Ingediende aanvraag/melding omgevingsvergunning

Formulierversie
2020.01

Aanvraaggegevens

Algemeen

Aanvraagnummer	6855961
Aanvraagnaam	ENS-ZL Aanpassen bestaande hoogspanningsmasten ZL
Uw referentiecode	-

Ingediend op	07-04-2022
Soort procedure	Reguliere procedure

Projectomschrijving	Het beperkt constructief aanpassen van tien hoogspanningsmasten in het kader van het project ENS-ZL 380kV.
Opmerking	Totale projectkosten zijn nog niet te geven. Zie voor een toelichting op de aanvraag bijlage 1.
Gefaseerd	Nee
Blokkerende onderdelen weglaten	Nee
Persoonsgegevens openbaar maken	Nee
Kosten openbaar maken	Nee
Bijlagen die later komen	bouwveiligheidsplan
Bijlagen n.v.t. of al bekend	nvt

Bevoegd gezag

Naam:	Gemeente Zwolle
Bezoekadres:	Lübeckplein 2 8017 JZ Zwolle
Postadres:	Postbus 10007 8000 GA Zwolle
Telefoonnummer:	14038
Faxnummer:	038 - 498 3379
E-mailadres:	omgevingsvergunning@zwolle.nl
Website:	www.zwolle.nl
Contactpersoon:	afdeling Vergunningen
Bereikbaar op:	werkdagen 9:00 - 17:00 uur

Overzicht bijgevoegde modulebladen

Aanvraaggegevens

Aanvragergegevens

Locatie van de werkzaamheden

Werkzaamheden en onderdelen

Overige veranderingen aan bestaande bouwwerken

- Bouwen

Bijlagen

Kosten

Aanvrager bedrijf

1 Bedrijf

KvK-nummer	09155985
Vestigingsnummer	000020300360
(Statutaire) naam	TenneT TSO B.V.
Handelsnaam	TenneT TSO

2 Contactpersoon

Geslacht	☑ Man ☐ Vrouw
Voorletters	
Voorvoegsels	-
Achternaam	
Functie	Adviseur vergunningen

3 Vestigingsadres bedrijf

Postcode	6812AR
Huisnummer	310
Huisletter	-
Huisnummertoevoeging	M01
Straatnaam	Utrechtseweg
Woonplaats	Arnhem

4 Correspondentieadres

Postbus	718
Postcode	6800AS
Plaats	Arnhem

5 Contactgegevens

Telefoonnummer	
Faxnummer	-
E-mailadres	

6 Akkoordverklaring

Akkoordverklaring	☑ Hierbij verklaar ik dat ik de aanvraag/melding naar waarheid heb ingevuld, dat ik correspondentie over mijn aanvraag/melding wil ontvangen op het door mij opgegeven e-mailadres of op het door mij opgegeven adres van de berichtenbox en dat ik weet dat er kosten verbonden kunnen zijn aan het indienen van een aanvraag.

Locatie

1 Kadastraal perceelnummer

Burgerlijke gemeente	Zwolle
Kadastrale gemeente	Zwolle
Kadastrale sectie	Y
Kadastraal perceelnummer	113
Bouwplannaam	-
Bouwnummer	-
Gelden de werkzaamheden in deze aanvraag/melding voor meerdere adressen of percelen?	☑ Ja ☐ Nee
Specificatie locatie	Voor een volledig overzicht van de kadastrale percelen, wordt verwezen naar bijlage 2.

2 Eigendomssituatie

Eigendomssituatie van het perceel	☐ U bent eigenaar van het perceel ☐ U bent erfpachter van het perceel ☐ U bent huurder van het perceel ☑ Anders
Uw belang bij deze aanvraag	Zakelijk recht overeenkomst

3 Toelichting

Eventuele toelichting op locatie	Het betreffen bestaande hoogspanningsmasten in een bestaande hoogspanningsverbinding.

Bouwen

Overige veranderingen aan bestaande bouwwerken

1 Woonboten en drijvende objecten

Betreft het bouwwerk een drijvend object?	☐ Ja ☑ Nee

2 Woning

Gaat het om de bouw van één of meer woningen?	☐ Ja ☑ Nee

3 De bouwwerkzaamheden

Wat is er op het bouwwerk van toepassing?	☐ Het wordt geheel vervangen ☑ Het wordt gedeeltelijk vervangen ☐ Het wordt nieuw geplaatst
Eventuele toelichting	Het betreft het uitwisselen/toevoegen van enkele stalen profielen in de mast en het vervangen van bijbehorende bouten. Het aanzicht en de kleur wijzigen hierbij niet of nauwelijks.
Hebt u voor deze bouwwerkzaamheden al eerder een vergunning aangevraagd?	☐ Ja ☑ Nee

4 Plaats van het bouwwerk

Waar gaat u bouwen?	Bijgebouw
Naam van het bijgebouw of bouwwerk	hoogspanningsmast

5 Seizoensgebonden en tijdelijke bouwwerken

Gaat het om een seizoensgebonden bouwwerk?	☐ Ja ☑ Nee
Gaat het om een tijdelijk bouwwerk?	☐ Ja ☑ Nee

6 Gebruik

Waar gebruikt u het bouwwerk en/of terrein momenteel voor?	☐ Wonen ☑ Overige gebruiksfuncties
Geef aan waar u het bouwwerk en/of terrein momenteel voor gebruikt.	hoogspanningsmast
Waar gaat u het bouwwerk voor gebruiken?	☐ Wonen ☑ Overige gebruiksfuncties
Geef aan waar u het bouwwerk voor gaat gebruiken.	hoogspanningsmast

7 Gebruiksfuncties

In onderstaande tabel staan in de eerste kolom mogelijke gebruiksfuncties die in een bouwwerk kunnen voorkomen. Vul voor alle gebruiksfuncties die voor u van toepassing zijn het aantal personen, de totale gebruiksoppervlakte en de totale vloeroppervlakte van het verblijfsgebied in m2 in hele getallen in.

Gebruiksfunctie	Aantal personen	Gebruiksoppervlakte (m2)	Verblijfsoppervlakte (m2)
Bijeenkomst	-	-	-
Cel	-	-	-
Gezondheidszorg	-	-	-
Industrie	-	-	-
Kantoor	-	-	-
Logies	-	-	-
Onderwijs	-	-	-
Sport	-	-	-
Winkel	-	-	-
Overige gebruiksfuncties	-	-	-

8 Uiterlijk bouwwerk/welstand

Beschrijf van de onderstaande onderdelen de materialen en kleuren die u voor het bouwwerk gebruikt. U mag het veld leeg laten als u materialen en kleuren in de bijlagen vermeldt

Onderdelen	Materiaal	Kleur
Gevels	-	-
- Plint gebouw	-	-
- Gevelbekleding	-	-
- Borstweringen	-	-
- Voegwerk	-	-
Kozijnen	-	-
- Ramen	-	-
- Deuren	-	-
- Luiken	-	-
Balkonhekken	-	-
Dakgoten en boeidelen	-	-
Dakbedekking	-	-

Vul hier overige onderdelen en bijbehorende materialen en kleuren in.

Metalen profielen mast. Kleur grijs (gelijk aan huidige kleur).

9 Mondeling toelichten

Ik wil mijn bouwplan mondeling toelichten voor de welstandscommissie/ stadsbouwmeester.

- ☐ Ja
- ☑ Nee

Bijlagen

Formele bijlagen

Naam bijlage	Bestandsnaam	Type	Datum ingediend	Status document
2__Kadastraal_Maste-nboek_v8_2_pdf	2. Kadastraal Mastenboek_v8.2.pdf	Anders	07-04-2022	In behandeling
3__Overzicht_masten-_pdf	3. Overzicht masten.pdf	Anders	07-04-2022	In behandeling
4_2_DO_Mast_HB--3_R_-X_pdf	4.2 DO Mast HB-3 R_X.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
4_3_DO_Mast_HA--6_RC-_pdf	4.3 DO Mast HA-6_RC.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
4_4_DO_Mast_S_-15_R_pdf	4.4 DO Mast S_15_R.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
4_5_DO_Mast_EC--3_R_pdf	4.5 DO Mast EC-3_R.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_1_1_S-6R_Mast_Ove-rzichtstek_pdf	5.1.1 S-6R Mast Overzichtstek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_1_2_S-6R_Mast_Ond-erdeeltek_pdf	5.1.2 S-6R Mast Onderdeeltek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_1_3_S-6R_Mast_Lij-sten_pdf	5.1.3 S-6R Mast Lijsten.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_1_4_S-6R_Mast_Det-ailberek_pdf	5.1.4 S-6R Mast Detailberek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en	07-04-2022	In behandeling

Naam bijlage	Bestandsnaam	Type	Datum ingediend	Status document
		detailtekeningen bouwen complexere bouwwerken		
5_2_1_HB-3R_Mast_51-_Overzichtstek_pdf	5.2.1 HB-3R Mast 51 Overzichtstek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_2_2_HB-3R_Mast_51-_Onderdeeltek_pdf	5.2.2 HB-3R Mast 51 Onderdeeltek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_2_3_HB-3R_Mast_51-_Lijsten_pdf	5.2.3 HB-3R Mast 51 Lijsten.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_2_4_HB-3R_Mast_51-_Detailberek_pdf	5.2.4 HB-3R Mast 51 Detailberek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
_3_1_HA-6RC_Mast_82-_88_Overzichtstek_pdf	5.3.1 HA-6RC Mast 82_88 Overzichtstek.-pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_3_2_HA-6RC_Mast_8-2_88_Onderdeeltek_pdf	5.3.2 HA-6RC Mast 82_88 Onderdeeltek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_3_3_HA-6RC_Mast_8-2_88_Lijsten_pdf	5.3.3 HA-6RC Mast 82 88 Lijsten.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_3_4_HA-6RC_Mast_8-2_88_Detailberek_pdf	5.3.4 HA-6RC Mast 82_88 Detailberek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_4_1_S_15R_Mast_89-_Overzichtstek_pdf	5.4.1 S_15R Mast 89 Overzichtstek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_4_2_S_15R_Mast_89-_Onderdeeltek_pdf	5.4.2 S_15R Mast 89 Onderdeeltek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_4_3_S_15R_Mast_89-_Lijsten_pdf	5.4.3 S_15R Mast 89 Lijsten.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling

Naam bijlage	Bestandsnaam	Type	Datum ingediend	Status document
5_4_4_S_15_R_Mast_8-9_Detailberek_pdf	5.4.4 S_15 R Mast 89 Detailberek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_5_1_EC-3_RX_Mast_-90_Overzichtstek_pdf	5.5.1 EC-3 RX Mast 90 Overzichtstek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_5_2_EC-3_RX_Mast_-90_Onderdeeltek_pdf	5.5.2 EC-3 RX Mast 90 Onderdeeltek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_5_3_EC-3_RX_Mast_-90_Lijsten_pdf	5.5.3 EC-3 RX Mast 90 Lijsten.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
5_5_4_EC-3_RX_Mast_-90_Detailberek_pdf	5.5.4 EC-3 RX Mast 90 Detailberek.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling
6__Archeologie_Zwol-le_pdf	6. Archeologie Zwolle.pdf	Anders	07-04-2022	In behandeling
7__Verk_Natuuronder-zoek_ZL-ENS_pdf	7. Verk Natuuronderzoek ZL-ENS.pdf	Anders	07-04-2022	In behandeling
8__Voortoets_werkza-amh_Zwolle--Ens_pdf	8. Voortoets werkzaamh Zwolle-Ens.pdf	Anders	07-04-2022	In behandeling
1__begeleidend_schr-ijven_Zwolle_pdf	1. begeleidend schrijven Zwolle.pdf	Anders	07-04-2022	In behandeling
4_1_DO_Mast_S--6_R_pdf	4.1 DO Mast S-6 R.pdf	Constructieve veiligheid complexere bouwwerken Plattegronden, doorsneden en detailtekeningen bouwen complexere bouwwerken	07-04-2022	In behandeling

Kosten

Bouwen

Overige veranderingen aan bestaande bouwwerken

Wat zijn de geschatte kosten in euro's (exclusief BTW)?	101000

Projectkosten

Wat zijn de geschatte kosten voor het totale project in euro's (exclusief BTW)?	101000

Postbus 718, 6800 AS Arnhem, Nederland

Gemeente Zwolle
T.a.v. college van burgemeester en wethouders
Postbus 10007
8000 GA ZWOLLE
Nederland

CLASSIFICATIE C1 - Publieke Informatie
DATUM 1 april 2022
ONZE REFERENTIE 002.515.20 1011146
BEHANDELD DOOR
TELEFOON DIRECT
E-MAIL

BETREFT Aanvraag omgevingsvergunning bouwen t.b.v. Ens-Zwolle 380 kV

Geacht college,

Hierbij vraagt TenneT TSO B.V. (hierna: TenneT) een omgevingsvergunning onderdeel bouwen aan voor het constructief aanpassen van bestaande 380 kV hoogspanningsmasten van de verbinding Ens – Zwolle 380kV binnen de gemeente Zwolle.

1. Achtergrond

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat een grotere transportcapaciteit mogelijk wordt gemaakt. Om die reden is TenneT voornemens de bestaande landelijke 380 kV ring, de 'ruggengraat' van het landelijk hoogspanningsnet, op te waarderen. Dit gebeurt binnen het programma Beter Benutten Bestaande 380 kV. Binnen het betreffende programma valt ook het deelproject Opwaardering 380 kV-verbinding Ens - Zwolle (ENS-ZL).
Het opwaarderen van de 380kV ring, inclusief de hieronder vallende deelprojecten vallen onder de Rijkscoördinatieregeling.

2. Werkzaamheden

Voor de opwaardering van de bestaande 380 kV verbinding ENS-ZL moeten diverse werkzaamheden worden uitgevoerd. In de basis betreft dit het ophangen van nieuwe HTLS (High Temperature Low Sag) geleiders met een hogere transportcapaciteit dan de huidige geleiders. De nieuwe geleiders zijn qua omvang en aantal gelijk aan de bestaande maar kunnen meer stroom transporteren, doordat ze hogere temperaturen kunnen weerstaan zonder te ver door te gaan hangen. De huidige hoogspanningsverbinding is bovendien inmiddels 35 jaar oud. Om deze reden worden ook andere onderdelen, zoals de isolatorkettingen en bliksemdraden als levensduur verlengende activiteit vervangen. In het kader van deze -niet omgevingsvergunningplichtige werkzaamheden - worden ook de hoogspanningsmasten en de mastfunderingen opnieuw constructief beschouwd.

Deze aanvraag omgevingsvergunning, onderdeel bouwen, heeft betrekking op het constructief aanpassen van 10 mastlichamen. Hieronder worden deze werkzaamheden toegelicht.

2.1 Aanpassingen mastlichaam
Per masttype is een constructieve controle uitgevoerd. Op basis hiervan is gebleken of- en in welke mast aanpassingen moeten plaatsvinden. Hiervan wordt vervolgens per masttype een detailontwerp gemaakt van de aanpassingen.
De aanpassingen van het mastlichaam bestaan op hoofdlijnen uit onderstaande werkzaamheden waarbij de hoofdopzet en de uitstraling van de masten niet wijzigt.
- Bouten vervangen
- Mastprofielen uitwisselen en/of toevoegen
- Knikverkorters toevoegen

Een overzicht met de aanpassingen per mast is opgenomen in bijlage 3 en de berekening van de mastconstructies in bijlagen 4.
Nadat alle werkzaamheden zijn uitgevoerd worden de masten waar nodig lokaal bijgewerkt met schilderwerk in de bestaande kleur.

2.2 Aanpassingen funderingen
Naast het aanpassen van de mastlichamen kan ook het aanpassen van de fundering aan de orde zijn. Per mastfundering is een constructieve controle uitgevoerd (bijlagen 9 t/m 11). Op basis hiervan is gebleken óf en hoe de aanpassingen moeten plaatsvinden. Hiervan is vervolgens een detailontwerp gemaakt van de aanpassingen.

De aanpassingen van de funderingen bestaan uit het toevoegen van extra ballast aan de bestaande poeren. Er hoeven geen heipalen te worden bijgeplaatst. Het ontwerp hiervoor is in 5 op UO niveau uitgewerkt.

2.3 Archeologie
Ter plaatse van de werkzaamheden van de verbinding KIJ-GT is een archeologisch onderzoek uitgevoerd. Er is geen noodzaak tot vervolgonderzoek. Het uitgevoerde archeologische onderzoek betreffende gemeente Molenlanden is bijgevoegd in bijlage 6.

2.4 Natuur
Adviesbureau Sweco heeft in 2021 onderzoek gedaan naar de aanwezigheid van beschermde flora en fauna op het tracé. Tevens zijn in het onderzoek de effecten ten aanzien van Natura 2000-gebieden onderzocht. Op basis van het uitgevoerde natuuronderzoek is geconcludeerd dat in één mast van de verbinding ENS-ZL (mast 50, gemeente Zwolle) een jaarrond bescherm nest aanwezig is. Hiervoor is een ontheffing voor soortenbescherming in het kader van de Wet natuurbescherming (Wnb) aangevraagd. Opgemerkt wordt hierbij dat er in de loop van 2022 nog verder onderzoek zal plaatsvinden naar nesten in masten omdat de werkzaamheden pas in de loop van 2023 van start zullen gaan. Dit omdat er anders 2 broedseizoenen zitten tussen het eerste onderzoek en realisatie.
Het uitgangspunt is dat er met een werkprotocol zodanig gewerkt kan worden, dat nesten zo veel mogelijk behouden kunnen blijven en niet verstoord worden. Indien er uit het nader onderzoek (blijkt dat er toch andere jaarrond beschermde nesten verstoord of (tijdelijk) verwijderd moeten worden, dan zal hiervoor later zo nodig aanvullend een ontheffing worden aangevraagd. Het uitvoeren van de werkzaamheden zal verder

onder ecologische begeleiding worden uitgevoerd.
Een vergunning voor gebiedsbescherming in het kader van de Wnb is niet noodzakelijk. Het ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV) is op grond van artikel 1.3 lid 5 van de Wnb bevoegd gezag.

3. Vergunning en procedures

3.1 Omgevingsvergunning

Voor de werkzaamheden als benoemd in paragraaf 2 vraagt TenneT een omgevingsvergunning aan voor de volgende in de Wet algemene bepalingen omgevingsrecht (Wabo) genoemde activiteiten:

- het bouwen van een bouwwerk (veranderen), artikel 2.1 lid 1 onder a Wabo.

3.2 Rijkscoördinatieregeling

Ten aanzien van uw besluit op deze aanvraag ingevolge artikel 2.1 van de Wet algemene bepalingen omgevingsrecht is op grond van artikel 20c Elektriciteitswet j° artikel 2 lid 1 onder a Uitvoeringsbesluit Rijkscoördinatieregeling energie-infrastructuurprojecten de Rijkscoördinatieregeling uit de Wet op de ruimtelijke ordening van toepassing (artikel 3.35). Hierbij is de minister van Economische Zaken de aangewezen minister voor de coördinatie van de besluiten.
In verband daarmee heeft de minister van Economische Zaken ons gevraagd het volgende op te nemen in deze aanvraag:
1. Ingevolge de Rijkscoördinatieregeling dient u een kopie van onderhavige aanvraag te verzenden aan de minister van Economische Zaken. TenneT zal er echter voor zorgen dat de minister van Economische Zaken een exemplaar van deze aanvraag ontvangt. U hoeft dus geen exemplaar door te sturen.
2. In reactie op deze kopie van de aanvraag zal de minister u per brief melden wanneer van u verwacht wordt een ontwerpbesluit gereed te hebben.
3. U wordt verzocht het ontwerpbesluit en later ook het besluit aan de minister van Economische Zaken te verzenden. Deze zal het besluit doorzenden naar TenneT.

3.3 Uitgestelde gegevensverstrekking

Onder verwijzing naar artikel 2.7 van de Regeling omgevingsrecht (Mor) verzoeken wij u om in uw besluit te bepalen dat de in artikel 2.7 lid 1 en 3 Mor bedoelde gegevens uiterlijk 3 weken voorafgaand aan de start van de werkzaamheden van de mastaanpassing of fundering, ter goedkeuring zullen worden aangeleverd. Het gaat in ieder geval om de volgende gegevens:

- (Bouw)veiligheidsplan.

3.4 Bouwkosten voor legesbepaling

Een inschatting van de bouwkosten ten behoeve van legesbepaling is op basis van ervaringen met andere projecten door onze cost-engineer ingeschat. Zodra het werk is aanbesteed (eind 2022) zijn definitieve bedragen beschikbaar.

4. Werkproces en overige vergunningen

Voor het feitelijk uitvoeren van de werkzaamheden zullen nog diverse andere vergunningen en meldingen benodigd zijn. Te denken is hierbij aan kruisingen met (spoor)wegen en waterwegen, bemaling, uitritten etc. Voor deze aanvragen of meldingen zijn veel details nodig die door de aannemer worden uitgewerkt. Het aanvragen van deze vergunningen/meldingen zal daarom grotendeels op een later tijdstip door de aannemer worden gedaan.
Met de eigenaren van de gronden waarop de masten staan heeft TenneT privaatrechtelijke overeenkomsten gesloten. De werkzaamheden worden in nauw overleg met alle rechthebbenden uitgevoerd.

4.1 Planning

Volgens de huidige inzichten zullen de werkzaamheden in het tweede kwartaal van 2023 starten.

4.2 Omgevingsveiligheid

Aannemers worden contractueel verplicht te werken volgens de veiligheidsvoorschriften van TenneT, te weten:
- "General SHE requirements for contractors, referentie SSC 15-037"
- "Operational SHE requirements for contractors – Onshore NL, referentie SSC 16-004"
(https://www.tennet.eu/nl/bedrijf/safety-bij-tennet/safety-publicaties/)

5. Ondertekening

Wij verzoeken u de vergunning op naam te stellen van TenneT TSO B.V.

Wij verzoeken u alle inhoudelijke correspondentie met betrekking tot deze aanvraag te richten aan:

TenneT TSO B.V.

Postbus 718
6800 AS Arnhem

Wij verzoeken u het ontwerpbesluit en het definitieve besluit te zenden naar:

Ministerie van Economische Zaken
T.a.v. Bureau Energieprojecten
Postbus 93144
2509 AC Den Haag

Met vriendelijke groet,
TenneT TSO B.V.

Bijlagenblad

1. Brief / begeleidend schrijven
2. Mastenboek voorzien van Kadastrale gegevens (gehele verbinding)
3. Overzicht van aan te passen masten
4. Gegevens DO per masttype
5. Gegevens UO per masttype
6. Archeologisch onderzoek
7. Natuuronderzoek, verkennend
8. Natuuronderzoek, voortoets

Bijlagenoverzicht

1. Brief / begeleidend schrijven
2. Mastenboek voorzien van Kadastrale gegevens (gehele verbinding)
3. Overzicht van aan te passen masten
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5. Gegevens UO per masttype
6. Archeologisch onderzoek
7. Natuuronderzoek, verkennend
8. Natuuronderzoek, voortoets

Bijlage 2

Kadastraal Mastenboek

Beter Benutten

Mastenboek Ens - Zwolle

kaart 1

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

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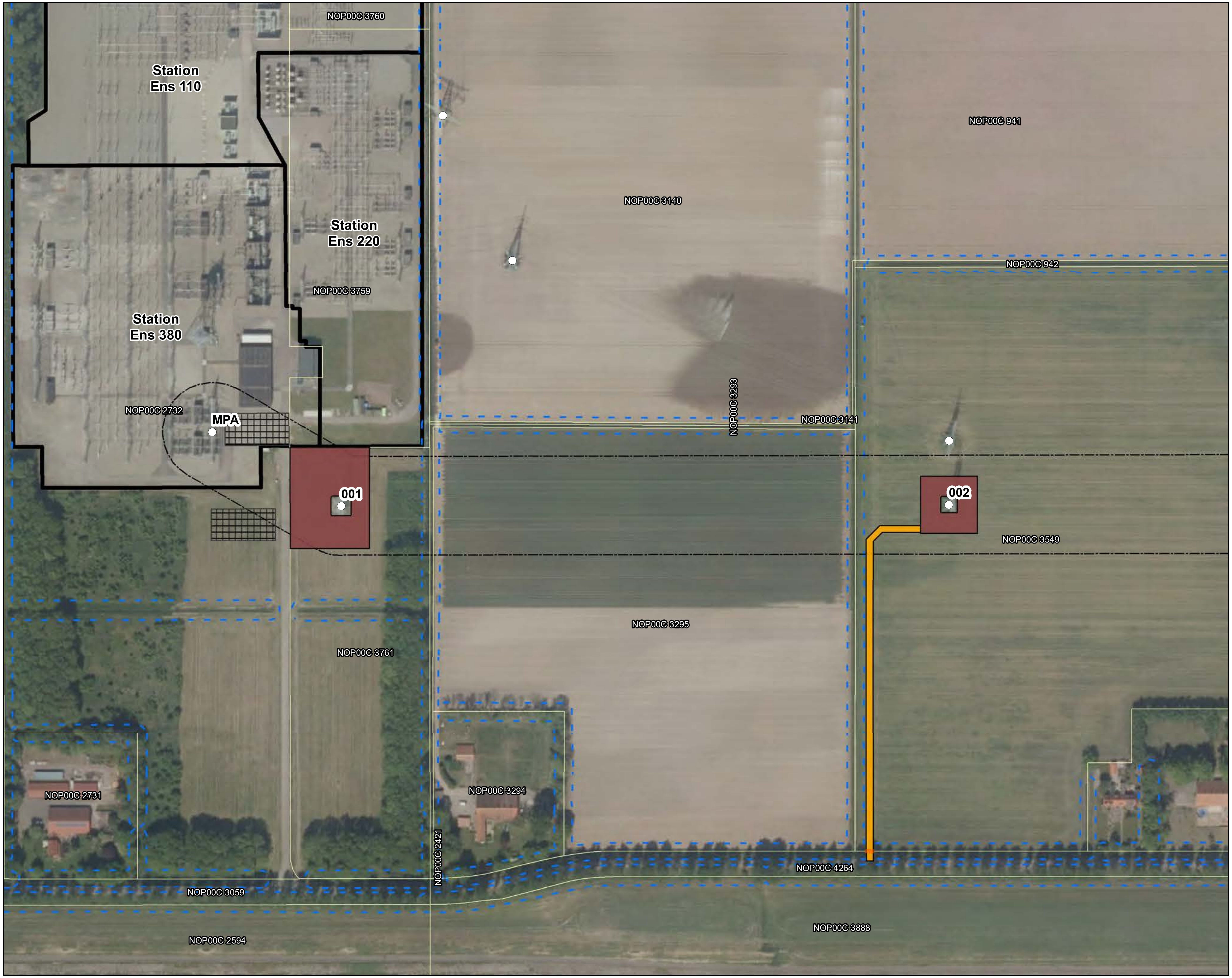

Beter Benutten

Mastenboek Ens - Zwolle

kaart 2

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
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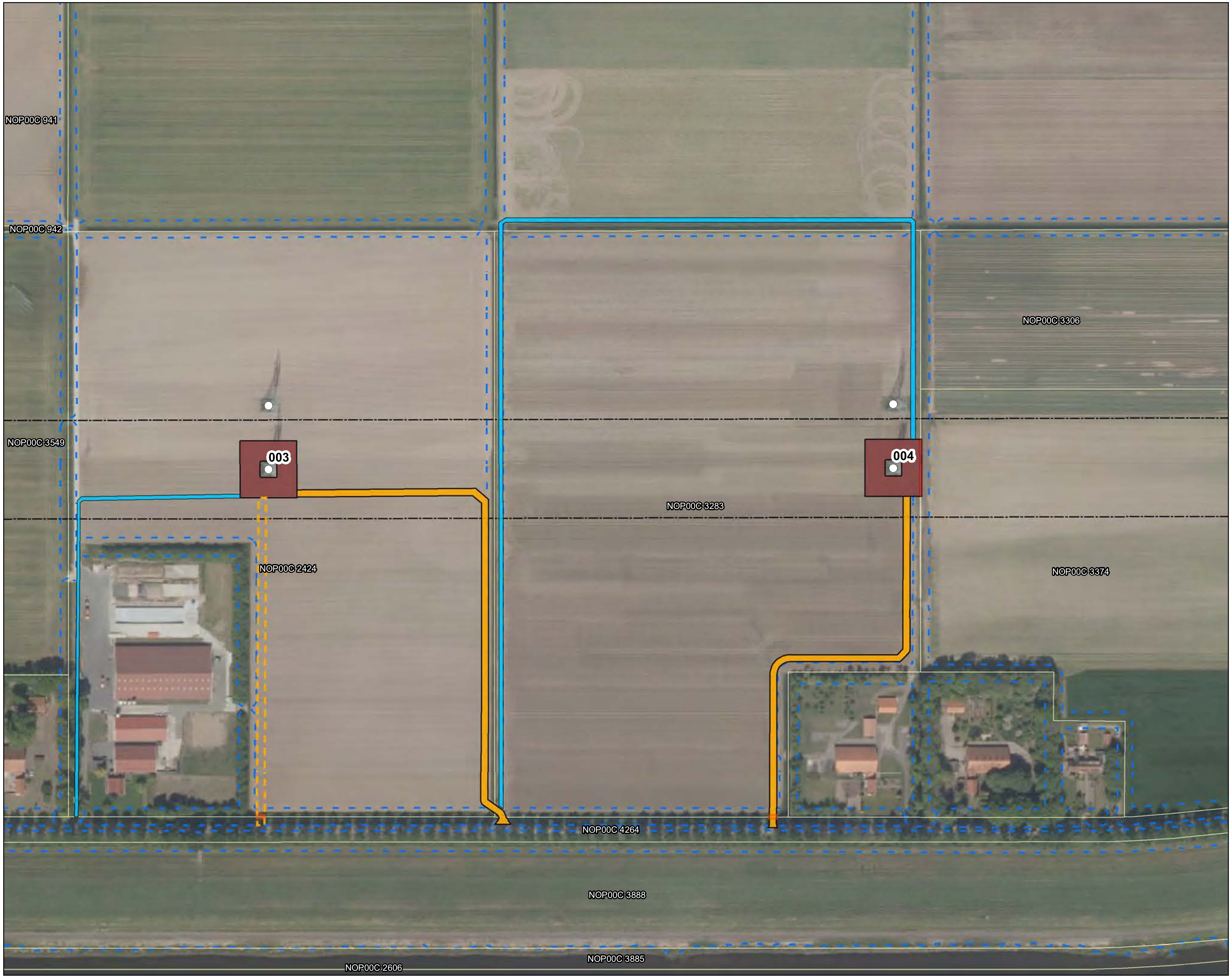
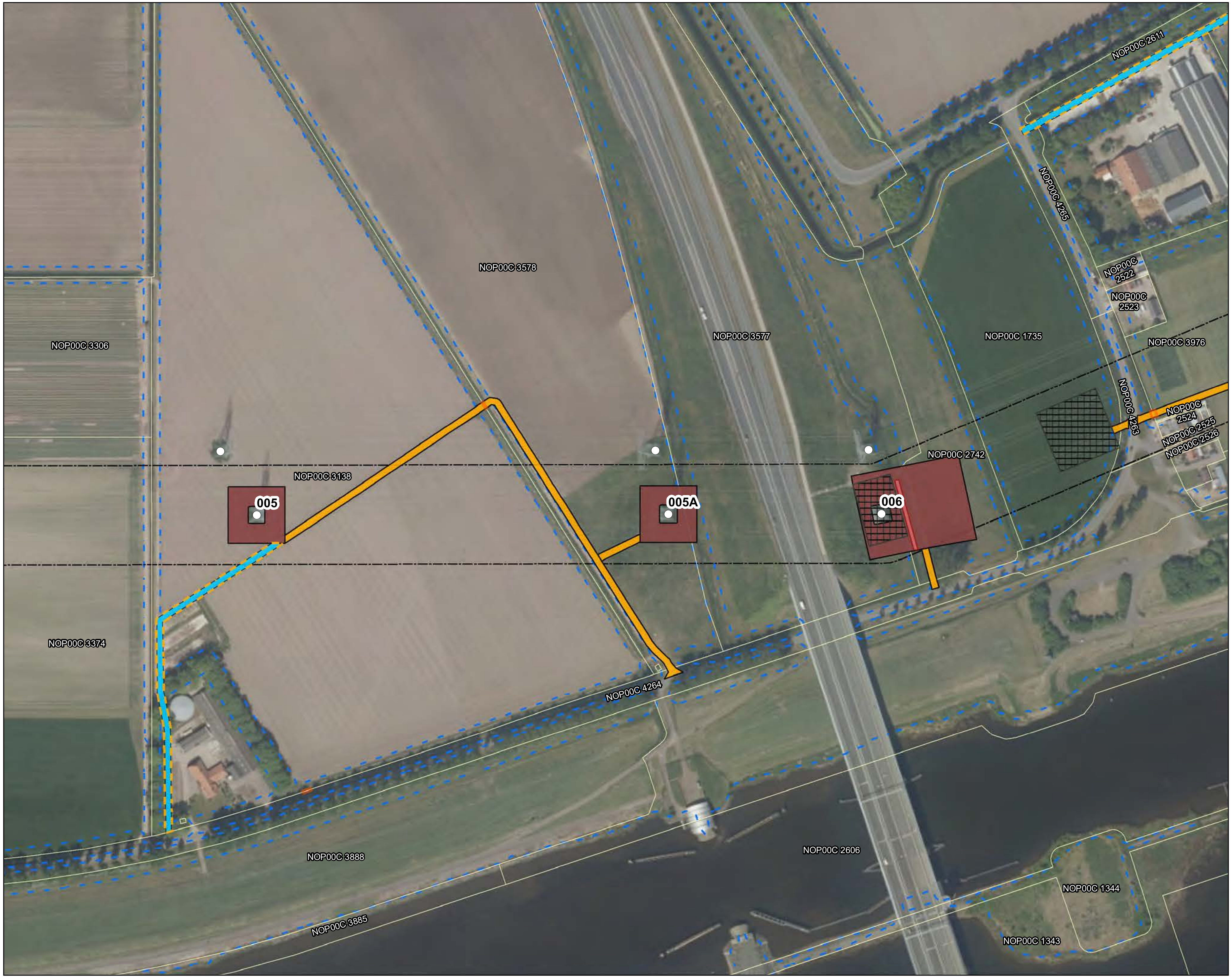


Beter Benutten	Mastenboek Ens - Zwolle	kaart 3

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel



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Kenmerk	[illegible]		

0 20 40 60 80 100 m. N

Beter Benutten | Mastenboek Ens - Zwolle | kaart 4

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

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Beter Benutten

Mastenboek Ens - Zwolle

kaart 5

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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0 20 40 60 80 100 m.

N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 6

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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0 20 40 60 80 100 m. N

Beter Benutten **Mastenboek Ens - Zwolle** **kaart 7**

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

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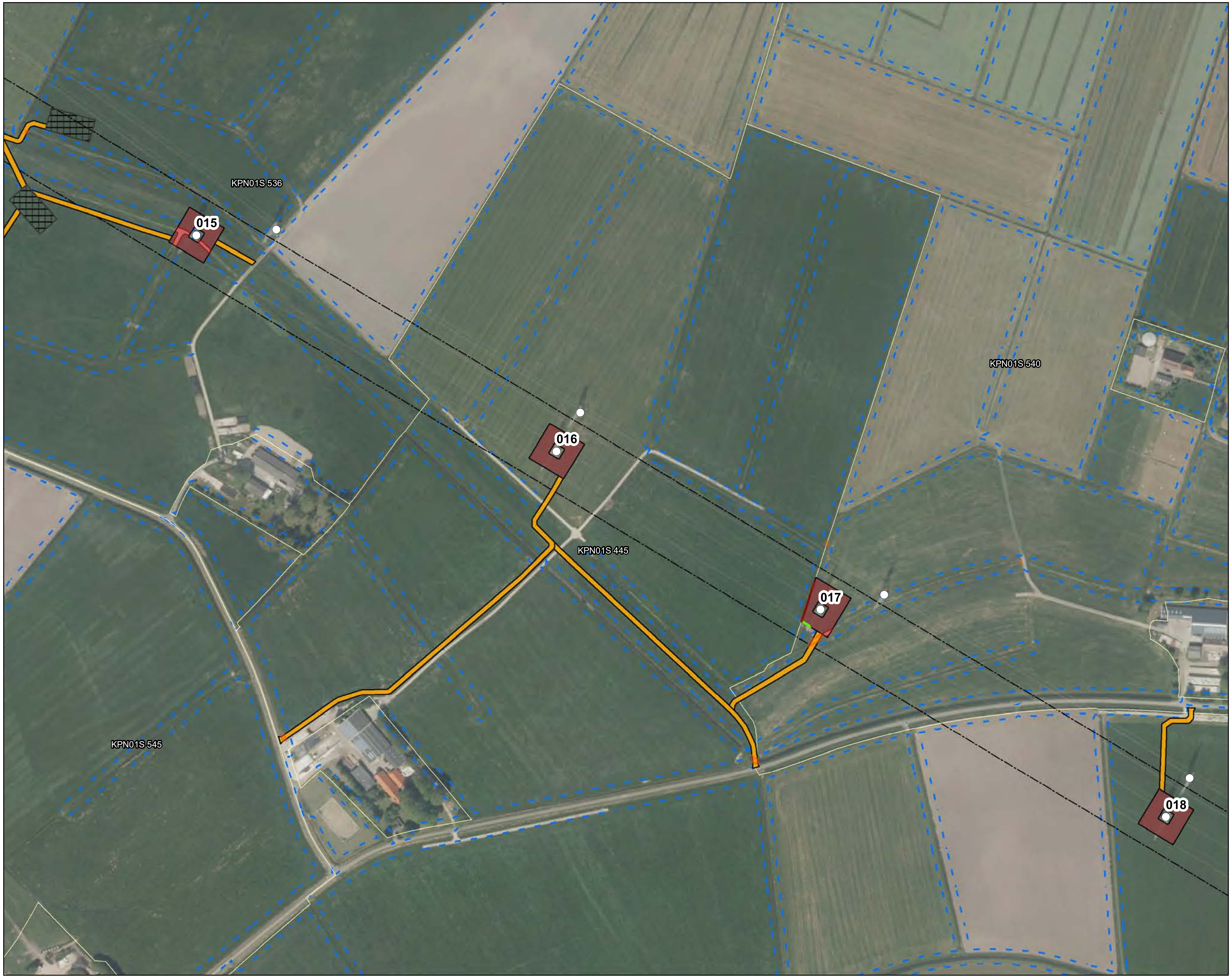
Beter Benutten

Mastenboek Ens - Zwolle

kaart 8



Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
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0 20 40 60 80 100 m.

N

Beter Benutten — Mastenboek Ens - Zwolle — kaart 9

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
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Beter Benutten — Mastenboek Ens - Zwolle — kaart 10

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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0 20 40 60 80 100 m.

N

Beter Benutten   Mastenboek Ens - Zwolle   kaart 11

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
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0 20 40 60 80 100 m. N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 13

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

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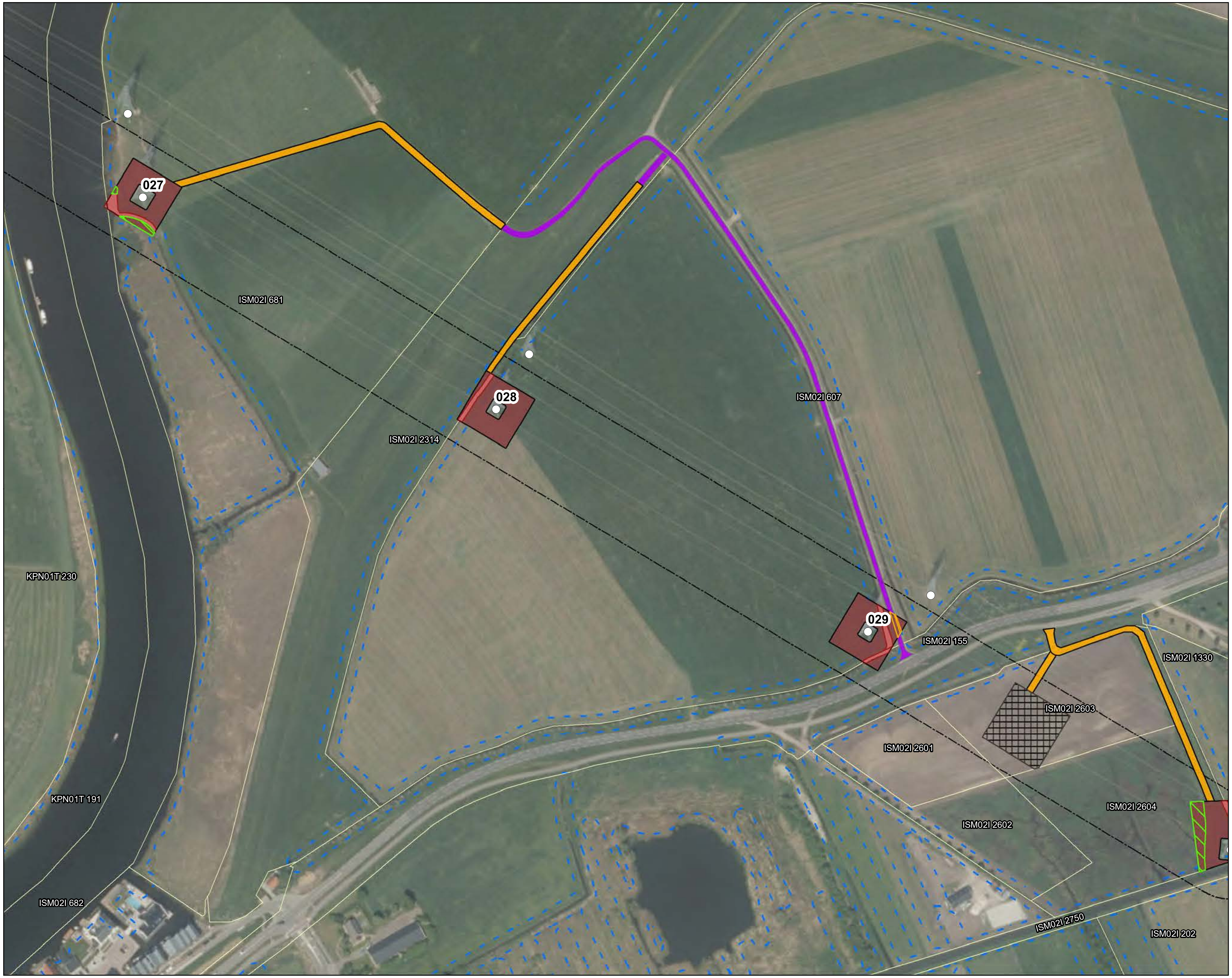

Beter Benutten — Mastenboek Ens - Zwolle — kaart 14

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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0 20 40 60 80 100 m. N

Beter Benutten   Mastenboek Ens - Zwolle   kaart 15

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
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0 20 40 60 80 100 m.

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Beter Benutten — Mastenboek Ens - Zwolle — kaart 16

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Beter Benutten | Mastenboek Ens - Zwolle | kaart 18

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
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0 20 40 60 80 100 m.

N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 19

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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0 20 40 60 80 100 m. N

Beter Benutten **Mastenboek Ens - Zwolle** **kaart 20**

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
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0 20 40 60 80 100 m.

N

Beter Benutten   Mastenboek Ens - Zwolle   kaart 21

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

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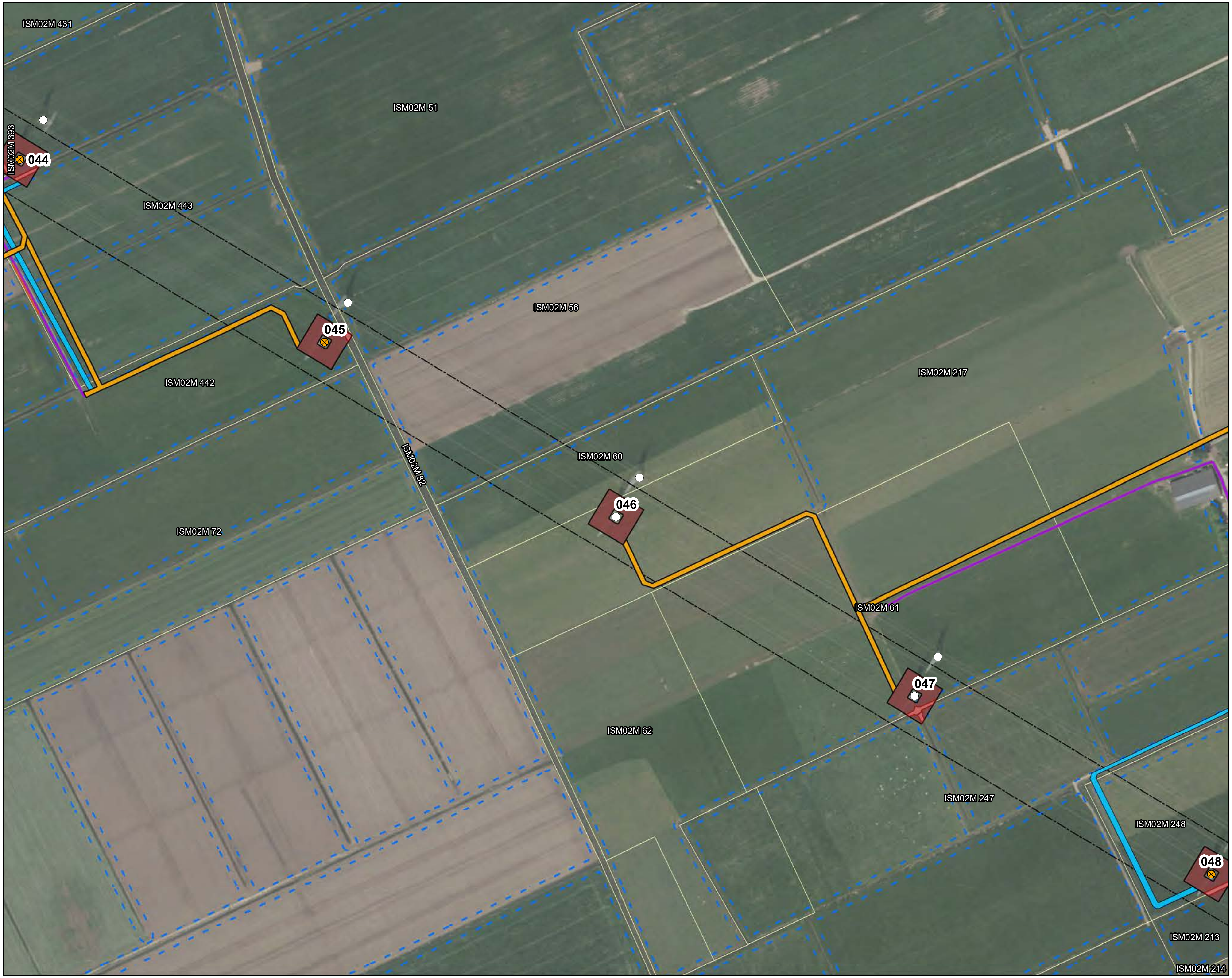

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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0 20 40 60 80 100 m. N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 23

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\ 220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m. N

Beter Benutten   Mastenboek Ens - Zwolle   kaart 24

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 25

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m. N

Beter Benutten — Mastenboek Ens - Zwolle — kaart 26

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m.

N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 27

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m. N

Beter Benutten **Mastenboek Ens - Zwolle** **kaart 28**

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\ 220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m. N

Beter Benutten — Mastenboek Ens - Zwolle — kaart 29

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m.

N

Beter Benutten — Mastenboek Ens - Zwolle — kaart 30

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\ 220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m.

N

Beter Benutten — Mastenboek Ens - Zwolle — kaart 31

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

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Beter Benutten

Mastenboek Ens - Zwolle

kaart 32

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m.

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Beter Benutten — Mastenboek Ens - Zwolle — kaart 33

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk	J:\GisData\p_overig\Beter benutten bestaande 380kV\Producten\ENS-ZL\producten\mastenboek\220209_ENS-ZL_Mastenboek_v8.2_GertJan.mxd		

0 20 40 60 80 100 m. — N

Beter Benutten   Mastenboek Ens - Zwolle   kaart 34

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
Kenmerk			

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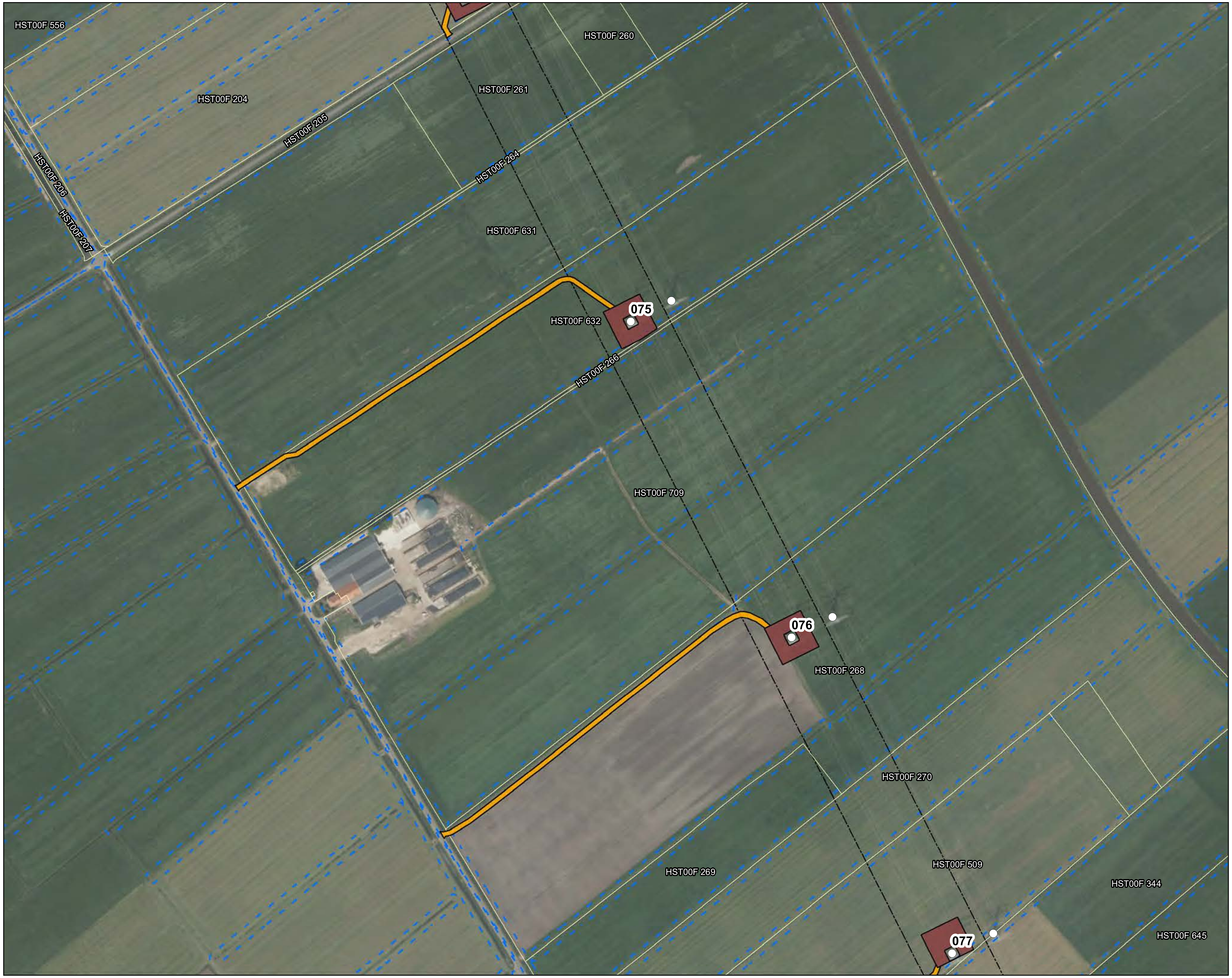

Beter Benutten | Mastenboek Ens - Zwolle | kaart 35

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m. N

Beter Benutten — Mastenboek Ens - Zwolle — kaart 36

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
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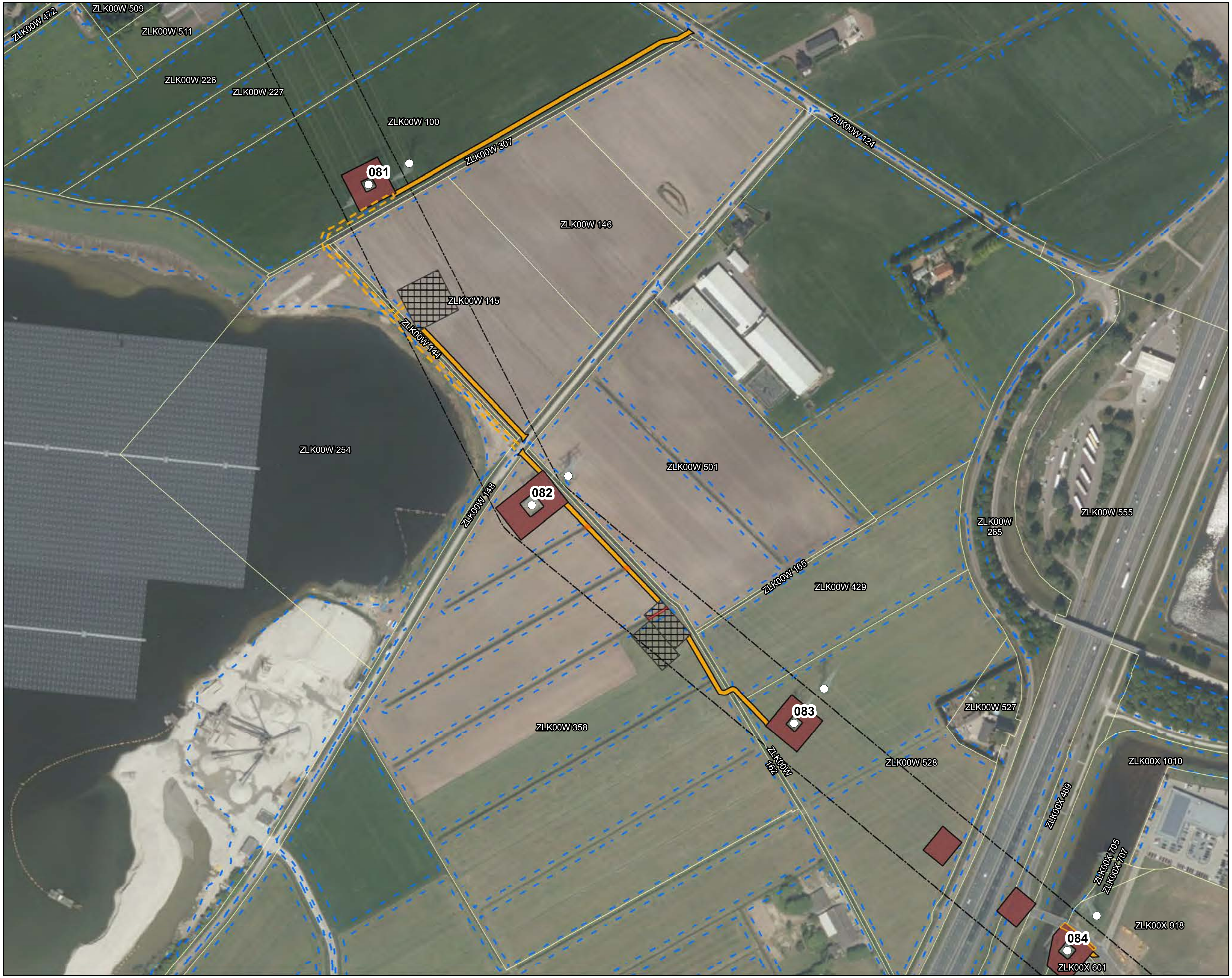
Beter Benutten **Mastenboek Ens - Zwolle** **kaart 37**

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel



Versie	8.2	Datum	10-2-2022
Schaal	1:3.500	Formaat	A3
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Beter Benutten

Mastenboek Ens - Zwolle

kaart 38

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m. N

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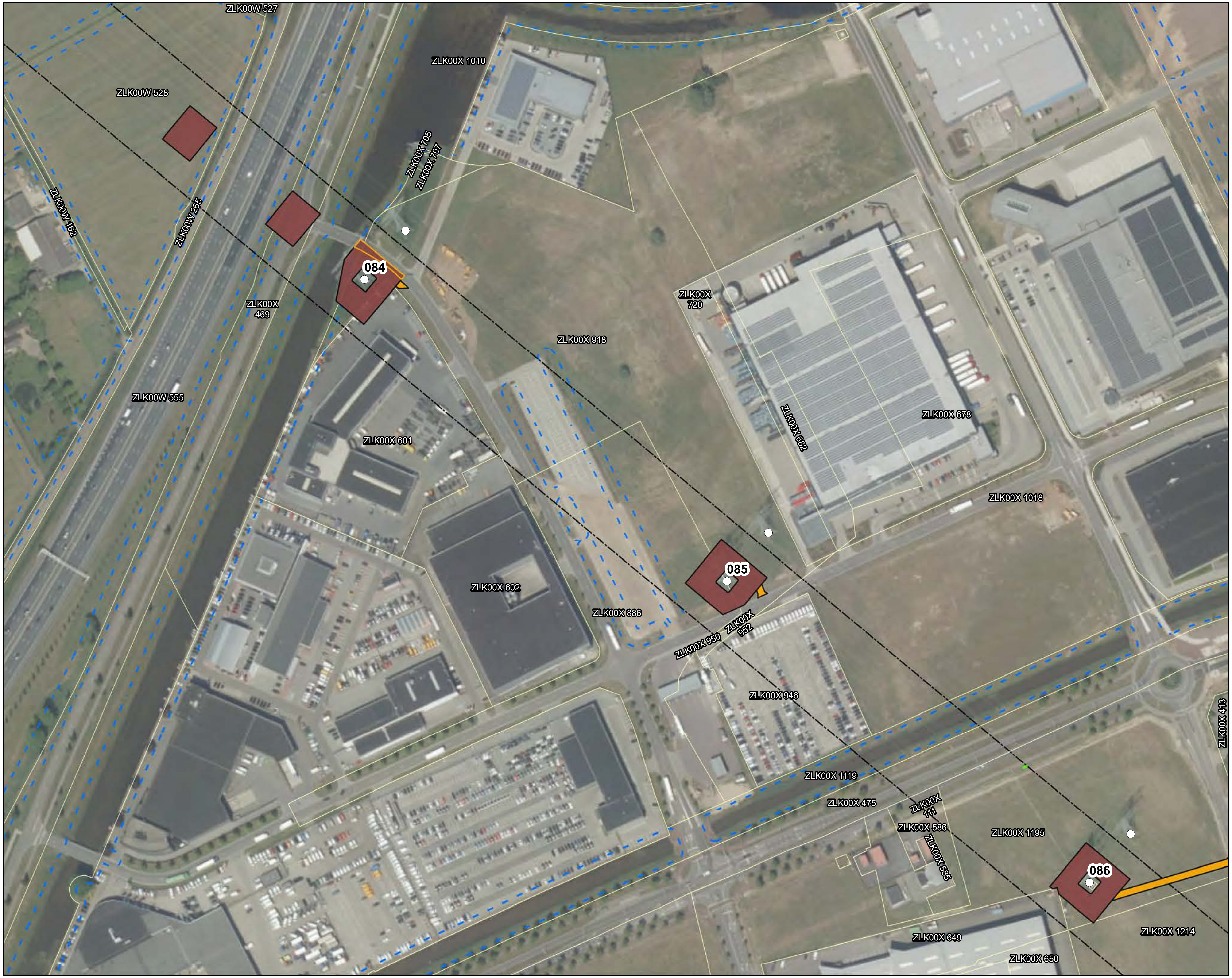

Beter Benutten   Mastenboek Ens - Zwolle   kaart 39

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 40

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Beter Benutten

Mastenboek Ens - Zwolle

kaart 41

Legenda

- Mastfundering aanpassen
- Mastfundering niet aanpassen
- Zakelijk rechtstrook
- Station
- Mogelijk snoeien
- Op weg of spoorweg
- Op water
- Over water
- Werkterrein Mast
- Werkterrein Lierlocatie
- Ruimtereservering werkweg
- Aan te leggen dijk (rijbaan)
- Route optionele werkweg
- Bestaande weg / verharding benutten
- Ruimtereservering aanrijroute (nat weer)
- Aanrijroute (t.b.v. onderzoek / en indien geen werkweg
- Zonnepark
- Waterbuffer (5m afstand)
- 1234 Kadastraal perceel

Versie	8.2	Datum	10-2-2022
Schaal	1:2.500	Formaat	A3
Kenmerk			

0 20 40 60 80 100 m.

