	Sum of loads in Y	-5,53	kN	
	Sum of support forces in Y	-5,53	kN	Deviation: 0.00 %
	Sum of loads in Z	48,76	kN	
	Sum of support forces in Z	48,76	kN	Deviation: 0.00 %
	Resultant of reactions about X	-5,388	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-132,930	kNm	At center of gravity of model
	Resultant of reactions about Z	-9,513	kNm	At center of gravity of model
	Maximum displacement in X-direction	63,7	mm	Member No. 50, x: 1.737 m
	Maximum displacement in Y-direction	-11,7	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	79,5	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	96,0	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	20,6	mrad	Member No. 195, x: 0.336 m
	Maximum rotation about Y-axis	-46,4	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-11,5	mrad	Member No. 168, x: 0.095 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC15 - Out-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-9,87	kN	
	Sum of support forces in Y	-9,87	kN	Deviation: 0.00 %
	Sum of loads in Z	38,61	kN	
	Sum of support forces in Z	38,61	kN	Deviation: 0.00 %
	Resultant of reactions about X	-4,784	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	7,1	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-10,3	mm	Member No. 178, x: 1.056 m
	Maximum displacement in Z-direction	37,3	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	38,9	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	13,6	mrad	Member No. 172, x: 0.353 m
	Maximum rotation about Y-axis	-25,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	10,6	mrad	Member No. 165, x: 0.095 m
	Method of analysis	Linear		Geometrically Linear Analysis

3.4 Calculation result of RC1 - General loading without wind 1 * (CO1 – CO4)

	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	-70,84	kN	
	Sum of support forces in Z	-70,84	kN	Deviation: 0.00 %
	Resultant of reactions about X	54,929	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,003	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	-19,9	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-15,9	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-46,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	46,5	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	11,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-10,8	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-6,2	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO2 - 1.15*LC1 + 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	-48,07	kN	
	Sum of support forces in Z	-48,07	kN	Deviation: 0.00 %
	Resultant of reactions about X	30,058	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,002	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	-25,7	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-14,5	mm	Member No. 79, x: 0.000 m
	Maximum displacement in Z-direction	-59,0	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	59,2	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	14,4	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-13,0	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-10,2	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO3 - 1.15*LC1 + 1.35*LC4			
	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	-71,69	kN	
	Sum of support forces in Z	-71,69	kN	Deviation: 0.00 %
	Resultant of reactions about X	55,846	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,003	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	-29,7	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-21,1	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-64,9	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	65,2	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	16,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-15,9	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-8,2	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO4 - 1.15*LC1 + 1.35*LC5			
	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	-70,34	kN	
	Sum of support forces in Z	-70,34	kN	Deviation: 0.00 %
	Resultant of reactions about X	60,517	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,003	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	-34,2	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-23,5	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-77,3	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	77,6	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	19,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-17,8	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-11,4	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.5 Calculation result of RC2 – Design Values In-service: 1 * (CO10 – CO34)

	Description	Value	Unit	Comment
	CO10 - 1.15*LC1 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,58	kN	
	Sum of support forces in Y	22,58	kN	Deviation: 0.00 %
	Sum of loads in Z	11,09	kN	
	Sum of support forces in Z	11,09	kN	Deviation: 0.00 %
	Resultant of reactions about X	-70,845	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,003	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	19,9	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	45,4	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	26,9	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	55,4	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	21,5	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-16,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-28,8	mrad	Member No. 197, x: 1.760 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO11 - 1.15*LC1 + 1.35*LC2 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,58	kN	
	Sum of support forces in Y	22,58	kN	Deviation: 0.00 %
	Sum of loads in Z	-47,98	kN	
	Sum of support forces in Z	-47,98	kN	Deviation: 0.00 %
	Resultant of reactions about X	-19,352	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	27,3	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	53,9	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	-32,1	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	67,3	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	12,6	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-17,9	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-29,6	mrad	Member No. 197, x: 1.760 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO12 - 1.15*LC1 + 1.35*LC3 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,58	kN	
	Sum of support forces in Y	22,58	kN	Deviation: 0.00 %
	Sum of loads in Z	-25,21	kN	
	Sum of support forces in Z	-25,21	kN	Deviation: 0.00 %
	Resultant of reactions about X	-43,964	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	39,1	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	52,5	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	-54,5	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	74,7	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	16,4	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-20,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-30,1	mrad	Member No. 197, x: 1.760 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO13 - 1.15*LC1 + 1.35*LC4 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,58	kN	
	Sum of support forces in Y	22,58	kN	Deviation: 0.00 %
	Sum of loads in Z	-48,83	kN	
	Sum of support forces in Z	-48,83	kN	Deviation: 0.00 %
	Resultant of reactions about X	-19,274	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	35,6	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	58,1	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	-41,2	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	76,3	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-9,5	mrad	Member No. 169, x: 0.119 m
	Maximum rotation about Y-axis	-19,8	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-30,3	mrad	Member No. 197, x: 2.112 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)

	Description	Value	Unit	Comment
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO14 - 1.15*LC1 + 1.35*LC5 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,58	kN	
	Sum of support forces in Y	22,58	kN	Deviation: 0.00 %
	Sum of loads in Z	-47,48	kN	
	Sum of support forces in Z	-47,48	kN	Deviation: 0.00 %
	Resultant of reactions about X	-14,679	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	38,7	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	59,2	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	-48,6	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	79,5	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-9,7	mrad	Member No. 169, x: 0.119 m
	Maximum rotation about Y-axis	-20,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-30,5	mrad	Member No. 197, x: 2.112 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO20 - 1.15*LC1 + 1.35*LC11			
	Sum of loads in X	8,97	kN	
	Sum of support forces in X	8,97	kN	Deviation: 0.00 %
	Sum of loads in Y	0,04	kN	
	Sum of support forces in Y	0,04	kN	Deviation: 0.00 %
	Sum of loads in Z	-2,41	kN	
	Sum of support forces in Z	-2,41	kN	Deviation: 0.00 %
	Resultant of reactions about X	-31,113	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-40,313	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,594	kNm	At center of gravity of model
	Maximum displacement in X-direction	23,0	mm	Member No. 174, x: 0.000 m
	Maximum displacement in Y-direction	-4,0	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	-19,5	mm	Member No. 131, x: 1.613 m
	Maximum vectorial displacement	29,4	mm	Member No. 131, x: 1.255 m
	Maximum rotation about X-axis	-4,9	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	10,1	mrad	Member No. 123, x: 1.167 m
	Maximum rotation about Z-axis	-5,3	mrad	Member No. 124, x: 1.333 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO21 - 1.15*LC1 + 1.35*LC2 + 1.35*LC11			
	Sum of loads in X	8,97	kN	
	Sum of support forces in X	8,97	kN	Deviation: 0.00 %
	Sum of loads in Y	0,04	kN	
	Sum of support forces in Y	0,04	kN	Deviation: 0.00 %
	Sum of loads in Z	-61,47	kN	
	Sum of support forces in Z	-61,47	kN	Deviation: 0.00 %
	Resultant of reactions about X	21,497	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-39,444	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,640	kNm	At center of gravity of model
	Maximum displacement in X-direction	23,6	mm	Member No. 45, x: 0.257 m
	Maximum displacement in Y-direction	-7,5	mm	Member No. 88, x: 0.360 m
	Maximum displacement in Z-direction	-18,4	mm	Member No. 100, x: 0.840 m
	Maximum vectorial displacement	24,6	mm	Member No. 100, x: 0.840 m
	Maximum rotation about X-axis	4,5	mrad	Member No. 104, x: 1.012 m
	Maximum rotation about Y-axis	11,5	mrad	Member No. 116, x: 0.203 m
	Maximum rotation about Z-axis	-4,5	mrad	Member No. 165, x: 0.119 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO22 - 1.15*LC1 + 1.35*LC3 + 1.35*LC11			
	Sum of loads in X	8,97	kN	
	Sum of support forces in X	8,97	kN	Deviation: 0.00 %
	Sum of loads in Y	0,04	kN	
	Sum of support forces in Y	0,04	kN	Deviation: 0.00 %
	Sum of loads in Z	-38,70	kN	
	Sum of support forces in Z	-38,70	kN	Deviation: 0.00 %
	Resultant of reactions about X	-3,355	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-39,719	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,645	kNm	At center of gravity of model
	Maximum displacement in X-direction	32,5	mm	Member No. 78, x: 2.054 m
	Maximum displacement in Y-direction	-9,6	mm	Member No. 198, x: 0.704 m
	Maximum displacement in Z-direction	-30,9	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	35,5	mm	Member No. 198, x: 0.704 m
	Maximum rotation about X-axis	8,4	mrad	Member No. 197, x: 2.112 m
	Maximum rotation about Y-axis	16,4	mrad	Member No. 119, x: 0.203 m
	Maximum rotation about Z-axis	8,2	mrad	Member No. 119, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO23 - 1.15*LC1 + 1.35*LC4 + 1.35*LC11			

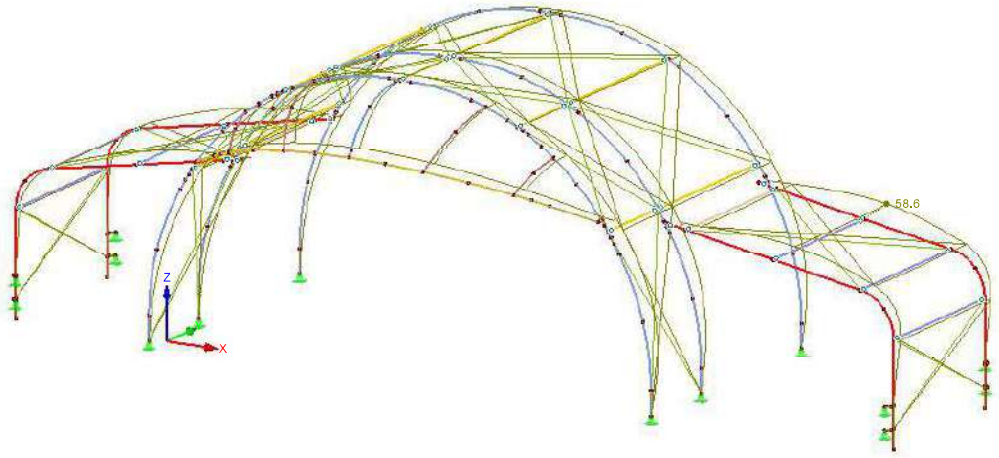
	Description	Value	Unit	Comment
	Sum of loads in X	8,97	kN	
	Sum of support forces in X	8,97	kN	Deviation: 0.00 %
	Sum of loads in Y	0,04	kN	
	Sum of support forces in Y	0,04	kN	Deviation: 0.00 %
	Sum of loads in Z	-62,33	kN	
	Sum of support forces in Z	-62,33	kN	Deviation: 0.00 %
	Resultant of reactions about X	22,245	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-39,239	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,656	kNm	At center of gravity of model
	Maximum displacement in X-direction	32,8	mm	Member No. 44, x: 0.062 m
	Maximum displacement in Y-direction	-12,4	mm	Member No. 88, x: 0.360 m
	Maximum displacement in Z-direction	-36,4	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	40,0	mm	Member No. 100, x: 0.420 m
	Maximum rotation about X-axis	9,3	mrad	Member No. 100, x: 1.260 m
	Maximum rotation about Y-axis	16,4	mrad	Member No. 116, x: 0.203 m
	Maximum rotation about Z-axis	-5,6	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO24 - 1.15*LC1 + 1.35*LC5 + 1.35*LC11			
	Sum of loads in X	8,97	kN	
	Sum of support forces in X	8,97	kN	Deviation: 0.00 %
	Sum of loads in Y	0,04	kN	
	Sum of support forces in Y	0,04	kN	Deviation: 0.00 %
	Sum of loads in Z	-60,98	kN	
	Sum of support forces in Z	-60,98	kN	Deviation: 0.00 %
	Resultant of reactions about X	26,887	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-39,291	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,671	kNm	At center of gravity of model
	Maximum displacement in X-direction	37,4	mm	Member No. 44, x: 0.125 m
	Maximum displacement in Y-direction	-14,6	mm	Member No. 79, x: 1.467 m
	Maximum displacement in Z-direction	-48,4	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	51,2	mm	Member No. 100, x: 0.420 m
	Maximum rotation about X-axis	12,2	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	18,5	mrad	Member No. 134, x: 3.764 m
	Maximum rotation about Z-axis	-8,8	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO30 - 1.15*LC1 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,30	kN	
	Sum of support forces in Y	-23,30	kN	Deviation: 0.00 %
	Sum of loads in Z	-25,26	kN	
	Sum of support forces in Z	-25,26	kN	Deviation: 0.00 %
	Resultant of reactions about X	-79,016	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	6,7	mm	Member No. 76, x: 0.521 m
	Maximum displacement in Y-direction	-46,2	mm	Member No. 178, x: 0.000 m
	Maximum displacement in Z-direction	-25,7	mm	Member No. 176, x: 1.767 m
	Maximum vectorial displacement	52,8	mm	Member No. 178, x: 0.000 m
	Maximum rotation about X-axis	11,1	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-17,5	mrad	Member No. 177, x: 0.000 m
	Maximum rotation about Z-axis	-24,5	mrad	Member No. 124, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO31 - 1.15*LC1 + 1.35*LC2 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,30	kN	
	Sum of support forces in Y	-23,30	kN	Deviation: 0.00 %
	Sum of loads in Z	-84,33	kN	
	Sum of support forces in Z	-84,33	kN	Deviation: 0.00 %
	Resultant of reactions about X	-25,198	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,003	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	23,0	mm	Member No. 43, x: 1.956 m
	Maximum displacement in Y-direction	-48,8	mm	Member No. 178, x: 0.000 m
	Maximum displacement in Z-direction	-46,7	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	54,2	mm	Member No. 176, x: 1.767 m
	Maximum rotation about X-axis	12,7	mrad	Member No. 166, x: 0.166 m
	Maximum rotation about Y-axis	-15,9	mrad	Member No. 177, x: 0.000 m
	Maximum rotation about Z-axis	-24,0	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO32 - 1.15*LC1 + 1.35*LC3 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	

	Description	Value	Unit	Comment
	Sum of loads in Y	-23,30	kN	
	Sum of support forces in Y	-23,30	kN	Deviation: 0.00 %
	Sum of loads in Z	-61,56	kN	
	Sum of support forces in Z	-61,56	kN	Deviation: 0.00 %
	Resultant of reactions about X	-50,422	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	28,3	mm	Member No. 43, x: 2.347 m
	Maximum displacement in Y-direction	-53,1	mm	Member No. 178, x: 0.000 m
	Maximum displacement in Z-direction	-59,2	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	62,7	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	13,8	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	16,3	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-28,4	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO33 - 1.15*LC1 + 1.35*LC4 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,30	kN	
	Sum of support forces in Y	-23,30	kN	Deviation: 0.00 %
	Sum of loads in Z	-85,18	kN	
	Sum of support forces in Z	-85,18	kN	Deviation: 0.00 %
	Resultant of reactions about X	-24,147	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,003	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	32,7	mm	Member No. 43, x: 2.347 m
	Maximum displacement in Y-direction	-51,8	mm	Member No. 176, x: 1.767 m
	Maximum displacement in Z-direction	-65,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	69,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	16,5	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	19,4	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-25,4	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO34 - 1.15*LC1 + 1.35*LC5 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,30	kN	
	Sum of support forces in Y	-23,30	kN	Deviation: 0.00 %
	Sum of loads in Z	-83,83	kN	
	Sum of support forces in Z	-83,83	kN	Deviation: 0.00 %
	Resultant of reactions about X	-19,531	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,003	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	37,1	mm	Member No. 43, x: 2.347 m
	Maximum displacement in Y-direction	-52,0	mm	Member No. 176, x: 1.767 m
	Maximum displacement in Z-direction	-77,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	81,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	19,2	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	21,3	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-25,0	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.5.1 Deformation of the In-service situation characteristic max and min values.

RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Max Values

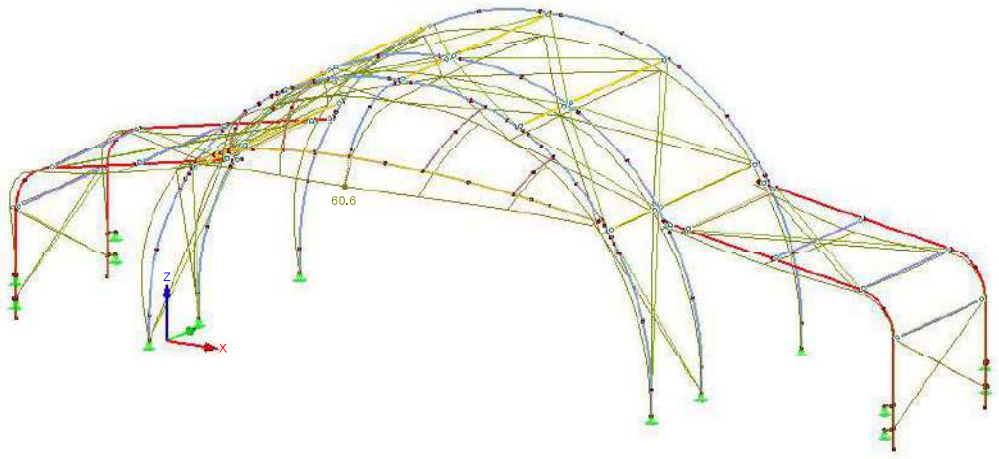
Isometric



Max u: 58.6, Min u: 0.0 mm
Factor of deformations: 10.00

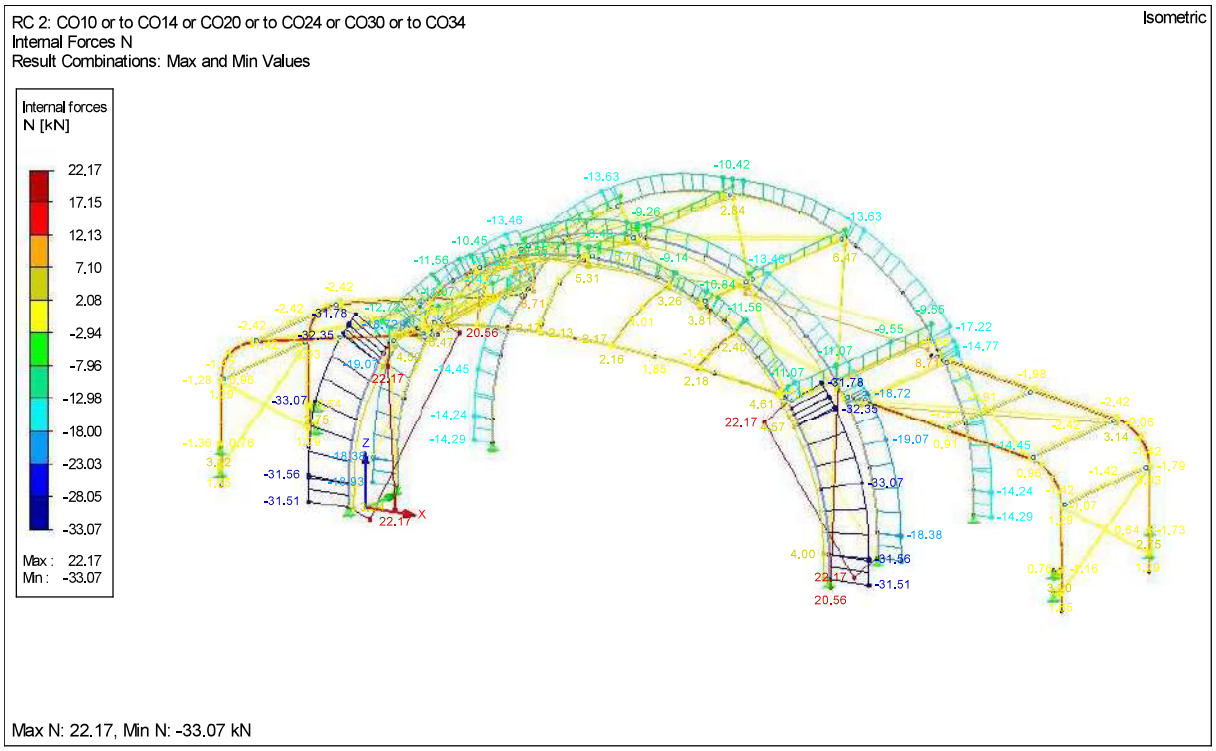
RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Min Values

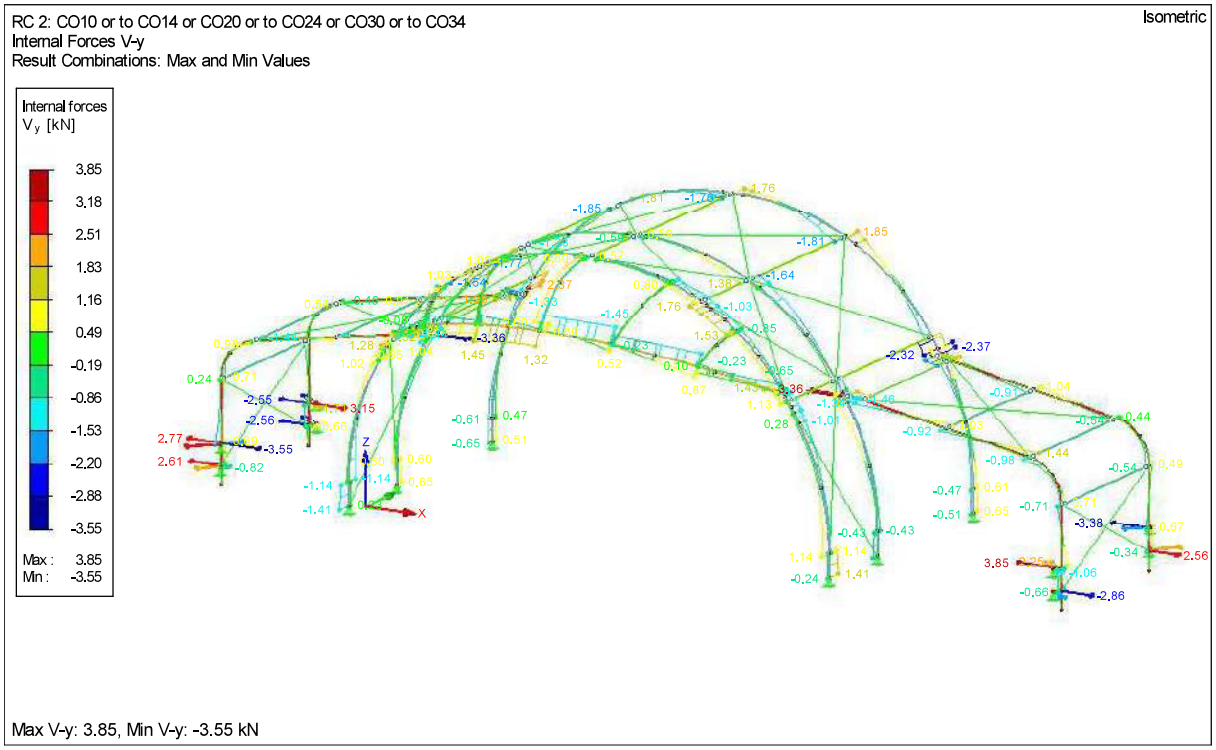
Isometric



Max u: 60.6, Min u: 0.0 mm
Factor of deformations: 10.00

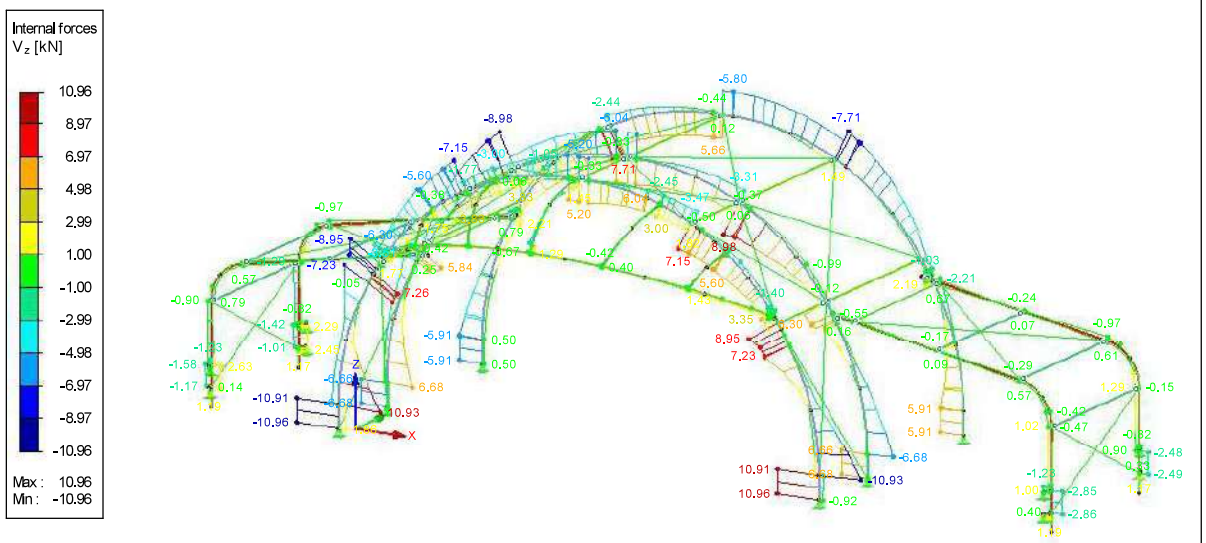
3.5.2 Internal force diagram RC2 Design values In-service.





RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

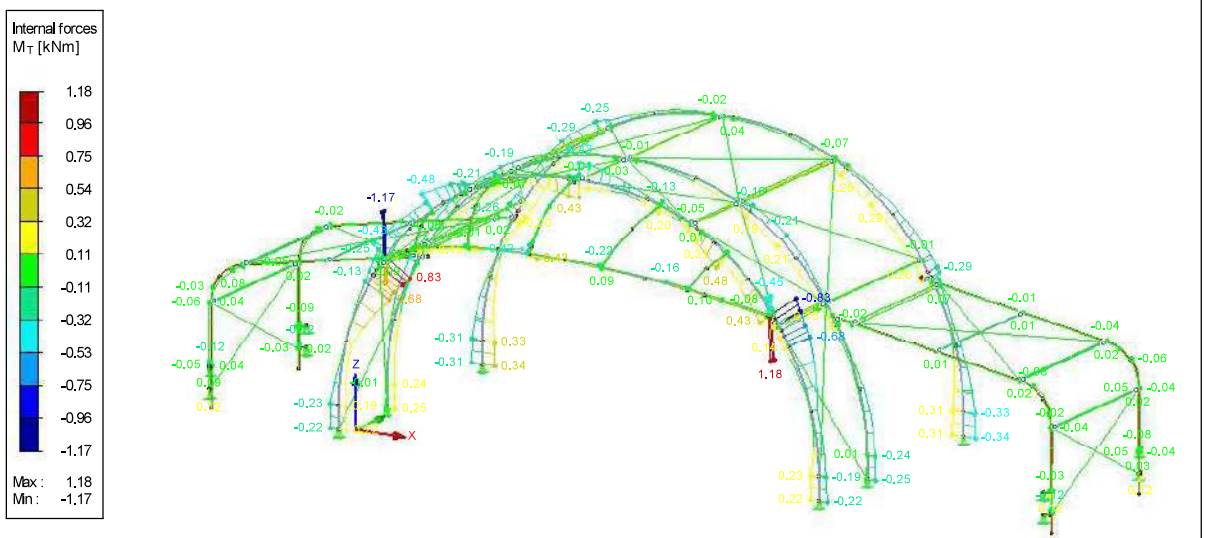
Isometric



Max V-z: 10.96, Min V-z: -10.96 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-T
Result Combinations: Max and Min Values

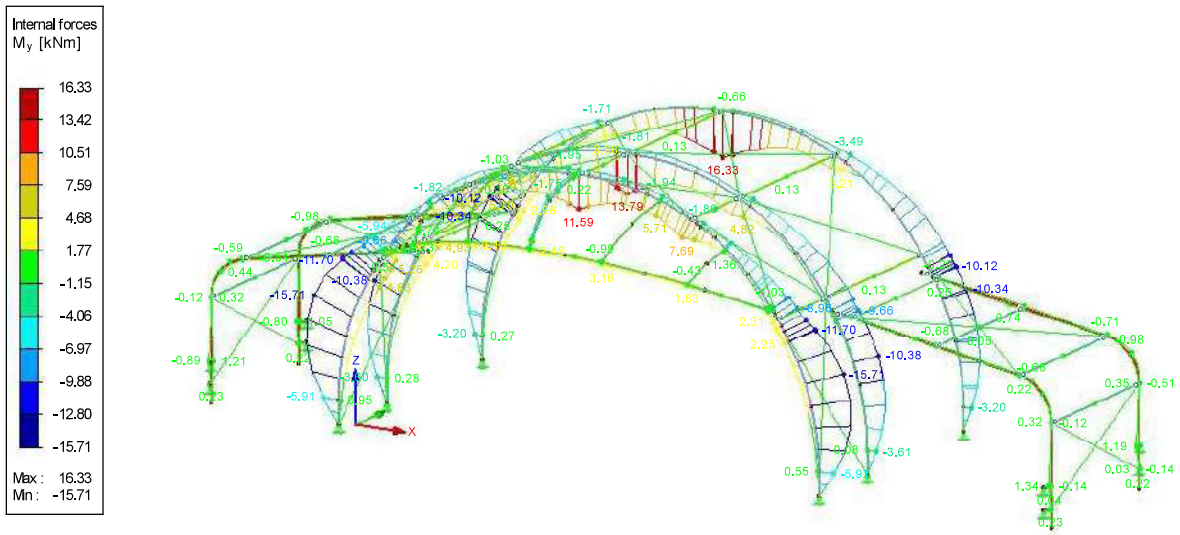
Isometric



Max M-T: 1.18, Min M-T: -1.17 kNm

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

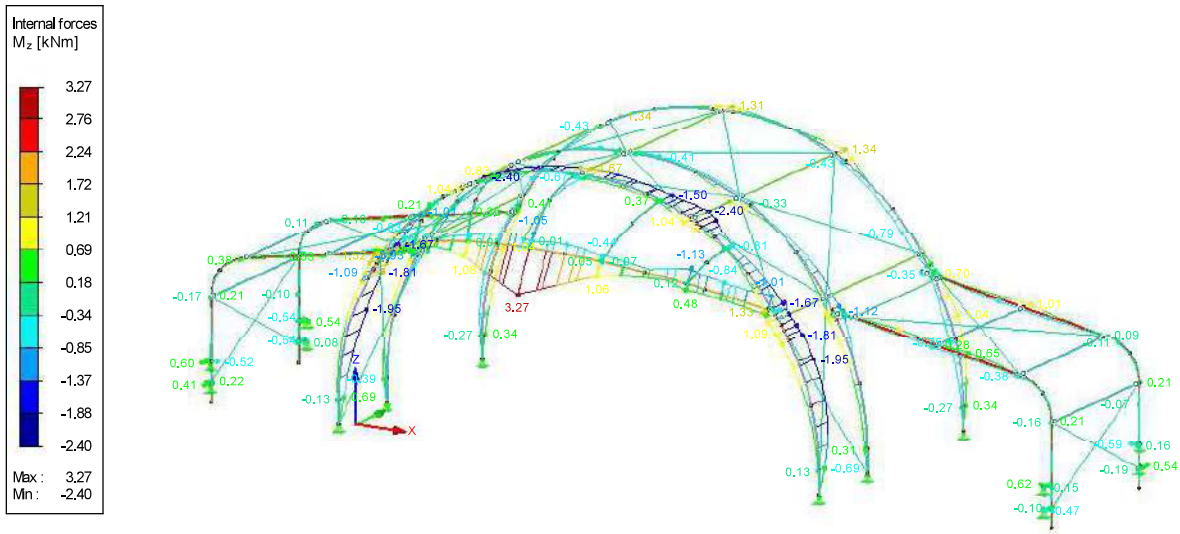
Isometric



Max M-y: 16.33, Min M-y: -15.71 kNm

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 3.27, Min M-z: -2.40 kNm

3.6 Calculation result of RC4 - Design Values Out-service: 1 * (CO100 – CO124)

	Description	Value	Unit	Comment
	CO100 - 1.15*LC1 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	44,36	kN	
	Sum of support forces in Z	44,36	kN	Deviation: 0.00 %
	Resultant of reactions about X	-27,972	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,006	kNm	At center of gravity of model
	Resultant of reactions about Z	0,010	kNm	At center of gravity of model
	Maximum displacement in X-direction	14,2	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	12,4	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	45,5	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	48,2	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	17,6	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-30,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	14,2	mrad	Member No. 165, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO101 - 1.15*LC1 + 1.35*LC2 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-14,70	kN	
	Sum of support forces in Z	-14,70	kN	Deviation: 0.00 %
	Resultant of reactions about X	24,271	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,010	kNm	At center of gravity of model
	Maximum displacement in X-direction	20,8	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	9,6	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	48,7	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	53,0	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-15,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-31,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	10,5	mrad	Member No. 165, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO102 - 1.15*LC1 + 1.35*LC3 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	8,07	kN	
	Sum of support forces in Z	8,07	kN	Deviation: 0.00 %
	Resultant of reactions about X	-0,544	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,010	kNm	At center of gravity of model
	Maximum displacement in X-direction	32,3	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	13,6	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	55,1	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	64,0	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-15,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-34,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	11,0	mrad	Member No. 165, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO103 - 1.15*LC1 + 1.35*LC4 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-15,56	kN	
	Sum of support forces in Z	-15,56	kN	Deviation: 0.00 %
	Resultant of reactions about X	24,585	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,010	kNm	At center of gravity of model
	Maximum displacement in X-direction	28,8	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	12,6	mm	Member No. 101, x: 0.839 m
	Maximum displacement in Z-direction	52,9	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	60,3	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-16,4	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-33,4	mrad	Member No. 196, x: 0.000 m

	Description	Value	Unit	Comment
	Maximum rotation about Z-axis	8,6	mrad	Member No. 165, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO104 - 1.15*LC1 + 1.35*LC5 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-14,21	kN	
	Sum of support forces in Z	-14,21	kN	Deviation: 0.00 %
	Resultant of reactions about X	29,164	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,010	kNm	At center of gravity of model
	Maximum displacement in X-direction	31,8	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	13,5	mm	Member No. 101, x: 0.033 m
	Maximum displacement in Z-direction	54,5	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	63,3	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-16,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-34,0	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	7,6	mrad	Member No. 169, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO110 - 1.15*LC1 + 1.35*LC14			
	Sum of loads in X	31,67	kN	
	Sum of support forces in X	31,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	54,05	kN	
	Sum of support forces in Z	54,05	kN	Deviation: 0.00 %
	Resultant of reactions about X	-5,491	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-182,639	kNm	At center of gravity of model
	Resultant of reactions about Z	-13,291	kNm	At center of gravity of model
	Maximum displacement in X-direction	81,2	mm	Member No. 72, x: 1.197 m
	Maximum displacement in Y-direction	-15,0	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	96,2	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	117,9	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	26,1	mrad	Member No. 195, x: 0.336 m
	Maximum rotation about Y-axis	-55,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-14,2	mrad	Member No. 168, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO111 - 1.15*LC1 + 1.35*LC2 + 1.35*LC14			
	Sum of loads in X	31,67	kN	
	Sum of support forces in X	31,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-5,02	kN	
	Sum of support forces in Z	-5,02	kN	Deviation: 0.00 %
	Resultant of reactions about X	47,075	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-179,467	kNm	At center of gravity of model
	Resultant of reactions about Z	-13,420	kNm	At center of gravity of model
	Maximum displacement in X-direction	85,1	mm	Member No. 72, x: 1.467 m
	Maximum displacement in Y-direction	-17,0	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	102,8	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	131,2	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	28,3	mrad	Member No. 195, x: 0.000 m
	Maximum rotation about Y-axis	-58,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	13,9	mrad	Member No. 119, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO112 - 1.15*LC1 + 1.35*LC3 + 1.35*LC14			
	Sum of loads in X	31,67	kN	
	Sum of support forces in X	31,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	17,75	kN	
	Sum of support forces in Z	17,75	kN	Deviation: 0.00 %
	Resultant of reactions about X	22,088	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-180,593	kNm	At center of gravity of model
	Resultant of reactions about Z	-13,504	kNm	At center of gravity of model
	Maximum displacement in X-direction	90,4	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-21,6	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	109,6	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	143,3	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	29,1	mrad	Member No. 195, x: 0.336 m
	Maximum rotation about Y-axis	-61,4	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	18,4	mrad	Member No. 119, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)

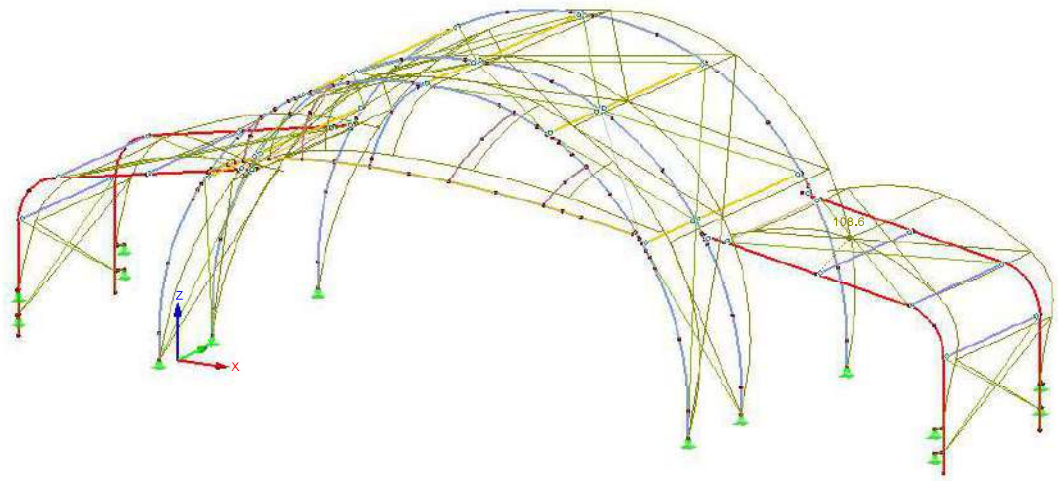
	Description	Value	Unit	Comment
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO113 - 1.15*LC1 + 1.35*LC4 + 1.35*LC14			
	Sum of loads in X	31,67	kN	
	Sum of support forces in X	31,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-5,87	kN	
	Sum of support forces in Z	-5,87	kN	Deviation: 0.00 %
	Resultant of reactions about X	47,643	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-178,735	kNm	At center of gravity of model
	Resultant of reactions about Z	-13,508	kNm	At center of gravity of model
	Maximum displacement in X-direction	90,6	mm	Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	-19,9	mm	Member No. 78, x: 0.489 m
	Maximum displacement in Z-direction	108,6	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	142,5	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	29,6	mrad	Member No. 195, x: 0.000 m
	Maximum rotation about Y-axis	-60,9	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	16,0	mrad	Member No. 119, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO114 - 1.15*LC1 + 1.35*LC5 + 1.35*LC14			
	Sum of loads in X	31,67	kN	
	Sum of support forces in X	31,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-4,52	kN	
	Sum of support forces in Z	-4,52	kN	Deviation: 0.00 %
	Resultant of reactions about X	52,187	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-178,965	kNm	At center of gravity of model
	Resultant of reactions about Z	-13,557	kNm	At center of gravity of model
	Maximum displacement in X-direction	95,0	mm	Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	-21,6	mm	Member No. 78, x: 0.489 m
	Maximum displacement in Z-direction	111,2	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	147,3	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	30,0	mrad	Member No. 195, x: 0.000 m
	Maximum rotation about Y-axis	-61,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	15,5	mrad	Member No. 119, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO120 - 1.15*LC1 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-13,32	kN	
	Sum of support forces in Y	-13,32	kN	Deviation: 0.00 %
	Sum of loads in Z	40,35	kN	
	Sum of support forces in Z	40,35	kN	Deviation: 0.00 %
	Resultant of reactions about X	-4,794	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,012	kNm	At center of gravity of model
	Maximum displacement in X-direction	8,6	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-13,2	mm	Member No. 178, x: 1.056 m
	Maximum displacement in Z-direction	42,5	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	44,7	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	17,0	mrad	Member No. 174, x: 0.528 m
	Maximum rotation about Y-axis	-29,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	13,0	mrad	Member No. 165, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO121 - 1.15*LC1 + 1.35*LC2 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-13,32	kN	
	Sum of support forces in Y	-13,32	kN	Deviation: 0.00 %
	Sum of loads in Z	-18,72	kN	
	Sum of support forces in Z	-18,72	kN	Deviation: 0.00 %
	Resultant of reactions about X	47,972	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,012	kNm	At center of gravity of model
	Maximum displacement in X-direction	19,3	mm	Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	-19,1	mm	Member No. 73, x: 2.445 m
	Maximum displacement in Z-direction	48,0	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	53,4	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	18,7	mrad	Member No. 173, x: 0.336 m
	Maximum rotation about Y-axis	-31,1	mrad	Member No. 195, x: 0.000 m
	Maximum rotation about Z-axis	11,0	mrad	Member No. 165, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO122 - 1.15*LC1 + 1.35*LC3 + 1.35*LC15			

	Description	Value	Unit	Comment
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-13,32	kN	
	Sum of support forces in Y	-13,32	kN	Deviation: 0.00 %
	Sum of loads in Z	4,05	kN	
	Sum of support forces in Z	4,05	kN	Deviation: 0.00 %
	Resultant of reactions about X	22,898	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,012	kNm	At center of gravity of model
	Maximum displacement in X-direction	28,0	mm	Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	-17,9	mm	Member No. 178, x: 0.704 m
	Maximum displacement in Z-direction	52,8	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	62,0	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	19,6	mrad	Member No. 172, x: 0.353 m
	Maximum rotation about Y-axis	-33,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-14,8	mrad	Member No. 124, x: 1.333 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO123 - 1.15*LC1 + 1.35*LC4 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-13,32	kN	
	Sum of support forces in Y	-13,32	kN	Deviation: 0.00 %
	Sum of loads in Z	-19,57	kN	
	Sum of support forces in Z	-19,57	kN	Deviation: 0.00 %
	Resultant of reactions about X	48,659	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,012	kNm	At center of gravity of model
	Maximum displacement in X-direction	28,7	mm	Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	-24,1	mm	Member No. 73, x: 2.445 m
	Maximum displacement in Z-direction	52,9	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	62,1	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	20,0	mrad	Member No. 173, x: 0.042 m
	Maximum rotation about Y-axis	-33,2	mrad	Member No. 195, x: 0.000 m
	Maximum rotation about Z-axis	-11,8	mrad	Member No. 124, x: 1.333 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO124 - 1.05*LC1 + 1.35*LC5 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-13,32	kN	
	Sum of support forces in Y	-13,32	kN	Deviation: 0.00 %
	Sum of loads in Z	-17,20	kN	
	Sum of support forces in Z	-17,20	kN	Deviation: 0.00 %
	Resultant of reactions about X	53,025	kNm	At center of gravity of model (X: 5.670, Y: 2.647, Z: 3.859 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,012	kNm	At center of gravity of model
	Maximum displacement in X-direction	32,9	mm	Member No. 197, x: 0.000 m
	Maximum displacement in Y-direction	-26,2	mm	Member No. 73, x: 2.445 m
	Maximum displacement in Z-direction	55,7	mm	Member No. 197, x: 0.000 m
	Maximum vectorial displacement	66,5	mm	Member No. 139, x: 0.000 m
	Maximum rotation about X-axis	20,5	mrad	Member No. 173, x: 0.000 m
	Maximum rotation about Y-axis	-34,3	mrad	Member No. 195, x: 0.000 m
	Maximum rotation about Z-axis	-11,1	mrad	Member No. 124, x: 1.333 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.6.1 Deformation of the Out-service situation characteristic max and min values.

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Global Deformations u
Result Combinations: Max Values

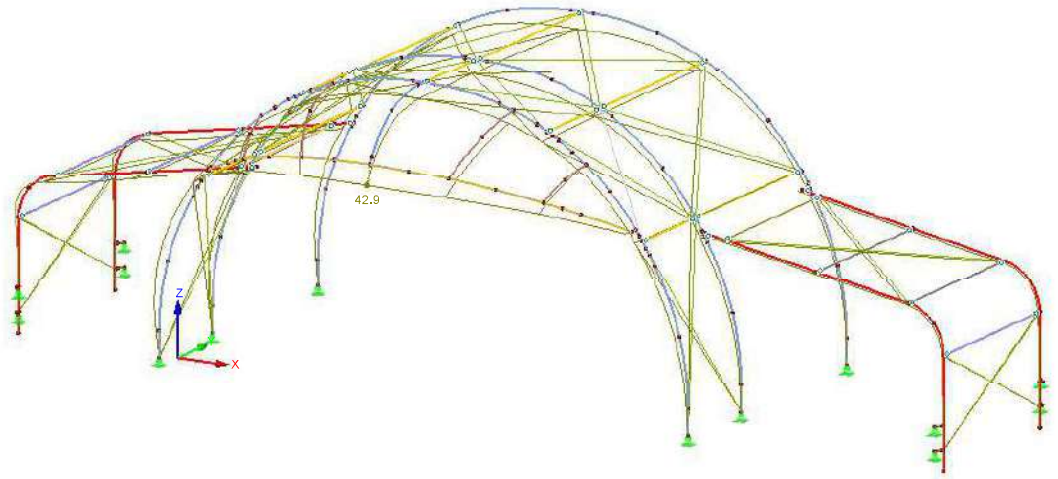
Isometric



Max u: 108.6, Min u: 0.0 mm
Factor of deformations: 10.00

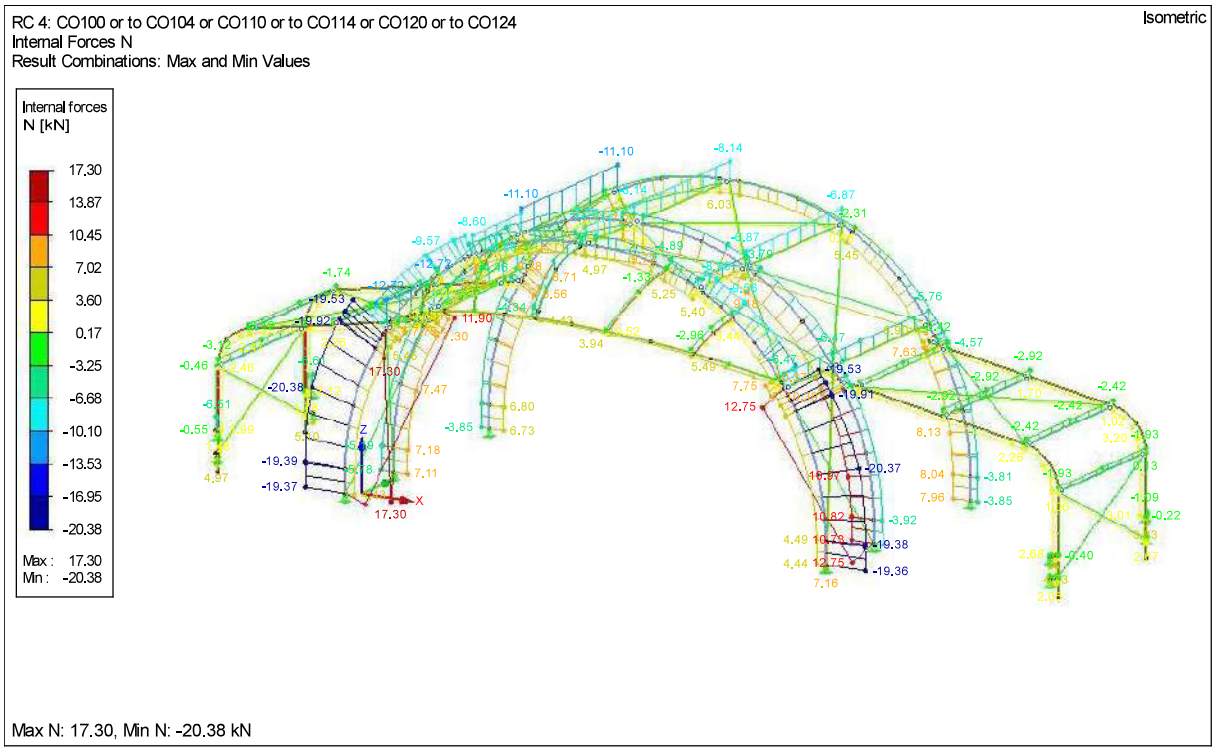
RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Global Deformations u
Result Combinations: Min Values

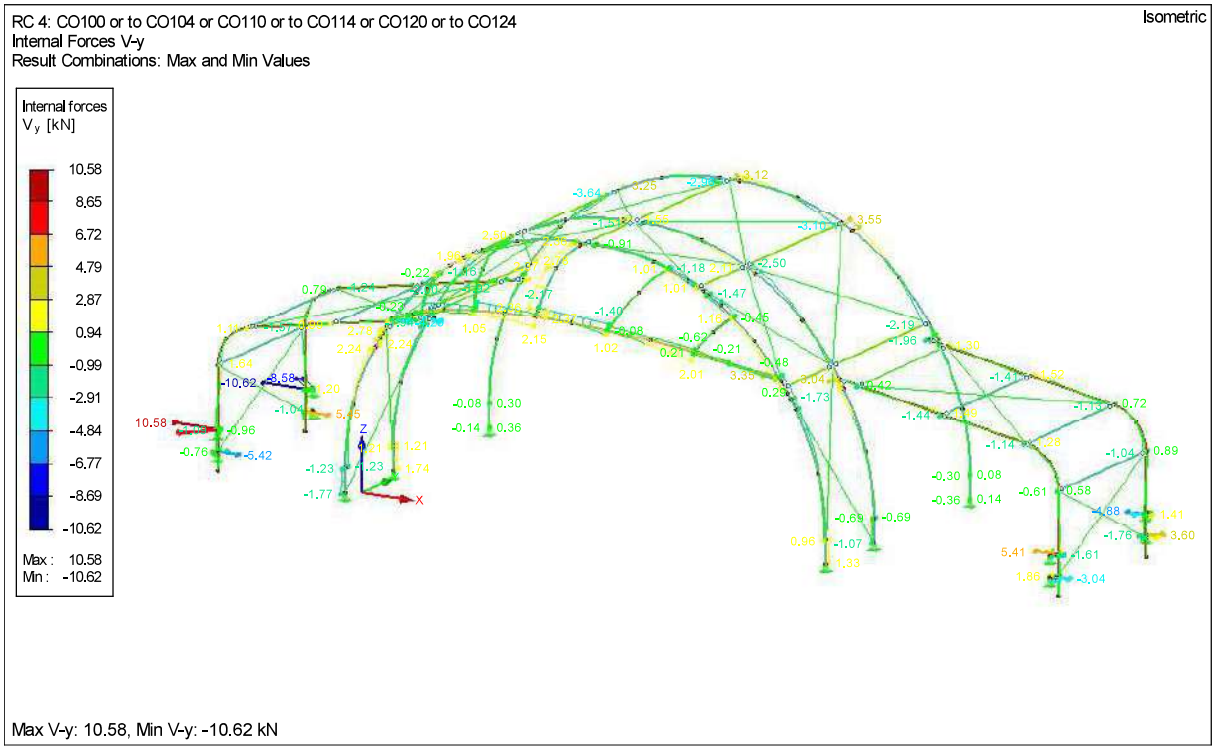
Isometric



Max u: 42.9, Min u: 0.0 mm
Factor of deformations: 10.00

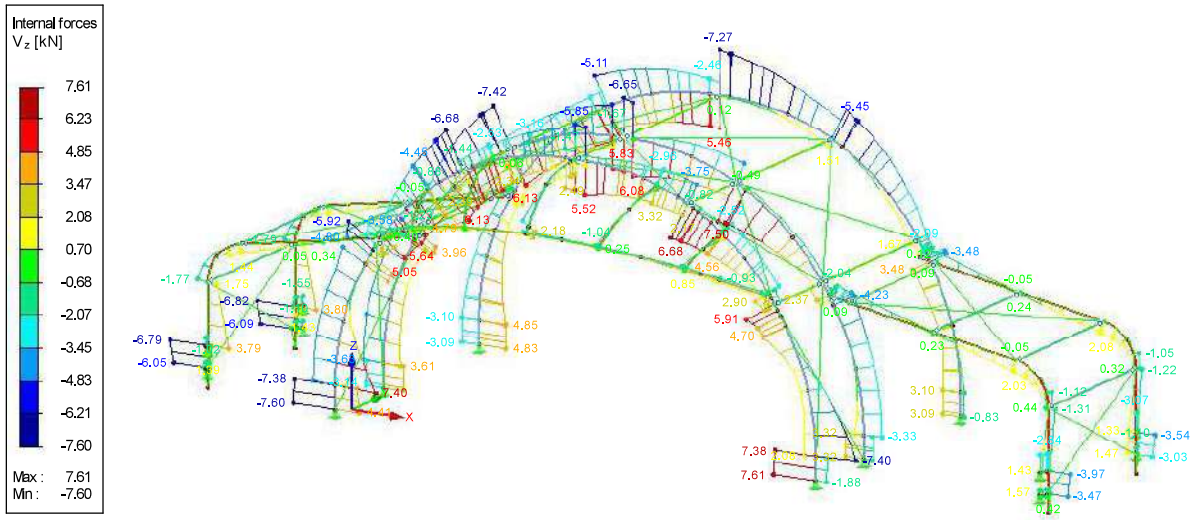
3.6.2 Internal force diagram RC4 Design Values Out-service.





RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

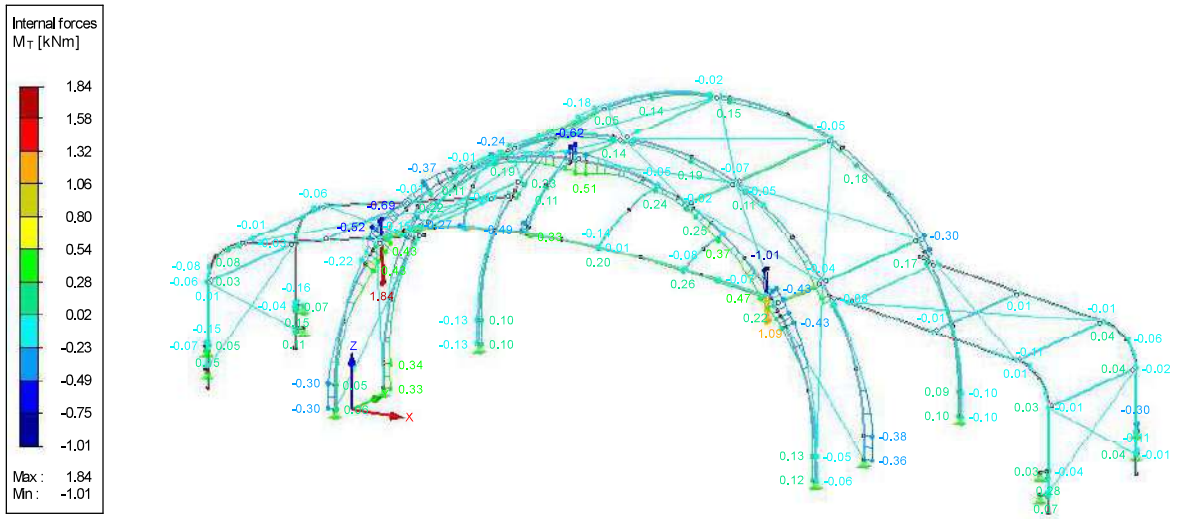
Isometric



Max V-z: 7.61, Min V-z: -7.60 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-T
Result Combinations: Max and Min Values

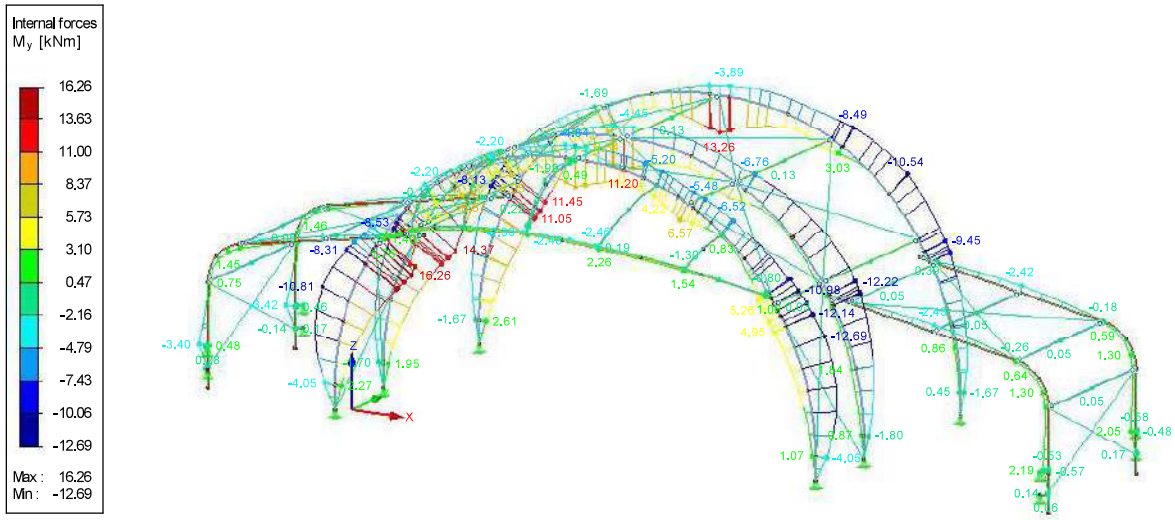
Isometric



Max M-T: 1.84, Min M-T: -1.01 kNm

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

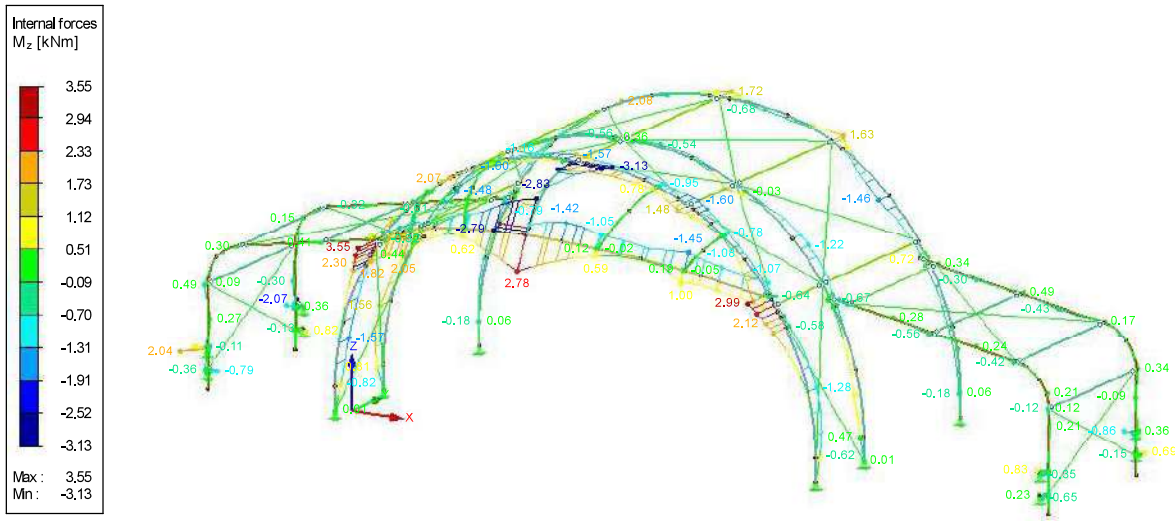
Isometric



Max M-y: 16.26, Min M-y: -12.69 kNm

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric

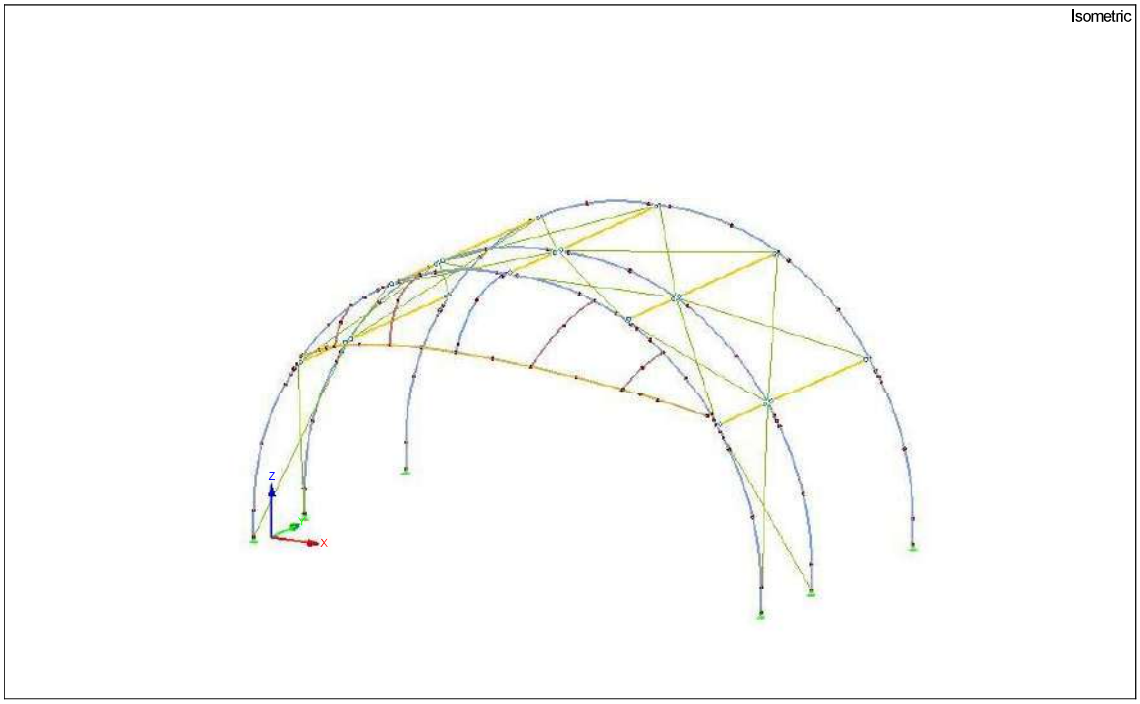


Max M-z: 3.55, Min M-z: -3.13 kNm

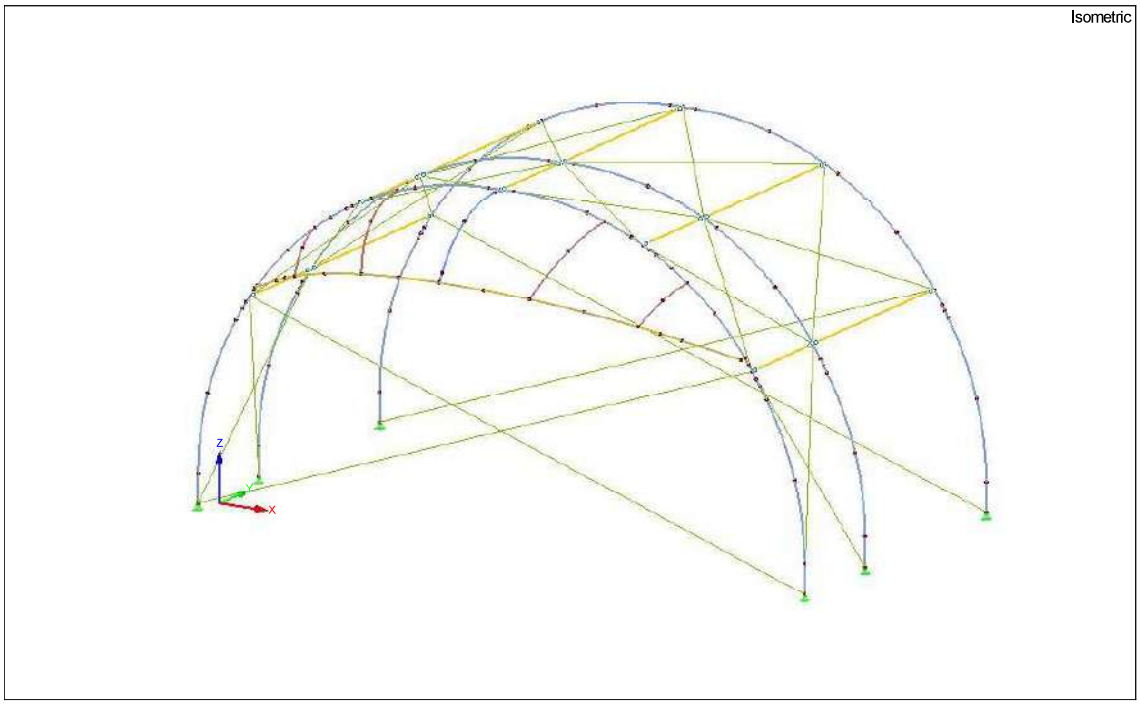
3.7 General calculation of the medium Tunnel Roof 12x6 option 3.

3.7.1 construction scheme.

In service model.



Out service model.



Cross-Sections
1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
4: RD 10; steel 8.8 kw aliteit

3.7.2 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	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
2	steel 8.8 kwaliteit | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic

3.7.3 Used cross sections.

Section No.	Cross-Section Description [mm]	Material No.	Moments of inertia [cm⁴] Torsion J	Bending I_y	Bending I_z	Cross-Sectional Areas [cm²] Axial A	Shear A_y	Shear A_z	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Depth h
1	Interal truss Protruss S31	1	500,00	2096,00	2096,00	16,97	16,97	16,97	0,00	0,00	290,0	290,0
2	Interal Truss Protruss T31	1	150,00	1057,40	1057,40	12,72	12,72	12,72	0,00	0,00	289,0	257,0
3	Ring 50/4	1	30,81	15,41	15,41	5,78	2,93	2,93	0,00	0,00	50,0	50,0
4	RD 10	3	0,10	0,05	0,05	0,79	0,66	0,66	0,00	0,00	10,0	10,0

3.8 Calculation summary model option 3.

In Service situation.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	54,5	mm	CO22, Member No. 79, x: 2.054 m
	Maximum displacement in Y-direction	32,2	mm	CO12, Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-77,5	mm	CO4, Member No. 101, x: 1.677 m
	Maximum vectorial displacement	77,8	mm	CO4, Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	19,8	mrad	CO4, Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	23,0	mrad	CO24, Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-11,5	mrad	CO4, Member No. 104, x: 0.772 m
	Number of 1D finite elements (member elements)	242		
	Number of 2D finite elements (surface elements)	0		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	209		
	Number of equations	1254		
	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		
	Allow failing members	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

Out Service situation.

	Description	Value	Unit	Comment
	Summary			
	Maximum displacement in X-direction	53,6		
	Maximum displacement in Y-direction	-13,8	mm	CO124, Member No. 73, x: 1.676 m
	Maximum displacement in Z-direction	39,3	mm	CO110, Member No. 101, x: 1.129 m
	Maximum vectorial displacement	54,2	mm	CO110, Member No. 72, x: 0.000 m
	Maximum rotation about X-axis	-11,4	mrad	CO100, Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	23,7	mrad	CO110, Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-9,2	mrad	CO110, Member No. 103, x: 0.579 m
	Number of 1D finite elements (member elements)	246		
	Number of 2D finite elements (surface elements)	0		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	209		
	Number of equations	1254		
	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		
	Allow failing members	+		
	Precision of convergence criteria of nonlinear calculation	1,0		
	Maximum displacement in X-direction	53,6	mm	CO110, Member No. 72, x: 0.000 m

3.9 Calculation result of the separate load cases.

In service situation.

	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	-7,79	kN	
	Sum of support forces in Z	-7,79	kN	Deviation: 0.00 %
	Resultant of reactions about X	-0,230	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 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	-2,3	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-1,7	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-5,4	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	5,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	1,4	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-1,2	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-0,8	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC2 - UDL Loading			
	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	-43,75	kN	
	Sum of support forces in Z	-43,75	kN	Deviation: 0.00 %
	Resultant of reactions about X	15,351	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,002	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	-12,4	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-9,7	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-28,6	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	28,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	7,4	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-6,7	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-3,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC3 - CPL Loading setup			
	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	-26,89	kN	
	Sum of support forces in Z	-26,89	kN	Deviation: 0.00 %
	Resultant of reactions about X	6,041	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,002	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	-16,6	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-8,5	mm	Member No. 79, x: 0.000 m
	Maximum displacement in Z-direction	-37,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	37,9	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	9,0	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-8,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-6,8	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC4 - 2x point load per truss 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	-44,39	kN	
	Sum of support forces in Z	-44,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	15,334	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,002	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	-19,4	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,1	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-41,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	42,0	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	10,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-10,4	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-5,3	mrad	Member No. 104, x: 0.675 m
	Method of analysis	Linear		Geometrically Linear Analysis

	Description	Value	Unit	Comment
	LC5 - 3x point load per truss 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	-43,39	kN	
	Sum of support forces in Z	-43,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	19,243	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,002	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	-22,7	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-14,7	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-50,7	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	50,9	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	13,0	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-11,7	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-7,7	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC10 - In-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	10,02	kN	
	Sum of support forces in Y	10,02	kN	Deviation: 0.00 %
	Sum of loads in Z	14,31	kN	
	Sum of support forces in Z	14,31	kN	Deviation: 0.00 %
	Resultant of reactions about X	-55,454	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,003	kNm	At center of gravity of model
	Maximum displacement in X-direction	15,4	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	20,4	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	26,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	30,5	mm	Member No. 2, x: 0.000 m
	Maximum rotation about X-axis	-8,7	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	8,0	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	3,5	mrad	Member No. 6, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC11 - In-service wind 90°			
	Sum of loads in X	8,60	kN	
	Sum of support forces in X	8,60	kN	Deviation: 0.00 %
	Sum of loads in Y	0,04	kN	
	Sum of support forces in Y	0,04	kN	Deviation: 0.00 %
	Sum of loads in Z	7,10	kN	
	Sum of support forces in Z	7,10	kN	Deviation: 0.00 %
	Resultant of reactions about X	-20,410	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-34,804	kNm	At center of gravity of model
	Resultant of reactions about Z	-7,639	kNm	At center of gravity of model
	Maximum displacement in X-direction	29,1	mm	Member No. 97, x: 0.121 m
	Maximum displacement in Y-direction	2,5	mm	Member No. 40, x: 0.978 m
	Maximum displacement in Z-direction	18,7	mm	Member No. 101, x: 0.581 m
	Maximum vectorial displacement	29,7	mm	Member No. 97, x: 0.121 m
	Maximum rotation about X-axis	-5,0	mrad	Member No. 99, x: 1.451 m
	Maximum rotation about Y-axis	10,7	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-4,1	mrad	Member No. 103, x: 0.579 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC12 - In-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-12,24	kN	
	Sum of support forces in Y	-12,24	kN	Deviation: 0.00 %
	Sum of loads in Z	-6,81	kN	
	Sum of support forces in Z	-6,81	kN	Deviation: 0.00 %
	Resultant of reactions about X	-64,034	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,003	kNm	At center of gravity of model
	Maximum displacement in X-direction	7,2	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	-8,8	mm	Member No. 72, x: 0.880 m
	Maximum displacement in Z-direction	-11,3	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	13,0	mm	Member No. 74, x: 0.250 m
	Maximum rotation about X-axis	3,4	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Y-axis	3,9	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	2,9	mrad	Member No. 70, x: 2.445 m
	Method of analysis	Linear		Geometrically Linear Analysis

Out service situation.

	Description	Value	Unit	Comment
	LC13 - Out-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	2,41	kN	
	Sum of support forces in Y	2,41	kN	Deviation: 0.00 %
	Sum of loads in Z	33,31	kN	
	Sum of support forces in Z	33,31	kN	Deviation: 0.00 %
	Resultant of reactions about X	-16,253	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	11,4	mm	Member No. 37, x: 0.000 m
	Maximum displacement in Y-direction	8,7	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	31,7	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	31,7	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-9,5	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	7,3	mrad	Member No. 104, x: 0.000 m
	Maximum rotation about Z-axis	4,3	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC14 - Out-service wind 90°			
	Sum of loads in X	29,56	kN	
	Sum of support forces in X	29,56	kN	Deviation: 0.00 %
	Sum of loads in Y	2,32	kN	
	Sum of support forces in Y	2,32	kN	Deviation: 0.00 %
	Sum of loads in Z	34,01	kN	
	Sum of support forces in Z	34,01	kN	Deviation: 0.00 %
	Resultant of reactions about X	14,626	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	-115,508	kNm	At center of gravity of model
	Resultant of reactions about Z	-25,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	41,9	mm	Member No. 72, x: 0.000 m
	Maximum displacement in Y-direction	-7,4	mm	Member No. 101, x: 0.581 m
	Maximum displacement in Z-direction	32,8	mm	Member No. 101, x: 1.258 m
	Maximum vectorial displacement	42,3	mm	Member No. 72, x: 0.000 m
	Maximum rotation about X-axis	-8,1	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	18,5	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-7,4	mrad	Member No. 103, x: 0.579 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC15 - Out-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-7,28	kN	
	Sum of support forces in Y	-7,28	kN	Deviation: 0.00 %
	Sum of loads in Z	33,31	kN	
	Sum of support forces in Z	33,31	kN	Deviation: 0.00 %
	Resultant of reactions about X	-18,981	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,007	kNm	At center of gravity of model
	Maximum displacement in X-direction	9,8	mm	Member No. 38, x: 0.000 m
	Maximum displacement in Y-direction	-3,3	mm	Member No. 70, x: 1.676 m
	Maximum displacement in Z-direction	27,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	27,3	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-8,3	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	6,8	mrad	Member No. 104, x: 0.000 m
	Maximum rotation about Z-axis	4,0	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis

3.10 Calculation result of RC1 - General loading without wind 1 * (CO1 – CO4)

	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	-68,02	kN	
	Sum of support forces in Z	-68,02	kN	Deviation: 0.00 %
	Resultant of reactions about X	21,033	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,003	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	-20,0	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-15,6	mm	Member No. 30, x: 0.000 m
	Maximum displacement in Z-direction	-46,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	46,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	11,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-10,8	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-6,3	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO2 - 1.15*LC1 + 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	-45,25	kN	
	Sum of support forces in Z	-45,25	kN	Deviation: 0.00 %
	Resultant of reactions about X	8,365	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,003	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	-25,7	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-14,0	mm	Member No. 79, x: 0.000 m
	Maximum displacement in Z-direction	-58,6	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	58,7	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	14,1	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-13,0	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-10,2	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO3 - 1.15*LC1 + 1.35*LC4			
	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	-68,88	kN	
	Sum of support forces in Z	-68,88	kN	Deviation: 0.00 %
	Resultant of reactions about X	21,476	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,003	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	-30,0	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-20,6	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-65,0	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	65,3	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	16,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-16,0	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-8,3	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO4 - 1.15*LC1 + 1.35*LC5			
	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	-67,53	kN	
	Sum of support forces in Z	-67,53	kN	Deviation: 0.00 %
	Resultant of reactions about X	26,869	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,003	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	-34,6	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-23,0	mm	Member No. 74, x: 0.250 m
	Maximum displacement in Z-direction	-77,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	77,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	19,8	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-18,0	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-11,5	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.11 Calculation result of RC2 – Design Values In-service: 1 * (CO10 – CO34)

	Description	Value	Unit	Comment
	CO10 - 1.15*LC1 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	10,36	kN	
	Sum of support forces in Z	10,36	kN	Deviation: 0.00 %
	Resultant of reactions about X	-74,843	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	22,3	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	27,6	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-32,9	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	42,9	mm	Member No. 2, x: 0.000 m
	Maximum rotation about X-axis	-10,3	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	11,6	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	4,6	mrad	Member No. 6, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO11 - 1.15*LC1 + 1.35*LC2 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-48,71	kN	
	Sum of support forces in Z	-48,71	kN	Deviation: 0.00 %
	Resultant of reactions about X	-54,942	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	28,8	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	27,3	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-42,6	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	50,4	mm	Member No. 2, x: 0.000 m
	Maximum rotation about X-axis	-5,3	mrad	Member No. 2, x: 4.144 m
	Maximum rotation about Y-axis	15,1	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	3,2	mrad	Member No. 6, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO12 - 1.15*LC1 + 1.35*LC3 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-25,94	kN	
	Sum of support forces in Z	-25,94	kN	Deviation: 0.00 %
	Resultant of reactions about X	-67,389	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	40,7	mm	Member No. 76, x: 0.000 m
	Maximum displacement in Y-direction	32,2	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-66,3	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	73,5	mm	Member No. 2, x: 0.000 m
	Maximum rotation about X-axis	-7,0	mrad	Member No. 2, x: 4.144 m
	Maximum rotation about Y-axis	20,3	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-6,0	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO13 - 1.15*LC1 + 1.35*LC4 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-49,56	kN	
	Sum of support forces in Z	-49,56	kN	Deviation: 0.00 %
	Resultant of reactions about X	-55,359	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	36,9	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	31,4	mm	Member No. 101, x: 1.677 m
	Maximum displacement in Z-direction	-52,2	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	60,2	mm	Member No. 2, x: 0.000 m
	Maximum rotation about X-axis	-6,2	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Y-axis	19,3	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-4,3	mrad	Member No. 104, x: 0.337 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)

	Description	Value	Unit	Comment
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO14 - 1.15*LC1 + 1.35*LC5 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-48,21	kN	
	Sum of support forces in Z	-48,21	kN	Deviation: 0.00 %
	Resultant of reactions about X	-50,045	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	39,6	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	32,1	mm	Member No. 101, x: 1.129 m
	Maximum displacement in Z-direction	-59,7	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	66,8	mm	Member No. 2, x: 0.000 m
	Maximum rotation about X-axis	-6,4	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Y-axis	20,3	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-7,2	mrad	Member No. 104, x: 0.674 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO20 - 1.15*LC1 + 1.35*LC11			
	Sum of loads in X	11,61	kN	
	Sum of support forces in X	11,61	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	0,63	kN	
	Sum of support forces in Z	0,63	kN	Deviation: 0.00 %
	Resultant of reactions about X	-27,803	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-47,020	kNm	At center of gravity of model
	Resultant of reactions about Z	-10,293	kNm	At center of gravity of model
	Maximum displacement in X-direction	37,2	mm	Member No. 97, x: 0.121 m
	Maximum displacement in Y-direction	-2,8	mm	Member No. 101, x: 0.419 m
	Maximum displacement in Z-direction	19,9	mm	Member No. 101, x: 0.419 m
	Maximum vectorial displacement	38,2	mm	Member No. 50, x: 2.054 m
	Maximum rotation about X-axis	-5,5	mrad	Member No. 99, x: 1.451 m
	Maximum rotation about Y-axis	13,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-4,9	mrad	Member No. 103, x: 0.579 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO21 - 1.15*LC1 + 1.35*LC2 + 1.35*LC11			
	Sum of loads in X	11,61	kN	
	Sum of support forces in X	11,61	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-58,43	kN	
	Sum of support forces in Z	-58,43	kN	Deviation: 0.00 %
	Resultant of reactions about X	-6,863	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-45,266	kNm	At center of gravity of model
	Resultant of reactions about Z	-10,375	kNm	At center of gravity of model
	Maximum displacement in X-direction	43,4	mm	Member No. 78, x: 0.978 m
	Maximum displacement in Y-direction	-9,6	mm	Member No. 80, x: 0.371 m
	Maximum displacement in Z-direction	-19,5	mm	Member No. 106, x: 2.258 m
	Maximum vectorial displacement	45,7	mm	Member No. 78, x: 0.978 m
	Maximum rotation about X-axis	5,4	mrad	Member No. 104, x: 1.012 m
	Maximum rotation about Y-axis	15,8	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-5,1	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO22 - 1.15*LC1 + 1.35*LC3 + 1.35*LC11			
	Sum of loads in X	11,61	kN	
	Sum of support forces in X	11,61	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-35,66	kN	
	Sum of support forces in Z	-35,66	kN	Deviation: 0.00 %
	Resultant of reactions about X	-19,543	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-45,795	kNm	At center of gravity of model
	Resultant of reactions about Z	-10,400	kNm	At center of gravity of model
	Maximum displacement in X-direction	54,5	mm	Member No. 79, x: 2.054 m
	Maximum displacement in Y-direction	-9,4	mm	Member No. 86, x: 1.274 m
	Maximum displacement in Z-direction	-30,2	mm	Member No. 100, x: 0.840 m
	Maximum vectorial displacement	56,3	mm	Member No. 78, x: 2.054 m
	Maximum rotation about X-axis	8,0	mrad	Member No. 104, x: 1.012 m
	Maximum rotation about Y-axis	19,7	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-9,1	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO23 - 1.15*LC1 + 1.35*LC4 + 1.35*LC11			

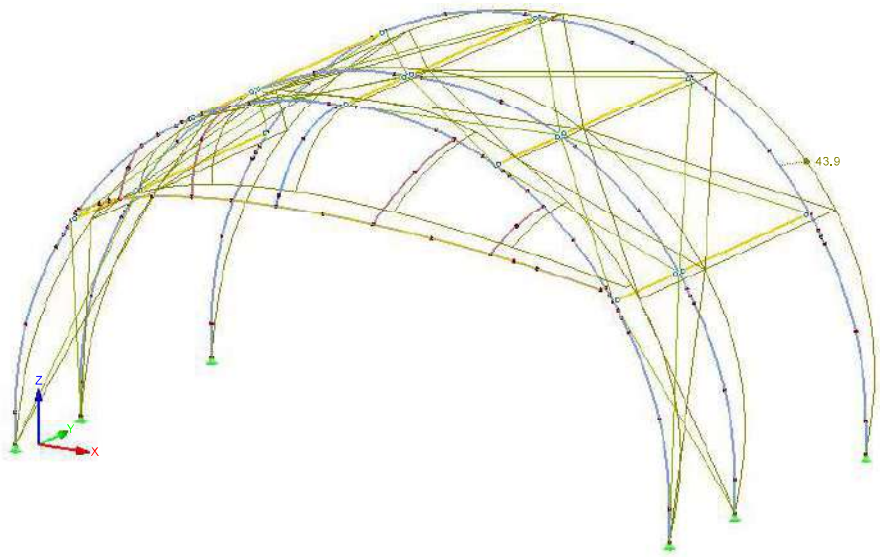
	Description	Value	Unit	Comment
	Sum of loads in X	11,61	kN	
	Sum of support forces in X	11,61	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-59,29	kN	
	Sum of support forces in Z	-59,29	kN	Deviation: 0.00 %
	Resultant of reactions about X	-6,588	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-44,831	kNm	At center of gravity of model
	Resultant of reactions about Z	-10,413	kNm	At center of gravity of model
	Maximum displacement in X-direction	49,6	mm	Member No. 78, x: 2.054 m
	Maximum displacement in Y-direction	-13,9	mm	Member No. 80, x: 0.371 m
	Maximum displacement in Z-direction	-36,6	mm	Member No. 100, x: 0.840 m
	Maximum vectorial displacement	52,1	mm	Member No. 78, x: 2.054 m
	Maximum rotation about X-axis	9,6	mrad	Member No. 102, x: 0.483 m
	Maximum rotation about Y-axis	21,0	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-7,1	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO24 - 1.15*LC1 + 1.35*LC5 + 1.35*LC11			
	Sum of loads in X	11,61	kN	
	Sum of support forces in X	11,61	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-57,94	kN	
	Sum of support forces in Z	-57,94	kN	Deviation: 0.00 %
	Resultant of reactions about X	-1,227	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-44,924	kNm	At center of gravity of model
	Resultant of reactions about Z	-10,438	kNm	At center of gravity of model
	Maximum displacement in X-direction	53,6	mm	Member No. 45, x: 0.183 m
	Maximum displacement in Y-direction	-15,9	mm	Member No. 80, x: 0.741 m
	Maximum displacement in Z-direction	-48,5	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	58,1	mm	Member No. 100, x: 0.420 m
	Maximum rotation about X-axis	12,1	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	23,0	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-10,4	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO30 - 1.15*LC1 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-18,16	kN	
	Sum of support forces in Z	-18,16	kN	Deviation: 0.00 %
	Resultant of reactions about X	-86,642	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	11,2	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	-13,2	mm	Member No. 72, x: 1.197 m
	Maximum displacement in Z-direction	-17,5	mm	Member No. 2, x: 0.000 m
	Maximum vectorial displacement	20,4	mm	Member No. 74, x: 0.250 m
	Maximum rotation about X-axis	5,0	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Y-axis	6,0	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	4,0	mrad	Member No. 70, x: 2.445 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO31 - 1.15*LC1 + 1.35*LC2 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-77,22	kN	
	Sum of support forces in Z	-77,22	kN	Deviation: 0.00 %
	Resultant of reactions about X	-64,772	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	20,0	mm	Member No. 43, x: 2.200 m
	Maximum displacement in Y-direction	-24,3	mm	Member No. 79, x: 0.978 m
	Maximum displacement in Z-direction	-38,4	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	41,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	9,0	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	12,2	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-5,1	mrad	Member No. 93, x: 0.407 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO32 - 1.15*LC1 + 1.35*LC3 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	

	Description	Value	Unit	Comment
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-54,45	kN	
	Sum of support forces in Z	-54,45	kN	Deviation: 0.00 %
	Resultant of reactions about X	-77,761	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	29,1	mm	Member No. 76, x: 0.000 m
	Maximum displacement in Y-direction	-23,5	mm	Member No. 78, x: 0.753 m
	Maximum displacement in Z-direction	-50,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	55,0	mm	Member No. 74, x: 0.250 m
	Maximum rotation about X-axis	11,0	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-14,8	mrad	Member No. 79, x: 2.640 m
	Maximum rotation about Z-axis	-8,5	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO33 - 1.15*LC1 + 1.35*LC4 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-78,08	kN	
	Sum of support forces in Z	-78,08	kN	Deviation: 0.00 %
	Resultant of reactions about X	-64,286	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	30,0	mm	Member No. 43, x: 2.200 m
	Maximum displacement in Y-direction	-29,2	mm	Member No. 79, x: 0.978 m
	Maximum displacement in Z-direction	-57,2	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	59,6	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	14,1	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	17,4	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-7,5	mrad	Member No. 93, x: 0.678 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO34 - 1.15*LC1 + 1.35*LC5 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-76,73	kN	
	Sum of support forces in Z	-76,73	kN	Deviation: 0.00 %
	Resultant of reactions about X	-58,939	kNm	At center of gravity of model (X: 5.670, Y: 2.111, Z: 4.499 m)
	Resultant of reactions about Y	-0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	34,3	mm	Member No. 43, x: 2.445 m
	Maximum displacement in Y-direction	-31,5	mm	Member No. 79, x: 0.978 m
	Maximum displacement in Z-direction	-69,6	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	71,9	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	16,8	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	19,4	mrad	Member No. 42, x: 0.540 m
	Maximum rotation about Z-axis	-10,0	mrad	Member No. 104, x: 0.674 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.11.1 Deformation of the In-service situation characteristic max and min values.

RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Max Values

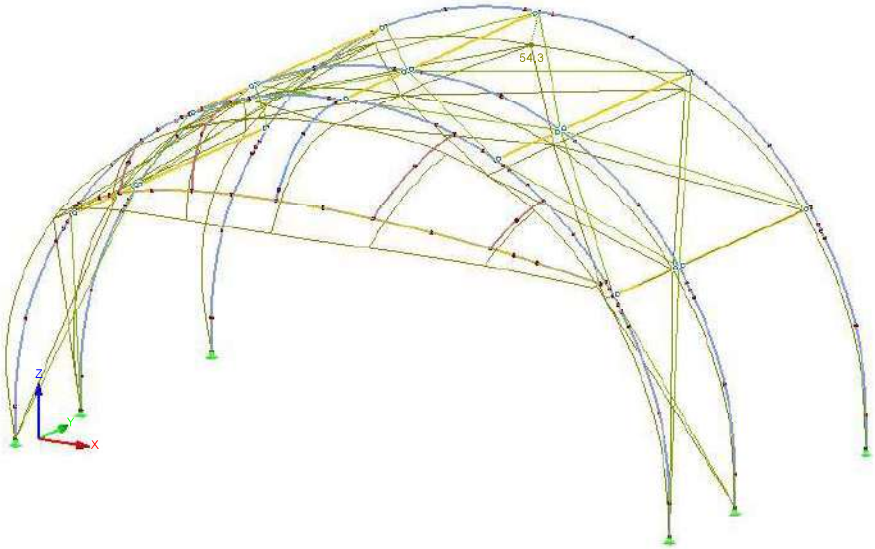
Isometric



Max u: 43.9, Min u: 0.0 mm
Factor of deformations: 10.00

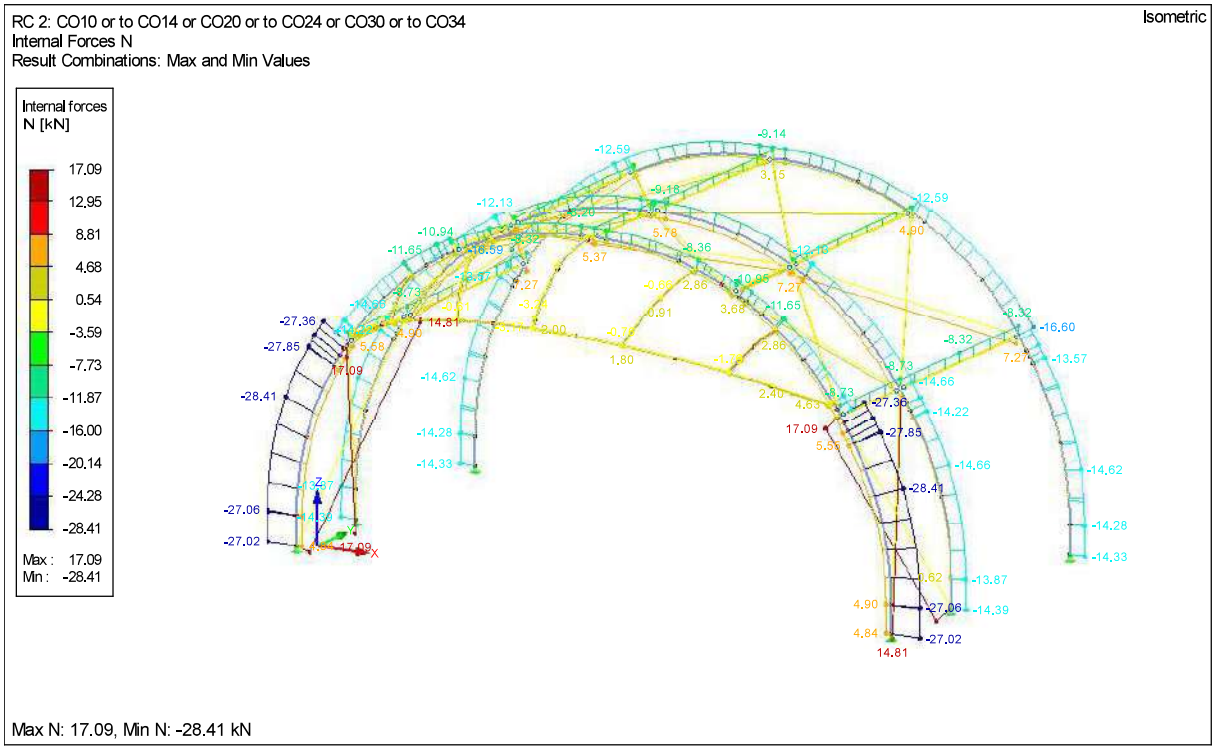
RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Min Values

Isometric

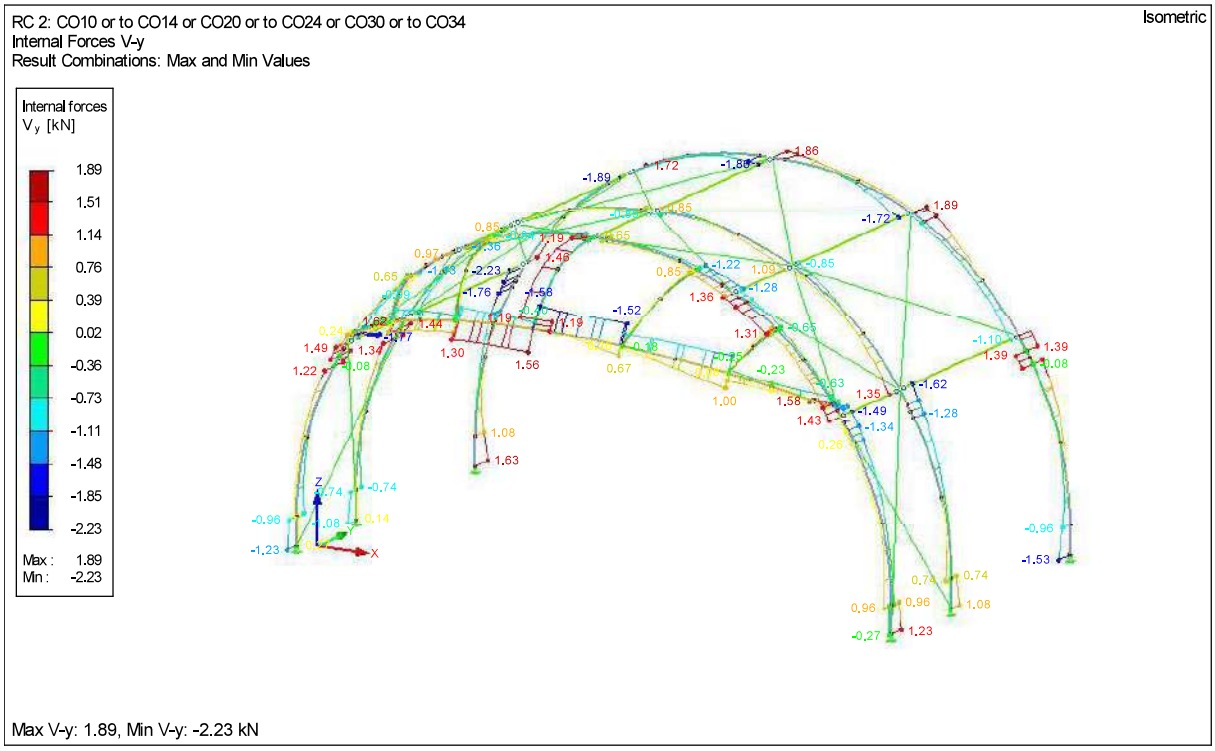


Max u: 54.3, Min u: 0.0 mm
Factor of deformations: 10.00

3.11.2 Internal force diagram RC2 Design values In-service.



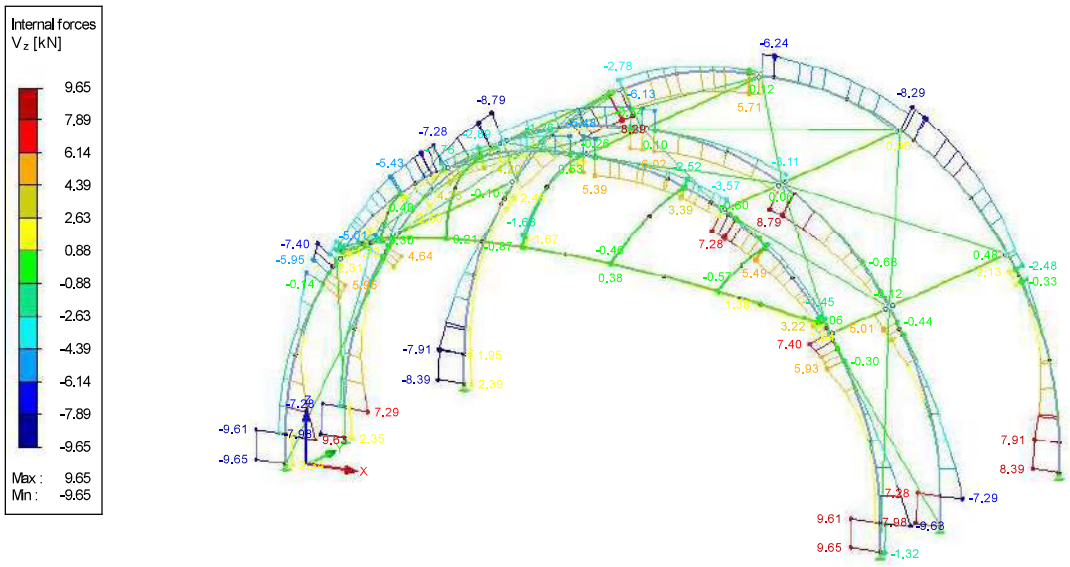
Max N: 17.09, Min N: -28.41 kN



Max V-y: 1.89, Min V-y: -2.23 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

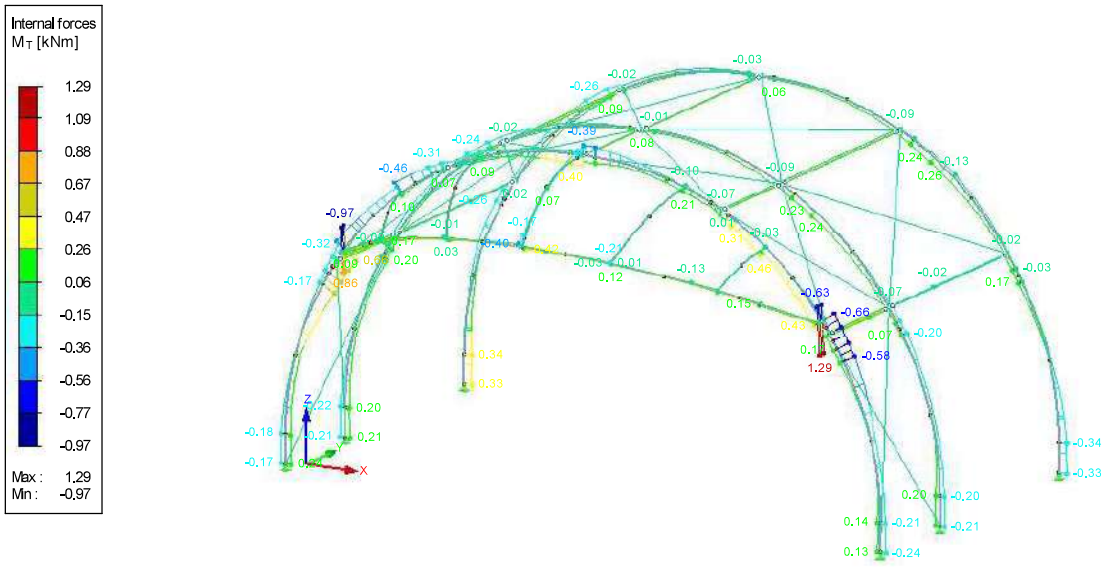
Isometric



Max V-z: 9.65, Min V-z: -9.65 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-T
Result Combinations: Max and Min Values

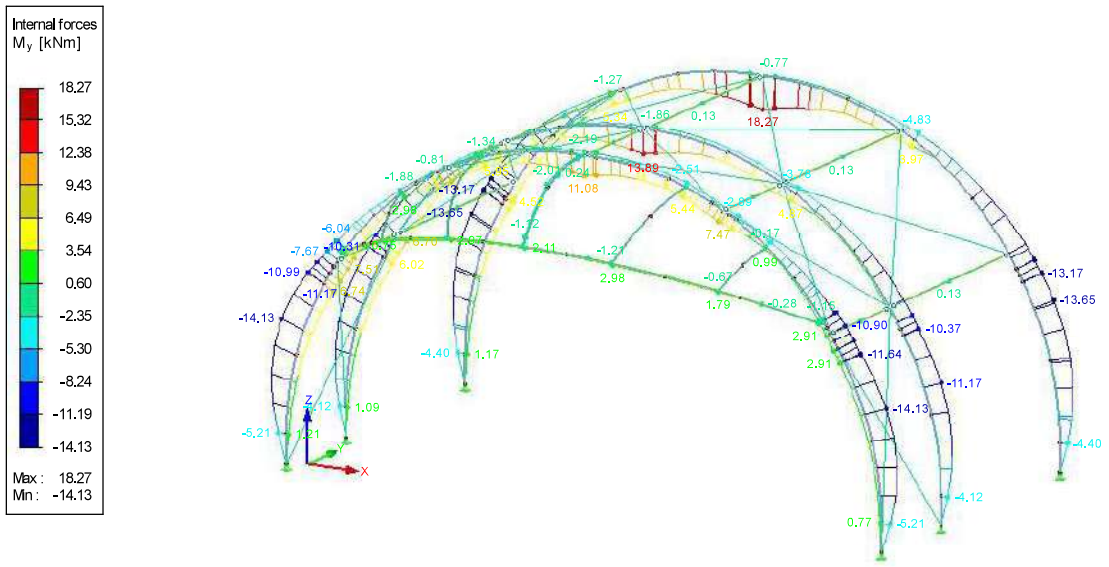
Isometric



Max M-T: 1.29, Min M-T: -0.97 kNm

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

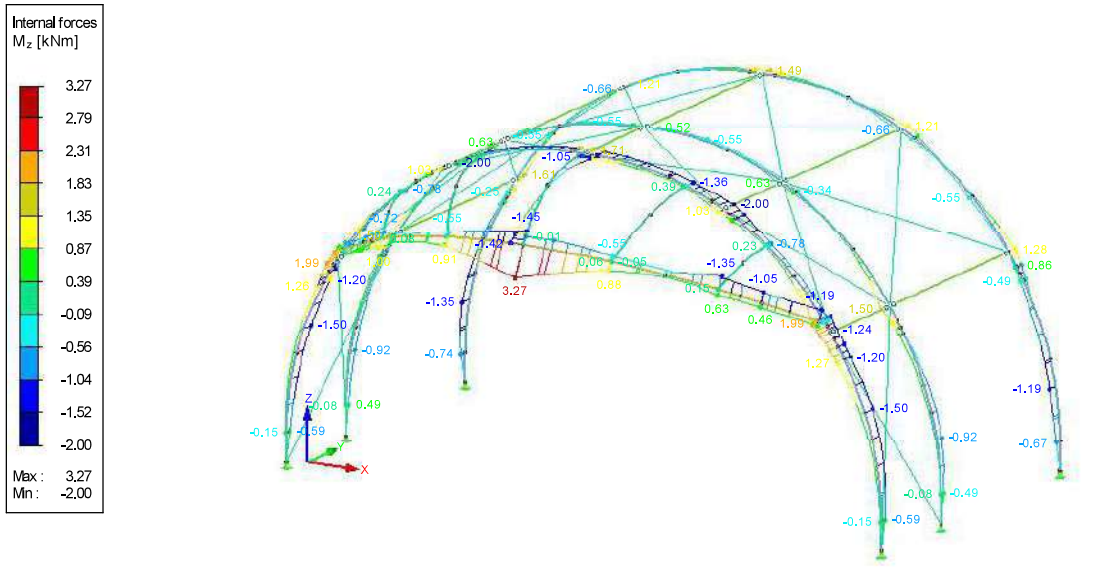
Isometric



Max M-y: 18.27, Min M-y: -14.13 kNm

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 3.27, Min M-z: -2.00 kNm

3.12 Calculation result of RC4 - Design Values Out-service: 1 * (CO100 – CO124)

	Description	Value	Unit	Comment
	CO100 - 1.15*LC1 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	36,01	kN	
	Sum of support forces in Z	36,01	kN	Deviation: 0.00 %
	Resultant of reactions about X	-21,734	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,005	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	13,0	mm	Member No. 37, x: 0.000 m
	Maximum displacement in Y-direction	10,5	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	36,7	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	36,7	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-11,4	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	8,6	mrad	Member No. 104, x: 0.000 m
	Maximum rotation about Z-axis	4,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO101 - 1.15*LC1 + 1.35*LC2 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,06	kN	
	Sum of support forces in Z	-23,06	kN	Deviation: 0.00 %
	Resultant of reactions about X	1,446	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	4,4	mm	Member No. 54, x: 1.956 m
	Maximum displacement in Y-direction	5,8	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-5,7	mm	Member No. 2, x: 1.381 m
	Maximum vectorial displacement	7,9	mm	Member No. 2, x: 2.072 m
	Maximum rotation about X-axis	-3,7	mrad	Member No. 105, x: 1.889 m
	Maximum rotation about Y-axis	3,0	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	2,0	mrad	Member No. 70, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO102 - 1.15*LC1 + 1.35*LC3 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-0,29	kN	
	Sum of support forces in Z	-0,29	kN	Deviation: 0.00 %
	Resultant of reactions about X	-12,112	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,003	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	7,9	mm	Member No. 55, x: 0.000 m
	Maximum displacement in Y-direction	6,4	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-16,0	mm	Member No. 2, x: 2.072 m
	Maximum vectorial displacement	17,2	mm	Member No. 2, x: 2.072 m
	Maximum rotation about X-axis	-3,6	mrad	Member No. 91, x: 0.110 m
	Maximum rotation about Y-axis	5,0	mrad	Member No. 73, x: 1.257 m
	Maximum rotation about Z-axis	2,8	mrad	Member No. 103, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO103 - 1.15*LC1 + 1.35*LC4 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,91	kN	
	Sum of support forces in Z	-23,91	kN	Deviation: 0.00 %
	Resultant of reactions about X	1,388	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	9,4	mm	Member No. 54, x: 2.096 m
	Maximum displacement in Y-direction	7,7	mm	Member No. 101, x: 0.419 m
	Maximum displacement in Z-direction	-9,6	mm	Member No. 51, x: 1.676 m
	Maximum vectorial displacement	11,7	mm	Member No. 57, x: 1.467 m
	Maximum rotation about X-axis	-3,8	mrad	Member No. 105, x: 1.889 m
	Maximum rotation about Y-axis	5,5	mrad	Member No. 53, x: 0.540 m

	Description	Value	Unit	Comment
	Maximum rotation about Z-axis	2,1	mrad	Member No. 6, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO104 - 1.15*LC1 + 1.35*LC5 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,25	kN	
	Sum of support forces in Y	3,25	kN	Deviation: 0.00 %
	Sum of loads in Z	-22,56	kN	
	Sum of support forces in Z	-22,56	kN	Deviation: 0.00 %
	Resultant of reactions about X	6,627	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	11,2	mm	Member No. 54, x: 2.515 m
	Maximum displacement in Y-direction	7,7	mm	Member No. 99, x: 1.419 m
	Maximum displacement in Z-direction	-16,7	mm	Member No. 52, x: 0.250 m
	Maximum vectorial displacement	17,9	mm	Member No. 3, x: 0.000 m
	Maximum rotation about X-axis	-3,0	mrad	Member No. 3, x: 2.072 m
	Maximum rotation about Y-axis	5,9	mrad	Member No. 53, x: 0.540 m
	Maximum rotation about Z-axis	2,6	mrad	Member No. 103, x: 0.964 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO110 - 1.15*LC1 + 1.35*LC14			
	Sum of loads in X	39,91	kN	
	Sum of support forces in X	39,91	kN	Deviation: 0.00 %
	Sum of loads in Y	3,13	kN	
	Sum of support forces in Y	3,13	kN	Deviation: 0.00 %
	Sum of loads in Z	36,95	kN	
	Sum of support forces in Z	36,95	kN	Deviation: 0.00 %
	Resultant of reactions about X	19,903	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	-156,738	kNm	At center of gravity of model
	Resultant of reactions about Z	-33,685	kNm	At center of gravity of model
	Maximum displacement in X-direction	53,6	mm	Member No. 72, x: 0.000 m
	Maximum displacement in Y-direction	-9,5	mm	Member No. 101, x: 0.581 m
	Maximum displacement in Z-direction	39,3	mm	Member No. 101, x: 1.129 m
	Maximum vectorial displacement	54,2	mm	Member No. 72, x: 0.000 m
	Maximum rotation about X-axis	-9,8	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	23,7	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-9,2	mrad	Member No. 103, x: 0.579 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO111 - 1.15*LC1 + 1.35*LC2 + 1.35*LC14			
	Sum of loads in X	39,91	kN	
	Sum of support forces in X	39,91	kN	Deviation: 0.00 %
	Sum of loads in Y	3,13	kN	
	Sum of support forces in Y	3,13	kN	Deviation: 0.00 %
	Sum of loads in Z	-22,11	kN	
	Sum of support forces in Z	-22,11	kN	Deviation: 0.00 %
	Resultant of reactions about X	43,319	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	-155,500	kNm	At center of gravity of model
	Resultant of reactions about Z	-33,764	kNm	At center of gravity of model
	Maximum displacement in X-direction	43,4	mm	Member No. 72, x: 0.000 m
	Maximum displacement in Y-direction	-9,7	mm	Member No. 79, x: 1.257 m
	Maximum displacement in Z-direction	29,6	mm	Member No. 79, x: 0.419 m
	Maximum vectorial displacement	43,9	mm	Member No. 72, x: 0.000 m
	Maximum rotation about X-axis	3,6	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Y-axis	19,0	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-5,3	mrad	Member No. 48, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO112 - 1.15*LC1 + 1.35*LC3 + 1.35*LC14			
	Sum of loads in X	39,91	kN	
	Sum of support forces in X	39,91	kN	Deviation: 0.00 %
	Sum of loads in Y	3,13	kN	
	Sum of support forces in Y	3,13	kN	Deviation: 0.00 %
	Sum of loads in Z	0,66	kN	
	Sum of support forces in Z	0,66	kN	Deviation: 0.00 %
	Resultant of reactions about X	29,708	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	-155,892	kNm	At center of gravity of model
	Resultant of reactions about Z	-33,738	kNm	At center of gravity of model
	Maximum displacement in X-direction	25,0	mm	Member No. 71, x: 0.031 m
	Maximum displacement in Y-direction	-7,1	mm	Member No. 79, x: 1.467 m
	Maximum displacement in Z-direction	12,3	mm	Member No. 79, x: 2.054 m
	Maximum vectorial displacement	25,3	mm	Member No. 71, x: 0.000 m
	Maximum rotation about X-axis	4,3	mrad	Member No. 105, x: 1.889 m
	Maximum rotation about Y-axis	11,9	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-4,6	mrad	Member No. 48, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)

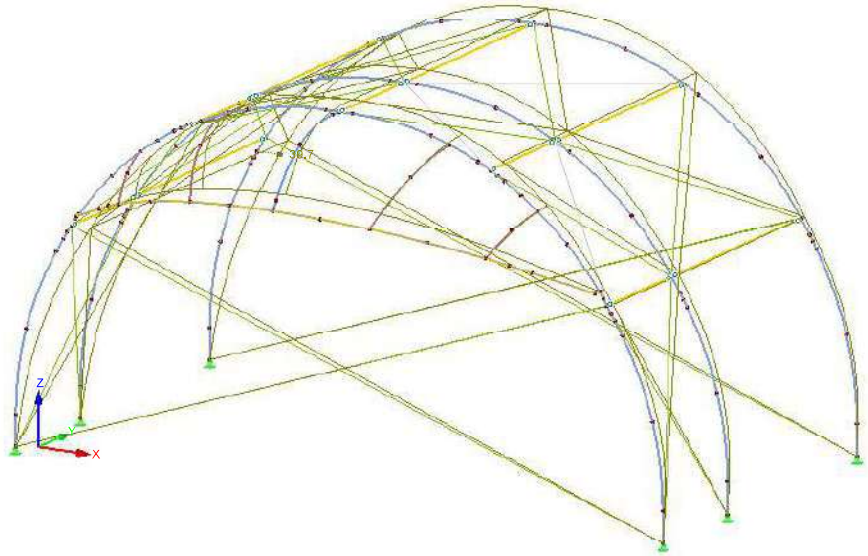
	Description	Value	Unit	Comment
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO113 - 1.15*LC1 + 1.35*LC4 + 1.35*LC14			
	Sum of loads in X	39,91	kN	
	Sum of support forces in X	39,91	kN	Deviation: 0.00 %
	Sum of loads in Y	3,13	kN	
	Sum of support forces in Y	3,13	kN	Deviation: 0.00 %
	Sum of loads in Z	-22,97	kN	
	Sum of support forces in Z	-22,97	kN	Deviation: 0.00 %
	Resultant of reactions about X	43,478	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	-155,529	kNm	At center of gravity of model
	Resultant of reactions about Z	-33,781	kNm	At center of gravity of model
	Maximum displacement in X-direction	32,3	mm	Member No. 115, x: 5.059 m
	Maximum displacement in Y-direction	-11,6	mm	Member No. 79, x: 1.467 m
	Maximum displacement in Z-direction	22,0	mm	Member No. 79, x: 0.000 m
	Maximum vectorial displacement	32,8	mm	Member No. 5, x: 0.000 m
	Maximum rotation about X-axis	4,4	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Y-axis	14,0	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-5,5	mrad	Member No. 48, x: 1.257 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO114 - 1.15*LC1 + 1.35*LC5 + 1.35*LC14			
	Sum of loads in X	39,91	kN	
	Sum of support forces in X	39,91	kN	Deviation: 0.00 %
	Sum of loads in Y	3,13	kN	
	Sum of support forces in Y	3,13	kN	Deviation: 0.00 %
	Sum of loads in Z	-21,62	kN	
	Sum of support forces in Z	-21,62	kN	Deviation: 0.00 %
	Resultant of reactions about X	48,724	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	-155,689	kNm	At center of gravity of model
	Resultant of reactions about Z	-33,829	kNm	At center of gravity of model
	Maximum displacement in X-direction	27,1	mm	Member No. 72, x: 0.000 m
	Maximum displacement in Y-direction	-12,3	mm	Member No. 79, x: 1.467 m
	Maximum displacement in Z-direction	-15,9	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	27,4	mm	Member No. 72, x: 0.000 m
	Maximum rotation about X-axis	6,0	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	12,2	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Z-axis	-5,9	mrad	Member No. 48, x: 0.978 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO120 - 1.15*LC1 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-9,82	kN	
	Sum of support forces in Y	-9,82	kN	Deviation: 0.00 %
	Sum of loads in Z	36,01	kN	
	Sum of support forces in Z	36,01	kN	Deviation: 0.00 %
	Resultant of reactions about X	-25,578	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,005	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	10,9	mm	Member No. 38, x: 0.031 m
	Maximum displacement in Y-direction	-4,5	mm	Member No. 70, x: 1.676 m
	Maximum displacement in Z-direction	30,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	30,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-9,8	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	7,9	mrad	Member No. 104, x: 0.000 m
	Maximum rotation about Z-axis	4,5	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO121 - 1.15*LC1 + 1.35*LC2 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-9,82	kN	
	Sum of support forces in Y	-9,82	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,06	kN	
	Sum of support forces in Z	-23,06	kN	Deviation: 0.00 %
	Resultant of reactions about X	-2,069	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	4,9	mm	Member No. 54, x: 2.096 m
	Maximum displacement in Y-direction	-10,2	mm	Member No. 73, x: 1.467 m
	Maximum displacement in Z-direction	-6,2	mm	Member No. 52, x: 0.250 m
	Maximum vectorial displacement	11,5	mm	Member No. 2, x: 4.144 m
	Maximum rotation about X-axis	4,8	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Y-axis	-3,6	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	4,1	mrad	Member No. 70, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO122 - 1.15*LC1 + 1.35*LC3 + 1.35*LC15			

	Description	Value	Unit	Comment
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-9,82	kN	
	Sum of support forces in Y	-9,82	kN	Deviation: 0.00 %
	Sum of loads in Z	-0,29	kN	
	Sum of support forces in Z	-0,29	kN	Deviation: 0.00 %
	Resultant of reactions about X	-15,789	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,003	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	8,6	mm	Member No. 55, x: 0.125 m
	Maximum displacement in Y-direction	-9,8	mm	Member No. 50, x: 1.467 m
	Maximum displacement in Z-direction	-16,8	mm	Member No. 52, x: 0.250 m
	Maximum vectorial displacement	18,9	mm	Member No. 2, x: 4.144 m
	Maximum rotation about X-axis	4,9	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Y-axis	-5,2	mrad	Member No. 57, x: 0.880 m
	Maximum rotation about Z-axis	4,2	mrad	Member No. 70, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO123 - 1.15*LC1 + 1.35*LC4 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-9,82	kN	
	Sum of support forces in Y	-9,82	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,91	kN	
	Sum of support forces in Z	-23,91	kN	Deviation: 0.00 %
	Resultant of reactions about X	-1,885	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	10,0	mm	Member No. 54, x: 2.445 m
	Maximum displacement in Y-direction	-13,1	mm	Member No. 73, x: 1.676 m
	Maximum displacement in Z-direction	-10,4	mm	Member No. 51, x: 1.467 m
	Maximum vectorial displacement	16,2	mm	Member No. 51, x: 1.467 m
	Maximum rotation about X-axis	5,6	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Y-axis	-6,4	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	4,4	mrad	Member No. 70, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO124 - 1.15*LC1 + 1.35*LC5 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-9,82	kN	
	Sum of support forces in Y	-9,82	kN	Deviation: 0.00 %
	Sum of loads in Z	-22,56	kN	
	Sum of support forces in Z	-22,56	kN	Deviation: 0.00 %
	Resultant of reactions about X	3,335	kNm	At center of gravity of model (X: 5.670, Y: 2.155, Z: 4.357 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	11,9	mm	Member No. 54, x: 2.515 m
	Maximum displacement in Y-direction	-13,8	mm	Member No. 73, x: 1.676 m
	Maximum displacement in Z-direction	-17,9	mm	Member No. 52, x: 0.250 m
	Maximum vectorial displacement	22,2	mm	Member No. 2, x: 4.144 m
	Maximum rotation about X-axis	5,6	mrad	Member No. 69, x: 0.000 m
	Maximum rotation about Y-axis	-7,0	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	4,3	mrad	Member No. 70, x: 1.467 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.12.1 Deformation of the Out-service situation characteristic max and min values.

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Global Deformations u
Result Combinations: Max Values

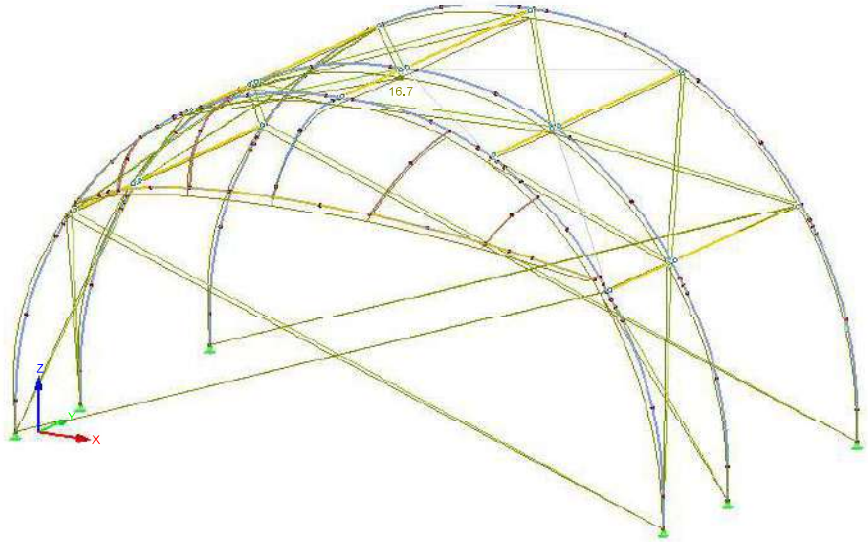
Isometric



Max u: 39.7, Min u: 0.0 mm
Factor of deformations: 10.00

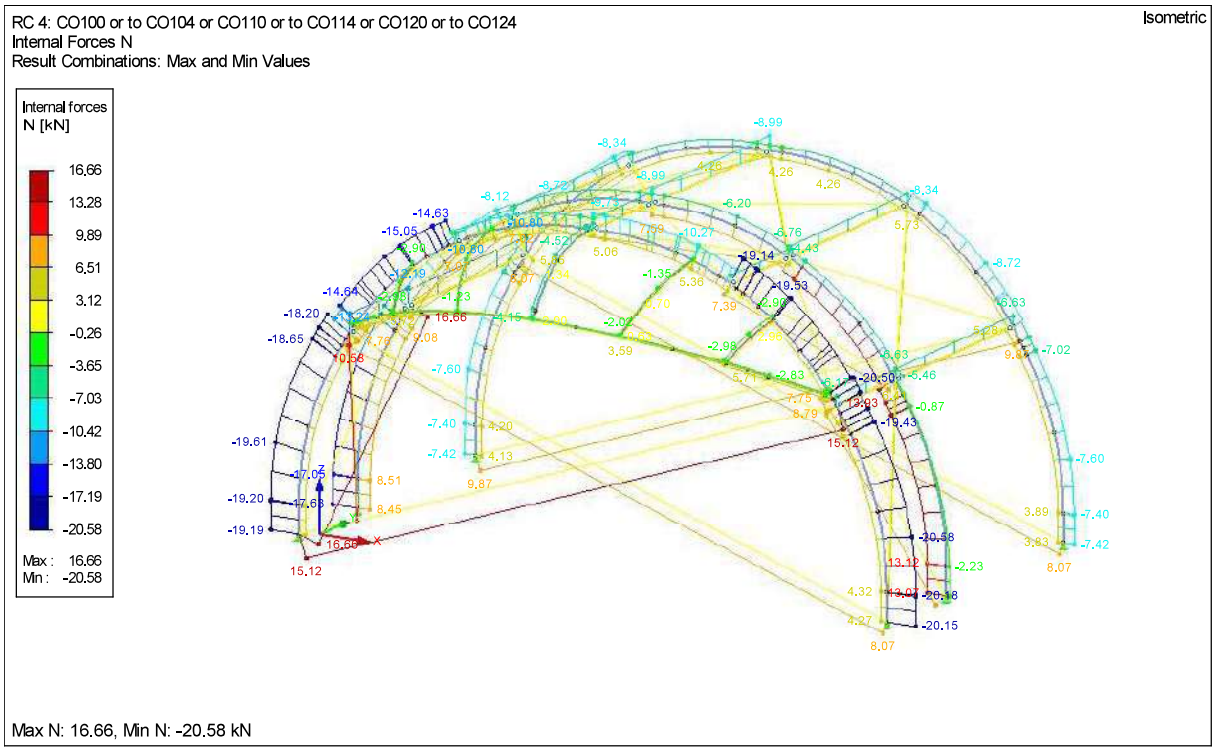
RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Global Deformations u
Result Combinations: Min Values

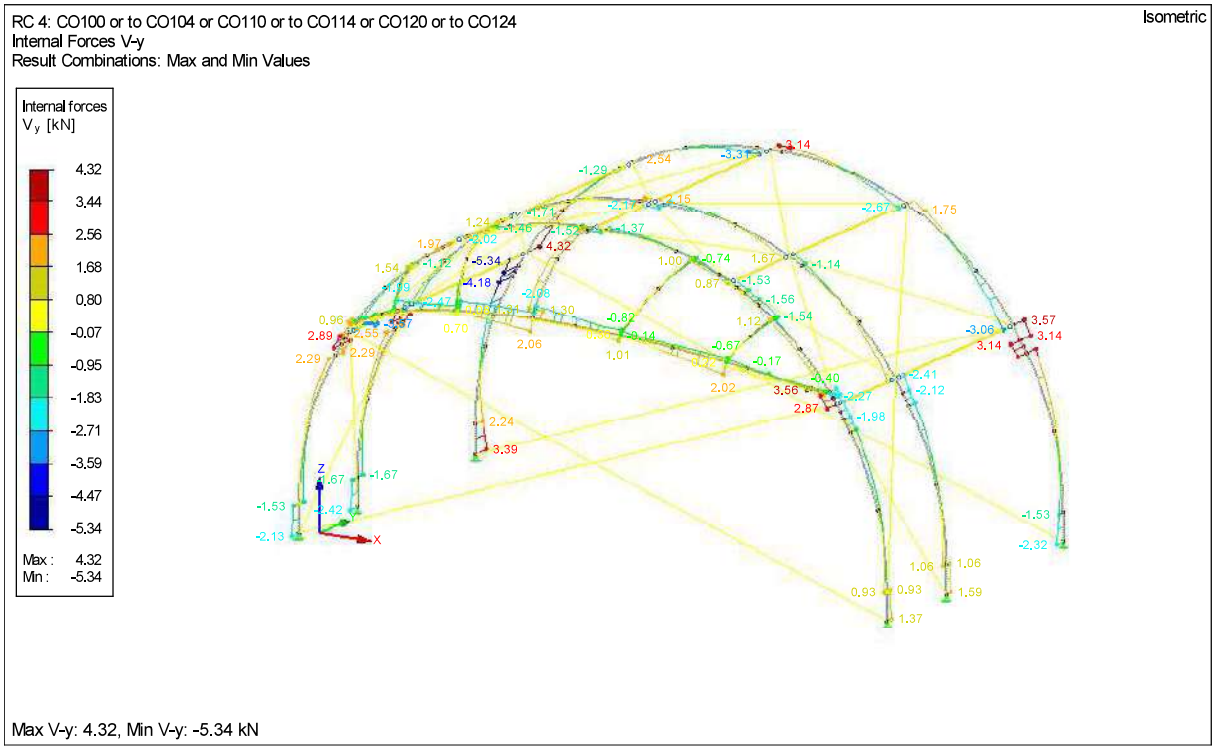
Isometric



Max u: 16.7, Min u: 0.0 mm
Factor of deformations: 10.00

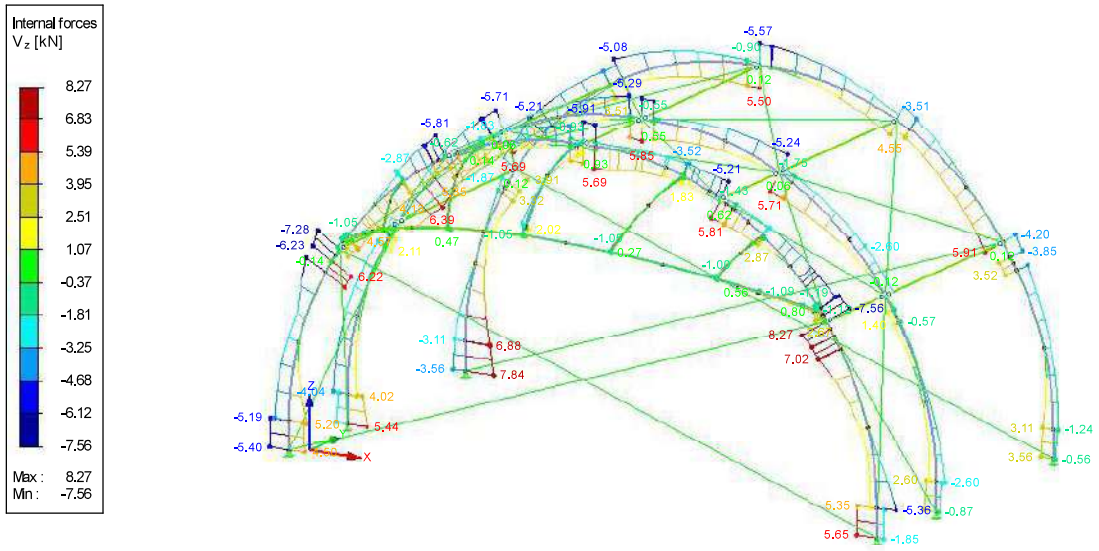
3.12.2 Internal force diagram RC4 Design Values Out-service.





RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

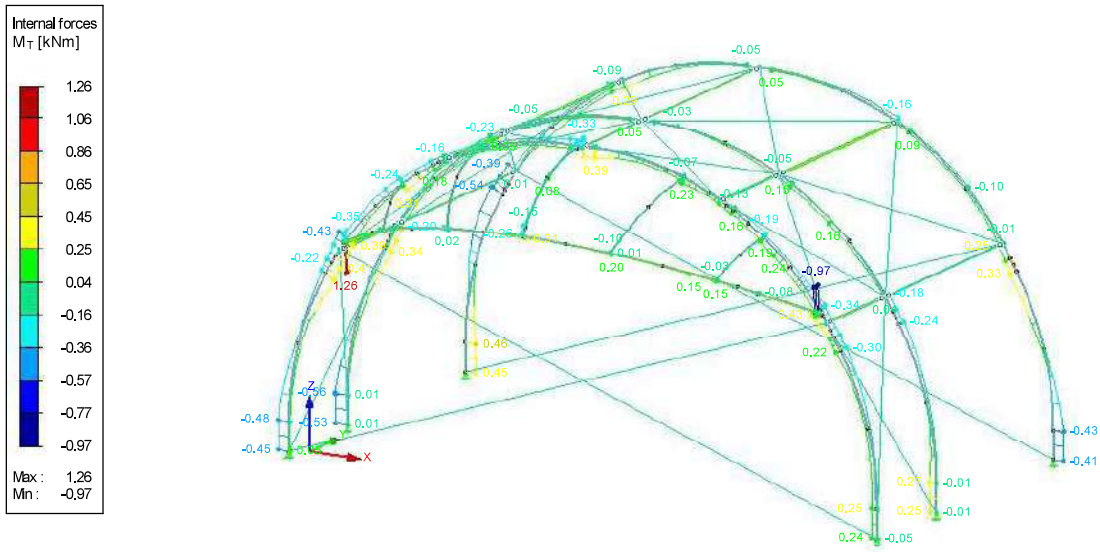
Isometric



Max V-z: 8.27, Min V-z: -7.56 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-T
Result Combinations: Max and Min Values

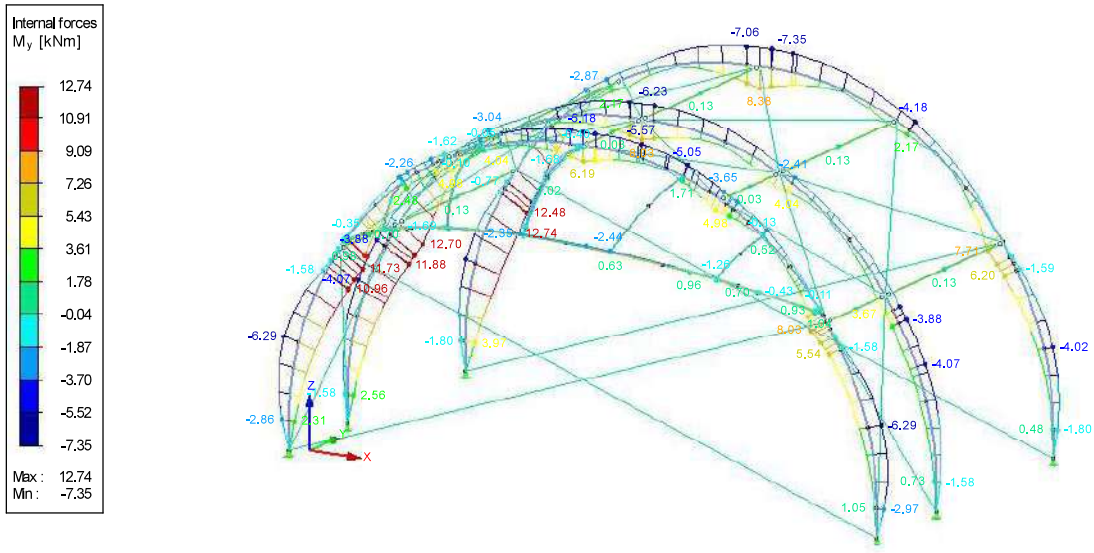
Isometric



Max M-T: 1.26, Min M-T: -0.97 kNm

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

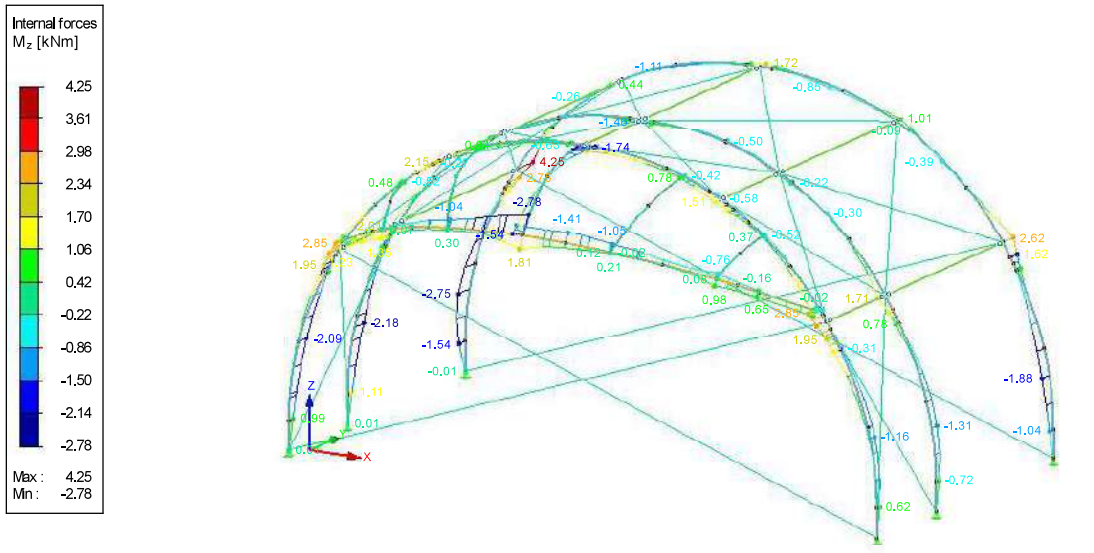
Isometric



Max M-y: 12.74, Min M-y: -7.35 kNm

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric

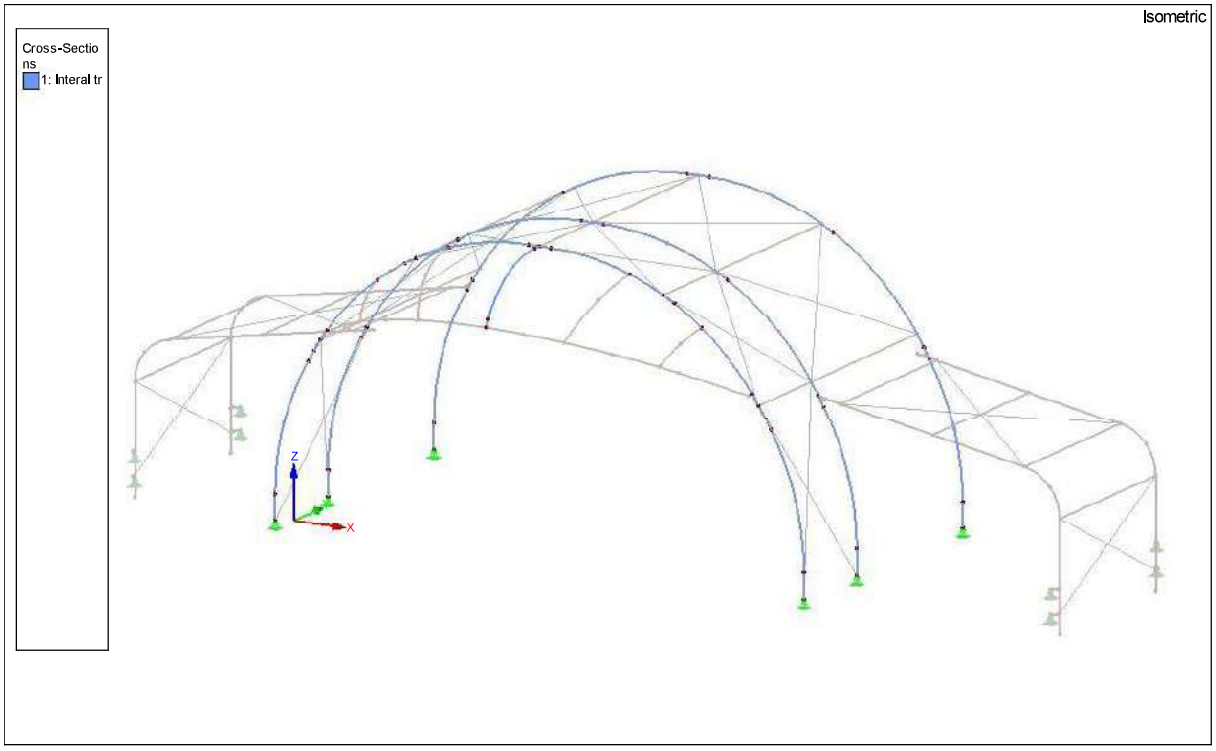


Max M-z: 4.25, Min M-z: -2.78 kNm

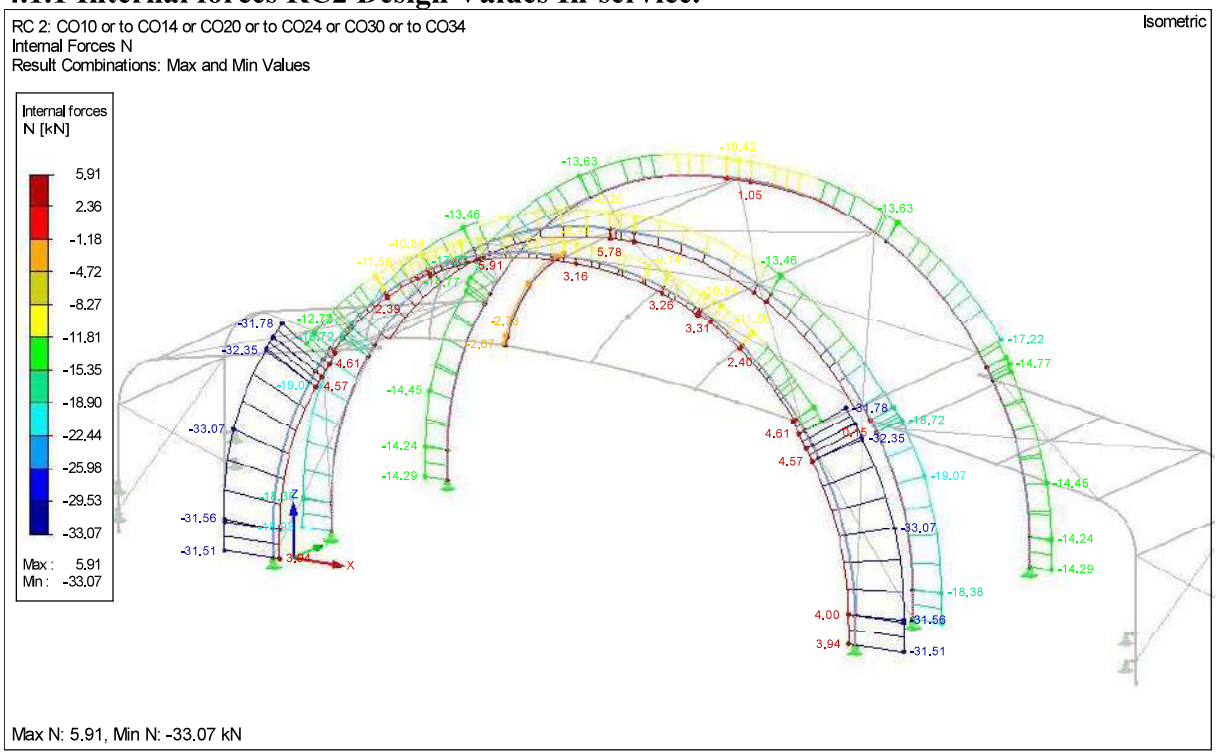
4.0 Detail calculations for different parts.

In this chapter, necessary detail calculations of different parts for the roof are made.
The model of option 1 and 2 are used.

4.1 Detail Check of the Protruss S31 Main arches.

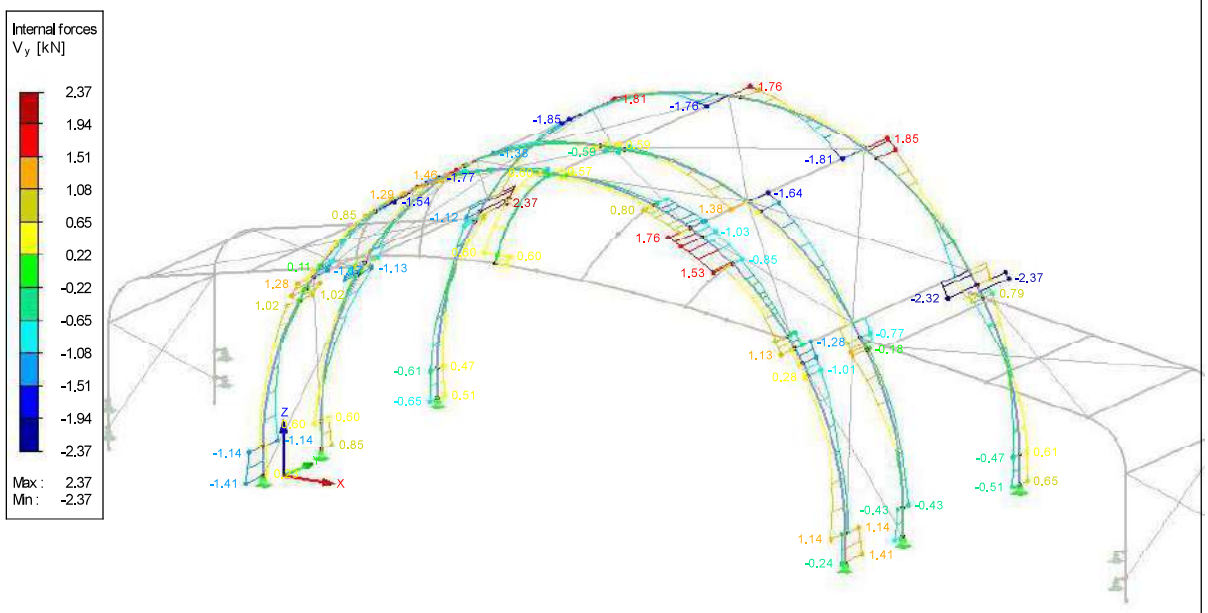


4.1.1 Internal forces RC2 Design Values In-service.



RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-y
Result Combinations: Max and Min Values

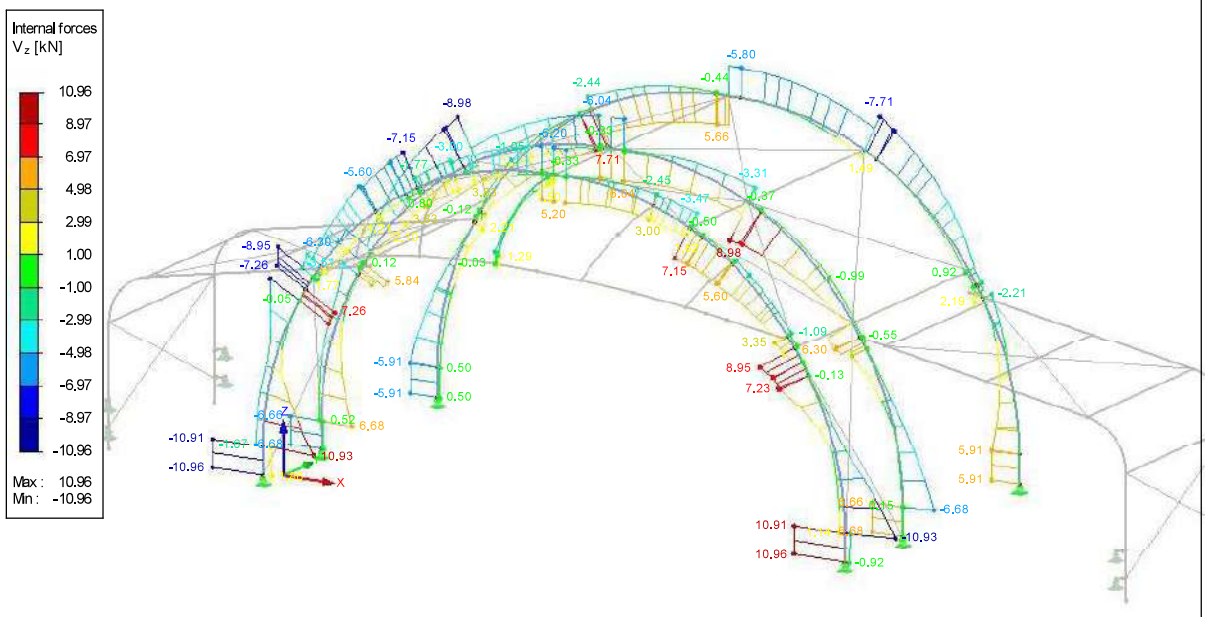
Isometric



Max V-y: 2.37, Min V-y: -2.37 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

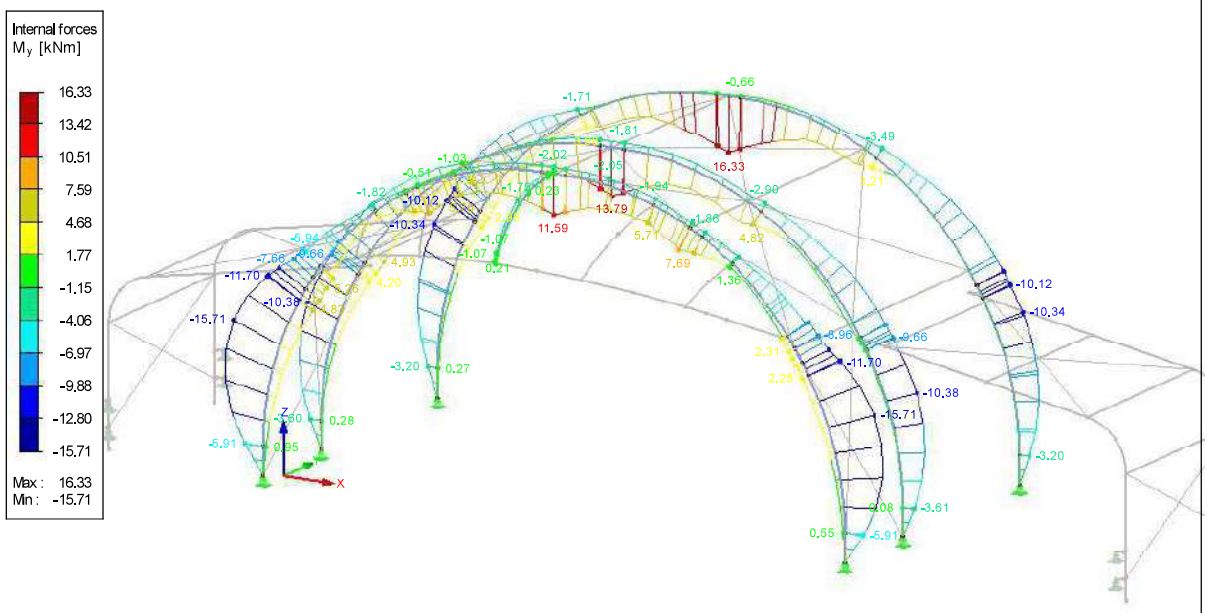
Isometric



Max V-z: 10.96, Min V-z: -10.96 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

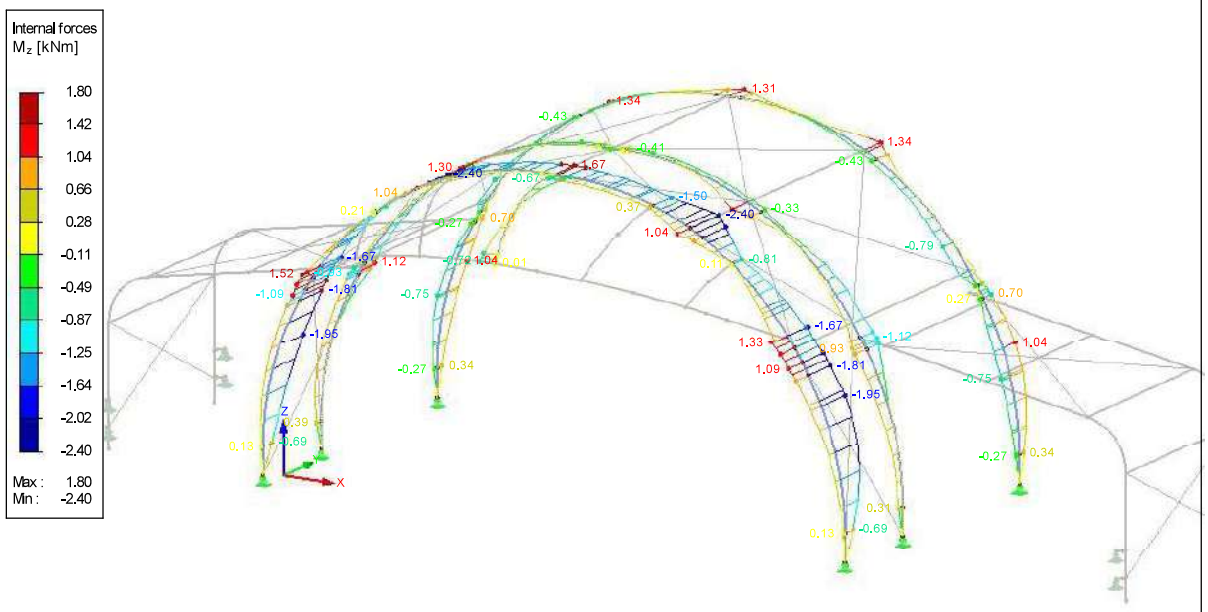
Isometric



Max M-y: 16.33, Min M-y: -15.71 kNm

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 1.80, Min M-z: -2.40 kNm

4.1.2 Check of the Interaction of moment and transversal force with the RC2- Design values.

The check of the Interaction between the bending moment and the transversal force has been done in a separate excel sheet.
This check has been done for each separate truss arch

Check of truss arch 1 (front arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 34	-33,07	-0,21	2	0,17	-15,48	-0,47

$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(0.21^2 + 2^2)}$
$V_{d,\ main\ chord} = 0.50\ kN$
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 0.50 * 5$
$M_{d,\ main\ chord} = 2.51\ kNcm$
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 33.07 / 4 + 15.48 / 2 / 0.239 + 0.47 / 2 / 0.239$
$N_{d,\ main\ chord} = 41.63\ kN$

Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914\ kN$ and the $M_{Rd,\ main\ chord} = 53.19\ kNcm$.

$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (41.63 / 50.914)^{1,3} + ((2.51 / 53.19)^{1.7})^{0.6} = 0.81 < 1$

Check of truss arch 2 (middle arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 34	-32,23	-0,11	-7,14	0,36	-9,92	-0,73

$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(0.11^2 + 7.14^2)}$
$V_{d,\ main\ chord} = 1.78\ kN$
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 1.78 * 5$
$M_{d,\ main\ chord} = 8.92\ kNcm$
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 32.23 / 4 + 9.92 / 2 / 0.239 + 0.73 / 2 / 0.239$
$N_{d,\ main\ chord} = 30.34\ kN$

Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914\ kN$ and the $M_{Rd,\ main\ chord} = 53.19\ kNcm$.

$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (30.34 / 50.914)^{1,3} + ((8.92 / 53.19)^{1.7})^{0.6} = 0.67 < 1$

Check of truss arch 3 (back arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 12	-3,09	-0,19	5,45	0	16,33	0,44

$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(0.19^2 + 5.45^2)}$
$V_{d,\ main\ chord} = 1.36$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 1.36 * 5$
$M_{d,\ main\ chord} = 6.81$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 3.09 / 4 + 16.33 / 2 / 0.239 + 0.44 / 2 / 0.239$
$N_{d,\ main\ chord} = 35.85$ kN

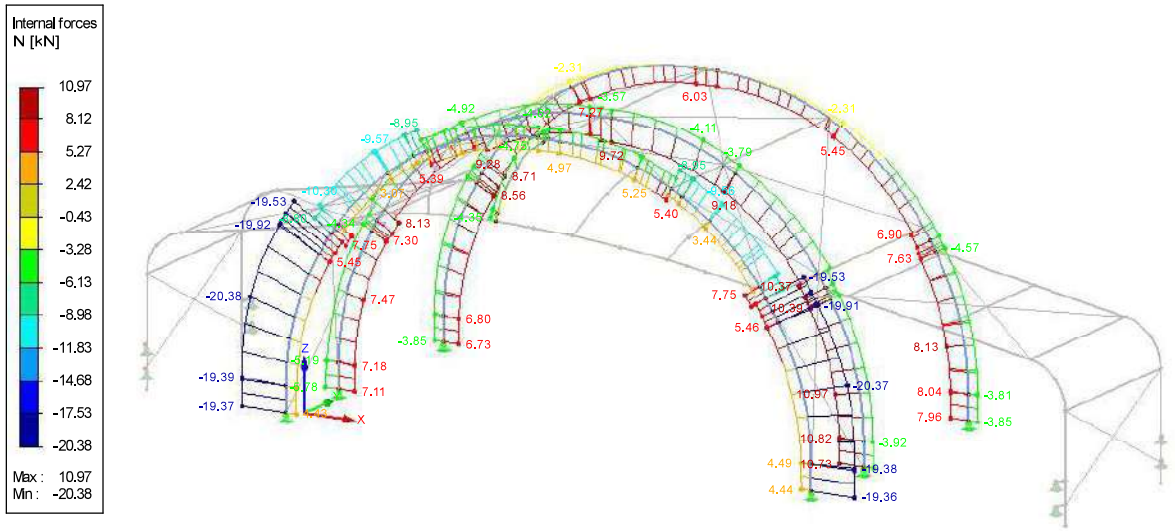
Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (35.85 / 50.914)^{1,3} + ((6.81 / 53.19)^{1.7})^{0.6} = 0.76 < 1$

4.1.3 Internal forces RC4 Design Values Out-service.

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces N
Result Combinations: Max and Min Values

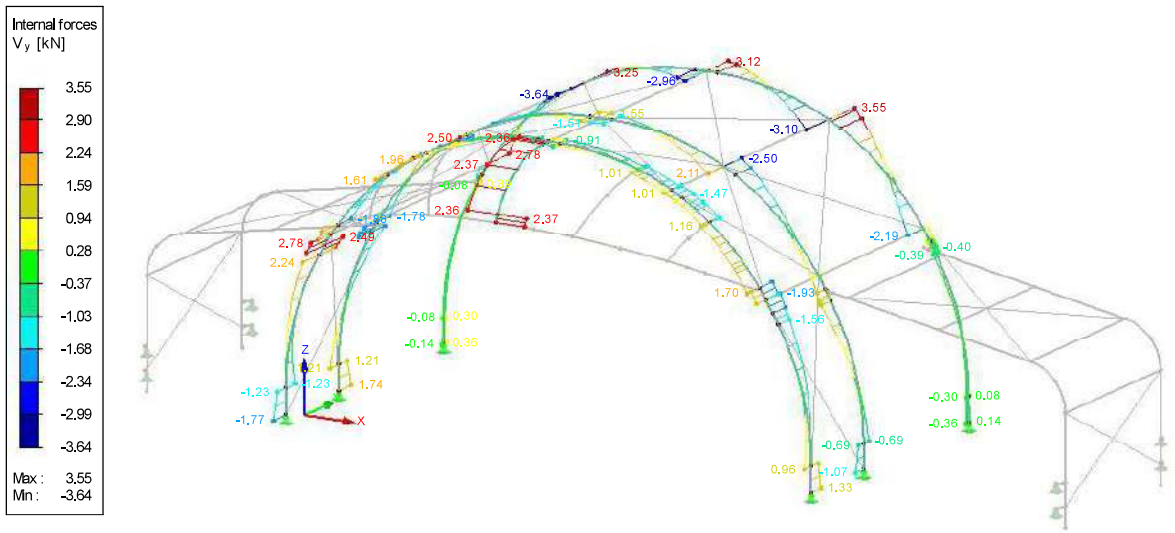
Isometric



Max N: 10.97, Min N: -20.38 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

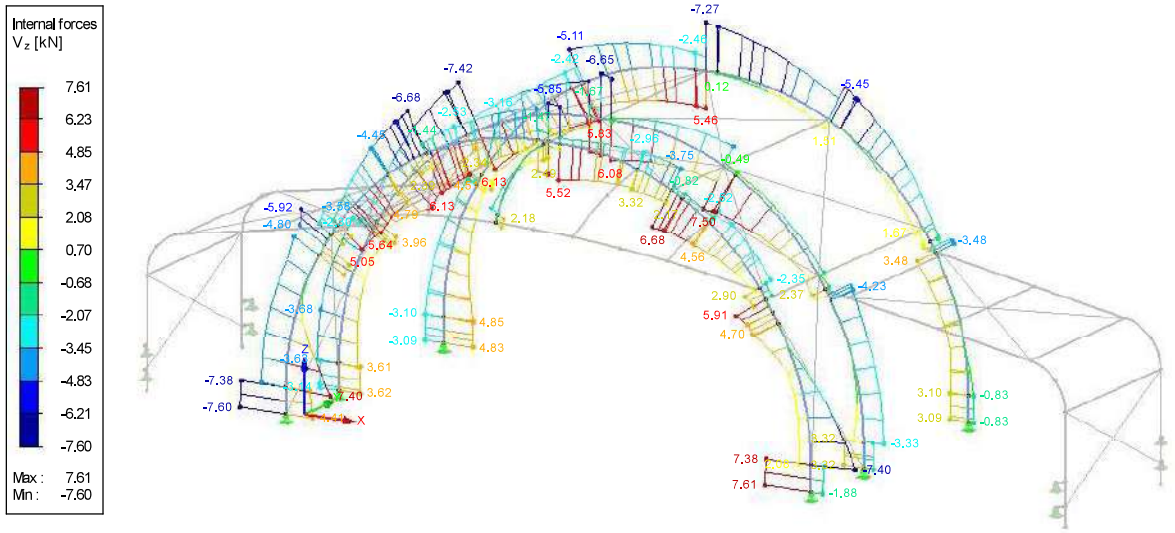
Isometric



Max V-y: 3.55, Min V-y: -3.64 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

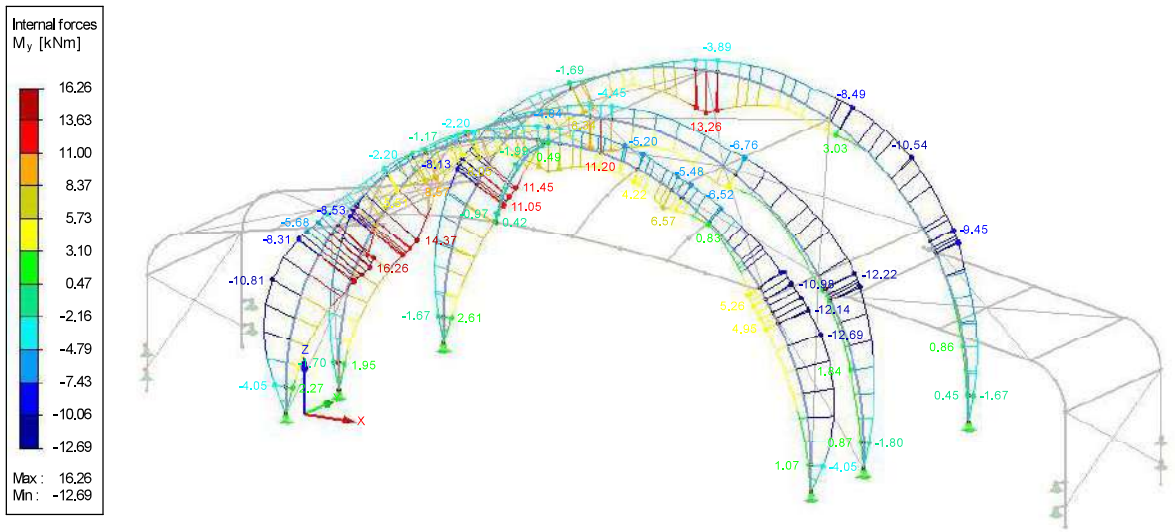
Isometric



Max V-z: 7.61, Min V-z: -7.60 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

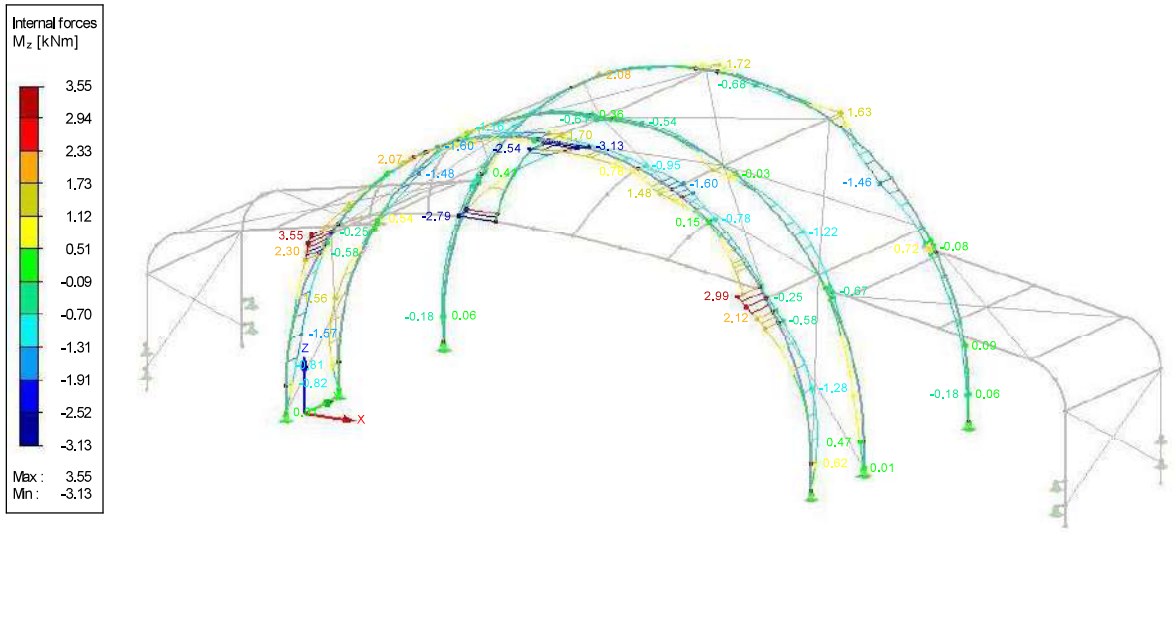
Isometric



Max M-y: 16.26, Min M-y: -12.69 kNm

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 3.55, Min M-z: -3.13 kNm

4.1.4 Check of the Interaction of moment and transversal force with the RC4- Design values.

The check of the Interaction between the bending moment and the transversal force has been done in a separate excel sheet.
This check has been done for each separate truss arch

Check of truss arch 1 (front arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 110	-3,26	2,78	-3,62	-0,36	16,23	3,05

$V_{d, main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(2.78^2 + 3.62^2)}$
$V_{d, main\ chord} = 1.14$ kN
$M_{d, main\ chord} = Vd, main\ chord * e = 1.14 * 5$
$M_{d, main\ chord} = 5.70$ kNcm
$N_{d, main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, main\ chord} = 3.26 / 4 + 16.23 / 2 / 0.239 + 3.05 / 2 / 0.239$
$N_{d, main\ chord} = 41.149$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd, main\ chord} = 50.914$ kN and the $M_{Rd, main\ chord} = 53.19$ kNcm.

