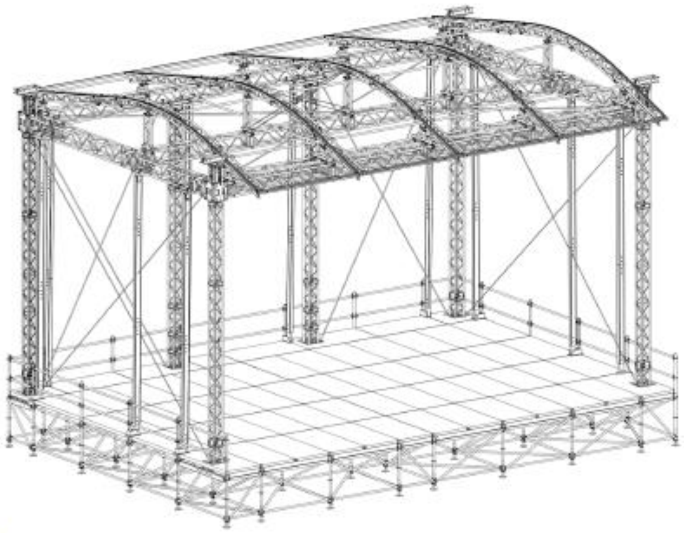
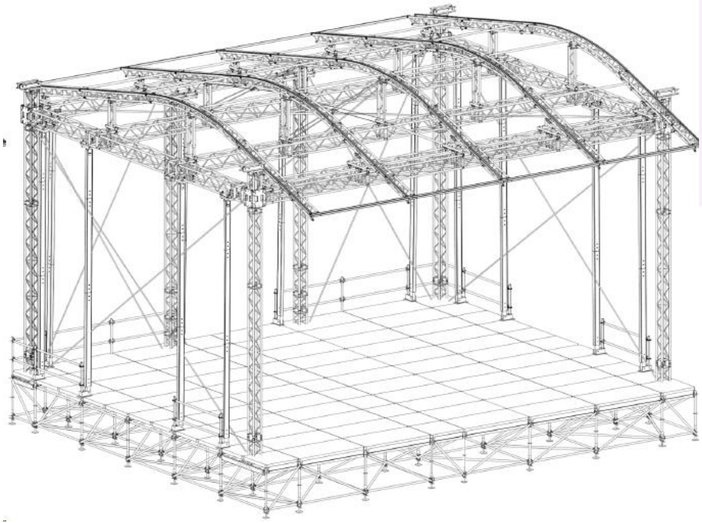
# PODIUM – BOEK
# CLT

Eekels Verhuur 112023-15





## Inhoudsopgave

# Voorwoord

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

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

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

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

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

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

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

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

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

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

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

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

Overdekte podia zijn onder te verdelen in:
- (gedeeltelijk) met zijwanden van harde panelen of zeil
- zonder zijwanden
- voorzien van meer bouwlagen

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

**NOODNUMMER: +31 0 467 870 112**

# 1. Algemene informatie

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

## 1.1 Algemene gegevens fabrikant(en);

| | |
|---|---|
| Zeil | **POLYMAR – FR COLOR 700** |
| Constructie | Prolyte H30V – H40V – H30D |
| Type zeil | PVC; artikel 8509 5240 |

## 1.2 Algemene gegevens;

| | |
|---|---|
| Naam | **CLT** |
| Type | CLT 12x8 – 12x10 roof |
| Configuratie(s) | 12x8 – 12x10 meter |

## 2 Gegevens verhuurder of leverancier

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

| | |
|---|---|
| **Rechtsvorm** | Besloten Vennootschap |
| **Handelsnaam** | Eekels Verhuur B.V. |
| **Bezoekadres** | Hallenstraat 20<br>5531 AB BLADEL |
| **Postadres** | P.O. Box 175<br>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: 12x8 – 12x10 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.

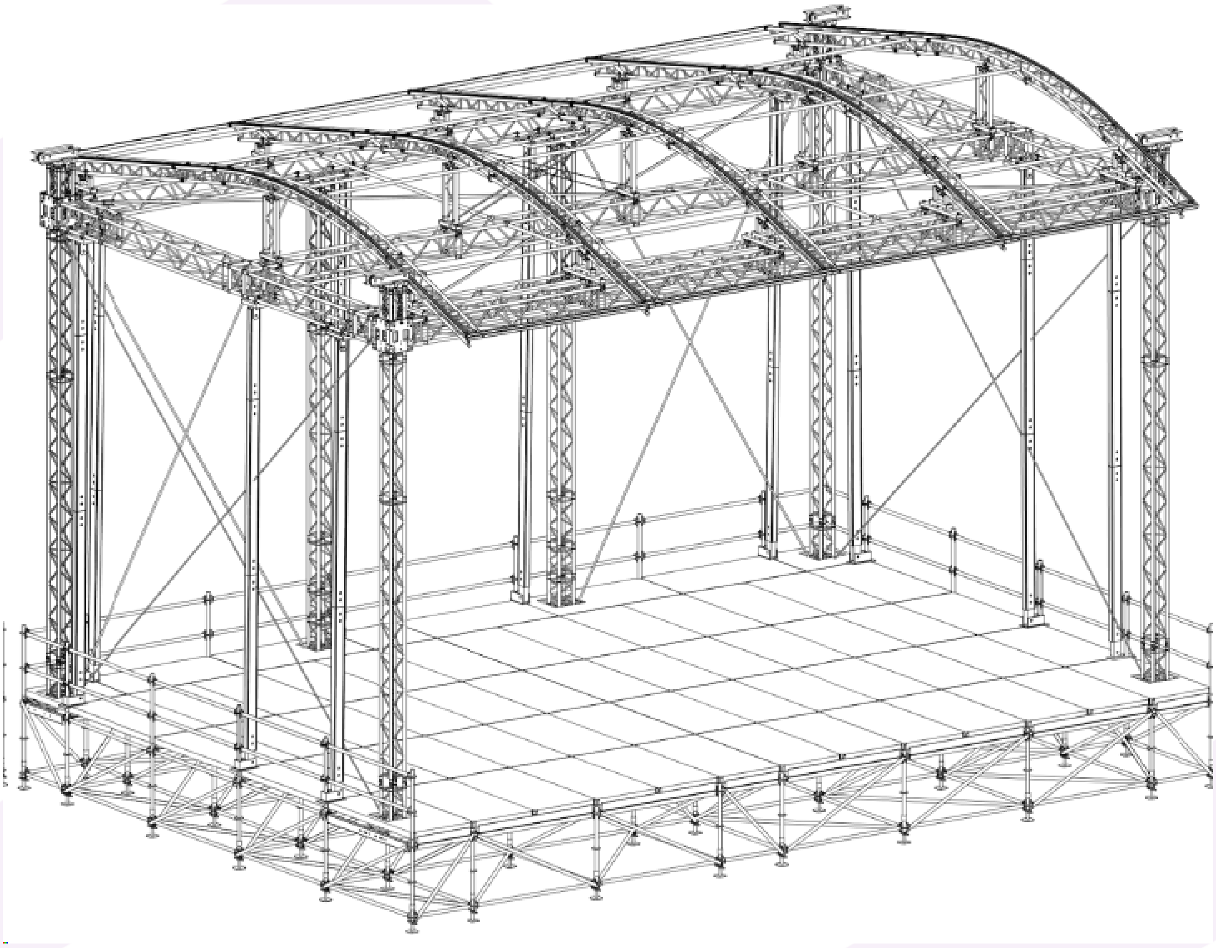
- Een constructie wordt berekend op een stuwdruk (de windbelasting per m2). De stuwdruk ontstaat door de windsnelheid. De windsnelheid is opgebouwd uit een stationair deel en een turbulent deel. Hierdoor ontstaan er pieken in de windsnelheid.
- Windsnelheid wordt standaard gemeten op 10 meter hoogte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

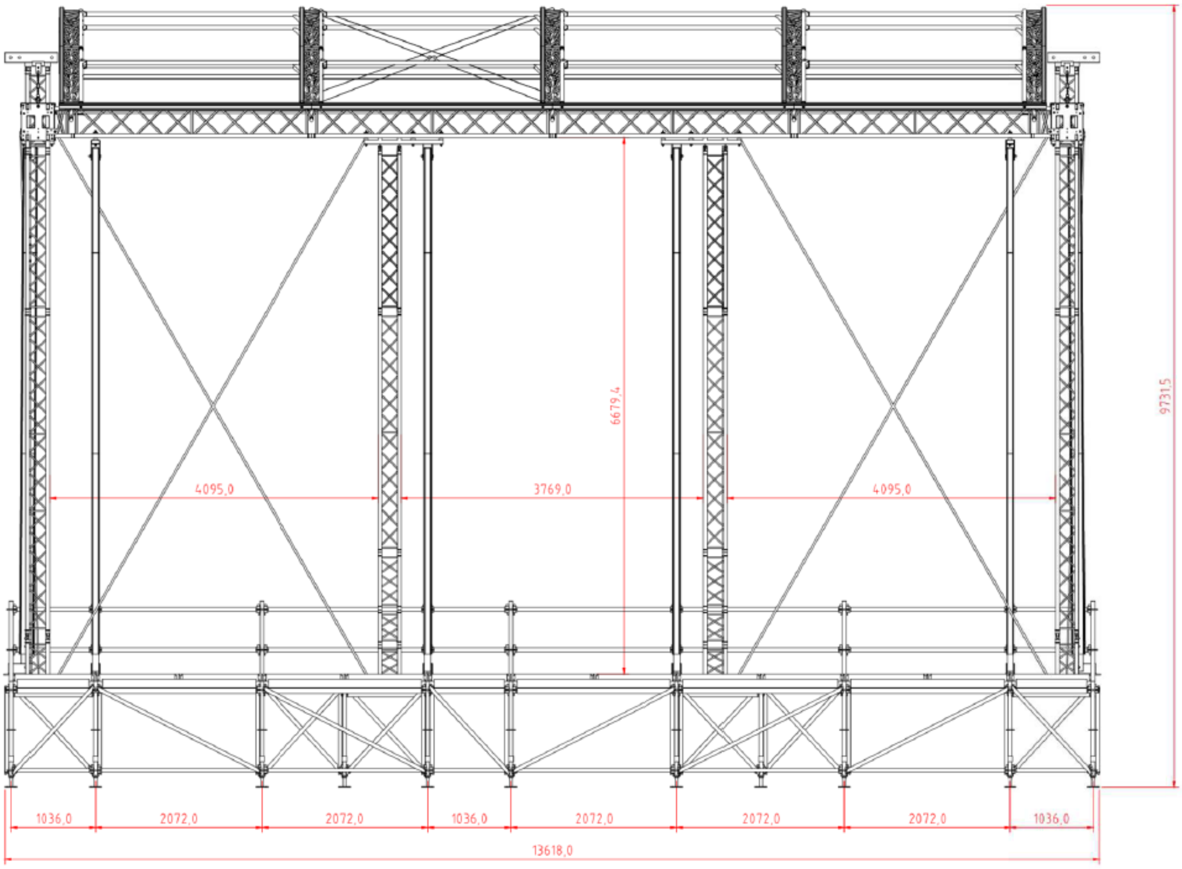
De windkracht volgens de Schaal van Beaufort (bron: KNMI). De schaal van Beaufort wordt gebruikt voor de gemiddelde windsnelheid, over minstens 10 minuten gemeten, níet voor de snelheid van rukwinden/windstoten(piekwind).

| **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)





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6679,4
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2072,0
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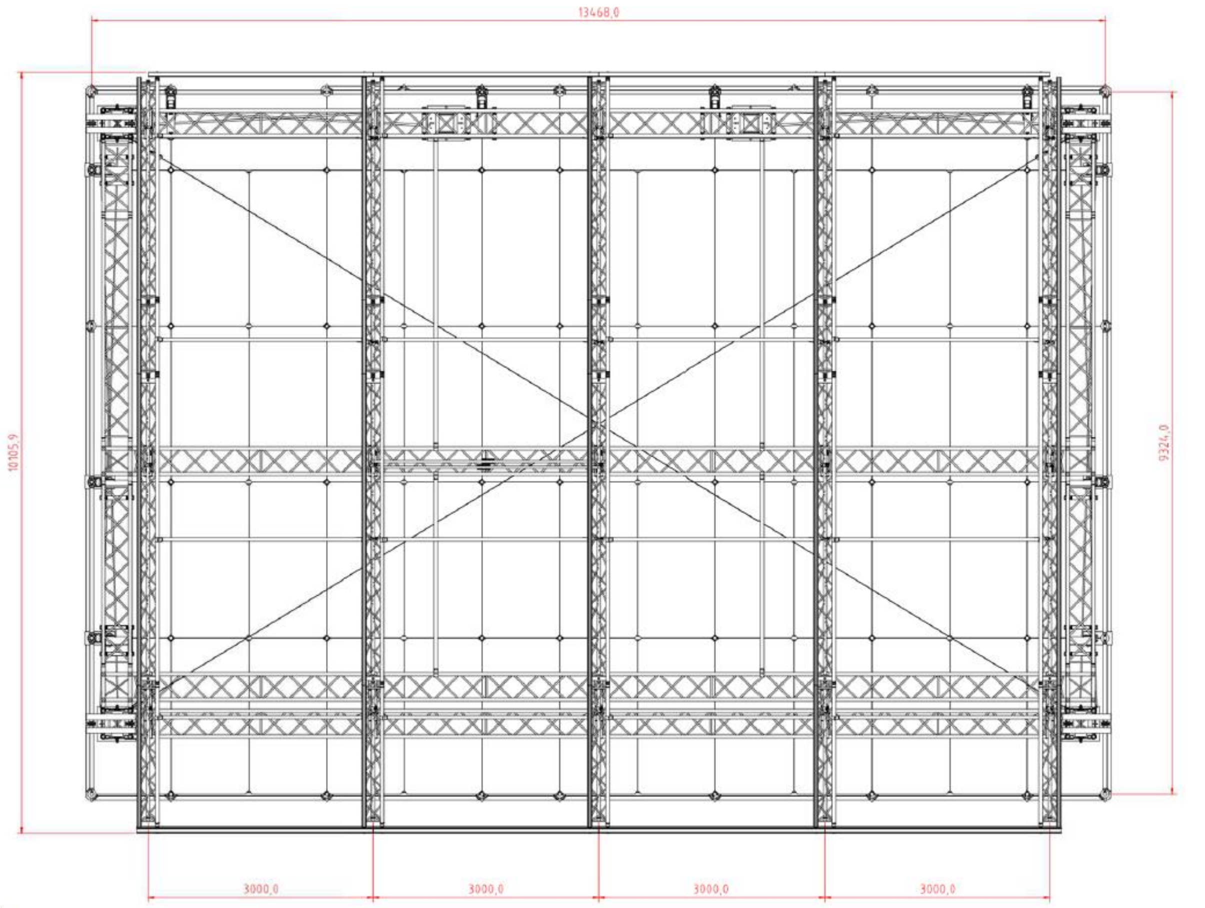
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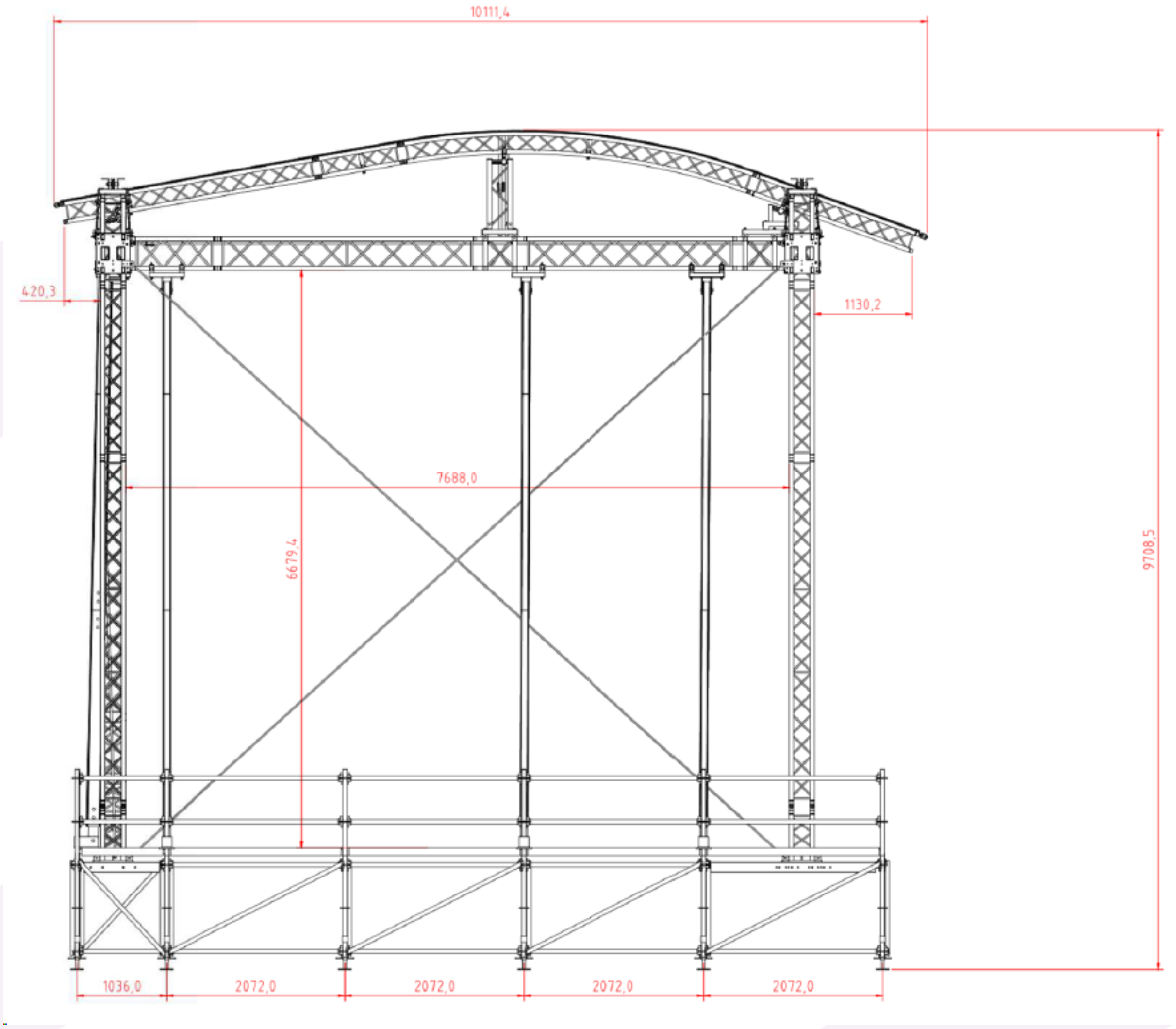
3000,0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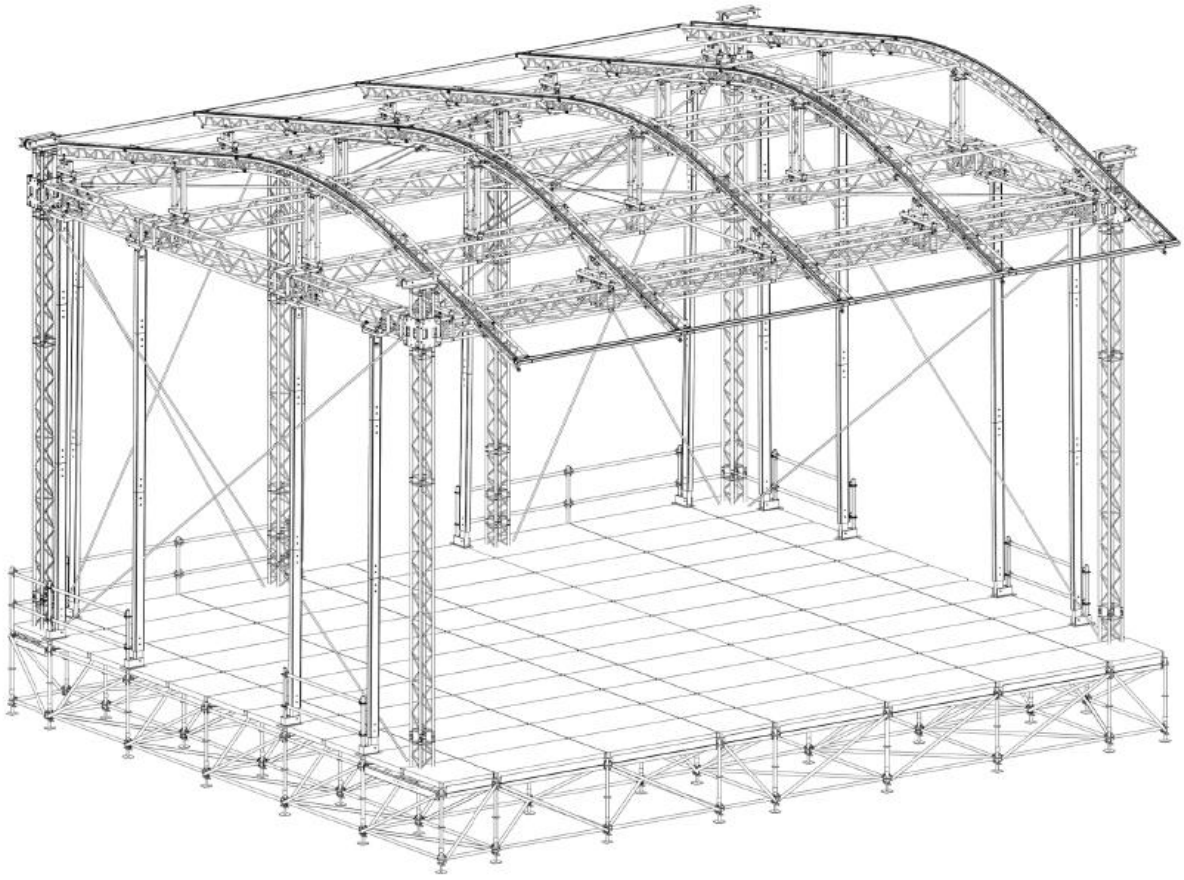

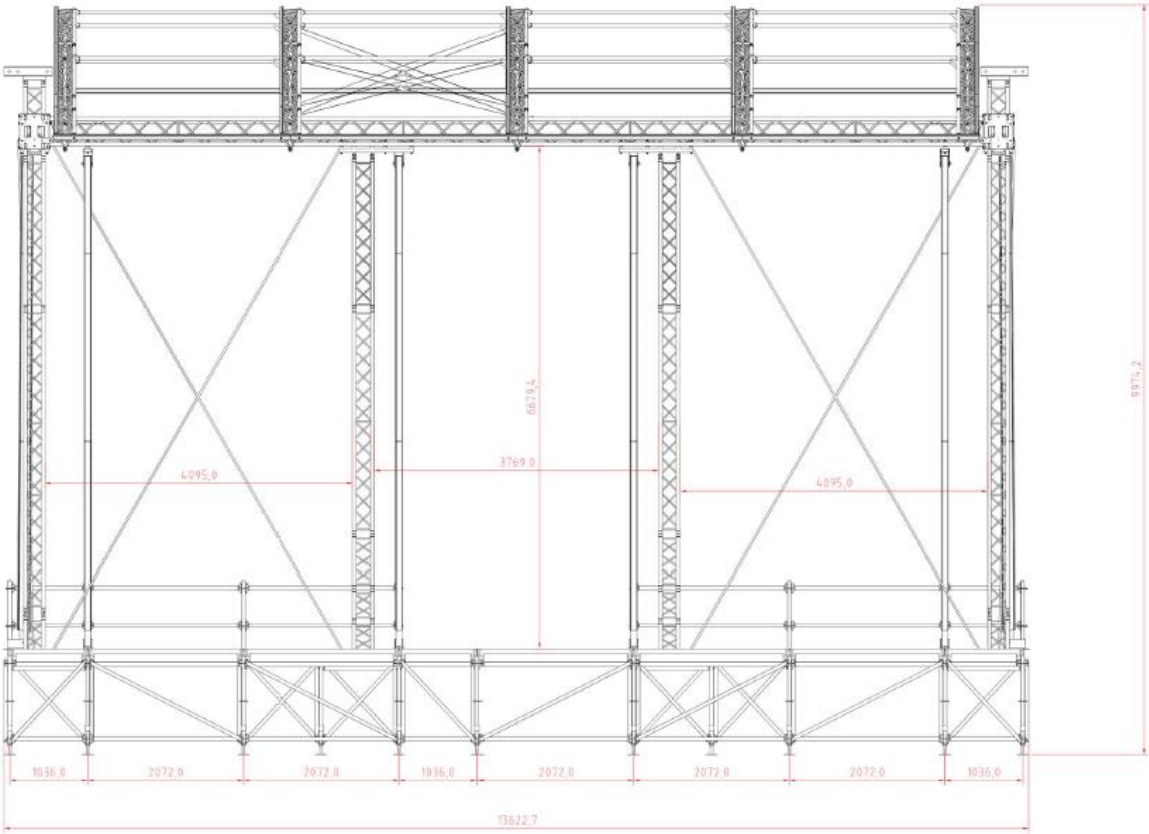
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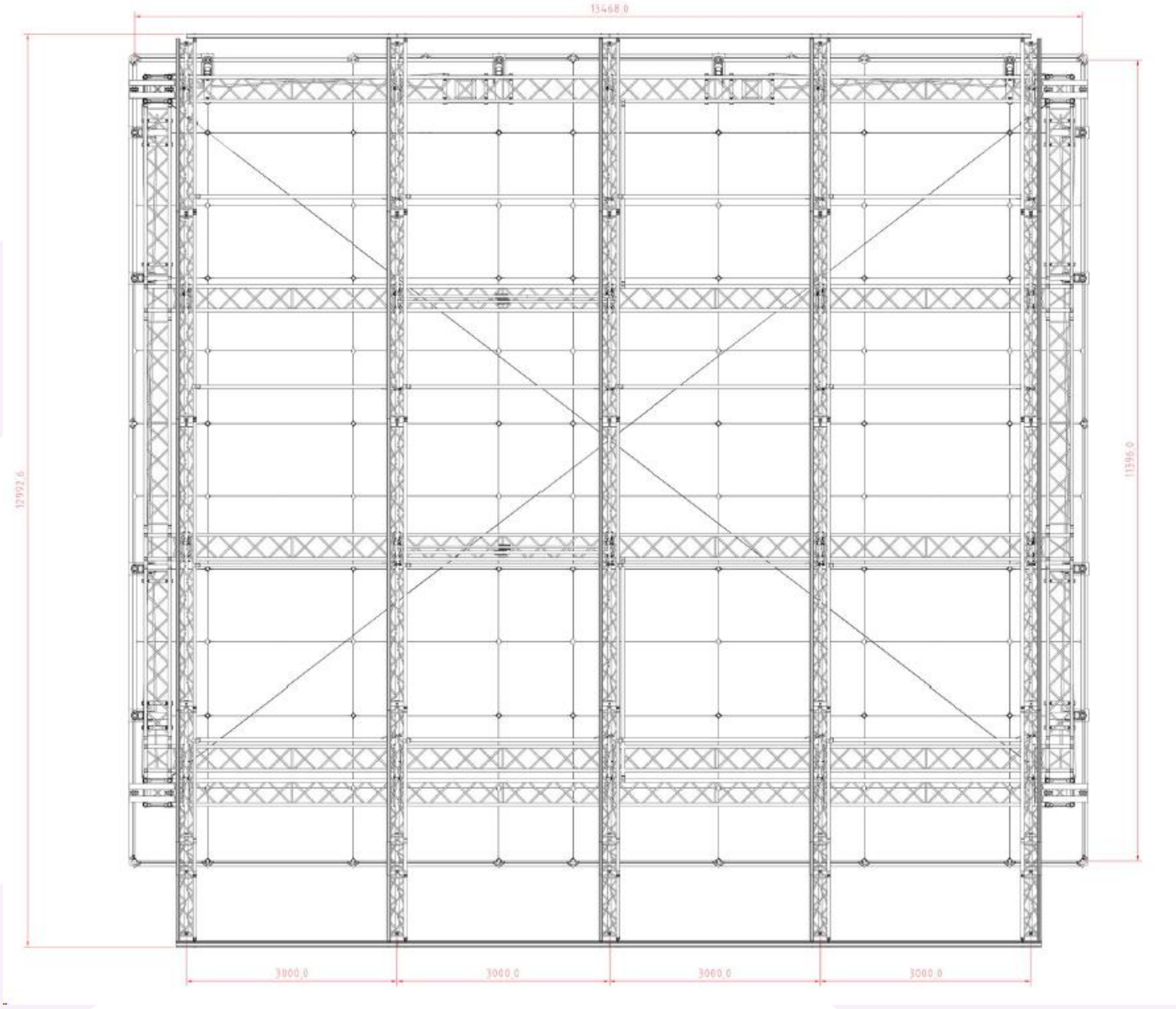
1036,0
13622,7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3000.0
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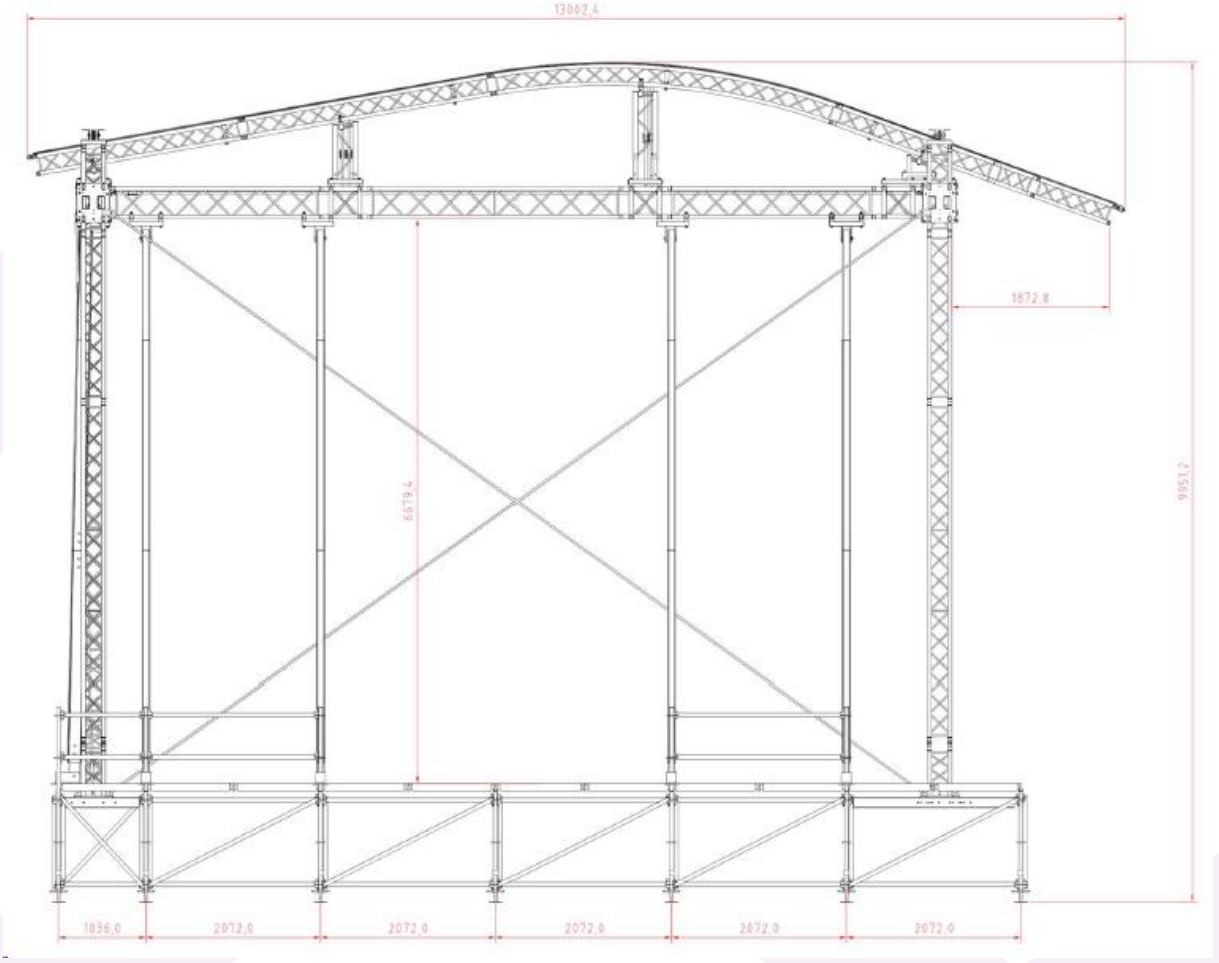
13002,4
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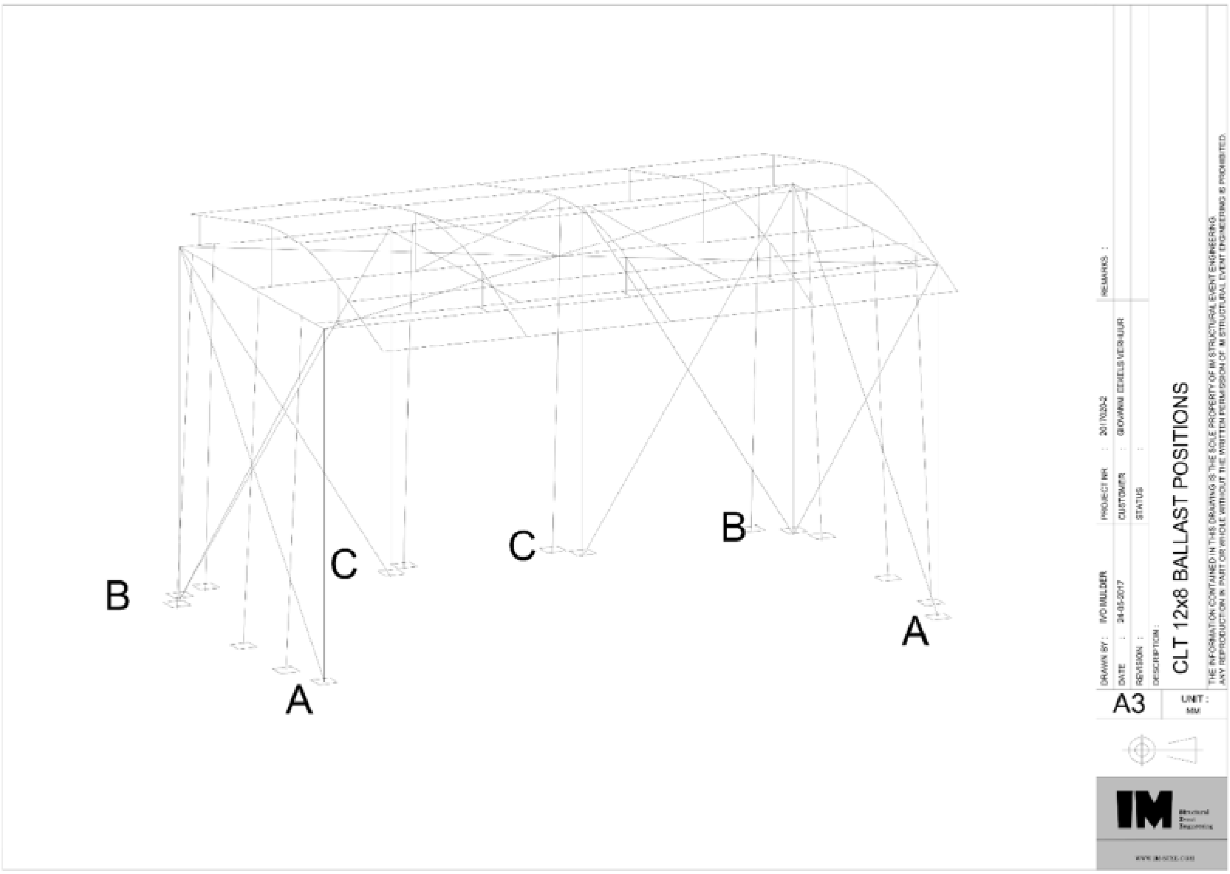
2072,0
2072,0
2072,0
2072,0

## 7 Bijlage II: Ballastplan

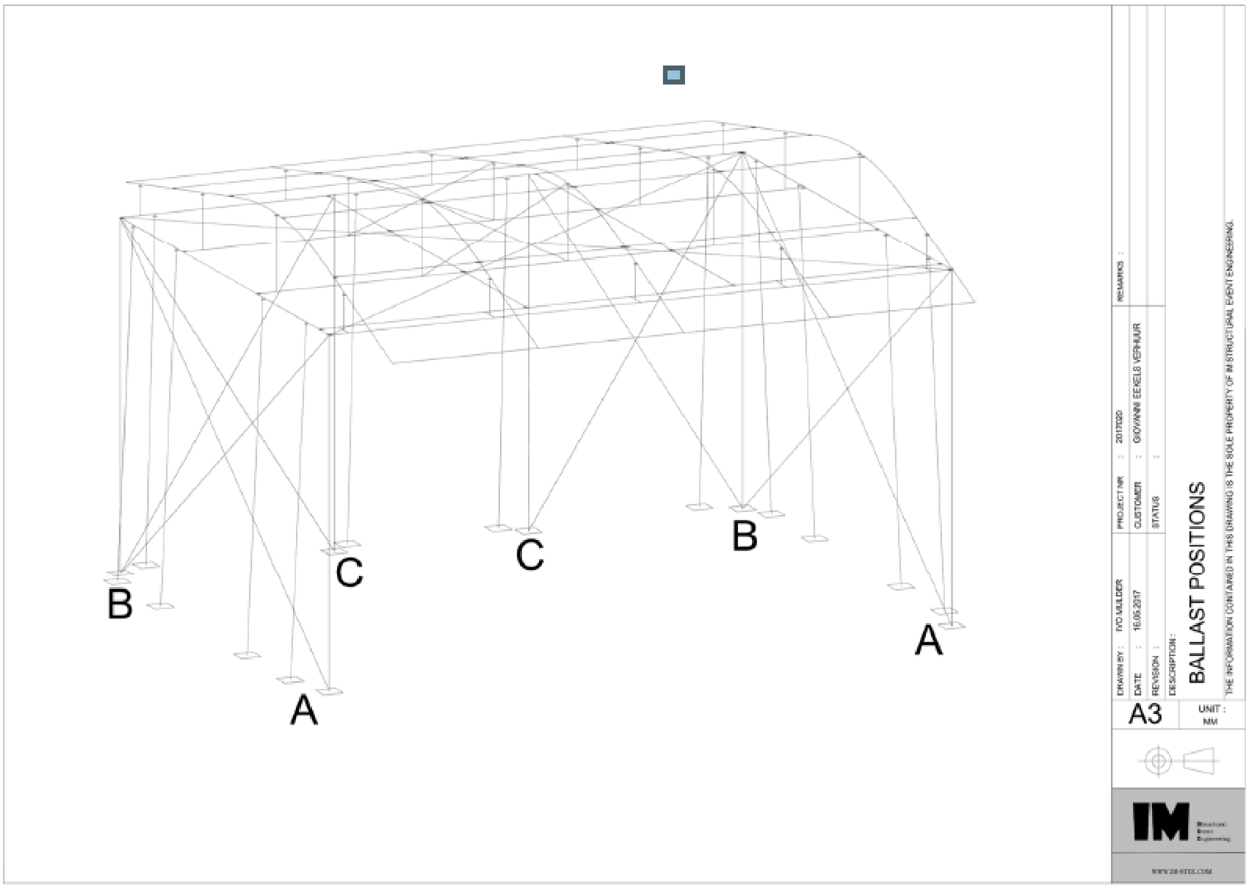



The Ballast calculation has been done in chapter 5 underneath are the result of the nece4sary ballast per point. For the ballast at the stack tower in the middle of the back span the self-weight of the Layher system will be taken.

**Point A = 1200 kg**

**Point B = 1400 kg**

**Point C = 1000 kg**




The Ballast calculation has been done in chapter 5 underneath are the result of the nece4sary ballast per point. For the ballast at the stack tower in the middle of the back span the self-weight of the Layher system will be taken.

**Point A = 1400 kg**

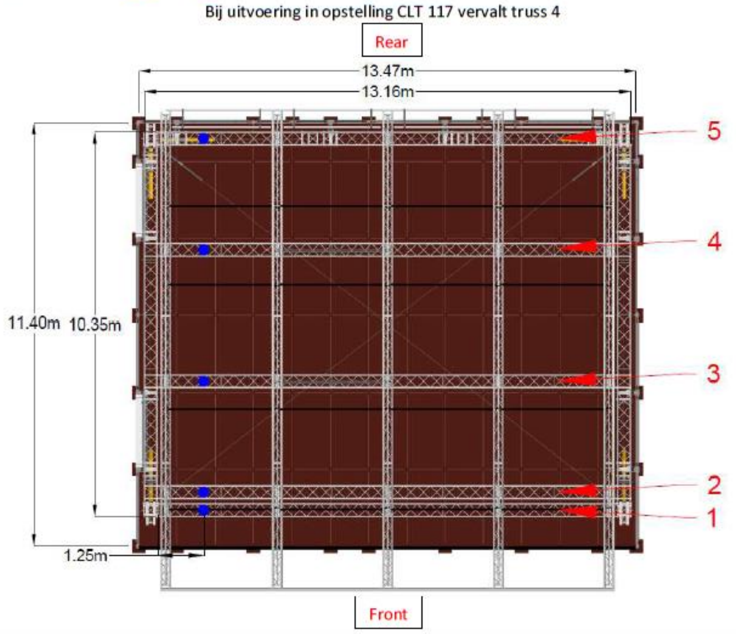
**Point B = 1750 kg**

**Point C = 1100 kg**

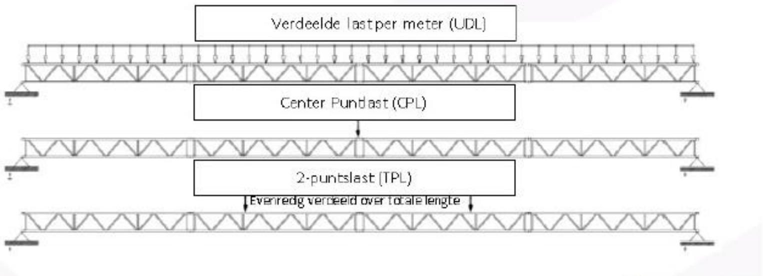
# 8 Bijlage III: Riggingscapaciteit

## Riggingscapaciteit CLT 143/117

Bij uitvoering in opstelling CLT 117 vervalt truss 4




| Naam | Waarde | Maximale Gebruiksbelasting per punt | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| A. Verdeelde last per meter (UDL) | kg/m | 25 | 25 | 50 | 50 | 100 |
| B. Center puntlast (CPL) | kg | 125 | 125 | 400 | 400 | 1000 |
| C. 2-puntslast (TPL) | kg | 100 | 100 | 325 | 325 | 1000 |
| D. puntlast 1.25m vanaf mast in-service | kg | 500 | 500 | 500 | 500 | 1000 |
| E. puntlast 1.25m vanaf mast out-service | kg | 100 | 100 | 500 | 500 | 1000 |




*Figuur 1*

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


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

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

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

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

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

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

| **Gebied** | **10 minuten gemiddelde windsnelheid (m/s)** | **Beaufort (Bft)** | **Piekwindsnelheid (m/s)** | **Stuwdruk ($kN/m^2$)** |
|---|---|---|---|---|
| **Kust** | 10.58 | 5 | 17.79 | 0.20$kN/m^2$ |
| **Onbebouwd** | 12.03 | 6 | 17.79 | 0.20$kN/m^2$ |
| **Bebouwd** | 17.57 | 7 | 17.79 | 0.20$kN/m^2$ |

0<8 meter

| **Gebied** | **10 minuten gemiddelde windsnelheid (m/s)** | **Beaufort (Bft)** | **Piekwindsnelheid (m/s)** | **Stuwdruk ($kN/m^2$)** |
|---|---|---|---|---|
| **Kust** | 11.9 | 6 | 21.91 | 0.30$kN/m^2$ |
| **Onbebouwd** | 13.07 | 6 | 21.91 | 0.20$kN/m^2$ |
| **Bebouwd** | 17.09 | 7 | 21.91 | 0.20$kN/m^2$ |

8<20 meter

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

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

0<8 meter

| Gebied | 10 minuten gemiddelde windsnelheid (m/s) | Beaufort (Bft) | Piekwindsnelheid (m/s) | Stuwdruk ($kN/m^2$) |
|---|---|---|---|---|
| **Kust** | 17.18 | 7 | 31.62 | 0.625$kN/m^2$ |
| **Onbebouwd** | 18.87 | 8 | 31.62 | 0.625$kN/m^2$ |
| **Bebouwd** | 24.66 | 8 | 31.62 | 0.625$kN/m^2$ |

8<20 meter

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

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

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

# 10 Bijlage V: Zeilcertificaat

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

IM

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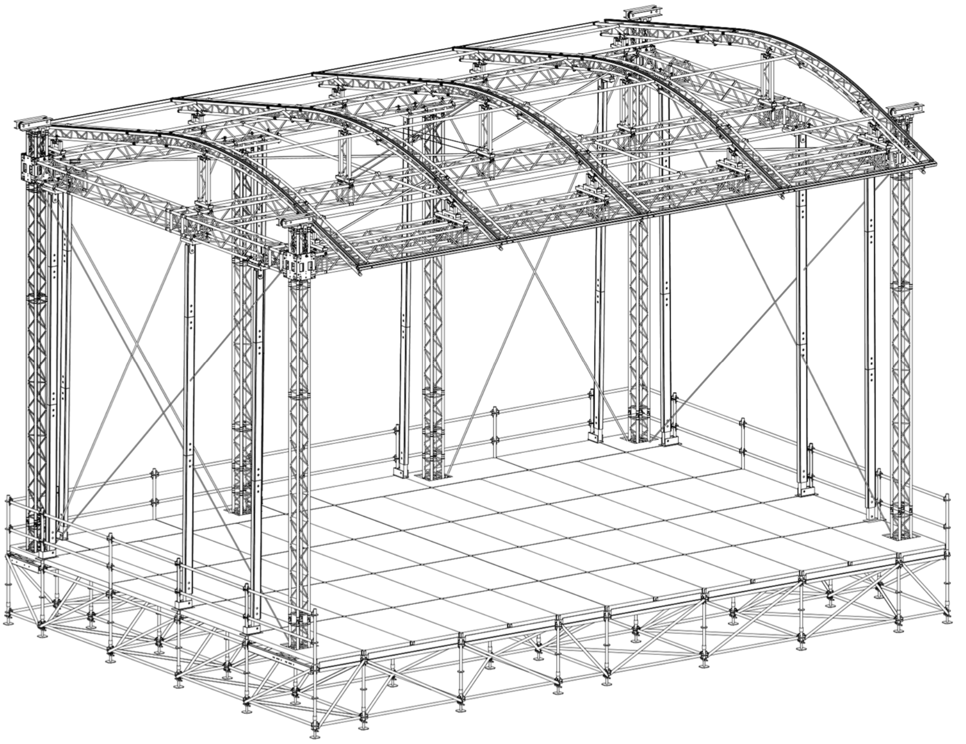

Project number: 2016020-2

Structural calculation Report

CLT roof 12x8

Eekels verhuur

This calculation report has been specific prepared for the company Eekels Verhuur 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 InterStage. 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 an written permission from the company IM Structural Event Engineering.

Date : **25-05-2017**

Ivo Mulder BCs

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

Index:

# 1 General Preliminary notes.

## 1.1 Construction description.

This report concerns the calculation of the CLT 12x8 roof owned by the company Eekels Verhuur. The  dimensions of the roof construction are 12 meter wide 8 meters depth and 10 meters high.

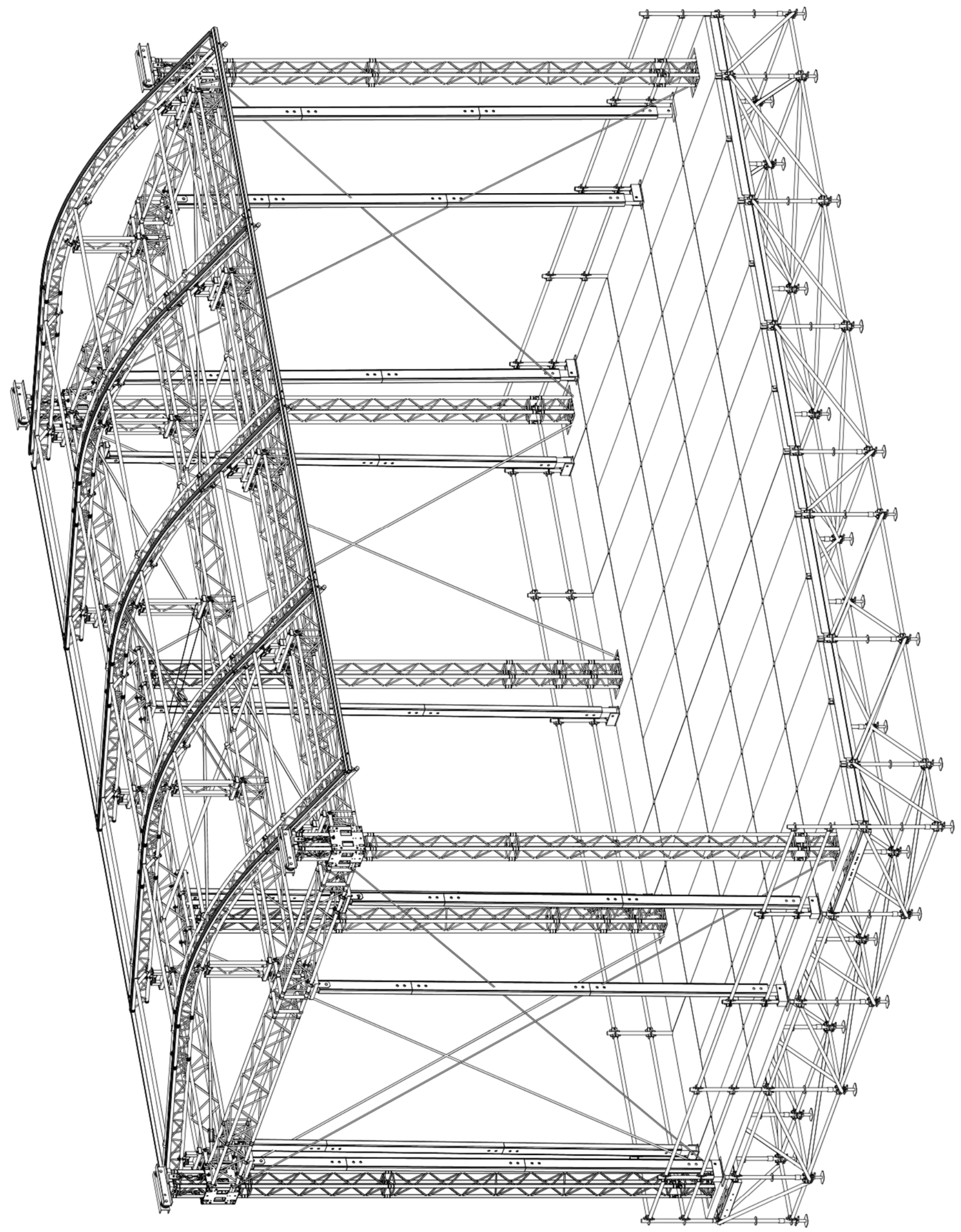
The roof constructions is built from mainly aluminium truss which are produced by Prolyte. The stage underneath the roof construction is constructed from the Layher scaffolding system, and is an integrated system.

The stage is calculated as a 2 meter stage but can also be built as a 1.5 meter stage.

The construction will mainly be used as a staging system for festivals or outdoor events.

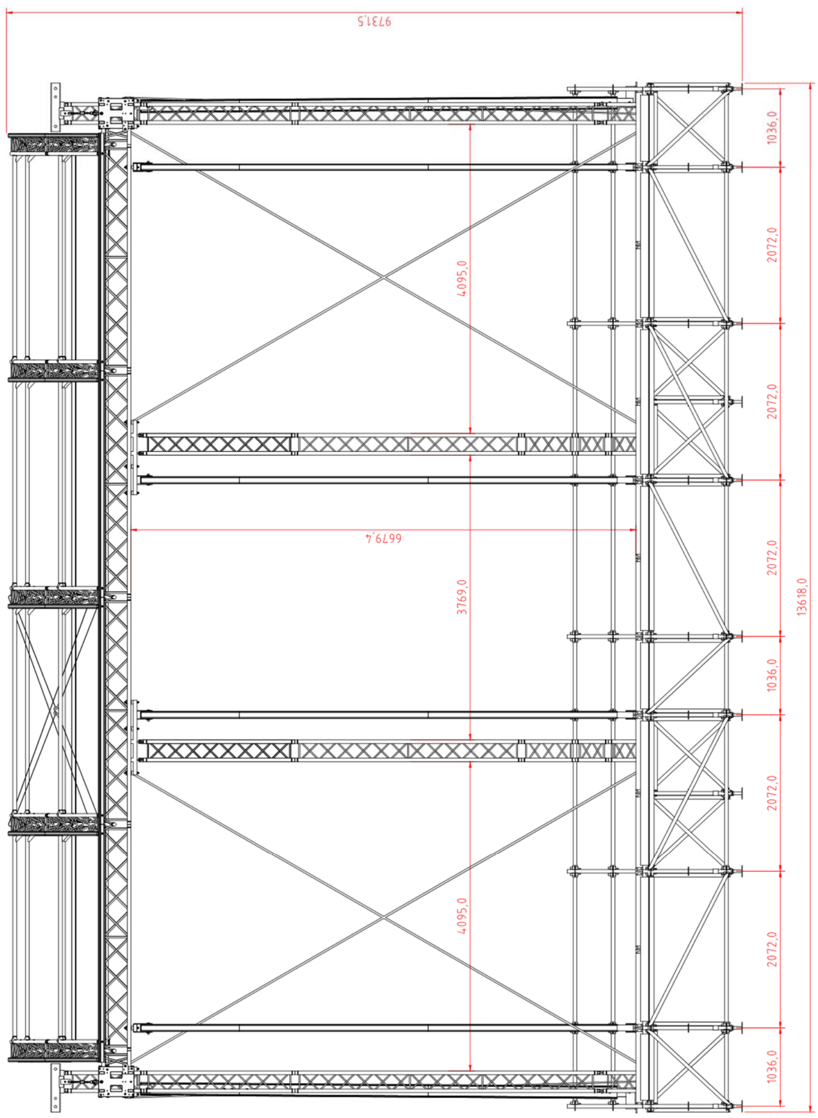
## 1.2 Construction drawing.

### 1.2.1 Perspective



| | | | | | |
|---|---|---|---|---|---|
| DRAWN BY : IVO MULDER | PROJECT NR : 2016020-2 | REMARKS : SHEET 1/5 | UNIT : MM | | |
| DATE : 24-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | | | | |
| REVISION : | STATUS : | | | | |
| DESCRIPTION : CLT 12X8 ISO VIEW | | | A3 | | WWW.IM-STEE.COM |

## 1.2.2 Front view




| | | | | | |
|---|---|---|---|---|---|
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| DATE : | 24-05-2017 | CUSTOMER : | GIOVANNI EEKELS VERHUUR | | |
| REVISION : | | STATUS : | | | |

DESCRIPTION :

CLT 12X8 FRONT VIEW

UNIT : MM

A3

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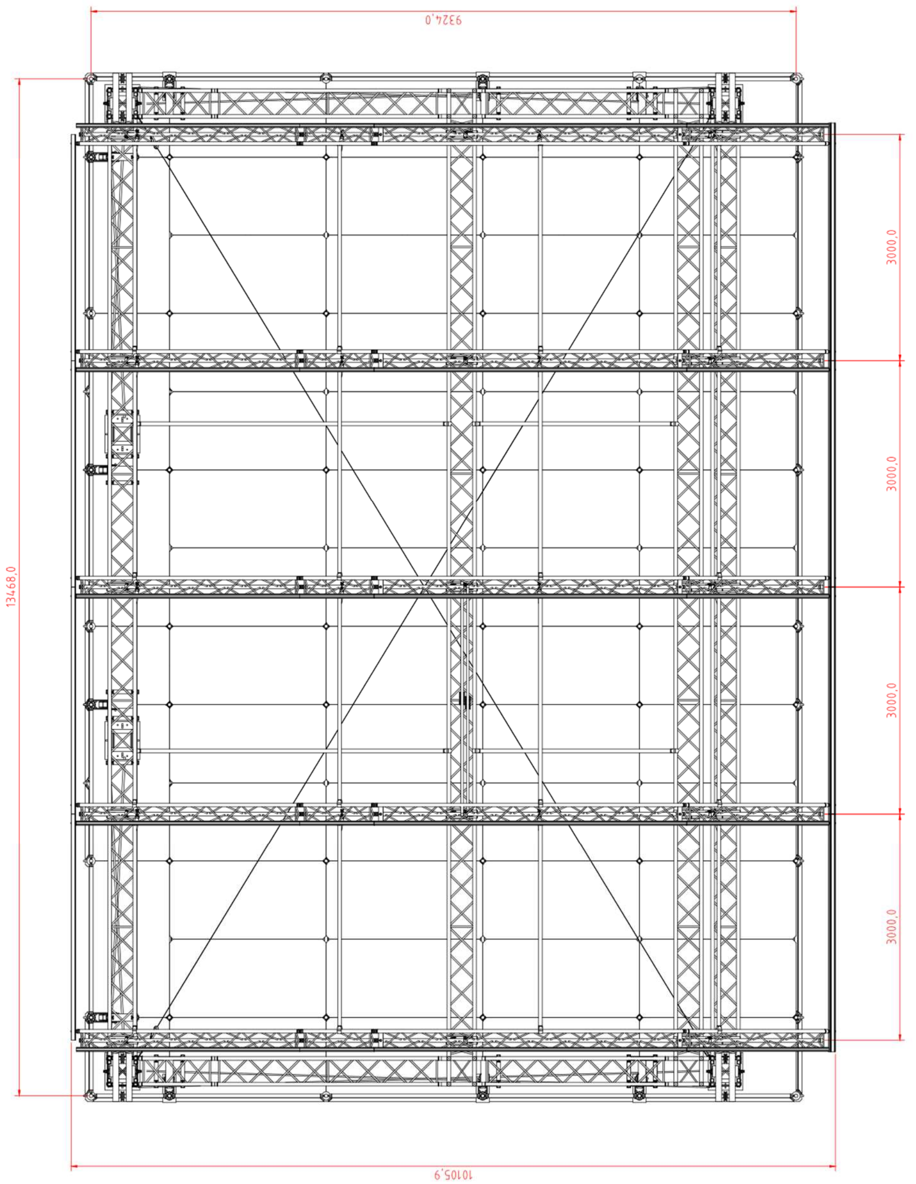
## 1.2.3 Top view

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|---|---|---|---|---|---|
| DRAWN BY : | IVO MULDER | PROJECT NR : | 2016020-2 | REMARKS : | SHEET 3/5 |
| DATE : | 24-05-2017 | CUSTOMER : | GIOVANNI EEKELS VERHUUR | | |
| REVISION : | | STATUS : | | | |

DESCRIPTION :

CLT 12X8 TOP VIEW

UNIT : MM

A3



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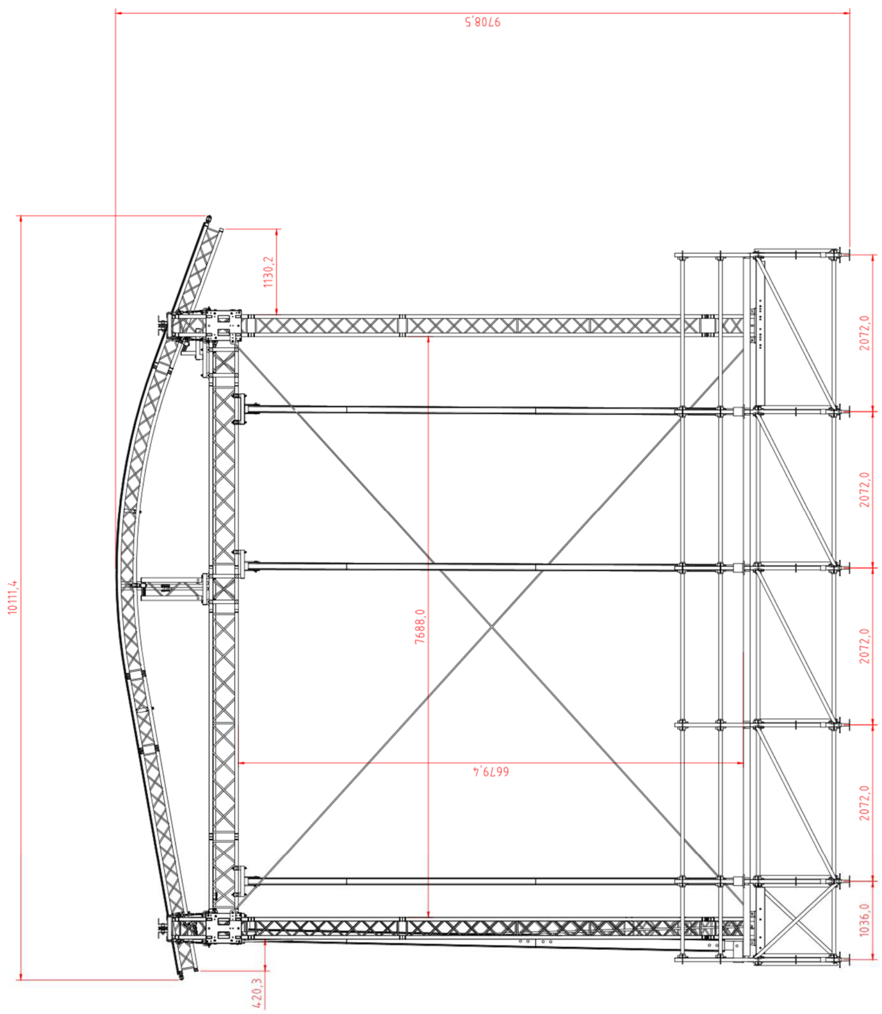
## 1.2.4 Side view




| | | | | | |
|---|---|---|---|---|---|
| DRAWN BY : IVO MULDER | PROJECT NR : 2016020-2 | REMARKS : SHEET 4/5 | UNIT : MM | | |
| DATE : 24-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | | | | |
| REVISION : | STATUS : | | | | |

DESCRIPTION :

CLT 12X8 SIDE VIEW

A3

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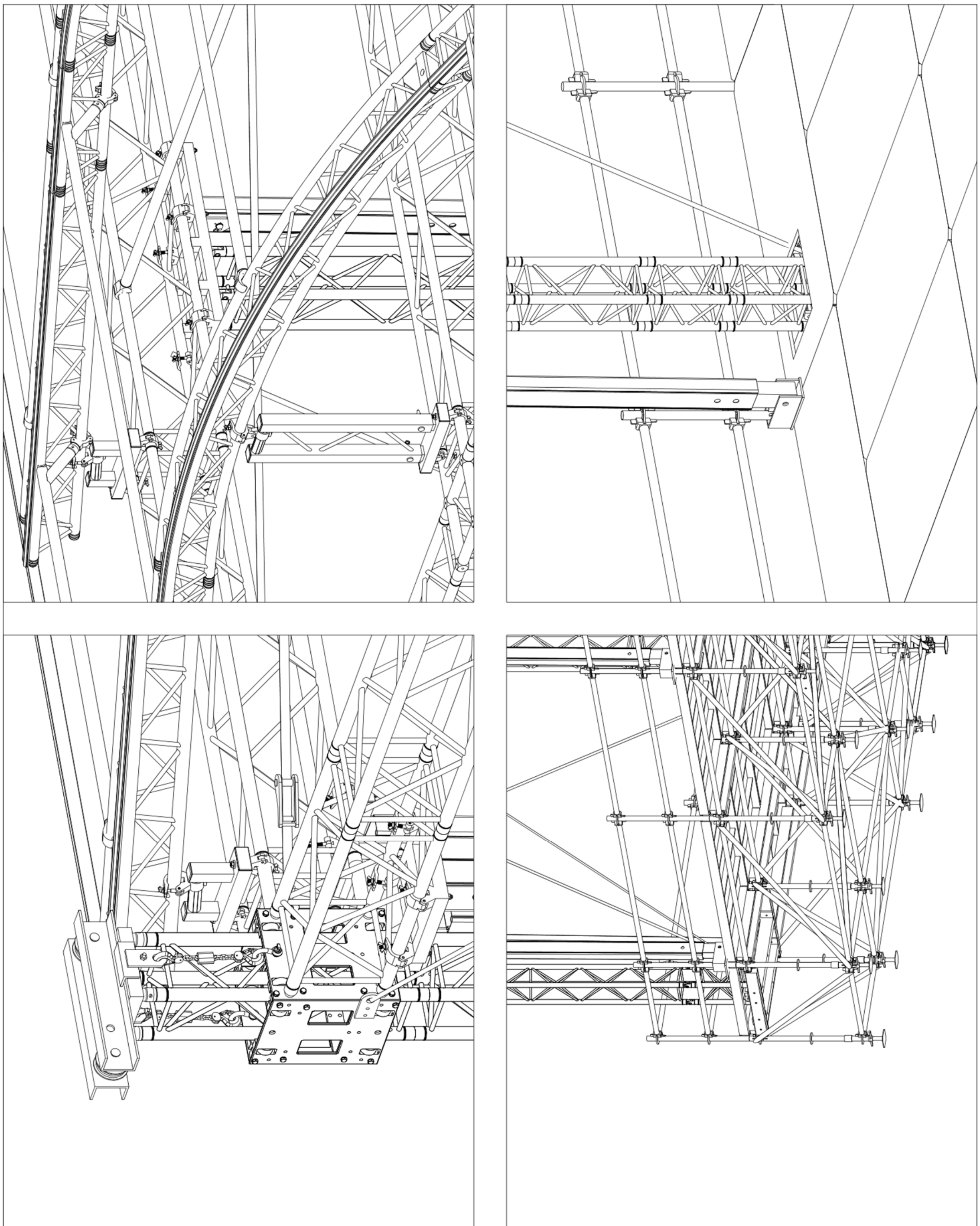
## 1.2.5 Details



| | | |
|---|---|---|
| DRAWN BY : IVO MULDER | PROJECT NR : 2016020-2 | REMARKS : SHEET 5/5 |
| DATE : 24-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | |
| REVISION : | STATUS : | |

DESCRIPTION :

CLT 12X8 DETAILS

UNIT : MM

A3

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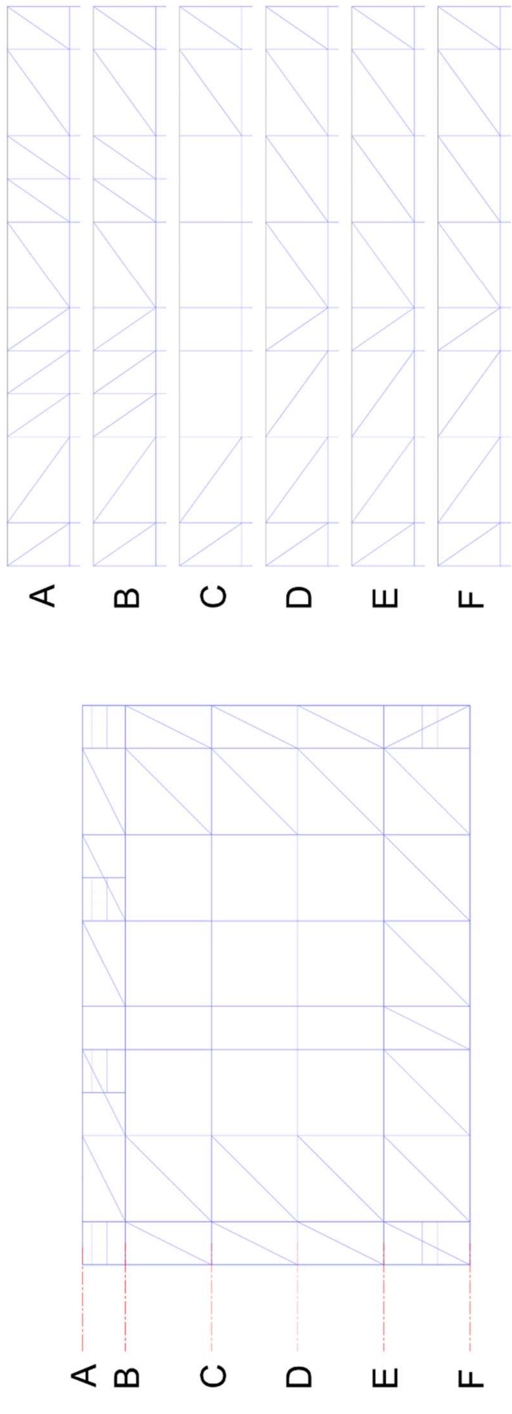
### 1.2.6 Layher plan drawing 1




| | | | |
|---|---|---|---|
| DRAWN BY : IVO MULDER | PROJECT NR : 2016020 | REMARKS : | UNIT : MM |
| DATE : 16-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | | |
| REVISION : | STATUS : | | |
| DESCRIPTION : CLT 12x8 LAYHER SETUP DRAWING 1 | | | A3 |



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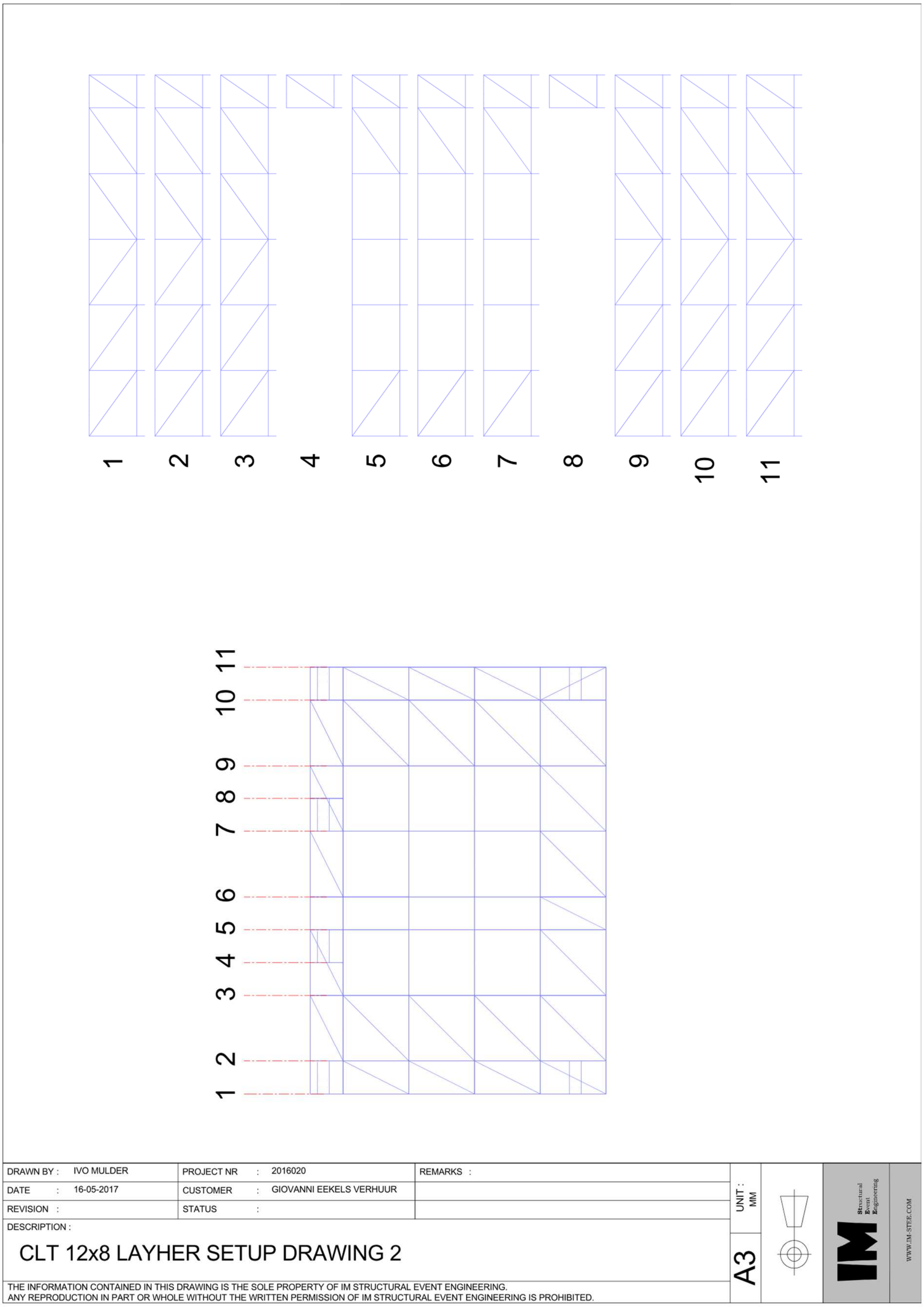
### 1.2.7 Layher plan drawing 1



### 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.

In the Appendix the structural information off each truss series and different parts can be found. The truss which is used is produced by Prolyte, and the different used series are.

| | |
|---|---|
| Tower | Prolyte H30V truss |
| Main grid | Prolyte H40V truss |
| Roof construction | Prolyte H30D truss in combination with special adapters |
| Side wall Profiles | Kedar profile 170x88 |
| Flooring system | Layher scaffolding with Layher Event system with as floor on top |
| Canopy sheets | PVC |

Steel wires or retched straps to stabilize the construction

## 1.6 Load assumptions

### 1.6.1 Wind loading

According to the Eurocode 13814, two wind situation calculations are made of a temporary demountable structures. 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 situations all the side walls are 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 all the side walls, banners, PA load 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 gust higher than the 28 m/s the construction side need to be completely cleared from all people.

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

In the NEN-EN 1991 there are 4 different terrain category's 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 Vb 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.

### 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 17.98 m/s for 0 < 8 m and the wind gust 21.91 m/s for 8 < 20 m.

0 < 8 meter 0.20 kN/m²

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

8 < 20 meter 0.30 kN/m²

| Terrain category | $V_b$ in m/s (1) | Max. wind gust (2) |
|---|---|---|
| Sea or coastal area exposed to open sea | 11.9 | 21.91 |
| Lakes or flat and horizontal area with negligible vegetation and without obstacles | 12.25 | 21.91 |
| Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights | 13.07 | 21.91 |
| 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) | 14.83 | 21.91 |
| Area in which at least 15% of the surface is covered with buildings and their average heights exceeds 15 m. | 17.09 | 21.91 |

### 1.6.3 Out-service situation.

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

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

0 < 8 meter 0,4375 kN/m²

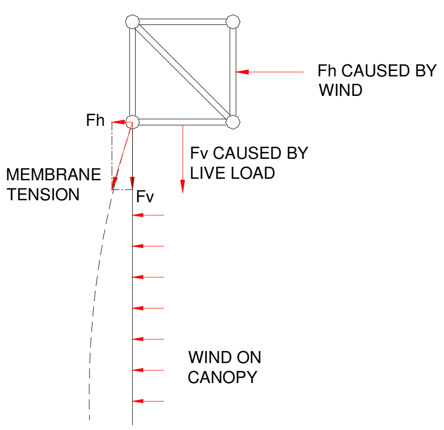
| Terrain category | $V_b$ in m/s (1) | Max. wind gust (2) |
|---|---|---|
| Sea or coastal area exposed to open sea | 15.65 | 26.46 |
| Lakes or flat and horizontal area with negligible vegetation and without obstacles | 16.3 | 26.46 |
| Area with low vegetation such as grass and isolated obstacles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

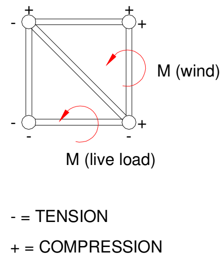
8 < 20 meter 0.625 kN/m²

| Terrain category | $V_b$ in m/s (1) | Max. wind gust (2) |
|---|---|---|
| Sea or coastal area exposed to open sea | 17.18 | 31.62 |
| Lakes or flat and horizontal area with negligible vegetation and without obstacles | 17.68 | 31.62 |
| Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights | 18.87 | 31.62 |
| 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) | 21.41 | 31.62 |
| Area in which at least 15% of the surface is covered with buildings and their average heights exceeds 15 m. | 24.66 | 31.62 |

### 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.

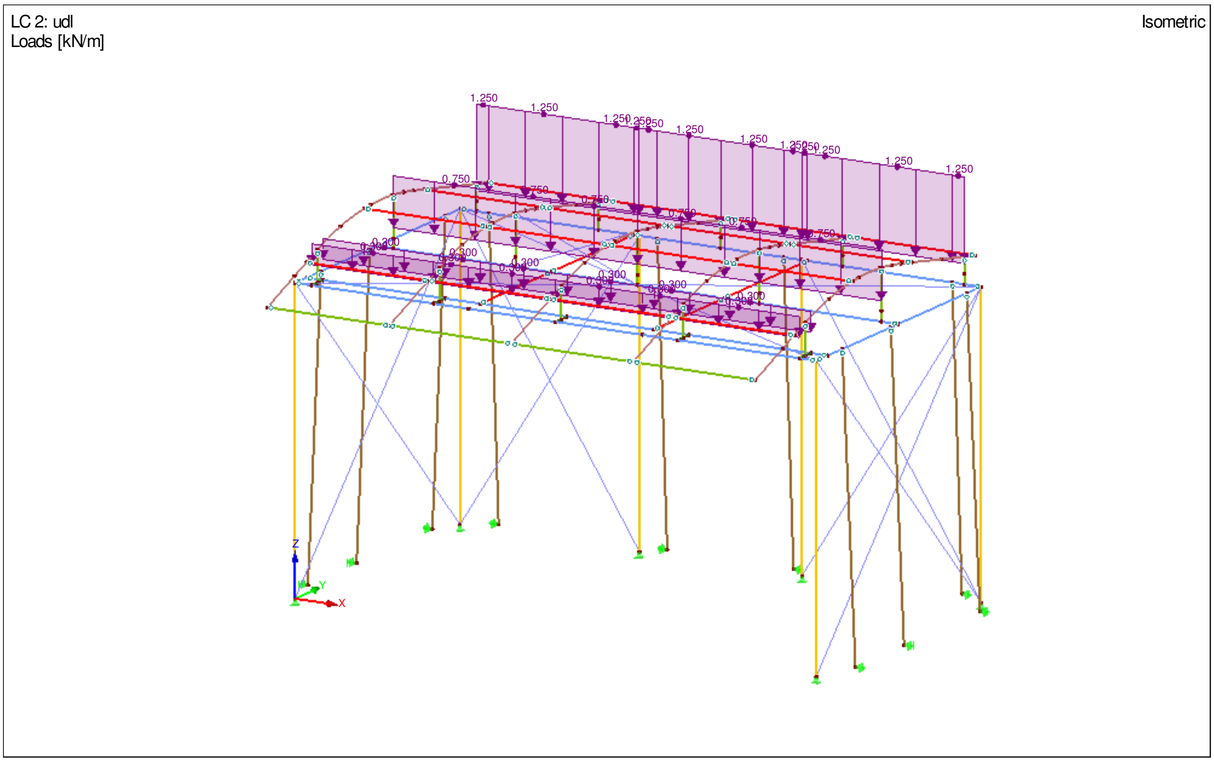
In this structural report there are Live load scenario's presented. These are intended to give an indication of the Rigging possibilities in the construction. If the actual loading of the construction deviates from the these Rigging plots an additional comparison calculation need to be made. The shifting 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.

The calculation of the roof system has been done with 5 different loading scenarios. Uniform distributed load , Center point load, point loads in the third point and point load 1.25 meter from the side span. In the Out-service situation the PA load and big scenery need to be derigged from the roof, the loading of the main roof can stay in the roof. This is taken into account in this calculation.

### 1.7.1 UDL Loading setup




Equally divided load along the main span.

Span 1 = 30 kg/m

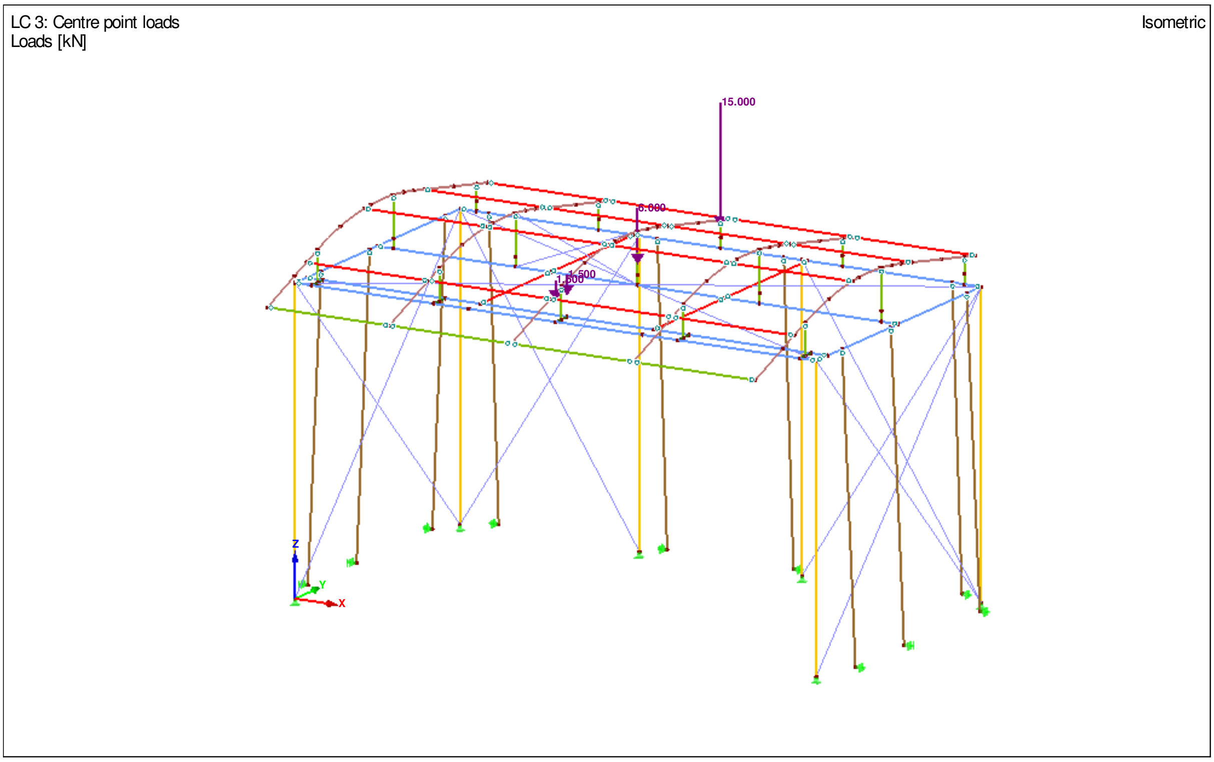
Span 2 = 30 kg/m

Span 3 = 75 kg/m

Span 4 = 125 kg/m

The total load on the main system is ~ 3120 kg

### 1.7.2 Centre point load




Span 1 = 150 kg

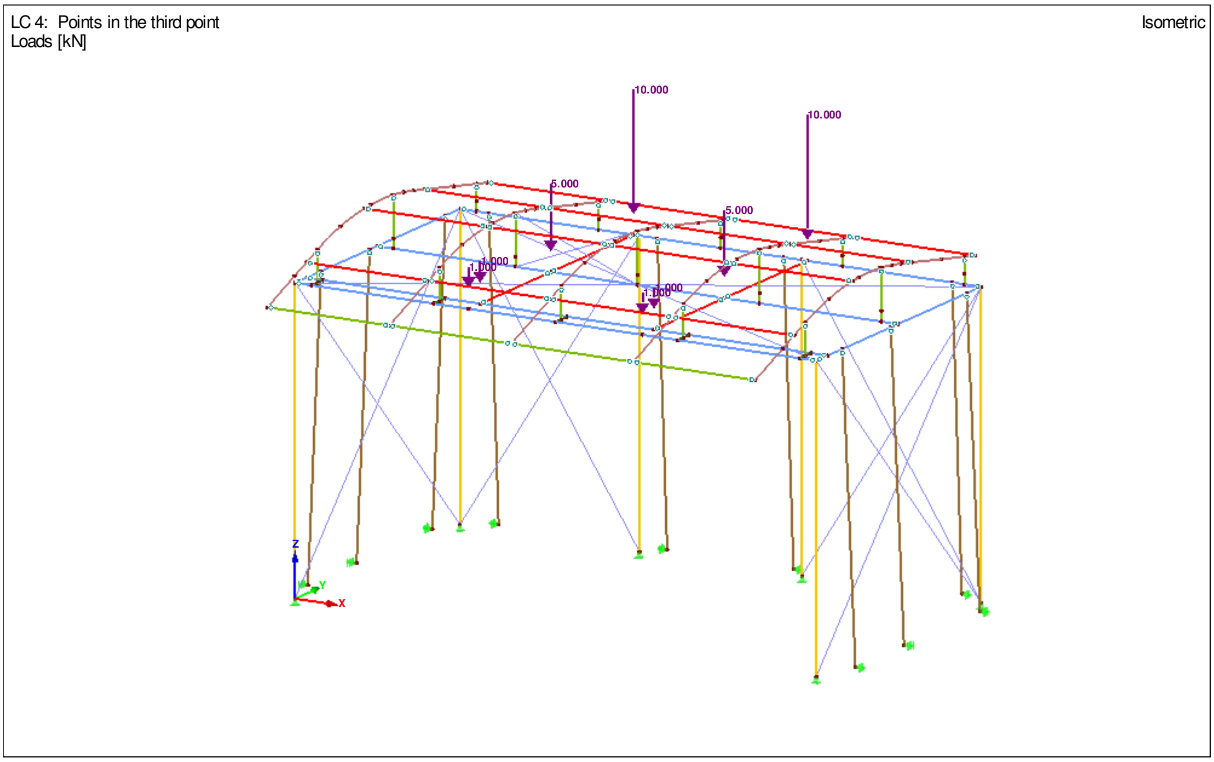
Span 2 = 150 kg

Span 3 = 600 kg

Span 4 = 1500 kg

The total load on the main system is ~ 2400 Kg

### 1.7.3 Point loads in the third point




Span 1 = 2x 100 kg

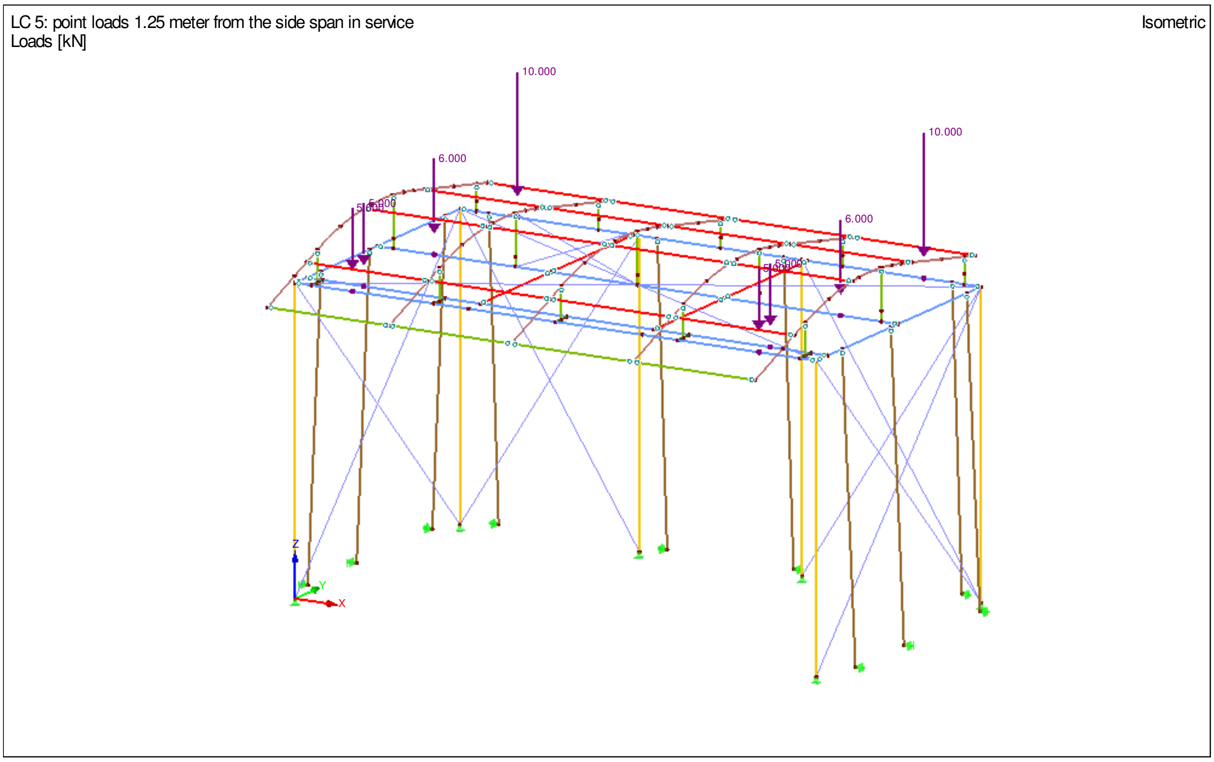
Span 2 = 2x 100 kg

Span 3 = 2x 600 kg

Span 4 = 2x 1000 kg

The total load on the main system is ~ 3600 Kg

### 1.7.4 Point loads 1.25 meter from side span in service




Span 1 = 2x 500 kg

Span 2 = 2x 500 kg

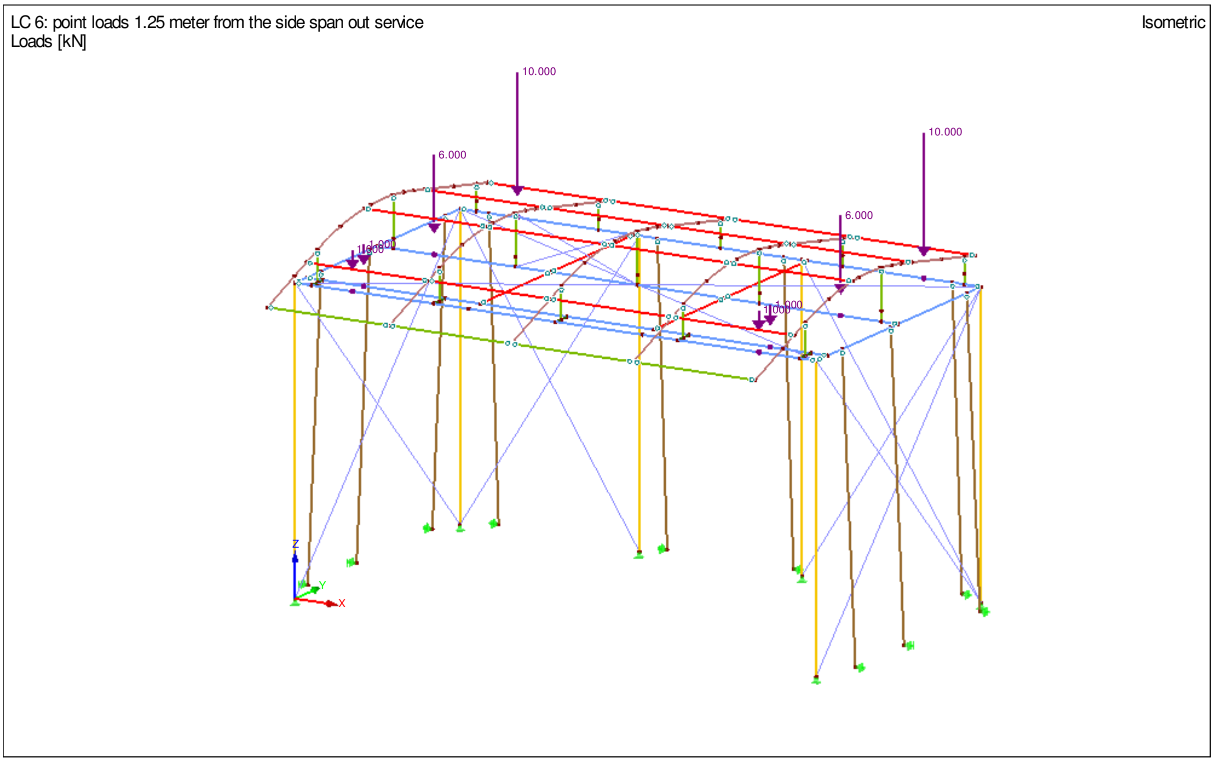
Span 3 = 2x 600 kg

Span 4 = 2x 1000 kg

The total load on the main system is ~ 5200 Kg

**This loading scenario can only be used in the In service situation. When the out service situation is in place the two main loading points in the front two spans need to be removed and this loading setup will be replaced by LC6!!**

## 1.7.5 Point loads 1.25 meter from side span out service




Span 1 = 2x 100 kg

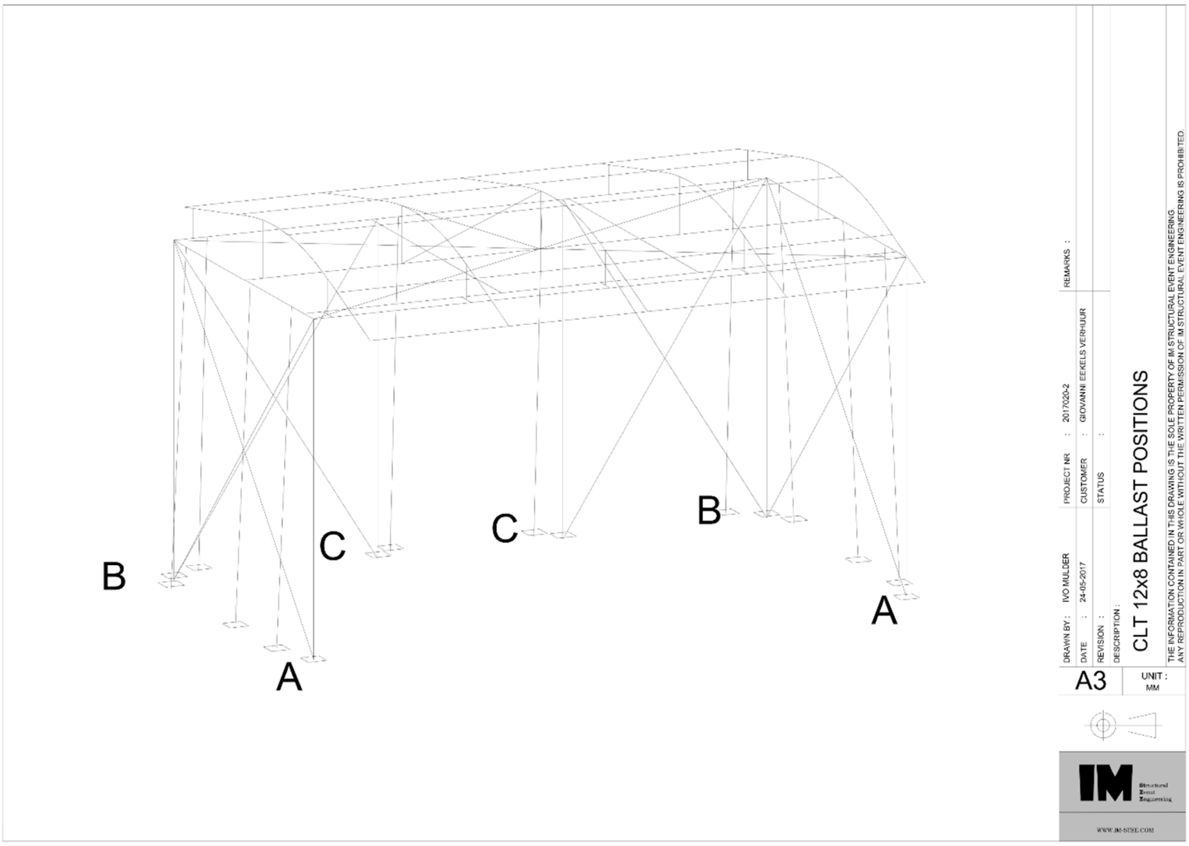
Span 2 = 2x 100 kg

Span 3 = 2x 600 kg

Span 4 = 2x 1000 kg

The total load on the main system is ~ 3600 Kg

## 1.8 Necessary Ballast loading, full system

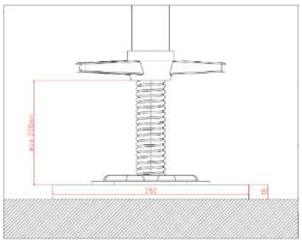



The Ballast calculation has been done in chapter 5 underneath are the result of the nece4sary ballast per point. For the ballast at the stack tower in the middle of the back span the self-weight of the Layher system will be taken.

**Point A = 1200 kg**

**Point B = 1400 kg**

**Point C = 1000 kg**



For the proof against sliding a minimum friction coefficient of 0,4 is taken into account. Which means that every Layher spindle need a wood pad underneath. The recommended minimum dimensions of the wood pad is 25x25x18 mm.

## 2.0 General calculation input.

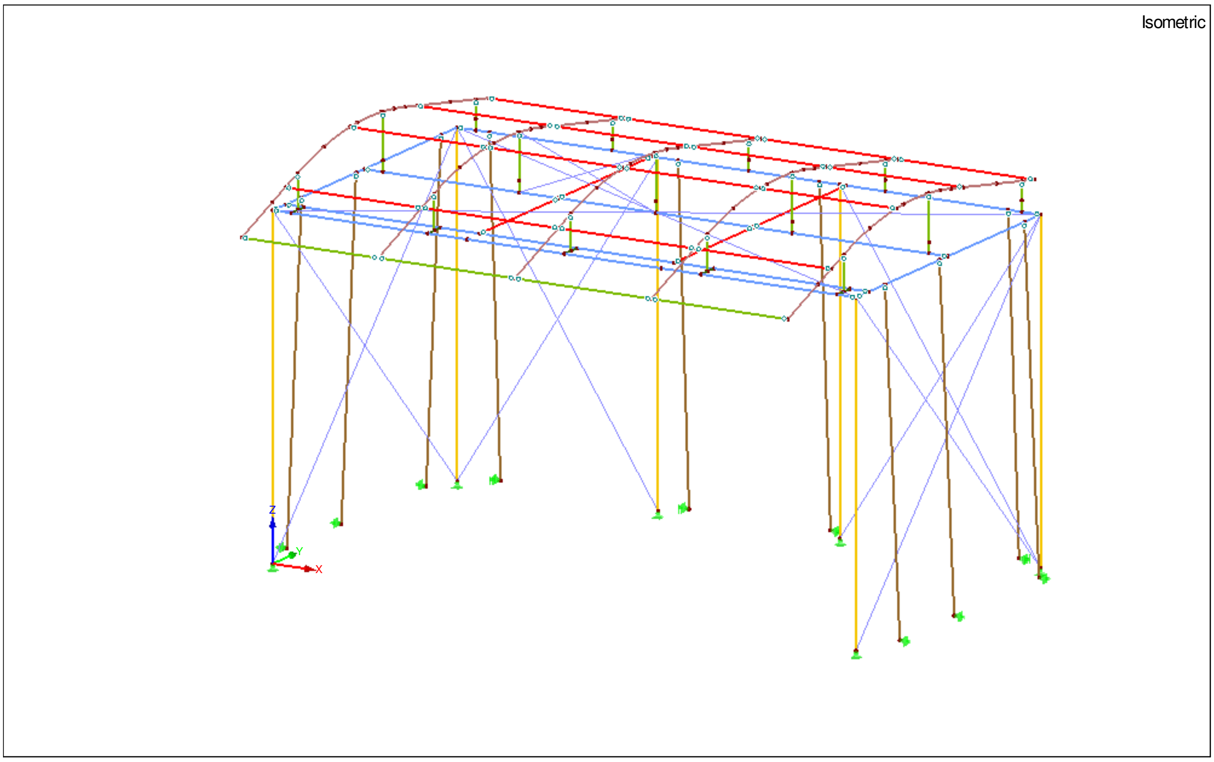
### 2.1 Used program information.

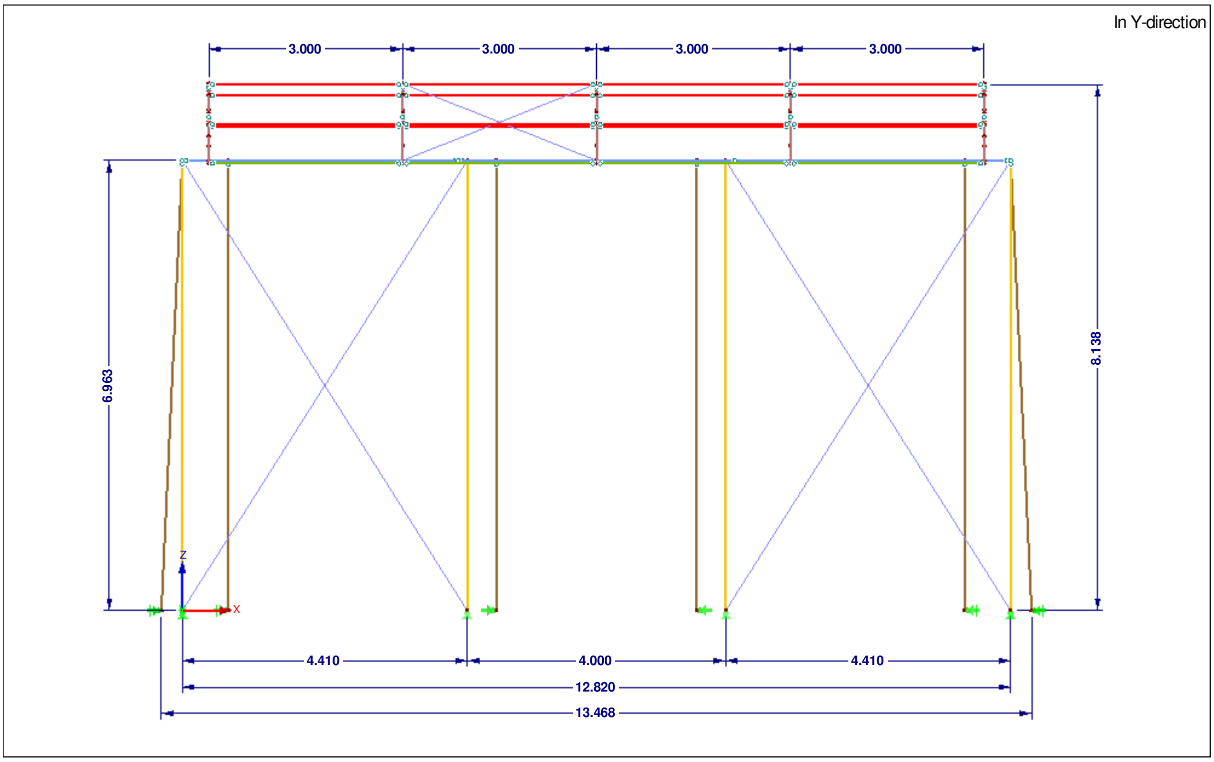
For the calculation of the construction the program RFem 5.08.001 is used.

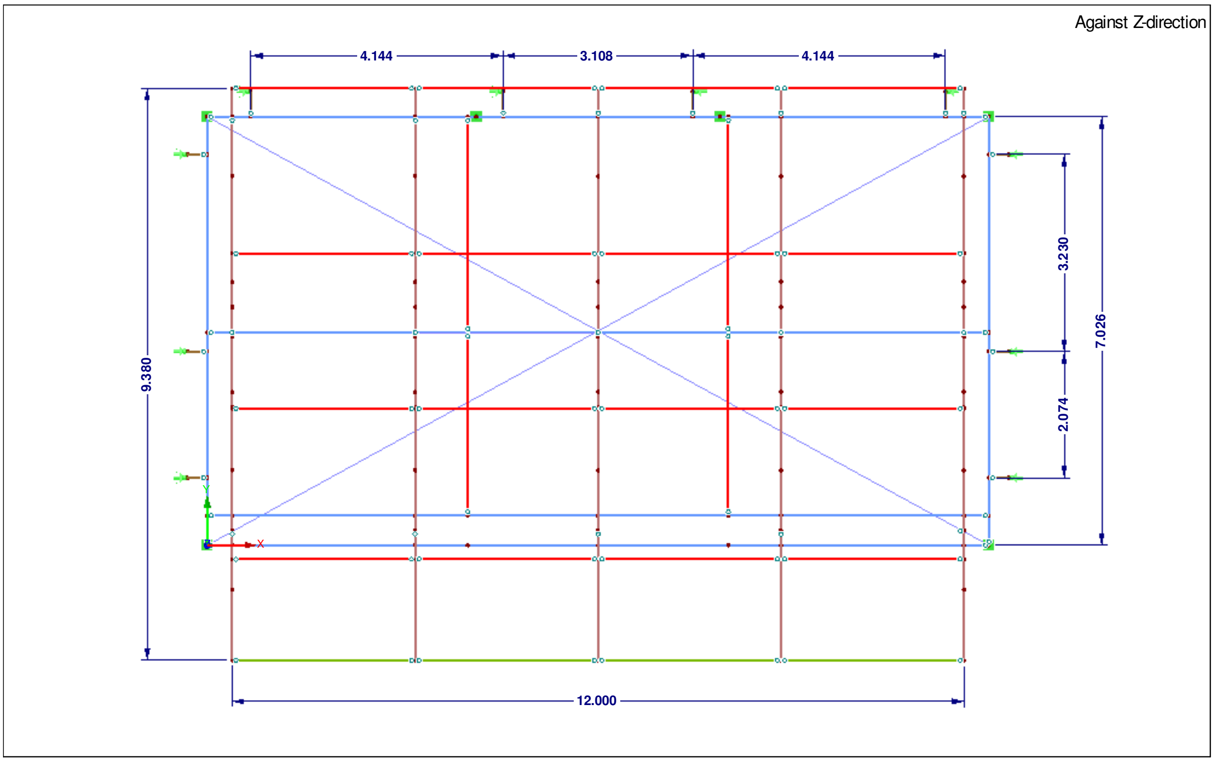
### 2.2 Program input for the main roof construction calculation.

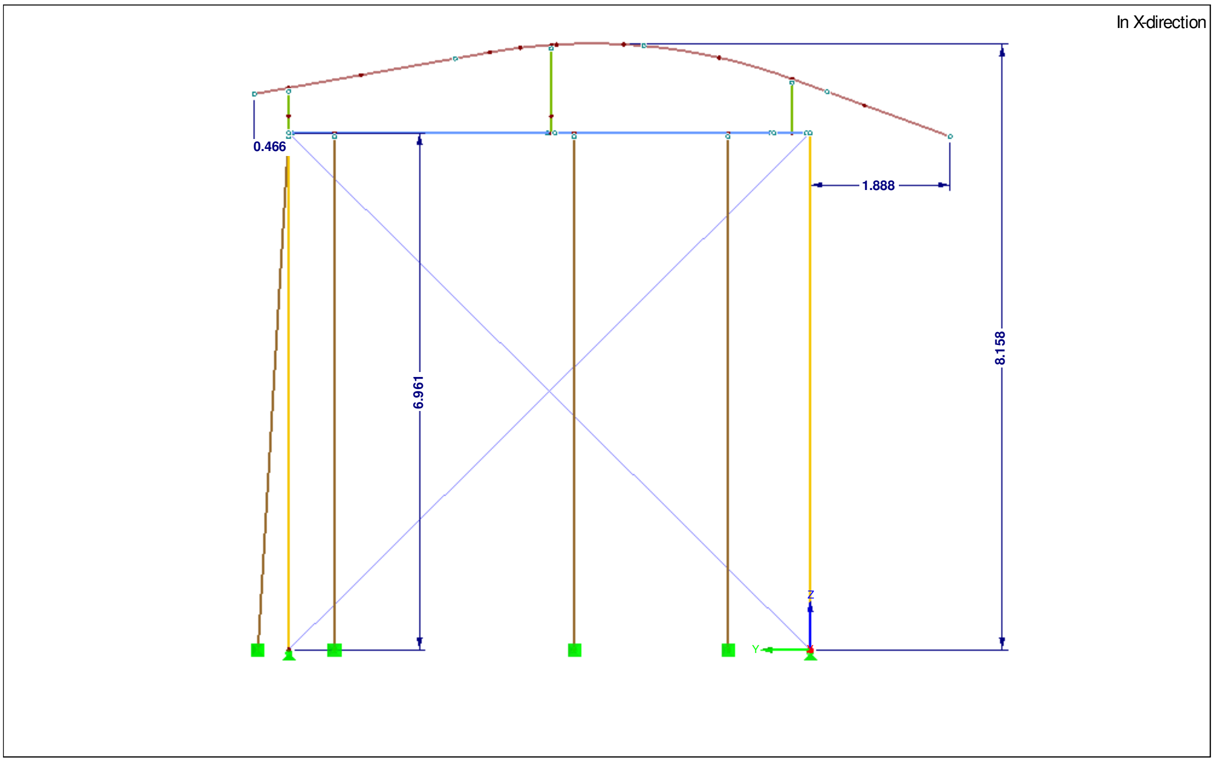
For the roof system CLT 12 x10 is a model constructed in the RFem program. For special parts of the roof construction which need a more detailed calculation a separate model constructed and loaded with the results of the main roof system model, which makes the calculation more accurate.
The Layher staging system is constructed as a separate model and will be loaded with the support reaction forces of the main models of the roof.

## 2.3 Construction model of the main roof system.




Against Z-direction
4.144
3.108
4.144
9.380
3.230
7.026
2.074
12.000
Y
X


In X-direction
0.466
1.888
6.961
8.158
Z
Y

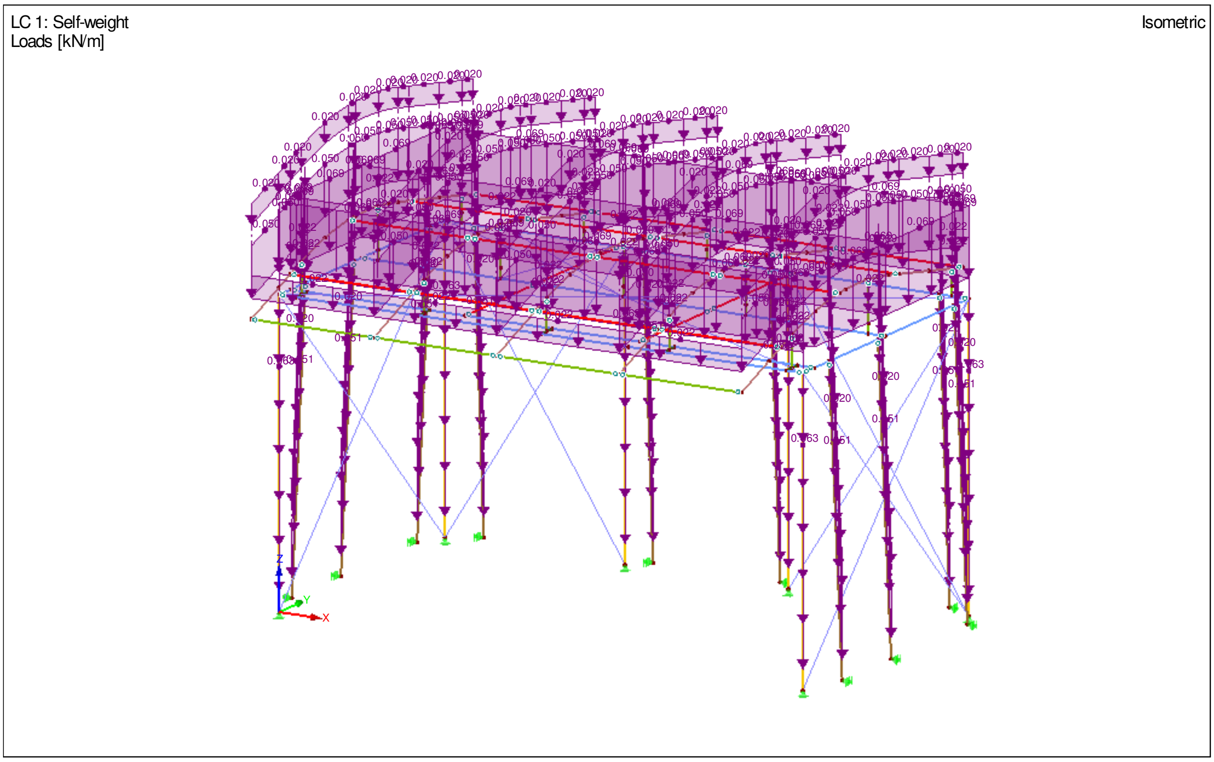
## 2.4 Different load cases for the In-service and Out service situation

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

| Load | Load Case | | EN 1990 \| CEN | Self-Weight - Factor in Direction | | | |
|---|---|---|---|---|---|---|---|
| Case | Description | To Solve | Action Category | 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 | Centre point loads | + | Permanent | - | 0,000 | 0,000 | -1,000 |
| LC4 | point loads in the third point | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC5 | point loads1.25 meter from side span in service | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC6 | point loads1.25 meter from side span out service | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC10 | in-service wind dir.0° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC11 | in-service wind dir. 0° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC12 | in-service wind dir. 0° back and side wall | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC13 | in-service wind dir. 0° back and side wall membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC20 | in-service wind dir. 90° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC21 | in-service wind dir. 90° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC22 | in-service wind dir. 90° back and side wall | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC23 | in-service wind dir. 90° back and side wall membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC30 | in-service wind dir. 180° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC31 | in-service wind dir. 180° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC32 | in-service wind dir. 180° back and side wall | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC33 | in-service wind dir. 180° back and side wall membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC34 | in-service wind dir. 180° roof structure compression | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC35 | in-service wind dir. 180° roof structure membrane tension compression | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC110 | Out-service wind dir. 0° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC111 | Out-service wind dir. 0° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC112 | Out-service wind dir. 0° tower + profiles | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC113 | Out-service wind dir. 0° roof structure compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC114 | Out-service wind dir. 0° roof structure membrane tension compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| | | | | | | | |
| LC120 | Out-service wind dir. 90° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC121 | Out-service wind dir. 90° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC122 | Out-service wind dir. 90° tower + profiles | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| | | | | | | | |
| LC130 | Out-service wind dir. 180° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC131 | Out-service wind dir. 180° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC132 | Out-service wind dir. 180° tower + profiles | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC133 | Out-service wind dir. 180° roof structure compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC134 | Out-service wind dir. 180° roof structure membrane tension compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |

### 2.5 Load case input for the self-weight and the loading possibilities.

### 2.5.1 Load case 1 Self-Weight




Self-weight different components

H30V Towers = 6.3 kg/m

H40V = 6.9 kg/m

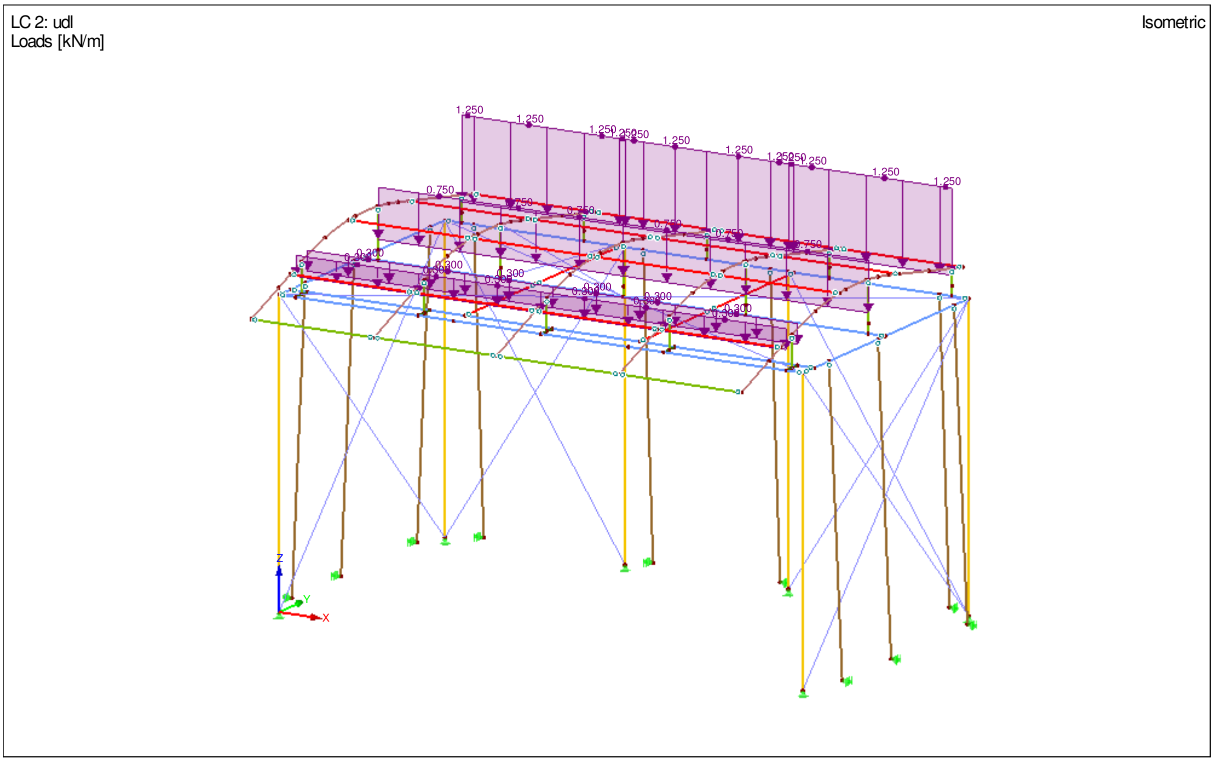
H30D = 5 kg/m

Kedar Profile 170x88x3 = 5.1 kg/m

Canopy skin = 1 kg/m²

Aluminium adapters = 2.2 kg/m Profile

### 2.5.2 load case 2 UDL loading




Equally divided load along the main span.

Span 1 = 30 kg/m

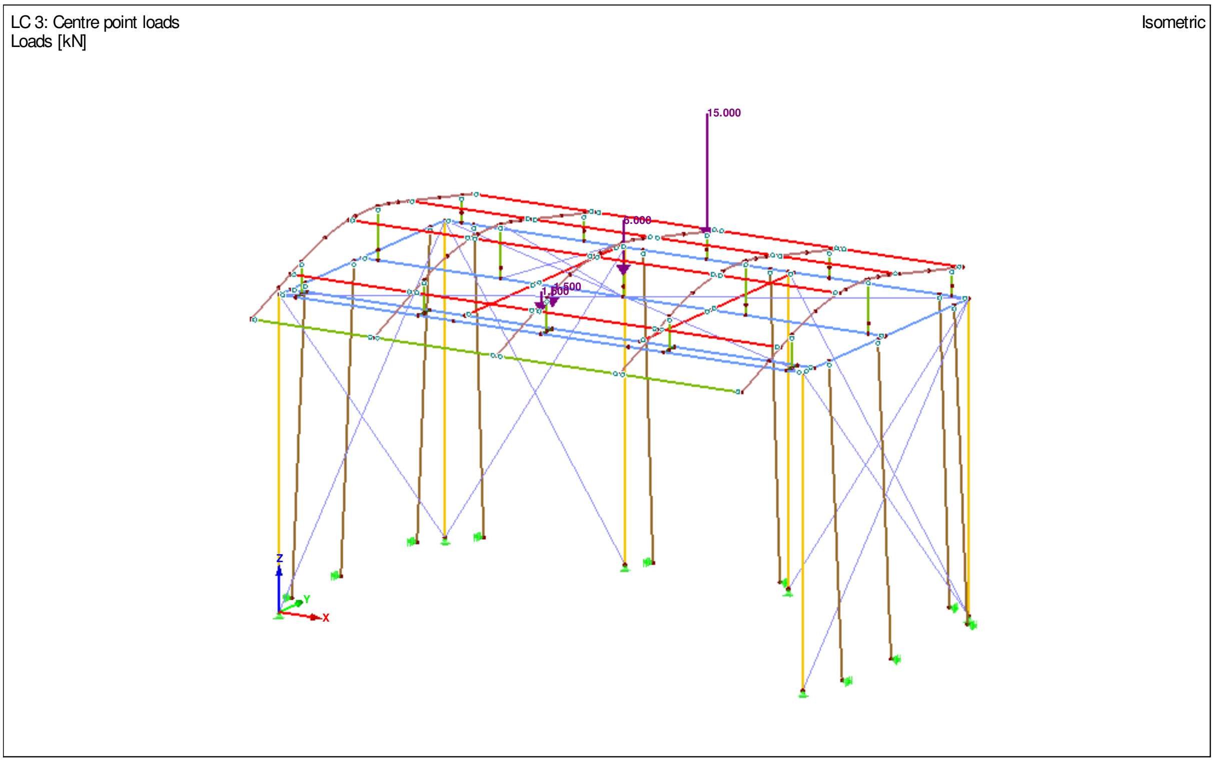
Span 2 = 30 kg/m

Span 3 = 75 kg/m

Span 4 = 125 kg/m

The total load on the main system is ~ 3120 kg

### 2.5.3 load case 3 Center point load.




Span 1 = 150 kg

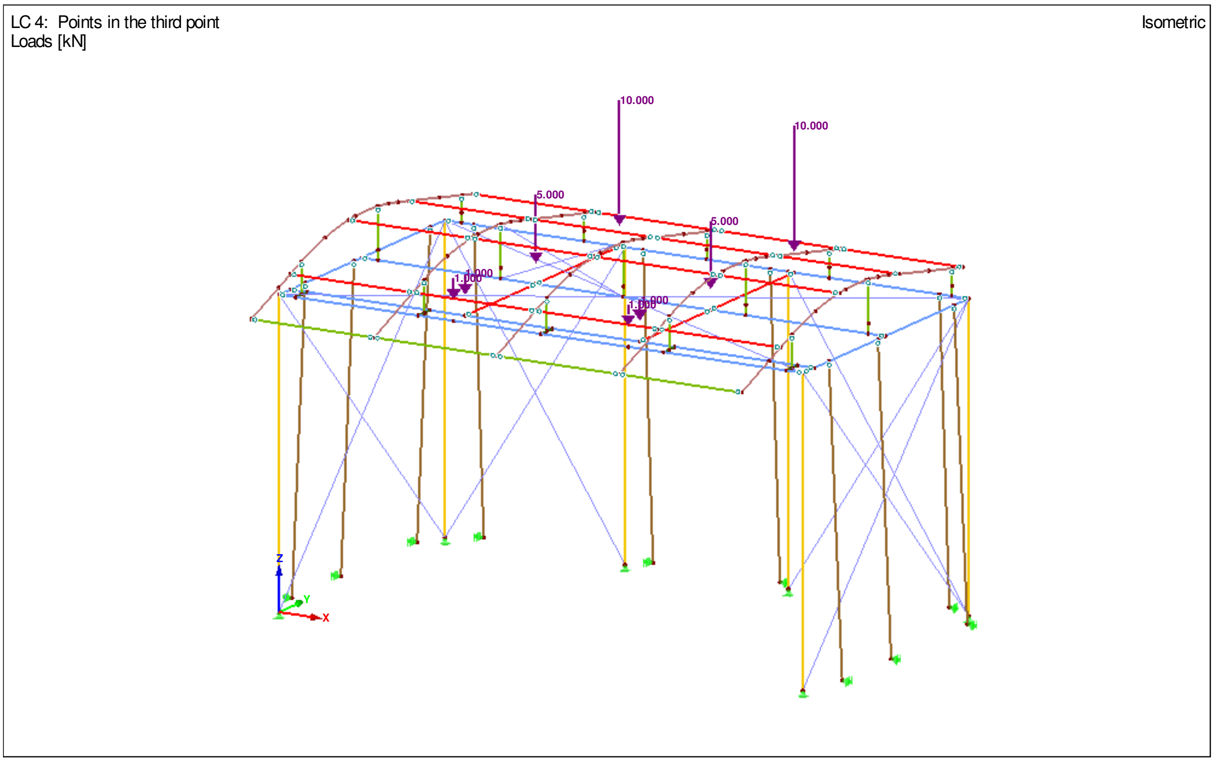
Span 2 = 150 kg

Span 3 = 600 kg

Span 4 = 1500 kg

The total load on the main system is ~ 2400 Kg

### 2.5.4 load case 4 Point load in the third point




Span 1 = 2x 100 kg

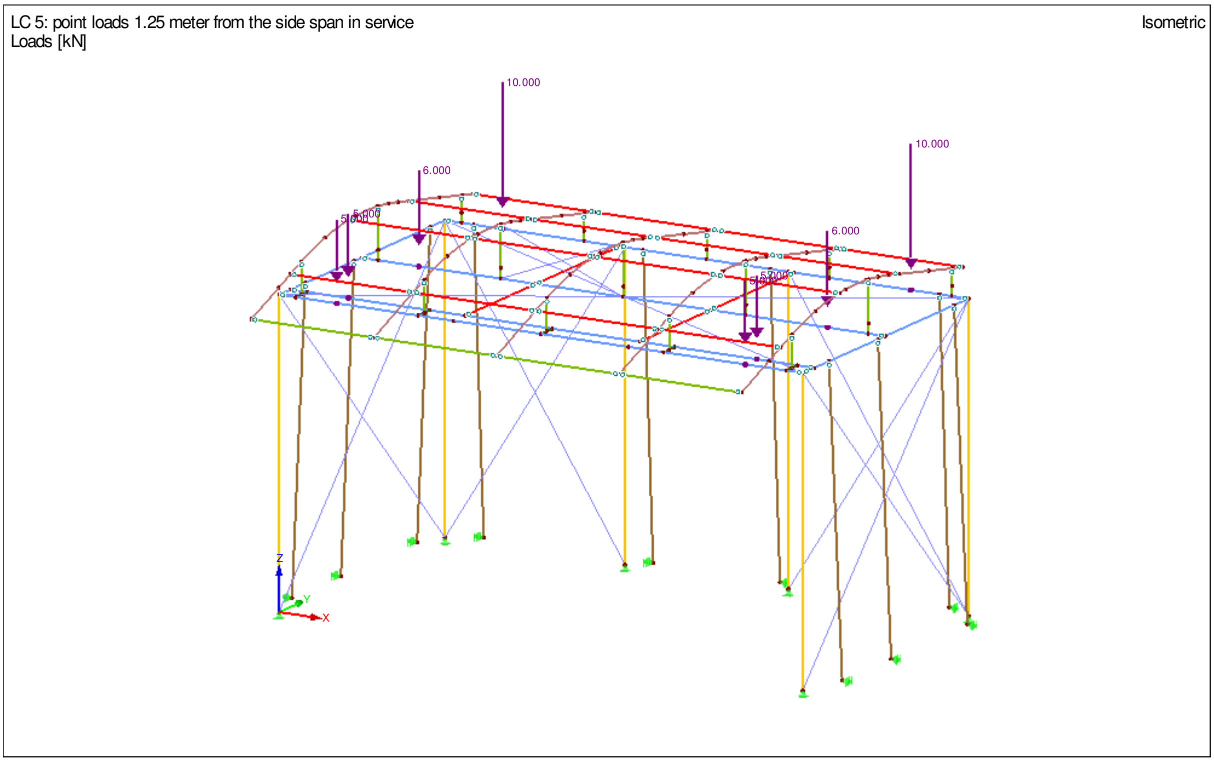
Span 2 = 2x 100 kg

Span 3 = 2x 500 kg

Span 4 = 2x 1000 kg

The total load on the main system is ~ 3400 Kg

### 2.5.5 load case 5 Point loads 1.25 meter from side span in service




Span 1 = 2x 500 kg

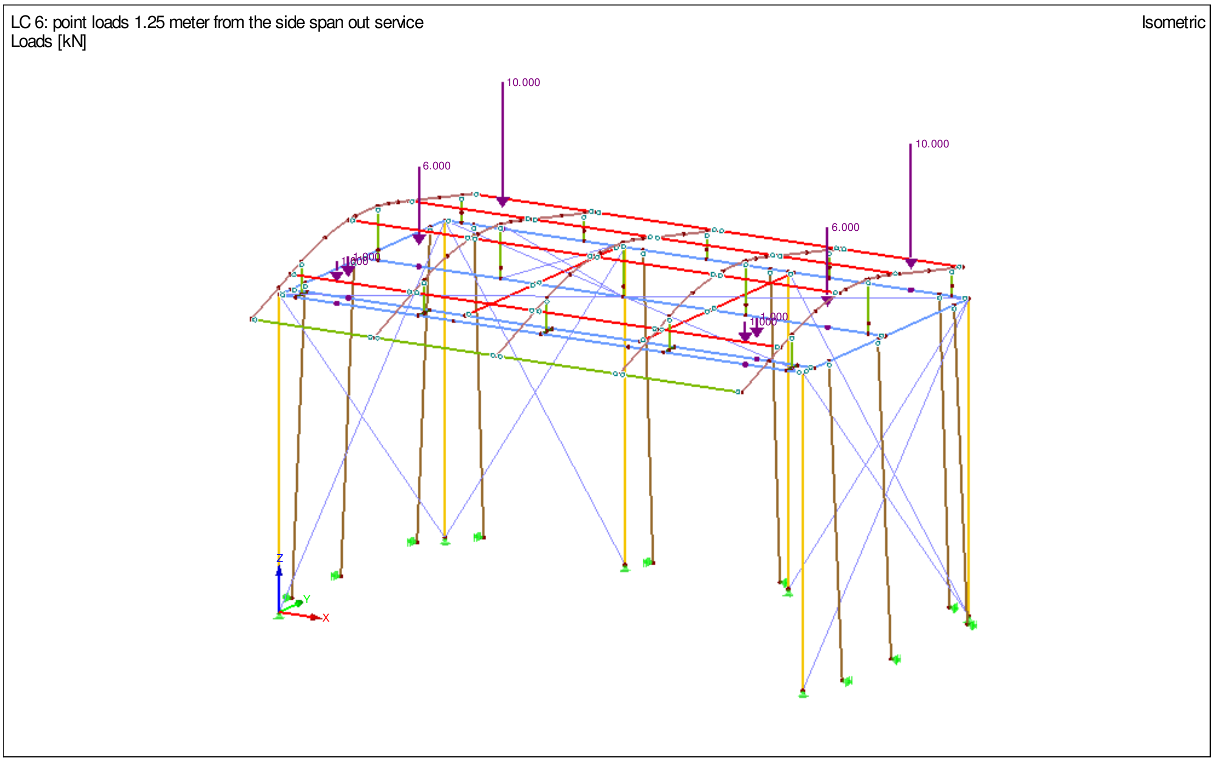
Span 2 = 2x 500 kg

Span 3 = 2x 600 kg

Span 4 = 2x 1000 kg

The total load on the main system is ~ 5200 Kg

### 2.5.6 load case 6 Point loads 1.25 meter from side span out service




Span 1 = 2x 100 kg

Span 2 = 2x 100 kg

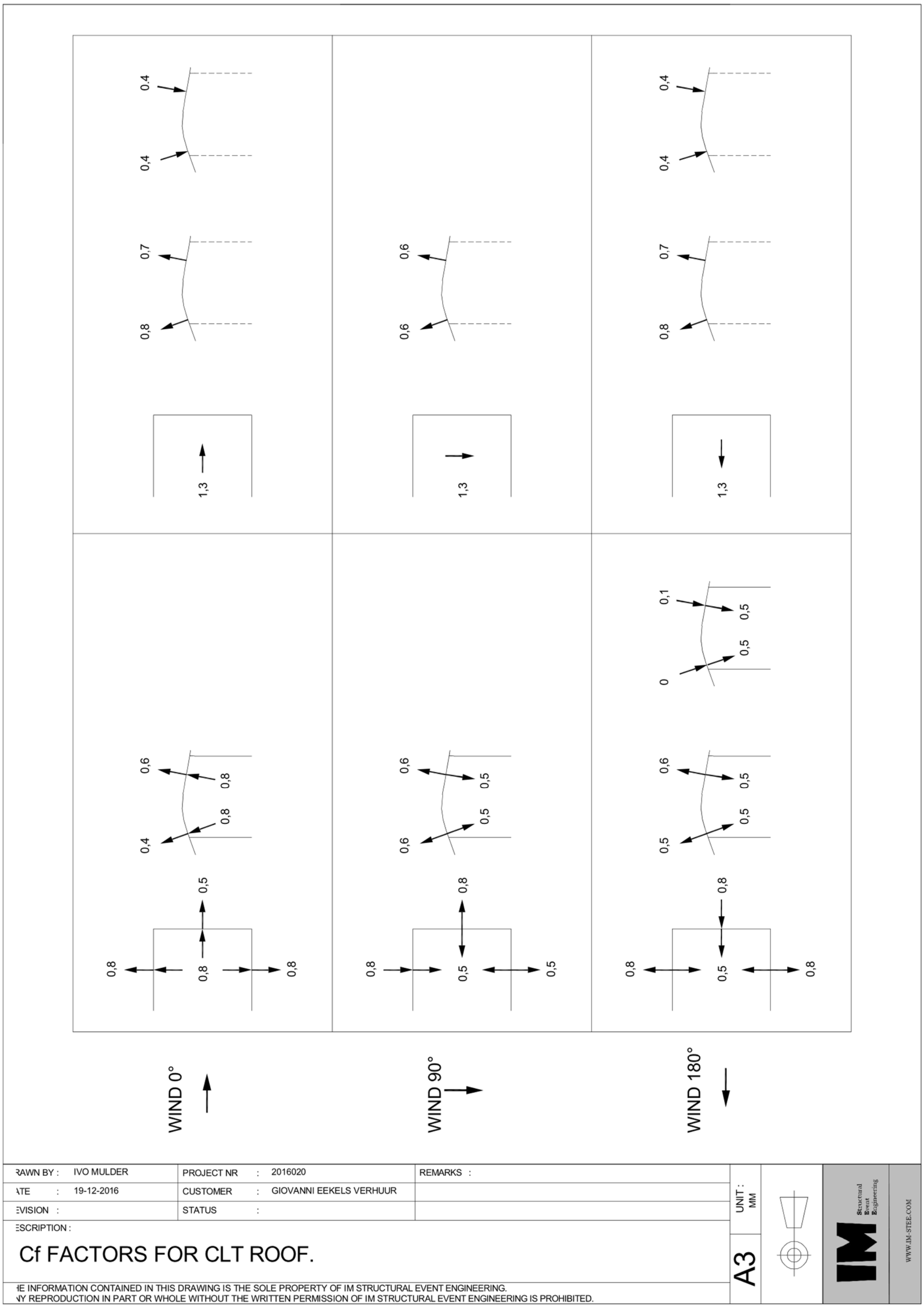
Span 3 = 2x 600 kg

Span 4 = 2x 1000 kg

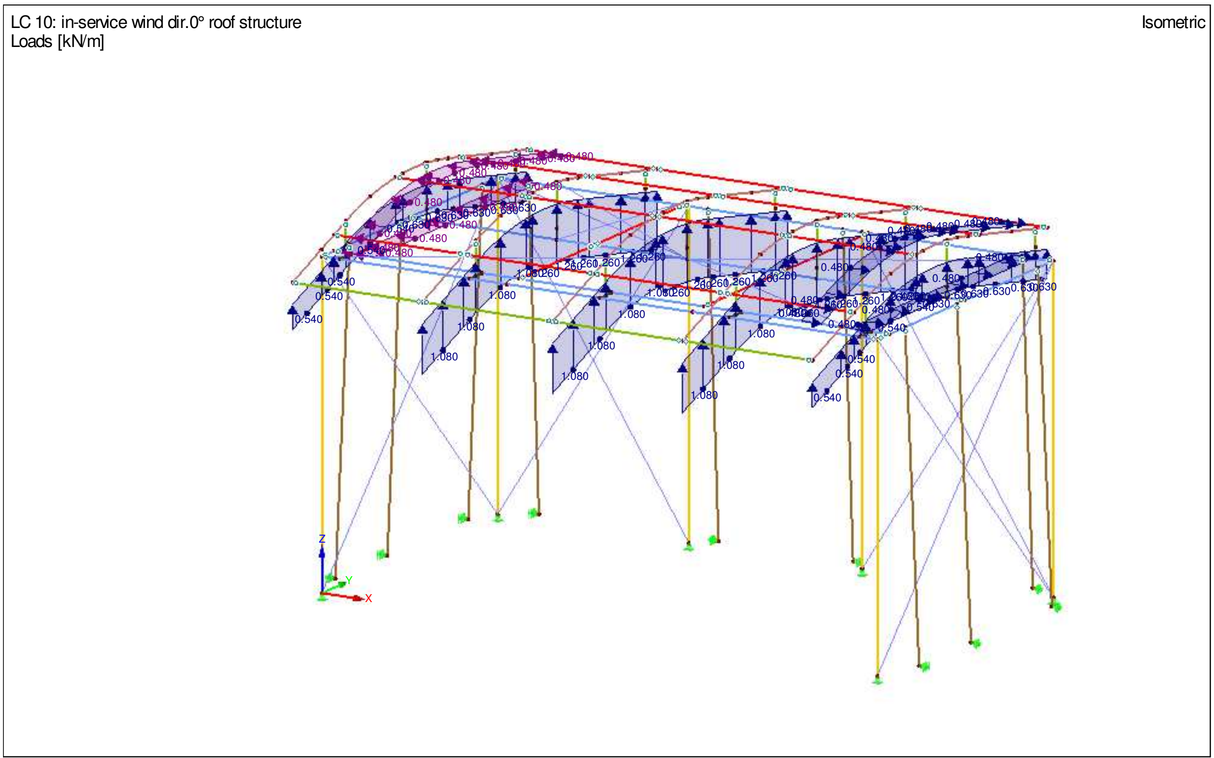
The total load on the main system is ~ 3600 Kg

## 2.6 load cases concerning wing loading.

For the calculation of the wind loading the next wind coefficient are used. These factors are subtracted from the Eurocode NEN-EN 1999-1 1-4: general actions – wind actions.



### 2.6.1 load case 10 In-service wind dir. 0° roof structure




Wind calculations roof construction wind 0°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 1.2 * 0.3 * 1.5 = 0.540 kN/m
$q_{w,\text{ roof span 2, front}}$ = 1.2 * 0.3 * 3 = 1.080 kN/m
$q_{w,\text{ roof span 3, front}}$ = 1.2 * 0.3 * 3 = 1.080 kN/m
$q_{w,\text{ roof span 4, front}}$ = 1.2 * 0.3 * 3 = 1.080 kN/m
$q_{w,\text{ roof span 5, front}}$ = 1.2 * 0.3 * 1.5 = 0.540 kN/m

Main roof structure back side

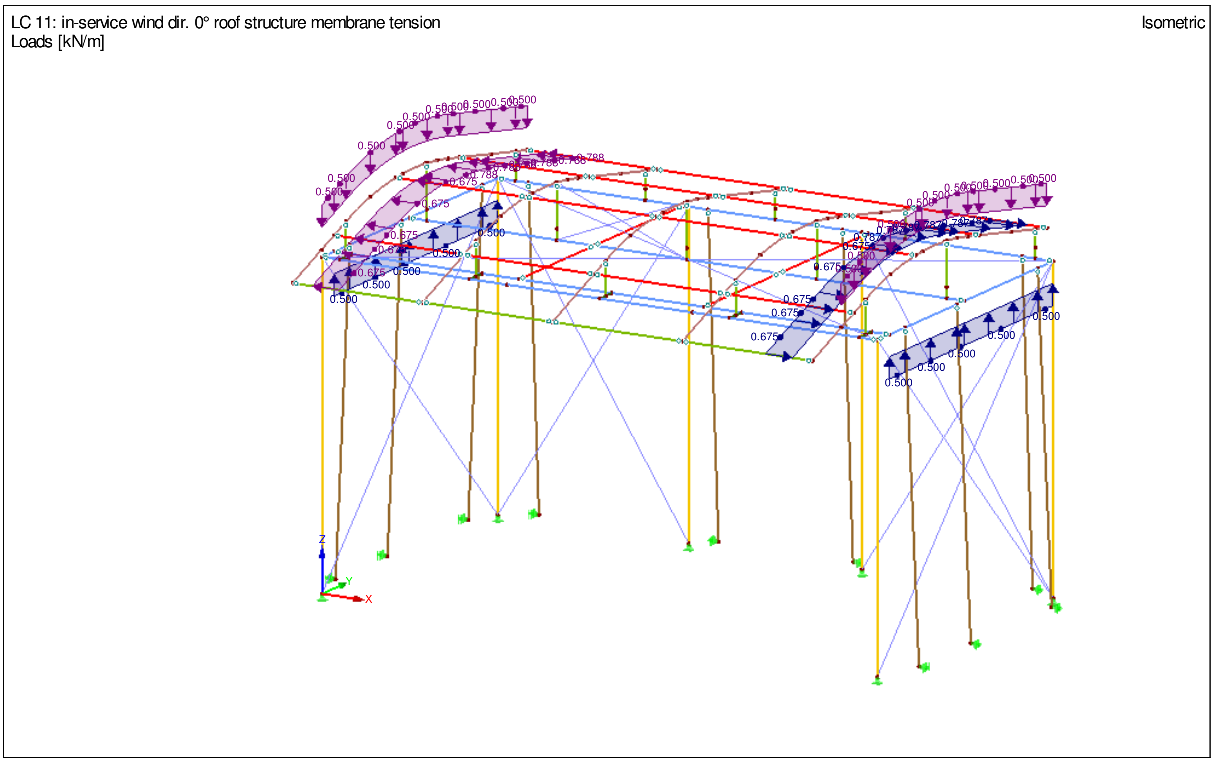
$q_{w,\text{ roof span 1, back}}$ = 1.4 * 0.3 * 1.5 = 0.630 kN/m
$q_{w,\text{ roof span 2, back}}$ = 1.4 * 0.3 * 3 = 1.260 kN/m
$q_{w,\text{ roof span 3, back}}$ = 1.4 * 0.3 * 3 = 1.260 kN/m
$q_{w,\text{ roof span 4, back}}$ = 1.4 * 0.3 * 3 = 1.260 kN/m
$q_{w,\text{ roof span 5, back}}$ = 1.4 * 0.3 * 1.5 = 0.630 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 12.5 m²
$Q_{w,\text{ side canopy roof structure}}$ = 1.6 * 0.3 * 12.5 = 6 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 6 / 15 = 0.400 kN/m

## 2.6.2 load case 11 In-service wind dir. 0° roof structure membrane tension




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\text{ roof span 1, front}} = 0.675$ kN/m
$q_{mt,\text{ roof span 2, front}} = 0$ kN/m
$q_{mt,\text{ roof span 3, front}} = 0$ kN/m
$q_{mt,\text{ roof span 4, front}} = 0$ kN/m
$q_{mt,\text{ roof span 5, front}} = 0.675$ kN/m

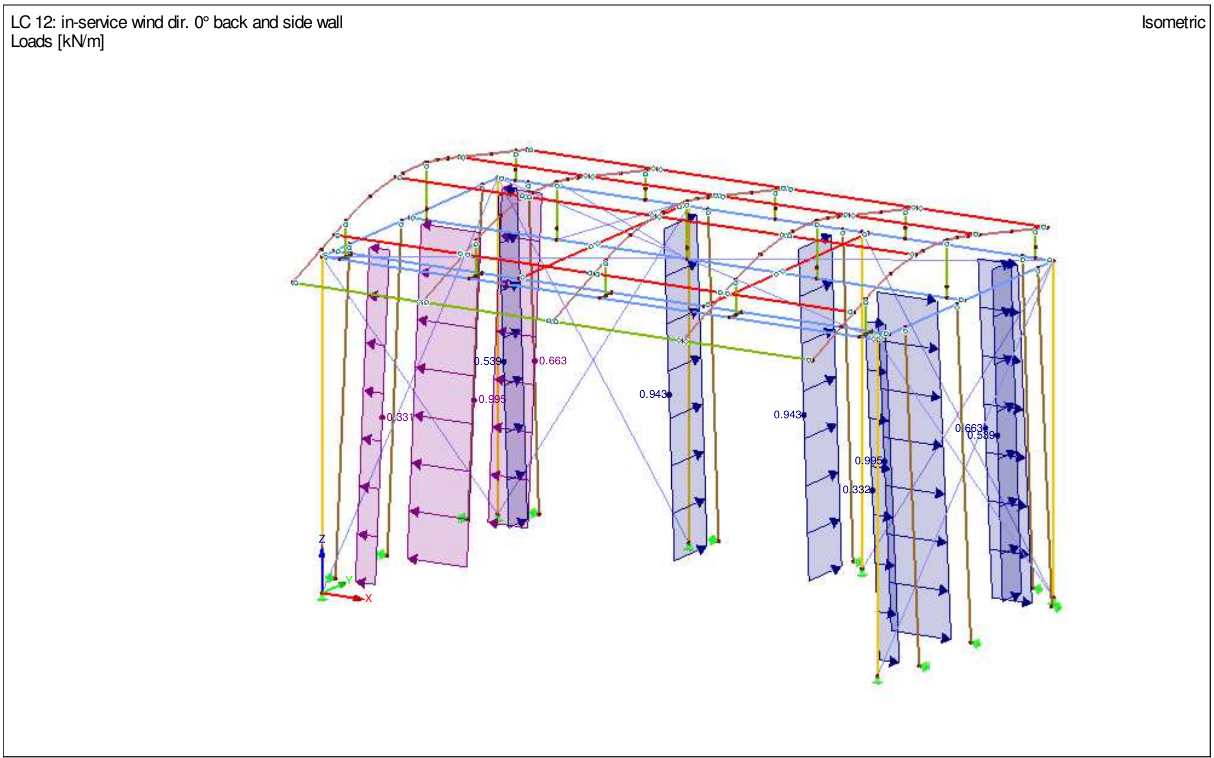
Membrane tension of roof structure back side

$q_{mt,\text{ roof span 1, back}} = 0.788$ kN/m
$q_{mt,\text{ roof span 2, back}} = 0$ kN/m
$q_{mt,\text{ roof span 3, back}} = 0$ kN/m
$q_{mt,\text{ roof span 4, back}} = 0$ kN/m
$q_{mt,\text{ roof span 5, back}} = 0.788$ kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\text{ side canopy roof structure}} = 0.400 / 0.8 = 0.500$ kN/m

### 2.6.3 load case 12 In-service wind dir. 0° side and back wall




Calculation of the wind loading on the different profiles.

In the back wall you have 4 profiles, profile 1 is the first profile at stage right.

Calculation of the wind on the back walls

$q_{w,\text{ back profile 1}} = 1.3 * 0.2 * 2.072 = 0.539$ kN/m

$q_{w,\text{ back profile 2}} = 1.3 * 0.2 * 3.626 = 0.943$ kN/m

$q_{w,\text{ back profile 3}} = 1.3 * 0.2 * 3.626 = 0.943$ kN/m

$q_{w,\text{ back profile 4}} = 1.3 * 0.2 * 2.072 = 0.539$ kN/m

In the side wall you have 3 profiles, profile 1 is the first profile on the front of the stage.

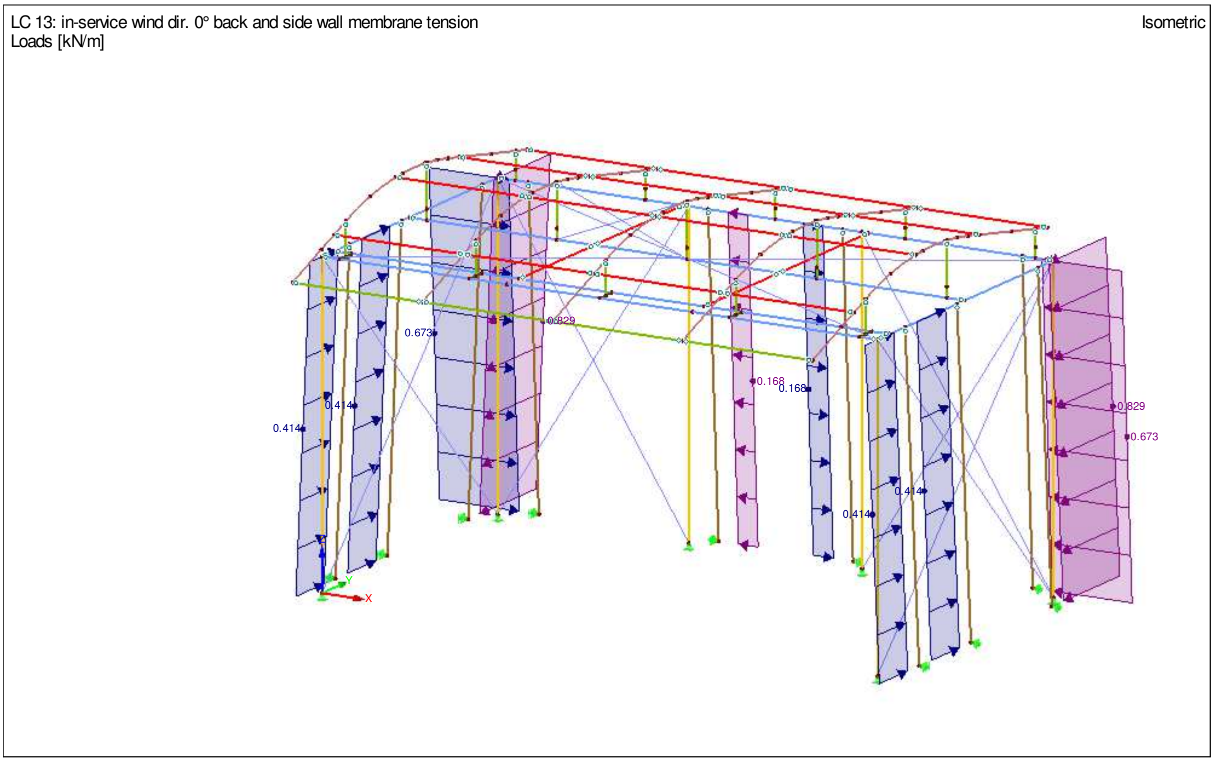
Calculation of the wind on the side walls

$q_{w,\text{ side profile 1}} = 1.6 * 0.2 * 1.036 = 0.331$ kN/m

$q_{w,\text{ side profile 2}} = 1.6 * 0.2 * 3.108 = 0.995$ kN/m

$q_{w,\text{ side profile 3}} = 1.6 * 0.2 * 2.072 = 0.663$ kN/m

## 2.6.4 load case 13 In-service wind dir. 0° side and back wall membrane tension




Membrane tension calculations side wall wind 0°

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Calculation of the membrane tension on the back walls

$q_{mt,\ back\ profile\ 1} = 0.673$ kN/m

$q_{mt,\ back\ profile\ 2} = 0.168$ kN/m

$q_{mt,\ back\ profile\ 3} = 0.168$ kN/m

$q_{mt,\ back\ profile\ 4} = 0.673$ kN/m

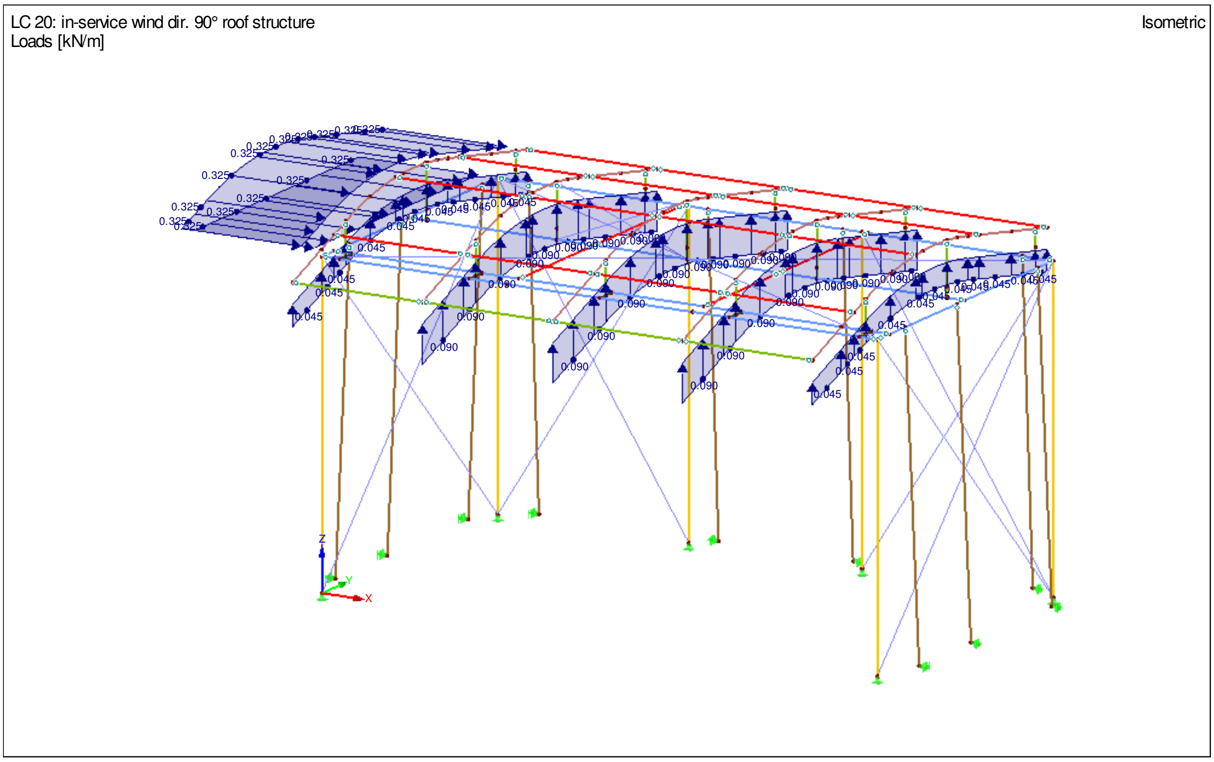
Calculation of the membrane tension on the side walls

$q_{mt,\ side\ profile\ 1} = 0.414$ kN/m

$q_{mt,\ side\ profile\ 2} = 0.414$ kN/m

$q_{mt,\ side\ profile\ 3} = 0.829$ kN/m

### 2.6.5 load case 20 In-service wind dir. 90° roof structure




Wind calculations roof construction wind 90°.

Main roof structure front side

$q_{w,\ roof\ span\ 1,\ front}$ = 0.1 * 0.3 * 1.5 = 0.045 kN/m
$q_{w,\ roof\ span\ 2,\ front}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\ roof\ span\ 3,\ front}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\ roof\ span\ 4,\ front}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\ roof\ span\ 5,\ front}$ = 0.1 * 0.3 * 1.5 = 0.045 kN/m

Main roof structure back side

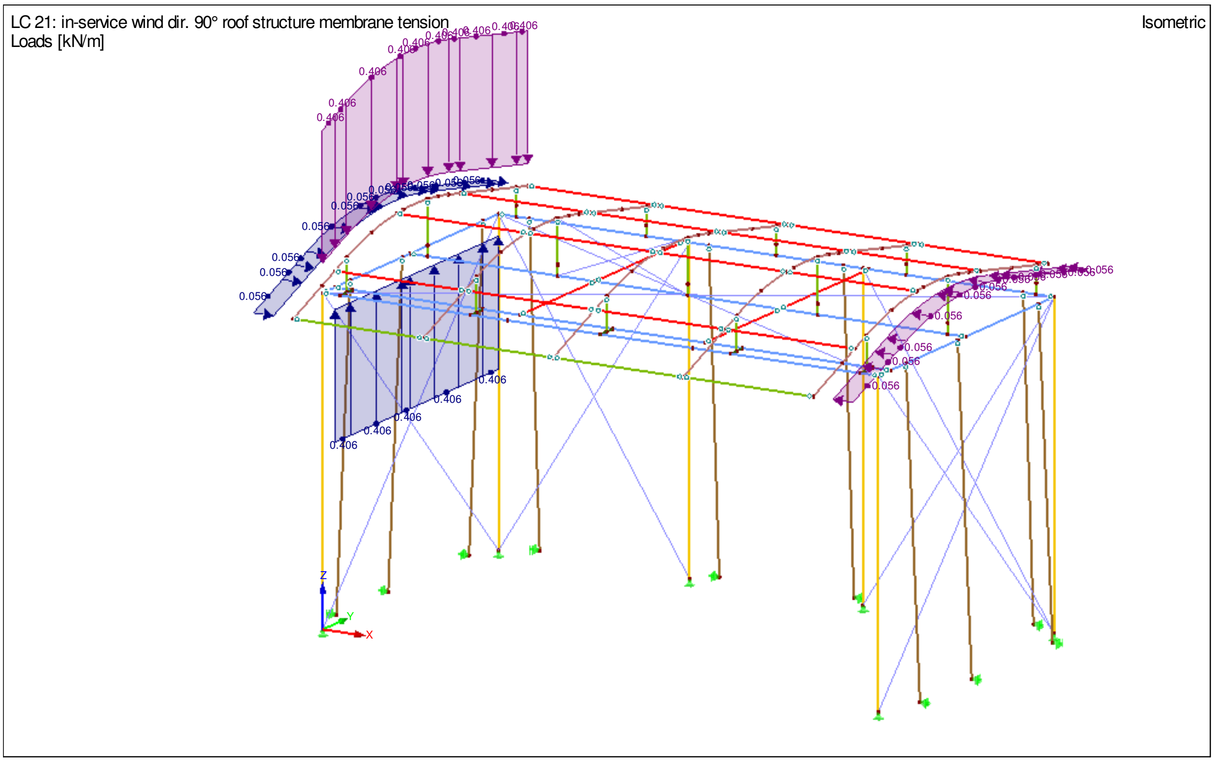
$q_{w,\ roof\ span\ 1,\ back}$ = 0.1 * 0.3 * 1.5 = 0.045 kN/m
$q_{w,\ roof\ span\ 2,\ back}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\ roof\ span\ 3,\ back}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\ roof\ span\ 4,\ back}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\ roof\ span\ 5,\ back}$ = 0.1 * 0.3 * 1.5 = 0.045 kN/m

Wind on side canopy of the roof construction

$A_{canopy}$ = 12.5 m²
$Q_{w,\ side\ canopy\ roof\ structure}$ = 1.3 * 0.3 * 12.5 = 4.875 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\ side\ canopy\ roof\ structure}$ = 4.875 / 15 = 0.325 kN/m

### 2.6.6 load case 21 In-service wind dir. 90° roof structure membrane tension




Membrane tension calculations roof construction wind 90°.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{\text{mt, roof span 1, front}} = 0.563$ kN/m
$q_{\text{mt, roof span 2, front}} = 0$ kN/m
$q_{\text{mt, roof span 3, front}} = 0$ kN/m
$q_{\text{mt, roof span 4, front}} = 0$ kN/m
$q_{\text{mt, roof span 5, front}} = 0.563$ kN/m

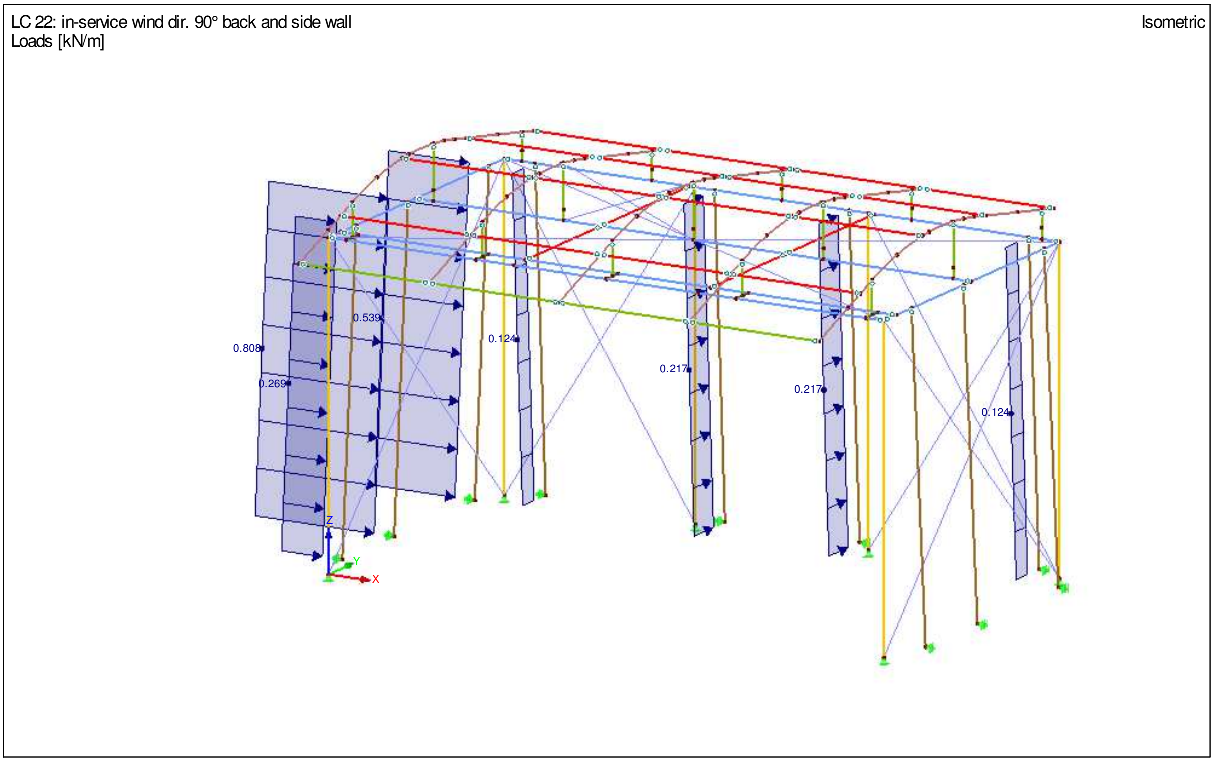
Membrane tension of roof structure back side

$q_{\text{mt, roof span 1, back}} = 0.563$ kN/m
$q_{\text{mt, roof span 2, back}} = 0$ kN/m
$q_{\text{mt, roof span 3, back}} = 0$ kN/m
$q_{\text{mt, roof span 4, back}} = 0$ kN/m
$q_{\text{mt, roof span 5, back}} = 0.563$ kN/m

Membrane tension of the side canopy of the roof structure

$q_{\text{mt, side canopy roof structure}} = 0.325 / 0.8 = 0.406$ kN/m

### 2.6.7 load case 22 In-service wind dir. 90° side and back wall




Calculation of the wind loading on the different profiles.

In the back wall you have 4 profiles, profile 1 is the first profile at stage right.

Calculation of the wind on the back walls

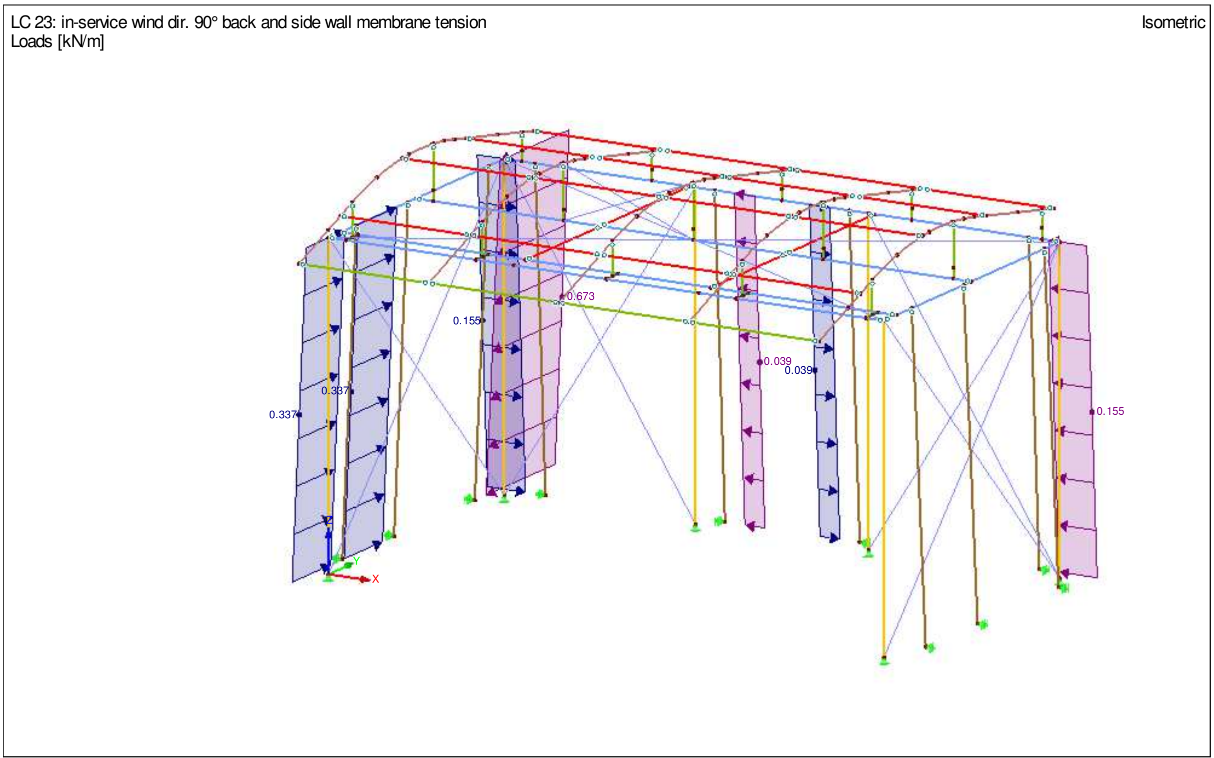
$q_{w,\ back\ profile\ 1}$ = 0.3 * 0.2 * 2.072 = 0.124 kN/m
$q_{w,\ back\ profile\ 2}$ = 0.3 * 0.2 * 3.626 = 0.218 kN/m
$q_{w,\ back\ profile\ 3}$ = 0.3 * 0.2 * 3.626 = 0.218 kN/m
$q_{w,\ back\ profile\ 4}$ = 0.3 * 0.2 * 2.072 = 0.124 kN/m

In the side wall you have 3 profiles, profile 1 is the first profile on the front of the stage.

Calculation of the wind on the side walls

$q_{w,\ side\ profile\ 1}$ = 1.3 * 0.2 * 1.036 = 0.269 kN/m
$q_{w,\ side\ profile\ 2}$ = 1.3 * 0.2 * 3.108 = 0.808 kN/m
$q_{w,\ side\ profile\ 3}$ = 1.3 * 0.2 * 2.072 = 0.539 kN/m

### 2.6.8 load case 23 In-service wind dir. 90° side and back wall membrane tension




Membrane tension calculations side wall wind 90°

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Calculation of the membrane tension on the back walls

$q_{mt,\ back\ profile\ 1}$ = 0.155 kN/m

$q_{mt,\ back\ profile\ 2}$ = 0.039 kN/m

$q_{mt,\ back\ profile\ 3}$ = 0.039 kN/m

$q_{mt,\ back\ profile\ 4}$ = 0.155 kN/m

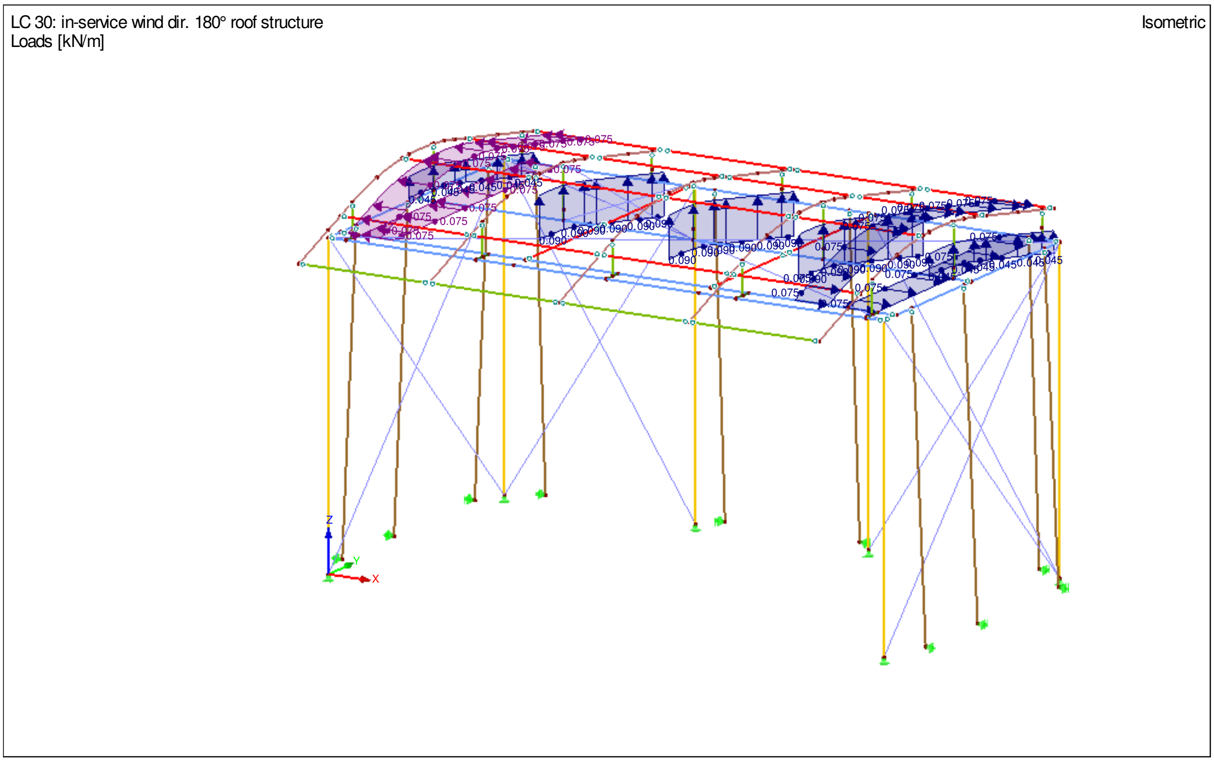
Calculation of the membrane tension on the side walls

$q_{mt,\ side\ profile\ 1}$ = 0.337 kN/m

$q_{mt,\ side\ profile\ 2}$ = 0.337 kN/m

$q_{mt,\ side\ profile\ 3}$ = 0.673 kN/m

## 2.6.9 load case 30 In-service wind dir. 180° roof structure.




Wind calculations roof construction wind 180°.

Main roof structure front side the Cf of the front side is 0

Main roof structure back side

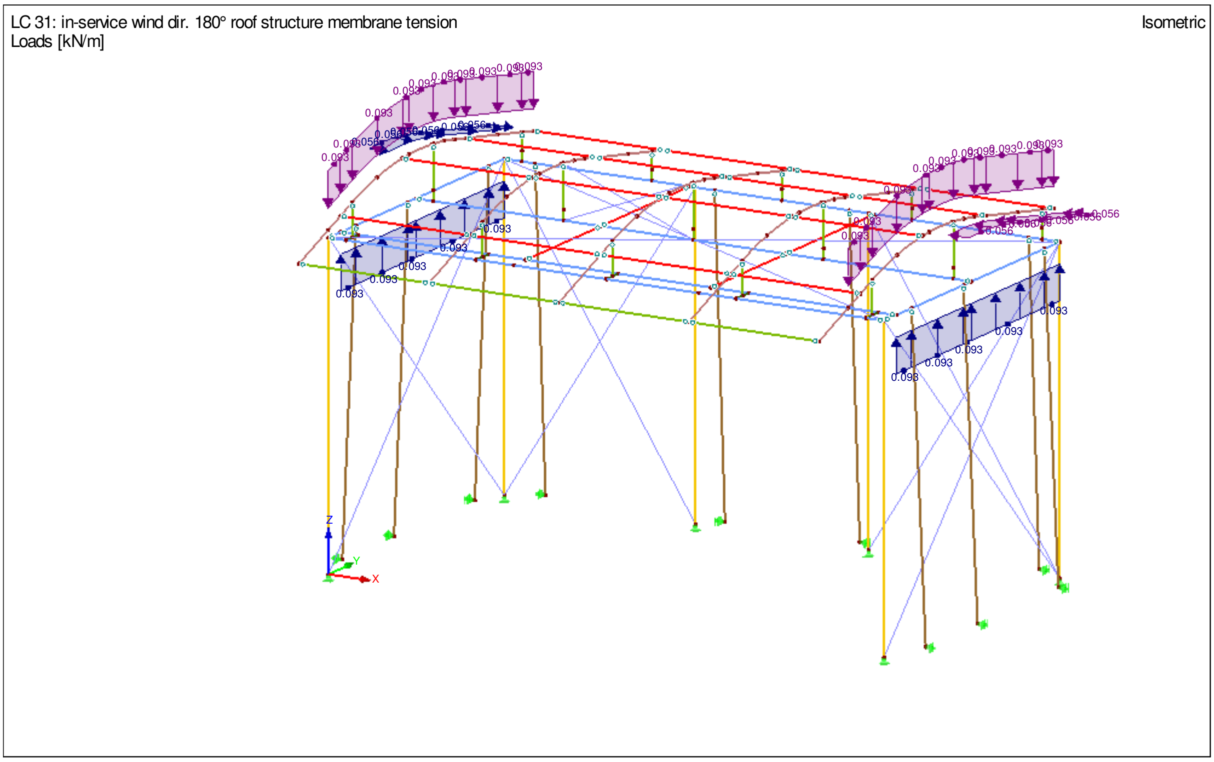
$q_{w,\text{ roof span 1, back}}$ = 0.1 * 0.3 * 1.5 = 0.045 kN/m
$q_{w,\text{ roof span 2, back}}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\text{ roof span 3, back}}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\text{ roof span 4, back}}$ = 0.1 * 0.3 * 3 = 0.090 kN/m
$q_{w,\text{ roof span 5, back}}$ = 0.1 * 0.3 * 1.5 = 0.045 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 12.5 m²
$Q_{w,\text{ side canopy roof structure}}$ = 0.3 * 0.3 * 12.5 = 1.125 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 1.125 / 15 = 0.075 kN/m

### 2.6.10 load case 31 In-service wind dir. 180° roof structure membrane tension.




Membrane tension calculations roof construction wind 180°.

The membrane tension is calculated according to the calculation  on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

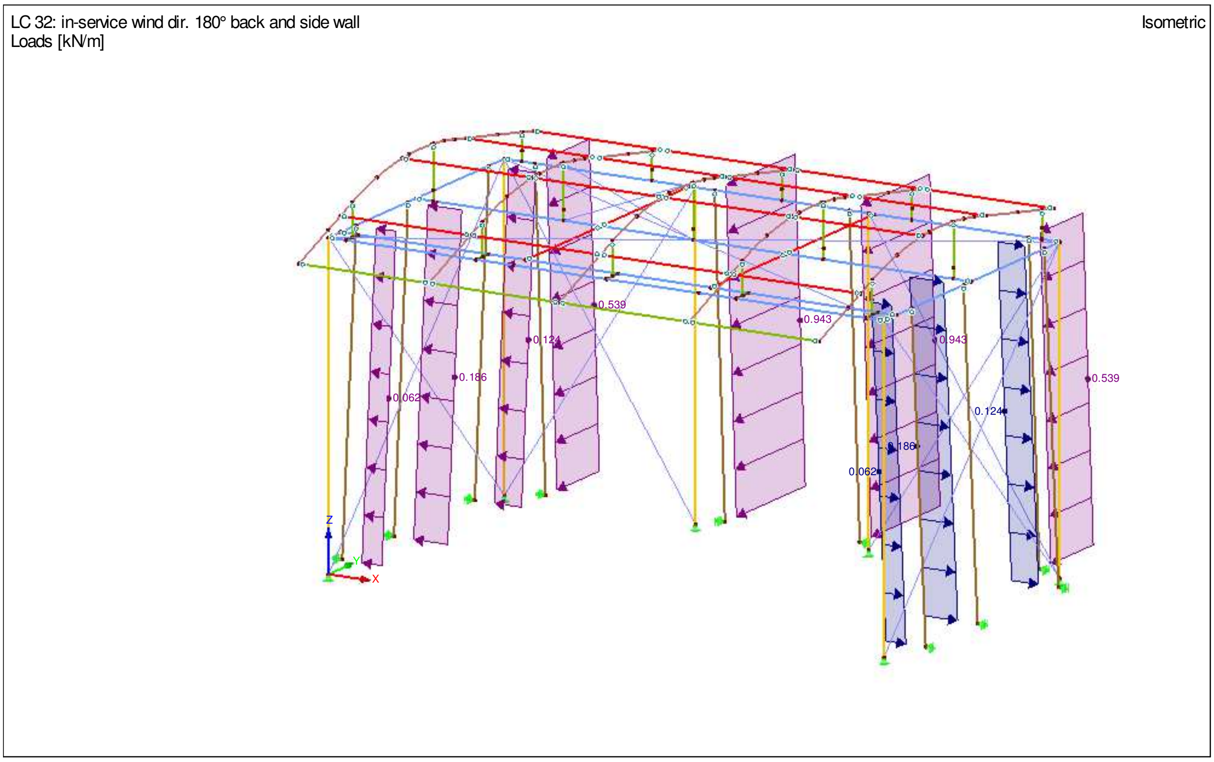
Membrane tension  of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.056 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.056 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.075 / 0.8 = 0.094 kN/m

### 2.6.11 load case 32 In-service wind dir. 180° side and back wall




Calculation of the wind loading on the different profiles.

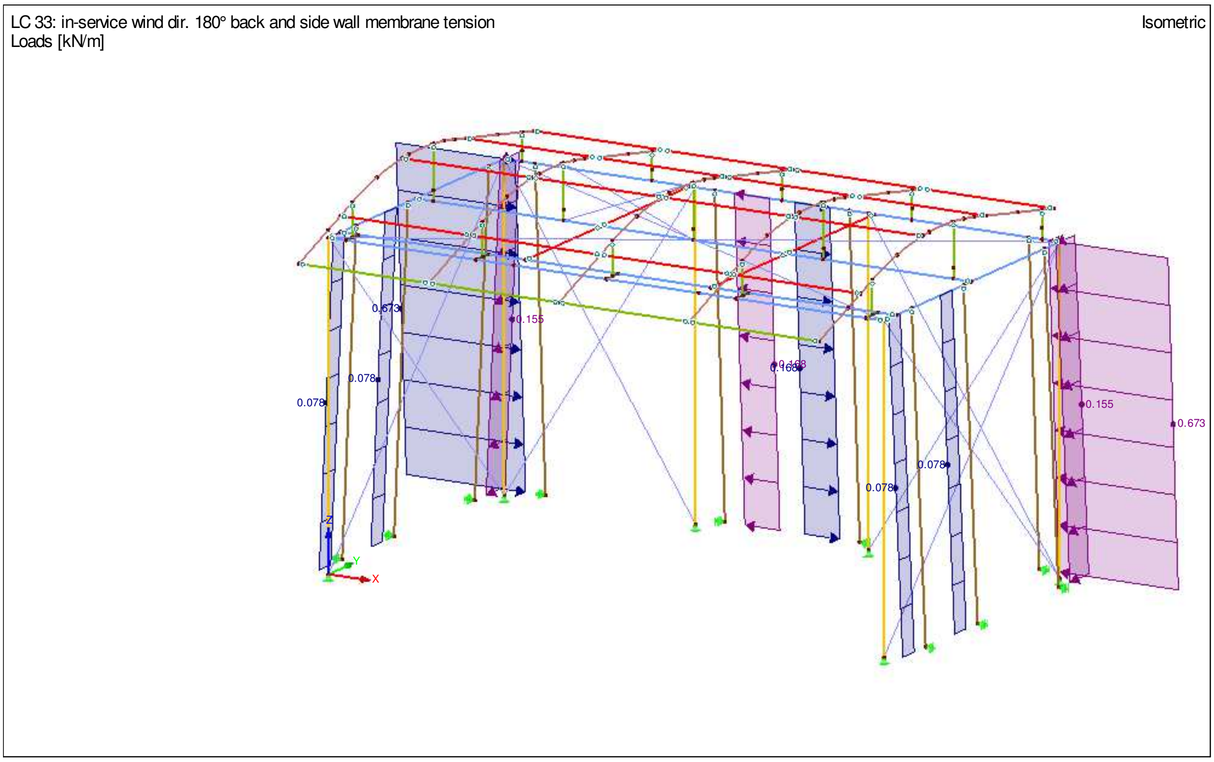
In the back wall you have 4 profiles, profile 1 is the first profile at stage right.

Calculation of the wind on the back walls
$q_{w, \text{back profile 1}}$ = 1.3 * 0.2 * 2.072 = 0.539 kN/m
$q_{w, \text{back profile 2}}$ = 1.3 * 0.2 * 3.626 = 0.943 kN/m
$q_{w, \text{back profile 3}}$ = 1.3 * 0.2 * 3.626 = 0.943 kN/m
$q_{w, \text{back profile 4}}$ = 1.3 * 0.2 * 2.072 = 0.539 kN/m

In the side wall you have 4 profiles, profile 1 is the first profile on the front of the stage.

Calculation of the wind on the side walls
$q_{w, \text{side profile 1}}$ = 0.3 * 0.2 * 1.036 = 0.062 kN/m
$q_{w, \text{side profile 2}}$ = 0.3 * 0.2 * 3.108 = 0.186 kN/m
$q_{w, \text{side profile 3}}$ = 0.3 * 0.2 * 2.072 = 0.124 kN/m

### 2.6.12 load case 33 In-service wind dir. 180° side and back wall membrane tension




Membrane tension calculations side wall wind 180°

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

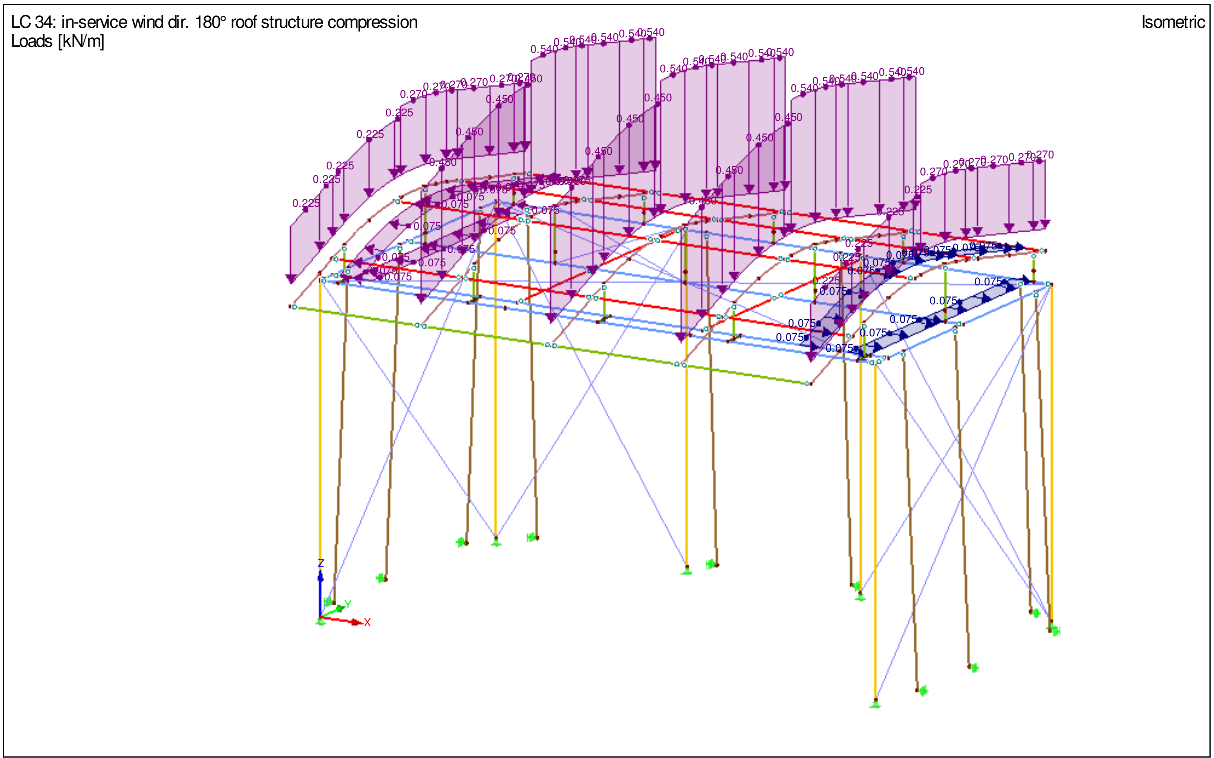
Calculation of the membrane tension on the back walls

$q_{mt,\ back\ profile\ 1}$ = 0.673 kN/m
$q_{mt,\ back\ profile\ 2}$ = 0.168 kN/m
$q_{mt,\ back\ profile\ 3}$ = 0.168 kN/m
$q_{mt,\ back\ profile\ 4}$ = 0.673 kN/m

Calculation of the membrane tension on the side walls

$q_{mt,\ side\ profile\ 1}$ = 0.078 kN/m
$q_{mt,\ side\ profile\ 2}$ = 0.078 kN/m
$q_{mt,\ side\ profile\ 3}$ = 0.155 kN/m

### 2.6.13 load case 34 In-service wind dir. 180° roof structure compression.




Wind calculations roof construction wind 180° compression.

Main roof structure front side

$q_{w,\ roof\ span\ 1,\ front}$ = 0.5 * 0.3 * 1.5 = 0.225 kN/m
$q_{w,\ roof\ span\ 2,\ front}$ = 0.5 * 0.3 * 3 = 0.450 kN/m
$q_{w,\ roof\ span\ 3,\ front}$ = 0.5 * 0.3 * 3 = 0.450 kN/m
$q_{w,\ roof\ span\ 4,\ front}$ = 0.5 * 0.3 * 3 = 0.450 kN/m
$q_{w,\ roof\ span\ 5,\ front}$ = 0.5 * 0.3 * 1.5 = 0.225 kN/m

Main roof structure back side

$q_{w,\ roof\ span\ 1,\ back}$ = 0.6 * 0.3 * 1.5 = 0.270 kN/m
$q_{w,\ roof\ span\ 2,\ back}$ = 0.6 * 0.3 * 3 = 0.540 kN/m
$q_{w,\ roof\ span\ 3,\ back}$ = 0.6 * 0.3 * 3 = 0.540 kN/m
$q_{w,\ roof\ span\ 4,\ back}$ = 0.6 * 0.3 * 3 = 0.540 kN/m
$q_{w,\ roof\ span\ 5,\ back}$ = 0.6 * 0.3 * 1.5 = 0.270 kN/m

Wind on side canopy of the roof construction

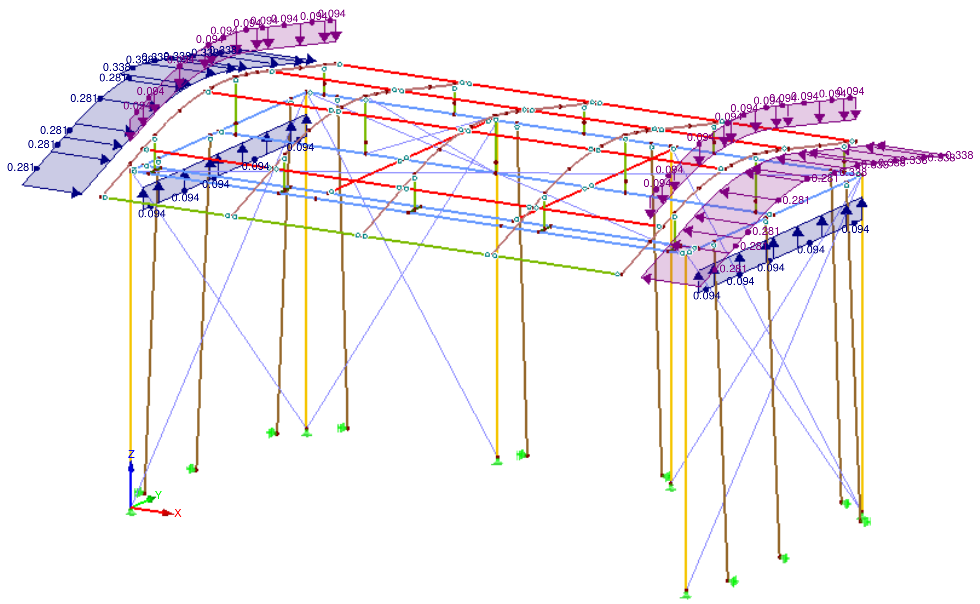
$A_{canopy}$ = 12.5 m²
$Q_{w,\ side\ canopy\ roof\ structure}$ = 0.3 * 0.3 * 12.5 = 1.125 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\ side\ canopy\ roof\ structure}$ = 1.125 / 15 = 0.075 kN/m

### 2.6.14 load case 35 In-service wind dir. 180° roof structure membrane tension compression.

LC 35: in-service wind dir. 180° roof structure membrane tension compression
Loads [kN/m]

Isometric



Membrane tension calculations roof construction wind 180° compression.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.281 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.281 kN/m

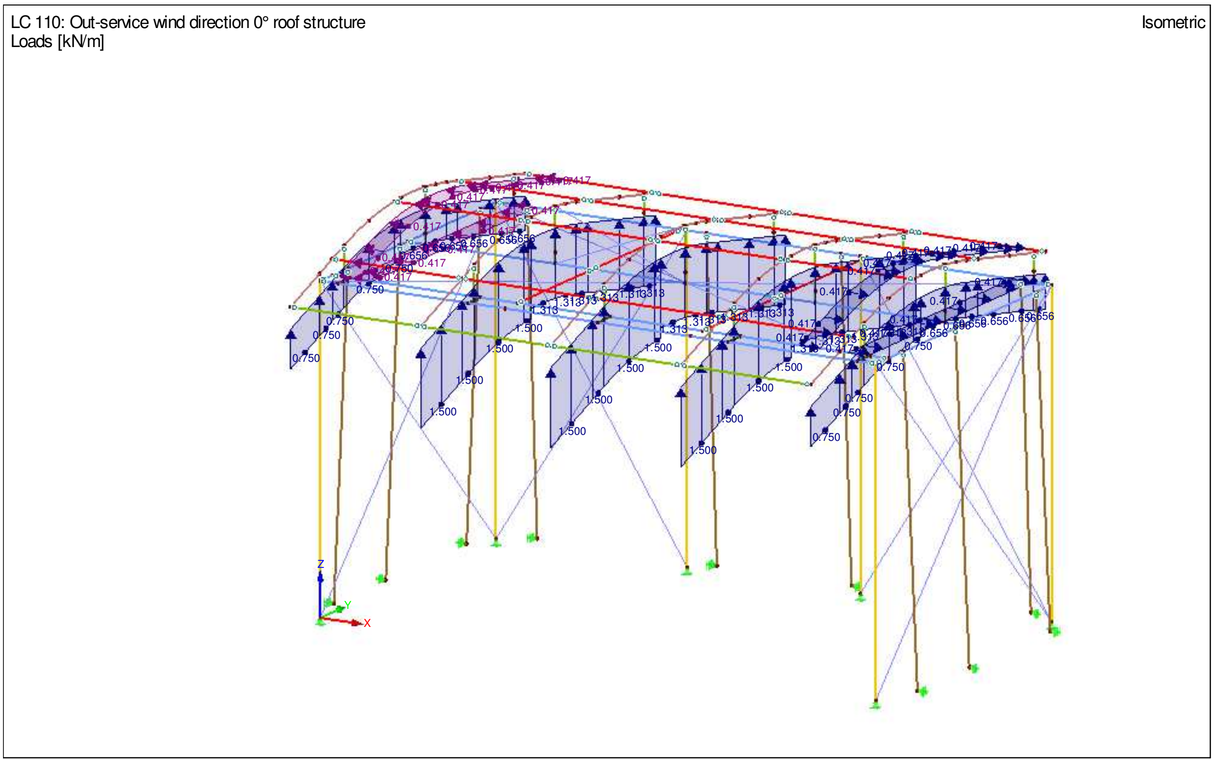
Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.338 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.338 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.075 / 0.8 = 0.094 kN/m

### 2.6.15 load case 110 Out-service wind dir. 0° roof structure.




Wind calculations roof construction wind 0°.