N

Bijlage 3

Overzicht Masten

mastnummer	masttype	aanpassen mast	aanpassen fundering	gemeente
portaal ENS	Portaal	nee		Noordoostpolder
1	EC-3 RX	ja		Noordoostpolder
2	S-3	n		Noordoostpolder
3	S-3	n		Noordoostpolder
4	S-3	n		Noordoostpolder
5	S-3	n		Noordoostpolder
5a	S+6	nee		Noordoostpolder
6	HB-3 RX	ja		Noordoostpolder
7	S+0	n		Noordoostpolder
8	S+0	n		Noordoostpolder
9	S+0	n		Noordoostpolder
10	HC-3 RII	ja		Noordoostpolder
11	S+30	n		Noordoostpolder
12	S+30	n		Noordoostpolder
13	S+0	n		Kampen
14	HA-3	nee		Kampen
15	S-3	n		Kampen
16	S-3	n		Kampen
17	S-3	n		Kampen
18	S-3	n		Kampen
19	S-6 R	ja		Kampen
20	S-6 R	ja		Kampen
21	S-6 R	ja		Kampen
22	S-6 R	ja		Kampen
23	S-6 R	ja		Kampen
24	S-6 R	ja		Kampen
25	S-6 R	ja		Kampen
26	S+12	n		Kampen
27	S+12	n		Kampen
28	S-6 R	ja		Kampen
29	S-6 R	ja		Kampen
30	HC-3 R	ja		Kampen
31	S-3	n		Kampen
32	S+0	n		Kampen
33	S+0	n		Kampen
34	HC-3 R	ja		Kampen
35	HB+0 RX	ja		Zwartewaterland
36	S-3	n		Zwartewaterland
37	S-3	n		Zwartewaterland
38	S+0	n		Kampen
39	S-3	n		Kampen
40	HB-3 R	ja		Kampen
41	S-6 R	ja		Kampen
42	S-6 R	ja		Kampen
43	S-6 R	ja		Kampen
44	S-6 R	ja	ja	Kampen
45	S-6 R	ja	ja	Kampen
46	S-6 R	ja		Kampen

47	S-6 R	ja		Kampen
48	S-6 R	ja	ja	Kampen
49	HB-3 R	ja		Zwolle
50	S-6 R	ja		Zwolle
51	HB-3 R	ja		Zwolle
52	S-6 R	ja		Zwolle
53	S-6 R	ja		Zwolle
54	S-6 R	ja		Zwolle
55	S-3	n		Zwolle
56	S-3	n		Zwolle
57	S-3	n		Zwartewaterland
58	S-6 R	ja		Zwartewaterland
59	S-6 R	ja		Zwartewaterland
60	S-6 R	ja		Zwartewaterland
61	S-6 R	ja	ja	Zwartewaterland
62	S-6 R	ja		Zwartewaterland
63	S-6 R	ja		Zwartewaterland
64	S-6 R	ja	ja	Zwartewaterland
65	HB+9 RX	ja		Zwartewaterland
66	S+12	n		Zwartewaterland
67	S+0	n		Zwartewaterland
68	S-6 R	ja		Zwartewaterland
69	S-6 R	ja		Zwartewaterland
70	S-6 R	ja		Zwartewaterland
71	S-6 R	ja		Zwartewaterland
72	S-6 R	ja		Zwartewaterland
73	HC-3RC	ja		Zwartewaterland
74	S-3	n		Zwartewaterland
75	S-6	nee		Zwartewaterland
76	S-6	nee		Zwartewaterland
77	S-6	nee		Zwartewaterland
78	S-6	nee		Zwolle
79	S-6	nee		Zwolle
80	S-6	nee		Zwolle
81	S-6	nee		Zwolle
82	HA-6 RC	ja		Zwolle
83	S-6	nee		Zwolle
84	S-3	nee		Zwolle
85	S-6	nee		Zwolle
86	S-6	nee		Zwolle
87	S-6	nee		Zwolle
88	HA-6RC	ja		Zwolle
89	S+15 R	ja		Zwolle
90	EC-3 RX	ja		Zwolle
portaal Zwolle	juk	n		Zwolle

Bijlage 4

Gegevens DO per masttype

TOETSING EN HERONTWERP MASTEN EN FUNDATIES BBB380

ENS-ZL380 – Rapportage masttype S-6/R

TenneT TSO B.V.

Rapport nr.: 22-0535, Rev. 0
Meridian doc.nr.: 002.515.40 1007973
Datum: 2022-04-01

Projectnaam:	Toetsing en herontwerp masten en fundaties BBB380	Energy Systems
Rapport titel:	ENS-ZL380 – Rapportage masttype S-6/R	DNV Netherlands B.V.
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Datum uitgave:	2022-04-01	
Project nr.:	10166260	
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Rapport nr.:	22-0535, Rev. 0	

Geschreven door:	Beoordeeld door:	Goedgekeurd door:
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DNV Distributie: :

☒ Open

☐ Intern

☐ Commercieel vertrouwelijk

☐ Vertrouwelijk

☐ Geheim

*Specificatie distributie: --

Rev.	Datum	Reden van uitgave	Auteur	Beoordeeld	Goedgekeurd
0	2022-04-01	Eerste uitgave	M.H. Khan	A.J. Börger	C. Schutte

Inhoudsopgave

1 INLEIDING

1.1 Inleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt.

Om die reden is de opdrachtgever (OG) voornemens de bestaande 380 kV-koppelnetring op te waarderen. Het opwaarderen van de bestaande verbindingen valt onder het programma "Beter benutten bestaande 380 kV-ring" en omvat de volgende deelprojecten:

- Opwaardering 380 kV-verbinding Lelystad – Ens (LLS-ENS380)
- Opwaardering 380 kV-verbinding Diemen – Lelystad (DIM-LLS380)
- Opwaardering 380 kV-verbinding Rilland – Zandvliet (RLL-ZVL380)
- Opwaardering 380 kV-verbinding Krimpen aan den IJssel - Geertruidenberg (KIJ-GT380)
- Opwaardering 380 kV-verbinding Ens - Zwolle (ENS-ZL380)
- Opwaardering 380 kV-verbinding Maasbracht - Eindhoven (MBT-EHV380)

Om te komen tot een DO waarmee de werkzaamheden kunnen worden gestart is door TenneT aan DNV opdracht verstrekt voor de volgende onderdelen:

1. In eerste fase het opstellen en creëren van:

1.1 E-studie deel 1

1.2 Uitgangspuntenrapporten ten behoeve van de constructieve analyse van masten en fundaties

1.3 Sonderingmodellen

1.4 Fundatiemodellen

1.5 Mastmodellen

2. In tweede fase de uitvoering van de DO-fase bevattende:

2.1 Toetsing conform het uitgangspuntenrapport van de bestaande fundaties

2.2 Globale specificatie van benodigde fundatieversterkingen ten behoeve van aanbesteding

2.3 Toetsing conform het uitgangspuntenrapport van de bestaande masten

2.4 Globale specificatie van benodigde mastversterkingen ten behoeve van aanbesteding

2.5 E-studie deel 2

1.2 Doel van dit rapport

In dit rapport wordt voor de hoogspanningslijn Ens - Zwolle de controle van de mastconstructie van masttype S-6/R gerapporteerd. Het doel is om te bepalen of de in dit rapport beschreven bestaande mast geschikt is om te worden uitgerust met de nieuwe ACCC-Warsaw geleider waarmee een hogere capaciteit kan worden gerealiseerd.

Nadat de wijzigingen zijn toegepast dient aantoonbaar geverifieerd te worden dat het systeem voldoet aan de vigerende eisen.

In de defintief-ontwerpfase zijn ten behoeve van de contractvorming Engelstalige rapporten geleverd. Het voorliggende rapport is bedoeld voor vergunningsaanvraag en is inhoudelijk ongewijzigd ten opzichte van de Engelse versie. Om deze reden zijn de bijlagen in dit rapport één op één overgenomen uit de Engelse versie. Hierdoor wijkt het revisienummer van de bijlagen af van het revisienummer van de rapportage.

1.3 Gerelateerde documenten

1.3.1 Verificatie & validatieplan

De door TenneT aangeleverde set met eisen is beoordeeld op relevantie en voor de relevante eisen is aangegeven in welk document wordt aangetoond dat er aan de eis wordt voldaan. De resultaten hiervan zijn opgenomen in het rapport "Verificatie & Validatieplan 380 kV verbinding Ens - Zwolle".

1.3.2 E-studie deel 1

In de rapportage "ENS-ZL380 - E-studie deel 1" [1] is bepaald welke aanpassingen benodigd zijn om de ACCC-Warsaw geleider toe te passen binnen de verbinding Ens – Zwolle.

Op een aantal masten locaties waar masttype S-6/R staat is sprake van overschrijdingen op de interne afstanden. Dit omvat mast 28 en 72. Voor deze masten is het vereist dat de ophangisolatoren worden gewijzigd in een V-ophanging bestaande uit stijve post-isolatoren

1.3.3 Uitgangspuntendocument

De uitgangspunten op basis waarvan de berekeningen in deze rapportage zijn uitgevoerd zijn opgenomen in het rapport "Uitgangspuntenrapport 380kV verbinding Ens - Zwolle" [2].

2 EISEN

In onderstaande Tabel 1zijn de eisen opgenomen die binnen deze rapportage worden getoetst.

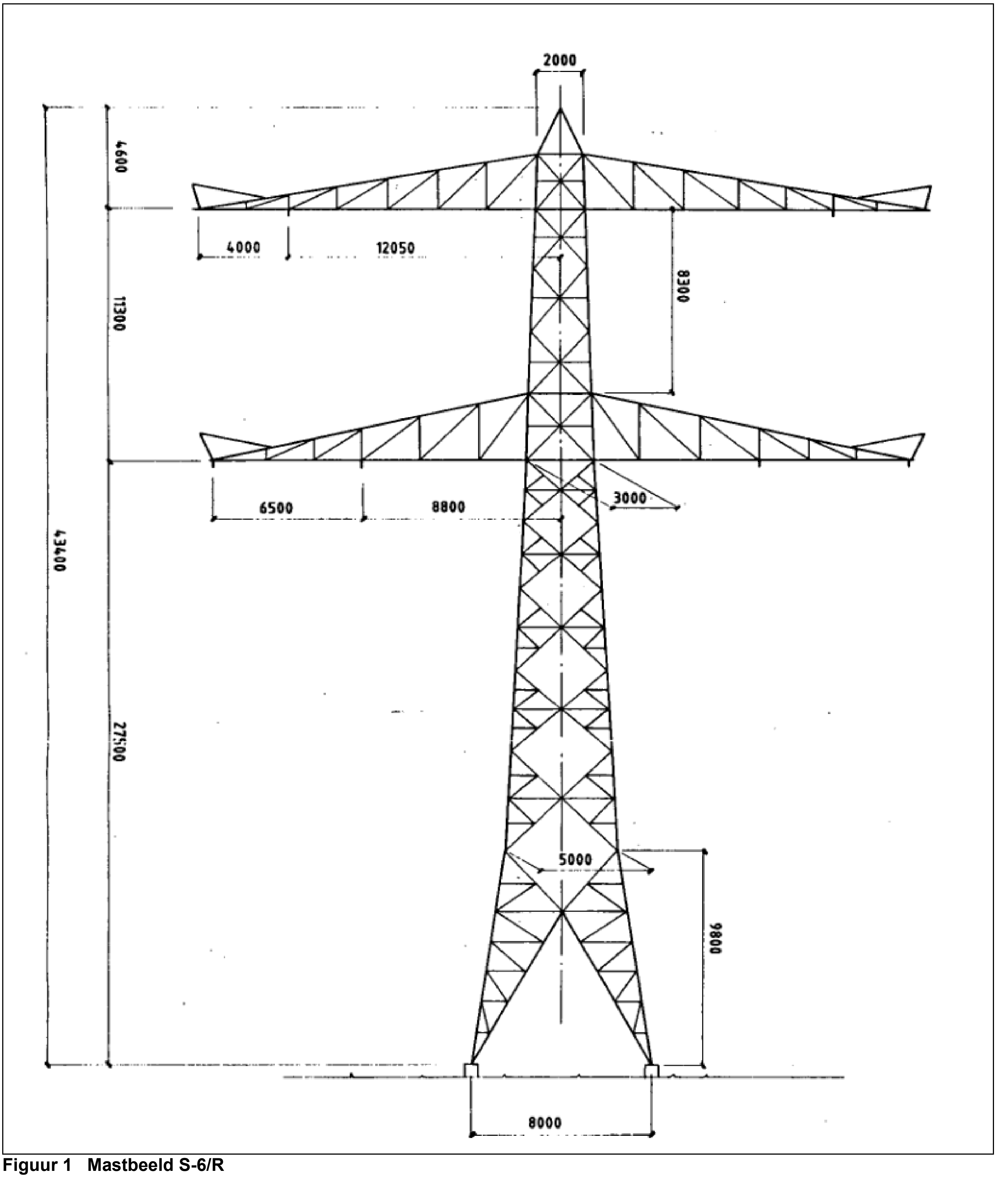
Tabel 1 Relevante eisen

Req. Id	Title	Req. text	Verification
BO Eis: H2.7-6	Omgeving, beperkingsf actoren	Het ontwerp dient geverifieerd te worden op de uitvoerbaarheid.	Tabel 6
PVE.05.001 5.14	Masten	Aanwijzingen t.a.v. klimvoorziening en valbeveiliging: Huidige klimweg blijft gehandhaafd en zal voldoen aan de eisen zoals opgenomen in de NEN 1060:1987. Valbeveiliging is/zal worden uitgevoerd in het type "latch way". Indien staaldelen in de nabijheid (aangrenzend profiel) van de klimweg gewijzigd worden, dient geverifieerd te worden dat de klimvoorziening in overeenstemming is met de NEN 1060:1987.	Tabel 6

3 BEREKENINGEN

3.1 Mastbeeld

Het mastbeeld op basis van de Asset-data is weergegeven in Figuur 1.



Figuur 1 Mastbeeld S-6/R

3.2 Mastenlijst

In deze rapportage wordt masttype S-6/R getoetst. De S-6/R masten bevinden zich in windgebied II. De geleider belastingen zijn gebaseerd op hoogte van aangrenzende masten (positieve waarden duiden op een toename in hoogte). De wind en span van de verschillende masten zijn in Tabel 2 weergegeven.

Masten 28 en 72 vereisen V-fixaties vanwege overschrijdingen met de interne afstanden, daarom wordt mast 28 als maatgevende mast van 28 en 72 ook berekend in dit rapport.

Tabel 2 Mastnummers

Tower number	Tower type	Governing tower number	Wind span (m)	Weight span (m)	Height difference back (m)	Height difference ahead (m)
19	S-6/R	22	347	334	3,1	-0,3
20	S-6/R	22	351	350	0,3	-0,1
21	S-6/R	22	355	356	0,1	-0,1
22	S-6/R	22	361	360	0,1	0,4
23	S-6/R	22	341	343	-0,4	-0,2
24	S-6/R	22	320	321	0,2	-0,2
25	S-6/R	22	341	243	0,2	18,3
28	S-6/R	22	298	174	19,8	-0,4
29	S-6/R	22	302	291	0,4	1,6
41	S-6/R	22	289	267	2,7	0,0
42	S-6/R	22	350	351	0,0	0,0
43	S-6/R	22	347	346	0,0	0,3
44	S-6/R	22	350	352	-0,3	0,0
45	S-6/R	22	343	343	0,0	0,1
46	S-6/R	22	339	340	-0,1	0,1
47	S-6/R	22	342	344	-0,1	-0,1
48	S-6/R	22	347	331	0,1	3,0
50	S-6/R	22	316	284	2,8	2,7
52	S-6/R	22	363	350	3,1	0,2
53	S-6/R	22	358	358	-0,2	0,0
54	S-6/R	22	304	283	0,0	3,0
58	S-6/R	22	358	344	3,0	0,0
59	S-6/R	22	358	357	0,0	0,6
60	S-6/R	22	324	326	-0,6	0,1
61	S-6/R	22	320	322	-0,1	0,1
62	S-6/R	22	350	352	-0,1	-0,2
63	S-6/R	22	287	279	0,2	1,0
64	S-6/R	22	281	206	-1,0	16,7
68	S-6/R	22	341	309	6,5	-0,7
69	S-6/R	22	354	351	0,7	-0,2
70	S-6/R	22	350	350	0,2	-0,2
71	S-6/R	22	346	347	0,2	0,2
72	S-6/R	22	265	152	-0,2	12,4

3.3 Uitgangspunten berekening

De berekening is uitgevoerd op basis van de uitgangspunten zoals opgenomen in het uitgangspuntenrapport [2]. Hierin is een volledig overzicht opgenomen van de belastingcombinaties en toegepaste belastingfactoren

Tabel 3 Uitgangspunten berekening

Algemeen	Norm Windgebied Terreincategorie Reductiefactor cdir	NEN-EN50341-2-15:2019 III II (onbebouwde omgeving) 1,00
Situatie initieel	Gevolgklasse Betrouwbaarheidsniveau Referentieperiode	CC2-0 Afkeur CC2-0 30 jaar
Situatie na aanpassingen	Gevolgklasse Betrouwbaarheidsniveau Referentieperiode	CC2 Verbouw 50 jaar

3.4 Proces stappen

Het proces van het bepalen van eventueel benodigde verstevigingen bestaat uit de volgende stappen:

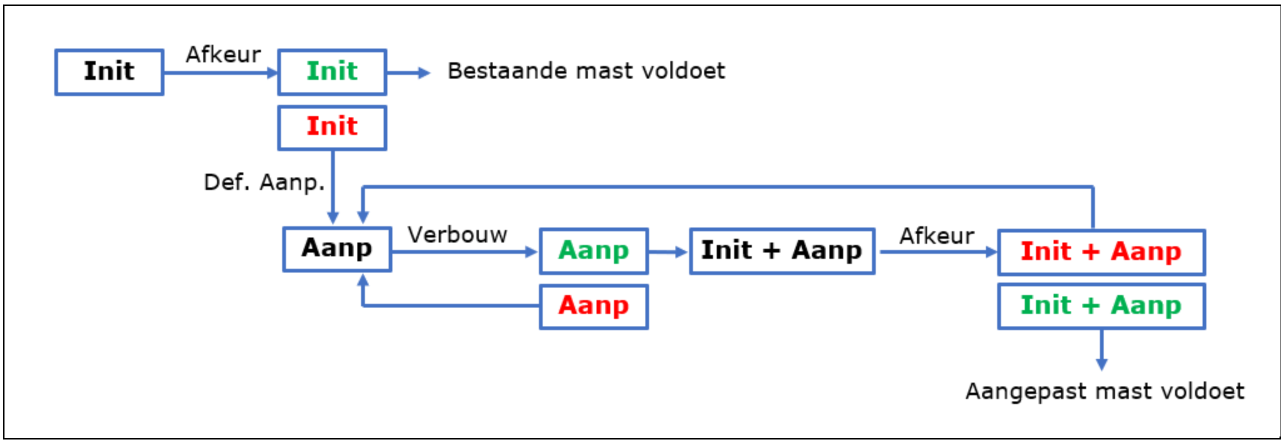
Stap 1: Toets bestaande (Init) mast op Afkeur

Stap 2: Definiëren benodigde aanpassingen indien initiële mast niet voldoet aan toets op Afkeur (Def. Aanp.)

Stap 3: Het toetsen van (alleen) de uitgewerkte aanpassingen (Aanp) op Verbouw

Stap 4: Het opnieuw toetsen van de complete mast inclusief aanpassingen (Initi + Aanp) op Afkeur

Het hierboven omschreven proces is in Figuur 2 weergegeven.



Figuur 2 Proces diagram

3.5 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV. In Appendix A zijn de resultaten van de geleiderbelastingen samengevat.

3.6 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma, zie ook Appendix A.

3.7 Modellering

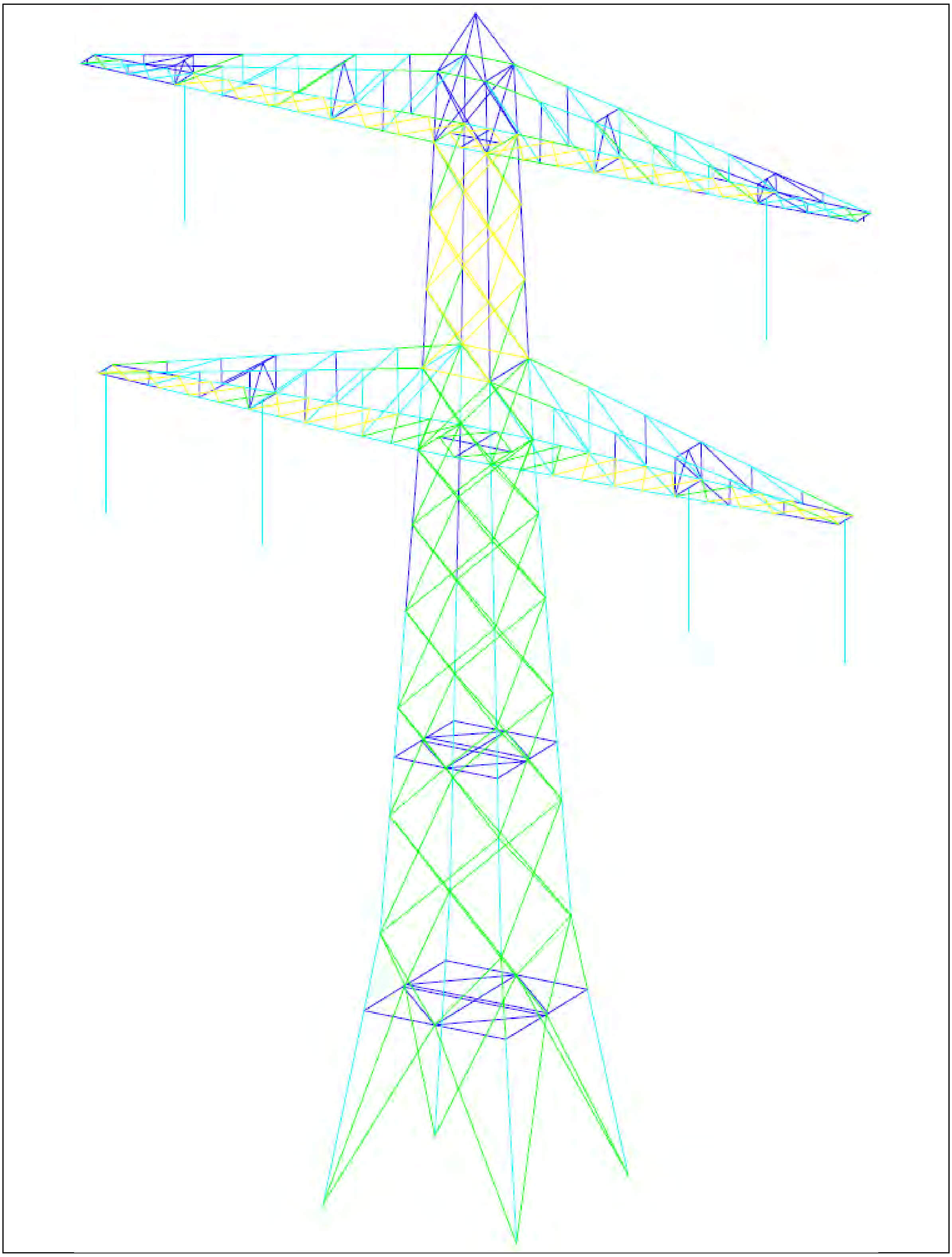
Op basis van de as-built tekeningen is de mast in PLS-TOWER ingevoerd. De hoofdelementen zijn gemodelleerd. Niet-dragende profielen als knikverkorters zijn weggelaten en worden separaat getoetst. De profielen inclusief de boutverbindingen zijn in PLS-TOWER ingevoerd en getoetst. Controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

De geleiderbelastingen vanuit het geleiderbelastingenprogramma zijn als invoer voor de belastingen gebruikt.

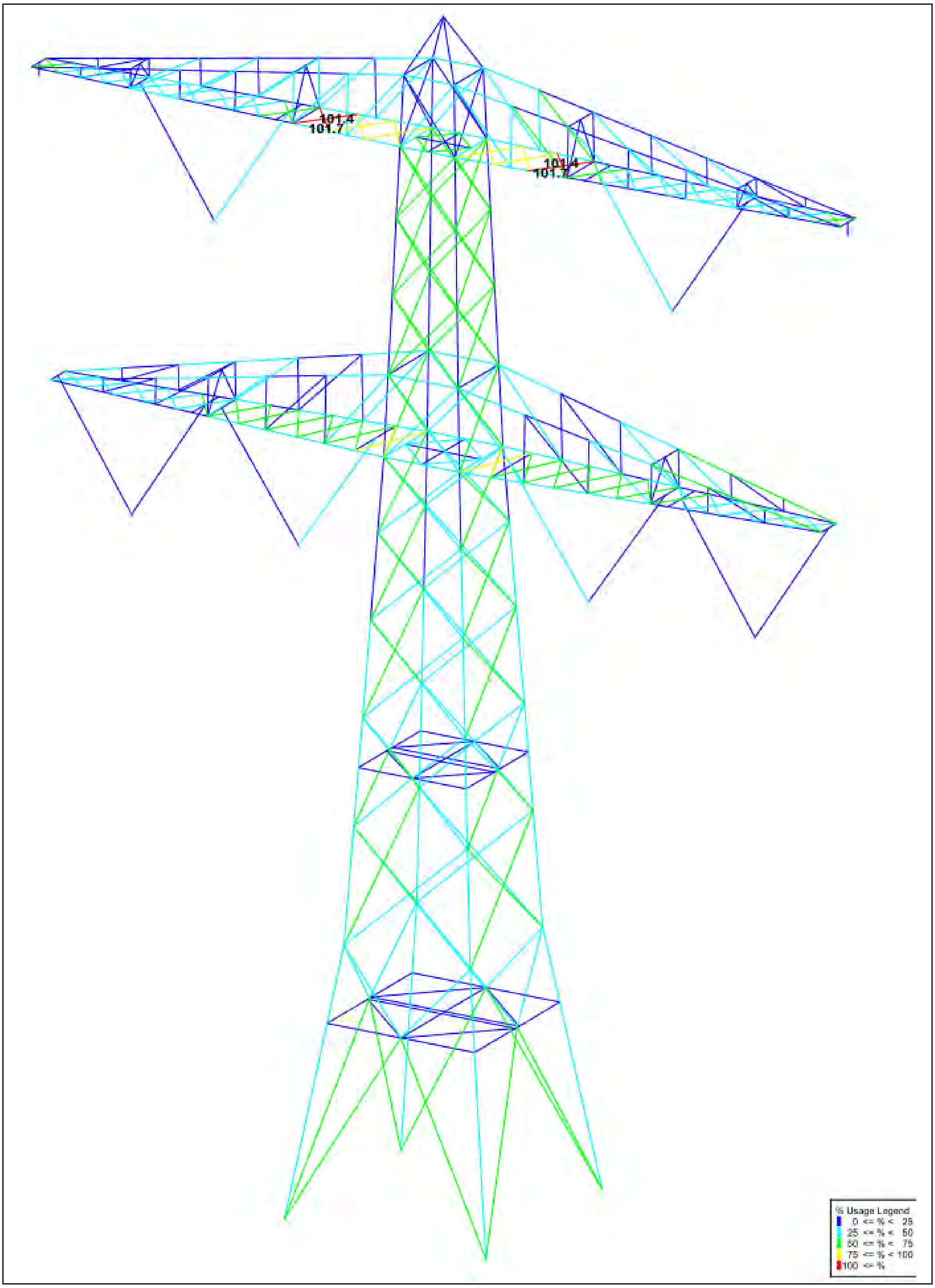
Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep en de toetsing wordt per staafgroep uitgevoerd. Ingeval dat een element uit een groep is overbelast, geldt dit voor alle elementen uit de betreffende groep.

4 TOETSING MASTCONSTRUCTIE

Het resultaat van de controle van de mastconstructie type S-6/R met belastingen op afkeurniveau is weergegeven in Figuur 3 en Figuur 4.



Figuur 3 Resultaat PLS-TOWER S-6/R(22)



Figuur 4 Resultaat PLS-TOWER S-6/R(28)

De resultaten van de controles van profielen, knikverkorters en ankers randstijl zijn opgenomen in Tabel 4.

Sommige profielen in PLS-TOWER zijn berekend aan de hand van een conservatieve aanpak met betrekking tot de stuikcapaciteit, daarom heeft DNV de capaciteit overschreven van deze profielen (Groep 316, 317,320, 321, 322, 323 en 418) aan de hand van handmatige berekeningen. Deze berekeningen zijn weergegeven in Appendix D.

Tabel 4 Samenvatting controle

Controle van	Beoordeling		Referentie
Profielen van S-6/R (22)	Voldoen		Figuur 3 Appendix B
Profielen van S-6/R (28)		Voldoen niet	Figuur 4 Appendix B
Knikverkorters	Voldoen		Appendix C
Blokdeuvels	Voldoen		Appendix D

5 AANPASSINGEN

5.1 Inleiding

In deze paragraaf worden versterkingen voorgesteld om ervoor te zorgen dat de mast aan de eisen van het “afkeurniveau” voldoet. Het voorstel bevat de volgende maatregelen:

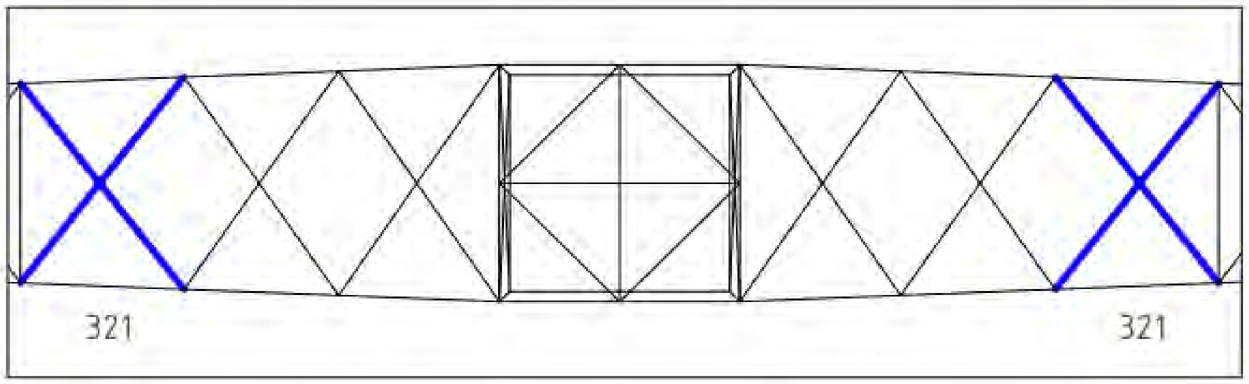
- Uitwisselen van een kruisende diagonaal in de onderste koorde van de bovenste traverse;

- Extra nieuwe liggers ter ondersteuning van V-bevestigingen;

- Extra klimladder.

5.2 Aanpassingen

Overeenkomstig de resultaten in Appendix B moeten de eerder in dit hoofdstuk beschreven wijzigingen worden toegepast.



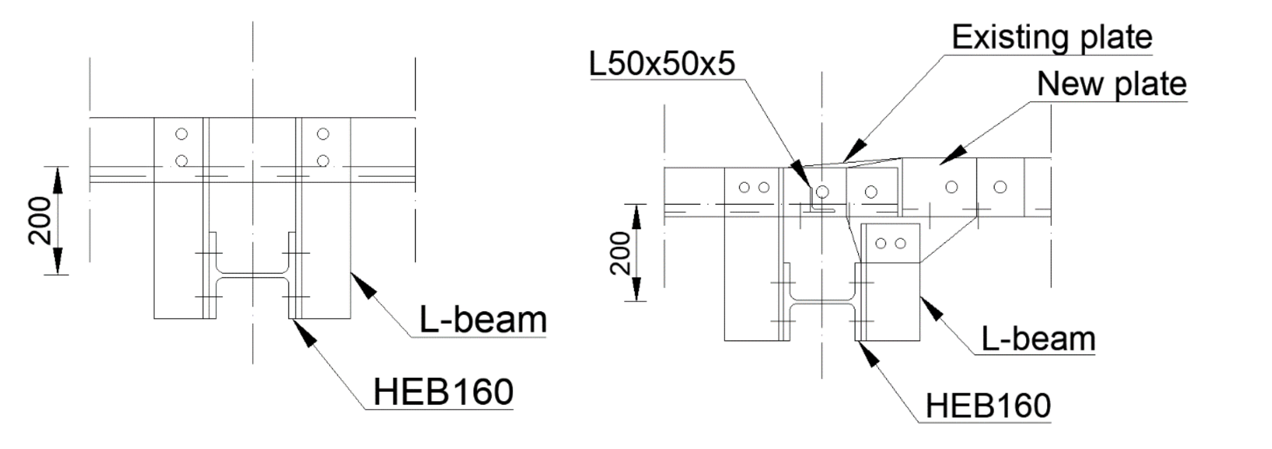
Figuur 5 Bovenaanzicht - Ondervlak van boventraverse (Mast 28)

5.2.1 Controle van nieuwe liggers

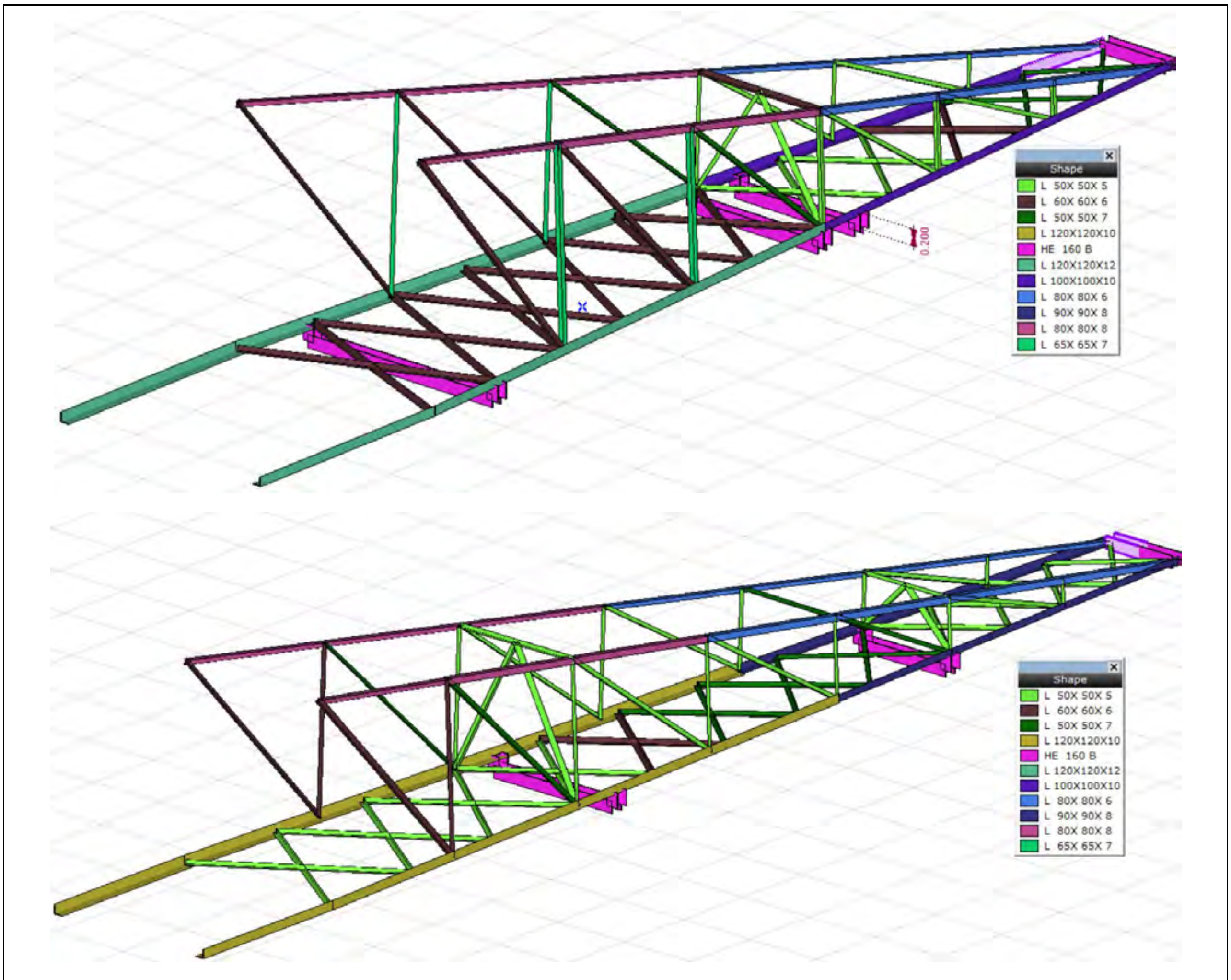
Voor de ophanging van de isolatorkettingen zijn onder de traverse nieuwe HE-balken aangebracht. Het ontwerp van de liggers is afgeleid van bestaande S+0 masten van RLL-ZVL. Zie Figuur 6.

Figuur 6 Principe ophanging isolator kettingen met HE-balken

Om de nieuwe locatie van de isolator te ondersteunen, zijn onder extra liggers toegevoegd. Zie Figuur 7 voor de principe aansluitingen op bestaande liggers en zie figuur 5 4 voor een overzicht van de staven.



Figuur 7 Principe aansluitingen op bestaande liggers



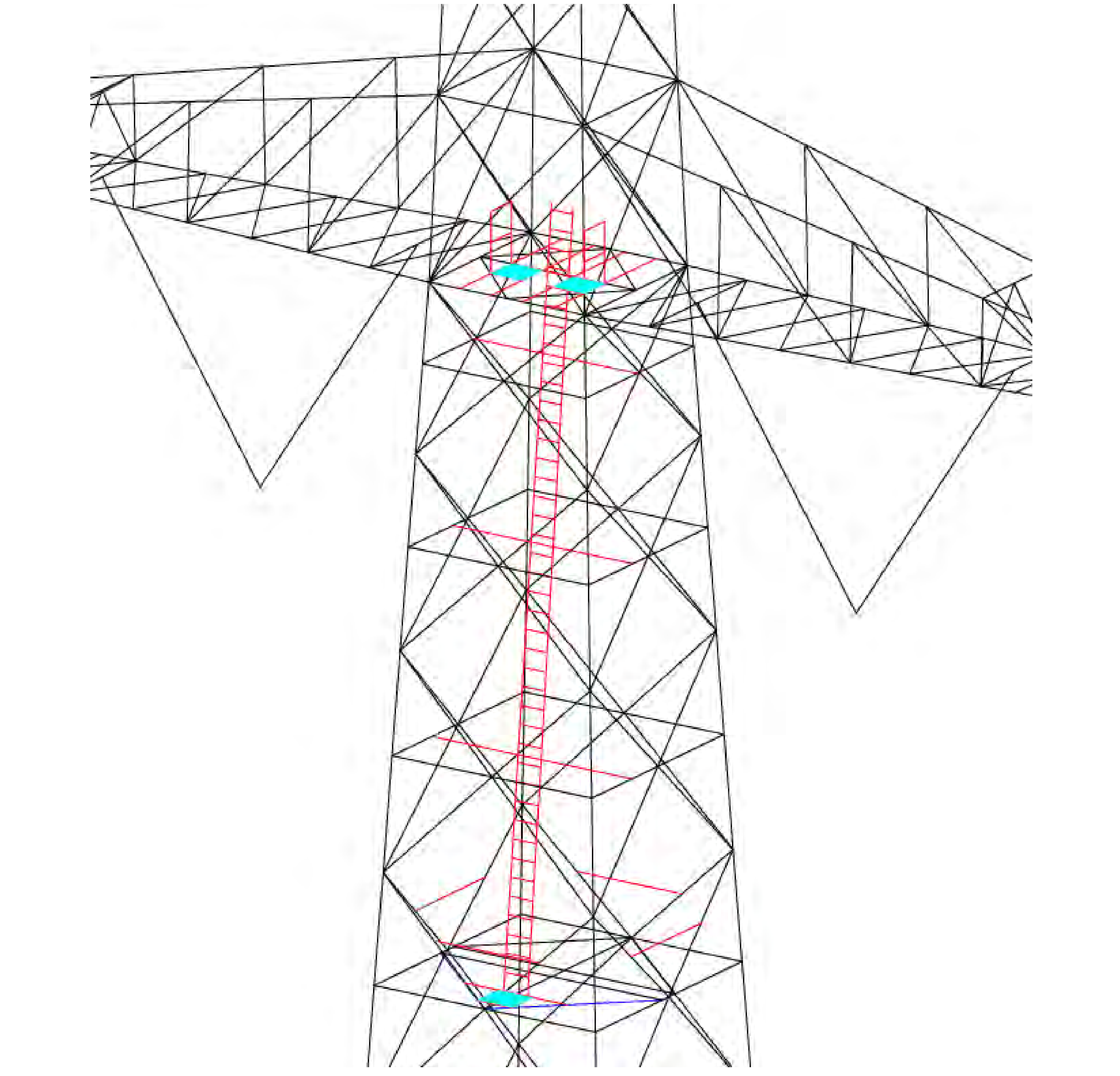
Figuru 8 Overzicht mast leden

Berekening van de traverse met nieuwe toegevoegde staven is te vinden in Appendix F.

5.2.2 Klimladder

De geleiders worden dichter bij het mastenlichaam geplaatst. Er moet een centrale klimweg worden voorzien om veilige klimafstanden te kunnen halen. Deze loopt van het horizontaal verband in het tussenstuk naar de onderste traverse. Bestaande klimpennen dienen over de hoogte van de ladder te worden verwijderd. Een valbeveiligingssysteem in de vorm van een vergrendelingssysteem of gelijkwaardig loopt met de ladder mee. De ladder wordt uitgevoerd met bordessen aan de boven- en onderkant.

De berekening van de klimladder is afgeleid van de ladder van masttype S+0/K van RLL-ZVL. De afmetingen van de ladder van masten S-6/R (28) zijn kleiner in vergelijking met S+0/K, waardoor het veilig is om dezelfde geometrie te gebruiken. Voor de berekening van de klimladder zie Appendix G.



Figuur 9 Overzicht klimladder met bordessen

Voor informatie over staafmaten en boutmaten, zie tekening in Appendix E. De afmetingen zijn weergegeven in Tabel 5. Extra gewichten voor bouten en platen in de verbindingen zijn niet inbegrepen.

Tabel 5 Gewicht van profielen vereist voor aanpassingen aan masten S-6/R (28)

Group Label	Profile ini.	Material ini.	Bolts ini.	Profile new	Material new	Bolts new	Mitigation	Number	Length (m)	Weight (kg)
321	L50.5	S235	1M16-8.8t	L50.5	S355	1M16-8.8t	Profile exchanged	4	2.41	36.3
L1				L100.50.6	S355	M16-8.8t	Profile added	2	12.36	169.1
L2				Rod 20mm diam	S355	M16-8.8t	Profile added	42	0.40	41.5
L3				L60.6	S355	M16-8.8t	Profile added	3	0.60	9.76
L4				L80.8	S355	M16-8.8t	Profile added	1	1.80	18
L5				L100.8	S355	M16-8.8t	Profile added	1	4.19	52
L6				L80.8	S355	M16-8.8t	Profile added	1	3.66	36
L7				L80.8	S355	M16-8.8t	Profile added	1	3.20	31
L8				L80.8	S355	M16-8.8t	Profile added	4	3.00	118
L9				L80.8	S355	M16-8.8t	Profile added	1	1.80	18
L10				L80.8	S355	M16-8.8t	Profile added	2	0.60	12
R1				L60.6	S355	M16-8.8t	Profile added	4	1.00	22
R2				L60.6	S355	M16-8.8t	Profile added	4	0.60	13
R3				L60.6	S355	M16-8.8t	Profile added	4	2.25	50
T1				HEB160	S355	M24-8.8t	Profile added	2	1.78	151.66
T2				HEB160	S355	M24-8.8t	Profile added	2	1.31	111.61
T3				HEB160	S355	M24-8.8t	Profile added	2	2.82	240.26
T4				HEB160	S355	M24-8.8t	Profile added	2	1.94	165.29
T5				HEB160	S355	M24-8.8t	Profile added	2	1.84	156.77
T6				HEB160	S355	M24-8.8t	Profile added	2	1.00	85.2
T7				L50.5	S355	M16-8.8t	Profile added	2	1.84	13.87
229	L60.6	S235	1M16-8.8t	L80.8	S355	1M20-8.8t	Profile exchanged	2	2.89	55.6
Totaal									127.05	1606.97

5.3 Eisenverificatie

De verificatie van de van toepassing zijnde eisen is uitgevoerd in onderstaande Tabel 6.

Tabel 6 Verificatie eisen

Eis Id	Eis Tekst	Ja	Nee	N.v.t.	toelichting
BO Eis: H2.7-6	Aanpassingen uitvoerbaar?	X			De toe te voegen staalonderdelen zijn met geboute verbindingen te bevestigen. Dit is een bewezen methode.
PVE.05.001 5.14	Staaldelen in nabijheid van klimweg gewijzigd?	X			De wijzigingen in de nabijheid van de klimweg (knikverkorters) zijn in te passen zonder negatieve invloed op de begaanbaarheid.
	klimvoorziening nog in overeenstemming is met de NEN 1060:1987?	X			Geen wijzigingen

6 REFERENTIES

[1] „002.515.40 0825824 - 21-0462 - Verificatie & validatieplan 380kV verbinding Ens - Zwolle”.
[2] „002.515.40 0825812 - 20-1465 - E-studie deel 1 380kV verbinding Ens - Zwolle”.
[3] „002.515.40 0825820 - 20-1245 - Uitgangspuntenrapport 380kV verbinding Ens - Zwolle”.

APPENDIX A

Geleiderbelastingen

Inhoud

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2020-10-30			

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2-0
Betrouwbaarheidsniveau	Afkeur
Referentieperiode	30 jaar
Na aanpassing	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Verbouw
Referentieperiode	50 jaar
Windgebied	III
Terreincategorie	II
IJsgebied	B
Masttype	Steunmast
Masthoogte	43,4 m
Veldlengte	372,2 m
Lijnhoek	180°
Trekparameter	1760 m

Client: TenneT Taking power further

DNV·GL

Title:

Berekening masttype S-6 R

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_S-6 R_22_Report.pdf

Project number:

Project client number:

0.0

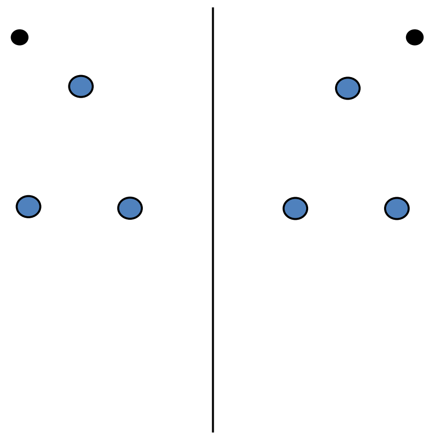
Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Geleiderbelastingen

Auteur: TBR
Versie: v10.4

Algemeen

Benaming	S-6 R
Masttype	Steunmast
Aantal circuits	2
Configuratie	2-circuit-donau
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2-0
Betrouwbaarheidsniveau initieel	Afkeur CC2-0
Referentieperiode initieel	30 jaar
Gevolgklasse na aanpassing	CC2
Betrouwbaarheidsniveau na aanpassing	Verbouw
Referentieperiode na aanpassing	50 jaar
Windgebied	III
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	B

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	Halfverankering	2,00	4,50	1,00
Circuit 2	Halfverankering	2,00	4,50	1,00
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,30	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,30	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast (3) Horizontale afstand
Circuit 1	10	380ct1f1	23,0 m	27,5 m	-15,3 m
Circuit 1	11	380ct1f2	23,0 m	27,5 m	-8,8 m
Circuit 1	12	380ct1f3	34,3 m	38,8 m	-12,1 m
Circuit 2	21	380ct2f1	23,0 m	27,5 m	15,3 m
Circuit 2	20	380ct2f2	23,0 m	27,5 m	8,8 m
Circuit 2	22	380ct2f3	34,3 m	38,8 m	12,1 m
Bliksemdraad 1	1	bl1	38,5 m	38,8 m	-16,0 m
Bliksemdraad 2	3	bl2	38,5 m	38,8 m	16,0 m

1. Positief = aangrenzende mast hoger
2. Positief = in draairichting assenstelsel x => y

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	3,0 m	3,0 m	(positief: omhoog)
Verlaging voor verticale belasting	0,0 m	0,0 m	(negatief: omlaag, grotere weight span)
Verlaging: Niet in 0,9EG-combinaties			

Hoogteafwijking mastbeeld naastgelegen masten en richtingsverandering t.o.v. Lijnrichting

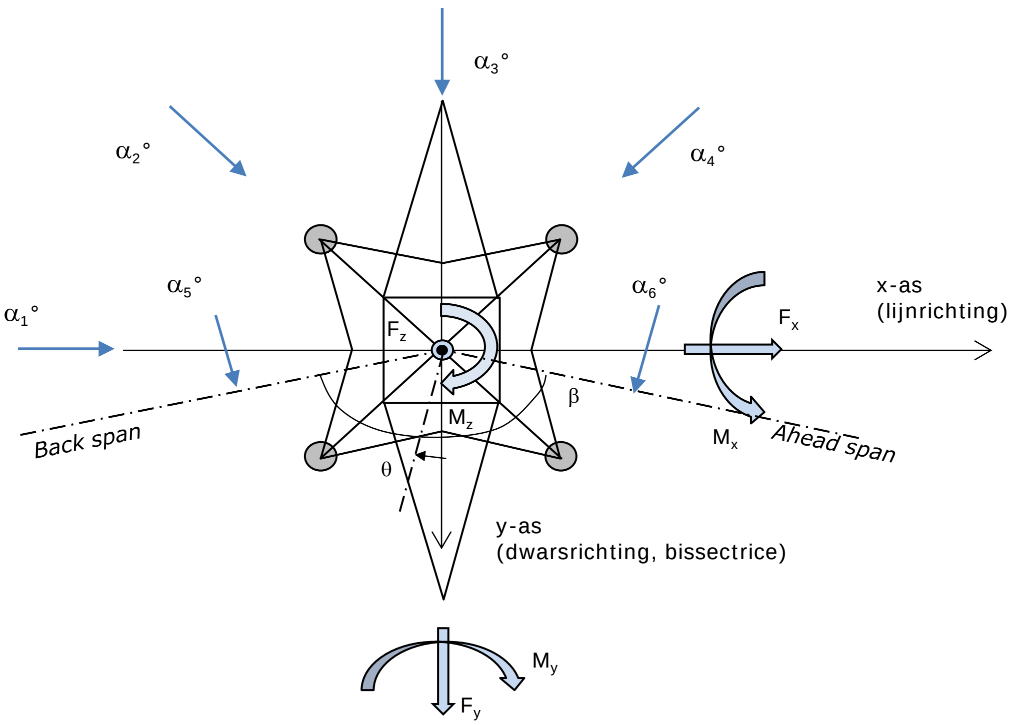
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,1	0,4 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,1	0,4 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,1	0,4 m	0,0	0,0 m
Circuit 2	21	380ct2f1	0,1	0,4 m	0,0	0,0 m
Circuit 2	20	380ct2f2	0,1	0,4 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,1	0,4 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,1	0,4 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,1	0,4 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
Overspanning		350,5	372,2 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		343,9	343,9 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		5416	5416 m
Hoogte onderkant mast t.o.v. maaiveld		0,5 m	
Beschouwde windrichtingen	α_1	0 °	
Windrichtingen volgens:	α_2	45 °	
Geleiderbelastingen	α_3	90 °	
	α_4	135 °	
	α_5	- °	
	α_6	- °	

Windrichtingen gelden t.o.v. hoofdrichting mastconstructie, niet t.o.v. bissectrice.

Windrichtingen en positieve richtingen belastingen



Beschouwd aantal windrichtingen	
1a	4
3	4
4	1
6	1
Overig	1

DNV·GL

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

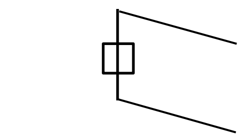
Geleiderafval

		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	0,8	0
Circuit 1	380ct1f2	1	0	1	0	0,8	0
Circuit 1	380ct1f3	1	0	1	0	0,8	0
Circuit 2	380ct2f1	0	1	1	0	0,8	0
Circuit 2	380ct2f2	0	1	1	0	0,8	0
Circuit 2	380ct2f3	0	1	1	0	0,8	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

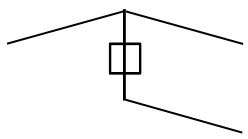
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS bij steunmast niet van toepassing

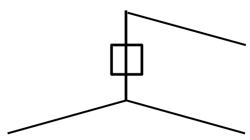
Principe belastingssituaties:



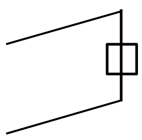
1. Ba All cts



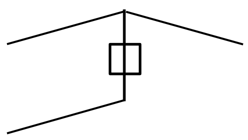
2. Ba ct1



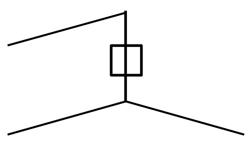
3. Ba ct2



4. Ah All cts



5. Ah ct1

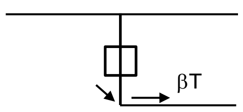


6. Ah ct2

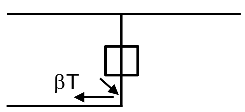
Belastingsituaties 5a. Geleiderbreuk

Beschouwde situaties geleiderbreuk 5a: 1 en 2, alle mogelijke situaties.

Principe belastingssituaties:



1. Ba



2. Ah

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

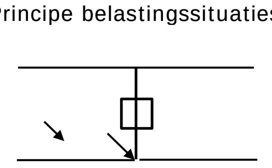
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht.
Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate controle bordessen etc. De situaties worden in ULS en in iedere SPLS-situatie (in geval van hoekmast) toegepast.

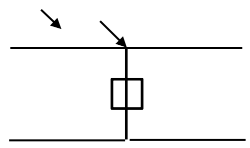
	Fase	Bliksem
Lijnwagen	3,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

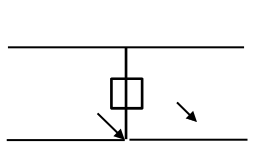
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

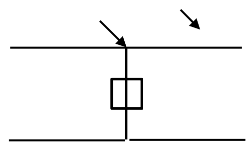
Aanwezigheid lijnwagen: Circuit, belasting tegelijk aanwezig in alle geleiders per circuit.

Principe belastingssituaties:


1. Ba Ct1


2. Ba Ct2


3. Ah Ct1


4. Ah Ct2

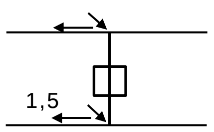
Belastingsituaties 8. Lijndansen als statische belasting

Geleider	Lijnrichting	Verticaal
Steunmast fase	0,866 W	1,5 W
Steunmast bliksem	1,5 EDS	1,5 W
Hoekmast fase en bliksem	1,5 EDS	1,5 W

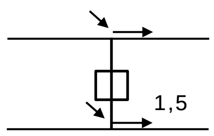
Beschouwde situaties lijndansen 8: Geen

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principe belastingssituaties:



1. Ba



2. Ah

Belastingcombinatie 8. Lijndansen als dynamische belasting
Alleen van toepassing op hoek- en eindmasten
Belasting bestaat uit EDS-trekbelasting in één van de geleiders aan één zijde van de mast
Door gebruiker via het belastingsspectrum van tabel 4.11/NL.1 om te zetten naar spanningspectrum

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Mastconstructie

Eigenschappen

Masttype	Steunmast	
Mastbenaming	S-6 R	
Voetplaat t.o.v. maaiveld	0,5	m
Masthoogte t.o.v. voetplaat	43,4	m
Gewicht mast	200,0	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	8,00	8,00	m
Helling van de randstijl	0,153	0,153	-
Factor spatkracht	1,3	1,3	-

Berekening windbelasting

Dynamische invloed G_T	1,00 *(Masthoogte < 60 m)*
Windbelasting overhoeks op mastlichaam evenredig met:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Windbelasting overhoeks op traverse evenredig met:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Vergroting wind overhoeks mastlichaam	(1+0,2sin^2(2phi))
Vergroting wind overhoeks traverse	(1+0,2sin^2(2phi))
Factor wind evenwijdig t.o.v. haaks op traverse	0,4

Eigenschappen mastsecties lijnrichting (vooraanzicht, yz-vlak)

Omschrijving	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	9,80	8,00	5,00	9,80	0,153	63,70	8,48	0,13	3,24
Eerste tussenstuk	18,05	5,00	4,07	8,25	0,056	37,41	6,27	0,17	3,08
Tweede tussenstuk	27,50	4,07	3,00	9,45	0,057	33,40	6,78	0,20	2,92
Bovenstuk 1	33,40	3,00	2,58	5,90	0,036	16,45	3,83	0,23	2,79
Bovenstuk 2	41,40	2,58	2,00	8,00	0,036	18,30	4,44	0,24	2,75
Topstuk	43,40	2,00		2,00		2,00	0,38	0,19	2,97
Ondertraverse	27,50	13,80		3,00		20,70	4,66	0,22	2,82
Boventraverse	38,80	15,00		2,60		19,50	4,82	0,25	2,73

Eigenschappen mastsecties dwarsrichting (zijaanzicht, xz-vlak)

Omschrijving	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	9,80	8,00	5,00	9,80	0,153	63,70	8,48	0,13	3,24
Eerste tussenstuk	18,05	5,00	4,07	8,25	0,056	37,41	6,27	0,17	3,08
Tweede tussenstuk	27,50	4,07	3,00	9,45	0,057	33,40	6,78	0,20	2,92
Bovenstuk 1	33,40	3,00	2,58	5,90	0,036	16,45	3,83	0,23	2,79
Bovenstuk 2	41,40	2,58	2,00	8,00	0,036	18,30	4,44	0,24	2,75
Topstuk	43,40	2,00		2,00		2,00	0,38	0,19	2,97
Ondertraverse	27,50	13,80		3,00		20,70	4,66	0,22	2,82
Boventraverse	38,80	15,00		2,60		19,50	4,82	0,25	2,73

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Windoppervlak feeders telecominstallaties

Onderdeel	A (m²/m)	Δh	A_1
Broekstuk			
Eerste tussenstuk			
Tweede tussenstuk			
Bovenstuk 1			
Bovenstuk 2			

Invoer antennes

Omschrijving	A	h	C_f
Antenne top			
Antenne o.t.			