$\eta = (N_{d, main\ chord} / N_{Rd})^{1,3} + M_{d, main\ chord} / M_{Rd}$
$\eta = (41.149 / 50.914)^{1,3} + ((5.70 / 53.19)^{1.7})^{0.6} = 0.86 < 1$

Check of truss arch 2 (middle arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 110	4,5	-1,19	2,38	-0,35	14,34	-0,73

$V_{d, main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(1.19^2 + 2.38^2)}$
$V_{d, main\ chord} = 0.66$ kN
$M_{d, main\ chord} = Vd, main\ chord * e = 0.66 * 5$
$M_{d, main\ chord} = 3.33$ kNcm
$N_{d, main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, main\ chord} = 4.5 / 4 + 14.34 / 2 / 0.239 + 0.73 / 2 / 0.239$
$N_{d, main\ chord} = 32.6522$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd, main\ chord} = 50.914$ kN and the $M_{Rd, main\ chord} = 53.19$ kNcm.

$\eta = (N_{d, main\ chord} / N_{Rd})^{1.3} + M_{d, main\ chord} / M_{Rd}$
$\eta = (32.65 / 50.914)^{1.3} + ((3.33 / 53.19)^{1.7})^{0.6} = 0.62 < 1$

Check of truss arch 3 (back arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 102	2,04	-1,47	5,46	0	13,26	1,09

$V_{d, \text{main chord}} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(1.47^2 + 5.46^2)}$
$V_{d, \text{main chord}} = 1.41$ kN
$M_{d, \text{main chord}} = Vd, \text{main chord} * e = 1.41 * 5$
$M_{d, \text{main chord}} = 7.07$ kNcm
$N_{d, \text{main chord}} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, \text{main chord}} = 2.04 / 4 + 13.26 / 2 / 0.239 + 1.09 / 2 / 0.239$
$N_{d, \text{main chord}} = 30.53$ kN

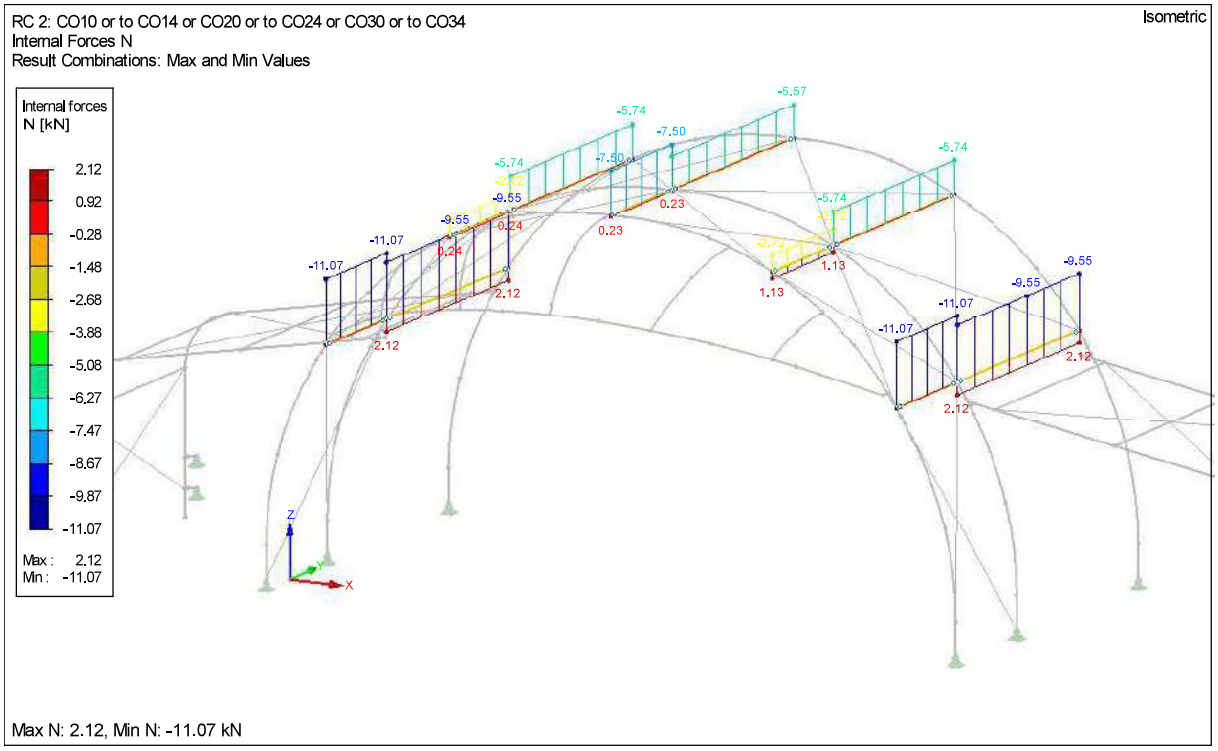
Check
According to information of the Protruss S31 truss the $N_{Rd, \text{main chord}} = 50.914$ kN and the $M_{Rd, \text{main chord}} = 53.19$ kNcm.

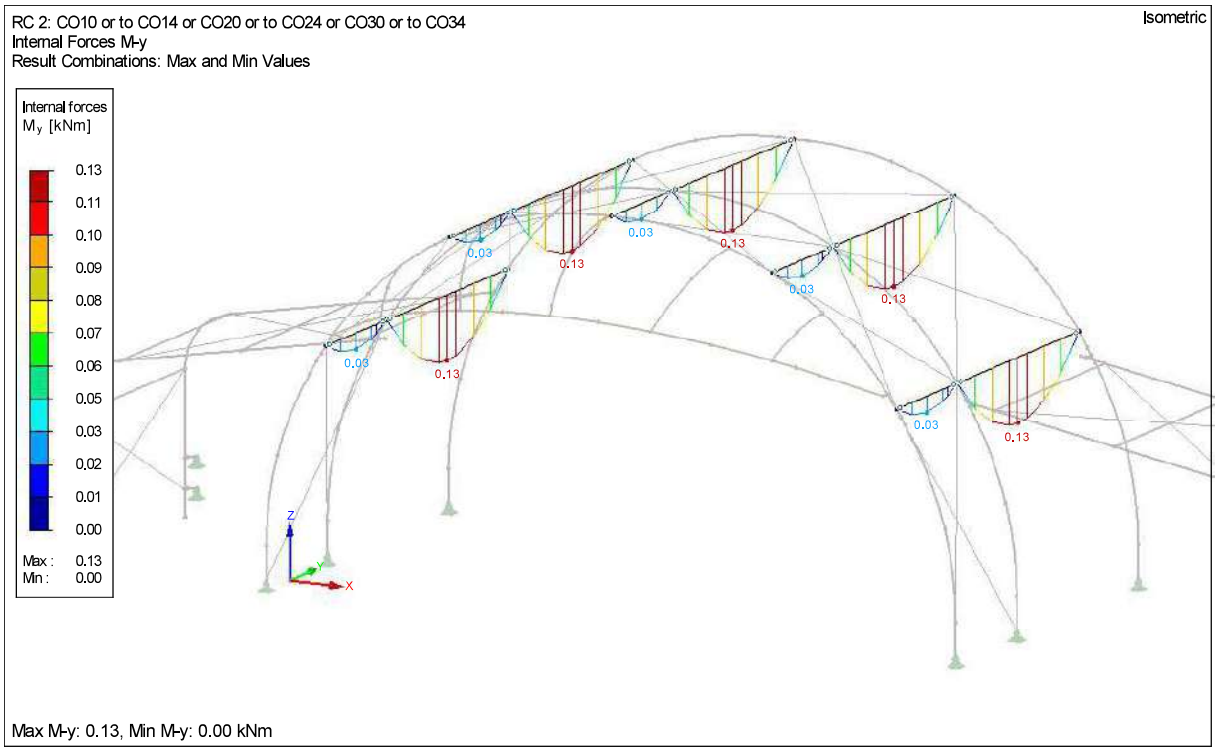
$\eta = (N_{d, \text{main chord}} / N_{Rd})^{1.3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = (30.53 / 50.914)^{1.3} + ((7.07 / 53.19)^{1.7})^{0.6} = 0.64 < 1$

4.2 Detail check of the Protruss T31 Roof truss.

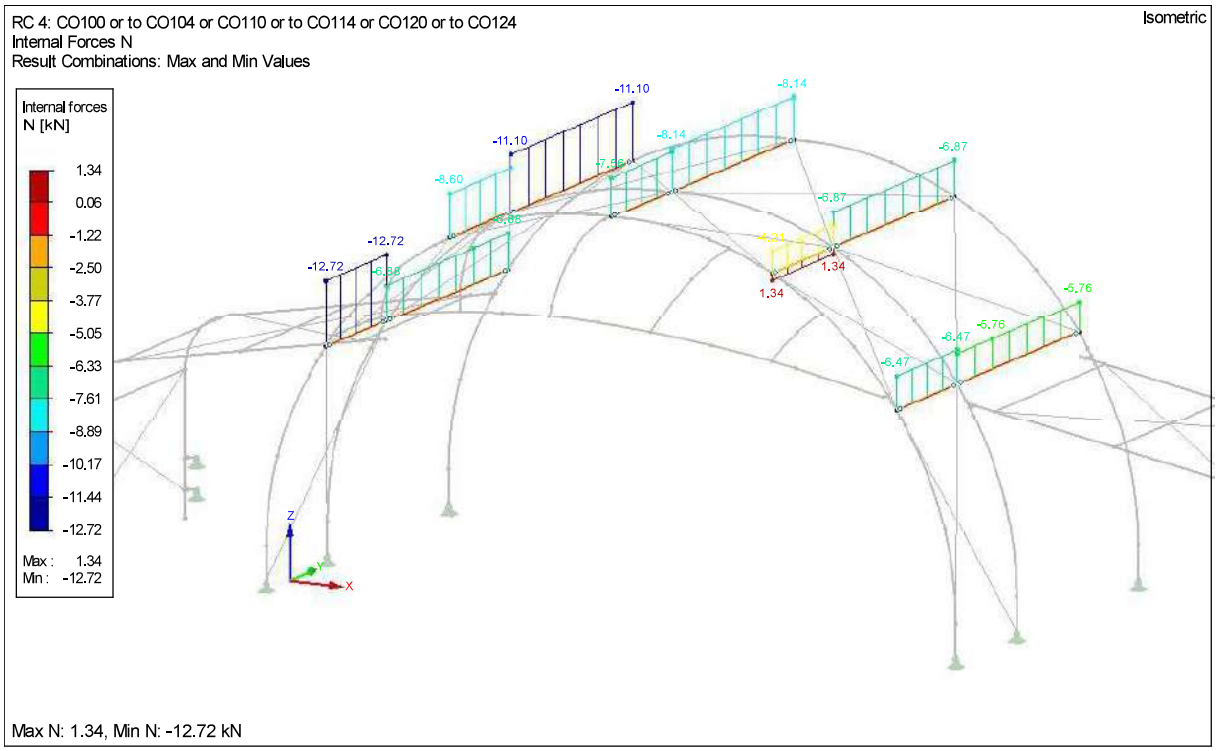
The roof trusses are loaded on compression therefor these trusses will be checked on buckling With the Internal forces of RC2 and RC4

4.2.1 Internal forces RC2 Design Values In-service.

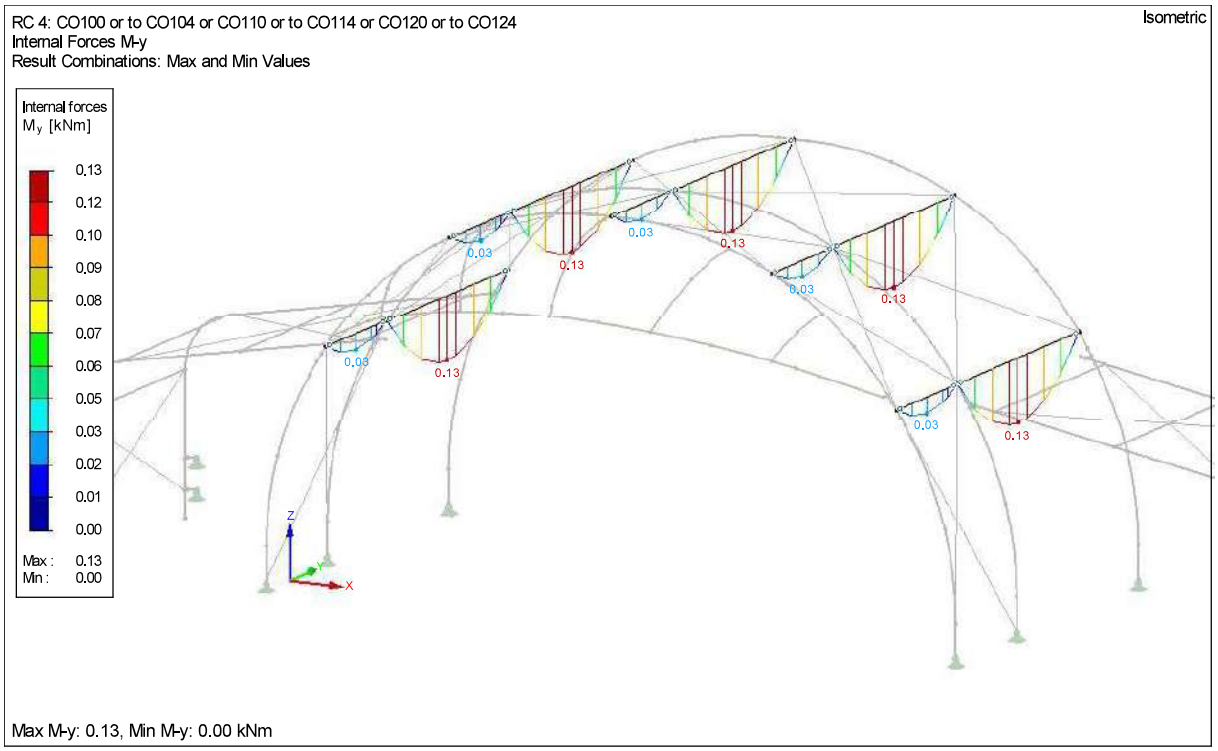




4.2.2 Internal forces RC4 Design Values Out-service.



Max N: 1.34, Min N: -12.72 kN



Max M-y: 0.13, Min M-y: 0.00 kNm

4.2.3 Check of the Protruss T31 Roof truss on buckling in the Out-service situation.

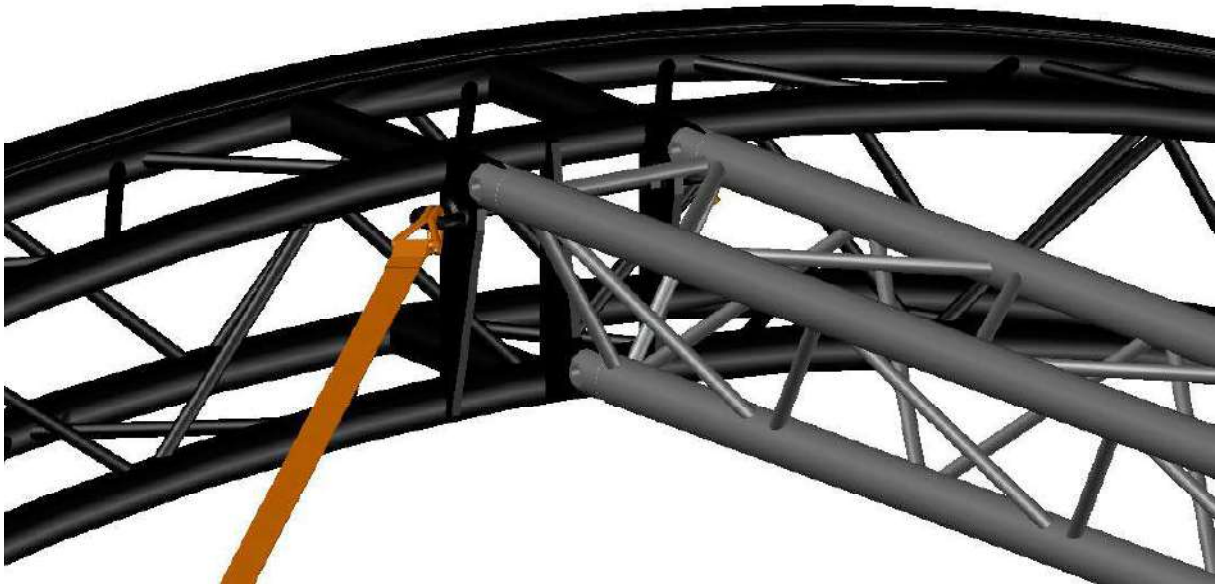
N = 11.10 kN
M_y = 0.13 kNm
M_z = 0 kNm

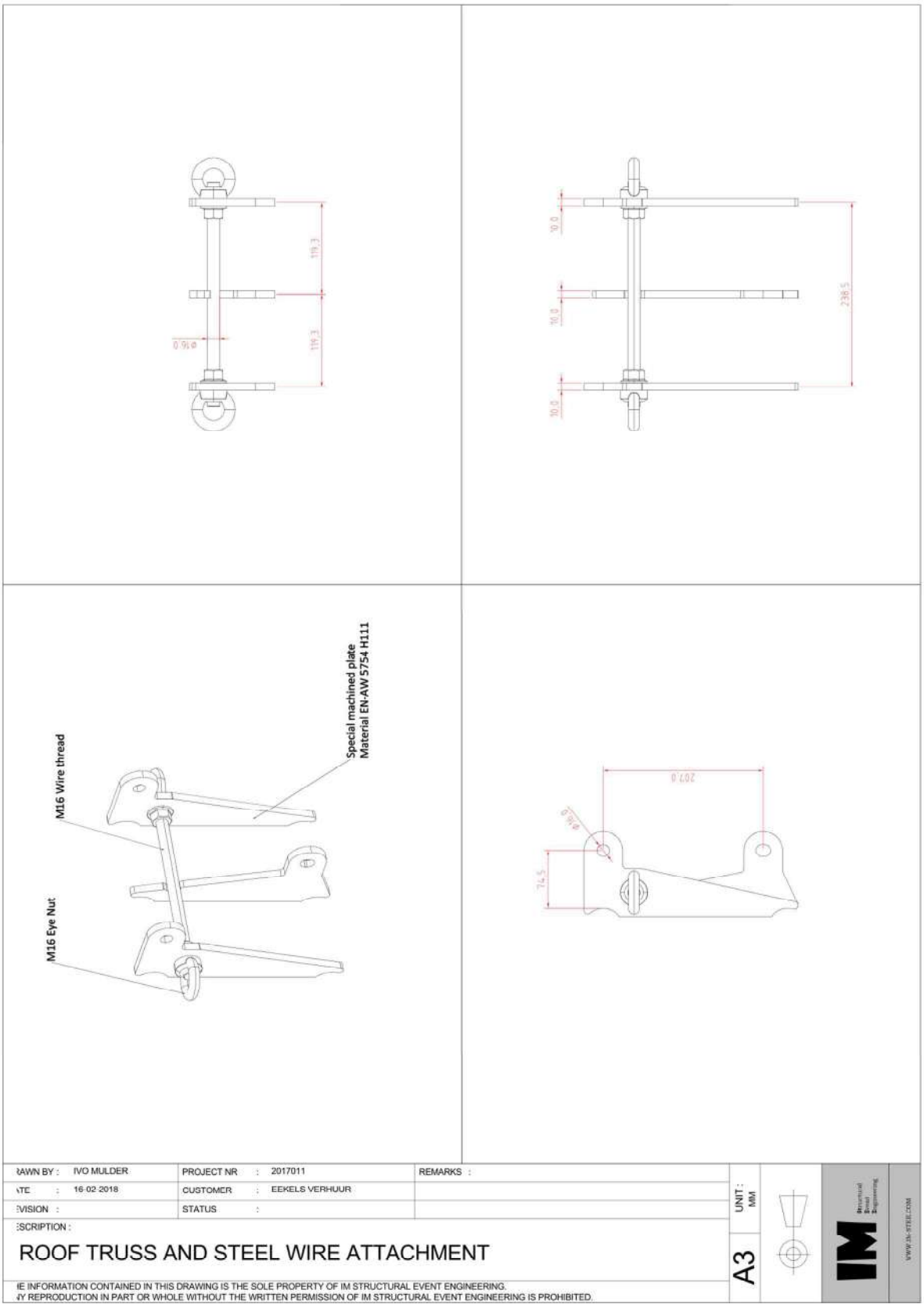
$N_{ED,\ main\ chord} = N / 4 + M_y / 2 / height_{(centre\ to\ centre)} + M_z / 2 / width_{(centre\ to\ centre)}$
$N_{ED,\ main\ chord} = 11.10 / 3 + 0.13 / 0.207 + 0 / 0.239 = 4.24\ kN < 50.22\ kN$

Buckling calculation:
Buckling Length factor K = 1 table 6,8 NEN-EN 1999-1-1
$L_{cr} = 1 * 414 = 414$
$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$
$\lambda_z = 414 / (9.89 * \pi) * \sqrt{((12.723 * 25) / (12.723 * 7000))} = 0.79$
$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$
$\Theta_z = 0.5 * (1 + 0.2 * (0.79 - 0.10) + 0.79^2) = 0.88$
$X_z = 1 / (\Theta_z + \sqrt{(\Theta_z^2 - \lambda_z^2)})$
$X_z = 1 / (0.88 + \sqrt{(0.88^2 - 0.79^2)}) = 0.79$

$(N / (X_z * N_{RD}))^{0.8} + ((M_y / M_{y,\ RD})^{1,7} + (M_z / M_{z,\ RD})^{1,7})^{0.6} < 1$
$(11.10 / (0.79 * 150.66))^{0.8} + ((0.13 / 9.48)^{1,7} + (0 / 10.95)^{1,7})^{0.6} = 0.16 < 1$

4.2.4 Check of T31 Roof truss to the S31 Main arch truss.





RAWN BY : IVO MULDER	PROJECT NR : 2017011	REMARKS :	
ATE : 16-02-2018	CUSTOMER : EEKELS VERHUUR		UNIT : MM
EVISION :	STATUS :		A3

ESCRIPTION :

ROOF TRUSS AND STEEL WIRE ATTACHMENT

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Check of the bearing forces in the holes of plate

Plate Information
Material EN-AW 5754 H111
f_u 18 kN/cm²
$f_{u,haz}$ 18 kN/cm²

T = 10 mm
D = 16 mm

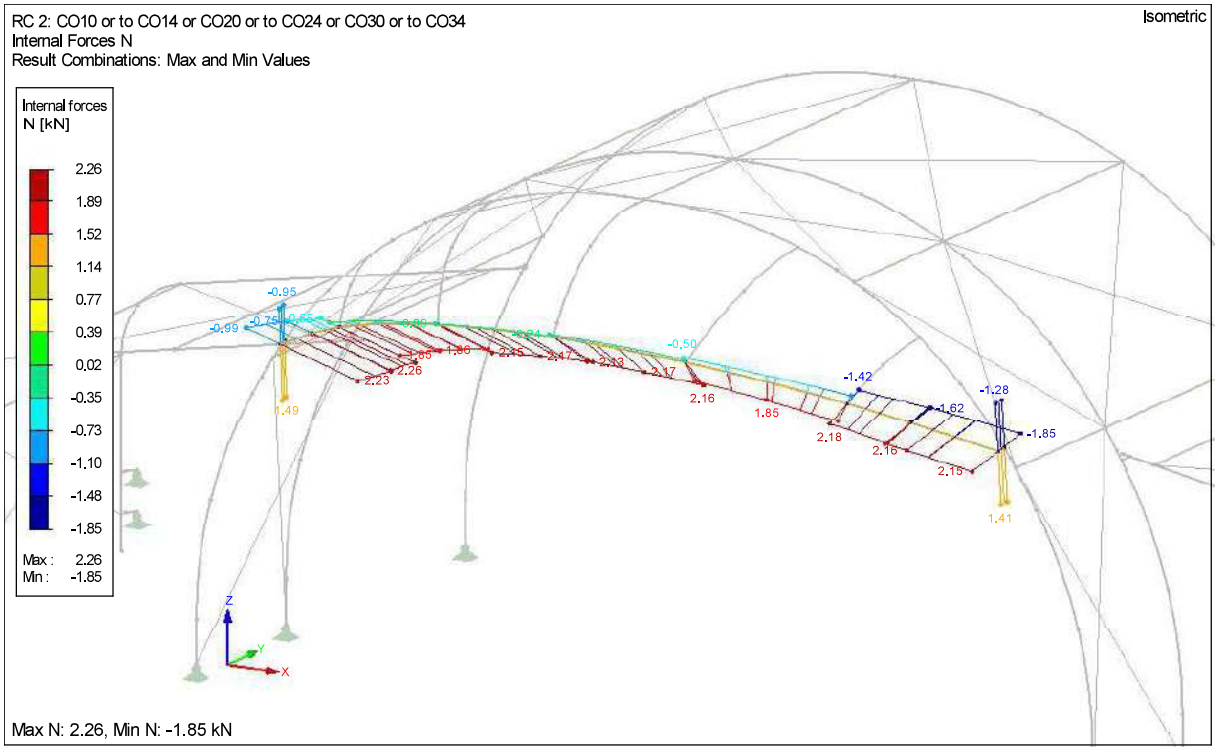
Maximum normal force in the T31 Roof truss = 11.10 kN

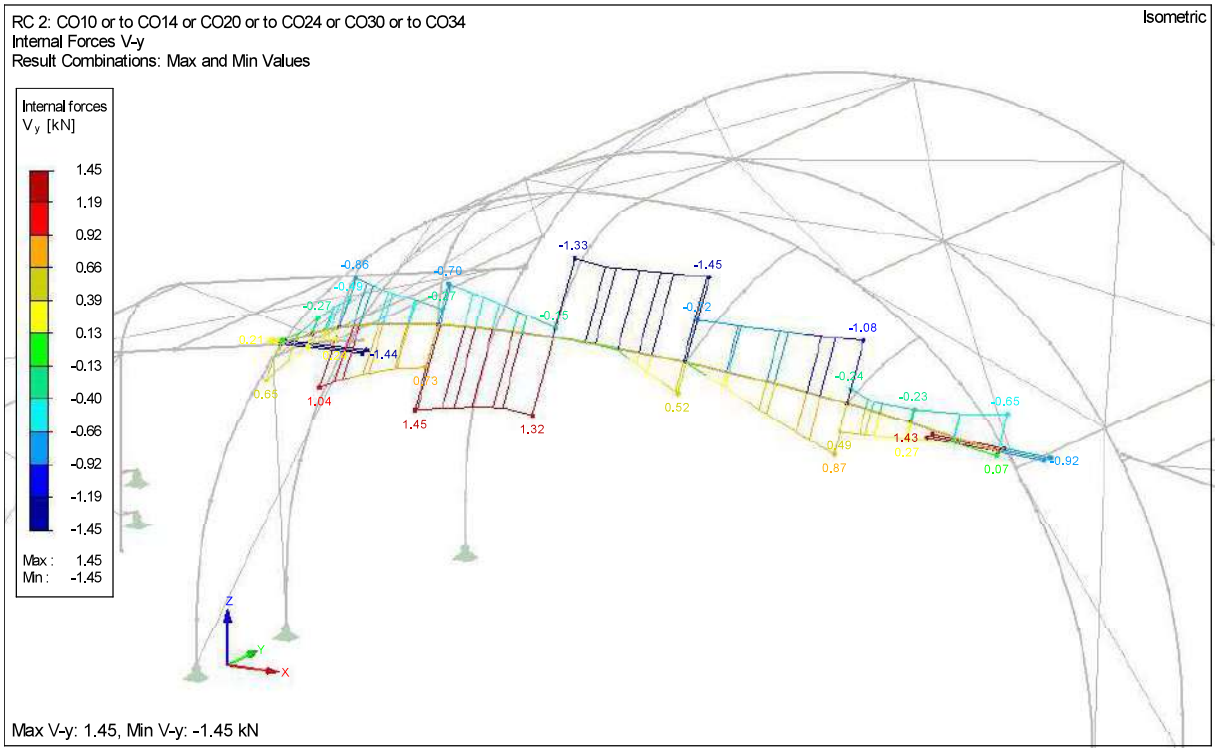
$F_{b,Ed}$ = 11.10 kN / 3 = 3.7 kN
$F_{b,Rd}$ = 1.5 * f_u * D * T / γ_{m2} = 1.5 * 18 * 1.6 * 1 / 1.25 = 34.56 kN
$F_{b,Ed}$ / $F_{b,Rd}$ < 1
3.7 / 34.56 = 0.10 < 1.0

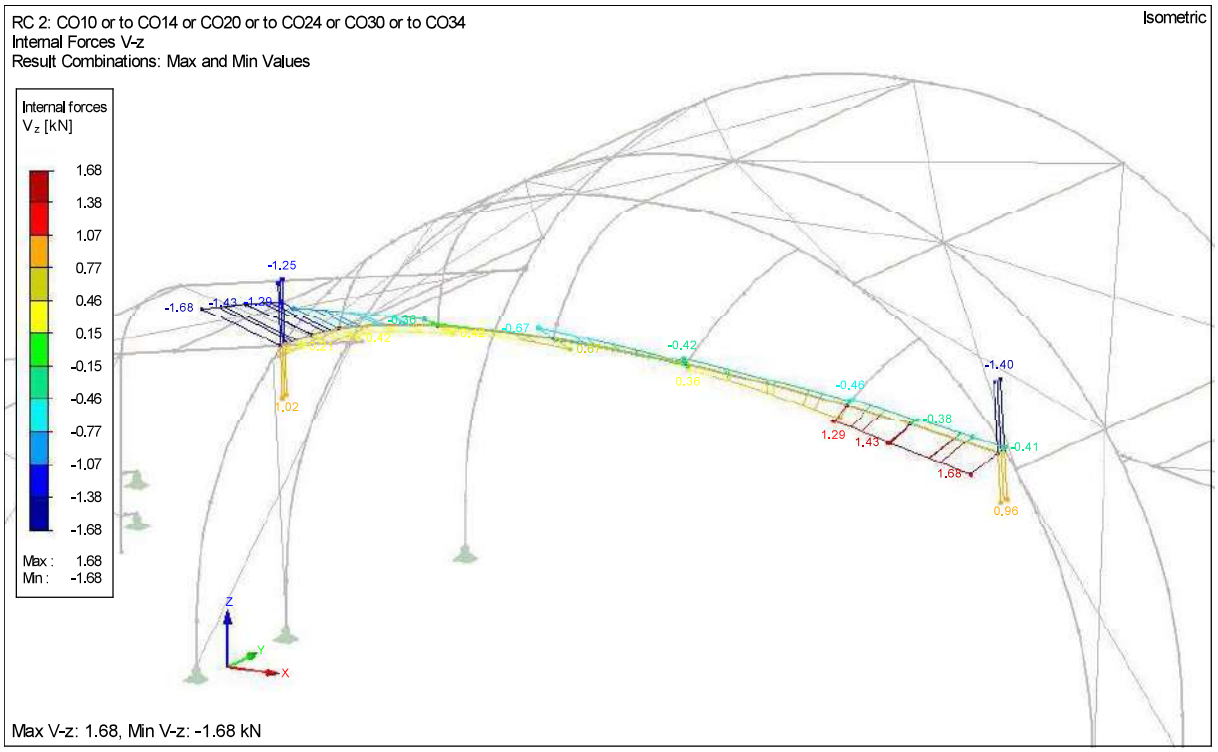
Due to the low maximum normal force the welding of the plate to the main tube and truss pin are not decisive.

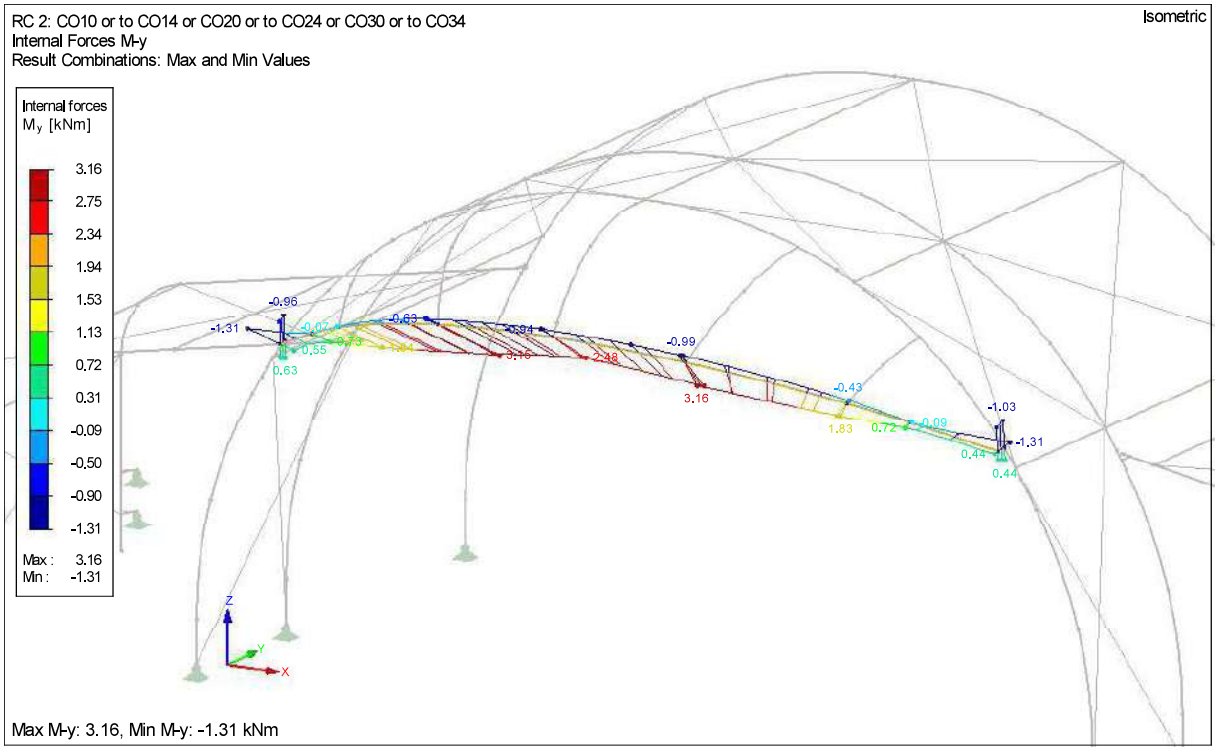
4.3 Detail Check of the cantilever.

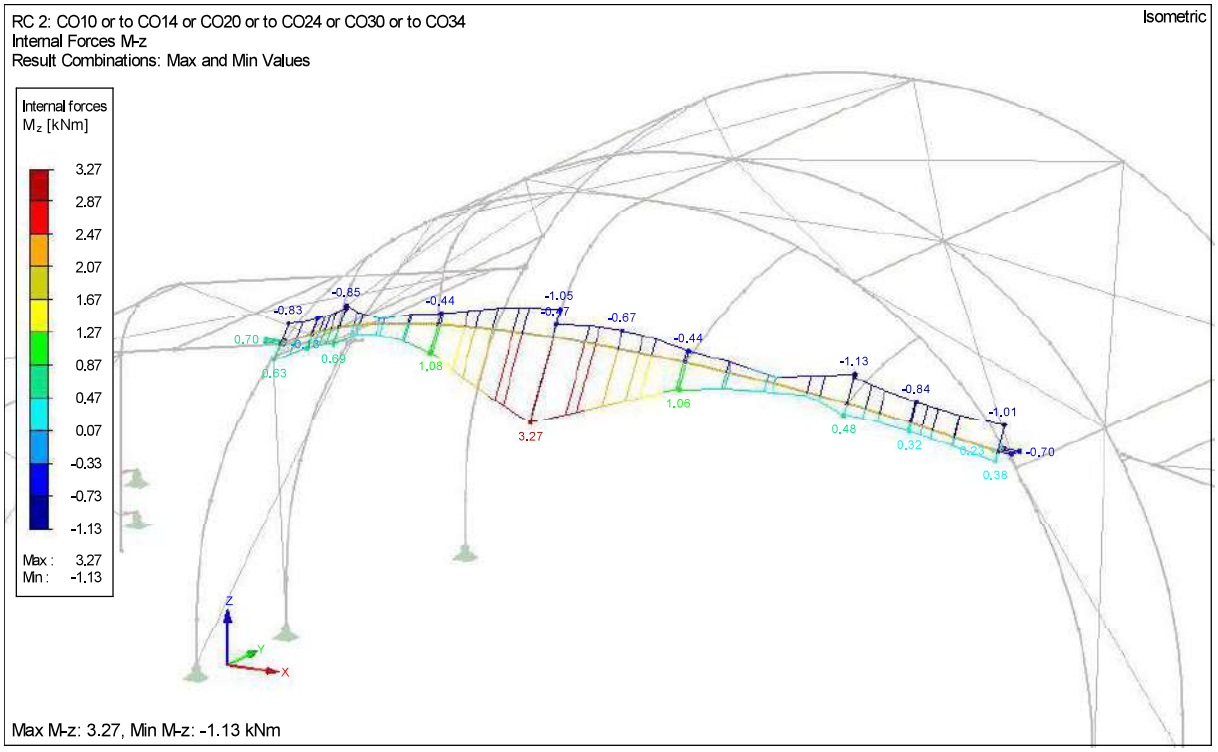
4.3.1 Internal forces T31 truss RC2 Design Values In-service.






RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
1.68
1.38
1.07
0.77
0.46
0.15
-0.15
-0.46
-0.77
-1.07
-1.38
-1.68
Max : 1.68
Min : -1.68
Max V-z: 1.68, Min V-z: -1.68 kN


RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
3.16
2.75
2.34
1.94
1.53
1.13
0.72
0.31
-0.09
-0.50
-0.90
-1.31
Max : 3.16
Min : -1.31
Max M-y: 3.16, Min M-y: -1.31 kNm



4.3.2 Check of the Interaction of moment and transversal force with the RC2- Design values.

The check of the Interaction between the bending moment and the transversal force has been done with the maximum internal forces of RC2

Check of T31 truss arch

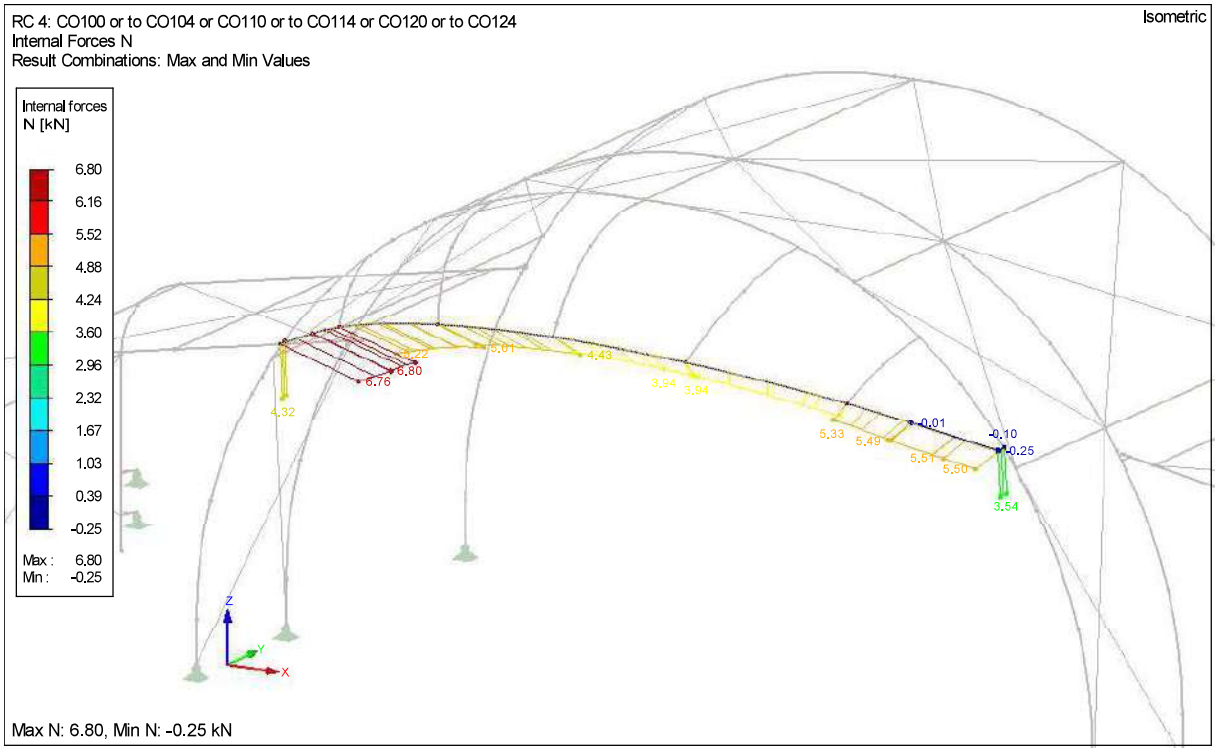
Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
RC2	2.26	-1.45	1.68	1.18	3.16	3.27

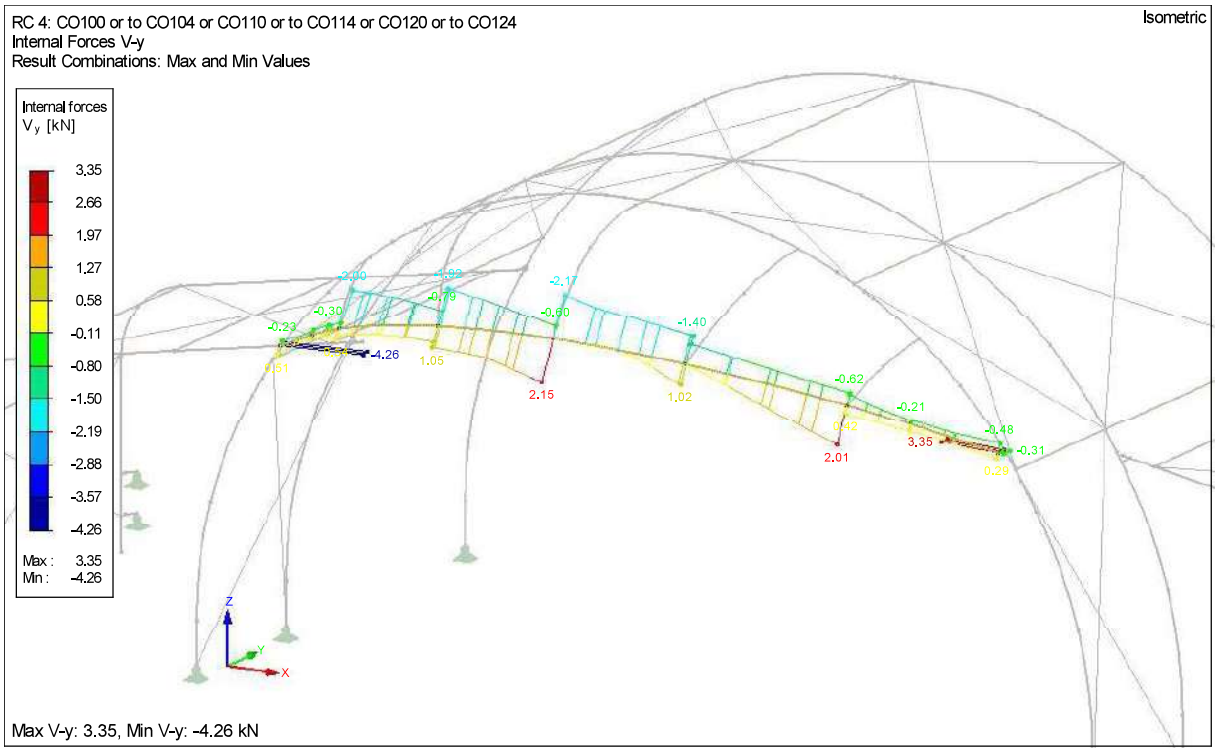
$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.333 * \sqrt{(1.45^2 + 1.68^2)}$
$V_{d,\ main\ chord} = 0.74$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 0.74 * 5$
$M_{d,\ main\ chord} = 3.7$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 2.26 / 3 + 3.16 / 0.239 + 3.27 / 0.207$
$N_{d,\ main\ chord} = 29.77$ kN

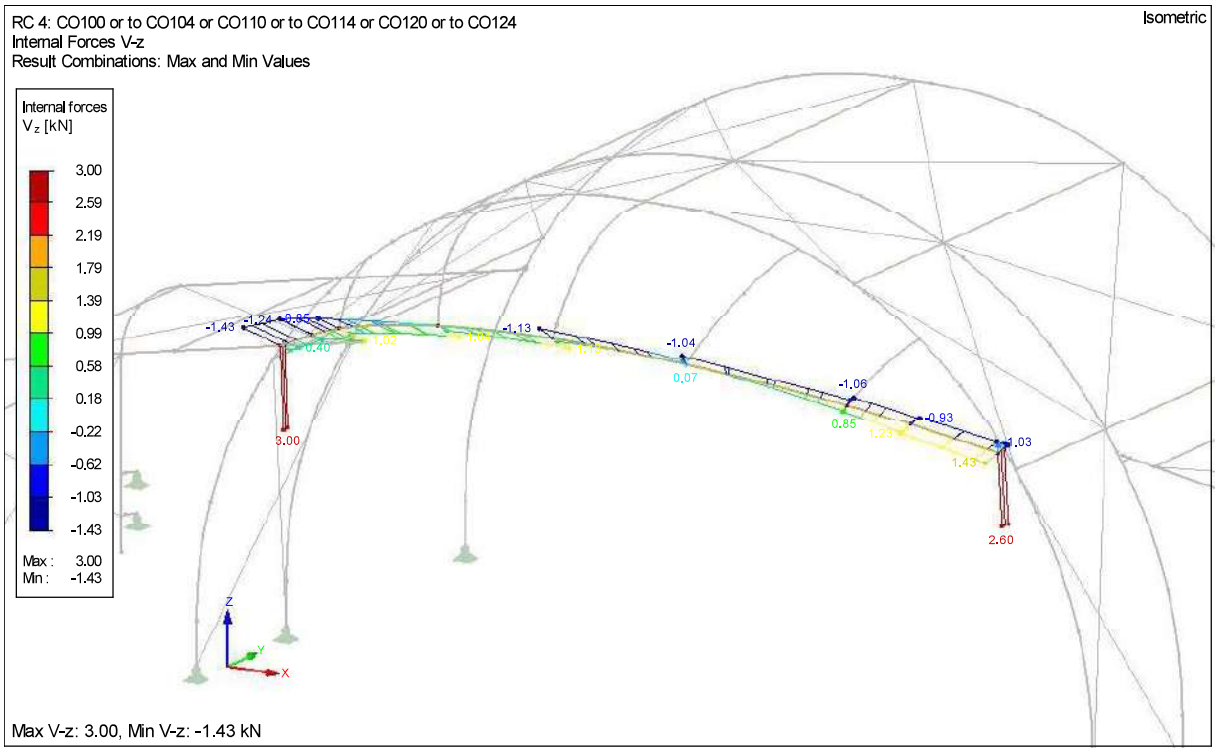
Check
According to information of the Protruss T31 truss the $N_{Rd,\ main\ chord} = 45.744$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

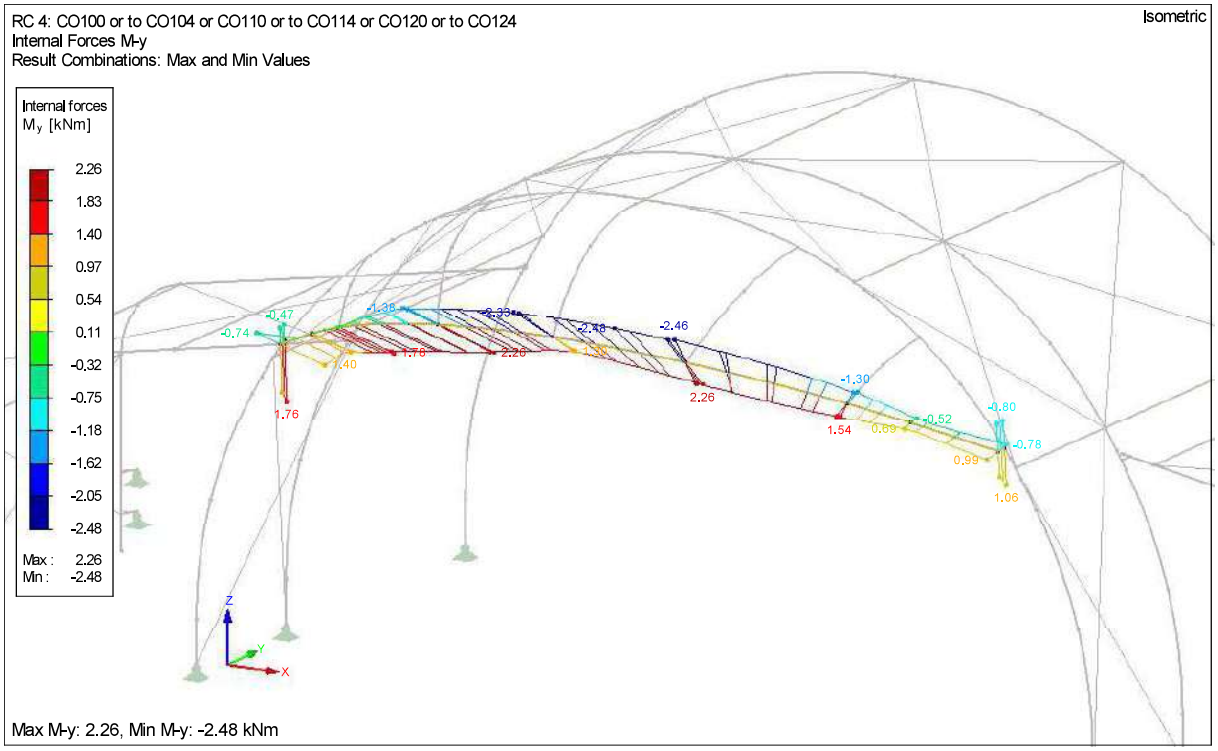
$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (29.77 / 45.744)^{1,3} + ((3.7 / 53.19)^{1.7})^{0.6} = 0.57 < 1$

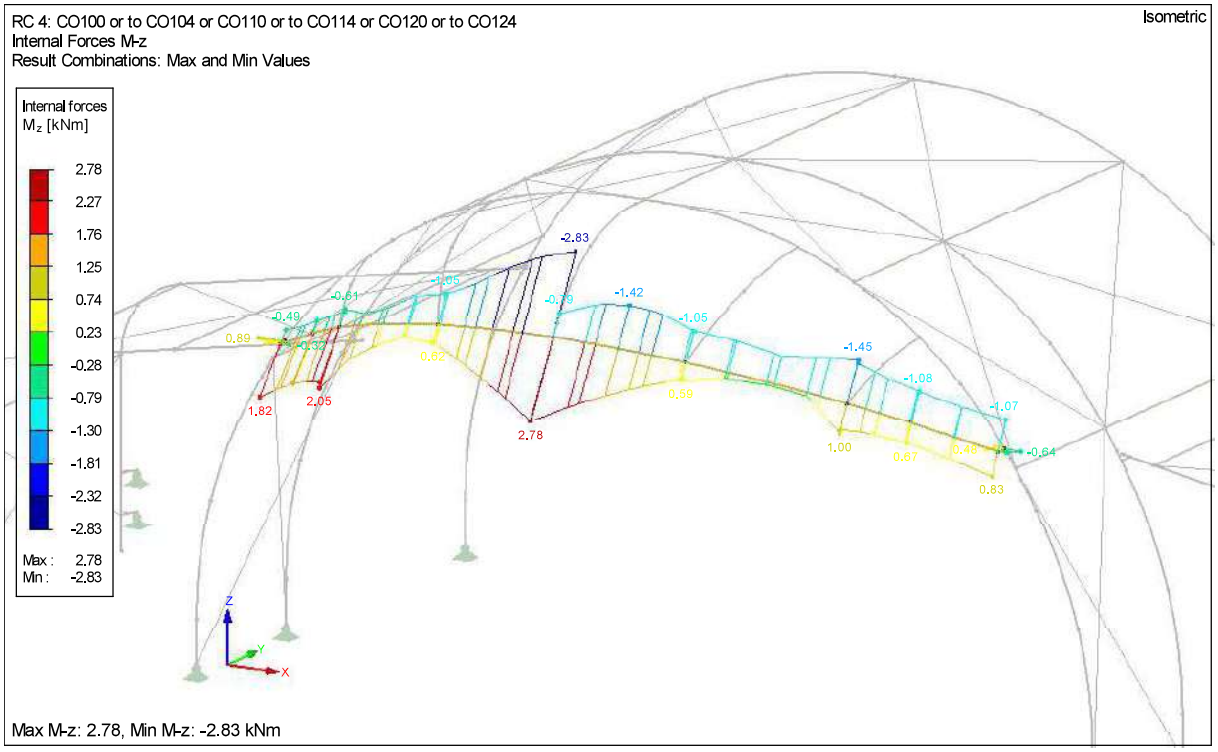
4.3.3 Internal forces T31 truss RC4 Design Values Out-service.






RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
3.00
2.59
2.19
1.79
1.39
0.99
0.58
0.18
-0.22
-0.62
-1.03
-1.43
Max : 3.00
Min : -1.43
Max V-z: 3.00, Min V-z: -1.43 kN


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
2.26
1.83
1.40
0.97
0.54
0.11
-0.32
-0.75
-1.18
-1.62
-2.05
-2.48
Max : 2.26
Min : -2.48
Max M-y: 2.26, Min M-y: -2.48 kNm



4.3.4 Check of the Interaction of moment and transversal force with the RC4- Design values.

The check of the Interaction between the bending moment and the transversal force has been done with the maximum internal forces of RC4

Check of T31 truss arch

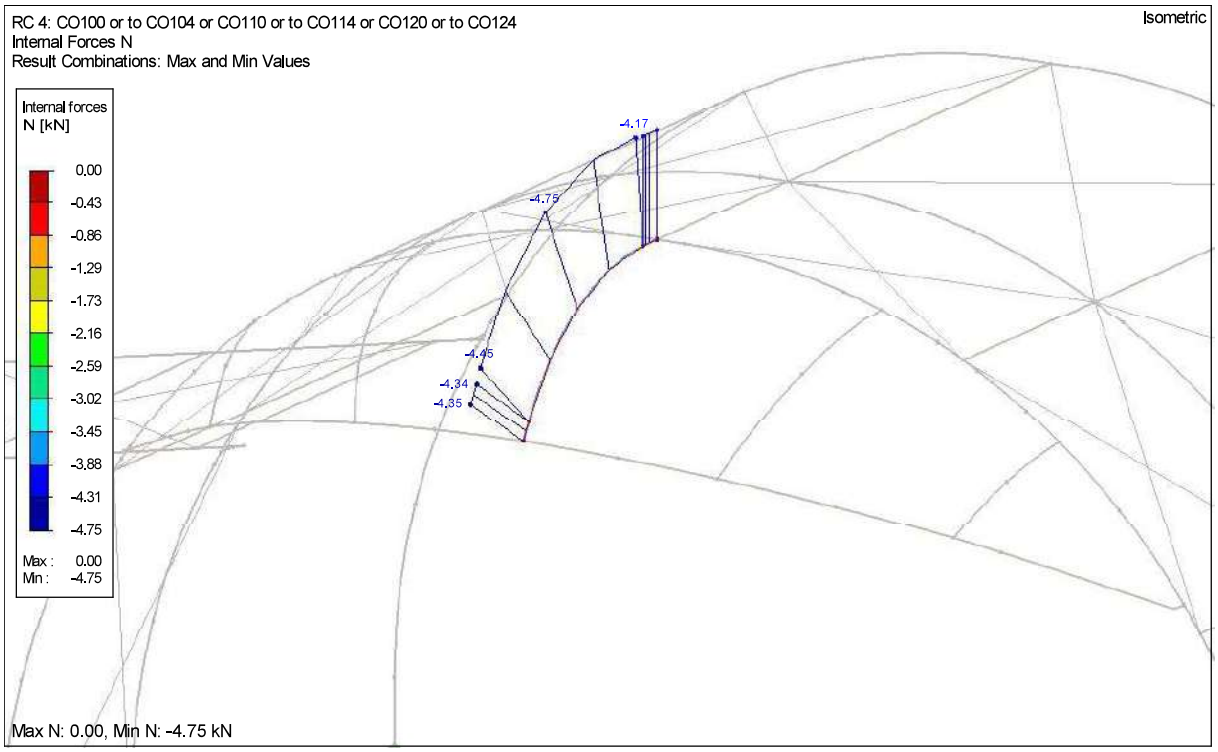
Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
RC4	6.80	-4.26	3.00	2.01	-2.48	-2.83

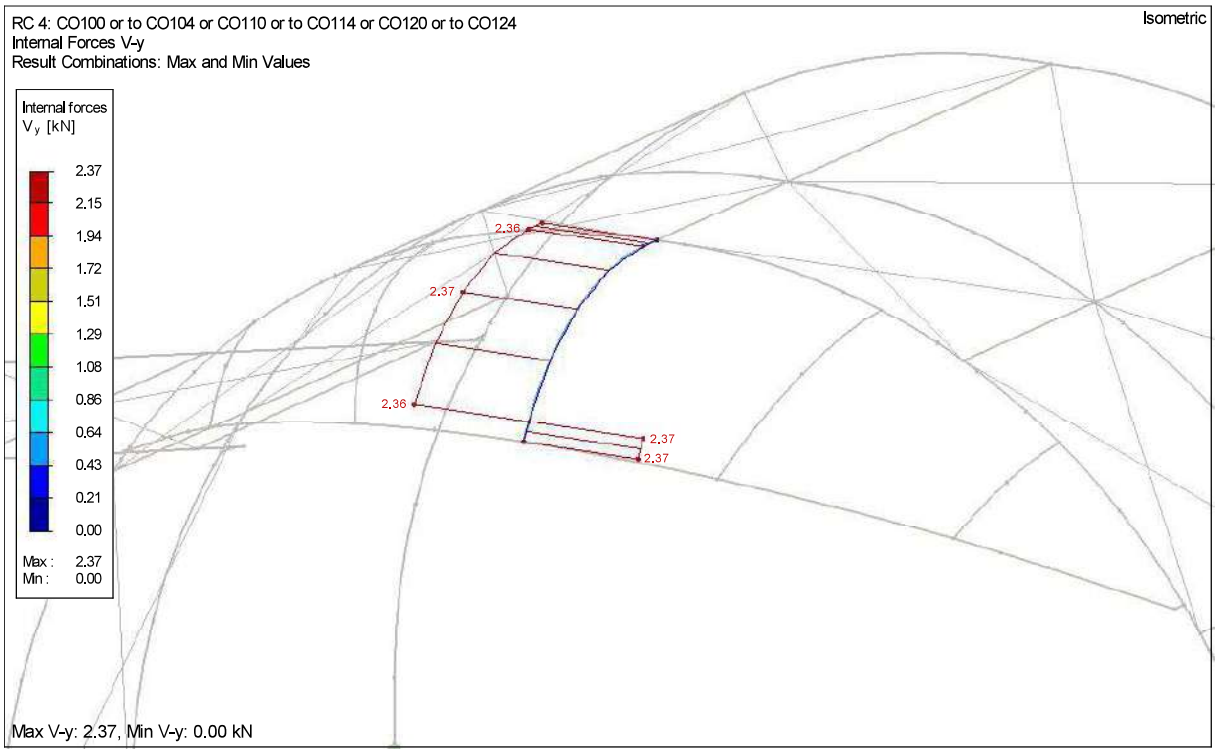
$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.333 * \sqrt{(4.26^2 + 3.00^2)}$
$V_{d,\ main\ chord} = 1.73$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 1.73 * 5$
$M_{d,\ main\ chord} = 8.65$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 6.80 / 3 + 2.48 / 0.239 + 2.83 / 0.207$
$N_{d,\ main\ chord} = 26.31$ kN

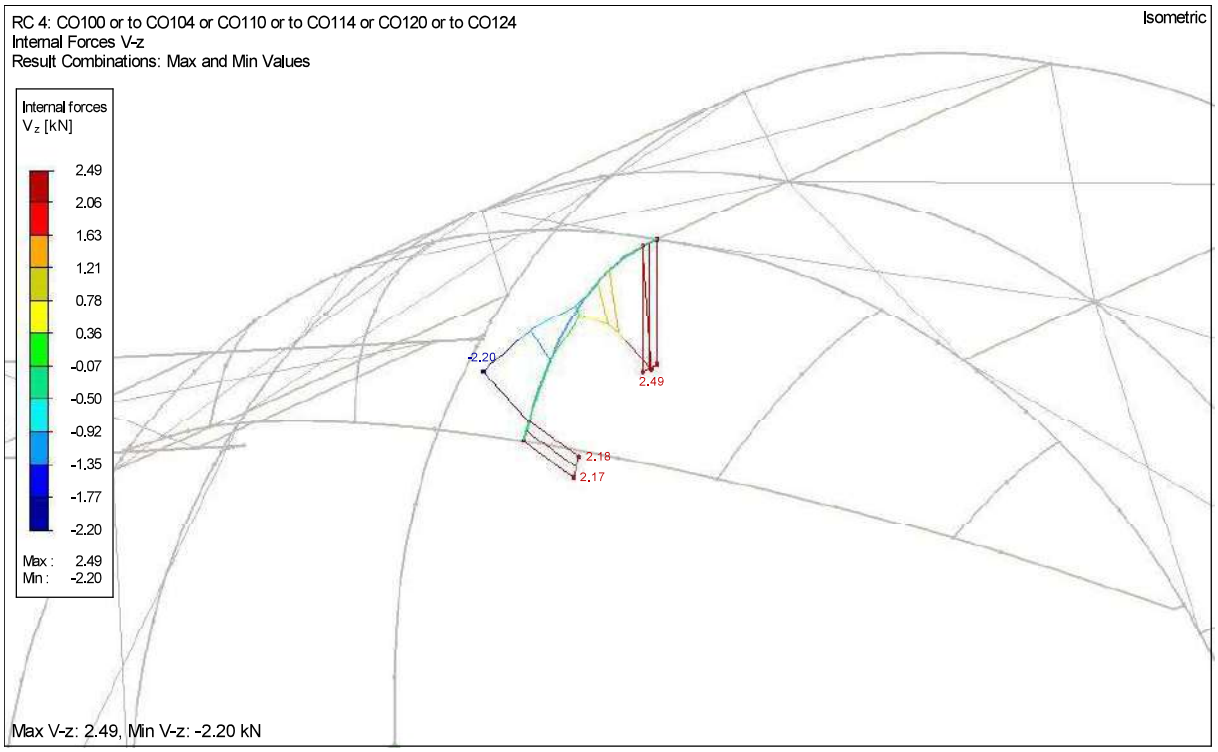
Check
According to information of the Protruss T31 truss the $N_{Rd,\ main\ chord} = 45.744$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

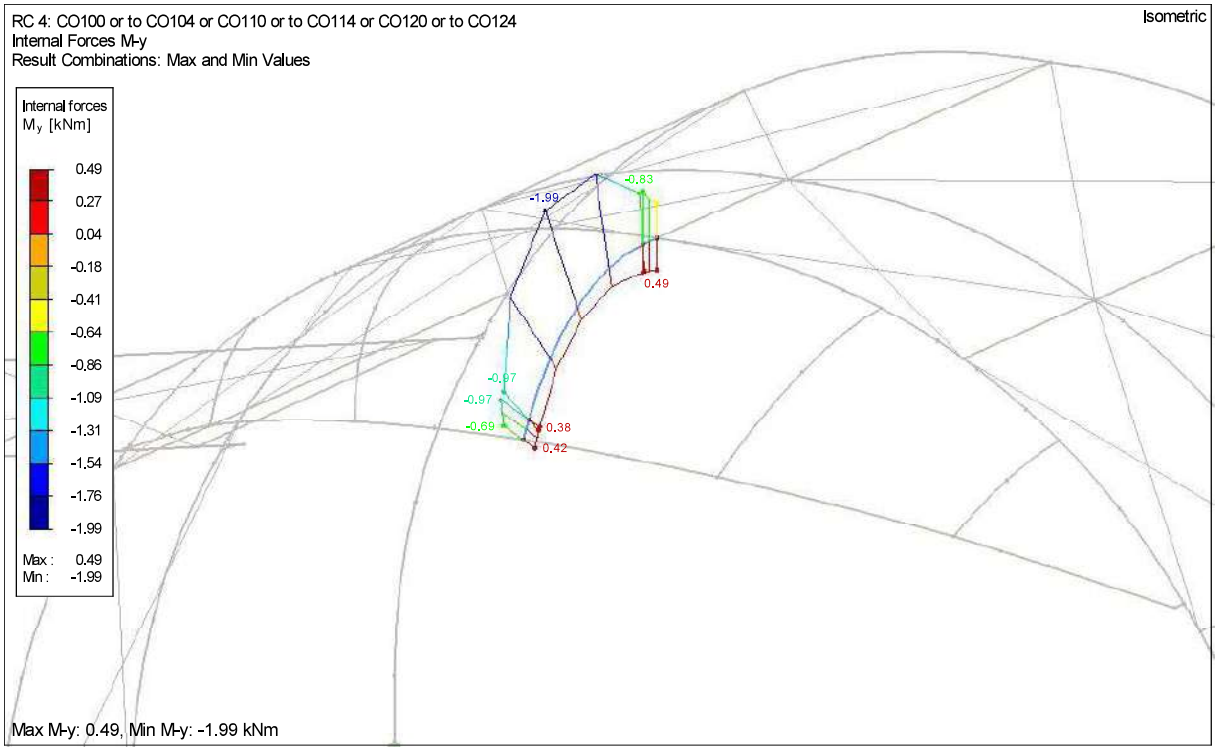
$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (26.31 / 45.744)^{1,3} + ((8.65 / 53.19)^{1.7})^{0.6} = 0.64 < 1$

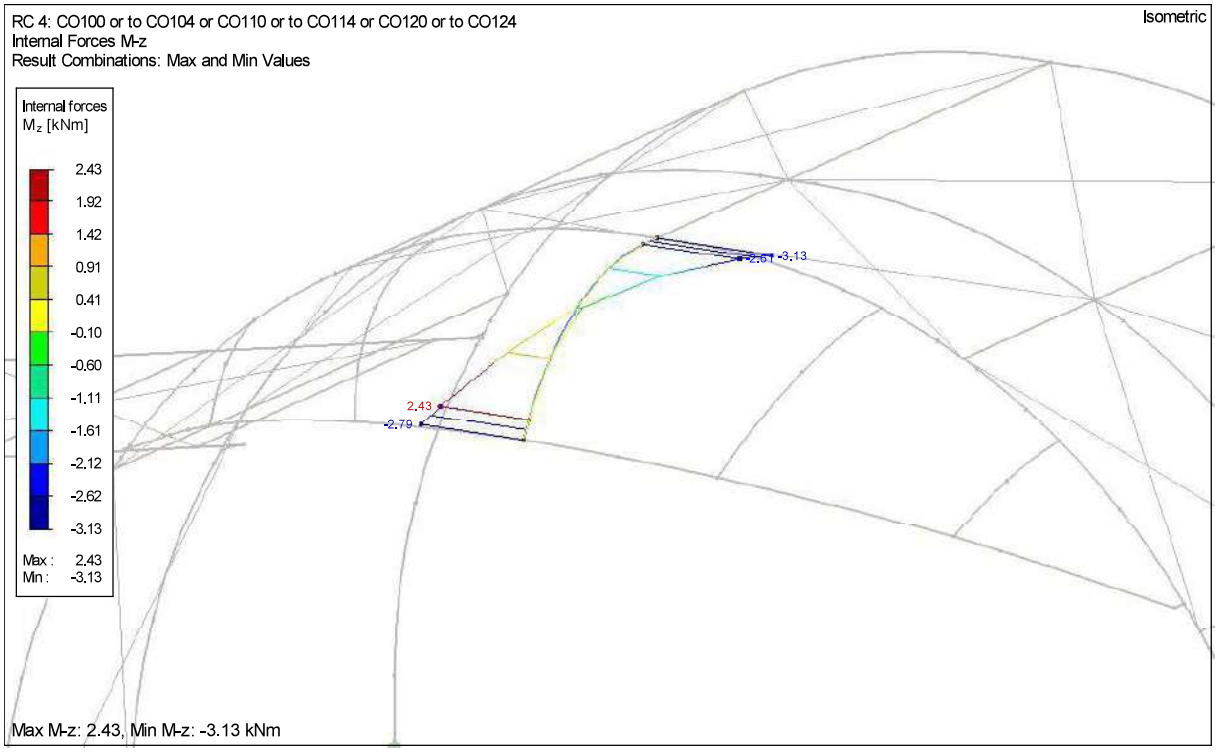
4.3.5 Internal forces S31 truss RC4 Design Values Out-service.






RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
2.49
2.06
1.63
1.21
0.78
0.36
-0.07
-0.50
-0.92
-1.35
-1.77
-2.20
Max: 2.49
Min: -2.20
-2.20
2.49
2.18
2.17
Max V-z: 2.49, Min V-z: -2.20 kN


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
0.49
0.27
0.04
-0.18
-0.41
-0.64
-0.86
-1.09
-1.31
-1.54
-1.76
-1.99
Max: 0.49
Min: -1.99
-1.99
-0.83
0.49
-0.97
-0.97
-0.69
0.38
0.42
Max M-y: 0.49, Min M-y: -1.99 kNm



4.3.6 Check of the Interaction of moment and transversal force with the RC4- Design values.

The check of the Interaction between the bending moment and the transversal force has been done with the maximum internal forces of RC4

Check of S31 truss arch

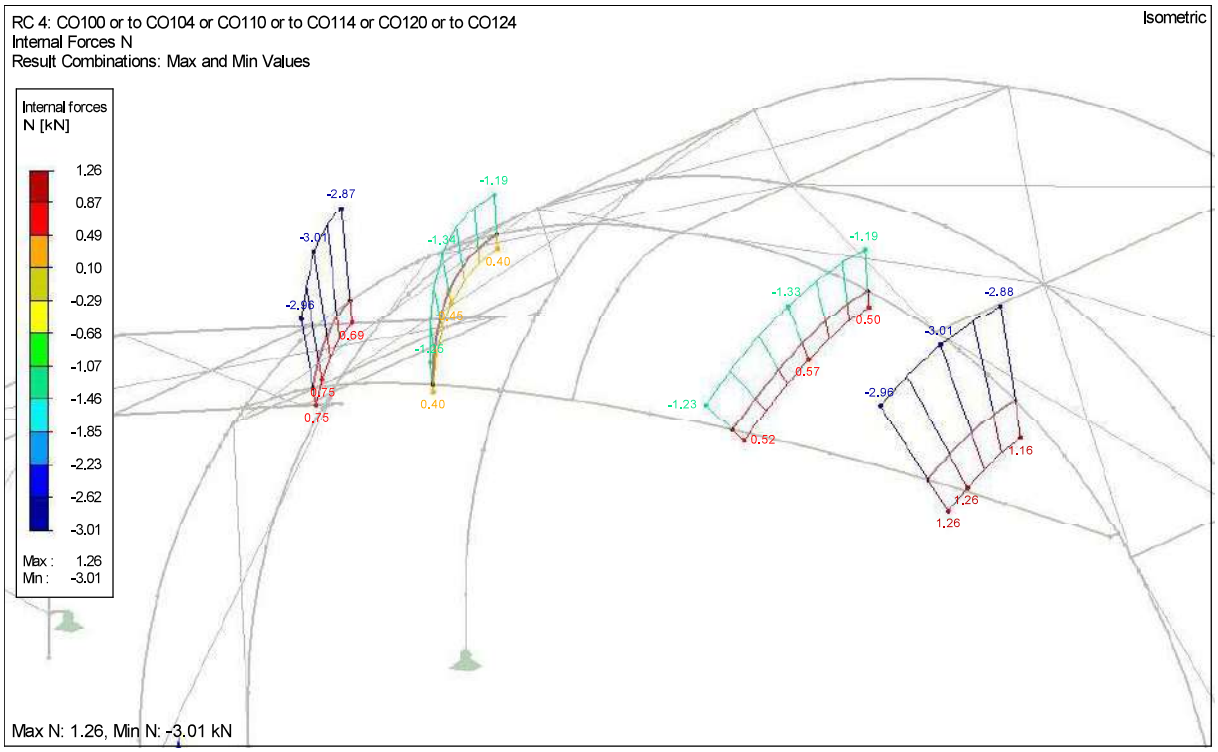
Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
RC4	-4.75	2.37	2.49	-0,62	-1.99	-3.13

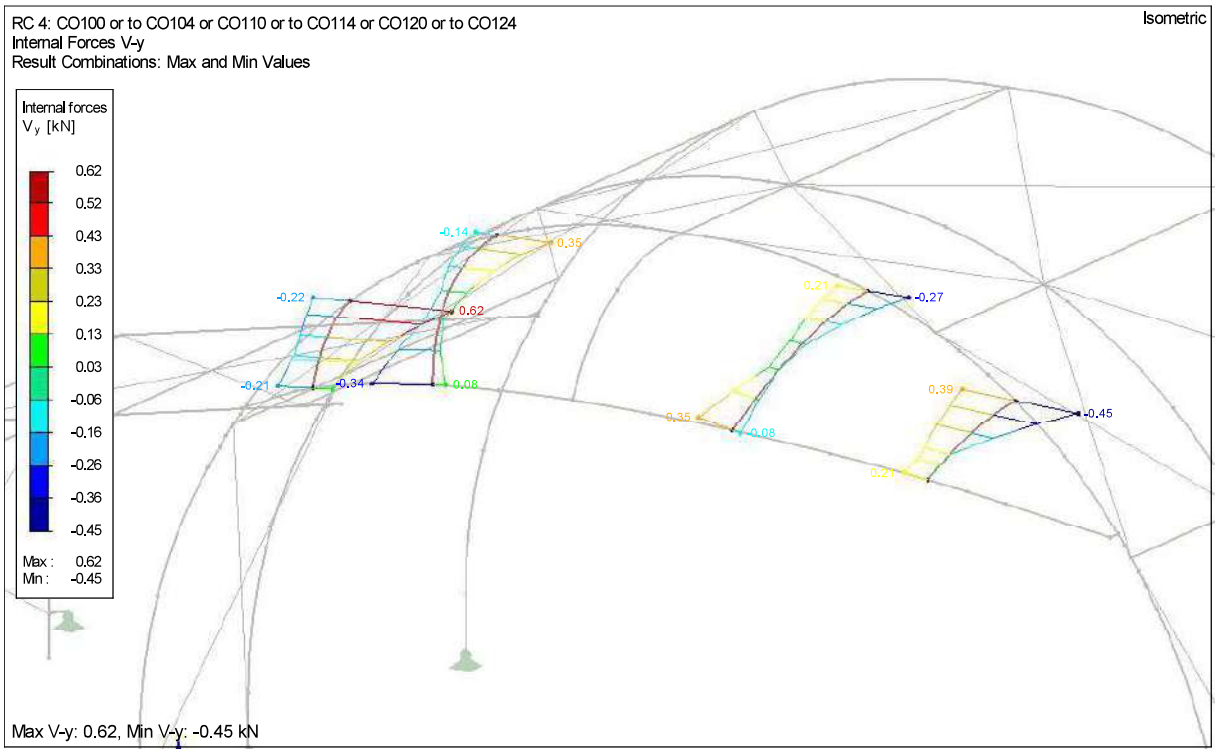
$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(2.37^2 + 2.49^2)}$
$V_{d,\ main\ chord} = 0.86$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 0.86 * 5$
$M_{d,\ main\ chord} = 4.30$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 4.75 / 4 + 1.99 / 2 / 0.239 + 3.13 / 2 / 0.239$
$N_{d,\ main\ chord} = 11.90$ kN

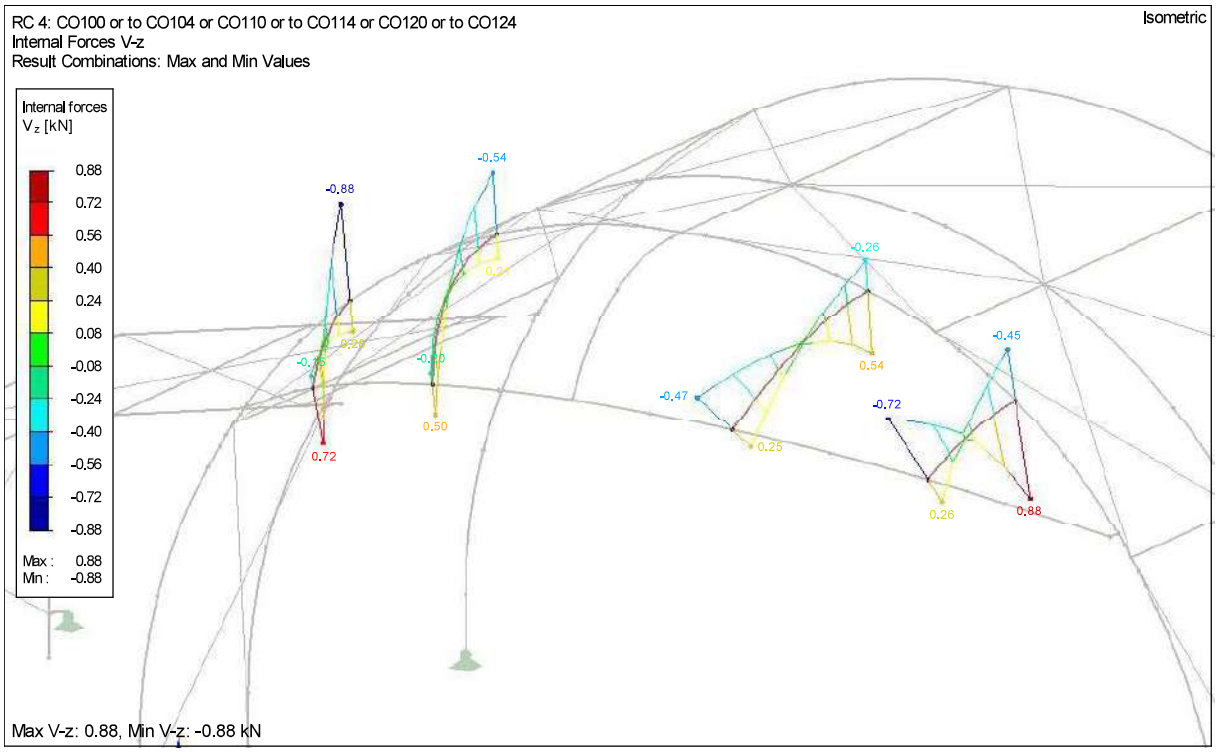
Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

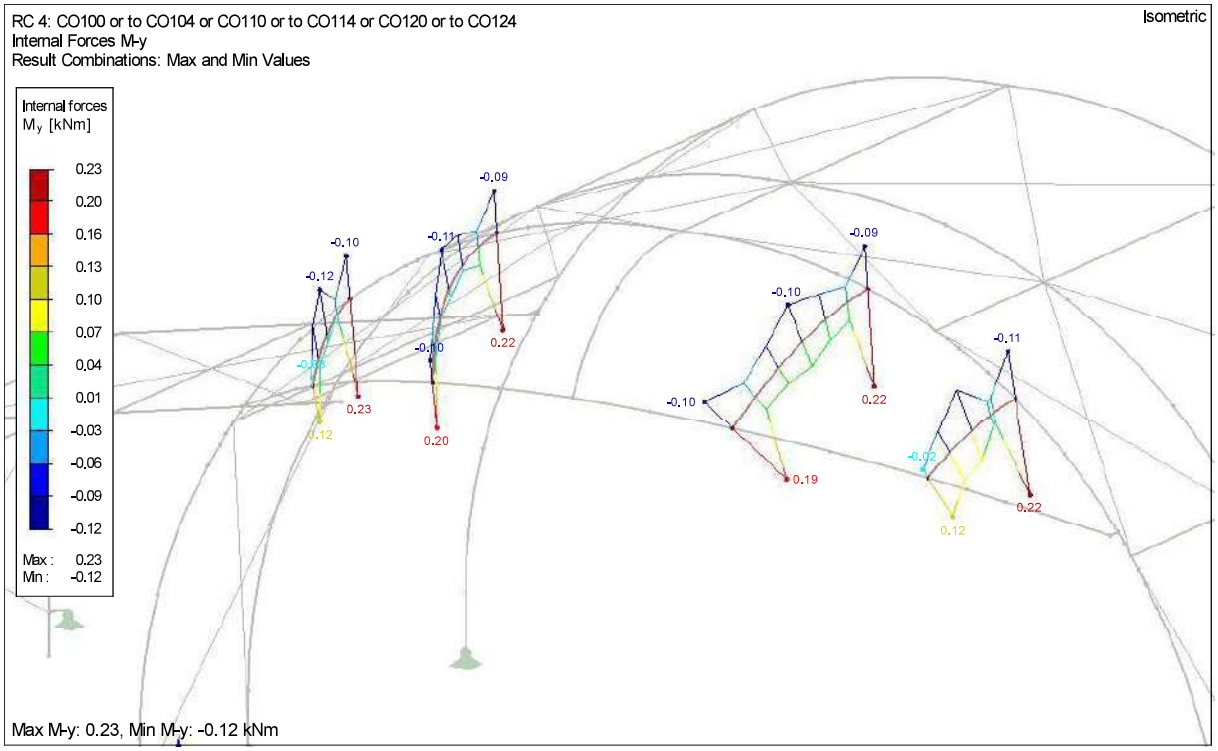
$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (11.90 / 50.914)^{1.3} + ((4.30 / 53.19)^{1.7})^{0.6} = 0.23 < 1$

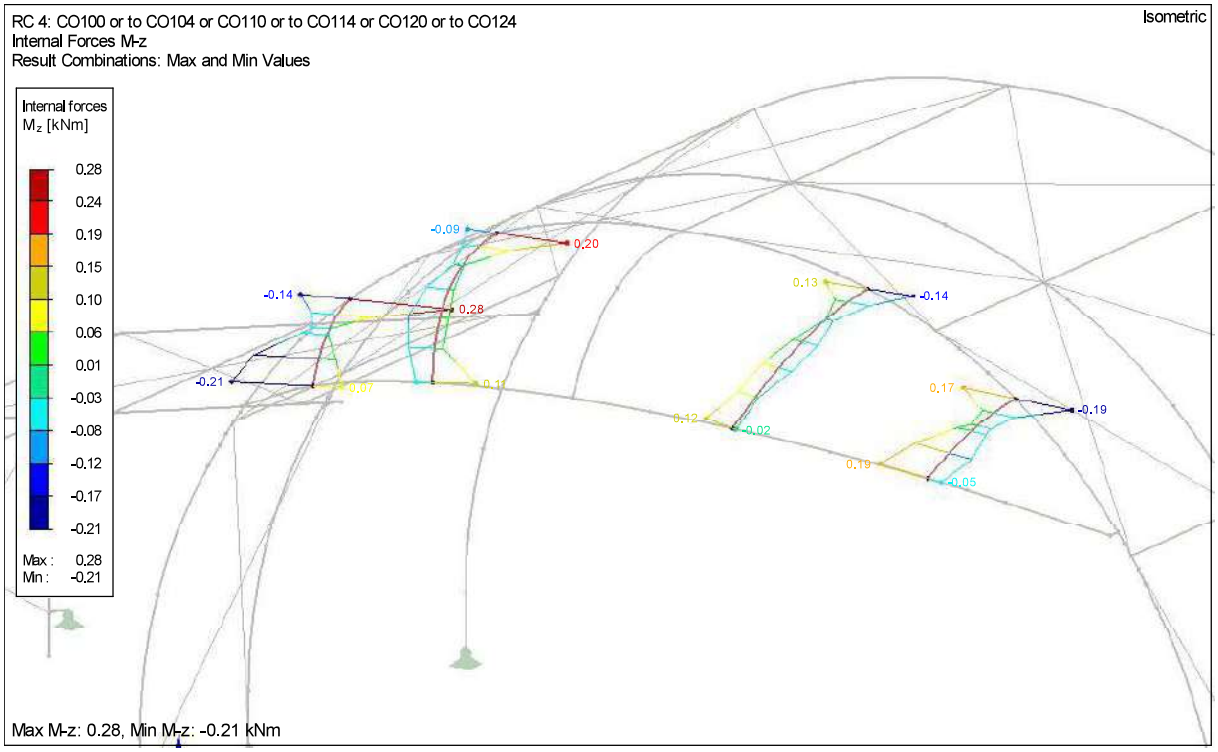
4.3.7 Internal forces 50x4 support tubes RC4 Design Values Out-service.






RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
0.88
0.72
0.56
0.40
0.24
0.08
-0.08
-0.24
-0.40
-0.56
-0.72
-0.88
Max: 0.88
Min: -0.88
Max V-z: 0.88, Min V-z: -0.88 kN


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
0.23
0.20
0.16
0.13
0.10
0.07
0.04
0.01
-0.03
-0.06
-0.09
-0.12
Max: 0.23
Min: -0.12
Max M-y: 0.23, Min M-y: -0.12 kNm



4.3.8 stress analyse for tube 50x4 with the Maximum values in RC4 Design values.

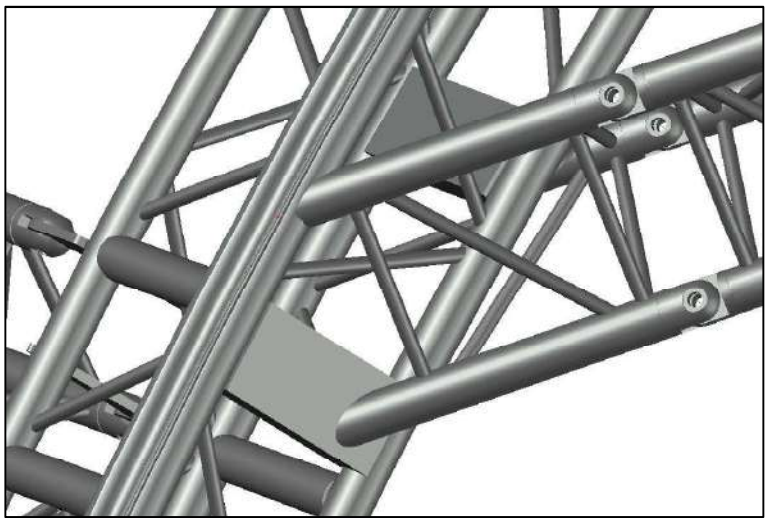
Round Tube 50x4 mm profile
Material EN-AW-6082 T6 $f_{y,haz} = 12.5$ kN/cm²

$A = 5.78$ cm
$A_{shear} = 2.93$ cm
$I = 15.41$ cm^4
$W = 6.16$ cm^4

$N_{ed,\,max} = 3.01$ kN
$V_{y,\,ed\,max} = 0.62$ kN
$V_{z,\,ed\,max} = 0.88$ kN
$M_{y,\,ed\,max} = 0.23$ kNm
$M_{z,\,ed\,max} = 0.28$ kNm

Calculation
$\sigma_n = N_{ed,\,max} / A = 3.01 / 5.78 = 0.52$ kN/cm²
$\sigma_{vy} = V_{y,\,ed\,max} / A_{shear} = 0.62 / 2.93 = 0.21$ kN/cm²
$\sigma_{vz} = V_{z,\,ed\,max} / A_{shear} = 0.88 / 2.93 = 0.30$ kN/cm²
$\sigma_{my} = M_{y,\,ed\,max} / (W) = 23 / 6.16 = 3.73$ kN/cm²
$\sigma_{mz} = M_{z,\,ed\,max} / (W) = 28 / 6.16 = 4.54$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.52 + 3.73 + 4.54)^2 + 3*(0.21 + 0.30)^2)}$
$\sigma_{tot} = 8.83$ kN/cm²
check $\sigma_{tot} / (f_{y,haz} / \gamma_m) < 1$
$8.83 / (12.5 / 1.25) = 0.88 < 1$

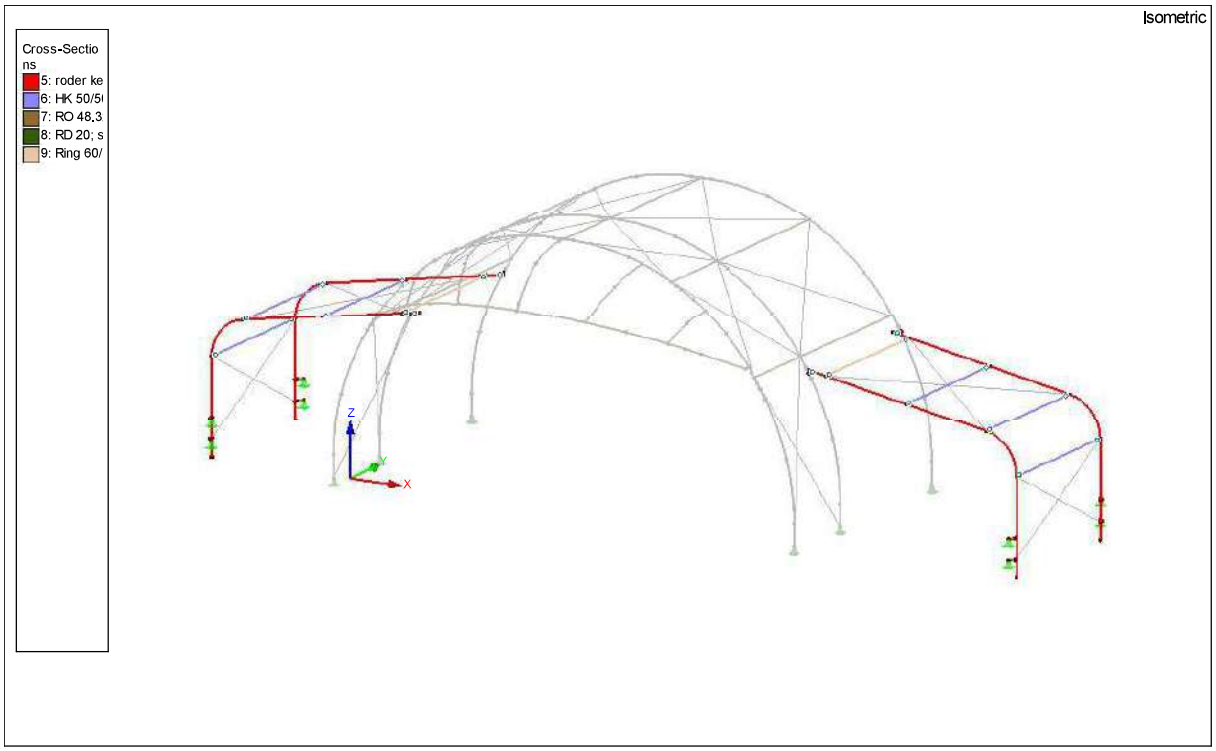
4.3.9 Attachment of the cantilever to the main arch.



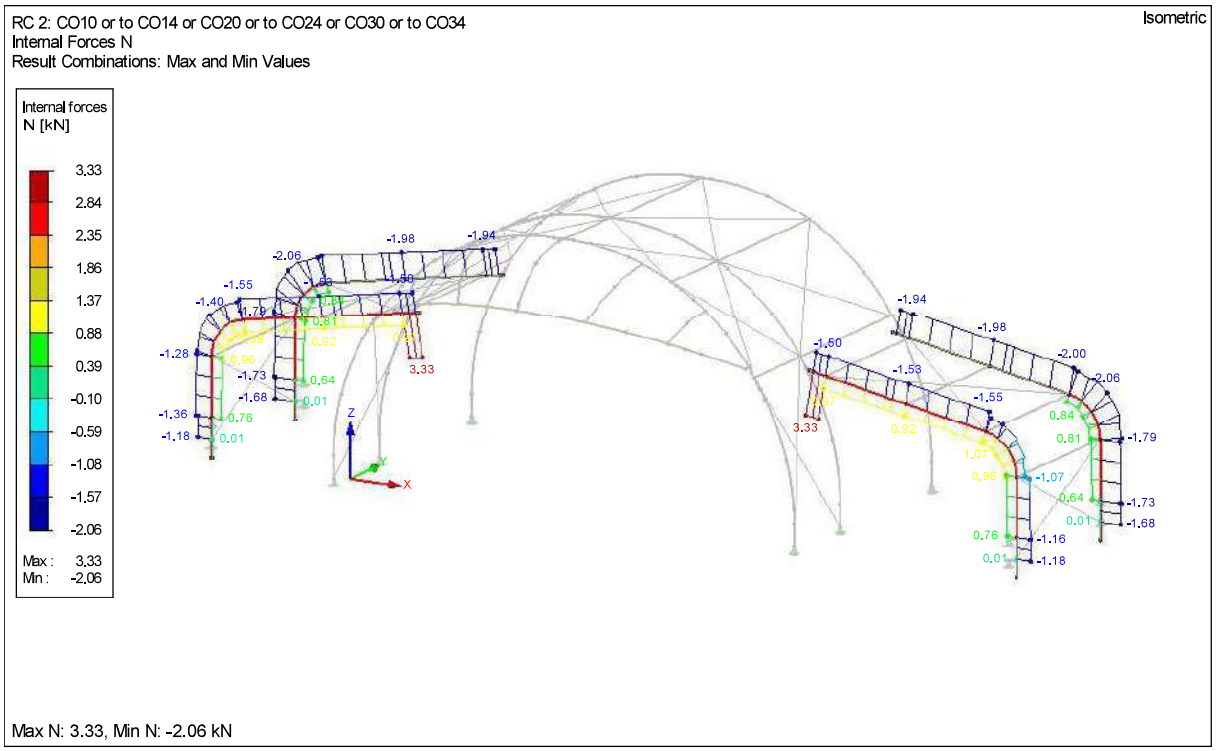
A short piece of truss is welded on 2 pieces of 100x50x4 rectangular profile which are welded into the main arch. The third main tube is welded to the main tube of the arch.

Maximum utilisation of the T31 truss 64% which occurs in the middle of the arch no further proof necessary.

4.4 Detail check of the side stage areas.

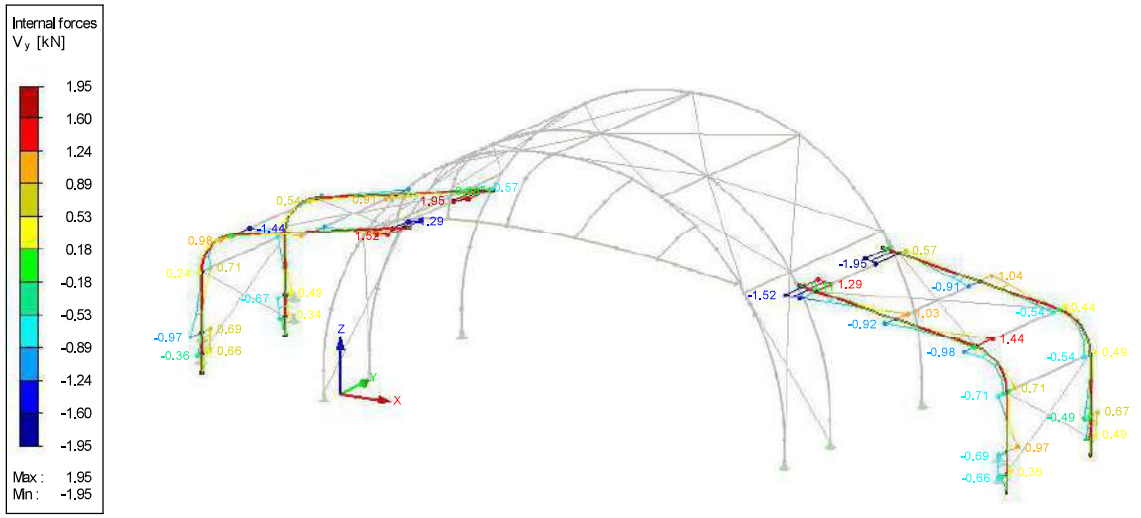


4.4.1 Internal forces of the keder profiles in RC2 Design Values In-service.



RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-y
Result Combinations: Max and Min Values

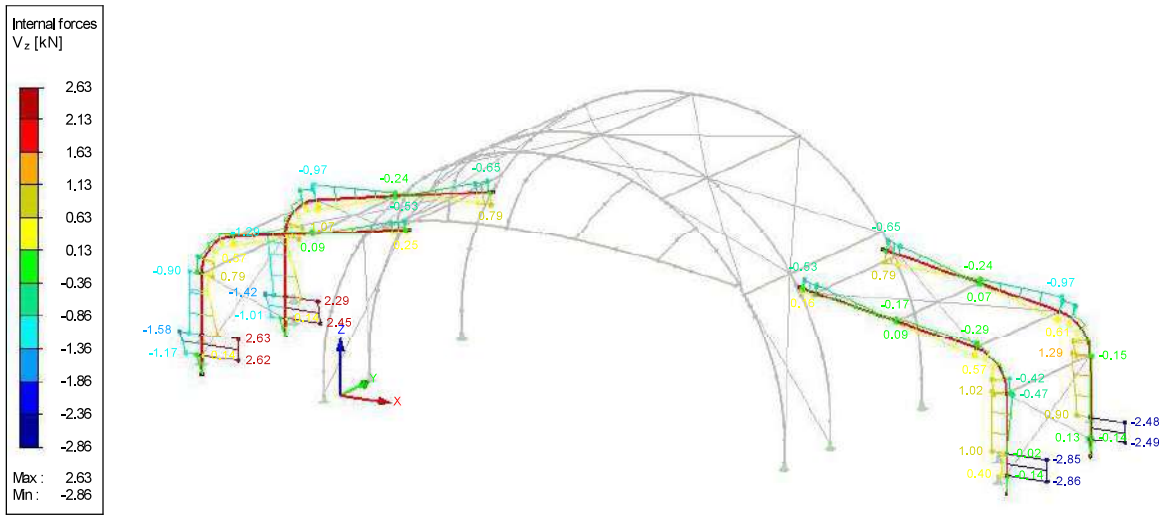
Isometric



Max V-y: 1.95, Min V-y: -1.95 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

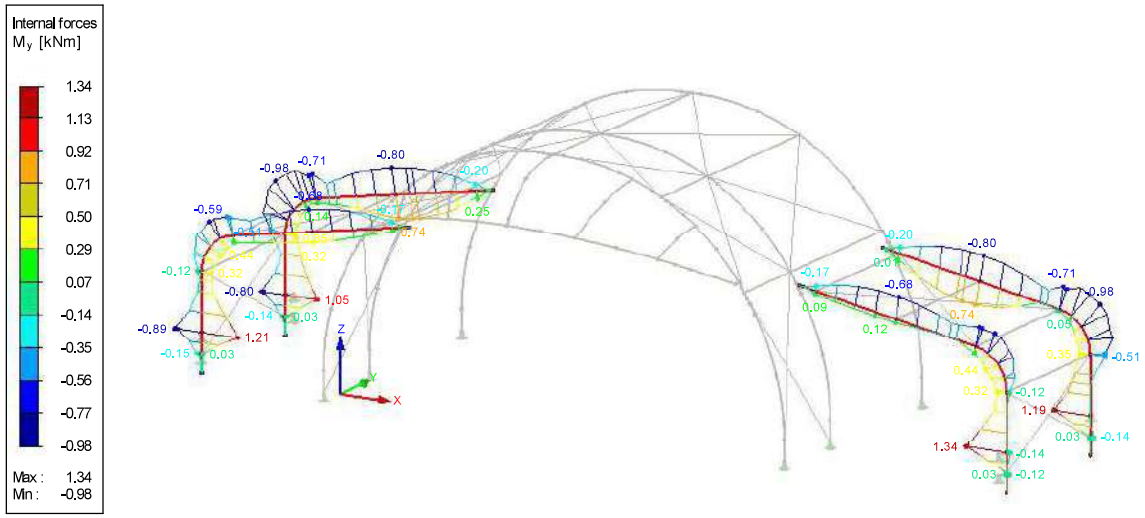
Isometric



Max V-z: 2.63, Min V-z: -2.86 kN

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

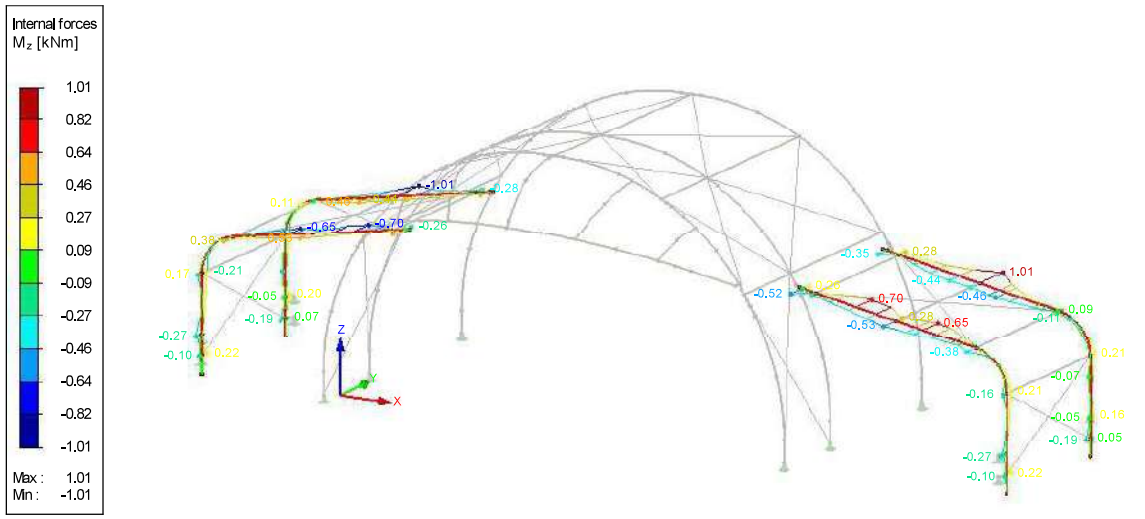
Isometric



Max M-y: 1.34, Min M-y: -0.98 kNm

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

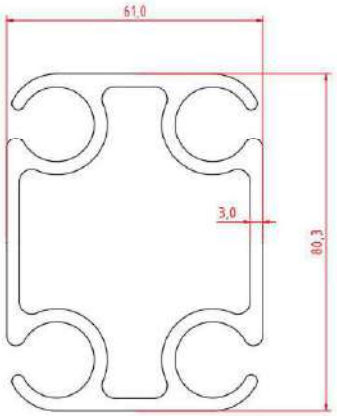
Isometric



Max M-z: 1.01, Min M-z: -1.01 kNm

4.4.2 Check of the keder profiles with the RC2- Design values.

Stress calculation for the keder profiles



keder profile 80x61x3	
I_1 [mm^4]	934003
I_2 [mm^4]	497649
S_c [mm]	40.14
S_t [mm]	40.14
A [mm^2]	1194.632

Keder Profile 80x61x3
Material = EN-AW-6061 T6
f_o = 24 kN/cm²

The stress analyse has been done with the maximum values from RC2

$N_{ed,\ max}$ = 3.33 kN
$V_{y,\ ed\ max}$ = 1.95 kN
$Vz_{,\ ed\ max}$ = 2.86 kN
$M_{y,\ ed\ max}$ = 1.34 kNm
$M_{z,\ ed\ max}$ = 1.01 kNm

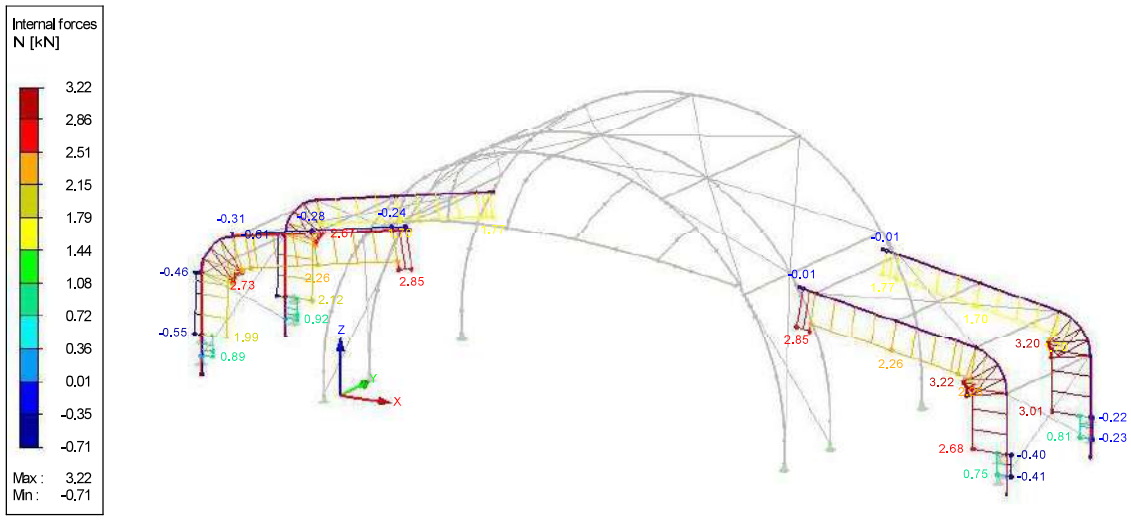
Calculation
$\sigma_n = N_{ed,\ max} / A = 3.33 / 11.94 = 0.36$ kN/cm²
$\sigma_{vy} = V_{y,\ ed\ max} / A = 1.95 / 11.94 = 0.210$ kN/cm²
$\sigma_{vz} = V_{z,\ ed\ max} / A = 2.86 / 11.94 = 0.322$ kN/cm²
$\sigma_{my} = M_{y,\ ed\ max} / (I_y / e) = 134 / (93.4 / 4) = 5.74$ kN/cm²
$\sigma_{mz} = M_{z,\ ed\ max} / (I_z / e) = 101 / (49.8 / 3) = 6.07$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.36 + 5.74 + 6.07)^2 + 3 * (0.210 + 0.322)^2)}$
σ_{tot} =12.47 kN/cm²

check $\sigma_{tot} / (f_0 / \gamma_m) < 1$
$12.47 / (24 / 1.1) = 0.57 < 1$

4.4.3 Internal forces of the keder profiles in RC4 Design Values Out-service.

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces N
Result Combinations: Max and Min Values

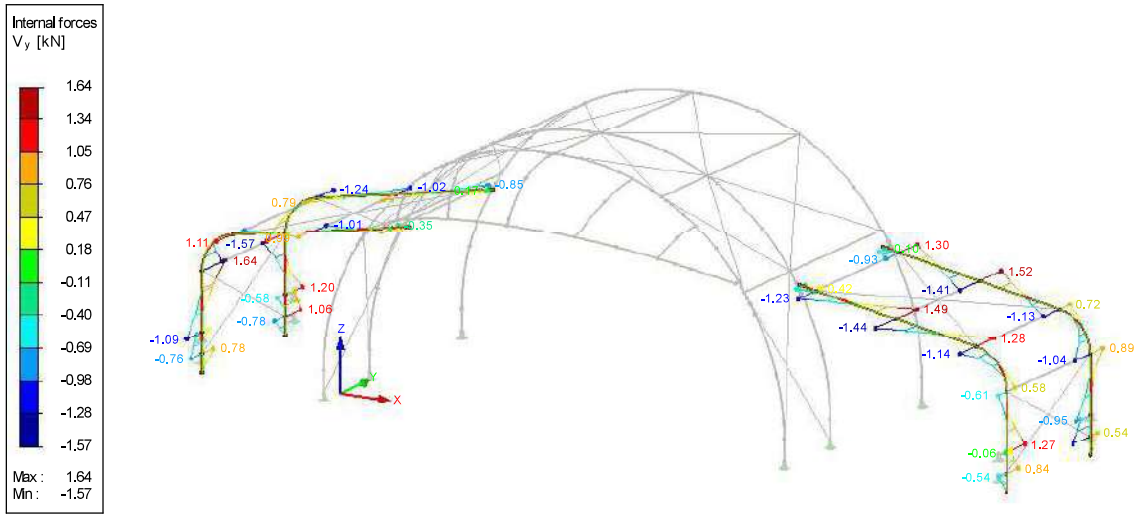
Isometric



Max N: 3.22, Min N: -0.71 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

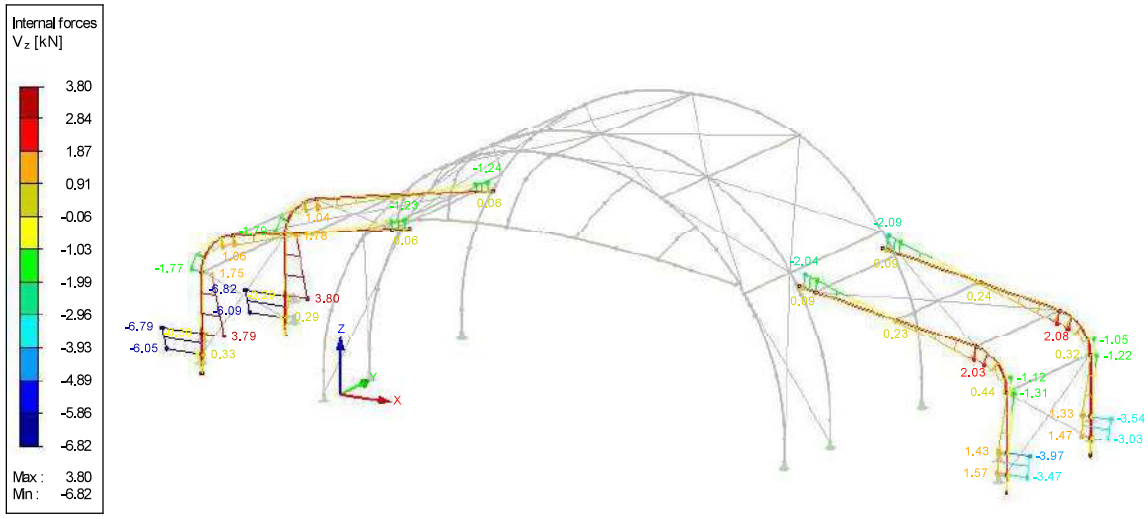
Isometric



Max V-y: 1.64, Min V-y: -1.57 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

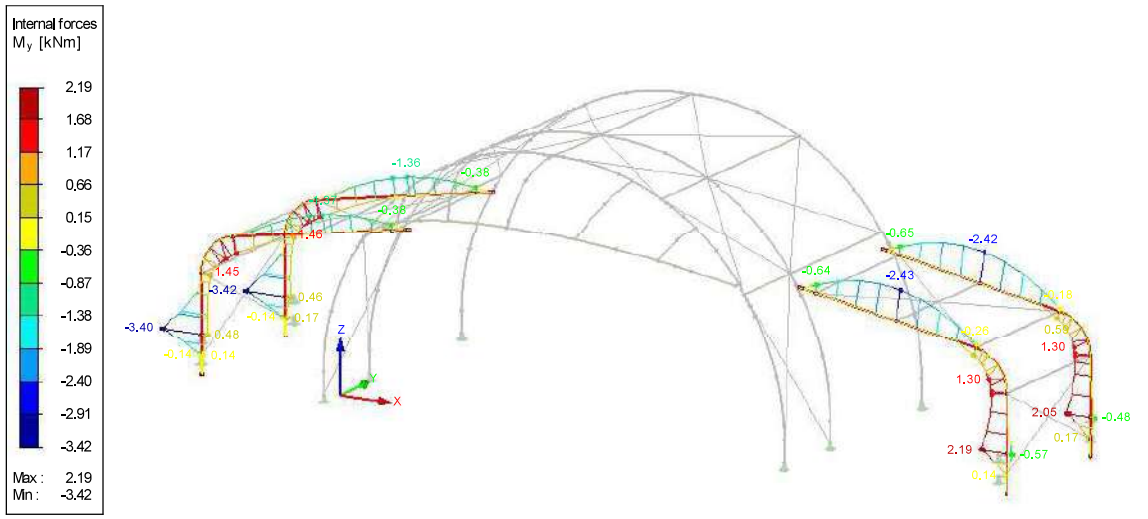
Isometric



Max V-z: 3.80, Min V-z: -6.82 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

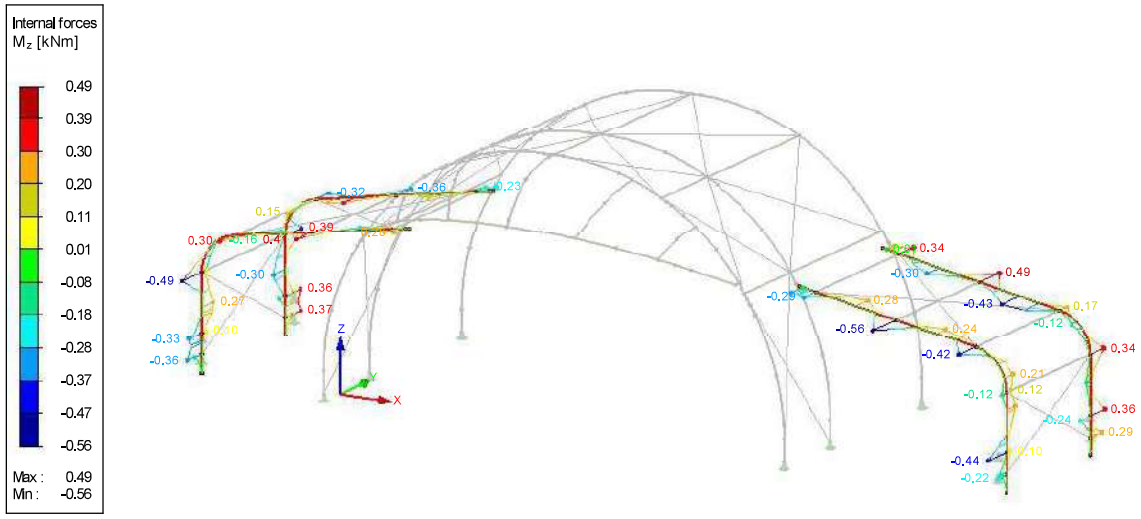
Isometric



Max M-y: 2.19, Min M-y: -3.42 kNm

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values

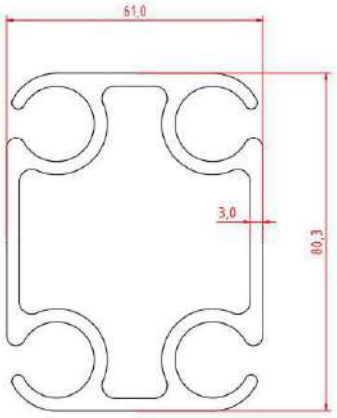
Isometric



Max M-z: 0.49, Min M-z: -0.56 kNm

4.4.4 Check of the keder profiles with the RC4- Design values.

Stress calculation for the keder profiles



keder profile 80x61x3	
I_1 [mm^4]	934003
I_2 [mm^4]	497649
S_c [mm]	40.14
S_t [mm]	40.14
A [mm^2]	1194.632

Keder Profile 80x61x3
Material = EN-AW-6061 T6
f_o = 24 kN/cm²

The stress analyse has been done with the maximum values from RC4

$N_{ed,\ max}$ = 3.22 kN
$V_{y,\ ed\ max}$ = 1.64 kN
$Vz_{,\ ed\ max}$ = 6.82 kN
$M_{y,\ ed\ max}$ = 3.42 kNm
$M_{z,\ ed\ max}$ = 0.56 kNm

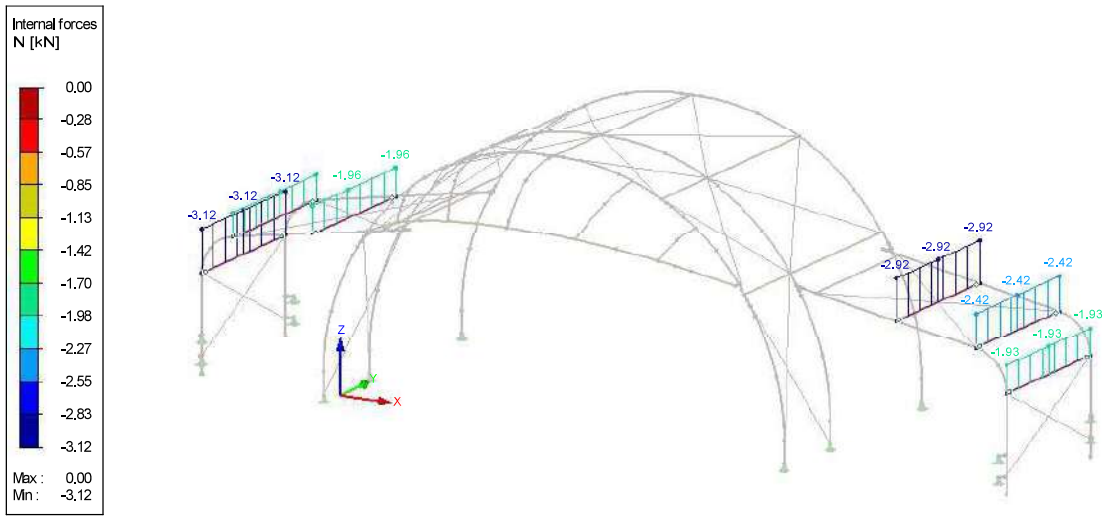
Calculation
$\sigma_n = N_{ed,\ max} / A = 3.22 / 11.94 = 0.346$ kN/cm²
$\sigma_{vy} = V_{y,\ ed\ max} / A = 1.64 / 11.94 = 0.177$ kN/cm²
$\sigma_{vz} = V_{z,\ ed\ max} / A = 6.82 / 11.94 = 0.735$ kN/cm²
$\sigma_{my} = M_{y,\ ed\ max} / (I_y / e) = 342 / (93.4 / 4) = 14.66$ kN/cm²
$\sigma_{mz} = M_{z,\ ed\ max} / (I_z / e) = 56 / (49.8 / 3) = 3.367$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.346 + 14.66 + 3.367)^2 + 3 * (0.177 + 0.735)^2)}$
σ_{tot} =18.9 kN/cm²

check $\sigma_{tot} / (f_0 / \gamma_m) < 1$
$18.9 / (24 / 1.1) = 0.87 < 1$

4.4.5 Internal forces of the square profiles in RC4 Design Values Out-service.

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces N
Result Combinations: Max and Min Values

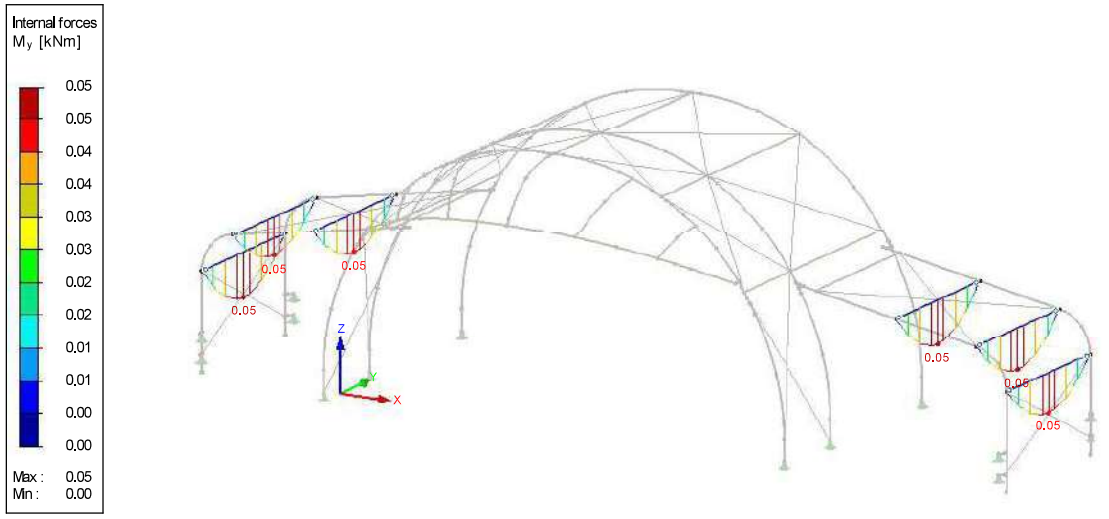
Isometric



Max N: 0.00, Min N: -3.12 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

Isometric

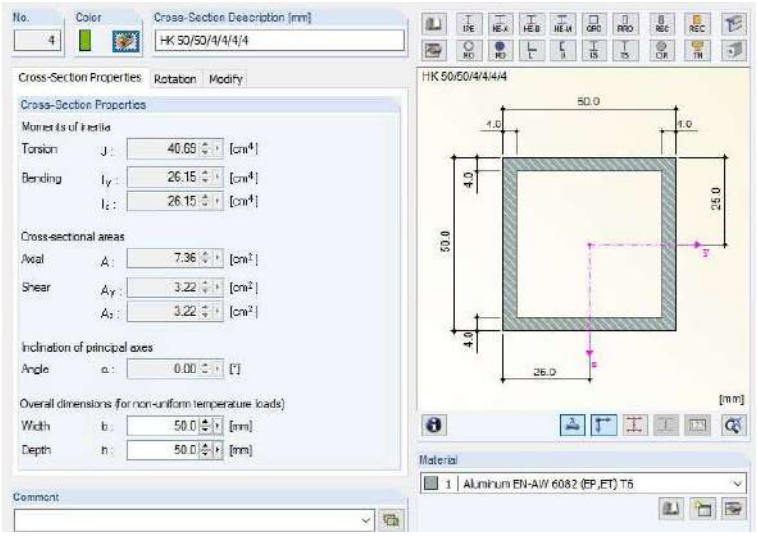


Max M-y: 0.05, Min M-y: 0.00 kNm

4.4.6 Check of the square profiles with the maximum RC4 Design Values Out-service.

Decisive result combination RC4 Design Values Out-service situation

Profile information pressure bar.



Buckling calculation

N = 3.13 kN
M_y ~ 0 kNm
M_z = 0 kNm

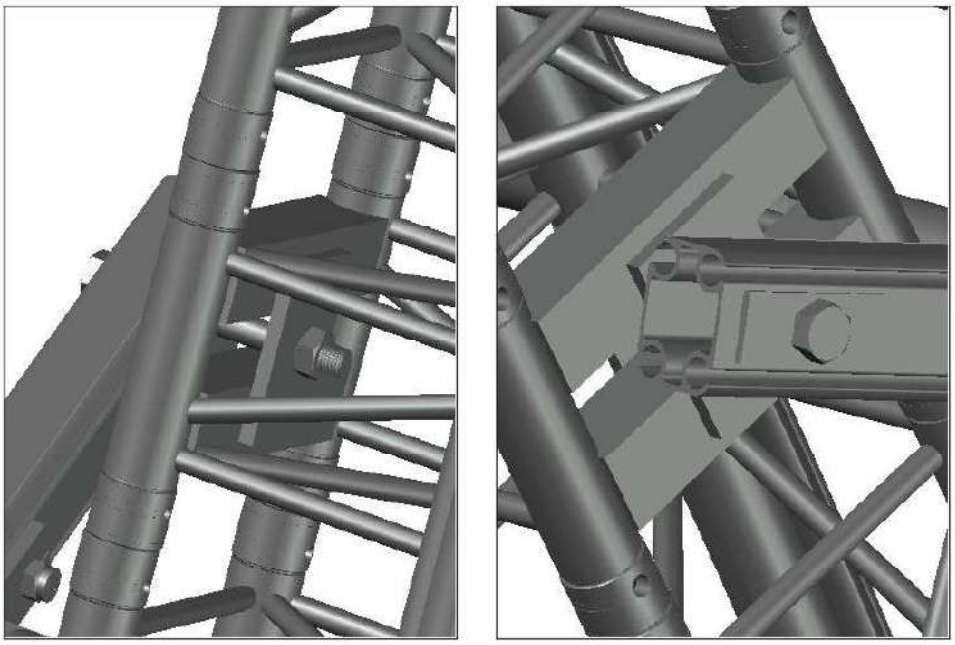
Buckling length factor K = 1.50
The factor K is according to table 6,8 NEN-EN 1999-1-1
L = 377 cm
L_{cr} = 1.5 * 377 = 565.50
$I_y = \sqrt{(I_y / A)} = \sqrt{(10.46 / 7.36)} = 1.89$
$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$
$\lambda_z = 565.50 / (1.89 * \pi) * \sqrt{((7.36 * 25) / (7.36 * 7000))} = 5.71$
$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$
$\Theta_z = 0.5 * (1 + 0.2 * (5.71 - 0.10) + 1.55^2) = 17.36$
$X_z = 1 / (\Theta_z + \sqrt{(\Theta_z^2 - \lambda_z^2)})$
$X_z = 1 / (17.36 + \sqrt{(17.36^2 - 5.71^2)}) = 0.03$

$N_{b,RD} = X_z * A * f_0 / 1.1 = 0.03 * 7.36 * 25 / 1.1 = 4.96$ kN

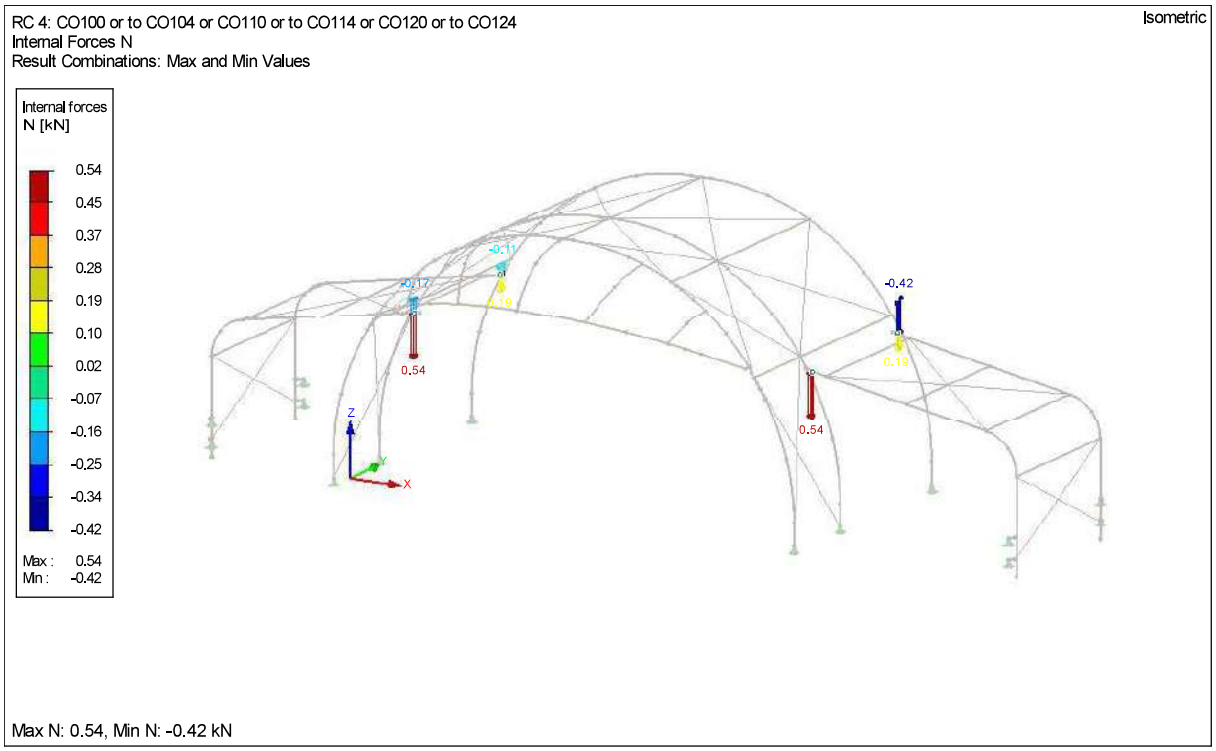
$N / N_{b,RD} < 1$
$3.13 / 4.96 = 0.63 < 1$

4.4.7 Check of the side stage attachment to the main roof.

The connection between the side stage area profiles and the main arches is made by M20 bolts. The bolt is going through the keder profile which is reinforced by two pieces of flat material 40x5 and two pieces of flat material 80x10 which are welded in the 25-meter S31 truss piece of the main arch. The M20 bolt is class 8.8 and the pieces of flat material are EN-AW-6082 T6.

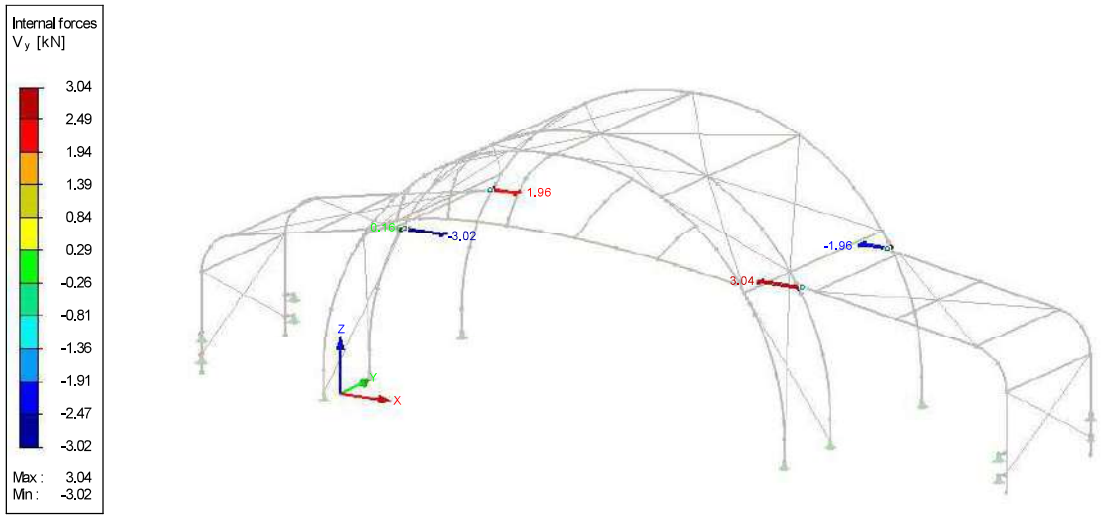


Internal forces of the decisive result combination RC4 design values Out-service



RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

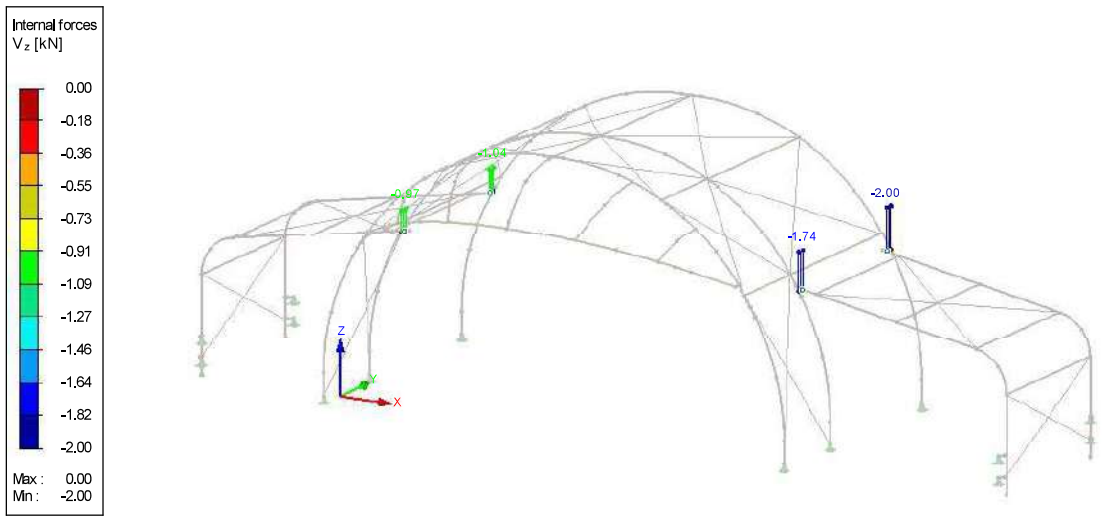
Isometric



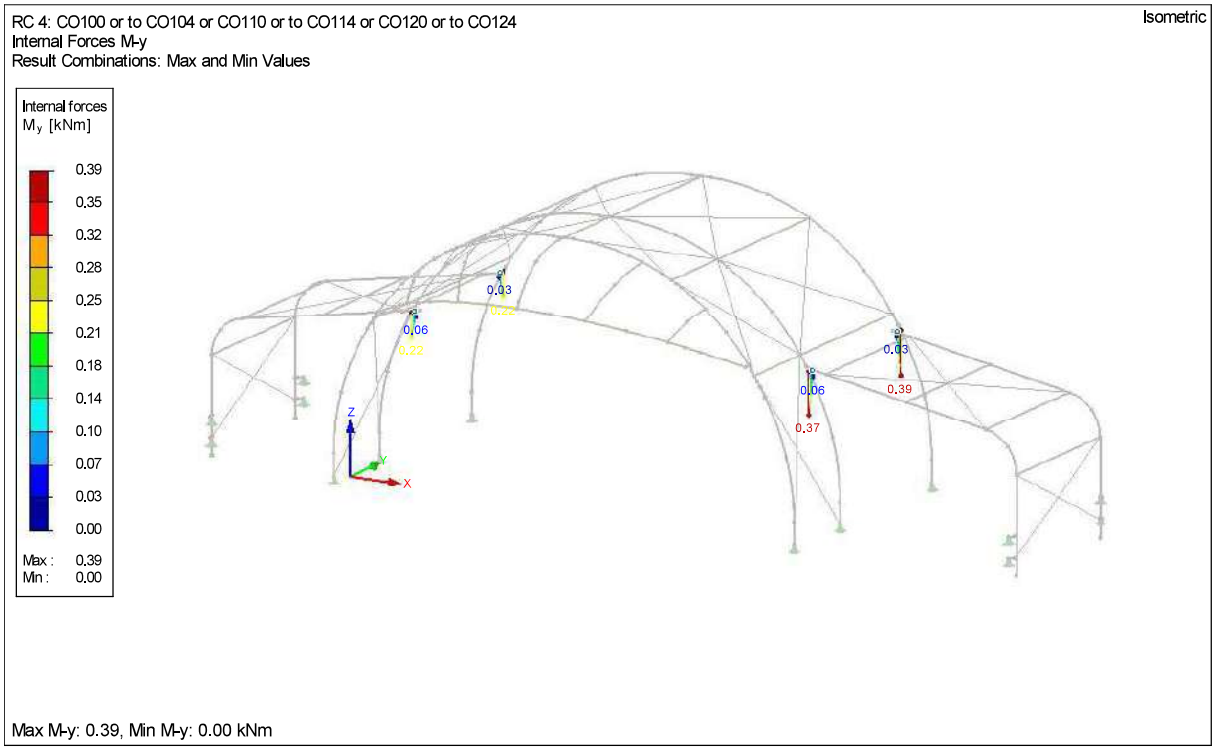
Max V-y: 3.04, Min V-y: -3.02 kN

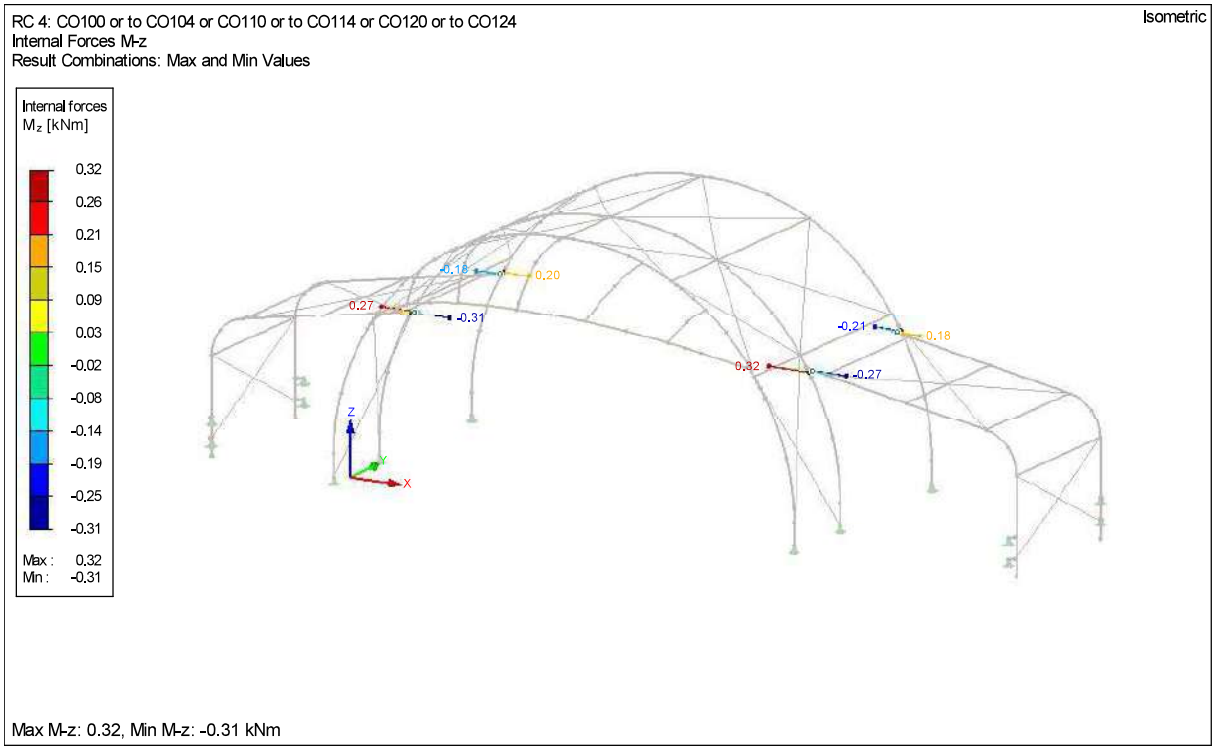
RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

Isometric



Max V-z: 0.00, Min V-z: -2.00 kN





Maximum allowable force for the M20 bolt
Maximum tension force = 141.1 kN
Maximum shear force in wire thread = 94.1 kN

Due to the low maximum design forces, no further proof necessary of the M20 bolt.

Check of the bearing forces in the holes of flat material. This check will be done with the plates which are welded on the Keder profile. This is the weakest spot.

Profile Information
Material EN-AW 6082 T6
f_u 24 kN/cm²
$f_{u,haz}$ 12.5 kN/cm²

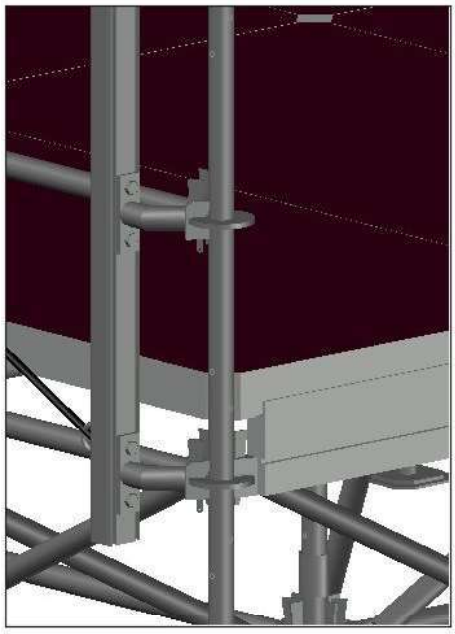
T = 5 mm
D = 21 mm

Maximum shear force in the bolt $F_{b,Ed} = \sqrt{(3.04^2 + 2.00^2)} = 3.63$ kN

$F_{b,Rd} = 1.5 * f_{u,haz} * D * T / \gamma_{m2} = 1.5 * 12.5 * 2.1 * 0.5 / 1.25 = 15.75$ kN
$F_{b,Ed} / F_{b,Rd} < 1$
$3.63 / 15.75 = 0.23 < 1.0$

4.4.8 Check of the side stage attachment to the Layher stage.

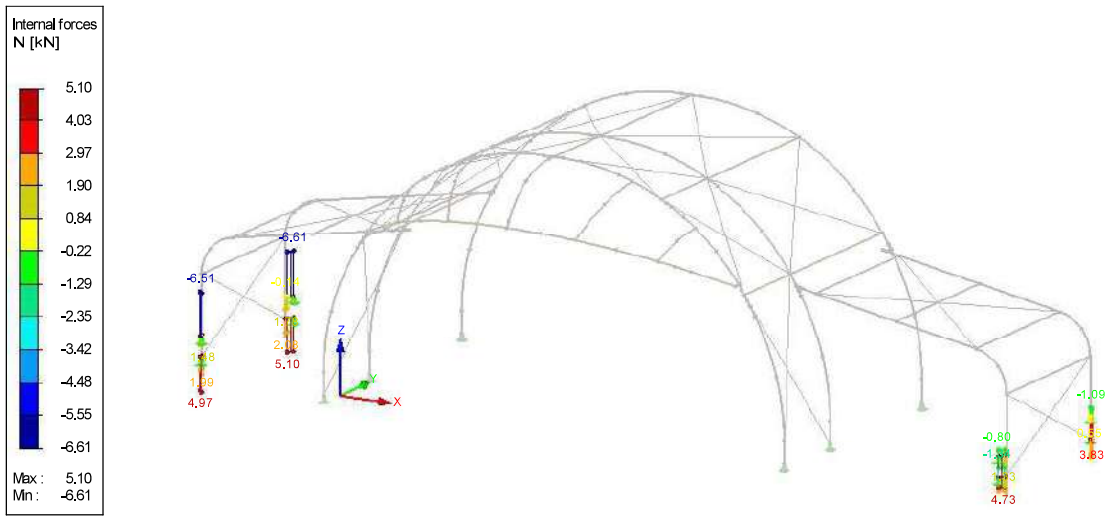
The connection of the Keder profile to the Layher stage is made by two special designed adapters. These adapters have a Layher wedge coupling welded to the end which is mounted on the Layher rosette. The bottom adapter is mounted on the same level as the Layher event deck to spread the load inside the Layher stage. The second adapter is mounted 1rosette higher to stabilize the profiles.



Internal forces of the decisive result combination RC4 design values Out-service.

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces N
Result Combinations: Max and Min Values

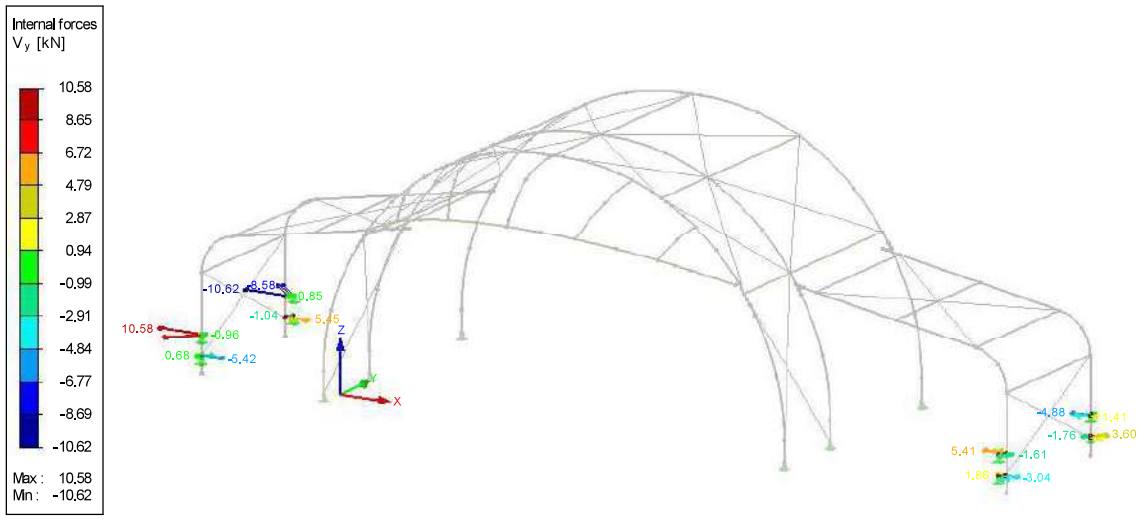
Isometric



Max N: 5.10, Min N: -6.61 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

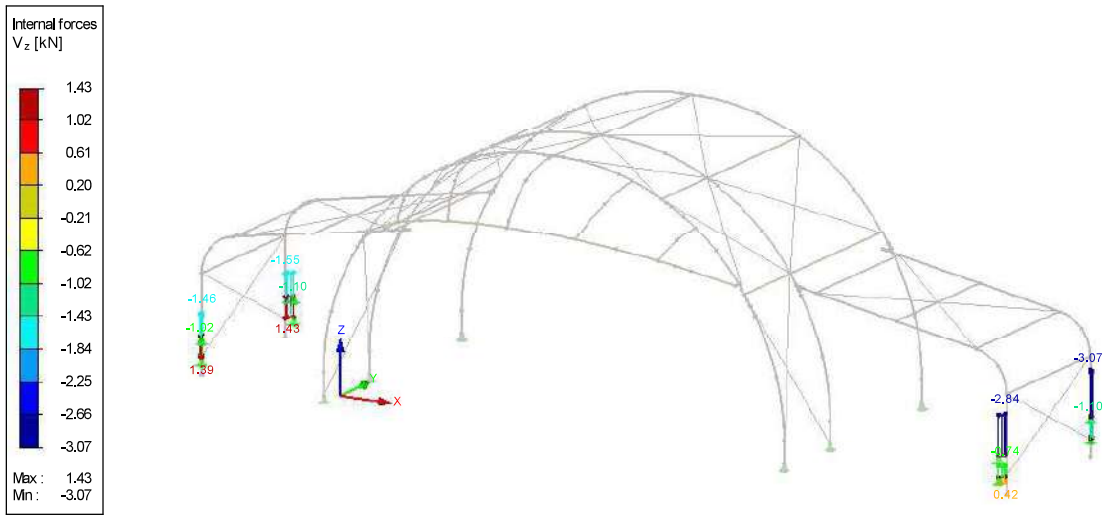
Isometric



Max V-y: 10.58, Min V-y: -10.62 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

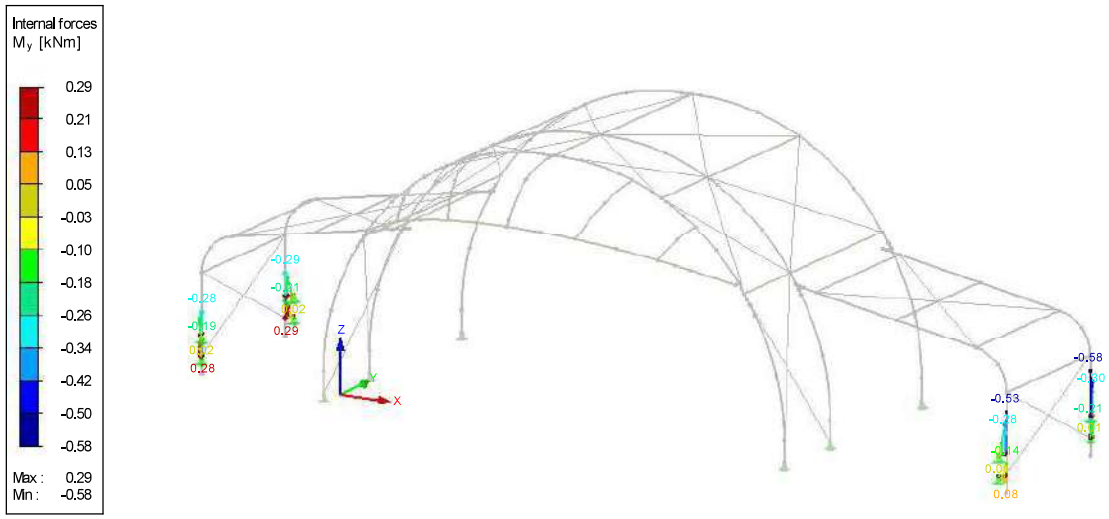
Isometric



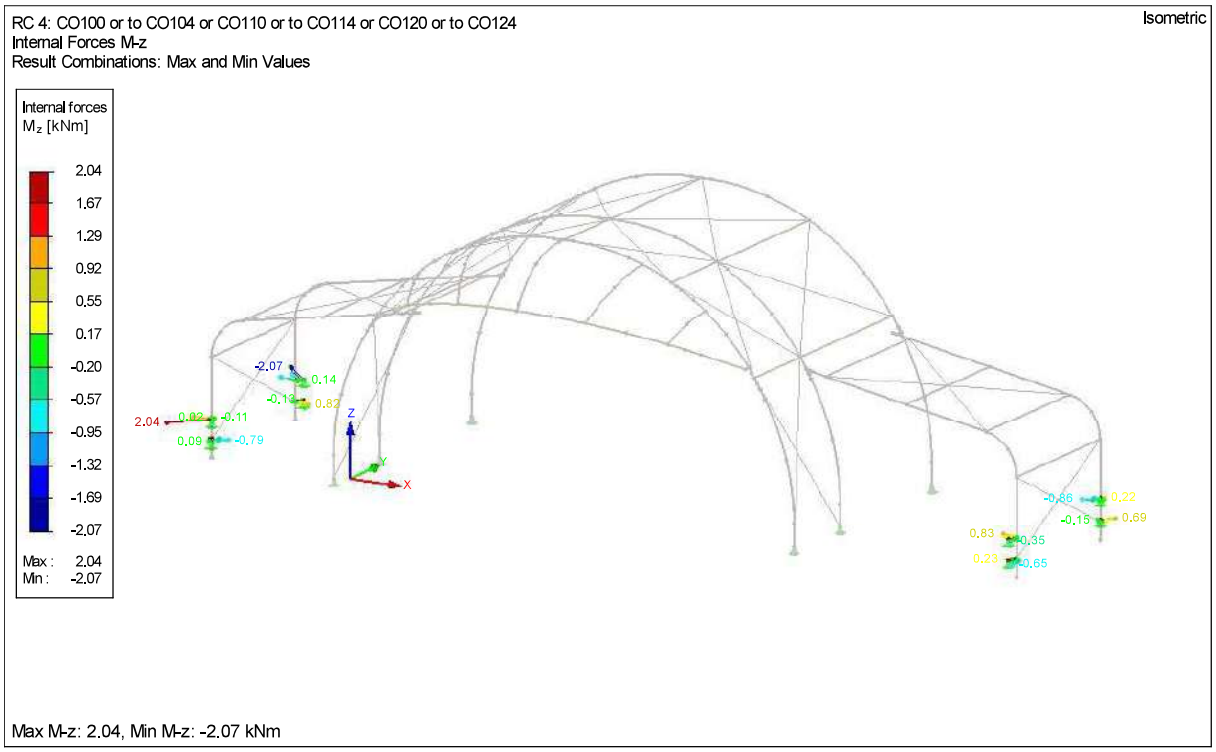
Max V-z: 1.43, Min V-z: -3.07 kN

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

Isometric



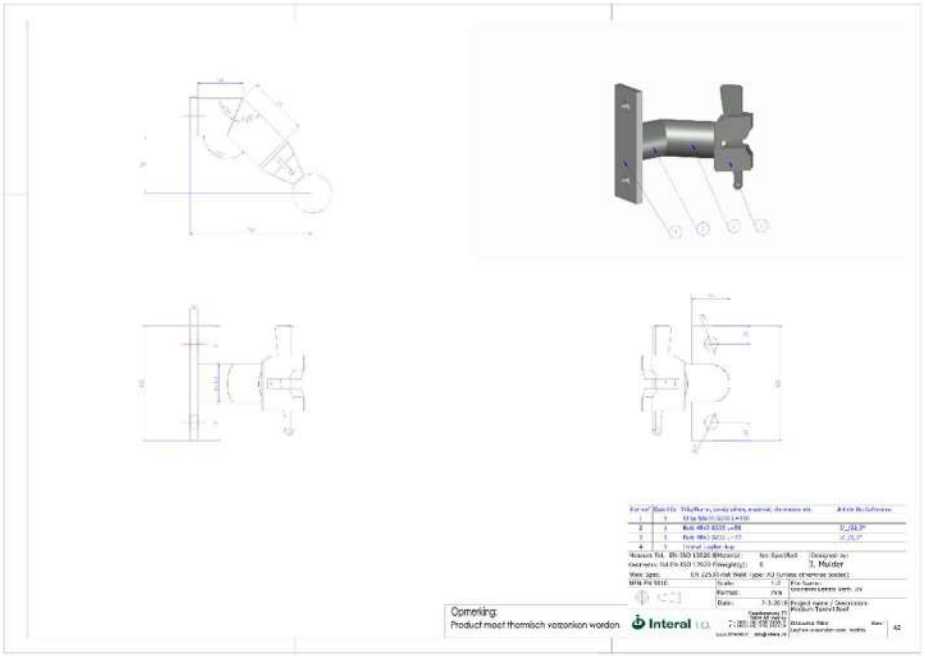
Max M-y: 0.29, Min M-y: -0.58 kNm



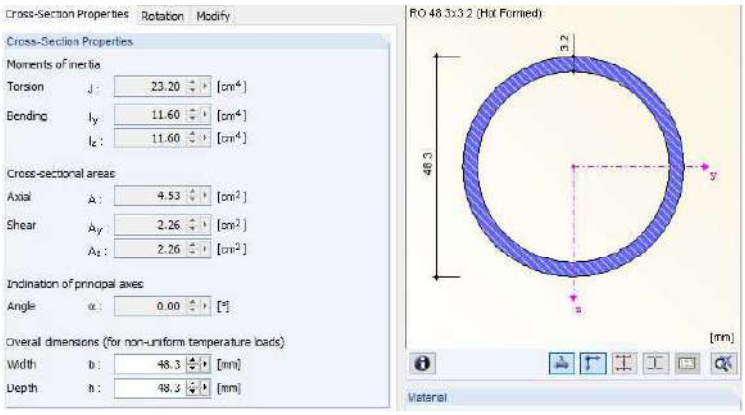
The maximum forces of the Layher parts could be find in chapter 6.

The maximum vertical shear force of the Layher Wedge coupling = 26.4 kN > 4.04 kN
The maximum horizontal shear force of the Layher Wedge coupling = 10 kN > 9.07 kN
The maximum normal force of the Layher Wedge coupling = 31 kN > 8.79 kN

Check of the round Profile.



Profile 48x3



Material S235RJ
$f_y = 23.5$ kN/cm²

$A_{nett} = 4.53$ cm²
$W_{pl} = 6.17$ cm^3

The decisive adapter is located far upstage stage right

$N_{ed,\,max} = 6.61$ kN
$V_{y,\,ed\,max} = 10.62$ kN
$Vz_{,\,ed\,max} = 1.55$ kN
$M_{y,\,ed\,max} = 0.23$ kNm
$M_{z,\,ed\,max} = 0.85$ kNm

Calculation
$\sigma_n = N_{ed,\,max} / A = 6.61 / 4.53 = 1.46$ kN/cm²
$\sigma_{vy} = V_{y,\,ed\,max} / A = 10.62 / 4.53 = 2.34$ kN/cm²
$\sigma_{vz} = V_{z,\,ed\,max} / A = 1.55 / 4.53 = 0.34$ kN/cm²
$\sigma_{my} = M_{y,\,ed\,max} / (W_{pl}) = 23 / (6.17) = 3.72$ kN/cm²
$\sigma_{mz} = M_{z,\,ed\,max} / (W_{pl}) = 85 / (6.17) = 13.77$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((1.46 + 3.72 + 13.77)^2 + 3*(2.34 + 0.34)^2)}$
$\sigma_{tot} = 20.52$ kN/cm²

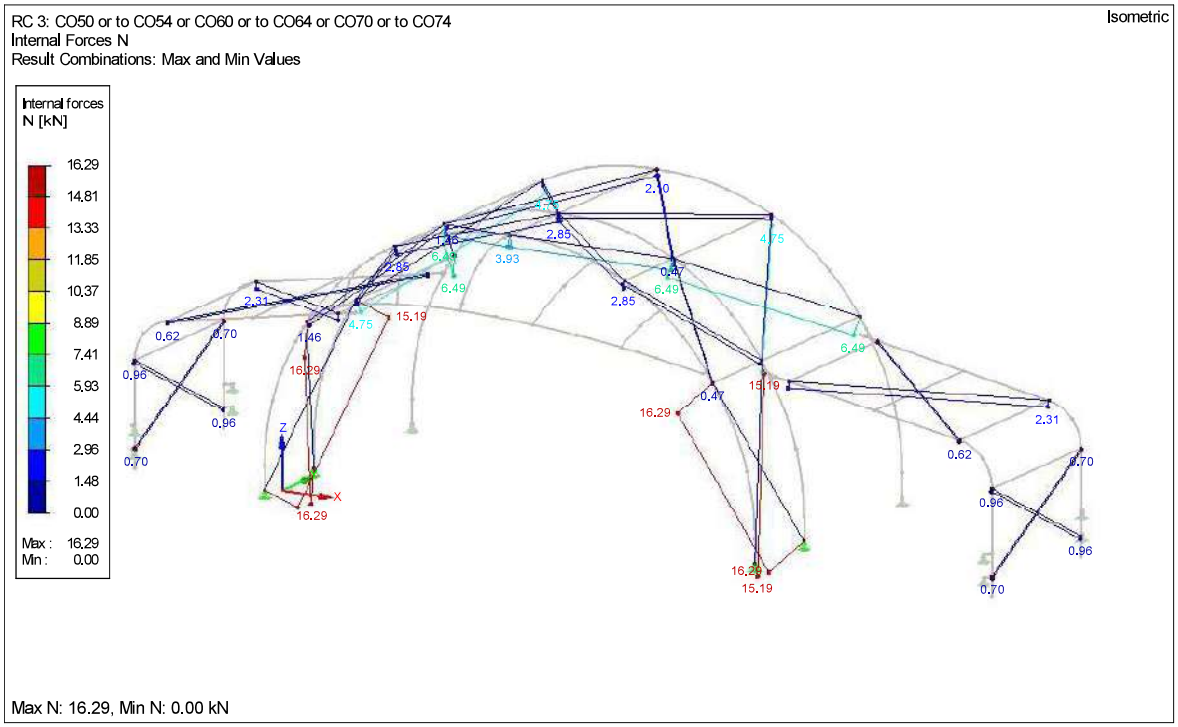
Check $\sigma_{tot} / (f_y / \gamma_m) < 1$
$20.52 / (23.5 / 1.1) = 0.96 < 1$

4.5 Check of the cross wire's.

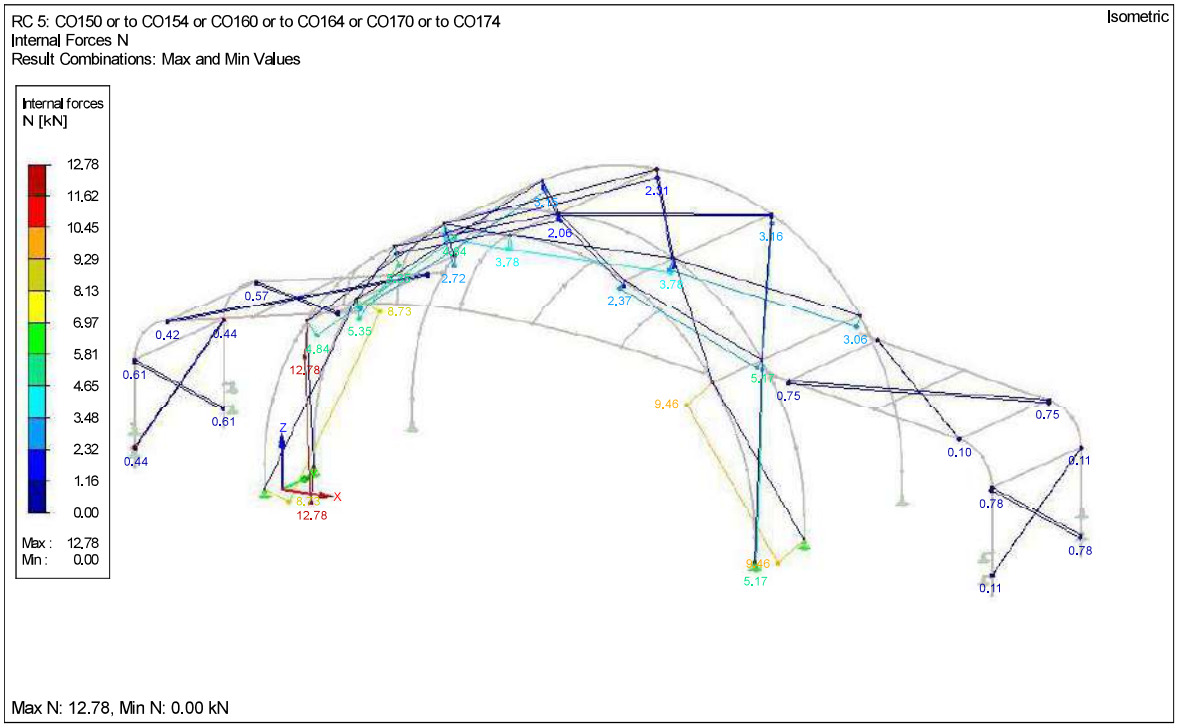
The check of the cross wire's will be done against the characteristic values of RC3 and RC5. This because the cross wires require different safety factors against breaking strength. The used components for the cross wires are ratchet straps

4.5.1 Internal forces cross wire's

Maximum normal forces in RC3: characteristic values In service



Maximum normal forces in RC5: characteristic Out service situation.