Main roof structure front side

$q_{w,\ roof\ span\ 1,\ front}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m
$q_{w,\ roof\ span\ 2,\ front}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\ roof\ span\ 3,\ front}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\ roof\ span\ 4,\ front}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\ roof\ span\ 5,\ front}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m

Main roof structure back side

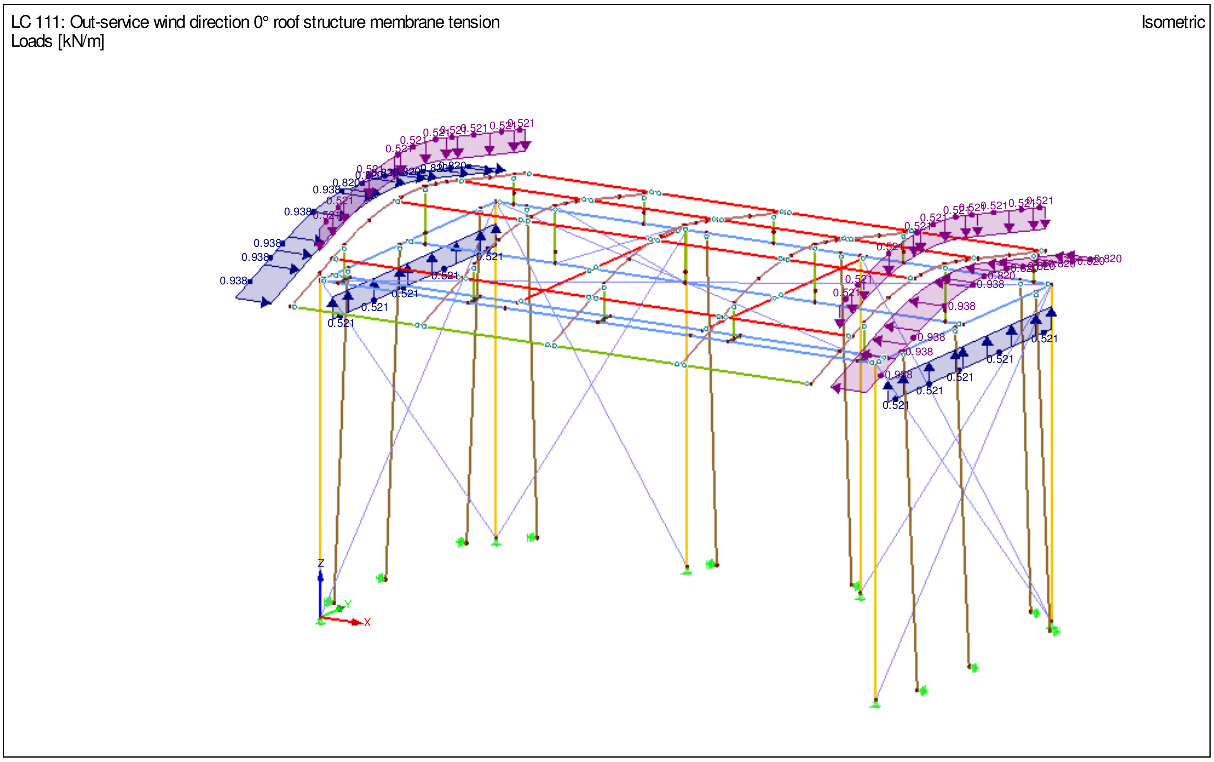
$q_{w,\ roof\ span\ 1,\ back}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m
$q_{w,\ roof\ span\ 2,\ back}$ = 0.7 * 0.625 * 3 = 1.313 kN/m
$q_{w,\ roof\ span\ 3,\ back}$ = 0.7 * 0.625 * 3 = 1.313 kN/m
$q_{w,\ roof\ span\ 4,\ back}$ = 0.7 * 0.625 * 3 = 1.313 kN/m
$q_{w,\ roof\ span\ 5,\ back}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m

Wind on side canopy of the roof construction

$A_{canopy}$ = 12.5 m²
$Q_{w,\ side\ canopy\ roof\ structure}$ = 0.8 * 0.625 * 12.5 = 6.25 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\ side\ canopy\ roof\ structure}$ = 6.25 / 15 = 0.417 kN/m

### 2.6.16 load case 111 Out-service wind dir. 0° roof structure membrane tension.




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{\text{mt, roof span 1, front}} = 0.938$ kN/m
$q_{\text{mt, roof span 2, front}} = 0$ kN/m
$q_{\text{mt, roof span 3, front}} = 0$ kN/m
$q_{\text{mt, roof span 4, front}} = 0$ kN/m
$q_{\text{mt, roof span 5, front}} = 0.938$ kN/m

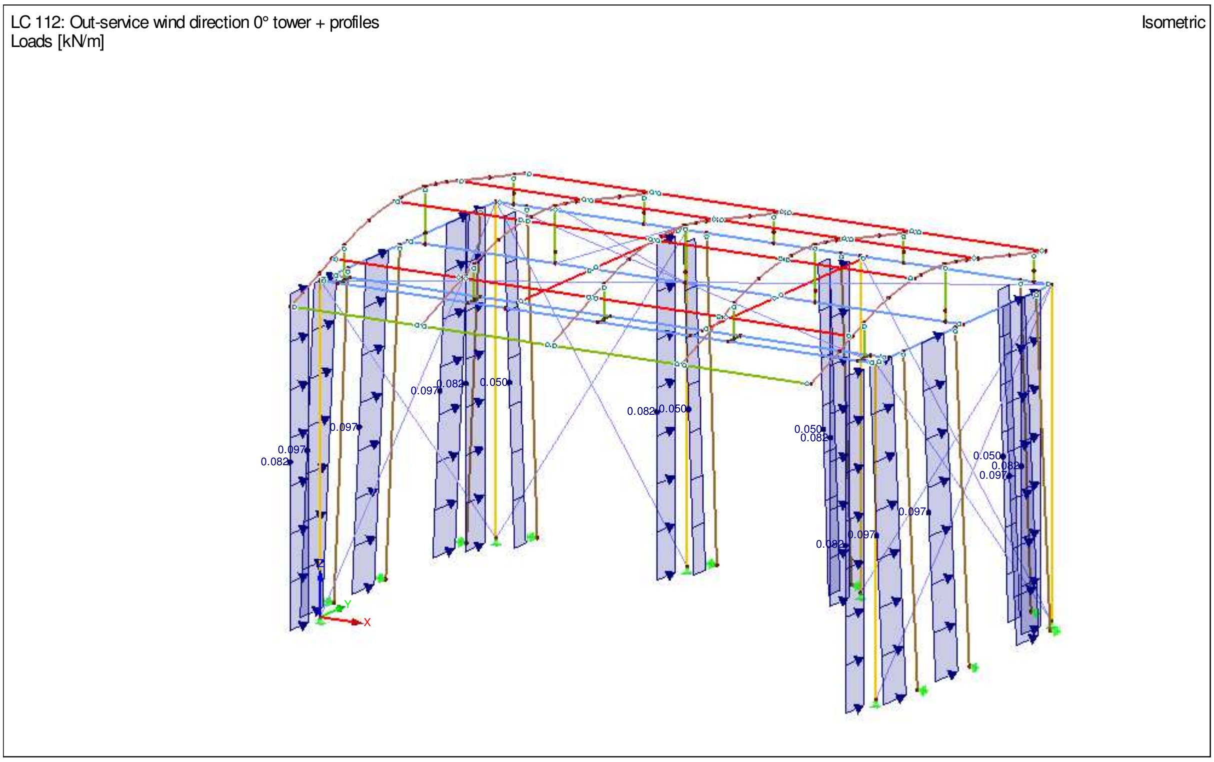
Membrane tension of roof structure back side

$q_{\text{mt, roof span 1, back}} = 0.820$ kN/m
$q_{\text{mt, roof span 2, back}} = 0$ kN/m
$q_{\text{mt, roof span 3, back}} = 0$ kN/m
$q_{\text{mt, roof span 4, back}} = 0$ kN/m
$q_{\text{mt, roof span 5, back}} = 0.820$ kN/m

Membrane tension of the side canopy of the roof structure

$q_{\text{mt, side canopy roof structure}} = 0.417 / 0.8 = 0.521$ kN/m

### 2.6.17 load case 112 Out-service wind dir. 0° towers + profiles



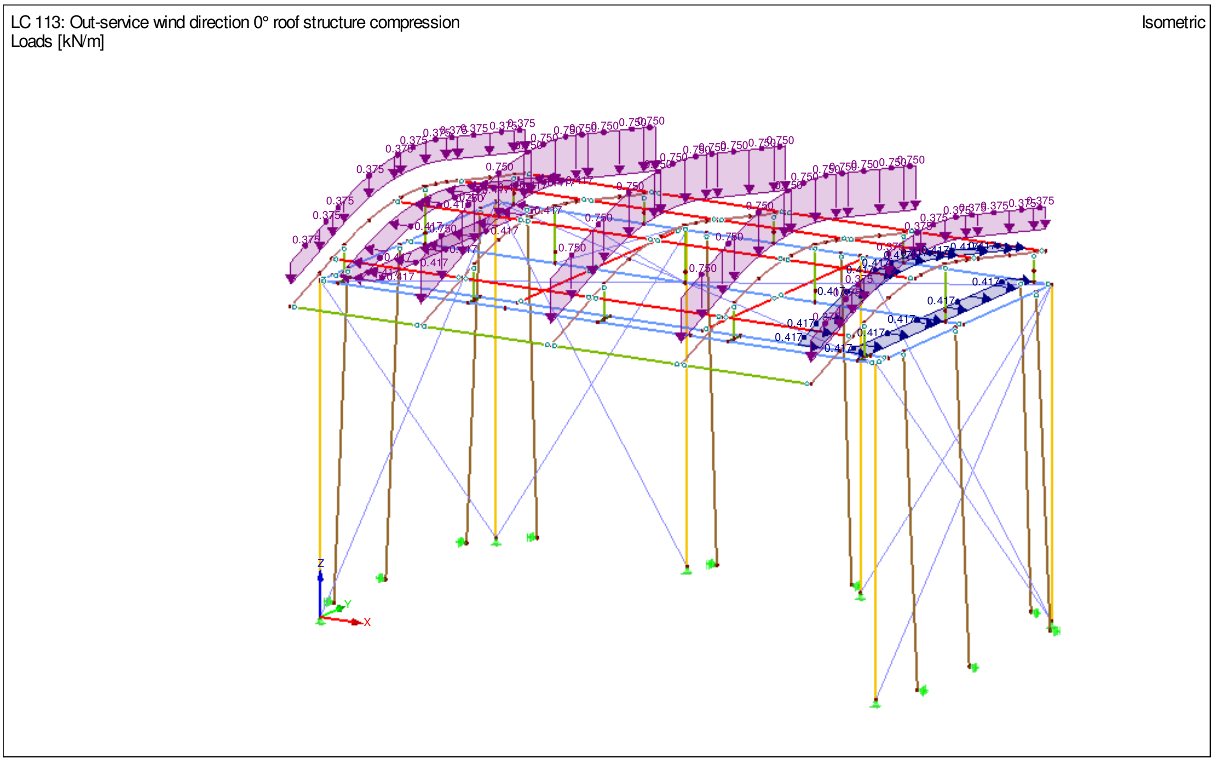

Wind on tower truss 0°

$q_{w,\ tower\ truss} = 1.3 * 0.4375 * ( 0.5 * 0.290 ) = 0.082$ kN/m

Wind on wall Keder profile 170x88

$q_{w,\ keder\ profile\ 88mm} = 1.3 * 0.438 * 0.088 = 0.050$ kN/m
$q_{w\ keder\ profile\ 170mm} = 1.3 * 0.438 * 0.017 = 0.097$ kN/m

### 2.6.18 load case 113 Out-service wind dir. 0° roof structure compression.




Wind calculations roof construction wind 0° compression.

Main roof structure front side

$q_{w,\text{ roof span 1, front}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m
$q_{w,\text{ roof span 2, front}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 3, front}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 4, front}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 5, front}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m

Main roof structure back side

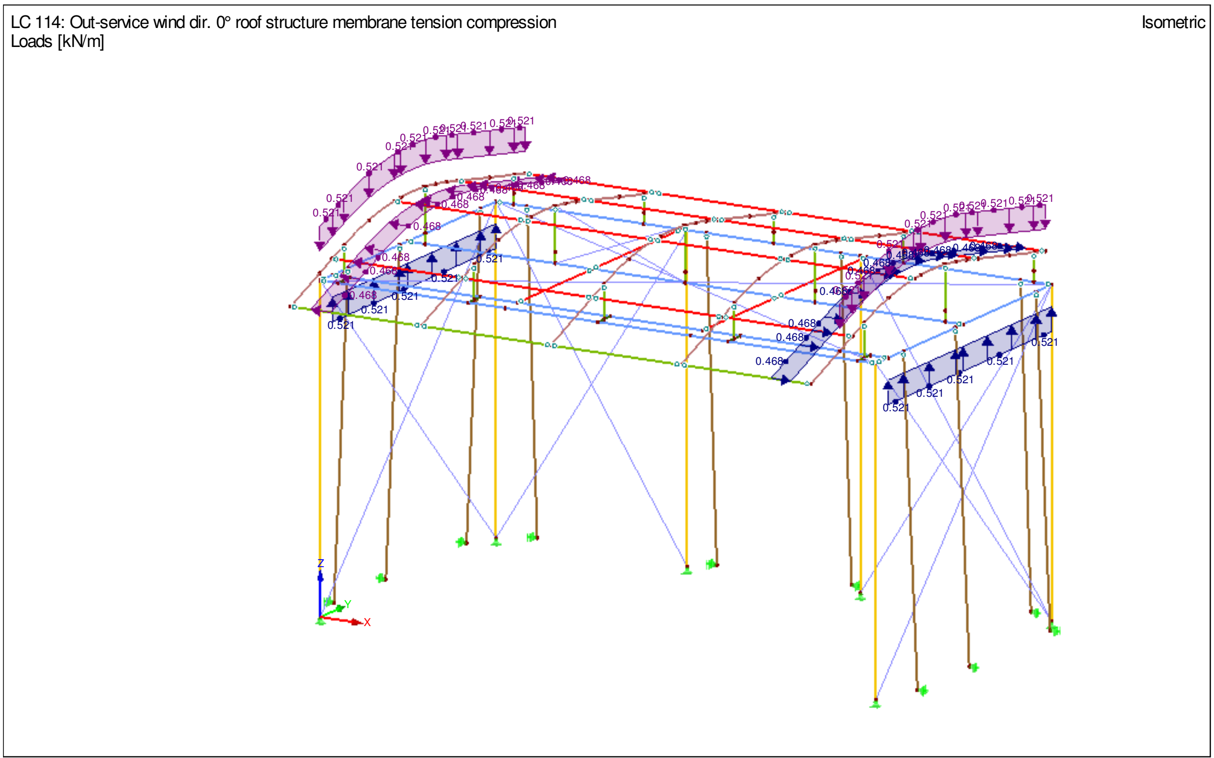
$q_{w,\text{ roof span 1, back}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m
$q_{w,\text{ roof span 2, back}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 3, back}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 4, back}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 5, back}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}} = 12.5$ m²
$Q_{w,\text{ side canopy roof structure}} = 0.8 * 0.625 * 12.5 = 6.25$ kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\text{ side canopy roof structure}} = 6.25 / 15 = 0.417$ kN/m

### 2.6.19 load case 114 In-service wind dir. 0° roof structure membrane tension compression.




Membrane tension calculations roof construction wind 0° compression.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.468 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.468 kN/m

Membrane tension of roof structure back side

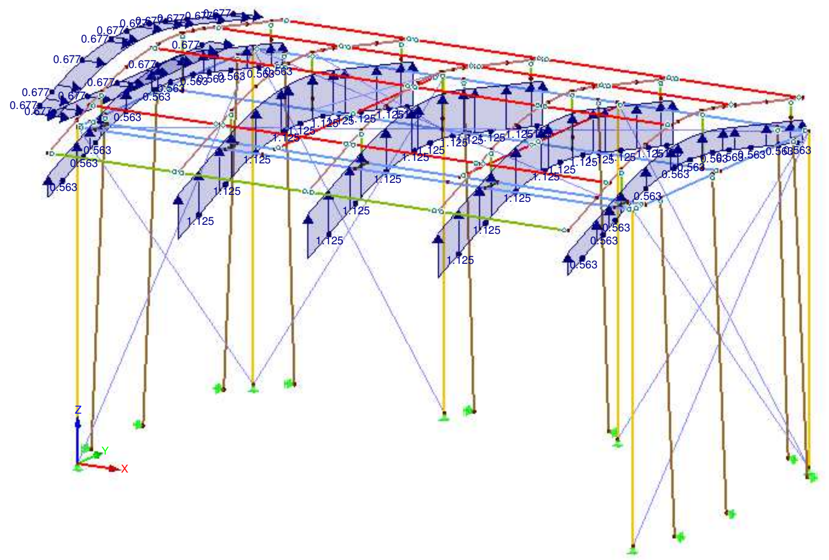
$q_{mt,\ roof\ span\ 1,\ back}$ = 0.468 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.468 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.417 / 0.8 = 0.521 kN/m

### 2.6.20 load case 120 Out-service wind dir. 90° roof structure.

LC 120: Out-service wind direction 90° roof structure
Loads [kN/m]
Isometric



Wind calculations roof construction wind 90°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 0.6 * 0.625 * 1.5 = 0.563 kN/m
$q_{w,\text{ roof span 2, front}}$ = 0.6 * 0.625 * 3 = 1.125 kN/m
$q_{w,\text{ roof span 3, front}}$ = 0.6 * 0.625 * 3 = 1.125 kN/m
$q_{w,\text{ roof span 4, front}}$ = 0.6 * 0.625 * 3 = 1.125 kN/m
$q_{w,\text{ roof span 5, front}}$ = 0.6 * 0.625 * 1.5 = 0.563 kN/m

Main roof structure back side

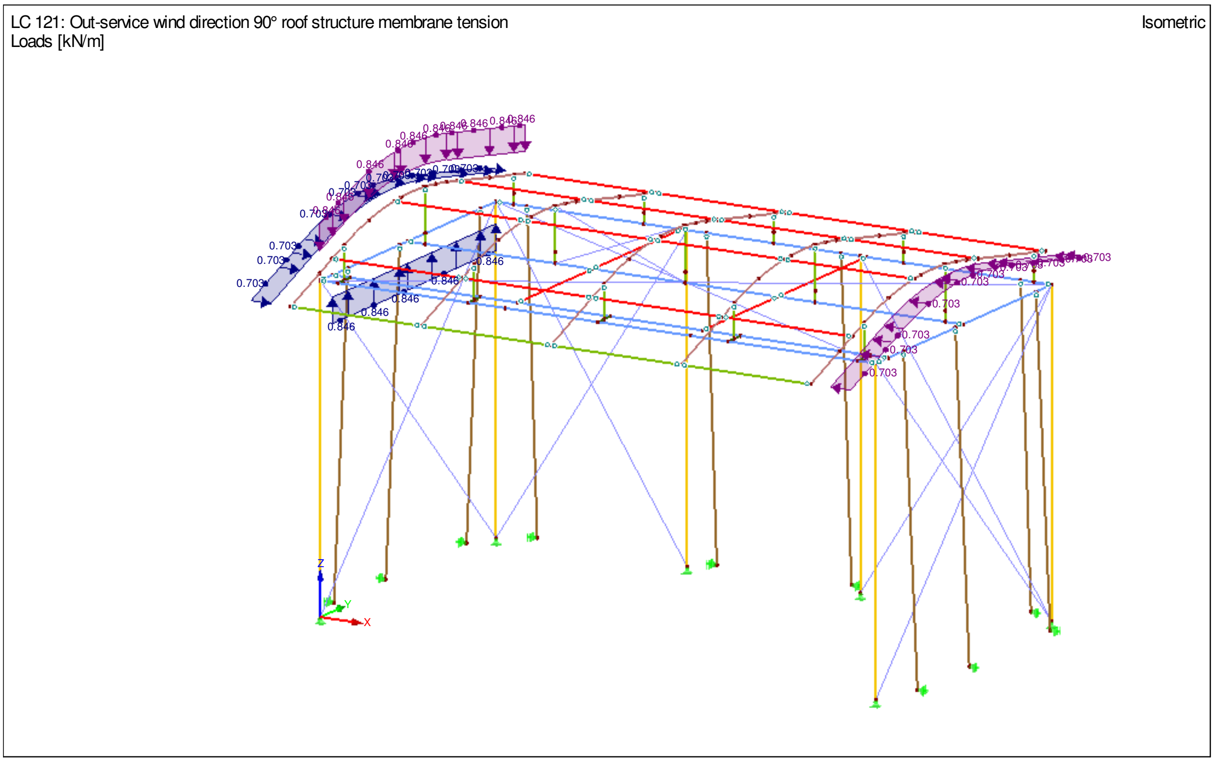
$q_{w,\text{ roof span 1, back}}$ = 0.6 * 0.625 * 1.5 = 0.563 kN/m
$q_{w,\text{ roof span 2, back}}$ = 0.6 * 0.625 * 3 = 1.125 kN/m
$q_{w,\text{ roof span 3, back}}$ = 0.6 * 0.625 * 3 = 1.125 kN/m
$q_{w,\text{ roof span 4, back}}$ = 0.6 * 0.625 * 3 = 1.125 kN/m
$q_{w,\text{ roof span 5, back}}$ = 0.6 * 0.625 * 1.5 = 0.563 kN/m

Wind on side canopy of the roof construction

$A_{canopy}$ = 12.5 m²
$Q_{w,\text{ side canopy roof structure}}$ = 1.3 * 0.625 * 12.5 = 10.15 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 10.15 / 15 = 0.677 kN/m

### 2.6.21 load case 121 Out-service wind dir. 90° roof structure membrane tension.




Membrane tension calculations roof construction wind 90°.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front} = 0.703$ kN/m
$q_{mt,\ roof\ span\ 2,\ front} = 0$ kN/m
$q_{mt,\ roof\ span\ 3,\ front} = 0$ kN/m
$q_{mt,\ roof\ span\ 4,\ front} = 0$ kN/m
$q_{mt,\ roof\ span\ 5,\ front} = 0.703$ kN/m

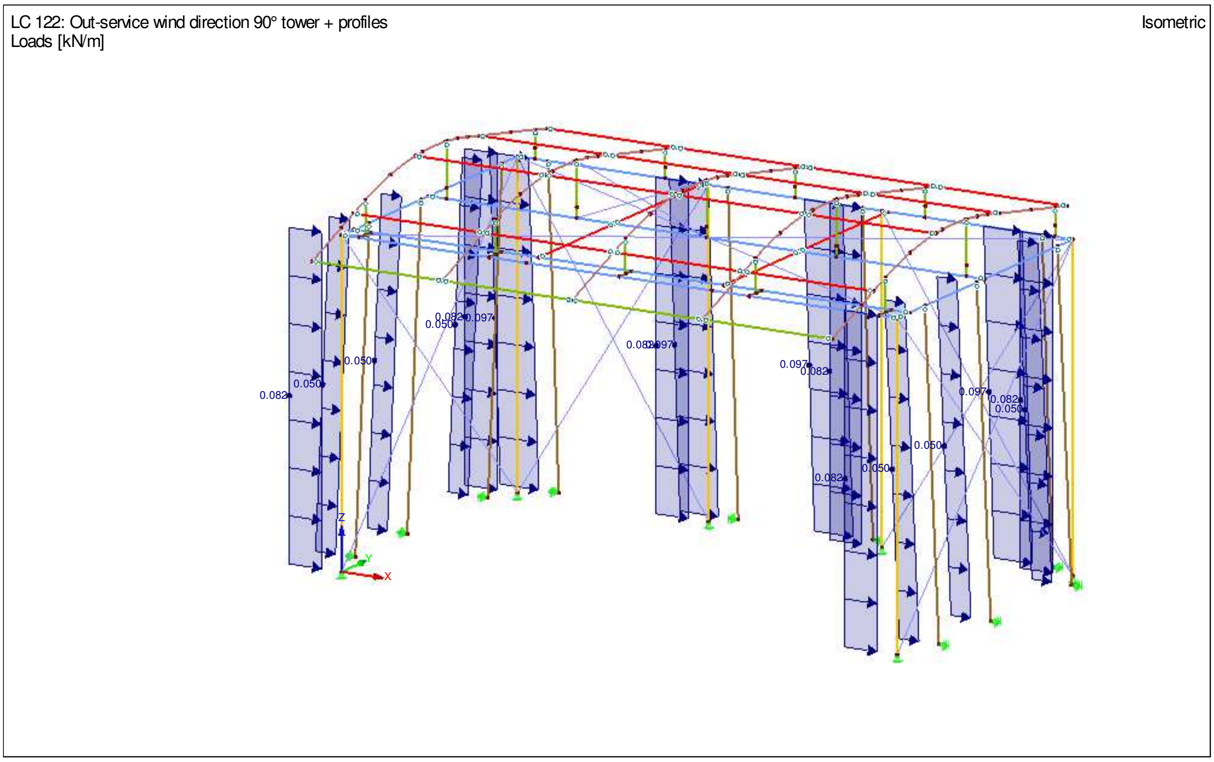
Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back} = 0.703$ kN/m
$q_{mt,\ roof\ span\ 2,\ back} = 0$ kN/m
$q_{mt,\ roof\ span\ 3,\ back} = 0$ kN/m
$q_{mt,\ roof\ span\ 4,\ back} = 0$ kN/m
$q_{mt,\ roof\ span\ 5,\ back} = 0.703$ kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure} = 0.677 / 0.8 = 0.846$ kN/m

### 2.6.22 load case 122 Out-service wind dir. 90° towers + profiles



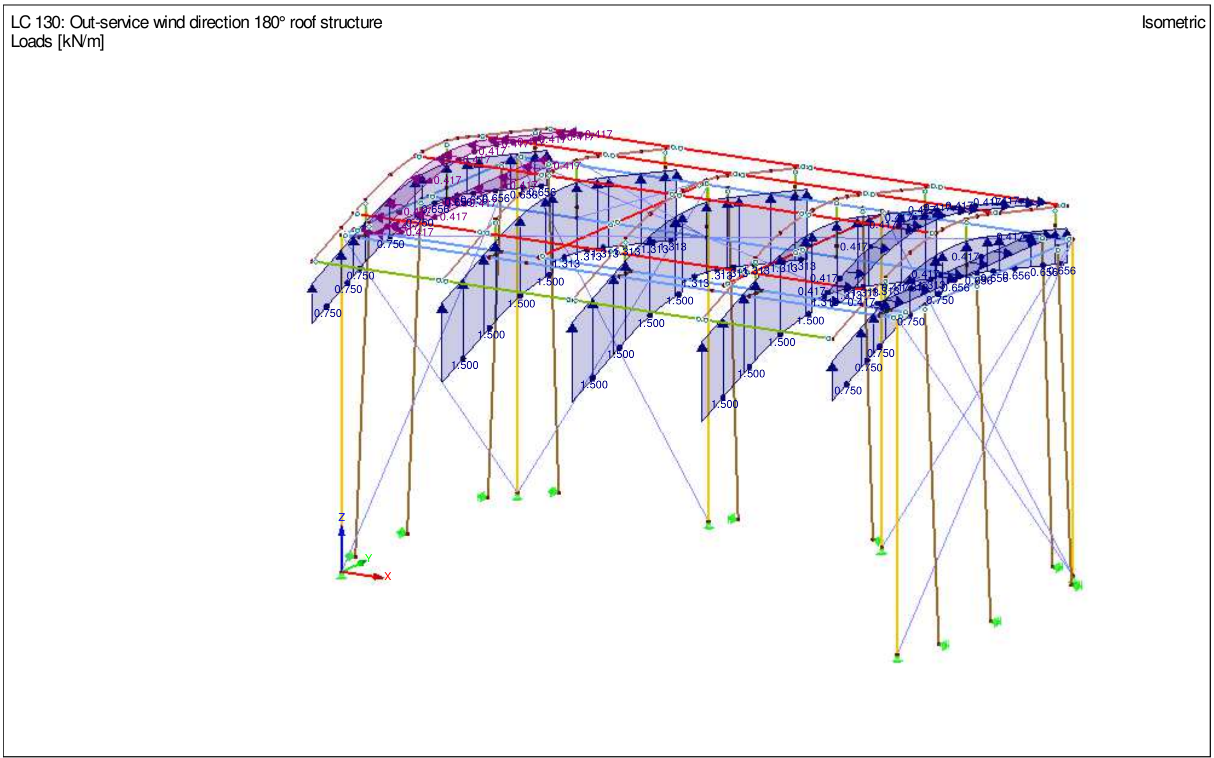

Wind on tower truss 90°

$q_{w,\ tower\ truss} = 1.3 * 0.4375 * ( 0.5 * 0.290 ) = 0.082$ kN/m

Wind on wall Keder profile 170x88

$q_{w,\ keder\ profile\ 88mm} = 1.3 * 0.438 * 0.088 = 0.050$ kN/m
$q_{w\ keder\ profile\ 170mm} = 1.3 * 0.438 * 0.017 = 0.097$ kN/m

### 2.6.23 load case 130 Out-service wind dir. 180° roof structure.




Wind calculations roof construction wind 180°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m
$q_{w,\text{ roof span 2, front}}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\text{ roof span 3, front}}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\text{ roof span 4, front}}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\text{ roof span 5, front}}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m

Main roof structure back side

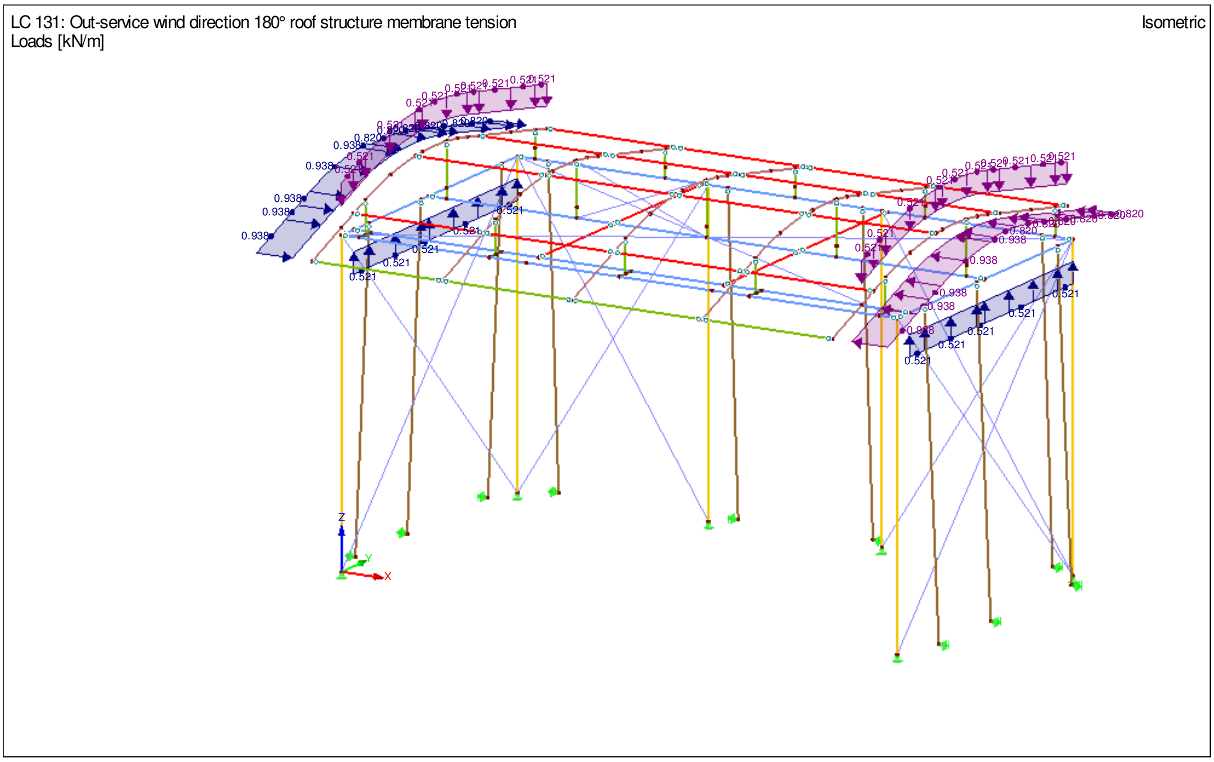
$q_{w,\text{ roof span 1, back}}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m
$q_{w,\text{ roof span 2, back}}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\text{ roof span 3, back}}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\text{ roof span 4, back}}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\text{ roof span 5, back}}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 12.5 m²
$Q_{w,\text{ side canopy roof structure}}$ = 0.8 * 0.625 * 12.5 = 6.25 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 6.25 / 15 = 0.417 kN/m

### 2.6.24 load case 131 Out-service wind dir. 180° roof structure membrane tension.




Membrane tension calculations roof construction wind 180°.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.938 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.938 kN/m

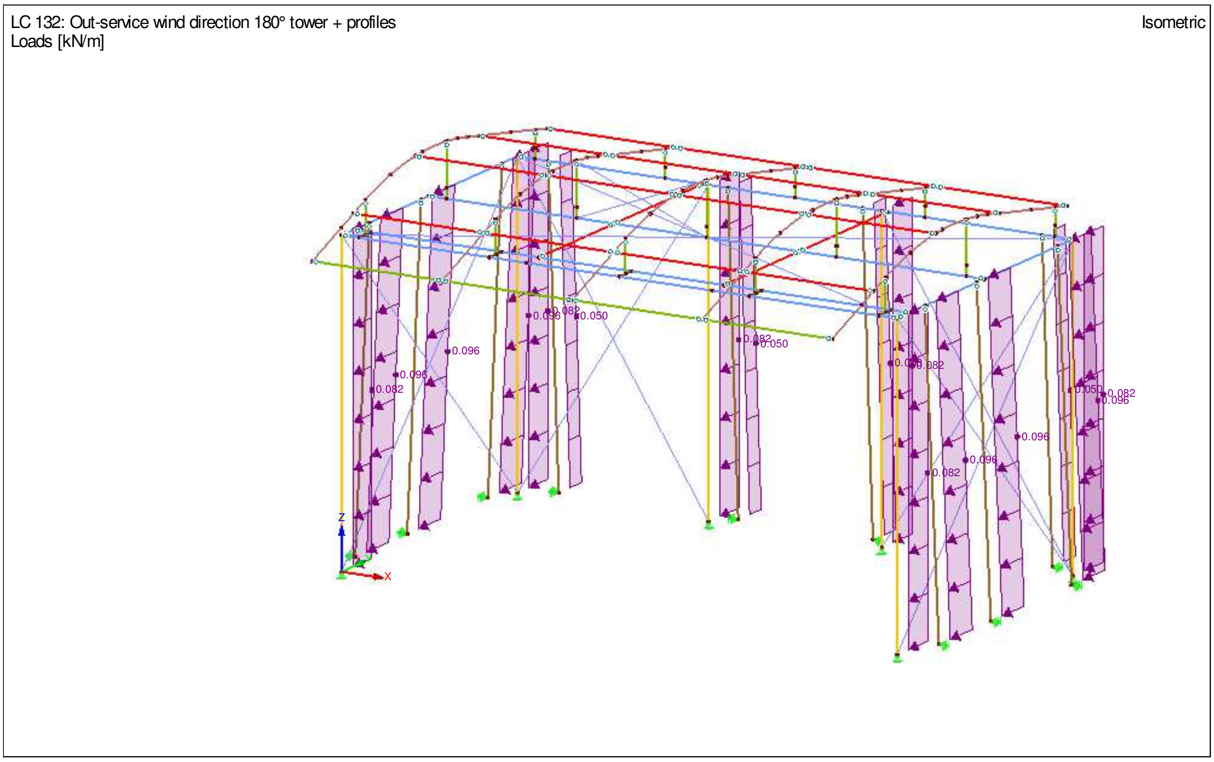
Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.820 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.820 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.417 / 0.8 = 0.521 kN/m

### 2.6.25 load case 132 Out-service wind dir. 180° towers + profiles



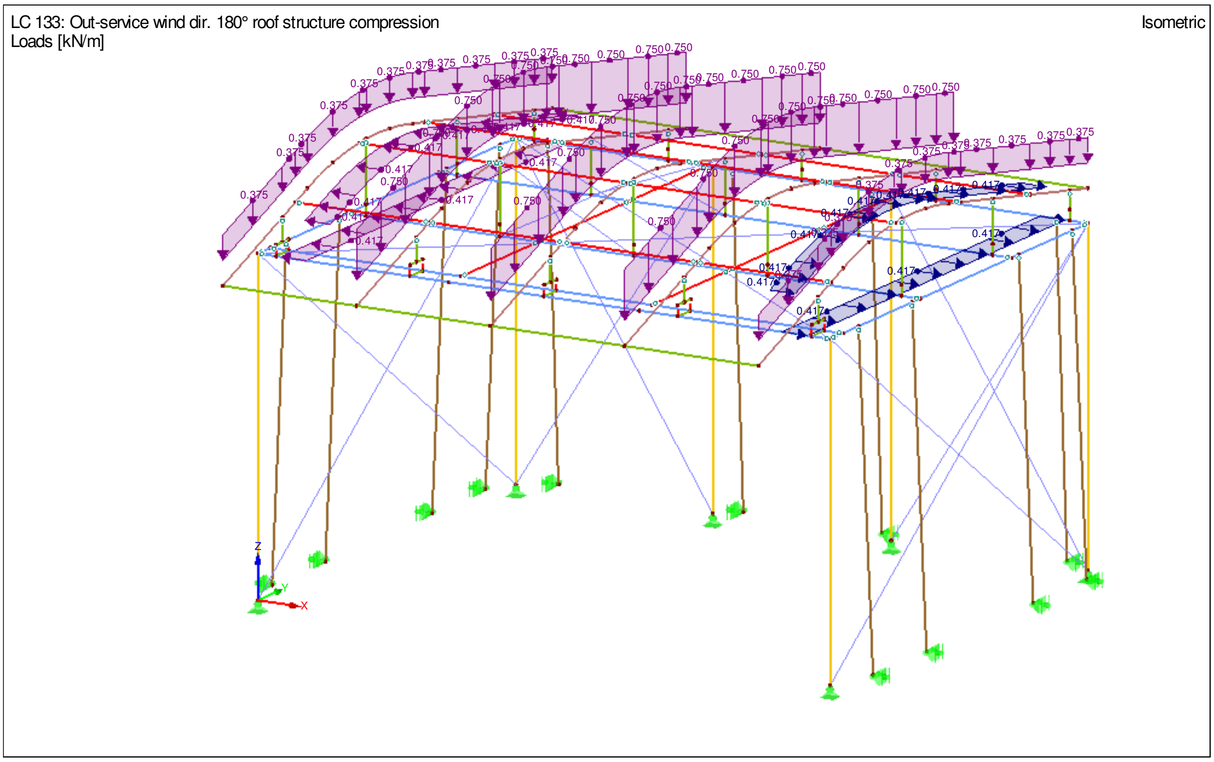

Wind on tower truss 180°

$q_{w,\ tower\ truss}$ = 1.3 * 0.4375 * ( 0.5 * 0.290 ) = 0.082 kN/m

Wind on wall Keder profile 170x88

$q_{w,\ keder\ profile\ 88mm}$ = 1.3 * 0.438 * 0.088 = 0.050 kN/m
$q_{w\ keder\ profile\ 170mm}$ = 1.3 * 0.438 * 0.017 = 0.097 kN/m

### 2.6.26 load case 133 Out-service wind dir. 180° roof structure compression.




Wind calculations roof construction wind 180° compression.

Main roof structure front side

$q_{w,\text{ roof span 1, front}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m
$q_{w,\text{ roof span 2, front}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 3, front}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 4, front}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 5, front}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m

Main roof structure back side

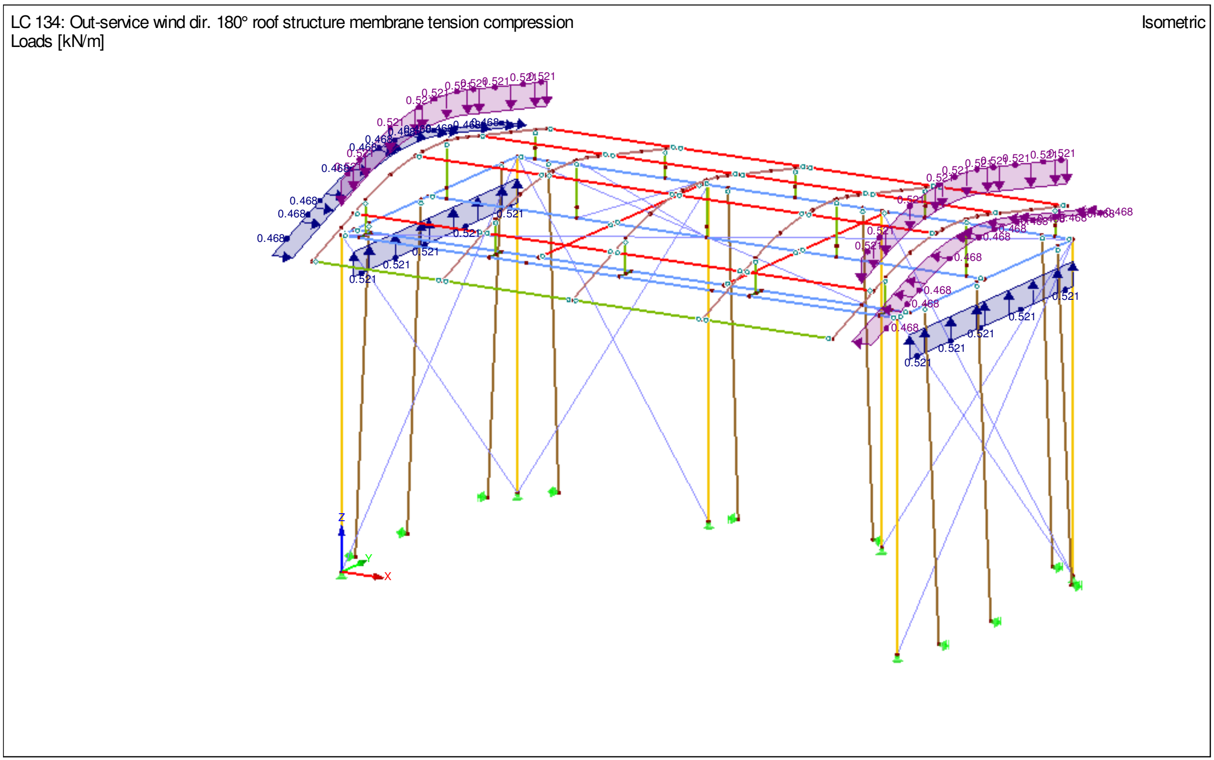
$q_{w,\text{ roof span 1, back}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m
$q_{w,\text{ roof span 2, back}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 3, back}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 4, back}} = 0.4 * 0.625 * 3 = 0.750$ kN/m
$q_{w,\text{ roof span 5, back}} = 0.4 * 0.625 * 1.5 = 0.375$ kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}} = 12.5$ m²
$Q_{w,\text{ side canopy roof structure}} = 0.8 * 0.625 * 12.5 = 6.25$ kN

The canopy is attached to the side truss and the roof kedar profile over a length of 15 Meter.
$q_{w,\text{ side canopy roof structure}} = 6.25 / 15 = 0.417$ kN/m

**2.6.27 load case 134 In-service wind dir. 180° roof structure membrane tension compression.**




Membrane tension calculations roof construction wind 180° compression.

The membrane tension is calculated according to the calculation on page 16. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt, roof\ span\ 1,\ front}$ = 0.468 kN/m
$q_{mt, roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt, roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt, roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt, roof\ span\ 5,\ front}$ = 0.468 kN/m

Membrane tension of roof structure back side

$q_{mt, roof\ span\ 1,\ back}$ = 0.468 kN/m
$q_{mt, roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt, roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt, roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt, roof\ span\ 5,\ back}$ = 0.468 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt, side\ canopy\ roof\ structure}$ = 0.417 / 0.8 = 0.521 kN/m

**2.7 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

| | |
|---|---|
| **$\gamma_G$ = 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 $\gamma_G$ 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….**

### 2.7.1 load combinations

CO1-CO4 Design calculation live load

CO50-CO53 Characteristic calculation live load

CO100-CO134 Design calculation In-service situation

CO150-CO184 Characteristic calculation In-service situation

CO200-CO229 Design calculation Out-service situation

CO250-CO279 Characteristic calculation Out-service situation

| Load Combin. | DS | Load Combination Description | To Solve |
|---|---|---|---|
| CO1 | 0 | 1.15*LC1 + 1.35*LC2 | + |
| CO2 | 0 | 1.15*LC1 + 1.35*LC3 | + |
| CO3 | 0 | 1.15*LC1 + 1.35*LC4 | + |
| CO4 | 0 | 1.15*LC1 + 1.35*LC5 | + |
| | | | |
| CO50 | 0 | LC1 + LC2 | + |
| CO51 | 0 | LC1 + LC3 | + |
| CO52 | 0 | LC1 + LC4 | + |
| CO53 | 0 | LC1 + LC5 | + |
| | | | |
| CO100 | 0 | 1.15*LC1 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO101 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO102 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO103 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO104 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO110 | 0 | 1.15*LC1 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO111 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO112 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO113 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO114 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO120 | 0 | 1.15*LC1 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO121 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO122 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO123 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO124 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO130 | 0 | 1.15*LC1 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO131 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO132 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO133 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO134 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| | | | |
| CO150 | 0 | LC1 + LC10 + LC11 + LC12 + LC13 | + |
| CO151 | 0 | LC1 + LC2 + LC10 + LC11 + LC12 + LC13 | + |
| CO152 | 0 | LC1 + LC3 + LC10 + LC11 + LC12 + LC13 | + |
| CO153 | 0 | LC1 + LC4 + LC10 + LC11 + LC12 + LC13 | + |
| CO154 | 0 | LC1 + LC5 + LC10 + LC11 + LC12 + LC13 | + |
| CO160 | 0 | LC1 + LC20 + LC21 + LC22 + LC23 | + |
| CO161 | 0 | LC1 + LC2 + LC20 + LC21 + LC22 + LC23 | + |
| CO162 | 0 | LC1 + LC3 + LC20 + LC21 + LC22 + LC23 | + |
| CO163 | 0 | LC1 + LC4 + LC20 + LC21 + LC22 + LC23 | + |
| CO164 | 0 | LC1 + LC5 + LC20 + LC21 + LC22 + LC23 | + |
| CO170 | 0 | LC1 + LC30 + LC31 + LC32 + LC33 | + |
| CO171 | 0 | LC1 + LC2 + LC30 + LC31 + LC32 + LC33 | + |
| CO172 | 0 | LC1 + LC3 + LC30 + LC31 + LC32 + LC33 | + |
| CO173 | 0 | LC1 + LC4 + LC30 + LC31 + LC32 + LC33 | + |
| CO174 | 0 | LC1 + LC5 + LC30 + LC31 + LC32 + LC33 | + |
| CO180 | 0 | LC1 + LC32 + LC33 + LC34 + LC35 | + |
| CO181 | 0 | LC1 + LC2 + LC32 + LC33 + LC34 + LC35 | + |

| | | | |
|---|---|---|---|
| CO182 | 0 | LC1 + LC3 + LC32 + LC33 + LC34 + LC35 | + |
| CO183 | 0 | LC1 + LC4 + LC32 + LC33 + LC34 + LC35 | + |
| CO184 | 0 | LC1 + LC5 + LC32 + LC33 + LC34 + LC35 | + |
| | | | |
| CO200 | 0 | 1.15*LC1 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO201 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO202 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO203 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO204 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO205 | 0 | 1.15*LC1 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO206 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO207 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO208 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO209 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO210 | 0 | 1.15*LC1 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO211 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO212 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO213 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO214 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO220 | 0 | 1.15*LC1 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO221 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO222 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO223 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO224 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO225 | 0 | 1.15*LC1 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO226 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO227 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO228 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO229 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| | | | |
| CO250 | 0 | LC1 + LC110 + LC111 + LC112 | + |
| CO251 | 0 | LC1 + LC2 + LC110 + LC111 + LC112 | + |
| CO252 | 0 | LC1 + LC3 + LC110 + LC111 + LC112 | + |
| CO253 | 0 | LC1 + LC4 + LC110 + LC111 + LC112 | + |
| CO254 | 0 | LC1 + LC6 + LC110 + LC111 + LC112 | + |
| CO255 | 0 | LC1 + LC112 + LC113 + LC114 | + |
| CO256 | 0 | LC1 + LC2 + LC112 + LC113 + LC114 | + |
| CO257 | 0 | LC1 + LC3 + LC112 + LC113 + LC114 | + |
| CO258 | 0 | LC1 + LC4 + LC112 + LC113 + LC114 | + |
| CO259 | 0 | LC1 + LC6 + LC112 + LC113 + LC114 | + |
| CO260 | 0 | LC1 + LC120 + LC121 + LC122 | + |
| CO261 | 0 | LC1 + LC2 + LC120 + LC121 + LC122 | + |
| CO262 | 0 | LC1 + LC3 + LC120 + LC121 + LC122 | + |
| CO263 | 0 | LC1 + LC4 + LC120 + LC121 + LC122 | + |
| CO264 | 0 | LC1 + LC6 + LC120 + LC121 + LC122 | + |
| CO270 | 0 | LC1 + LC130 + LC131 + LC132 | + |
| CO271 | 0 | LC1 + LC2 + LC130 + LC131 + LC132 | + |
| CO272 | 0 | LC1 + LC3 + LC130 + LC131 + LC132 | + |
| CO273 | 0 | LC1 + LC4 + LC130 + LC131 + LC132 | + |
| CO274 | 0 | LC1 + LC6 + LC130 + LC131 + LC132 | + |
| CO275 | 0 | LC1 + LC132 + LC133 + LC134 | + |
| CO276 | 0 | LC1 + LC2 + LC132 + LC133 + LC134 | + |
| CO277 | 0 | LC1 + LC3 + LC132 + LC133 + LC134 | + |
| CO278 | 0 | LC1 + LC4 + LC132 + LC133 + LC134 | + |
| CO279 | 0 | LC1 + LC6 + LC132 + LC133 + LC134 | + |

### 2.7.2 result combinations

Different Result combinations have been generated in the program.

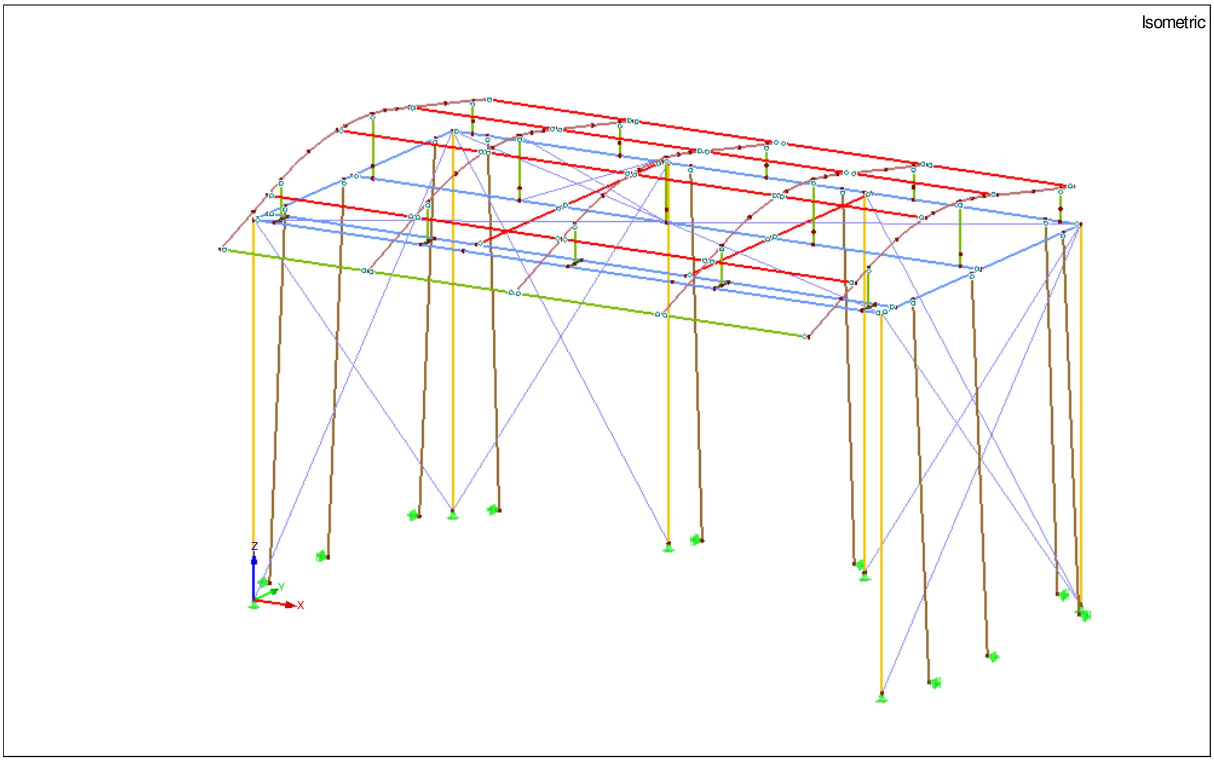
| | |
|---|---|
| RC1 – SW + Loading - Design Values | : 1 * (CO1 or to CO4) |
| RC2 – SW + Loading - Characteristic Values | : 1 * (CO50 or to CO53) |
| RC3 - SW + Loading + In service Wind - Design Values | : 1 * (CO100 or to CO134) |
| RC4 - SW + Loading + In service Wind - Characteristic Values | : 1 * (CO150 or to CO184) |
| RC5 - SW + Loading + Out service Wind - Design Values | : 1 * (CO200 or to CO129) |
| RC6 - SW + Loading + Out service Wind - Characteristic Values | : 1 * (CO250 or to CO279) |

## 3 Calculation results for different Load Cases and Load Combinations.

In this chapter the results of the different load cases and load combinations 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 input information

#### 3.1.1 construction scheme




#### 3.1.2 Used Materials

| Material No. | Material Description | Modulus of Elasticity E [kN/cm$^2$] | Shear Modulus G [kN/cm$^2$] | Poisson's Ratio ν [-] | Specific Weight γ [kN/m$^3$] | Coeff. of Th. Exp. α [1/°C] | Partial Factor $\gamma_M$ [-] | 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 |

### 3.1.3 Used cross sections

| Section | Cross-Section | Material | Moments of inertia [cm$^4$] | | | Cross-Sectional Areas [cm$^2$] | | | Principal Axes | Rotation | Overall Dimensions [mm] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Description [mm] | No. | Torsion J | Bending $I_y$ | Bending $I_z$ | Axial A | Shear $A_y$ | Shear $A_z$ | α [°] | α' [°] | Width b | Depth h |
| 1 | Prolyte H40V | 1 | 900,00 | 4179,54 | 4179,54 | 16,96 | 16,50 | 16,50 | 0,00 | 0,00 | 390,0 | 390,0 |
| 2 | Prolyte H30V | 1 | 500,00 | 2095,86 | 2095,85 | 16,96 | 16,50 | 16,50 | 0,00 | 0,00 | 290,0 | 290,0 |
| 3 | Prolyte H30D | 1 | 150,00 | 1057,29 | 1057,10 | 12,72 | 12,00 | 12,00 | 0,00 | 0,00 | 290,0 | 255,0 |
| 4 | HK 50/50/5/5/5/5 | 1 | 48,28 | 30,75 | 30,75 | 9,00 | 4,00 | 4,00 | 0,00 | 0,00 | 50,0 | 50,0 |
| 5 | Ring 50/4 | 1 | 30.81 | 15.41 | 15.41 | 5.78 | 2.93 | 2.93 | 0,00 | 0,00 | 50,0 | 50,0 |
| 6 | Circle 12 | 2 | 0,20 | 0,10 | 0,10 | 1,13 | 0,96 | 0,96 | 0,00 | 0,00 | 12,0 | 12,0 |
| 7 | RODER roder keder 170x88x3 | 1 | 100,00 | 766,50 | 230,70 | 18,98 | 18,50 | 18,50 | 0,00 | 0,00 | 170,0 | 88,0 |
| 8 | HK 50/100/6/6/6/6 | 1 | 155.83 | 63.93 | 200.87 | 16.56 | 10.64 | 3.74 | 0,00 | 0,00 | 100,0 | 50,0 |

## 3.2 Calculation result summary’s

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **Summary** | | | |
| | Calculation Status | OK | | |
| | Maximum displacement in X-direction | -171,8 | mm | CO132, Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -208,3 | mm | CO100, Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | -218,0 | mm | CO226, Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 218,5 | mm | CO226, Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -97,9 | mrad | CO104, Member No. 19, x: 6.971 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | CO103, Member No. 205, x: 6.973 m |
| | Maximum rotation about Z-axis | -9,3 | mrad | CO102, Member No. 203, x: 0.000 m |
| | Number of 1D finite elements (member elements) | 302 | | |
| | Number of 2D finite elements (surface elements) | 0 | | |
| | Number of 3D finite elements (solid elements) | 0 | | |
| | Number of FE nodes | 249 | | |
| | Number of equations | 1494 | | |
| | 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. Result for RC1 and RC2

## 3.3.1 Result for the single load cases LC1 to LC6.

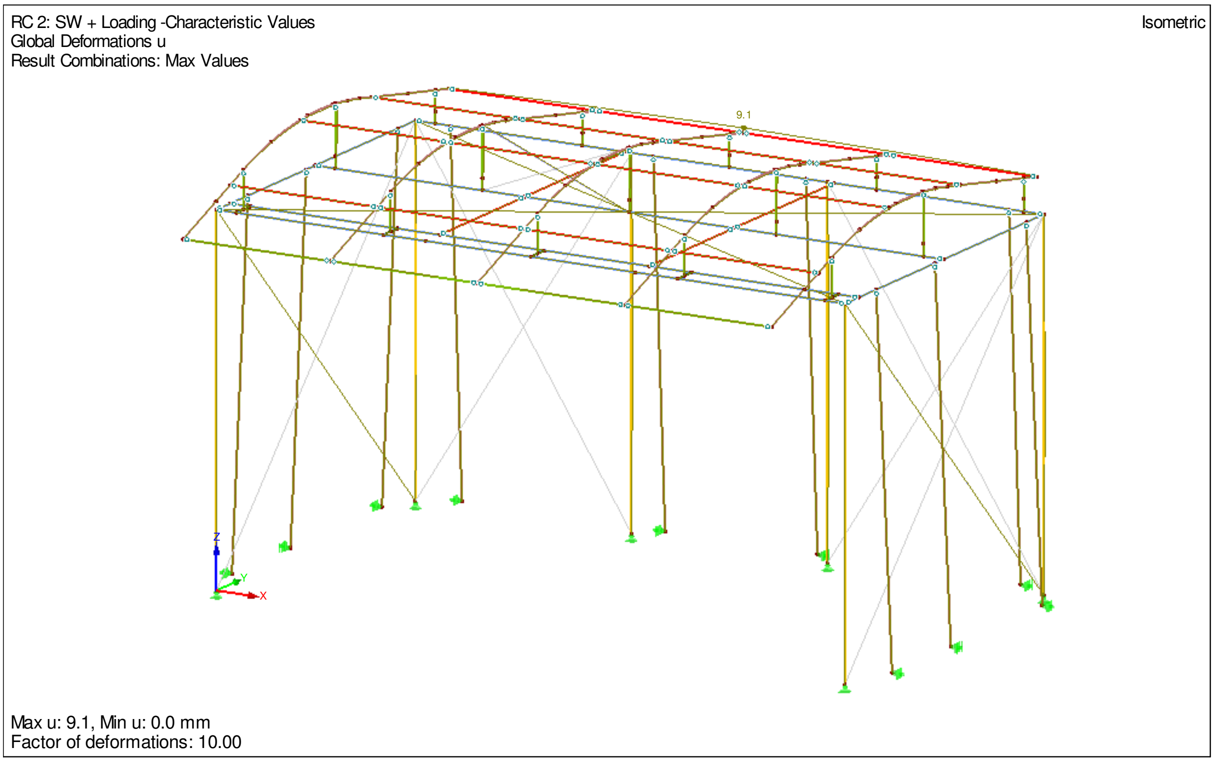
| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **LC1 - Self-weight** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -15,98 | kN | |
| | Sum of support forces in Z | -15,98 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 0,776 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -0,019 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -1,0 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 1,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | -24,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 24,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 3,2 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -6,5 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -0,7 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC2 - udl** | | | |
| | 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 | -31,20 | kN | |
| | Sum of support forces in Z | -31,20 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -19,673 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,210 | 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 | -4,4 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -4,4 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -48,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 49,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 12,2 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 11,6 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,8 | mrad | Member No. 45, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC3 - Centre point loads** | | | |
| | 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 | -24,00 | kN | |
| | Sum of support forces in Z | -24,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -35,620 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,162 | 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 | -5,5 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -4,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | -35,9 | mm | Member No. 26, x: 1.796 m |
| | Maximum vectorial displacement | 36,1 | mm | Member No. 26, x: 1.796 m |
| | Maximum rotation about X-axis | 10,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 8,1 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,9 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC4 - Points in the third point** | | | |
| | 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 | -34,00 | kN | |

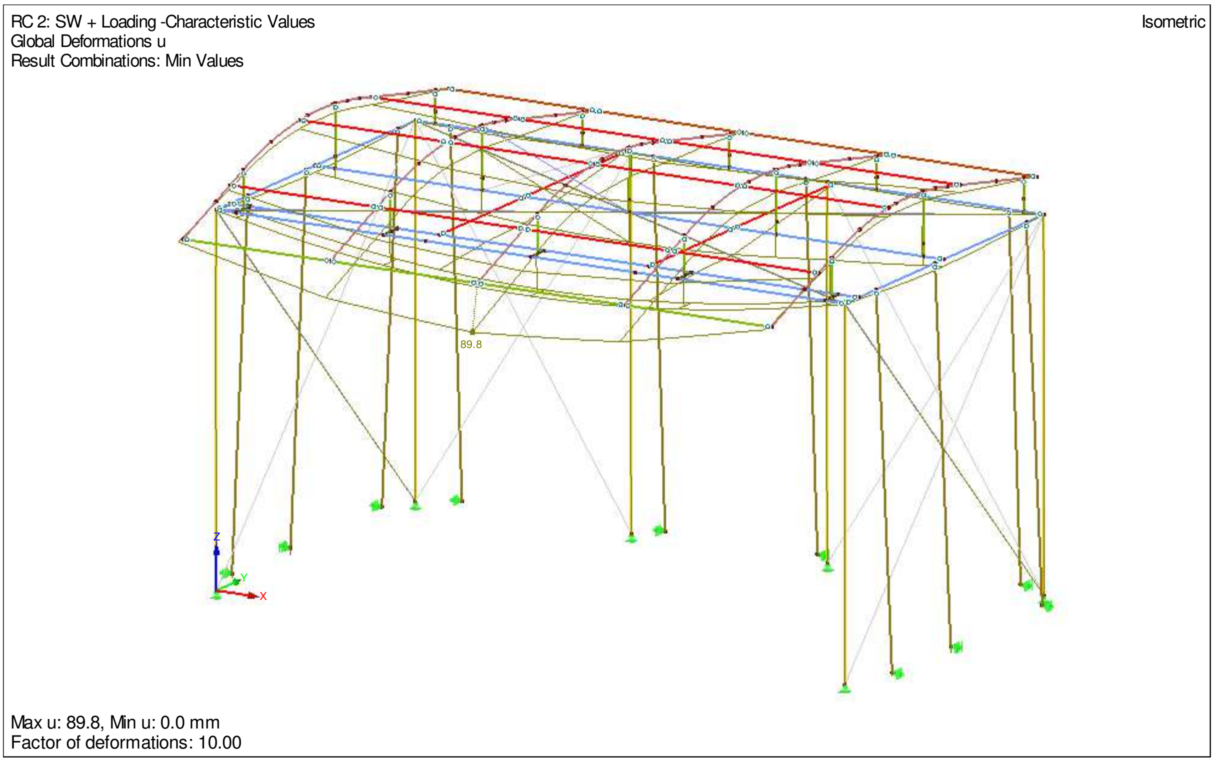
| | | | | |
|---|---|---|---|---|
| | Sum of support forces in Z | -34,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -46,847 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,229 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -5,5 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -7,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | -47,0 | mm | Member No. 26, x: 1.796 m |
| | Maximum vectorial displacement | 47,3 | mm | Member No. 168, x: 0.000 m |
| | Maximum rotation about X-axis | 15,2 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 10,8 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -1,4 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC5 - point loads 1.25 meter from the side span in service** | | | |
| | 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 | -52,00 | kN | |
| | Sum of support forces in Z | -52,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 10,860 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,350 | 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. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -5,1 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -65,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 65,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 10,6 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -15,4 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | -1,5 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC6 - point loads 1.25 meter from the side span out service** | | | |
| | 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 | -36,00 | kN | |
| | Sum of support forces in Z | -36,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -46,202 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,242 | 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 | -2,1 | mm | Member No. 10, x: 4.178 m |
| | Maximum displacement in Y-direction | -4,1 | mm | Member No. 131, x: 0.000 m |
| | Maximum displacement in Z-direction | -21,5 | mm | Member No. 26, x: 1.796 m |
| | Maximum vectorial displacement | 21,7 | mm | Member No. 26, x: 1.796 m |
| | Maximum rotation about X-axis | 7,3 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 5,6 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,3 | mrad | Member No. 40, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |

## 3.3.2 Calculation results Load combinations 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 | -60,50 | kN | |
| | Sum of support forces in Z | -60,50 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -7,1 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -7,7 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -93,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 94,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 20,2 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -22,4 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -1,4 | mrad | Member No. 45, 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 + 1.35*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 | -50,78 | kN | |
| | Sum of support forces in Z | -50,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -8,6 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -5,9 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -69,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 69,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 17,4 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -16,7 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -1,2 | mrad | Member No. 45, 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 + 1.35*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 | -64,28 | kN | |
| | Sum of support forces in Z | -64,28 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -8,6 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -8,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | -80,6 | mm | Member No. 197, x: 0.000 m |
| | Maximum vectorial displacement | 80,8 | mm | Member No. 26, x: 1.026 m |
| | Maximum rotation about X-axis | 24,3 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 19,8 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -1,5 | mrad | Member No. 45, 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 + 1.35*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 | -88,58 | kN | |
| | Sum of support forces in Z | -88,58 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -4,3 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -8,6 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -115,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 116,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 18,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -28,4 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -2,8 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

### 3.3.3 Deformation RC2 – SW + Loading setup - Characteristic Values



## 3.4 Result for RC3 and RC4

### 3.4.1 Result for the single load cases LC10 to LC35.

| Description | Value | Unit | Comment |
|---|---|---|---|
| **LC10 - in-service wind dir.0° roof structure** | | | |
| 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 | 45,22 | kN | |
| Sum of support forces in Z | 45,22 | kN | Deviation: 0.00 % |
| Resultant of reactions about X | -39,452 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| Resultant of reactions about Y | -0,305 | 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 | 8,9 | mm | Member No. 15, x: 0.000 m |
| Maximum displacement in Y-direction | 9,1 | mm | Member No. 168, x: 0.273 m |
| Maximum displacement in Z-direction | 129,3 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 129,6 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | -25,2 | mrad | Member No. 145, x: 0.472 m |
| Maximum rotation about Y-axis | 28,3 | mrad | Member No. 32, x: 0.000 m |
| Maximum rotation about Z-axis | 1,8 | mrad | Member No. 45, x: 0.000 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **LC11 - in-service wind dir. 0° roof structure membrane tension** | | | |
| 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 | 0,00 | kN | |
| Sum of support forces in Y | 0,00 | kN | |
| Sum of loads in Z | -1,86 | kN | |
| Sum of support forces in Z | -1,86 | kN | Deviation: 0.00 % |
| Resultant of reactions about X | 3,487 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 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 | 0,7 | mm | Member No. 138, x: 0.000 m |
| Maximum displacement in Y-direction | -0,3 | mm | Member No. 11, x: 4.177 m |
| Maximum displacement in Z-direction | -2,3 | mm | Member No. 197, x: 0.000 m |
| Maximum vectorial displacement | 2,3 | mm | Member No. 197, x: 0.000 m |
| Maximum rotation about X-axis | 0,7 | mrad | Member No. 65, x: 0.124 m |
| Maximum rotation about Y-axis | 1,1 | mrad | Member No. 86, x: 0.959 m |
| Maximum rotation about Z-axis | -0,5 | mrad | Member No. 126, x: 0.000 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **LC12 - in-service wind dir. 0° back and side wall** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 20,66 | kN | |
| Sum of support forces in Y | 20,66 | kN | Deviation: 0.00 % |
| Sum of loads in Z | 0,00 | kN | |
| Sum of support forces in Z | 0,00 | kN | |
| Resultant of reactions about X | 40,782 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| Resultant of reactions about Y | -0,007 | kNm | At center of gravity of model |
| Resultant of reactions about Z | 0,149 | kNm | At center of gravity of model |
| Maximum displacement in X-direction | 57,2 | mm | Member No. 130, x: 3.485 m |
| Maximum displacement in Y-direction | 62,9 | mm | Member No. 204, x: 3.487 m |
| Maximum displacement in Z-direction | 2,7 | mm | Member No. 204, x: 3.487 m |
| Maximum vectorial displacement | 62,9 | mm | Member No. 204, x: 3.487 m |
| Maximum rotation about X-axis | -27,3 | mrad | Member No. 204, x: 0.000 m |
| Maximum rotation about Y-axis | 26,2 | mrad | Member No. 130, x: 0.000 m |
| Maximum rotation about Z-axis | 3,6 | mrad | Member No. 2, x: 0.000 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **LC13 - in-service wind dir. 0° back and side wall membrane tension** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -0,02 | kN | |
| Sum of support forces in Y | -0,02 | kN | Deviation: 0.00 % |
| Sum of loads in Z | 0,00 | kN | |
| Sum of support forces in Z | 0,00 | kN | |
| Resultant of reactions about X | -0,044 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 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 | 128,4 | mm | Member No. 205, x: 3.487 m |
| | Maximum displacement in Y-direction | -158,0 | mm | Member No. 202, x: 3.486 m |
| | Maximum displacement in Z-direction | 0,0 | mm | Member No. 17, x: 3.485 m |
| | Maximum vectorial displacement | 158,0 | mm | Member No. 202, x: 3.486 m |
| | Maximum rotation about X-axis | 72,4 | mrad | Member No. 202, x: 0.000 m |
| | Maximum rotation about Y-axis | 58,8 | mrad | Member No. 205, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,5 | mrad | Member No. 205, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC20 - in-service wind dir. 90° roof structure** | | | |
| | Sum of loads in X | 4,85 | kN | |
| | Sum of support forces in X | 4,85 | 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 | 3,47 | kN | |
| | Sum of support forces in Z | 3,47 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -3,650 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 9,779 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 1,359 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 8,8 | mm | Member No. 14, x: 1.026 m |
| | Maximum displacement in Y-direction | 1,5 | mm | Member No. 20, x: 0.257 m |
| | Maximum displacement in Z-direction | 10,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 12,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -1,7 | mrad | Member No. 28, x: 0.124 m |
| | Maximum rotation about Y-axis | 3,6 | mrad | Member No. 126, x: 0.000 m |
| | Maximum rotation about Z-axis | 1,6 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC21 - in-service wind dir. 90° roof structure membrane tension** | | | |
| | 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 | -0,75 | kN | |
| | Sum of support forces in Z | -0,75 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,416 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -3,428 | 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. 59, x: 0.360 m |
| | Maximum displacement in Y-direction | -0,2 | mm | Member No. 7, x: 4.177 m |
| | Maximum displacement in Z-direction | -1,0 | mm | Member No. 119, x: 1.424 m |
| | Maximum vectorial displacement | 1,0 | mm | Member No. 119, x: 1.424 m |
| | Maximum rotation about X-axis | 0,5 | mrad | Member No. 65, x: 0.124 m |
| | Maximum rotation about Y-axis | 0,6 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,1 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC22 - in-service wind dir. 90° back and side wall** | | | |
| | Sum of loads in X | 11,26 | kN | |
| | Sum of support forces in X | 11,26 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 4,76 | kN | |
| | Sum of support forces in Y | 4,76 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 9,386 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -22,243 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -1,111 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 50,8 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | 14,7 | mm | Member No. 204, x: 3.487 m |
| | Maximum displacement in Z-direction | -2,0 | mm | Member No. 16, x: 3.485 m |
| | Maximum vectorial displacement | 50,9 | mm | Member No. 16, x: 3.485 m |
| | Maximum rotation about X-axis | -6,4 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | 22,5 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 2,0 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC23 - in-service wind dir. 90° back and side wall membrane tension** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |

| | | | | |
|---|---|---|---|---|
| | Sum of loads in Y | 0,01 | kN | |
| | Sum of support forces in Y | 0,01 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 0,010 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,042 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 29,6 | mm | Member No. 205, x: 3.487 m |
| | Maximum displacement in Y-direction | -128,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 0,0 | mm | Member No. 17, x: 3.485 m |
| | Maximum vectorial displacement | 128,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | -58,8 | mrad | Member No. 19, x: 6.971 m |
| | Maximum rotation about Y-axis | -13,5 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -2,7 | mrad | Member No. 19, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC30 - in-service wind dir. 180° roof structure** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | 1,81 | kN | |
| | Sum of support forces in Z | 1,81 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 2,176 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -0,012 | 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 | 0,3 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Y-direction | 1,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | 2,9 | mm | Member No. 153, x: 0.697 m |
| | Maximum vectorial displacement | 2,9 | mm | Member No. 153, x: 0.697 m |
| | Maximum rotation about X-axis | -1,3 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -0,6 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,2 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC31 - in-service wind dir. 180° roof structure membrane tension** | | | |
| | 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 | -0,35 | kN | |
| | Sum of support forces in Z | -0,35 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 0,655 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 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 | 0,1 | mm | Member No. 59, x: 0.599 m |
| | Maximum displacement in Y-direction | -0,1 | mm | Member No. 7, x: 4.177 m |
| | Maximum displacement in Z-direction | -0,5 | mm | Member No. 197, x: 0.000 m |
| | Maximum vectorial displacement | 0,5 | mm | Member No. 197, x: 0.000 m |
| | Maximum rotation about X-axis | 0,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 0,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,0 | mrad | Member No. 137, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC32 - in-service wind dir. 180° back and side wall** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -20,67 | kN | |
| | Sum of support forces in Y | -20,67 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | -40,781 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,139 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -10,6 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -62,6 | mm | Member No. 204, x: 3.487 m |
| | Maximum displacement in Z-direction | -2,7 | mm | Member No. 204, x: 3.487 m |
| | Maximum vectorial displacement | 62,7 | mm | Member No. 204, x: 3.487 m |
| | Maximum rotation about X-axis | 27,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -4,9 | mrad | Member No. 130, x: 6.971 m |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Z-axis | 3,4 | mrad | Member No. 109, x: 0.410 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC33 - in-service wind dir. 180° back and side wall membrane tension** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,01 | kN | |
| | Sum of support forces in Y | 0,01 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 0,012 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 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 | 128,4 | mm | Member No. 205, x: 3.487 m |
| | Maximum displacement in Y-direction | -29,5 | mm | Member No. 202, x: 3.486 m |
| | Maximum displacement in Z-direction | 0,0 | mm | Member No. 145, x: 0.000 m |
| | Maximum vectorial displacement | 128,4 | mm | Member No. 205, x: 3.487 m |
| | Maximum rotation about X-axis | -13,5 | mrad | Member No. 202, x: 6.971 m |
| | Maximum rotation about Y-axis | 58,8 | mrad | Member No. 205, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,5 | mrad | Member No. 205, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC34 - in-service wind dir. 180° roof structure compression** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -19,14 | kN | |
| | Sum of support forces in Z | -19,14 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 16,076 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,129 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -3,7 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -4,0 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -53,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 54,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 10,7 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -11,8 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,7 | mrad | Member No. 45, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC35 - in-service wind dir. 180° roof structure membrane tension compression** | | | |
| | 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 | -0,35 | kN | |
| | Sum of support forces in Z | -0,35 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 0,655 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 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 | 0,3 | mm | Member No. 65, x: 0.867 m |
| | Maximum displacement in Y-direction | -0,1 | mm | Member No. 11, x: 4.177 m |
| | Maximum displacement in Z-direction | -0,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 0,5 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | 0,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 0,4 | mrad | Member No. 56, x: 0.381 m |
| | Maximum rotation about Z-axis | 0,2 | mrad | Member No. 126, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |

## 3.4.2 Calculation results Load Combination CO100-CO134

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **CO100 - 1.15*LC1 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,86 | kN | |
| | Sum of support forces in Y | 27,86 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 40,16 | kN | |
| | Sum of support forces in Z | 40,16 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -208,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 141,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 214,5 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | -97,8 | mrad | Member No. 19, x: 6.971 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 205, x: 6.973 m |
| | Maximum rotation about Z-axis | -9,1 | mrad | Member No. 203, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | $N, V_y, V_z, M_y, M_z, M_T$ |
| | **CO101 - 1.15*LC1 + 1.35*LC2 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,86 | kN | |
| | Sum of support forces in Y | 27,86 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -1,96 | kN | |
| | Sum of support forces in Z | -1,96 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -208,2 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 76,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 214,4 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | -97,8 | mrad | Member No. 19, x: 6.971 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 205, x: 6.973 m |
| | Maximum rotation about Z-axis | -9,2 | mrad | Member No. 203, 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*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,86 | kN | |
| | Sum of support forces in Y | 27,86 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 7,76 | kN | |
| | Sum of support forces in Z | 7,76 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -208,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 101,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 214,5 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | -97,8 | mrad | Member No. 19, x: 6.971 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 205, x: 6.973 m |
| | Maximum rotation about Z-axis | -9,3 | mrad | Member No. 203, 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*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,86 | kN | |
| | Sum of support forces in Y | 27,86 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -5,74 | kN | |
| | Sum of support forces in Z | -5,74 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -208,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 91,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 214,5 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | -97,8 | mrad | Member No. 19, x: 6.971 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 205, x: 6.973 m |
| | Maximum rotation about Z-axis | -9,3 | mrad | Member No. 203, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | $N, V_y, V_z, M_y, M_z, M_T$ |

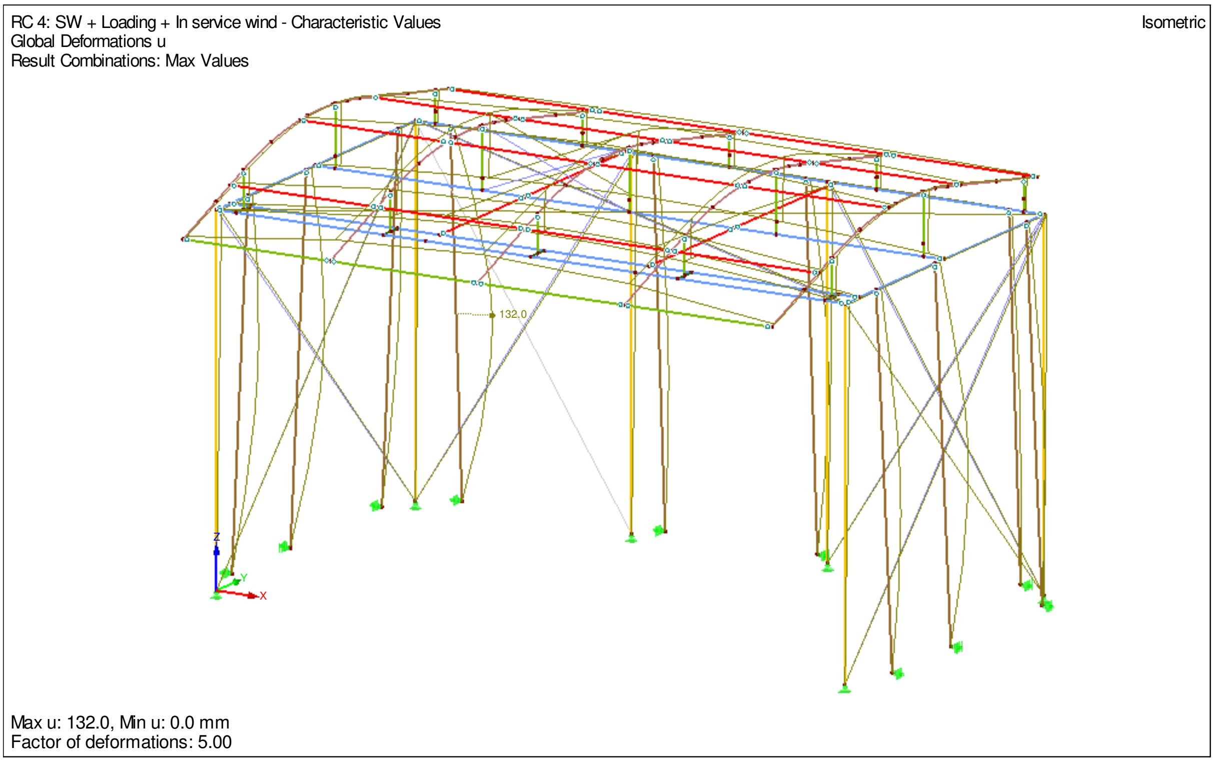
| | | | |
|---|---|---|---|
| **CO104 - 1.15*LC1 + 1.35*LC5 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 27,86 | kN | |
| Sum of support forces in Y | 27,86 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -30,04 | kN | |
| Sum of support forces in Z | -30,04 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| Maximum displacement in Y-direction | -208,0 | mm | Member No. 19, x: 3.486 m |
| Maximum displacement in Z-direction | 55,2 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 214,2 | mm | Member No. 19, x: 3.486 m |
| Maximum rotation about X-axis | -97,9 | mrad | Member No. 19, x: 6.971 m |
| Maximum rotation about Y-axis | -78,9 | mrad | Member No. 205, x: 6.973 m |
| Maximum rotation about Z-axis | -9,1 | mrad | Member No. 203, 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| Sum of loads in X | 21,76 | kN | |
| Sum of support forces in X | 21,76 | kN | Deviation: 0.00 % |
| Sum of loads in Y | 6,43 | kN | |
| Sum of support forces in Y | 6,43 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -14,72 | kN | |
| Sum of support forces in Z | -14,72 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 74,0 | mm | Member No. 16, x: 3.485 m |
| Maximum displacement in Y-direction | -172,7 | mm | Member No. 19, x: 3.486 m |
| Maximum displacement in Z-direction | -14,6 | mm | Member No. 34, x: 2.625 m |
| Maximum vectorial displacement | 179,4 | mm | Member No. 19, x: 3.486 m |
| Maximum rotation about X-axis | 79,2 | mrad | Member No. 19, x: 0.000 m |
| Maximum rotation about Y-axis | 32,0 | mrad | Member No. 16, x: 0.000 m |
| Maximum rotation about Z-axis | 8,4 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| Sum of loads in X | 21,76 | kN | |
| Sum of support forces in X | 21,76 | kN | Deviation: 0.00 % |
| Sum of loads in Y | 6,43 | kN | |
| Sum of support forces in Y | 6,43 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -56,84 | kN | |
| Sum of support forces in Z | -56,84 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 74,4 | mm | Member No. 16, x: 3.485 m |
| Maximum displacement in Y-direction | -173,0 | mm | Member No. 19, x: 3.486 m |
| Maximum displacement in Z-direction | -81,8 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 179,8 | mm | Member No. 19, x: 3.486 m |
| Maximum rotation about X-axis | 79,3 | mrad | Member No. 19, x: 0.000 m |
| Maximum rotation about Y-axis | 32,1 | mrad | Member No. 16, x: 0.000 m |
| Maximum rotation about Z-axis | 8,5 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| Sum of loads in X | 21,76 | kN | |
| Sum of support forces in X | 21,76 | kN | Deviation: 0.00 % |
| Sum of loads in Y | 6,43 | kN | |
| Sum of support forces in Y | 6,43 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -47,12 | kN | |
| Sum of support forces in Z | -47,12 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 74,3 | mm | Member No. 16, x: 3.485 m |
| Maximum displacement in Y-direction | -172,8 | mm | Member No. 19, x: 3.486 m |
| Maximum displacement in Z-direction | -58,6 | mm | Member No. 197, x: 0.000 m |
| Maximum vectorial displacement | 179,6 | mm | Member No. 19, x: 3.486 m |
| Maximum rotation about X-axis | 79,2 | mrad | Member No. 19, x: 0.000 m |
| Maximum rotation about Y-axis | 32,1 | mrad | Member No. 16, x: 0.000 m |
| Maximum rotation about Z-axis | 8,4 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| Sum of loads in X | 21,76 | kN | |
| Sum of support forces in X | 21,76 | kN | Deviation: 0.00 % |

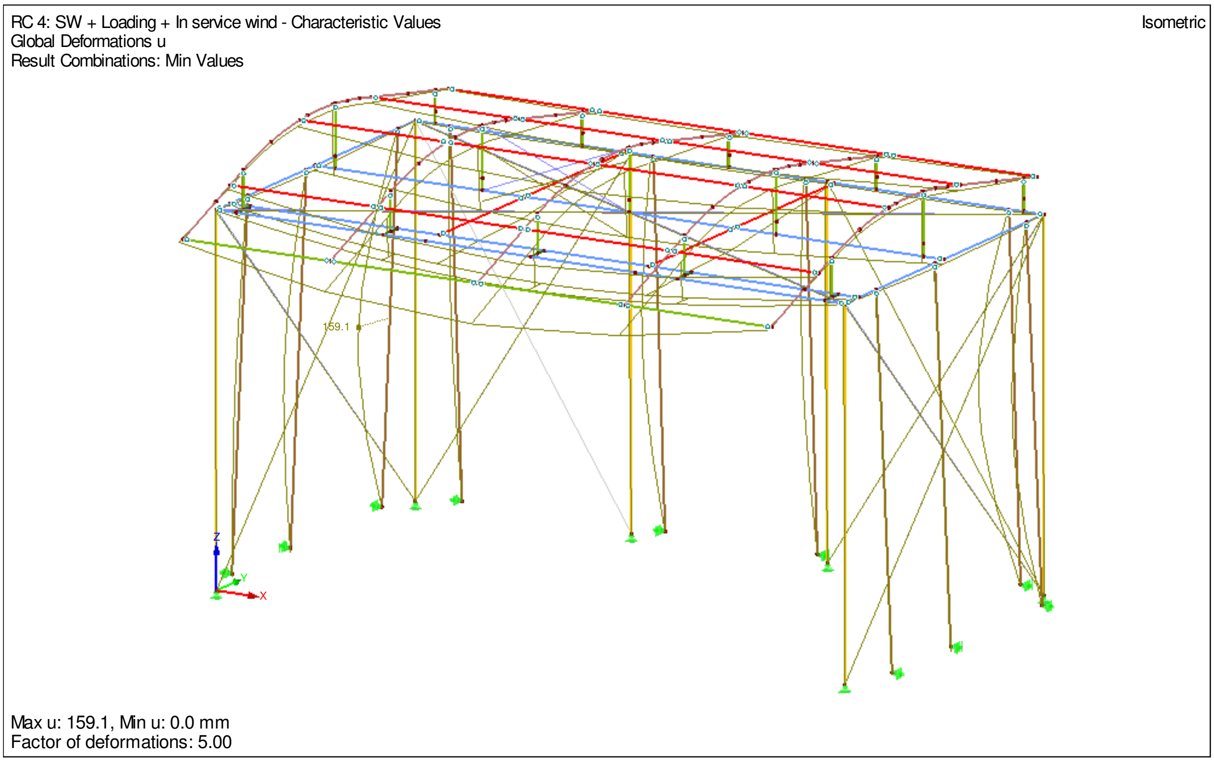
| | | | | |
|---|---|---|---|---|
| | Sum of loads in Y | 6,43 | kN | |
| | Sum of support forces in Y | 6,43 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -60,62 | kN | |
| | Sum of support forces in Z | -60,62 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 74,5 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -172,9 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | -73,4 | mm | Member No. 26, x: 1.540 m |
| | Maximum vectorial displacement | 179,7 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | 79,3 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | 32,1 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,5 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| | Sum of loads in X | 21,76 | kN | |
| | Sum of support forces in X | 21,76 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 6,43 | kN | |
| | Sum of support forces in Y | 6,43 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -84,92 | kN | |
| | Sum of support forces in Z | -84,92 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 74,7 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -173,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | -104,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 180,2 | mm | Member No. 19, x: 3.486 m |
| | Maximum rotation about X-axis | 79,4 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | 32,2 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,7 | mrad | Member No. 19, x: 6.971 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,89 | kN | |
| | Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -16,40 | kN | |
| | Sum of support forces in Z | -16,40 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -84,7 | mm | Member No. 206, x: 3.487 m |
| | Maximum displacement in Z-direction | -28,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 178,1 | mm | Member No. 203, x: 3.487 m |
| | Maximum rotation about X-axis | 36,9 | mrad | Member No. 206, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 9,0 | mrad | Member No. 203, x: 6.973 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,89 | kN | |
| | Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -58,52 | kN | |
| | Sum of support forces in Z | -58,52 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -84,9 | mm | Member No. 204, x: 3.487 m |
| | Maximum displacement in Z-direction | -94,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 178,2 | mm | Member No. 203, x: 3.487 m |
| | Maximum rotation about X-axis | 36,9 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 9,0 | mrad | Member No. 203, x: 6.973 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,89 | kN | |
| | Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -48,80 | kN | |

| | | | |
|---|---|---|---|
| Sum of support forces in Z | -48,80 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| Maximum displacement in Y-direction | -84,8 | mm | Member No. 204, x: 3.487 m |
| Maximum displacement in Z-direction | -69,8 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 178,1 | mm | Member No. 203, x: 3.487 m |
| Maximum rotation about X-axis | 36,9 | mrad | Member No. 204, x: 0.000 m |
| Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| Maximum rotation about Z-axis | 8,9 | mrad | Member No. 203, x: 6.973 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -27,89 | kN | |
| Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -62,30 | kN | |
| Sum of support forces in Z | -62,30 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| Maximum displacement in Y-direction | -84,9 | mm | Member No. 204, x: 3.487 m |
| Maximum displacement in Z-direction | -79,6 | mm | Member No. 197, x: 0.000 m |
| Maximum vectorial displacement | 178,1 | mm | Member No. 203, x: 3.487 m |
| Maximum rotation about X-axis | 36,9 | mrad | Member No. 204, x: 0.000 m |
| Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| Maximum rotation about Z-axis | 9,0 | mrad | Member No. 203, x: 6.973 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -27,89 | kN | |
| Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -86,60 | kN | |
| Sum of support forces in Z | -86,60 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| Maximum displacement in Y-direction | -85,3 | mm | Member No. 204, x: 3.487 m |
| Maximum displacement in Z-direction | -116,9 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 178,3 | mm | Member No. 203, x: 3.487 m |
| Maximum rotation about X-axis | 37,0 | mrad | Member No. 204, x: 0.000 m |
| Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| Maximum rotation about Z-axis | 9,1 | mrad | Member No. 203, x: 6.973 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | $N, V_y, V_z, M_y, M_z, M_T$ |
| **CO130 - 1.15*LC1 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -27,89 | kN | |
| Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -44,69 | kN | |
| Sum of support forces in Z | -44,69 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| Maximum displacement in Y-direction | -85,0 | mm | Member No. 204, x: 3.487 m |
| Maximum displacement in Z-direction | -102,5 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 178,1 | mm | Member No. 203, x: 3.487 m |
| Maximum rotation about X-axis | 36,9 | mrad | Member No. 204, x: 0.000 m |
| Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| Maximum rotation about Z-axis | 9,0 | mrad | Member No. 203, x: 6.973 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | $N, V_y, V_z, M_y, M_z, M_T$ |
| **CO131 - 1.15*LC1 + 1.35*LC2 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -27,89 | kN | |
| Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -86,81 | kN | |
| Sum of support forces in Z | -86,81 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| Maximum displacement in Y-direction | -85,2 | mm | Member No. 204, x: 3.487 m |

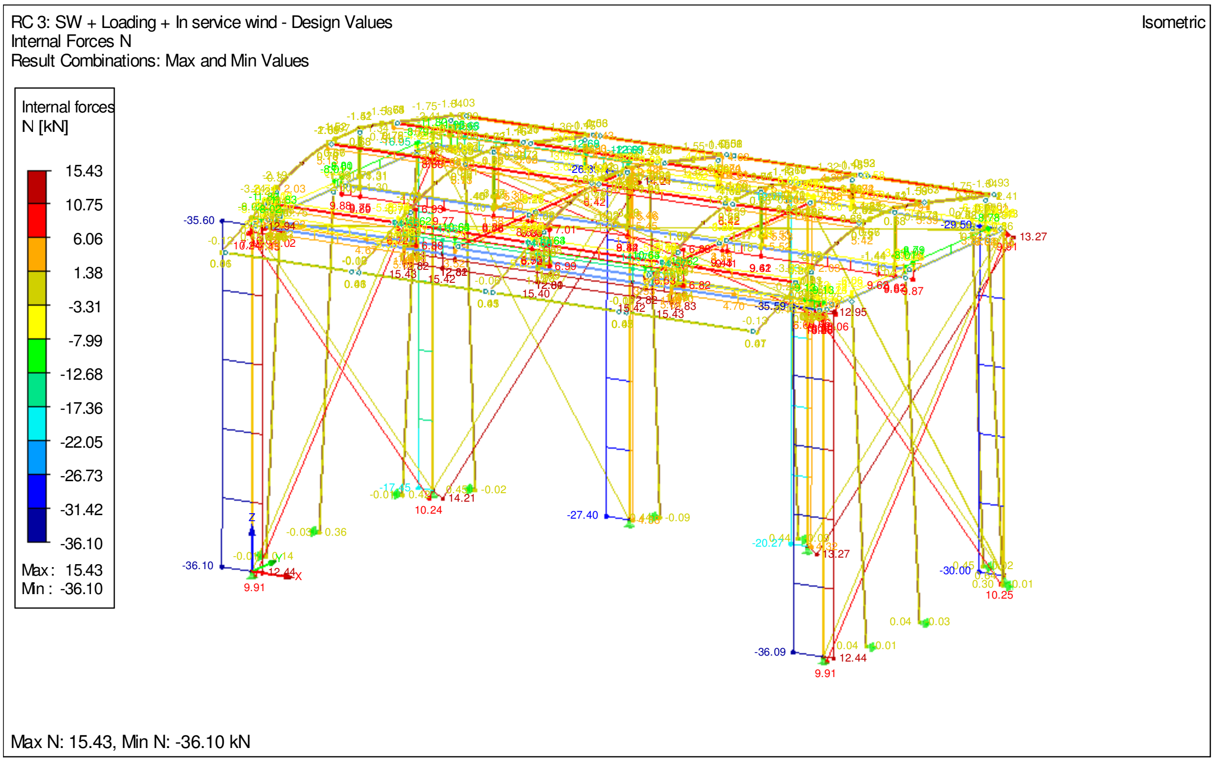
| | | | | |
|---|---|---|---|---|
| | Maximum displacement in Z-direction | -168,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 178,2 | mm | Member No. 203, x: 3.487 m |
| | Maximum rotation about X-axis | 37,0 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,9 | mrad | Member No. 203, x: 6.973 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO132 - 1.15*LC1 + 1.35*LC3 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,89 | kN | |
| | Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -77,09 | kN | |
| | Sum of support forces in Z | -77,09 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -85,1 | mm | Member No. 204, x: 3.487 m |
| | Maximum displacement in Z-direction | -143,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 178,2 | mm | Member No. 203, x: 3.487 m |
| | Maximum rotation about X-axis | 37,0 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,9 | mrad | Member No. 203, x: 6.973 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO133 - 1.15*LC1 + 1.35*LC4 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,89 | kN | |
| | Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -90,59 | kN | |
| | Sum of support forces in Z | -90,59 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -85,1 | mm | Member No. 204, x: 3.487 m |
| | Maximum displacement in Z-direction | -153,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 178,2 | mm | Member No. 203, x: 3.487 m |
| | Maximum rotation about X-axis | 39,4 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,9 | mrad | Member No. 203, x: 6.973 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO134 - 1.15*LC1 + 1.35*LC5 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,89 | kN | |
| | Sum of support forces in Y | -27,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -114,89 | kN | |
| | Sum of support forces in Z | -114,89 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.487 m |
| | Maximum displacement in Y-direction | -85,5 | mm | Member No. 204, x: 3.487 m |
| | Maximum displacement in Z-direction | -191,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 192,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 37,1 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 9,0 | mrad | Member No. 203, x: 6.973 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

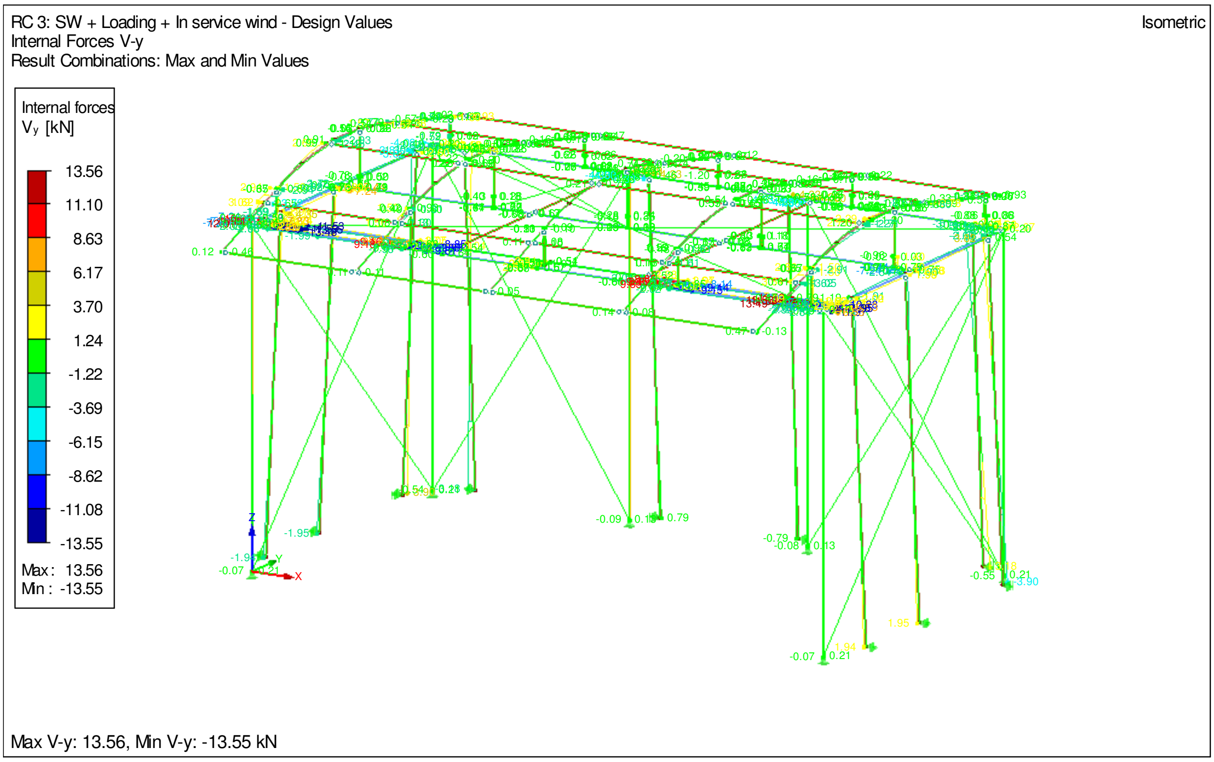
### 3.4.3 Deformation RC4 - SW + Loading setup + In service Wind - Characteristic Values

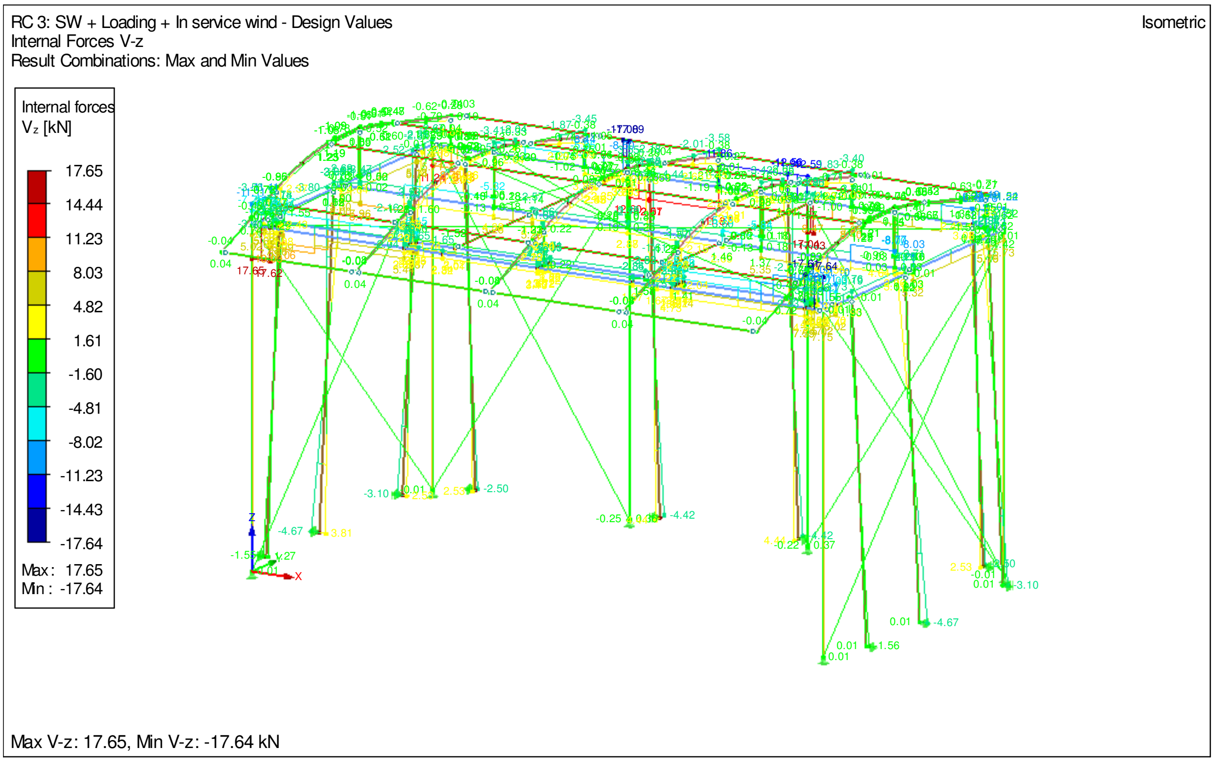


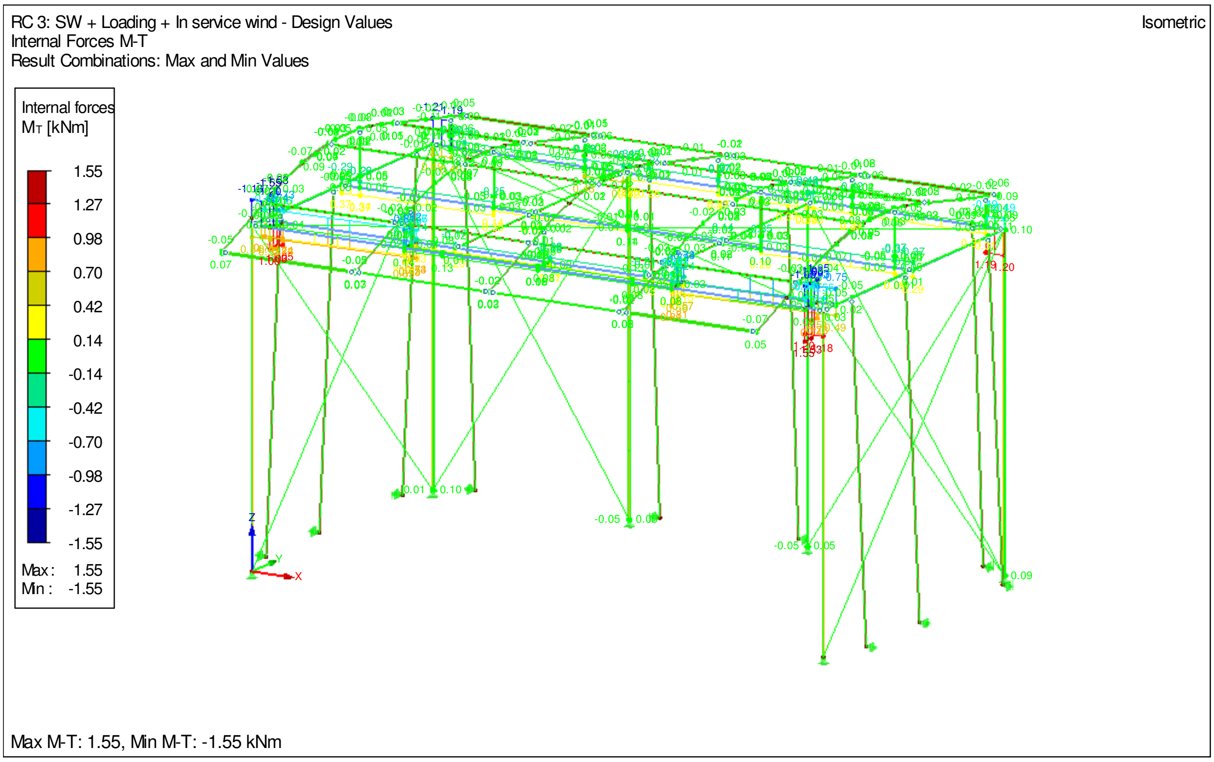



### 3.4.4 Internal force diagram RC3 - SW + Loading + In service Wind - Design Values



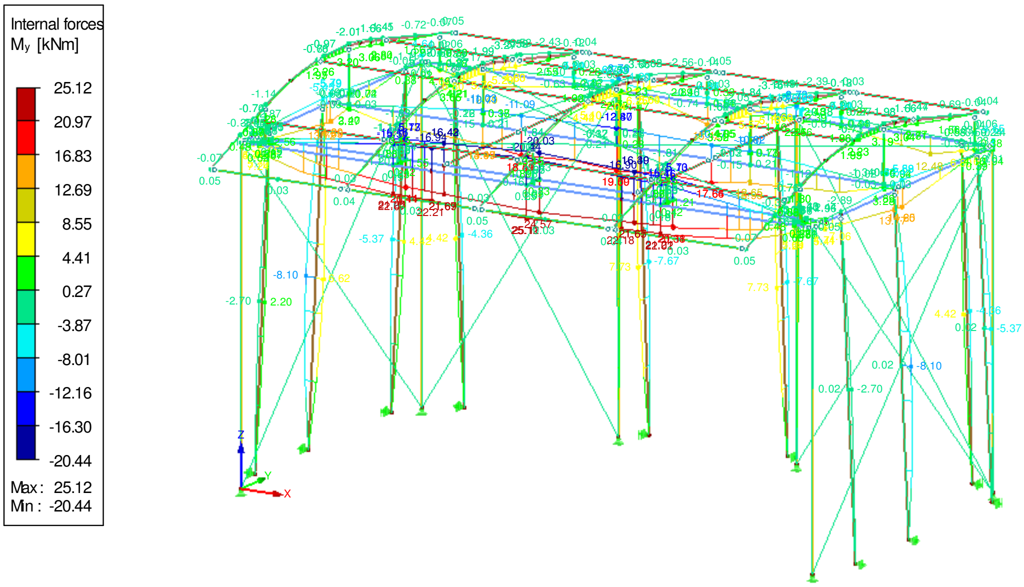




RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
$V_z$ [kN]
17.65
14.44
11.23
8.03
4.82
1.61
-1.60
-4.81
-8.02
-11.23
-14.43
-17.64
Max : 17.65
Min : -17.64
Max V-z: 17.65, Min V-z: -17.64 kN


RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-T
Result Combinations: Max and Min Values
Isometric
Internal forces
$M_T$ [kNm]
1.55
1.27
0.98
0.70
0.42
0.14
-0.14
-0.42
-0.70
-0.98
-1.27
-1.55
Max : 1.55
Min : -1.55
Max M-T: 1.55, Min M-T: -1.55 kNm

RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values

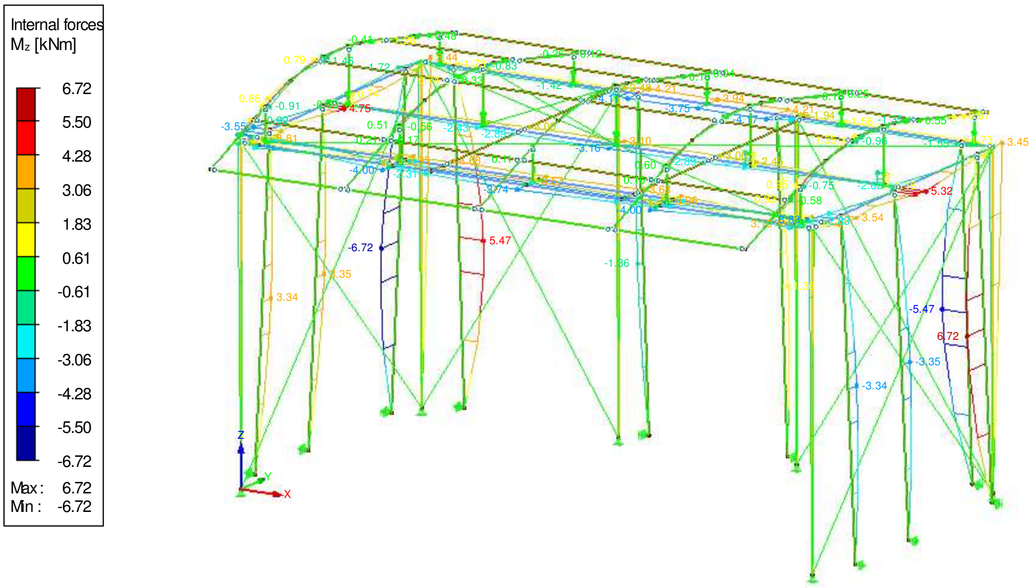
Isometric




Max M-y: 25.12, Min M-y: -20.44 kNm

RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric




Max M-z: 6.72, Min M-z: -6.72 kNm

## 3.5 Result for RC5 and RC6

### 3.5.1 Result for the single load cases LC110 to LC134.

| Description | Value | Unit | Comment |
|---|---|---|---|
| **LC110 - Out-service wind direction 0° roof structure** | | | |
| 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 | 53,99 | kN | |
| Sum of support forces in Z | 53,99 | kN | Deviation: 0.00 % |
| Resultant of reactions about X | -65,377 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| Resultant of reactions about Y | -0,364 | 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 | 10,7 | mm | Member No. 35, x: 0.000 m |
| Maximum displacement in Y-direction | 11,5 | mm | Member No. 168, x: 0.273 m |
| Maximum displacement in Z-direction | 177,3 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 177,9 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | -28,9 | mrad | Member No. 28, x: 0.124 m |
| Maximum rotation about Y-axis | 38,5 | mrad | Member No. 32, x: 0.000 m |
| Maximum rotation about Z-axis | 3,0 | mrad | Member No. 32, x: 0.000 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **LC111 - Out-service wind direction 0° roof structure membrane tension** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 0,00 | kN | |
| Sum of support forces in Y | 0,00 | kN | |
| Sum of loads in Z | -1,93 | kN | |
| Sum of support forces in Z | -1,93 | kN | Deviation: 0.00 % |
| Resultant of reactions about X | 3,633 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| Resultant of reactions about Y | 0,008 | kNm | At center of gravity of model |
| Resultant of reactions about Z | -0,008 | kNm | At center of gravity of model |
| Maximum displacement in X-direction | -0,7 | mm | Member No. 89, x: 0.867 m |
| Maximum displacement in Y-direction | -0,3 | mm | Member No. 11, x: 4.177 m |
| Maximum displacement in Z-direction | -2,7 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 2,7 | mm | Member No. 33, x: 0.000 m |
| Maximum rotation about X-axis | 0,8 | mrad | Member No. 145, x: 0.472 m |
| Maximum rotation about Y-axis | 1,2 | mrad | Member No. 170, x: 0.440 m |
| Maximum rotation about Z-axis | -0,6 | mrad | Member No. 137, x: 0.000 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **LC112 - Out-service wind direction 0° tower + profiles** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 8,88 | kN | |
| Sum of support forces in Y | 8,88 | kN | Deviation: 0.00 % |
| Sum of loads in Z | 0,00 | kN | |
| Sum of support forces in Z | 0,00 | kN | |
| Resultant of reactions about X | 17,527 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| Resultant of reactions about Z | 0,060 | kNm | At center of gravity of model |
| Maximum displacement in X-direction | -0,1 | mm | Member No. 73, x: 1.613 m |
| Maximum displacement in Y-direction | 19,5 | mm | Member No. 200, x: 3.485 m |
| Maximum displacement in Z-direction | -0,2 | mm | Member No. 203, x: 0.000 m |
| Maximum vectorial displacement | 19,5 | mm | Member No. 200, x: 3.485 m |
| Maximum rotation about X-axis | -8,8 | mrad | Member No. 16, x: 0.000 m |
| Maximum rotation about Y-axis | -0,2 | mrad | Member No. 126, x: 0.000 m |
| Maximum rotation about Z-axis | -0,5 | mrad | Member No. 109, x: 0.410 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **LC113 - Out-service wind direction 0° roof structure compression** | | | |
| 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 | -28,88 | kN | |
| Sum of support forces in Z | -28,88 | kN | Deviation: 0.00 % |
| Resultant of reactions about X | 30,420 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |

| | | | | |
|---|---|---|---|---|
| | Resultant of reactions about Y | 0,195 | 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 | -5,7 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -6,1 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -89,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 89,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 15,8 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -19,4 | mrad | Member No. 32, x: 0.375 m |
| | Maximum rotation about Z-axis | -1,4 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC114 - Out-service wind dir. 0° roof structure membrane tension compression** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -1,93 | kN | |
| | Sum of support forces in Z | -1,93 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 3,633 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,013 | 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 | 0,4 | mm | Member No. 138, x: 0.000 m |
| | Maximum displacement in Y-direction | -0,3 | mm | Member No. 7, x: 4.177 m |
| | Maximum displacement in Z-direction | -2,4 | mm | Member No. 197, x: 0.000 m |
| | Maximum vectorial displacement | 2,4 | mm | Member No. 197, x: 0.000 m |
| | Maximum rotation about X-axis | 0,7 | mrad | Member No. 65, x: 0.124 m |
| | Maximum rotation about Y-axis | 0,9 | mrad | Member No. 86, x: 0.959 m |
| | Maximum rotation about Z-axis | -0,3 | mrad | Member No. 126, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC120 - Out-service wind direction 90° roof structure** | | | |
| | Sum of loads in X | 10,11 | kN | |
| | Sum of support forces in X | 10,11 | 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 | 43,32 | kN | |
| | Sum of support forces in Z | 43,32 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -45,630 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 20,126 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 2,831 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 21,4 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Y-direction | 9,3 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | 133,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 135,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -23,2 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 29,2 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,3 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC121 - Out-service wind direction 90° roof structure membrane tension** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -1,57 | kN | |
| | Sum of support forces in Z | -1,57 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 2,950 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -7,144 | 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 | -0,6 | mm | Member No. 138, x: 0.000 m |
| | Maximum displacement in Y-direction | -0,5 | mm | Member No. 7, x: 4.177 m |
| | Maximum displacement in Z-direction | -2,2 | mm | Member No. 119, x: 1.424 m |
| | Maximum vectorial displacement | 2,2 | mm | Member No. 119, x: 1.424 m |
| | Maximum rotation about X-axis | 1,1 | mrad | Member No. 65, x: 0.124 m |
| | Maximum rotation about Y-axis | 1,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,5 | mrad | Member No. 137, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC122 - Out-service wind direction 90° tower + profiles** | | | |
| | Sum of loads in X | 8,22 | kN | |
| | Sum of support forces in X | 8,22 | kN | Deviation: 0.00 % |

| | | | | |
|---|---|---|---|---|
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 0,000 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -16,233 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -11,746 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 20,0 | mm | Member No. 205, x: 3.487 m |
| | Maximum displacement in Y-direction | 0,7 | mm | Member No. 179, x: 14.619 m |
| | Maximum displacement in Z-direction | -0,3 | mm | Member No. 202, x: 0.000 m |
| | Maximum vectorial displacement | 20,0 | mm | Member No. 205, x: 3.487 m |
| | Maximum rotation about X-axis | -0,1 | mrad | Member No. 200, x: 6.971 m |
| | Maximum rotation about Y-axis | 8,9 | mrad | Member No. 205, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,6 | mrad | Member No. 206, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC130 - Out-service wind direction 180° roof structure** | | | |
| | 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 | 53,99 | kN | |
| | Sum of support forces in Z | 53,99 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -65,377 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | -0,364 | 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 | 10,7 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Y-direction | 11,5 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | 177,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 177,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -28,9 | mrad | Member No. 28, x: 0.124 m |
| | Maximum rotation about Y-axis | 38,5 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,0 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC131 - Out-service wind direction 180° roof structure membrane tension** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -1,93 | kN | |
| | Sum of support forces in Z | -1,93 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 3,633 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,008 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,008 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,7 | mm | Member No. 89, x: 0.867 m |
| | Maximum displacement in Y-direction | -0,3 | mm | Member No. 11, x: 4.177 m |
| | Maximum displacement in Z-direction | -2,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 2,7 | mm | Member No. 33, x: 0.000 m |
| | Maximum rotation about X-axis | 0,8 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 1,2 | mrad | Member No. 170, x: 0.440 m |
| | Maximum rotation about Z-axis | -0,6 | mrad | Member No. 137, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC132 - Out-service wind direction 180° tower + profiles** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -8,84 | kN | |
| | Sum of support forces in Y | -8,84 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | -17,444 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,060 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,1 | mm | Member No. 93, x: 1.613 m |
| | Maximum displacement in Y-direction | -19,3 | mm | Member No. 202, x: 3.486 m |
| | Maximum displacement in Z-direction | -0,3 | mm | Member No. 134, x: 0.000 m |
| | Maximum vectorial displacement | 19,3 | mm | Member No. 202, x: 3.486 m |
| | Maximum rotation about X-axis | 8,7 | mrad | Member No. 202, x: 0.000 m |
| | Maximum rotation about Y-axis | 0,2 | mrad | Member No. 126, x: 0.000 m |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Z-axis | 0,4 | mrad | Member No. 109, x: 0.410 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC133 - Out-service wind direction 180° roof structure compression** | | | |
| | 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 | -28,88 | kN | |
| | Sum of support forces in Z | -28,88 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 30,420 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,195 | 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 | -5,7 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -6,1 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | -89,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 89,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 15,8 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -19,4 | mrad | Member No. 32, x: 0.375 m |
| | Maximum rotation about Z-axis | -1,4 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC134 - Out-service wind dir. 180° roof structure membrane tension compression** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -1,93 | kN | |
| | Sum of support forces in Z | -1,93 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 3,633 | kNm | At center of gravity of model (X: 6.403, Y: 3.810, Z: 5.456 m) |
| | Resultant of reactions about Y | 0,013 | 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 | 0,4 | mm | Member No. 127, x: 0.000 m |
| | Maximum displacement in Y-direction | -0,3 | mm | Member No. 7, x: 4.177 m |
| | Maximum displacement in Z-direction | -2,6 | mm | Member No. 197, x: 0.000 m |
| | Maximum vectorial displacement | 2,6 | mm | Member No. 197, x: 0.000 m |
| | Maximum rotation about X-axis | 0,7 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 0,9 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,3 | mrad | Member No. 137, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |

## 3.5.2 Calculation results Load Combination CO200-CO229

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **CO200 - 1.15*LC1 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 11,98 | kN | |
| | Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 51,90 | kN | |
| | Sum of support forces in Z | 51,90 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 12,9 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 26,1 | mm | Member No. 200, x: 3.485 m |
| | Maximum displacement in Z-direction | 210,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 211,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -34,1 | mrad | Member No. 28, x: 0.124 m |
| | Maximum rotation about Y-axis | 47,2 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,2 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO201 - 1.15*LC1 + 1.35*LC2 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 11,98 | kN | |
| | Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 9,78 | kN | |

| | | | |
|---|---|---|---|
| Sum of support forces in Z | 9,78 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 6,9 | mm | Member No. 15, x: 0.000 m |
| Maximum displacement in Y-direction | 26,2 | mm | Member No. 17, x: 3.485 m |
| Maximum displacement in Z-direction | 143,6 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 144,2 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | -22,6 | mrad | Member No. 132, x: 0.196 m |
| Maximum rotation about Y-axis | 32,0 | mrad | Member No. 32, x: 0.000 m |
| Maximum rotation about Z-axis | 3,2 | mrad | Member No. 32, x: 0.000 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| **CO202 - 1.15*LC1 + 1.35*LC3 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 11,98 | kN | |
| Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| Sum of loads in Z | 19,50 | kN | |
| Sum of support forces in Z | 19,50 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 5,6 | mm | Member No. 15, x: 0.000 m |
| Maximum displacement in Y-direction | 26,1 | mm | Member No. 17, x: 3.485 m |
| Maximum displacement in Z-direction | 168,6 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 169,3 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | -26,4 | mrad | Member No. 132, x: 0.196 m |
| Maximum rotation about Y-axis | 37,8 | mrad | Member No. 32, x: 0.000 m |
| Maximum rotation about Z-axis | 4,2 | mrad | Member No. 32, x: 0.000 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| **CO203 - 1.15*LC1 + 1.35*LC4 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 11,98 | kN | |
| Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| Sum of loads in Z | 6,00 | kN | |
| Sum of support forces in Z | 6,00 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 5,4 | mm | Member No. 15, x: 0.000 m |
| Maximum displacement in Y-direction | 26,1 | mm | Member No. 17, x: 3.485 m |
| Maximum displacement in Z-direction | 158,8 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 159,9 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | -27,9 | mrad | Member No. 132, x: 0.196 m |
| Maximum rotation about Y-axis | 35,6 | mrad | Member No. 32, x: 0.000 m |
| Maximum rotation about Z-axis | 4,8 | mrad | Member No. 32, x: 0.000 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| **CO204 - 1.15*LC1 + 1.35*LC6 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 11,98 | kN | |
| Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| Sum of loads in Z | 3,30 | kN | |
| Sum of support forces in Z | 3,30 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 11,9 | mm | Member No. 15, x: 0.000 m |
| Maximum displacement in Y-direction | 26,3 | mm | Member No. 200, x: 3.485 m |
| Maximum displacement in Z-direction | 185,6 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 186,4 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | -25,8 | mrad | Member No. 132, x: 0.196 m |
| Maximum rotation about Y-axis | 40,6 | mrad | Member No. 32, x: 0.000 m |
| Maximum rotation about Z-axis | 3,1 | mrad | Member No. 32, x: 1.125 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| **CO205 - 1.15*LC1 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | 11,98 | kN | |
| Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -59,98 | kN | |
| Sum of support forces in Z | -59,98 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -9,3 | mm | Member No. 15, x: 0.000 m |
| Maximum displacement in Y-direction | 26,2 | mm | Member No. 17, x: 3.485 m |

| | | | | |
|---|---|---|---|---|
| | Maximum displacement in Z-direction | -149,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 149,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 25,7 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -33,8 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -3,0 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO206 - 1.15*LC1 + 1.35*LC2 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 11,98 | kN | |
| | Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -102,10 | kN | |
| | Sum of support forces in Z | -102,10 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -15,3 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 26,3 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | -213,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 214,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 42,0 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -48,5 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -2,9 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO207 - 1.15*LC1 + 1.35*LC3 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 11,98 | kN | |
| | Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -92,38 | kN | |
| | Sum of support forces in Z | -92,38 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -16,7 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 26,2 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | -189,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 190,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 39,3 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -42,9 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -2,3 | mrad | Member No. 45, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO208 - 1.15*LC1 + 1.35*LC4 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 11,98 | kN | |
| | Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -105,88 | kN | |
| | Sum of support forces in Z | -105,88 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -16,8 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 26,3 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | -198,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 199,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 46,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -45,0 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -2,6 | mrad | Member No. 45, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO209 - 1.15*LC1 + 1.35*LC6 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 11,98 | kN | |
| | Sum of support forces in Y | 11,98 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -108,58 | kN | |
| | Sum of support forces in Z | -108,58 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -10,3 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 26,5 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | -173,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 173,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 35,5 | mrad | Member No. 145, x: 0.472 m |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Y-axis | -40,2 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -3,0 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO210 - 1.15*LC1 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 24,75 | kN | |
| | Sum of support forces in X | 24,75 | 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 | 37,99 | kN | |
| | Sum of support forces in Z | 37,99 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 33,7 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | 11,0 | mm | Member No. 168, x: 0.273 m |
| | Maximum displacement in Z-direction | 154,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 158,3 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | -27,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | 35,0 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,1 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO211 - 1.15*LC1 + 1.35*LC2 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 24,75 | kN | |
| | Sum of support forces in X | 24,75 | 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 | -4,13 | kN | |
| | Sum of support forces in Z | -4,13 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 32,0 | mm | Member No. 205, x: 4.184 m |
| | Maximum displacement in Y-direction | -9,9 | mm | Member No. 34, x: 3.000 m |
| | Maximum displacement in Z-direction | 86,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 91,3 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | -15,0 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 19,5 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,1 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO212 - 1.15*LC1 + 1.35*LC3 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 24,75 | kN | |
| | Sum of support forces in X | 24,75 | 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 | 5,59 | kN | |
| | Sum of support forces in Z | 5,59 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 32,0 | mm | Member No. 205, x: 4.184 m |
| | Maximum displacement in Y-direction | -13,1 | mm | Member No. 34, x: 3.000 m |
| | Maximum displacement in Z-direction | 111,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 115,3 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | -18,8 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 25,4 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,1 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO213 - 1.15*LC1 + 1.35*LC4 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 24,75 | kN | |
| | Sum of support forces in X | 24,75 | 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 | -7,91 | kN | |
| | Sum of support forces in Z | -7,91 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 32,1 | mm | Member No. 205, x: 4.184 m |
| | Maximum displacement in Y-direction | -16,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | 101,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 106,2 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | -20,3 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 23,1 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,1 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |

| | | | | |
|---|---|---|---|---|
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO214 - 1.15*LC1 + 1.35*LC6 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 24,75 | kN | |
| | Sum of support forces in X | 24,75 | 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 | -10,61 | kN | |
| | Sum of support forces in Z | -10,61 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 34,4 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -11,3 | mm | Member No. 131, x: 0.000 m |
| | Maximum displacement in Z-direction | 128,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 133,8 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | -18,2 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 28,3 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,1 | mrad | Member No. 102, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO220 - 1.15*LC1 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 51,90 | kN | |
| | Sum of support forces in Z | 51,90 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 12,9 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -25,3 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 210,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 211,7 | mm | Member No. 34, x: 3.000 m |
| | Maximum rotation about X-axis | -34,2 | mrad | Member No. 28, x: 0.124 m |
| | Maximum rotation about Y-axis | 47,3 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 4,2 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO221 - 1.15*LC1 + 1.35*LC2 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 9,78 | kN | |
| | Sum of support forces in Z | 9,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 7,0 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -25,5 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 143,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 145,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -22,6 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 32,2 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 4,2 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO222 - 1.15*LC1 + 1.35*LC3 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 19,50 | kN | |
| | Sum of support forces in Z | 19,50 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 5,5 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -25,4 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 168,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 170,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -26,4 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 38,0 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,2 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO223 - 1.15*LC1 + 1.35*LC4 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |

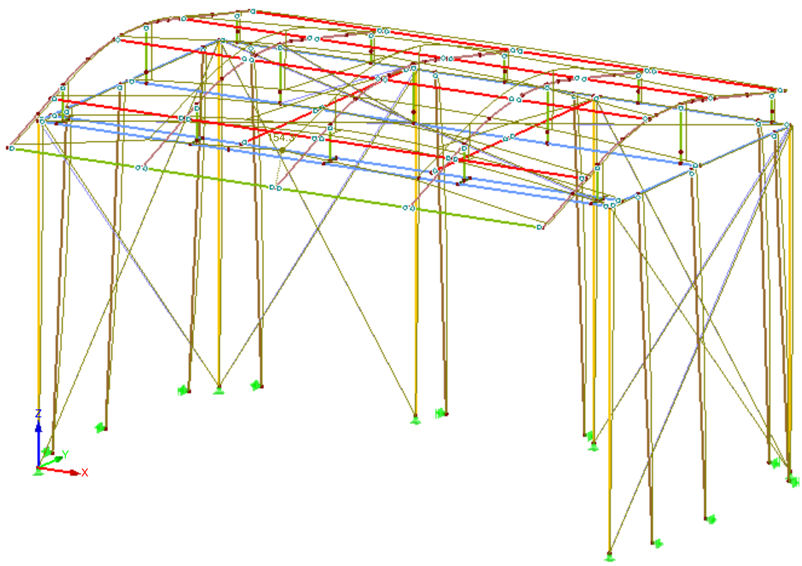
| | | | | |
|---|---|---|---|---|
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 6,00 | kN | |
| | Sum of support forces in Z | 6,00 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 5,5 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -26,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum displacement in Z-direction | 158,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 161,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -27,9 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 35,7 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,8 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO224 - 1.15*LC1 + 1.35*LC6 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 3,30 | kN | |
| | Sum of support forces in Z | 3,30 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 12,0 | mm | Member No. 15, x: 0.000 m |
| | Maximum displacement in Y-direction | -25,5 | mm | Member No. 19, x: 3.486 m |
| | Maximum displacement in Z-direction | 185,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 187,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -25,8 | mrad | Member No. 132, x: 0.196 m |
| | Maximum rotation about Y-axis | 40,8 | mrad | Member No. 32, x: 0.000 m |
| | Maximum rotation about Z-axis | 4,2 | mrad | Member No. 32, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO225 - 1.15*LC1 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -59,98 | kN | |
| | Sum of support forces in Z | -59,98 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -9,1 | mm | Member No. 134, x: 0.000 m |
| | Maximum displacement in Y-direction | -26,4 | mm | Member No. 202, x: 3.486 m |
| | Maximum displacement in Z-direction | -151,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 152,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 26,1 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -34,5 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -2,4 | mrad | Member No. 45, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO226 - 1.15*LC1 + 1.35*LC2 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -102,10 | kN | |
| | Sum of support forces in Z | -102,10 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -15,1 | mm | Member No. 134, x: 0.000 m |
| | Maximum displacement in Y-direction | -26,7 | mm | Member No. 202, x: 3.486 m |
| | Maximum displacement in Z-direction | -218,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 218,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 42,5 | mrad | Member No. 145, x: 0.472 m |
| | Maximum rotation about Y-axis | -49,5 | mrad | Member No. 32, x: 3.000 m |
| | Maximum rotation about Z-axis | -3,5 | mrad | Member No. 45, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO227 - 1.15*LC1 + 1.35*LC3 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -11,93 | kN | |
| | Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |

| | | | |
|---|---|---|---|
| Sum of loads in Z | -92,38 | kN | |
| Sum of support forces in Z | -92,38 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -16,6 | mm | Member No. 134, x: 0.000 m |
| Maximum displacement in Y-direction | -26,5 | mm | Member No. 202, x: 3.486 m |
| Maximum displacement in Z-direction | -193,2 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 194,0 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | 39,8 | mrad | Member No. 145, x: 0.472 m |
| Maximum rotation about Y-axis | -43,7 | mrad | Member No. 32, x: 3.000 m |
| Maximum rotation about Z-axis | -3,4 | mrad | Member No. 45, x: 0.000 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| **CO228 - 1.15*LC1 + 1.35*LC4 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -11,93 | kN | |
| Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -105,88 | kN | |
| Sum of support forces in Z | -105,88 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -16,6 | mm | Member No. 134, x: 0.000 m |
| Maximum displacement in Y-direction | -26,6 | mm | Member No. 202, x: 3.486 m |
| Maximum displacement in Z-direction | -202,8 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 203,6 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | 46,7 | mrad | Member No. 145, x: 0.472 m |
| Maximum rotation about Y-axis | -45,9 | mrad | Member No. 32, x: 3.000 m |
| Maximum rotation about Z-axis | -3,6 | mrad | Member No. 45, x: 1.500 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| **CO229 - 1.15*LC1 + 1.35*LC6 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| Sum of loads in X | 0,00 | kN | |
| Sum of support forces in X | 0,00 | kN | |
| Sum of loads in Y | -11,93 | kN | |
| Sum of support forces in Y | -11,93 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -108,58 | kN | |
| Sum of support forces in Z | -108,58 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -10,1 | mm | Member No. 134, x: 0.000 m |
| Maximum displacement in Y-direction | -26,7 | mm | Member No. 202, x: 3.486 m |
| Maximum displacement in Z-direction | -176,5 | mm | Member No. 132, x: 0.000 m |
| Maximum vectorial displacement | 176,8 | mm | Member No. 132, x: 0.000 m |
| Maximum rotation about X-axis | 35,9 | mrad | Member No. 145, x: 0.472 m |
| Maximum rotation about Y-axis | -41,0 | mrad | Member No. 32, x: 3.000 m |
| Maximum rotation about Z-axis | -2,8 | mrad | Member No. 45, x: 1.500 m |
| Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

### 3.5.3 Deformation RC6 characteristic calculations Out-service situation

RC 6: SW + Loading + Out service wind - Characteristic Values
Global Deformations u
Result Combinations: Max Values

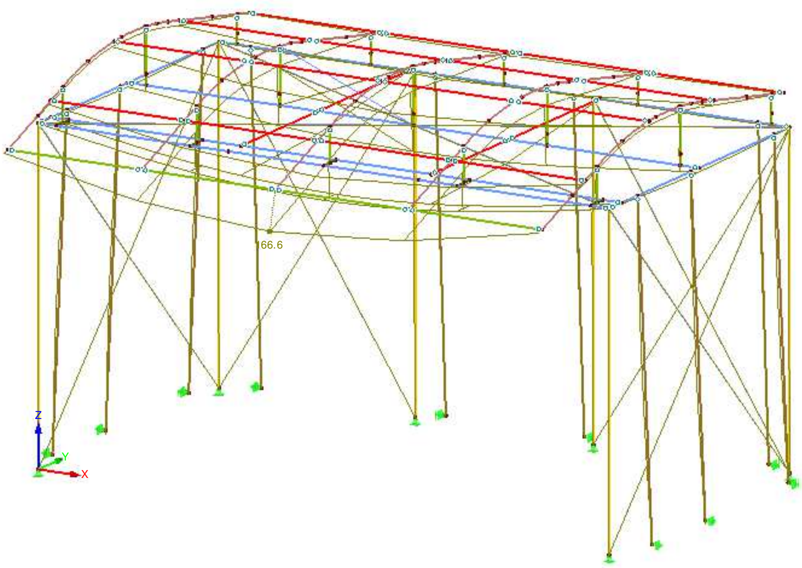
Isometric




Max u: 154.3, Min u: 0.0 mm
Factor of deformations: 5.00

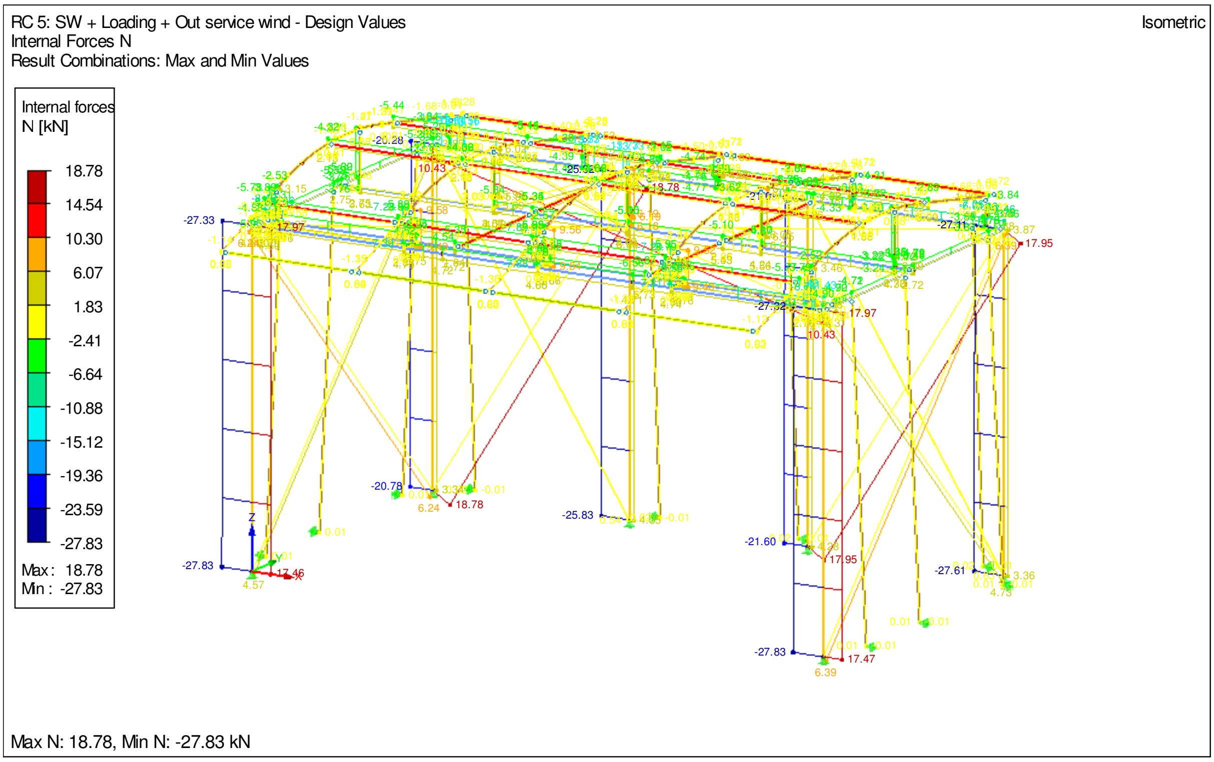
RC 6: SW + Loading + Out service wind - Characteristic Values
Global Deformations u
Result Combinations: Min Values

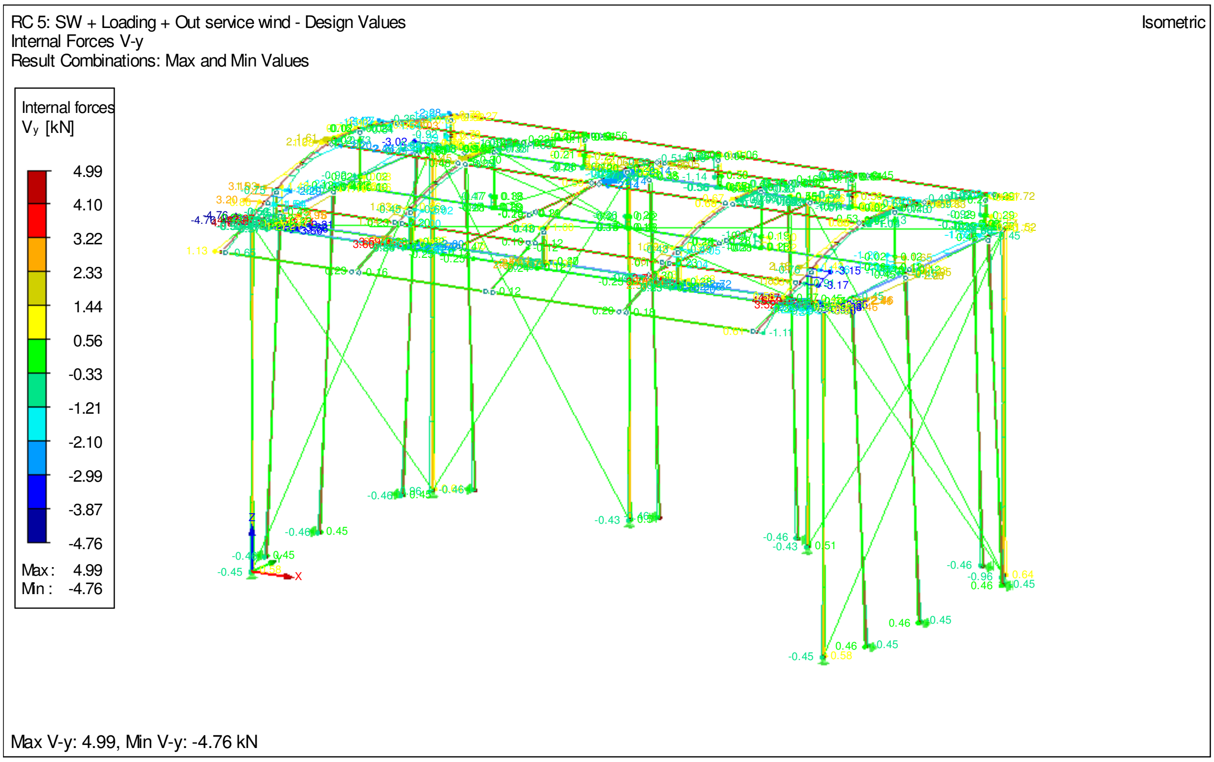
Isometric

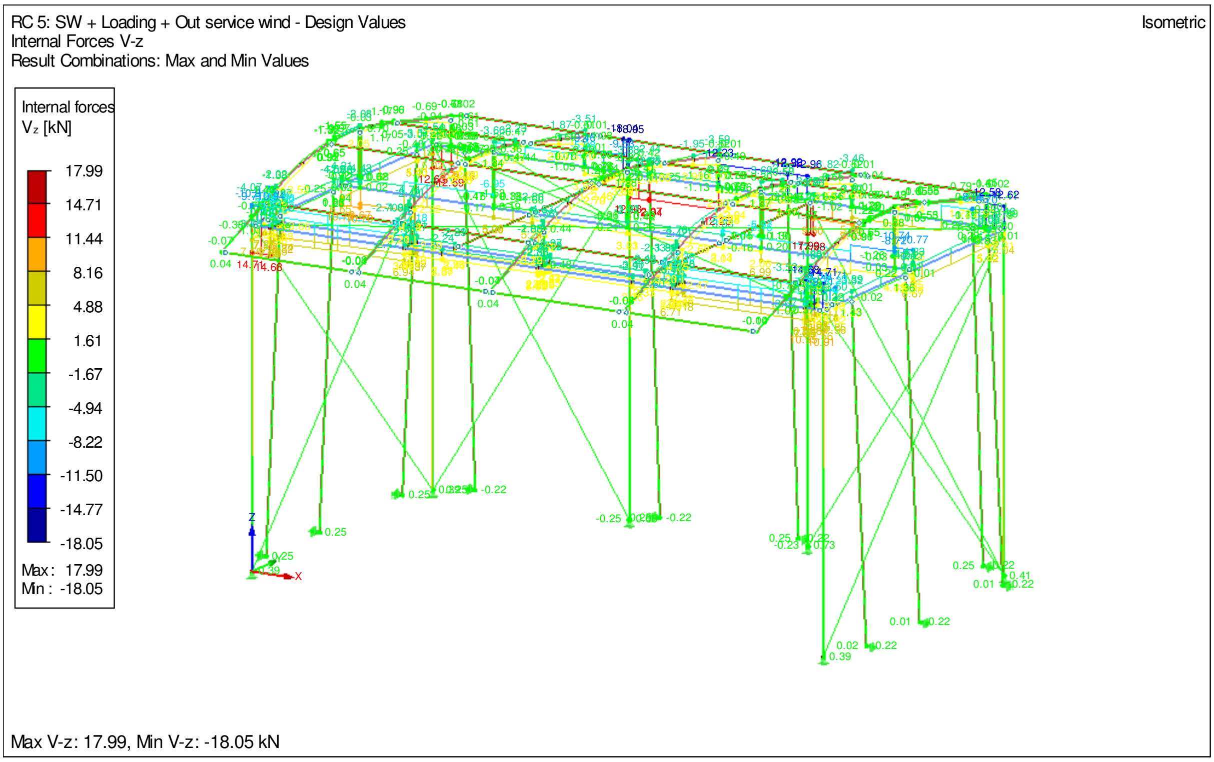


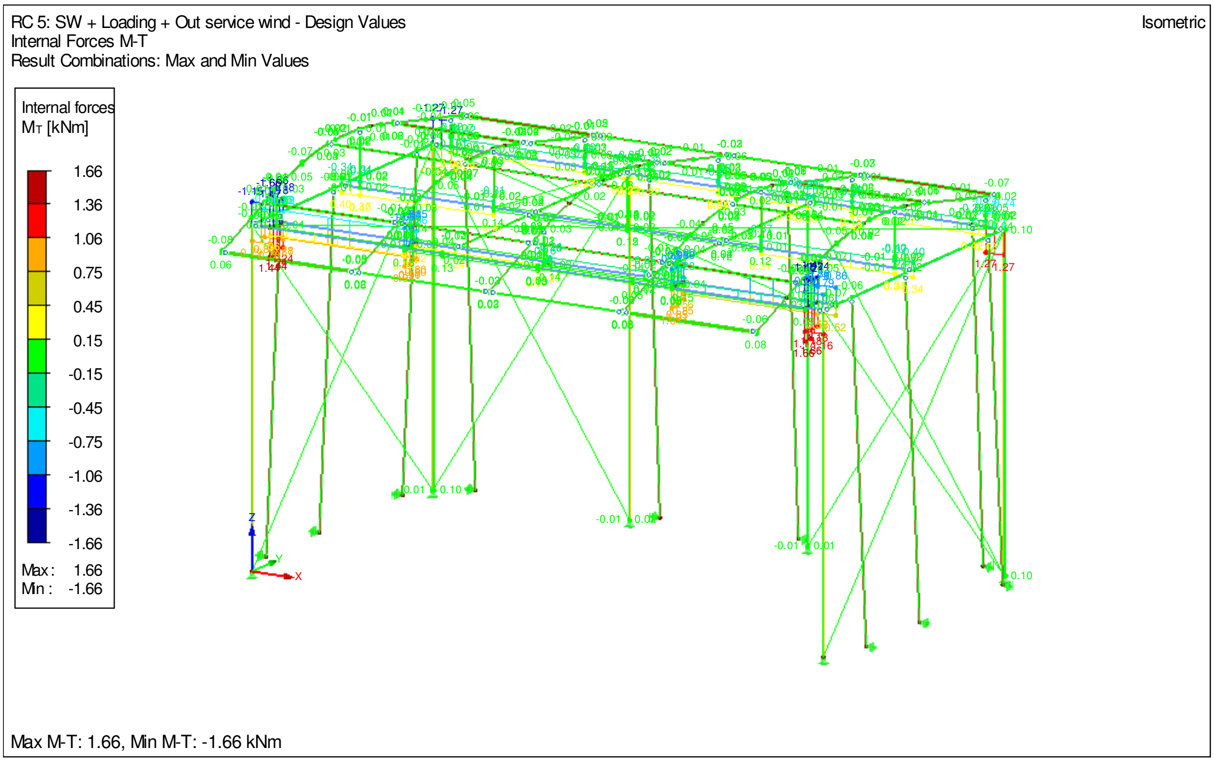

Max u: 166.6, Min u: 0.0 mm
Factor of deformations: 5.00

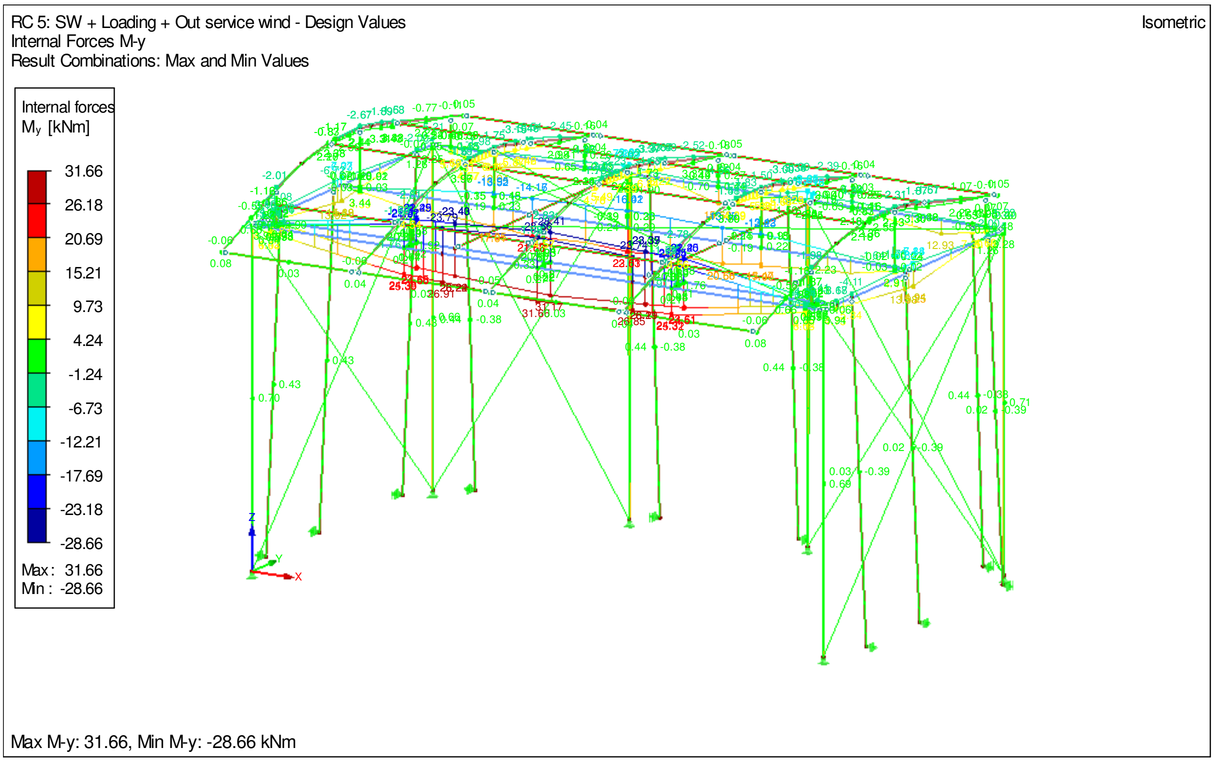
## 3.5.4 Internal force diagram RC5 - SW + Loading setup + Out service Wind - Design Values

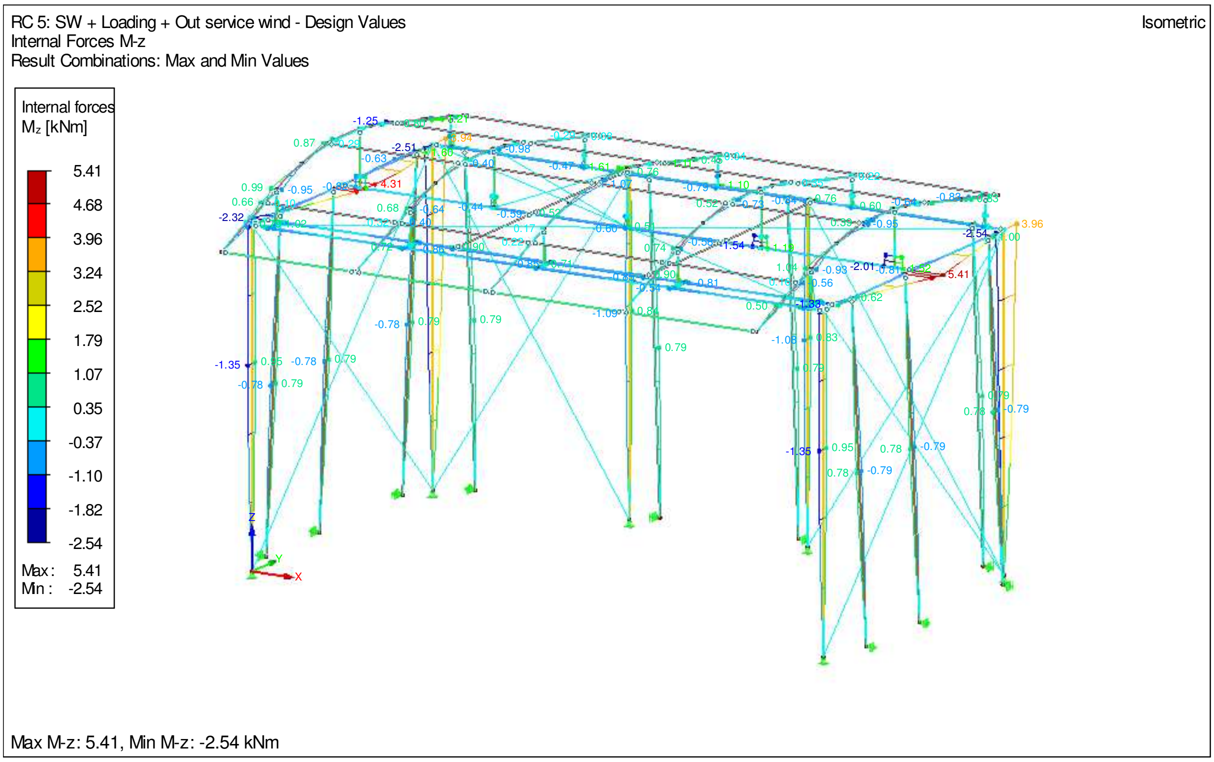



RC 5: SW + Loading + Out service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
17.99
14.71
11.44
8.16
4.88
1.61
-1.67
-4.94
-8.22
-11.50
-14.77
-18.05
Max : 17.99
Min : -18.05
Max V-z: 17.99, Min V-z: -18.05 kN

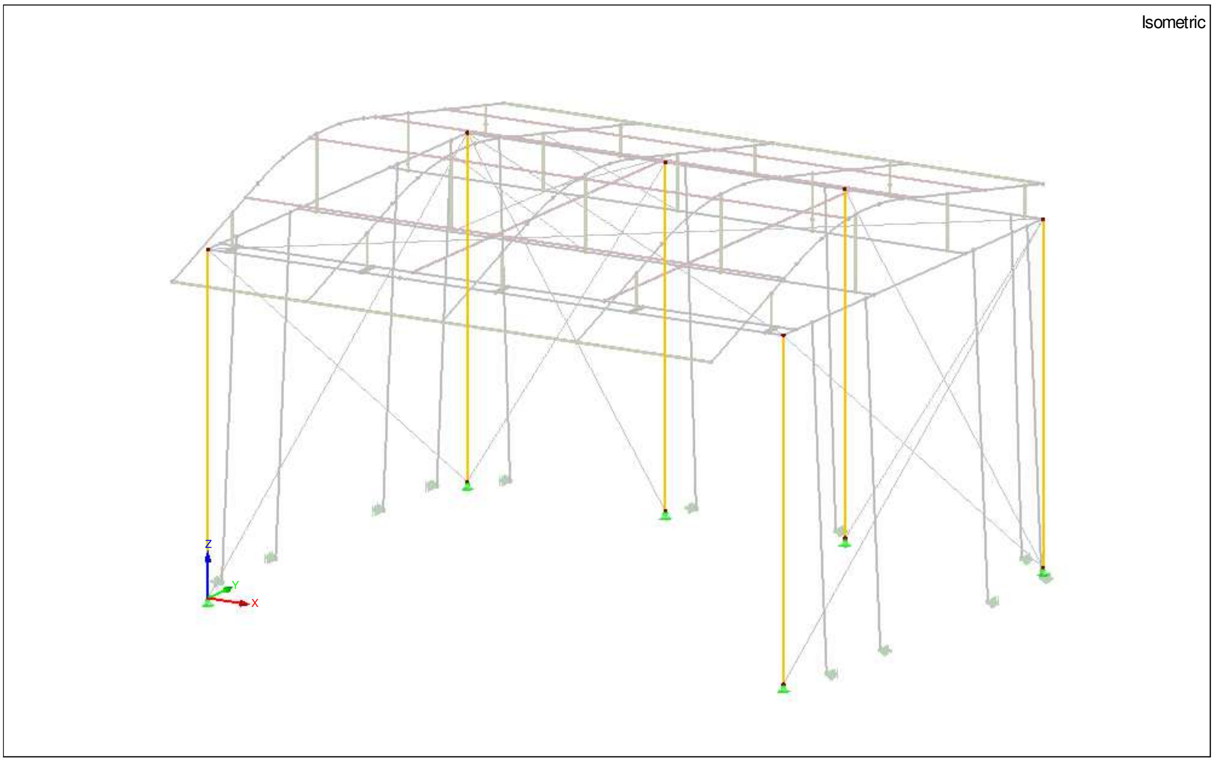

RC 5: SW + Loading + Out service wind - Design Values
Internal Forces M-T
Result Combinations: Max and Min Values
Isometric
Internal forces
MT [kNm]
1.66
1.36
1.06
0.75
0.45
0.15
-0.15
-0.45
-0.75
-1.06
-1.36
-1.66
Max : 1.66
Min : -1.66
Max M-T: 1.66, Min M-T: -1.66 kNm


RC 5: SW + Loading + Out service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
31.66
26.18
20.69
15.21
9.73
4.24
-1.24
-6.73
-12.21
-17.69
-23.18
-28.66
Max : 31.66
Min : -28.66
Max M-y: 31.66, Min M-y: -28.66 kNm

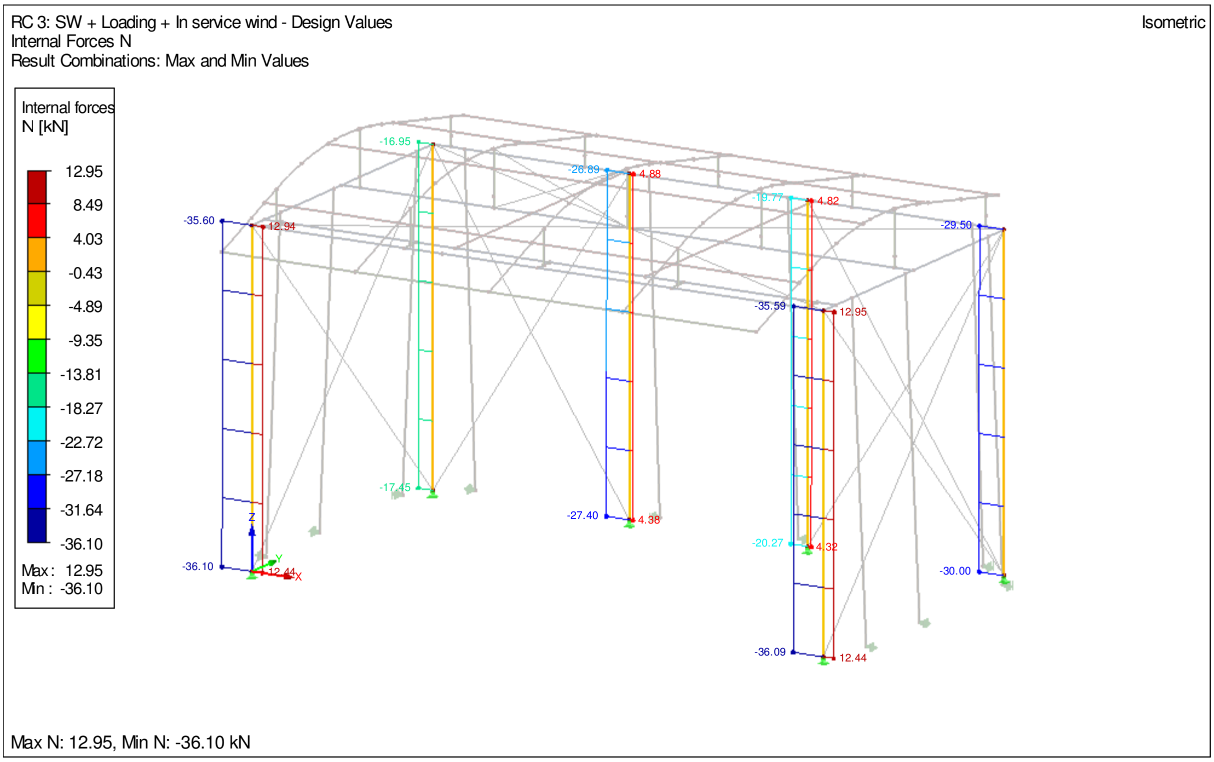

RC 5: SW + Loading + Out service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
5.41
4.68
3.96
3.24
2.52
1.79
1.07
0.35
-0.37
-1.10
-1.82
-2.54
Max : 5.41
Min : -2.54
Max M-z: 5.41, Min M-z: -2.54 kNm

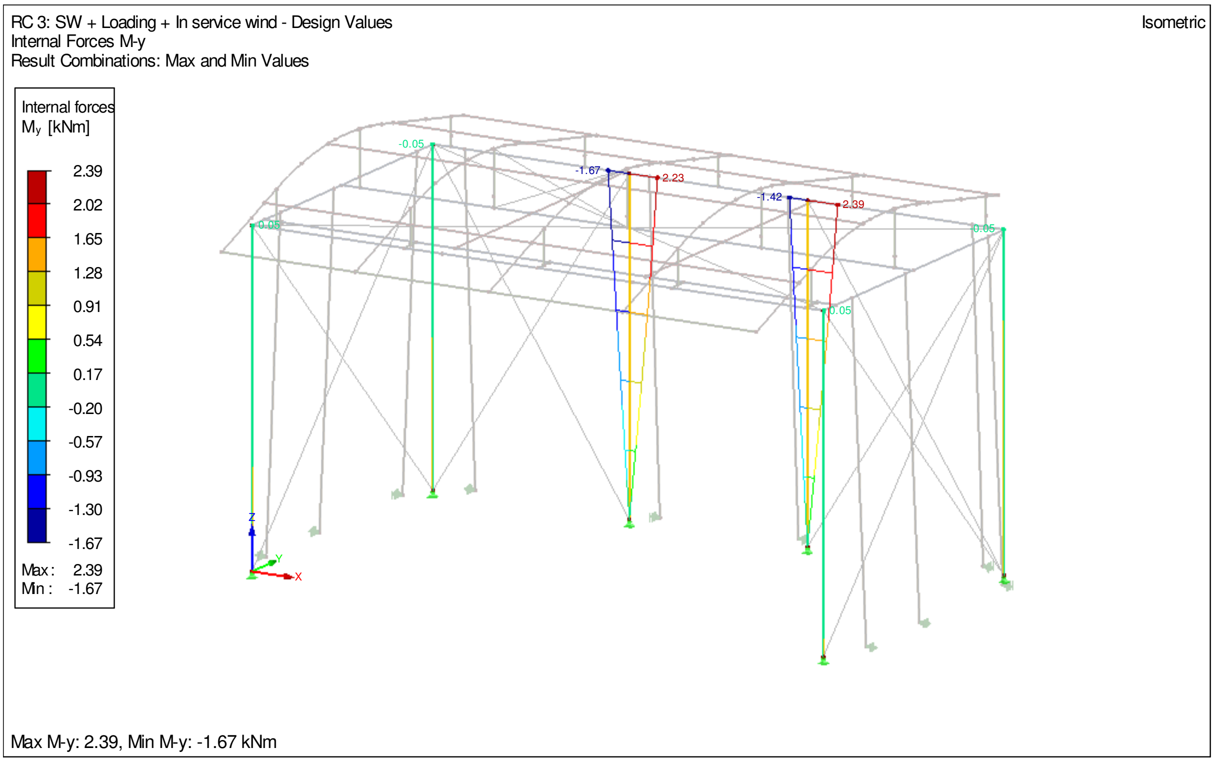
# 4.0 Detail calculations for different parts.

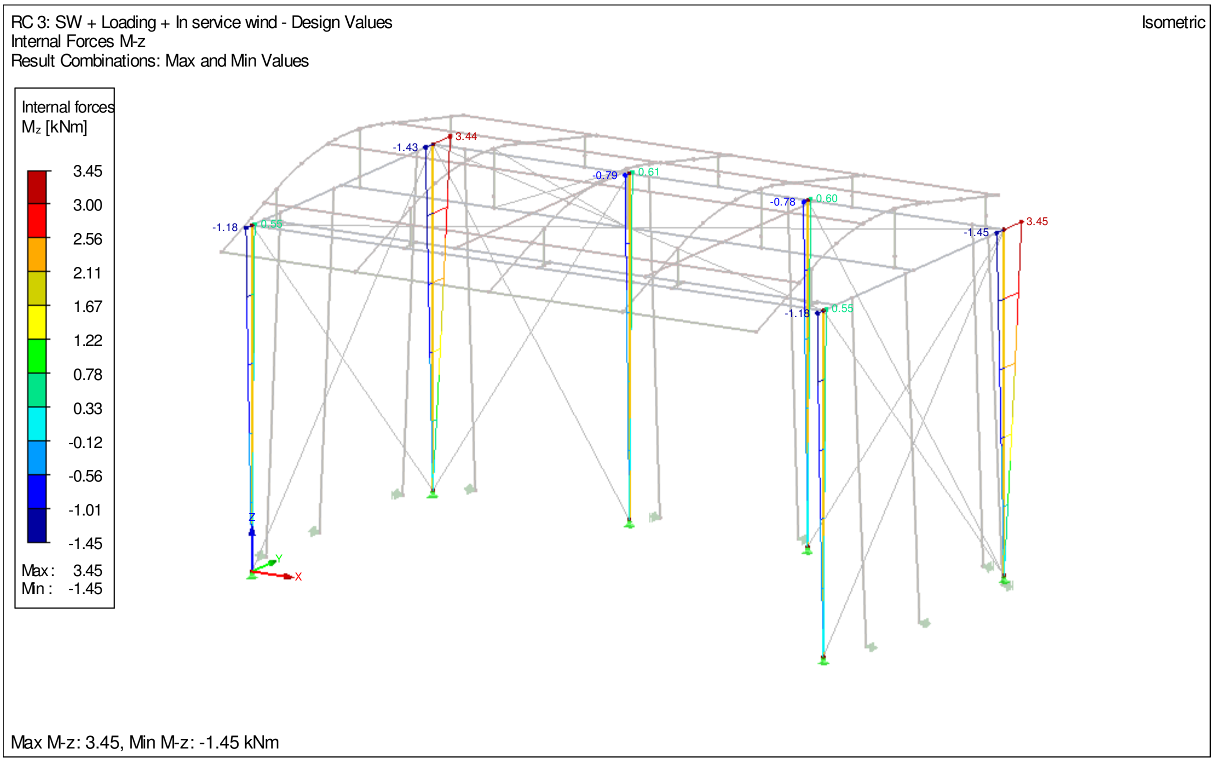
## 4.1 Detail calculation of tower.




The in service situation presents the highest internal forces.




RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
2.39
2.02
1.65
1.28
0.91
0.54
0.17
-0.20
-0.57
-0.93
-1.30
-1.67
Max : 2.39
Min : -1.67
-0.05
-1.67
2.23
-1.42
2.39
0.05
Max M-y: 2.39, Min M-y: -1.67 kNm


RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
3.45
3.00
2.56
2.11
1.67
1.22
0.78
0.33
-0.12
-0.56
-1.01
-1.45
Max : 3.45
Min : -1.45
-1.43
3.44
-0.79
0.61
-0.78
0.60
-1.18
-1.45
3.45
0.55
Max M-z: 3.45, Min M-z: -1.45 kNm

Check of the front Tower

Maximum internal forces in the front tower

$N =$ 36.16 kN

$M_y =$ 0.05 kNm

$M_z =$ 1.18 kNm

$N_{ED,\text{ main chord}} = N / 4 + M_y / 2 / \text{height}_{(\text{centre to centre})} + M_z / 2 / \text{width}_{(\text{centre to centre})}$

$N_{ED,\text{ main chord}} = 36.16 / 4 + 0.05 / 2 / 0.239 + 1.18 / 2 / 0.239 = 11.61 \text{ kN} < 50.22 \text{ kN}$

Buckling calculation:

Buckling Length factor K = 1.5

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

$L_{cr} = 1.5 * 700 = 1050$

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

$\lambda_z = 1050 / (11.12 * \pi) * \sqrt{((16.96 * 25) / (16.96 * 7000))} = 1.796$

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

$\Theta_z = 0.5 * (1 + 0.2 * (1.796 - 0.10) + 1.796^2) = 2.283$

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

$X_z = 1 / (2.283 + \sqrt{(2.283^2 - 1.796^2)}) = 0.271$

$(N / (X_z * N_{RD}))^{0.8} + ((M_y / M_{y,RD})^{1,7} + (M_z / M_{z,RD})^{1,7})^{0.6} < 1$

$(36.16 / (0.271 * 200.88))^{0.8} + ((0.05 / 24)^{1,7} + (1.18 / 24)^{1,7})^{0.6} = 0.77 < 1$

Check of the stack tower

Maximum internal forces in the stack tower

$N =$ 26.69 kN

$M_y =$ 2.23 kNm

$M_z =$ 0.79 kNm

$N_{ED,\ main\ chord} = N / 4 + M_y / 2 / height_{(centre\ to\ centre)} + M_z / 2 / width_{(centre\ to\ centre)}$

$N_{ED,\ main\ chord} = 26.69 / 4 + 2.23 / 2 / 0.239 + 0.79 / 2 / 0.239 = 12.99$ kN < 50.22 kN

Buckling calculation:

Buckling Length factor K = 1.25

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

$L_{cr} = 1.25 * 700 = 875$

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

$\lambda_z = 875 / (11.12 * \pi) * \sqrt{((16.96 * 250) / (16.96 * 7000))} = 1.497$

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

$\Theta_z = 0.5 * (1 + 0.2 * (1.497 - 0.10) + 1.497^2) = 1.760$

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

$X_z = 1 / (1.760 + \sqrt{(1.760^2 - 1.497^2)}) = 0.372$

$(N / (X_z * N_{RD}))^{0.8} + ((M_y / M_{y,RD})^{1,7} + (M_z / M_{z,RD})^{1,7})^{0.6} < 1$

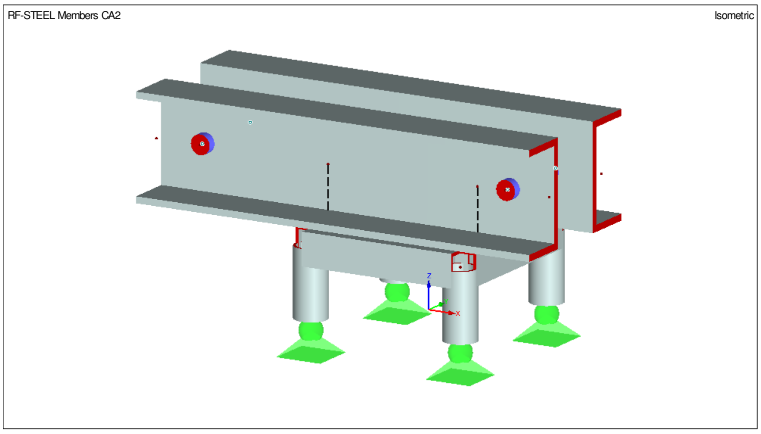
$(26.69 / (0.372 * 200.88))^{0.8} + ((2.23 / 24)^{1,7} + (0.79 / 24)^{1,7})^{0.6} = 0.54 < 1$

## 4.2 Detailed calculation of the tower head section and safety system.

### 4.2.1 Detailed calculation of the tower head section.

### Construction model

The calculation of the tower top section has been done in a separate model.




### Cross section description

| Section No. | Material No. | Cross-Section Description |
|---|---|---|
| 1 | 1 | UM 80/160/10/10 |
| 2 | 3 | HK 50/50/5/5/5/5 |
| 3 | 2 | Circle 30 |
| 4 | 3 | Ring 50/4 |

### Used material

| Material No. | Material Description | Safety Factor $\gamma_M$ [-] | Yield Strength $f_{yk}$ [kN/cm²] | Limit Stresses [kN/cm²] Manually | Limit $\sigma_x$ | Limit $\tau$ | Limit $\sigma_{eqv}$ |
|---|---|---|---|---|---|---|---|
| 1 | Aluminium EN-AW 6060 (ET,EP,ER/B) T6* \| EN 1999-1-1:2007 | 1,10 | 11,50 | - | 10,45 | 6,04 | 10,45 |
| 2 | ETG100+W3000C | 1.10 | 90.00 | - | 81.82 | 47.24 | 81.82 |
| 3 | Aluminium EN-AW 6082 (EP,ET) T6* \| EN 1999-1-1:2007 | 1,10 | 12,50 | - | 11,36 | 6,56 | 11,36 |

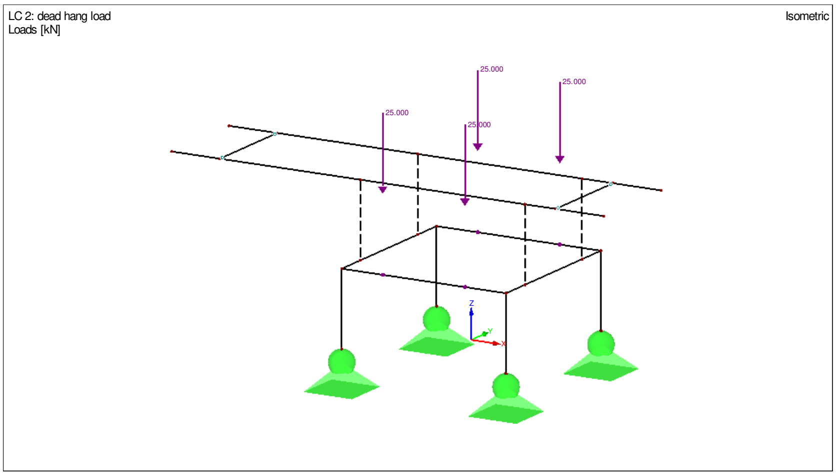
The Yield strength has been manually changed in 12.5 kN/cm². This is according to the Eurocode NEN-EN 1999-1-1 Table 3.2 the $f_{o,haz}$ for the heat affective zone. This check is concerning a welded construction with heat affective zones in the main elements, there for the choice to check the construction according to the lower $f_{o\ haz}$.

## Load cases

| Load Case | Load Case Description | To Solve |
|---|---|---|
| LC1 | Self-Weight Construction | + |
| LC2 | dead hang load | + |
| LC3 | lifting load | + |

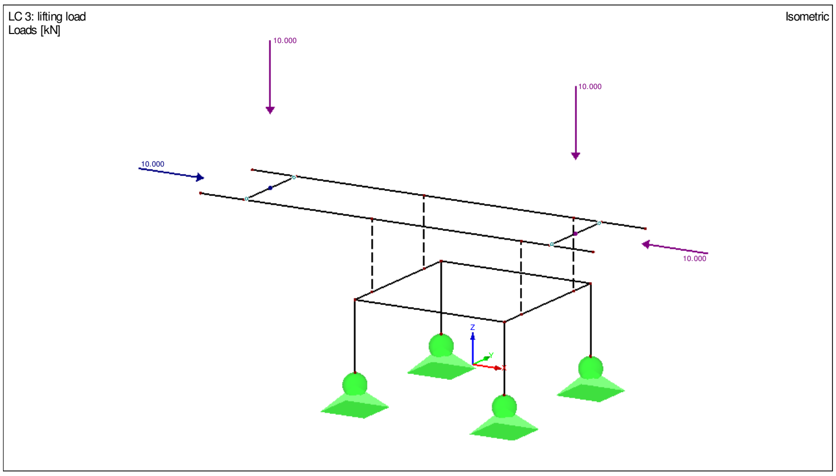
Load case 1 is the self-weight of the Top section which is calculated by the program itself.

Load case 2 dead hang of the system.




The design forces which are taken into account are 50 kN per side of the top section. This is more than the maximum forces in result combination RC3 which is the design calculation including all the load cases multiplied with the different Partial safety factors. Because these are design forces the safety factor in the load combination CO1 is set to 1 instead of 1.5.

Load case 3 lifting of the system

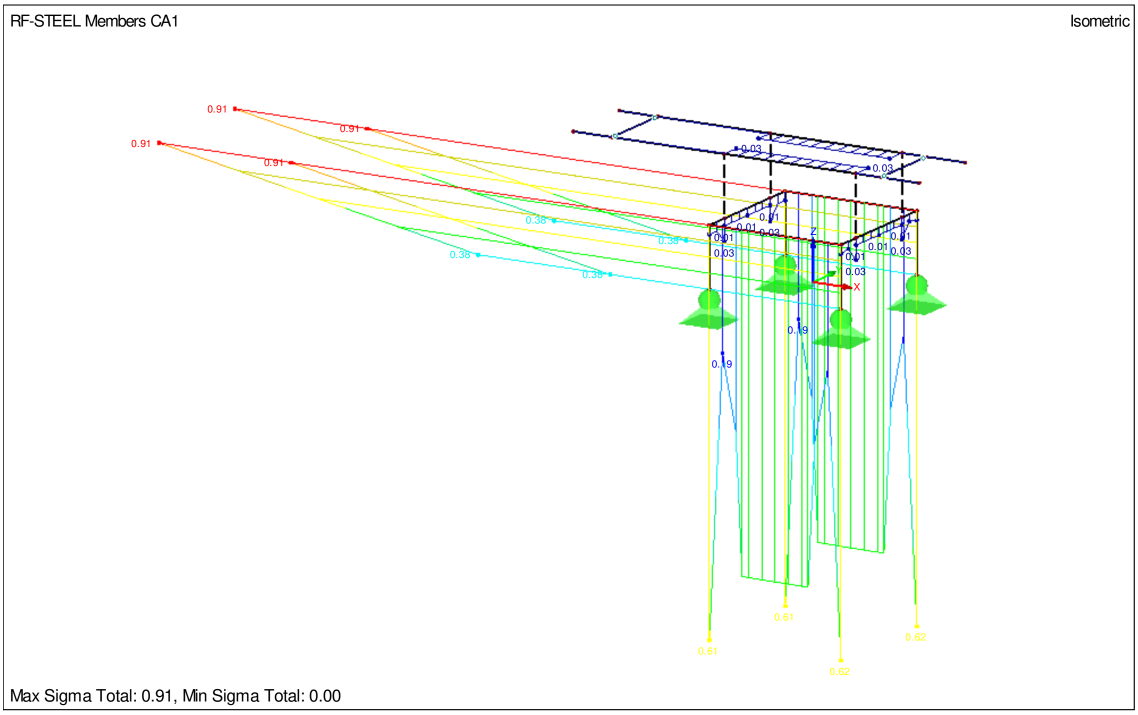


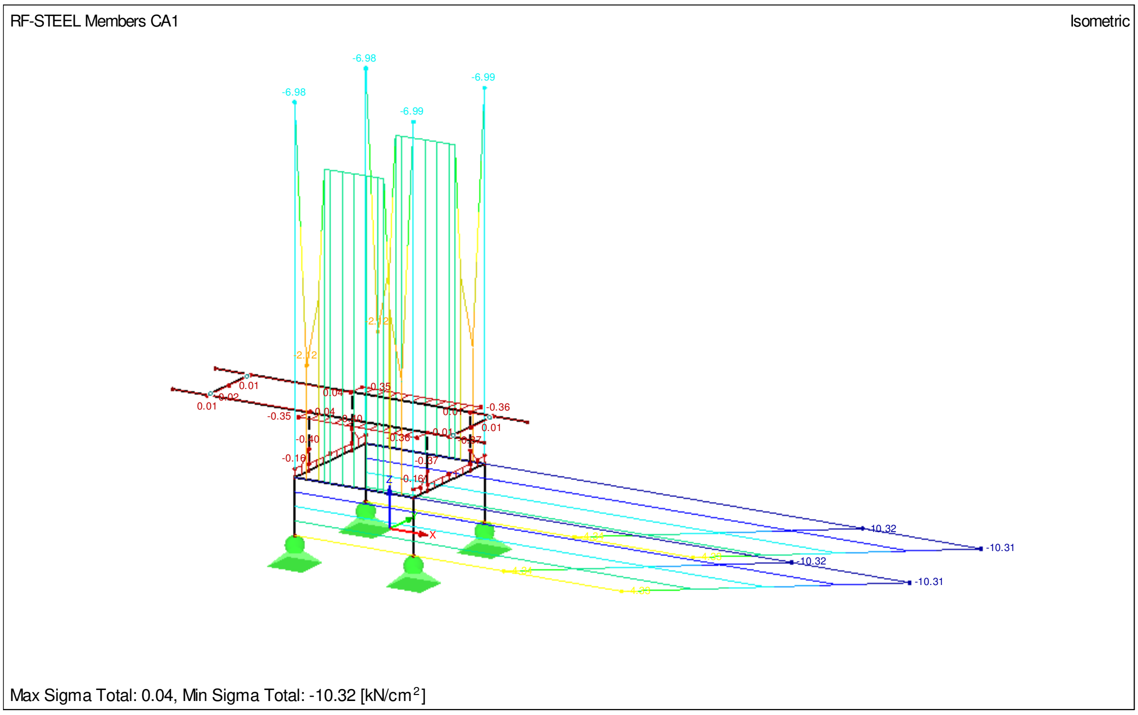

The forces which are taken into account are when using a 1 ton chain hoist.

## Load combinations

| Load Combin. | DS | Load Combination Description | To Solve | LC.1 Factor | LC.1 No. | LC.2 Factor | LC.2 No. |
|---|---|---|---|---|---|---|---|
| CO1 | 0 | 1.35*LC1 + LC2 | + | 1,350 | LC1 | 1,000 | LC2 |
| CO2 | 0 | 1.35*LC1 + 1.5*LC3 | + | 1,350 | LC1 | 1,500 | LC3 |

## Stress calculation for dead hang of the system.



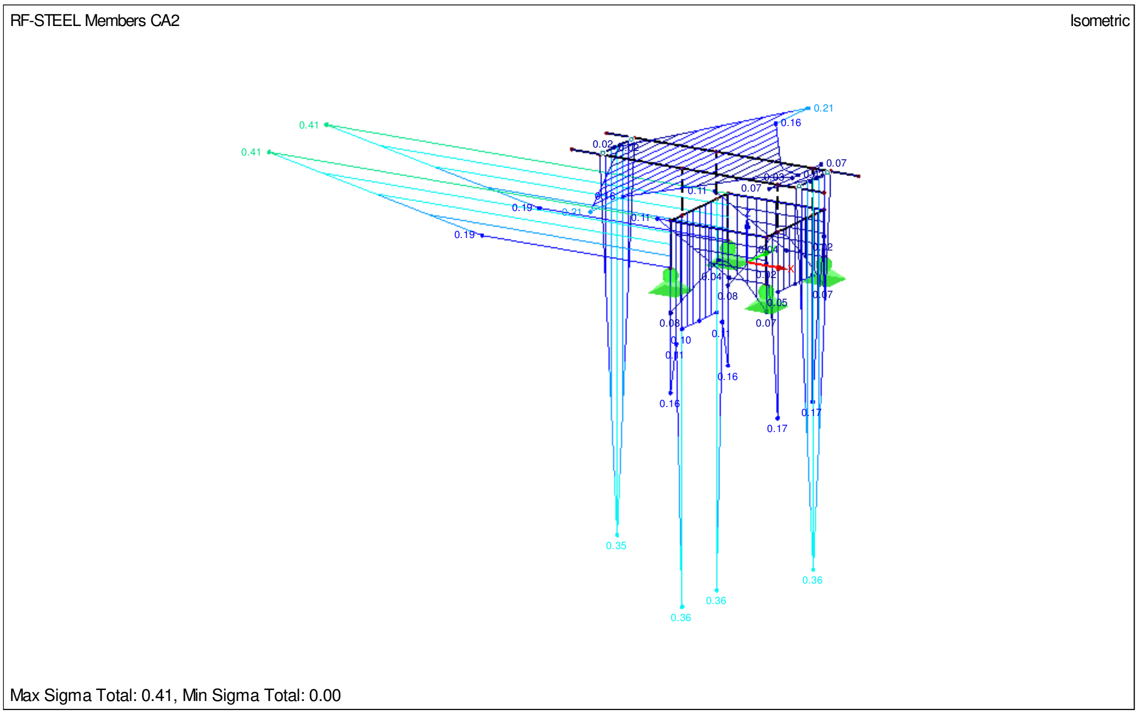



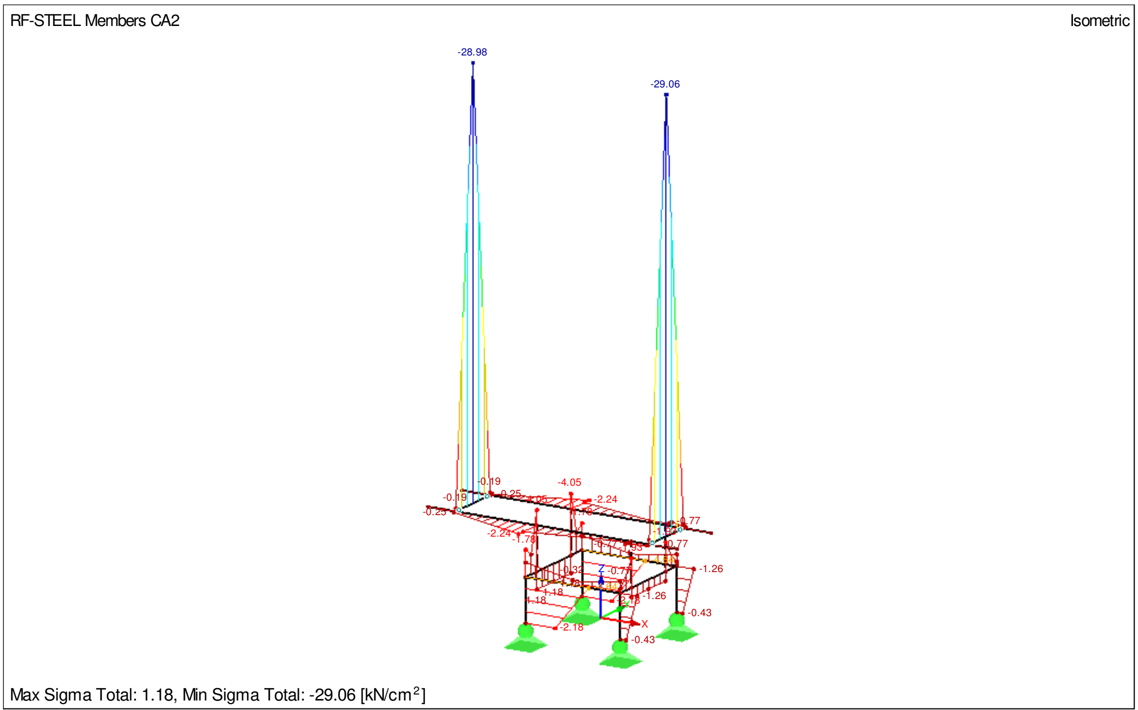
## Maximum Stress analyses per cross section

| Section No. | Member No. | Location x [m] | S-Point No. | Load-ing | Stress Type | Stress [kN/cm²] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 1 | UM 80/160/10/10 | | | | | | | |
| | 27 | 0,239 | 1 | CO1 | Sigma Total | -0,36 | 10,45 | 0,03 |
| | 21 | 0,239 | 12 | CO1 | Tau Total | 0,02 | 6,04 | 0,00 |
| | 21 | 0,239 | 4 | CO1 | Sigma-eqv | 0,36 | 10,45 | 0,03 |
| | | | | | | | | |
| 2 | HK 50/50/5/5/5/5 | | | | | | | |
| | 6 | 0,000 | 14 | CO1 | Sigma Total | -6,99 | 11,36 | 0,62 |
| | 6 | 0,215 | 8 | CO1 | Tau Total | 6,20 | 6,56 | 0,95 |
| | 6 | 0,215 | 16 | CO1 | Sigma-eqv | 10,75 | 11,36 | 0,95 |
| | | | | | | | | |
| 3 | Circle 30 | | | | | | | |
| | 13 | 0,072 | 28 | CO1 | Sigma Total | 0,02 | 81,82 | 0,00 |
| | 38 | 0,000 | 37 | CO1 | Tau Total | 0,00 | 47,24 | 0,00 |
| | 13 | 0,072 | 28 | CO1 | Sigma-eqv | 0,02 | 81,82 | 0,00 |
| | | | | | | | | |
| 4 | Ring 50/4 | | | | | | | |
| | 2 | 0,000 | 28 | CO1 | Sigma Total | -10,32 | 11,36 | 0,91 |
| | 1 | 0,105 | 19 | CO1 | Tau Total | -1,25 | 6,56 | 0,19 |
| | 2 | 0,000 | 28 | CO1 | Sigma-eqv | 10,32 | 11,36 | 0,91 |

The maximum utilisation in the dead hang load case is 91%.