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m²]	F_{x1} [kN]	F_{x2} [kN]	F_{x3} [kN]	F_{x4} [kN]	h_{ef} [m]	M_{y1} [kNm]	M_{y2} [kNm]	M_{y3} [kNm]	M_{y4} [kNm]
Broekstuk	0,70	19,3	16,3	0,0	-16,3	4,9	94,4	80,1	0,0	-80,1
Eerste tussenstuk	0,78	15,1	12,8	0,0	-12,8	13,9	210,4	178,5	0,0	-178,5
Tweede tussenstuk	0,91	18,1	15,3	0,0	-15,3	22,8	411,1	348,9	0,0	-348,9
Bovenstuk 1	0,99	10,6	9,0	0,0	-9,0	30,5	323,2	274,2	0,0	-274,2
Bovenstuk 2	1,05	12,8	10,9	0,0	-10,9	37,4	480,3	407,5	0,0	-407,5
Topstuk	1,09	1,2	1,0	0,0	-1,0	42,4	52,1	44,2	0,0	-44,2
Ondertraverse	0,97	25,6	15,2	0,0	-15,2	28,5	730,1	433,7	0,0	-433,7
Boventraverse	1,07	28,1	16,7	0,0	-16,7	39,7	1116,0	662,9	0,0	-662,9
Totaal		130,9	97,4	0,0	-97,4		3417,6	2430,0	0,0	-2430,0

Belastingen mastsectie langsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m²]	F_{y1} [kN]	F_{y2} [kN]	F_{y3} [kN]	F_{x4} [kN]	h_{ef} [m]	M_{x1} [kNm]	M_{x2} [kNm]	M_{x3} [kNm]	M_{x4} [kNm]
Broekstuk	0,70	0,0	16,3	19,3	16,3	4,9	0,0	80,1	94,4	80,1
Eerste tussenstuk	0,78	0,0	12,8	15,1	12,8	13,9	0,0	178,5	210,4	178,5
Tweede tussenstuk	0,91	0,0	15,3	18,1	15,3	22,8	0,0	348,9	411,1	348,9
Bovenstuk 1	0,99	0,0	9,0	10,6	9,0	30,5	0,0	274,2	323,2	274,2
Bovenstuk 2	1,05	0,0	10,9	12,8	10,9	37,4	0,0	407,5	480,3	407,5
Topstuk	1,09	0,0	1,0	1,2	1,0	42,4	0,0	44,2	52,1	44,2
Ondertraverse	0,97	0,0	15,2	10,2	15,2	28,5	0,0	433,7	292,0	433,7
Boventraverse	1,07	0,0	16,7	11,3	16,7	39,7	0,0	662,9	446,4	662,9
Totaal		0,0	97,4	98,6	97,4		0,0	2430,0	2309,9	2430,0

Resulterende belastingen vanuit mastconstructie incl. antenne zonder geleiders niveau fundatie (kar. waarde)

Belasting / windrichting	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
Permanente belasting	0	0	200	0	0	0
Windrichting 0°	131	0	0	0	3418	0
Windrichting 45°	97	97	0	2430	2430	0
Windrichting 90°	0	99	0	2310	0	0
Windrichting 135°	-97	97	0	2430	-2430	0

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Circuit 2	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Bliksemdraad 1	OPGW 226	21,7	264,0	9,80	81000	2,30E-05
Bliksemdraad 2	OPGW 226	21,7	264,0	9,80	81000	2,30E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Circuit 2	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Bliksemdraad 1	OPGW 226	21,7	264,0	9,80	81000	2,30E-05
Bliksemdraad 2	OPGW 226	21,7	264,0	9,80	81000	2,30E-05

Verticale belasting back

Circuit	Bundel [-]	Toeslag [%]	$w_{z,G}$ [N/m]	IJsgebied	Formule	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46,3	B	4+0,2d	9,5	28,6
Circuit 2	3	3	46,3	B	4+0,2d	9,5	28,6
Bliksemdraad 1	1	3	10,1	B	4+0,2d	8,3	8,3
Bliksemdraad 2	1	3	10,1	B	4+0,2d	8,3	8,3

Verticale belasting ahead

Circuit	Bundel [-]	Toeslag [%]	$w_{z,G}$ [N/m]	IJsgebied	Formule	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46,3	B	4+0,2d	9,5	28,6
Circuit 2	3	3	46,3	B	4+0,2d	9,5	28,6
Bliksemdraad 1	1	3	10,1	B	4+0,2d	8,3	8,3
Bliksemdraad 2	1	3	10,1	B	4+0,2d	8,3	8,3

Isolatoren

Geleider	$G_{isolator}$ [kN]	Aantal -	$F_{v,iso}$ [kN]	Lengte [m]	Windopp. [m^2]	Windhoogte [m]	Stuwdruk [kN/m^2]	Vormfactor [-]	$F_{h,iso}$ [kN]
380ct1f1	2,00	1	2	4,5	1,0	25,75	0,95	1,2	1,14
380ct1f2	2,00	1	2	4,5	1,0	25,75	0,95	1,2	1,14
380ct1f3	2,00	1	2	4,5	1,0	37,05	1,05	1,2	1,26
380ct2f1	2,00	1	2	4,5	1,0	25,75	0,95	1,2	1,14
380ct2f2	2,00	1	2	4,5	1,0	25,75	0,95	1,2	1,14
380ct2f3	2,00	1	2	4,5	1,0	37,05	1,05	1,2	1,26
bl1	0,10	1	0,1	0,3	0,1	39,15	1,06	1,2	0,13
bl2	0,10	1	0,1	0,3	0,1	39,15	1,06	1,2	0,13

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Windbelasting back

Geleider	hoogte wind [m]	Stuwdruk [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{toeslag}$ [mm]	w_y [N/m]	$w_{y,vak}$ [N/m]	$D_{ijs,toeslag}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,vak}$ [N/m]
380ct1f1	19,2	0,87	0,55	0,45	1,13	28,53	46,2	38,1	47,4	81,3	67,0
380ct1f2	19,2	0,87	0,55	0,45	1,13	28,53	46,2	38,1	47,4	81,3	67,0
380ct1f3	30,5	0,99	0,59	0,48	1,10	28,53	54,7	45,0	47,4	99,4	81,7
380ct2f1	19,2	0,87	0,55	0,45	1,13	28,53	46,2	38,1	47,4	81,3	67,0
380ct2f2	19,2	0,87	0,55	0,45	1,13	28,53	46,2	38,1	47,4	81,3	67,0
380ct2f3	30,5	0,99	0,59	0,48	1,10	28,53	54,7	45,0	47,4	99,4	81,7
bl1	35,7	1,04	0,60	0,49	1,20	22,35	16,7	13,7	41,8	31,2	25,6
bl2	35,7	1,04	0,60	0,49	1,20	22,35	16,7	13,7	41,8	31,2	25,6

Windbelasting ahead

Geleider	hoogte wind [m]	Stuwdruk [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{toeslag}$ [mm]	w_y [N/m]	$w_{y,vak}$ [N/m]	$D_{ijs,toeslag}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,vak}$ [N/m]
380ct1f1	18,6	0,86	0,55	0,45	1,14	28,53	45,7	37,7	47,4	80,1	66,0
380ct1f2	18,6	0,86	0,55	0,45	1,14	28,53	45,7	37,7	47,4	80,1	66,0
380ct1f3	29,9	0,99	0,58	0,48	1,10	28,53	54,4	44,7	47,4	98,5	81,0
380ct2f1	18,6	0,86	0,55	0,45	1,14	28,53	45,7	37,7	47,4	80,1	66,0
380ct2f2	18,6	0,86	0,55	0,45	1,14	28,53	45,7	37,7	47,4	80,1	66,0
380ct2f3	29,9	0,99	0,58	0,48	1,10	28,53	54,4	44,7	47,4	98,5	81,0
bl1	35,2	1,03	0,60	0,49	1,20	22,35	16,6	13,6	41,8	31,0	25,5
bl2	35,2	1,03	0,60	0,49	1,20	22,35	16,6	13,6	41,8	31,0	25,5

Uitgangspunten

Betrouwbaarheidsniveau	Afkeur CC2-0
Referentieperiode	30 jaar

ULS (bezwijksterkte)		NEN-EN50341-2-15:2019						
Belastingsgeval	omschrijving	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1,05	1,05	0,00	1,12	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,05	0,00	1,12	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,12	0,00	0,0
ULS 3	Wind+ijs	-5°	1,05	1,05	0,00	0,34	0,97	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,05	0,00	0,34	0,97	0,0
ULS 4	Koude+wind	-20°	1,05	1,05	0,00	0,22	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,05	0,00	0,22	0,00	0,0
ULS 5a	Torsional loads	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinal loads	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Construction + maintainence	5°	1,05	1,05	1,20	0,22	0,00	0,0
ULS 6_0,9	Construction + maintainence	5°	1,05	1,05	0,00	0,22	0,00	0,0
ULS 7	Permanent	10°	1,15	1,15	0,00	0,00	0,00	0,0
ULS 8	Special	10°	1,00	1,00	0,00	0,00	0,00	1,0
SPLS (Bezwijksterkte, enkel voor hoekmasten: afwezigheid geleiders)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1,05	1,05	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,05	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	1,05	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,05	1,05	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,05	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,05	1,05	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,05	0,0	0,24	0,00	0,0
SPLS 6	Onderhoud	5°	1,05	1,05	1,2	0,24	0,0	0,0
SPLS 6_0,9	Onderhoud	5°	1,05	1,05	0,0	0,24	0,0	0,0
SLS (controle van de vervormingen, vermoeiing, EDS)				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1,00	1,00	0,0	0,94	0,0	0,0
SLS 3	Wind+ijs	-5°	1,00	1,00	0,0	0,28	0,88	0,0
SLS 4	Wind	-20°	1,00	1,00	0,0	0,19	0,0	0,0
SLS 6	Onderhoud	5°	1,00	1,00	0,0	0,19	0,0	0,0
SLS 7	PB	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	44
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	440

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Samenvattingstabellen geleiderbelastingen

In de onderstaande vier tabellen is weergegeven:
- De maximale geleiderbelasting in het globale assenstelsel, gesplitst in aandeel van back en ahead span
- De gecombineerde geleiderbelasting in het globale assenstelsen met in het lokale assenstelsel de maximaal optredende trekkracht.
Componenten Fx en Fy als absolute waarde
- De alledaagse (EDS) waarden van de gecombineerde geleiderbelastingen (ba+Ah) met bijbehorende trekkrachten
- Controle op uplift, waar een negatieve waarde duidt op uplift
Note: Maximale waarden voor Fx, Fy en Fz behoren niet noodzakelijkerwijs tot dezelfde belastingscombinatie.

Maximale waarden voor back en ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-37,0	37,0	3,3	3,5	4,9	5,2
bl2	-37,0	37,0	3,3	3,5	4,9	5,2
380ct1f1	-132,2	132,2	9,7	10,1	14,4	15,1
380ct1f2	-132,2	132,2	9,7	10,1	14,4	15,1
380ct1f3	-134,1	134,1	11,4	12,0	14,4	15,1
380ct2f1	-132,2	132,2	9,7	10,1	14,4	15,1
380ct2f2	-132,2	132,2	9,7	10,1	14,4	15,1
380ct2f3	-134,1	134,1	11,4	12,0	14,4	15,1

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Maximale waarden back+ahead span — Maximale waarden trekkracht geleider

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	21,2	6,8	7,7	-40,0	40,0
bl2	21,2	6,8	7,7	-40,0	40,0
380ct1f1	65,2	19,8	29,5	-132,2	132,1
380ct1f2	65,2	19,8	29,5	-132,2	132,1
380ct1f3	65,2	23,4	29,5	-134,1	134,0
380ct2f1	65,2	19,8	29,5	-132,2	132,1
380ct2f2	65,2	19,8	29,5	-132,2	132,1
380ct2f3	65,2	23,4	29,5	-134,1	134,0

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	3,7	-21,2	21,2
bl2	0,0	0,0	3,7	-21,2	21,2
380ct1f1	0,0	0,0	18,6	-81,5	81,5
380ct1f2	0,0	0,0	18,6	-81,5	81,5
380ct1f3	0,0	0,0	18,6	-81,5	81,5
380ct2f1	0,0	0,0	18,6	-81,5	81,5
380ct2f2	0,0	0,0	18,6	-81,5	81,5
380ct2f3	0,0	0,0	18,6	-81,5	81,5

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 1a	bl1	1,8	1,9
	bl2	1,8	1,9
	380ct1f1	9,1	9,5
	380ct1f2	9,1	9,5
	380ct1f3	9,1	9,5
	380ct2f1	9,1	9,5
	380ct2f2	9,1	9,5
	380ct2f3	9,1	9,5

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

ULS-fundatiebelasting combinatie 1 en 3 wind haaks op de lijn of bissectrice en EDS, vanuit geleiders

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	140	125	4527	0	0
ULS 1a_0,9_90	0	140	125	4527	0	0
ULS 3_90	0	73	191	2374	0	0
ULS 3_0,9_90	0	73	191	2374	0	0
SLS 7	0	0	119	0	0	0

ULS-fundatiebelasting combinatie 1 en 3 wind haaks op de lijn of bissectrice en EDS, totaal geleiders en mast

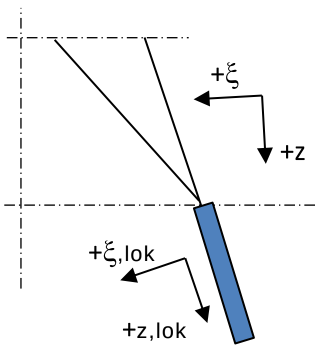
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	250	335	7107	0	0
ULS 3_90	0	106	401	3148	0	0
SLS 7	0	0	319	0	0	0

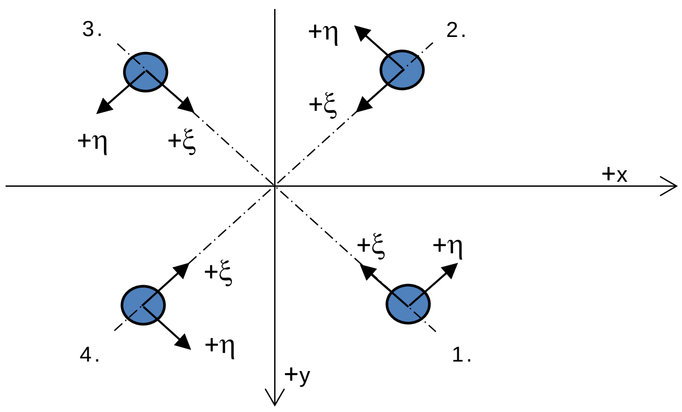
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_0,9_90	0	250	287	7107	0	0
ULS 1a_0	148	0	335	0	3890	0
ULS 5a Ba 10	65	0	319	124	1792	-997
ULS 1a_45	110	180	335	5031	2765	0

Noot: grootste waarden kunnen in meerdere combinaties voorkomen, een combinatie is weergegeven.

Oplegreacties op fundering per randstijl





Assenstelsels

Maximale drukbelasting

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_45	107	96	571	8	-144	-20	584
2	ULS 1a_0	54	-65	327	8	-84	-13	334
3	ULS 5a Ah 22	-9	-72	244	-45	-57	-4	250
4	ULS 1a_135	-107	96	571	-8	-144	-20	584

Maximale trekbelasting

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 22	-26	9	-85	-25	12	-6	-87
2	ULS 1a_0,9_0,9_135	-76	65	-415	8	100	10	-425
3	ULS 1a_0,9_0,9_45	76	65	-415	-8	100	10	-425
4	ULS 1a_0,9_0,9_0	23	-34	-171	-8	40	3	-175

Maximale torsiebelasting (positief)

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 10	32	-38	-24	49	4	-2	-25
2	ULS 5a Ba 21	3	-69	200	47	-51	-8	204
3	ULS 5a Ba 21	-32	38	-25	49	4	-2	-25
4	ULS 5a Ah 10	-3	69	200	47	-51	-8	204

Maximale torsiebelasting (negatief)

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ba 10	3	69	200	-47	-51	-8	204
2	ULS 5a Ah 21	32	38	-24	-49	4	-2	-25
3	ULS 5a Ah 21	-3	-69	200	-47	-51	-8	204
4	ULS 5a Ba 10	-32	-38	-25	-49	4	-2	-25

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Combinatie Ftrek+Fh

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 12	25	-40	-72	46	10	-5	-74
2	ULS 1a_0,9_0,9_135	-76	65	-415	8	100	10	-425
3	ULS 1a_0,9_0,9_45	76	65	-415	-8	100	10	-425
4	ULS 5a Ba 12	-25	-40	-72	-46	10	-5	-74

Permanente belasting

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	16	16	80	0	-22	-5	82
2	SLS 7	16	-16	80	0	-22	-5	82
3	SLS 7	-16	-16	80	0	-22	-5	82
4	SLS 7	-16	16	80	0	-22	-5	82

Omhullenden ongeacht stijl

Belasting	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. druk	ULS 1a_45	107	96	571	8	-144	-20	584
Max. trek	ULS 1a_0,9_0,9_45	76	65	-415	-8	100	10	-425
Max. pos. torsie	ULS 5a Ah 10	32	-38	-24	49	4	-2	-25
Max. neg. torsie	ULS 5a Ah 21	32	38	-24	-49	4	-2	-25
Comb. trek+torsie	ULS 1a_0,9_45	76	65	-415	-8	100	10	-425

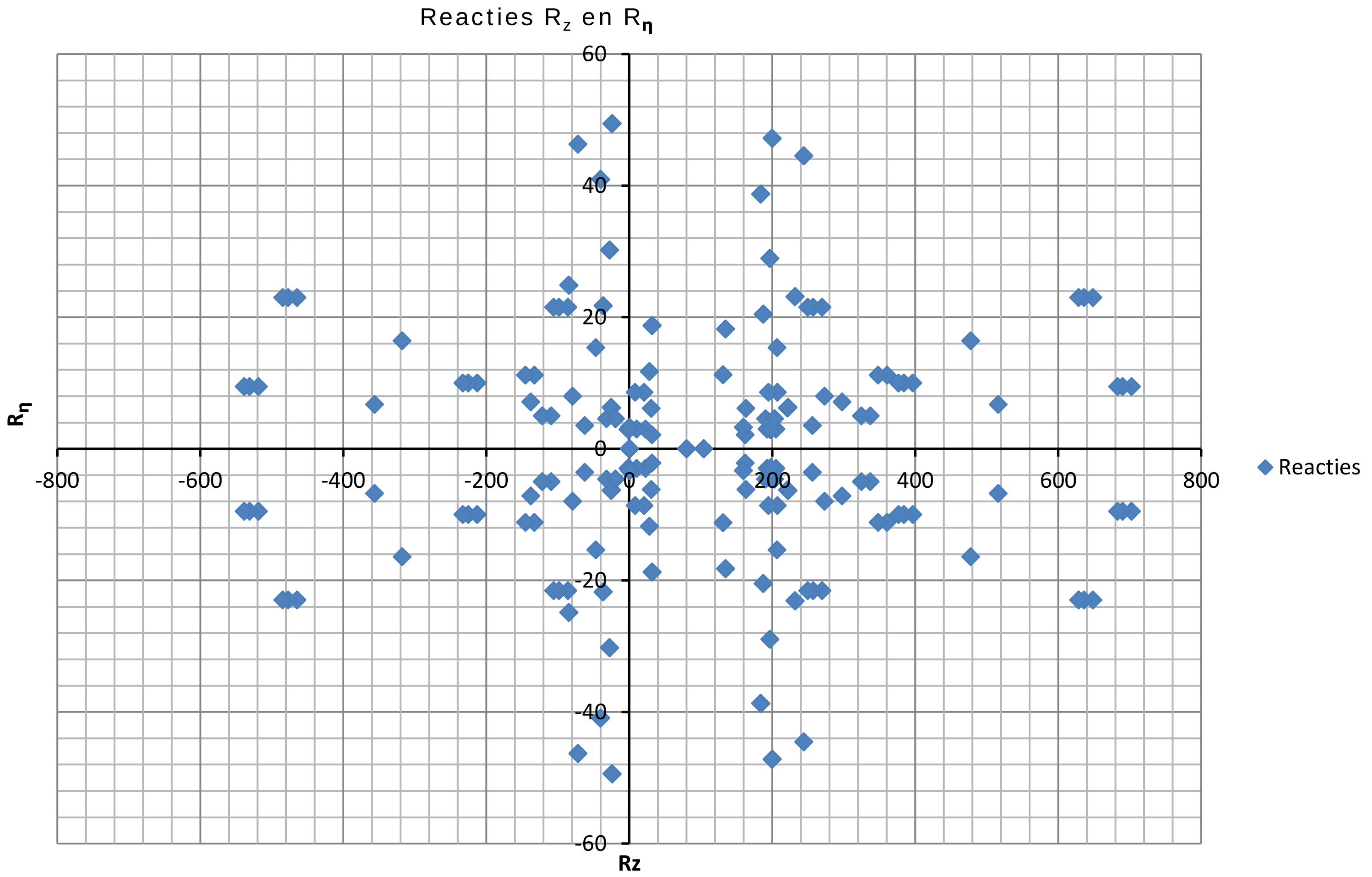
Maximale trekbelasting SLS

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	16	16	80	0	-22	-5	82
2	SLS 1a_135	-60	51	-332	6	79	7	-339
3	SLS 1a_45	60	51	-332	-6	79	7	-339
4	SLS 1a_0	15	-25	-126	-7	29	1	-128

Maximale drukbelasting SLS

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_45	92	83	491	6	-124	-17	503
2	SLS 1a_0	47	-57	285	7	-74	-12	292
3	SLS 7	-16	-16	80	0	-22	-5	82
4	SLS 1a_135	-92	83	491	-6	-124	-17	503

Project: ENS-ZL
Masttype: S-6 R
Mast: 22



Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Geleiderbelastingen

Auteur: TBR
Versie: v10.4

Uitgangspunten

Betrouwbaarheidsniveau Verbouw CC2
Referentieperiode 50 jaar

ULS	(bezwijksterkte)	NEN-EN50341-2-15:2019						
Belastingsgeval	omschrijving	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1,15	1,15	0,00	1,40	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,15	0,00	1,40	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,40	0,00	0,0
ULS 3	Wind+ijs	-5°	1,15	1,15	0,00	0,42	1,30	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,15	0,00	0,42	1,30	0,0
ULS 4	Koude+wind	-20°	1,15	1,15	0,00	0,28	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,15	0,00	0,28	0,00	0,0
ULS 5a	Torsional loads	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinal loads	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Construction + maintainence	5°	1,15	1,15	1,30	0,28	0,00	0,0
ULS 6_0,9	Construction + maintainence	5°	1,15	1,15	0,00	0,28	0,00	0,0
ULS 7	Permanent	10°	1,30	1,30	0,00	0,00	0,00	0,0
ULS 8	Special	10°	1,00	1,00	0,00	0,00	0,00	1,0
SPLS	(Bezwijksterkte, enkel voor hoekmasten: afwezigheid geleiders)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1,15	1,15	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,15	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	1,15	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,15	1,15	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,15	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,15	1,15	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,15	0,0	0,24	0,00	0,0
SPLS 6	Onderhoud	5°	1,15	1,15	1,2	0,24	0,0	0,0
SPLS 6_0,9	Onderhoud	5°	1,15	1,15	0,0	0,24	0,0	0,0
SLS	(controle van de vervormingen, vermoeiing, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1,00	1,00	0,0	1,00	0,0	0,0
SLS 3	Wind+ijs	-5°	1,00	1,00	0,0	0,30	1,00	0,0
SLS 4	Wind	-20°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 6	Onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	44
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	440

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Samenvattingstabellen geleiderbelastingen

In de onderstaande vier tabellen is weergegeven:
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- De gecombineerde geleiderbelasting in het globale assenstelsen met in het lokale assenstelsel de maximaal optredende trekkracht.
Componenten Fx en Fy als absolute waarde
- De alledaagse (EDS) waarden van de gecombineerde geleiderbelastingen (ba+Ah) met bijbehorende trekkrachten
- Controle op uplift, waar een negatieve waarde duidt op uplift
Note: Maximale waarden voor Fx, Fy en Fz behoren niet noodzakelijkerwijs tot dezelfde belastingscombinatie.

Maximale waarden voor back en ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-41,9	41,9	4,2	4,4	5,4	5,6
bl2	-41,9	41,9	4,2	4,4	5,4	5,6
380ct1f1	-150,4	150,4	12,1	12,7	17,0	17,8
380ct1f2	-150,4	150,4	12,1	12,7	17,0	17,8
380ct1f3	-152,8	152,8	14,3	15,0	17,0	17,8
380ct2f1	-150,4	150,4	12,1	12,7	17,0	17,8
380ct2f2	-150,4	150,4	12,1	12,7	17,0	17,8
380ct2f3	-152,8	152,8	14,3	15,0	17,0	17,8

DNV·GL

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Maximale waarden back+ahead span / Maximale waarden trekkracht geleider

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	21,2	8,6	8,4	-42,4	42,4
bl2	21,2	8,6	8,4	-42,4	42,4
380ct1f1	65,2	24,8	34,8	-150,5	150,4
380ct1f2	65,2	24,8	34,8	-150,5	150,4
380ct1f3	65,2	29,4	34,8	-152,8	152,7
380ct2f1	65,2	24,8	34,8	-150,5	150,4
380ct2f2	65,2	24,8	34,8	-150,5	150,4
380ct2f3	65,2	29,4	34,8	-152,8	152,7

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	3,7	-21,2	21,2
bl2	0,0	0,0	3,7	-21,2	21,2
380ct1f1	0,0	0,0	18,6	-81,5	81,5
380ct1f2	0,0	0,0	18,6	-81,5	81,5
380ct1f3	0,0	0,0	18,6	-81,5	81,5
380ct2f1	0,0	0,0	18,6	-81,5	81,5
380ct2f2	0,0	0,0	18,6	-81,5	81,5
380ct2f3	0,0	0,0	18,6	-81,5	81,5

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 1a	bl1	1,8	1,9
	bl2	1,8	1,9
	380ct1f1	9,1	9,5
	380ct1f2	9,1	9,5
	380ct1f3	9,1	9,5
	380ct2f1	9,1	9,5
	380ct2f2	9,1	9,5
	380ct2f3	9,1	9,5

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

ULS-fundatiebelasting combinatie 1 en 3 wind haaks op de lijn of bissectrice en EDS, vanuit geleiders

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	175	137	5675	0	0
ULS 1a_0,9_90	0	175	137	5675	0	0
ULS 3_90	0	92	225	2976	0	0
ULS 3_0,9_90	0	92	225	2976	0	0
SLS 7	0	0	119	0	0	0

ULS-fundatiebelasting combinatie 1 en 3 wind haaks op de lijn of bissectrice en EDS, totaal geleiders en mast

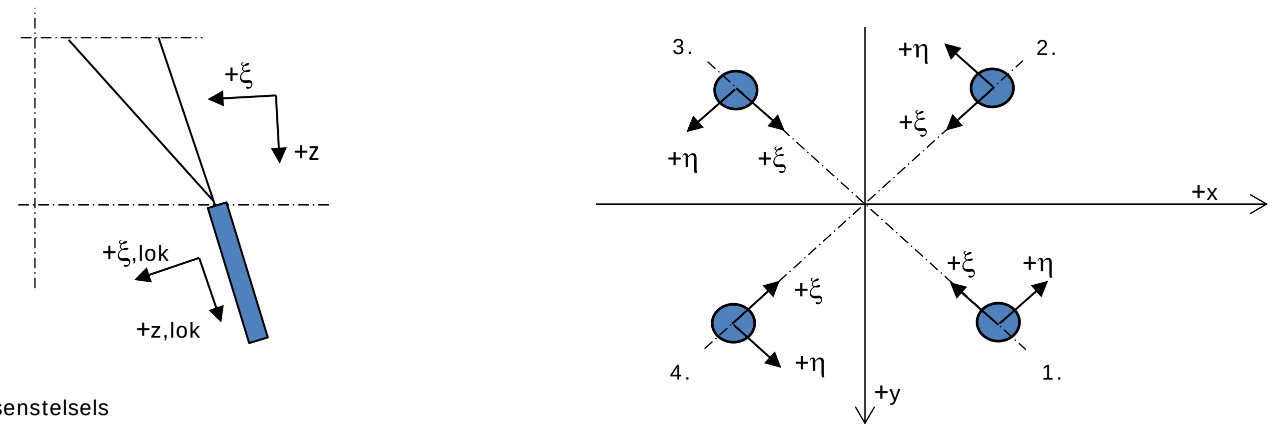
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	313	367	8909	0	0
ULS 3_90	0	133	455	3946	0	0
SLS 7	0	0	319	0	0	0

Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	313	367	8909	0	0
ULS 1a_0	186	0	367	0	4876	0
ULS 5a Ba 10	65	0	319	124	1792	-997
ULS 1a_45	138	226	367	6307	3467	0

Noot: grootste waarden kunnen in meerdere combinaties voorkomen, een combinatie is weergegeven.

Oplegreacties op fundering per randstijl



Assenstelsels

Maximale drukbelasting

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_45	131	118	703	9	-176	-24	719
2	ULS 1a_0	65	-79	397	10	-102	-16	406
3	ULS 5a Ah 22	-9	-72	244	-45	-57	-4	250
4	ULS 1a_135	-131	118	703	-9	-176	-24	719

Maximale trekbelasting

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 22	-26	9	-85	-25	12	-6	-87
2	ULS 1a_0,9_0,9_135	-99	85	-539	9	130	13	-552
3	ULS 1a_0,9_0,9_45	99	85	-539	-9	130	13	-552
4	ULS 1a_0,9_0,9_0	32	-46	-233	-10	56	5	-238

Maximale torsiebelasting (positief)

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 10	32	-38	-24	49	4	-2	-25
2	ULS 5a Ba 21	3	-69	200	47	-51	-8	204
3	ULS 5a Ba 21	-32	38	-25	49	4	-2	-25
4	ULS 5a Ah 10	-3	69	200	47	-51	-8	204

Maximale torsiebelasting (negatief)

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ba 10	3	69	200	-47	-51	-8	204
2	ULS 5a Ah 21	32	38	-24	-49	4	-2	-25
3	ULS 5a Ah 21	-3	-69	200	-47	-51	-8	204
4	ULS 5a Ba 10	-32	-38	-25	-49	4	-2	-25

Project: ENS-ZL
Masttype: S-6 R
Mast: 22

Combinatie Ftrek+Fh

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 12	25	-40	-72	46	10	-5	-74
2	ULS 1a_0,9_0,9_135	-99	85	-539	9	130	13	-552
3	ULS 1a_0,9_0,9_45	99	85	-539	-9	130	13	-552
4	ULS 1a_0,9_0,9_0	32	-46	-233	-10	56	5	-238

Permanente belasting

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	16	16	80	0	-22	-5	82
2	SLS 7	16	-16	80	0	-22	-5	82
3	SLS 7	-16	-16	80	0	-22	-5	82
4	SLS 7	-16	16	80	0	-22	-5	82

Omhullenden ongeacht stijl

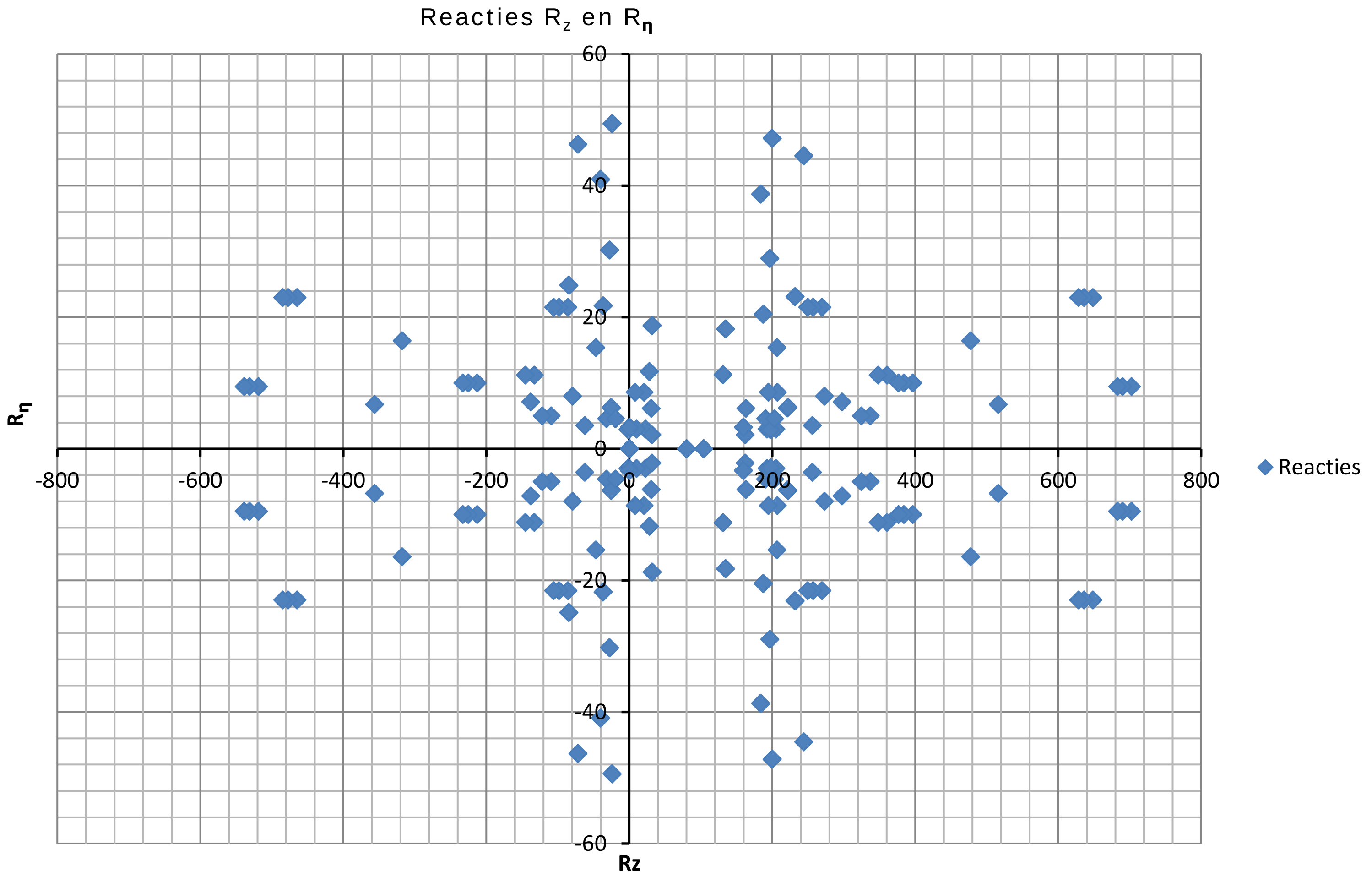
Belasting	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. druk	ULS 1a_45	131	118	703	9	-176	-24	719
Max. trek	ULS 1a_0,9_0,9_45	99	85	-539	-9	130	13	-552
Max. pos. torsie	ULS 5a Ah 10	32	-38	-24	49	4	-2	-25
Max. neg. torsie	ULS 5a Ah 21	32	38	-24	-49	4	-2	-25
Comb. trek+torsie	ULS 1a_0,9_45	99	85	-539	-9	130	13	-552

Maximale trekbelasting SLS

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	16	16	80	0	-22	-5	82
2	SLS 1a_135	-65	55	-357	7	85	8	-365
3	SLS 1a_45	65	55	-357	-7	85	8	-365
4	SLS 1a_0	17	-27	-138	-7	32	2	-141

Maximale drukbelasting SLS

Stijl	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_45	97	87	516	7	-130	-18	528
2	SLS 1a_0	49	-59	297	7	-77	-12	304
3	SLS 7	-16	-16	80	0	-22	-5	82
4	SLS 1a_135	-97	87	516	-7	-130	-18	528


Reacties R_z en R_η
60
40
20
0
-20
-40
-60
-800
-600
-400
-200
0
200
400
600
800
R_η
Rz
Reacties

Content

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	III
Wind speed	24.5 m/s
Terrain categorie	II
Reduction factor Cdir	1.00
Ice region	B
Tower type	Steunmast
Tower height	43.4 m
Max. Span	305.2 m
Line angle	180°
Catenary	1760 m
Wind span	298 m
EDS Weight span	180 m
Min. Weight span	23 m
Max. Weight span	191 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-02-19			

Client:

TenneT Taking power further

DNV·GL

Title:

Berekening masttype S-6 R

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_S-6 R_28_Report.pdf

Project number:

Project client number:

0.0

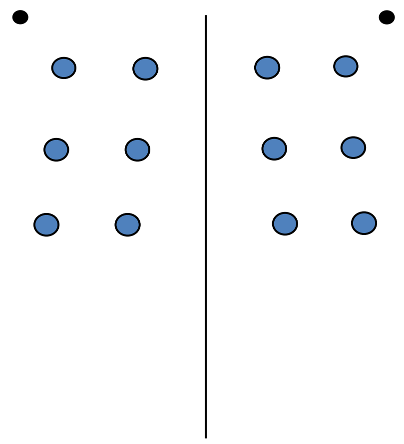
Project: ENS-ZL
Tower: S-6 R
Number: 28

Conductor loads

Auteur: TBR
Versie: v11.6

General

Description	S-6 R
Tower type	Steunmast
Number of circuits	2
Configuration	2-circuit-donau
Number of earth wires	2



Configuratie geleiders

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	III
Terrain category	24.5 m/s
Reduction factor c_{dir}	II
Ice region phase conductor	1.00
Ice region earth conductor	B
	B

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area [m^2]
Circuit 1	V-ketting	3.00	4.50	2.00
Circuit 2	V-ketting	3.00	4.50	2.00
Bliksemdraad 1	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 2	Vast (Bliksemdraad)	0.10	0.30	0.10

1. Properties apply to the entire isolator set

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower Horizontal distance
Circuit 1	10	380ct1f1	23.0 m	27.5 m	-12.4 m
Circuit 1	11	380ct1f2	23.0 m	27.5 m	-5.7 m
Circuit 1	12	380ct1f3	34.3 m	38.8 m	-9.1 m
Circuit 2	21	380ct2f1	23.0 m	27.5 m	12.4 m
Circuit 2	20	380ct2f2	23.0 m	27.5 m	5.7 m
Circuit 2	22	380ct2f3	34.3 m	38.8 m	9.1 m
Bliksemdraad 1	1	bl1	38.5 m	38.8 m	-16.0 m
Bliksemdraad 2	3	bl2	38.5 m	38.8 m	16.0 m

Project: ENS-ZL
Tower: S-6 R
Number: 28

Height adjustment adjacent masts (wind and weight span adjustment)

	Back	Ahead	
Height increase for wind pressure	0.0 m	0.0 m	(positive: higher)
Height decrease for vertical load	0.0 m	0.0 m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

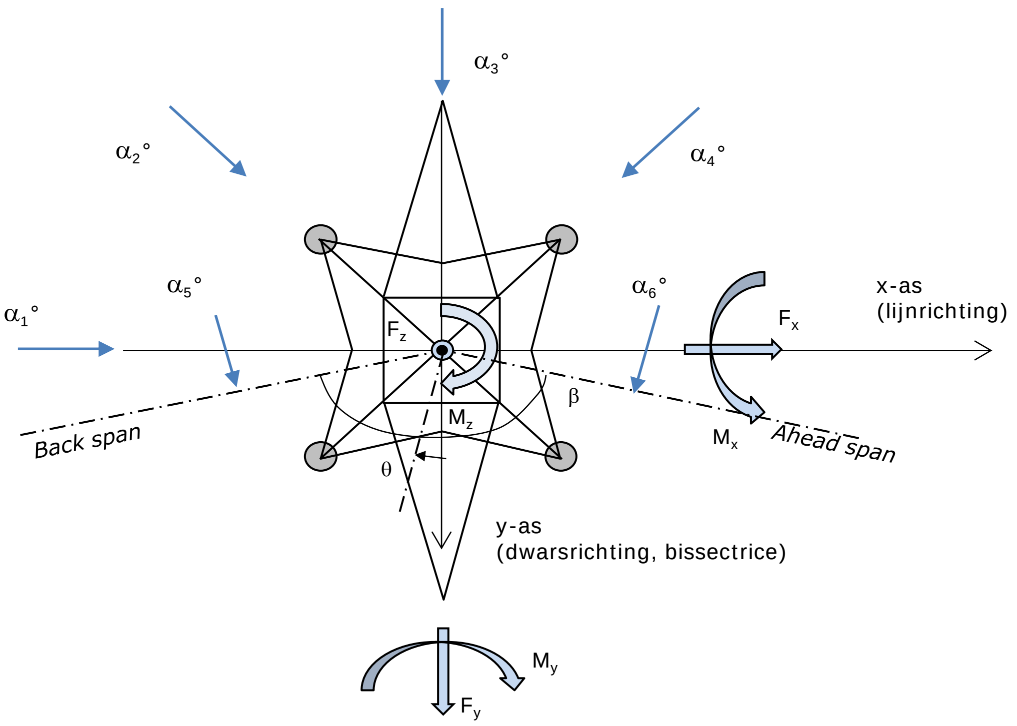
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	19.8	-0.4 m	0.0	0.0 m
Circuit 1	11	380ct1f2	19.8	-0.4 m	0.0	0.0 m
Circuit 1	12	380ct1f3	19.8	-0.4 m	0.0	0.0 m
Circuit 2	21	380ct2f1	19.8	-0.4 m	0.0	0.0 m
Circuit 2	20	380ct2f2	19.8	-0.4 m	0.0	0.0 m
Circuit 2	22	380ct2f3	19.8	-0.4 m	0.0	0.0 m
Bliksemdraad 1	1	bl1	19.8	-0.4 m	0.0	0.0 m
Bliksemdraad 2	3	bl2	19.8	-0.4 m	0.0	0.0 m

Line and tower data

		Back	Ahead
		290.2	305.2 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		343.9	343.9 m
Line angle	β	180 °	
Tower orientation with respect to bis	θ	0 °	
Section length		5416	5416 m
Height bottom of tower to ground level		0.5 m	
Wind directions considered	α_1	0 °	
Wind directions according to:	α_2	45 °	
Geleiderbelastingen	α_3	90 °	
	α_4	135 °	
	α_5	- °	
	α_6	- °	

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Considered number of wind directions	
1a	4
3	4
4	1
6	1
Overig	1

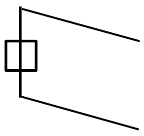
Absence of conductors

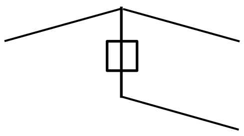
		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	0.8	0
Circuit 1	380ct1f2	1	0	1	0	0.8	0
Circuit 1	380ct1f3	1	0	1	0	0.8	0
Circuit 2	380ct2f1	0	1	1	0	0.8	0
Circuit 2	380ct2f2	0	1	1	0	0.8	0
Circuit 2	380ct2f3	0	1	1	0	0.8	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

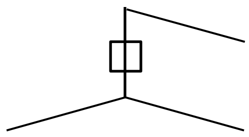
Load situations SPLS

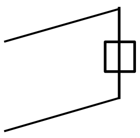
Considered situations SPLS: SPLS for suspension tower not applicable

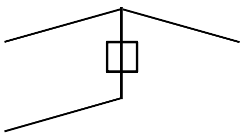
Principle of load situations:

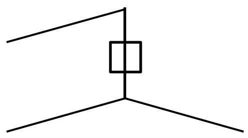

1. Ba All cts


2. Ba ct1


3. Ba ct2


4. Ah All cts

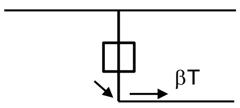

5. Ah ct1


6. Ah ct2

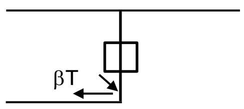
Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



1. Ba



2. Ah

Project: ENS-ZL
Tower: S-6 R
Number: 28

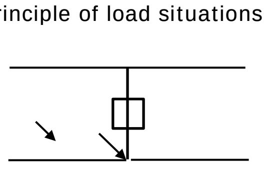
Load situations LC6. Construction and maintenance
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

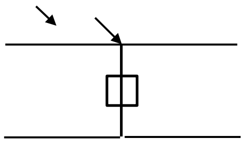
3.0 kN	2.0 kN
1.0 kN	1.0 kN

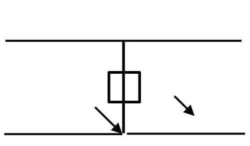
Considered situations construction and maintenance 6a: 1 up to 4, all possible situations

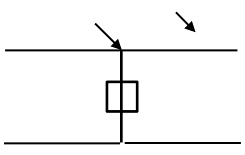
Presence line vehicle: Circuit, load present in all conductors of a circuit

Principle of load situations:


1. Ba Ct1


2. Ba Ct2


3. Ah Ct1


4. Ah Ct2

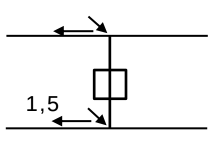
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0.866 W	1.5 W
Suspension tower earth	1.5 EDS	1.5 W
Strain tower phase and earth	1.5 EDS	1.5 W

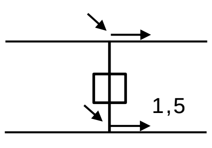
Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



1. Ba



2. Ah

Load combination 8. Galloping as a dynamic load
Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

Project: ENS-ZL
Tower: S-6 R
Number: 28

Tower structure

Properties

Tower type	Steunmast	
Tower designation	S-6 R	
Base plate w.r.t. ground level	0.5	m
Tower height w.r.t. base plate	43.4	m
Tower self weight	200.0	kN

Width and slope at foundation	x-ri.	y-ri.	
Leg spread	8.00	8.00	m
Inclination of main leg	0.153	0.153	-
Horizontal force factor	1.3	1.3	-

Calculation Wind load

Dynamic factor G_T	1.00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross a	0.4

Properties mast sections longitudinal direction (front view, yz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	9.80	8.00	5.00	9.80	0.153	63.70	8.49	0.13	3.24
Eerste tussenstuk	18.05	5.00	4.07	8.25	0.056	37.41	6.41	0.17	3.06
Tweede tussenstuk	27.50	4.07	3.00	9.45	0.057	33.40	7.92	0.24	2.77
Bovenstuk 1	33.40	3.00	2.58	5.90	0.036	16.45	4.06	0.25	2.73
Bovenstuk 2	41.40	2.58	2.00	8.00	0.036	18.30	4.44	0.24	2.75
Topstuk	43.40	2.00		2.00		2.00	0.36	0.18	3.02
Ondertraverse	27.50	13.80		3.00		20.70	4.66	0.22	2.82
Boventraverse	38.80	15.00		2.60		19.50	4.82	0.25	2.73

Properties tower sections transversal direction (side view, xz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	9.80	8.00	5.00	9.80	0.153	63.70	8.49	0.13	3.24
Eerste tussenstuk	18.05	5.00	4.07	8.25	0.056	37.41	6.41	0.17	3.06
Tweede tussenstuk	27.50	4.07	3.00	9.45	0.057	33.40	7.92	0.24	2.77
Bovenstuk 1	33.40	3.00	2.58	5.90	0.036	16.45	4.06	0.25	2.73
Bovenstuk 2	41.40	2.58	2.00	8.00	0.036	18.30	4.44	0.24	2.75
Topstuk	43.40	2.00		2.00		2.00	0.36	0.18	3.02
Ondertraverse	27.50	13.80		3.00		20.70	4.66	0.22	2.82
Boventraverse	38.80	15.00		2.60		19.50	4.82	0.25	2.73

Note: Surface transverse direction is reduced in calculation.

DNV·GL

Project: ENS-ZL
Tower: S-6 R
Number: 28

Wind surface feeders telecom installations				
Part	A (m^2/m)	Factor	Δh	A_1
Broekstuk				
Eerste tussenstuk				
Tweede tussenstuk				
Bovenstuk 1				
Bovenstuk 2				

Input antennas			
Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	19.3	16.4	0.0	-16.4	4.9	94.5	80.2	0.0	-80.2
Eerste tussenstuk	0.78	15.4	13.0	0.0	-13.0	13.9	213.8	181.4	0.0	-181.4
Tweede tussenstuk	0.91	20.1	17.0	0.0	-17.0	22.8	456.7	387.5	0.0	-387.5
Bovenstuk 1	1.00	11.1	9.4	0.0	-9.4	30.5	337.3	286.2	0.0	-286.2
Bovenstuk 2	1.05	12.8	10.9	0.0	-10.9	37.4	480.1	407.4	0.0	-407.4
Topstuk	1.09	1.2	1.0	0.0	-1.0	42.4	49.9	42.3	0.0	-42.3
Ondertraverse	0.97	25.6	15.2	0.0	-15.2	28.5	730.1	433.7	0.0	-433.7
Boventraverse	1.07	28.1	16.7	0.0	-16.7	39.7	1116.0	662.9	0.0	-662.9
Totaal		133.5	99.6	0.0	-99.6		3478.5	2481.7	0.0	-2481.7

Tower section loads transversal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	0.0	16.4	19.3	16.4	4.9	0.0	80.2	94.5	80.2
Eerste tussenstuk	0.78	0.0	13.0	15.4	13.0	13.9	0.0	181.4	213.8	181.4
Tweede tussenstuk	0.91	0.0	17.0	20.1	17.0	22.8	0.0	387.5	456.7	387.5
Bovenstuk 1	1.00	0.0	9.4	11.1	9.4	30.5	0.0	286.2	337.3	286.2
Bovenstuk 2	1.05	0.0	10.9	12.8	10.9	37.4	0.0	407.4	480.1	407.4
Topstuk	1.09	0.0	1.0	1.2	1.0	42.4	0.0	42.3	49.9	42.3
Ondertraverse	0.97	0.0	15.2	10.2	15.2	28.5	0.0	433.7	292.0	433.7
Boventraverse	1.07	0.0	16.7	11.3	16.7	39.7	0.0	662.9	446.4	662.9
Total		0.0	99.6	101.3	99.6		0.0	2481.7	2370.8	2481.7

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	200	0	0	0
Windrichting 0°	134	0	0	0	3478	0
Windrichting 45°	100	100	0	2482	2482	0
Windrichting 90°	0	101	0	2371	0	0
Windrichting 135°	-100	100	0	2482	-2482	0

Project: ENS-ZL
Tower: S-6 R
Number: 28

Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m^2]	Wind heigth [m]	Pressure [kN/m^2]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	3.00	1	3	4.5	2.0	25.75	0.95	1.2	2.27
380ct1f2	3.00	1	3	4.5	2.0	25.75	0.95	1.2	2.27
380ct1f3	3.00	1	3	4.5	2.0	37.05	1.05	1.2	2.52
380ct2f1	3.00	1	3	4.5	2.0	25.75	0.95	1.2	2.27
380ct2f2	3.00	1	3	4.5	2.0	25.75	0.95	1.2	2.27
380ct2f3	3.00	1	3	4.5	2.0	37.05	1.05	1.2	2.52
bl1	0.10	1	0.1	0.3	0.1	39.15	1.06	1.2	0.13
bl2	0.10	1	0.1	0.3	0.1	39.15	1.06	1.2	0.13

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Wind load back

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	29.4	0.98	0.60	0.48	1.10	28.53	55.5	44.4	47.4	100.4	80.4
380ct1f2	29.4	0.98	0.60	0.48	1.10	28.53	55.5	44.4	47.4	100.4	80.4
380ct1f3	40.7	1.08	0.63	0.50	1.08	28.53	61.9	49.4	47.4	114.7	91.6
380ct2f1	29.4	0.98	0.60	0.48	1.10	28.53	55.5	44.4	47.4	100.4	80.4
380ct2f2	29.4	0.98	0.60	0.48	1.10	28.53	55.5	44.4	47.4	100.4	80.4
380ct2f3	40.7	1.08	0.63	0.50	1.08	28.53	61.9	49.4	47.4	114.7	91.6
bl1	45.6	1.11	0.63	0.51	1.19	22.35	18.7	15.0	41.8	35.3	28.2
bl2	45.6	1.11	0.63	0.51	1.19	22.35	18.7	15.0	41.8	35.3	28.2

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	18.9	0.86	0.56	0.45	1.14	28.53	47.1	37.9	47.4	82.7	66.5
380ct1f2	18.9	0.86	0.56	0.45	1.14	28.53	47.1	37.9	47.4	82.7	66.5
380ct1f3	30.2	0.99	0.60	0.48	1.10	28.53	56.0	44.8	47.4	101.5	81.3
380ct2f1	18.9	0.86	0.56	0.45	1.14	28.53	47.1	37.9	47.4	82.7	66.5
380ct2f2	18.9	0.86	0.56	0.45	1.14	28.53	47.1	37.9	47.4	82.7	66.5
380ct2f3	30.2	0.99	0.60	0.48	1.10	28.53	56.0	44.8	47.4	101.5	81.3
bl1	35.1	1.03	0.61	0.49	1.20	22.35	17.0	13.6	41.8	31.8	25.4
bl2	35.1	1.03	0.61	0.49	1.20	22.35	17.0	13.6	41.8	31.8	25.4

Project: ENS-ZL
Tower: S-6 R
Number: 28

Conductor loads	Auteur: TBR
	Versie: v11.6

Starting points

Consequence class	Afkeur CC2-0
Reference period	30 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.05	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.12	0.00	0.0
ULS 3	Wind+ice	-5°	1.05	1.05	0.00	0.34	0.97	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.05	0.00	0.34	0.97	0.0
ULS 4	Cold+wind	-20°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.05	0.00	0.22	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.05	1.05	1.20	0.22	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 7	Permanent	10°	1.15	1.15	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.05	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.05	1.05	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.05	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.05	1.05	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.05	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.05	1.05	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.05	1.05	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	0.94	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.28	0.88	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	4
Number of load combinations for ULS	44
Number of load combinations for SPLS	0
Number of load combinations for SLS	11
Number of concentrated loads	440

Project: ENS-ZL
Tower: S-6 R
Number: 28

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-37.3	37.3	3.1	3.0	1.5	4.5
380ct1f1	-133.0	133.0	10.3	9.3	4.4	13.4
380ct1f2	-133.0	133.0	10.3	9.3	4.4	13.4
380ct1f3	-134.8	134.8	11.4	10.9	4.3	13.4
380ct2f1	-133.0	133.0	10.3	9.3	4.4	13.4
380ct2f2	-133.0	133.0	10.3	9.3	4.4	13.4
380ct2f3	-134.8	134.8	11.4	10.9	4.3	13.4
bl2	-37.3	37.3	3.1	3.0	1.5	4.5

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	93.2	115.5	157.0
380ct1f1	147.8	157.8	179.7
380ct1f2	147.8	157.8	179.7
380ct1f3	141.7	157.4	179.7
380ct2f1	147.8	157.8	179.7
380ct2f2	147.8	157.8	179.7
380ct2f3	141.7	157.4	179.7
bl2	93.2	115.5	157.0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	159.1	172.5
380ct1f1	180.9	185.0
380ct1f2	180.9	185.0
380ct1f3	180.9	185.0
380ct2f1	180.9	185.0
380ct2f2	180.9	185.0
380ct2f3	180.9	185.0
bl2	159.1	172.5

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	188.3 m	0.633 -
Min. weight span	55.7 m	0.187 -

Project: ENS-ZL
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Maximum values back + ahead span / Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	21.2	6.1	5.0	-40.1	40.0
380ct1f1	65.2	19.6	17.3	-133.9	132.2
380ct1f2	65.2	19.6	17.3	-133.9	132.2
380ct1f3	65.2	22.4	17.3	-135.6	134.0
380ct2f1	65.2	19.6	17.3	-133.9	132.2
380ct2f2	65.2	19.6	17.3	-133.9	132.2
380ct2f3	65.2	22.4	17.3	-135.6	134.0
bl2	21.2	6.1	5.0	-40.1	40.0

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0.0	0.0	1.7	-21.2	21.2
380ct1f1	0.0	0.0	11.3	-81.5	81.5
380ct1f2	0.0	0.0	11.3	-81.5	81.5
380ct1f3	0.0	0.0	11.3	-81.5	81.5
380ct2f1	0.0	0.0	11.3	-81.5	81.5
380ct2f2	0.0	0.0	11.3	-81.5	81.5
380ct2f3	0.0	0.0	11.3	-81.5	81.5
bl2	0.0	0.0	1.7	-21.2	21.2

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	-0.4	1.6
	380ct1f1	1.6	8.7
	380ct1f2	1.6	8.7
	380ct1f3	1.6	8.7
	380ct2f1	1.6	8.7
	380ct2f2	1.6	8.7
	380ct2f3	1.6	8.7
	bl2	-0.4	1.6

Project: ENS-ZL
Tower: S-6 R
Number: 28

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	135	62	4359	0	0
ULS 1a_0,9_90		0	135	62	4359	0	0
ULS 3_90		0	69	107	2250	0	0
ULS 3_0,9_90		0	69	107	2250	0	0
SLS 7		0	0	71	0	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

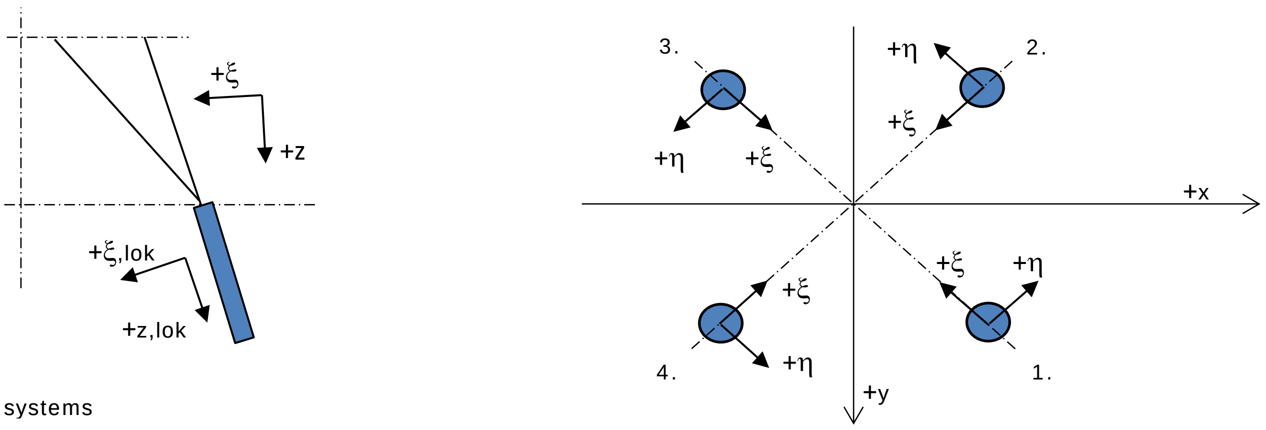
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	248	272	7007	0	0
ULS 3_90	0	103	317	3044	0	0
SLS 7	0	0	271	0	0	0

Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	248	272	7007	0	0
ULS 1a_0	157	0	285	0	4144	0
ULS 5a Ba 10	65	0	278	14	1792	-807
ULS 1a_135	-117	182	281	5056	-2955	0

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_45	106	96	571	7	-143	-20	584
2	ULS 1a_0	54	-66	330	9	-84	-13	338
3	ULS 5a Ah 22	-12	-63	230	-36	-53	-4	235
4	ULS 1a_135	-106	96	571	-7	-143	-20	584

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 22	-22	1	-94	-16	15	-5	-96
2	ULS 1a_0,9_0,9_135	-80	70	-441	7	107	11	-451
3	ULS 1a_0,9_0,9_45	80	70	-441	-7	107	11	-451
4	ULS 1a_0,9_0,9_0	27	-39	-198	-9	47	4	-203

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 10	24	-34	-38	41	7	-1	-39
2	ULS 5a Ba 21	5	-61	182	40	-47	-7	187
3	ULS 5a Ba 21	-23	34	-42	40	8	-1	-43
4	ULS 5a Ah 10	-6	61	186	39	-47	-7	190

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	ULS 5a Ba 10	5	61	182	-40	-47	-7	187
2	ULS 5a Ah 21	24	34	-38	-41	7	-1	-39
3	ULS 5a Ah 21	-6	-61	186	-39	-47	-7	190
4	ULS 5a Ba 10	-23	-34	-42	-40	8	-1	-43

Project: ENS-ZL
Tower: S-6 R
Number: 28

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 12	17	-36	-86	37	14	-5	-88
2	ULS 1a_0,9_0,9_135	-80	70	-441	7	107	11	-451
3	ULS 1a_0,9_0,9_45	80	70	-441	-7	107	11	-451
4	ULS 1a_0,9_0,9_0	27	-39	-198	-9	47	4	-203

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	uls 1a_90	101	76	506	18	-125	-15	518
2	uls 1a_90	-74	49	-370	18	86	6	-379
3	uls 1a_90	74	49	-370	-18	86	6	-379
4	uls 1a_90	-101	76	506	-18	-125	-15	518