Maximum cross wire force is 16.29 kN.

For the cross wire is a safety factor required of 3.5.
The minimum breaking strength which is required is 16.29 x 3.5 = 58.07 kN

The used Ratchet strap is a 50mm ratchet strap with a LC of 25 kN.
LC = 3* breaking strength
25 * 3 / 3.5 = 21.4 kN

Check 16.29 / 21.40 = 0.76 < 1

The Ratchet straps can be replaced by any system which is suitable for these purposes.
The minimum required safety factor against breaking strength for these systems is 3.5

The connection of the steel wire to the structure is done by an M16 eye nut which is Bolted to the welded plates.

The minimum required WLL of the M16 Eye nut is 16 kN.
Check (16 * 5) / 3.5 = 22.8 kN > 16.29 kN

When only the Medium tunnel stage option 3 is build, it is necessary to install cross wires in the front and the back of the system in the Out-service wind conditions. This for the structural integrity and stability of the system. Minimum required load capacity of the cross wire is the same as all the other cross wires.

5.0 Necessary Ballast.

5.1 Ballast calculation model option 1 and 2.

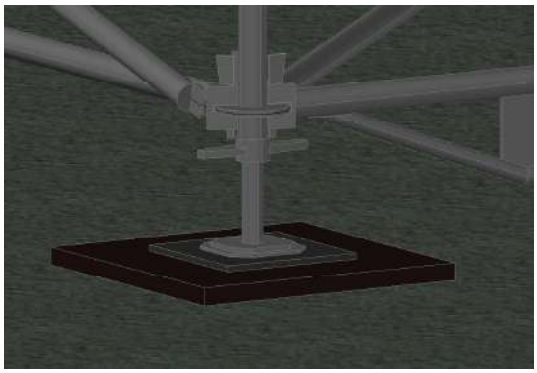
The ballast will be checked for uplift, overturning and sliding. The Layher stage which is designed as a ridged stage will be taken into account.

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

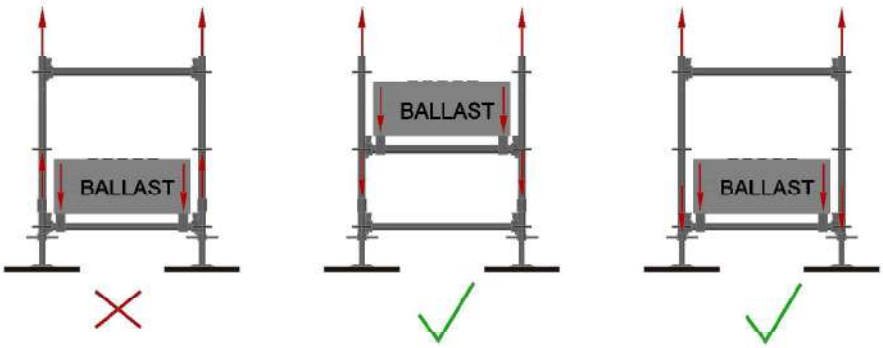
The safety factor for the ballast calculation against slipping is set to 1.2 according to the NEN-EN 13814. This is based on a horizontal load which is relying on friction.
For the friction coefficient the factor of 0.6 has been taken into account.
The Ballast calculation with factor 0.6 can be justified because rubber underlayment plate is used.

Table 3 — Coefficients of friction μ

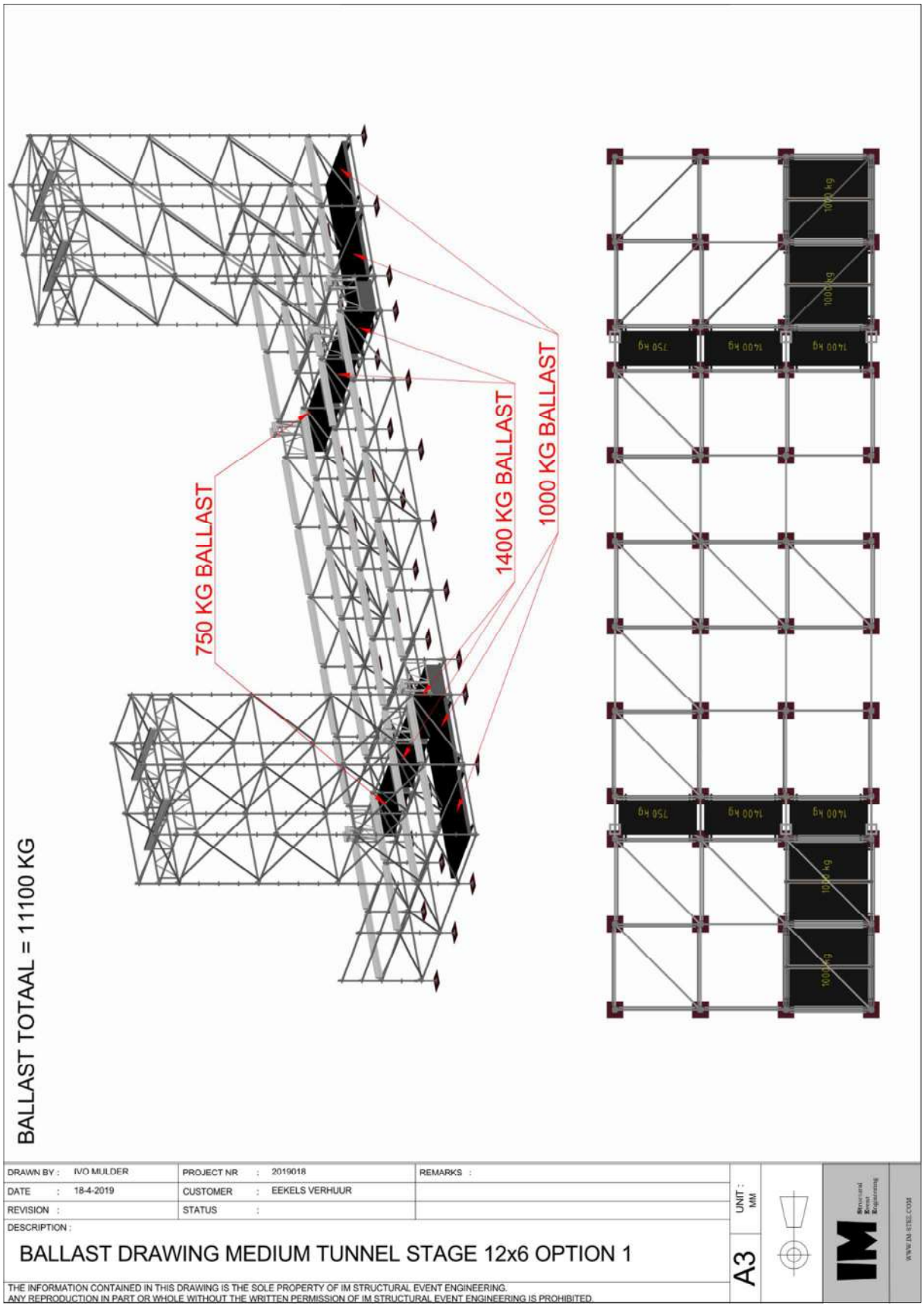
	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay[a]	0,25	0,2	0,25
Loam[a]	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65
[a] At least of stiff consistency in accordance with ENV 1997-1.			

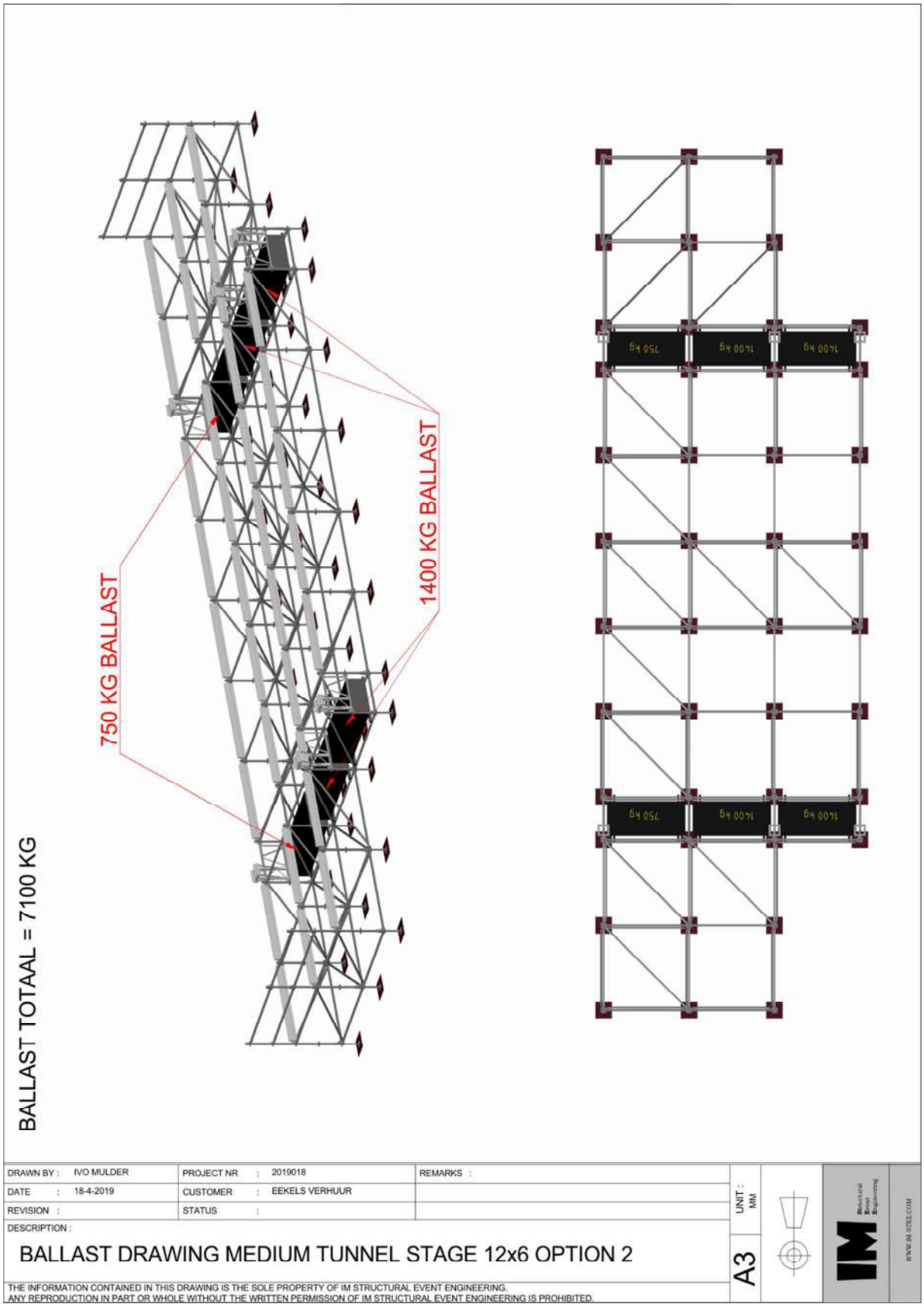


The ballast need to be placed in such a way that it will be activated when lifting forces are applied. If the ballast is placed on the bottom level the use of Layher uprights with connected base collar is necessary.



5.2 Ballast drawing model option 1 and 2.





DRAWN BY : IVO MULDER	PROJECT NR : 2019018	REMARKS :
DATE : 18-4-2019	CUSTOMER : EEKELS VERHUUR	
REVISION :	STATUS :	

DESCRIPTION :

BALLAST DRAWING MEDIUM TUNNEL STAGE 12x6 OPTION 2

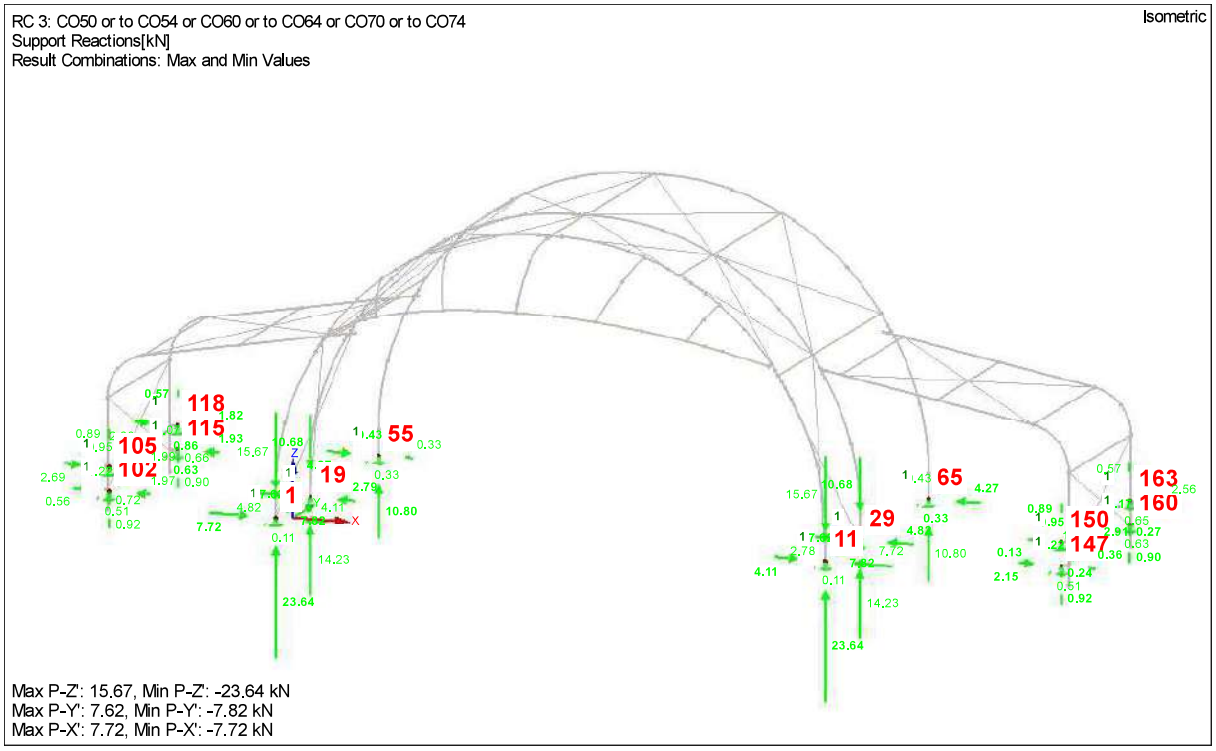
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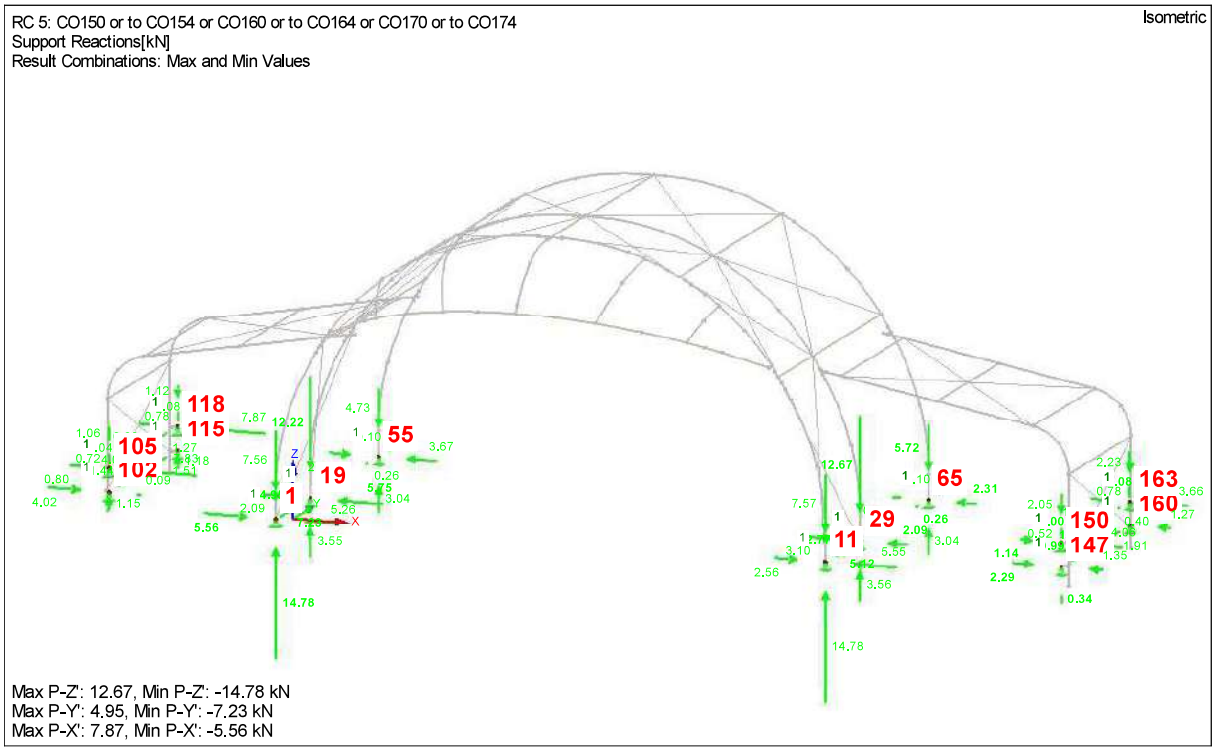
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5.3 Ballast calculation against uplift.

Reaction forces RC3 In-service situation



Reaction forces RC5 Out service situation



Maximum and minimum reaction forces in RC3 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	4,11	7,62	15,67	0,00	0,00	0,16
	Min	-7,72	-0,11	-23,64	0,00	0,00	-0,17
11	Max	7,72	7,62	15,67	0,00	0,00	0,17
	Min	-4,11	-0,11	-23,64	0,00	0,00	-0,16
19	Max	2,79	0,00	10,68	0,00	0,00	0,18
	Min	-4,82	-7,82	-14,23	0,00	0,00	-0,02
29	Max	4,82	0,00	10,68	0,00	0,00	0,02
	Min	-2,78	-7,82	-14,23	0,00	0,00	-0,18
55	Max	0,33	0,43	0,00	0,00	0,00	0,25
	Min	-4,27	-0,33	-10,80	0,00	0,00	-0,23
65	Max	4,27	0,43	0,00	0,00	0,00	0,23
	Min	0,00	-0,33	-10,80	0,00	0,00	-0,25
102	Max	1,97	1,22	0,00	0,00	0,00	0,09
	Min	-0,56	-0,51	-0,92	0,00	0,00	-0,31
105	Max	1,99	0,95	0,89	0,00	0,00	0,39
	Min	-2,69	0,00	-0,72	0,00	0,00	-0,44
115	Max	1,93	0,07	0,00	0,00	0,00	0,41
	Min	-0,45	-0,63	-0,90	0,00	0,00	-0,05
118	Max	1,82	0,00	0,57	0,00	0,00	0,39
	Min	-2,38	-0,86	-0,66	0,00	0,00	-0,41
147	Max	0,36	1,22	0,00	0,00	0,00	0,35
	Min	-2,15	-0,51	-0,92	0,00	0,00	-0,01
150	Max	2,91	0,95	0,89	0,00	0,00	0,10
	Min	-0,13	0,00	-0,24	0,00	0,00	-0,47
160	Max	0,00	0,17	0,00	0,00	0,00	0,00
	Min	-1,93	-0,63	-0,90	0,00	0,00	-0,41
163	Max	2,56	0,00	0,57	0,00	0,00	0,44
	Min	0,00	-0,65	-0,27	0,00	0,00	0,00

Maximum and minimum reaction forces in RC5 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	5,26	4,95	7,56	0,00	0,00	0,04
	Min	-5,56	0,00	-14,78	0,00	0,00	-0,22
11	Max	5,55	2,77	7,57	0,00	0,00	0,09
	Min	-2,56	0,00	-14,78	0,00	0,00	-0,04
19	Max	5,75	0,00	12,22	0,00	0,00	0,25
	Min	-2,09	-7,23	-3,55	0,00	0,00	0,00
29	Max	2,09	0,00	12,67	0,00	0,00	0,00
	Min	-3,10	-5,12	-3,56	0,00	0,00	-0,27
55	Max	3,67	0,10	4,73	0,00	0,00	0,07
	Min	-2,31	-0,26	-3,04	0,00	0,00	-0,10
65	Max	2,31	0,10	5,72	0,00	0,00	0,07
	Min	-0,58	-0,26	-3,04	0,00	0,00	-0,07
102	Max	0,09	1,44	0,72	0,00	0,00	0,59
	Min	-4,02	0,00	0,00	0,00	0,00	-0,08
105	Max	7,83	1,04	1,06	0,00	0,00	0,09
	Min	-0,80	0,00	-1,15	0,00	0,00	-1,51
115	Max	0,00	0,00	0,78	0,00	0,00	0,10
	Min	-4,06	-1,51	0,00	0,00	0,00	-0,61
118	Max	7,87	0,08	1,12	0,00	0,00	1,53
	Min	-0,68	-1,27	-1,18	0,00	0,00	-0,11
147	Max	1,35	0,99	0,52	0,00	0,00	0,49
	Min	-2,29	0,00	-0,34	0,00	0,00	-0,17
150	Max	4,06	1,00	2,05	0,00	0,00	0,25
	Min	-1,14	0,00	0,00	0,00	0,00	-0,62
160	Max	1,27	0,00	0,78	0,00	0,00	0,09
	Min	-1,96	-1,91	0,00	0,00	0,00	-0,52
163	Max	3,66	0,08	2,23	0,00	0,00	0,64
	Min	-1,00	-0,40	0,00	0,00	0,00	-0,16

For the calculation of the ballast against uplift per support point a part of the Layher stage self-weight is taken into account.
The total self-weight of the Layher system is approx. 4100 kg.
The center of the stage will not help against the uplift forces for the separate supports, therefor only 50% of the self-weight is taken into account, which is 2050Kg.
Layher weight per support point = 2050 / 10 = 205 kg.

Calculation of the ballast for the main roof.

The ballast on each side need to be the same, therefor the maximum uplift force of the two opposite supports will be used to calculate the ballast.

Ballast calculation support 1 and 11
(15.67 – 2.05) * 1.2 = 16.34 kN Ballast ~ 1650 kg.

Ballast calculation support 19 and 29
(12.22– 2.05) * 1.2 = 12.20 kN Ballast ~ 1250 kg.

Ballast calculation support 55 and 65
(4.73 – 2.05) * 1.2 = 3.21 kN Ballast ~ 350 kg.

Because the Layher system is a ridged system, the ballast can be shifted a little bit. This has also been done in the ballast drawing. The shifting of the ballast has also been taken into account in the Layher stage calculation.

The uplift forces of the side stage areas are supported by the Layher. In the calculation of the Layher is an extra load case with the ballast forces.

5.4 Calculation of ballast against overturning and slipping.

Description	Value	Unit	Description	Value	Unit
CO50 - LC1 + LC10			**CO150 - LC1 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	16,73	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	6,70	kN	Sum of loads in Z	31,35	kN
CO51 - LC1 + LC2 + LC10			**CO151 - LC1 + LC2 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	16,73	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-37,06	kN	Sum of loads in Z	-12,41	kN
CO52 - LC1 + LC3 + LC10			**CO152 - LC1 + LC3 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	16,73	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-20,19	kN	Sum of loads in Z	4,46	kN
CO53 - LC1 + LC4 + LC10			**CO153 - LC1 + LC4 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	16,73	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-37,69	kN	Sum of loads in Z	-13,04	kN
CO54 - LC1 + LC5 + LC10			**CO154 - LC1 + LC5 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	16,73	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-36,69	kN	Sum of loads in Z	-12,04	kN
CO60 - LC1 + LC11			**CO160 - LC1 + LC14**		
Sum of loads in X	6,65	kN	Sum of loads in X	23,46	kN
Sum of loads in Y	0,03	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-3,30	kN	Sum of loads in Z	38,52	kN
CO61 - LC1 + LC2 + LC11			**CO161 - LC1 + LC2 + LC14**		
Sum of loads in X	6,65	kN	Sum of loads in X	23,46	kN
Sum of loads in Y	0,03	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-47,05	kN	Sum of loads in Z	-5,23	kN
CO62 - LC1 + LC3 + LC11			**CO162 - LC1 + LC3 + LC14**		
Sum of loads in X	6,65	kN	Sum of loads in X	23,46	kN
Sum of loads in Y	0,03	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-30,18	kN	Sum of loads in Z	11,63	kN
CO63 - LC1 + LC4 + LC11			**CO163 - LC1 + LC4 + LC14**		
Sum of loads in X	6,65	kN	Sum of loads in X	23,46	kN
Sum of loads in Y	0,03	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-47,68	kN	Sum of loads in Z	-5,87	kN
CO64 - LC1 + LC5 + LC11			**CO164 - LC1 + LC5 + LC14**		
Sum of loads in X	6,65	kN	Sum of loads in X	23,46	kN
Sum of loads in Y	0,03	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-46,68	kN	Sum of loads in Z	-4,87	kN
CO70 - LC1 + LC12			**CO170 - LC1 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-17,26	kN	Sum of loads in Y	-9,87	kN
Sum of loads in Z	-20,23	kN	Sum of loads in Z	28,37	kN
CO71 - LC1 + LC2 + LC12			**CO171 - LC1 + LC2 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-17,26	kN	Sum of loads in Y	-9,87	kN
Sum of loads in Z	-63,98	kN	Sum of loads in Z	-15,38	kN
CO72 - LC1 + LC3 + LC12			**CO172 - LC1 + LC3 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-17,26	kN	Sum of loads in Y	-9,87	kN
Sum of loads in Z	-47,11	kN	Sum of loads in Z	1,49	kN
CO73 - LC1 + LC4 + LC12			**CO173 - LC1 + LC4 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-17,26	kN	Sum of loads in Y	-9,87	kN
Sum of loads in Z	-64,61	kN	Sum of loads in Z	-16,01	kN
CO74 - LC1 + LC5 + LC12			**CO174 - LC1 + LC5 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-17,26	kN	Sum of loads in Y	-9,87	kN
Sum of loads in Z	-63,61	kN	Sum of loads in Z	-15,01	kN

For the calculation of the ballast against overturning and sliding of the system the total self-weight of the Layher stage can be taken into account.
The total self-weight of the Layher system is approx. 4100 kg.

Two load combinations will be checked CO50 and CO 160.

5.4.1 Calculation of ballast against overturning in CO50.

Check: $M_{stab}/ M_{ov} > 1.2$

Used info for the stability calculation.
Sum of vertical forces = 6.70 kN
Sum of horizontal load = 16.73 kN
Self-weight of the Layher stage = 41 kN
(The self-weight of the stage is calculated in chapter 6.)

The center of gravity of the complete system lays on a height of 3.75 meter.

Overturning moment
M_{ov} = 16.73 * (3.75+1) = 79.46 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight + down force) * width / 2
M_{stab} = (ballast + 41 – 6.70) * 6 / 2

M_{stab}/ M_{ov} = ((ballast + 41 – 6.370) * 6 / 2) / 79.46 > 1.2
Ballast = ((79.46 *1.2) / 3) – 34.3
Ballast = -2.5 kN ~ 0 kg per side.

This is less than the necessary ballast against uplift.

5.4.2 Calculation of ballast against overturning in CO160.

Check: $M_{stab}/ M_{ov} > 1.2$

Used info for the stability calculation.
Sum of vertical forces = 23.46 kN
Sum of horizontal load = 24.10 kN
Self-weight of the Layher stage = 41 kN
(The self-weight of the stage is calculated in chapter 6.)

The center of gravity of the complete system lays on a height of 3.75 meter.

Overturning moment
M_{ov} = 24.10 * (3.75+1) = 114.5 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight + down force) * width / 2
M_{stab} = (ballast + 41 – 23.46) * 12 / 2

M_{stab}/ M_{ov} = ((ballast + 41 – 23.46) * 12 / 2) / 114.5 > 1.2
Ballast = ((114.5 *1.2) / 6) – 17.54
Ballast = 5.36 kN ~ 550 kg per side.

This is less than the necessary ballast against uplift.

5.4.3 Calculation of ballast against slipping.

Used info for the stability calculation.
Sum of vertical forces = 23.46 kN
Sum of horizontal load = 24.10 kN
Self-weight of the Layher stage = 41 kN
(The self-weight of the stage is calculated in chapter 6.)

Ballast calculation with the friction coefficient 0.6
(ballast + Self-weight) * friction coefficient / wind loading > 1.2
(Ballast per side * 2 + 41 – 23.46) * 0.6 / 24.10 > 1.2
(24.10 * 1.2) / 0.6 = B * 2 + 17.54
(48.2 – 17.54) / 2 = Ballast per side
Ballast = 15.33 kN ~ 1550 kg per side

This is less than the necessary ballast against uplift.

5.5 Ballast calculation model option 3.

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.

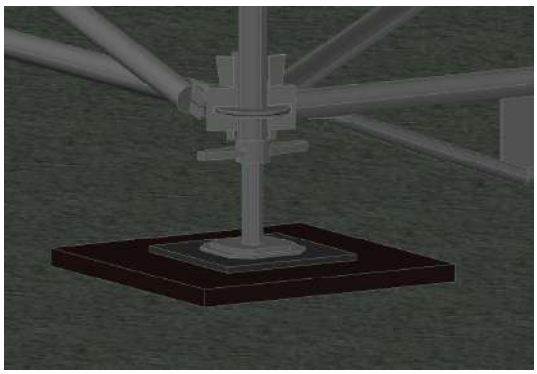
All permanent installed loading can be subtracted from the nearest Ballast position

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 0.6 has been taken into account.
The Ballast calculation with factor 0.6 can be justified because rubber underlayment plate is used.

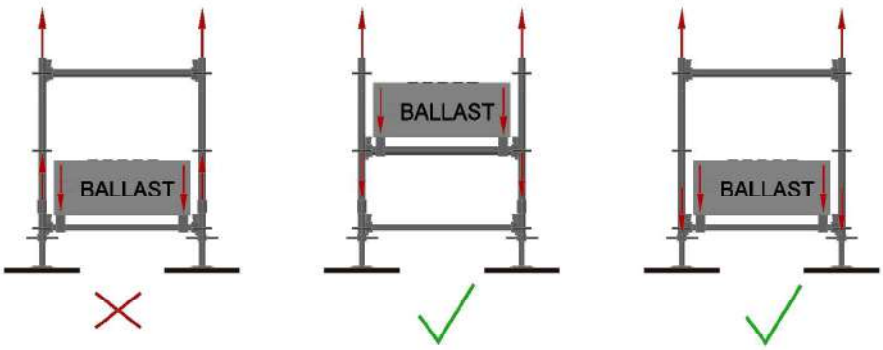
Table 3 — Coefficients of friction μ

	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

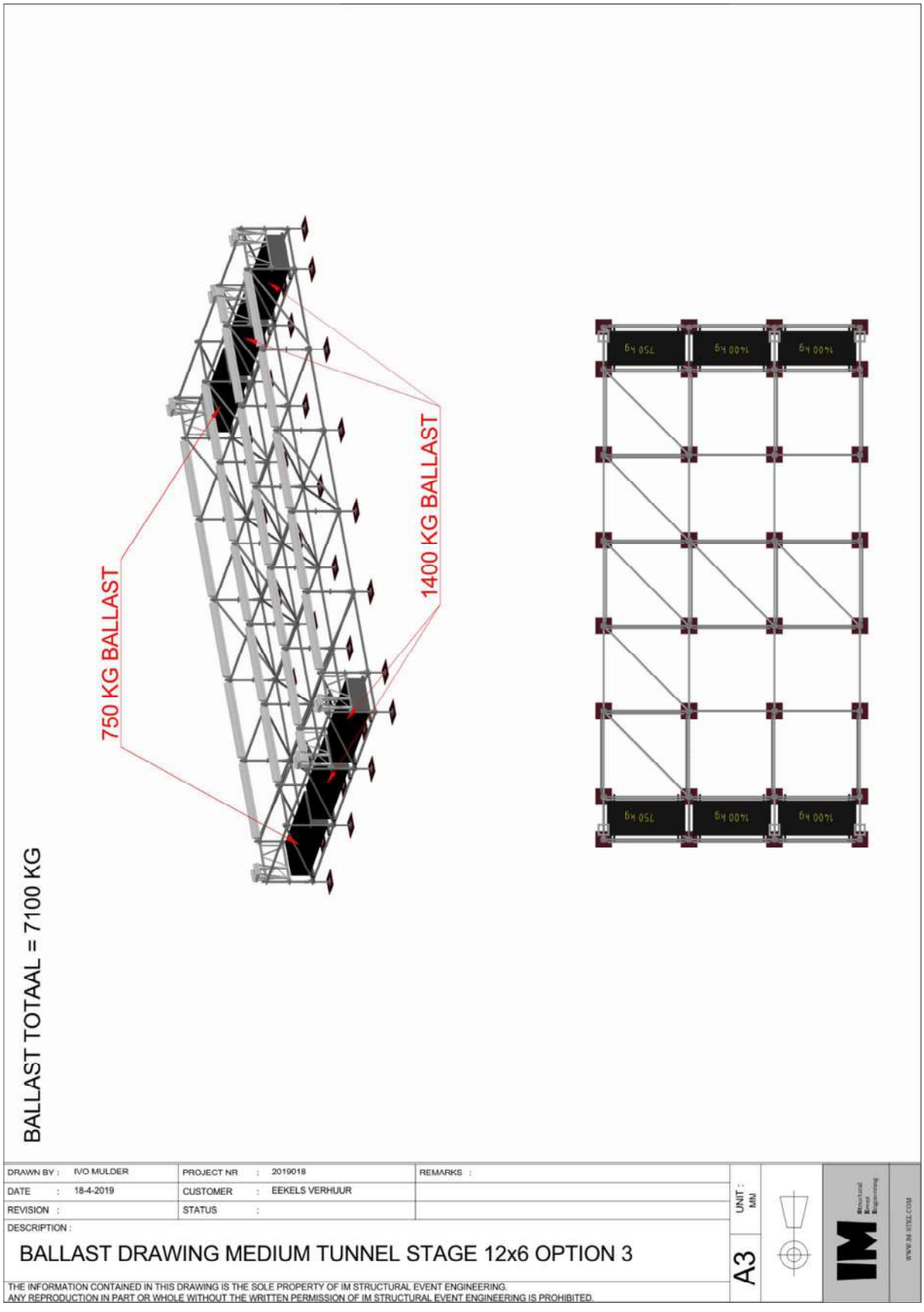
[a] At least of stiff consistency in accordance with ENV 1997-1.



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.

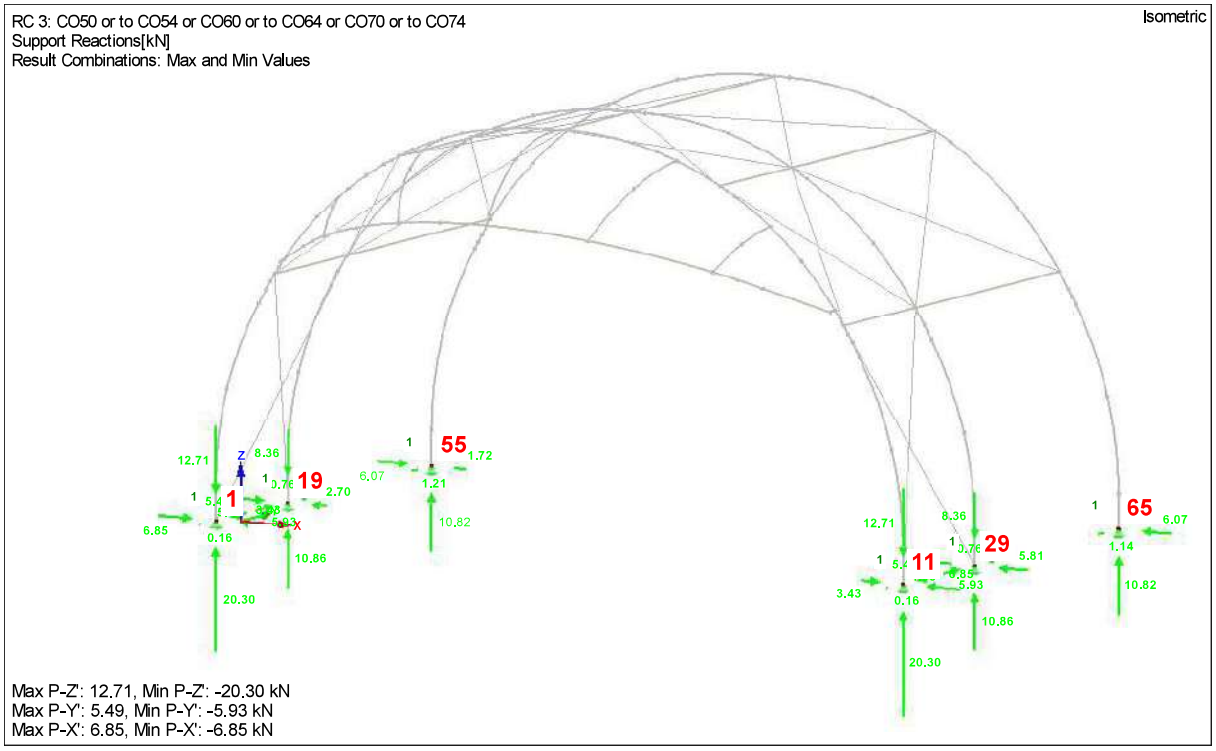


5.6 Ballast drawing model option 3.

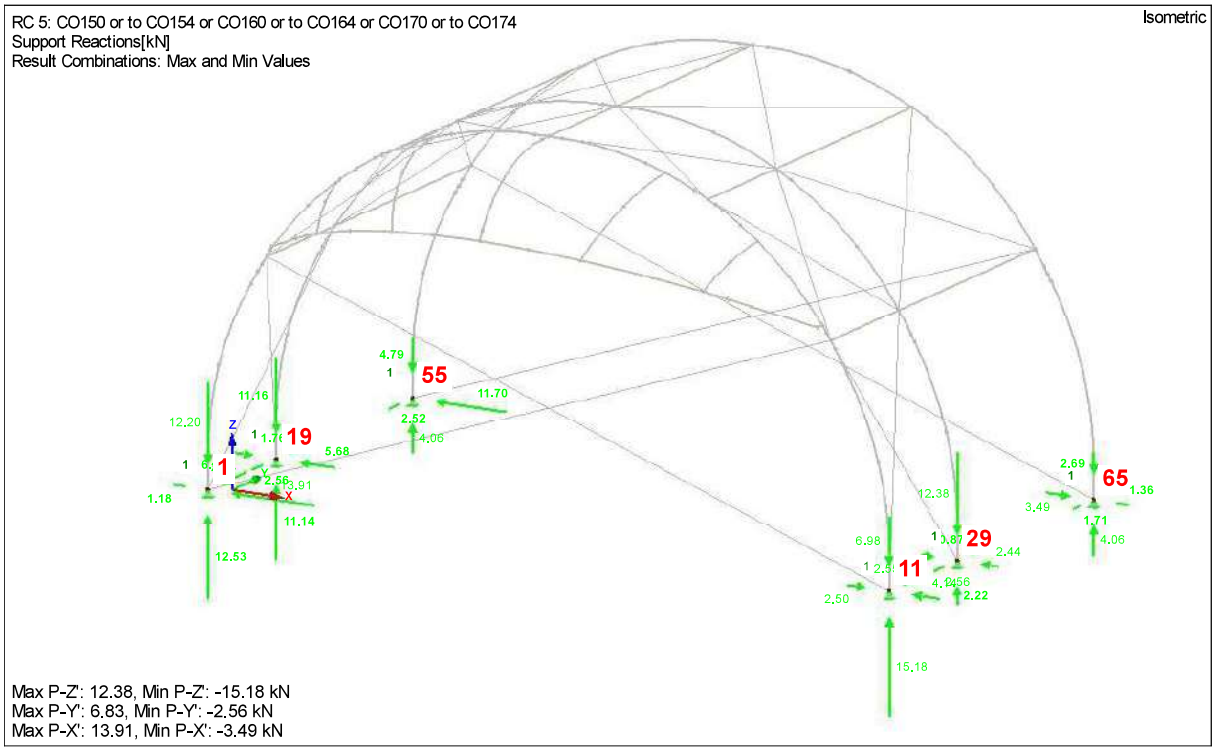


5.7 Ballast calculation against uplift.

Reaction forces RC3 In-service situation



Reaction forces RC5 Out service situation.



Maximum and minimum reaction forces in RC3 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	3,43	5,48	12,71	0,00	0,00	0,17
	Min	-6,85	-0,16	-20,30	0,00	0,00	-0,13
11	Max	6,85	5,49	12,71	0,00	0,00	0,10
	Min	-3,43	-0,16	-20,30	0,00	0,00	-0,17
19	Max	2,70	0,76	8,36	0,00	0,00	0,15
	Min	-5,81	-5,93	-10,86	0,00	0,00	-0,16
29	Max	5,81	0,76	8,36	0,00	0,00	0,15
	Min	-1,95	-5,93	-10,86	0,00	0,00	-0,15
55	Max	1,72	0,00	0,00	0,00	0,00	0,24
	Min	-6,07	-1,21	-10,82	0,00	0,00	0,00
65	Max	6,07	0,00	0,00	0,00	0,00	0,00
	Min	0,00	-1,14	-10,82	0,00	0,00	-0,24

Maximum and minimum reaction forces in RC5 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	13,91	6,83	12,20	0,00	0,00	0,04
	Min	-1,18	0,00	-12,53	0,00	0,00	-0,34
11	Max	4,14	2,55	6,98	0,00	0,00	0,18
	Min	-2,50	0,00	-15,18	0,00	0,00	-0,04
19	Max	5,68	1,76	11,16	0,00	0,00	0,01
	Min	-2,44	-2,56	-11,14	0,00	0,00	-0,40
29	Max	2,44	0,87	12,38	0,00	0,00	0,18
	Min	-1,65	-2,56	-2,22	0,00	0,00	-0,01
55	Max	11,70	0,00	4,79	0,00	0,00	0,33
	Min	0,00	-2,52	-4,06	0,00	0,00	0,00
65	Max	1,36	0,00	2,69	0,00	0,00	0,00
	Min	-3,49	-1,71	-4,06	0,00	0,00	-0,30

For the calculation of the ballast against uplift per support point a part of the Layher stage self-weight is taken into account.
The total self-weight of the Layher system is approx. 2860 kg.
The center of the stage will not help against the uplift forces for the separate supports, therefor only 50% of the self-weight is taken into account, which is 1430 Kg.
Layher weight per support point = 1430 / 6 = 239 kg.

Calculation of the ballast for the main roof.

The ballast on each side need to be the same, therefor the maximum uplift force of the two opposite supports will be used to calculate the ballast.

Ballast calculation support 1 and 11
(12.71 – 2.39) * 1.2 = 12.38 kN Ballast ~ 1250 kg.

Ballast calculation support 19 and 29
(12.38 – 2.39) * 1.2 = 11.99 kN Ballast ~ 1200 kg.

Ballast calculation support 55 and 65
(4.79 – 2.39) * 1.2 = 2.88 kN Ballast ~ 300 kg.

Because the Layher system is a ridged system, the ballast can be shifted a little bit. This has also been done in the ballast drawing. The shifting of the ballast has also been taken into account in the Layher stage calculation.

The uplift forces of the side stage areas are supported by the Layher. In the calculation of the Layher is an extra load case with the ballast forces.

5.8 Calculation of ballast against overturning and slipping.

Description	Value	Unit	Description	Value	Unit
CO50 - LC1 + LC10			**CO150 - LC1 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	6,52	kN	Sum of loads in Z	25,52	kN
CO51 - LC1 + LC2 + LC10			**CO151 - LC1 + LC2 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-37,23	kN	Sum of loads in Z	-18,23	kN
CO52 - LC1 + LC3 + LC10			**CO152 - LC1 + LC3 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-20,37	kN	Sum of loads in Z	-1,37	kN
CO53 - LC1 + LC4 + LC10			**CO153 - LC1 + LC4 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-37,87	kN	Sum of loads in Z	-18,87	kN
CO54 - LC1 + LC5 + LC10			**CO154 - LC1 + LC5 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	2,41	kN
Sum of loads in Z	-36,87	kN	Sum of loads in Z	-17,87	kN
CO60 - LC1 + LC11			**CO160 - LC1 + LC14**		
Sum of loads in X	8,60	kN	Sum of loads in X	29,56	kN
Sum of loads in Y	0,04	kN	Sum of loads in Y	2,32	kN
Sum of loads in Z	-0,69	kN	Sum of loads in Z	26,22	kN
CO61 - LC1 + LC2 + LC11			**CO161 - LC1 + LC2 + LC14**		
Sum of loads in X	8,60	kN	Sum of loads in X	29,56	kN
Sum of loads in Y	0,04	kN	Sum of loads in Y	2,32	kN
Sum of loads in Z	-44,44	kN	Sum of loads in Z	-17,53	kN
CO62 - LC1 + LC3 + LC11			**CO162 - LC1 + LC3 + LC14**		
Sum of loads in X	8,60	kN	Sum of loads in X	29,56	kN
Sum of loads in Y	0,04	kN	Sum of loads in Y	2,32	kN
Sum of loads in Z	-27,57	kN	Sum of loads in Z	-0,67	kN
CO63 - LC1 + LC4 + LC11			**CO163 - LC1 + LC4 + LC14**		
Sum of loads in X	8,60	kN	Sum of loads in X	29,56	kN
Sum of loads in Y	0,04	kN	Sum of loads in Y	2,32	kN
Sum of loads in Z	-45,07	kN	Sum of loads in Z	-18,17	kN
CO64 - LC1 + LC5 + LC11			**CO164 - LC1 + LC5 + LC14**		
Sum of loads in X	8,60	kN	Sum of loads in X	29,56	kN
Sum of loads in Y	0,04	kN	Sum of loads in Y	2,32	kN
Sum of loads in Z	-44,07	kN	Sum of loads in Z	-17,17	kN
CO70 - LC1 + LC12			**CO170 - LC1 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-7,28	kN
Sum of loads in Z	-14,60	kN	Sum of loads in Z	25,52	kN
CO71 - LC1 + LC2 + LC12			**CO171 - LC1 + LC2 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-7,28	kN
Sum of loads in Z	-58,36	kN	Sum of loads in Z	-18,23	kN
CO72 - LC1 + LC3 + LC12			**CO172 - LC1 + LC3 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-7,28	kN
Sum of loads in Z	-41,49	kN	Sum of loads in Z	-1,37	kN
CO73 - LC1 + LC4 + LC12			**CO173 - LC1 + LC4 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-7,28	kN
Sum of loads in Z	-58,99	kN	Sum of loads in Z	-18,87	kN
CO74 - LC1 + LC5 + LC12			**CO174 - LC1 + LC5 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-7,28	kN
Sum of loads in Z	-57,99	kN	Sum of loads in Z	-17,87	kN

For the calculation of the ballast against overturning and sliding of the system the total self-weight of the Layher stage can be taken into account.
The total self-weight of the Layher system is approx. 2860 kg.

Two load combinations will be checked CO50 and CO 160.

5.4.1 Calculation of ballast against overturning in CO50.

Check: $M_{stab}/ M_{ov} > 1.2$

Used info for the stability calculation.
Sum of vertical forces = 6.52 kN
Sum of horizontal load = 10.02 kN
Self-weight of the Layher stage = 28.60 kN
(The self-weight of the stage is calculated in chapter 6.)

The centre of gravity of the complete system lays on a height of 3.75 meter.

Overturning moment
M_{ov} = 10.02 * (3.75+1) = 47.60 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight + down force) * width / 2
M_{stab} = (ballast + 28.60 – 6.52) * 6 / 2

M_{stab}/ M_{ov} = ((ballast + 28.60 – 6.52) * 6 / 2) / 47.60 > 1.2
Ballast = ((47.60 *1.2) / 3) – 22.08
Ballast = -3.04 kN ~ 0 kg per side.

This is less than the necessary ballast against uplift.

5.4.2 Calculation of ballast against overturning in CO160.

Check: $M_{stab}/ M_{ov} > 1.2$

Used info for the stability calculation.
Sum of vertical forces = 26.22 kN
Sum of horizontal load = 29.65 kN
Self-weight of the Layher stage = 28.60 kN
(The self-weight of the stage is calculated in chapter 6.)

The centre of gravity of the complete system lays on a height of 3.75 meter.

Overturning moment
M_{ov} = 29.65 * (3.75+1) = 140.84 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight + down force) * width / 2
M_{stab} = (ballast + 28.60 – 26.22) * 12 / 2

M_{stab}/ M_{ov} = ((ballast + 28.60 – 26.22) * 12 / 2) / 140.84 > 1.2
Ballast = ((140.84 *1.2) / 6) – 2.38
Ballast = 25.79 kN ~ 2600 kg per side.

This is less than the necessary ballast against uplift.

5.8.2 Calculation of ballast against slipping.

Sum of vertical forces = 26.22 kN
Sum of horizontal load = 29.65 kN
Self-weight of the Layher stage = 28.60 kN
(The self-weight of the stage is calculated in chapter 6.)

Ballast calculation with the friction coefficient 0.6
(ballast + Self-weight) * friction coefficient / wind loading > 1.2
(Ballast per side * 2 + 28.60 – 26.22) * 0.6 / 29.65 > 1.2
(29.67 * 1.2) / 0.6 = B * 2 + 2.38
(59.34 – 2.38) / 2 = Ballast per side
Ballast = 28.48 kN ~ 2850 kg per side

5.9 Ballast Loading PA tower.

If the system is built including a PA wing (option 1) Extra ballast in the PA wing is required.

Calculation.
The calculation is done for the In service wind loading. If the gust wind speed exceeds 21 m/s all the banners of the PA wing need to be removed. In the Out service situation, it's an open 3d frame which requires less ballast.

Self-weight of the PA wing is 12.47 kg
Wind loading on the PA wing = 1.4 * 0.2 * 4.144 * 8 = 9.28 kN

Overturning moment
M_{ov} = 9.28 * 3 = 27.84 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight) * 2.072 / 2
M_{stab} = (ballast + 12.47) * 1.036

Check
M_{stab}/ M_{ov} = ((ballast + 12.47) * 2) / 27.84 > 1.2
Ballast = ((37.12 *1.2) / 2) – 12.47
Ballast = 19.78 kN ~ 2000 kg per side.

6.0 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 for the K2000+.
For the calculation of the Layher system the Stage configuration of Option 1 will be used. For this setup there are different load combinations calculated. The first 3 are from the In-service situation. The In-service load combinations will be combined with the floor loading. The other two are from the Out-service situation These load case will not be combined with the floor loading while there is nobody allowed on stage in the Out-service situation.
The different reaction forces are taken from the load combinations

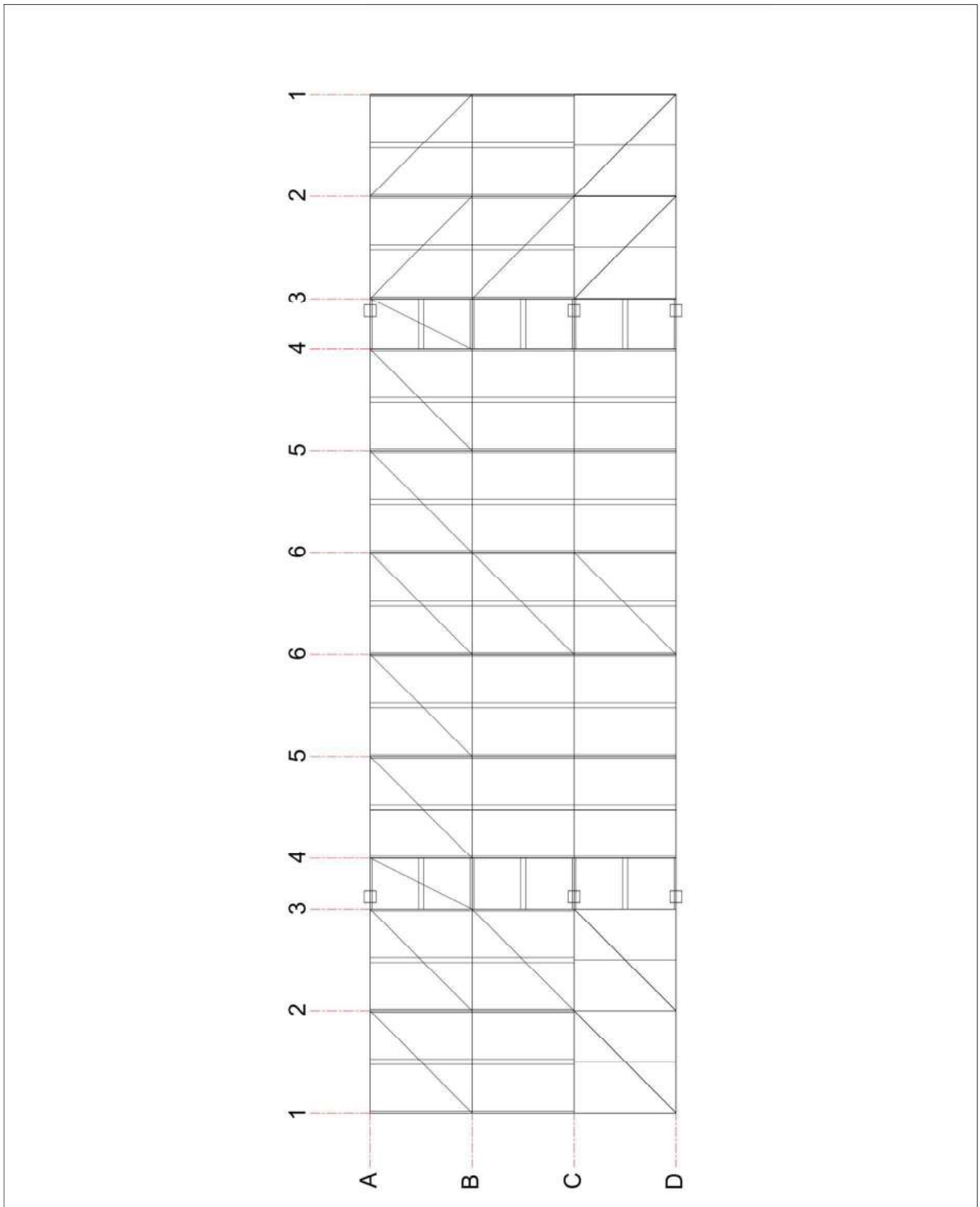
- : CO50
- : CO60
- : CO70
- : CO150
- : CO160

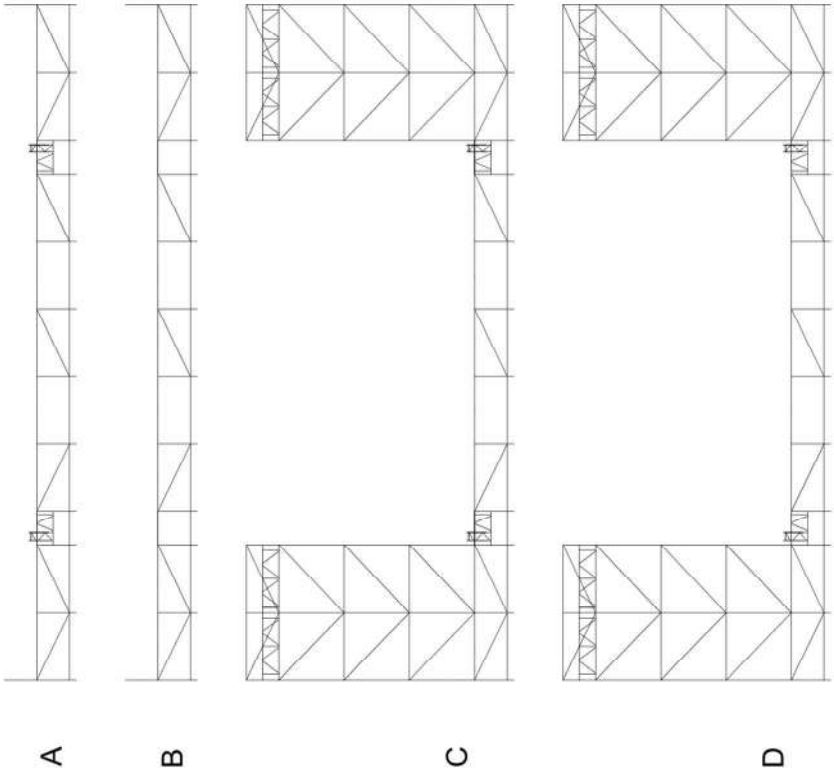
6.1 RFem Layher stage Model.

For the Layher stage a separate model is constructed in the RFem program.
In this model the forces of the different load combinations are set as forces on the different node positions. The result calculations will be compared with the Layher design forces as shown in chapter 6.5 Layher Design values.

6.1.1 Layher Stage Layout.

Layher stage Layout for stage setup Option 1





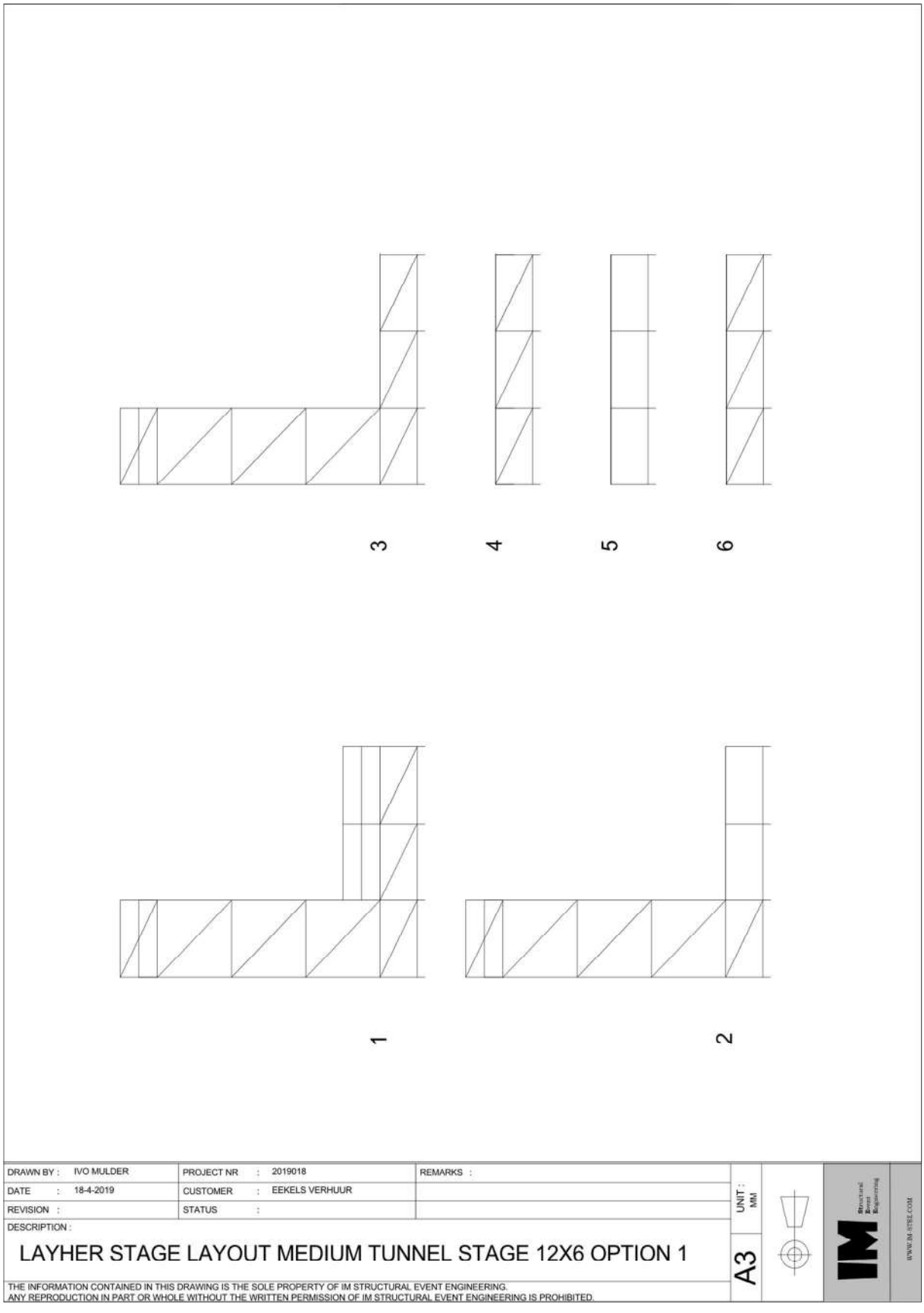
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DATE : 18-4-2019	CUSTOMER : EEKELS VERHUUR				
REVISION :	STATUS :				
DESCRIPTION :					

LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 12X6 OPTION 1

A3

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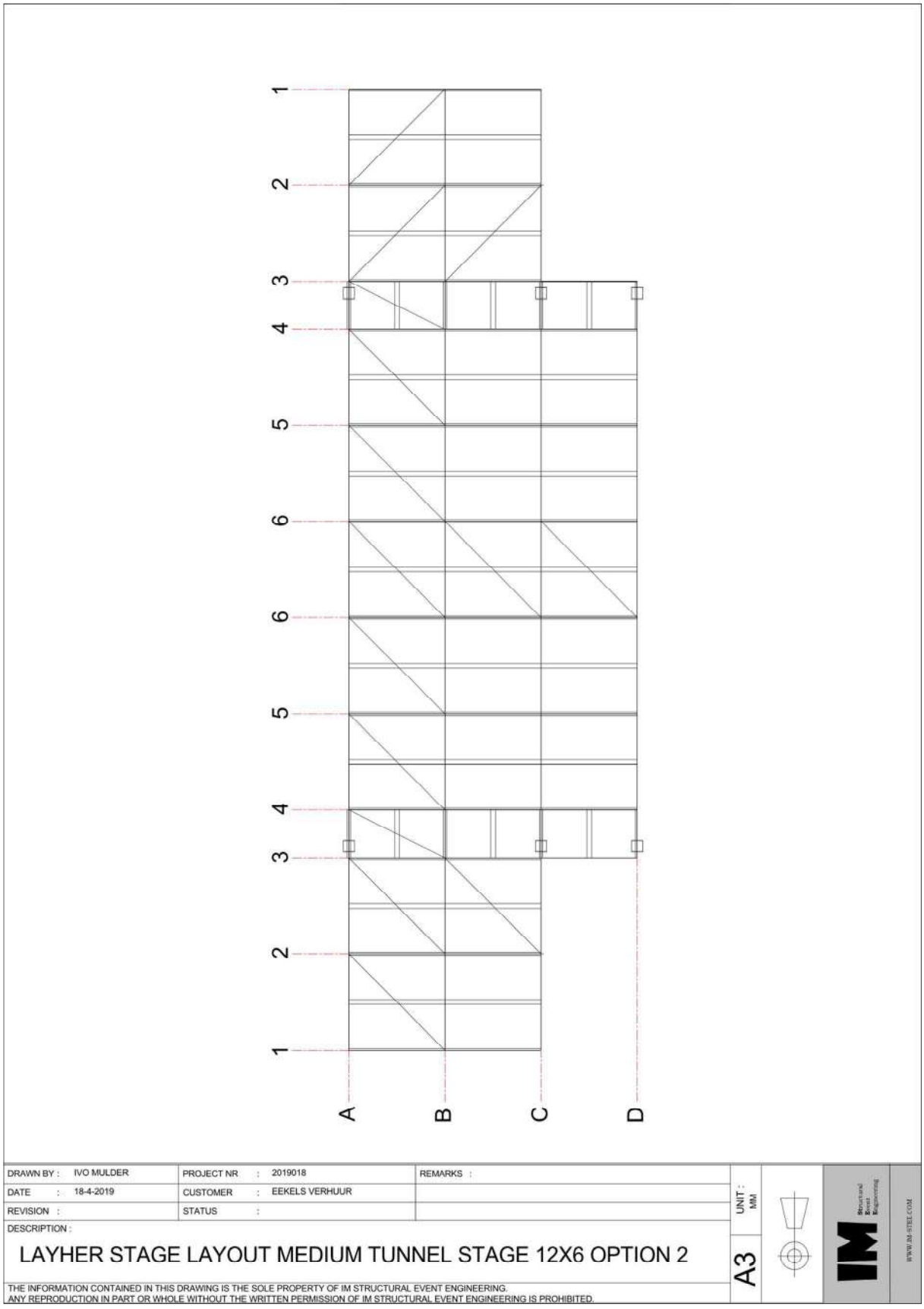
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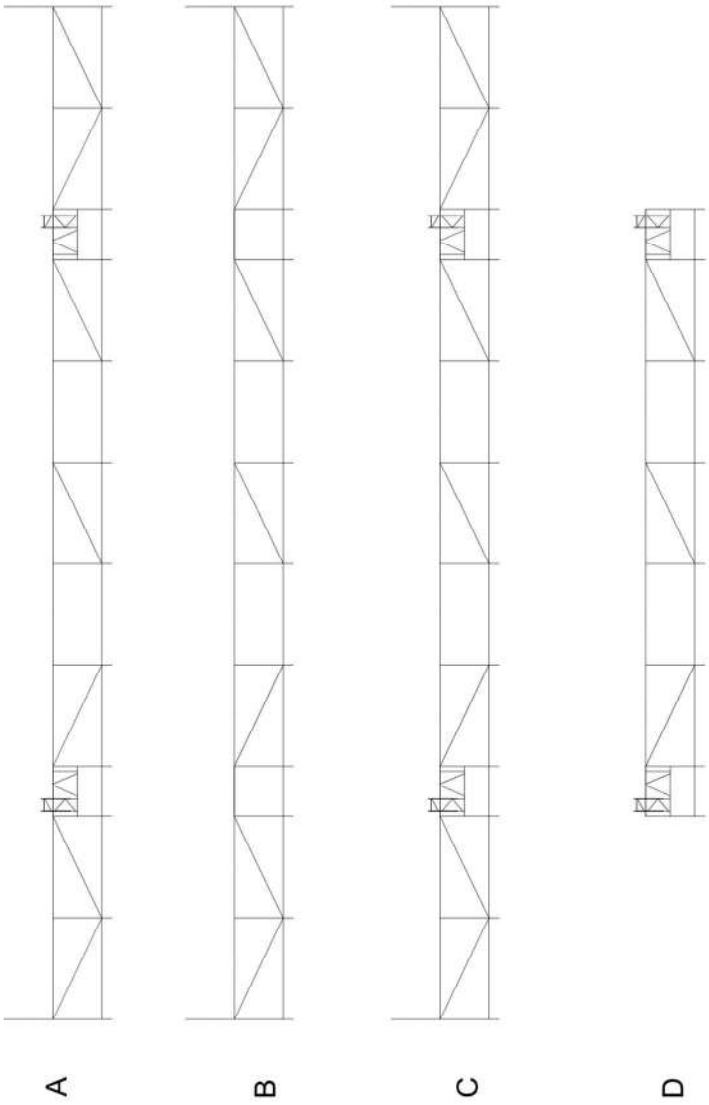


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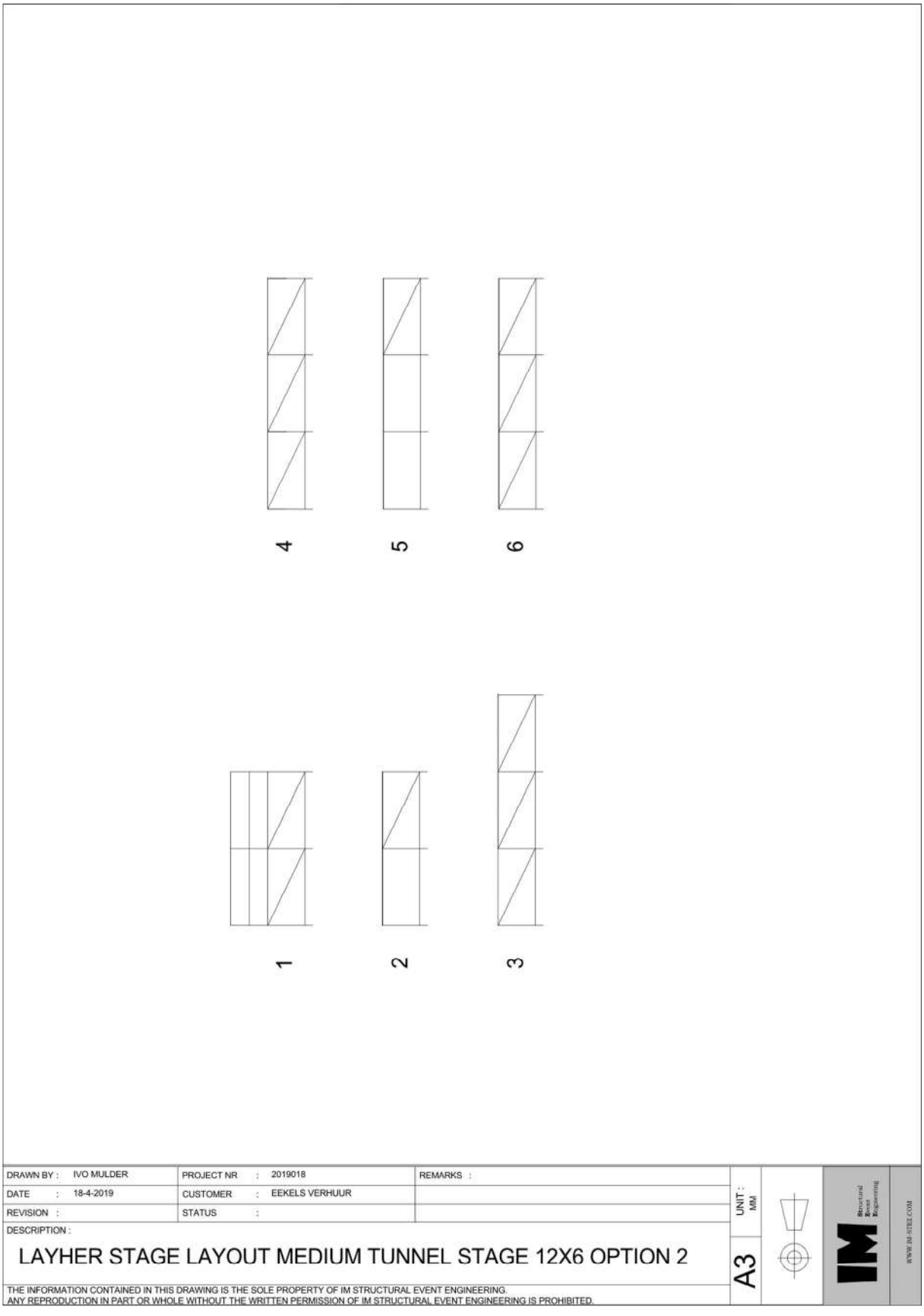
Layher stage Layout for stage setup Option 2





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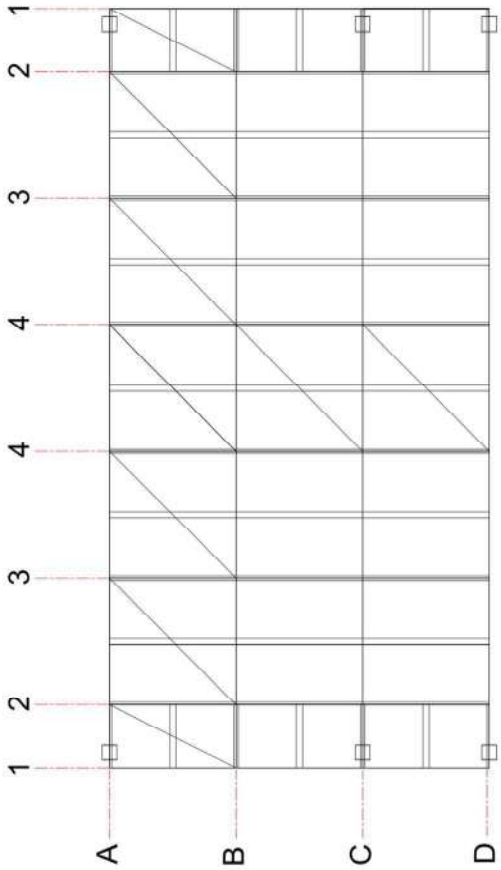
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LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 12X6 OPTION 2

A3

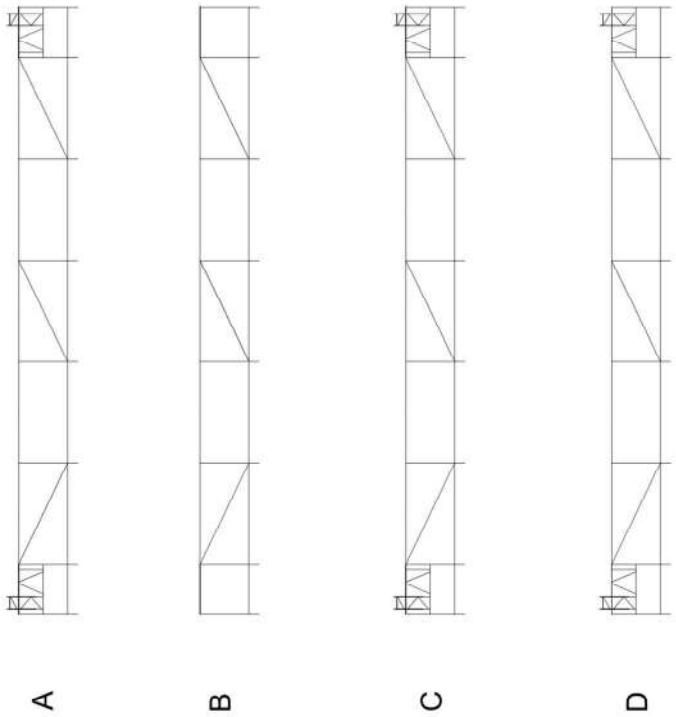
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Layher stage Layout for stage setup Option 3



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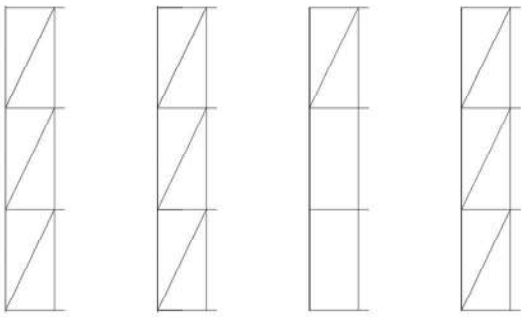
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REVISION :	STATUS :				
DESCRIPTION :					

LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 12X6 OPTION 3

UNIT : MM

A3

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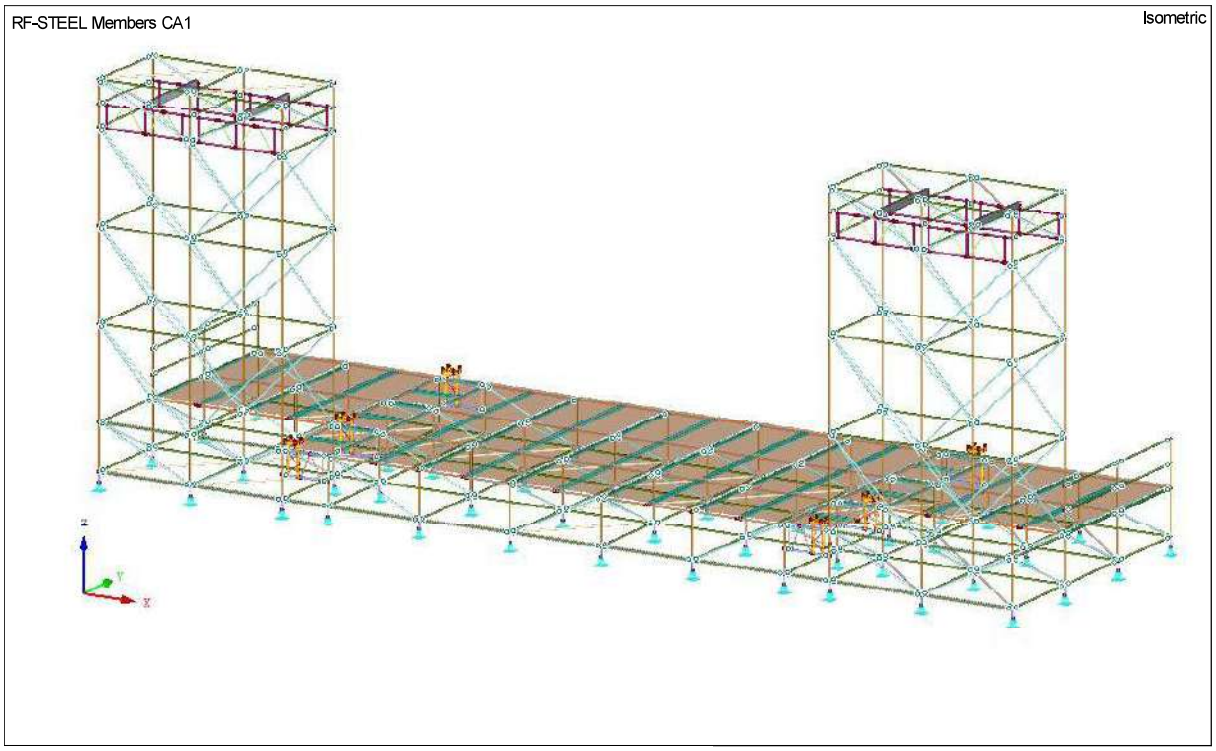


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REVISION :	STATUS :				
DESCRIPTION : LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 12X6 OPTION 3			A3		

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6.1.2 The Layher construction scheme option 1.

Layher stage layout 1 will be used for the calculation.



Cross-Sections
- 1: Ring 51/5; Steel S 355 JR
- 2: QRO 50x4 (Hot Formed); Steel S 235 JR
- 3: Ring 30/3; Steel S 235 JR
- 4: Rectangle 60/15; Steel S 235 JR
- 5: Ring 20/2; Steel S 235 JR
- 6: RO 38x4.5 | DIN EN 10220; Steel S 355 JR
- 7: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 8: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 9: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 10: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 11: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 12: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 13: IPE 160; Steel S 235 JR
- 14: HK 30/20/2/2/2/2; Steel S 235 JR
- 15: RO 48.3x3.2 (Hot Formed); S320GD 1.0250

6.1.3 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	Steel S 235 JR | EN 10025-2:2004-11	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
2	S320GD 1.0250 | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
3	Steel S 355 JR | EN 10025-2:2004-11	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
4	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...
5	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

6.1.4 Used cross sections.

Section	Cross-Section	Material	Moments of inertia [cm⁴]			Cross-Sectional Areas [cm²]			Principal Axes	Rotation	Overall Dimensions [mm]	
			Torsion	Bending	Bending	Axial	Shear	Shear			Width	Depth
No.	Description [mm]	No.	J	I_y	I_z	A	A_y	A_z	α [°]	α' [°]	b	h
1	Ring 51/5	3	38,68	19,34	19,34	7,23	3,68	3,68	0,00	0,00	51,0	51,0
2	QRO 50x4 (Hot Formed)	1	40,40	25,00	25,00	7,19	3,12	3,12	0,00	0,00	50,0	50,0
3	Ring 30/3	1	4,69	2,35	2,35	2,54	1,30	1,30	0,00	0,00	30,0	30,0
4	Rectangle 60/15	1	5,69	1,69	27,00	9,00	7,50	7,50	0,00	0,00	60,0	15,0
5	Ring 20/2	1	0,93	0,46	0,46	1,13	0,58	0,58	0,00	0,00	20,0	20,0
6	RO 38x4.5 | DIN EN 10220	3	13,53	6,76	6,76	4,74	2,38	2,38	0,00	0,00	38,0	38,0
7	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
8	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
9	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
10	RO 48.3x2.6 (Hot Formed)	1	19,60	9,78	9,78	3,73	1,85	1,85	0,00	0,00	48,3	48,3
11	EV transom	5	50,00	554,00	70,00	18,78	18,00	18,00	0,00	0,00	49,0	172,5
12	HK 50/30/4/4/4/4	5	16,87	17,67	7,52	5,76	1,62	3,48	0,00	0,00	30,0	50,0
13	IPE 160	1	3,60	869,30	68,31	20,09	10,17	7,33	0,00	0,00	82,0	160,0
14	HK 30/20/2/2/2/2	1	2,31	2,16	1,11	1,84	0,57	1,04	0,00	0,00	20,0	30,0
15	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

6.1.5 Load cases, load combinations and result combinations.

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self-weight	+	Permanent	-	0,000	0,000	-1,000
LC2	ballast loading	+	Permanent	-	0,000	0,000	-1,000
LC3	PA wing loading	+	Permanent/Imposed	-	0,000	0,000	0,000
LC4	floor loading 0°	+	Permanent/Imposed	-	0,000	0,000	0,000
LC5	floor loading 90°	+	Permanent/Imposed	-	0,000	0,000	0,000
LC6	floor loading 180°	+	Permanent/Imposed	-	0,000	0,000	0,000
LC10	Reaction forces CO50	-	Permanent/Imposed	-	0,000	0,000	0,000
LC11	Reaction forces CO60	-	Permanent/Imposed	-	0,000	0,000	0,000
LC12	Reaction forces CO70	-	Permanent/Imposed	-	0,000	0,000	0,000
LC13	Reaction forces CO150	-	Permanent/Imposed	-	0,000	0,000	0,000
LC14	Reaction forces CO160	-	Permanent/Imposed	-	0,000	0,000	0,000

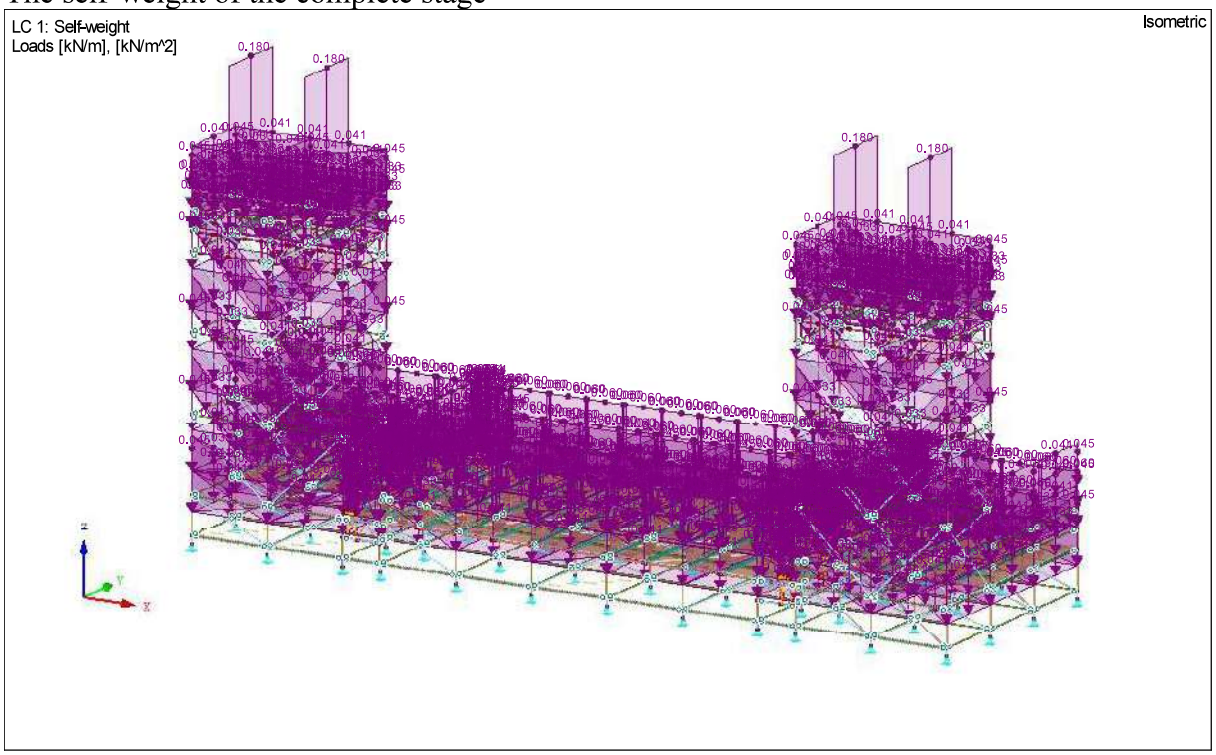
Load Combin.	Load Combination DS	Description	To Solve	LC.1 Factor	No.	LC.2 Factor	No.	LC.3 Factor	No.	LC.4 Factor	No.	LC.5 Factor	No.
CO1	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC4 + 1.35*LC10	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC4	1,350	LC10
CO2	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC5 + 1.35*LC11	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC5	1,350	LC11
CO3	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC6 + 1.35*LC12	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC6	1,350	LC12
CO4	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC13	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC13		
CO5	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC14	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC14		
CO50	0	LC1 + LC2 + LC3 + LC4 + LC10	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC4	1,000	LC10
CO51	0	LC1 + LC2 + LC3 + LC5 + LC11	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC5	1,000	LC11
CO52	0	LC1 + LC2 + LC3 + LC6 + LC12	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC6	1,000	LC12
CO53	0	LC1 + LC2 + LC3 + LC13	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC13		
CO54	0	LC1 + LC2 + LC3 + LC14	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC14		

RC1 –load combinations Design values : 1 * (CO1 or to CO5)
RC2 –load combinations Characteristic values : 1 * (CO50 or to CO54)

6.2 Loading Input.

6.2.1 LC1: Self-weight.

The self-weight of the complete stage

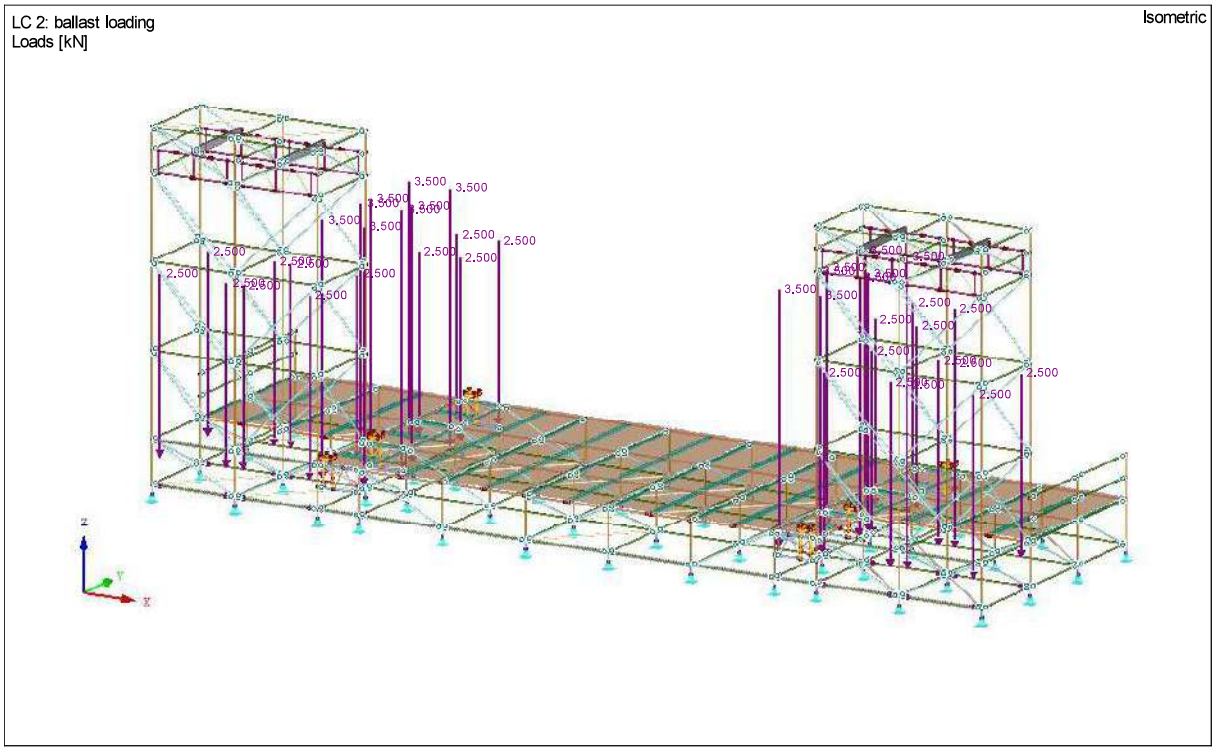


Layher pole = 0.045 kN/m^{-1}
Layher Ledger = 0.041 kN/m^{-1}
Layher Diagonal = 0.033 kN/m^{-1}
Layher event Ledger = 0.06 kN/m^{-1}
Layher Adapter main profile = 0.054 kN/m^{-1}
PA support beam 0.18 kN/m^{-1}
Layher event deck 18 kg/m^2

Total self-weight complete Layher state 57 kN

6.2.2 LC2: Ballast loading.

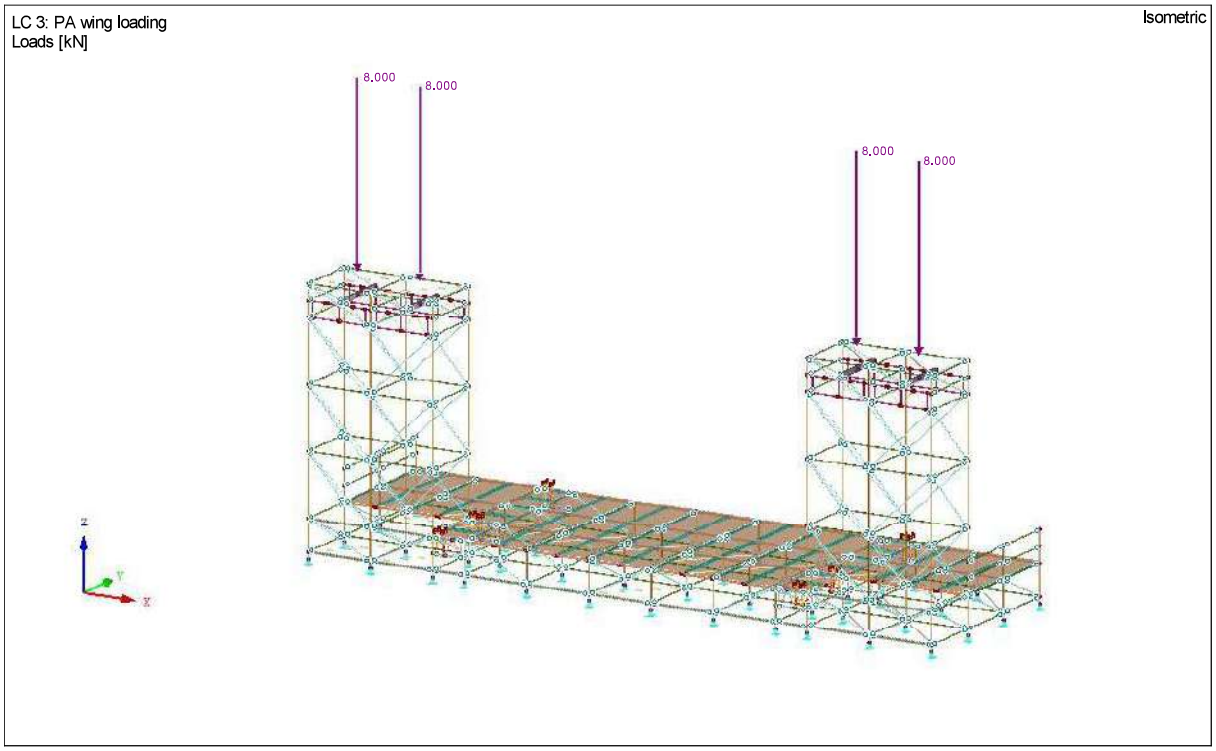
The ballast has been set as a separate load case, for the check of the structural integrity of the system.



Ballast main stage
4 * 3.5 kN = 14 kN in the first two bays from the front
4 * 2.5 kN = 10 kN in de third bay from the front

Ballast PA wings
4 * 2.5 kN = 10 kN per bay

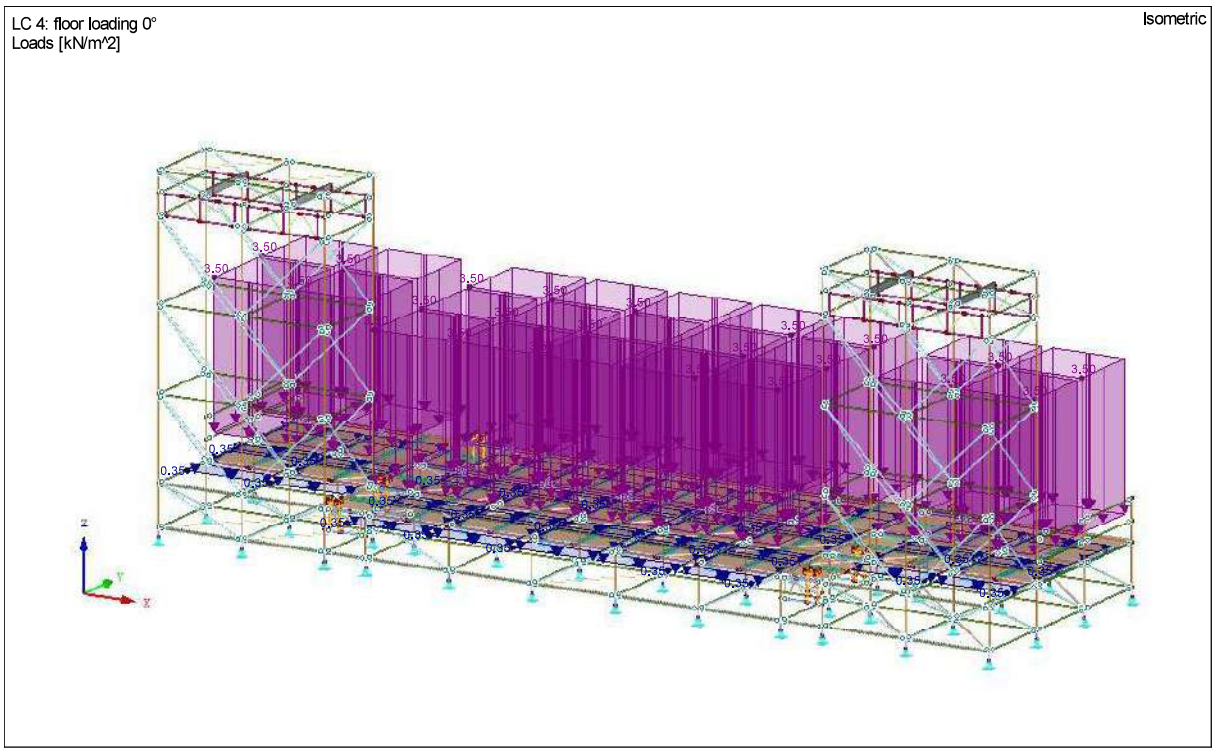
6.2.3 LC3: PA wing loading.



PA wing loading
4 * 8 kN

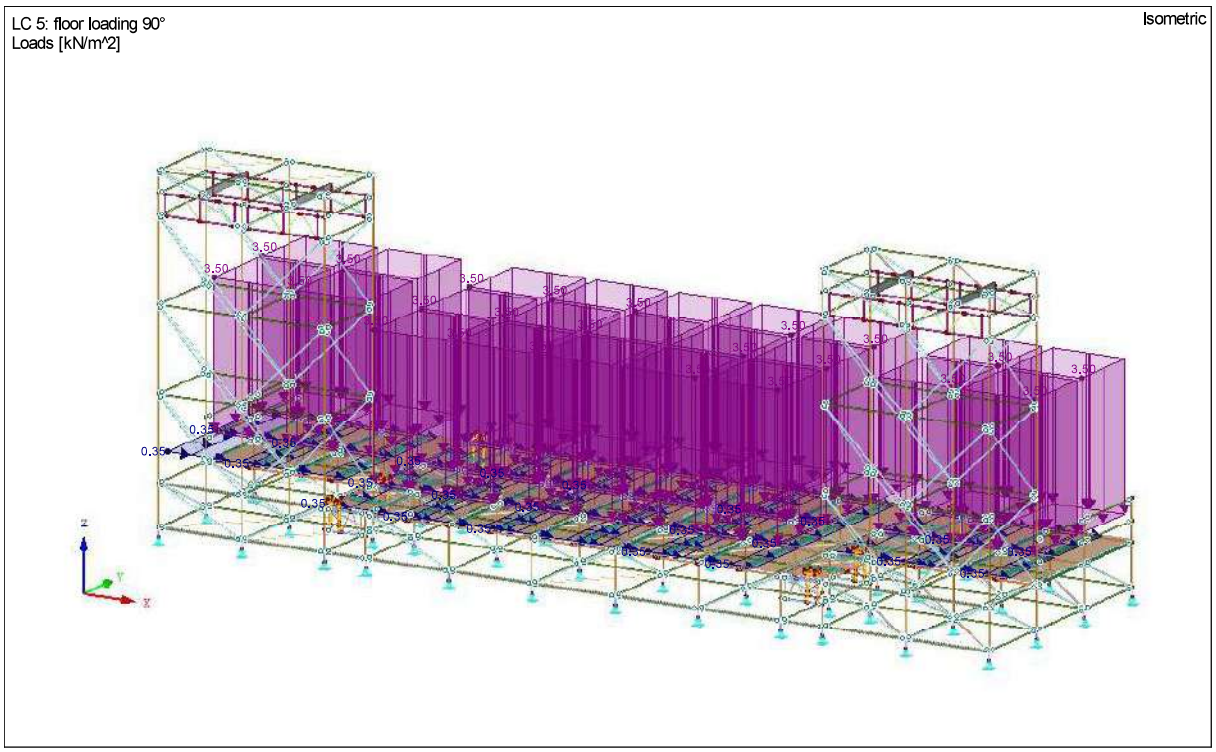
6.2.4 LC4: Floor loading 0°.

The floor loading which is taken into account is 350 kg/m² which is according to the NEN-EN 13814. For the horizontal stability check an extra loading of 10% of the vertical loading is set as an extra horizontal force. This horizontal force has been set in the direction of the wind.



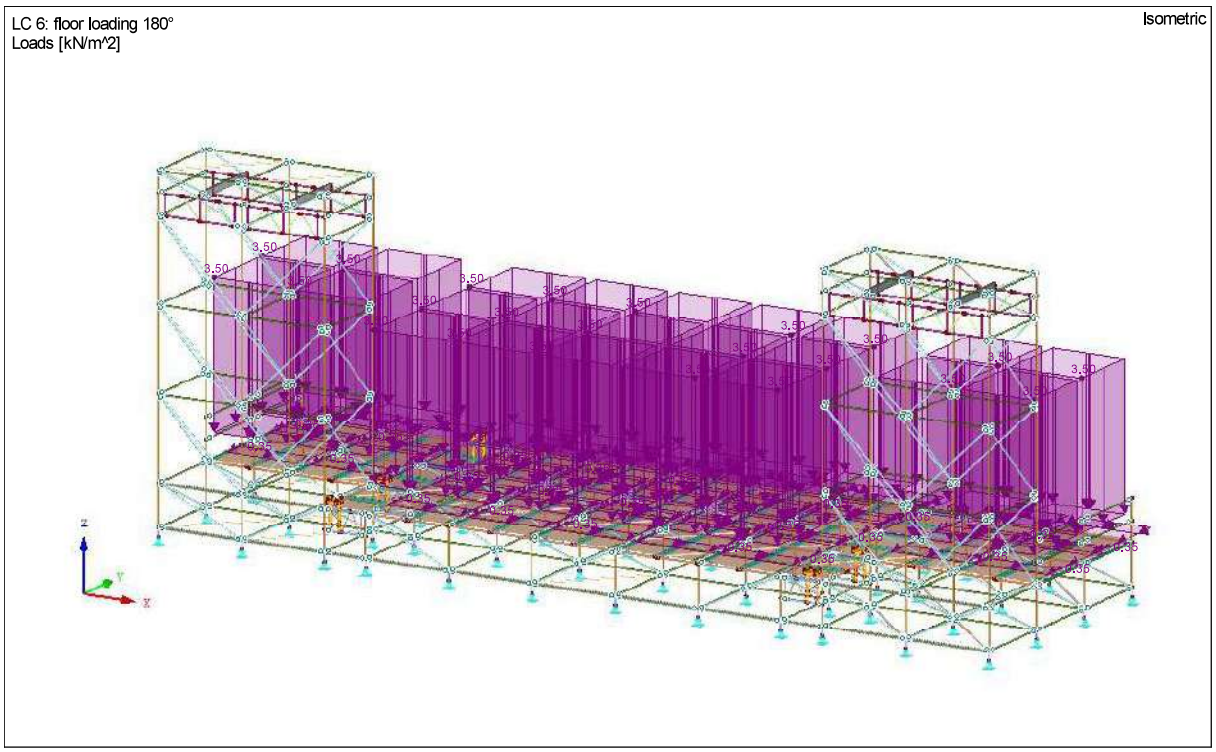
6.2.5 LC5: Floor loading 90°.

The floor loading which is taken into account is 350 kg/m² which is according to the NEN-EN 13814. For the horizontal stability check an extra loading of 10% of the vertical loading is set as an extra horizontal force. This horizontal force has been set in the direction of the wind.



6.2.6 LC6: Floor loading 180°.

The floor loading which is taken into account is 350 kg/m² which is according to the NEN-EN 13814. For the horizontal stability check an extra loading of 10% of the vertical loading is set as an extra horizontal force. This horizontal force has been set in the direction of the wind.

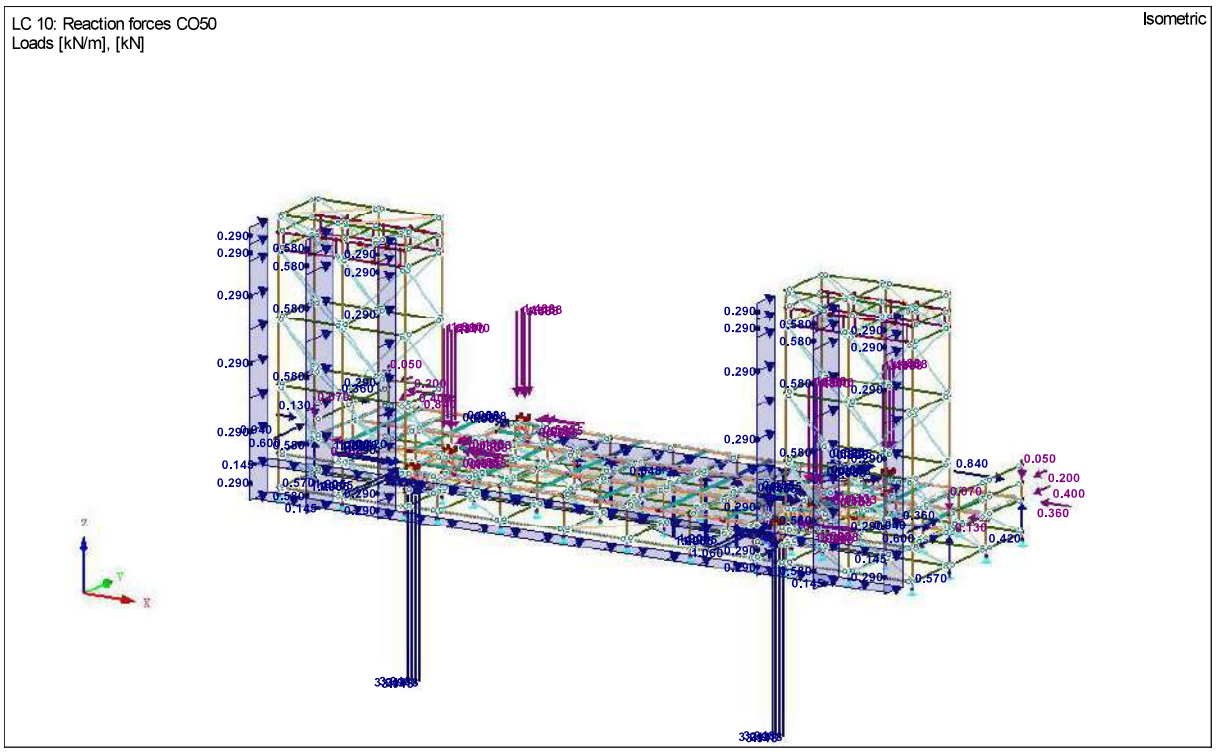


6.2.7 LC10: Reaction forces CO50.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	4,11	7,62	15,67	0,00	0,00	-0,09
11	-4,11	7,62	15,67	0,00	0,00	0,09
19	-1,82	-0,53	-7,24	0,00	0,00	0,10
29	1,82	-0,53	-7,24	0,00	0,00	-0,10
55	-2,10	0,35	-5,95	0,00	0,00	-0,11
65	2,10	0,35	-5,95	0,00	0,00	0,11
102	-0,36	0,60	-0,07	0,00	0,00	0,01
105	0,13	0,94	0,57	0,00	0,00	-0,10
115	0,36	-0,40	-0,05	0,00	0,00	0,10
118	-0,84	-0,20	0,42	0,00	0,00	-0,12
147	0,36	0,60	-0,07	0,00	0,00	-0,01
150	-0,13	0,94	0,57	0,00	0,00	0,10
160	-0,36	-0,40	-0,05	0,00	0,00	-0,10
163	0,84	-0,20	0,42	0,00	0,00	0,12
Σ Forces	0,00	16,73	6,70			
Σ Loads	0,00	16,73	6,70			

Load input in Layher stage model.



The loading of the wind on the stage, PA wing and part of the loading of the wind on the back wall are added as member loads on the model.

Wind on stage
$q_{w,\ stage}$ = 1.4 * 0.2 * 1 = 0.290 kN/m
this is divided on the top and bottom ledger of the stage

Wind on PA wing.
Wind on outer Layher Pole
qw = 1.4 * 0.2 * 1.036 = 0.29

Wind on middle Layher Pole
qw = 1.4 * 0.2 * 2.072 = 0.58

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 1.3 * 0.2 * 6.525 * 0.5 = 0.848kN/m
$q_{w,\ back\ wall\ side}$ = 1.3 * 0.2 * 0 = 0 kN/m

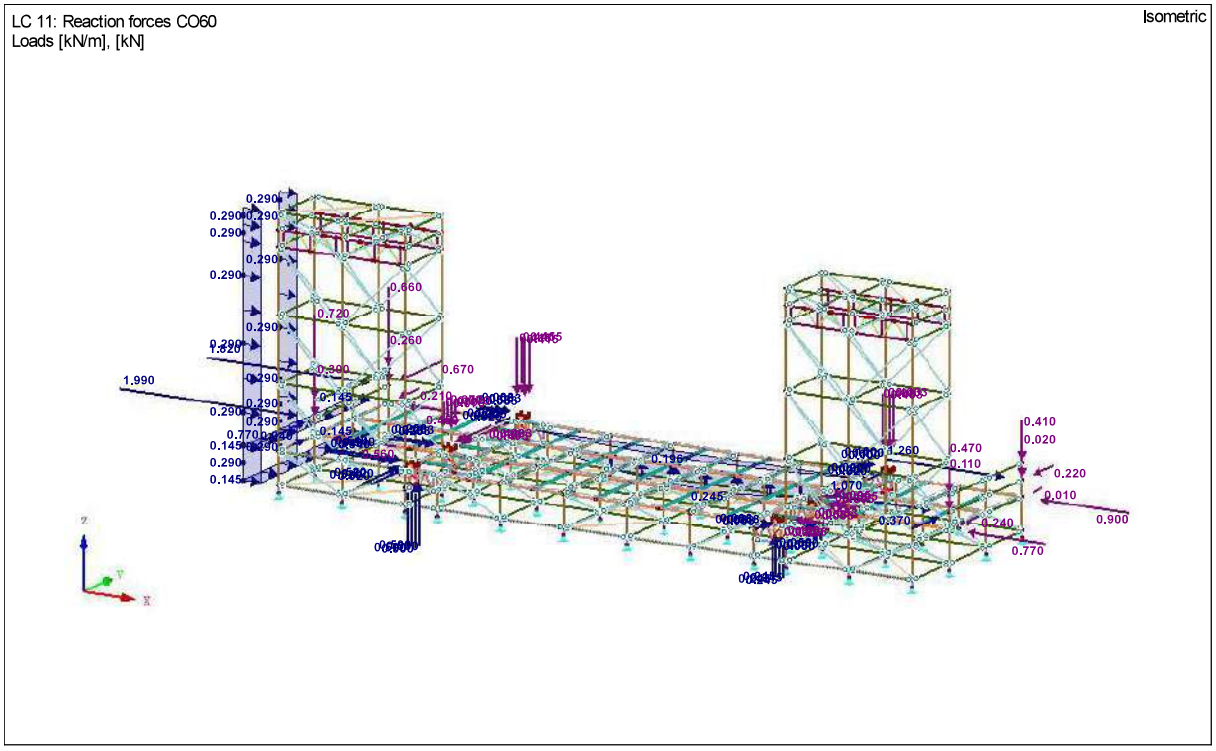
Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.848 / 0.8 = 1.060 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

6.2.8 LC11: Reaction forces CO60.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	2,16	2,08	2,00	0,00	0,00	-0,08
11	-0,51	0,27	0,98	0,00	0,00	-0,01
19	1,01	-1,97	-0,28	0,00	0,00	0,11
29	-0,21	-0,38	0,20	0,00	0,00	-0,03
55	0,33	0,10	-1,66	0,00	0,00	0,00
65	0,40	0,08	-1,61	0,00	0,00	-0,01
102	-0,56	0,04	-0,30	0,00	0,00	0,09
105	1,99	0,77	-0,72	0,00	0,00	-0,44
115	-0,45	-0,21	-0,26	0,00	0,00	-0,05
118	1,82	-0,67	-0,66	0,00	0,00	0,39
147	-0,77	-0,24	-0,47	0,00	0,00	0,11
150	1,07	0,37	-0,11	0,00	0,00	-0,15
160	-0,90	-0,01	-0,41	0,00	0,00	-0,16
163	1,26	-0,22	-0,02	0,00	0,00	0,21
Σ Forces	6,65	0,03	-3,30			
Σ Loads	6,65	0,03	-3,30			

Load input in Layher stage model.



The loading of the wind on the stage, PA wing and part of the loading of the wind on the back wall are added as member loads on the model.

Wind on stage
$q_{w,\ stage}$ = 1.4 * 0.2 * 1 = 0.290 kN/m
this is divided on the top and bottom ledger of the stage

Wind on PA wing.
Wind on outer Layher Pole
qw = 1.4 * 0.2 * 1.036 = 0.29

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 0.3 * 0.2 * 6.525 * 0.5 = 0.196 kN/m
$q_{w,\ back\ wall\ side}$ = 0.3 * 0.2 * 0 = 0 kN/m

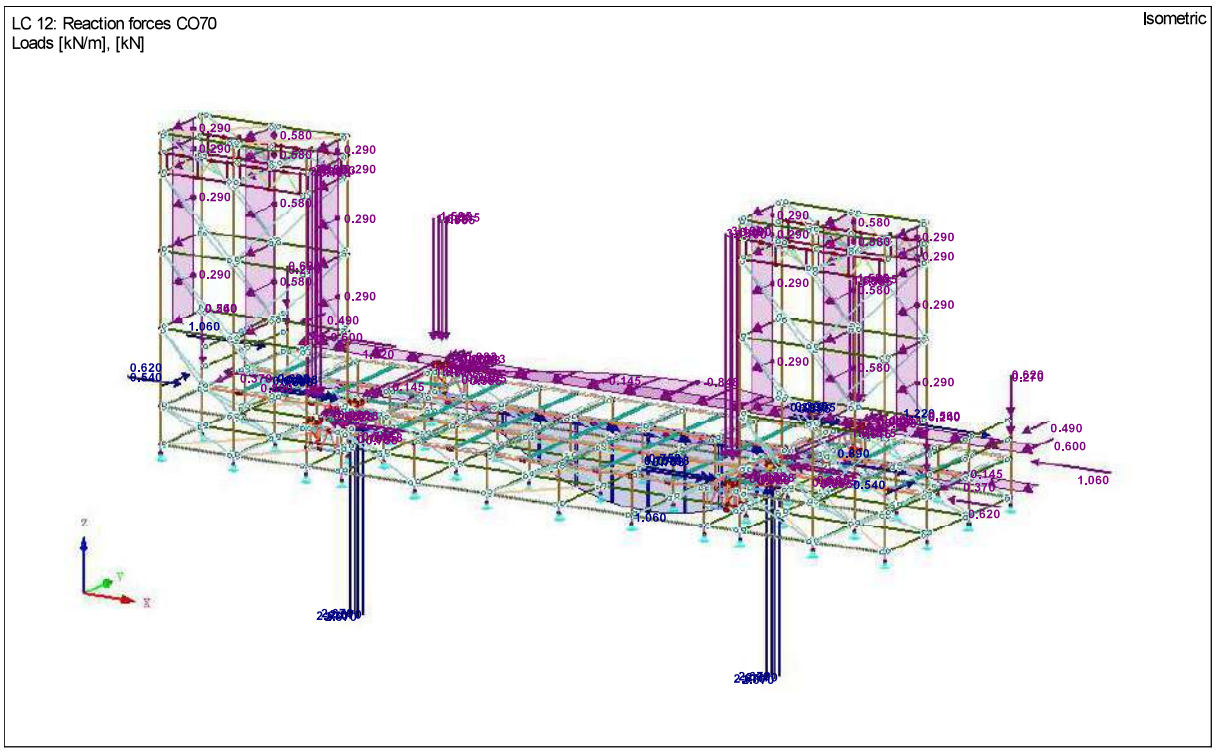
Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.196 / 0.8 = 0.245 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

6.2.9 LC12: Reaction forces CO70.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	-3,03	-0,11	-12,77	0,00	0,00	0,12
11	3,03	-0,11	-12,76	0,00	0,00	-0,12
19	2,79	-7,26	10,68	0,00	0,00	0,17
29	-2,78	-7,26	10,68	0,00	0,00	-0,17
55	-1,58	-0,33	-6,34	0,00	0,00	0,23
65	1,58	-0,33	-6,34	0,00	0,00	-0,23
102	0,62	-0,37	-0,56	0,00	0,00	-0,08
105	-0,89	0,54	-0,24	0,00	0,00	0,08
115	1,06	-0,60	-0,62	0,00	0,00	0,25
118	-1,22	-0,49	-0,27	0,00	0,00	-0,20
147	-0,62	-0,37	-0,56	0,00	0,00	0,08
150	0,89	0,54	-0,24	0,00	0,00	-0,08
160	-1,06	-0,60	-0,62	0,00	0,00	-0,25
163	1,22	-0,49	-0,27	0,00	0,00	0,20
Σ Forces	0,00	-17,26	-20,23			
Σ Loads	0,00	-17,26	-20,23			

Load input in Layher stage model.



The loading of the wind on the stage, PA wing and part of the loading of the wind on the back wall are added as member loads on the model.

Wind on stage
$q_{w,\ stage}$ = 1.4 * 0.2 * 1 = 0.290 kN/m
this is divided on the top and bottom ledger of the stage

Wind on PA wing.
Wind on outer Layher Pole
qw = 1.4 * 0.2 * 1.036 = 0.29

Wind on middle Layher Pole
qw = 1.4 * 0.2 * 2.072 = 0.58

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 1.3 * 0.2 * 6.525 * 0.5 = 0.848kN/m
$q_{w,\ back\ wall\ side}$ = 1.3 * 0.2 * 0 = 0 kN/m

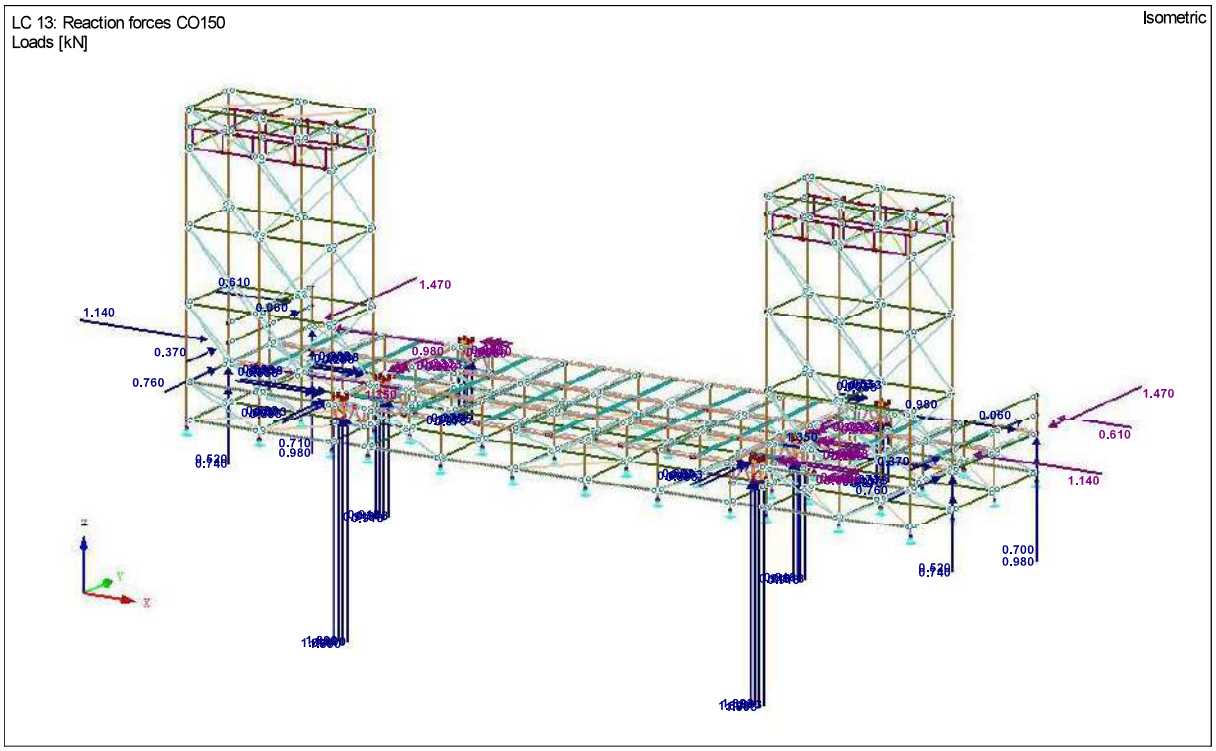
Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.848 / 0.8 = 1.060 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

6.2.10 LC13: Reaction forces CO150.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	2,55	2,77	7,56	0,00	0,00	-0,01
11	-2,56	2,77	7,57	0,00	0,00	0,01
19	1,15	-1,29	3,67	0,00	0,00	0,22
29	-1,15	-1,29	3,67	0,00	0,00	-0,22
55	-0,20	0,00	1,50	0,00	0,00	0,04
65	0,21	0,00	1,49	0,00	0,00	-0,04
102	-1,35	0,76	0,52	0,00	0,00	0,17
105	1,14	0,37	0,74	0,00	0,00	-0,25
115	-0,98	-1,47	0,71	0,00	0,00	-0,03
118	0,61	0,06	0,98	0,00	0,00	0,09
147	1,35	0,76	0,52	0,00	0,00	-0,17
150	-1,14	0,37	0,74	0,00	0,00	0,25
160	0,98	-1,47	0,70	0,00	0,00	0,03
163	-0,61	0,06	0,98	0,00	0,00	-0,09
Σ Forces	0,00	2,41	31,35			
Σ Loads	0,00	2,41	31,35			

Load input in Layher stage model.



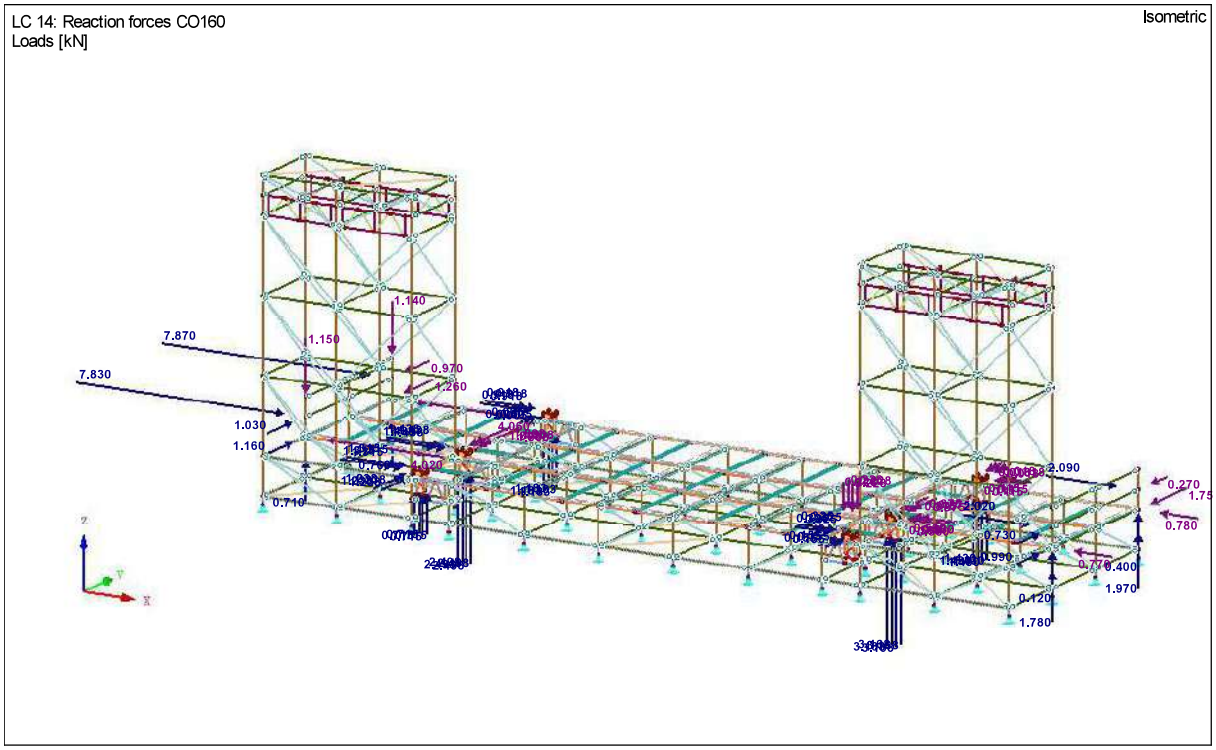
During the Out-service situation, the back wall and the stage scrim need to be removed therefor no extra loading will be added to the model.

6.2.11 LC14: Reaction forces CO160.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	5,26	4,95	2,86	0,00	0,00	-0,18
11	1,30	0,62	-0,91	0,00	0,00	0,09
19	5,75	-7,23	9,99	0,00	0,00	0,25
29	-2,24	-3,50	12,67	0,00	0,00	-0,25
55	3,67	0,02	4,73	0,00	0,00	-0,03
65	-0,46	-0,07	5,72	0,00	0,00	0,01
102	-4,02	1,16	0,71	0,00	0,00	0,59
105	7,83	1,03	-1,15	0,00	0,00	-1,51
115	-4,06	-1,26	0,76	0,00	0,00	-0,59
118	7,87	-0,97	-1,14	0,00	0,00	1,51
147	-0,77	0,99	0,12	0,00	0,00	0,23
150	2,02	0,73	1,78	0,00	0,00	-0,28
160	-0,78	-1,75	0,40	0,00	0,00	-0,31
163	2,09	-0,27	1,97	0,00	0,00	0,37
Σ Forces	23,46	-5,53	38,52			
Σ Loads	23,46	-5,53	38,52			

Load input in Layher stage model.



During the Out-service situation, the back wall and the stage scrim need to be removed therefor no extra loading will be added to the model.

6.3 Results summary of the Layher stage Calculation.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	42,7	mm	CO5, Member No. 87, x: 0.000 m
	Maximum displacement in Y-direction	7,8	mm	CO1, Member No. 1767, x: 0.857 m
	Maximum displacement in Z-direction	-19,9	mm	CO3, Member No. 582, x: 1.036 m
	Maximum vectorial displacement	42,7	mm	CO5, Member No. 87, x: 0.000 m
	Maximum rotation about X-axis	-34,5	mrad	CO3, Member No. 582, x: 2.072 m
	Maximum rotation about Y-axis	49,7	mrad	CO5, Member No. 1745, x: 0.438 m
	Maximum rotation about Z-axis	-15,7	mrad	CO5, Member No. 87, x: 0.000 m
	Number of 1D finite elements (member elements)	3388		
	Number of 2D finite elements (surface elements)	3566		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	4460		
	Number of equations	26760		
	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		
	Activate ineffective supports	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

6.3.1 Result for the single load cases LC1 to LC6.

	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	-62,65	kN	
	Sum of support forces in Z	-62,65	kN	Deviation: 0.00 %
	Resultant of reactions about X	-2,513	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 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. 884, x: 1.440 m
	Maximum displacement in Y-direction	-0,8	mm	Member No. 933, x: 1.440 m
	Maximum displacement in Z-direction	-1,7	mm	Member No. 1069, x: 1.465 m
	Maximum vectorial displacement	1,7	mm	Member No. 1069, x: 1.465 m
	Maximum rotation about X-axis	-1,3	mrad	Member No. 1352, x: 2.930 m
	Maximum rotation about Y-axis	1,3	mrad	Member No. 697, x: 0.000 m
	Maximum rotation about Z-axis	-0,2	mrad	Member No. 92, x: 0.500 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC2 - ballast loading			
	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	-116,00	kN	
	Sum of support forces in Z	-116,01	kN	Deviation: -0.01 %
	Resultant of reactions about X	44,943	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	-0,009	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	0,0	mm	Member No. 1067, x: 0.000 m
	Maximum displacement in Y-direction	0,0	mm	Member No. 892, x: 2.301 m
	Maximum displacement in Z-direction	-15,8	mm	Member No. 599, x: 1.036 m
	Maximum vectorial displacement	15,8	mm	Member No. 599, x: 1.036 m
	Maximum rotation about X-axis	27,8	mrad	Member No. 582, x: 0.000 m
	Maximum rotation about Y-axis	-19,8	mrad	Member No. 996, x: 0.000 m
	Maximum rotation about Z-axis	0,0	mrad	Member No. 97, x: 0.500 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC3 - PA wing loading			
	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	-32,00	kN	
	Sum of support forces in Z	-32,01	kN	Deviation: -0.03 %
	Resultant of reactions about X	51,271	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	0,034	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	-0,1	mm	Member No. 1757, x: 1.333 m
	Maximum displacement in Y-direction	-0,5	mm	Member No. 1495, x: 0.500 m
	Maximum displacement in Z-direction	-1,3	mm	Member No. 792, x: 1.036 m
	Maximum vectorial displacement	1,3	mm	Member No. 792, x: 1.036 m
	Maximum rotation about X-axis	-1,1	mrad	Member No. 1214, x: 0.000 m
	Maximum rotation about Y-axis	-0,5	mrad	Member No. 1198, x: 0.032 m
	Maximum rotation about Z-axis	1,1	mrad	Member No. 97, x: 0.500 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC4 - floor loading 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	33,36	kN	
	Sum of support forces in Y	33,36	kN	Deviation: 0.00 %
	Sum of loads in Z	-333,59	kN	
	Sum of support forces in Z	-333,59	kN	Deviation: 0.00 %
	Resultant of reactions about X	-240,956	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 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	2,2	mm	Member No. 88, x: 0.000 m
	Maximum displacement in Y-direction	1,6	mm	Member No. 262, x: 0.571 m
	Maximum displacement in Z-direction	-9,9	mm	FE Mesh Node No. 4326 (X: 9.765, Y: -1.035, Z: 0.314 m)
	Maximum vectorial displacement	9,9	mm	FE Mesh Node No. 4326 (X: 9.765, Y: -1.035, Z: 0.314 m)
	Maximum rotation about X-axis	16,3	mrad	FE Mesh Node No. 4319 (X: 9.868, Y: -0.272, Z: 0.314 m)

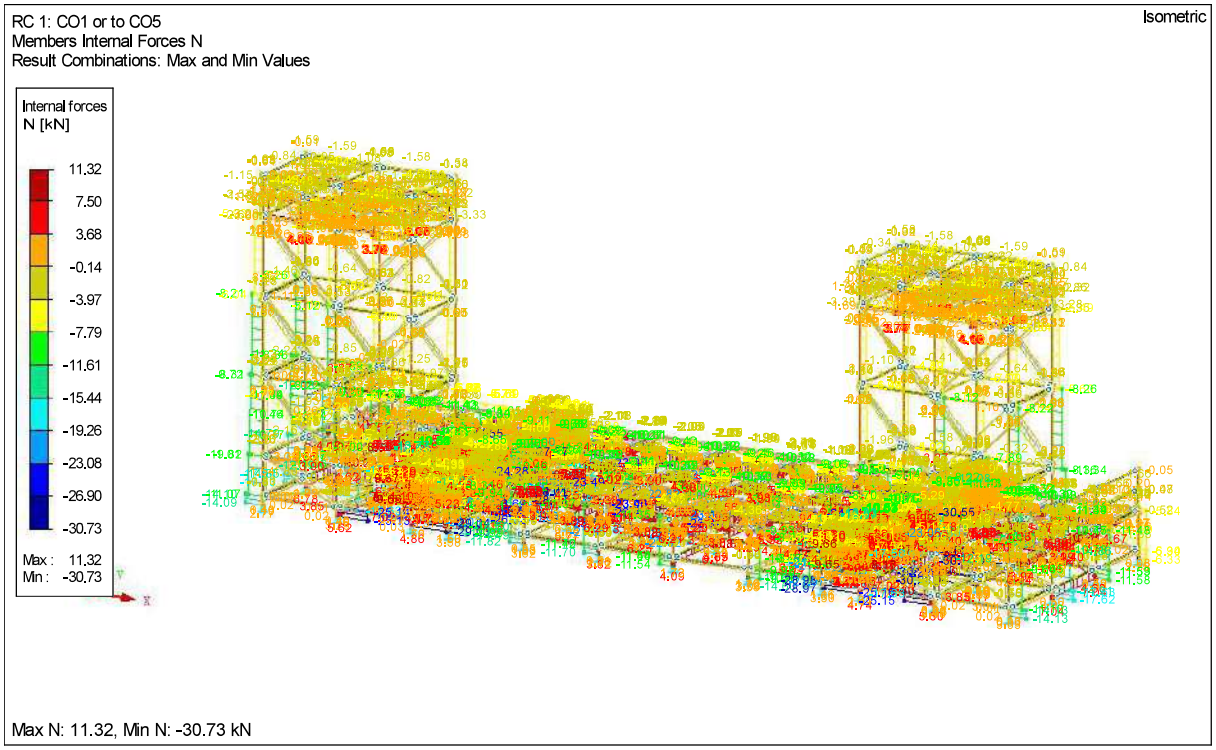
	Description	Value	Unit	Comment
	Maximum rotation about Y-axis	-20,6	mrad	FE Mesh Node No. 3488 (X: 8.057, Y: -3.101, Z: 0.314 m)
	Maximum rotation about Z-axis	1,6	mrad	Member No. 717, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC5 - floor loading 90°			
	Sum of loads in X	33,36	kN	
	Sum of support forces in X	33,36	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	-333,59	kN	
	Sum of support forces in Z	-333,59	kN	Deviation: 0.00 %
	Resultant of reactions about X	-276,990	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	-36,034	kNm	At center of gravity of model
	Resultant of reactions about Z	-27,699	kNm	At center of gravity of model
	Maximum displacement in X-direction	2,8	mm	Member No. 88, x: 0.000 m
	Maximum displacement in Y-direction	1,0	mm	Member No. 31, x: 0.667 m
	Maximum displacement in Z-direction	-9,9	mm	FE Mesh Node No. 4326 (X: 9.765, Y: -1.035, Z: 0.314 m)
	Maximum vectorial displacement	9,9	mm	FE Mesh Node No. 4076 (X: 2.667, Y: -1.037, Z: 0.314 m)
	Maximum rotation about X-axis	16,2	mrad	FE Mesh Node No. 4319 (X: 9.868, Y: -0.272, Z: 0.314 m)
	Maximum rotation about Y-axis	-20,6	mrad	FE Mesh Node No. 3488 (X: 8.057, Y: -3.101, Z: 0.314 m)
	Maximum rotation about Z-axis	-1,5	mrad	Member No. 844, x: 2.880 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC6 - floor loading 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-33,36	kN	
	Sum of support forces in Y	-33,36	kN	Deviation: 0.00 %
	Sum of loads in Z	-333,59	kN	
	Sum of support forces in Z	-333,59	kN	Deviation: 0.00 %
	Resultant of reactions about X	-313,024	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 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	2,3	mm	Member No. 88, x: 0.000 m
	Maximum displacement in Y-direction	-1,7	mm	FE Mesh Node No. 4229 (X: 6.708, Y: -1.800, Z: 0.314 m)
	Maximum displacement in Z-direction	-9,8	mm	FE Mesh Node No. 125 (X: 2.667, Y: -5.181, Z: 0.314 m)
	Maximum vectorial displacement	9,9	mm	FE Mesh Node No. 4076 (X: 2.667, Y: -1.037, Z: 0.314 m)
	Maximum rotation about X-axis	-16,2	mrad	FE Mesh Node No. 3352 (X: 2.564, Y: -5.944, Z: 0.314 m)
	Maximum rotation about Y-axis	20,6	mrad	FE Mesh Node No. 2827 (X: 4.375, Y: -3.115, Z: 0.314 m)
	Maximum rotation about Z-axis	1,6	mrad	Member No. 879, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis

6.3.2 Result for the load combination CO1-CO5.

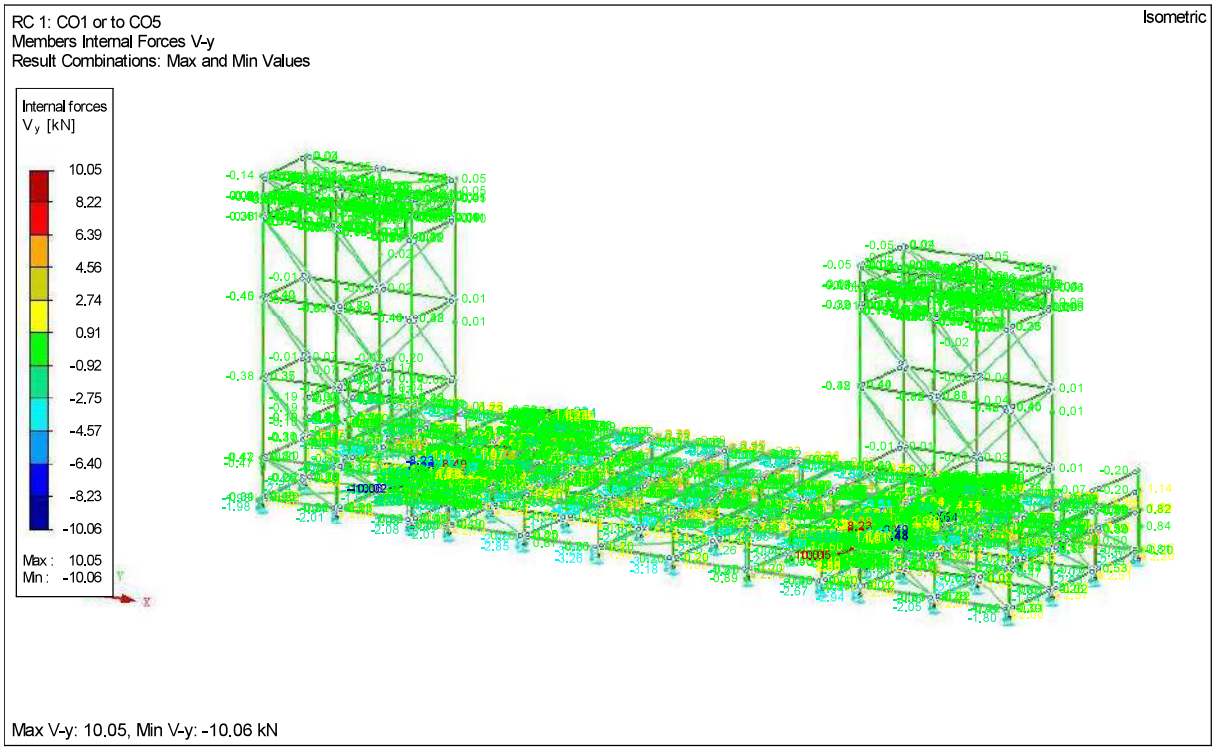
	Description	Value	Unit	Comment
	CO1 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC4 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	108,74	kN	
	Sum of support forces in Y	108,74	kN	Deviation: 0.00 %
	Sum of loads in Z	-680,07	kN	
	Sum of support forces in Z	-680,07	kN	Deviation: 0.00 %
	Resultant of reactions about X	-332,719	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	0,011	kNm	At center of gravity of model
	Resultant of reactions about Z	0,006	kNm	At center of gravity of model
	Maximum displacement in X-direction	-2,6	mm	FE Mesh Node No. 1993 (X: -2.877, Y: -1.043, Z: 0.314 m)
	Maximum displacement in Y-direction	7,8	mm	Member No. 1767, x: 0.857 m
	Maximum displacement in Z-direction	-19,2	mm	FE Mesh Node No. 4326 (X: 9.765, Y: -1.035, Z: 0.314 m)
	Maximum vectorial displacement	19,3	mm	FE Mesh Node No. 4076 (X: 2.667, Y: -1.037, Z: 0.314 m)
	Maximum rotation about X-axis	31,5	mrad	Member No. 434, x: 0.000 m
	Maximum rotation about Y-axis	41,8	mrad	FE Mesh Node No. 3840 (X: 4.375, Y: -1.043, Z: 0.314 m)
	Maximum rotation about Z-axis	10,2	mrad	Member No. 1846, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO2 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC5 + 1.35*LC11			
	Sum of loads in X	62,70	kN	
	Sum of support forces in X	62,70	kN	Deviation: 0.00 %
	Sum of loads in Y	1,84	kN	
	Sum of support forces in Y	1,84	kN	Deviation: 0.00 %
	Sum of loads in Z	-701,20	kN	
	Sum of support forces in Z	-701,20	kN	Deviation: 0.00 %

	Description	Value	Unit	Comment
	Resultant of reactions about X	-277,522	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	-54,632	kNm	At center of gravity of model
	Resultant of reactions about Z	-34,926	kNm	At center of gravity of model
	Maximum displacement in X-direction	12,6	mm	Member No. 87, x: 0.000 m
	Maximum displacement in Y-direction	1,7	mm	FE Mesh Node No. 4029 (X: 2.563, Y: -0.271, Z: 0.314 m)
	Maximum displacement in Z-direction	-19,1	mm	FE Mesh Node No. 4326 (X: 9.765, Y: -1.035, Z: 0.314 m)
	Maximum vectorial displacement	19,2	mm	FE Mesh Node No. 4076 (X: 2.667, Y: -1.037, Z: 0.314 m)
	Maximum rotation about X-axis	-32,6	mrad	Member No. 599, x: 2.072 m
	Maximum rotation about Y-axis	-41,7	mrad	FE Mesh Node No. 4447 (X: 8.057, Y: -1.029, Z: 0.314 m)
	Maximum rotation about Z-axis	-3,1	mrad	Member No. 146, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO3 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC6 + 1.35*LC12			
	Sum of loads in X	0,01	kN	
	Sum of support forces in X	0,01	kN	Deviation: 0.00 %
	Sum of loads in Y	-99,99	kN	
	Sum of support forces in Y	-99,99	kN	Deviation: 0.00 %
	Sum of loads in Z	-716,43	kN	
	Sum of support forces in Z	-716,43	kN	Deviation: 0.00 %
	Resultant of reactions about X	-253,460	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	-0,084	kNm	At center of gravity of model
	Resultant of reactions about Z	0,007	kNm	At center of gravity of model
	Maximum displacement in X-direction	4,4	mm	Member No. 146, x: 2.072 m
	Maximum displacement in Y-direction	-5,8	mm	Member No. 1883, x: 0.000 m
	Maximum displacement in Z-direction	-19,9	mm	Member No. 582, x: 1.036 m
	Maximum vectorial displacement	19,9	mm	Member No. 582, x: 1.036 m
	Maximum rotation about X-axis	-34,5	mrad	Member No. 582, x: 2.072 m
	Maximum rotation about Y-axis	42,0	mrad	FE Mesh Node No. 253 (X: 4.375, Y: -5.187, Z: 0.314 m)
	Maximum rotation about Z-axis	9,7	mrad	Member No. 1868, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO4 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	3,24	kN	
	Sum of support forces in Y	3,24	kN	Deviation: 0.00 %
	Sum of loads in Z	-206,33	kN	
	Sum of support forces in Z	-206,33	kN	Deviation: 0.00 %
	Resultant of reactions about X	89,460	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	0,140	kNm	At center of gravity of model
	Resultant of reactions about Z	-0,084	kNm	At center of gravity of model
	Maximum displacement in X-direction	3,5	mm	Member No. 87, x: 0.000 m
	Maximum displacement in Y-direction	1,7	mm	Member No. 1861, x: 0.000 m
	Maximum displacement in Z-direction	-18,6	mm	Member No. 582, x: 1.036 m
	Maximum vectorial displacement	18,6	mm	Member No. 582, x: 1.036 m
	Maximum rotation about X-axis	32,6	mrad	Member No. 582, x: 0.000 m
	Maximum rotation about Y-axis	-23,8	mrad	Member No. 757, x: 0.000 m
	Maximum rotation about Z-axis	-3,7	mrad	Member No. 1890, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO5 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC14			
	Sum of loads in X	31,67	kN	
	Sum of support forces in X	31,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,49	kN	
	Sum of support forces in Y	-7,49	kN	Deviation: 0.00 %
	Sum of loads in Z	-196,66	kN	
	Sum of support forces in Z	-196,66	kN	Deviation: 0.00 %
	Resultant of reactions about X	145,553	kNm	At center of gravity of model (X: 6.216, Y: -3.578, Z: 1.454 m)
	Resultant of reactions about Y	-88,595	kNm	At center of gravity of model
	Resultant of reactions about Z	-19,524	kNm	At center of gravity of model
	Maximum displacement in X-direction	42,7	mm	Member No. 87, x: 0.000 m
	Maximum displacement in Y-direction	-4,2	mm	Member No. 1929, x: 0.000 m
	Maximum displacement in Z-direction	-19,0	mm	Member No. 566, x: 1.036 m
	Maximum vectorial displacement	42,7	mm	Member No. 87, x: 0.000 m
	Maximum rotation about X-axis	33,1	mrad	Member No. 566, x: 2.072 m
	Maximum rotation about Y-axis	49,7	mrad	Member No. 1745, x: 0.438 m
	Maximum rotation about Z-axis	-15,7	mrad	Member No. 87, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

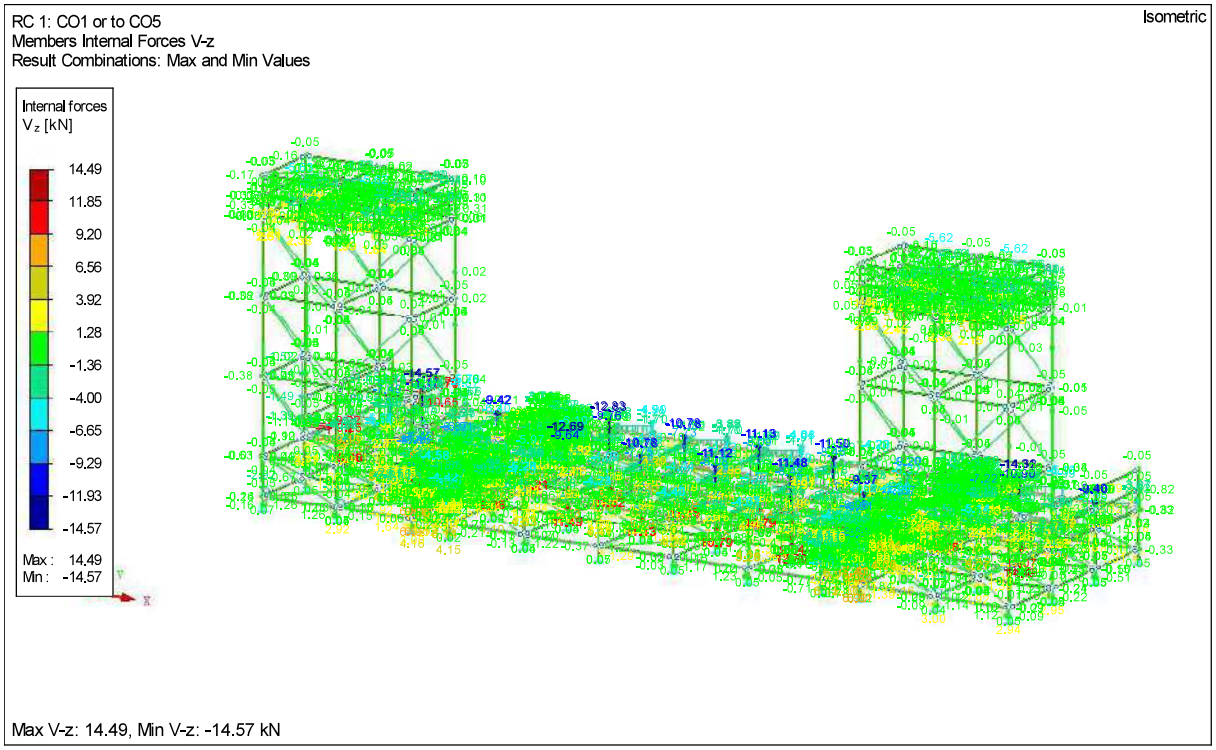
6.3.3 internal force diagrams –load combinations Design values: 1 * (CO1 or to CO5).



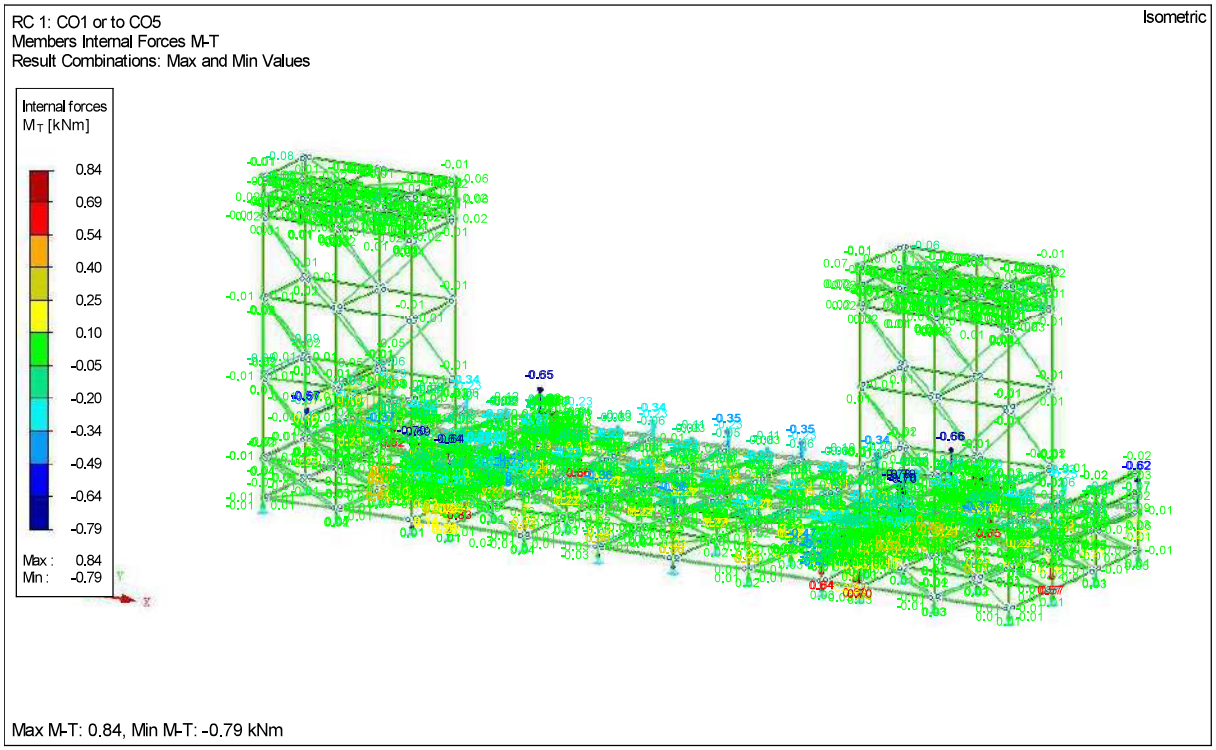
Max N: 11.32, Min N: -30.73 kN



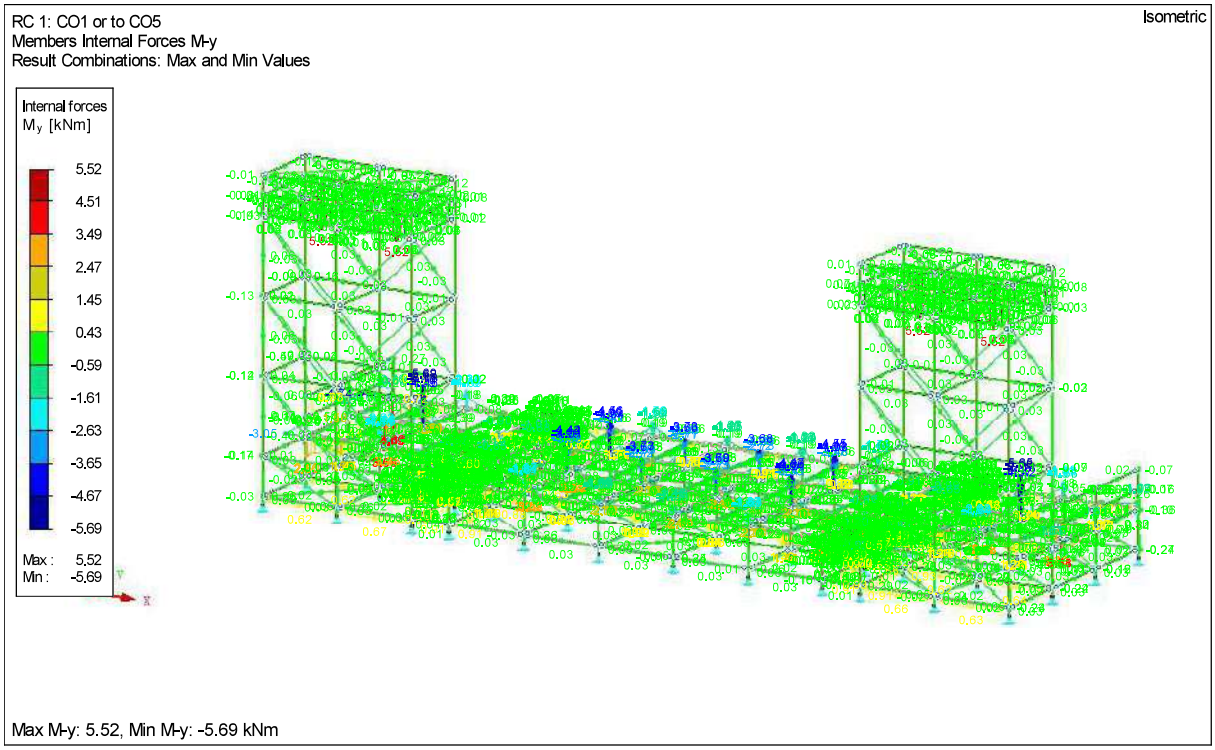
Max V-y: 10.05, Min V-y: -10.06 kN



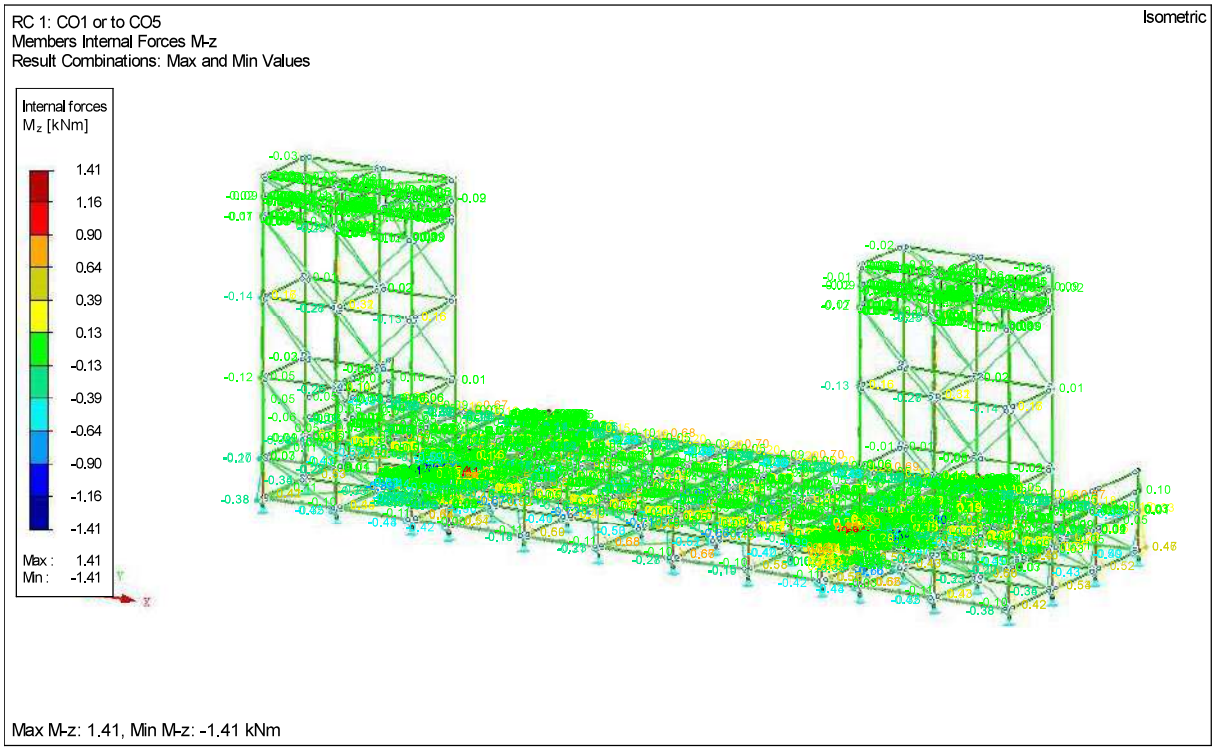
Max V-z: 14.49, Min V-z: -14.57 kN



Max M-T: 0.84, Min M-T: -0.79 kNm



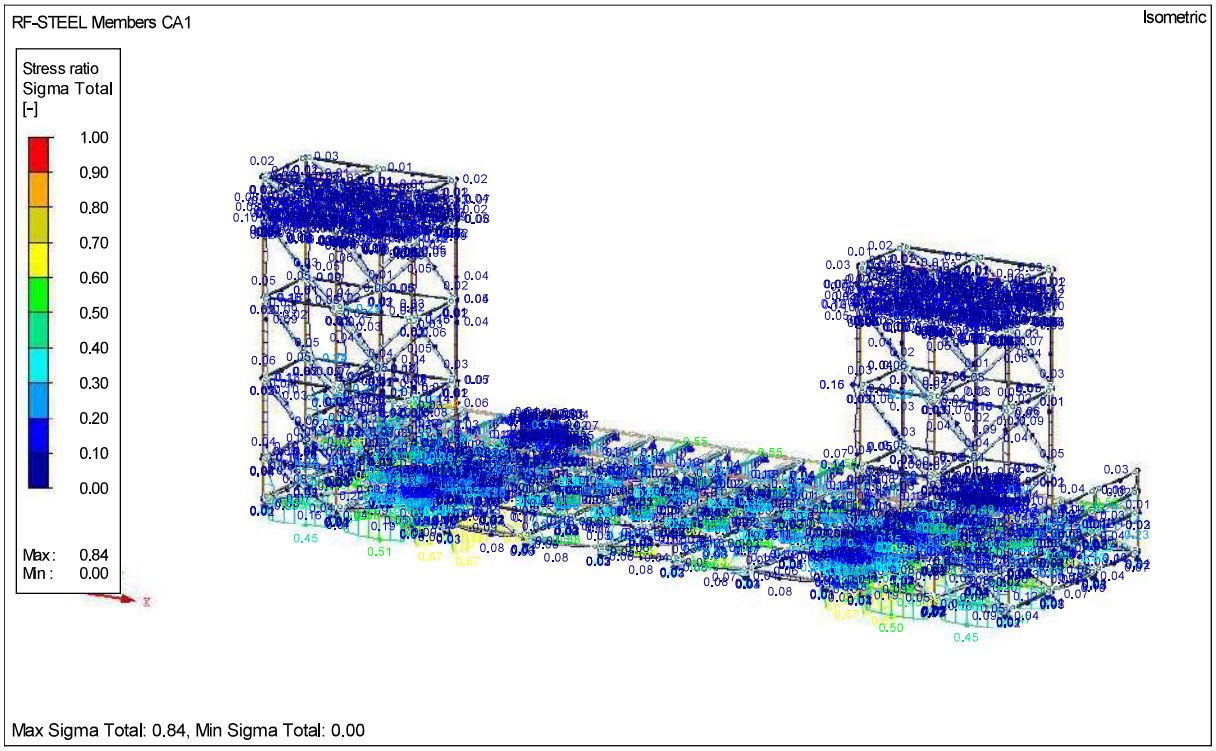
Max M-y: 5.52, Min M-y: -5.69 kNm

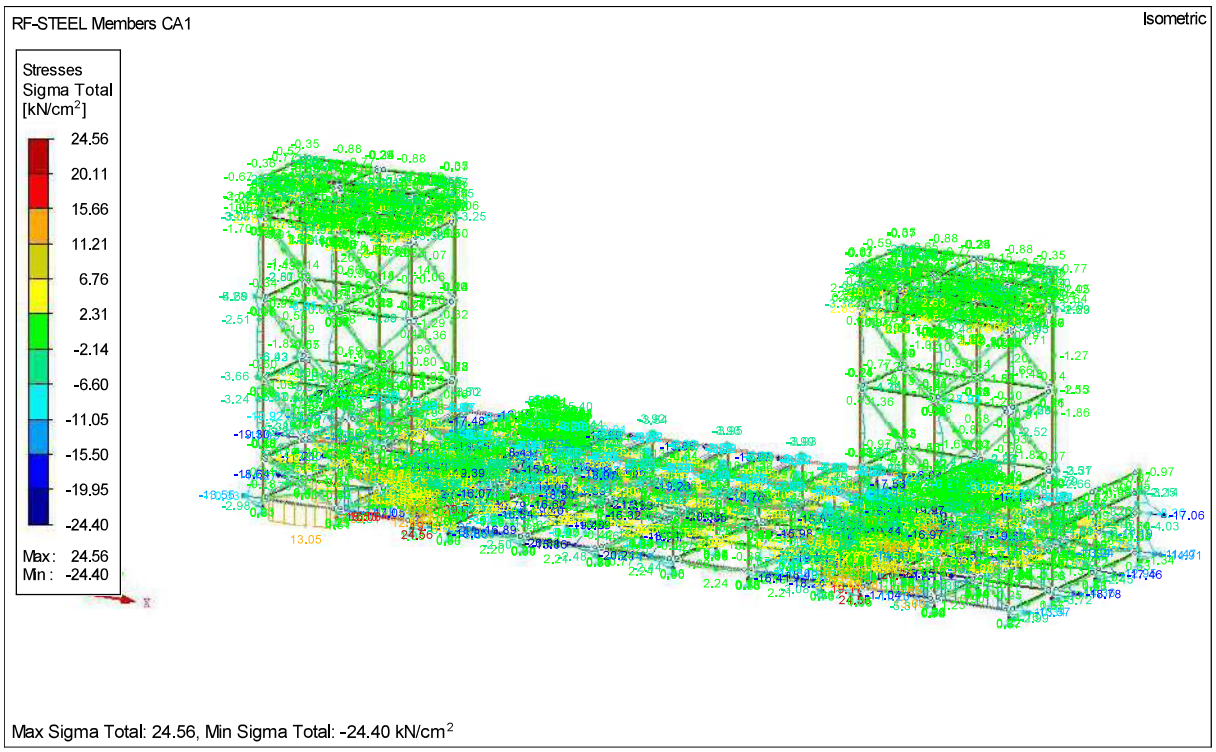


Max M-z: 1.41, Min M-z: -1.41 kNm

6.4 Stress analyse calculation for the stage components.

For the complete stage a stress calculation has been made.