Stress calculation for the lifting of the system.



Maximum Stress analyses per cross section

| Section No. | Member No. | Location x [m] | S-Point No. | Load-ing | Stress Type | Stress [kN/cm²] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 1 | UM 80/160/10/10 | | | | | | | |
| | 20 | 0,205 | 1 | CO2 | Sigma Total | -2,24 | 10,45 | 0,21 |
| | 21 | 0,239 | 12 | CO2 | Tau Total | 0,60 | 6,04 | 0,10 |
| | 20 | 0,205 | 1 | CO2 | Sigma-eqv | 2,24 | 10,45 | 0,21 |
| | | | | | | | | |
| 2 | HK 50/50/5/5/5/5 | | | | | | | |
| | 7 | 0,047 | 2 | CO2 | Sigma Total | -4,05 | 11,36 | 0,36 |
| | 7 | 0,000 | 8 | CO2 | Tau Total | 3,03 | 6,56 | 0,46 |
| | 7 | 0,047 | 2 | CO2 | Sigma-eqv | 5,42 | 11,36 | 0,48 |
| | | | | | | | | |
| 3 | Circle 30 | | | | | | | |
| | 38 | 0,072 | 14 | CO2 | Sigma Total | -29,06 | 81,82 | 0,36 |
| | 38 | 0,000 | 37 | CO2 | Tau Total | 2,00 | 47,24 | 0,04 |
| | 38 | 0,072 | 14 | CO2 | Sigma-eqv | 29,06 | 81,82 | 0,36 |
| | | | | | | | | |
| 4 | Ring 50/4 | | | | | | | |
| | 2 | 0,000 | 18 | CO2 | Sigma Total | -4,64 | 11,36 | 0,41 |
| | 2 | 0,105 | 27 | CO2 | Tau Total | -0,54 | 6,56 | 0,08 |
| | 3 | 0,000 | 2 | CO2 | Sigma-eqv | 4,64 | 11,36 | 0,41 |

The utilisation of the 30mm pin used for the dead hang chain is 41%.

Bearing forces of the holes in the U profile.

Material = EN AW-6060-T6

$f_u$ = 17,0 Kn/cm²

T = 10 mm

D = 30 mm

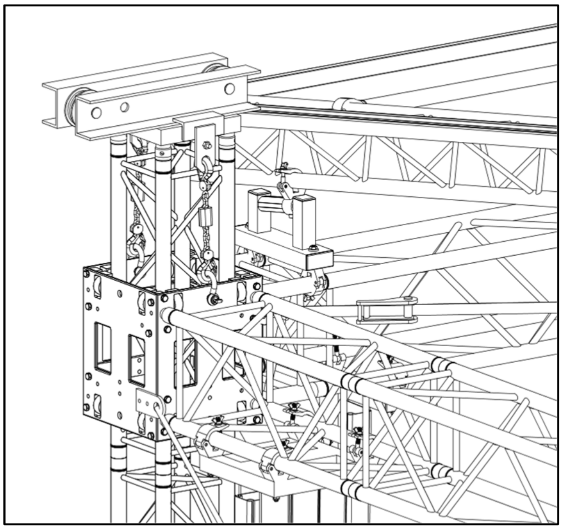
$F_{b,\,Ed} = \sqrt{(7.52^2 + 7.52^2)} = 7.52$ kN

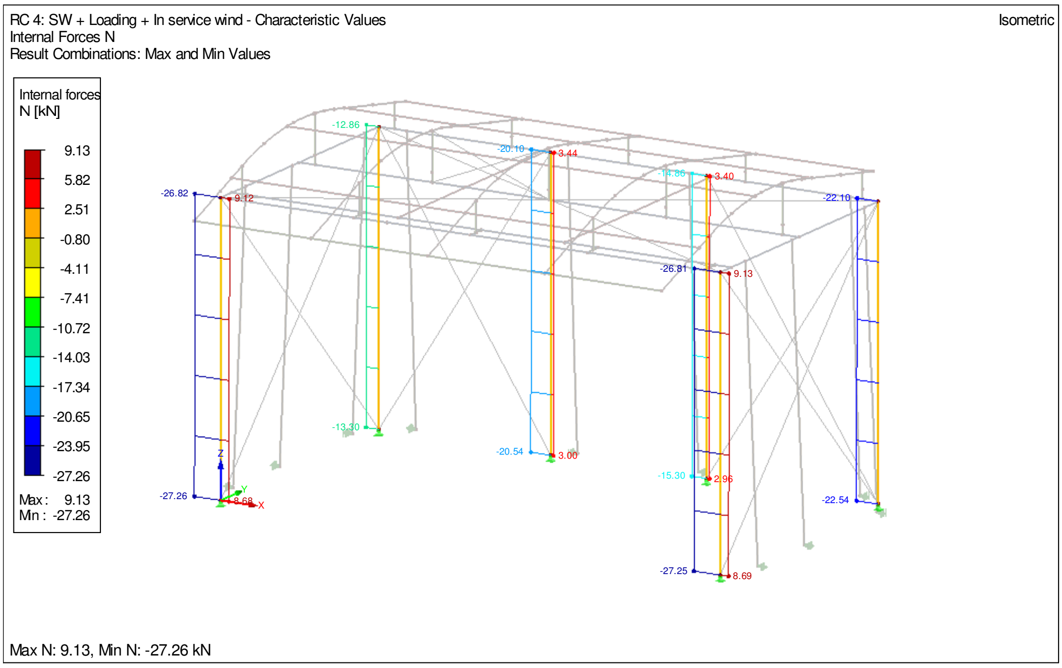
$F_{b,\,Rd} = 1.5 * f_u * D * T / \gamma_{m2} = 1,5 * 17 * 3 * 1 / 1.25 = 61.2$ kN

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

7.52 / 61.2 = 0.12 < 1

### 4.2.2 check of the dead hang chain

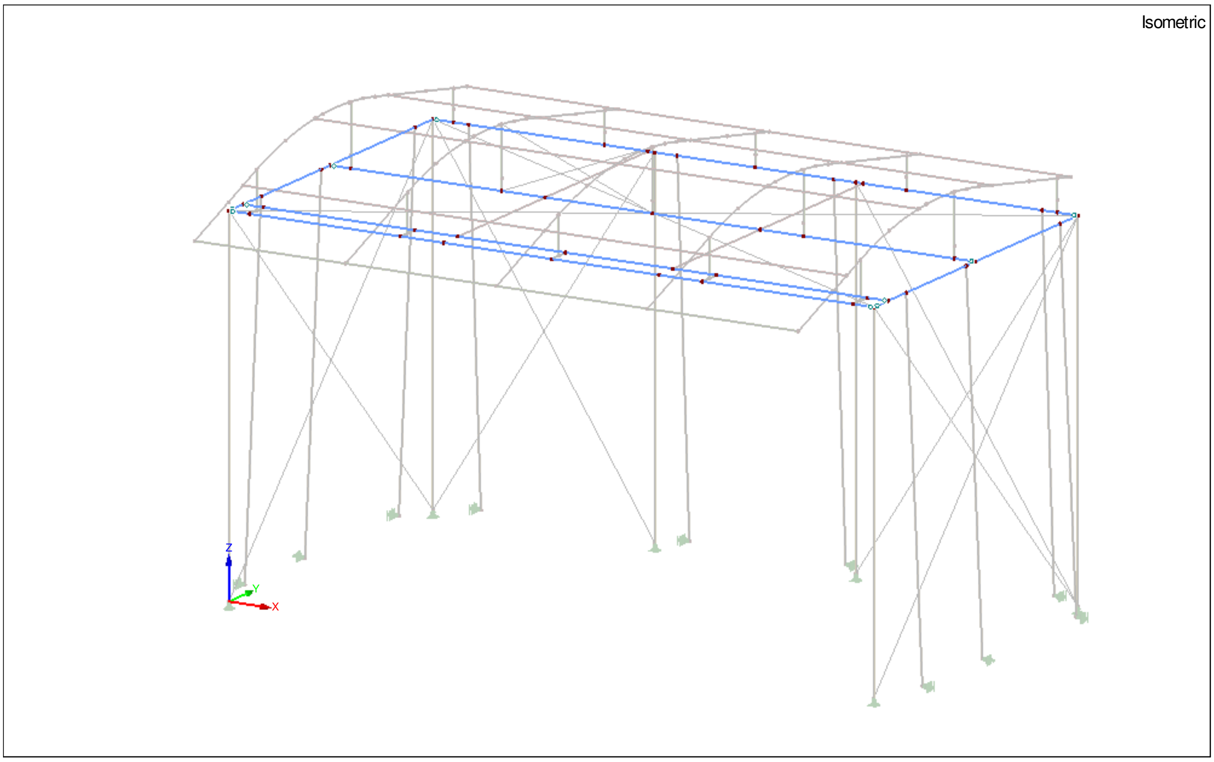




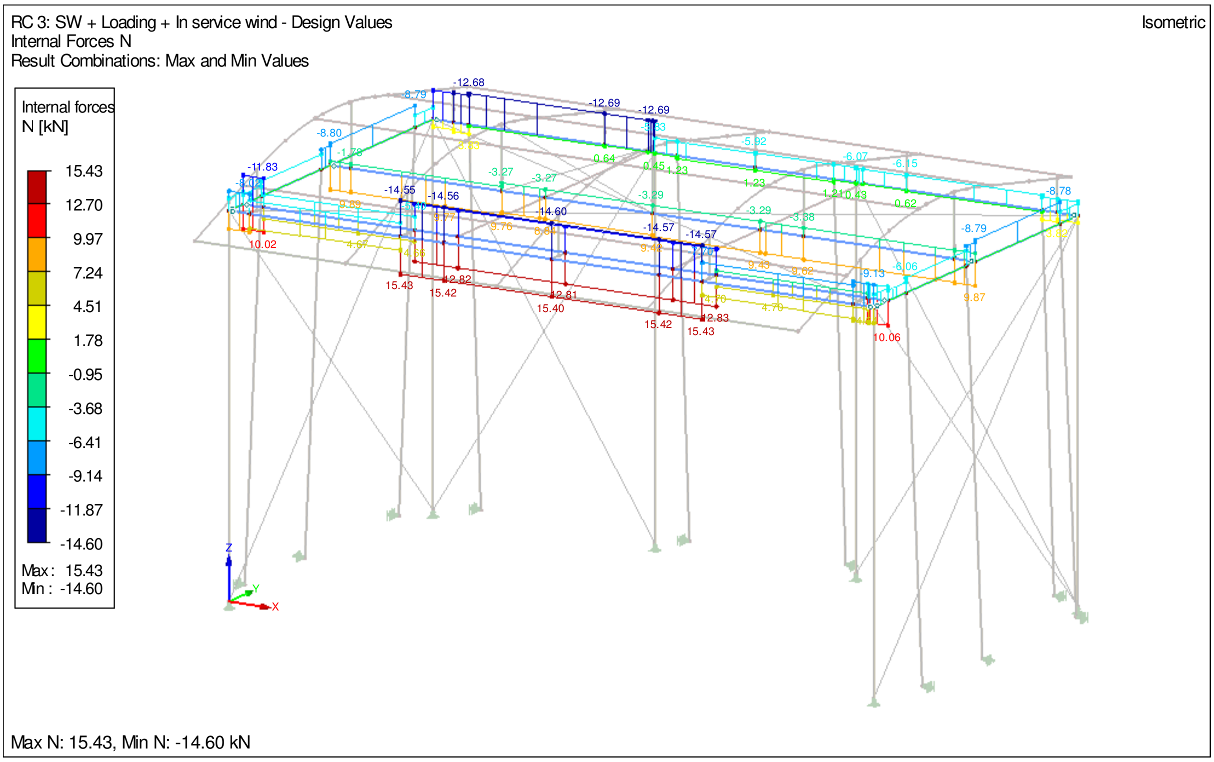

normative load result is RC4 In service characteristic values
Maximum down force at the top of the tower is 26.82 kN
The chains are checked against the characteristic values, because the SWL of the chain has a safety factor of 4 taken into count.

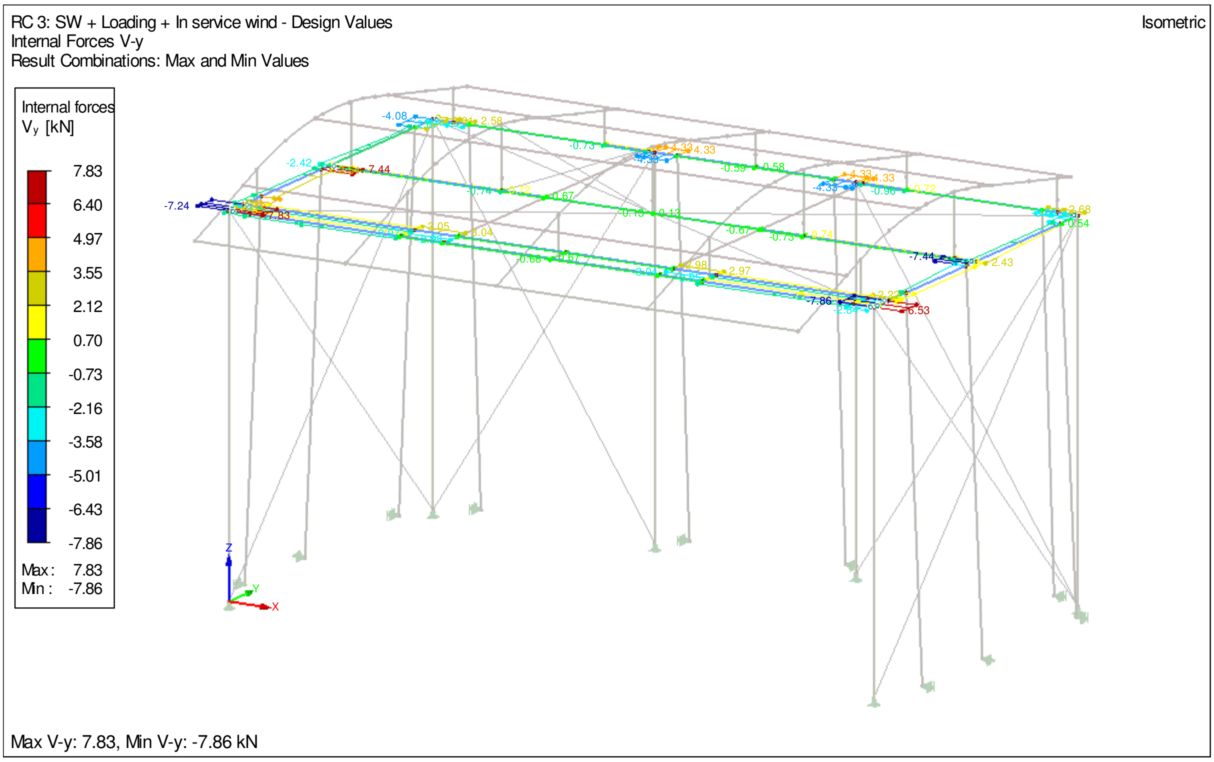
This maximum down force is divided into two chain falls, which means the maximum force in the chain is
$F_{chain} = N_{Ed, max} / 2 = 26.82 / 2 = 13.41$ kN
The used chain has a SWL of 15 kN
Check $F_{chain}$ / SWL < 1
13.41 / 15 = 0.89 < 1

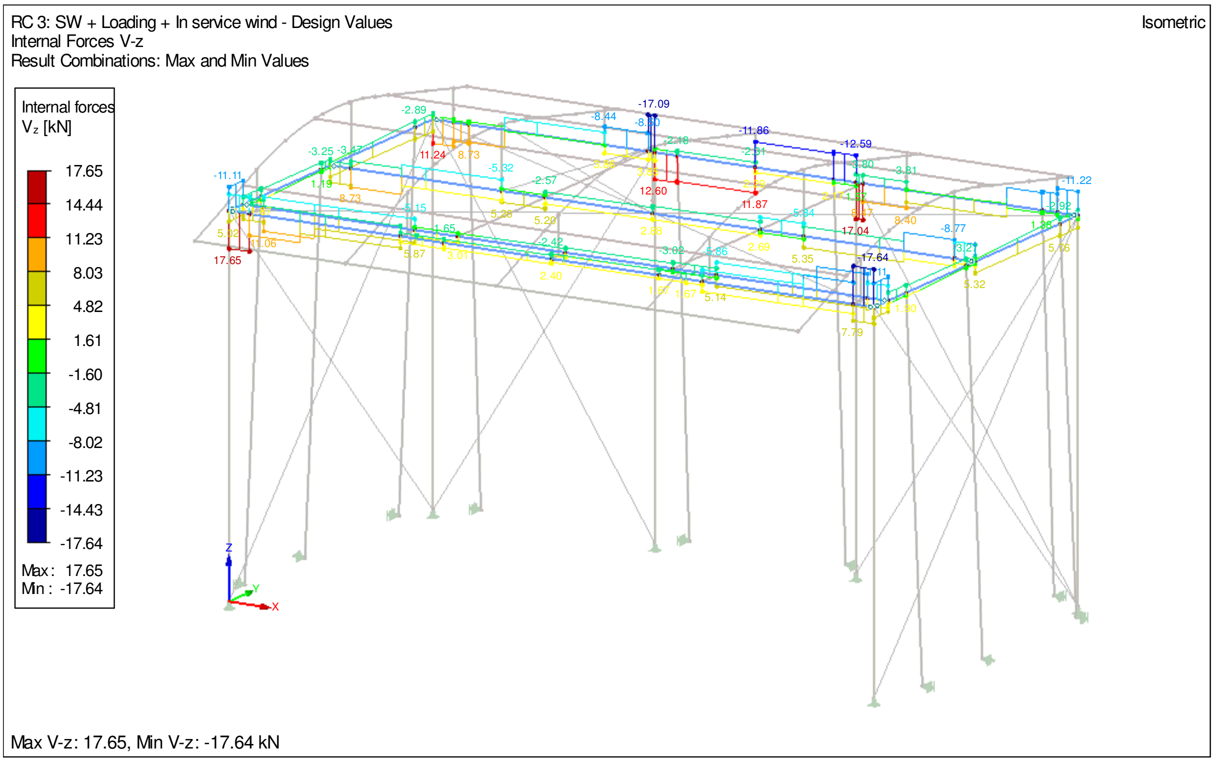
## 4.3 Detailed calculation of the main grid constructed from H40V.

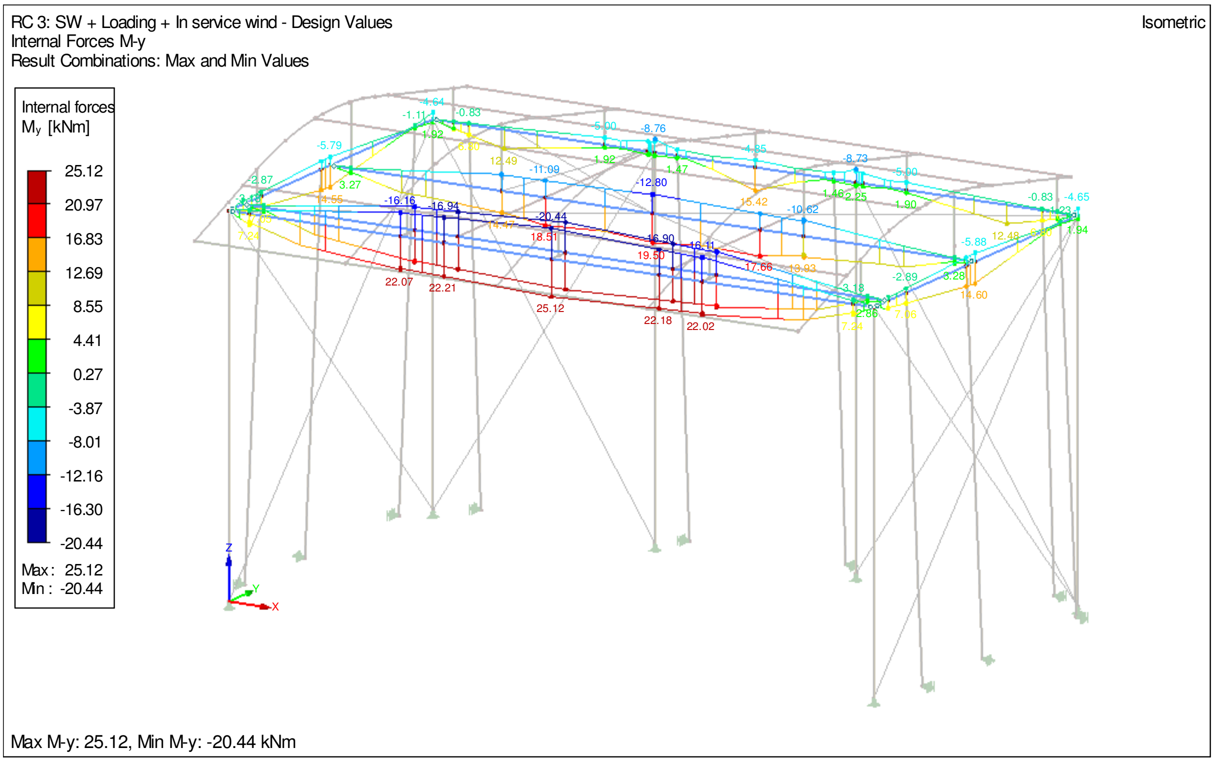


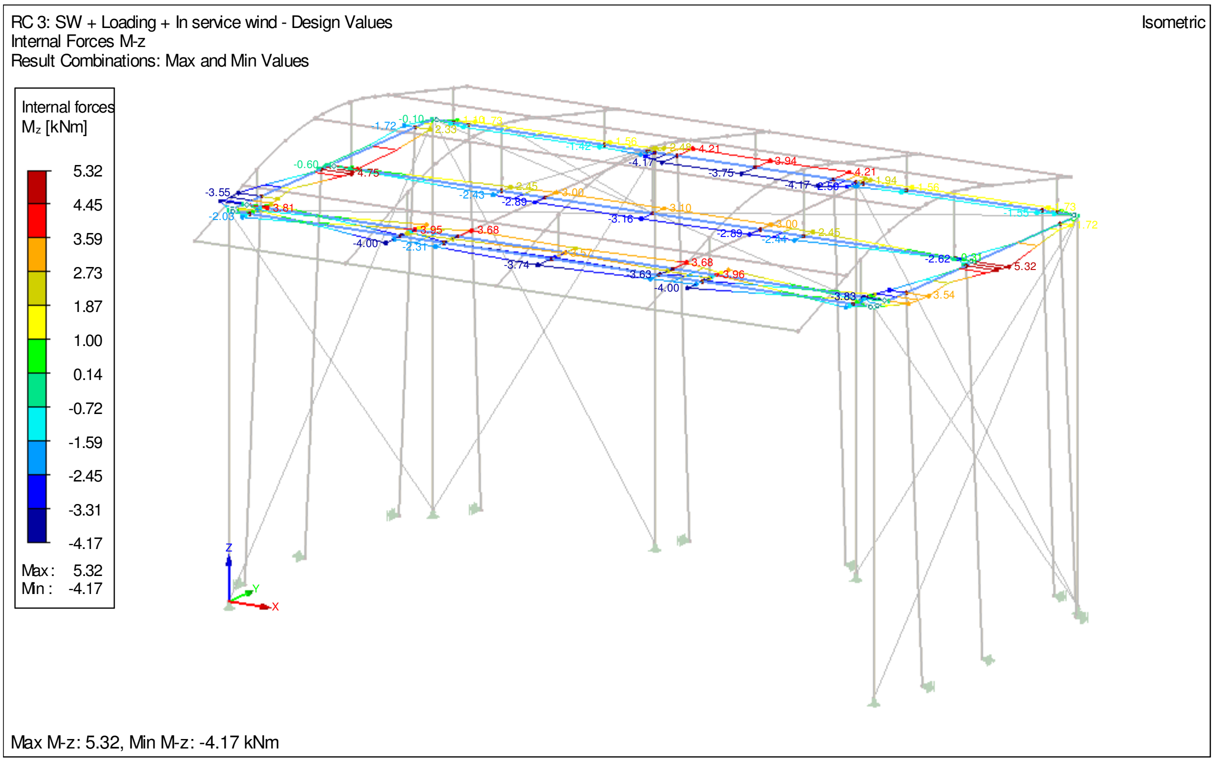

### 4.3.1 Calculation results for the In-service situation.




RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-y
Result Combinations: Max and Min Values
Isometric
Internal forces
Vy [kN]
7.83
6.40
4.97
3.55
2.12
0.70
-0.73
-2.16
-3.58
-5.01
-6.43
-7.86
Max : 7.83
Min : -7.86
Max V-y: 7.83, Min V-y: -7.86 kN


RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
17.65
14.44
11.23
8.03
4.82
1.61
-1.60
-4.81
-8.02
-11.23
-14.43
-17.64
Max : 17.65
Min : -17.64
Max V-z: 17.65, Min V-z: -17.64 kN

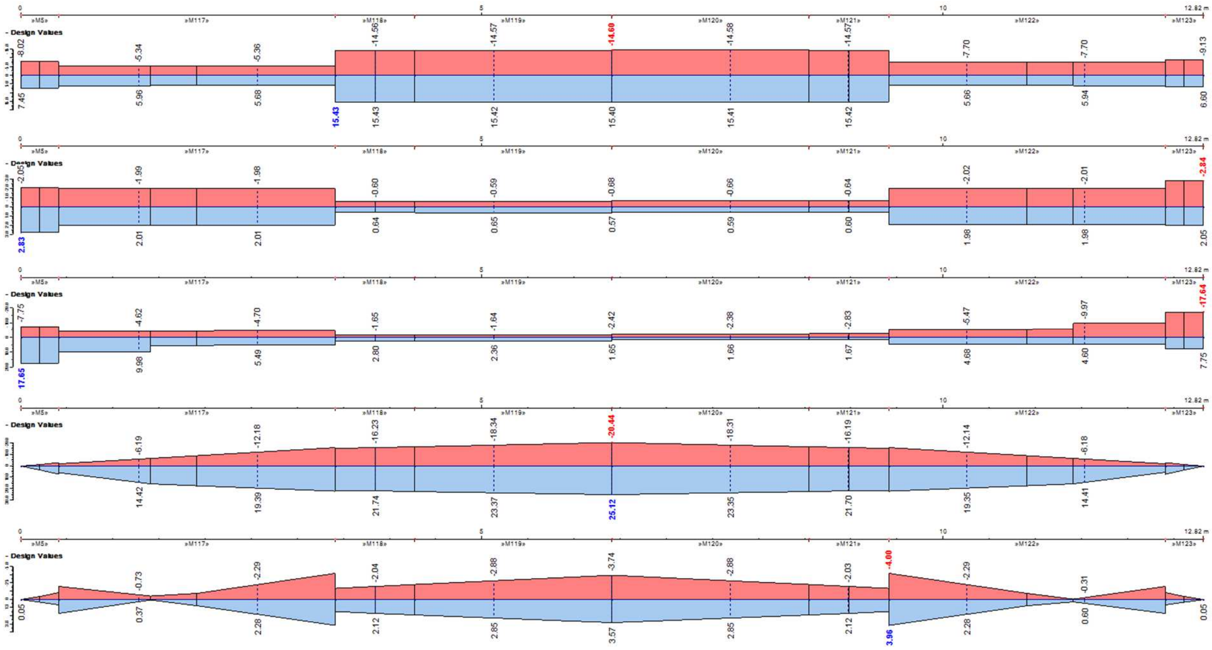

RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
$M_y$ [kNm]
25.12
20.97
16.83
12.69
8.55
4.41
0.27
-3.87
-8.01
-12.16
-16.30
-20.44
Max : 25.12
Min : -20.44
Max M-y: 25.12, Min M-y: -20.44 kNm


RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
$M_z$ [kNm]
5.32
4.45
3.59
2.73
1.87
1.00
0.14
-0.72
-1.59
-2.45
-3.31
-4.17
Max : 5.32
Min : -4.17
Max M-z: 5.32, Min M-z: -4.17 kNm

### 4.3.2 Internal forces for different spans in the In-service situation.

Span 1 : front span

Normative Load combination CO131



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 131 | 15,21 | -0,66 | -1,4 | -0,1 | 25,12 | -3,67 |

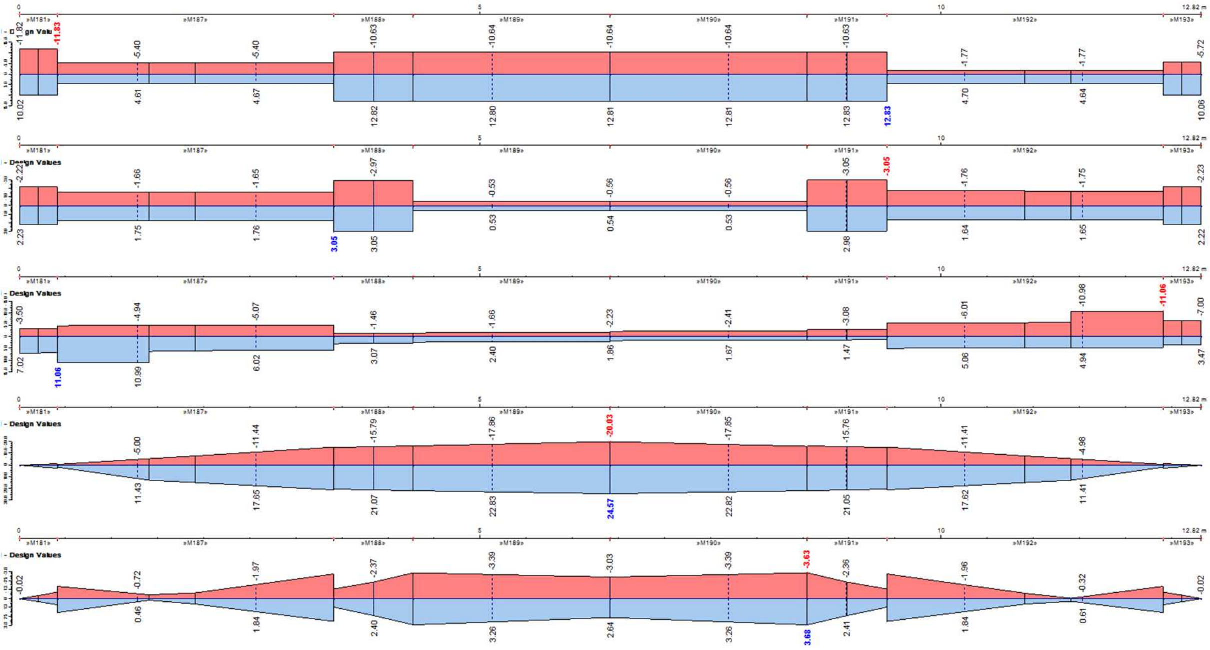
Interaction of moment and transversal force calculation on the maximum position.

$N_d$ = 15.12 kN
$V_{dy}$ = 0.66 kN
$V_{dz}$ = 1.4 kN
$M_{dy}$ = 25.12 kN
$M_{dz}$ = 3.67 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.66^2 + 1.40^2)}$
$V_{d,\ main\ chord}$ = 0.387 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.387 * 0.05$
$M_{d,\ main\ chord}$ = 0.019 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord}$ = 15.12 / 4 + 15.12 / 2 / 0.339 + 3.67 / 2 / 0.339
$N_{d,\ main\ chord}$ = 46.24 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 46.24 / 50.22 )^{1.3} + 0.019 / 0.532 = 0.93 < 1$

Span 2 : second span from the front

Normative Load combination CO131



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 131 | -8,4 | 0,24 | -1,21 | -0,18 | 24,57 | -2,91 |

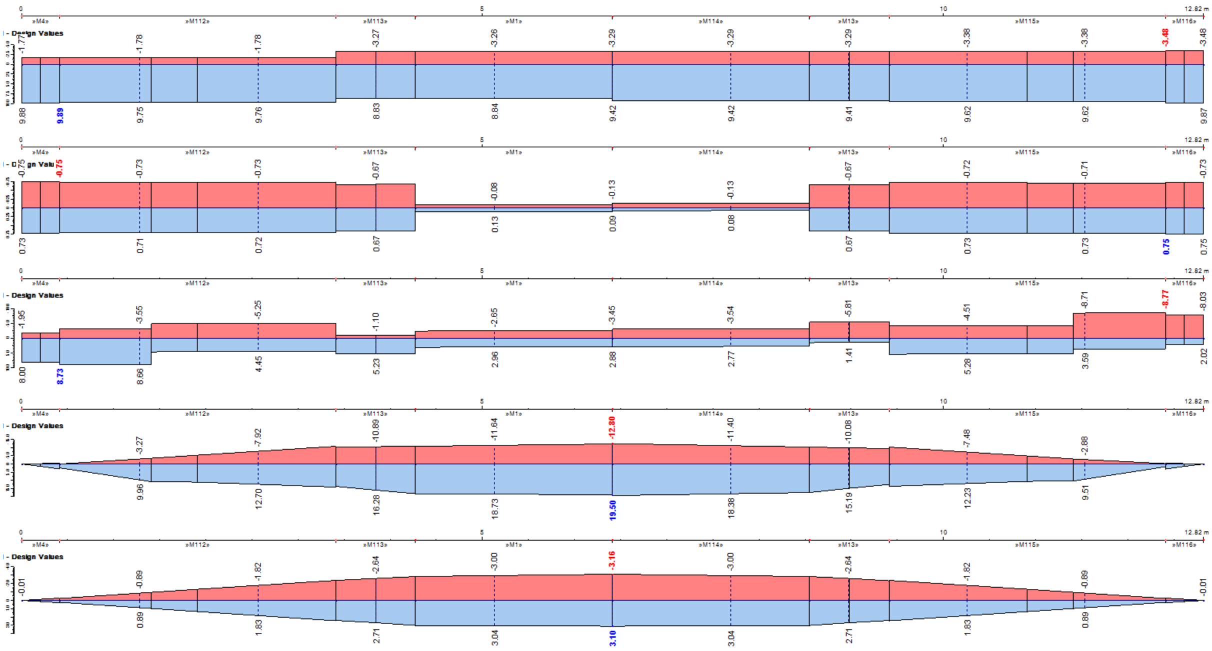
Interaction of moment and transversal force calculation on the maximum position.

$N_d$ = 8.4 kN
$V_{dy}$ = 0.24 kN
$V_{dz}$ = 1.21 kN
$M_{dy}$ = 24.57 kN
$M_{dz}$ = 2.91 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.24^2 + 1.21^2)}$
$V_{d,\ main\ chord}$ = 0.308 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.308 * 0.05$
$M_{d,\ main\ chord}$ = 0.015 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 8.4 / 4 + 24.57 / 2 / 0.339 + 2.91 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 42.63 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 42.63 / 50.22 )^{1.3} + 0.015 / 0.532 = 0.83 < 1$

Span 3 : third span from the front

Normative Load combination CO132



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 132 | 1,83 | -0,13 | -3,45 | -0,12 | 19,5 | -3,15 |

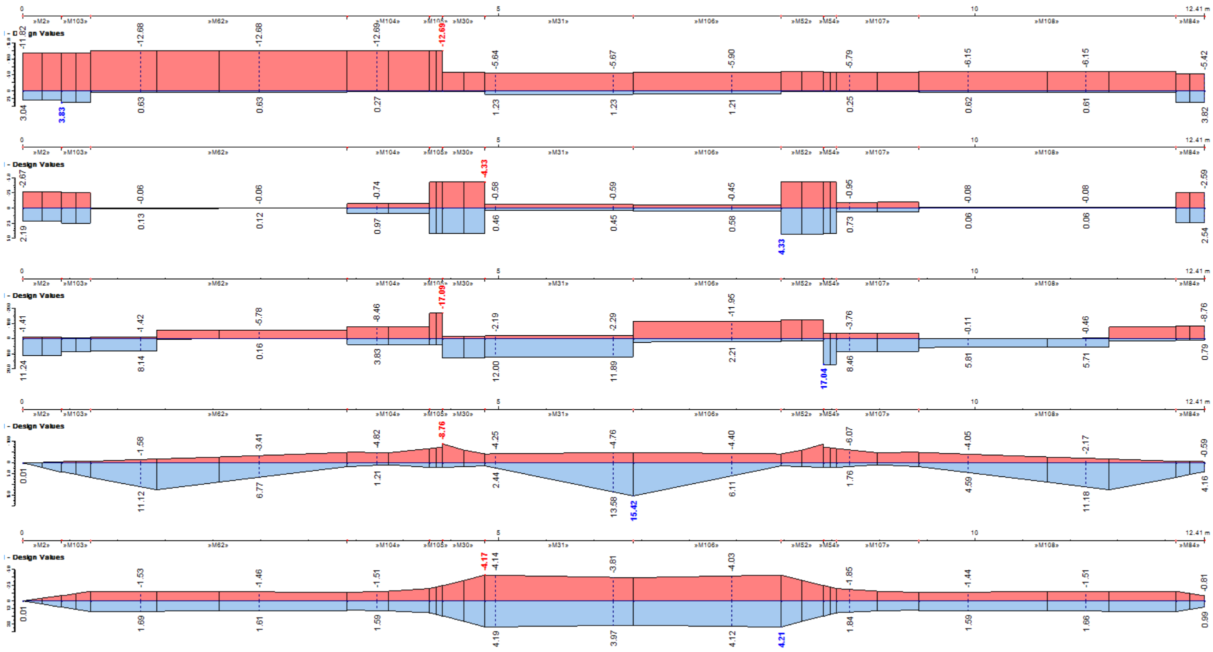
Interaction of moment and transversal force calculation on the maximum position.

$N_d$ = 1.83 kN
$V_{dy}$ = 0.13 kN
$V_{dz}$ = 3.45 kN
$M_{dy}$ = 19.5 kN
$M_{dz}$ = 3.15 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.13^2 + 3.45^2)}$
$V_{d,\ main\ chord}$ = 0.863 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.863 * 0.05$
$M_{d,\ main\ chord}$ = 0.043 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 1.83 / 4 + 19.05 / 2 / 0.339 + 3.51 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 33.86 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 33.86 / 50.22 )^{1.3} + 0.043 / 0.532 = 0.67 < 1$

Span 4 : fourth span from the front

Normative Load combination CO132



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 132 | -1,98 | -0,48 | 11,87 | -0,3 | 15,42 | -3,38 |

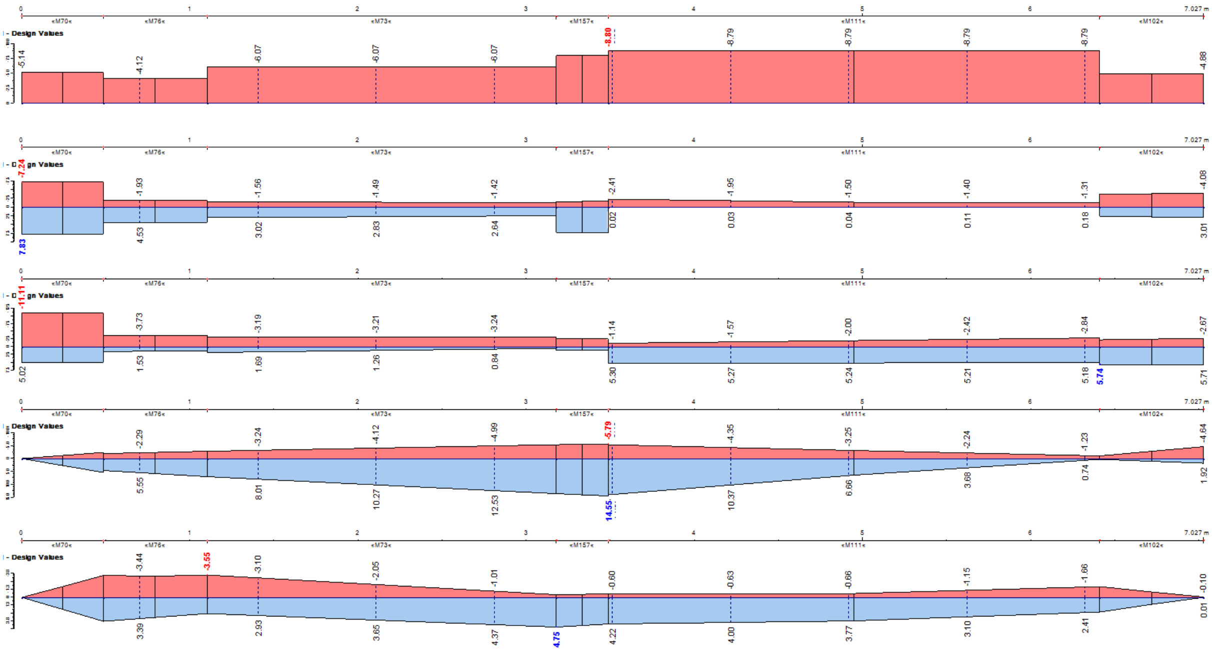
Interaction of moment and transversal force calculation on the maximum position.

$N_d$ = 1.98 kN
$V_{dy}$ = 0.48 kN
$V_{dz}$ = 11.87 kN
$M_{dy}$ = 15.42 kN
$M_{dz}$ = 3.38 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.48^2 + 11.87^2)}$
$V_{d,\ main\ chord}$ = 2.970 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 2.970 * 0.05$
$M_{d,\ main\ chord}$ = 0.15 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 1.98 / 4 + 15.42 / 2 / 0.339 + 3.38 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 28.22 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 28.22 / 50.22 )^{1.3} + 0.15 / 0.532 = 0.74 < 1$

Side span left side

Internal forces for the normative load case CO134



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 134 | -4,7 | 7,8 | -11,11 | -0,03 | 5,41 | 3,8 |

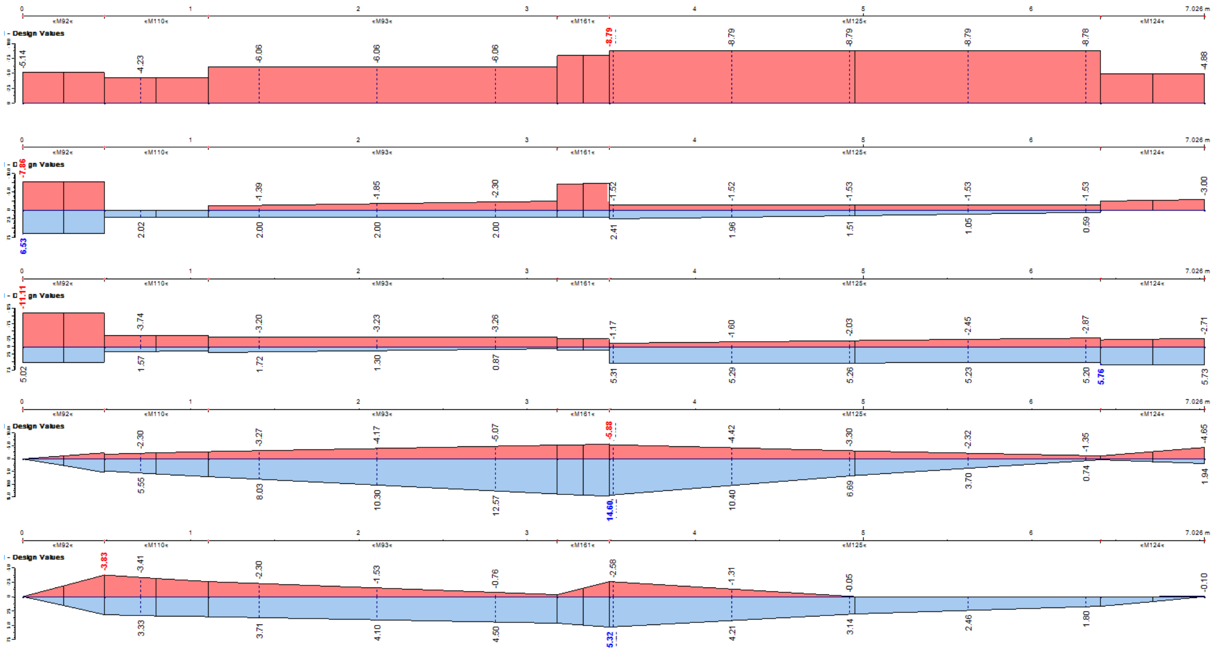
Interaction of moment and transversal force calculation on the maximum position.

$N_d = 4.7$ kN
$V_{dy} = 7.8$ kN
$V_{dz} = 11.11$ kN
$M_{dy} = 5.41$ kN
$M_{dz} = 3.8$ kN
$V_{d,\text{ main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 7.8^2 + 11.11^2)}$
$V_{d,\text{ main chord}} = 3.39$ kN
$M_{d,\text{ main chord}} = V_{d,\text{ main chord}} * e = 3.39 * 0.05$
$M_{d,\text{ main chord}} = 0.169$ kNcm
$N_{d,\text{ main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\text{ main chord}} = 4.7 / 4 + 5.41 / 2 / 0.339 + 3.8 / 2 / 0.339$
$N_{d,\text{ main chord}} = 14.76$ kN

Check
$\eta = ( N_{d,\text{ main chord}} / N_{Rd} )^{1.3} + M_{d,\text{ main chord}} / M_{Rd}$
$\eta = ( 14.76 / 50.22 )^{1.3} + 0.169 / 0.532 = 0.52 < 1$

Side span right side

Internal forces for the normative load case CO134



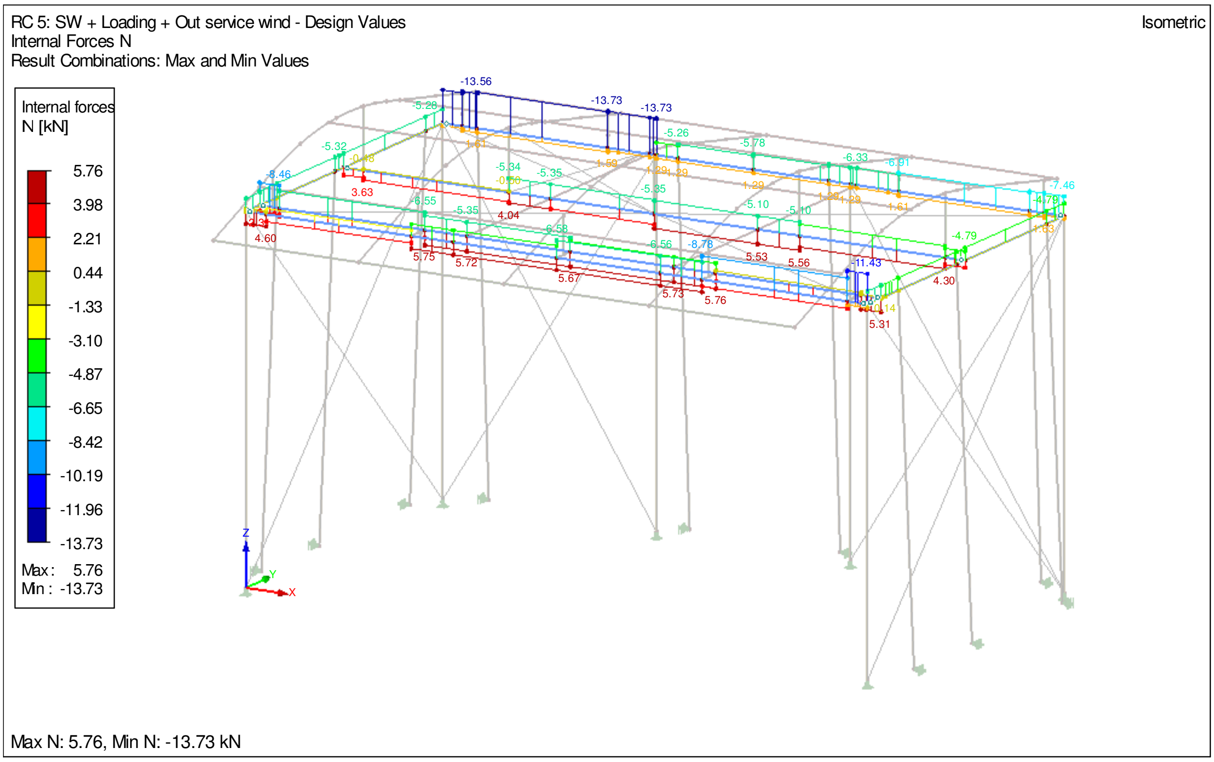
| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 134 | -4,71 | -7,83 | -11,1 | 0,03 | 5,41 | -3,81 |

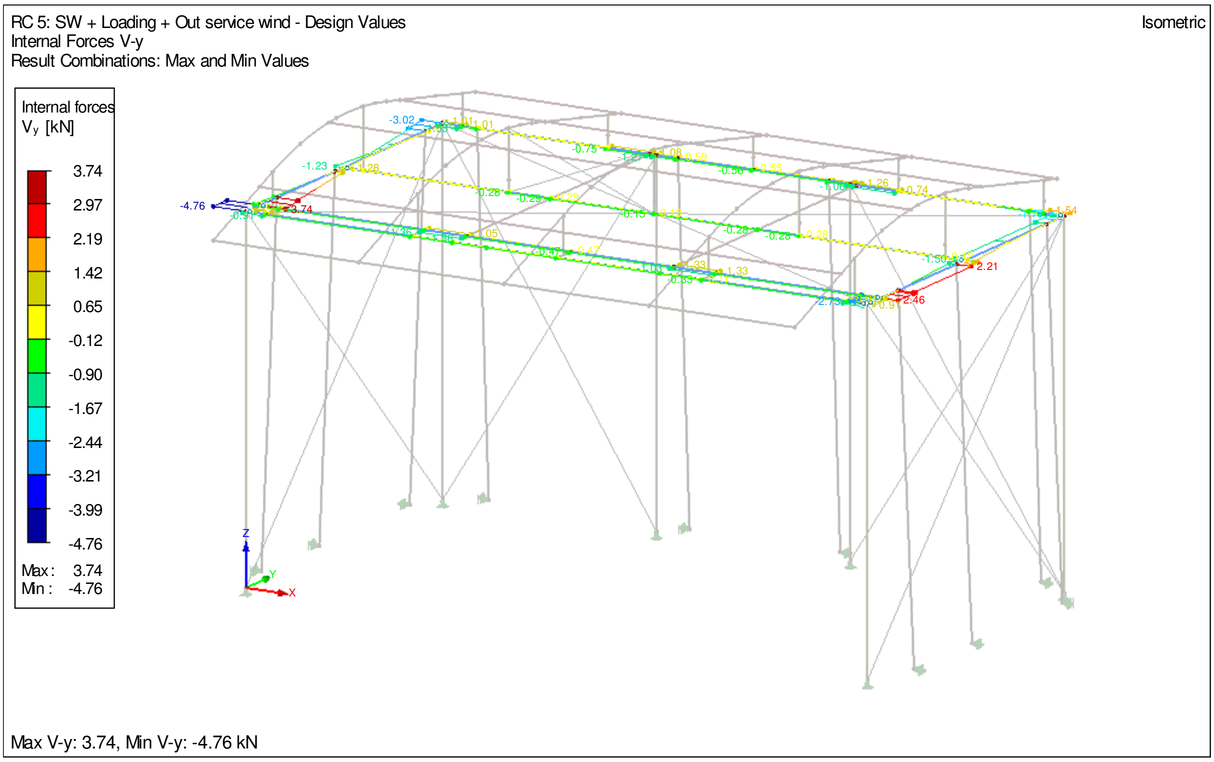
Interaction of moment and transversal force calculation on the maximum position.

$N_d = 4.71$ kN
$V_{dy} = 7.83$ kN
$V_{dz} = 11.1$ kN
$M_{dy} = 5.41$ kN
$M_{dz} = 3.81$ kN
$V_{d,\text{ main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 7.83^2 + 11.1^2)}$
$V_{d,\text{ main chord}} = 3.39$ kN
$M_{d,\text{ main chord}} = V_{d,\text{ main chord}} * e = 3.39 * 0.05$
$M_{d,\text{ main chord}} = 0.170$ kNcm
$N_{d,\text{ main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\text{ main chord}} = 4.71 / 4 + 5.41 / 2 / 0.339 + 3.81 / 2 / 0.339$
$N_{d,\text{ main chord}} = 14.76$ kN

Check
$\eta = ( N_{d,\text{ main chord}} / N_{Rd} )^{1.3} + M_{d,\text{ main chord}} / M_{Rd}$
$\eta = ( 14.76 / 50.22 )^{1.3} + 0.170 / 0.532 = 0.52 < 1$

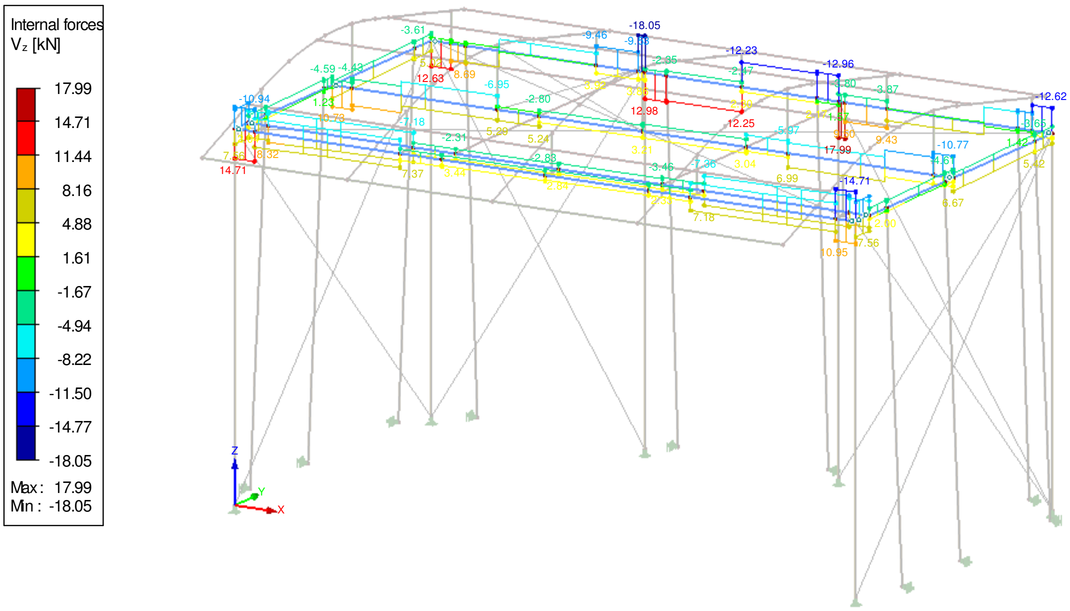
### 4.3.3 Calculation results for the Out-service situation.



RC 5: SW + Loading + Out service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values

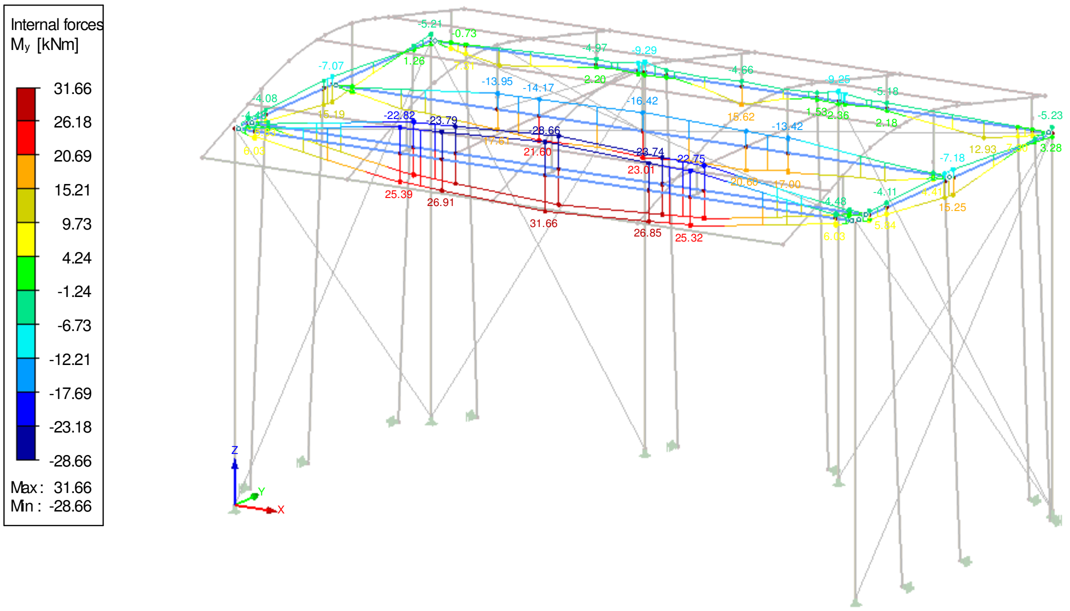
Isometric




Max V-z: 17.99, Min V-z: -18.05 kN

RC 5: SW + Loading + Out service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values

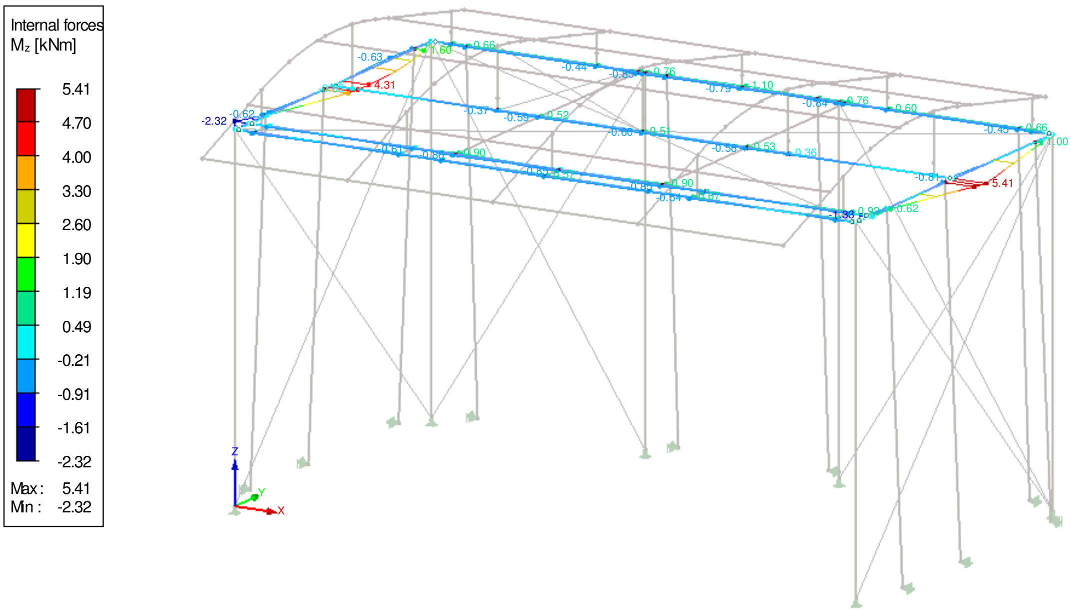
Isometric




Max M-y: 31.66, Min M-y: -28.66 kNm

RC 5: SW + Loading + Out service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric

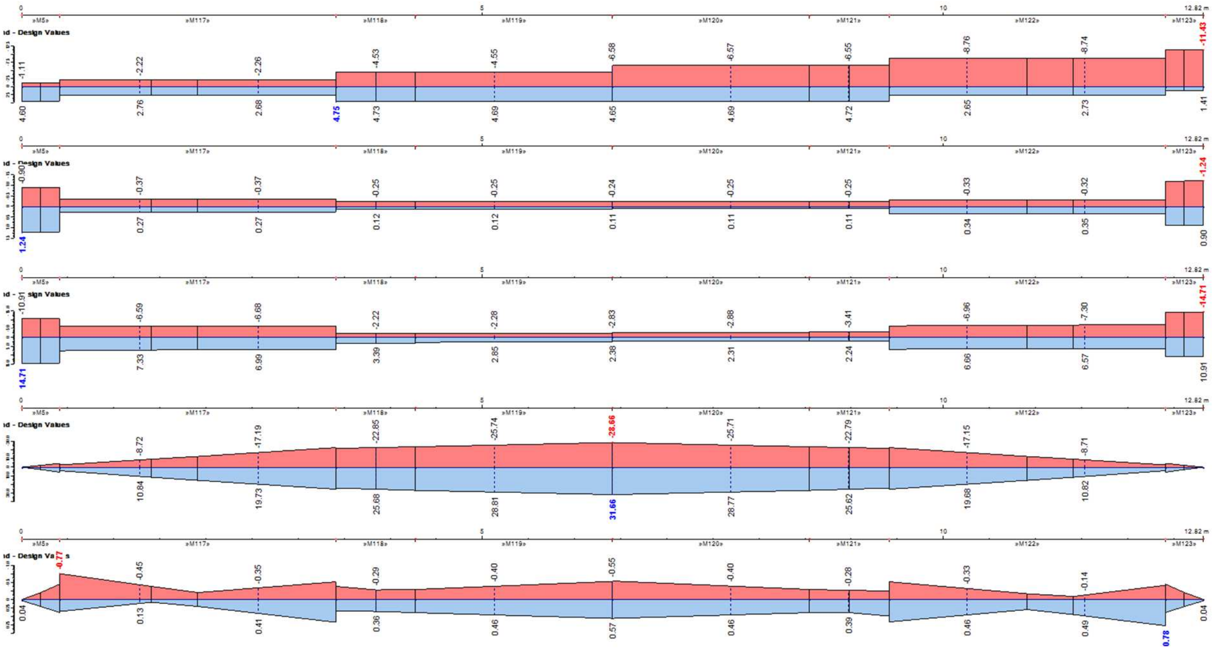



Max M-z: 5.41, Min M-z: -2.32 kNm

### 4.3.4 Internal forces for different spans in the In-service situation.

Span 1 : front span

Internal forces for the normative load case CO226



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 226 | 4,65 | -0,11 | -1,79 | -0,11 | 31,66 | -0,48 |

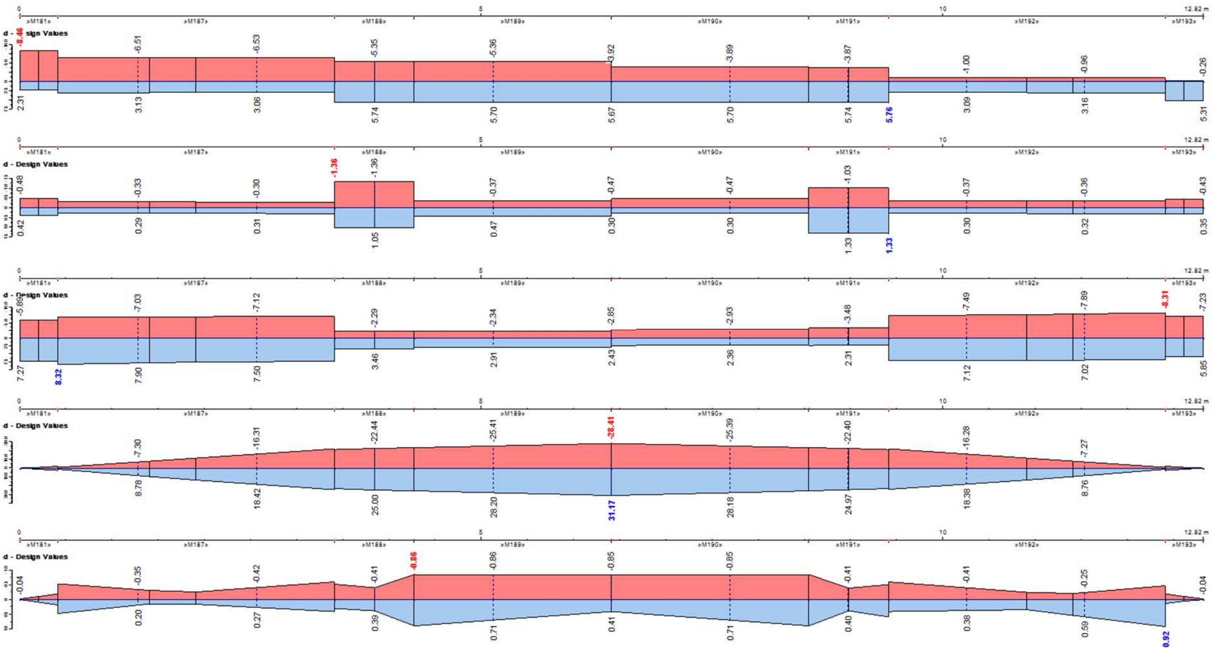
Interaction of moment and transversal force calculation on the maximum position

$N_d$ = 4.65 kN
$V_{dy}$ = 0.11 kN
$V_{dz}$ = 1.79 kN
$M_{dy}$ = 31.66 kN
$M_{dz}$ = 0.48 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.11^2 + 1.79^2)}$
$V_{d,\ main\ chord}$ = 0.448 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.448 * 0.05$
$M_{d,\ main\ chord}$ = 0.022 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 4.65 / 4 + 31.66 / 2 / 0.339 + 0.48 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 48.57 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 48.57 / 50.22 )^{1.3} + 0.022 / 0.532 = 0.996 < 1$

Span 2 : second span from the front

Internal forces for the normative load case CO226



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 226 | 2,56 | -0,26 | -1,84 | -0,2 | 31,17 | -0,73 |

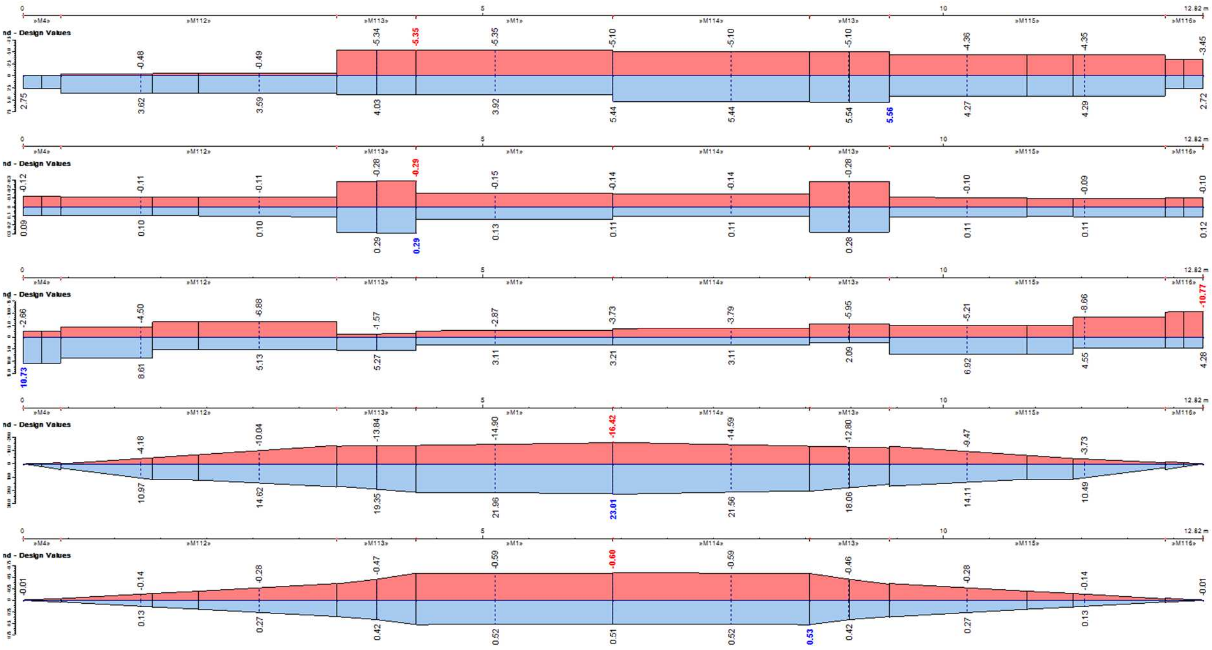
Interaction of moment and transversal force calculation on the maximum position

$N_d = 2.56$ kN
$V_{dy} = 0.26$ kN
$V_{dz} = 1.84$ kN
$M_{dy} = 31.17$ kN
$M_{dz} = 0.73$ kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.26^2 + 1.84^2)}$
$V_{d,\ main\ chord} = 0.465$ kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.465 * 0.05$
$M_{d,\ main\ chord} = 0.023$ kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 2.56 / 4 + 31.17 / 2 / 0.339 + 0.73 / 2 / 0.339$
$N_{d,\ main\ chord} = 47.69$ kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 47.69 / 50.22 )^{1.3} + 0.023 / 0.532 = 0.98 < 1$

Span 3 : third span from the front

Internal forces for the normative load case CO227



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 227 | 4,68 | -0,14 | -3,73 | -0,12 | 23,01 | -0,59 |

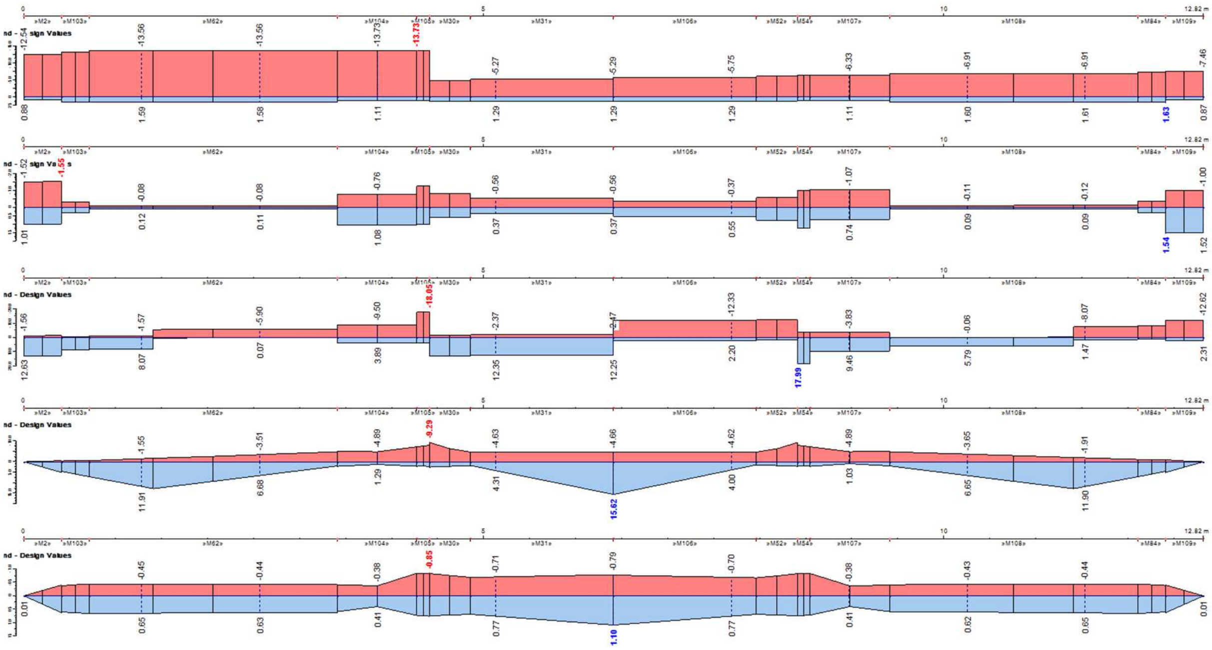
Interaction of moment and transversal force calculation on the maximum position

$N_d$ = 4.68 kN
$V_{dy}$ = 0.14 kN
$V_{dz}$ = 3.73 kN
$M_{dy}$ = 23.01 kN
$M_{dz}$ = 0.59 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.14^2 + 3.73^2)}$
$V_{d,\ main\ chord}$ = 0.933 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.933 * 0.05$
$M_{d,\ main\ chord}$ = 0.047 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 4.68 / 4 + 23.01 / 2 / 0.339 + 0.59 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 35.98 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 35.98 / 50.22 )^{1.3} + 0.047 / 0.532 = 0.73 < 1$

Span 4 : fourth span from the front

Internal forces for the normative load case CO227



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 227 | 0,53 | -0,49 | 12,25 | -0,28 | 15,62 | 0,1 |

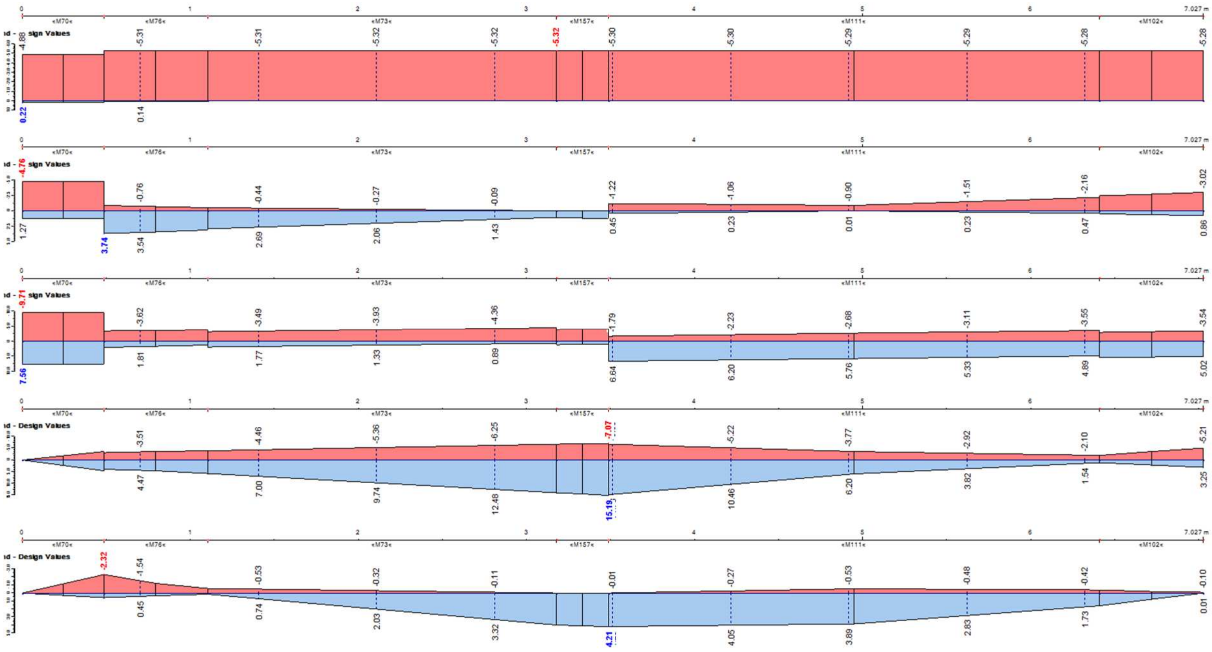
Interaction of moment and transversal force calculation on the maximum position

$N_d$ = 0.53 kN
$V_{dy}$ = 0.49 kN
$V_{dz}$ = 12.25 kN
$M_{dy}$ = 15.62 kN
$M_{dz}$ = 0.10 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.49^2 + 12.25^2)}$
$V_{d,\ main\ chord}$ = 3.065 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 3.065 * 0.05$
$M_{d,\ main\ chord}$ = 0.015 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 0.53 / 4 + 15.62 / 2 / 0.339 + 0.10 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 23.32 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 23.32 / 50.22 )^{1.3} + 0.015 / 0.532 = 0.65 < 1$

Side span left side

Internal forces for the normative load case CO209



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 209 | -0,9 | -1,23 | 6,52 | 0 | 14,88 | 0,81 |

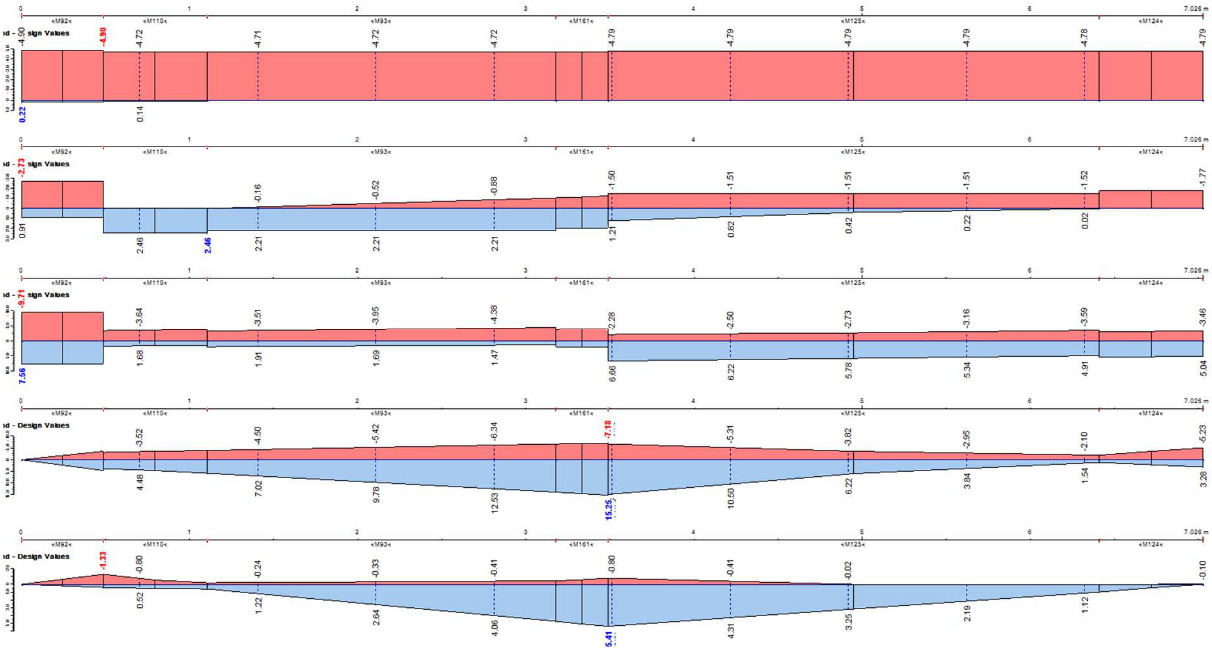
Interaction of moment and transversal force calculation on the maximum position

$N_d$ = 0.90 kN
$V_{dy}$ = 1.23 kN
$V_{dz}$ = 6.52 kN
$M_{dy}$ = 14.88 kN
$M_{dz}$ = 0.81 kN
$V_{d,\text{ main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 1.23^2 + 6.52^2)}$
$V_{d,\text{ main chord}}$ = 1.66 kN
$M_{d,\text{ main chord}} = V_{d,\text{ main chord}} * e = 1.66 * 0.05$
$M_{d,\text{ main chord}}$ = 0.083 kNcm
$N_{d,\text{ main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\text{ main chord}} = 0.90 / 4 + 14.88 / 2 / 0.339 + 0.81 / 2 / 0.339$
$N_{d,\text{ main chord}}$ = 23.37 kN

Check
$\eta = ( N_{d,\text{ main chord}} / N_{Rd} )^{1.3} + M_{d,\text{ main chord}} / M_{Rd}$
$\eta = ( 23.37 / 50.22 )^{1.3} + 0.083 / 0.532 = 0.52 < 1$

Side span right side

Internal forces for the normative load case CO209



| Normative | Forces [kN] | | | Moments [kNm] | | |
|---|---|---|---|---|---|---|
| Load Combination | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ |
| CO 209 | -0,9 | 1,22 | 6,54 | 0 | 14,94 | -0,78 |

Interaction of moment and transversal force calculation on the maximum position

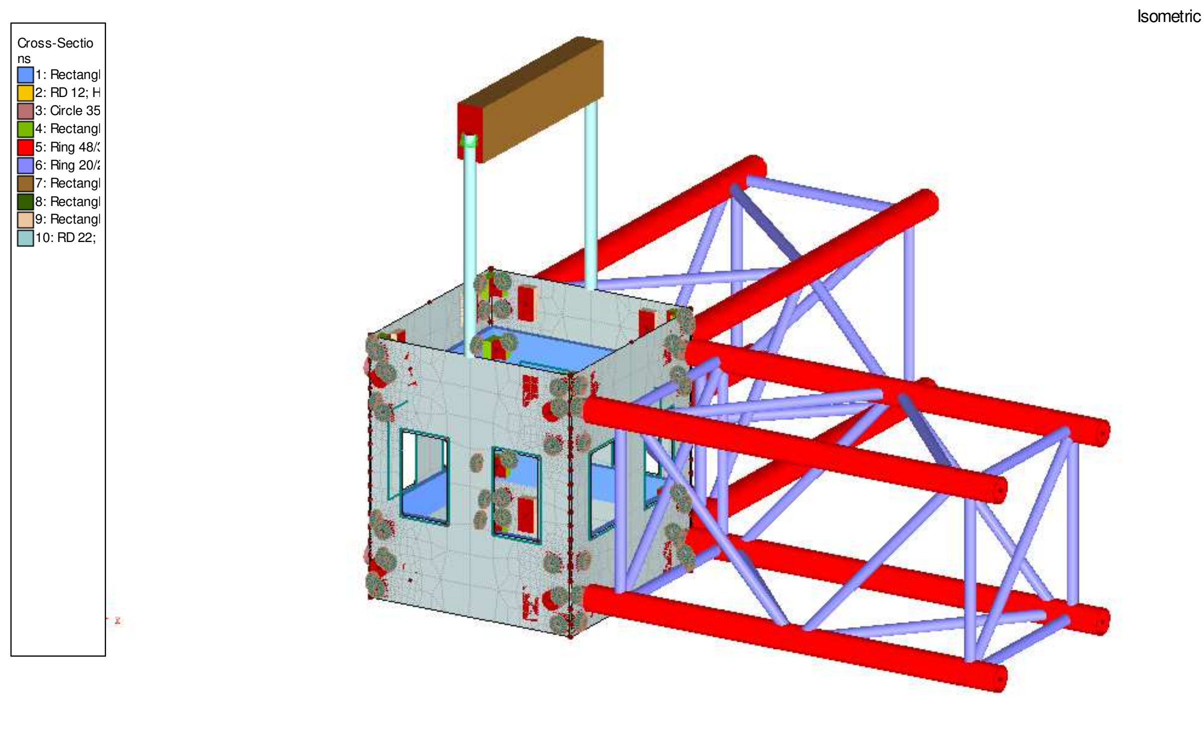
$N_d$ = 0.90 kN
$V_{dy}$ = 1.22 kN
$V_{dz}$ = 6.54 kN
$M_{dy}$ = 14.94 kN
$M_{dz}$ = 0.78 kN
$V_{d,\, main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 1.22^2 + 6.54^2)}$
$V_{d,\, main\ chord}$ = 1.66 kN
$M_{d,\, main\ chord} = V_{d,\, main\ chord} * e = 1.66 * 0.05$
$M_{d,\, main\ chord}$ = 0.083 kNcm
$N_{d,\, main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\, main\ chord} = 0.90 / 4 + 14.94 / 2 / 0.339 + 0.78 / 2 / 0.339$
$N_{d,\, main\ chord}$ = 23.41 kN

Check
$\eta = ( N_{d,\, main\ chord} / N_{Rd} )^{1.3} + M_{d,\, main\ chord} / M_{Rd}$
$\eta = ( 23.41 / 50.22 )^{1.3} + 0.083 / 0.532 = 0.52 < 1$

### 4.4 Check of the sleeve block.

The decisive sleeve  block is the front sleeve block on the left or the right of the stage The sleeve block on the left side of the main construction is checked.

For the check of the Sleeve block a separate model has been constructed in the calculation program. The truss sections are constructed to create a more accurate model. These will be left out from the results. Only the sleeve block will be checked.




Used cross sections

| Section | Cross-Section | Material | Moments of inertia [cm⁴] | | | Cross-Sectional Areas [cm²] | | | Principal Axes | Rotation | Overall Dimensions [mm] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Description [mm] | No. | Torsion J | Bending $I_y$ | Bending $I_z$ | Axial A | Shear $A_y$ | Shear $A_z$ | α [°] | α' [°] | Width b | Depth h |
| 1 | Rectangle 12/60 | 2 | 3,02 | 21,60 | 0,86 | 7,20 | 6,00 | 6,00 | 0,00 | 0,00 | 12,0 | 60,0 |
| 2 | RD 12 | 5 | 0,20 | 0,10 | 0,10 | 1,13 | 0,95 | 0,95 | 0,00 | 0,00 | 12,0 | 12,0 |
| 3 | Circle 35 | 1 | 14,73 | 7,37 | 7,37 | 9,62 | 8,15 | 8,15 | 0,00 | 0,00 | 35,0 | 35,0 |
| 4 | Rectangle 35/35 | 3 | 21,11 | 12,51 | 12,51 | 12,25 | 10,21 | 10,21 | 0,00 | 0,00 | 35,0 | 35,0 |
| 5 | Ring 48/3 | 4 | 21,57 | 10,78 | 10,78 | 4,24 | 2,14 | 2,14 | 0,00 | 0,00 | 48,0 | 48,0 |
| 6 | Ring 20/2 | 4 | 0,93 | 0,46 | 0,46 | 1,13 | 0,58 | 0,58 | 0,00 | 0,00 | 20,0 | 20,0 |
| 7 | Rectangle 50/100 | 1 | 286,09 | 416,67 | 104,17 | 50,00 | 41,67 | 41,67 | 0,00 | 0,00 | 50,0 | 100,0 |
| 8 | Rectangle 8/8 | 1 | 0,06 | 0,03 | 0,03 | 0,64 | 0,53 | 0,53 | 0,00 | 0,00 | 8,0 | 8,0 |
| 9 | Rectangle 30/60 | 1 | 37,08 | 54,00 | 13,50 | 18,00 | 15,00 | 15,00 | 0,00 | 0,00 | 30,0 | 60,0 |
| 10 | RD 22 | 2 | 2,30 | 1,15 | 1,15 | 3,80 | 3,19 | 3,19 | 0,00 | 0,00 | 22,0 | 22,0 |

## Used Material

| Material No. | Material Description | Safety Factor $\gamma_M$ [-] | Yield Strength $f_{yk}$ [kN/cm²] | Limit Stresses [kN/cm²] Manually | Limit $\sigma_x$ | Limit $\tau$ | Limit $\sigma_{eqv}$ |
|---|---|---|---|---|---|---|---|
| 1 | Aluminium EN-AW 6082 (EP,ET) T6* \| EN 1999-1-1:2007 | 1,00 | 26,00 | - | 26.00 | 15,01 | 26,00 |
| 3 | steel 8.8 Quality \| EN 10346:2009-03 | 1,00 | 64,00 | - | 64,00 | 36,95 | 64 |

## Inserted Load Cases.

## Internal forces for result calculation RC4 In service characteristic values

| Member No. | Node No. | Location x [m] | | Forces [kN] N | $V_y$ | $V_z$ | Moments [kNm] $M_T$ | $M_y$ | $M_z$ | Corresponding Load Cases |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 2 | 0,000 | max N | **5,48** | 0,05 | 9,22 | -0,67 | 0,00 | 0,01 | CO 164 |
| | | | min N | **-5,94** | 1,46 | 2,04 | -0,23 | 0,00 | 0,00 | CO 170 |
| | | | max $V_y$ | -5,64 | **2,12** | 13,29 | -0,90 | 0,00 | 0,03 | CO 184 |
| | | | min $V_y$ | 4,93 | **-1,51** | -5,51 | 0,37 | 0,00 | 0,01 | CO 150 |
| | | | max $V_z$ | -5,64 | 2,12 | **13,29** | -0,90 | 0,00 | 0,03 | CO 184 |
| | | | min $V_z$ | 4,93 | -1,51 | **-5,51** | 0,37 | 0,00 | 0,01 | CO 150 |
| | | | max $M_y$ | -5,64 | 2,12 | 13,29 | -0,90 | **0,00** | 0,03 | CO 184 |
| | | | min $M_y$ | 5,48 | 0,05 | 9,22 | -0,67 | **0,00** | 0,01 | CO 164 |
| | | | max $M_z$ | -5,64 | 2,12 | 13,29 | -0,90 | 0,00 | **0,03** | CO 184 |
| | | | min $M_z$ | 4,83 | -1,09 | 1,99 | -0,09 | 0,00 | **0,00** | CO 154 |
| | 59 | 0,410 | max N | **5,48** | 0,04 | 9,19 | -0,67 | 3,77 | 0,00 | CO 164 |
| | | | min N | **-5,94** | 1,46 | 2,01 | -0,23 | 0,83 | -0,60 | CO 170 |
| | | | max $V_y$ | -5,65 | **2,10** | 13,26 | -0,92 | 5,45 | -0,83 | CO 184 |
| | | | min $V_y$ | 4,93 | **-1,51** | -5,54 | 0,36 | -2,26 | 0,63 | CO 150 |
| | | | max $V_z$ | -5,65 | 2,10 | **13,26** | -0,92 | 5,45 | -0,83 | CO 184 |
| | | | min $V_z$ | 4,93 | -1,51 | **-5,54** | 0,36 | -2,26 | 0,63 | CO 150 |
| | | | max $M_y$ | -5,65 | 2,10 | 13,26 | -0,92 | **5,45** | -0,83 | CO 184 |
| | | | min $M_y$ | 4,93 | -1,51 | -5,54 | 0,36 | **-2,26** | 0,63 | CO 150 |
| | | | max $M_z$ | 4,93 | -1,51 | -5,54 | 0,36 | -2,26 | **0,63** | CO 150 |
| | | | min $M_z$ | -5,65 | 2,10 | 13,26 | -0,92 | 5,45 | **-0,83** | CO 184 |
| | 2 | 0,000 | Max N | **5,48** | 0,05 | 9,22 | -0,67 | 0,00 | 0,01 | CO 164 |
| | 59 | 0,410 | Min N | **-5,94** | 1,46 | 2,01 | -0,23 | 0,83 | -0,60 | CO 170 |
| | 2 | 0,000 | Max $V_y$ | -5,64 | **2,12** | 13,29 | -0,90 | 0,00 | 0,03 | CO 184 |
| | 59 | 0,410 | Min $V_y$ | 4,93 | **-1,51** | -5,54 | 0,36 | -2,26 | 0,63 | CO 150 |
| | 2 | 0,000 | Max $V_z$ | -5,64 | 2,12 | **13,29** | -0,90 | 0,00 | 0,03 | CO 184 |
| | 59 | 0,410 | Min $V_z$ | 4,93 | -1,51 | **-5,54** | 0,36 | -2,26 | 0,63 | CO 150 |
| | 59 | 0,410 | Max $M_y$ | -5,65 | 2,10 | 13,26 | -0,92 | **5,45** | -0,83 | CO 184 |
| | 59 | 0,410 | Min $M_y$ | 4,93 | -1,51 | -5,54 | 0,36 | **-2,26** | 0,63 | CO 150 |
| | 59 | 0,410 | Max $M_z$ | 4,93 | -1,51 | -5,54 | 0,36 | -2,26 | **0,63** | CO 150 |
| | 59 | 0,410 | Min $M_z$ | -5,65 | 2,10 | 13,26 | -0,92 | 5,45 | **-0,83** | CO 184 |
| 70 | 85 | 0,000 | max N | **0,00** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| | | | min N | **-3,80** | 5,78 | -1,20 | 0,00 | 0,58 | 2,81 | CO 170 |
| | | | max $V_y$ | -3,69 | **5,78** | -2,37 | 0,00 | 1,16 | 2,82 | CO 172 |
| | | | min $V_y$ | -1,70 | **-5,36** | -2,69 | -0,03 | 1,31 | -2,61 | CO 163 |
| | | | max $V_z$ | -1,45 | -4,82 | **3,51** | -0,01 | -1,71 | -2,35 | CO 150 |
| | | | min $V_z$ | -3,48 | 5,76 | **-8,42** | -0,01 | 4,10 | 2,81 | CO 184 |
| | | | max $M_y$ | -3,48 | 5,76 | -8,42 | -0,01 | **4,10** | 2,81 | CO 184 |
| | | | min $M_y$ | -1,45 | -4,82 | 3,51 | -0,01 | **-1,71** | -2,35 | CO 150 |
| | | | max $M_z$ | -3,69 | 5,78 | -2,37 | 0,00 | 1,16 | **2,82** | CO 172 |
| | | | min $M_z$ | -1,70 | -5,36 | -2,69 | -0,03 | 1,31 | **-2,61** | CO 163 |
| | 2 | 0,487 | max N | **0,00** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| | | | min N | **-3,79** | 5,78 | -1,20 | 0,00 | 0,00 | 0,00 | CO 170 |
| | | | max $V_y$ | -3,69 | **5,78** | -2,37 | 0,00 | 0,00 | 0,00 | CO 172 |
| | | | min $V_y$ | -1,69 | **-5,36** | -2,69 | -0,04 | 0,00 | 0,00 | CO 163 |
| | | | max $V_z$ | -1,44 | -4,82 | **3,51** | 0,00 | 0,00 | 0,00 | CO 150 |
| | | | min $V_z$ | -3,47 | 5,76 | **-8,42** | 0,00 | 0,00 | 0,00 | CO 184 |
| | | | max $M_y$ | -1,88 | -5,32 | -1,01 | -0,04 | **0,00** | 0,00 | CO 160 |
| | | | min $M_y$ | -3,52 | 5,76 | -5,71 | 0,00 | **0,00** | 0,00 | CO 181 |
| | | | max $M_z$ | -3,47 | 5,76 | -8,42 | 0,00 | 0,00 | **0,00** | CO 184 |
| | | | min $M_z$ | -1,68 | -5,33 | -5,86 | -0,04 | 0,00 | **0,00** | CO 164 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 85 | 0,000 | Max N | **0,00** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| | 85 | 0,000 | Min N | **-3,80** | 5,78 | -1,20 | 0,00 | 0,58 | 2,81 | CO 170 |
| | 2 | 0,487 | Max $V_y$ | -3,69 | **5,78** | -2,37 | 0,00 | 0,00 | 0,00 | CO 172 |
| | | 0,243 | Min $V_y$ | -1,70 | **-5,36** | -2,69 | -0,03 | 0,65 | -1,30 | CO 163 |
| | 2 | 0,487 | Max $V_z$ | -1,44 | -4,82 | **3,51** | 0,00 | 0,00 | 0,00 | CO 150 |
| | 2 | 0,487 | Min $V_z$ | -3,47 | 5,76 | **-8,42** | 0,00 | 0,00 | 0,00 | CO 184 |
| | 85 | 0,000 | Max $M_y$ | -3,48 | 5,76 | -8,42 | -0,01 | **4,10** | 2,81 | CO 184 |
| | 85 | 0,000 | Min $M_y$ | -1,45 | -4,82 | 3,51 | -0,01 | **-1,71** | -2,35 | CO 150 |
| | 85 | 0,000 | Max $M_z$ | -3,69 | 5,78 | -2,37 | 0,00 | 1,16 | **2,82** | CO 172 |
| | 85 | 0,000 | Min $M_z$ | -1,70 | -5,36 | -2,69 | -0,03 | 1,31 | **-2,61** | CO 163 |

Normative load combinations for the In-service situation is Load combination CO184

The forces of this load combination is set as component forces on the node's next to the sleeve block

Check of load Combination CO184

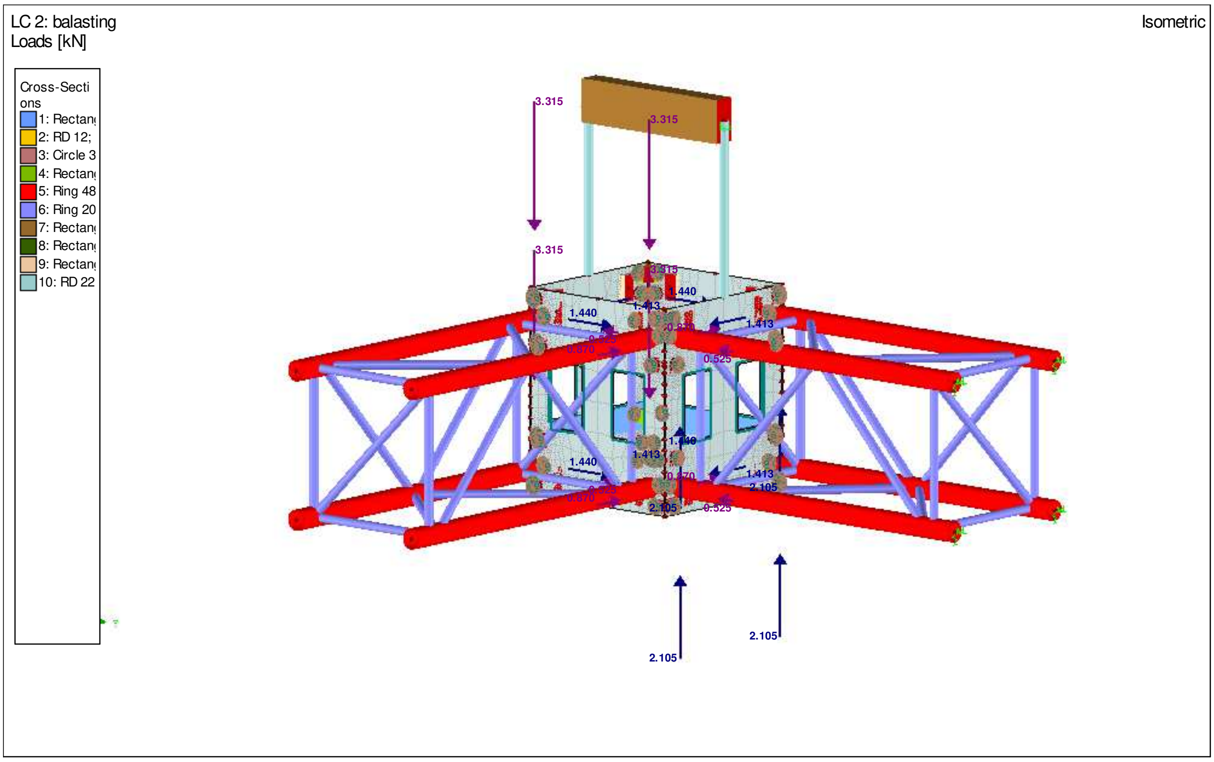
Internal forces on the 4 node points in Load combination 110 from the total construction model are

| Member | Node | Location | Forces [kN] | | | Moments [kNm] | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | No. | x [m] | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ | Cross-Section |
| 5 | 59 | 0,410 | -5,65 | 2,10 | 13,26 | -0,92 | 5,45 | -0,83 | 1 - Prolyte H40V |
| 70 | 85 | 0,000 | -3,48 | 5,76 | -8,42 | -0,01 | 4,10 | 2,81 | 1 - Prolyte H40V |

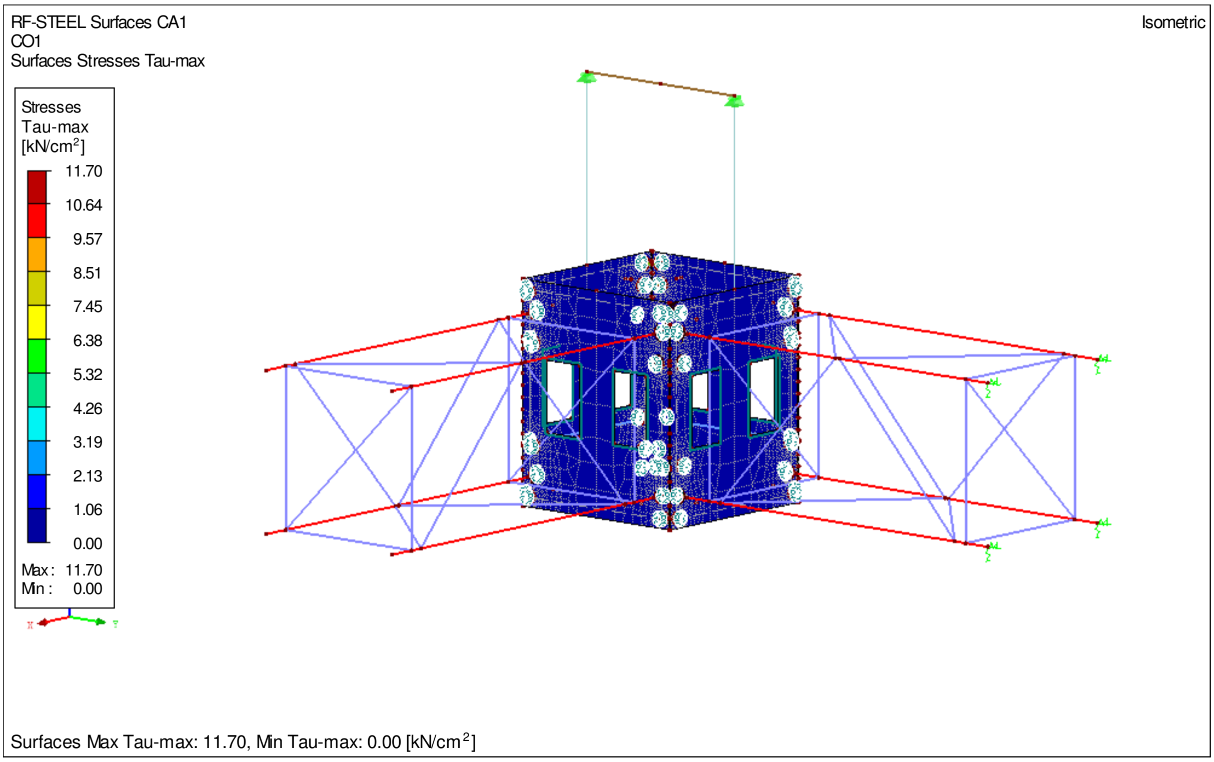
Load in put into sleeve block model

| | | Definition | Coordinate | Force [kN] | | | Moment [kNm] | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | On Nodes No. | Type | System | $P_X$ | $P_Y$ | $P_Z$ | $M_X$ | $M_Y$ | $M_Z$ |
| 1 | 78,80,82,84 | By components | 0 \| Global XYZ | 1,413 | -0,525 | -3,315 | 0,000 | 0,000 | 0,000 |
| 2 | 29,56,58,60 | By components | 0 \| Global XYZ | -0,870 | 1,440 | 2,105 | 0,000 | 0,000 | 0,000 |

Visual input different load cases.



## Stress calculation of the sleeve block



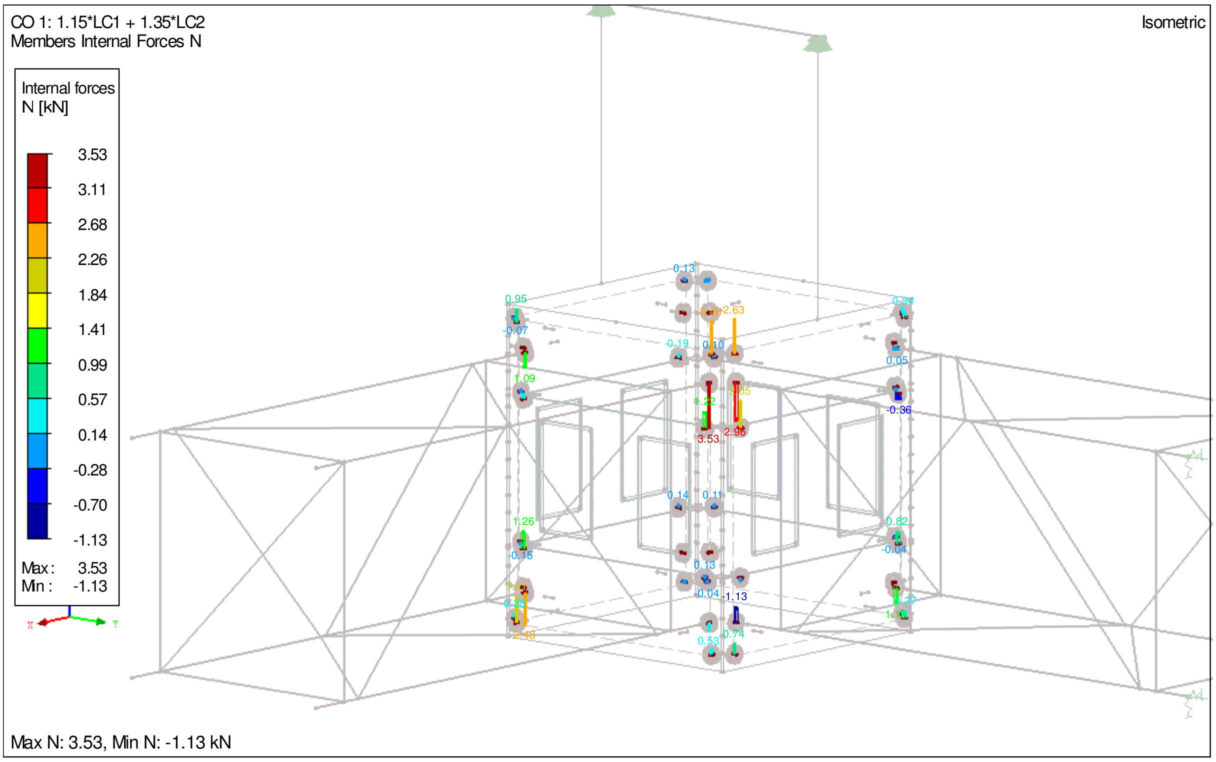

## Maximum stress analyse for the aluminium sheets

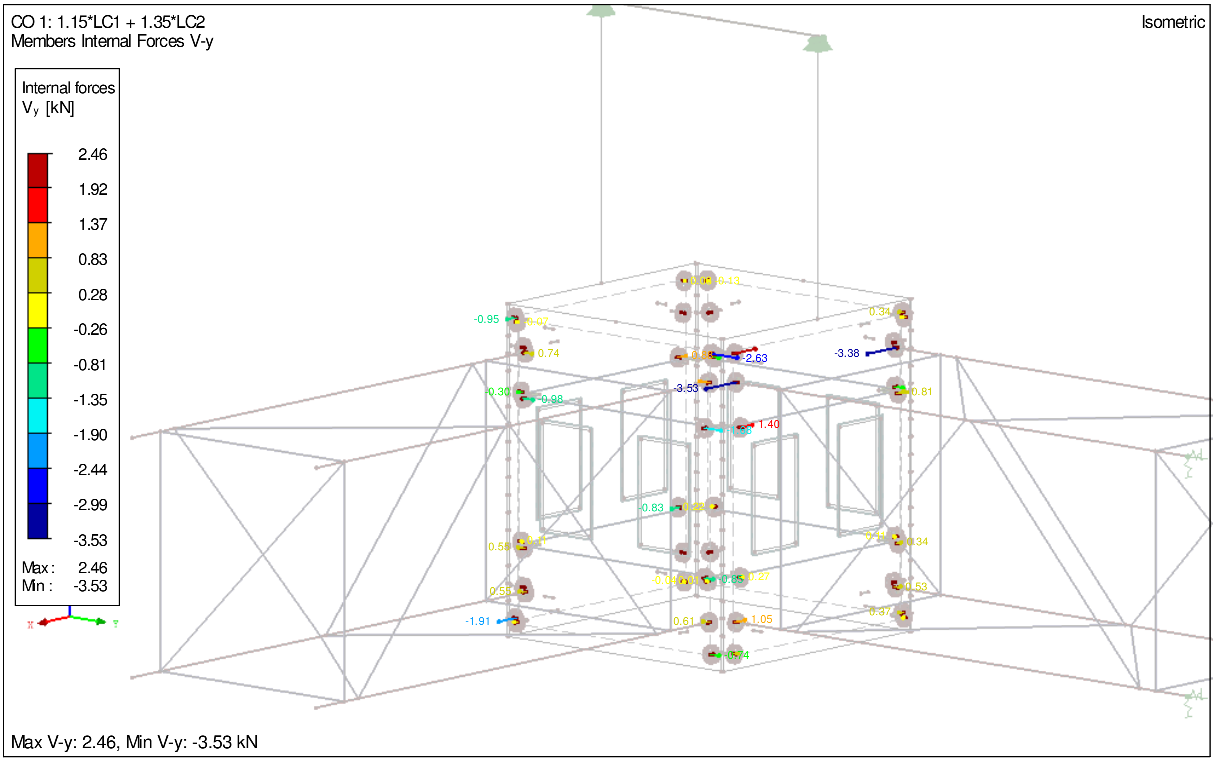
| Load-ing | Surface No. | FE Mesh Point No. | Point Coordinates [m] X | Y | Z | Stress [kN/cm²] Symbol | Existing | Limit | Stress Ratio [-] |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | |
| | 4 | 6 | -1,196 | -2,808 | 3,446 | $\tau_{max}$ | 8,58 | 15,01 | 0,57 |
| | 4 | 1764 | -1,226 | -2,808 | 3,370 | $\sigma_{1,+}$ | 14,91 | 26,00 | 0,57 |
| | 4 | 1518 | -1,215 | -2,808 | 3,046 | $\sigma_{2,+}$ | -11,15 | 26,00 | 0,43 |
| | 31 | 1486 | -1,225 | -2,814 | 3,042 | $\sigma_{1,-}$ | 33,32 | 64,00 | 0,52 |
| | 31 | 1486 | -1,225 | -2,814 | 3,042 | $\sigma_{2,-}$ | -36,24 | 64,00 | 0,57 |
| | 29 | 1483 | -1,225 | -2,814 | 3,381 | $\sigma_{1,m}$ | 9,04 | 64,00 | 0,14 |
| | 1 | 88 | -1,196 | -2,812 | 3,446 | $\sigma_{2,m}$ | -5,36 | 26,00 | 0,21 |
| | 31 | 1486 | -1,225 | -2,814 | 3,042 | $\sigma_{eqv,max}$ | 38,40 | 64,00 | 0,60 |
| | 1 | 88 | -1,196 | -2,812 | 3,446 | $\sigma_{eqv,m}$ | 5,92 | 26,00 | 0,23 |

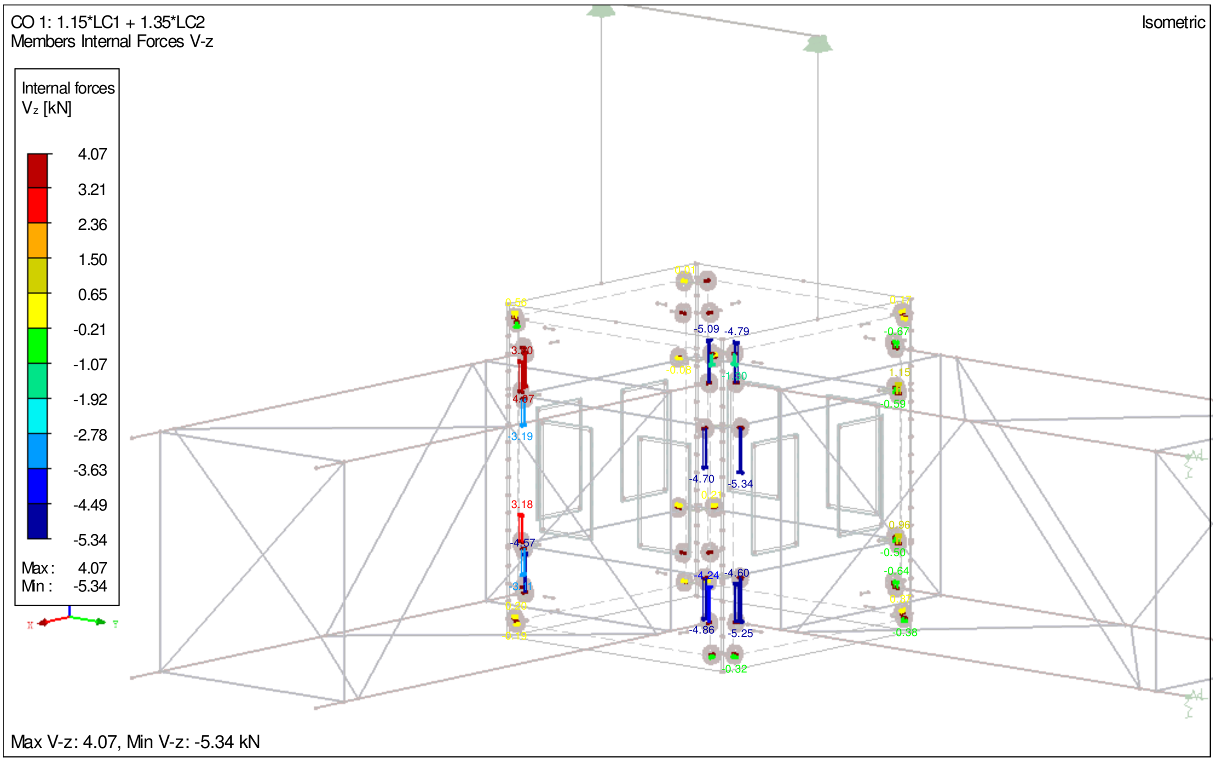
Maximum utilization $\sigma$eqv,max 0.75%

## Check of the M12 bolts

### Internal forces of the bolts






Maximum shear force = $\sqrt{(Vy^2 + Vz^2)} = \sqrt{(2.46^2 + 5.34^2)} = 5.88$ kN

$F_{v,rd} = 0,6 * f_{ub} * A/1.25 = 0.6 * 80 * 1.13/1.25 = 43.39$ kN

5.88 / 43.39 = 0.13 < 1

Maximum tension force = $N_{ed}$ = 3.53 kN

$F_{t,rd}$ = k2 * fub * As / 1.25 = 0.9 * 80 * 0.843 / 1.25 = 48.55 kN

3.53 / 48.55 = 0.072 < 1

Check of the interaction between shear and tension force

$F_{v,ed} / F_{v, rd} + F_{t, ed} / 1.4 * F_{t, rd} < 1$

5.88 / 43.39 + 3.53 / 1.4 * 48.55 = 0.19 < 1

Check of the bearing force in the hole of the plate.

Maximum shear force is $\sqrt{(Vy^2 + Vz^2)} = \sqrt{(2.46^2 + 5.34^2)} = 5.88$ kN

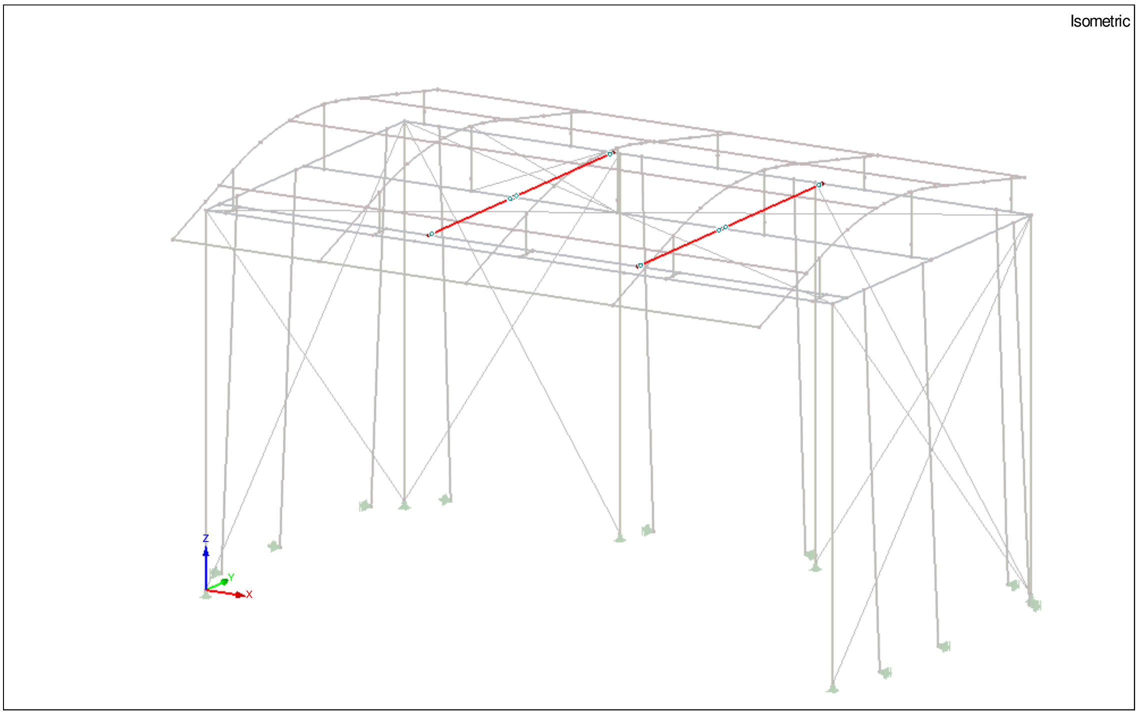
$F_{b,rd} = (k_1 * \alpha_b * f_u * d * t) / 1.25 = (2.5 * 1 * 25 * 1.25 * 0.8) / 1.25 = 50$ kN

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

5.88 / 50 = 0.12 < 1

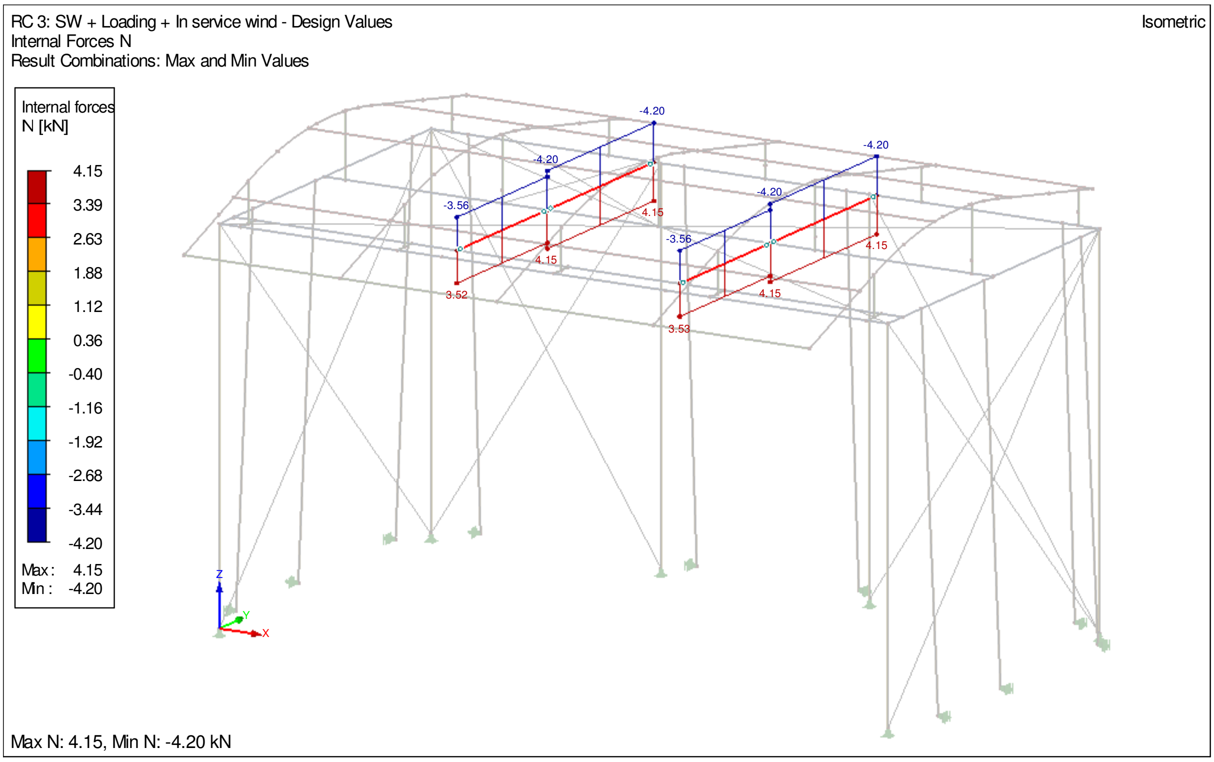
## 4.5 Check of the compression tubes in the main grid and the roof.

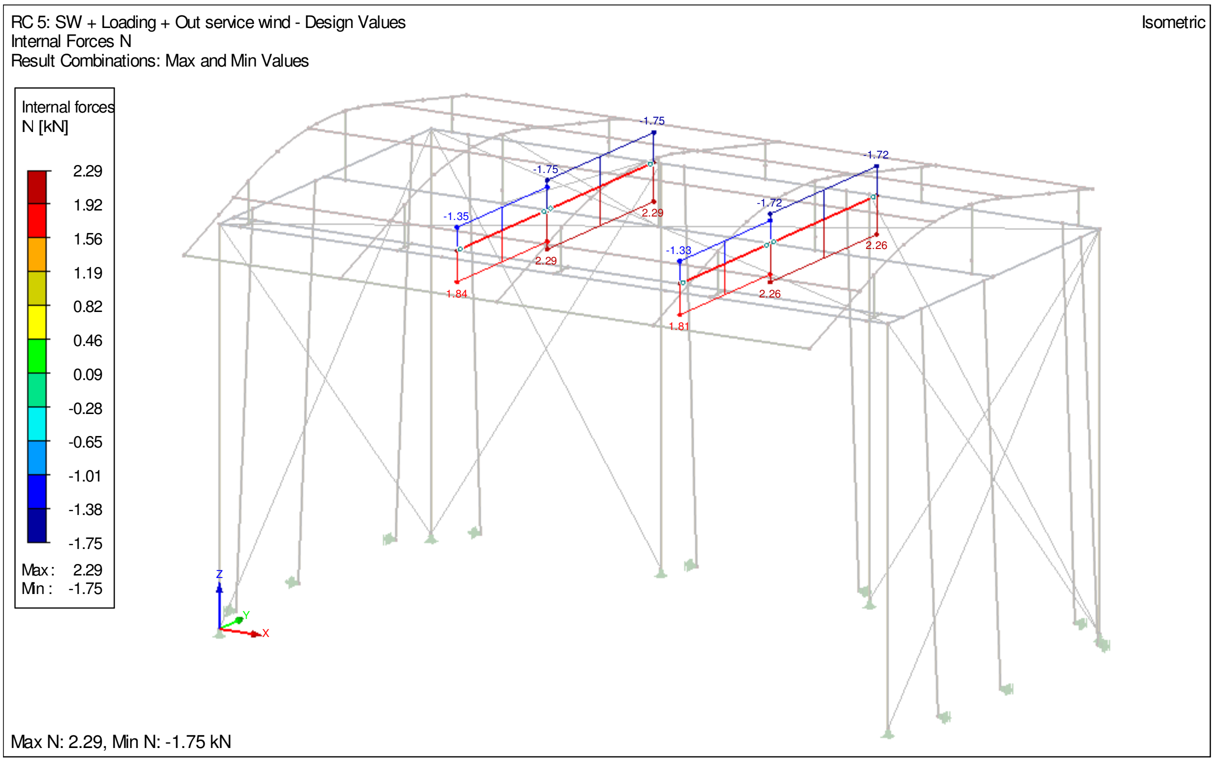
### 4.5.1 check of the 50x4 compression tubes in the main grid




.

The profile will be checked for buckling.






Normative load case In service

Maximum compression force in the 50x4 profile is 4.20 kN.
Buckling calculation for the profile
Buckling Length factor K = 1,5
The factor K is according to table 6,8 NEN-EN 1999-1-1

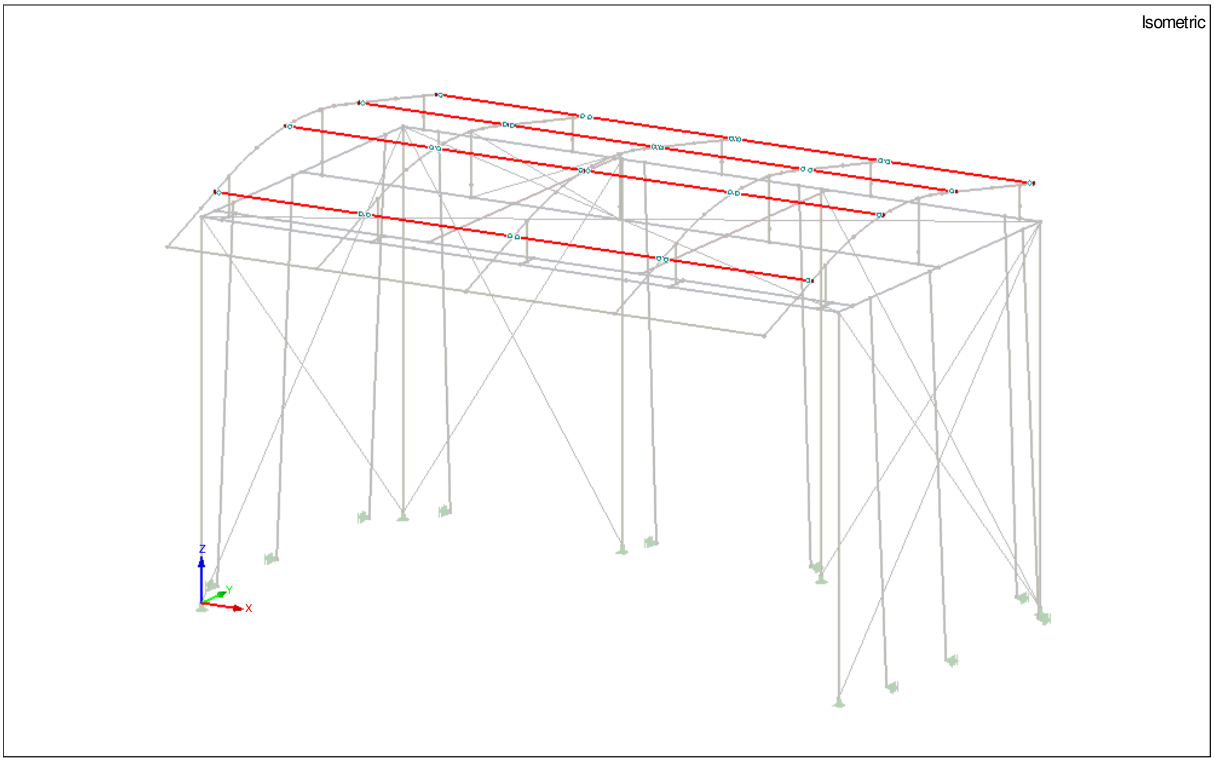
| | |
|---|---|
| L | 311 cm |
| Profile cross section A | 5.78 cm² |
| E | 7000 |
| $f_{0,\ haz}$ | 12.5 kN/cm² |
| I | 15.41 $cm^4$ |
| i √( I/A ) | 1.63 |

Buckling calculation
Lcr = L * K = 1.5 * 311 = 466.5 cm
$\lambda_z = Lcr / (iz * \pi) * (\sqrt{((A_{eff} * f_0 ) / A * E )})$
$\lambda_z = 466.5 / (1.63 * \pi) * (\sqrt{((5.78 * 12.5 ) / 5.78 * 7000 )}) = 5.44$
$\Theta_z = 0.5 * ( 1 + \alpha * ( \lambda_z – \lambda_0 ) + \lambda_z^2 )$
$\Theta_z = 0.5 * ( 1 + 0.2 * ( 5.44 – 0.1 ) + 5.44^2 ) = 15.82$
$X_z = 1 / (\Theta_z + \sqrt{( \Theta_z^2 - \lambda_z^2 )})$
$X_z = 1 / (15.82 + \sqrt{( 15.82^2 - 5.44^2 )}) = 0.03$

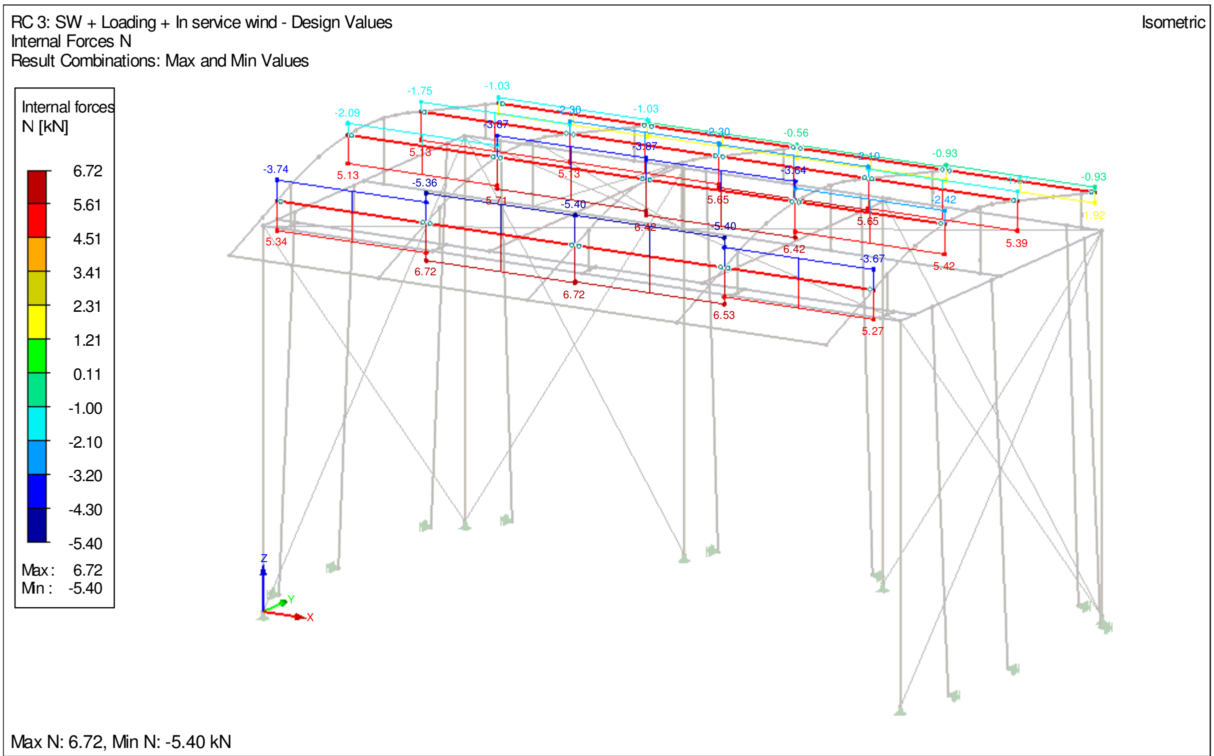
$N_{b,rd} = Xz * A * f_{0,\ haz} /1.1$
$N_{b,rd} = 0.03 * 5.78 * 12.5 /1.1 = 4.5$ kN
$N_{Ed,\ max} =4.20$ kN

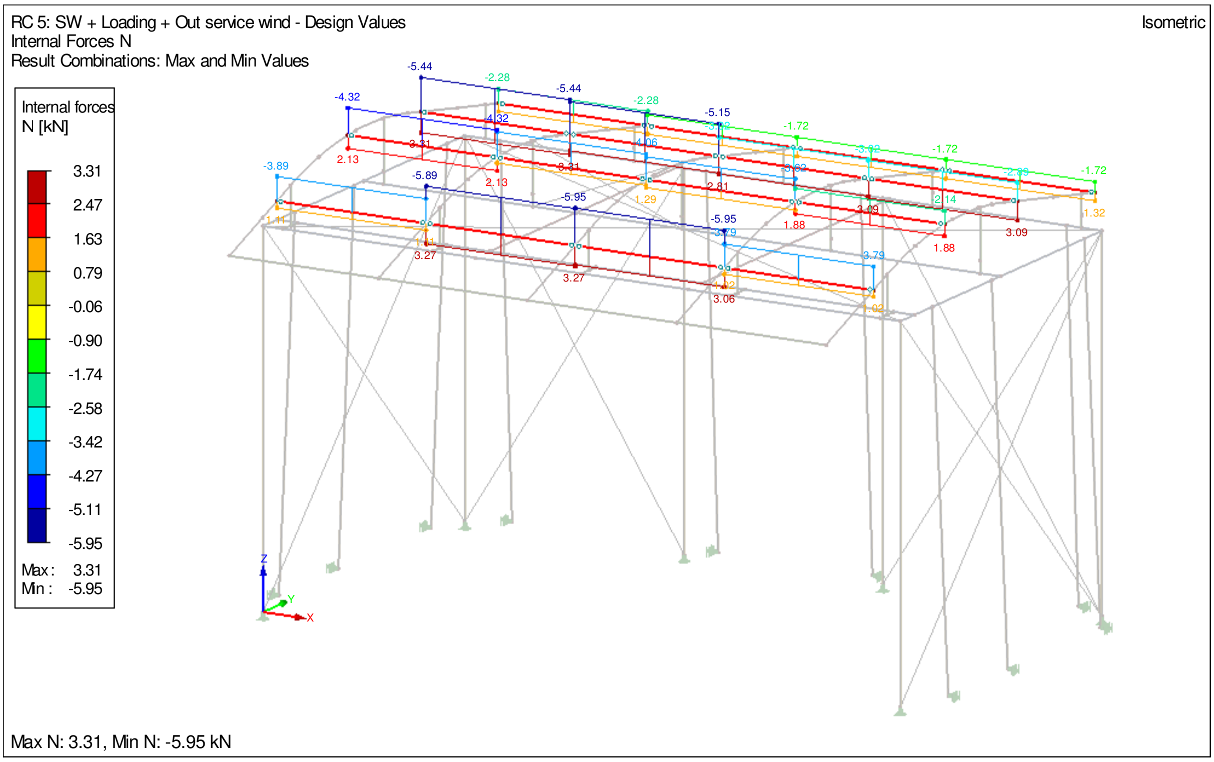
check = $N_{Ed,\ max} / N_{b,rd} < 1$
4.20 / 4.5 = 0.98 < 1

## 4.5.2 check of the 50x4 compression tubes of the roof structure.




The profile will be checked for buckling.






Normative load case Out service

Maximum compression force in the 50x4 profile is 5.95 kN.

Buckling calculation for the profile

Buckling Length factor K = 1

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

| | |
|---|---|
| L | 300 cm |
| Profile cross section A | 5.78 cm² |
| E | 7000 |
| $f_{0,\ haz}$ | 12.5 kN/cm² |
| I | 15.41 $cm^4$ |
| i √( I/A ) | 1.63 |

Buckling calculation

Lcr = L * K = 1 * 300 = 300 cm

$\lambda_z$ = Lcr / (iz * π) * (√(($A_{eff}$ * $f_0$ ) / A * E ))

$\lambda_z$ = 300 / (1.63 * π) * (√((5.78 * 12.5 ) / 5.78 * 7000 )) = 2.48

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

$\Theta_z = 0.5 * ( 1 + 0.2 * ( 2.48 - 0.1 ) + 2.48^2 ) = 3.81$

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

$X_z = 1 / (3.81 + \sqrt{( 3.81^2 - 2.48^2 )}) = 0.15$

$N_{b,rd}$ = Xz * A * $f_{0,\ haz}$ /1.1

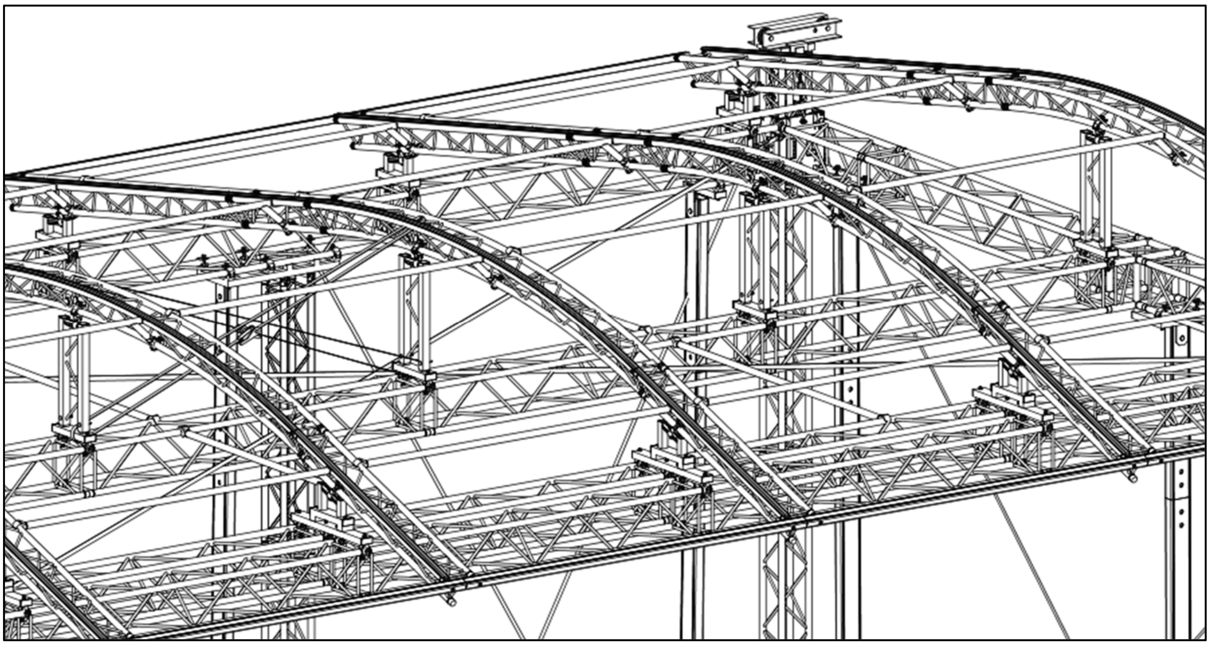
$N_{b,rd}$ = 0.15 * 5.78 * 12.5 /1.1 = 9.81 kN

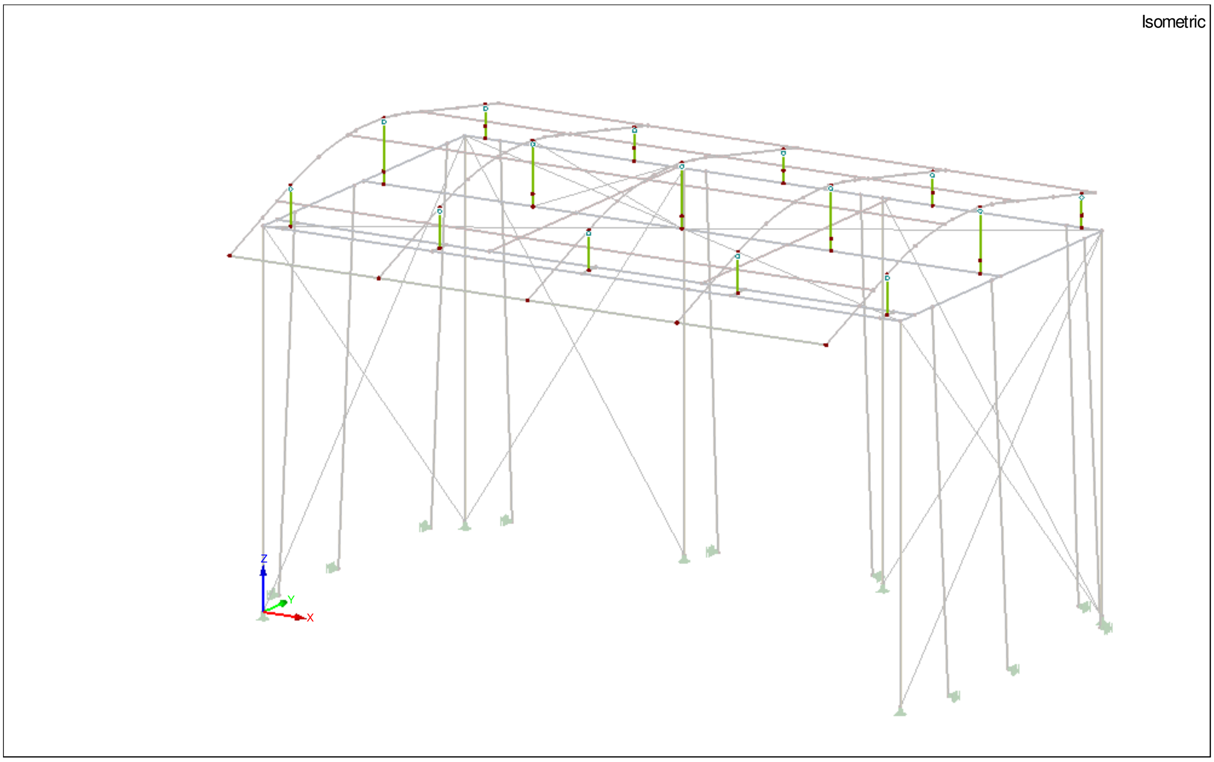
$N_{Ed,\ max}$ = 5.95 kN

check = $N_{Ed,\ max}$ / $N_{b,rd}$ < 1

5.95 / 9.81 = 0.60 < 1

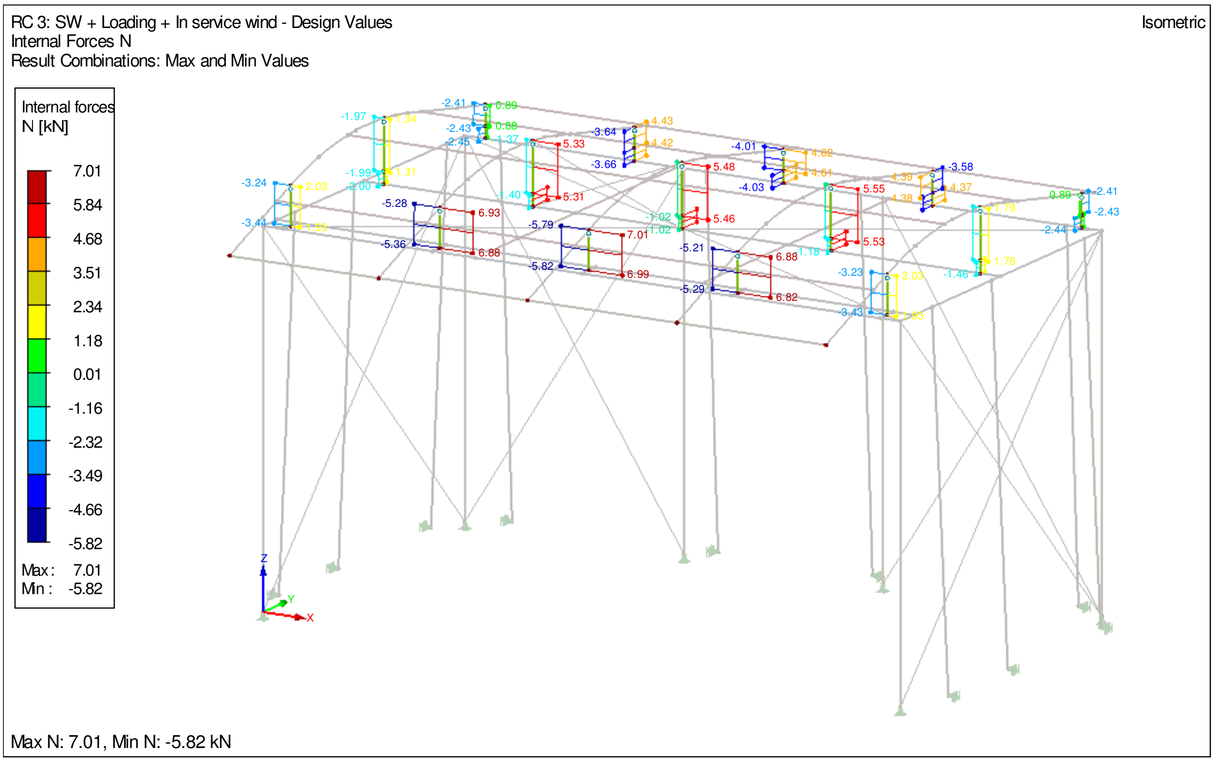
## 4.6 Check of the roof structure support.



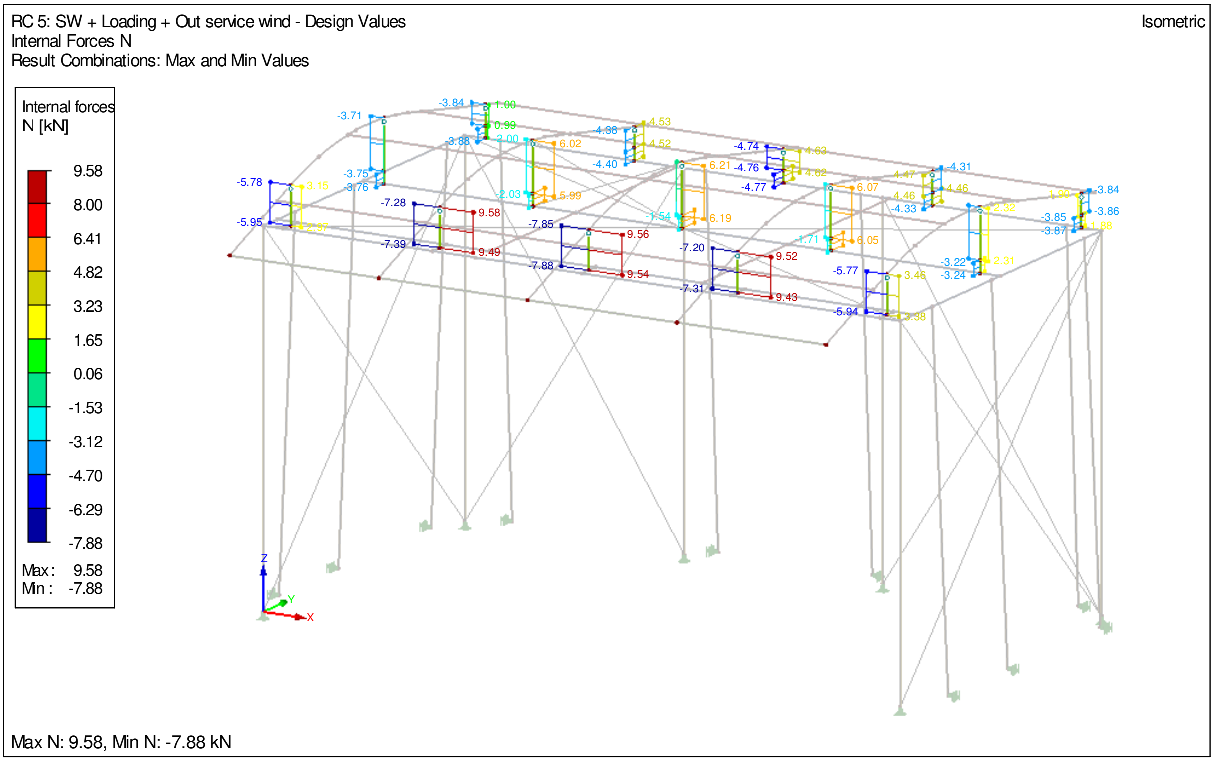


## Internal normal forces for the adapters

### Normal forces for RC3 In service




### Normal forces for RC5 Out service



Check of the adapters for the maximum tension force

Normative load result is the out-service situation.
Maximum tension force in the roof adapter is 9.58 kN.

A = 2 * A(50x4 square tube) = 2 * 7.36 = 14.72 cm²

The profile is Tig welded at both ends therefor 0.8 * $f_{0,haz}$ is used to determine the maximum tension force in the profile.

Maximum tension force = (0.8 * $f_{0,haz}$) / 1.1 * $A_{net}$ = 4.8 / 1.1 * 14.72 = 64.23 kN

8.54 / 64.32 = 0.13 < 1

The adapter is mounted with two doughty clamps to the main grid. Each Doughty clamp has a WLL of 500 kg and a safety factor of 5.

The maximum characteristic tension force in the Out service situation is 7.02 kN

7.02 / (5 * 2) = 0.70 < 1

Check of the adapters with maximum compression force
Normative load result is the Out service
Maximum compression force is 7.88 kN which works in two tubes.
Buckling calculation for the 60x60 profile
Buckling Length factor K = 1.5
The factor K is according to table 6,8 NEN-EN 1999-1-1

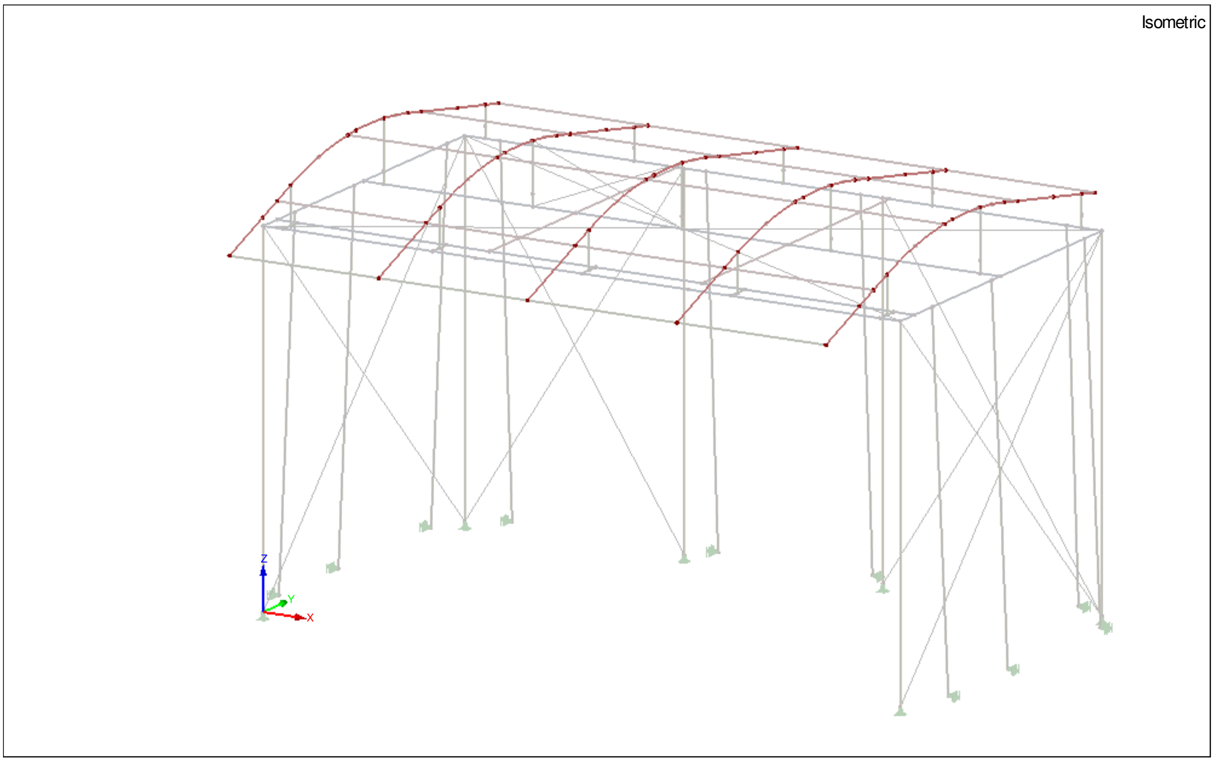
| | |
|---|---|
| L | 120 cm |
| Profile cross section A | 7.36 cm² |
| E | 7000 |
| $f_{0,\,haz}$ | 6.0 kN/cm² |
| I | 26.15 $cm^4$ |
| i √( I/A ) | 1.89 |

Buckling calculation
Lcr = L * K = 1.5 x 120 = 180 cm
$\lambda_z$ = Lcr / (iz * π) * (√(($A_{eff}$ * $f_0$ ) / A * E ))
$\lambda_z$ = 180 / (1.89 * π) * (√((4.27 * 4.8 ) / 4.27 * 7000 )) = 2.07
$\Theta_z$ = 0.5 * ( 1 + α * ( $\lambda_z - \lambda_0$ ) + $\lambda_z^2$ )
$\Theta_z$ = 0.5 * ( 1 + 0.2 * ( 2.07 – 0.1 ) + $2.07^2$ ) = 2.84
$X_z$ = 1 / ($\Theta_z$ + √( $\Theta_z^2 - \lambda_z^2$ ))
$X_z$ = 1 / (2.84 + √( 2.84² - 2.07² )) = 0.21

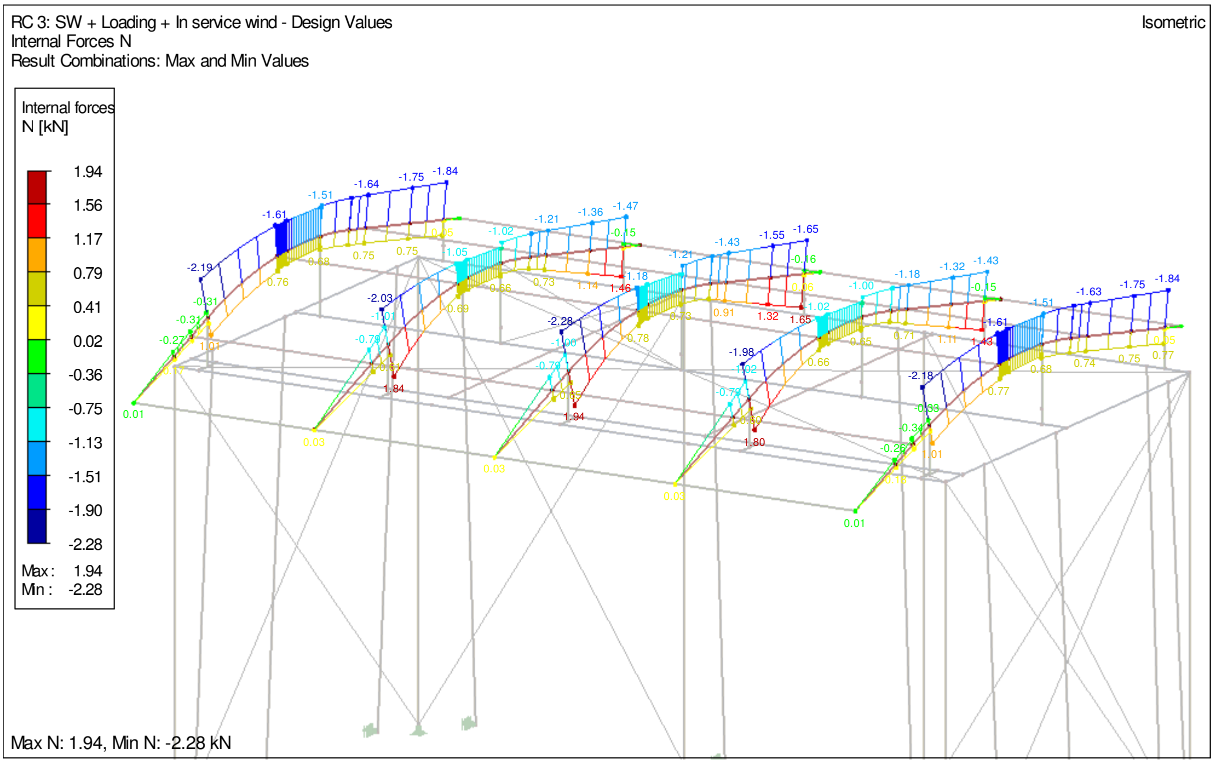
$N_{b,rd}$ = Xz * A * $f_{0,\,haz}$ /1.1
$N_{b,rd}$ = 0.21 * (2*7.36) * 6.0 /1.1 = 25.97 kN
$N_{Ed,\,max}$ =7.88 / 2 = 3.94 kN

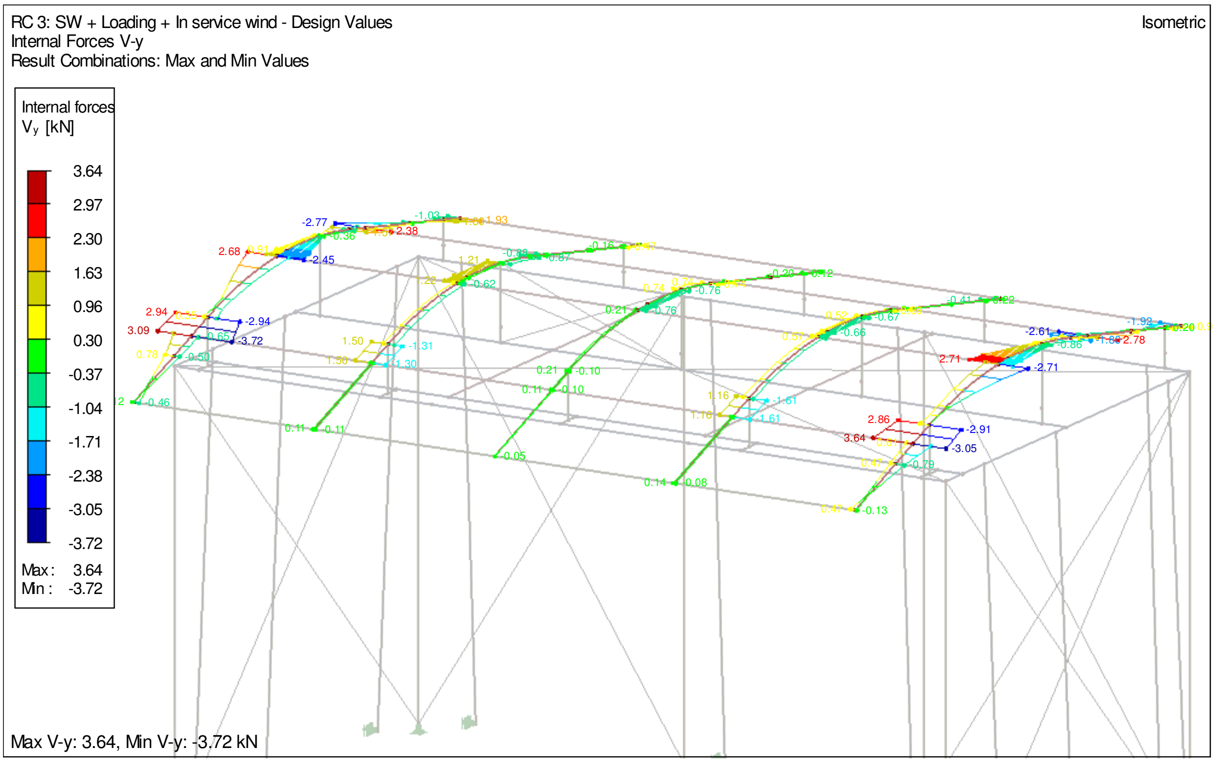
check = $N_{Ed,\,max}$ / $N_{b,rd}$ < 1
3.94 / 25.97 = 0.19 < 1

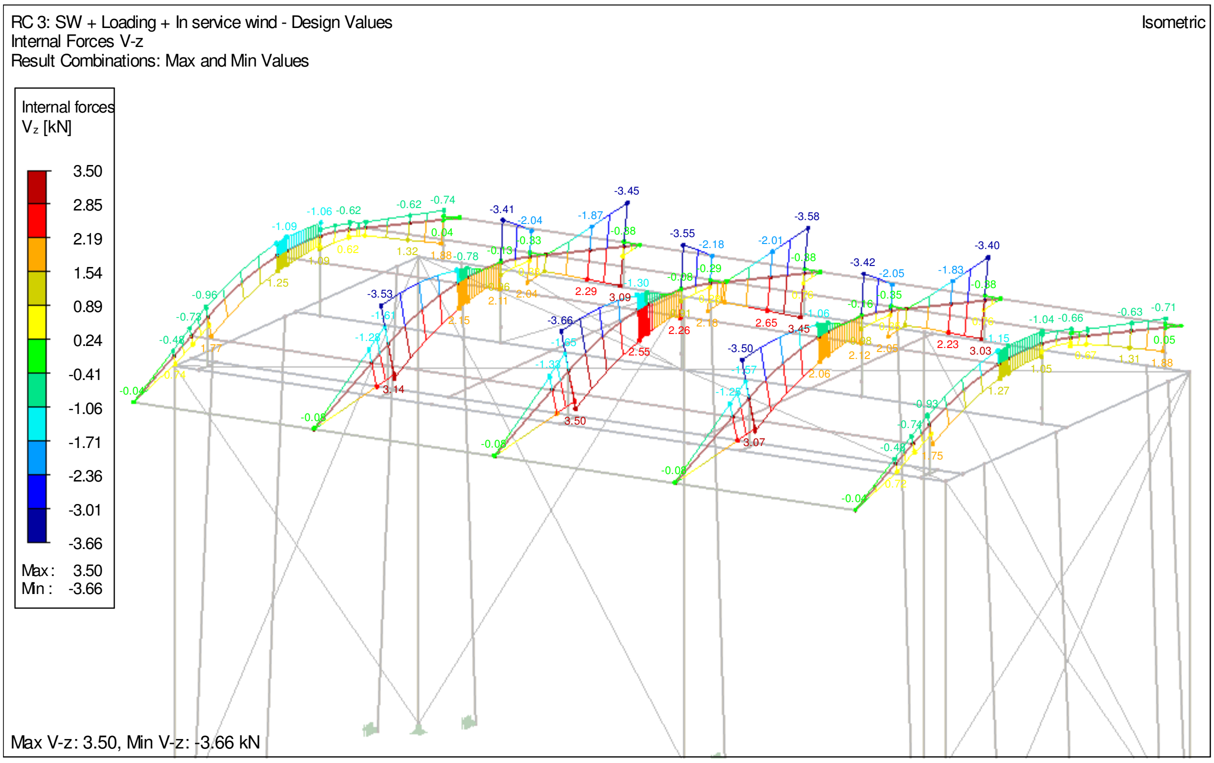
## 4.7 Check of the H30D roof truss

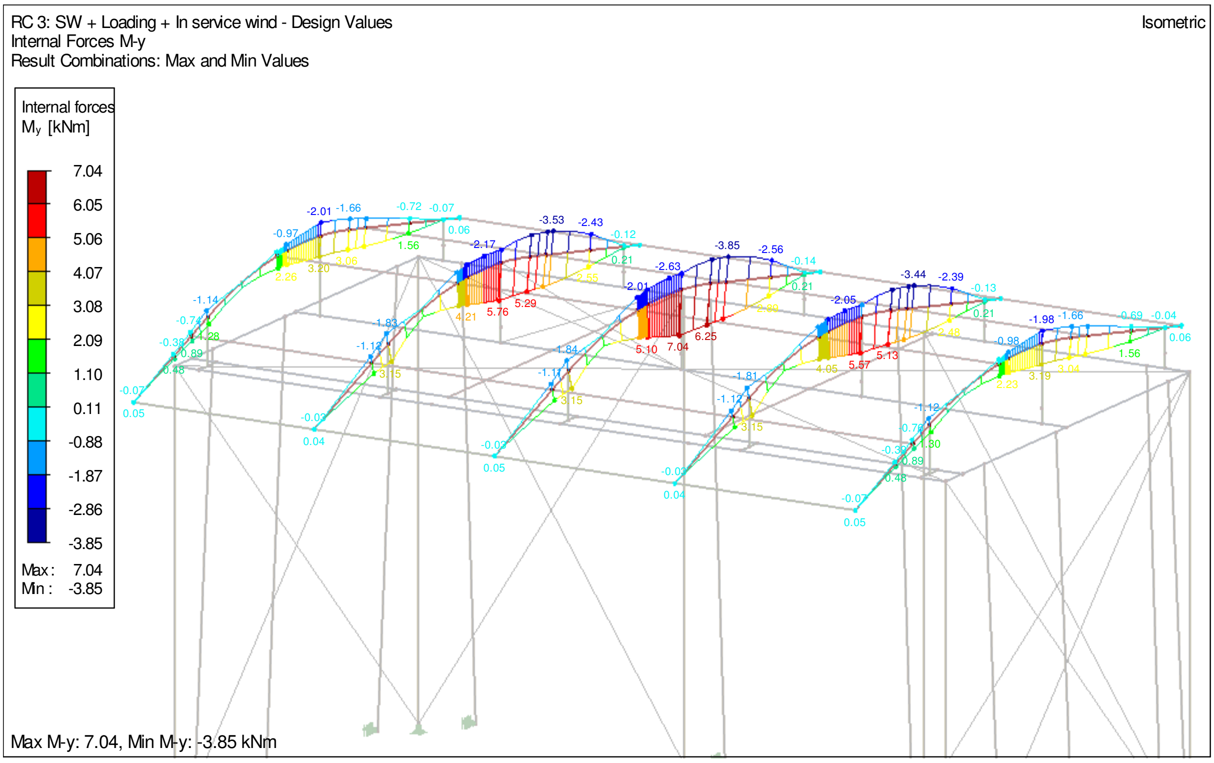


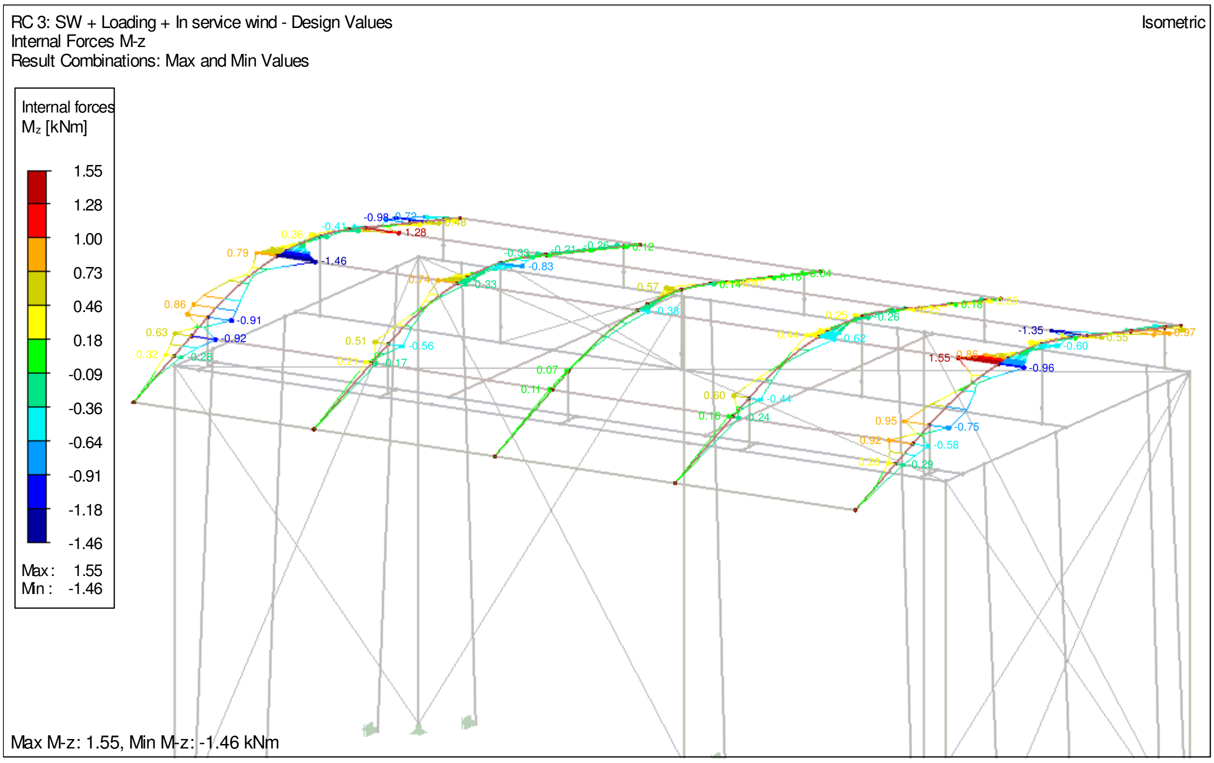

Internal forces for the RC3 In service



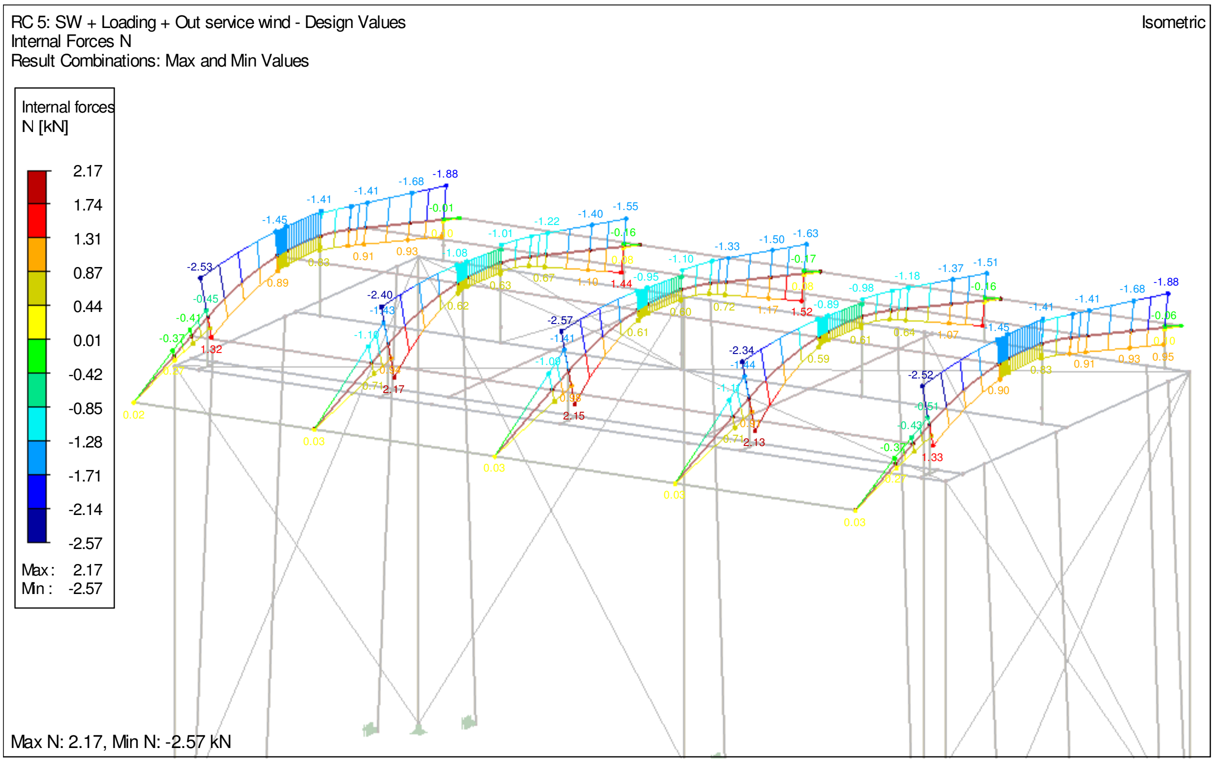

RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-y
Result Combinations: Max and Min Values
Isometric
Internal forces
Vy [kN]
3.64
2.97
2.30
1.63
0.96
0.30
-0.37
-1.04
-1.71
-2.38
-3.05
-3.72
Max : 3.64
Min : -3.72
Max V-y: 3.64, Min V-y: -3.72 kN

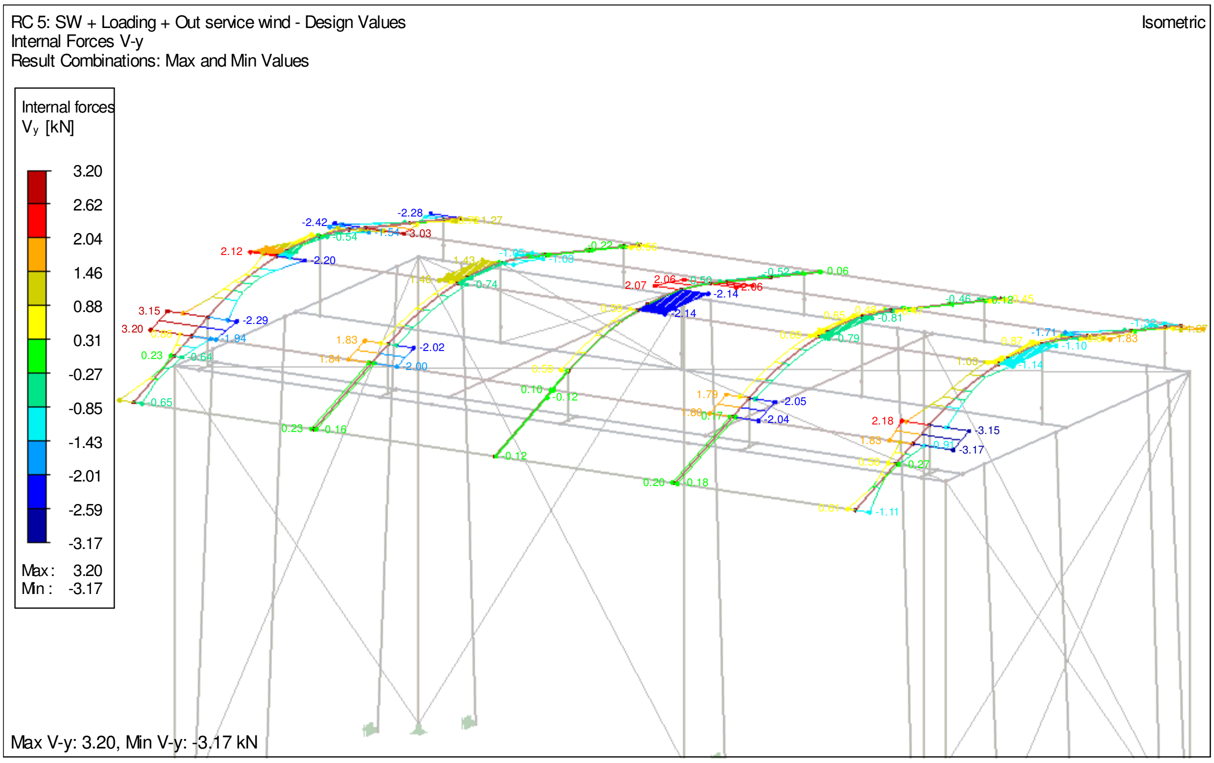

RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
3.50
2.85
2.19
1.54
0.89
0.24
-0.41
-1.06
-1.71
-2.36
-3.01
-3.66
Max : 3.50
Min : -3.66
Max V-z: 3.50, Min V-z: -3.66 kN

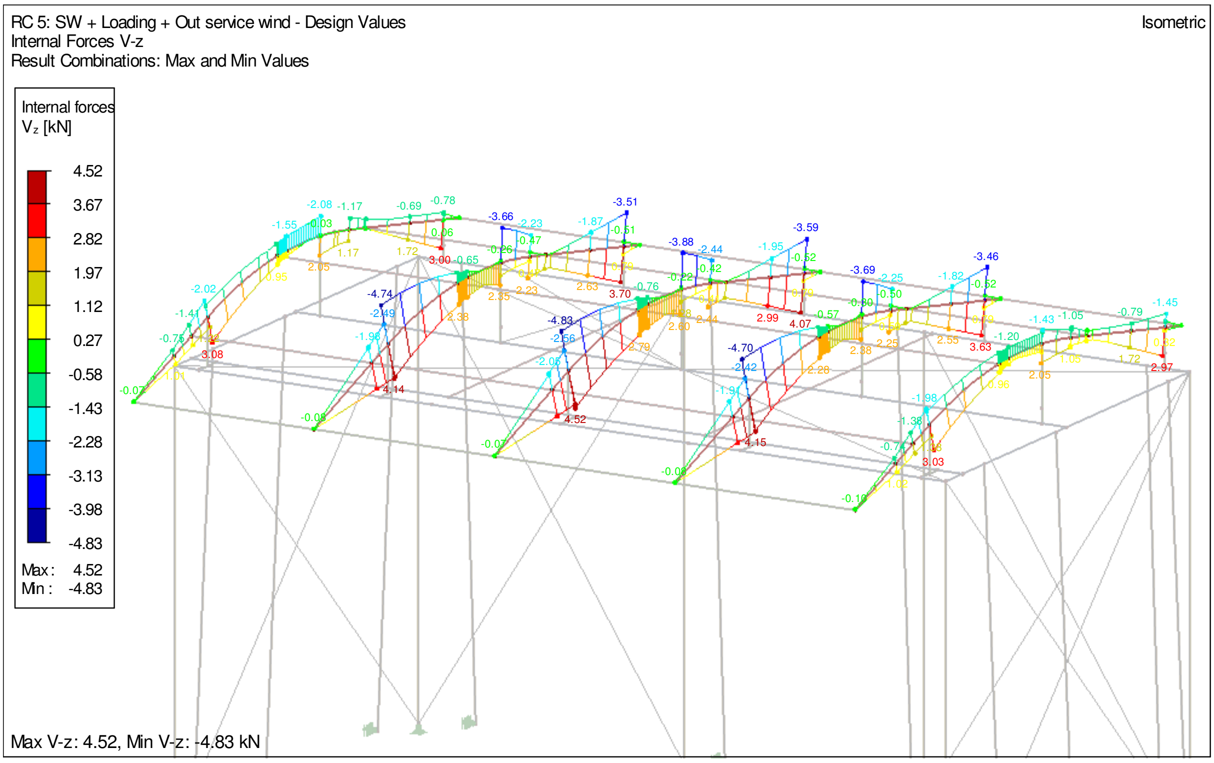

RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
7.04
6.05
5.06
4.07
3.08
2.09
1.10
0.11
-0.88
-1.87
-2.86
-3.85
Max : 7.04
Min : -3.85
Max M-y: 7.04, Min M-y: -3.85 kNm

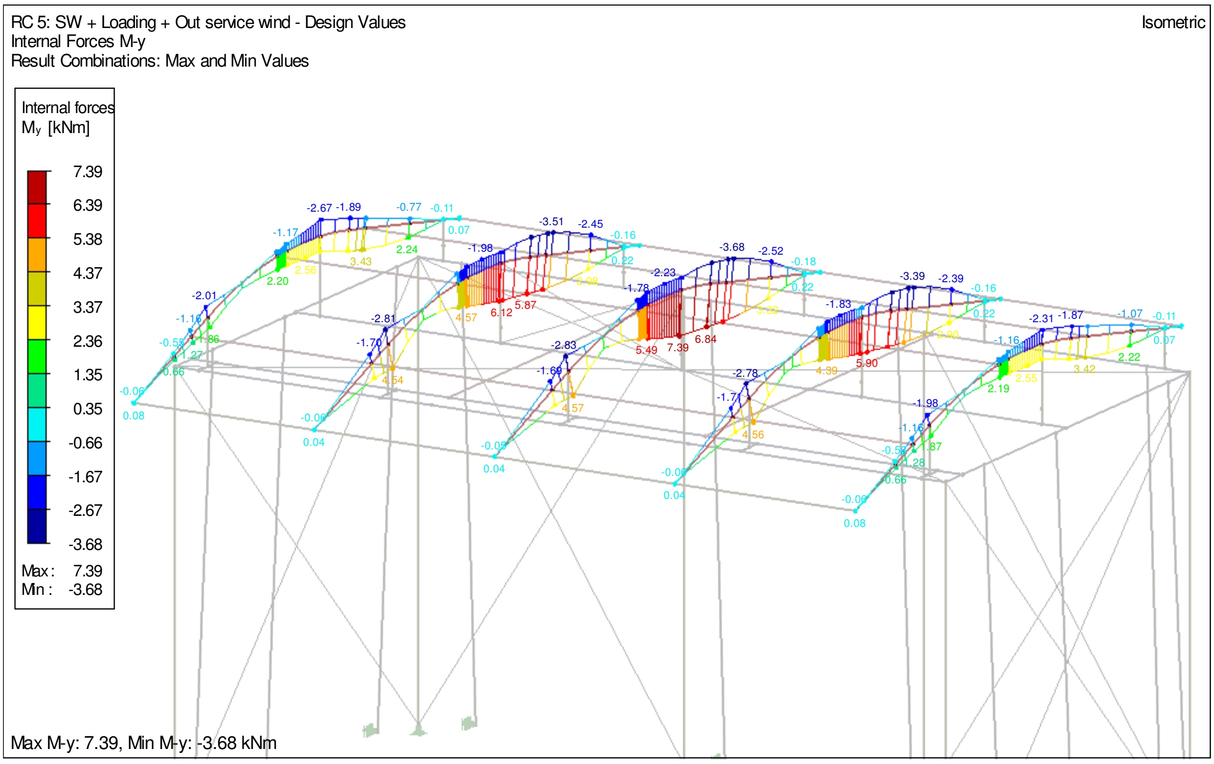

RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
1.55
1.28
1.00
0.73
0.46
0.18
-0.09
-0.36
-0.64
-0.91
-1.18
-1.46
Max : 1.55
Min : -1.46
Max M-z: 1.55, Min M-z: -1.46 kNm

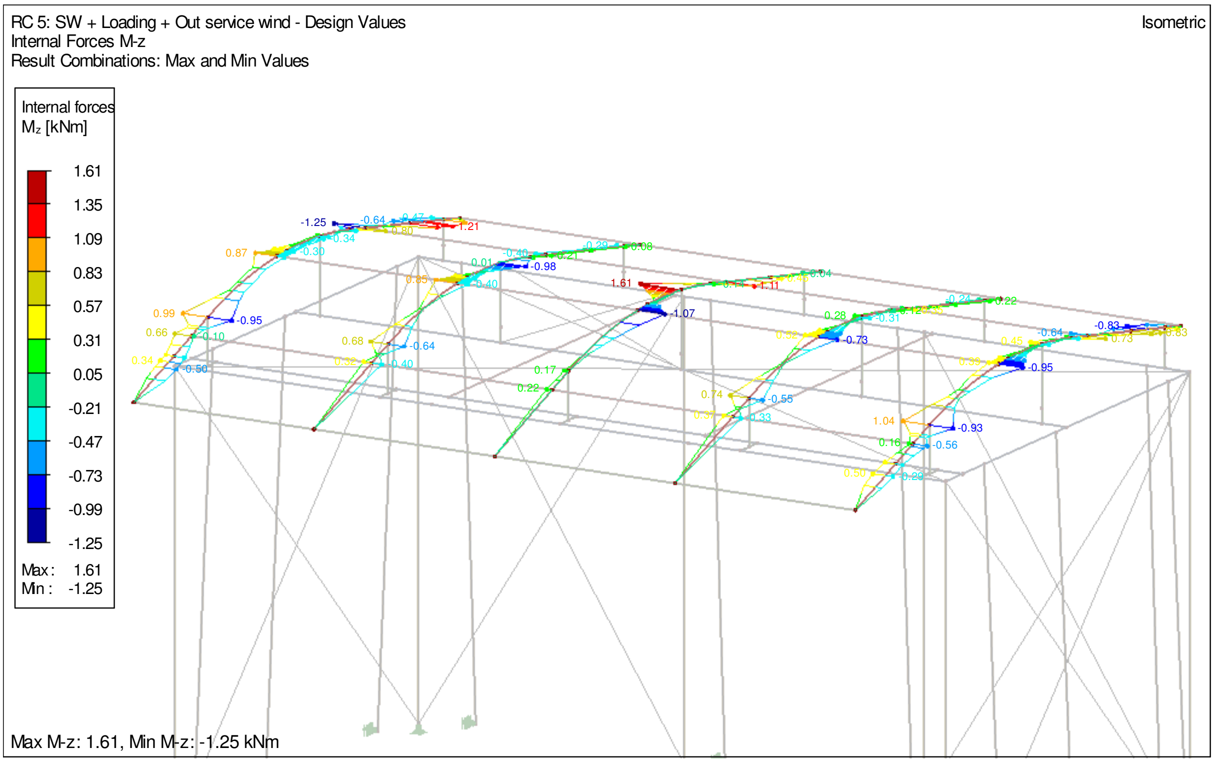
## Internal forces for the RC5 Out service



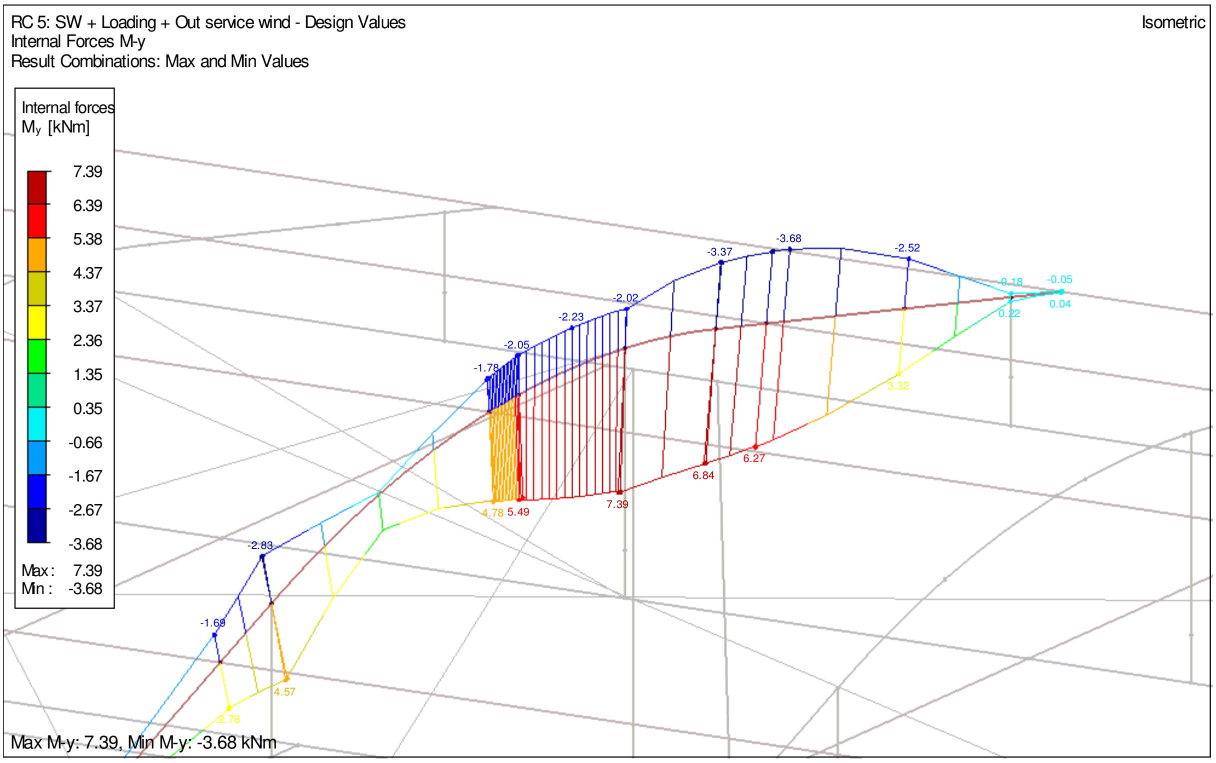

RC 5: SW + Loading + Out service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
$V_z$ [kN]
4.52
3.67
2.82
1.97
1.12
0.27
-0.58
-1.43
-2.28
-3.13
-3.98
-4.83
Max : 4.52
Min : -4.83
Max V-z: 4.52, Min V-z: -4.83 kN


RC 5: SW + Loading + Out service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
$M_y$ [kNm]
7.39
6.39
5.38
4.37
3.37
2.36
1.35
0.35
-0.66
-1.67
-2.67
-3.68
Max : 7.39
Min : -3.68
Max M-y: 7.39, Min M-y: -3.68 kNm




Normative Result combination RC5 Out service

Maximum Internal forces in the middle span on the back side.