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_45	106	96	571	7	-143	-20	584
Max. tension	ULS 1a_0,9_0,9_45	80	70	-441	-7	107	11	-451
Max. pos. torsie	ULS 5a Ah 10	24	-34	-38	41	7	-1	-39
Max. neg. torsie	ULS 5a Ah 21	24	34	-38	-41	7	-1	-39
Comb. tension+torsie	ULS 1a_45	80	70	-441	-7	107	11	-451

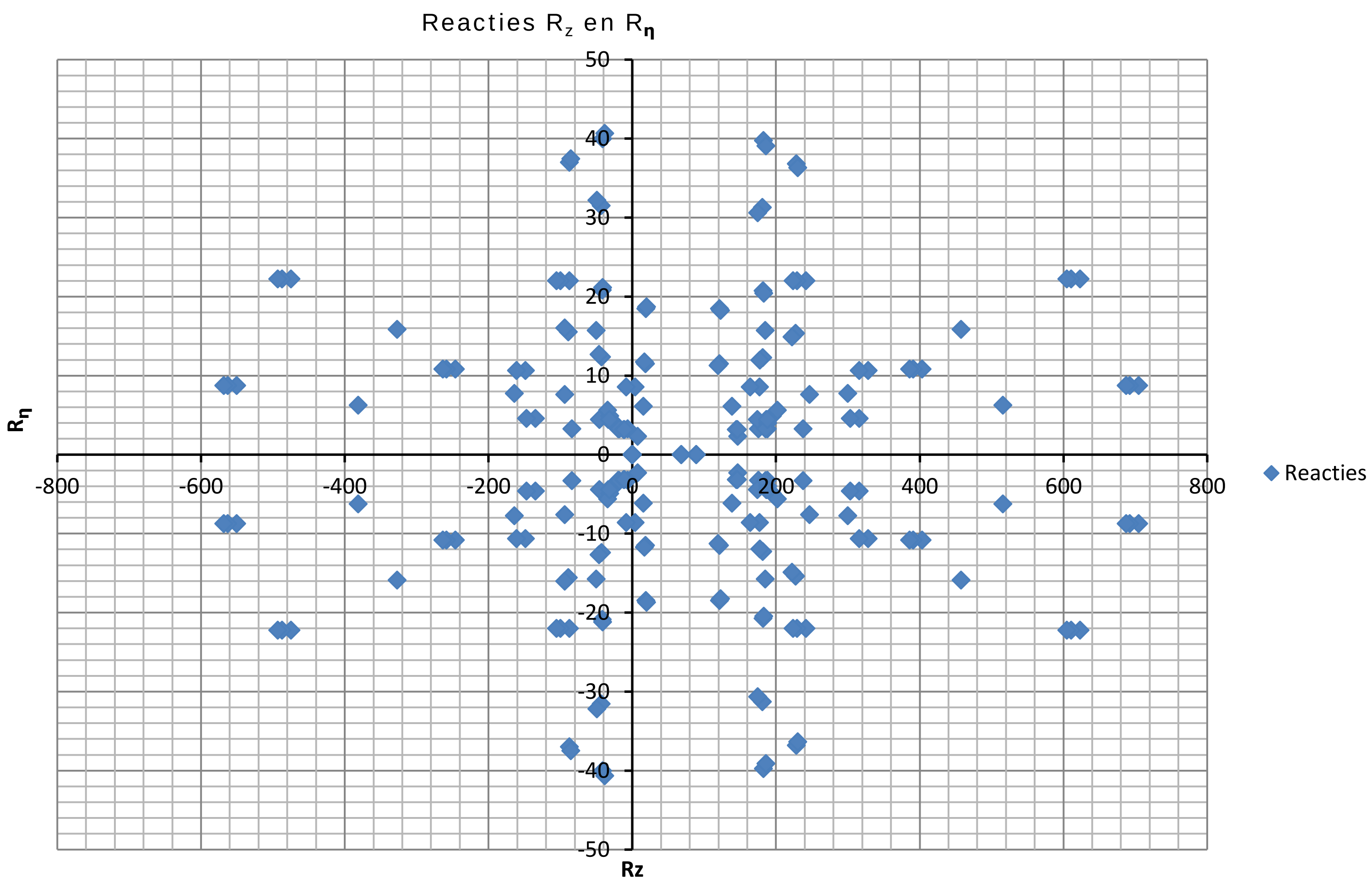
Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	13	13	68	0	-19	-4	69
2	SLS 1a_135	-64	56	-356	6	85	8	-364
3	SLS 1a_45	64	56	-356	-6	85	8	-364
4	SLS 1a_0	20	-30	-151	-7	35	3	-154

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_45	91	83	490	6	-123	-17	501
2	SLS 1a_0	47	-57	287	7	-73	-11	293
3	SLS 7	-13	-13	68	0	-19	-4	69
4	SLS 1a_135	-91	83	490	-6	-123	-17	501

Project: ENS-ZL
Tower: S-6 R
Number: 28



Project: ENS-ZL
Tower: S-6 R
Number: 28

Auteur: TBR
Versie: v11.6

Conductor loads

Starting points

Consequence class	Verbouw CC2
Reference period	50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.15	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.40	0.00	0.0
ULS 3	Wind+ice	-5°	1.15	1.15	0.00	0.42	1.30	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.15	0.00	0.42	1.30	0.0
ULS 4	Cold+wind	-20°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.15	0.00	0.28	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.15	1.15	1.30	0.28	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 7	Permanent	10°	1.30	1.30	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS (strength, for angle towers: absence of conductors)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.15	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.15	1.15	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.15	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.15	1.15	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.15	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.15	1.15	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.15	1.15	0.0	0.24	0.0	0.0
SLS (deformations, fatigue, EDS)								
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	1.00	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.30	1.00	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	4
Number of load combinations for ULS	44
Number of load combinations for SPLS	0
Number of load combinations for SLS	11
Number of concentrated loads	440

Project: ENS-ZL
Tower: S-6 R
Number: 28

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-42.1	42.1	3.9	3.7	1.7	4.8
380ct1f1	-151.5	151.5	12.9	11.7	4.9	15.7
380ct1f2	-151.5	151.5	12.9	11.7	4.9	15.7
380ct1f3	-153.7	153.7	14.3	13.7	4.9	15.7
380ct2f1	-151.5	151.5	12.9	11.7	4.9	15.7
380ct2f2	-151.5	151.5	12.9	11.7	4.9	15.7
380ct2f3	-153.7	153.7	14.3	13.7	4.9	15.7
bl2	-42.1	42.1	3.9	3.7	1.7	4.8

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	87.6	115.1	157.0
380ct1f1	144.5	157.6	179.7
380ct1f2	144.5	157.6	179.7
380ct1f3	137.9	157.2	179.7
380ct2f1	144.5	157.6	179.7
380ct2f2	144.5	157.6	179.7
380ct2f3	137.9	157.2	179.7
bl2	87.6	115.1	157.0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	162.9	180.6
380ct1f1	182.9	189.9
380ct1f2	182.9	189.9
380ct1f3	182.9	189.9
380ct2f1	182.9	189.9
380ct2f2	182.9	189.9
380ct2f3	182.9	189.9
bl2	162.9	180.6

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	191.2 m	0.642 -
Min. weight span	23.5 m	0.079 -

Project: ENS-ZL
Tower: S-6 R
Number: 28

Maximum values back + ahead span / Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	21.2	7.6	5.5	-42.5	42.4
380ct1f1	65.2	24.5	20.6	-152.6	150.4
380ct1f2	65.2	24.5	20.6	-152.6	150.4
380ct1f3	65.2	28.1	20.6	-154.7	152.8
380ct2f1	65.2	24.5	20.6	-152.6	150.4
380ct2f2	65.2	24.5	20.6	-152.6	150.4
380ct2f3	65.2	28.1	20.6	-154.7	152.8
bl2	21.2	7.6	5.5	-42.5	42.4

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0.0	0.0	1.7	-21.2	21.2
380ct1f1	0.0	0.0	11.3	-81.5	81.5
380ct1f2	0.0	0.0	11.3	-81.5	81.5
380ct1f3	0.0	0.0	11.3	-81.5	81.5
380ct2f1	0.0	0.0	11.3	-81.5	81.5
380ct2f2	0.0	0.0	11.3	-81.5	81.5
380ct2f3	0.0	0.0	11.3	-81.5	81.5
bl2	0.0	0.0	1.7	-21.2	21.2

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	-0.4	1.6
	380ct1f1	1.6	8.7
	380ct1f2	1.6	8.7
	380ct1f3	1.6	8.7
	380ct2f1	1.6	8.7
	380ct2f2	1.6	8.7
	380ct2f3	1.6	8.7
	bl2	-0.4	1.6

Project: ENS-ZL
Tower: S-6 R
Number: 28

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	169	65	5465	0	0
ULS 1a_0,9_90		0	169	65	5465	0	0
ULS 3_90		0	87	128	2821	0	0
ULS 3_0,9_90		0	87	128	2821	0	0
SLS 7		0	0	71	0	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

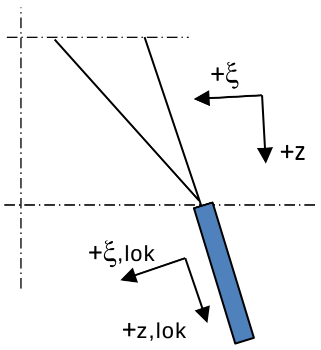
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	311	295	8784	0	0
ULS 3_90	0	130	358	3816	0	0
SLS 7	0	0	271	0	0	0

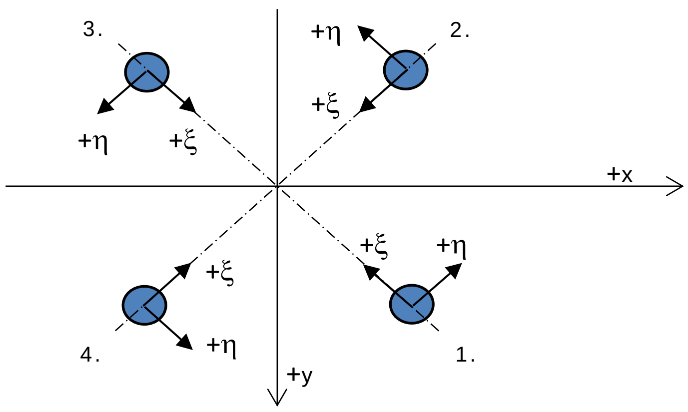
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	311	295	8784	0	0
ULS 1a_0	197	0	313	0	5195	0
ULS 5a Ba 10	65	0	278	14	1792	-807
ULS 1a_45	147	228	308	6339	3704	0

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_45	131	118	705	9	-176	-24	721
2	ULS 1a_0	65	-80	403	11	-103	-15	412
3	ULS 5a Ah 22	-12	-63	230	-36	-53	-4	235
4	ULS 1a_135	-131	118	705	-9	-176	-24	721

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 22	-22	1	-94	-16	15	-5	-96
2	ULS 1a_0,9_0,9_135	-104	91	-569	9	138	15	-582
3	ULS 1a_0,9_0,9_45	104	91	-569	-9	138	15	-582
4	ULS 1a_0,9_0,9_0	37	-52	-264	-11	63	6	-270

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 10	24	-34	-38	41	7	-1	-39
2	ULS 5a Ba 21	5	-61	182	40	-47	-7	187
3	ULS 5a Ba 21	-23	34	-42	40	8	-1	-43
4	ULS 5a Ah 10	-6	61	186	39	-47	-7	190

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	ULS 5a Ba 10	5	61	182	-40	-47	-7	187
2	ULS 5a Ah 21	24	34	-38	-41	7	-1	-39
3	ULS 5a Ah 21	-6	-61	186	-39	-47	-7	190
4	ULS 5a Ba 10	-23	-34	-42	-40	8	-1	-43

Project: ENS-ZL
Tower: S-6 R
Number: 28

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 12	17	-36	-86	37	14	-5	-88
2	ULS 1a_0,9_0,9_135	-104	91	-569	9	138	15	-582
3	ULS 1a_0,9_0,9_45	104	91	-569	-9	138	15	-582
4	ULS 1a_0,9_0,9_0	37	-52	-264	-11	63	6	-270

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	uls 1a_90	124	93	623	22	-153	-18	637
2	uls 1a_90	-95	63	-475	22	111	9	-486
3	uls 1a_90	95	63	-475	-22	111	9	-486
4	uls 1a_90	-124	93	623	-22	-153	-18	637

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_45	131	118	705	9	-176	-24	721
Max. tension	ULS 1a_0,9_0,9_45	104	91	-569	-9	138	15	-582
Max. pos. torsie	ULS 5a Ah 10	24	-34	-38	41	7	-1	-39
Max. neg. torsie	ULS 5a Ah 21	24	34	-38	-41	7	-1	-39
Comb. tension+torsie	ULS 1a_0,9_45	104	91	-569	-9	138	15	-582

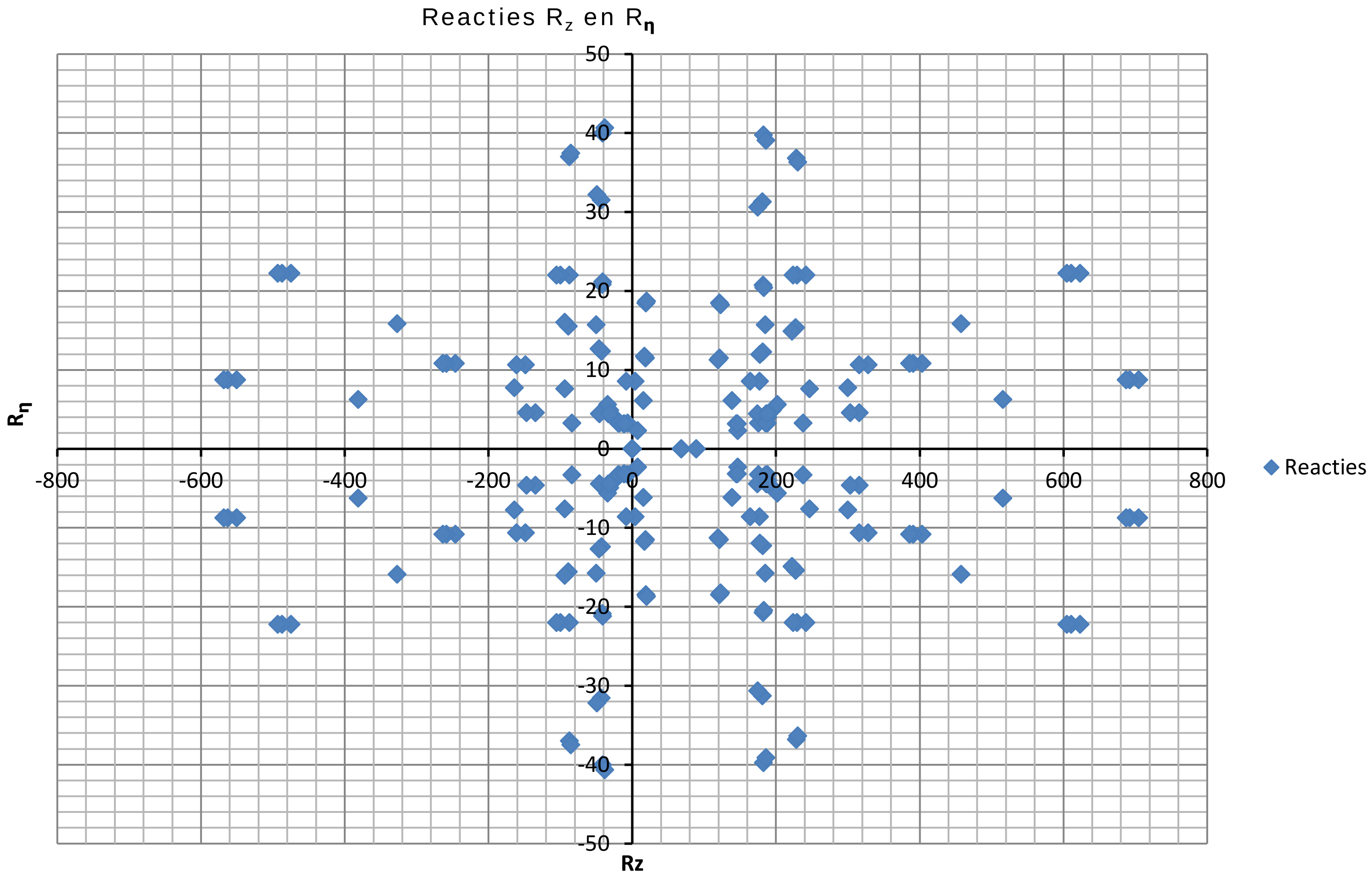
Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	13	13	68	0	-19	-4	69
2	SLS 1a_135	-69	60	-381	6	92	9	-390
3	SLS 1a_45	69	60	-381	-6	92	9	-390
4	SLS 1a_0	22	-33	-164	-8	38	3	-168

Maximum compression load - SLS

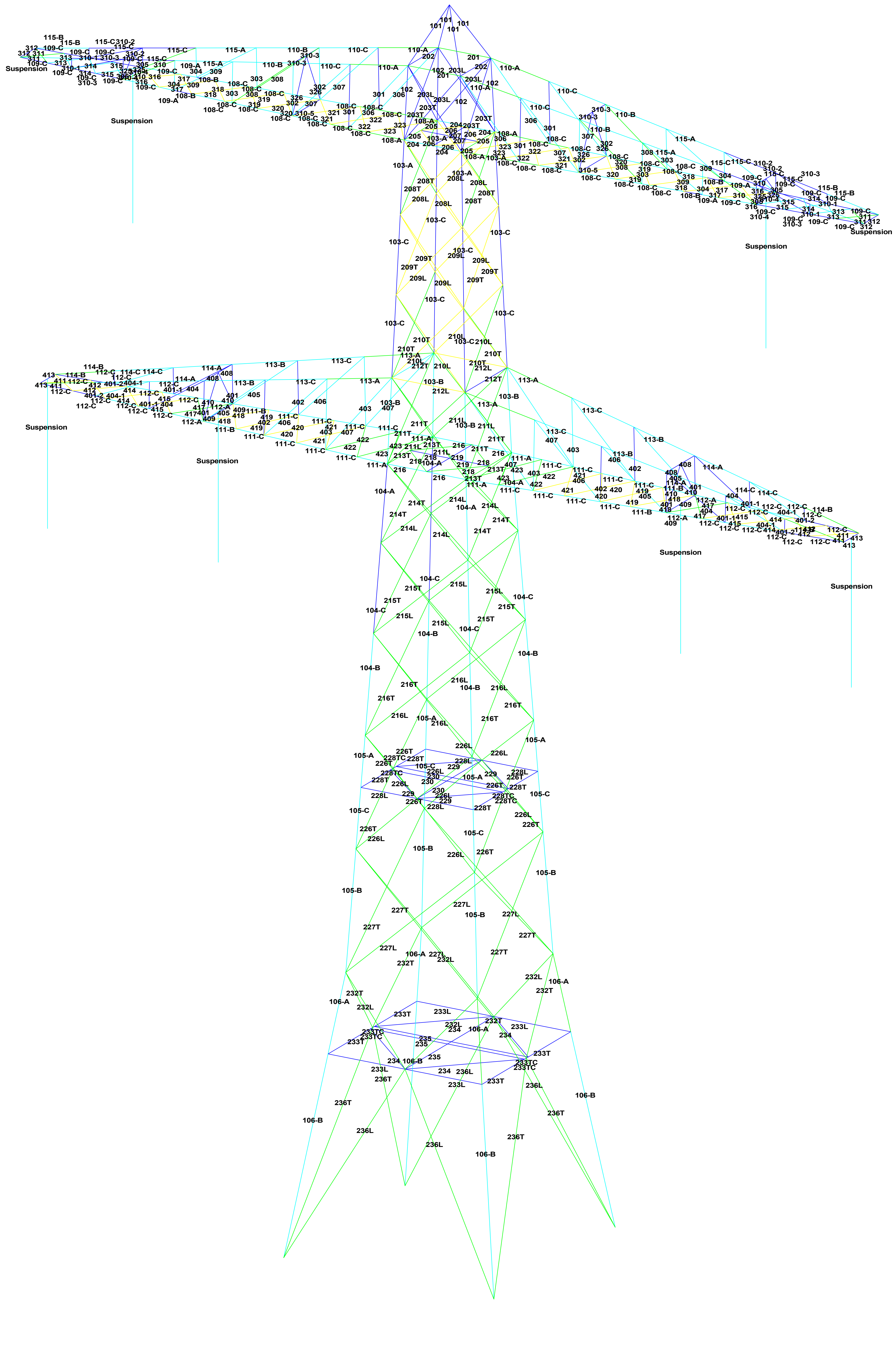
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_45	96	87	515	6	-129	-18	527
2	SLS 1a_0	49	-60	300	8	-77	-12	307
3	SLS 7	-13	-13	68	0	-19	-4	69
4	SLS 1a_135	-96	87	515	-6	-129	-18	527

Project: ENS-ZL
Tower: S-6 R
Number: 28



APPENDIX B
Uitvoer PLS-TOWER

DNV GL Nederlands BV, Project: "S-6_R (hv).ini"
Tower Version 16.12, 16:07:26 Thursday, 29 October, 2020
Undeformed geometry displayed



% Usage Legend
0 <= % < 25
25 <= % < 50
50 <= % < 75
75 <= % < 100
100 <= %

Assessment of groups for initial mast (afkeur level)

Date 30-10-20
Author MKh
Version 1.0

ENS-ZL 380
S-6_R
22

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101	Earth Peak	80x80x7#	S235	2M20-8.8t	1.00	1.00	1.00	155	-15.0	ULS 5a Ba 12	87.1	188.2	151.2	0.17		14.9	ULS 5a Ba 22	129.9	188.2	137.5	0.11	
102	Main Leg Level 6	100x100x8	S355	7M20-8.8t	0.52	0.52	0.52	69	-49.5	ULS 5a Ah 12	394.0	658.6	823.2	0.13		4.4	ULS 5a Ah 22	422.7	658.6	823.2	0.01	
103-A	Main Leg Level 5	120x120x10	S355	4M24-8.8t	0.52	0.52	0.52	57	-49.4	ULS 1a_135	656.6	542.2	705.6	0.09		29.8	ULS 5a Ah 22	635.0	542.2	663.4	0.05	
103-B	Main Leg Level 5	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	66	-184.1	ULS 1a_45	607.0	2168.8	1411.2	0.30		98.4	ULS 1a_0,9_0,9_135	635.0	2168.8	1411.2	0.15	
103-C	Main Leg Level 5	120x120x10	S355		0.52	0.52	0.52	64	-145.0	ULS 1a_135	619.8	0.0	0.0	0.23		96.2	ULS 1a_0,9_0,9_45	823.6	0.0	0.0	0.12	
104-A	Main Leg Level 4	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	49	-282.9	ULS 1a_135	1050.7	2168.8	1693.4	0.27		175.9	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.17	
104-B	Main Leg Level 4	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	63	-419.6	ULS 1a_135	940.1	2168.8	1693.4	0.45		302.6	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.30	
104-C	Main Leg Level 4	150x150x12	S355		0.52	0.52	0.52	56	-350.7	ULS 1a_45	998.1	0.0	0.0	0.35		230.2	ULS 1a_0,9_0,9_45	1235.4	0.0	0.0	0.19	
105-A	Main Leg Level 3	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	32	-478.8	ULS 1a_45	1155.2	2168.8	1693.4	0.41		350.6	ULS 1a_0,9_0,9_135	1007.6	2168.8	1461.9	0.35	
105-B	Main Leg Level 3	150x150x12	S355	8M24-8.8t	0.25	0.25	0.25	37	-561.3	ULS 1a_135	1128.8	2168.8	1693.4	0.50		424.5	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.42	
105-C	Main Leg Level 3	150x150x12	S355		0.52	0.52	0.52	38	-479.9	ULS 1a_135	1121.1	0.0	0.0	0.43		349.4	ULS 1a_0,9_0,9_135	1235.4	0.0	0.0	0.28	
106-A	Main Leg Level 1 (Base)	150x150x12	S355	10M24-8.8t	0.52	0.52	0.52	51	-519.3	ULS 1a_45	1037.3	2711.0	2116.8	0.50		404.7	ULS 1a_0,9_0,9_135	1007.6	2711.0	1827.3	0.40	
106-B	Main Leg Level 1 (Base)	150x150x12	S355	8M24-8.8t	0.20	0.20	0.20	49	-521.3	ULS 1a_135	1051.2	2168.8	1693.4	0.50		402.6	ULS 1a_0,9_0,9_45	1007.6	2168.8	1592.1	0.40	
108-A	Boven Traverse Lower 1	120x120x10	S355	12M24-8.8t	1.00	1.47	1.00	62	-358.2	ULS 5a Ba 22	630.9	1562.2	2116.8	0.57		240.1	ULS 5a Ah 12	635.0	1562.2	1990.2	0.38	
108-C	Boven Traverse Lower 1	120x120x10	S355		3.11	2.03	1.00	59	-331.3	ULS 5a Ba 12	648.8	0.0	0.0	0.51		216.1	ULS 5a Ah 22	823.6	0.0	0.0	0.26	
108-B	Boven Traverse Lower 1	120x120x10	S355	4M24-8.8t	1.86	3.28	1.00	61	-128.2	ULS 5a Ba 3	634.8	542.2	705.6	0.24		33.9	ULS 5a Ah 12	635.0	542.2	663.4	0.06	
109-A	Boven Traverse Lower 2	90x90x8	S355	4M24-8.8t	3.38	2.16	1.00	73	-113.0	ULS 5a Ba 1	338.8	542.2	564.5	0.33		42.5	ULS 5a Ah 12	343.6	542.2	530.7	0.12	
109-C	Boven Traverse Lower 2	90x90x8	S355		1.00	1.42	1.00	80	-96.2	ULS 5a Ba 1	311.0	0.0	0.0	0.31		32.4	ULS 5a Ah 1	493.5	0.0	0.0	0.07	
110-A	Boven Traverse Upper	80x80x8	S235	4M20-8.8t	1.00	1.98	1.00	186	0.0		73.9	376.3	345.6	0.00		101.4	ULS 3_0	168.3	376.3	310.2	0.60	
110-B	Boven Traverse Upper	80x80x8	S235	4M20-8.8t	1.00	2.81	1.00	276	0.0		41.7	376.3	345.6	0.00		78.5	ULS 3_0	227.6	376.3	314.2	0.35	
110-C	Boven Traverse Upper	80x80x8	S235		1.00	1.98	1.00	182	0.0		76.1	0.0	0.0	0.00		91.6	ULS 3_135	289.1	0.0	0.0	0.32	
115-A	Boven Traverse Upper	80x80x6#	S235	4M20-8.8t	1.00	2.93	1.00	271	0.0		32.7	376.3	259.2	0.00		59.2	ULS 3_0	175.2	376.3	235.6	0.34	
115-B	Boven Traverse Upper	80x80x6#	S235	2M20-8.8t	1.00	2.00	1.00	164	-1.4	ULS 5a Ah 1	66.2	188.2	129.6	0.02		29.4	ULS 5a Ah 22	93.1	188.2	100.8	0.32	
115-C	Boven Traverse Upper	80x80x6#	S235		1.00	2.00	1.00	164	-1.4	ULS 5a Ah 3	66.2	0.0	0.0	0.02		34.4	ULS 5a Ba 22	220.9	0.0	0.0	0.16	
111-A	Onder Traverse Lower 1	120x120x12	S355	11M24-8.8t	2.04	1.00	1.00	67	-350.9	ULS 5a Ba 10	712.0	1447.6	2328.5	0.49		208.9	ULS 5a Ah 10	750.1	1447.6	2189.2	0.28	
111-C	Onder Traverse Lower 1	120x120x12	S355		1.96	1.00	1.00	67	-340.6	ULS 5a Ba 10	711.2	0.0	0.0	0.48		199.8	ULS 5a Ah 10	976.3	0.0	0.0	0.20	
111-B	Onder Traverse Lower 1	120x120x12	S355	4M24-8.8t	1.00	1.85	1.00	66	-262.6	ULS 5a Ba 10	719.7	542.2	846.7	0.48		161.3	ULS 5a Ah 21	750.1	542.2	796.1	0.30	
112-A	Onder Traverse Lower 2	100x100x10	S355	4M24-8.8t	1.00	1.67	1.00	71	-223.1	ULS 5a Ba 10	476.0	542.2	705.6	0.47		153.3	ULS 5a Ah 10	493.9	542.2	663.4	0.31	
112-C	Onder Traverse Lower 2	100x100x10	S355		1.50	2.50	1.00	71	-195.9	ULS 5a Ba 10	476.2	0.0	0.0	0.41		129.5	ULS 5a Ah 10	681.6	0.0	0.0	0.19	
113-A	Onder Traverse Upper 1	80x80x8	S235	4M20-8.8t	2.90	1.00	1.00	313	0.0		34.3	376.3	345.6	0.00		119.3	ULS 3_0	168.3	376.3	310.2	0.71	
113-B	Onder Traverse Upper 1	80x80x8	S235	4M20-8.8t	3.09	1.00	1.00	313	0.0		34.3	376.3	345.6	0.00		81.7	ULS 3_0	227.6	376.3	314.2	0.36	
113-C	Onder Traverse Upper 1	80x80x8	S235		3.02	1.00	1.00	312	0.0		34.3	0.0	0.0	0.00		103.9	ULS 3_45	289.1	0.0	0.0	0.36	
114-A	Onder Traverse Upper 2	80x80x6#	S235	4M20-8.8t	3.00	1.00	1.00	270	0.0		33.0	376.3	259.2	0.00		77.9	ULS 3_0	175.2	376.3	235.6	0.44	
114-B	Onder Traverse Upper 2	80x80x6#	S235	4M20-8.8t	3.00	1.00	1.00	270	0.0		33.0	376.3	259.2	0.00		71.7	ULS 3_0	116.4	376.3	196.0	0.62	
114-C	Onder Traverse Upper 2	80x80x6#	S235		3.00	1.00	1.00	270	0.0		33.0	0.0	0.0	0.00		71.6	ULS 3_0	220.9	0.0	0.0	0.32	
201	Earth Peak Hrz Trans	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	128	0.0		122.6	376.3	345.6	0.00		107.8	ULS 3_0	157.3	376.3	277.6	0.69	
202	Earth Peak Hrz Long	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	171	-1.6	ULS 5a Ah 22	48.7	120.6	103.7	0.03		1.4	ULS 5a Ah 22	78.2	120.6	67.3	0.02	
203L	Boven Cross-Arm to Mast Int X-Diag Trar	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	109	-26.1	ULS 5a Ah 22	110.0	188.2	129.6	0.24		19.8	ULS 5a Ah 22	112.1	188.2	117.8	0.18	
203T	Boven Cross-Arm to Mast Int X-Diag Lonç	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	109	-15.6	ULS 5a Ah 12	110.0	188.2	129.6	0.14		8.9	ULS 5a Ah 22	112.1	188.2	117.8	0.08	
204	Boven Cross-Arm to Mast Hrz Trans	120x120x10	S355	12M24-8.8t	1.00	2.00	1.00	60	-278.9	ULS 5a Ba 22	644.6	1562.2	2116.8	0.43		140.3	ULS 5a Ah 22	635.0	1562.2	1990.2	0.22	
205	Boven Cross-Arm to Mast Hrz Long	65x65x7	S235	4M20-8.8t	1.00	2.00	1.00	112	-60.4	ULS 5a Ah 22	94.3	376.3	302.4	0.64		75.0	ULS 5a Ah 12	145.7	376.3	190.9	0.51	
206	Boven Cross-Arm to Mast Internal Diag	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	97	-92.2	ULS 5a Ba 12	121.6	188.2	129.6	0.76		92.2	ULS 5a Ba 22	99.4	188.2	110.5	0.93	
207	Boven Cross-Arm to Mast Interal X-Brac	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	113	-0.3	ULS 3_0	43.6	60.3	43.2	0.01		0.2	ULS 3_0	46.1	60.3	32.7	0.01	
208L	Mast Level 6 Cross-Diag 1 T	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	102	-139.4	ULS 5a Ba 12	172.5	271.1	207.4	0.81		144.5	ULS 5a Ah 22	159.7	271.1	183.4	0.90	
208T	Mast Level 6 Cross-Diag 1 L	100x100x8	S235	3M24-8.8t	0.52	0.52	0.52	92	-151.0	ULS 5a Ba 22	209.6	406.7	311.0	0.72		150.3	ULS 5a Ah 22	211.1	406.7	276.0	0.71	
209L	Mast Level 6 Cross-Diag 2 T	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	110	-134.0	ULS 5a Ah 12	161.0	271.1	207.4	0.83		127.2	ULS 5a Ba 12	159.7	271.1	183.4	0.80	
209T	Mast Level 6 Cross-Diag 2 L	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	99	-138.1	ULS 5a Ah 22	197.3	271.1	207.4	0.70		138.5	ULS 5a Ba 12	181.4	271.1	189.2	0.76	
210L	Mast Level 6 Cross-Diag 3 T	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	117	-114.2	ULS 5a Ba 12	152.7	271.1	207.4	0.75		120.5	ULS 5a Ah 22	159.7	271.1	183.4	0.75	
210T	Mast Level 6 Cross-Diag 3 L	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	105	-125.3	ULS 5a Ba 22	188.3	271.1	207.4	0.67		124.0	ULS 5a Ah 22	181.4	271.1	189.2	0.68	
212L	Onder Cross-Arm to Mast Upper Hrz Tran	80x80x8	S235	3M20-8.8t	1.00	1.00	1.00	178	0.0		82.0	282.2	259.2	0.00		129.7	ULS 3_0	168.3	282.2	234.2	0.77	
212T	Onder Cross-Arm to Mast Upper Hrz Long	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	178	-23.5	ULS 1a_0,9_0,9_90	82.0	188.2	172.8	0.29		28.1	ULS 1a_90	146.3	188.2	157.1	0.19	
211L	Onder Cross-Arm to Mast Int X-Diag Trar	100x100x10	S235	2M24-8.8t	0.52	0.52	0.52	111	-120.3	ULS 5a Ba 12	221.0	271.1	259.2	0.54		120.6	ULS 5a Ah 22	224.3	271.1	236.4	0.54	
211T	Onder Cross-Arm to Mast Int X-Diag Lonç	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	111	-119.3	ULS 5a Ba 22	179.3	271.1	207.4	0.67		104.9	ULS 5a Ah 22	181.4	271.1	189.2	0.58	
216	Hor Verb D Hrz Trans	120x120x12	S355	11M24-8.8t	1.00	2.00	1.00	82	-268.1	ULS 5a Ba 21	597.6	1447.6	2328.5	0.45		114.4	ULS 5a Ah 21	750.1	1447.6	2189.2	0.15	
213T	Hor Verb D Hrz Long	80x80x6#	S235	4M20-8.8t	1.00	2.00	1.00	121	-54.9	ULS 5a Ah 21	93.7	376.3	259.2	0.59		75.8	ULS 5a Ah 10	175.2	376.3	235.6	0.43	
218	Hor Verb D Internal Diag	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	121	-90.1	ULS 5a Ah 21	147.8	271.1	207.4	0.61		90.3	ULS 5a Ba 21	159.7	271.1	183.4	0.57	
219	Hor Verb D X-Brace	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	155	-0.4	ULS 3_0	30.8	60.3	43.2	0.01		0.4	ULS 3_0	46.1	60.3	32.7	0.01	
214L	Mast Level 4 Cross-Diag 1 T	100x100x8	S235	2M24-8.8t	0.53	0.27	0.27	73	-111.4	ULS 5a Ba 10	231.3	271.1	207.4	0.54		106.6	ULS 5a Ah 21	181.4	271.1	189.2	0.59	
214T	Mast Level 4 Cross-Diag 1 L	100x100x8	S235	2M24-8.8t	0.53	0.27	0.27	73	-124.3	ULS 5a Ba 21	231.3	271.1	207.4	0.60		123.6	ULS 5a Ah 10	181.4	271.1	189.2	0.68	
215L	Mast Level 4 Cross-Diag 2 T	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	91	-98.6	ULS 5a Ah 10	179.1	271.1	207.4	0.55		100.9	ULS 5a Ba 10	173.9	271.1	193.2	0.58	
215T	Mast Level 4 Cross-Diag 2 L	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	91	-113.7	ULS 5a Ba 21	179.1	271.1	207.4	0.63		114.5	ULS 5a Ba 21	173.9	271.1	193.2	0.66	
216L	Mast Level 4 Cross-Diag 3 T	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	102	-91.5	ULS 5a Ah 10	163.9	271.1	207.4	0.56		88.9	ULS 5a Ah 10	159.7	271.1	183.4	0.56	
216T	Mast Level 4 Cross-Diag 3 L	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	102	-104.4	ULS 5a Ba 21	163.9	271.1	207.4	0.64		103.0	ULS 5a Ba 10	159.7	271.1	183.4	0.64	
226T	Mast Level 3 Cross-Diag 1 T	90x90x8	S235	2M24-8.8t	1.00	0.52	0.52	114	-98.6	ULS 5a Ba 10	148.1	271.1	207.4	0.67		92.6	ULS 5a Ah 21	159.7	271.1	183.4	0.58	
226L	Mast Level 3 Cross-Diag 1 L	90x90x8	S235	2M24-8.8t	1.00	0.52	0.52	114	-81.1	ULS 5a Ah 10	148.1	271.1	207.4	0.55		81.6	ULS 5a Ah 21	159.7	271.1	183.4	0.51	
227T	Mast Level 3 Cross-Diag 2 T	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	124	-83.1	ULS 5a Ah 10	135.5	271.1	207.4	0.61		86.5	ULS 5a Ba 10	159.7	271.1	183.4	0.54	
227L	Mast Level 3 Cross-Diag 2 L	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	124	-72.3	ULS 5a Ah 10	135.5	271.1	207.4	0.53		71.0	ULS 5a Ah 21	159.7	271.1	183.4	0.44	
228T	Hor Verb G Hrz Trans	60x60x6	S235	1M16-8.8t	1.10	1.00	1.00	166	-2.1	ULS 1a_0,9_0,9_45	45.4	60.3	51.8	0.05		1.8	ULS 1a_135	48.4	60.3	33.7	0.05	
228TC	Hor Verb G Hrz Trans	60x60x6	S235		2.00	11.24	1.00	117	-3.7	ULS 1a_0,9_0,9_45	71.2	0.0	0.0	0.05		3.6	ULS 1a_0,9_45	162.2	0.0	0.0	0.02	
228L	Hor Verb G Hrz Long	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	183	-1.8	ULS 1a_0,9_0,9_45	40.1	60.3	51.8	0.05		1.8	ULS 1a_45	48.4	60.3	33.7	0.05	
229	Hor Verb G Internal Diag	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	247	-1.5	ULS 1a_135	23.1	60.3	51.8	0.07		1.8	ULS 1a_0,9_0,9_45	48.4	60.3	33.7	0.05	
230	Hor Verb G Internal X-Brace	60x60x6	S235	1M16-8.8t	0.50	0.50	0.50	183	-0.4	ULS 1a_0	35.7	60.3	51.8	0.01		0.3	ULS 1a_0,9_0	48.4	60.3	33.7	0.01	
232T	Mast Level 1 Cross-Diag 1 T	100x100x8	S235	2M24-8.8t	0.52	1.00	0.52	123	-79.9	ULS 5a Ah 22	152.0	271.1	207.4	0.53		58.3	ULS 1a_0,9_0,9_90	181.4	271.1	189.2	0.32	
232L	Mast Level 1 Cross-Diag 1 L	100x100x8	S235	2M24-8.8t	0.52	1.00	0.52	123	-85.8	ULS 5a Ba 21	152.0	271.1	207.4	0.56		72.6	ULS 5a Ah 10	181.4	271.1	189.2	0.40	
233T	Hor Verb E Hrz Trans	60x60x6	S235	1M16-8.8t	1.00	1.04	1.00	240	-2.5	ULS 1a_45	27.1	60.3	51.8	0.09		0.8	ULS 1a_0,9_0	48.4	60.3	33.7	0.02	
233TC	Hor Verb E Hrz Trans	60x60x6	S235		23.81	2.00	1.00	161	-5.1	ULS 1a_45	50.0	0.0	0.0	0.10		3.4	ULS 1a_0,9_0,9_135	162.2	0.0	0.0	0.02	
233L	Hor Verb E Hrz Long	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	250	-2.6	ULS 1a_90	25.4	60.3	51.8	0.10		0.6	ULS 1a_0,9_135	48.4	60.3	33.7	0.02	
234	Hor Verb E Internal Diag	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	347	-2.3	ULS 1a_45	13.5	60.3	51.8	0.17		2.6	ULS 1a_0,9_0,9_45	48.4	60.3	33.7	0.08	
235	Hor Verb E Internal X-Brace	65x65x7	S235	1M16-8.8t	0.50	0.50	0.50	232	-0.8	ULS 1a_0	31.9	60.3	60.5	0.02		0.2	ULS 1a_0,9_0,9_0	72.6	60.3	52.3	0.00	
236T	Mast Level 1 Cross-Diag 2 T	80x80x8	S235	2M20-8.8t	0.20	0.20	0.20	104	-103.5	ULS 5a Ah 12	150.1	188.2	172.8	0.69		76.3	ULS 5a Ba 12	138.0	188.2	151.7	0.55	
236L	Mast Level 1 Cross-Diag 2 L	80x80x8	S235	2M20-8.8t	0.20	0.20	0.20	104	-104.5	ULS 5a Ba 21	150.1	188.2	172.8	0.70		93.0	ULS 5a Ah 21	138.0	188.2	151.7	0.67	
301	Upper Cross-Arm Trans Face Vert Brace 1	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	189	-8.5	ULS 3_0	34.0	60.3	51.8	0.25		0.0		48.4	60.3	33.7	0.00	
302	Upper Cross-Arm Trans Face Vert Brace 2	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	189	-8.4	ULS 3_0	23.7	60.3	43.2	0.35		0.0		37.4	60.3	25.7	0.00	
303	Upper Cross-Arm Trans Face Diag Brace 1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	-9.5	ULS 3_0	32.7	60.3	43.2	0.29		0.0		37.4	60.3	25.7	0.00	

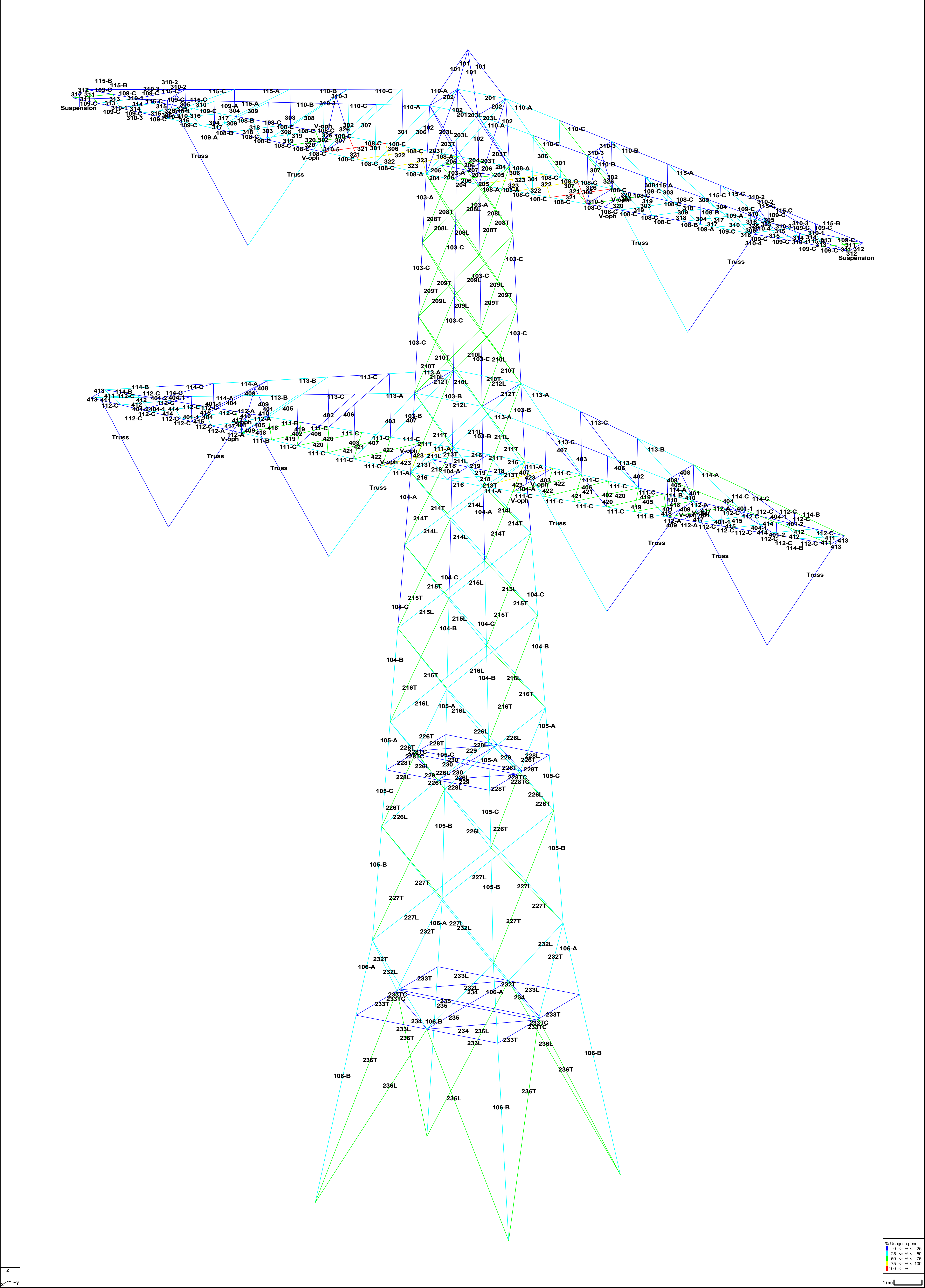
Assessment of groups for initial mast (afkeur level)

Date 30-10-20
Author MKh
Version 1.0

ENS-ZL 380
S-6_R
22

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
304	Upper Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	107	**-11.5**	ULS 3_0	45.8	60.3	43.2	0.27		**0.0**		37.4	60.3	25.7	0.00	
305	Upper Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	71	**-1.1**	ULS 5a Ba 3	58.4	60.3	43.2	0.02		**0.0**		37.4	60.3	25.7	0.00	
306	Upper Cross-Arm Trans Face Diag Brace	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	294	**0.0**		17.6	60.3	51.8	0.00		**11.7**	ULS 3_0	48.4	60.3	33.7	0.35	
307	Upper Cross-Arm Trans Face Diag Brace	50x50x7	S235	1M16-8.8t	1.00	1.00	1.00	328	**0.0**		14.0	60.3	60.5	0.00		**13.7**	ULS 3_0	52.4	60.3	36.0	0.38	
308	Upper Cross-Arm Bovenvlak Lateral Brac	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	307	**0.0**		11.4	60.3	43.2	0.00		**16.7**	ULS 3_0	37.4	60.3	25.7	0.65	
309	Upper Cross-Arm Ondervlak Lateral Brac	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	275	**0.0**		17.0	120.6	86.4	0.00		**23.4**	ULS 3_0	52.4	120.6	51.4	0.45	
310	Upper Cross-Arm Internal Diagonal Brace	50x50x7	S235	2M16-8.8t	1.00	1.00	1.00	237	**0.0**		29.1	120.6	121.0	0.00		**35.7**	ULS 3_0	71.2	120.6	72.0	0.50	
311	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	80	**-14.4**	ULS 5a Ba 1	56.0	60.3	43.2	0.33		**13.6**	ULS 5a Ah 3	37.4	60.3	25.7	0.53	
312	Upper Cross-Arm End Hrz Brace	HEB160	S355	2M20-8.8t	1.00	2.00	1.00	15	**-10.3**	ULS 5a Ah 1	1562.7	188.2	235.2	0.06		**10.9**	ULS 5a Ba 1	1739.7	188.2	0.0	0.06	
313	Upper Cross-Arm Ondervlak Cross-Diag 2	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	78	**-12.3**	ULS 5a Ah 1	56.5	60.3	43.2	0.28		**12.6**	ULS 5a Ba 3	37.4	60.3	25.7	0.49	
314	Upper Cross-Arm Ondervlak Cross-Diag 3	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	81	**-11.3**	ULS 5a Ba 1	55.6	60.3	43.2	0.26		**11.3**	ULS 5a Ba 1	37.4	60.3	25.7	0.44	
315	Upper Cross-Arm Ondervlak Cross-Diag 4	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	89	**-10.8**	ULS 5a Ba 3	53.1	60.3	43.2	0.25		**10.3**	ULS 5a Ah 3	37.4	60.3	25.7	0.40	
316	Upper Cross-Arm Ondervlak Cross-Diag 5	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	108	**-46.5**	ULS 5a Ba 22	62.2	60.3	60.5	0.77		**42.3**	ULS 5a Ah 22	52.4	60.3	36.0	0.90	stuik
317	Upper Cross-Arm Ondervlak Cross-Diag 6	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	107	**-37.0**	ULS 5a Ah 12	62.6	60.3	60.5	0.61		**39.9**	ULS 5a Ba 12	52.4	60.3	36.0	0.85	stuik
318	Upper Cross-Arm Ondervlak Cross-Diag 7	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	111	**-35.8**	ULS 5a Ba 12	60.4	60.3	60.5	0.59		**33.7**	ULS 5a Ah 12	52.4	60.3	36.0	0.94	
319	Upper Cross-Arm Ondervlak Cross-Diag 8	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	94	**-31.5**	ULS 5a Ah 12	73.4	60.3	51.8	0.61		**32.9**	ULS 5a Ba 12	48.4	60.3	33.7	0.98	
320	Upper Cross-Arm Ondervlak Cross-Diag 9	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	120	**-30.8**	ULS 5a Ba 22	40.9	60.3	43.2	0.75		**29.1**	ULS 5a Ah 22	37.4	60.3	25.7	0.85	stuik
321	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	129	**-30.0**	ULS 5a Ba 12	37.9	60.3	43.2	0.79		**27.3**	ULS 5a Ah 12	37.4	60.3	25.7	0.80	stuik
322	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	132	**-25.5**	ULS 5a Ah 12	37.2	60.3	43.2	0.69		**27.2**	ULS 5a Ba 12	37.4	60.3	25.7	0.80	stuik
323	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	138	**-23.8**	ULS 5a Ba 22	35.1	60.3	43.2	0.68		**21.6**	ULS 5a Ah 22	37.4	60.3	25.7	0.84	
325	Upper Cross-Arm Internal Diagonal Brac1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	98	**-1.6**	ULS 1a_0	49.2	60.3	43.2	0.04		**1.2**	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.05	
326	Upper Cross-Arm Internal Diagonal Brac2	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	211	**-2.4**	ULS 1a_0	20.2	60.3	43.2	0.12		**2.0**	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.08	
401	Lower Cross-Arm Trans Face Vert Brace 1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	145	**-2.5**	ULS 5a Ah 21	33.4	60.3	43.2	0.07		**0.0**		46.1	60.3	32.7	0.00	
402	Lower Cross-Arm Trans Face Vert Brace	65x65x7	S235	1M16-8.8t	1.00	1.00	1.00	152	**-13.9**	ULS 3_0	63.9	60.3	60.5	0.23		**0.0**		84.7	60.3	52.3	0.00	
403	Lower Cross-Arm Trans Face Vert Brace	65x65x7	S235	1M16-8.8t	1.00	1.00	1.00	194	**-12.3**	ULS 3_0	46.4	60.3	60.5	0.26		**0.0**		84.7	60.3	52.3	0.00	
404	Lower Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	266	**0.0**		14.3	60.3	43.2	0.00		**5.6**	ULS 5a Ba 21	46.1	60.3	32.7	0.17	
405	Lower Cross-Arm Trans Face Diag Brace	50x50x7	S235	2M16-8.8t	1.00	1.00	1.00	324	**0.0**		17.9	120.6	121.0	0.00		**29.2**	ULS 3_0	71.2	120.6	72.0	0.41	
406	Lower Cross-Arm Trans Face Diag Brace	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	296	**0.0**		21.7	120.6	103.7	0.00		**21.3**	ULS 3_0	78.2	120.6	67.3	0.32	
407	Lower Cross-Arm Trans Face Diag Brace	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	337	**0.0**		14.1	60.3	51.8	0.00		**16.4**	ULS 3_135	48.4	60.3	33.7	0.49	
408	Lower Cross-Arm Bovenvlak Lateral Brac	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	101	**-1.0**	ULS 1a_0	73.8	60.3	51.8	0.02		**0.9**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.03	
409	Lower Cross-Arm Ondervlak Lateral Brac	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	48	**-30.0**	ULS 5a Ah 11	960.6	188.2	172.8	0.17		**35.2**	ULS 5a Ba 11	1278.1	188.2	0.0	0.20	
410	Lower Cross-Arm Internal Diagonal Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	176	**-2.3**	ULS 1a_0	26.1	60.3	43.2	0.09		**1.8**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.05	
411	Lower Cross-Arm Ondervlak Cross-Diag 1	50x50x7	S235	1M16-8.8t	0.55	0.55	0.55	98	**-46.7**	ULS 5a Ba 10	67.3	60.3	60.5	0.77		**44.0**	ULS 5a Ah 21	64.5	60.3	45.8	0.96	
412	Lower Cross-Arm Ondervlak Cross-Diag 2	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	104	**-35.9**	ULS 5a Ah 10	64.3	60.3	60.5	0.60		**37.4**	ULS 5a Ba 10	56.4	60.3	39.3	0.95	
413	Lower Cross-Arm End Hrz Brace	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	25	**-31.8**	ULS 5a Ah 21	1067.2	188.2	172.8	0.18		**33.7**	ULS 5a Ba 21	1278.1	188.2	0.0	0.20	
414	Lower Cross-Arm Ondervlak Cross-Diag 3	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	87	**-30.3**	ULS 5a Ba 21	77.4	60.3	51.8	0.58		**29.1**	ULS 5a Ah 10	48.4	60.3	33.7	0.86	
415	Lower Cross-Arm Ondervlak Cross-Diag 4	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	113	**-24.6**	ULS 5a Ah 10	43.5	60.3	43.2	0.57		**25.5**	ULS 5a Ba 10	46.1	60.3	32.7	0.78	
417	Lower Cross-Arm Ondervlak Cross-Diag 6	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	121	**-21.9**	ULS 5a Ba 10	40.6	60.3	43.2	0.54		**20.6**	ULS 5a Ah 10	46.1	60.3	32.7	0.63	
418	Lower Cross-Arm Ondervlak Cross-Diag 7	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	107	**-37.7**	ULS 5a Ba 20	65.6	60.3	51.8	0.73		**33.9**	ULS 5a Ah 11	48.4	60.3	33.7	0.83	stuik

DNV GL Nederlands BV. Project: "S-6_R (V) ini"
Tower Version 16.63, 09:19:25 Monday, 22 February, 2021
Undeformed geometry displayed



DNV·GL

Assessment of groups for initial mast (afkeur level)