Result of the stress analyse by cross section.

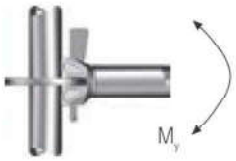
Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 51/5							
	1846	0,134	23	CO1	Sigma Total	24,56	32,27	0,76
	1912	0,000	24	CO3	Tau Total	8,78	18,63	0,47
	1890	0,134	32	CO1	Sigma-eqv	26,09	32,27	0,81
2	QRO 50x4 (Hot Formed)							
	1336	0,033	10	CO1	Sigma Total	14,51	21,36	0,68
	167	0,000	11	CO1	Tau Total	-5,24	12,33	0,43
	1336	0,033	10	CO1	Sigma-eqv	15,32	21,36	0,72
3	Ring 30/3							
	1855	0,543	33	CO1	Sigma Total	8,99	21,36	0,42
	1854	0,250	35	CO1	Tau Total	-2,10	12,33	0,17
	1855	0,543	33	CO1	Sigma-eqv	9,06	21,36	0,42
4	Rectangle 60/15							
	1863	0,065	2	CO1	Sigma Total	8,97	21,36	0,42
	1863	0,065	5	CO1	Tau Total	0,49	12,33	0,04
	1863	0,065	2	CO1	Sigma-eqv	8,97	21,36	0,42
5	Ring 20/2							
	1909	0,000	22	CO1	Sigma Total	6,00	21,36	0,28
	1866	0,000	24	CO1	Tau Total	0,83	12,33	0,07
	1909	0,000	22	CO1	Sigma-eqv	6,11	21,36	0,29
6	RO 38x4.5 | DIN EN 10220							
	744	0,000	1	CO1	Sigma Total	-23,50	32,27	0,73
	585	0,210	10	CO3	Tau Total	-1,39	18,63	0,07
	744	0,000	1	CO1	Sigma-eqv	23,51	32,27	0,73
7	RO 48.3x3.2 (Hot Formed)							
	1745	0,000	26	CO2	Sigma Total	-24,40	29,09	0,84
	33	0,000	3	CO2	Tau Total	1,27	16,80	0,08
	1745	0,000	26	CO2	Sigma-eqv	24,40	29,09	0,84
8	RO 48.3x3.2 (Hot Formed)							
	582	0,888	10	CO3	Sigma Total	-19,97	29,09	0,69
	582	0,000	19	CO3	Tau Total	-1,90	16,80	0,11
	582	0,888	10	CO3	Sigma-eqv	19,97	29,09	0,69
9	RO 48.3x3.2 (Hot Formed)							
	1349	1,465	10	CO3	Sigma Total	-1,61	29,09	0,06
	1349	2,930	1	CO1	Tau Total	-0,12	16,80	0,01
	1349	1,465	10	CO3	Sigma-eqv	1,62	29,09	0,06
10	RO 48.3x2.6 (Hot Formed)							
	712	1,150	10	CO1	Sigma Total	-3,67	21,36	0,17
	717	2,301	19	CO1	Tau Total	1,16	12,33	0,09
	712	1,150	10	CO1	Sigma-eqv	3,68	21,36	0,17
12	HK 50/30/4/4/4/4							
	784	2,072	14	CO2	Sigma Total	-9,39	22,50	0,42
	825	2,072	8	CO3	Tau Total	2,88	12,99	0,22
	784	2,072	14	CO2	Sigma-eqv	9,46	22,50	0,42
13	IPE 160							
	929	1,036	1	CO3	Sigma Total	-5,35	21,36	0,25
	792	2,072	13	CO1	Tau Total	-0,80	12,33	0,07
	929	1,036	1	CO3	Sigma-eqv	5,35	21,36	0,25
14	HK 30/20/2/2/2/2							
	1528	0,620	14	CO1	Sigma Total	-3,57	21,36	0,17
	1501	0,620	8	CO1	Tau Total	0,11	12,33	0,01
	1528	0,620	14	CO1	Sigma-eqv	3,57	21,36	0,17
15	RO 48.3x3.2 (Hot Formed)							
	1156	0,000	27	CO2	Sigma Total	-3,96	29,09	0,14
	1141	0,000	1	CO2	Tau Total	1,37	16,80	0,08
	1156	0,000	27	CO2	Sigma-eqv	3,96	29,09	0,14

6.5 Layher information design values.

The used Layher system is the Layher K2000+ system.
When parts need to be replaced by Layher Variant II system, take care that these will be in places with less internal forces.

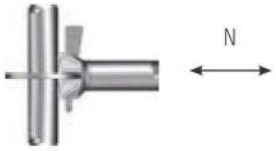
Z-8.22-64: K 2000+

Biegemoment



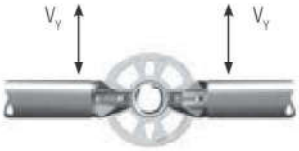
Biegemoment
$M_{y,Rd} = \pm 101{,}0$ kNcm

Normalkraft

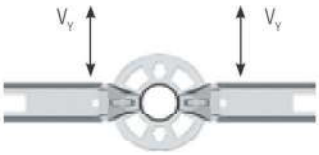


$N_{Rd} = \pm 31{,}0$ kN

Horizontale Querkraft



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



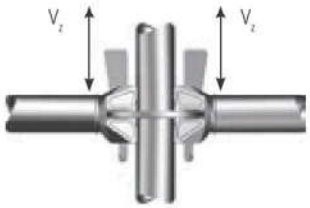
U-Riegel: $V_{y,Rd} = \pm 5{,}9$ kN

Torsionsmoment



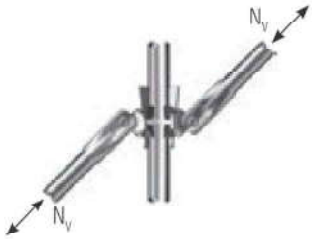
$M_{T,Rd} = \pm 52{,}5$ kNcm

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
$N_{V,Rd}$ [kN]	-16,1	-16,8	-15,5	-14,8	-12,4	-10,2	-8,3	-5,3	+17,9

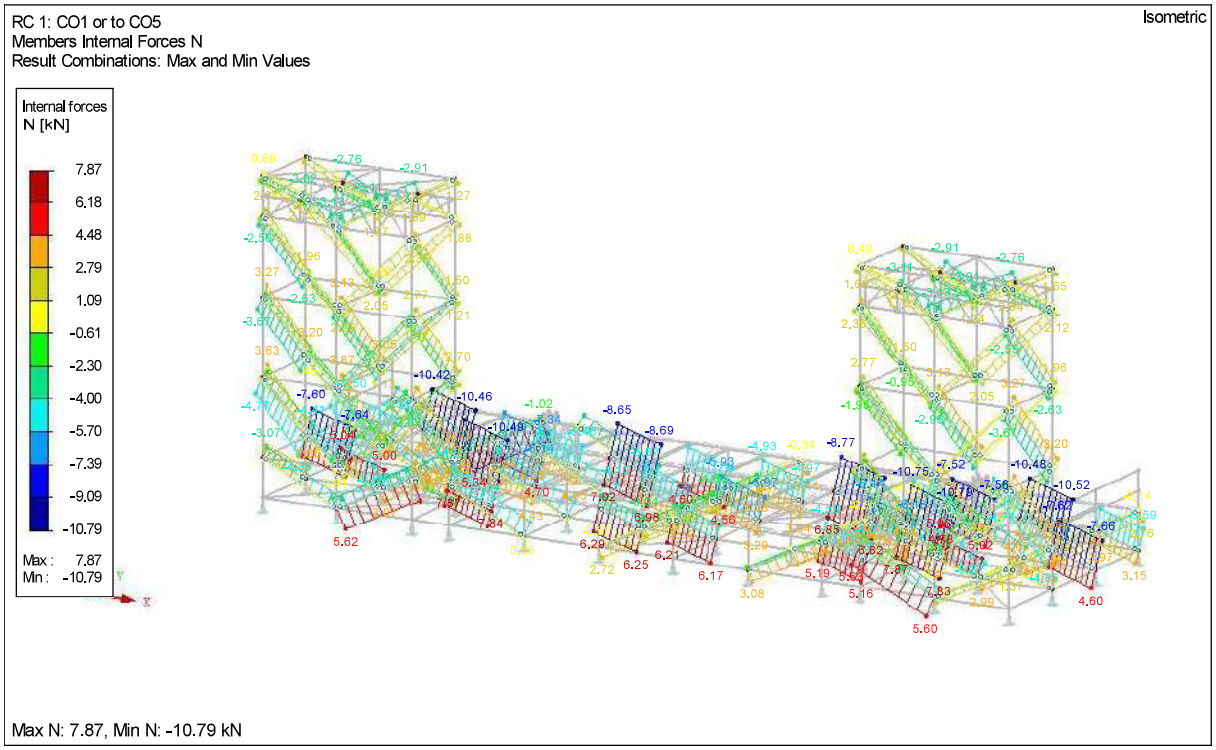
K 2000+ Bauteile können mit Bauteilen der Variante LW, Variante II und Variante I vermischt werden. Beanspruchbarkeiten siehe Zulassung Z-8.22-64 und Z-8.22-949.

Rd = Beanspruchbarkeit,
(enthält Teilsicherheitsbeiwert γ_M)

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

6.6 Check of the Layher diagonals.

The Maximum compression of the Layher K2000+ diagonals is according to the figure in chapter 6.5. In the next figure the minimum and maximum forces are displayed.



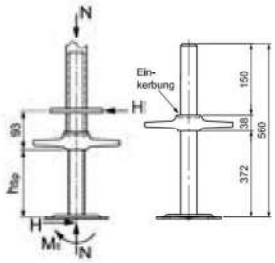
The maximum N_{ed} in a diagonal is 10.79 kN. According to the table on page 220 the maximum design force for this diagonal is 12.4 kN
Check of the diagonals
$N_{ed} / N_{rd} < 1$
$10.79 / 12.4 = 0.87 < 1$

6.7 Check of the Layher Spindle's.

In the next table the spindle loading capacity in conjunction with height is given

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

Ausspindellänge h_{sp} [cm]	Zulässige Vertikallast N [kN]* bei gleichzeitiger Wirkung einer Horizontallast H [kN]																								Zul. Horizontallast H [kN] wenn N = 0
	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		
	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

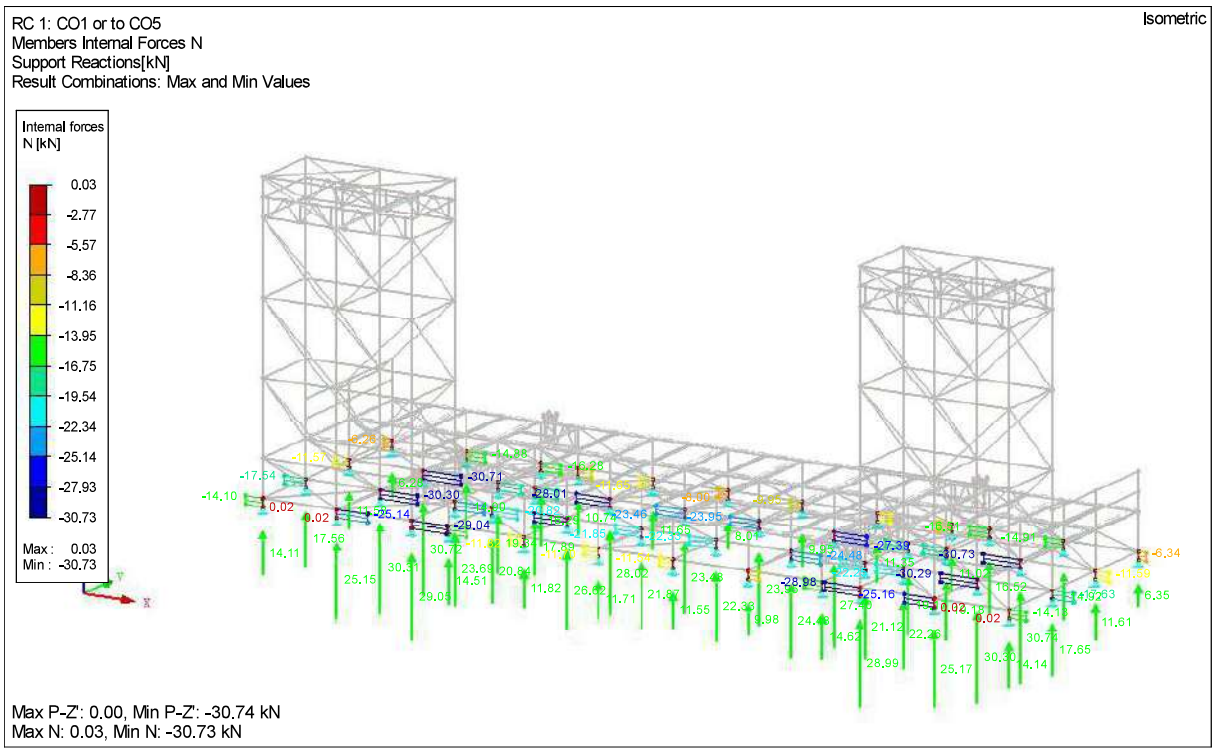
*Die zulässigen Vertikallasten wurden berechnet unter Anwendung des Berechnungsmodells nach DIN EN 12811-1, Abs. 10.2.3.2. Zur Erfassung der Biegesteifigkeit des Ständerrohres, der Schnittgrößenanteile aus Theorie II. Ordnung und der maximalen Beanspruchbarkeit der Ständer wurden folgende Raumgerüste 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.

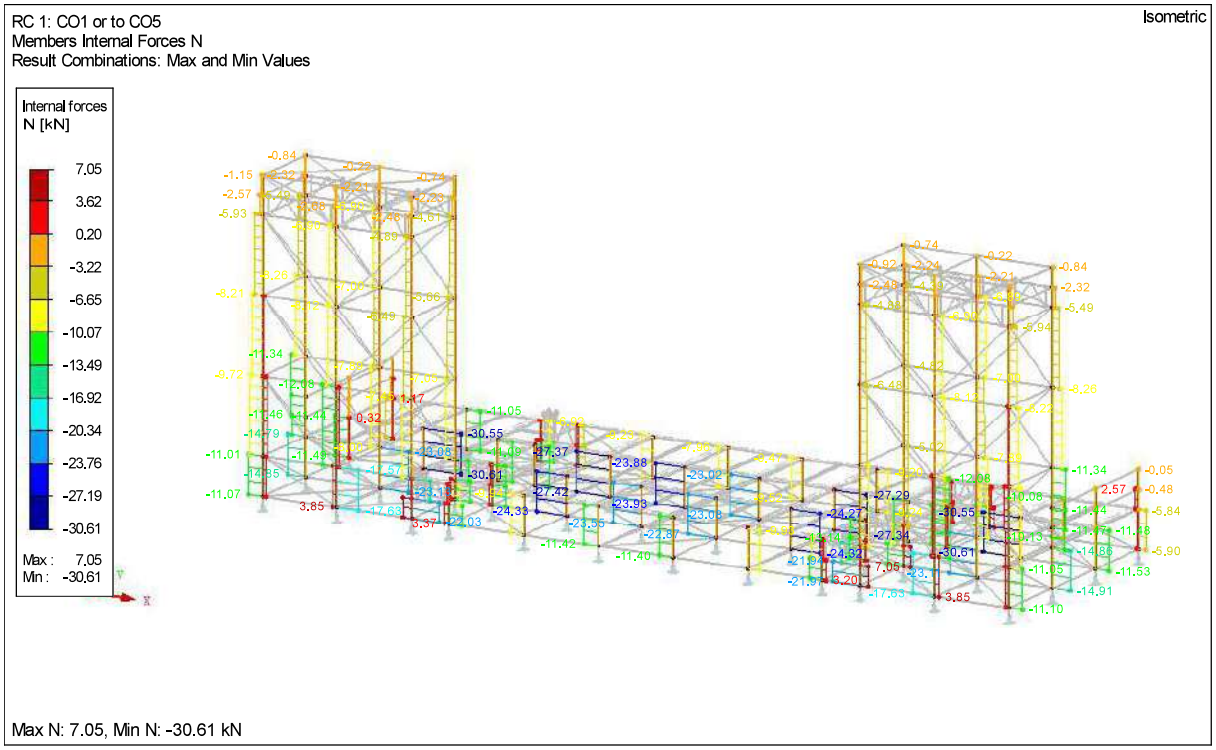
In the next figure the maximum support forces for Result combination are presented.



The maximum support force is 30.73kN.

The maximum total horizontal force is 108.74 kN. This force will be divided over the 48 spindles. 108.74 / 48 = 2.26 kN of horizontal force per spindle. According to the table of the Layher spindle the combination between the vertical and the horizontal force allows for a maximum spindle length of 15 cm on the highest loaded spindles.

6.8 Check of the Layher columns.



Proof against buckling.
$\beta = 0.9$
$L_{cr} = 0.9 * 100 = 90$ cm
$A = 4.53$ cm²
$I = 11.60$ cm^4
$W = 4.80$ cm³
$i = 1.60$cm

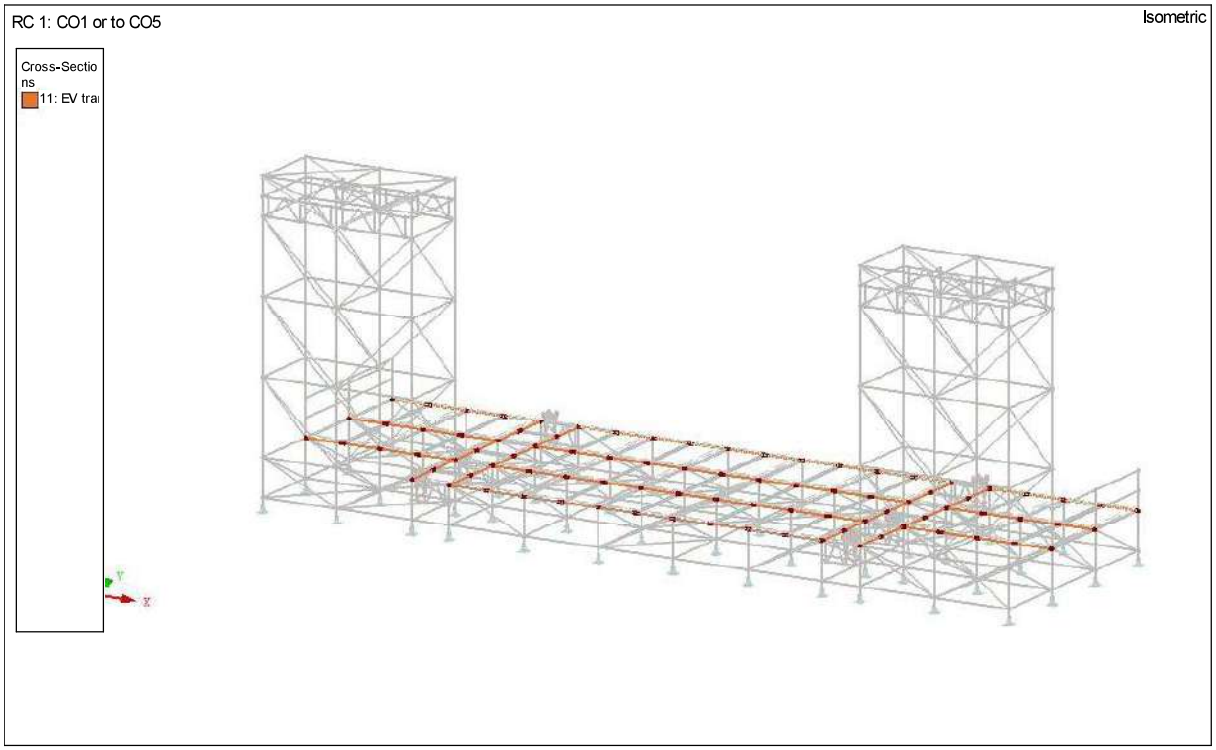
$\lambda_1 = \pi * \sqrt{(210000/320)} = 80{,}48$
$\overline{\lambda} = 90 / (1.6 * 80.48) = 0.699$
Buckling curve for hollow section line c (table 6.2 from en-1993-1-1)
$\alpha = 0{,}49$
$\Phi = 0.5 * (1 + \alpha * (\overline{\lambda} - 0.2) + \overline{\lambda}^2)$
$\Phi = 0.5 * (1 + 0.49 * (0.699 - 0.2) + 0.699^2) = 0.866$
$\chi_{min} = 1 / (\Phi + \sqrt{(\Phi^2 - \overline{\lambda}^2)})$
$\chi_{min} = 1 / (0.866 + \sqrt{(0.866^2 - 0.699^2)}) = 0.505$

$N_{b,rd} = \chi * A * f_0 / 1.1$
$N_{b,rd} = 0.505 * 4.53 * 32 / 1.1 = 66.59$ kN
$N_{ed,\,max} = 28.49$ kN

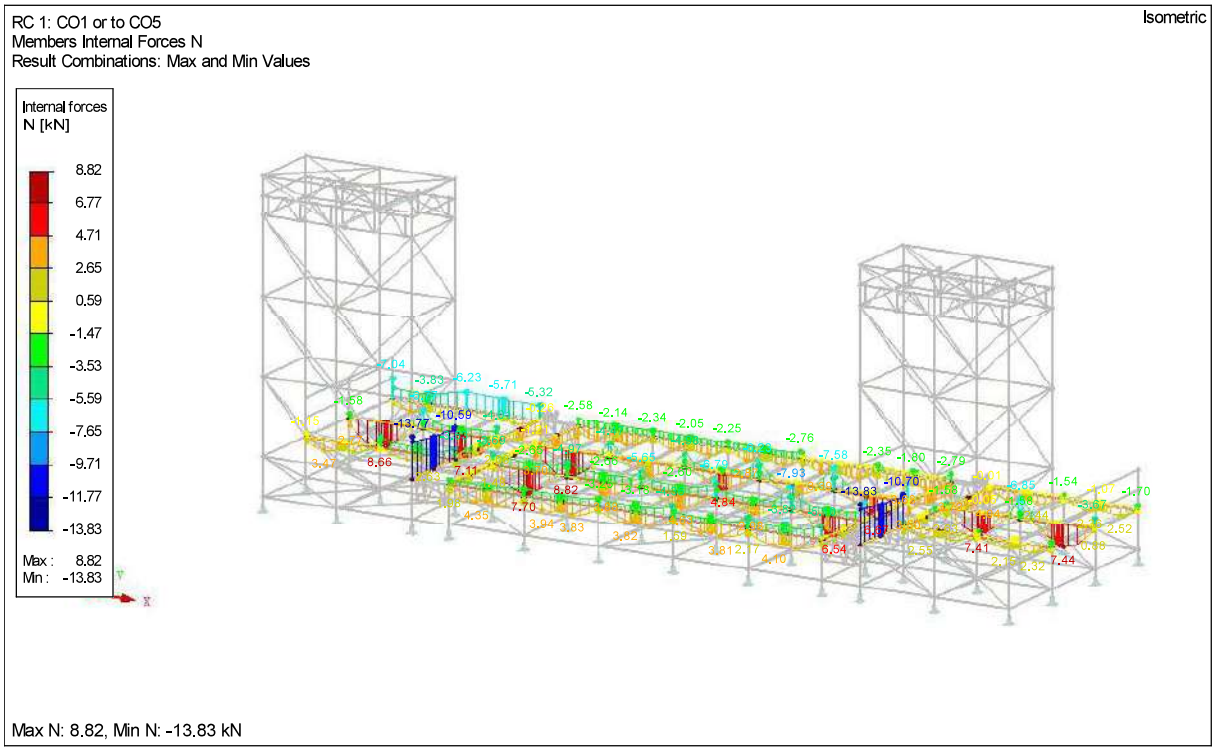
check = $N_{ed,\,max} / N_{b,rd} < 1$
$30.61 / 66.59 = 0.46 < 1$

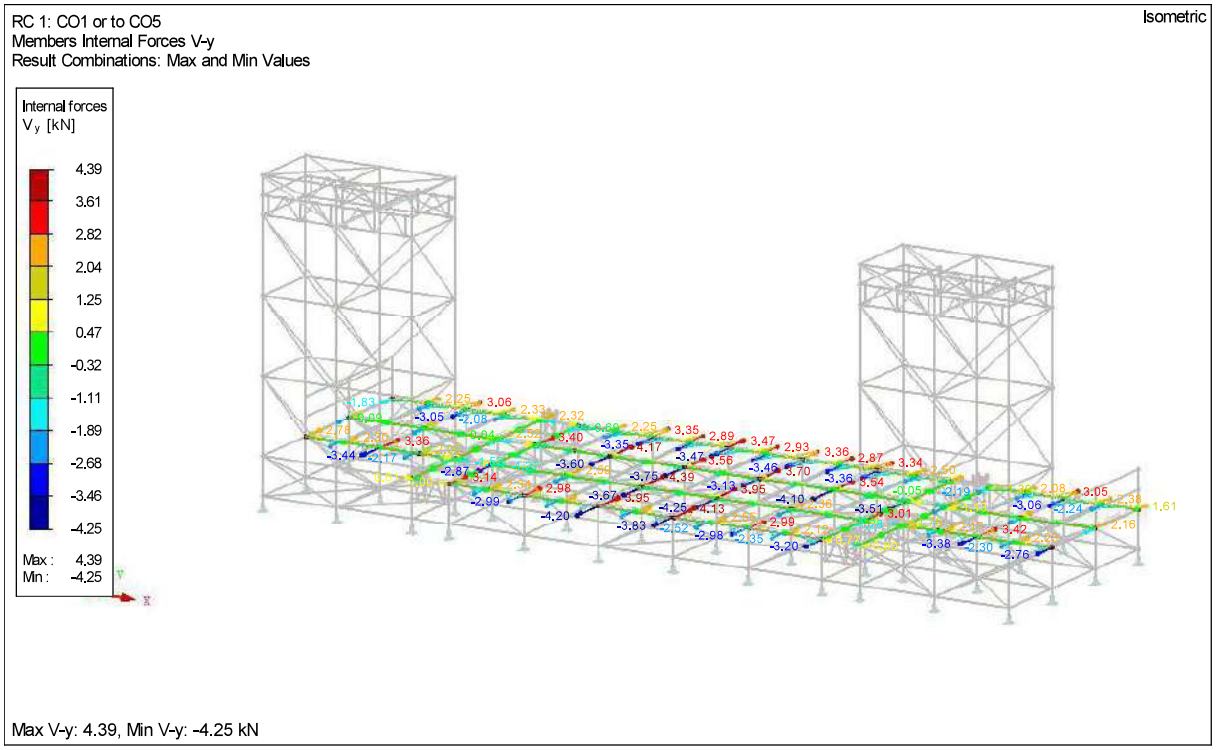
6.9 Check of the Event Layher staging system.

The event Layher staging system exist of Layher transom beams with a decking system on top.

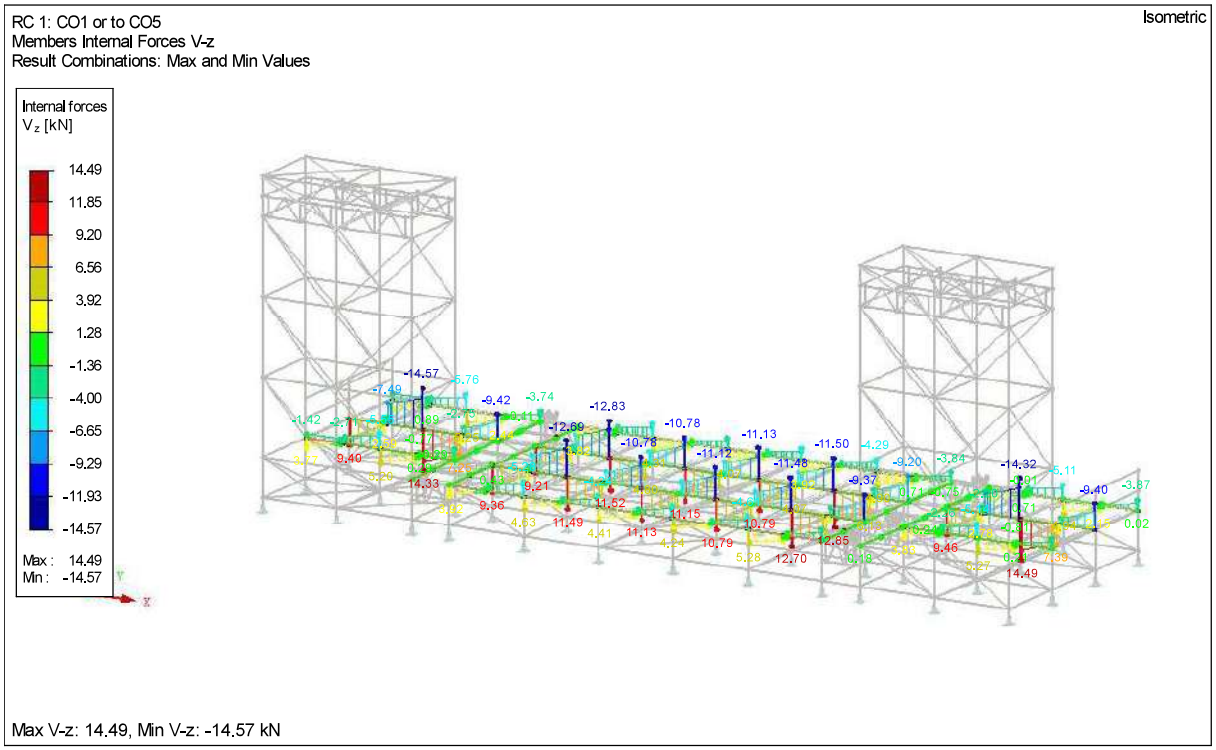


In the next figures the internal forces of the floor beam are shown.





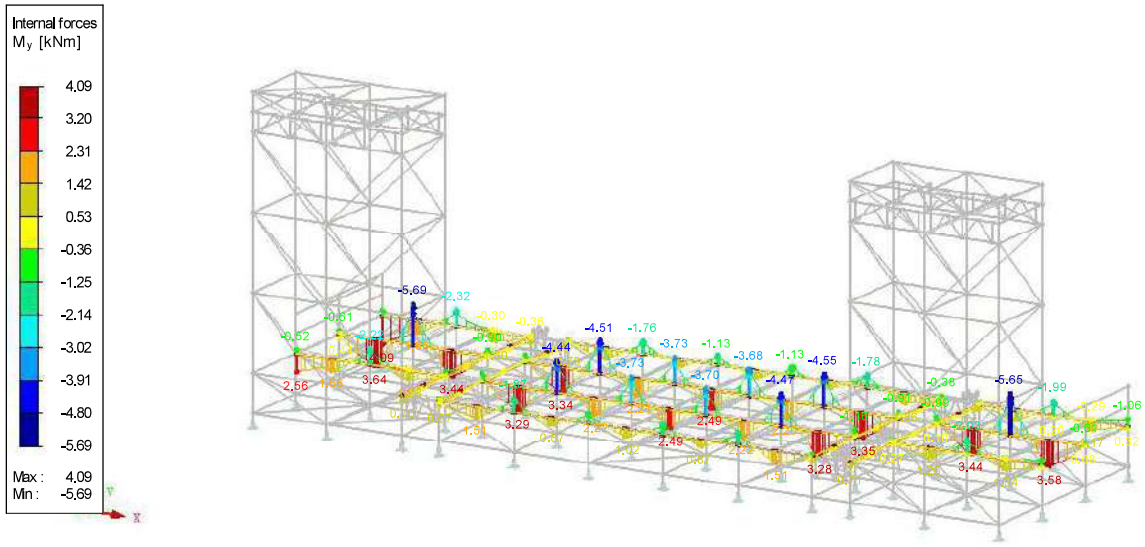
Max V-y: 4.39, Min V-y: -4.25 kN



Max V-z: 14.49, Min V-z: -14.57 kN

RC 1: CO1 or to CO5
Members Internal Forces M-y
Result Combinations: Max and Min Values

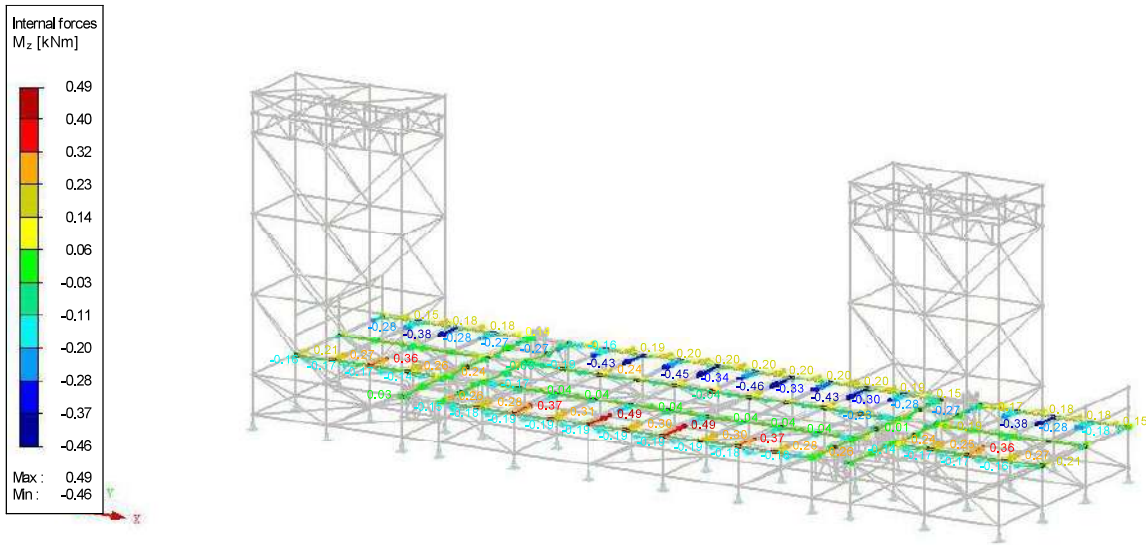
Isometric



Max M-y: 4.09, Min M-y: -5.69 kNm

RC 1: CO1 or to CO5
Members Internal Forces M-z
Result Combinations: Max and Min Values

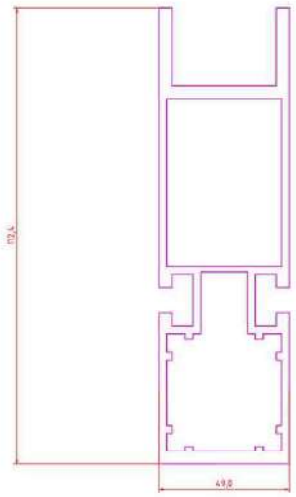
Isometric



Max M-z: 0.49, Min M-z: -0.46 kNm

Profiel berekening.

Layher Event Beam speciaal profiel Aluminium 6005A T6



I_1 [cm⁴]	5542580
I_2 [cm⁴]	701986
e_z [cm]	90.03
e_y [cm]	82.36
A [cm²]	1878.072

$Wy = I_1 / e_y = 554 / 8.25 = 67.15\ cm^3$
$Wz = I_2 / e_z = 70.2 / 2.5 = 28.08\ cm^3$

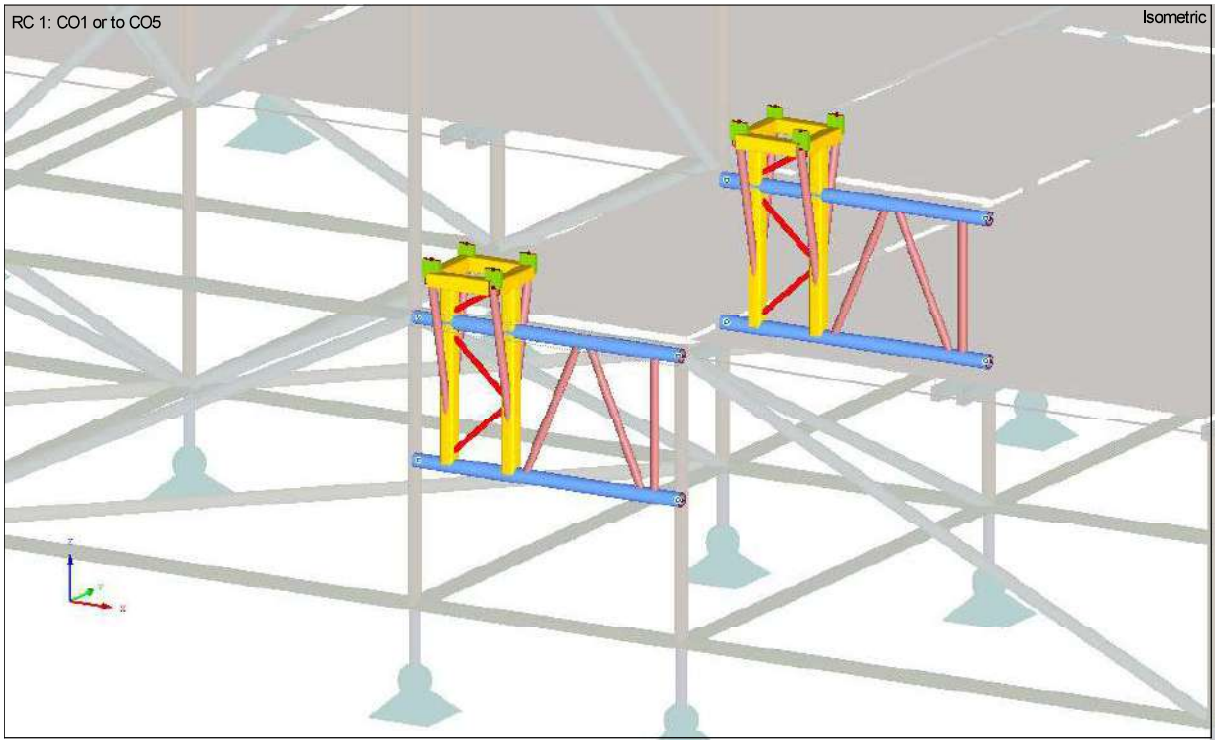
$N_{ed} = 13.83\ kN$
$\sigma N_{ed} = N_{ed} / A = 13.83 / 18.78 = 0.73\ kN/cm^2$
$V_{y,ed} = 4.39\ kN$
$\sigma v_{z,ed} = V_{y,ed} / A = 4.39 / 18.78 = 0.23\ kN/cm^2$
$V_{z,ed} = 14.57\ kN$
$\sigma v_{z,ed} = V_{z,ed} / A = 14.57 / 18.78 = 0.77\ kN/cm^2$
$My,ed = 5.69\ kNm$
$\sigma M_{y,ed} = M_{y,ed} / Wy = 569 / 67.15 = 8.47\ kN/cm^2$
$Mz,ed = 0.49\ kNm$
$\sigma M_{z,ed} = M_{z,ed} / Wy = 49 / 28.08 = 1.74\ kN/cm^2$

$\sigma tot = \sigma N_{ed} + 0{,}58 * \sigma v_{z,ed} + 0{,}58 * \sigma v_{z,ed} + \sigma M_{y,ed} + \sigma M_{y,ed}$
$0.73 + 0.58 * 0.23 + 0.58 * 0.77 + 8.47 + 1.74 = 11.52\ kN/cm^2$

Check
$\sigma tot / (fy / \gamma) < 1$
$11.52 / (22.5 / 1.1) = 0.56 < 1$

6.10 Check of the truss connection to the Layher stage.

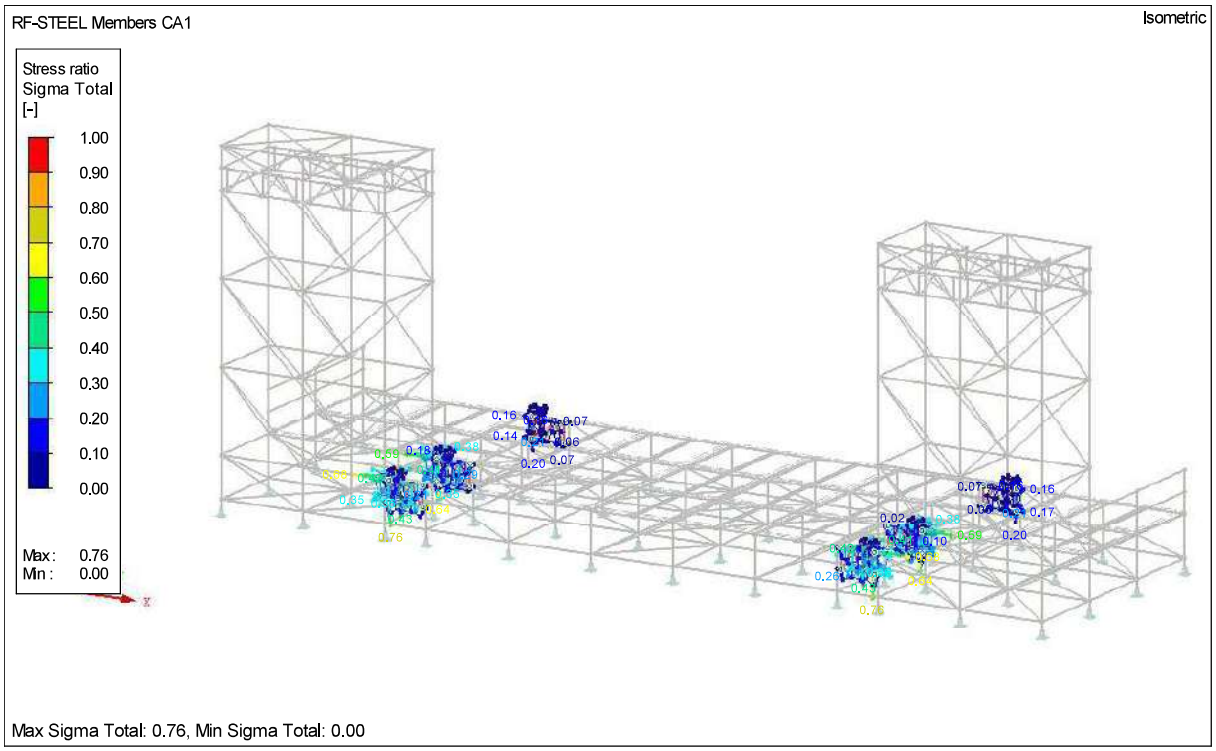
The Layher bases are inserted in the RFem model.

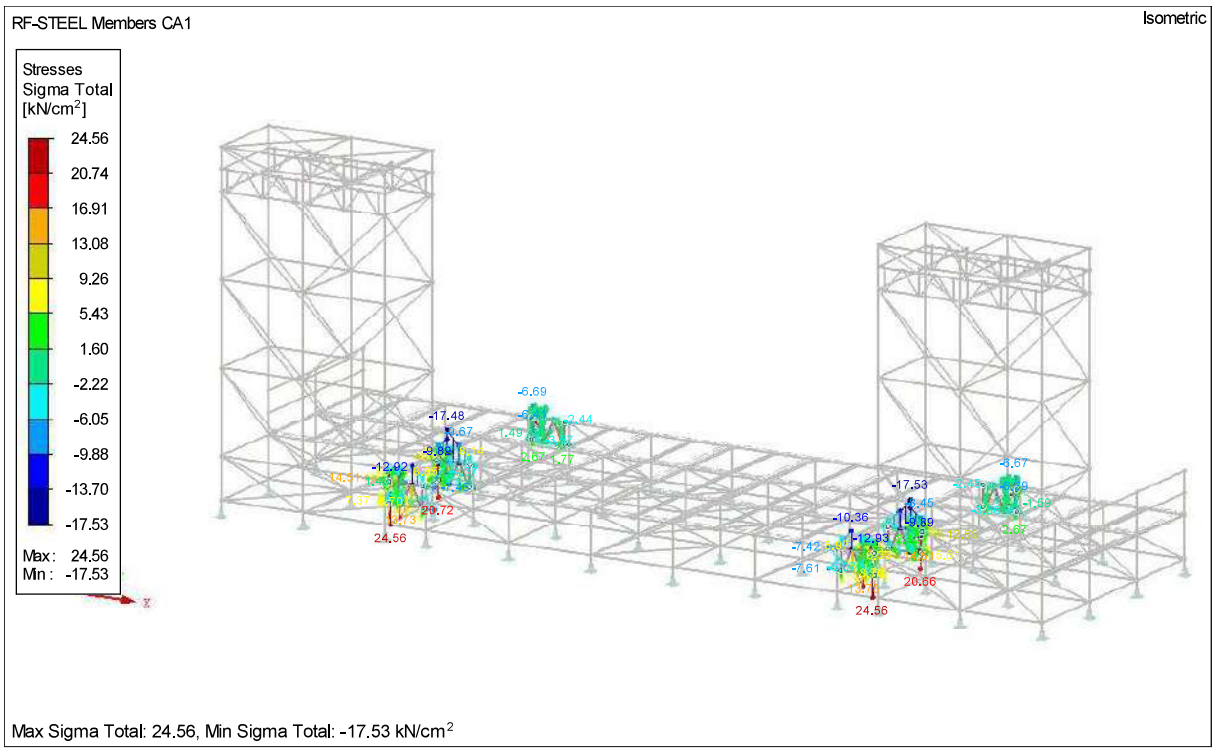


Cross-Sections
1: Ring 51/5; Steel S 355 JR
2: QRO 50x4 (Hot Formed); Steel S 235 JR
3: Ring 30/3; Steel S 235 JR
4: Rectangle 60/15; Steel S 235 JR
5: Ring 20/2; Steel S 235 JR

The Layher Adapter will be mounted with 4 Layher wedge couplers to the Staging system.

Maximum stress analyses for the members.





Result from the stress analyse.

Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 51/5							
	1846	0,134	23	CO1	Sigma Total	24,56	32,27	0,76
	1912	0,000	24	CO3	Tau Total	8,78	18,63	0,47
	1890	0,134	32	CO1	Sigma-eqv	26,09	32,27	0,81
2	QRO 50x4 (Hot Formed)							
	1336	0,033	10	CO1	Sigma Total	14,51	21,36	0,68
	167	0,000	11	CO1	Tau Total	-5,24	12,33	0,43
	1336	0,033	10	CO1	Sigma-eqv	15,32	21,36	0,72
3	Ring 30/3							
	1855	0,543	33	CO1	Sigma Total	8,99	21,36	0,42
	1854	0,250	35	CO1	Tau Total	-2,10	12,33	0,17
	1855	0,543	33	CO1	Sigma-eqv	9,06	21,36	0,42
4	Rectangle 60/15							
	1863	0,065	2	CO1	Sigma Total	8,97	21,36	0,42
	1863	0,065	5	CO1	Tau Total	0,49	12,33	0,04
	1863	0,065	2	CO1	Sigma-eqv	8,97	21,36	0,42
5	Ring 20/2							
	1909	0,000	22	CO1	Sigma Total	6,00	21,36	0,28
	1866	0,000	24	CO1	Tau Total	0,83	12,33	0,07
	1909	0,000	22	CO1	Sigma-eqv	6,11	21,36	0,29

Maximum utilisation is 81%

Interal PROTRUSS S31

Truss series	PROTRUSS S31
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	+/- 50.914 kN
Normal force coupling system	+/- 60.54 kN
Normal force diagonals	+/- 10.415 kN
Bending moment $M_{yR,d}$	24.34 kNm
Bending moment $M_{zR,d}$	24.34 kNm
Normal Force $N_{R,d}$	203.66 kN
Transversal Force $V_{yr,d}$	14.73 kN
Transversal Force $V_{zr,d}$	14.73 kN

Truss geometry

Main chords	48x3 EN AW-6082T6
Diagonals	16x2 EN AW-6082T6
Coupling system	CONICAL COUPLING SYSTEM
Height	239 mm Centre to centre distance main chords
Width	239 mm Centre to centre distance main chords
A	16.96 cm²
I_y	2466 cm^4
I_z	2466 cm^4
i_y	12.06 cm
i_z	12.06 cm

The Main chord of the Protruss S31 has been produced from the material aluminium EN AW 6060 T6 instead of EN AW 6082 T6. This has been done because of the small radius of the arch trusses. This results in a lower maximum normal force in the main chord.

The lower Maximum normal force in the main chord is.
Limiting factor is the weld of the coupler to the main chord.
The coupling system and braces are the same and will have no influence.

$N_{rd,Haz\ Chord} = A_{eff} * f_{uk,haz} * 0.8 * 1 / \gamma m2 = 4.241 * 10 * 0.8 * 1/1.25 = 27.14$ kN
$M_{Rd,\ main\ chord} = W_{chord} * f_{uk,haz} * 0.8 * 1 / \gamma m2 = 4.493 * 10 * 0.8 * 1/1.25 = 28.75$ kNcm

All the structural geometry such as sectional area and moment of inertia and of the truss will stay the same as printed above

Interal PROTRUSS T31

Truss series	PROTRUSS T31
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

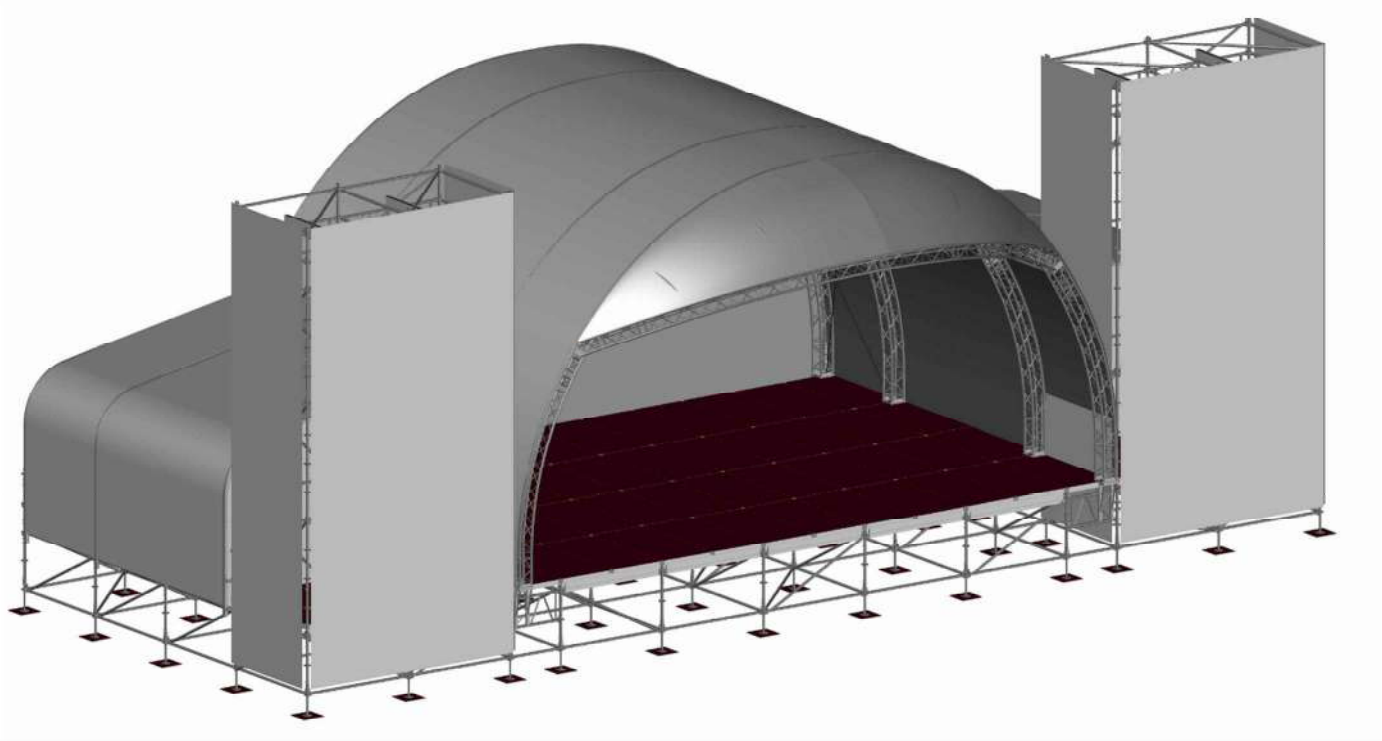
Normal force main chord	+/- 50.215 kN
Normal force coupling system	+/- 60.54 kN
Normal force diagonals	+/- 7.792 kN
Bending moment $M_{yR,d}$	9.48 kNm
Bending moment $M_{zR,d}$	10.95 kNm
Normal Force $N_{R,d}$	137.4 kN
Transversal Force $V_{yr,d}$	11.02 kN
Transversal Force $V_{zr,d}$	11.02 kN

Truss geometry

Main chords	48x3 EN AW-6082T6
Diagonals	16x2 EN AW-6082T6
Coupling system	CONICAL COUPLING SYSTEM
Height	207 mm Centre to centre distance main chords
Width	239 mm Centre to centre distance main chords
A	12.72 cm²
I_y	1244 cm^4
I_z	1244 cm^4
i_y	9.89 cm
i_z	9.89 cm

Structural
Event
Engineering

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Project number: 2017032
Structural calculation Report
Medium Tunnel Roof 10x8
Eekels verhuur

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Date: 09-04-2018

Ivo Mulder BCs



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Truss information

1 General Preliminary notes.

1.1 Project description.

This project concerns the calculation of a Medium Tunnel Roof dimensions 10 x 8 m with a height of 8 meter.

The Medium Tunnel Roof is constructed from Interal Protruss. The main arches are square Protruss S31 with dimensions 0.29 x 0.29m and the truss between the main arches is Protruss T31 with dimensions 0.29 x 0.257m. The cantilever on the front is constructed from Protruss T31 which is supported by an arched Protruss S31 and 4 additional tubes which are mainly used to support the canopy.

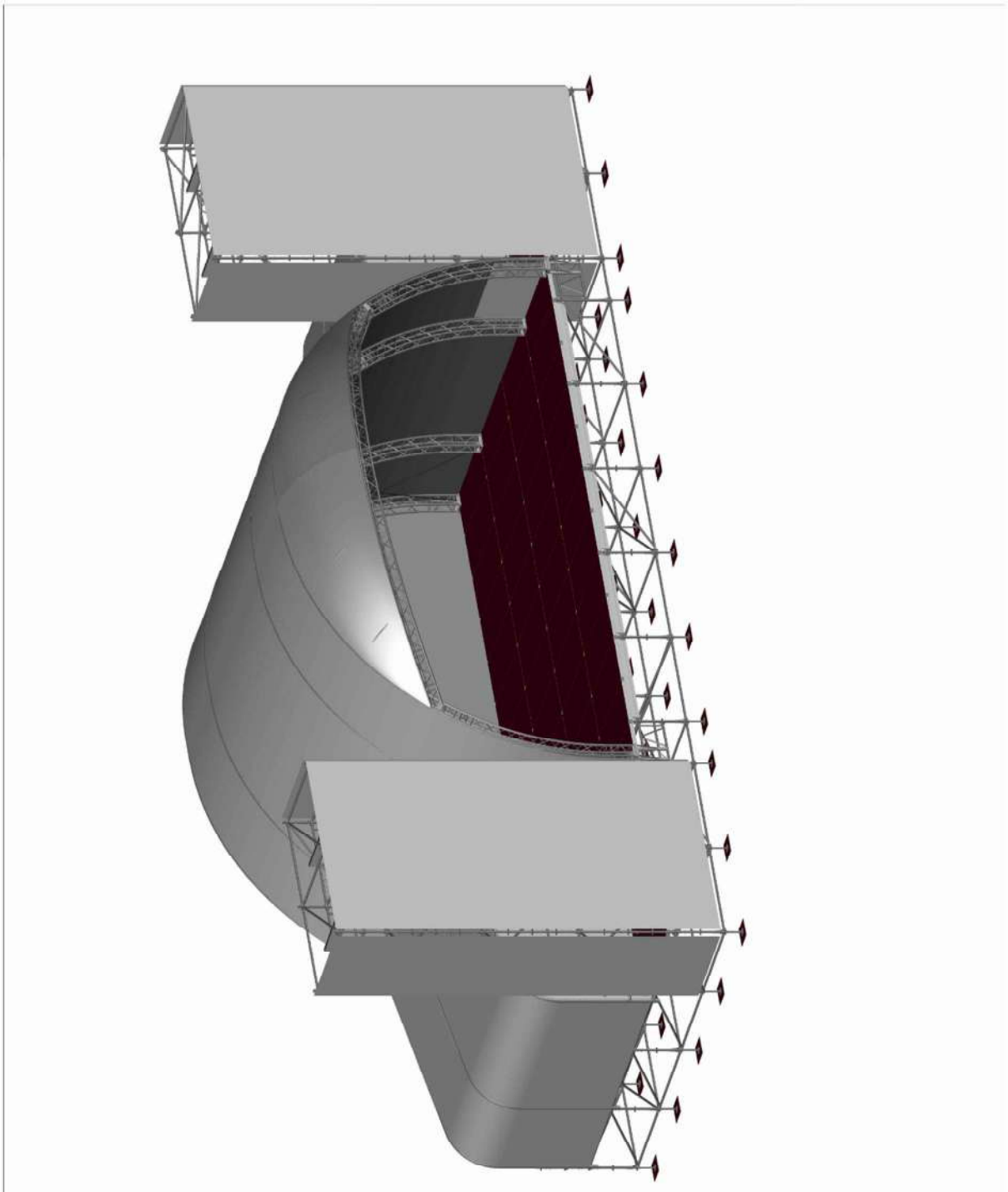
The System is built on a Layher staging floor which is part of this calculation. The height of the Layher stage which is taken into account in this calculation is 1.6 meter.

The Medium tunnel stage can be built in two different depths, 6 or 8 meter.
Optional the Medium tunnel stage can be built with Side stage areas of 6x4 meter on the left and the right side and two PA towers on the front next to the roof. These PA Towers are constructed from Layher and are fully integrated into the Layher stage.

When only the Medium tunnel stage option 3 is build, it is necessary to install cross wires in the front and the back of the system in the Out-service wind conditions. This for the structural integrity and stability of the system.

1.2 Construction drawing of the Medium tunnel stage 10x8.

1.2.1 Medium tunnel stage 10x8 Option 1.



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DATE :	30-3-2018	CUSTOMER :	EEKELS VERHUUR		
REVISION :		STATUS :			

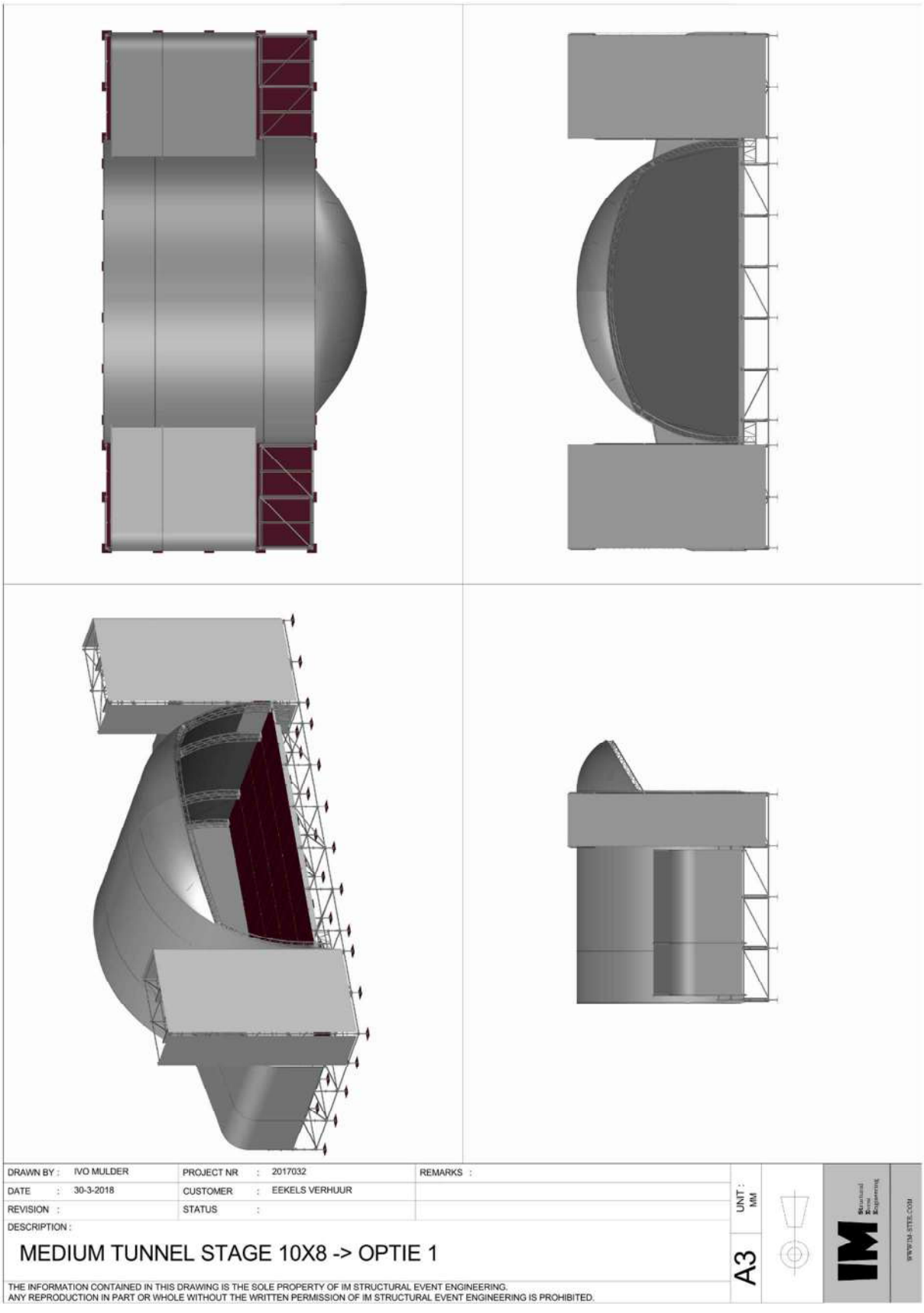
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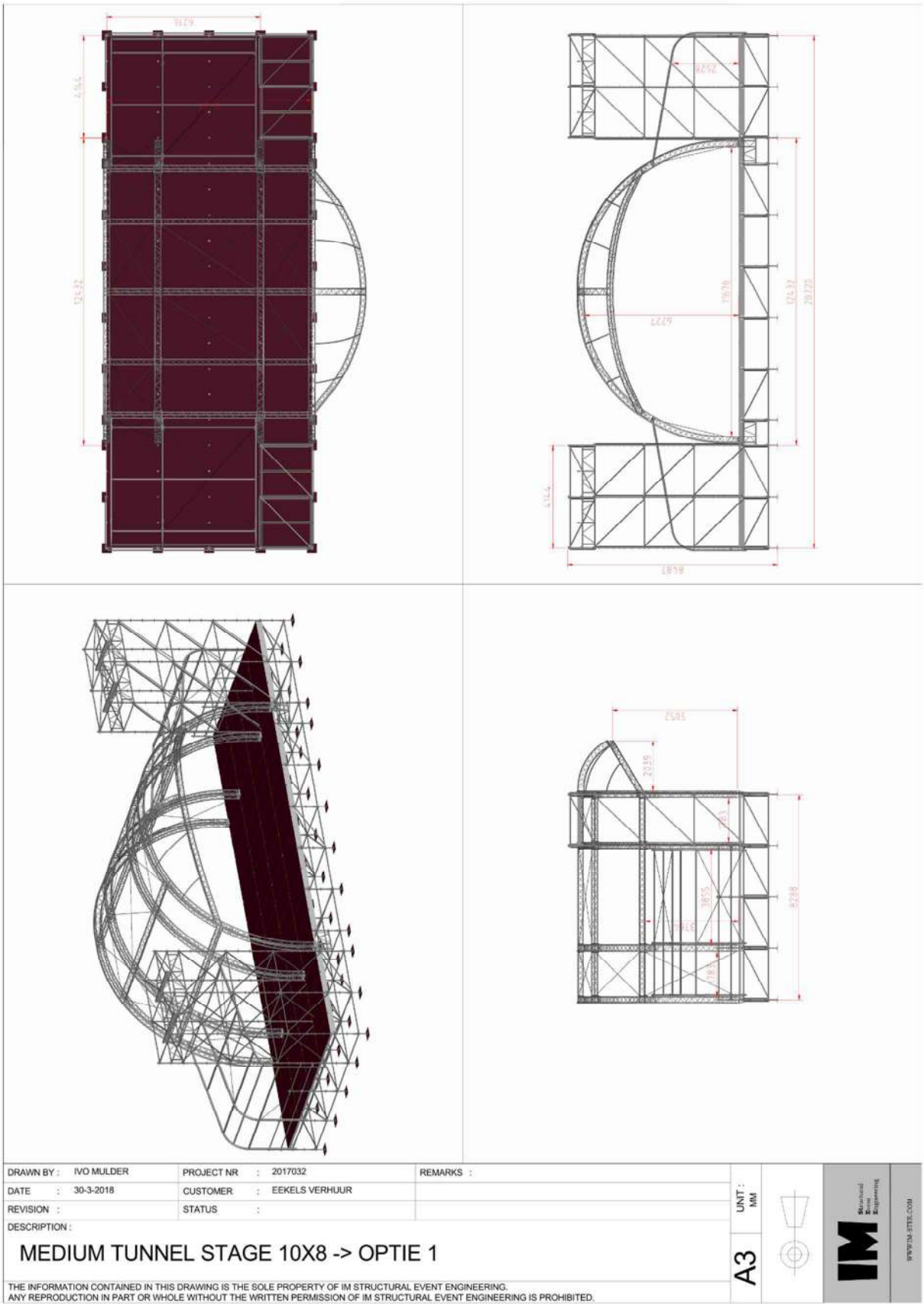
MEDIUM TUNNEL STAGE 10X8 -> OPTIE 1

UNIT : MM

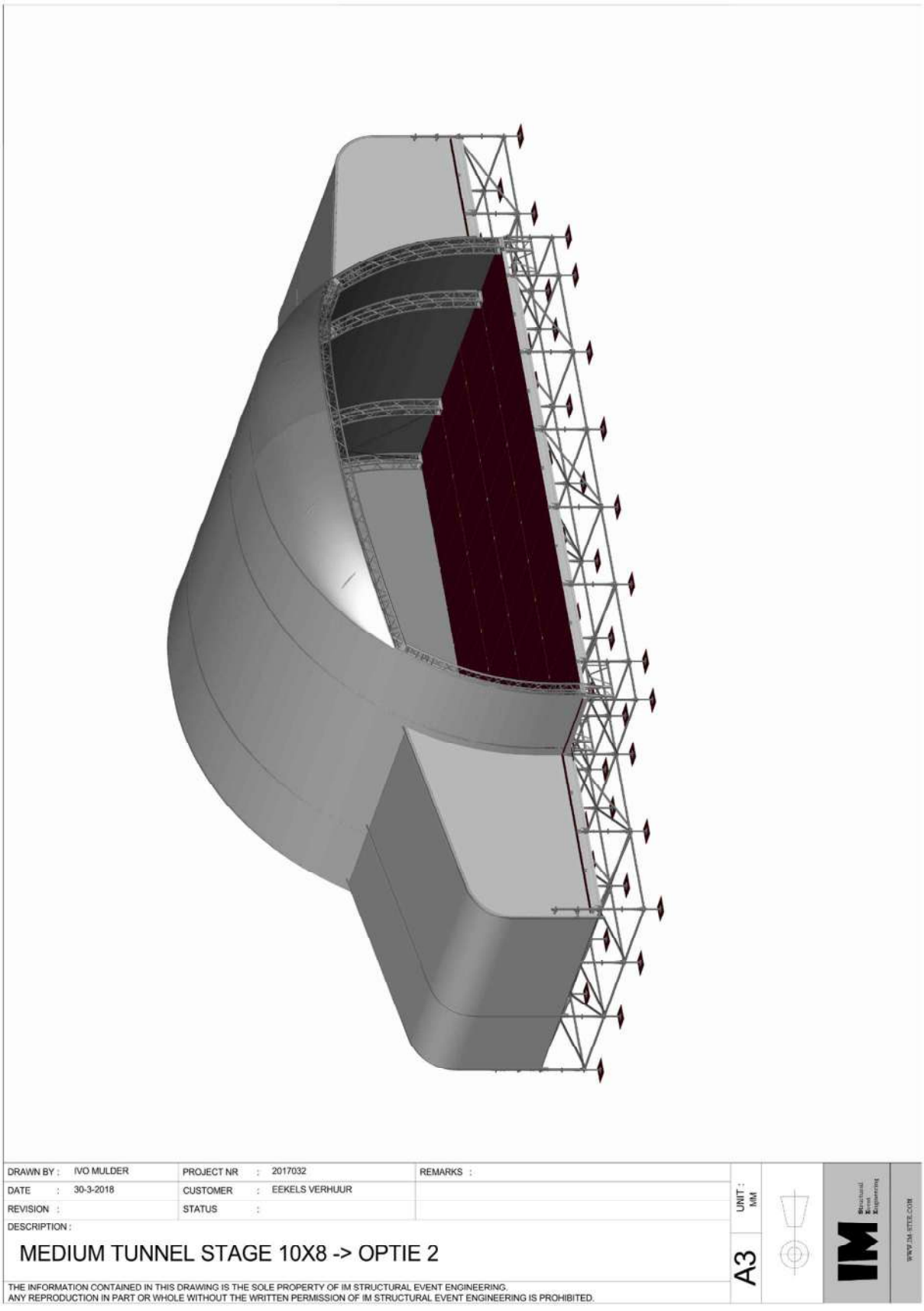
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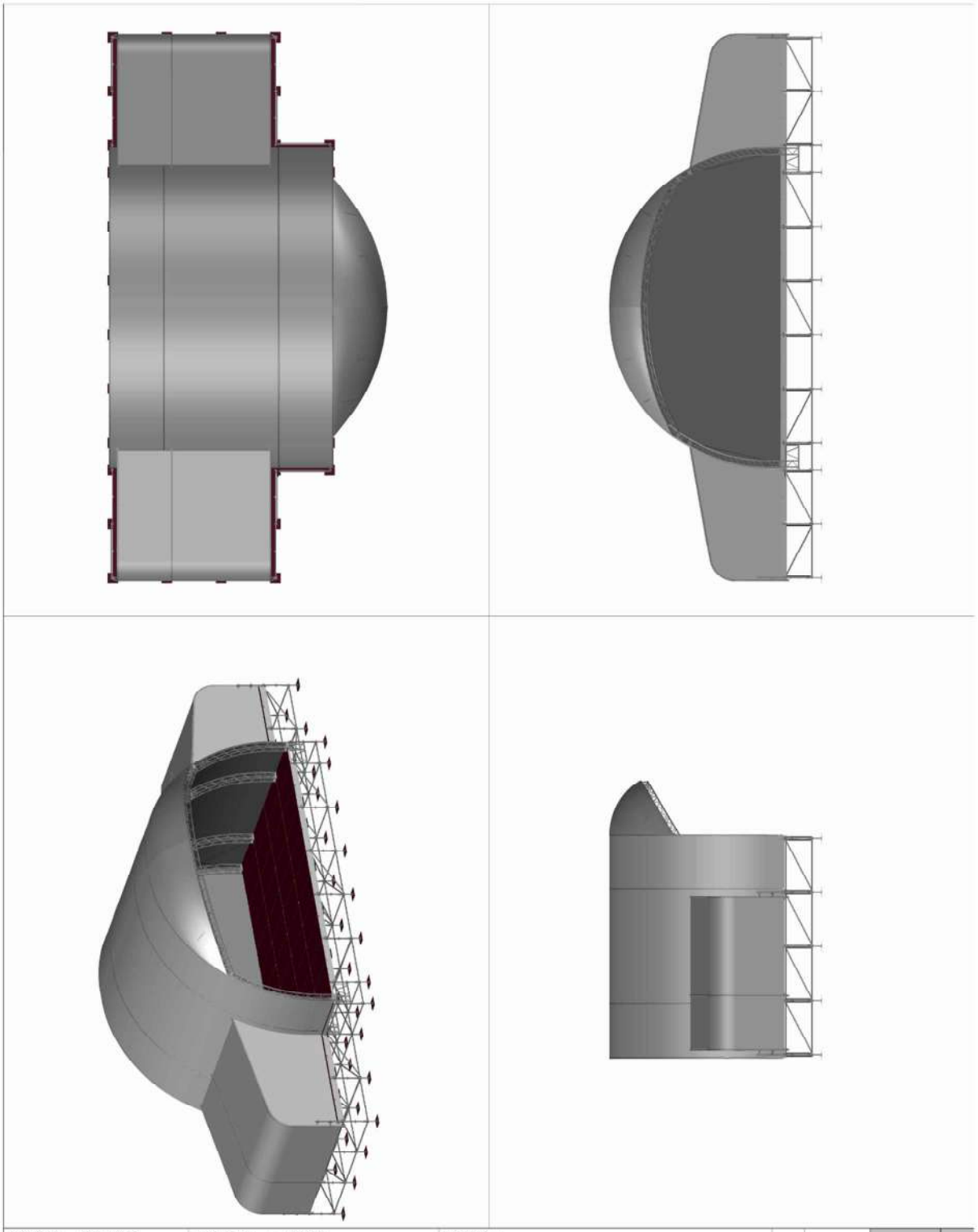
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REVISION :
STATUS :
DESCRIPTION :
MEDIUM TUNNEL STAGE 10X8 -> OPTIE 1
UNIT : MM
A3
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1.2.2 Medium tunnel stage 10x8 Option 2.





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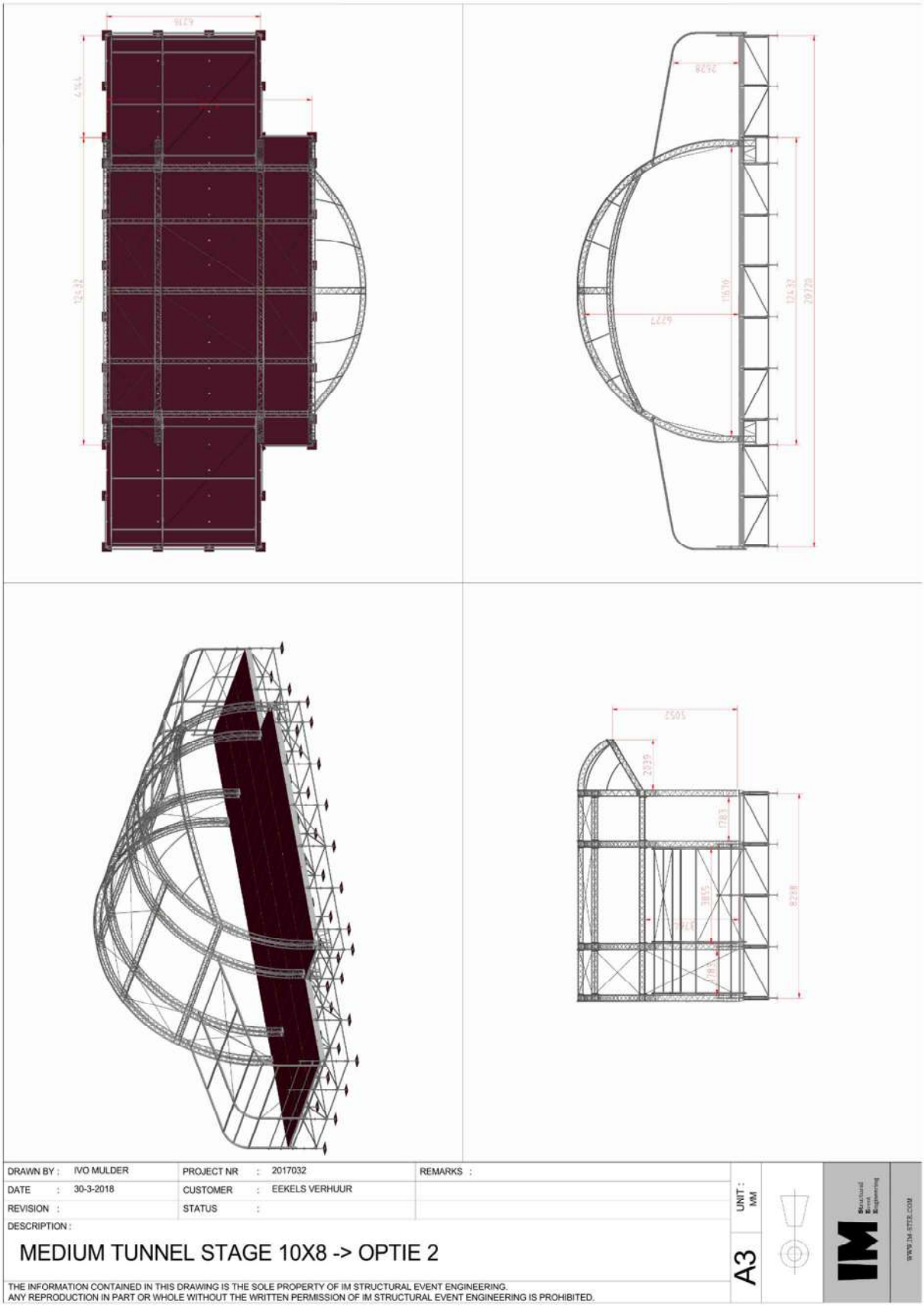
DESCRIPTION :

MEDIUM TUNNEL STAGE 10X8 -> OPTIE 2

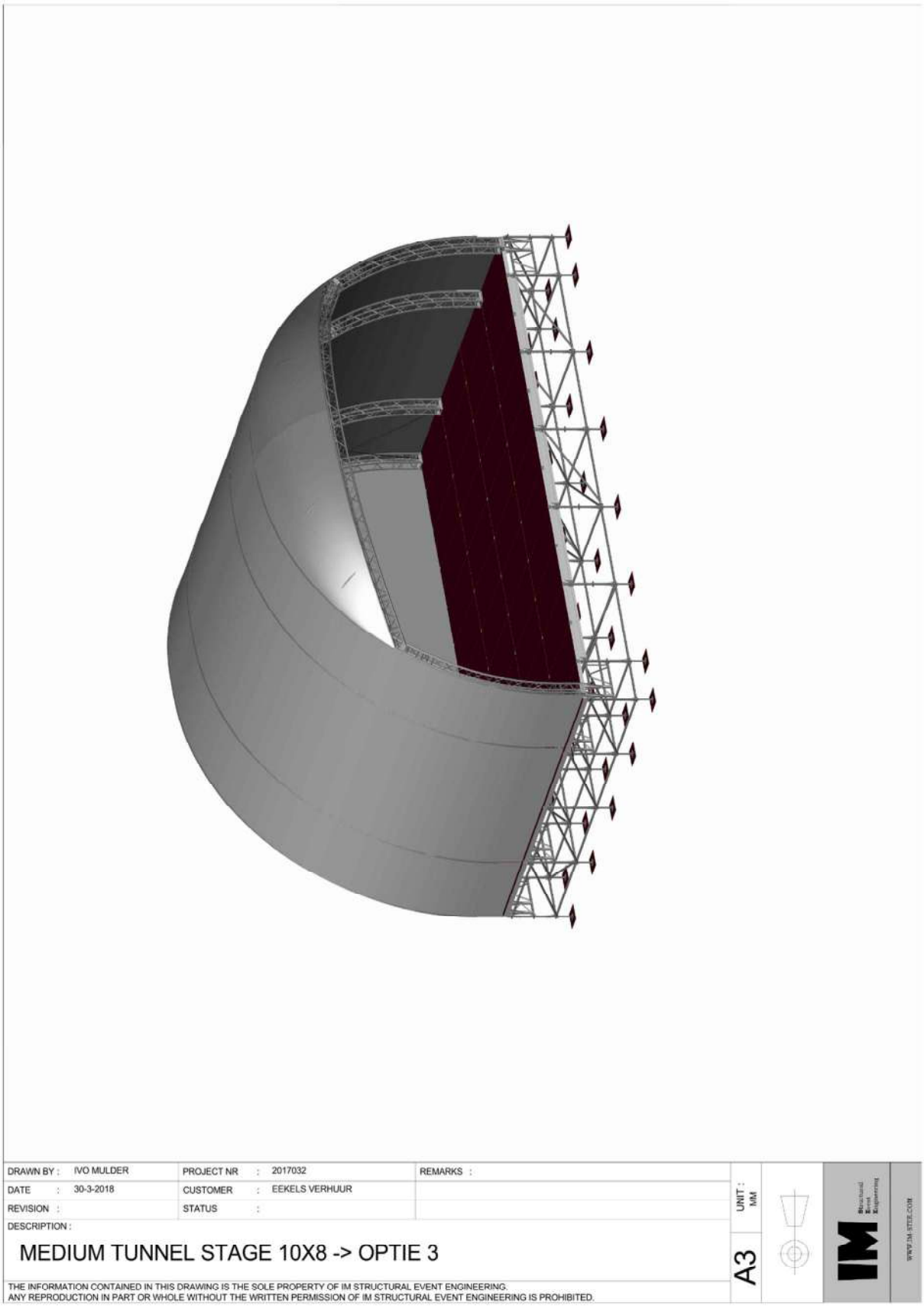
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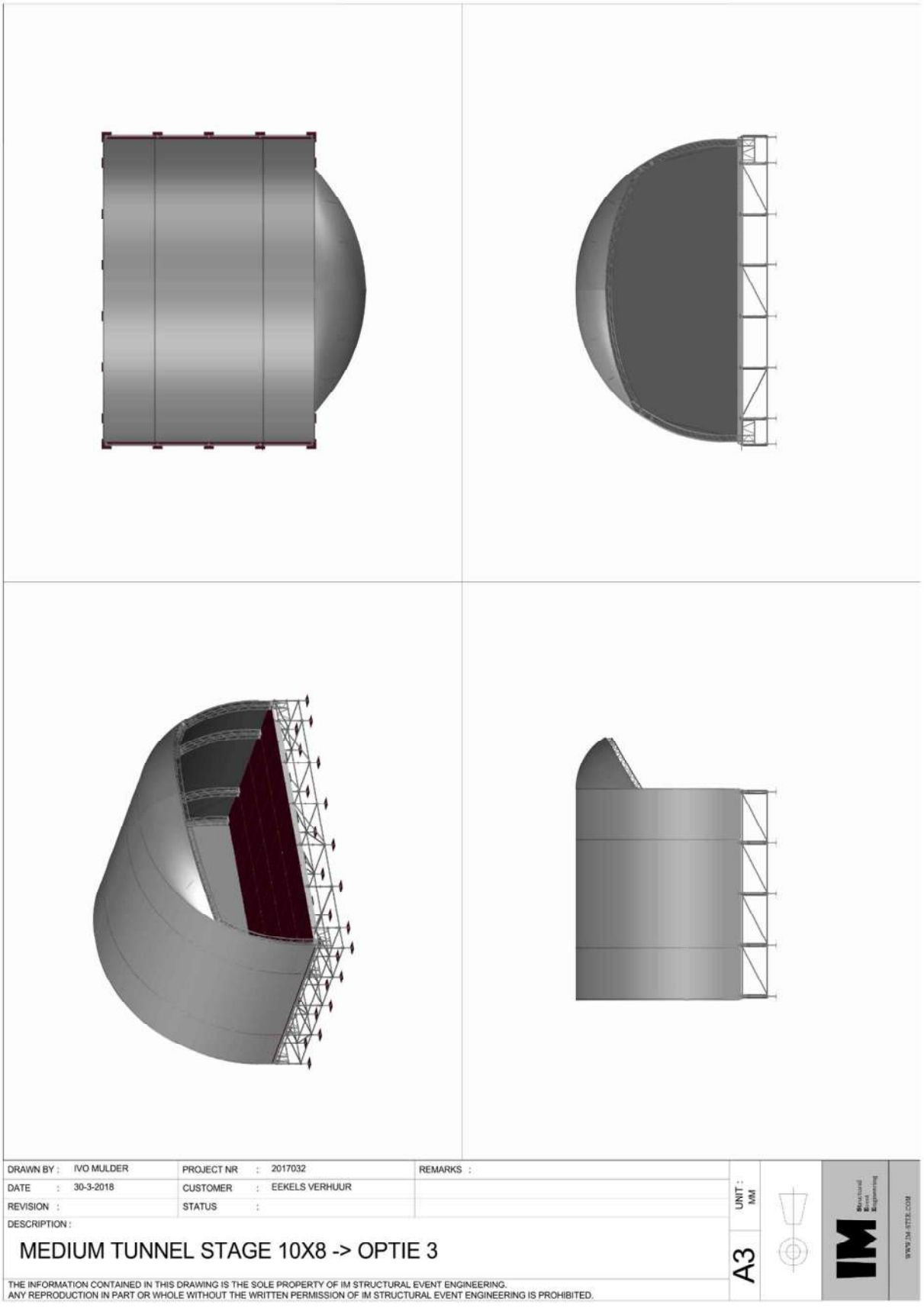
A3

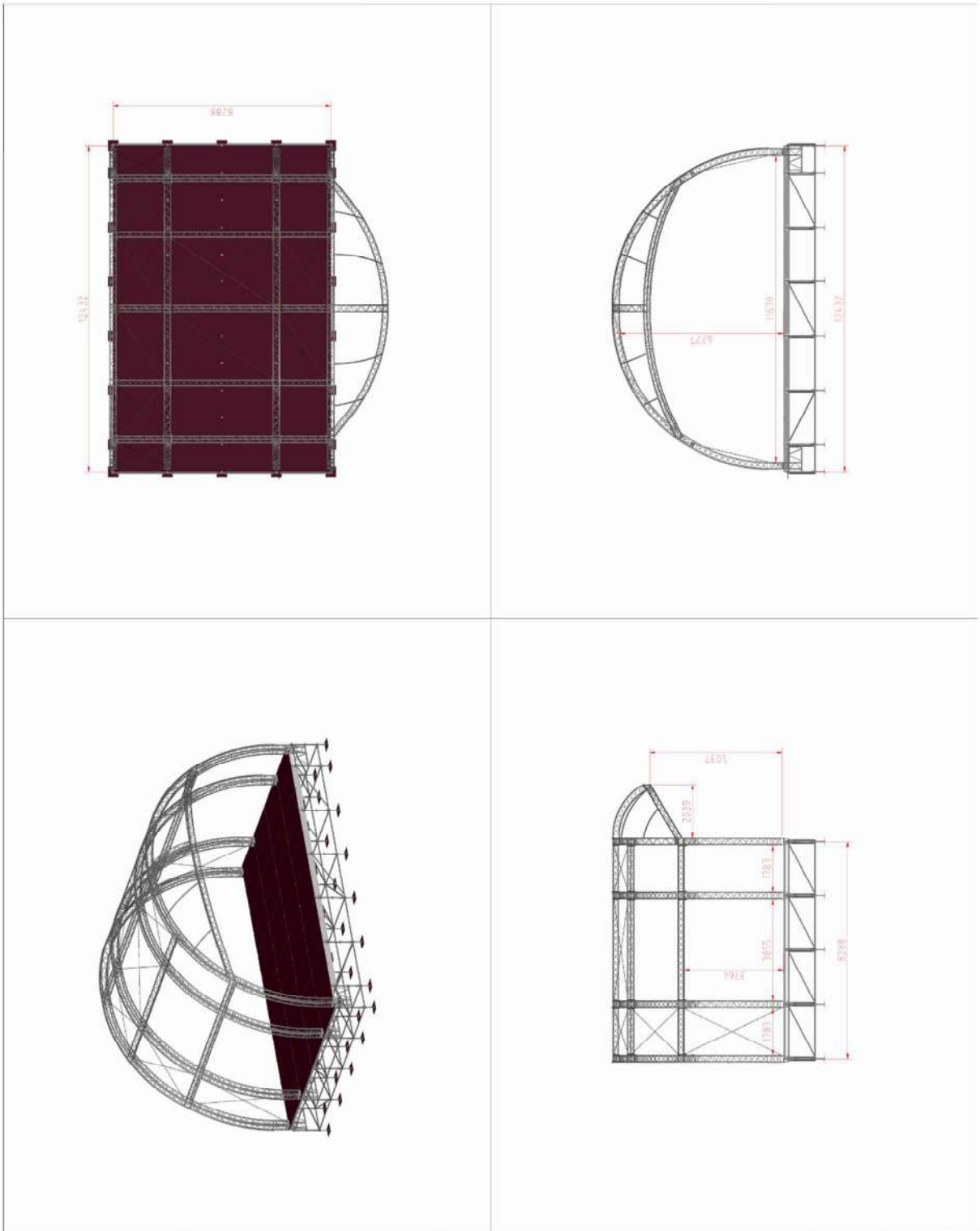
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DRAWN BY : IVO MULDER
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REMARKS :
DATE : 30-3-2018
CUSTOMER : EEKELS VERHUUR
REVISION :
STATUS :
DESCRIPTION :
MEDIUM TUNNEL STAGE 10X8 -> OPTIE 2
UNIT : MM
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1.2.3 Medium tunnel stage 10x8 Option 3.




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REMARKS :
DATE : 30-3-2018
CUSTOMER : EEKELS VERHUUR
REVISION :
STATUS :
DESCRIPTION :
MEDIUM TUNNEL STAGE 10X8 -> OPTIE 3
UNIT : MM
A3
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DRAWN BY :	IVO MULDER	PROJECT NR :	2017032	REMARKS :	
DATE :	30-3-2018	CUSTOMER :	EEKELS VERHUUR		
REVISION :		STATUS :			

DESCRIPTION :

MEDIUM TUNNEL STAGE 10X8 -> OPTIE 3

UNIT : MM

A3

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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 these 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.

Truss	Interal Protruss S31
Stage	Layher Event system K2000

Connection between roof and stage is made by special steel adapters.

The cross wires are made from ratchet straps with a Load capacity of 25 Kn.

1.6 Load assumptions.

1.6.1 Wind loading.

According to the Eurocode 13814, two wind situation calculations have to be made for a temporary demountable structure. The first situation has a wind speed from 0 to 21 m/s and is called the In-service situation and the second situation has a wind speed from 21 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 back wall is mounted. 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 21 m/s the back wall and big scenery objects need to be removed, so the wind can pass underneath the roof. 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 site 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 5 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 1.5-meter floor level is just below 8 meters, only the table from 0 < 8 m is presented on the next page.

When only the Medium tunnel stage option 3 is build, it is necessary to install cross wires in the front and the back of the system in the Out-service wind conditions. This for the structural integrity and stability of the system.

1.6.2 In-service situation.

The 21 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	Vb 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.

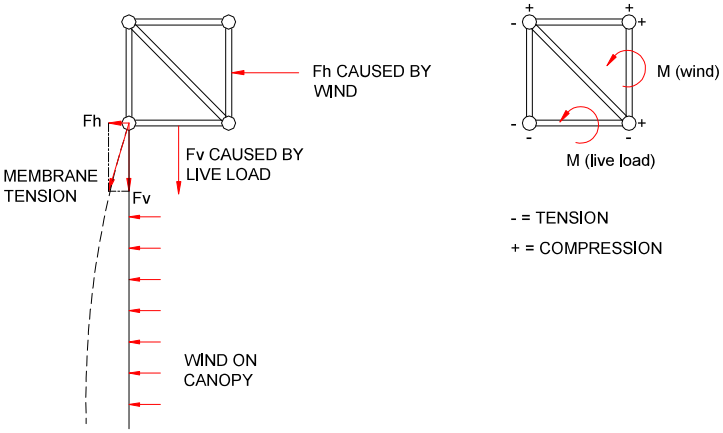
The 28m m/s which is mentioned as the maximum wind gust for the Out-service situation is based on an average between the wind gust 26.46 m/s for 0 < 8 m and the wind gust 31.62 m/s for 8 < 20 m. The wind pressure which is mentioned in the table below is increased with 20 % in comparison to the Eurocode 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	Vb 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

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.

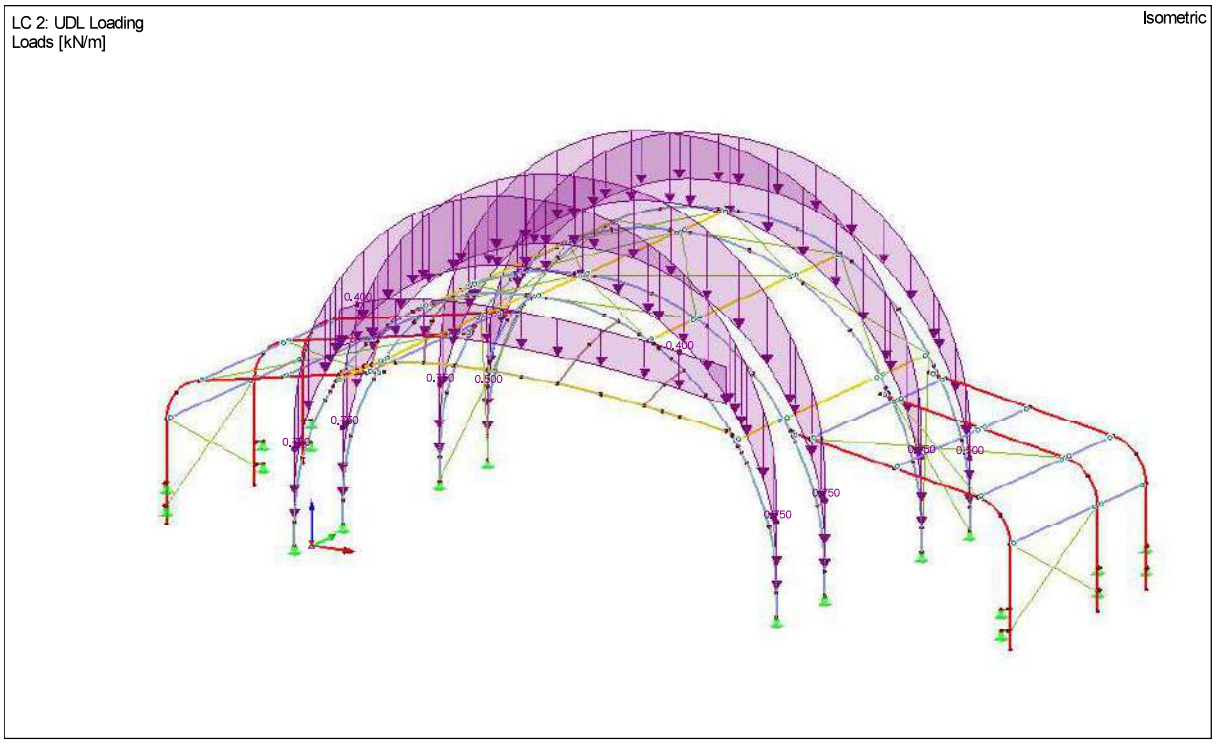
1.6.6 Live load.

In this structural report there are Live load configurations presented. These are intended to give an indication of the Rigging possibilities in the construction. If the actual loading of the construction deviates from these Rigging plots an additional calculation need to be made.
The shifting of Rigging point can influence the maximum loading of the construction.
Each Rigging point need to be attached to the node point of the truss.

1.7 Loading Configurations.

In the next 4 paragraphs the different live load configurations are presented. These loads are possible in all the roof setup options. Additional two PA wing could be installed with each PA wing two point loads of 800 kg

1.7.1 UDL Loading setup.

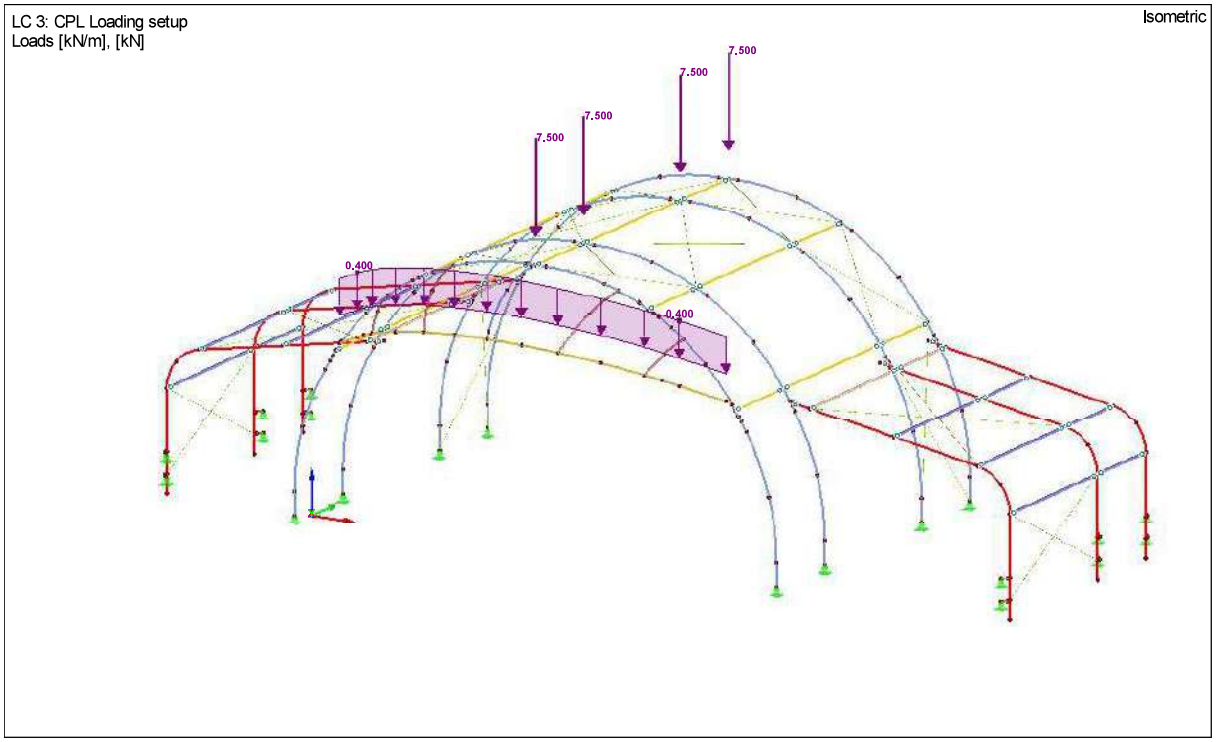


The loading which is taken into account in the UDL Loading setup are:
Truss 1 = 75 kg/m
Truss 2 = 75 kg/m
Truss 3 = 75 kg/m
Truss 3 = 50 kg/m

Cantilever truss 40 kg/m

The total load on the main system is ~ 5850 Kg

1.7.2 Center point load per truss arch.

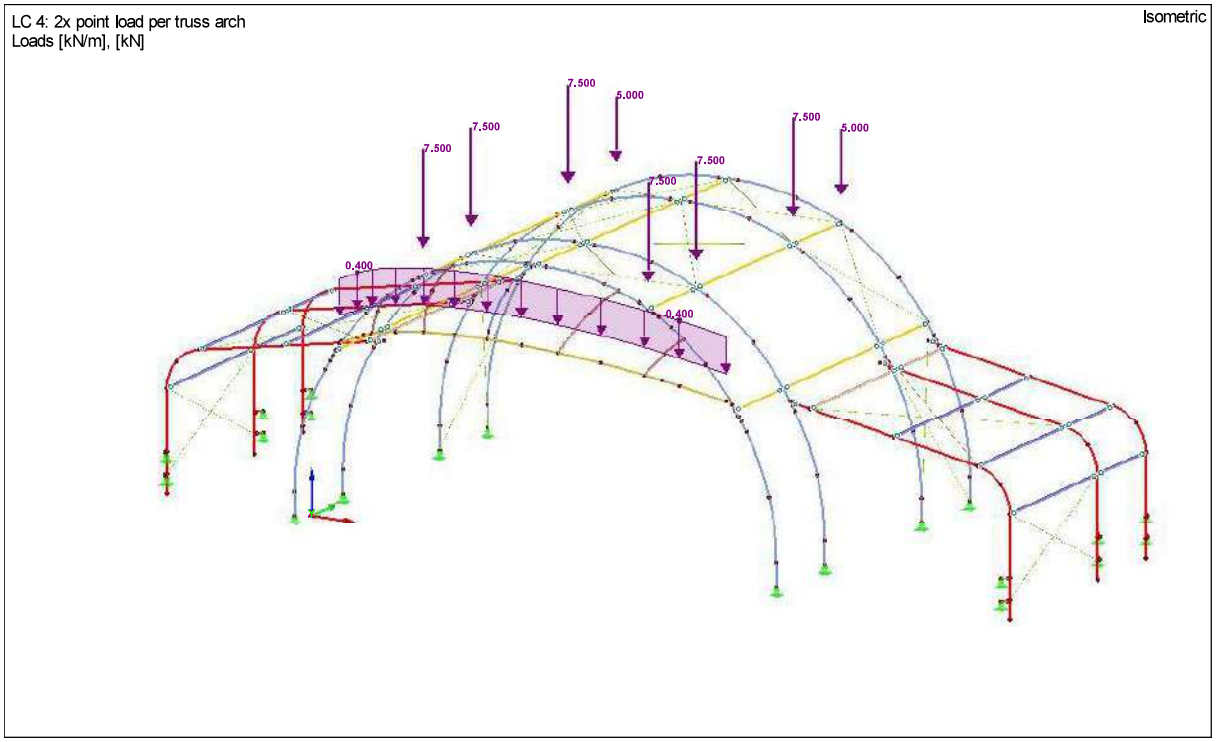


The loading which is taken into account in the Centre point Load setup are:
Truss 1 = 750 kg
Truss 2 = 750 kg
Truss 3 = 750 kg
Truss 4 = 750 kg

Cantilever truss 40 kg/m

The total load on the main system is ~ 3400 Kg

1.7.3 2x Point loads per truss arch.

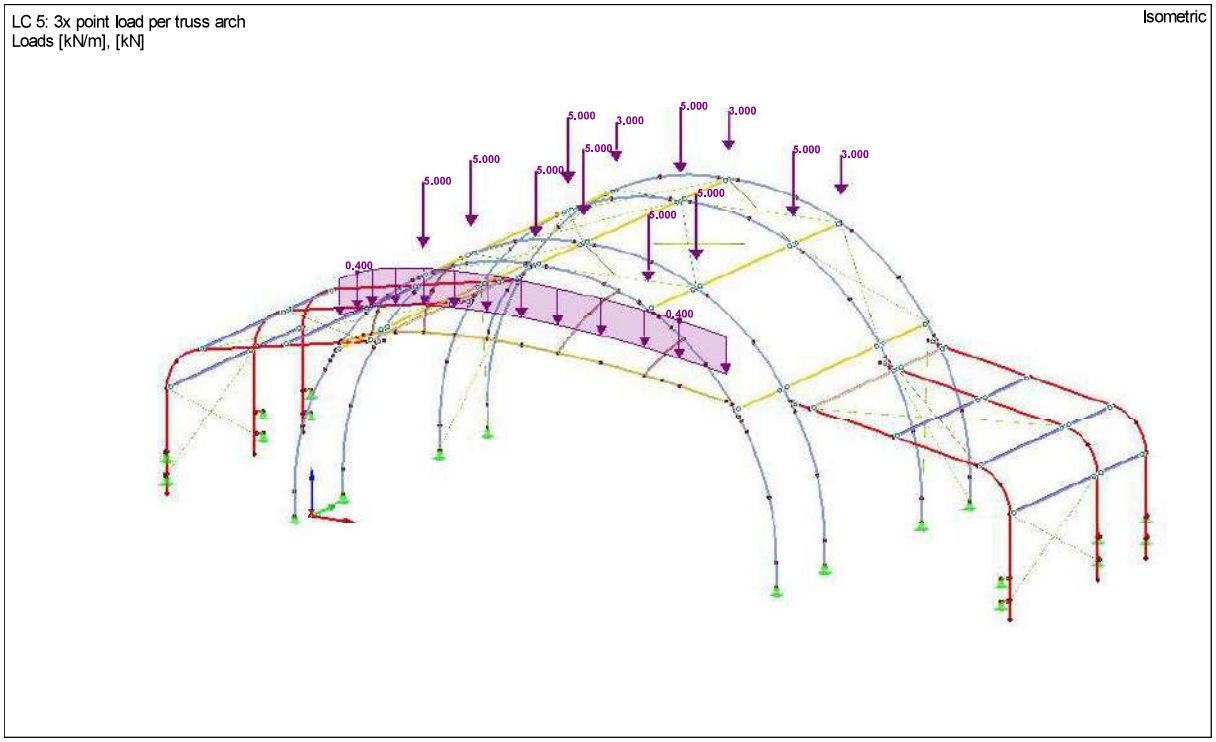


The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 2 x 750 kg
Truss 2 = 2 x 750 kg
Truss 3 = 2 x 750 kg
Truss 4 = 2 x 500 kg

Cantilever truss 40 kg/m

The total load on the main system is ~ 5900 Kg

1.7.4 3x Point loads per truss arch.



The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 3 x 500 kg
Truss 2 = 3 x 500 kg
Truss 3 = 3 x 500 kg
Truss 4 = 3 x 300 kg

Cantilever truss 40 kg/m

The total load on the main system is ~ 5800 Kg

1.8 Necessary Ballast loading.

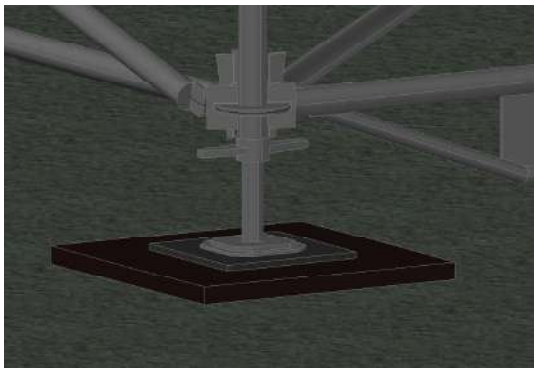
The ballast will be checked for uplift, overturning and sliding. The Layher stage which is designed as a ridged stage will be taken into account.

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

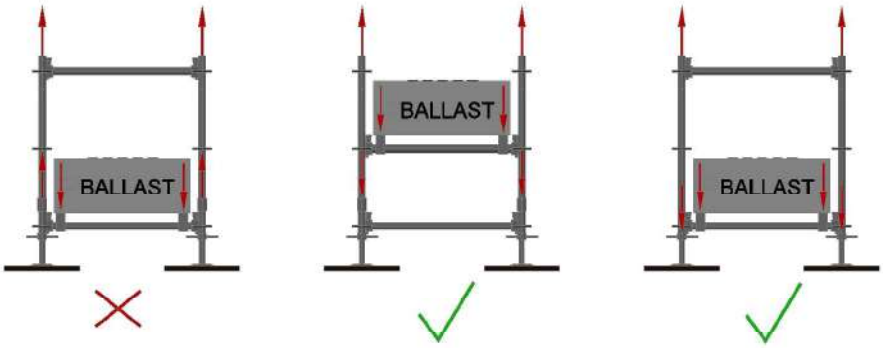
The safety factor for the ballast calculation against slipping is set to 1.2 according to the NEN-EN 13814. This is based on a horizontal load which is relying on friction.
For the friction coefficient the factor of 0.6 has been taken into account.
The Ballast calculation with factor 0.6 can be justified because rubber underlayment plate is used.

Table 3 — Coefficients of friction μ

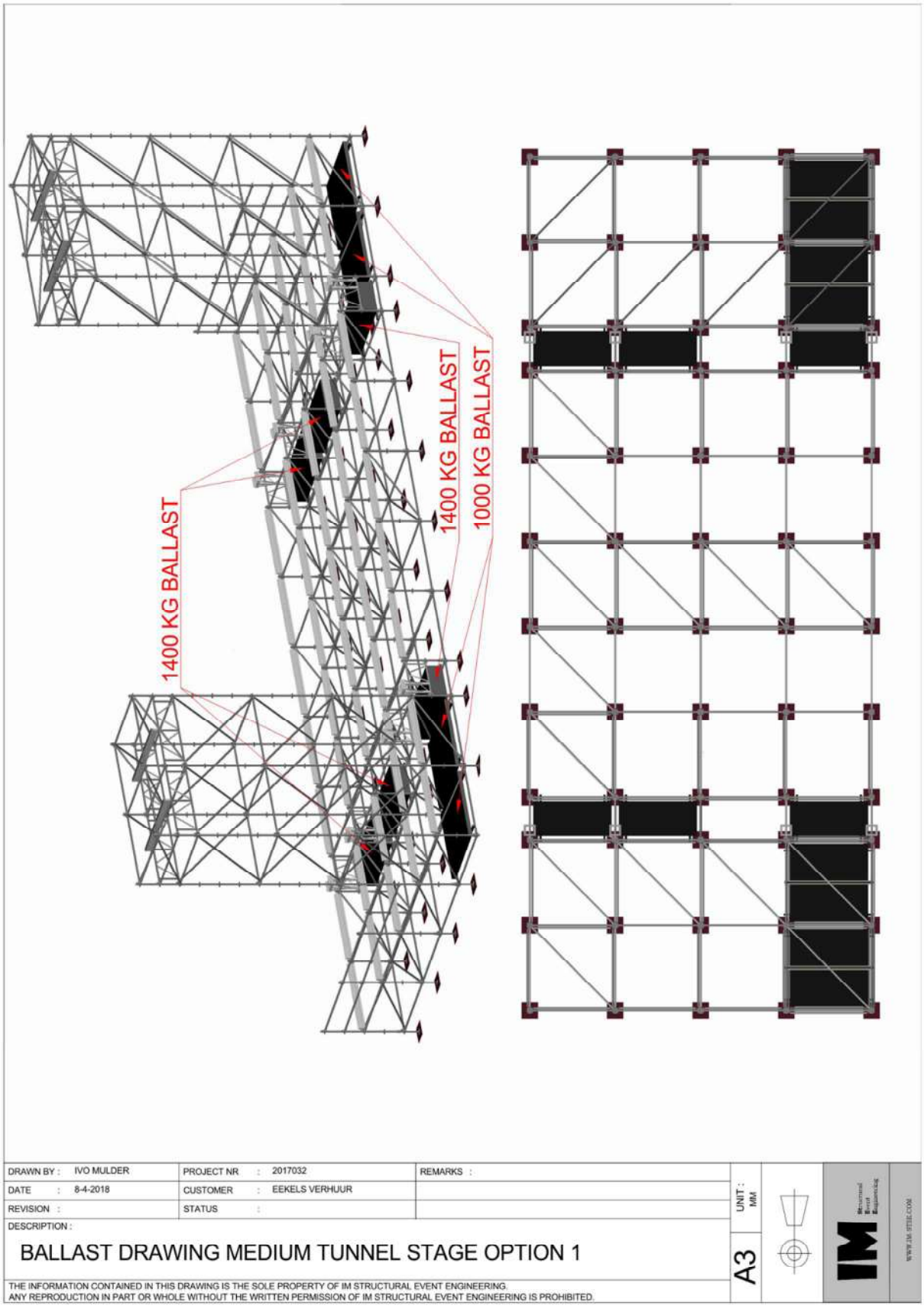
	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay[a]	0,25	0,2	0,25
Loam[a]	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65
[a] At least of stiff consistency in accordance with ENV 1997-1.			



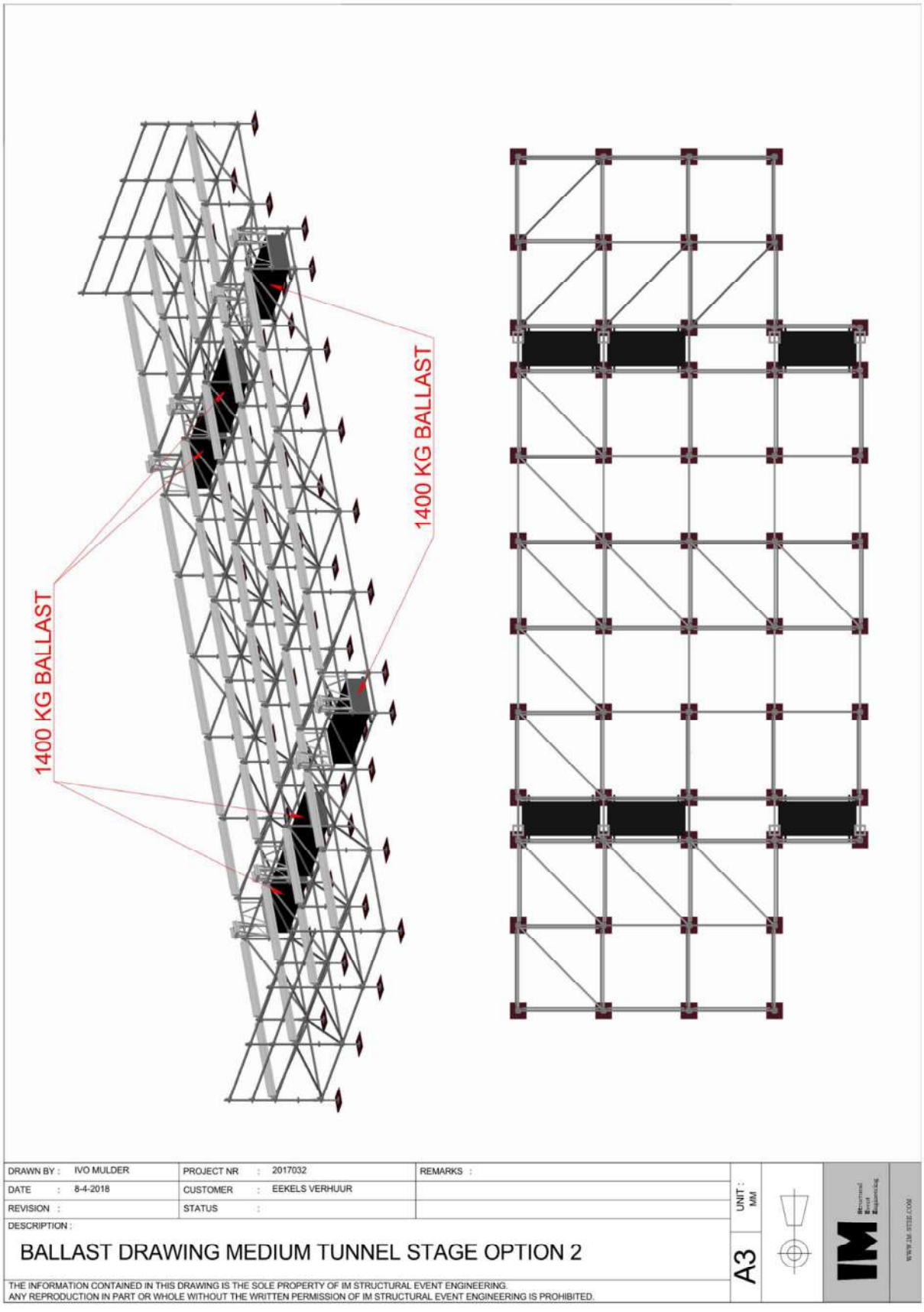
The ballast need to be placed in such a way that it will be activated when lifting forces are applied. If the ballast is placed on the bottom level the use of Layher uprights with connected base collar is necessary.



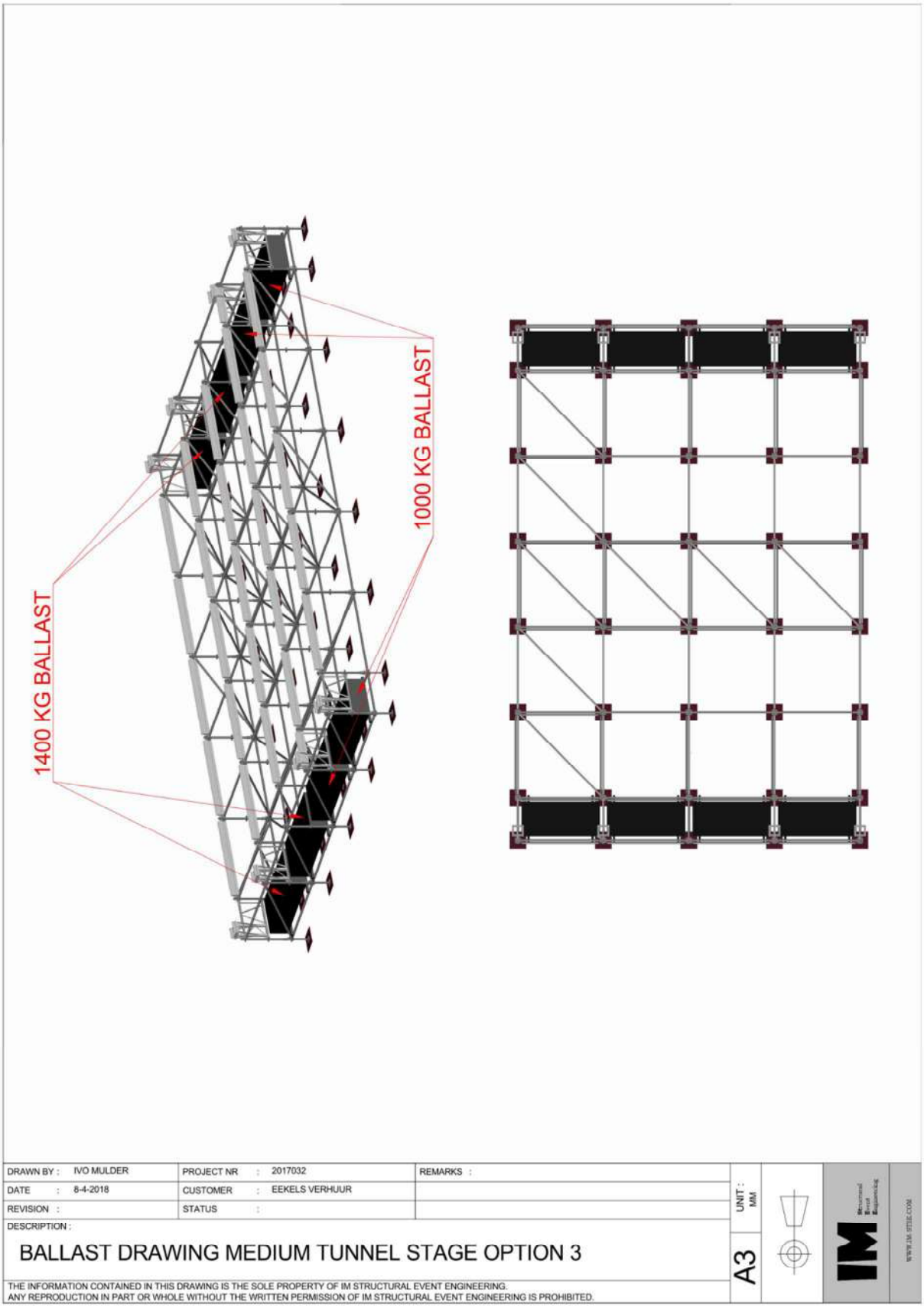
Ballast drawing Medium tunnel stage 10x8 Option 1.



Ballast drawing Medium tunnel stage 10x8 Option 2.



Ballast drawing Medium tunnel stage 10x8 Option 3.

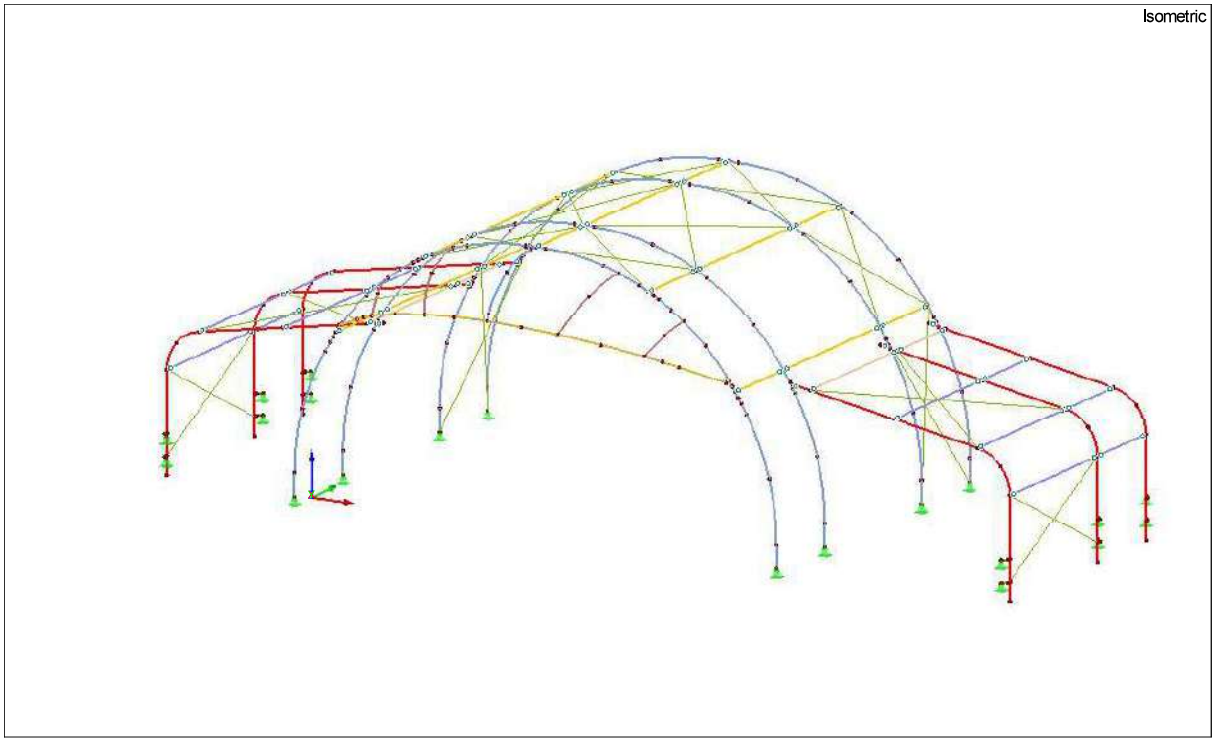


2.0 General calculation input.

2.1 Information About the calculation program.

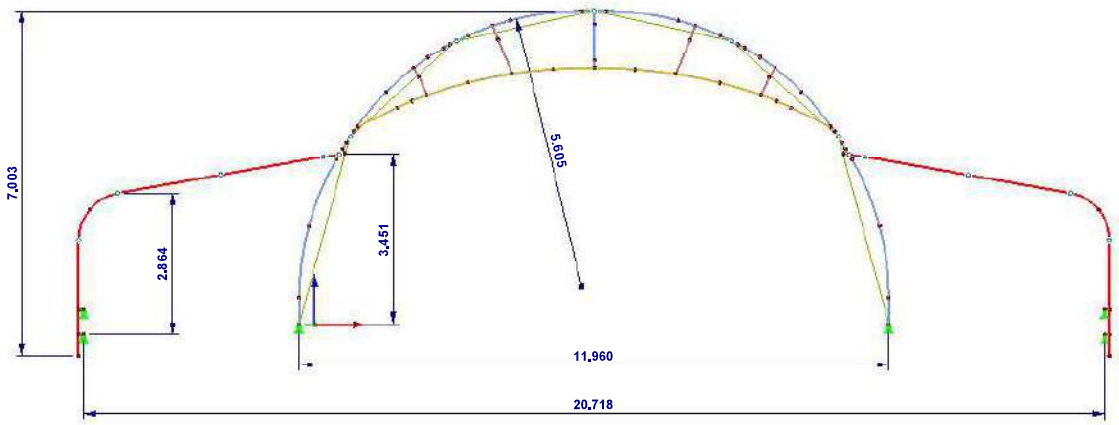
For the calculation of the construction the program RFem from Dlubal software GmbH has been used. The calculation of the Load cases has been made according to the Geometrically Linear analyses principle. The calculation of the Load combinations has been made according to the second order analysis (nonlinear) principle.

2.2 Construction model of the Medium Tunnel Roof 10x8 setup option 1 and 2.

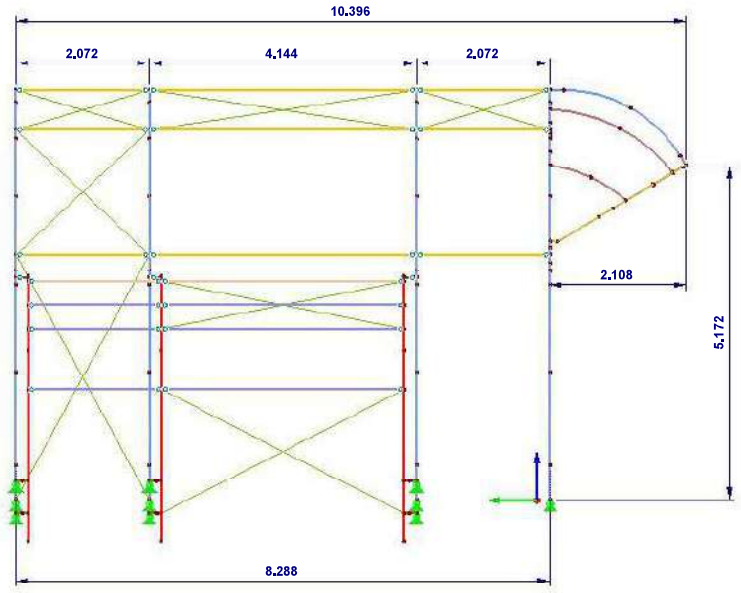


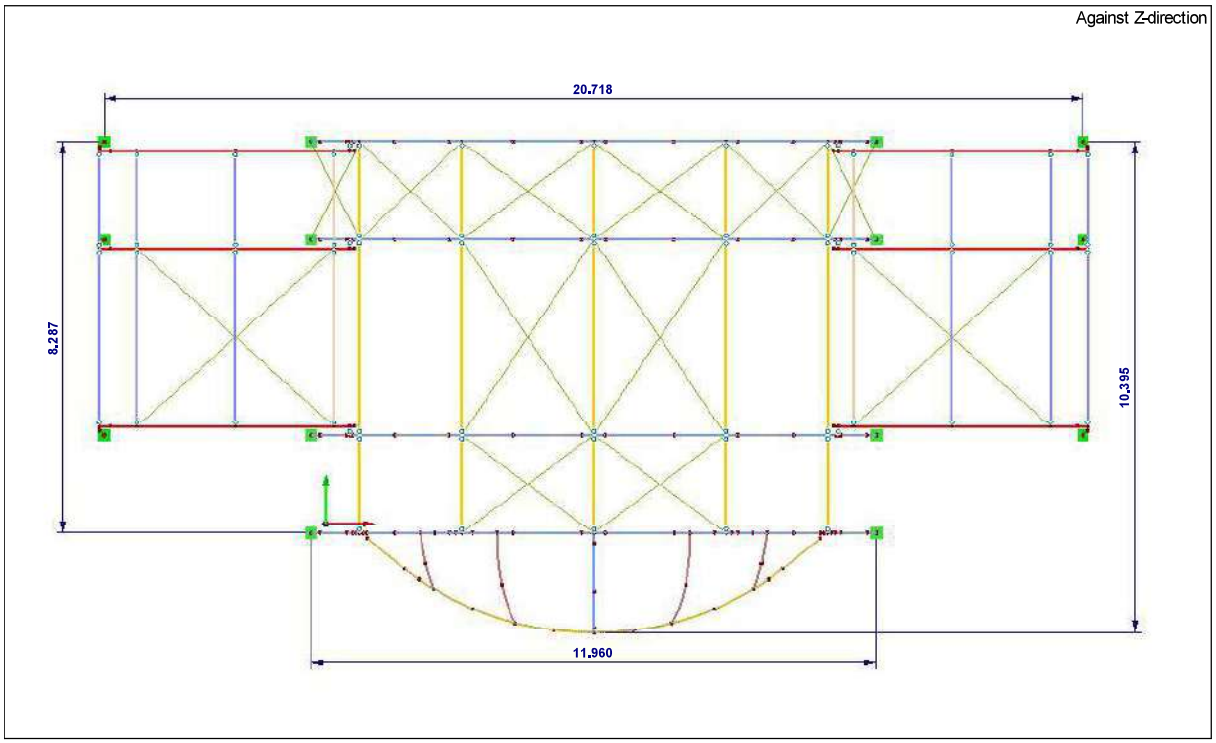
Cross-Sections
- 1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
- 2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
- 3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 4: RD 10; steel 8.8 kw aliteit
- 5: roder keder profiel 80x61x3; Aluminum EN-AW 6061 (ET,EP,ER/B) T6
- 6: HK 50/50/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 7: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 8: RD 20; steel 8.8 kw aliteit
- 9: Ring 60/5; Aluminum EN-AW 6082 (EP,ET) T6

In Y-direction



In X-direction




Against Z-direction
20.718
8.287
10.395
11.960

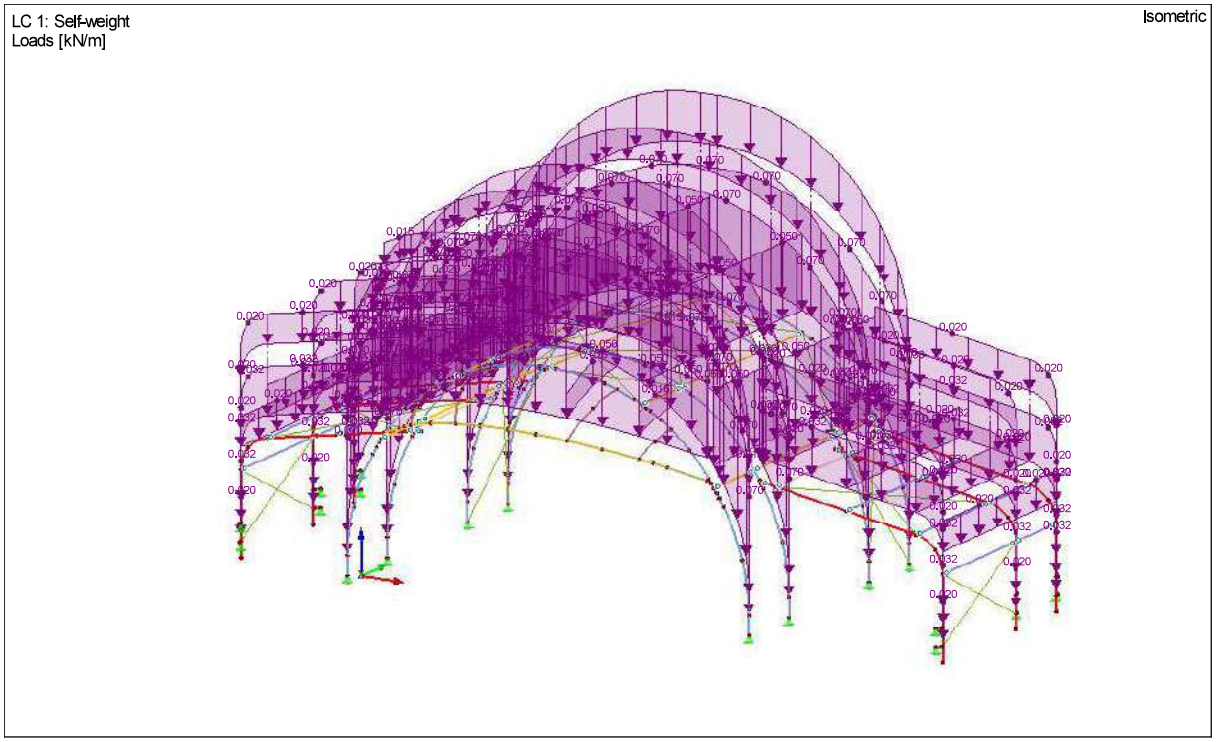
2.3 Single Load cases model option 1 and 2.

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

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self-weight	+	Permanent	-	0,000	0,000	-1,000
LC2	UDL Loading	+	Permanent/Imposed	-	0,000	0,000	0,000
LC3	CPL Loading setup	+	Permanent/Imposed	-	0,000	0,000	0,000
LC4	2x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC5	3x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC10	In-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC11	In-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC12	In-service wind 180°	+	Wind	-	0,000	0,000	0,000
LC13	Out-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC14	Out-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC15	Out-service wind 180°	+	Wind	-	0,000	0,000	0,000

2.4 load case input model option 1 and 2.

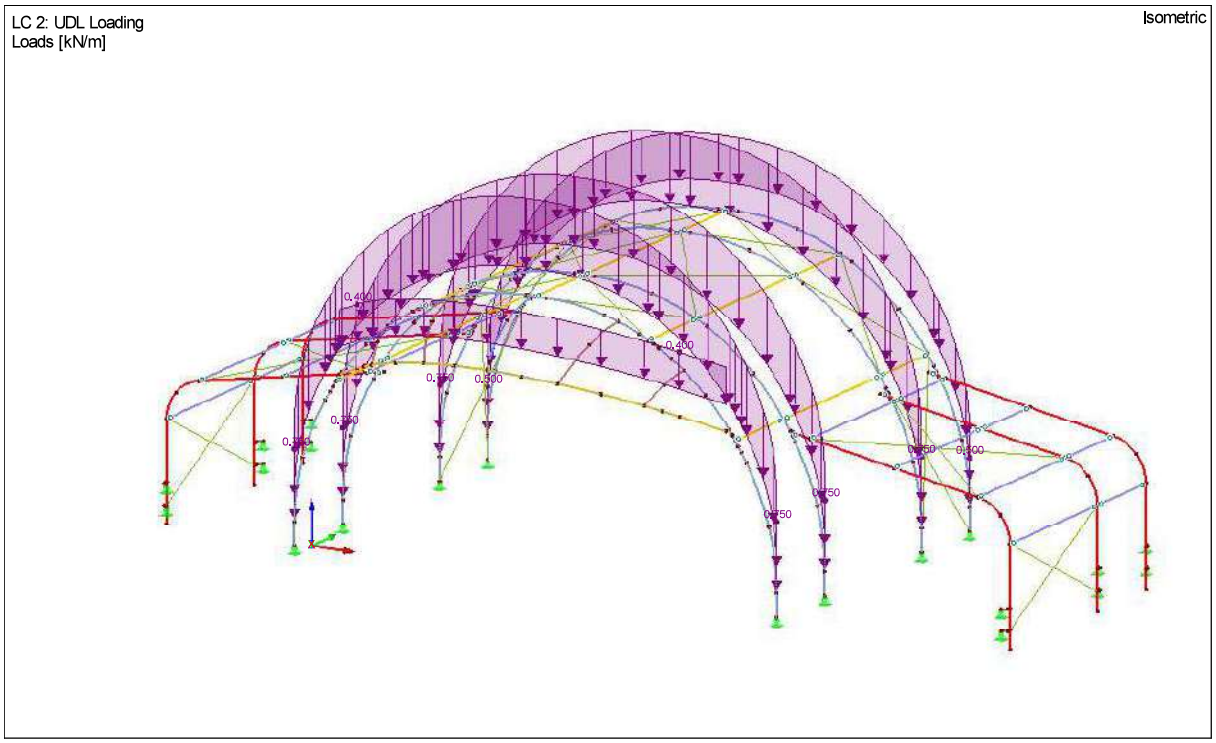
2.4.1 LC1 Self-Weight.



Interal Protruss S31 = 0.07 kN/m^{-1}
Interal Protruss T31 = 0.05 kN/m^{-1}
Keder Profile 80x61 = 0.032 kN/m^{-1}
Tube 50x4 = 0.016 kN/m^{-1}
Tube 60x5 = 0.02 kN/m^{-1}

Canopy truss1 + cantilever truss = 0.015 kN/m^{-1}
Canopy truss2 + truss3 = 0.02 kN/m^{-1}
Canopy truss4 = 0.033 kN/m^{-1}
Canopy keder profile side stage = 0.02 kN/m^{-1}

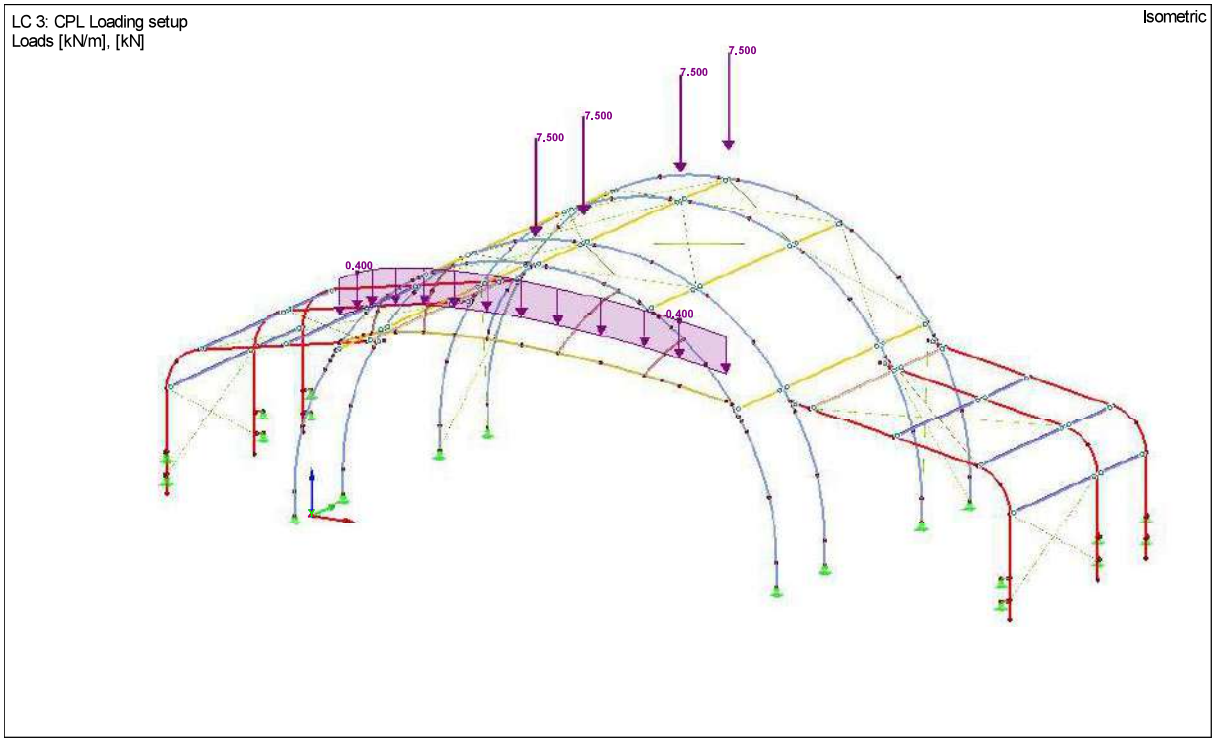
2.4.2 LC2 UDL Loading setup.



The loading which is taken into account in the UDL Loading setup are:
Truss 1 = 0.75 kN/m^{-1}
Truss 2 = 0.75 kN/m^{-1}
Truss 3 = 0.75 kN/m^{-1}
Truss 3 = 0.50 kN/m^{-1}

Cantilever truss 0.40 kN/m^{-1}

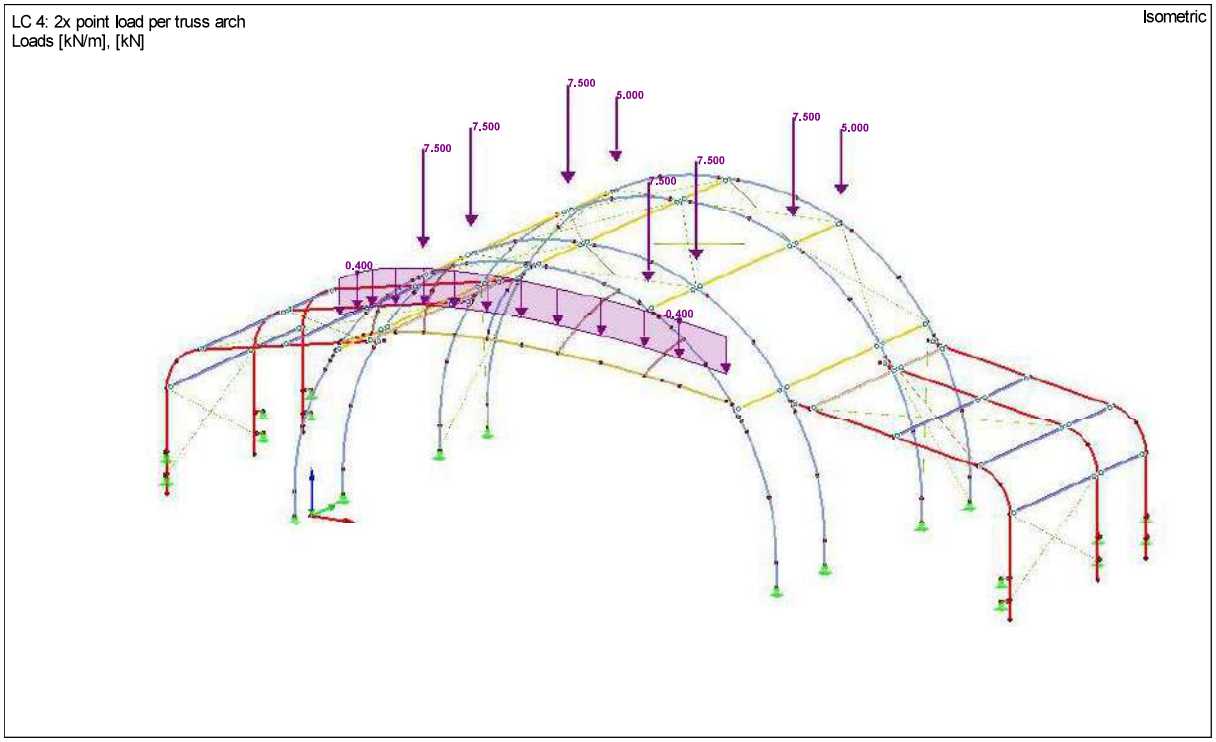
2.4.3 LC3 Center point load per truss arch.



The loading which is taken into account in the Centre point Load setup are:
Truss 1 = 7.50 kN
Truss 2 = 7.50 kN
Truss 3 = 7.50 kN
Truss 4 = 7.50 kN

Cantilever truss 0.40 kN/m^{-1}

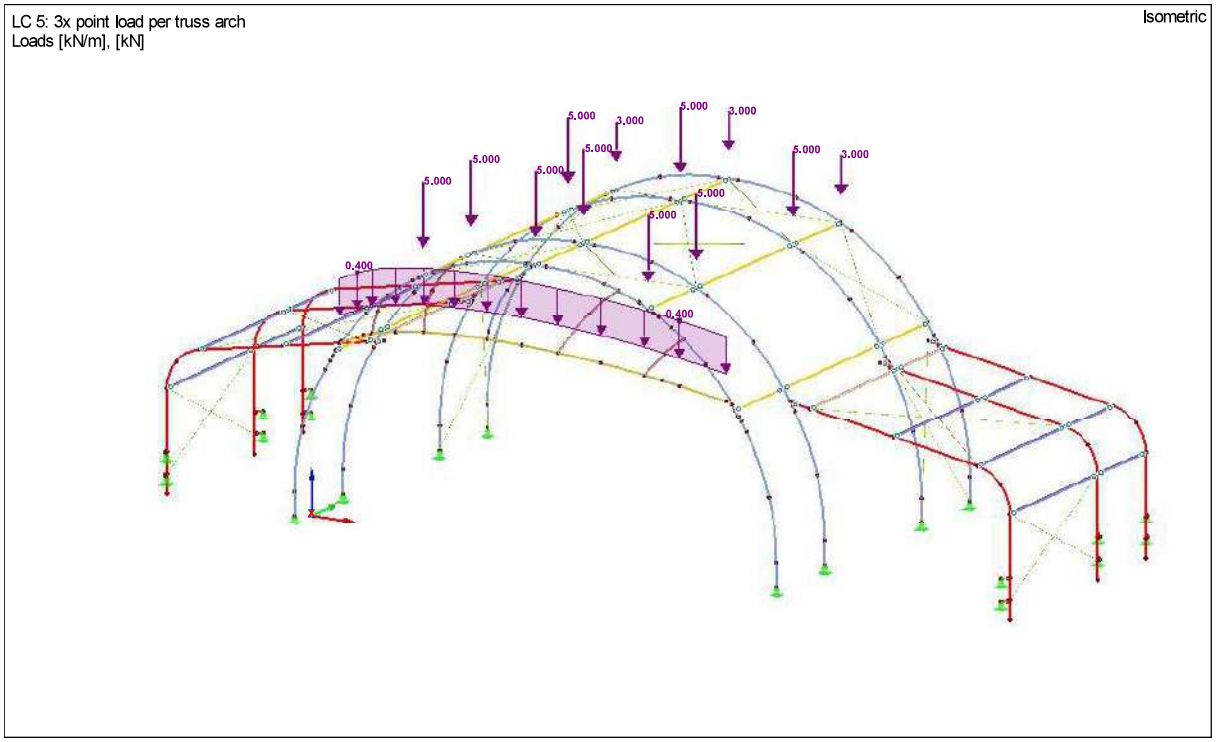
2.4.4 LC4 2x Point loads per truss arch.



The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 2 x 7.50 kN
Truss 2 = 2 x 7.50 kN
Truss 3 = 2 x 7.50 kN
Truss 4 = 2 x 5.00 kN

Cantilever truss 0.40 kN/m^{-1}

2.4.5 LC5 3x Point loads per truss arch.

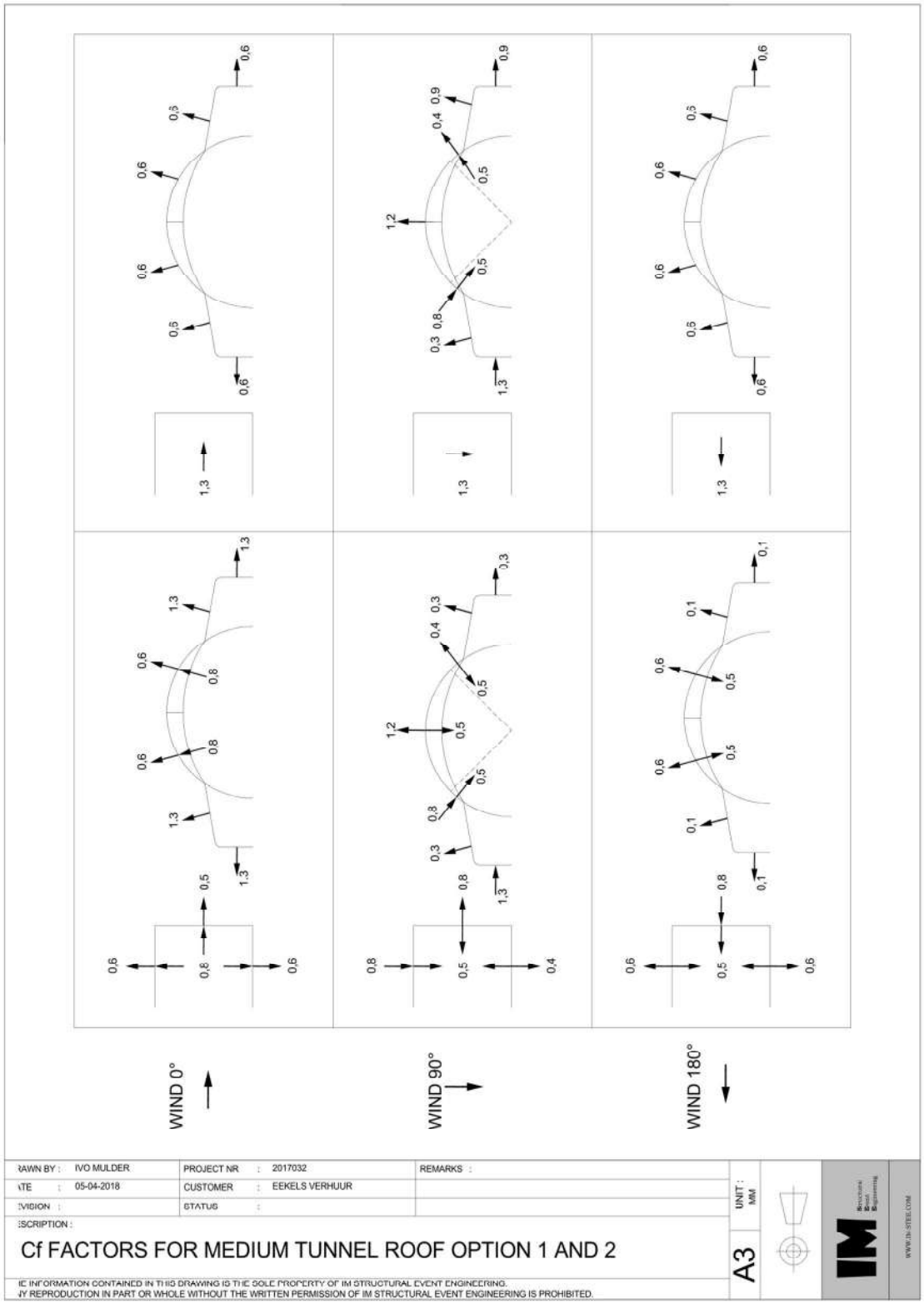


The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 3 x 5.00 kN
Truss 2 = 3 x 5.00 kN
Truss 3 = 3 x 5.00 kN
Truss 4 = 3 x 3.00 kN

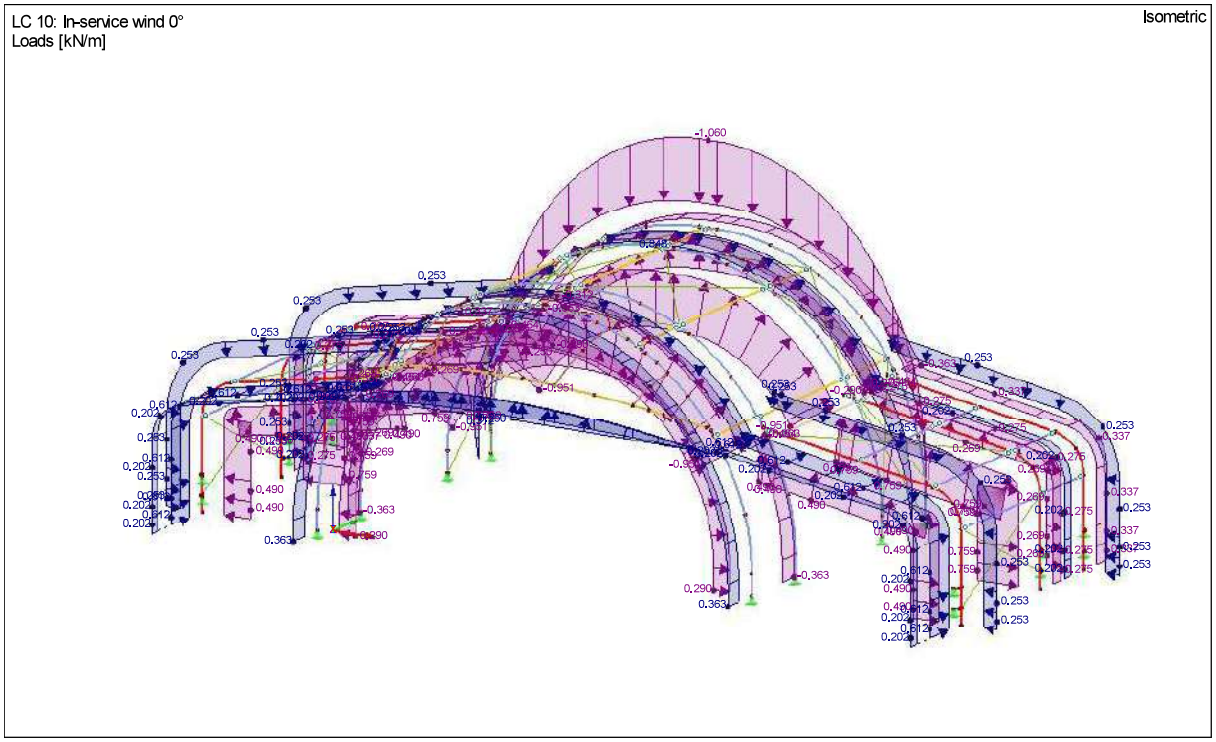
Cantilever truss 0.40 kN/m^{-1}

2.5 Load cases concerning wing loading model option 1 and 2.

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 NEN-EN 13814: Fairground and amusement park machinery and structures safety.