Internal forces for the selected truss parts in normative load combination CO228

| Member No. | Node No. | Location x [m] | Forces [kN] N | $V_y$ | $V_z$ | Moments [kNm] $M_T$ | $M_y$ | $M_z$ |
|---|---|---|---|---|---|---|---|---|
| 29 | 93 | 0,000 | -1,10 | 0,20 | -0,26 | -0,02 | 7,39 | 0,02 |
| | 18 | 0,420 | -1,16 | 0,19 | -0,66 | -0,02 | 7,20 | -0,06 |
| | 24 | 0,839 | -1,25 | 0,19 | -1,06 | -0,02 | 6,84 | -0,14 |
| 146 | 91 | 0,000 | -1,50 | -0,09 | 2,99 | -0,01 | 3,32 | 0,12 |
| | 45 | 1,287 | -1,33 | -0,06 | 1,59 | -0,02 | 6,27 | 0,22 |
| 147 | 45 | 0,000 | -1,33 | 0,17 | 1,57 | -0,02 | 6,22 | 0,22 |
| | 24 | 0,471 | -1,26 | 0,18 | 1,05 | -0,02 | 6,84 | 0,14 |
| 153 | 98 | 0,000 | -0,95 | -0,17 | 2,46 | -0,02 | 5,49 | -0,16 |
| | 144 | 0,906 | -0,81 | -0,19 | 1,52 | -0,02 | 7,29 | 0,01 |
| | 93 | 0,974 | -0,72 | -0,19 | 1,49 | -0,02 | 7,39 | 0,02 |

Interaction of moment and transversal force calculation in node 93

$N_d$ = 1.10 kN
$V_{dy}$ = 0.20 kN
$V_{dz}$ = 0.26 kN
$M_{dy}$ = 7.39 kN
$M_{dz}$ = 0.02 kN
$V_{d,\ main\ chord} = 0.33 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.33 * \sqrt{(0.20^2 + 0.26^2)}$
$V_{d,\ main\ chord}$ = 0.109 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.109 * 0.05$
$M_{d,\ main\ chord}$ = 0.005 kNcm
$N_{d,\ main\ chord} = N_d/3 + M_{dy} / h + M_{dz} / b$
$N_{d,\ main\ chord} = 1.10/ 3 + 7.39 / 0.207 + 0.02 / 0.239$
$N_{d,\ main\ chord}$ = 36.15 kN

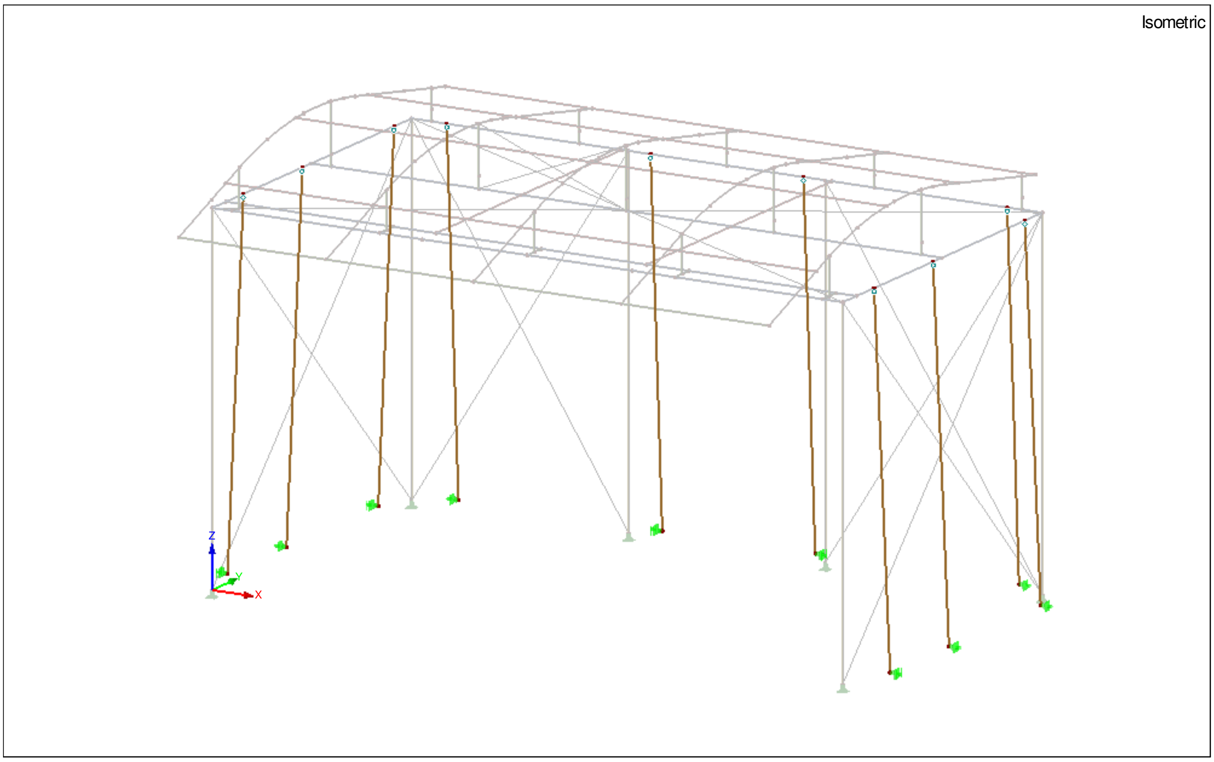
Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 36.15 / 50.22 )^{1.3} + 0.005 / 0.532 = 0.66 < 1$

Interaction of moment and transversal force calculation in node 45

$N_d$ = 1.33 kN
$V_{dy}$ = 0.06 kN
$V_{dz}$ = 1.59 kN
$M_{dy}$ = 6.27 kN
$M_{dz}$ = 0.22 kN
$V_{d,\ main\ chord} = 0.33 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.33 * \sqrt{(0.06^2 + 1.59^2)}$
$V_{d,\ main\ chord}$ = 0.53 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.53 * 0.05$
$M_{d,\ main\ chord}$ = 0.026 kNcm
$N_{d,\ main\ chord} = N_d/3 + M_{dy} / h + M_{dz} / b$
$N_{d,\ main\ chord} = 1.33 / 3 + 6.27 / 0.207 + 0.22 / 0.239$
$N_{d,\ main\ chord}$ = 31.65 kN

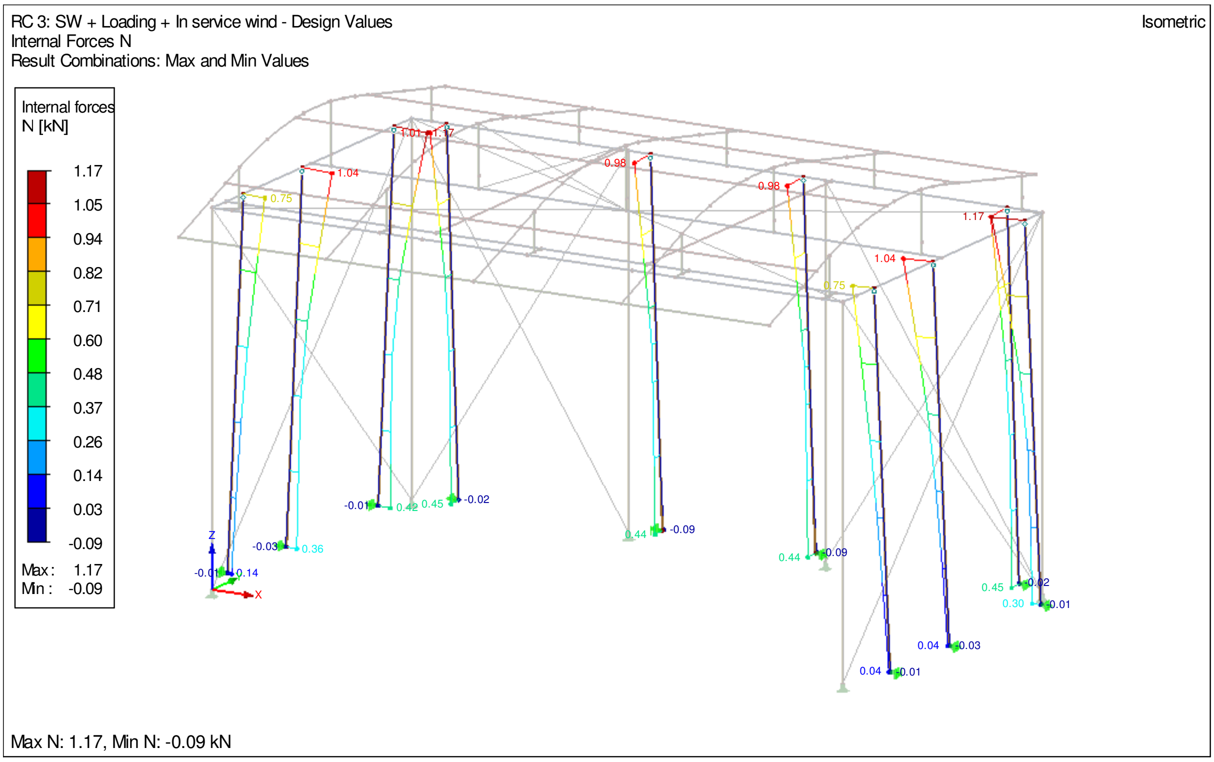
Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 31.65 / 50.22 )^{1.3} + 0.026 / 0.532 = 0.59 < 1$

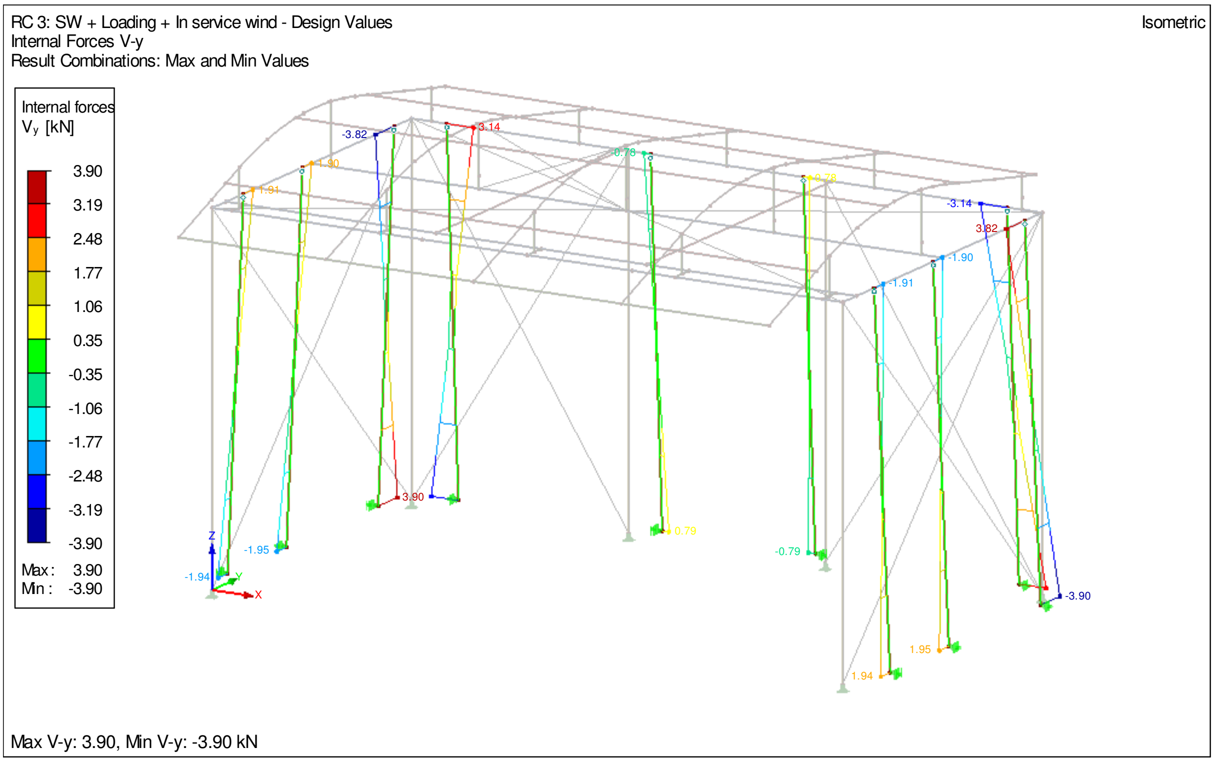
## 4.8 Check of the Side and back wall kedar system.

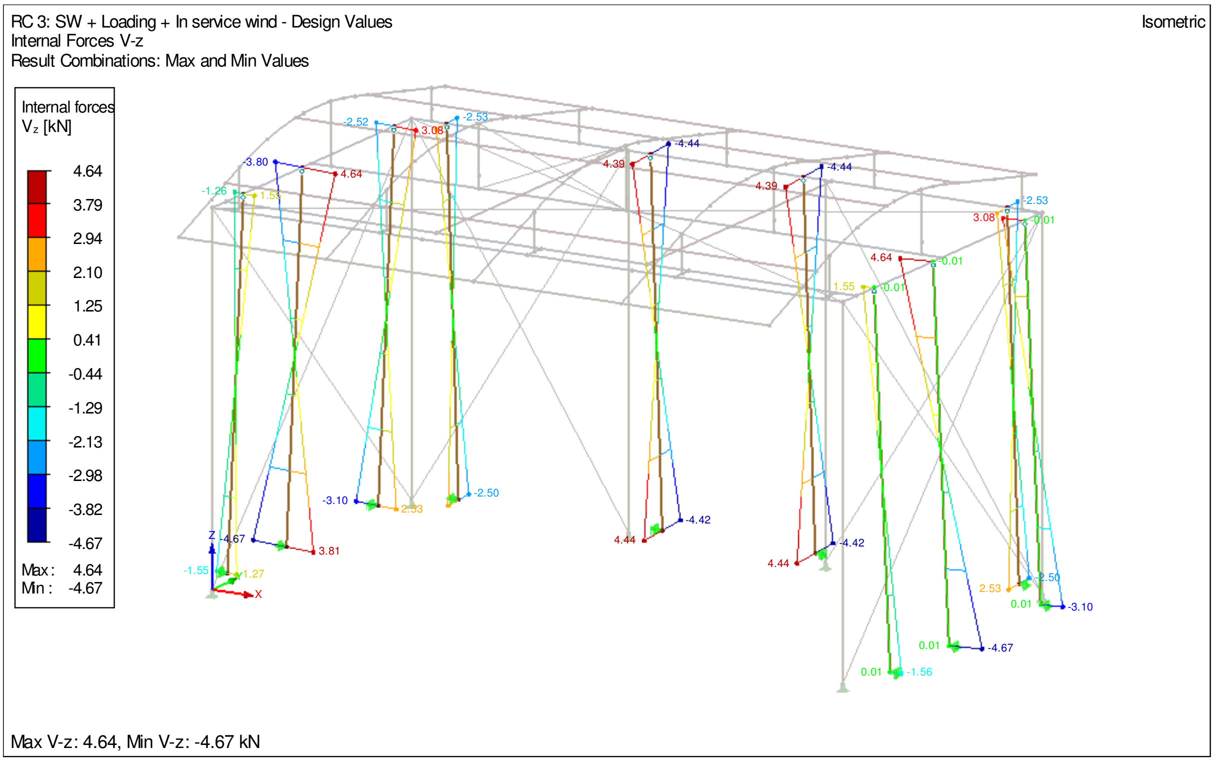


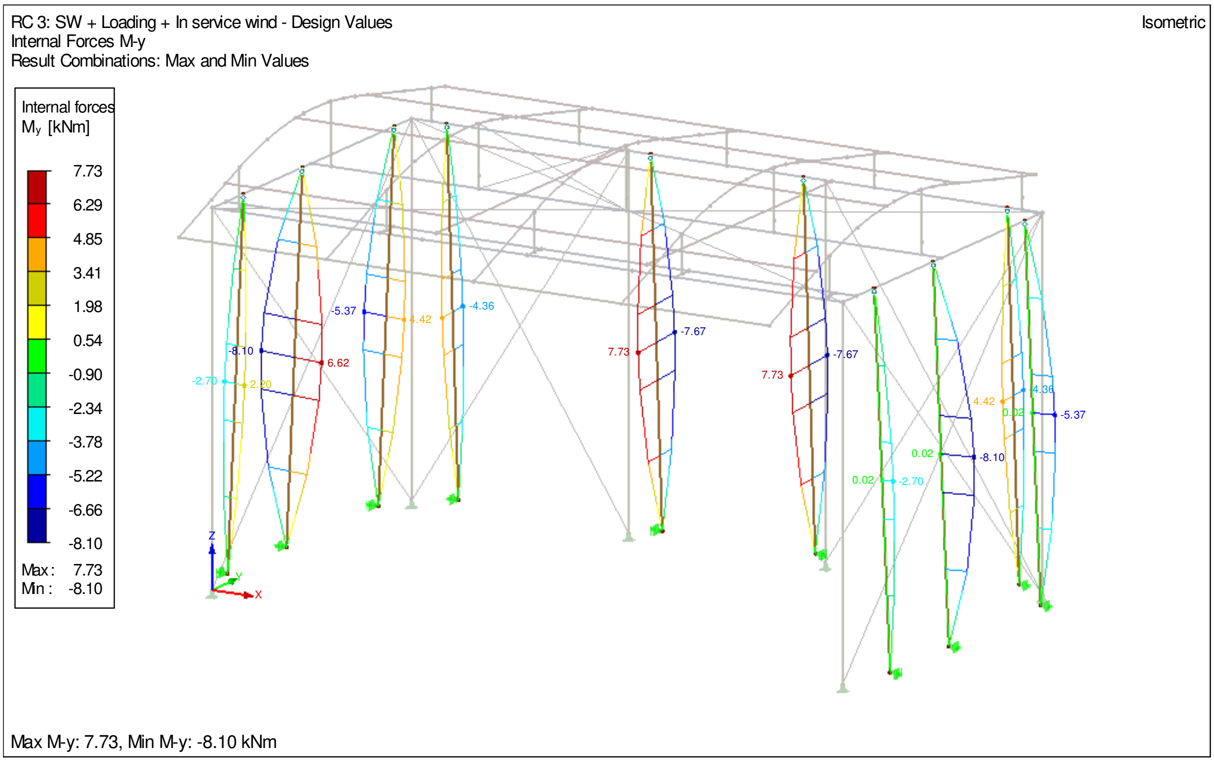

Normative load result is RC3 because In the out service there are no Side walls attached.

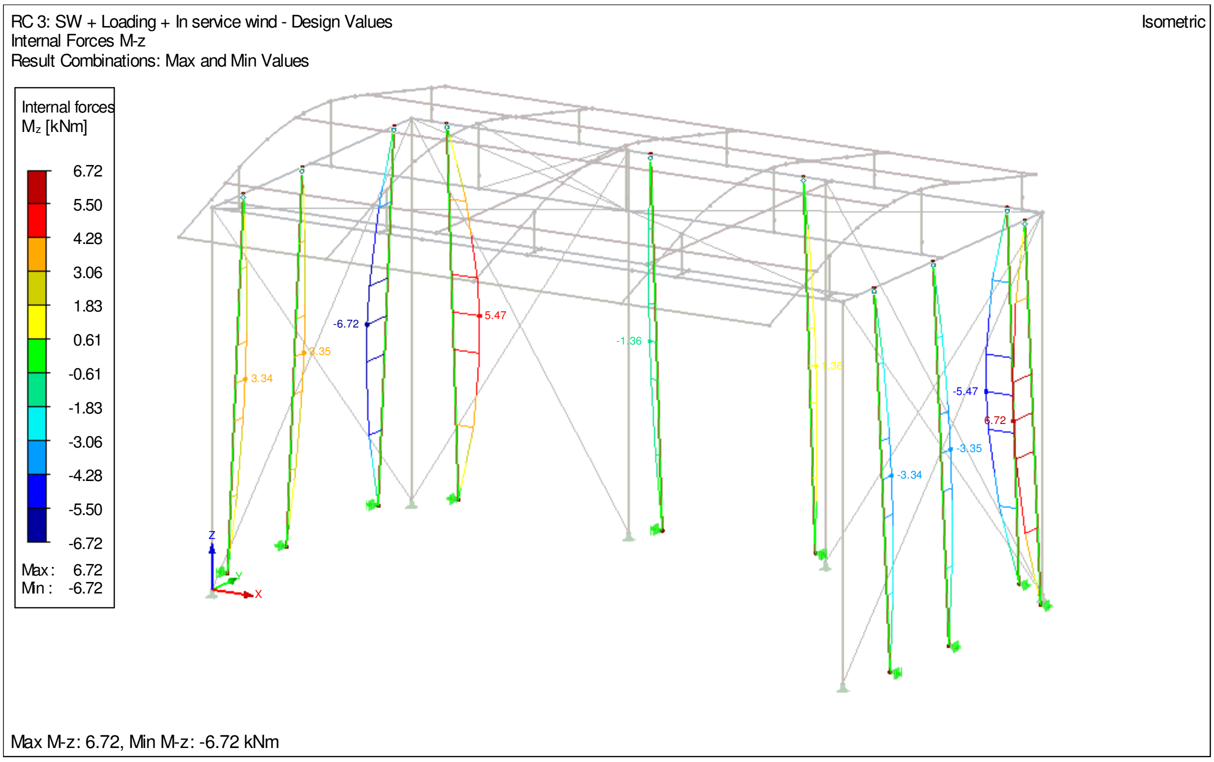
Internal forces of the side keder profile for RC3 In service

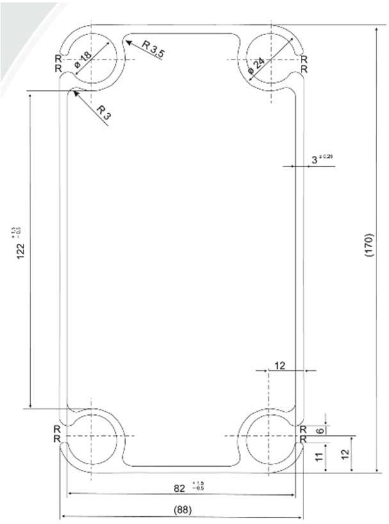



RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-y
Result Combinations: Max and Min Values
Isometric
Internal forces
Vy [kN]
3.90
3.19
2.48
1.77
1.06
0.35
-0.35
-1.06
-1.77
-2.48
-3.19
-3.90
Max : 3.90
Min : -3.90
Max V-y: 3.90, Min V-y: -3.90 kN


RC 3: SW + Loading + In service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
4.64
3.79
2.94
2.10
1.25
0.41
-0.44
-1.29
-2.13
-2.98
-3.82
-4.67
Max : 4.64
Min : -4.67
Max V-z: 4.64, Min V-z: -4.67 kN


RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
$M_y$ [kNm]
7.73
6.29
4.85
3.41
1.98
0.54
-0.90
-2.34
-3.78
-5.22
-6.66
-8.10
Max : 7.73
Min : -8.10
Max M-y: 7.73, Min M-y: -8.10 kNm


RC 3: SW + Loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
$M_z$ [kNm]
6.72
5.50
4.28
3.06
1.83
0.61
-0.61
-1.83
-3.06
-4.28
-5.50
-6.72
Max : 6.72
Min : -6.72
Max M-z: 6.72, Min M-z: -6.72 kNm




**Cross-Section Properties**

| | | | |
|---|---|---|---|
| **Moments of inertia** | | | |
| Torsion | J : | 100.00 | [cm⁴] |
| Bending | $I_y$ : | 766.50 | [cm⁴] |
| | $I_z$ : | 230.70 | [cm⁴] |
| **Cross-sectional areas** | | | |
| Axial | A : | 18.98 | [cm²] |
| Shear | $A_y$ : | 18.50 | [cm²] |
| | $A_z$ : | 18.50 | [cm²] |
| **Inclination of principal axes** | | | |
| Angle | α : | 0.00 | [°] |
| **Overall dimensions (for non-uniform temperature loads)** | | | |
| Width | b : | 170.0 | [mm] |
| Depth | h : | 88.0 | [mm] |

Material = EN AW-6005A

$f_0 = 21.5$ kN/cm²

$\gamma_m = 1.1$

The Check of the middle profile in the side wall with the maximum forces in the result combination RC3

Weakest cross section

$A_{nett} = A_{profiel} – 2 * 30$mm hole
$A_{nett} = 18.89 – 2 * 3 * 0.3 = 17.09$ cm²

$N_{ed, max} = 1.04$ kN
$V_{y, ed max} = 1.95$ kN
$Vz_{, ed max} = 4.67$ kN
$M_{y, ed max} = 8.10$ kNm
$M_{z, ed max} = 3.35$ kNm

Calculation

$\sigma_n = N_{ed, max} / A = 1.04 / 17.09 = 0.061$ kN/cm²
$\sigma_{vy} = V_{y, ed max} / A = 1.95 / 17.09 = 0.114$ kN/cm²
$\sigma_{vz} = V_{z, ed max} / A = 4.67 / 17.09 = 0.273$ kN/cm²
$\sigma_{my} = M_{y, ed max} / (I_y / e) = 810 / (766.5 / 8.5) = 8.982$ kN/cm²
$\sigma_{mz} = M_{z, ed max} / (I_z / e) = 335 / (230.7 / 4.4) = 6.389$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2}$
$\sigma_{tot} = \sqrt{((0.061 + 8.982 + 6.389)^2 + 3*(0.114 + 0.273)^2}$
$\sigma_{tot} = 15.66$ kN/cm²
check $\sigma_{tot} / (f_0 / \gamma_m) < 1$

$15.66 / (21.5 / 1.1) = 0.80 < 1$

The Check of the side profile in the back wall with the maximum forces in the result combination RC3

Weakest cross section

$A_{nett} = A_{profiel} - 2 * 30mm$ hole
$A_{nett} = 18.89 - 2 * 3 * 0.3 = 17.09$ cm²

$N_{ed, max} = 1.10$ kN
$V_{y, ed max} = 3.18$ kN
$Vz_{, ed max} = 2.53$ kN
$M_{y, ed max} = 436$ kNm
$M_{z, ed max} = 547$ kNm

Calculation

$\sigma_n = N_{ed, max} / A = 1.10 / 17.09 = 0.064$ kN/cm²
$\sigma_{vy} = V_{y, ed max} / A = 3.18 / 17.09 = 0.186$ kN/cm²
$\sigma_{vz} = V_{z, ed max} / A = 2.53 / 17.09 = 0.148$ kN/cm²
$\sigma_{my} = M_{y, ed max} / (I_y / e) = 436 / (766.5 / 8.5) = 4.835$ kN/cm²
$\sigma_{mz} = M_{z, ed max} / (I_z / e) = 547 / (230.7 / 4.4) = 10.432$ kN/cm²
$\sigma_{tot} = \sqrt{((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2}$
$\sigma_{tot} = \sqrt{((0.064 + 4.835 + 10.432)^2 + 3*(0.186 + 0.146)^2}$
$\sigma_{tot} = 15.52$ kN/cm²
check $\sigma_{tot} / (f_0 / \gamma_m) < 1$

$15.52 / (21.5 / 1.1) = 0.79 < 1$

Check of the bearing force in the hole of the profile in the joint.

Maximum normal force 1.17 kN

$F_{b,rd} = (k_1 * \alpha_b * f_u * d * t) / 1.25 = (2.5 * 1 * 11.5 * 3 * 0.3) / 1.25 = 20.7$ kN

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

$1.17 / 20.7 = 0.06 < 1$

Check of the bearing force in the hole at the top roof adapter

Maximum normal force 1.07 kN

Maximum shear force 4.67 kN

$V_{d, pin} = \sqrt{(N^2 + V^2)} = \sqrt{(1.07^2 + 4.67^2)} = 4.79$ kN
This force will be divided over two side = 4.79 / 2 = 2.396 kN

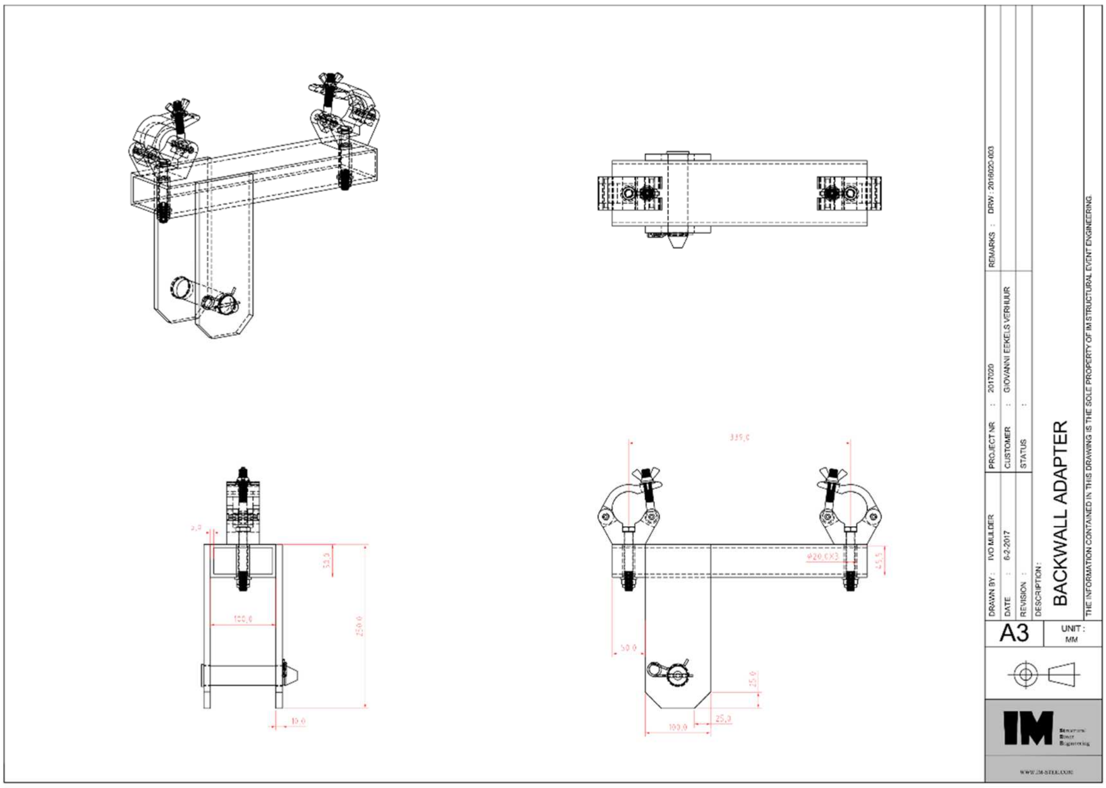
$F_{b,rd} = (k_1 * \alpha_b * f_u * d * t) / 1.25 = (2.5 * 1 * 11.5 * 3 * 0.3) / 1.25 = 20.7$ kN

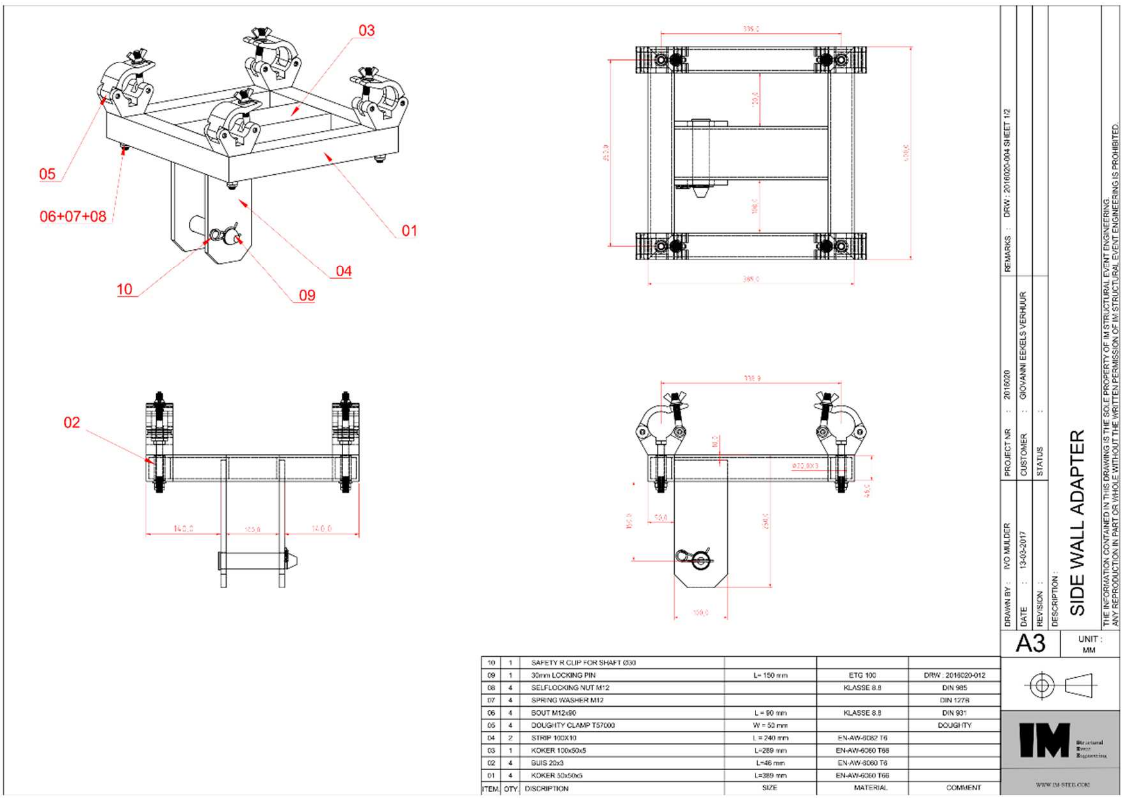
$F_{b, ed} / F_{b,rd} < 1$

$2.396 / 20.7 = 0.11 < 1$

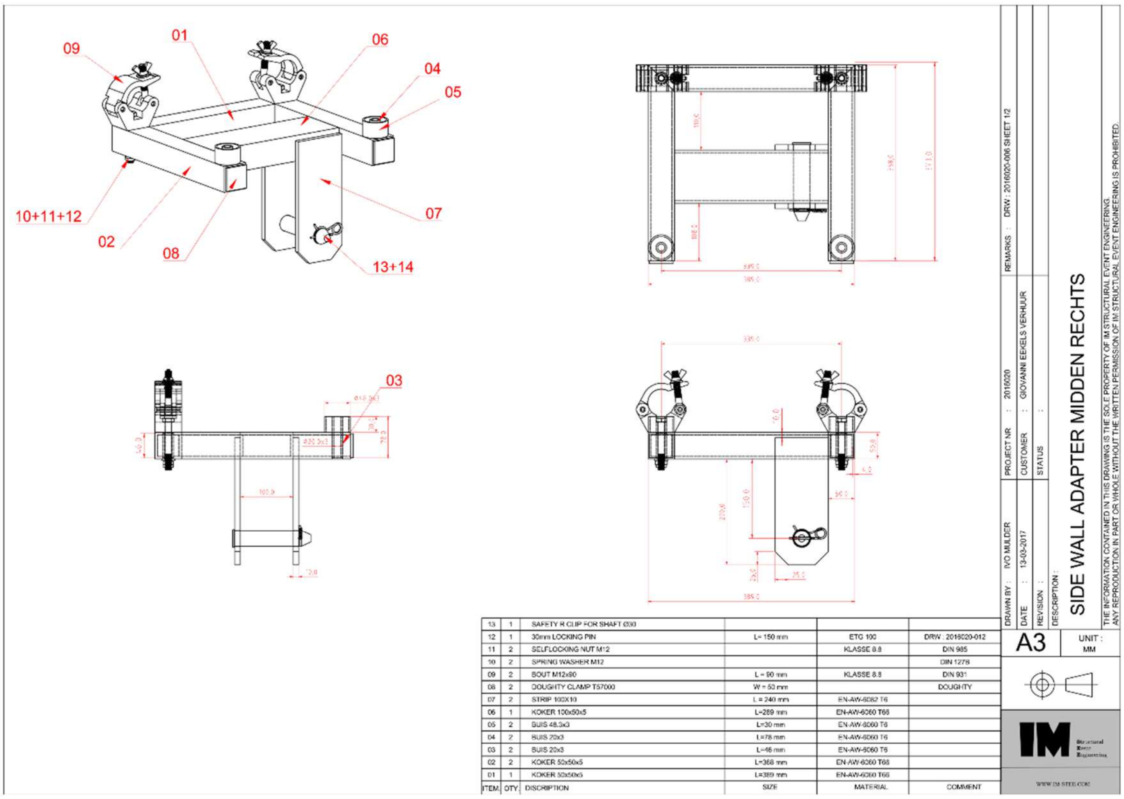
## 4.9 Check of the side and back wall adapter on the top.

For the attachment to the top 3 different types of adapters are use




| ITEM | QTY | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 10 | 1 | SAFETY R CLIP FOR SHAFT Ø30 | | | |
| 09 | 1 | 30mm LOCKING PIN | L= 150 mm | ETG 100 | DRW : 2016020-012 |
| 08 | 4 | SELFLOCKING NUT M12 | | KLASSE 8.8 | DIN 985 |
| 07 | 4 | SPRING WASHER M12 | | | DIN 127B |
| 06 | 4 | BOUT M12x90 | L = 90 mm | KLASSE 8.8 | DIN 931 |
| 05 | 4 | DOUGHTY CLAMP T57000 | W = 50 mm | | DOUGHTY |
| 04 | 2 | STRIP 100X10 | L = 240 mm | EN-AW-6082 T6 | |
| 03 | 1 | KOKER 100x50x5 | L=289 mm | EN-AW-6060 T66 | |
| 02 | 4 | BUIS 20x3 | L=46 mm | EN-AW-6060 T6 | |
| 01 | 4 | KOKER 50x50x5 | L=389 mm | EN-AW-6060 T66 | |




Check of the doughty clamp

The maximum normal force in one of the adapters is 1.07 kN

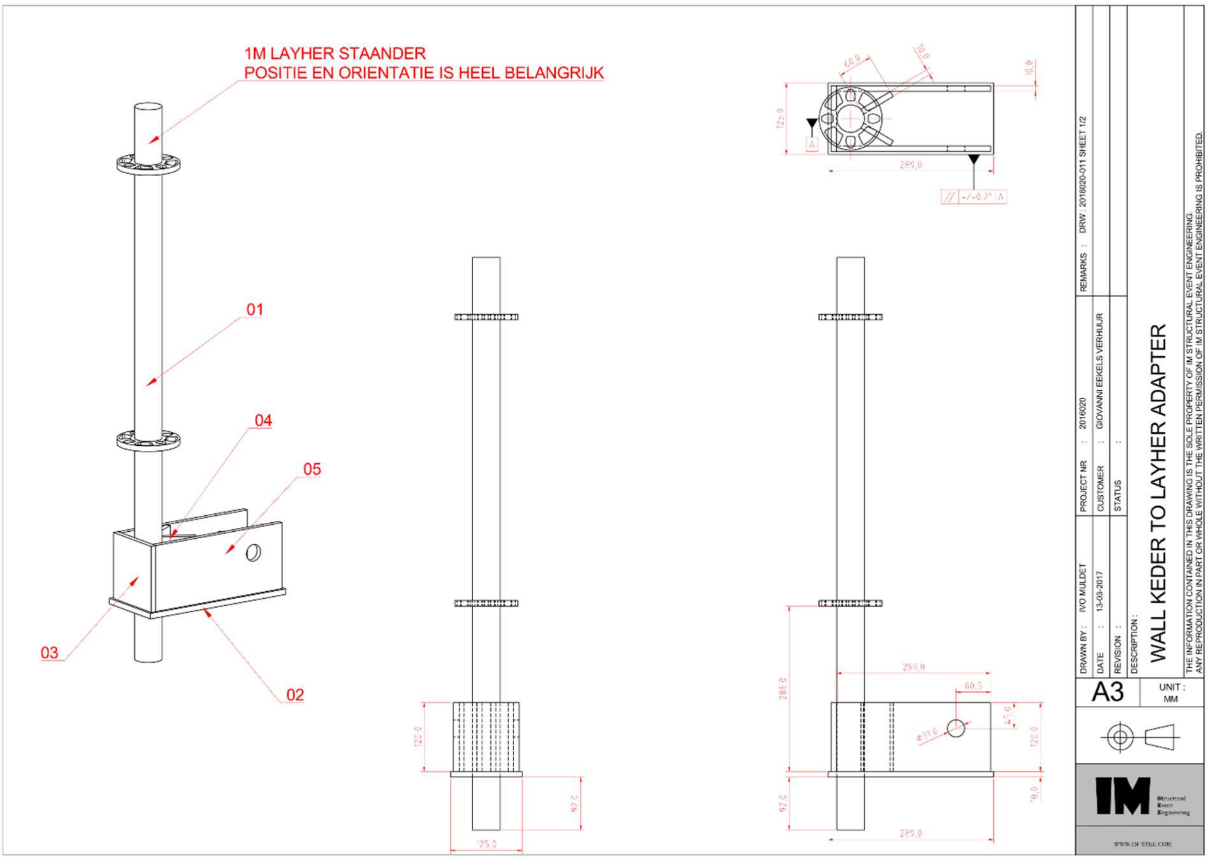
The maximum shear force to the 4.79 kN

Force on the doughty clamp

$N_{ed} / 2 + V_{ed} * 15 / 23.9 = 1.07 / 2 + 4.79 * 15 / 23.9 = 3.54$ kN

The adapter is mounted with a minimum of two doughty clamps to the main grid. Each Doughty clamp has a WLL of 500 kg and a safety factor of 5.

## 4.10 Check of wall kedar Layher adapter




Maximum forces from the side and back wall profiles on the Layher connection

$V_{ed}$ = 4.67 kN

The adapter will be connected to the Layher stage with the use of a connection pin from Layher.

Dimensions of connection pin RRO 38 x 3.6  S275

Material = S275 J0H

$F_y$ = 27.5 kN/cm²

$\gamma_{m0} = 1$

Maximum allowable shear stress

$V_{rd} = Av * ( f_y / \sqrt{3}) * ( 1 / \gamma_{mo} )$

$V_{rd} = 3.89 * ( 27.5 / \sqrt{3}) = 61.79$ kN

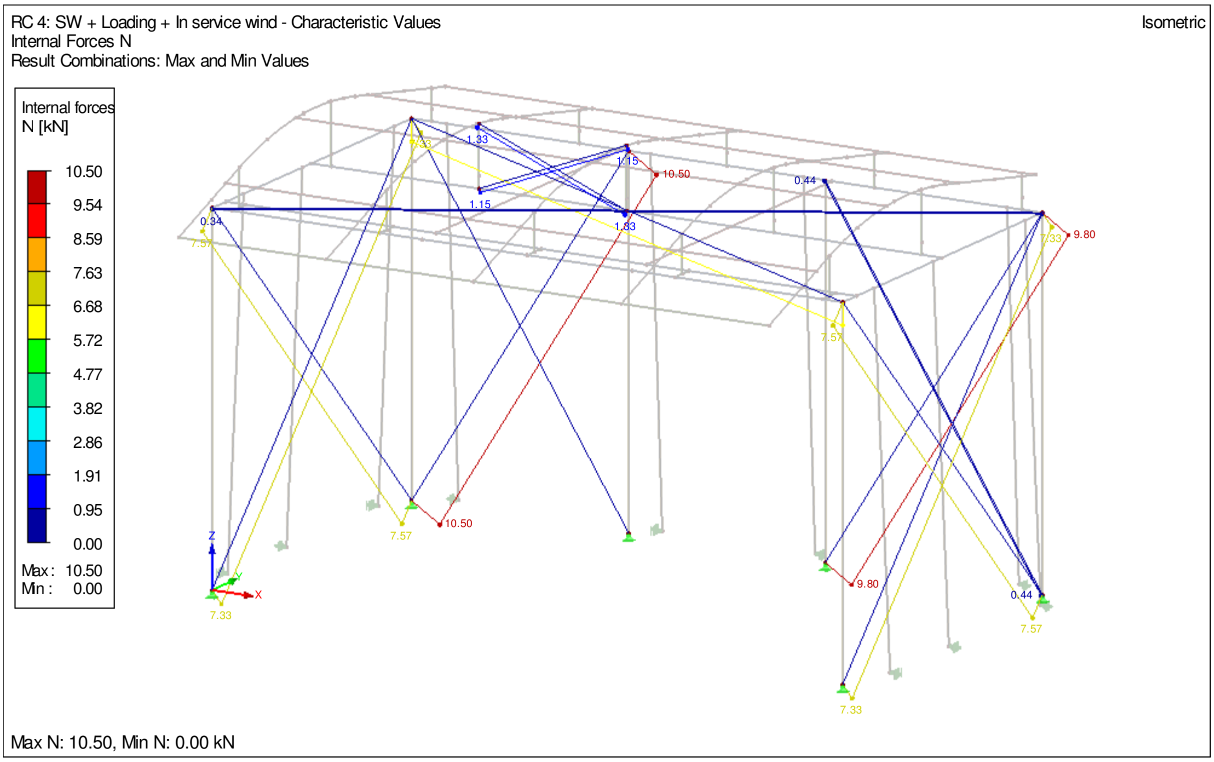
$V_{ed} / V_{rd} < 1$

$4.67 / 61.79 = 0.07 < 1$

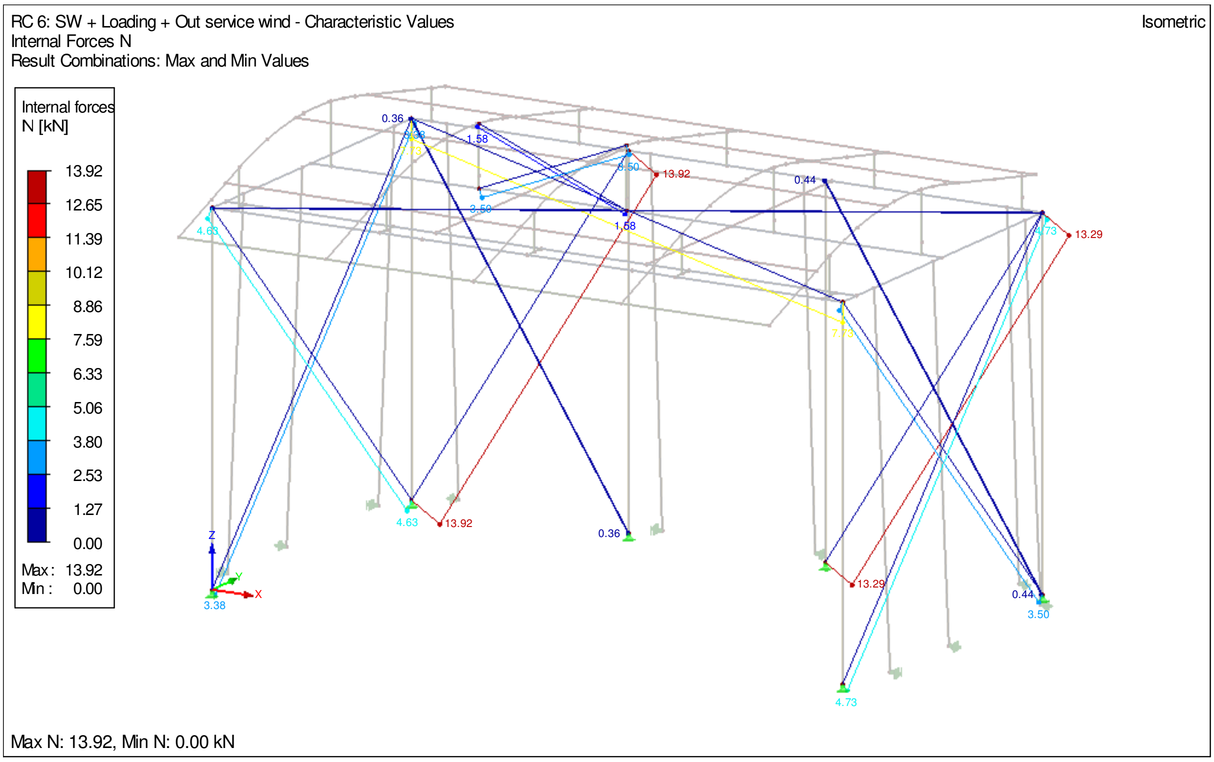
## 4.11 Check of the steel cable in the roof construction and side and back wall.

The steel wire's will be checked characteristic values because the steel wire already has a safety factor.

Internal force for the RC4 In service characteristic values




Internal forces for RC6 Out service characteristic values



Normative result combination is RC6 Out service
Maximum steel wire force is 13.92 kN.

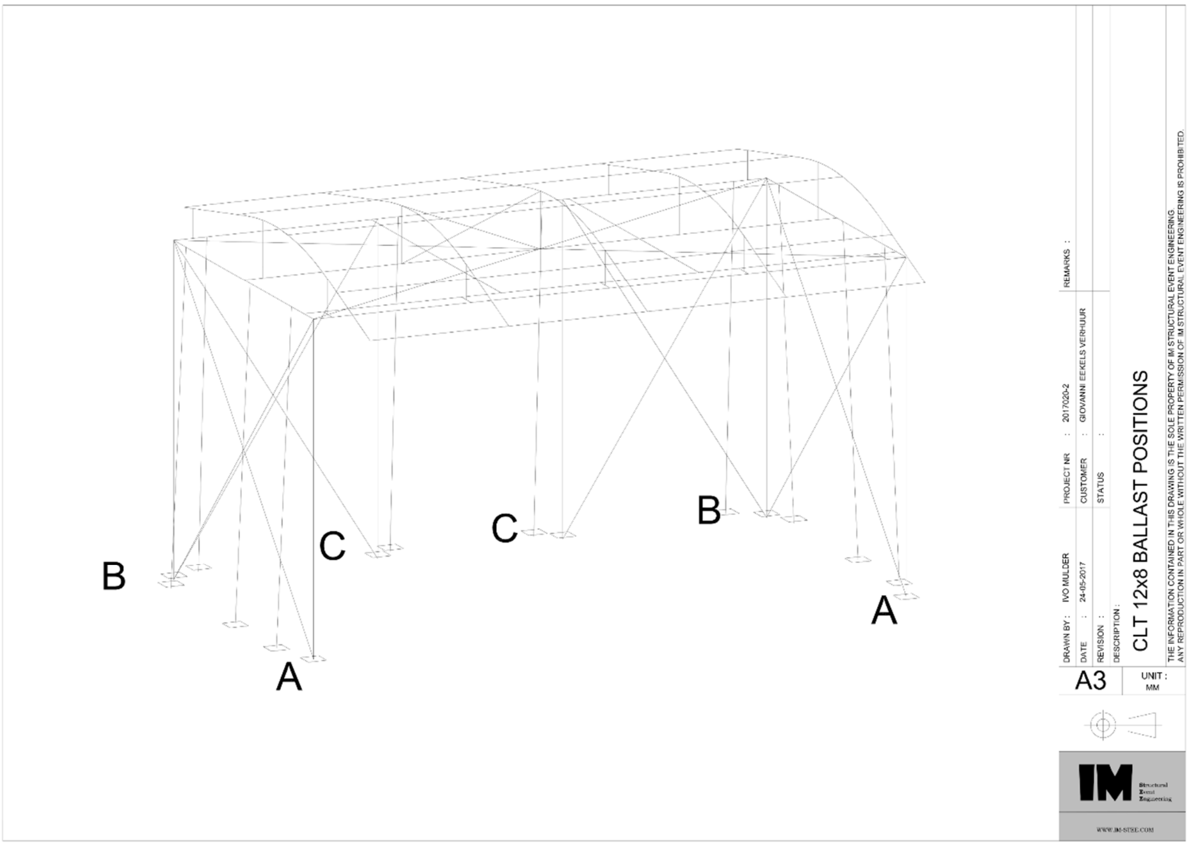
For the steel wire a safety factor of 3.5 is required.
Recommended steel wire 6x36 with steel core $\sigma$ = 1770 kN/mm²
Minimum diameter 10 mm with minimum breaking strength of 63 kN
Check 63 / 3.5 = 18 kN > 17.18 kN

The connection of the steel wire to the sleeve block is made by a 10mm aluminium plate which is bolted on with two M12 bolts, The connection to the base unit is made with a 3.25 T shackle which is connected to a 10mm steel plate which welded on the base unit.
The required retched strap to tension the steel wire need a minimum LC of 2000 daN in a straight line. According to the EN-12195-2.

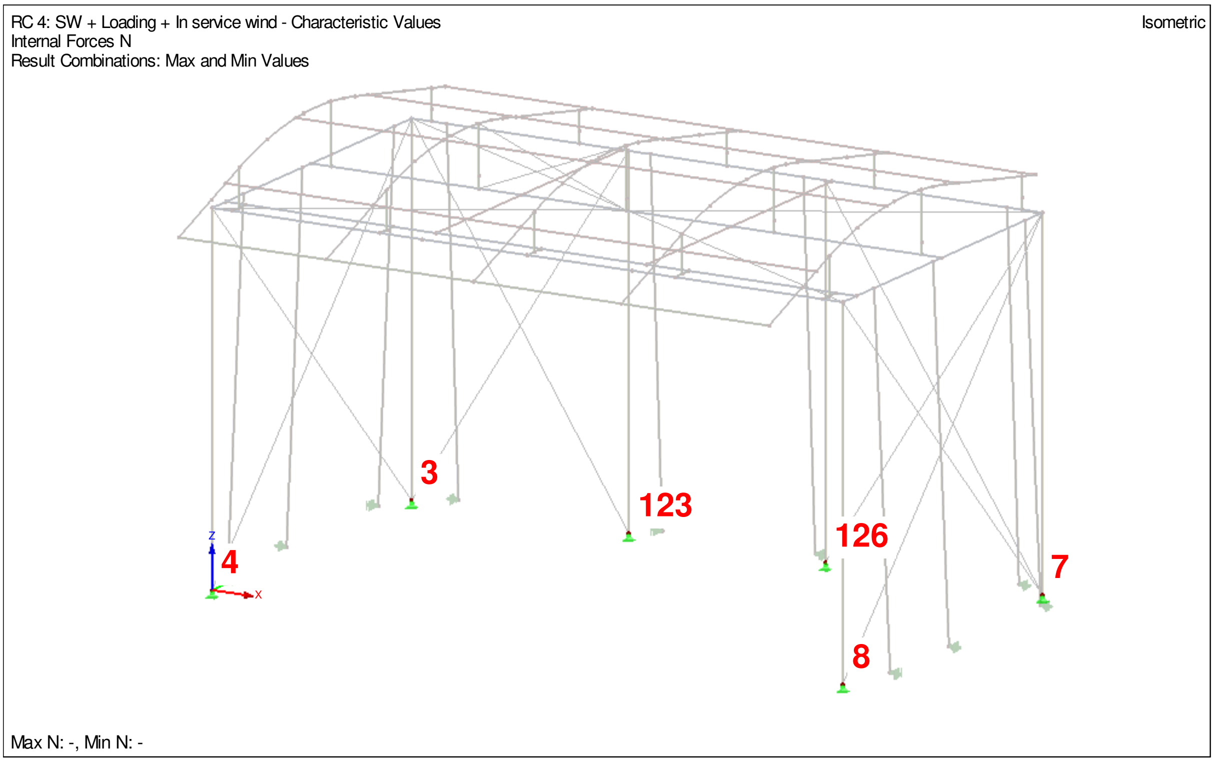
In the roof system retched straps will be used. The required retched strap has a minimum LC of 2000 daN in a straight line, According to the EN-12195-2.

# 5 Ballast and support load calculations.

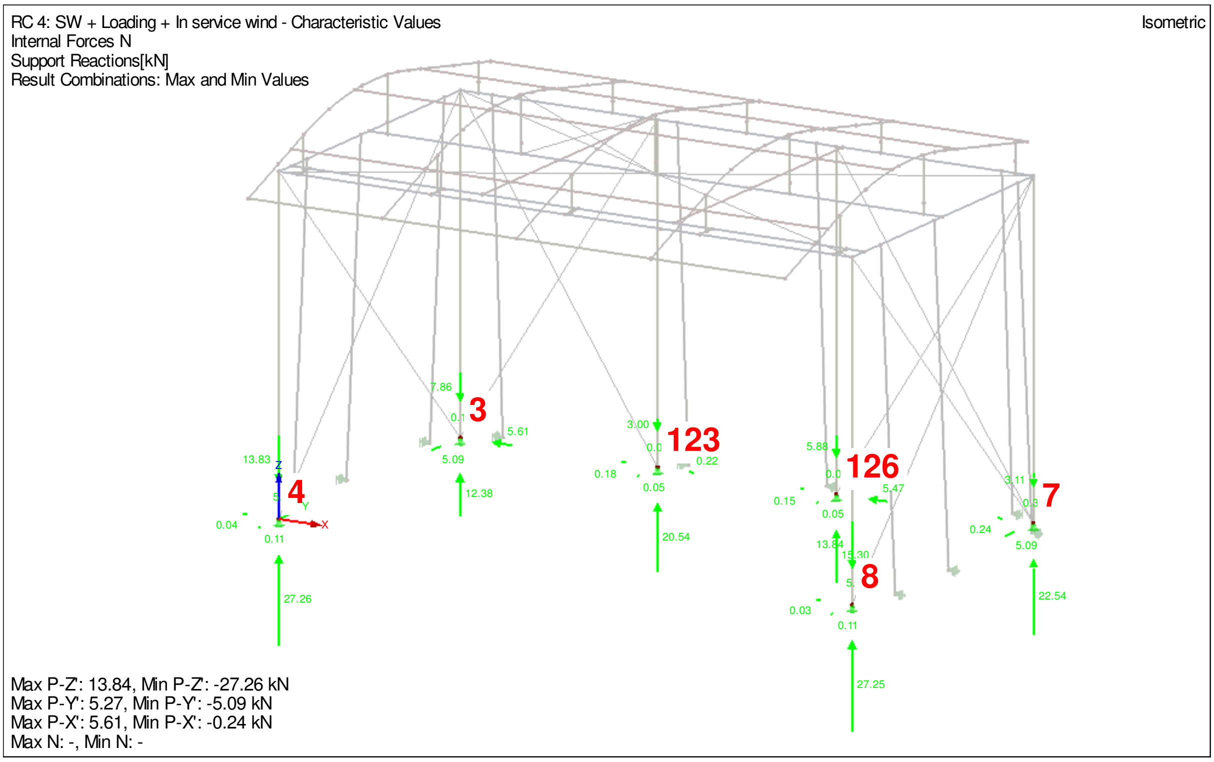
## 5.1 Ballast positions




## 5.2 Over view support node numbers



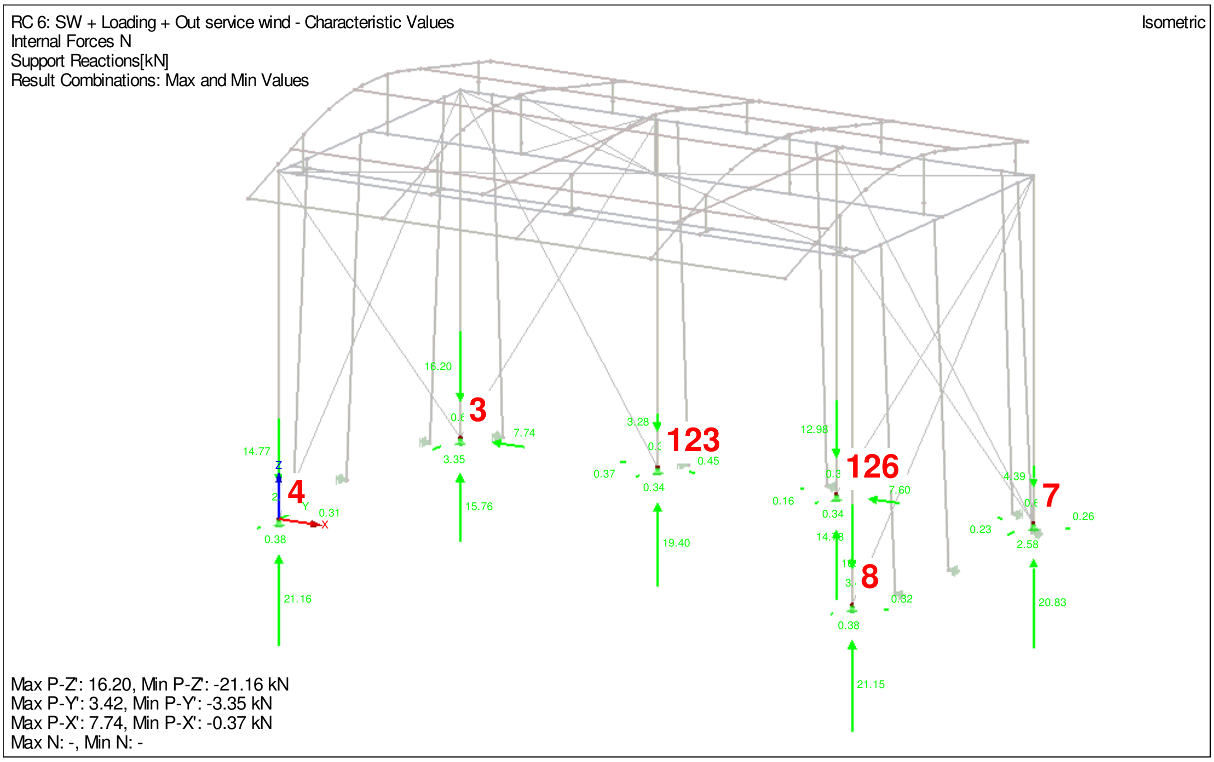
## 5.3 reaction forces in the In-service situation of the main support nodes, characteristic values.




Reaction forces on the support nodes of the main construction, in the In–service situation

| Node | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| No. | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 5,61 | 0,11 | 7,86 | 0,00 | 0,00 | 0,07 |
| | Min | 0,00 | -5,09 | -12,38 | 0,00 | 0,00 | -0,01 |
| 4 | Max | 0,00 | 5,26 | 13,83 | 0,00 | 0,00 | 0,00 |
| | Min | -0,04 | -0,11 | -27,26 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,00 | 0,33 | 3,11 | 0,00 | 0,00 | 0,07 |
| | Min | -0,24 | -5,09 | -22,54 | 0,00 | 0,00 | 0,00 |
| 8 | Max | 0,00 | 5,27 | 13,84 | 0,00 | 0,00 | 0,00 |
| | Min | -0,03 | -0,11 | -27,25 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,22 | 0,07 | 3,00 | 0,00 | 0,00 | 0,04 |
| | Min | -0,18 | -0,05 | -20,54 | 0,00 | 0,00 | -0,04 |
| 126 | Max | 5,47 | 0,07 | 5,88 | 0,00 | 0,00 | 0,04 |
| | Min | -0,15 | -0,05 | -15,30 | 0,00 | 0,00 | -0,04 |

## 5.4 reaction forces in the Out-service situation of the main support nodes, characteristic values.




Reaction forces on the support nodes of the main construction, in the Out–service situation

| Node No. | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 7,74 | 0,66 | 16,20 | 0,00 | 0,00 | 0,07 |
| | Min | 0,00 | -3,35 | -15,76 | 0,00 | 0,00 | 0,00 |
| 4 | Max | 0,31 | 2,75 | 14,77 | 0,00 | 0,00 | 0,00 |
| | Min | 0,00 | -0,38 | -21,16 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,26 | 0,66 | 4,39 | 0,00 | 0,00 | 0,07 |
| | Min | -0,23 | -2,58 | -20,83 | 0,00 | 0,00 | 0,00 |
| 8 | Max | 0,32 | 3,42 | 14,78 | 0,00 | 0,00 | 0,00 |
| | Min | 0,00 | -0,38 | -21,15 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,45 | 0,32 | 3,28 | 0,00 | 0,00 | 0,01 |
| | Min | -0,37 | -0,34 | -19,40 | 0,00 | 0,00 | 0,00 |
| 126 | Max | 7,60 | 0,32 | 12,98 | 0,00 | 0,00 | 0,01 |
| | Min | -0,16 | -0,34 | -16,27 | 0,00 | 0,00 | -0,01 |

### 5.5 Ballast calculation against uplift.

For the uplift ballast calculation the maximum uplift force per main support nodes are taken into account. The maximum values are taken from the table's in chapter 5.2 and 5.3.

As shown in the tables below the results of the out service are the normative results

maximum values in-service situation

| Node | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| No. | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 5,61 | 0,11 | 7,86 | 0,00 | 0,00 | 0,07 |
| 4 | Max | 0,00 | 5,26 | 13,83 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,00 | 0,33 | 3,11 | 0,00 | 0,00 | 0,07 |
| 8 | Max | 0,00 | 5,27 | 13,84 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,22 | 0,07 | 3,00 | 0,00 | 0,00 | 0,04 |
| 126 | Max | 5,47 | 0,07 | 5,88 | 0,00 | 0,00 | 0,04 |

Maximum values Out-service situation

| Node | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| No. | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 7,74 | 0,66 | 16,20 | 0,00 | 0,00 | 0,07 |
| 4 | Max | 0,31 | 2,75 | 14,77 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,26 | 0,66 | 4,39 | 0,00 | 0,00 | 0,07 |
| 8 | Max | 0,32 | 3,42 | 14,78 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,45 | 0,32 | 3,28 | 0,00 | 0,00 | 0,01 |
| 126 | Max | 7,60 | 0,32 | 12,98 | 0,00 | 0,00 | 0,01 |

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

The self-weight of the Layher system will be partly subtracted from the uplift force.

The total weight of the Layer system is 55 kN. The weight of the Layher system which is taken into account is 30 kN, Because the middle of the stage will not help against the uplift of the towers. The 30 kN will be equally divided along the 6 points

Partial safety factor for the uplift $\gamma = 1.2$

Calculation

**Support A ( node 4 and 8 )**

$P_{z,\ min}$ = 14.77 kN

Ballast A = (14.77-5) * 1.2 = 11.7 kN ~ 1200 kg

**Support B ( node 3 and 7 )**

$P_{z,\ min}$ =16.20 kN

Ballast B = (16.20 -5) * 1.2 = 13.44 kN ~ 1400 kg

**Support C ( node 123 and 126 )**

$P_{z,\ min}$ = 12.98 kN

Ballast C = (12.98-5) * 1.2 = 9.58 kN ~1000 kg

## 5.6 Calculation of the system against overturning.

Results from the RFem program

| | Description | Value | Unit |
|---|---|---|---|
| | **LC1 - Self-weight** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | -15,98 | kN |
| | **CO150 - LC1 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,64 | kN |
| | Sum of loads in Z | 27,38 | kN |
| | **CO151 - LC1 + LC2 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,64 | kN |
| | Sum of loads in Z | -3,82 | kN |
| | **CO152 - LC1 + LC3 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,64 | kN |
| | Sum of loads in Z | 3,38 | kN |
| | **CO153 - LC1 + LC4 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,64 | kN |
| | Sum of loads in Z | -6,62 | kN |
| | **CO154 - LC1 + LC5 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,64 | kN |
| | Sum of loads in Z | -24,62 | kN |
| | **CO160 - LC1 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 16,12 | kN |
| | Sum of loads in Y | 4,76 | kN |
| | Sum of loads in Z | -13,27 | kN |
| | **CO161 - LC1 + LC2 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 16,12 | kN |
| | Sum of loads in Y | 4,76 | kN |
| | Sum of loads in Z | -44,47 | kN |
| | **CO162 - LC1 + LC3 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 16,12 | kN |
| | Sum of loads in Y | 4,76 | kN |

| | Description | Value | Unit |
|---|---|---|---|
| | **CO250 - LC1 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | 36,07 | kN |
| | **CO251 - LC1 + LC2 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | 4,87 | kN |
| | **CO252 - LC1 + LC3 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | 12,07 | kN |
| | **CO253 - LC1 + LC4 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | 2,07 | kN |
| | **CO254 - LC1 + LC6 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | 0,07 | kN |
| | **CO255 - LC1 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | -46,80 | kN |
| | **CO256 - LC1 + LC2 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | -78,00 | kN |
| | **CO257 - LC1 + LC3 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |
| | Sum of loads in Z | -70,80 | kN |
| | **CO258 - LC1 + LC4 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 8,88 | kN |

| | | |
|---|---|---|
| Sum of loads in Z | -37,27 | kN |
| **CO163 - LC1 + LC4 + LC20 + LC21 + LC22 + LC23** | | |
| Sum of loads in X | 16,12 | kN |
| Sum of loads in Y | 4,76 | kN |
| Sum of loads in Z | -47,27 | kN |
| **CO164 - LC1 + LC5 + LC20 + LC21 + LC22 + LC23** | | |
| Sum of loads in X | 16,12 | kN |
| Sum of loads in Y | 4,76 | kN |
| Sum of loads in Z | -65,27 | kN |
| **CO170 - LC1 + LC30 + LC31 + LC32 + LC33** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -14,52 | kN |
| **CO171 - LC1 + LC2 + LC30 + LC31 + LC32 + LC33** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -45,72 | kN |
| **CO172 - LC1 + LC3 + LC30 + LC31 + LC32 + LC33** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -38,52 | kN |
| **CO173 - LC1 + LC4 + LC30 + LC31 + LC32 + LC33** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -48,52 | kN |
| **CO174 - LC1 + LC5 + LC30 + LC31 + LC32 + LC33** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -66,52 | kN |
| **CO180 - LC1 + LC32 + LC33 + LC34 + LC35** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -35,47 | kN |
| **CO181 - LC1 + LC2 + LC32 + LC33 + LC34 + LC35** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -66,67 | kN |
| **CO182 - LC1 + LC3 + LC32 + LC33 + LC34 + LC35** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -59,47 | kN |
| **CO183 - LC1 + LC4 + LC32 + LC33 + LC34 + LC35** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -69,47 | kN |
| **CO184 - LC1 + LC5 + LC32 + LC33 + LC34 + LC35** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -20,66 | kN |
| Sum of loads in Z | -87,47 | kN |

| | | |
|---|---|---|
| Sum of loads in Z | -80,80 | kN |
| **CO259 - LC1 + LC6 + LC112 + LC113 + LC114** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | 8,88 | kN |
| Sum of loads in Z | -82,80 | kN |
| **CO260 - LC1 + LC120 + LC121 + LC122** | | |
| Sum of loads in X | 18,33 | kN |
| Sum of loads in Y | 0,00 | kN |
| Sum of loads in Z | 25,77 | kN |
| **CO261 - LC1 + LC2 + LC120 + LC121 + LC122** | | |
| Sum of loads in X | 18,33 | kN |
| Sum of loads in Y | 0,00 | kN |
| Sum of loads in Z | -5,43 | kN |
| **CO262 - LC1 + LC3 + LC120 + LC121 + LC122** | | |
| Sum of loads in X | 18,33 | kN |
| Sum of loads in Y | 0,00 | kN |
| Sum of loads in Z | 1,77 | kN |
| **CO263 - LC1 + LC4 + LC120 + LC121 + LC122** | | |
| Sum of loads in X | 18,33 | kN |
| Sum of loads in Y | 0,00 | kN |
| Sum of loads in Z | -8,23 | kN |
| **CO264 - LC1 + LC6 + LC120 + LC121 + LC122** | | |
| Sum of loads in X | 18,33 | kN |
| Sum of loads in Y | 0,00 | kN |
| Sum of loads in Z | -10,23 | kN |
| **CO270 - LC1 + LC130 + LC131 + LC132** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | 36,07 | kN |
| **CO271 - LC1 + LC2 + LC130 + LC131 + LC132** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | 4,87 | kN |
| **CO272 - LC1 + LC3 + LC130 + LC131 + LC132** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | 12,07 | kN |
| **CO273 - LC1 + LC4 + LC130 + LC131 + LC132** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | 2,07 | kN |
| **CO274 - LC1 + LC6 + LC130 + LC131 + LC132** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | 0,07 | kN |
| **CO275 - LC1 + LC132 + LC133 + LC134** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | -46,80 | kN |
| **CO276 - LC1 + LC2 + LC132 + LC133 + LC134** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | -78,00 | kN |
| **CO277 - LC1 + LC3 + LC132 + LC133 + LC134** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | -70,80 | kN |
| **CO278 - LC1 + LC4 + LC132 + LC133 + LC134** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | -80,80 | kN |
| **CO279 - LC1 + LC6 + LC132 + LC133 + LC134** | | |
| Sum of loads in X | 0,00 | kN |
| Sum of loads in Y | -8,84 | kN |
| Sum of loads in Z | -82,80 | kN |

### 5.6.1 Calculation against overturning in the In-service situation

decisive load combination CO150

Self-weight of Layher stage = 55 kN
Wind on Stage 2 * 14 * 0.2 * 1.3 = 7.28 kN
Sum of load in Y direction = 20.64 kN
Sum of load in Z direction = 27.38 kN

Overturning moment
$M_{ov}$ = (7.28 * 2/2) + (20.64 * 10.5/2) + (27.38 * 8/2)=
$M_{ov}$ = 7.28 + 108.36 + 109.44 = 225.1 kNm
Stabilization moment
$M_{stab}$ = (55 * 9/2) + (2 * 12 * 9)
$M_{stab}$ = 247.5 + 216 = 463.5 kN

$M_{stab}$/ $M_{ov}$ = 463.5 / 225.1 = 2.06 > 1.2

### 5.6.2 Calculation against overturning in the Out-service situation

decisive load combination CO250

Self-weight of Layher stage = 55 kN
Wind on Stage 2 * 14 * 0.4325 * 1.3 = 15.74 kN
Sum of load in X direction = 8.88 kN
Sum of load in Z direction = 36.07 kN

Overturning moment
$M_{ov}$ = (15.74 * 2/2) + (8.8 * 10.5/2) + (36.07 * 8/2)=
$M_{ov}$ = 15.74 + 46.2 + 144.28 = 206.22 kNm
Stabilization moment
$M_{stab}$ = (55 * 9/2) + (2 * 12 * 9)
$M_{stab}$ = 247.5 + 216 = 463.5 kN

$M_{stab}$/ $M_{ov}$ = 463.5 / 206.22 = 2.25 > 1.2

## 5.7 Ballast calculation against sliding.

For the friction coefficient the factor of 0.4 has been taken into account according to the table below.

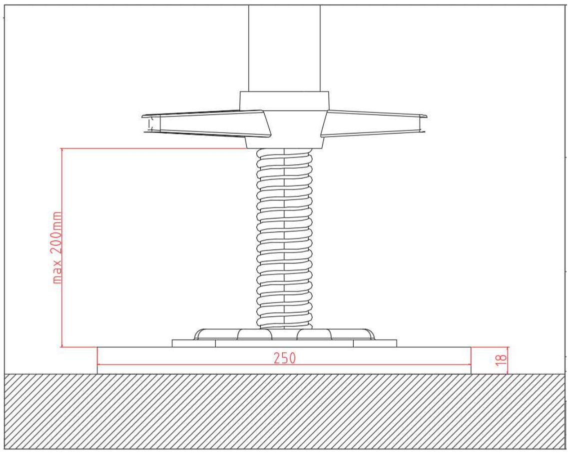



**Table 3 — Coefficients of friction $\mu$**

| | 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.

### 5.7.1 Ballast calculation against slipping In service

Decive load combination is CO150
For the friction coefficient the factor of 0.4 has been taken into account.
Horizontal force = 20.64 kN
Uplift force = 27.38 kN
Self-weight Layher = 55 kN

Check
(ballast + Self-weight Layher– uplift force) * friction coefficient / wind loading > 1,2
( 2*12 + 2*14 + 2* 10 + 55 – 27.38) * 0.4 / 20.64 =
99.66 * 0.4 / 20.64 = 1.09 > 1.2

### 5.7.2 Ballast calculation against slipping In service

Decisive load combination is CO260
For the friction coefficient the factor of 0.4 has been taken into account.
Horizontal force = 18.33 kN
Uplift force = 25.77 kN
Self-weight Layher = 55 kN

Check
(ballast + Self-weight Layher– uplift force) * friction coefficient / wind loading > 1,2
( 2*12 + 2*14 + 2* 10 + 55 – 27.38) * 0.4 / 18.33 =
99.66 * 0.4 / 18.33 = 2.17 > 1.2

## 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 from the K2000+ series.

For the calculation of the Layher system there are 5 different situations calculated. These are chosen from the in-service situation, due to the fact that they have the side and back wall still attached and will generate the highest horizontal loading on the Layher system.

The different forces are taken from the load combinations

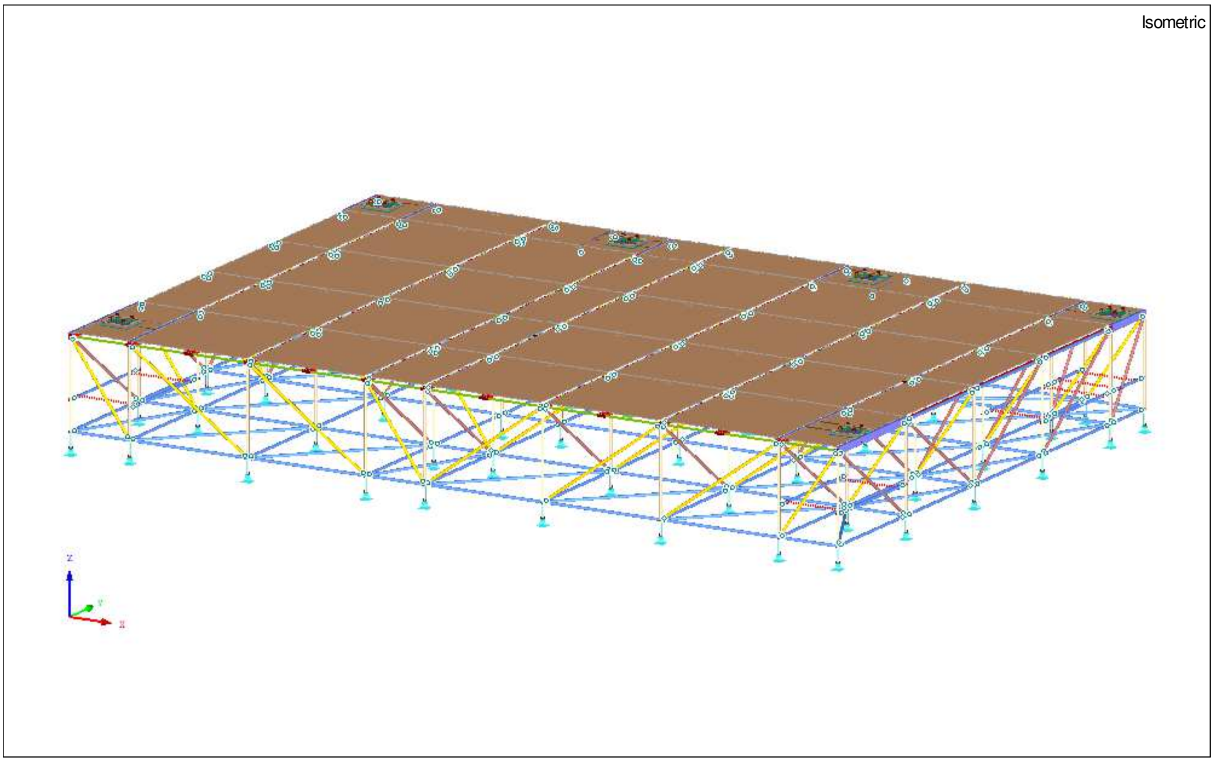
- : CO53
- : CO150
- : CO164
- : CO174
- : CO184

### 6.1 RFem Layher stage Model

For the Layher stage a separate model is constructed in the RFem program.

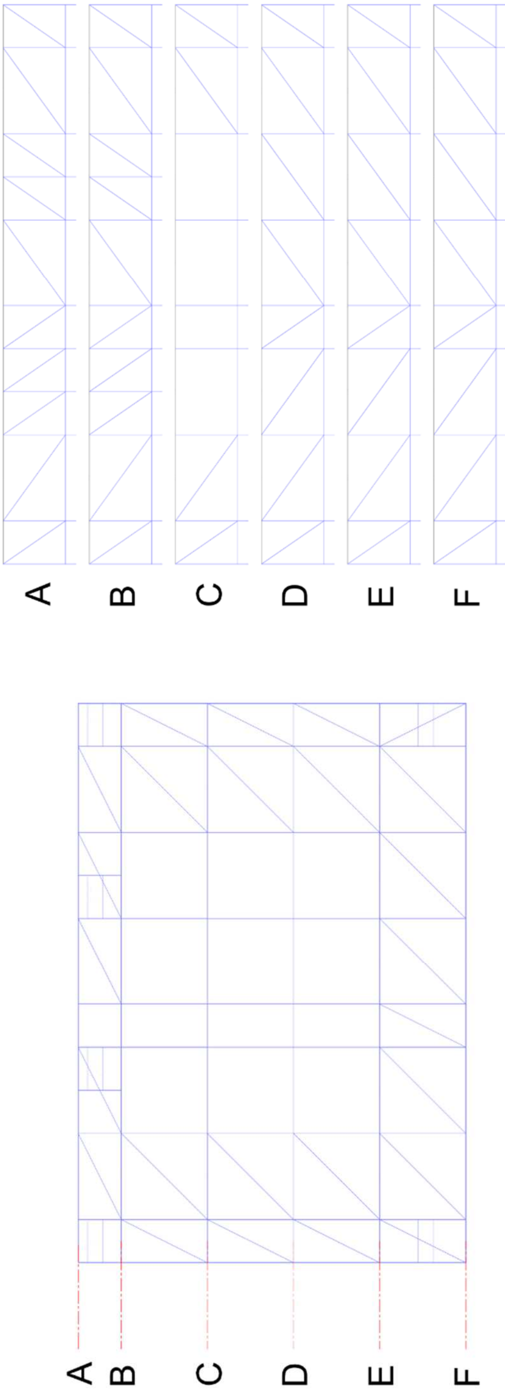
In this model the forces of the different load combinations are set as forces on the different node positions. The result calculations will be compared with the Layher design forces as shown in chapter 6.5 Layher Design values on page 185.

#### 6.1.1 The Layher construction scheme.



### 6.1.2 Layher setup

### CLT 12x8 Layher plan drawing 1




| | | | |
|---|---|---|---|
| DRAWN BY : IVO MULDER | PROJECT NR : 2016020 | REMARKS : | UNIT : MM |
| DATE : 16-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | | |
| REVISION : | STATUS : | | |

DESCRIPTION :

CLT 12x8 LAYHER SETUP DRAWING 1

A3

IM Structural Event Engineering

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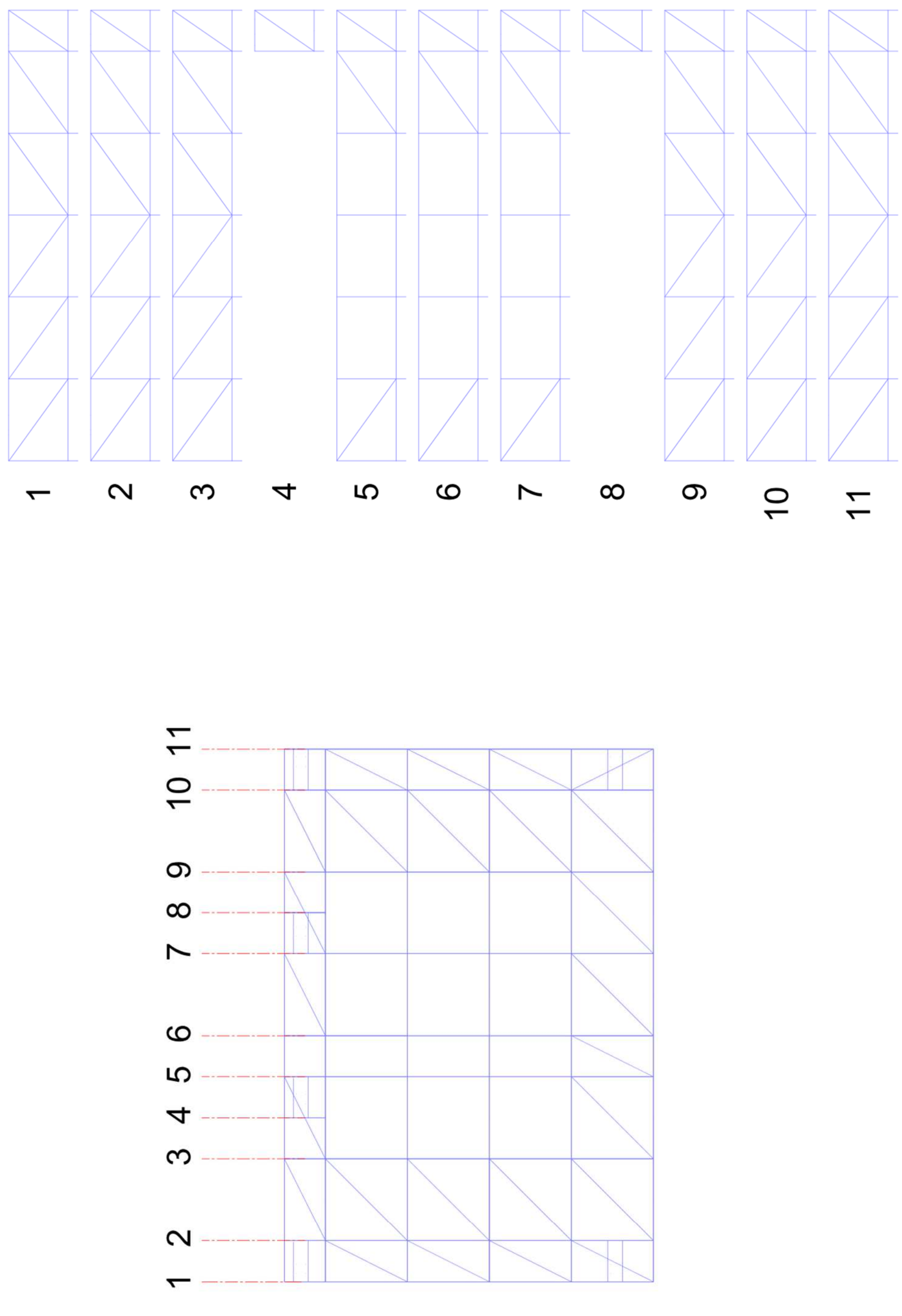
## CLT 12x8 Layher plan drawing 2




| | | | | | |
|---|---|---|---|---|---|
| DRAWN BY : | IVO MULDER | PROJECT NR : | 2016020 | REMARKS : | UNIT : MM |
| DATE : | 16-05-2017 | CUSTOMER : | GIOVANNI EEKELS VERHUUR | | |
| REVISION : | | STATUS : | | | |

DESCRIPTION :

CLT 12x8 LAYHER SETUP DRAWING 2

A3



Structural Event Engineering WWW.IM-STEE.COM

### 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 $\gamma_M$ [-] | Material Model |
|---|---|---|---|---|---|---|---|---|
| 1 | Steel S 235 \| DIN EN 1993-1-1:2010-12 | 21000,00 | 8100,00 | 0,296 | 78,50 | 1,20E-05 | 1,000 | Isotropic Linear Elastic |
| 2 | 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... |
| 3 | 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 |
| 4 | 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 |
| 5 | S320GD 1.0250 \| EN 10346:2009-03 | 21000,00 | 8076,92 | 0,300 | 78,50 | 1,20E-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] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Description [mm] | No. | Torsion J | Bending $I_y$ | Bending $I_z$ | Axial A | Shear $A_y$ | Shear $A_z$ | α [°] | α' [°] | Width b | Depth h |
| 1 | RO 48.3x3.2 (Hot Formed) | 1 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 2 | RO 48.3x3.2 (Hot Formed) | 1 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 3 | RO 48.3x3.2 (Hot Formed) | 1 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 4 | EV transom | 3 | 50,00 | 554,00 | 70,00 | 18,78 | 18,00 | 18,00 | 0,00 | 0,00 | 49,0 | 172,5 |
| 5 | HK 50/30/4/4/4/4 | 3 | 16,87 | 17,67 | 7,52 | 5,76 | 1,62 | 3,48 | 0,00 | 0,00 | 30,0 | 50,0 |
| 6 | RRO 120x60x6.3 (Hot Formed) | 1 | 290,00 | 358,00 | 116,00 | 20,70 | 4,54 | 13,22 | 0,00 | 0,00 | 60,0 | 120,0 |
| 7 | RRO 120x80x6.3 (Hot Formed) | 1 | 487,00 | 440,00 | 230,00 | 23,20 | 6,99 | 12,93 | 0,00 | 0,00 | 80,0 | 120,0 |
| 8 | Ring 48/6 | 4 | 35,63 | 17,81 | 17,81 | 7,92 | 4,09 | 4,09 | 0,00 | 0,00 | 48,0 | 48,0 |
| 9 | RO 48.3x3.2 (Hot Formed) | 5 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 10 | Ring 38/8.1 | 1 | 18,25 | 9,13 | 9,13 | 7,61 | 4,26 | 4,26 | 0,00 | 0,00 | 38,0 | 38,0 |

### 6.1.5 solved load cases, load combinations and result combinations.

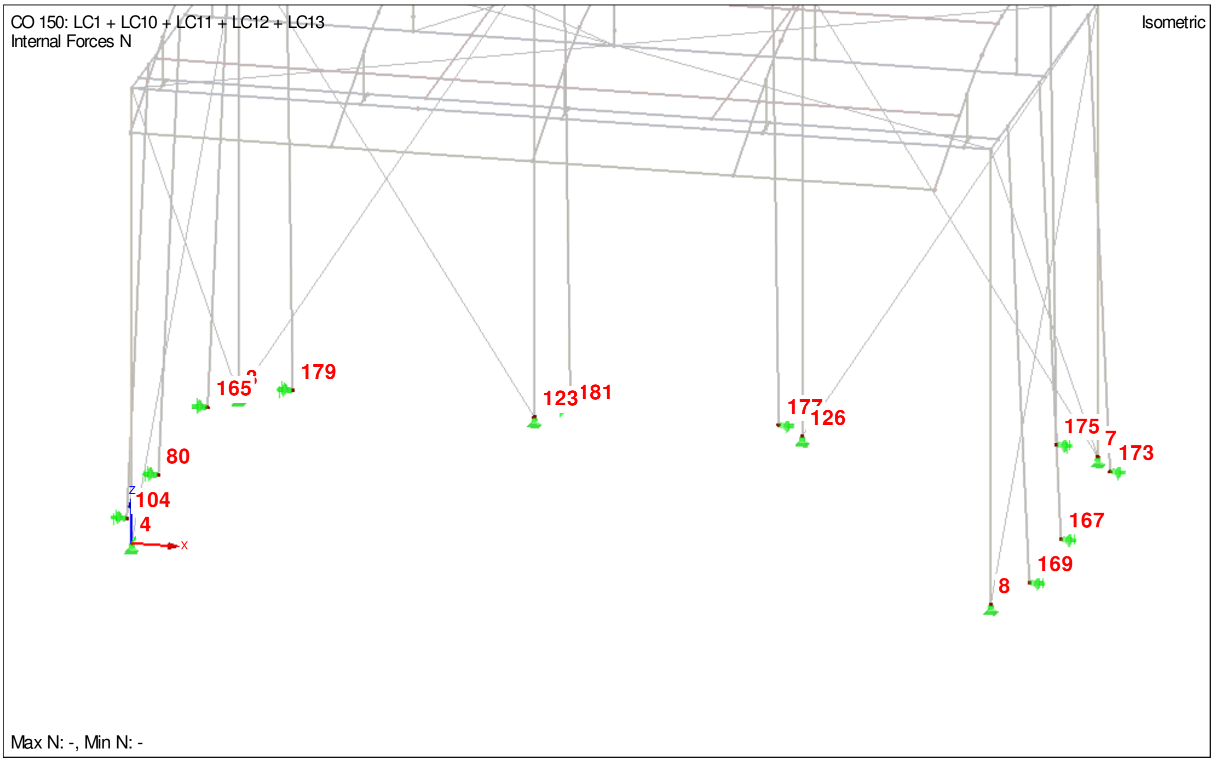
| Load Case | Load Case Description | To Solve | EN 1990 \| CEN Action Category | Self-Weight - Factor in Direction Active | X | Y | Z | Comment |
|---|---|---|---|---|---|---|---|---|
| LC1 | Self-weight | + | Permanent | - | 0,000 | 0,000 | -1,000 | |
| LC2 | belasting 350Kg/m² wind ditr 0° | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC3 | belasting 350Kg/m² wind ditr 90° | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC4 | belasting 350Kg/m² wind ditr 180° | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC5 | ballast loading | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC10 | Nodel support forces from CO53 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC11 | Nodel support forces from CO150 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC12 | Nodel support forces from CO164 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC13 | Nodel support forces from CO174 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |
| LC14 | Nodel support forces from CO184 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 | |

| Load Combin. | DS | Load Combination Description | To Solve | LC.1 Factor | LC.1 No. | LC.2 Factor | LC.2 No. | LC.3 Factor | LC.3 No. | LC.4 Factor | LC.4 No. | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC5 + 1.35*LC10 | + | 1,150 | LC1 | 1,350 | LC2 | 1,350 | LC5 | 1,350 | LC10 | |
| CO2 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC5 + 1.35*LC11 | + | 1,150 | LC1 | 1,350 | LC2 | 1,350 | LC5 | 1,350 | LC11 | |
| CO3 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC5 + 1.35*LC12 | + | 1,150 | LC1 | 1,350 | LC3 | 1,350 | LC5 | 1,350 | LC12 | |
| CO4 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC5 + 1.35*LC13 | + | 1,150 | LC1 | 1,350 | LC4 | 1,350 | LC5 | 1,350 | LC13 | |
| CO5 | 0 | 1.35*LC1 + 1.35*LC4 + 1.35*LC5 + 1.35*LC14 | + | 1,350 | LC1 | 1,350 | LC4 | 1,350 | LC5 | 1,350 | LC14 | |
| CO10 | 0 | LC1 + LC2 + LC5 + LC10 | + | 1,000 | LC1 | 1,000 | LC2 | 1,000 | LC5 | 1,000 | LC10 | |
| CO11 | 0 | LC1 + LC2 + 1.35*LC5 + LC11 | + | 1,000 | LC1 | 1,000 | LC2 | 1,350 | LC5 | 1,000 | LC11 | |
| CO12 | 0 | LC1 + LC3 + LC5 + LC12 | + | 1,000 | LC1 | 1,000 | LC3 | 1,000 | LC5 | 1,000 | LC12 | |
| CO13 | 0 | LC1 + LC4 + LC5 + LC13 | + | 1,000 | LC1 | 1,000 | LC4 | 1,000 | LC5 | 1,000 | LC13 | |
| CO14 | 0 | LC1 + LC4 + LC5 + LC14 | + | 1,000 | LC1 | 1,000 | LC4 | 1,000 | LC5 | 1,000 | LC14 | |

RC1 : CO1-CO5

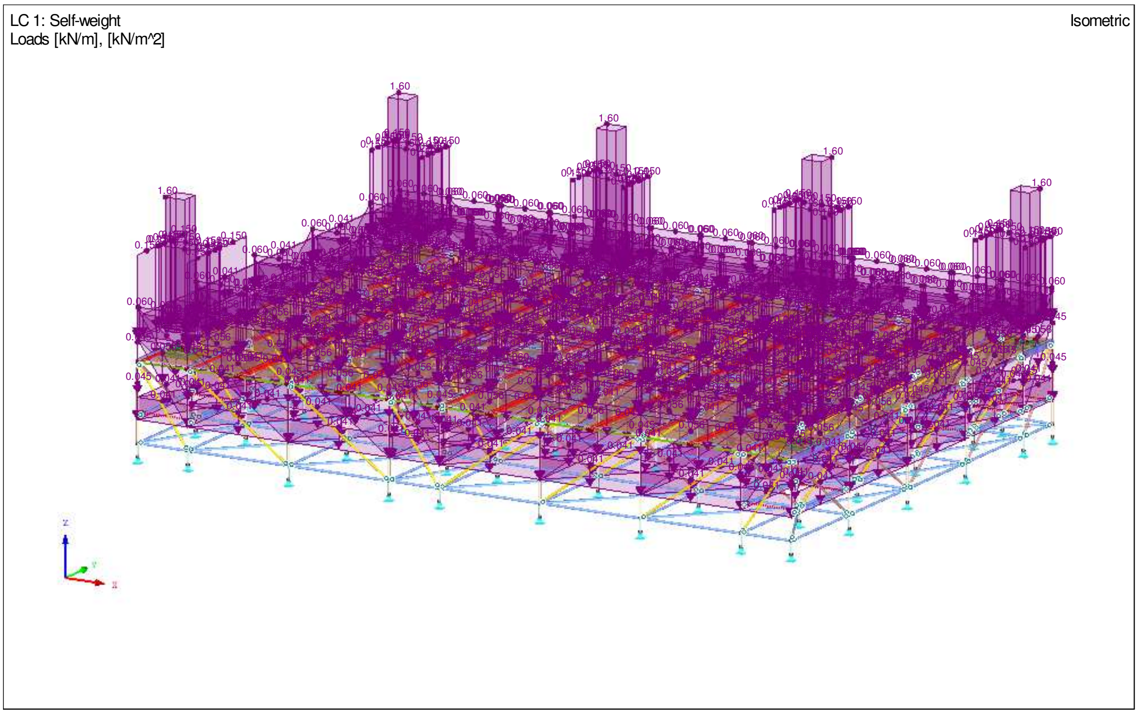
RC2 : CO10-CO14

### 6.1.6 Nodal support points numbering of main roof construction.



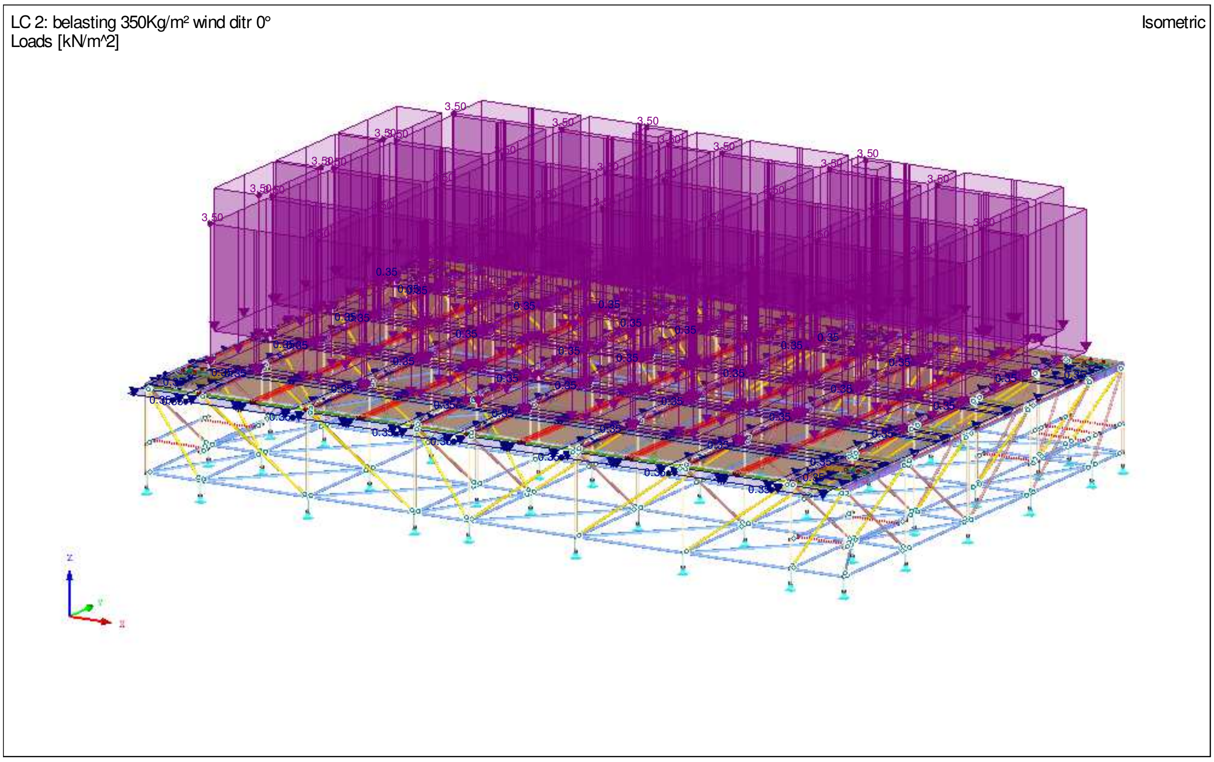

## 6.2 Loading Input

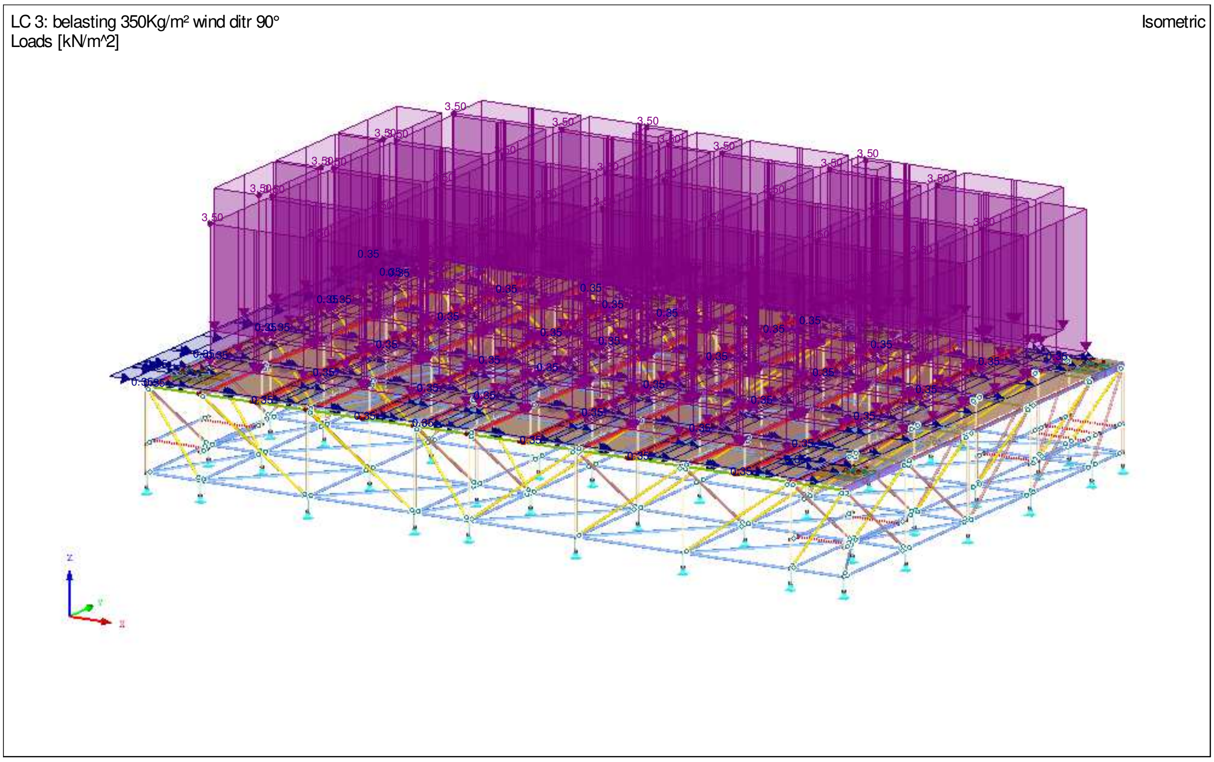
### 6.2.1 Self weight of the stage



### 6.2.2 Loading of the stage

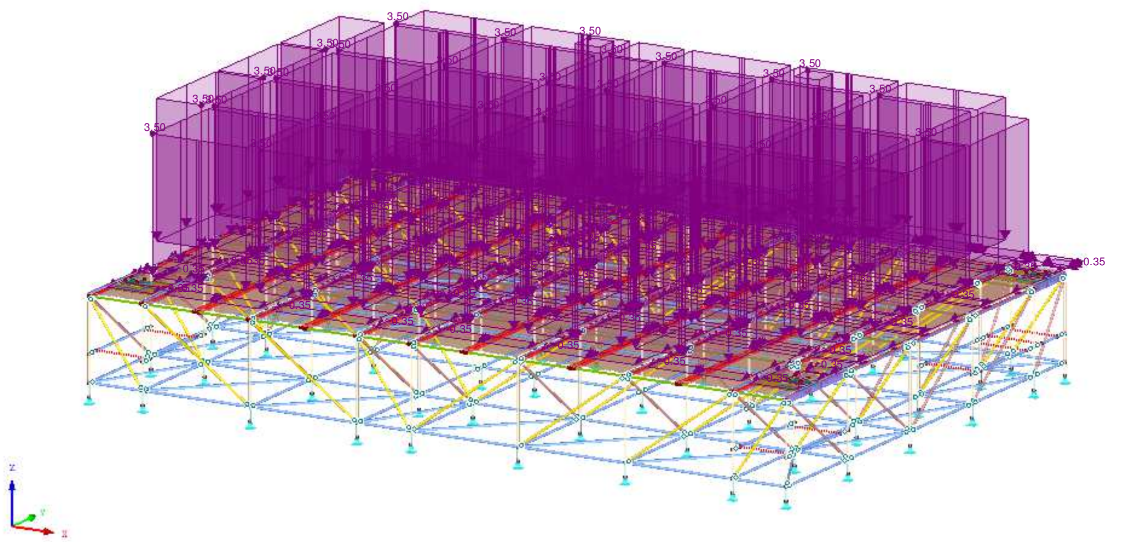
The floor loading which is taken into account is 350 kg/m² which is according to the EN-13814.
For the horizontal stability check an extra loading of 10% of the vertical loading is set as a horizontal force in the direction of the wind



LC 4: belasting 350Kg/m² wind ditr 180°
Loads [kN/m^2]

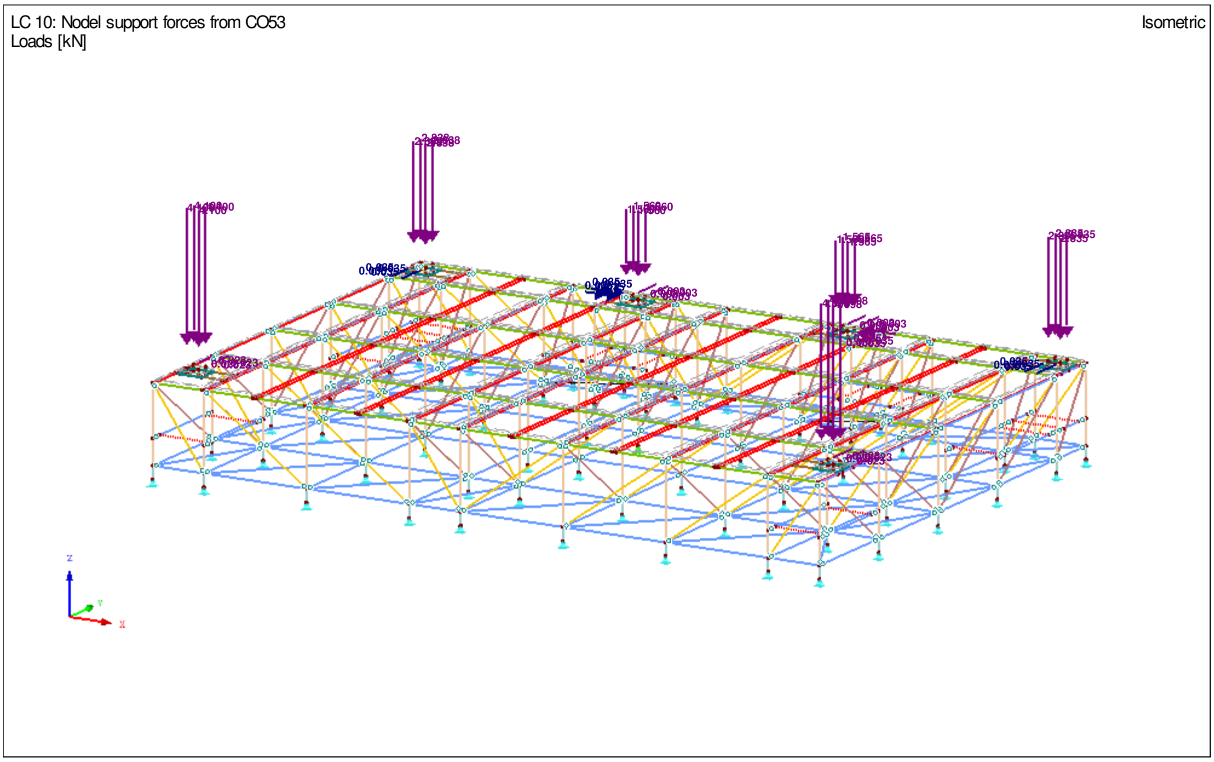
Isometric



### 6.2.3 nodal forces from load combination CO53

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 0,00 | 0,14 | -11,35 | 0,00 | 0,00 | 0,00 |
| 4 | 0,00 | -0,09 | -16,40 | 0,00 | 0,00 | 0,00 |
| 7 | 0,00 | 0,14 | -11,34 | 0,00 | 0,00 | 0,00 |
| 8 | 0,00 | -0,09 | -16,39 | 0,00 | 0,00 | 0,00 |
| 80 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,14 | -0,01 | -6,26 | 0,00 | 0,00 | 0,00 |
| 126 | -0,14 | -0,01 | -6,24 | 0,00 | 0,00 | 0,00 |
| 165 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 167 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 173 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 175 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| 177 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| 179 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| 181 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| Σ Forces | 0,00 | 0,00 | -67,98 | | | |
| Σ Loads | 0,00 | 0,00 | -67,98 | | | |

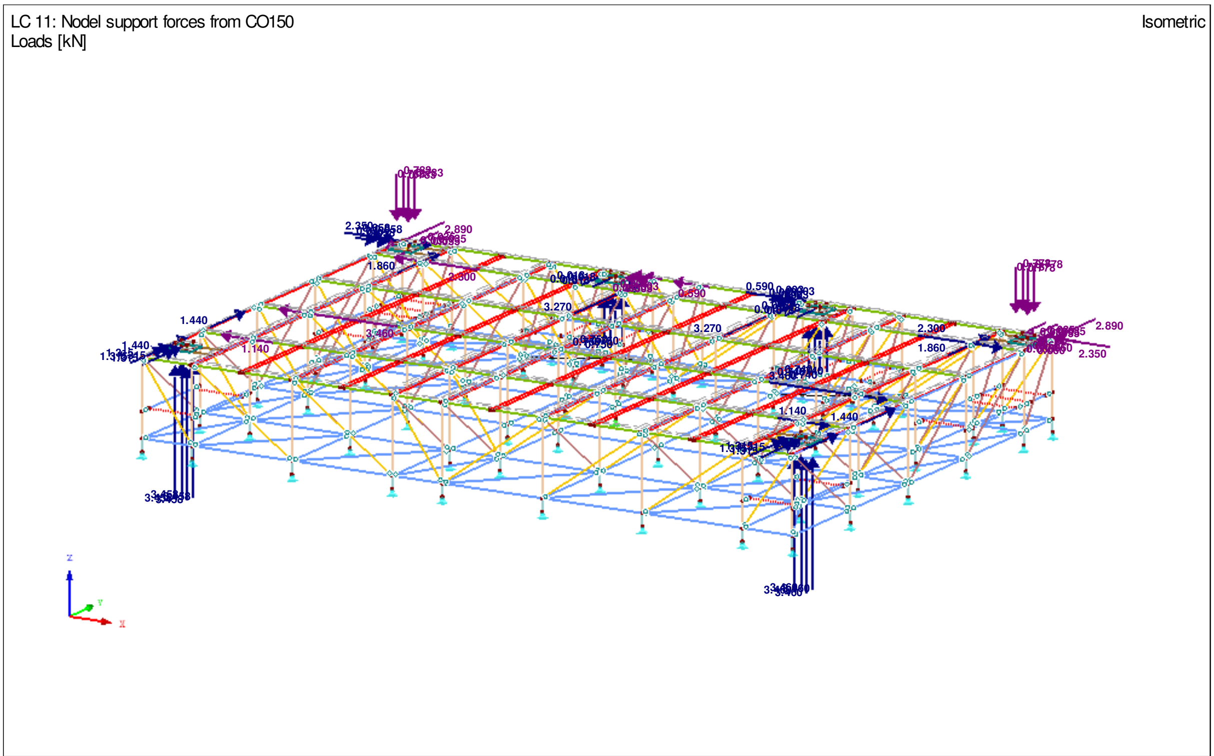
### Load input in Layher stage model.



## 6.2.4 nodal forces from load combination CO150

| Node | Support Forces [kN] | | | Support Moments [kNm] | | | |
|---|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ | |
| 3 | 0,23 | -0,14 | -3,13 | 0,00 | 0,00 | -0,01 | |
| 4 | 0,00 | 5,26 | 13,83 | 0,00 | 0,00 | 0,00 | |
| 7 | -0,24 | -0,14 | -3,11 | 0,00 | 0,00 | 0,01 | |
| 8 | 0,00 | 5,26 | 13,84 | 0,00 | 0,00 | 0,00 | |
| 80 | -3,46 | 1,44 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 104 | -1,14 | 1,44 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 123 | -0,01 | 0,07 | 3,00 | 0,00 | 0,00 | 0,04 | |
| 126 | 0,01 | 0,07 | 2,96 | 0,00 | 0,00 | -0,04 | |
| 165 | -2,30 | -2,89 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 167 | 3,46 | 1,44 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 169 | 1,14 | 1,44 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 173 | 2,30 | -2,89 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 175 | -2,35 | 1,86 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 177 | 0,59 | 3,27 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 179 | 2,35 | 1,86 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 181 | -0,59 | 3,27 | 0,00 | 0,00 | 0,00 | 0,00 | |
| Σ Forces | 0,00 | 20,64 | 27,38 | | | | |
| Σ Loads | 0,00 | 20,64 | 27,38 | | | | |

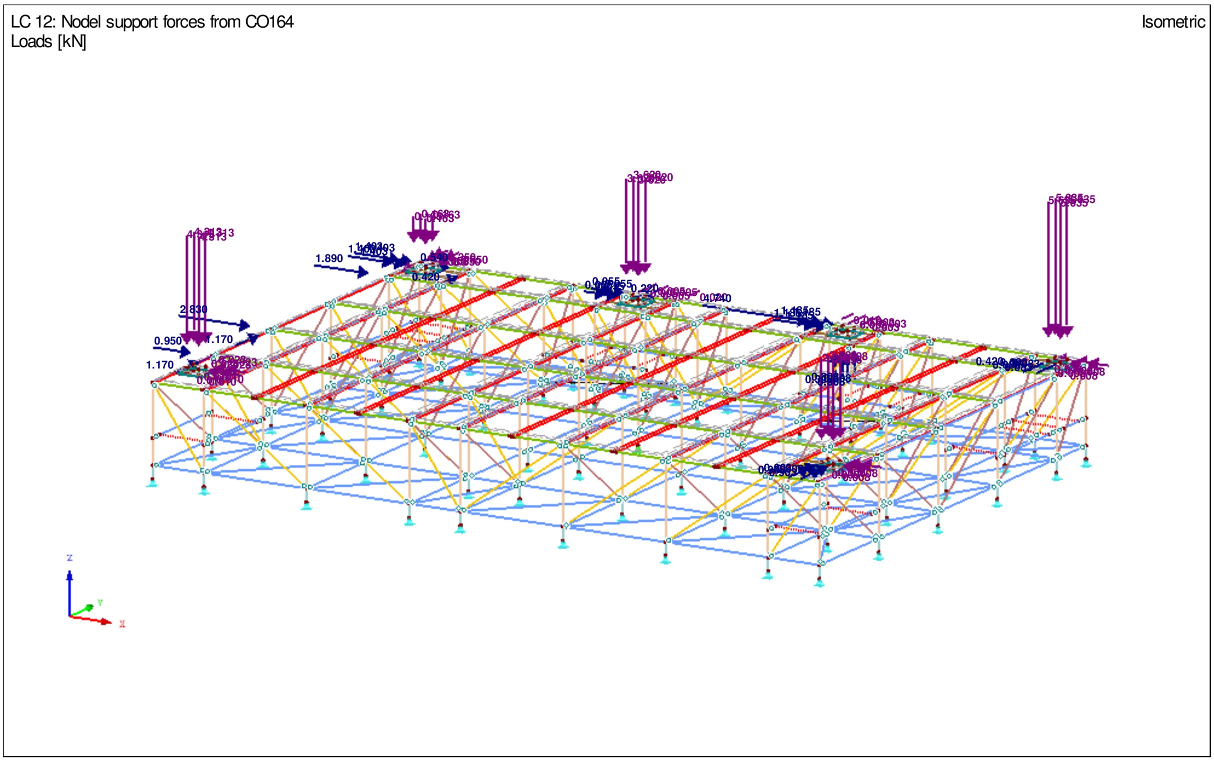
## Load input in Layher stage model.



## 6.2.5 nodal forces from load combination CO164

| Node | Support Forces [kN] | | | Support Moments [kNm] | | | |
|---|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ | |
| 3 | 5,61 | -1,40 | -0,65 | 0,00 | 0,00 | 0,07 | |
| 4 | -0,04 | -0,09 | -17,25 | 0,00 | 0,00 | 0,00 | |
| 7 | -0,03 | 0,33 | -22,54 | 0,00 | 0,00 | 0,07 | |
| 8 | -0,03 | 3,61 | -11,59 | 0,00 | 0,00 | 0,00 | |
| 80 | 2,83 | 1,17 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 104 | 0,95 | 1,17 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 123 | 0,22 | -0,02 | -14,48 | 0,00 | 0,00 | 0,02 | |
| 126 | 4,74 | -0,01 | 1,23 | 0,00 | 0,00 | 0,00 | |
| 165 | 1,89 | -2,35 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 167 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 169 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 173 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 175 | -0,54 | 0,42 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 177 | 0,14 | 0,74 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 179 | 0,54 | 0,42 | 0,00 | 0,00 | 0,00 | 0,00 | |
| 181 | -0,13 | 0,74 | 0,00 | 0,00 | 0,00 | 0,00 | |
| Σ Forces | 16,12 | 4,76 | -65,27 | | | | |
| Σ Loads | 16,12 | 4,76 | -65,27 | | | | |

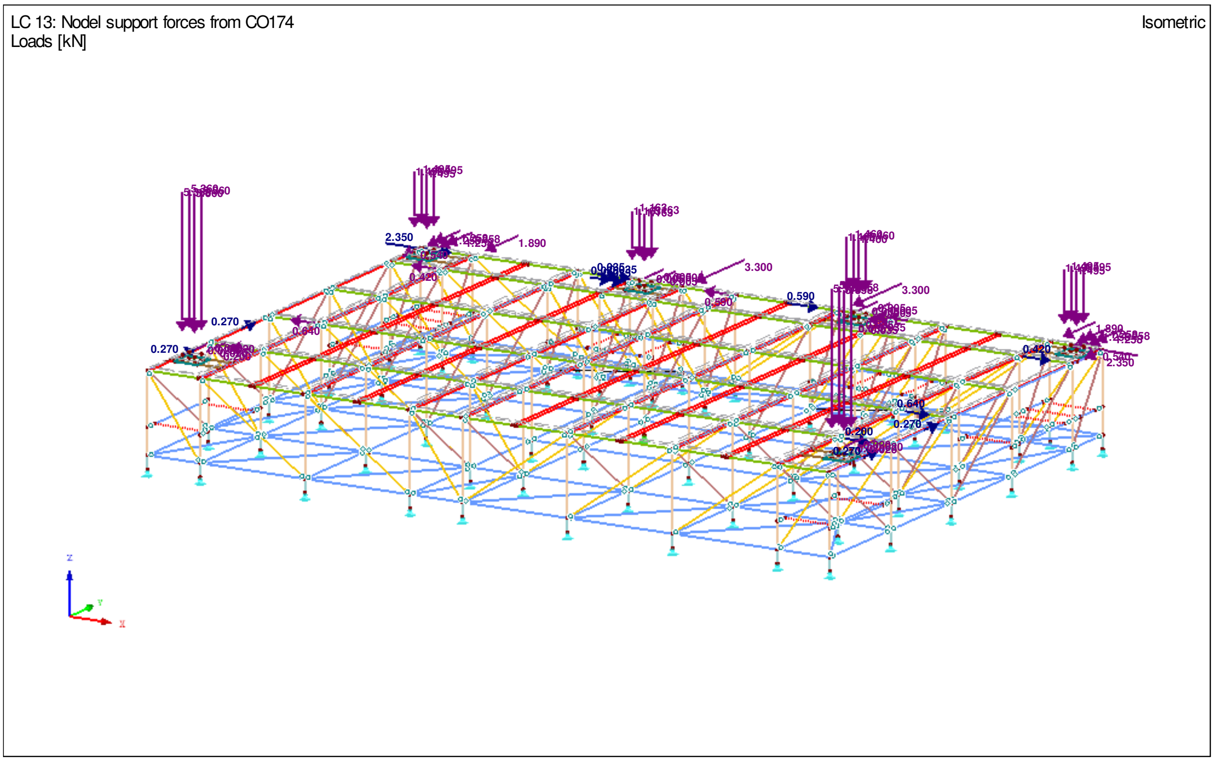
## Load input in Layher stage model.



## 6.2.6 nodal forces load combination CO174

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 0,00 | -5,03 | -5,98 | 0,00 | 0,00 | 0,00 |
| 4 | 0,00 | -0,08 | -21,44 | 0,00 | 0,00 | 0,00 |
| 7 | 0,00 | -5,03 | -5,98 | 0,00 | 0,00 | 0,00 |
| 8 | 0,00 | -0,08 | -21,43 | 0,00 | 0,00 | 0,00 |
| 80 | -0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | -0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,14 | -0,02 | -5,85 | 0,00 | 0,00 | -0,04 |
| 126 | -0,14 | -0,02 | -5,84 | 0,00 | 0,00 | 0,04 |
| 165 | -0,42 | -0,54 | 0,00 | 0,00 | 0,00 | 0,00 |
| 167 | 0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | 0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 173 | 0,42 | -0,54 | 0,00 | 0,00 | 0,00 | 0,00 |
| 175 | -2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,00 |
| 177 | 0,59 | -3,30 | 0,00 | 0,00 | 0,00 | 0,00 |
| 179 | 2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,00 |
| 181 | -0,59 | -3,30 | 0,00 | 0,00 | 0,00 | 0,00 |
| Σ Forces | 0,00 | -20,66 | -66,52 | | | |
| Σ Loads | 0,00 | -20,66 | -66,52 | | | |

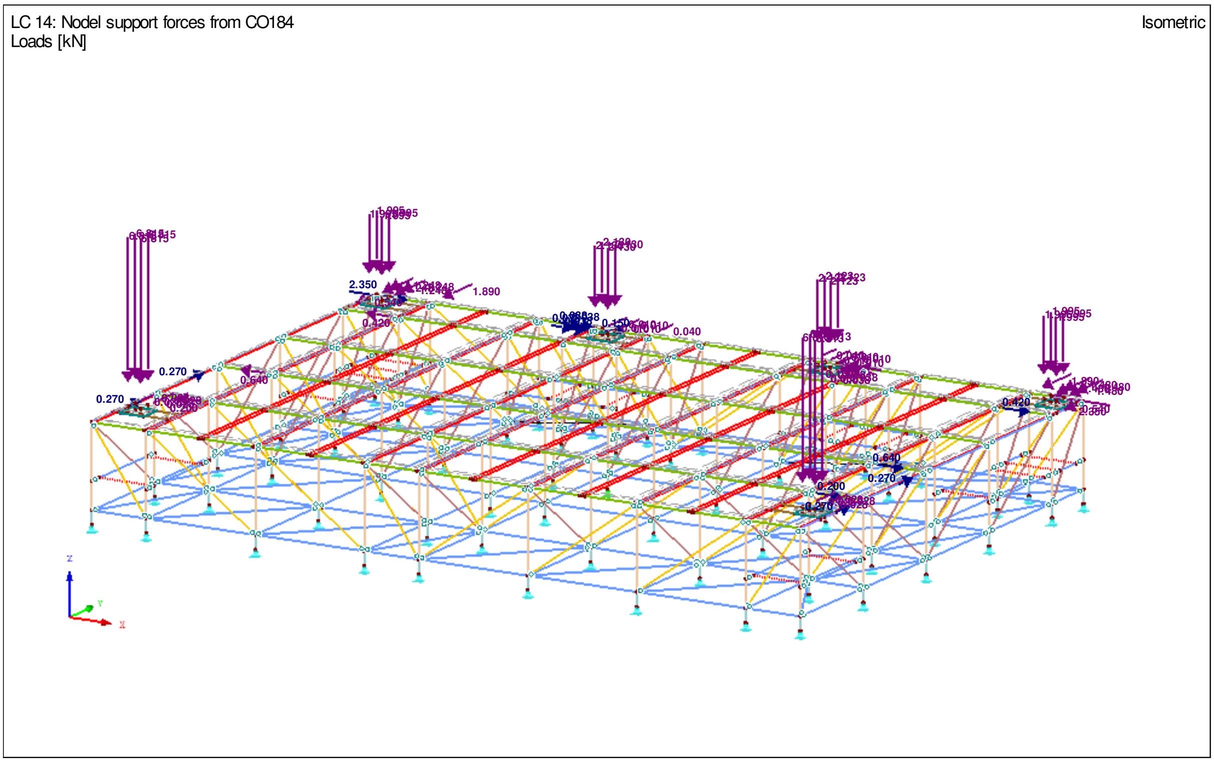
## Load input in Layher stage model.



### 6.2.7 nodal forces load combination CO184

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 0,00 | -4,99 | -7,98 | 0,00 | 0,00 | 0,00 |
| 4 | 0,00 | -0,11 | -27,26 | 0,00 | 0,00 | 0,00 |
| 7 | 0,00 | -4,99 | -7,98 | 0,00 | 0,00 | 0,00 |
| 8 | 0,00 | -0,11 | -27,25 | 0,00 | 0,00 | 0,00 |
| 80 | -0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | -0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,15 | -0,04 | -8,52 | 0,00 | 0,00 | -0,04 |
| 126 | -0,15 | -0,04 | -8,49 | 0,00 | 0,00 | 0,04 |
| 165 | -0,42 | -0,54 | 0,00 | 0,00 | 0,00 | 0,00 |
| 167 | 0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | 0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 173 | 0,42 | -0,54 | 0,00 | 0,00 | 0,00 | 0,00 |
| 175 | -2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,00 |
| 177 | 0,59 | -3,30 | 0,00 | 0,00 | 0,00 | 0,00 |
| 179 | 2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,00 |
| 181 | -0,59 | -3,30 | 0,00 | 0,00 | 0,00 | 0,00 |
| Σ Forces | 0,00 | -20,66 | -87,47 | | | |
| Σ Loads | 0,00 | -20,66 | -87,47 | | | |

### Load input in Layher stage model.



## 6.3 Results of the Calculation.

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **Summary** | | | |
| | Calculation Status | OK | | |
| | Maximum displacement in X-direction | 3,7 | mm | CO3, FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 13,0 | mm | LC11, Member No. 1016, x: 0.105 m |
| | Maximum displacement in Z-direction | 69,7 | mm | LC11, Member No. 992, x: 0.000 m |
| | Maximum vectorial displacement | 70,7 | mm | LC11, Member No. 992, x: 0.000 m |
| | Maximum rotation about X-axis | -38,4 | mrad | CO2, Member No. 1011, x: 0.000 m |
| | Maximum rotation about Y-axis | -41,9 | mrad | CO5, FE Node No. 1622 (X: 8.082, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 5,2 | mrad | LC11, Member No. 174, x: 1.823 m |
| | Number of 1D finite elements (member elements) | 4939 | | |
| | Number of 2D finite elements (surface elements) | 4894 | | |
| | Number of 3D finite elements (solid elements) | 0 | | |
| | Number of FE nodes | 7159 | | |
| | Number of equations | 42954 | | |
| | 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 | | |

## Results per load case and Load combination

| | 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 | -54,82 | kN | |
| | Sum of support forces in Z | -54,82 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,943 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | -0,083 | 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 | 0,6 | mm | Member No. 405, x: 1.279 m |
| | Maximum displacement in Y-direction | 0,6 | mm | Member No. 236, x: 1.279 m |
| | Maximum displacement in Z-direction | -1,6 | mm | Member No. 271, x: 1.465 m |
| | Maximum vectorial displacement | 1,6 | mm | Member No. 271, x: 1.465 m |
| | Maximum rotation about X-axis | 1,3 | mrad | Member No. 629, x: 2.558 m |
| | Maximum rotation about Y-axis | 1,3 | mrad | Member No. 405, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,1 | mrad | Member No. 404, x: 2.558 m |
| | Method of analysis | Large | | Large Deformation Analysis (Newton-Raphson) |
| | **LC2 - belasting 350Kg/m² wind ditr 0°** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 41,69 | kN | |
| | Sum of support forces in Y | 41,69 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -398,69 | kN | |
| | Sum of support forces in Z | -398,69 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 101,961 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 7,201 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,729 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -1,5 | mm | FE Node No. 3702 (X: 3.367, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 2,1 | mm | FE Node No. 7002 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| | Maximum displacement in Z-direction | -10,2 | mm | FE Node No. 1073 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 10,3 | mm | FE Node No. 1073 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -16,9 | mrad | FE Node No. 7147 (X: 6.733, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 22,8 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 2,1 | mrad | Member No. 106, x: 0.000 m |
| | Method of analysis | Large | | Large Deformation Analysis (Newton-Raphson) |
| | **LC3 - belasting 350Kg/m² wind ditr 90°** | | | |

| | | | | |
|---|---|---|---|---|
| | Sum of loads in X | 41,72 | kN | |
| | Sum of support forces in X | 41,72 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | -0,02 | kN | |
| | Sum of support forces in Y | -0,02 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -398,69 | kN | |
| | Sum of support forces in Z | -398,69 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 123,053 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 28,193 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 15,178 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 1,9 | mm | FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -1,2 | mm | Member No. 129, x: 1.000 m |
| | Maximum displacement in Z-direction | -10,3 | mm | FE Node No. 1073 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 10,3 | mm | FE Node No. 1073 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -17,0 | mrad | FE Node No. 7143 (X: 5.749, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 22,7 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 2,2 | mrad | Member No. 106, x: 0.000 m |
| | Method of analysis | Large | | Large Deformation Analysis (Newton-Raphson) |
| | **LC4 - belasting 350Kg/m² wind ditr 180°** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -41,73 | kN | |
| | Sum of support forces in Y | -41,73 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -398,69 | kN | |
| | Sum of support forces in Z | -398,69 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 144,132 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 7,215 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,767 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 1,4 | mm | FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -2,6 | mm | Member No. 411, x: 0.750 m |
| | Maximum displacement in Z-direction | -10,3 | mm | FE Node No. 1073 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 10,4 | mm | FE Node No. 1073 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -17,0 | mrad | FE Node No. 7143 (X: 5.749, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 22,7 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -2,3 | mrad | Member No. 404, x: 2.558 m |
| | Method of analysis | Large | | Large Deformation Analysis (Newton-Raphson) |
| | **LC5 - 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 | -74,00 | kN | |
| | Sum of support forces in Z | -74,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -63,241 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 1,114 | 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. 993, x: 0.000 m |
| | Maximum displacement in Y-direction | 0,0 | mm | Member No. 186, x: 0.714 m |
| | Maximum displacement in Z-direction | -16,3 | mm | Member No. 199, x: 1.036 m |
| | Maximum vectorial displacement | 16,3 | mm | Member No. 199, x: 1.036 m |
| | Maximum rotation about X-axis | 28,0 | mrad | Member No. 620, x: 2.072 m |
| | Maximum rotation about Y-axis | -5,0 | mrad | Member No. 870, x: 1.036 m |
| | Maximum rotation about Z-axis | 0,0 | mrad | Member No. 752, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC10 - Nodel support forces from CO53** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,07 | kN | |
| | Sum of support forces in Y | 0,07 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -67,98 | kN | |
| | Sum of support forces in Z | -67,98 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -3,934 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 0,937 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,001 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,4 | mm | FE Node No. 3264 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -0,5 | mm | Member No. 756, x: 0.429 m |
| | Maximum displacement in Z-direction | -3,2 | mm | FE Node No. 3185 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 3,2 | mm | FE Node No. 3185 (X: 12.133, Y: -0.380, Z: 2.250 m) |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about X-axis | -6,2 | mrad | FE Node No. 3280 (X: 11.988, Y: -0.748, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 6,1 | mrad | FE Node No. 3040 (X: -0.905, Y: -0.454, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -1,2 | mrad | Member No. 744, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC11 - Nodel support forces from CO150** | | | |
| | 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 | 20,62 | kN | |
| | Sum of support forces in Y | 20,62 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 27,39 | kN | |
| | Sum of support forces in Z | 27,39 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -123,584 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | -0,169 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,342 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -2,2 | mm | Member No. 143, x: 1.000 m |
| | Maximum displacement in Y-direction | 13,0 | mm | Member No. 1016, x: 0.105 m |
| | Maximum displacement in Z-direction | 69,7 | mm | Member No. 992, x: 0.000 m |
| | Maximum vectorial displacement | 70,7 | mm | Member No. 992, x: 0.000 m |
| | Maximum rotation about X-axis | -23,4 | mrad | Member No. 154, x: 0.000 m |
| | Maximum rotation about Y-axis | 13,1 | mrad | Member No. 356, x: 0.518 m |
| | Maximum rotation about Z-axis | 5,2 | mrad | Member No. 174, x: 1.823 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC12 - Nodel support forces from CO164** | | | |
| | Sum of loads in X | 21,10 | kN | |
| | Sum of support forces in X | 21,10 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 3,22 | kN | |
| | Sum of support forces in Y | 3,22 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -65,28 | kN | |
| | Sum of support forces in Z | -65,28 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -26,430 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 82,209 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -28,610 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 0,8 | mm | FE Node No. 4009 (X: 4.030, Y: 7.544, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 0,6 | mm | Member No. 757, x: 0.429 m |
| | Maximum displacement in Z-direction | -3,3 | mm | FE Node No. 3016 (X: -0.687, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 3,3 | mm | FE Node No. 3016 (X: -0.687, Y: -0.380, Z: 2.250 m) |
| | Maximum rotation about X-axis | -6,2 | mrad | FE Node No. 4396 (X: 12.139, Y: 7.412, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 7,0 | mrad | FE Node No. 3938 (X: 3.258, Y: 7.473, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -1,3 | mrad | Member No. 744, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC13 - Nodel support forces from CO174** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -20,64 | kN | |
| | Sum of support forces in Y | -20,64 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -65,32 | kN | |
| | Sum of support forces in Z | -65,32 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 96,720 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 3,446 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,311 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,5 | mm | FE Node No. 3264 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -1,2 | mm | Member No. 183, x: 0.571 m |
| | Maximum displacement in Z-direction | -4,2 | mm | FE Node No. 3185 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 4,3 | mm | FE Node No. 3185 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum rotation about X-axis | -8,1 | mrad | FE Node No. 3280 (X: 11.988, Y: -0.748, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 8,0 | mrad | FE Node No. 3040 (X: -0.905, Y: -0.454, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -1,6 | mrad | Member No. 744, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC14 - Nodel support forces from CO184** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -15,08 | kN | |
| | Sum of support forces in Y | -15,08 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -87,48 | kN | |
| | Sum of support forces in Z | -87,48 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 100,635 | kNm | At center of gravity of model (X: 5.708, Y: 3.872, Z: 1.807 m) |
| | Resultant of reactions about Y | 1,206 | kNm | At center of gravity of model |

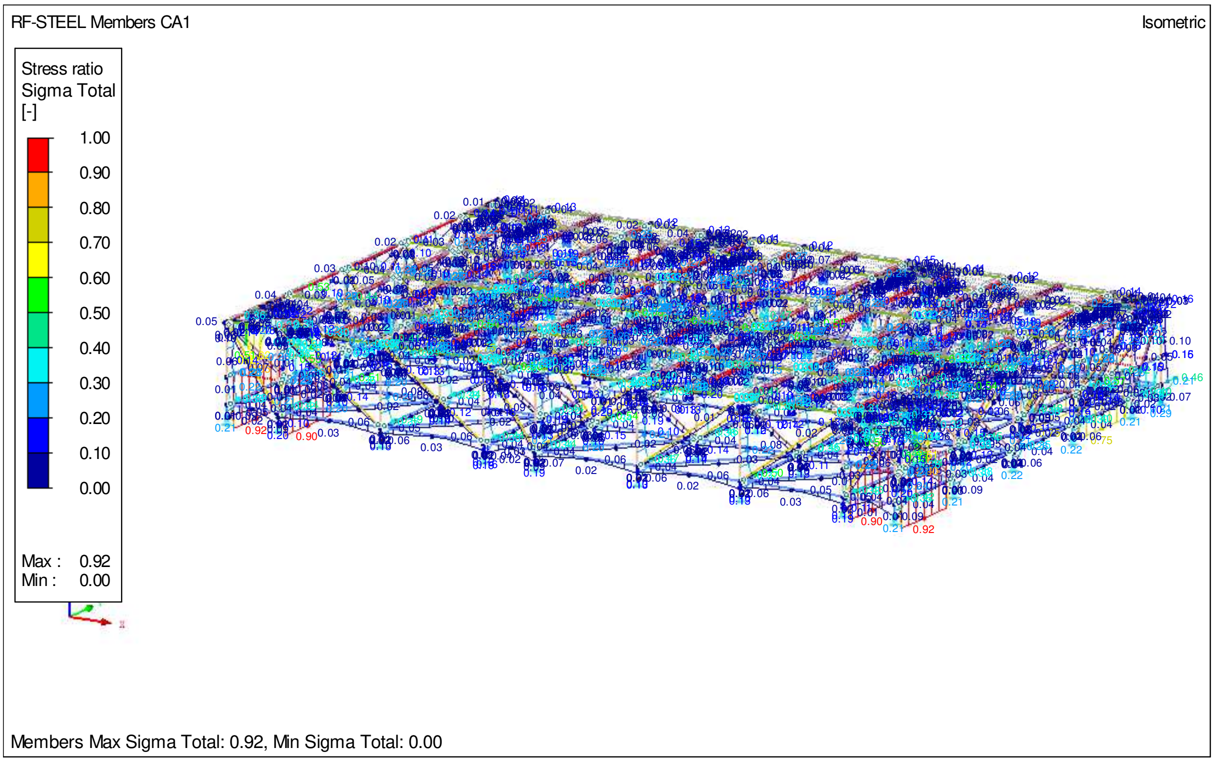
| | | | |
|---|---|---|---|
| Resultant of reactions about Z | -6,175 | kNm | At center of gravity of model |
| Maximum displacement in X-direction | -0,6 | mm | FE Node No. 3264 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| Maximum displacement in Y-direction | -1,3 | mm | Member No. 183, x: 0.571 m |
| Maximum displacement in Z-direction | -5,4 | mm | FE Node No. 3185 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| Maximum vectorial displacement | 5,4 | mm | FE Node No. 3185 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| Maximum rotation about X-axis | -10,3 | mrad | FE Node No. 3280 (X: 11.988, Y: -0.748, Z: 2.250 m) |
| Maximum rotation about Y-axis | 10,1 | mrad | FE Node No. 3040 (X: -0.905, Y: -0.454, Z: 2.250 m) |
| Maximum rotation about Z-axis | -2,0 | mrad | Member No. 744, x: 0.000 m |
| Method of analysis | Linear | | Geometrically Linear Analysis |
| **CO1 - 1.15*LC1 + 1.35*LC2 + 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 | 56,37 | kN | |
| Sum of support forces in Y | 56,37 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -793,08 | kN | |
| Sum of support forces in Z | -793,08 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -2,4 | mm | FE Node No. 3702 (X: 3.367, Y: 6.108, Z: 2.250 m) |
| Maximum displacement in Y-direction | 3,1 | mm | FE Node No. 7002 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| Maximum displacement in Z-direction | -21,7 | mm | Member No. 620, x: 1.036 m |
| Maximum vectorial displacement | 21,8 | mm | Member No. 620, x: 1.036 m |
| Maximum rotation about X-axis | -37,3 | mrad | Member No. 199, x: 0.000 m |
| Maximum rotation about Y-axis | 36,9 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| Maximum rotation about Z-axis | 3,3 | mrad | Member No. 106, x: 0.000 m |
| Method of analysis | Large | | Large Deformation Analysis (Picard) |
| **CO2 - 1.15*LC1 + 1.35*LC2 + 1.35*LC5 + 1.35*LC11** | | | |
| 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 | 84,13 | kN | |
| Sum of support forces in Y | 84,13 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -663,91 | kN | |
| Sum of support forces in Z | -663,91 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -2,6 | mm | FE Node No. 6895 (X: 1.295, Y: 6.108, Z: 2.250 m) |
| Maximum displacement in Y-direction | 3,7 | mm | FE Node No. 7002 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| Maximum displacement in Z-direction | -22,1 | mm | Member No. 767, x: 1.036 m |
| Maximum vectorial displacement | 22,3 | mm | Member No. 1011, x: 1.036 m |
| Maximum rotation about X-axis | -38,4 | mrad | Member No. 1011, x: 0.000 m |
| Maximum rotation about Y-axis | 41,7 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| Maximum rotation about Z-axis | 3,0 | mrad | Member No. 106, 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 + 1.35*LC3 + 1.35*LC5 + 1.35*LC12** | | | |
| Sum of loads in X | 84,76 | kN | |
| Sum of support forces in X | 84,76 | kN | Deviation: 0.00 % |
| Sum of loads in Y | 4,35 | kN | |
| Sum of support forces in Y | 4,35 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -789,02 | kN | |
| Sum of support forces in Z | -789,02 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | 3,7 | mm | FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| Maximum displacement in Y-direction | -1,8 | mm | Member No. 129, x: 1.000 m |
| Maximum displacement in Z-direction | -21,9 | mm | Member No. 620, x: 1.036 m |
| Maximum vectorial displacement | 21,9 | mm | Member No. 620, x: 1.036 m |
| Maximum rotation about X-axis | -37,7 | mrad | Member No. 620, x: 0.000 m |
| Maximum rotation about Y-axis | 41,8 | mrad | FE Node No. 3702 (X: 3.367, Y: 6.108, Z: 2.250 m) |
| Maximum rotation about Z-axis | 3,3 | mrad | Member No. 106, 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 + 1.35*LC4 + 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 | -84,15 | kN | |
| Sum of support forces in Y | -84,15 | kN | Deviation: 0.00 % |
| Sum of loads in Z | -789,07 | kN | |
| Sum of support forces in Z | -789,07 | kN | Deviation: 0.00 % |
| Maximum displacement in X-direction | -2,6 | mm | FE Node No. 126 (X: 1.292, Y: -0.110, Z: 2.250 m) |
| Maximum displacement in Y-direction | -4,8 | mm | Member No. 510, x: 0.750 m |
| Maximum displacement in Z-direction | -21,9 | mm | Member No. 620, x: 1.036 m |
| Maximum vectorial displacement | 22,1 | mm | Member No. 620, x: 1.036 m |

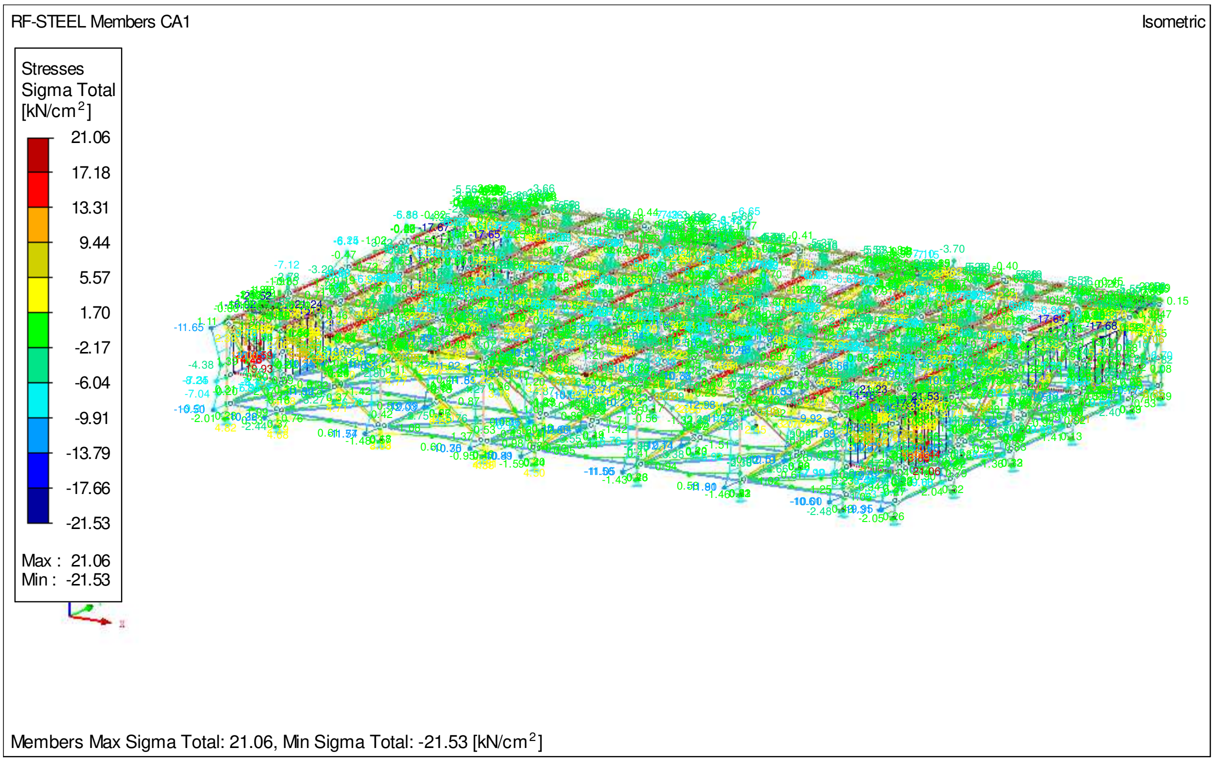
| | | | | |
|---|---|---|---|---|
| | Maximum rotation about X-axis | -37,6 | mrad | Member No. 620, x: 0.000 m |
| | Maximum rotation about Y-axis | -41,7 | mrad | FE Node No. 1622 (X: 8.082, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -3,7 | mrad | Member No. 404, x: 2.558 m |
| | 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 - 1.35*LC1 + 1.35*LC4 + 1.35*LC5 + 1.35*LC14** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -76,64 | kN | |
| | Sum of support forces in Y | -76,64 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -829,95 | kN | |
| | Sum of support forces in Z | -829,95 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -2,7 | mm | FE Node No. 126 (X: 1.292, Y: -0.110, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -4,6 | mm | Member No. 510, x: 0.750 m |
| | Maximum displacement in Z-direction | -21,8 | mm | Member No. 620, x: 1.036 m |
| | Maximum vectorial displacement | 22,0 | mm | Member No. 620, x: 1.036 m |
| | Maximum rotation about X-axis | -37,5 | mrad | Member No. 620, x: 0.000 m |
| | Maximum rotation about Y-axis | -41,9 | mrad | FE Node No. 1622 (X: 8.082, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -3,7 | mrad | Member No. 503, x: 2.558 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO10 - LC1 + LC2 + LC5 + LC10** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 41,76 | kN | |
| | Sum of support forces in Y | 41,76 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -595,28 | kN | |
| | Sum of support forces in Z | -595,28 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -1,9 | mm | FE Node No. 3702 (X: 3.367, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 2,3 | mm | FE Node No. 7002 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| | Maximum displacement in Z-direction | -16,2 | mm | Member No. 620, x: 1.036 m |
| | Maximum vectorial displacement | 16,3 | mm | Member No. 620, x: 1.036 m |
| | Maximum rotation about X-axis | -27,9 | mrad | Member No. 620, x: 0.000 m |
| | Maximum rotation about Y-axis | 30,6 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 2,3 | mrad | Member No. 106, 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 - LC1 + LC2 + 1.35*LC5 + LC11** | | | |
| | 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 | 62,31 | kN | |
| | Sum of support forces in Y | 62,31 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -525,80 | kN | |
| | Sum of support forces in Z | -525,80 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -1,9 | mm | FE Node No. 6895 (X: 1.295, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 2,7 | mm | FE Node No. 7002 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| | Maximum displacement in Z-direction | -22,1 | mm | Member No. 767, x: 1.036 m |
| | Maximum vectorial displacement | 22,2 | mm | Member No. 1011, x: 1.036 m |
| | Maximum rotation about X-axis | -38,2 | mrad | Member No. 1011, x: 0.000 m |
| | Maximum rotation about Y-axis | 30,6 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 2,2 | mrad | Member No. 106, 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 - LC1 + LC3 + LC5 + LC12** | | | |
| | Sum of loads in X | 62,79 | kN | |
| | Sum of support forces in X | 62,79 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 3,22 | kN | |
| | Sum of support forces in Y | 3,22 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -592,58 | kN | |
| | Sum of support forces in Z | -592,58 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 2,7 | mm | FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -1,3 | mm | Member No. 129, x: 1.000 m |
| | Maximum displacement in Z-direction | -16,3 | mm | Member No. 620, x: 1.036 m |
| | Maximum vectorial displacement | 16,3 | mm | Member No. 620, x: 1.036 m |
| | Maximum rotation about X-axis | -28,0 | mrad | Member No. 620, x: 0.000 m |
| | Maximum rotation about Y-axis | 30,6 | mrad | FE Node No. 3702 (X: 3.367, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 2,5 | mrad | Member No. 106, x: 0.000 m |

| | | | | |
|---|---|---|---|---|
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO13 - LC1 + LC4 + LC5 + LC13** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -62,33 | kN | |
| | Sum of support forces in Y | -62,33 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -592,62 | kN | |
| | Sum of support forces in Z | -592,62 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 1,9 | mm | FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -3,4 | mm | Member No. 510, x: 0.750 m |
| | Maximum displacement in Z-direction | -16,2 | mm | Member No. 620, x: 1.036 m |
| | Maximum vectorial displacement | 16,4 | mm | Member No. 620, x: 1.036 m |
| | Maximum rotation about X-axis | -27,9 | mrad | Member No. 620, x: 0.000 m |
| | Maximum rotation about Y-axis | 30,5 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -2,7 | mrad | Member No. 404, x: 2.558 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 - LC1 + LC4 + LC5 + LC14** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -56,77 | kN | |
| | Sum of support forces in Y | -56,77 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -614,78 | kN | |
| | Sum of support forces in Z | -614,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 1,9 | mm | FE Node No. 2042 (X: 8.079, Y: 6.108, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -3,3 | mm | Member No. 510, x: 0.750 m |
| | Maximum displacement in Z-direction | -16,2 | mm | Member No. 620, x: 1.036 m |
| | Maximum vectorial displacement | 16,4 | mm | Member No. 620, x: 1.036 m |
| | Maximum rotation about X-axis | -27,8 | mrad | Member No. 620, x: 0.000 m |
| | Maximum rotation about Y-axis | 30,5 | mrad | FE Node No. 2046 (X: 8.547, Y: 6.108, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -2,7 | mrad | Member No. 503, x: 2.558 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

## 6.4 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/cm$^2$] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 1 | RO 48.3x3.2 (Hot Formed) - 0 | | | | | | | |
| | 1011 | 1,036 | 10 | CO2 | Sigma Total | -21,53 | 23,50 | 0,92 |
| | 620 | 1,822 | 19 | CO2 | Tau Total | 1,80 | 13,57 | 0,13 |
| | 1011 | 1,036 | 10 | CO2 | Sigma-eqv | 21,53 | 23,50 | 0,92 |
| | | | | | | | | |
| 2 | RO 48.3x3.2 (Hot Formed) - Defpoints | | | | | | | |
| | 109 | 1,421 | 10 | CO3 | Sigma Total | -2,66 | 23,50 | 0,11 |
| | 404 | 0,000 | 19 | CO4 | Tau Total | -0,96 | 13,57 | 0,07 |
| | 109 | 1,421 | 10 | CO3 | Sigma-eqv | 2,66 | 23,50 | 0,11 |
| | | | | | | | | |
| 3 | RO 48.3x3.2 (Hot Formed) | | | | | | | |
| | 530 | 1,421 | 10 | CO1 | Sigma Total | -3,11 | 23,50 | 0,13 |
| | 237 | 0,000 | 19 | CO3 | Tau Total | -0,23 | 13,57 | 0,02 |
| | 530 | 1,421 | 10 | CO1 | Sigma-eqv | 3,12 | 23,50 | 0,13 |
| | | | | | | | | |
| 5 | HK 50/30/4/4/4/4 | | | | | | | |
| | 904 | 0,375 | 10 | CO3 | Sigma Total | 10,08 | 22,50 | 0,45 |
| | 638 | 0,000 | 8 | CO2 | Tau Total | 2,84 | 12,99 | 0,22 |
| | 904 | 0,375 | 10 | CO3 | Sigma-eqv | 10,16 | 22,50 | 0,45 |
| | | | | | | | | |
| 6 | RRO 120x60x6.3 (Hot Formed) | | | | | | | |
| | 996 | 0,375 | 11 | CO5 | Sigma Total | 21,06 | 23,50 | 0,90 |
| | 946 | 0,916 | 16 | CO5 | Tau Total | -2,14 | 13,57 | 0,16 |
| | 996 | 0,375 | 11 | CO5 | Sigma-eqv | 21,18 | 23,50 | 0,90 |
| | | | | | | | | |
| 7 | RRO 120x80x6.3 (Hot Formed) | | | | | | | |
| | 1003 | 0,054 | 11 | CO5 | Sigma Total | 8,20 | 23,50 | 0,35 |
| | 1002 | 0,035 | 15 | CO5 | Tau Total | -5,69 | 13,57 | 0,42 |
| | 1002 | 0,035 | 14 | CO5 | Sigma-eqv | 9,92 | 23,50 | 0,42 |
| | | | | | | | | |
| 8 | Ring 48/6 | | | | | | | |
| | 1020 | 0,000 | 1 | CO5 | Sigma Total | -3,18 | 26,00 | 0,12 |
| | 1021 | 0,000 | 10 | CO5 | Tau Total | -0,49 | 15,01 | 0,03 |
| | 1020 | 0,000 | 1 | CO5 | Sigma-eqv | 3,18 | 26,00 | 0,12 |
| | | | | | | | | |
| 9 | RO 48.3x3.2 (Hot Formed) | | | | | | | |
| | 121 | 1,000 | 10 | CO5 | Sigma Total | -17,37 | 32,00 | 0,54 |
| | 121 | 0,250 | 19 | CO5 | Tau Total | -0,52 | 18,48 | 0,03 |
| | 121 | 1,000 | 10 | CO5 | Sigma-eqv | 17,37 | 32,00 | 0,54 |
| | | | | | | | | |
| 10 | Ring 38/8.1 | | | | | | | |
| | 72 | 0,250 | 9 | CO4 | Sigma Total | -13,67 | 23,50 | 0,58 |
| | 163 | 0,250 | 17 | CO2 | Tau Total | -0,63 | 13,57 | 0,05 |
| | 72 | 0,250 | 9 | CO4 | Sigma-eqv | 13,67 | 23,50 | 0,58 |

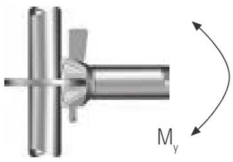
## 6.5 Layher design information

The company Eekels verhuur owns the Layher K2000+ system.

Information of the Layher 2000+ system

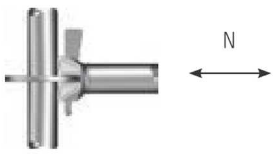
### Z-8.22-64: K 2000+

**Biegemoment**



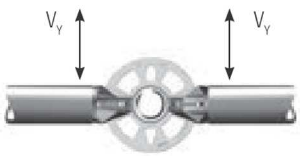

Biegemoment
$M_{y,\,Rd} = \pm\ 101{,}0$ kNcm

**Normalkraft**

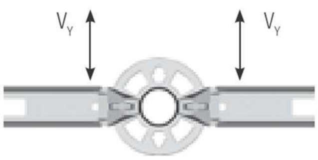



$N_{Rd} = \pm\ 31{,}0$ kN

**Horizontale Querkraft**

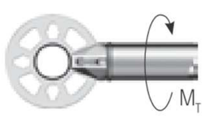



O-Riegel: $V_{y,\,Rd} = \pm\ 10{,}0$ kN



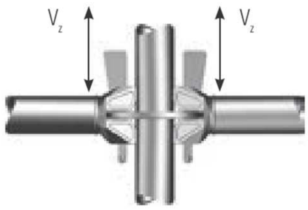

U-Riegel: $V_{y,\,Rd} = \pm\ 5{,}9$ kN

**Torsionsmoment**



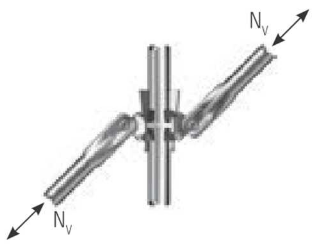

$M_{T,\,Rd} = \pm\ 52{,}5$ kNcm

**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.**

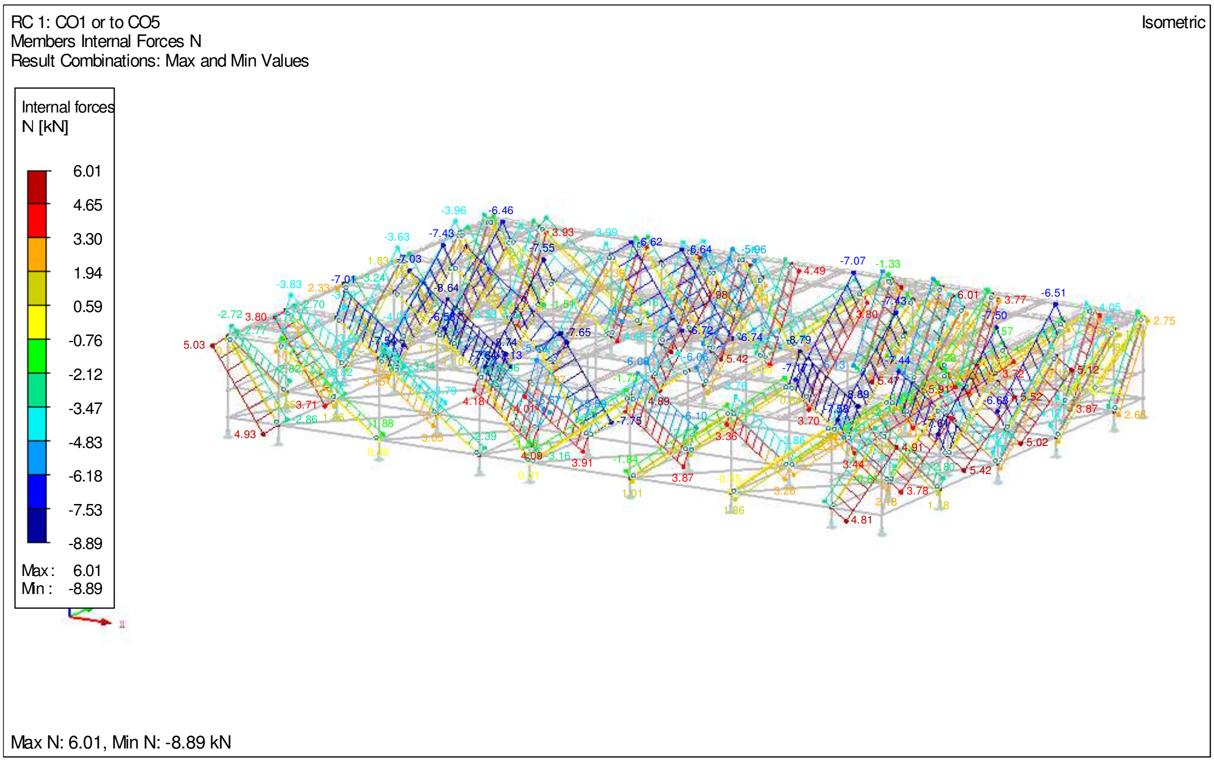
Rd = Beanspruchbarkeit,
(enthält Teilsicherheitsbeiwert $\gamma_M$)

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

15

## 6.6 Check of the Layher diagonals.

The Maximum tension or compression of the Layher K2000+ system is +/- 12.4 kN. In the next figurer the minimum and maximum forces are displayed.




The maximum Ned is 8.89 kN

Check of the diagonals

Ned / Nrd < 1

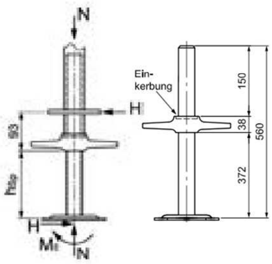
8.98 / 12.4 = 0.72 < 1

## 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

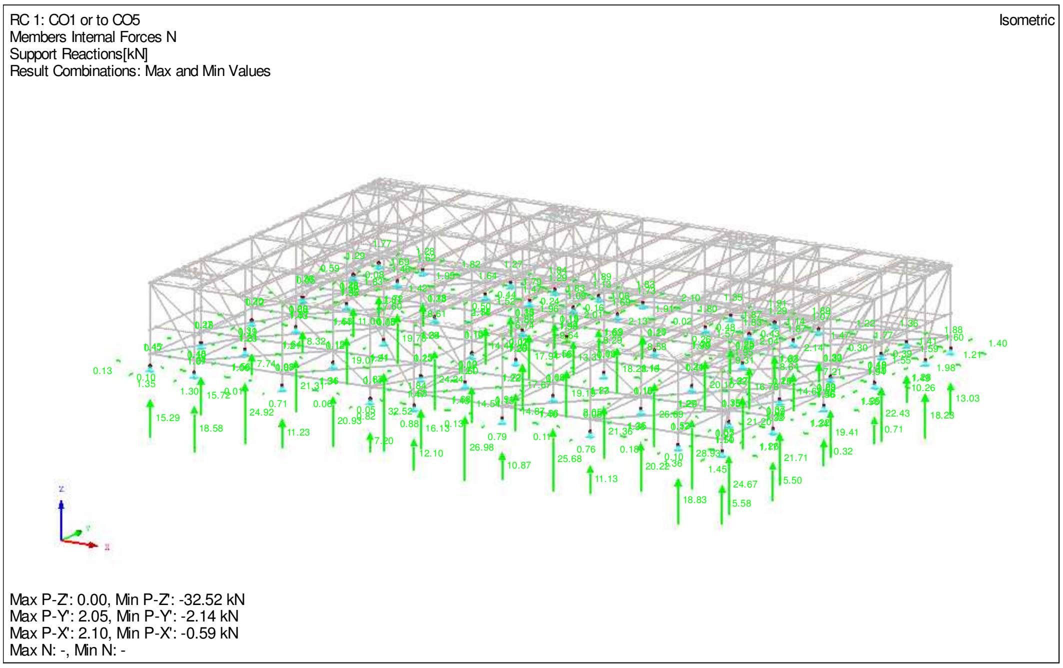
**Tab. 12 Belastung Fußspindeln**

| Aus-spindel-länge $h_{Sp}$ [cm] | Zulässige Vertikallast N [kN]* bei gleichzeitiger Wirkung einer Horizontallast H [kN] | | | | | | | | | | | | | | | | | | | | | | | | | | Zul. 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**

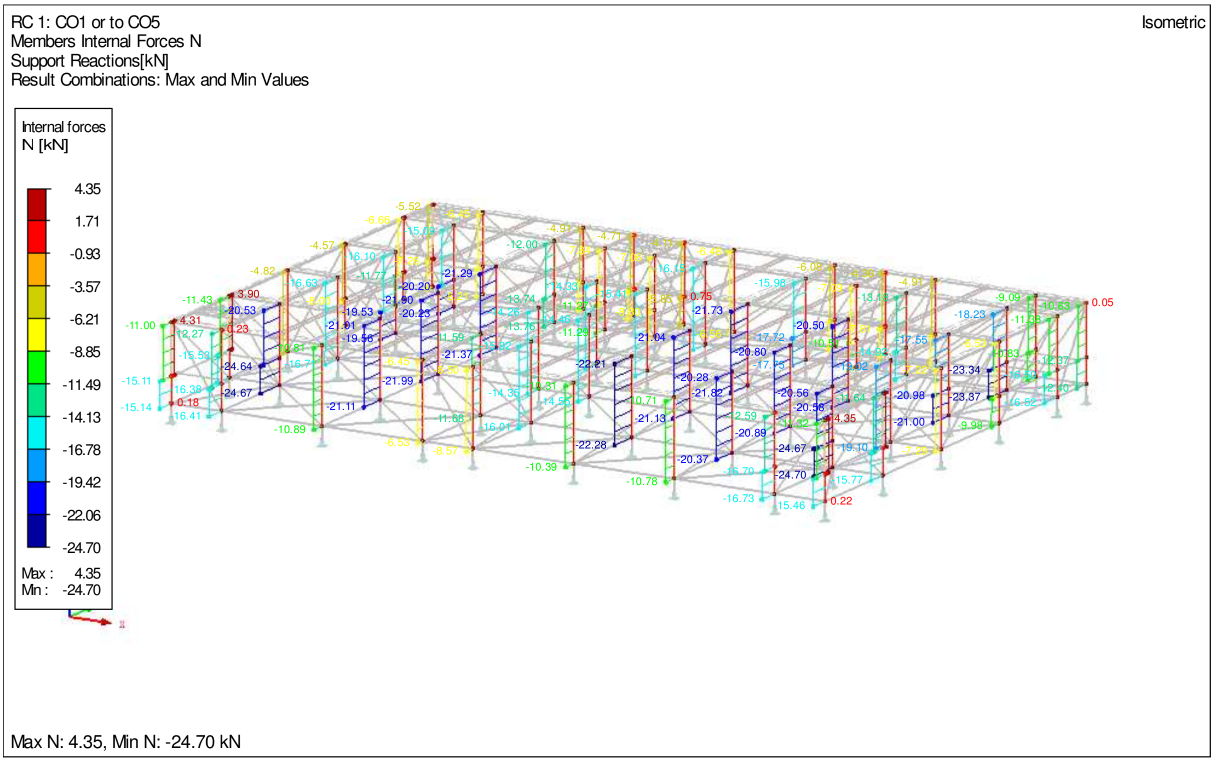
(–) Bei dieser Kombination von Ausspindellänge und Horizontallast ist die Biegebeanspruchbarkeit der Spindel überschritten.

In the next figure the maximum support forces are displayed.




The maximum support force is 32.52 kN. Which occurs in Load Combination CO3. The maximum horizontal force in Load Combination CO3 at this point is 1.34 kN. According to the table of the Layher spindle the combination between the vertical and the horizontal force allows for a maximum spindle length of 20 cm

## 6.8 Check of the Layher columns




Proof against buckling.

$\beta = 0.9$
$L_{cr} = 0.9 * 150 = 135$ cm
$A = 4.53$ cm²
$I = 11.60$ cm$^4$
$W = 4.80$ cm³
$i = 1.60$cm

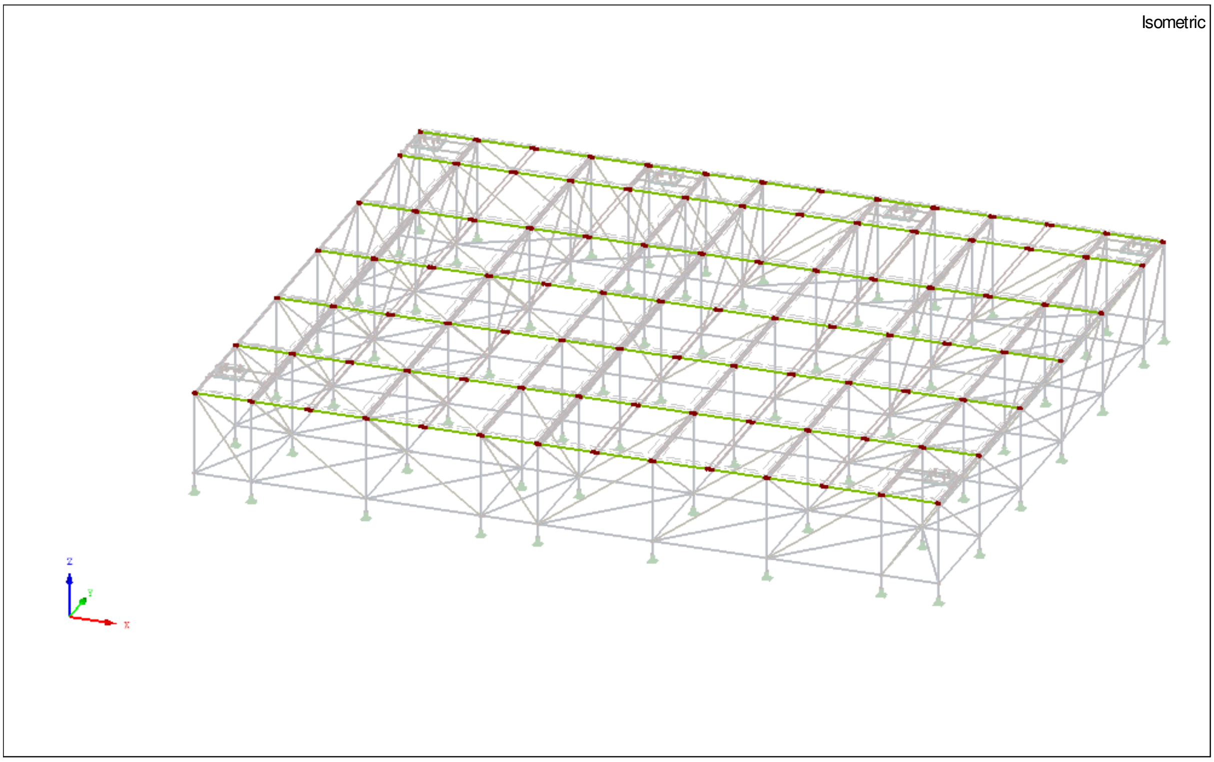
$\lambda_1 = \pi * \sqrt{(210000/320)} = 80{,}48$
$\bar{\lambda} = 135 / (1.6 * 80.48) = 1.048$
Buckling curve for hollow section line c ( table 6.2 from en-1993-1-1)
$\alpha = 0{,}49$
$\Phi = 0.5 * (1 + \alpha * (\bar{\lambda} - 0.2) + \bar{\lambda}^2)$
$\Phi = 0.5 * (1 + 0.49 * (1.048 - 0.2) + 1.048^2) = 1.257$
$\chi_{min} = 1 / (\Phi + \sqrt{(\Phi^2 - \bar{\lambda}^2)})$
$\chi_{min} = 1 / (1.257 + \sqrt{(1.257^2 - 1.048^2)}) = 0.512$

$N_{b,rd} = \chi * A * f_0 / 1.1$
$N_{b,rd} = 0.512 * 4.53 * 32 / 1.1 = 67.54$ kN
$N_{ed,\,max} = 24.70$ kN

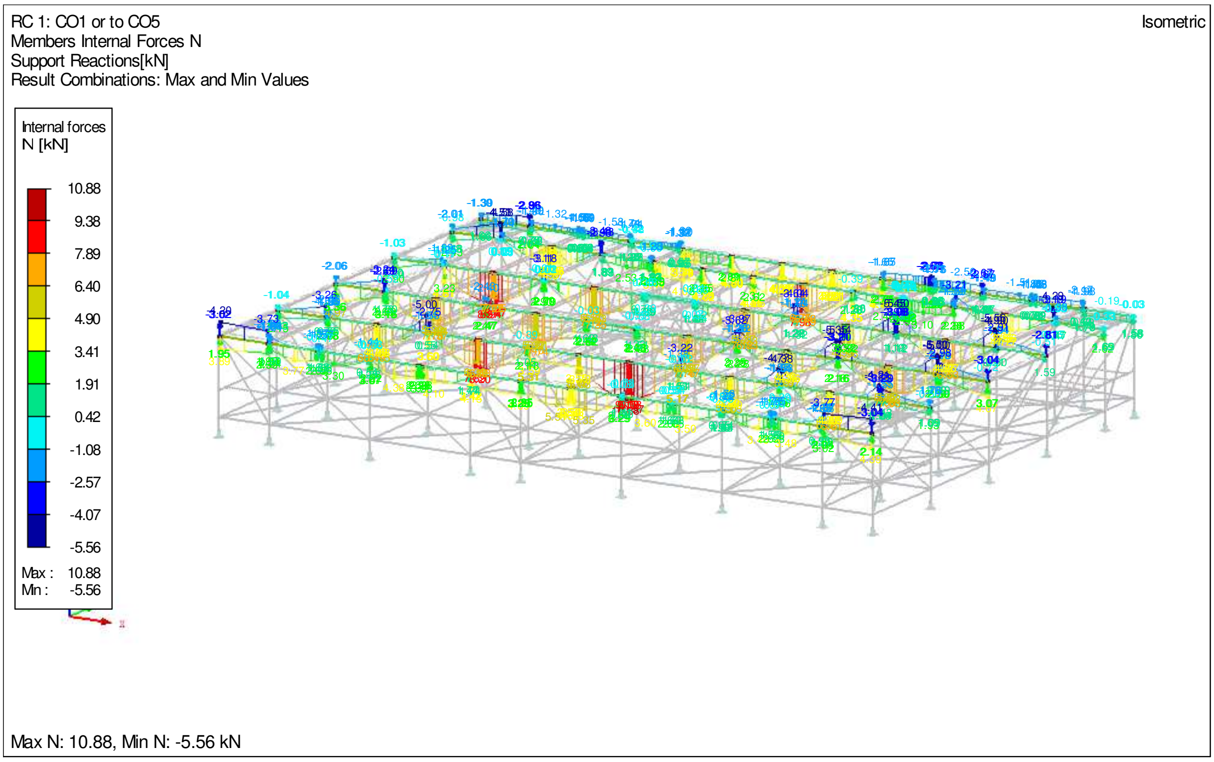
check = $N_{ed,\,max} / N_{b,rd} < 1$
$24.70 / 67.54 = 0.36 < 1$

## 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.

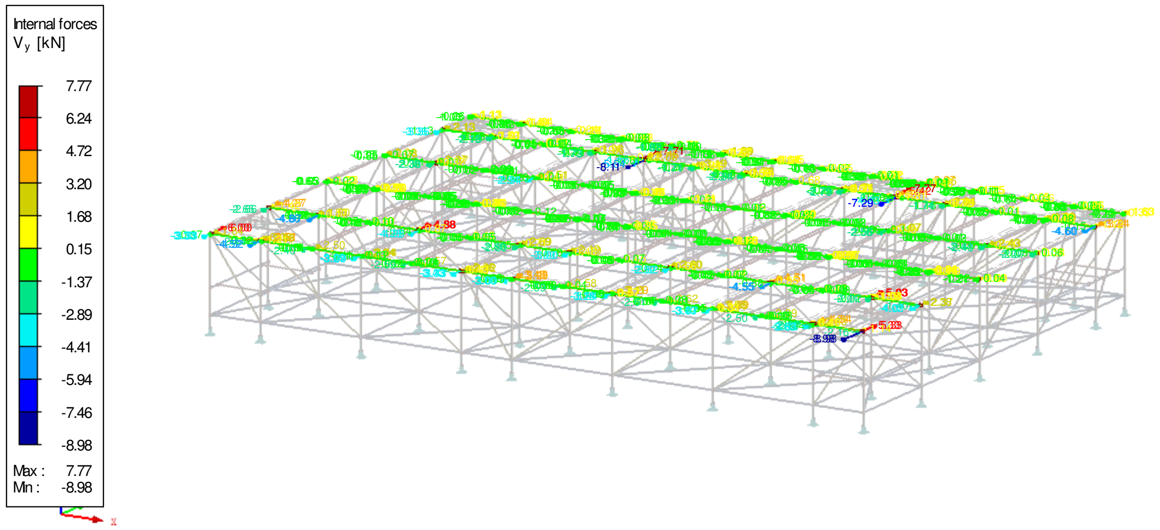



In the next figures the internal forces of the floor beam are shown.



RC 1: CO1 or to CO5
Members Internal Forces V-y
Support Reactions[kN]
Result Combinations: Max and Min Values

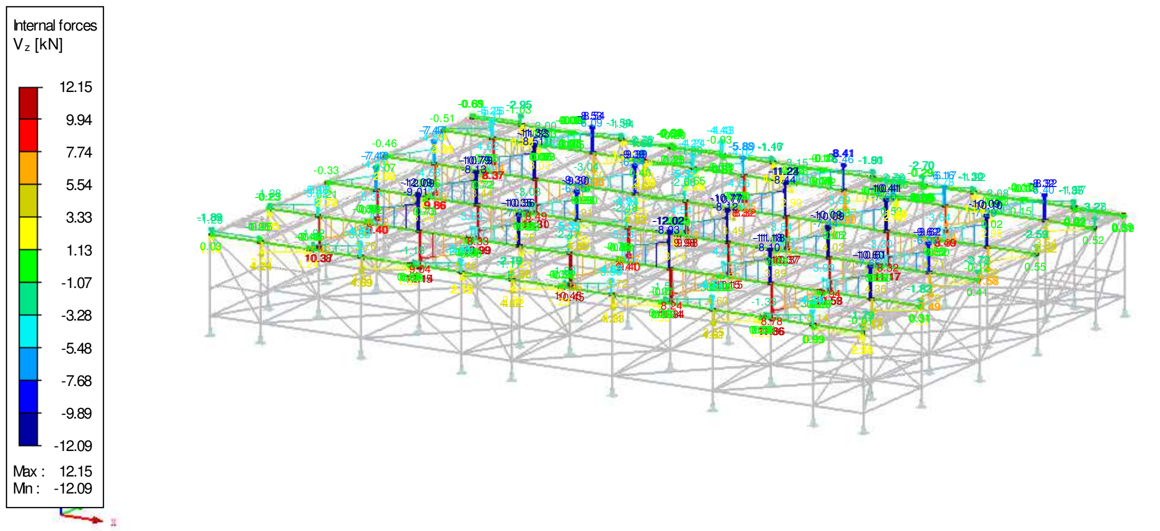
Isometric



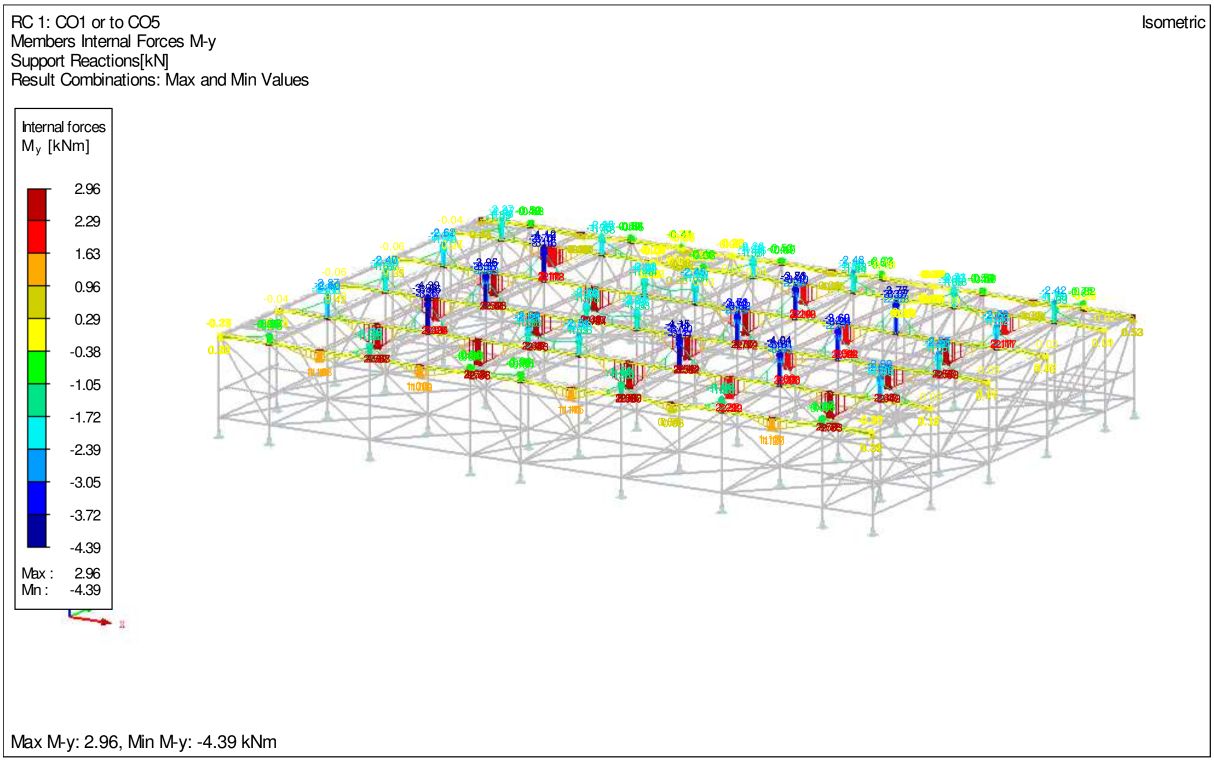

Max V-y: 7.77, Min V-y: -8.98 kN

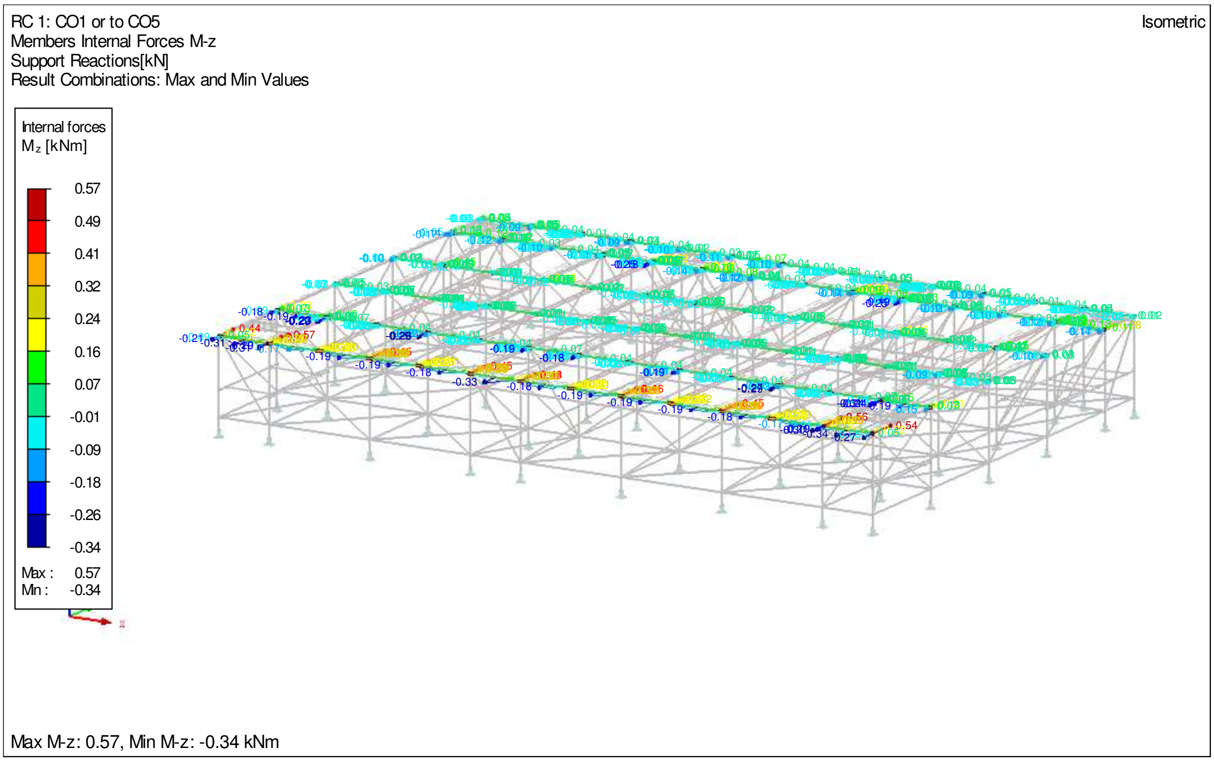
RC 1: CO1 or to CO5
Members Internal Forces V-z
Support Reactions[kN]
Result Combinations: Max and Min Values

Isometric



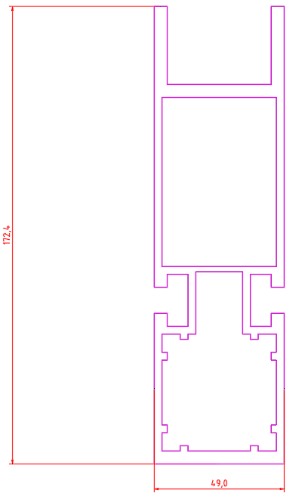

Max V-z: 12.15, Min V-z: -12.09 kN


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]
2.96
2.29
1.63
0.96
0.29
-0.38
-1.05
-1.72
-2.39
-3.05
-3.72
-4.39
Max : 2.96
Min : -4.39
Max M-y: 2.96, Min M-y: -4.39 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]
0.57
0.49
0.41
0.32
0.24
0.16
0.07
-0.01
-0.09
-0.18
-0.26
-0.34
Max : 0.57
Min : -0.34
Max M-z: 0.57, Min M-z: -0.34 kNm

**Profiel berekening.**

Layher Event Beam speciaal profiel Aluminium 6005A T6



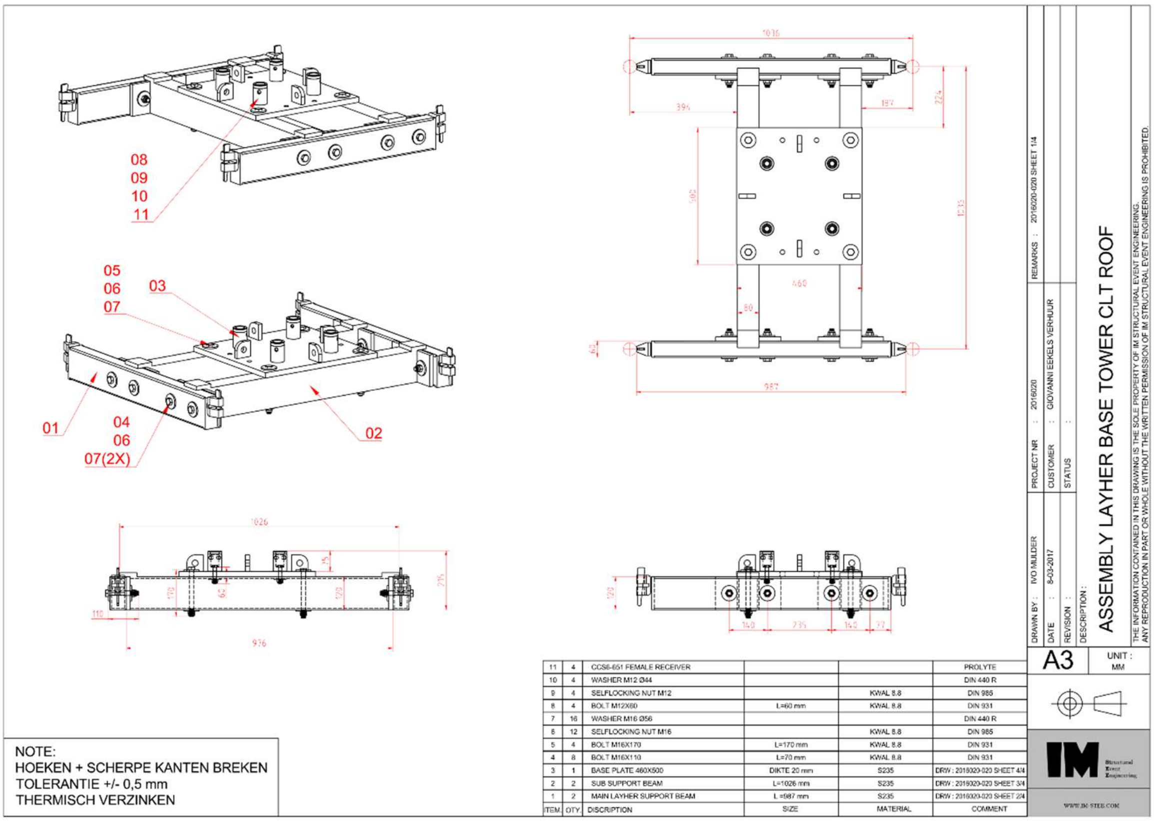

| | | |
|---|---|---|
| $I_1$ | [INCH^4] | 5542580 |
| $I_2$ | [INCH^4] | 701985 |
| $S_c$ | [INCH] | 90.03 |
| $S_t$ | [INCH] | 82.38 |
| A | [INCH^2] | 1878.072 |

$W_y = I_1 / e_y = 554 / 8.25 = 67.15\ cm^3$

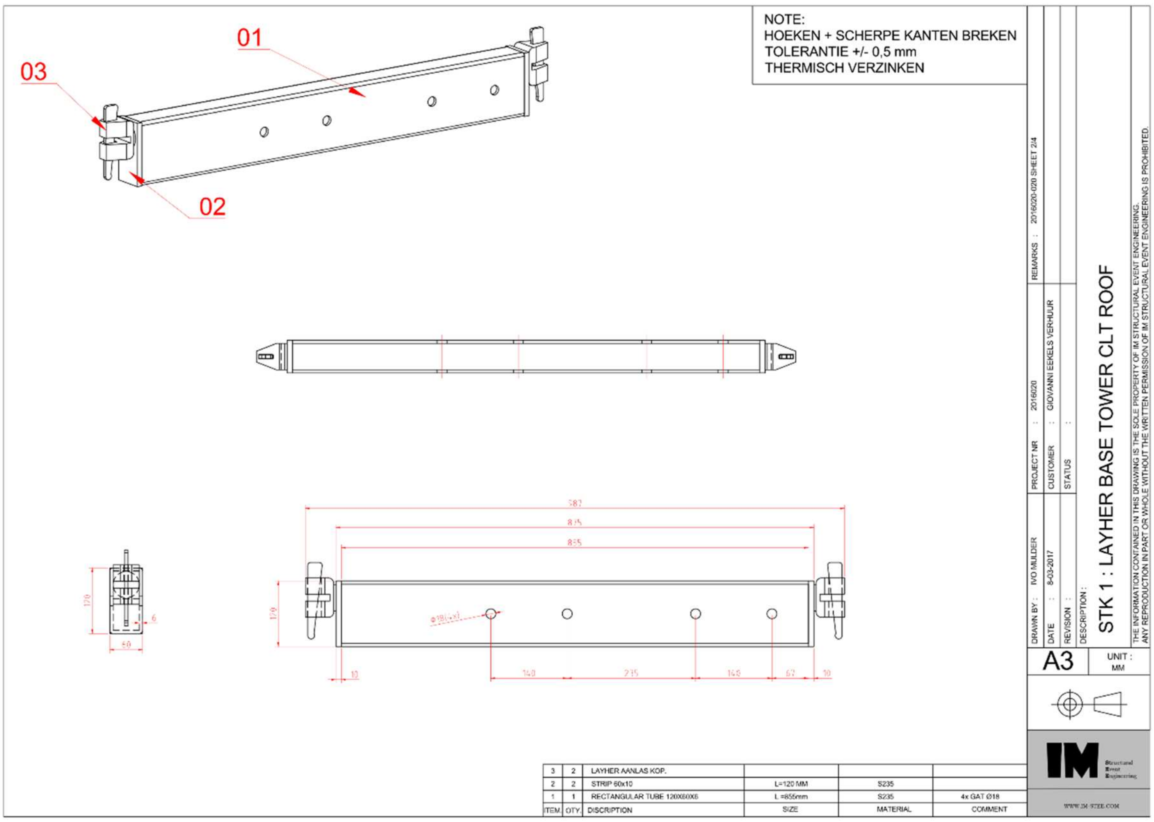
$N_{ed} = 10.88$
$\sigma N_{ed} = N_{ed} / A = 10.88 / 18.78 = 0.58\ kN/cm^2$
$V_{y,ed} = 8.98\ kN$
$\sigma v_{z,ed} = V_{y,ed} / A = 8.98 / 18.78 = 0.48\ kN/cm^2$
$V_{z,ed} = 12.15\ kN$
$\sigma v_{z,ed} = V_{z,ed} / A = 12.15 / 18.78 = 0.65\ kN/cm^2$
$M_{y,ed} = 4.39\ kNm$
$\sigma M_{y,ed} = M_{y,ed} / W_y = 439 / 61.6 = 7.13\ kN/cm^2$
$M_{z,ed} = 0.57\ kNm$
$\sigma M_{z,ed} = M_{z,ed} / W_z = 60 / 28 = 2.04\ kN/cm^2$

$\sigma tot = \sigma N_{ed} + 0{,}58 * \sigma v_{z,ed} + 0{,}58 * \sigma v_{z,ed} + \sigma M_{y,ed} + \sigma M_{y,ed}$
$0.58 + 0.58 * 0.48 + 0.58 * 0.65 + 7.13 + 2.04 = 10.39\ kN/cm^2$
Check
$\sigma tot / (fy / \gamma) < 1$
$10.39 / (21.5 / 1.1) = 0.53 < 1$

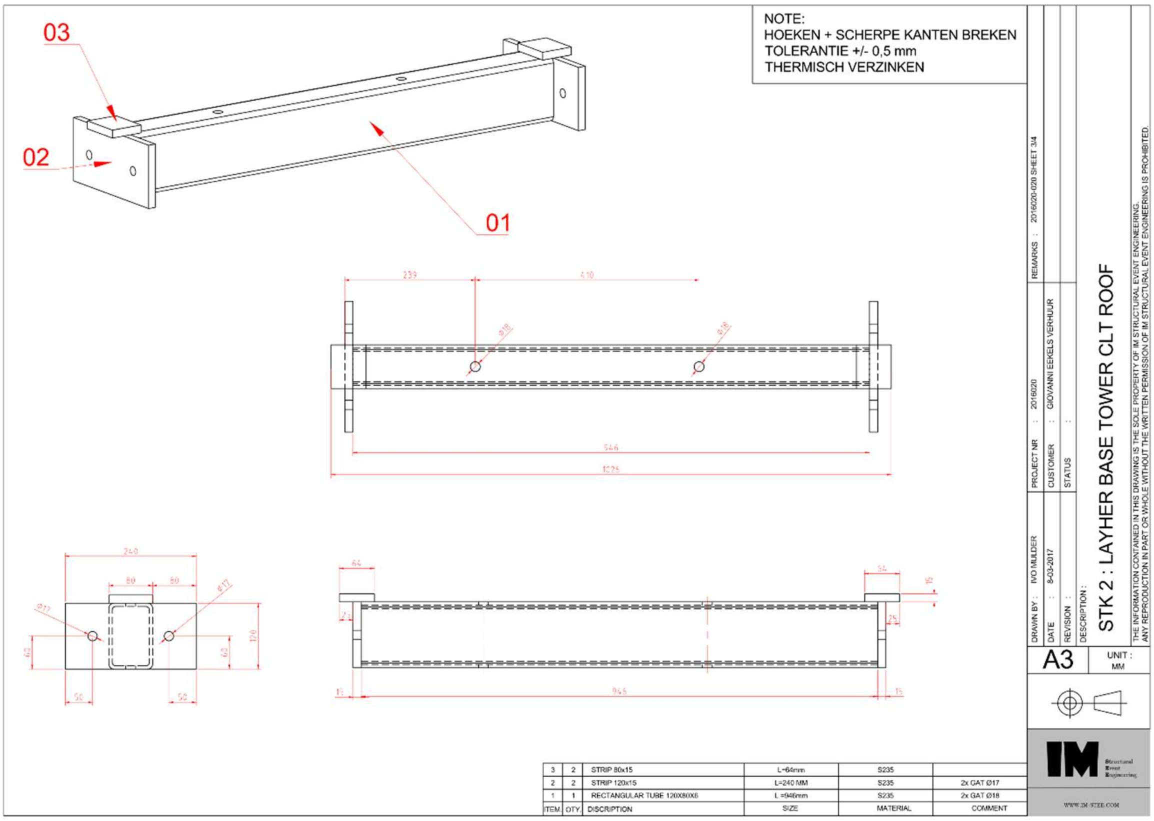
## 6.10 Check of the roof Tower connection to the Layher stage.