Date 22-02-21
Author MKh
Version 1.0

ENS-ZL 380
S-6_R
28

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101	Earth Peak	80x80x7#	S235	2M20-8.8t	1.00	1.00	1.00	155	-10.1	ULS 5a Ba 12	87.1	188.2	151.2	0.12		10.0	ULS 5a Ba 22	129.9	188.2	137.5	0.08	
102	Main Leg Level 6	100x100x8	S355	7M20-8.8t	0.52	0.52	0.52	69	-35.0	ULS 5a Ah 12	394.0	658.6	823.2	0.09		8.2	ULS 1a_0,9_0,9_90	422.7	658.6	823.2	0.02	
103-A	Main Leg Level 5	120x120x10	S355	4M24-8.8t	0.52	0.52	0.52	57	-39.1	ULS 5a Ba 22	656.6	542.2	705.6	0.07		22.2	ULS 5a Ah 12	635.0	542.2	663.4	0.04	
103-B	Main Leg Level 5	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	66	-139.8	ULS 1a_45	607.0	2168.8	1411.2	0.23		78.7	ULS 1a_0,9_0,9_135	635.0	2168.8	1411.2	0.12	
103-C	Main Leg Level 5	120x120x10	S355		0.52	0.52	0.52	64	-120.7	ULS 1a_135	619.8	0.0	0.0	0.19		82.4	ULS 1a_0,9_0,9_45	823.6	0.0	0.0	0.10	
104-A	Main Leg Level 4	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	49	-227.2	ULS 1a_135	1050.7	2168.8	1693.4	0.22		141.1	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.14	
104-B	Main Leg Level 4	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	63	-377.6	ULS 1a_45	940.1	2168.8	1693.4	0.40		280.7	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.28	
104-C	Main Leg Level 4	150x150x12	S355		0.52	0.52	0.52	56	-300.7	ULS 1a_45	998.1	0.0	0.0	0.30		202.5	ULS 1a_0,9_0,9_135	1235.4	0.0	0.0	0.16	
105-A	Main Leg Level 3	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	32	-443.0	ULS 1a_45	1155.2	2168.8	1693.4	0.38		335.0	ULS 1a_0,9_0,9_135	1007.6	2168.8	1461.9	0.33	
105-B	Main Leg Level 3	150x150x12	S355	8M24-8.8t	0.25	0.25	0.25	37	-532.7	ULS 1a_135	1128.8	2168.8	1693.4	0.47		414.4	ULS 1a_0,9_0,9_135	1007.6	2168.8	1461.9	0.41	
105-C	Main Leg Level 3	150x150x12	S355		0.52	0.52	0.52	38	-444.3	ULS 1a_45	1121.1	0.0	0.0	0.40		333.7	ULS 1a_0,9_0,9_45	1235.4	0.0	0.0	0.27	
106-A	Main Leg Level 1 (Base)	150x150x12	S355	10M24-8.8t	0.52	0.52	0.52	51	-500.6	ULS 1a_45	1037.3	2711.0	2116.8	0.48		401.9	ULS 1a_0,9_0,9_45	1007.6	2711.0	1827.3	0.40	
106-B	Main Leg Level 1 (Base)	150x150x12	S355	8M24-8.8t	0.20	0.20	0.20	49	-502.6	ULS 1a_135	1051.2	2168.8	1693.4	0.48		399.8	ULS 1a_0,9_0,9_45	1007.6	2168.8	1592.1	0.40	
108-A	Boven Traverse Lower 1	120x120x10	S355	12M24-8.8t	1.00	1.47	1.00	62	-258.5	ULS 5a Ba 12	630.9	1562.2	2116.8	0.41		173.3	ULS 5a Ah 22	635.0	1562.2	1990.2	0.27	
108-C	Boven Traverse Lower 1	120x120x10	S355		3.11	2.03	1.00	59	-226.3	ULS 5a Ba 22	648.8	0.0	0.0	0.35		143.7	ULS 5a Ah 12	823.6	0.0	0.0	0.17	
108-B	Boven Traverse Lower 1	120x120x10	S355	4M24-8.8t	1.86	3.28	1.00	61	-108.4	ULS 5a Ba 1	634.8	542.2	705.6	0.20		49.3	ULS 5a Ah 3	635.0	542.2	663.4	0.09	
109-A	Boven Traverse Lower 2	90x90x8	S355	4M24-8.8t	3.38	2.16	1.00	73	-100.7	ULS 5a Ba 1	338.8	542.2	564.5	0.30		54.8	ULS 5a Ah 1	343.6	542.2	530.7	0.16	
109-C	Boven Traverse Lower 2	90x90x8	S355		1.00	1.42	1.00	80	-84.8	ULS 5a Ba 1	311.0	0.0	0.0	0.27		42.3	ULS 5a Ah 3	493.5	0.0	0.0	0.09	
110-A	Boven Traverse Upper	80x80x8	S235	4M20-8.8t	1.00	1.98	1.00	186	0.0		73.9	376.3	345.6	0.00		65.0	ULS 3_90	168.3	376.3	310.2	0.39	
110-B	Boven Traverse Upper	80x80x8	S235	4M20-8.8t	1.00	2.81	1.00	276	-7.2	ULS 1a_0,9_0,9_90	41.7	376.3	345.6	0.17		49.9	ULS 1a_90	227.6	376.3	314.2	0.22	
110-C	Boven Traverse Upper	80x80x8	S235		1.00	1.98	1.00	182	-4.3	ULS 1a_0,9_0,9_90	76.1	0.0	0.0	0.06		58.4	ULS 1a_90	289.1	0.0	0.0	0.20	
115-A	Boven Traverse Upper	80x80x6#	S235	4M20-8.8t	1.00	2.93	1.00	271	-2.3	ULS 1a_0,9_0,9_90	32.7	376.3	259.2	0.07		35.9	ULS 3_90	175.2	376.3	235.6	0.20	
115-B	Boven Traverse Upper	80x80x6#	S235	2M20-8.8t	1.00	2.00	1.00	164	-6.1	ULS 5a Ah 3	66.2	188.2	129.6	0.09		21.1	ULS 5a Ba 3	93.1	188.2	100.8	0.23	
115-C	Boven Traverse Upper	80x80x6#	S235		1.00	3.30	1.00	271	-3.1	ULS 5a Ah 3	32.7	0.0	0.0	0.09		25.4	ULS 5a Ba 3	220.9	0.0	0.0	0.12	
111-A	Onder Traverse Lower 1	120x120x12	S355	11M24-8.8t	2.04	1.00	1.00	67	-268.3	ULS 5a Ba 10	712.0	1447.6	2328.5	0.38		179.2	ULS 5a Ah 10	750.1	1447.6	2189.2	0.24	
111-C	Onder Traverse Lower 1	120x120x12	S355		1.96	1.00	1.00	67	-255.6	ULS 5a Ba 10	711.2	0.0	0.0	0.36		162.8	ULS 5a Ah 21	976.3	0.0	0.0	0.17	
111-B	Onder Traverse Lower 1	120x120x12	S355	4M24-8.8t	1.00	1.85	1.00	66	-158.7	ULS 5a Ba 10	719.7	542.2	846.7	0.29		94.5	ULS 5a Ah 21	750.1	542.2	796.1	0.17	
112-A	Onder Traverse Lower 2	100x100x10	S355		1.00	1.00	1.00	33	-125.4	ULS 5a Ba 10	632.9	0.0	0.0	0.20		78.6	ULS 5a Ah 10	681.6	0.0	0.0	0.12	
112-C	Onder Traverse Lower 2	100x100x10	S355		1.50	2.50	1.00	71	-109.9	ULS 5a Ba 21	476.2	0.0	0.0	0.23		54.0	ULS 5a Ah 10	681.6	0.0	0.0	0.08	
113-A	Onder Traverse Upper 1	80x80x8	S235	4M20-8.8t	2.90	1.00	1.00	313	0.0		34.3	376.3	345.6	0.00		75.2	ULS 1a_90	168.3	376.3	310.2	0.45	
113-B	Onder Traverse Upper 1	80x80x8	S235	4M20-8.8t	3.09	1.00	1.00	313	-14.0	ULS 1a_0,9_0,9_90	34.3	376.3	345.6	0.41		57.1	ULS 1a_90	227.6	376.3	314.2	0.25	
113-C	Onder Traverse Upper 1	80x80x8	S235		3.02	1.00	1.00	312	-3.7	ULS 1a_0,9_0,9_90	34.3	0.0	0.0	0.11		66.9	ULS 1a_90	289.1	0.0	0.0	0.23	
114-A	Onder Traverse Upper 2	80x80x6#	S235	4M20-8.8t	3.00	1.00	1.00	270	-21.3	ULS 1a_0,9_0,9_90	33.0	376.3	259.2	0.64		55.4	ULS 1a_90	175.2	376.3	235.6	0.32	
114-B	Onder Traverse Upper 2	80x80x6#	S235	4M20-8.8t	3.00	1.00	1.00	270	-22.3	ULS 1a_0,9_0,9_90	33.0	376.3	259.2	0.67		49.4	ULS 1a_90	116.4	376.3	196.0	0.42	
114-C	Onder Traverse Upper 2	80x80x6#	S235		3.00	1.00	1.00	270	-22.1	ULS 1a_0,9_0,9_90	33.0	0.0	0.0	0.67		49.2	ULS 1a_90	220.9	0.0	0.0	0.22	
201	Earth Peak Hrz Trans	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	128	0.0		122.6	376.3	345.6	0.00		62.9	ULS 3_0	157.3	376.3	277.6	0.40	
202	Earth Peak Hrz Long	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	171	-2.1	ULS 1a_0,9_0,9_90	48.7	120.6	103.7	0.04		2.7	ULS 1a_90	78.2	120.6	67.3	0.04	
203L	Boven Cross-Arm to Mast Int X-Diag Trar	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	109	-28.3	ULS 1a_90	110.0	188.2	129.6	0.26		26.3	ULS 1a_0,9_0,9_90	112.1	188.2	117.8	0.23	
203T	Boven Cross-Arm to Mast Int X-Diag Long	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	109	-10.8	ULS 5a Ah 12	110.0	188.2	129.6	0.10		5.5	ULS 5a Ah 22	112.1	188.2	117.8	0.05	
204	Boven Cross-Arm to Mast Hrz Trans	120x120x10	S355	12M24-8.8t	1.00	2.00	1.00	60	-198.1	ULS 5a Ba 22	644.6	1562.2	2116.8	0.31		105.9	ULS 5a Ah 12	635.0	1562.2	1990.2	0.17	
205	Boven Cross-Arm to Mast Hrz Long	65x65x7	S235	4M20-8.8t	1.00	2.00	1.00	112	-41.5	ULS 5a Ah 12	94.3	376.3	302.4	0.44		52.0	ULS 5a Ah 22	145.7	376.3	190.9	0.36	
206	Boven Cross-Arm to Mast Internal Diag	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	97	-64.1	ULS 5a Ba 22	121.6	188.2	129.6	0.53		64.2	ULS 5a Ba 22	99.4	188.2	110.5	0.65	
207	Boven Cross-Arm to Mast Interal X-Brac	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	113	-0.2	ULS 3_0	43.6	60.3	43.2	0.00		0.2	ULS 3_0	46.1	60.3	32.7	0.01	
208L	Mast Level 6 Cross-Diag 1 T	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	102	-106.7	ULS 5a Ba 12	172.5	271.1	207.4	0.62		107.9	ULS 5a Ah 12	159.7	271.1	183.4	0.68	
208T	Mast Level 6 Cross-Diag 1 L	100x100x8	S235	3M24-8.8t	0.52	0.52	0.52	92	-120.1	ULS 5a Ba 22	209.6	406.7	311.0	0.57		118.6	ULS 5a Ah 22	211.1	406.7	276.0	0.56	
209L	Mast Level 6 Cross-Diag 2 T	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	110	-100.0	ULS 5a Ah 22	161.0	271.1	207.4	0.62		97.5	ULS 5a Ba 22	159.7	271.1	183.4	0.61	
209T	Mast Level 6 Cross-Diag 2 L	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	99	-109.0	ULS 5a Ah 12	197.3	271.1	207.4	0.55		110.4	ULS 5a Ba 22	181.4	271.1	189.2	0.61	
210L	Mast Level 6 Cross-Diag 3 T	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	117	-87.7	ULS 5a Ba 22	152.7	271.1	207.4	0.57		89.9	ULS 5a Ah 22	159.7	271.1	183.4	0.56	
210T	Mast Level 6 Cross-Diag 3 L	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	105	-99.8	ULS 5a Ba 22	188.3	271.1	207.4	0.53		97.9	ULS 5a Ah 22	181.4	271.1	189.2	0.54	
212L	Onder Cross-Arm to Mast Upper Hrz Tran	80x80x8	S235	3M20-8.8t	1.00	1.00	1.00	178	0.0		82.0	282.2	259.2	0.00		76.1	ULS 1a_0	168.3	282.2	234.2	0.45	
212T	Onder Cross-Arm to Mast Upper Hrz Long	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	178	-13.2	ULS 1a_0,9_0,9_90	82.0	188.2	172.8	0.16		18.3	ULS 1a_90	146.3	188.2	157.1	0.13	
211L	Onder Cross-Arm to Mast Int X-Diag Trar	100x100x10	S235	2M24-8.8t	0.52	0.52	0.52	111	-99.5	ULS 5a Ba 22	221.0	271.1	259.2	0.45		94.8	ULS 5a Ah 22	224.3	271.1	236.4	0.42	
211T	Onder Cross-Arm to Mast Int X-Diag Long	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	111	-96.5	ULS 5a Ba 22	179.3	271.1	207.4	0.54		82.9	ULS 5a Ah 22	181.4	271.1	189.2	0.46	
216	Hor Verb D Hrz Trans	120x120x12	S355	11M24-8.8t	1.00	2.00	1.00	82	-196.7	ULS 5a Ba 21	597.6	1447.6	2328.5	0.33		107.2	ULS 5a Ah 10	750.1	1447.6	2189.2	0.14	
213T	Hor Verb D Hrz Long	80x80x6#	S235	4M20-8.8t	1.00	2.00	1.00	121	-42.5	ULS 5a Ah 21	93.7	376.3	259.2	0.45		56.3	ULS 5a Ah 10	175.2	376.3	235.6	0.32	
218	Hor Verb D Internal Diag	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	121	-68.4	ULS 5a Ah 10	147.8	271.1	207.4	0.46		68.7	ULS 5a Ba 21	159.7	271.1	183.4	0.43	
219	Hor Verb D X-Brace	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	155	-0.5	ULS 5a Ba 20	30.8	60.3	43.2	0.02		0.6	ULS 5a Ba 11	46.1	60.3	32.7	0.02	
214L	Mast Level 4 Cross-Diag 1 T	100x100x8	S235	2M24-8.8t	0.53	0.27	0.27	73	-90.3	ULS 5a Ba 10	231.3	271.1	207.4	0.44		85.7	ULS 5a Ah 21	181.4	271.1	189.2	0.47	
214T	Mast Level 4 Cross-Diag 1 L	100x100x8	S235	2M24-8.8t	0.53	0.27	0.27	73	-104.6	ULS 5a Ba 10	231.3	271.1	207.4	0.50		103.0	ULS 5a Ah 10	181.4	271.1	189.2	0.57	
215L	Mast Level 4 Cross-Diag 2 T	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	91	-79.5	ULS 5a Ah 10	179.1	271.1	207.4	0.44		81.5	ULS 5a Ba 10	173.9	271.1	193.2	0.47	
215T	Mast Level 4 Cross-Diag 2 L	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	91	-94.8	ULS 5a Ba 21	179.1	271.1	207.4	0.53		96.6	ULS 5a Ba 21	173.9	271.1	193.2	0.56	
216L	Mast Level 4 Cross-Diag 3 T	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	102	-73.6	ULS 5a Ah 21	163.9	271.1	207.4	0.45		71.5	ULS 5a Ah 10	159.7	271.1	183.4	0.45	
216T	Mast Level 4 Cross-Diag 3 L	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	102	-88.1	ULS 5a Ah 21	163.9	271.1	207.4	0.54		85.8	ULS 5a Ba 21	159.7	271.1	183.4	0.54	
226T	Mast Level 3 Cross-Diag 1 T	90x90x8	S235	2M24-8.8t	1.00	0.52	0.52	114	-82.9	ULS 5a Ba 10	148.1	271.1	207.4	0.56		78.0	ULS 5a Ah 21	159.7	271.1	183.4	0.49	
226L	Mast Level 3 Cross-Diag 1 L	90x90x8	S235	2M24-8.8t	1.00	0.52	0.52	114	-65.8	ULS 5a Ba 21	148.1	271.1	207.4	0.44		65.8	ULS 5a Ah 10	159.7	271.1	183.4	0.41	
227T	Mast Level 3 Cross-Diag 2 T	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	124	-69.5	ULS 5a Ah 10	135.5	271.1	207.4	0.51		72.6	ULS 5a Ba 21	159.7	271.1	183.4	0.45	
227L	Mast Level 3 Cross-Diag 2 L	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	124	-58.1	ULS 5a Ah 10	135.5	271.1	207.4	0.43		57.8	ULS 5a Ba 10	159.7	271.1	183.4	0.36	
228T	Hor Verb G Hrz Trans	60x60x6	S235	1M16-8.8t	1.10	1.00	1.00	166	-1.9	ULS 1a_0,9_0,9_45	45.4	60.3	51.8	0.04		1.6	ULS 1a_135	48.4	60.3	33.7	0.05	
228TC	Hor Verb G Hrz Trans	60x60x6	S235		2.00	11.24	1.00	117	-3.6	ULS 1a_0,9_0,9_45	71.2	0.0	0.0	0.05		3.4	ULS 1a_135	162.2	0.0	0.0	0.02	
228L	Hor Verb G Hrz Long	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	183	-1.9	ULS 1a_0,9_0,9_135	40.1	60.3	51.8	0.05		1.7	ULS 1a_135	48.4	60.3	33.7	0.05	
229	Hor Verb G Internal Diag	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	247	-1.6	ULS 1a_135	23.1	60.3	51.8	0.07		1.8	ULS 1a_0,9_135	48.4	60.3	33.7	0.05	
230	Hor Verb G Internal X-Brace	60x60x6	S235	1M16-8.8t	0.50	0.50	0.50	183	-0.4	ULS 1a_0	35.7	60.3	51.8	0.01		0.3	ULS 1a_0,9_0	48.4	60.3	33.7	0.01	
232T	Mast Level 1 Cross-Diag 1 T	100x100x8	S235	2M24-8.8t	0.52	1.00	0.52	123	-67.4	ULS 1a_90	152.0	271.1	207.4	0.44		51.4	ULS 1a_0,9_0,9_90	181.4	271.1	189.2	0.28	
232L	Mast Level 1 Cross-Diag 1 L	100x100x8	S235	2M24-8.8t	0.52	1.00	0.52	123	-75.4	ULS 5a Ba 10	152.0	271.1	207.4	0.50		60.3	ULS 5a Ah 21	181.4	271.1	189.2	0.33	
233T	Hor Verb E Hrz Trans	60x60x6	S235	1M16-8.8t	1.00	1.04	1.00	240	-2.5	ULS 1a_45	27.1	60.3	51.8	0.09		0.8	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.02	
233TC	Hor Verb E Hrz Trans	60x60x6	S235		23.81	2.00	1.00	161	-5.1	ULS 1a_45	50.0	0.0	0.0	0.10		3.4	ULS 1a_0,9_0,9_45	162.2	0.0	0.0	0.02	
233L	Hor Verb E Hrz Long	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	250	-2.5	ULS 1a_135	25.4	60.3	51.8	0.10		0.6	ULS 1a_0,9_0,9_45	48.4	60.3	33.7	0.02	
234	Hor Verb E Internal Diag	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	347	-2.4	ULS 1a_45	13.5	60.3	51.8	0.18		2.6	ULS 1a_0,9_0,9_135	48.4	60.3	33.7	0.08	
235	Hor Verb E Internal X-Brace	65x65x7	S235	1M16-8.8t	0.50	1.00	0.50	299	-0.1	ULS 1a_0	5.2	60.3	60.5	0.02		0.1	ULS 1a_0,9_0,9_0	72.6	60.3	52.3	0.00	
236T	Mast Level 1 Cross-Diag 2 T	80x80x8	S235	2M20-8.8t	0.20	0.20	0.20	104	-85.1	ULS 5a Ah 12	150.1	188.2	172.8	0.57		60.9	ULS 5a Ba 12	138.0	188.2	151.7	0.44	
236L	Mast Level 1 Cross-Diag 2 L	80x80x8	S235	2M20-8.8t	0.20	0.20	0.20	104	-90.7	ULS 5a Ba 21	150.1	188.2	172.8	0.60		76.1	ULS 5a Ah 10	138.0	188.2	151.7	0.55	
301	Upper Cross-Arm Trans Face Vert Brace 1	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	189	-10.9	ULS 1a_90	34.0	60.3	51.8	0.32		0.0		48.4	60.3	33.7	0.00	
302	Upper Cross-Arm Trans Face Vert Brace 2	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	189	-5.9	ULS 3_90	23.7	60.3	43.2	0.25		0.0		37.4	60.3	25.7	0.00	
303	Upper Cross-Arm Trans Face Diag Brace :	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	-7.7	ULS 1a_90	32.7	60.3	43.2	0.23		2.0	ULS 1a_0,9_0,9_90	37.4	60.3	25.7	0.08	

Assessment of groups for initial mast (afkeur level)

Date 22-02-21
Author MKh
Version 1.0

ENS-ZL 380
S-6_R
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Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
304	Upper Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	107	**-8.7**	ULS 1a_90	45.8	60.3	43.2	0.20		**3.1**	ULS 1a_0,9_0,9_90	37.4	60.3	25.7	0.12	
305	Upper Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	71	**-1.1**	ULS 5a Ba 1	58.4	60.3	43.2	0.02		**0.0**		37.4	60.3	25.7	0.00	
306	Upper Cross-Arm Trans Face Diag Brace	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	294	**0.0**		17.6	60.3	51.8	0.00		**13.9**	ULS 1a_135	48.4	60.3	33.7	0.41	
307	Upper Cross-Arm Trans Face Diag Brace	50x50x7	S235	1M16-8.8t	1.00	1.00	1.00	328	**0.0**		14.0	60.3	60.5	0.00		**18.1**	ULS 1a_90	52.4	60.3	36.0	0.50	
308	Upper Cross-Arm Bovenvlak Lateral Brac	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	307	**0.0**		11.4	60.3	43.2	0.00		**11.6**	ULS 3_90	37.4	60.3	25.7	0.45	
309	Upper Cross-Arm Ondervlak Lateral Brac	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	275	**-5.9**	ULS 1a_0,9_0,9_90	17.0	120.6	86.4	0.35		**18.8**	ULS 1a_90	52.4	120.6	51.4	0.37	
310	Upper Cross-Arm Internal Diagonal Brace	50x50x7	S235	2M16-8.8t	1.00	1.00	1.00	237	**-10.8**	ULS 1a_0,9_0,9_90	29.1	120.6	121.0	0.37		**27.0**	ULS 1a_90	71.2	120.6	72.0	0.38	
311	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	80	**-14.5**	ULS 5a Ba 1	56.0	60.3	43.2	0.33		**13.9**	ULS 5a Ah 1	37.4	60.3	25.7	0.54	
312	Upper Cross-Arm End Hrz Brace	HEB160	S355	2M20-8.8t	1.00	2.00	1.00	15	**-10.4**	ULS 5a Ah 1	1562.7	188.2	235.2	0.06		**10.9**	ULS 5a Ba 1	1739.7	188.2	0.0	0.06	
313	Upper Cross-Arm Ondervlak Cross-Diag 2	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	78	**-12.3**	ULS 5a Ah 1	56.5	60.3	43.2	0.28		**12.6**	ULS 5a Ba 1	37.4	60.3	25.7	0.49	
314	Upper Cross-Arm Ondervlak Cross-Diag 3	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	81	**-11.3**	ULS 5a Ba 3	55.6	60.3	43.2	0.26		**11.3**	ULS 5a Ba 1	37.4	60.3	25.7	0.44	
315	Upper Cross-Arm Ondervlak Cross-Diag 4	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	89	**-10.8**	ULS 5a Ba 3	53.1	60.3	43.2	0.25		**10.3**	ULS 5a Ah 1	37.4	60.3	25.7	0.40	
316	Upper Cross-Arm Ondervlak Cross-Diag 5	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	108	**-23.9**	ULS 5a Ba 22	62.2	60.3	60.5	0.40		**19.9**	ULS 5a Ah 22	52.4	60.3	36.0	0.42	
317	Upper Cross-Arm Ondervlak Cross-Diag 6	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	107	**-17.0**	ULS 5a Ah 22	62.6	60.3	60.5	0.28		**20.6**	ULS 5a Ba 22	52.4	60.3	36.0	0.44	
318	Upper Cross-Arm Ondervlak Cross-Diag 7	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	111	**-19.1**	ULS 5a Ba 22	60.4	60.3	60.5	0.32		**16.0**	ULS 5a Ah 22	52.4	60.3	36.0	0.44	
319	Upper Cross-Arm Ondervlak Cross-Diag 8	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	94	**-12.6**	ULS 5a Ah 22	73.4	60.3	51.8	0.24		**15.4**	ULS 5a Ba 12	48.4	60.3	33.7	0.46	
320	Upper Cross-Arm Ondervlak Cross-Diag 9	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	120	**-22.8**	ULS 5a Ba 12	40.9	60.3	43.2	0.56		**22.9**	ULS 5a Ah 22	37.4	60.3	25.7	0.67	
321	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	129	**-36.8**	ULS 5a Ba 12	37.9	60.3	43.2	0.97		**34.6**	ULS 5a Ah 12	37.4	60.3	25.7	1.02	stuik
322	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	132	**-29.7**	ULS 5a Ah 22	37.2	60.3	43.2	0.80		**31.5**	ULS 5a Ba 22	37.4	60.3	25.7	0.93	stuik
323	Upper Cross-Arm Ondervlak Cross-Diag 1	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	138	**-28.5**	ULS 5a Ba 22	35.1	60.3	43.2	0.81		**26.7**	ULS 5a Ah 22	37.4	60.3	25.7	0.79	stuik
325	Upper Cross-Arm Internal Diagonal Brac1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	98	**-1.6**	ULS 1a_0	49.2	60.3	43.2	0.04		**1.2**	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.05	
326	Upper Cross-Arm Internal Diagonal Brac2	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	211	**-2.3**	ULS 1a_0	20.2	60.3	43.2	0.11		**1.9**	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.07	
401	Lower Cross-Arm Trans Face Vert Brace 1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	145	**-3.7**	ULS 1a_90	33.4	60.3	43.2	0.11		**0.0**		46.1	60.3	32.7	0.00	
402	Lower Cross-Arm Trans Face Vert Brace	65x65x7	S235	1M16-8.8t	1.00	1.00	1.00	152	**-10.0**	ULS 3_135	63.9	60.3	60.5	0.17		**0.0**		84.7	60.3	52.3	0.00	
403	Lower Cross-Arm Trans Face Vert Brace	65x65x7	S235	1M16-8.8t	1.00	1.00	1.00	194	**-8.3**	ULS 3_135	46.4	60.3	60.5	0.18		**0.0**		84.7	60.3	52.3	0.00	
404	Lower Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	266	**0.0**		14.3	60.3	43.2	0.00		**9.1**	ULS 1a_90	46.1	60.3	32.7	0.28	
405	Lower Cross-Arm Trans Face Diag Brace	50x50x7	S235	2M16-8.8t	1.00	1.00	1.00	324	**0.0**		17.9	120.6	121.0	0.00		**20.8**	ULS 3_45	71.2	120.6	72.0	0.29	
406	Lower Cross-Arm Trans Face Diag Brace	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	296	**0.0**		21.7	120.6	103.7	0.00		**14.2**	ULS 3_135	78.2	120.6	67.3	0.21	
407	Lower Cross-Arm Trans Face Diag Brace	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	337	**0.0**		14.1	60.3	51.8	0.00		**15.7**	ULS 3_90	48.4	60.3	33.7	0.47	
408	Lower Cross-Arm Bovenvlak Lateral Brac	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	101	**-1.0**	ULS 1a_0	73.8	60.3	51.8	0.02		**0.9**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.03	
409	Lower Cross-Arm Ondervlak Lateral Brac	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	48	**-15.4**	ULS 5a Ah 20	960.6	188.2	172.8	0.09		**17.1**	ULS 5a Ba 20	1278.1	188.2	0.0	0.10	
410	Lower Cross-Arm Internal Diagonal Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	176	**-2.2**	ULS 1a_0	26.1	60.3	43.2	0.09		**1.7**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.05	
411	Lower Cross-Arm Ondervlak Cross-Diag 1	50x50x7	S235	1M16-8.8t	0.55	0.55	0.55	98	**-23.7**	ULS 5a Ba 21	67.3	60.3	60.5	0.39		**21.5**	ULS 5a Ah 10	64.5	60.3	45.8	0.47	
412	Lower Cross-Arm Ondervlak Cross-Diag 2	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	104	**-17.0**	ULS 5a Ah 10	64.3	60.3	60.5	0.28		**19.1**	ULS 5a Ba 10	56.4	60.3	39.3	0.49	
413	Lower Cross-Arm End Hrz Brace	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	25	**-16.4**	ULS 5a Ah 10	1067.2	188.2	172.8	0.09		**16.1**	ULS 5a Ba 21	1278.1	188.2	0.0	0.09	
414	Lower Cross-Arm Ondervlak Cross-Diag 3	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	87	**-15.9**	ULS 5a Ba 10	77.4	60.3	51.8	0.31		**14.1**	ULS 5a Ah 21	48.4	60.3	33.7	0.42	
415	Lower Cross-Arm Ondervlak Cross-Diag 4	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	113	**-10.6**	ULS 5a Ah 21	43.5	60.3	43.2	0.25		**12.0**	ULS 5a Ba 10	46.1	60.3	32.7	0.37	
417	Lower Cross-Arm Ondervlak Cross-Diag 6	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	121	**-15.1**	ULS 5a Ba 21	40.6	60.3	43.2	0.37		**16.5**	ULS 5a Ah 21	46.1	60.3	32.7	0.50	
418	Lower Cross-Arm Ondervlak Cross-Diag 7	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	107	**-27.8**	ULS 5a Ba 21	65.6	60.3	51.8	0.54		**26.3**	ULS 5a Ah 21	48.4	60.3	33.7	0.64	
419	Lower Cross-Arm Ondervlak Cross-Diag 8	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	110	**-22.8**	ULS 5a Ah 21	64.3	60.3	51.8	0.44		**24.6**	ULS 5a Ba 10	48.4	60.3	33.7	0.73	
420	Lower Cross-Arm Ondervlak Cross-Diag 9	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	121	**-23.2**	ULS 5a Ba 21	58.6	60.3	51.8	0.45		**21.5**	ULS 5a Ah 21	48.4	60.3	33.7	0.64	
421	Lower Cross-Arm Ondervlak Cross-Diag 1	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	125	**-19.4**	ULS 5a Ah 10	56.6	60.3	51.8	0.37		**20.7**	ULS 5a Ba 10	48.4	60.3	33.7	0.62	
422	Lower Cross-Arm Ondervlak Cross-Diag 1	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	134	**-18.9**	ULS 5a Ba 21	52.6	60.3	51.8	0.36		**18.0**	ULS 5a Ah 10	48.4	60.3	33.7	0.53	
423	Lower Cross-Arm Ondervlak Cross-Diag 1	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	140	**-26.9**	ULS 5a Ah 20	49.9	60.3	51.8	0.54		**26.6**	ULS 5a Ba 11	48.4	60.3	33.7	0.79	
310-1	Boven Traverse Upper	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	36	**-0.5**	ULS 5a Ba 3	68.1	60.3	43.2	0.01		**0.0**		37.4	60.3	25.7	0.00	
310-2	Boven Traverse Upper	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	84	**-0.8**	ULS 1a_0,9_0,9_0	59.0	60.3	43.2	0.02		**0.8**	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.03	
310-3	Boven Traverse	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	113	**-0.8**	ULS 1a_0	46.3	60.3	43.2	0.02		**4.4**	ULS 6a_90 Ah Ct1	37.4	60.3	25.7	0.17	
310-4	Boven Traverse	HEB160	S355	2M20-8.8t	1.00	2.00	1.00	19	**-14.2**	ULS 5a Ah 22	1527.7	188.2	235.2	0.08		**17.9**	ULS 5a Ba 22	1739.7	188.2	0.0	0.10	
310-5	Boven Traverse	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	190	**-2.4**	ULS 1a_0,9_0,9_90	23.5	60.3	43.2	0.10		**3.7**	ULS 1a_90	37.4	60.3	25.7	0.14	
401-1	Lower Cross-Arm Trans Face Vert Brace 1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	96	**-1.8**	ULS 1a_90	50.0	60.3	43.2	0.04		**0.0**		46.1	60.3	32.7	0.00	
401-2	Lower Cross-Arm Trans Face Vert Brace 1	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	48	**-0.8**	ULS 1a_90	64.8	60.3	43.2	0.02		**0.0**		46.1	60.3	32.7	0.00	
404-1	Lower Cross-Arm Trans Face Diag Brace	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	244	**0.0**		16.4	60.3	43.2	0.00		**6.7**	ULS 1a_90	46.1	60.3	32.7	0.20	
V-oph	Lower Cross-Arm Ondervlak V-suspensio	HEB160	S235		1.00	1.00	1.00	35	**-15.5**	ULS 5a Ah 11	984.4	0.0	0.0	0.00		**18.2**	ULS 5a Ba 10	1276.1	0.0	0.0	0.00	

DNV·GL

Assessment of groups for strenghtened mast (afkeur level)

Date 22-02-21
Author MKh
Version 1.0

ENS-ZL 380
S-6_R
28

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	mpression	Load Case (Compres	Buckling	Shear (Comp)	earing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	hear (Tens)	earing (Tens)	U.C. (Tens)
101	Earth Peak	80x80x7#	S235	2M20-8.8t	1.00	1.00	1.00	155	**-10.1**	ULS 5a Ba 12	87.1	188.2	151.2	0.12		**10.0**	ULS 5a Ba 22	129.9	188.2	137.5	0.08
102	Main Leg Level	100x100x8	S355	7M20-8.8t	0.52	0.52	0.52	69	**-35.0**	ULS 5a Ah 12	394.0	658.6	823.2	0.09		**8.2**	ULS 1a_0,9_0,9_90	422.7	658.6	823.2	0.02
103-A	Main Leg Level	120x120x10	S355	4M24-8.8t	0.52	0.52	0.52	57	**-39.1**	ULS 5a Ba 22	656.6	542.2	705.6	0.07		**22.2**	ULS 5a Ah 12	635.0	542.2	663.4	0.04
103-B	Main Leg Level	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	66	**-139.8**	ULS 1a_45	607.0	2168.8	1411.2	0.23		**78.7**	ULS 1a_0,9_0,9_135	635.0	2168.8	1411.2	0.12
103-C	Main Leg Level	120x120x10	S355		0.52	0.52	0.52	64	**-120.7**	ULS 1a_135	619.8	0.0	0.0	0.19		**82.4**	ULS 1a_0,9_0,9_45	823.6	0.0	0.0	0.10
104-A	Main Leg Level	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	49	**-227.2**	ULS 1a_135	1050.7	2168.8	1693.4	0.22		**141.1**	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.14
104-B	Main Leg Level	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	63	**-377.6**	ULS 1a_45	940.1	2168.8	1693.4	0.40		**280.7**	ULS 1a_0,9_0,9_45	1007.6	2168.8	1461.9	0.28
104-C	Main Leg Level	150x150x12	S355		0.52	0.52	0.52	56	**-300.7**	ULS 1a_45	998.1	0.0	0.0	0.30		**202.5**	ULS 1a_0,9_0,9_135	1235.4	0.0	0.0	0.16
105-A	Main Leg Level	150x150x12	S355	8M24-8.8t	0.52	0.52	0.52	32	**-443.0**	ULS 1a_45	1155.2	2168.8	1693.4	0.38		**335.0**	ULS 1a_0,9_0,9_135	1007.6	2168.8	1461.9	0.33
105-B	Main Leg Level	150x150x12	S355	8M24-8.8t	0.25	0.25	0.25	37	**-532.7**	ULS 1a_135	1128.8	2168.8	1693.4	0.47		**414.4**	ULS 1a_0,9_0,9_135	1007.6	2168.8	1461.9	0.41
105-C	Main Leg Level	150x150x12	S355		0.52	0.52	0.52	38	**-444.3**	ULS 1a_45	1121.1	0.0	0.0	0.40		**333.7**	ULS 1a_0,9_0,9_45	1235.4	0.0	0.0	0.27
106-A	Main Leg Level	150x150x12	S355	10M24-8.8t	0.52	0.52	0.52	51	**-500.6**	ULS 1a_45	1037.3	2711.0	2116.8	0.48		**401.9**	ULS 1a_0,9_0,9_45	1007.6	2711.0	1827.3	0.40
106-B	Main Leg Level	150x150x12	S355	8M24-8.8t	0.20	0.20	0.20	49	**-502.6**	ULS 1a_135	1051.2	2168.8	1693.4	0.48		**399.8**	ULS 1a_0,9_0,9_45	1007.6	2168.8	1592.1	0.40
108-A	Boven Traverse	120x120x10	S355	12M24-8.8t	1.00	1.47	1.00	62	**-258.5**	ULS 5a Ba 12	630.9	1562.2	2116.8	0.41		**173.3**	ULS 5a Ah 22	635.0	1562.2	1990.2	0.27
108-C	Boven Traverse	120x120x10	S355		3.11	2.03	1.00	59	**-226.3**	ULS 5a Ba 22	648.8	0.0	0.0	0.35		**143.7**	ULS 5a Ah 12	823.6	0.0	0.0	0.17
108-B	Boven Traverse	120x120x10	S355	4M24-8.8t	1.86	3.28	1.00	61	**-108.4**	ULS 5a Ba 1	634.8	542.2	705.6	0.20		**49.3**	ULS 5a Ah 3	635.0	542.2	663.4	0.09
109-A	Boven Traverse	90x90x8	S355	4M24-8.8t	3.38	2.16	1.00	73	**-100.7**	ULS 5a Ba 1	338.8	542.2	564.5	0.30		**54.8**	ULS 5a Ah 1	343.6	542.2	530.7	0.16
109-C	Boven Traverse	90x90x8	S355		1.00	1.42	1.00	80	**-84.8**	ULS 5a Ba 1	311.0	0.0	0.0	0.27		**42.3**	ULS 5a Ah 3	493.5	0.0	0.0	0.09
110-A	Boven Traverse	80x80x8	S235	4M20-8.8t	1.00	1.98	1.00	186	**0.0**		73.9	376.3	345.6	0.00		**65.0**	ULS 3_90	168.3	376.3	310.2	0.39
110-B	Boven Traverse	80x80x8	S235	4M20-8.8t	1.00	2.81	1.00	276	**-7.2**	ULS 1a_0,9_0,9_90	41.7	376.3	345.6	0.17		**49.9**	ULS 1a_90	227.6	376.3	314.2	0.22
110-C	Boven Traverse	80x80x8	S235		1.00	1.98	1.00	182	**-4.3**	ULS 1a_0,9_0,9_90	76.1	0.0	0.0	0.06		**58.4**	ULS 1a_90	289.1	0.0	0.0	0.20
115-A	Boven Traverse	80x80x6#	S235	4M20-8.8t	1.00	2.93	1.00	271	**-2.3**	ULS 1a_0,9_0,9_90	32.7	376.3	259.2	0.07		**35.9**	ULS 3_90	175.2	376.3	235.6	0.20
115-B	Boven Traverse	80x80x6#	S235	2M20-8.8t	1.00	2.00	1.00	164	**-6.1**	ULS 5a Ah 3	66.2	188.2	129.6	0.09		**21.1**	ULS 5a Ba 3	93.1	188.2	100.8	0.23
115-C	Boven Traverse	80x80x6#	S235		1.00	3.30	1.00	271	**-3.1**	ULS 5a Ah 3	32.7	0.0	0.0	0.09		**25.4**	ULS 5a Ba 3	220.9	0.0	0.0	0.12
111-A	Onder Traverse	120x120x12	S355	11M24-8.8t	2.04	1.00	1.00	67	**-268.3**	ULS 5a Ba 10	712.0	1447.6	2328.5	0.38		**179.2**	ULS 5a Ah 10	750.1	1447.6	2189.2	0.24
111-C	Onder Traverse	120x120x12	S355		1.96	1.00	1.00	67	**-255.6**	ULS 5a Ba 10	711.2	0.0	0.0	0.36		**162.8**	ULS 5a Ah 21	976.3	0.0	0.0	0.17
111-B	Onder Traverse	120x120x12	S355	4M24-8.8t	1.00	1.85	1.00	66	**-158.7**	ULS 5a Ba 10	719.7	542.2	846.7	0.29		**94.5**	ULS 5a Ah 21	750.1	542.2	796.1	0.17
112-A	Onder Traverse	100x100x10	S355		1.00	1.00	1.00	33	**-125.4**	ULS 5a Ba 10	632.9	0.0	0.0	0.20		**78.6**	ULS 5a Ah 10	681.6	0.0	0.0	0.12
112-C	Onder Traverse	100x100x10	S355		1.50	2.50	1.00	71	**-109.9**	ULS 5a Ba 21	476.2	0.0	0.0	0.23		**54.0**	ULS 5a Ah 10	681.6	0.0	0.0	0.08
113-A	Onder Traverse	80x80x8	S235	4M20-8.8t	2.90	1.00	1.00	313	**0.0**		34.3	376.3	345.6	0.00		**75.2**	ULS 1a_90	168.3	376.3	310.2	0.45
113-B	Onder Traverse	80x80x8	S235	4M20-8.8t	3.09	1.00	1.00	313	**-14.0**	ULS 1a_0,9_0,9_90	34.3	376.3	345.6	0.41		**57.1**	ULS 1a_90	227.6	376.3	314.2	0.25
113-C	Onder Traverse	80x80x8	S235		3.02	1.00	1.00	312	**-3.7**	ULS 1a_0,9_0,9_90	34.3	0.0	0.0	0.11		**66.9**	ULS 1a_90	289.1	0.0	0.0	0.23
114-A	Onder Traverse	80x80x6#	S235	4M20-8.8t	3.00	1.00	1.00	270	**-21.3**	ULS 1a_0,9_0,9_90	33.0	376.3	259.2	0.64		**55.4**	ULS 1a_90	175.2	376.3	235.6	0.32
114-B	Onder Traverse	80x80x6#	S235	4M20-8.8t	3.00	1.00	1.00	270	**-22.3**	ULS 1a_0,9_0,9_90	33.0	376.3	259.2	0.67		**49.4**	ULS 1a_90	116.4	376.3	196.0	0.42
114-C	Onder Traverse	80x80x6#	S235		3.00	1.00	1.00	270	**-22.1**	ULS 1a_0,9_0,9_90	33.0	0.0	0.0	0.67		**49.2**	ULS 1a_90	220.9	0.0	0.0	0.22
201	Earth Peak Hrz	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	128	**0.0**		122.6	376.3	345.6	0.00		**62.9**	ULS 3_0	157.3	376.3	277.6	0.40
202	Earth Peak Hrz	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	171	**-2.1**	ULS 1a_0,9_0,9_90	48.7	120.6	103.7	0.04		**2.7**	ULS 1a_90	78.2	120.6	67.3	0.04
203L	Boven Cross-Ar	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	109	**-28.3**	ULS 1a_90	110.0	188.2	129.6	0.26		**26.3**	ULS 1a_0,9_0,9_90	112.1	188.2	117.8	0.23
203T	Boven Cross-Ar	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	109	**-10.8**	ULS 5a Ah 12	110.0	188.2	129.6	0.10		**5.5**	ULS 5a Ah 22	112.1	188.2	117.8	0.05
204	Boven Cross-Ar	120x120x10	S355	12M24-8.8t	1.00	2.00	1.00	60	**-198.1**	ULS 5a Ba 22	644.6	1562.2	2116.8	0.31		**105.9**	ULS 5a Ah 12	635.0	1562.2	1990.2	0.17
205	Boven Cross-Ar	65x65x7	S235	4M20-8.8t	1.00	2.00	1.00	112	**-41.5**	ULS 5a Ah 12	94.3	376.3	302.4	0.44		**52.0**	ULS 5a Ah 22	145.7	376.3	190.9	0.36
206	Boven Cross-Ar	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	97	**-64.1**	ULS 5a Ba 22	121.6	188.2	129.6	0.53		**64.2**	ULS 5a Ba 22	99.4	188.2	110.5	0.65
207	Boven Cross-Ar	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	113	**-0.2**	ULS 3_0	43.6	60.3	43.2	0.00		**0.2**	ULS 3_0	46.1	60.3	32.7	0.01
208L	Mast Level 6 Cr	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	102	**-106.7**	ULS 5a Ba 12	172.5	271.1	207.4	0.62		**107.9**	ULS 5a Ah 12	159.7	271.1	183.4	0.68
208T	Mast Level 6 Cr	100x100x8	S235	3M24-8.8t	0.52	0.52	0.52	92	**-120.1**	ULS 5a Ba 22	209.6	406.7	311.0	0.57		**118.6**	ULS 5a Ah 22	211.1	406.7	276.0	0.56
209L	Mast Level 6 Cr	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	110	**-100.0**	ULS 5a Ah 22	161.0	271.1	207.4	0.62		**97.5**	ULS 5a Ba 22	159.7	271.1	183.4	0.61
209T	Mast Level 6 Cr	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	99	**-109.0**	ULS 5a Ah 12	197.3	271.1	207.4	0.55		**110.4**	ULS 5a Ba 22	181.4	271.1	189.2	0.61
210L	Mast Level 6 Cr	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	117	**-87.7**	ULS 5a Ba 22	152.7	271.1	207.4	0.57		**89.9**	ULS 5a Ah 22	159.7	271.1	183.4	0.56
210T	Mast Level 6 Cr	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	105	**-99.8**	ULS 5a Ba 22	188.3	271.1	207.4	0.53		**97.9**	ULS 5a Ah 22	181.4	271.1	189.2	0.54
212L	Onder Cross-Ar	80x80x8	S235	3M20-8.8t	1.00	1.00	1.00	178	**0.0**		82.0	282.2	259.2	0.00		**76.1**	ULS 1a_0	168.3	282.2	234.2	0.45
212T	Onder Cross-Ar	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	178	**-13.2**	ULS 1a_0,9_0,9_90	82.0	188.2	172.8	0.16		**18.3**	ULS 1a_90	146.3	188.2	157.1	0.13
211L	Onder Cross-Ar	100x100x10	S235	2M24-8.8t	0.52	0.52	0.52	111	**-99.5**	ULS 5a Ba 22	221.0	271.1	259.2	0.45		**94.8**	ULS 5a Ah 22	224.3	271.1	236.4	0.42
211T	Onder Cross-Ar	100x100x8	S235	2M24-8.8t	0.52	0.52	0.52	111	**-96.5**	ULS 5a Ba 22	179.3	271.1	207.4	0.54		**82.9**	ULS 5a Ah 22	181.4	271.1	189.2	0.46
216	Hor Verb D Hrz	120x120x12	S355	11M24-8.8t	1.00	2.00	1.00	82	**-196.7**	ULS 5a Ba 21	597.6	1447.6	2328.5	0.33		**107.2**	ULS 5a Ah 10	750.1	1447.6	2189.2	0.14
213T	Hor Verb D Hrz	80x80x6#	S235	4M20-8.8t	1.00	2.00	1.00	121	**-42.5**	ULS 5a Ah 21	93.7	376.3	259.2	0.45		**56.3**	ULS 5a Ah 10	175.2	376.3	235.6	0.32
218	Hor Verb D Inte	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	121	**-68.4**	ULS 5a Ah 10	147.8	271.1	207.4	0.46		**68.7**	ULS 5a Ba 21	159.7	271.1	183.4	0.43
219	Hor Verb D X-B	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	155	**-0.5**	ULS 5a Ba 20	30.8	60.3	43.2	0.02		**0.6**	ULS 5a Ba 11	46.1	60.3	32.7	0.02
214L	Mast Level 4 Cr	100x100x8	S235	2M24-8.8t	0.53	0.27	0.27	73	**-90.3**	ULS 5a Ba 10	231.3	271.1	207.4	0.44		**85.7**	ULS 5a Ah 21	181.4	271.1	189.2	0.47
214T	Mast Level 4 Cr	100x100x8	S235	2M24-8.8t	0.53	0.27	0.27	73	**-104.6**	ULS 5a Ba 10	231.3	271.1	207.4	0.50		**103.0**	ULS 5a Ah 10	181.4	271.1	189.2	0.57
215L	Mast Level 4 Cr	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	91	**-79.5**	ULS 5a Ah 10	179.1	271.1	207.4	0.44		**81.5**	ULS 5a Ba 10	173.9	271.1	193.2	0.47
215T	Mast Level 4 Cr	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	91	**-94.8**	ULS 5a Ba 21	179.1	271.1	207.4	0.53		**96.6**	ULS 5a Ba 21	173.9	271.1	193.2	0.56
216L	Mast Level 4 Cr	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	102	**-73.6**	ULS 5a Ah 21	163.9	271.1	207.4	0.45		**71.5**	ULS 5a Ah 10	159.7	271.1	183.4	0.45
216T	Mast Level 4 Cr	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	102	**-88.1**	ULS 5a Ah 21	163.9	271.1	207.4	0.54		**85.8**	ULS 5a Ba 21	159.7	271.1	183.4	0.54
226T	Mast Level 3 Cr	90x90x8	S235	2M24-8.8t	1.00	0.52	0.52	114	**-82.9**	ULS 5a Ba 10	148.1	271.1	207.4	0.56		**78.0**	ULS 5a Ah 21	159.7	271.1	183.4	0.49
226L	Mast Level 3 Cr	90x90x8	S235	2M24-8.8t	1.00	0.52	0.52	114	**-65.8**	ULS 5a Ba 21	148.1	271.1	207.4	0.44		**65.8**	ULS 5a Ah 10	159.7	271.1	183.4	0.41
227T	Mast Level 3 Cr	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	124	**-69.5**	ULS 5a Ah 10	135.5	271.1	207.4	0.51		**72.6**	ULS 5a Ba 21	159.7	271.1	183.4	0.45
227L	Mast Level 3 Cr	90x90x8	S235	2M24-8.8t	0.53	0.27	0.27	124	**-58.1**	ULS 5a Ah 10	135.5	271.1	207.4	0.43		**57.8**	ULS 5a Ba 10	159.7	271.1	183.4	0.36
228T	Hor Verb G Hrz	60x60x6	S235	1M16-8.8t	1.10	1.00	1.00	166	**-1.9**	ULS 1a_0,9_0,9_45	45.4	60.3	51.8	0.04		**1.6**	ULS 1a_135	48.4	60.3	33.7	0.05
228TC	Hor Verb G Hrz	60x60x6	S235		2.00	11.24	1.00	117	**-3.6**	ULS 1a_0,9_0,9_45	71.2	0.0	0.0	0.05		**3.4**	ULS 1a_135	162.2	0.0	0.0	0.02
228L	Hor Verb G Hrz	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	183	**-1.9**	ULS 1a_0,9_0,9_135	40.1	60.3	51.8	0.05		**1.7**	ULS 1a_135	48.4	60.3	33.7	0.05
229	Hor Verb G Inte	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	247	**-1.6**	ULS 1a_135	23.1	60.3	51.8	0.07		**1.8**	ULS 1a_0,9_135	48.4	60.3	33.7	0.05
230	Hor Verb G Inte	60x60x6	S235	1M16-8.8t	0.50	0.50	0.50	183	**-0.4**	ULS 1a_0	35.7	60.3	51.8	0.01		**0.3**	ULS 1a_0,9_0	48.4	60.3	33.7	0.01
232T	Mast Level 1 Cr	100x100x8	S235	2M24-8.8t	0.52	1.00	0.52	123	**-67.4**	ULS 1a_90	152.0	271.1	207.4	0.44		**51.4**	ULS 1a_0,9_0,9_90	181.4	271.1	189.2	0.28
232L	Mast Level 1 Cr	100x100x8	S235	2M24-8.8t	0.52	1.00	0.52	123	**-75.4**	ULS 5a Ba 10	152.0	271.1	207.4	0.50		**60.3**	ULS 5a Ah 21	181.4	271.1	189.2	0.33
233T	Hor Verb E Hrz	60x60x6	S235	1M16-8.8t	1.00	1.04	1.00	240	**-2.5**	ULS 1a_45	27.1	60.3	51.8	0.09		**0.8**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.02
233TC	Hor Verb E Hrz	60x60x6	S235		23.81	2.00	1.00	161	**-5.1**	ULS 1a_45	50.0	0.0	0.0	0.10		**3.4**	ULS 1a_0,9_0,9_45	162.2	0.0	0.0	0.02
233L	Hor Verb E Hrz	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	250	**-2.5**	ULS 1a_135	25.4	60.3	51.8	0.10		**0.6**	ULS 1a_0,9_0,9_45	48.4	60.3	33.7	0.02
234	Hor Verb E Inte	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	347	**-2.4**	ULS 1a_45	13.5	60.3	51.8	0.18		**2.6**	ULS 1a_0,9_0,9_135	48.4	60.3	33.7	0.08
235	Hor Verb E Inte	65x65x7	S235	1M16-8.8t	0.50	1.00	0.50	299	**-0.1**	ULS 1a_0	5.2	60.3	60.5	0.02		**0.1**	ULS 1a_0,9_0,9_0	72.6	60.3	52.3	0.00
236T	Mast Level 1 Cr	80x80x8	S235	2M20-8.8t	0.20	0.20	0.20	104	**-85.1**	ULS 5a Ah 12	150.1	188.2	172.8	0.57		**60.9**	ULS 5a Ba 12	138.0	188.2	151.7	0.44
236L	Mast Level 1 Cr	80x80x8	S235	2M20-8.8t	0.20	0.20	0.20	104	**-90.7**	ULS 5a Ba 21	150.1	188.2	172.8	0.60		**76.1**	ULS 5a Ah 10	138.0	188.2	151.7	0.55

Assessment of groups for strengthened mast (afkeur level)

Date 22-02-21
Author MKh
Version 1.0

ENS-ZL 380
S-6_R
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Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	mpression	Load Case (Compres	Buckling	Shear (Comp)	earing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	hear (Tens)	earing (Tens)	U.C. (Tens)
301	Upper Cross-Ar	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	189	-10.9	ULS 1a_90	34.0	60.3	51.8	0.32		0.0		48.4	60.3	33.7	0.00
302	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	189	-5.9	ULS 3_90	23.7	60.3	43.2	0.25		0.0		37.4	60.3	25.7	0.00
303	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	-7.7	ULS 1a_90	32.7	60.3	43.2	0.23		2.0	ULS 1a_0,9_0,9_90	37.4	60.3	25.7	0.08
304	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	107	-8.7	ULS 1a_90	45.8	60.3	43.2	0.20		3.1	ULS 1a_0,9_0,9_90	37.4	60.3	25.7	0.12
305	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	71	-1.1	ULS 5a Ba 1	58.4	60.3	43.2	0.02		0.0		37.4	60.3	25.7	0.00
306	Upper Cross-Ar	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	294	0.0		17.6	60.3	51.8	0.00		13.9	ULS 1a_135	48.4	60.3	33.7	0.41
307	Upper Cross-Ar	50x50x7	S235	1M16-8.8t	1.00	1.00	1.00	328	0.0		14.0	60.3	60.5	0.00		18.1	ULS 1a_90	52.4	60.3	36.0	0.50
308	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	307	0.0		11.4	60.3	43.2	0.00		11.6	ULS 3_90	37.4	60.3	25.7	0.45
309	Upper Cross-Ar	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	275	-5.9	ULS 1a_0,9_0,9_90	17.0	120.6	86.4	0.35		18.8	ULS 1a_90	52.4	120.6	51.4	0.37
310	Upper Cross-Ar	50x50x7	S235	2M16-8.8t	1.00	1.00	1.00	237	-10.8	ULS 1a_0,9_0,9_90	29.1	120.6	121.0	0.37		27.0	ULS 1a_90	71.2	120.6	72.0	0.38
311	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	80	-14.5	ULS 5a Ba 1	56.0	60.3	43.2	0.33		13.9	ULS 5a Ah 1	37.4	60.3	25.7	0.54
312	Upper Cross-Ar	HEB160	S355	2M20-8.8t	1.00	2.00	1.00	15	-10.4	ULS 5a Ah 1	1562.7	188.2	235.2	0.06		10.9	ULS 5a Ba 1	1739.7	188.2	0.0	0.06
313	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	78	-12.3	ULS 5a Ah 1	56.5	60.3	43.2	0.28		12.6	ULS 5a Ba 1	37.4	60.3	25.7	0.49
314	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	81	-11.3	ULS 5a Ba 3	55.6	60.3	43.2	0.26		11.3	ULS 5a Ba 1	37.4	60.3	25.7	0.44
315	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	89	-10.8	ULS 5a Ba 3	53.1	60.3	43.2	0.25		10.3	ULS 5a Ah 1	37.4	60.3	25.7	0.40
316	Upper Cross-Ar	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	108	-23.9	ULS 5a Ba 22	62.2	60.3	60.5	0.40		19.9	ULS 5a Ah 22	52.4	60.3	36.0	0.42
317	Upper Cross-Ar	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	107	-17.0	ULS 5a Ah 22	62.6	60.3	60.5	0.28		20.6	ULS 5a Ba 22	52.4	60.3	36.0	0.44
318	Upper Cross-Ar	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	111	-19.1	ULS 5a Ba 22	60.4	60.3	60.5	0.32		16.0	ULS 5a Ah 22	52.4	60.3	36.0	0.44
319	Upper Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	94	-12.6	ULS 5a Ah 22	73.4	60.3	51.8	0.24		15.4	ULS 5a Ba 12	48.4	60.3	33.7	0.46
320	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	120	-22.8	ULS 5a Ba 12	40.9	60.3	43.2	0.56		22.9	ULS 5a Ah 22	37.4	60.3	25.7	0.67
321	Upper Cross-Ar	50x50x5	**S355**	1M16-8.8t	0.52	0.52	0.52	129	-36.8	ULS 5a Ba 12	44.9	60.3	58.8	0.82		34.6	ULS 5a Ah 12	51.0	60.3	35.0	0.99
322	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	132	-29.7	ULS 5a Ah 22	37.2	60.3	43.2	0.80		31.5	ULS 5a Ba 22	37.4	60.3	25.7	0.93
323	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	138	-28.5	ULS 5a Ba 22	35.1	60.3	43.2	0.81		26.7	ULS 5a Ah 22	37.4	60.3	25.7	0.79
325	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	98	-1.6	ULS 1a_0	49.2	60.3	43.2	0.04		1.2	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.05
326	Upper Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	211	-2.3	ULS 1a_0	20.2	60.3	43.2	0.11		1.9	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.07
401	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	145	-3.7	ULS 1a_90	33.4	60.3	43.2	0.11		0.0		46.1	60.3	32.7	0.00
402	Lower Cross-Ar	65x65x7	S235	1M16-8.8t	1.00	1.00	1.00	152	-10.0	ULS 3_135	63.9	60.3	60.5	0.17		0.0		84.7	60.3	52.3	0.00
403	Lower Cross-Ar	65x65x7	S235	1M16-8.8t	1.00	1.00	1.00	194	-8.3	ULS 3_135	46.4	60.3	60.5	0.18		0.0		84.7	60.3	52.3	0.00
404	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	266	0.0		14.3	60.3	43.2	0.00		9.1	ULS 1a_90	46.1	60.3	32.7	0.28
405	Lower Cross-Ar	50x50x7	S235	2M16-8.8t	1.00	1.00	1.00	324	0.0		17.9	120.6	121.0	0.00		20.8	ULS 3_45	71.2	120.6	72.0	0.29
406	Lower Cross-Ar	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	296	0.0		21.7	120.6	103.7	0.00		14.2	ULS 3_135	78.2	120.6	67.3	0.21
407	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	337	0.0		14.1	60.3	51.8	0.00		15.7	ULS 3_90	48.4	60.3	33.7	0.47
408	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	101	-1.0	ULS 1a_0	73.8	60.3	51.8	0.02		0.9	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.03
409	Lower Cross-Ar	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	48	-15.4	ULS 5a Ah 20	960.6	188.2	172.8	0.09		17.1	ULS 5a Ba 20	1278.1	188.2	0.0	0.10
410	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	176	-2.2	ULS 1a_0	26.1	60.3	43.2	0.09		1.7	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.05
411	Lower Cross-Ar	50x50x7	S235	1M16-8.8t	0.55	0.55	0.55	98	-23.7	ULS 5a Ba 21	67.3	60.3	60.5	0.39		21.5	ULS 5a Ah 10	64.5	60.3	45.8	0.47
412	Lower Cross-Ar	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	104	-17.0	ULS 5a Ah 10	64.3	60.3	60.5	0.28		19.1	ULS 5a Ba 10	56.4	60.3	39.3	0.49
413	Lower Cross-Ar	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	25	-16.4	ULS 5a Ah 10	1067.2	188.2	172.8	0.09		16.1	ULS 5a Ba 21	1278.1	188.2	0.0	0.09
414	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	87	-15.9	ULS 5a Ba 10	77.4	60.3	51.8	0.31		14.1	ULS 5a Ah 21	48.4	60.3	33.7	0.42
415	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	113	-10.6	ULS 5a Ah 21	43.5	60.3	43.2	0.25		12.0	ULS 5a Ba 10	46.1	60.3	32.7	0.37
417	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	121	-15.1	ULS 5a Ba 21	40.6	60.3	43.2	0.37		16.5	ULS 5a Ah 21	46.1	60.3	32.7	0.50
418	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	107	-27.8	ULS 5a Ba 21	65.6	60.3	51.8	0.54		26.3	ULS 5a Ah 21	48.4	60.3	33.7	0.64
419	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	110	-22.8	ULS 5a Ah 21	64.3	60.3	51.8	0.44		24.6	ULS 5a Ba 10	48.4	60.3	33.7	0.73
420	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	121	-23.2	ULS 5a Ba 21	58.6	60.3	51.8	0.45		21.5	ULS 5a Ah 21	48.4	60.3	33.7	0.64
421	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	125	-19.4	ULS 5a Ah 10	56.6	60.3	51.8	0.37		20.7	ULS 5a Ba 10	48.4	60.3	33.7	0.62
422	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	134	-18.9	ULS 5a Ba 21	52.6	60.3	51.8	0.36		18.0	ULS 5a Ah 10	48.4	60.3	33.7	0.53
423	Lower Cross-Ar	60x60x6	S235	1M16-8.8t	0.52	0.52	0.52	140	-26.9	ULS 5a Ah 20	49.9	60.3	51.8	0.54		26.6	ULS 5a Ba 11	48.4	60.3	33.7	0.79
310-1	Boven Traverse	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	36	-0.5	ULS 5a Ba 3	68.1	60.3	43.2	0.01		0.0		37.4	60.3	25.7	0.00
310-2	Boven Traverse	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	84	-0.8	ULS 1a_0,9_0,9_0	59.0	60.3	43.2	0.02		0.8	ULS 1a_0,9_0,9_0	37.4	60.3	25.7	0.03
310-3	Boven Traverse	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	113	-0.8	ULS 1a_0	46.3	60.3	43.2	0.02		4.4	ULS 6a_90 Ah Ct1	37.4	60.3	25.7	0.17
310-4	Boven Traverse	HEB160	S355	2M20-8.8t	1.00	2.00	1.00	19	-14.2	ULS 5a Ah 22	1527.7	188.2	235.2	0.08		17.9	ULS 5a Ba 22	1739.7	188.2	0.0	0.10
310-5	Boven Traverse	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	190	-2.4	ULS 1a_0,9_0,9_90	23.5	60.3	43.2	0.10		3.7	ULS 1a_90	37.4	60.3	25.7	0.14
401-1	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	96	-1.8	ULS 1a_90	50.0	60.3	43.2	0.04		0.0		46.1	60.3	32.7	0.00
401-2	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	48	-0.8	ULS 1a_90	64.8	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00
404-1	Lower Cross-Ar	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	244	0.0		16.4	60.3	43.2	0.00		6.7	ULS 1a_90	46.1	60.3	32.7	0.20
V-oph	Lower Cross-Ar	HEB160	S235		1.00	1.00	1.00	35	-15.5	ULS 5a Ah 11	984.4	0.0	0.0	0.00		18.2	ULS 5a Ba 10	1276.1	0.0	0.0	0.00

Assessment of groups for strengthened mast (verbouw level)

Date	22-02-21
Author	MKh
Version	1.0

ENS-ZL 380
S-6_R
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Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	ımpression	Load Case (Compres:	Buckling	Shear (Comp)	ɜaring (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	ɜhear (Tens)	ɜearing (Tens)	U.C. (Tens)
321	Upper Cross-Arı	50x50x5	**S355**	1M16-8.8t	0.52	0.52	0.52	129	**-36.8**	ULS 5a Ba 12	44.9	60.3	58.8	0.82		**34.6**	ULS 5a Ah 12	51.0	60.3	35.0	0.99

APPENDIX C
Toetsing knikverkorters

DNV·GL

Knikverkorters initial construction (afkeur)