2.5.1 load case 10 In-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 1.4 * 0.2 * 1.036 = 0.290$ kN/m
$q_{w,\ roof\ truss\ 2} = 1.4 * 0.2 * 3.398 = 0.951$ kN/m
$q_{w,\ roof\ truss\ 3} = 1.4 * 0.2 * 3.398 = 0.951$ kN/m
$q_{w,\ roof\ truss\ 3} = 1.4 * 0.2 * 1.036 = 0.290$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.290 / 0.8 = 0.363$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.661/0.8) - (0.290 / 0.8) = 0.464$ kN/m
$q_{mt,\ roof\ truss\ 3} = (0.661/0.8) - (0.290 / 0.8) = 0.464$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.290 / 0.8 = 0.363$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.2 * 2.5 * 0.5 = 0.25 kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.2 * 0 = 0 kN/m

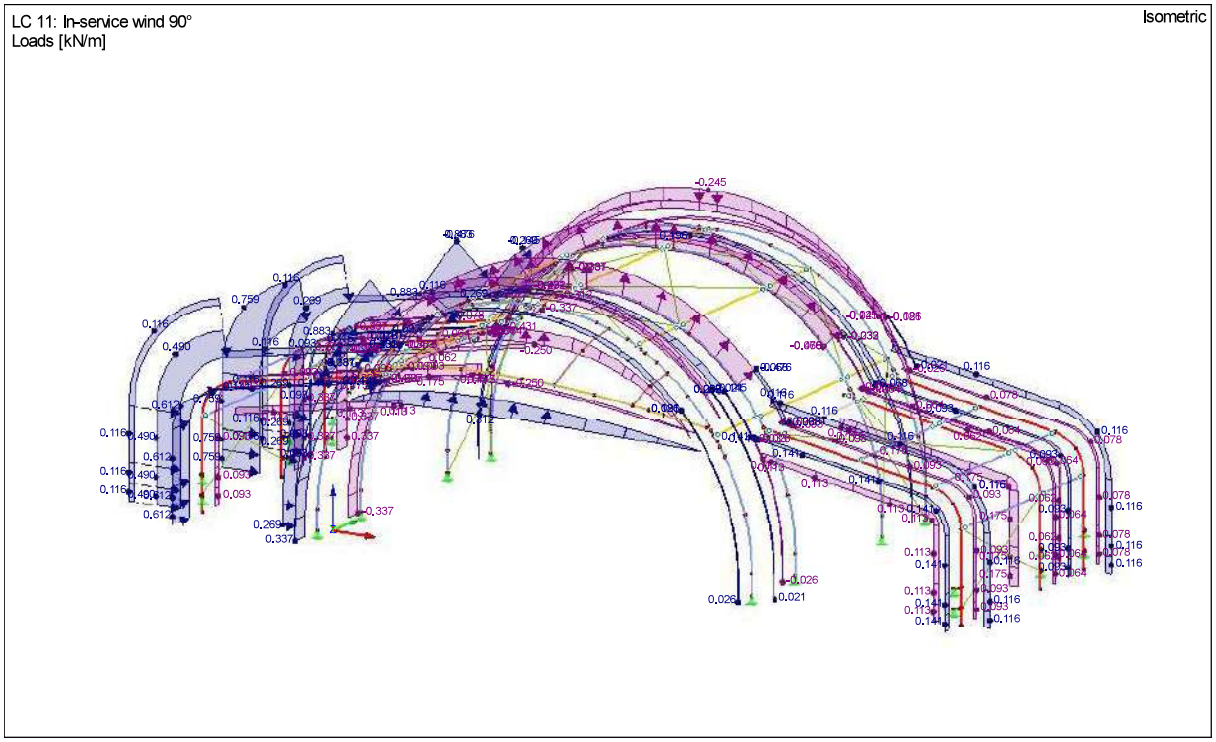
Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.25 / 0.8 = 0.312 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1}$ = 1.3 * 0.2 * 1.883 = 0.490 kN/m
$q_{w,\ profile\ 2}$ = 1.3 * 0.2 * 2.919 = 0.759 kN/m
$q_{w,\ profile\ 3}$ = 1.3 * 0.2 * 1.036 = 0.269 kN/m

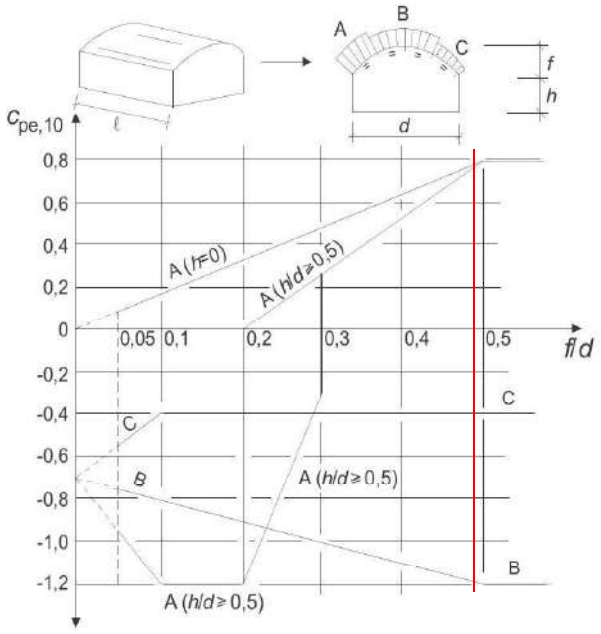
Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1}$ = 0.490 / 0.8 = 0.612 kN/m
$q_{mt,\ profile\ 2}$ = (0.612/0.8) - (0.269 / 0.8) = 0.275 kN/m
$q_{mt,\ profile\ 4}$ = 0.269 / 0.8 = 0.337 kN/m

Side stage front and back canopy
The front and back Canopy are attached to Profile and Layher.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 1.3 * 0.2 * 12.13 = 3.154 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 3.154 / 2 / 7.81= 0.202 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.202 / 0.8 = 0.253 kN/m

2.5.2 load case 11 In-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling the structure down.
The result of these two forces are
A = -1.3 B = 0.7 C = -0.1

Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.2 * 1.036 = 0.269$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 0.7 * 0.2 * 1.036 = 0.145$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.2 * 3.398 = 0.883$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 0.7 * 0.2 * 3.398 = 0.476$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.2 * 3.398 = 0.883$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 0.7 * 0.2 * 3.398 = 0.476$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\text{ roof truss 4 section A}} = 1.3 * 0.2 * 1.036 = 0.269$ kN/m
$q_{w,\text{ roof truss 4 section B}} = 0.7 * 0.2 * 1.036 = 0.145$ kN/m
$q_{w,\text{ roof truss 4 section C}} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.269 / 0{,}8 = 0.337$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.145 / 0.8 = 0.181$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.020 / 0.8 = 0.026$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (0.614 / 0.8) - (0.269 / 0.8) = 0.431$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (0.331 / 0.8) - (0.145 / 0.8) = 0.232$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.047 / 0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (0.614 / 0.8) - (0.269 / 0.8) = 0.431$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (0.331 / 0.8) - (0.145 / 0.8) = 0.232$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.047 / 0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\text{ roof truss 4 section A}} = 0.269 / 0{,}8 = 0.337$ kN/m
$q_{mt,\text{ roof truss 4 section B}} = 0.145 / 0.8 = 0.181$ kN/m
$q_{mt,\text{ roof truss 4 section C}} = 0.020 / 0.8 = 0.026$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\text{ back wall mid}} = 0.3 * 0.2 * 6.525 * 0.5 = 0.196$ kN/m
$q_{w,\text{ back wall side}} = 0.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\text{ back wall mid}} = 0.196 / 0.8 = 0.245$ kN/m
$q_{mt,\text{ back wall side}} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.2 * 2.5 * 0.5 = 0.25kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.2 * 0 = 0 kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.25 / 0.8 = 0.312 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on side stage area's
Wind calculations of the side stage canopy windward side.
$q_{w,\ profile\ 1\ side}$ = 1.3 * 0.2 * 1.883 = 0.490 kN/m
$q_{w,\ profile\ 1\ roof}$ = 0.3 * 0.2 * 1.883 = 0.113 kN/m
$q_{w,\ profile\ 2\ side}$ = 1.3 * 0.2 * 2.919 = 0.759 kN/m
$q_{w,\ profile\ 2\ roof}$ = 0.3 * 0.2 * 2.919 = 0.175 kN/m
$q_{w,\ profile\ 3\ side}$ = 1.3 * 0.2 * 1.036 = 0.269 kN/m
$q_{w,\ profile\ 3\ roof}$ = 0.3 * 0.2 * 1.036 = 0.062 kN/m

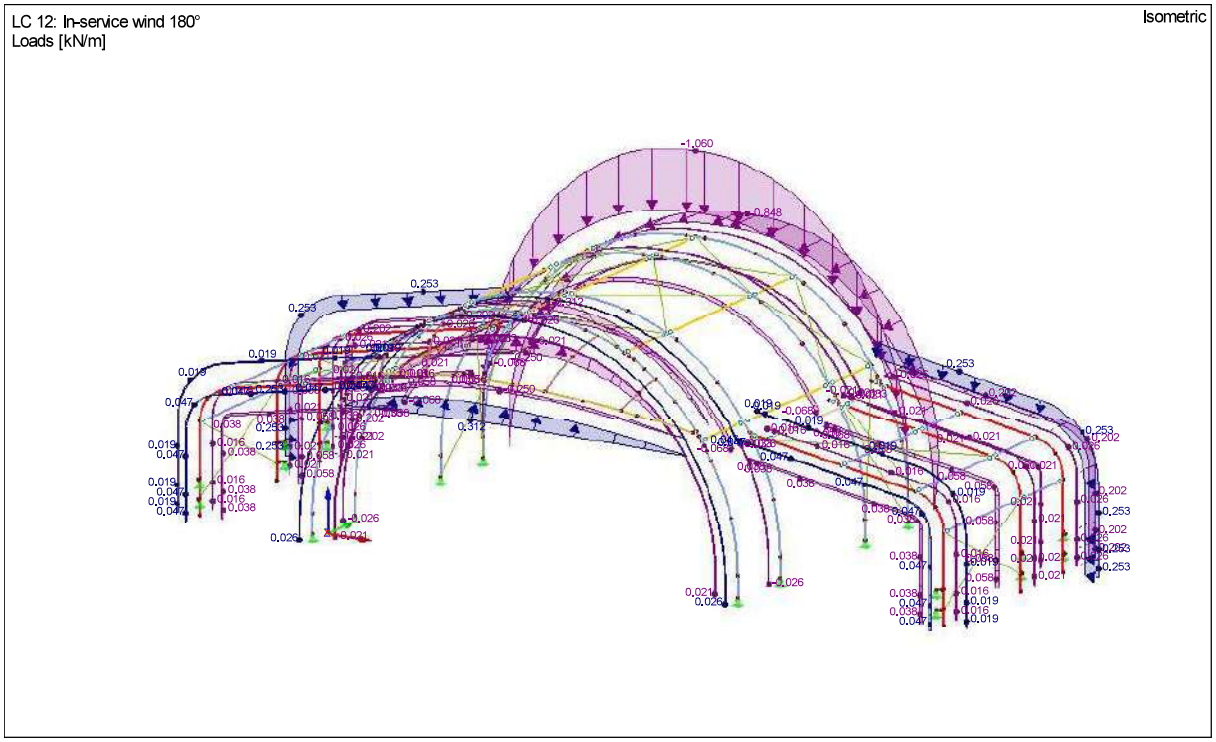
Membrane tension of the side stage canopy windward side.
$q_{mt,\ profile\ 1\ side}$ = 0.490 / 0.8 = 0.612 kN/m
$q_{mt,\ profile\ 1\ roof}$ = 0.113 / 0.8 = 0.141 kN/m
$q_{mt,\ profile\ 2\ side}$ = (0.490 / 0.8) - (0.269 / 0.8) = 0.275 kN/m
$q_{mt,\ profile\ 2\ roof}$ = (0.113 / 0.8) - (0.062 / 0.8) = 0.064 kN/m
$q_{mt,\ profile\ 3\ side}$ = 0.269 / 0.8 = 0.337 kN/m
$q_{mt,\ profile\ 3\ roof}$ = 0.062 / 0.8 = 0.078 kN/m

Wind calculations of the side stage canopy lee side.
$q_{w,\ profile\ 1}$ = 0.3 * 0.2 * 1.883 = 0.113 kN/m
$q_{w,\ profile\ 2}$ = 0.3 * 0.2 * 2.919 = 0.175 kN/m
$q_{w,\ profile\ 3}$ = 0.3 * 0.2 * 1.036 = 0.062 kN/m

Membrane tension of the side stage canopy lee side.
$q_{mt,\ profile\ 1}$ = 0.113 / 0.8 = 0.141 kN/m
$q_{mt,\ profile\ 2}$ = (0.113 / 0.8) - (0.062 / 0.8) = 0.064 kN/m
$q_{mt,\ profile\ 3}$ = 0.062 / 0.8 = 0.078 kN/m

Side stage front and back canopy
The front and back Canopy are attached to Profile and Layher.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 0.3 * 0.2 * 12.13 = 0.728 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 0.728 / 2 / 7.81= 0.093 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.093 / 0.8 = 0.116 kN/m

2.5.3 load case 12 In-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.021 / 0.8 = 0.026$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.047/0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\ roof\ truss\ 3} = (0.047/0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.021 / 0.8 = 0.026$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.2 * 2.5 * 0.5 = 0.25kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.2 * 0 = 0 kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.25 / 0.8 = 0.312 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

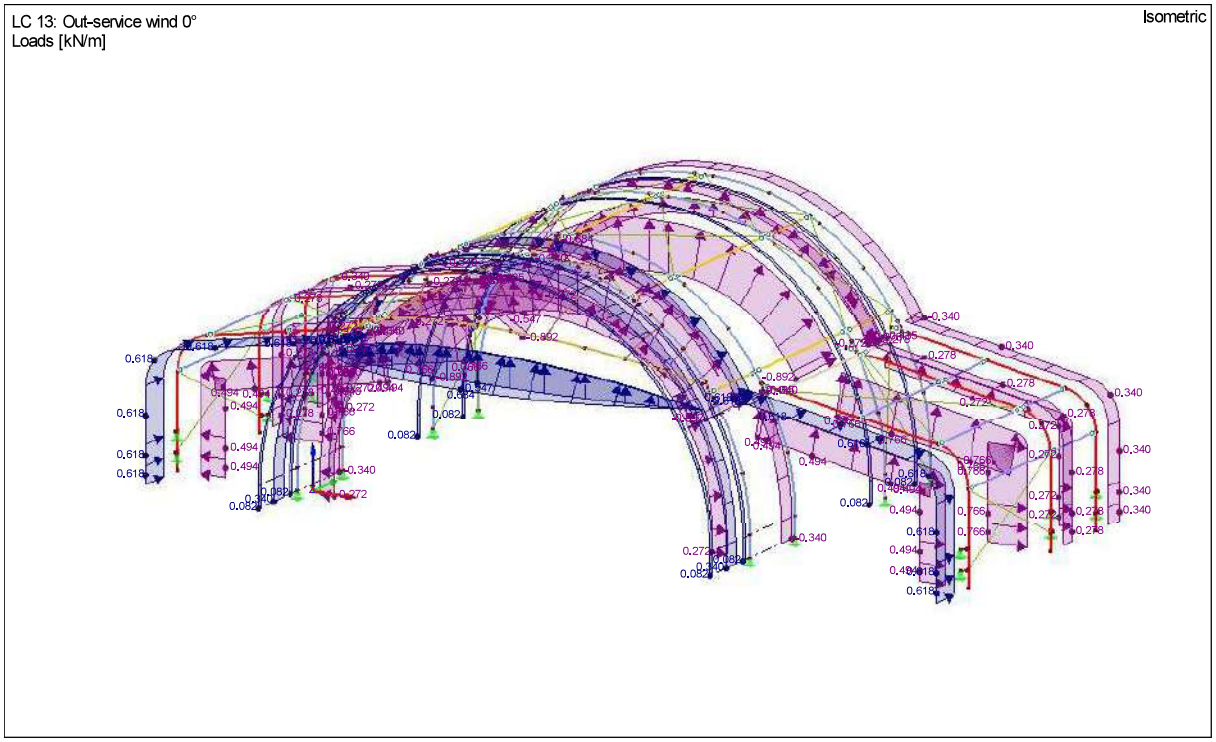
Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1}$ = 0.1 * 0.2 * 1.883 = 0.038 kN/m
$q_{w,\ profile\ 2}$ = 0.1 * 0.2 * 2.919 = 0.058 kN/m
$q_{w,\ profile\ 3}$ = 0.1 * 0.2 * 1.036 = 0.021 kN/m

Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1}$ = 0.038 / 0.8 = 0.047 kN/m
$q_{mt,\ profile\ 2}$ = (0.038 / 0.8) - (0.021 / 0.8) = 0.021 kN/m
$q_{mt,\ profile\ 4}$ = 0.21 / 0.8 = 0.026 kN/m

Side stage front canopy
The front Canopy is attached to the Profile and Layher stage.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 0.1 * 0.2 * 12.13 = 0.243 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 0.243 / 2 / 7.81 = 0.016 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.016 / 0.8 = 0.019 kN/m

Side stage Back canopy
The Back Canopy is attached to the Profile and Layher stage.
Wind calculation
Surface canopy = 12.13 m²
Length of profile = 7.81 m
$Q_{w,\ total}$ = 1.3 * 0.2 * 12.13 = 3.154 kN/m
Wind on profile
$q_{w,\ profile}$ = $Q_{w,\ total}$ / 2 / L = 3.154 / 2 / 7.81 = 0.202 kN/m
membrane tension on profile
$q_{mt,\ profile}$ = 0.202 / 0.8 = 0.252 kN/m

2.5.4 load case 13 Out-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m
$q_{w,\ roof\ truss\ 2}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1}$ = 0.272 / 0.8 = 0.340 kN/m
$q_{mt,\ roof\ truss\ 2}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 3}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 4}$ = 0.272 / 0.8 = 0.340 kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.4375 * 2.5 * 0.5 = 0.547kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.4375 * 0 = 0 kN/m

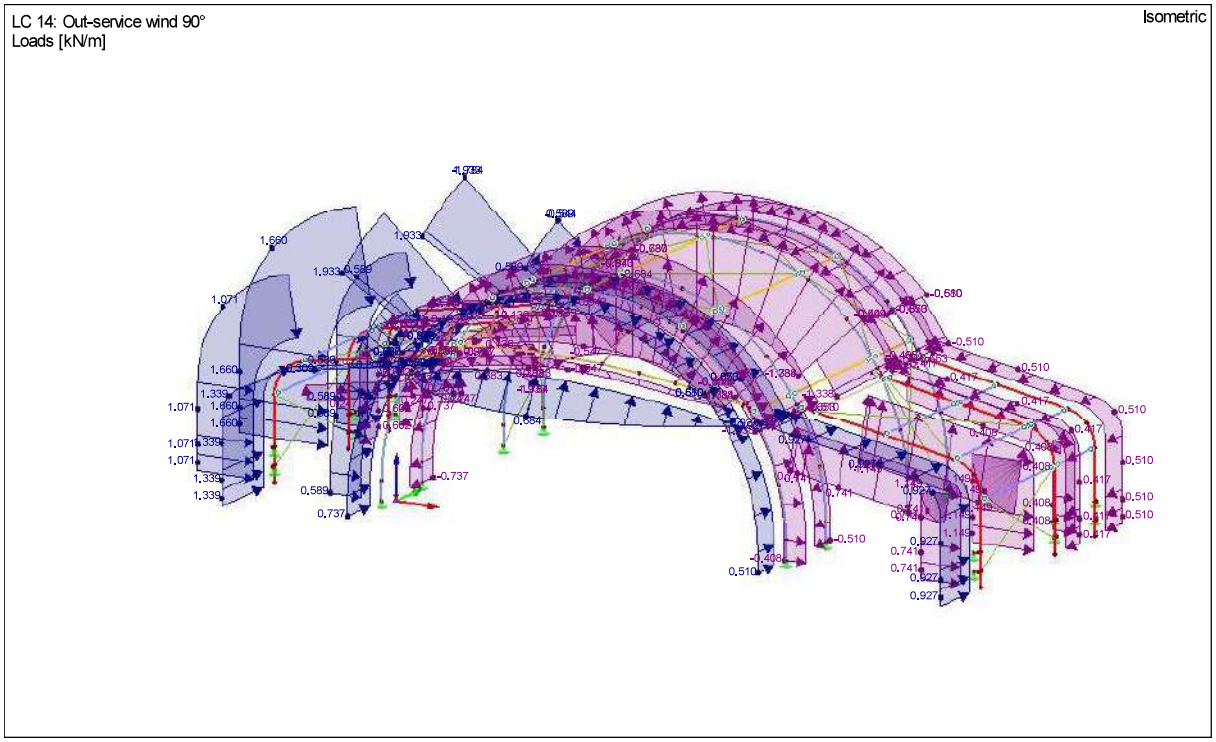
Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.547 / 0.8 = 0.684 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1} = 0.6 * 0.4375 * 1.883 = 0.494$ kN/m
$q_{w,\ profile\ 2} = 0.6 * 0.4375 * 2.919 = 0.766$ kN/m
$q_{w,\ profile\ 3} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m

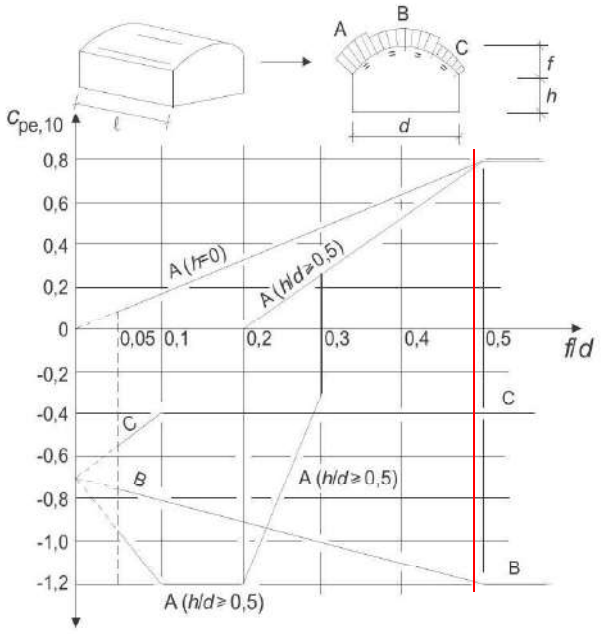
Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1} = 0.494 / 0.8 = 0.618$ kN/m
$q_{mt,\ profile\ 2} = (0.494 / 0.8) - (0.272 / 0.8) = 0.278$ kN/m
$q_{mt,\ profile\ 4} = 0.272 / 0.8 = 0.340$ kN/m

Wind on truss
$q_{w,\ truss} = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082$ kN/m

2.5.5 load case 14 Out-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling and pushing the structure.
The result of these two forces are
A = -1.3 B = 1.2 C = 0.9

Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.4375 * 1.036 = 0.589$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 1.2 * 0.4375 * 1.036 = 0.544$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.9 * 0.4375 * 1.036 = 0.408$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.4375 * 3.398 = 1.933$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 1.2 * 0.4375 * 3.398 = 1.784$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.9 * 0.4375 * 3.398 = 1.338$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.4375 * 3.398 = 1.933$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 1.2 * 0.4375 * 3.398 = 1.784$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.9 * 0.4375 * 3.398 = 1.338$ kN/m
$q_{w,\text{ roof truss 4 section A}} = 1.3 * 0.4375 * 1.036 = 0.589$ kN/m
$q_{w,\text{ roof truss 4 section B}} = 1.2 * 0.4375 * 1.036 = 0.544$ kN/m
$q_{w,\text{ roof truss 4 section C}} = 0.9 * 0.4375 * 1.036 = 0.408$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.589 / 0.8 = 0.737$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.544 / 0.8 = 0.680$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.408 / 0.8 = 0.510$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (1.343 / 0.8) - (0.589 / 0.8) = 0.943$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (1.240 / 0.8) - (0.544 / 0.8) = 0.870$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.930 / 0.8) - (0.408 / 0.8) = 0.653$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (1.343 / 0.8) - (0.589 / 0.8) = 0.943$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (1.240 / 0.8) - (0.544 / 0.8) = 0.870$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.930 / 0.8) - (0.408 / 0.8) = 0.653$ kN/m
$q_{mt,\text{ roof truss 4 section A}} = 0.589 / 0,8 = 0.737$ kN/m
$q_{mt,\text{ roof truss 4 section B}} = 0.544 / 0.8 = 0.680$ kN/m
$q_{mt,\text{ roof truss 4 section C}} = 0.408 / 0.8 = 0.510$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.4375 * 2.5 * 0.5 = 0.547 kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.4375 * 0 = 0 kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.547 / 0.8 = 0.684 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

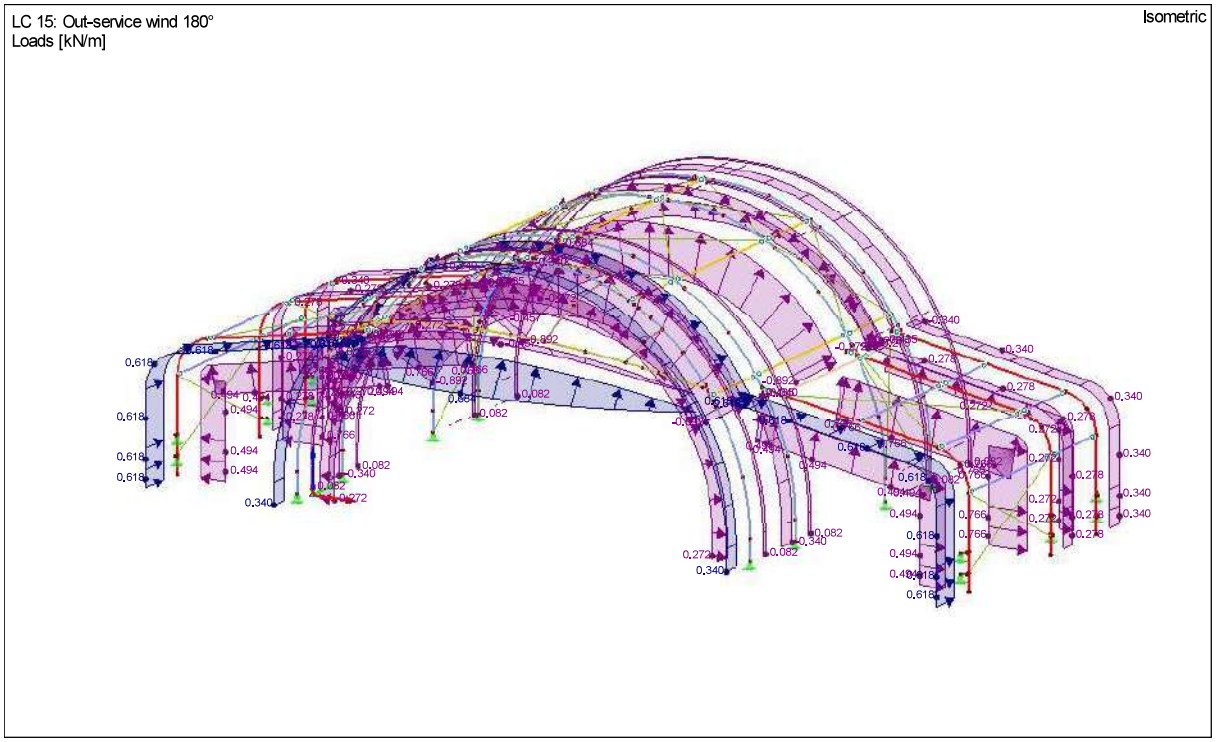
Wind on side stage area's
Wind calculations of the side stage canopy windward side.
$q_{w,\ profile\ 1\ side}$ = 1.3 * 0.4375 * 1.883 = 1.071 kN/m
$q_{w,\ profile\ 1\ roof}$ = 0.3 * 0.4375 * 1.883 = 0.247 kN/m
$q_{w,\ profile\ 2\ side}$ = 1.3 * 0.4375 * 2.919 = 1.660 kN/m
$q_{w,\ profile\ 2\ roof}$ = 0.3 * 0.4375 * 2.919 = 0.383 kN/m
$q_{w,\ profile\ 3\ side}$ = 1.3 * 0.4375 * 1.036 = 0.589 kN/m
$q_{w,\ profile\ 3\ roof}$ = 0.3 * 0.4375 * 1.036 = 0.136 kN/m

Membrane tension of the side stage canopy windward side.
$q_{mt,\ profile\ 1\ side}$ = 1.071 / 0.8 = 1.339 kN/m
$q_{mt,\ profile\ 1\ roof}$ = 0.247 / 0.8 = 0.309 kN/m
$q_{mt,\ profile\ 2\ side}$ = (1.071 / 0.8) - (0.589 / 0.8) = 0.602 kN/m
$q_{mt,\ profile\ 2\ roof}$ = (0.247 / 0.8) - (0.136 / 0.8) = 0.139 kN/m
$q_{mt,\ profile\ 3\ side}$ = 0.589 / 0.8 = 0.737 kN/m
$q_{mt,\ profile\ 3\ roof}$ = 0.136 / 0.8 = 0.170 kN/m

Wind calculations of the side stage canopy lee side.
$q_{w,\ profile\ 1}$ = 0.9 * 0.4375 * 1.883 = 0.741 kN/m
$q_{w,\ profile\ 2}$ = 0.9 * 0.4375 * 2.919 = 1.149 kN/m
$q_{w,\ profile\ 3}$ = 0.9 * 0.4375 * 1.036 = 0.408 kN/m

Membrane tension of the side stage canopy lee side.
$q_{mt,\ profile\ 1}$ = 0.741 / 0.8 = 0.927 kN/m
$q_{mt,\ profile\ 2}$ = (0.741 / 0.8) - (0.408 / 0.8) = 0.417 kN/m
$q_{mt,\ profile\ 3}$ = 0.408 / 0.8 = 0.510 kN/m

2.5.6 load case 15 Out-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.6 * 0.4375 * 3.398 = 0.892$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.6 * 0.4375 * 3.398 = 0.892$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.272 / 0.8 = 0.340$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.620/0.8) - (0.272 / 0.8) = 0.435$ kN/m
$q_{mt,\ roof\ truss\ 3} = (0.620/0.8) - (0.272 / 0.8) = 0.435$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.272 / 0.8 = 0.340$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$kN/m
$q_{w,\ cantilever\ side} = 1 * 0.4375 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

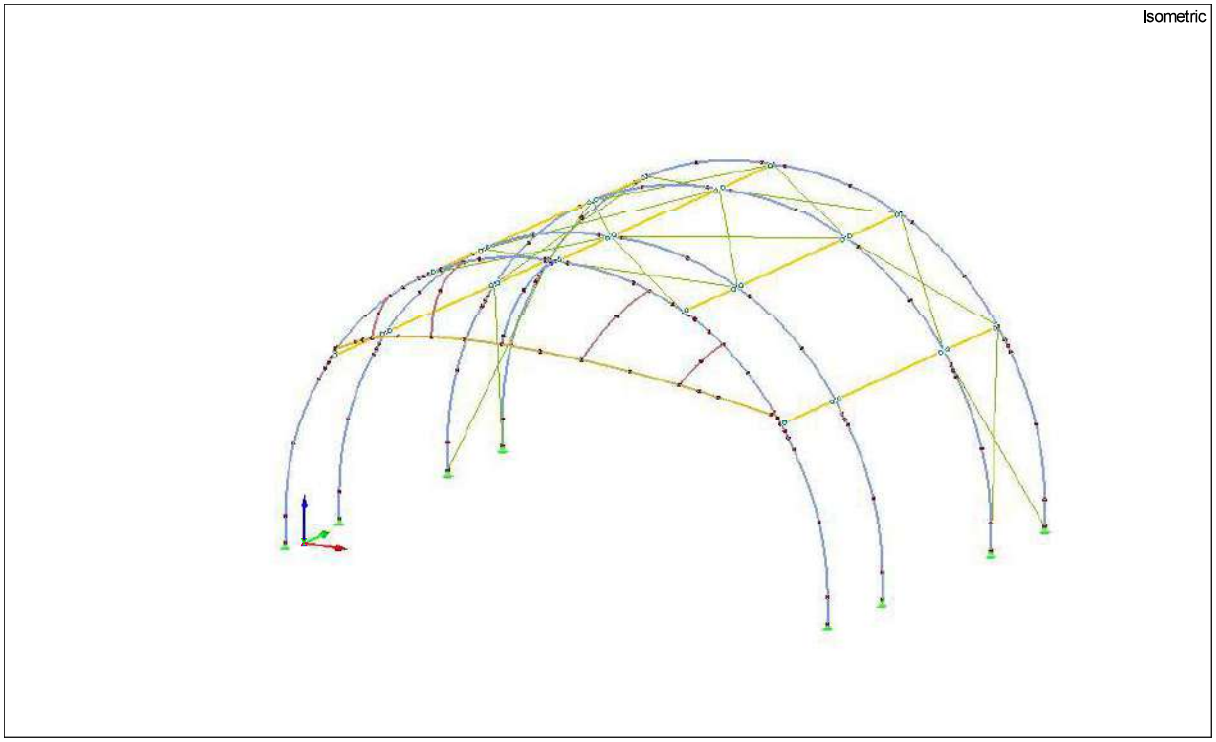
Wind on side stage area's
Wind calculations of the side stage roof canopy.
$q_{w,\ profile\ 1} = 0.6 * 0.4375 * 1.883 = 0.494$ kN/m
$q_{w,\ profile\ 2} = 0.6 * 0.4375 * 2.919 = 0.766$ kN/m
$q_{w,\ profile\ 3} = 0.6 * 0.4375 * 1.036 = 0.272$ kN/m

Membrane tension of the side stage roof canopy.
$q_{mt,\ profile\ 1} = 0.494 / 0.8 = 0.618$ kN/m
$q_{mt,\ profile\ 2} = (0.494 / 0.8) - (0.272 / 0.8) = 0.278$ kN/m
$q_{mt,\ profile\ 4} = 0.272 / 0.8 = 0.340$ kN/m

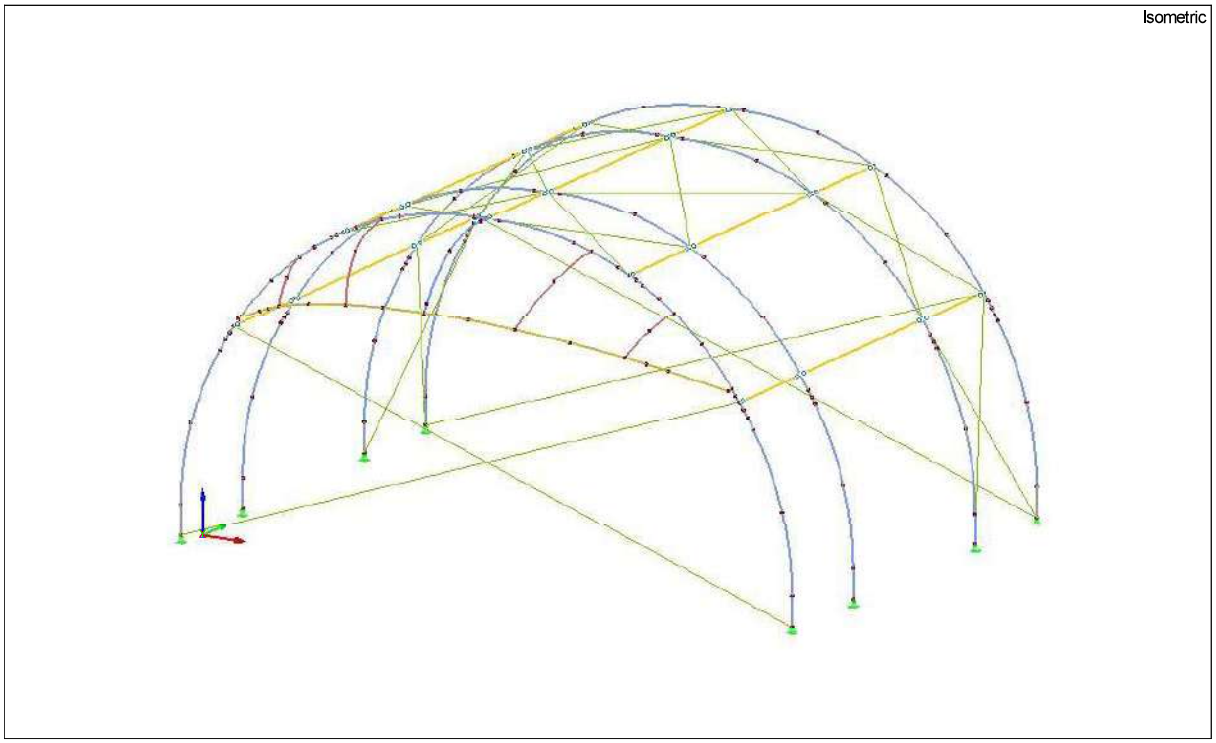
Wind on truss
$q_{w,\ truss} = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082$ kN/m

2.6 Construction model of the Medium Tunnel Roof 10x8 setup option 3.

In service model.

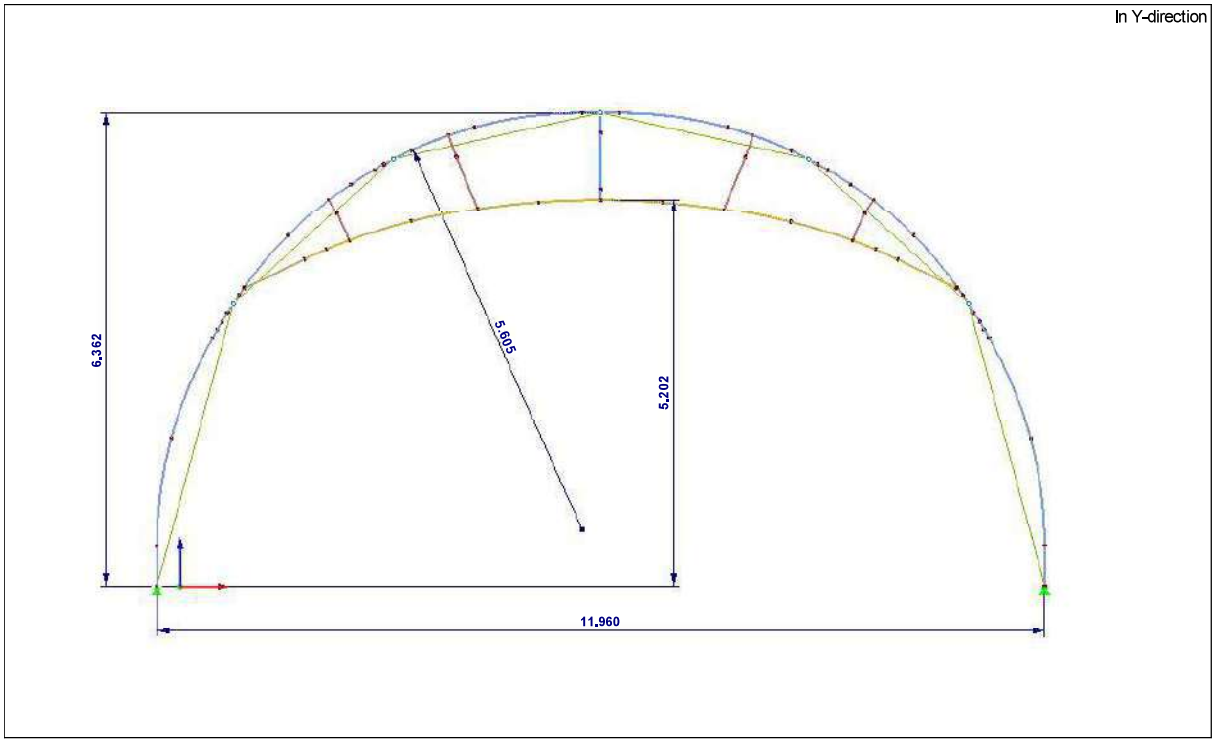


Out service model.

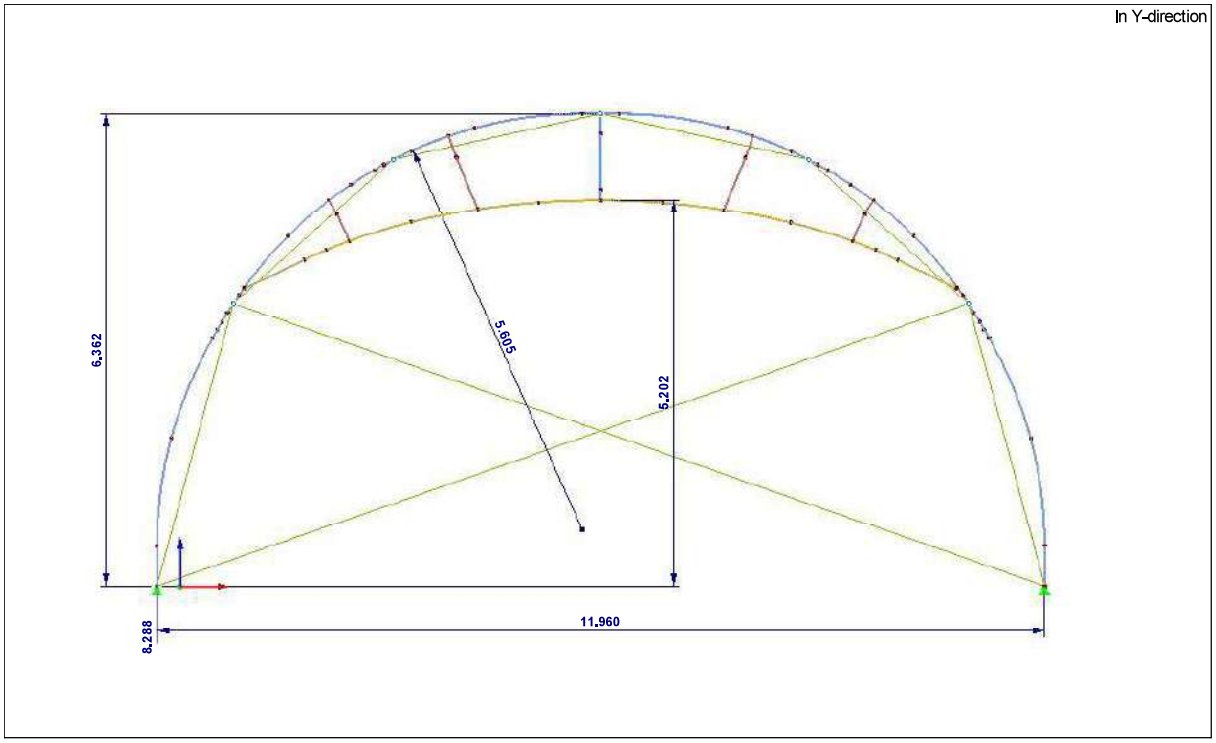


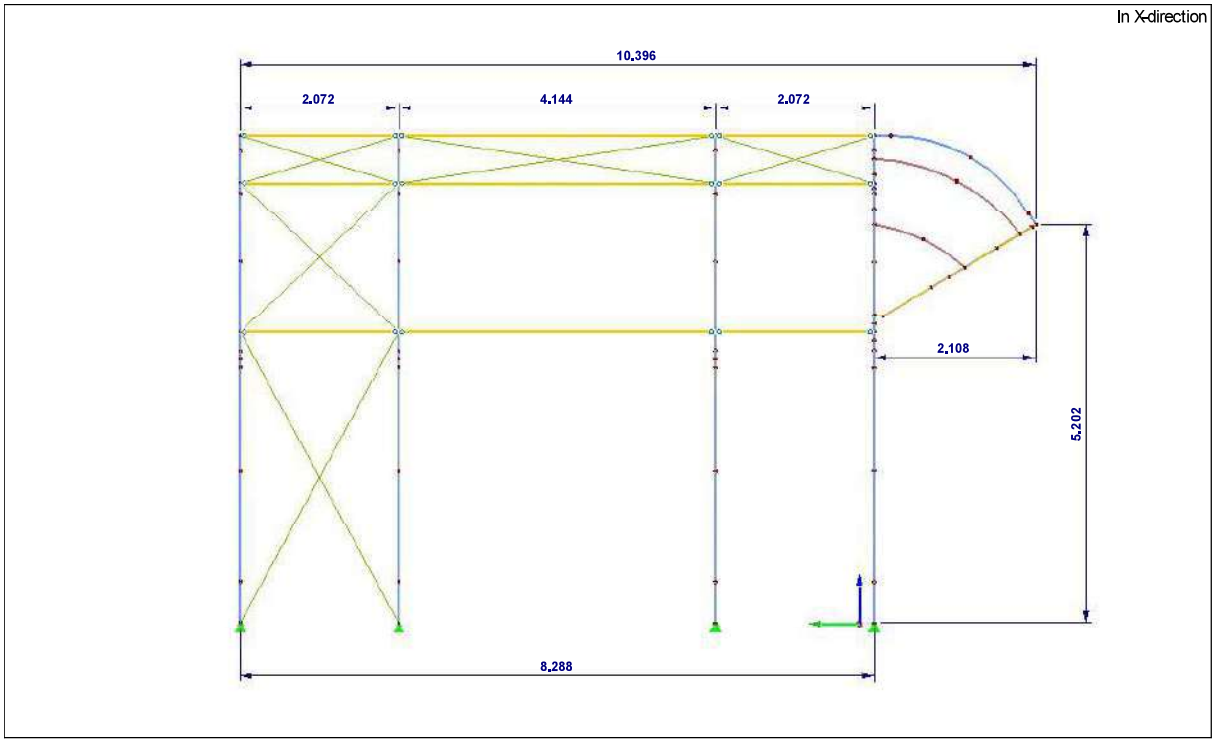
Cross-Sections
1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
4: RD 10; steel 8.8 kw aliteit

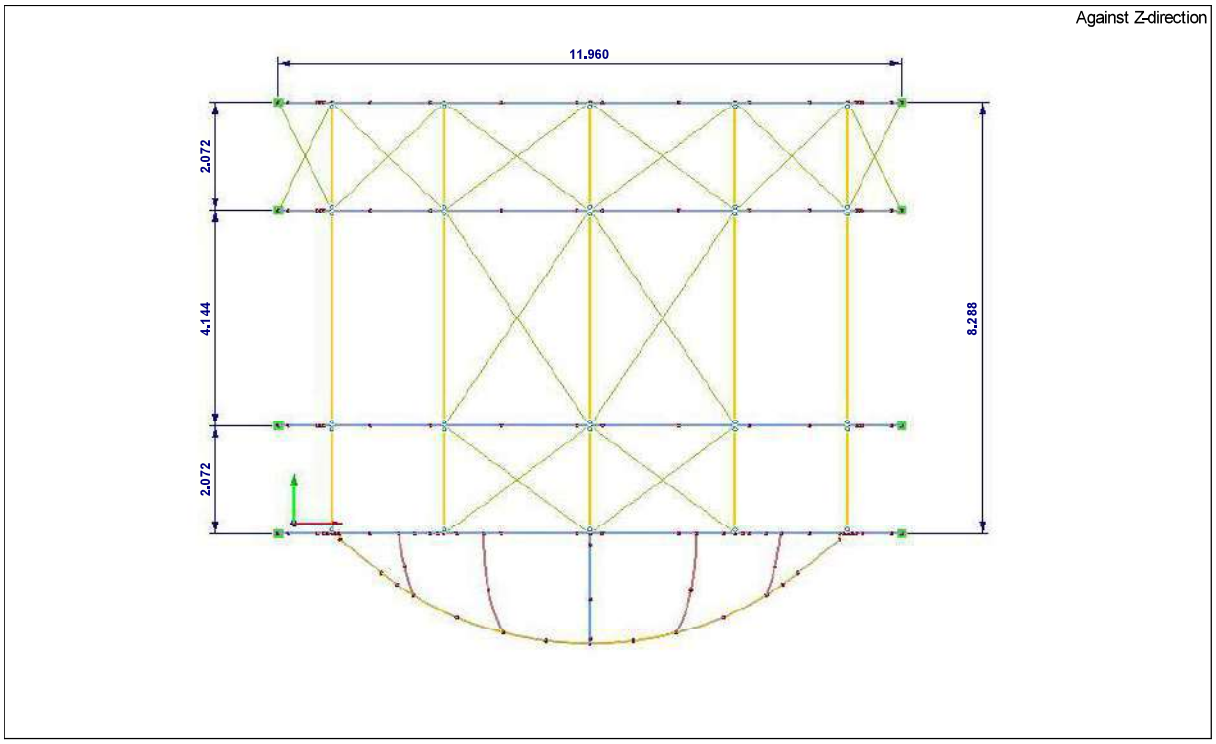
In service front view.



Out service front view.







For the structural integrity and stability of the system it is necessary to ad cross wires in the front and the back of the system in the out-service situation for Medium tunnel stage option 3.

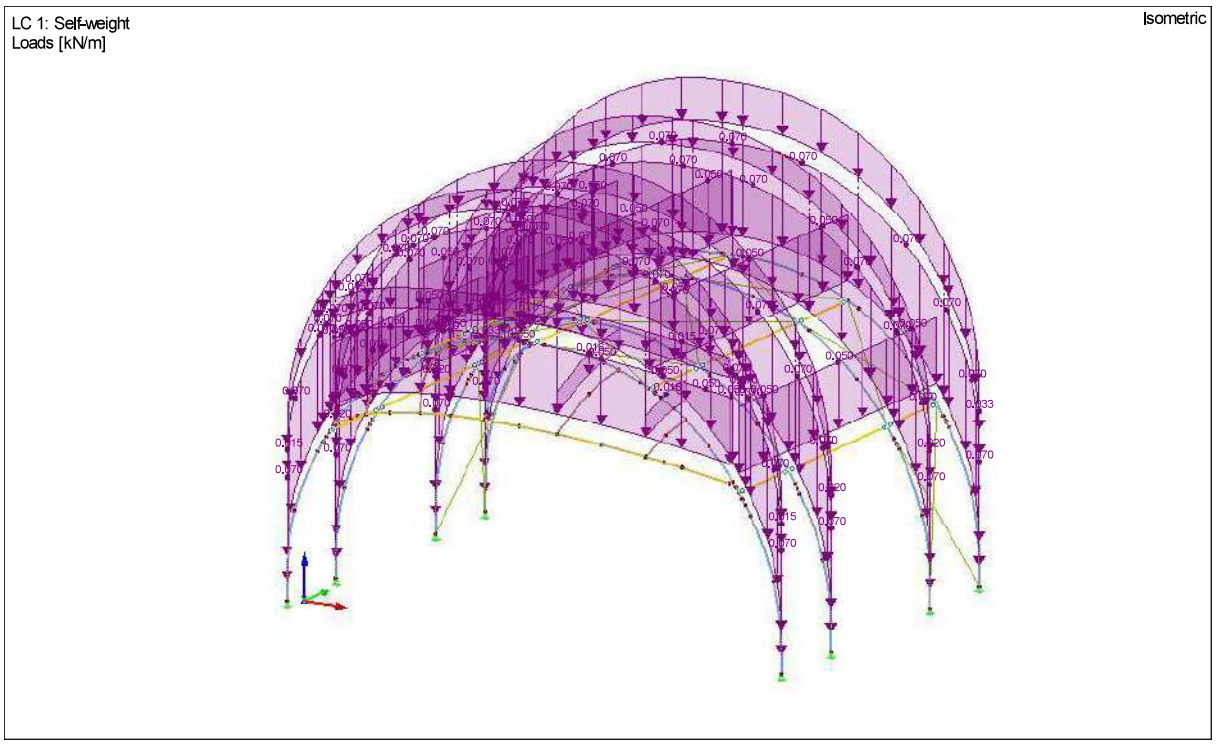
2.7 Single Load cases model option 3.

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

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self-weight	+	Permanent	-	0,000	0,000	-1,000
LC2	UDL Loading	+	Permanent/Imposed	-	0,000	0,000	0,000
LC3	CPL Loading setup	+	Permanent/Imposed	-	0,000	0,000	0,000
LC4	2x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC5	3x point load per truss arch	+	Permanent/Imposed	-	0,000	0,000	0,000
LC10	In-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC11	In-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC12	In-service wind 180°	+	Wind	-	0,000	0,000	0,000
LC13	Out-service wind 0°	+	Wind	-	0,000	0,000	0,000
LC14	Out-service wind 90°	+	Wind	-	0,000	0,000	0,000
LC15	Out-service wind 180°	+	Wind	-	0,000	0,000	0,000

2.8 Load case input Model option 3.

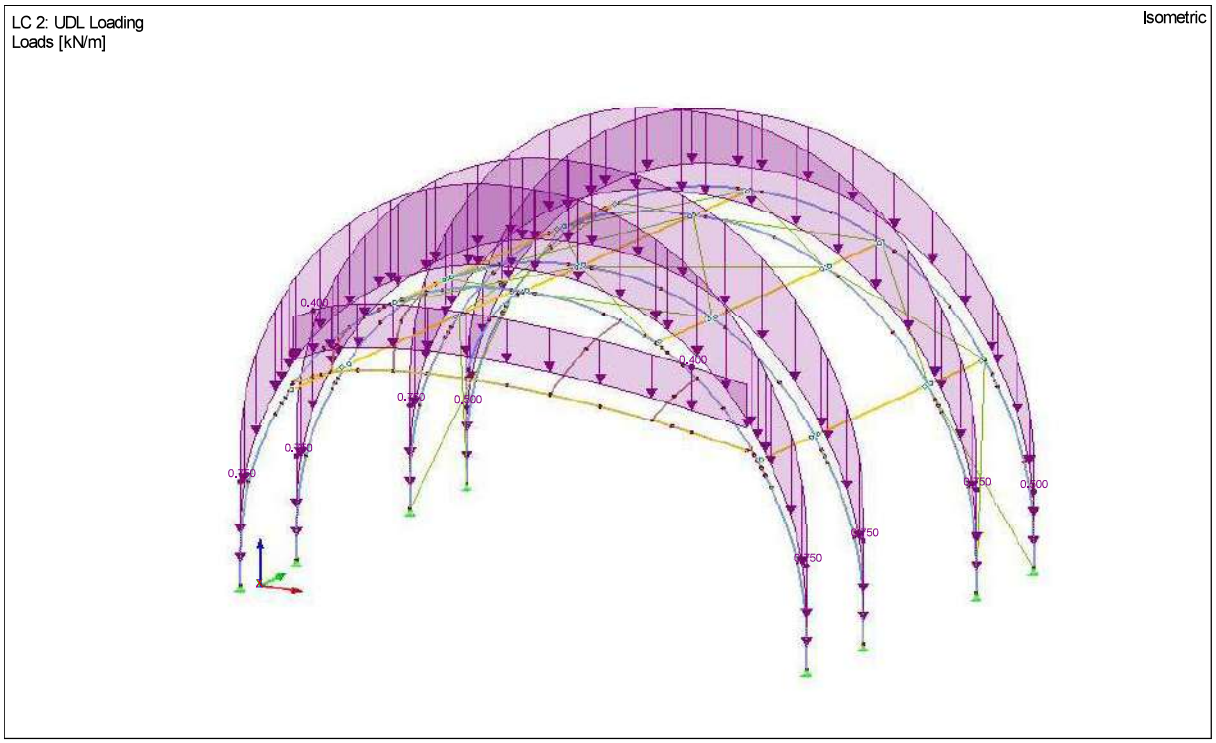
2.8.1 LC1 Self-Weight.



Interal Protruss S31 = 0.07 kN/m^{-1}
Interal Protruss T31 = 0.05 kN/m^{-1}
Tube 50x4 = 0.016 kN/m^{-1}

Canopy truss1 + cantilever truss = 0.015 kN/m^{-1}
Canopy truss2 + truss3 = 0.02 kN/m^{-1}
Canopy truss4 = 0.033 kN/m^{-1}

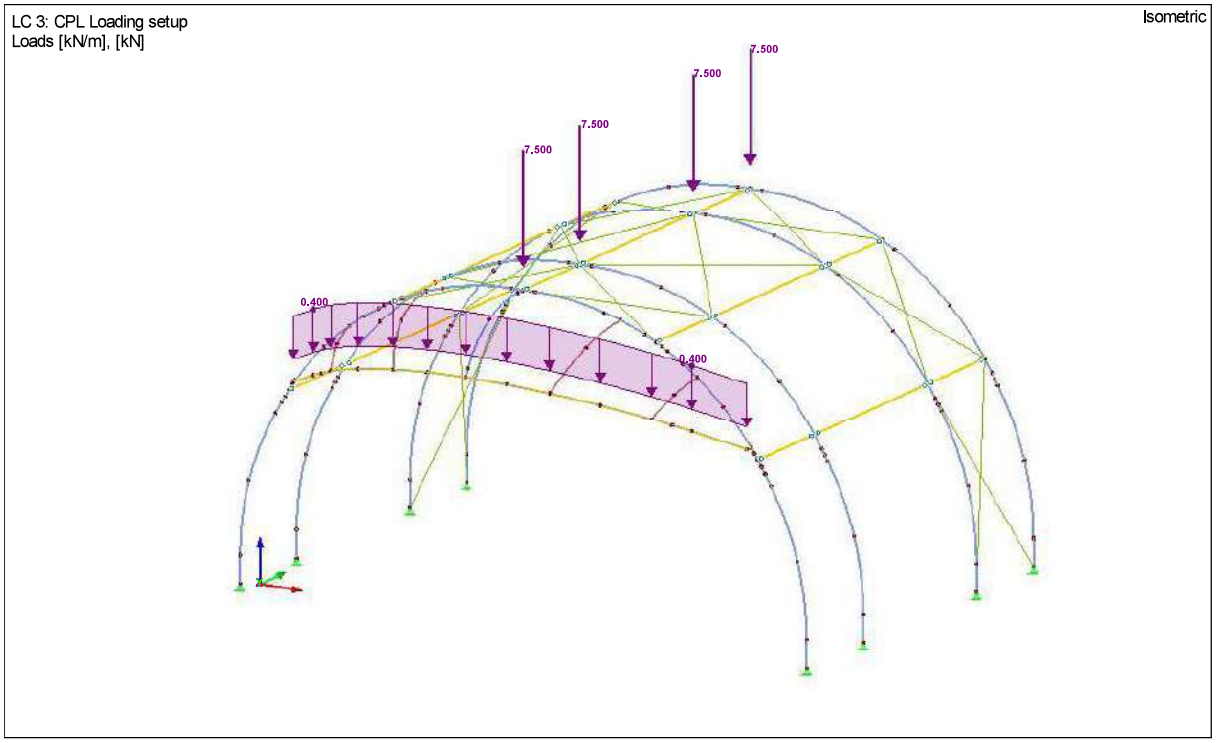
2.8.2 LC2 UDL Loading setup.



The loading which is taken into account in the UDL Loading setup are:
Truss 1 = 0.75 kN/m^{-1}
Truss 2 = 0.75 kN/m^{-1}
Truss 3 = 0.75 kN/m^{-1}
Truss 3 = 0.50 kN/m^{-1}

Cantilever truss 0.40 kN/m^{-1}

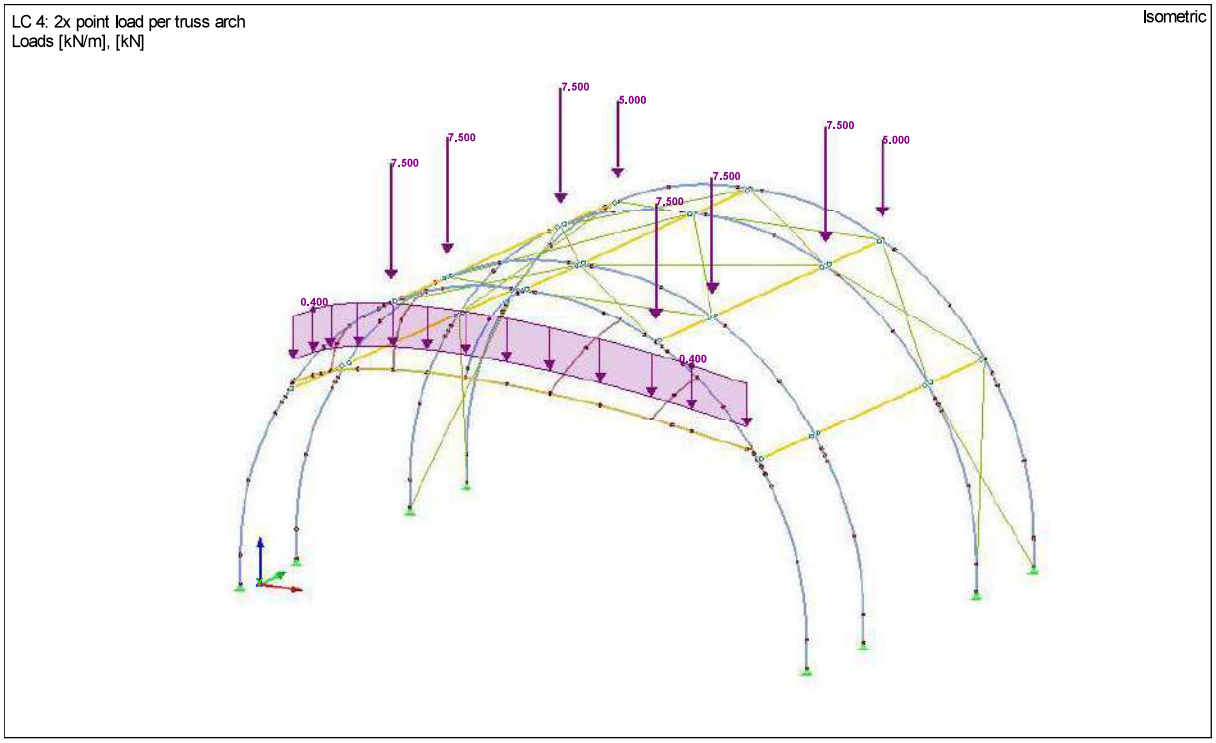
2.8.3 LC3 Center point load per truss arch.



The loading which is taken into account in the Centre point Load setup are:
Truss 1 = 7.50 kN
Truss 2 = 7.50 kN
Truss 3 = 7.50 kN
Truss 4 = 7.50 kN

Cantilever truss 0.40 kN/m^{-1}

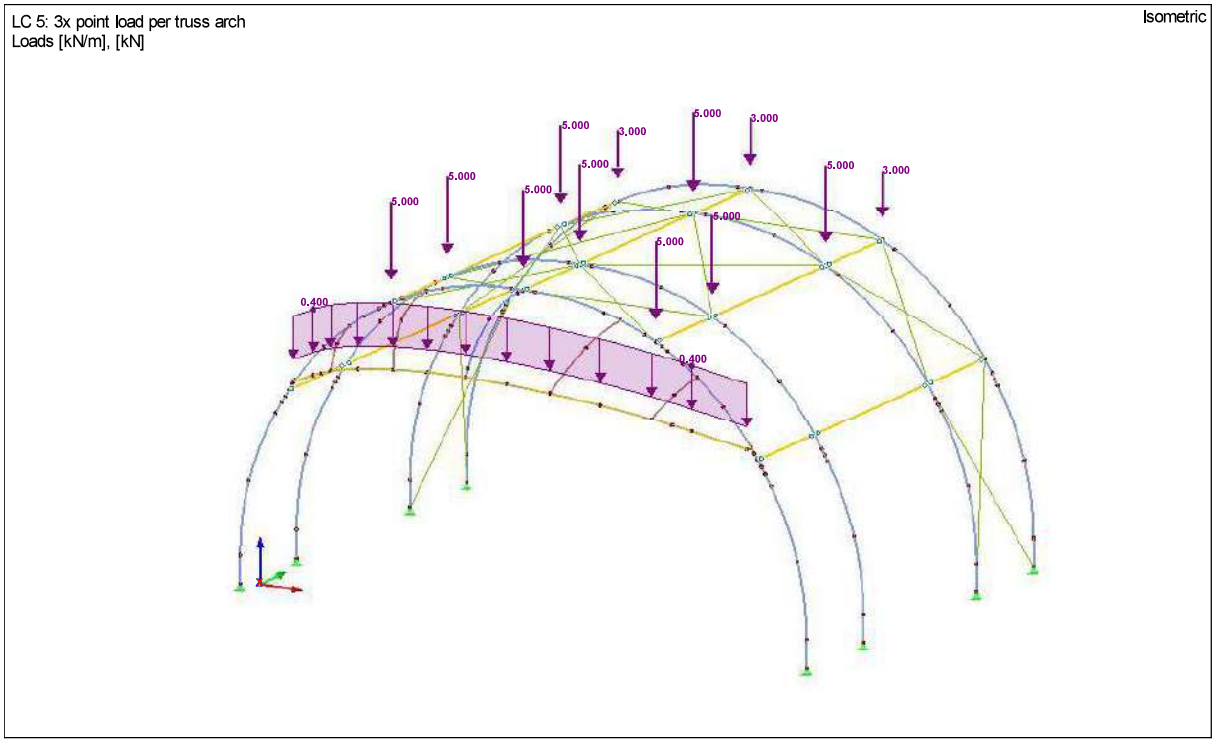
2.8.4 LC4 2x Point loads per truss arch.



The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 2 x 7.50 kN
Truss 2 = 2 x 7.50 kN
Truss 3 = 2 x 7.50 kN
Truss 4 = 2 x 5.00 kN

Cantilever truss 0.40 kN/m^{-1}

2.8.5 LC5 3x Point loads per truss arch.

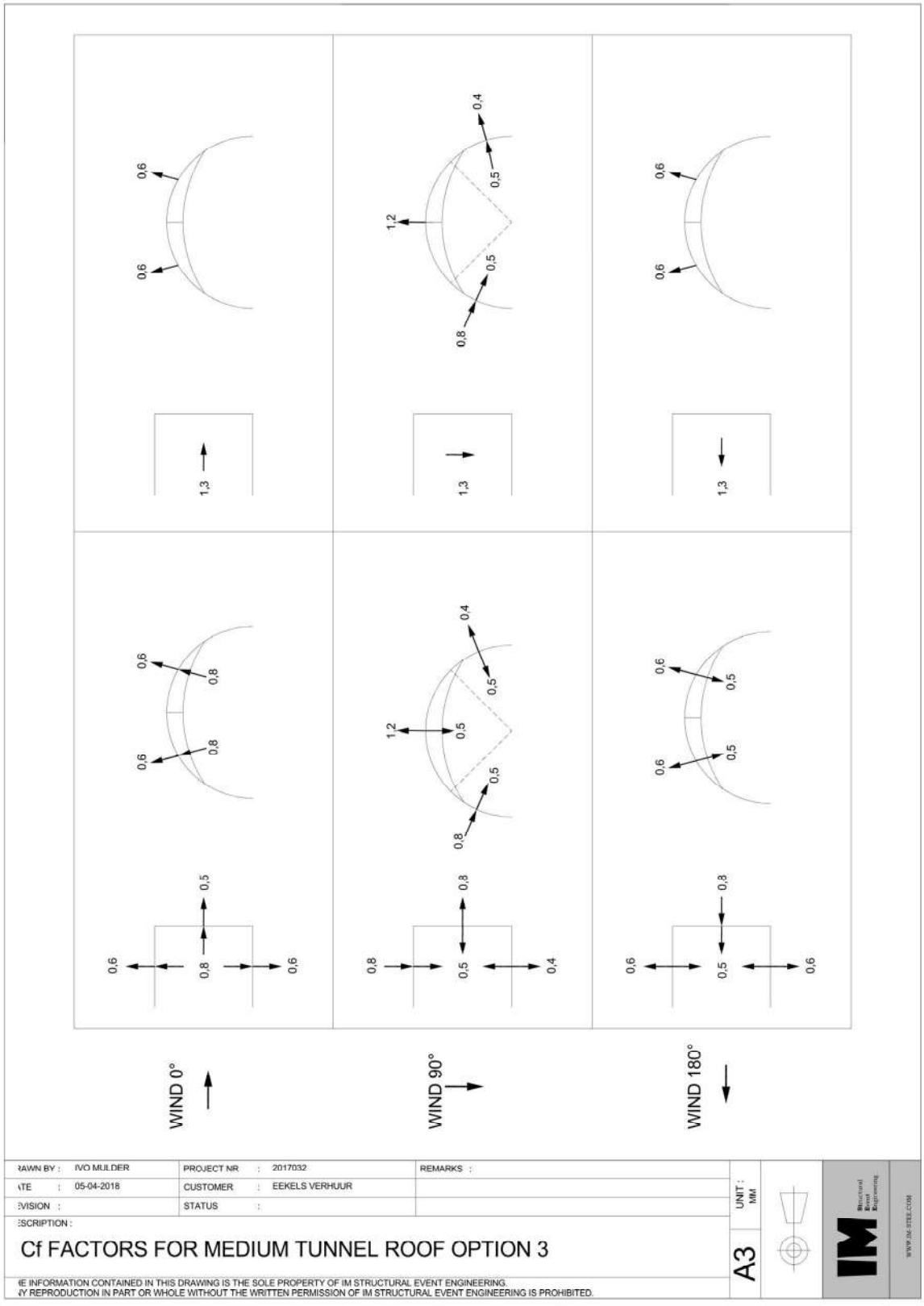


The loading which is taken into account in the fourth point Loading setup are:
Truss 1 = 3 x 5.00 kN
Truss 2 = 3 x 5.00 kN
Truss 3 = 3 x 5.00 kN
Truss 4 = 3 x 3.00 kN

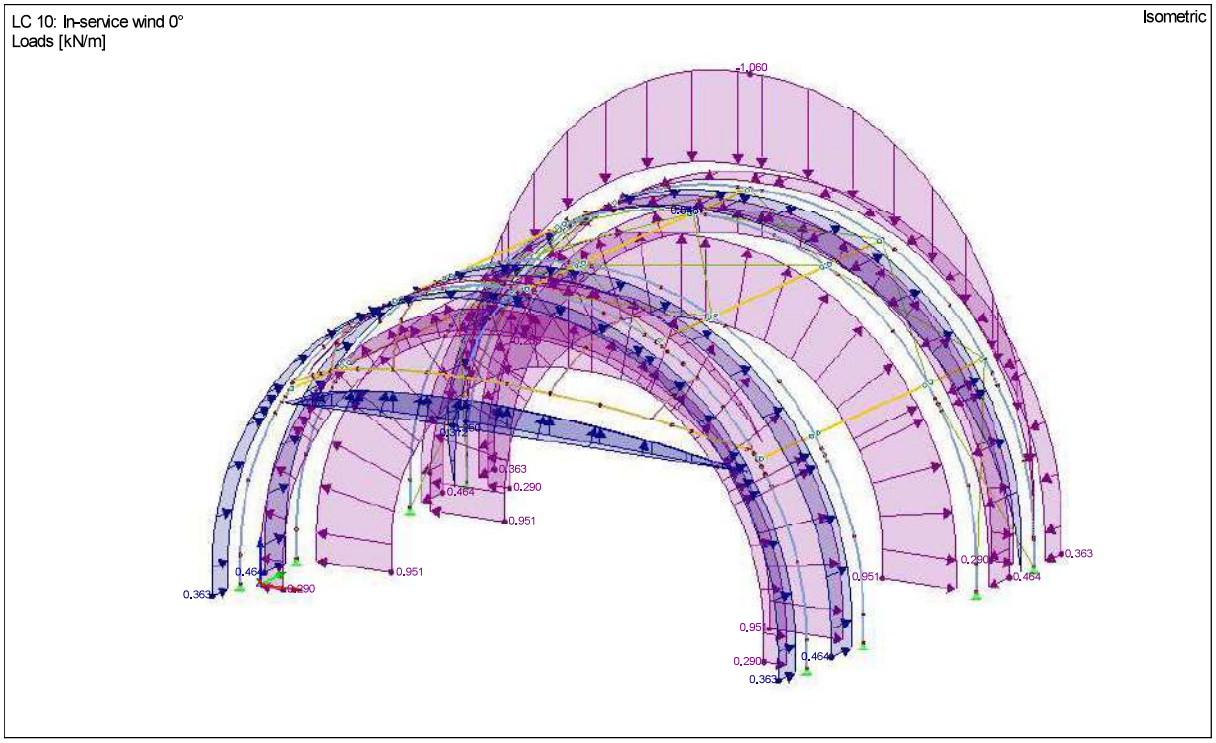
Cantilever truss 0.40 kN/m^{-1}

2.9 Load cases concerning wing loading model option 3.

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 NEN-EN 13814: Fairground and amusement park machinery and structures safety.



2.9.1 load case 10 In-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1}$ = 1.4 * 0.2 * 1.036 = 0.290 kN/m
$q_{w,\ roof\ truss\ 2}$ = 1.4 * 0.2 * 3.398 = 0.951 kN/m
$q_{w,\ roof\ truss\ 3}$ = 1.4 * 0.2 * 3.398 = 0.951 kN/m
$q_{w,\ roof\ truss\ 3}$ = 1.4 * 0.2 * 1.036 = 0.290 kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1}$ = 0.290 / 0.8 = 0.363 kN/m
$q_{mt,\ roof\ truss\ 2}$ = (0.661/0.8) - (0.290 / 0.8) = 0.464 kN/m
$q_{mt,\ roof\ truss\ 3}$ = (0.661/0.8) - (0.290 / 0.8) = 0.464 kN/m
$q_{mt,\ roof\ truss\ 4}$ = 0.290 / 0.8 = 0.363 kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 1.3 * 0.2 * 6.525 * 0.5 = 0.848kN/m
$q_{w,\ back\ wall\ side}$ = 1.3 * 0.2 * 0 = 0 kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.848 / 0.8 = 1.060 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.

$q_{w,\ cantilever\ mid} = 1 * 0.2 * 2.5 * 0.5 = 0.25$ kN/m

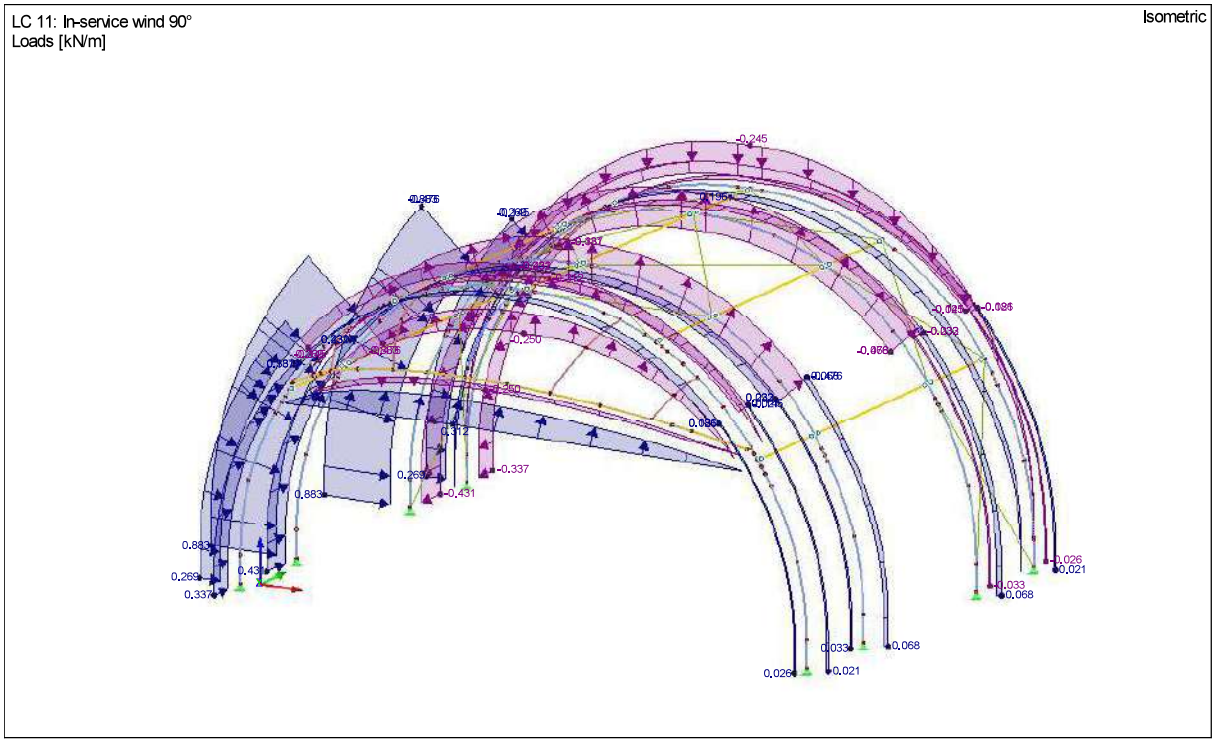
$q_{w,\ cantilever\ side} = 1 * 0.2 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.

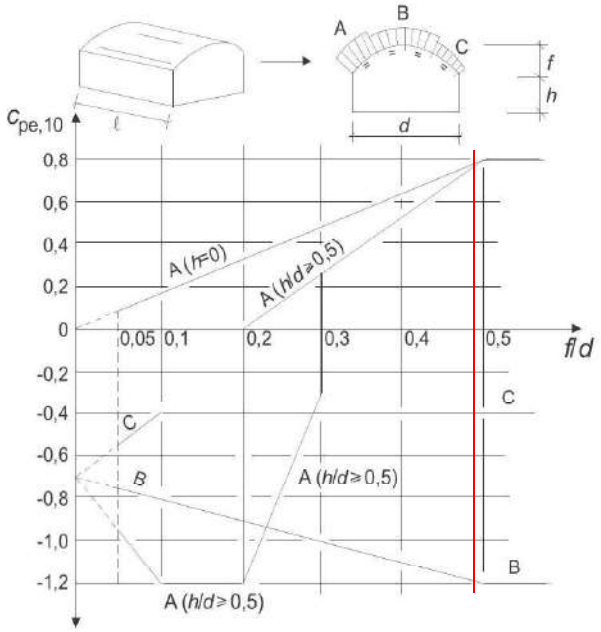
$q_{mt,\ cantilever\ mid} = 0.25 / 0.8 = 0.312$ kN/m

$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0$ kN/m

2.9.2 load case 11 In-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling the structure down.
The result of these two forces are
A = -1.3 B = 0.7 C = -0.1

Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.2 * 1.036 = 0.269$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 0.7 * 0.2 * 1.036 = 0.145$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.2 * 3.398 = 0.883$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 0.7 * 0.2 * 3.398 = 0.476$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.2 * 3.398 = 0.883$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 0.7 * 0.2 * 3.398 = 0.476$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\text{ roof truss 4 section A}} = 1.3 * 0.2 * 1.036 = 0.269$ kN/m
$q_{w,\text{ roof truss 4 section B}} = 0.7 * 0.2 * 1.036 = 0.145$ kN/m
$q_{w,\text{ roof truss 4 section C}} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.269 / 0{,}8 = 0.337$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.145 / 0.8 = 0.181$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.020 / 0.8 = 0.026$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (0.614 / 0.8) - (0.269 / 0.8) = 0.431$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (0.331 / 0.8) - (0.145 / 0.8) = 0.232$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.047 / 0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (0.614 / 0.8) - (0.269 / 0.8) = 0.431$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (0.331 / 0.8) - (0.145 / 0.8) = 0.232$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.047 / 0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\text{ roof truss 4 section A}} = 0.269 / 0{,}8 = 0.337$ kN/m
$q_{mt,\text{ roof truss 4 section B}} = 0.145 / 0.8 = 0.181$ kN/m
$q_{mt,\text{ roof truss 4 section C}} = 0.020 / 0.8 = 0.026$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\text{ back wall mid}} = 0.3 * 0.2 * 6.525 * 0.5 = 0.196$ kN/m
$q_{w,\text{ back wall side}} = 0.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\text{ back wall mid}} = 0.196 / 0.8 = 0.245$ kN/m
$q_{mt,\text{ back wall side}} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.

$q_{w,\ cantilever\ mid} = 1 * 0.2 * 2.5 * 0.5 = 0.25 kN/m$

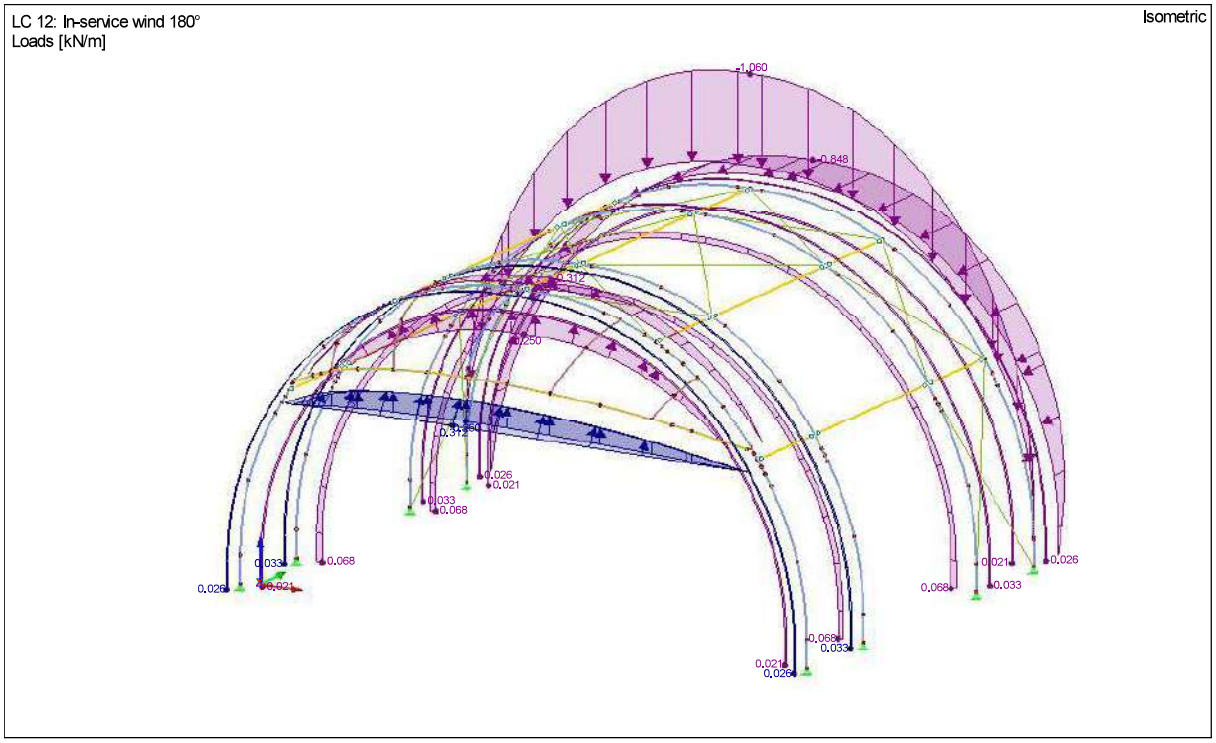
$q_{w,\ cantilever\ side} = 1 * 0.2 * 0 = 0\ kN/m$

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.

$q_{mt,\ cantilever\ mid} = 0.25 / 0.8 = 0.312\ kN/m$

$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0\ kN/m$

2.9.3 load case 12 In-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m
$q_{w,\ roof\ truss\ 2} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.1 * 0.2 * 3.398 = 0.068$ kN/m
$q_{w,\ roof\ truss\ 3} = 0.1 * 0.2 * 1.036 = 0.021$ kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1} = 0.021 / 0.8 = 0.026$ kN/m
$q_{mt,\ roof\ truss\ 2} = (0.047/0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\ roof\ truss\ 3} = (0.047/0.8) - (0.021 / 0.8) = 0.033$ kN/m
$q_{mt,\ roof\ truss\ 4} = 0.021 / 0.8 = 0.026$ kN/m

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid} = 1.3 * 0.2 * 6.525 * 0.5 = 0.848$kN/m
$q_{w,\ back\ wall\ side} = 1.3 * 0.2 * 0 = 0$ kN/m

Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid} = 0.848 / 0.8 = 1.060$ kN/m
$q_{mt,\ back\ wall\ side} = 0 / 0.8 = 0$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.

$q_{w,\ cantilever\ mid} = 1 * 0.2 * 2.5 * 0.5 = 0.25 kN/m$

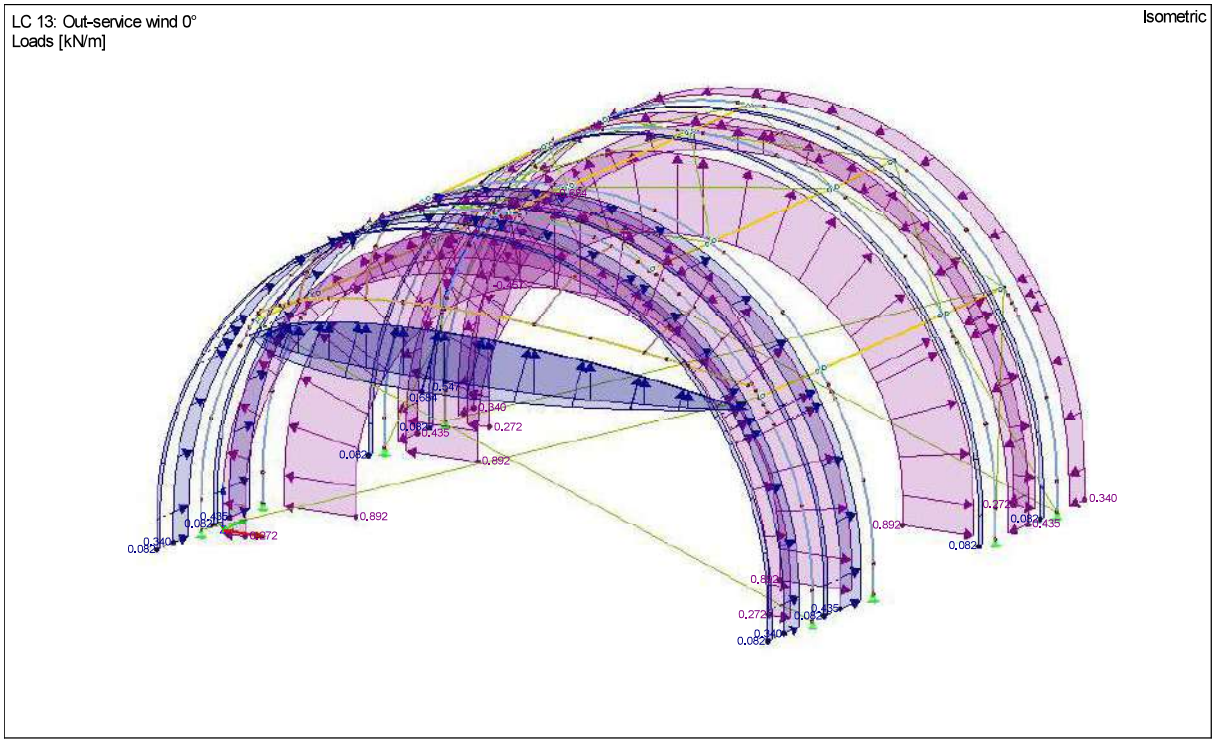
$q_{w,\ cantilever\ side} = 1 * 0.2 * 0 = 0\ kN/m$

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.

$q_{mt,\ cantilever\ mid} = 0.25 / 0.8 = 0.312\ kN/m$

$q_{mt,\ cantilever\ side} = 0 / 0.8 = 0\ kN/m$

2.9.4 load case 13 Out-service wind 0°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m
$q_{w,\ roof\ truss\ 2}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m

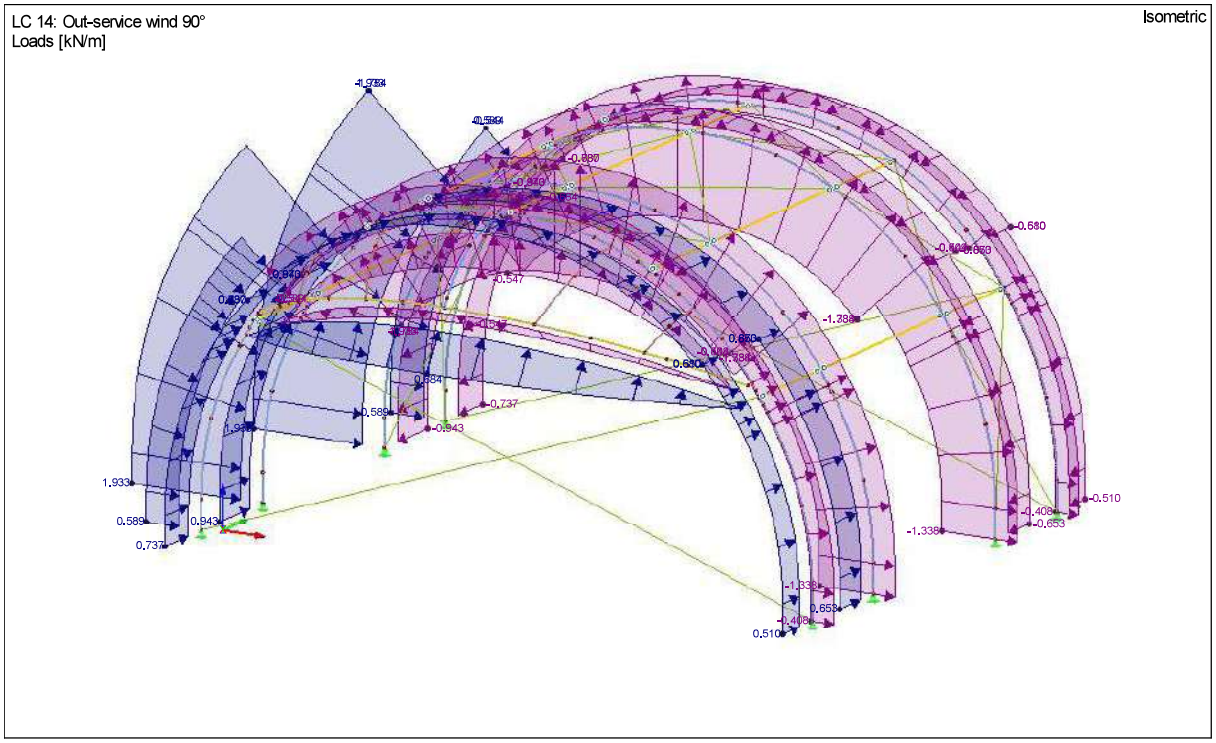
Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1}$ = 0.272 / 0.8 = 0.340 kN/m
$q_{mt,\ roof\ truss\ 2}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 3}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 4}$ = 0.272 / 0.8 = 0.340 kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.4375 * 2.5 * 0.5 = 0.547kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.4375 * 0 = 0 kN/m

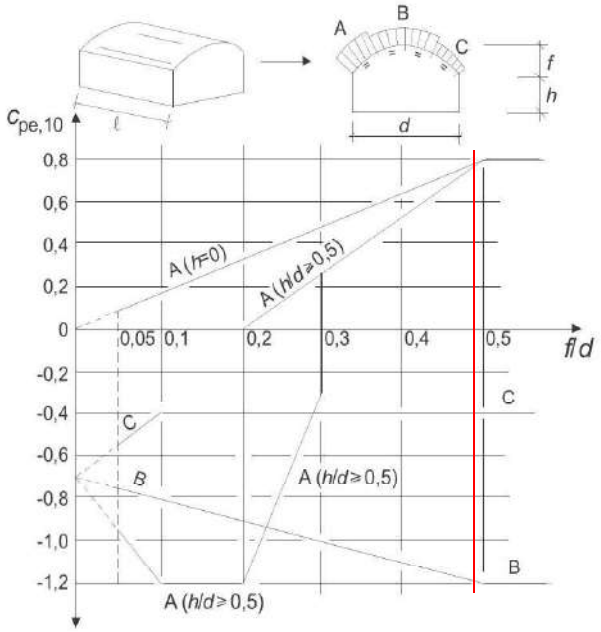
Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.547 / 0.8 = 0.684 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on truss
$q_{w,\ truss}$ = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082 kN/m

2.9.5 load case 14 Out-service situation wind direction 90°.



To determine the wind loading on the walls the next diagram of the Eurocode NEN-EN 1991-1 1-4: General actions – wind actions has been used.



In which
f = 6 Meter
h = 0.55 meter
d = 12.25 meter
f / d = 6 / 12.25 = 0.49
h / d = 0.55 / 12.25 = 0.045

Extracting from the diagram the different C_{pe10} are,
A = -0.8 B = 1.2 C = 0.4
On the same time there is a Cf 0.5 working on the inside pulling and pushing the structure.
The result of these two forces are
A = -1.3 B = 1.2 C = 0.9

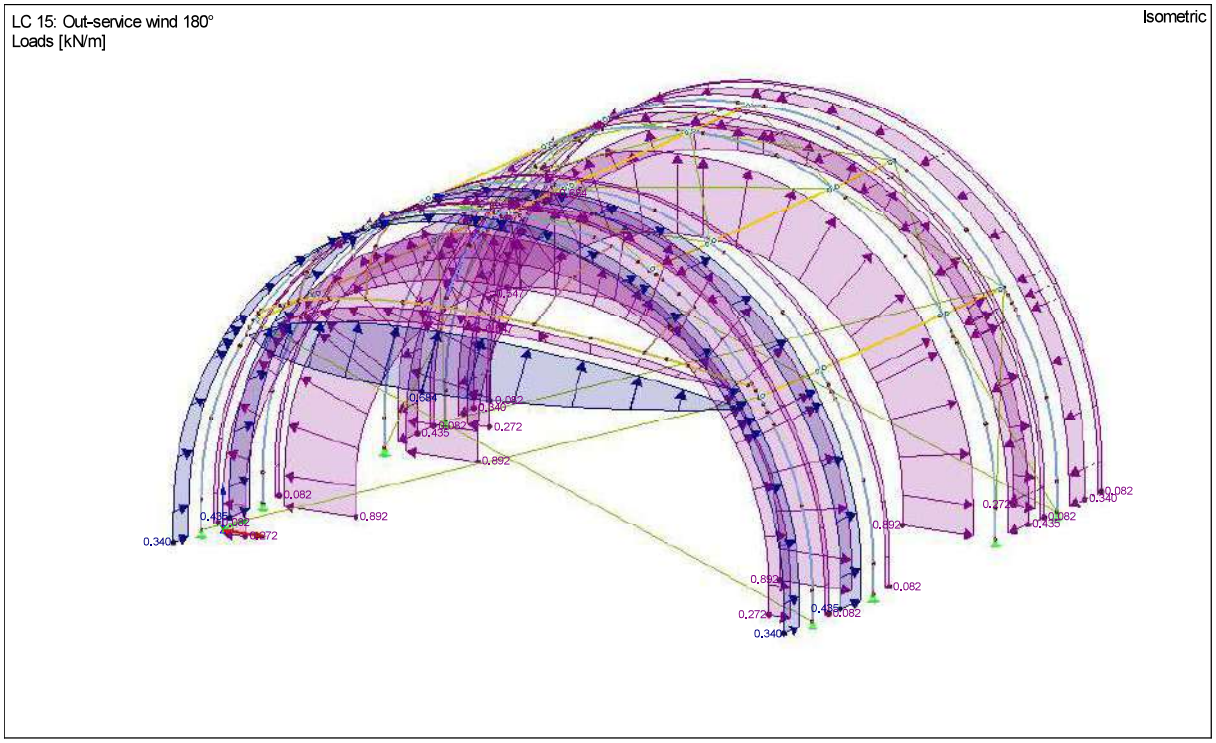
Wind calculations for the Roof spans
$q_{w,\text{ roof truss 1 section A}} = 1.3 * 0.4375 * 1.036 = 0.589$ kN/m
$q_{w,\text{ roof truss 1 section B}} = 1.2 * 0.4375 * 1.036 = 0.544$ kN/m
$q_{w,\text{ roof truss 1 section C}} = 0.9 * 0.4375 * 1.036 = 0.408$ kN/m
$q_{w,\text{ roof truss 2 section A}} = 1.3 * 0.4375 * 3.398 = 1.933$ kN/m
$q_{w,\text{ roof truss 2 section B}} = 1.2 * 0.4375 * 3.398 = 1.784$ kN/m
$q_{w,\text{ roof truss 2 section C}} = 0.9 * 0.4375 * 3.398 = 1.338$ kN/m
$q_{w,\text{ roof truss 3 section A}} = 1.3 * 0.4375 * 3.398 = 1.933$ kN/m
$q_{w,\text{ roof truss 3 section B}} = 1.2 * 0.4375 * 3.398 = 1.784$ kN/m
$q_{w,\text{ roof truss 3 section C}} = 0.9 * 0.4375 * 3.398 = 1.338$ kN/m
$q_{w,\text{ roof truss 4 section A}} = 1.3 * 0.4375 * 1.036 = 0.589$ kN/m
$q_{w,\text{ roof truss 4 section B}} = 1.2 * 0.4375 * 1.036 = 0.544$ kN/m
$q_{w,\text{ roof truss 4 section C}} = 0.9 * 0.4375 * 1.036 = 0.408$ kN/m

membrane tension calculations for the Roof spans
$q_{mt,\text{ roof truss 1 section A}} = 0.589 / 0.8 = 0.737$ kN/m
$q_{mt,\text{ roof truss 1 section B}} = 0.544 / 0.8 = 0.680$ kN/m
$q_{mt,\text{ roof truss 1 section C}} = 0.408 / 0.8 = 0.510$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (1.343 / 0.8) - (0.589 / 0.8) = 0.943$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (1.240 / 0.8) - (0.544 / 0.8) = 0.870$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.930 / 0.8) - (0.408 / 0.8) = 0.653$ kN/m
$q_{mt,\text{ roof truss 2 section A}} = (1.343 / 0.8) - (0.589 / 0.8) = 0.943$ kN/m
$q_{mt,\text{ roof truss 2 section B}} = (1.240 / 0.8) - (0.544 / 0.8) = 0.870$ kN/m
$q_{mt,\text{ roof truss 2 section C}} = (0.930 / 0.8) - (0.408 / 0.8) = 0.653$ kN/m
$q_{mt,\text{ roof truss 4 section A}} = 0.589 / 0,8 = 0.737$ kN/m
$q_{mt,\text{ roof truss 4 section B}} = 0.544 / 0.8 = 0.680$ kN/m
$q_{mt,\text{ roof truss 4 section C}} = 0.408 / 0.8 = 0.510$ kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\text{ cantilever mid}} = 1 * 0.4375 * 2.5 * 0.5 = 0.547$ kN/m
$q_{w,\text{ cantilever side}} = 1 * 0.4375 * 0 = 0$ kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\text{ cantilever mid}} = 0.547 / 0.8 = 0.684$ kN/m
$q_{mt,\text{ cantilever side}} = 0 / 0.8 = 0$ kN/m

2.9.6 load case 15 Out-service wind 180°.



Wind calculations of the main roof canopy.
$q_{w,\ roof\ truss\ 1}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m
$q_{w,\ roof\ truss\ 2}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 3.398 = 0.892 kN/m
$q_{w,\ roof\ truss\ 3}$ = 0.6 * 0.4375 * 1.036 = 0.272 kN/m

Membrane tension of the main roof canopy.
$q_{mt,\ roof\ truss\ 1}$ = 0.272 / 0.8 = 0.340 kN/m
$q_{mt,\ roof\ truss\ 2}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 3}$ = (0.620/0.8) - (0.272 / 0.8) = 0.435 kN/m
$q_{mt,\ roof\ truss\ 4}$ = 0.272 / 0.8 = 0.340 kN/m

Wind on the cantilever canopy.
The cantilever canopy is attached to Truss 1 and the T31 truss in the front of the stage. The load will be divided as a parabolic load on these two trusses. The distance in the center between these trusses is 2.5m.
$q_{w,\ cantilever\ mid}$ = 1 * 0.4375 * 2.5 * 0.5 = 0.547kN/m
$q_{w,\ cantilever\ side}$ = 1 * 0.4375 * 0 = 0 kN/m

Membrane tension of the cantilever canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ cantilever\ mid}$ = 0.547 / 0.8 = 0.684 kN/m
$q_{mt,\ cantilever\ side}$ = 0 / 0.8 = 0 kN/m

Wind on truss
$q_{w,\ truss}$ = 1.3 * 0.4375 * (0.29 * 0.5) = 0.082 kN/m

2.10 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 factor for permanent actions
$\gamma_{k,i}$ = 1.35 Partial safety factor 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….

2.10.1 load combinations.

For all the models the same load combinations are generated.

CO1-CO4	Live load without wind
CO10-CO34	Design Values In-service situation
CO50-CO74	Characteristic Values In-service situation
CO100-CO124	Design Values Out-service situation
CO150-CO174	Characteristic Values Out-service situation

Load	Load Combination		To	LC.1		LC.2		LC.3	
Combin.	DS	Description	Solve	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*LC3	+	1,150	LC1	1,350	LC3		
CO3	0	1.15*LC1 + 1.35*LC4	+	1,150	LC1	1,350	LC4		
CO4	0	1.15*LC1 + 1.35*LC5	+	1,150	LC1	1,350	LC5		
CO10	0	1.15*LC1 + 1.35*LC10	+	1,150	LC1	1,350	LC10		
CO11	0	1.15*LC1 + 1.35*LC2 + 1.35*LC10	+	1,150	LC1	1,350	LC2	1,350	LC10
CO12	0	1.15*LC1 + 1.35*LC3 + 1.35*LC10	+	1,150	LC1	1,350	LC3	1,350	LC10
CO13	0	1.15*LC1 + 1.35*LC4 + 1.35*LC10	+	1,150	LC1	1,350	LC4	1,350	LC10
CO14	0	1.15*LC1 + 1.35*LC5 + 1.35*LC10	+	1,150	LC1	1,350	LC5	1,350	LC10
CO20	0	1.15*LC1 + 1.35*LC11	+	1,150	LC1	1,350	LC11		
CO21	0	1.15*LC1 + 1.35*LC2 + 1.35*LC11	+	1,150	LC1	1,350	LC2	1,350	LC11
CO22	0	1.15*LC1 + 1.35*LC3 + 1.35*LC11	+	1,150	LC1	1,350	LC3	1,350	LC11
CO23	0	1.15*LC1 + 1.35*LC4 + 1.35*LC11	+	1,150	LC1	1,350	LC4	1,350	LC11
CO24	0	1.15*LC1 + 1.35*LC5 + 1.35*LC11	+	1,150	LC1	1,350	LC5	1,350	LC11
CO30	0	1.15*LC1 + 1.35*LC12	+	1,150	LC1	1,350	LC12		
CO31	0	1.15*LC1 + 1.35*LC2 + 1.35*LC12	+	1,150	LC1	1,350	LC2	1,350	LC12
CO32	0	1.15*LC1 + 1.35*LC3 + 1.35*LC12	+	1,150	LC1	1,350	LC3	1,350	LC12
CO33	0	1.15*LC1 + 1.35*LC4 + 1.35*LC12	+	1,150	LC1	1,350	LC4	1,350	LC12
CO34	0	1.15*LC1 + 1.35*LC5 + 1.35*LC12	+	1,150	LC1	1,350	LC5	1,350	LC12
CO50	0	LC1 + LC10	+	1,000	LC1	1,000	LC10		
CO51	0	LC1 + LC2 + LC10	+	1,000	LC1	1,000	LC2	1,000	LC10
CO52	0	LC1 + LC3 + LC10	+	1,000	LC1	1,000	LC3	1,000	LC10
CO53	0	LC1 + LC4 + LC10	+	1,000	LC1	1,000	LC4	1,000	LC10
CO54	0	LC1 + LC5 + LC10	+	1,000	LC1	1,000	LC5	1,000	LC10
CO60	0	LC1 + LC11	+	1,000	LC1	1,000	LC11		
CO61	0	LC1 + LC2 + LC11	+	1,000	LC1	1,000	LC2	1,000	LC11
CO62	0	LC1 + LC3 + LC11	+	1,000	LC1	1,000	LC3	1,000	LC11
CO63	0	LC1 + LC4 + LC11	+	1,000	LC1	1,000	LC4	1,000	LC11
CO64	0	LC1 + LC5 + LC11	+	1,000	LC1	1,000	LC5	1,000	LC11
CO70	0	LC1 + LC12	+	1,000	LC1	1,000	LC12		
CO71	0	LC1 + LC2 + LC12	+	1,000	LC1	1,000	LC2	1,000	LC12
CO72	0	LC1 + LC3 + LC12	+	1,000	LC1	1,000	LC3	1,000	LC12
CO73	0	LC1 + LC4 + LC12	+	1,000	LC1	1,000	LC4	1,000	LC12
CO74	0	LC1 + LC5 + LC12	+	1,000	LC1	1,000	LC5	1,000	LC12
CO100	0	1.15*LC1 + 1.35*LC13	+	1,150	LC1	1,350	LC13		
CO101	0	1.15*LC1 + 1.35*LC2 + 1.35*LC13	+	1,150	LC1	1,350	LC2	1,350	LC13
CO102	0	1.15*LC1 + 1.35*LC3 + 1.35*LC13	+	1,150	LC1	1,350	LC3	1,350	LC13
CO103	0	1.15*LC1 + 1.35*LC4 + 1.35*LC13	+	1,150	LC1	1,350	LC4	1,350	LC13
CO104	0	1.15*LC1 + 1.35*LC5 + 1.35*LC13	+	1,150	LC1	1,350	LC5	1,350	LC13
CO110	0	1.15*LC1 + 1.35*LC14	+	1,150	LC1	1,350	LC14		
CO111	0	1.15*LC1 + 1.35*LC2 + 1.35*LC14	+	1,150	LC1	1,350	LC2	1,350	LC14
CO112	0	1.15*LC1 + 1.35*LC3 + 1.35*LC14	+	1,150	LC1	1,350	LC3	1,350	LC14
CO113	0	1.15*LC1 + 1.35*LC4 + 1.35*LC14	+	1,150	LC1	1,350	LC4	1,350	LC14
CO114	0	1.15*LC1 + 1.35*LC5 + 1.35*LC14	+	1,150	LC1	1,350	LC5	1,350	LC14
CO120	0	1.15*LC1 + 1.35*LC15	+	1,150	LC1	1,350	LC15		
CO121	0	1.15*LC1 + 1.35*LC2 + 1.35*LC15	+	1,150	LC1	1,350	LC2	1,350	LC15
CO122	0	1.15*LC1 + 1.35*LC3 + 1.35*LC15	+	1,150	LC1	1,350	LC3	1,350	LC15
CO123	0	1.15*LC1 + 1.35*LC4 + 1.35*LC15	+	1,150	LC1	1,350	LC4	1,350	LC15
CO124	0	1.05*LC1 + 1.35*LC5 + 1.35*LC15	+	1,050	LC1	1,350	LC5	1,350	LC15
CO150	0	LC1 + LC13	+	1,000	LC1	1,000	LC13		
CO151	0	LC1 + LC2 + LC13	+	1,000	LC1	1,000	LC2	1,000	LC13
CO152	0	LC1 + LC3 + LC13	+	1,000	LC1	1,000	LC3	1,000	LC13
CO153	0	LC1 + LC4 + LC13	+	1,000	LC1	1,000	LC4	1,000	LC13
CO154	0	LC1 + LC5 + LC13	+	1,000	LC1	1,000	LC5	1,000	LC13

CO160	0	LC1 + LC14	+	1,000	LC1	1,000	LC14		
CO161	0	LC1 + LC2 + LC14	+	1,000	LC1	1,000	LC2	1,000	LC14
CO162	0	LC1 + LC3 + LC14	+	1,000	LC1	1,000	LC3	1,000	LC14
CO163	0	LC1 + LC4 + LC14	+	1,000	LC1	1,000	LC4	1,000	LC14
CO164	0	LC1 + LC5 + LC14	+	1,000	LC1	1,000	LC5	1,000	LC14
CO170	0	LC1 + LC15	+	1,000	LC1	1,000	LC15		
CO171	0	LC1 + LC2 + LC15	+	1,000	LC1	1,000	LC2	1,000	LC15
CO172	0	LC1 + LC3 + LC15	+	1,000	LC1	1,000	LC3	1,000	LC15
CO173	0	LC1 + LC4 + LC15	+	1,000	LC1	1,000	LC4	1,000	LC15
CO174	0	LC1 + LC5 + LC15	+	1,000	LC1	1,000	LC5	1,000	LC15

2.10.2 result combinations.

Different Result calculation have been generated in the program.

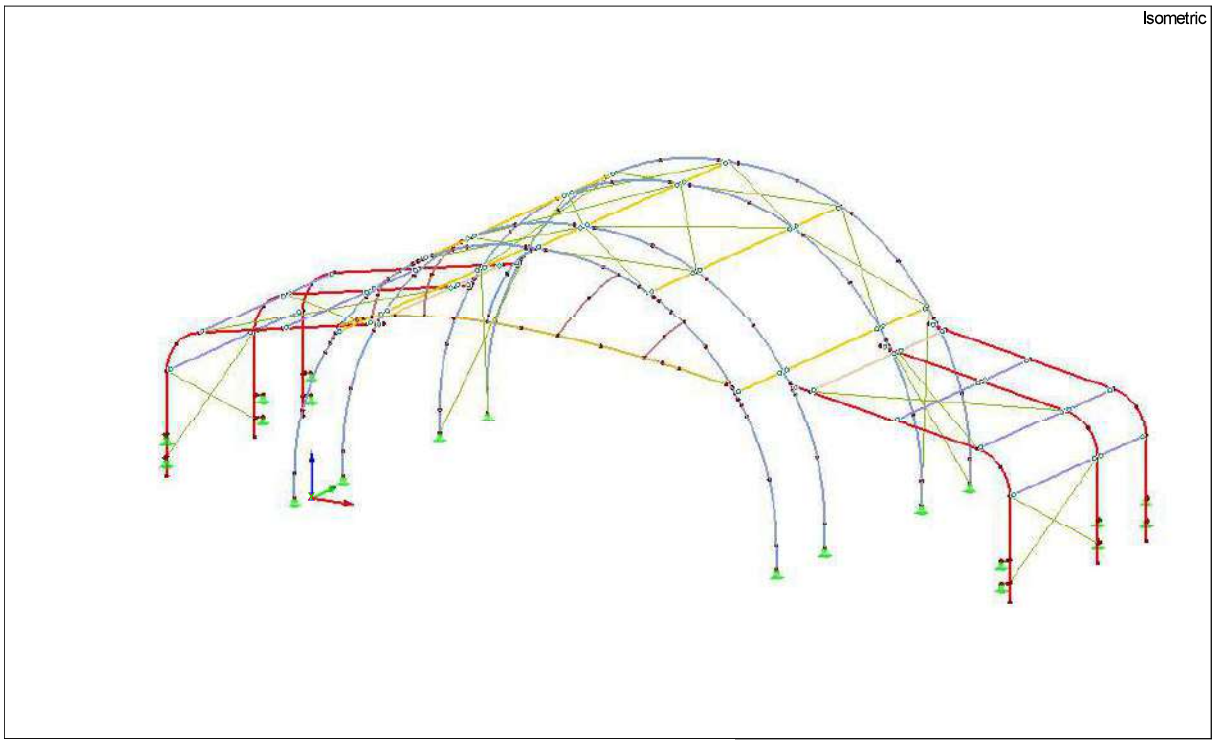
RC1 - Live loading without wind : 1 * (CO1 - CO4)
RC2 - Design Values In-service : 1 * (CO10 – CO34)
RC3 - Characteristic Values In-service : 1 * (CO50 – CO74)
RC4 - Design Values Out-service : 1 * (CO100 – CO124)
RC5 - Characteristic Values Out-service : 1 * (CO150 – CO174)

3 Calculation results for different Load Cases and Load Combinations.

In this chapter the results of the different load cases and load combinations of the medium tunnel stage option 1 and 2 are presented. The design calculations will be used to check the structural integrity of separate parts of the structure. The results for the characteristic calculations will be used to determine the deflection of the system and the steel wires which need to be used. These results will not be presented for each load combination. If the use of these results is necessary, the particular information will be given.

3.1 General calculation of the medium Tunnel Roof 10x8 option 1 and 2.

3.1.1 construction scheme.



Cross-Sections
- 1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
- 2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
- 3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
- 4: RD 10; steel 8.8 kw aliteit
- 5: roder keder profiel 80x61x3; Aluminum EN-AW 6061 (ET,EP,ER/B) T6
- 6: HK 50/50/4/4/4/4; Aluminum EN-AW 6082 (EP,ET) T6
- 7: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 8: RD 20; steel 8.8 kw aliteit
- 9: Ring 60/5; Aluminum EN-AW 6082 (EP,ET) T6

3.1.2 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	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
2	Aluminum EN-AW 6061 (ET,EP,ER/B) T6 | EN 1999-1-1:2007	7000,00	2700,00	0,296	27,00	2,30E-05	1,000	Isotropic Linear Elastic
3	steel 8.8 kwaliteit | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
4	S320GD 1.0250 | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic

3.1.3 Used cross sections.

Section No.	Cross-Section Description [mm]	Material No.	Moments of inertia [cm⁴] Torsion J	Bending I_y	Bending I_z	Cross-Sectional Areas [cm²] Axial A	Shear A_y	Shear A_z	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Depth h
1	Interal truss Protruss S31	1	500,00	2096,00	2096,00	16,97	16,97	16,97	0,00	0,00	290,0	290,0
2	Interal Truss Protruss T31	1	150,00	1057,40	1057,40	12,72	12,72	12,72	0,00	0,00	289,0	257,0
3	Ring 50/4	1	30,81	15,41	15,41	5,78	2,93	2,93	0,00	0,00	50,0	50,0
4	RD 10	3	0,10	0,05	0,05	0,79	0,66	0,66	0,00	0,00	10,0	10,0
5	roder keder profiel 80x61x3	2	10,00	93,40	49,76	11,94	11,50	11,50	0,00	0,00	80,0	61,0
6	HK 50/50/4/4/4/4	1	40,69	26,15	26,15	7,36	3,22	3,22	0,00	0,00	50,0	50,0
7	RO 48.3x3.2 (Hot Formed)	4	23,20	11,60	11,60	4,53	2,26	2,26	0,00	0,00	48,3	48,3
8	RD 20	3	1,57	0,79	0,79	3,14	2,64	2,64	0,00	0,00	20,0	20,0
9	Ring 60/5	1	65,88	32,94	32,94	8,64	4,38	4,38	0,00	0,00	60,0	60,0

3.2 Calculation summary model option 1 and 2.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	106,5	mm	CO114, Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-56,5	mm	CO34, Member No. 111, x: 2.556 m
	Maximum displacement in Z-direction	145,8	mm	CO114, Member No. 198, x: 0.000 m
	Maximum vectorial displacement	181,4	mm	CO114, Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-35,6	mrad	CO110, Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-83,2	mrad	CO114, Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-38,1	mrad	CO34, Member No. 123, x: 1.000 m
	Number of 1D finite elements (member elements)	459		
	Number of 2D finite elements (surface elements)	0		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	398		
	Number of equations	2388		
	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		
	Allow failing members	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

3.3 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	-13,98	kN	
Sum of support forces in Z	-13,98	kN	Deviation: 0.00 %
Resultant of reactions about X	1,510	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 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	-2,3	mm	Member No. 37, x: 0.489 m
Maximum displacement in Y-direction	-1,7	mm	Member No. 68, x: 0.000 m
Maximum displacement in Z-direction	-8,0	mm	Member No. 139, x: 1.882 m
Maximum vectorial displacement	8,0	mm	Member No. 139, x: 1.882 m
Maximum rotation about X-axis	-2,6	mrad	Member No. 131, x: 0.000 m
Maximum rotation about Y-axis	3,8	mrad	Member No. 196, x: 0.000 m
Maximum rotation about Z-axis	-0,8	mrad	Member No. 169, x: 0.119 m
Method of analysis	Linear		Geometrically Linear Analysis
LC2 - UDL Loading			
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	-58,51	kN	
Sum of support forces in Z	-58,51	kN	Deviation: 0.00 %
Resultant of reactions about X	48,652	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
Resultant of reactions about Y	-0,002	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	-11,9	mm	Member No. 37, x: 0.489 m
Maximum displacement in Y-direction	-8,2	mm	Member No. 68, x: 0.000 m
Maximum displacement in Z-direction	-27,7	mm	Member No. 101, x: 1.677 m
Maximum vectorial displacement	27,8	mm	Member No. 101, x: 1.677 m
Maximum rotation about X-axis	7,2	mrad	Member No. 101, x: 0.839 m
Maximum rotation about Y-axis	-6,4	mrad	Member No. 36, x: 0.000 m
Maximum rotation about Z-axis	-3,7	mrad	Member No. 104, x: 0.772 m
Method of analysis	Linear		Geometrically Linear Analysis
LC3 - CPL Loading setup			
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	-34,39	kN	
Sum of support forces in Z	-34,39	kN	Deviation: 0.00 %
Resultant of reactions about X	26,646	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 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	-16,1	mm	Member No. 37, x: 0.000 m
Maximum displacement in Y-direction	-7,9	mm	Member No. 68, x: 0.489 m
Maximum displacement in Z-direction	-37,6	mm	Member No. 101, x: 1.677 m
Maximum vectorial displacement	37,6	mm	Member No. 101, x: 1.677 m
Maximum rotation about X-axis	9,2	mrad	Member No. 101, x: 0.839 m
Maximum rotation about Y-axis	-8,0	mrad	Member No. 36, x: 0.000 m
Maximum rotation about Z-axis	-6,6	mrad	Member No. 104, x: 0.772 m
Method of analysis	Linear		Geometrically Linear Analysis
LC4 - 2x point load per truss 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	-59,39	kN	
Sum of support forces in Z	-59,39	kN	Deviation: 0.00 %
Resultant of reactions about X	49,037	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
Resultant of reactions about Y	-0,002	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	-18,7	mm	Member No. 37, x: 0.489 m
Maximum displacement in Y-direction	-11,5	mm	Member No. 68, x: 0.000 m
Maximum displacement in Z-direction	-40,9	mm	Member No. 101, x: 1.677 m
Maximum vectorial displacement	41,0	mm	Member No. 101, x: 1.677 m
Maximum rotation about X-axis	10,8	mrad	Member No. 101, x: 0.419 m
Maximum rotation about Y-axis	-9,9	mrad	Member No. 36, x: 0.000 m
Maximum rotation about Z-axis	-5,0	mrad	Member No. 104, x: 0.675 m
Method of analysis	Linear		Geometrically Linear Analysis
LC5 - 3x point load per truss 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	-58,39	kN	
	Sum of support forces in Z	-58,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	53,114	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	-0,002	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	-21,9	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-12,8	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-49,7	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	49,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	12,8	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-11,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-7,4	mrad	Member No. 104, x: 0.675 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC10 - In-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	16,77	kN	
	Sum of support forces in Y	16,77	kN	Deviation: 0.00 %
	Sum of loads in Z	28,71	kN	
	Sum of support forces in Z	28,71	kN	Deviation: 0.00 %
	Resultant of reactions about X	-78,209	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	17,4	mm	Member No. 140, x: 2.072 m
	Maximum displacement in Y-direction	36,0	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	53,2	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	65,2	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-20,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-34,1	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-17,8	mrad	Member No. 197, x: 2.112 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC11 - In-service wind 90°			
	Sum of loads in X	9,38	kN	
	Sum of support forces in X	9,38	kN	Deviation: 0.00 %
	Sum of loads in Y	-0,11	kN	
	Sum of support forces in Y	-0,11	kN	Deviation: 0.00 %
	Sum of loads in Z	9,81	kN	
	Sum of support forces in Z	9,81	kN	Deviation: 0.00 %
	Resultant of reactions about X	-35,098	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	-42,518	kNm	At center of gravity of model
	Resultant of reactions about Z	-0,753	kNm	At center of gravity of model
	Maximum displacement in X-direction	19,8	mm	Member No. 85, x: 0.147 m
	Maximum displacement in Y-direction	5,8	mm	Member No. 40, x: 0.489 m
	Maximum displacement in Z-direction	21,2	mm	Member No. 101, x: 1.258 m
	Maximum vectorial displacement	24,6	mm	Member No. 101, x: 1.258 m
	Maximum rotation about X-axis	-6,3	mrad	Member No. 132, x: 0.000 m
	Maximum rotation about Y-axis	9,2	mrad	Member No. 110, x: 0.811 m
	Maximum rotation about Z-axis	-3,4	mrad	Member No. 103, x: 0.579 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC12 - In-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-17,30	kN	
	Sum of support forces in Y	-17,30	kN	Deviation: 0.00 %
	Sum of loads in Z	-9,16	kN	
	Sum of support forces in Z	-9,16	kN	Deviation: 0.00 %
	Resultant of reactions about X	-77,185	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,005	kNm	At center of gravity of model
	Maximum displacement in X-direction	8,5	mm	Member No. 76, x: 0.978 m
	Maximum displacement in Y-direction	-33,3	mm	Member No. 178, x: 0.352 m
	Maximum displacement in Z-direction	-14,7	mm	Member No. 111, x: 2.334 m
	Maximum vectorial displacement	36,2	mm	Member No. 132, x: 2.072 m
	Maximum rotation about X-axis	18,0	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-9,5	mrad	Member No. 167, x: 0.000 m
	Maximum rotation about Z-axis	-22,8	mrad	Member No. 200, x: 1.419 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC13 - Out-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	4,02	kN	
	Sum of support forces in Y	4,02	kN	Deviation: 0.00 %
	Sum of loads in Z	53,10	kN	
	Sum of support forces in Z	53,10	kN	Deviation: 0.00 %
	Resultant of reactions about X	-45,804	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	0,005	kNm	At center of gravity of model
	Resultant of reactions about Z	0,010	kNm	At center of gravity of model

	Maximum displacement in X-direction	14,2	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	15,0	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	54,6	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	55,9	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-19,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-36,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	10,3	mrad	Member No. 169, x: 0.119 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC14 - Out-service wind 90°			
	Sum of loads in X	32,71	kN	
	Sum of support forces in X	32,71	kN	Deviation: 0.00 %
	Sum of loads in Y	-5,53	kN	
	Sum of support forces in Y	-5,53	kN	Deviation: 0.00 %
	Sum of loads in Z	62,74	kN	
	Sum of support forces in Z	62,74	kN	Deviation: 0.00 %
	Resultant of reactions about X	-30,004	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	-191,290	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,222	kNm	At center of gravity of model
	Maximum displacement in X-direction	67,7	mm	Member No. 87, x: 0.033 m
	Maximum displacement in Y-direction	-10,0	mm	Member No. 120, x: 3.964 m
	Maximum displacement in Z-direction	106,1	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	122,9	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-27,8	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-62,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-11,6	mrad	Member No. 168, x: 0.095 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC15 - Out-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-11,48	kN	
	Sum of support forces in Y	-11,48	kN	Deviation: 0.00 %
	Sum of loads in Z	50,13	kN	
	Sum of support forces in Z	50,13	kN	Deviation: 0.00 %
	Resultant of reactions about X	-22,462	kNm	At center of gravity of model (X: 5.670, Y: 4.015, Z: 3.785 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,011	kNm	At center of gravity of model
	Maximum displacement in X-direction	13,9	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-13,4	mm	Member No. 178, x: 1.056 m
	Maximum displacement in Z-direction	55,2	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	58,0	mm	Member No. 140, x: 0.000 m
	Maximum rotation about X-axis	18,3	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-36,9	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-12,7	mrad	Member No. 200, x: 1.419 m
	Method of analysis	Linear		Geometrically Linear Analysis

3.4 Calculation result of RC1 - General loading without wind 1 * (CO1 – CO4)

	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	-95,07	kN	
	Sum of support forces in Z	-95,07	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-19,2	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,5	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-45,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	45,2	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	11,8	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-10,4	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-5,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO2 - 1.15*LC1 + 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	-62,50	kN	
	Sum of support forces in Z	-62,50	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-25,0	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,0	mm	Member No. 68, x: 0.489 m
	Maximum displacement in Z-direction	-58,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	58,5	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	14,5	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-12,6	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-9,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO3 - 1.15*LC1 + 1.35*LC4			
	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	-96,25	kN	
	Sum of support forces in Z	-96,25	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-28,9	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-18,4	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-63,9	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	64,0	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	16,9	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	-15,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-7,9	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO4 - 1.15*LC1 + 1.35*LC5			
	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	-94,90	kN	
	Sum of support forces in Z	-94,90	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-33,4	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-20,2	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-76,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	76,2	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	19,7	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-17,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-11,1	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.5 Calculation result of RC2 – Design Values In-service: 1 * (CO10 – CO34)

	Description	Value	Unit	Comment
	CO10 - 1.15*LC1 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,64	kN	
	Sum of support forces in Y	22,64	kN	Deviation: 0.00 %
	Sum of loads in Z	22,68	kN	
	Sum of support forces in Z	22,68	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	23,3	mm	Member No. 120, x: 3.260 m
	Maximum displacement in Y-direction	47,7	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	63,9	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	81,0	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-26,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-40,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-23,2	mrad	Member No. 197, x: 2.112 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO11 - 1.15*LC1 + 1.35*LC2 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,64	kN	
	Sum of support forces in Y	22,64	kN	Deviation: 0.00 %
	Sum of loads in Z	-56,32	kN	
	Sum of support forces in Z	-56,32	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	30,2	mm	Member No. 120, x: 3.260 m
	Maximum displacement in Y-direction	50,3	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	69,5	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	90,2	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-27,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-42,9	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-24,4	mrad	Member No. 115, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO12 - 1.15*LC1 + 1.35*LC3 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,64	kN	
	Sum of support forces in Y	22,64	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,74	kN	
	Sum of support forces in Z	-23,74	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	41,2	mm	Member No. 120, x: 3.260 m
	Maximum displacement in Y-direction	51,2	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	74,9	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	98,1	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-28,3	mrad	Member No. 169, x: 0.190 m
	Maximum rotation about Y-axis	-45,0	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-24,5	mrad	Member No. 121, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO13 - 1.15*LC1 + 1.35*LC4 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,64	kN	
	Sum of support forces in Y	22,64	kN	Deviation: 0.00 %
	Sum of loads in Z	-57,49	kN	
	Sum of support forces in Z	-57,49	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	38,7	mm	Member No. 120, x: 3.260 m
	Maximum displacement in Y-direction	53,4	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	74,4	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	99,0	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-28,7	mrad	Member No. 169, x: 0.190 m
	Maximum rotation about Y-axis	-45,0	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-26,9	mrad	Member No. 121, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO14 - 1.15*LC1 + 1.35*LC5 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	22,64	kN	
	Sum of support forces in Y	22,64	kN	Deviation: 0.00 %
	Sum of loads in Z	-56,14	kN	
	Sum of support forces in Z	-56,14	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	42,5	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	53,9	mm	Member No. 193, x: 1.767 m
	Maximum displacement in Z-direction	76,8	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	102,9	mm	Member No. 139, x: 3.764 m

	Maximum rotation about X-axis	-28,9	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-45,9	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-27,4	mrad	Member No. 121, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO20 - 1.15*LC1 + 1.35*LC11			
	Sum of loads in X	12,67	kN	
	Sum of support forces in X	12,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-0,15	kN	
	Sum of support forces in Y	-0,15	kN	Deviation: 0.00 %
	Sum of loads in Z	-2,83	kN	
	Sum of support forces in Z	-2,83	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	24,6	mm	Member No. 174, x: 0.000 m
	Maximum displacement in Y-direction	6,6	mm	Member No. 40, x: 0.489 m
	Maximum displacement in Z-direction	22,0	mm	Member No. 101, x: 1.129 m
	Maximum vectorial displacement	29,9	mm	Member No. 174, x: 0.000 m
	Maximum rotation about X-axis	-8,6	mrad	Member No. 132, x: 0.000 m
	Maximum rotation about Y-axis	11,1	mrad	Member No. 110, x: 0.811 m
	Maximum rotation about Z-axis	4,1	mrad	Member No. 167, x: 0.119 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO21 - 1.15*LC1 + 1.35*LC2 + 1.35*LC11			
	Sum of loads in X	12,67	kN	
	Sum of support forces in X	12,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-0,15	kN	
	Sum of support forces in Y	-0,15	kN	Deviation: 0.00 %
	Sum of loads in Z	-81,83	kN	
	Sum of support forces in Z	-81,83	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	25,4	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-4,8	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	20,7	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	33,1	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-9,8	mrad	Member No. 132, x: 0.000 m
	Maximum rotation about Y-axis	12,2	mrad	Member No. 118, x: 0.833 m
	Maximum rotation about Z-axis	4,1	mrad	Member No. 119, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO22 - 1.15*LC1 + 1.35*LC3 + 1.35*LC11			
	Sum of loads in X	12,67	kN	
	Sum of support forces in X	12,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-0,15	kN	
	Sum of support forces in Y	-0,15	kN	Deviation: 0.00 %
	Sum of loads in Z	-49,25	kN	
	Sum of support forces in Z	-49,25	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	34,3	mm	Member No. 198, x: 0.352 m
	Maximum displacement in Y-direction	-7,1	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	-29,8	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	43,4	mm	Member No. 198, x: 0.352 m
	Maximum rotation about X-axis	-9,4	mrad	Member No. 132, x: 0.000 m
	Maximum rotation about Y-axis	17,0	mrad	Member No. 122, x: 0.203 m
	Maximum rotation about Z-axis	-7,2	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO23 - 1.15*LC1 + 1.35*LC4 + 1.35*LC11			
	Sum of loads in X	12,67	kN	
	Sum of support forces in X	12,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-0,15	kN	
	Sum of support forces in Y	-0,15	kN	Deviation: 0.00 %
	Sum of loads in Z	-83,00	kN	
	Sum of support forces in Z	-83,00	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	34,8	mm	Member No. 198, x: 0.352 m
	Maximum displacement in Y-direction	-9,7	mm	Member No. 88, x: 0.360 m
	Maximum displacement in Z-direction	-35,0	mm	Member No. 100, x: 0.420 m
	Maximum vectorial displacement	44,0	mm	Member No. 198, x: 0.352 m
	Maximum rotation about X-axis	-10,1	mrad	Member No. 132, x: 0.000 m
	Maximum rotation about Y-axis	16,7	mrad	Member No. 118, x: 1.000 m
	Maximum rotation about Z-axis	6,7	mrad	Member No. 115, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO24 - 1.15*LC1 + 1.35*LC5 + 1.35*LC11			
	Sum of loads in X	12,67	kN	
	Sum of support forces in X	12,67	kN	Deviation: 0.00 %
	Sum of loads in Y	-0,15	kN	
	Sum of support forces in Y	-0,15	kN	Deviation: 0.00 %
	Sum of loads in Z	-81,65	kN	
	Sum of support forces in Z	-81,65	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	39,0	mm	Member No. 198, x: 0.352 m
	Maximum displacement in Y-direction	-12,2	mm	Member No. 79, x: 1.467 m
	Maximum displacement in Z-direction	-47,1	mm	Member No. 100, x: 0.420 m

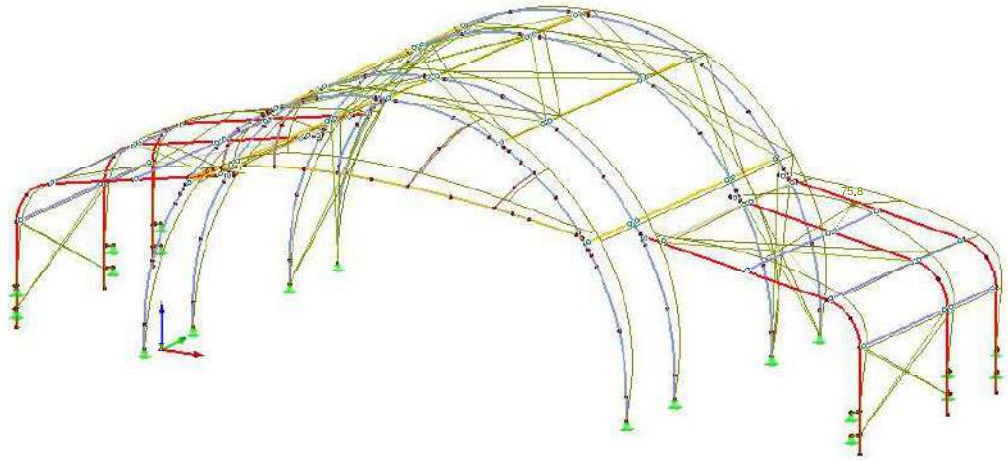
	Maximum vectorial displacement	50,0	mm	Member No. 100, x: 0.420 m
	Maximum rotation about X-axis	11,7	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	18,8	mrad	Member No. 118, x: 1.000 m
	Maximum rotation about Z-axis	-8,4	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO30 - 1.15*LC1 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,35	kN	
	Sum of support forces in Y	-23,35	kN	Deviation: 0.00 %
	Sum of loads in Z	-28,45	kN	
	Sum of support forces in Z	-28,45	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	13,2	mm	Member No. 76, x: 0.978 m
	Maximum displacement in Y-direction	-47,2	mm	Member No. 178, x: 0.352 m
	Maximum displacement in Z-direction	-26,1	mm	Member No. 111, x: 2.334 m
	Maximum vectorial displacement	53,7	mm	Member No. 111, x: 2.556 m
	Maximum rotation about X-axis	24,9	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-17,1	mrad	Member No. 167, x: 0.000 m
	Maximum rotation about Z-axis	-32,1	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO31 - 1.15*LC1 + 1.35*LC2 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,35	kN	
	Sum of support forces in Y	-23,35	kN	Deviation: 0.00 %
	Sum of loads in Z	-107,44	kN	
	Sum of support forces in Z	-107,44	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	23,7	mm	Member No. 76, x: 0.978 m
	Maximum displacement in Y-direction	-52,4	mm	Member No. 178, x: 0.352 m
	Maximum displacement in Z-direction	-40,0	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	57,1	mm	Member No. 111, x: 2.556 m
	Maximum rotation about X-axis	28,0	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-15,4	mrad	Member No. 167, x: 0.000 m
	Maximum rotation about Z-axis	-35,6	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO32 - 1.15*LC1 + 1.35*LC3 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,35	kN	
	Sum of support forces in Y	-23,35	kN	Deviation: 0.00 %
	Sum of loads in Z	-74,87	kN	
	Sum of support forces in Z	-74,87	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-31,3	mm	Member No. 70, x: 2.347 m
	Maximum displacement in Y-direction	-55,0	mm	Member No. 178, x: 0.352 m
	Maximum displacement in Z-direction	-52,9	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	63,3	mm	Member No. 178, x: 0.352 m
	Maximum rotation about X-axis	29,7	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	17,7	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-37,5	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO33 - 1.15*LC1 + 1.35*LC4 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,35	kN	
	Sum of support forces in Y	-23,35	kN	Deviation: 0.00 %
	Sum of loads in Z	-108,62	kN	
	Sum of support forces in Z	-108,62	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-32,7	mm	Member No. 70, x: 2.347 m
	Maximum displacement in Y-direction	-56,2	mm	Member No. 178, x: 0.352 m
	Maximum displacement in Z-direction	-58,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	65,7	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	30,0	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	19,3	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-38,1	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO34 - 1.15*LC1 + 1.35*LC5 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-23,35	kN	
	Sum of support forces in Y	-23,35	kN	Deviation: 0.00 %
	Sum of loads in Z	-107,27	kN	
	Sum of support forces in Z	-107,27	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-36,3	mm	Member No. 70, x: 2.347 m
	Maximum displacement in Y-direction	-56,5	mm	Member No. 111, x: 2.556 m

	Maximum displacement in Z-direction	-70,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	76,9	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	29,8	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	20,9	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-38,1	mrad	Member No. 123, x: 1.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.5.1 Deformation of the In-service situation characteristic max and min values.

RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Max Values

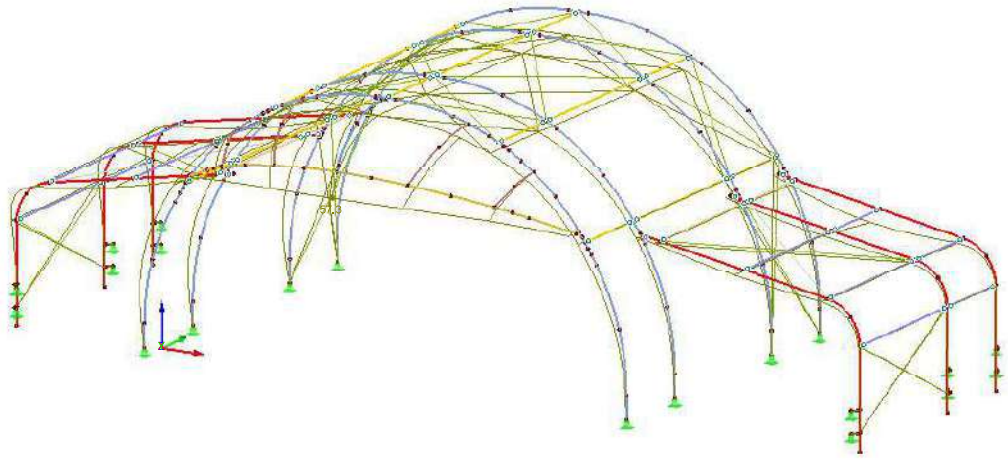
Isometric



Max u: 75.8, Min u: 0.0 [mm]
Factor of deformations: 10.00

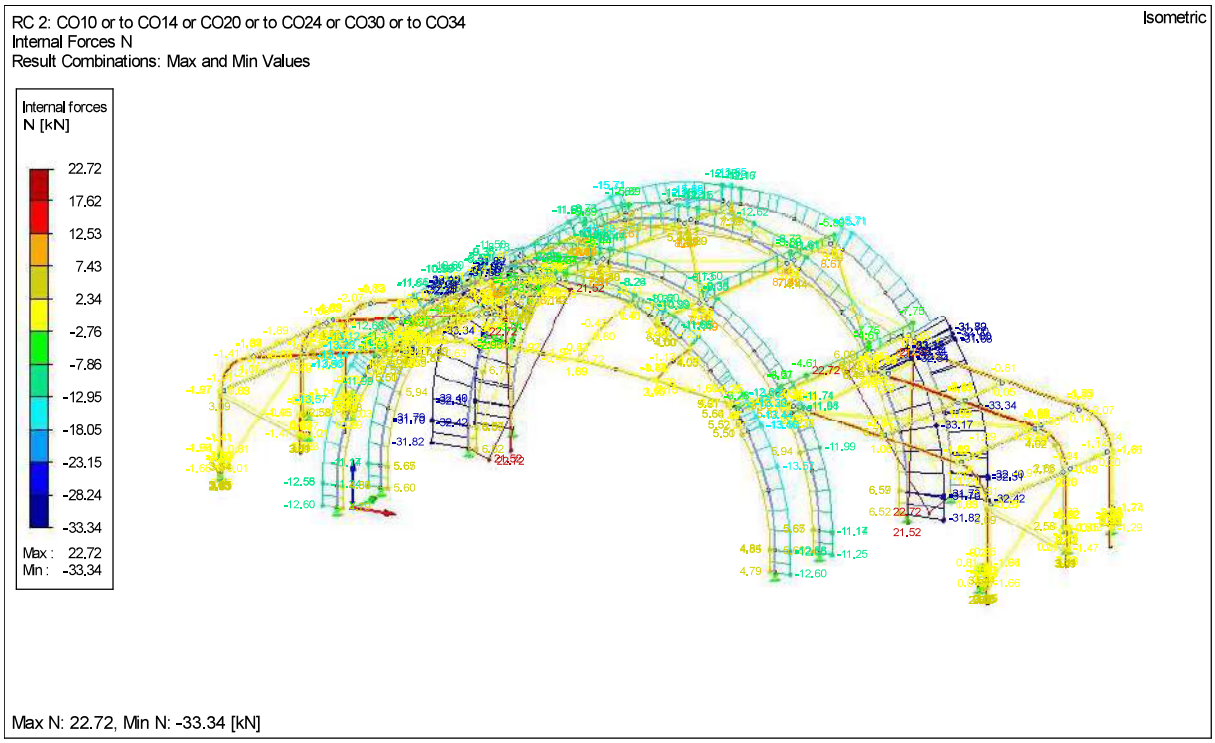
RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Min Values

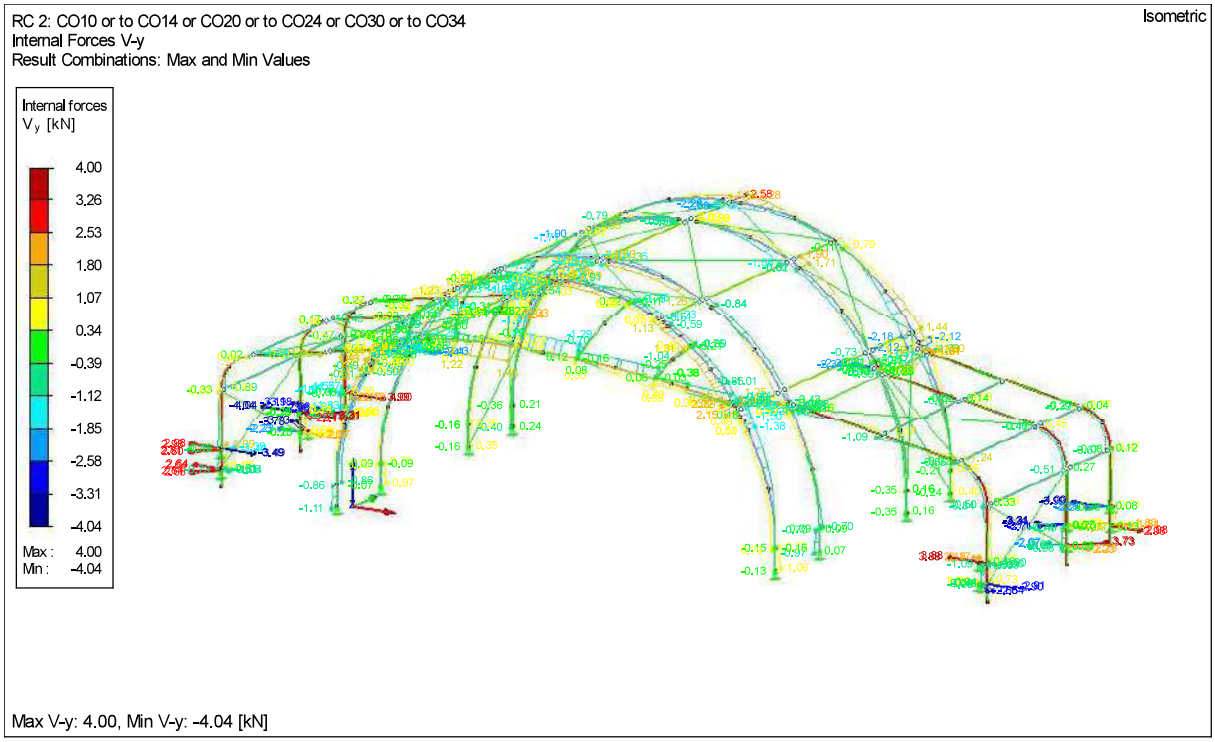
Isometric



Max u: 57.3, Min u: 0.0 [mm]
Factor of deformations: 10.00

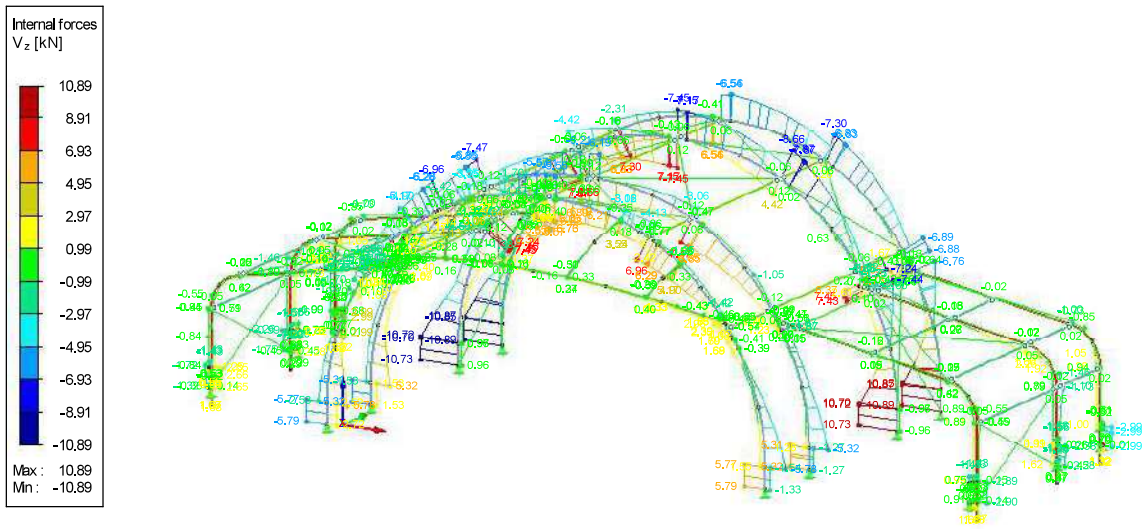
3.5.2 Internal force diagram RC2 Design values In-service.





RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

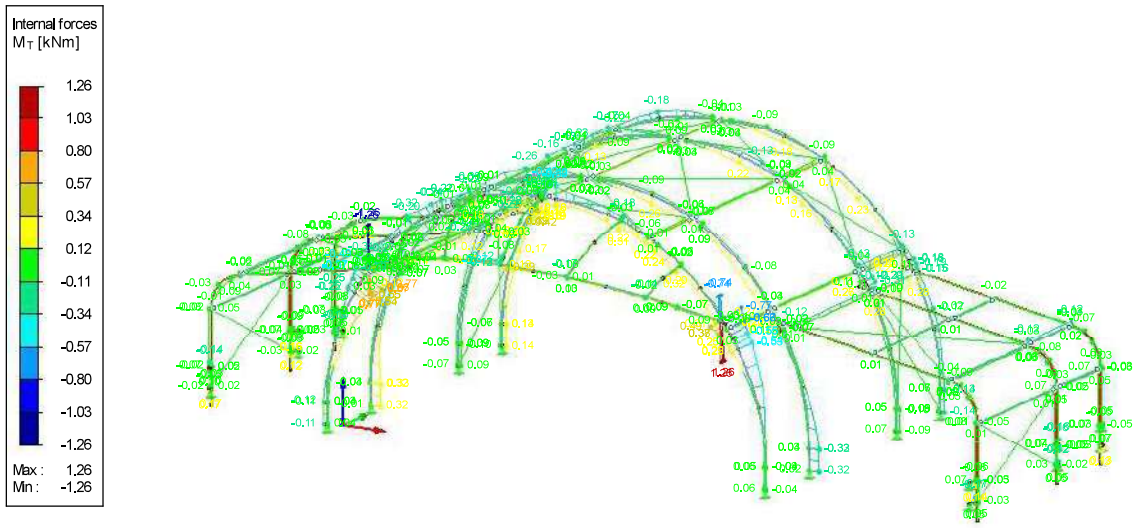
Isometric



Max V-z: 10.89, Min V-z: -10.89 [kN]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-T
Result Combinations: Max and Min Values

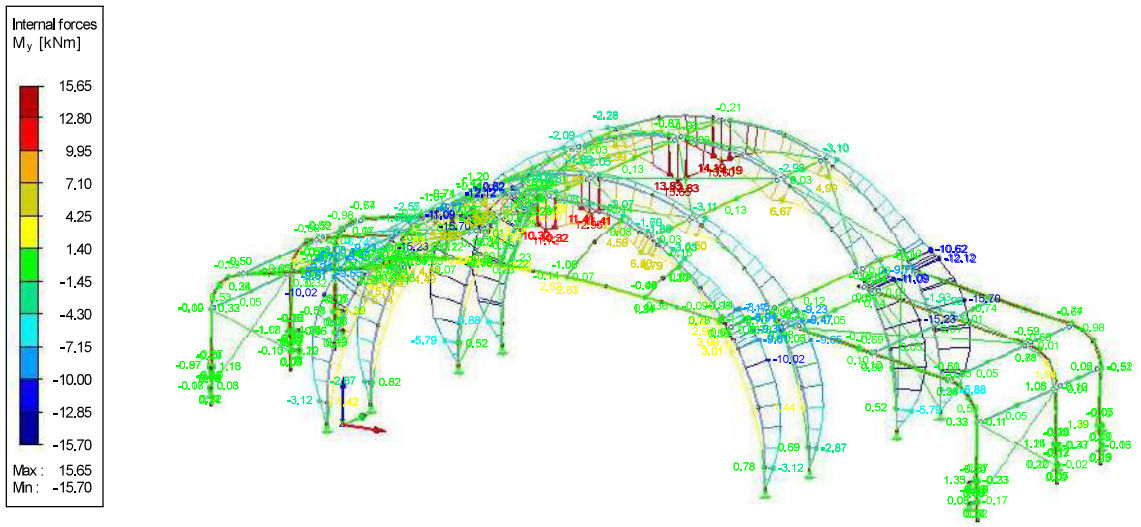
Isometric



Max M-T: 1.26, Min M-T: -1.26 [kNm]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

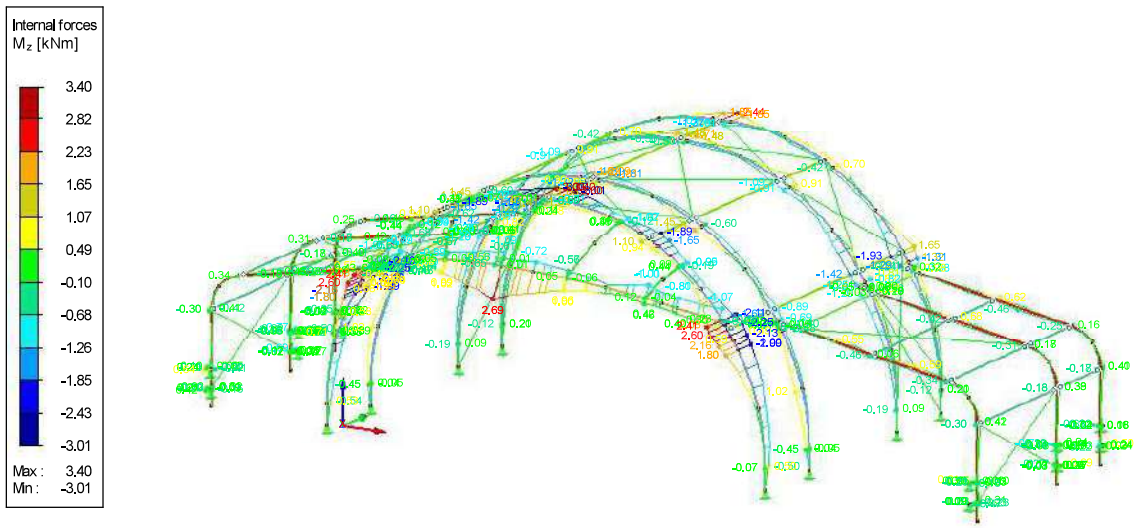
Isometric



Max M-y: 15.65, Min M-y: -15.70 [kNm]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 3.40, Min M-z: -3.01 [kNm]

3.6 Calculation result of RC4 - Design Values Out-service: 1 * (CO100 – CO124)

	Description	Value	Unit	Comment
	CO100 - 1.15*LC1 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	55,60	kN	
	Sum of support forces in Z	55,60	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	16,1	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	19,1	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	63,7	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	65,5	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-24,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-41,8	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	13,0	mrad	Member No. 169, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO101 - 1.15*LC1 + 1.35*LC2 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,39	kN	
	Sum of support forces in Z	-23,39	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	25,0	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	15,6	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	68,9	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	73,6	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-25,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-44,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	13,9	mrad	Member No. 169, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO102 - 1.15*LC1 + 1.35*LC3 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	9,18	kN	
	Sum of support forces in Z	9,18	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	34,3	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	20,9	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	74,2	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	82,0	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-26,1	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-46,1	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	12,4	mrad	Member No. 169, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO103 - 1.15*LC1 + 1.35*LC4 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-24,57	kN	
	Sum of support forces in Z	-24,57	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	34,3	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	17,7	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	73,7	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	81,9	mm	Member No. 139, x: 3.764 m
	Maximum rotation about X-axis	-26,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-46,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	14,1	mrad	Member No. 169, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO104 - 1.15*LC1 + 1.35*LC5 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-23,22	kN	
	Sum of support forces in Z	-23,22	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	38,7	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	18,6	mm	Member No. 101, x: 0.033 m

	Maximum displacement in Z-direction	76,2	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	85,9	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-26,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-47,1	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	13,9	mrad	Member No. 169, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO110 - 1.15*LC1 + 1.35*LC14			
	Sum of loads in X	44,15	kN	
	Sum of support forces in X	44,15	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	68,62	kN	
	Sum of support forces in Z	68,62	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	84,5	mm	Member No. 97, x: 0.121 m
	Maximum displacement in Y-direction	-13,2	mm	Member No. 120, x: 3.964 m
	Maximum displacement in Z-direction	129,3	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	151,3	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-35,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-75,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-14,4	mrad	Member No. 168, x: 0.095 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO111 - 1.15*LC1 + 1.35*LC2 + 1.35*LC14			
	Sum of loads in X	44,15	kN	
	Sum of support forces in X	44,15	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-10,37	kN	
	Sum of support forces in Z	-10,37	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	92,4	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-17,7	mm	Member No. 120, x: 3.964 m
	Maximum displacement in Z-direction	137,6	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	166,4	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-35,0	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-79,6	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	16,7	mrad	Member No. 122, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO112 - 1.15*LC1 + 1.35*LC3 + 1.35*LC14			
	Sum of loads in X	44,15	kN	
	Sum of support forces in X	44,15	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	22,20	kN	
	Sum of support forces in Z	22,20	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	100,5	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-20,0	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	142,7	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	175,3	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-34,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-81,7	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	18,6	mrad	Member No. 122, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO113 - 1.15*LC1 + 1.35*LC4 + 1.35*LC14			
	Sum of loads in X	44,15	kN	
	Sum of support forces in X	44,15	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-11,55	kN	
	Sum of support forces in Z	-11,55	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	102,3	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-20,4	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	143,3	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	177,0	mm	Member No. 140, x: 0.000 m
	Maximum rotation about X-axis	-34,4	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-82,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	18,7	mrad	Member No. 122, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO114 - 1.15*LC1 + 1.35*LC5 + 1.35*LC14			
	Sum of loads in X	44,15	kN	
	Sum of support forces in X	44,15	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-10,20	kN	
	Sum of support forces in Z	-10,20	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	106,5	mm	Member No. 198, x: 0.000 m

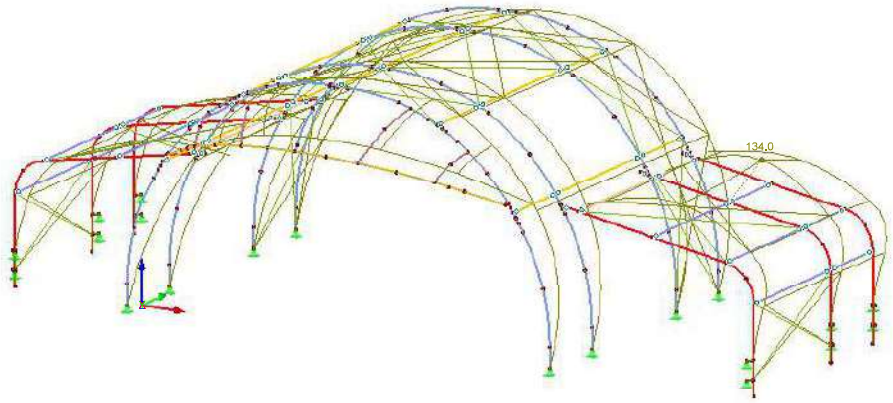
	Maximum displacement in Y-direction	-20,5	mm	Member No. 198, x: 1.056 m
	Maximum displacement in Z-direction	145,8	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	181,4	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	-34,3	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Y-axis	-83,2	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	18,6	mrad	Member No. 122, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO120 - 1.15*LC1 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-15,50	kN	
	Sum of support forces in Y	-15,50	kN	Deviation: 0.00 %
	Sum of loads in Z	51,59	kN	
	Sum of support forces in Z	51,59	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	18,2	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-17,7	mm	Member No. 178, x: 1.056 m
	Maximum displacement in Z-direction	65,8	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	69,9	mm	Member No. 140, x: 0.000 m
	Maximum rotation about X-axis	24,2	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-43,8	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-16,8	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO121 - 1.15*LC1 + 1.35*LC2 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-15,50	kN	
	Sum of support forces in Y	-15,50	kN	Deviation: 0.00 %
	Sum of loads in Z	-27,41	kN	
	Sum of support forces in Z	-27,41	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	28,6	mm	Member No. 140, x: 0.000 m
	Maximum displacement in Y-direction	-26,8	mm	Member No. 62, x: 1.956 m
	Maximum displacement in Z-direction	71,1	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	79,1	mm	Member No. 140, x: 0.000 m
	Maximum rotation about X-axis	26,8	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-46,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-19,6	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO122 - 1.15*LC1 + 1.35*LC3 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-15,50	kN	
	Sum of support forces in Y	-15,50	kN	Deviation: 0.00 %
	Sum of loads in Z	5,17	kN	
	Sum of support forces in Z	5,17	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	37,2	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-25,6	mm	Member No. 62, x: 1.467 m
	Maximum displacement in Z-direction	76,2	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	87,5	mm	Member No. 198, x: 0.000 m
	Maximum rotation about X-axis	28,6	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-48,5	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-21,4	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO123 - 1.15*LC1 + 1.35*LC4 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-15,50	kN	
	Sum of support forces in Y	-15,50	kN	Deviation: 0.00 %
	Sum of loads in Z	-28,58	kN	
	Sum of support forces in Z	-28,58	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	37,7	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-31,4	mm	Member No. 62, x: 1.956 m
	Maximum displacement in Z-direction	76,0	mm	Member No. 198, x: 0.000 m
	Maximum vectorial displacement	87,8	mm	Member No. 140, x: 0.000 m
	Maximum rotation about X-axis	28,7	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-48,8	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-21,7	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO124 - 1.05*LC1 + 1.35*LC5 + 1.35*LC15			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-15,50	kN	
	Sum of support forces in Y	-15,50	kN	Deviation: 0.00 %
	Sum of loads in Z	-25,83	kN	
	Sum of support forces in Z	-25,83	kN	Deviation: 0.00 %

	Maximum displacement in X-direction	41,8	mm	Member No. 198, x: 0.000 m
	Maximum displacement in Y-direction	-32,8	mm	Member No. 62, x: 1.956 m
	Maximum displacement in Z-direction	78,8	mm	Member No. 194, x: 2.120 m
	Maximum vectorial displacement	92,1	mm	Member No. 194, x: 2.120 m
	Maximum rotation about X-axis	28,5	mrad	Member No. 174, x: 2.112 m
	Maximum rotation about Y-axis	-50,0	mrad	Member No. 196, x: 0.000 m
	Maximum rotation about Z-axis	-21,5	mrad	Member No. 200, x: 1.419 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.6.1 Deformation of the Out-service situation characteristic max and min values.

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Global Deformations u
Result Combinations: Max Values

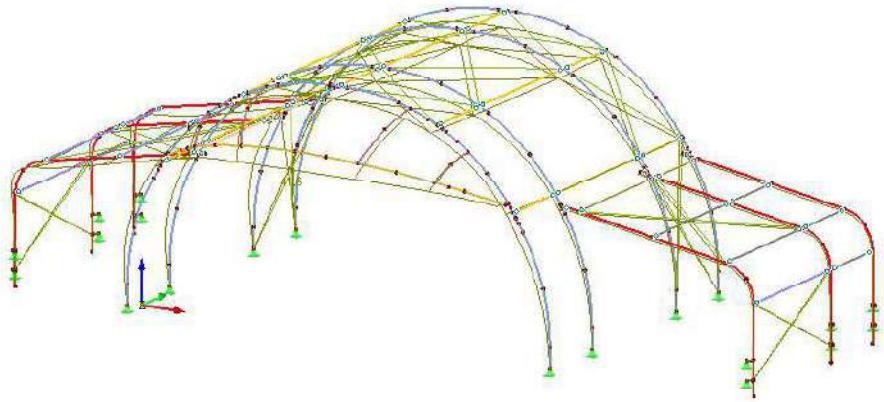
Isometric



Max u: 134.0, Min u: 0.0 [mm]
Factor of deformations: 11.00

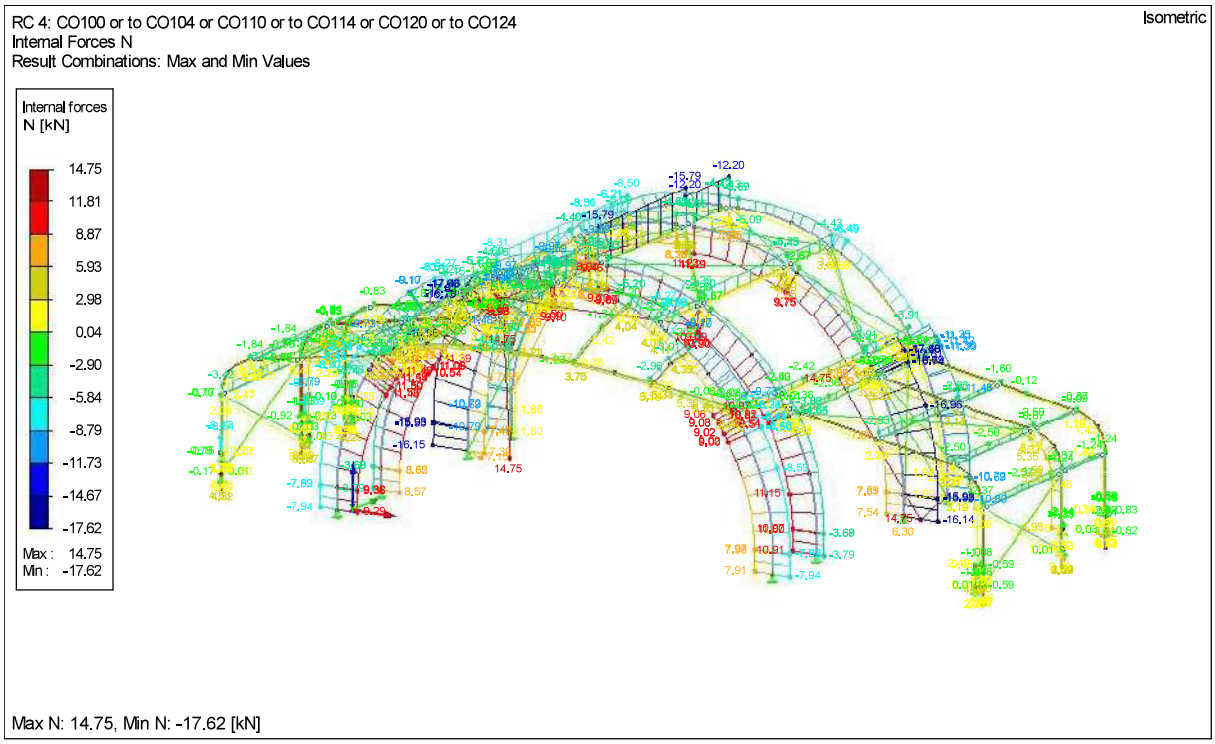
RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Global Deformations u
Result Combinations: Min Values

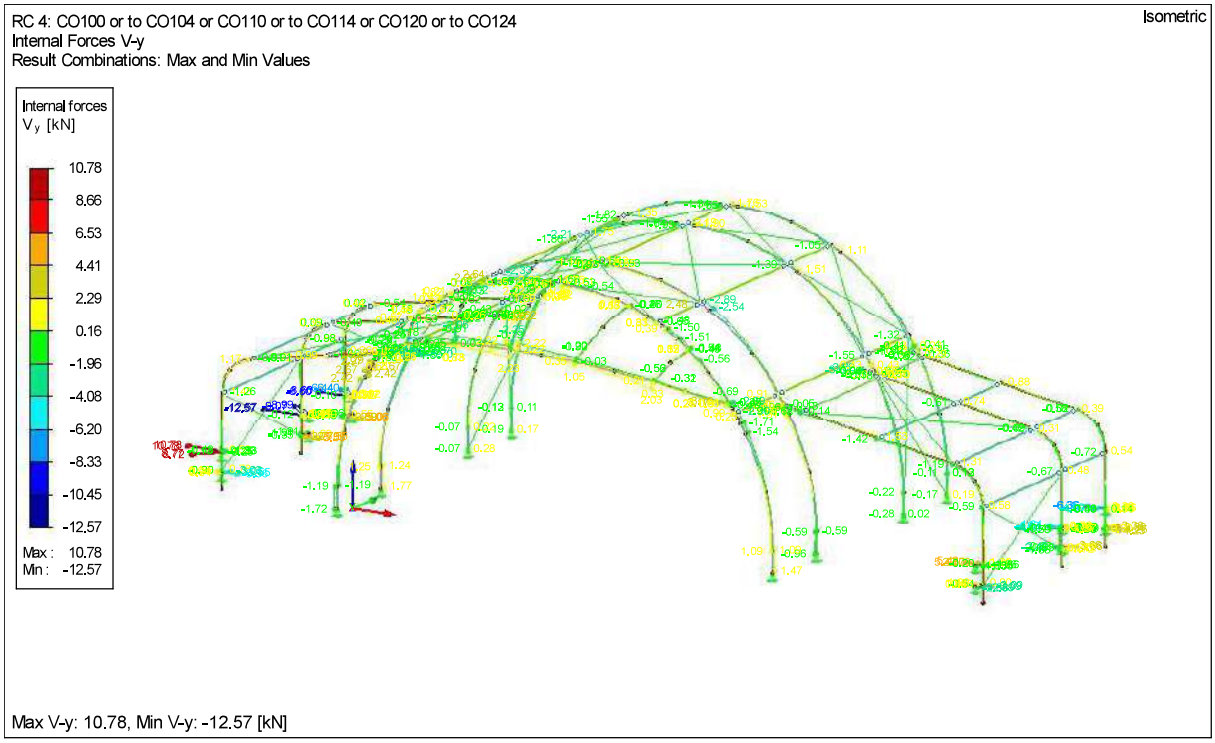
Isometric



Max u: 41.6, Min u: 0.0 [mm]
Factor of deformations: 11.00

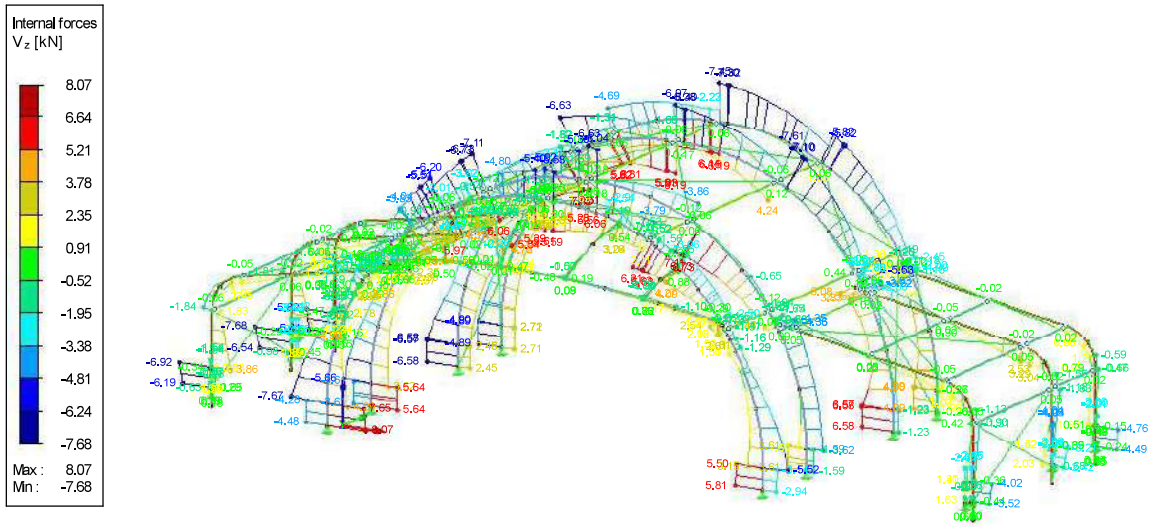
3.6.2 Internal force diagram RC4 Design Values Out-service.





RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

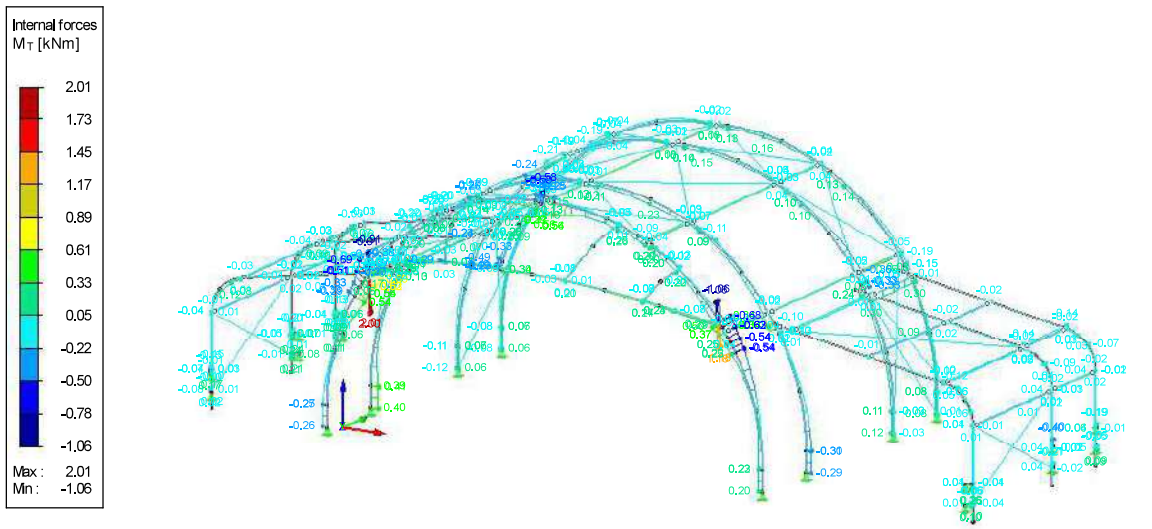
Isometric



Max V-z: 8.07, Min V-z: -7.68 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-T
Result Combinations: Max and Min Values

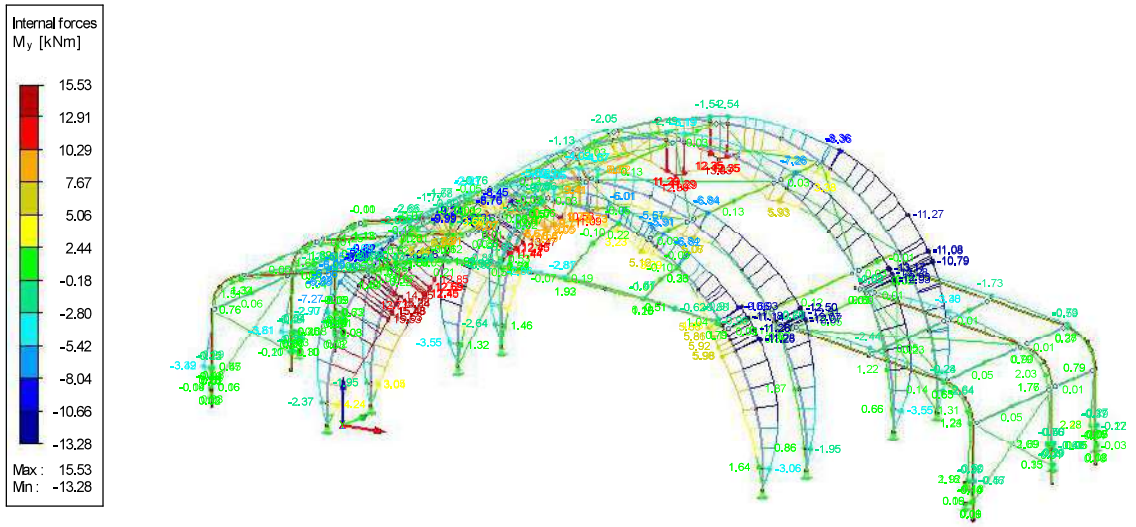
Isometric



Max M-T: 2.01, Min M-T: -1.06 [kNm]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

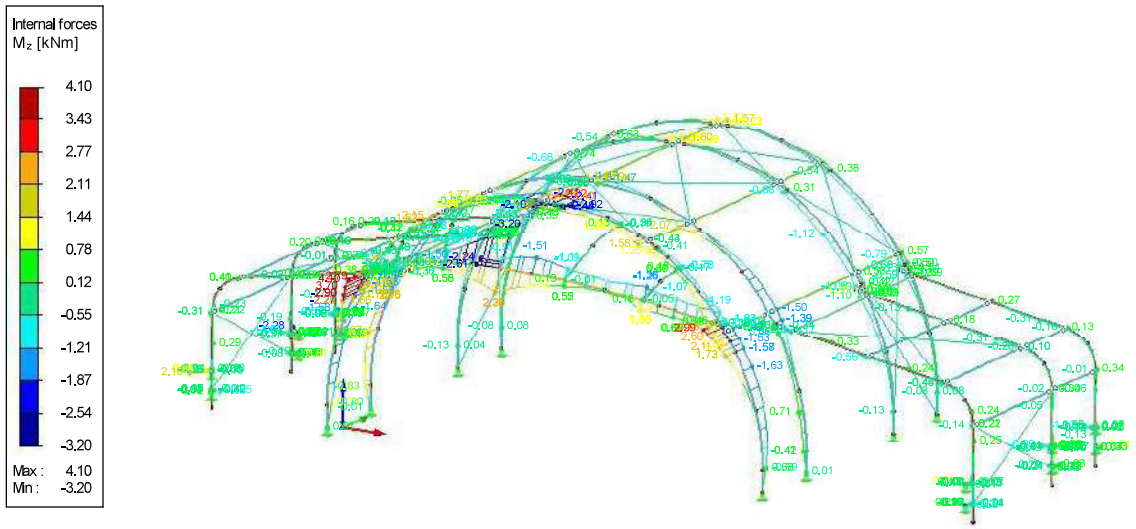
Isometric



Max M-y: 15.53, Min M-y: -13.28 [kNm]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric

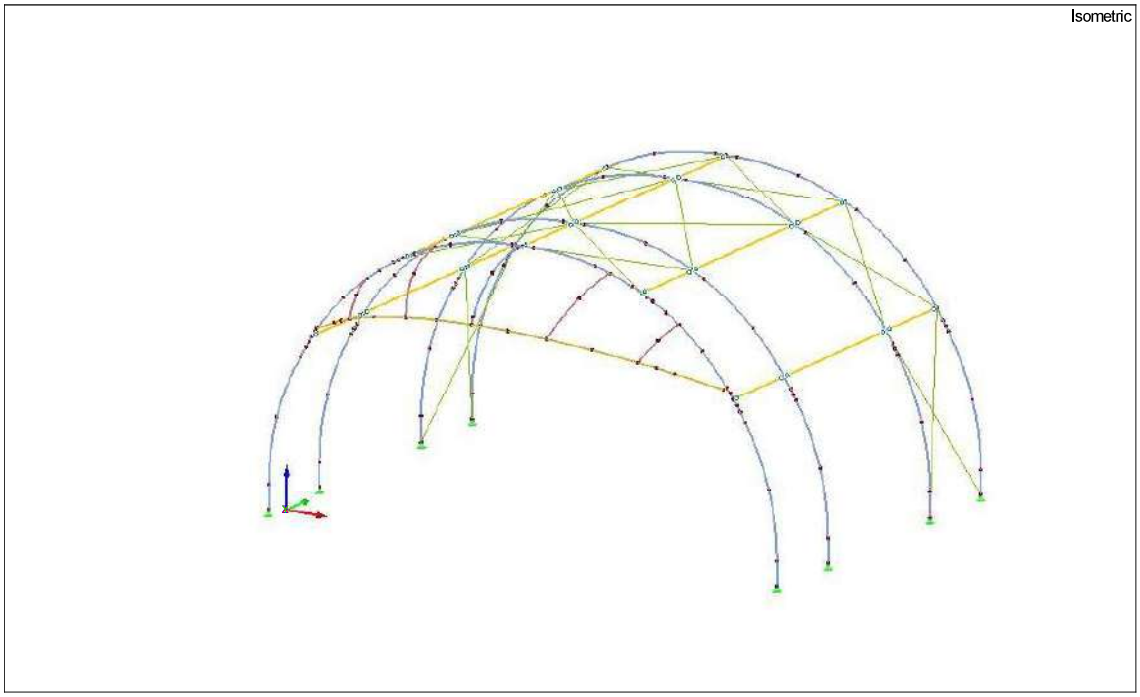


Max M-z: 4.10, Min M-z: -3.20 [kNm]

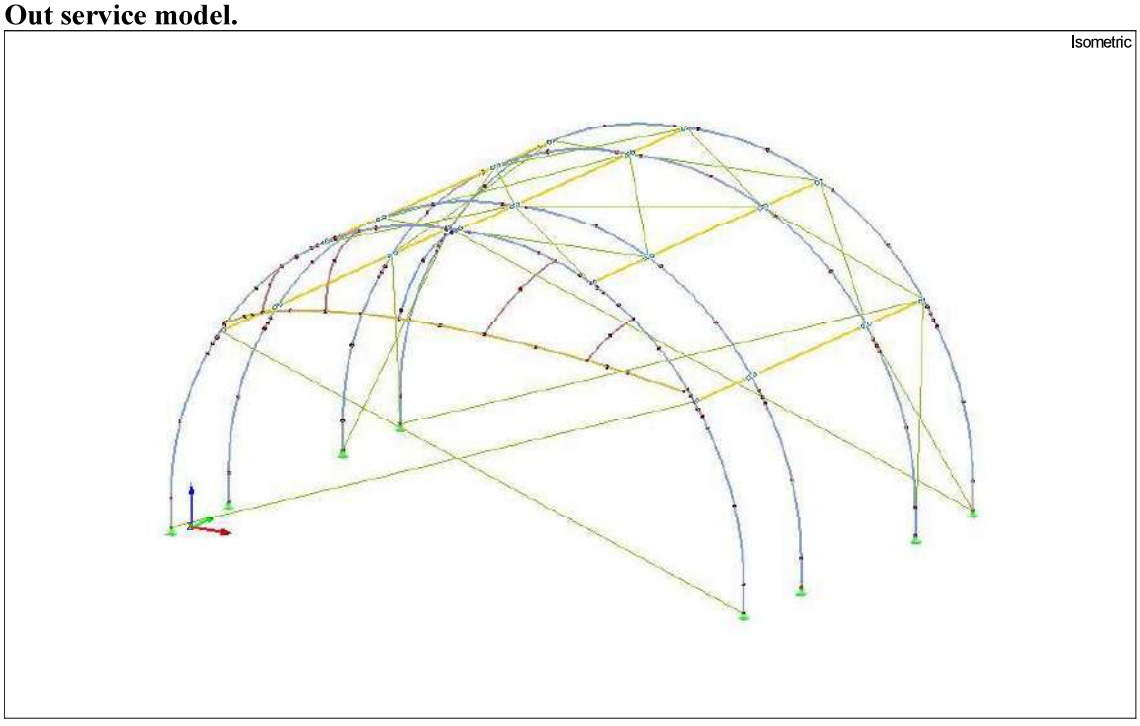
3.7 General calculation of the medium Tunnel Roof 10x8 option 3.

3.7.1 construction scheme.

In service model.



Out service model.



Cross-Sections
1: Interal truss Protruss S31; Aluminum EN-AW 6082 (EP,ET) T6
2: Interal Truss Protruss T31; Aluminum EN-AW 6082 (EP,ET) T6
3: Ring 50/4; Aluminum EN-AW 6082 (EP,ET) T6
4: RD 10; steel 8.8 kw aliteit

3.7.2 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	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
2	steel 8.8 kwaliteit | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic

3.7.3 Used cross sections.

Section No.	Cross-Section Description [mm]	Material No.	Moments of inertia [cm⁴] Torsion J	Bending I_y	Bending I_z	Cross-Sectional Areas [cm²] Axial A	Shear A_y	Shear A_z	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Depth h
1	Interal truss Protruss S31	1	500,00	2096,00	2096,00	16,97	16,97	16,97	0,00	0,00	290,0	290,0
2	Interal Truss Protruss T31	1	150,00	1057,40	1057,40	12,72	12,72	12,72	0,00	0,00	289,0	257,0
3	Ring 50/4	1	30,81	15,41	15,41	5,78	2,93	2,93	0,00	0,00	50,0	50,0
4	RD 10	3	0,10	0,05	0,05	0,79	0,66	0,66	0,00	0,00	10,0	10,0

3.8 Calculation summary model option 3.

In Service situation.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	50,3	mm	CO24, Member No. 67, x: 2.249 m
	Maximum displacement in Y-direction	46,9	mm	CO12, Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	-76,5	mm	CO4, Member No. 101, x: 1.677 m
	Maximum vectorial displacement	79,0	mm	CO12, Member No. 63, x: 0.250 m
	Maximum rotation about X-axis	19,7	mrad	CO4, Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	23,2	mrad	CO14, Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	-11,2	mrad	CO4, Member No. 104, x: 0.675 m
	Number of 1D finite elements (member elements)	305		
	Number of 2D finite elements (surface elements)	0		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	268		
	Number of equations	1608		
	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		
	Allow failing members	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

out Service situation.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	63,9	mm	CO110, Member No. 50, x: 2.934 m
	Maximum displacement in Y-direction	-43,2	mm	CO124, Member No. 62, x: 1.956 m
	Maximum displacement in Z-direction	59,0	mm	CO110, Member No. 101, x: 1.258 m
	Maximum vectorial displacement	69,2	mm	CO110, Member No. 101, x: 1.258 m
	Maximum rotation about X-axis	-13,9	mrad	CO110, Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	28,6	mrad	CO110, Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-12,0	mrad	CO110, Member No. 103, x: 0.579 m
	Number of 1D finite elements (member elements)	309		
	Number of 2D finite elements (surface elements)	0		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	268		
	Number of equations	1608		
	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		
	Allow failing members	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

3.9 Calculation result of the separate load cases.

In service situation.

	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	-10,33	kN	
	Sum of support forces in Z	-10,33	kN	Deviation: 0.00 %
	Resultant of reactions about X	-0,472	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 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	-2,2	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-1,6	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-5,3	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	5,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	1,4	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-1,2	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-0,7	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC2 - UDL Loading			
	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	-58,51	kN	
	Sum of support forces in Z	-58,51	kN	Deviation: 0.00 %
	Resultant of reactions about X	19,049	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	-0,002	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	-11,9	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-8,6	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-28,0	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	28,1	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	7,3	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-6,5	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-3,7	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC3 - CPL Loading setup			
	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	-34,39	kN	
	Sum of support forces in Z	-34,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	9,250	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	-0,002	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	-16,2	mm	Member No. 38, x: 0.000 m
	Maximum displacement in Y-direction	-8,5	mm	Member No. 68, x: 0.489 m
	Maximum displacement in Z-direction	-37,9	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	37,9	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	9,3	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-8,1	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-6,6	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC4 - 2x point load per truss 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	-59,39	kN	
	Sum of support forces in Z	-59,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	18,993	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	-0,002	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	-18,9	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-12,1	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-41,3	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	41,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	10,9	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	-10,0	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-5,1	mrad	Member No. 104, x: 0.675 m
	Method of analysis	Linear		Geometrically Linear Analysis

	LC5 - 3x point load per truss 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	-58,39	kN	
	Sum of support forces in Z	-58,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	23,576	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	-0,002	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	-22,1	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,5	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-50,2	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	50,3	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	12,9	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-11,4	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-7,4	mrad	Member No. 104, x: 0.675 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC10 - In-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	10,02	kN	
	Sum of support forces in Y	10,02	kN	Deviation: 0.00 %
	Sum of loads in Z	21,24	kN	
	Sum of support forces in Z	21,24	kN	Deviation: 0.00 %
	Resultant of reactions about X	-79,773	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	0,002	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	16,5	mm	Member No. 65, x: 0.521 m
	Maximum displacement in Y-direction	33,5	mm	Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	33,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	40,0	mm	Member No. 90, x: 0.538 m
	Maximum rotation about X-axis	-11,4	mrad	Member No. 101, x: 0.581 m
	Maximum rotation about Y-axis	9,8	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	5,4	mrad	Member No. 4, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC11 - In-service wind 90°			
	Sum of loads in X	9,61	kN	
	Sum of support forces in X	9,61	kN	Deviation: 0.00 %
	Sum of loads in Y	0,05	kN	
	Sum of support forces in Y	0,05	kN	Deviation: 0.00 %
	Sum of loads in Z	8,30	kN	
	Sum of support forces in Z	8,30	kN	Deviation: 0.00 %
	Resultant of reactions about X	-30,987	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	-38,806	kNm	At center of gravity of model
	Resultant of reactions about Z	-4,217	kNm	At center of gravity of model
	Maximum displacement in X-direction	27,6	mm	Member No. 50, x: 2.640 m
	Maximum displacement in Y-direction	7,3	mm	Member No. 40, x: 0.978 m
	Maximum displacement in Z-direction	23,4	mm	Member No. 101, x: 0.839 m
	Maximum vectorial displacement	30,4	mm	Member No. 101, x: 0.839 m
	Maximum rotation about X-axis	-6,6	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	11,3	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-4,2	mrad	Member No. 103, x: 0.579 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC12 - In-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-12,24	kN	
	Sum of support forces in Y	-12,24	kN	Deviation: 0.00 %
	Sum of loads in Z	-6,31	kN	
	Sum of support forces in Z	-6,31	kN	Deviation: 0.00 %
	Resultant of reactions about X	-81,413	kNm	At center of gravity of model (X: 5.670, Y: 3.509, Z: 4.488 m)
	Resultant of reactions about Y	0,001	kNm	At center of gravity of model
	Resultant of reactions about Z	0,004	kNm	At center of gravity of model
	Maximum displacement in X-direction	8,9	mm	Member No. 76, x: 0.978 m
	Maximum displacement in Y-direction	-16,3	mm	Member No. 105, x: 0.756 m
	Maximum displacement in Z-direction	-10,5	mm	Member No. 63, x: 0.250 m
	Maximum vectorial displacement	18,8	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	3,8	mrad	Member No. 58, x: 0.000 m
	Maximum rotation about Y-axis	5,6	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	2,1	mrad	Member No. 6, x: 0.518 m
	Method of analysis	Linear		Geometrically Linear Analysis

Out service situation.

	Description	Value	Unit	Comment
	LC13 - Out-service wind 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	4,02	kN	
	Sum of support forces in Y	4,02	kN	Deviation: 0.00 %
	Sum of loads in Z	39,20	kN	
	Sum of support forces in Z	39,20	kN	Deviation: 0.00 %
	Resultant of reactions about X	-36,238	kNm	At center of gravity of model (X: 5.670, Y: 3.528, Z: 4.374 m)
	Resultant of reactions about Y	0,004	kNm	At center of gravity of model
	Resultant of reactions about Z	0,009	kNm	At center of gravity of model
	Maximum displacement in X-direction	13,7	mm	Member No. 37, x: 0.419 m
	Maximum displacement in Y-direction	12,2	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	36,3	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	36,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-10,3	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	7,9	mrad	Member No. 94, x: 0.560 m
	Maximum rotation about Z-axis	4,7	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC14 - Out-service wind 90°			
	Sum of loads in X	38,59	kN	
	Sum of support forces in X	38,59	kN	Deviation: 0.00 %
	Sum of loads in Y	-5,53	kN	
	Sum of support forces in Y	-5,53	kN	Deviation: 0.00 %
	Sum of loads in Z	48,40	kN	
	Sum of support forces in Z	48,40	kN	Deviation: 0.00 %
	Resultant of reactions about X	-23,085	kNm	At center of gravity of model (X: 5.670, Y: 3.528, Z: 4.374 m)
	Resultant of reactions about Y	-151,375	kNm	At center of gravity of model
	Resultant of reactions about Z	-16,186	kNm	At center of gravity of model
	Maximum displacement in X-direction	50,4	mm	Member No. 50, x: 2.934 m
	Maximum displacement in Y-direction	-10,6	mm	Member No. 101, x: 1.129 m
	Maximum displacement in Z-direction	48,9	mm	Member No. 101, x: 1.258 m
	Maximum vectorial displacement	56,6	mm	Member No. 101, x: 1.258 m
	Maximum rotation about X-axis	-11,6	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	22,6	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-9,6	mrad	Member No. 103, x: 0.579 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC15 - Out-service wind 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-11,99	kN	
	Sum of support forces in Y	-11,99	kN	Deviation: 0.00 %
	Sum of loads in Z	37,77	kN	
	Sum of support forces in Z	37,77	kN	Deviation: 0.00 %
	Resultant of reactions about X	-29,474	kNm	At center of gravity of model (X: 5.670, Y: 3.528, Z: 4.374 m)
	Resultant of reactions about Y	0,000	kNm	At center of gravity of model
	Resultant of reactions about Z	0,011	kNm	At center of gravity of model
	Maximum displacement in X-direction	10,8	mm	Member No. 37, x: 0.419 m
	Maximum displacement in Y-direction	-16,4	mm	Member No. 101, x: 1.677 m
	Maximum displacement in Z-direction	20,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	25,9	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-4,3	mrad	Member No. 3, x: 0.000 m
	Maximum rotation about Y-axis	6,3	mrad	Member No. 104, x: 0.000 m
	Maximum rotation about Z-axis	3,7	mrad	Member No. 104, x: 0.772 m
	Method of analysis	Linear		Geometrically Linear Analysis

3.10 Calculation result of RC1 - General loading without wind 1 * (CO1 – CO4)

	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	-90,88	kN	
	Sum of support forces in Z	-90,88	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-19,2	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,9	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-45,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	45,2	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	11,8	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-10,4	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-5,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO2 - 1.15*LC1 + 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	-58,30	kN	
	Sum of support forces in Z	-58,30	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-25,0	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-13,8	mm	Member No. 68, x: 0.489 m
	Maximum displacement in Z-direction	-58,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	58,6	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	14,4	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-12,6	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-9,9	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO3 - 1.15*LC1 + 1.35*LC4			
	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	-92,05	kN	
	Sum of support forces in Z	-92,05	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-29,0	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-19,2	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-64,1	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	64,2	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	16,9	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	-15,4	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-7,9	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO4 - 1.15*LC1 + 1.35*LC5			
	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	-90,70	kN	
	Sum of support forces in Z	-90,70	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	-33,5	mm	Member No. 37, x: 0.489 m
	Maximum displacement in Y-direction	-21,0	mm	Member No. 68, x: 0.000 m
	Maximum displacement in Z-direction	-76,5	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	76,6	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	19,7	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	-17,3	mrad	Member No. 36, x: 0.000 m
	Maximum rotation about Z-axis	-11,2	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.11 Calculation result of RC2 – Design Values In-service: 1 * (CO10 – CO34)

	Description	Value	Unit	Comment
	CO10 - 1.15*LC1 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	16,79	kN	
	Sum of support forces in Z	16,79	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	23,9	mm	Member No. 65, x: 0.521 m
	Maximum displacement in Y-direction	44,9	mm	Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	38,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	54,8	mm	Member No. 63, x: 0.250 m
	Maximum rotation about X-axis	-13,9	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	14,2	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	7,1	mrad	Member No. 4, x: 0.691 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO11 - 1.15*LC1 + 1.35*LC2 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-62,20	kN	
	Sum of support forces in Z	-62,20	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	30,6	mm	Member No. 65, x: 0.521 m
	Maximum displacement in Y-direction	41,5	mm	Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	-41,8	mm	Member No. 63, x: 0.250 m
	Maximum vectorial displacement	58,8	mm	Member No. 63, x: 0.250 m
	Maximum rotation about X-axis	-7,9	mrad	Member No. 1, x: 2.072 m
	Maximum rotation about Y-axis	17,7	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	5,3	mrad	Member No. 4, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO12 - 1.15*LC1 + 1.35*LC3 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-29,63	kN	
	Sum of support forces in Z	-29,63	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	41,2	mm	Member No. 65, x: 0.489 m
	Maximum displacement in Y-direction	46,9	mm	Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	-63,7	mm	Member No. 63, x: 0.250 m
	Maximum vectorial displacement	78,9	mm	Member No. 1, x: 0.000 m
	Maximum rotation about X-axis	-9,0	mrad	Member No. 1, x: 2.072 m
	Maximum rotation about Y-axis	22,3	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	6,0	mrad	Member No. 4, x: 0.345 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO13 - 1.15*LC1 + 1.35*LC4 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-63,38	kN	
	Sum of support forces in Z	-63,38	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	39,2	mm	Member No. 65, x: 0.521 m
	Maximum displacement in Y-direction	44,3	mm	Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	-52,1	mm	Member No. 63, x: 0.250 m
	Maximum vectorial displacement	68,3	mm	Member No. 63, x: 0.250 m
	Maximum rotation about X-axis	-8,0	mrad	Member No. 73, x: 0.000 m
	Maximum rotation about Y-axis	22,0	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	5,0	mrad	Member No. 4, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO14 - 1.15*LC1 + 1.35*LC5 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	13,52	kN	
	Sum of support forces in Y	13,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-62,03	kN	
	Sum of support forces in Z	-62,03	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	42,3	mm	Member No. 65, x: 0.521 m
	Maximum displacement in Y-direction	44,2	mm	Member No. 88, x: 1.827 m
	Maximum displacement in Z-direction	-60,7	mm	Member No. 27, x: 0.000 m
	Maximum vectorial displacement	74,9	mm	Member No. 1, x: 0.000 m

	Maximum rotation about X-axis	-8,0	mrad	Member No. 78, x: 0.489 m
	Maximum rotation about Y-axis	23,2	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	-7,1	mrad	Member No. 104, x: 0.675 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO20 - 1.15*LC1 + 1.35*LC11			
	Sum of loads in X	12,98	kN	
	Sum of support forces in X	12,98	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-0,68	kN	
	Sum of support forces in Z	-0,68	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	35,6	mm	Member No. 50, x: 2.200 m
	Maximum displacement in Y-direction	8,9	mm	Member No. 40, x: 0.978 m
	Maximum displacement in Z-direction	25,5	mm	Member No. 101, x: 0.839 m
	Maximum vectorial displacement	36,8	mm	Member No. 101, x: 0.839 m
	Maximum rotation about X-axis	-7,3	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	14,2	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-4,8	mrad	Member No. 103, x: 0.579 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO21 - 1.15*LC1 + 1.35*LC2 + 1.35*LC11			
	Sum of loads in X	12,98	kN	
	Sum of support forces in X	12,98	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-79,67	kN	
	Sum of support forces in Z	-79,67	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	39,5	mm	Member No. 67, x: 1.467 m
	Maximum displacement in Y-direction	-6,5	mm	Member No. 104, x: 1.350 m
	Maximum displacement in Z-direction	-15,6	mm	Member No. 106, x: 2.258 m
	Maximum vectorial displacement	40,9	mm	Member No. 67, x: 1.467 m
	Maximum rotation about X-axis	4,4	mrad	Member No. 104, x: 1.012 m
	Maximum rotation about Y-axis	13,8	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	-4,1	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO22 - 1.15*LC1 + 1.35*LC3 + 1.35*LC11			
	Sum of loads in X	12,98	kN	
	Sum of support forces in X	12,98	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-47,10	kN	
	Sum of support forces in Z	-47,10	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	49,5	mm	Member No. 67, x: 2.054 m
	Maximum displacement in Y-direction	-7,7	mm	Member No. 86, x: 1.274 m
	Maximum displacement in Z-direction	-31,0	mm	Member No. 62, x: 2.445 m
	Maximum vectorial displacement	50,9	mm	Member No. 67, x: 2.054 m
	Maximum rotation about X-axis	7,3	mrad	Member No. 104, x: 1.012 m
	Maximum rotation about Y-axis	18,4	mrad	Member No. 64, x: 0.540 m
	Maximum rotation about Z-axis	-8,1	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO23 - 1.15*LC1 + 1.35*LC4 + 1.35*LC11			
	Sum of loads in X	12,98	kN	
	Sum of support forces in X	12,98	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-80,85	kN	
	Sum of support forces in Z	-80,85	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	46,4	mm	Member No. 67, x: 2.054 m
	Maximum displacement in Y-direction	-11,3	mm	Member No. 80, x: 0.371 m
	Maximum displacement in Z-direction	-33,1	mm	Member No. 100, x: 0.840 m
	Maximum vectorial displacement	48,1	mm	Member No. 67, x: 2.054 m
	Maximum rotation about X-axis	8,4	mrad	Member No. 102, x: 0.483 m
	Maximum rotation about Y-axis	18,6	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-6,1	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO24 - 1.15*LC1 + 1.35*LC5 + 1.35*LC11			
	Sum of loads in X	12,98	kN	
	Sum of support forces in X	12,98	kN	Deviation: 0.00 %
	Sum of loads in Y	0,06	kN	
	Sum of support forces in Y	0,06	kN	Deviation: 0.00 %
	Sum of loads in Z	-79,50	kN	
	Sum of support forces in Z	-79,50	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	50,1	mm	Member No. 67, x: 2.054 m
	Maximum displacement in Y-direction	-13,0	mm	Member No. 80, x: 0.741 m
	Maximum displacement in Z-direction	-45,1	mm	Member No. 100, x: 0.420 m

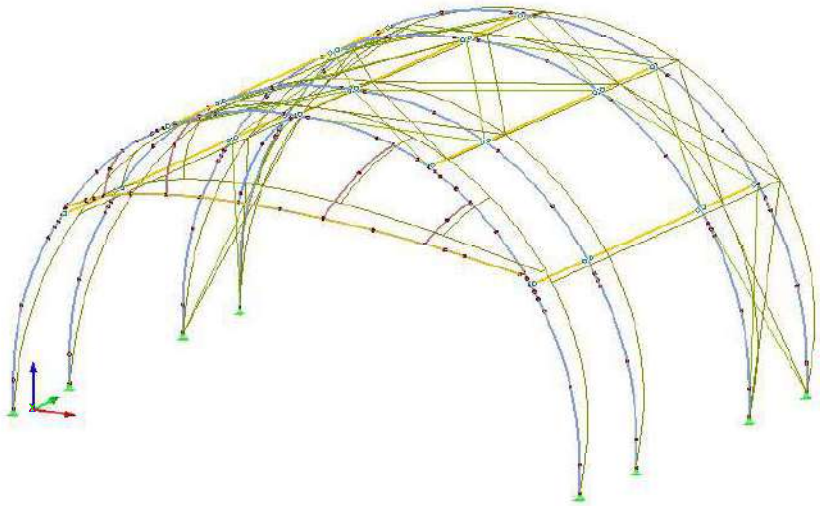
	Maximum vectorial displacement	52,1	mm	Member No. 67, x: 2.054 m
	Maximum rotation about X-axis	11,1	mrad	Member No. 101, x: 0.839 m
	Maximum rotation about Y-axis	20,2	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-9,4	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO30 - 1.15*LC1 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-20,41	kN	
	Sum of support forces in Z	-20,41	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	14,1	mm	Member No. 76, x: 0.978 m
	Maximum displacement in Y-direction	-23,6	mm	Member No. 62, x: 1.467 m
	Maximum displacement in Z-direction	-16,8	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	28,3	mm	Member No. 74, x: 0.188 m
	Maximum rotation about X-axis	5,4	mrad	Member No. 58, x: 0.000 m
	Maximum rotation about Y-axis	8,8	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	2,6	mrad	Member No. 6, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO31 - 1.15*LC1 + 1.35*LC2 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-99,40	kN	
	Sum of support forces in Z	-99,40	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	25,6	mm	Member No. 76, x: 0.733 m
	Maximum displacement in Y-direction	-35,6	mm	Member No. 68, x: 0.978 m
	Maximum displacement in Z-direction	-33,0	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	48,0	mm	Member No. 1, x: 2.072 m
	Maximum rotation about X-axis	10,4	mrad	Member No. 99, x: 1.419 m
	Maximum rotation about Y-axis	15,3	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-3,5	mrad	Member No. 104, x: 0.579 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO32 - 1.15*LC1 + 1.35*LC3 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-66,83	kN	
	Sum of support forces in Z	-66,83	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	34,1	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	-35,1	mm	Member No. 62, x: 1.467 m
	Maximum displacement in Z-direction	-52,1	mm	Member No. 74, x: 0.250 m
	Maximum vectorial displacement	62,2	mm	Member No. 1, x: 2.072 m
	Maximum rotation about X-axis	12,2	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	18,7	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-7,3	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO33 - 1.15*LC1 + 1.35*LC4 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-100,58	kN	
	Sum of support forces in Z	-100,58	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	35,4	mm	Member No. 76, x: 0.733 m
	Maximum displacement in Y-direction	-41,0	mm	Member No. 68, x: 0.978 m
	Maximum displacement in Z-direction	-51,8	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	59,4	mm	Member No. 1, x: 2.072 m
	Maximum rotation about X-axis	15,6	mrad	Member No. 99, x: 1.451 m
	Maximum rotation about Y-axis	20,3	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-5,8	mrad	Member No. 94, x: 0.098 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO34 - 1.15*LC1 + 1.35*LC5 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-16,52	kN	
	Sum of support forces in Y	-16,52	kN	Deviation: 0.00 %
	Sum of loads in Z	-99,23	kN	
	Sum of support forces in Z	-99,23	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	39,2	mm	Member No. 76, x: 0.489 m
	Maximum displacement in Y-direction	-42,8	mm	Member No. 68, x: 0.978 m

	Maximum displacement in Z-direction	-63,9	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	69,4	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	17,8	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	21,9	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	-8,7	mrad	Member No. 104, x: 0.674 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.11.1 Deformation of the In-service situation characteristic max and min values.

RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Max Values

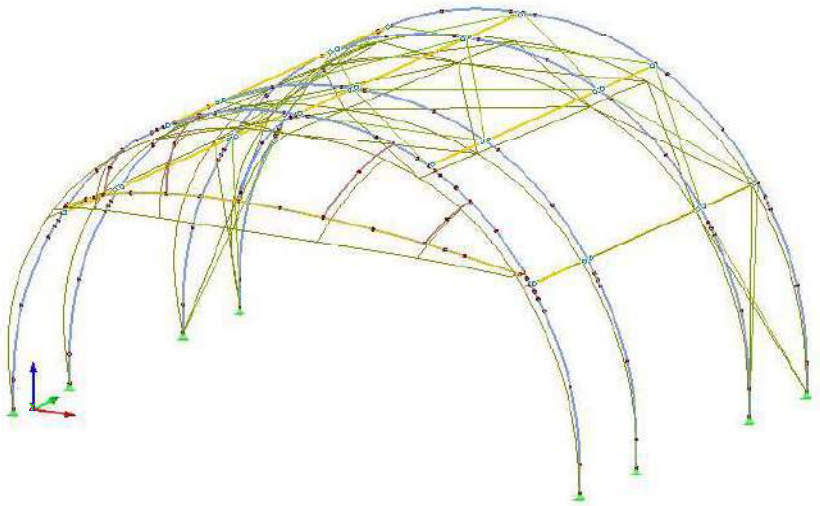
Isometric



Max u: 46.4, Min u: 0.0 [mm]
Factor of deformations: 10.00

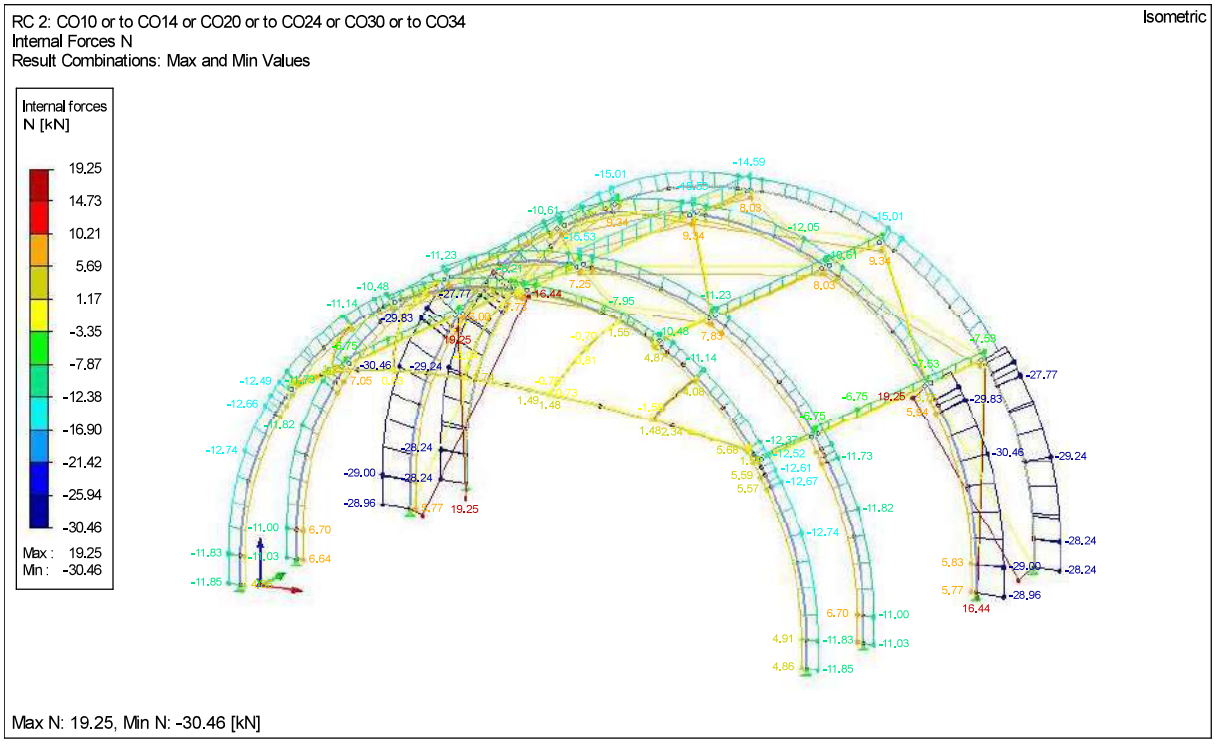
RC 3: CO50 or to CO54 or CO60 or to CO64 or CO70 or to CO74
Global Deformations u
Result Combinations: Min Values

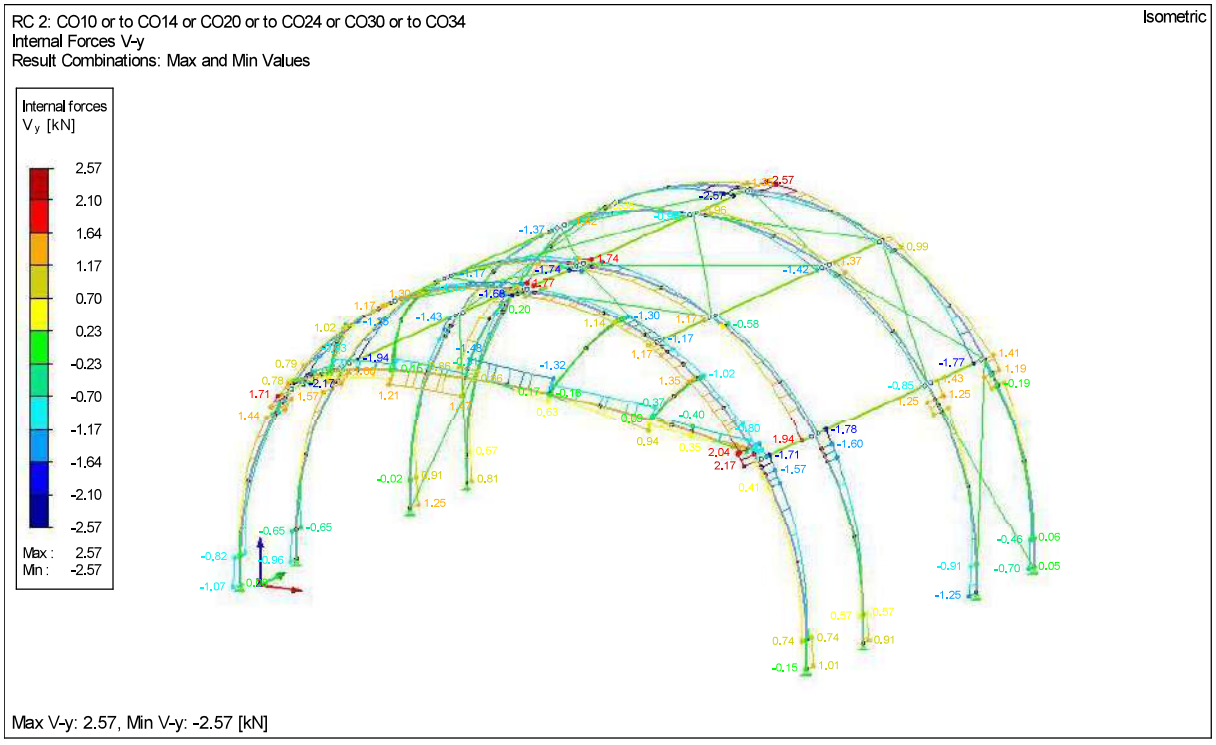
Isometric



Max u: 56.5, Min u: 0.0 [mm]
Factor of deformations: 10.00

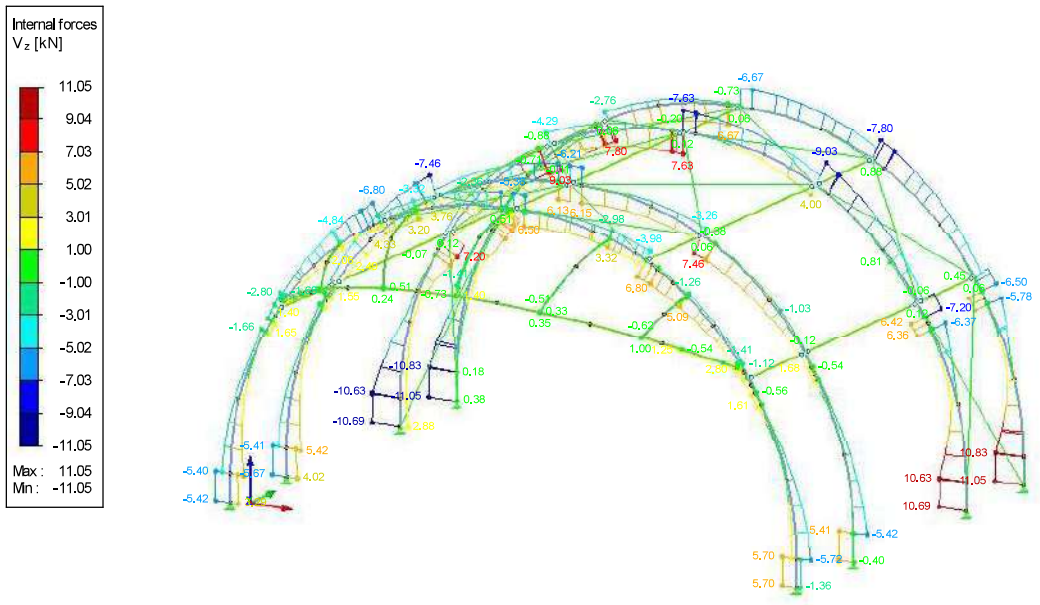
3.11.2 Internal force diagram RC2 Design values In-service.





RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

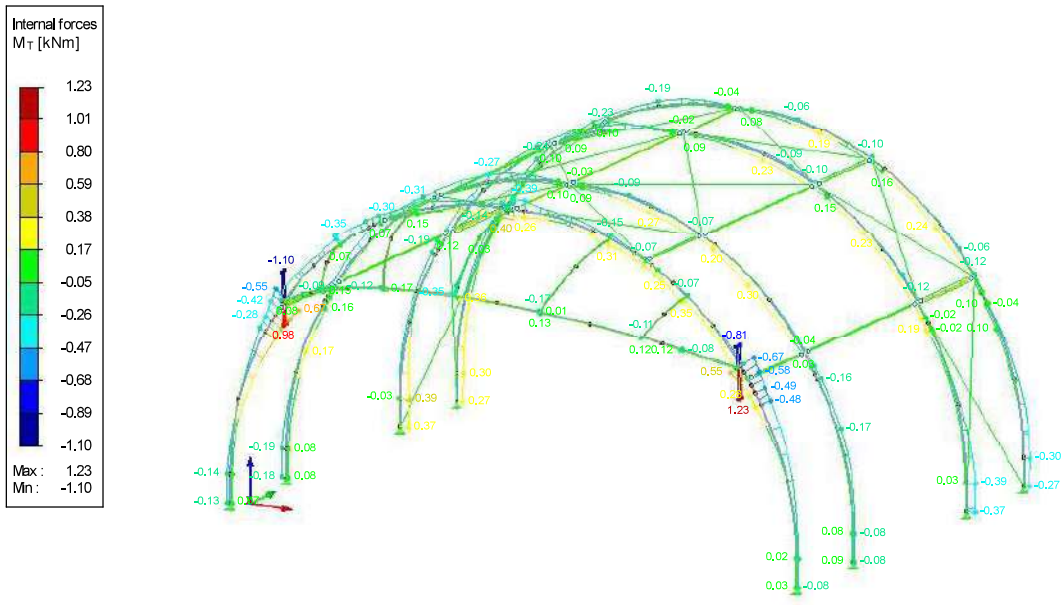
Isometric



Max V-z: 11.05, Min V-z: -11.05 [kN]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-T
Result Combinations: Max and Min Values

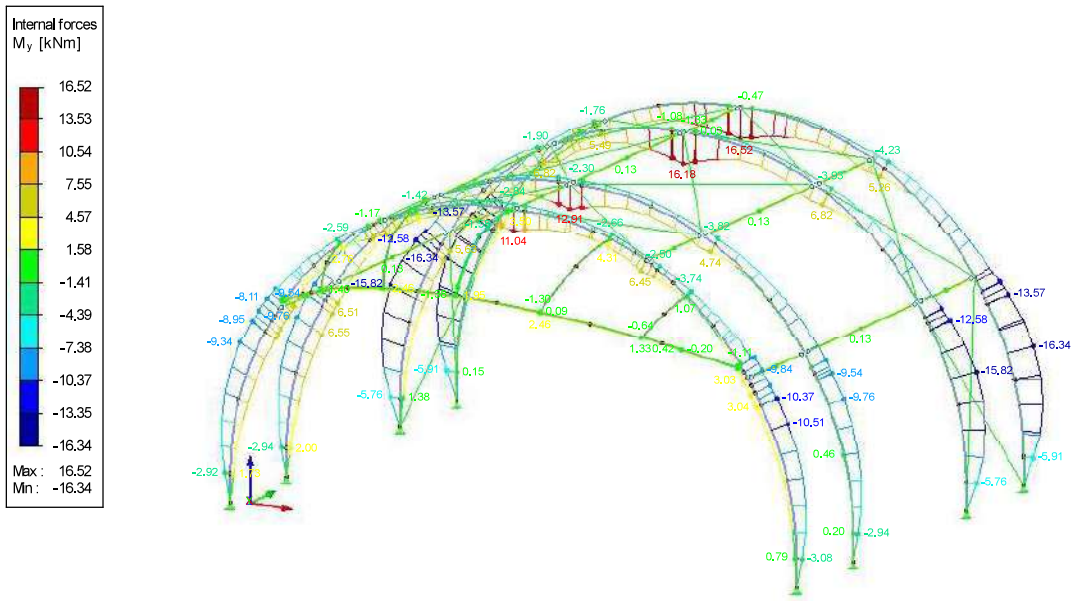
Isometric



Max M-T: 1.23, Min M-T: -1.10 [kNm]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

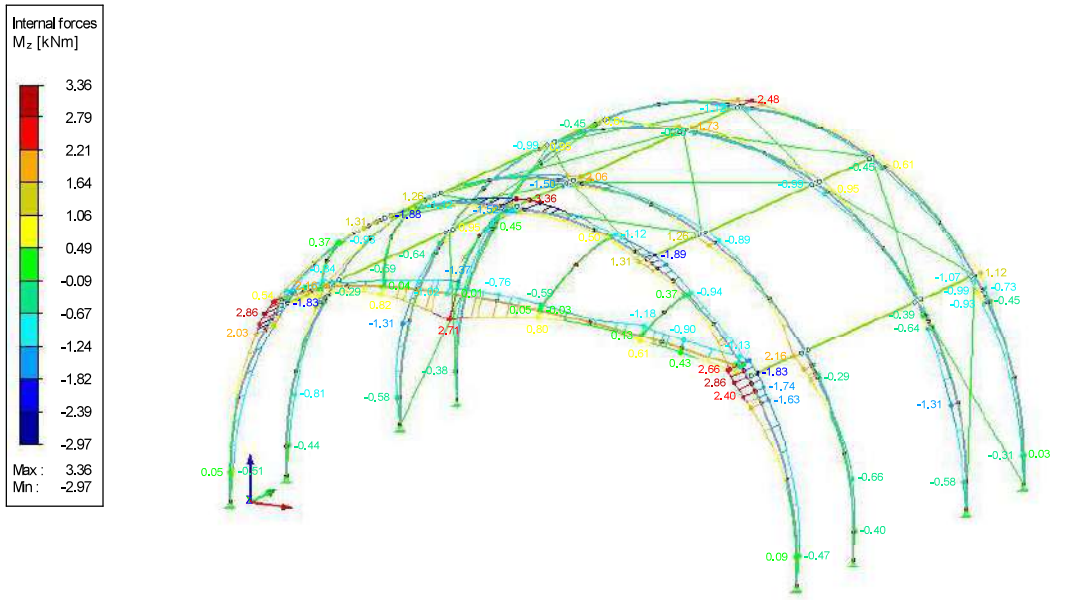
Isometric



Max M-y: 16.52, Min M-y: -16.34 [kNm]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 3.36, Min M-z: -2.97 [kNm]

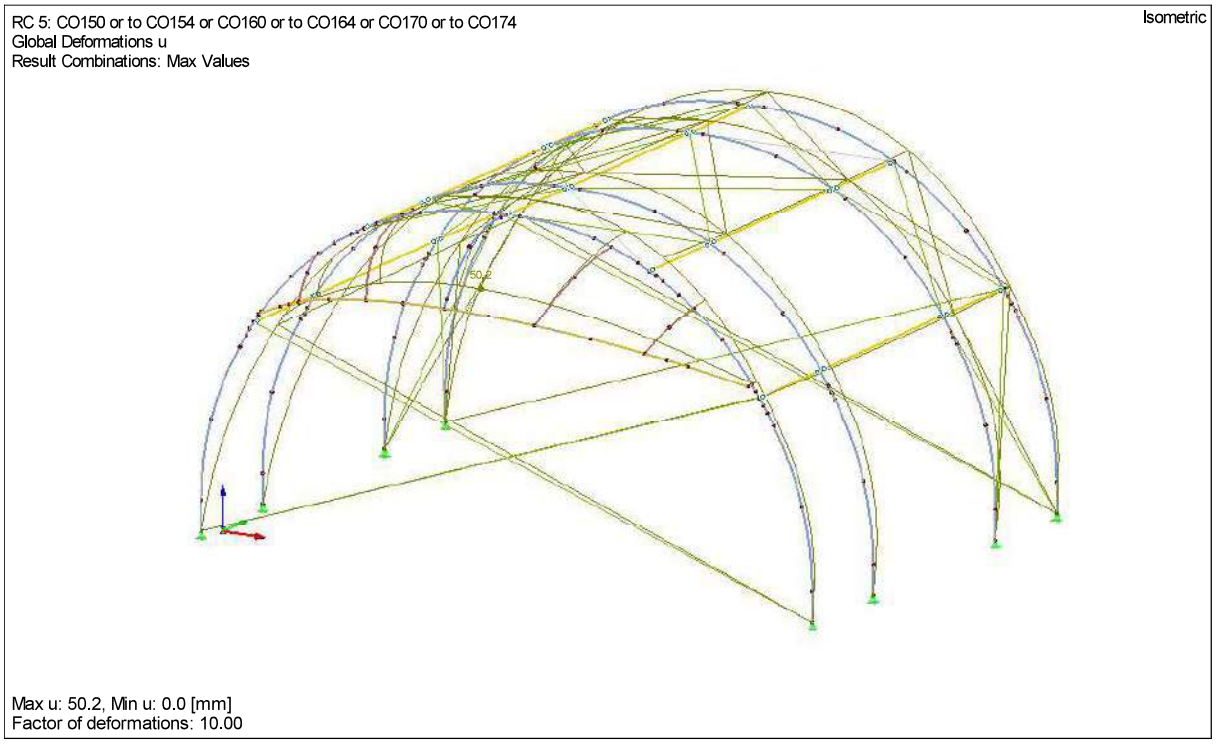
3.12 Calculation result of RC4 - Design Values Out-service: 1 * (CO100 – CO124)

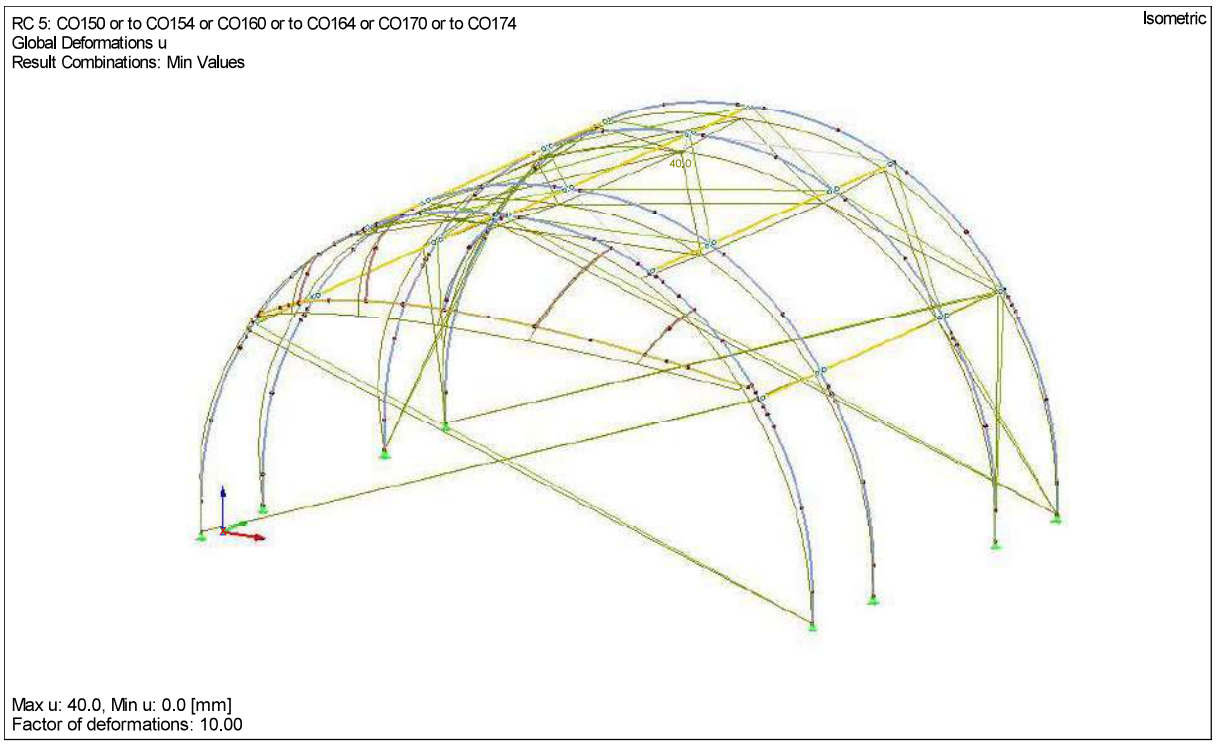
	Description	Value	Unit	Comment
	CO100 - 1.15*LC1 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	41,04	kN	
	Sum of support forces in Z	41,04	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	15,5	mm	Member No. 37, x: 0.419 m
	Maximum displacement in Y-direction	15,3	mm	Member No. 41, x: 0.000 m
	Maximum displacement in Z-direction	41,7	mm	Member No. 101, x: 1.677 m
	Maximum vectorial displacement	42,0	mm	Member No. 101, x: 1.677 m
	Maximum rotation about X-axis	-12,2	mrad	Member No. 105, x: 1.700 m
	Maximum rotation about Y-axis	9,2	mrad	Member No. 104, x: 0.000 m
	Maximum rotation about Z-axis	5,3	mrad	Member No. 104, x: 0.772 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO101 - 1.15*LC1 + 1.35*LC2 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-37,96	kN	
	Sum of support forces in Z	-37,96	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	8,0	mm	Member No. 54, x: 2.445 m
	Maximum displacement in Y-direction	8,6	mm	Member No. 91, x: 0.000 m
	Maximum displacement in Z-direction	-9,6	mm	Member No. 2, x: 3.453 m
	Maximum vectorial displacement	12,8	mm	Member No. 3, x: 0.000 m
	Maximum rotation about X-axis	-4,1	mrad	Member No. 3, x: 2.072 m
	Maximum rotation about Y-axis	4,7	mrad	Member No. 53, x: 0.540 m
	Maximum rotation about Z-axis	-3,1	mrad	Member No. 12, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO102 - 1.15*LC1 + 1.35*LC3 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-5,38	kN	
	Sum of support forces in Z	-5,38	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	13,0	mm	Member No. 55, x: 0.000 m
	Maximum displacement in Y-direction	8,7	mm	Member No. 102, x: 1.061 m
	Maximum displacement in Z-direction	-22,1	mm	Member No. 2, x: 2.763 m
	Maximum vectorial displacement	23,6	mm	Member No. 2, x: 2.763 m
	Maximum rotation about X-axis	-6,2	mrad	Member No. 3, x: 2.072 m
	Maximum rotation about Y-axis	-6,5	mrad	Member No. 79, x: 2.096 m
	Maximum rotation about Z-axis	-4,9	mrad	Member No. 12, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO103 - 1.15*LC1 + 1.35*LC4 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-39,13	kN	
	Sum of support forces in Z	-39,13	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	15,8	mm	Member No. 54, x: 2.445 m
	Maximum displacement in Y-direction	9,1	mm	Member No. 101, x: 0.033 m
	Maximum displacement in Z-direction	-16,6	mm	Member No. 51, x: 0.419 m
	Maximum vectorial displacement	18,3	mm	Member No. 52, x: 0.000 m
	Maximum rotation about X-axis	-6,0	mrad	Member No. 3, x: 2.072 m
	Maximum rotation about Y-axis	8,7	mrad	Member No. 53, x: 0.540 m
	Maximum rotation about Z-axis	-5,1	mrad	Member No. 12, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO104 - 1.15*LC1 + 1.35*LC5 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,43	kN	
	Sum of support forces in Y	5,43	kN	Deviation: 0.00 %
	Sum of loads in Z	-37,78	kN	
	Sum of support forces in Z	-37,78	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	19,0	mm	Member No. 54, x: 2.515 m
	Maximum displacement in Y-direction	8,4	mm	Member No. 99, x: 0.967 m

	Maximum displacement in Z-direction	-26,1	mm	Member No. 52, x: 0.250 m
	Maximum vectorial displacement	26,8	mm	Member No. 3, x: 0.000 m
	Maximum rotation about X-axis	-7,4	mrad	Member No. 3, x: 2.072 m
	Maximum rotation about Y-axis	9,9	mrad	Member No. 53, x: 0.540 m
	Maximum rotation about Z-axis	-6,1	mrad	Member No. 12, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO110 - 1.15*LC1 + 1.35*LC14			
	Sum of loads in X	52,09	kN	
	Sum of support forces in X	52,09	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	53,45	kN	
	Sum of support forces in Z	53,45	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	63,9	mm	Member No. 50, x: 2.934 m
	Maximum displacement in Y-direction	-13,9	mm	Member No. 101, x: 1.129 m
	Maximum displacement in Z-direction	59,0	mm	Member No. 101, x: 1.258 m
	Maximum vectorial displacement	69,2	mm	Member No. 101, x: 1.258 m
	Maximum rotation about X-axis	-13,9	mrad	Member No. 101, x: 0.419 m
	Maximum rotation about Y-axis	28,6	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-12,0	mrad	Member No. 103, x: 0.579 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO111 - 1.15*LC1 + 1.35*LC2 + 1.35*LC14			
	Sum of loads in X	52,09	kN	
	Sum of support forces in X	52,09	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-25,55	kN	
	Sum of support forces in Z	-25,55	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	46,1	mm	Member No. 50, x: 2.934 m
	Maximum displacement in Y-direction	-15,7	mm	Member No. 101, x: 0.581 m
	Maximum displacement in Z-direction	28,9	mm	Member No. 68, x: 0.978 m
	Maximum vectorial displacement	47,0	mm	Member No. 113, x: 0.377 m
	Maximum rotation about X-axis	5,6	mrad	Member No. 57, x: 0.293 m
	Maximum rotation about Y-axis	20,4	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-7,6	mrad	Member No. 103, x: 0.579 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO112 - 1.15*LC1 + 1.35*LC3 + 1.35*LC14			
	Sum of loads in X	52,09	kN	
	Sum of support forces in X	52,09	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	7,03	kN	
	Sum of support forces in Z	7,03	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	32,2	mm	Member No. 49, x: 0.000 m
	Maximum displacement in Y-direction	-13,1	mm	Member No. 101, x: 1.129 m
	Maximum displacement in Z-direction	15,3	mm	Member No. 68, x: 2.054 m
	Maximum vectorial displacement	32,7	mm	Member No. 49, x: 0.062 m
	Maximum rotation about X-axis	4,8	mrad	Member No. 57, x: 0.000 m
	Maximum rotation about Y-axis	15,5	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	-6,2	mrad	Member No. 12, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO113 - 1.15*LC1 + 1.35*LC4 + 1.35*LC14			
	Sum of loads in X	52,09	kN	
	Sum of support forces in X	52,09	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-26,72	kN	
	Sum of support forces in Z	-26,72	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	35,4	mm	Member No. 113, x: 0.754 m
	Maximum displacement in Y-direction	-19,1	mm	Member No. 68, x: 1.467 m
	Maximum displacement in Z-direction	20,9	mm	Member No. 68, x: 0.978 m
	Maximum vectorial displacement	38,7	mm	Member No. 68, x: 0.978 m
	Maximum rotation about X-axis	6,5	mrad	Member No. 57, x: 0.293 m
	Maximum rotation about Y-axis	13,7	mrad	Member No. 47, x: 0.000 m
	Maximum rotation about Z-axis	6,7	mrad	Member No. 10, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO114 - 1.15*LC1 + 1.35*LC5 + 1.35*LC14			
	Sum of loads in X	52,09	kN	
	Sum of support forces in X	52,09	kN	Deviation: 0.00 %
	Sum of loads in Y	-7,47	kN	
	Sum of support forces in Y	-7,47	kN	Deviation: 0.00 %
	Sum of loads in Z	-25,37	kN	
	Sum of support forces in Z	-25,37	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	28,5	mm	Member No. 113, x: 0.754 m

	Maximum displacement in Y-direction	-20,7	mm	Member No. 68, x: 1.467 m
	Maximum displacement in Z-direction	15,1	mm	Member No. 68, x: 1.718 m
	Maximum vectorial displacement	34,9	mm	Member No. 68, x: 1.718 m
	Maximum rotation about X-axis	6,9	mrad	Member No. 80, x: 0.741 m
	Maximum rotation about Y-axis	11,4	mrad	Member No. 75, x: 0.540 m
	Maximum rotation about Z-axis	7,2	mrad	Member No. 10, x: 0.777 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

3.12.1 Deformation of the Out-service situation characteristic max and min values.

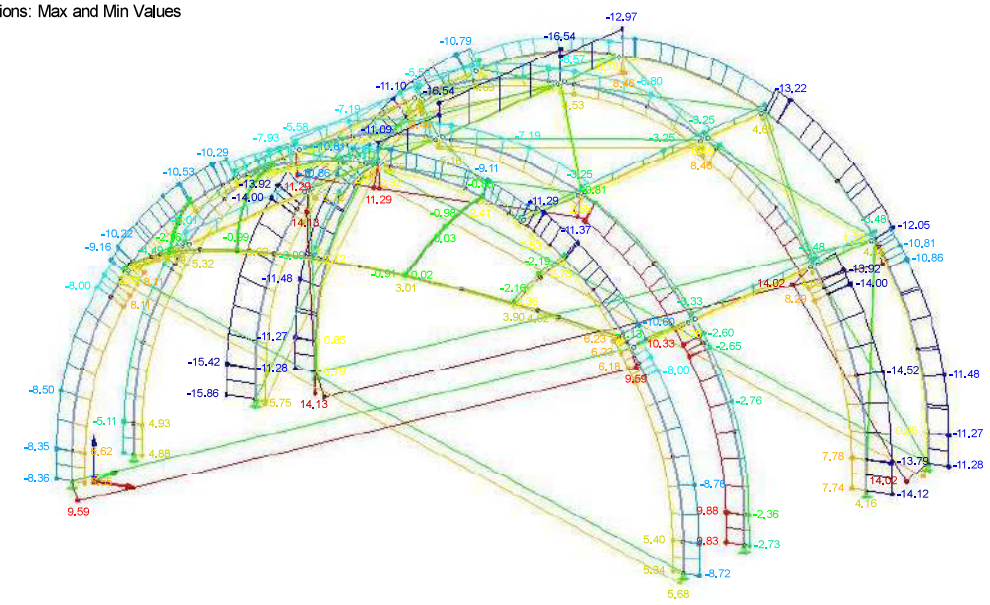




3.12.2 Internal force diagram RC4 Design Values Out-service.

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Internal Forces N
Result Combinations: Max and Min Values

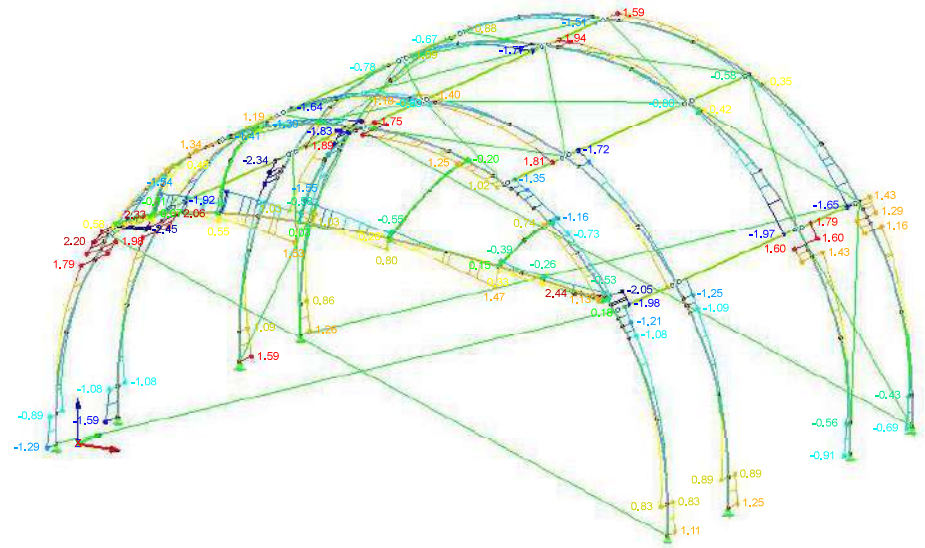
Isometric



Max N: 14.13, Min N: -16.54 [kN]

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Internal Forces V-y
Result Combinations: Max and Min Values

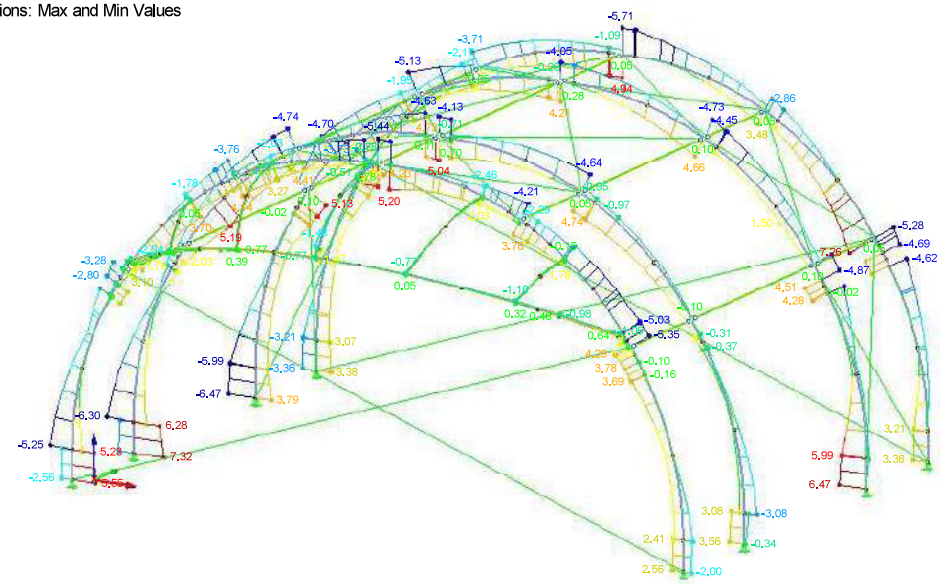
Isometric



Max V-y: 2.44, Min V-y: -2.45 [kN]

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Internal Forces V-z
Result Combinations: Max and Min Values

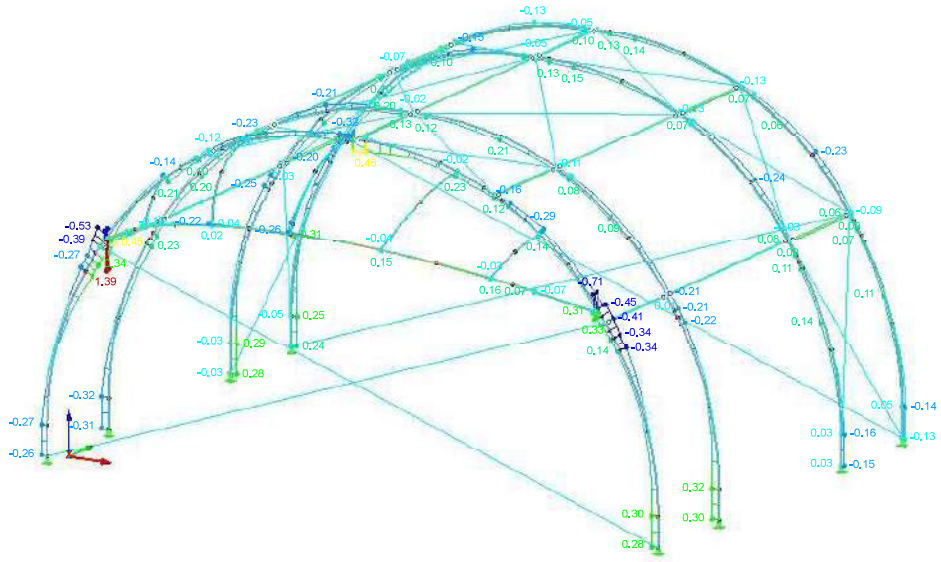
Isometric



Max V-z: 7.32, Min V-z: -6.47 [kN]

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Internal Forces M-T
Result Combinations: Max and Min Values

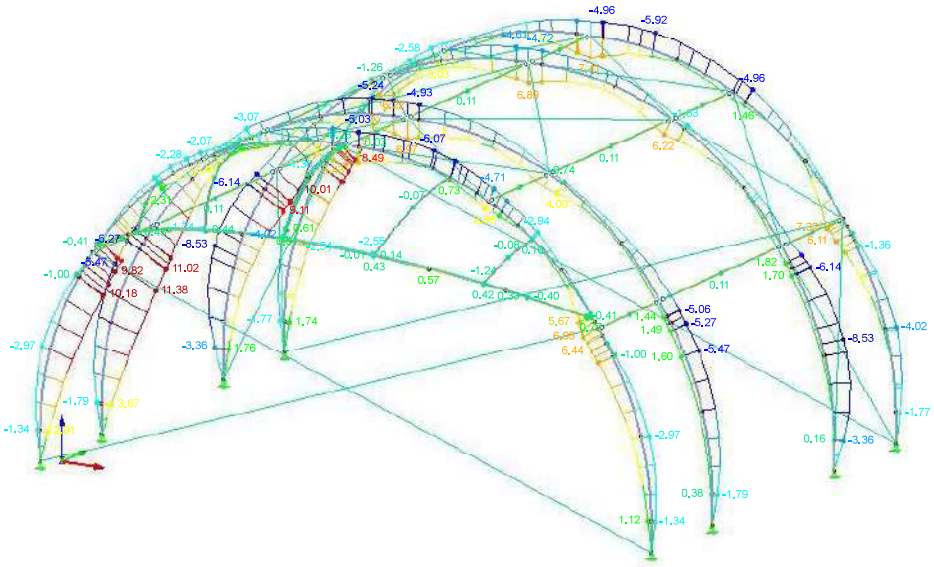
Isometric



Max M-T: 1.39, Min M-T: -0.71 [kNm]

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Internal Forces M-y
Result Combinations: Max and Min Values

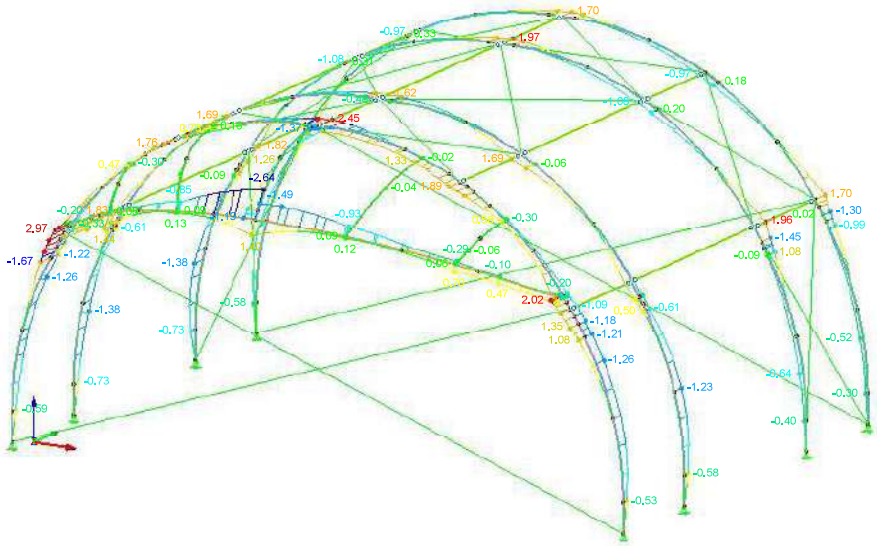
Isometric



Max M-y: 11.38, Min M-y: -8.53 [kNm]

RC 5: CO150 or to CO154 or CO160 or to CO164 or CO170 or to CO174
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric

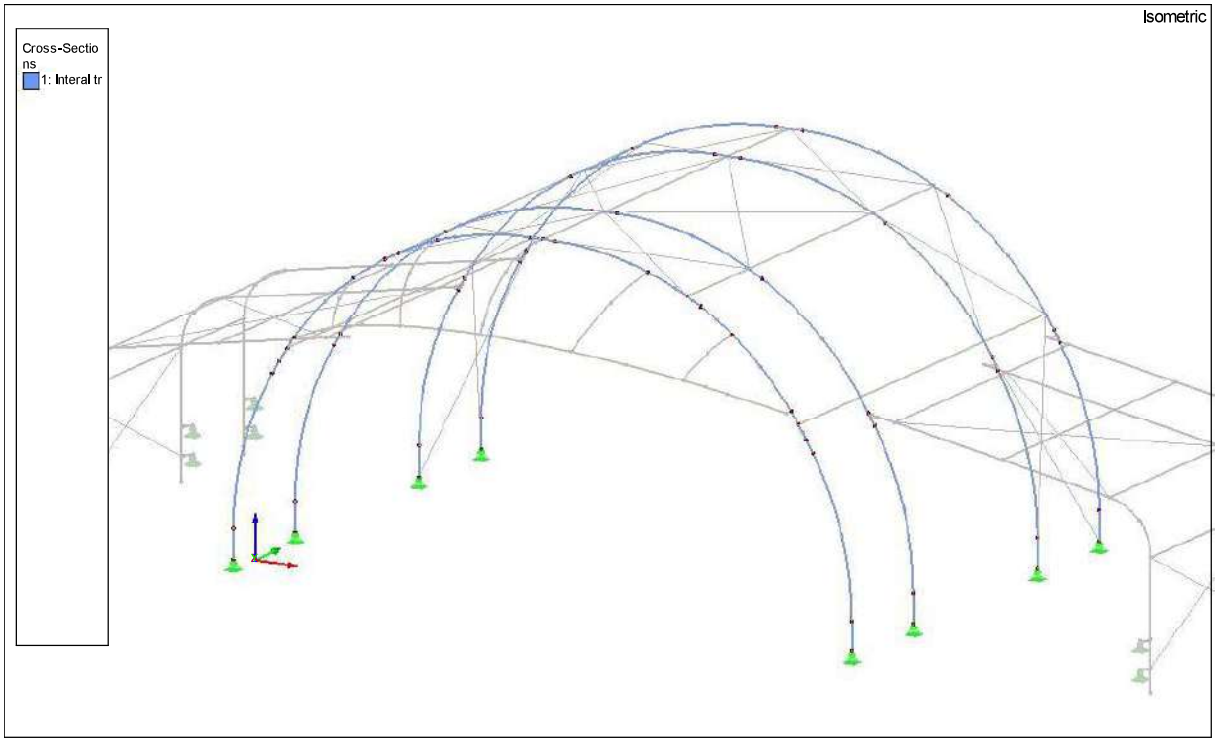


Max M-z: 2.97, Min M-z: -2.64 [kNm]

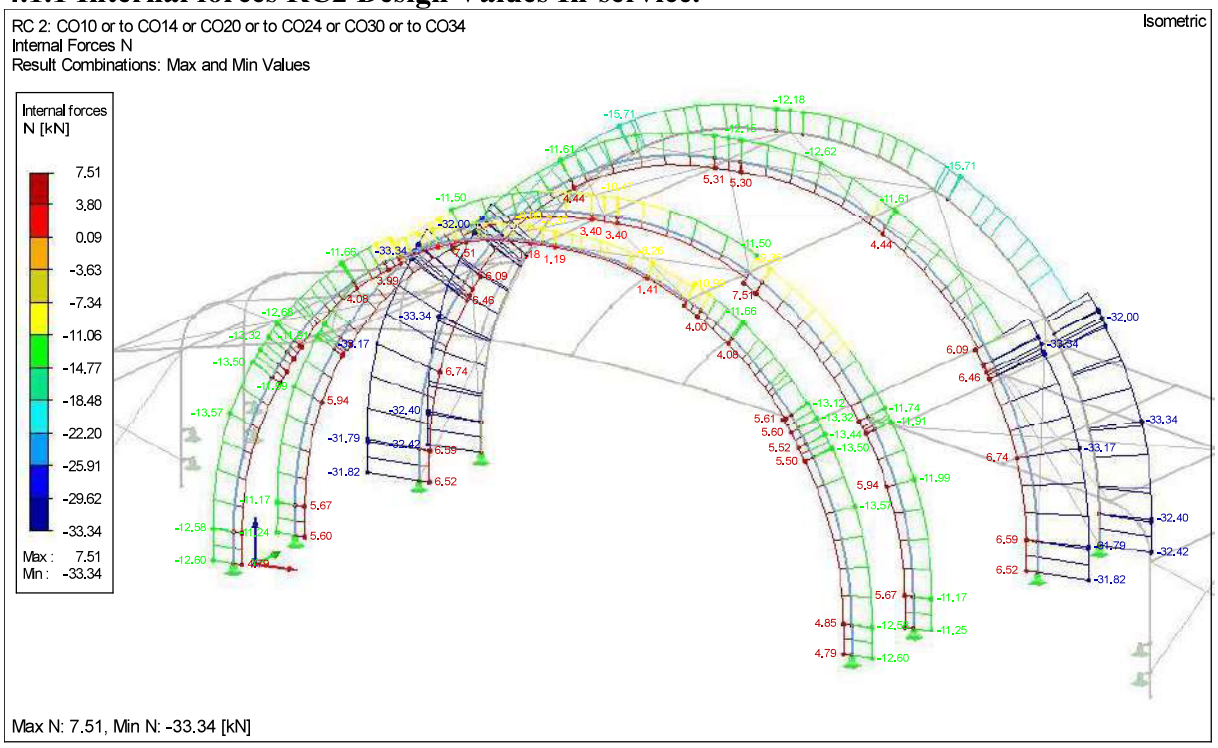
4.0 Detail calculations for different parts.

In this chapter, necessary detail calculations of different parts for the roof are made.
The model of option 1 and 2 are used.

4.1 Detail Check of the Protruss S31 Main arches.

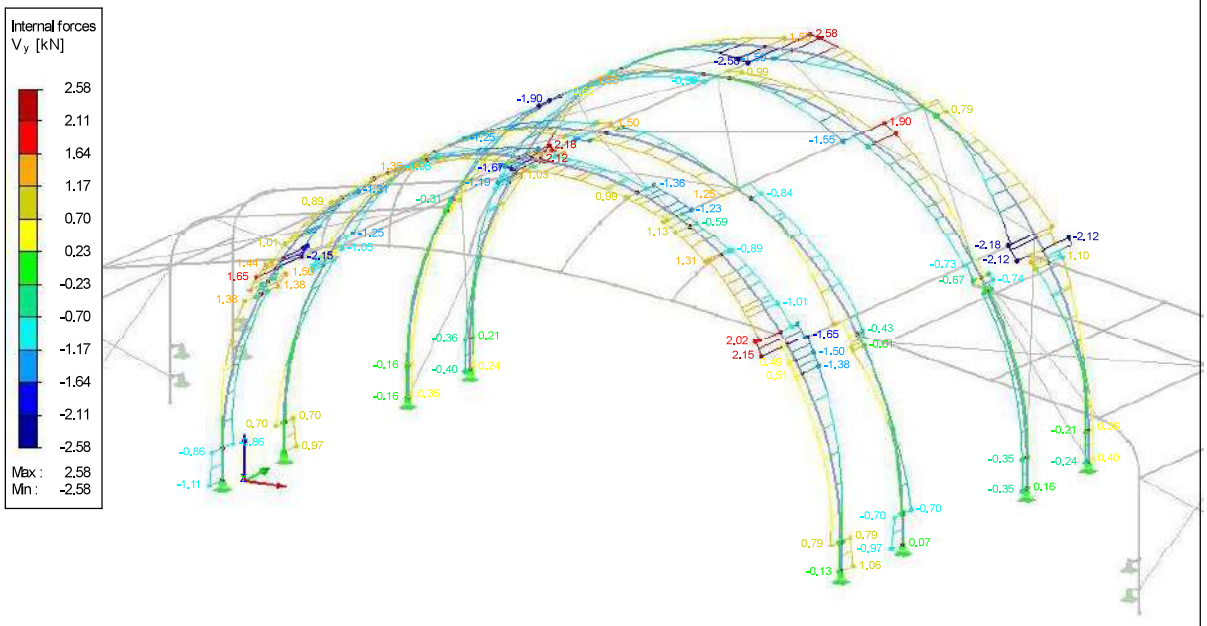


4.1.1 Internal forces RC2 Design Values In-service.



RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-y
Result Combinations: Max and Min Values

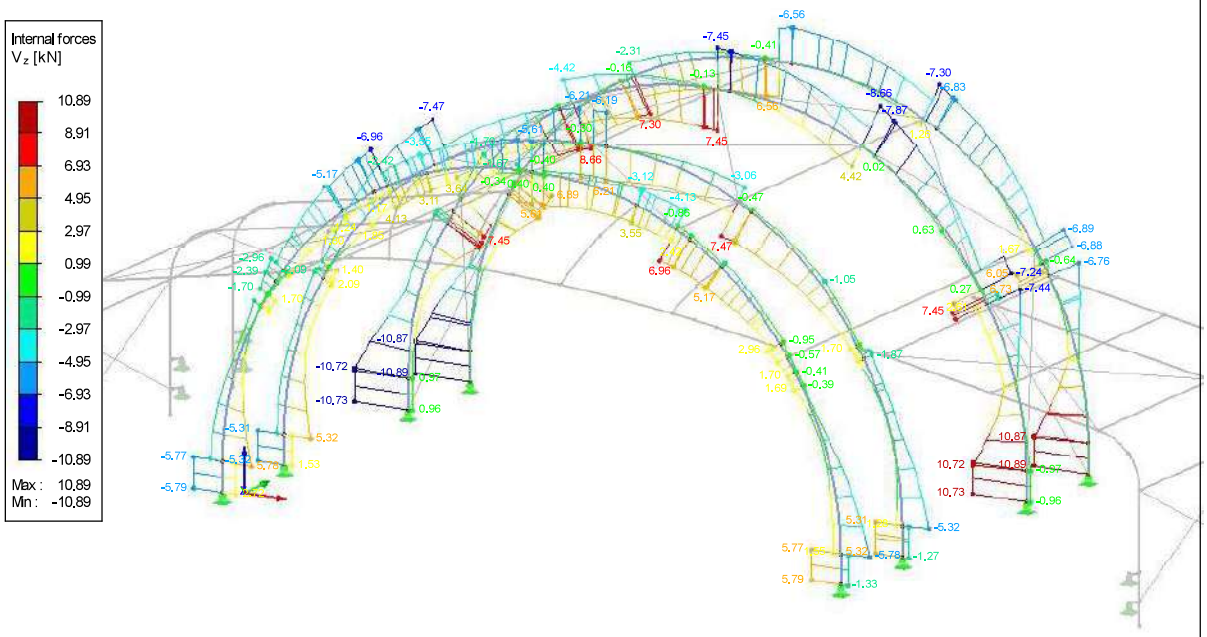
Isometric



Max V-y: 2.58, Min V-y: -2.58 [kN]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

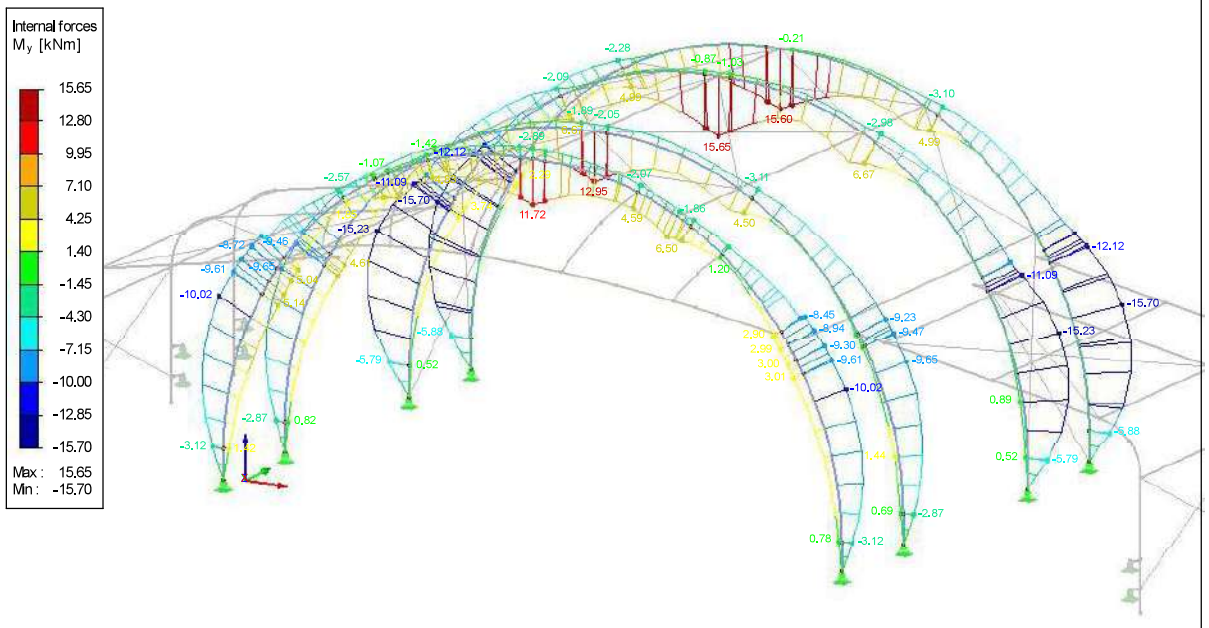
Isometric



Max V-z: 10.89, Min V-z: -10.89 [kN]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

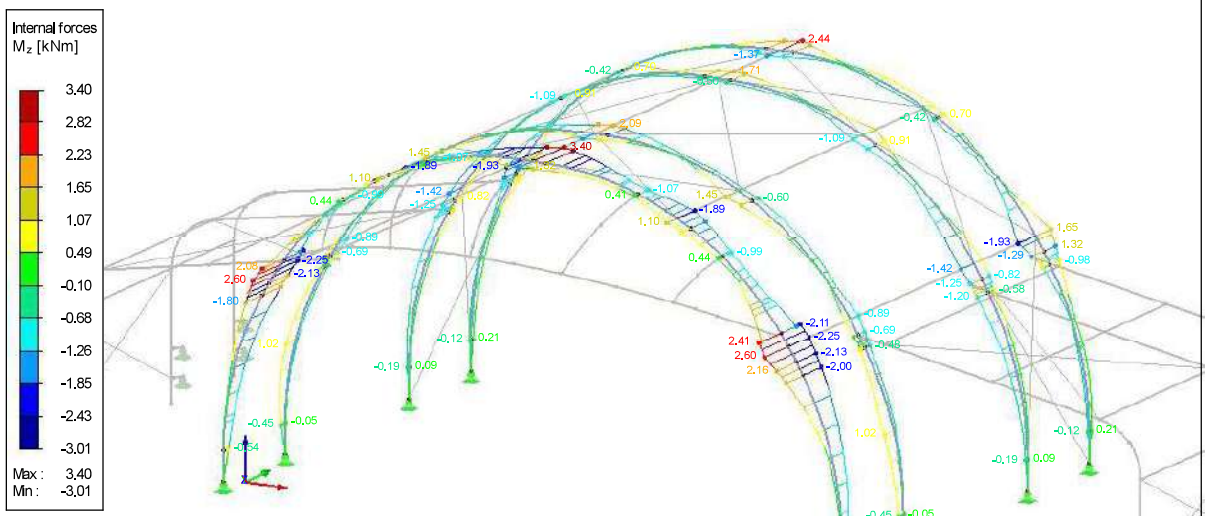
Isometric



Max M-y: 15.65, Min M-y: -15.70 [kNm]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 3.40, Min M-z: -3.01 [kNm]

4.1.2 Check of the Interaction of moment and transversal force with the RC2- Design values.

The check of the Interaction between the bending moment and the transversal force has been done in a separate excel sheet.
This check has been done for each separate truss arch

Check of truss arch 1 (front arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 32	-4,93	-1,5	5,61	0,21	11,72	2,93

$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(1.5^2 + 5.61^2)}$
$V_{d,\ main\ chord} = 1.45$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 1.45 * 5$
$M_{d,\ main\ chord} = 7.25$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 4.93 / 4 + 11.72 / 2 / 0.239 + 2.93 / 2 / 0.239$
$N_{d,\ main\ chord} = 31.88$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (31.88 / 50.914)^{1,3} + ((7.25 / 53.19)^{1.7})^{0.6} = 0.68 < 1$

Check of truss arch 2 (front middle arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 32	-7,28	-1,02	6,17	0	12,95	2,01

$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(1.02^2 + 6.17^2)}$
$V_{d,\ main\ chord} = 1.56$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 1.56 * 5$
$M_{d,\ main\ chord} = 7.81$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 7.28 / 4 + 12.95 / 2 / 0.239 + 2.01 / 2 / 0.239$
$N_{d,\ main\ chord} = 33.12$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (33.12 / 50.914)^{1,3} + ((7.81 / 53.19)^{1.7})^{0.6} = 0.71 < 1$

Check of truss arch 3 (back middle arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 34	-33,08	0,16	1,83	0,07	-15,08	0,35

$V_{d, \text{main chord}} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(0.16^2 + 1.83^2)}$
$V_{d, \text{main chord}} = 0.46$ kN
$M_{d, \text{main chord}} = Vd, \text{main chord} * e = 0.46 * 5$
$M_{d, \text{main chord}} = 2.30$ kNcm
$N_{d, \text{main chord}} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, \text{main chord}} = 33.08 / 4 + 15.08 / 2 / 0.239 + 0.35 / 2 / 0.239$
$N_{d, \text{main chord}} = 40.55$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd, \text{main chord}} = 50.914$ kN and the $M_{Rd, \text{main chord}} = 53.19$ kNcm.

$\eta = (N_{d, \text{main chord}} / N_{Rd})^{1,3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = (40.55 / 50.914)^{1,3} + ((2.30 / 53.19)^{1.7})^{0.6} = 0.78 < 1$

Check of truss arch 4 (back arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 32	-12,18	-2,53	6,13	0	14,93	2,44

$V_{d, \text{main chord}} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(2.53^2 + 6.13^2)}$
$V_{d, \text{main chord}} = 1.65$ kN
$M_{d, \text{main chord}} = Vd, \text{main chord} * e = 1.65 * 5$
$M_{d, \text{main chord}} = 8.29$ kNcm
$N_{d, \text{main chord}} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, \text{main chord}} = 12.18 / 4 + 14.93 / 2 / 0.239 + 2.44 / 2 / 0.239$
$N_{d, \text{main chord}} = 39.38$ kN

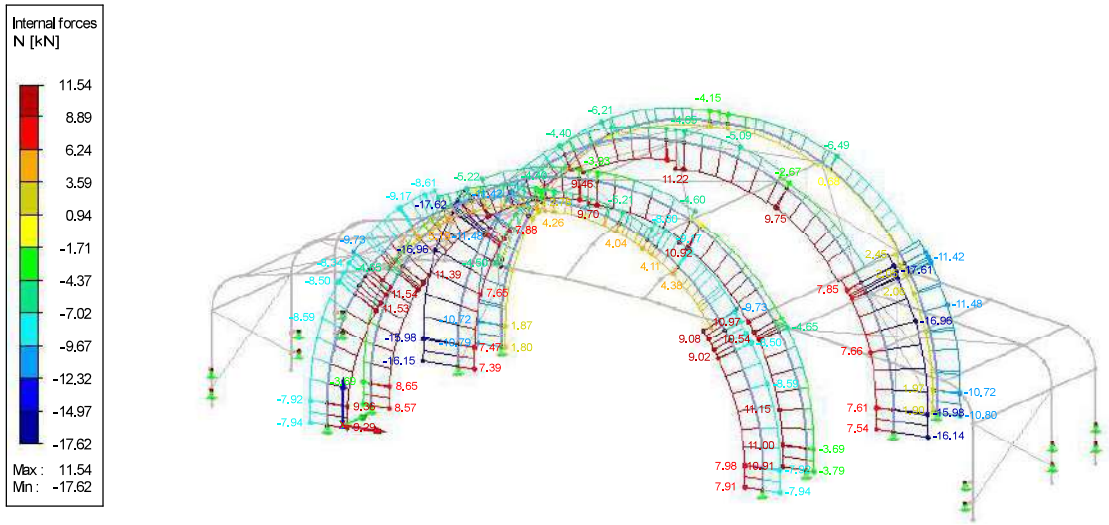
Check
According to information of the Protruss S31 truss the $N_{Rd, \text{main chord}} = 50.914$ kN and the $M_{Rd, \text{main chord}} = 53.19$ kNcm.

$\eta = (N_{d, \text{main chord}} / N_{Rd})^{1,3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = (39.38 / 50.914)^{1,3} + ((8.29 / 53.19)^{1.7})^{0.6} = 0.87 < 1$

4.1.3 Internal forces RC4 Design Values Out-service.

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces N
Result Combinations: Max and Min Values

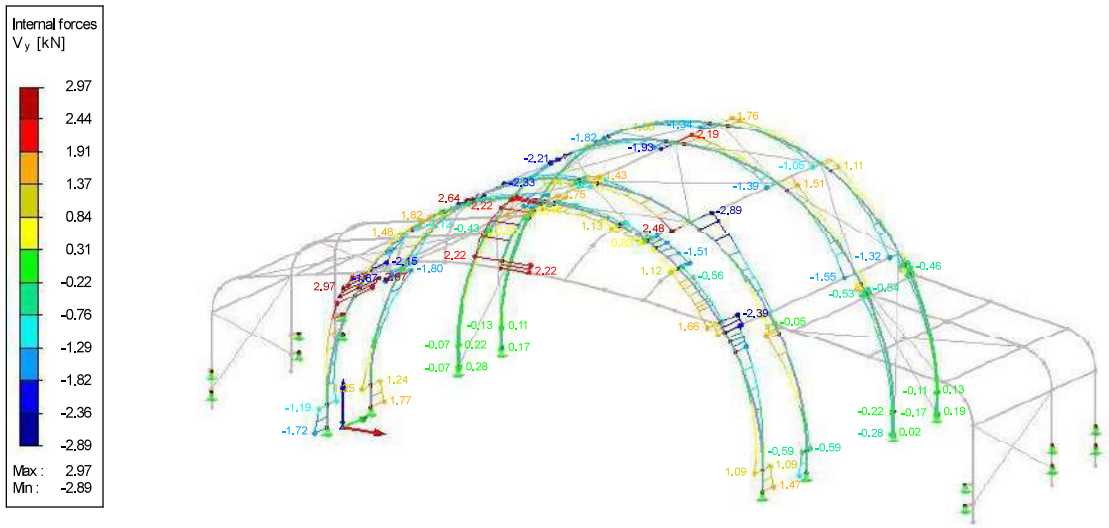
Isometric



Max N: 11.54, Min N: -17.62 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

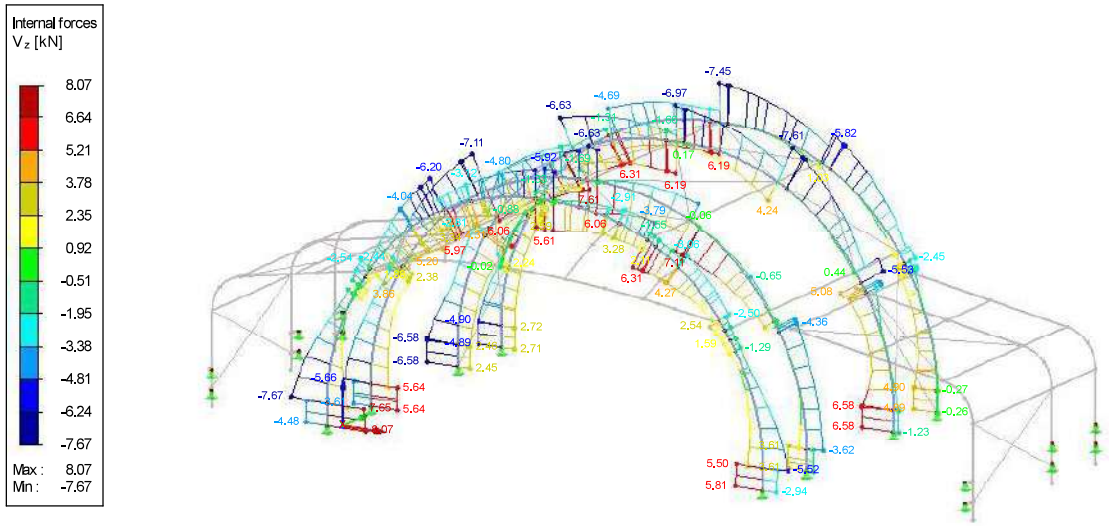
Isometric



Max V-y: 2.97, Min V-y: -2.89 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

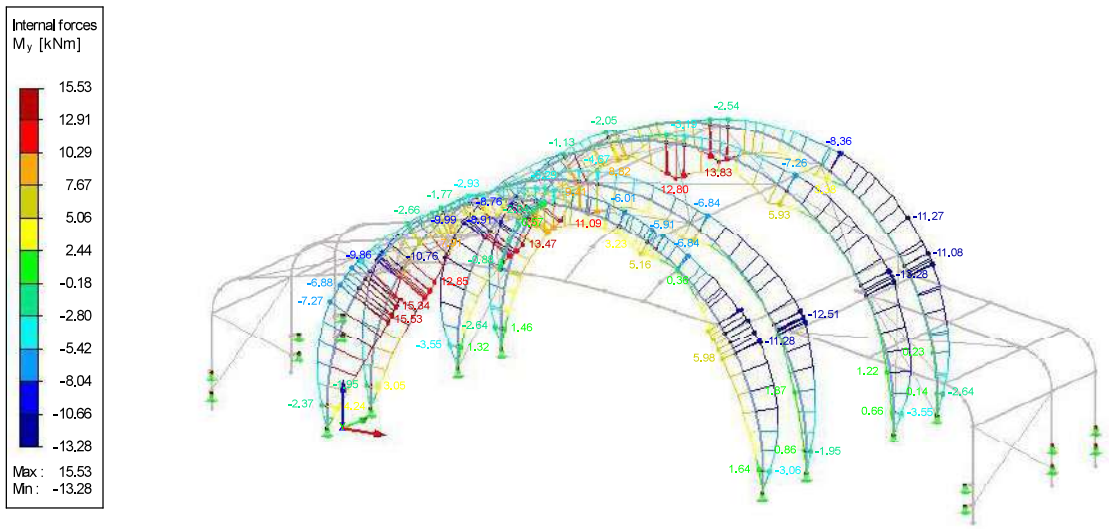
Isometric



Max V-z: 8.07, Min V-z: -7.67 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

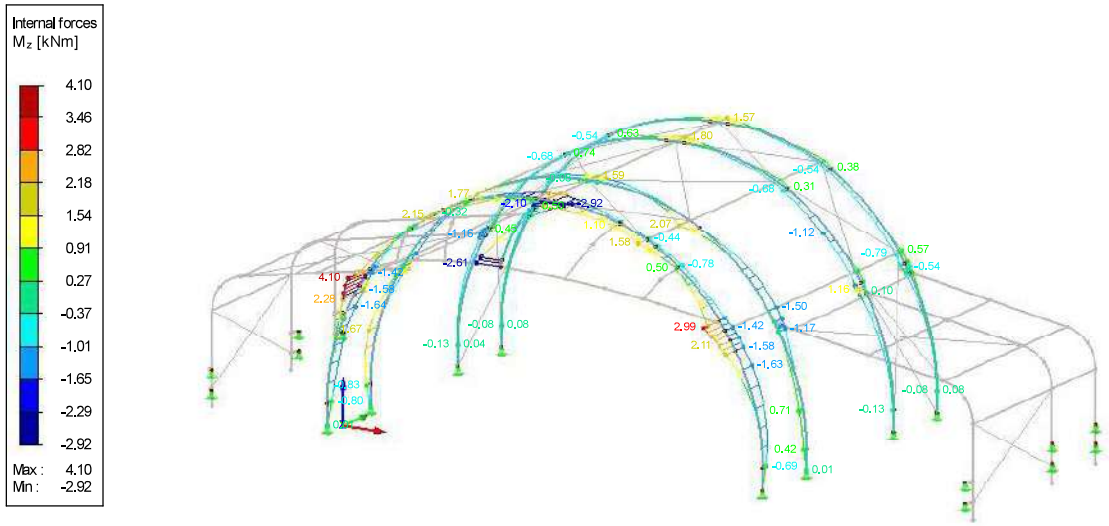
Isometric



Max M-y: 15.53, Min M-y: -13.28 [kNm]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric



Max M-z: 4.10, Min M-z: -2.92 [kNm]

4.1.4 Check of the Interaction of moment and transversal force with the RC4- Design values.

The check of the Interaction between the bending moment and the transversal force has been done in a separate excel sheet.
This check has been done for each separate truss arch

Check of truss arch 1 (front arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 110	11,49	2,97	1,11	-0,51	15,28	3,7

$V_{d, main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(2.97^2 + 1.11^2)}$
$V_{d, main\ chord} = 0.79$ kN
$M_{d, main\ chord} = Vd, main\ chord * e = 0.79 * 5$
$M_{d, main\ chord} = 3.96$ kNcm
$N_{d, main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, main\ chord} = 11.49 / 4 + 15.28 / 2 / 0.239 + 3.70 / 2 / 0.239$
$N_{d, main\ chord} = 42.58$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd, main\ chord} = 50.914$ kN and the $M_{Rd, main\ chord} = 53.19$ kNcm.

$\eta = (N_{d, main\ chord} / N_{Rd})^{1,3} + M_{d, main\ chord} / M_{Rd}$
$\eta = (42.58 / 50.914)^{1,3} + ((3.96 / 53.19)^{1.7})^{0.6} = 0.86 < 1$

Check of truss arch 2 (front middle arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 114	-0,41	1,51	-3,49	-0,1	-12,51	-1,24

$V_{d, main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(1.51^2 + 3.49^2)}$
$V_{d, main\ chord} = 0.95$ kN
$M_{d, main\ chord} = Vd, main\ chord * e = 0.95 * 5$
$M_{d, main\ chord} = 4.75$ kNcm
$N_{d, main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, main\ chord} = 0.41 / 4 + 12.51 / 2 / 0.239 + 1.24 / 2 / 0.239$
$N_{d, main\ chord} = 28.87$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd, main\ chord} = 50.914$ kN and the $M_{Rd, main\ chord} = 53.19$ kNcm.

$\eta = (N_{d, main\ chord} / N_{Rd})^{1,3} + M_{d, main\ chord} / M_{Rd}$
$\eta = (28.87 / 50.914)^{1,3} + ((4.75 / 53.19)^{1.7})^{0.6} = 0.56 < 1$

Check of truss arch 3 (back middle arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 102	0,11	-0,67	6,19	0	12,8	0,37

$V_{d, \text{main chord}} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(0.67^2 + 6.19^2)}$
$V_{d, \text{main chord}} = 1.55$ kN
$M_{d, \text{main chord}} = Vd, \text{main chord} * e = 1.55 * 5$
$M_{d, \text{main chord}} = 7.78$ kNcm
$N_{d, \text{main chord}} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, \text{main chord}} = 0.11 / 4 + 12.8 / 2 / 0.239 + 0.37 / 2 / 0.239$
$N_{d, \text{main chord}} = 27.58$ kN

Check
According to information of the Protruss S31 truss the $N_{Rd, \text{main chord}} = 50.914$ kN and the $M_{Rd, \text{main chord}} = 53.19$ kNcm.

$\eta = (N_{d, \text{main chord}} / N_{Rd})^{1,3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = (27.58 / 50.914)^{1,3} + ((7.78 / 53.19)^{1.7})^{0.6} = 0.59 < 1$

Check of truss arch 4 (back arch)

Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
CO 102	-3,44	-0,43	5,94	0	13,83	0,26

$V_{d, \text{main chord}} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(0.43^2 + 5.94^2)}$
$V_{d, \text{main chord}} = 1.49$ kN
$M_{d, \text{main chord}} = Vd, \text{main chord} * e = 1.49 * 5$
$M_{d, \text{main chord}} = 7.44$ kNcm
$N_{d, \text{main chord}} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d, \text{main chord}} = 3.44 / 4 + 13.83 / 2 / 0.239 + 0.26 / 2 / 0.239$
$N_{d, \text{main chord}} = 30.337$ kN

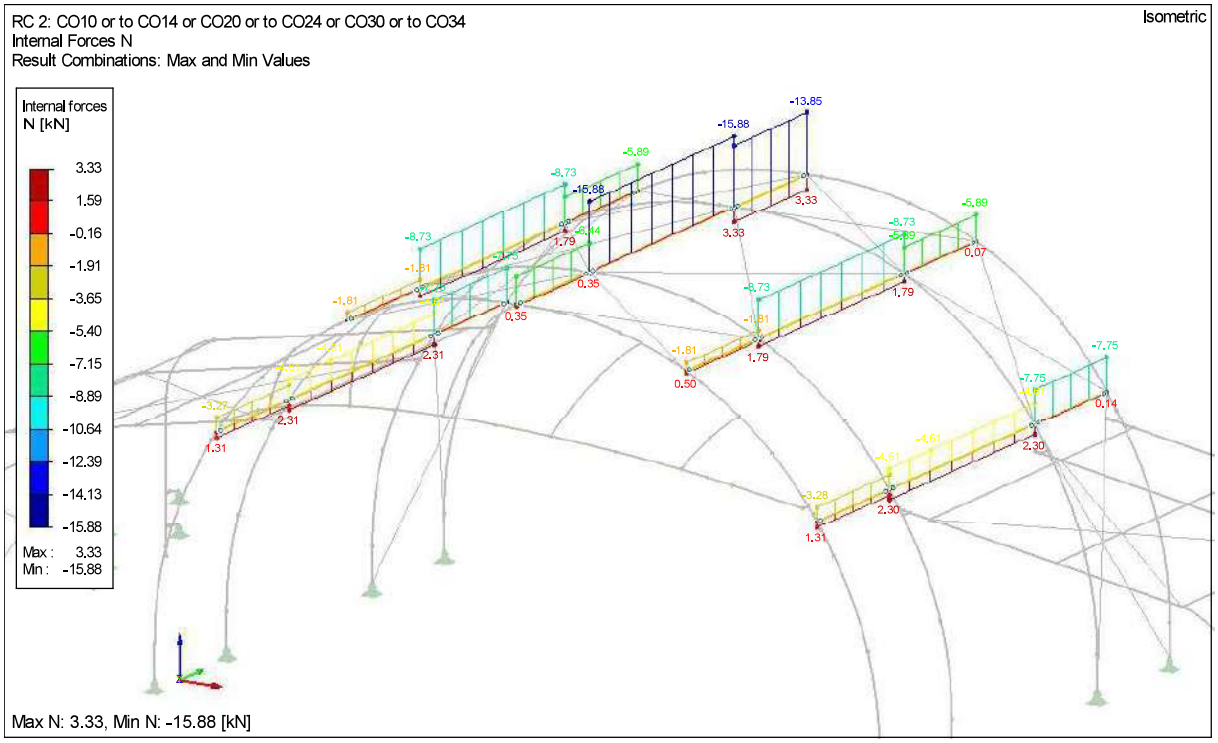
Check
According to information of the Protruss S31 truss the $N_{Rd, \text{main chord}} = 50.914$ kN and the $M_{Rd, \text{main chord}} = 53.19$ kNcm.

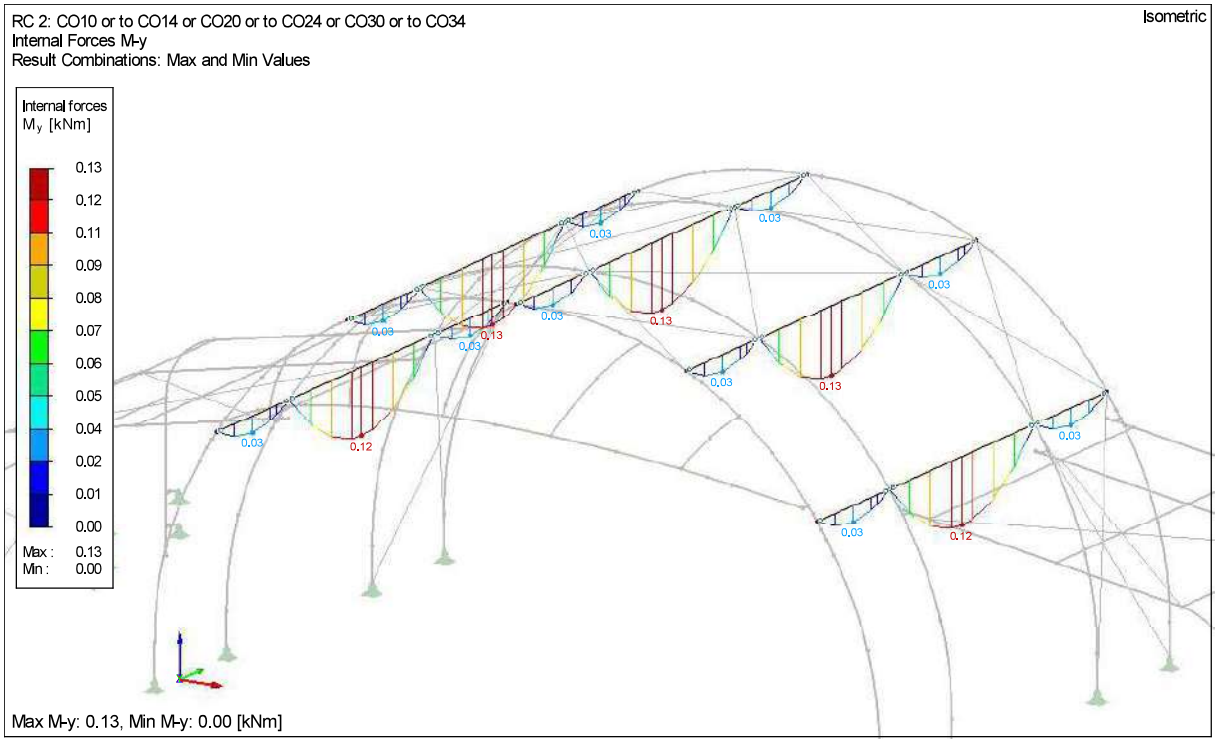
$\eta = (N_{d, \text{main chord}} / N_{Rd})^{1,3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = (30.337 / 50.914)^{1,3} + ((7.44 / 53.19)^{1.7})^{0.6} = 0.64 < 1$

4.2 Detail check of the Protruss T31 Roof truss.

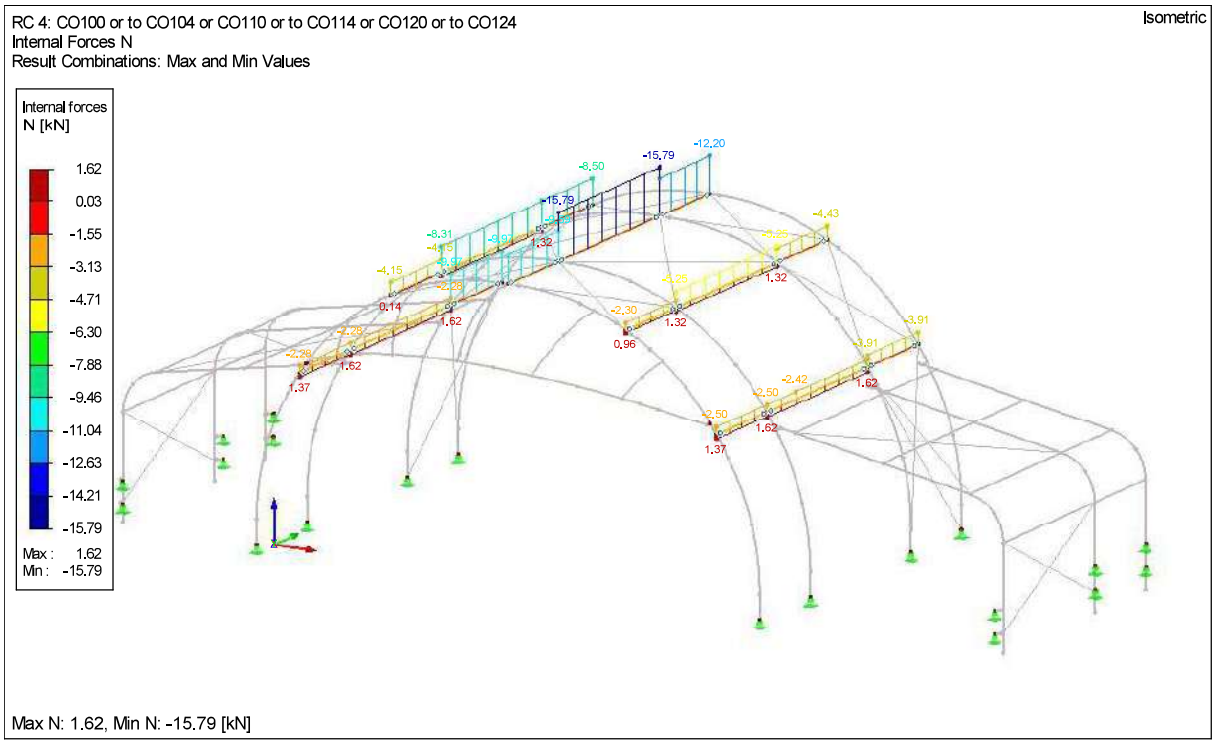
The roof trusses are loaded on compression therefor these trusses will be checked on buckling With the Internal forces of RC2 and RC4

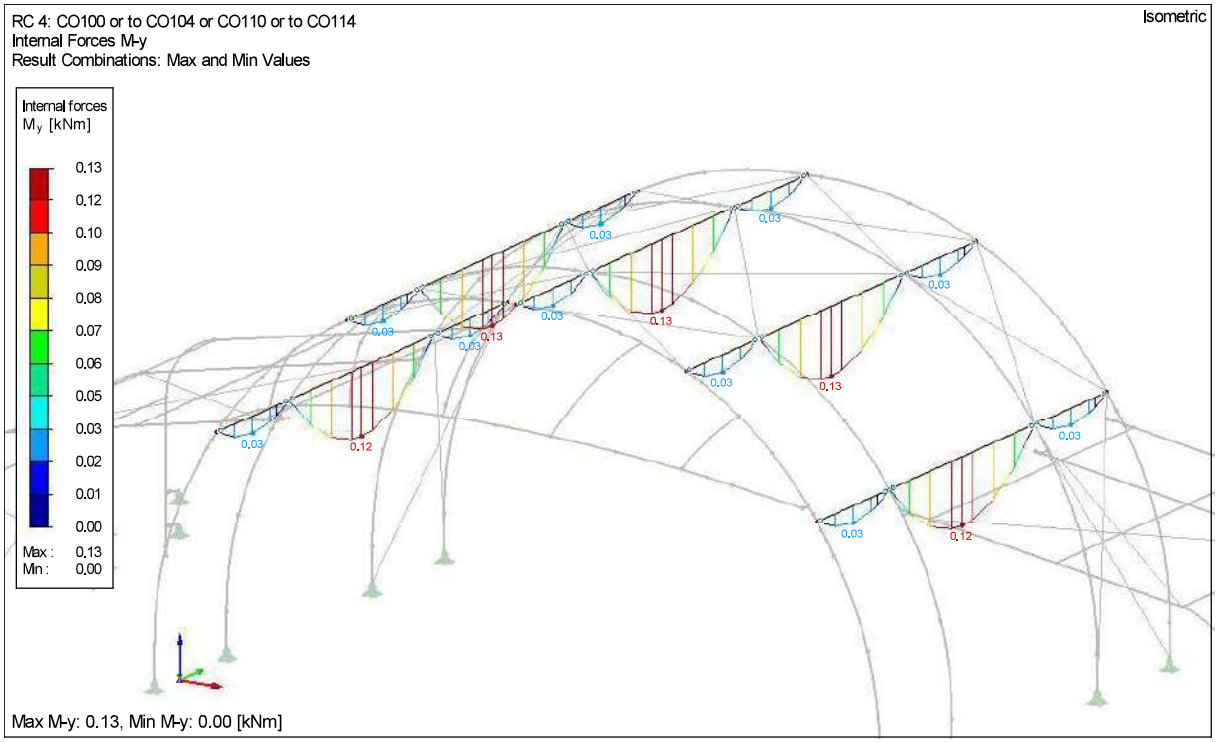
4.2.1 Internal forces RC2 Design Values In-service.





4.2.2 Internal forces RC4 Design Values Out-service.





4.2.3 Check of the Protruss T31 Roof truss on buckling in the In-service situation.

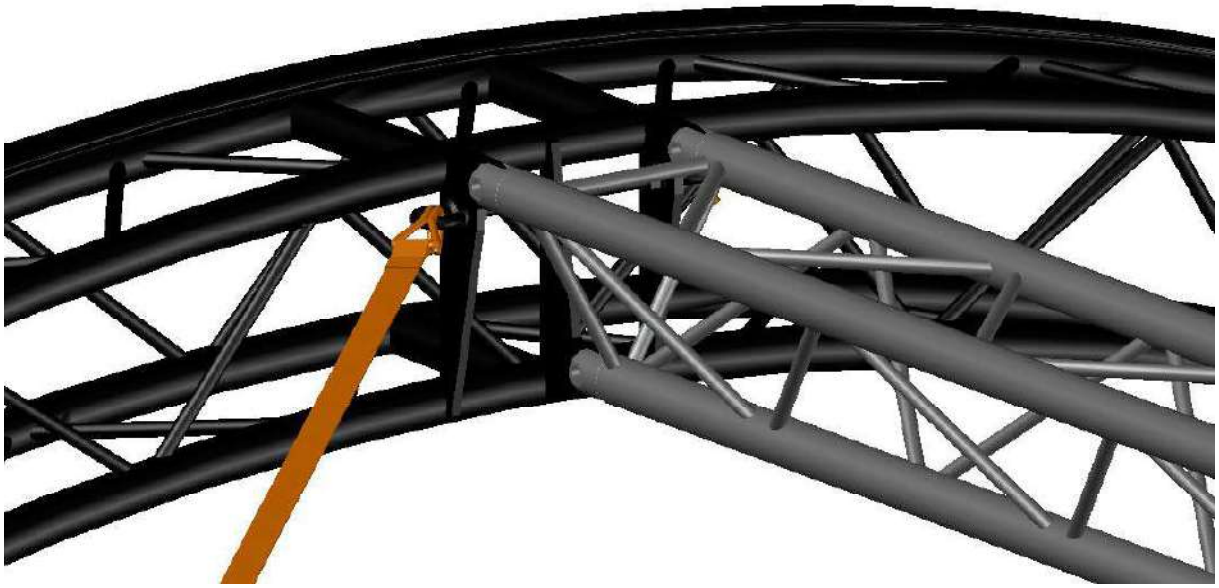
N = 15.88 kN
M_y = 0.13 kNm
M_z = 0 kNm

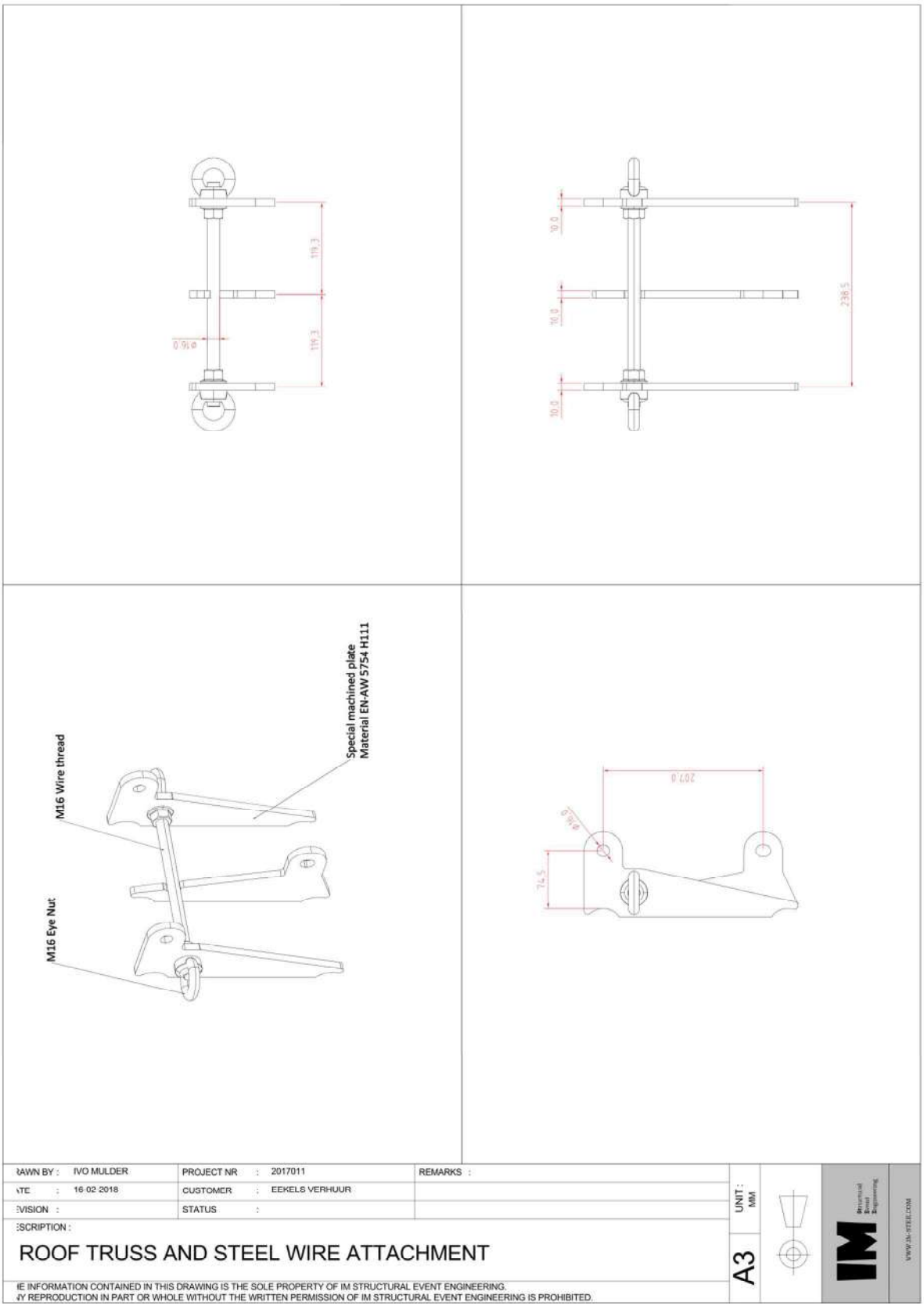
$N_{ED,\ main\ chord} = N / 4 + M_y / 2 / height_{(centre\ to\ centre)} + M_z / 2 / width_{(centre\ to\ centre)}$
$N_{ED,\ main\ chord} = 15.88 / 3 + 0.13 / 0.207 + 0 / 0.239 = 5.57\ kN < 50.22\ kN$

Buckling calculation:
Buckling Length factor K = 1 table 6,8 NEN-EN 1999-1-1
$L_{cr} = 1 * 414 = 414$
$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$
$\lambda_z = 414 / (9.89 * \pi) * \sqrt{((12.723 * 25) / (12.723 * 7000))} = 0.79$
$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$
$\Theta_z = 0.5 * (1 + 0.2 * (0.79 - 0.10) + 0.79^2) = 0.88$
$X_z = 1 / (\Theta_z + \sqrt{(\Theta_z^2 - \lambda_z^2)})$
$X_z = 1 / (0.88 + \sqrt{(0.88^2 - 0.79^2)}) = 0.79$

$(N / (X_z * N_{RD}))^{0.8} + ((M_y / M_{y,\ RD})^{1,7} + (M_z / M_{z,\ RD})^{1,7})^{0.6} < 1$
$(15.88 / (0.79 * 150.66))^{0.8} + ((0.13 / 9.48)^{1,7} + (0 / 10.95)^{1,7})^{0.6} = 0.21 < 1$

4.2.4 Check of T31 Roof truss to the S31 Main arch truss.




119.3
119.3
Ø16.0
10.0
10.0
10.0
238.5
Special machined plate
Material EN-AW 5754 H111
M16 Wire thread
M16 Eye Nut
207.0
Ø18.0
74.5
RAWN BY : IVO MULDER
PROJECT NR : 2017011
REMARKS :
ATE : 16-02-2018
CUSTOMER : EEKELS VERHUUR
EVISION :
STATUS :
ESCRIPTION :
ROOF TRUSS AND STEEL WIRE ATTACHMENT
UNIT : MM
A3
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WWW.IM-STEEL.COM

Check of the bearing forces in the holes of plate

Plate Information
Material EN-AW 5754 H111
f_u 18 kN/cm²
$f_{u,haz}$ 18 kN/cm²

T = 10 mm
D = 16 mm

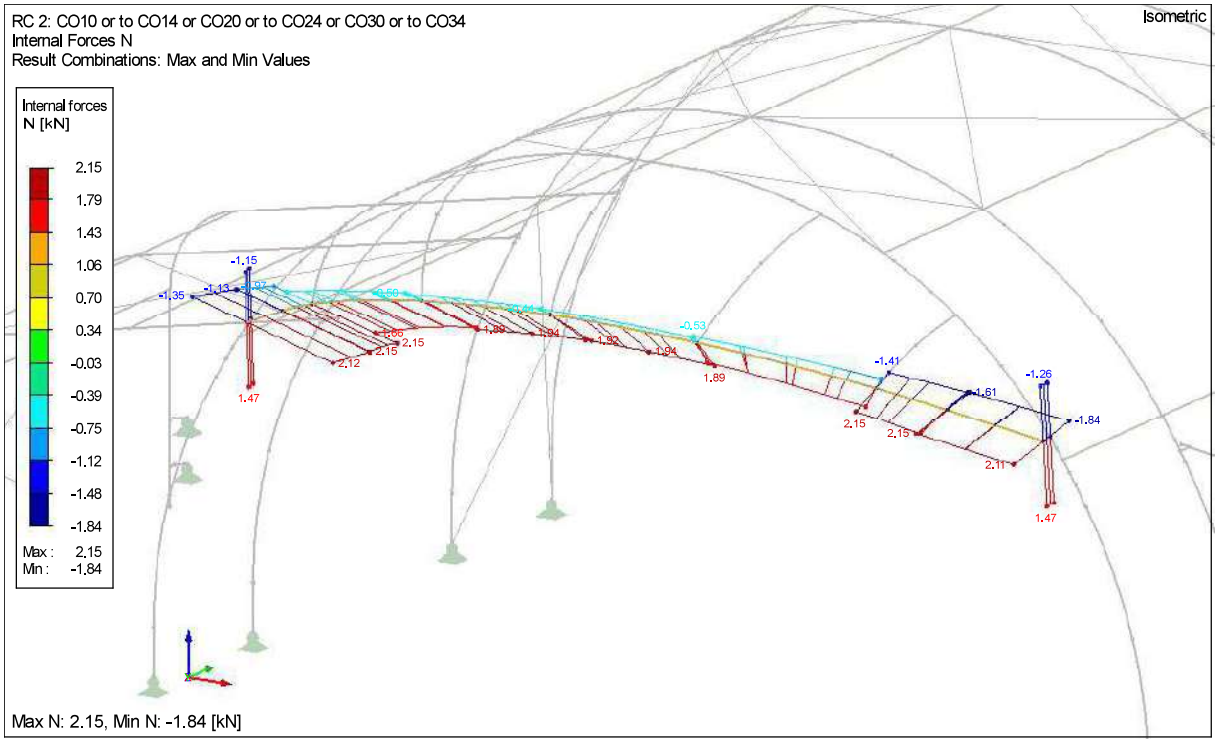
Maximum normal force in the T31 Roof truss = 15.88 kN

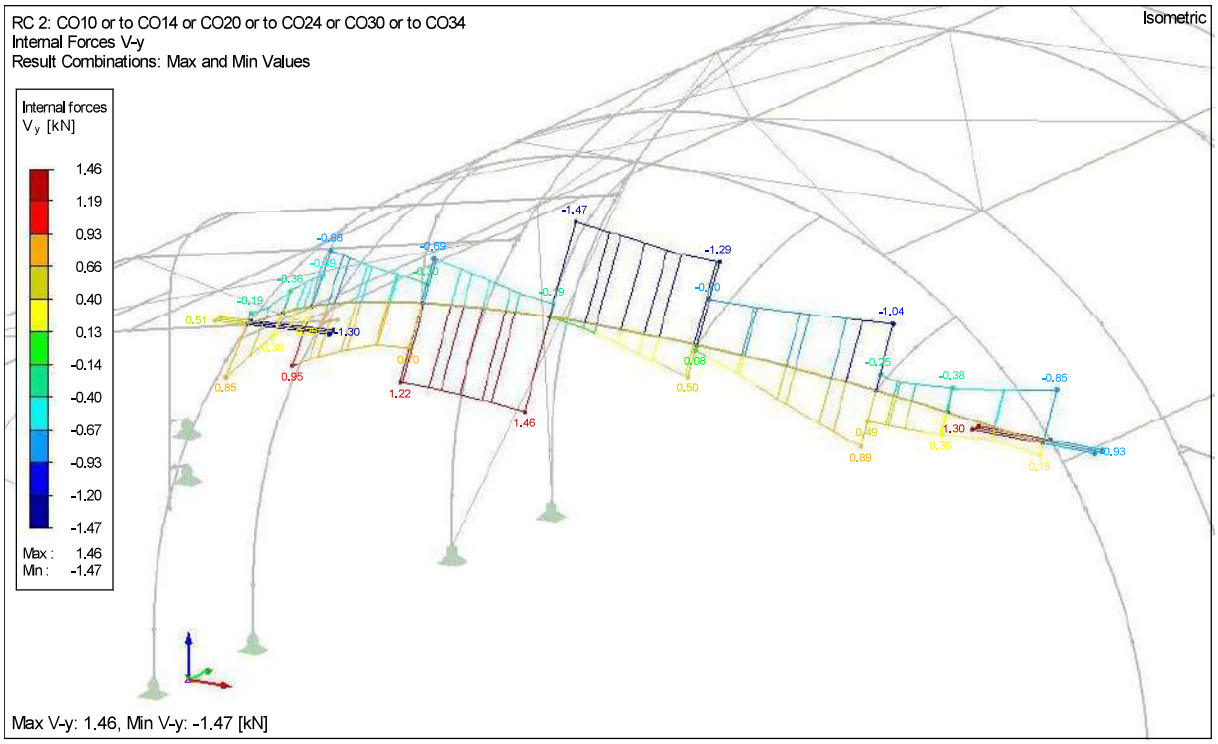
$F_{b,Ed}$ = 15.88 kN / 3 = 5.29 kN
$F_{b,Rd}$ = 1.5 * f_u * D * T / γ_{m2} = 1.5 * 18 * 1.6 * 1 / 1.25 = 34.56 kN
$F_{b,Ed}$ / $F_{b,Rd}$ < 1
5.29 / 34.56 = 0.15 < 1.0

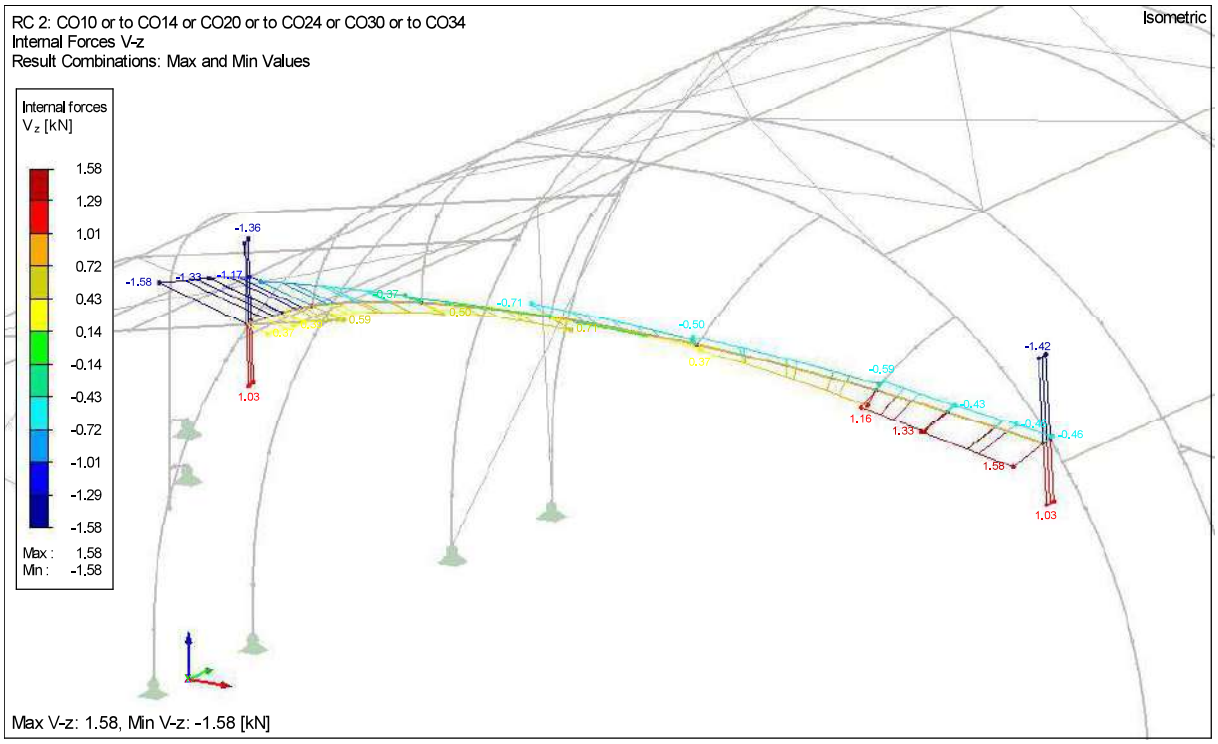
Due to the low maximum normal force the welding of the plate to the main tube and truss pin are not decisive.

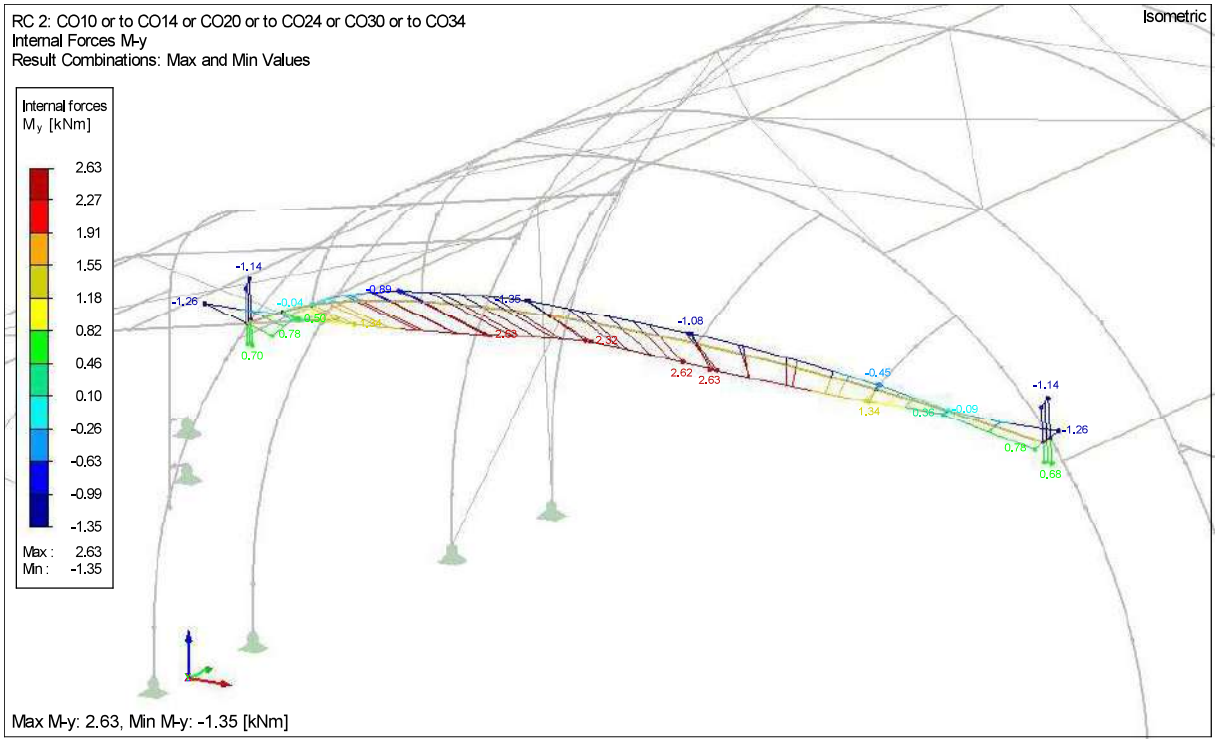
4.3 Detail Check of the cantilever.

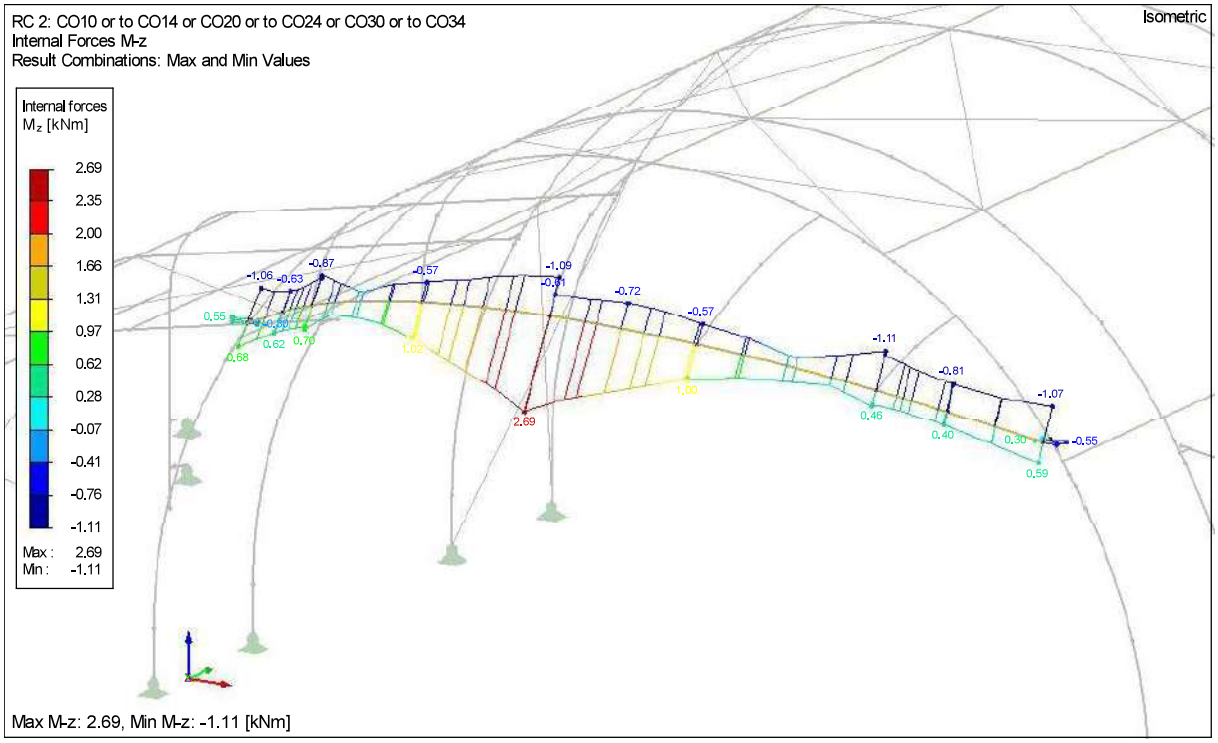
4.3.1 Internal forces T31 truss RC2 Design Values In-service.






RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
1.58
1.29
1.01
0.72
0.43
0.14
-0.14
-0.43
-0.72
-1.01
-1.29
-1.58
Max : 1,58
Min : -1.58
Max V-z: 1.58, Min V-z: -1.58 [kN]


RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
2.63
2.27
1.91
1.55
1.18
0.82
0.46
0.10
-0.26
-0.63
-0.99
-1.35
Max : 2.63
Min : -1.35
Max M-y: 2.63, Min M-y: -1.35 [kNm]



4.3.2 Check of the Interaction of moment and transversal force with the RC2- Design values.

The check of the Interaction between the bending moment and the transversal force has been done with the maximum internal forces of RC2

Check of T31 truss arch

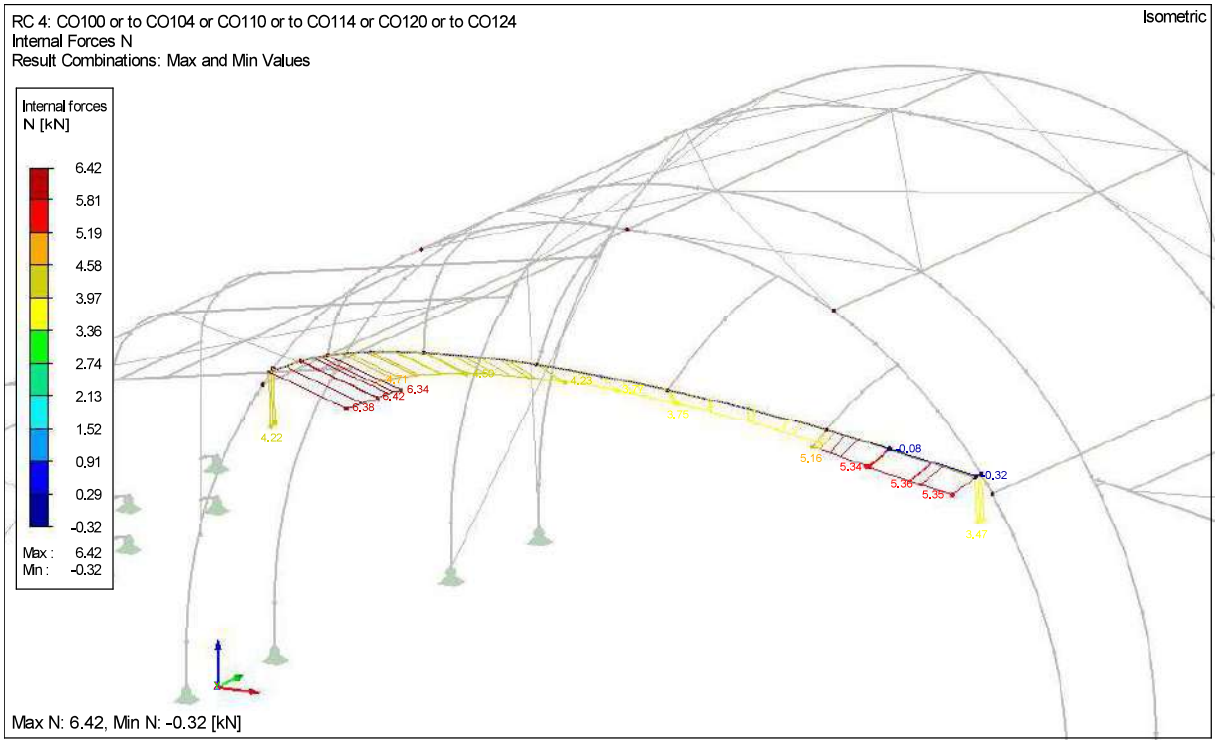
Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
RC2	2.15	-1,47	1.58	1.26	2.63	2,69

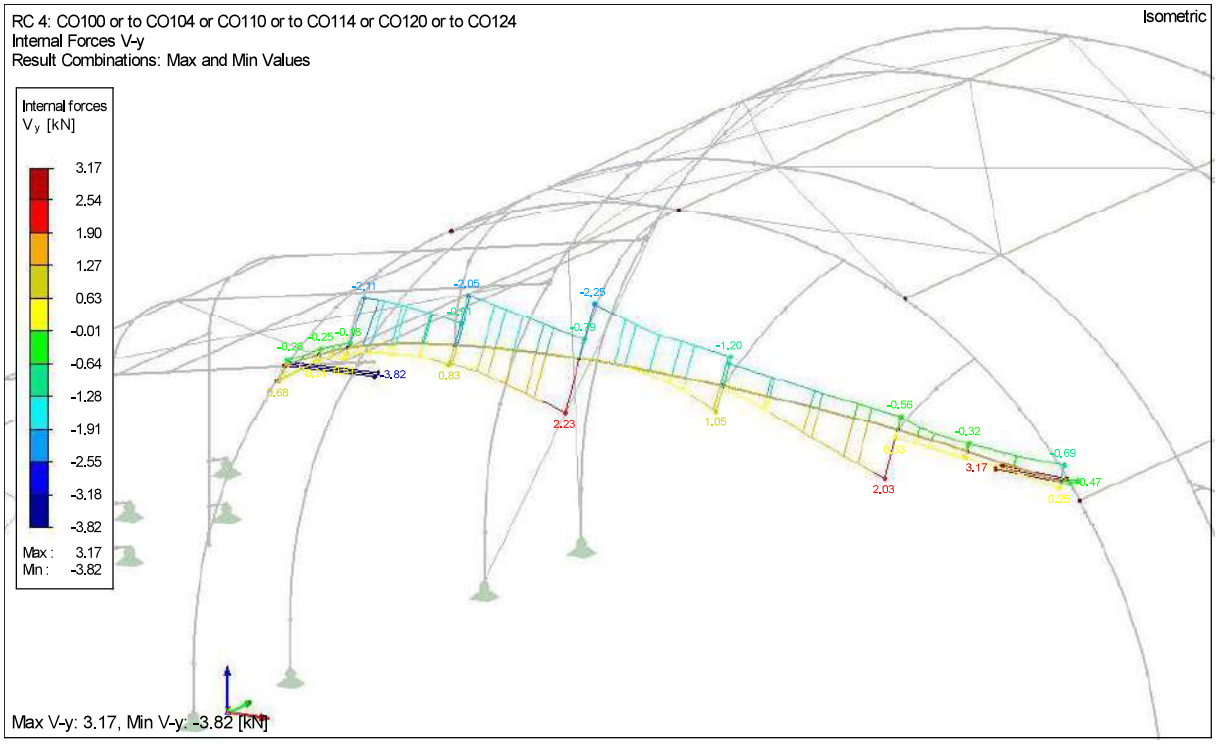
$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.333 * \sqrt{(1.47^2 + 1.58^2)}$
$V_{d,\ main\ chord} = 0.72$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 0.72 * 5$
$M_{d,\ main\ chord} = 3.59$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 2.15 / 3 + 2.63 / 0.239 + 2.69 / 0.207$
$N_{d,\ main\ chord} = 24.72$ kN

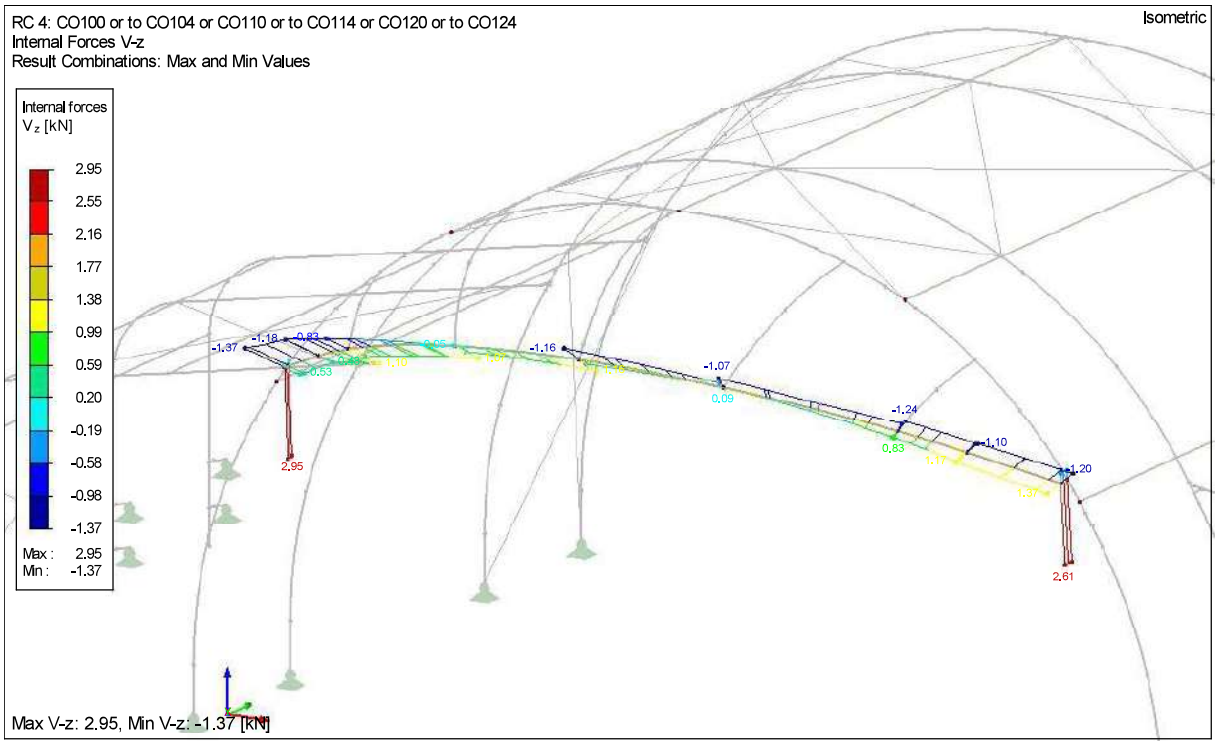
Check
According to information of the Protruss T31 truss the $N_{Rd,\ main\ chord} = 45.744$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

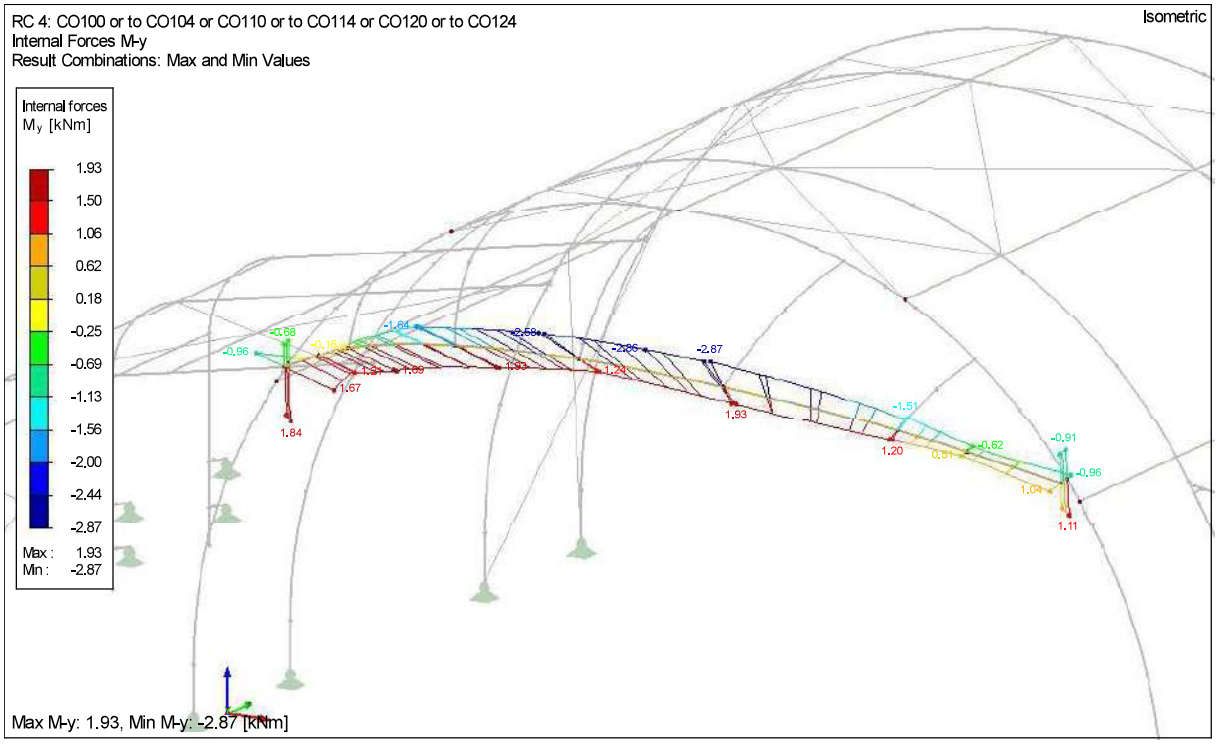
$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (24.72 / 45.744)^{1,3} + ((3.59 / 53.19)^{1.7})^{0.6} = 0.51 < 1$

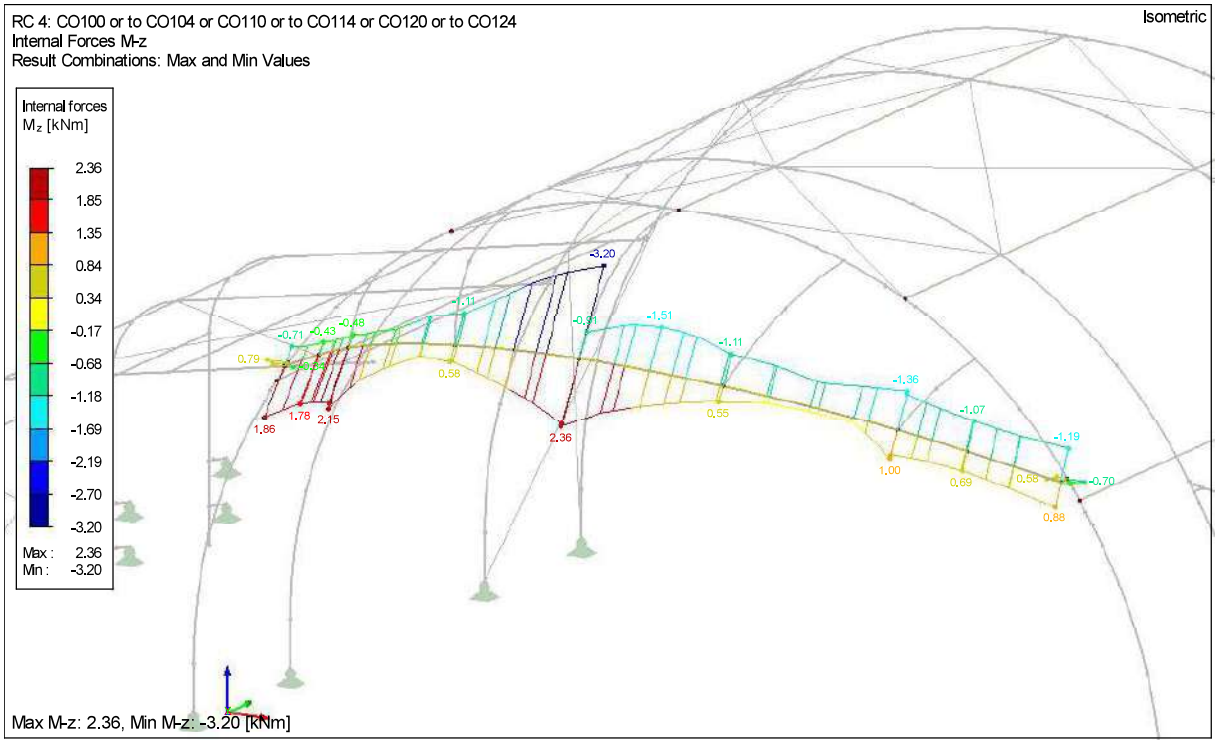
4.3.3 Internal forces T31 truss RC4 Design Values Out-service.






RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
2.95
2.55
2.16
1.77
1.38
0.99
0.59
0.20
-0.19
-0.58
-0.98
-1.37
Max : 2.95
Min : -1.37
Max V-z: 2.95, Min V-z: -1.37 [kN]


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
1.93
1.50
1.06
0.62
0.18
-0.25
-0.69
-1.13
-1.56
-2.00
-2.44
-2.87
Max : 1.93
Min : -2.87
Max M-y: 1.93, Min M-y: -2.87 [kNm]



4.3.4 Check of the Interaction of moment and transversal force with the RC4- Design values.

The check of the Interaction between the bending moment and the transversal force has been done with the maximum internal forces of RC4

Check of T31 truss arch

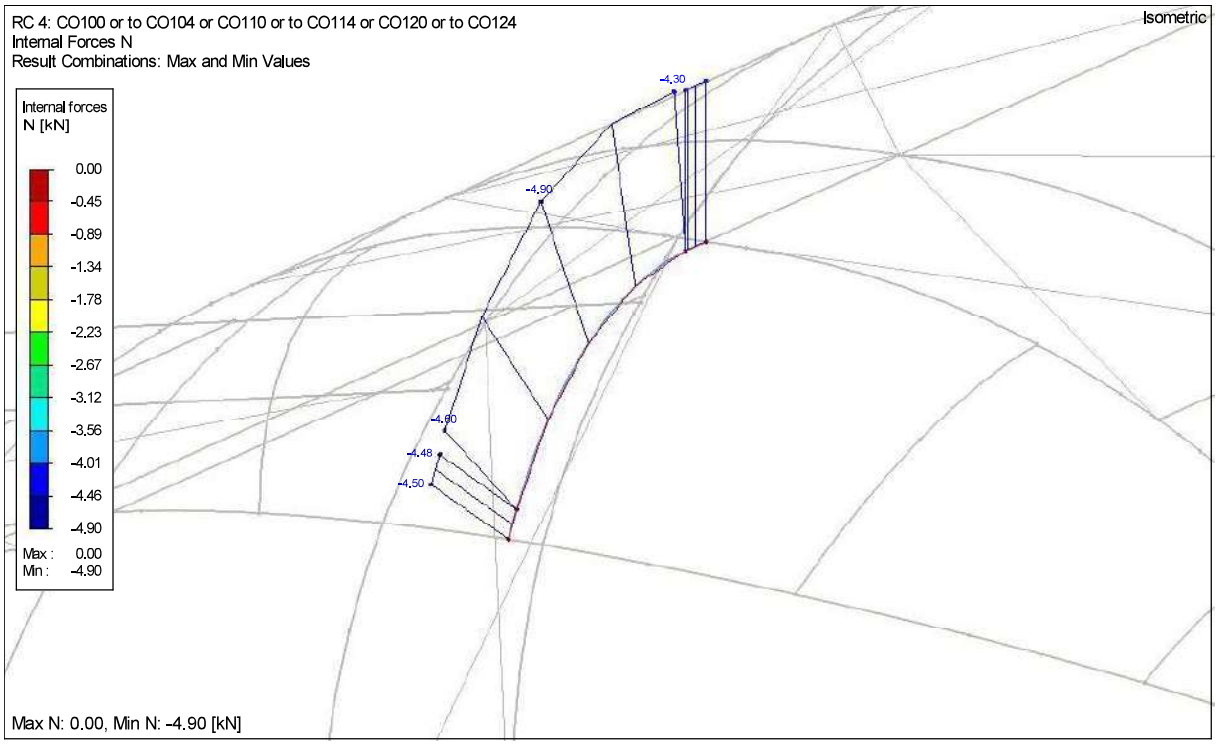
Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
RC4	6.42	-3.82	2.59	2.01	-2.87	-3.20

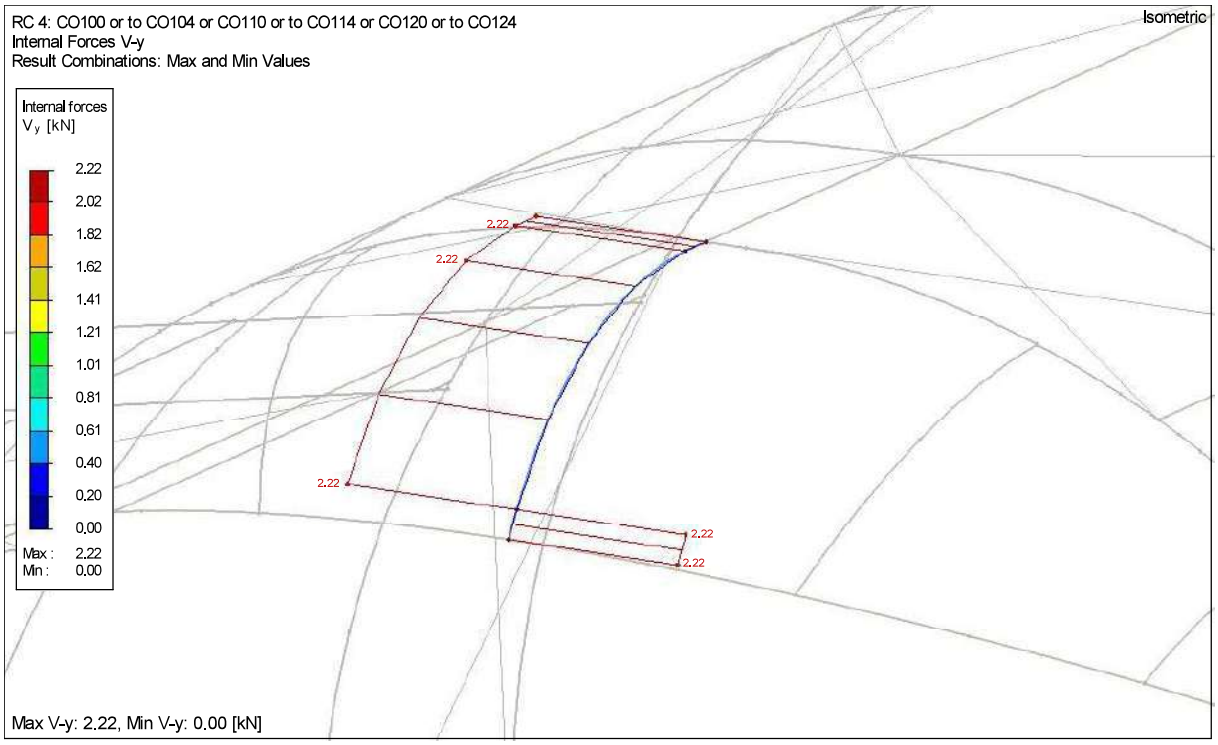
$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.333 * \sqrt{(3.82^2 + 2.59^2)}$
$V_{d,\ main\ chord} = 1.53$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 1.53 * 5$
$M_{d,\ main\ chord} = 7.69$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 6.42 / 3 + 2.87 / 0.239 + 3.20 / 0.207$
$N_{d,\ main\ chord} = 29.61$ kN

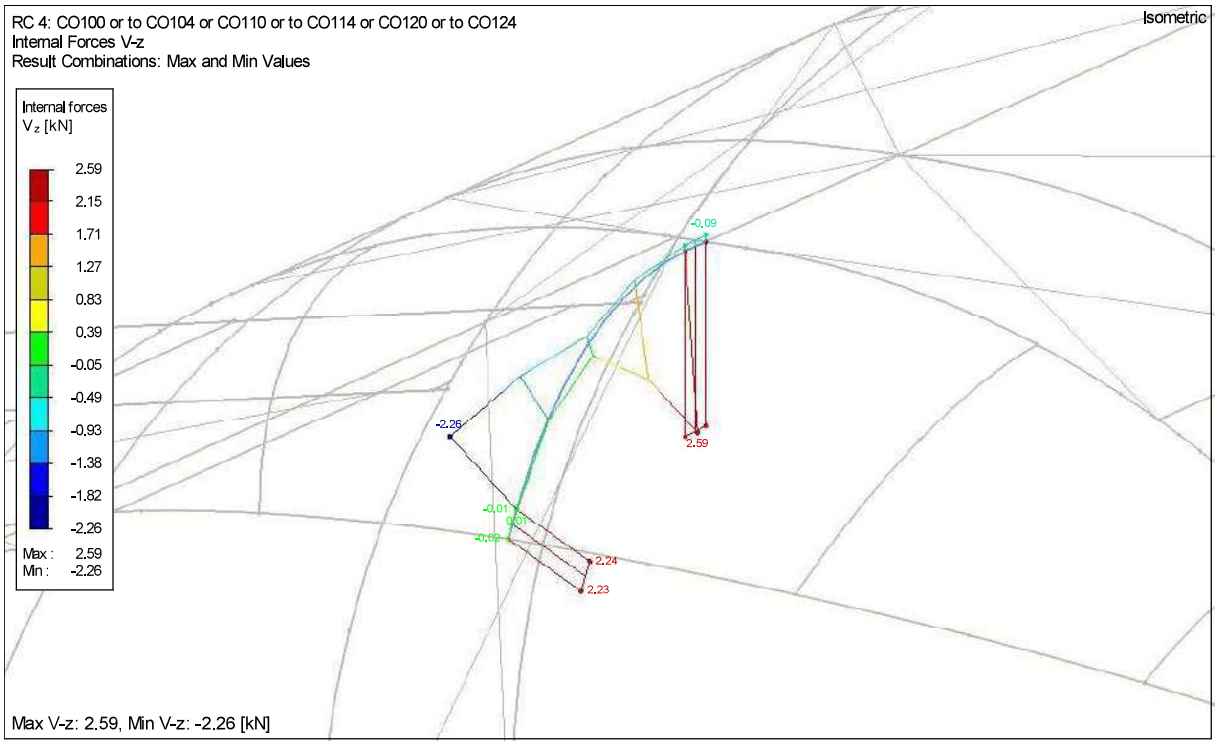
Check
According to information of the Protruss T31 truss the $N_{Rd,\ main\ chord} = 45.744$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

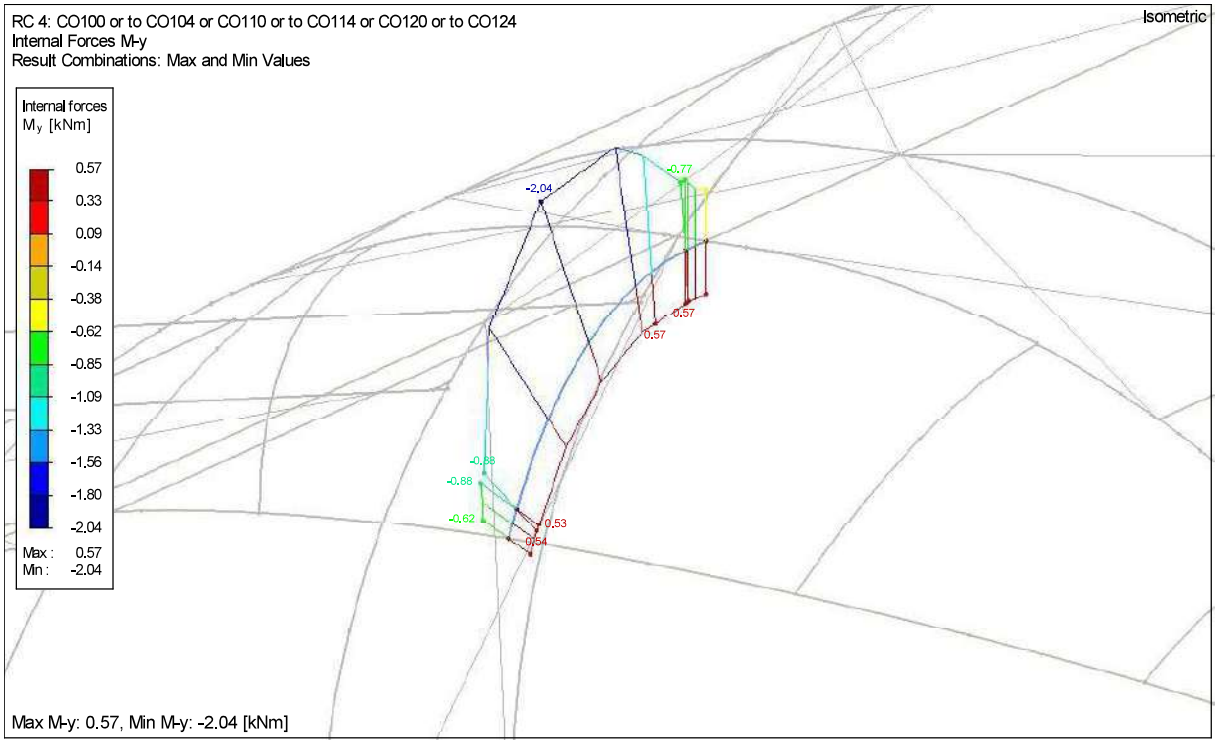
$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (29.61 / 45.744)^{1,3} + ((7.69 / 53.19)^{1.7})^{0.6} = 0.71 < 1$

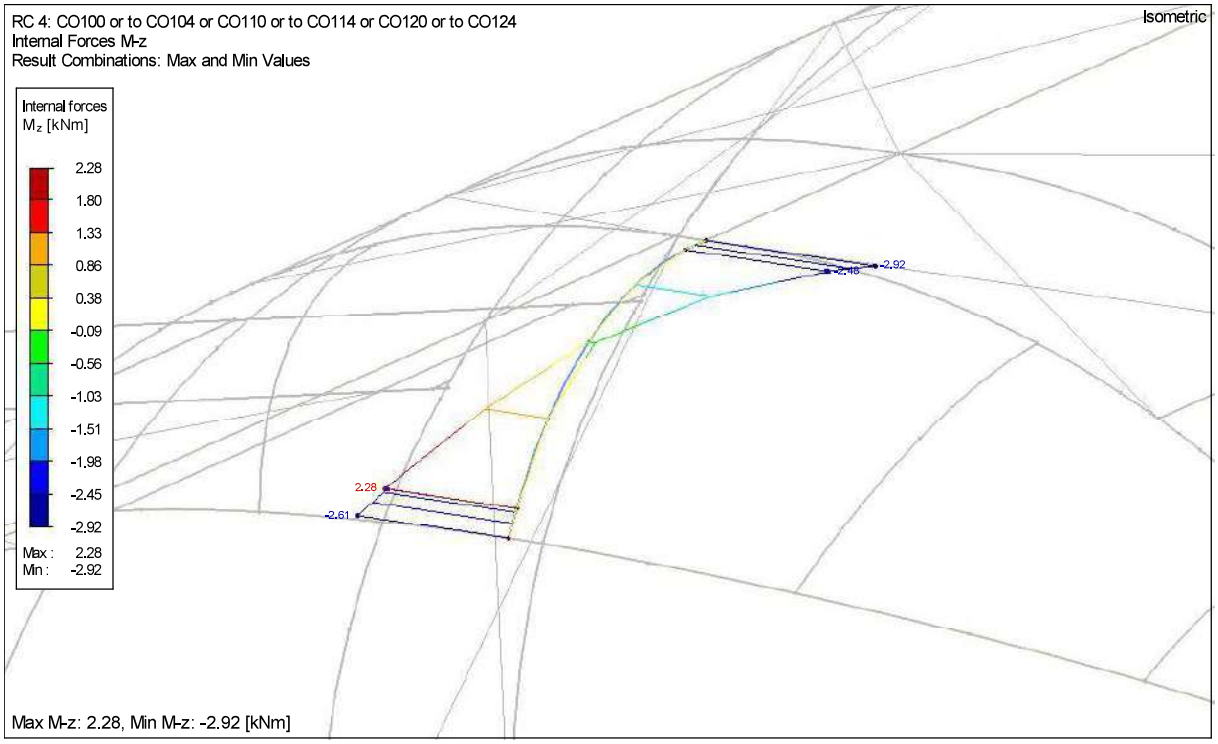
4.3.5 Internal forces S31 truss RC4 Design Values Out-service.






RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
2.59
2.15
1.71
1.27
0.83
0.39
-0.05
-0.49
-0.93
-1.38
-1.82
-2.26
Max : 2.59
Min : -2.26
-0.09
-2.26
2.59
-0.01
0.01
-0.02
2.24
2.23
Max V-z: 2.59, Min V-z: -2.26 [kN]


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
0.57
0.33
0.09
-0.14
-0.38
-0.62
-0.85
-1.09
-1.33
-1.56
-1.80
-2.04
Max : 0.57
Min : -2.04
-0.77
-2.04
0.57
0.57
-0.88
-0.88
-0.62
0.53
0.54
Max M-y: 0.57, Min M-y: -2.04 [kNm]



4.3.6 Check of the Interaction of moment and transversal force with the RC4- Design values.

The check of the Interaction between the bending moment and the transversal force has been done with the maximum internal forces of RC4

Check of S31 truss arch

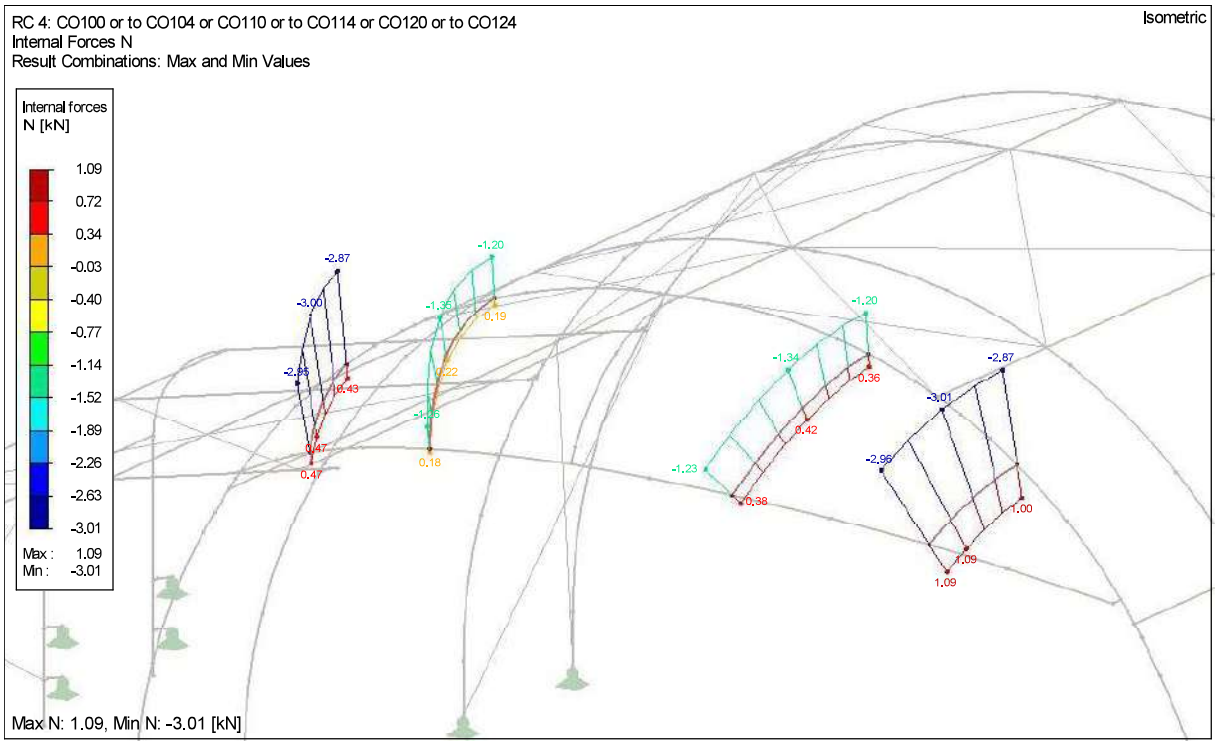
Normative	Forces [kN]			Moments [kNm]		
Load Combination	N	V_y	V_z	M_T	M_y	M_z
RC4	-4.90	2.22	2.59	-0,58	-2.04	-2.92

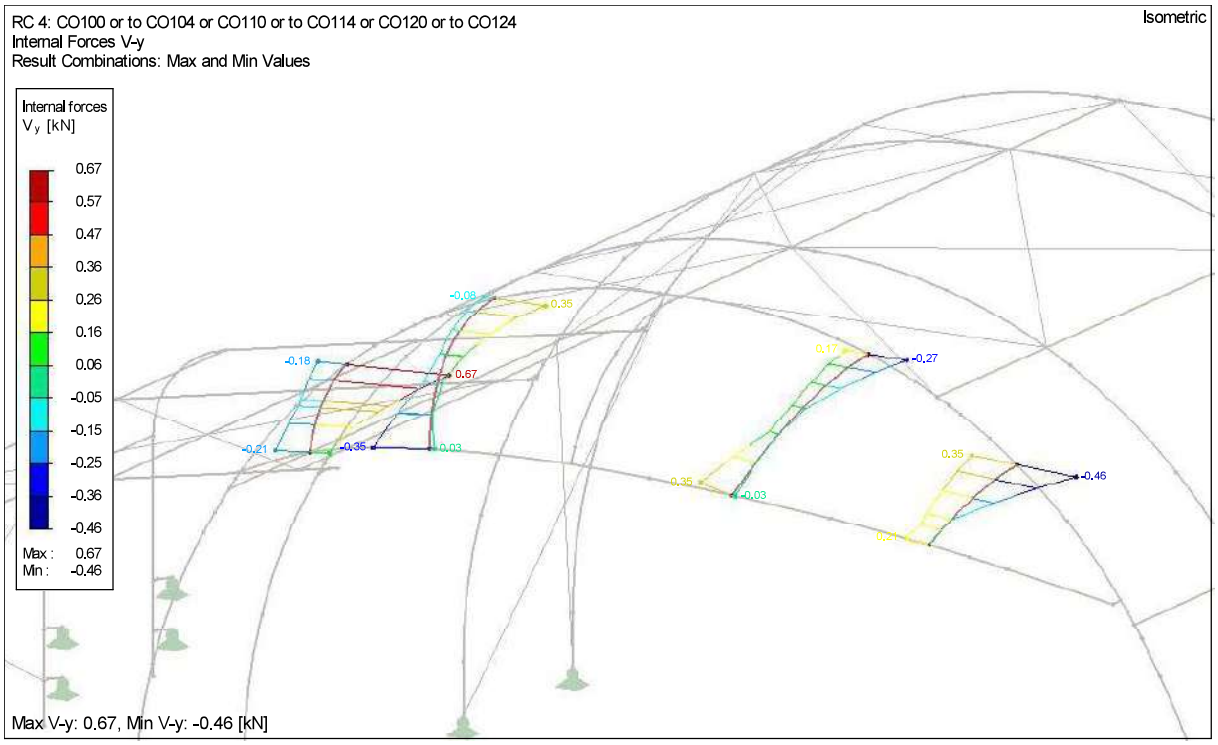
$V_{d,\ main\ chord} = 0.25 * \sqrt{(Vdy^2 + Vdz^2)} = 0.25 * \sqrt{(2.22^2 + 2.59^2)}$
$V_{d,\ main\ chord} = 0.85$ kN
$M_{d,\ main\ chord} = Vd,\ main\ chord * e = 0.85 * 5$
$M_{d,\ main\ chord} = 4.26$ kNcm
$N_{d,\ main\ chord} = Nd/4 + Mdy / 2 / h + Mdz / 2 / h$
$N_{d,\ main\ chord} = 4.90 / 4 + 2.04 / 2 / 0.239 + 2.92 / 2 / 0.239$
$N_{d,\ main\ chord} = 11.60$ kN

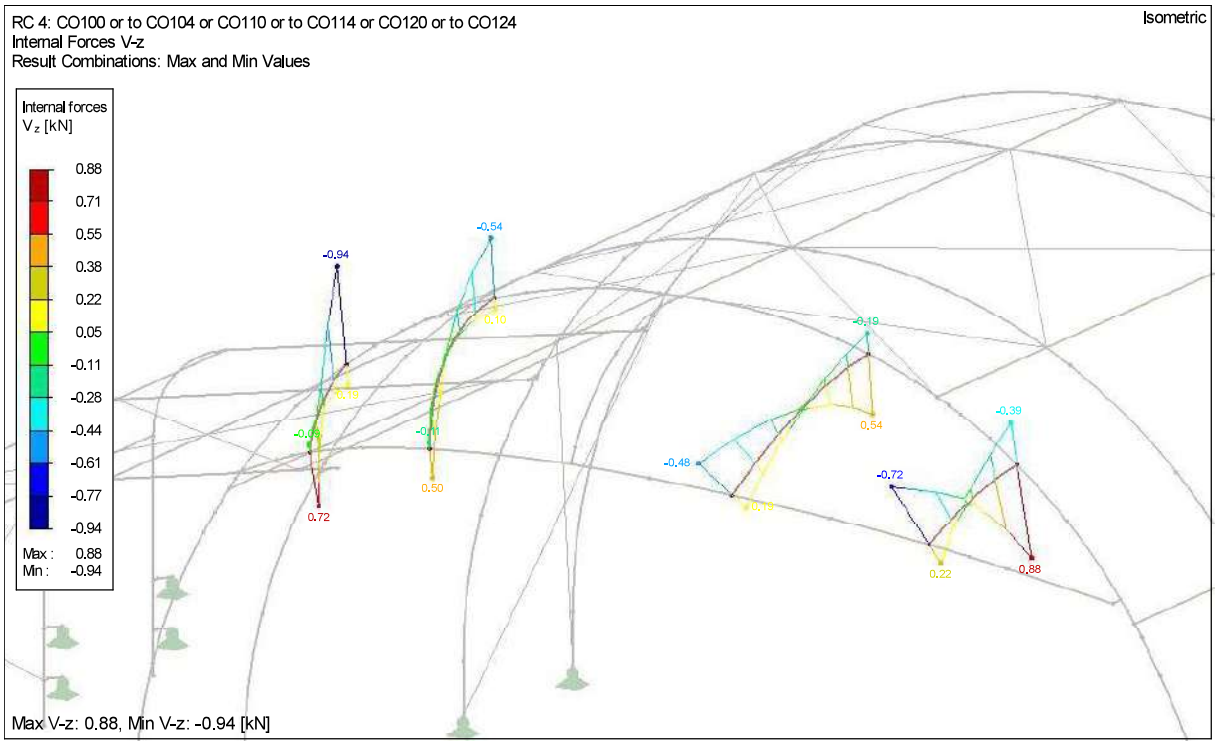
Check
According to information of the Protruss S31 truss the $N_{Rd,\ main\ chord} = 50.914$ kN and the $M_{Rd,\ main\ chord} = 53.19$ kNcm.

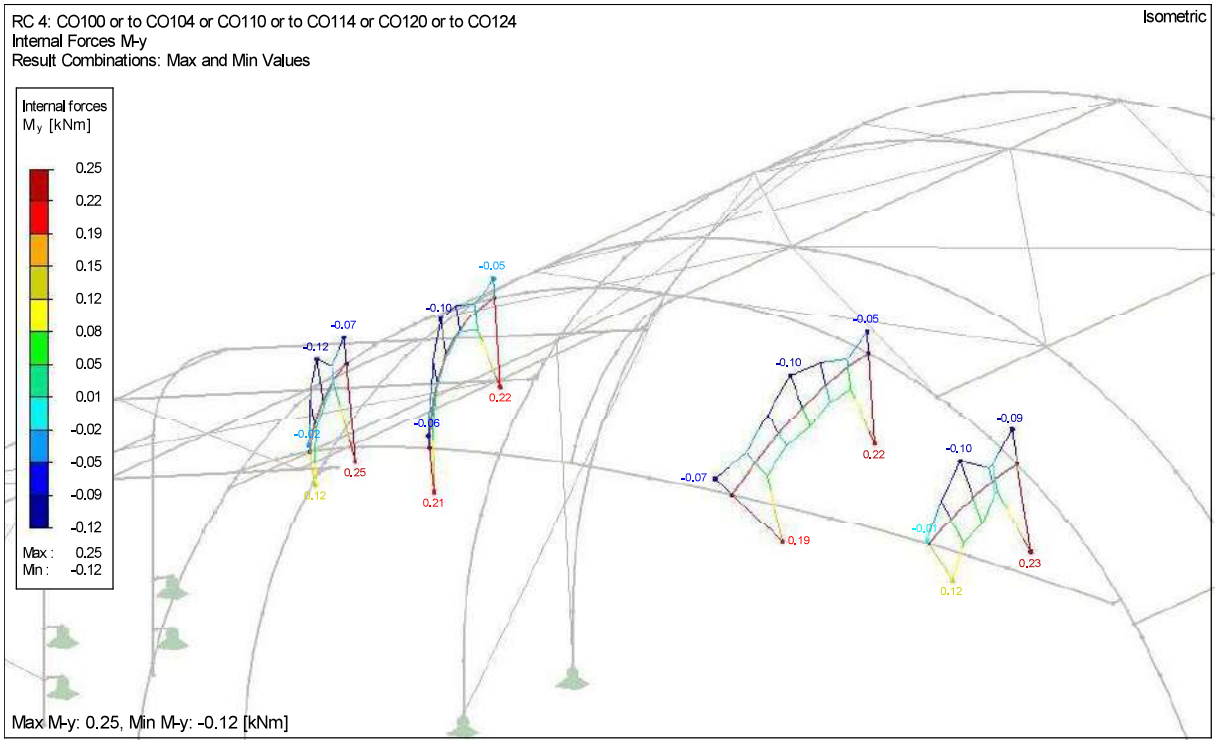
$\eta = (N_{d,\ main\ chord} / N_{Rd})^{1,3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (11.60 / 50.914)^{1,3} + ((4.26 / 53.19)^{1.7})^{0.6} = 0.22 < 1$

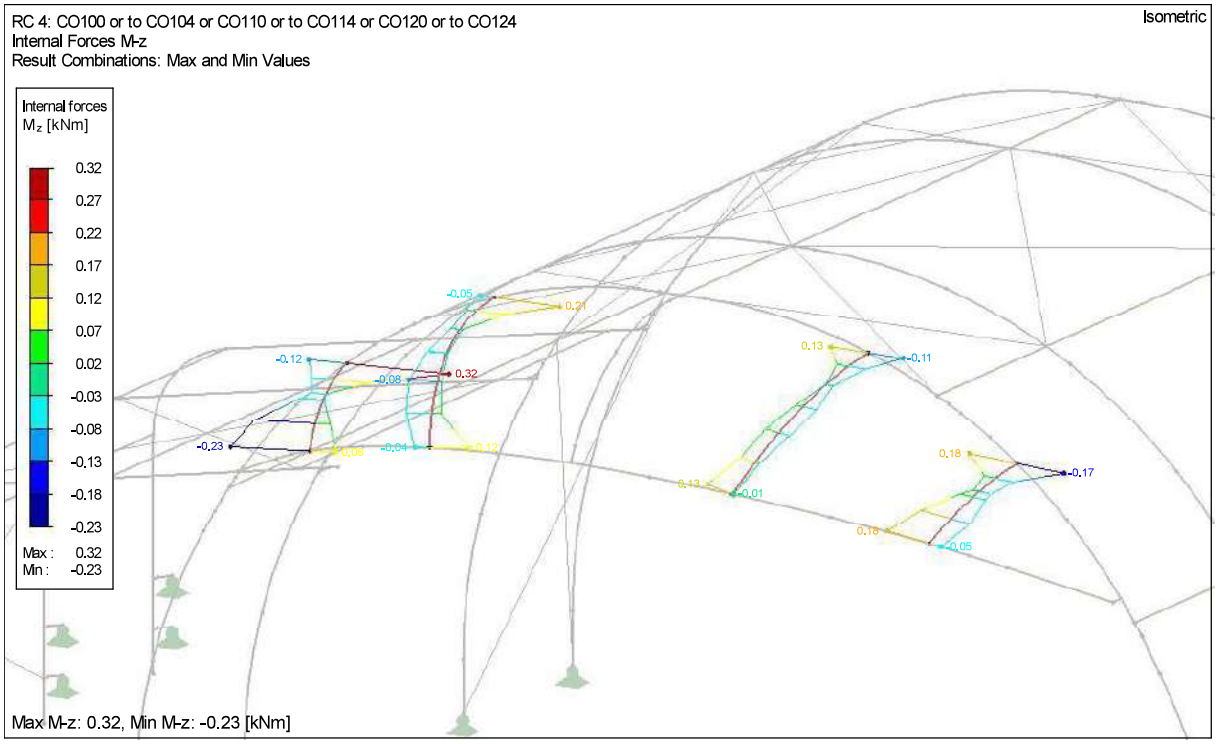
4.3.7 Internal forces 50x4 support tubes RC4 Design Values Out-service.






RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
0.88
0.71
0.55
0.38
0.22
0.05
-0.11
-0.28
-0.44
-0.61
-0.77
-0.94
Max : 0.88
Min : -0.94
Max V-z: 0.88, Min V-z: -0.94 [kN]


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
0.25
0.22
0.19
0.15
0.12
0.08
0.05
0.01
-0.02
-0.05
-0.09
-0.12
Max : 0.25
Min : -0.12
Max M-y: 0.25, Min M-y: -0.12 [kNm]



4.3.8 stress analyse for tube 50x4 with the Maximum values in RC4 Design values.

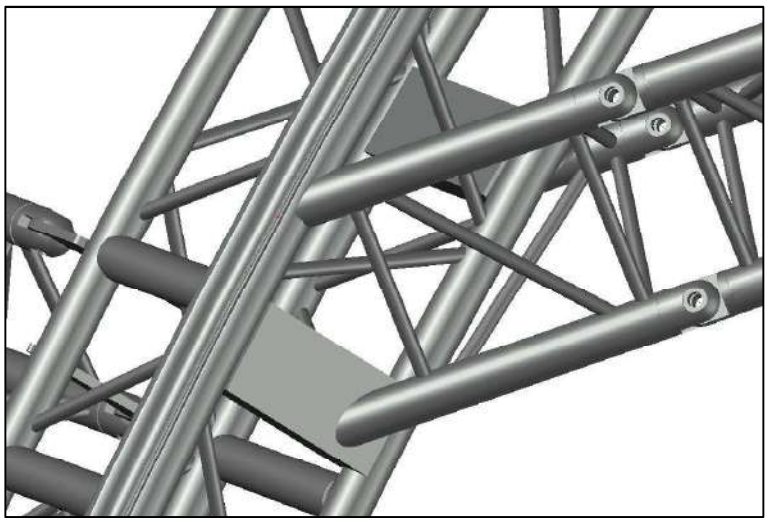
Round Tube 50x4 mm profile
Material EN-AW-6082 T6 $f_{y,haz} = 12.5$ kN/cm²

A = 5.78 cm
A_{shear} = 2.93 cm
I = 15.41 cm^4
W = 6.16 cm^4

$N_{ed,\,max}$ = 3.01 kN
$V_{y,\,ed\,max}$ = 0.67 kN
$V_{z,\,ed\,max}$ = 0.94 kN
$M_{y,\,ed\,max}$ = 0.25 kNm
$M_{z,\,ed\,max}$ = 0.32 kNm

Calculation
$\sigma_n = N_{ed,\,max} / A = 3.01 / 5.78 = 0.52$ kN/cm²
$\sigma_{vy} = V_{y,\,ed\,max} / A_{shear} = 0.67 / 2.93 = 0.22$ kN/cm²
$\sigma_{vz} = V_{z,\,ed\,max} / A_{shear} = 0.94 / 2.93 = 0.32$ kN/cm²
$\sigma_{my} = M_{y,\,ed\,max} / (W) = 25 / 6.16 = 4.06$ kN/cm²
$\sigma_{mz} = M_{z,\,ed\,max} / (W) = 32 / 6.16 = 5.19$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.52 + 4.06 + 5.19)^2 + 3*(0.22 + 0.32)^2)}$
σ_{tot} =9.81 kN/cm²
check $\sigma_{tot} / (f_{y,haz} / \gamma_m) < 1$
$9.81 / (12.5 / 1.25) = 0.98 < 1$

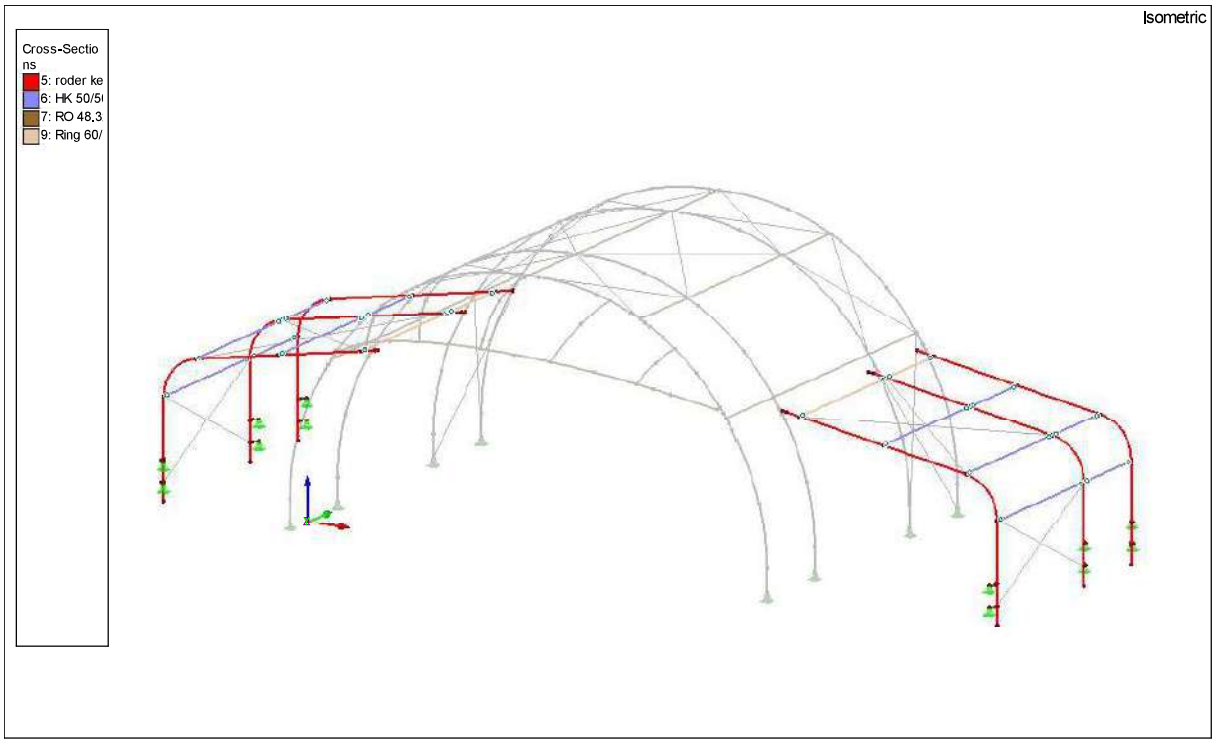
4.3.9 Attachment of the cantilever to the main arch.



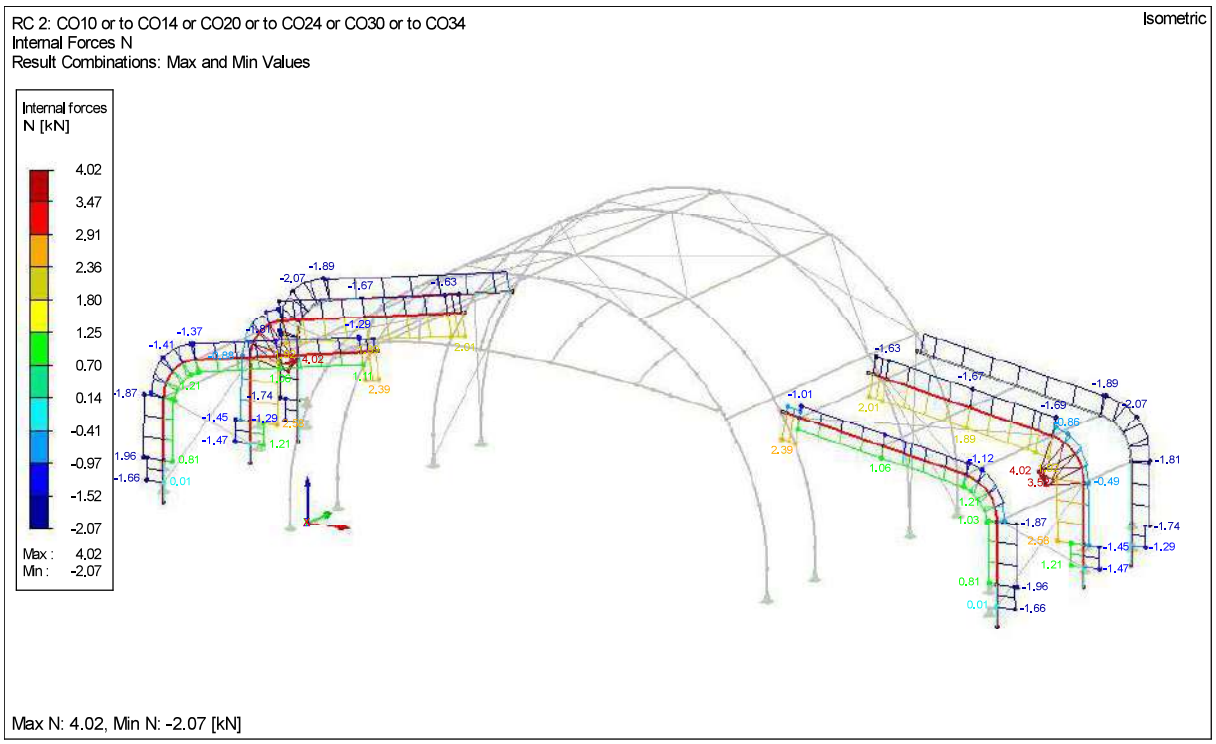
A short piece of truss is welded on 2 pieces of 100x50x4 rectangular profile which are welded into the main arch. The third main tube is welded to the main tube of the arch.

Maximum utilisation of the T31 truss 71% which occurs in the middle of the arch no further proof necessary.

4.4 Detail check of the side stage areas.

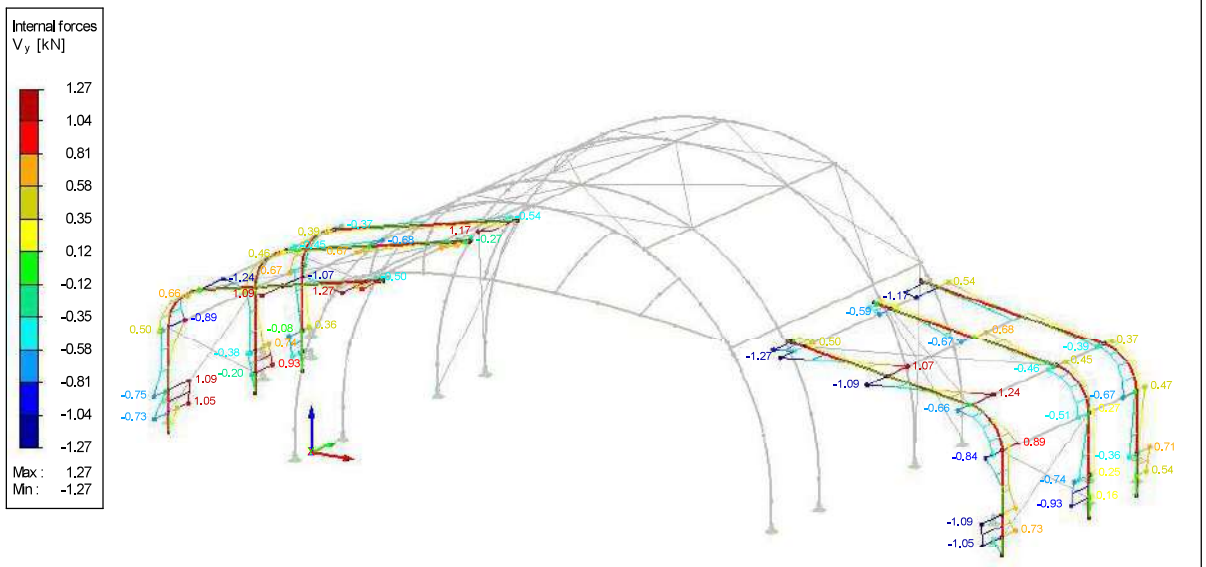


4.4.1 Internal forces of the keder profiles in RC2 Design Values In-service.



RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-y
Result Combinations: Max and Min Values

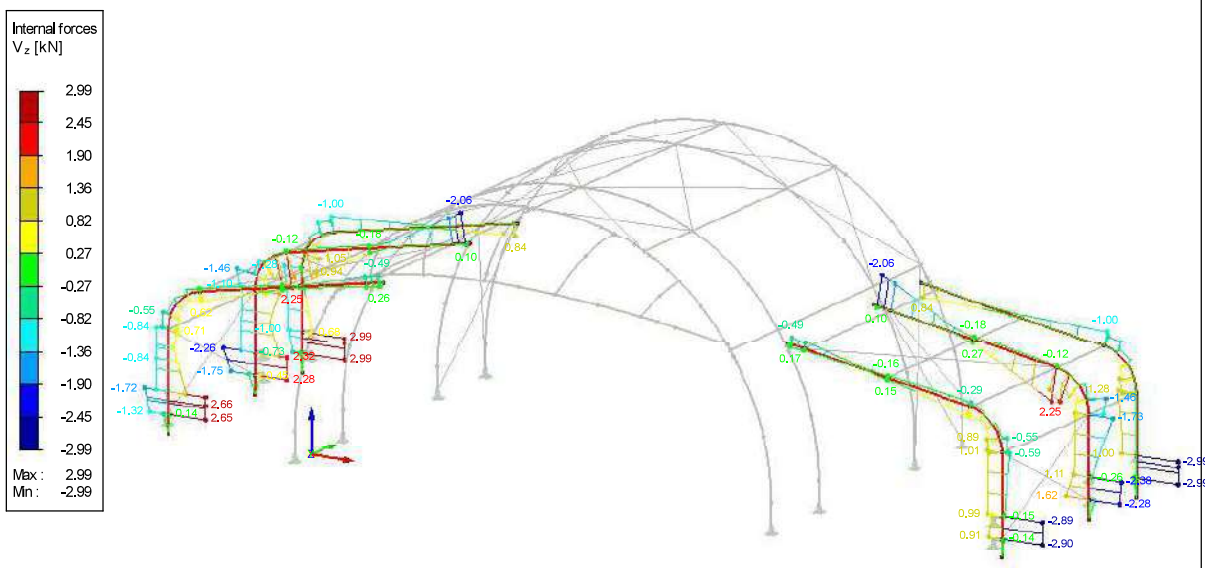
Isometric



Max V-y: 1.27, Min V-y: -1.27 [kN]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces V-z
Result Combinations: Max and Min Values

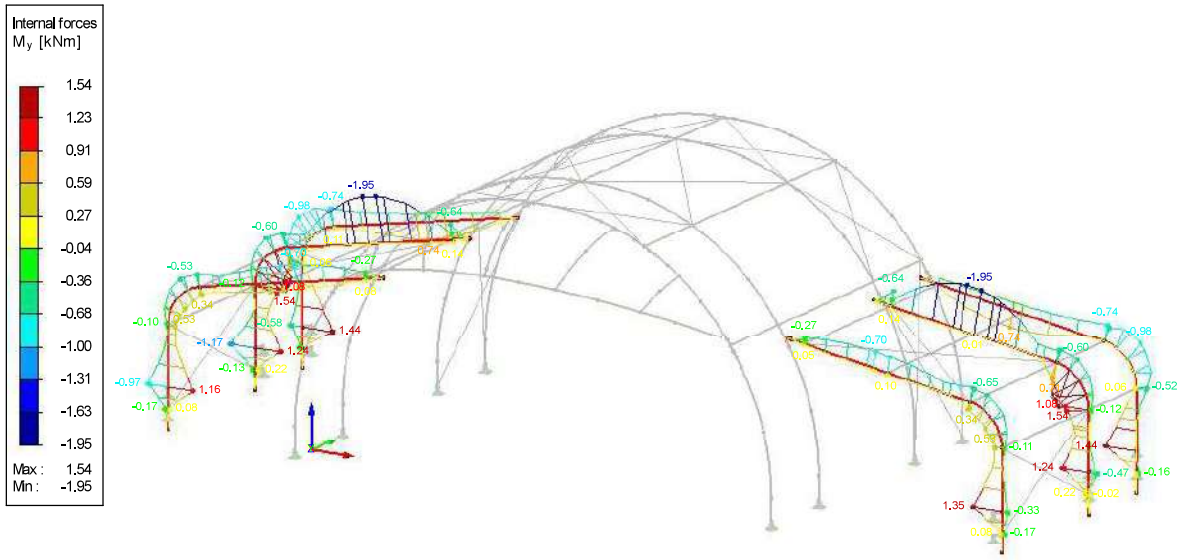
Isometric



Max V-z: 2.99, Min V-z: -2.99 [kN]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-y
Result Combinations: Max and Min Values

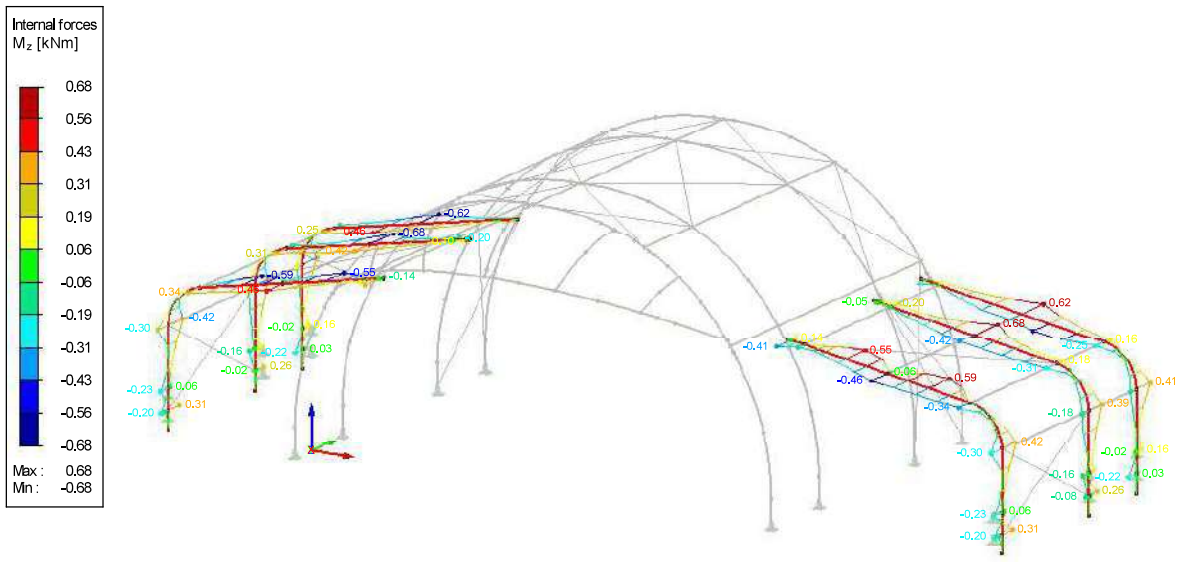
Isometric



Max M-y: 1.54, Min M-y: -1.95 [kNm]

RC 2: CO10 or to CO14 or CO20 or to CO24 or CO30 or to CO34
Internal Forces M-z
Result Combinations: Max and Min Values

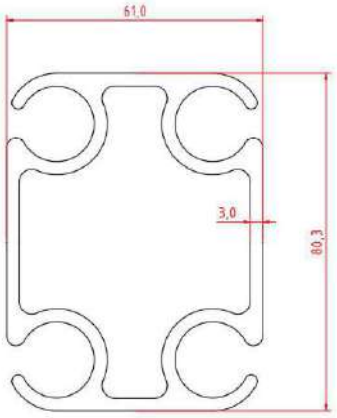
Isometric



Max M-z: 0.68, Min M-z: -0.68 [kNm]

4.4.2 Check of the keder profiles with the RC2- Design values.

Stress calculation for the keder profiles



keder profile 80x61x3	
I_1 [mm^4]	934003
I_2 [mm^4]	497649
S_c [mm]	40.14
S_t [mm]	40.14
A [mm^2]	1194.632

Keder Profile 80x61x3
Material = EN-AW-6061 T6
f_o = 24 kN/cm²

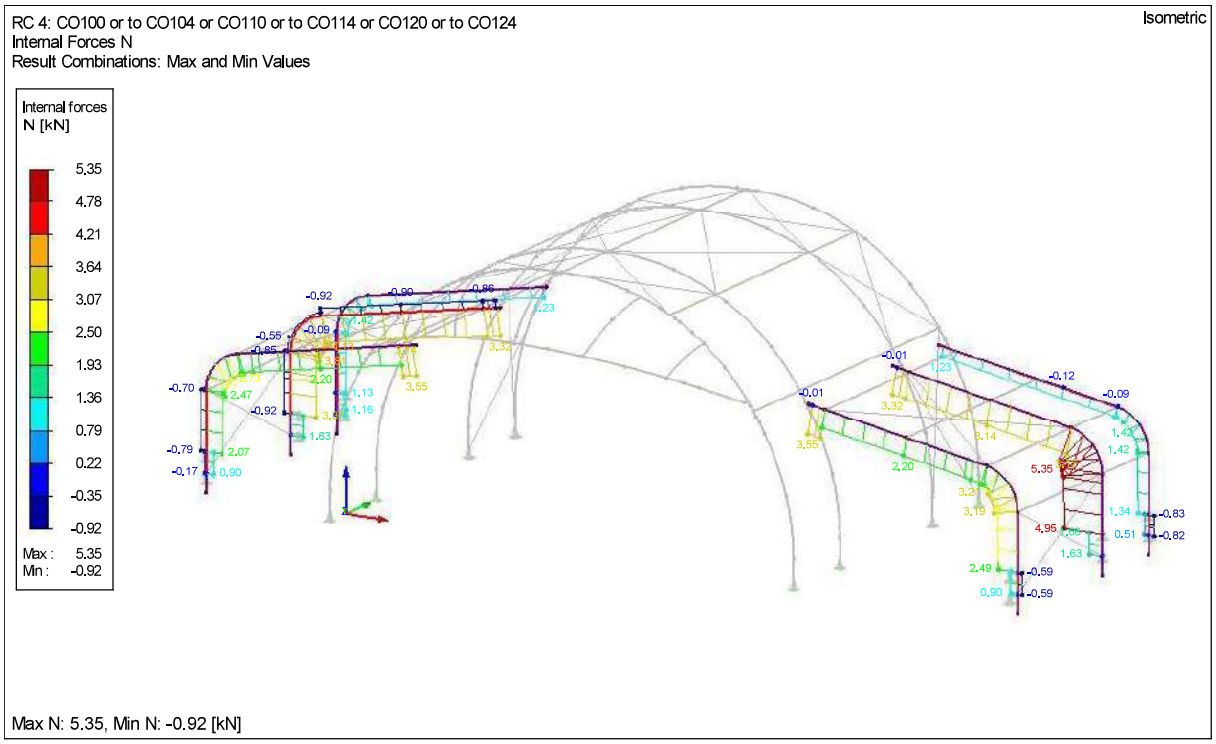
The stress analyse has been done with the maximum values from RC2

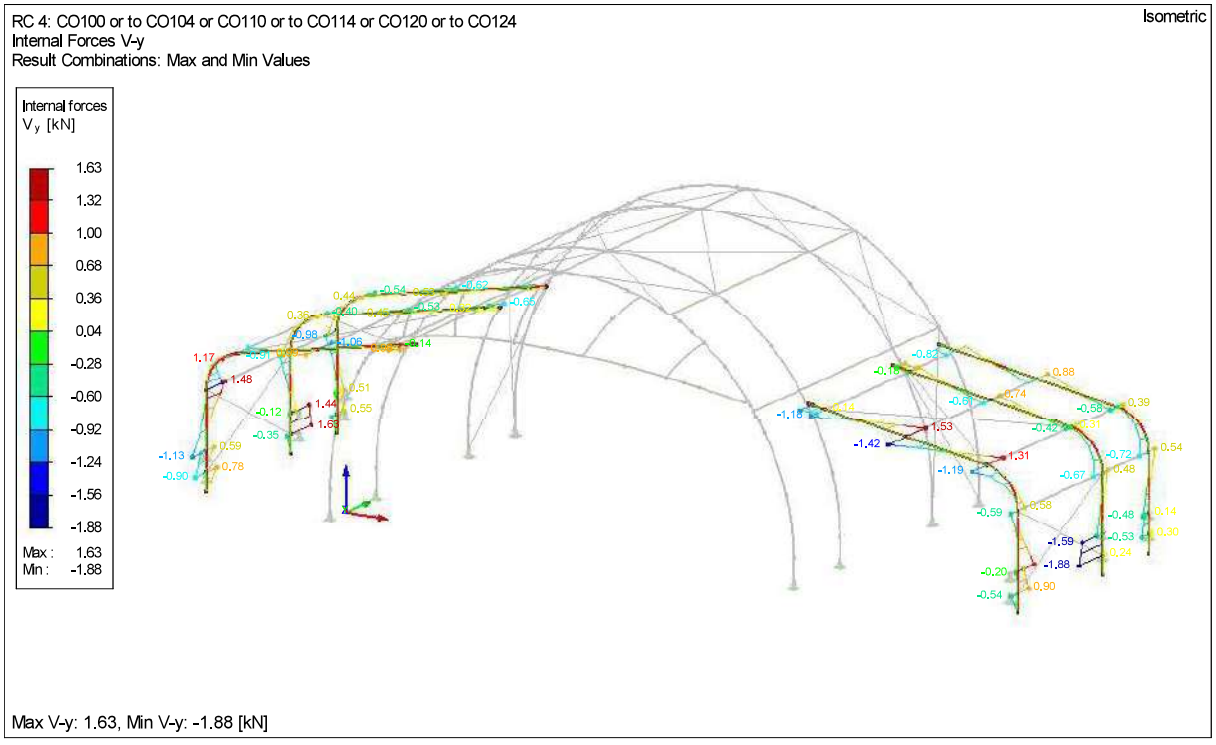
$N_{ed,\ max}$ = 4.02 kN
$V_{y,\ ed\ max}$ = 1.27 kN
$Vz_{,\ ed\ max}$ = 2.99 kN
$M_{y,\ ed\ max}$ = 1.95 kNm
$M_{z,\ ed\ max}$ = 0.68 kNm

Calculation
$\sigma_n = N_{ed,\ max} / A = 4.02 / 11.94 = 0.433$ kN/cm²
$\sigma_{vy} = V_{y,\ ed\ max} / A = 1.27 / 11.94 = 0.137$ kN/cm²
$\sigma_{vz} = V_{z,\ ed\ max} / A = 2.99 / 11.94 = 0.322$ kN/cm²
$\sigma_{my} = M_{y,\ ed\ max} / (I_y / e) = 195 / (93.4 / 4) = 8.357$ kN/cm²
$\sigma_{mz} = M_{z,\ ed\ max} / (I_z / e) = 68 / (49.8 / 3) = 4.089$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.433 + 8.357 + 4.089)^2 + 3 * (0.137 + 0.322)^2)}$
σ_{tot} =13.15 kN/cm²

check $\sigma_{tot} / (f_0 / \gamma_m) < 1$
$13.15 / (24 / 1.1) = 0.60 < 1$

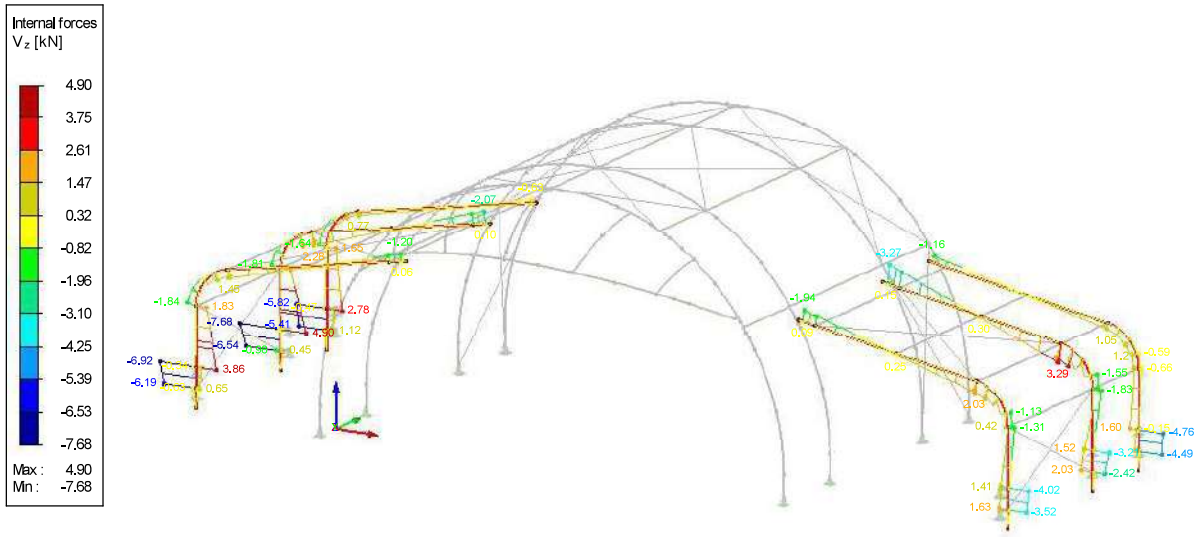
4.4.3 Internal forces of the keder profiles in RC4 Design Values Out-service.





RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

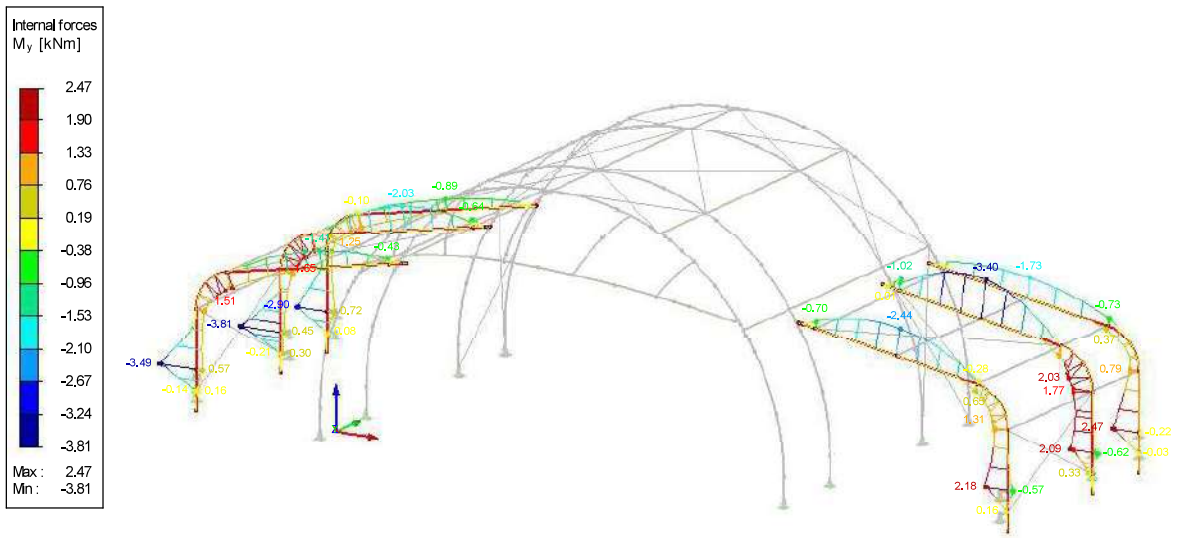
Isometric



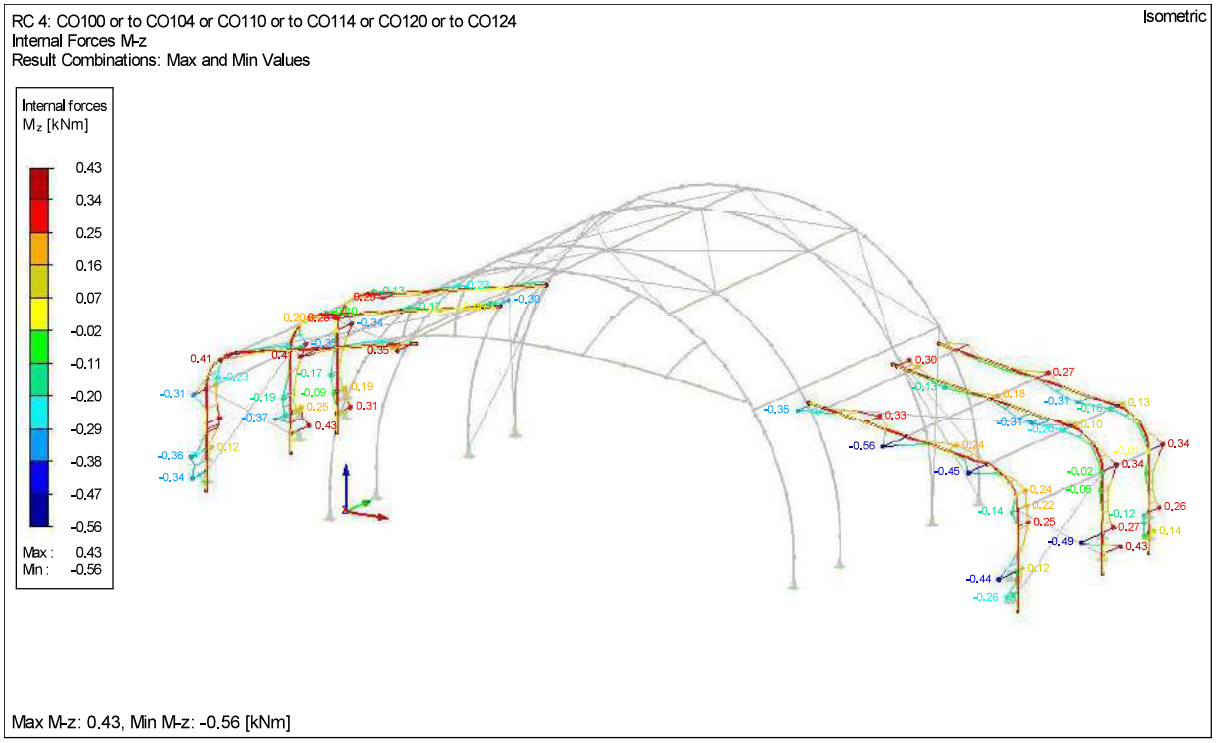
Max V-z: 4.90, Min V-z: -7.68 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

Isometric

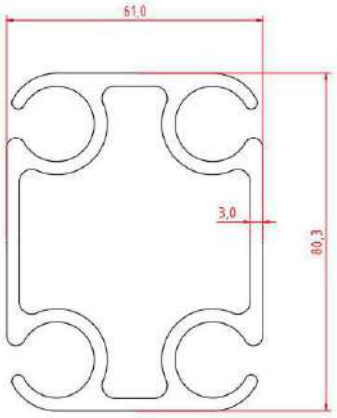


Max M-y: 2.47, Min M-y: -3.81 [kNm]


RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
0.43
0.34
0.25
0.16
0.07
-0.02
-0.11
-0.20
-0.29
-0.38
-0.47
-0.56
Max : 0.43
Min : -0.56
Max M-z: 0.43, Min M-z: -0.56 [kNm]

4.4.4 Check of the keder profiles with the RC4- Design values.

Stress calculation for the keder profiles



keder profile 80x61x3	
I_1 [mm^4]	934003
I_2 [mm^4]	497649
S_c [mm]	40.14
S_t [mm]	40.14
A [mm^2]	1194.632

Keder Profile 80x61x3
Material = EN-AW-6061 T6
f_o = 24 kN/cm²

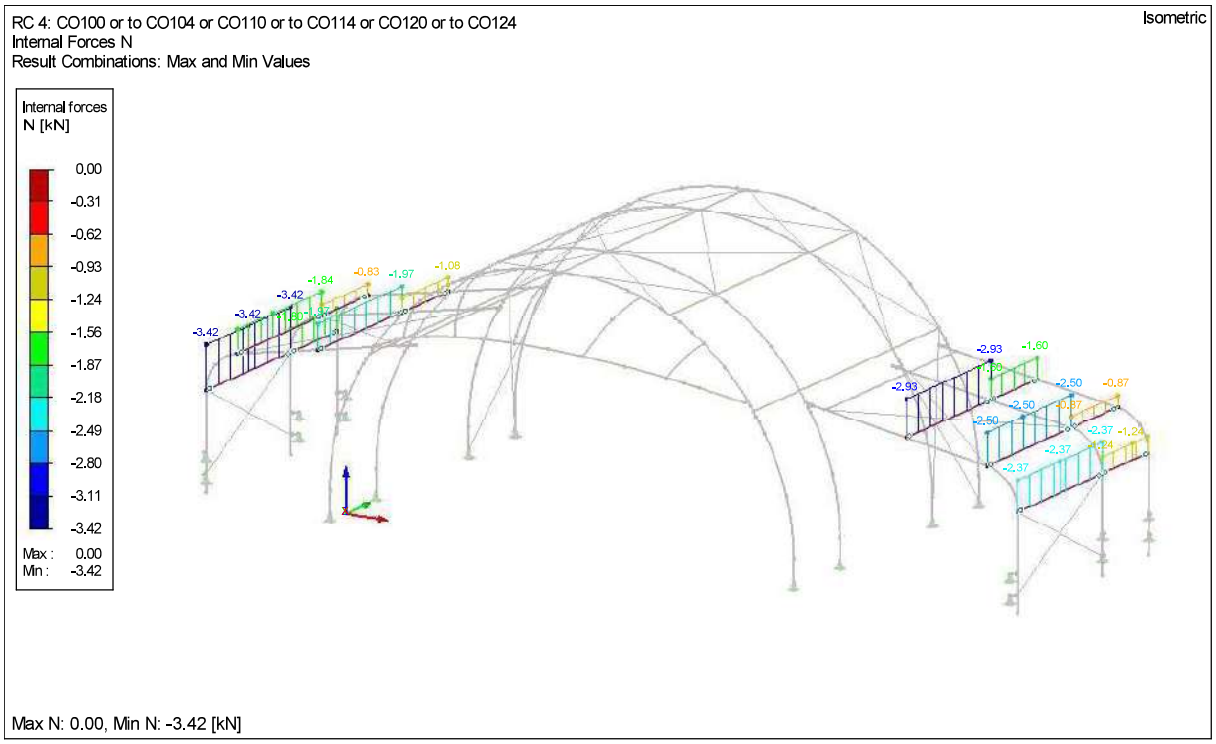
The stress analyse has been done with the maximum values from RC4

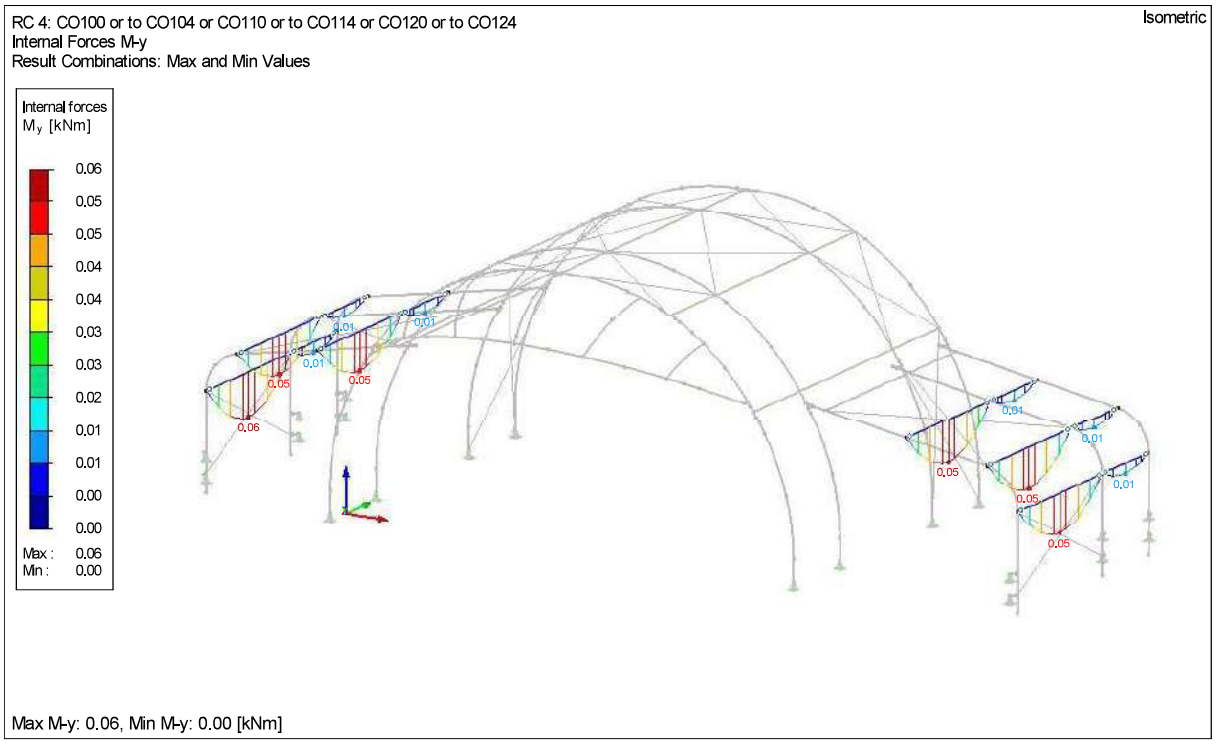
$N_{ed, max}$ = 5.35 kN
$V_{y, ed\ max}$ = 1.88 kN
$Vz_{, ed\ max}$ = 7.68 kN
$M_{y, ed\ max}$ = 3.81 kNm
$M_{z, ed\ max}$ = 0.56 kNm

Calculation
$\sigma_n = N_{ed, max} / A = 5.35 / 11.94 = 0.576$ kN/cm²
$\sigma_{vy} = V_{y, ed\ max} / A = 1.88 / 11.94 = 0.203$ kN/cm²
$\sigma_{vz} = V_{z, ed\ max} / A = 7.68 / 11.94 = 0.827$ kN/cm²
$\sigma_{my} = M_{y, ed\ max} / (I_y / e) = 381 / (93.4 / 4) = 16.329$ kN/cm²
$\sigma_{mz} = M_{z, ed\ max} / (I_z / e) = 56 / (49.8 / 3) = 3.367$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.576 + 16.329 + 3.367)^2 + 3 * (0.203 + 0.827)^2)}$
σ_{tot} =20.35 kN/cm²

check $\sigma_{tot} / (f_0 / \gamma_m) < 1$
$20.35 / (24 / 1.1) = 0.93 < 1$

4.4.5 Internal forces of the square profiles in RC4 Design Values Out-service.

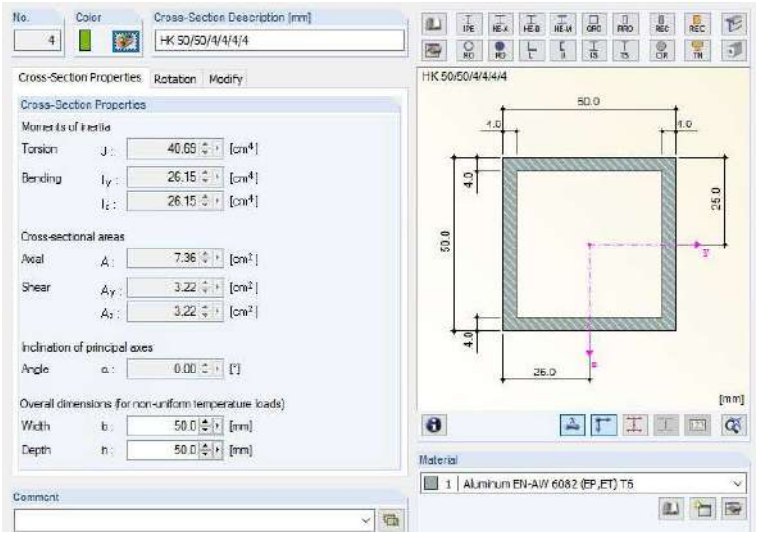




4.4.6 Check of the square profiles with the maximum RC4 Design Values Out-service.

Decisive result combination RC4 Design Values Out-service situation

Profile information pressure bar.



Buckling calculation

N = 3.42 kN
M_y ~ 0 kNm
M_z = 0 kNm

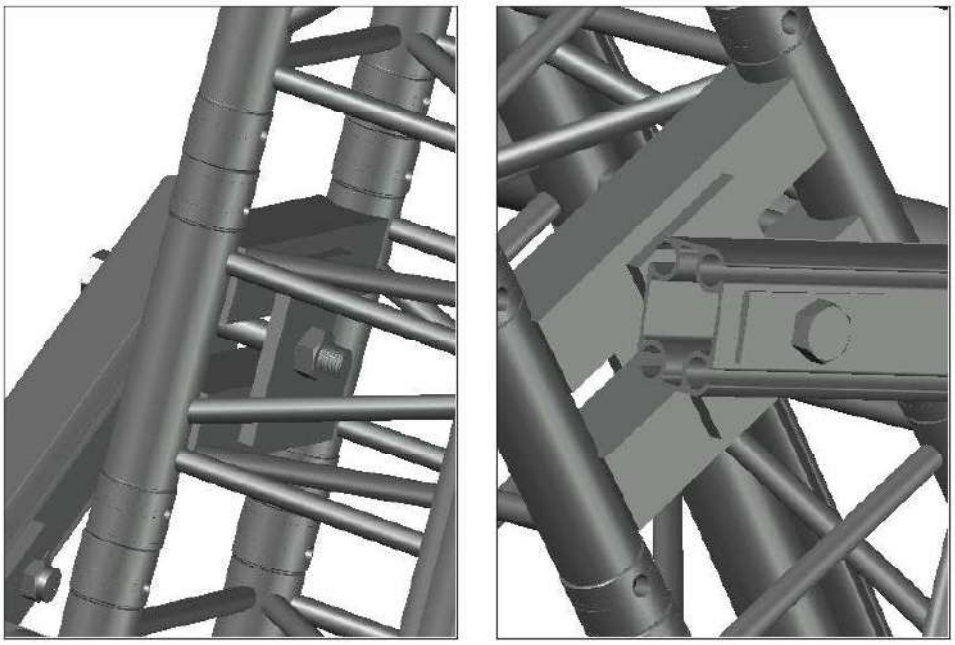
Buckling length factor K = 1.50
The factor K is according to table 6,8 NEN-EN 1999-1-1
L = 377 cm
L_{cr} = 1.5 * 377 = 565.50
$I_y = \sqrt{(I_y / A)} = \sqrt{(10.46 / 7.36)} = 1.89$
$\lambda_z = L_{cr} / (i_z * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$
$\lambda_z = 565.50 / (1.89 * \pi) * \sqrt{((7.36 * 25) / (7.36 * 7000))} = 5.71$
$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$
$\Theta_z = 0.5 * (1 + 0.2 * (5.71 - 0.10) + 1.55^2) = 17.36$
$X_z = 1 / (\Theta_z + \sqrt{(\Theta_z^2 - \lambda_z^2)})$
$X_z = 1 / (17.36 + \sqrt{(17.36^2 - 5.71^2)}) = 0.03$

$N_{b,RD} = X_z * A * f_0 / 1.1 = 0.03 * 7.36 * 25 / 1.1 = 4.96$ kN

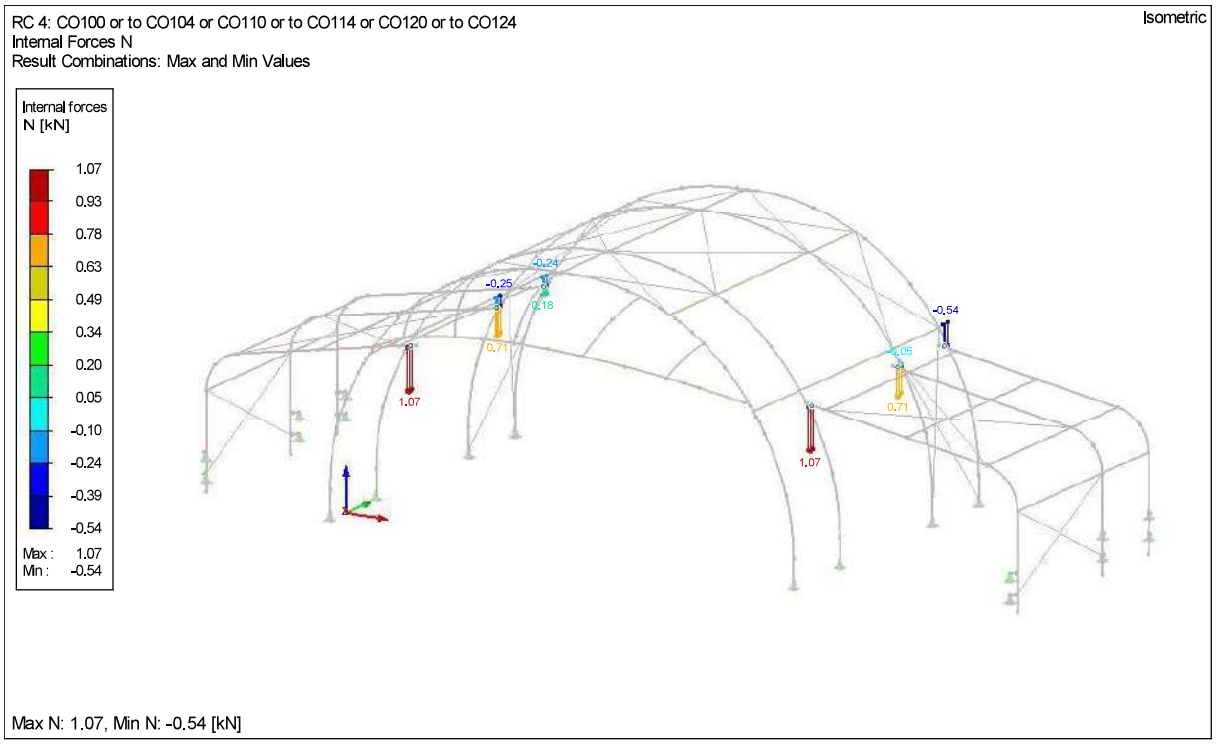
$N / N_{b,RD} < 1$
$3.42 / 4.96 = 0.69 < 1$

4.4.7 Check of the side stage attachment to the main roof.

The connection between the side stage area profiles and the main arches is made by M20 bolts. The bolt is going through the keder profile which is reinforced by two pieces of flat material 40x5 and two pieces of flat material 80x10 which are welded in the 25-meter S31 truss piece of the main arch. The M20 bolt is class 8.8 and the pieces of flat material are EN-AW-6082 T6.

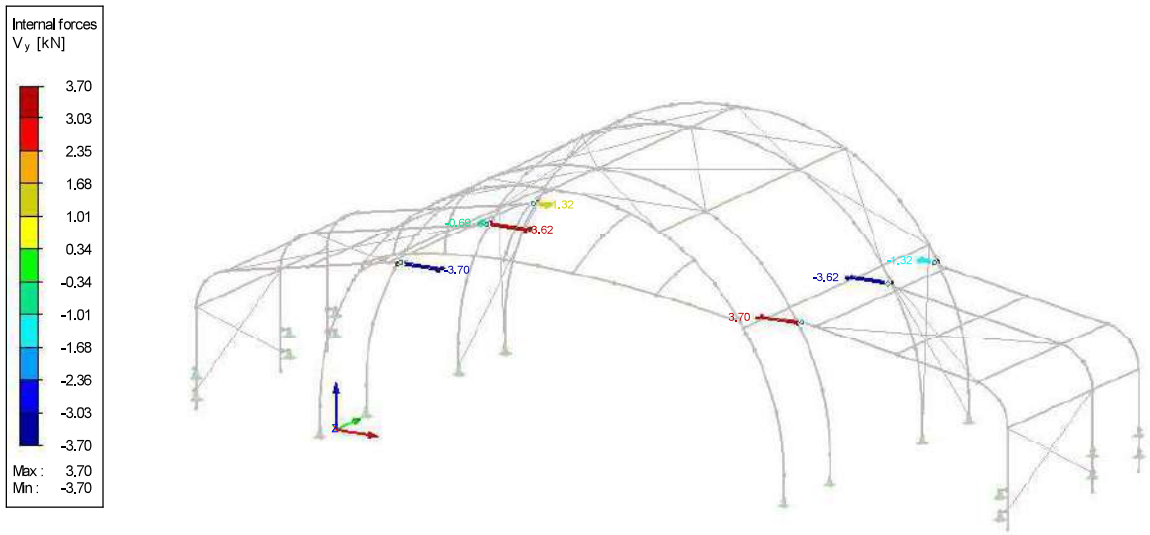


Internal forces of the decisive result combination RC4 design values Out-service



RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

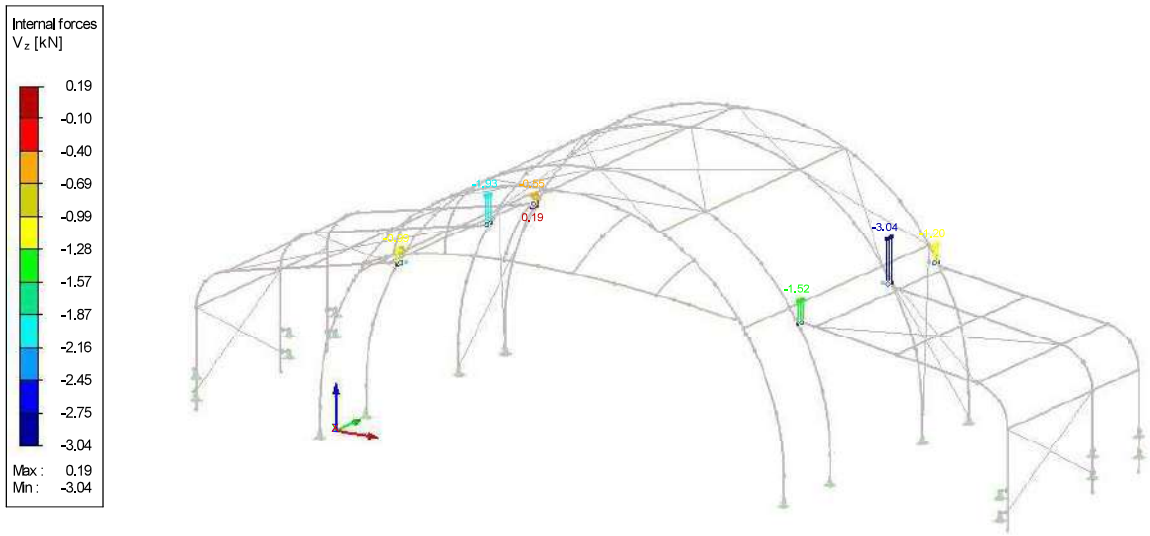
Isometric



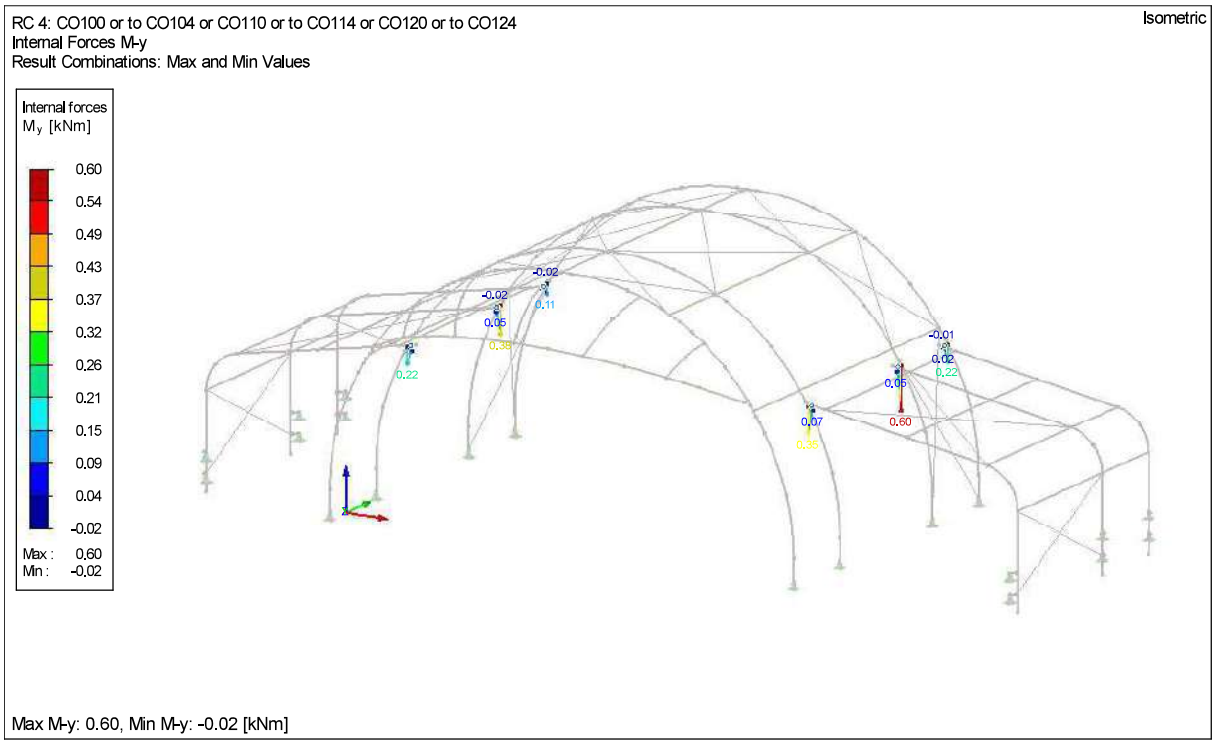
Max V-y: 3.70, Min V-y: -3.70 [kN]

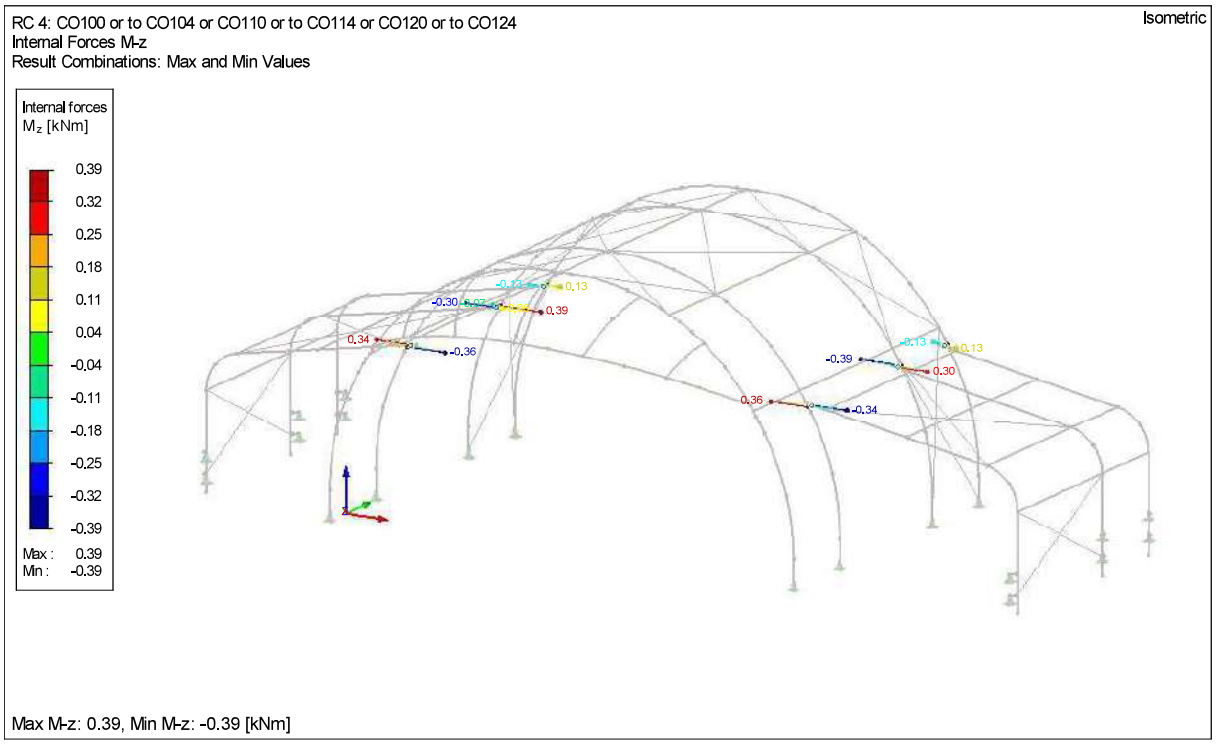
RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

Isometric



Max V-z: 0.19, Min V-z: -3.04 [kN]





Maximum allowable force for the M20 bolt
Maximum tension force = 141.1 kN
Maximum shear force in wire thread = 94.1 kN

Due to the low maximum design forces, no further proof necessary of the M20 bolt.

Check of the bearing forces in the holes of flat material. This check will be done with the plates which are welded on the Keder profile. This is the weakest spot.

Profile Information
Material EN-AW 6082 T6
f_u 24 kN/cm²
$f_{u,haz}$ 12.5 kN/cm²

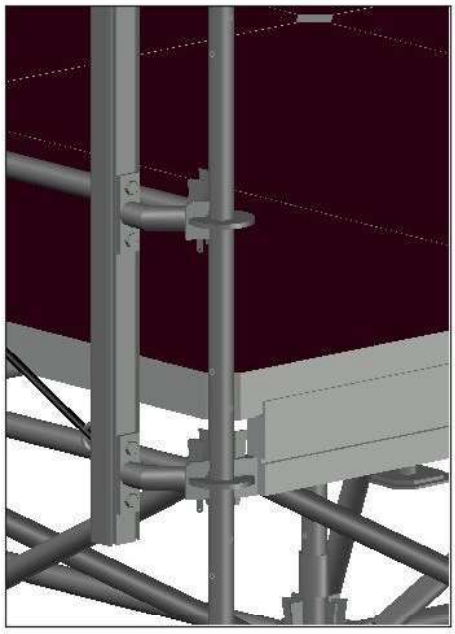
T = 5 mm
D = 21 mm

Maximum shear force in the bolt $F_{b,Ed} = \sqrt{(3.62^2 + 3.04^2)} = 4.72$ kN

$F_{b,Rd} = 1.5 * f_{u,haz} * D * T / \gamma_{m2} = 1.5 * 12.5 * 2.1 * 0.5 / 1.25 = 15.75$ kN
$F_{b,Ed} / F_{b,Rd} < 1$
$4.72 / 15.75 = 0.30 < 1.0$

4.4.8 Check of the side stage attachment to the Layher stage.

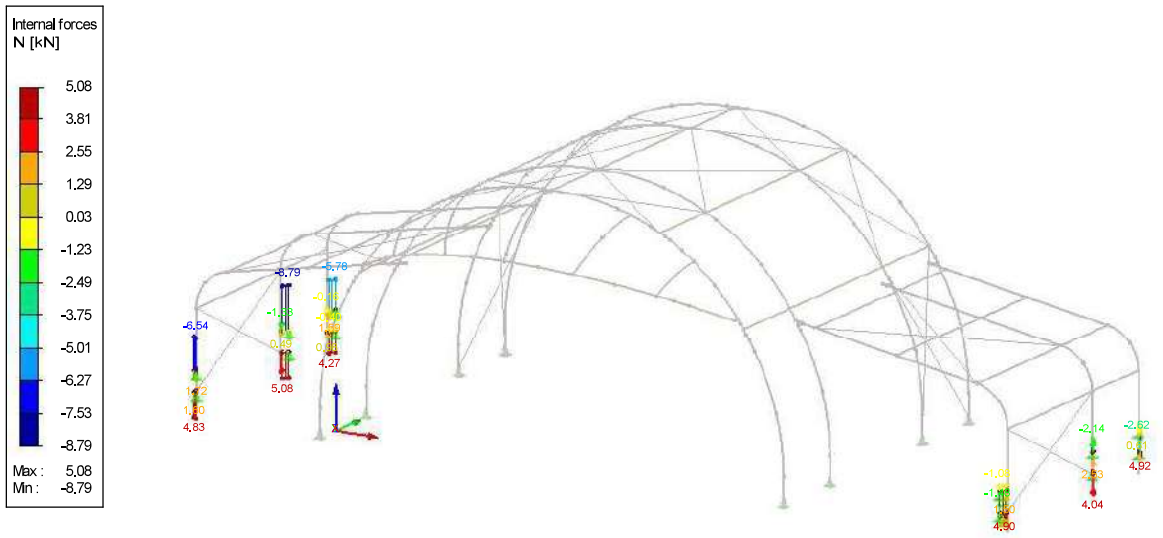
The connection of the Keder profile to the Layher stage is made by two special designed adapters. These adapters have a Layher wedge coupling welded to the end which is mounted on the Layher rosette. The bottom adapter is mounted on the same level as the Layher event deck to spread the load inside the Layher stage. The second adapter is mounted 1rosette higher to stabilize the profiles.



Internal forces of the decisive result combination RC4 design values Out-service.

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces N
Result Combinations: Max and Min Values

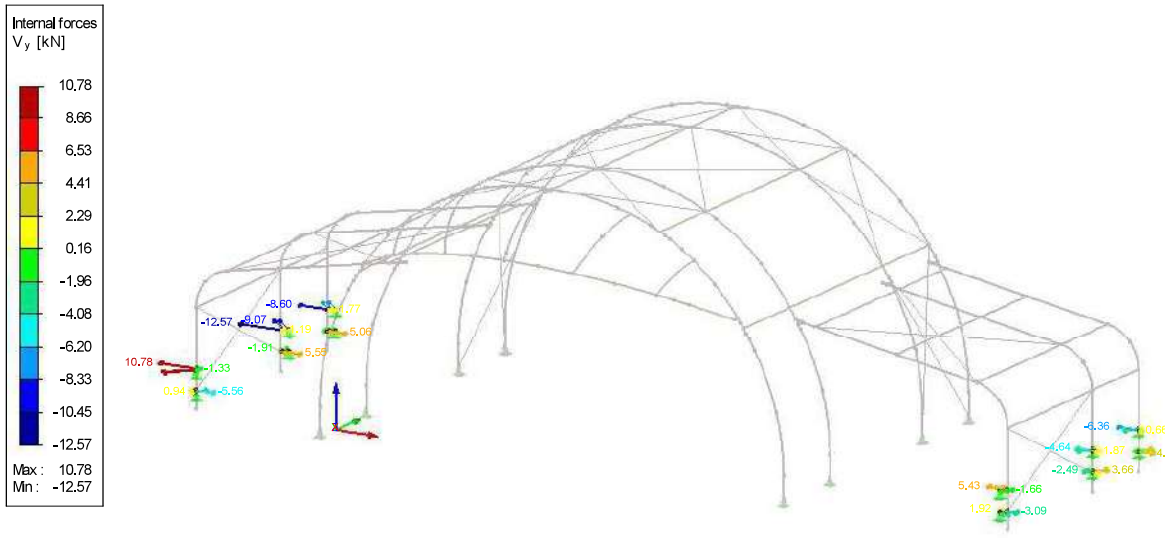
Isometric



Max N: 5.08, Min N: -8.79 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-y
Result Combinations: Max and Min Values

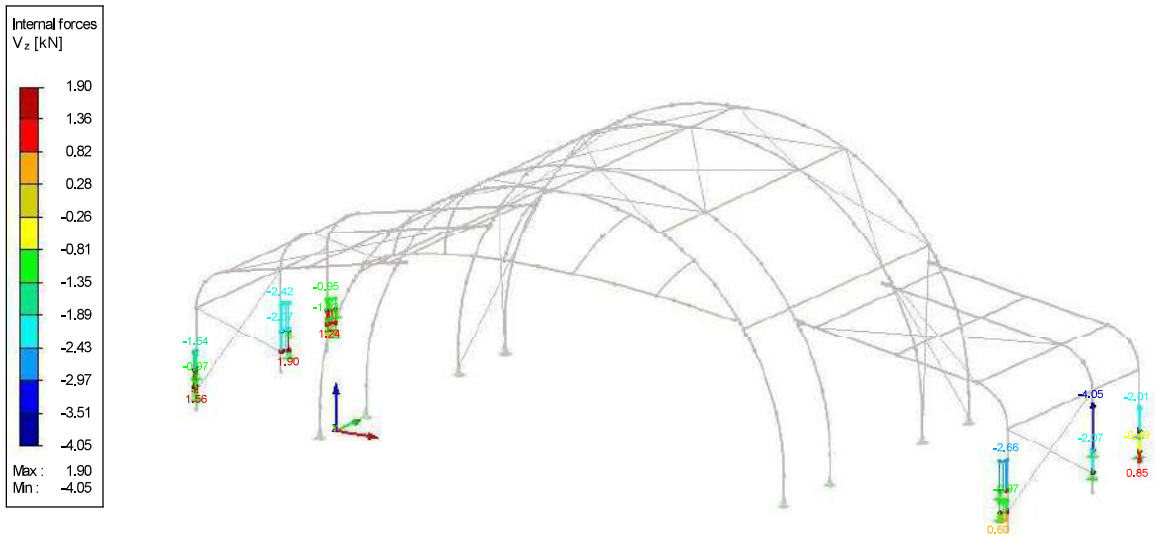
Isometric



Max V-y: 10.78, Min V-y: -12.57 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces V-z
Result Combinations: Max and Min Values

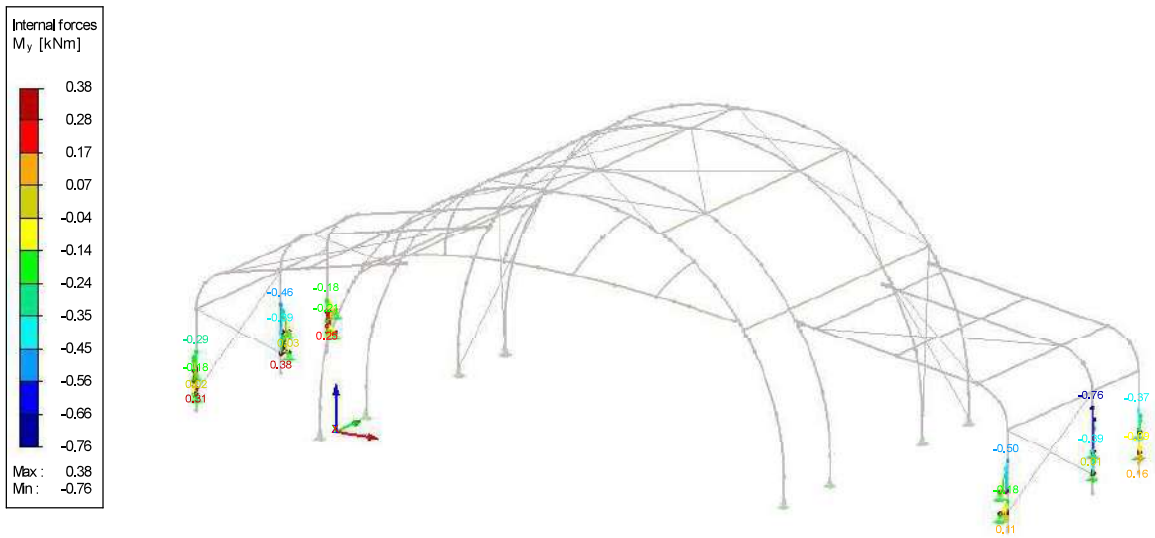
Isometric



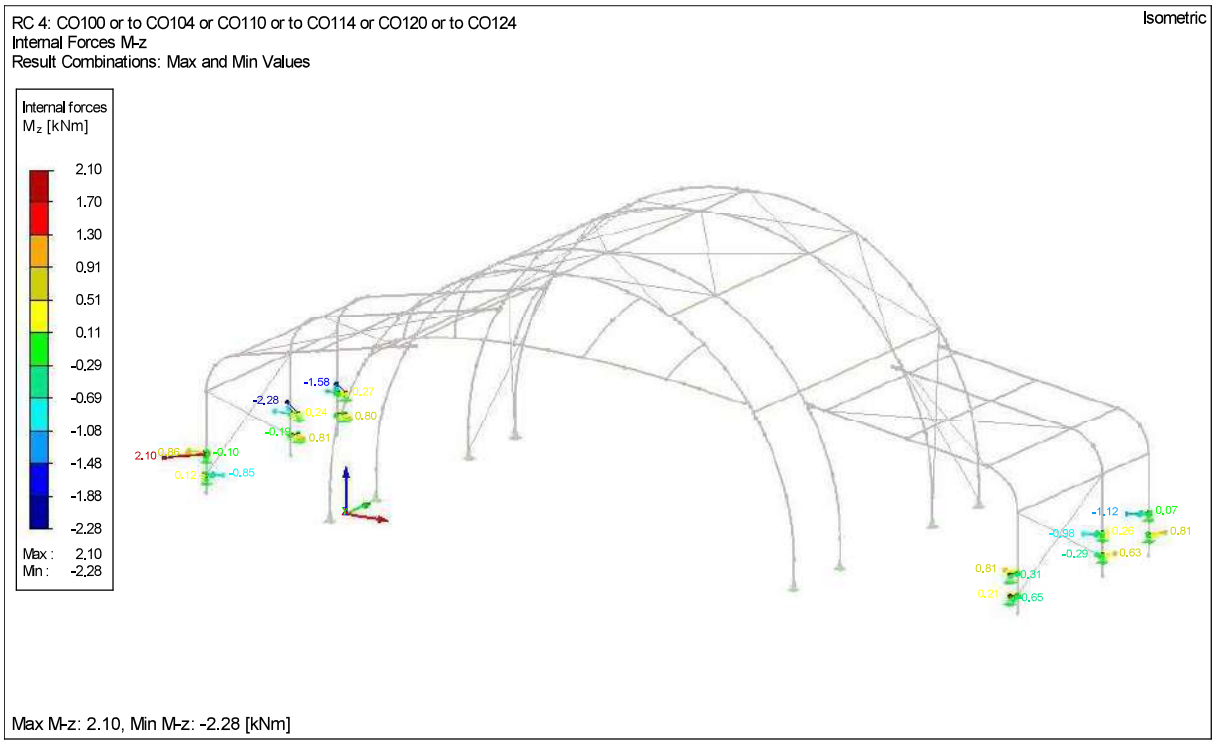
Max V-z: 1.90, Min V-z: -4.05 [kN]

RC 4: CO100 or to CO104 or CO110 or to CO114 or CO120 or to CO124
Internal Forces M-y
Result Combinations: Max and Min Values

Isometric



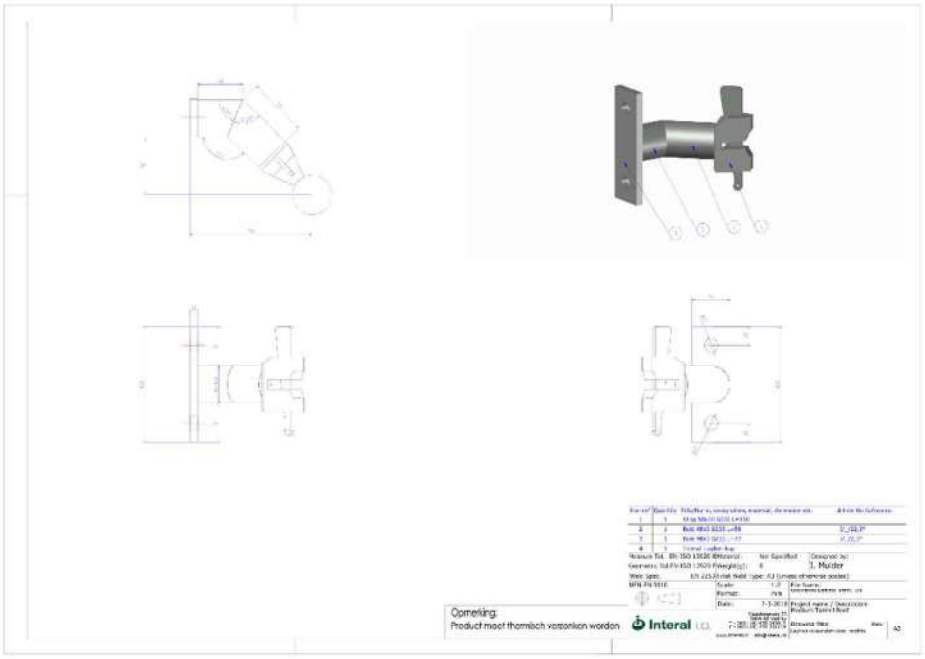
Max M-y: 0.38, Min M-y: -0.76 [kNm]



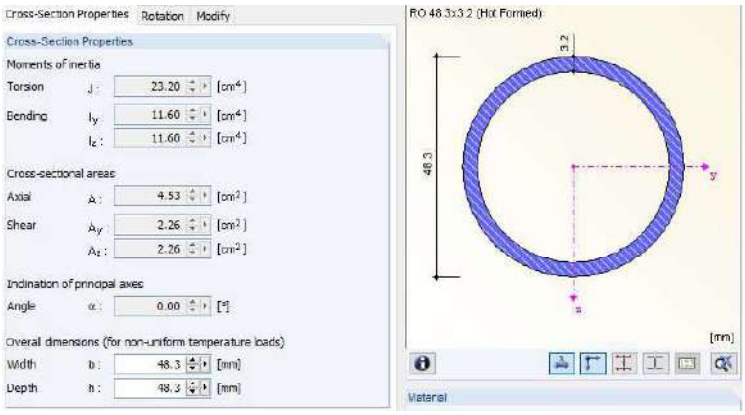
The maximum forces of the Layher parts could be find in chapter 6.

The maximum vertical shear force of the Layher Wedge coupling = 26.4 kN > 4.04 kN
The maximum horizontal shear force of the Layher Wedge coupling = 10 kN > 9.07 kN
The maximum normal force of the Layher Wedge coupling = 31 kN > 8.79 kN

Check of the round Profile.



Profile 48x3



Material S235RJ
$f_y = 23.5$ kN/cm²

$A_{nett} = 4.53$ cm²
$W_{pl} = 6.17$ cm³

$N_{ed,\,max} = 0.26$ kN
$V_{y,\,ed\,max} = 12.57$ kN
$Vz_{,\,ed\,max} = 1.89$ kN
$M_{y,\,ed\,max} = 0.21$ kNm
$M_{z,\,ed\,max} = 1.00$ kNm

Calculation
$\sigma_n = N_{ed,\,max} / A = 0.26 / 4.53 = 0.057$ kN/cm²
$\sigma_{vy} = V_{y,\,ed\,max} / A = 12.57 / 4.53 = 2.77$ kN/cm²
$\sigma_{vz} = V_{z,\,ed\,max} / A = 1.89 / 4.53 = 0.42$ kN/cm²
$\sigma_{my} = M_{y,\,ed\,max} / (W_{el}) = 21 / (6.17) = 3.40$ kN/cm²
$\sigma_{mz} = M_{z,\,ed\,max} / (W_{el}) = 100 / (6.17) = 16.21$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2)}$
$\sigma_{tot} = \sqrt{((0.057 + 3.40 + 16.21)^2 + 3*(2.77 + 0.42)^2)}$
$\sigma_{tot} = 20.43$ kN/cm²

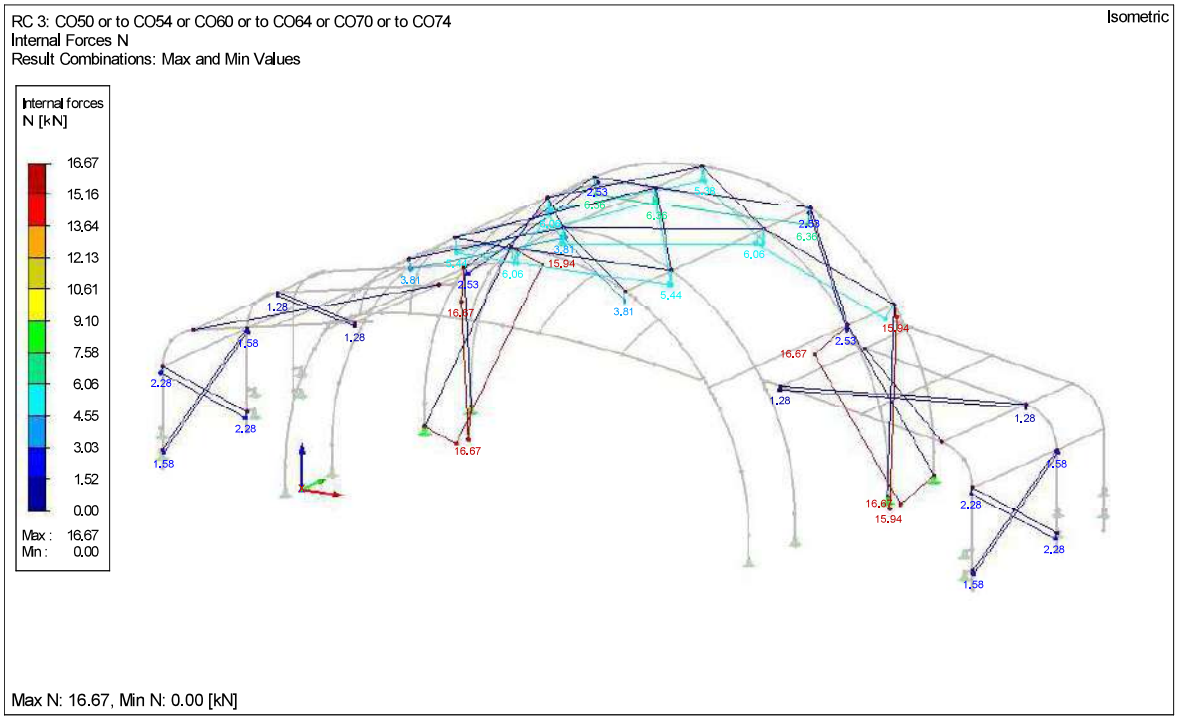
Check $\sigma_{tot} / (f_y / \gamma_m) < 1$
$20.43 / (23.5 / 1.1) = 0.95 < 1$

4.5 Check of the cross wire's.

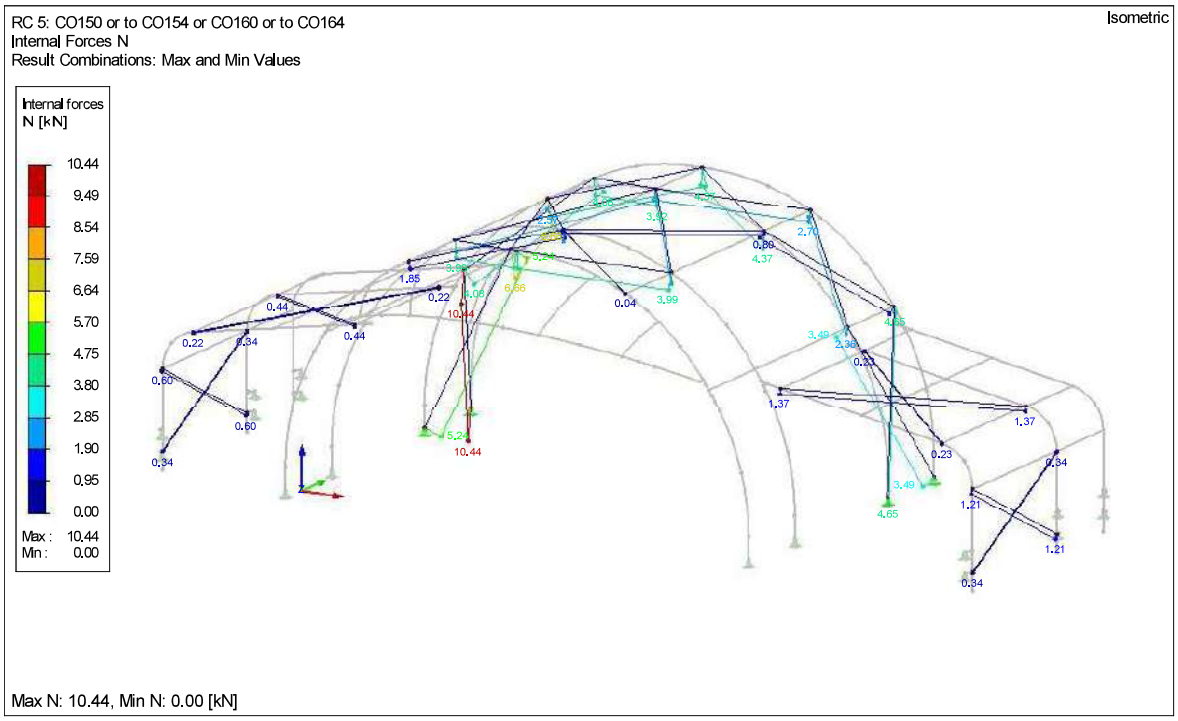
The check of the cross wire's will be done against the characteristic values of RC3 and RC5. This because the cross wires require different safety factors against breaking strength. The used components for the cross wires are ratchet straps

4.5.1 Internal forces cross wire's

Maximum normal forces in RC3: characteristic values In service



Maximum normal forces in RC5: characteristic Out service situation.



Maximum cross wire force is 16.67 kN.

For the cross wire is a safety factor required of 3.5.
The minimum breaking strength which is required is 16.67 x 3.5 = 58.34 kN

The used Ratchet strap is a 50mm ratchet strap with a LC of 25 kN.
LC = 3* breaking strength
25 * 3 / 3.5 = 21.4 kN

Check 16.67 / 21.40 = 0.77 < 1

The Ratchet straps can be replaced by any system which is suitable for these purposes.
The minimum required safety factor against breaking strength for these systems is 3.5

The connection of the steel wire to the structure is done by an M16 eye nut which is Bolted to the welded plates.

The minimum required WLL of the M16 Eye nut is 16 kN.
Check (16 * 5) / 3.5 = 22.8 kN > 16.67 kN

When only the Medium tunnel stage option 3 is build, it is necessary to install cross wires in the front and the back of the system in the Out-service wind conditions. This for the structural integrity and stability of the system. Minimum required load capacity of the cross wire is the same as all the other cross wires.

5.0 Necessary Ballast.

5.1 Ballast calculation model option 1 and 2.

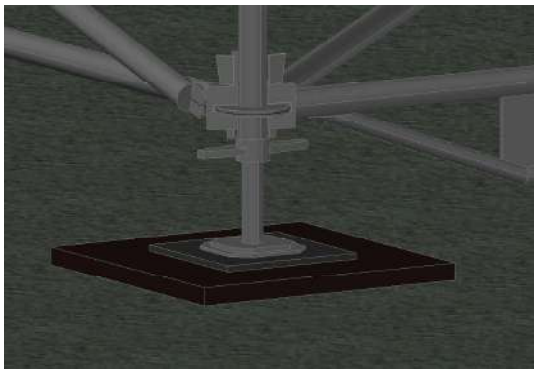
The ballast will be checked for uplift, overturning and sliding. The Layher stage which is designed as a ridged stage will be taken into account.

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

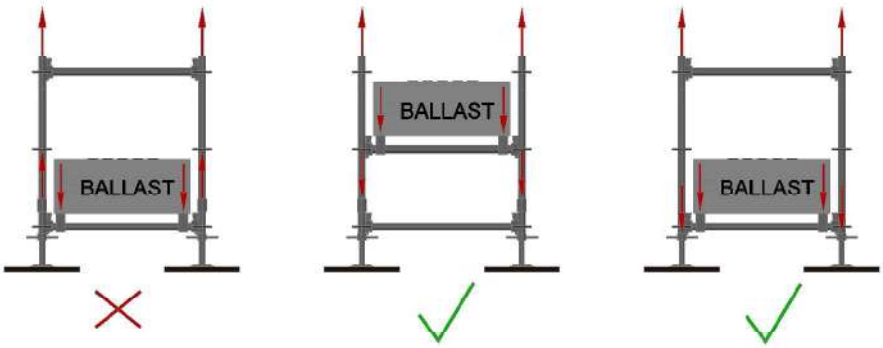
The safety factor for the ballast calculation against slipping is set to 1.2 according to the NEN-EN 13814. This is based on a horizontal load which is relying on friction.
For the friction coefficient the factor of 0.6 has been taken into account.
The Ballast calculation with factor 0.6 can be justified because rubber underlayment plate is used.

Table 3 — Coefficients of friction μ

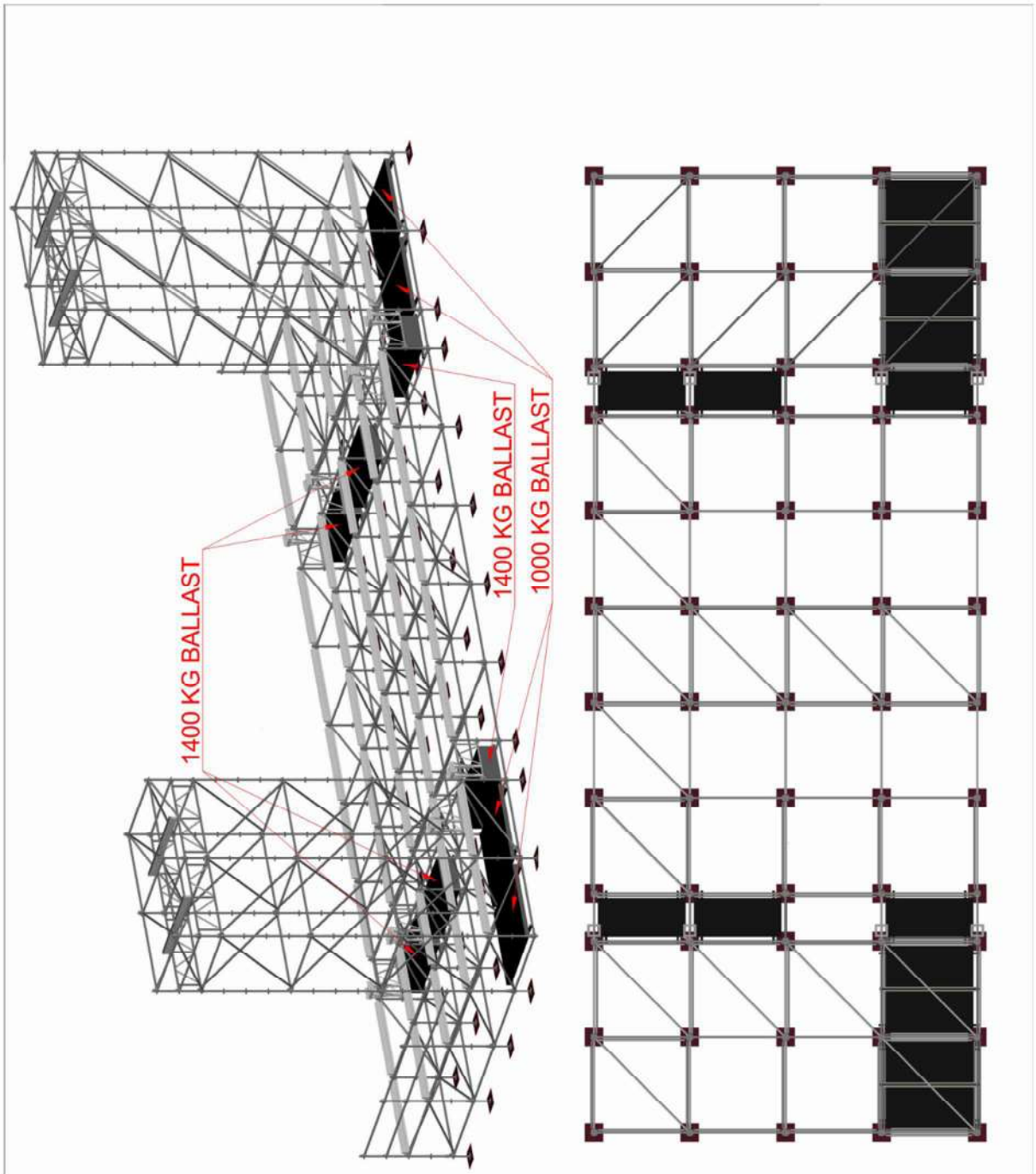
	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay[a]	0,25	0,2	0,25
Loam[a]	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65
[a] At least of stiff consistency in accordance with ENV 1997-1.			



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 drawing model option 1 and 2.



DRAWN BY :	IVO MULDER	PROJECT NR :	2017032	REMARKS :	
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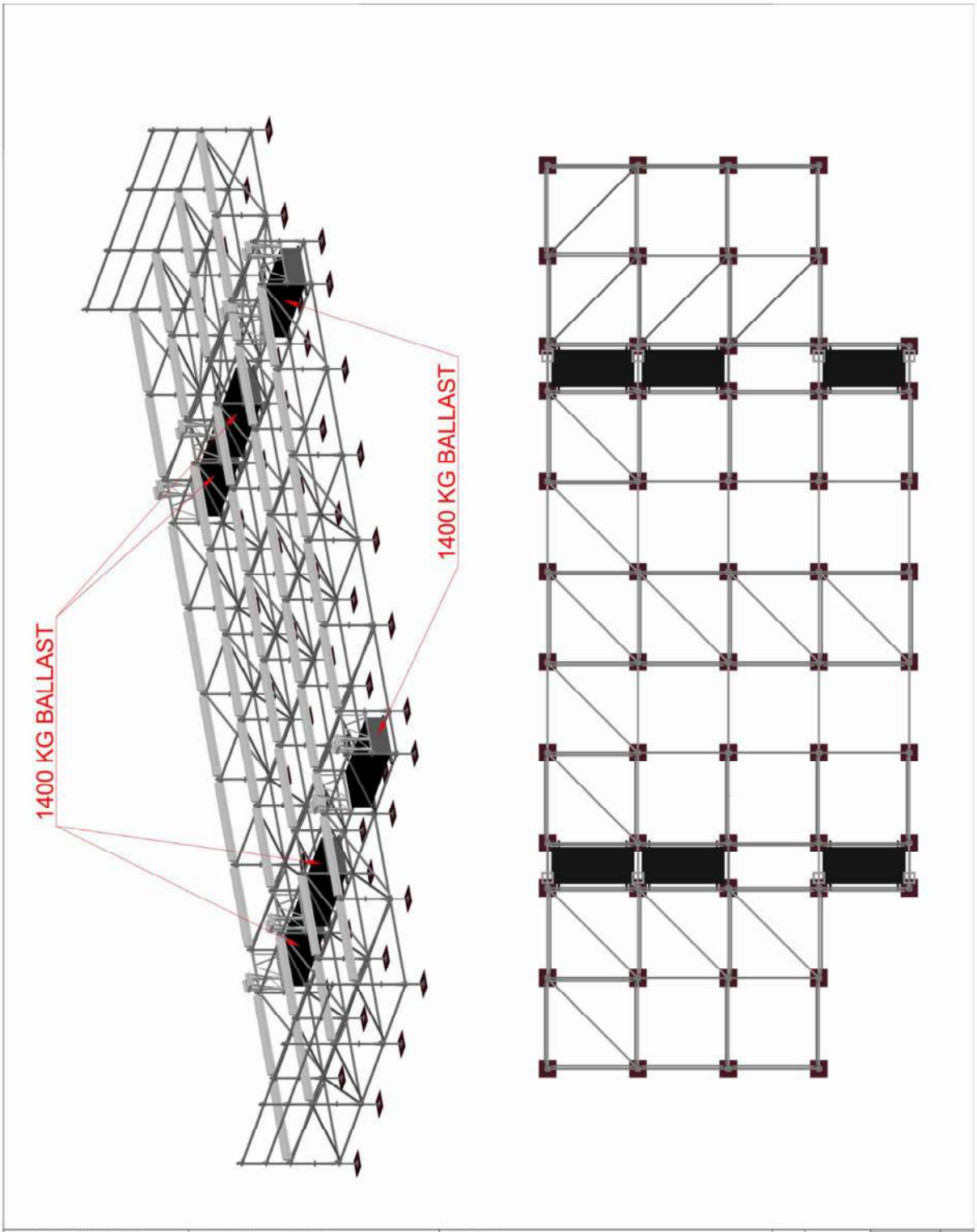
DESCRIPTION :

BALLAST DRAWING MEDIUM TUNNEL STAGE OPTION 1

UNIT : MM

A3

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DESCRIPTION :

BALLAST DRAWING MEDIUM TUNNEL STAGE OPTION 2

UNIT : MM

A3

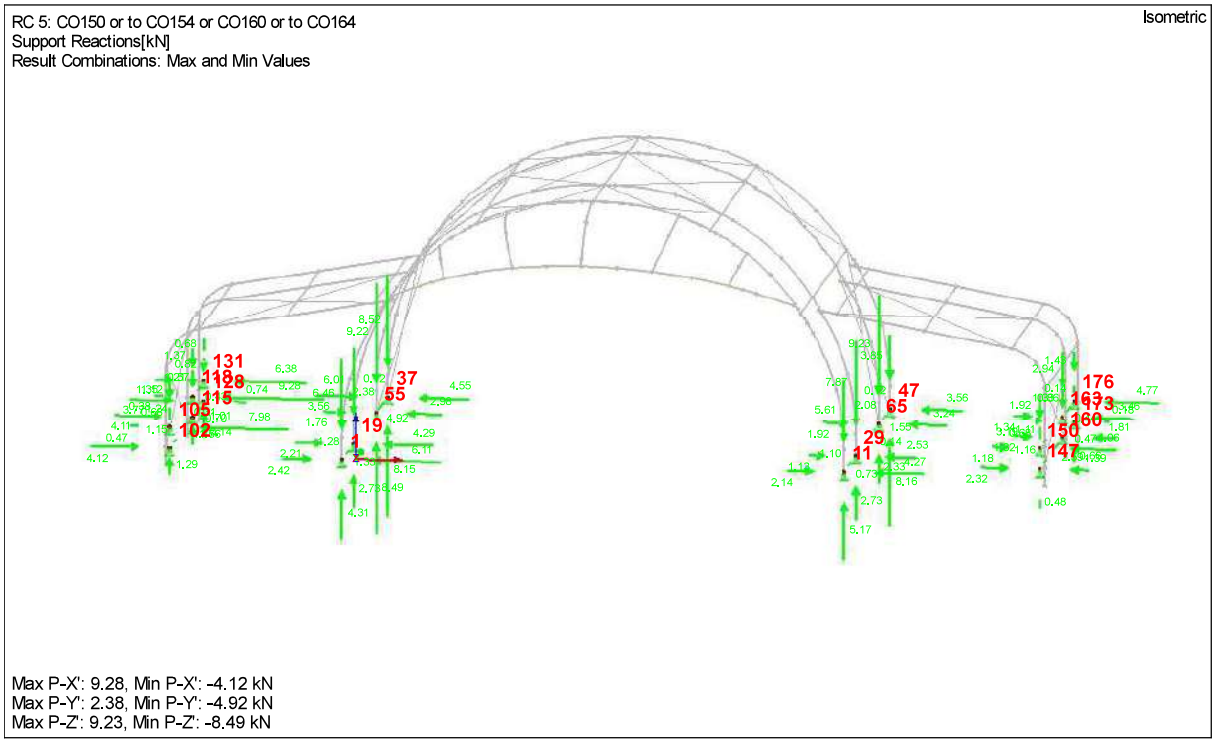
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5.3 Ballast calculation against uplift.

Reaction forces RC3 In-service situation



Reaction forces RC5 Out service situation



Maximum and minimum reaction forces in RC3 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	1,95	0,83	3,31	0,00	0,00	0,03
	Min	-4,24	0,00	-9,61	0,00	0,00	-0,09
11	Max	4,24	0,76	3,31	0,00	0,00	0,05
	Min	-0,92	-0,08	-9,61	0,00	0,00	-0,03
19	Max	1,07	0,10	3,93	0,00	0,00	0,23
	Min	-3,88	-0,70	-8,56	0,00	0,00	-0,01
29	Max	3,88	0,10	3,93	0,00	0,00	0,01
	Min	-0,89	-0,70	-8,56	0,00	0,00	-0,23
37	Max	2,06	0,16	6,70	0,00	0,00	0,10
	Min	-7,60	-7,87	-24,24	0,00	0,00	-0,08
47	Max	7,60	0,16	6,70	0,00	0,00	0,08
	Min	-2,06	-7,87	-24,24	0,00	0,00	-0,10
55	Max	4,29	7,24	18,22	0,00	0,00	0,06
	Min	-7,53	0,00	-23,82	0,00	0,00	-0,06
65	Max	7,53	7,24	18,23	0,00	0,00	0,06
	Min	-4,29	0,00	-23,82	0,00	0,00	-0,06
102	Max	1,99	2,21	0,35	0,00	0,00	0,11
	Min	-0,73	-0,79	-1,27	0,00	0,00	-0,31
105	Max	2,14	1,14	1,03	0,00	0,00	0,32
	Min	-2,65	0,00	-0,77	0,00	0,00	-0,46
115	Max	1,70	0,00	0,85	0,00	0,00	0,52
	Min	-1,49	-2,26	-0,26	0,00	0,00	-0,19
118	Max	2,91	0,43	1,13	0,00	0,00	0,56
	Min	-2,51	-0,50	-0,66	0,00	0,00	-0,53
128	Max	2,22	0,33	0,00	0,00	0,00	0,37
	Min	-0,34	0,00	-1,01	0,00	0,00	-0,06
131	Max	1,18	0,00	0,34	0,00	0,00	0,25
	Min	-2,99	-0,70	-0,60	0,00	0,00	-0,44
147	Max	0,73	2,21	0,35	0,00	0,00	0,35
	Min	-2,19	-0,79	-1,27	0,00	0,00	0,00
150	Max	2,94	1,14	1,03	0,00	0,00	0,12
	Min	-0,60	0,00	-0,49	0,00	0,00	-0,46
160	Max	1,49	0,00	0,85	0,00	0,00	0,19
	Min	-1,70	-2,26	-0,39	0,00	0,00	-0,52
163	Max	2,51	0,43	1,13	0,00	0,00	0,53
	Min	-0,96	-0,11	0,00	0,00	0,00	-0,17
173	Max	0,00	0,38	0,00	0,00	0,00	0,00
	Min	-2,22	0,00	-1,01	0,00	0,00	-0,37
176	Max	2,99	0,00	0,34	0,00	0,00	0,47
	Min	0,00	-0,70	-0,54	0,00	0,00	0,00

Maximum and minimum reaction forces in RC5 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	6,11	1,28	6,46	0,00	0,00	0,00
	Min	-2,42	0,00	-4,31	0,00	0,00	-0,20
11	Max	4,27	1,10	5,61	0,00	0,00	0,15
	Min	-2,14	0,00	-5,17	0,00	0,00	0,00
19	Max	4,29	0,00	6,01	0,00	0,00	0,30
	Min	-2,21	-1,33	-2,73	0,00	0,00	0,00
29	Max	2,53	0,00	7,87	0,00	0,00	0,00
	Min	-1,13	-0,73	-2,73	0,00	0,00	-0,22
37	Max	4,55	0,12	8,52	0,00	0,00	0,04
	Min	-3,56	-4,92	-8,15	0,00	0,00	-0,06
47	Max	3,56	0,12	3,85	0,00	0,00	0,06
	Min	0,00	-1,55	-8,16	0,00	0,00	-0,04
55	Max	2,98	2,38	9,22	0,00	0,00	0,05
	Min	-1,76	0,00	-8,49	0,00	0,00	-0,09
65	Max	3,24	2,08	9,23	0,00	0,00	0,09
	Min	-1,92	-0,14	-2,33	0,00	0,00	-0,02
102	Max	0,00	1,15	0,68	0,00	0,00	0,63
	Min	-4,12	0,00	0,00	0,00	0,00	-0,08
105	Max	7,98	1,24	1,12	0,00	0,00	0,08
	Min	-0,47	0,00	-1,29	0,00	0,00	-1,56
115	Max	0,00	0,00	1,21	0,00	0,00	0,00
	Min	-4,11	-1,17	0,00	0,00	0,00	-0,60
118	Max	9,28	0,57	1,37	0,00	0,00	1,69
	Min	-0,38	-0,31	-1,56	0,00	0,00	-0,09
128	Max	0,74	0,00	0,82	0,00	0,00	0,16
	Min	-3,77	-0,70	-0,14	0,00	0,00	-0,60
131	Max	6,38	0,00	0,68	0,00	0,00	1,17

	Min	-1,35	-0,43	-1,01	0,00	0,00	-0,20
147	Max	1,39	1,16	0,68	0,00	0,00	0,48
	Min	-2,32	0,00	-0,48	0,00	0,00	-0,15
150	Max	4,06	1,11	1,92	0,00	0,00	0,22
	Min	-1,18	0,00	0,00	0,00	0,00	-0,60
160	Max	1,81	0,00	1,33	0,00	0,00	0,22
	Min	-1,32	-2,59	0,00	0,00	0,00	-0,47
163	Max	3,46	0,86	2,94	0,00	0,00	0,73
	Min	-1,34	0,00	0,00	0,00	0,00	-0,18
173	Max	0,18	0,00	0,14	0,00	0,00	0,00
	Min	-3,19	-0,47	-0,66	0,00	0,00	-0,60
176	Max	4,77	0,00	1,43	0,00	0,00	0,84
	Min	0,00	-0,44	0,00	0,00	0,00	0,00

For the calculation of the ballast against uplift per support point a part of the Layher stage self-weight is taken into account.
The total self-weight of the Layher system is approx. 5700 kg.
The center of the stage will not help against the uplift forces for the separate supports, therefor only 50% of the self-weight is taken into account, which is 2850 Kg.
Layher weight per support point = 2850 / 14 = 203 kg.

Calculation of the ballast for the main roof.

The ballast on each side need to be the same, therefor the maximum uplift force of the two opposite supports will be used to calculate the ballast.

Ballast calculation support 1 and 11
(6.46 – 2.03) * 1.2 = 5.32 kN Ballast ~ 550 kg.

Ballast calculation support 19 and 29
(7.87– 2.03) * 1.2 = 7.00 kN Ballast ~ 700 kg.

Ballast calculation support 55 and 65
(18.23 – 2.03) * 1.2 = 19.44 kN Ballast ~ 1950 kg.

Ballast calculation support 37 and 47
(8.52 – 2.03) * 1.2 = 7.79 kN Ballast ~ 775 kg.

Because the Layher system is a ridged system, the ballast can be shifted a little bit. This has also been done in the ballast drawing. The shifting of the ballast has also been taken into account in the Layher stage calculation.

The uplift forces of the side stage areas are supported by the Layher. In the calculation of the Layher is an extra load case with the ballast forces.

5.4 Calculation of ballast against overturning and slipping.

Description	Value	Unit	Description	Value	Unit
CO50 - LC1 + LC10			**CO150 - LC1 + LC13**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	16,77	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	14,73	kN	Sum of loads in Z	39,12	kN
CO51 - LC1 + LC2 + LC10			**CO151 - LC1 + LC2 + LC13**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	16,77	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-43,79	kN	Sum of loads in Z	-19,4	kN
CO52 - LC1 + LC3 + LC10			**CO152 - LC1 + LC3 + LC13**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	16,77	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-19,66	kN	Sum of loads in Z	4,73	kN
CO53 - LC1 + LC4 + LC10			**CO153 - LC1 + LC4 + LC13**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	16,77	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-44,66	kN	Sum of loads in Z	-20,27	kN
CO54 - LC1 + LC5 + LC10			**CO154 - LC1 + LC5 + LC13**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	16,77	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-43,66	kN	Sum of loads in Z	-19,27	kN
CO60 - LC1 + LC11			**CO160 - LC1 + LC14**		
Sum of loads in X	9,38	kN	Sum of loads in X	32,71	kN
Sum of loads in Y	-0,11	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-4,17	kN	Sum of loads in Z	48,76	kN
CO61 - LC1 + LC2 + LC11			**CO161 - LC1 + LC2 + LC14**		
Sum of loads in X	9,38	kN	Sum of loads in X	32,71	kN
Sum of loads in Y	-0,11	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-62,68	kN	Sum of loads in Z	-9,76	kN
CO62 - LC1 + LC3 + LC11			**CO162 - LC1 + LC3 + LC14**		
Sum of loads in X	9,38	kN	Sum of loads in X	32,71	kN
Sum of loads in Y	-0,11	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-38,56	kN	Sum of loads in Z	14,37	kN
CO63 - LC1 + LC4 + LC11			**CO163 - LC1 + LC4 + LC14**		
Sum of loads in X	9,38	kN	Sum of loads in X	32,71	kN
Sum of loads in Y	-0,11	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-63,56	kN	Sum of loads in Z	-10,63	kN
CO64 - LC1 + LC5 + LC11			**CO164 - LC1 + LC5 + LC14**		
Sum of loads in X	9,38	kN	Sum of loads in X	32,71	kN
Sum of loads in Y	-0,11	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-62,56	kN	Sum of loads in Z	-9,63	kN
CO70 - LC1 + LC12			**CO170 - LC1 + LC15**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	-17,3	kN	Sum of loads in Y	-11,48	kN
Sum of loads in Z	-23,15	kN	Sum of loads in Z	36,14	kN
CO71 - LC1 + LC2 + LC12			**CO171 - LC1 + LC2 + LC15**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	-17,3	kN	Sum of loads in Y	-11,48	kN
Sum of loads in Z	-81,66	kN	Sum of loads in Z	-22,37	kN
CO72 - LC1 + LC3 + LC12			**CO172 - LC1 + LC3 + LC15**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	-17,3	kN	Sum of loads in Y	-11,48	kN
Sum of loads in Z	-57,53	kN	Sum of loads in Z	1,76	kN
CO73 - LC1 + LC4 + LC12			**CO173 - LC1 + LC4 + LC15**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	-17,3	kN	Sum of loads in Y	-11,48	kN
Sum of loads in Z	-82,53	kN	Sum of loads in Z	-23,24	kN
CO74 - LC1 + LC5 + LC12			**CO174 - LC1 + LC5 + LC15**		
Sum of loads in X	0	kN	Sum of loads in X	0	kN
Sum of loads in Y	-17,3	kN	Sum of loads in Y	-11,48	kN
Sum of loads in Z	-81,53	kN	Sum of loads in Z	-22,24	kN

For the calculation of the ballast against overturning and sliding of the system the total self-weight of the Layher stage can be taken into account.
The total self-weight of the Layher system is approx. 5700 kg.

Decisive load combination CO 160.

5.4.1 Calculation of ballast against overturning.

Check: $M_{stab}/ M_{ov} > 1.2$

Used info for the stability calculation.
Sum of vertical forces = 48.76 kN
Sum of horizontal load = 32.71 kN
Self-weight of the Layher stage = 57 kN
(The self-weight of the stage is calculated in chapter 6.)

The center of gravity of the complete system lays on a height of 3.75 meter.

Overturning moment
M_{ov} = 32.71 * (3.75+1) = 155.4 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight + down force) * width / 2
M_{stab} = (ballast + 57 – 48.76) * 12 / 2

M_{stab}/ M_{ov} = ((ballast + 57 – 48.76) * 12 / 2) / 155.4 > 1.2
Ballast = ((155.4 *1.2) / 6) – 8.24
Ballast = 22.84 kN ~ 2300 kg per side.

This is less than the necessary ballast against uplift.

5.4.2 Calculation of ballast against slipping.

Sum of vertical forces = 48.76 kN
Sum of horizontal load = 32.71 kN
Self-weight of the Layher stage = 57 kN
(The self-weight of the stage is calculated in chapter 6.)

Ballast calculation with the friction coefficient 0.6
(ballast + Self-weight) * friction coefficient / wind loading > 1.2
(Ballast per side * 2 + 57 - 48.76) * 0.6 / 32.71 > 1.2
(32.71 * 1.2) / 0.6 = B * 2 + 8.24
(39.25 – 8.24) / 2 = Ballast per side
Ballast = 15.50 kN ~ 1550 kg per side

This is less than the necessary ballast against uplift.

5.5 Ballast calculation model option 3.

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.

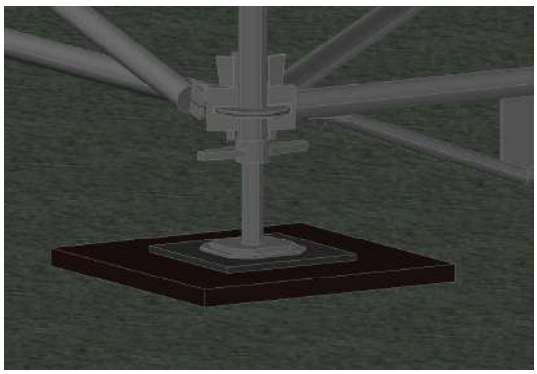
All permanent installed loading can be subtracted from the nearest Ballast position

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 0.6 has been taken into account.
The Ballast calculation with factor 0.6 can be justified because rubber underlayment plate is used.

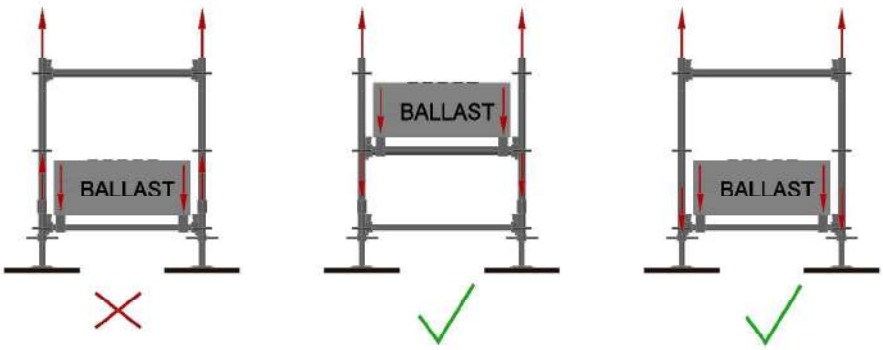
Table 3 — Coefficients of friction μ

	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

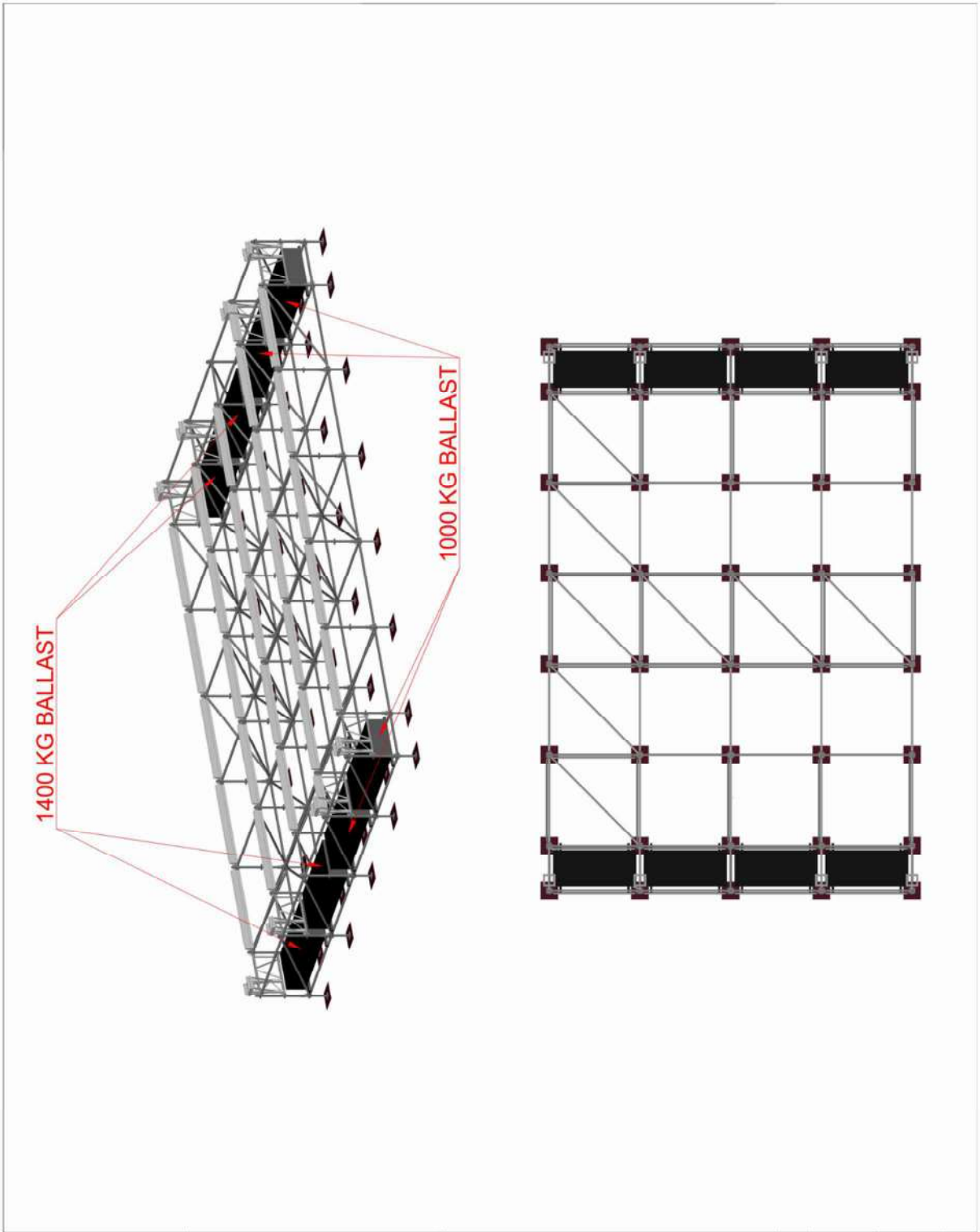
[a] At least of stiff consistency in accordance with ENV 1997-1.



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.



5.6 Ballast drawing model option 3.



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DATE : 8-4-2018	CUSTOMER : EEKELS VERHUUR	
REVISION :	STATUS :	

DESCRIPTION :

BALLAST DRAWING MEDIUM TUNNEL STAGE OPTION 3

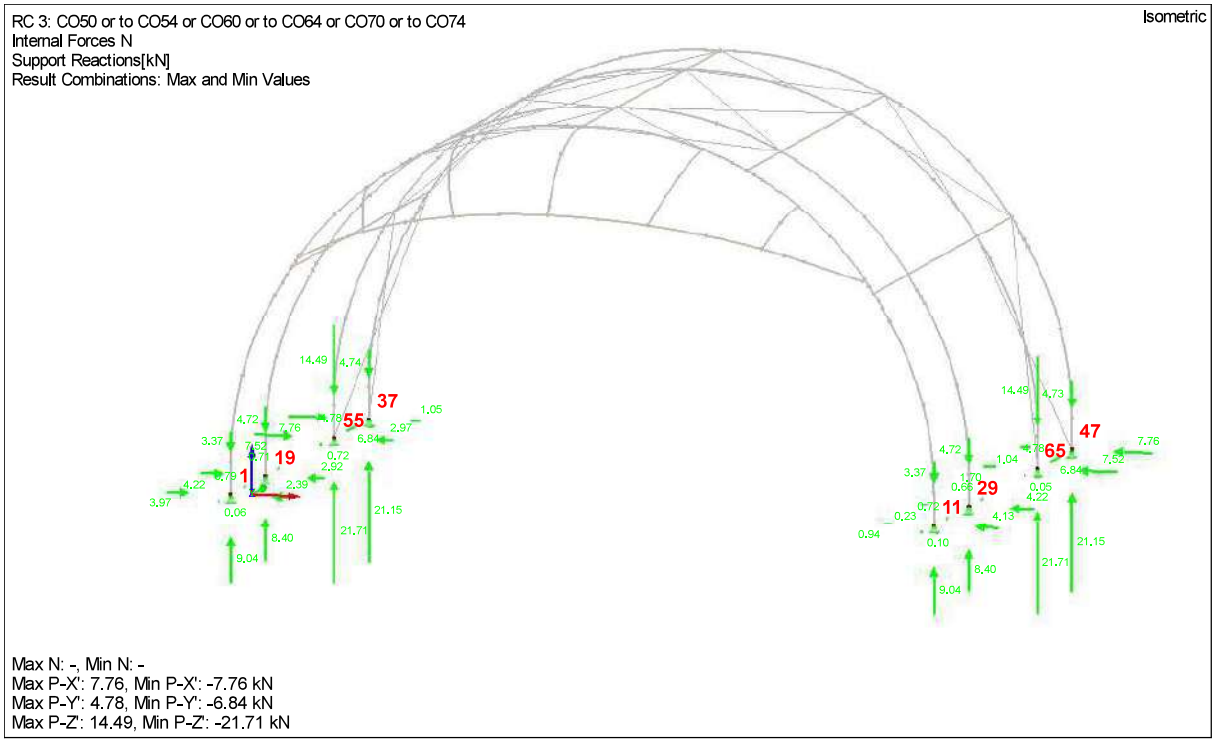
UNIT : MM

A3

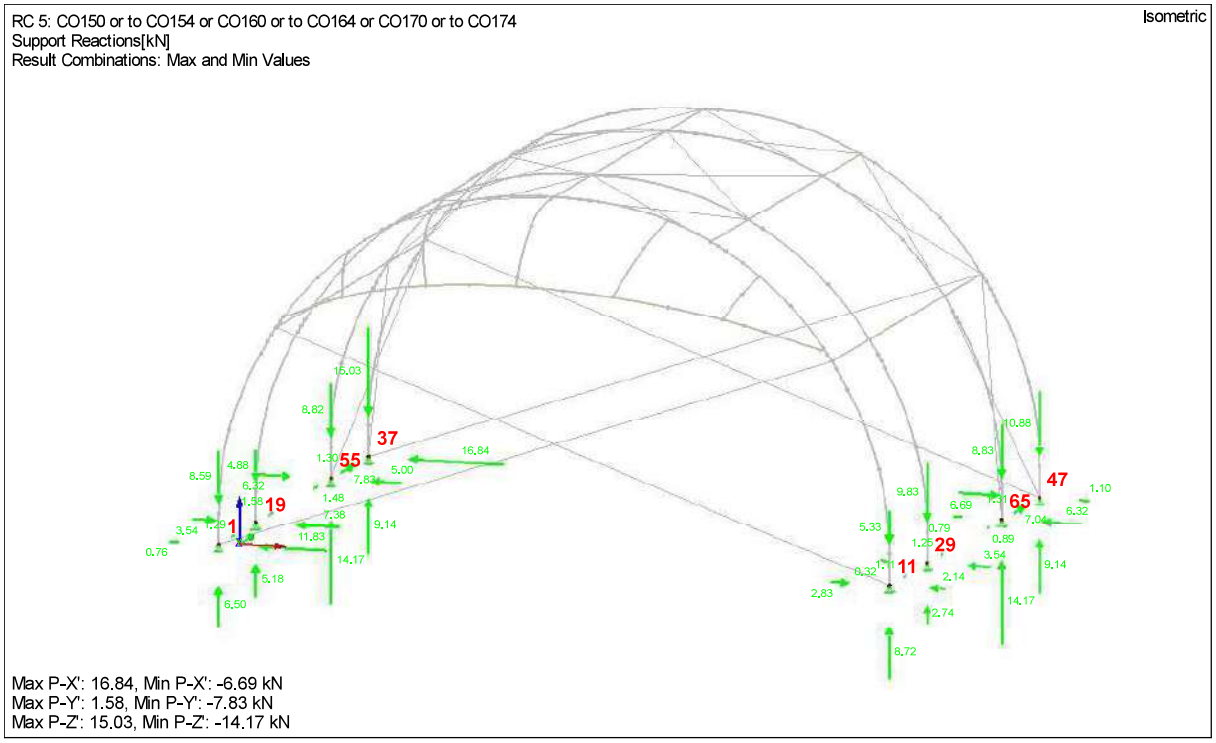
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5.7 Ballast calculation against uplift.

Reaction forces RC3 In-service situation



Reaction forces RC5 Out service situation.



Maximum and minimum reaction forces in RC3 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	2,39	0,79	3,37	0,00	0,00	0,05
	Min	-3,97	-0,06	-9,04	0,00	0,00	-0,10
11	Max	4,13	0,72	3,37	0,00	0,00	0,02
	Min	-0,94	-0,10	-9,04	0,00	0,00	-0,05
19	Max	2,92	0,71	4,72	0,00	0,00	0,05
	Min	-4,22	0,00	-8,40	0,00	0,00	-0,13
29	Max	4,22	0,66	4,72	0,00	0,00	0,07
	Min	-0,23	0,00	-8,40	0,00	0,00	-0,05
37	Max	1,05	0,00	4,74	0,00	0,00	0,20
	Min	-7,76	-6,84	-21,15	0,00	0,00	0,00
47	Max	7,76	0,00	4,73	0,00	0,00	0,00
	Min	-1,04	-6,84	-21,15	0,00	0,00	-0,20
55	Max	2,97	4,78	14,49	0,00	0,00	0,27
	Min	-7,52	-0,72	-21,71	0,00	0,00	0,00
65	Max	7,52	4,78	14,49	0,00	0,00	0,00
	Min	-1,70	-0,05	-21,71	0,00	0,00	-0,27

Maximum and minimum reaction forces in RC5 per support.

Node No.		Support Forces [kN]			Support Moments [kNm]		
		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	Max	11,83	1,29	8,59	0,00	0,00	0,00
	Min	-0,76	0,00	-6,50	0,00	0,00	-0,26
11	Max	2,14	1,11	5,33	0,00	0,00	0,28
	Min	-2,83	0,00	-8,72	0,00	0,00	0,00
19	Max	7,38	1,58	4,88	0,00	0,00	0,00
	Min	-3,54	0,00	-5,18	0,00	0,00	-0,31
29	Max	3,54	1,25	9,83	0,00	0,00	0,30
	Min	-0,32	0,00	-2,74	0,00	0,00	0,00
37	Max	16,84	0,00	15,03	0,00	0,00	0,24
	Min	0,00	-7,83	-9,14	0,00	0,00	-0,05
47	Max	1,10	0,00	10,88	0,00	0,00	0,05
	Min	-6,69	-7,04	-9,14	0,00	0,00	-0,13
55	Max	5,00	1,30	8,82	0,00	0,00	0,28
	Min	-6,32	-1,48	-14,17	0,00	0,00	-0,03
65	Max	6,32	1,31	8,83	0,00	0,00	0,03
	Min	-0,79	-0,89	-14,17	0,00	0,00	-0,15

For the calculation of the ballast against uplift per support point a part of the Layher stage self-weight is taken into account.
The total self-weight of the Layher system is approx. 3835 kg.
The center of the stage will not help against the uplift forces for the separate supports, therefor only 50% of the self-weight is taken into account, which is 1917 Kg.
Layher weight per support point = 1917 / 8 = 239 kg.

Calculation of the ballast for the main roof.

The ballast on each side need to be the same, therefor the maximum uplift force of the two opposite supports will be used to calculate the ballast.

Ballast calculation support 1 and 11
(8.59 – 2.39) * 1.2 = 7.48 kN Ballast ~ 750 kg.

Ballast calculation support 19 and 29
(9.83 – 2.39) * 1.2 = 8.97 kN Ballast ~ 900 kg.

Ballast calculation support 55 and 65
(15.03 – 2.39) * 1.2 = 15.21 kN Ballast ~ 1500 kg.

Ballast calculation support 37 and 47
(14.46 – 2.39) * 1.2 = 14.57 kN Ballast ~ 1500 kg.

5.8 Calculation of ballast against overturning and slipping.

Description	Value	Unit	Description	Value	Unit
CO50 - LC1 + LC10			**CO150 - LC1 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	10,91	kN	Sum of loads in Z	28,87	kN
CO51 - LC1 + LC2 + LC10			**CO151 - LC1 + LC2 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-47,61	kN	Sum of loads in Z	-29,65	kN
CO52 - LC1 + LC3 + LC10			**CO152 - LC1 + LC3 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-23,48	kN	Sum of loads in Z	-5,52	kN
CO53 - LC1 + LC4 + LC10			**CO153 - LC1 + LC4 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-48,48	kN	Sum of loads in Z	-30,52	kN
CO54 - LC1 + LC5 + LC10			**CO154 - LC1 + LC5 + LC13**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	10,02	kN	Sum of loads in Y	4,02	kN
Sum of loads in Z	-47,48	kN	Sum of loads in Z	-29,52	kN
CO60 - LC1 + LC11			**CO160 - LC1 + LC14**		
Sum of loads in X	9,61	kN	Sum of loads in X	38,58	kN
Sum of loads in Y	0,05	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-2,03	kN	Sum of loads in Z	38,06	kN
CO61 - LC1 + LC2 + LC11			**CO161 - LC1 + LC2 + LC14**		
Sum of loads in X	9,61	kN	Sum of loads in X	38,58	kN
Sum of loads in Y	0,05	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-60,55	kN	Sum of loads in Z	-20,45	kN
CO62 - LC1 + LC3 + LC11			**CO162 - LC1 + LC3 + LC14**		
Sum of loads in X	9,61	kN	Sum of loads in X	38,58	kN
Sum of loads in Y	0,05	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-36,42	kN	Sum of loads in Z	3,67	kN
CO63 - LC1 + LC4 + LC11			**CO163 - LC1 + LC4 + LC14**		
Sum of loads in X	9,61	kN	Sum of loads in X	38,58	kN
Sum of loads in Y	0,05	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-61,42	kN	Sum of loads in Z	-21,33	kN
CO64 - LC1 + LC5 + LC11			**CO164 - LC1 + LC5 + LC14**		
Sum of loads in X	9,61	kN	Sum of loads in X	38,58	kN
Sum of loads in Y	0,05	kN	Sum of loads in Y	-5,53	kN
Sum of loads in Z	-60,42	kN	Sum of loads in Z	-20,33	kN
CO70 - LC1 + LC12			**CO170 - LC1 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-11,99	kN
Sum of loads in Z	-16,65	kN	Sum of loads in Z	27,44	kN
CO71 - LC1 + LC2 + LC12			**CO171 - LC1 + LC2 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-11,99	kN
Sum of loads in Z	-75,16	kN	Sum of loads in Z	-31,07	kN
CO72 - LC1 + LC3 + LC12			**CO172 - LC1 + LC3 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-11,99	kN
Sum of loads in Z	-51,03	kN	Sum of loads in Z	-6,95	kN
CO73 - LC1 + LC4 + LC12			**CO173 - LC1 + LC4 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-11,99	kN
Sum of loads in Z	-76,03	kN	Sum of loads in Z	-31,95	kN
CO74 - LC1 + LC5 + LC12			**CO174 - LC1 + LC5 + LC15**		
Sum of loads in X	0,00	kN	Sum of loads in X	0,00	kN
Sum of loads in Y	-12,24	kN	Sum of loads in Y	-11,99	kN
Sum of loads in Z	-75,03	kN	Sum of loads in Z	-30,95	kN

For the calculation of the ballast against overturning and sliding of the system the total self-weight of the Layher stage can be taken into account.
The total self-weight of the Layher system is approx. 3835 kg.

Decisive load combination CO 160.

5.8.1 Calculation of ballast against overturning.

Check: $M_{stab}/ M_{ov} > 1.2$

Used info for the stability calculation.
Sum of vertical forces = 38.06 kN
Sum of horizontal load = 38.97 kN
Self-weight of the Layher stage = 38.35 kN

The center of gravity of the complete system lays on a height of 3.75 meter.

Overturning moment
M_{ov} = 38.97 * (3.75+1) = 185.10 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight + down force) * width / 2
M_{stab} = (ballast + 38.35 – 38.06) * 12 / 2

M_{stab}/ M_{ov} = ((ballast + 38.35 – 38.06) * 12 / 2) / 185.35 > 1.2
Ballast = ((185.35 *1.2) / 6) – 0.29
Ballast = 36.78 kN ~ 3700 kg per side.

This is less than the necessary ballast against uplift.