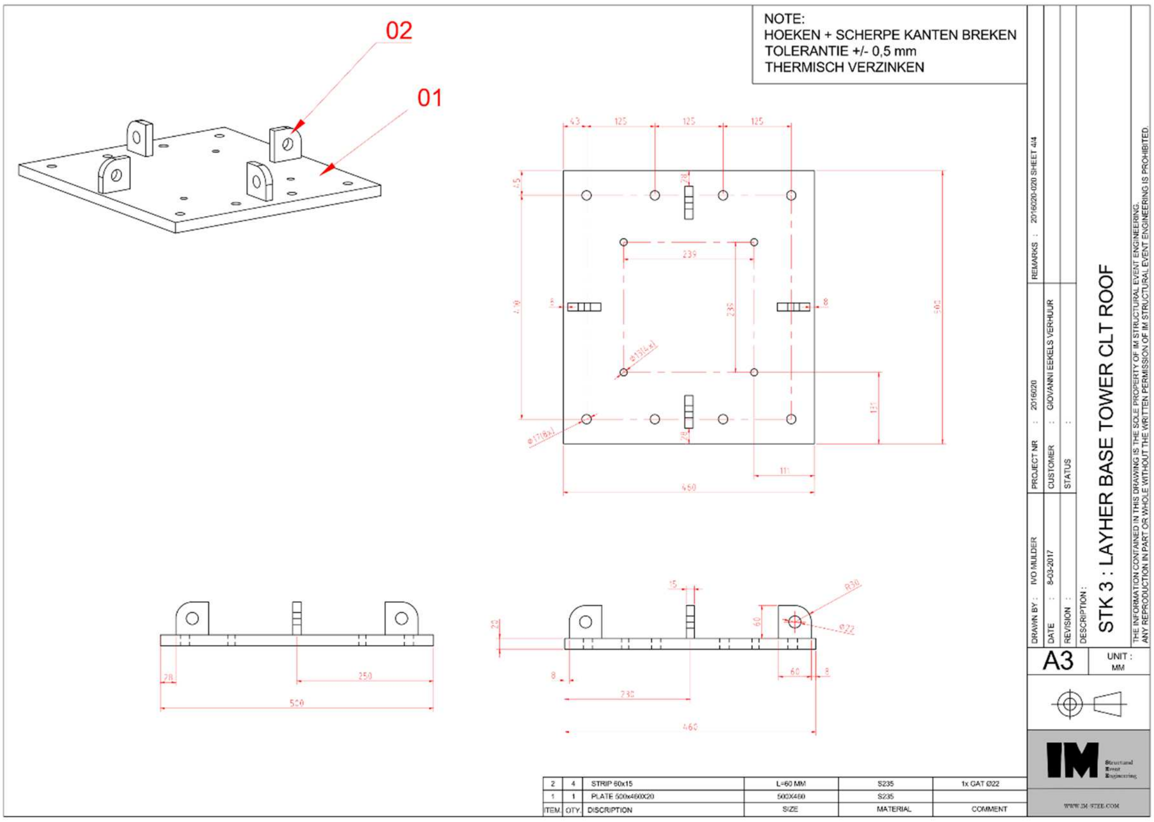



| ITEM. | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 11 | 4 | CCS6-651 FEMALE RECEIVER | | | PROLYTE |
| 10 | 4 | WASHER M12 Ø44 | | | DIN 440 R |
| 9 | 4 | SELFLOCKING NUT M12 | | KWAL 8.8 | DIN 985 |
| 8 | 4 | BOLT M12X60 | L=60 mm | KWAL 8.8 | DIN 931 |
| 7 | 16 | WASHER M16 Ø56 | | | DIN 440 R |
| 6 | 12 | SELFLOCKING NUT M16 | | KWAL 8.8 | DIN 985 |
| 5 | 4 | BOLT M16X170 | L=170 mm | KWAL 8.8 | DIN 931 |
| 4 | 8 | BOLT M16X110 | L=70 mm | KWAL 8.8 | DIN 931 |
| 3 | 1 | BASE PLATE 460X500 | DIKTE 20 mm | S235 | DRW : 2016020-020 SHEET 4/4 |
| 2 | 2 | SUB SUPPORT BEAM | L=1026 mm | S235 | DRW : 2016020-020 SHEET 3/4 |
| 1 | 2 | MAIN LAYHER SUPPORT BEAM | L =987 mm | S235 | DRW : 2016020-020 SHEET 2/4 |

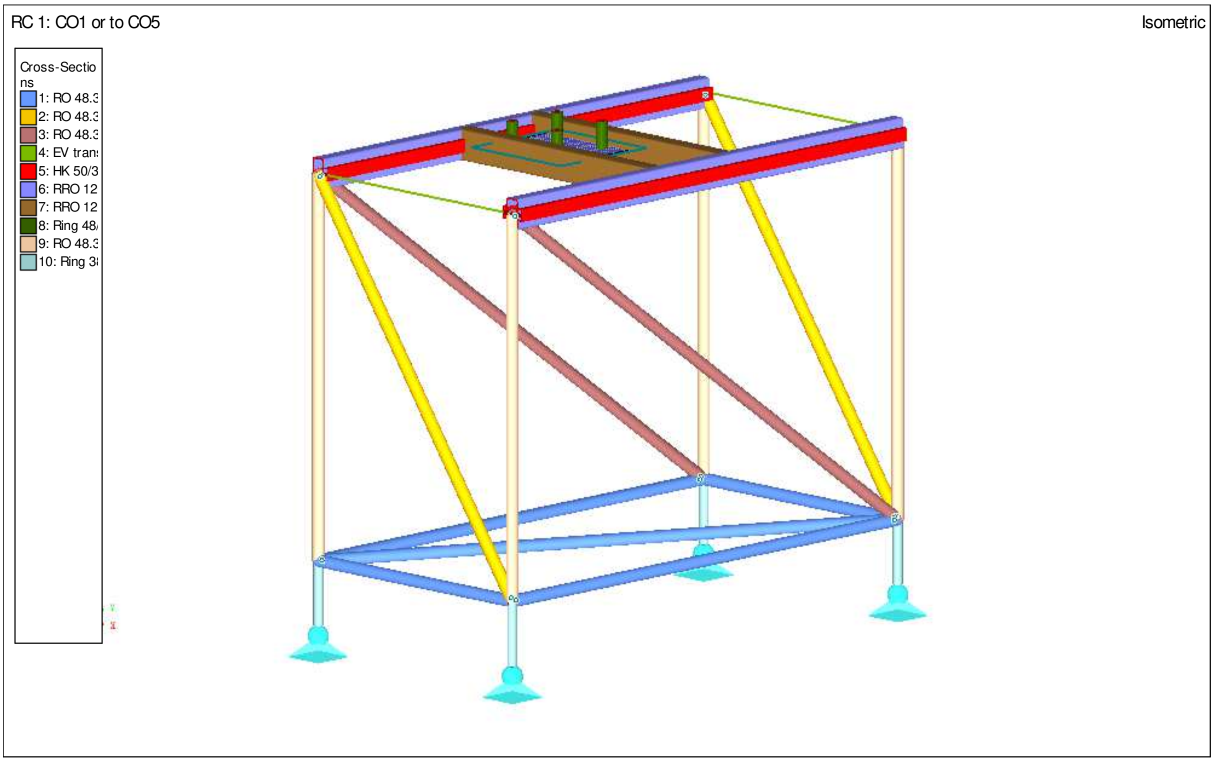



| ITEM. | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 3 | 2 | LAYHER AANLAS KOP. | | | |
| 2 | 2 | STRIP 60x10 | L=120 MM | S235 | |
| 1 | 1 | RECTANGULAR TUBE 120X60X6 | L =855mm | S235 | 4x GAT Ø18 |


NOTE:
HOEKEN + SCHERPE KANTEN BREKEN
TOLERANTIE +/- 0,5 mm
THERMISCH VERZINKEN
03
02
01
STK 2 : LAYHER BASE TOWER CLT ROOF
A3
UNIT : MM
3 2 STRIP 80x15 L=64mm S235
2 2 STRIP 120x15 L=240 MM S235 2x GAT Ø17
1 1 RECTANGULAR TUBE 120X80X6 L =946mm S235 2x GAT Ø18
ITEM QTY DISCRIPTION SIZE MATERIAL COMMENT


NOTE:
HOEKEN + SCHERPE KANTEN BREKEN
TOLERANTIE +/- 0,5 mm
THERMISCH VERZINKEN
02
01
STK 3 : LAYHER BASE TOWER CLT ROOF
A3
UNIT : MM
2 4 STRIP 60x15 L=60 MM S235 1x GAT Ø22
1 1 PLATE 500x460X20 500X460 S235
ITEM QTY DISCRIPTION SIZE MATERIAL COMMENT

The Layher bases are inserted in the RFem model.




The Layher base has 2 different sizes of 2.072 x 1.036 and 1.036 x 1.036.

The Layher base which is checked is the one of 2.072 x 1.036.

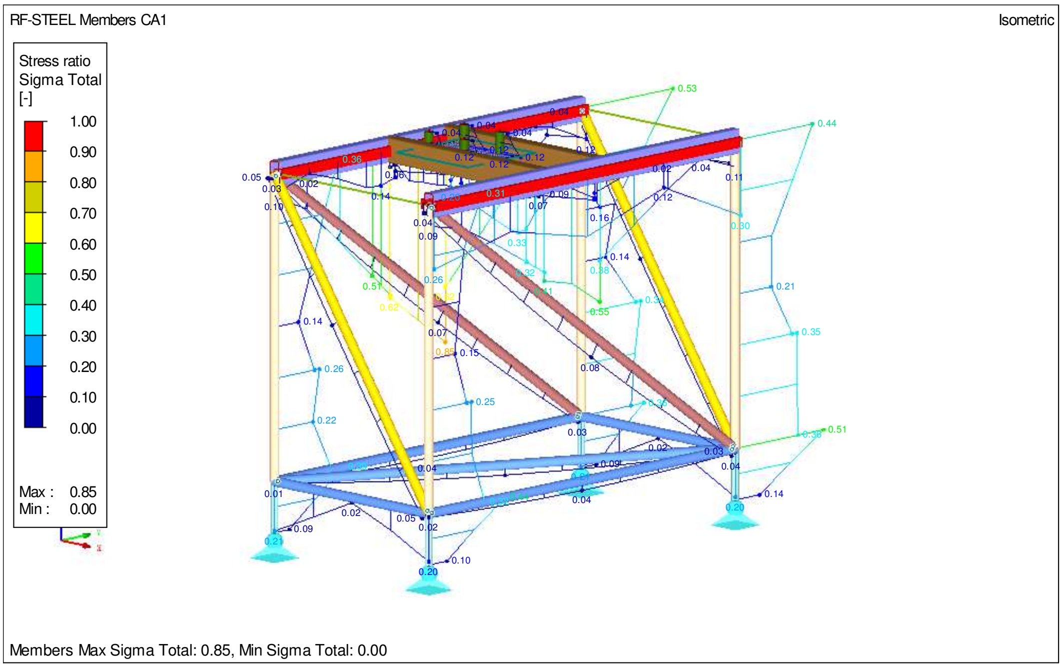
Check of the Layher attachment.

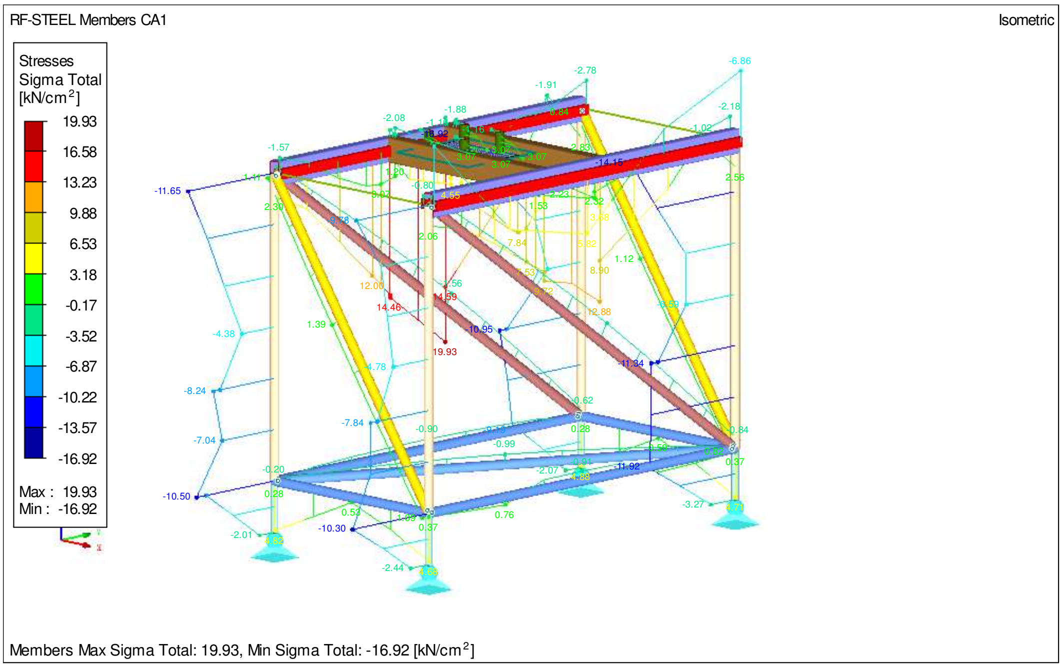
Maximum shear force in the Layher connection point $V_{ed}$ = 12.00 kN

The maximum shear force of the Layher head is according to the figures at page 168 $V_{rd}$ = 26.4 kN

12.00 / 26.4 = 0.45 < 1

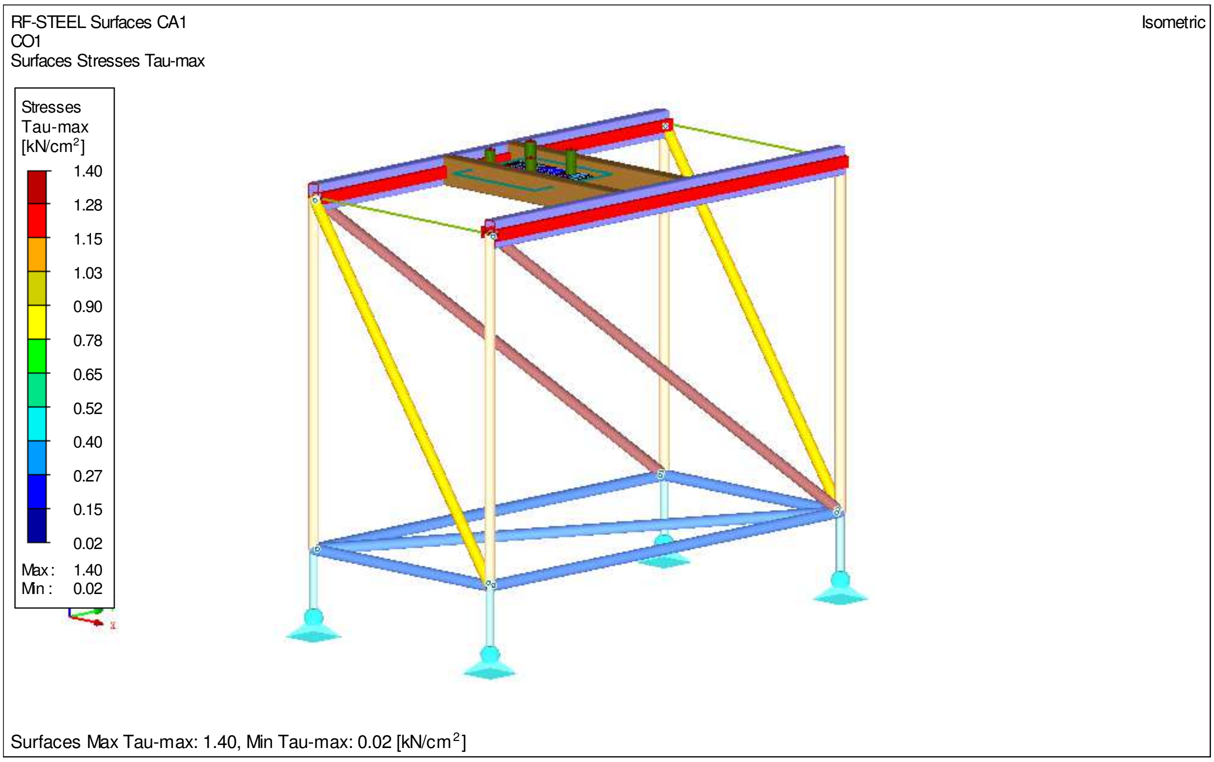
# Maximum stress analyse for the members




| Section No. | Member No. | Location x [m] | S-Point No. | Load-ing | Stress Type | Stress [kN/cm$^2$] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 6 | RRO 120x60x6.3 (Hot Formed) | | | | | | | |
| | 996 | 0,375 | 11 | CO5 | Sigma Total | 21,06 | 23,50 | 0,90 |
| | 946 | 0,916 | 16 | CO5 | Tau Total | -2,14 | 13,57 | 0,16 |
| | 996 | 0,375 | 11 | CO5 | Sigma-eqv | 21,18 | 23,50 | 0,90 |
| | | | | | | | | |
| 7 | RRO 120x80x6.3 (Hot Formed) | | | | | | | |
| | 1003 | 0,054 | 11 | CO5 | Sigma Total | 8,20 | 23,50 | 0,35 |
| | 1002 | 0,035 | 15 | CO5 | Tau Total | -5,69 | 13,57 | 0,42 |
| | 1002 | 0,035 | 14 | CO5 | Sigma-eqv | 9,92 | 23,50 | 0,42 |

# Maximum stress analyse for the steel plate




| Load-ing | Surface No. | FE Mesh Point No. | Point Coordinates [m] X | Y | Z | Stress [kN/cm²] Symbol | Existing | Limit | Stress Ratio [-] |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\tau_{max}$ | 1,52 | 13,57 | 0,11 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | -1,35 | 23,50 | 0,06 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -4,53 | 23,50 | 0,19 |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 11,85 | 23,50 | 0,50 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 4,03 | 23,50 | 0,17 |
| CO2 | | | | | | | | | |
| | 54 | 506 | -0,807 | -0,062 | 2,250 | $\tau_{max}$ | 0,93 | 13,57 | 0,07 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | 2,93 | 23,50 | 0,12 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | 0,87 | 23,50 | 0,04 |
| | 59 | 543 | 11,915 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 9,98 | 23,50 | 0,42 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 2,61 | 23,50 | 0,11 |
| CO3 | | | | | | | | | |
| | 58 | 549 | 12,350 | 7,957 | 2,250 | $\tau_{max}$ | 1,55 | 13,57 | 0,11 |
| | 56 | 92 | 3,389 | 7,957 | 2,250 | $\sigma_{1,m}$ | -1,55 | 23,50 | 0,07 |
| | 58 | 549 | 12,350 | 7,957 | 2,250 | $\sigma_{2,m}$ | -4,84 | 23,50 | 0,21 |
| | 58 | 549 | 12,350 | 7,957 | 2,250 | $\sigma_{eqv,max}$ | 15,15 | 23,50 | 0,64 |
| | 58 | 549 | 12,350 | 7,957 | 2,250 | $\sigma_{eqv,m}$ | 4,30 | 23,50 | 0,18 |
| CO4 | | | | | | | | | |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\tau_{max}$ | 1,53 | 13,57 | 0,11 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | -1,73 | 23,50 | 0,07 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -5,73 | 23,50 | 0,24 |
| | 59 | 543 | 11,915 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 15,41 | 23,50 | 0,66 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 5,09 | 23,50 | 0,22 |
| | | | | | | | | | |
| - | Maximum Stresses | | | | | | | | |
| | 58 | 549 | 12,350 | 7,957 | 2,250 | $\tau_{max}$ | 1,55 | 13,57 | 0,11 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | 2,93 | 23,50 | 0,12 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -5,73 | 23,50 | 0,24 |
| | 59 | 543 | 11,915 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 15,41 | 23,50 | 0,66 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 5,09 | 23,50 | 0,22 |

## 7.0 Appendixes and extra information

| | |
|---|---|
| Truss series | Prolyte H40V |
| Truss manufacturer | Prolyte Group |
| Truss series calculated by: | Krasenbrink + Bastians. |
| Structural report number: | 12500-4 |

Design internal forces for the complete truss

| | |
|---|---|
| Normal force main chord | +/- 50.22 kN |
| Normal force coupling system | +/- 52.58 kN |
| Normal force diagonals | +/- 13.39 kN |
| Bending moment $M_{yR,d}$ | 34.05 kNm |
| Bending moment $M_{zR,d}$ | 34.05 kNm |
| Normal Force $N_{R,d}$ | 200.86 kN |
| Transversal Force $V_{yr,d}$ | 18.94 kN |
| Transversal Force $V_{zr,d}$ | 18.94 kN |

Truss geometry

| | | | |
|---|---|---|---|
| Main chords | 48x3 | EN AW-6082T6 | |
| Diagonals | 20x2 | EN AW-6082T6 | |
| Coupling system | CCS6 | | |
| Height | 339 mm | | Centre to centre distance main chords |
| Width | 339 mm | | Centre to centre distance main chords |
| A | 16.96 $cm^2$ | | |
| $I_y$ | 4179.54 $cm^4$ | | |
| $I_z$ | 4179.54 $cm^4$ | | |
| $i_y$ | 15.70 cm | | |
| $i_z$ | 15.70 cm | | |
| $I_T$ | 900 $cm^4$ | | |

| | |
|---|---|
| Truss series | Prolyte H30V |
| Truss manufacturer | Prolyte Group |
| Truss series calculated by: | Krasenbrink + Bastians. |
| Structural report number: | 12500-2 |

Design internal forces for the complete truss

| | |
|---|---|
| Normal force main chord | +/- 50.22 kN |
| Normal force coupling system | +/- 52.58 kN |
| Normal force diagonals | +/- 10.42 kN |
| Bending moment $M_{yR,d}$ | 24.00 kNm |
| Bending moment $M_{zR,d}$ | 24.00 kNm |
| Normal Force $N_{R,d}$ | 200.86 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 | CCS6 | |
| Height | 239 mm | Centre to centre distance main chords |
| Width | 239 mm | Centre to centre distance main chords |
| A | 16.96 $cm^2$ | |
| $I_y$ | 2095.86 $cm^4$ | |
| $I_z$ | 2095.86 $cm^4$ | |
| $i_y$ | 11.12 cm | |
| $i_z$ | 11.12 cm | |
| $I_T$ | 500 $cm^4$ | |

| | |
|---|---|
| Truss series | Prolyte H30D |
| Truss manufacturer | Prolyte Group |
| Truss series calculated by: | Krasenbrink + Bastians. |
| Structural report number: | 12500-1 |

Design internal forces for the complete truss

| | |
|---|---|
| Normal force main chord | +/- 50.22 kN |
| Normal force coupling system | +/- 52.58 kN |
| Normal force diagonals | +/- 10.42 kN |
| Bending moment $M_{yR,d}$ | 10.39 kNm |
| Bending moment $M_{zR,d}$ | 12 kNm |
| Normal Force $N_{R,d}$ | 150.65 kN |
| Transversal Force $V_{yr,d}$ | 12.76 kN |
| Transversal Force $V_{zr,d}$ | 7.36 kN |

Truss geometry

| | | |
|---|---|---|
| Main chords | 48x3 EN AW-6082T6 | |
| Diagonals | 16x2 EN AW-6082T6 | |
| Coupling system | CCS6 | |
| Height | 207 mm | Centre to centre distance main chords |
| Width | 239 mm | Centre to centre distance main chords |
| A | 12.72 $cm^2$ | |
| $I_y$ | 1057.29 $cm^4$ | |
| $I_z$ | 1057.10 $cm^4$ | |
| $i_y$ | 9.12 cm | |
| $i_z$ | 9.11 cm | |
| $I_T$ | 150 $cm^4$ | |

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Project number: 2016020-1

# Structural calculation Report

CLT roof 12x10

Eekels verhuur

This calculation report has been specific prepared for the company Eekels Verhuur 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 InterStage. 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 an written permission from the company IM Structural Event Engineering.

Date : 16-05-2017

Ivo Mulder BCs

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+31 (0) 646597297
imulder@im-stee.com

Index:

# 1 General Preliminary notes.

## 1.1 Construction description.

This report concerns the calculation of the CLT roof owned by the company Eekels Verhuur. The dimensions of the CLT roof construction are 12 meter wide 10 meters depth and 10 meters high.

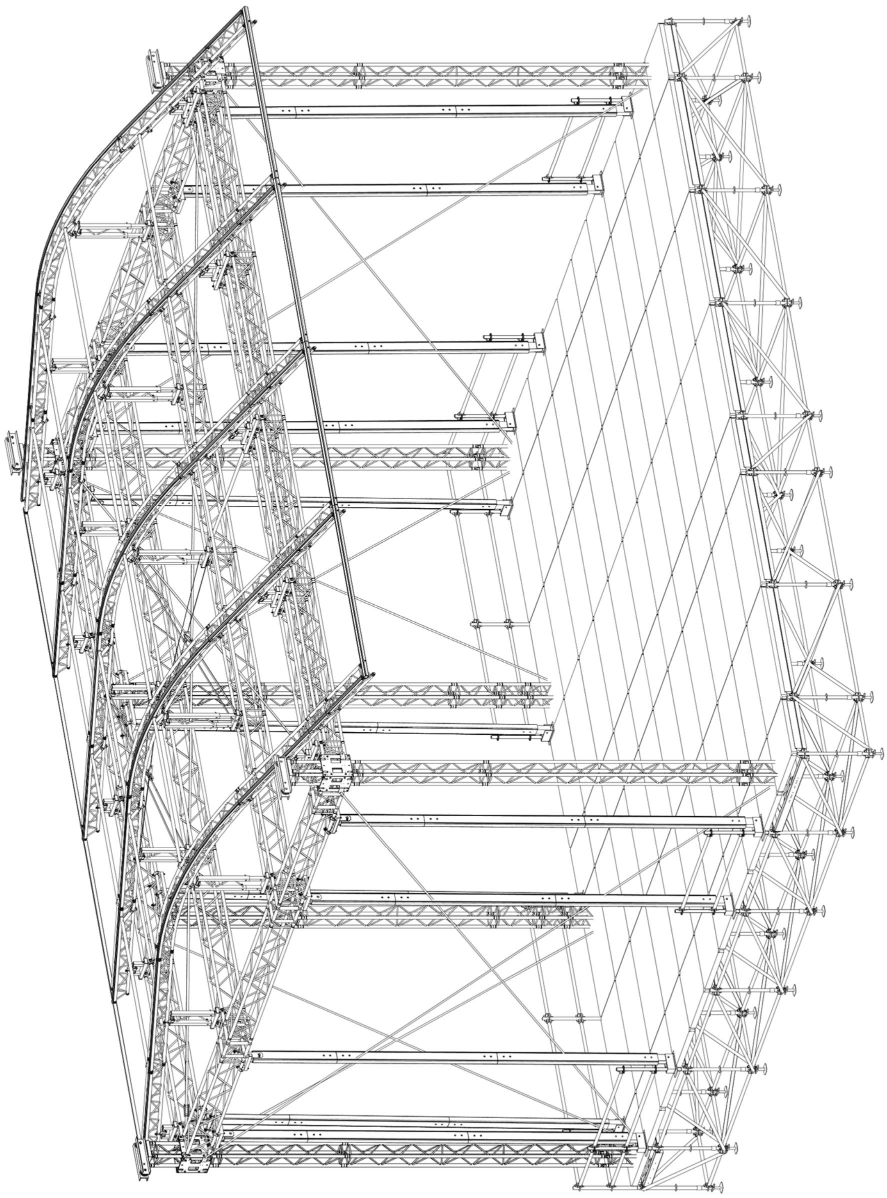
The roof constructions is built from mainly aluminium truss which are produced by Prolyte. The stage underneath the roof construction is constructed from the Layher scaffolding system, and is an integrated system.

The stage is calculated as a 2 meter stage but can also be built as a 1.5 meter stage.

The construction will mainly be used as a staging system for festivals or outdoor events.

## 1.2 Construction drawing.

### 1.2.1 Perspective



| | | | | | |
|---|---|---|---|---|---|
| RAWN BY : | IVO MULDER | PROJECT NR : | 2016020 | REMARKS : | SHEET 1/4 |
| ATE : | 14-05-2017 | CUSTOMER : | GIOVANNI EEKELS VERHUUR | | |
| EVISION : | | STATUS : | | | |

ESCRIPTION :

CLT 12X10 ISO VIEW

UNIT : MM

A3

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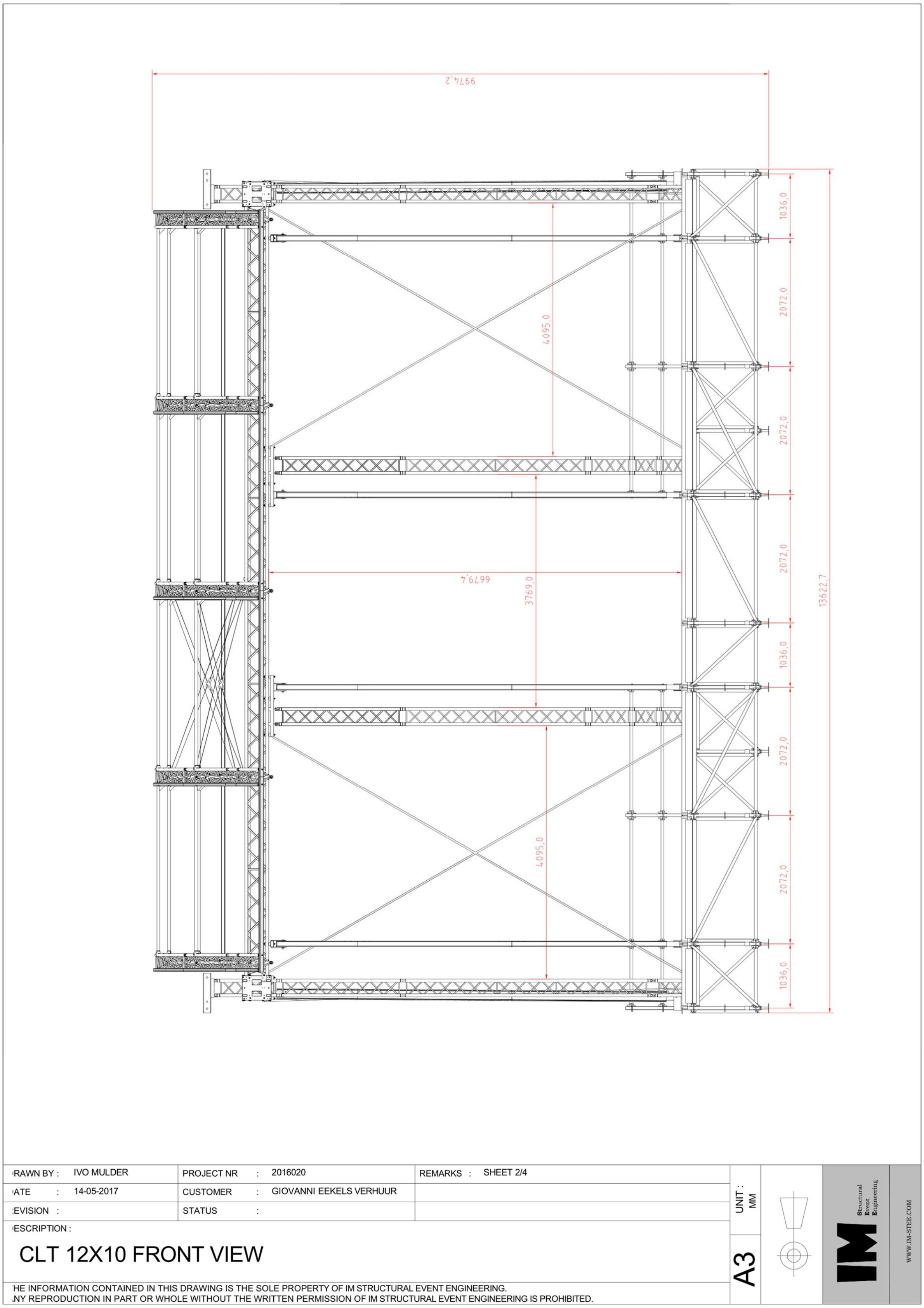
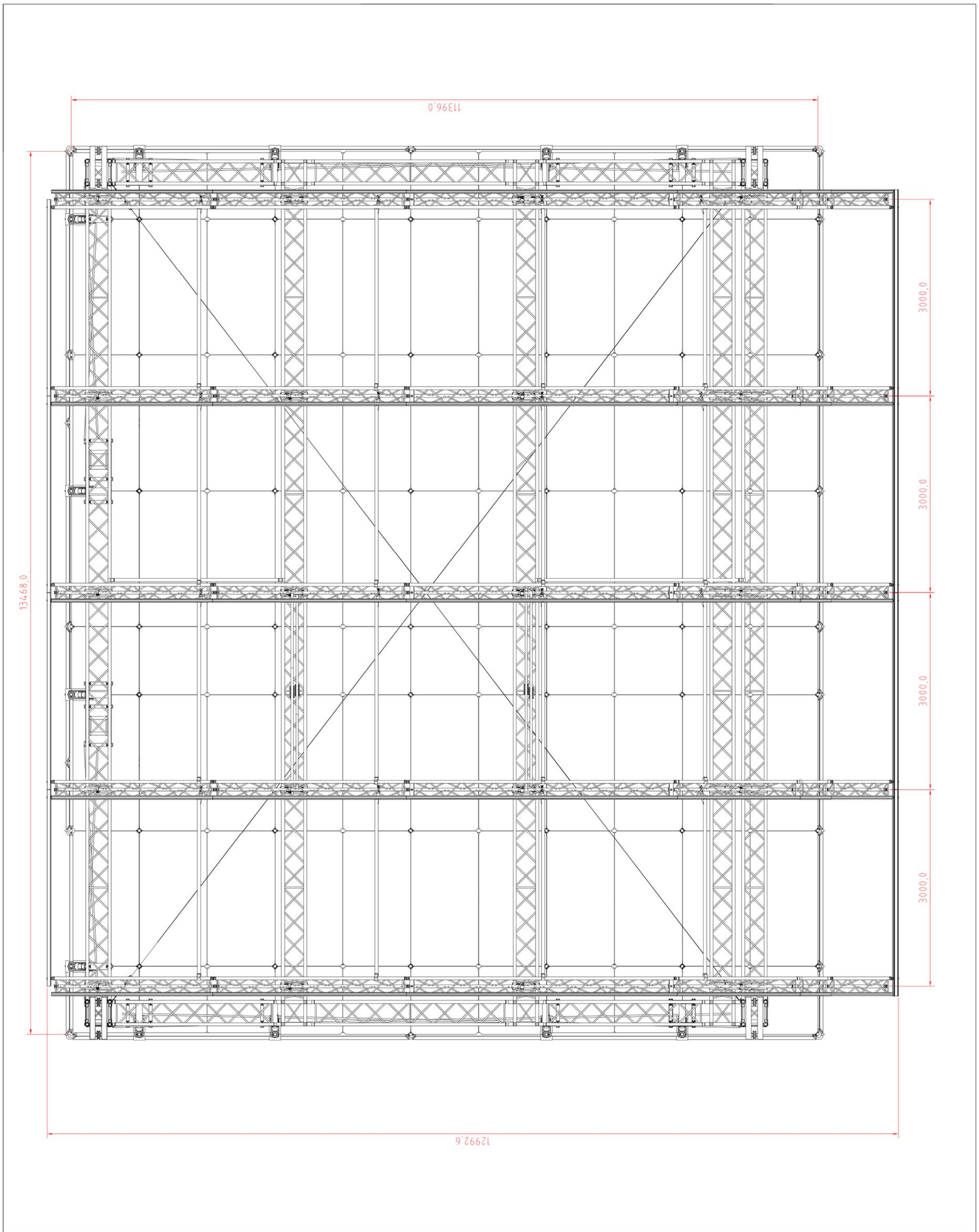
### 1.2.2 Front view



### 1.2.3 Top view




| | | | | | |
|---|---|---|---|---|---|
| RAWN BY : | IVO MULDER | PROJECT NR : | 2016020 | REMARKS : | SHEET 2/4 |
| ATE : | 14-05-2017 | CUSTOMER : | GIOVANNI EEKELS VERHUUR | | |
| EVISION : | | STATUS : | | | |

ESCRIPTION :

CLT 12X10 TOP VIEW

UNIT : MM

A3



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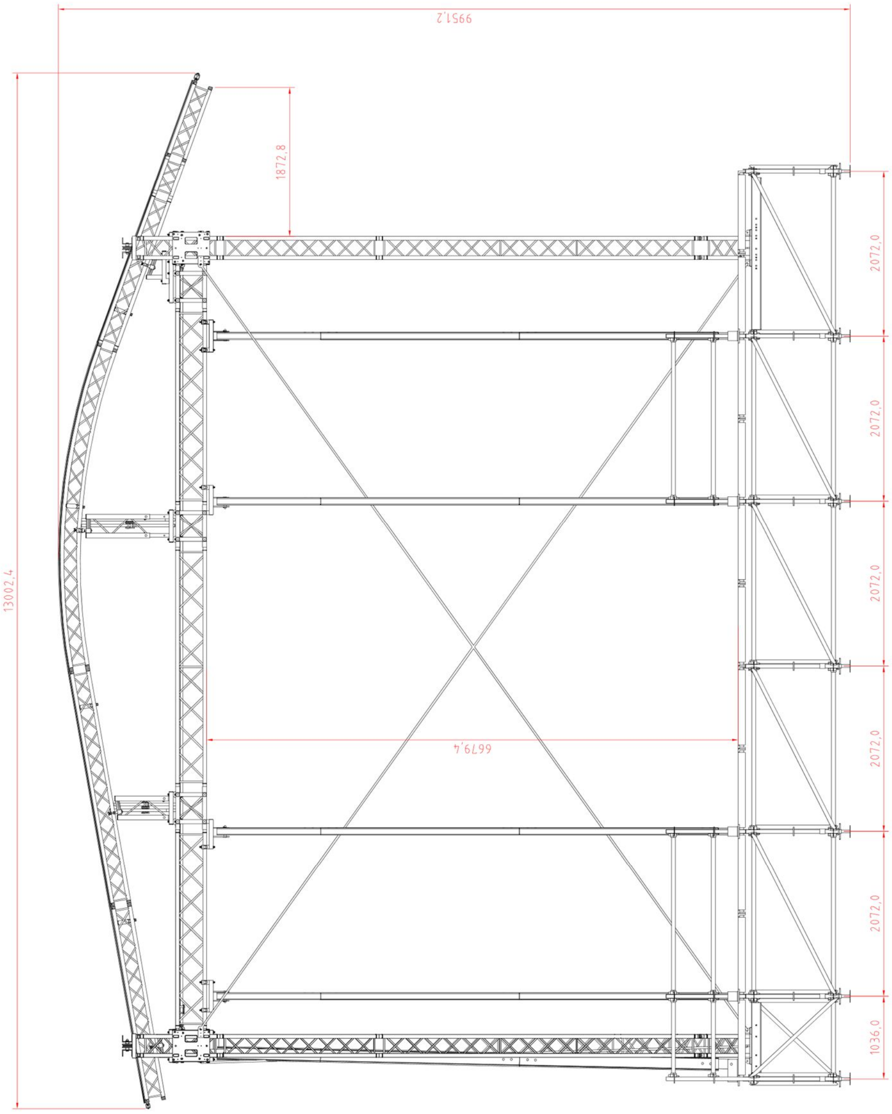
### 1.2.4 Side view




| | | | |
|---|---|---|---|
| RAWN BY : IVO MULDER | PROJECT NR : 2016020 | REMARKS : SHEET 3/4 | UNIT : MM |
| ATE : 14-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | | |
| EVISION : | STATUS : | | |
| ESCRIPTION : | | | A3 |

CLT 12X10 FRONT VIEW



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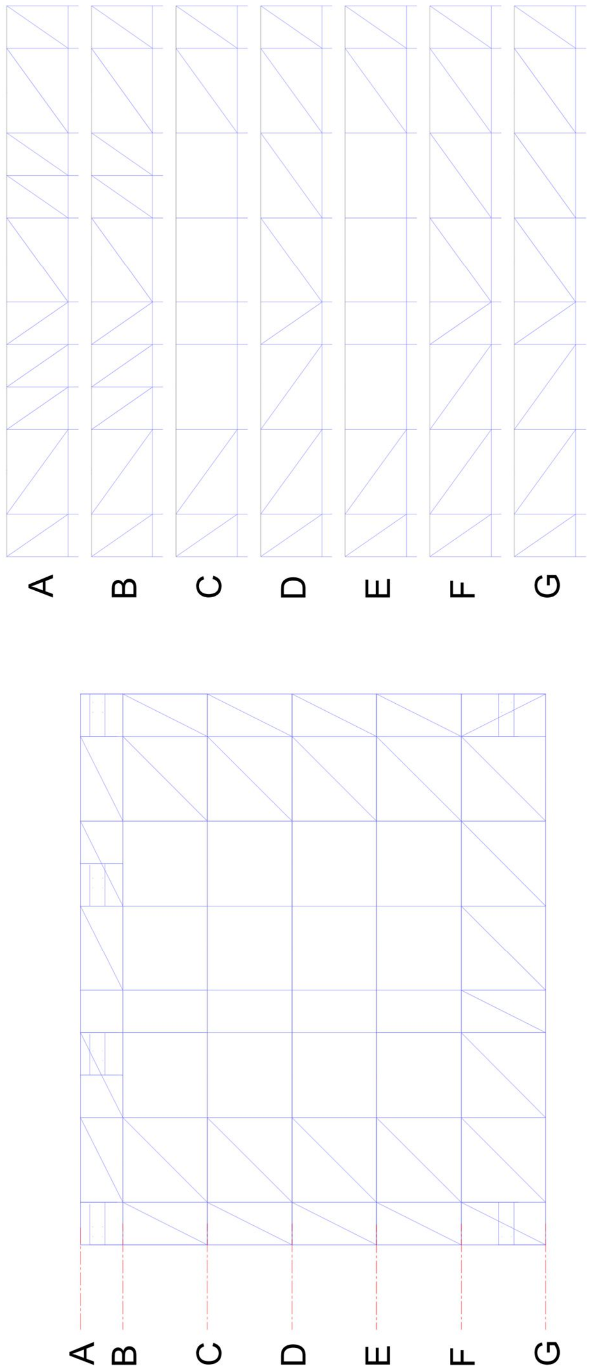
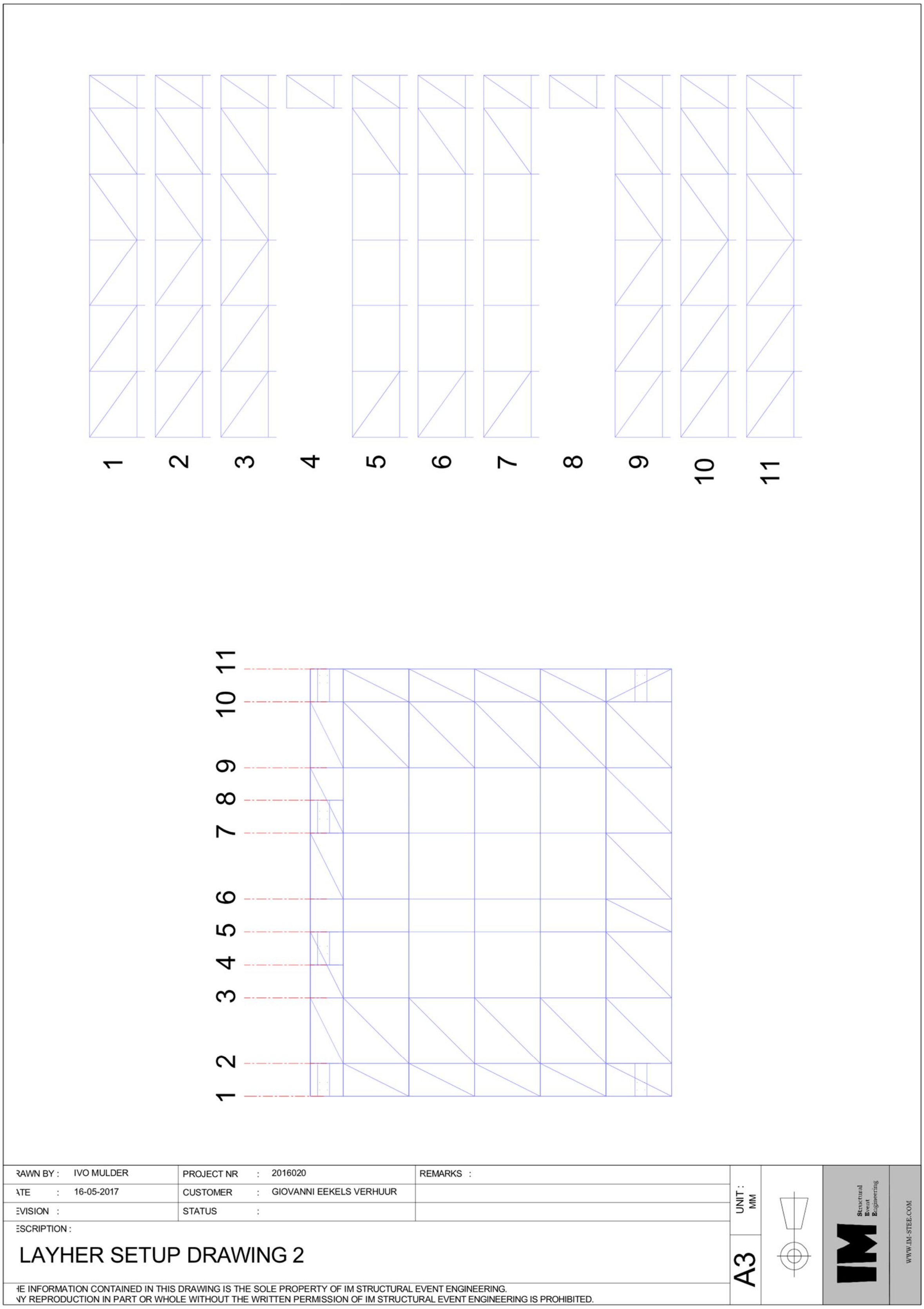
### 1.2.5 Layher plan drawing 1




| | | | | |
|---|---|---|---|---|
| DRAWN BY : IVO MULDER | PROJECT NR : 2016020 | REMARKS : | UNIT : MM | |
| DATE : 16-05-2017 | CUSTOMER : GIOVANNI EEKELS VERHUUR | | | |
| REVISION : | STATUS : | | | |
| DESCRIPTION : LAYHER SETUP DRAWING 1 | | | A3 | WWW.IM-STEE.COM |

## 1.2.6 Layher plan drawing 1



### 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.

In the Appendix the structural information off each truss series and different parts can be found. The truss which is used is produced by Prolyte, and the different used series are.

| | |
|---|---|
| Tower | Prolyte H30V truss |
| Main grid | Prolyte H40V truss |
| Roof construction | Prolyte H30D truss in combination with special adapters |
| Side wall Profiles | Kedar profile 170x88 |
| Flooring system | Layher scaffolding system |
| Canopy sheets | PVC |

Steel wires or retched straps to stabilize the construction

## 1.6 Load assumptions

### 1.6.1 Wind loading

According to the Eurocode 13814, two wind situation calculations are made of a temporary demountable structures. 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 situations all the side walls are 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 all the side walls, banners, PA load 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 gust higher than the 28 m/s the construction side need to be completely cleared from all people.

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

In the NEN-EN 1991 there are 4 different terrain category's 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 Vb 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.

### 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 17.98 m/s for 0 < 8 m and the wind gust 21.91 m/s for 8 < 20 m.

0 < 8 meter 0.20 kN/m²

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

8 < 20 meter 0.30 kN/m²

| Terrain category | $V_b$ in m/s (1) | Max. wind gust (2) |
|---|---|---|
| Sea or coastal area exposed to open sea | 11.9 | 21.91 |
| Lakes or flat and horizontal area with negligible vegetation and without obstacles | 12.25 | 21.91 |
| Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights | 13.07 | 21.91 |
| 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) | 14.83 | 21.91 |
| Area in which at least 15% of the surface is covered with buildings and their average heights exceeds 15 m. | 17.09 | 21.91 |

### 1.6.3 Out-service situation.

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

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

0 < 8 meter 0,4375 kN/m²

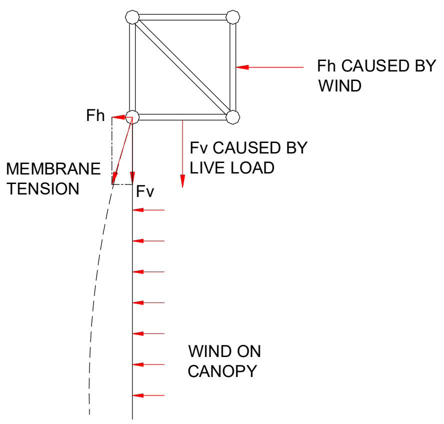
| Terrain category | $V_b$ in m/s (1) | Max. wind gust (2) |
|---|---|---|
| Sea or coastal area exposed to open sea | 15.65 | 26.46 |
| Lakes or flat and horizontal area with negligible vegetation and without obstacles | 16.3 | 26.46 |
| Area with low vegetation such as grass and isolated obstacles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

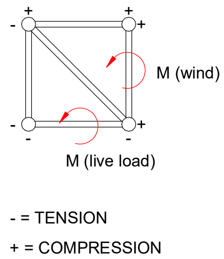
8 < 20 meter 0.625 kN/m²

| Terrain category | $V_b$ in m/s (1) | Max. wind gust (2) |
|---|---|---|
| Sea or coastal area exposed to open sea | 17.18 | 31.62 |
| Lakes or flat and horizontal area with negligible vegetation and without obstacles | 17.68 | 31.62 |
| Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights | 18.87 | 31.62 |
| 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) | 21.41 | 31.62 |
| Area in which at least 15% of the surface is covered with buildings and their average heights exceeds 15 m. | 24.66 | 31.62 |

### 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.

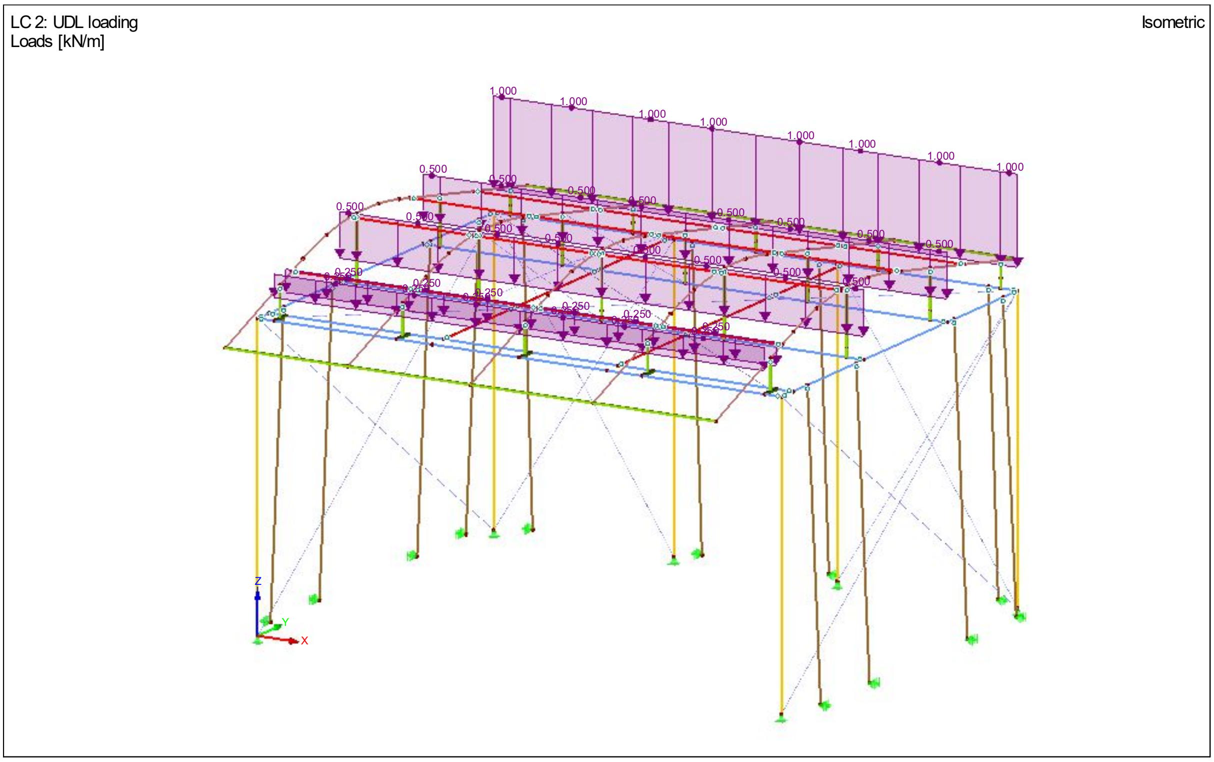
In this structural report there are Live load scenario's presented. These are intended to give an indication of the Rigging possibilities in the construction. If the actual loading of the construction deviates from the these Rigging plots an additional comparison calculation need to be made. The shifting 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.

The calculation of the roof system has been done with 5 different loading scenarios. Uniform distributed load , Center point load, point loads in the third point and point load 1.25 meter from the side span. In the Out-service situation  the PA load and big scenery need to be derigged from the roof, the loading of the main roof can stay in the roof. This is taken into account in this calculation.

### 1.7.1 UDL Loading setup




Equally divided load along the main span.

Span 1 = 25 kg/m

Span 2 = 25 kg/m

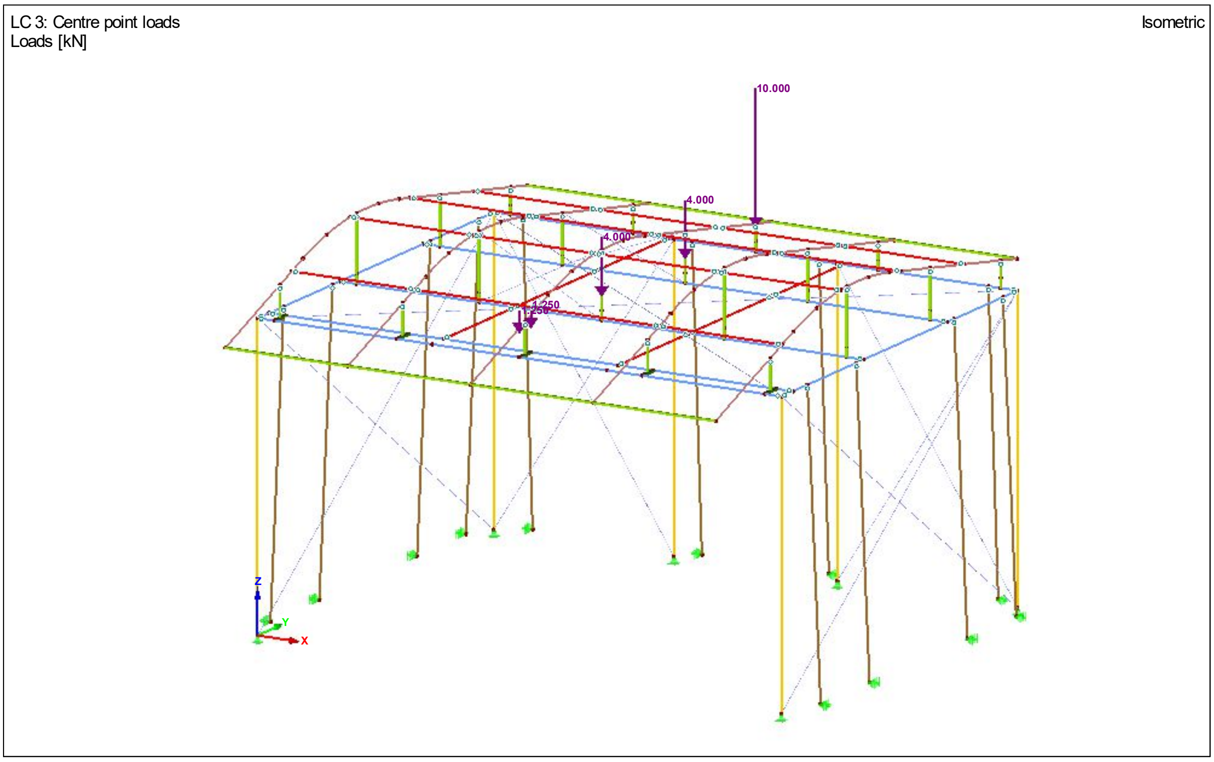
Span 3 = 50 kg/m

Span 4 = 50 kg/m

Span 5 = 100 kg/m

The total load on the main system is ~ 3000 kg

### 1.7.2 Centre point load




Span 1 = 125 kg

Span 2 = 125 kg

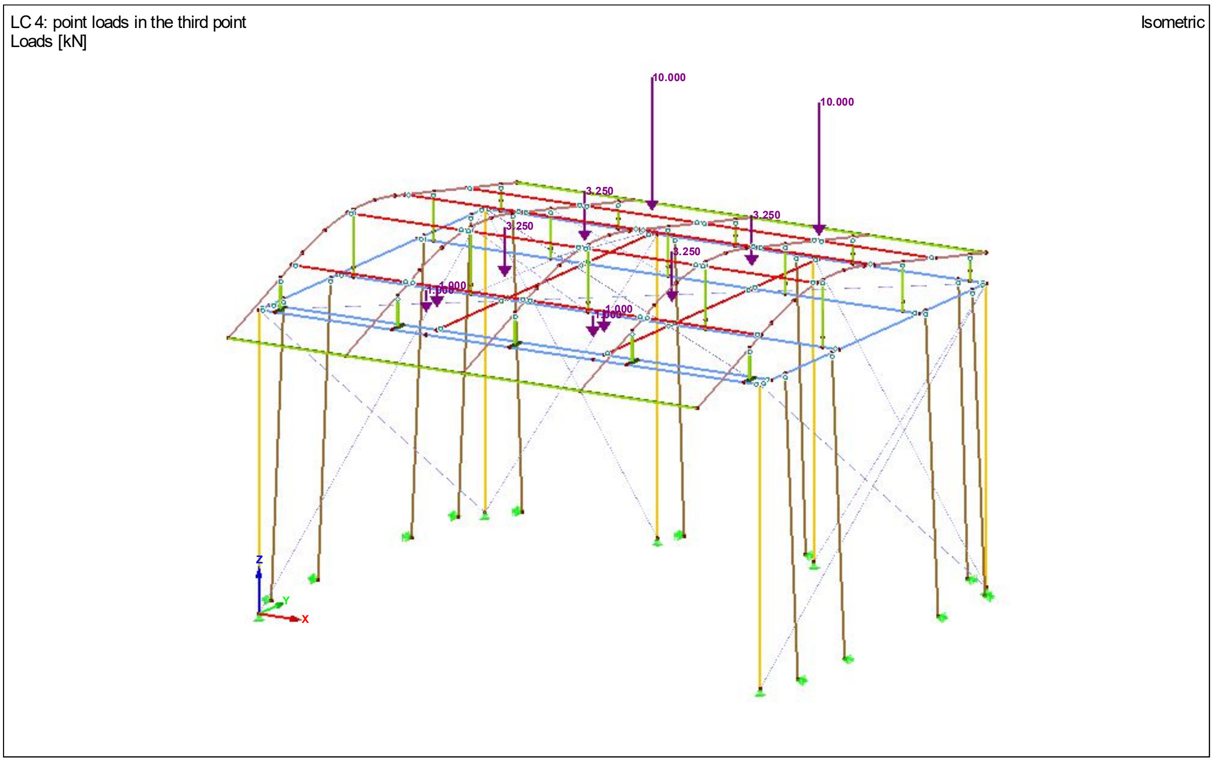
Span 3 = 400 kg

Span 4 = 400 kg

Span 5 = 1000 kg

The total load on the main system is ~ 1060 Kg

### 1.7.3 Point loads in the third point




Span 1 = 2x 100 kg

Span 2 = 2x 100 kg

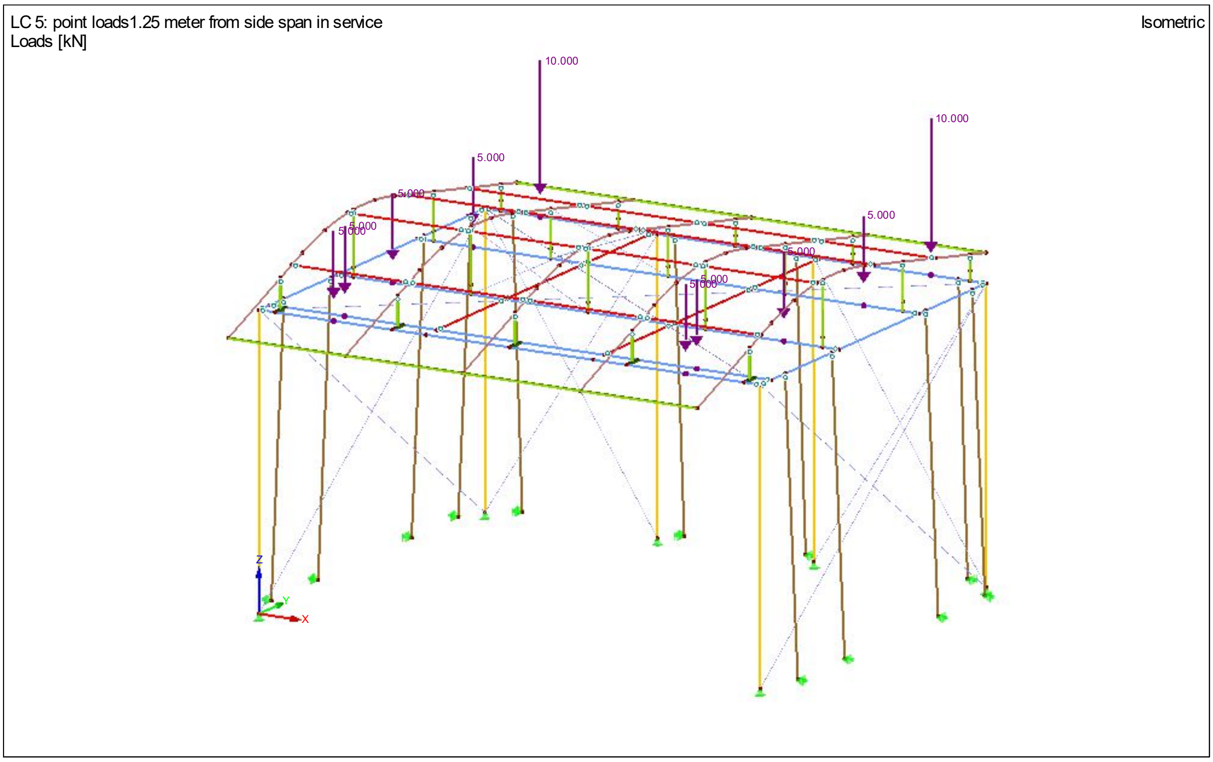
Span 3 = 2x 325 kg

Span 4 = 2x 325 kg

Span 5 = 2x 1000 kg

The total load on the main system is ~ 3700 Kg

### 1.7.4 Point loads 1.25 meter from side span in service




Span 1 = 2x 500 kg

Span 2 = 2x 500 kg

Span 3 = 2x 500 kg

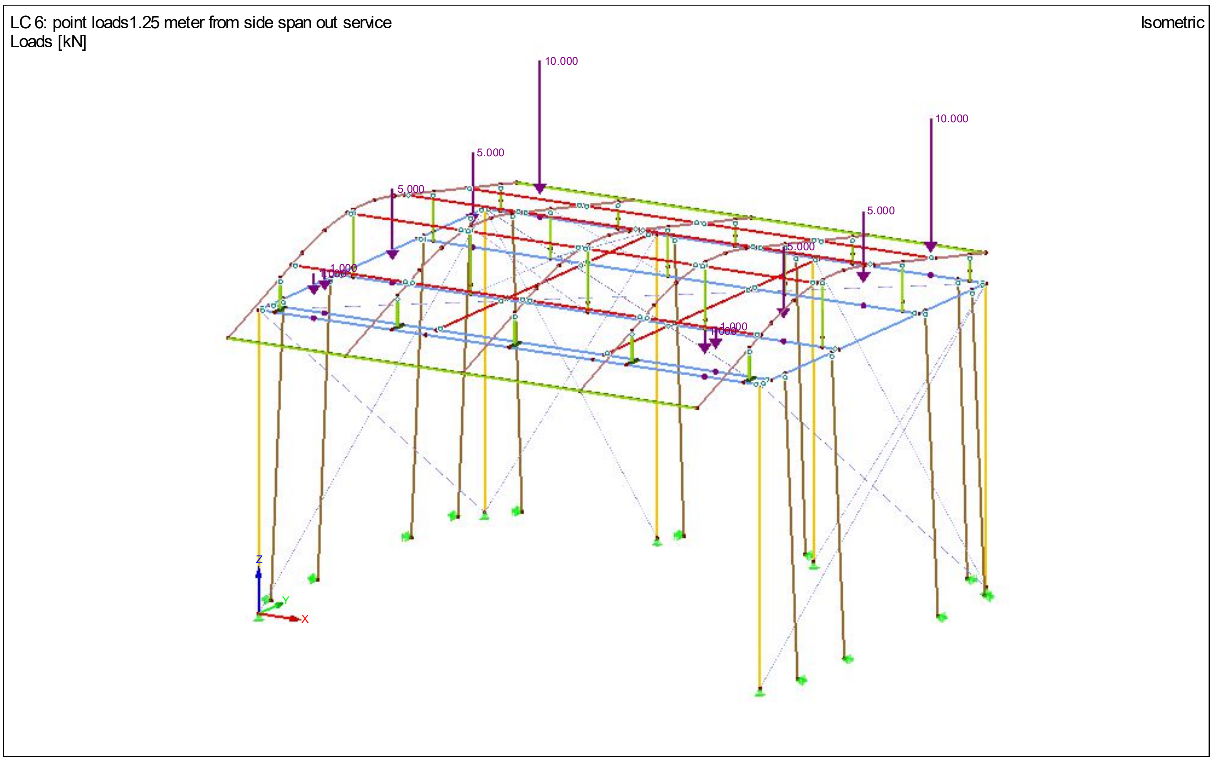
Span 4 = 2x 500 kg

Span 5 = 2x 1000 kg

The total load on the main system is ~ 6000 Kg

**This loading scenario can only be used in the In service situation. When the out service situation is in place the two main loading points in the front two spans need to be removed and this loading setup will be replaced by LC6!!**

### 1.7.5 Point loads 1.25 meter from side span out service




Span 1 = 2x 100 kg

Span 2 = 2x 100 kg

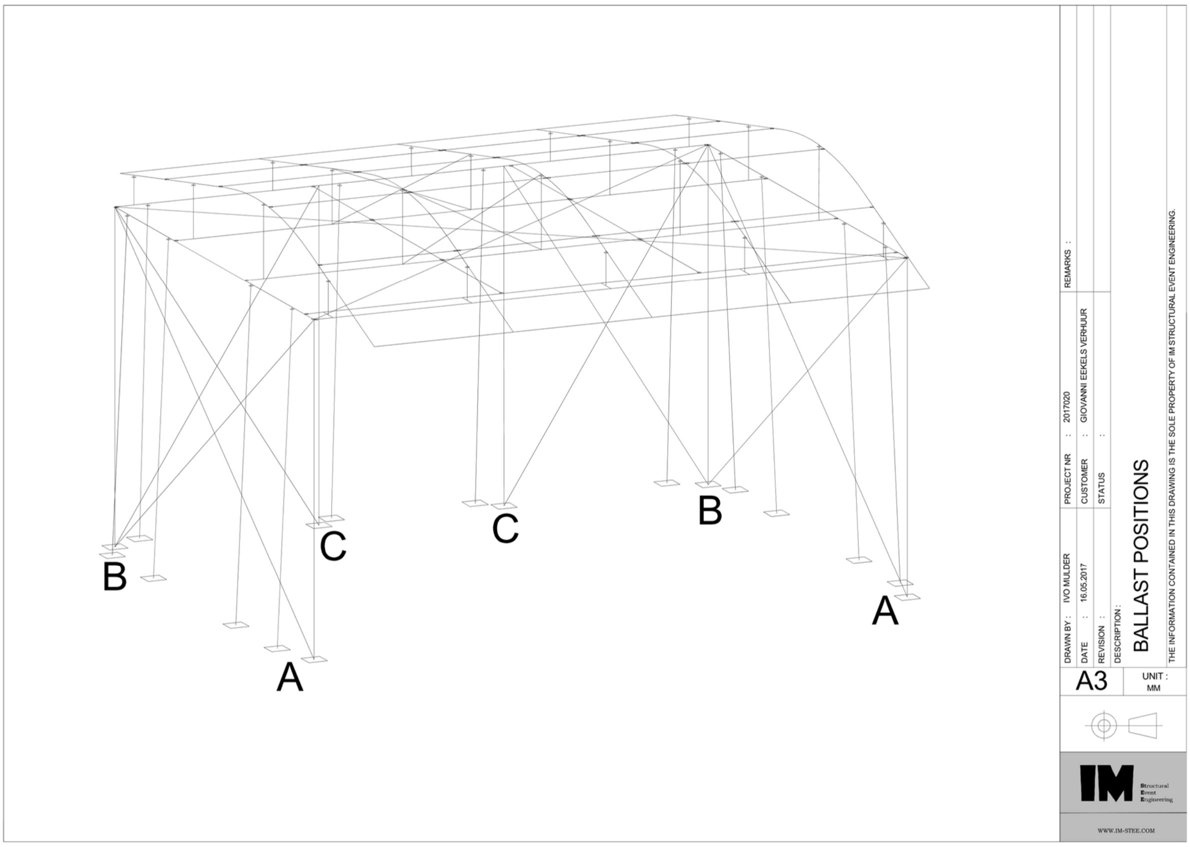
Span 3 = 2x 500 kg

Span 4 = 2x 500 kg

Span 5 = 2x 1000 kg

The total load on the main system is ~ 4400 Kg

## 1.8 Necessary Ballast loading, full system

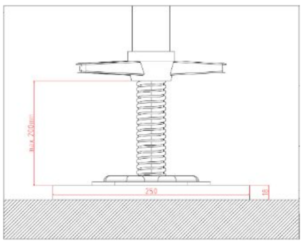



The Ballast calculation has been done in chapter 5 underneath are the result of the nece4sary ballast per point. For the ballast at the stack tower in the middle of the back span the self-weight of the Layher system will be taken.

**Point A = 1400 kg**

**Point B = 1750 kg**

**Point C = 1100 kg**



For the proof against sliding a minimum friction coefficient of 0,4 is taken into account. Which means that every Layher spindle need a wood pad underneath. The recommended minimum dimensions of the wood pad is 25x25x18 mm.

## 2.0 General calculation input.

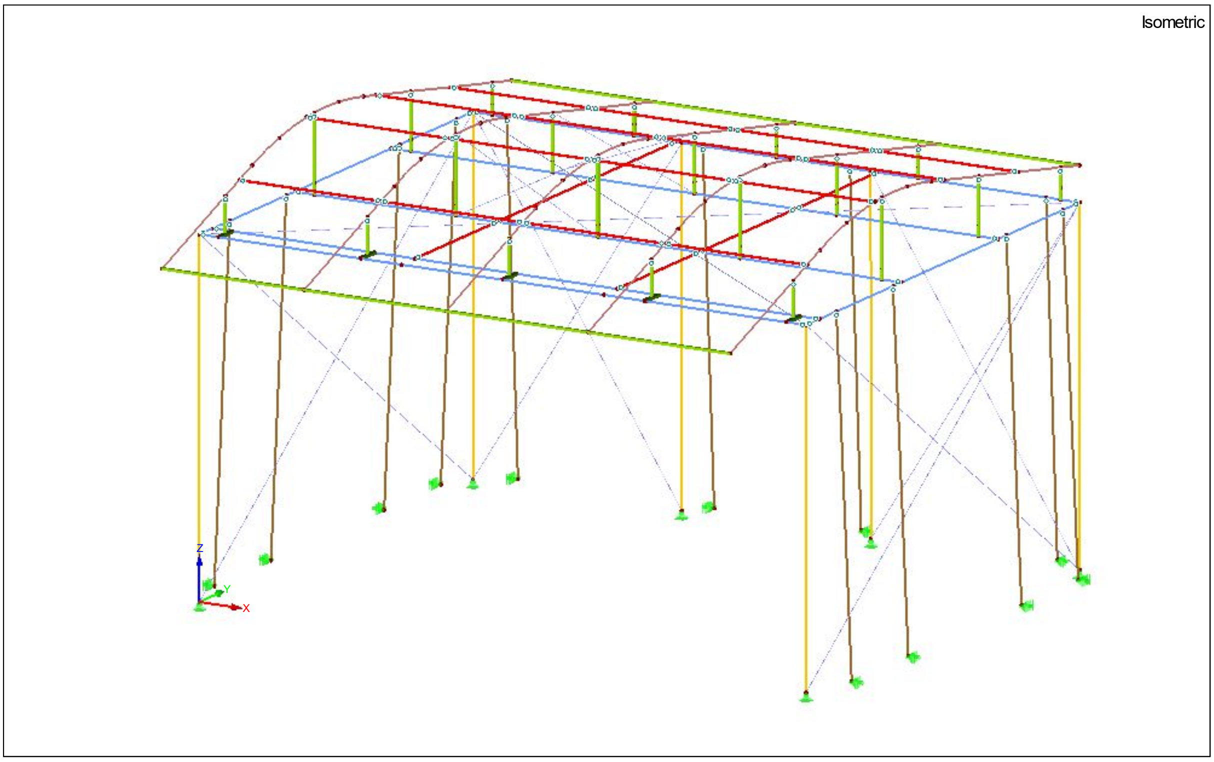
### 2.1 Used program information.

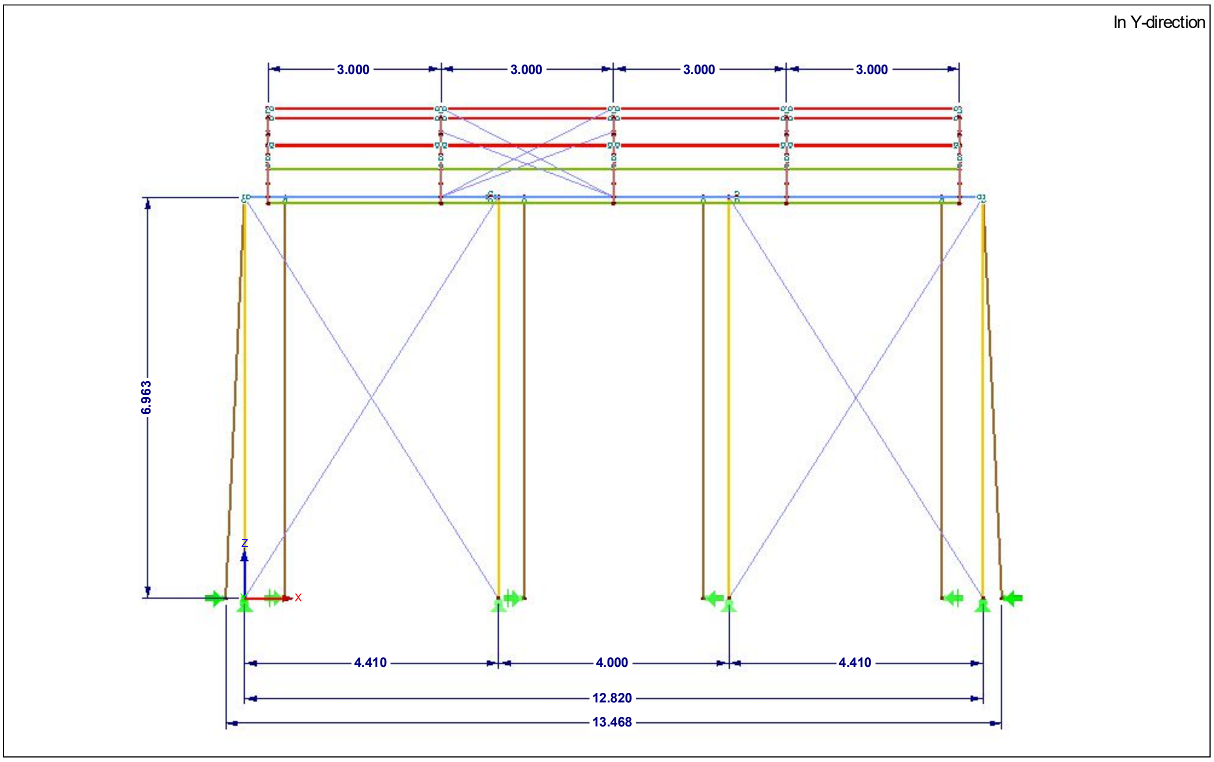
For the calculation of the construction the program RFem 5.08.001 is used.

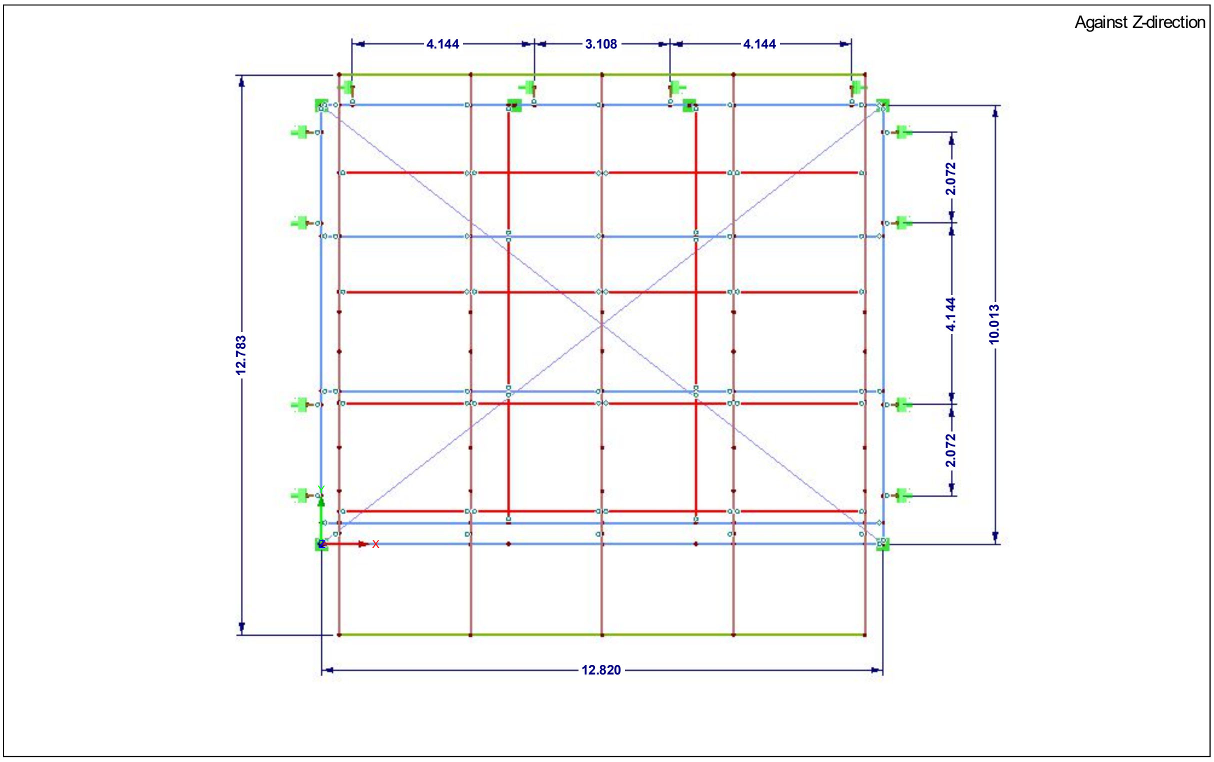
### 2.2 Program input for the main roof construction calculation.

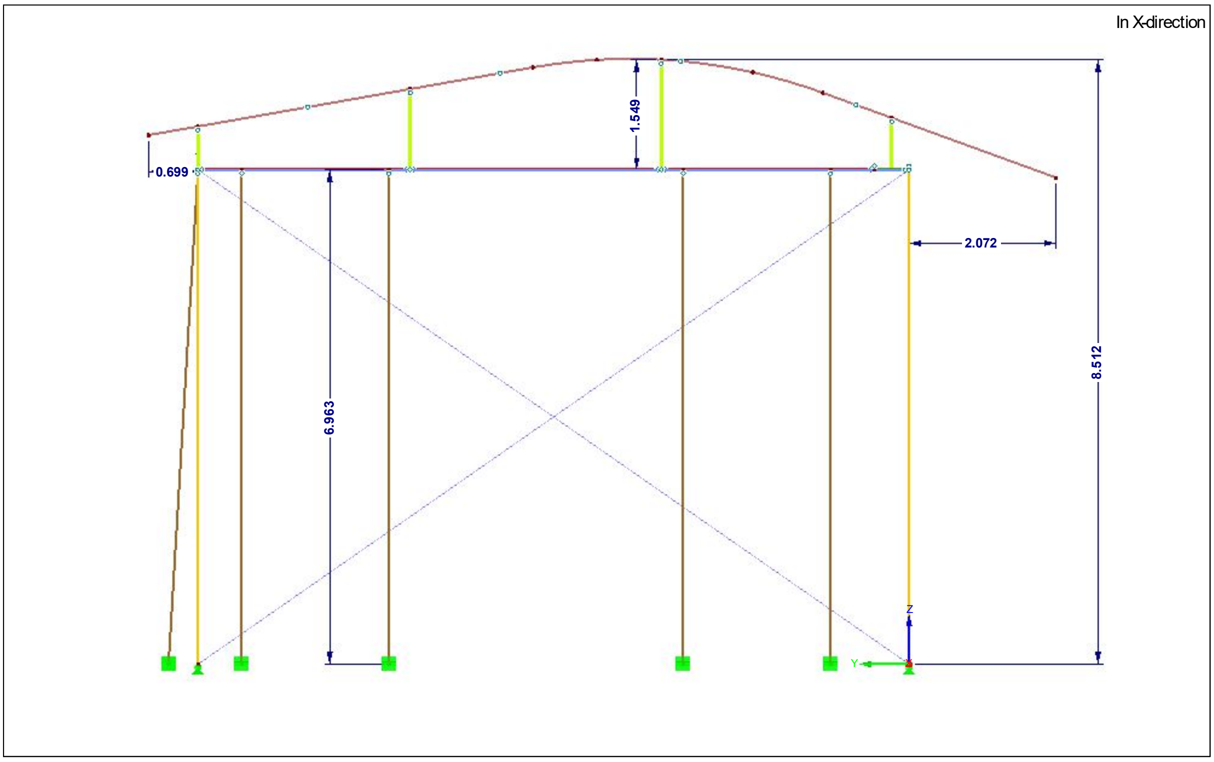
For the roof system CLT 12 x10 is a model constructed in the RFem program. For special parts of the roof construction which need a more detailed calculation a separate model constructed and loaded with the results of the main roof system model, which makes the calculation more accurate.
The Layher staging system is constructed as a separate model and will be loaded with the support reaction forces of the main models of the roof.

## 2.3 Construction model of the main roof system.




Against Z-direction
4.144
3.108
4.144
2.072
4.144
10.013
2.072
12.783
12.820


In X-direction
1.549
0.699
2.072
6.963
8.512

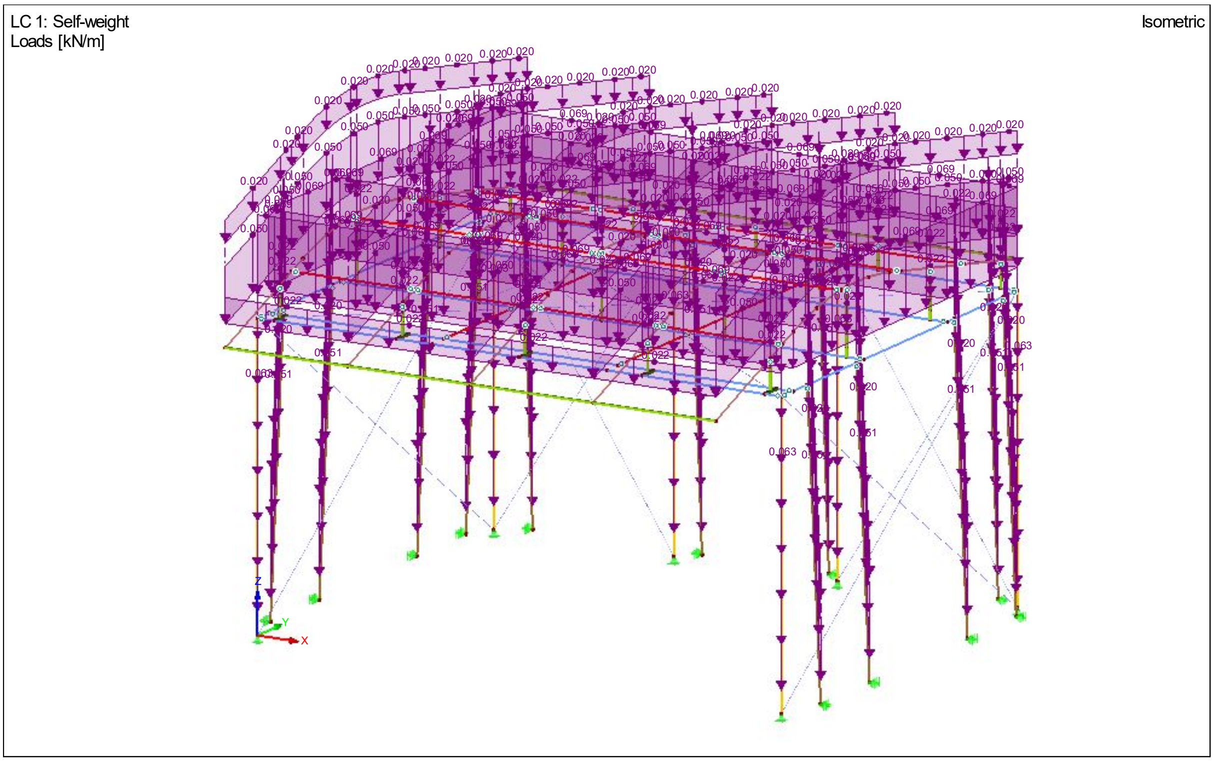
## 2.4 Different load cases for the In-service and Out service situation

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 | Centre point loads | + | Permanent | - | 0,000 | 0,000 | -1,000 |
| LC4 | point loads in the third point | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC5 | point loads1.25 meter from side span in service | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC6 | point loads1.25 meter from side span out service | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC10 | in-service wind dir.0° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC11 | in-service wind dir. 0° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC12 | in-service wind dir. 0° back and side wall | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC13 | in-service wind dir. 0° back and side wall membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC20 | in-service wind dir. 90° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC21 | in-service wind dir. 90° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC22 | in-service wind dir. 90° back and side wall | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC23 | in-service wind dir. 90° back and side wall membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC30 | in-service wind dir. 180° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC31 | in-service wind dir. 180° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC32 | in-service wind dir. 180° back and side wall | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC33 | in-service wind dir. 180° back and side wall membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC34 | in-service wind dir. 180° roof structure compression | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC35 | in-service wind dir. 180° roof structure membrane tension compression | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| | | | | | | | |
| LC110 | Out-service wind dir. 0° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC111 | Out-service wind dir. 0° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC112 | Out-service wind dir. 0° tower + profiles | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC113 | Out-service wind dir. 0° roof structure compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC114 | Out-service wind dir. 0° roof structure membrane tension compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| | | | | | | | |
| LC120 | Out-service wind dir. 90° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC121 | Out-service wind dir. 90° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC122 | Out-service wind dir. 90° tower + profiles | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| | | | | | | | |
| LC130 | Out-service wind dir. 180° roof structure | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC131 | Out-service wind dir. 180° roof structure membrane tension | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC132 | Out-service wind dir. 180° tower + profiles | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC133 | Out-service wind dir. 180° roof structure compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |
| LC134 | Out-service wind dir. 180° roof structure membrane tension compression | + | Permanent/Imposed | - | 0,000 | 0,000 | -1,000 |

## 2.5 Load case input for the self-weight and the loading possibilities.

### 2.5.1 Load case 1 Self-Weight




Self-weight different components

H30V Towers = 6.3 kg/m

H40V = 6.9 kg/m

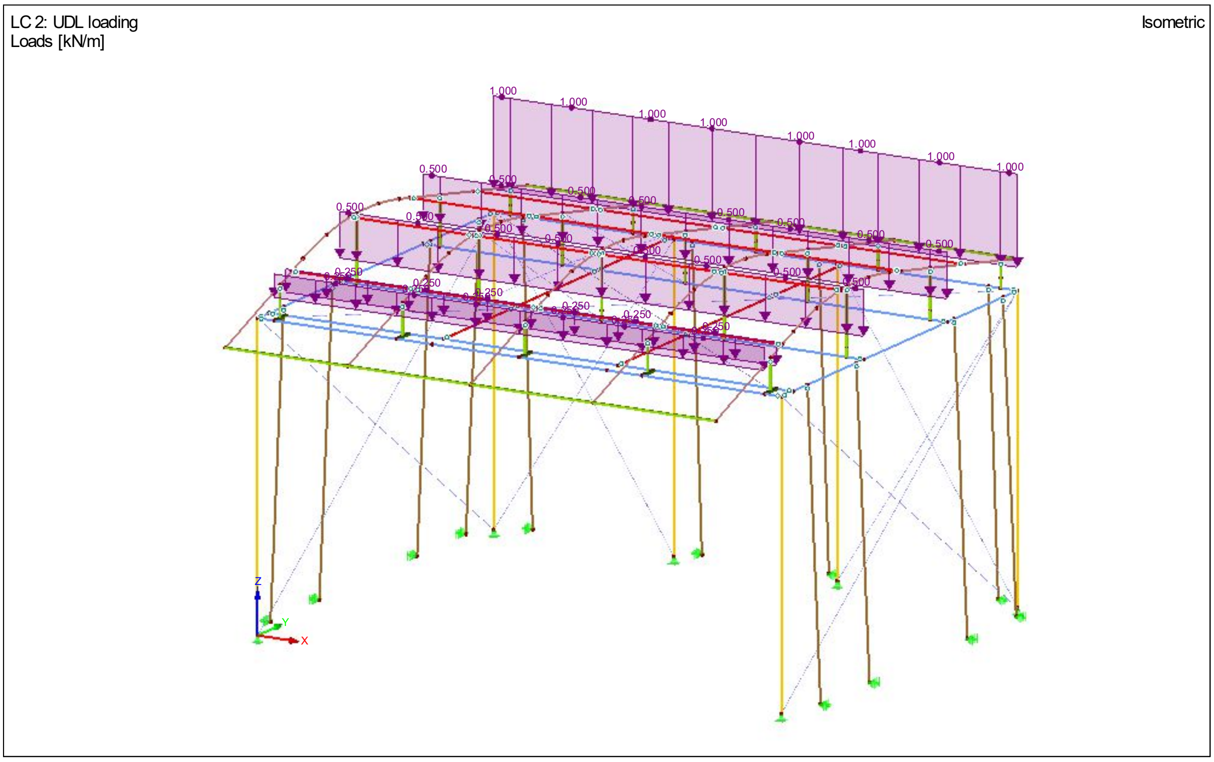
H30D = 5 kg/m

Kedar Profile 170x88x3 = 5.1 kg/m

Canopy skin = 1 kg/m²

Aluminium adapters = 2.2 kg/m Profile

### 2.5.2 load case 2 UDL loading




Equally divided load along the main span.

Span 1 = 25 kg/m

Span 2 = 25 kg/m

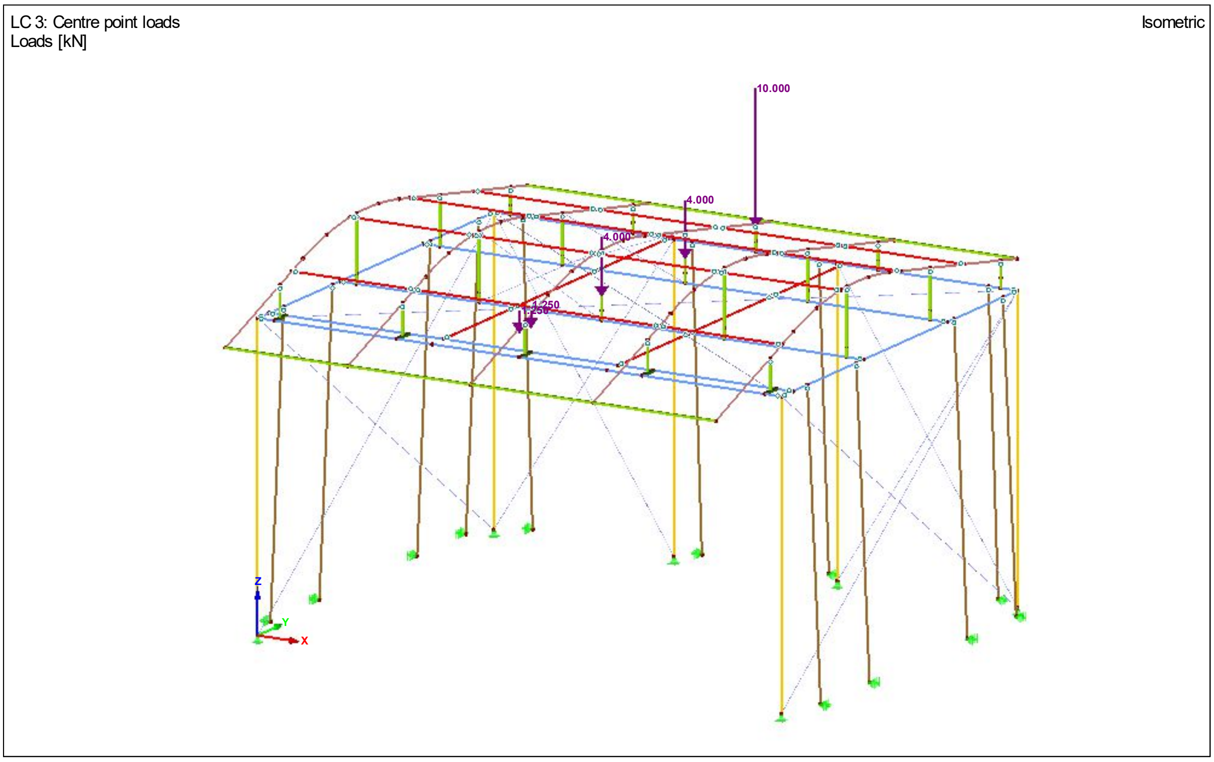
Span 3 = 50 kg/m

Span 4 = 50 kg/m

Span 5 = 100 kg/m

The total load on the main system is ~ 3000 kg

### 2.5.3 load case 3 Center point load.




Span 1 = 125 kg

Span 2 = 125 kg

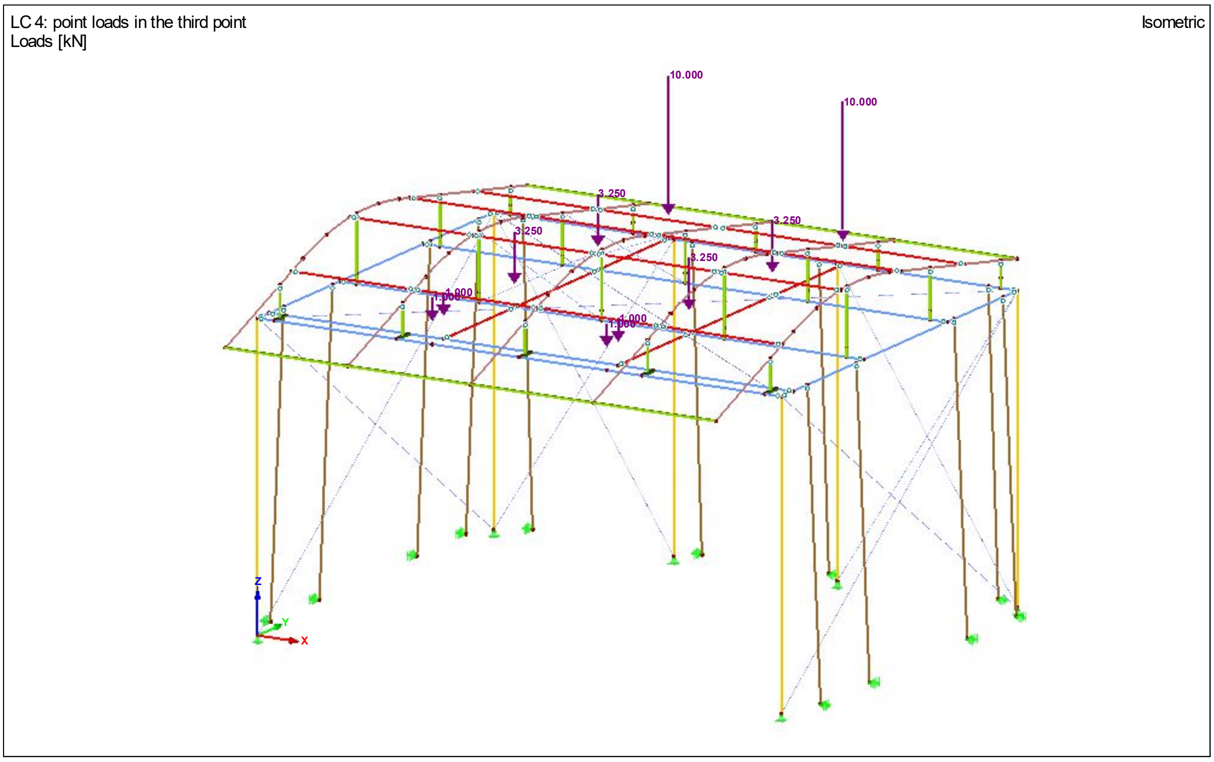
Span 3 = 400 kg

Span 4 = 400 kg

Span 5 = 1000 kg

The total load on the main system is ~ 1060 Kg

## 2.5.4 load case 4 Point load in the third point




Span 1 = 2x 100 kg

Span 2 = 2x 100 kg

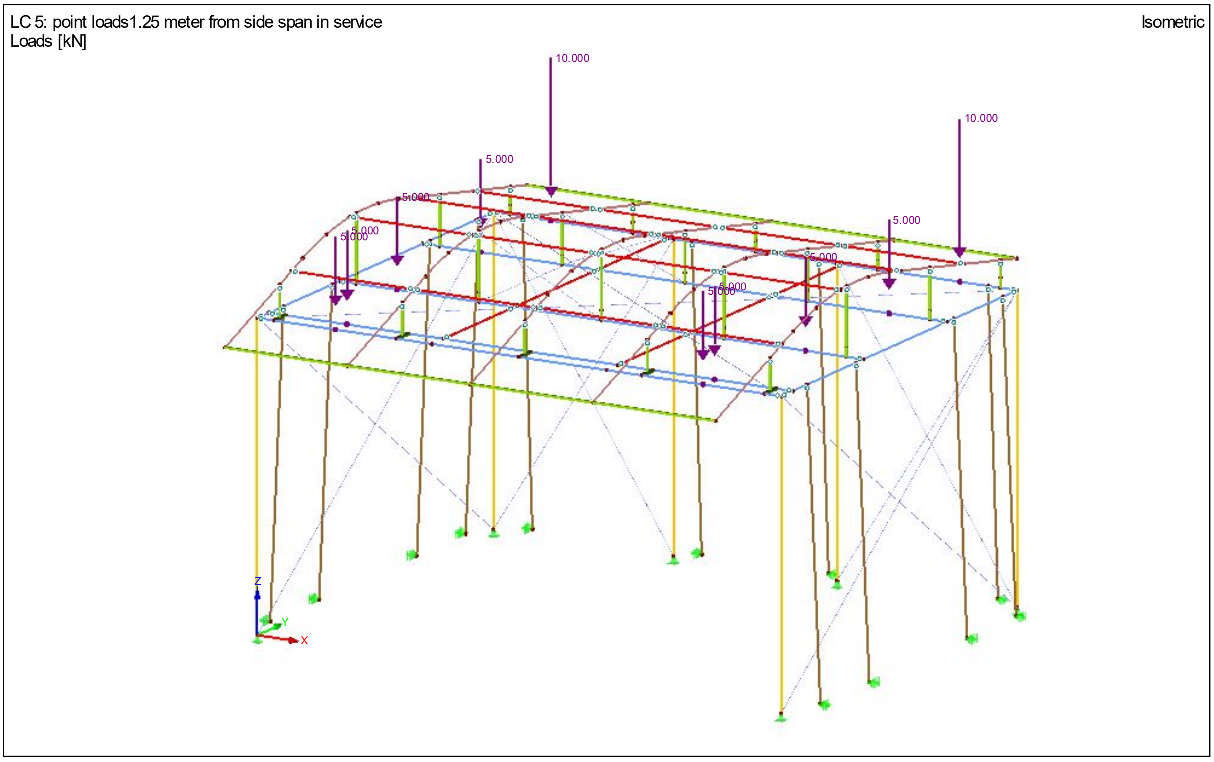
Span 3 = 2x 325 kg

Span 4 = 2x 325 kg

Span 5 = 2x 1000 kg

The total load on the main system is ~ 3700 Kg

### 2.5.5 load case 5 Point loads 1.25 meter from side span in service




Span 1 = 2x 500 kg

Span 2 = 2x 500 kg

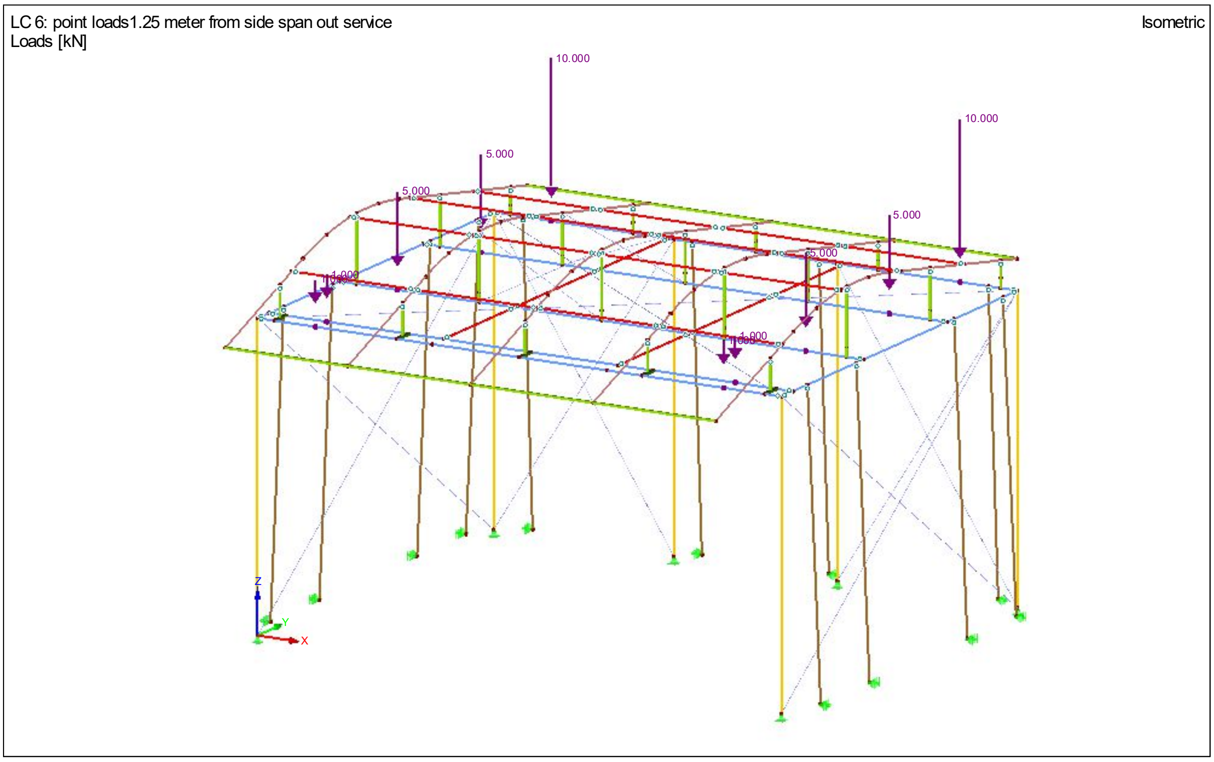
Span 3 = 2x 500 kg

Span 4 = 2x 500 kg

Span 5 = 2x 1000 kg

The total load on the main system is ~ 6000 Kg

### 2.5.6 load case 5 Point loads 1.25 meter from side span out service




Span 1 = 2x 100 kg

Span 2 = 2x 100 kg

Span 3 = 2x 500 kg

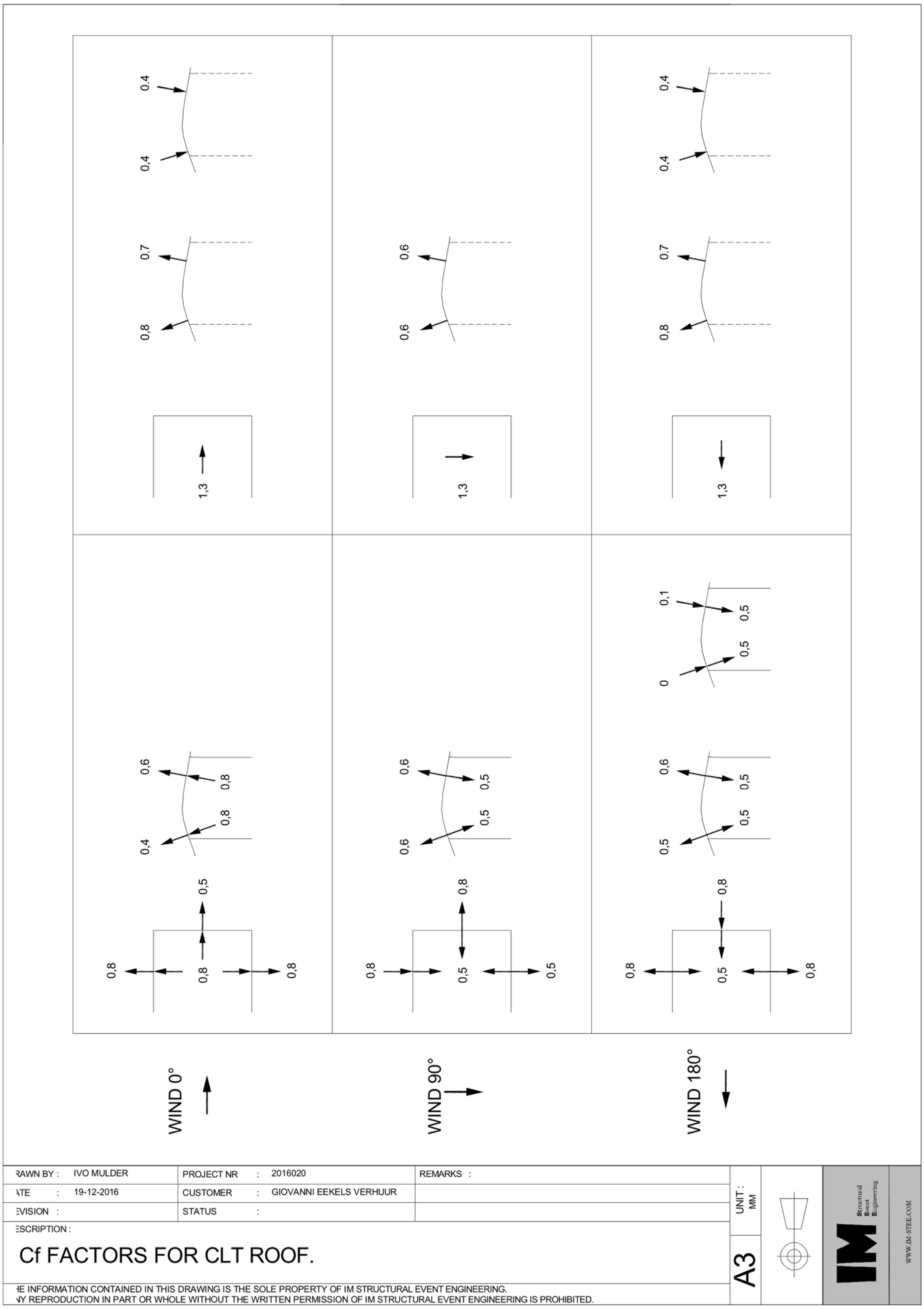
Span 4 = 2x 500 kg

Span 5 = 2x 1000 kg

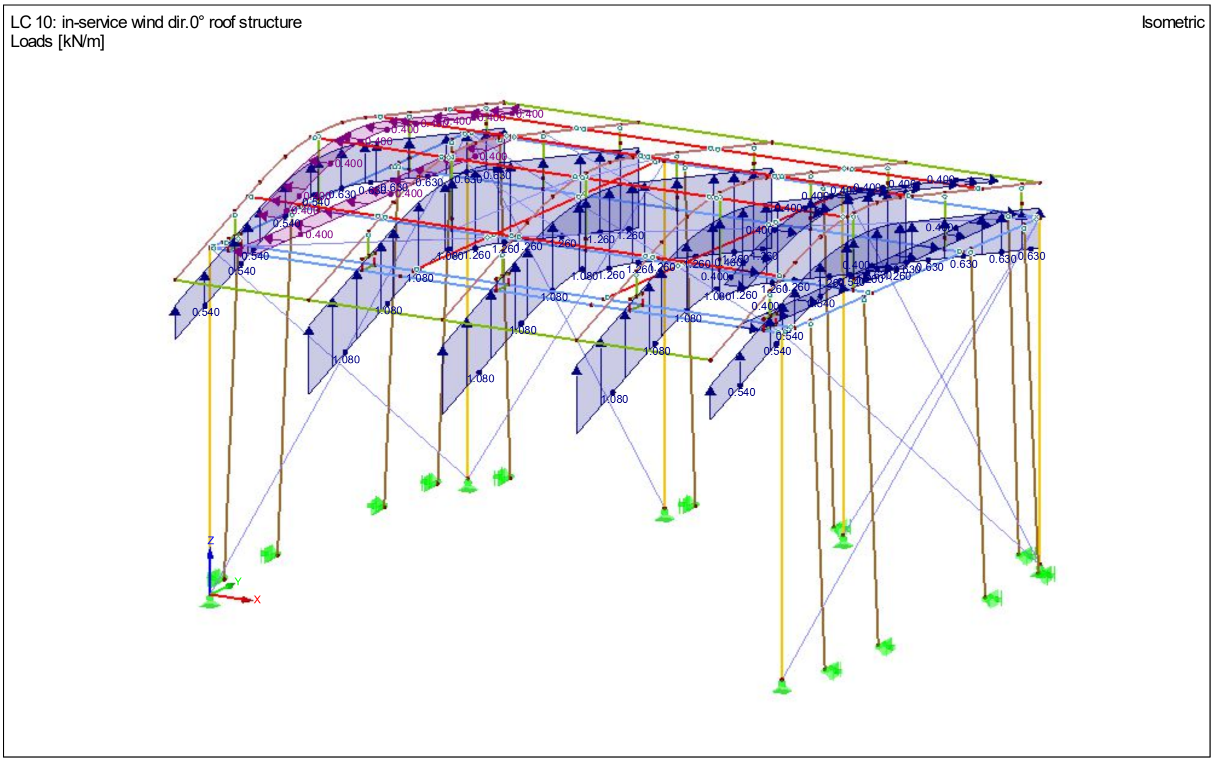
The total load on the main system is ~ 4400 Kg

## 2.6 load cases concerning wing loading.

For the calculation of the wind loading the next wind coefficient are used. These factors are subtracted from the Eurocode NEN-EN 1999-1 1-4: general actions – wind actions.



### 2.6.1 load case 10 In-service wind dir. 0° roof structure




Wind calculations roof construction wind 0°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 1.2 * 0.3 * 1.5 = 0.540 kN/m
$q_{w,\text{ roof span 2, front}}$ = 1.2 * 0.3 * 3 = 1.080 kN/m
$q_{w,\text{ roof span 3, front}}$ = 1.2 * 0.3 * 3 = 1.080 kN/m
$q_{w,\text{ roof span 4, front}}$ = 1.2 * 0.3 * 3 = 1.080 kN/m
$q_{w,\text{ roof span 5, front}}$ = 1.2 * 0.3 * 1.5 = 0.540 kN/m

Main roof structure back side

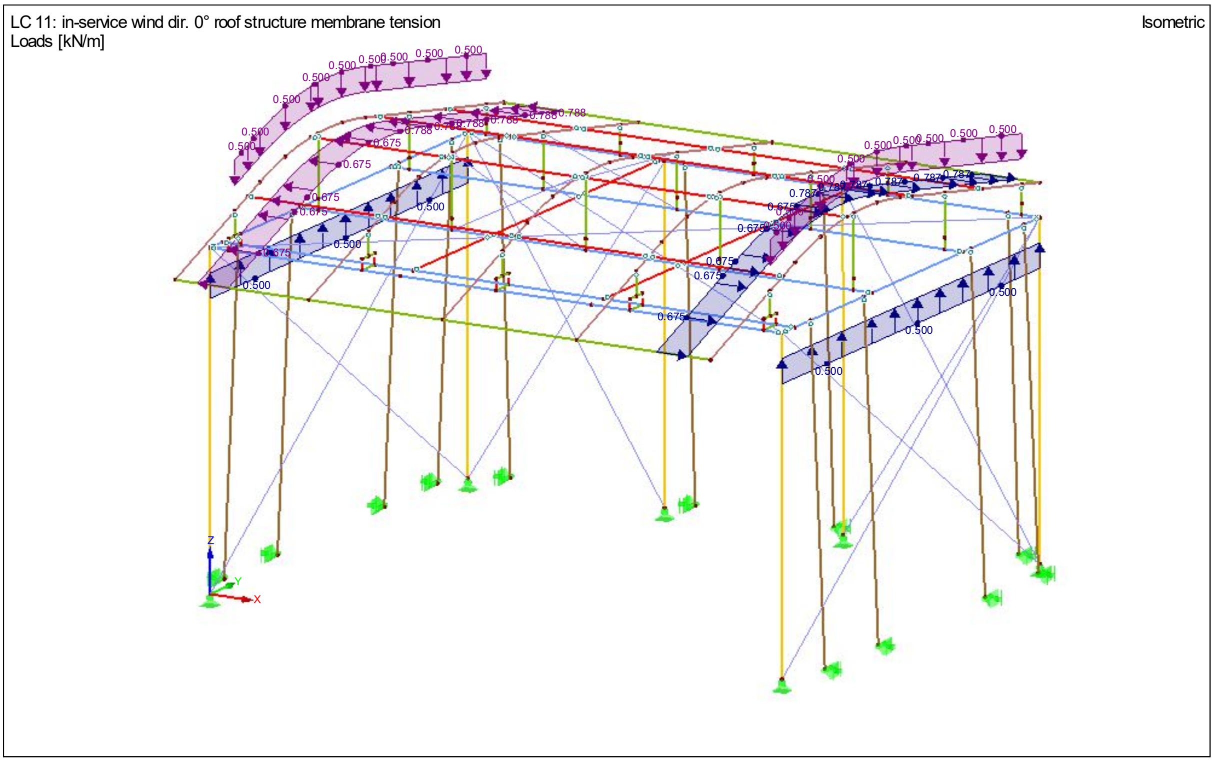
$q_{w,\text{ roof span 1, back}}$ = 1.4 * 0.3 * 1.5 = 0.630 kN/m
$q_{w,\text{ roof span 2, back}}$ = 1.4 * 0.3 * 3 = 1.260 kN/m
$q_{w,\text{ roof span 3, back}}$ = 1.4 * 0.3 * 3 = 1.260 kN/m
$q_{w,\text{ roof span 4, back}}$ = 1.4 * 0.3 * 3 = 1.260 kN/m
$q_{w,\text{ roof span 5, back}}$ = 1.4 * 0.3 * 1.5 = 0.630 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 15 m²
$Q_{w,\text{ side canopy roof structure}}$ = 1.6 * 0.3 * 15 = 7.2 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 7.2 / 18 = 0.400 kN/m

### 2.6.2 load case 11 In-service wind dir. 0° roof structure membrane tension




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation  on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension  of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.675 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.675 kN/m

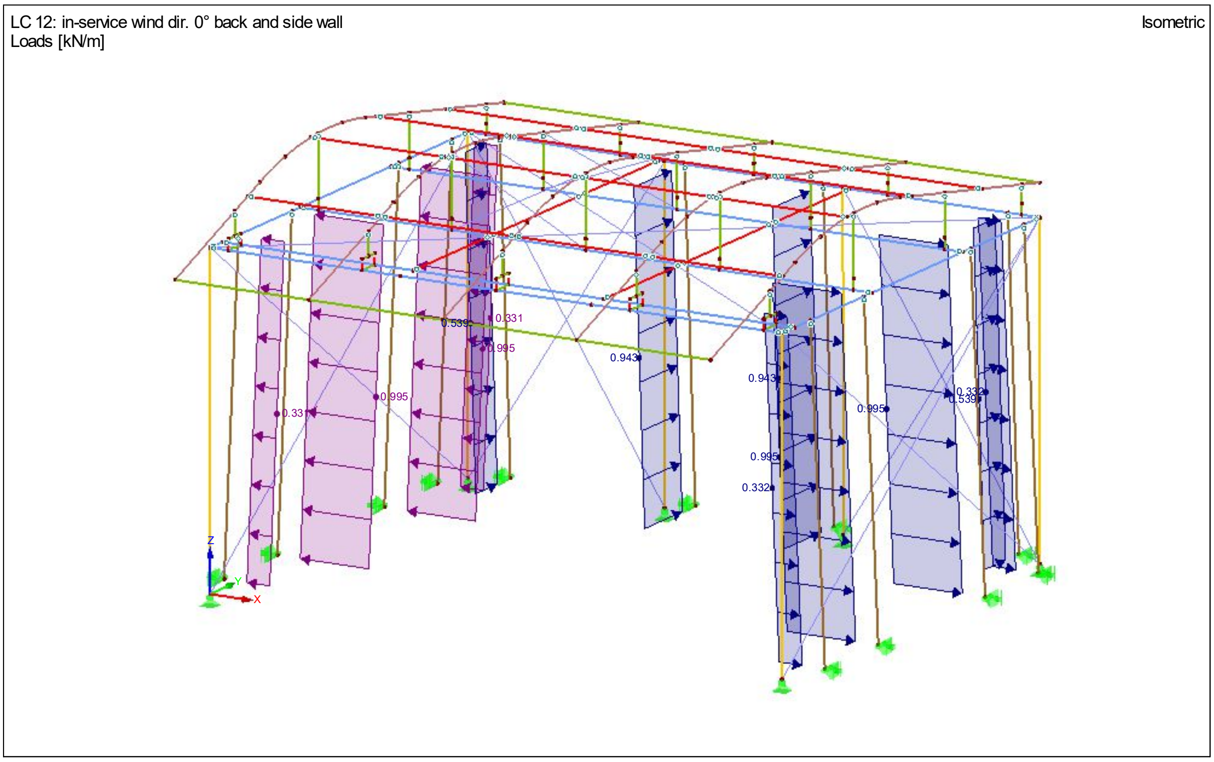
Membrane tension  of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.788 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.788 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.400 / 0.8 = 0.500 kN/m

### 2.6.3 load case 12 In-service wind dir. 0° side and back wall




Calculation of the wind loading on the different profiles.

In the back wall you have 4 profiles, profile 1 is the first profile at stage right.

Calculation of the wind on the back walls

$q_{w,\text{ back profile 1}} = 1.3 * 0.2 * 2.072 = 0.539$ kN/m

$q_{w,\text{ back profile 2}} = 1.3 * 0.2 * 3.626 = 0.943$ kN/m

$q_{w,\text{ back profile 3}} = 1.3 * 0.2 * 3.626 = 0.943$ kN/m

$q_{w,\text{ back profile 4}} = 1.3 * 0.2 * 2.072 = 0.539$ kN/m

In the side wall you have 4 profiles, profile 1 is the first profile on the front of the stage.

Calculation of the wind on the side walls

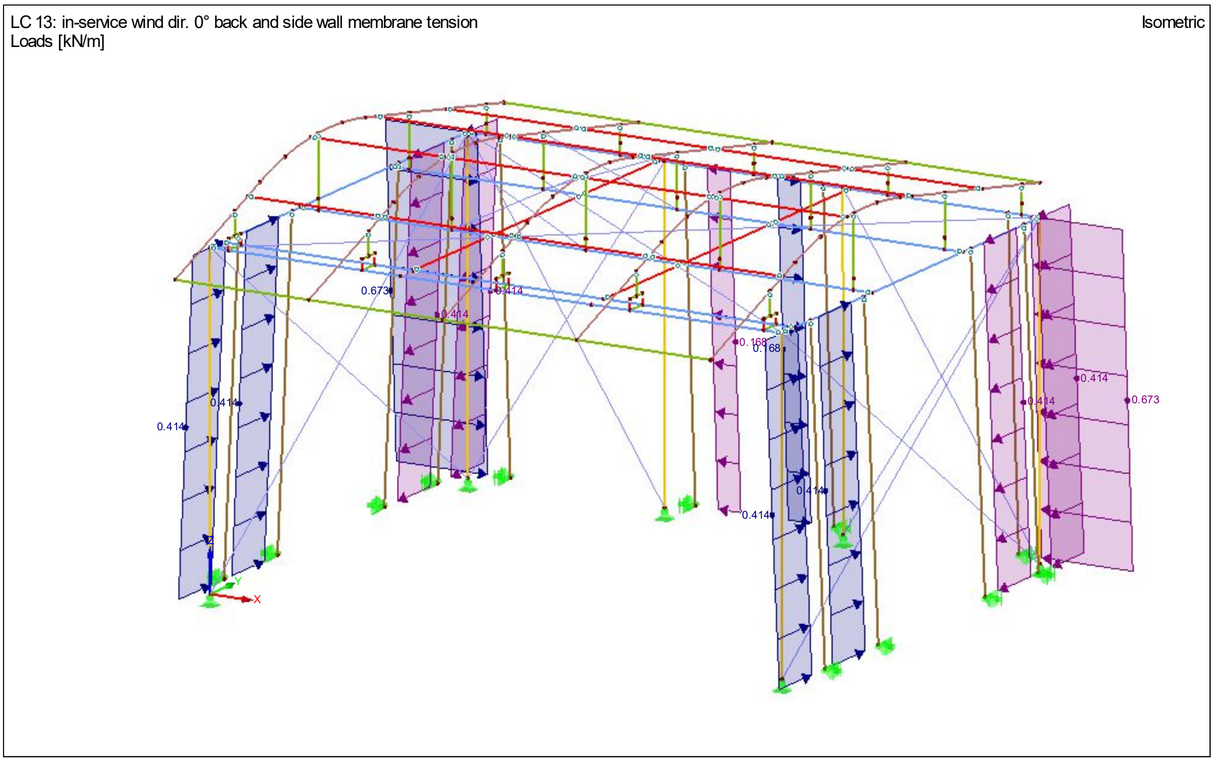
$q_{w,\text{ side profile 1}} = 1.6 * 0.2 * 1.036 = 0.335$ kN/m

$q_{w,\text{ side profile 2}} = 1.6 * 0.2 * 3.108 = 0.995$ kN/m

$q_{w,\text{ side profile 3}} = 1.6 * 0.2 * 3.108 = 0.995$ kN/m

$q_{w,\text{ side profile 4}} = 1.6 * 0.2 * 1.036 = 0.335$ kN/m

### 2.6.4 load case 13 In-service wind dir. 0° side and back wall membrane tension




Membrane tension calculations side wall wind 0°

The membrane tension is calculated according to the calculation  on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Calculation of the membrane tension on the back walls

$q_{mt,\ back\ profile\ 1}$ = 0.673 kN/m

$q_{mt,\ back\ profile\ 2}$ = 0.168 kN/m

$q_{mt,\ back\ profile\ 3}$ = 0.168 kN/m

$q_{mt,\ back\ profile\ 4}$ = 0.673 kN/m

Calculation of the membrane tension on the side walls

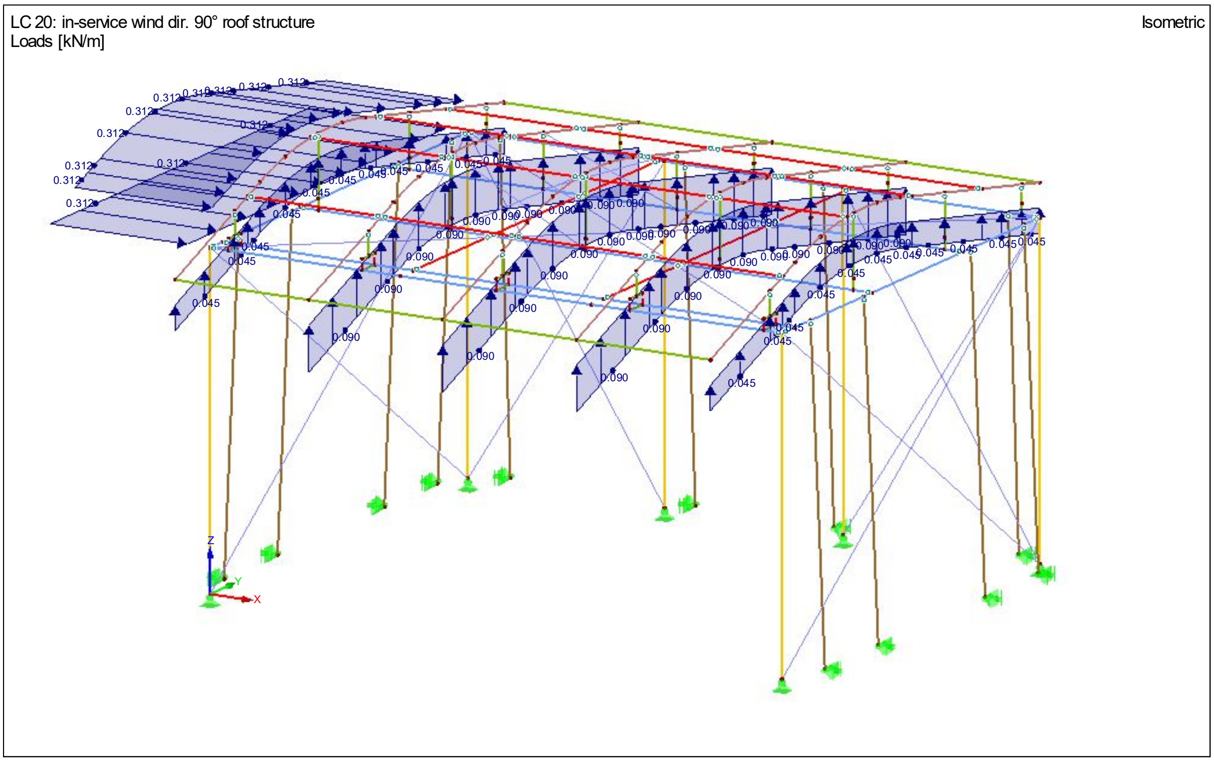
$q_{mt,\ side\ profile\ 1}$ = 0.414 kN/m

$q_{mt,\ side\ profile\ 2}$ = 0.414 kN/m

$q_{mt,\ side\ profile\ 3}$ = 0.414 kN/m

$q_{mt,\ side\ profile\ 4}$ = 0.414 kN/m

### 2.6.5 load case 20 In-service wind dir. 90° roof structure




Wind calculations roof construction wind 0°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}} = 0.1 * 0.3 * 1.5 = 0.045$ kN/m
$q_{w,\text{ roof span 2, front}} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\text{ roof span 3, front}} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\text{ roof span 4, front}} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\text{ roof span 5, front}} = 0.1 * 0.3 * 1.5 = 0.045$ kN/m

Main roof structure back side

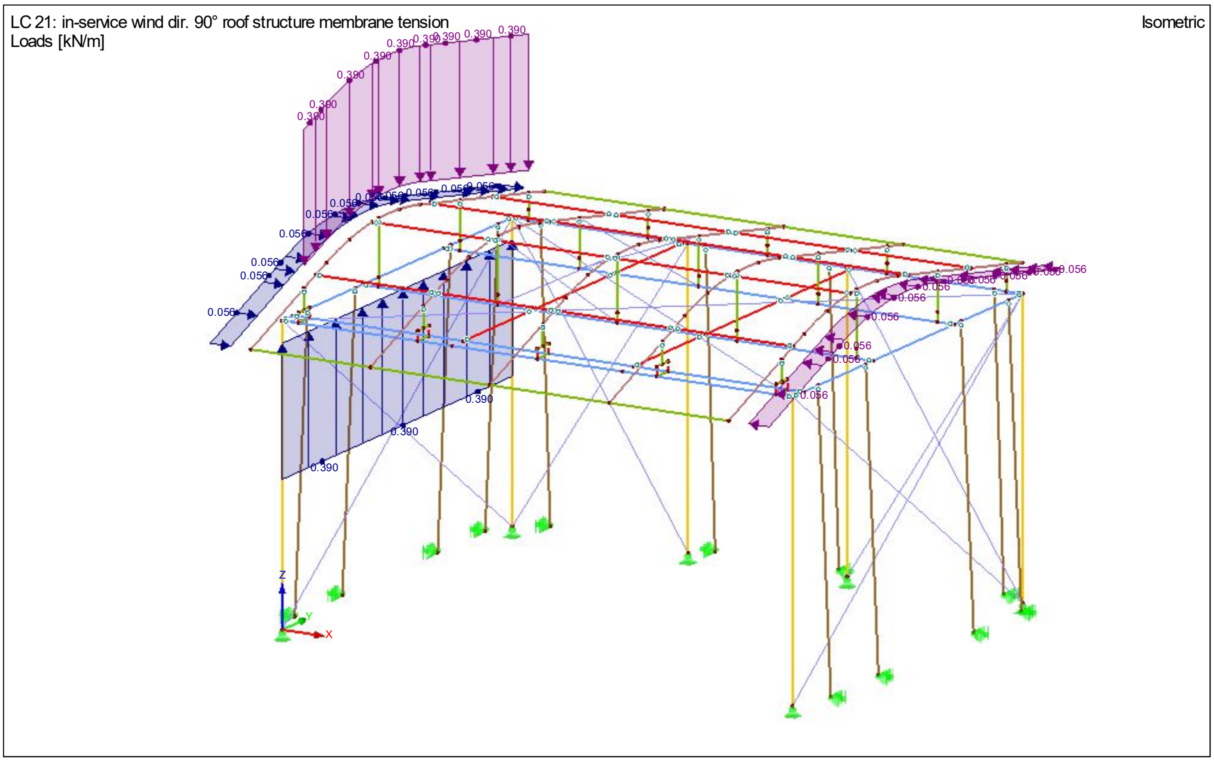
$q_{w,\text{ roof span 1, back}} = 0.1 * 0.3 * 1.5 = 0.045$ kN/m
$q_{w,\text{ roof span 2, back}} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\text{ roof span 3, back}} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\text{ roof span 4, back}} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\text{ roof span 5, back}} = 0.1 * 0.3 * 1.5 = 0.045$ kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}} = 15\ m^2$
$Q_{w,\text{ side canopy roof structure}} = 1.3 * 0.3 * 15 = 5.616$ kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}} = 5.616 / 18 = 0.312$ kN/m

### 2.6.6 load case 21 In-service wind dir. 90° roof structure membrane tension




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation  on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension  of roof structure front side

$q_{\text{mt, roof span 1, front}} = 0.563$ kN/m
$q_{\text{mt, roof span 2, front}} = 0$ kN/m
$q_{\text{mt, roof span 3, front}} = 0$ kN/m
$q_{\text{mt, roof span 4, front}} = 0$ kN/m
$q_{\text{mt, roof span 5, front}} = 0.563$ kN/m

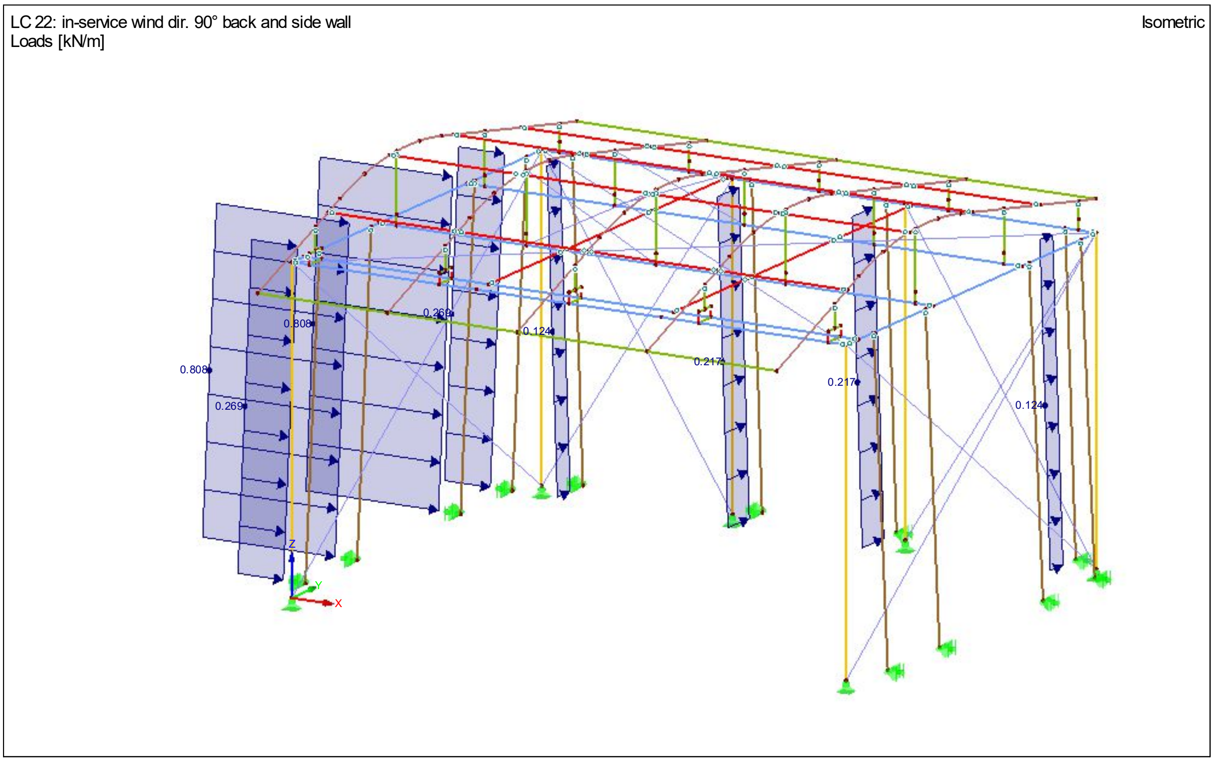
Membrane tension  of roof structure back side

$q_{\text{mt, roof span 1, back}} = 0.563$ kN/m
$q_{\text{mt, roof span 2, back}} = 0$ kN/m
$q_{\text{mt, roof span 3, back}} = 0$ kN/m
$q_{\text{mt, roof span 4, back}} = 0$ kN/m
$q_{\text{mt, roof span 5, back}} = 0.563$ kN/m

Membrane tension of the side canopy of the roof structure

$q_{\text{mt, side canopy roof structure}} = 0.312 / 0.8 = 0.390$ kN/m

## 2.6.7 load case 22 In-service wind dir. 90° side and back wall




Calculation of the wind loading on the different profiles.

In the back wall you have 4 profiles, profile 1 is the first profile at stage right.

Calculation of the wind on the back walls

$q_{w,\text{ back profile 1}}$ = 0.3 * 0.2 * 2.072 = 0.124 kN/m

$q_{w,\text{ back profile 2}}$ = 0.3 * 0.2 * 3.626 = 0.218 kN/m

$q_{w,\text{ back profile 3}}$ = 0.3 * 0.2 * 3.626 = 0.218 kN/m

$q_{w,\text{ back profile 4}}$ = 0.3 * 0.2 * 2.072 = 0.124 kN/m

In the side wall you have 4 profiles, profile 1 is the first profile on the front of the stage.

Calculation of the wind on the side walls

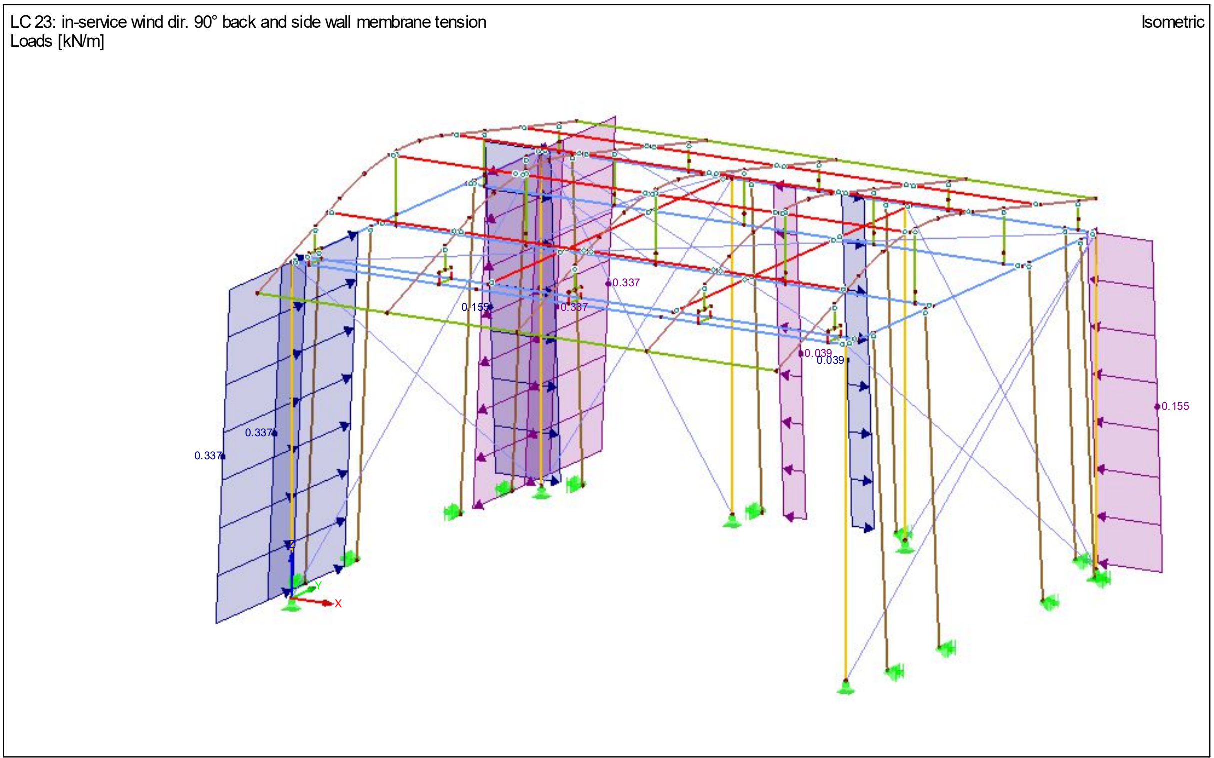
$q_{w,\text{ side profile 1}}$ = 1.3 * 0.2 * 1.036 = 0.269 kN/m

$q_{w,\text{ side profile 2}}$ = 1.3 * 0.2 * 3.108 = 0.808 kN/m

$q_{w,\text{ side profile 3}}$ = 1.3 * 0.2 * 3.108 = 0.808 kN/m

$q_{w,\text{ side profile 4}}$ = 1.3 * 0.2 * 1.036 = 0.269 kN/m

### 2.6.8 load case 23 In-service wind dir. 90° side and back wall membrane tension




Membrane tension calculations side wall wind 0°

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Calculation of the membrane tension on the back walls

$q_{mt,\ back\ profile\ 1}$ = 0.155 kN/m

$q_{mt,\ back\ profile\ 2}$ = 0.039 kN/m

$q_{mt,\ back\ profile\ 3}$ = 0.039 kN/m

$q_{mt,\ back\ profile\ 4}$ = 0.155 kN/m

Calculation of the membrane tension on the side walls

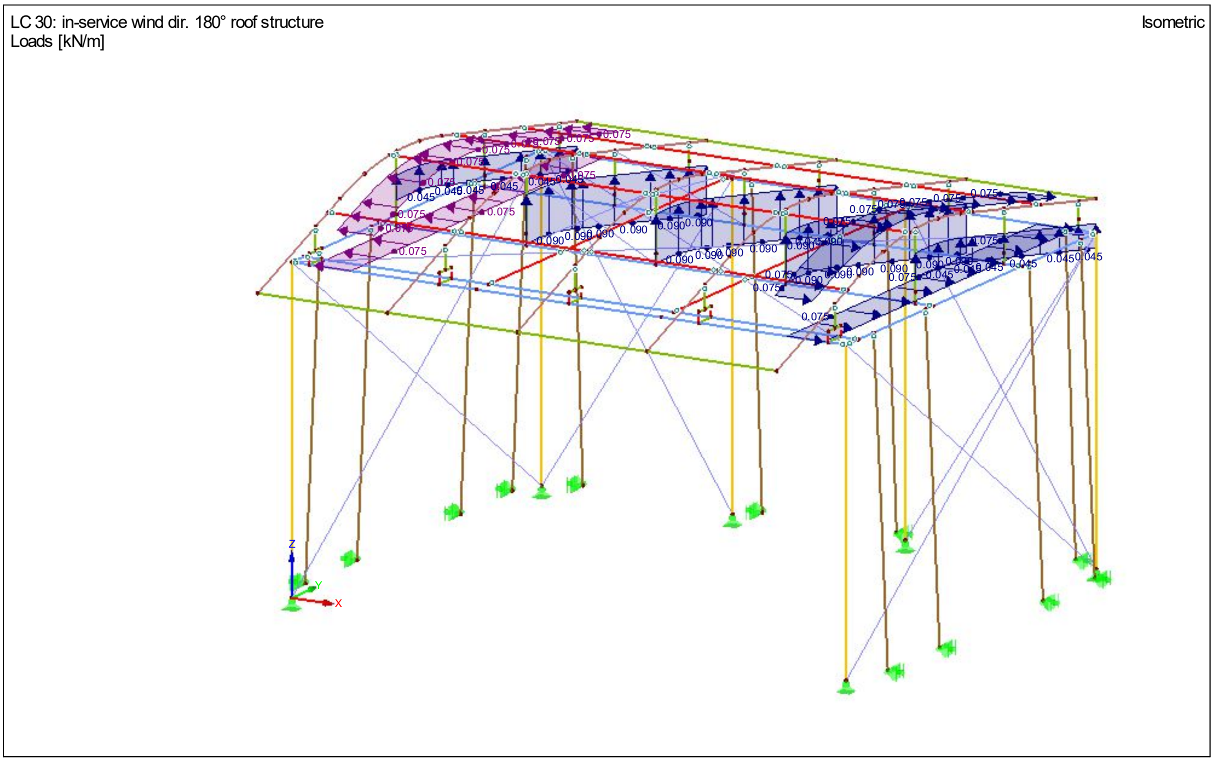
$q_{mt,\ side\ profile\ 1}$ = 0.337 kN/m

$q_{mt,\ side\ profile\ 2}$ = 0.337 kN/m

$q_{mt,\ side\ profile\ 3}$ = 0.337 kN/m

$q_{mt,\ side\ profile\ 4}$ = 0.337 kN/m

## 2.6.9 load case 30 In-service wind dir. 180° roof structure.




Wind calculations roof construction wind 0°.

Main roof structure front side the Cf of the front side is 0

Main roof structure back side

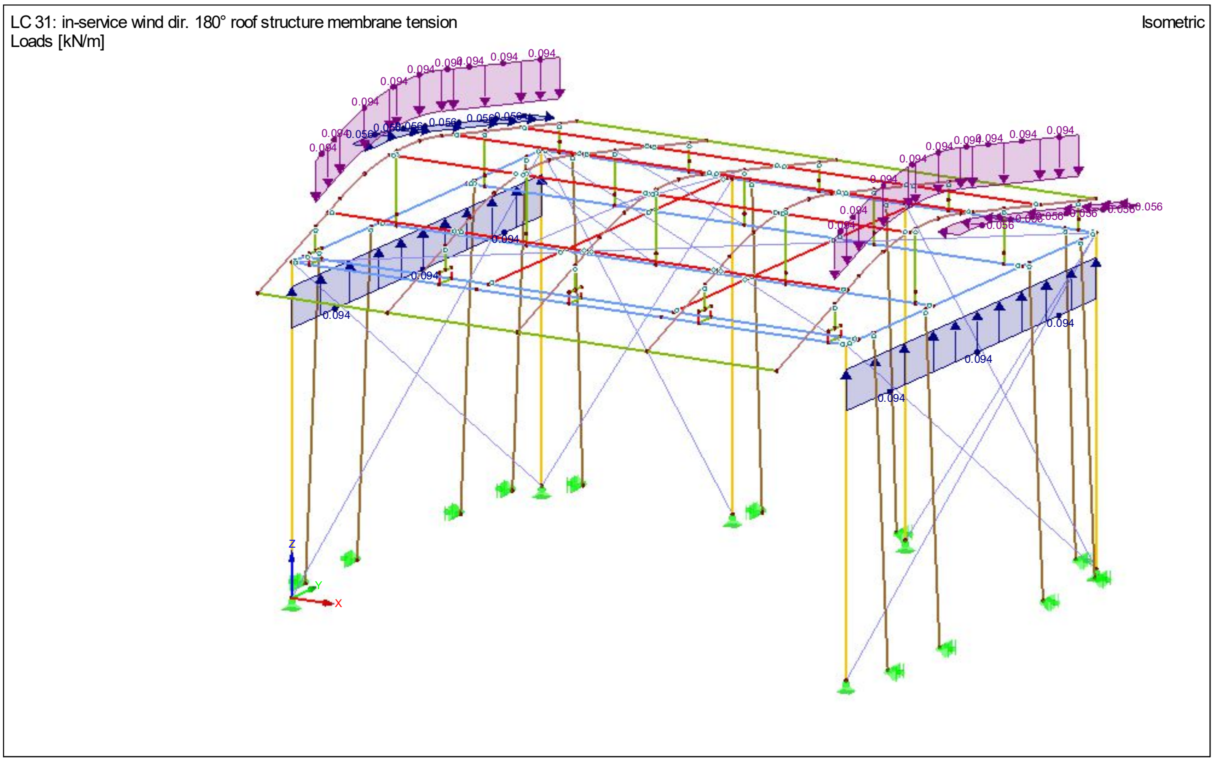
$q_{w,\ roof\ span\ 1,\ back} = 0.1 * 0.3 * 1.5 = 0.045$ kN/m
$q_{w,\ roof\ span\ 2,\ back} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\ roof\ span\ 3,\ back} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\ roof\ span\ 4,\ back} = 0.1 * 0.3 * 3 = 0.090$ kN/m
$q_{w,\ roof\ span\ 5,\ back} = 0.1 * 0.3 * 1.5 = 0.045$ kN/m

Wind on side canopy of the roof construction

$A_{canopy} = 15\ m^2$
$Q_{w,\ side\ canopy\ roof\ structure} = 0.3 * 0.3 * 15 = 1.35$ kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\ side\ canopy\ roof\ structure} = 1.35 / 18 = 0.075$ kN/m

### 2.6.10 load case 31 In-service wind dir. 180° roof structure membrane tension.




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

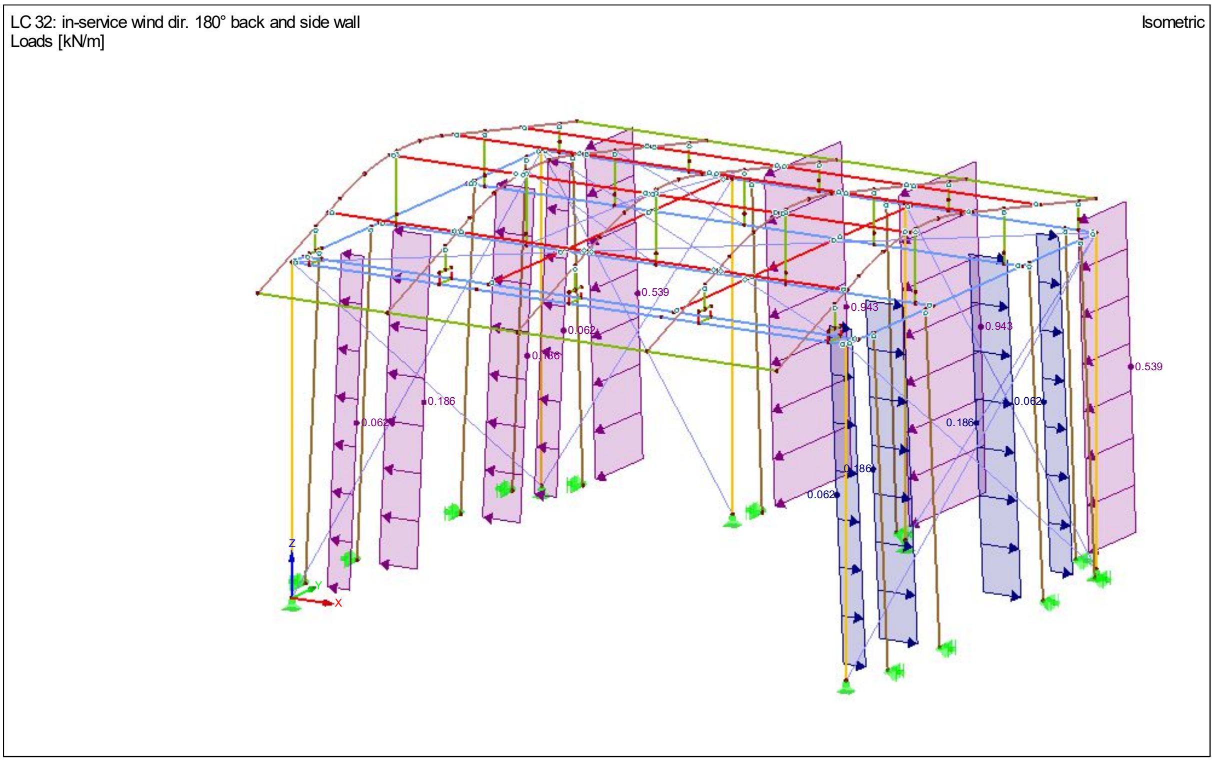
Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.056 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.056 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.075 / 0.8 = 0.094 kN/m

### 2.6.11 load case 32 In-service wind dir. 180° side and back wall




Calculation of the wind loading on the different profiles.

In the back wall you have 4 profiles, profile 1 is the first profile at stage right.

Calculation of the wind on the back walls

$q_{w,\text{ back profile 1}}$ = 1.3 * 0.2 * 2.072 = 0.539 kN/m

$q_{w,\text{ back profile 2}}$ = 1.3 * 0.2 * 3.626 = 0.943 kN/m

$q_{w,\text{ back profile 3}}$ = 1.3 * 0.2 * 3.626 = 0.943 kN/m

$q_{w,\text{ back profile 4}}$ = 1.3 * 0.2 * 2.072 = 0.539 kN/m

In the side wall you have 4 profiles, profile 1 is the first profile on the front of the stage.

Calculation of the wind on the side walls

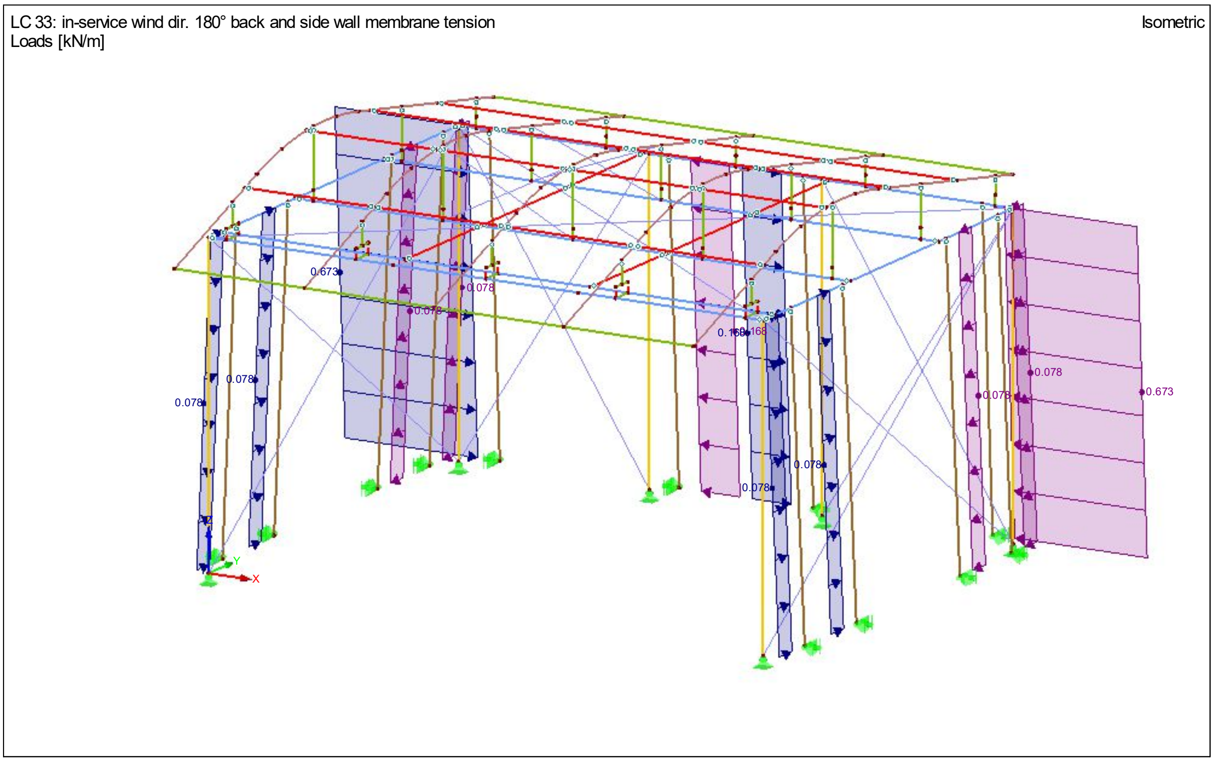
$q_{w,\text{ side profile 1}}$ = 0.3 * 0.2 * 1.036 = 0.062 kN/m

$q_{w,\text{ side profile 2}}$ = 0.3 * 0.2 * 3.108 = 0.186 kN/m

$q_{w,\text{ side profile 3}}$ = 0.3 * 0.2 * 3.108 = 0.186 kN/m

$q_{w,\text{ side profile 4}}$ = 0.3 * 0.2 * 1.036 = 0.062 kN/m

### 2.6.12 load case 33 In-service wind dir. 180° side and back wall membrane tension




Membrane tension calculations side wall wind 180°

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Calculation of the membrane tension on the back walls

$q_{mt,\text{ back profile 1}} = 0.673$ kN/m

$q_{mt,\text{ back profile 2}} = 0.168$ kN/m

$q_{mt,\text{ back profile 3}} = 0.168$ kN/m

$q_{mt,\text{ back profile 4}} = 0.673$ kN/m

Calculation of the membrane tension on the side walls

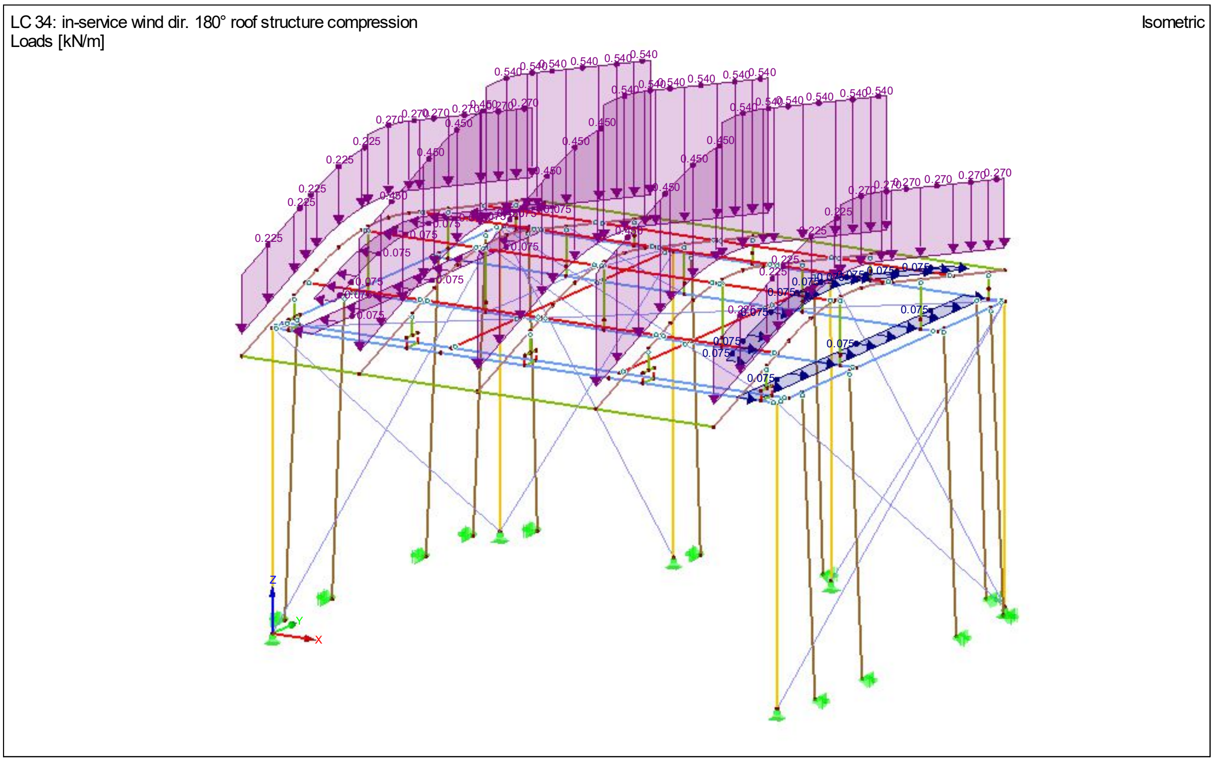
$q_{mt,\text{ side profile 1}} = 0.077$ kN/m

$q_{mt,\text{ side profile 2}} = 0.077$ kN/m

$q_{mt,\text{ side profile 3}} = 0.077$ kN/m

$q_{mt,\text{ side profile 4}} = 0.077$ kN/m

### 2.6.13 load case 34 In-service wind dir. 180° roof structure compression.




Wind calculations roof construction wind 180° compression.

Main roof structure front side

$q_{w,\text{ roof span 1, front}} = 0.5 * 0.3 * 1.5 = 0.225$ kN/m
$q_{w,\text{ roof span 2, front}} = 0.5 * 0.3 * 3 = 0.450$ kN/m
$q_{w,\text{ roof span 3, front}} = 0.5 * 0.3 * 3 = 0.450$ kN/m
$q_{w,\text{ roof span 4, front}} = 0.5 * 0.3 * 3 = 0.450$ kN/m
$q_{w,\text{ roof span 5, front}} = 0.5 * 0.3 * 1.5 = 0.225$ kN/m

Main roof structure back side

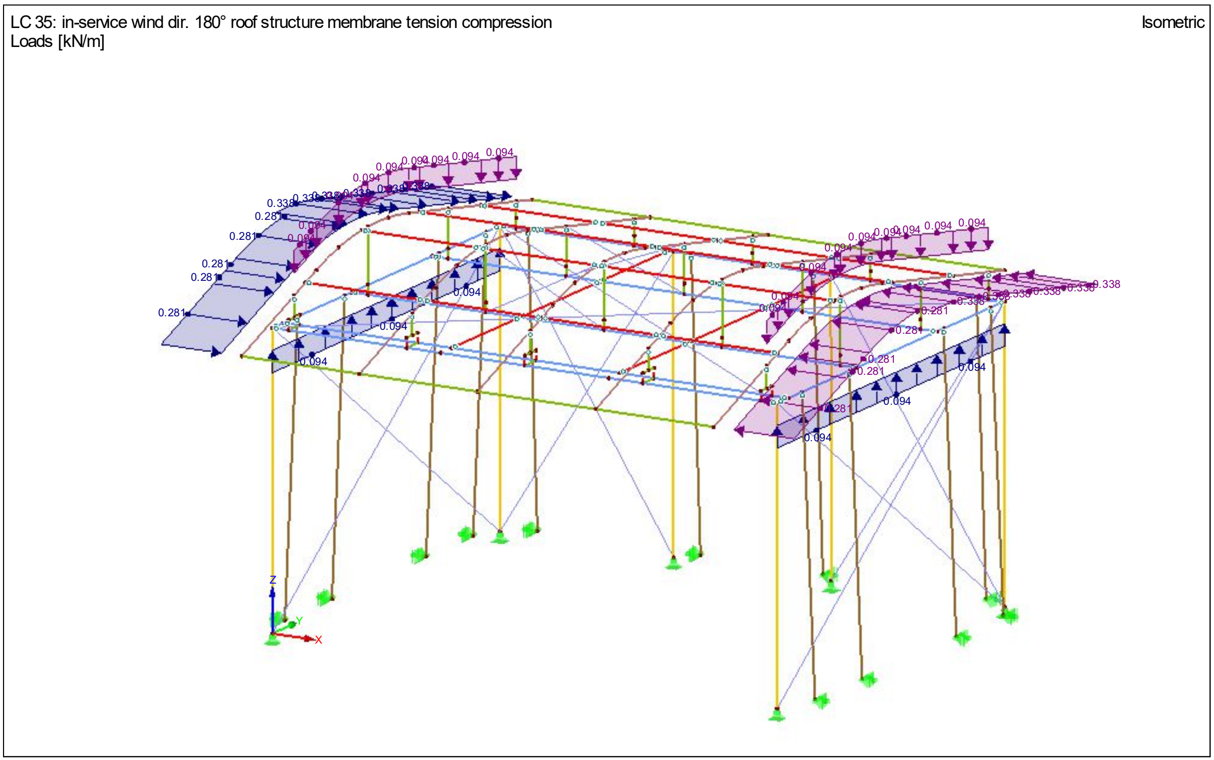
$q_{w,\text{ roof span 1, back}} = 0.6 * 0.3 * 1.5 = 0.270$ kN/m
$q_{w,\text{ roof span 2, back}} = 0.6 * 0.3 * 3 = 0.540$ kN/m
$q_{w,\text{ roof span 3, back}} = 0.6 * 0.3 * 3 = 0.540$ kN/m
$q_{w,\text{ roof span 4, back}} = 0.6 * 0.3 * 3 = 0.540$ kN/m
$q_{w,\text{ roof span 5, back}} = 0.6 * 0.3 * 1.5 = 0.270$ kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}} = 15$ m²
$Q_{w,\text{ side canopy roof structure}} = 0.3 * 0.3 * 15 = 1.35$ kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}} = 1.35 / 18 = 0.094$ kN/m

### 2.6.14 load case 35 In-service wind dir. 180° roof structure membrane tension compression.




Membrane tension calculations roof construction wind 180° compression.

The membrane tension is calculated according to the calculation  on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension  of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.281 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.281 kN/m

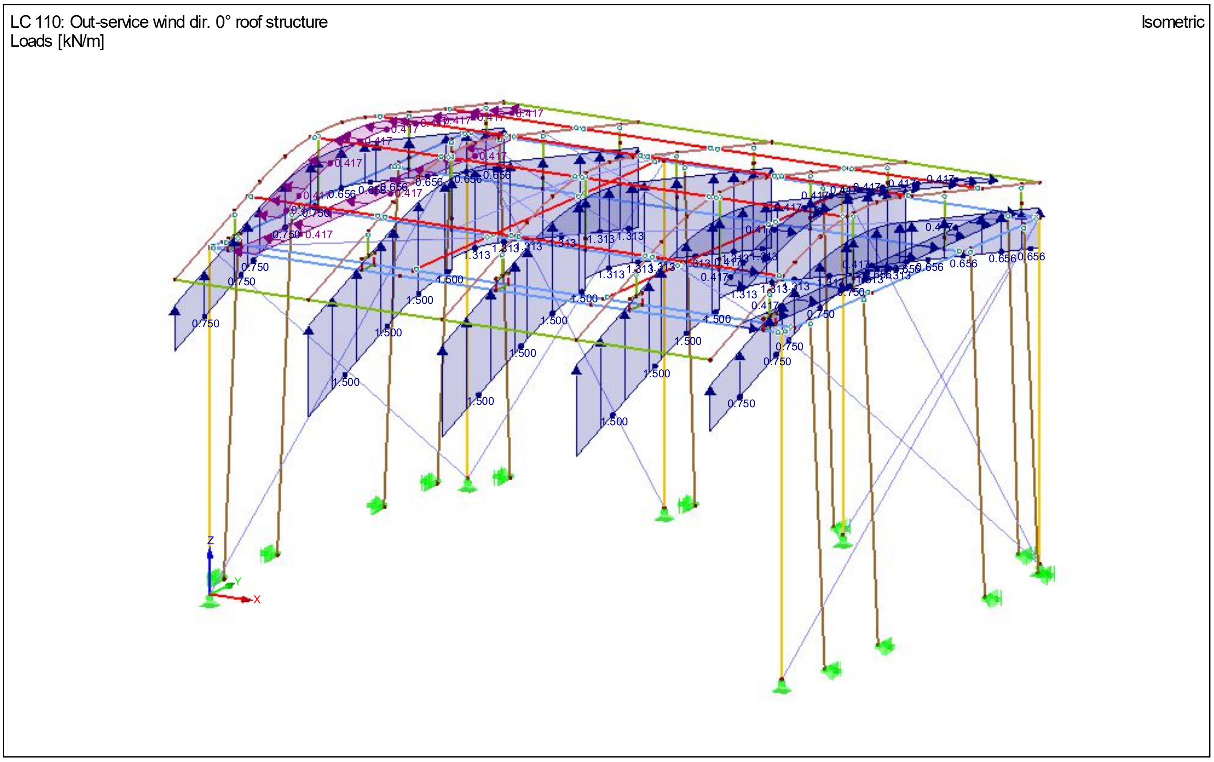
Membrane tension  of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.338 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.338 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.075 / 0.8 = 0.094 kN/m

### 2.6.15 load case 110 Out-service wind dir. 0° roof structure.




Wind calculations roof construction wind 0°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m
$q_{w,\text{ roof span 2, front}}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\text{ roof span 3, front}}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\text{ roof span 4, front}}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\text{ roof span 5, front}}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m

Main roof structure back side

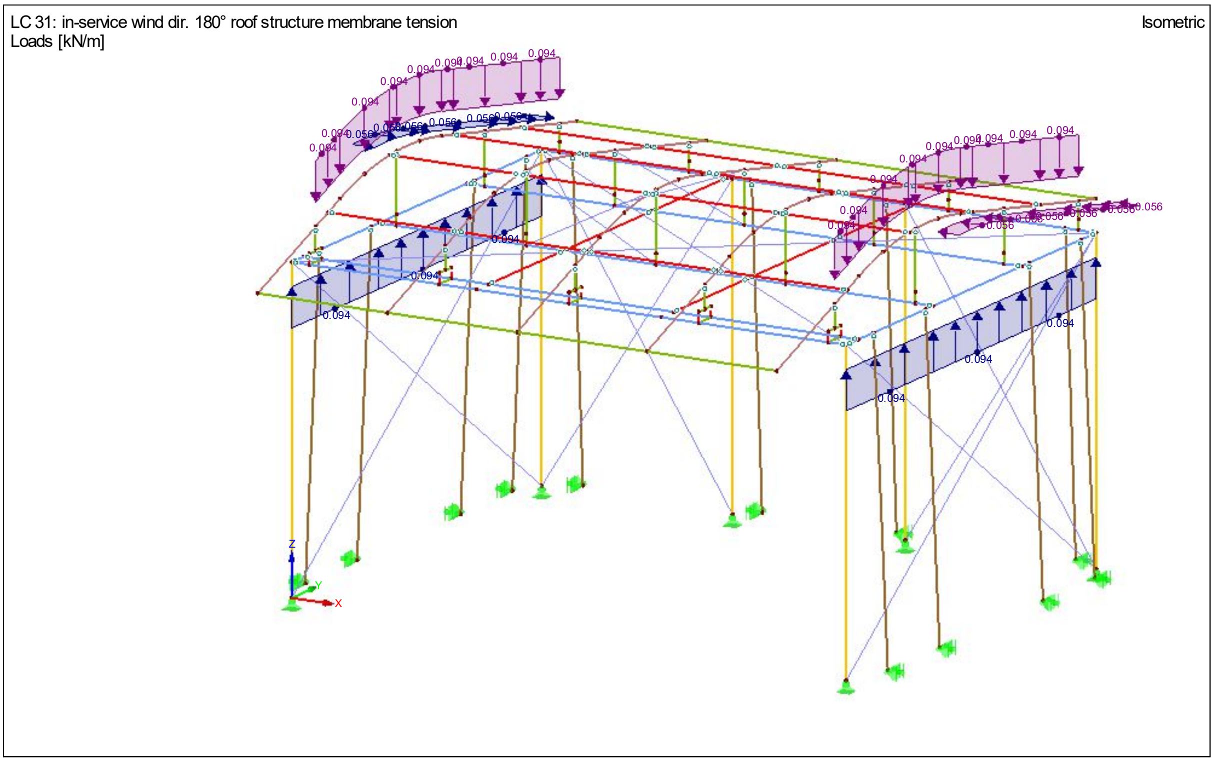
$q_{w,\text{ roof span 1, back}}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m
$q_{w,\text{ roof span 2, back}}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\text{ roof span 3, back}}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\text{ roof span 4, back}}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\text{ roof span 5, back}}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 15 m²
$Q_{w,\text{ side canopy roof structure}}$ = 0.8 * 0.625 * 15 = 7.5 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 7.5 / 18 = 0.417 kN/m

**2.6.16 load case 111 Out-service wind dir. 0° roof structure membrane tension.**




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.938 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.938 kN/m

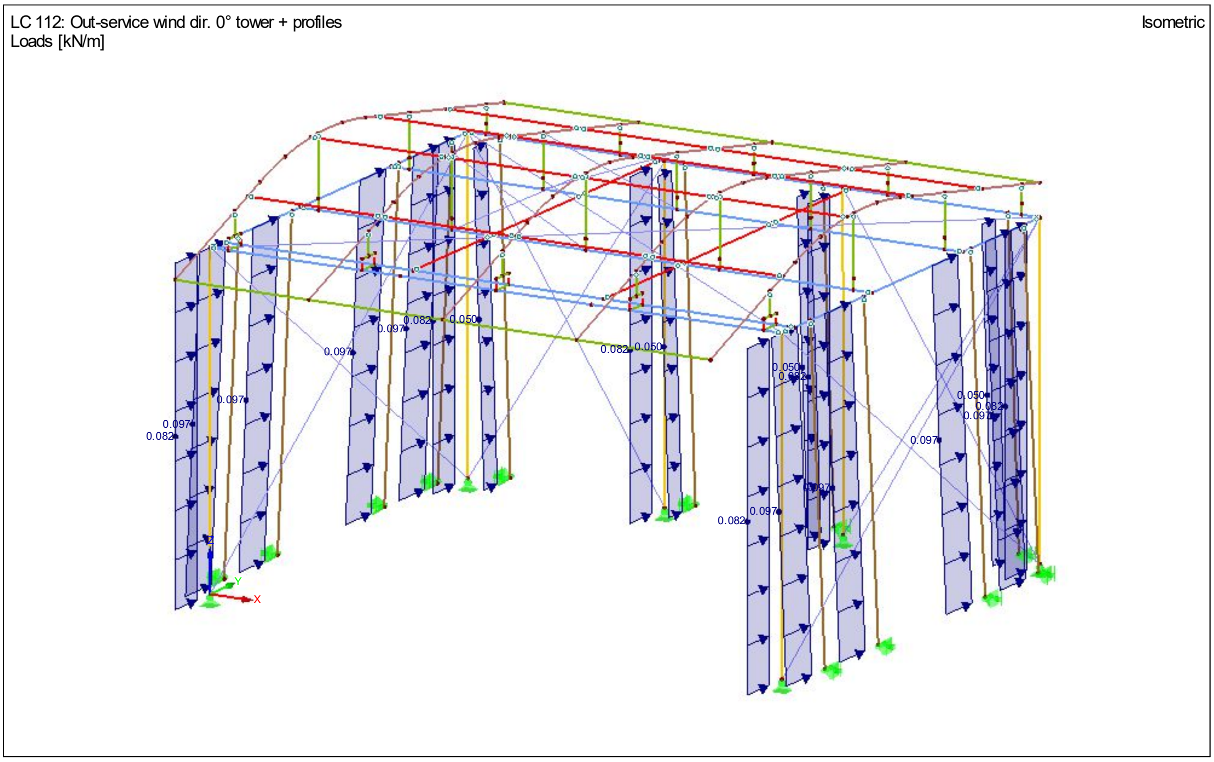
Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.820 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.820 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.417 / 0.8 = 0.521 kN/m

## 2.6.17 load case 112 Out-service wind dir. 0° towers + profiles



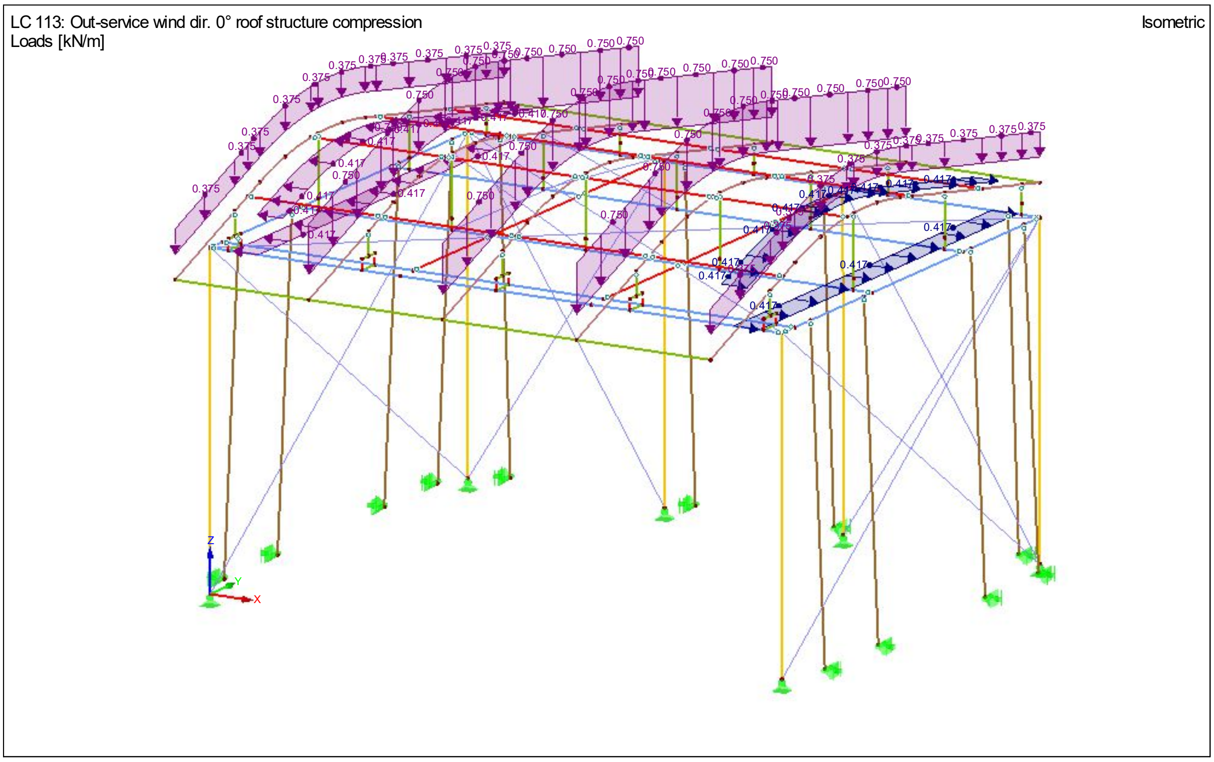

Wind on tower truss 0°

$q_{w,\ \text{tower truss}} = 1.3 * 0.4375 * ( 0.5 * 0.290 ) = 0.082$ kN/m

Wind on wall Keder profile 170x88

$q_{w,\ \text{keder profile 88mm}} = 1.3 * 0.438 * 0.088 = 0.050$ kN/m
$q_{w\ \text{keder profile 170mm}} = 1.3 * 0.438 * 0.017 = 0.097$ kN/m

## 2.6.18 load case 113 Out-service wind dir. 0° roof structure compression.




Wind calculations roof construction wind 0° compression.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m
$q_{w,\text{ roof span 2, front}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 3, front}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 4, front}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 5, front}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m

Main roof structure back side

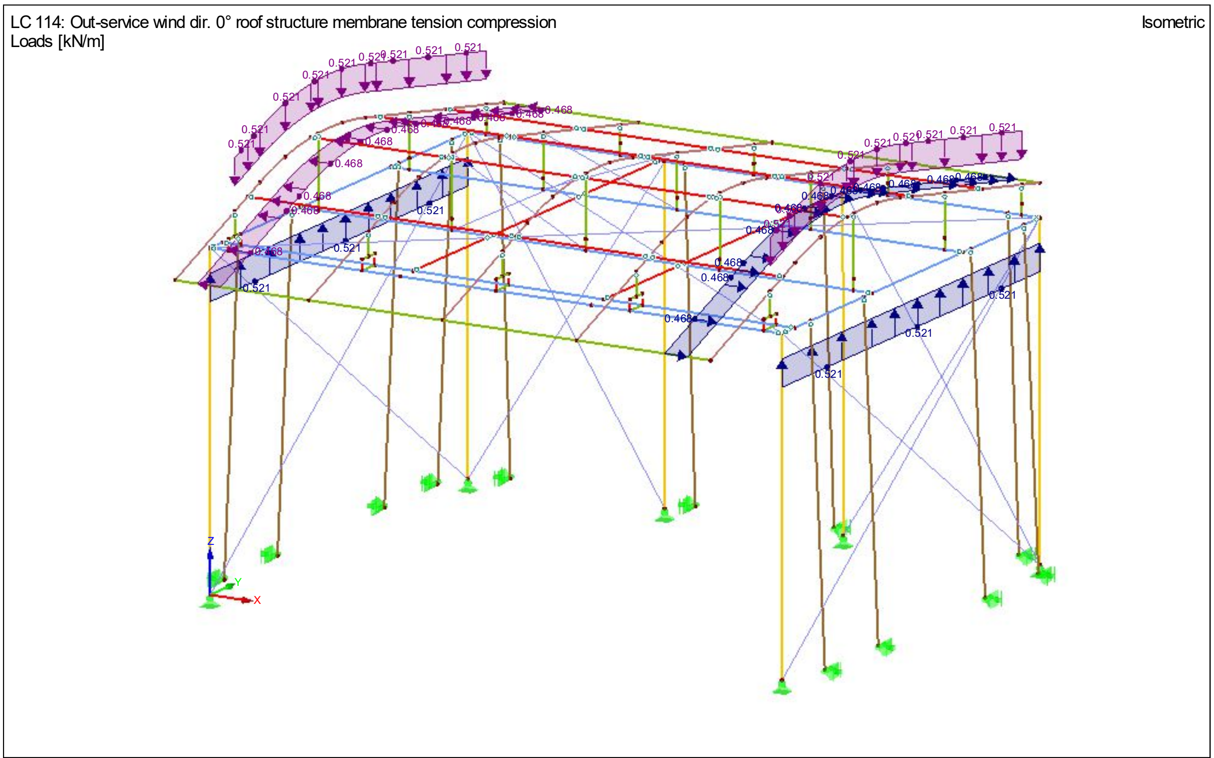
$q_{w,\text{ roof span 1, back}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m
$q_{w,\text{ roof span 2, back}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 3, back}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 4, back}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 5, back}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 15 m²
$Q_{w,\text{ side canopy roof structure}}$ = 0.8 * 0.625 * 15 = 7.5 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 7.5 / 18 = 0.417 kN/m

**2.6.19 load case 114 In-service wind dir. 0° roof structure membrane tension compression.**




Membrane tension calculations roof construction wind 180° compression.

The membrane tension is calculated according to the calculation  on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension  of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.469 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.469 kN/m

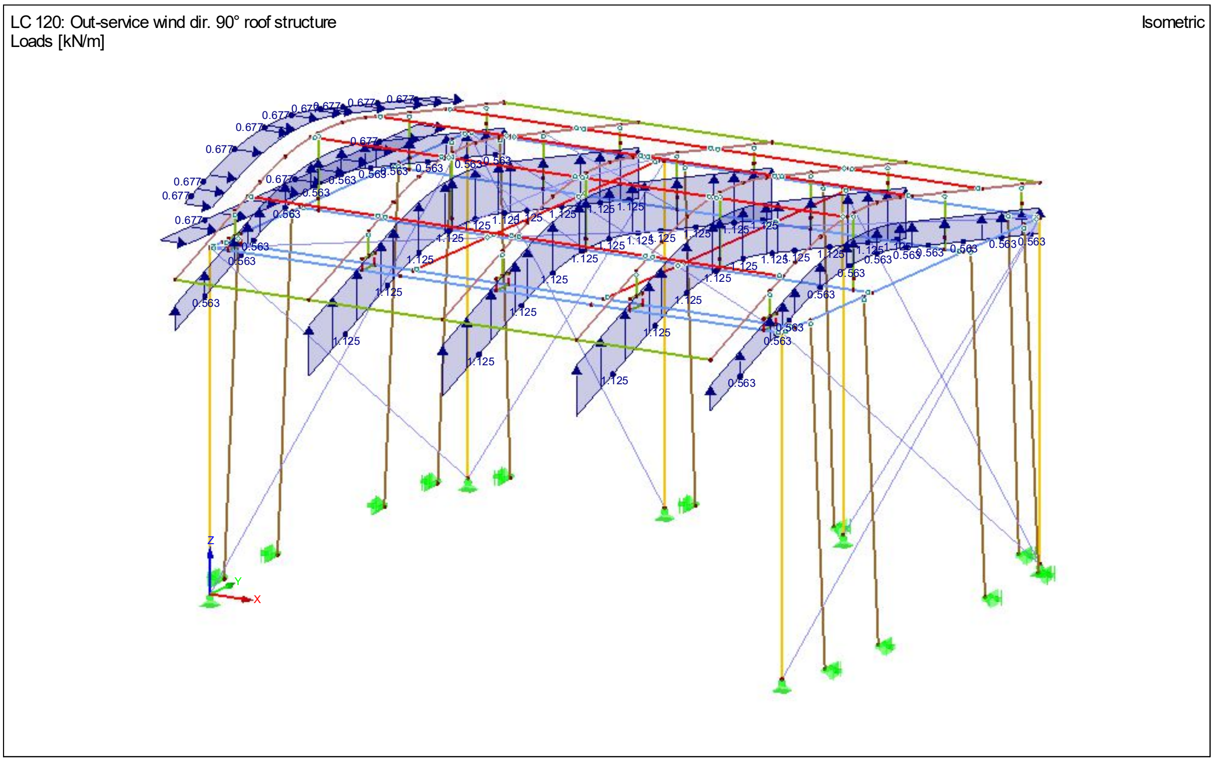
Membrane tension  of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.469 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.469 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.417 / 0.8 = 0.521 kN/m

## 2.6.20 load case 120 Out-service wind dir. 90° roof structure.




Wind calculations roof construction wind 90°.