Date: 2021-02-22
Author: K H Chan
Version: 1.8

ENS - ZL
S-6_R
22&28

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
1021	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	0.57	0	59	**10.5**	**0.14**	61.9	60.3	30.3	31.7	0.72	0.35		
1019	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.42	69	146	**10.5**	**0.00**	33.1	60.3	30.3	31.7	0.72	0.35		
1018	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.12	0	115	**10.5**	**0.28**	42.9	60.3	30.3	31.7	0.72	0.39		
1017	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.72	56	177	**10.5**	**0.00**	25.9	60.3	30.3	31.7	0.72	0.41		
1016	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.70	0	175	**10.5**	**0.43**	26.3	60.3	30.3	31.7	0.72	0.59		
1015	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	2.09	43	215	**10.5**	**0.00**	19.8	60.3	30.3	31.7	0.72	0.53		
1014	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	2.28	0	195	**10.5**	**0.57**	32.6	60.3	38.4	72.6	1.24	0.46		
1012	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	2.54	34	261	**10.5**	**0.00**	14.8	60.3	30.3	31.7	0.72	0.71		
1007	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	2.88	0	246	**10.5**	**0.72**	23.2	60.3	38.4	72.6	1.24	0.58		
1011	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	2.12	39	218	**10.5**	**0.00**	19.4	60.3	30.3	31.7	0.72	0.54		
1010	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.44	0	148	**10.5**	**0.36**	32.5	60.3	30.3	31.7	0.72	0.50		
1029	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	0.78	0	81	**1.5**	**0.20**	55.8	60.3	30.3	31.7	0.72	0.27		
1025	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	1.57	76	161	**1.5**	**0.00**	29.3	60.3	30.3	31.7	0.72	0.05		
1028	Pootverband	Kniksteun en verticale steur	L50.5	S235	M16	8.8	1.55	0	102	**1.5**	**0.19**	36.7	60.3	30.3	31.7	0.54	0.37		
1024	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	1.79	64	184	**1.5**	**0.00**	24.6	60.3	30.3	31.7	0.72	0.06		
1027	Pootverband	Kniksteun en verticale steur	L60.6	S235	M16	8.8	2.38	0	131	**1.5**	**0.30**	41.9	60.3	38.4	72.6	0.93	0.33		
1023	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	1.99	53	204	**1.5**	**0.00**	21.2	60.3	30.3	31.7	0.72	0.07		
1026	Pootverband	Kniksteun en verticale steur	L60.6	S235	M16	8.8	3.21	0	177	**1.5**	**0.40**	29.9	60.3	38.4	72.6	0.93	0.45		
1022	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.23	44	229	**1.5**	**0.00**	18.0	60.3	30.3	31.7	0.72	0.08		
1008	Tussenschot	Kniksteun en verticale steur	L60.6	S235	M16	8.8	3.91	0	215	**0.3**	**0.49**	23.2	60.3	38.4	72.6	0.93	0.54		
1009	Tussenschot	Kruisende staaf halverwege	L65.7	S235	M16	8.8	5.75	0	293	**0.3**	**0.72**	18.9	60.3	44.8	84.7	1.69	0.43		
1610	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.18	0	121	**11.6**	**0.30**	40.6	60.3	30.3	31.7	0.72	0.41		
1611	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.61	45	165	**11.6**	**0.00**	28.3	60.3	30.3	31.7	0.72	0.41		
1612	1e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.37	0	203	**11.6**	0.59	30.9	60.3	38.4	72.6	1.2	0.48		
1613	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.60	35	164	**11.6**	**0.00**	28.6	60.3	30.3	31.7	0.72	0.40		
1614	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.16	0	119	**11.6**	**0.29**	41.3	60.3	30.3	31.7	0.72	0.40		
1615	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.06	0	109	**11.6**	**0.27**	45.1	60.3	30.3	31.7	0.72	0.38		
1616	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.47	45	151	**11.6**	**0.00**	31.7	60.3	30.3	31.7	0.72	0.38		
1629	1e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.00	0	171	**11.6**	**0.50**	39.0	60.3	38.4	72.6	1.24	0.40		
1630	1e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.87	0	246	**11.6**	**0.72**	23.3	60.3	38.4	72.6	1.24	0.58		
1632	1e tussenstuk	Kruisende staaf halverwege	L60.6	S235	M16	8.8	4.36	0	240	**11.6**	0.55	20.0	60.3	38.4	72.6	1.2	0.58		
1617	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.39	65	143	**11.6**	0.00	33.9	60.3	30.3	31.7	0.7	0.38		
1618	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.05	0	108	**11.6**	**0.26**	45.4	60.3	30.3	31.7	0.72	0.38		
1619	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	0.96	0	99	**10.5**	**0.24**	49.1	60.3	30.3	31.7	0.72	0.35		
1620	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.32	45	136	**10.5**	**0.00**	36.0	60.3	30.3	31.7	0.72	0.35		
1621	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.92	0	197	**10.5**	**0.48**	22.3	60.3	30.3	31.7	0.72	0.67		
1622	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.26	40	129	**10.5**	**0.00**	37.9	60.3	30.3	31.7	0.7	0.35		
1623	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.18	46	121	**10.5**	**0.00**	40.6	60.3	30.3	31.7	0.7	0.35		
1624	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.74	0	178	**10.5**	0.43	25.6	60.3	30.3	31.7	0.7	0.60		
1625	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.12	39	115	**10.5**	**0.00**	42.8	60.3	30.3	31.7	0.7	0.35		
1626	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.06	45	109	**10.5**	**0.00**	45.1	60.3	30.3	31.7	0.7	0.35		
1627	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.57	0	161	**10.5**	**0.39**	29.3	60.3	30.3	31.7	0.7	0.55		
1628	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.01	37	104	**10.5**	**0.00**	47.0	60.3	30.3	31.7	0.7	0.35		

APPENDIX D
Toetsing blokdeuvels

Project: ENS-ZL380
Mast: S-6 R (22)

Blokdeuvels

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2020-10-28
Auteur: TBR
Versie: 1.2

Belasting			
Druk	$F_{Ed,druk}$	571	kN
Trek	$F_{Ed,trek}$	415	kN

Conclusie			
Druk	U.C.	0.51	< 1,00 OK
Trek	U.C.	0.39	< 1,00 OK

Hoekstijl

Profiel		L150.12	
Staalsoort		S355	
Oppervlak		3480	mm^2
Doorsnedecapaciteit	N_{pl}	1235	kN
Breedte	b	150	mm
Dikte	t	12	mm
Ingestorte lengte		1200	mm

Blokdeuvels randstijl

Breedte	b	50	mm
Dikte	h	30	mm
Lengte	L	160	mm
Lassen	a	5	mm
Hoh afstand	s	250	mm
Aantal voor druk	n	8	-
Aantal voor trek	n	8	-

Voetplaat

Dikte	t	20	mm
Overstek	m	30	mm
Lassen	a	5	mm

Paal

Benaming		Buispaal	
Diameter		588	mm
Wanddikte		10	mm
Oppervlak		18158	mm^2
Staalsoort		S235	
Doorsnedecapaciteit		4267	kN
Betonkwaliteit		C20/25	

Blokdeuvels paal

Toetsing		Druk en trek	
Breedte	b	50	mm
Dikte	h	30	mm
Lengte	L	1000	mm
Lassen	a	5	mm
Hoh afstand	s	500	mm
Aantal voor druk	n	3	-
Aantal voor trek	n	3	-

Rekenwaarde druksterkte

Materiaalfactor	γ_c	1.5	
Extra mat.factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Staal randstijl

Vloeigrens	f_{yd} =	355	N/mm^2
Treksterkte	f_{ud} =	510	N/mm^2

Capaciteit blokdeuvels hoekstijl

A_{f1} =	4800	mm^2
A_{f2} =	16800	mm^2
Helling	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.87	
$f_{jd} = C_A \times f_{cd}$ =	20.0	N/mm^2
$F_{Rd,druk} = n \times A_{f1} \times f_{jd}$ =	766	kN
$F_{Rd,trek} = n \times A_{f1} \times f_{jd}$ =	766	kN

Capaciteit voetplaat

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	49	mm
$m^* = \min(c,m)$ =	30	mm
Type voetplaat	Diagonaal afgesneden	
Effectief op	Druk en trek	
$A_{p,trek}$ =	15768	mm^2
$F_{Rd} = A_{p,trek} \times f_{jd}$ =	291	kN
Lassen voetplaat	754	kN
$A_{p,druk}$ =	19248	mm^2
$F_{Rd} = A_{p,druk} \times f_{jd}$ =	356	kN

Capaciteit blokdeuvels paal

A_{f1} =	30000	mm^2
A_{f2} =	90000	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,druk} = n \times A_{f1} \times f_{jd}$ =	1663	kN
$F_{Rd,trek} = n \times A_{f1} \times f_{jd}$ =	1663	kN

"Splijten" paal

Spreidingshoek		45	°
Lengte krachtsoverdracht		916	mm
Splijtkracht		227	kN/m
Vloeigrens buiswand	f_{yd} =	235	N/mm^2
Capaciteit buis		4700	kN/m
U.C.		0.05	< 1,00 OK

Capaciteiten

Randstijl op trek	1058	kN
Buis op trek	1663	kN
Randstijl op druk	1122	kN
Buis op druk	1663	kN

Toetsing lassen

Deuvels randstijl	0.28	< 1,00 OK
Deuvels paal	0.39	< 1,00 OK

Project: ENS-ZL380
Mast: 22

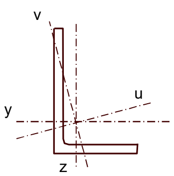
DNV·GL

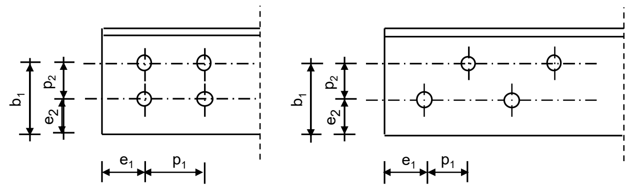
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G129**	***Conclusion***			
Section	**L60.6**	U.C.	(compression)	**0.72**	**< 1,0 OK**
		U.C.	(tension)	**0.82**	**< 1,0 OK**





Steel grade		**S235**	
Member loads			
Compressive force	N_{Ed} =	**-38**	kN
Tensile force		**34**	kN
Crossing diagonal loads			
Applicable:		**Yes**	
Min. tensile force diagonal 2		**34**	kN
Max. comp. force diagonal 1		**-38**	kN
Position crossing diagonal y-axis		1.26	m
Construction loads			
Vertical construction load		**1.0**	kN
Member angle to horizontal		**0**	°
Bending around axis		y-axis	
Geometry			
System length y-axis	$L_{y,buc}$ =	2.42	m
System length z-axis	$L_{z,buc}$ =	1.26	m
System length v-axis	$L_{v,buc}$ =	1.26	m
Member type		**Other**	
Type bracing		Non staggered	
End conditions			
Begin		One bolt	
End		Continuous	
Restraint code TOWER		C5	

Bolted connection				
Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	23	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	120	mm	OK
	t_p =	12	mm	OK
	e_2 =	35	mm	OK
A		691	mm^2	
G		5.5	kg/m	
Partial safety factor	$\gamma_{f;Q}$ =	1.50		
Material factors	γ_{M0} =	1.00		
	γ_{M1} =	1.00		
	γ_{M2} =	1.25		
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN	
Slenderness	λ_{max} = L / i	108	-	
Allowed:		180		**OK**
Bending due to vertical construction load				
$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} =		0.91	kNm	
U.C. =		**0.73**	**< 1,00 OK**	

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.26	m	0.74	0,4+0,7 l	0.92	0.65	0.9	95	0.40
$L_{z,buc}$ =	1.26	m	0.74	0,4+0,7 l	0.92	0.65	0.9	95	0.40
$L_{v,buc}$ =	1.26	m	1.15	0,35+0,70 l	1.15	0.50	0.9	74	0.52

Bolted connection

Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	162	0.23		*Net section angle*	$F_{u;Rd}$ =	48	0.70	
Cross section tie plate	$F_{u;Rd}$ =	338	0.11		*Net section tie plate*	$F_{u;Rd}$ =	317	0.11	
Shear strength	$F_{v;Rd}$ =	60	0.63		*Block shear*	$F_{u;Rd}$ =	50	0.68	
Bearing strength	$F_{b;Rd}$ =	53	0.72		*Shear strength*	$F_{v;Rd}$ =	60	0.56	
Combined effect	$F_{v;Rd}$ =	53	0.72	plastisch	*Bearing strength*	$F_{b;Rd}$ =	41	0.82	
					Combined effect	$F_{v;Rd}$ =	41	0.82	plastisch

Project: ENS-ZL380
Mast: 22

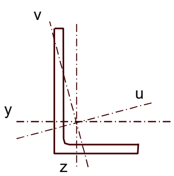
DNV·GL

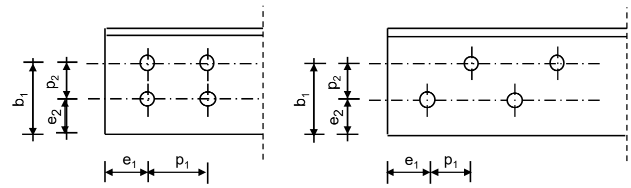
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	G176	***Conclusion***			
Section	L50.7	U.C.	(compression)	**0.78**	**< 1,0 OK**
		U.C.	(tension)	**0.91**	**< 1,0 OK**





Steel grade		**S235**	
Member loads			
Compressive force	N_{Ed} =	**-47**	kN
Tensile force		**43**	kN
Crossing diagonal loads			
Applicable:		**Yes**	
Min. tensile force diagonal 2		**43**	kN
Max. comp. force diagonal 1		**-47**	kN
Position crossing diagonal y-axis		1.02	m
Construction loads			
Vertical construction load		**1.0**	kN
Member angle to horizontal		**0**	°
Bending around axis		y-axis	
Geometry			
System length y-axis	$L_{y,buc}$ =	2.00	m
System length z-axis	$L_{z,buc}$ =	1.02	m
System length v-axis	$L_{v,buc}$ =	1.02	m
Member type		**Other**	
Type bracing		Non staggered	
End conditions			
Begin		One bolt	
End		Continuous	
Restraint code TOWER		C5	

Bolted connection				
Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	90	mm	OK
	t_p =	8	mm	OK
	e_2 =	27	mm	OK
A		656	mm^2	
G		5.2	kg/m	
Partial safety factor	$\gamma_{f;Q}$ =	1.50		
Material factors	γ_{M0} =	1.00		
	γ_{M1} =	1.00		
	γ_{M2} =	1.25		
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN	
Slenderness	λ_{max} = L / i	107	-	
Allowed:		180		**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.75 kNm

U.C. = **0.77** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.02	m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.52
$L_{z,buc}$ =	1.02	m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.52
$L_{v,buc}$ =	1.02	m	1.14	0,35+0,70 l	1.15	0.51	0.9	71	0.67

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	154	0.30	
Cross section tie plate	$F_{u;Rd}$ =	169	0.28	
Shear strength	$F_{v;Rd}$ =	60	0.78	
Bearing strength	$F_{b;Rd}$ =	62	0.76	
Combined effect	$F_{v;Rd}$ =	60	0.78	elastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	52	0.82	
Net section tie plate	$F_{u;Rd}$ =	149	0.29	
Block shear	$F_{u;Rd}$ =	56	0.76	
Shear strength	$F_{v;Rd}$ =	60	0.71	
Bearing strength	$F_{b;Rd}$ =	47	0.91	
Combined effect	$F_{v;Rd}$ =	47	0.91	plastisch

Project: ENS-ZL380
Mast: 22

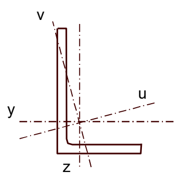
DNV·GL

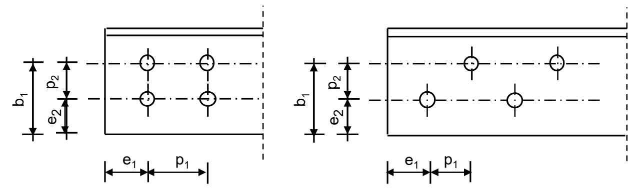
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	G177	***Conclusion***			
Section	L50.7	U.C.	(compression)	**0.61**	**< 1,0 OK**
		U.C.	(tension)	**0.85**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-37**	kN
Tensile force		**40**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**40**	kN
Max. comp. force diagonal 1	**-37**	kN
Position crossing diagonal y-axis	1.02	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.00	m
System length z-axis	$L_{z,buc}$ =	1.02	m
System length v-axis	$L_{v,buc}$ =	1.02	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance ǀ	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	90	mm	OK
	t_p =	8	mm	OK
	e_2 =	27	mm	OK

A		656	mm^2
G		5.2	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	106	-
Allowed:		180	**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.75 kNm
U.C. = **0.77** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi Af_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.02	m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.41
$L_{z,buc}$ =	1.02	m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.41
$L_{v,buc}$ =	1.02	m	1.13	0,35+0,70 l	1.14	0.51	0.9	71	0.52

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	154	0.24	
Cross section tie plate	$F_{u;Rd}$ =	169	0.22	
Shear strength	$F_{v;Rd}$ =	60	0.61	
Bearing strength	$F_{b;Rd}$ =	62	0.60	
Combined effect	$F_{v;Rd}$ =	60	0.61	elastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	52	0.76	
Net section tie plate	$F_{u;Rd}$ =	149	0.27	
Block shear	$F_{u;Rd}$ =	56	0.71	
Shear strength	$F_{v;Rd}$ =	60	0.66	
Bearing strength	$F_{b;Rd}$ =	47	0.85	
Combined effect	$F_{v;Rd}$ =	47	0.85	plastisch

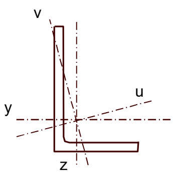
Project: ENS-ZL380
Mast: 22

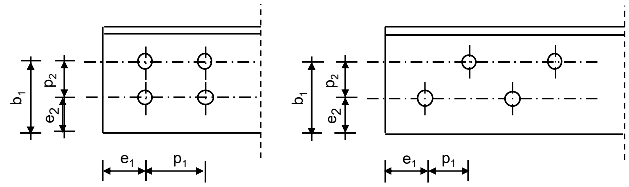
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G180**	***Conclusion***			
Section	**L50.5**	U.C.	(compression)	**0.70**	**< 1,0 OK**
		U.C.	(tension)	**0.89**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-31**	kN
Tensile force		**30**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**30**	kN
Max. comp. force diagonal 1	**-31**	kN
Position crossing diagonal y-axis	1.17	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.25	m
System length z-axis	$L_{z,buc}$ =	1.17	m
System length v-axis	$L_{v,buc}$ =	1.17	m

Member type **Other**
Type bracing Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	110	mm	OK
	t_p =	10	mm	OK
	e_2 =	35	mm	OK

A		480	mm^2
G		3.8	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	120	-
Allowed:		180	**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.84 kNm
U.C. = **1.18** **> 1,00 Not OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.17	m	0.82	0,4+0,7 l	0.98	0.61	0.9	62	0.50
$L_{z,buc}$ =	1.17	m	0.82	0,4+0,7 l	0.98	0.61	0.9	62	0.50
$L_{v,buc}$ =	1.17	m	1.28	0,35+0,70 l	1.25	0.45	0.9	46	0.67

Bolted connection

Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	113	0.27		*Net section angle*	$F_{u;Rd}$ =	37	0.80	
Cross section tie plate	$F_{u;Rd}$ =	259	0.12		*Net section tie plate*	$F_{u;Rd}$ =	238	0.13	
Shear strength	$F_{v;Rd}$ =	60	0.51		*Block shear*	$F_{u;Rd}$ =	40	0.74	
Bearing strength	$F_{b;Rd}$ =	44	0.70		*Shear strength*	$F_{v;Rd}$ =	60	0.50	
Combined effect	$F_{v;Rd}$ =	44	0.70	plastisch	*Bearing strength*	$F_{b;Rd}$ =	34	0.89	
					Combined effect	$F_{v;Rd}$ =	34	0.89	plastisch

Project: ENS-ZL380
Mast: 22

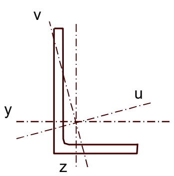
DNV·GL

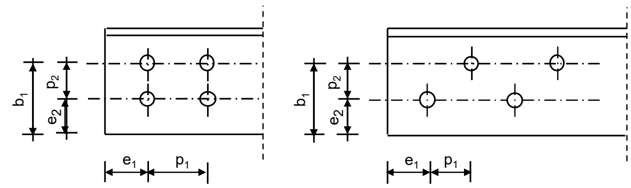
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G184**	***Conclusion***			
Section	**L50.5**	U.C.	(compression)	**0.72**	**< 1,0 OK**
		U.C.	(tension)	**0.83**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-31**	kN
Tensile force		**28**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**28**	kN
Max. comp. force diagonal 1	**-31**	kN
Position crossing diagonal y-axis	1.25	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.41	m
System length z-axis	$L_{z,buc}$ =	1.25	m
System length v-axis	$L_{v,buc}$ =	1.25	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	110	mm	OK
	t_p =	10	mm	OK
	e_2 =	35	mm	OK

A		480	mm^2
G		3.8	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	128	-	
Allowed:		180		**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} =	0.90	kNm	
U.C. =	**1.26**		**> 1,00 Not OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd}$ = $\eta\chi A f_y$ / γ_{M1}	
$L_{y,buc}$ =	1.25	m	0.88	0,4+0,7 l	1.02	0.59	0.9	60	0.52
$L_{z,buc}$ =	1.25	m	0.88	0,4+0,7 l	1.02	0.59	0.9	60	0.52
$L_{v,buc}$ =	1.25	m	1.37	0,35+0,70 l	1.31	0.42	0.9	43	0.72

Bolted connection

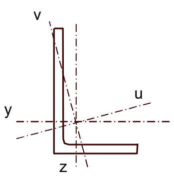
Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	113	0.27		*Net section angle*	$F_{u;Rd}$ =	37	0.75	
Cross section tie plate	$F_{u;Rd}$ =	259	0.12		*Net section tie plate*	$F_{u;Rd}$ =	238	0.12	
Shear strength	$F_{v;Rd}$ =	60	0.51		*Block shear*	$F_{u;Rd}$ =	40	0.69	
Bearing strength	$F_{b;Rd}$ =	44	0.70		*Shear strength*	$F_{v;Rd}$ =	60	0.46	
Combined effect	$F_{v;Rd}$ =	44	0.70	plastisch	*Bearing strength*	$F_{b;Rd}$ =	34	0.83	
					Combined effect	$F_{v;Rd}$ =	34	0.83	plastisch

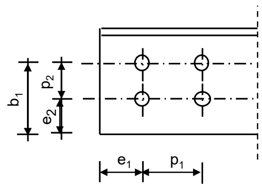
Project: ENS-ZL380
Mast: 22

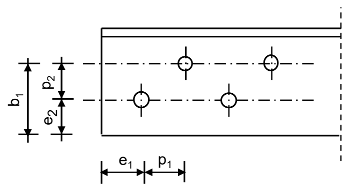
Angle check *NEN-EN1993-1-1 and EN1993-3-1*

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G185**	***Conclusion***			
Section	**L50.5**	U.C.	(compression)	**0.62**	**< 1,0 OK**
		U.C.	(tension)	**0.83**	**< 1,0 OK**







Steel grade		**S235**	
Member loads			
Compressive force	N_{Ed} =	**-26**	kN
Tensile force		**28**	kN
Crossing diagonal loads			
Applicable:		**Yes**	
Min. tensile force diagonal 2		**28**	kN
Max. comp. force diagonal 1		**-26**	kN
Position crossing diagonal y-axis		1.28	m
Construction loads			
Vertical construction load		**1.0**	kN
Member angle to horizontal		**0**	°
Bending around axis		y-axis	
Geometry			
System length y-axis	$L_{y,buc}$ =	2.46	m
System length z-axis	$L_{z,buc}$ =	1.28	m
System length v-axis	$L_{v,buc}$ =	1.28	m
Member type		**Other**	
Type bracing		Non staggered	
End conditions			
Begin		One bolt	
End		Continuous	
Restraint code TOWER		C5	

Bolted connection				
Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	110	mm	OK
	t_p =	10	mm	OK
	e_2 =	35	mm	OK
A		480	mm^2	
G		3.8	kg/m	
Partial safety factor	$\gamma_{f;Q}$ =	1.50		
Material factors	γ_{M0} =	1.00		
	γ_{M1} =	1.00		
	γ_{M2} =	1.25		
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN	
Slenderness	λ_{max} = L / i	132	-	
Allowed:		180		**OK**
Bending due to vertical construction load				
$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} =		0.92	kNm	
U.C. =		**1.28**	**> 1,00 Not OK**	

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi Af_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.28	m	0.90	0,4+0,7 l	1.03	0.58	0.9	59	0.44
$L_{z,buc}$ =	1.28	m	0.90	0,4+0,7 l	1.03	0.58	0.9	59	0.44
$L_{v,buc}$ =	1.28	m	1.40	0,35+0,70 l	1.33	0.41	0.9	42	0.62

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	113	0.23	
Cross section tie plate	$F_{u;Rd}$ =	259	0.10	
Shear strength	$F_{v;Rd}$ =	60	0.43	
Bearing strength	$F_{b;Rd}$ =	44	0.59	
Combined effect	$F_{v;Rd}$ =	44	0.59	plastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	37	0.75	
Net section tie plate	$F_{u;Rd}$ =	238	0.12	
Block shear	$F_{u;Rd}$ =	40	0.69	
Shear strength	$F_{v;Rd}$ =	60	0.46	
Bearing strength	$F_{b;Rd}$ =	34	0.83	
Combined effect	$F_{v;Rd}$ =	34	0.83	plastisch

DNV·GL

Project: ENS-ZL380
Mast: S-6 R (28)

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2021-02-22
Auteur: TBR
Versie: 1.4

Load				*Results*			
Compression	$F_{Ed,c}$	**584**	kN	Compression	U.C.	0.52	< 1,00 OK
Tension	$F_{Ed,t}$	**451**	kN	Tension	U.C.	0.43	< 1,00 OK

Main leg

Profile		**L150.12**	
Steel material		S355	
Cross section		3480	mm^2
Axial capacity	N_{pl}	1235	kN
Width	b	150	mm
Thickness	t	12	mm
Length in concrete		1200	mm

Shear blocks main leg

Width	b	50	mm
Thickness	h	30	mm
Length	L	160	mm
Welds	a	5	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	8	-
Number for tension	n_t	8	-

Foot plate

Thickness	t	20	mm
Ext. length	m	30	mm
Welds	a	5	mm

Pile

Name		Buispaal	
Diameter		558	mm
Thickness		10	mm
Cross section		17216	mm^2
Steel material		S235	
Capacity		4046	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	1000	mm
Welds	a	5	mm
c.t.c. separation	s	500	mm
Number for compr.	n_c	3	-
Number for tension	n_t	3	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	490	N/mm^2

Capacity shear blocks main leg

A_{f1} =	4800	mm^2
A_{f2} =	16800	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.87	
$f_{jd} = C_A \times f_{cd}$ =	20.0	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	766	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	766	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	49	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,c}$ =	19248	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	356	kN
$A_{p,t}$ =	15768	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	291	kN

Capacities

$F_{rd,c,plate}$ =	356	kN
$F_{rd,blocks,c}$ =	766	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**1122**	kN
U.C. compression	0.52	< 1,00 OK
Welds foot plate (see next page)	724	kN
$F_{rd,t}$ = min. (welds / foot plate) =	291	kN
$F_{rd,blocks,t}$ =	766	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**1058**	kN
U.C. tension	0.43	< 1,00 OK
U.C. welds	0.39	< 1,00 OK

Capacity shear blocks pile

A_{f1} =	30000	mm^2
A_{f2} =	90000	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	**1663**	kN
U.C. compression	0.35	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	**1663**	kN
U.C. tension	0.27	< 1,00 OK
U.C. welds	0.34	< 1,00 OK

"Splitting" of pile

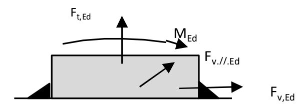
Spread of forces		45	°
Length force flow		931	mm
Splitting force		242	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.05	< 1,00 OK

Project: ENS-ZL380
Mast: S-6 R (28)

Welds of shear blocks of main leg

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S355		l =	150	mm
f_{yd} =	355	N/mm²	β_w =	0.9	-
f_u =	490	N/mm²	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 4al$ =	0	N/mm²
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 4al$ =	54	N/mm²
$F_{v,Ed} = F_{rd,c}$ / n =	**115**	kN		54	N/mm²
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54.7	mm
M_{Ed} = 1/2 b / h x $F_{v,Ed}$ =	**1.72**	kNm	$\sigma_1 = \tau_1 = 0{,}706 M_{Ed} / al\, b^*$ =	30	N/mm²
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm²
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	168	N/mm²

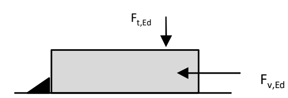
Check

$\sigma_{vw,Ed}$ =	168	N/mm²	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm²	U.C. =	**0.39** OK
σ_1 =	84	N/mm²	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm²	U.C. =	**0.24** OK

Welds of shear blocks of pile

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S235		l =	1000	mm
f_{yd} =	235	N/mm²	β_w =	0.8	-
f_u =	360	N/mm²	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 2al$ =	14	N/mm²
$F_{t,Ed}$ = 1/2 b / h x $F_{v,Ed}$ =	**200**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 2al$ =	47	N/mm²
$F_{v,Ed}$ =	**665**	kN		61	N/mm²
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0.00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm²
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	122	N/mm²

Check

$\sigma_{vw,Ed}$ =	122	N/mm²	≤	$f_u / \beta_w \gamma_{M2}$ =	360	N/mm²	U.C. =	**0.34** OK
σ_1 =	61	N/mm²	≤	$0{,}9 f_u / \gamma_{M2}$ =	259	N/mm²	U.C. =	**0.24** OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm²
Weld size	a =	5	mm
Length	l = 2b+ 2b - t =	576	mm
Capacity	F_{Rd} = a x l x $f_{w,d}$ / √3 =	**724**	kN

Project: ENS-ZL380
Mast: 22

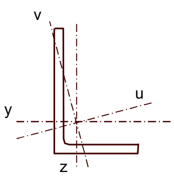
DNV·GL

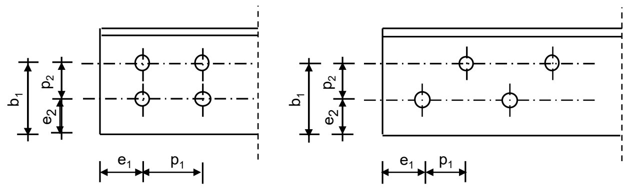
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G129**	***Conclusion***			
Section	**L60.6**	U.C.	(compression)	**0.72**	**< 1,0 OK**
		U.C.	(tension)	**0.82**	**< 1,0 OK**





Steel grade		**S235**	
Member loads			
Compressive force	N_{Ed} =	**-38**	kN
Tensile force		**34**	kN
Crossing diagonal loads			
Applicable:		**Yes**	
Min. tensile force diagonal 2		**34**	kN
Max. comp. force diagonal 1		**-38**	kN
Position crossing diagonal y-axis		1.26	m
Construction loads			
Vertical construction load		**1.0**	kN
Member angle to horizontal		**0**	°
Bending around axis		y-axis	
Geometry			
System length y-axis	$L_{y,buc}$ =	2.42	m
System length z-axis	$L_{z,buc}$ =	1.26	m
System length v-axis	$L_{v,buc}$ =	1.26	m
Member type		**Other**	
Type bracing		Non staggered	
End conditions			
Begin		One bolt	
End		Continuous	
Restraint code TOWER		C5	

Bolted connection				
Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ˩	e_2 =	23	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	120	mm	OK
	t_p =	12	mm	OK
	e_2 =	35	mm	OK
A		691	mm^2	
G		5.5	kg/m	
Partial safety factor	$\gamma_{f;Q}$ =	1.50		
Material factors	γ_{M0} =	1.00		
	γ_{M1} =	1.00		
	γ_{M2} =	1.25		
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN	
Slenderness	λ_{max} = L / i	108	-	
Allowed:		180	**OK**	

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.91 kNm
U.C. = **0.73** **< 1,00 OK**

Results stability

		$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.26 m	0.74	0,4+0,7 l	0.92	0.65	0.9	95	0.40
$L_{z,buc}$ =	1.26 m	0.74	0,4+0,7 l	0.92	0.65	0.9	95	0.40
$L_{v,buc}$ =	1.26 m	1.15	0,35+0,70 l	1.15	0.50	0.9	74	0.52

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	162	0.23	
Cross section tie plate	$F_{u;Rd}$ =	338	0.11	
Shear strength	$F_{v;Rd}$ =	60	0.63	
Bearing strength	$F_{b;Rd}$ =	53	0.72	
Combined effect	$F_{v;Rd}$ =	53	0.72	plastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	48	0.70	
Net section tie plate	$F_{u;Rd}$ =	317	0.11	
Block shear	$F_{u;Rd}$ =	50	0.68	
Shear strength	$F_{v;Rd}$ =	60	0.56	
Bearing strength	$F_{b;Rd}$ =	41	0.82	
Combined effect	$F_{v;Rd}$ =	41	0.82	plastisch

Project: ENS-ZL380
Mast: 22

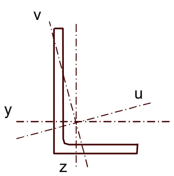
DNV·GL

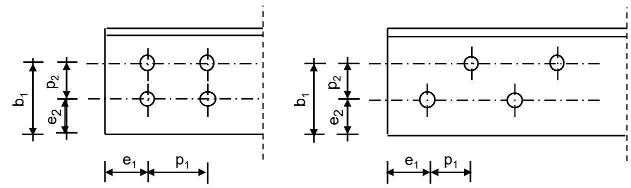
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	G176	***Conclusion***			
Section	L50.7	U.C.	(compression)	**0.78**	**< 1,0 OK**
		U.C.	(tension)	**0.91**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-47**	kN
Tensile force		**43**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**43**	kN
Max. comp. force diagonal 1	**-47**	kN
Position crossing diagonal y-axis	1.02	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.00	m
System length z-axis	$L_{z,buc}$ =	1.02	m
System length v-axis	$L_{v,buc}$ =	1.02	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	90	mm	OK
	t_p =	8	mm	OK
	e_2 =	27	mm	OK

A		656	mm^2
G		5.2	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	107	-
Allowed:		180	**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.75 kNm
U.C. = **0.77** **< 1,00 OK**

Results stability

		$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.02 m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.52
$L_{z,buc}$ =	1.02 m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.52
$L_{v,buc}$ =	1.02 m	1.14	0,35+0,70 l	1.15	0.51	0.9	71	0.67

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	154	0.30	
Cross section tie plate	$F_{u;Rd}$ =	169	0.28	
Shear strength	$F_{v;Rd}$ =	60	0.78	
Bearing strength	$F_{b;Rd}$ =	62	0.76	
Combined effect	$F_{v;Rd}$ =	60	0.78	elastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	52	0.82	
Net section tie plate	$F_{u;Rd}$ =	149	0.29	
Block shear	$F_{u;Rd}$ =	56	0.76	
Shear strength	$F_{v;Rd}$ =	60	0.71	
Bearing strength	$F_{b;Rd}$ =	47	0.91	
Combined effect	$F_{v;Rd}$ =	47	0.91	plastisch

Project: ENS-ZL380
Mast: 22

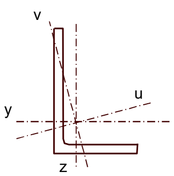
DNV·GL

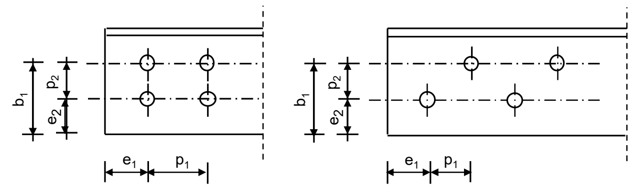
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	G177	***Conclusion***		
Section	L50.7	U.C. (compression)	**0.61**	**< 1,0 OK**
		U.C. (tension)	**0.85**	**< 1,0 OK**





Steel grade		**S235**	
Member loads			
Compressive force	N_{Ed} =	**-37**	kN
Tensile force		**40**	kN
Crossing diagonal loads			
Applicable:		**Yes**	
Min. tensile force diagonal 2		**40**	kN
Max. comp. force diagonal 1		**-37**	kN
Position crossing diagonal y-axis		1.02	m
Construction loads			
Vertical construction load		**1.0**	kN
Member angle to horizontal		**0**	°
Bending around axis		y-axis	
Geometry			
System length y-axis	$L_{y,buc}$ =	2.00	m
System length z-axis	$L_{z,buc}$ =	1.02	m
System length v-axis	$L_{v,buc}$ =	1.02	m
Member type		**Other**	
Type bracing		Non staggered	
End conditions			
Begin		One bolt	
End		Continuous	
Restraint code TOWER		C5	

Bolted connection				
Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	90	mm	OK
	t_p =	8	mm	OK
	e_2 =	27	mm	OK
A		656	mm^2	
G		5.2	kg/m	
Partial safety factor	$\gamma_{f;Q}$ =	1.50		
Material factors	γ_{M0} =	1.00		
	γ_{M1} =	1.00		
	γ_{M2} =	1.25		
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN	
Slenderness	λ_{max} = L / i	106	-	
Allowed:		180	**OK**	
Bending due to vertical construction load				
$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} =		0.75	kNm	
U.C. =		**0.77**	**< 1,00 OK**	

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.02	m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.41
$L_{z,buc}$ =	1.02	m	0.73	0,4+0,7 l	0.91	0.65	0.9	91	0.41
$L_{v,buc}$ =	1.02	m	1.13	0,35+0,70 l	1.14	0.51	0.9	71	0.52

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	154	0.24	
Cross section tie plate	$F_{u;Rd}$ =	169	0.22	
Shear strength	$F_{v;Rd}$ =	60	0.61	
Bearing strength	$F_{b;Rd}$ =	62	0.60	
Combined effect	$F_{v;Rd}$ =	60	0.61	elastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	52	0.76	
Net section tie plate	$F_{u;Rd}$ =	149	0.27	
Block shear	$F_{u;Rd}$ =	56	0.71	
Shear strength	$F_{v;Rd}$ =	60	0.66	
Bearing strength	$F_{b;Rd}$ =	47	0.85	
Combined effect	$F_{v;Rd}$ =	47	0.85	plastisch

Project: ENS-ZL380
Mast: 22

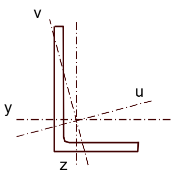
DNV·GL

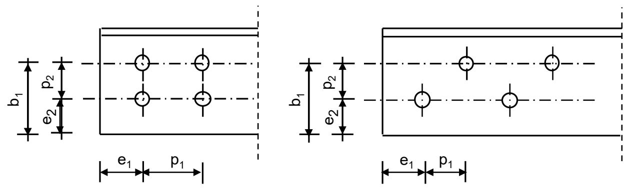
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G180**	***Conclusion***		
Section	**L50.5**	U.C. (compression)	**0.70**	**< 1,0 OK**
		U.C. (tension)	**0.89**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-31**	kN
Tensile force		**30**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**30**	kN
Max. comp. force diagonal 1	**-31**	kN
Position crossing diagonal y-axis	1.17	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.25	m
System length z-axis	$L_{z,buc}$ =	1.17	m
System length v-axis	$L_{v,buc}$ =	1.17	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	110	mm	OK
	t_p =	10	mm	OK
	e_2 =	35	mm	OK

A		480	mm^2
G		3.8	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	120	-
Allowed:		180	**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} =	0.84	kNm
U.C. =	**1.18**	**> 1,00 Not OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.17	m	0.82	0,4+0,7 l	0.98	0.61	0.9	62	0.50
$L_{z,buc}$ =	1.17	m	0.82	0,4+0,7 l	0.98	0.61	0.9	62	0.50
$L_{v,buc}$ =	1.17	m	1.28	0,35+0,70 l	1.25	0.45	0.9	46	0.67

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	113	0.27	
Cross section tie plate	$F_{u;Rd}$ =	259	0.12	
Shear strength	$F_{v;Rd}$ =	60	0.51	
Bearing strength	$F_{b;Rd}$ =	44	0.70	
Combined effect	$F_{v;Rd}$ =	44	0.70	plastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	37	0.80	
Net section tie plate	$F_{u;Rd}$ =	238	0.13	
Block shear	$F_{u;Rd}$ =	40	0.74	
Shear strength	$F_{v;Rd}$ =	60	0.50	
Bearing strength	$F_{b;Rd}$ =	34	0.89	
Combined effect	$F_{v;Rd}$ =	34	0.89	plastisch

Project: ENS-ZL380
Mast: 22

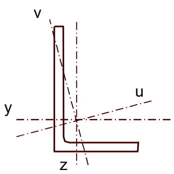
DNV·GL

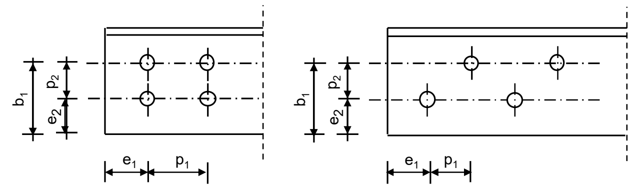
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-10-28
Auteur: TBR
Versie: 2.7

Member name	**G185**	***Conclusion***			
Section	**L50.5**	U.C.	(compression)	**0.62**	**< 1,0 OK**
		U.C.	(tension)	**0.83**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-26**	kN
Tensile force		**28**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**28**	kN
Max. comp. force diagonal 1	**-26**	kN
Position crossing diagonal y-axis	1.28	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.46	m
System length z-axis	$L_{z,buc}$ =	1.28	m
System length v-axis	$L_{v,buc}$ =	1.28	m

Member type **Other**
Type bracing Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance ⊥	p_2 =	0	mm	Ok
End distance ⊥	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	110	mm	OK
	t_p =	10	mm	OK
	e_2 =	35	mm	OK
A		480	mm^2	
G		3.8	kg/m	
Partial safety factor	$\gamma_{f;Q}$ =	1.50		
Material factors	γ_{M0} =	1.00		
	γ_{M1} =	1.00		
	γ_{M2} =	1.25		
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN	

Slenderness	λ_{max} = L / i	132	-	
Allowed:		180		**OK**

Bending due to vertical construction load

$M_{y,Ed} = 1/4\ F_{Ed}\ L_{pr}$ =	0.92	kNm
U.C. =	**1.28**	**> 1,00 Not OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.28	m	0.90	0,4+0,7 l	1.03	0.58	0.9	59	0.44
$L_{z,buc}$ =	1.28	m	0.90	0,4+0,7 l	1.03	0.58	0.9	59	0.44
$L_{v,buc}$ =	1.28	m	1.40	0,35+0,70 l	1.33	0.41	0.9	42	0.62

Bolted connection

Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	113	0.23		*Net section angle*	$F_{u;Rd}$ =	37	0.75	
Cross section tie plate	$F_{u;Rd}$ =	259	0.10		*Net section tie plate*	$F_{u;Rd}$ =	238	0.12	
Shear strength	$F_{v;Rd}$ =	60	0.43		*Block shear*	$F_{u;Rd}$ =	40	0.69	
Bearing strength	$F_{b;Rd}$ =	44	0.59		*Shear strength*	$F_{v;Rd}$ =	60	0.46	
Combined effect	$F_{v;Rd}$ =	44	0.59	plastisch	*Bearing strength*	$F_{b;Rd}$ =	34	0.83	
					Combined effect	$F_{v;Rd}$ =	34	0.83	plastisch

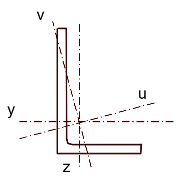
Project: ENS-ZL380
Mast: 28

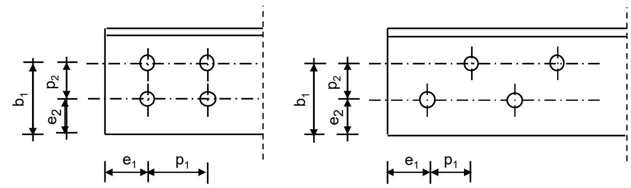
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2021-02-22
Auteur: TBR
Versie: 2.7

Member name	**G186**	***Conclusion***			
Section	**L50.5**	U.C.	(compression)	**0.73**	**< 1,0 OK**
		U.C.	(tension)	**0.80**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-29**	kN
Tensile force		**27**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**27**	kN
Max. comp. force diagonal 1	**-29**	kN
Position crossing diagonal y-axis	1.34	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.58	m
System length z-axis	$L_{z,buc}$ =	1.34	m
System length v-axis	$L_{v,buc}$ =	1.34	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	22	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	110	mm	OK
	t_p =	10	mm	OK
	e_2 =	35	mm	OK

A		480	mm^2
G		3.8	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	138	-	
Allowed:		180		**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} =	0.97	kNm	
U.C. =	**1.35**		**> 1,00 Not OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.34	m	0.94	0,4+0,7 l	1.06	0.56	0.9	57	0.51
$L_{z,buc}$ =	1.34	m	0.94	0,4+0,7 l	1.06	0.56	0.9	57	0.51
$L_{v,buc}$ =	1.34	m	1.47	0,35+0,70 l	1.38	0.39	0.9	40	0.73

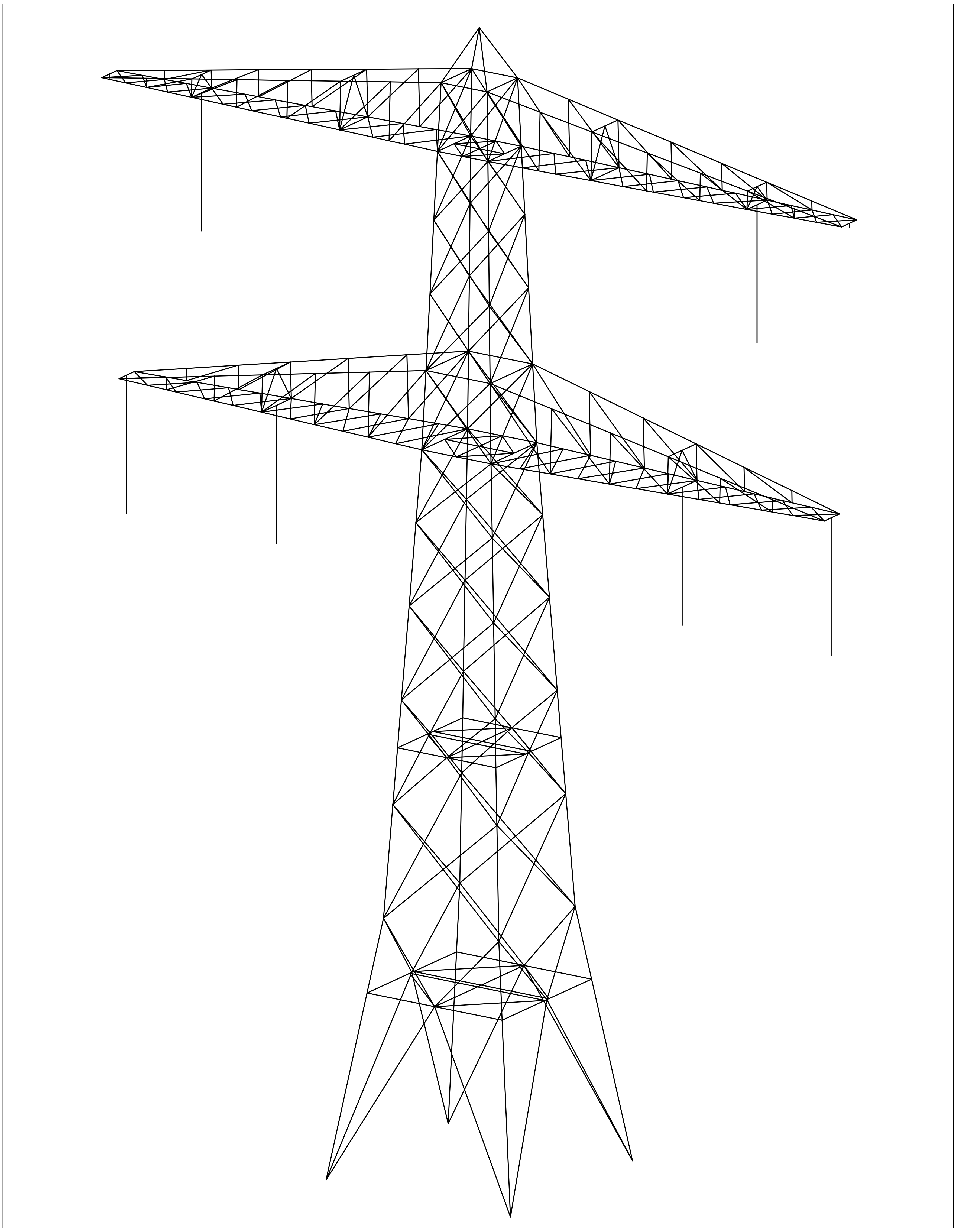
Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	113	0.26	
Cross section tie plate	$F_{u;Rd}$ =	259	0.11	
Shear strength	$F_{v;Rd}$ =	60	0.48	
Bearing strength	$F_{b;Rd}$ =	44	0.66	
Combined effect	$F_{v;Rd}$ =	44	0.66	plastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	37	0.72	
Net section tie plate	$F_{u;Rd}$ =	238	0.11	
Block shear	$F_{u;Rd}$ =	40	0.67	
Shear strength	$F_{v;Rd}$ =	60	0.45	
Bearing strength	$F_{b;Rd}$ =	34	0.80	
Combined effect	$F_{v;Rd}$ =	34	0.80	plastisch

APPENDIX E
Tekeningen

Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)



Overview

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table

All changes are symmetrical unless otherwise indicated

- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Profile exchanged

New redundant

Bolt exchanged

Rev.	Date	Description
01	22-02-2021	Dimension added
00	30-10-2020	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-037

Design state: FINAL

Scale: -

Drawn by: KCh 22-02-2021

Units: m

Checked by: TBR 22-02-2021

Project no: 10166260

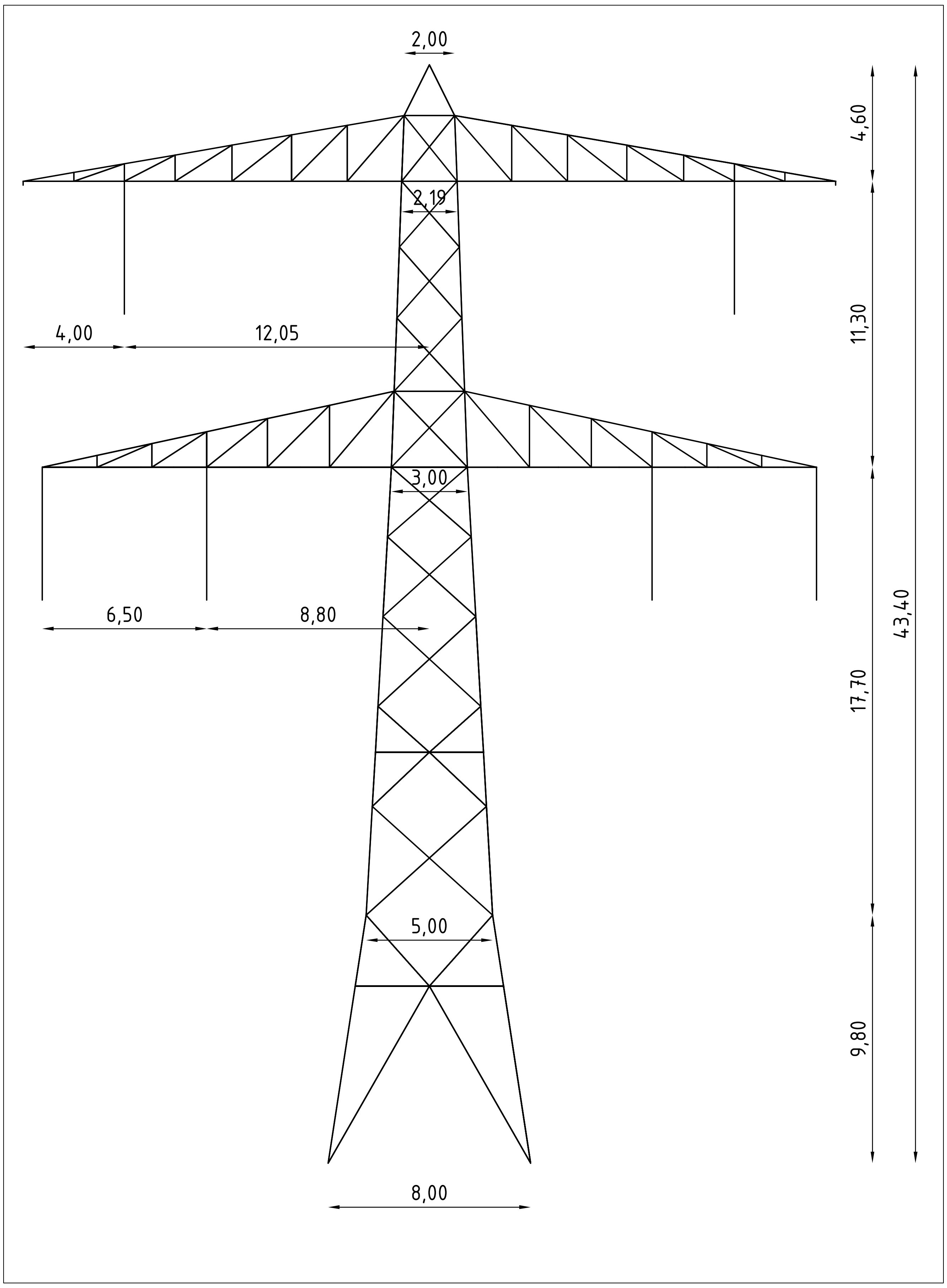
Approved by: JHu 22-02-2021

Company: TenneT

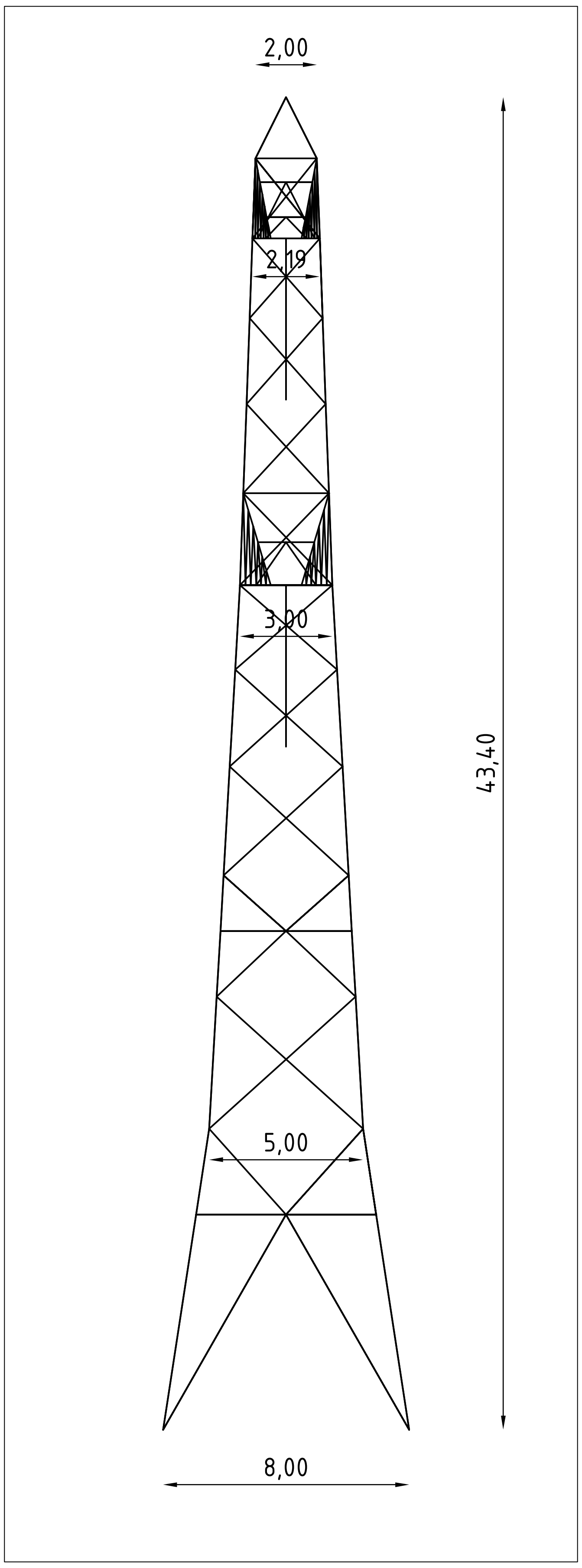
Description: Modifications overview for mast type S-6_R (Mast 22) page 1 of 2

Revision: 00

Format: A2



Front View



Side View

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table

All changes are symmetrical unless otherwise indicated

- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Profile exchanged
New redundant
Bolt exchanged

01	22-02-2021	Dimension added
00	30-10-2020	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-037

Design state:	FINAL		Scale:	-
Drawn by:	KCh	22-02-2021	Units:	m
Checked by:	TBR	22-02-2021	Project no:	10166260
Approved by:	JHu	22-02-2021	Company:	TenneT

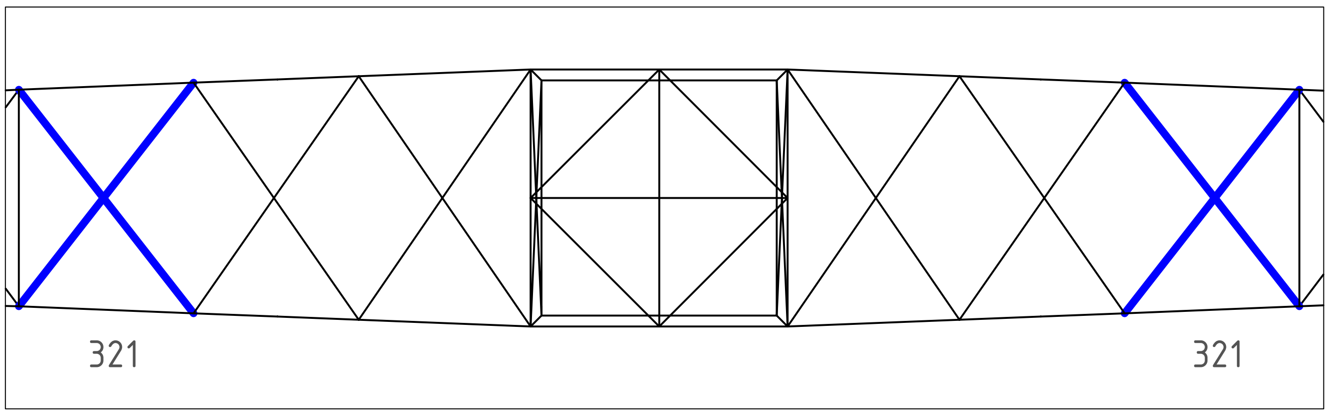
Description: Modifications overview for mast type S-6_R (Mast 22) page 2 of 2