5.8.2 Calculation of ballast against slipping.

Sum of vertical forces = 38.06 kN
Sum of horizontal load = 38.97 kN
Self-weight of the Layher stage = 38.35 kN

Ballast calculation with the friction coefficient 0.6
(ballast + Self-weight) * friction coefficient / wind loading > 1.2
(Ballast per side * 2 + 38.35 – 38.06) * 0.6 / 38.97 > 1.2
(38.97 * 1.2) / 0.6 = B * 2 + 0.29
(77.94 – 0.29) / 2 = Ballast per side
Ballast = 38.82 kN ~ 3882 kg per side

This is less than the necessary ballast against uplift.

5.9 Ballast Loading PA tower.

If the system is built including a PA wing (option 1) Extra ballast in the PA wing is required.

Calculation.
The calculation is done for the In service wind loading. If the gust wind speed exceeds 21 m/s all the banners of the PA wing need to be removed. In the Out service situation it's an open 3d frame which requires less ballast.

Self-weight of the PA wing is 12.47 kg
Wind loading on the PA wing = 1.4 * 0.2 * 4.144 * 8 = 9.28 kN

Overturning moment
M_{ov} = 9.28 * 3 = 27.84 kNm

Stabilization moment
M_{stab} = (Ballast + Layher self-weight) * 2.072 / 2
M_{stab} = (ballast + 12.47) * 1.036

Check
M_{stab}/ M_{ov} = ((ballast + 12.47) * 2) / 27.84 > 1.2
Ballast = ((37.12 *1.2) / 2) – 12.47
Ballast = 19.78 kN ~ 2000 kg per side.

6.0 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 for the K2000+.
For the calculation of the Layher system the Stage configuration of Option 1 will be used. For this setup there are different load combinations calculated. The first 3 are from the In-service situation. The In-service load combinations will be combined with the floor loading. The other two are from the Out-service situation These load case will not be combined with the floor loading while there is nobody allowed on stage in the Out-service situation.
The different reaction forces are taken from the load combinations

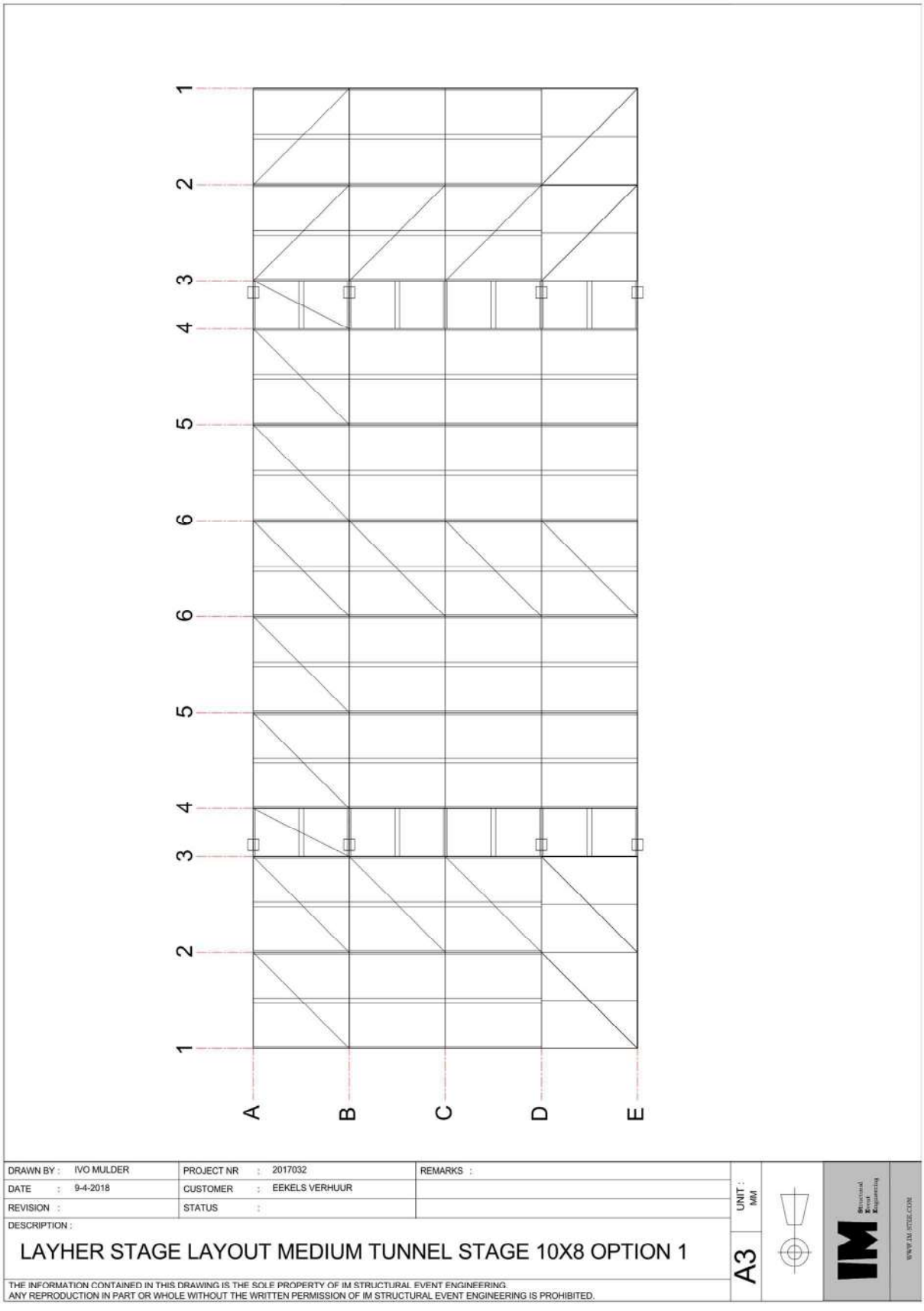
- : CO50
- : CO60
- : CO70
- : CO150
- : CO160

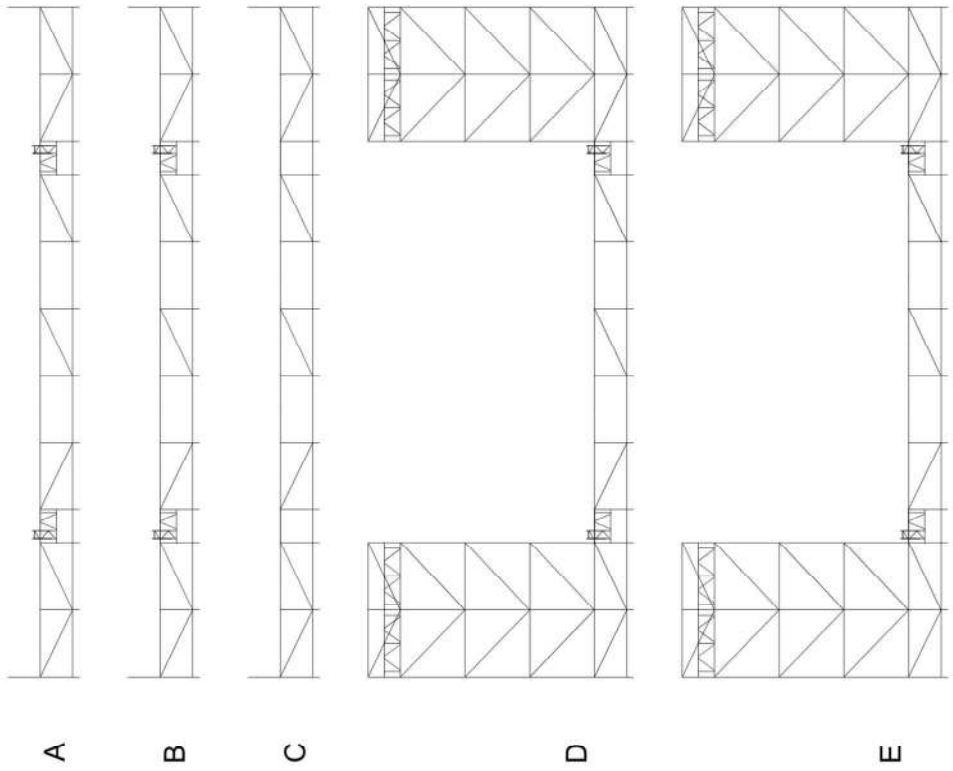
6.1 RFem Layher stage Model.

For the Layher stage a separate model is constructed in the RFem program.
In this model the forces of the different load combinations are set as forces on the different node positions. The result calculations will be compared with the Layher design forces as shown in chapter 6.5 Layher Design values.

6.1.1 Layher Stage Layout.

Layher stage Layout for stage setup Option 1





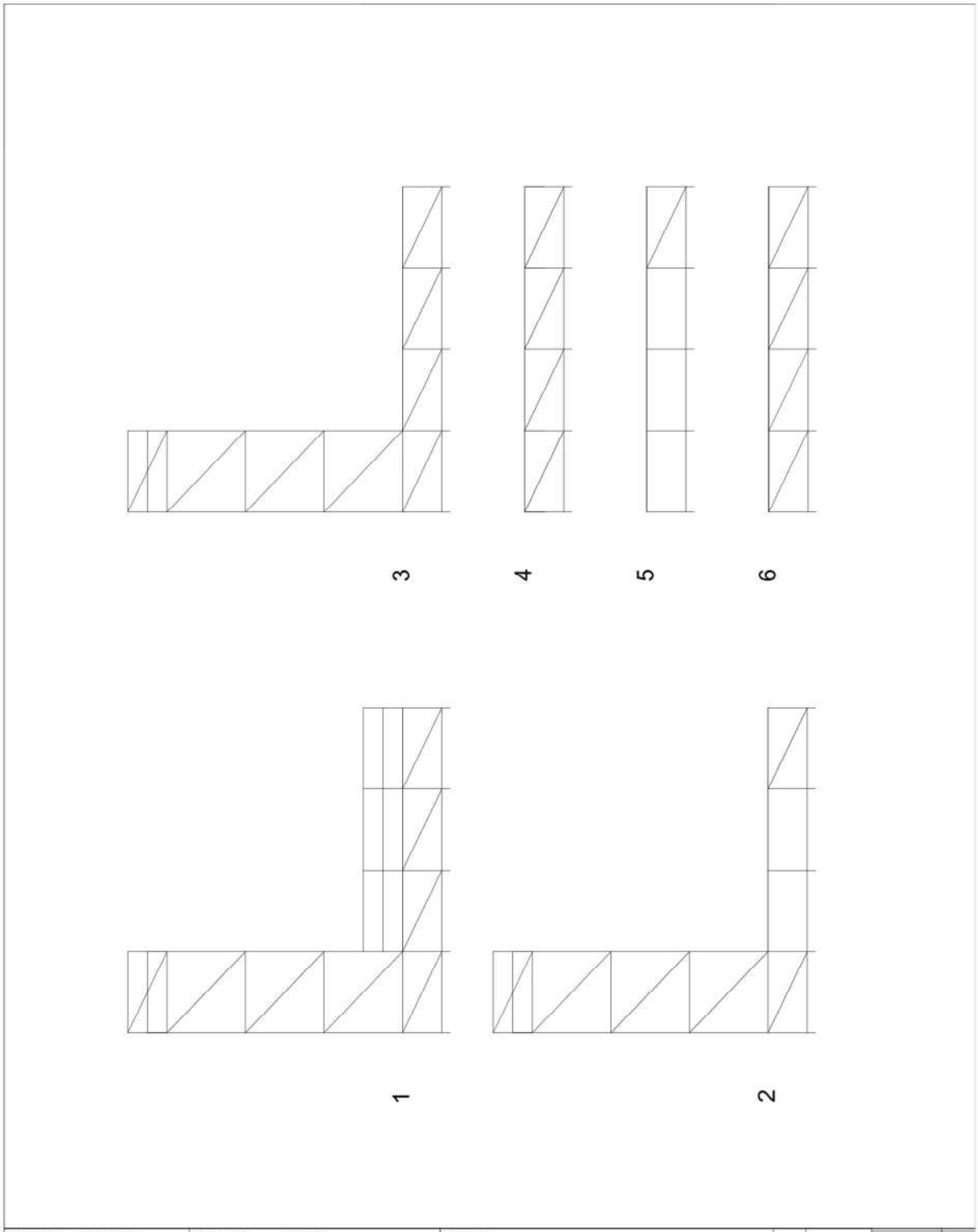
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DESCRIPTION :

LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 10X8 OPTION 1

A3

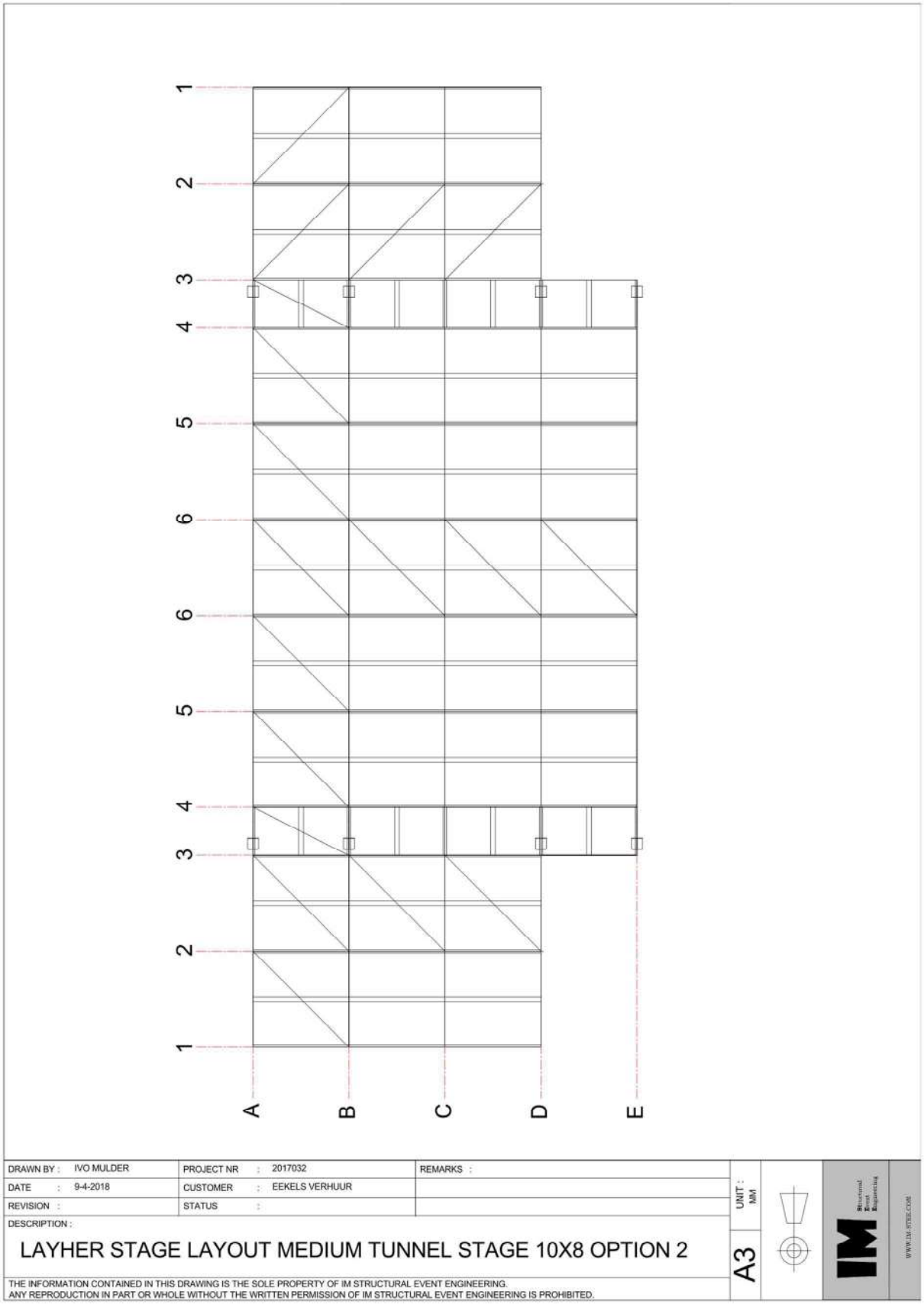
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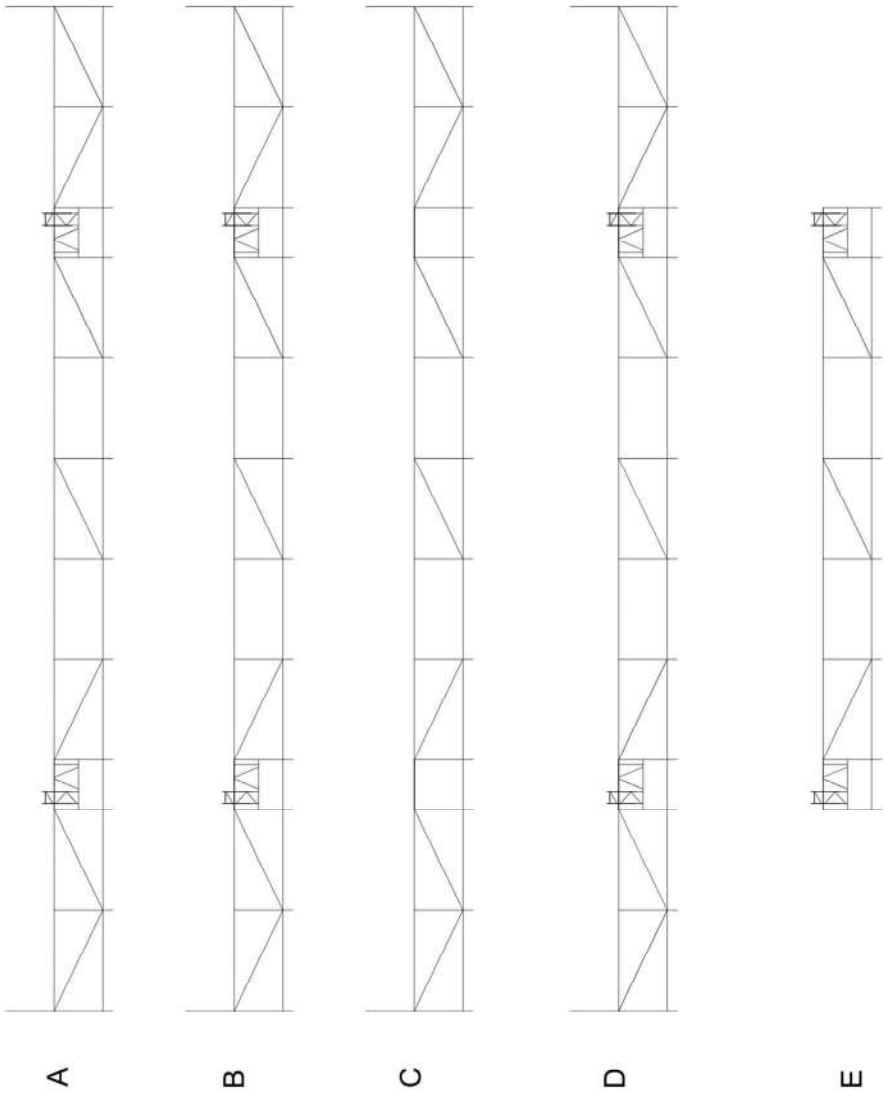


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LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 10X8 OPTION 1			A3		

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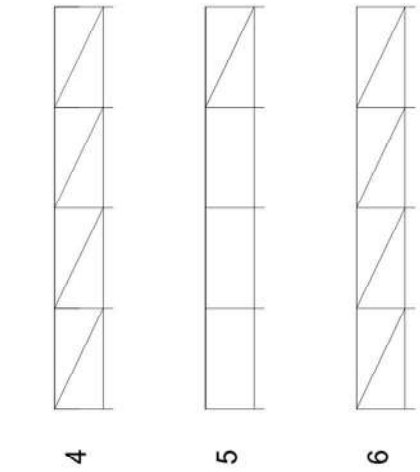
Layher stage Layout for stage setup Option 2

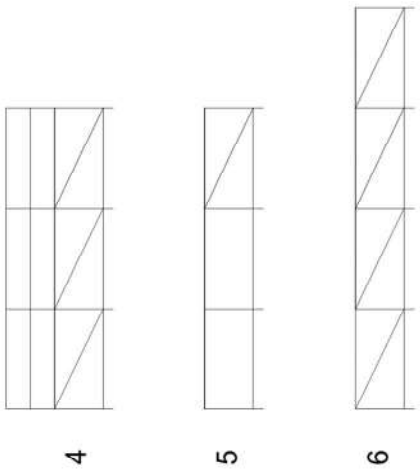




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DESCRIPTION :					
LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 10X8 OPTION 2			A3		

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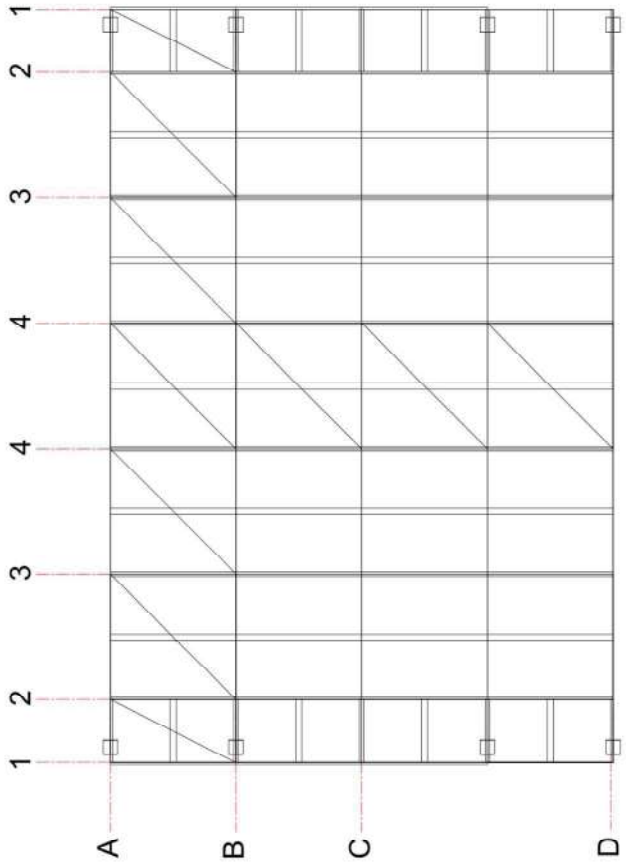




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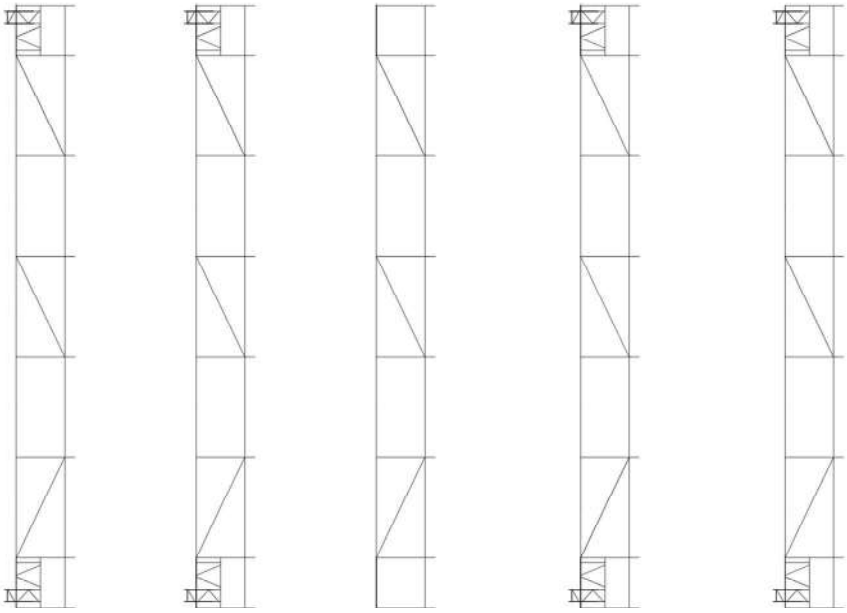
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Layher stage Layout for stage setup Option 3



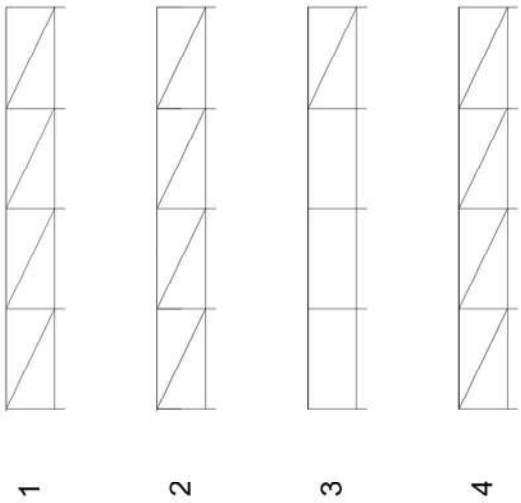
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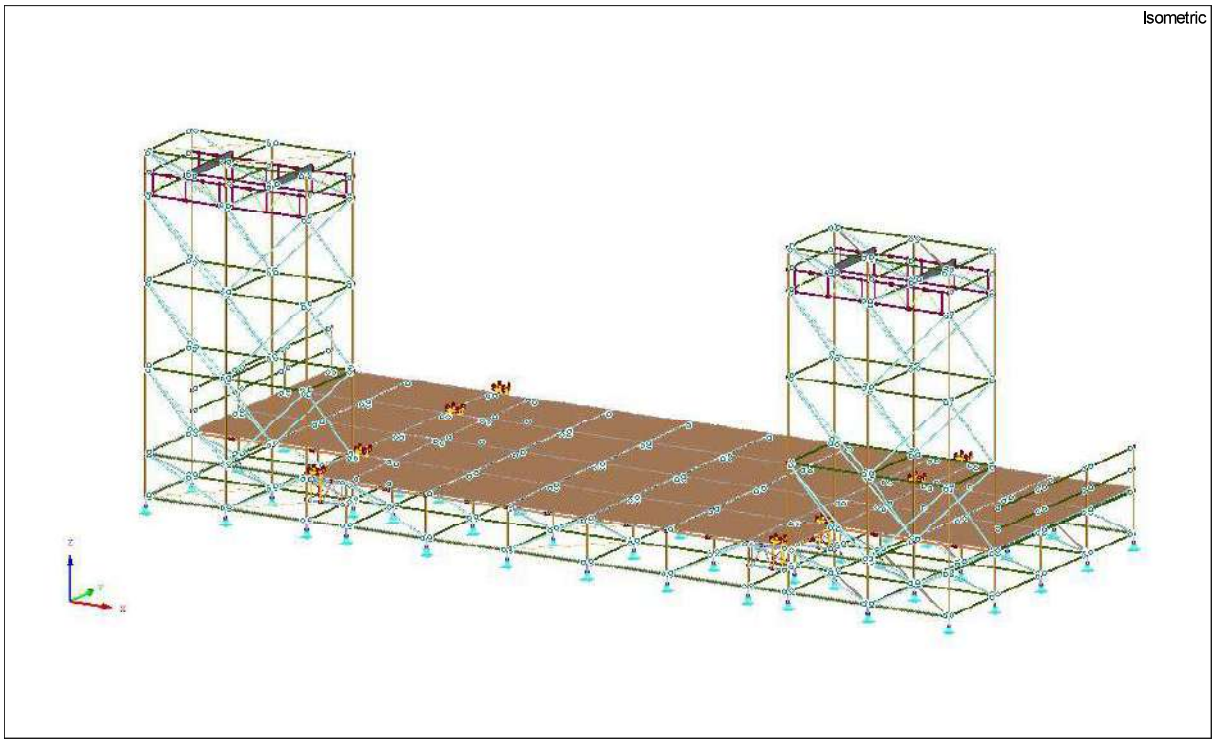


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DESCRIPTION : LAYHER STAGE LAYOUT MEDIUM TUNNEL STAGE 10X8 OPTION 3			A3		

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6.1.2 The Layher construction scheme option 1.

Layher stage layout 1 will be used for the calculation.



Cross-Sections
- 1: Ring 51/5; Steel S 355 JR
- 2: QRO 50x4 (Hot Formed); Steel S 235 JR
- 3: Ring 30/3; Steel S 235 JR
- 4: Rectangle 60/15; Steel S 235 JR
- 5: Ring 20/2; Steel S 235 JR
- 6: RO 38x4.5 | DIN EN 10220; Steel S 355 JR
- 7: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 8: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 9: RO 48.3x3.2 (Hot Formed); S320GD 1.0250
- 10: RO 48.3x2.6 (Hot Formed); Steel S 235 JR
- 11: EV transom; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 12: HK 50/30/4/4/4/4; Aluminum EN-AW 6005A (EP/O,ER/B) T6
- 13: IPE 160; Steel S 235 JR
- 14: HK 30/20/2/2/2/2; Steel S 235 JR
- 15: RO 48.3x3.2 (Hot Formed); S320GD 1.0250

6.1.3 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	Steel S 235 JR | EN 10025-2:2004-11	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
2	S320GD 1.0250 | EN 10346:2009-03	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
3	Steel S 355 JR | EN 10025-2:2004-11	21000,00	8076,92	0,300	78,50	1,20E-05	1,000	Isotropic Linear Elastic
4	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...
5	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

6.1.4 Used cross sections.

Section	Cross-Section	Material	Moments of inertia [cm⁴]			Cross-Sectional Areas [cm²]			Principal Axes	Rotation	Overall Dimensions [mm]	
			Torsion	Bending	Bending	Axial	Shear	Shear			Width	Depth
No.	Description [mm]	No.	J	I_y	I_z	A	A_y	A_z	α [°]	α' [°]	b	h
1	Ring 51/5	3	38,68	19,34	19,34	7,23	3,68	3,68	0,00	0,00	51,0	51,0
2	QRO 50x4 (Hot Formed)	1	40,40	25,00	25,00	7,19	3,12	3,12	0,00	0,00	50,0	50,0
3	Ring 30/3	1	4,69	2,35	2,35	2,54	1,30	1,30	0,00	0,00	30,0	30,0
4	Rectangle 60/15	1	5,69	1,69	27,00	9,00	7,50	7,50	0,00	0,00	60,0	15,0
5	Ring 20/2	1	0,93	0,46	0,46	1,13	0,58	0,58	0,00	0,00	20,0	20,0
6	RO 38x4.5 | DIN EN 10220	3	13,53	6,76	6,76	4,74	2,38	2,38	0,00	0,00	38,0	38,0
7	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
8	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
9	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
10	RO 48.3x2.6 (Hot Formed)	1	19,60	9,78	9,78	3,73	1,85	1,85	0,00	0,00	48,3	48,3
11	EV transom	5	50,00	554,00	70,00	18,78	18,00	18,00	0,00	0,00	49,0	172,5
12	HK 50/30/4/4/4/4	5	16,87	17,67	7,52	5,76	1,62	3,48	0,00	0,00	30,0	50,0
13	IPE 160	1	3,60	869,30	68,31	20,09	10,17	7,33	0,00	0,00	82,0	160,0
14	HK 30/20/2/2/2/2	1	2,31	2,16	1,11	1,84	0,57	1,04	0,00	0,00	20,0	30,0
15	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

6.1.5 Load cases, load combinations and result combinations.

Load Case	Load Case Description	To Solve	EN 1990 | CEN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self-weight	+	Permanent	-	0,000	0,000	-1,000
LC2	ballast loading	+	Permanent	-	0,000	0,000	-1,000
LC3	PA wing loading	+	Permanent/Imposed	-	0,000	0,000	0,000
LC4	floor loading 0°	+	Permanent/Imposed	-	0,000	0,000	0,000
LC5	floor loading 90°	+	Permanent/Imposed	-	0,000	0,000	0,000
LC6	floor loading 180°	+	Permanent/Imposed	-	0,000	0,000	0,000
LC10	Reaction forces CO50	-	Permanent/Imposed	-	0,000	0,000	0,000
LC11	Reaction forces CO60	-	Permanent/Imposed	-	0,000	0,000	0,000
LC12	Reaction forces CO70	-	Permanent/Imposed	-	0,000	0,000	0,000
LC13	Reaction forces CO150	-	Permanent/Imposed	-	0,000	0,000	0,000
LC14	Reaction forces CO160	-	Permanent/Imposed	-	0,000	0,000	0,000

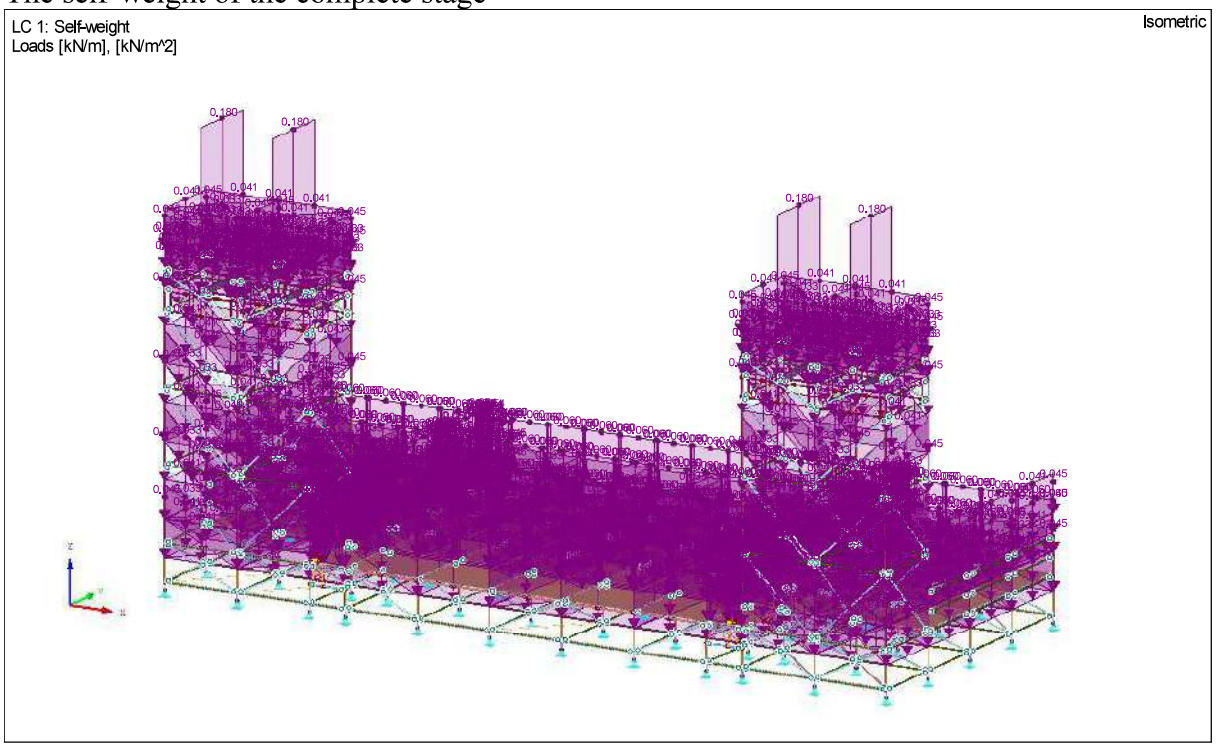
Load Combin.	Load Combination DS	Description	To Solve	LC.1 Factor	No.	LC.2 Factor	No.	LC.3 Factor	No.	LC.4 Factor	No.	LC.5 Factor	No.
CO1	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC4 + 1.35*LC10	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC4	1,350	LC10
CO2	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC5 + 1.35*LC11	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC5	1,350	LC11
CO3	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC6 + 1.35*LC12	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC6	1,350	LC12
CO4	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC13	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC13		
CO5	0	1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC14	+	1,150	LC1	1,150	LC2	1,350	LC3	1,350	LC14		
CO50	0	LC1 + LC2 + LC3 + LC4 + LC10	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC4	1,000	LC10
CO51	0	LC1 + LC2 + LC3 + LC5 + LC11	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC5	1,000	LC11
CO52	0	LC1 + LC2 + LC3 + LC6 + LC12	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC6	1,000	LC12
CO53	0	LC1 + LC2 + LC3 + LC13	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC13		
CO54	0	LC1 + LC2 + LC3 + LC14	+	1,000	LC1	1,000	LC2	1,000	LC3	1,000	LC14		

RC1 –load combinations Design values : 1 * (CO1 or to CO5)
RC2 –load combinations Characteristic values : 1 * (CO50 or to CO54)

6.2 Loading Input.

6.2.1 LC1: Self-weight.

The self-weight of the complete stage

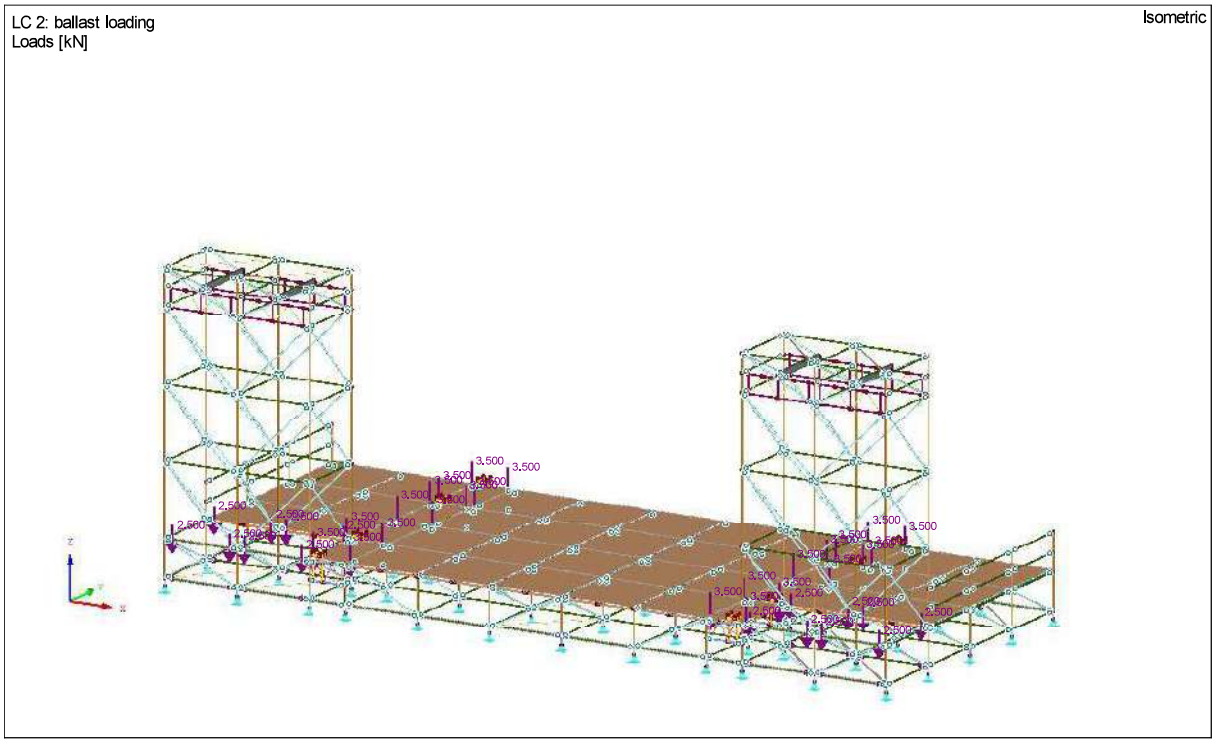


Layher pole = 0.045 kN/m^{-1}
Layher Ledger = 0.041 kN/m^{-1}
Layher Diagonal = 0.033 kN/m^{-1}
Layher event Ledger = 0.06 kN/m^{-1}
Layher Adapter main profile = 0.054 kN/m^{-1}
PA support beam 0.18 kN/m^{-1}
Layher event deck 18 kg/m²

Total self-weight complete Layher state 57 kN

6.2.2 LC2: Ballast loading.

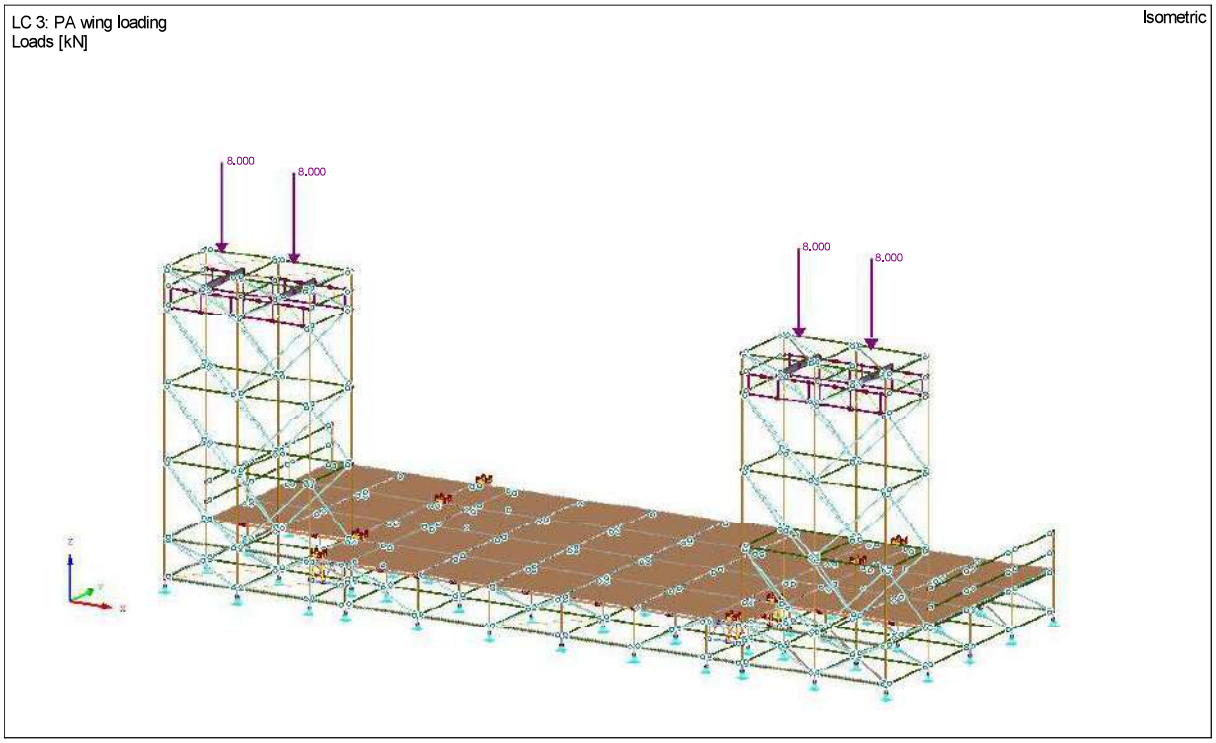
The ballast has been set as a separate load case, for the check of the structural integrity of the system.



Ballast main stage
4 * 3.5 kN = 14 kN per bay

Ballast PA wings
4 * 2.5 kN = 10 kN per bay

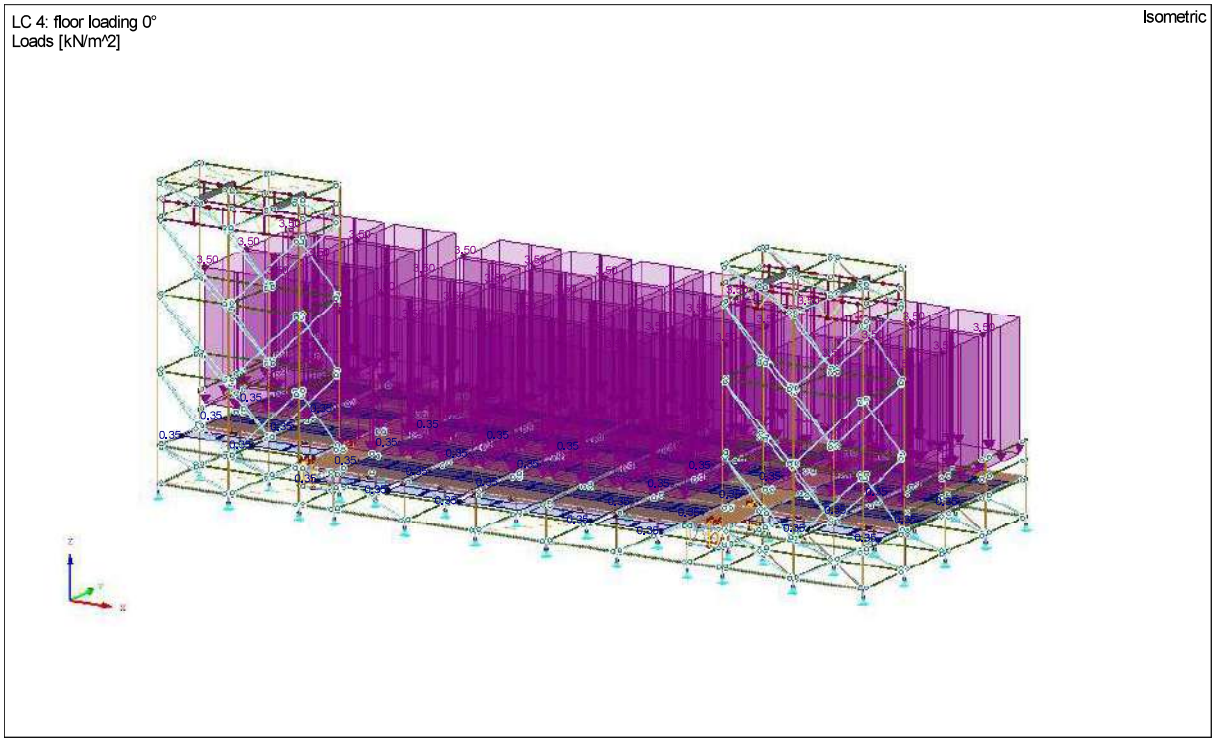
6.2.3 LC3: PA wing loading.



PA wing loading
4 * 8 kN

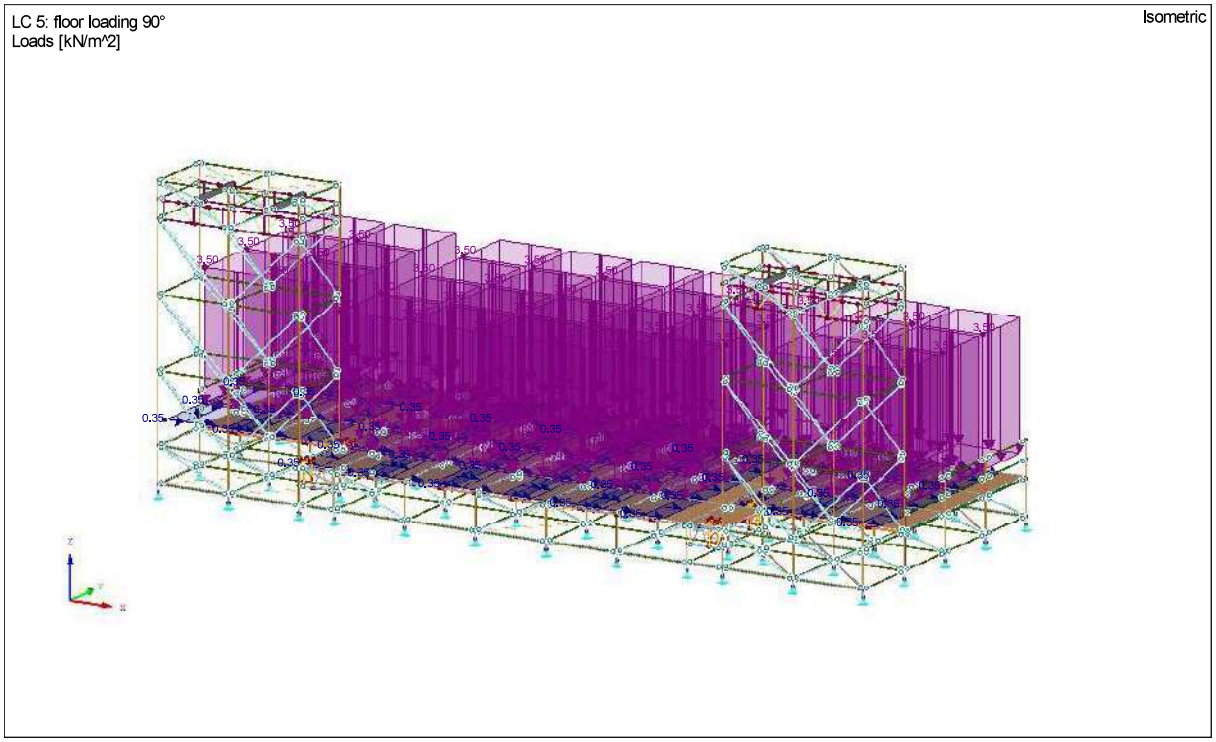
6.2.4 LC4: Floor loading 0°.

The floor loading which is taken into account is 350 kg/m² which is according to the NEN-EN 13814. For the horizontal stability check an extra loading of 10% of the vertical loading is set as an extra horizontal force. This horizontal force has been set in the direction of the wind.



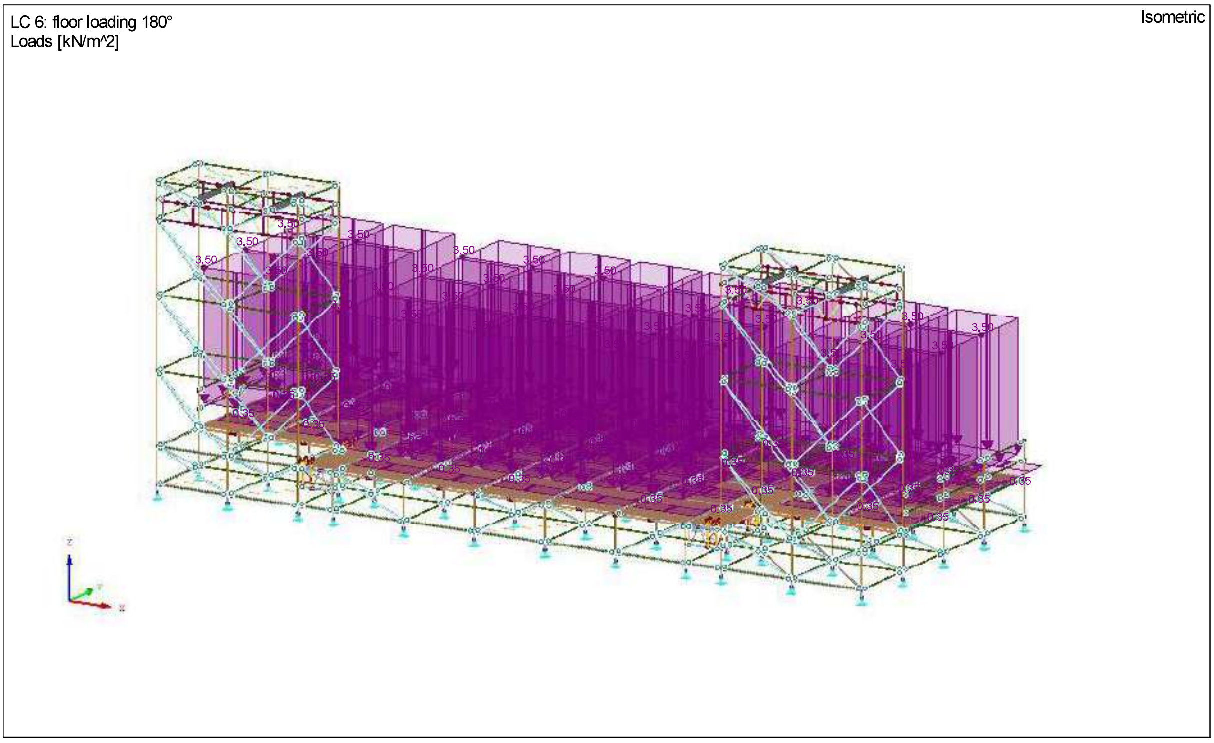
6.2.5 LC5: Floor loading 90°.

The floor loading which is taken into account is 350 kg/m² which is according to the NEN-EN 13814. For the horizontal stability check an extra loading of 10% of the vertical loading is set as an extra horizontal force. This horizontal force has been set in the direction of the wind.



6.2.6 LC6: Floor loading 180°.

The floor loading which is taken into account is 350 kg/m² which is according to the NEN-EN 13814. For the horizontal stability check an extra loading of 10% of the vertical loading is set as an extra horizontal force. This horizontal force has been set in the direction of the wind.

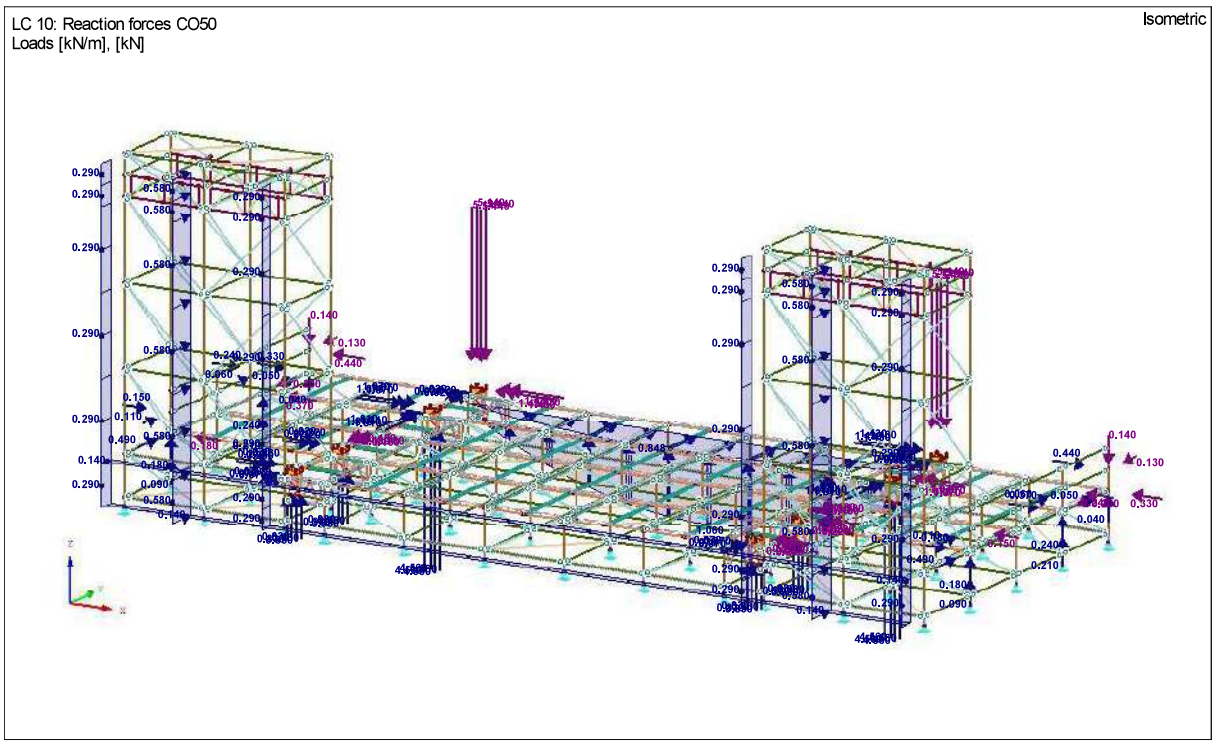


6.2.7 LC10: Reaction forces CO50.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	0,92	0,27	3,31	0,00	0,00	0,03
11	-0,92	0,27	3,31	0,00	0,00	-0,03
19	0,89	-0,70	3,93	0,00	0,00	0,23
29	-0,89	-0,70	3,93	0,00	0,00	-0,23
37	-5,73	0,07	-20,55	0,00	0,00	0,04
47	5,73	0,07	-20,55	0,00	0,00	-0,04
55	4,29	7,24	18,22	0,00	0,00	0,06
65	-4,29	7,24	18,23	0,00	0,00	-0,06
102	-0,73	1,95	0,35	0,00	0,00	-0,06
105	0,61	0,43	0,71	0,00	0,00	-0,12
115	-1,49	-0,78	0,85	0,00	0,00	-0,19
118	0,96	0,24	0,96	0,00	0,00	0,17
128	1,30	0,19	-0,57	0,00	0,00	0,21
131	-1,77	-0,52	0,15	0,00	0,00	-0,24
147	0,73	1,95	0,35	0,00	0,00	0,06
150	-0,60	0,43	0,71	0,00	0,00	0,12
160	1,49	-0,78	0,85	0,00	0,00	0,19
163	-0,96	0,24	0,96	0,00	0,00	-0,17
173	-1,30	0,19	-0,57	0,00	0,00	-0,21
176	1,77	-0,52	0,15	0,00	0,00	0,24
Σ Forces	0,00	16,77	14,73			
Σ Loads	0,00	16,77	14,73			

Load input in Layher stage model.



The loading of the wind on the stage, PA wing and part of the loading of the wind on the back wall are added as member loads on the model.

Wind on stage
$q_{w,\,stage} = 1.4 * 0.2 * 1 = 0.290$ kN/m
this is divided on the top and bottom ledger of the stage

Wind on PA wing.
Wind on outer Layher Pole
qw = 1.4 * 0.2 * 1.036 = 0.29

Wind on middle Layher Pole
qw = 1.4 * 0.2 * 2.072 = 0.58

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 1.3 * 0.2 * 6.525 * 0.5 = 0.848kN/m
$q_{w,\ back\ wall\ side}$ = 1.3 * 0.2 * 0 = 0 kN/m

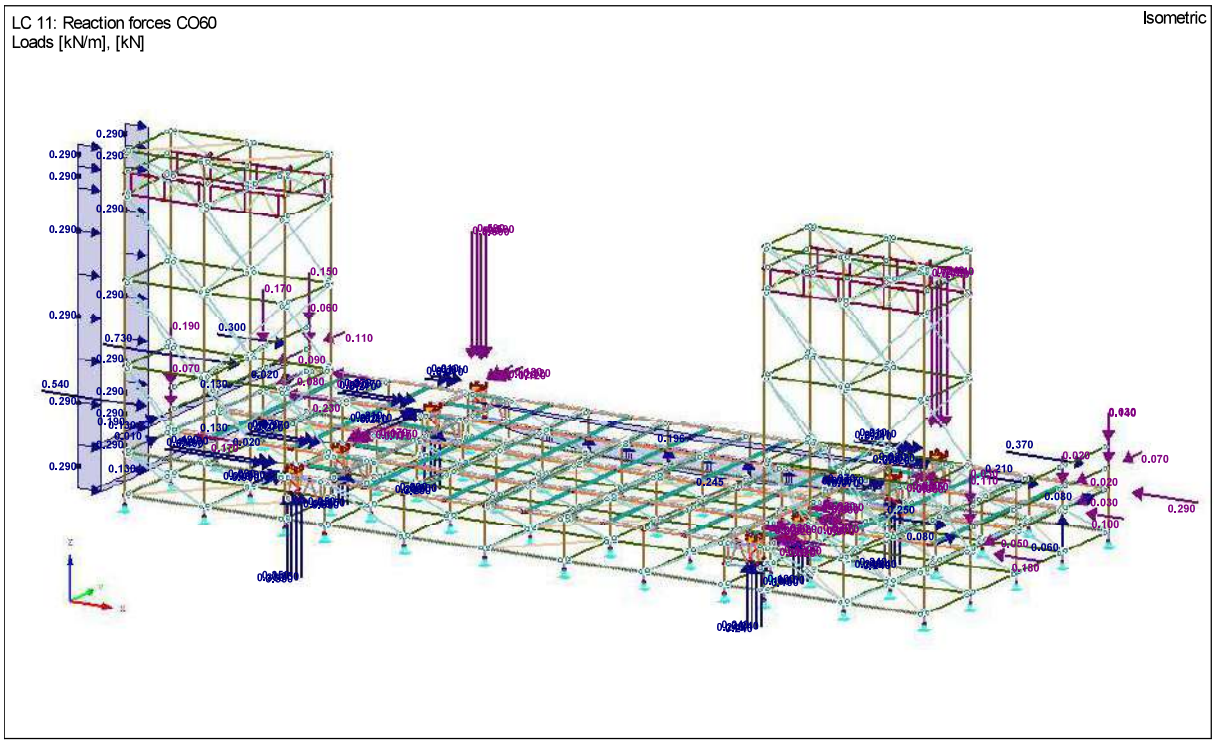
Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.848 / 0.8 = 1.060 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

6.2.8 LC11: Reaction forces CO60.

Reaction forces Mini Tunnel roof construction

Node	Support Forces [kN]			Support Moments [kNm]		
No.	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	1,95	0,34	1,40	0,00	0,00	-0,03
11	-0,49	-0,08	0,96	0,00	0,00	-0,01
19	1,07	-0,67	0,19	0,00	0,00	0,16
29	-0,29	-0,10	0,39	0,00	0,00	-0,04
37	0,03	-0,47	-2,37	0,00	0,00	0,06
47	0,84	0,07	-2,96	0,00	0,00	-0,02
55	1,08	0,84	0,79	0,00	0,00	0,06
65	-0,18	0,26	0,96	0,00	0,00	-0,02
102	-0,66	0,05	-0,27	0,00	0,00	0,11
105	2,14	0,75	-0,77	0,00	0,00	-0,46
115	-0,91	-0,32	0,07	0,00	0,00	-0,12
118	2,91	-0,37	-0,66	0,00	0,00	0,56
128	-0,34	0,09	-0,25	0,00	0,00	-0,06
131	1,18	-0,43	-0,60	0,00	0,00	0,25
147	-0,72	-0,21	-0,42	0,00	0,00	0,11
150	0,99	0,31	-0,11	0,00	0,00	-0,15
160	-0,39	-0,13	-0,09	0,00	0,00	-0,08
163	0,82	-0,06	0,24	0,00	0,00	0,14
173	-1,14	0,30	-0,55	0,00	0,00	-0,17
176	1,49	-0,28	-0,12	0,00	0,00	0,24
Σ Forces	9,38	-0,11	-4,17			
Σ Loads	9,38	-0,11	-4,17			

Load input in Layher stage model.



The loading of the wind on the stage, PA wing and part of the loading of the wind on the back wall are added as member loads on the model.

Wind on stage
$q_{w,\ stage} = 1.4 * 0.2 * 1 = 0.290$ kN/m
this is divided on the top and bottom ledger of the stage

Wind on PA wing.
Wind on outer Layher Pole
qw = 1.4 * 0.2 * 1.036 = 0.29

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 0.3 * 0.2 * 6.525 * 0.5 = 0.196 kN/m
$q_{w,\ back\ wall\ side}$ = 0.3 * 0.2 * 0 = 0 kN/m

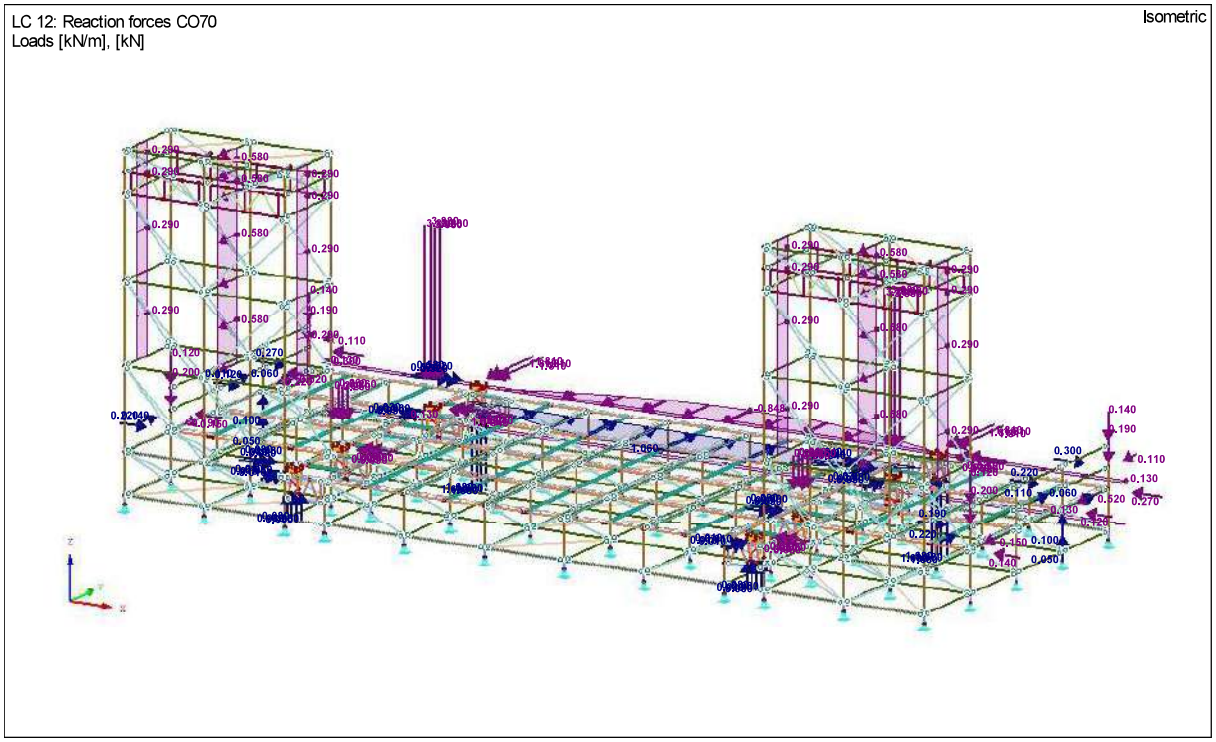
Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.196 / 0.8 = 0.245 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

6.2.9 LC12: Reaction forces CO70.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	0,33	0,03	0,32	0,00	0,00	0,00
11	-0,33	0,03	0,32	0,00	0,00	0,00
19	-0,35	-0,01	-1,05	0,00	0,00	0,04
29	0,35	-0,01	-1,05	0,00	0,00	-0,04
37	2,06	-7,23	6,70	0,00	0,00	0,10
47	-2,06	-7,23	6,70	0,00	0,00	-0,10
55	-4,14	0,10	-15,52	0,00	0,00	0,04
65	4,14	0,10	-15,51	0,00	0,00	-0,04
102	0,57	-0,59	-0,80	0,00	0,00	-0,05
105	-0,77	0,86	-0,49	0,00	0,00	0,01
115	0,48	-2,07	0,18	0,00	0,00	0,29
118	-0,88	0,43	0,38	0,00	0,00	-0,24
128	1,08	0,25	-0,75	0,00	0,00	0,17
131	-1,18	-0,43	-0,54	0,00	0,00	-0,21
147	-0,57	-0,59	-0,80	0,00	0,00	0,05
150	0,77	0,86	-0,49	0,00	0,00	-0,01
160	-0,48	-2,06	0,18	0,00	0,00	-0,29
163	0,88	0,43	0,38	0,00	0,00	0,24
173	-1,08	0,25	-0,75	0,00	0,00	-0,17
176	1,18	-0,43	-0,54	0,00	0,00	0,21
Σ Forces	0,00	-17,30	-23,15			
Σ Loads	0,00	-17,30	-23,15			

Load input in Layher stage model.



The loading of the wind on the stage, PA wing and part of the loading of the wind on the back wall are added as member loads on the model.

Wind on stage
$q_{w,\ stage} = 1.4 * 0.2 * 1 = 0.290$ kN/m
this is divided on the top and bottom ledger of the stage

Wind on PA wing.
Wind on outer Layher Pole
qw = 1.4 * 0.2 * 1.036 = 0.29

Wind on middle Layher Pole
qw = 1.4 * 0.2 * 2.072 = 0.58

Wind on the back-wall canopy.
The round back wall canopy is attached to Truss 4 and the Layher stage. The load will be divided as a parabolic load on Truss 1 and the Layher stage. The height in the center of the roof is 6.55m
$q_{w,\ back\ wall\ mid}$ = 1.3 * 0.2 * 6.525 * 0.5 = 0.848kN/m
$q_{w,\ back\ wall\ side}$ = 1.3 * 0.2 * 0 = 0 kN/m

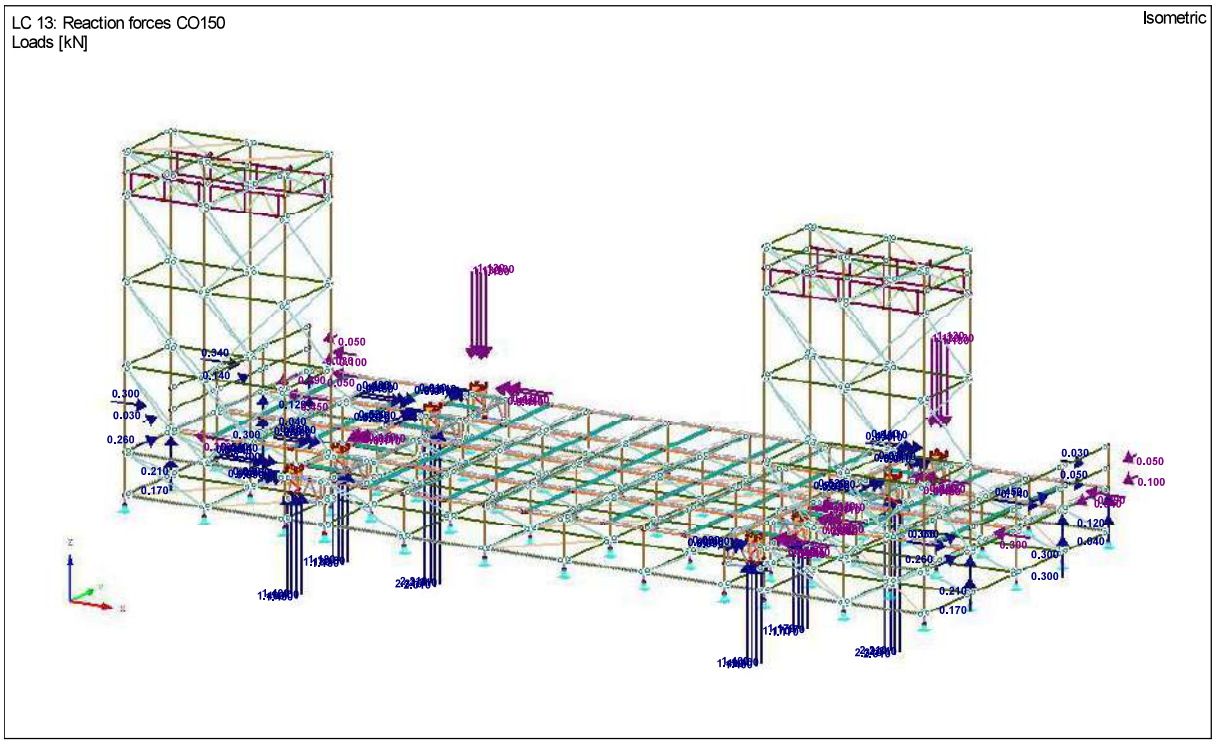
Membrane tension of the back-wall canopy.
The membrane tension of the round back wall canopy will be divided as a parabolic load on Truss 1 and the Layher stage.
$q_{mt,\ back\ wall\ mid}$ = 0.848 / 0.8 = 1.060 kN/m
$q_{mt,\ back\ wall\ side}$ = 0 / 0.8 = 0 kN/m

6.2.10 LC13: Reaction forces CO150.

Reaction forces Mini Tunnel roof construction

Node No.	Support Forces [kN]			Support Moments [kNm]		
	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	2,14	0,37	5,61	0,00	0,00	-0,03
11	-2,14	0,37	5,61	0,00	0,00	0,03
19	1,13	-0,44	4,70	0,00	0,00	0,19
29	-1,13	-0,44	4,69	0,00	0,00	-0,19
37	-1,64	0,02	-4,51	0,00	0,00	0,04
47	1,64	0,02	-4,52	0,00	0,00	-0,04
55	1,92	2,08	9,22	0,00	0,00	0,02
65	-1,92	2,08	9,23	0,00	0,00	-0,02
102	-1,39	1,02	0,68	0,00	0,00	0,15
105	1,19	0,12	0,82	0,00	0,00	-0,22
115	-1,81	-1,15	1,21	0,00	0,00	-0,22
118	1,34	0,57	1,20	0,00	0,00	0,18
128	-0,18	-0,39	0,14	0,00	0,00	0,00
131	-0,13	-0,19	0,49	0,00	0,00	0,00
147	1,39	1,02	0,68	0,00	0,00	-0,15
150	-1,18	0,12	0,82	0,00	0,00	0,22
160	1,81	-1,14	1,21	0,00	0,00	0,22
163	-1,34	0,57	1,20	0,00	0,00	-0,18
173	0,18	-0,39	0,14	0,00	0,00	0,00
176	0,13	-0,19	0,49	0,00	0,00	0,00
Σ Forces	0,00	4,02	39,12			
Σ Loads	0,00	4,02	39,12			

Load input in Layher stage model.



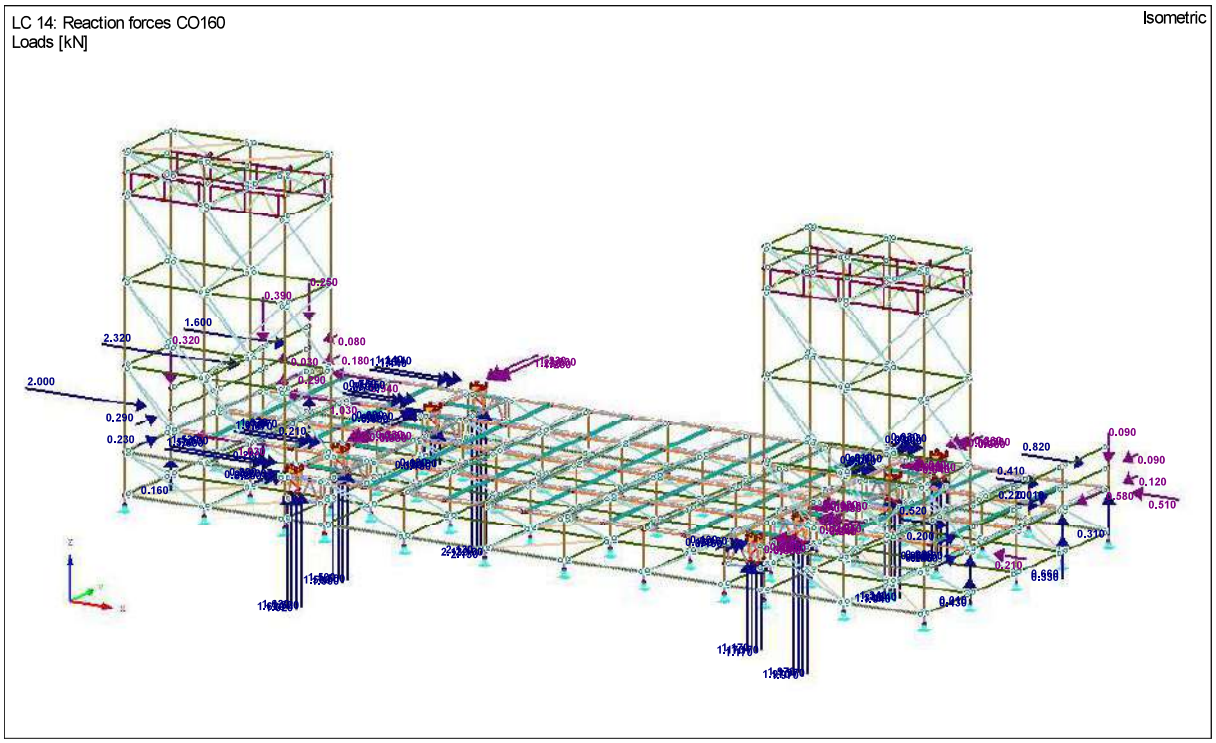
During the Out-service situation, the back wall and the stage scrim need to be removed therefor no extra loading will be added to the model.

6.2.11 LC14: Reaction forces CO160.

Reaction forces Mini Tunnel roof construction

Node	Support Forces [kN]			Support Moments [kNm]		
No.	$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$
1	6,11	0,78	6,46	0,00	0,00	-0,13
11	-0,19	0,64	4,69	0,00	0,00	0,13
19	4,29	-1,33	6,01	0,00	0,00	0,30
29	-0,94	-0,73	7,87	0,00	0,00	-0,22
37	4,55	-4,92	8,52	0,00	0,00	0,04
47	0,12	-1,43	3,85	0,00	0,00	0,01
55	2,98	2,38	0,73	0,00	0,00	0,05
65	0,03	-0,14	5,35	0,00	0,00	0,04
102	-4,12	0,91	0,63	0,00	0,00	0,63
105	7,98	1,15	-1,29	0,00	0,00	-1,56
115	-4,11	-1,17	1,11	0,00	0,00	-0,60
118	9,28	-0,12	-1,56	0,00	0,00	1,69
128	-3,77	-0,70	0,82	0,00	0,00	-0,60
131	6,38	-0,33	-1,01	0,00	0,00	1,17
147	-0,82	0,94	0,04	0,00	0,00	0,24
150	2,07	0,80	1,71	0,00	0,00	-0,28
160	0,03	-2,31	1,33	0,00	0,00	-0,21
163	1,63	0,86	2,62	0,00	0,00	0,40
173	-2,04	-0,47	-0,34	0,00	0,00	-0,41
176	3,26	-0,36	1,23	0,00	0,00	0,57
Σ Forces	32,71	-5,53	48,76			
Σ Loads	32,71	-5,53	48,76			

Load input in Layher stage model.



During the Out-service situation, the back wall and the stage scrim need to be removed therefor no extra loading will be added to the model.

6.3 Results summary of the Layher stage Calculation.

	Description	Value	Unit	Comment
	Summary			
	Calculation Status	OK		
	Maximum displacement in X-direction	12,6	mm	CO5, Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	-5,9	mm	CO3, Member No. 1973, x: 0.000 m
	Maximum displacement in Z-direction	-19,5	mm	CO3, Member No. 599, x: 1.036 m
	Maximum vectorial displacement	19,5	mm	CO3, Member No. 599, x: 1.036 m
	Maximum rotation about X-axis	33,9	mrad	CO3, Member No. 599, x: 0.000 m
	Maximum rotation about Y-axis	41,9	mrad	CO3, FE Mesh Node No. 253 (X: 4.375, Y: -5.187, Z: 0.314 m)
	Maximum rotation about Z-axis	-9,8	mrad	CO3, Member No. 1956, x: 0.000 m
	Number of 1D finite elements (member elements)	4297		
	Number of 2D finite elements (surface elements)	4928		
	Number of 3D finite elements (solid elements)	0		
	Number of FE mesh nodes	5878		
	Number of equations	35268		
	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		
	Activate ineffective supports	+		
	Precision of convergence criteria of nonlinear calculation	1,0		

6.3.1 Result for the single load cases LC1 to LC5.

	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	-77,39	kN	
	Sum of support forces in Z	-77,39	kN	Deviation: 0.00 %
	Resultant of reactions about X	-3,724	kNm	At center of gravity of model (X: 6.216, Y: -2.632, Z: 1.206 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. 884, x: 1.440 m
	Maximum displacement in Y-direction	-0,8	mm	Member No. 933, x: 1.440 m
	Maximum displacement in Z-direction	-1,7	mm	Member No. 1067, x: 1.465 m
	Maximum vectorial displacement	1,7	mm	Member No. 1069, x: 1.465 m
	Maximum rotation about X-axis	-1,3	mrad	Member No. 1045, x: 2.930 m
	Maximum rotation about Y-axis	1,3	mrad	Member No. 697, x: 0.000 m
	Maximum rotation about Z-axis	-0,2	mrad	Member No. 92, x: 0.500 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC2 - ballast loading			
	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	-124,00	kN	
	Sum of support forces in Z	-124,01	kN	Deviation: -0.01 %
	Resultant of reactions about X	25,877	kNm	At center of gravity of model (X: 6.216, Y: -2.632, Z: 1.206 m)
	Resultant of reactions about Y	-0,004	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	0,0	mm	Member No. 93, x: 1.150 m
	Maximum displacement in Y-direction	0,0	mm	Member No. 1070, x: 2.930 m
	Maximum displacement in Z-direction	-15,8	mm	Member No. 599, x: 1.036 m
	Maximum vectorial displacement	15,8	mm	Member No. 599, x: 1.036 m
	Maximum rotation about X-axis	27,8	mrad	Member No. 337, x: 2.072 m
	Maximum rotation about Y-axis	-19,8	mrad	Member No. 1043, x: 0.000 m
	Maximum rotation about Z-axis	0,0	mrad	Member No. 1038, x: 2.301 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC3 - PA wing loading			
	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	-32,00	kN	
	Sum of support forces in Z	-32,08	kN	Deviation: -0.24 %
	Resultant of reactions about X	81,653	kNm	At center of gravity of model (X: 6.216, Y: -2.632, Z: 1.206 m)
	Resultant of reactions about Y	0,007	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	0,1	mm	Member No. 1769, x: 0.667 m
	Maximum displacement in Y-direction	-0,5	mm	Member No. 1495, x: 0.500 m
	Maximum displacement in Z-direction	-1,3	mm	Member No. 792, x: 1.036 m
	Maximum vectorial displacement	1,3	mm	Member No. 792, x: 1.036 m
	Maximum rotation about X-axis	-1,1	mrad	Member No. 1214, x: 0.000 m
	Maximum rotation about Y-axis	-0,5	mrad	Member No. 1198, x: 0.032 m
	Maximum rotation about Z-axis	-1,1	mrad	Member No. 129, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC4 - floor loading 0°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	46,41	kN	
	Sum of support forces in Y	46,41	kN	Deviation: 0.00 %
	Sum of loads in Z	-464,13	kN	
	Sum of support forces in Z	-464,13	kN	Deviation: 0.00 %
	Resultant of reactions about X	-401,583	kNm	At center of gravity of model (X: 6.216, Y: -2.632, Z: 1.206 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	2,5	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	1,7	mm	Member No. 320, x: 0.571 m
	Maximum displacement in Z-direction	-9,8	mm	FE Mesh Node No. 5608 (X: 9.765, Y: 1.037, Z: 0.314 m)
	Maximum vectorial displacement	9,9	mm	FE Mesh Node No. 5608 (X: 9.765, Y: 1.037, Z: 0.314 m)
	Maximum rotation about X-axis	16,3	mrad	FE Mesh Node No. 3243 (X: 15.048, Y: 1.800, Z: 0.314 m)
	Maximum rotation about Y-axis	20,5	mrad	FE Mesh Node No. 3016 (X: -0.805, Y: -1.043, Z: 0.314 m)
	Maximum rotation about Z-axis	1,6	mrad	Member No. 726, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC5 - floor loading 90°			
	Sum of loads in X	46,41	kN	
	Sum of support forces in X	46,41	kN	Deviation: 0.00 %

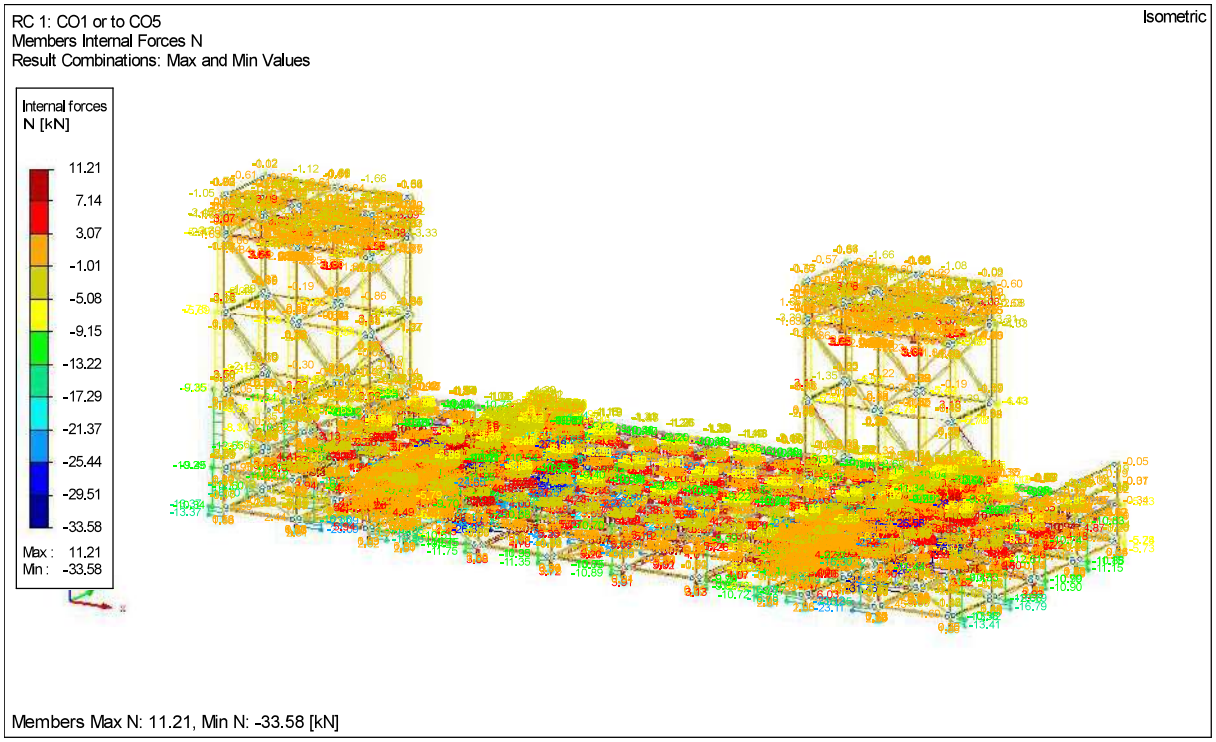
	Sum of loads in Y	0,00	kN	
	Sum of support forces in Y	0,00	kN	
	Sum of loads in Z	-464,13	kN	
	Sum of support forces in Z	-464,13	kN	Deviation: 0.00 %
	Resultant of reactions about X	-440,211	kNm	At center of gravity of model (X: 6.216, Y: -2.632, Z: 1.206 m)
	Resultant of reactions about Y	-38,628	kNm	At center of gravity of model
	Resultant of reactions about Z	-44,021	kNm	At center of gravity of model
	Maximum displacement in X-direction	3,1	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	1,0	mm	Member No. 31, x: 0.667 m
	Maximum displacement in Z-direction	-9,8	mm	FE Mesh Node No. 3264 (X: 14.945, Y: 1.037, Z: 0.314 m)
	Maximum vectorial displacement	9,9	mm	FE Mesh Node No. 5096 (X: 2.667, Y: 1.035, Z: 0.314 m)
	Maximum rotation about X-axis	16,2	mrad	FE Mesh Node No. 3243 (X: 15.048, Y: 1.800, Z: 0.314 m)
	Maximum rotation about Y-axis	-20,5	mrad	FE Mesh Node No. 3714 (X: 13.237, Y: -1.029, Z: 0.314 m)
	Maximum rotation about Z-axis	-1,6	mrad	Member No. 844, x: 2.880 m
	Method of analysis	Linear		Geometrically Linear Analysis
	LC6 - floor loading 180°			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-46,41	kN	
	Sum of support forces in Y	-46,41	kN	Deviation: 0.00 %
	Sum of loads in Z	-464,13	kN	
	Sum of support forces in Z	-464,13	kN	Deviation: 0.00 %
	Resultant of reactions about X	-478,840	kNm	At center of gravity of model (X: 6.216, Y: -2.632, Z: 1.206 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	2,5	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	-1,7	mm	FE Mesh Node No. 5343 (X: 6.708, Y: 0.272, Z: 0.314 m)
	Maximum displacement in Z-direction	-9,8	mm	FE Mesh Node No. 125 (X: 2.667, Y: -5.181, Z: 0.314 m)
	Maximum vectorial displacement	9,9	mm	FE Mesh Node No. 125 (X: 2.667, Y: -5.181, Z: 0.314 m)
	Maximum rotation about X-axis	16,2	mrad	FE Mesh Node No. 3243 (X: 15.048, Y: 1.800, Z: 0.314 m)
	Maximum rotation about Y-axis	20,5	mrad	FE Mesh Node No. 3016 (X: -0.805, Y: -1.043, Z: 0.314 m)
	Maximum rotation about Z-axis	1,7	mrad	Member No. 879, x: 0.000 m
	Method of analysis	Linear		Geometrically Linear Analysis

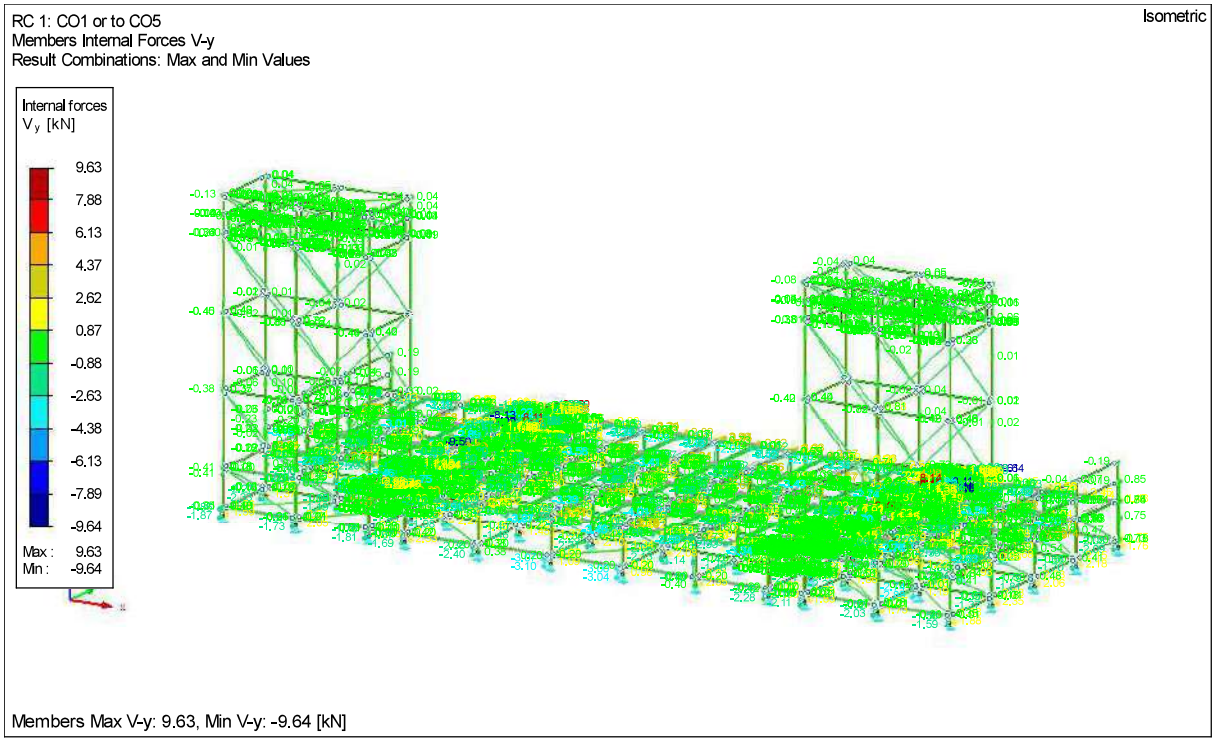
6.3.2 Result for the load combination CO1-CO5.

	Description	Value	Unit	Comment
	CO1 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC4 + 1.35*LC10			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	124,07	kN	
	Sum of support forces in Y	124,07	kN	Deviation: 0.00 %
	Sum of loads in Z	-875,26	kN	
	Sum of support forces in Z	-875,26	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	4,3	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	5,8	mm	Member No. 1949, x: 0.000 m
	Maximum displacement in Z-direction	-19,1	mm	FE Mesh Node No. 3264 (X: 14.945, Y: 1.037, Z: 0.314 m)
	Maximum vectorial displacement	19,2	mm	FE Mesh Node No. 3264 (X: 14.945, Y: 1.037, Z: 0.314 m)
	Maximum rotation about X-axis	-32,6	mrad	Member No. 431, x: 2.072 m
	Maximum rotation about Y-axis	41,8	mrad	FE Mesh Node No. 5202 (X: 4.375, Y: 1.029, Z: 0.314 m)
	Maximum rotation about Z-axis	9,7	mrad	Member No. 1934, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO2 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC5 + 1.35*LC11			
	Sum of loads in X	79,09	kN	
	Sum of support forces in X	79,09	kN	Deviation: 0.00 %
	Sum of loads in Y	2,24	kN	
	Sum of support forces in Y	2,24	kN	Deviation: 0.00 %
	Sum of loads in Z	-900,80	kN	
	Sum of support forces in Z	-900,80	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	8,3	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	-1,7	mm	FE Mesh Node No. 5794 (X: -2.616, Y: -3.872, Z: 0.314 m)
	Maximum displacement in Z-direction	-19,1	mm	FE Mesh Node No. 2082 (X: -2.513, Y: 1.035, Z: 0.314 m)
	Maximum vectorial displacement	19,2	mm	FE Mesh Node No. 2082 (X: -2.513, Y: 1.035, Z: 0.314 m)
	Maximum rotation about X-axis	-32,6	mrad	Member No. 599, x: 2.072 m
	Maximum rotation about Y-axis	41,7	mrad	FE Mesh Node No. 253 (X: 4.375, Y: -5.187, Z: 0.314 m)
	Maximum rotation about Z-axis	-2,7	mrad	Member No. 70, x: 2.072 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO3 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC6 + 1.35*LC12			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	-103,53	kN	
	Sum of support forces in Y	-103,53	kN	Deviation: 0.00 %
	Sum of loads in Z	-928,42	kN	
	Sum of support forces in Z	-928,42	kN	Deviation: 0.00 %

	Maximum displacement in X-direction	3,0	mm	Member No. 88, x: 0.000 m
	Maximum displacement in Y-direction	-5,9	mm	Member No. 1973, x: 0.000 m
	Maximum displacement in Z-direction	-19,5	mm	Member No. 599, x: 1.036 m
	Maximum vectorial displacement	19,5	mm	Member No. 599, x: 1.036 m
	Maximum rotation about X-axis	33,9	mrad	Member No. 599, x: 0.000 m
	Maximum rotation about Y-axis	41,9	mrad	FE Mesh Node No. 253 (X: 4.375, Y: -5.187, Z: 0.314 m)
	Maximum rotation about Z-axis	-9,8	mrad	Member No. 1956, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO4 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC13			
	Sum of loads in X	0,00	kN	
	Sum of support forces in X	0,00	kN	
	Sum of loads in Y	5,48	kN	
	Sum of support forces in Y	5,48	kN	Deviation: 0.00 %
	Sum of loads in Z	-231,16	kN	
	Sum of support forces in Z	-231,16	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	1,7	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	1,3	mm	Member No. 1949, x: 0.000 m
	Maximum displacement in Z-direction	-18,7	mm	Member No. 580, x: 1.036 m
	Maximum vectorial displacement	18,7	mm	Member No. 580, x: 1.036 m
	Maximum rotation about X-axis	32,8	mrad	Member No. 580, x: 0.000 m
	Maximum rotation about Y-axis	-23,7	mrad	Member No. 757, x: 0.000 m
	Maximum rotation about Z-axis	2,7	mrad	Member No. 1934, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T
	CO5 - 1.15*LC1 + 1.15*LC2 + 1.35*LC3 + 1.35*LC14			
	Sum of loads in X	28,24	kN	
	Sum of support forces in X	28,24	kN	Deviation: 0.00 %
	Sum of loads in Y	-6,63	kN	
	Sum of support forces in Y	-6,63	kN	Deviation: 0.00 %
	Sum of loads in Z	-214,29	kN	
	Sum of support forces in Z	-214,29	kN	Deviation: 0.00 %
	Maximum displacement in X-direction	12,6	mm	Member No. 89, x: 2.072 m
	Maximum displacement in Y-direction	-3,2	mm	Member No. 1973, x: 0.000 m
	Maximum displacement in Z-direction	-18,7	mm	Member No. 575, x: 1.036 m
	Maximum vectorial displacement	18,7	mm	Member No. 575, x: 1.036 m
	Maximum rotation about X-axis	-32,7	mrad	Member No. 575, x: 0.000 m
	Maximum rotation about Y-axis	-24,2	mrad	Member No. 757, x: 0.000 m
	Maximum rotation about Z-axis	-6,5	mrad	Member No. 1956, x: 0.000 m
	Method of analysis	2nd Order		Second order analysis (Nonlinear)
	Internal forces referred to deformed system for...	+		N, V_y, V_z, M_y, M_z, M_T

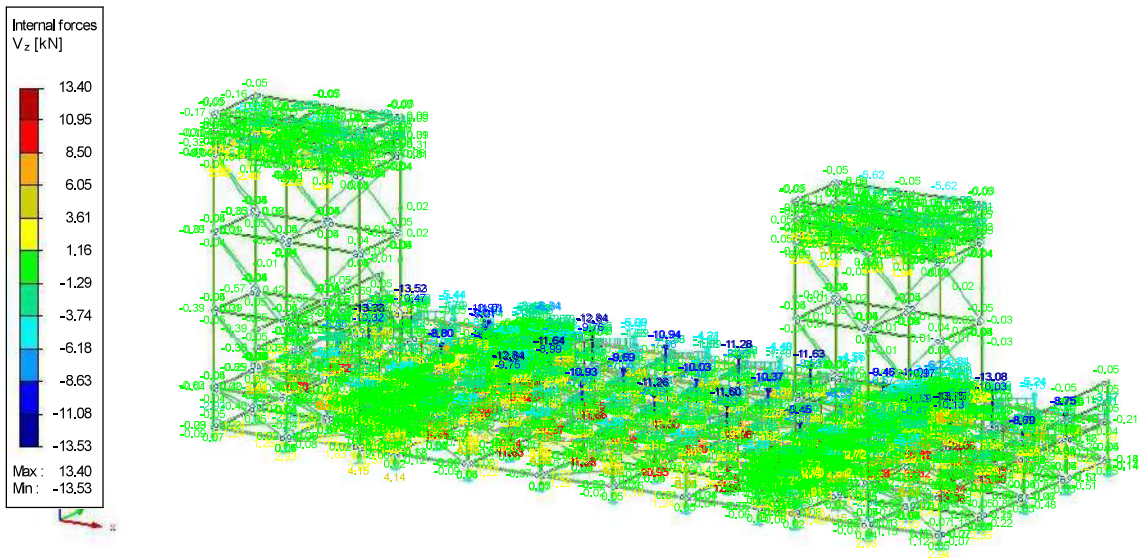
6.3.3 internal force diagrams –load combinations Design values: 1 * (CO1 or to CO5).





RC 1: CO1 or to CO5
Members Internal Forces V-z
Result Combinations: Max and Min Values

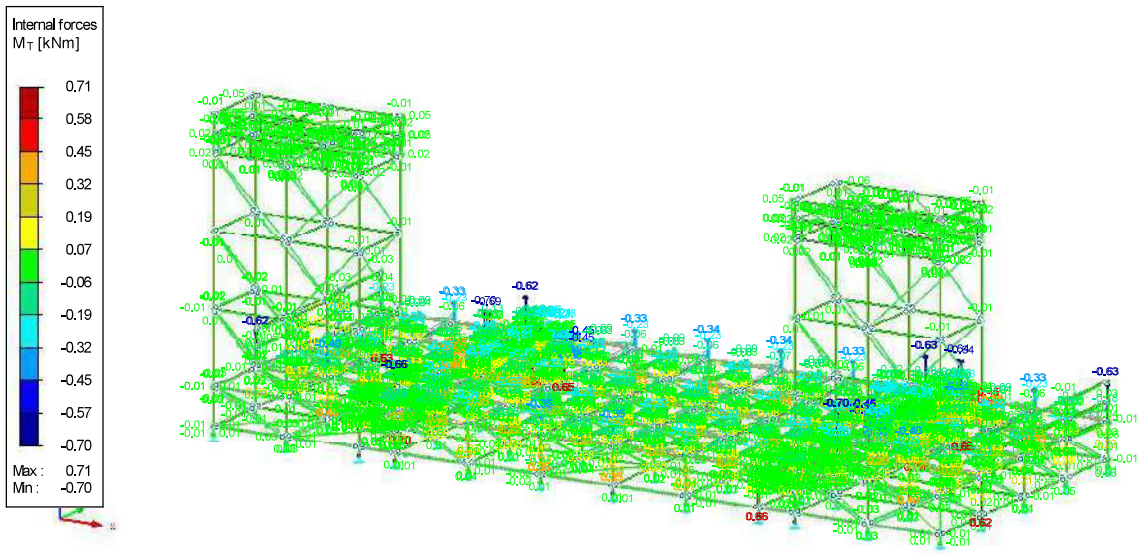
Isometric



Members Max V-z: 13.40, Min V-z: -13.53 [kN]

RC 1: CO1 or to CO5
Members Internal Forces M-T
Result Combinations: Max and Min Values

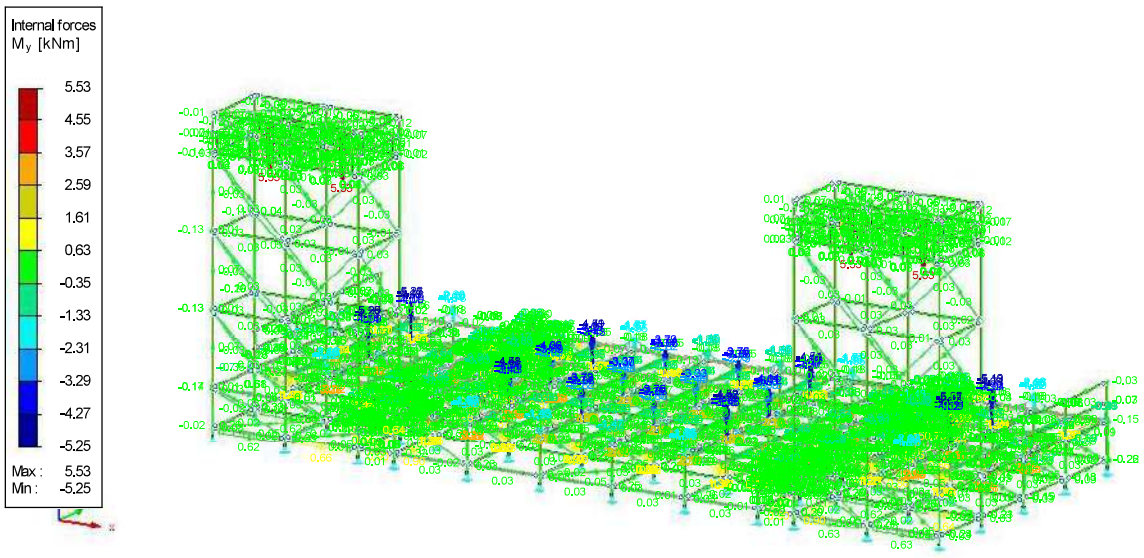
Isometric



Members Max M-T: 0.71, Min M-T: -0.70 [kNm]

RC 1: CO1 or to CO5
Members Internal Forces M-y
Result Combinations: Max and Min Values

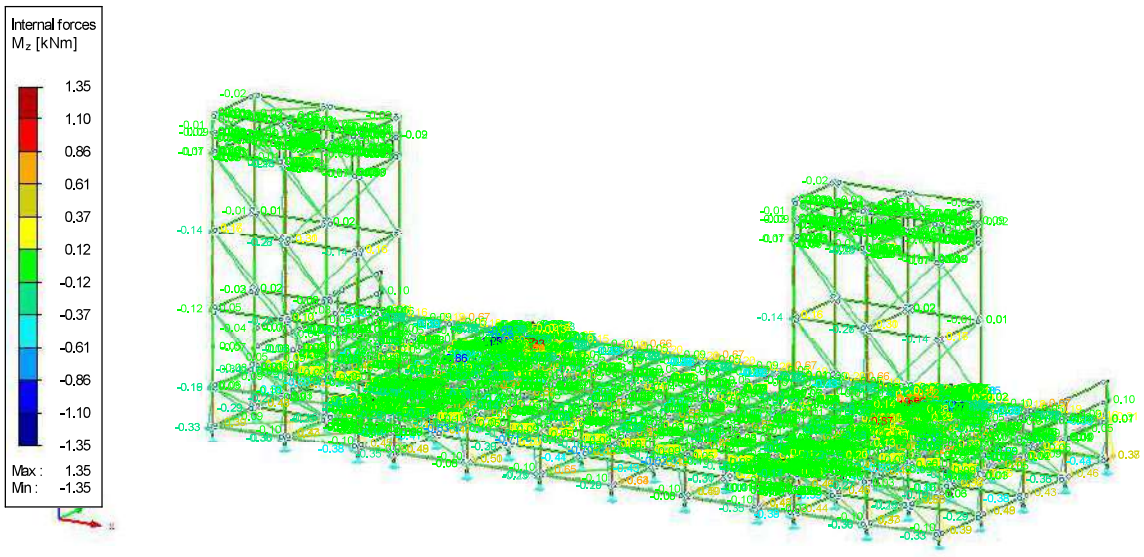
Isometric



Members Max M-y: 5.53, Min M-y: -5.25 [kNm]

RC 1: CO1 or to CO5
Members Internal Forces M-z
Result Combinations: Max and Min Values

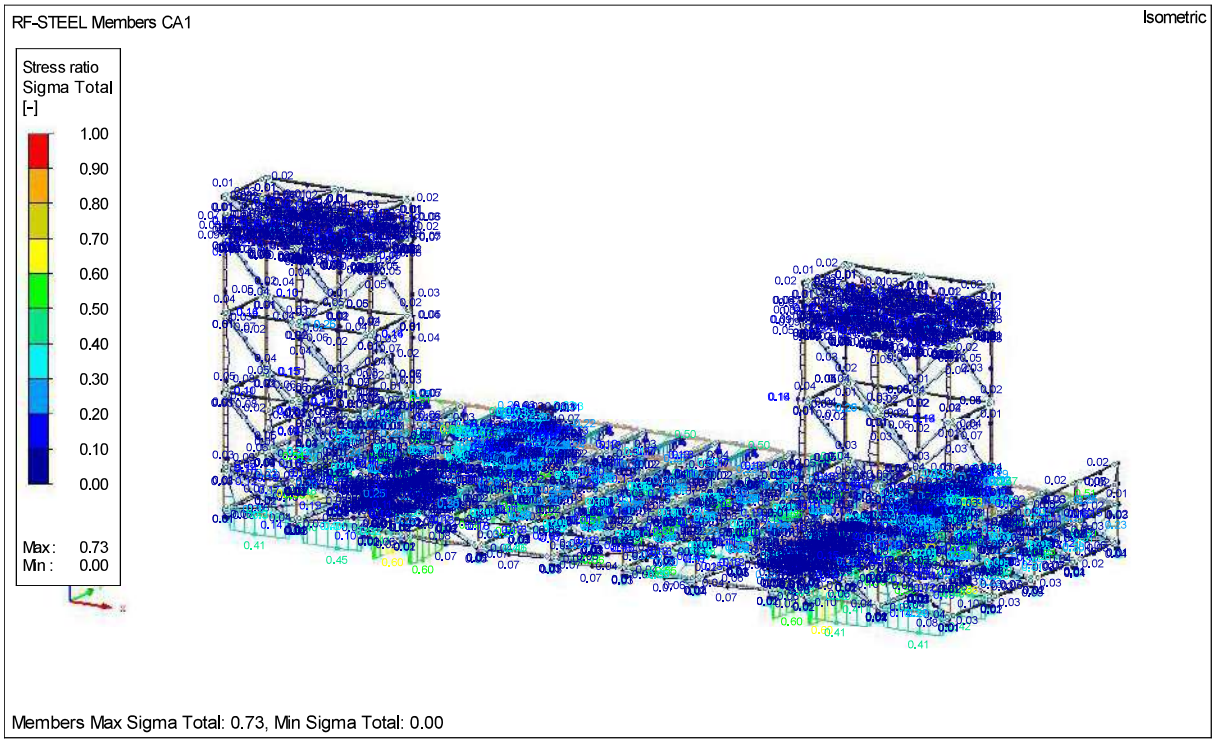
Isometric

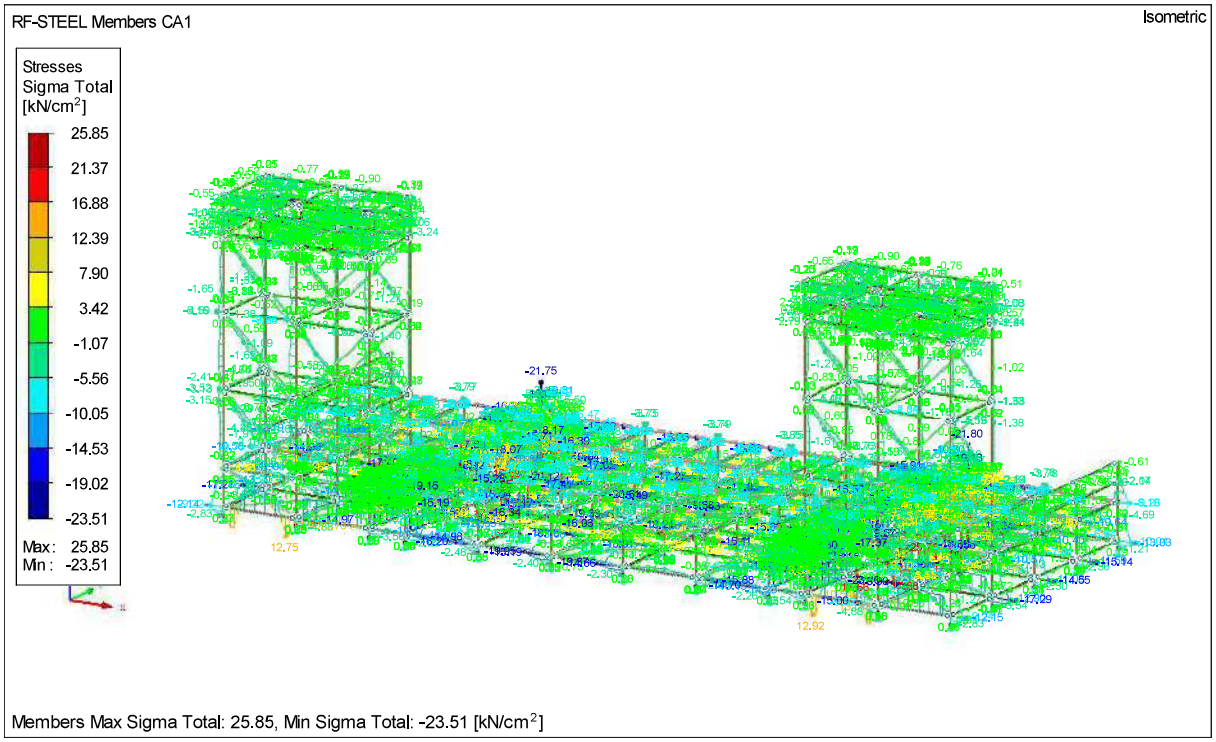


Members Max M-z: 1.35, Min M-z: -1.35 [kNm]

6.4 Stress analyse calculation for the stage components.

For the complete stage a stress calculation has been made.





Result of the stress analyse by 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 51/5							
	1934	0,134	24	CO1	Sigma Total	25,85	35,50	0,73
	1824	0,000	23	CO1	Tau Total	8,98	20,50	0,44
	1934	0,134	24	CO1	Sigma-eqv	27,26	35,50	0,77
2	QRO 50x4 (Hot Formed)							
	209	0,033	14	CO1	Sigma Total	14,90	23,50	0,63
	209	0,000	11	CO1	Tau Total	-5,06	13,57	0,37
	209	0,033	14	CO1	Sigma-eqv	15,52	23,50	0,66
3	Ring 30/3							
	1964	0,500	11	CO1	Sigma Total	8,07	23,50	0,34
	1942	0,250	35	CO1	Tau Total	-1,88	13,57	0,14
	1964	0,500	11	CO1	Sigma-eqv	8,07	23,50	0,34
4	Rectangle 60/15							
	1951	0,065	2	CO1	Sigma Total	8,76	23,50	0,37
	1951	0,065	5	CO1	Tau Total	0,47	13,57	0,03
	1951	0,065	2	CO1	Sigma-eqv	8,76	23,50	0,37
5	Ring 20/2							
	1843	0,000	22	CO1	Sigma Total	7,57	23,50	0,32
	1976	0,322	35	CO3	Tau Total	-0,79	13,57	0,06
	1843	0,000	22	CO1	Sigma-eqv	7,64	23,50	0,33
6	RO 38x4.5 | DIN EN 10220							
	744	0,000	1	CO1	Sigma Total	-23,51	35,50	0,66
	259	0,210	10	CO1	Tau Total	1,50	20,50	0,07
	744	0,000	1	CO1	Sigma-eqv	23,51	35,50	0,66
7	RO 48.3x3.2 (Hot Formed)							
	47	0,500	19	CO1	Sigma Total	17,63	32,00	0,55
	1739	0,000	28	CO3	Tau Total	1,01	18,48	0,05
	47	0,500	19	CO1	Sigma-eqv	17,63	32,00	0,55
8	RO 48.3x3.2 (Hot Formed)							
	599	1,184	10	CO3	Sigma Total	-19,30	32,00	0,60
	423	0,000	19	CO2	Tau Total	-1,88	18,48	0,10
	599	1,184	10	CO3	Sigma-eqv	19,30	32,00	0,60
9	RO 48.3x3.2 (Hot Formed)							
	730	1,465	28	CO1	Sigma Total	1,71	32,00	0,05
	730	2,930	1	CO1	Tau Total	-0,13	18,48	0,01
	730	1,465	28	CO1	Sigma-eqv	1,72	32,00	0,05
10	RO 48.3x2.6 (Hot Formed)							
	740	1,150	10	CO1	Sigma Total	-3,05	23,50	0,13
	726	2,301	19	CO1	Tau Total	1,13	13,57	0,08
	740	1,150	10	CO1	Sigma-eqv	3,05	23,50	0,13
12	HK 50/30/4/4/4/4							
	467	2,072	10	CO3	Sigma Total	-8,53	22,50	0,38
	1299	2,072	8	CO2	Tau Total	2,88	12,99	0,22
	819	2,072	10	CO3	Sigma-eqv	8,66	22,50	0,38
13	IPE 160							
	929	1,036	1	CO3	Sigma Total	-5,35	23,50	0,23
	929	0,000	13	CO1	Tau Total	0,80	13,57	0,06
	929	1,036	1	CO3	Sigma-eqv	5,35	23,50	0,23
14	HK 30/20/2/2/2/2							
	1535	0,620	10	CO2	Sigma Total	-3,54	23,50	0,15
	1538	0,000	8	CO1	Tau Total	0,11	13,57	0,01
	1535	0,620	10	CO2	Sigma-eqv	3,54	23,50	0,15
15	RO 48.3x3.2 (Hot Formed)							
	1156	0,000	27	CO2	Sigma Total	-3,83	32,00	0,12
	1173	0,063	1	CO2	Tau Total	-1,37	18,48	0,07
	1156	0,000	27	CO2	Sigma-eqv	3,84	32,00	0,12

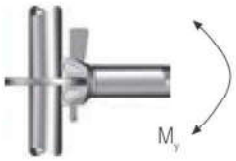
Maximum utilisation is 77% which occurs in the base unit of the tunnel stage.

6.5 Layher information design values.

The used Layher system is the Layher K2000+ system.
When parts need to be replaced by Layher Variant II system, take care that these will be in places with less internal forces.

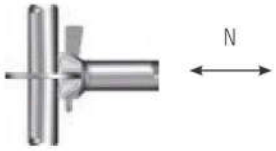
Z-8.22-64: K 2000+

Biegemoment



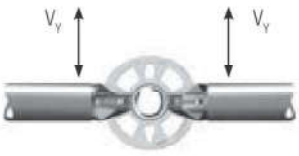
Biegemoment
$M_{y,Rd} = \pm 101{,}0$ kNcm

Normalkraft

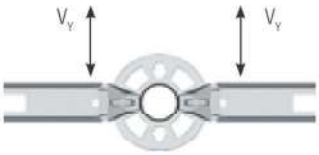


$N_{Rd} = \pm 31{,}0$ kN

Horizontale Querkraft



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



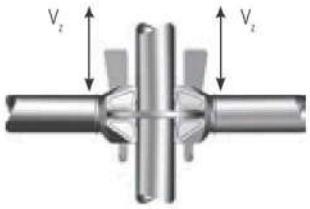
U-Riegel: $V_{y,Rd} = \pm 5{,}9$ kN

Torsionsmoment



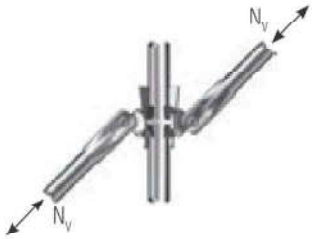
$M_{T,Rd} = \pm 52{,}5$ kNcm

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
$N_{V,Rd}$ [kN]	-16,1	-16,8	-15,5	-14,8	-12,4	-10,2	-8,3	-5,3	+17,9

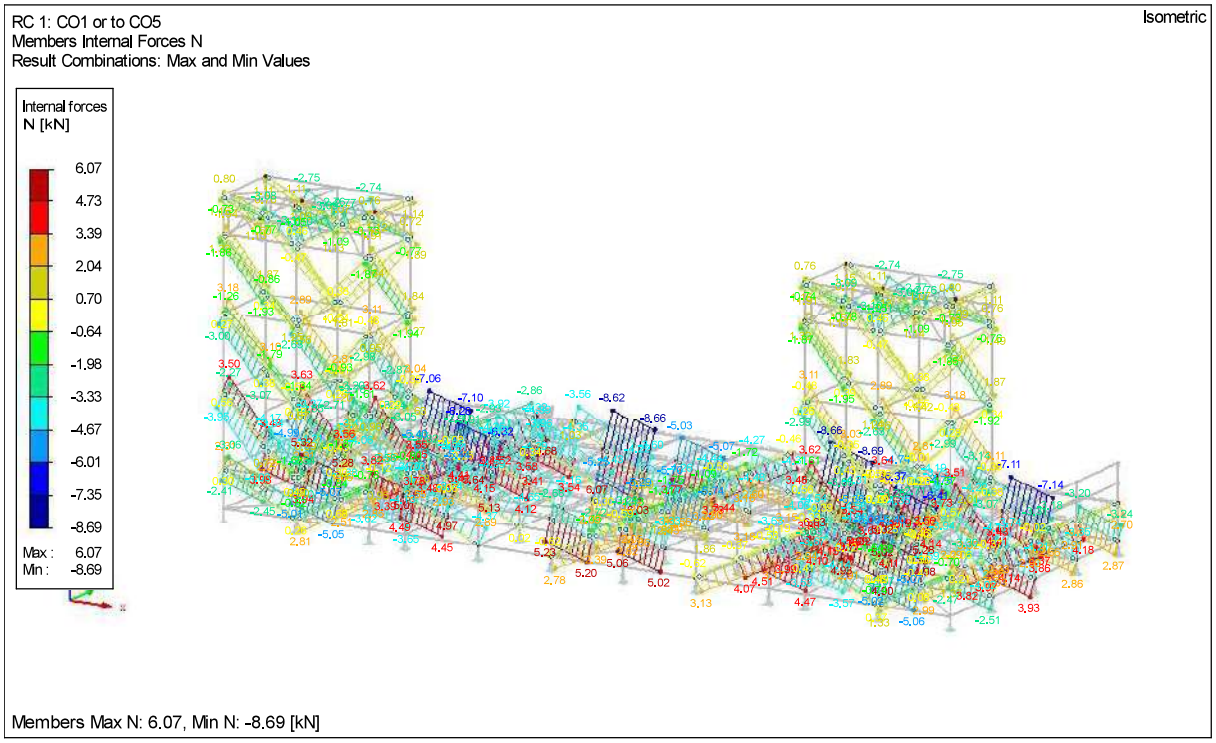
K 2000+ Bauteile können mit Bauteilen der Variante LW, Variante II und Variante I vermischt werden. Beanspruchbarkeiten siehe Zulassung Z-8.22-64 und Z-8.22-949.

Rd = Beanspruchbarkeit,
(enthält Teilsicherheitsbeiwert γ_M)

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

6.6 Check of the Layher diagonals.

The Maximum compression of the Layher K2000+ diagonals is according to the figure in chapter 6.5. In the next figure the minimum and maximum forces are displayed.



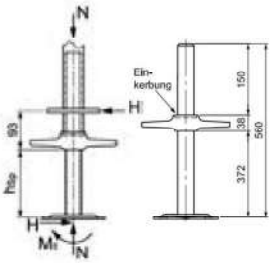
The maximum N_{ed} in a diagonal is 8.69 kN. According to the table on page 211 the maximum design force for this diagonal is 12.4 kN
Check of the diagonals
$N_{ed} / N_{rd} < 1$
$8.69 / 12.4 = 0.70 < 1$

6.7 Check of the Layher Spindle's.

In the next table the spindle loading capacity in conjunction with height is given

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

Aus-spindel-länge h_{sp} [cm]	Zulässige Vertikallast N [kN]* bei gleichzeitiger Wirkung einer Horizontallast H [kN]																								Zul. Hori-zontallast H [kN] wenn N = 0
	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		
	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

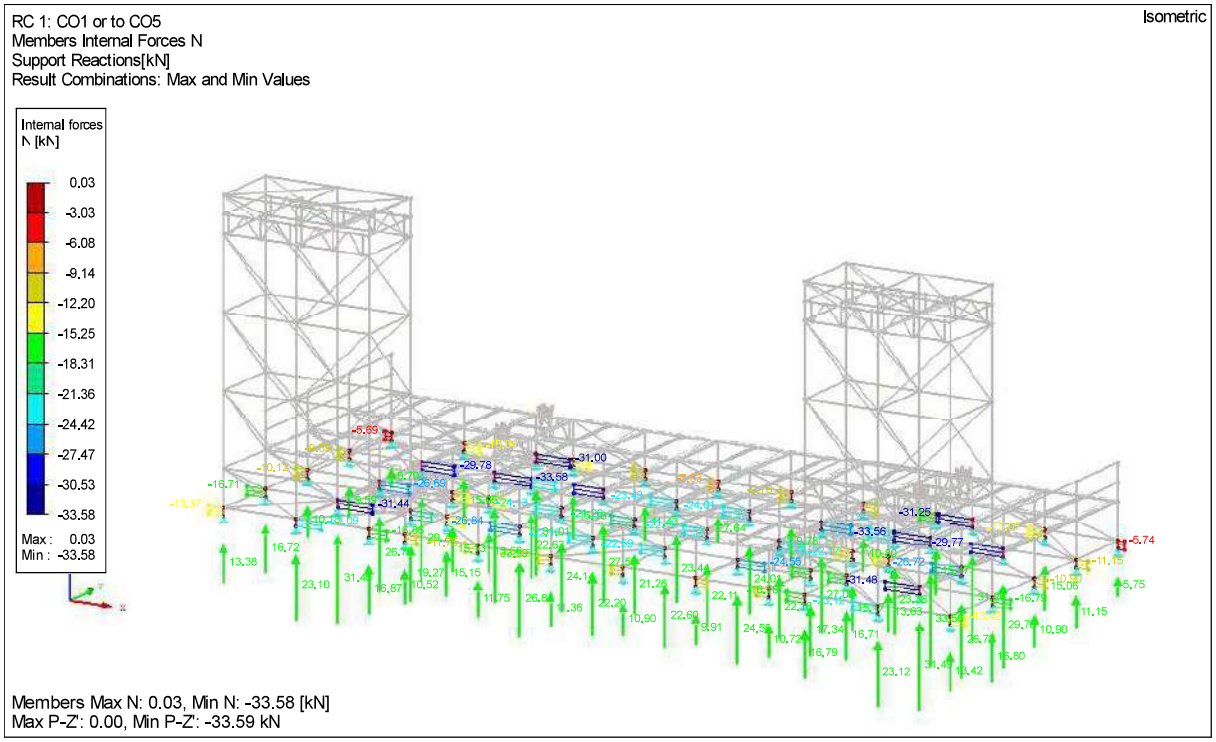
*Die zulässigen Vertikallasten wurden berechnet unter Anwendung des Berechnungsmodells nach DIN EN 12811-1, Abs. 10.2.3.2. Zur Erfassung der Biegesteifigkeit des Ständerrohres, der Schnittgrößenanteile aus Theorie II. Ordnung und der maximalen Beanspruchbarkeit der Ständer wurden folgende Raumgerüste 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.

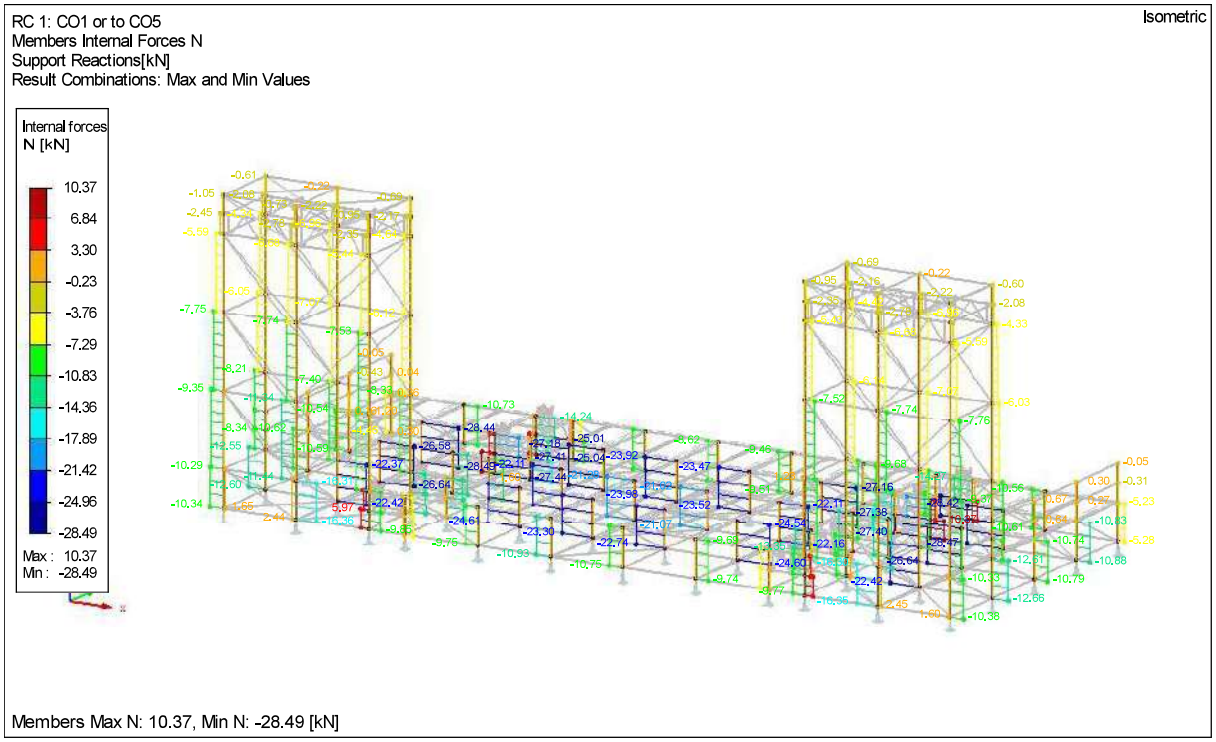
In the next figure the maximum support forces for Result combination are presented.



The maximum support force is 33.59kN.

The maximum total horizontal force is 103.53 kN. This force will be divided over the 60 spindles. 103.53 / 60 = 1.725 kN of horizontal force per spindle. According to the table of the Layher spindle the combination between the vertical and the horizontal force allows for a maximum spindle length of 15 cm on the highest loaded spindles.

6.8 Check of the Layher columns.



Proof against buckling.
$\beta = 0.9$
$L_{cr} = 0.9 * 100 = 90$ cm
$A = 4.53$ cm²
$I = 11.60$ cm^4
$W = 4.80$ cm³
$i = 1.60$cm

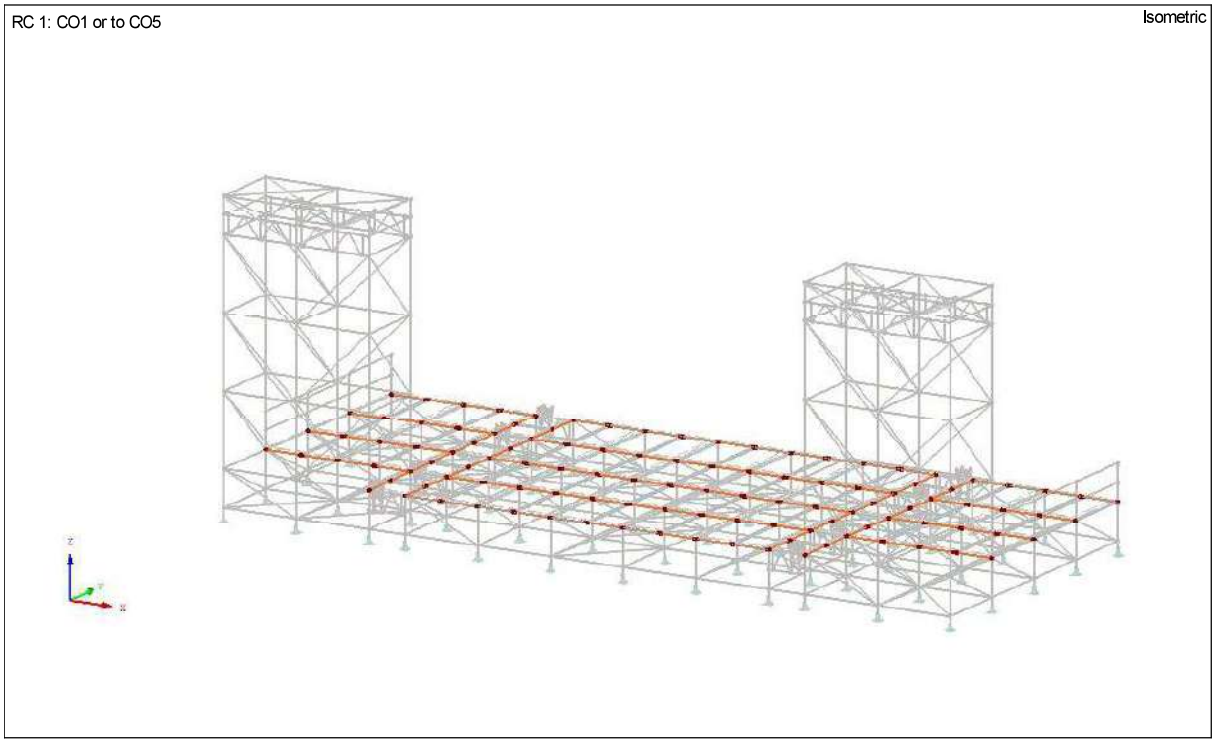
$\lambda_1 = \pi * \sqrt{(210000/320)} = 80{,}48$
$\overline{\lambda} = 90 / (1.6 * 80.48) = 0.699$
Buckling curve for hollow section line c (table 6.2 from en-1993-1-1)
$\alpha = 0{,}49$
$\Phi = 0.5 * (1 + \alpha * (\overline{\lambda} - 0.2) + \overline{\lambda}^2)$
$\Phi = 0.5 * (1 + 0.49 * (0.699 - 0.2) + 0.699^2) = 0.866$
$\chi_{min} = 1 / (\Phi + \sqrt{(\Phi^2 - \overline{\lambda}^2)})$
$\chi_{min} = 1 / (0.866 + \sqrt{(0.866^2 - 0.699^2)}) = 0.505$

$N_{b,rd} = \chi * A * f_0 / 1.1$
$N_{b,rd} = 0.505 * 4.53 * 32 / 1.1 = 66.59$ kN
$N_{ed,\,max} = 28.49$ kN

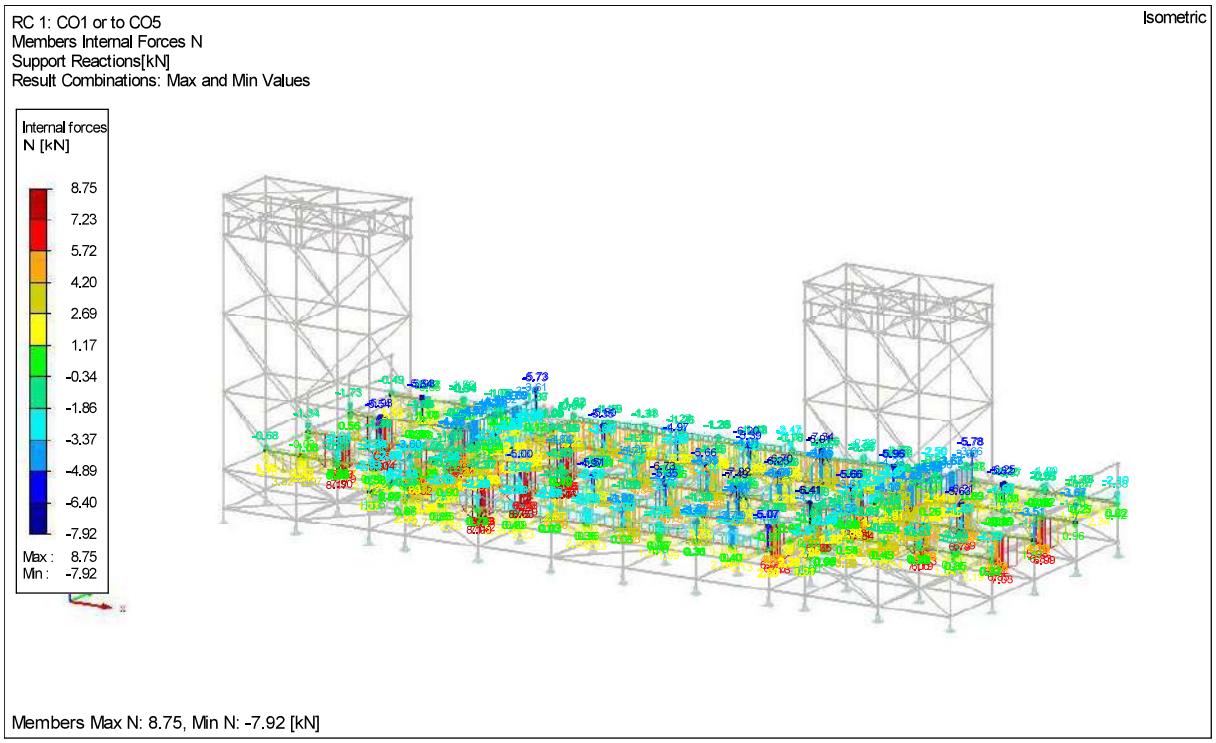
check = $N_{ed,\,max} / N_{b,rd} < 1$
$28.49 / 66.59 = 0.43 < 1$

6.9 Check of the Event Layher staging system.

The event Layher staging system exist of Layher transom beams with a decking system on top.

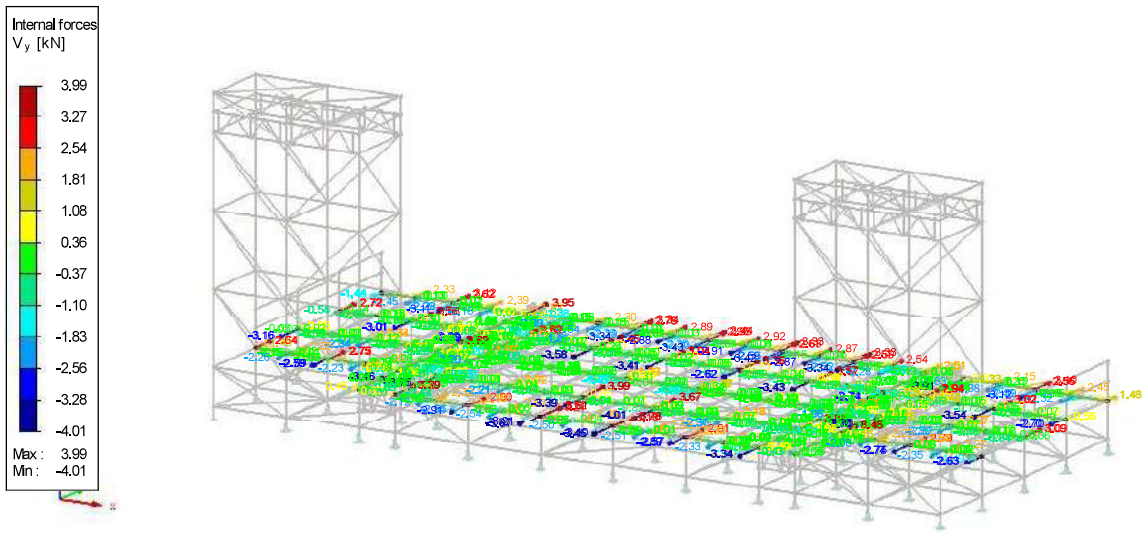


In the next figures the internal forces of the floor beam are shown.



RC 1: CO1 or to CO5
Members Internal Forces V-y
Support Reactions[kN]
Result Combinations: Max and Min Values

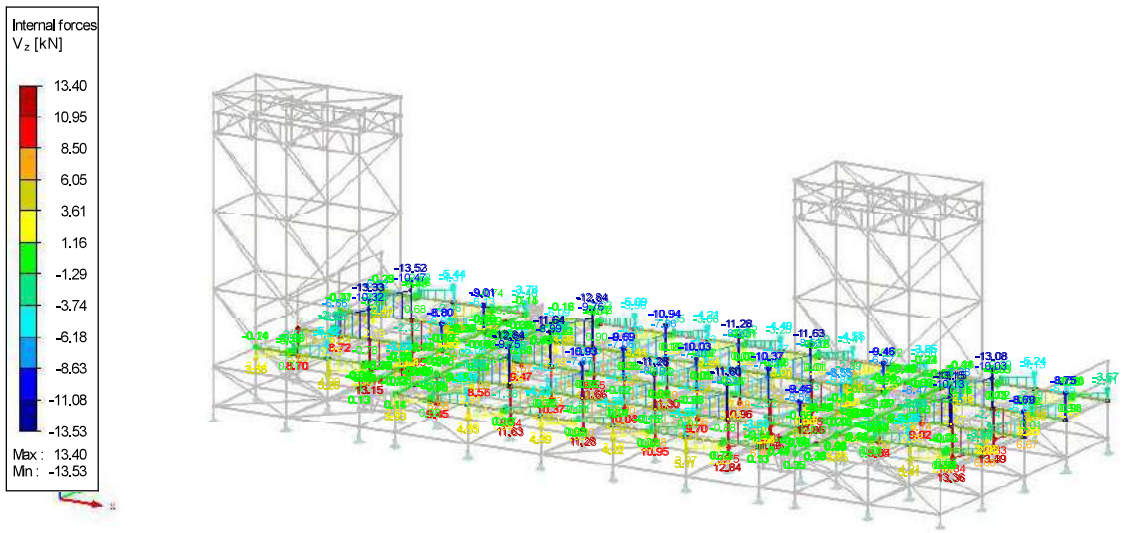
Isometric



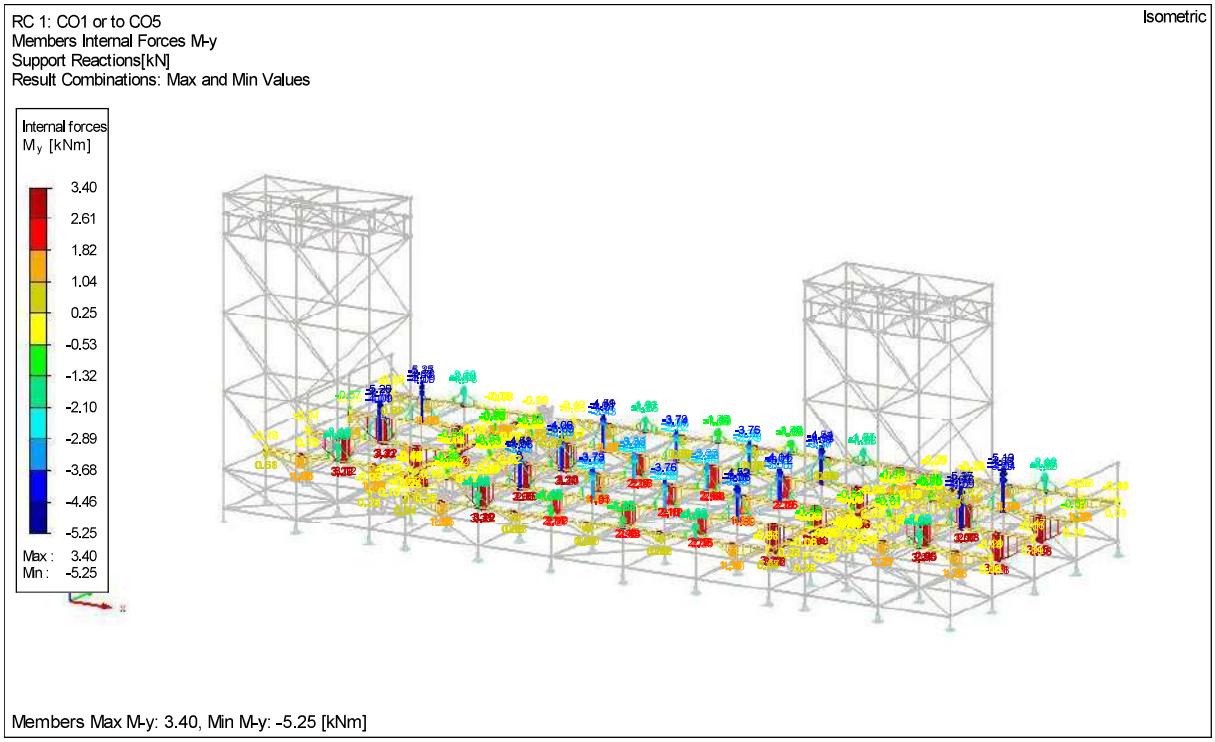
Members Max V-y: 3.99, Min V-y: -4.01 [kN]

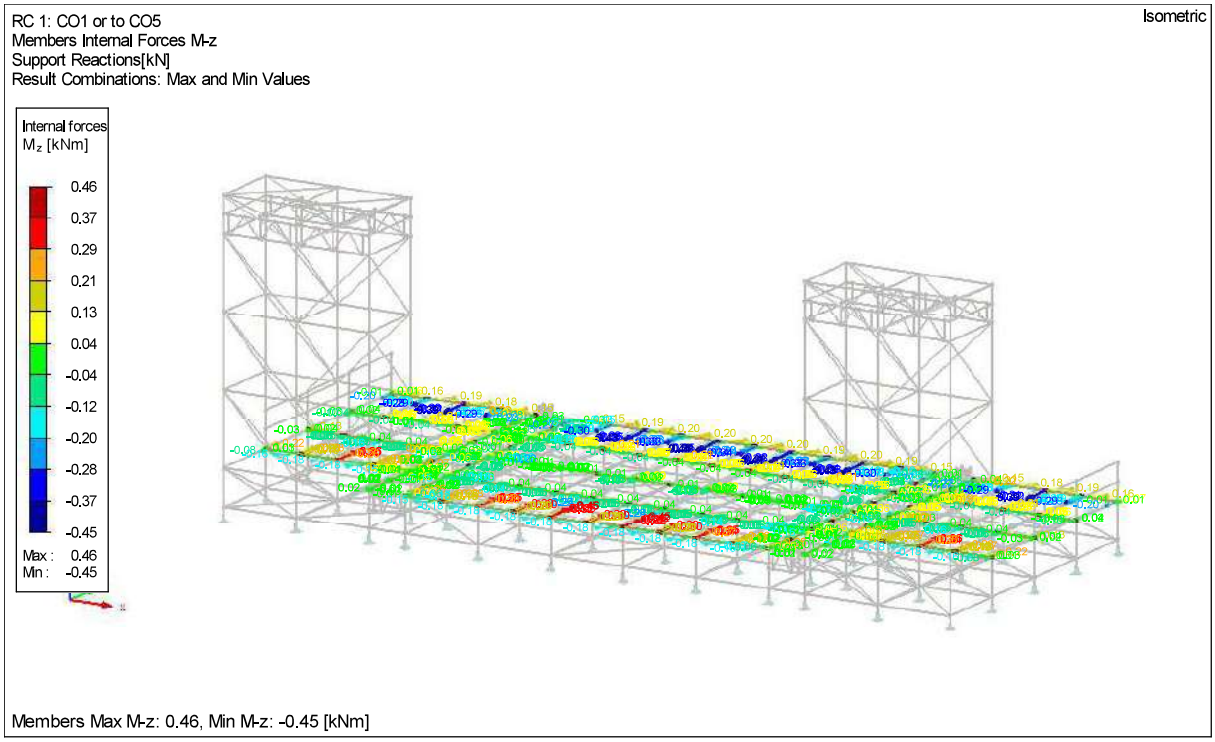
RC 1: CO1 or to CO5
Members Internal Forces V-z
Support Reactions[kN]
Result Combinations: Max and Min Values

Isometric



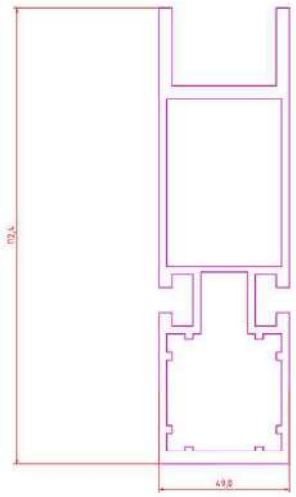
Members Max V-z: 13.40, Min V-z: -13.53 [kN]


RC 1: CO1 or to CO5
Members Internal Forces M-y
Support Reactions[kN]
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
3.40
2.61
1.82
1.04
0.25
-0.53
-1.32
-2.10
-2.89
-3.68
-4.46
-5.25
Max : 3.40
Min : -5.25
Members Max M-y: 3.40, Min M-y: -5.25 [kNm]


RC 1: CO1 or to CO5
Members Internal Forces M-z
Support Reactions[kN]
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
0.46
0.37
0.29
0.21
0.13
0.04
-0.04
-0.12
-0.20
-0.28
-0.37
-0.45
Max : 0.46
Min : -0.45
Members Max M-z: 0.46, Min M-z: -0.45 [kNm]

Profiel berekening.

Layher Event Beam speciaal profiel Aluminium 6005A T6



I [cm⁴]	5542580
I [cm⁴]	701986
e [cm]	90.03
g [cm]	82.36
A [cm²]	1878.072

$W_y = I_1 / e_y = 554 / 8.25 = 67.15\ cm^3$
$W_z = I_2 / e_z = 70.2 / 2.5 = 28.08\ cm^3$

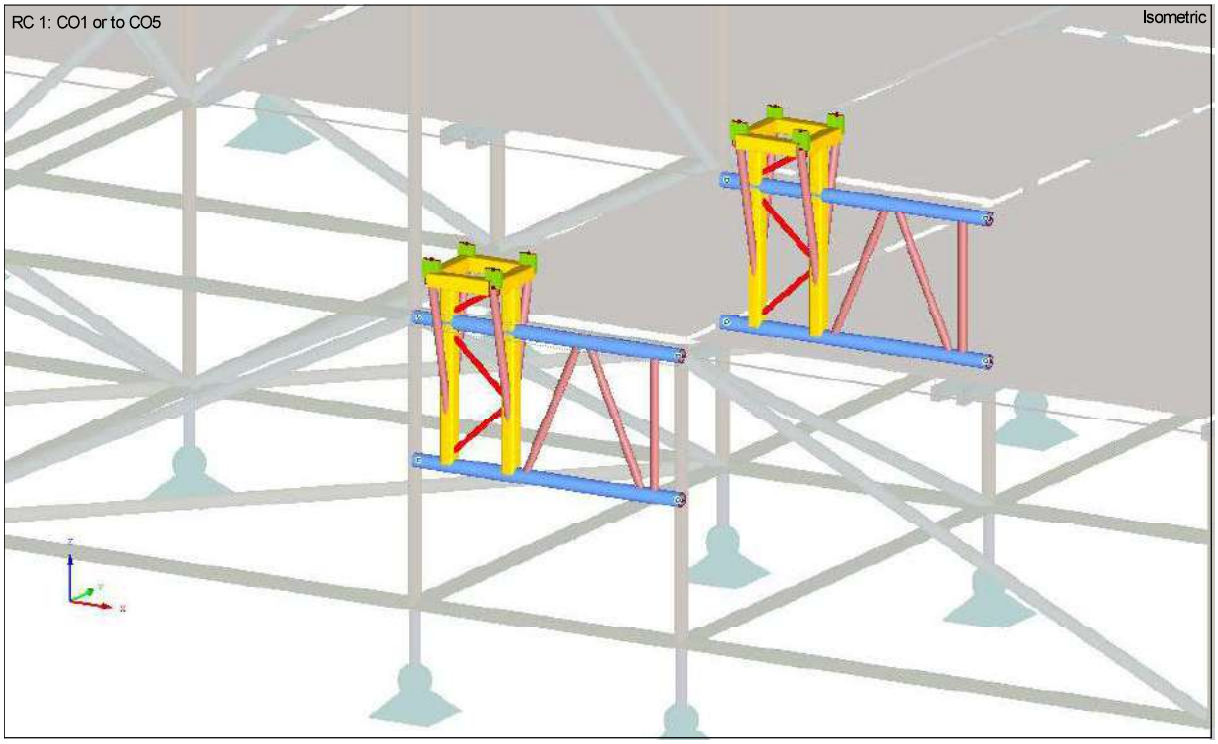
$N_{ed} = 8.75$
$\sigma N_{ed} = N_{ed} / A = 8.75 / 18.78 = 0.47\ kN/cm^2$
$V_{y,ed} = 4.01\ kN$
$\sigma v_{z,ed} = V_{y,ed} / A = 4.01 / 18.78 = 0.21\ kN/cm^2$
$V_{z,ed} = 13.53\ kN$
$\sigma v_{z,ed} = V_{z,ed} / A = 13.53 / 18.78 = 0.72\ kN/cm^2$
My,ed = 5.25 kNm
$\sigma M_{y,ed} = M_{y,ed} / Wy = 525 / 67.15 = 7.82\ kN/cm^2$
Mz,ed = 0.46 kNm
$\sigma M_{z,ed} = M_{z,ed} / Wy = 46 / 28.08 = 1.64\ kN/cm^2$

$\sigma tot = \sigma N_{ed} + 0{,}58 * \sigma v_{z,ed} + 0{,}58 * \sigma v_{z,ed} + \sigma M_{y,ed} + \sigma M_{y,ed}$
$0.47 + 0.58 * 0.21 + 0.58 * 0.72 + 7.82 + 1.64 = 10.47\ kN/cm^2$

Check
$\sigma tot / (fy / \gamma) < 1$
$10.47 / (22.5 / 1.1) = 0.51 < 1$

6.10 Check of the truss connection to the Layher stage.

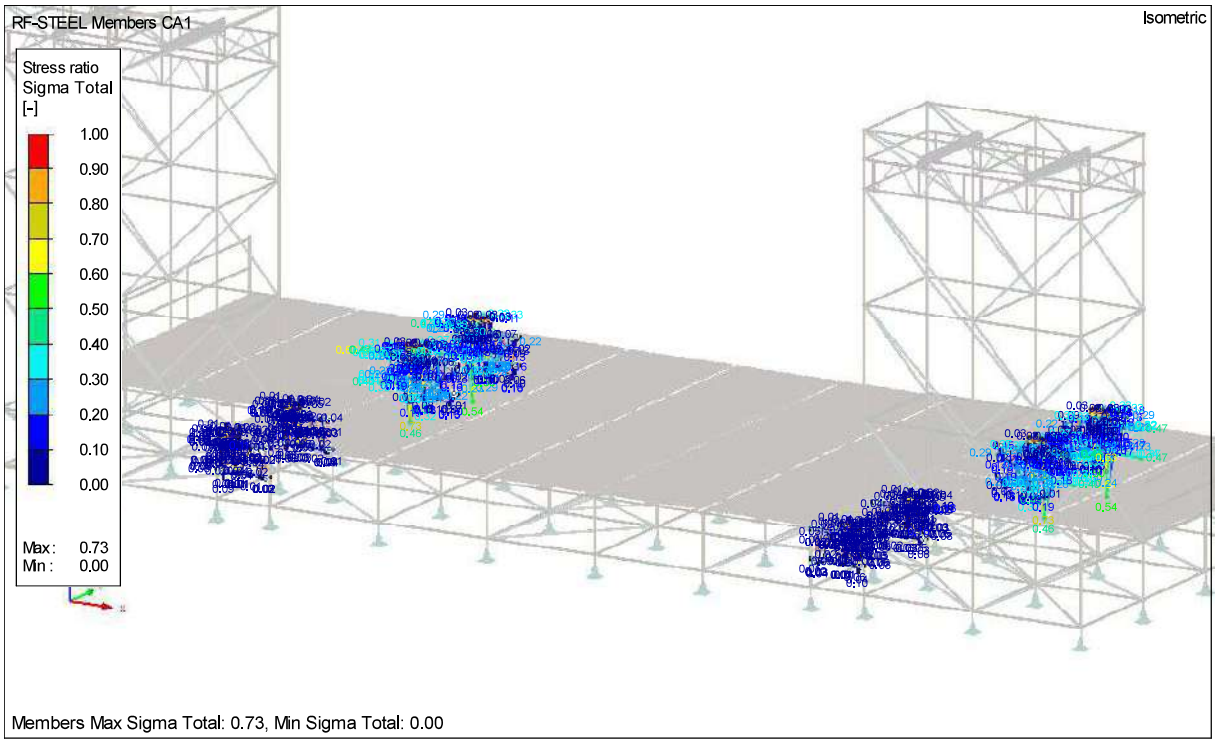
The Layher bases are inserted in the RFem model.

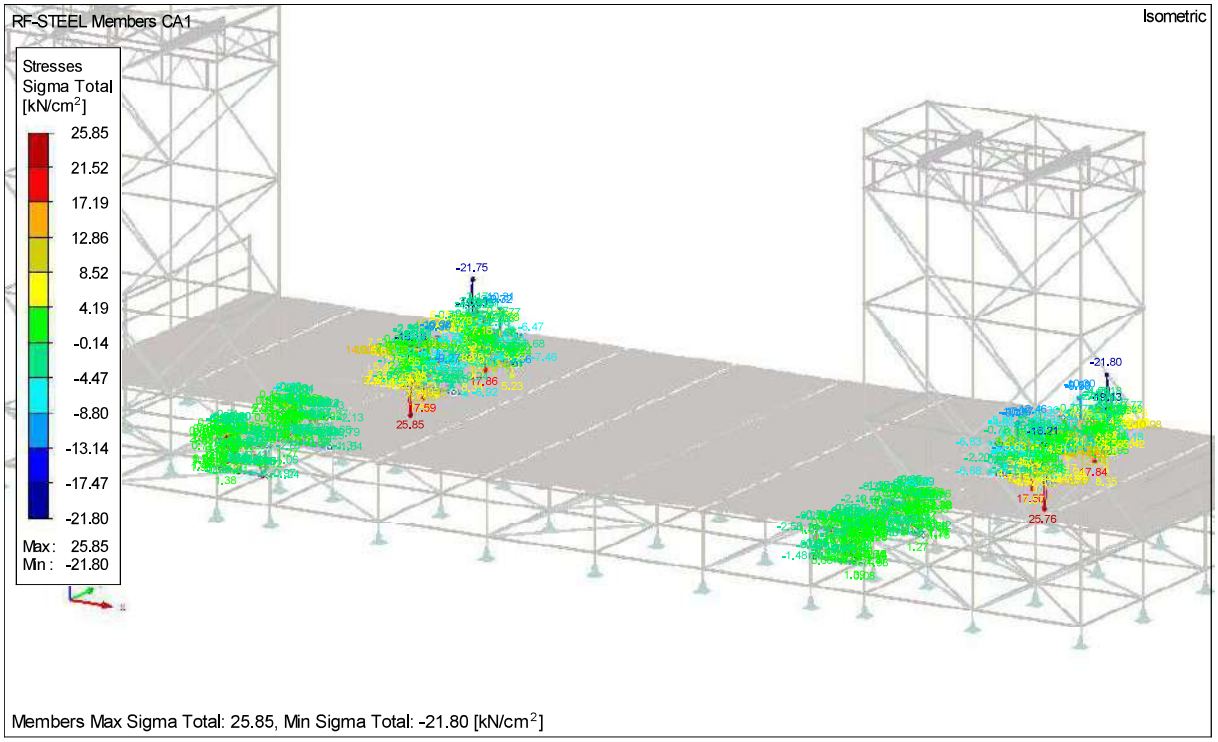


Cross-Sections
1: Ring 51/5; Steel S 355 JR
2: QRO 50x4 (Hot Formed); Steel S 235 JR
3: Ring 30/3; Steel S 235 JR
4: Rectangle 60/15; Steel S 235 JR
5: Ring 20/2; Steel S 235 JR

The Layher Adapter will be mounted with 4 Layher wedge couplers to the Staging system.

Maximum stress analyses for the members.





Result from the stress analyse.

Section No.	Member No.	Location x [m]	S-Point No.	Load-ing	Stress Type	Stress [kN/cm²] Existing	Limit	Stress Ratio
1	Ring 51/5							
	1934	0,134	24	CO1	Sigma Total	25,85	35,50	0,73
	1824	0,000	23	CO1	Tau Total	8,98	20,50	0,44
	1934	0,134	24	CO1	Sigma-eqv	27,26	35,50	0,77
2	QRO 50x4 (Hot Formed)							
	209	0,033	14	CO1	Sigma Total	14,90	23,50	0,63
	209	0,000	11	CO1	Tau Total	-5,06	13,57	0,37
	209	0,033	14	CO1	Sigma-eqv	15,52	23,50	0,66
3	Ring 30/3							
	1964	0,500	11	CO1	Sigma Total	8,07	23,50	0,34
	1942	0,250	35	CO1	Tau Total	-1,88	13,57	0,14
	1964	0,500	11	CO1	Sigma-eqv	8,07	23,50	0,34
4	Rectangle 60/15							
	1951	0,065	2	CO1	Sigma Total	8,76	23,50	0,37
	1951	0,065	5	CO1	Tau Total	0,47	13,57	0,03
	1951	0,065	2	CO1	Sigma-eqv	8,76	23,50	0,37
5	Ring 20/2							
	1843	0,000	22	CO1	Sigma Total	7,57	23,50	0,32
	1976	0,322	35	CO3	Tau Total	-0,79	13,57	0,06
	1843	0,000	22	CO1	Sigma-eqv	7,64	23,50	0,33

Maximum utilisation is 77%

Interal PROTRUSS S31

Truss series	PROTRUSS S31
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	+/- 50.914 kN
Normal force coupling system	+/- 60.54 kN
Normal force diagonals	+/- 10.415 kN
Bending moment $M_{yR,d}$	24.34 kNm
Bending moment $M_{zR,d}$	24.34 kNm
Normal Force $N_{R,d}$	203.66 kN
Transversal Force $V_{yr,d}$	14.73 kN
Transversal Force $V_{zr,d}$	14.73 kN

Truss geometry

Main chords	48x3 EN AW-6082T6
Diagonals	16x2 EN AW-6082T6
Coupling system	CONICAL COUPLING SYSTEM
Height	239 mm Centre to centre distance main chords
Width	239 mm Centre to centre distance main chords
A	16.96 cm²
I_y	2466 cm^4
I_z	2466 cm^4
i_y	12.06 cm
i_z	12.06 cm

The Main chord of the Protruss S31 has been produced from the material aluminium EN AW 6060 T6 instead of EN AW 6082 T6. This has been done because of the small radius of the arch trusses. This results in a lower maximum normal force in the main chord.

The lower Maximum normal force in the main chord is.
Limiting factor is the weld of the coupler to the main chord.
The coupling system and braces are the same and will have no influence.

$N_{rd,Haz\ Chord} = A_{eff} * f_{uk,haz} * 0.8 * 1 / \gamma m2 = 4.241 * 10 * 0.8 * 1/1.25 = 27.14$ kN
$M_{Rd,\ main\ chord} = W_{chord} * f_{uk,haz} * 0.8 * 1 / \gamma m2 = 4.493 * 10 * 0.8 * 1/1.25 = 28.75$ kNcm

All the structural geometry such as sectional area and moment of inertia and of the truss will stay the same as printed above

Interal PROTRUSS T31

Truss series	PROTRUSS T31
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	+/- 50.215 kN
Normal force coupling system	+/- 60.54 kN
Normal force diagonals	+/- 7.792 kN
Bending moment $M_{yR,d}$	9.48 kNm
Bending moment $M_{zR,d}$	10.95 kNm
Normal Force $N_{R,d}$	137.4 kN
Transversal Force $V_{yr,d}$	11.02 kN
Transversal Force $V_{zr,d}$	11.02 kN

Truss geometry

Main chords	48x3 EN AW-6082T6
Diagonals	16x2 EN AW-6082T6
Coupling system	CONICAL COUPLING SYSTEM
Height	207 mm Centre to centre distance main chords
Width	239 mm Centre to centre distance main chords
A	12.72 cm²
I_y	1244 cm^4
I_z	1244 cm^4
i_y	9.89 cm
i_z	9.89 cm