Main roof structure front side

$q_{w,\text{ roof span 1, front}} = 0.6 * 0.625 * 1.5 = 0.563$ kN/m
$q_{w,\text{ roof span 2, front}} = 0.6 * 0.625 * 3 = 1.125$ kN/m
$q_{w,\text{ roof span 3, front}} = 0.6 * 0.625 * 3 = 1.125$ kN/m
$q_{w,\text{ roof span 4, front}} = 0.6 * 0.625 * 3 = 1.125$ kN/m
$q_{w,\text{ roof span 5, front}} = 0.6 * 0.625 * 1.5 = 0.563$ kN/m

Main roof structure back side

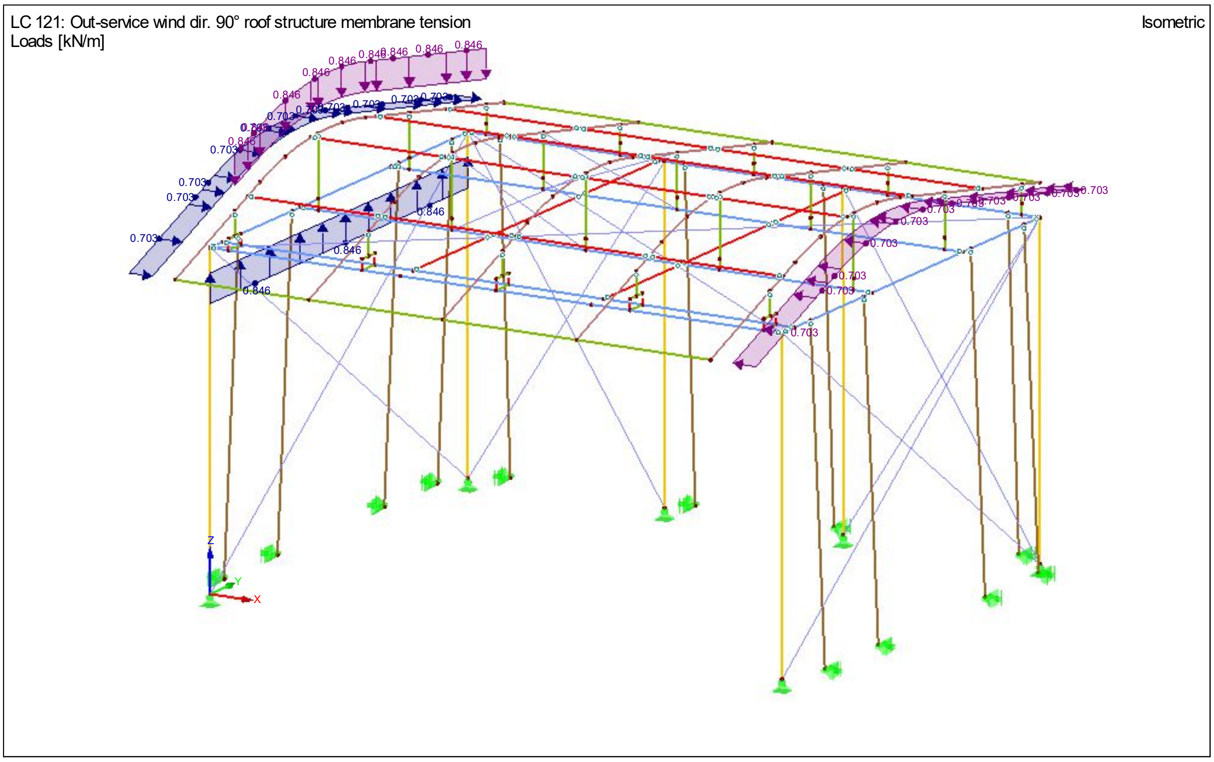
$q_{w,\text{ roof span 1, back}} = 0.6 * 0.625 * 1.5 = 0.563$ kN/m
$q_{w,\text{ roof span 2, back}} = 0.6 * 0.625 * 3 = 1.125$ kN/m
$q_{w,\text{ roof span 3, back}} = 0.6 * 0.625 * 3 = 1.125$ kN/m
$q_{w,\text{ roof span 4, back}} = 0.6 * 0.625 * 3 = 1.125$ kN/m
$q_{w,\text{ roof span 5, back}} = 0.6 * 0.625 * 1.5 = 0.563$ kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}} = 15$ m²
$Q_{w,\text{ side canopy roof structure}} = 1.3 * 0.625 * 15 = 12.188$ kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}} = 12.188 / 18 = 0.677$ kN/m

### 2.6.21 load case 121 Out-service wind dir. 90° roof structure membrane tension.




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front} = 0.703$ kN/m
$q_{mt,\ roof\ span\ 2,\ front} = 0$ kN/m
$q_{mt,\ roof\ span\ 3,\ front} = 0$ kN/m
$q_{mt,\ roof\ span\ 4,\ front} = 0$ kN/m
$q_{mt,\ roof\ span\ 5,\ front} = 0.703$ kN/m

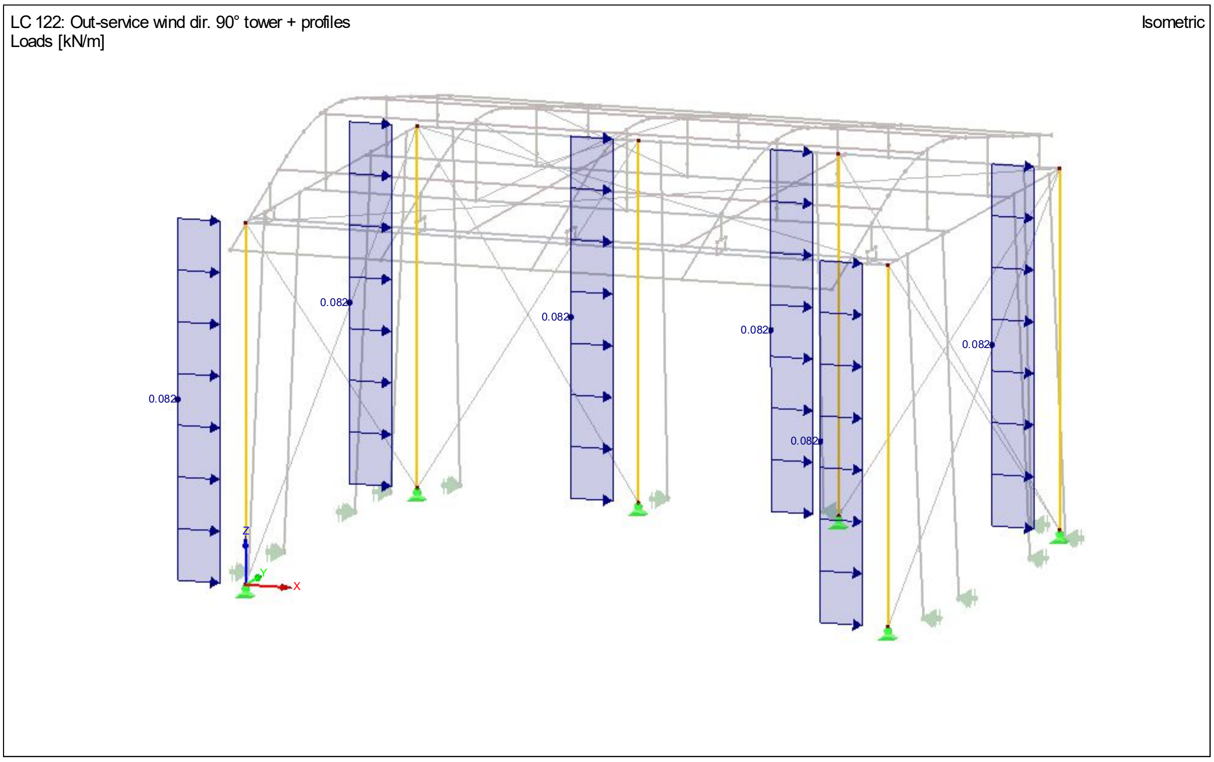
Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back} = 0.703$ kN/m
$q_{mt,\ roof\ span\ 2,\ back} = 0$ kN/m
$q_{mt,\ roof\ span\ 3,\ back} = 0$ kN/m
$q_{mt,\ roof\ span\ 4,\ back} = 0$ kN/m
$q_{mt,\ roof\ span\ 5,\ back} = 0.703$ kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure} = 0.677 / 0.8 = 0.846$ kN/m

## 2.6.22 load case 122 Out-service wind dir. 90° towers + profiles



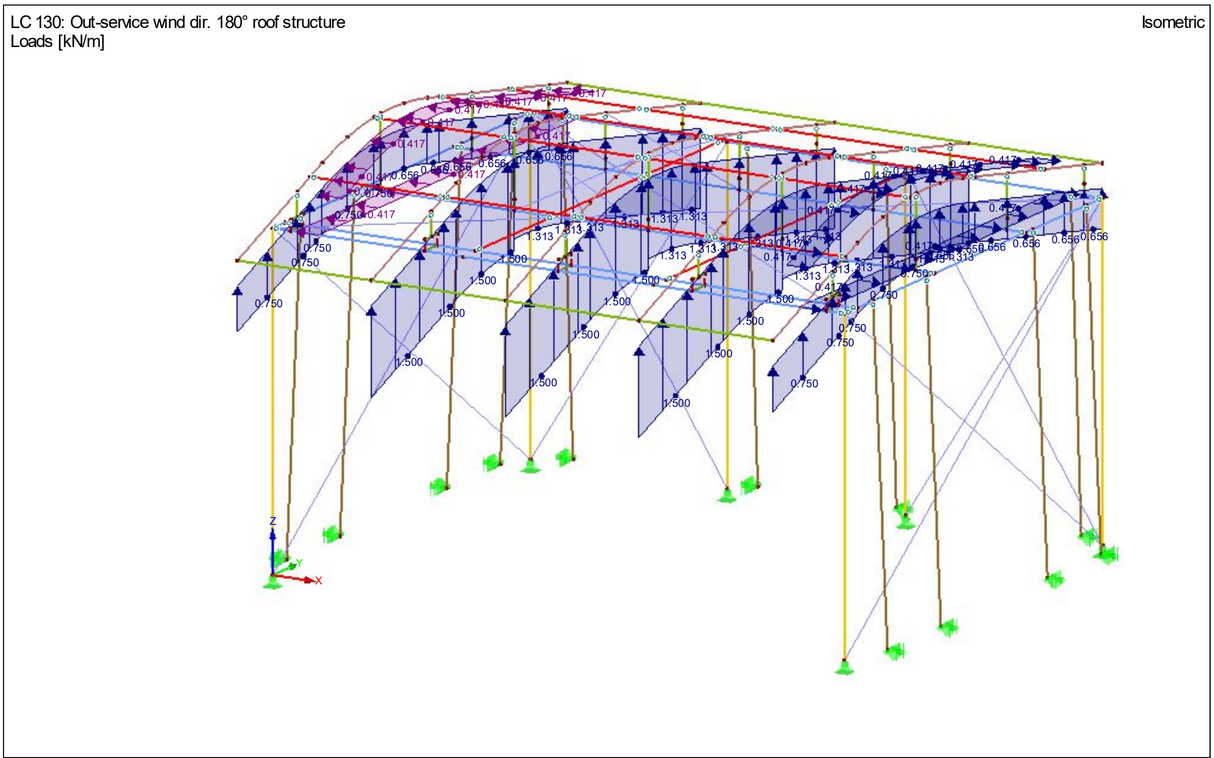

Wind on tower truss 0°

$q_{w,\ tower\ truss} = 1.3 * 0.4375 * ( 0.5 * 0.290 ) = 0.082$ kN/m

Wind on wall Keder profile 170x88

$q_{w,\ keder\ profile\ 88mm} = 1.3 * 0.438 * 0.088 = 0.050$ kN/m
$q_{w\ keder\ profile\ 170mm} = 1.3 * 0.438 * 0.017 = 0.097$ kN/m

### 2.6.23 load case 130 Out-service wind dir. 180° roof structure.




Wind calculations roof construction wind 180°.

Main roof structure front side

$q_{w,\ roof\ span\ 1,\ front}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m
$q_{w,\ roof\ span\ 2,\ front}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\ roof\ span\ 3,\ front}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\ roof\ span\ 4,\ front}$ = 0.8 * 0.625 * 3 = 1.500 kN/m
$q_{w,\ roof\ span\ 5,\ front}$ = 0.8 * 0.625 * 1.5 = 0.750 kN/m

Main roof structure back side

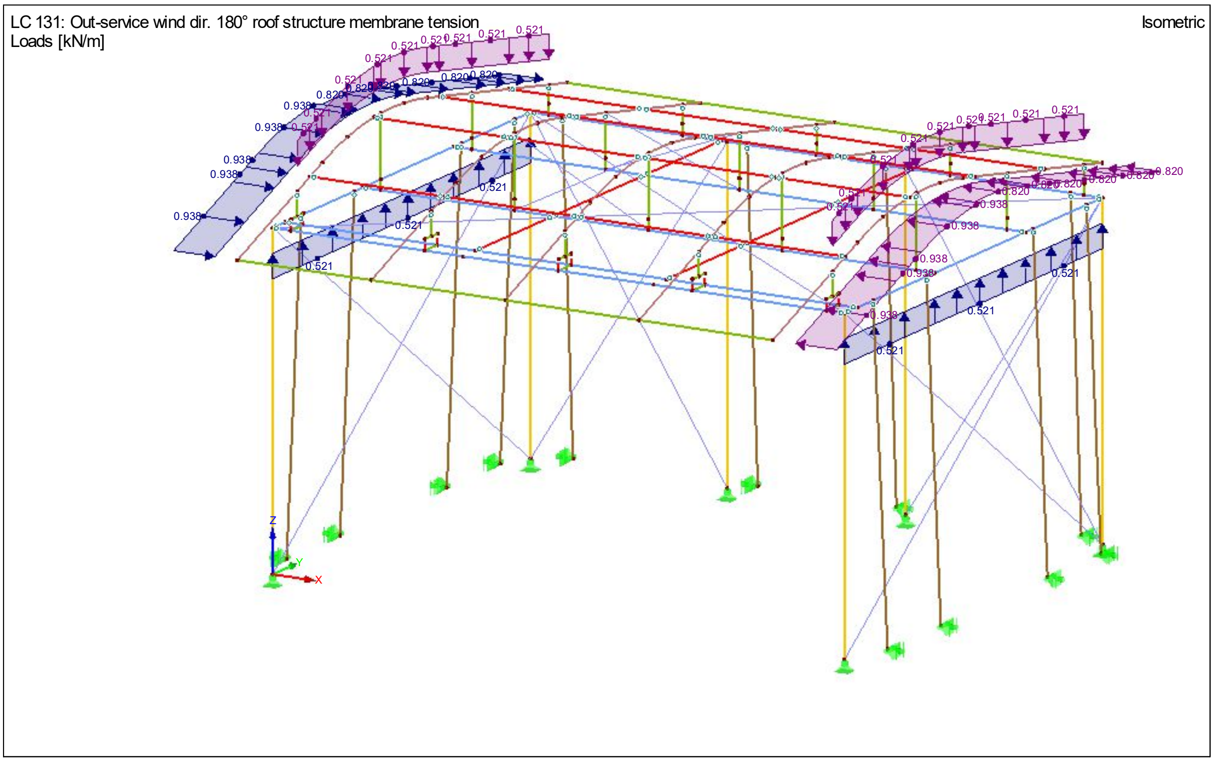
$q_{w,\ roof\ span\ 1,\ back}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m
$q_{w,\ roof\ span\ 2,\ back}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\ roof\ span\ 3,\ back}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\ roof\ span\ 4,\ back}$ = 0.7 * 0.625 * 3 = 1.312 kN/m
$q_{w,\ roof\ span\ 5,\ back}$ = 0.7 * 0.625 * 1.5 = 0.656 kN/m

Wind on side canopy of the roof construction

$A_{canopy}$ = 15 m²
$Q_{w,\ side\ canopy\ roof\ structure}$ = 0.8 * 0.625 * 15 = 7.5 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\ side\ canopy\ roof\ structure}$ = 7.5 / 18 = 0.417 kN/m

### 2.6.24 load case 131 Out-service wind dir. 180° roof structure membrane tension.




Membrane tension calculations roof construction wind 0°.

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt, \text{roof span 1, front}}$ = 0.938 kN/m
$q_{mt, \text{roof span 2, front}}$ = 0 kN/m
$q_{mt, \text{roof span 3, front}}$ = 0 kN/m
$q_{mt, \text{roof span 4, front}}$ = 0 kN/m
$q_{mt, \text{roof span 5, front}}$ = 0.938 kN/m

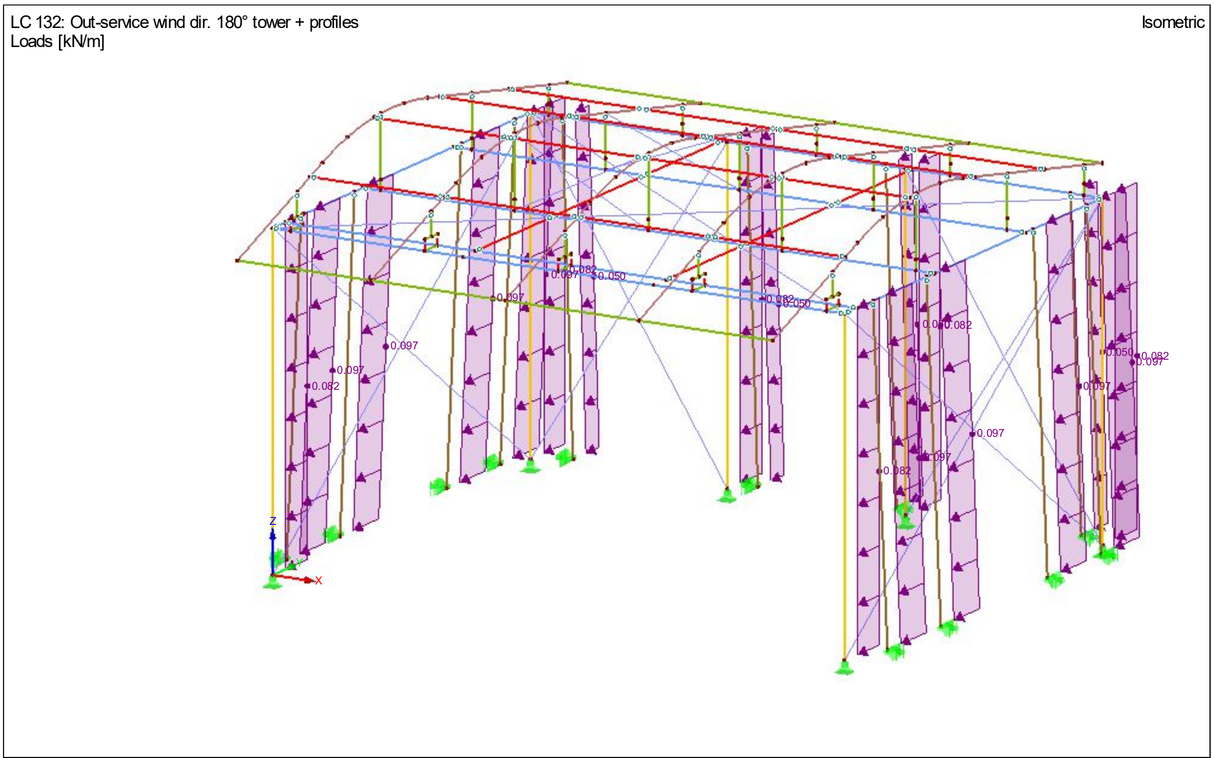
Membrane tension of roof structure back side

$q_{mt, \text{roof span 1, back}}$ = 0.820 kN/m
$q_{mt, \text{roof span 2, back}}$ = 0 kN/m
$q_{mt, \text{roof span 3, back}}$ = 0 kN/m
$q_{mt, \text{roof span 4, back}}$ = 0 kN/m
$q_{mt, \text{roof span 5, back}}$ = 0.820 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt, \text{side canopy roof structure}}$ = 0.417 / 0.8 = 0.521 kN/m

### 2.6.25 load case 132 Out-service wind dir. 180° towers + profiles



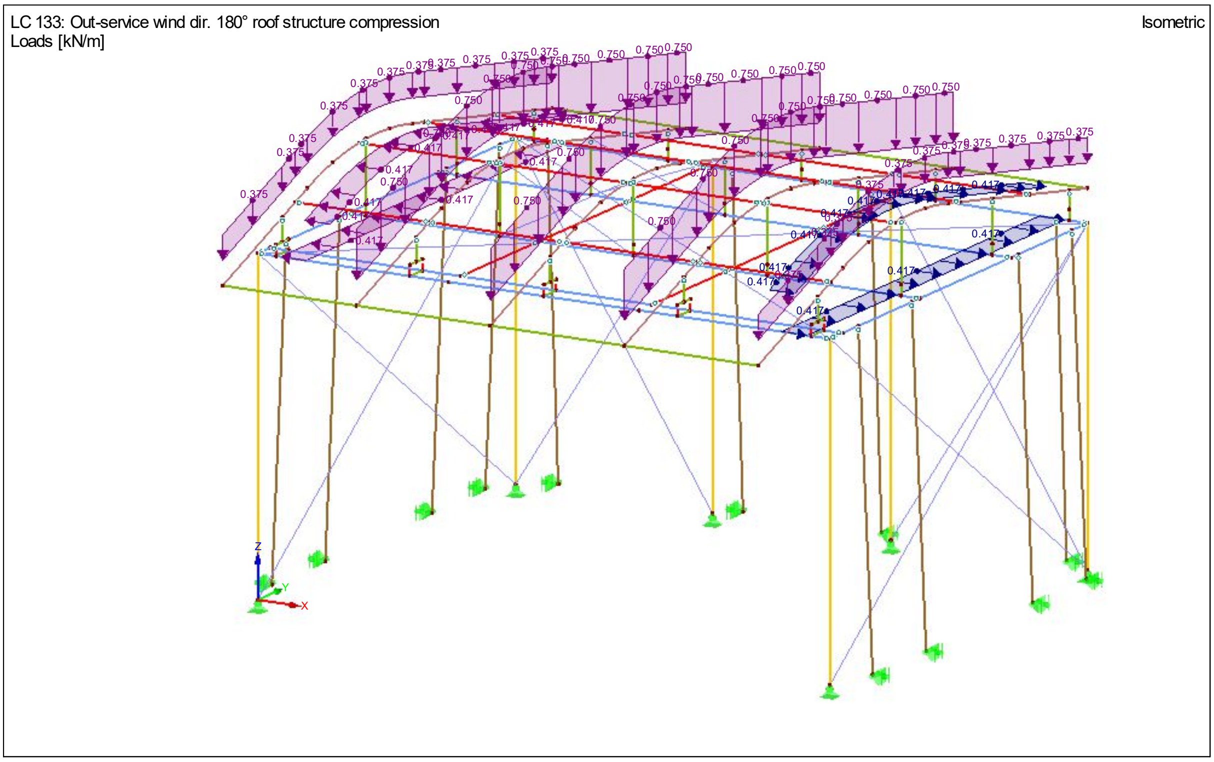

Wind on tower truss 0°

$q_{w,\ tower\ truss} = 1.3 * 0.4375 * ( 0.5 * 0.290 ) = 0.082$ kN/m

Wind on wall Keder profile 170x88

$q_{w,\ keder\ profile\ 88mm} = 1.3 * 0.438 * 0.088 = 0.050$ kN/m
$q_{w\ keder\ profile\ 170mm} = 1.3 * 0.438 * 0.017 = 0.097$ kN/m

## 2.6.26 load case 133 Out-service wind dir. 180° roof structure compression.




Wind calculations roof construction wind 180° compression.

Main roof structure front side

$q_{w,\text{ roof span 1, front}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m
$q_{w,\text{ roof span 2, front}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 3, front}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 4, front}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 5, front}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m

Main roof structure back side

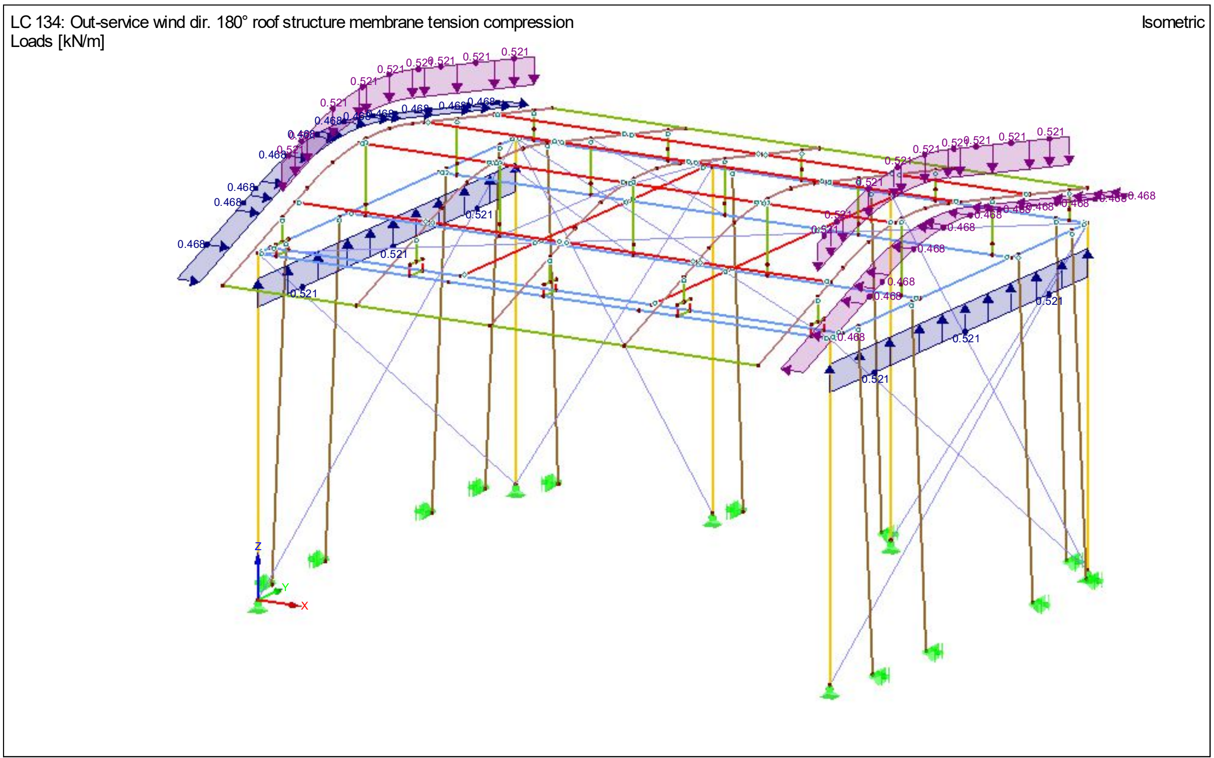
$q_{w,\text{ roof span 1, back}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m
$q_{w,\text{ roof span 2, back}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 3, back}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 4, back}}$ = 0.4 * 0.625 * 3 = 0.750 kN/m
$q_{w,\text{ roof span 5, back}}$ = 0.4 * 0.625 * 1.5 = 0.375 kN/m

Wind on side canopy of the roof construction

$A_{\text{canopy}}$ = 15 m²
$Q_{w,\text{ side canopy roof structure}}$ = 0.8 * 0.625 * 15 = 7.5 kN

The canopy is attached to the side truss and the roof kedar profile over a length of 18 Meter.
$q_{w,\text{ side canopy roof structure}}$ = 7.5 / 18 = 0.417 kN/m

### 2.6.27 load case 134 In-service wind dir. 180° roof structure membrane tension compression.




Membrane tension calculations roof construction wind 180° compression.

The membrane tension is calculated according to the calculation on page 15. The different membrane tension in each canopy sections which work in opposite directions are taken into account.

Membrane tension of roof structure front side

$q_{mt,\ roof\ span\ 1,\ front}$ = 0.469 kN/m
$q_{mt,\ roof\ span\ 2,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ front}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ front}$ = 0.469 kN/m

Membrane tension of roof structure back side

$q_{mt,\ roof\ span\ 1,\ back}$ = 0.469 kN/m
$q_{mt,\ roof\ span\ 2,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 3,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 4,\ back}$ = 0 kN/m
$q_{mt,\ roof\ span\ 5,\ back}$ = 0.469 kN/m

Membrane tension of the side canopy of the roof structure

$q_{mt,\ side\ canopy\ roof\ structure}$ = 0.417 / 0.8 = 0.521 kN/m

**2.7 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

| | |
|---|---|
| **$\gamma_G$ = 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 $\gamma_G$ 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….**

### 2.7.1 load combinations

CO1-CO4 Design calculation live load

CO50-CO53 Characteristic calculation live load

CO100-CO134 Design calculation In-service situation

CO150-CO184 Characteristic calculation In-service situation

CO200-CO229 Design calculation Out-service situation

CO250-CO279 Characteristic calculation Out-service situation

| Load Combin. | Load Combination DS | Description | To Solve |
|---|---|---|---|
| CO1 | 0 | 1.15*LC1 + 1.35*LC2 | + |
| CO2 | 0 | 1.15*LC1 + 1.35*LC3 | + |
| CO3 | 0 | 1.15*LC1 + 1.35*LC4 | + |
| CO4 | 0 | 1.15*LC1 + 1.35*LC5 | + |
| | | | |
| CO50 | 0 | LC1 + LC2 | + |
| CO51 | 0 | LC1 + LC3 | + |
| CO52 | 0 | LC1 + LC4 | + |
| CO53 | 0 | LC1 + LC5 | + |
| | | | |
| CO100 | 0 | 1.15*LC1 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO101 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO102 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO103 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO104 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13 | + |
| CO110 | 0 | 1.15*LC1 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO111 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO112 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO113 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO114 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23 | + |
| CO120 | 0 | 1.15*LC1 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO121 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO122 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO123 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO124 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33 | + |
| CO130 | 0 | 1.15*LC1 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO131 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO132 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO133 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| CO134 | 0 | 1.15*LC1 + 1.35*LC5 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35 | + |
| | | | |
| CO150 | 0 | LC1 + LC10 + LC11 + LC12 + LC13 | + |
| CO151 | 0 | LC1 + LC2 + LC10 + LC11 + LC12 + LC13 | + |
| CO152 | 0 | LC1 + LC3 + LC10 + LC11 + LC12 + LC13 | + |
| CO153 | 0 | LC1 + LC4 + LC10 + LC11 + LC12 + LC13 | + |
| CO154 | 0 | LC1 + LC5 + LC10 + LC11 + LC12 + LC13 | + |
| CO160 | 0 | LC1 + LC20 + LC21 + LC22 + LC23 | + |
| CO161 | 0 | LC1 + LC2 + LC20 + LC21 + LC22 + LC23 | + |
| CO162 | 0 | LC1 + LC3 + LC20 + LC21 + LC22 + LC23 | + |
| CO163 | 0 | LC1 + LC4 + LC20 + LC21 + LC22 + LC23 | + |
| CO164 | 0 | LC1 + LC5 + LC20 + LC21 + LC22 + LC23 | + |
| CO170 | 0 | LC1 + LC30 + LC31 + LC32 + LC33 | + |
| CO171 | 0 | LC1 + LC2 + LC30 + LC31 + LC32 + LC33 | + |
| CO172 | 0 | LC1 + LC3 + LC30 + LC31 + LC32 + LC33 | + |
| CO173 | 0 | LC1 + LC4 + LC30 + LC31 + LC32 + LC33 | + |
| CO174 | 0 | LC1 + LC5 + LC30 + LC31 + LC32 + LC33 | + |
| CO180 | 0 | LC1 + LC32 + LC33 + LC34 + LC35 | + |
| CO181 | 0 | LC1 + LC2 + LC32 + LC33 + LC34 + LC35 | + |

| | | | |
|---|---|---|---|
| CO182 | 0 | LC1 + LC3 + LC32 + LC33 + LC34 + LC35 | + |
| CO183 | 0 | LC1 + LC4 + LC32 + LC33 + LC34 + LC35 | + |
| CO184 | 0 | LC1 + LC5 + LC32 + LC33 + LC34 + LC35 | + |
| | | | |
| CO200 | 0 | 1.15*LC1 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO201 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO202 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO203 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO204 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112 | + |
| CO205 | 0 | 1.15*LC1 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO206 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO207 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO208 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO209 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114 | + |
| CO210 | 0 | 1.15*LC1 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO211 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO212 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO213 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO214 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122 | + |
| CO220 | 0 | 1.15*LC1 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO221 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO222 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO223 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO224 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132 | + |
| CO225 | 0 | 1.15*LC1 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO226 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO227 | 0 | 1.15*LC1 + 1.35*LC3 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO228 | 0 | 1.15*LC1 + 1.35*LC4 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| CO229 | 0 | 1.15*LC1 + 1.35*LC6 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134 | + |
| | | | |
| CO250 | 0 | LC1 + LC110 + LC111 + LC112 | + |
| CO251 | 0 | LC1 + LC2 + LC110 + LC111 + LC112 | + |
| CO252 | 0 | LC1 + LC3 + LC110 + LC111 + LC112 | + |
| CO253 | 0 | LC1 + LC4 + LC110 + LC111 + LC112 | + |
| CO254 | 0 | LC1 + LC6 + LC110 + LC111 + LC112 | + |
| CO255 | 0 | LC1 + LC112 + LC113 + LC114 | + |
| CO256 | 0 | LC1 + LC2 + LC112 + LC113 + LC114 | + |
| CO257 | 0 | LC1 + LC3 + LC112 + LC113 + LC114 | + |
| CO258 | 0 | LC1 + LC4 + LC112 + LC113 + LC114 | + |
| CO259 | 0 | LC1 + LC6 + LC112 + LC113 + LC114 | + |
| CO260 | 0 | LC1 + LC120 + LC121 + LC122 | + |
| CO261 | 0 | LC1 + LC2 + LC120 + LC121 + LC122 | + |
| CO262 | 0 | LC1 + LC3 + LC120 + LC121 + LC122 | + |
| CO263 | 0 | LC1 + LC4 + LC120 + LC121 + LC122 | + |
| CO264 | 0 | LC1 + LC6 + LC120 + LC121 + LC122 | + |
| CO270 | 0 | LC1 + LC130 + LC131 + LC132 | + |
| CO271 | 0 | LC1 + LC2 + LC130 + LC131 + LC132 | + |
| CO272 | 0 | LC1 + LC3 + LC130 + LC131 + LC132 | + |
| CO273 | 0 | LC1 + LC4 + LC130 + LC131 + LC132 | + |
| CO274 | 0 | LC1 + LC6 + LC130 + LC131 + LC132 | + |
| CO275 | 0 | LC1 + LC132 + LC133 + LC134 | + |
| CO276 | 0 | LC1 + LC2 + LC132 + LC133 + LC134 | + |
| CO277 | 0 | LC1 + LC3 + LC132 + LC133 + LC134 | + |
| CO278 | 0 | LC1 + LC4 + LC132 + LC133 + LC134 | + |
| CO279 | 0 | LC1 + LC6 + LC132 + LC133 + LC134 | + |

### 2.7.2 result combinations

Different Result combinations have been generated in the program.

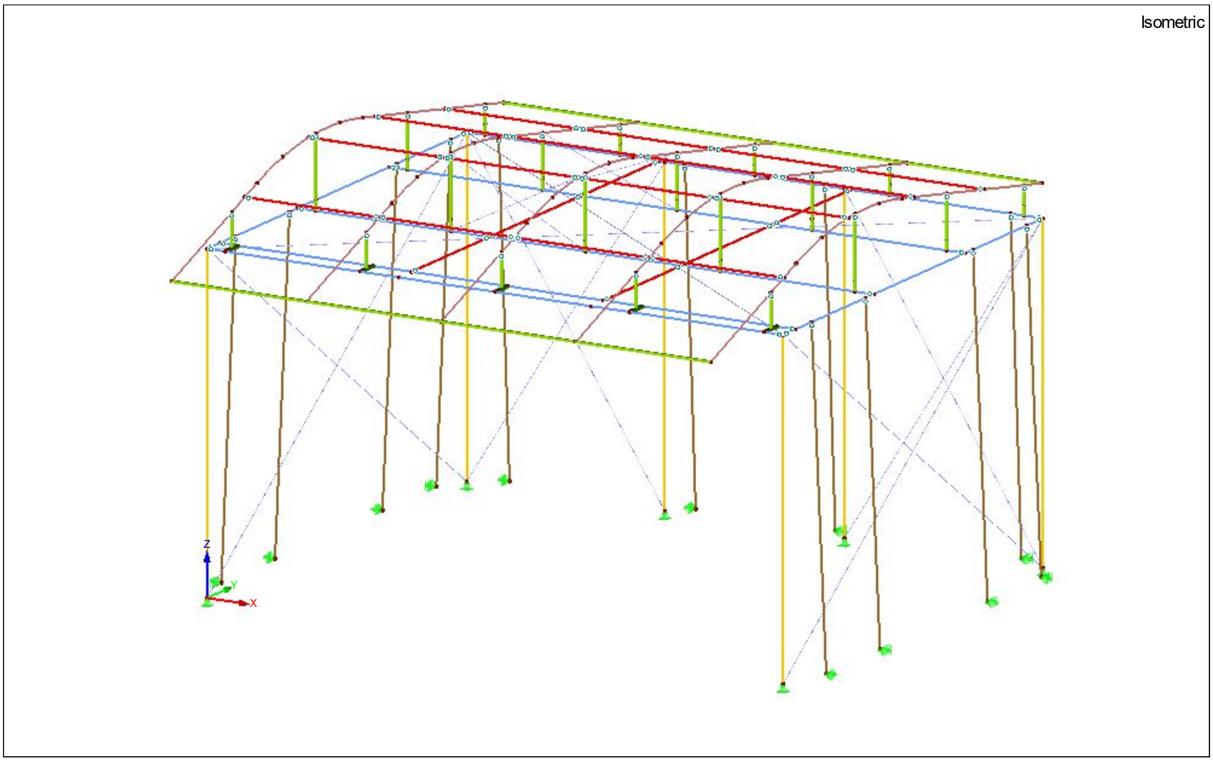
| | |
|---|---|
| RC1 – SW + Loading - Design Values | : 1 * (CO1 or to CO4) |
| RC2 – SW + Loading - Characteristic Values | : 1 * (CO50 or to CO53) |
| RC3 - SW + Loading + In service Wind - Design Values | : 1 * (CO100 or to CO134) |
| RC4 - SW + Loading + In service Wind - Characteristic Values | : 1 * (CO150 or to CO184) |
| RC5 - SW + Loading + Out service Wind - Design Values | : 1 * (CO200 or to CO129) |
| RC6 - SW + Loading + Out service Wind - Characteristic Values | : 1 * (CO250 or to CO279) |

# 3 Calculation results for different Load Cases and Load Combinations.

In this chapter the results of the different load cases and load combinations 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 input information

### 3.1.1 construction scheme




### 3.1.2 Used Materials

| Material<br>No. | Material<br>Description | Modulus of Elasticity E [kN/cm$^2$] | Shear Modulus G [kN/cm$^2$] | Poisson's Ratio ν [-] | Specific Weight γ [kN/m$^3$] | Coeff. of Th. Exp. α [1/°C] | Partial Factor $\gamma_M$ [-] | Material<br>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 |

### 3.1.3 Used cross sections

| Section | Cross-Section | Material | Moments of inertia [cm$^4$] | | | Cross-Sectional Areas [cm$^2$] | | | Principal Axes | Rotation | Overall Dimensions [mm] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Description [mm] | No. | Torsion J | Bending $I_y$ | Bending $I_z$ | Axial A | Shear $A_y$ | Shear $A_z$ | $\alpha$ [°] | $\alpha'$ [°] | Width b | Depth h |
| 1 | Prolyte H40V | 1 | 900,00 | 4179,54 | 4179,54 | 16,96 | 16,50 | 16,50 | 0,00 | 0,00 | 390,0 | 390,0 |
| 2 | Prolyte H30V | 1 | 500,00 | 2095,86 | 2095,85 | 16,96 | 16,50 | 16,50 | 0,00 | 0,00 | 290,0 | 290,0 |
| 3 | Prolyte H30D | 1 | 150,00 | 1057,29 | 1057,10 | 12,72 | 12,00 | 12,00 | 0,00 | 0,00 | 290,0 | 255,0 |
| 4 | HK 50/50/5/5/5/5 | 1 | 48,28 | 30,75 | 30,75 | 9,00 | 4,00 | 4,00 | 0,00 | 0,00 | 50,0 | 50,0 |
| 5 | Ring 50/4 | 1 | 30.81 | 15.41 | 15.41 | 5.78 | 2.93 | 2.93 | 0,00 | 0,00 | 50,0 | 50,0 |
| 6 | Circle 12 | 2 | 0,20 | 0,10 | 0,10 | 1,13 | 0,96 | 0,96 | 0,00 | 0,00 | 12,0 | 12,0 |
| 7 | RODER roder keder 170x88x3 | 1 | 100,00 | 766,50 | 230,70 | 18,98 | 18,50 | 18,50 | 0,00 | 0,00 | 170,0 | 88,0 |
| 8 | HK 50/100/6/6/6/6 | 1 | 155.83 | 63.93 | 200.87 | 16.56 | 10.64 | 3.74 | 0,00 | 0,00 | 100,0 | 50,0 |

## 3.2 Calculation result summary's

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **Summary** | | | |
| | Calculation Status | OK | | |
| | Maximum displacement in X-direction | -172,3 | mm | CO131, Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 108,5 | mm | CO104, Member No. 16, x: 3.485 m |
| | Maximum displacement in Z-direction | -214,7 | mm | CO228, Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 216,3 | mm | CO228, Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 59,7 | mrad | CO228, Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,1 | mrad | CO131, Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 16,1 | mrad | CO220, Member No. 134, x: 0.000 m |
| | Number of 1D finite elements (member elements) | 349 | | |
| | Number of 2D finite elements (surface elements) | 0 | | |
| | Number of 3D finite elements (solid elements) | 0 | | |
| | Number of FE nodes | 282 | | |
| | Number of equations | 1692 | | |
| | 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. Result for RC1 and RC2

### 3.3.1 Result for the single load cases LC1 to LC6.

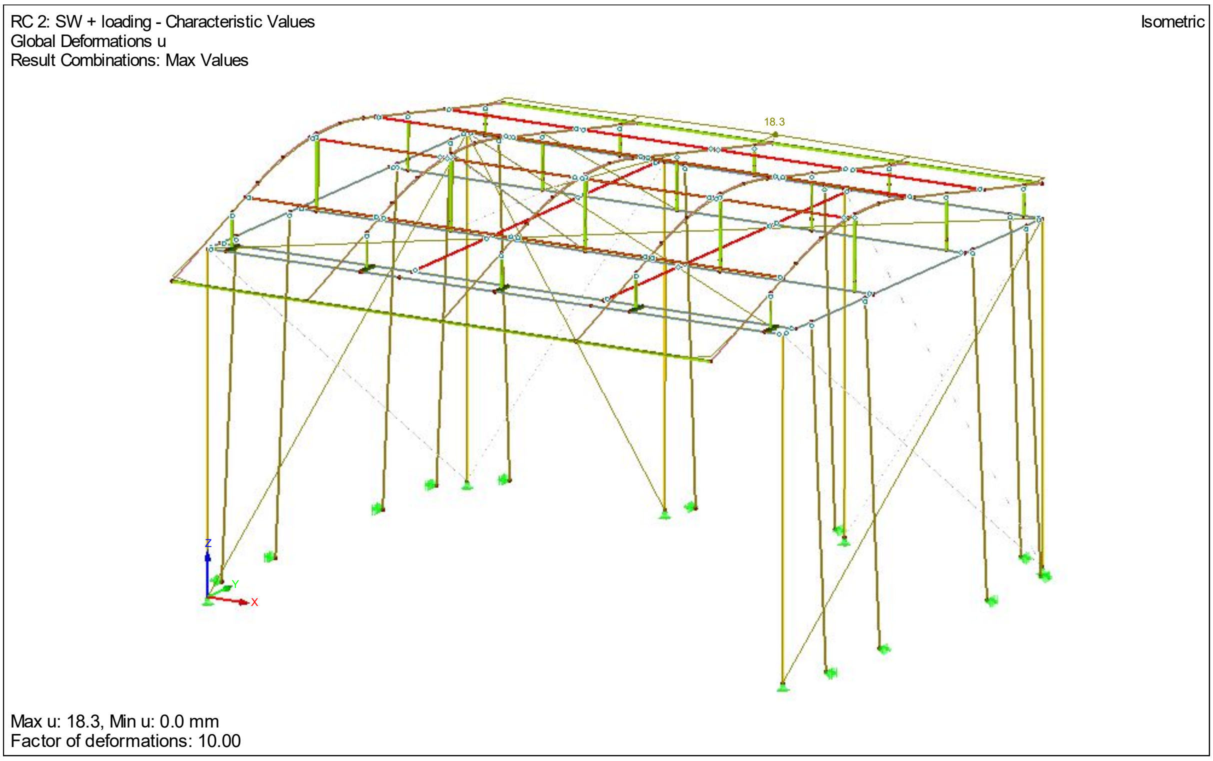
| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **LC1 - Self-weight** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -19,95 | kN | |
| | Sum of support forces in Z | -19,95 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,226 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,223 | 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 | 0,9 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -3,8 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Z-direction | -22,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 22,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -5,4 | mrad | Member No. 56, x: 0.380 m |
| | Maximum rotation about Y-axis | -6,8 | mrad | Member No. 32, x: 1.875 m |
| | Maximum rotation about Z-axis | -2,0 | mrad | Member No. 134, x: 0.000 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 | -31,64 | kN | |
| | Sum of support forces in Z | -31,64 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -23,612 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,356 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 3,4 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -9,3 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -48,9 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 49,1 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 13,4 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | 10,4 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -2,6 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC3 - Centre point loads** | | | |
| | 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 | -20,50 | kN | |
| | Sum of support forces in Z | -20,50 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -30,309 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,228 | 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 | 4,2 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | -10,8 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -42,0 | mm | Member No. 153, x: 0.680 m |
| | Maximum vectorial displacement | 42,3 | mm | Member No. 153, x: 0.680 m |
| | Maximum rotation about X-axis | 11,2 | mrad | Member No. 23, x: 0.354 m |
| | Maximum rotation about Y-axis | 8,1 | mrad | Member No. 91, x: 1.320 m |
| | Maximum rotation about Z-axis | 3,2 | mrad | Member No. 32, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC4 - point loads in the third point** | | | |
| | 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 | -37,00 | kN | |

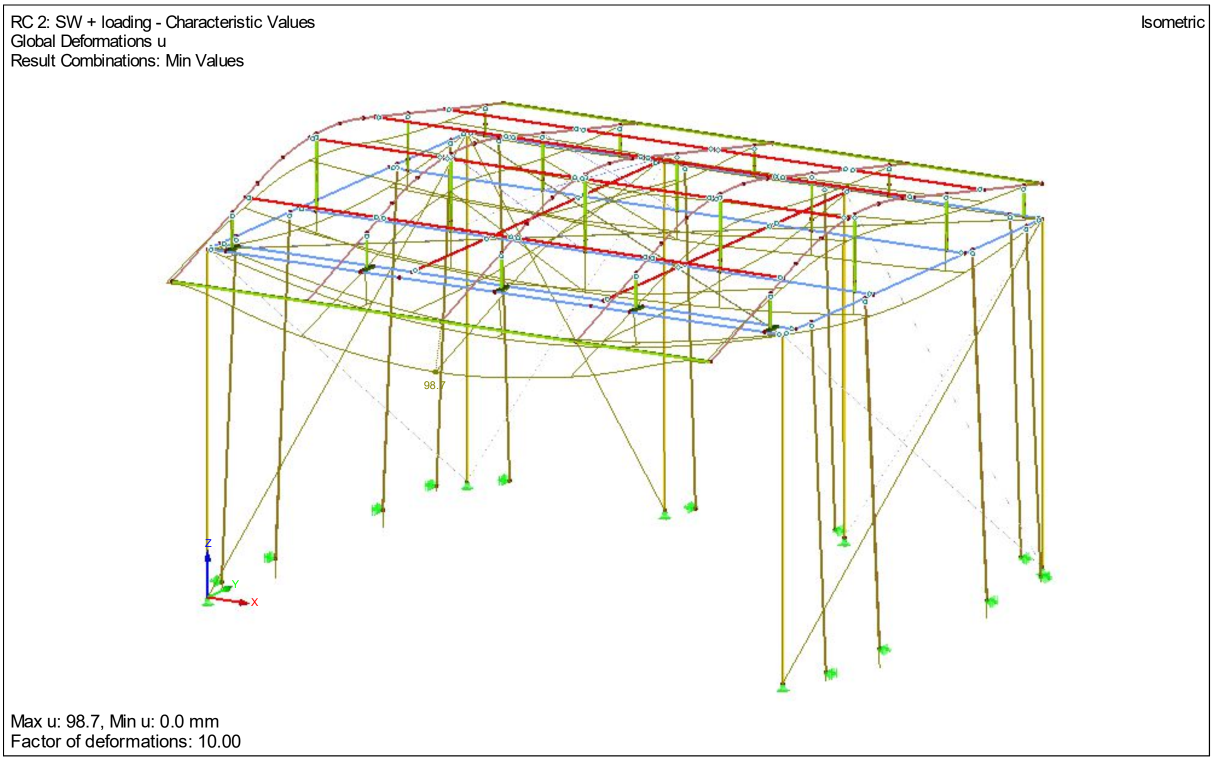
| | | | | |
|---|---|---|---|---|
| | Sum of support forces in Z | -37,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -66,551 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,416 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 4,7 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | -15,3 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -59,1 | mm | Member No. 153, x: 0.680 m |
| | Maximum vectorial displacement | 59,4 | mm | Member No. 153, x: 0.680 m |
| | Maximum rotation about X-axis | 17,0 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | 11,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | 4,2 | mrad | Member No. 32, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC5 - point loads1.25 meter from side span in service** | | | |
| | 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 | -60,00 | kN | |
| | Sum of support forces in Z | -60,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 18,952 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,669 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 3,3 | mm | Member No. 59, x: 0.660 m |
| | Maximum displacement in Y-direction | -12,0 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Z-direction | -75,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 75,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -15,1 | mrad | Member No. 56, x: 0.380 m |
| | Maximum rotation about Y-axis | -22,9 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -6,0 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC6 - point loads1.25 meter from side span out service** | | | |
| | 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 | -44,00 | kN | |
| | Sum of support forces in Z | -44,00 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -64,943 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,490 | 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. 10, x: 4.642 m |
| | Maximum displacement in Y-direction | -12,4 | mm | Member No. 35, x: 2.625 m |
| | Maximum displacement in Z-direction | -42,8 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 42,9 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 13,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | 7,4 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -1,6 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |

## 3.3.2 Calculation results Load combinations 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 | -65,65 | kN | |
| | Sum of support forces in Z | -65,65 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 5,5 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -14,8 | mm | Member No. 32, x: 0.750 m |
| | Maximum displacement in Z-direction | -88,7 | mm | Member No. 222, x: 2.136 m |
| | Maximum vectorial displacement | 89,1 | mm | Member No. 168, x: 0.273 m |
| | Maximum rotation about X-axis | 23,8 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -21,1 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -5,8 | mrad | Member No. 134, 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 + 1.35*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 | -50,62 | kN | |
| | Sum of support forces in Z | -50,62 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 6,5 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | -15,2 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -79,0 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 79,4 | mm | Member No. 153, x: 0.453 m |
| | Maximum rotation about X-axis | 20,9 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | 15,7 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | -4,4 | mrad | Member No. 134, 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 + 1.35*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 | -72,89 | kN | |
| | Sum of support forces in Z | -72,89 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 7,2 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | -21,3 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -102,1 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 102,6 | mm | Member No. 153, x: 0.453 m |
| | Maximum rotation about X-axis | 28,7 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | 20,0 | mrad | Member No. 5, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,4 | mrad | Member No. 32, x: 1.500 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 | -103,94 | kN | |
| | Sum of support forces in Z | -103,94 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 4,9 | mm | Member No. 59, x: 0.660 m |
| | Maximum displacement in Y-direction | -20,6 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Z-direction | -126,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 127,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -26,7 | mrad | Member No. 56, x: 0.380 m |
| | Maximum rotation about Y-axis | -38,6 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -10,4 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

### 3.3.3 Deformation RC2 – SW + Loading setup - Characteristic Values



## 3.4 Result for RC3 and RC4

### 3.4.1 Result for the single load cases LC10 to LC35.

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **LC10 - in-service wind dir.0° roof structure** | | | |
| | 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 | 62,03 | kN | |
| | Sum of support forces in Z | 62,03 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -61,285 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,699 | 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 | -9,3 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | 15,6 | mm | Member No. 32, x: 0.750 m |
| | Maximum displacement in Z-direction | 125,5 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 126,3 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | -35,6 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 33,4 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 9,1 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC11 - in-service wind dir. 0° roof structure membrane tension** | | | |
| | 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 | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -0,44 | kN | |
| | Sum of support forces in Z | -0,44 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,585 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,013 | 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 | -0,8 | mm | Member No. 15, x: 1.232 m |
| | Maximum displacement in Y-direction | -1,0 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -2,8 | mm | Member No. 153, x: 1.133 m |
| | Maximum vectorial displacement | 2,9 | mm | Member No. 153, x: 1.133 m |
| | Maximum rotation about X-axis | 0,9 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 1,4 | mrad | Member No. 89, x: 0.906 m |
| | Maximum rotation about Z-axis | -0,8 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC12 - in-service wind dir. 0° back and side wall** | | | |
| | 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 | 20,66 | kN | |
| | Sum of support forces in Y | 20,66 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 44,811 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,015 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,235 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 57,3 | mm | Member No. 130, x: 3.485 m |
| | Maximum displacement in Y-direction | 61,8 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | 2,8 | mm | Member No. 204, x: 3.486 m |
| | Maximum vectorial displacement | 61,9 | mm | Member No. 204, x: 3.486 m |
| | Maximum rotation about X-axis | -27,0 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | 26,2 | mrad | Member No. 130, x: 0.000 m |
| | Maximum rotation about Z-axis | -3,7 | mrad | Member No. 31, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC13 - in-service wind dir. 0° back and side wall membrane tension** | | | |
| | 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 | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | -0,009 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 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 | -128,4 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -78,9 | mm | Member No. 202, x: 3.485 m |
| | Maximum displacement in Z-direction | 0,0 | mm | Member No. 124, x: 2.654 m |
| | Maximum vectorial displacement | 128,4 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,2 | mrad | Member No. 202, x: 0.000 m |
| | Maximum rotation about Y-axis | -59,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,5 | mrad | Member No. 203, x: 5.810 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC20 - in-service wind dir. 90° roof structure** | | | |
| | Sum of loads in X | 6,08 | kN | |
| | Sum of support forces in X | 6,08 | 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 | 4,73 | kN | |
| | Sum of support forces in Z | 4,73 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -5,818 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 11,604 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 1,905 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 14,4 | mm | Member No. 91, x: 0.660 m |
| | Maximum displacement in Y-direction | -3,0 | mm | Member No. 28, x: 0.000 m |
| | Maximum displacement in Z-direction | 10,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 16,5 | mm | Member No. 26, x: 1.796 m |
| | Maximum rotation about X-axis | -2,5 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 3,4 | mrad | Member No. 129, x: 1.360 m |
| | Maximum rotation about Z-axis | 2,7 | mrad | Member No. 6, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC21 - in-service wind dir. 90° roof structure membrane tension** | | | |
| | 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 | -0,17 | kN | |
| | Sum of support forces in Z | -0,17 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 0,618 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,492 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 0,2 | mm | Member No. 59, x: 0.495 m |
| | Maximum displacement in Y-direction | -0,4 | mm | Member No. 35, x: 2.250 m |
| | Maximum displacement in Z-direction | -1,2 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 1,2 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | -0,4 | mrad | Member No. 196, x: 0.000 m |
| | Maximum rotation about Y-axis | 0,7 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,1 | mrad | Member No. 32, x: 1.875 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC22 - in-service wind dir. 90° back and side wall** | | | |
| | Sum of loads in X | 15,01 | kN | |
| | Sum of support forces in X | 15,01 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 4,76 | kN | |
| | Sum of support forces in Y | 4,76 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 10,314 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -32,584 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 3,598 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 54,9 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | 14,6 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -2,2 | mm | Member No. 18, x: 3.485 m |
| | Maximum vectorial displacement | 54,9 | mm | Member No. 16, x: 3.485 m |
| | Maximum rotation about X-axis | -6,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | 23,7 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 3,5 | mrad | Member No. 1, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC23 - in-service wind dir. 90° back and side wall membrane tension** | | | |
| | 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 | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 0,000 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 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 | -29,6 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 64,2 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | 0,0 | mm | Member No. 102, x: 2.654 m |
| | Maximum vectorial displacement | 64,2 | mm | Member No. 17, x: 3.485 m |
| | Maximum rotation about X-axis | -29,5 | mrad | Member No. 17, x: 0.000 m |
| | Maximum rotation about Y-axis | -13,6 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -1,4 | mrad | Member No. 17, x: 5.809 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC30 - in-service wind dir. 180° roof structure** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | 2,63 | kN | |
| | Sum of support forces in Z | 2,63 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 4,267 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,030 | 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 | -0,4 | mm | Member No. 129, x: 0.907 m |
| | Maximum displacement in Y-direction | 2,4 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | 6,3 | mm | Member No. 153, x: 1.813 m |
| | Maximum vectorial displacement | 6,4 | mm | Member No. 153, x: 1.813 m |
| | Maximum rotation about X-axis | -2,2 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | -0,9 | mrad | Member No. 3, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,5 | mrad | Member No. 32, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC31 - in-service wind dir. 180° roof structure membrane tension** | | | |
| | 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 | -0,08 | kN | |
| | Sum of support forces in Z | -0,08 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 0,298 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 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 | 0,1 | mm | Member No. 129, x: 0.907 m |
| | Maximum displacement in Y-direction | -0,2 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -0,6 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 0,6 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 0,2 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 0,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,0 | mrad | Member No. 32, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC32 - in-service wind dir. 180° back and side wall** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -20,67 | kN | |
| | Sum of support forces in Y | -20,67 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | -44,814 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,233 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 10,7 | mm | Member No. 201, x: 3.485 m |
| | Maximum displacement in Y-direction | -61,6 | mm | Member No. 206, x: 3.486 m |
| | Maximum displacement in Z-direction | -2,8 | mm | Member No. 204, x: 3.486 m |
| | Maximum vectorial displacement | 61,7 | mm | Member No. 206, x: 3.486 m |
| | Maximum rotation about X-axis | 27,0 | mrad | Member No. 206, x: 0.000 m |
| | Maximum rotation about Y-axis | 4,9 | mrad | Member No. 16, x: 6.971 m |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Z-axis | 3,5 | mrad | Member No. 31, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC33 - in-service wind dir. 180° back and side wall membrane tension** | | | |
| | 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 | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 0,000 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 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 | 128,4 | mm | Member No. 205, x: 3.486 m |
| | Maximum displacement in Y-direction | 14,9 | mm | Member No. 130, x: 3.485 m |
| | Maximum displacement in Z-direction | 0,0 | mm | Member No. 30, x: 0.000 m |
| | Maximum vectorial displacement | 128,4 | mm | Member No. 205, x: 3.486 m |
| | Maximum rotation about X-axis | -6,8 | mrad | Member No. 130, x: 0.000 m |
| | Maximum rotation about Y-axis | -59,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -3,6 | mrad | Member No. 205, x: 5.810 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC34 - in-service wind dir. 180° roof structure compression** | | | |
| | 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 | -26,28 | kN | |
| | Sum of support forces in Z | -26,28 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 24,824 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,296 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,000 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 3,9 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | 7,0 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -53,3 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 53,6 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 15,2 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -13,9 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -3,8 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC35 - in-service wind dir. 180° roof structure membrane tension compression** | | | |
| | 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 | -0,08 | kN | |
| | Sum of support forces in Z | -0,08 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 0,298 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 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 | -0,3 | mm | Member No. 134, x: 1.540 m |
| | Maximum displacement in Y-direction | -0,2 | mm | Member No. 35, x: 1.125 m |
| | Maximum displacement in Z-direction | -0,6 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 0,6 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 0,2 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 0,4 | mrad | Member No. 58, x: 0.730 m |
| | Maximum rotation about Z-axis | -0,3 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |

## 3.4.2 Calculation results Load Combination CO100-CO134

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **CO100 - 1.15*LC1 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,88 | kN | |
| | Sum of support forces in Y | 27,88 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 60,20 | kN | |
| | Sum of support forces in Z | 60,20 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,7 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 108,1 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Z-direction | 137,1 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 177,4 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | -49,2 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -8,5 | mrad | Member No. 32, x: 1.500 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*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,88 | kN | |
| | Sum of support forces in Y | 27,88 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 17,49 | kN | |
| | Sum of support forces in Z | 17,49 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,7 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 108,3 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Z-direction | 90,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 177,6 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | -49,3 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -5,9 | mrad | Member No. 32, x: 1.500 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*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,88 | kN | |
| | Sum of support forces in Y | 27,88 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 32,53 | kN | |
| | Sum of support forces in Z | 32,53 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,7 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 108,1 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Z-direction | 109,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 177,5 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | -49,3 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 6,2 | mrad | Member No. 134, 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*LC10 + 1.35*LC11 + 1.35*LC12 + 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 | 27,88 | kN | |
| | Sum of support forces in Y | 27,88 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 10,25 | kN | |
| | Sum of support forces in Z | 10,25 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,7 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 108,2 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Z-direction | 100,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 177,6 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | -49,3 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 5,5 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

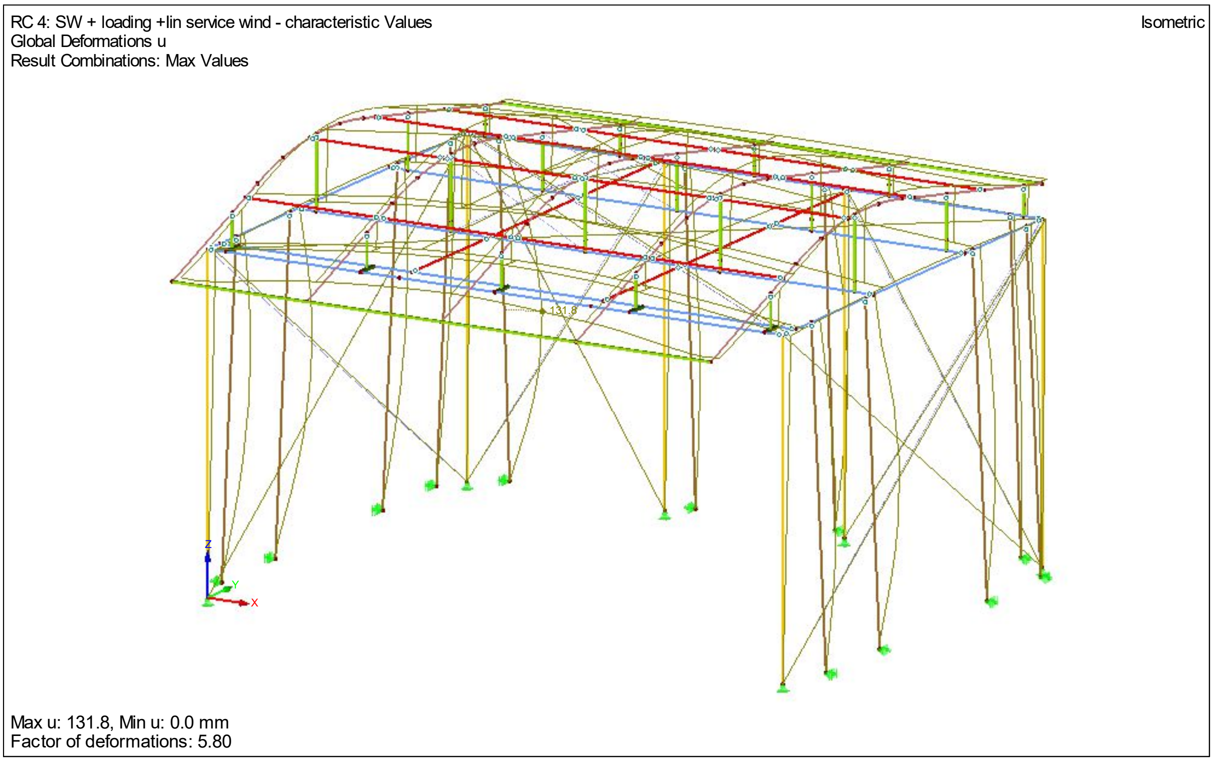
| | | | | |
|---|---|---|---|---|
| | **CO104 - 1.15*LC1 + 1.35*LC5 + 1.35*LC10 + 1.35*LC11 + 1.35*LC12 + 1.35*LC13** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 27,88 | kN | |
| | Sum of support forces in Y | 27,88 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -20,80 | kN | |
| | Sum of support forces in Z | -20,80 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,6 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | 108,5 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Z-direction | 61,5 | mm | Member No. 153, x: 1.587 m |
| | Maximum vectorial displacement | 177,6 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | -49,4 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -10,0 | mrad | Member No. 32, x: 1.500 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| | Sum of loads in X | 28,48 | kN | |
| | Sum of support forces in X | 28,48 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 6,42 | kN | |
| | Sum of support forces in Y | 6,42 | 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 | 83,8 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -88,4 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | -13,3 | mm | Member No. 26, x: 1.283 m |
| | Maximum vectorial displacement | 119,0 | mm | Member No. 18, x: 3.485 m |
| | Maximum rotation about X-axis | 40,2 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | 34,8 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 10,2 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| | Sum of loads in X | 28,48 | kN | |
| | Sum of support forces in X | 28,48 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 6,42 | kN | |
| | Sum of support forces in Y | 6,42 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -59,50 | kN | |
| | Sum of support forces in Z | -59,50 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 84,1 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -88,4 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | -79,8 | mm | Member No. 222, x: 2.136 m |
| | Maximum vectorial displacement | 122,0 | mm | Member No. 16, x: 3.485 m |
| | Maximum rotation about X-axis | 40,2 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | 34,9 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 10,6 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| | Sum of loads in X | 28,48 | kN | |
| | Sum of support forces in X | 28,48 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 6,42 | kN | |
| | Sum of support forces in Y | 6,42 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -44,46 | kN | |
| | Sum of support forces in Z | -44,46 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 83,8 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -88,4 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | -69,9 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 120,0 | mm | Member No. 18, x: 3.485 m |
| | Maximum rotation about X-axis | 40,2 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | 34,8 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 10,2 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| | Sum of loads in X | 28,48 | kN | |
| | Sum of support forces in X | 28,48 | kN | Deviation: 0.00 % |

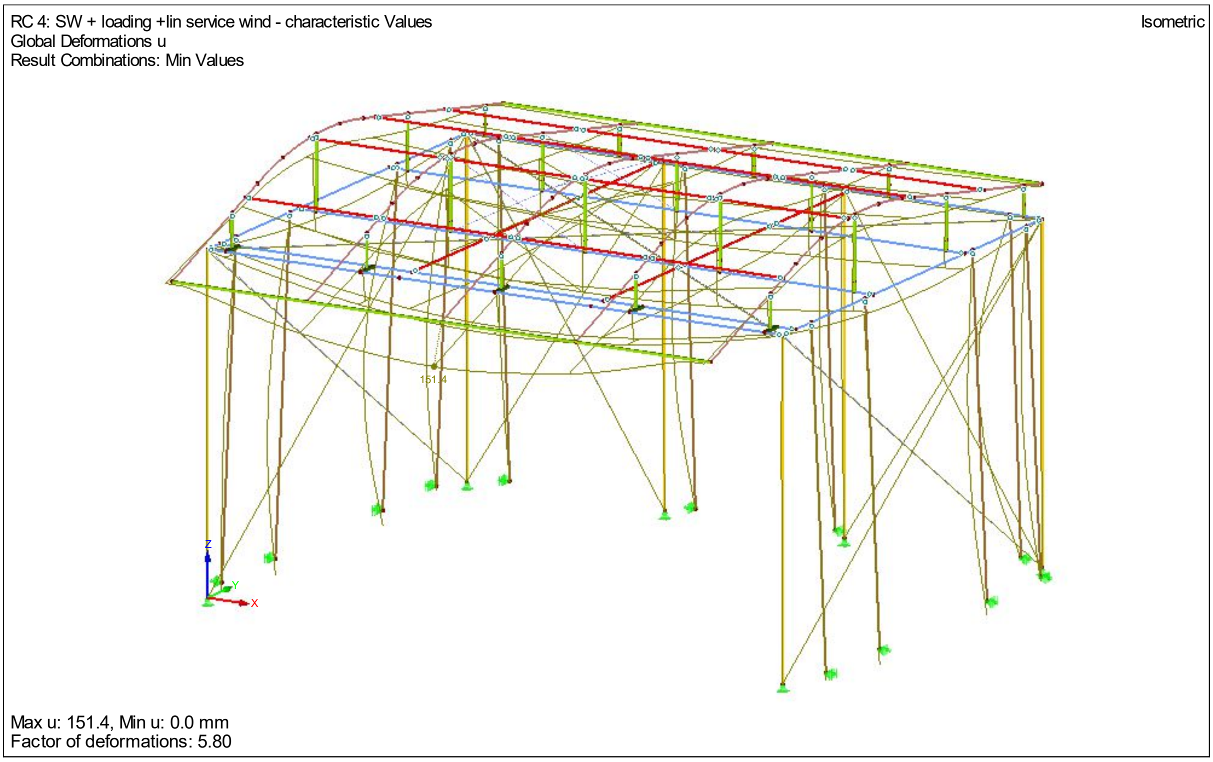
| | | | | |
|---|---|---|---|---|
| | Sum of loads in Y | 6,42 | kN | |
| | Sum of support forces in Y | 6,42 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -66,74 | kN | |
| | Sum of support forces in Z | -66,74 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 84,0 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -88,4 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | -93,2 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 121,3 | mm | Member No. 18, x: 3.485 m |
| | Maximum rotation about X-axis | 40,2 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | 34,9 | mrad | Member No. 16, x: 0.000 m |
| | Maximum rotation about Z-axis | 10,4 | mrad | Member No. 19, x: 6.971 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*LC20 + 1.35*LC21 + 1.35*LC22 + 1.35*LC23** | | | |
| | Sum of loads in X | 28,48 | kN | |
| | Sum of support forces in X | 28,48 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 6,42 | kN | |
| | Sum of support forces in Y | 6,42 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -97,79 | kN | |
| | Sum of support forces in Z | -97,79 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 84,7 | mm | Member No. 16, x: 3.485 m |
| | Maximum displacement in Y-direction | -88,6 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | -116,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 128,8 | mm | Member No. 16, x: 3.485 m |
| | Maximum rotation about X-axis | 40,2 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | -36,4 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 11,2 | mrad | Member No. 19, x: 6.971 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -19,50 | kN | |
| | Sum of support forces in Z | -19,50 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,8 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -83,2 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -28,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 177,9 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,4 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -78,9 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,4 | mrad | Member No. 203, x: 6.972 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -62,21 | kN | |
| | Sum of support forces in Z | -62,21 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,0 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,8 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -82,0 | mm | Member No. 168, x: 0.000 m |
| | Maximum vectorial displacement | 178,1 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,1 | mrad | Member No. 203, x: 6.972 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -47,17 | kN | |

| | | | | |
|---|---|---|---|---|
| | Sum of support forces in Z | -47,17 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,9 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,9 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -71,7 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 178,0 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,1 | mrad | Member No. 203, x: 6.972 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -69,45 | kN | |
| | Sum of support forces in Z | -69,45 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,0 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,8 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -94,9 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 178,1 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 9,4 | mrad | Member No. 32, x: 1.500 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*LC30 + 1.35*LC31 + 1.35*LC32 + 1.35*LC33** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -100,50 | kN | |
| | Sum of support forces in Z | -100,50 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,0 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,9 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -129,1 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 178,2 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -9,9 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO130 - 1.15*LC1 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -58,54 | kN | |
| | Sum of support forces in Z | -58,54 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -171,9 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,8 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -95,9 | mm | Member No. 168, x: 0.273 m |
| | Maximum vectorial displacement | 178,0 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 36,3 | mrad | Member No. 204, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 8,1 | mrad | Member No. 203, x: 6.972 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO131 - 1.15*LC1 + 1.35*LC2 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -101,25 | kN | |
| | Sum of support forces in Z | -101,25 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,3 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,5 | mm | Member No. 204, x: 3.486 m |

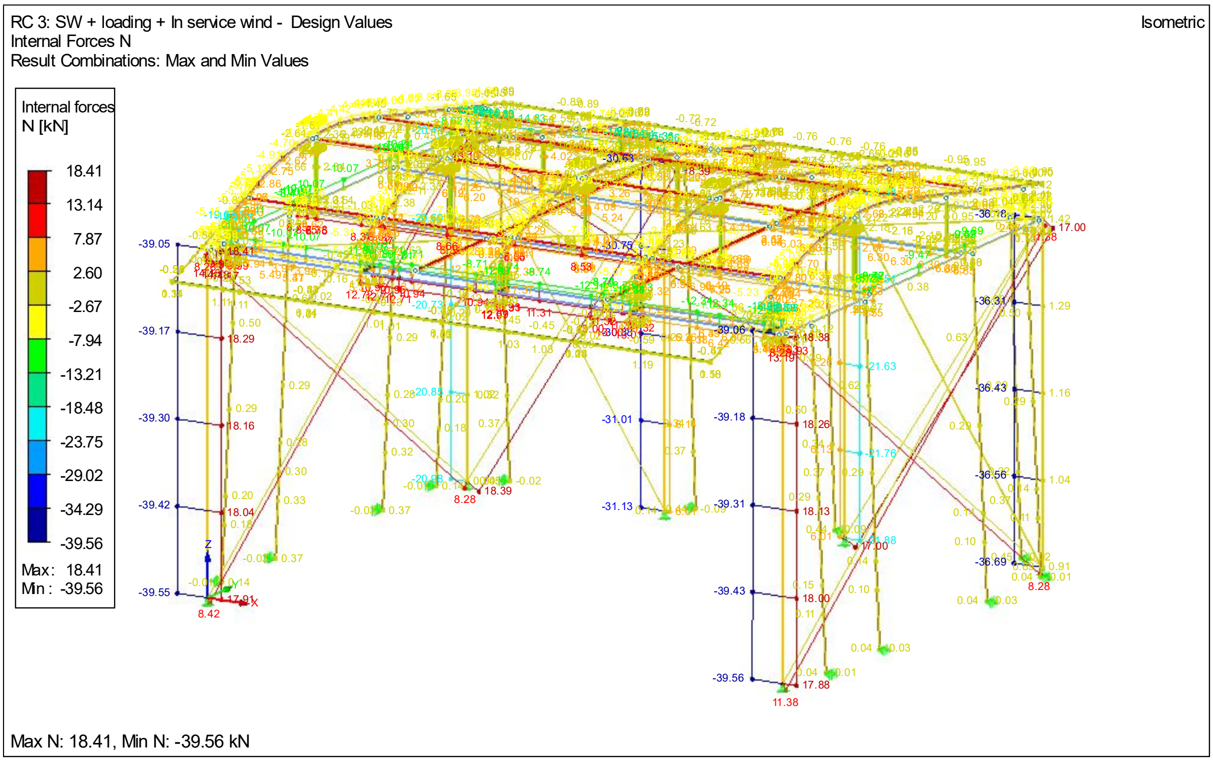
| | | | | |
|---|---|---|---|---|
| | Maximum displacement in Z-direction | -162,9 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 178,4 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 45,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,1 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -10,0 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO132 - 1.15*LC1 + 1.35*LC3 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -86,21 | kN | |
| | Sum of support forces in Z | -86,21 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,2 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,5 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -153,3 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 178,2 | mm | Member No. 203, x: 3.486 m |
| | Maximum rotation about X-axis | 42,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,0 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 11,0 | mrad | Member No. 32, x: 1.500 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO133 - 1.15*LC1 + 1.35*LC4 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -108,49 | kN | |
| | Sum of support forces in Z | -108,49 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,2 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,4 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -176,8 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 180,9 | mm | Member No. 153, x: 0.453 m |
| | Maximum rotation about X-axis | 50,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -79,1 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | 12,5 | mrad | Member No. 32, x: 1.500 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO134 - 1.15*LC1 + 1.35*LC5 + 1.35*LC32 + 1.35*LC33 + 1.35*LC34 + 1.35*LC35** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -27,90 | kN | |
| | Sum of support forces in Y | -27,90 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -139,54 | kN | |
| | Sum of support forces in Z | -139,54 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -172,3 | mm | Member No. 203, x: 3.486 m |
| | Maximum displacement in Y-direction | -82,5 | mm | Member No. 204, x: 3.486 m |
| | Maximum displacement in Z-direction | -192,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 195,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 46,9 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -79,1 | mrad | Member No. 203, x: 0.000 m |
| | Maximum rotation about Z-axis | -14,6 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

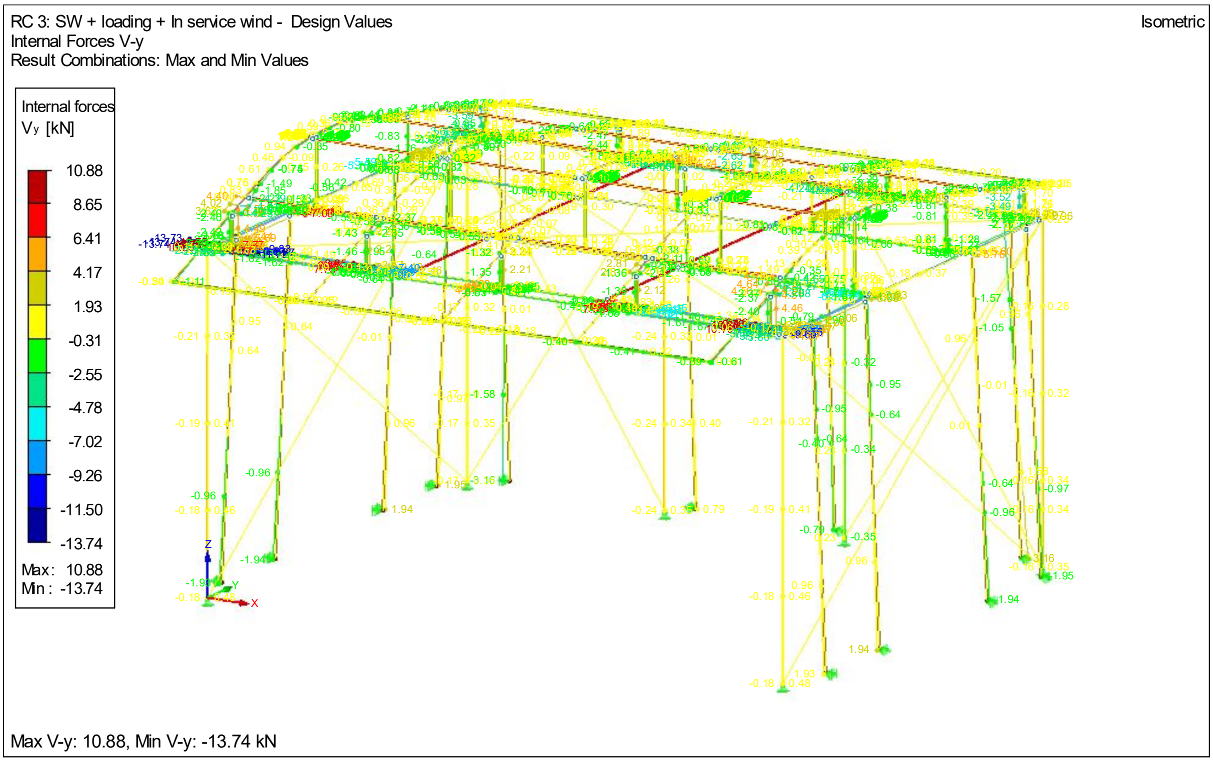
### 3.4.3 Deformation RC4 - SW + Loading setup + In service Wind - Characteristic Values



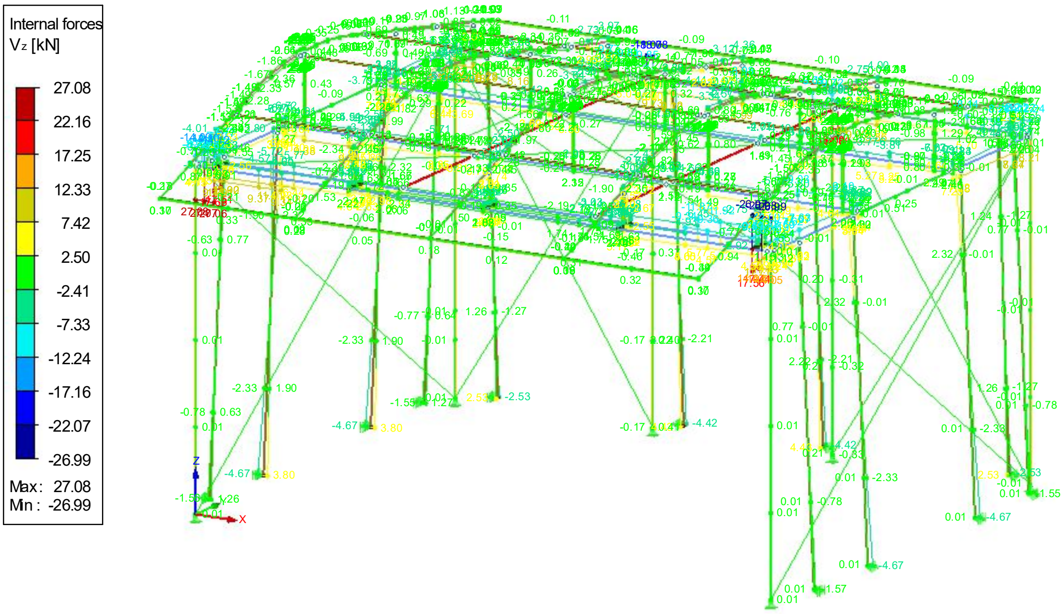



## 3.4.4 Internal force diagram RC3 - SW + Loading + In service Wind - Design Values



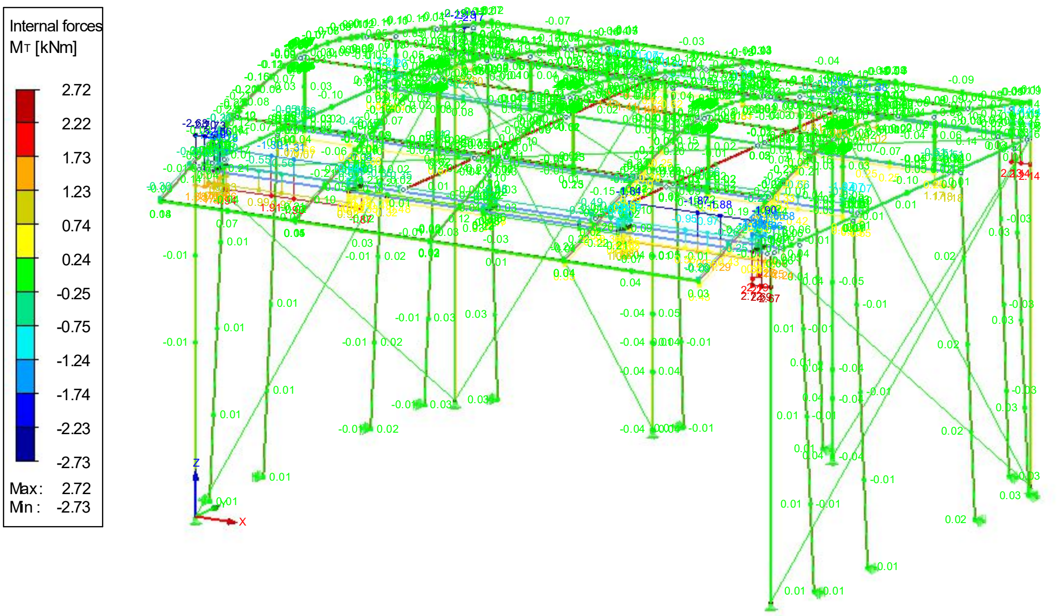



RC 3: SW + loading + In service wind - Design Values    Isometric
Internal Forces V-z
Result Combinations: Max and Min Values




Max V-z: 27.08, Min V-z: -26.99 kN

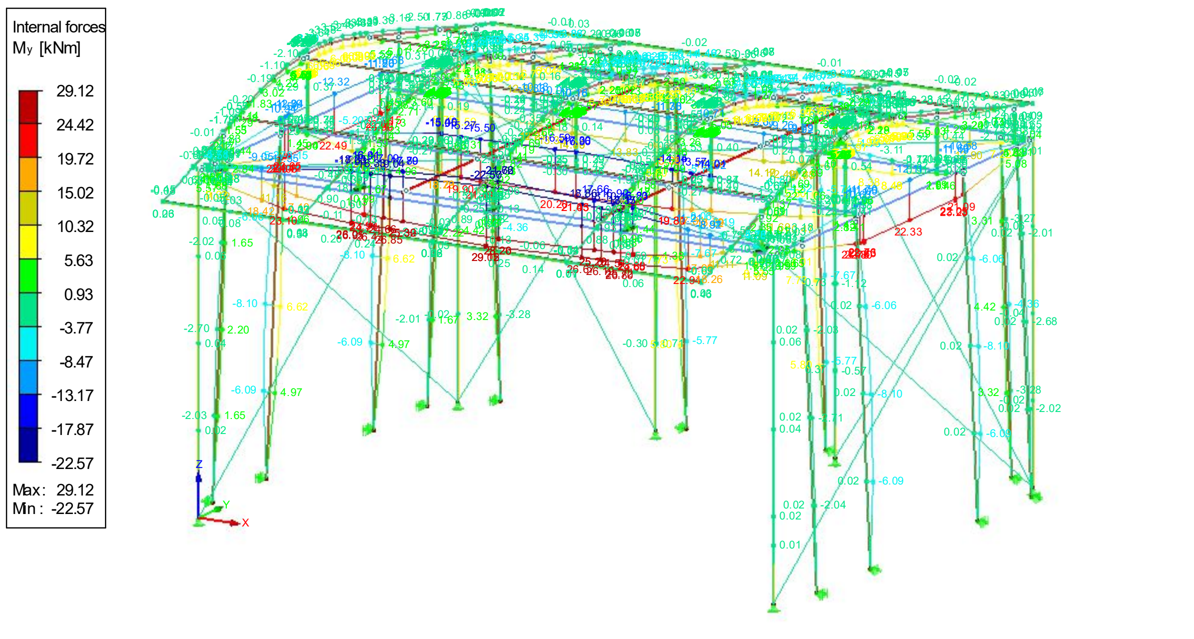
RC 3: SW + loading + In service wind - Design Values    Isometric
Internal Forces M-T
Result Combinations: Max and Min Values




Max M-T: 2.72, Min M-T: -2.73 kNm

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values

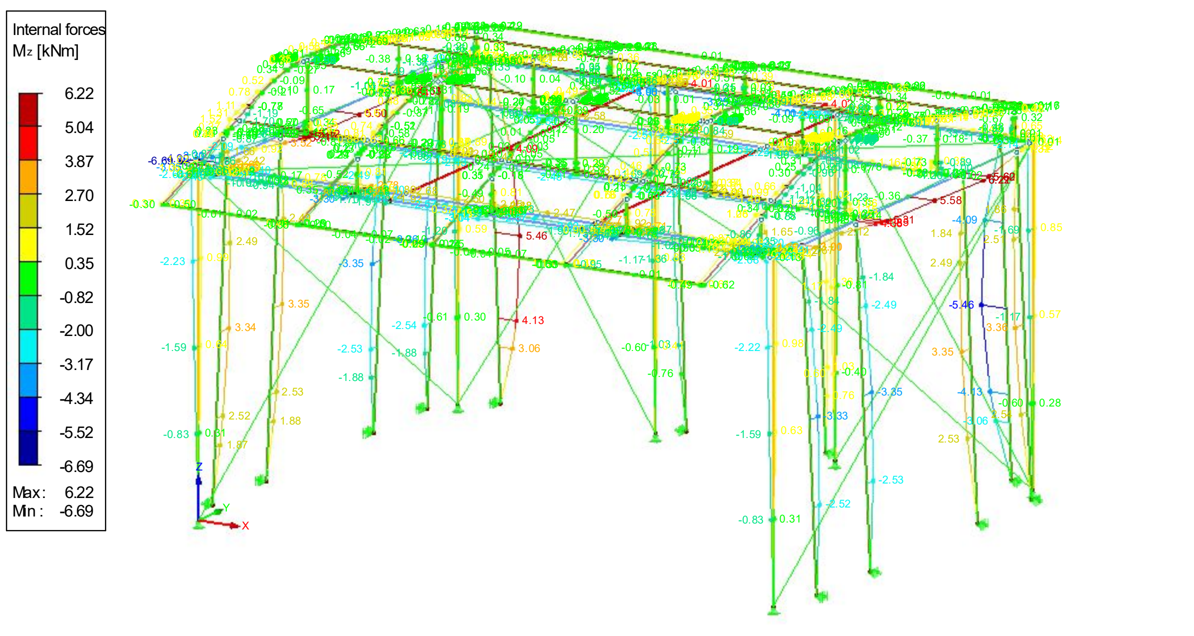
Isometric




Max M-y: 29.12, Min M-y: -22.57 kNm

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric




Max M-z: 6.22, Min M-z: -6.69 kNm

## 3.5 Result for RC1 and RC2

## 3.5.1 Result for the single load cases LC110 to LC134.

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **LC110 - Out-service wind dir. 0° roof structure** | | | |
| | 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 | 73,35 | kN | |
| | Sum of support forces in Z | 73,35 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -105,869 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,826 | 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 | -11,0 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -16,3 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | 168,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 168,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -38,9 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 46,0 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 12,5 | mrad | Member No. 32, x: 3.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC111 - Out-service wind dir. 0° roof structure membrane tension** | | | |
| | 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 | -0,46 | kN | |
| | Sum of support forces in Z | -0,46 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,652 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,001 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,014 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -1,1 | mm | Member No. 134, x: 1.540 m |
| | Maximum displacement in Y-direction | -1,1 | mm | Member No. 35, x: 1.125 m |
| | Maximum displacement in Z-direction | -3,3 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 3,3 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 1,0 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 1,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,8 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC112 - Out-service wind dir. 0° tower + profiles** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 10,23 | kN | |
| | Sum of support forces in Y | 10,23 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 22,199 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,114 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,1 | mm | Member No. 200, x: 3.485 m |
| | Maximum displacement in Y-direction | 19,5 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | -0,2 | mm | Member No. 203, x: 0.000 m |
| | Maximum vectorial displacement | 19,5 | mm | Member No. 17, x: 3.485 m |
| | Maximum rotation about X-axis | -8,8 | mrad | Member No. 17, x: 0.000 m |
| | Maximum rotation about Y-axis | 0,1 | mrad | Member No. 136, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,5 | mrad | Member No. 31, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC113 - Out-service wind dir. 0° roof structure compression** | | | |
| | 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 | -39,42 | kN | |
| | Sum of support forces in Z | -39,42 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 48,485 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |

| | | | | |
|---|---|---|---|---|
| | Resultant of reactions about Y | 0,444 | 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 | 5,9 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 9,9 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -82,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 82,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 21,7 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -23,1 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -6,2 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC114 - Out-service wind dir. 0° roof structure membrane tension compression** | | | |
| | 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 | -0,46 | kN | |
| | Sum of support forces in Z | -0,46 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,652 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,005 | 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 | -0,6 | mm | Member No. 15, x: 1.232 m |
| | Maximum displacement in Y-direction | -1,0 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -3,0 | mm | Member No. 153, x: 1.133 m |
| | Maximum vectorial displacement | 3,0 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 1,0 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 1,1 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,6 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC120 - Out-service wind dir. 90° roof structure** | | | |
| | Sum of loads in X | 13,20 | kN | |
| | Sum of support forces in X | 13,20 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | 59,13 | kN | |
| | Sum of support forces in Z | 59,13 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -72,729 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 24,627 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 4,133 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 34,6 | mm | Member No. 91, x: 0.330 m |
| | Maximum displacement in Y-direction | 16,5 | mm | Member No. 134, x: 0.000 m |
| | Maximum displacement in Z-direction | 124,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 127,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -32,3 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 34,0 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 8,3 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC121 - Out-service wind dir. 90° roof structure membrane tension** | | | |
| | 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 | -0,37 | kN | |
| | Sum of support forces in Z | -0,37 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,341 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 1,067 | 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 | 0,8 | mm | Member No. 15, x: 1.540 m |
| | Maximum displacement in Y-direction | -1,1 | mm | Member No. 35, x: 1.125 m |
| | Maximum displacement in Z-direction | -2,7 | mm | Member No. 222, x: 1.068 m |
| | Maximum vectorial displacement | 2,7 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | -0,9 | mrad | Member No. 196, x: 0.000 m |
| | Maximum rotation about Y-axis | 1,5 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,6 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC122 - Out-service wind dir. 90° tower + profiles** | | | |
| | Sum of loads in X | 8,92 | kN | |
| | Sum of support forces in X | 8,92 | kN | Deviation: 0.00 % |

| | | | | |
|---|---|---|---|---|
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | 0,000 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -19,354 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -16,213 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 20,1 | mm | Member No. 205, x: 3.486 m |
| | Maximum displacement in Y-direction | 1,0 | mm | Member No. 179, x: 16.267 m |
| | Maximum displacement in Z-direction | -0,4 | mm | Member No. 202, x: 0.000 m |
| | Maximum vectorial displacement | 20,1 | mm | Member No. 205, x: 3.486 m |
| | Maximum rotation about X-axis | 0,2 | mrad | Member No. 58, x: 0.730 m |
| | Maximum rotation about Y-axis | 9,0 | mrad | Member No. 205, x: 0.000 m |
| | Maximum rotation about Z-axis | 0,7 | mrad | Member No. 6, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC130 - Out-service wind dir. 180° roof structure** | | | |
| | 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 | 73,35 | kN | |
| | Sum of support forces in Z | 73,35 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -105,869 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,826 | 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 | -11,0 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -16,3 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | 168,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 168,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -38,9 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 46,0 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 12,5 | mrad | Member No. 32, x: 3.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC131 - Out-service wind dir. 180° roof structure membrane tension** | | | |
| | 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 | -0,46 | kN | |
| | Sum of support forces in Z | -0,46 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,652 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | -0,001 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,014 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -1,1 | mm | Member No. 134, x: 1.540 m |
| | Maximum displacement in Y-direction | -1,1 | mm | Member No. 35, x: 1.125 m |
| | Maximum displacement in Z-direction | -3,3 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 3,3 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 1,0 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 1,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,8 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC132 - Out-service wind dir. 180° tower + profiles** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -10,23 | kN | |
| | Sum of support forces in Y | -10,23 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 0,00 | kN | |
| | Sum of support forces in Z | 0,00 | kN | |
| | Resultant of reactions about X | -22,199 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,000 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,114 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 0,1 | mm | Member No. 200, x: 3.485 m |
| | Maximum displacement in Y-direction | -19,5 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | 0,2 | mm | Member No. 206, x: 0.000 m |
| | Maximum vectorial displacement | 19,5 | mm | Member No. 19, x: 3.485 m |
| | Maximum rotation about X-axis | 8,8 | mrad | Member No. 19, x: 0.000 m |
| | Maximum rotation about Y-axis | -0,1 | mrad | Member No. 136, x: 0.000 m |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Z-axis | 0,4 | mrad | Member No. 31, x: 1.500 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC133 - Out-service wind dir. 180° roof structure compression** | | | |
| | 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 | -39,42 | kN | |
| | Sum of support forces in Z | -39,42 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 48,485 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,444 | 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 | 5,9 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 9,9 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -82,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 82,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 21,7 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -23,1 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -6,2 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC134 - Out-service wind dir. 180° roof structure membrane tension compression** | | | |
| | 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 | -0,46 | kN | |
| | Sum of support forces in Z | -0,46 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 1,652 | kNm | At center of gravity of model (X: 6.399, Y: 5.487, Z: 5.652 m) |
| | Resultant of reactions about Y | 0,005 | 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 | -0,6 | mm | Member No. 134, x: 1.232 m |
| | Maximum displacement in Y-direction | -1,0 | mm | Member No. 33, x: 0.375 m |
| | Maximum displacement in Z-direction | -3,2 | mm | Member No. 153, x: 0.907 m |
| | Maximum vectorial displacement | 3,2 | mm | Member No. 153, x: 0.907 m |
| | Maximum rotation about X-axis | 1,0 | mrad | Member No. 74, x: 0.730 m |
| | Maximum rotation about Y-axis | 1,2 | mrad | Member No. 4, x: 0.000 m |
| | Maximum rotation about Z-axis | -0,4 | mrad | Member No. 35, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |

## 3.5.2 Calculation results Load Combination CO200-CO229

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **CO200 - 1.15*LC1 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 75,46 | kN | |
| | Sum of support forces in Z | 75,46 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -13,1 | mm | Member No. 153, x: 0.453 m |
| | Maximum displacement in Y-direction | 25,9 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | 205,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 205,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -45,1 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 55,2 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 16,0 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | $N, V_y, V_z, M_y, M_z, M_T$ |
| | **CO201 - 1.15*LC1 + 1.35*LC2 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 32,74 | kN | |

| | | | | |
|---|---|---|---|---|
| | Sum of support forces in Z | 32,74 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -8,6 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 26,0 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | 162,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 162,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -27,3 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 41,2 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 12,3 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO202 - 1.15*LC1 + 1.35*LC3 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 47,78 | kN | |
| | Sum of support forces in Z | 47,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -7,8 | mm | Member No. 59, x: 0.825 m |
| | Maximum displacement in Y-direction | 25,9 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | 182,6 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 182,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -30,2 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 47,5 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 13,8 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO203 - 1.15*LC1 + 1.35*LC4 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 25,51 | kN | |
| | Sum of support forces in Z | 25,51 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -6,8 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 26,0 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | 173,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 173,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -22,5 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 44,0 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 13,0 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO204 - 1.15*LC1 + 1.35*LC6 + 1.35*LC110 + 1.35*LC111 + 1.35*LC112** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 16,06 | kN | |
| | Sum of support forces in Z | 16,06 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -11,8 | mm | Member No. 153, x: 0.453 m |
| | Maximum displacement in Y-direction | 26,2 | mm | Member No. 17, x: 3.485 m |
| | Maximum displacement in Z-direction | 189,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 189,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -27,5 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 45,8 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 13,8 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO205 - 1.15*LC1 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -76,78 | kN | |
| | Sum of support forces in Z | -76,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 9,4 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 26,5 | mm | Member No. 18, x: 3.485 m |

| | | | | |
|---|---|---|---|---|
| | Maximum displacement in Z-direction | -135,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 135,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 36,1 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -38,9 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -11,4 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO206 - 1.15*LC1 + 1.35*LC2 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -119,49 | kN | |
| | Sum of support forces in Z | -119,49 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 13,1 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 30,3 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -199,0 | mm | Member No. 168, x: 0.205 m |
| | Maximum vectorial displacement | 199,7 | mm | Member No. 168, x: 0.205 m |
| | Maximum rotation about X-axis | 54,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -52,2 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -14,9 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO207 - 1.15*LC1 + 1.35*LC3 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -104,45 | kN | |
| | Sum of support forces in Z | -104,45 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 14,4 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 28,8 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -189,0 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 189,7 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 51,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -46,2 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -13,5 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO208 - 1.15*LC1 + 1.35*LC4 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -126,73 | kN | |
| | Sum of support forces in Z | -126,73 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 15,0 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | 32,7 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -211,9 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 212,7 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 59,0 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -49,5 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -14,2 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO209 - 1.15*LC1 + 1.35*LC6 + 1.35*LC112 + 1.35*LC113 + 1.35*LC114** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 13,81 | kN | |
| | Sum of support forces in Y | 13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -136,18 | kN | |
| | Sum of support forces in Z | -136,18 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 10,3 | mm | Member No. 59, x: 0.825 m |
| | Maximum displacement in Y-direction | 31,4 | mm | Member No. 30, x: 0.375 m |
| | Maximum displacement in Z-direction | -190,2 | mm | Member No. 153, x: 0.453 m |
| | Maximum vectorial displacement | 190,6 | mm | Member No. 153, x: 0.453 m |
| | Maximum rotation about X-axis | 54,1 | mrad | Member No. 144, x: 0.000 m |

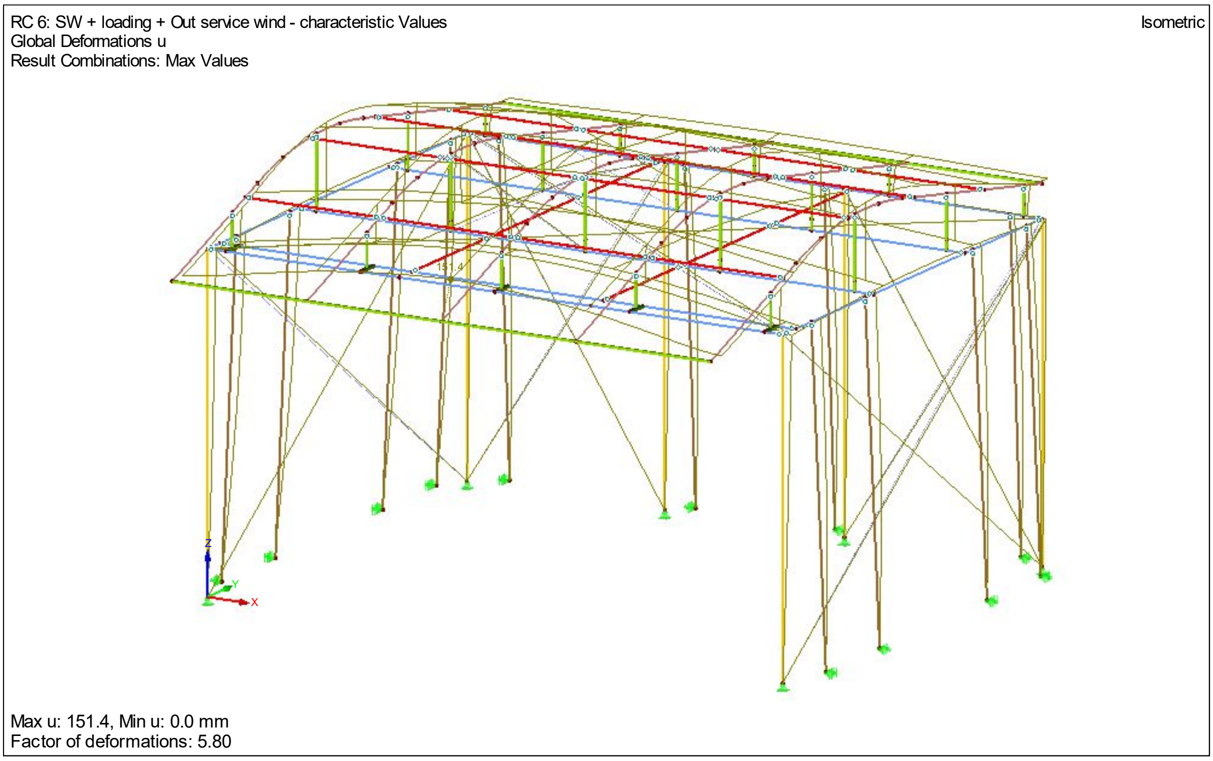
| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Y-axis | -47,7 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -13,5 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO210 - 1.15*LC1 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 29,86 | kN | |
| | Sum of support forces in X | 29,86 | 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 | 56,38 | kN | |
| | Sum of support forces in Z | 56,38 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 54,4 | mm | Member No. 91, x: 0.330 m |
| | Maximum displacement in Y-direction | -19,2 | mm | Member No. 28, x: 2.250 m |
| | Maximum displacement in Z-direction | 147,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 153,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -37,2 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | 39,6 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 10,2 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO211 - 1.15*LC1 + 1.35*LC2 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 29,86 | kN | |
| | Sum of support forces in X | 29,86 | 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 | 13,66 | kN | |
| | Sum of support forces in Z | 13,66 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 52,5 | mm | Member No. 91, x: 0.330 m |
| | Maximum displacement in Y-direction | -12,1 | mm | Member No. 28, x: 0.000 m |
| | Maximum displacement in Z-direction | 103,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 111,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -19,1 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 25,4 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 9,1 | mrad | Member No. 202, x: 6.971 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO212 - 1.15*LC1 + 1.35*LC3 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 29,86 | kN | |
| | Sum of support forces in X | 29,86 | 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 | 28,70 | kN | |
| | Sum of support forces in Z | 28,70 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 52,3 | mm | Member No. 91, x: 0.330 m |
| | Maximum displacement in Y-direction | -15,0 | mm | Member No. 28, x: 0.000 m |
| | Maximum displacement in Z-direction | 124,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 130,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -22,0 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -31,7 | mrad | Member No. 35, x: 1.500 m |
| | Maximum rotation about Z-axis | 9,2 | mrad | Member No. 202, x: 6.971 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO213 - 1.15*LC1 + 1.35*LC4 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 29,86 | kN | |
| | Sum of support forces in X | 29,86 | 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 | 6,43 | kN | |
| | Sum of support forces in Z | 6,43 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 51,7 | mm | Member No. 91, x: 0.330 m |
| | Maximum displacement in Y-direction | -13,2 | mm | Member No. 34, x: 1.125 m |
| | Maximum displacement in Z-direction | 114,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 122,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -16,2 | mrad | Member No. 132, x: 0.308 m |
| | Maximum rotation about Y-axis | -28,3 | mrad | Member No. 35, x: 1.500 m |
| | Maximum rotation about Z-axis | 9,1 | mrad | Member No. 202, x: 6.971 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |

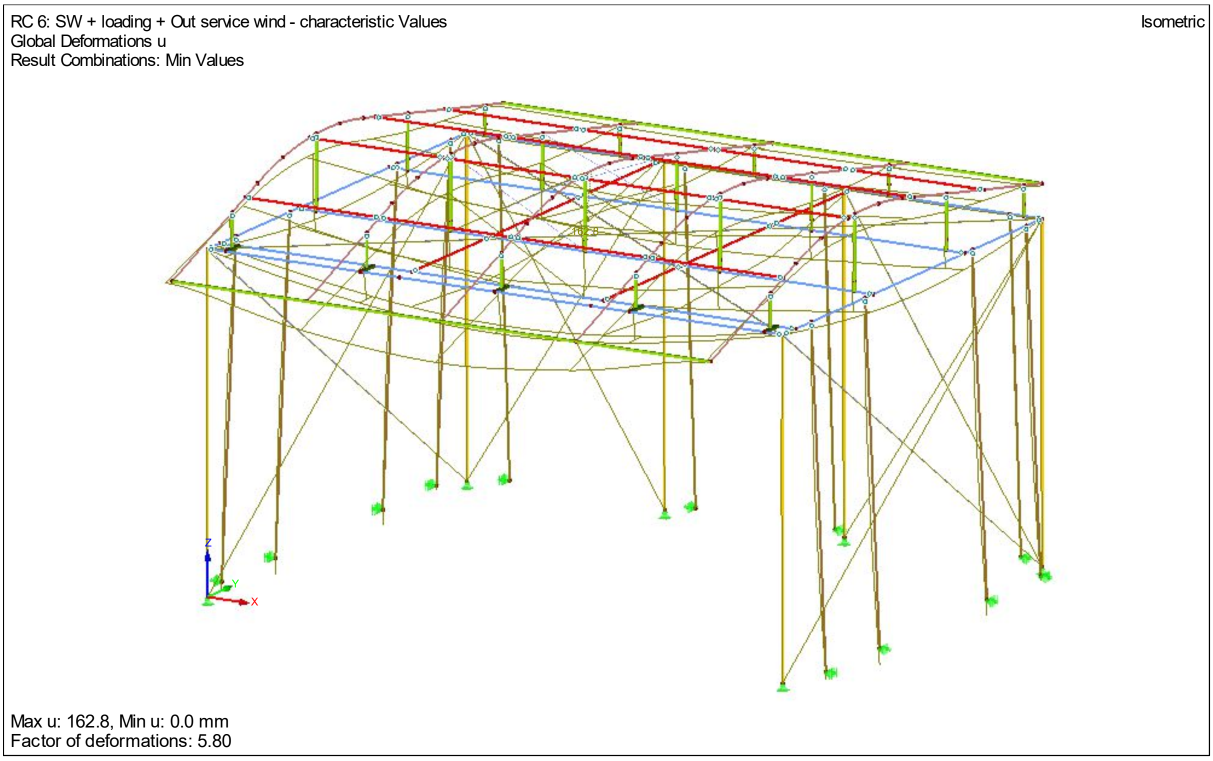
| | | | | |
|---|---|---|---|---|
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO214 - 1.15*LC1 + 1.35*LC6 + 1.35*LC120 + 1.35*LC121 + 1.35*LC122** | | | |
| | Sum of loads in X | 29,86 | kN | |
| | Sum of support forces in X | 29,86 | kN | 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 | -3,02 | kN | |
| | Sum of support forces in Z | -3,02 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 54,0 | mm | Member No. 91, x: 0.165 m |
| | Maximum displacement in Y-direction | 11,8 | mm | Member No. 154, x: 0.453 m |
| | Maximum displacement in Z-direction | 131,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 138,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -19,4 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 30,1 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 9,2 | 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, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO220 - 1.15*LC1 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 75,46 | kN | |
| | Sum of support forces in Z | 75,46 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -13,1 | mm | Member No. 153, x: 0.453 m |
| | Maximum displacement in Y-direction | -26,0 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | 204,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 205,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -45,2 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 55,0 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 16,1 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO221 - 1.15*LC1 + 1.35*LC2 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 32,74 | kN | |
| | Sum of support forces in Z | 32,74 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -8,6 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | -26,0 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | 161,9 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 162,5 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -27,3 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 41,1 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 12,4 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO222 - 1.15*LC1 + 1.35*LC3 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 47,78 | kN | |
| | Sum of support forces in Z | 47,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -7,8 | mm | Member No. 59, x: 0.825 m |
| | Maximum displacement in Y-direction | -26,0 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | 182,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 182,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -30,2 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 47,3 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 13,9 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO223 - 1.15*LC1 + 1.35*LC4 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |

| | | | | |
|---|---|---|---|---|
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 25,51 | kN | |
| | Sum of support forces in Z | 25,51 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -6,9 | mm | Member No. 135, x: 0.453 m |
| | Maximum displacement in Y-direction | -26,0 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | 172,7 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 173,8 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -22,5 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 43,8 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 13,1 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO224 - 1.15*LC1 + 1.35*LC6 + 1.35*LC130 + 1.35*LC131 + 1.35*LC132** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | 16,06 | kN | |
| | Sum of support forces in Z | 16,06 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -11,9 | mm | Member No. 153, x: 0.453 m |
| | Maximum displacement in Y-direction | -26,0 | mm | Member No. 19, x: 3.485 m |
| | Maximum displacement in Z-direction | 189,2 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 190,0 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | -27,5 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | 45,7 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | 13,9 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO225 - 1.15*LC1 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -76,78 | kN | |
| | Sum of support forces in Z | -76,78 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 9,3 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -26,3 | mm | Member No. 200, x: 3.485 m |
| | Maximum displacement in Z-direction | -138,4 | mm | Member No. 132, x: 0.000 m |
| | Maximum vectorial displacement | 139,3 | mm | Member No. 132, x: 0.000 m |
| | Maximum rotation about X-axis | 36,6 | mrad | Member No. 144, x: 0.196 m |
| | Maximum rotation about Y-axis | -39,9 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -10,2 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO226 - 1.15*LC1 + 1.35*LC2 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -119,49 | kN | |
| | Sum of support forces in Z | -119,49 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 13,5 | mm | Member No. 59, x: 0.990 m |
| | Maximum displacement in Y-direction | -32,8 | mm | Member No. 32, x: 0.750 m |
| | Maximum displacement in Z-direction | -201,6 | mm | Member No. 168, x: 0.171 m |
| | Maximum vectorial displacement | 203,1 | mm | Member No. 168, x: 0.188 m |
| | Maximum rotation about X-axis | 54,8 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -53,4 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -13,8 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO227 - 1.15*LC1 + 1.35*LC3 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |

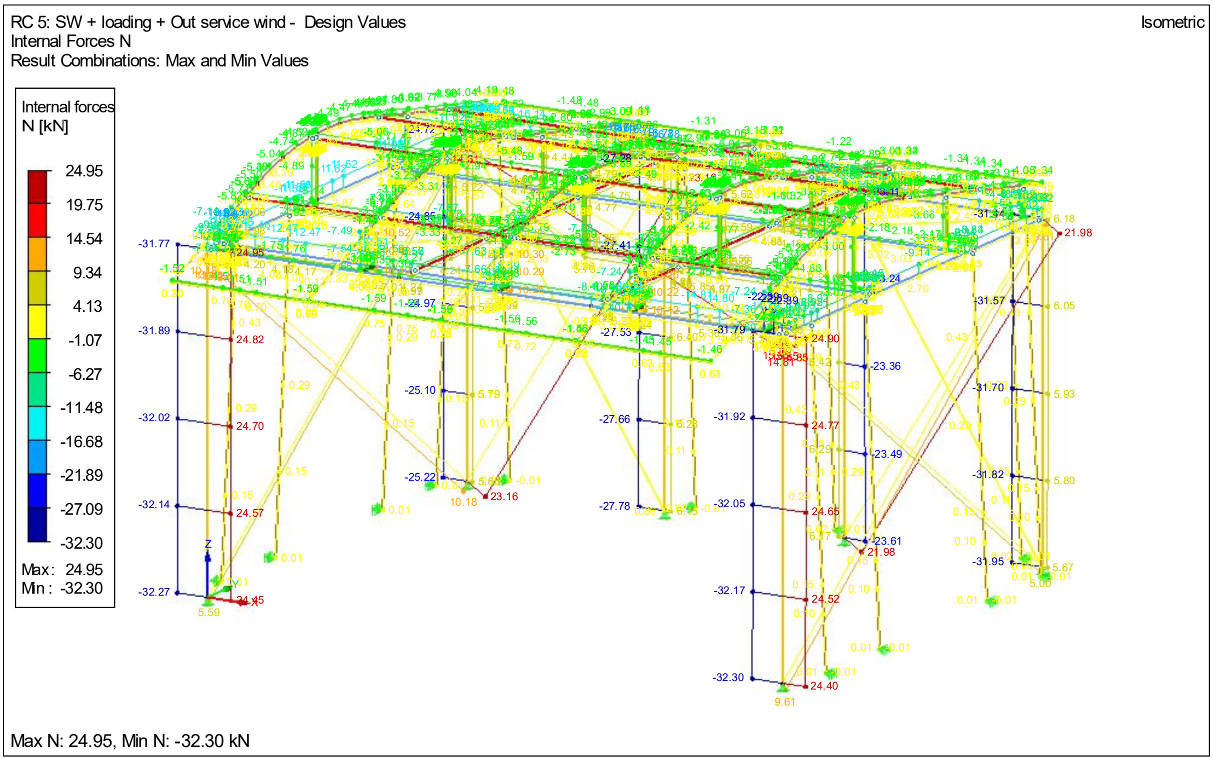
| | | | | |
|---|---|---|---|---|
| | Sum of loads in Z | -104,45 | kN | |
| | Sum of support forces in Z | -104,45 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 14,7 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | -31,3 | mm | Member No. 32, x: 0.375 m |
| | Maximum displacement in Z-direction | -191,5 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 193,1 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 51,9 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -47,3 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -12,4 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO228 - 1.15*LC1 + 1.35*LC4 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -126,73 | kN | |
| | Sum of support forces in Z | -126,73 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 15,5 | mm | Member No. 152, x: 0.453 m |
| | Maximum displacement in Y-direction | -37,5 | mm | Member No. 32, x: 0.375 m |
| | Maximum displacement in Z-direction | -214,7 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 216,3 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 59,7 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -50,6 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -13,1 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |
| | **CO229 - 1.15*LC1 + 1.35*LC6 + 1.35*LC132 + 1.35*LC133 + 1.35*LC134** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -13,81 | kN | |
| | Sum of support forces in Y | -13,81 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -136,18 | kN | |
| | Sum of support forces in Z | -136,18 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 10,7 | mm | Member No. 59, x: 0.825 m |
| | Maximum displacement in Y-direction | -37,9 | mm | Member No. 35, x: 0.000 m |
| | Maximum displacement in Z-direction | -192,3 | mm | Member No. 153, x: 0.227 m |
| | Maximum vectorial displacement | 193,6 | mm | Member No. 153, x: 0.227 m |
| | Maximum rotation about X-axis | 54,6 | mrad | Member No. 144, x: 0.000 m |
| | Maximum rotation about Y-axis | -48,8 | mrad | Member No. 32, x: 1.500 m |
| | Maximum rotation about Z-axis | -12,3 | mrad | Member No. 134, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

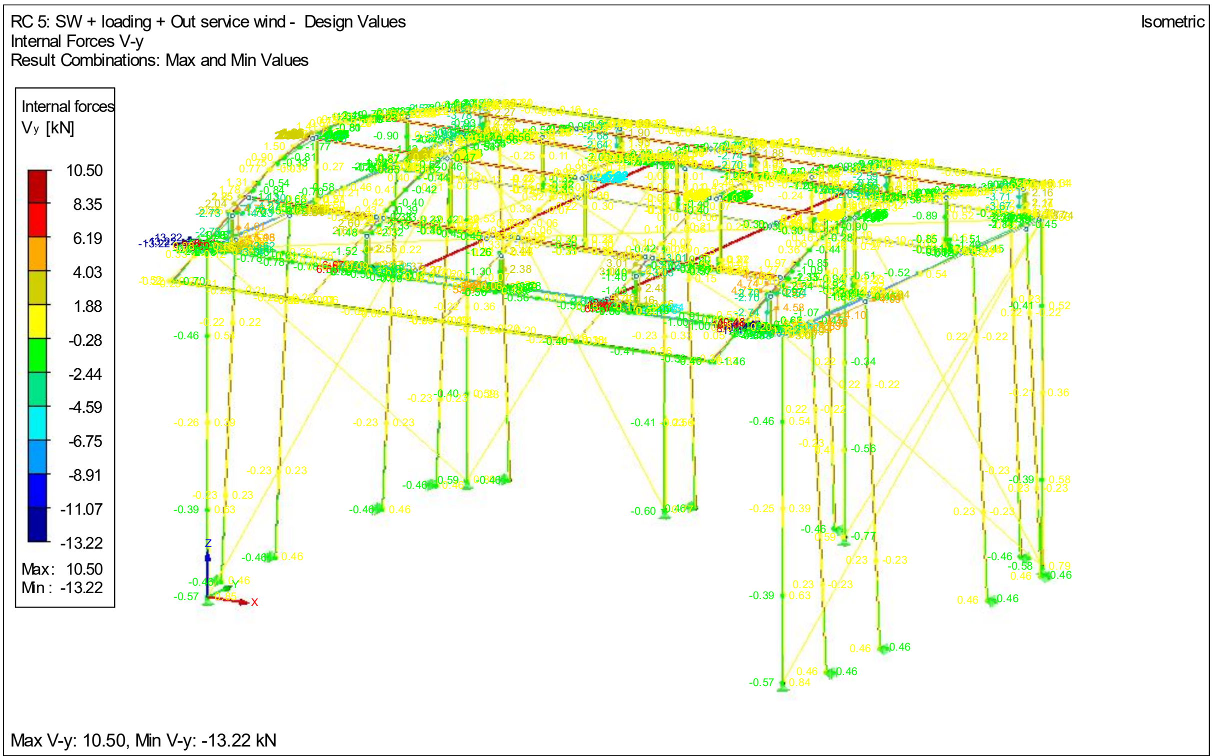
### 3.5.3 Deformation RC6 characteristic calculations Out-service situation



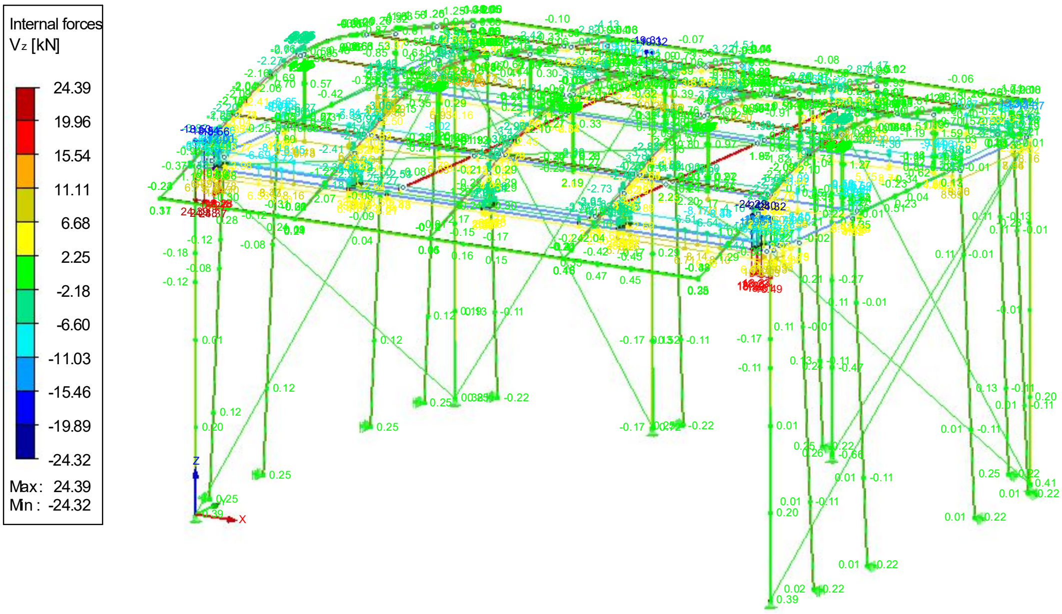
### 3.5.4 Internal force diagram RC5 - SW + Loading setup + Out service Wind - Design Values



RC 5: SW + loading + Out service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values

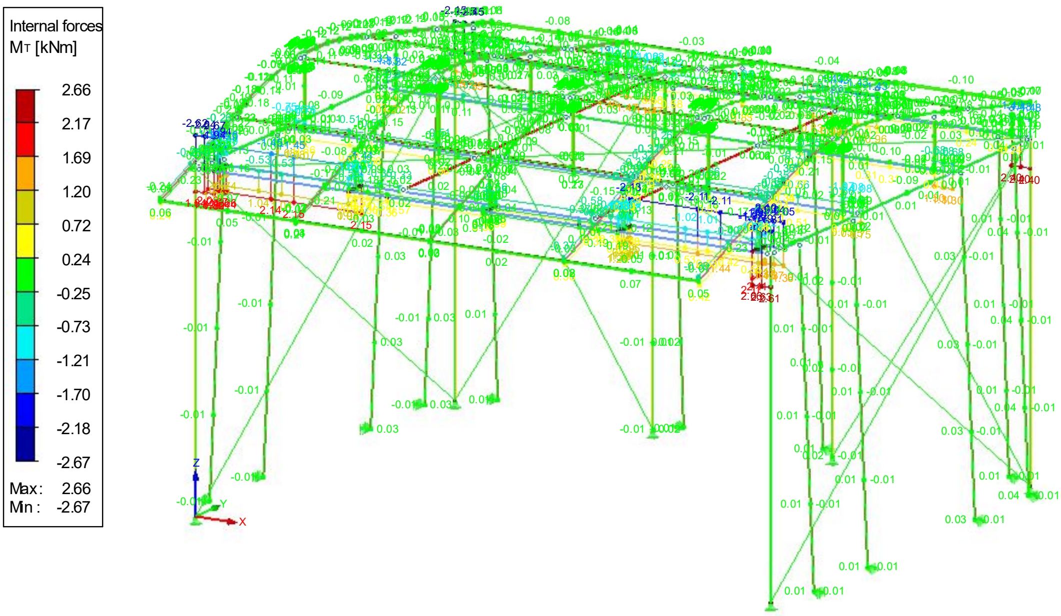
Isometric



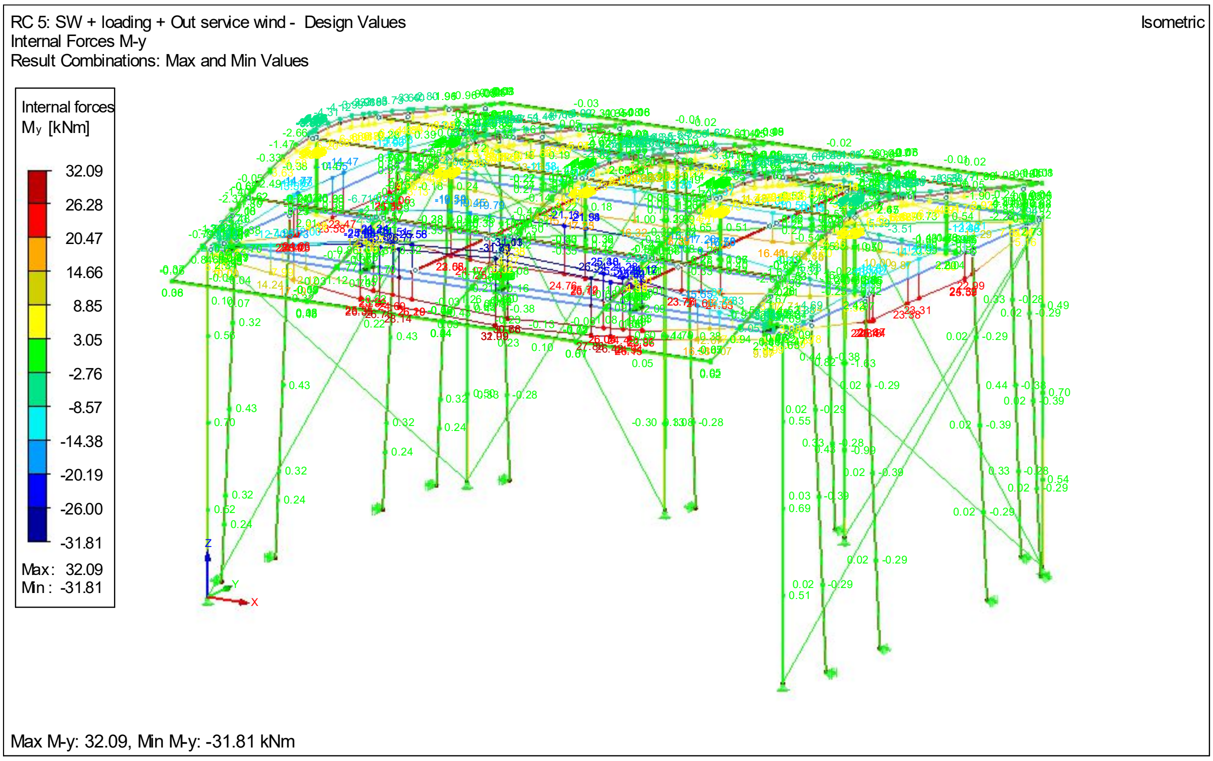

Max V-z: 24.39, Min V-z: -24.32 kN

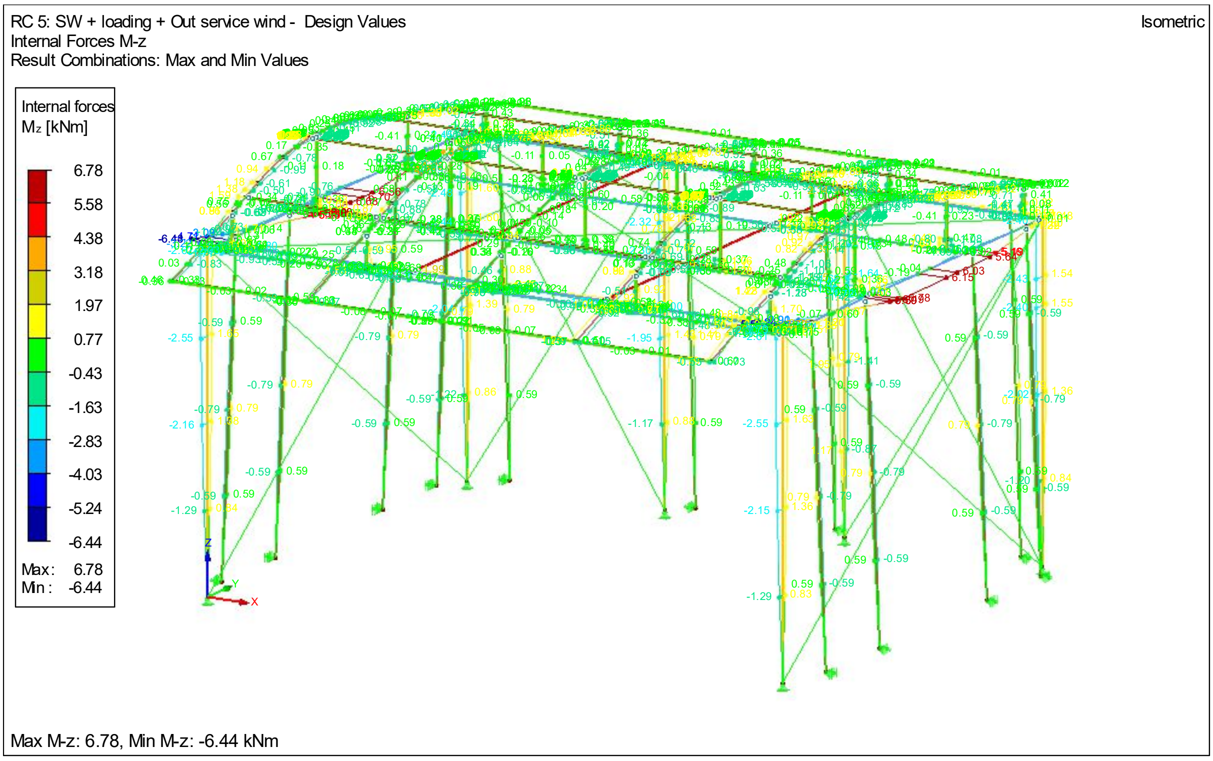
RC 5: SW + loading + Out service wind - Design Values
Internal Forces M-T
Result Combinations: Max and Min Values

Isometric



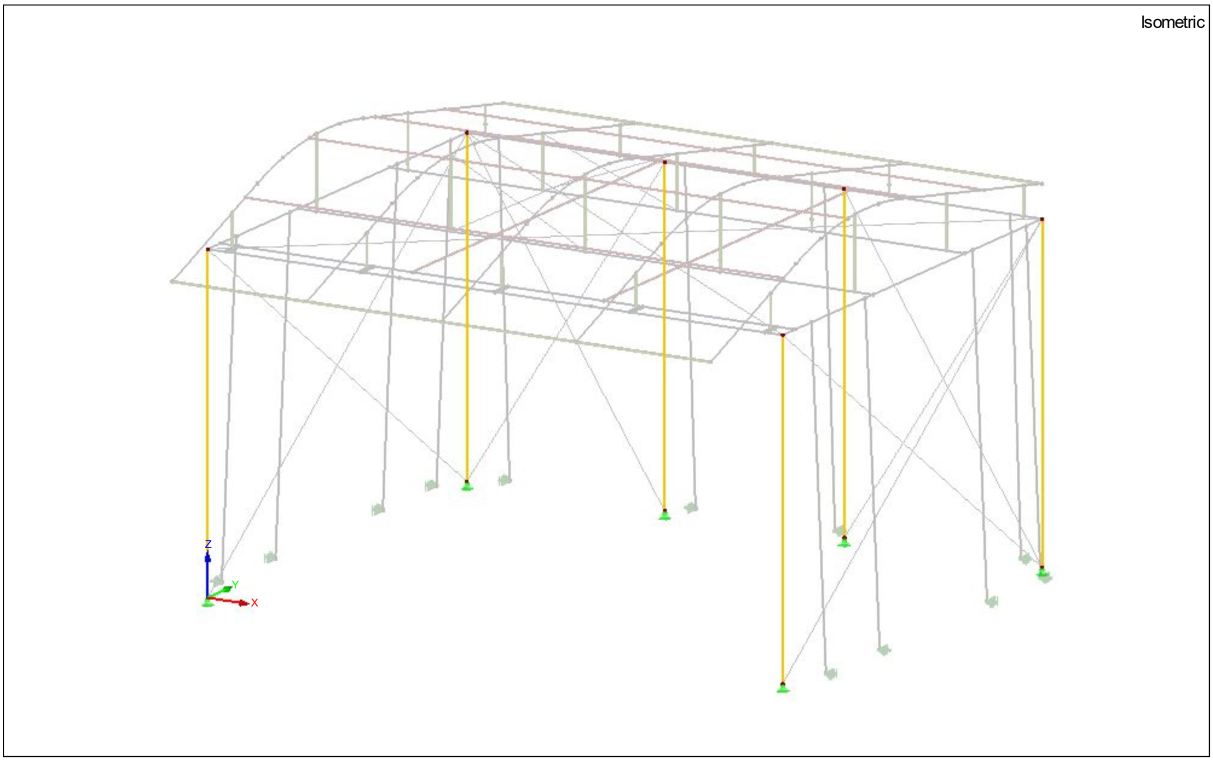

Max M-T: 2.66, Min M-T: -2.67 kNm


RC 5: SW + loading + Out service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
32.09
26.28
20.47
14.66
8.85
3.05
-2.76
-8.57
-14.38
-20.19
-26.00
-31.81
Max: 32.09
Min: -31.81
Max M-y: 32.09, Min M-y: -31.81 kNm

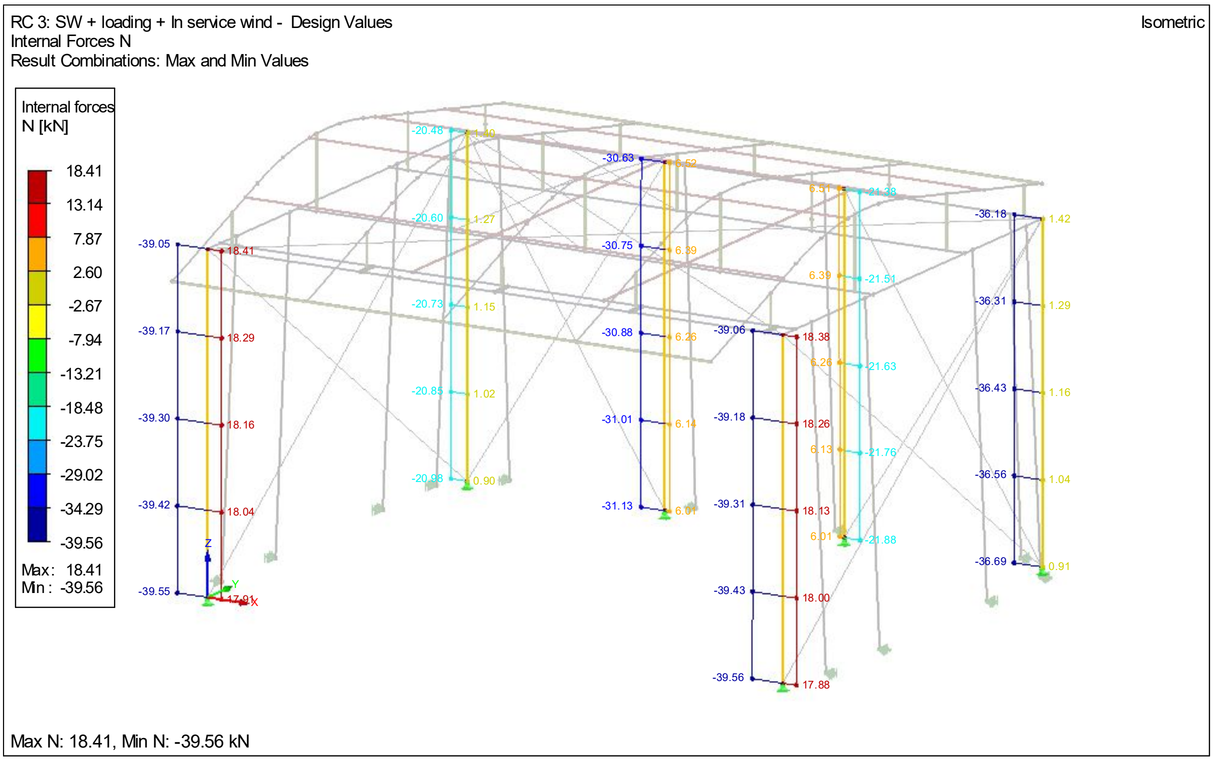

RC 5: SW + loading + Out service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
6.78
5.58
4.38
3.18
1.97
0.77
-0.43
-1.63
-2.83
-4.03
-5.24
-6.44
Max: 6.78
Min: -6.44
Max M-z: 6.78, Min M-z: -6.44 kNm

## 4.0 Detail calculations for different parts.

### 4.1 Detail calculation of tower.

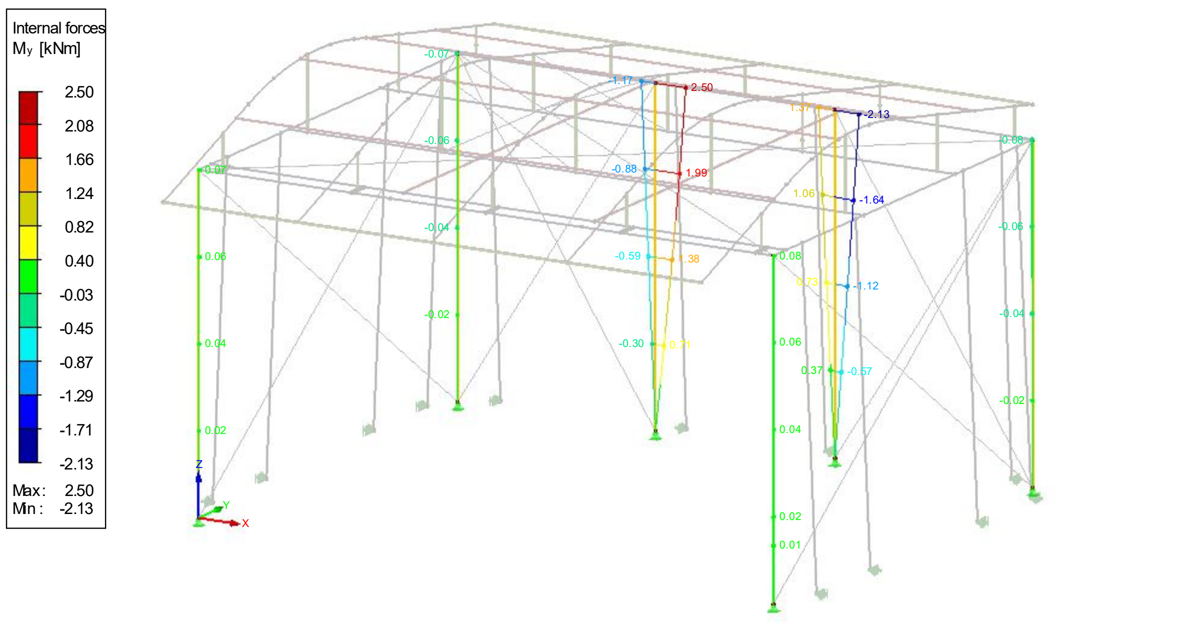



The in service situation presents the highest internal forces.



RC 3: SW + loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values

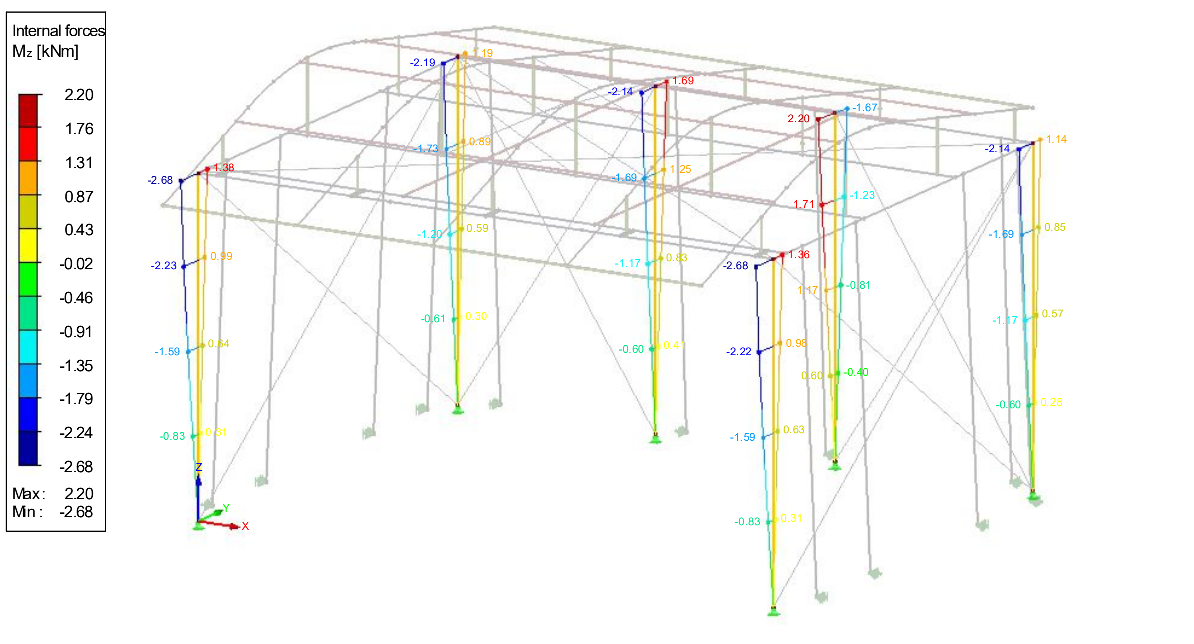
Isometric




Max M-y: 2.50, Min M-y: -2.13 kNm

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric




Max M-z: 2.20, Min M-z: -2.68 kNm

Check of the front Tower

Maximum internal forces in the front tower

N = 39.56 kN

$M_y$ = 0.07 kNm

$M_z$ = 2.68 kNm

$N_{ED,\ main\ chord} = N / 4 + M_y / 2 / height_{(centre\ to\ centre)} + M_z / 2 / width_{(centre\ to\ centre)}$

$N_{ED,\ main\ chord} = 39.56 / 4 + 0.07 / 2 / 0.239 + 2.68 / 2 / 0.239 = 15.64\ kN < 50.22\ kN$

Buckling calculation:

Buckling Length factor K = 1.5

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

$L_{cr} = 1.5 * 700 = 1050$

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

$\lambda_z = 1050 / ( 11.12 * \pi) * \sqrt{((16.96 * 25 ) / ( 16.96 * 7000 ))} = 1.796$

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

$\Theta_z = 0.5 * ( 1 + 0.2 * ( 1.796 - 0.10 ) + 1.796^2 ) = 2.283$

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

$X_z = 1 / (2.283 + \sqrt{( 2.283^2 - 1.796^2 )}) = 0.271$

$( N / (X_z * N_{RD} ))^{0.8} + (( M_y / M_{y,RD} )^{1,7} + ( M_z / M_{z,RD} )^{1,7} )^{0.6} < 1$

$( 39.56 / ( 0.271 * 200.88 ))^{0.8} + (( 0.07 / 24 )^{1,7} + ( 2.68 / 24 )^{1,7} )^{0.6} = 0.88 < 1$

Check of the stack tower

Maximum internal forces in the stack tower

$N =$ 31.13 kN

$M_y =$ 2.50 kNm

$M_z =$ 2.14 kNm

$N_{ED,\ main\ chord} = N / 4 + M_y / 2 / height_{(centre\ to\ centre)} + M_z / 2 / width_{(centre\ to\ centre)}$

$N_{ED,\ main\ chord} = 31.13 / 4 + 2.50 / 2 / 0.239 + 2.14 / 2 / 0.239 = 17.48\ kN < 50.22\ kN$

Buckling calculation:

Buckling Length factor K = 1.25

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

$L_{cr} = 1.25 * 700 = 875$

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

$\lambda_z = 875 / ( 11.12 * \pi) * \sqrt{((16.96 * 250) / (16.96 * 7000))} = 1.497$

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

$\Theta_z = 0.5 * ( 1 + 0.2 * ( 1.497 - 0.10 ) + 1.497^2 ) = 1.760$

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

$X_z = 1 / (1.760 + \sqrt{( 1.760^2 - 1.497^2 )}) = 0.372$

$( N / (X_z * N_{RD} ))^{0.8} + (( M_y / M_{y,RD} )^{1,7} + ( M_z / M_{z,RD} )^{1,7} )^{0.6} < 1$

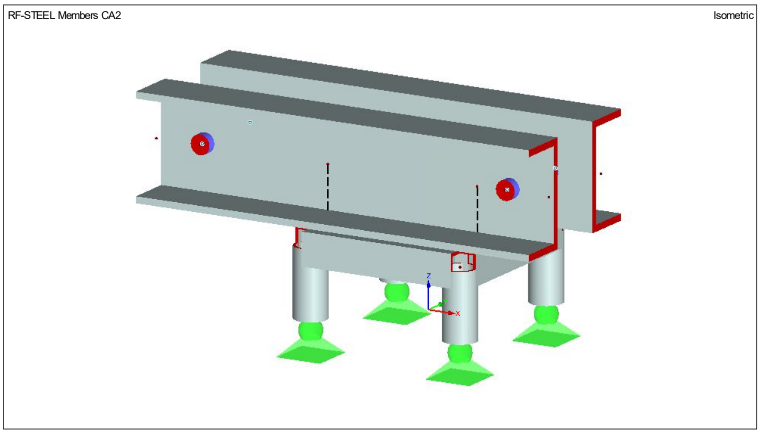
$( 31.13 / ( 0.636 * 200.88 ))^{0.8} + (( 2.50 / 24 )^{1,7} + ( 2.14 / 24 )^{1,7} )^{0.6} = 0.64 < 1$

## 4.2 Detailed calculation of the tower head section and safety system.

### 4.2.1 Detailed calculation of the tower head section.

### Construction model

The calculation of the tower top section has been done in a separate model.




### Cross section description

| Section No. | Material No. | Cross-Section Description |
|---|---|---|
| 1 | 1 | UM 80/160/10/10 |
| 2 | 3 | HK 50/50/5/5/5/5 |
| 3 | 2 | Circle 30 |
| 4 | 3 | Ring 50/4 |

### Used material

| Material No. | Material Description | Safety Factor $\gamma_M$ [-] | Yield Strength $f_{yk}$ [kN/cm²] | Limit Stresses [kN/cm²] Manually | Limit $\sigma_x$ | Limit $\tau$ | Limit $\sigma_{eqv}$ |
|---|---|---|---|---|---|---|---|
| 1 | Aluminium EN-AW 6060 (ET,EP,ER/B) T6* \| EN 1999-1-1:2007 | 1,10 | 11,50 | - | 10,45 | 6,04 | 10,45 |
| 2 | ETG100+W3000C | 1.10 | 90.00 | - | 81.82 | 47.24 | 81.82 |
| 3 | Aluminium EN-AW 6082 (EP,ET) T6* \| EN 1999-1-1:2007 | 1,10 | 12,50 | - | 11,36 | 6,56 | 11,36 |

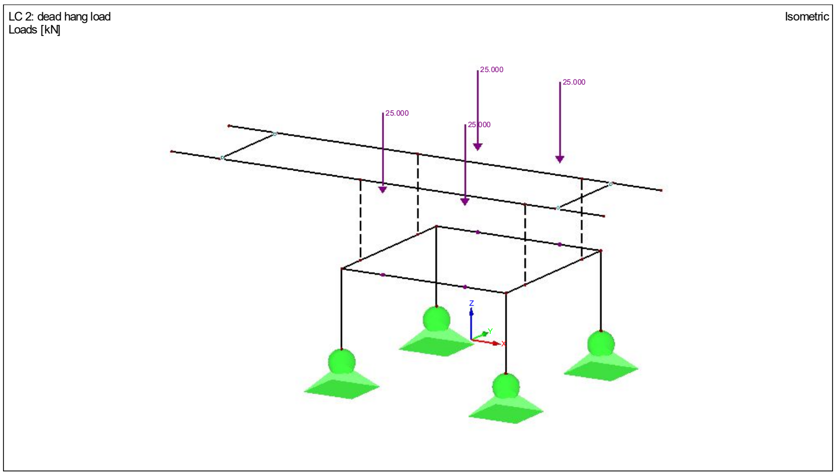
The Yield strength has been manually changed in 12.5 kN/cm². This is according to the Eurocode NEN-EN 1999-1-1 Table 3.2 the $f_{o,haz}$ for the heat affective zone. This check is concerning a welded construction with heat affective zones in the main elements, there for the choice to check the construction according to the lower $f_{o\ haz}$.

## Load cases

| Load Case | Load Case Description | To Solve |
|---|---|---|
| LC1 | Self-Weight Construction | + |
| LC2 | dead hang load | + |
| LC3 | lifting load | + |

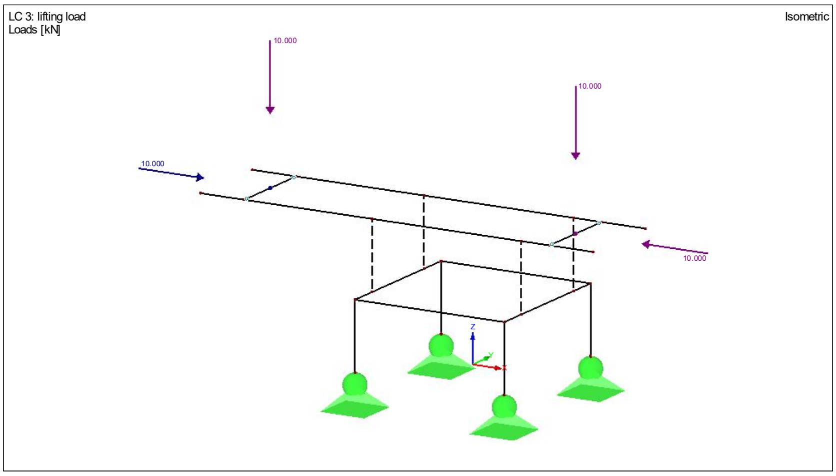
Load case 1 is the self-weight of the Top section which is calculated by the program itself.

Load case 2 dead hang of the system.




The forces which are taken into account are the maximum normal force in a single tower in RC1 of the general model. This is the design calculation including all the load cases multiplied with the different Partial safety factors, therefor the safety factor in the load combination CO1 is set to 1 instead of 1.5. The maximum load is set on one side of the top section for the case if 1 chain is taken all the load.

Load case 3 lifting of the system

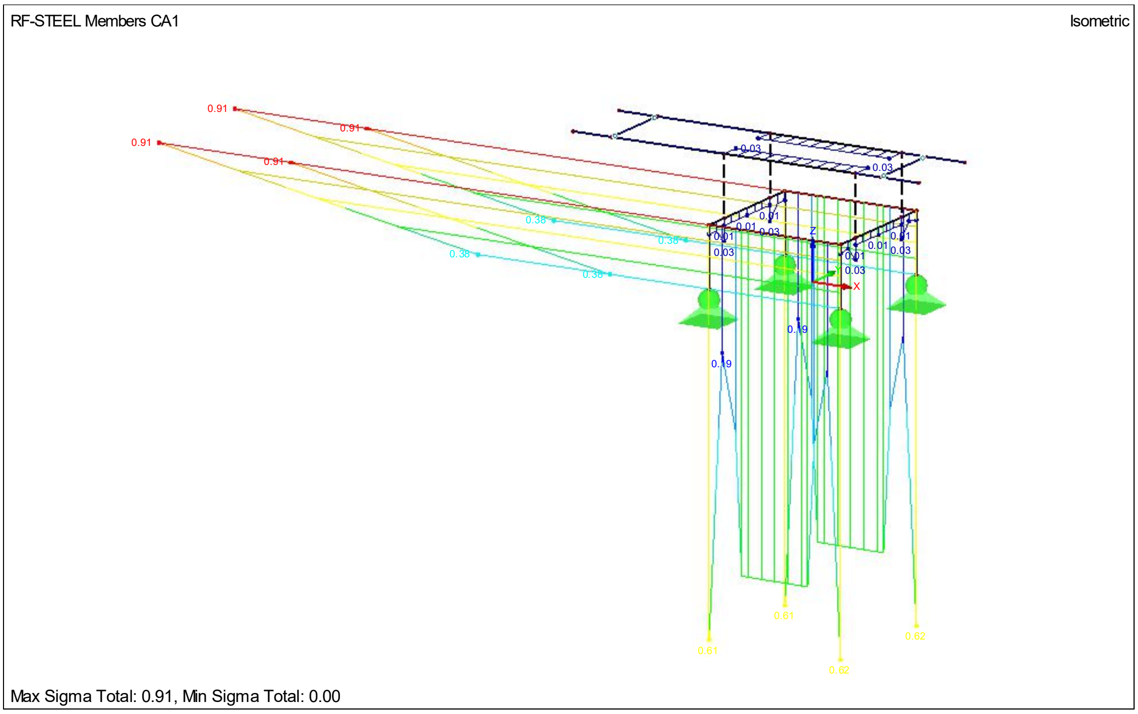


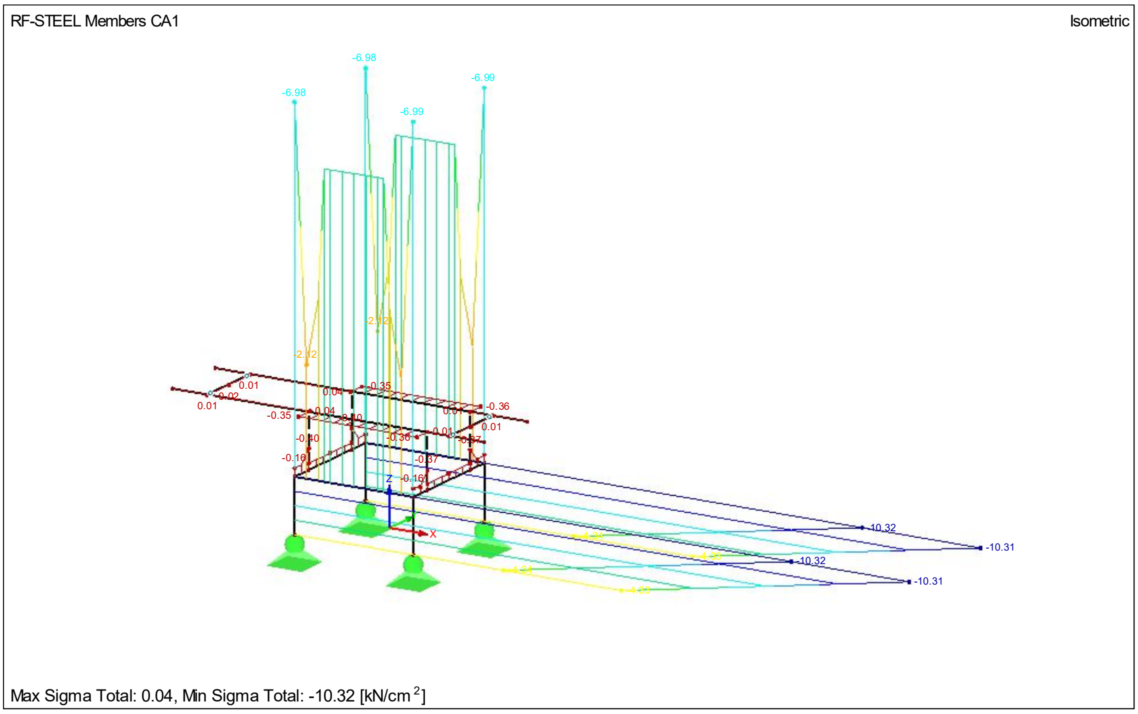

The forces which are taken into account are when using a 1 ton chain hoist.

## Load combinations

| Load Combin. | DS | Load Combination Description | To Solve | LC.1 Factor | LC.1 No. | LC.2 Factor | LC.2 No. |
|---|---|---|---|---|---|---|---|
| CO1 | 0 | 1.35*LC1 + LC2 | + | 1,350 | LC1 | 1,000 | LC2 |
| CO2 | 0 | 1.35*LC1 + 1.5*LC3 | + | 1,350 | LC1 | 1,500 | LC3 |

## Stress calculation for dead hang of the system.



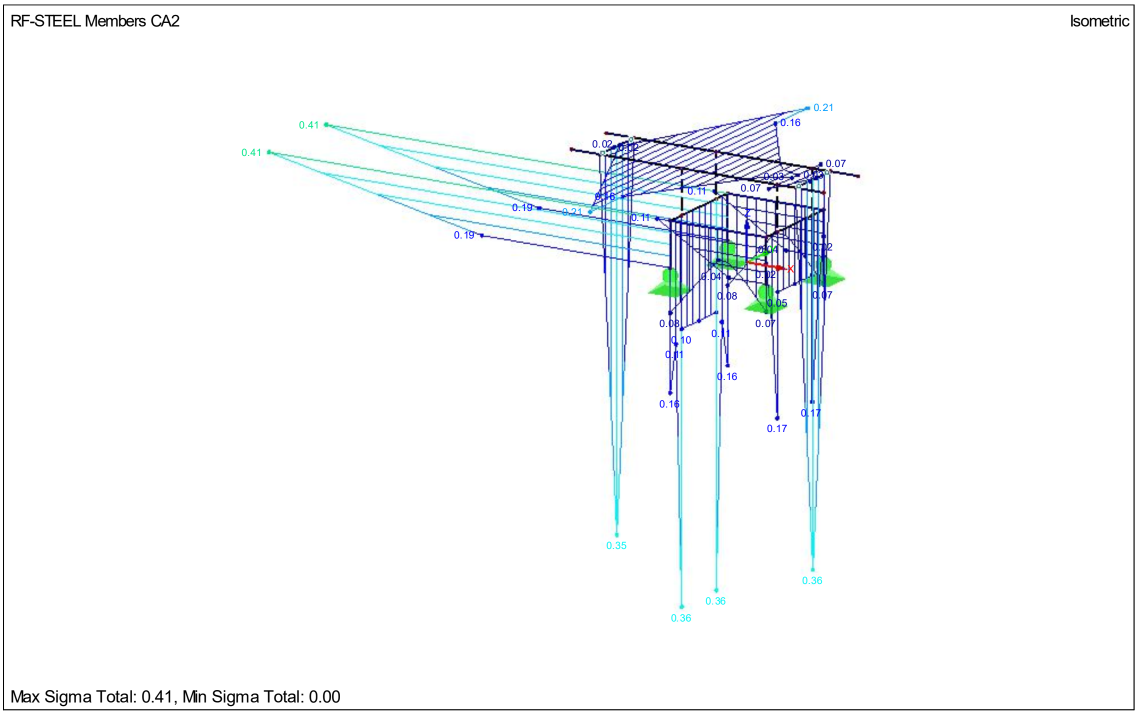



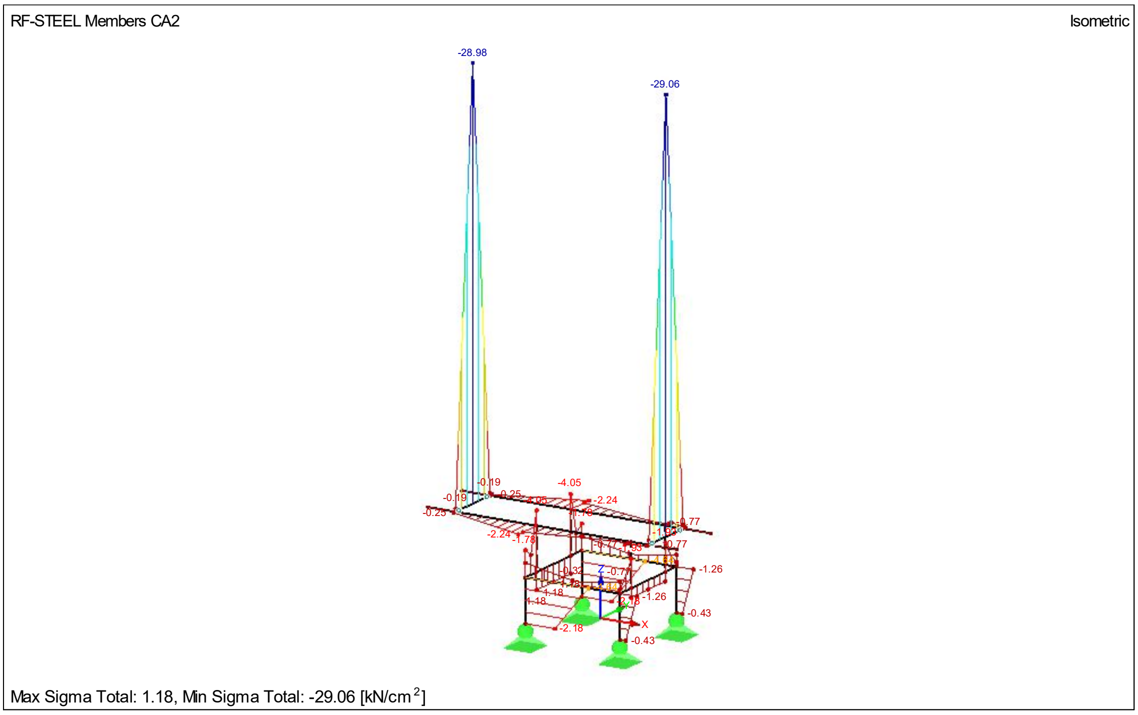
# Maximum Stress analyses per cross section

| Section No. | Member No. | Location x [m] | S-Point No. | Load-ing | Stress Type | Stress [kN/cm²] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 1 | UM 80/160/10/10 | | | | | | | |
| | 27 | 0,239 | 1 | CO1 | Sigma Total | -0,36 | 10,45 | 0,03 |
| | 21 | 0,239 | 12 | CO1 | Tau Total | 0,02 | 6,04 | 0,00 |
| | 21 | 0,239 | 4 | CO1 | Sigma-eqv | 0,36 | 10,45 | 0,03 |
| | | | | | | | | |
| 2 | HK 50/50/5/5/5/5 | | | | | | | |
| | 6 | 0,000 | 14 | CO1 | Sigma Total | -6,99 | 11,36 | 0,62 |
| | 6 | 0,215 | 8 | CO1 | Tau Total | 6,20 | 6,56 | 0,95 |
| | 6 | 0,215 | 16 | CO1 | Sigma-eqv | 10,75 | 11,36 | 0,95 |
| | | | | | | | | |
| 3 | Circle 30 | | | | | | | |
| | 13 | 0,072 | 28 | CO1 | Sigma Total | 0,02 | 81,82 | 0,00 |
| | 38 | 0,000 | 37 | CO1 | Tau Total | 0,00 | 47,24 | 0,00 |
| | 13 | 0,072 | 28 | CO1 | Sigma-eqv | 0,02 | 81,82 | 0,00 |
| | | | | | | | | |
| 4 | Ring 50/4 | | | | | | | |
| | 2 | 0,000 | 28 | CO1 | Sigma Total | -10,32 | 11,36 | 0,91 |
| | 1 | 0,105 | 19 | CO1 | Tau Total | -1,25 | 6,56 | 0,19 |
| | 2 | 0,000 | 28 | CO1 | Sigma-eqv | 10,32 | 11,36 | 0,91 |

The maximum utilisation in the the dead hang load case is 91%.

Stress calculation for the lifting of the system.



Maximum Stress analyses per cross section

| Section No. | Member No. | Location x [m] | S-Point No. | Load-ing | Stress Type | Stress [kN/cm²] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 1 | UM 80/160/10/10 | | | | | | | |
| | 20 | 0,205 | 1 | CO2 | Sigma Total | -2,24 | 10,45 | 0,21 |
| | 21 | 0,239 | 12 | CO2 | Tau Total | 0,60 | 6,04 | 0,10 |
| | 20 | 0,205 | 1 | CO2 | Sigma-eqv | 2,24 | 10,45 | 0,21 |
| | | | | | | | | |
| 2 | HK 50/50/5/5/5/5 | | | | | | | |
| | 7 | 0,047 | 2 | CO2 | Sigma Total | -4,05 | 11,36 | 0,36 |
| | 7 | 0,000 | 8 | CO2 | Tau Total | 3,03 | 6,56 | 0,46 |
| | 7 | 0,047 | 2 | CO2 | Sigma-eqv | 5,42 | 11,36 | 0,48 |
| | | | | | | | | |
| 3 | Circle 30 | | | | | | | |
| | 38 | 0,072 | 14 | CO2 | Sigma Total | -29,06 | 81,82 | 0,36 |
| | 38 | 0,000 | 37 | CO2 | Tau Total | 2,00 | 47,24 | 0,04 |
| | 38 | 0,072 | 14 | CO2 | Sigma-eqv | 29,06 | 81,82 | 0,36 |
| | | | | | | | | |
| 4 | Ring 50/4 | | | | | | | |
| | 2 | 0,000 | 18 | CO2 | Sigma Total | -4,64 | 11,36 | 0,41 |
| | 2 | 0,105 | 27 | CO2 | Tau Total | -0,54 | 6,56 | 0,08 |
| | 3 | 0,000 | 2 | CO2 | Sigma-eqv | 4,64 | 11,36 | 0,41 |

The utilisation of the 30mm pin used for the dead hang chain is 41%.

Bearing forces of the holes in the U profile.

Material = EN AW-6060-T6

$f_u$ = 17,0 Kn/cm²

T = 10 mm

D = 30 mm

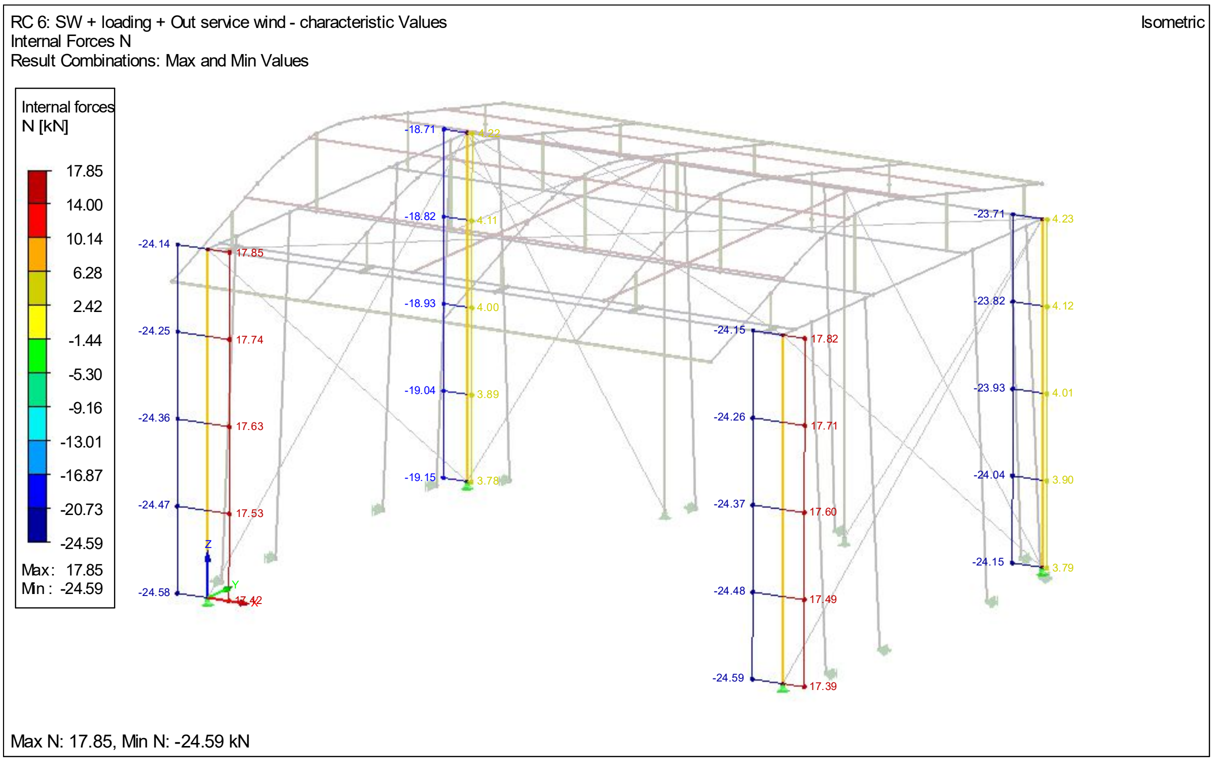
$F_{b, Ed} = \sqrt{(7.52^2 + 7.52^2)} = 7.52$ kN

$F_{b, Rd} = 1.5 * f_u * D * T / \gamma_{m2} = 1,5 * 17 * 3 * 1 / 1.25 = 61.2$ kN

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

7.52 / 61.2 = 0.12 < 1

### 4.2.2 check of the dead hang chain




normative load result is RC4 In service characteristic values

Maximum down force at the top of the tower is 29.52 kN

The chains are checked against the characteristic values, because the SWL of the chain has a safety factor of 4 taken into count.

This maximum down force is divided into two chain falls, which means the maximum force in the chain is

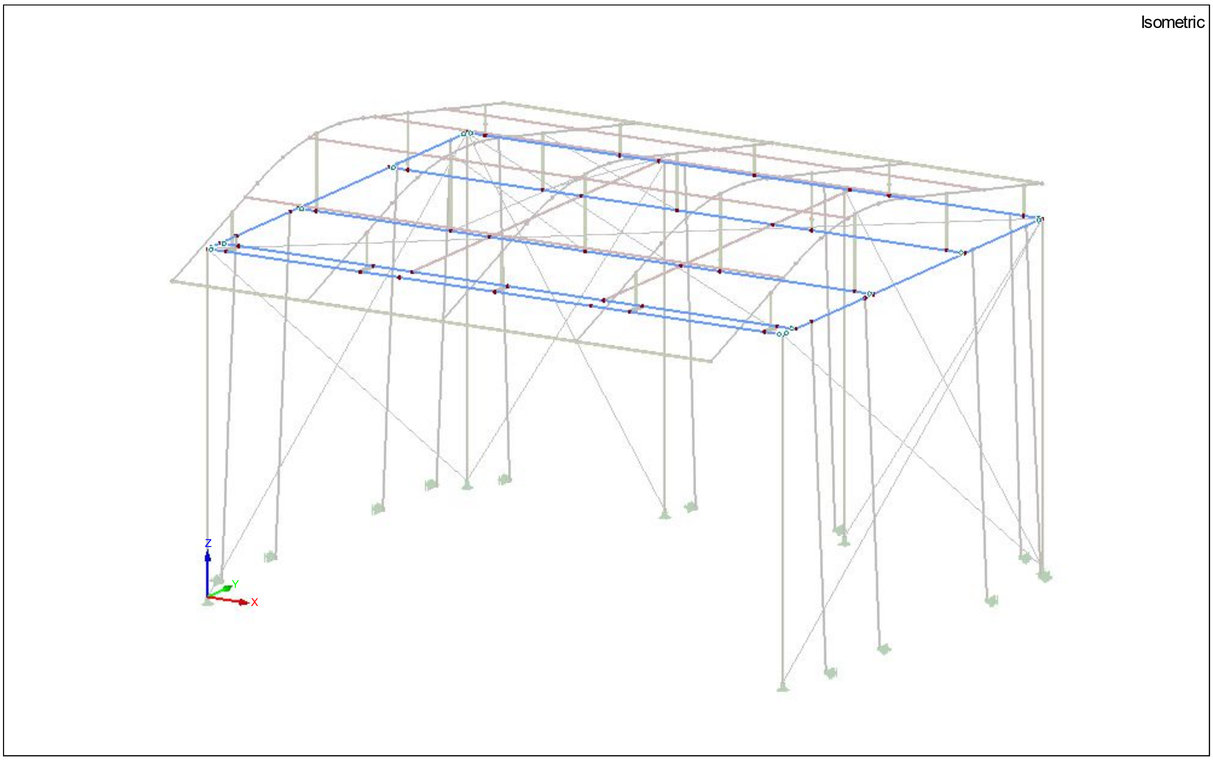
$F_{chain} = N_{Ed,\,max} / 2 = 29.52 / 2 = 14.76$ kN

The used chain has a SWL of 15 kN

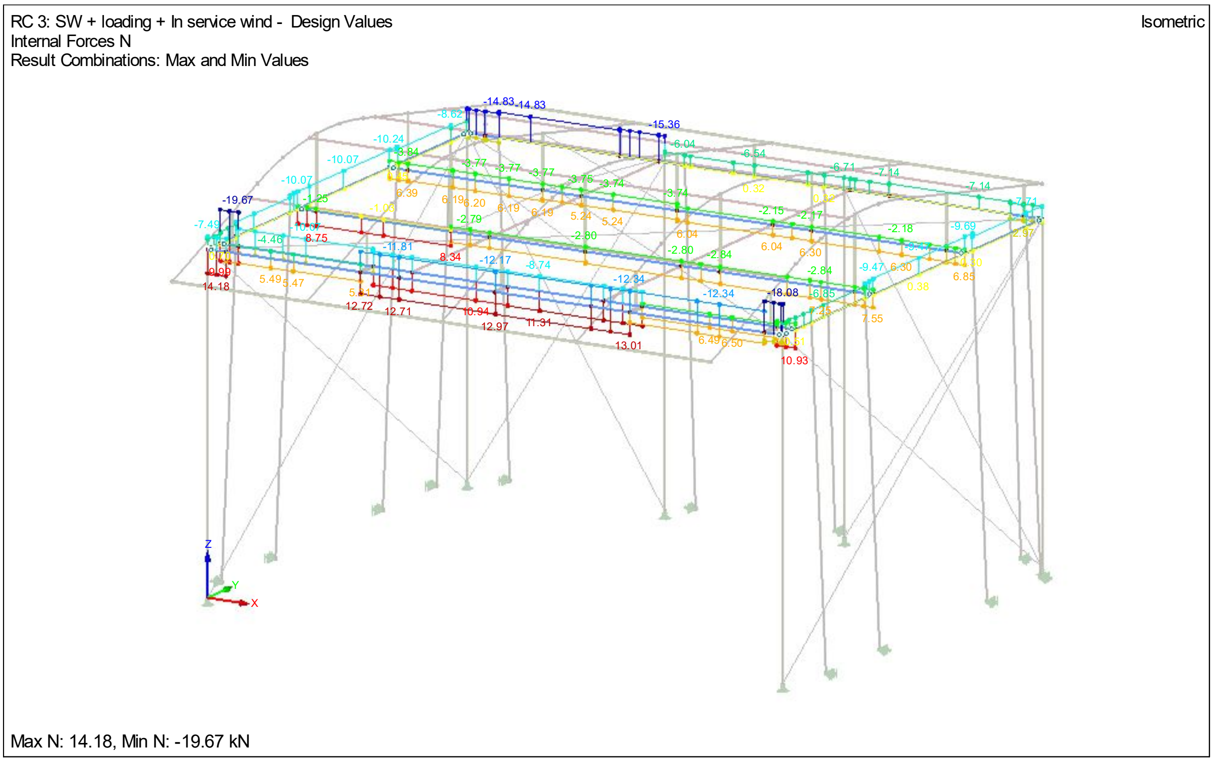
Check $F_{chain} / SWL < 1$

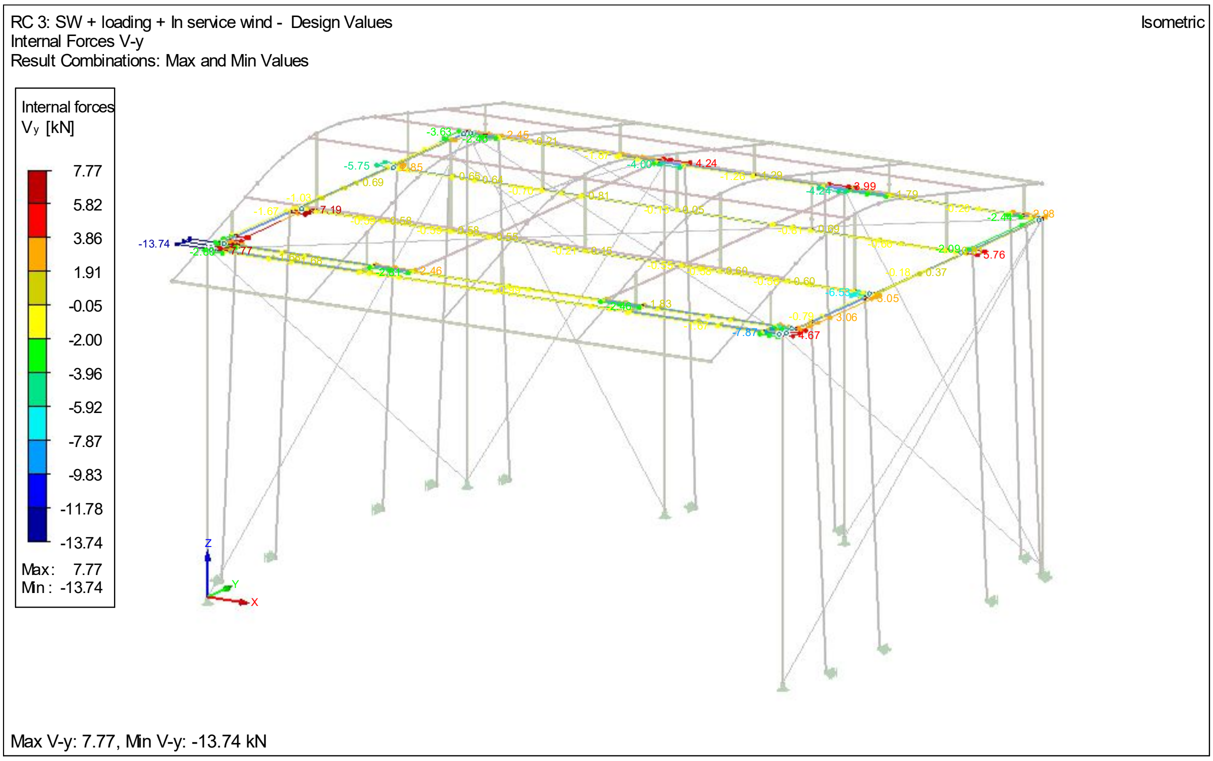
$14.76 / 15 = 0.98 < 1$

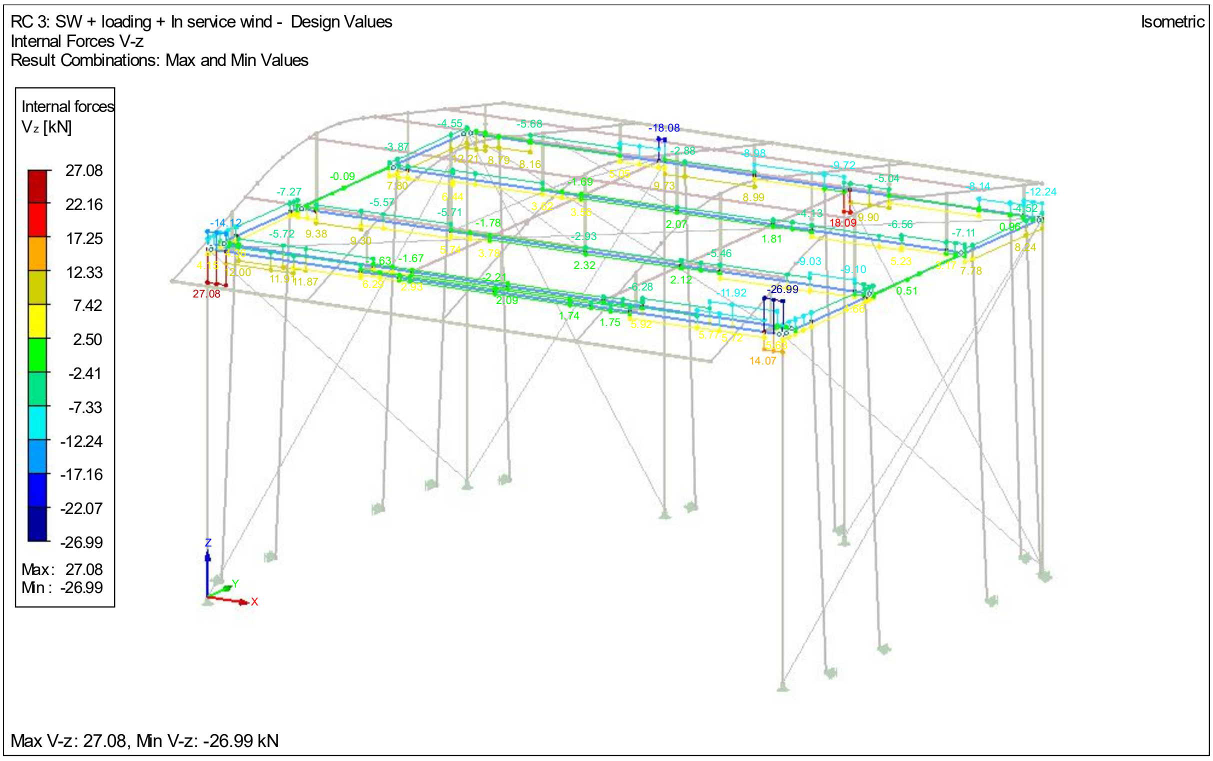
## 4.3 Detailed calculation of the main grid constructed from H40V.

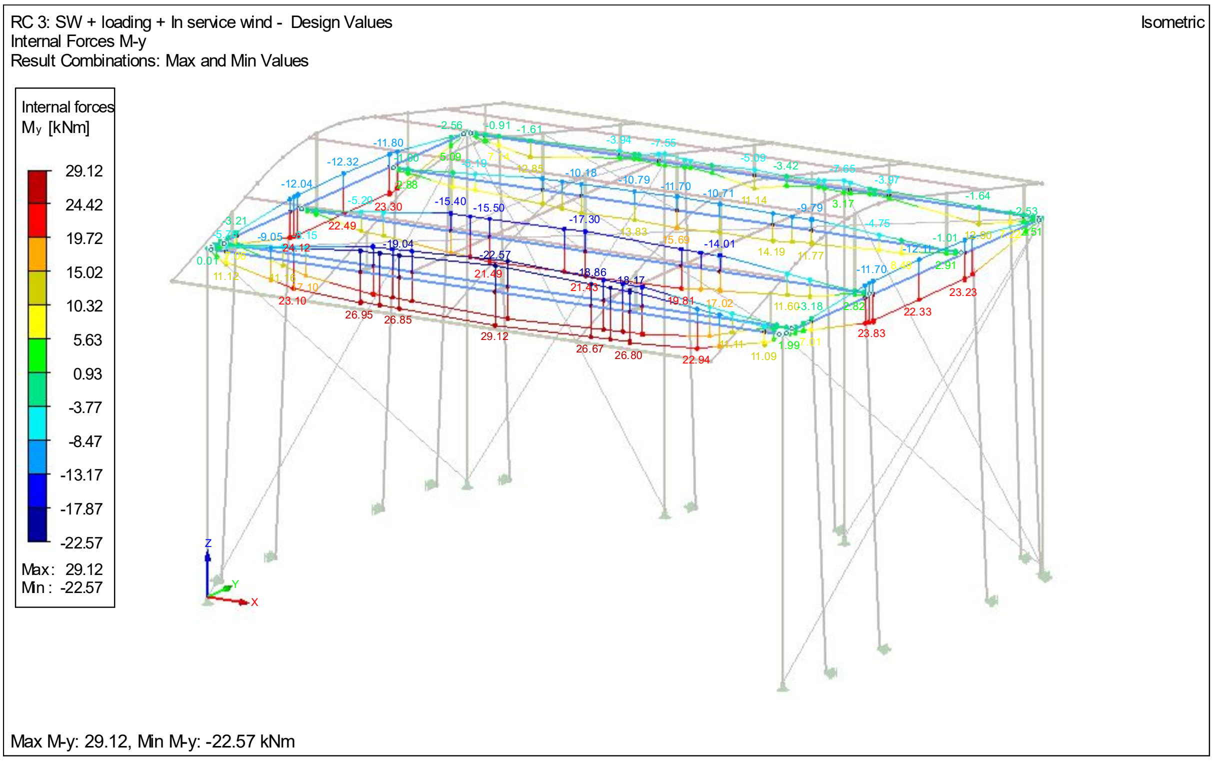


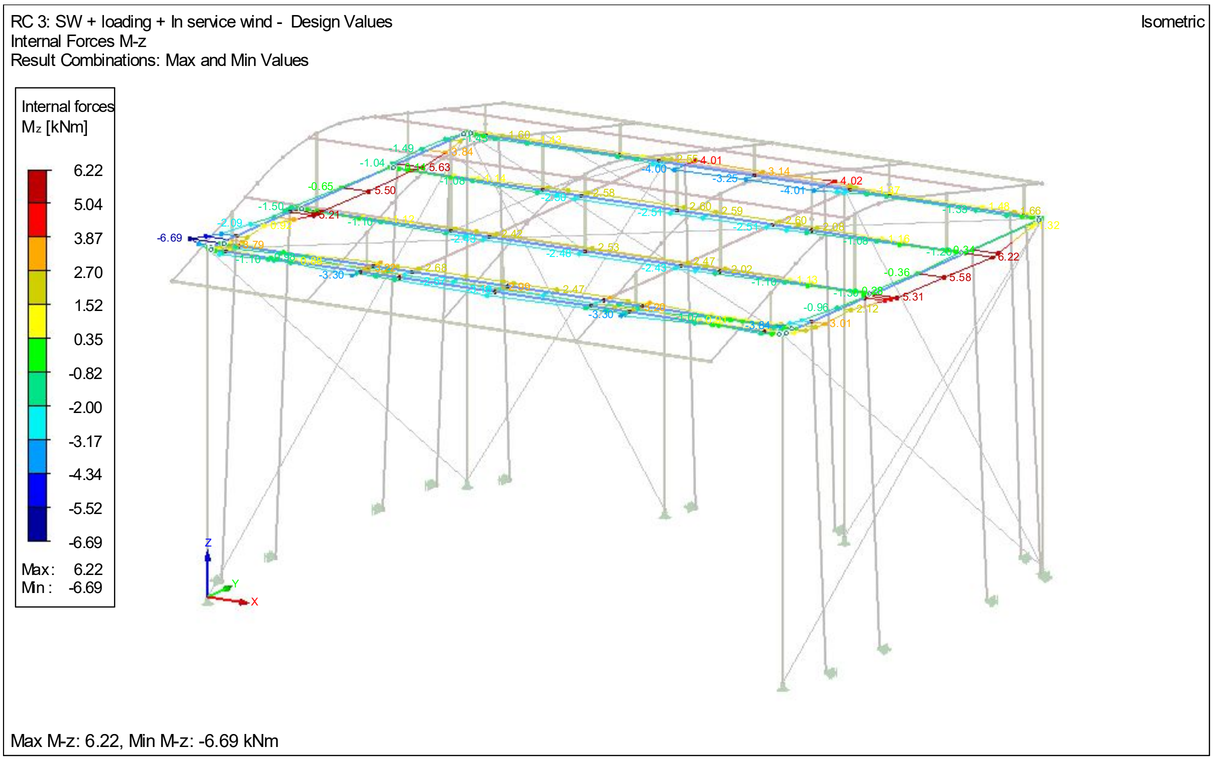

### 4.3.1 Calculation results for the In-service situation.




RC 3: SW + loading + In service wind - Design Values
Isometric
Internal Forces V-y
Result Combinations: Max and Min Values
Internal forces
Vy [kN]
7.77
5.82
3.86
1.91
-0.05
-2.00
-3.96
-5.92
-7.87
-9.83
-11.78
-13.74
Max: 7.77
Min: -13.74
Z
Y
X
Max V-y: 7.77, Min V-y: -13.74 kN


RC 3: SW + loading + In service wind - Design Values
Isometric
Internal Forces V-z
Result Combinations: Max and Min Values
Internal forces
Vz [kN]
27.08
22.16
17.25
12.33
7.42
2.50
-2.41
-7.33
-12.24
-17.16
-22.07
-26.99
Max: 27.08
Min: -26.99
Z
Y
X
Max V-z: 27.08, Min V-z: -26.99 kN

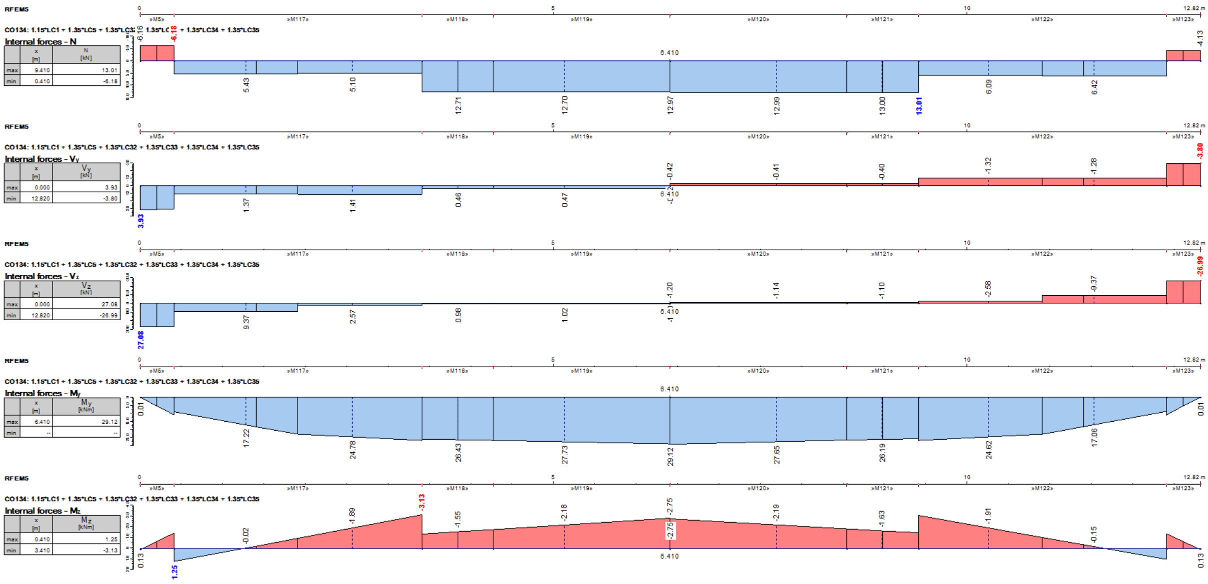

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
29.12
24.42
19.72
15.02
10.32
5.63
0.93
-3.77
-8.47
-13.17
-17.87
-22.57
Max: 29.12
Min: -22.57
Max M-y: 29.12, Min M-y: -22.57 kNm


RC 3: SW + loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
6.22
5.04
3.87
2.70
1.52
0.35
-0.82
-2.00
-3.17
-4.34
-5.52
-6.69
Max: 6.22
Min: -6.69
Max M-z: 6.22, Min M-z: -6.69 kNm

### 4.3.2 Internal forces for different spans in the In-service situation.

Span 1 : front span

Normative Load combination CO134



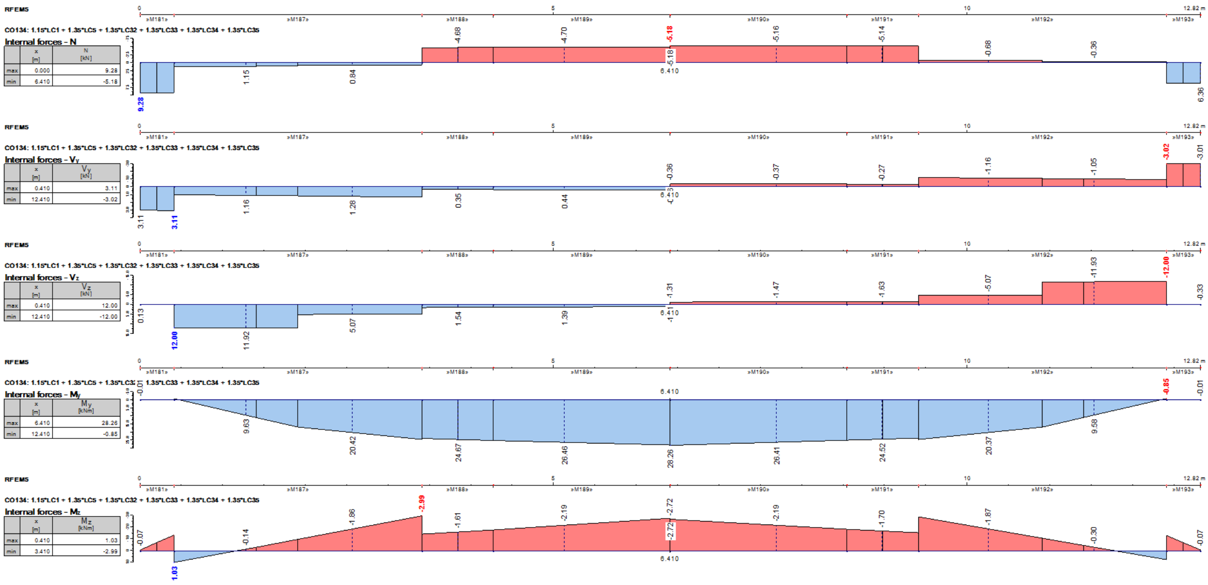
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 12.97$ kN
$V_{dy} = 0.42$ kN
$V_{dz} = 1.20$ kN
$M_{dy} = 29.12$ kN
$M_{dz} = 2.75$ kN
$V_{d,\,main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.42^2 + 1.20^2)}$
$V_{d,\,main\ chord} = 0.317$ kN
$M_{d,\,main\ chord} = V_{d,\,main\ chord} * e = 0.317 * 0.05$
$M_{d,\,main\ chord} = 0.015$ kNcm
$N_{d,\,main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\,main\ chord} = 12.97 / 4 + 29.12 / 2 / 0.339 + 2.75 / 2 / 0.339$
$N_{d,\,main\ chord} = 50.25$ kN

Check
$\eta = ( N_{d,\,main\ chord} / N_{Rd} )^{1.3} + M_{d,\,main\ chord} / M_{Rd}$
$\eta = ( 50.25 / 50.22 )^{1.3} + 0.015 / 0.532 = 1.02 \sim 1$

Span 2 : second span from the front

Normative Load combination CO134



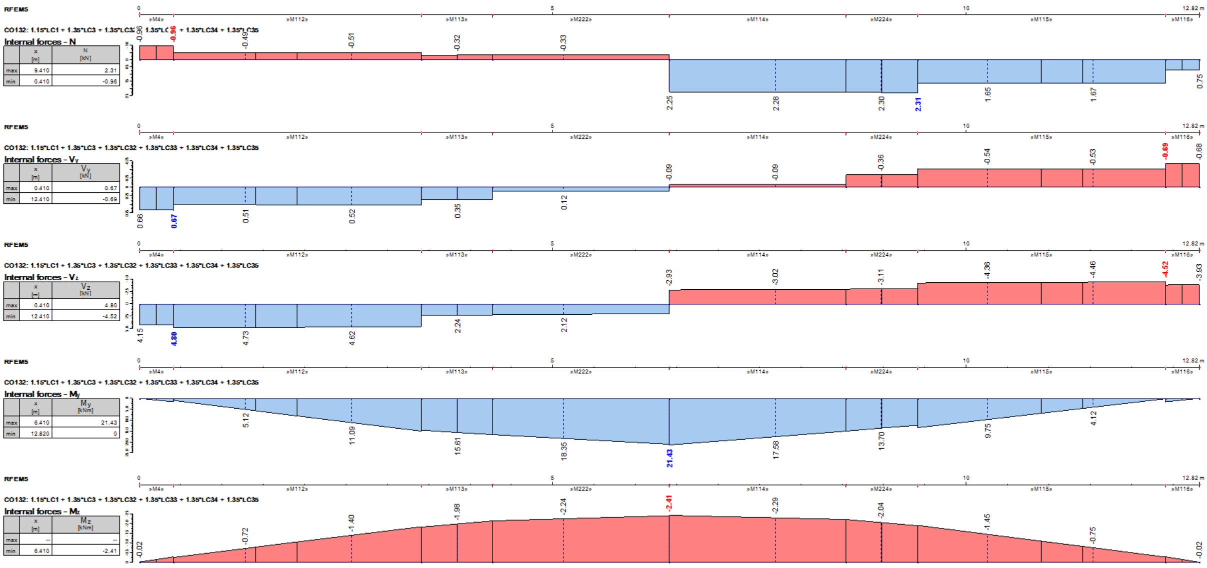
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 5.18$ kN
$V_{dy} = 0.43$ kN
$V_{dz} = 1.23$ kN
$M_{dy} = 28.26$ kN
$M_{dz} = 2.80$ kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{}(V_{dy}^2 + V_{dz}^2) = 0.25 * \sqrt{}(\ 0.43^2 + 1.23^2)$
$V_{d,\ main\ chord} =\ 0.325$ kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e\ = 0.325 * 0.05$
$M_{d,\ main\ chord} = 0.016$ kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 5.18 / 4 + 28.26 / 2 / 0.339 + 2.80 / 2 / 0.339$
$N_{d,\ main\ chord} = 47.11$ kN

Check
$\eta = (\ N_{d,\ main\ chord} / N_{Rd}\ )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = (\ 47.11 / 50.22\ )^{1.3} + 0.016\ / 0.532 = 0.95 < 1$

Span 3 : third span from the front

Normative Load combination CO132



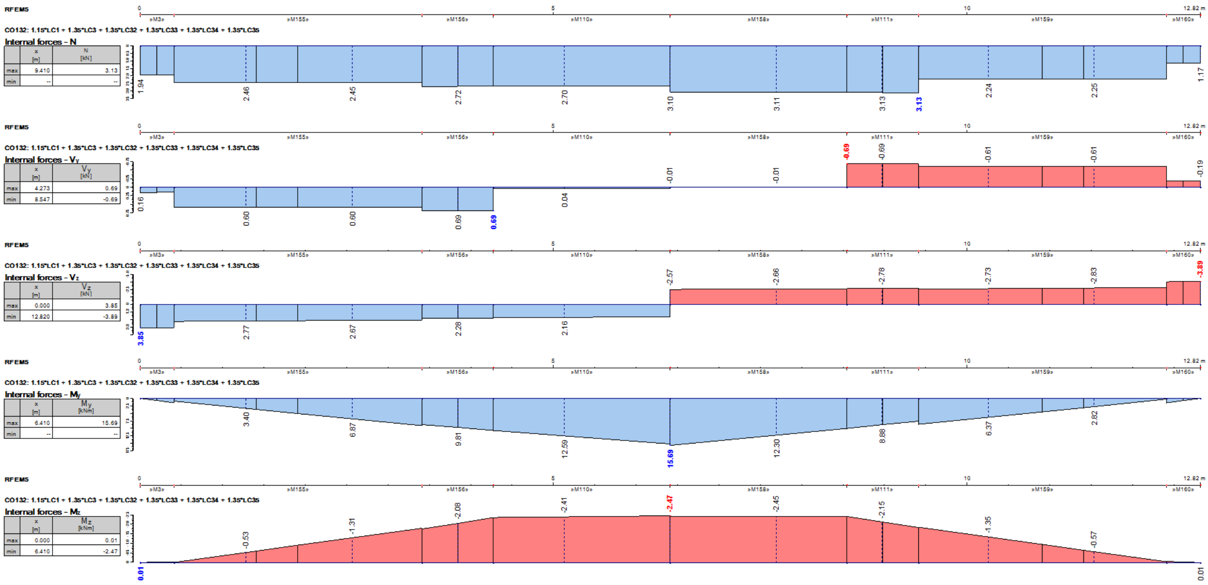
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 2.25$ kN
$V_{dy} = 0.12$ kN
$V_{dz} = 2.93$ kN
$M_{dy} = 21.43$ kN
$M_{dz} = 2.41$ kN
$V_{d, \text{main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.12^2 + 2.93^2)}$
$V_{d, \text{main chord}} = 0.733$ kN
$M_{d, \text{main chord}} = V_{d, \text{main chord}} * e = 0.733 * 0.05$
$M_{d, \text{main chord}} = 0.036$ kNcm
$N_{d, \text{main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d, \text{main chord}} = 2.25 / 4 + 21.43 / 2 / 0.339 + 2.41 / 2 / 0.339$
$N_{d, \text{main chord}} = 35.72$ kN

Check
$\eta = ( N_{d, \text{main chord}} / N_{Rd} )^{1.3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = ( 35.72 / 50.22 )^{1.3} + 0.036 / 0.532 = 0.71 < 1$

Span 4 : fourth span from the front

Normative Load combination CO132



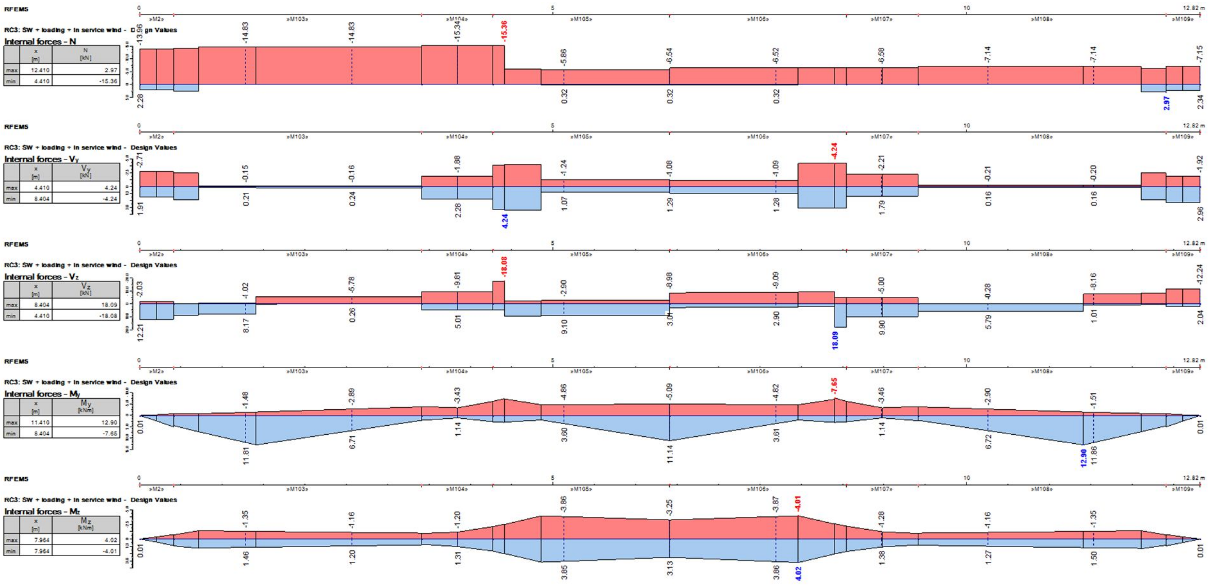
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 3.10$ kN
$V_{dy} = 0.05$ kN
$V_{dz} = 2.57$ kN
$M_{dy} = 15.69$ kN
$M_{dz} = 2.46$ kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.5^2 + 2.57^2)}$
$V_{d,\ main\ chord} = 0.643$ kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.643 * 0.05$
$M_{d,\ main\ chord} = 0.032$ kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 3.10 / 4 + 15.69 / 2 / 0.339 + 2.46 / 2 / 0.339$
$N_{d,\ main\ chord} = 27.54$ kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 27.54 / 50.22 )^{1.3} + 0.032 / 0.532 = 0.52 < 1$

Span 5 : fifth span from the front

Maximum internal forces for RC3



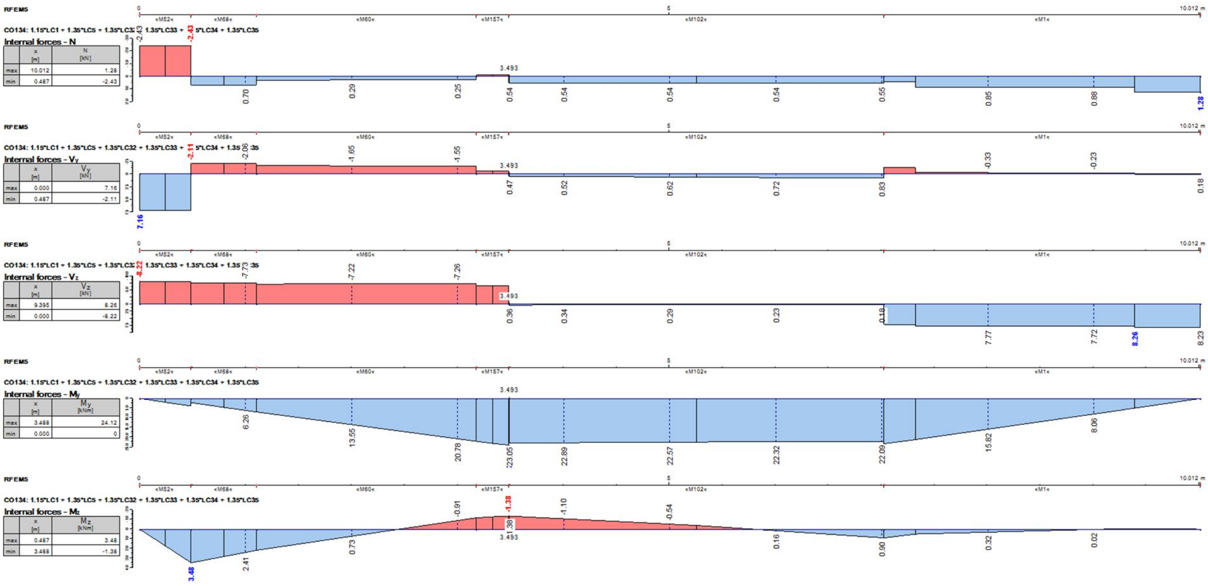
Interaction of moment and transversal force calculation on the maximum position which is at the position of the attachment of the stack tower.