Revision: 00

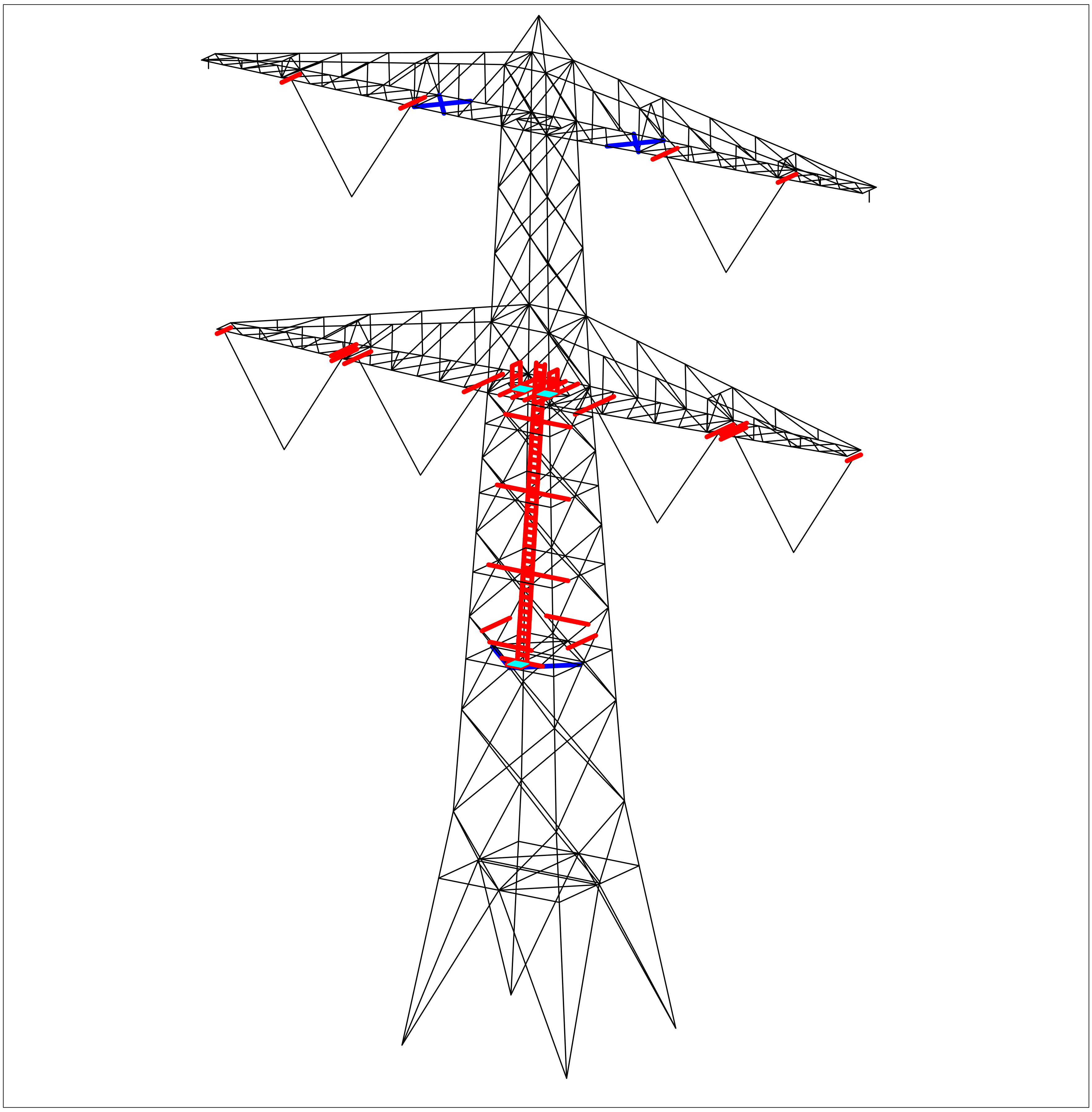
Format: A2

DNV GL Energy & Sustainability, Utrechtseweg 310, 6812 AR Arnhem, tel: +31 26 3 56 91 11, www.dnvgl.com

Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
321	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L50x5	S355 t=<40	M16-8.8t-NEN2012



Top View - Upper Crossarm



Overview

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Gratings
New profile
Profile exchanged
New redundant
Bolt exchanged

00	22-02-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-061

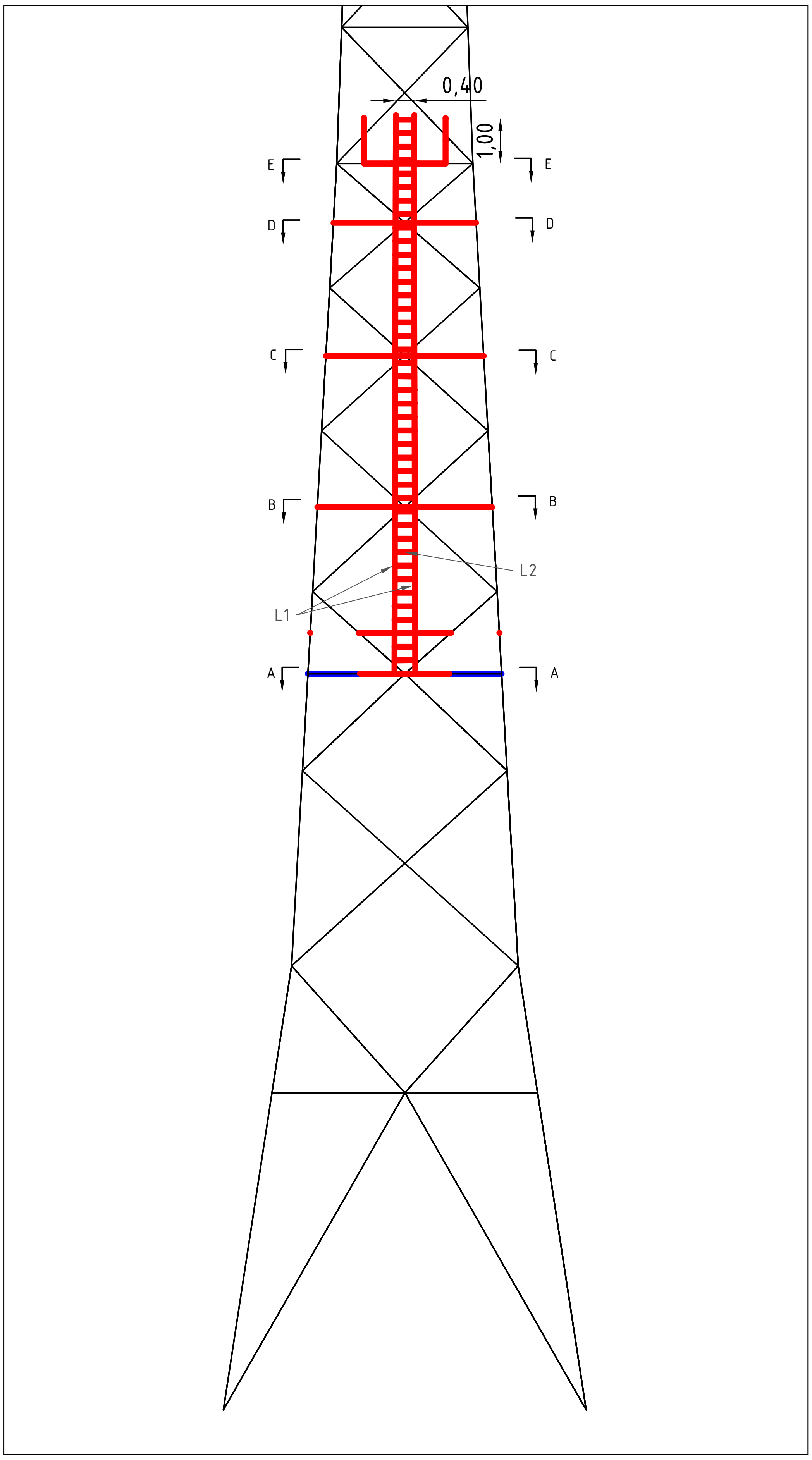
Design state: FINAL		Scale:	-	
Drawn by:	KCh	22-02-2021	Units:	m
Checked by:	TBR	22-02-2021	Project no:	10166260
Approved by:	JHu	22-02-2021	Company:	TenneT

Description: Modifications overview for mast type S-6_R (Mast 28) page 1 of 5

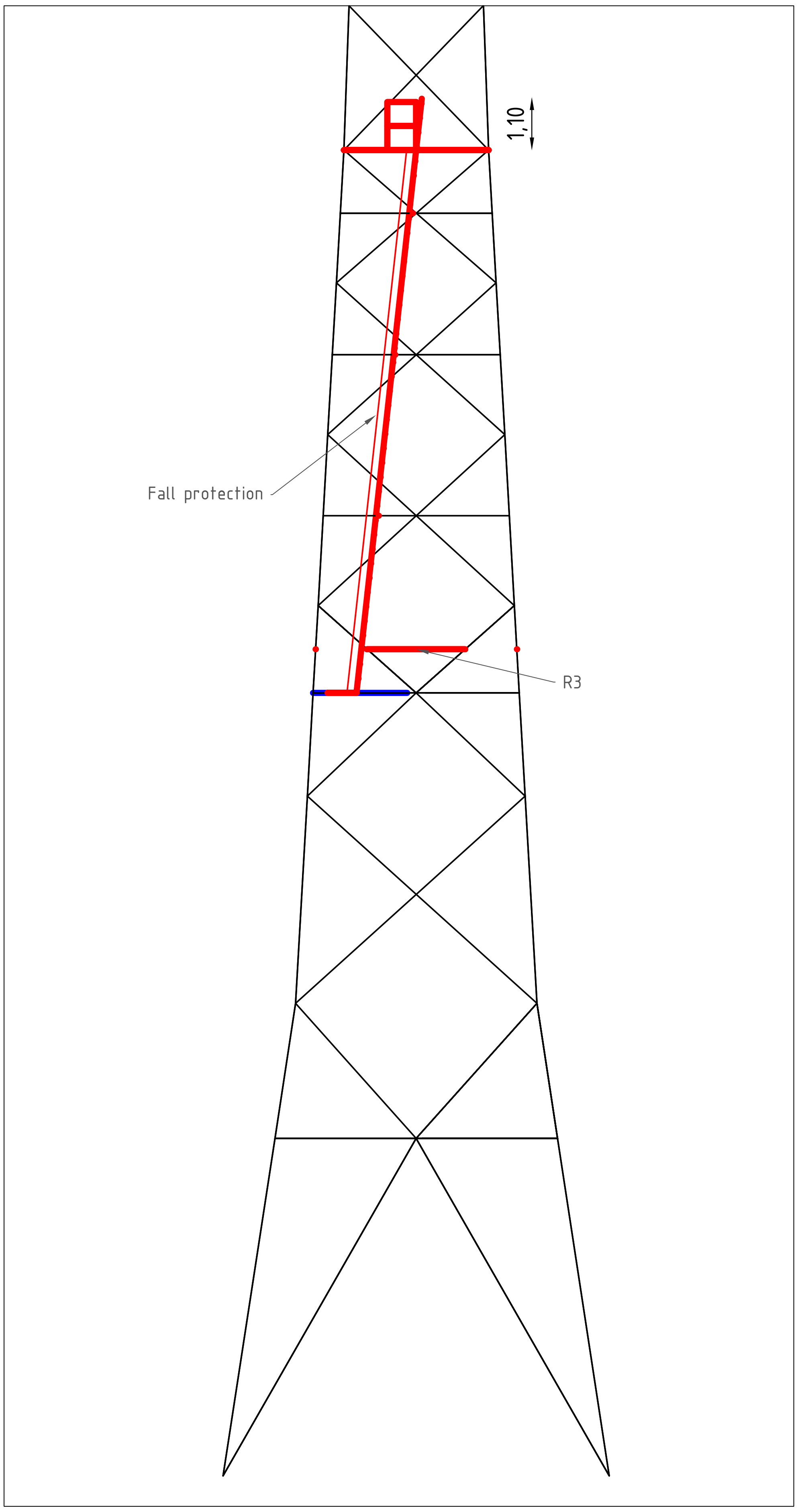
Revision: 00

Format: A2

Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
L1					UA	L100x50x6	S355 t=<40	M16-8.8t-NEN2012
L2					ø	20mm diam	S355 t=<40	
R3					EA	L60x6	S355 t=<40	M16-8.8t-NEN2012



Front View - Climbing Ladder



Side View - Climbing Ladder

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Gratings
New profile
Profile exchanged
New redundant
Bolt exchanged

00	22-02-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-061

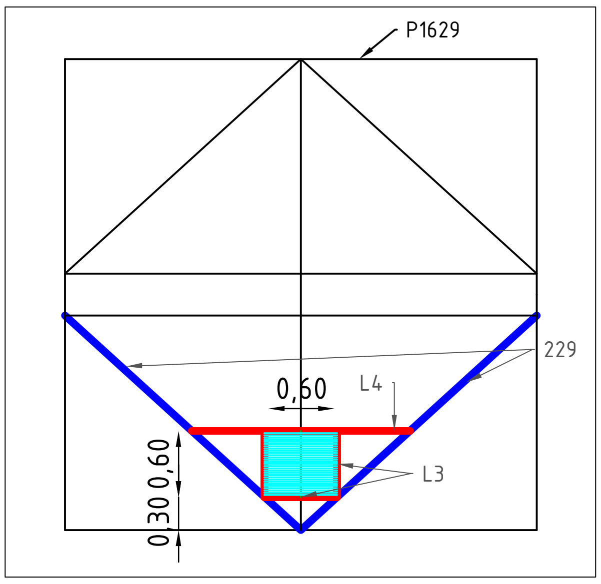
Design state: FINAL		Scale:	-
Drawn by: KCh	22-02-2021	Units:	m
Checked by: TBR	22-02-2021	Project no:	10166260
Approved by: JHu	22-02-2021	Company:	TenneT

Description: Modifications overview for mast type S-6_R (Mast 28) page 2 of 5

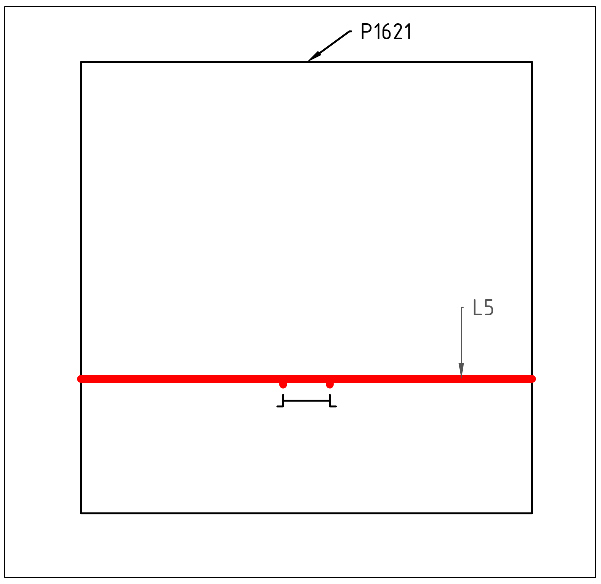
Revision: 00

Format: A2

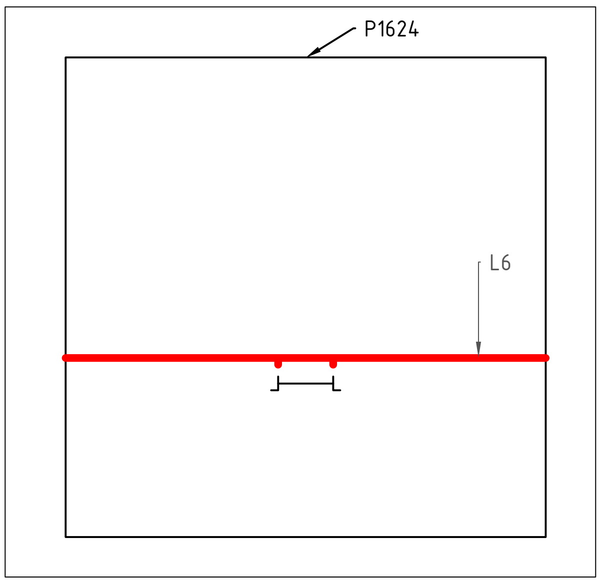
Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
L3					EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
L4					EA	L80x8	S355 t=<40	M16-8.8t-NEN2012
L5					EA	L100x8	S355 t=<40	M16-8.8t-NEN2012
L6					EA	L80x8	S355 t=<40	M16-8.8t-NEN2012
L7					EA	L80x8	S355 t=<40	M16-8.8t-NEN2012
L8					EA	L80x8	S355 t=<40	M16-8.8t-NEN2012
L9					EA	L80x8	S355 t=<40	M16-8.8t-NEN2012
L10					EA	L80x8	S355 t=<40	M16-8.8t-NEN2012
R1					EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
R2					EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
229	EA	L60x6	S235 t=<40	M16-8.8t-NEN2012	EA	L80x8	S355 t=<40	M20-8.8t-NEN2012



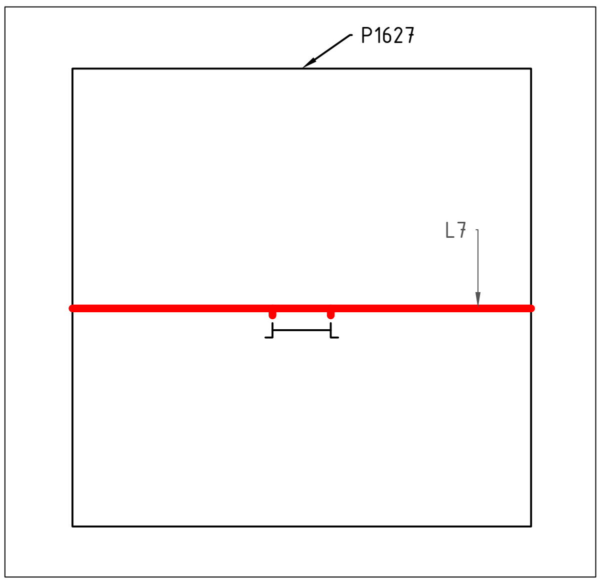
Section A-A



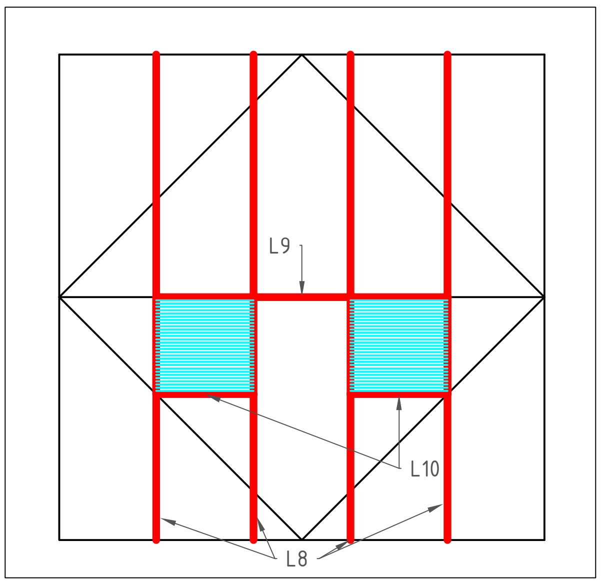
Section B-B



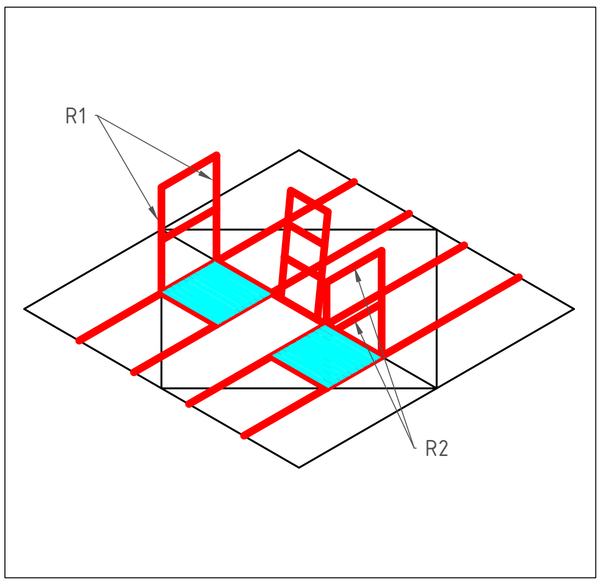
Section C-C



Section D-D



Section E-E



Section E-E Overview

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

Gratings
New profile
Profile exchanged
New redundant
Bolt exchanged

00	22-02-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-061

Design state: FINAL		Scale:	-
Drawn by: KCh	22-02-2021	Units:	m
Checked by: TBR	22-02-2021	Project no:	10166260
Approved by: JHu	22-02-2021	Company:	TenneT

Description: Modifications overview for mast type S-6_R (Mast 28) page 3 of 5

Revision: 00

Format: A2

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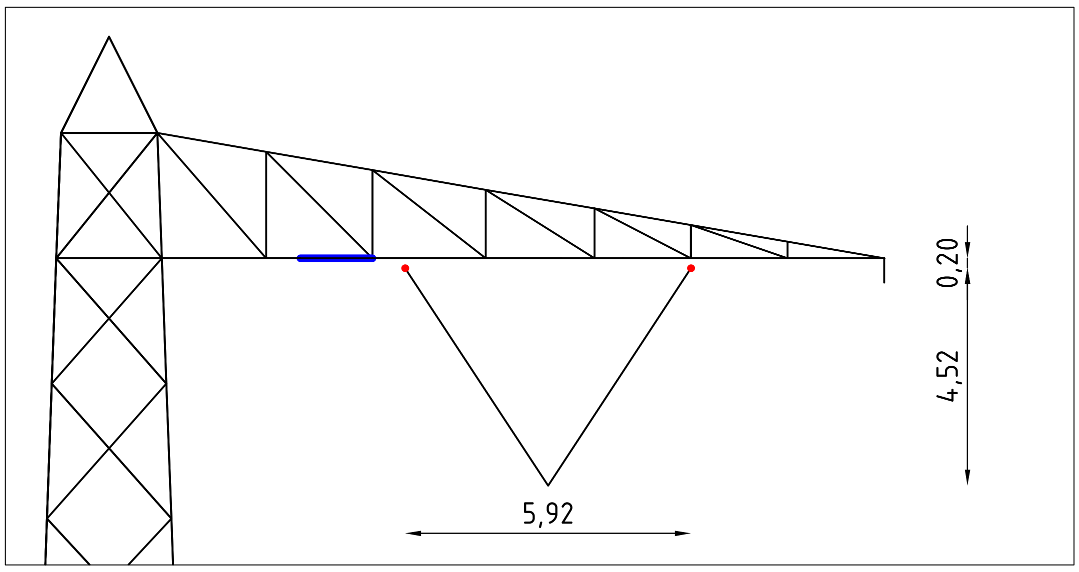
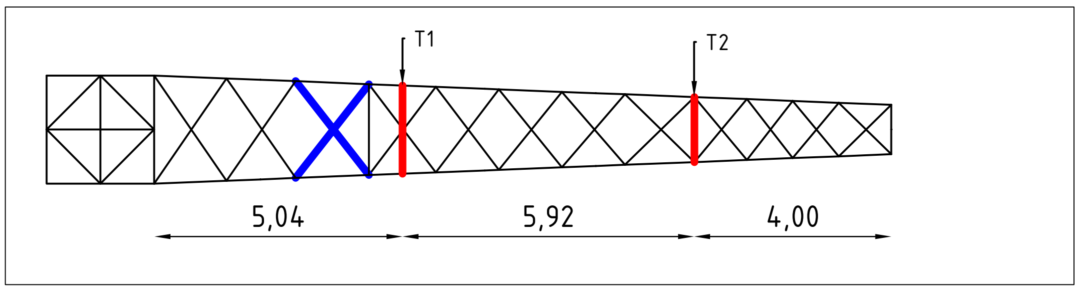
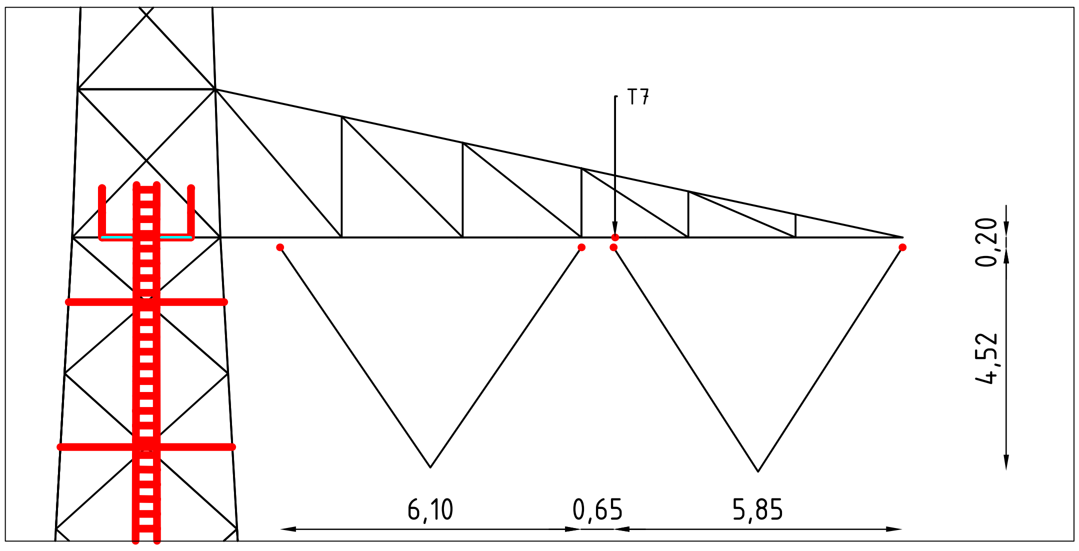
Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
T1					HEB	HEB160	S355 t=<40	M24-8.8t-NEN2012
T2					HEB	HEB160	S355 t=<40	M24-8.8t-NEN2012
T3					HEB	HEB160	S355 t=<40	M24-8.8t-NEN2012
T4					HEB	HEB160	S355 t=<40	M24-8.8t-NEN2012
T5					HEB	HEB160	S355 t=<40	M24-8.8t-NEN2012
T6					HEB	HEB160	S355 t=<40	M24-8.8t-NEN2012
T7					EA	L50x5	S355 t=<40	M16-8.8t-NEN2012



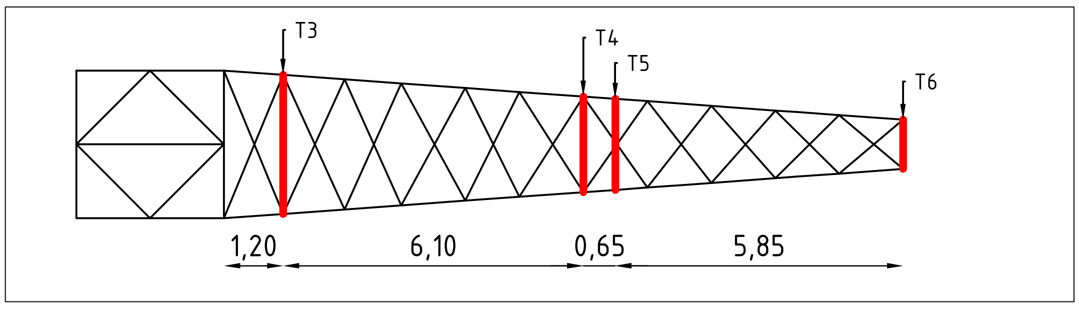
Front View - Upper Crossarm



Top View - Upper Crossarm



Front View - Lower Crossarm



Top View - Lower Crossarm

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Gratings
New profile
Profile exchanged
New redundant
Bolt exchanged

00	22-02-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-061

Design state: FINAL

Scale: -

Drawn by: KCh 22-02-2021

Units: m

Checked by: TBR 22-02-2021

Project no: 10166260

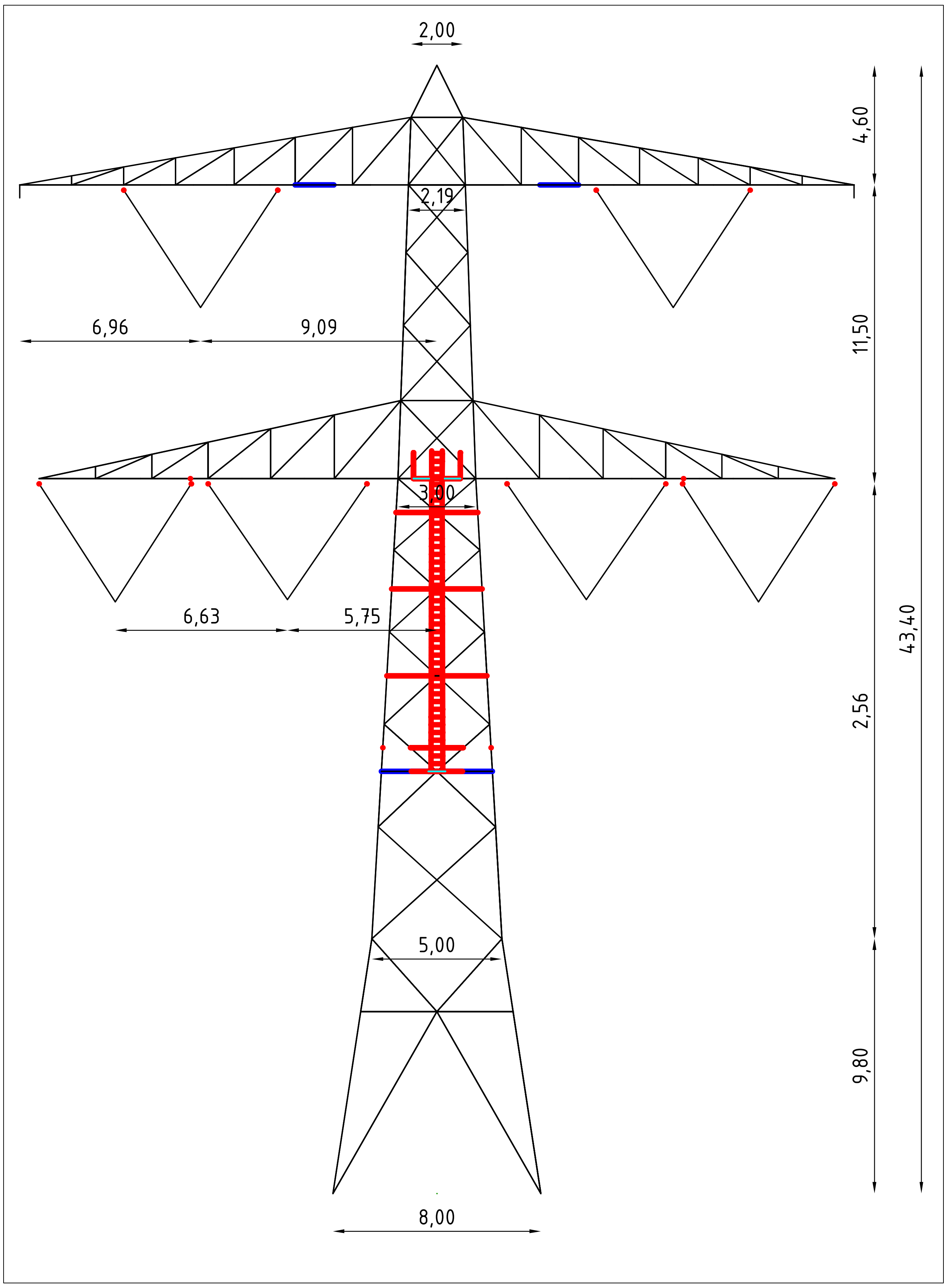
Approved by: JHu 22-02-2021

Company: TenneT

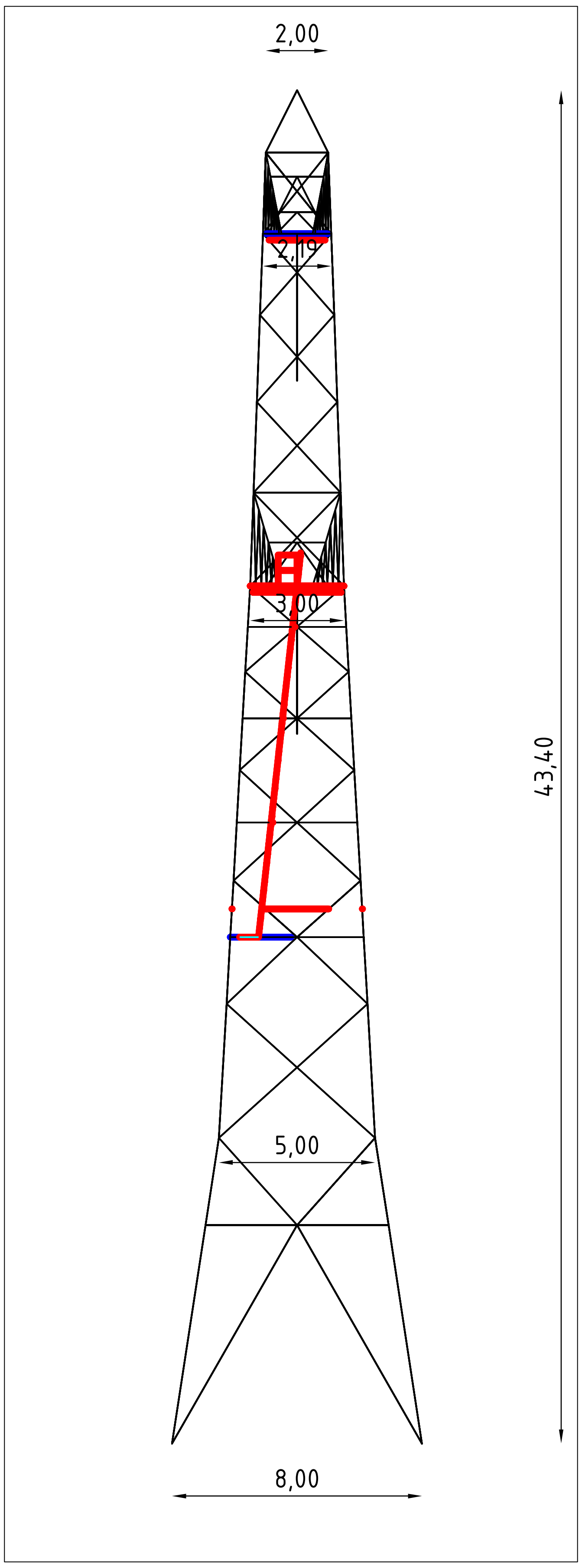
Description: Modifications overview for mast type S-6_R (Mast 28) page 4 of 5

Revision: 00

Format: A2



Front View



Side View

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

Gratings (cyan line)
New profile (red line)
Profile exchanged (blue line)
New redundant (green line)
Bolt exchanged (red dot)

00	22-02-2021	Version 1.0

DNV·GL	Projectname: Mast constructions ENS - ZL 380 kV
Third angle projection:	Drawing no.: 10166260-061

Design state:	FINAL		Scale:	-	Description: Modifications overview for mast type S-6_R (Mast 28) page 5 of 5	Revision: 00
Drawn by:	KCh	22-02-2021	Units:	m		
Checked by:	TBR	22-02-2021	Project no:	10166260		Format: A2
Approved by:	JHu	22-02-2021	Company:	TenneT		

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APPENDIX F
Berekening onderdelen V-fixaties

NEW MEMBERS LOWER CROSS ARM S-6 MAST 28

Contents

1 INTRODUCTION

The mast 28 and 72 is categorized as S-6 T tower in the "ENS ZWL" project. The PLS tower model of the tower with V-ketting configuration is shown in Figure 1. The insulators are changed to V – ketting configuration. There are two sets of the insulator in the bottom cross-arm (referred to as BCA Herforth) and one set in the top cross arm (referred to as TCA here forth).

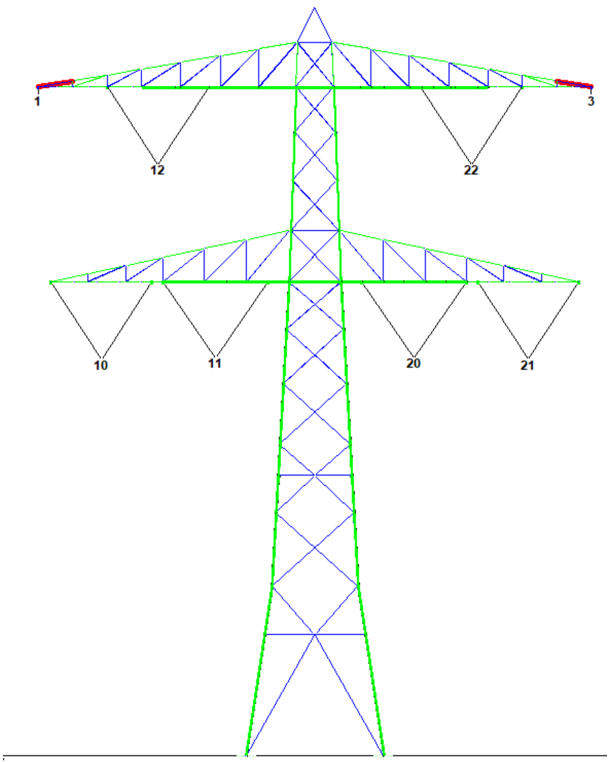


Figure 1 (a) S-6 PLS tower model

Figure 1 was taken from the PLS-Tower application for visualization. The insulators ID's: 10-12 and 20-22 are shown in black in the figure. The earth wire location is indicated by 1 and 3. The following report explores the effect of bending in the bottom chord of the cross-arms of the S-6 tower. The report highlights the geometry and the loading on the cross arm. The cross arms are analysed in isolation with the rest of the tower body. The report further compares the forces developing the cross arm with a focus on the bottom chord due to the bending forces induced by conductor loading via an insulator. Furthermore, the H beams housing the insulators are checked for torsion. The efficacy of the H – beams are checked as per EC-3. Axis VM report is attached as " Appendix – report AXIS-VM".

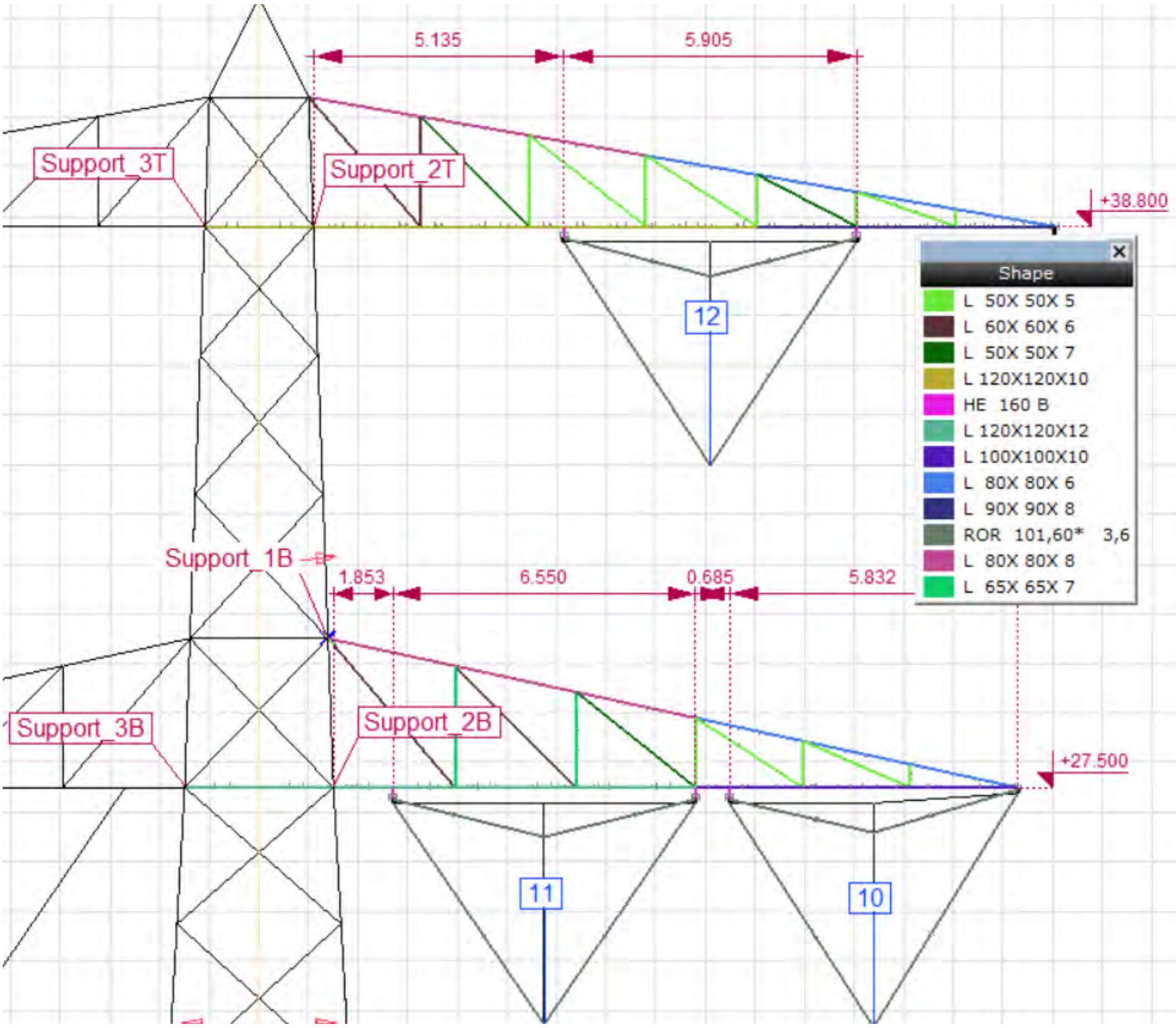


Figure 2 Location of the v-ketting insulator assembly in S-6 tower

Figure 2 shows a side view of the cross-arms. The figure also shows the V-ketting insulators marked in blue boxes. The no.s will be used to refer to the insulators in this report here forth.

2 GEOMETRY

To support the new location of the insulator additional members are added below the bottom chord. The newly added geometry is been shown in Figure 3. It also highlights the cross-section properties of these members. The v-ketting isolators have been modelled as Φ-101x3.6 mm bars.

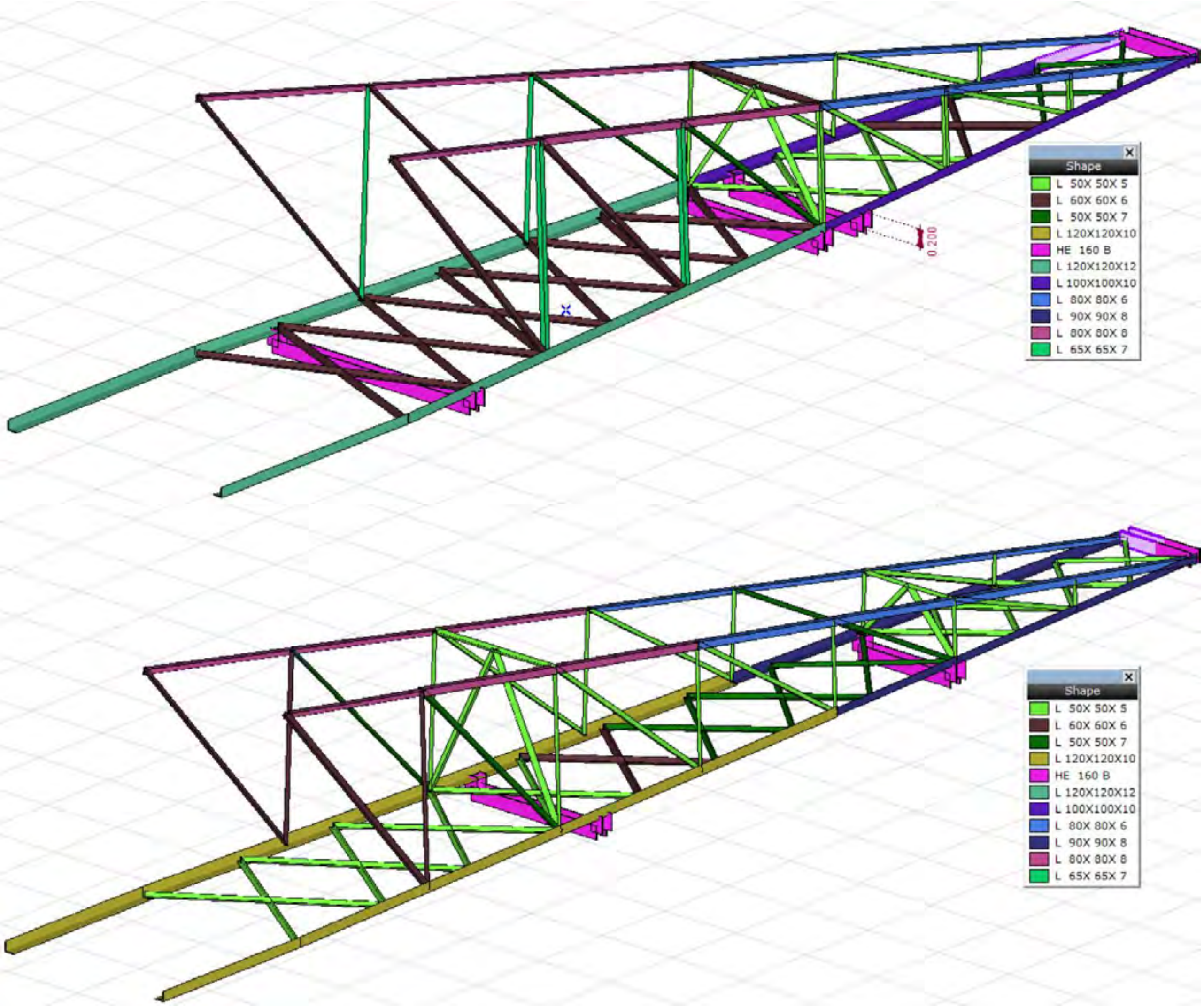


Figure 3 3D rendered geometry of the Cross arm.

Figure 4 shows the elevation 3d render of the cross arm. The V-ketting insulators are attached to an HEB 160 steel beam. The HEB 160 beams are in purple. They are located below the plane of the bottom chord with an offset of 200mm roughly. Figure 4 shows an image of the attachment point of an isolator. The centre lines of the bottom chord, H beam and in-plane hinge of the isolator is shown via white, yellow and red lines. The distance between the H beam (yellow) and the hinge (red) is 70+45 = 115 mm. The above-explained offsets were incorporated in the axis VM model via dummy elements with HEB 160 profile. The figure shows the H beams with relevant offsets. The isolators are hinged at the attachment points. This is in conjunction with the in-plane swing mechanism of the isolators. The v-ketting swing out of plane about a swing which is 45 mm the centre of the H beam.

The bottom chords are assumed to be continuous members. This assumption mandates that the connection at the transition of cross-section profiles in the top and bottom chords are capable of transferring moments. As a precautionary measure, the moments at and near the transition point need to be kept to a minimum.

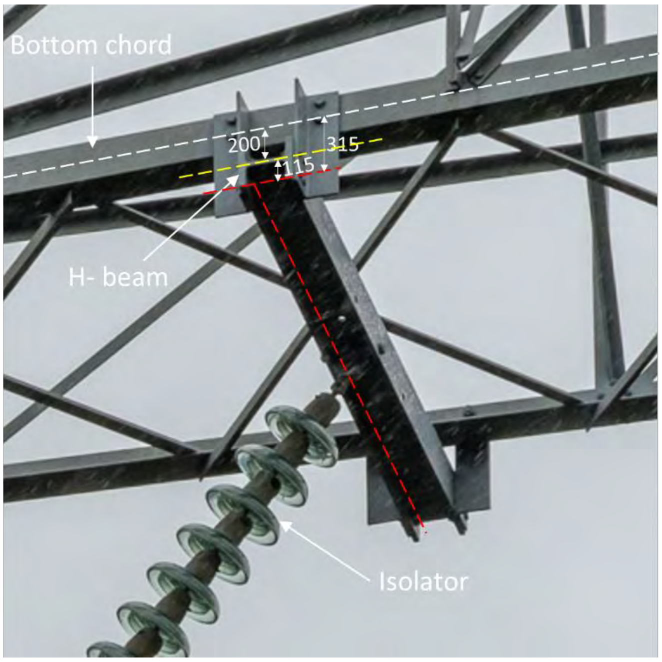


Figure 4 Zoomed image of isolator attachment point in S+6 tower.
The members of the cross arms expect the top and bottom chord is given release for rotation at both of their ends. This is done to simulated simple moment free joints. The release is shown in figure 2.

2.1 Supports

Only the cross arm of the tower is considered in isolation in this study. This assumes that the existing cross arm will be safe and the internal forces in it will not change a lot. Thus, the change in isolators will not have a global effect and only the new members required to connect the repositioned isolators to the cross arm need to be checked for efficacy. The part cross-arm is modelled and its connections with leg members are constrained (supported) as given in Table 1. The support_1 and support_2 are the connections of the bottom chord with the tower leg. Support_3 is the connection point between the top chord and tower leg. The B and T at the stands for the bottom and Top cross arms.

Table 1 Details of supports of the cross-arm model

ID	Node	K_x [kN/m]	K_y [kN/m]	K_z [kN/m]
Support_1B	22	1.00E+10	1.00E+10	1.00E+10
Support_1B	25	1.00E+10	1.00E+10	1.00E+10
Support_1T	3	1.00E+10	1.00E+10	1.00E+10
Support_1T	4	1.00E+10	1.00E+10	1.00E+10
Support_2B	26	1.00E+10	–	1.00E+10
Support_2B	29	1.00E+10	–	1.00E+10
Support_2T	7	1.00E+10	–	1.00E+10
Support_2T	8	1.00E+10	–	1.00E+10
Support_3T	6	–	1.00E+10	1.00E+10
Support_3T	9	–	1.00E+10	1.00E+10

Support_3B	27	–	1.00E+10	1.00E+10
Support_3B	28	–	1.00E+10	1.00E+10

3 LOADING

The loads are applied in the Axis VM model for the critical load cases. The loads are in conjunction with the loads applied in the PLS Tower model for the existing model. The loads are applied at the tip of the V-ketting isolators. The ID of the isolator is given in figure 2. The ID is matched with the PLS tower model. The ID of the isolators is used to identify and load the cross arms in Axis VM. The name of the load cases in the AxisVM model is also consistent with their counterparts in the PLS tower model. Furthermore, extra load cases are developed for ULS 1a_90 and ULS_3_90 with the angle at the end being 270. The direction of horizontal loads is reversed for these cases. Load case 1 is the worst wind and self-weight of the cross arm. Load case 3 has loaded from both self-weight, wind and ice with relevant partial load factors. Load case 5a is the special case, for the failure in the conductor. The conductor failure in conductor 20, 21 and 22 along with failure in earth conductor is simulated in Axis VM simulation. Table 2 shows the details of the individual load cases. Table 2 refers to the position of the isolator being the default or broken. The position of the isolator in case of the conductor being intact on both side (default and operating situation) by box b in figure 5. The position of the isolator when the conductor fails on 1 side is shown by box A in magenta in the figure below.

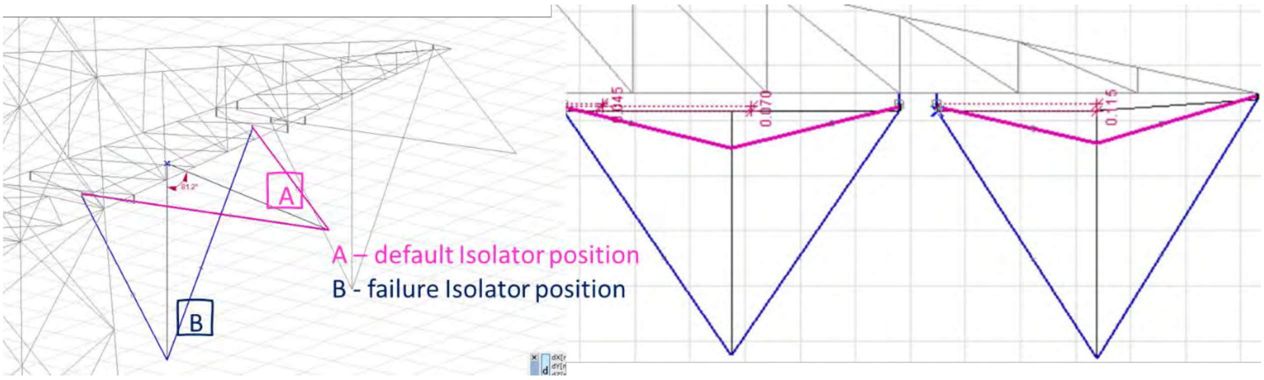
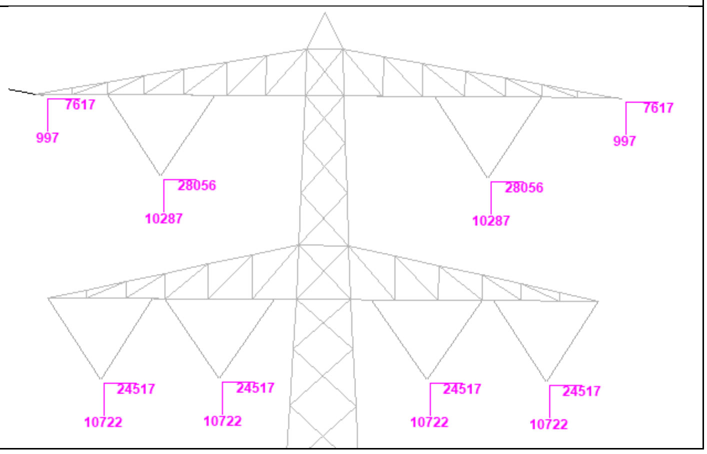
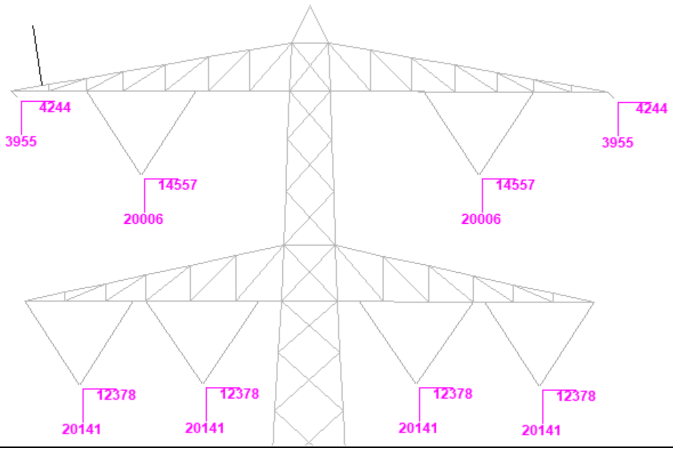
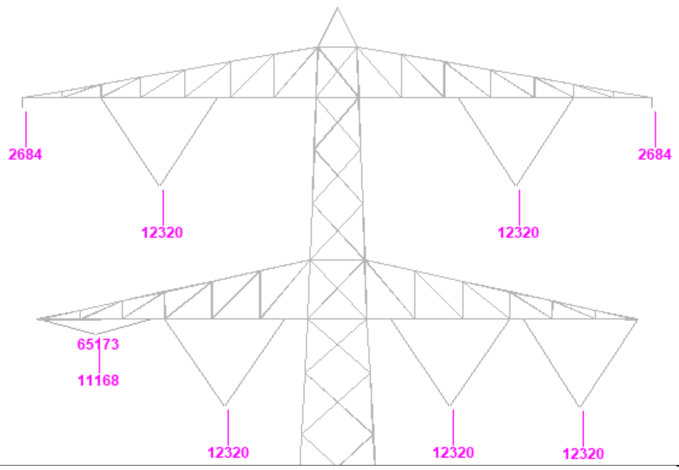
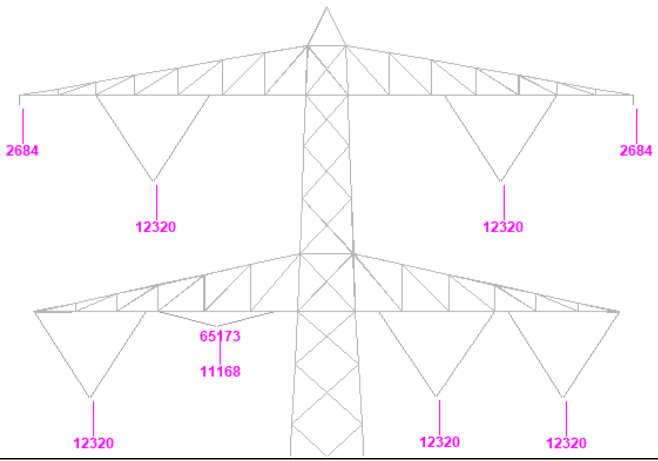
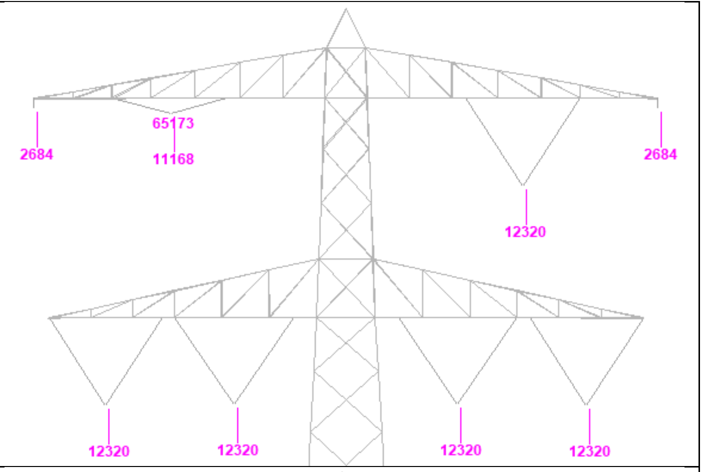
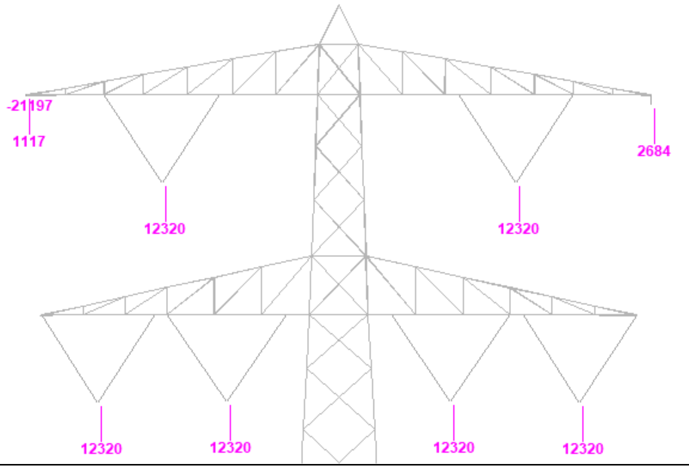


Figure 5 position of the isolators in working and broken conductors

Table 2 Details of load cases

Sr. No.	Load Case	Particular	The load applied in the PLS tower model
1	03 ULA 1a_90: isolator position B	Wind load – Critical for the max horizontal load. The isolators are modelled and thus the loads are applied at the tip of the v-ketting	

2	15 ULA 3a_90 (max – vertical load): isolator position B	Ice + wind – load case for the critical vertical load. Read the previous para for its application in the axisVM model.	
3	33 ULS 5a Ba 20: isolator position A only for isolator 20.	Failure of the conductor – 20 and 12: The load on the isolator with broken conductor 20 is applied at the isolator position shown in box A. The 150kV conductor in the bottom cross-arm fails. The rest of the loads are applied at the default isolator tip.	
4	34 ULS 5a Ba 21: isolator position A only for isolator 21.	Failure of the conductor - 22 and 11. The 380 kV conductor in the bottom cross-arm fails.	

5	35 ULS 5a Ba 22: isolator position A only for isolator 22.	Failure of the conductor - 22 and 10.	
	23 ULA 5a Ah 1:	Failure of earth conductor.	

Self-weight for the cross arms is applied in the load case EG. The load cases are applied. The loads in table 2 are combined with self-weight with factor 1.