$N_d = 15.36$ kN
$V_{dy} = 4.19$ kN
$V_{dz} = 18.07$ kN
$M_{dy} = 6.20$ kN
$M_{dz} = 2.11$ kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(4.19^2 + 18.07^2)}$
$V_{d,\ main\ chord} = 4.64$ kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 4.64 * 0.05$
$M_{d,\ main\ chord} = 0.232$ kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 15.36 / 4 + 6.20 / 2 / 0.339 + 2.11 / 2 / 0.339$
$N_{d,\ main\ chord} = 16.10$ kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 16.10 / 50.22 )^{1.3} + 0.232 / 0.532 = 0.66 < 1$

Side span left side

Internal forces for the normative load case CO134



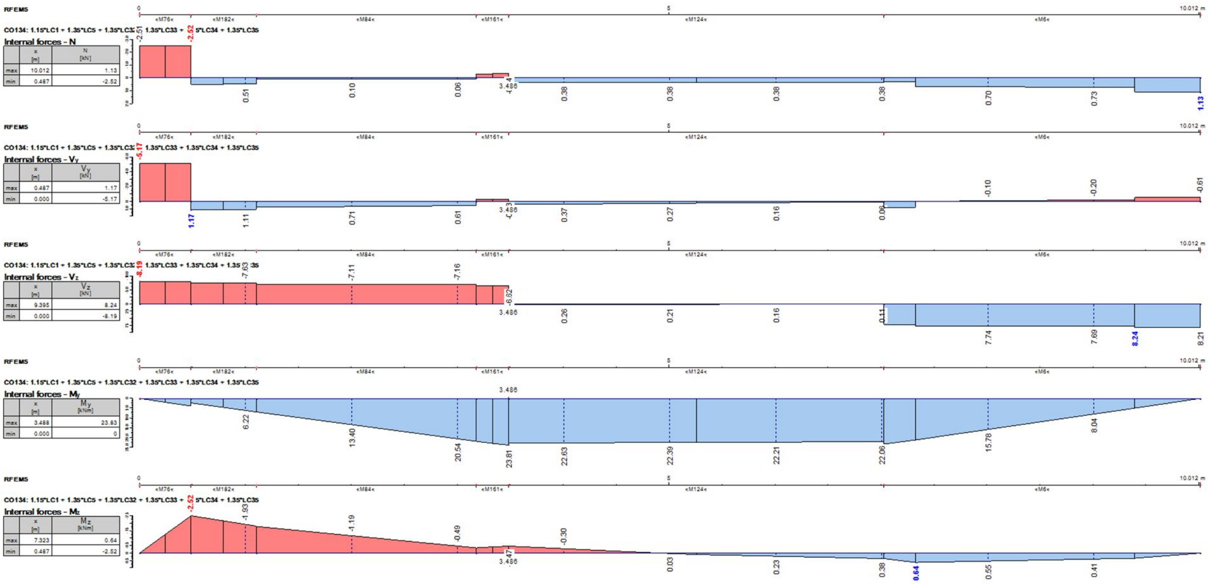
Interaction of moment and transversal force calculation on the maximum position which is at the X= 3.5 m

$N_d$ = 0.54 kN
$V_{dy}$ = 0.61 kN
$V_{dz}$ = 6.72 kN
$M_{dy}$ = 24.10 kN
$M_{dz}$ = 1.38 kN
$V_{d, \text{main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.61^2 + 6.72^2)}$
$V_{d, \text{main chord}}$ = 1.687 kN
$M_{d, \text{main chord}} = V_{d, \text{main chord}} * e = 1.687 * 0.05$
$M_{d, \text{main chord}}$ = 0.084 kNcm
$N_{d, \text{main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d, \text{main chord}} = 0.54 / 4 + 24.10 / 2 / 0.339 + 1.38 / 2 / 0.339$
$N_{d, \text{main chord}}$ = 37.72 kN

Check
$\eta = ( N_{d, \text{main chord}} / N_{Rd} )^{1.3} + M_{d, \text{main chord}} / M_{Rd}$
$\eta = ( 37.72 / 50.22 )^{1.3} + 0.084 / 0.532 = 0.84 < 1$

Side span right side

Internal forces for the normative load case CO134

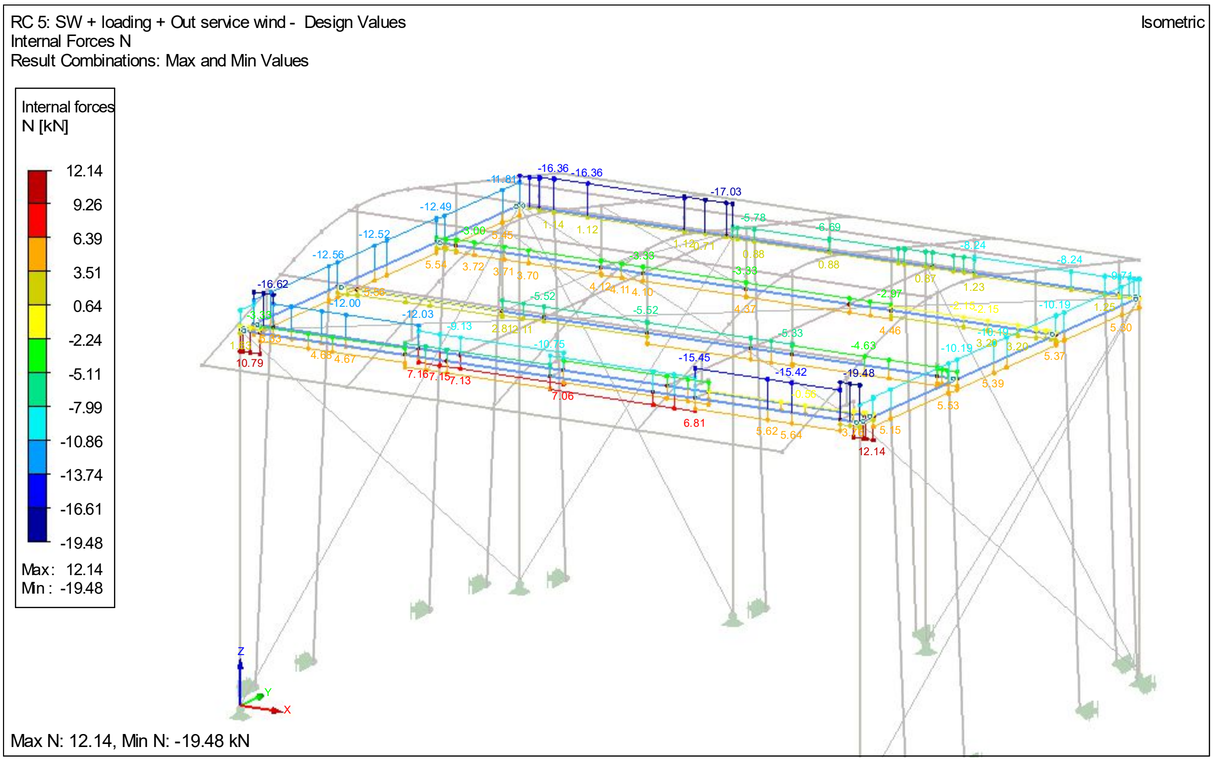


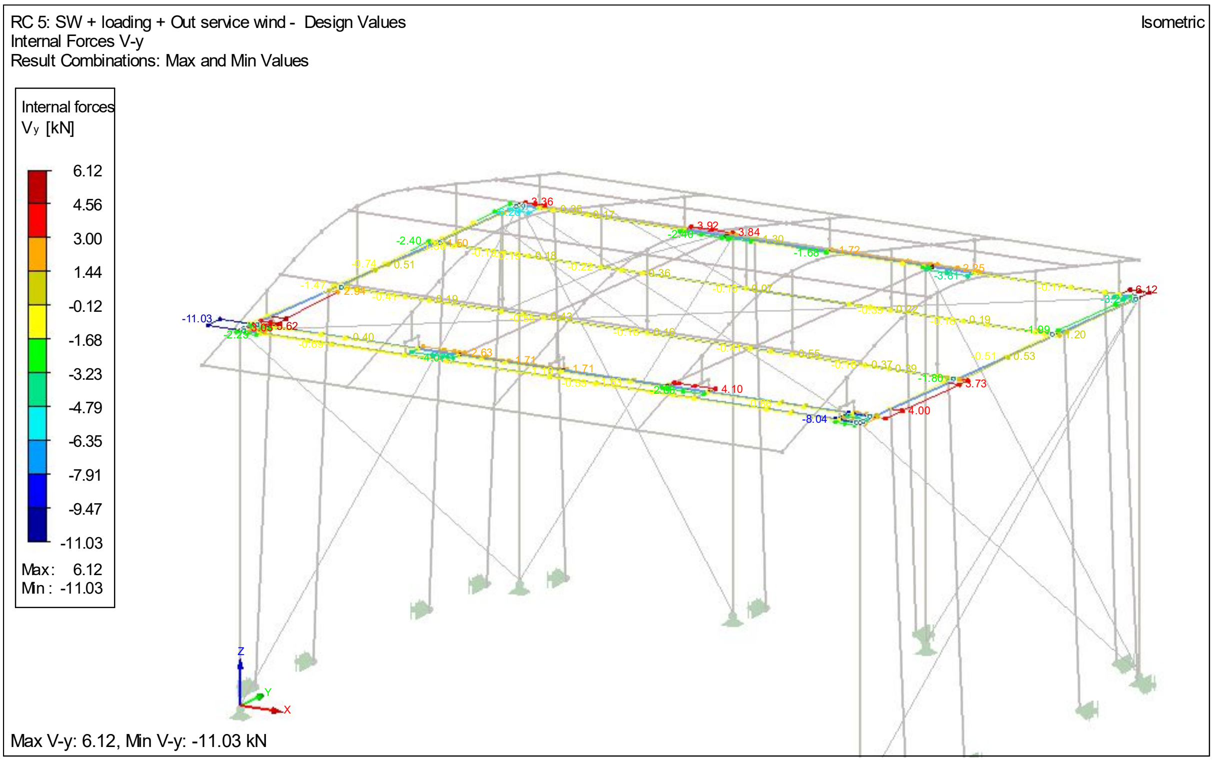
Interaction of moment and transversal force calculation on the maximum position which is at the X= 3.5 m

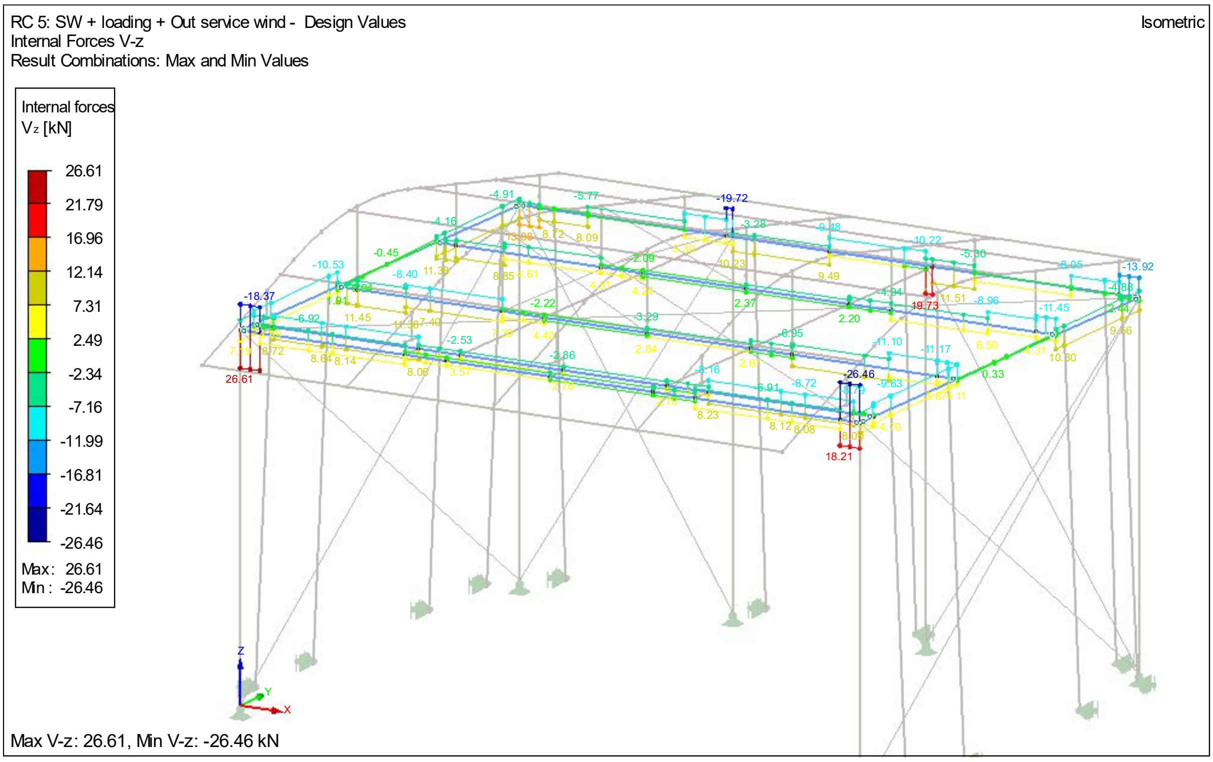
$N_d = 0.38$ kN
$V_{dy} = 0.42$ kN
$V_{dz} = 6.62$ kN
$M_{dy} = 23.83$ kN
$M_{dz} = 0.47$ kN
$V_{d,\text{ main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.42^2 + 6.62^2)}$
$V_{d,\text{ main chord}} = 1.658$ kN
$M_{d,\text{ main chord}} = V_{d,\text{ main chord}} * e = 1.658 * 0.05$
$M_{d,\text{ main chord}} = 0.083$ kNcm
$N_{d,\text{ main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\text{ main chord}} = 0.38 / 4 + 23.83 / 2 / 0.339 + 0.47 / 2 / 0.339$
$N_{d,\text{ main chord}} = 35.94$ kN

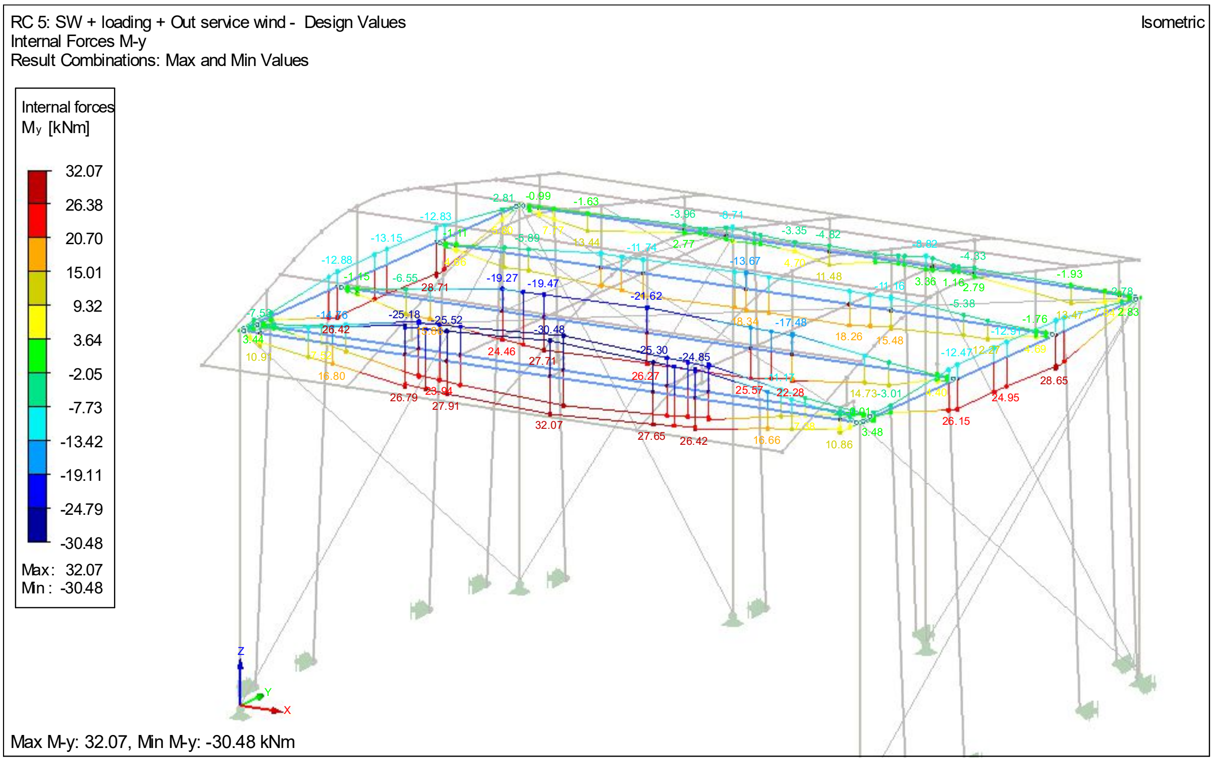
Check
$\eta = ( N_{d,\text{ main chord}} / N_{Rd} )^{1.3} + M_{d,\text{ main chord}} / M_{Rd}$
$\eta = ( 35.94 / 50.22 )^{1.3} + 0.083 / 0.532 = 0.80 < 1$

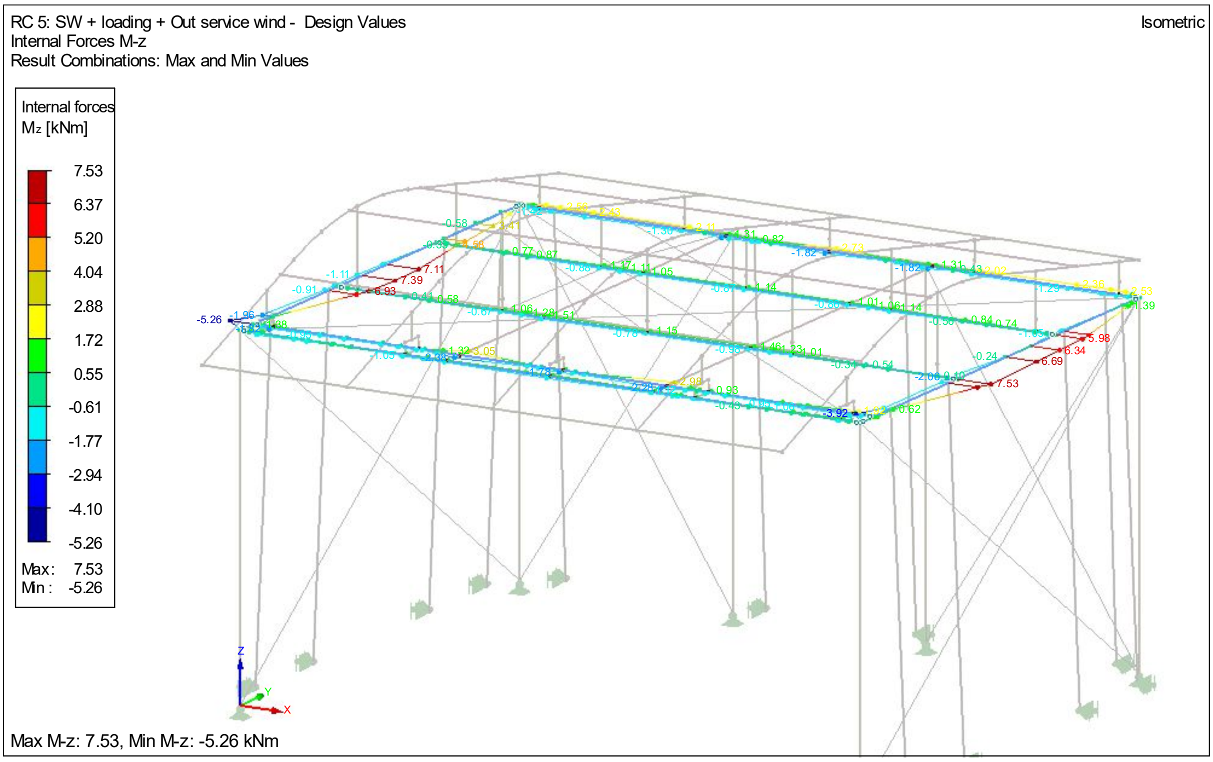
### 4.3.3 Calculation results for the Out-service situation.




RC 5: SW + loading + Out service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
26.61
21.79
16.96
12.14
7.31
2.49
-2.34
-7.16
-11.99
-16.81
-21.64
-26.46
Max : 26.61
Min : -26.46
Max V-z: 26.61, Min V-z: -26.46 kN

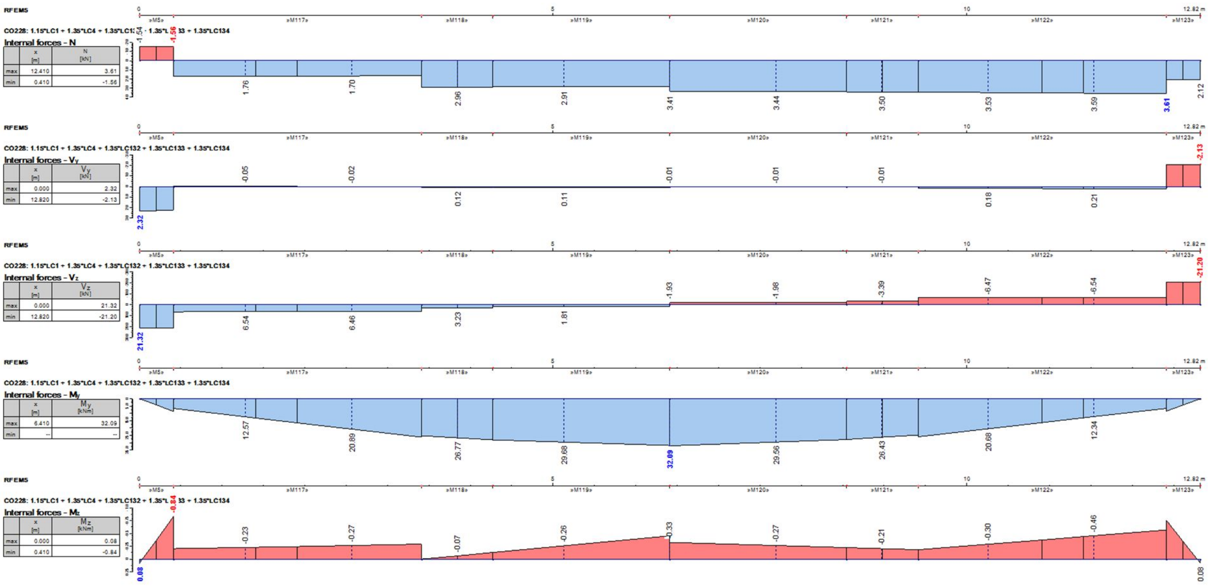

RC 5: SW + loading + Out service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
32.07
26.38
20.70
15.01
9.32
3.64
-2.05
-7.73
-13.42
-19.11
-24.79
-30.48
Max : 32.07
Min : -30.48
Max M-y: 32.07, Min M-y: -30.48 kNm


RC 5: SW + loading + Out service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
7.53
6.37
5.20
4.04
2.88
1.72
0.55
-0.61
-1.77
-2.94
-4.10
-5.26
Max: 7.53
Min: -5.26
Max M-z: 7.53, Min M-z: -5.26 kNm

### 4.3.4 Internal forces for different spans in the In-service situation.

Span 1 : front span

Internal forces for the normative load case CO228



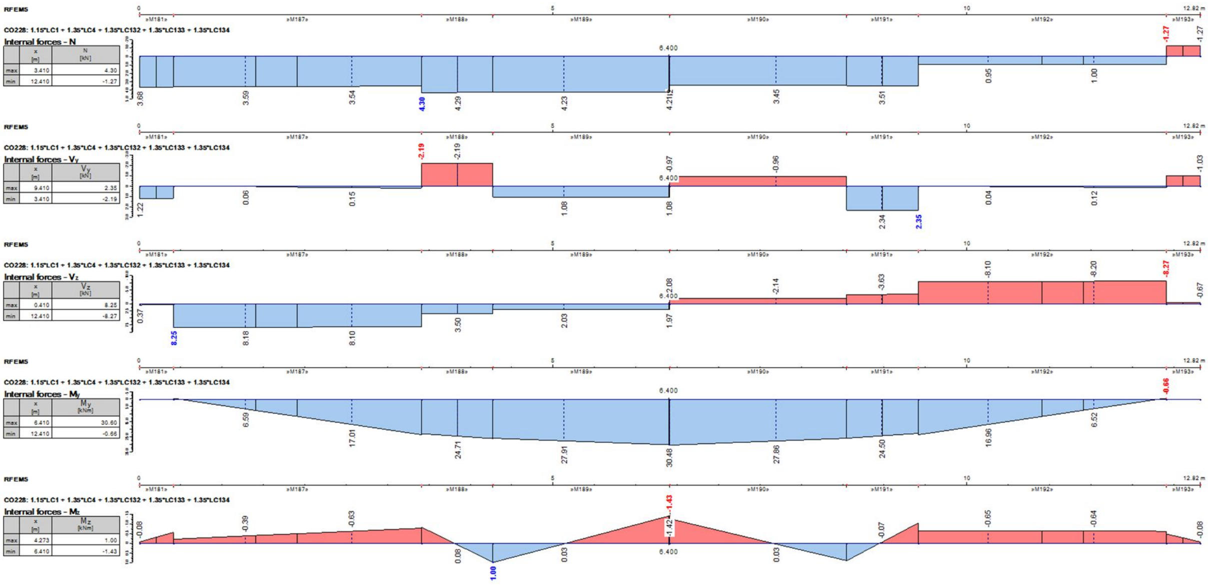
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 3.41$ kN
$V_{dy} = 0.11$ kN
$V_{dz} = 1.93$ kN
$M_{dy} = 32.09$ kN
$M_{dz} = 0.46$ kN
$V_{d,\text{ main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.11^2 + 1.93^2)}$
$V_{d,\text{ main chord}} = 0.483$ kN
$M_{d,\text{ main chord}} = V_{d,\text{ main chord}} * e = 0.483 * 0.05$
$M_{d,\text{ main chord}} = 0.024$ kNcm
$N_{d,\text{ main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\text{ main chord}} = 3.41 / 4 + 32.09 / 2 / 0.339 + 0.46 / 2 / 0.339$
$N_{d,\text{ main chord}} = 48.46$ kN

Check
$\eta = ( N_{d,\text{ main chord}} / N_{Rd} )^{1.3} + M_{d,\text{ main chord}} / M_{Rd}$
$\eta = ( 48.46 / 50.22 )^{1.3} + 0.024 / 0.532 = 1.00 \sim 1$

Span 2 : second span from the front

Internal forces for the normative load case CO228



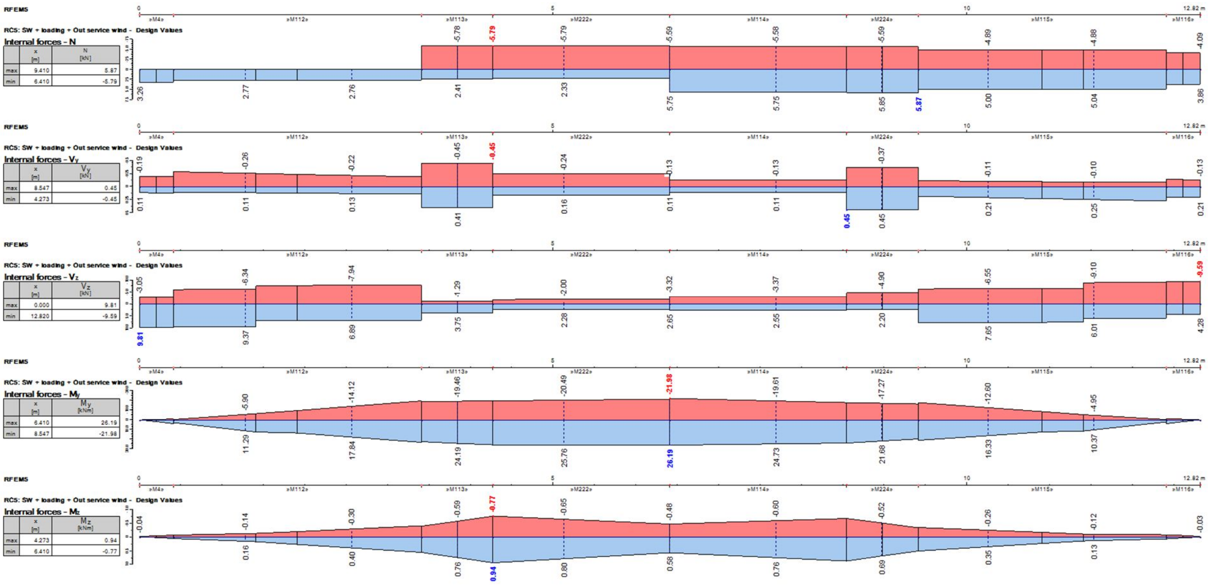
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 4.21$ kN
$V_{dy} = 1.08$ kN
$V_{dz} = 2.08$ kN
$M_{dy} = 30.60$ kN
$M_{dz} = 1.42$ kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(1.08^2 + 2.08^2)}$
$V_{d,\ main\ chord} = 0.586$ kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.586 * 0.05$
$M_{d,\ main\ chord} = 0.029$ kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 4.21 / 4 + 30.60 / 2 / 0.339 + 1.42 / 2 / 0.339$
$N_{d,\ main\ chord} = 48.28$ kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 48.28 / 50.22 )^{1.3} + 0.029 / 0.532 = 1.00 < 1$

Span 3 : third span from the front

Internal forces for RC5



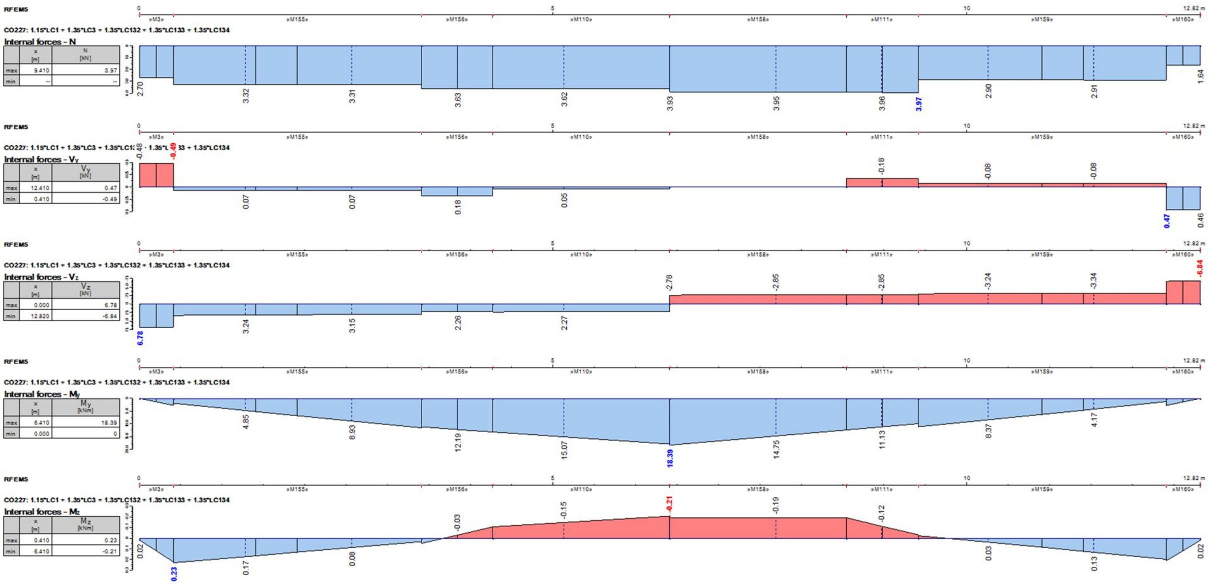
Interaction of moment and transversal force calculation on the maximum position which is in the middle of the span.

$N_d = 5.87$ kN
$V_{dy} = 0.45$ kN
$V_{dz} = 9.81$ kN
$M_{dy} = 26.19$ kN
$M_{dz} = 0.94$ kN
$V_{d,\,main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.45^2 + 9.81^2)}$
$V_{d,\,main\ chord} = 2.45$ kN
$M_{d,\,main\ chord} = V_{d,\,main\ chord} * e = 2.45 * 0.05$
$M_{d,\,main\ chord} = 0.12$ kNcm
$N_{d,\,main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\,main\ chord} = 5.87 / 4 + 26.19 / 2 / 0.339 + 0.94 / 2 / 0.339$
$N_{d,\,main\ chord} = 41.48$ kN

Check
$\eta = ( N_{d,\,main\ chord} / N_{Rd} )^{1.3} + M_{d,\,main\ chord} / M_{Rd}$
$\eta = ( 41.48 / 50.22 )^{1.3} + 0.12 / 0.532 = 1.00 < 1$

Span 4 : fourth span from the front

Internal forces for the normative load case CO227



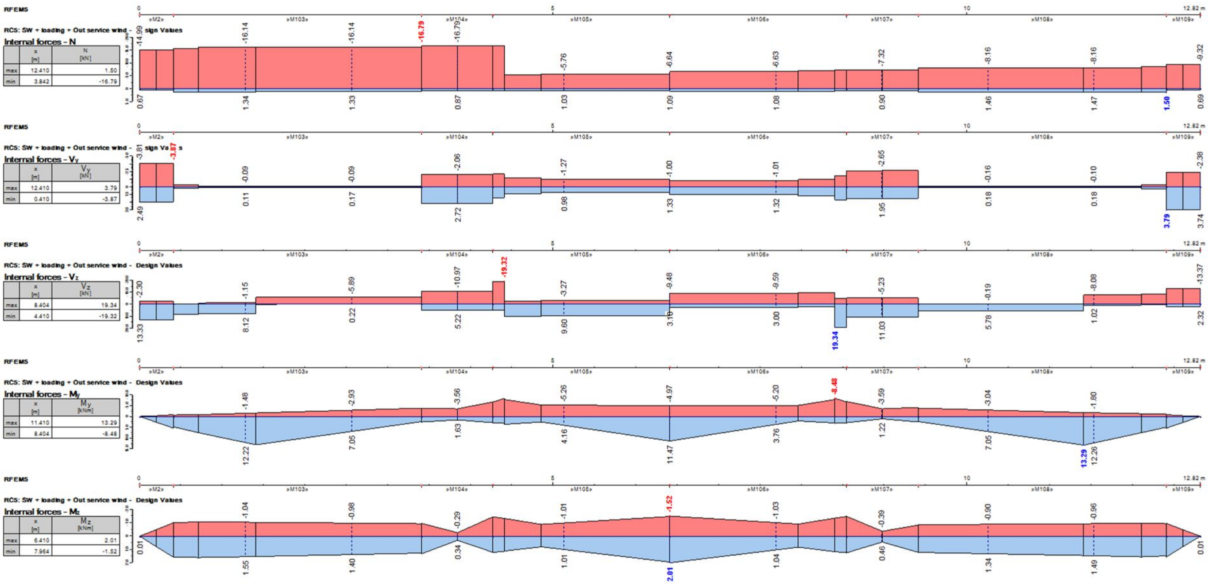
Interaction of moment and transversal force calculation on the maximum position which is in the third point of the span.

$N_d = 3.93$ kN
$V_{dy} = 0.05$ kN
$V_{dz} = 2.78$ kN
$M_{dy} = 18.39$ kN
$M_{dz} = 0.20$ kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 0.05^2 + 2.78^2)}$
$V_{d,\ main\ chord} = 0.695$ kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.695 * 0.05$
$M_{d,\ main\ chord} = 0.035$ kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 3.93 / 4 + 18.39 / 2 / 0.339 + 0.20 / 2 / 0.339$
$N_{d,\ main\ chord} = 28.40$ kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 28.40 / 50.22 )^{1.3} + 0.035 / 0.532 = 0.54 < 1$

Span 5 : fifth span from the front

Internal forces for RC5



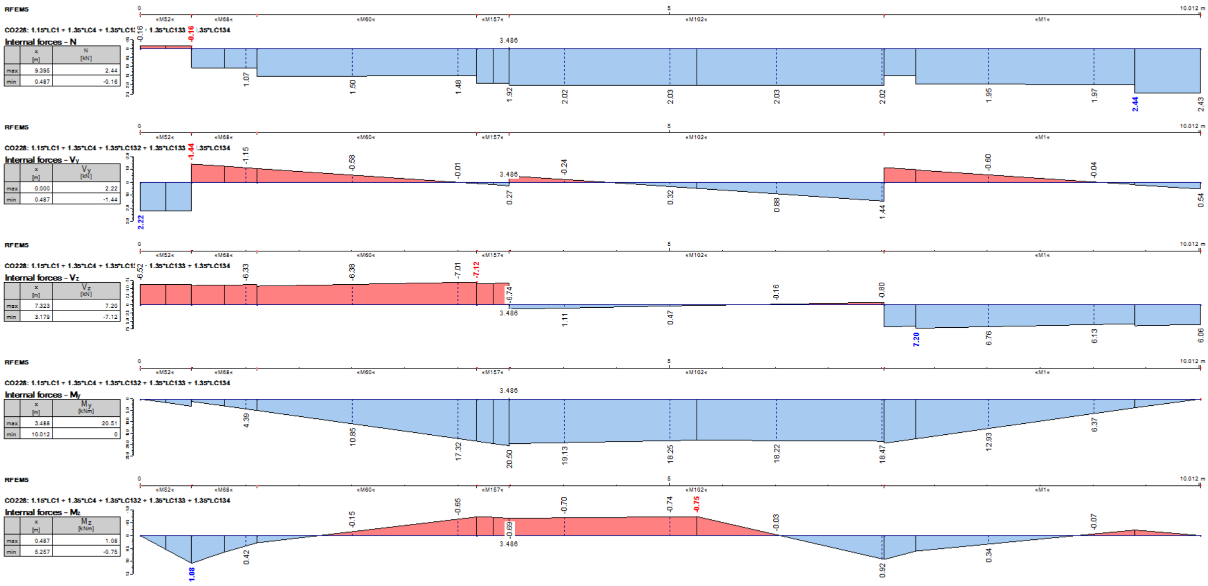
Interaction of moment and transversal force calculation on the maximum position which is at the position of the attachment of the stack tower.

$N_d$ = 16.79 kN
$V_{dy}$ = 3.87 kN
$V_{dz}$ = 19.34 kN
$M_{dy}$ = 13.29 kN
$M_{dz}$ = 2.01 kN
$V_{d,\ main\ chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{( 3.87^2 + 19.34^2)}$
$V_{d,\ main\ chord}$ = 4.93 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 4.93 * 0.05$
$M_{d,\ main\ chord}$ = 0.246 kNcm
$N_{d,\ main\ chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\ main\ chord} = 16.79 / 4 + 13.29 / 2 / 0.339 + 2.01 / 2 / 0.339$
$N_{d,\ main\ chord}$ = 26.76 kN

Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 26.76 / 50.22 )^{1.3} + 0.246 / 0.532 = 0.90 < 1$

Side span left side

Internal forces for the normative load case CO229



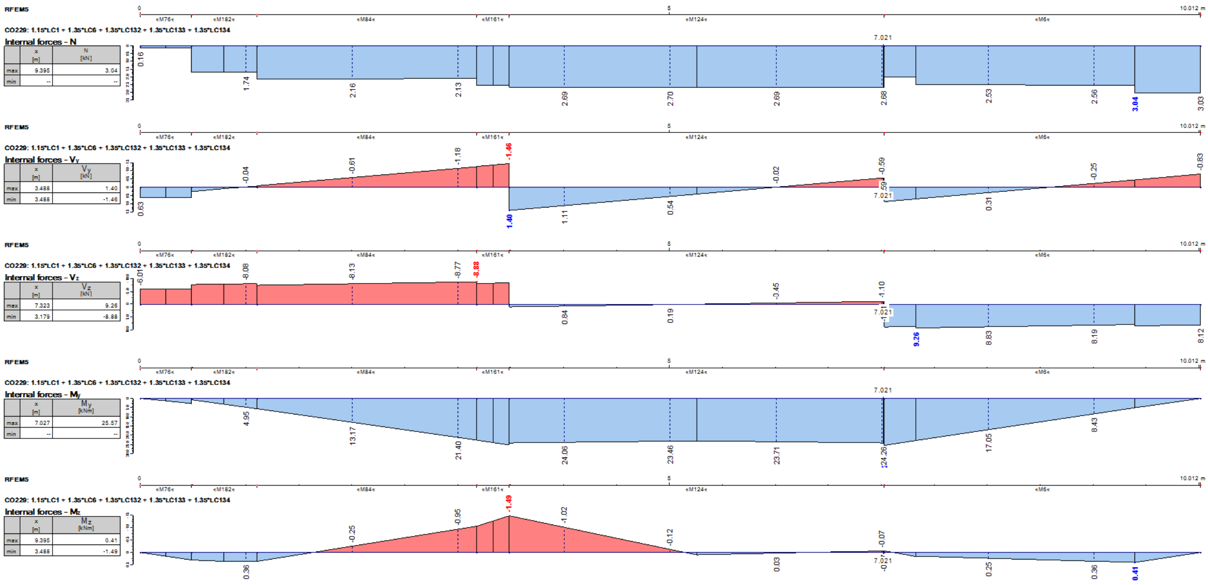
Interaction of moment and transversal force calculation on the maximum position which is at the X= 3.5 m

$N_d = 2.86$ kN
$V_{dy} = 0.60$ kN
$V_{dz} = 8.61$ kN
$M_{dy} = 25.73$ kN
$M_{dz} = 0.37$ kN
$V_{d,\text{ main chord}} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.60^2 + 8.61^2)}$
$V_{d,\text{ main chord}} = 2.16$ kN
$M_{d,\text{ main chord}} = V_{d,\text{ main chord}} * e = 2.16 * 0.05$
$M_{d,\text{ main chord}} = 0.107$ kNcm
$N_{d,\text{ main chord}} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\text{ main chord}} = 2.86 / 4 + 25.73 / 2 / 0.339 + 0.37 / 2 / 0.339$
$N_{d,\text{ main chord}} = 39.21$ kN

Check
$\eta = ( N_{d,\text{ main chord}} / N_{Rd} )^{1.3} + M_{d,\text{ main chord}} / M_{Rd}$
$\eta = ( 39.21 / 50.22 )^{1.3} + 0.107 / 0.532 = 0.92 < 1$

Side span right side

Internal forces for the normative load case CO134



Interaction of moment and transversal force calculation on the maximum position which is at the X= 7.0 m

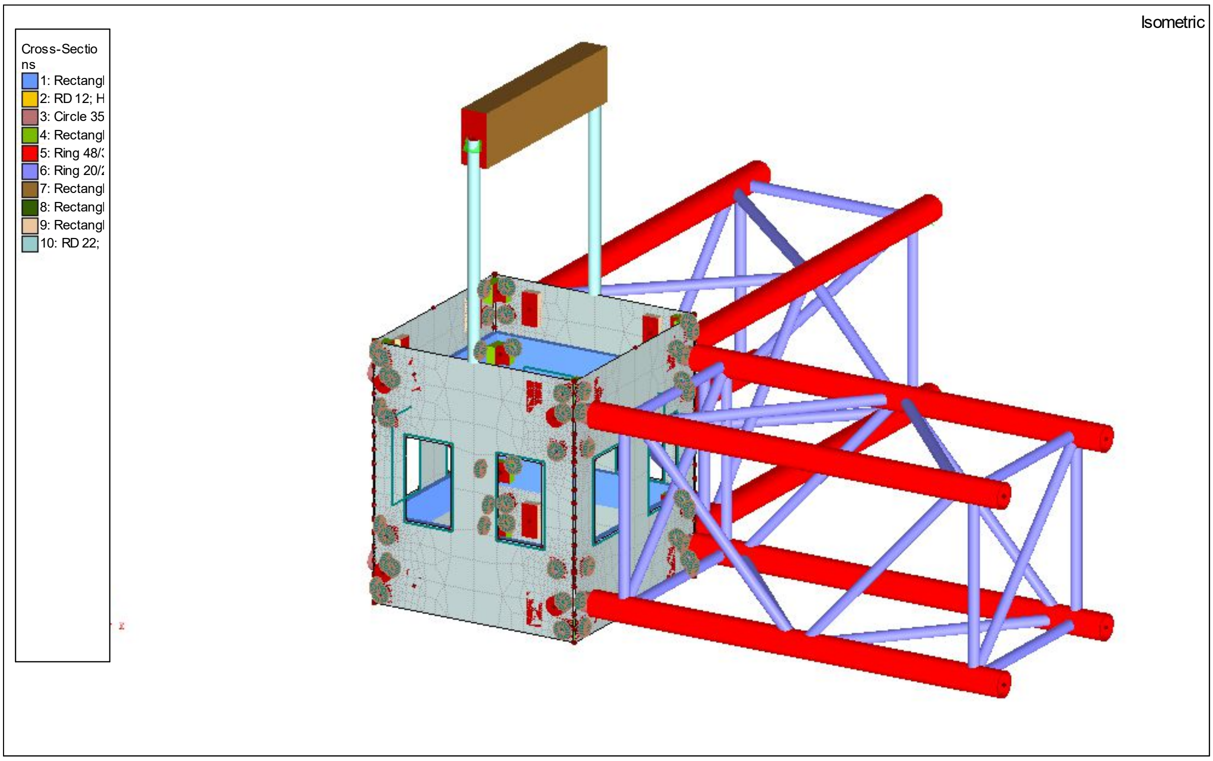
$N_d = 2.68$ kN
$V_{dy} = 0.88$ kN
$V_{dz} = 8.89$ kN
$M_{dy} = 25.57$ kN
$M_{dz} = 0.07$ kN
$V_{d,\, main\, chord} = 0.25 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.25 * \sqrt{(0.88^2 + 8.89^2)}$
$V_{d,\, main\, chord} = 2.23$ kN
$M_{d,\, main\, chord} = V_{d,\, main\, chord} * e = 2.23 * 0.05$
$M_{d,\, main\, chord} = 0.111$ kNcm
$N_{d,\, main\, chord} = N_d/4 + M_{dy} / 2 / h + M_{dz} / 2 / b$
$N_{d,\, main\, chord} = 2.68 / 4 + 25.57 / 2 / 0.339 + 0.07 / 2 / 0.339$
$N_{d,\, main\, chord} = 38.49$ kN

Check
$\eta = ( N_{d,\, main\, chord} / N_{Rd} )^{1.3} + M_{d,\, main\, chord} / M_{Rd}$
$\eta = ( 38.49 / 50.22 )^{1.3} + 0.111 / 0.532 = 0.91 < 1$

### 4.4 Check of the sleeve block.

The decisive sleeve block is the front sleeve block on the left or the right of the stage The sleeve block on the left side of the main construction is checked.

For the check of the Sleeve block a separate model has been constructed in the calculation program. The truss sections are constructed to create a more accurate model. These will be left out from the results. Only the sleeve block will be checked.




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 | Rectangle 12/60 | 2 | 3,02 | 21,60 | 0,86 | 7,20 | 6,00 | 6,00 | 0,00 | 0,00 | 12,0 | 60,0 |
| 2 | RD 12 | 5 | 0,20 | 0,10 | 0,10 | 1,13 | 0,95 | 0,95 | 0,00 | 0,00 | 12,0 | 12,0 |
| 3 | Circle 35 | 1 | 14,73 | 7,37 | 7,37 | 9,62 | 8,15 | 8,15 | 0,00 | 0,00 | 35,0 | 35,0 |
| 4 | Rectangle 35/35 | 3 | 21,11 | 12,51 | 12,51 | 12,25 | 10,21 | 10,21 | 0,00 | 0,00 | 35,0 | 35,0 |
| 5 | Ring 48/3 | 4 | 21,57 | 10,78 | 10,78 | 4,24 | 2,14 | 2,14 | 0,00 | 0,00 | 48,0 | 48,0 |
| 6 | Ring 20/2 | 4 | 0,93 | 0,46 | 0,46 | 1,13 | 0,58 | 0,58 | 0,00 | 0,00 | 20,0 | 20,0 |
| 7 | Rectangle 50/100 | 1 | 286,09 | 416,67 | 104,17 | 50,00 | 41,67 | 41,67 | 0,00 | 0,00 | 50,0 | 100,0 |
| 8 | Rectangle 8/8 | 1 | 0,06 | 0,03 | 0,03 | 0,64 | 0,53 | 0,53 | 0,00 | 0,00 | 8,0 | 8,0 |
| 9 | Rectangle 30/60 | 1 | 37,08 | 54,00 | 13,50 | 18,00 | 15,00 | 15,00 | 0,00 | 0,00 | 30,0 | 60,0 |
| 10 | RD 22 | 2 | 2,30 | 1,15 | 1,15 | 3,80 | 3,19 | 3,19 | 0,00 | 0,00 | 22,0 | 22,0 |

## Used Material

| Material No. | Material Description | Safety Factor $\gamma_M$ [-] | Yield Strength $f_{yk}$ [kN/cm²] | Limit Stresses [kN/cm²] Manually | Limit $\sigma_x$ | Limit $\tau$ | Limit $\sigma_{eqv}$ |
|---|---|---|---|---|---|---|---|
| 1 | Aluminium EN-AW 6082 (EP,ET) T6* \| EN 1999-1-1:2007 | 1,00 | 26,00 | - | 26.00 | 15,01 | 26,00 |
| 3 | steel 8.8 Quality \| EN 10346:2009-03 | 1,00 | 64,00 | - | 64,00 | 36,95 | 64 |

## Inserted Load Cases.

## Internal forces for result calculation RC3 In service

| Member No. | Node No. | Location x [m] | | Forces [kN] N | $V_y$ | $V_z$ | Moments [kNm] $M_T$ | $M_y$ | $M_z$ | Corresponding Load Cases |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 2 | 0,000 | max N | 10,41 | 0,61 | 13,44 | -1,48 | 0,00 | 0,03 | CO 164 |
| | | | min N | -5,63 | 2,37 | 11,79 | -1,05 | 0,00 | 0,03 | CO 182 |
| | | | max $V_y$ | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | CO 184 |
| | | | min $V_y$ | 4,67 | -1,99 | -9,99 | 0,95 | 0,00 | 0,02 | CO 150 |
| | | | max $V_z$ | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | CO 184 |
| | | | min $V_z$ | 4,67 | -1,99 | -9,99 | 0,95 | 0,00 | 0,02 | CO 150 |
| | | | max $M_y$ | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | CO 184 |
| | | | min $M_y$ | 10,41 | 0,61 | 13,44 | -1,48 | 0,00 | 0,03 | CO 164 |
| | | | max $M_z$ | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | CO 184 |
| | | | min $M_z$ | 4,44 | -0,99 | 1,08 | -0,18 | 0,00 | 0,00 | CO 154 |
| | 59 | 0,410 | max N | 10,40 | 0,58 | 13,42 | -1,49 | 5,50 | -0,20 | CO 164 |
| | | | min N | -5,63 | 2,35 | 11,76 | -1,06 | 4,83 | -0,94 | CO 182 |
| | | | max $V_y$ | -4,81 | 2,91 | 20,45 | -2,08 | 8,40 | -1,11 | CO 184 |
| | | | min $V_y$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | | | max $V_z$ | -4,81 | 2,91 | 20,45 | -2,08 | 8,40 | -1,11 | CO 184 |
| | | | min $V_z$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | | | max $M_y$ | -4,81 | 2,91 | 20,45 | -2,08 | 8,40 | -1,11 | CO 184 |
| | | | min $M_y$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | | | max $M_z$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | | | min $M_z$ | -4,81 | 2,91 | 20,45 | -2,08 | 8,40 | -1,11 | CO 184 |
| | 2 | 0,000 | Max N | 10,41 | 0,61 | 13,44 | -1,48 | 0,00 | 0,03 | CO 164 |
| | 59 | 0,410 | Min N | -5,63 | 2,35 | 11,76 | -1,06 | 4,83 | -0,94 | CO 182 |
| | 2 | 0,000 | Max $V_y$ | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | CO 184 |
| | 59 | 0,410 | Min $V_y$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | 2 | 0,000 | Max $V_z$ | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | CO 184 |
| | 59 | 0,410 | Min $V_z$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | 59 | 0,410 | Max $M_y$ | -4,81 | 2,91 | 20,45 | -2,08 | 8,40 | -1,11 | CO 184 |
| | 59 | 0,410 | Min $M_y$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | 59 | 0,410 | Max $M_z$ | 4,67 | -2,01 | -10,02 | 0,94 | -4,10 | 0,84 | CO 150 |
| | 59 | 0,410 | Min $M_z$ | -4,81 | 2,91 | 20,45 | -2,08 | 8,40 | -1,11 | CO 184 |
| 52 | 85 | 0,000 | max N | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| | | | min N | -4,17 | -10,14 | -0,45 | -0,04 | 0,22 | -4,94 | CO 160 |
| | | | max $V_y$ | -2,32 | 5,75 | -3,60 | -0,03 | 1,75 | 2,80 | CO 183 |
| | | | min $V_y$ | -4,17 | -10,14 | -0,45 | -0,04 | 0,22 | -4,94 | CO 160 |
| | | | max $V_z$ | -1,82 | -4,43 | 2,93 | -0,02 | -1,43 | -2,16 | CO 150 |
| | | | min $V_z$ | -1,76 | 5,30 | -6,21 | -0,05 | 3,03 | 2,58 | CO 184 |
| | | | max $M_y$ | -1,76 | 5,30 | -6,21 | -0,05 | 3,03 | 2,58 | CO 184 |
| | | | min $M_y$ | -1,82 | -4,43 | 2,93 | -0,02 | -1,43 | -2,16 | CO 150 |
| | | | max $M_z$ | -2,32 | 5,75 | -3,60 | -0,03 | 1,75 | 2,80 | CO 183 |
| | | | min $M_z$ | -4,17 | -10,14 | -0,45 | -0,04 | 0,22 | -4,94 | CO 160 |
| | 2 | 0,487 | max N | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| | | | min N | -4,17 | -10,14 | -0,45 | -0,05 | 0,00 | 0,00 | CO 160 |
| | | | max $V_y$ | -2,32 | 5,75 | -3,60 | 0,00 | 0,00 | 0,00 | CO 183 |
| | | | min $V_y$ | -4,17 | -10,14 | -0,45 | -0,05 | 0,00 | 0,00 | CO 160 |
| | | | max $V_z$ | -1,82 | -4,43 | 2,93 | 0,00 | 0,00 | 0,00 | CO 150 |
| | | | min $V_z$ | -1,76 | 5,30 | -6,22 | 0,00 | 0,00 | 0,00 | CO 184 |
| | | | max $M_y$ | -4,17 | -10,14 | -0,45 | -0,05 | 0,00 | 0,00 | CO 160 |
| | | | min $M_y$ | -1,53 | -4,00 | 2,26 | 0,00 | 0,00 | 0,00 | CO 152 |
| | | | max $M_z$ | -1,82 | -4,43 | 2,93 | 0,00 | 0,00 | 0,00 | CO 150 |
| | | | min $M_z$ | -3,03 | -10,14 | -3,95 | -0,05 | 0,00 | 0,00 | CO 164 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 85 | 0,000 | Max N | **0,00** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | |
| | 85 | 0,000 | Min N | **-4,17** | -10,14 | -0,45 | -0,04 | 0,22 | -4,94 | CO 160 |
| | 2 | 0,487 | Max $V_y$ | -2,32 | **5,75** | -3,60 | 0,00 | 0,00 | 0,00 | CO 183 |
| | 2 | 0,487 | Min $V_y$ | -4,17 | **-10,14** | -0,45 | -0,05 | 0,00 | 0,00 | CO 160 |
| | 2 | 0,487 | Max $V_z$ | -1,82 | -4,43 | **2,93** | 0,00 | 0,00 | 0,00 | CO 150 |
| | 2 | 0,487 | Min $V_z$ | -1,76 | 5,30 | **-6,22** | 0,00 | 0,00 | 0,00 | CO 184 |
| | 85 | 0,000 | Max $M_y$ | -1,76 | 5,30 | -6,21 | -0,05 | **3,03** | 2,58 | CO 184 |
| | 85 | 0,000 | Min $M_y$ | -1,82 | -4,43 | 2,93 | -0,02 | **-1,43** | -2,16 | CO 150 |
| | 85 | 0,000 | Max $M_z$ | -2,32 | 5,75 | -3,60 | -0,03 | 1,75 | **2,80** | CO 183 |
| | 85 | 0,000 | Min $M_z$ | -4,17 | -10,14 | -0,45 | -0,04 | 0,22 | **-4,94** | CO 160 |

Normative load combinations for the In-service situation is Load combination CO184

The forces of this load combination is set as component forces on the node's next to the sleeve block

Check of load Combination CO184

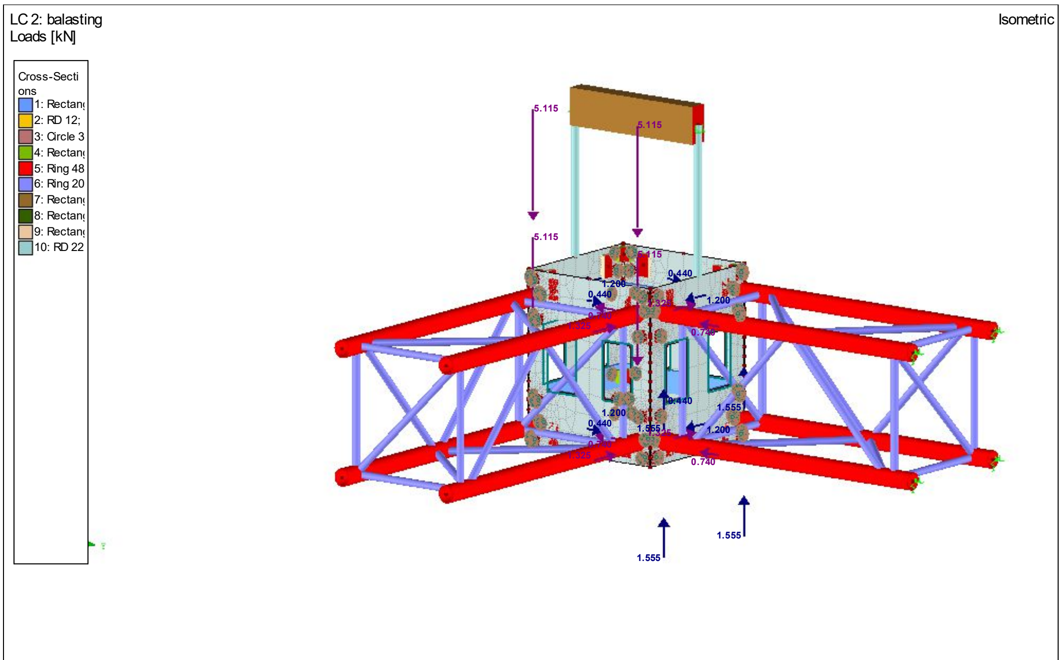
Internal forces on the 4 node points in Load combination 110 from the total construction model are

| Member | Node | Location | Forces [kN] | | | Moments [kNm] | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | No. | x [m] | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ | Cross-Section |
| 384 | 5 | 0,322 | -4,80 | 2,98 | 20,47 | -2,06 | 0,00 | 0,08 | 5 – Prolyte H40V |
| 393 | 52 | 0,320 | -1,76 | 5,30 | -6,22 | 0,00 | 0,00 | 0,00 | 2 - Prolyte H40V |

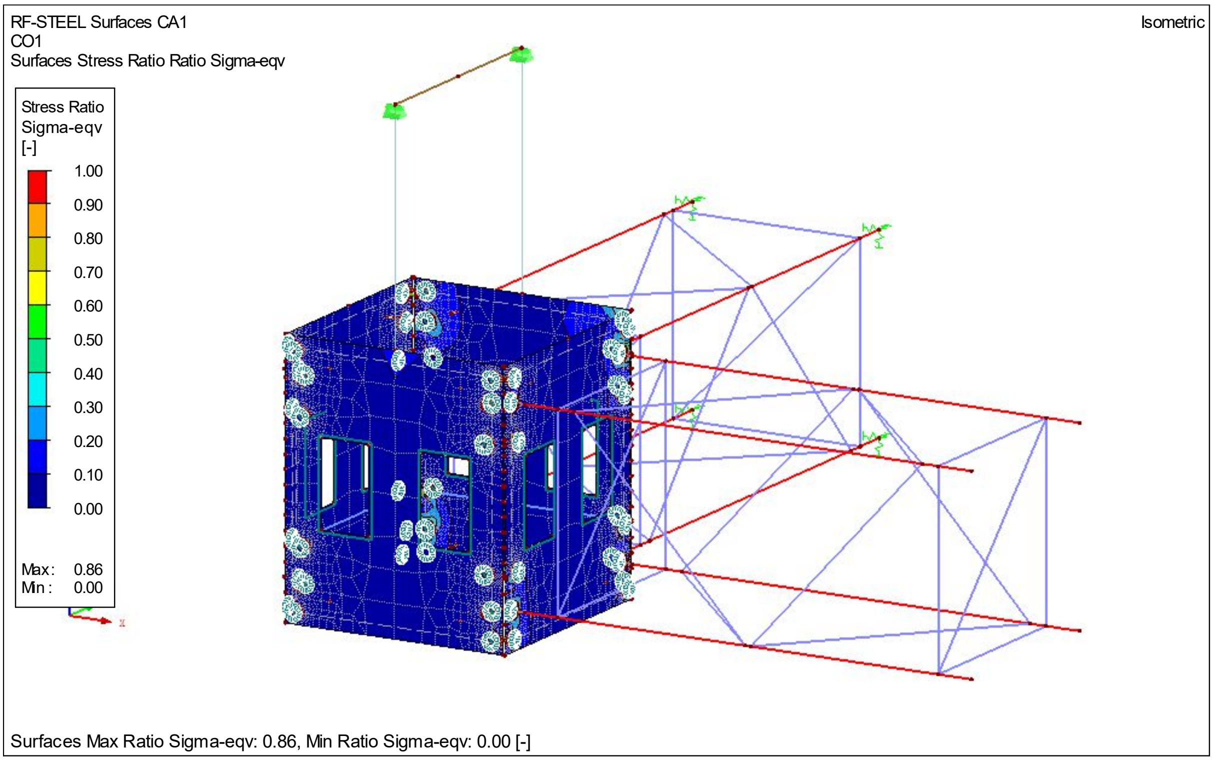
Load in put into sleeve block model

| No. | On Nodes No. | Definition Type | Coordinate System | Force [kN] $P_X$ | $P_Y$ | $P_Z$ | Moment [kNm] $M_X$ | $M_Y$ | $M_Z$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 78,80,82,84 | By components | 0 \| Global XYZ | 1,200 | -0,740 | -5,115 | 0,000 | 0,000 | 0,000 |
| 2 | 29,56,58,60 | By components | 0 \| Global XYZ | -1,325 | 0,440 | 1,555 | 0,000 | 0,000 | 0,000 |

Visual input different load cases.



## Stress calculation of the sleeve block



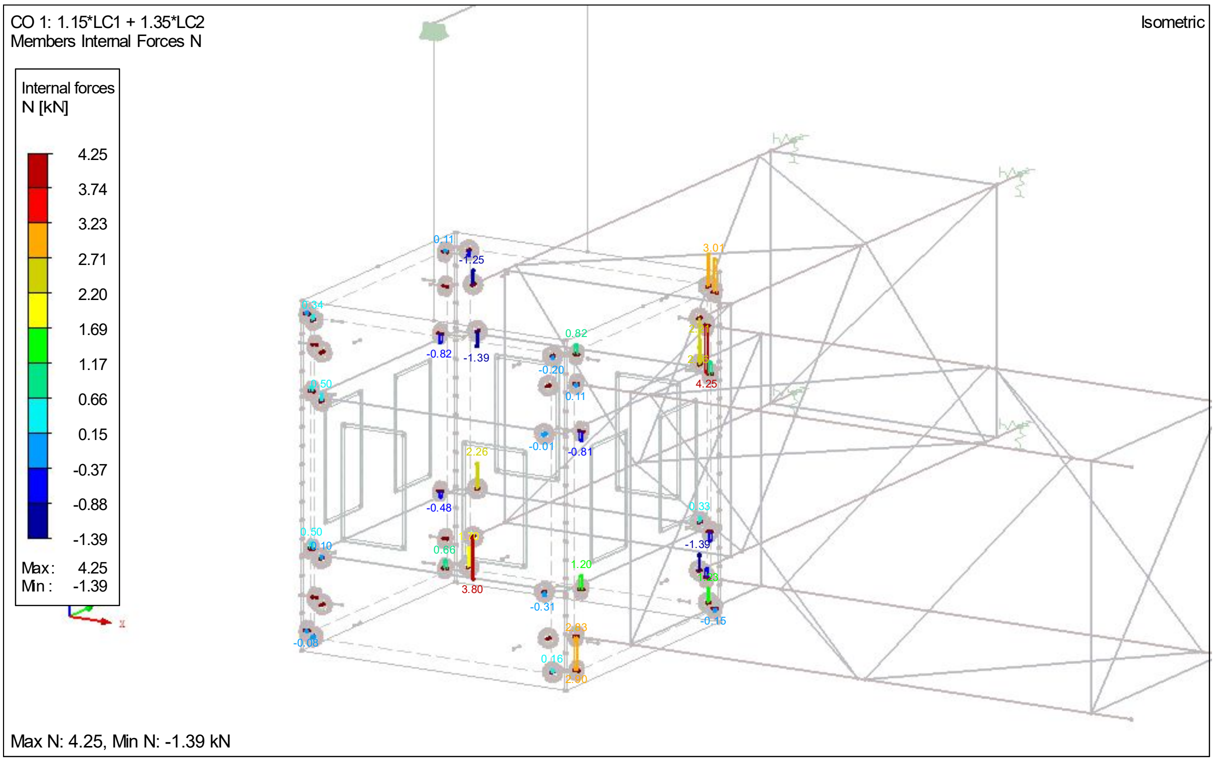

## Maximum stress analyse for the aluminium sheets

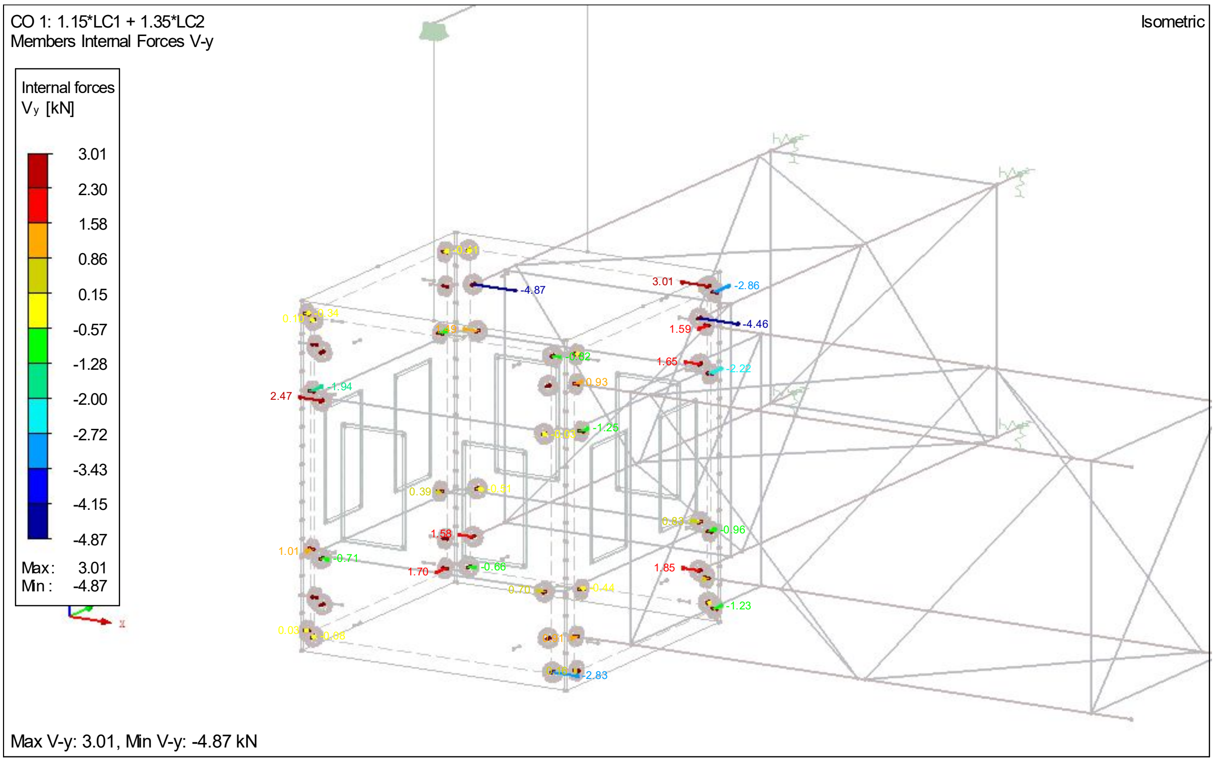
| Material No. | Surface No. | FE Mesh Point No. | Point Coordinates [m] X | Y | Z | Loading | Stress [kN/cm²] Symbol | Existing | Limit | Stress Ratio [-] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Aluminum EN-AW 6082 (EP,ET) T6* | | | | | | | | | |
| | 4 | 6 | -1,196 | -2,808 | 3,446 | CO1 | $\tau_{max}$ | 10,51 | 15,01 | 0,70 |
| | 1 | 246 | -1,196 | -2,842 | 3,391 | CO1 | $\sigma_{1,+}$ | 20,50 | 26,00 | 0,79 |
| | 4 | 1518 | -1,215 | -2,808 | 3,046 | CO1 | $\sigma_{2,+}$ | -16,62 | 26,00 | 0,64 |
| | 4 | 1543 | -1,221 | -2,808 | 3,052 | CO1 | $\sigma_{1,-}$ | 17,47 | 26,00 | 0,67 |
| | 1 | 13157 | -1,196 | -2,833 | 3,385 | CO1 | $\sigma_{2,-}$ | -20,71 | 26,00 | 0,80 |
| | 2 | 143 | -1,395 | -3,206 | 3,446 | CO1 | $\sigma_{1,m}$ | 4,68 | 26,00 | 0,18 |
| | 1 | 88 | -1,196 | -2,812 | 3,446 | CO1 | $\sigma_{2,m}$ | -6,56 | 26,00 | 0,25 |
| | 1 | 13157 | -1,196 | -2,833 | 3,385 | CO1 | $\sigma_{eqv,max}$ | 19,50 | 26,00 | 0,75 |
| | 1 | 88 | -1,196 | -2,812 | 3,446 | CO1 | $\sigma_{eqv,m}$ | 7,23 | 26,00 | 0,28 |
| | | | | | | | | | | |

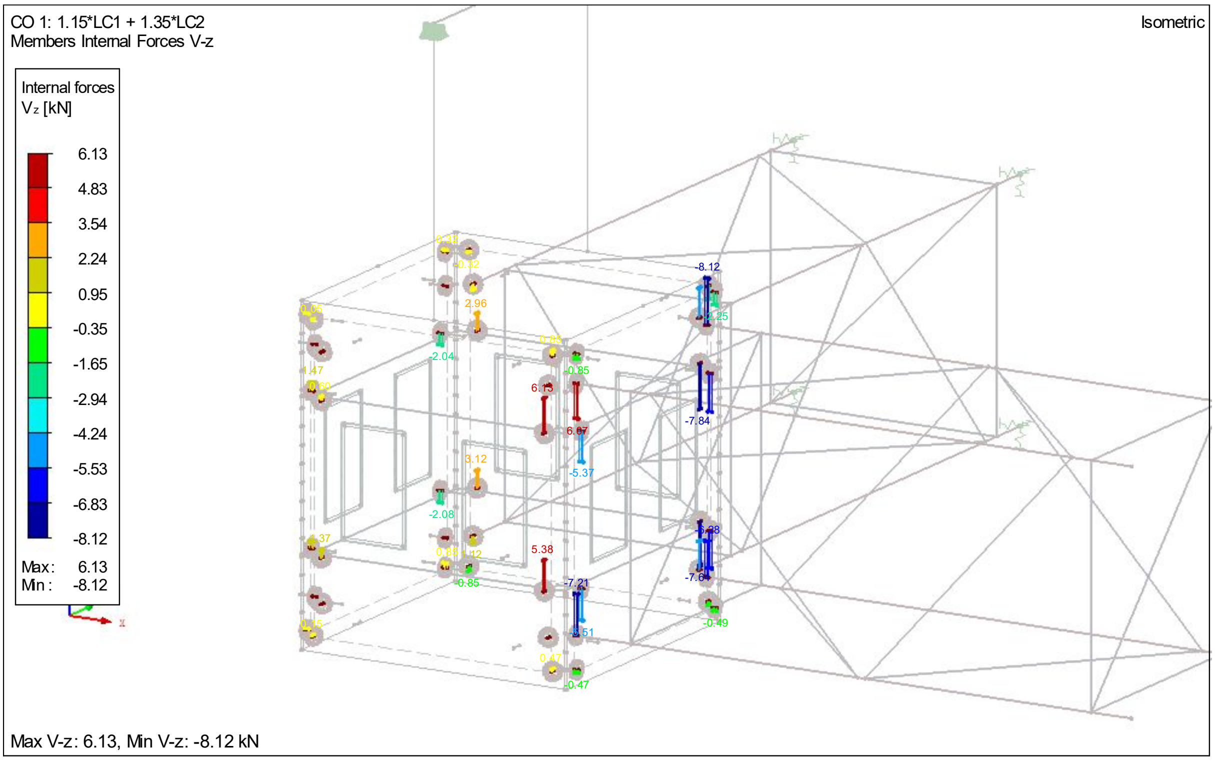
Maximum utilization $\sigma_{eqv,max}$ 0.75%

## Check of the M12 bolts

## Internal forces of the bolts






Maximum shear force = $\sqrt{(Vy^2 + Vz^2)} = \sqrt{(4.87^2 + 8.12^2)} = 9.46$ kN

$F_{v,rd} = 0,6 * f_{ub} * A/1.25 = 0.6 * 80 * 1.13/1.25 = 43.39$ kN

$9.46 / 43.39 = 0.21 < 1$

Maximum tension force = $N_{ed} = 4.25$ kN

$F_{t,rd} = k2 * fub * As / 1.25 = 0.9 * 80 * 0.843 / 1.25 = 48.55$ kN

$4.25 / 48.55 = 0.087 < 1$

Check of the interaction between shear and tension force

$F_{v,ed} / F_{v, rd} + F_{t, ed} / 1.4 * F_{t, rd} < 1$

$9.46 / 43.39 + 4.25 / 1.4 * 48.55 = 0.27 < 1$

Check of the bearing force in the hole of the plate.

Maximum shear force is $\sqrt{(Vy^2 + Vz^2)} = \sqrt{(4.87^2 + 8.12^2)} = 9.46$ kN

$F_{b,rd} = (k_1 * \alpha_b * f_u * d * t) / 1.25 = (2.5 * 1 * 25 * 1.25 * 0.8) / 1.25 = 50$ kN

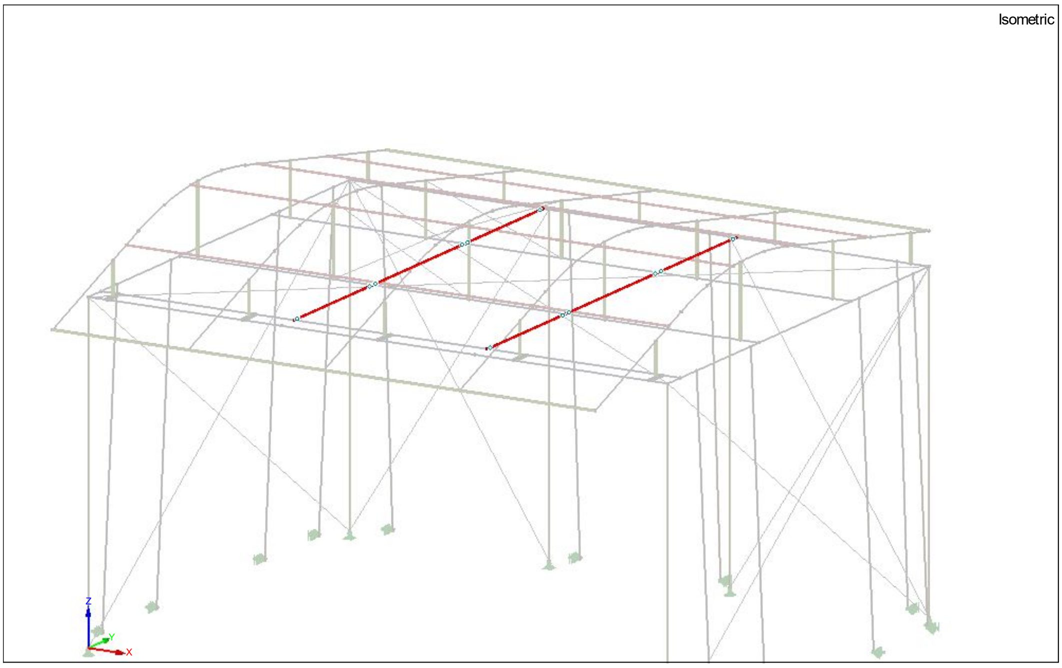
$F_{b, ed} / F_{b,rd} < 1$

$9.46 / 50 = 0.19 < 1$

## 4.5 Check of the compression tubes in the main grid and the roof.

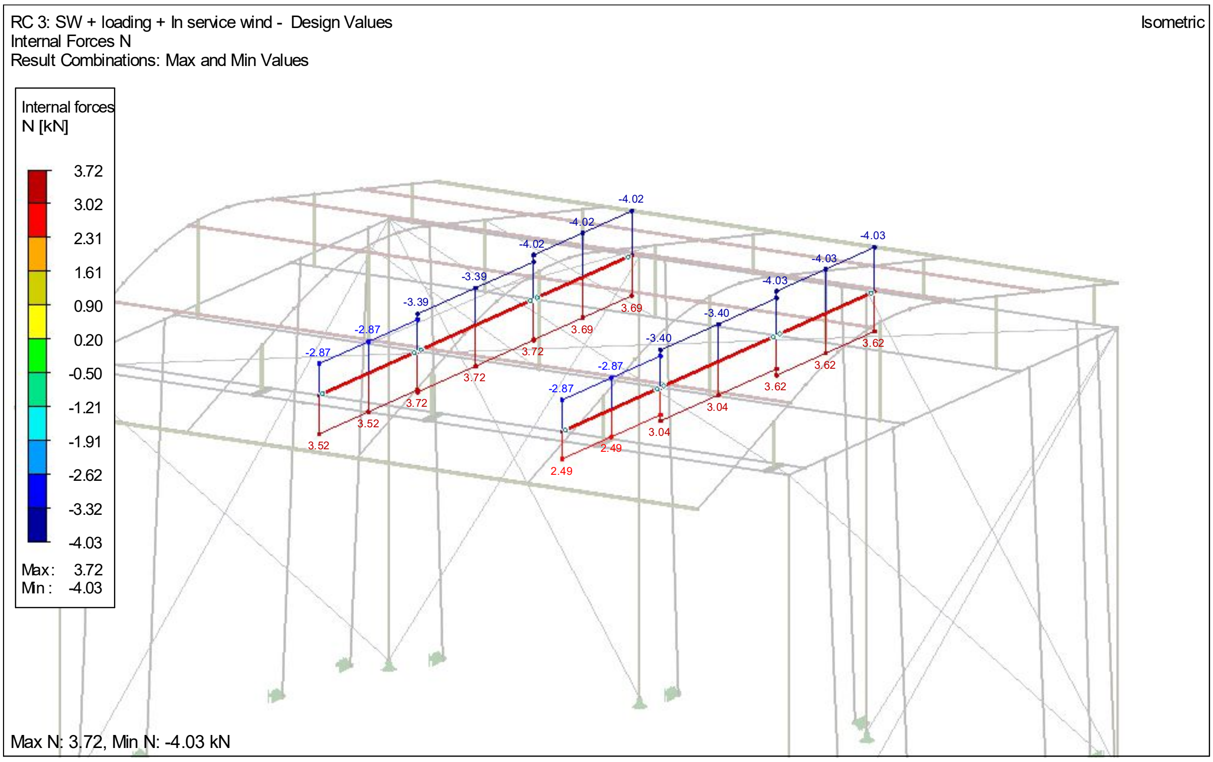
### 4.5.1 check of the 50x4 compression tubes in the main grid

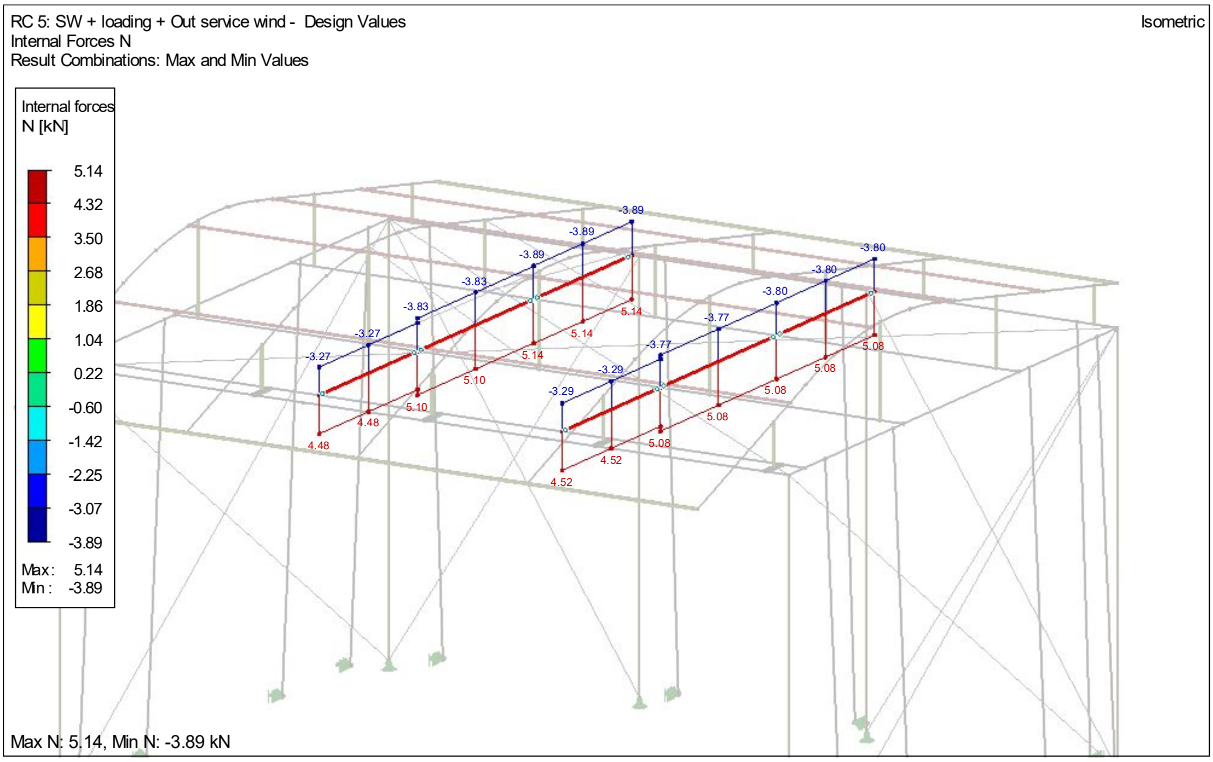
Normative load case in service




.

The profile will be checked for buckling.






Normative load case In service

Maximum compression force in the 50x4 profile is 4.02 kN.
Buckling calculation for the profile
Buckling Length factor K = 1,5
The factor K is according to table 6,8 NEN-EN 1999-1-1

| | |
|---|---|
| L | 300 cm |
| Profile cross section A | 5.78 cm² |
| E | 7000 |
| $f_{0, haz}$ | 12.5 kN/cm² |
| I | 15.41 $cm^4$ |
| i √( I/A ) | 1.63 |

Buckling calculation

$L_{cr} = L * K = 1.5 \times 300 = 450$ cm

$\lambda_z = Lcr / (iz * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$

$\lambda_z = 450 / (1.63 * \pi) * (\sqrt{((5.78 * 12.5) / 5.78 * 7000)}) = 3.72$

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

$\Theta_z = 0.5 * (1 + 0.2 * (3.72 - 0.1) + 3.72^2) = 7.62$

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

$X_z = 1 / (7.62 + \sqrt{(7.62^2 - 3.72^2)}) = 0.03$

$N_{b,rd} = Xz * A * f_{0, haz} / 1.1$

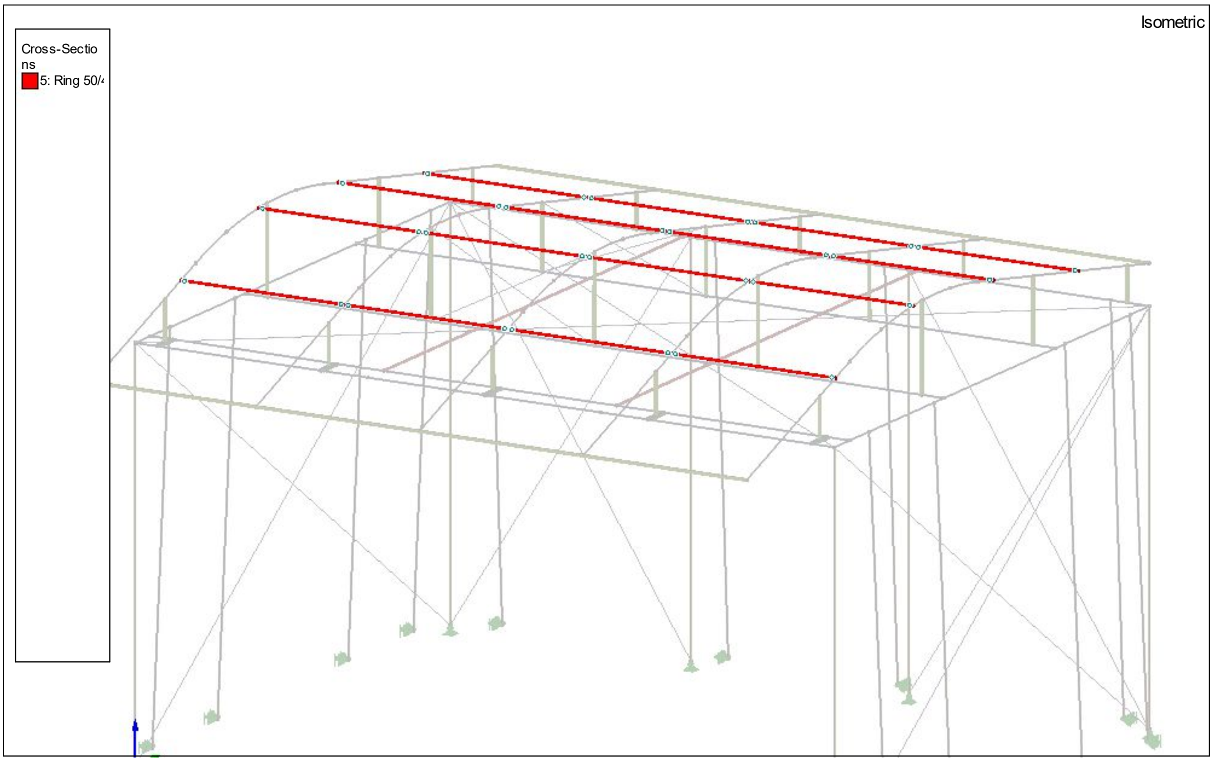
$N_{b,rd} = 0.03 * 5.78 * 12.5 / 1.1 = 4.5$ kN

$N_{Ed, max} = 4.02$ kN

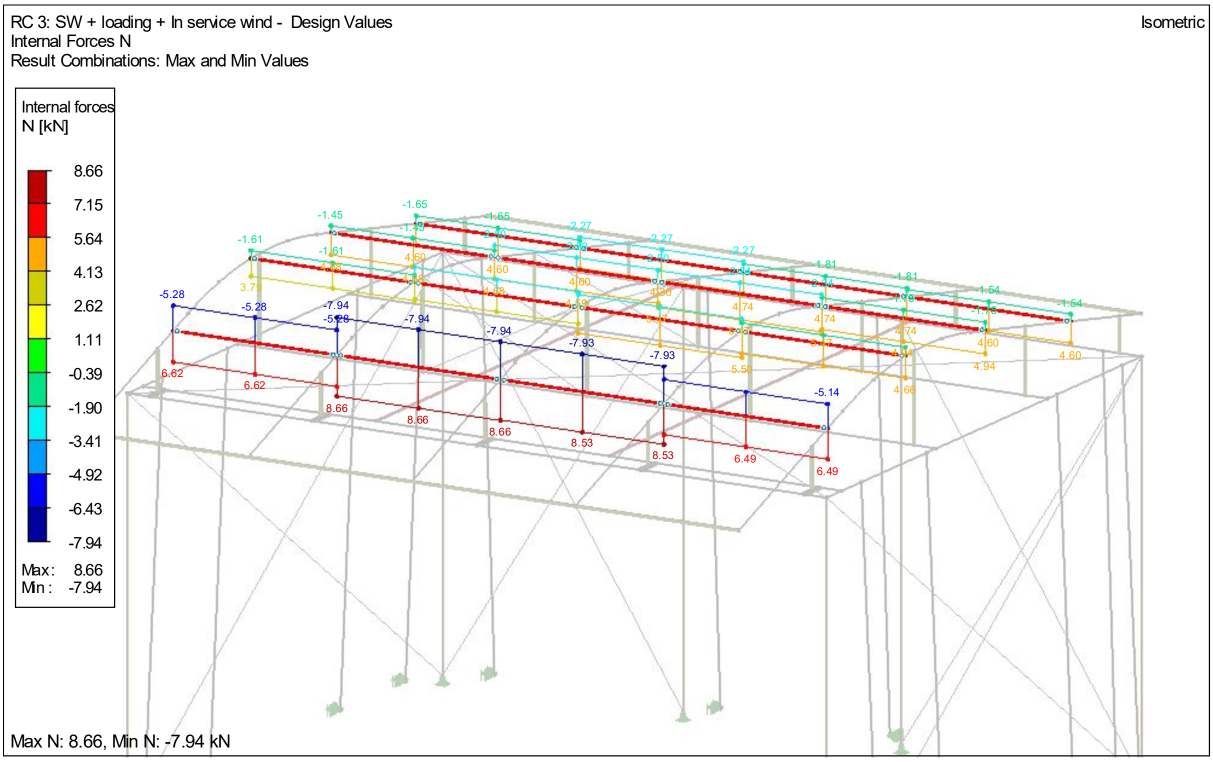
check = $N_{Ed, max} / N_{b,rd} < 1$

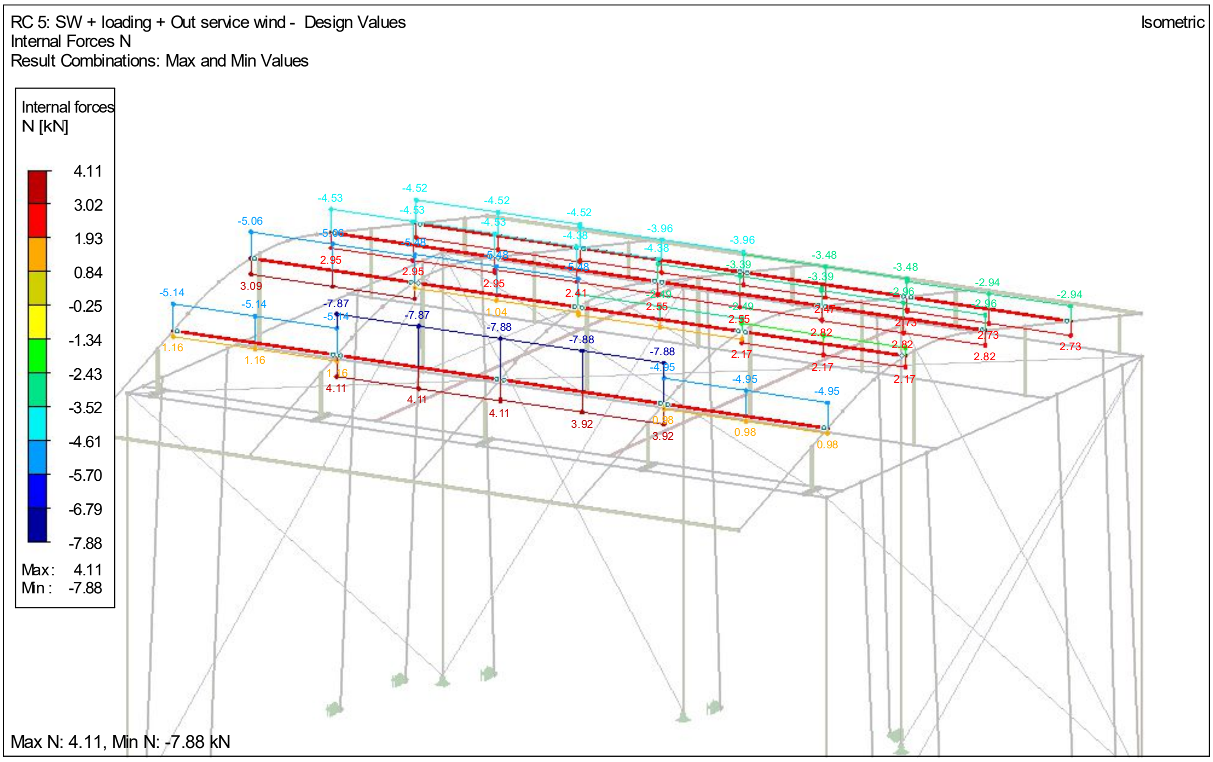
$4.02 / 4.5 = 0.89 < 1$

### 4.5.2 check of the 50x4 compression tubes of the roof structure.




The profile will be checked for buckling.






Normative load case Out service
Maximum compression force in the 50x4 profile is 7.88 kN.
Buckling calculation for the profile
Buckling Length factor K = 1
The factor K is according to table 6,8 NEN-EN 1999-1-1

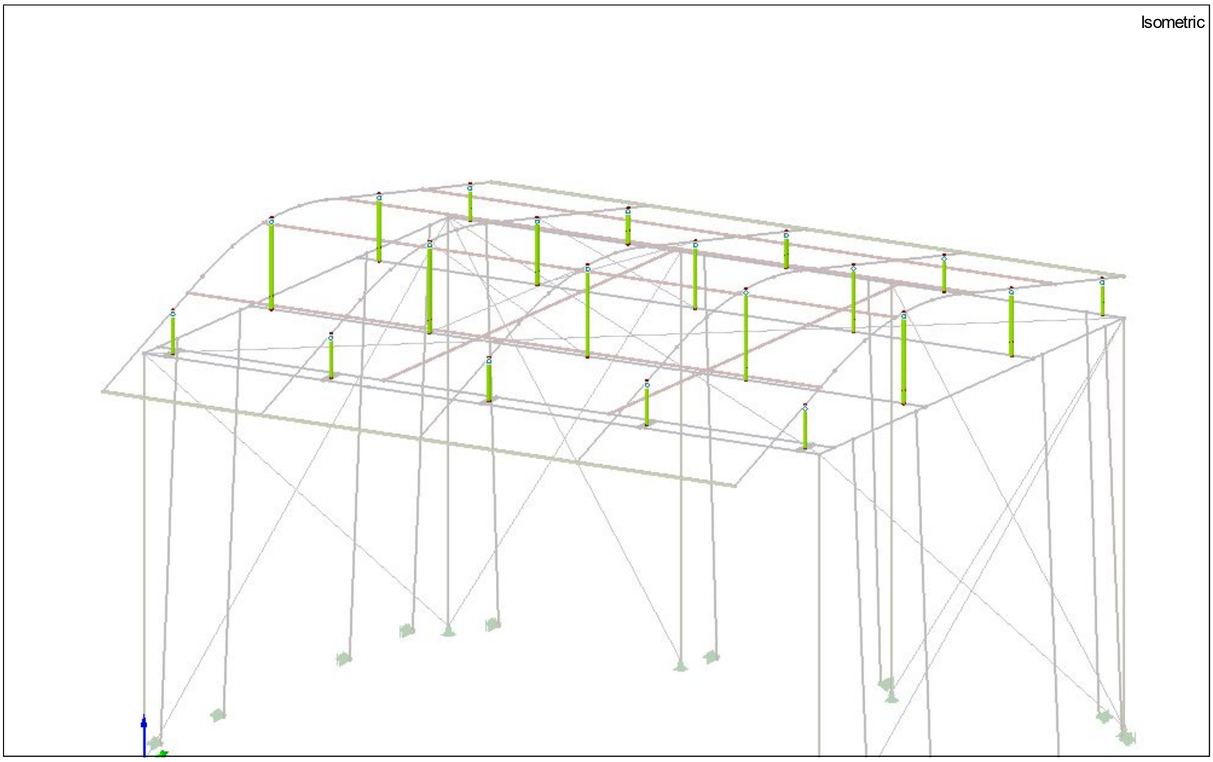
| | |
|---|---|
| L | 300 cm |
| Profile cross section A | 5.78 cm² |
| E | 7000 |
| $f_{0,\,haz}$ | 12.5 kN/cm² |
| I | 15.41 $cm^4$ |
| i √( I/A ) | 1.63 |

Buckling calculation
Lcr = L * K = 1 x 300 = 300 cm
$\lambda_z$ = Lcr / (iz * π) * (√(($A_{eff}$ * $f_0$ ) / A * E ))
$\lambda_z$ = 300 / (1.63 * π) * (√((5.78 * 12.5 ) / 5.78 * 7000 )) = 2.48
$\Theta_z = 0.5 * ( 1 + \alpha * ( \lambda_z - \lambda_0 ) + \lambda_z^2 )$
$\Theta_z = 0.5 * ( 1 + 0.2 * ( 2.48 - 0.1 ) + 2.48^2 ) = 3.81$
$X_z = 1 / (\Theta_z + \sqrt{\Theta_z^2 - \lambda_z^2})$
$X_z = 1 / (3.81 + \sqrt{3.81^2 - 2.48^2}) = 0.15$

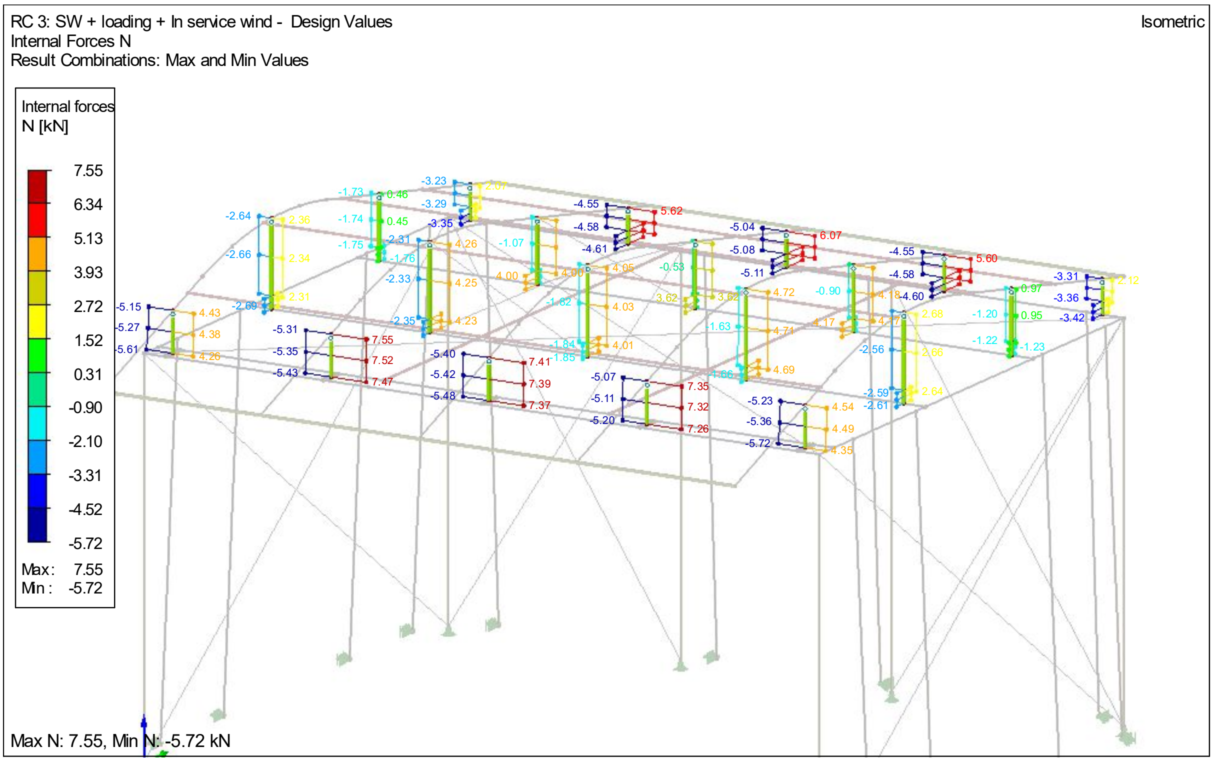
$N_{b,rd}$ = Xz * A * $f_{0,\,haz}$ /1.1
$N_{b,rd}$ = 0.15 * 5.78 * 12.5 /1.1 = 9.81 kN
$N_{Ed,\,max}$ =8.12 kN

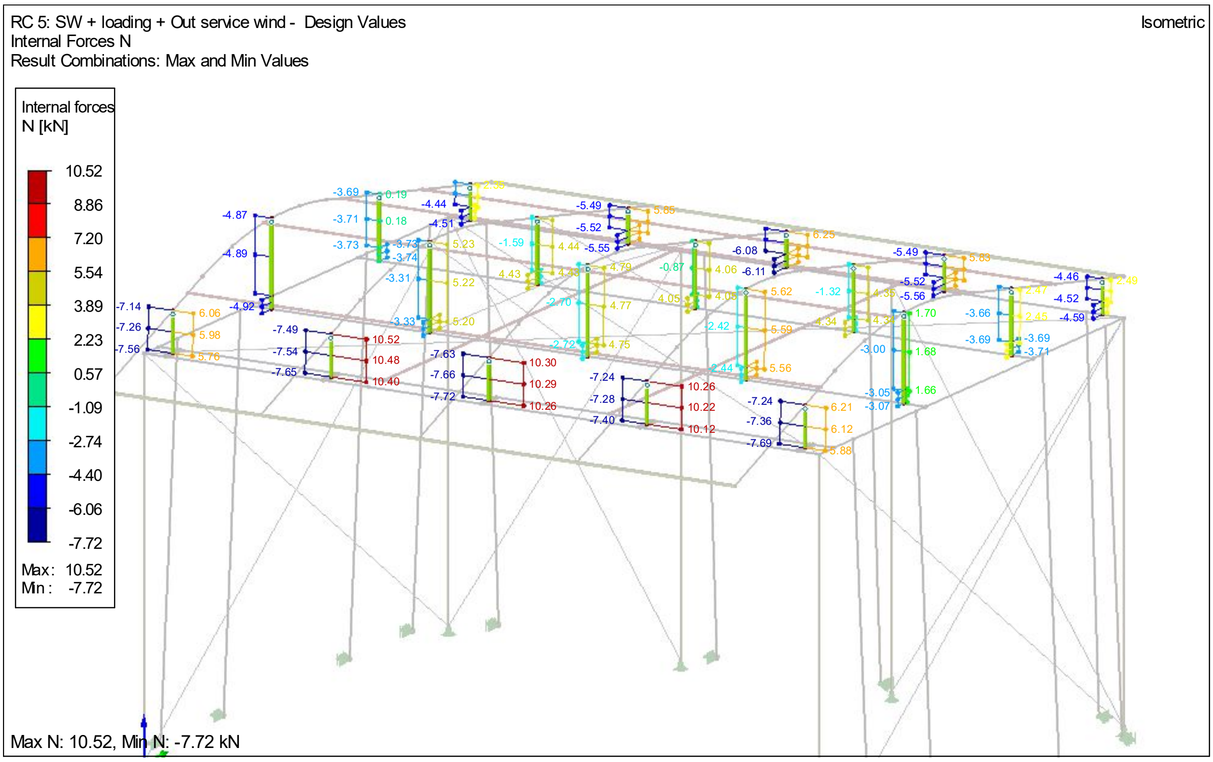
check = $N_{Ed,\,max}$ / $N_{b,rd}$ < 1
7.88 / 9.81 = 0.80 < 1

## 4.6 Check of the roof structure support.




## Internal normal forces for the adapters






Check of the adapters for the maximum tension force

Normative load result is the out-service situation.
Maximum tension force in the roof adapter is 10.52 kN.

A = 2 * A(48.3x3 tube) = 2 * 4.27 = 8.54 cm²

The profile is Tig welded at both ends therefor 0,8 * $f_{0,haz}$ is used to determine the maximum tension force in the profile.

Maximum tension force = (0,8 * $f_{0,haz}$) / 1.1 * $A_{net}$ = 4.8 / 1.1 * 8.54 = 37.2 kN

10.52 / 37.2 = 0.28 < 1

The adapter is mounted with two doughty clamps to the main grid. Each Doughty clamp has a WLL of 500 kg and a safety factor of 5.

The maximum characteristic tension force in the Out service situation is 7.67 kN

7.67 / (5 * 2) = 0.77 < 1

Check of the adapters with maximum compression force
Normative load result is the Out service
Maximum compression force is 7.72 kN which works in two tubes.
Buckling calculation for the 60x60 profile
Buckling Length factor K = 1.5
The factor K is according to table 6,8 NEN-EN 1999-1-1

| | |
|---|---|
| L | 155 cm |
| Profile cross section A | 4.27 cm² |
| E | 7000 |
| $f_{0,\,haz}$ | 4.8 kN/cm² |
| I | 11 $cm^4$ |
| i $\sqrt{(I/A)}$ | 1.61 |

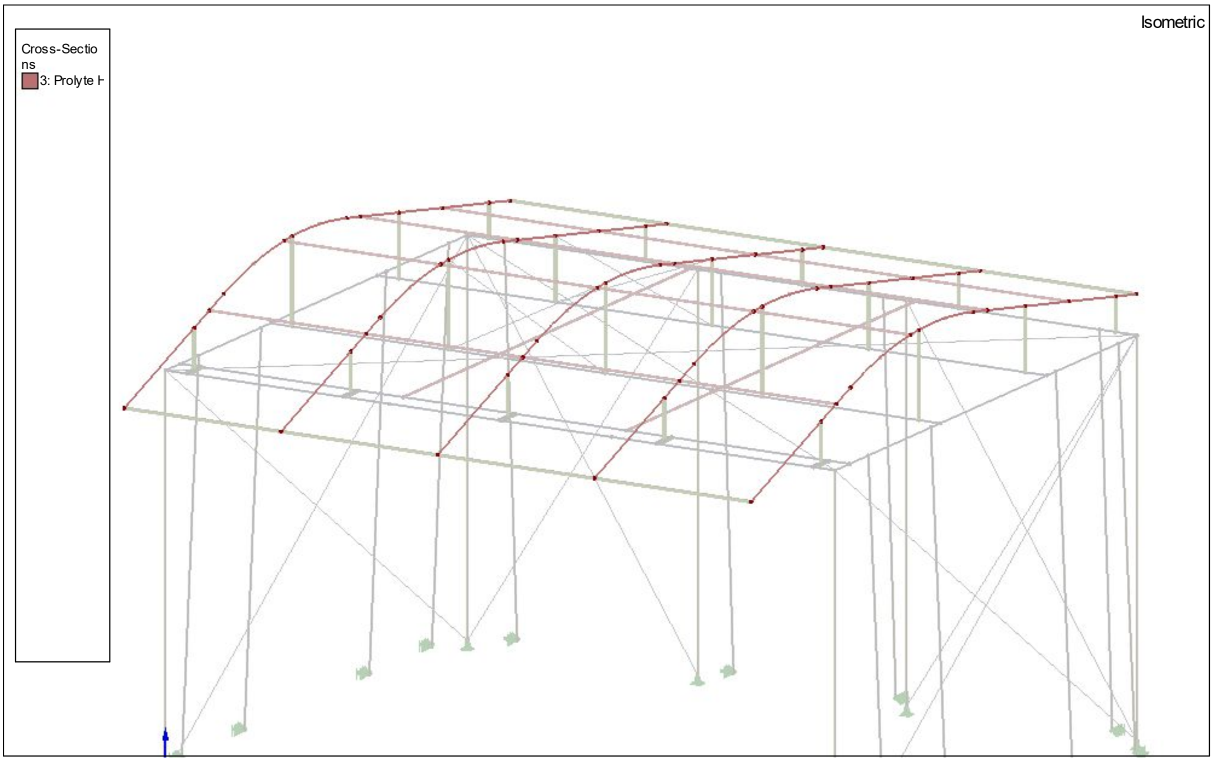
Buckling calculation
Lcr = L * K = 1.5 x 155 = 232.5 cm
$\lambda_z = Lcr / (iz * \pi) * (\sqrt{((A_{eff} * f_0) / A * E)})$
$\lambda_z = 235.5 / (1.61 * \pi) * (\sqrt{((4.27 * 4.8) / 4.27 * 7000)}) = 1.35$
$\Theta_z = 0.5 * (1 + \alpha * (\lambda_z - \lambda_0) + \lambda_z^2)$
$\Theta_z = 0.5 * (1 + 0.2 * (1.35 - 0.1) + 1.35^2) = 1.54$
$X_z = 1 / (\Theta_z + \sqrt{(\Theta_z^2 - \lambda_z^2)})$
$X_z = 1 / (1.54 + \sqrt{(1.54^2 - 1.35^2)}) = 0.44$

$N_{b,rd} = Xz * A * f_{0,\,haz} / 1.1$
$N_{b,rd} = 0.44 * (2*4.27) * 4.8 / 1.1 = 10.25$ kN
$N_{Ed,\,max} = 7.72 / 2 = 3.86$ kN

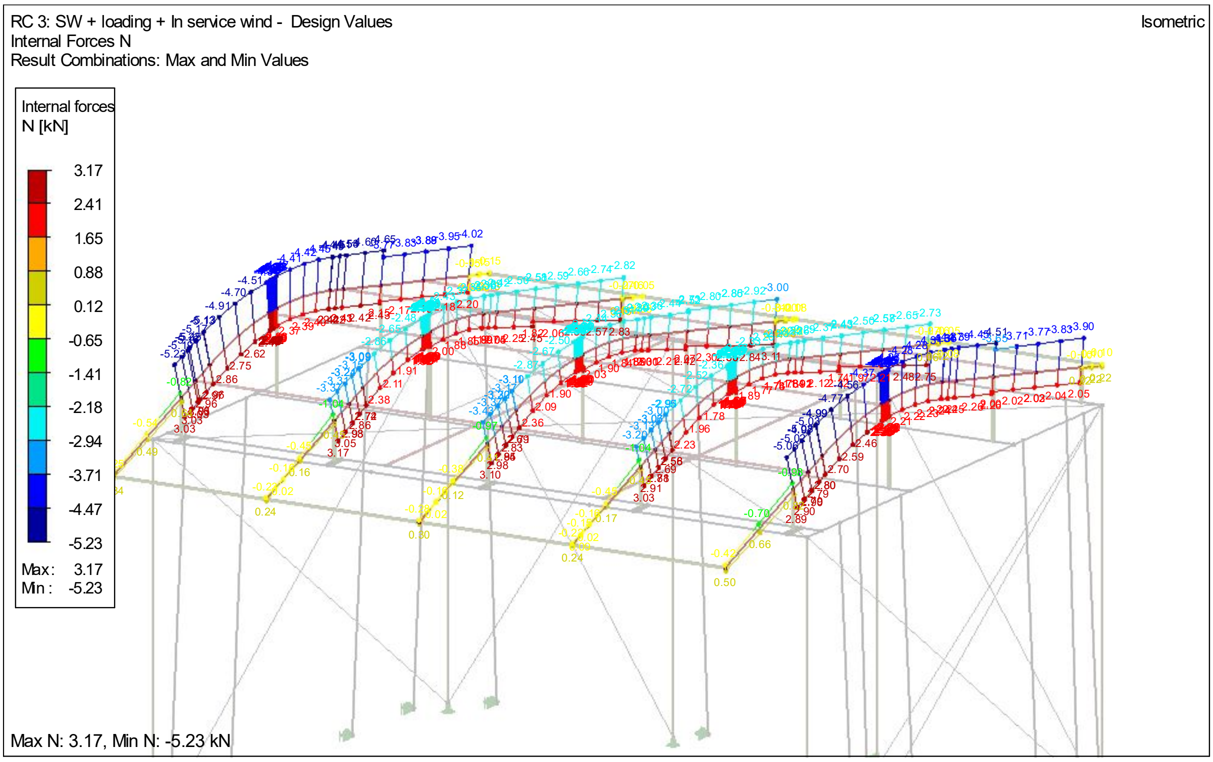
check = $N_{Ed,\,max} / N_{b,rd} < 1$
3.86 / 10.25 = 0.37 < 1

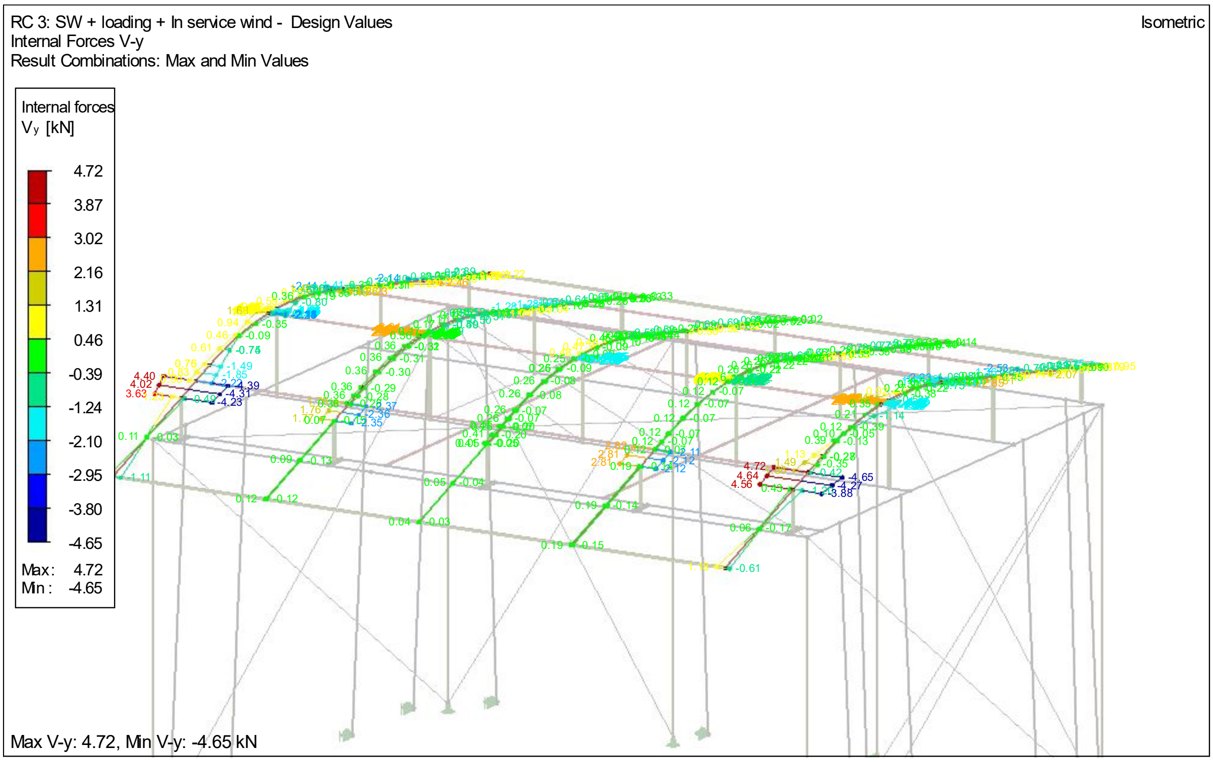
## 4.7 Check of the H30D roof truss

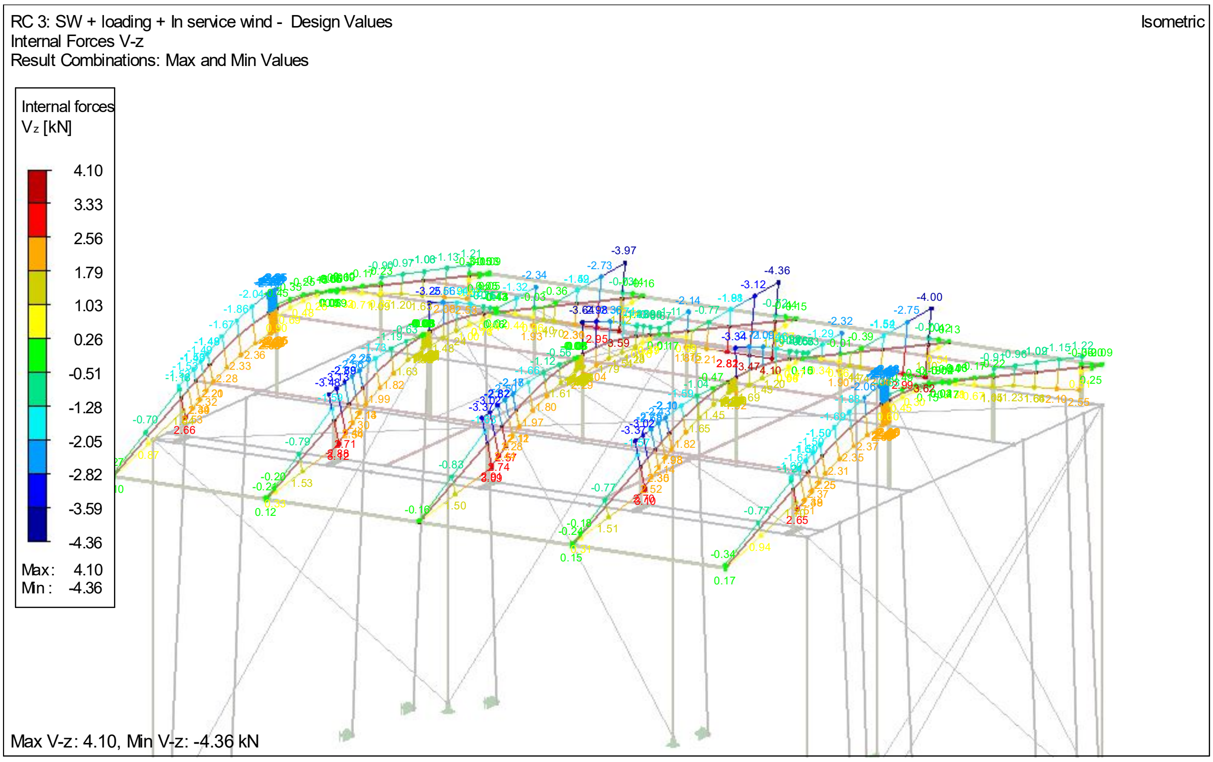
Decisive situation is the out service situation.

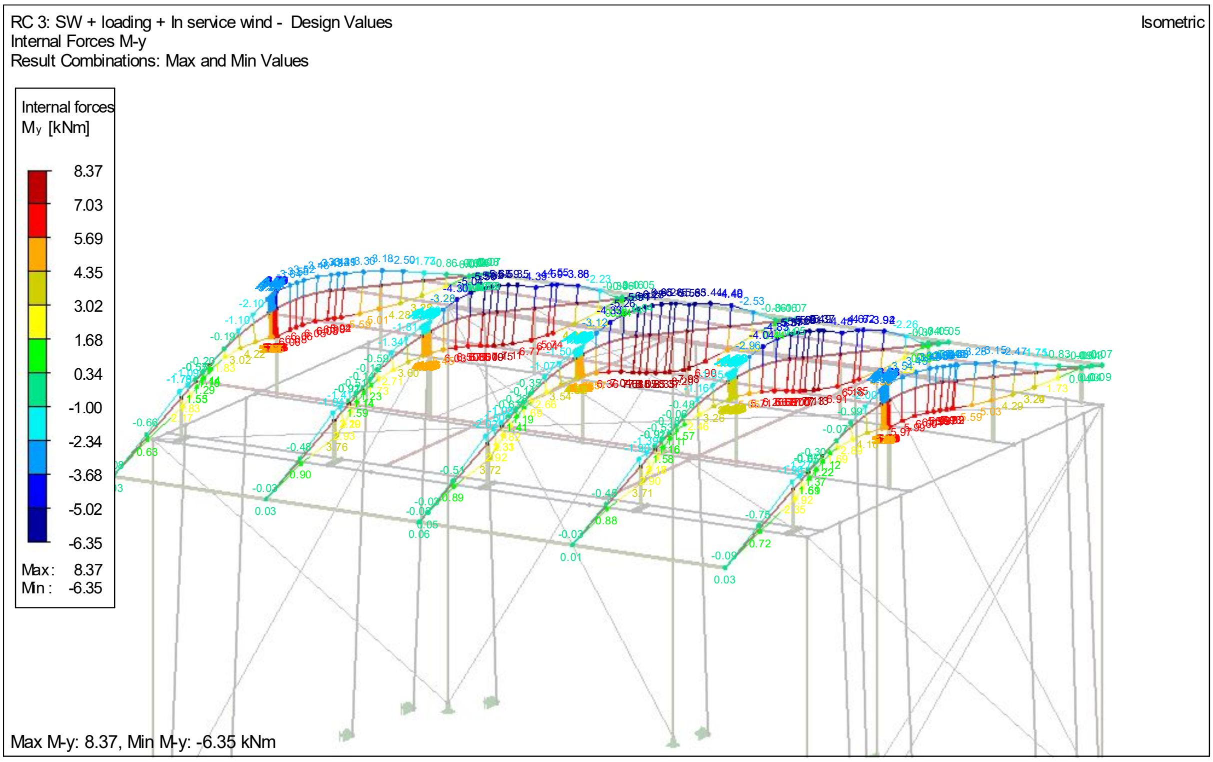


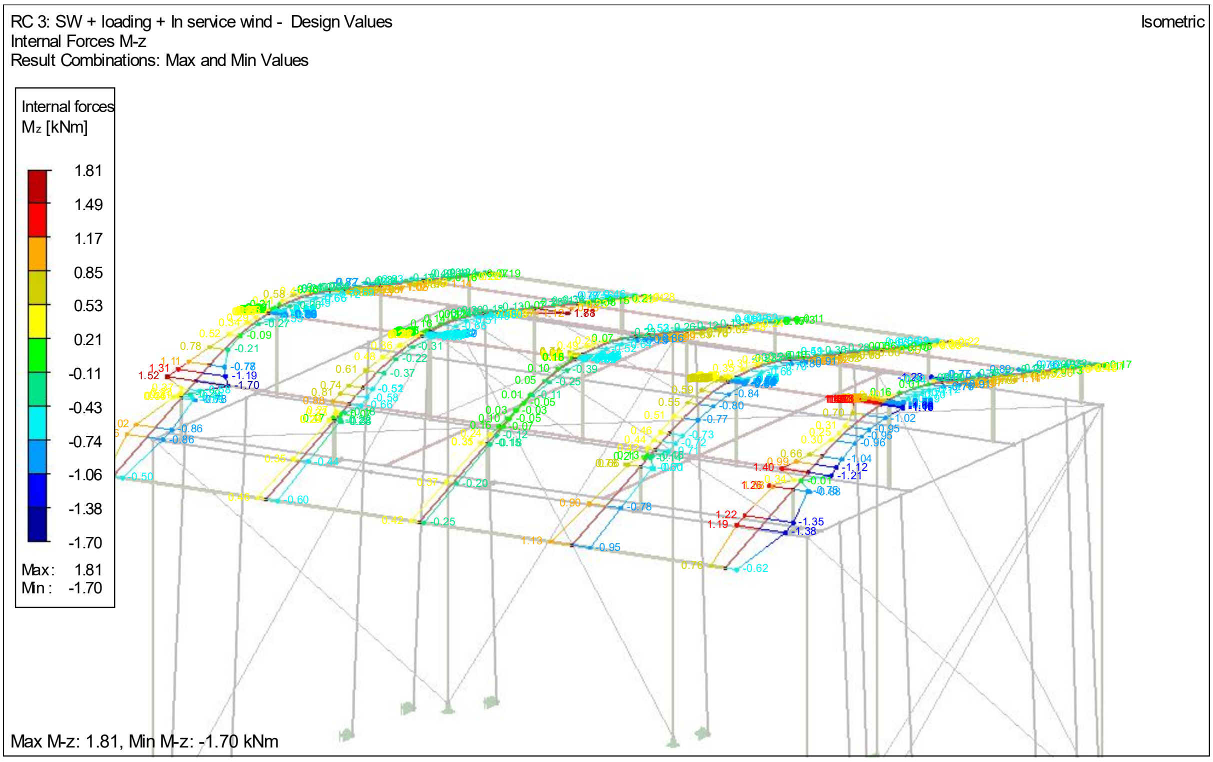

## Internal forces for the RC3 In service



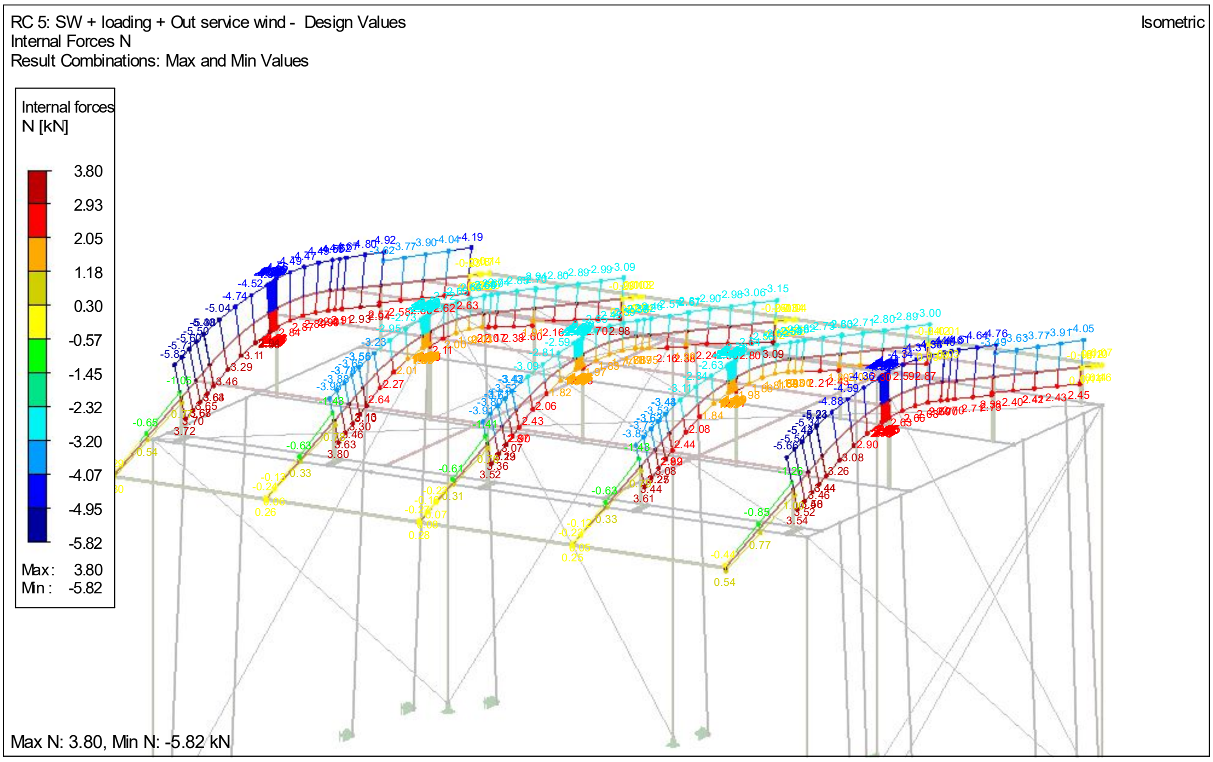

RC 3: SW + loading + In service wind - Design Values
Internal Forces V-y
Result Combinations: Max and Min Values
Isometric
Internal forces
$V_y$ [kN]
4.72
3.87
3.02
2.16
1.31
0.46
-0.39
-1.24
-2.10
-2.95
-3.80
-4.65
Max: 4.72
Min: -4.65
Max V-y: 4.72, Min V-y: -4.65 kN

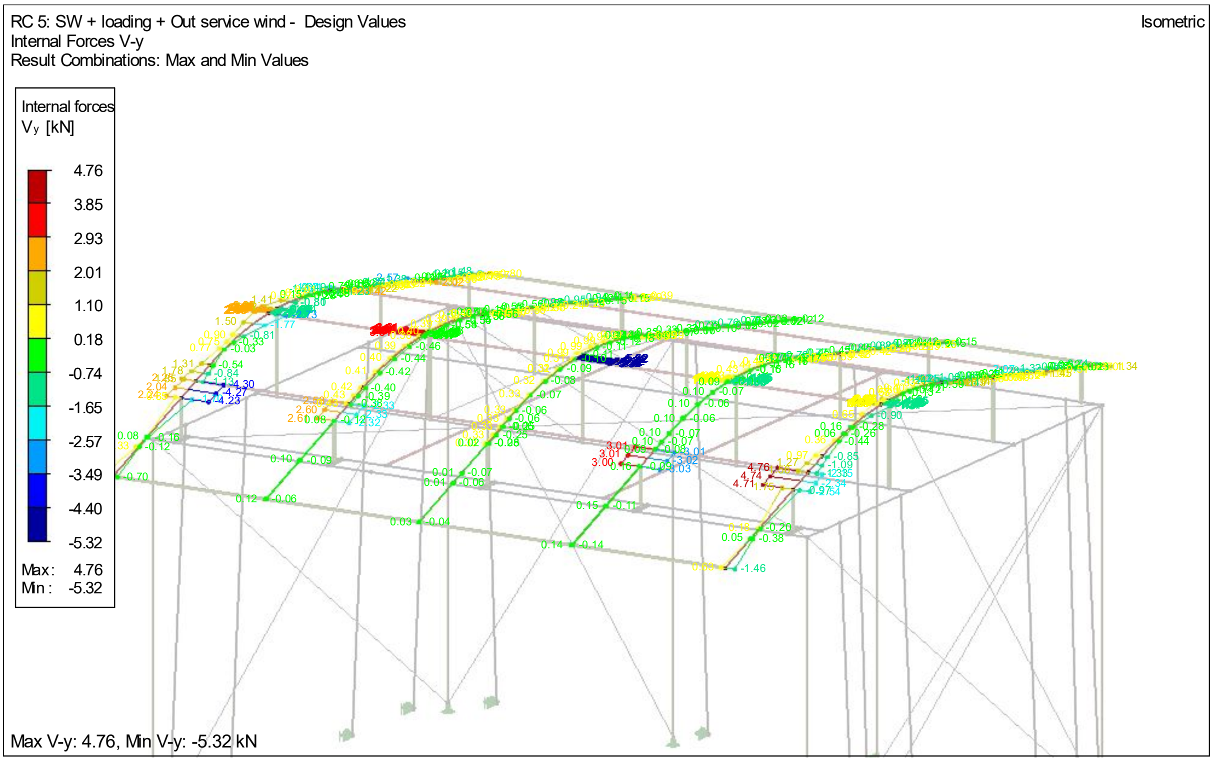

RC 3: SW + loading + In service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
$V_z$ [kN]
4.10
3.33
2.56
1.79
1.03
0.26
-0.51
-1.28
-2.05
-2.82
-3.59
-4.36
Max: 4.10
Min: -4.36
Max V-z: 4.10, Min V-z: -4.36 kN

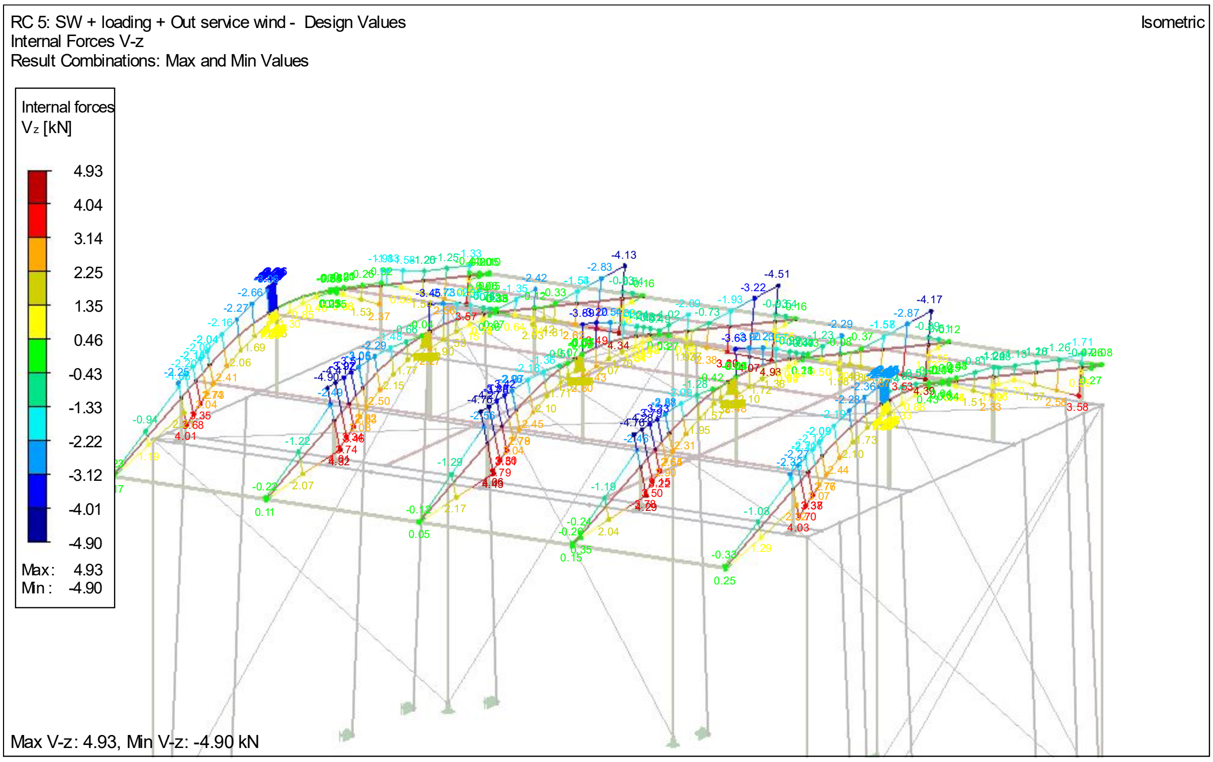

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
8.37
7.03
5.69
4.35
3.02
1.68
0.34
-1.00
-2.34
-3.68
-5.02
-6.35
Max: 8.37
Min: -6.35
Max M-y: 8.37, Min M-y: -6.35 kNm

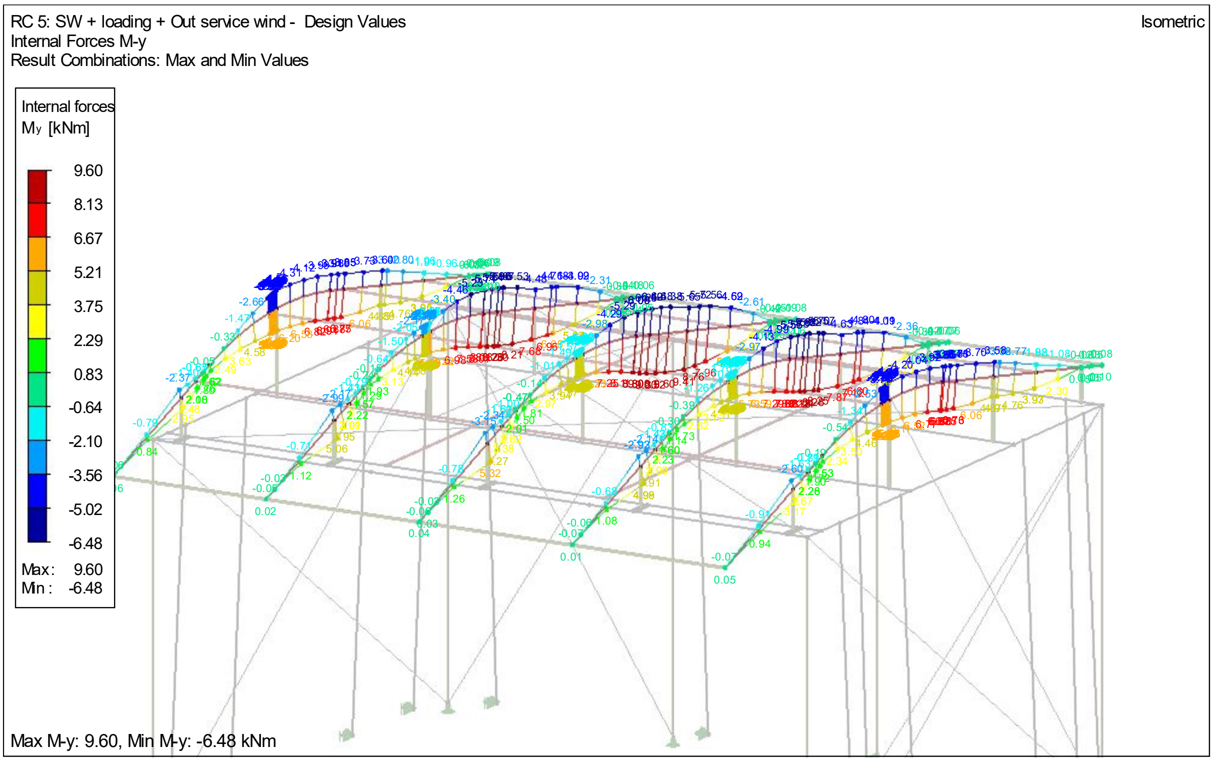

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Mz [kNm]
1.81
1.49
1.17
0.85
0.53
0.21
-0.11
-0.43
-0.74
-1.06
-1.38
-1.70
Max: 1.81
Min: -1.70
Max M-z: 1.81, Min M-z: -1.70 kNm

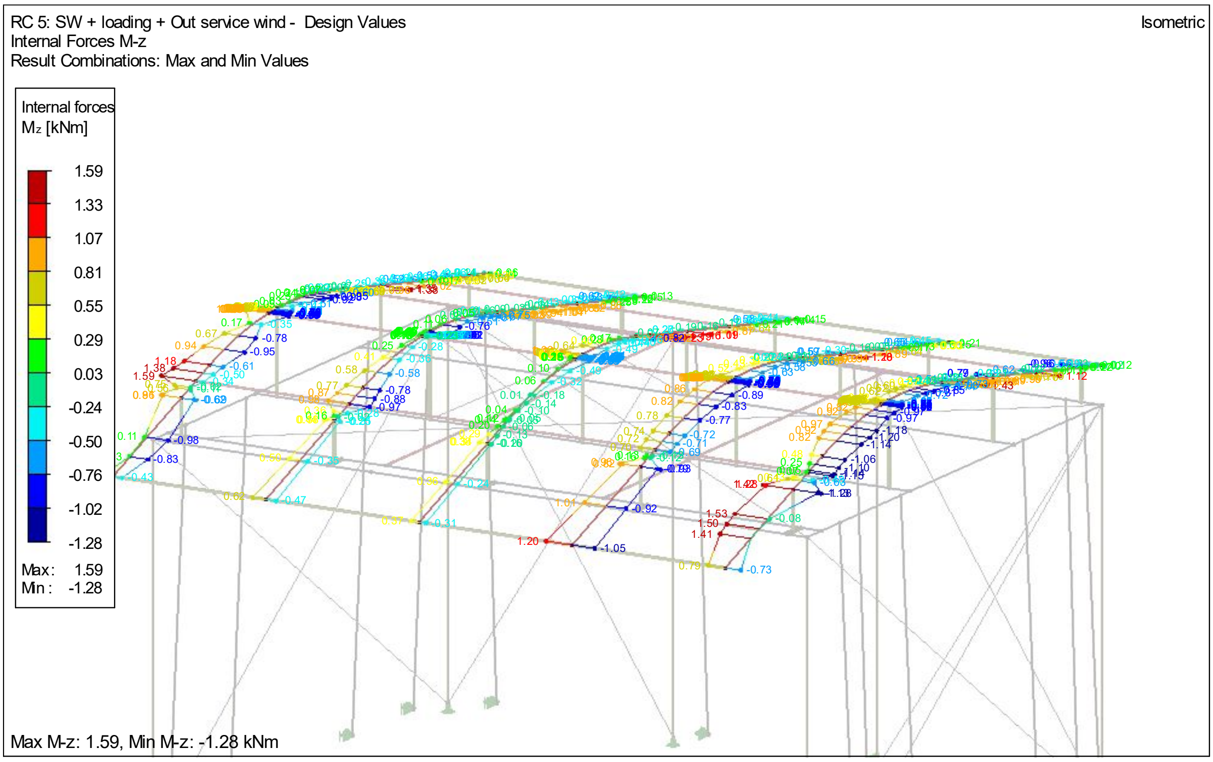
# Internal forces for the RC5 Out service



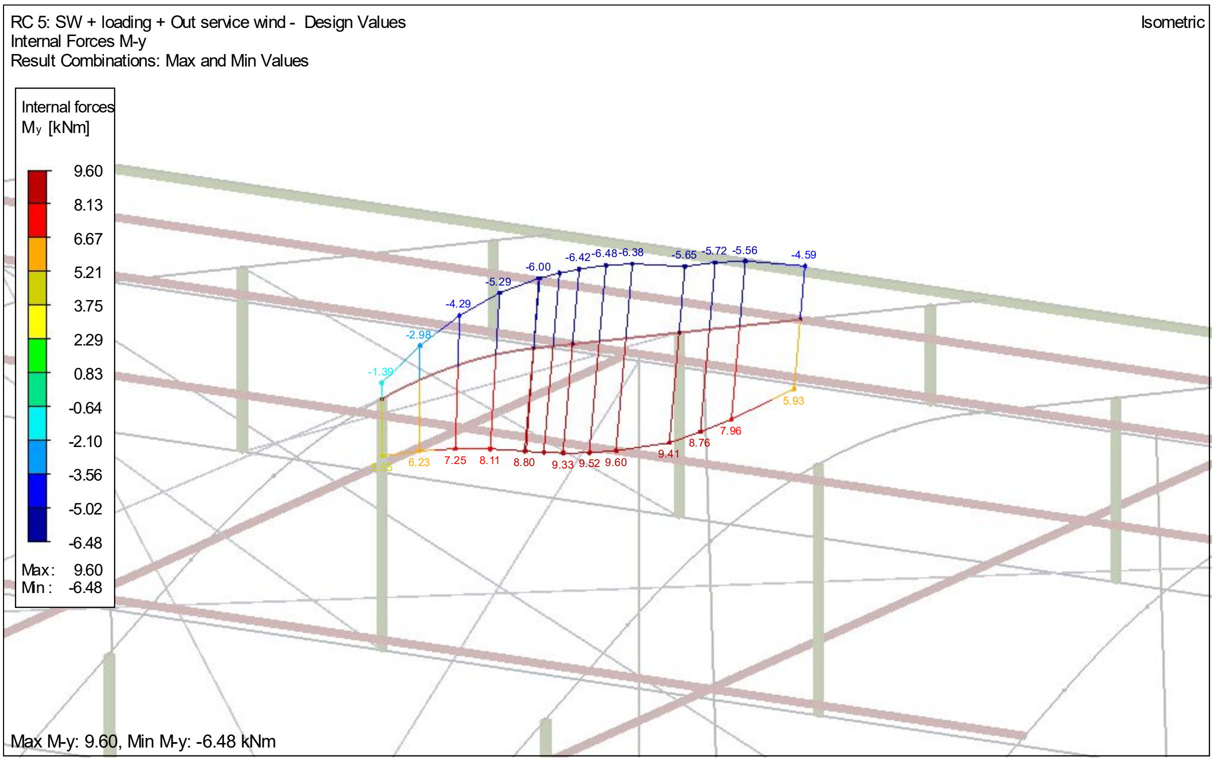

RC 5: SW + loading + Out service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
4.93
4.04
3.14
2.25
1.35
0.46
-0.43
-1.33
-2.22
-3.12
-4.01
-4.90
Max: 4.93
Min: -4.90
Max V-z: 4.93, Min V-z: -4.90 kN


RC 5: SW + loading + Out service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values
Isometric
Internal forces
My [kNm]
9.60
8.13
6.67
5.21
3.75
2.29
0.83
-0.64
-2.10
-3.56
-5.02
-6.48
Max: 9.60
Min: -6.48
Max M-y: 9.60, Min M-y: -6.48 kNm




Normative load case RC5 Out service

Maximum Internal forces in the middle span on the back side.



Internal forces for the selected truss parts.

| Member | Node | Location | | Forces [kN] | | | Moments [kNm] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | No. | x [m] | | N | $V_y$ | $V_z$ | $M_T$ | $M_y$ | $M_z$ | Corresponding Load Cases |
| 145 | 40 | 0,000 | max N | **2,50** | 0,06 | -1,93 | 0,05 | -4,59 | 0,25 | CO 220 |
| | | | min N | **-2,98** | 0,05 | 3,19 | -0,11 | 5,93 | -0,14 | CO 228 |
| | | | max $V_y$ | 1,12 | **0,15** | -0,74 | 0,05 | -2,81 | 0,22 | CO 224 |
| | | | min $V_y$ | 2,05 | **-0,33** | -1,71 | -0,01 | -4,06 | 0,63 | CO 210 |
| | | | max $V_z$ | -2,98 | 0,05 | **3,19** | -0,11 | 5,93 | -0,14 | CO 228 |
| | | | min $V_z$ | 2,50 | 0,06 | **-1,93** | 0,05 | -4,59 | 0,25 | CO 220 |
| | | | max $M_y$ | -2,98 | 0,05 | 3,19 | -0,11 | **5,93** | -0,14 | CO 228 |
| | | | min $M_y$ | 2,50 | 0,06 | -1,93 | 0,05 | **-4,59** | 0,25 | CO 220 |
| | | | max $M_z$ | 0,70 | -0,21 | -0,52 | -0,02 | -2,27 | **0,64** | CO 214 |
| | | | min $M_z$ | -2,67 | 0,04 | 2,82 | -0,09 | 5,35 | **-0,16** | CO 226 |
| | 91 | 1,463 | max N | **1,98** | 0,07 | 0,47 | 0,05 | -5,65 | 0,17 | CO 220 |
| | | | min N | **-2,81** | 0,06 | 1,56 | -0,12 | 9,41 | -0,19 | CO 228 |
| | | | max $V_y$ | 0,64 | **0,17** | 1,68 | 0,06 | -2,13 | 0,00 | CO 224 |
| | | | min $V_y$ | 1,62 | **-0,33** | 0,33 | -0,02 | -5,07 | 1,11 | CO 210 |
| | | | max $V_z$ | 0,33 | -0,05 | **1,93** | 0,03 | -1,39 | 0,21 | CO 203 |
| | | | min $V_z$ | 0,00 | 0,00 | **0,00** | 0,00 | 0,00 | 0,00 | |
| | | | max $M_y$ | -2,81 | 0,06 | 1,56 | -0,12 | **9,41** | -0,19 | CO 228 |
| | | | min $M_y$ | 1,98 | 0,07 | 0,47 | 0,05 | **-5,65** | 0,17 | CO 220 |
| | | | max $M_z$ | 1,62 | -0,33 | 0,33 | -0,02 | -5,07 | **1,11** | CO 210 |
| | | | min $M_z$ | -2,57 | 0,11 | 1,32 | -0,09 | 8,62 | **-0,26** | CO 209 |
| | 40 | 0,000 | Max N | **2,50** | 0,06 | -1,93 | 0,05 | -4,59 | 0,25 | CO 220 |
| | 40 | 0,000 | Min N | **-2,98** | 0,05 | 3,19 | -0,11 | 5,93 | -0,14 | CO 228 |
| | 91 | 1,463 | Max $V_y$ | 0,64 | **0,17** | 1,68 | 0,06 | -2,13 | 0,00 | CO 224 |
| | 91 | 1,463 | Min $V_y$ | 1,62 | **-0,33** | 0,33 | -0,02 | -5,07 | 1,11 | CO 210 |
| | 40 | 0,000 | Max $V_z$ | -2,98 | 0,05 | **3,19** | -0,11 | 5,93 | -0,14 | CO 228 |
| | 40 | 0,000 | Min $V_z$ | 2,50 | 0,06 | **-1,93** | 0,05 | -4,59 | 0,25 | CO 220 |
| | 91 | 1,463 | Max $M_y$ | -2,81 | 0,06 | 1,56 | -0,12 | **9,41** | -0,19 | CO 228 |
| | 91 | 1,463 | Min $M_y$ | 1,98 | 0,07 | 0,47 | 0,05 | **-5,65** | 0,17 | CO 220 |
| | 91 | 1,463 | Max $M_z$ | 1,62 | -0,33 | 0,33 | -0,02 | -5,07 | **1,11** | CO 210 |
| | 91 | 1,463 | Min $M_z$ | -2,57 | 0,11 | 1,32 | -0,09 | 8,62 | **-0,26** | CO 209 |
| 146 | 91 | 0,000 | max N | **2,38** | -0,08 | -1,65 | 0,05 | -5,63 | 0,18 | CO 200 |
| | | | min N | **-2,67** | -0,33 | 0,66 | -0,12 | 9,41 | -0,21 | CO 228 |
| | | | max $V_y$ | 1,47 | **0,06** | -1,86 | 0,03 | -2,93 | 0,27 | CO 202 |
| | | | min $V_y$ | -2,64 | **-0,33** | 0,62 | -0,12 | 9,33 | -0,20 | CO 208 |
| | | | max $V_z$ | -1,64 | -0,18 | **0,98** | -0,06 | 5,11 | -0,16 | CO 225 |
| | | | min $V_z$ | 1,06 | 0,05 | **-2,09** | 0,03 | -1,39 | 0,21 | CO 223 |
| | | | max $M_y$ | -2,67 | -0,33 | 0,66 | -0,12 | **9,41** | -0,21 | CO 228 |
| | | | min $M_y$ | 2,38 | -0,09 | -1,65 | 0,05 | **-5,65** | 0,18 | CO 220 |
| | | | max $M_z$ | 1,92 | -0,11 | -1,32 | -0,01 | -5,07 | **1,09** | CO 210 |
| | | | min $M_z$ | -2,52 | -0,30 | 0,63 | -0,08 | 8,62 | **-0,27** | CO 209 |
| | 45 | 1,287 | max N | **1,95** | -0,07 | 0,46 | 0,05 | -6,40 | 0,29 | CO 200 |
| | | | min N | **-2,46** | -0,32 | -0,78 | -0,11 | 9,33 | 0,23 | CO 228 |
| | | | max $V_y$ | 1,06 | **0,07** | 0,27 | 0,03 | -3,95 | 0,19 | CO 202 |
| | | | min $V_y$ | -2,44 | **-0,32** | -0,81 | -0,10 | 9,20 | 0,24 | CO 208 |
| | | | max $V_z$ | 1,56 | -0,11 | **0,48** | -0,01 | -5,62 | 1,23 | CO 210 |
| | | | min $V_z$ | -2,44 | -0,32 | **-0,81** | -0,10 | 9,20 | 0,24 | CO 208 |
| | | | max $M_y$ | -2,46 | -0,32 | -0,78 | -0,11 | **9,33** | 0,23 | CO 228 |
| | | | min $M_y$ | 1,94 | -0,07 | 0,46 | 0,05 | **-6,42** | 0,29 | CO 220 |
| | | | max $M_z$ | 1,56 | -0,11 | 0,48 | -0,01 | -5,62 | **1,23** | CO 210 |
| | | | min $M_z$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | |
| | 91 | 0,000 | Max N | **2,38** | -0,08 | -1,65 | 0,05 | -5,63 | 0,18 | CO 200 |
| | 91 | 0,000 | Min N | **-2,67** | -0,33 | 0,66 | -0,12 | 9,41 | -0,21 | CO 228 |
| | 45 | 1,287 | Max $V_y$ | 1,06 | **0,07** | 0,27 | 0,03 | -3,95 | 0,19 | CO 202 |
| | 91 | 0,000 | Min $V_y$ | -2,64 | **-0,33** | 0,62 | -0,12 | 9,33 | -0,20 | CO 208 |
| | 91 | 0,000 | Max $V_z$ | -1,64 | -0,18 | **0,98** | -0,06 | 5,11 | -0,16 | CO 225 |
| | 91 | 0,000 | Min $V_z$ | 1,06 | 0,05 | **-2,09** | 0,03 | -1,39 | 0,21 | CO 223 |
| | | 0,644 | Max $M_y$ | -2,57 | -0,33 | -0,06 | -0,11 | **9,60** | 0,01 | CO 228 |
| | 45 | 1,287 | Min $M_y$ | 1,94 | -0,07 | 0,46 | 0,05 | **-6,42** | 0,29 | CO 220 |
| | 45 | 1,287 | Max $M_z$ | 1,56 | -0,11 | 0,48 | -0,01 | -5,62 | **1,23** | CO 210 |
| | 91 | 0,000 | Min $M_z$ | -2,52 | -0,30 | 0,63 | -0,08 | 8,62 | **-0,27** | CO 209 |
| 147 | 45 | 0,000 | max N | **1,95** | 0,49 | 0,47 | 0,05 | -6,38 | 0,29 | CO 200 |
| | | | min N | **-2,46** | -0,14 | -0,82 | -0,11 | 9,30 | 0,23 | CO 228 |
| | | | max $V_y$ | 1,56 | **0,99** | 0,52 | -0,01 | -5,61 | 1,23 | CO 210 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | min $V_y$ | -2,22 | **-0,14** | -0,78 | -0,09 | 8,21 | 0,16 | CO 226 |
| | | | max $V_z$ | 1,56 | 0,99 | **0,52** | -0,01 | -5,61 | 1,23 | CO 210 |
| | | | min $V_z$ | -2,46 | -0,14 | **-0,82** | -0,11 | 9,30 | 0,23 | CO 228 |
| | | | max $M_y$ | -2,46 | -0,14 | -0,82 | -0,11 | **9,30** | 0,23 | CO 228 |
| | | | min $M_y$ | 1,94 | 0,49 | 0,47 | 0,05 | **-6,40** | 0,29 | CO 220 |
| | | | max $M_z$ | 1,56 | 0,99 | 0,52 | -0,01 | -5,61 | **1,23** | CO 210 |
| | | | min $M_z$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | |
| | 24 | 0,471 | max N | **1,80** | 0,50 | 1,24 | 0,05 | -5,98 | 0,06 | CO 200 |
| | | | min N | **-2,38** | -0,13 | -1,34 | -0,10 | 8,80 | 0,30 | CO 228 |
| | | | max $V_y$ | 1,44 | **0,99** | 1,18 | -0,01 | -5,21 | 0,76 | CO 210 |
| | | | min $V_y$ | -2,13 | **-0,14** | -1,30 | -0,09 | 7,72 | 0,23 | CO 226 |
| | | | max $V_z$ | 1,80 | 0,50 | **1,24** | 0,05 | -5,98 | 0,06 | CO 200 |
| | | | min $V_z$ | -2,38 | -0,13 | **-1,34** | -0,10 | 8,80 | 0,30 | CO 228 |
| | | | max $M_y$ | -2,38 | -0,13 | -1,34 | -0,10 | **8,80** | 0,30 | CO 228 |
| | | | min $M_y$ | 1,80 | 0,50 | 1,24 | 0,05 | **-6,00** | 0,06 | CO 220 |
| | | | max $M_z$ | 0,56 | 0,84 | 0,99 | -0,03 | -2,80 | **0,82** | CO 212 |
| | | | min $M_z$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | |
| | 45 | 0,000 | Max N | **1,95** | 0,49 | 0,47 | 0,05 | -6,38 | 0,29 | CO 200 |
| | 45 | 0,000 | Min N | **-2,46** | -0,14 | -0,82 | -0,11 | 9,30 | 0,23 | CO 228 |
| | 45 | 0,000 | Max $V_y$ | 1,56 | **0,99** | 0,52 | -0,01 | -5,61 | 1,23 | CO 210 |
| | 45 | 0,000 | Min $V_y$ | -2,22 | **-0,14** | -0,78 | -0,09 | 8,21 | 0,16 | CO 226 |
| | 24 | 0,471 | Max $V_z$ | 1,80 | 0,50 | **1,24** | 0,05 | -5,98 | 0,06 | CO 200 |
| | 24 | 0,471 | Min $V_z$ | -2,38 | -0,13 | **-1,34** | -0,10 | 8,80 | 0,30 | CO 228 |
| | 45 | 0,000 | Max $M_y$ | -2,46 | -0,14 | -0,82 | -0,11 | **9,30** | 0,23 | CO 228 |
| | 45 | 0,000 | Min $M_y$ | 1,94 | 0,49 | 0,47 | 0,05 | **-6,40** | 0,29 | CO 220 |
| | 45 | 0,000 | Max $M_z$ | 1,56 | 0,99 | 0,52 | -0,01 | -5,61 | **1,23** | CO 210 |
| | 45 | 0,000 | Min $M_z$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | |
| 153 | 93 | 0,000 | max N | **2,18** | 0,54 | -3,85 | -0,02 | -1,36 | 0,89 | CO 200 |
| | | | min N | **-2,70** | -0,10 | 2,79 | 0,00 | 5,05 | -0,54 | CO 228 |
| | | | max $V_y$ | 1,80 | **0,99** | -3,41 | -0,02 | -1,04 | 1,03 | CO 210 |
| | | | min $V_y$ | -2,46 | **-0,11** | 2,80 | 0,00 | 4,00 | -0,48 | CO 226 |
| | | | max $V_z$ | -2,46 | -0,11 | **2,80** | 0,00 | 4,00 | -0,48 | CO 226 |
| | | | min $V_z$ | 1,25 | 0,35 | **-3,89** | -0,01 | 0,85 | 0,58 | CO 222 |
| | | | max $M_y$ | -2,70 | -0,10 | 2,79 | 0,00 | **5,05** | -0,54 | CO 228 |
| | | | min $M_y$ | 2,17 | 0,55 | -3,85 | -0,02 | **-1,39** | 0,89 | CO 220 |
| | | | max $M_z$ | 1,80 | 0,99 | -3,41 | -0,02 | -1,04 | **1,03** | CO 210 |
| | | | min $M_z$ | -2,70 | -0,10 | 2,79 | 0,00 | 5,05 | **-0,54** | CO 228 |
| | 144 | 0,907 | max N | **1,83** | 0,52 | -2,54 | 0,04 | -4,26 | 0,40 | CO 200 |
| | | | min N | **-2,45** | -0,11 | 2,07 | -0,05 | 7,25 | -0,44 | CO 228 |
| | | | max $V_y$ | 1,48 | **0,99** | -2,30 | 0,03 | -3,63 | 0,13 | CO 210 |
| | | | min $V_y$ | -2,20 | **-0,12** | 2,05 | -0,05 | 6,20 | -0,37 | CO 226 |
| | | | max $V_z$ | -2,45 | -0,11 | **2,07** | -0,05 | 7,25 | -0,44 | CO 228 |
| | | | min $V_z$ | 1,83 | 0,52 | **-2,54** | 0,04 | -4,26 | 0,40 | CO 200 |
| | | | max $M_y$ | -2,45 | -0,11 | 2,07 | -0,05 | **7,25** | -0,44 | CO 228 |
| | | | min $M_y$ | 1,83 | 0,53 | -2,54 | 0,04 | **-4,29** | 0,40 | CO 220 |
| | | | max $M_z$ | 1,83 | 0,53 | -2,54 | 0,04 | -4,29 | **0,40** | CO 220 |
| | | | min $M_z$ | -2,45 | -0,11 | 2,07 | -0,05 | 7,25 | **-0,44** | CO 228 |
| | 24 | 1,813 | max N | **1,78** | 0,50 | -1,24 | 0,06 | -5,98 | -0,06 | CO 200 |
| | | | min N | **-2,37** | -0,13 | 1,34 | -0,10 | 8,80 | -0,31 | CO 228 |
| | | | max $V_y$ | 1,42 | **0,99** | -1,18 | 0,01 | -5,21 | -0,76 | CO 210 |
| | | | min $V_y$ | -2,12 | **-0,14** | 1,30 | -0,09 | 7,72 | -0,23 | CO 226 |
| | | | max $V_z$ | -2,37 | -0,13 | **1,34** | -0,10 | 8,80 | -0,31 | CO 228 |
| | | | min $V_z$ | 1,78 | 0,50 | **-1,24** | 0,06 | -5,98 | -0,06 | CO 200 |
| | | | max $M_y$ | -2,37 | -0,13 | 1,34 | -0,10 | **8,80** | -0,31 | CO 228 |
| | | | min $M_y$ | 1,78 | 0,50 | -1,24 | 0,06 | **-6,00** | -0,06 | CO 220 |
| | | | max $M_z$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | |
| | | | min $M_z$ | 0,54 | 0,84 | -0,99 | -0,02 | -2,80 | **-0,82** | CO 212 |
| | 93 | 0,000 | Max N | **2,18** | 0,54 | -3,85 | -0,02 | -1,36 | 0,89 | CO 200 |
| | 93 | 0,000 | Min N | **-2,70** | -0,10 | 2,79 | 0,00 | 5,05 | -0,54 | CO 228 |
| | 93 | 0,000 | Max $V_y$ | 1,80 | **0,99** | -3,41 | -0,02 | -1,04 | 1,03 | CO 210 |
| | 24 | 1,813 | Min $V_y$ | -2,12 | **-0,14** | 1,30 | -0,09 | 7,72 | -0,23 | CO 226 |
| | 93 | 0,000 | Max $V_z$ | -2,46 | -0,11 | **2,80** | 0,00 | 4,00 | -0,48 | CO 226 |
| | 93 | 0,000 | Min $V_z$ | 1,25 | 0,35 | **-3,89** | -0,01 | 0,85 | 0,58 | CO 222 |
| | 24 | 1,813 | Max $M_y$ | -2,37 | -0,13 | 1,34 | -0,10 | **8,80** | -0,31 | CO 228 |
| | 24 | 1,813 | Min $M_y$ | 1,78 | 0,50 | -1,24 | 0,06 | **-6,00** | -0,06 | CO 220 |
| | 93 | 0,000 | Max $M_z$ | 1,80 | 0,99 | -3,41 | -0,02 | -1,04 | **1,03** | CO 210 |
| | 24 | 1,813 | Min $M_z$ | 0,54 | 0,84 | -0,99 | -0,02 | -2,80 | **-0,82** | CO 212 |

Interaction of moment and transversal force calculation of CO228 the first marked row in the table

$N_d$ = 2.81 kN
$V_{dy}$ = 0.06 kN
$V_{dz}$ = 1.56 kN
$M_{dy}$ = 9.41 kN
$M_{dz}$ = 0.19 kN
$V_{d,\ main\ chord} = 0.33 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.33 * \sqrt{( 0.06^2 + 1.56^2)}$
$V_{d,\ main\ chord}$ = 0.52 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.52 * 0.05$
$M_{d,\ main\ chord}$ = 0.026 kNcm
$N_{d,\ main\ chord} = N_d/3 + M_{dy} / h + M_{dz} / b$
$N_{d,\ main\ chord} = 2.81/ 3 + 9.41 / 0.207 + 0.19 / 0.239$
$N_{d,\ main\ chord}$ = 47.19 kN

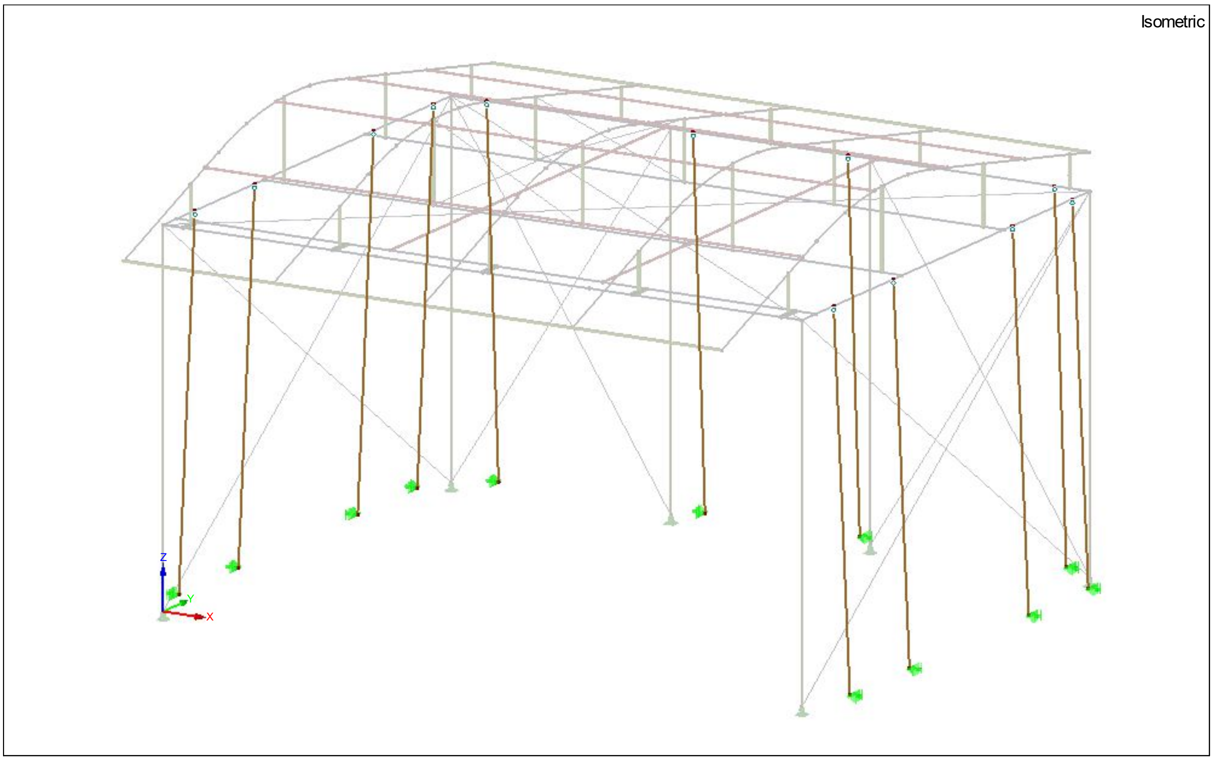
Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 47.19 / 50.22 )^{1.3} + 0.026 / 0.532 = 0.97 < 1$

Interaction of moment and transversal force calculation of CO228 the second marked row in the table

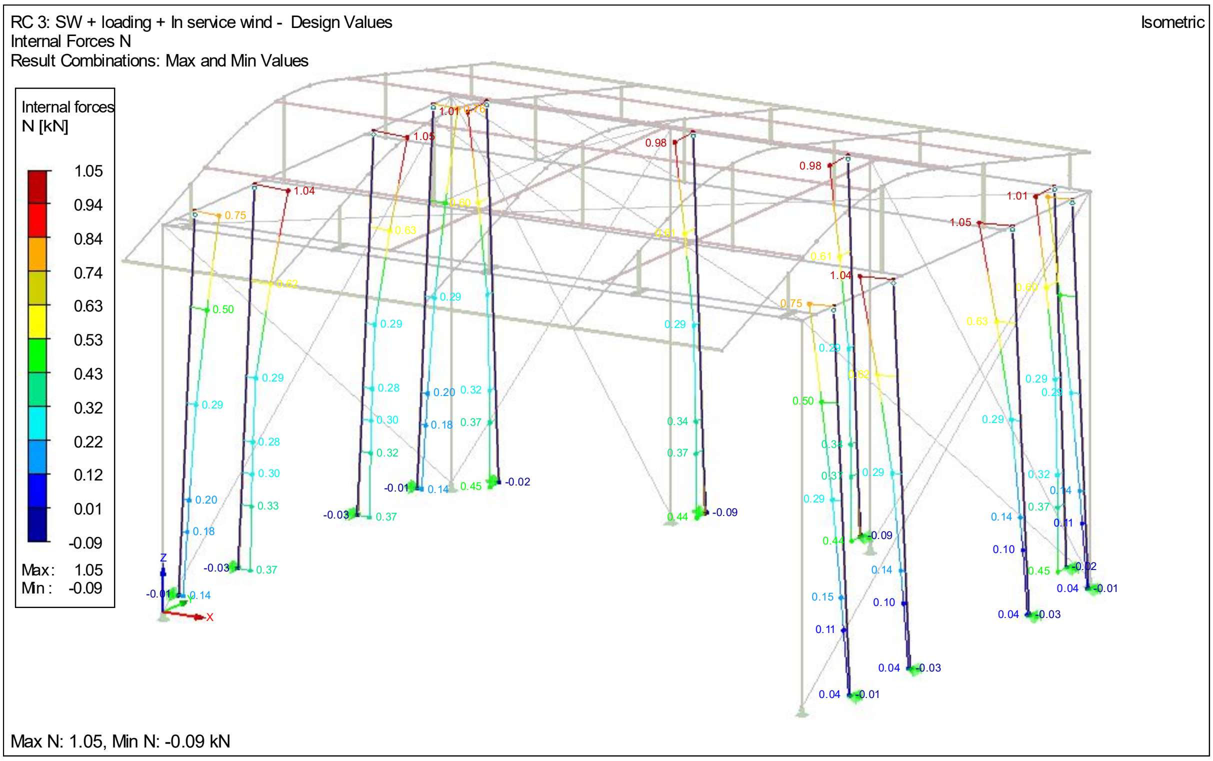
$N_d$ = 2.57 kN
$V_{dy}$ = 0.33 kN
$V_{dz}$ = 0.06 kN
$M_{dy}$ = 9.60 kN
$M_{dz}$ = 0.01 kN
$V_{d,\ main\ chord} = 0.33 * \sqrt{(V_{dy}^2 + V_{dz}^2)} = 0.33 * \sqrt{( 0.33^2 + 0.06^2)}$
$V_{d,\ main\ chord}$ = 0.11 kN
$M_{d,\ main\ chord} = V_{d,\ main\ chord} * e = 0.11 * 0.05$
$M_{d,\ main\ chord}$ = 0.0055 kNcm
$N_{d,\ main\ chord} = N_d/3 + M_{dy} / h + M_{dz} / b$
$N_{d,\ main\ chord} = 2.57/ 3 + 9.60 / 0.207 + 0.01 / 0.239$
$N_{d,\ main\ chord}$ = 47.27 kN

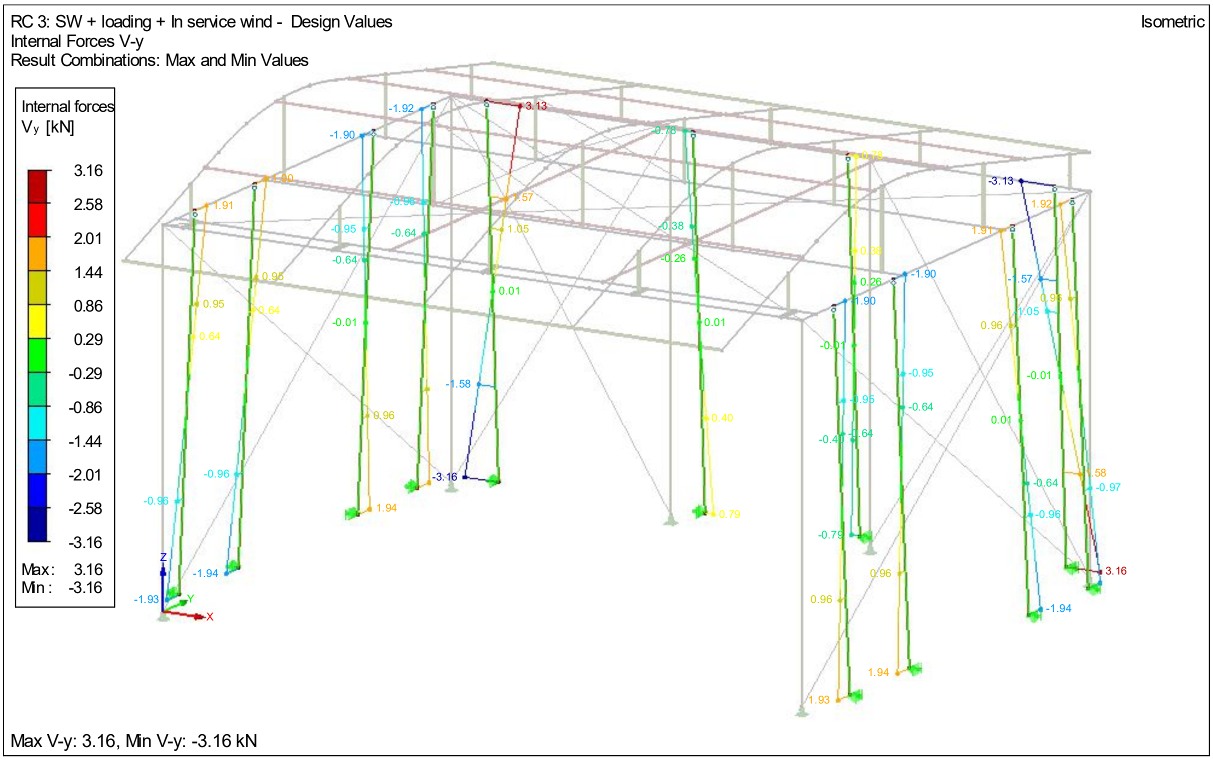
Check
$\eta = ( N_{d,\ main\ chord} / N_{Rd} )^{1.3} + M_{d,\ main\ chord} / M_{Rd}$
$\eta = ( 47.27 / 50.22 )^{1.3} + 0.0055 / 0.532 = 0.93 < 1$

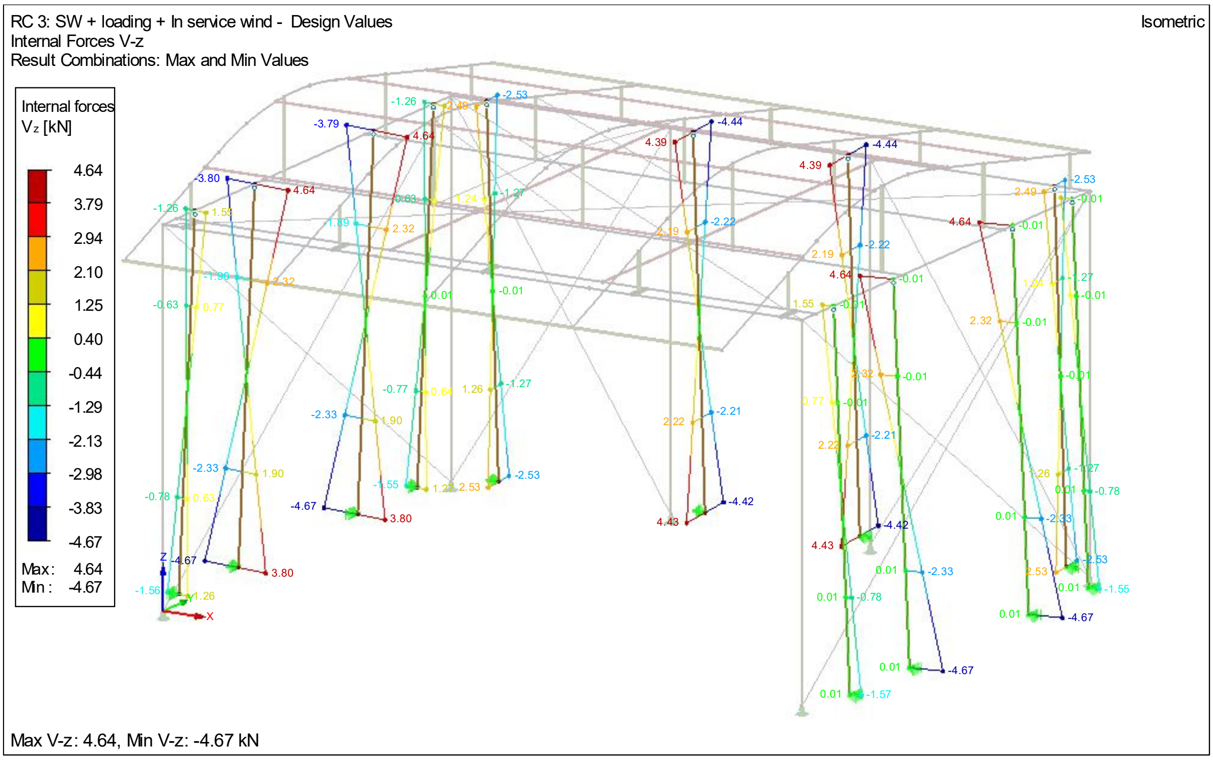
## 4.8 Check of the Side and back wall kedar system.




Normative load result is RC3
Internal forces of the side keder profile for RC3 In service

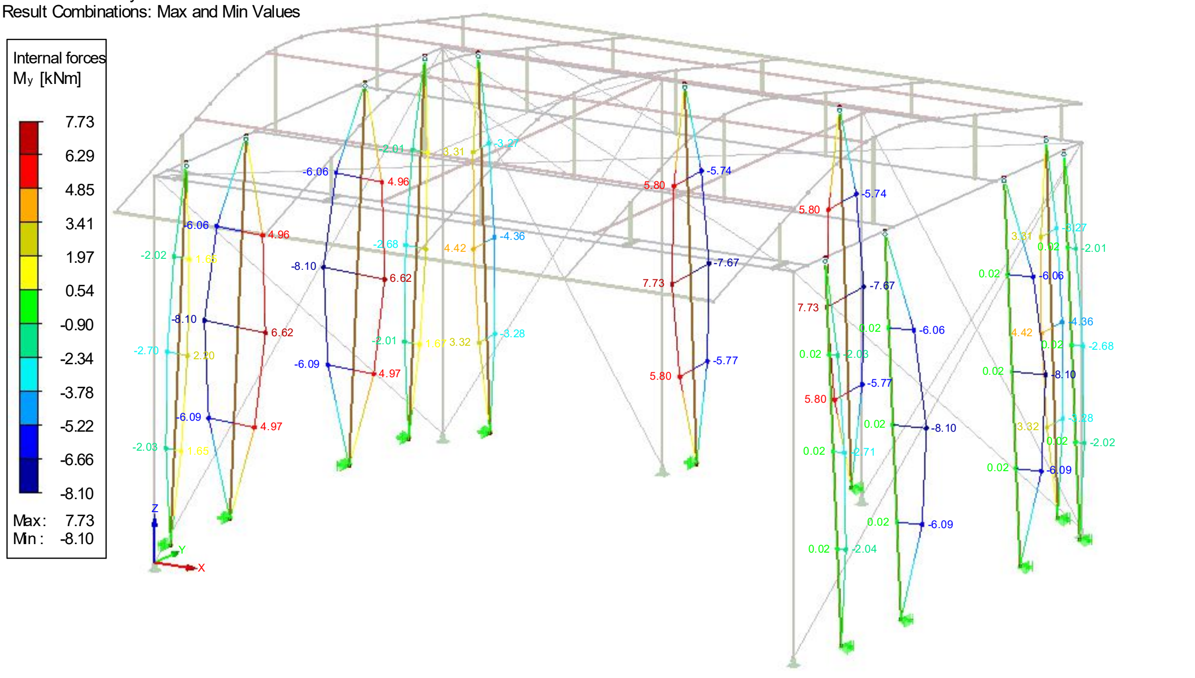



RC 3: SW + loading + In service wind - Design Values
Internal Forces V-y
Result Combinations: Max and Min Values
Isometric
Internal forces
Vy [kN]
3.16
2.58
2.01
1.44
0.86
0.29
-0.29
-0.86
-1.44
-2.01
-2.58
-3.16
Max: 3.16
Min: -3.16
Max V-y: 3.16, Min V-y: -3.16 kN


RC 3: SW + loading + In service wind - Design Values
Internal Forces V-z
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
4.64
3.79
2.94
2.10
1.25
0.40
-0.44
-1.29
-2.13
-2.98
-3.83
-4.67
Max: 4.64
Min: -4.67
Max V-z: 4.64, Min V-z: -4.67 kN

RC 3: SW + loading + In service wind - Design Values
Internal Forces M-y
Result Combinations: Max and Min Values

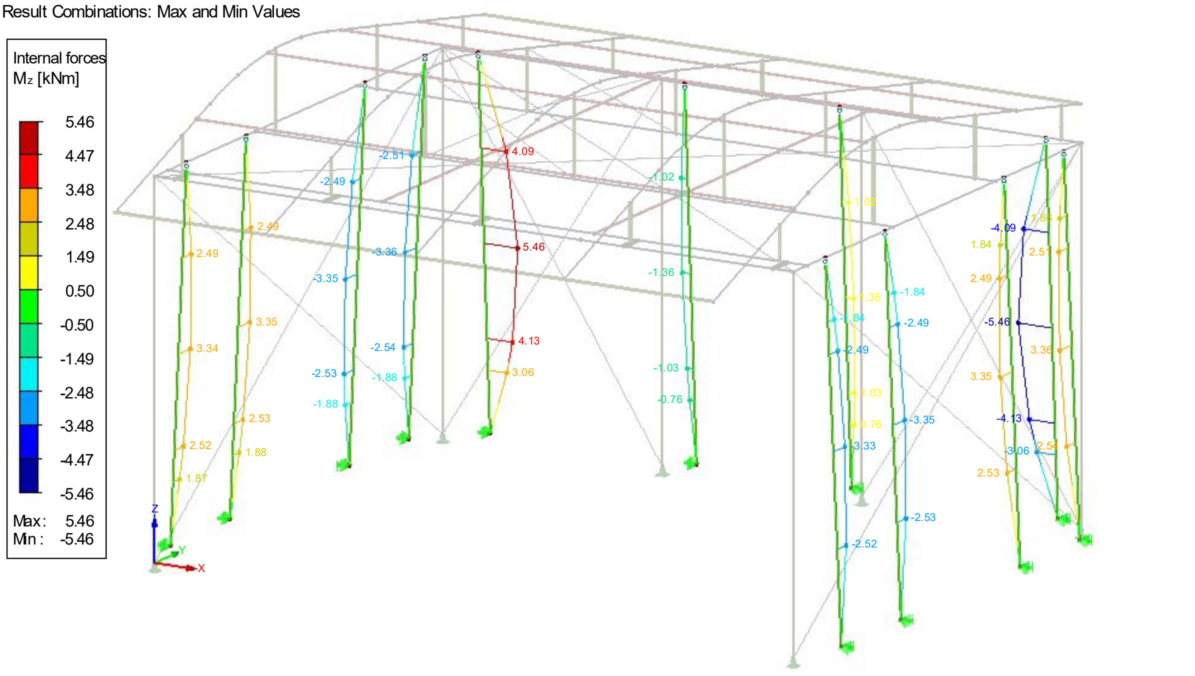
Isometric



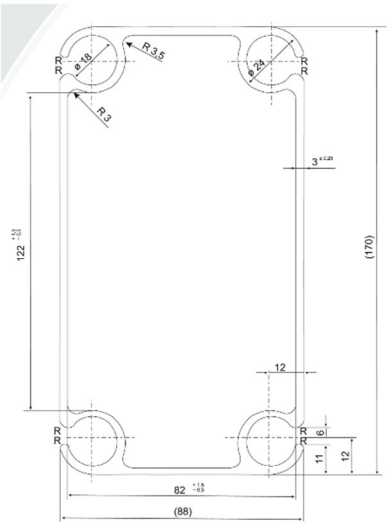

Max M-y: 7.73, Min M-y: -8.10 kNm

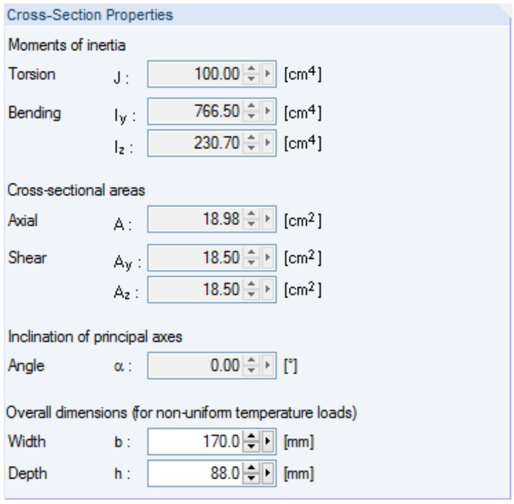
RC 3: SW + loading + In service wind - Design Values
Internal Forces M-z
Result Combinations: Max and Min Values

Isometric




Max M-z: 5.46, Min M-z: -5.46 kNm



Cross-Section Properties

| | | | |
|---|---|---|---|
| **Moments of inertia** | | | |
| Torsion | J : | 100.00 | [cm⁴] |
| Bending | $I_y$ : | 766.50 | [cm⁴] |
| | $I_z$ : | 230.70 | [cm⁴] |
| **Cross-sectional areas** | | | |
| Axial | A : | 18.98 | [cm²] |
| Shear | $A_y$ : | 18.50 | [cm²] |
| | $A_z$ : | 18.50 | [cm²] |
| **Inclination of principal axes** | | | |
| Angle | α : | 0.00 | [°] |
| **Overall dimensions (for non-uniform temperature loads)** | | | |
| Width | b : | 170.0 | [mm] |
| Depth | h : | 88.0 | [mm] |

Material = EN AW-6005A

$f_0 = 21.5$ kN/cm²

$f_{0,\,haz} = 11.5$ Kn/cm²

$\gamma_m = 1.1$

The Check of the profile is make with the maximum forces in the result combination RC3

Weakest cross section

$A_{nett} = A_{profiel} – 2 * 30\text{mm hole}$
$A_{nett} = 18.89 – 1.2 = 16.69$ cm²

$N_{ed,\,max} = 1.07$ kN
$V_{y,\,ed\,max} = 3.16$ kN
$Vz_{,\,ed\,max} = 4.67$ kN
$M_{y,\,ed\,max} = 8.09$ kNm
$M_{z,\,ed\,max} = 5.46$ kNm

Calculation

$\sigma_n = N_{ed,\,max} / A = 1.07 / 16.69 = 0.043$ kN/cm²
$\sigma_{vy} = V_{y,\,ed\,max} / A = 3.16 / 16.69 = 0.126$ kN/cm²
$\sigma_{vz} = V_{z,\,ed\,max} / A = 4.67 / 16.69 = 0.187$ kN/cm²
$\sigma_{my} = M_{y,\,ed\,max} / (I_y / e) = 809 / (1226 / 8.5) = 5.61$ kN/cm²
$\sigma_{mz} = M_{z,\,ed\,max} / (I_z / e) = 546 / (248 / 4.4) = 9.69$ kN/cm²
$\sigma_{tot} = \sqrt{}((\sigma_n + \sigma_{my} + \sigma_{mz})^2 + 3*(\sigma_{vy} + \sigma_{vz})^2$
$\sigma_{tot} = \sqrt{}((0.043 + 5.61 + 9.69)^2 + 3*(0.126 + 0.187)^2$
$\sigma_{tot} = 15.52$ kN/cm²
check $\sigma_{tot} / (f_0 / \gamma_m) < 1$

$15.52 / (11.5 / 1.1) = 0.76 < 1$

Check of the bearing force in the hole of the profile in the joint.

Maximum normal force 1.07 kN

$F_{b,rd} = (k_1 * \alpha_b * f_u * d * t) / 1.25 = (2.5 * 1 * 11.5 * 3 * 0.3) / 1.25 = 20.7$ kN

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

$1.07 / 20.7 = 0.05 < 1$

Check of the bearing force in the hole at the top roof adapter

Maximum normal force 1.07 kN

Maximum shear force 4.63 kN

$V_{d, pin} = \sqrt{(N^2 + V^2)} = \sqrt{( 1.07^2 + 4.63^2)} = 4.79$ kN
This force will be divided over two side = 4.79 / 2 = 2.396 kN

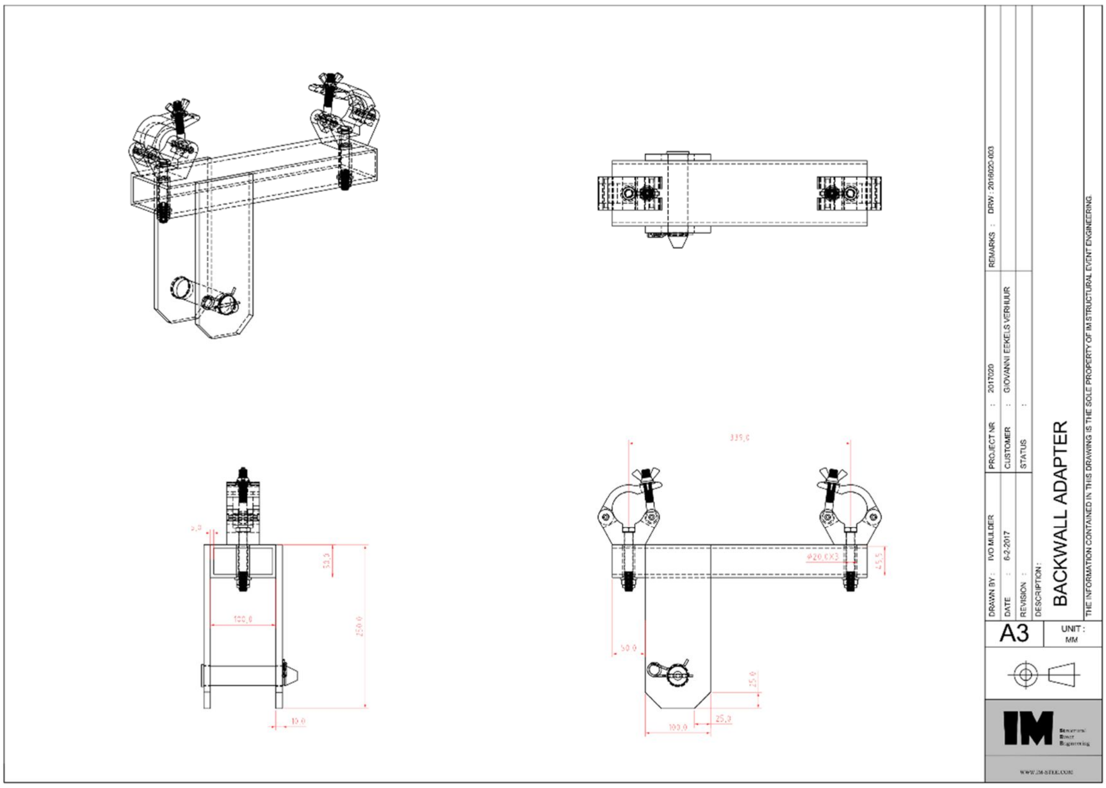
$F_{b,rd} = (k_1 * \alpha_b * f_u * d * t) / 1.25 = (2.5 * 1 * 11.5 * 3 * 0.3) / 1.25 = 20.7$ kN

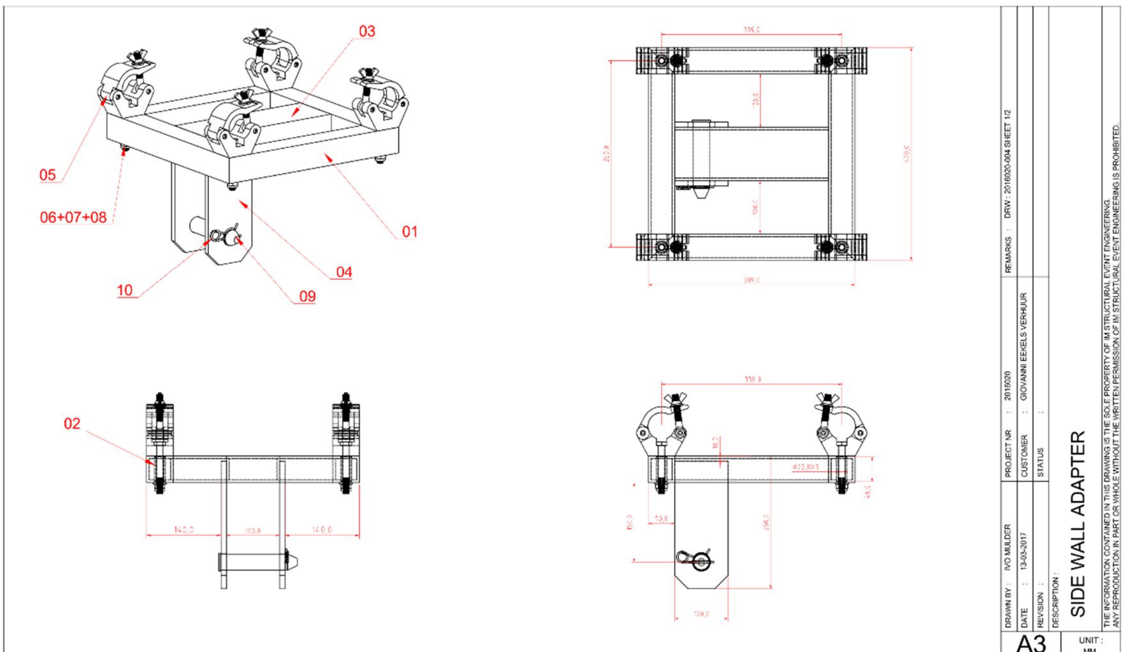
$F_{b, ed} / F_{b,rd} < 1$

$2.396 / 20.7 = 0.11 < 1$

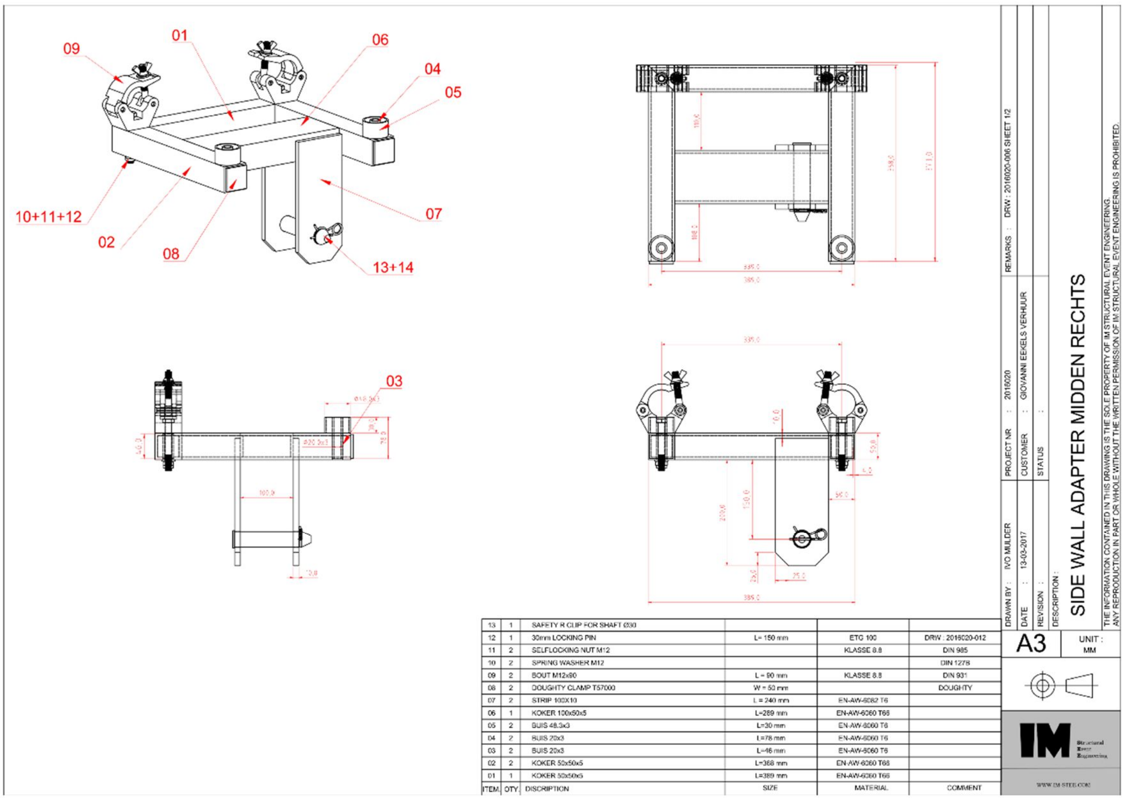
## 4.9 Check of the top adapter.

For the attachment to the top 3 different types of adapters are use




| ITEM | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 10 | 1 | SAFETY R CLIP FOR SHAFT Ø30 | | | |
| 09 | 1 | 30mm LOCKING PIN | L= 150 mm | ETG 100 | DRW : 2016020-012 |
| 08 | 4 | SELFLOCKING NUT M12 | | KLASSE 8.8 | DIN 985 |
| 07 | 4 | SPRING WASHER M12 | | | DIN 127B |
| 06 | 4 | BOUT M12x90 | L = 90 mm | KLASSE 8.8 | DIN 931 |
| 05 | 4 | DOUGHTY CLAMP T57000 | W = 50 mm | | DOUGHTY |
| 04 | 2 | STRIP 100X10 | L = 240 mm | EN-AW-6082 T6 | |
| 03 | 1 | KOKER 100x50x5 | L=289 mm | EN-AW-6060 T66 | |
| 02 | 4 | BUIS 20x3 | L=46 mm | EN-AW-6060 T6 | |
| 01 | 4 | KOKER 50x50x5 | L=389 mm | EN-AW-6060 T66 | |




Check of the doughty clamp

The maximum force normal force in one of the adapters is 1.07 kN

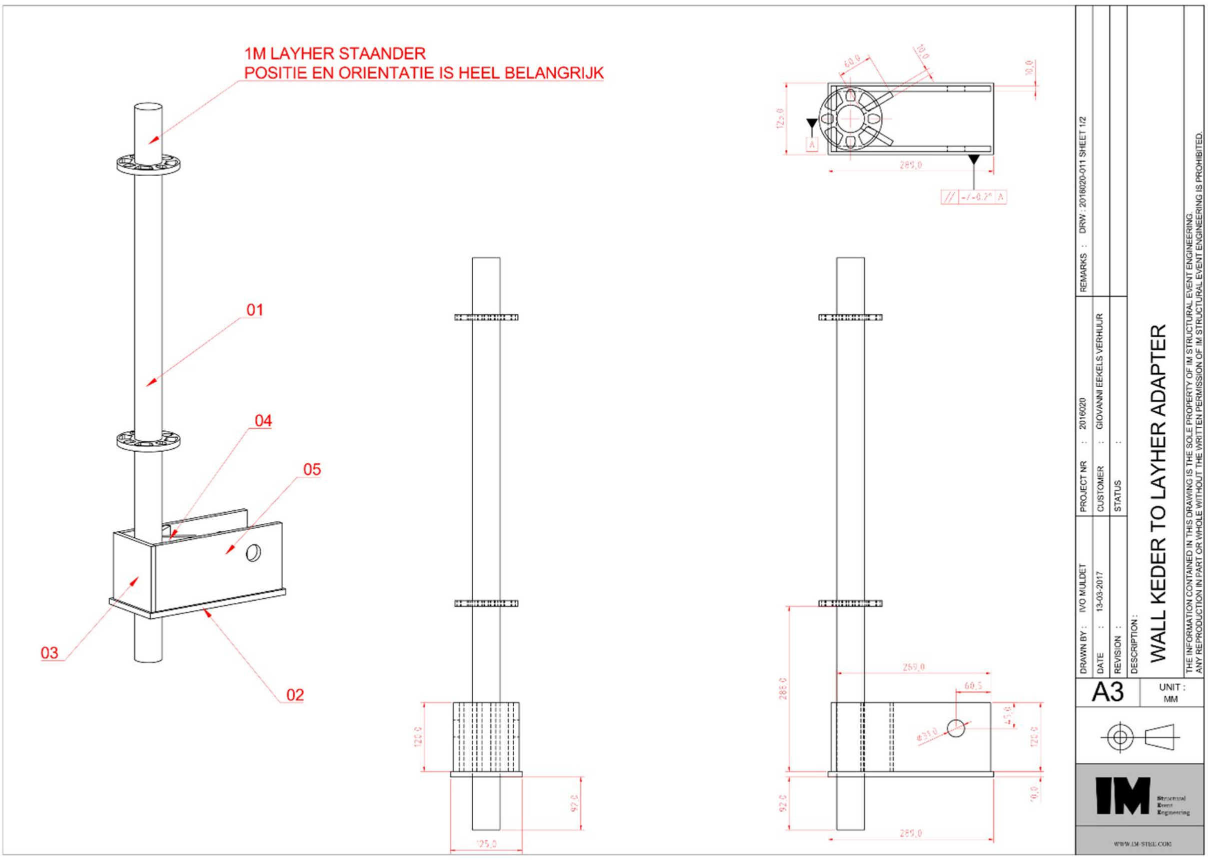
The maximum shear force to the 4.79 kN

Force on the doughty clamp

Ned / 2 + Ved * 15 / 23.9 = 1.07 / 2 + 4.79 * 15 / 23.9 = 3.54 kN

The adapter is mounted with a minimum of two doughty clamps to the main grid. Each Doughty clamp has a WLL of 500 kg and a safety factor of 5.

### 4.10 Check of wall kedar Layher adapter




Maximum forces from the side and back wall profiles on the Layher connection

$V_{ed}$ = 4.67 kN

The adapter will be connected to the Layher stage with the use of a connection pin from Layher.

Dimensions of connection pin RRO 38 x 3.6  S275

Material = S275 J0H

$F_y$ = 27.5 kN/cm²

$\gamma_{m0} = 1$

Maximum allowable shear stress

$V_{rd} = Av * ( f_y / \sqrt{3}) * ( 1 / \gamma_{mo} )$

$V_{rd} = 3.89 * ( 27.5 / \sqrt{3}) = 61.79$ kN

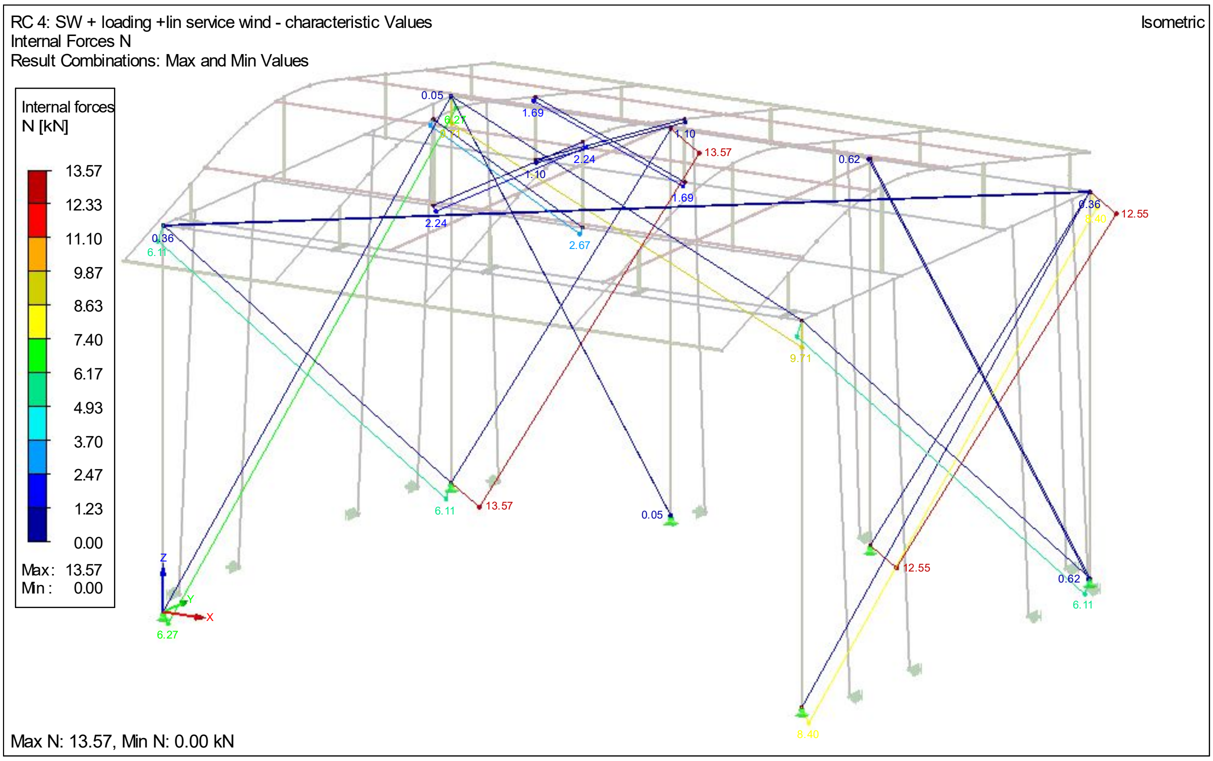
$V_{ed} / V_{rd} < 1$

$4.67 / 61.79 = 0.07 < 1$

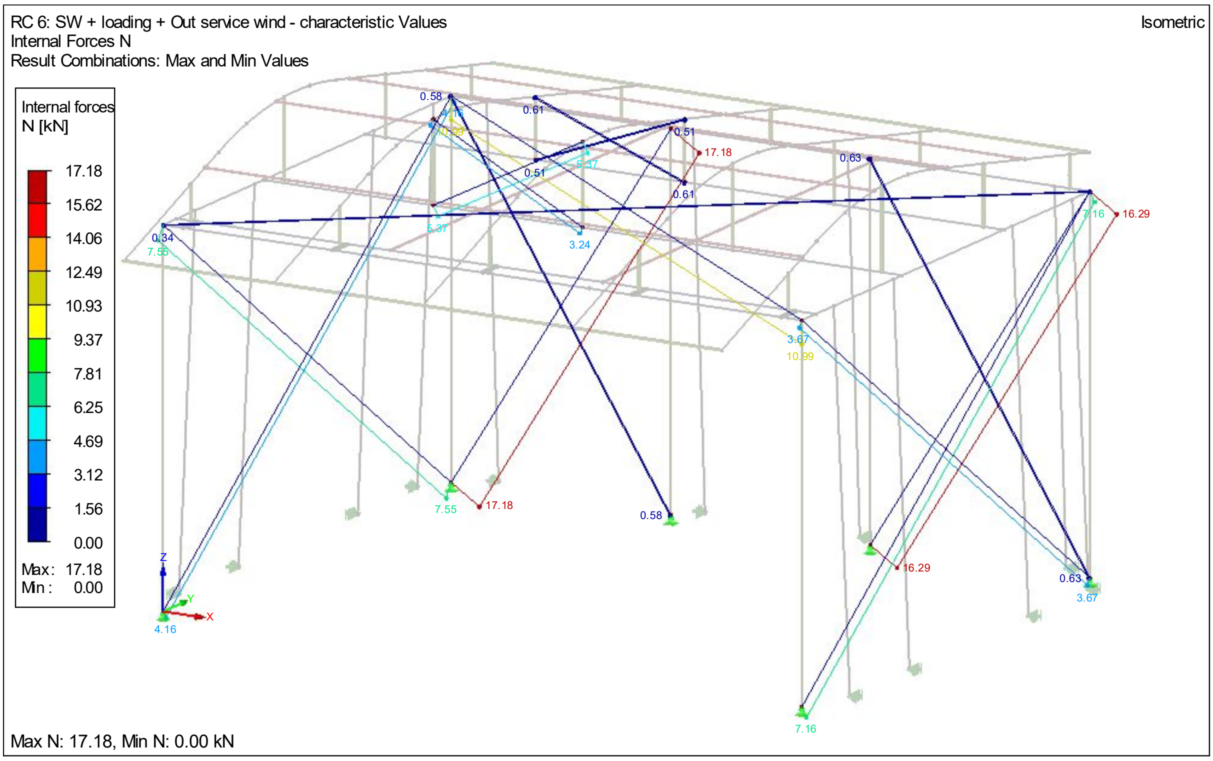
## 4.11 Check of the steel cable in the side and back wall.

The steel wire’s will be checked characteristic values because the steel wire itself has safety factor.

Internal force for the RC4 In service characteristic values




Internal forces for RC6 Out service characteristic values



Normative result combination is RC6 Out service
Maximum steel wire force is 17.18 kN.

For the steel wire is a safety factor required of 3.5
Required steel wire 6x36 with steel core σ = 1770 kN/mm²
Diameter 10 mm with minimum breaking strength of 63 kN
Check 63 / 3.5 = 18 kN > 17.18 kN

The connection to the top is done by the use of a 2 T steel flex in combination with a 3.25 T shackle.

The required retched strap to tension the steel wire need a minimum LC of 5000 daN in a straight line.
According to the EN-12195-2.

## 5.0 Calculation of the Layher System.

The staging system is built from the Layher scaffolding system. The type of Layher which is used in General is the K2000+ system. All the design figures which are taken into account in this calculation are taken from the K2000+.

For the calculation of the Layher system there are 4 different situations calculated. These are chosen from the in-service situation, due to the fact that they have the side and back wall still attached and will generate the highest loading on the Layher system.

The different forces are taken from the load combinations

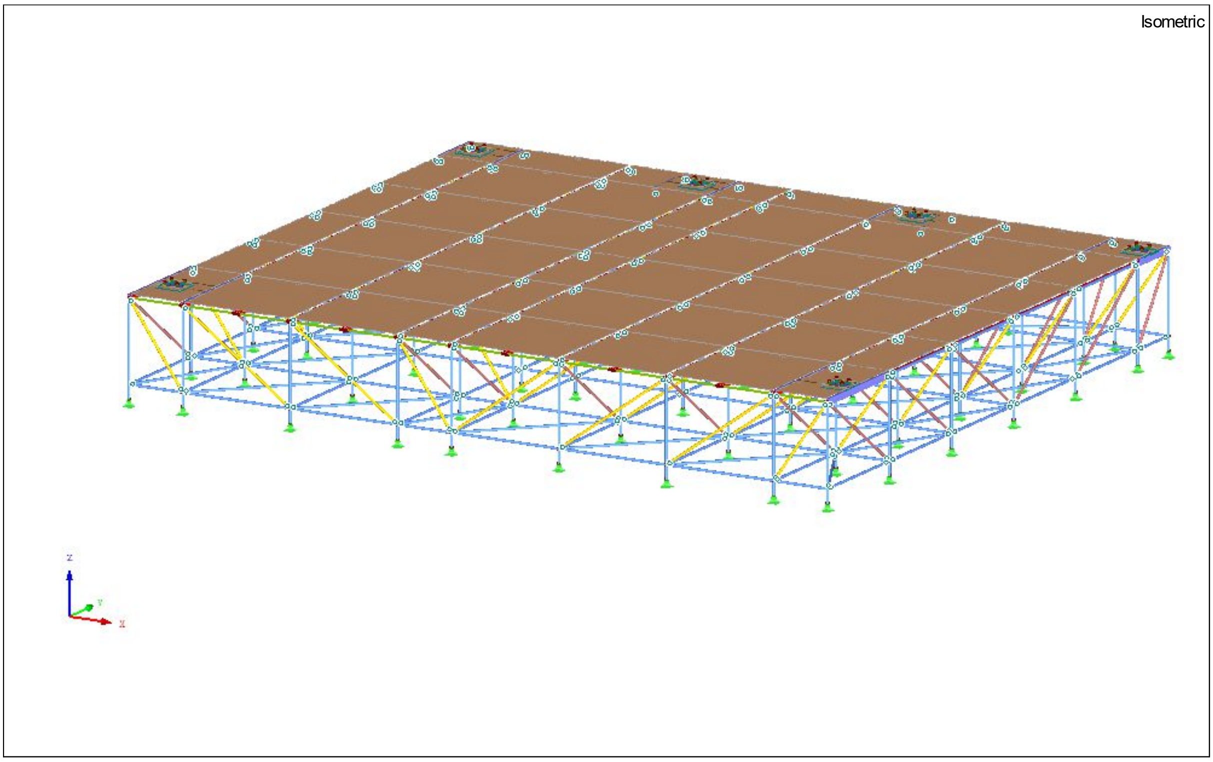
- : CO53
- : CO163
- : CO174
- : CO184

### 5.1 RFem Layher stage Model

For the Layher stage a separate model is constructed in the RFem program.

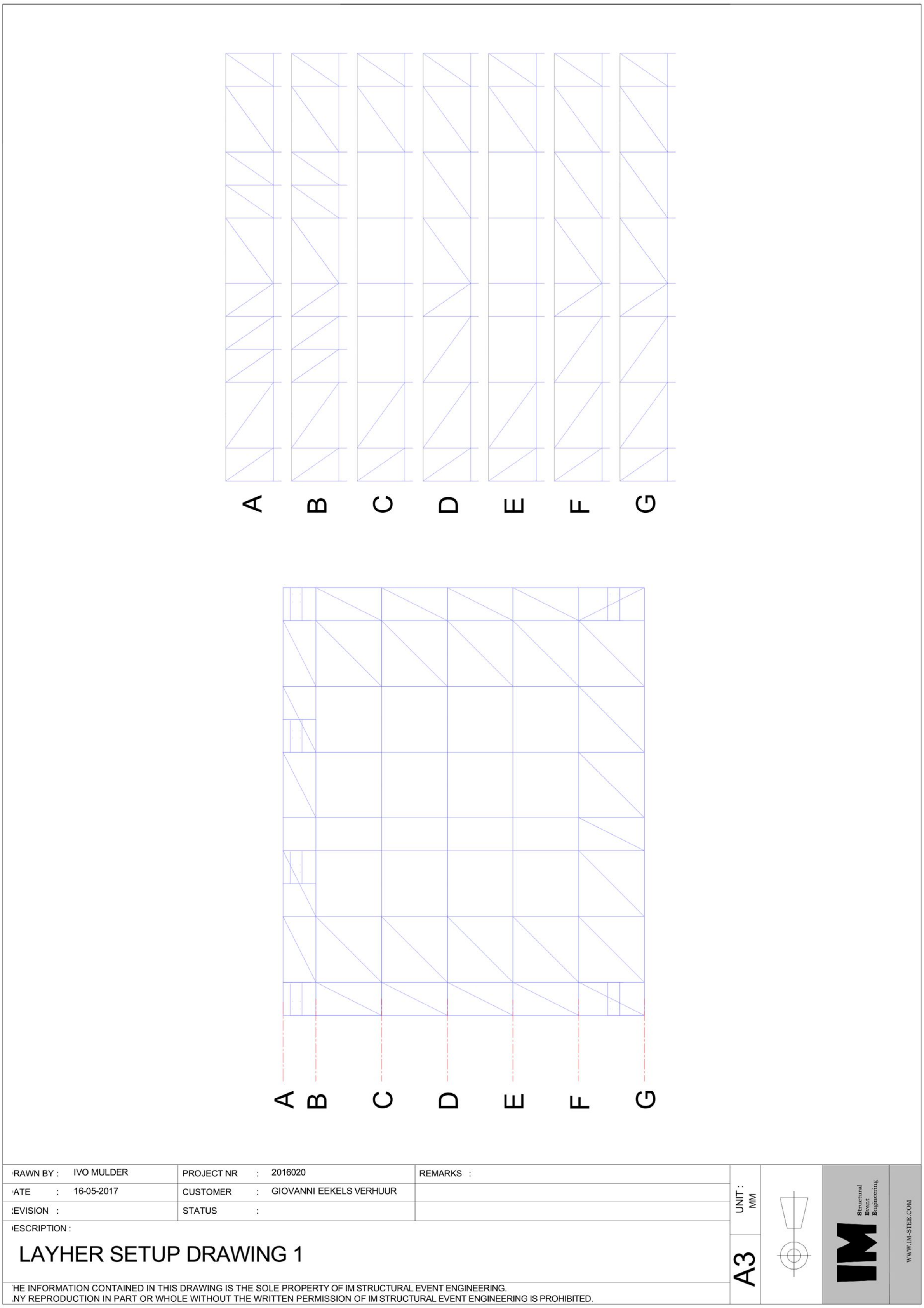
In this model the forces of the different load combinations are set as forces on the different node positions. The result calculations will be compared with the Layher design forces as shown in chapter 5.2 Layher Design values.

#### 5.1.1 The Layher construction scheme.

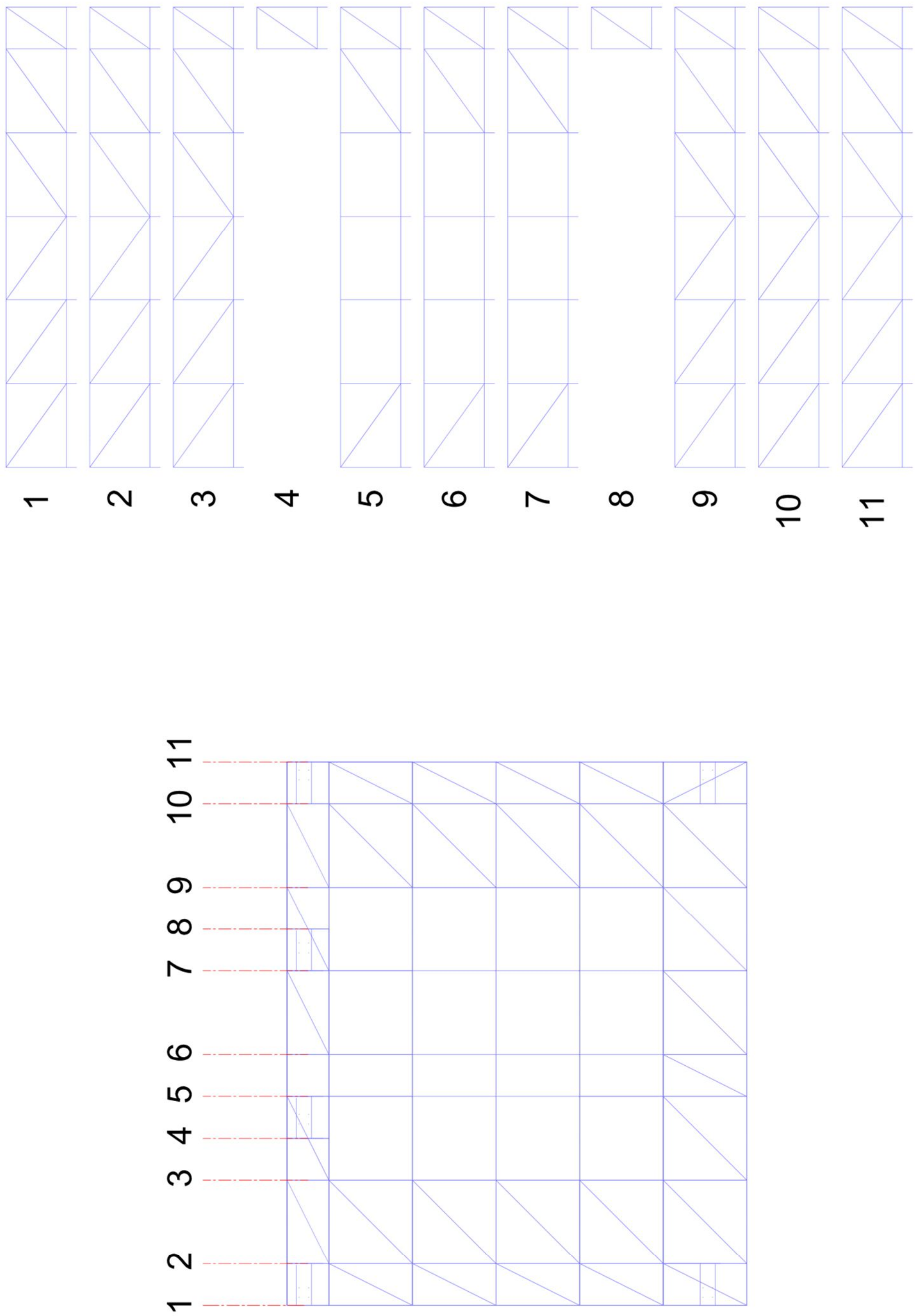


### 5.1.2 Layher setup

### Layher plan drawing 1



## Layher plan drawing 2




| | | | | | |
|---|---|---|---|---|---|
| RAWN BY : | IVO MULDER | PROJECT NR : | 2016020 | REMARKS : | |
| ATE : | 16-05-2017 | CUSTOMER : | GIOVANNI EEKELS VERHUUR | | |
| EVISION : | | STATUS : | | | |

ESCRIPTION :

LAYHER SETUP DRAWING 2

UNIT : MM

A3

WWW.IM-STEE.COM

### 5.1.3 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 $\gamma_M$ [-] | Material Model |
|---|---|---|---|---|---|---|---|---|
| 1 | Steel S 235 \| DIN EN 1993-1-1:2010-12 | 21000,00 | 8100,00 | 0,296 | 78,50 | 1,20E-05 | 1,000 | Isotropic Linear Elastic |
| 2 | 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... |
| 3 | 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 |
| 4 | 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 |

### 5.1.4 Used cross sections

| Section | Cross-Section | Material | Moments of inertia [cm⁴] | | | Cross-Sectional Areas [cm²] | | | Principal Axes | Rotation | Overall Dimensions [mm] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Description [mm] | No. | Torsion J | Bending $I_y$ | Bending $I_z$ | Axial A | Shear $A_y$ | Shear $A_z$ | α [°] | α' [°] | Width b | Depth h |
| 1 | RO 48.3x3.2 (Hot Formed) | 1 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 2 | RO 48.3x3.2 (Hot Formed) | 1 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 3 | RO 48.3x3.2 (Hot Formed) | 1 | 23,20 | 11,60 | 11,60 | 4,53 | 2,26 | 2,26 | 0,00 | 0,00 | 48,3 | 48,3 |
| 4 | EV transom | 3 | 50,00 | 554,00 | 70,00 | 18,78 | 18,00 | 18,00 | 0,00 | 0,00 | 49,0 | 172,5 |
| 5 | HK 50/30/4/4/4/4 | 3 | 16,87 | 17,67 | 7,52 | 5,76 | 1,62 | 3,48 | 0,00 | 0,00 | 30,0 | 50,0 |
| 6 | RRO 120x60x6.3 (Hot Formed) | 1 | 290.00 | 358.00 | 116.00 | 20.70 | 4.54 | 13.22 | 0.00 | 0.00 | 60.0 | 120.0 |
| 7 | RRO 120x80x6.3 (Hot Formed) | 1 | 487,00 | 440,00 | 230,00 | 23,20 | 6,99 | 12,93 | 0,00 | 0,00 | 80,0 | 120,0 |
| 8 | 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 |

### 5.1.5 solved load cases, load combinations and result combinations.

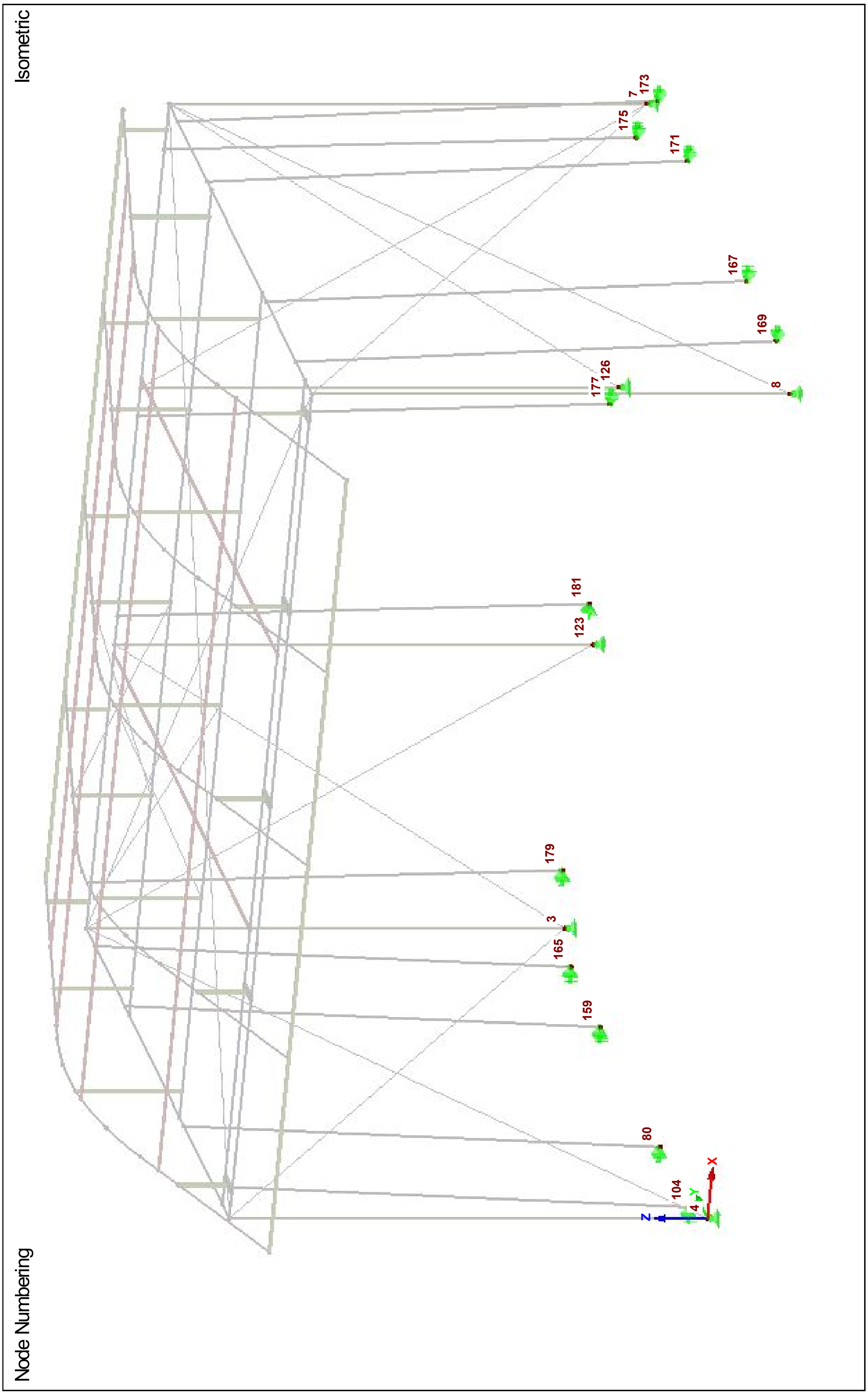
| Load Case | Load Case Description | To Solve | EN 1990 \| NEN Action Category | Self-Weight - Factor in Direction Active | X | Y | Z |
|---|---|---|---|---|---|---|---|
| LC1 | Self-weight | + | Permanent | + | 0,000 | 0,000 | -1,000 |
| LC2 | floor load of 350 Kg/m² | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC3 | Nodel support forces from CO53 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC4 | Nodel support forces from CO164 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC5 | Nodel support forces from CO174 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |
| LC6 | Nodel support forces from CO184 | + | Permanent/Imposed | - | 0,000 | 0,000 | 0,000 |

| Load | Load Combination | | | LC.1 | | LC.2 | | LC.3 | |
|---|---|---|---|---|---|---|---|---|---|
| Combin. | DS | Description | To Solve | Factor | No. | Factor | No. | Factor | No. |
| CO1 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC3 | + | 1,150 | LC1 | 1,350 | LC2 | 1,350 | LC3 |
| CO2 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC4 | + | 1,150 | LC1 | 1,350 | LC2 | 1,350 | LC4 |
| CO3 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC5 | + | 1,150 | LC1 | 1,350 | LC2 | 1,350 | LC5 |
| CO4 | 0 | 1.15*LC1 + 1.35*LC2 + 1.35*LC6 | + | 1,150 | LC1 | 1,350 | LC2 | 1,350 | LC6 |
| CO5 | | | | | | | | | |
| CO10 | 0 | LC1 + LC2 + LC3 | + | 1,000 | LC1 | 1,000 | LC2 | 1,000 | LC3 |
| CO11 | 0 | LC1 + LC2 + LC4 | + | 1,000 | LC1 | 1,000 | LC2 | 1,000 | LC4 |
| CO12 | 0 | LC1 + LC2 + LC5 | + | 1,000 | LC1 | 1,000 | LC2 | 1,000 | LC5 |
| CO13 | 0 | LC1 + LC2 + LC6 | + | 1,000 | LC1 | 1,000 | LC2 | 1,000 | LC6 |

RC1 : CO1-CO4

RC2 : CO10-CO13

## 5.1.6 Nodal support points numbering of main roof construction.

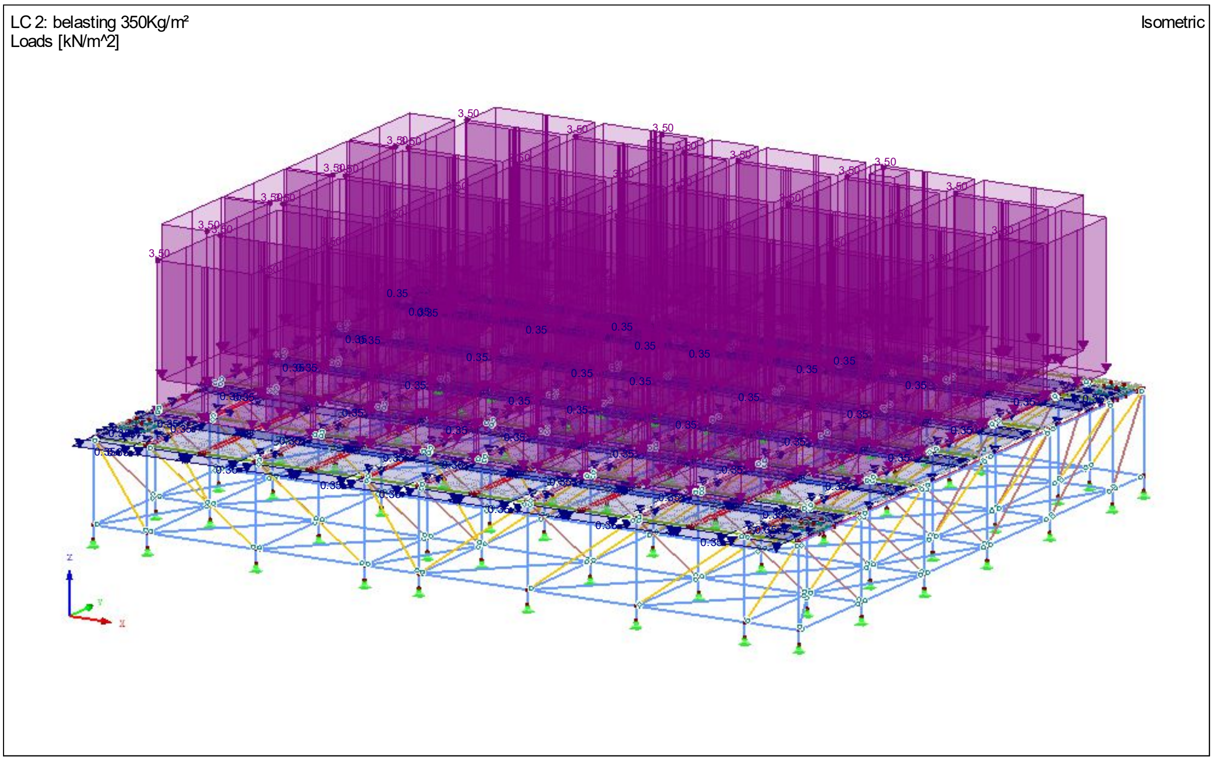


## 5.2 Loading Input

### 5.2.1 Loading of the stage

The floor loading which is taken into account is 350 kg/m² which is according to the EN-13814.

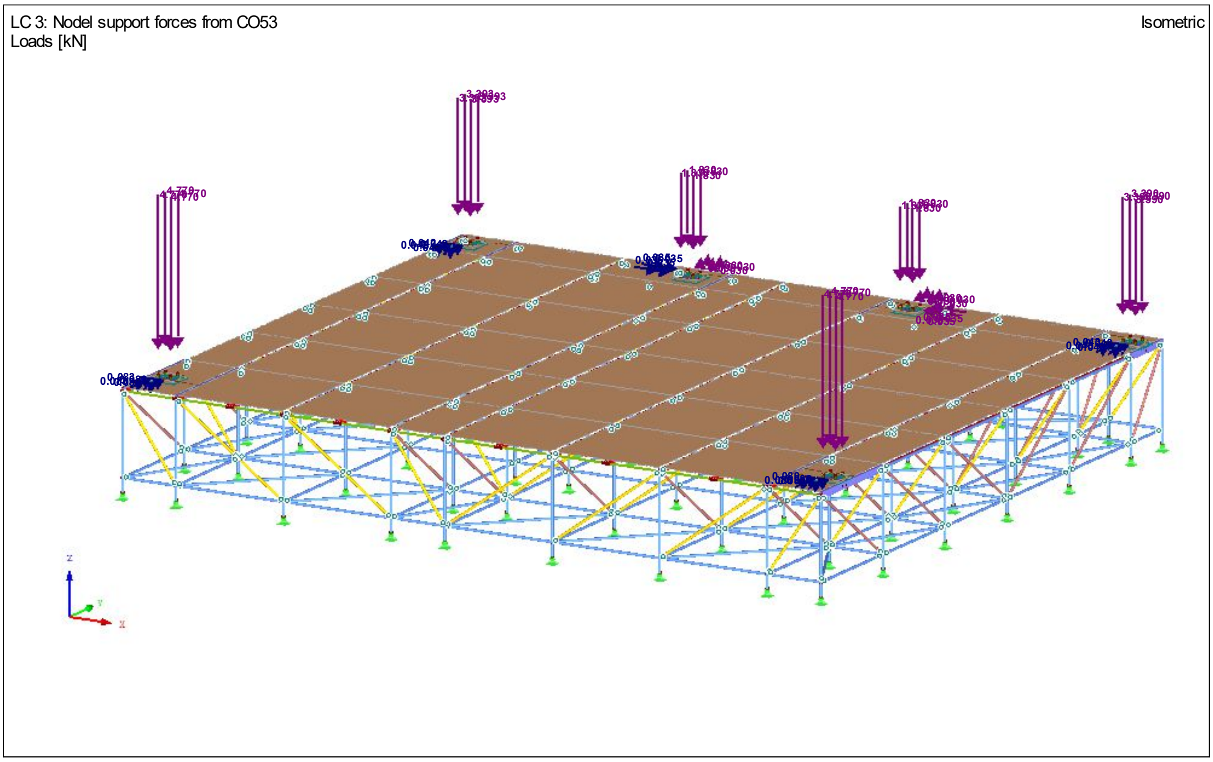
For the horizontal stability check an extra loading of 10% of the vertical loading is set as a horizontal force.



## 5.2.2 nodal forces from load combination CO53

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 0,00 | -0,17 | -13,57 | 0,00 | 0,00 | 0,00 |
| 4 | 0,00 | 0,33 | -19,08 | 0,00 | 0,00 | 0,00 |
| 7 | 0,00 | -0,17 | -13,56 | 0,00 | 0,00 | 0,00 |
| 8 | 0,00 | 0,32 | -19,07 | 0,00 | 0,00 | 0,00 |
| 80 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,14 | -0,12 | -7,32 | 0,00 | 0,00 | 0,00 |
| 126 | -0,15 | -0,12 | -7,35 | 0,00 | 0,00 | 0,00 |
| 159 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 165 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 167 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 171 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 173 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 175 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| 177 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| 179 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| 181 | 0,00 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| Σ Forces | 0,00 | 0,00 | -79,95 | | | |
| Σ Loads | 0,00 | 0,00 | -79,95 | | | |

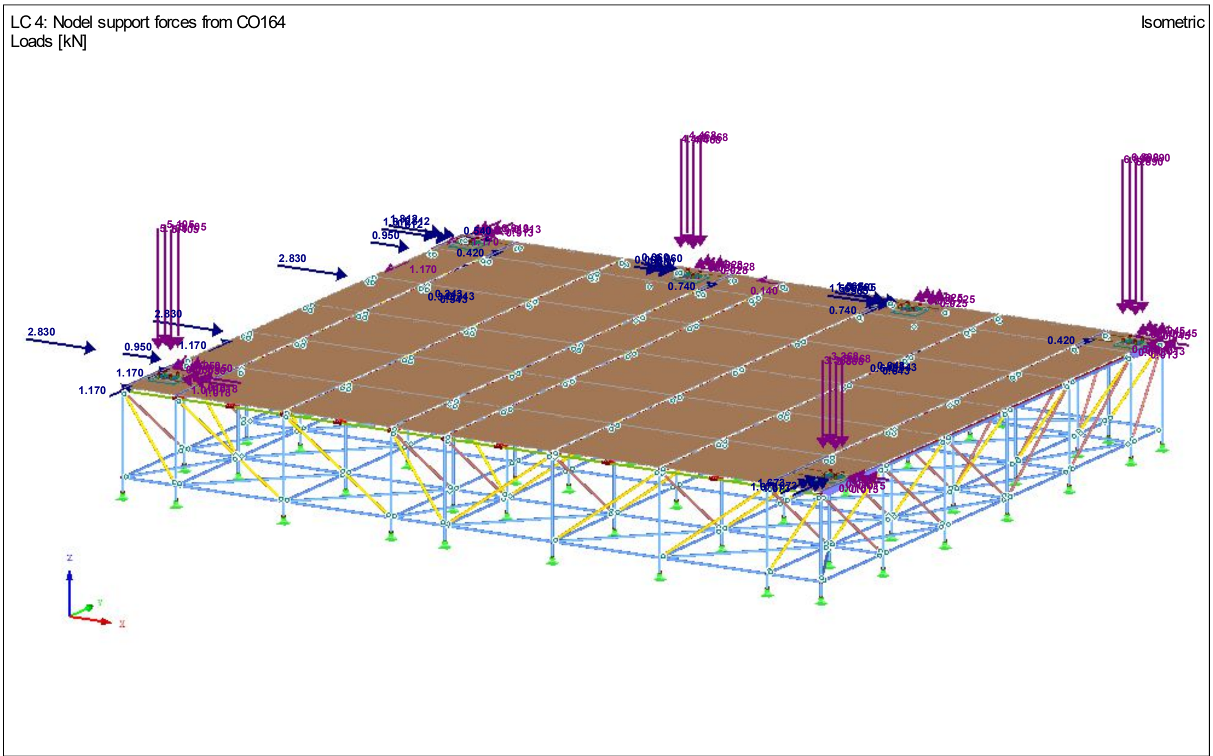
## Load input in Layher stage model.



## 5.2.3 nodal forces from load combination CO164

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 7,25 | -3,65 | 1,37 | 0,00 | 0,00 | 0,00 |
| 4 | -0,07 | -0,20 | -20,42 | 0,00 | 0,00 | 0,00 |
| 7 | -0,05 | -0,18 | -27,56 | 0,00 | 0,00 | 0,00 |
| 8 | -0,06 | 6,69 | -13,47 | 0,00 | 0,00 | 0,00 |
| 80 | 2,83 | 1,17 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | 0,95 | 1,17 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,24 | -0,11 | -17,87 | 0,00 | 0,00 | 0,03 |
| 126 | 6,26 | -0,10 | 2,57 | 0,00 | 0,00 | 0,01 |
| 159 | 2,83 | -1,17 | 0,00 | 0,00 | 0,00 | 0,01 |
| 165 | 0,95 | -1,17 | 0,00 | 0,00 | 0,00 | 0,02 |
| 167 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 171 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,01 |
| 173 | -0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,02 |
| 175 | -0,54 | 0,42 | 0,00 | 0,00 | 0,00 | 0,00 |
| 177 | 0,14 | 0,74 | 0,00 | 0,00 | 0,00 | 0,00 |
| 179 | 0,54 | 0,42 | 0,00 | 0,00 | 0,00 | 0,01 |
| 181 | -0,14 | 0,74 | 0,00 | 0,00 | 0,00 | 0,00 |
| Σ Forces | 21,10 | 4,76 | -75,39 | | | |
| Σ Loads | 21,10 | 4,76 | -75,39 | | | |

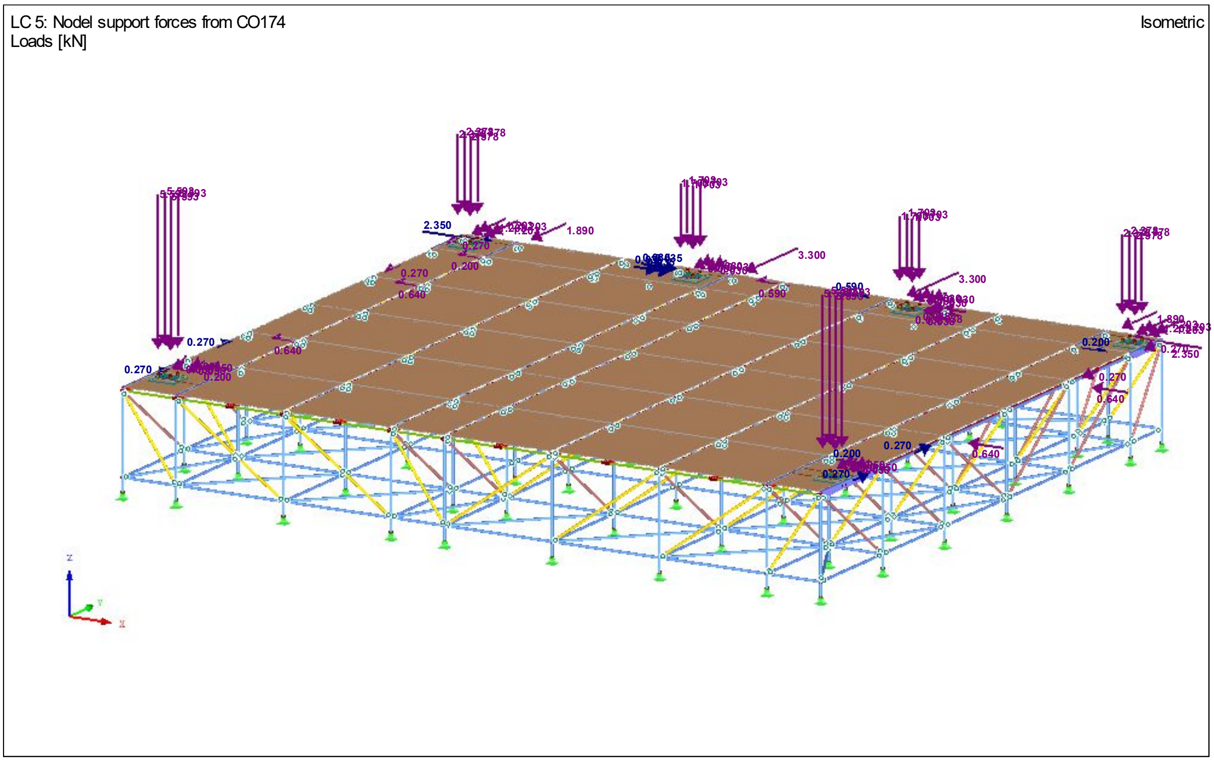
## Load input in Layher stage model.



## 5.2.4 nodal forces load combination CO174

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 0,00 | -4,81 | -9,51 | 0,00 | 0,00 | 0,00 |
| 4 | 0,00 | -0,20 | -22,37 | 0,00 | 0,00 | 0,00 |
| 7 | 0,00 | -4,81 | -9,50 | 0,00 | 0,00 | 0,00 |
| 8 | 0,00 | -0,20 | -22,36 | 0,00 | 0,00 | 0,00 |
| 80 | -0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | -0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,14 | -0,12 | -6,81 | 0,00 | 0,00 | -0,03 |
| 126 | -0,15 | -0,12 | -6,85 | 0,00 | 0,00 | 0,03 |
| 159 | -0,64 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 165 | -0,20 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 167 | 0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | 0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 171 | 0,64 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 173 | 0,20 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 175 | -2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,00 |
| 177 | 0,59 | -3,30 | 0,00 | 0,00 | 0,00 | 0,01 |
| 179 | 2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,00 |
| 181 | -0,59 | -3,30 | 0,00 | 0,00 | 0,00 | -0,01 |
| Σ Forces | 0,00 | -20,67 | -77,40 | | | |
| Σ Loads | 0,00 | -20,67 | -77,40 | | | |

## Load input in Layher stage model.



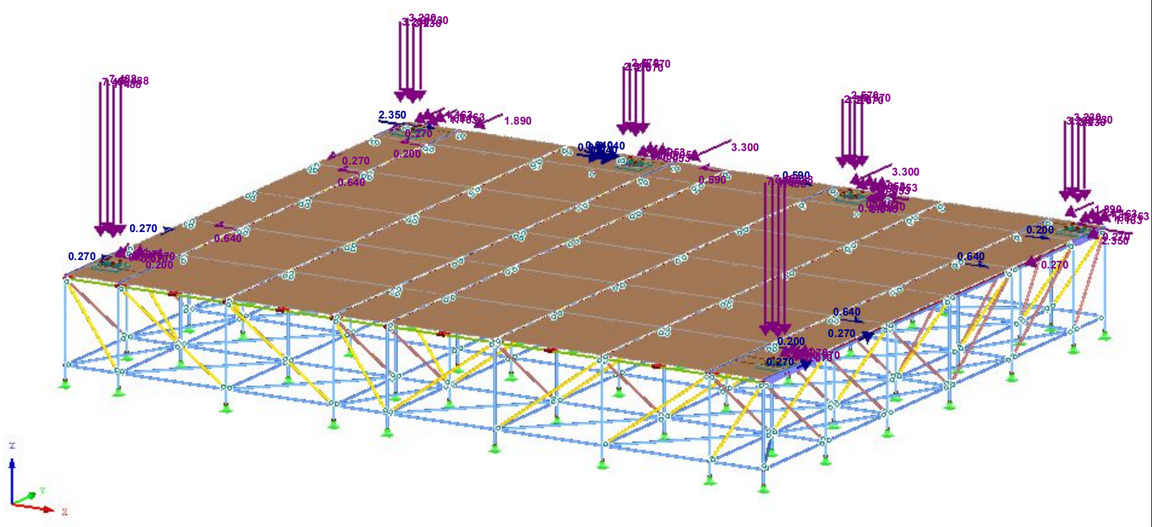
## 5.2.5 nodal forces load combination CO184

| Node | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|
| No. | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | 0,00 | -4,65 | -12,92 | 0,00 | 0,00 | 0,00 |
| 4 | 0,01 | -0,28 | -29,95 | 0,00 | 0,00 | 0,00 |
| 7 | 0,00 | -4,66 | -12,90 | 0,00 | 0,00 | 0,00 |
| 8 | 0,00 | -0,27 | -29,95 | 0,00 | 0,00 | 0,00 |
| 80 | -0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 104 | -0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 123 | 0,15 | -0,21 | -10,28 | 0,00 | 0,00 | -0,03 |
| 126 | -0,16 | -0,21 | -10,30 | 0,00 | 0,00 | 0,03 |
| 159 | -0,64 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 165 | -0,20 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 167 | 0,64 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 169 | 0,20 | 0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 171 | 0,64 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 173 | 0,20 | -0,27 | 0,00 | 0,00 | 0,00 | 0,00 |
| 175 | -2,35 | -1,89 | 0,00 | 0,00 | 0,00 | -0,01 |
| 177 | 0,59 | -3,30 | 0,00 | 0,00 | 0,00 | 0,01 |
| 179 | 2,35 | -1,89 | 0,00 | 0,00 | 0,00 | 0,01 |
| 181 | -0,59 | -3,30 | 0,00 | 0,00 | 0,00 | -0,01 |
| Σ Forces | 0,00 | -20,67 | -106,32 | | | |
| Σ Loads | 0,00 | -20,67 | -106,32 | | | |

## Load input in Layher stage model.

LC 6: Nodel support forces from CO184
Loads [kN]

Isometric



# 5.3 Results of the Calculation.

| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **Summary** | | | |
| | Calculation Status | OK | | |
| | Maximum displacement in X-direction | 2,9 | mm | CO2, FE Node No. 2390 (X: 8.079, Y: 8.180, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 3,4 | mm | CO2, Member No. 709, x: 0.750 m |
| | Maximum displacement in Z-direction | -19,6 | mm | CO4, FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 19,7 | mm | CO2, FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -31,5 | mrad | CO3, FE Node No. 2420 (X: 3.625, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | -43,1 | mrad | CO4, FE Node No. 4669 (X: 0.830, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 3,4 | mrad | CO1, Member No. 106, x: 0.000 m |
| | Number of 1D finite elements (member elements) | 5573 | | |
| | Number of 2D finite elements (surface elements) | 5568 | | |
| | Number of 3D finite elements (solid elements) | 0 | | |
| | Number of FE nodes | 8061 | | |
| | Number of equations | 48366 | | |
| | Matrix solver method | Direct | | |
| | Maximum number of iterations | 100 | | |
| | Number of divisions for member results | 10 | | |
| | Number of divisions of members with cable, elastic foundation, taper, or plastic characteristic | 10 | | |
| | Activate shear stiffness of members (A-y, A-z) | + | | |
| | Plate bending theory | Mindlin | | |
| | Precision of convergence criteria of nonlinear calculation | 1,0 | | |

# Results per load case and Load combination

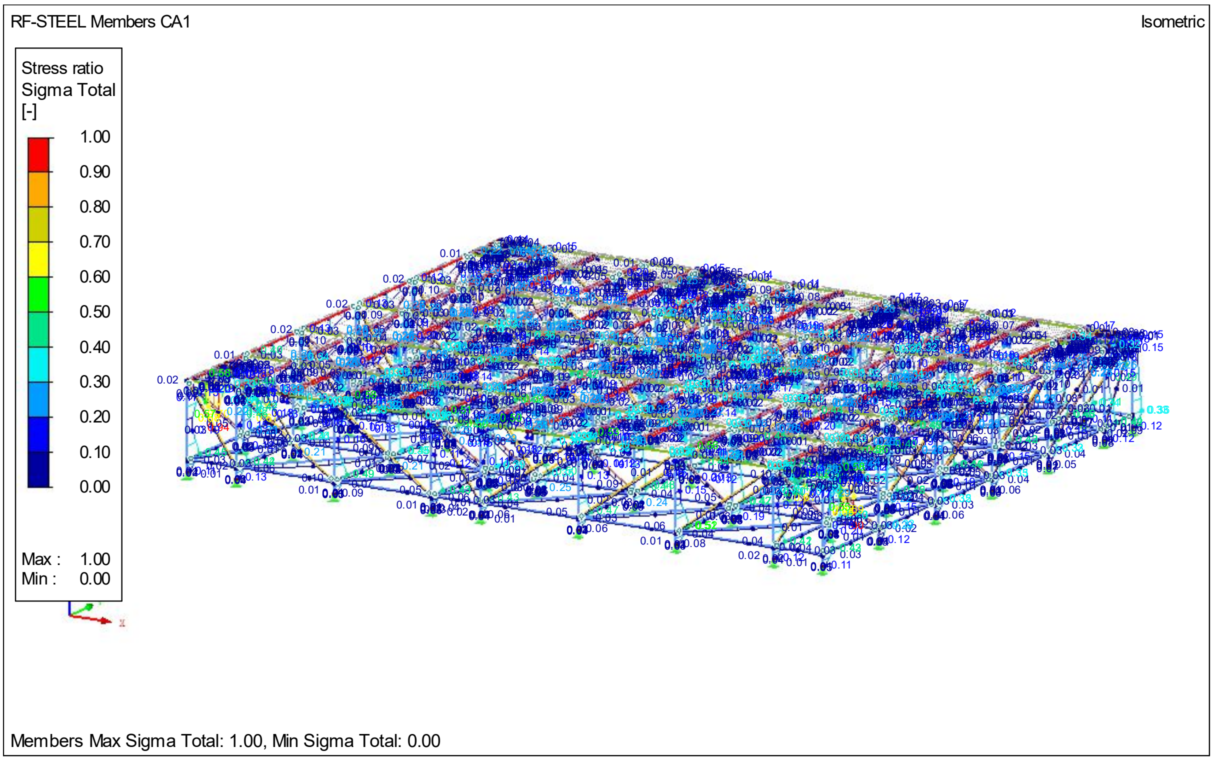
| | Description | Value | Unit | Comment |
|---|---|---|---|---|
| | **LC1 - Self-weight** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,00 | kN | |
| | Sum of support forces in Y | 0,00 | kN | |
| | Sum of loads in Z | -62,80 | kN | |
| | Sum of support forces in Z | -62,80 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 29,158 | kNm | At center of gravity of model (X: 5.709, Y: 4.881, Z: 1.830 m) |
| | Resultant of reactions about Y | -27,095 | 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 | -0,9 | mm | Member No. 108, x: 1.279 m |
| | Maximum displacement in Y-direction | -0,9 | mm | Member No. 227, x: 1.279 m |
| | Maximum displacement in Z-direction | -3,4 | mm | Member No. 271, x: 1.465 m |
| | Maximum vectorial displacement | 3,4 | mm | Member No. 271, x: 1.465 m |
| | Maximum rotation about X-axis | 2,6 | mrad | Member No. 272, x: 0.000 m |
| | Maximum rotation about Y-axis | 2,6 | mrad | Member No. 272, x: 2.930 m |
| | Maximum rotation about Z-axis | 0,2 | mrad | Member No. 106, x: 0.000 m |
| | Method of analysis | Large | | Large Deformation Analysis (Newton-Raphson) |
| | **LC2 - belasting 350Kg/m²** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 51,04 | kN | |
| | Sum of support forces in Y | 51,04 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -492,24 | kN | |
| | Sum of support forces in Z | -492,24 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 112,089 | kNm | At center of gravity of model (X: 5.709, Y: 4.881, Z: 1.830 m) |
| | Resultant of reactions about Y | 8,442 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,848 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 1,4 | mm | FE Node No. 2390 (X: 8.079, Y: 8.180, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 2,2 | mm | FE Node No. 8034 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| | Maximum displacement in Z-direction | -10,2 | mm | FE Node No. 1197 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 10,3 | mm | FE Node No. 1197 (X: 5.646, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -16,9 | mrad | FE Node No. 1177 (X: 6.733, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 22,7 | mrad | FE Node No. 2394 (X: 8.547, Y: 8.180, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -2,0 | mrad | Member No. 404, x: 2.558 m |
| | Method of analysis | Large | | Large Deformation Analysis (Newton-Raphson) |
| | **LC3 - Nodel support forces from CO53** | | | |
| | Sum of loads in X | 0,00 | kN | |

| | | | | |
|---|---|---|---|---|
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 0,75 | kN | |
| | Sum of support forces in Y | 0,75 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -79,93 | kN | |
| | Sum of support forces in Z | -79,93 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -13,963 | kNm | At center of gravity of model (X: 5.709, Y: 4.881, Z: 1.830 m) |
| | Resultant of reactions about Y | 1,067 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,041 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,4 | mm | FE Node No. 3748 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 0,8 | mm | Member No. 709, x: 1.000 m |
| | Maximum displacement in Z-direction | -3,8 | mm | FE Node No. 3669 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 3,8 | mm | FE Node No. 3669 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum rotation about X-axis | -7,0 | mrad | FE Node No. 3764 (X: 11.988, Y: -0.748, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 6,9 | mrad | FE Node No. 3748 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -1,5 | mrad | Member No. 744, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC4 - Nodel support forces from CO164** | | | |
| | Sum of loads in X | 19,96 | kN | |
| | Sum of support forces in X | 19,96 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 5,94 | kN | |
| | Sum of support forces in Y | 5,94 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -75,38 | kN | |
| | Sum of support forces in Z | -75,38 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | -36,554 | kNm | At center of gravity of model (X: 5.709, Y: 4.881, Z: 1.830 m) |
| | Resultant of reactions about Y | 108,096 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -20,383 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | 0,8 | mm | FE Node No. 4623 (X: 3.924, Y: 9.612, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 1,0 | mm | Member No. 757, x: 0.500 m |
| | Maximum displacement in Z-direction | -3,9 | mm | FE Node No. 3488 (X: -0.687, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 3,9 | mm | FE Node No. 3488 (X: -0.687, Y: -0.380, Z: 2.250 m) |
| | Maximum rotation about X-axis | -6,9 | mrad | FE Node No. 4992 (X: 12.139, Y: 9.484, Z: 2.250 m) |
| | Maximum rotation about Y-axis | -8,5 | mrad | FE Node No. 4623 (X: 3.924, Y: 9.612, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -1,7 | mrad | Member No. 744, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC5 - Nodel support forces from CO174** | | | |
| | Sum of loads in X | -2,57 | kN | |
| | Sum of support forces in X | -2,57 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | -20,64 | kN | |
| | Sum of support forces in Y | -20,64 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -77,38 | kN | |
| | Sum of support forces in Z | -77,38 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 74,686 | kNm | At center of gravity of model (X: 5.709, Y: 4.881, Z: 1.830 m) |
| | Resultant of reactions about Y | 0,015 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | 0,257 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,5 | mm | FE Node No. 3748 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -1,5 | mm | Member No. 756, x: 0.500 m |
| | Maximum displacement in Z-direction | -4,5 | mm | FE Node No. 3669 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 4,5 | mm | FE Node No. 3669 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum rotation about X-axis | -8,3 | mrad | FE Node No. 3764 (X: 11.988, Y: -0.748, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 8,2 | mrad | FE Node No. 3748 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 1,7 | mrad | Member No. 702, x: 1.823 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **LC6 - Nodel support forces from CO184** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | -20,66 | kN | |
| | Sum of support forces in Y | -20,66 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -106,30 | kN | |
| | Sum of support forces in Z | -106,30 | kN | Deviation: 0.00 % |
| | Resultant of reactions about X | 83,335 | kNm | At center of gravity of model (X: 5.709, Y: 4.881, Z: 1.830 m) |
| | Resultant of reactions about Y | 1,505 | kNm | At center of gravity of model |
| | Resultant of reactions about Z | -0,292 | kNm | At center of gravity of model |
| | Maximum displacement in X-direction | -0,7 | mm | FE Node No. 3748 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum displacement in Y-direction | -1,9 | mm | Member No. 756, x: 0.500 m |
| | Maximum displacement in Z-direction | -6,0 | mm | FE Node No. 3669 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum vectorial displacement | 6,0 | mm | FE Node No. 3669 (X: 12.133, Y: -0.380, Z: 2.250 m) |
| | Maximum rotation about X-axis | -11,1 | mrad | FE Node No. 3764 (X: 11.988, Y: -0.748, Z: 2.250 m) |

| | | | | |
|---|---|---|---|---|
| | Maximum rotation about Y-axis | 11,0 | mrad | FE Node No. 3748 (X: 11.692, Y: -0.413, Z: 2.250 m) |
| | Maximum rotation about Z-axis | -2,3 | mrad | Member No. 744, x: 0.000 m |
| | Method of analysis | Linear | | Geometrically Linear Analysis |
| | **CO1 - 1.15*LC1 + 1.35*LC2 + 1.35*LC3** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 69,89 | kN | |
| | Sum of support forces in Y | 69,89 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -844,80 | kN | |
| | Sum of support forces in Z | -844,80 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 2,3 | mm | FE Node No. 2390 (X: 8.079, Y: 8.180, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 3,2 | mm | FE Node No. 8034 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| | Maximum displacement in Z-direction | -16,6 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 16,7 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -28,1 | mrad | FE Node No. 6124 (X: 2.641, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 36,6 | mrad | FE Node No. 2394 (X: 8.547, Y: 8.180, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 3,4 | mrad | Member No. 106, x: 0.000 m |
| | Method of analysis | Large | | Large Deformation Analysis (Picard) |
| | **CO2 - 1.15*LC1 + 1.35*LC2 + 1.35*LC4** | | | |
| | Sum of loads in X | 26,94 | kN | |
| | Sum of support forces in X | 26,94 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 76,92 | kN | |
| | Sum of support forces in Y | 76,92 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -838,14 | kN | |
| | Sum of support forces in Z | -838,14 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | 2,9 | mm | FE Node No. 2390 (X: 8.079, Y: 8.180, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 3,4 | mm | Member No. 709, x: 0.750 m |
| | Maximum displacement in Z-direction | -19,5 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 19,7 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -31,4 | mrad | FE Node No. 2420 (X: 3.625, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 42,8 | mrad | FE Node No. 6347 (X: 3.364, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 3,3 | mrad | Member No. 106, 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 + 1.35*LC2 + 1.35*LC5** | | | |
| | Sum of loads in X | -3,47 | kN | |
| | Sum of support forces in X | -3,47 | kN | Deviation: 0.00 % |
| | Sum of loads in Y | 41,04 | kN | |
| | Sum of support forces in Y | 41,04 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -840,84 | kN | |
| | Sum of support forces in Z | -840,84 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -2,7 | mm | FE Node No. 4660 (X: 1.292, Y: -0.110, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 2,7 | mm | FE Node No. 8034 (X: 4.687, Y: 0.414, Z: 2.250 m) |
| | Maximum displacement in Z-direction | -19,6 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 19,7 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -31,5 | mrad | FE Node No. 2420 (X: 3.625, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | 42,9 | mrad | FE Node No. 6347 (X: 3.364, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 3,4 | mrad | Member No. 106, 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 + 1.35*LC2 + 1.35*LC6** | | | |
| | Sum of loads in X | 0,00 | kN | |
| | Sum of support forces in X | 0,00 | kN | |
| | Sum of loads in Y | 41,01 | kN | |
| | Sum of support forces in Y | 41,01 | kN | Deviation: 0.00 % |
| | Sum of loads in Z | -879,88 | kN | |
| | Sum of support forces in Z | -879,88 | kN | Deviation: 0.00 % |
| | Maximum displacement in X-direction | -2,7 | mm | FE Node No. 4660 (X: 1.292, Y: -0.110, Z: 2.250 m) |
| | Maximum displacement in Y-direction | 2,8 | mm | Member No. 709, x: 0.750 m |
| | Maximum displacement in Z-direction | -19,6 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum vectorial displacement | 19,7 | mm | FE Node No. 6353 (X: 3.728, Y: -0.105, Z: 2.250 m) |
| | Maximum rotation about X-axis | -31,5 | mrad | FE Node No. 2420 (X: 3.625, Y: -0.868, Z: 2.250 m) |
| | Maximum rotation about Y-axis | -43,1 | mrad | FE Node No. 4669 (X: 0.830, Y: -0.110, Z: 2.250 m) |
| | Maximum rotation about Z-axis | 3,4 | mrad | Member No. 106, x: 0.000 m |
| | Method of analysis | 2nd Order | | Second order analysis (Nonlinear) |
| | Internal forces referred to deformed system for... | + | | N, $V_y$, $V_z$, $M_y$, $M_z$, $M_T$ |

## 5.4 Stress analyse calculation for the stage components

For the complete stage a stress calculation has been made.




The result of the stress analyse calculation present a maximum of 100% utilisation which occurs in the main beam of the Layher adapter.

# 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 | RO 48.3x3.2 (Hot Formed) - 0 | | | | | | | |
| | 129 | 1,500 | 28 | CO1 | Sigma Total | -13,64 | 23,50 | 0,58 |
| | 462 | 0,000 | 2 | CO2 | Tau Total | 0,94 | 13,57 | 0,07 |
| | 129 | 1,500 | 28 | CO1 | Sigma-eqv | 13,64 | 23,50 | 0,58 |
| | | | | | | | | |
| 2 | RO 48.3x3.2 (Hot Formed) - Defpoints | | | | | | | |
| | 108 | 1,421 | 10 | CO2 | Sigma Total | -2,26 | 23,50 | 0,10 |
| | 744 | 1,823 | 1 | CO2 | Tau Total | -0,63 | 13,57 | 0,05 |
| | 108 | 1,421 | 10 | CO2 | Sigma-eqv | 2,35 | 23,50 | 0,10 |
| | | | | | | | | |
| 3 | RO 48.3x3.2 (Hot Formed) | | | | | | | |
| | 227 | 1,421 | 10 | CO1 | Sigma Total | -3,28 | 23,50 | 0,14 |
| | 631 | 0,000 | 19 | CO2 | Tau Total | -0,14 | 13,57 | 0,01 |
| | 227 | 1,421 | 10 | CO1 | Sigma-eqv | 3,28 | 23,50 | 0,14 |
| | | | | | | | | |
| 5 | HK 50/30/4/4/4/4 | | | | | | | |
| | 904 | 0,375 | 10 | CO2 | Sigma Total | 12,16 | 22,50 | 0,54 |
| | 275 | 0,000 | 8 | CO2 | Tau Total | 2,93 | 12,99 | 0,23 |
| | 904 | 0,375 | 10 | CO2 | Sigma-eqv | 12,26 | 22,50 | 0,54 |
| | | | | | | | | |
| 6 | RRO 120x60x6.3 (Hot Formed) | | | | | | | |
| | 996 | 0,375 | 11 | CO4 | Sigma Total | 23,46 | 23,50 | 1,00 |
| | 931 | 0,227 | 15 | CO2 | Tau Total | -2,45 | 13,57 | 0,18 |
| | 996 | 0,375 | 11 | CO4 | Sigma-eqv | 23,60 | 23,50 | 1,00 |
| | | | | | | | | |
| 7 | RRO 120x80x6.3 (Hot Formed) | | | | | | | |
| | 1003 | 0,054 | 11 | CO4 | Sigma Total | 8,99 | 23,50 | 0,38 |
| | 1002 | 0,035 | 14 | CO4 | Tau Total | -6,28 | 13,57 | 0,46 |
| | 1002 | 0,035 | 14 | CO4 | Sigma-eqv | 10,96 | 23,50 | 0,47 |
| | | | | | | | | |
| 8 | RO 48.3x3.2 (Hot Formed) | | | | | | | |
| | 1034 | 0,000 | 13 | CO2 | Sigma Total | 6,08 | 25,00 | 0,24 |
| | 1033 | 0,000 | 22 | CO2 | Tau Total | -1,19 | 14,43 | 0,08 |
| | 1034 | 0,000 | 13 | CO2 | Sigma-eqv | 6,08 | 25,00 | 0,24 |

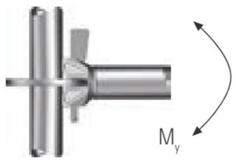
## 4.5 Layher design information

The company Eekels verhuur owns the Layher K2000+ system.

Information of the Layher 2000+ system

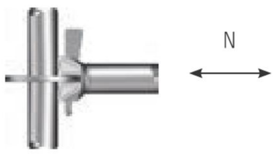
### Z-8.22-64: K 2000+

**Biegemoment**



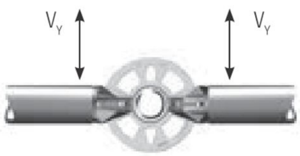

Biegemoment
$M_{y,Rd} = \pm 101{,}0$ kNcm

**Normalkraft**

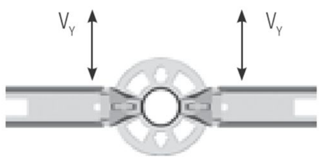



$N_{Rd} = \pm 31{,}0$ kN

**Horizontale Querkraft**

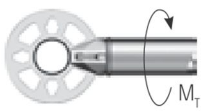



O-Riegel: $V_{y,Rd} = \pm 10{,}0$ kN



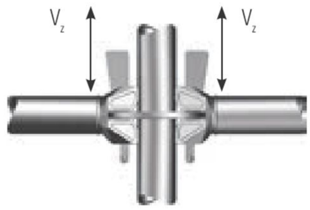

U-Riegel: $V_{y,Rd} = \pm 5{,}9$ kN

**Torsionsmoment**



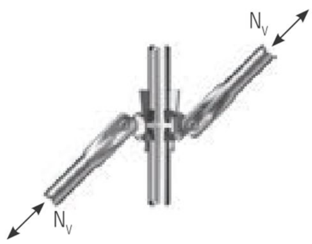

$M_{T,Rd} = \pm 52{,}5$ kNcm

**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.**

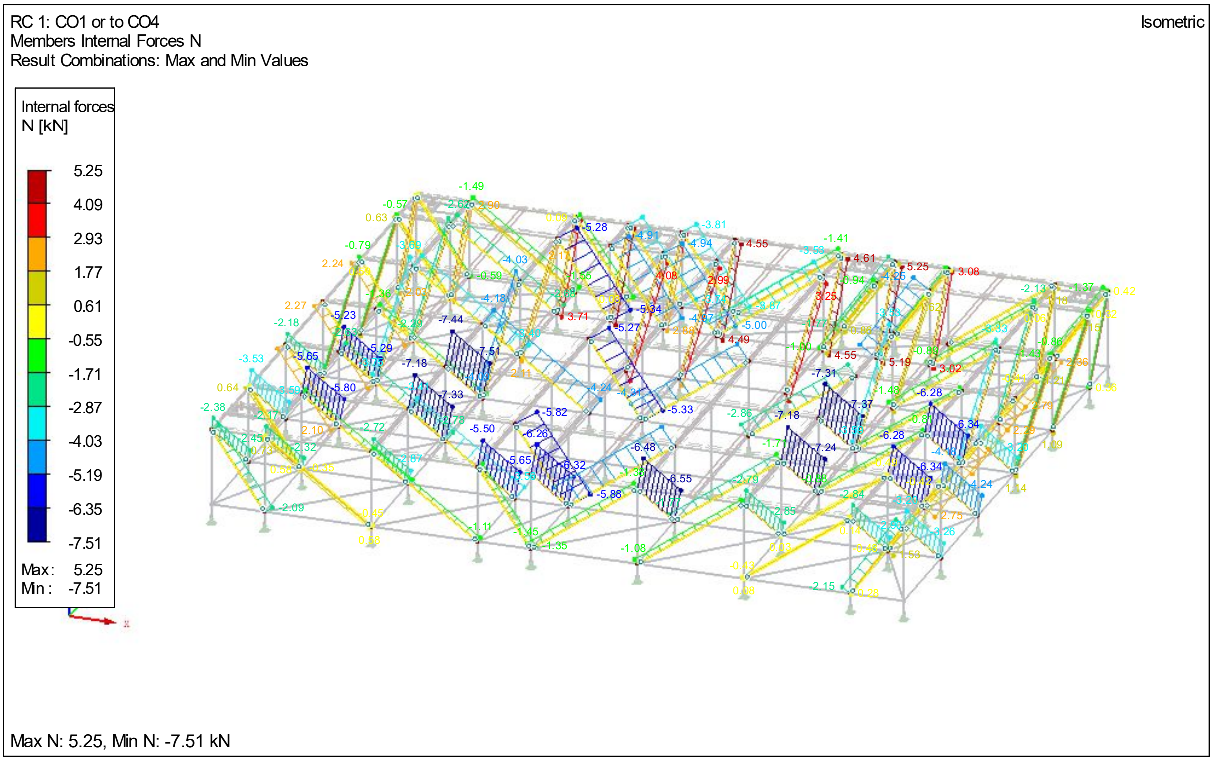
Rd = Beanspruchbarkeit,
(enthält Teilsicherheitsbeiwert $\gamma_M$)

*„Zulässige Lasten“ bzw. „Gebrauchslasten“ erhält man durch Division der Beanspruchbarkeit durch 1,5 (= $\gamma_F$)

15

## 5.6 Check of the Layher diagonals.

The Maximum tension or compression of the Layher K2000+ system is +/- 12.4 kN. In the next figurer the minimum and maximum forces are displayed.




The maximum Ned is 7.51 kN

Check of the diagonals

Ned / Nrd < 1

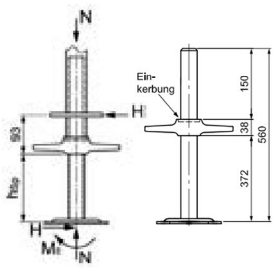
7.51 / 12.4 = 0.60 < 1

## 5.7 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

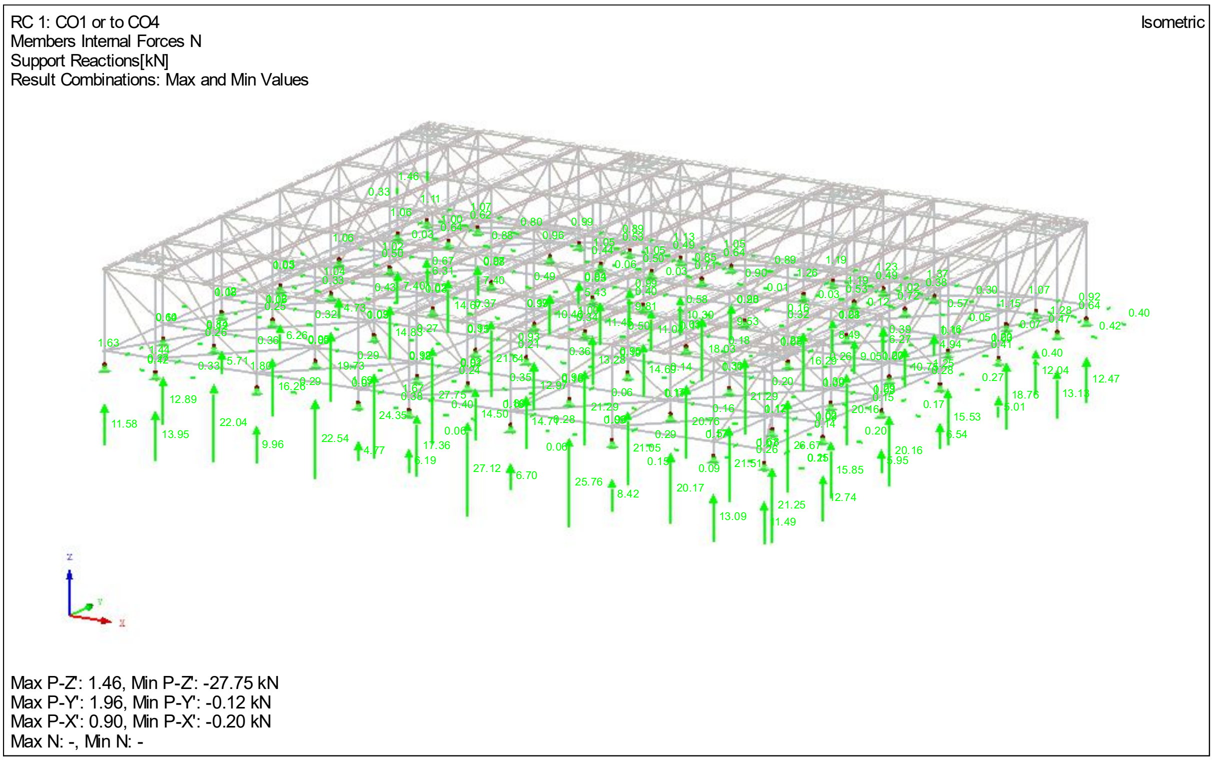
**Tab. 12 Belastung Fußspindeln**

| 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**

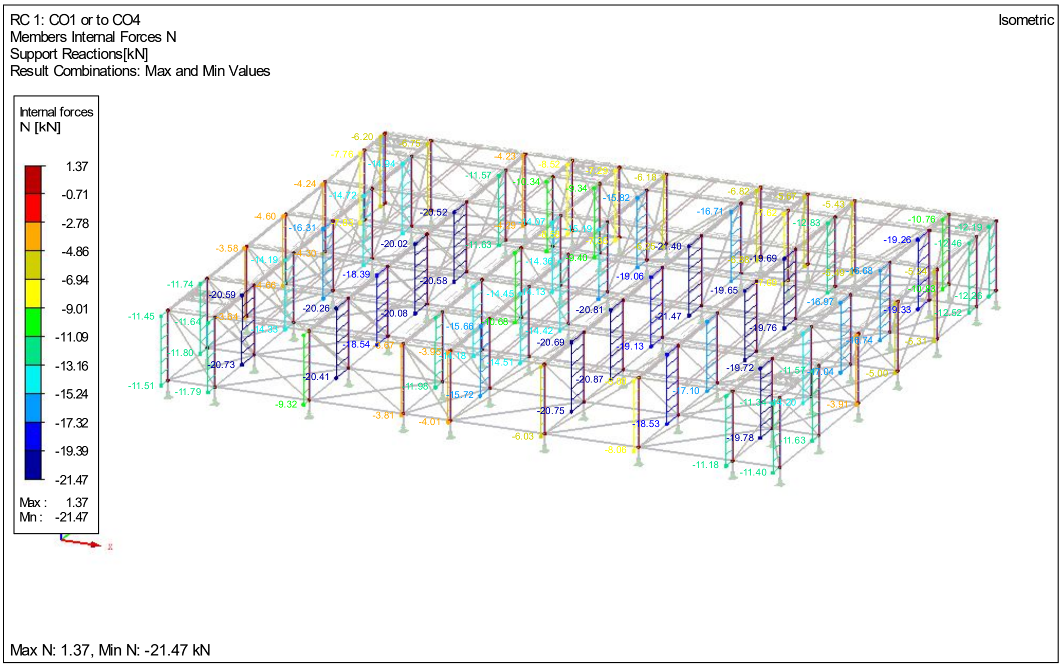
(–) Bei dieser Kombination von Ausspindellänge und Horizontallast ist die Biegebeanspruchbarkeit der Spindel überschritten.

In the next figure the maximum support forces are displayed.



The maximum support force is 27.75 kN. Which occurs in Load Combination CO1. The maximum horizontal force in Load Combination CO1 at this point is 1.01 kN. According to the table of the Layher spindle the combination between the vertical and the horizontal force allows for a maximum spindle length of 25 cm

### 5.8 Check of the Layher columns




Proof against buckling.

$\beta = 0.9$
$L_{cr} = 0.9 * 150 = 135$ cm
$A = 4.53$ cm²
$I = 11.60$ cm$^4$
$W = 4.80$ cm³
$i = 1.60$cm

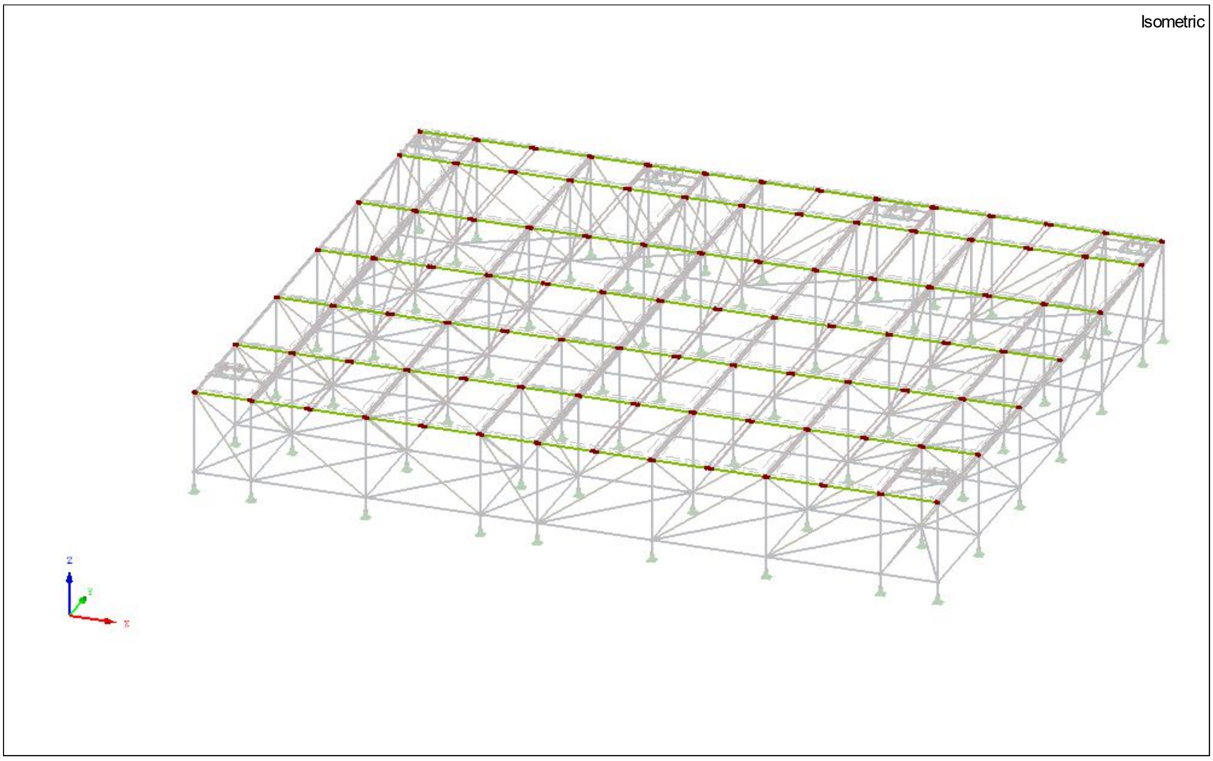
$\lambda_1 = \pi * \sqrt{(210000/320)} = 80{,}48$
$\bar{\lambda} = 135 / (1.6 * 80.48) = 1.048$
Buckling curve for hollow section line c ( table 6.2 from en-1993-1-1)
$\alpha = 0{,}49$
$\Phi = 0.5 * ( 1 + \alpha * (\bar{\lambda} - 0.2 ) + \bar{\lambda}^2 )$
$\Phi = 0.5 * ( 1 + 0.49 * ( 1.048 - 0.2 ) + 1.048^2 ) = 1.257$
$\chi_{min} = 1 / (\Phi + \sqrt{( \Phi^2 - \bar{\lambda}^2 )})$
$\chi_{min} = 1 / (1.257 + \sqrt{( 1.257^2 - 1.048^2 )}) = 0.512$

$N_{b,rd} = \chi * A * f_0 /1.1$
$N_{b,rd} = 0.512 * 4.53 * 32 /1.1 = 67.54$ kN
$N_{ed,\,max} = 21.47$ kN

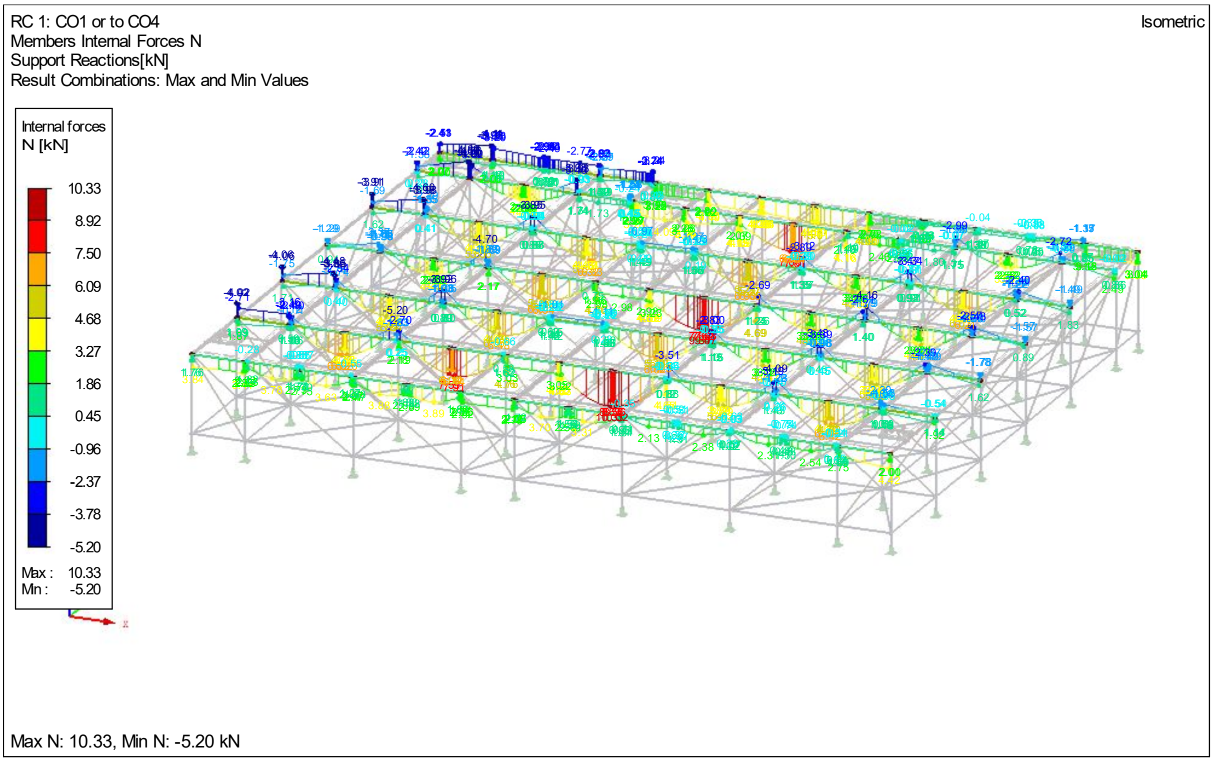
check = $N_{ed,\,max} / N_{b,rd} < 1$
$21.47/ 67.54 = 0.32 < 1$

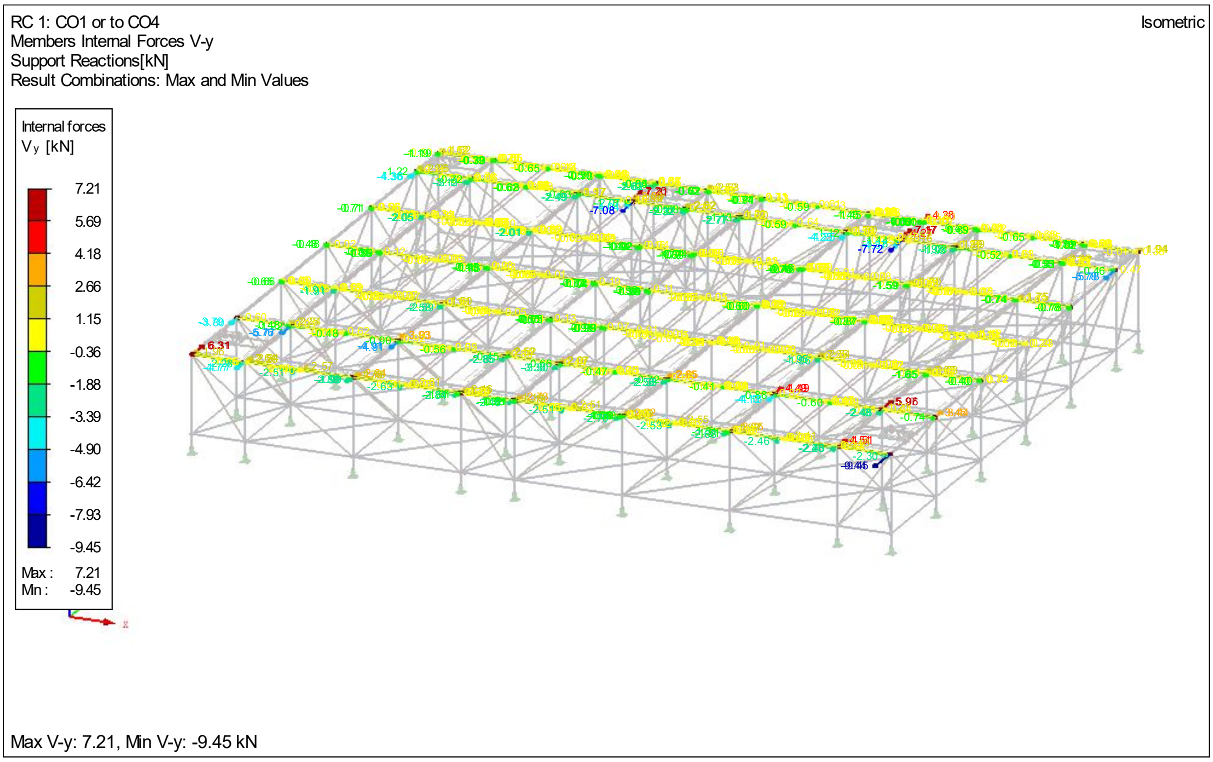
## 5.9 Check of the Event Layher staging system.

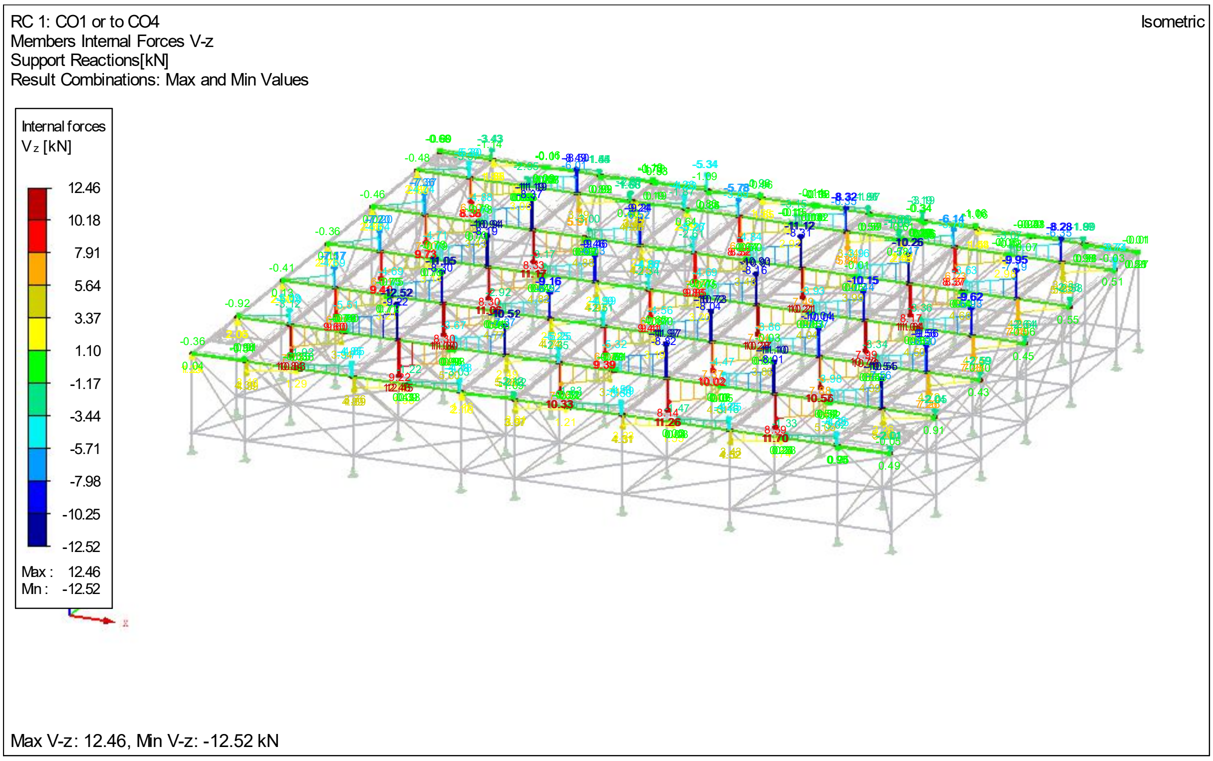
The event Layher staging system exist of Layher transom beams with a decking system on top.

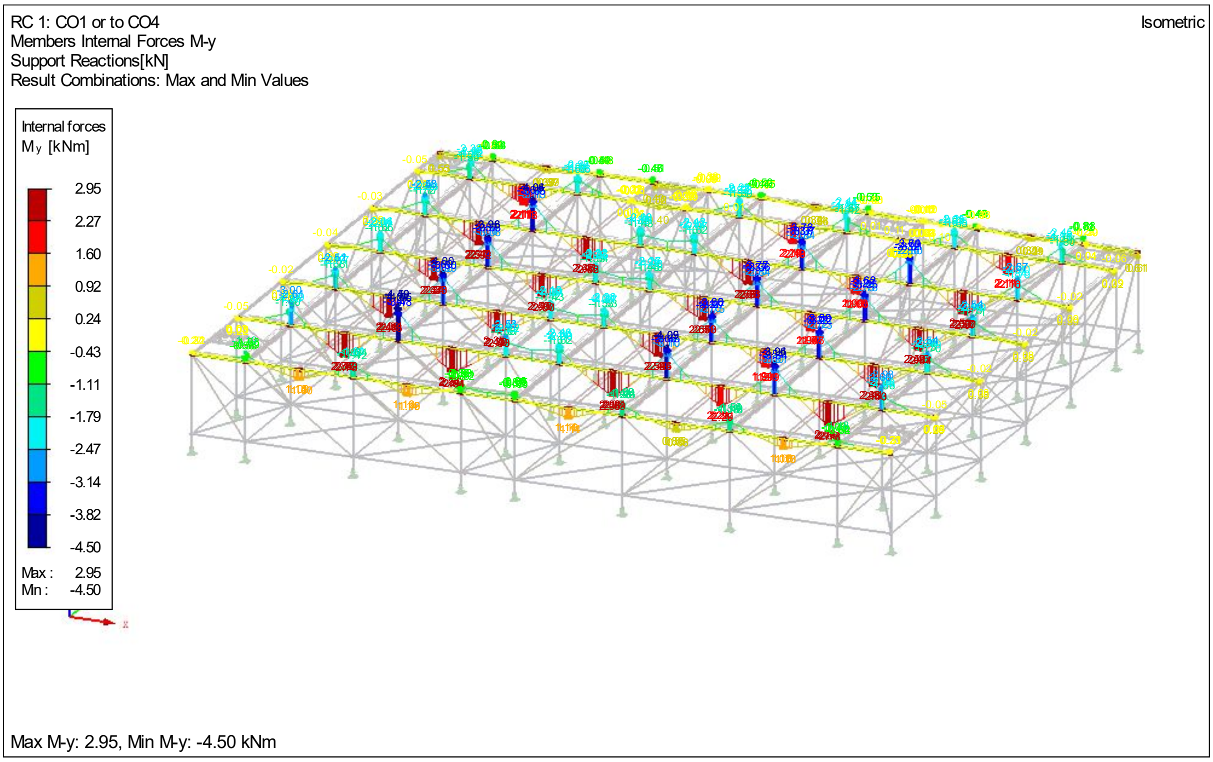


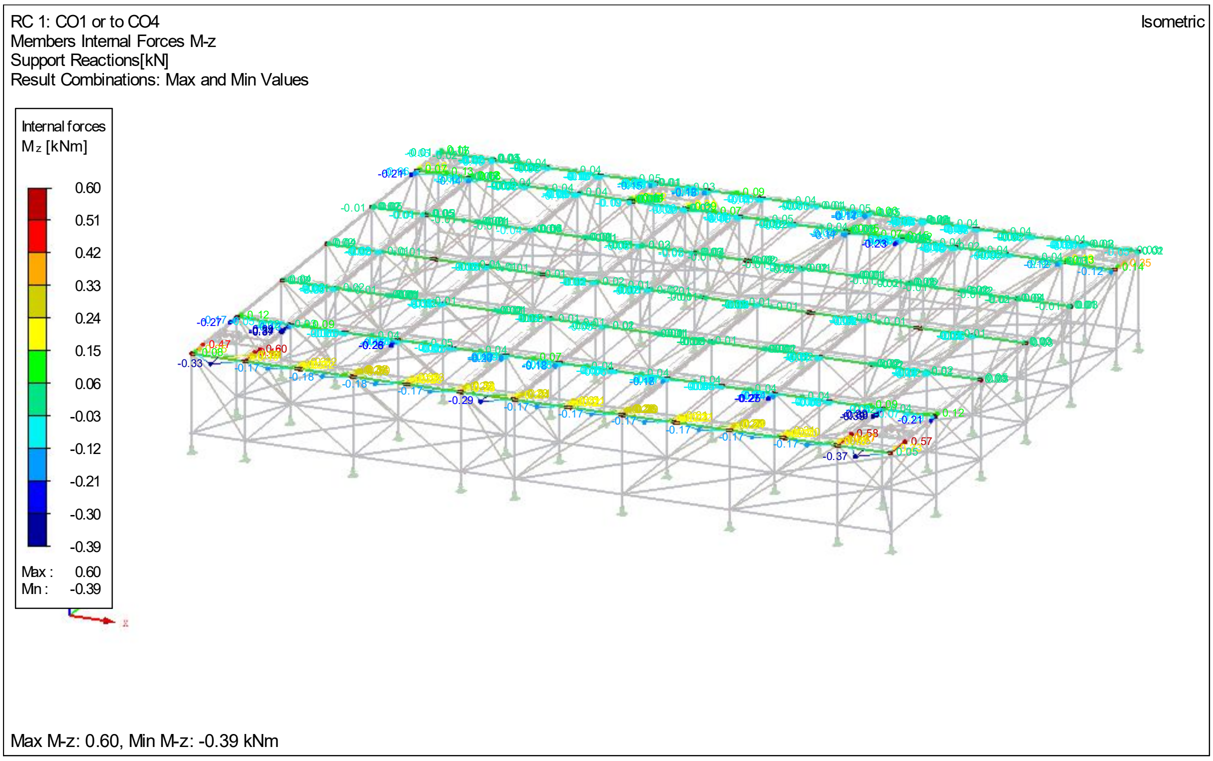

In the next figures the internal forces of the floor beam are shown.




RC 1: CO1 or to CO4
Members Internal Forces V-y
Support Reactions[kN]
Result Combinations: Max and Min Values
Isometric
Internal forces
Vy [kN]
7.21
5.69
4.18
2.66
1.15
-0.36
-1.88
-3.39
-4.90
-6.42
-7.93
-9.45
Max : 7.21
Min : -9.45
Max V-y: 7.21, Min V-y: -9.45 kN

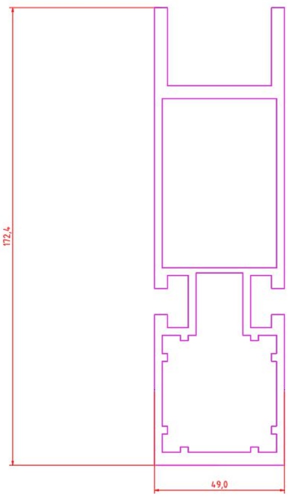

RC 1: CO1 or to CO4
Members Internal Forces V-z
Support Reactions[kN]
Result Combinations: Max and Min Values
Isometric
Internal forces
Vz [kN]
12.46
10.18
7.91
5.64
3.37
1.10
-1.17
-3.44
-5.71
-7.98
-10.25
-12.52
Max : 12.46
Min : -12.52
Max V-z: 12.46, Min V-z: -12.52 kN




**Profiel berekening.**

Layher Event Beam speciaal profiel Aluminium 6005A T6




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

$Wy = I_1 / e_y = 554 / 8.25 = 67.15\ cm^3$

$N_{ed} = 10.33$

$\sigma N_{ed} = N_{ed} / A = 10.33 / 18.78 = 0.55\ kN/cm^2$

$V_{y,ed} = 9.45\ kN$

$\sigma v_{z,ed} = V_{y,ed} / A = 9.45 / 18.78 = 0.50\ kN/cm^2$

$V_{z,ed} = 12.52\ kN$

$\sigma v_{z,ed} = V_{z,ed} / A = 12.52 / 18.78 = 0.66\ kN/cm^2$

My,ed = 4.50Knm

$\sigma M_{y,ed} = M_{y,ed} / Wy = 450 / 67.15 = 6.70\ kN/cm^2$

Mz,ed = 0.60 Knm

$\sigma M_{z,ed} = M_{z,ed} / Wy = 60 / 67.15 = 0.89\ kN/cm^2$

$\sigma tot = \sigma N_{ed} + 0{,}58 * \sigma v_{z,ed} + 0{,}58 * \sigma v_{z,ed} + \sigma M_{y,ed} + \sigma M_{y,ed}$

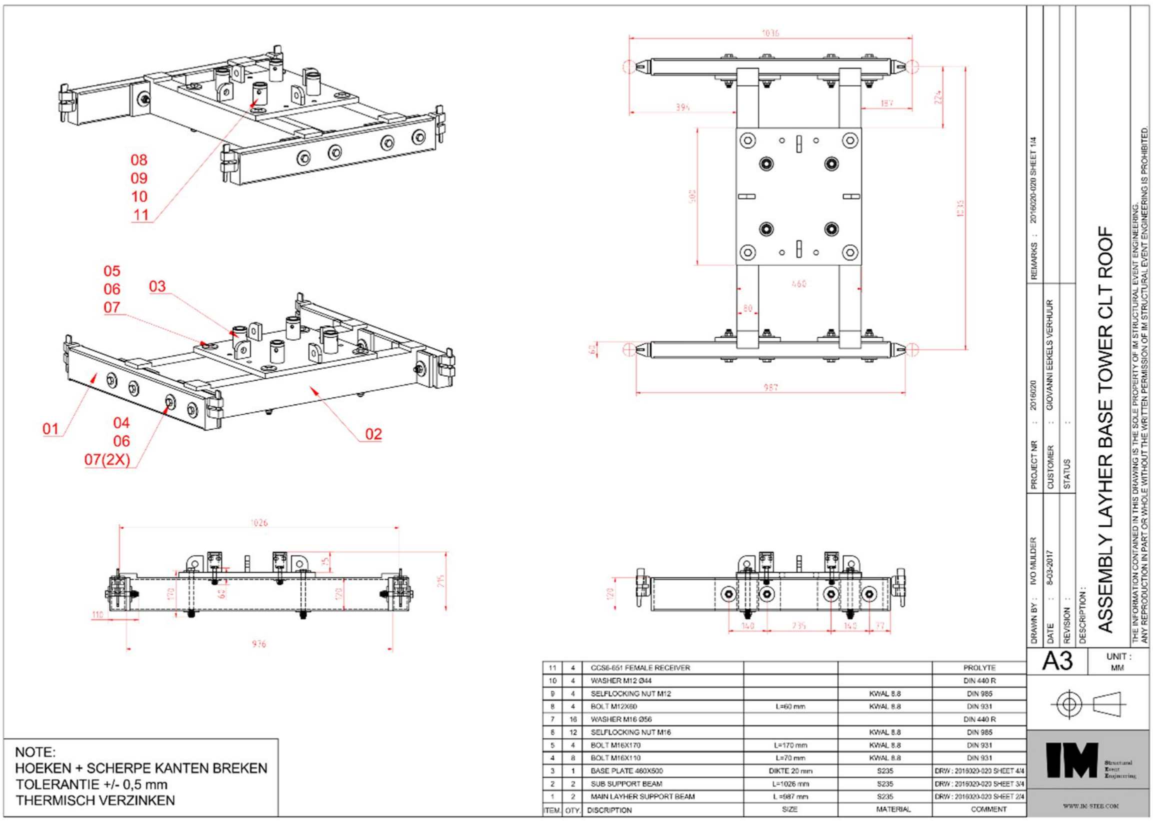
$0.55 + 0.58 * 0.50 + 0.58 * 0.66 + 6.70 + 0.98 = 8.9\ kN/cm^2$

Check

$\sigma tot / (fy / \gamma) < 1$

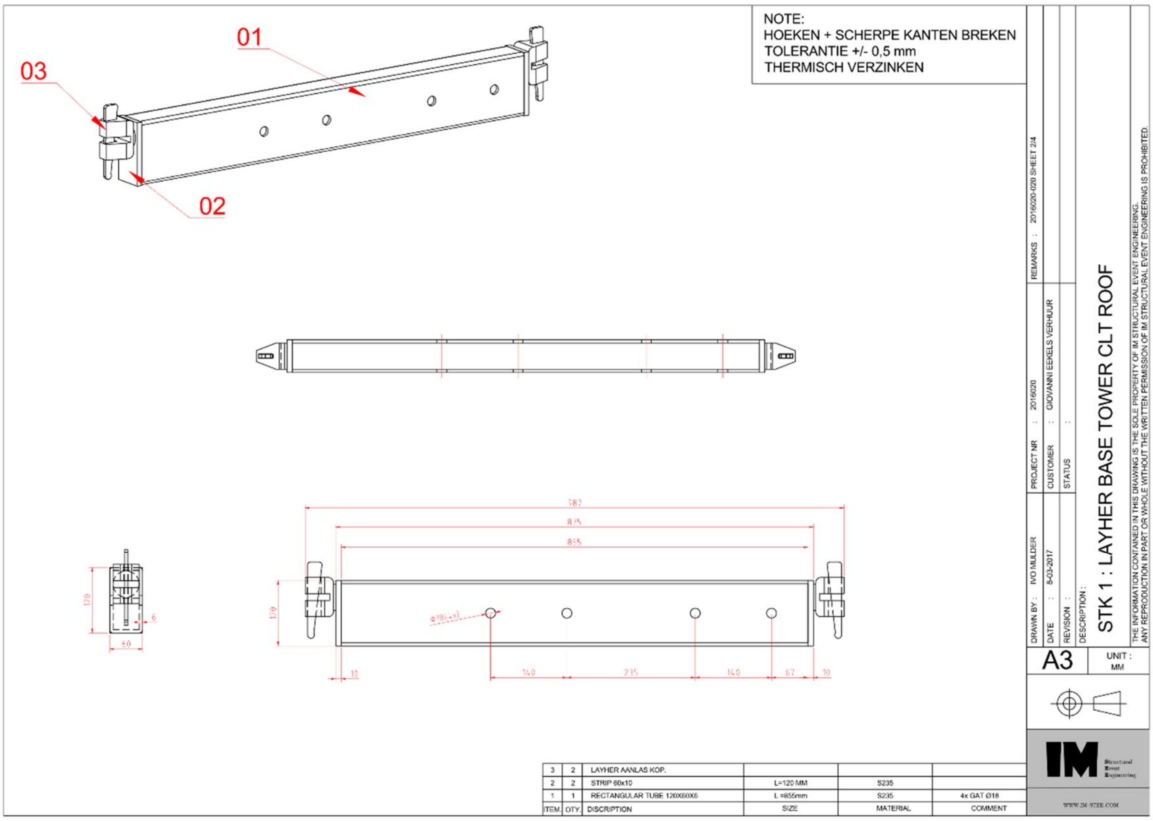
$8.90 / (22.5 / 1.1) = 0.43 < 1$

## 5.10 Check of the roof Tower connection to the Layher stage.



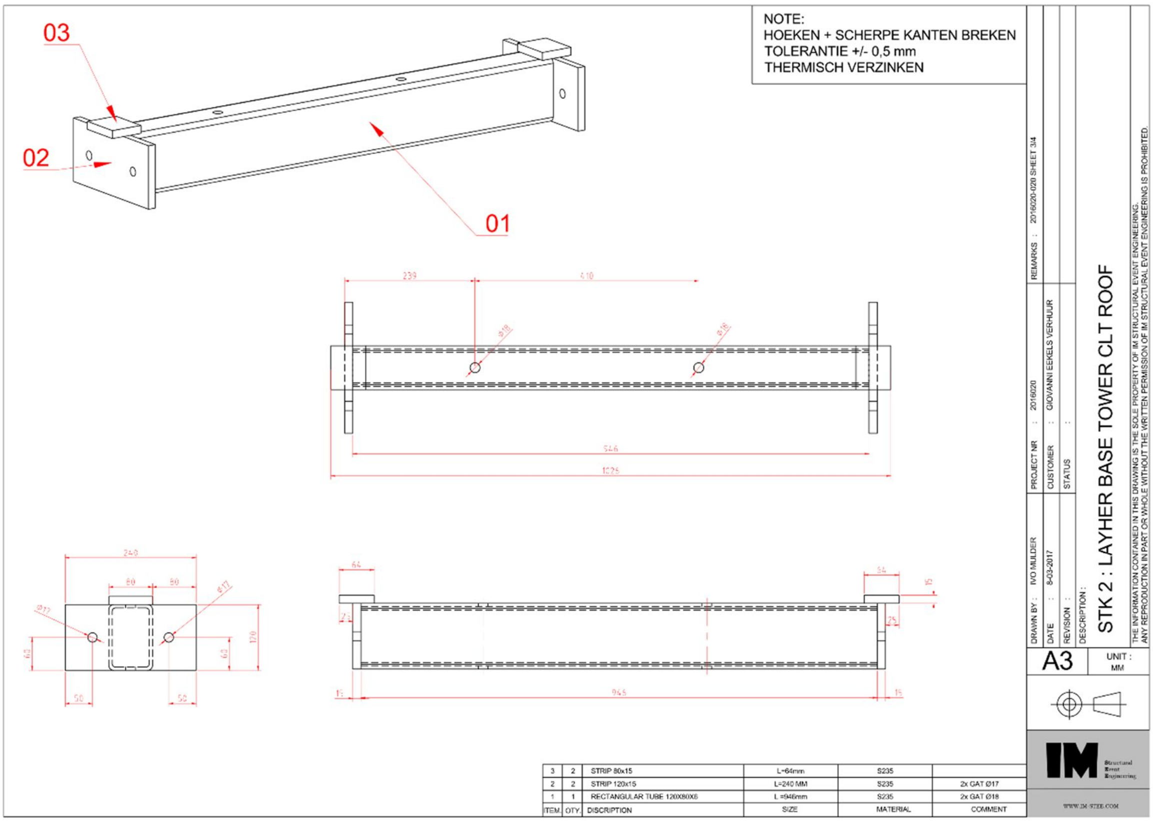

| ITEM. | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 11 | 4 | CCS6-651 FEMALE RECEIVER | | | PROLYTE |
| 10 | 4 | WASHER M12 Ø44 | | | DIN 440 R |
| 9 | 4 | SELFLOCKING NUT M12 | | KWAL 8.8 | DIN 985 |
| 8 | 4 | BOLT M12X60 | L=60 mm | KWAL 8.8 | DIN 931 |
| 7 | 16 | WASHER M16 Ø56 | | | DIN 440 R |
| 6 | 12 | SELFLOCKING NUT M16 | | KWAL 8.8 | DIN 985 |
| 5 | 4 | BOLT M16X170 | L=170 mm | KWAL 8.8 | DIN 931 |
| 4 | 8 | BOLT M16X110 | L=70 mm | KWAL 8.8 | DIN 931 |
| 3 | 1 | BASE PLATE 460X500 | DIKTE 20 mm | S235 | DRW : 2016020-020 SHEET 4/4 |
| 2 | 2 | SUB SUPPORT BEAM | L=1026 mm | S235 | DRW : 2016020-020 SHEET 3/4 |
| 1 | 2 | MAIN LAYHER SUPPORT BEAM | L =987 mm | S235 | DRW : 2016020-020 SHEET 2/4 |

NOTE:
HOEKEN + SCHERPE KANTEN BREKEN
TOLERANTIE +/- 0,5 mm
THERMISCH VERZINKEN

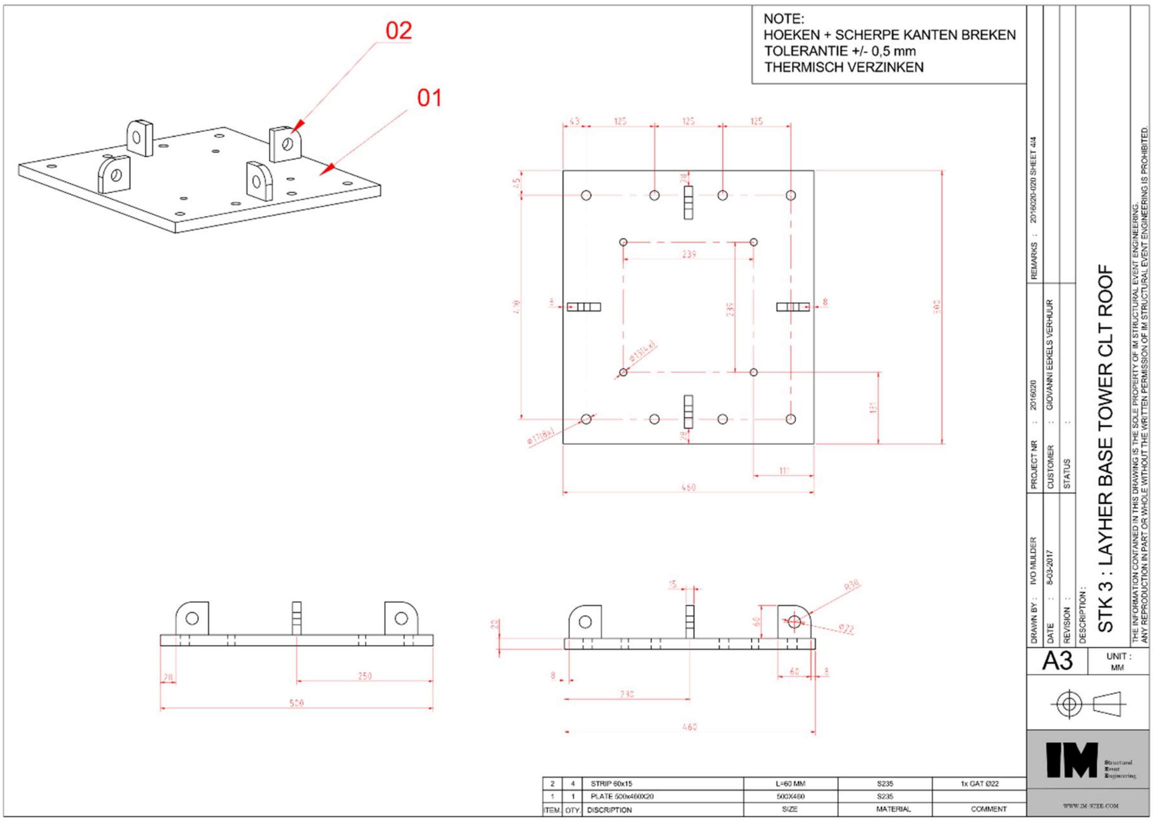



NOTE:
HOEKEN + SCHERPE KANTEN BREKEN
TOLERANTIE +/- 0,5 mm
THERMISCH VERZINKEN

| ITEM. | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 3 | 2 | LAYHER AANLAS KOP. | | | |
| 2 | 2 | STRIP 60x10 | L=120 MM | S235 | |
| 1 | 1 | RECTANGULAR TUBE 120X60X6 | L =855mm | S235 | 4x GAT Ø18 |

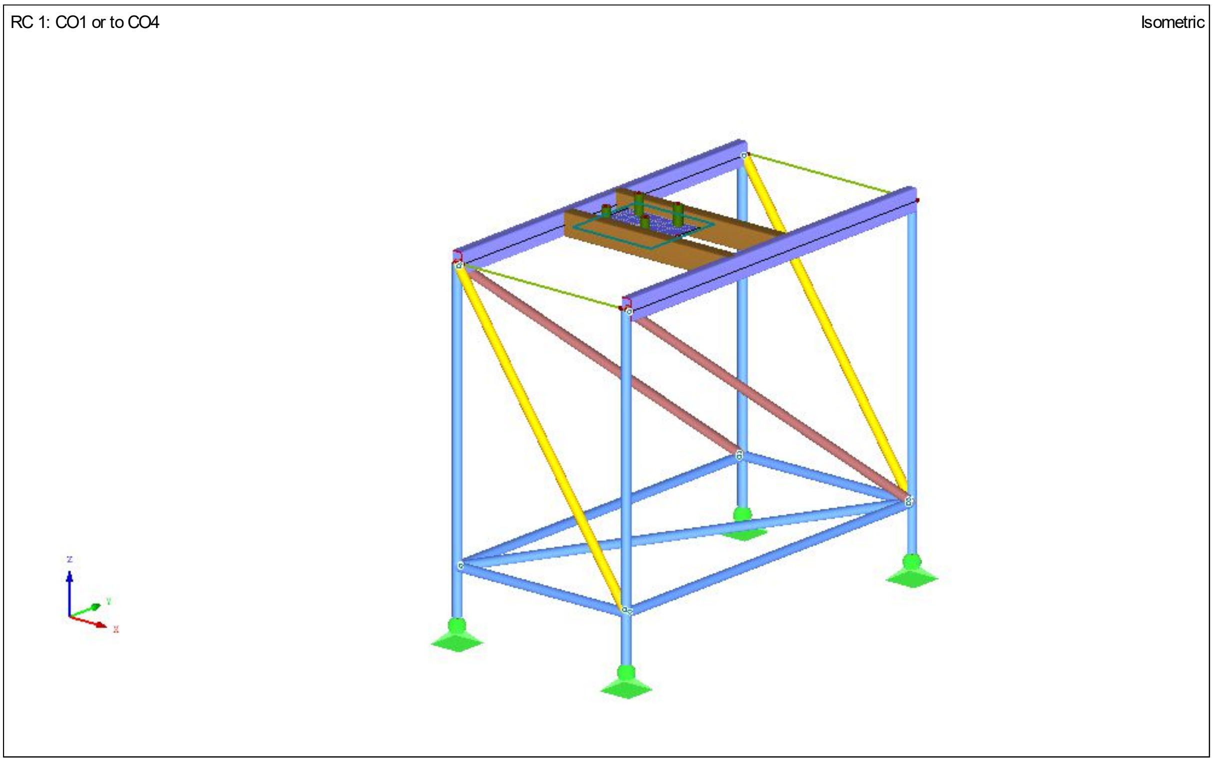



| ITEM. | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 3 | 2 | STRIP 80x15 | L=64mm | S235 | |
| 2 | 2 | STRIP 120x15 | L=240 MM | S235 | 2x GAT Ø17 |
| 1 | 1 | RECTANGULAR TUBE 120X80X6 | L =946mm | S235 | 2x GAT Ø18 |




| ITEM. | QTY. | DISCRIPTION | SIZE | MATERIAL | COMMENT |
|---|---|---|---|---|---|
| 2 | 4 | STRIP 60x15 | L=60 MM | S235 | 1x GAT Ø22 |
| 1 | 1 | PLATE 500x460X20 | 500X460 | S235 | |

The Layher bases are inserted in the RFem model.




The Layher base has 2 different sizes of 2.072 x 1.036 and 1.036 x 1.036.

The Layher base which is checked is the one of 2.072 x 1.036.

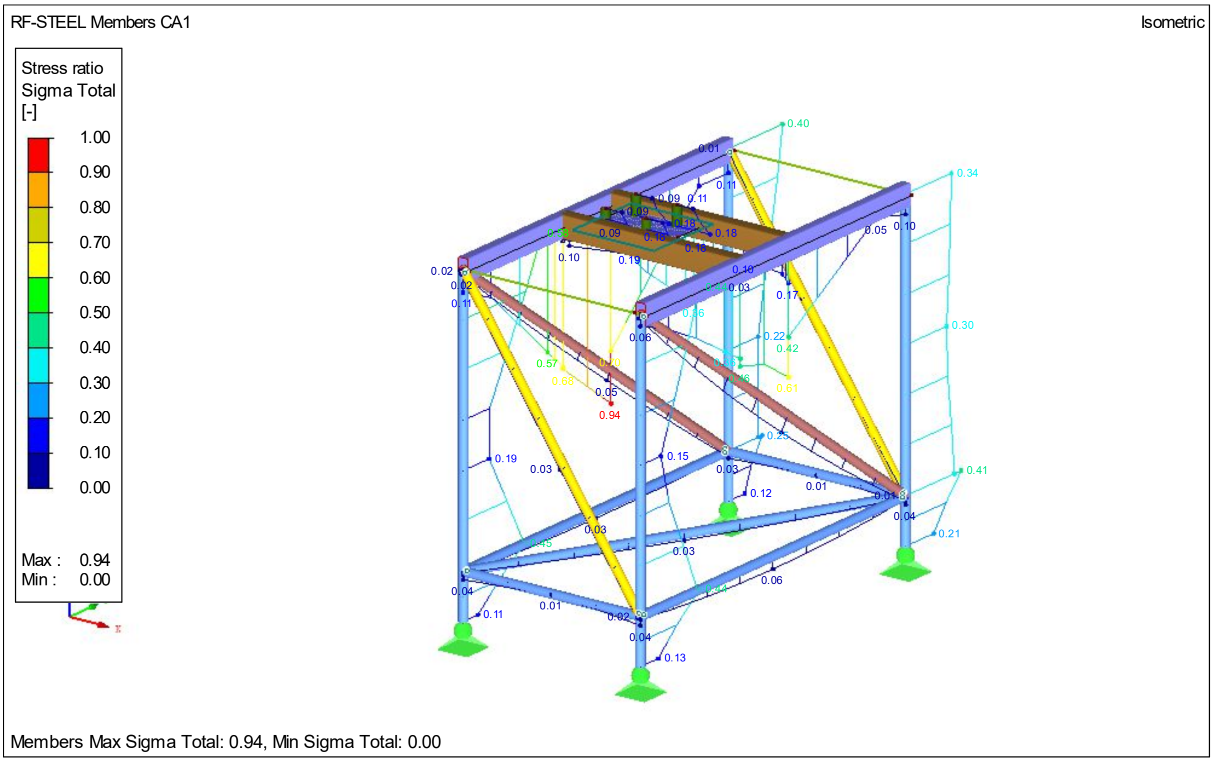
Check of the Layher attachment.

Maximum shear force in the Layher connection point $V_{ed}$ = 12.68 kN

The maximum shear force of the Layher head is according to the figures at page 168 $V_{rd}$ = 26.4 kN

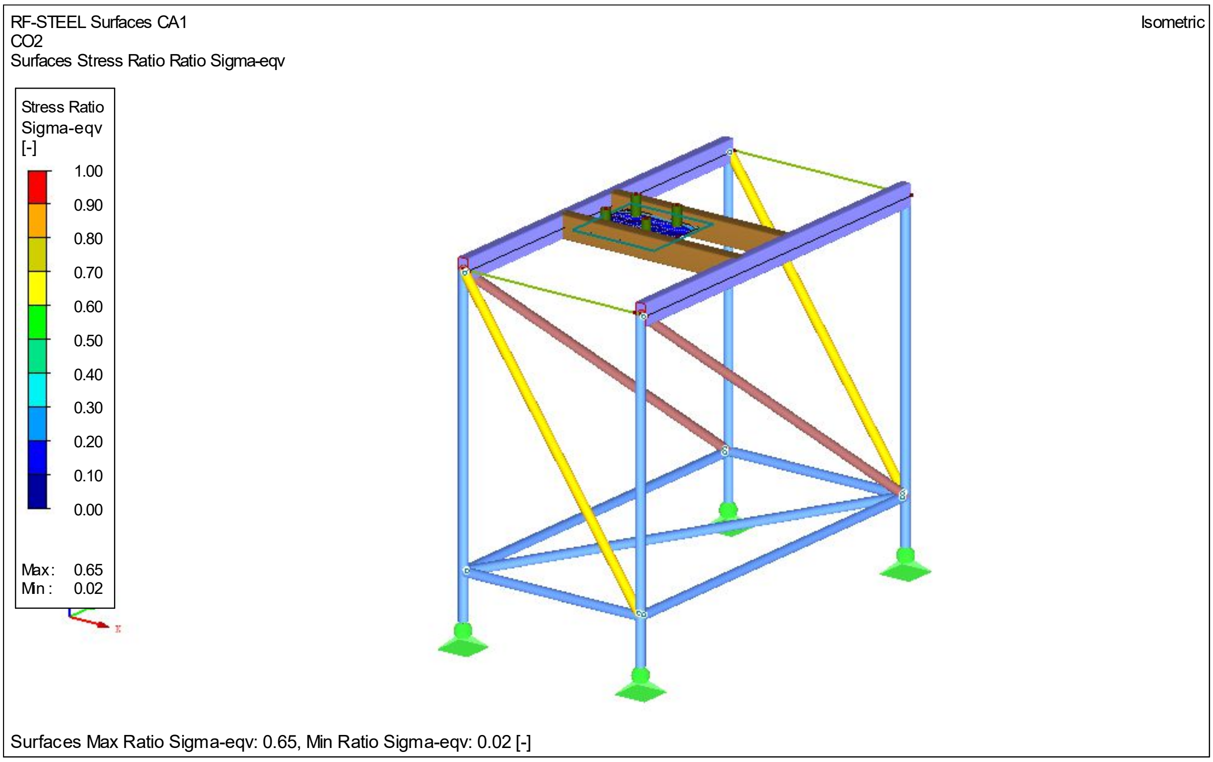
12.68 / 26.4 = 0.48 < 1

## Maximum stress analyse for the members




| Section No. | Member No. | Location x [m] | S-Point No. | Load-ing | Stress Type | Stress [kN/cm²] Existing | Limit | Stress Ratio |
|---|---|---|---|---|---|---|---|---|
| 6 | RRO 120x60x6.3 (Hot Formed) | | | | | | | |
| | 996 | 0,375 | 11 | CO4 | Sigma Total | 23,46 | 23,50 | 1,00 |
| | 931 | 0,227 | 15 | CO2 | Tau Total | -2,45 | 13,57 | 0,18 |
| | 996 | 0,375 | 11 | CO4 | Sigma-eqv | 23,60 | 23,50 | 1,00 |
| | | | | | | | | |
| 7 | RRO 120x80x6.3 (Hot Formed) | | | | | | | |
| | 1003 | 0,054 | 11 | CO4 | Sigma Total | 8,99 | 23,50 | 0,38 |
| | 1002 | 0,035 | 14 | CO4 | Tau Total | -6,28 | 13,57 | 0,46 |
| | 1002 | 0,035 | 14 | CO4 | Sigma-eqv | 10,96 | 23,50 | 0,47 |

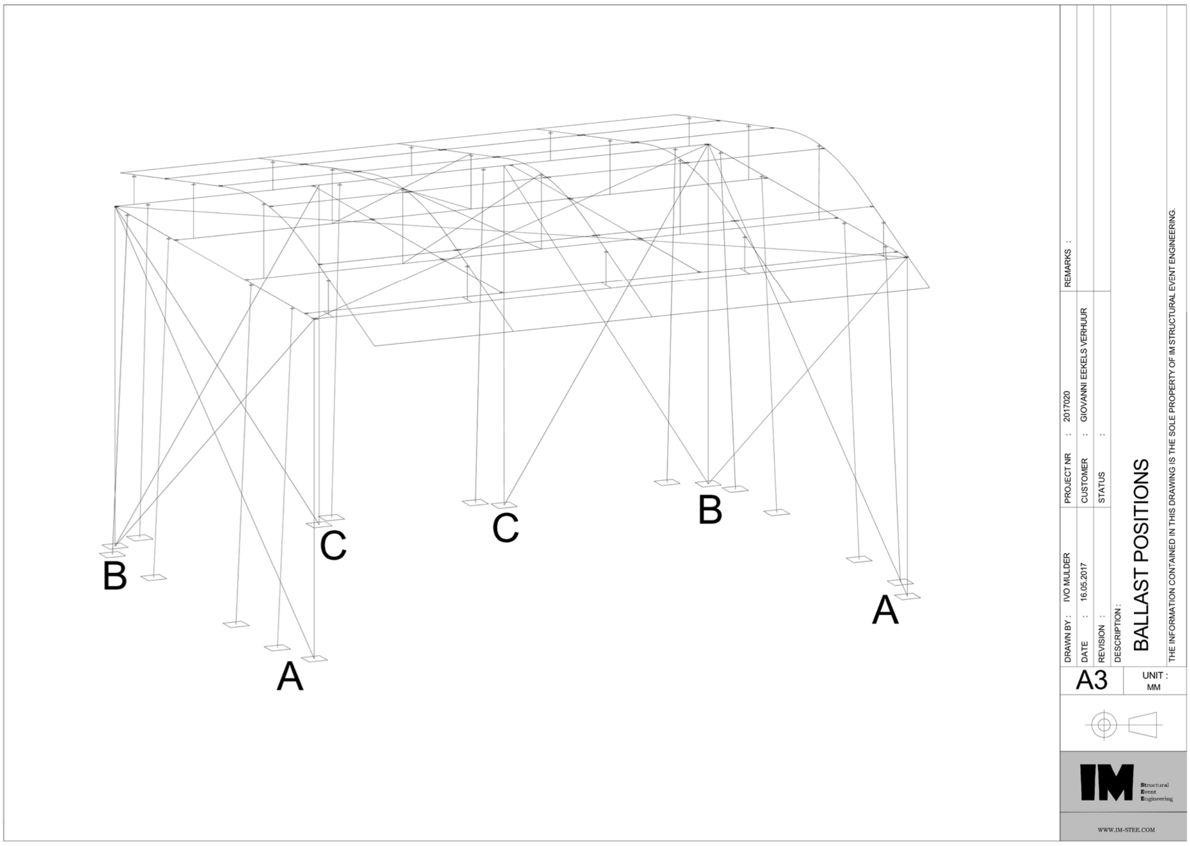
## Maximum stress analyse for the steel plate



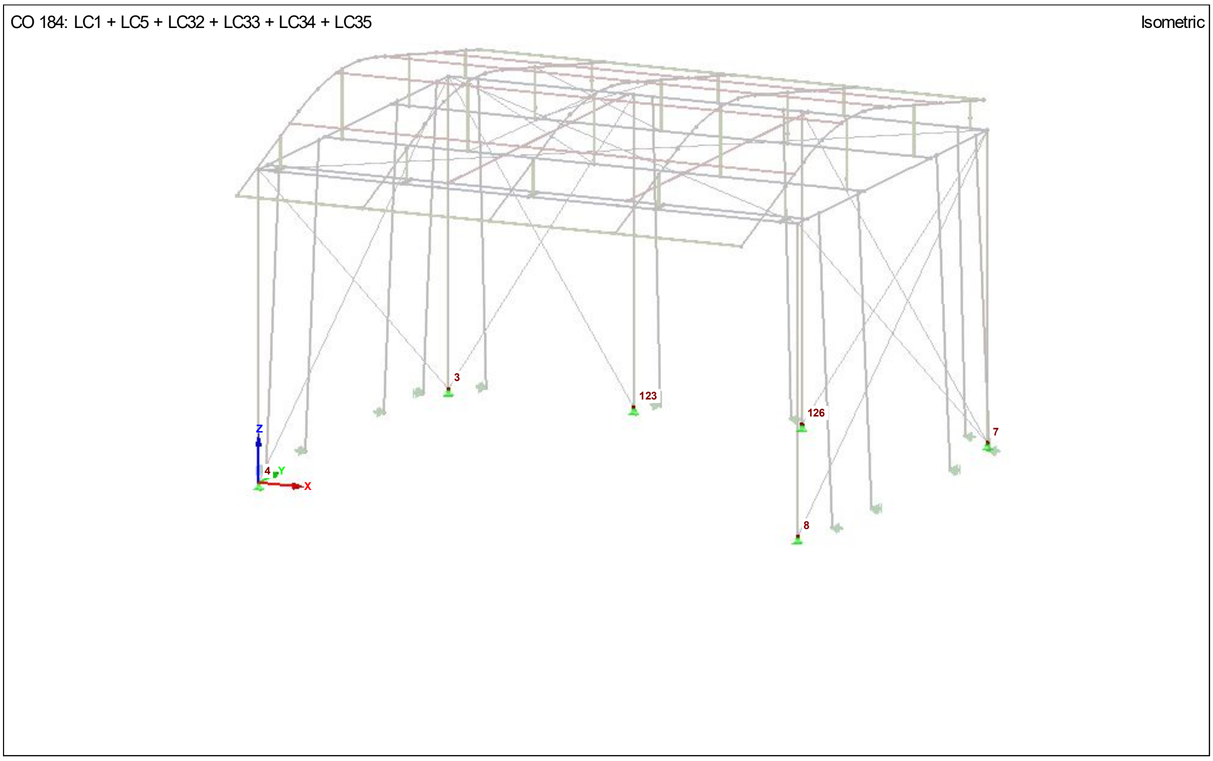

| Load-ing | Surface No. | FE Mesh Point No. | Point Coordinates [m] X | Y | Z | Stress [kN/cm²] Symbol | Existing | Limit | Stress Ratio [-] |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\tau_{max}$ | 1,77 | 13,57 | 0,13 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | -1,56 | 23,50 | 0,07 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -5,22 | 23,50 | 0,22 |
| | 59 | 543 | 11,915 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 13,67 | 23,50 | 0,58 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 4,64 | 23,50 | 0,20 |
| CO2 | | | | | | | | | |
| | 58 | 549 | 12,350 | 10,029 | 2,250 | $\tau_{max}$ | 1,89 | 13,57 | 0,14 |
| | 56 | 92 | 3,389 | 10,029 | 2,250 | $\sigma_{1,m}$ | -1,95 | 23,50 | 0,08 |
| | 58 | 549 | 12,350 | 10,029 | 2,250 | $\sigma_{2,m}$ | -6,01 | 23,50 | 0,26 |
| | 58 | 549 | 12,350 | 10,029 | 2,250 | $\sigma_{eqv,max}$ | 18,74 | 23,50 | 0,80 |
| | 58 | 549 | 12,350 | 10,029 | 2,250 | $\sigma_{eqv,m}$ | 5,35 | 23,50 | 0,23 |
| CO3 | | | | | | | | | |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\tau_{max}$ | 1,59 | 13,57 | 0,12 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | -1,82 | 23,50 | 0,08 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -6,06 | 23,50 | 0,26 |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 15,97 | 23,50 | 0,68 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 5,38 | 23,50 | 0,23 |
| CO4 | | | | | | | | | |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\tau_{max}$ | 2,13 | 13,57 | 0,16 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | -2,42 | 23,50 | 0,10 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -8,05 | 23,50 | 0,34 |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 21,34 | 23,50 | 0,91 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 7,15 | 23,50 | 0,30 |
| - | Maximum Stresses | | | | | | | | |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\tau_{max}$ | 2,13 | 13,57 | 0,16 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{1,m}$ | -2,42 | 23,50 | 0,10 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{2,m}$ | -8,05 | 23,50 | 0,34 |
| | 59 | 544 | 12,350 | 0,016 | 2,250 | $\sigma_{eqv,max}$ | 21,34 | 23,50 | 0,91 |
| | 54 | 516 | -0,905 | 0,016 | 2,250 | $\sigma_{eqv,m}$ | 7,15 | 23,50 | 0,30 |

# 6 Ballast and support load calculations.

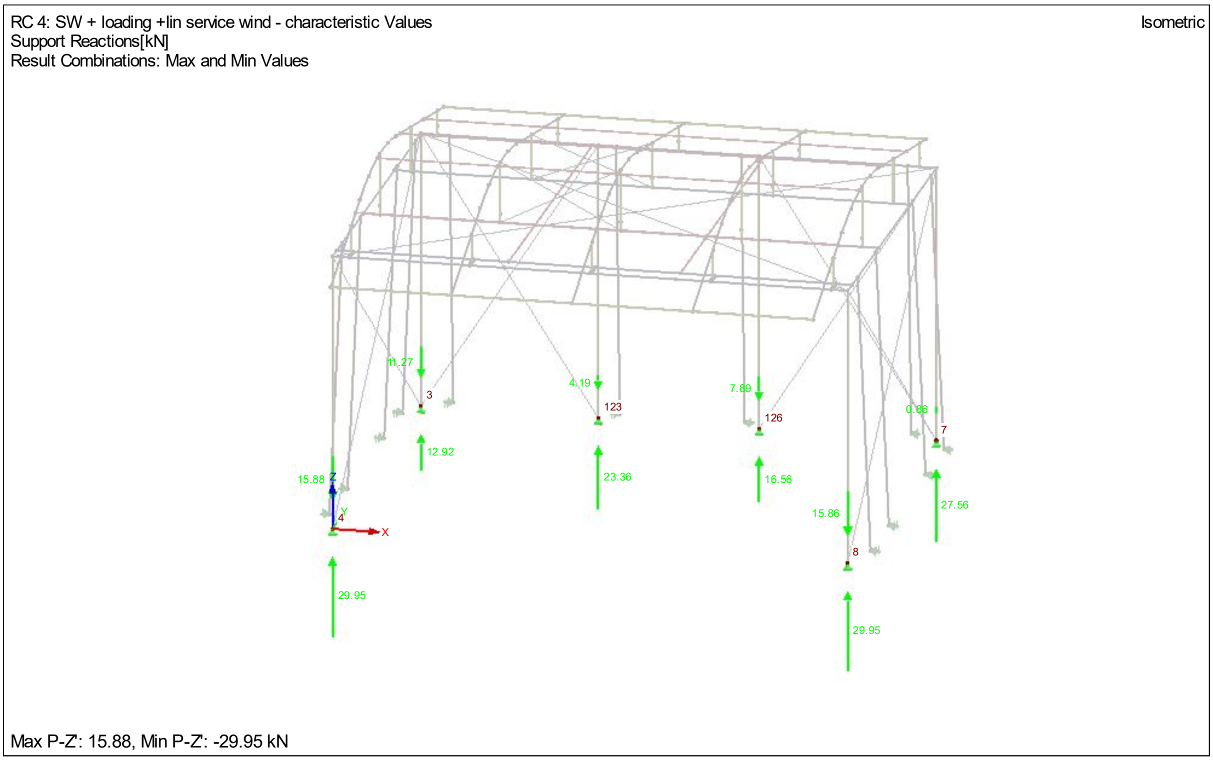
## 6.1 Ballast positions

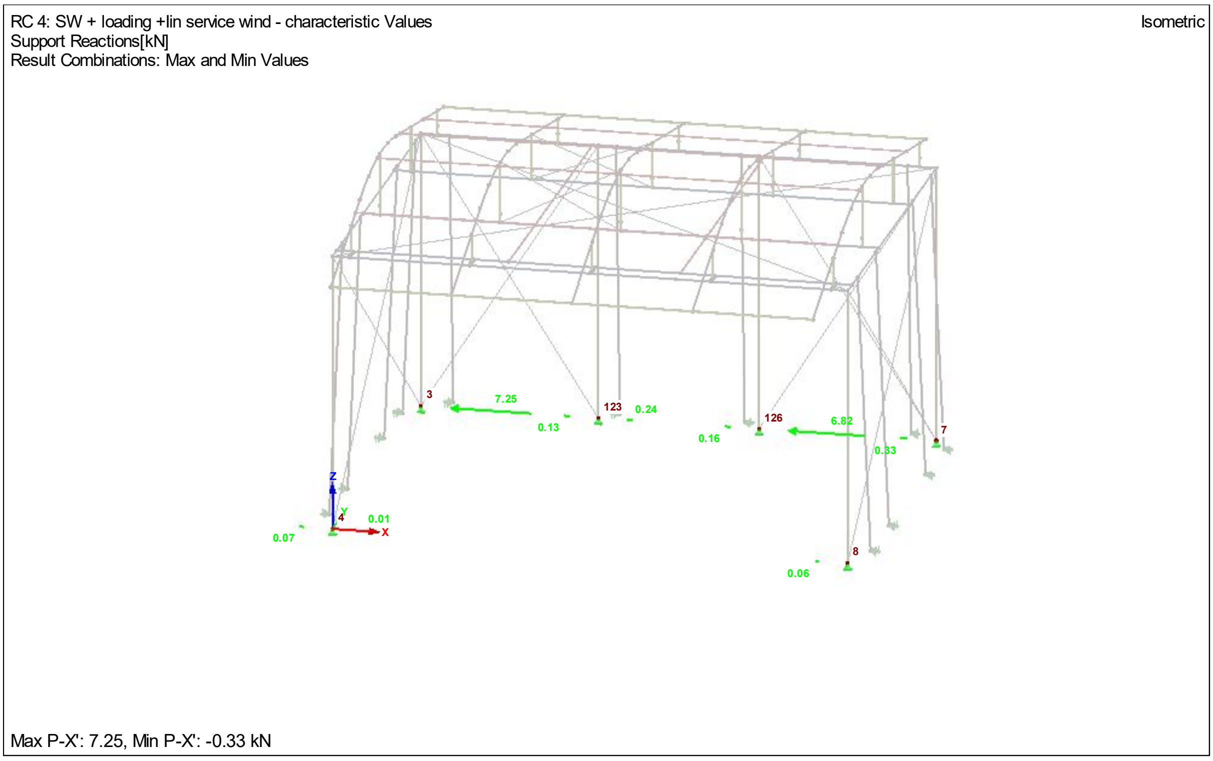



## 6.2 Over view support node numbers



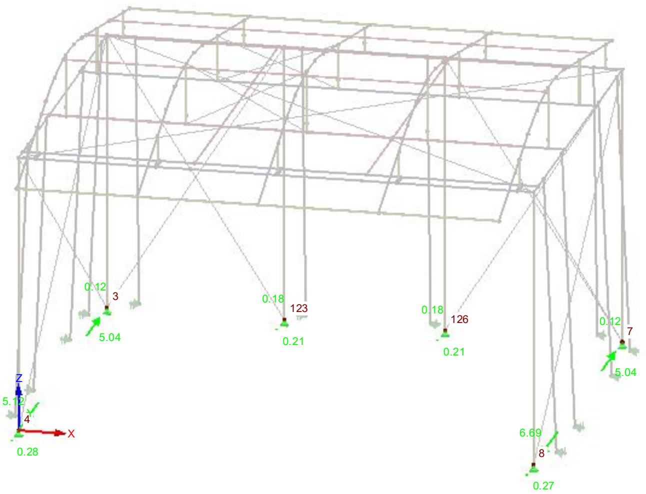
## 6.3 reaction forces in the In-service situation of the main support nodes, characteristic values.



RC 4: SW + loading +lin service wind - characteristic Values
Support Reactions[kN]
Result Combinations: Max and Min Values

Isometric

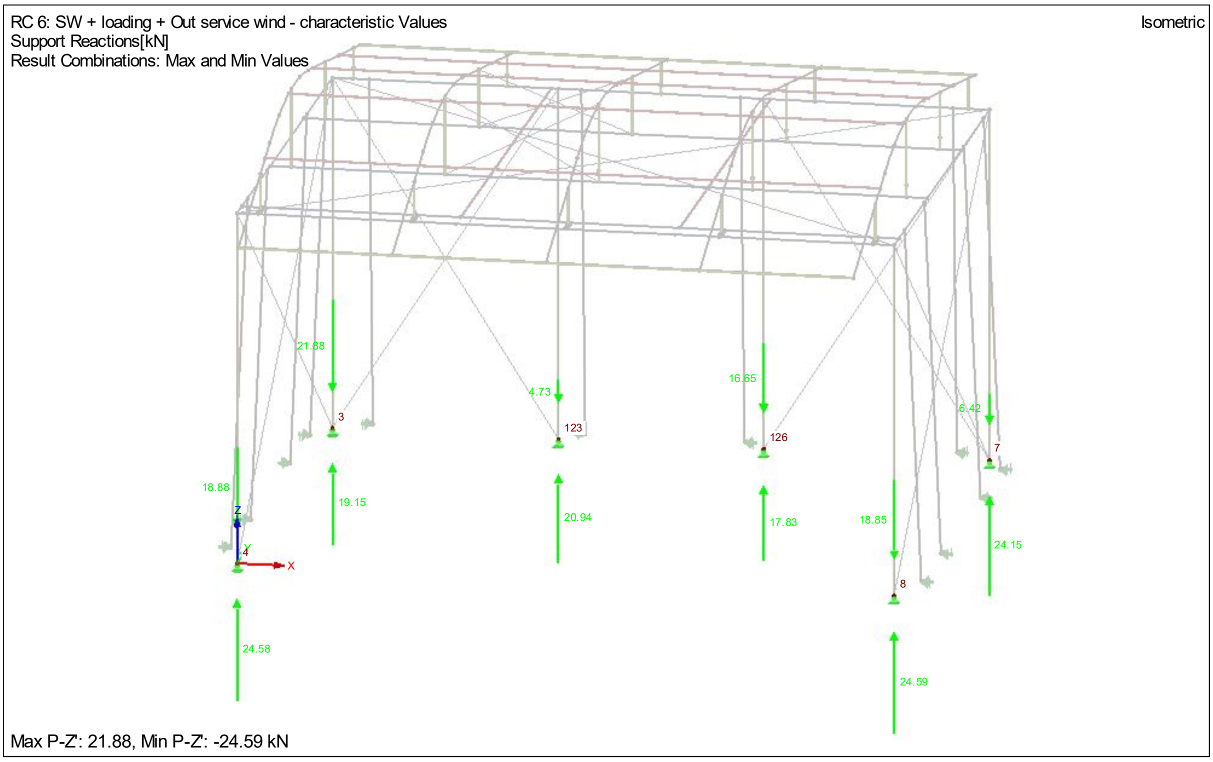


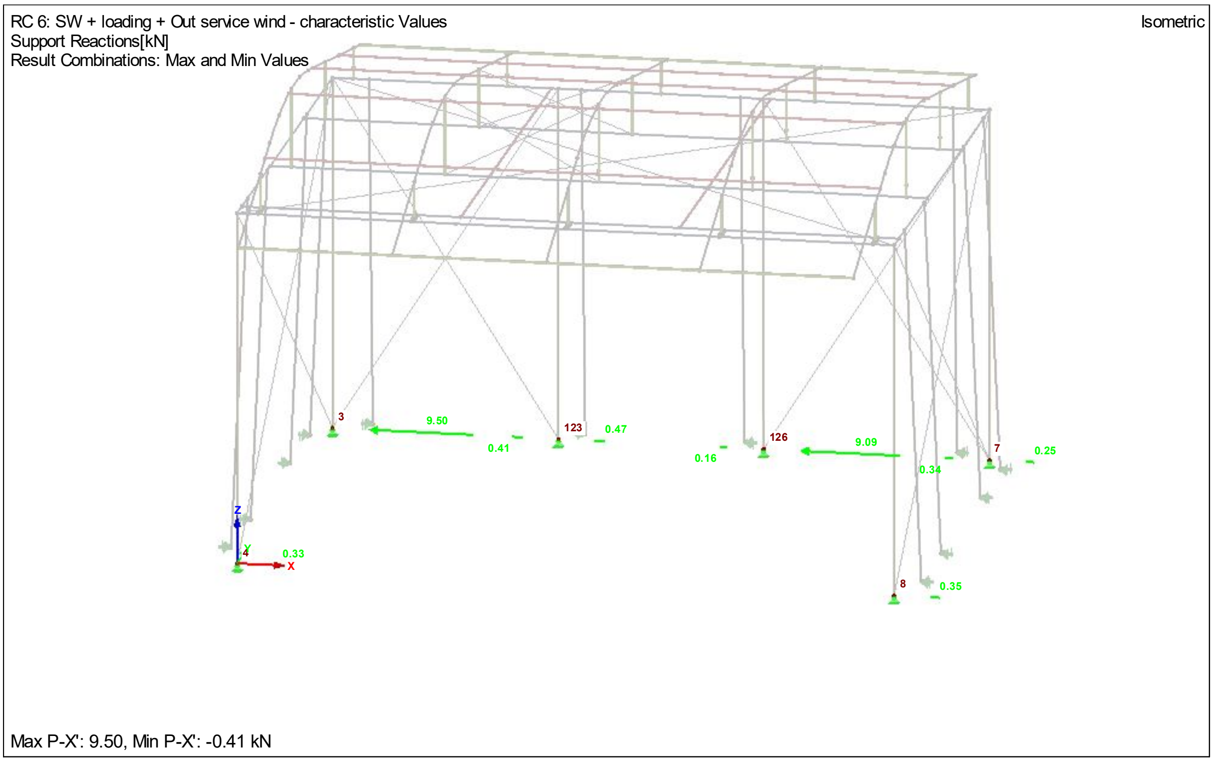

Max P-Y': 6.69, Min P-Y': -5.04 kN

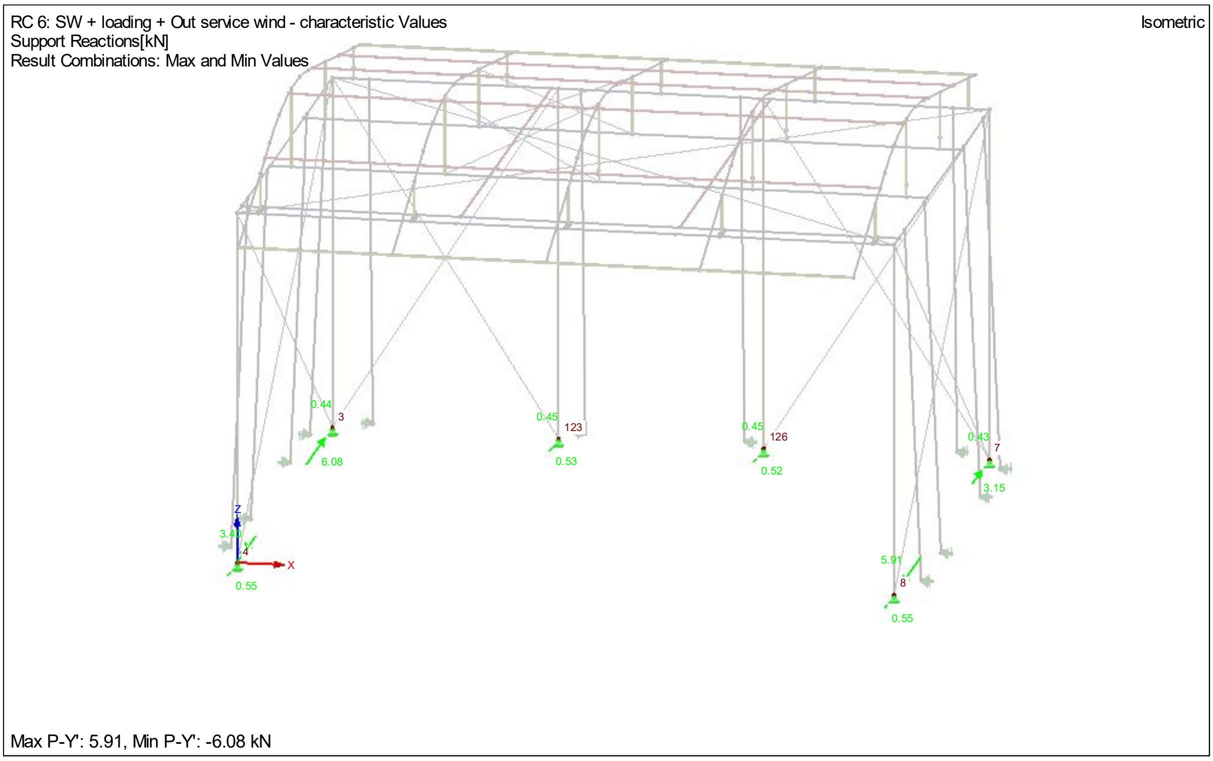
Reaction forces on the support nodes of the main construction, in the In–service situation

| Node | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| No. | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 7,25 | 0,12 | 11,27 | 0,00 | 0,00 | 0,00 |
| | Min | 0,00 | -5,04 | -12,92 | 0,00 | 0,00 | 0,00 |
| 4 | Max | 0,01 | 5,12 | 15,88 | 0,00 | 0,00 | 0,00 |
| | Min | -0,07 | -0,28 | -29,95 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,00 | 0,12 | 0,86 | 0,00 | 0,00 | 0,00 |
| | Min | -0,33 | -5,04 | -27,56 | 0,00 | 0,00 | 0,00 |
| 8 | Max | 0,00 | 6,69 | 15,86 | 0,00 | 0,00 | 0,00 |
| | Min | -0,06 | -0,27 | -29,95 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,24 | 0,18 | 4,19 | 0,00 | 0,00 | 0,03 |
| | Min | -0,13 | -0,21 | -23,36 | 0,00 | 0,00 | -0,03 |
| 126 | Max | 6,82 | 0,18 | 7,89 | 0,00 | 0,00 | 0,03 |
| | Min | -0,16 | -0,21 | -16,56 | 0,00 | 0,00 | -0,03 |

## 6.4 reaction forces in the Out-service situation of the main support nodes, characteristic values.






Reaction forces on the support nodes of the main construction, in the Out–service situation

| Node | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| No. | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 9,50 | 0,44 | 21,88 | 0,00 | 0,00 | 0,00 |
| | Min | 0,00 | -6,08 | -19,15 | 0,00 | 0,00 | 0,00 |
| 4 | Max | 0,33 | 3,40 | 18,88 | 0,00 | 0,00 | 0,00 |
| | Min | 0,00 | -0,55 | -24,58 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,25 | 0,43 | 6,42 | 0,00 | 0,00 | 0,00 |
| | Min | -0,34 | -3,15 | -24,15 | 0,00 | 0,00 | 0,00 |
| 8 | Max | 0,35 | 5,91 | 18,85 | 0,00 | 0,00 | 0,00 |
| | Min | 0,00 | -0,55 | -24,59 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,47 | 0,45 | 4,73 | 0,00 | 0,00 | 0,02 |
| | Min | -0,41 | -0,53 | -20,94 | 0,00 | 0,00 | 0,00 |
| 126 | Max | 9,09 | 0,45 | 16,65 | 0,00 | 0,00 | 0,02 |
| | Min | -0,16 | -0,52 | -17,83 | 0,00 | 0,00 | -0,01 |

### 6.5 Ballast calculation against uplift.

For the uplift ballast calculation the maximum uplift force per main support nodes are taken into account. The maximum values are taken from the table's in chapter 5.2 and 5.3.

As shown in the tables below the results of the out service are the normative results

maximum values in-service situation

| Node No. | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 7,25 | 0,12 | 11,27 | 0,00 | 0,00 | 0,00 |
| 4 | Max | 0,01 | 5,12 | 15,88 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,00 | 0,12 | 0,86 | 0,00 | 0,00 | 0,00 |
| 8 | Max | 0,00 | 6,69 | 15,86 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,24 | 0,18 | 4,19 | 0,00 | 0,00 | 0,03 |
| 126 | Max | 6,82 | 0,18 | 7,89 | 0,00 | 0,00 | 0,03 |

Maximum values Out-service situation

| Node No. | | Support Forces [kN] | | | Support Moments [kNm] | | |
|---|---|---|---|---|---|---|---|
| | | $P_{X'}$ | $P_{Y'}$ | $P_{Z'}$ | $M_{X'}$ | $M_{Y'}$ | $M_{Z'}$ |
| 3 | Max | 9,50 | 0,44 | 21,88 | 0,00 | 0,00 | 0,00 |
| 4 | Max | 0,33 | 3,40 | 18,88 | 0,00 | 0,00 | 0,00 |
| 7 | Max | 0,25 | 0,43 | 6,42 | 0,00 | 0,00 | 0,00 |
| 8 | Max | 0,35 | 5,91 | 18,85 | 0,00 | 0,00 | 0,00 |
| 123 | Max | 0,47 | 0,45 | 4,73 | 0,00 | 0,00 | 0,02 |
| 126 | Max | 9,09 | 0,45 | 16,65 | 0,00 | 0,00 | 0,02 |
| | | | | | | | |

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

The self weight of the Layher system will be partly subtracted from the uplift force.

The total weight of the Layer system is 65 kN. The weight of the Layher system which is taken into account is 45 kN, Because the middle of the stage will not help against uplift.  The 45 kN will be equally divided along the 6 points

Partial safety factor for the uplift $\gamma = 1.2$

Calculation

**Support A ( node 4 and 8 )**

$P_{z,\ min}$ = 18.88 kN

Ballast A = (18.88-7.5) * 1.2 = 13.6 kN ~ 1400 kg

**Support B ( node 3 and 7 )**

$P_{z,\ min}$ =21.88 kN

Ballast B = (21.88 -7.5) * 1.2 = 17.25 kN ~ 1750 kg

**Support C ( node 123 and 126 )**

$P_{z,\ min}$ = 16.65 kN

Ballast C = (16.65-7.5) * 1.2 = 10.98 kN ~1100 kg

## 6.6 Calculation of the system against overturning.

Results from the RFem program

| | Description | Value | Unit |
|---|---|---|---|
| | **LC1 - Self-weight** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | -19,95 | kN |
| | **CO150 - LC1 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,65 | kN |
| | Sum of loads in Z | 41,64 | kN |
| | **CO151 - LC1 + LC2 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,65 | kN |
| | Sum of loads in Z | 10,00 | kN |
| | **CO152 - LC1 + LC3 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,65 | kN |
| | Sum of loads in Z | 21,14 | kN |
| | **CO153 - LC1 + LC4 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,65 | kN |
| | Sum of loads in Z | 4,64 | kN |
| | **CO154 - LC1 + LC5 + LC10 + LC11 + LC12 + LC13** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 20,65 | kN |
| | Sum of loads in Z | -18,36 | kN |
| | **CO160 - LC1 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 21,10 | kN |
| | Sum of loads in Y | 4,76 | kN |
| | Sum of loads in Z | -15,39 | kN |
| | **CO161 - LC1 + LC2 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 21,10 | kN |
| | Sum of loads in Y | 4,76 | kN |
| | Sum of loads in Z | -47,03 | kN |
| | **CO162 - LC1 + LC3 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 21,10 | kN |
| | Sum of loads in Y | 4,76 | kN |

| | | | |
|---|---|---|---|
| | Sum of loads in Z | -35,89 | kN |
| | **CO163 - LC1 + LC4 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 21,10 | kN |
| | Sum of loads in Y | 4,76 | kN |
| | Sum of loads in Z | -52,39 | kN |
| | **CO164 - LC1 + LC5 + LC20 + LC21 + LC22 + LC23** | | |
| | Sum of loads in X | 21,10 | kN |
| | Sum of loads in Y | 4,76 | kN |
| | Sum of loads in Z | -75,39 | kN |
| | **CO170 - LC1 + LC30 + LC31 + LC32 + LC33** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -17,40 | kN |
| | **CO171 - LC1 + LC2 + LC30 + LC31 + LC32 + LC33** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -49,04 | kN |
| | **CO172 - LC1 + LC3 + LC30 + LC31 + LC32 + LC33** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -37,90 | kN |
| | **CO173 - LC1 + LC4 + LC30 + LC31 + LC32 + LC33** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -54,40 | kN |
| | **CO174 - LC1 + LC5 + LC30 + LC31 + LC32 + LC33** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -77,40 | kN |
| | **CO180 - LC1 + LC32 + LC33 + LC34 + LC35** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -46,32 | kN |
| | **CO181 - LC1 + LC2 + LC32 + LC33 + LC34 + LC35** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -77,96 | kN |
| | **CO182 - LC1 + LC3 + LC32 + LC33 + LC34 + LC35** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -66,82 | kN |
| | **CO183 - LC1 + LC4 + LC32 + LC33 + LC34 + LC35** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -83,32 | kN |
| | **CO184 - LC1 + LC5 + LC32 + LC33 + LC34 + LC35** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -20,67 | kN |
| | Sum of loads in Z | -106,32 | kN |
| | **CO250 - LC1 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | 52,94 | kN |
| | **CO251 - LC1 + LC2 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | 21,30 | kN |
| | **CO252 - LC1 + LC3 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | 32,44 | kN |
| | **CO253 - LC1 + LC4 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | 15,94 | kN |
| | **CO254 - LC1 + LC6 + LC110 + LC111 + LC112** | | |
| | Sum of loads in X | 0,00 | kN |

| | | | |
|---|---|---|---|
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | 8,94 | kN |
| | **CO255 - LC1 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | -59,83 | kN |
| | **CO256 - LC1 + LC2 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | -91,47 | kN |
| | **CO257 - LC1 + LC3 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | -80,33 | kN |
| | **CO258 - LC1 + LC4 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | -96,83 | kN |
| | **CO259 - LC1 + LC6 + LC112 + LC113 + LC114** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | 10,23 | kN |
| | Sum of loads in Z | -103,83 | kN |
| | **CO260 - LC1 + LC120 + LC121 + LC122** | | |
| | Sum of loads in X | 22,12 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | 38,81 | kN |
| | **CO261 - LC1 + LC2 + LC120 + LC121 + LC122** | | |
| | Sum of loads in X | 22,12 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | 7,17 | kN |
| | **CO262 - LC1 + LC3 + LC120 + LC121 + LC122** | | |
| | Sum of loads in X | 22,12 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | 18,31 | kN |
| | **CO263 - LC1 + LC4 + LC120 + LC121 + LC122** | | |
| | Sum of loads in X | 22,12 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | 1,81 | kN |
| | **CO264 - LC1 + LC6 + LC120 + LC121 + LC122** | | |
| | Sum of loads in X | 22,12 | kN |
| | Sum of loads in Y | 0,00 | kN |
| | Sum of loads in Z | -5,19 | kN |
| | **CO270 - LC1 + LC130 + LC131 + LC132** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | 52,94 | kN |
| | **CO271 - LC1 + LC2 + LC130 + LC131 + LC132** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | 21,30 | kN |
| | **CO272 - LC1 + LC3 + LC130 + LC131 + LC132** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | 32,44 | kN |
| | **CO273 - LC1 + LC4 + LC130 + LC131 + LC132** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | 15,94 | kN |
| | **CO274 - LC1 + LC6 + LC130 + LC131 + LC132** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | 8,94 | kN |
| | **CO275 - LC1 + LC132 + LC133 + LC134** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | -59,83 | kN |
| | **CO276 - LC1 + LC2 + LC132 + LC133 + LC134** | | |

| | | | |
|---|---|---|---|
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | -91,47 | kN |
| | **CO277 - LC1 + LC3 + LC132 + LC133 + LC134** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | -80,33 | kN |
| | **CO278 - LC1 + LC4 + LC132 + LC133 + LC134** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | -96,83 | kN |
| | **CO279 - LC1 + LC6 + LC132 + LC133 + LC134** | | |
| | Sum of loads in X | 0,00 | kN |
| | Sum of loads in Y | -10,23 | kN |
| | Sum of loads in Z | -103,83 | kN |

### 6.6.1 Calculation against overturning in the In-service situation

decisive load combination CO150

Self-weight of Layher stage = 65 kN
Wind on Stage 2 * 0.3 * 1.3 * 25 = 19.5 kN
Sum of load in Y direction = 20.65 kN
Sum of load in Z direction = 41.64 kN

Overturning moment
$M_{ov}$ = (19.5 * 2/2) + (20.65 * 10.5/2) + (41.64 * 10/2)=
$M_{ov}$ = 19.5 + 108.41 + 207.3 = 335.2 kNm
Stabilization moment
$M_{stab}$ = (65 * 10/2) + (2 * 13 * 9)
$M_{stab}$ = 325 + 234 = 559 kN

$M_{stab}$/ $M_{ov}$ = 559 / 335.2 = 1.66 > 1.2

### 6.6.2 Calculation against overturning in the Out-service situation

decisive load combination CO260

Self-weight of Layher stage = 65 kN
Wind on Stage 2 * 0.44 * 1.3 * 25 = 28.6 kN
Sum of load in X direction = 22.12 kN
Sum of load in Z direction = 38.81 kN

Overturning moment
$M_{ov}$ = (28.6 * 2/2) + (22.12 * 10.5/2) + (38.81 * 12/2)=
$M_{ov}$ = 28.6 + 116.13 + 232.86 = 377.59 kNm
Stabilization moment
$M_{stab}$ = (65 * 12/2) + ((14+17.5) * 12) + (11 * 8) + (11 * 6)
$M_{stab}$ = 96 + 224 + 88 + 66 = 474

$M_{stab}$/ $M_{ov}$ = 474 / 377.59 = 1.25 > 1.2

## 6.7 Ballast calculation against slipping

For the friction coefficient the factor of 0.4 has been taken into account according to the table below.

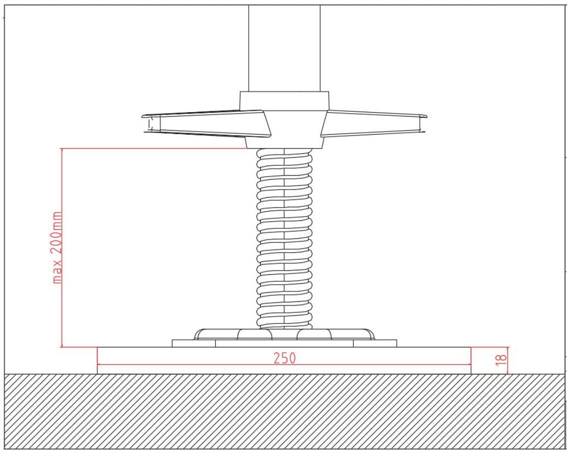



**Table 3 — Coefficients of friction $\mu$**

| | 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.

### 6.7.1 Ballast calculation against slipping In service

Decisive load combination is CO150
For the friction coefficient the factor of 0.4 has been taken into account.
Horizontal force = 20.65 kN
Uplift force = 41.64 kN
Self-weight Layher = 65 kN

Check
(ballast + Self-weight Layher– uplift force) * friction coefficient / wind loading > 1,2
( 2*14 + 2*17.5 + 2* 11 + 65 – 41.64) * 0.4 / 20.65 =
108.36 * 0.4 / 20.65 = 2.09 > 1.2

### 6.7.2 Ballast calculation against slipping In service

Decisive load combination is CO260
For the friction coefficient the factor of 0.4 has been taken into account.
Horizontal force = 22.12 kN
Uplift force = 38.81 kN
Self-weight Layher = 65 kN

Check
(ballast + Self-weight Layher– uplift force) * friction coefficient / wind loading > 1,2
( 2*14 + 2*17.5 + 2* 11 + 65 – 38.81) * 0.4 / 22.12 =
111.19 * 0.4 / 22.12 = 2.01 > 1.2

# 7.0 Appendixes and extra information

| | |
|---|---|
| Truss series | Prolyte H40V |
| Truss manufacturer | Prolyte Group |
| Truss series calculated by: | Krasenbrink + Bastians. |
| Structural report number: | 12500-4 |

Design internal forces for the complete truss

| | |
|---|---|
| Normal force main chord | +/- 50.22 kN |
| Normal force coupling system | +/- 52.58 kN |
| Normal force diagonals | +/- 13.39 kN |
| Bending moment $M_{yR,d}$ | 34.05 kNm |
| Bending moment $M_{zR,d}$ | 34.05 kNm |
| Normal Force $N_{R,d}$ | 200.86 kN |
| Transversal Force $V_{yr,d}$ | 18.94 kN |
| Transversal Force $V_{zr,d}$ | 18.94 kN |

Truss geometry

| | | | |
|---|---|---|---|
| Main chords | 48x3 | EN AW-6082T6 | |
| Diagonals | 20x2 | EN AW-6082T6 | |
| Coupling system | CCS6 | | |
| Height | 339 mm | | Centre to centre distance main chords |
| Width | 339 mm | | Centre to centre distance main chords |
| A | 16.96 $cm^2$ | | |
| $I_y$ | 4179.54 $cm^4$ | | |
| $I_z$ | 4179.54 $cm^4$ | | |
| $i_y$ | 15.70 cm | | |
| $i_z$ | 15.70 cm | | |
| $I_T$ | 900 $cm^4$ | | |

| | |
|---|---|
| Truss series | Prolyte H30V |
| Truss manufacturer | Prolyte Group |
| Truss series calculated by: | Krasenbrink + Bastians. |
| Structural report number: | 12500-2 |

Design internal forces for the complete truss

| | |
|---|---|
| Normal force main chord | +/- 50.22 kN |
| Normal force coupling system | +/- 52.58 kN |
| Normal force diagonals | +/- 10.42 kN |
| Bending moment $M_{yR,d}$ | 24.00 kNm |
| Bending moment $M_{zR,d}$ | 24.00 kNm |
| Normal Force $N_{R,d}$ | 200.86 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 | CCS6 | |
| Height | 239 mm | Centre to centre distance main chords |
| Width | 239 mm | Centre to centre distance main chords |
| A | 16.96 $cm^2$ | |
| $I_y$ | 2095.86 $cm^4$ | |
| $I_z$ | 2095.86 $cm^4$ | |
| $i_y$ | 11.12 cm | |
| $i_z$ | 11.12 cm | |
| $I_T$ | 500 $cm^4$ | |

| | |
|---|---|
| Truss series | Prolyte H30D |
| Truss manufacturer | Prolyte Group |
| Truss series calculated by: | Krasenbrink + Bastians. |
| Structural report number: | 12500-1 |

Design internal forces for the complete truss

| | |
|---|---|
| Normal force main chord | +/- 50.22 kN |
| Normal force coupling system | +/- 52.58 kN |
| Normal force diagonals | +/- 10.42 kN |
| Bending moment $M_{yR,d}$ | 10.39 kNm |
| Bending moment $M_{zR,d}$ | 12 kNm |
| Normal Force $N_{R,d}$ | 150.65 kN |
| Transversal Force $V_{yr,d}$ | 12.76 kN |
| Transversal Force $V_{zr,d}$ | 7.36 kN |

Truss geometry

| | | |
|---|---|---|
| Main chords | 48x3 | EN AW-6082T6 |
| Diagonals | 16x2 | EN AW-6082T6 |
| Coupling system | CCS6 | |
| Height | 207 mm | Centre to centre distance main chords |
| Width | 239 mm | Centre to centre distance main chords |
| A | 12.72 cm² | |
| $I_y$ | 1057.29 cm$^4$ | |
| $I_z$ | 1057.10 cm$^4$ | |
| $i_y$ | 9.12 cm | |
| $i_z$ | 9.11 cm | |
| $I_T$ | 150 cm$^4$ | |