4 RESULTS

4.1 H beams in torsion:

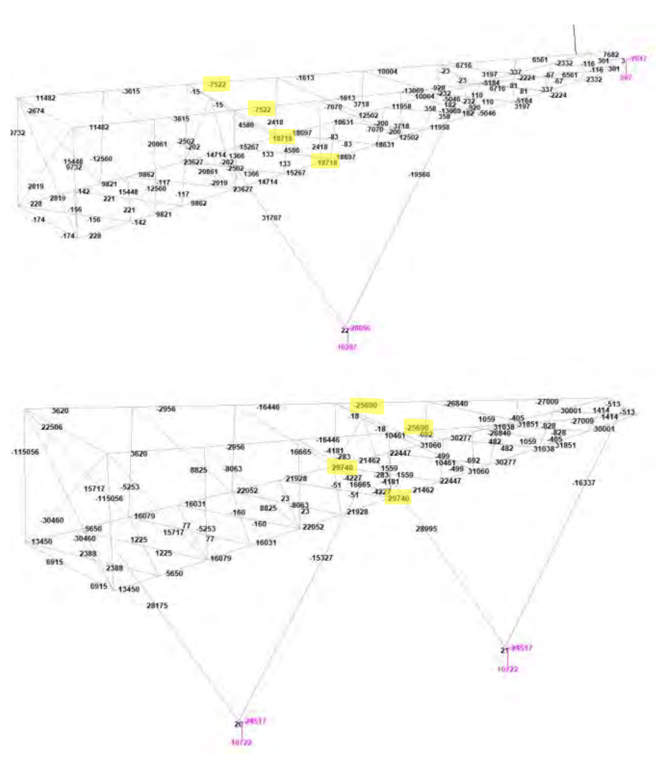
The HEB 160 beams are checked for the combined action of torsion and bending. Axis VM does not calculate the warping moments due to torsion. Therefore, the calculation shown in Figure 6 is used to verify the efficacy of the H beams under torsion. The location of the H beam is determined via the isolator it's housing. The beam ID of axis Vm is given to correlate to the detailed output in the axis VM report. The stress for bending and torsion are added and the max stress in the beams is 181 N/mm². Thus, the utility ratio is 0.54. There is ample reserve strength for the stability of the beams.

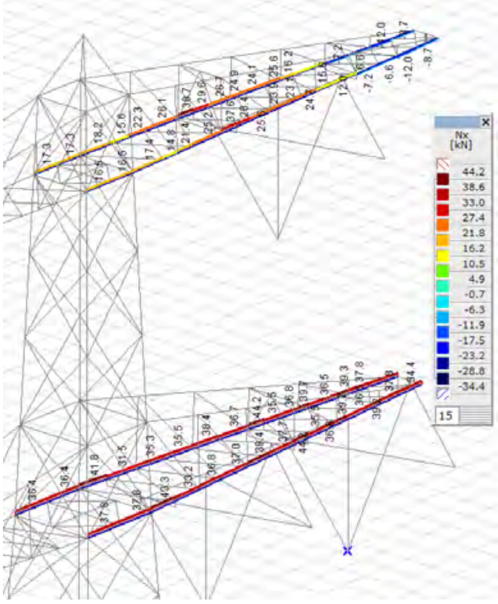
Axis VM ID		238,239	236,248	234,235	239,230	240,241	249,250	
Conductor ID		21	21	20	20	22	22	
position		left	right	left	right	left	right	
Profile of beam		HEB 160	HEB 160	HEB 160	HEB 160	HEB 160	HEB 160	
$M_{w,Ed}$ =								
$M_{y,Ed}$ =		11.5	8.8	9.4	6.2	9.5	6.9	kNm
$M_{z,Ed}$ =		15.8	11	9.7	5	9.8	7.5	kNm
Torsion =		0.3	0.37	0.92	0.89	0.83	0.83	kNm
Orientation of beam		z-as	z-as	z-as	y-as	y-as	y-as	
Torsional moment	T	0.30	0.37	0.92	0.89	0.83	0.83	kNm
Beams								
Beam length	L	3600	987	3748	3000	3000	3000	mm
Yield stress	f_y	355	355	355	355	355	355	Mpa
Elastic modulus	E	210000	210000	210000	210000	210000	210000	Mpa
Shear modulus	G	81000	81000	81000	81000	81000	81000	Mpa
Profile		HEB 160	HEB 160	HEB 160	HEB 160	HEB 160	HEB 160	
		HEB160	HEB160	HEB160	HEB160	HEB160	HEB160	
Height	h	160	160	160	160	160	160	mm
Width	b	160	160	160	160	160	160	mm
Web thickness	t_w	8.0	8.0	8.0	8.0	8.0	8.0	mm
Flange thickness	t_f	13.0	13.0	13.0	13.0	13.0	13.0	mm
Torsional constant	I_t	31	31	31	31	31	31	mm^4
Warping constant	I_{wa}	47943	47943	47943	47943	47943	47943	mm^6
Moment of inertia	I_y	2492	2492	2492	2492	2492	2492	mm^4
	I_z	889	889	889	889	889	889	mm^4
Flange stiffness	$I_f = I_z / 2 =$	445	445	445	445	445	445	mm^3
Moment of resistance	$W_{y,el}$	311	311	311	311	311	311	mm^3
	$W_{z,el}$	111	111	111	111	111	111	mm^3
Torsional bending constant	d	630	630	630	630	630	630	mm
	L/d	5.7	1.6	5.9	4.8	4.8	4.8	
	α	0.5	0.5	0.5	0.5	0.5	0.5	
Acting moments:								
$M_{w,Ed} = E \cdot I_f \cdot (h-t_f) \cdot \phi'' / 2 =$		0.6	0.5	2.0	1.9	1.8	1.8	kNm
$M_{y,Ed} = 1/4 \cdot F \cdot L =$		11.5	8.8	9.4	6.2	9.5	6.9	kNm
$M_{z,Ed} = 1/4 \cdot F \cdot L =$		15.8	11.0	9.7	5.0	9.8	7.5	kNm
Capacities of beams:								
$M_{w,Rd} = W_{z,el} \cdot f_y / 2 =$		19.7	19.7	19.7	19.7	19.7	19.7	kNm
$M_{y,Rd} = W_{y,el} \cdot f_y =$		110.6	110.6	110.6	110.6	110.6	110.6	kNm
$M_{z,Rd} = W_{z,el} \cdot f_y =$		39.5	39.5	39.5	39.5	39.5	39.5	kNm
Combined check of beam:								
UC		0.54	0.38	0.43	0.28	0.42	0.34	
Displacements:								
Factor F_{ed} / F_k		1.2	1.2	1.2	1.2	1.2	1.2	
Displacement y-direction	u_y	2.72	0.14	1.81	0.60	1.17	0.90	mm
Relative displacement	rel.	1325	6941	2073	5024	2563	3349	-
Displacement z-direction	u_z	5.54	0.32	4.91	2.08	3.18	2.31	mm
Relative displacement	rel.	650	3096	763	1446	944	1299	-

Figure 6 HEB 160 beams checked for torsion

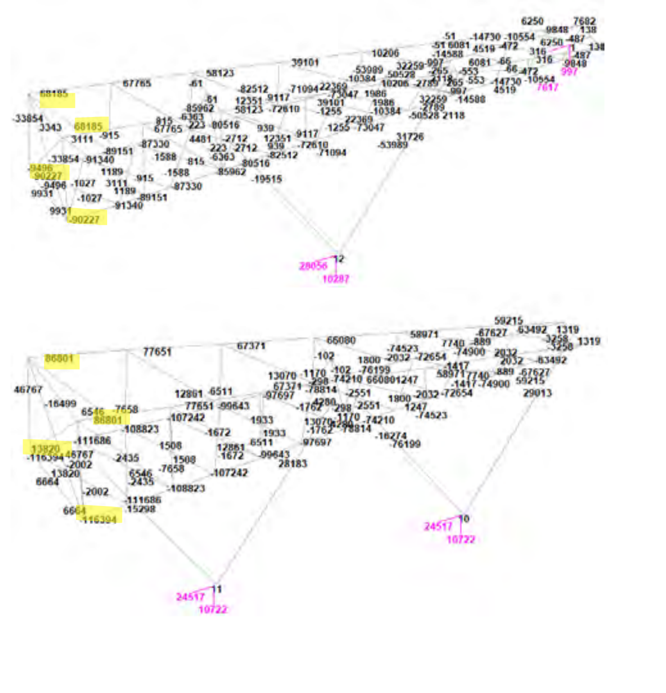
4.2 Comparison of the bottom chord with PLS-TOWER results

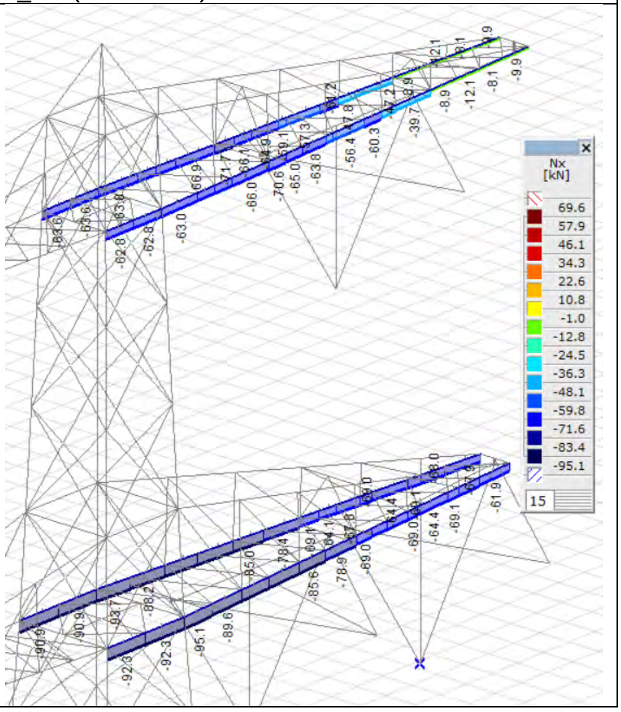
The existing model was analyzed in the PLS Tower application. This application can analyze the structure as a truss member and hence gives only axial forces as the output. Maximum compression occurs in the bottom chord and is also the most critical element in the structure. The axial force in the arms for the load 1) 03 ULA 1a_90, 2) 15 ULA 3a_90, 3) 33 ULS 5a Ba 20, 4) 34 ULS 5a Ba 21 and 5) 35 ULS 5a Ba 22 for PLS-TOWER and AxisVM is given in Figure 7. The compressive force has a negative sign. The Figures on the left are for the existing situation from the PLS Tower model while the ones on the right represent the axial force for the simulation in AxisVM.



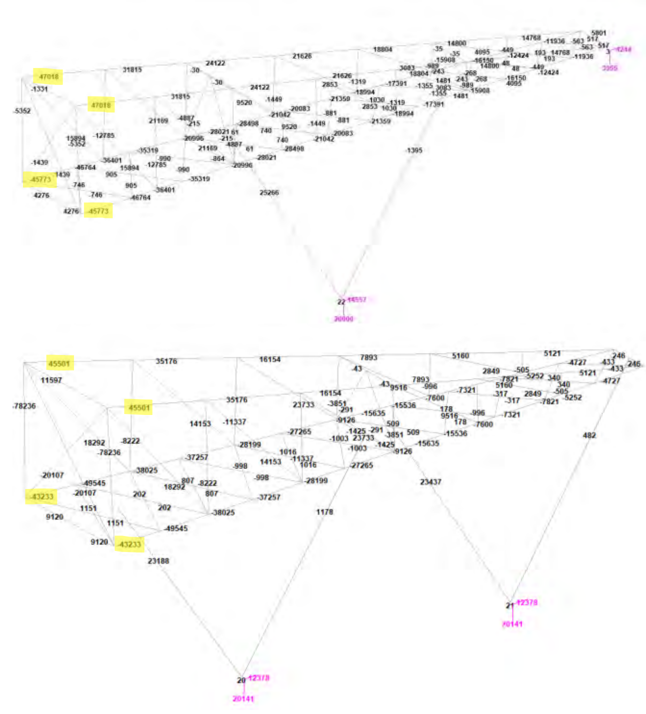


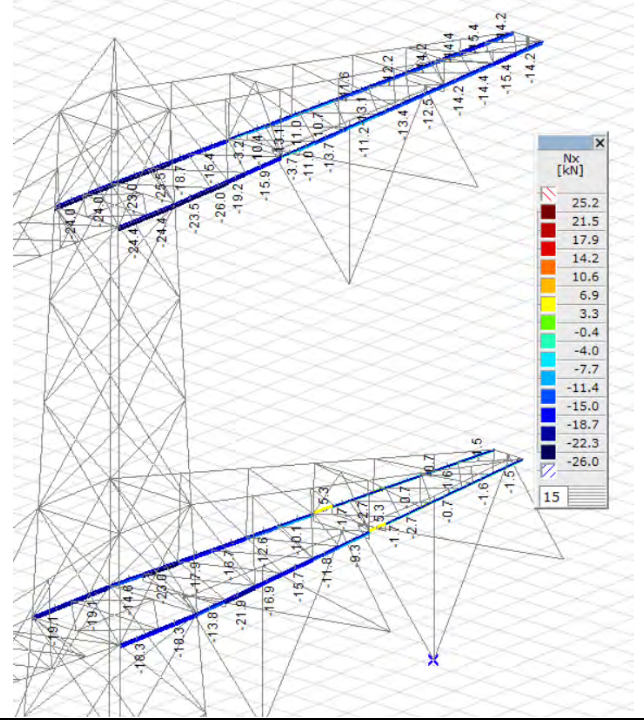
Load case – 03_ULA_1a_90 (max wind)



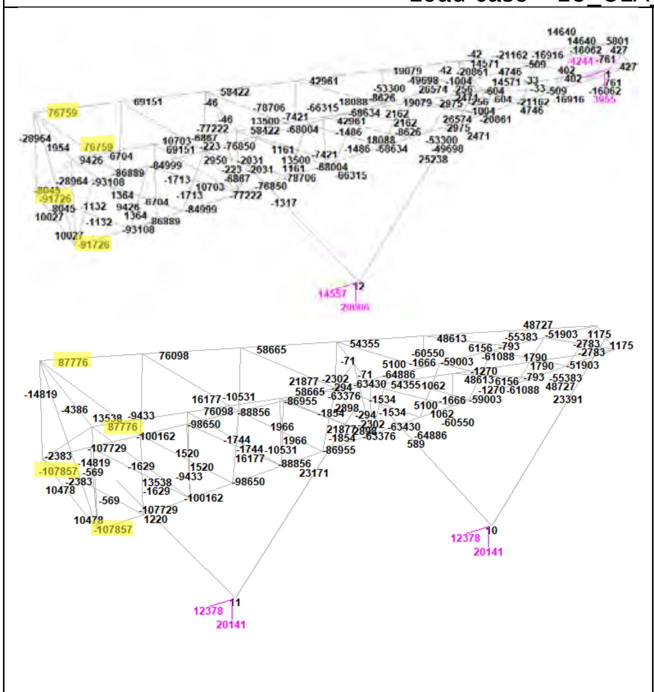


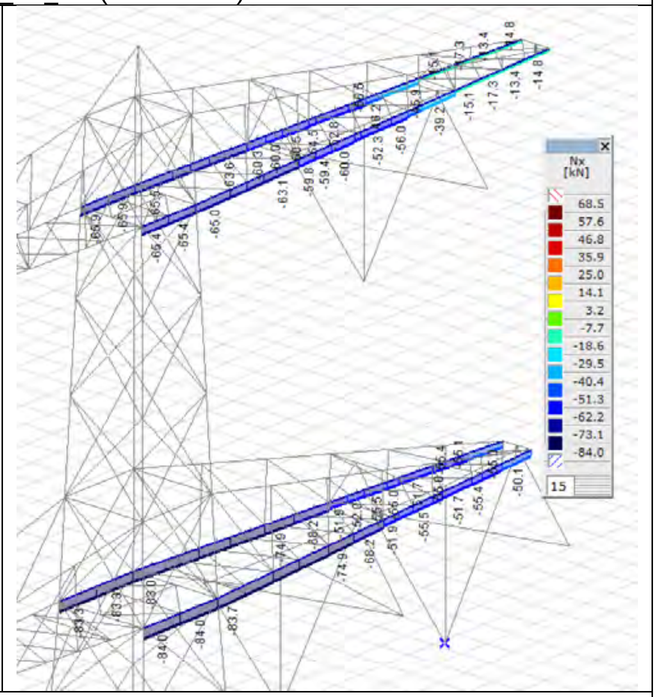
Load case – 03_ULA_1a_270 (max wind)



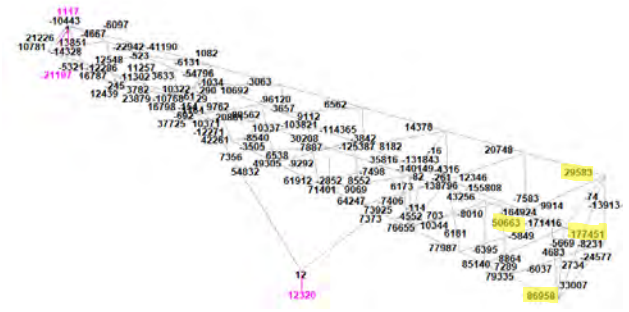


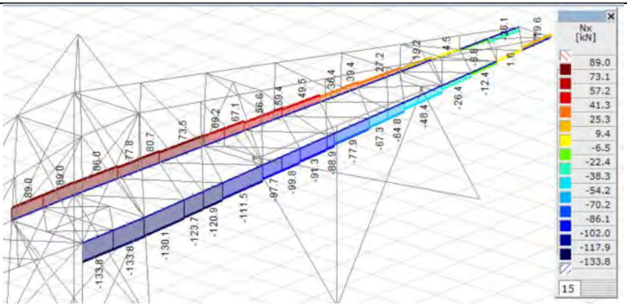
Load case - 15_ULA_3a_90 (ice + wind)



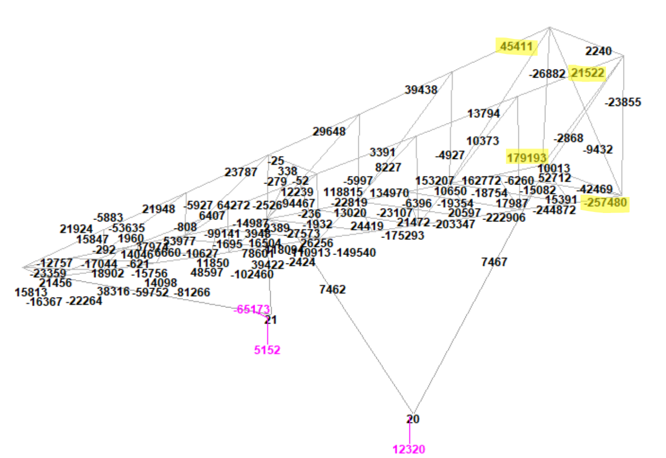
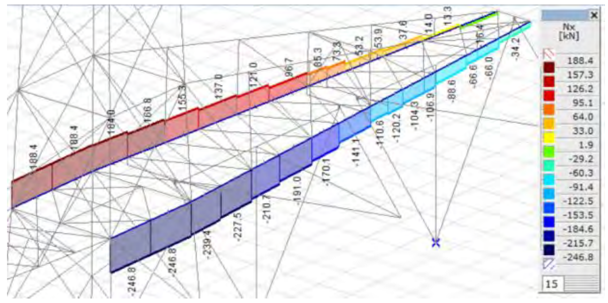


Load case - 15_ULA_3a_270 (ice + wind)

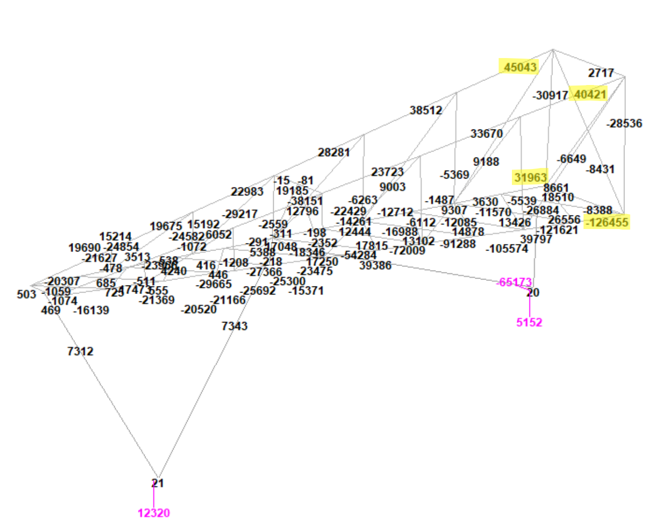
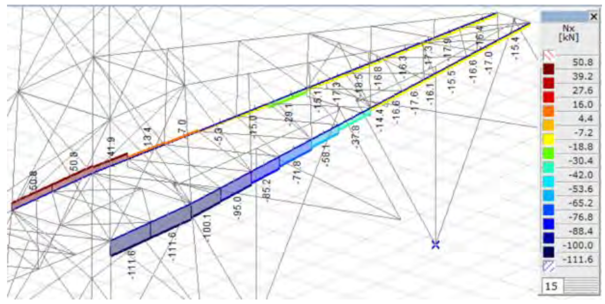




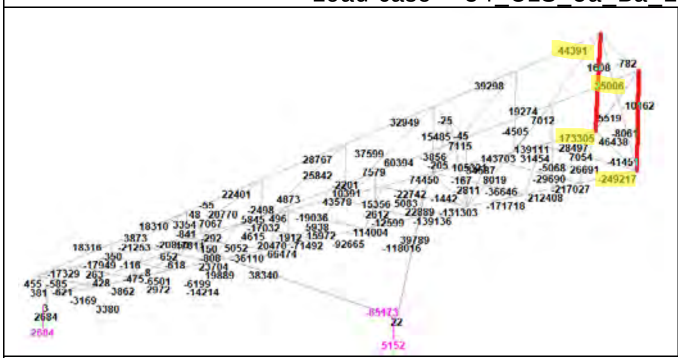
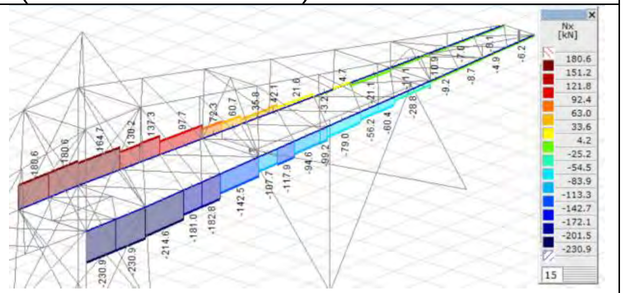
Load case – 33_ULS_5a_Ba_01 (Broken earth conductor)

Load case – 33_ULS_5a_Ba_20 (Broken conductor - 20)

Load case – 34_ULS_5a_Ba_21 (Broken conductor - 21)

Load case – 35_ULS_5a_Ba_22 (Broken conductor - 22)

Figure 7 Axial forces in the exiting cross-arm for vertical isolators

The forces in the bottom chord in the existing and new situation are tabulated in table 3. The maximum force occurs in loads case 35_ULS_5a_BA_20 across the models and the critical force is 246 kN in the bottom cross-arm in axisVM analysis. The corresponding force in the PLS output is 257 kN. The compressive force has reduced in the axis VM analysis compared to the PLS tower output as seen in table 3.

Table 3 Comparison of compressive force in kN

Load Case	PLS tower		AxisVM	
	TCA	BCA	TCA	BCA
03_ULS_1a_90	18.7	29.7	16.5	37.8
03_ULS_1a_270	90.3	116.4	62.8	92.3
15_ULA_3a_90	45.7	42.3	24.4	18.3
15_ULA_3a_270	91.8	107.8	65.4	84
22_ULS_5a_Ba_1	177		133	
33_ULS_5a_Ba_20	-	257	-	246
34_ULS_5a_Ba_21	-	126	-	116
35_ULS_5a_Ba_22	249	-	230	-

The maximum, stress in the bottom chord, other members of the existing cross arm and the newly added members are shown in Figure 8. The maximum stress of 218 MPa across the bottom chord of the cross arms. The yield stress of the bottom chord is 355 MPa (S355 steel grade). Thus the max utility ratio os 0.62 develops in the added members. There is reserve capacity in the members to consider stability issues.

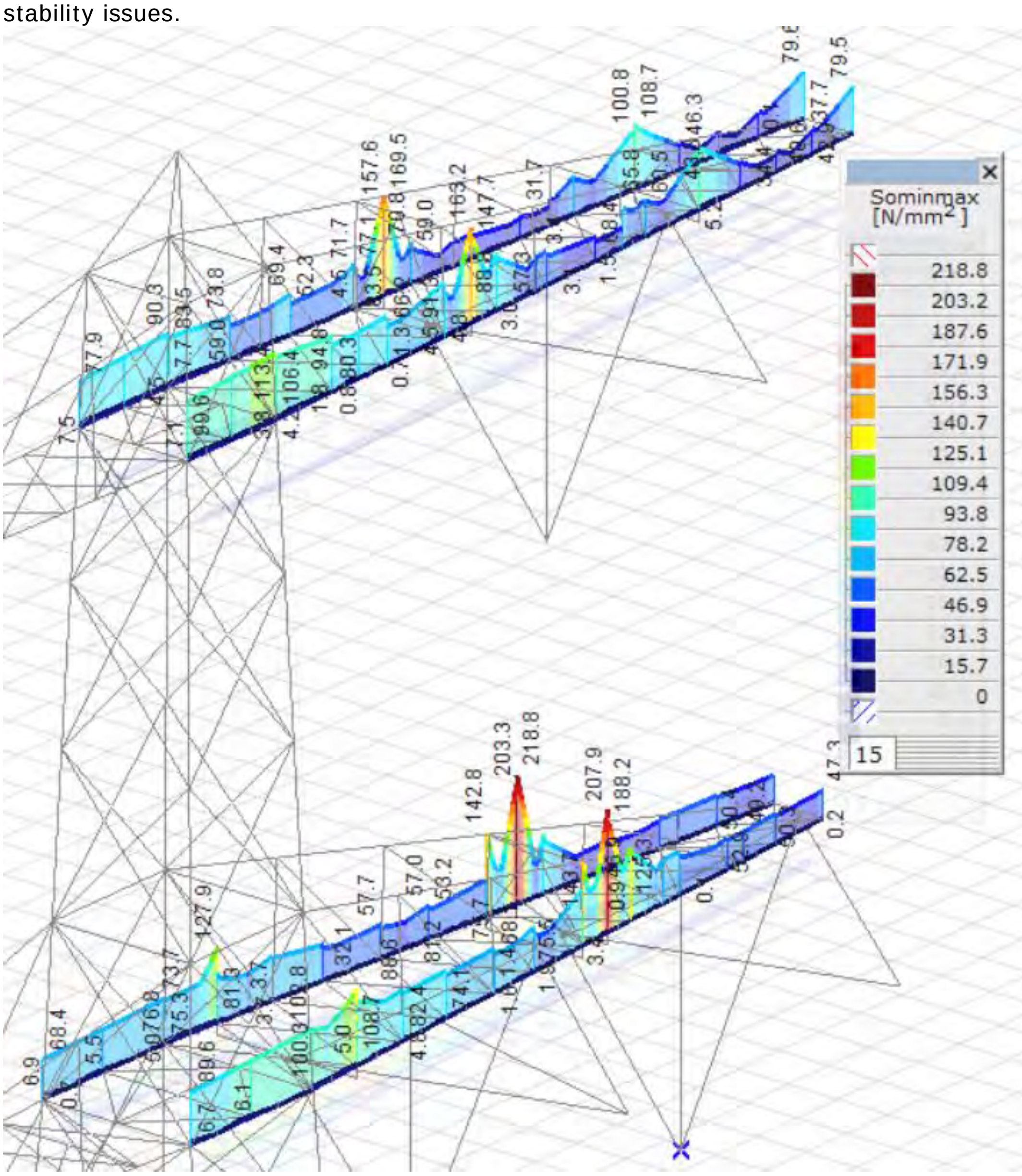
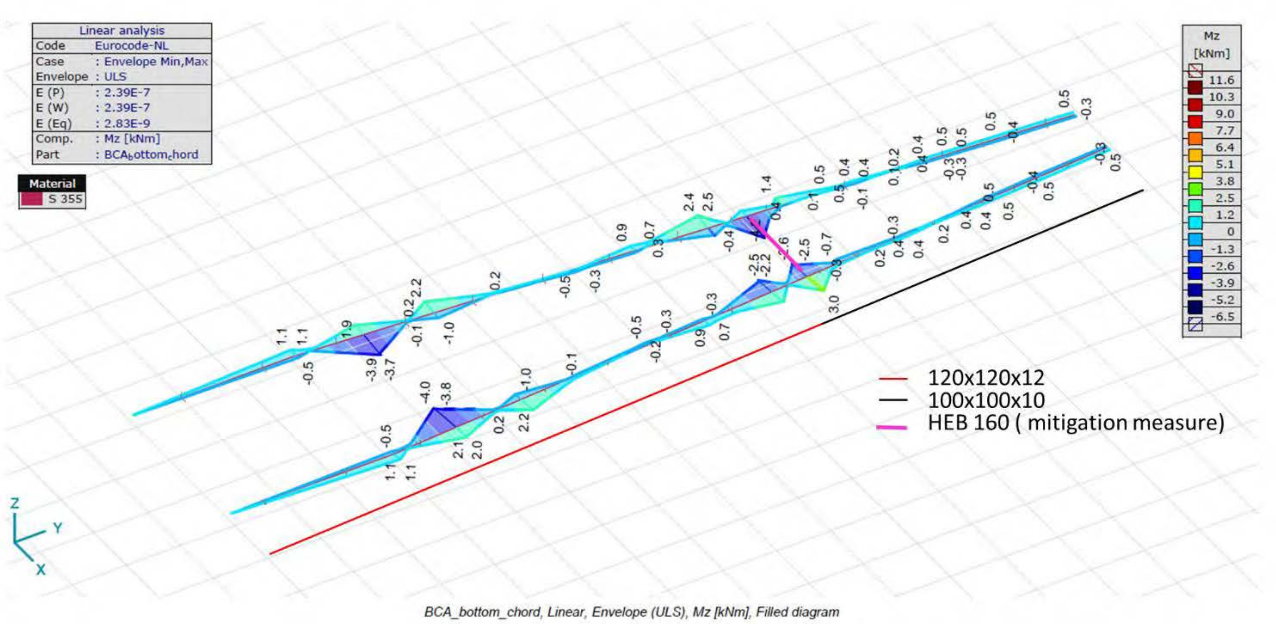


Figure 8 Stress for ULS Envelope in members

Spikes at the moment are seen in figure 8. These spiked are attributed to large minor axis moment (M_{yy}) at the points where the HEB 160 beams are connected to the bottom chord. Figure 9 confirms the peaks in M_{yy} in the bottom chord. The transition of the cross-section profiles occurs 0.5 m between the location of the peaks in the bottom chord. This can be detrimental and unsafe. A horizontal (L50x50x5) is added in the bottom chord just above the H beams as seen



in figure 9 in magenta colour.

Figure 9 Minor axis moment (M_{yy}) in the bottom chord of the bottom cross arm

Successive run after adding the horizontal shows the decrease in the Myy at the critical location from 3 to 2.1 kNm. The decrease is approx. 25%.

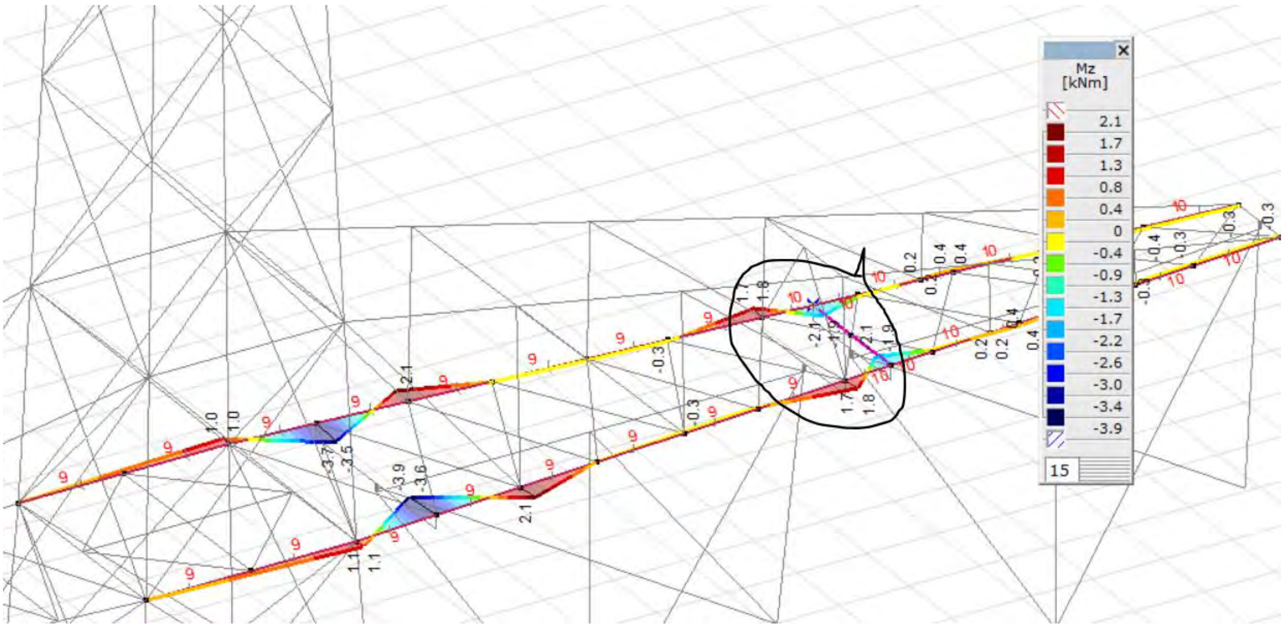
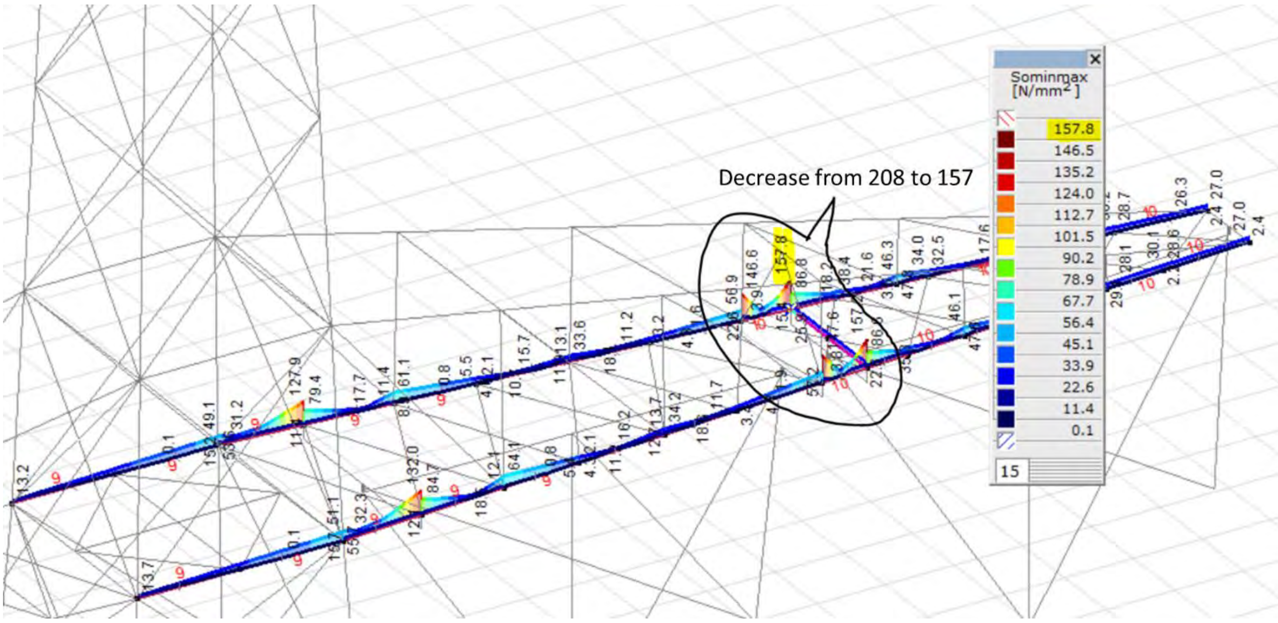


Figure 10 Minor axis moment in the strengthened bottom cross arm

The stress at the critical locations has decreased. The maximum stress has decreased to 158 MPa. This is a decrease of roughly 25% of the previous value of 208 MPa. The max stress is below 50 % of the yield stress of S355 grade steel. This is acceptable even with the local peaks occurring so close to the transition point.



4.3 Check of members

The H beams in the tower are classified as class 3 members as per Euro code classification. The max utilization as per guidelines of EC-3:1993 is 0.51 in Axis VM. The max utilization seen from the torsion + bending stress in excel is 0.54. The additional strength can be used for the losses in connection. Thus the structure is assumed to saf

5 CONCLUSION:

The maximum compressive force in the bottom chord has not increased from the PLS-TOWER. The existing cross arm can be assumed safe for the loads imposed by the torsion in the v − ketting isolator configuration. This ratifies the initial assumption of studying the cross arm in isolation.

The connection between the transition of the cross-section profiles in the top and bottom chord of the all cross arm should be capable of transferring moments. The concerned connection should be checked for the resulting moments. The moments at the connection should be minimised if possible as explained in the previous section.

The H beams are checked by comparing the combined stress (bending + torsion in excel) from the analysis to their yield stress and as well as by the checks as per Eurocode 3 in Axis VM. The additional capacity of approx. 40% is observed and is kept as a reserve for bolt holes and other unseen circumstances.

The H beams added to support the v-ketting insulators are shown in the figure below. The figure from left corresponds to (1) top view of the top cross arm, (2) top view of the bottom cross arm and (3) side view of the cross arms. The HEB 160 beams are highlighted in magenta. The additional horzontal on top of the bottom chord in BCA is shown in green.

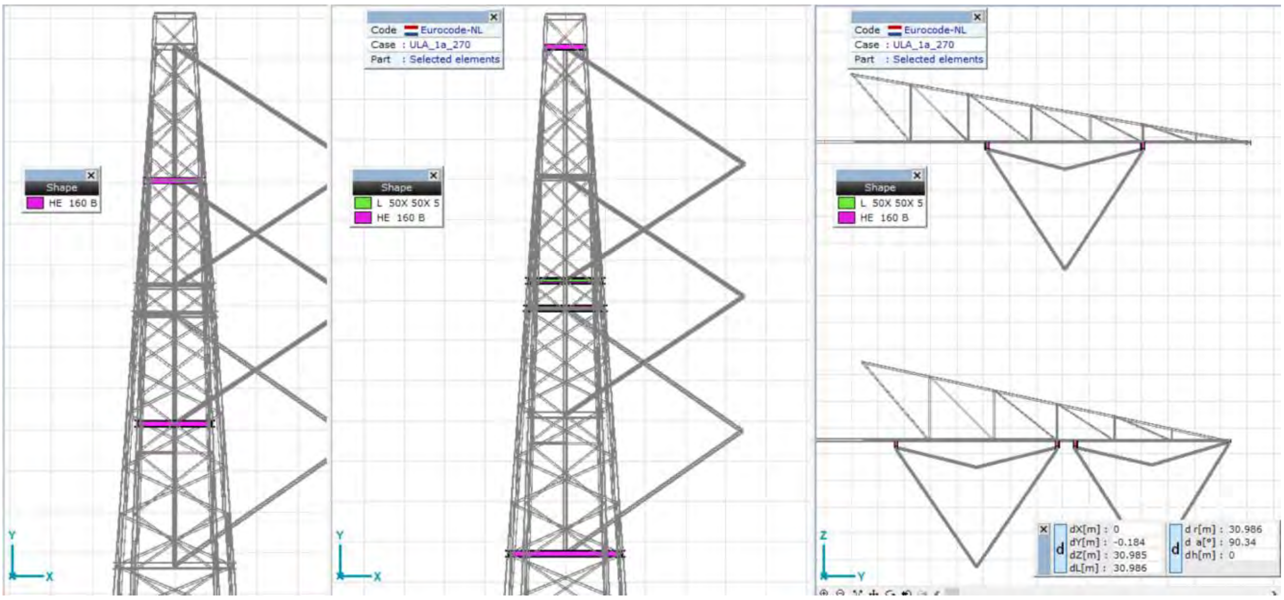


Figure 11 Beams added to support v-ketting insulator configuration

6 BIJLAGE: UITVOER AXISVM.

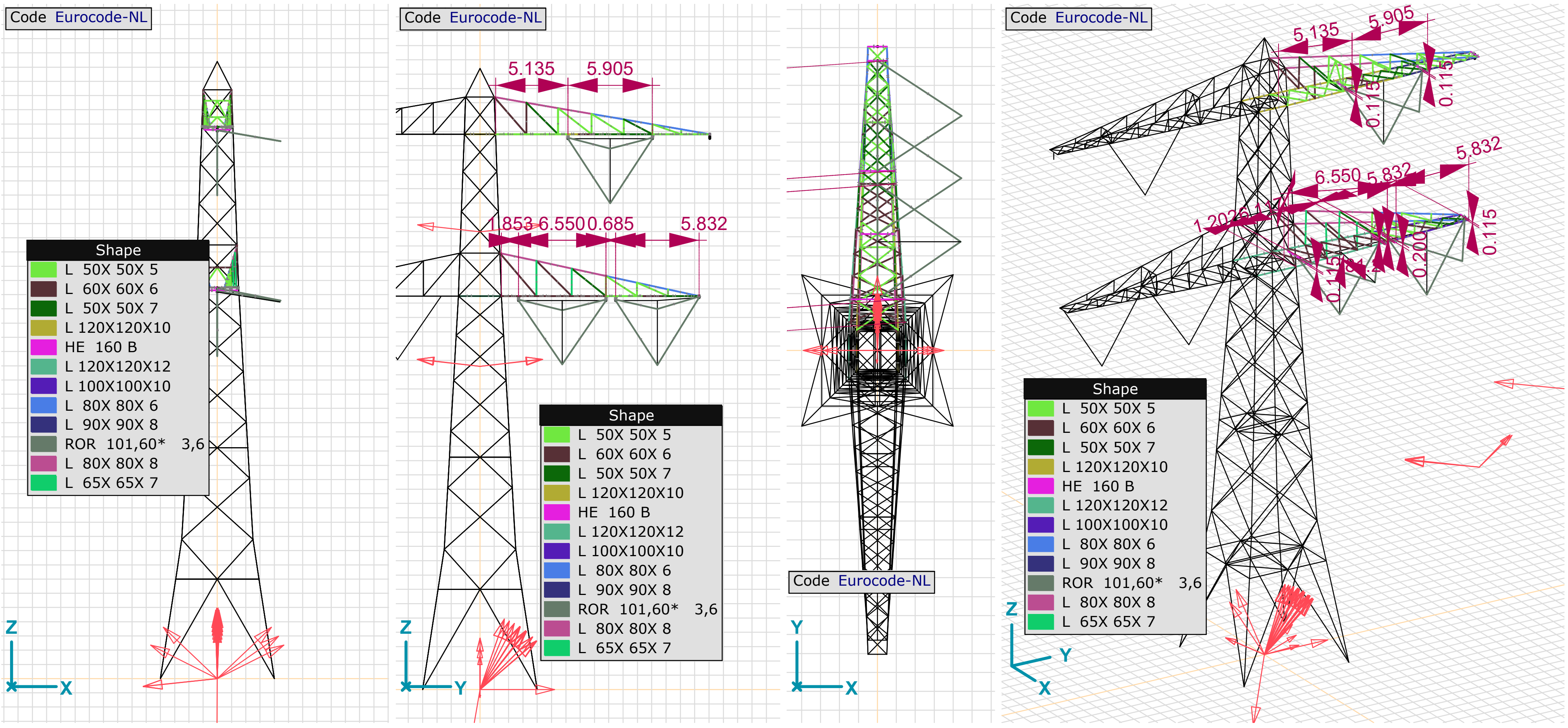
Project

Analysis by

AxisVM X5 R4h · Registered to DNV GL - Energy
S-6_v_ketting_1.axs

Report

Report, Table of contents



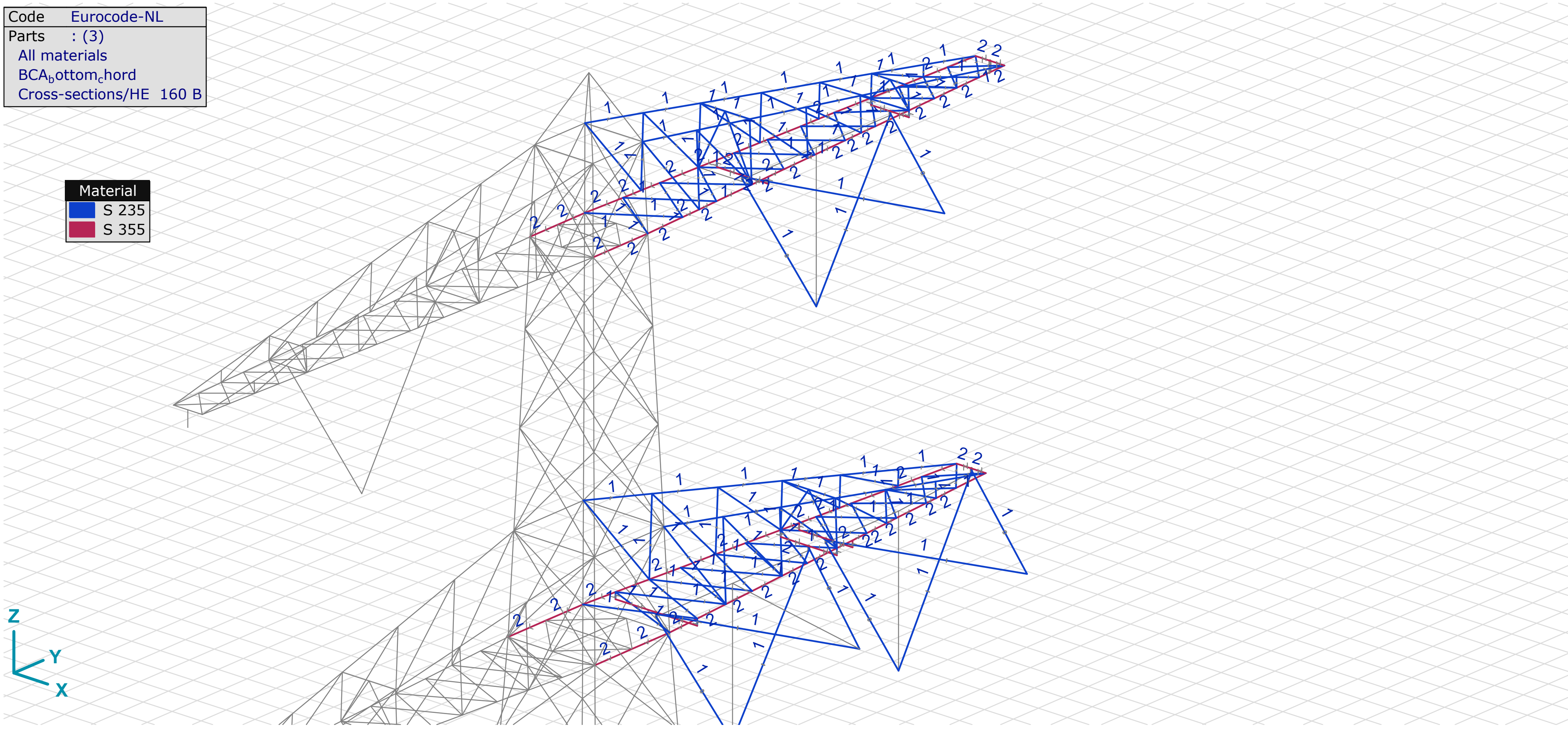
S-6 tower_views

Materials

	Name	Type	National design code	Material code	Model	E_x [N/mm²]	E_y [N/mm²]	ν	α_T [1/°C]	ρ [kg/m³]	Material color	Contour color	Texture
1	S 235	Steel	Eurocode-NL	SN EN 10025	NL elastic	210000	210000	0.30	1E-5	7850			Steel
2	S 355	Steel	Eurocode-NL	10025-2	NL elastic	210000	210000	0.30	1.2E-5	7850			Steel

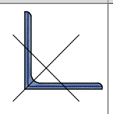
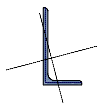
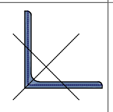
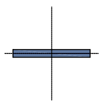
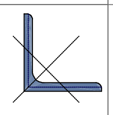
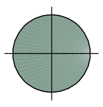
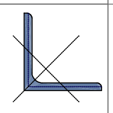
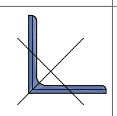
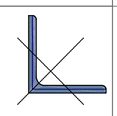
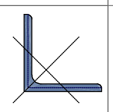
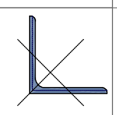
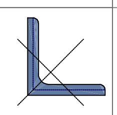
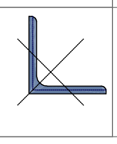
	Name	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}
1	S 235	f_y[N/mm²] = 235.00	f_u[N/mm²] = 360.00	f_y^*[N/mm²] = 215.00	f_u^*[N/mm²] = 340.00										
2	S 355	f_y[N/mm²] = 355.00	f_u[N/mm²] = 510.00	f_y^*[N/mm²] = 335.00	f_u^*[N/mm²] = 470.00										

Name: Material name; **Type:** Type of material; **Model:** Material model; **E_x:** Young's modulus of elasticity in local x direction; **E_y:** Young's modulus of elasticity in local y direction; **ν:** Poisson's ratio; **α_T:** Thermal expansion coefficient; **ρ:** Density; **Contour color:** Material outline color; **P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}, P_{11}, P_{12}, P_{13}, P_{14}:** Design parameter;



model_Material_details

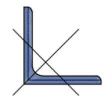
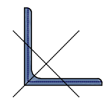
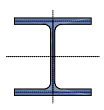
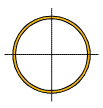
Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r_1 [mm]	r_2 [mm]	r_3 [mm]	Ax [mm^2]	Ay [mm^2]	Az [mm^2]
1	L 100X100X 8		Rolled	L	100.0	100.0	8.0	8.0	12.0	6.0	0	1551.52	669.67	678.46
2	L 100X 50X 6X		Rolled	L	100.0	50.0	6.0	6.0	9.0	4.5	0	872.73	231.48	516.47
3	L 120X120X10		Rolled	L	120.0	120.0	10.0	10.0	13.0	6.5	0	2318.22	1004.33	1014.85
4	80x8		Rolled	Rect.	8.0	80.0	0	0	0	0	0	640.00	533.33	533.33
5	L 55X 55X 6		Rolled	L	55.0	55.0	6.0	6.0	8.0	4.0	0	630.90	278.51	282.29
6	O 20		Other	Round	20.0	20.0	0	0	0	0	0	314.10	269.22	269.22
7	L 60X 60X 6		Rolled	L	60.0	60.0	6.0	6.0	8.0	4.0	0	690.90	302.80	306.64
8	L 80X 80X 8		Rolled	L	80.0	80.0	8.0	8.0	10.0	5.0	0	1226.78	537.99	544.05
9	L 120X120X12		Rolled	L	120.0	120.0	12.0	12.0	13.0	6.5	0	2754.22	1208.71	1219.23
10	L 100X100X10		Rolled	L	100.0	100.0	10.0	10.0	12.0	6.0	0	1915.52	840.25	849.06
11	L 80X 80X 6		Rolled	L	80.0	80.0	6.0	6.0	10.0	5.0	0	934.78	402.15	407.43
12	L 50X 50X 7		Rolled	L	50.0	50.0	7.0	7.0	7.0	3.5	0	656.28	298.47	301.38
13	L 50X 50X 5		Rolled	L	50.0	50.0	5.0	5.0	7.0	3.5	0	480.28	210.38	213.29

	Name	Ix [mm^4]	Iy [mm^4]	Iz [mm^4]	Iyz [mm^4]	I_1 [mm^4]	I_2 [mm^4]	α [°]	Iω [mm^6]	$W_{1,el,t}$ [mm^3]	$W_{1,el,b}$ [mm^3]	$W_{2,el,t}$ [mm^3]	$W_{2,el,b}$ [mm^3]
1	L 100X100X 8	36218.9	1448264.0	1448264.0	−849655.4	2297919.0	598608.2	45.00	2.3E+07	32497.5	32497.5	17014.9	15467.6
2	L 100X 50X 6X	11460.0	897072.9	152537.5	−207618.9	951054.9	98555.4	14.57	5624540	14496.4	21734.5	3281.0	5221.4
3	L 120X120X10	82759.6	3129113.0	3129113.0	−1840138.0	4969251.0	1288975.0	45.00	7.9E+07	58563.2	58563.2	30420.2	27507.4
4	80x8	12791.5	3413.3	341333.3	0	341333.3	3413.3	90.00	1736982	8533.3	8533.3	853.3	853.3
5	L 55X 55X 6	8324.3	172850.1	172850.2	−101063.0	273913.2	71787.1	45.00	1527235	7043.1	7043.1	3705.3	3247.9
6	O 20	15708.0	7850.8	7850.8	0	7850.8	7850.8	0	0	785.1	785.1	785.1	785.1
7	L 60X 60X 6	9044.2	227898.9	227898.9	−133497.7	361396.6	94401.2	45.00	2037188	8518.2	8518.2	4463.6	3956.0
8	L 80X 80X 8	28221.9	722397.8	722397.8	−423612.4	1146010.0	298785.4	45.00	1.2E+07	20258.8	20258.8	10570.7	9369.6
9	L 120X120X12	139579.2	3676399.0	3676399.0	−2160249.0	5836648.0	1516150.0	45.00	1.3E+08	68785.5	68785.5	35578.9	31565.4
10	L 100X100X10	68400.0	1766604.0	1766604.0	−1036581.0	2803186.0	730023.0	45.00	4.4E+07	39643.0	39643.0	20631.6	18290.5
11	L 80X 80X 6	12473.9	558166.2	558166.2	−326876.9	885043.1	231289.3	45.00	5085144	15645.5	15645.5	8233.3	7546.6
12	L 50X 50X 7	11417.9	146096.1	146096.2	−84979.3	231075.5	61116.8	45.00	1717204	6535.8	6535.8	3423.8	2909.6
13	L 50X 50X 5	4408.9	109629.1	109629.1	−64162.8	173791.9	45466.3	45.00	678722	4915.6	4915.6	2584.4	2290.7

	Name	$W_{1,pl}$ [mm^3]	$W_{2,pl}$ [mm^3]	i_y [mm]	i_z [mm]	Hy [mm]	Hz [mm]	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
1	L 100X100X 8	51224.3	26412.7	30.6	30.6	100.0	100.0	27.4	27.4	−22.6	−22.6	4
2	L 100X 50X 6X	25285.3	7359.8	32.1	13.2	50.0	100.0	10.4	34.9	−7.3	−30.2	4
3	L 120X120X10	92246.3	47331.9	36.7	36.7	120.0	120.0	33.1	33.1	−27.3	−27.3	4
4	80x8	12800.0	1280.0	2.3	23.1	80.0	8.0	40.0	4.0	0	0	5
5	L 55X 55X 6	11266.6	5820.9	16.6	16.6	55.0	55.0	15.6	15.6	−12.0	−12.0	4
6	O 20	1332.9	1332.9	5.0	5.0	20.0	20.0	10.0	10.0	0	0	5
7	L 60X 60X 6	13554.5	6989.1	18.2	18.2	60.0	60.0	16.9	16.9	−13.3	−13.3	4
8	L 80X 80X 8	32196.1	16562.3	24.3	24.3	80.0	80.0	22.5	22.5	−17.8	−17.8	4
9	L 120X120X12	109074.8	55859.7	36.5	36.5	120.0	120.0	34.0	34.0	−27.0	−27.0	4
10	L 100X100X10	62957.8	32342.2	30.4	30.4	100.0	100.0	28.2	28.2	−22.3	−22.3	4
11	L 80X 80X 6	24644.0	12753.5	24.4	24.4	80.0	80.0	21.7	21.7	−18.1	−18.1	4
12	L 50X 50X 7	10576.2	5453.1	14.9	14.9	50.0	50.0	14.9	14.9	−10.6	−10.6	4
13	L 50X 50X 5	7830.3	4045.4	15.1	15.1	50.0	50.0	14.0	14.0	−11.0	−11.0	4

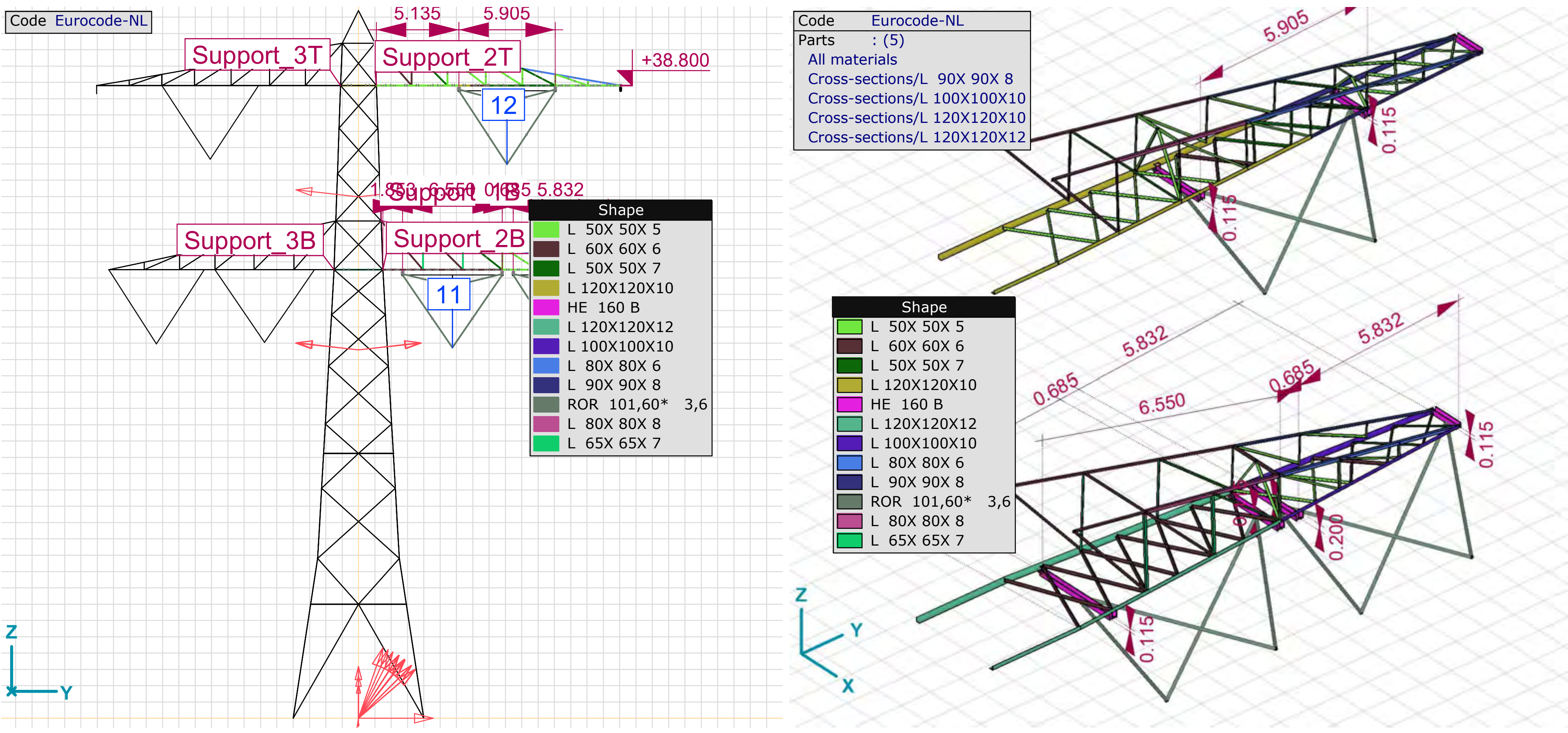
Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r_1 [mm]	r_2 [mm]	r_3 [mm]	Ax [mm^2]	Ay [mm^2]	Az [mm^2]
14	L 65X 65X 7		Rolled	L	65.0	65.0	7.0	7.0	9.0	4.5	0	869.73	383.63	388.46
15	L 90X 90X 8		Rolled	L	90.0	90.0	8.0	8.0	11.0	5.5	0	1389.04	603.70	611.07
16	HE 160 B		Rolled	I	160.0	160.0	8.0	13.0	15.0	0	0	5426.04	3754.44	1237.48
17	ROR 101,60* 3,6		Rolled	Pipe	101.6	101.6	3.6	3.6	0	0	0	1106.95	554.66	554.72

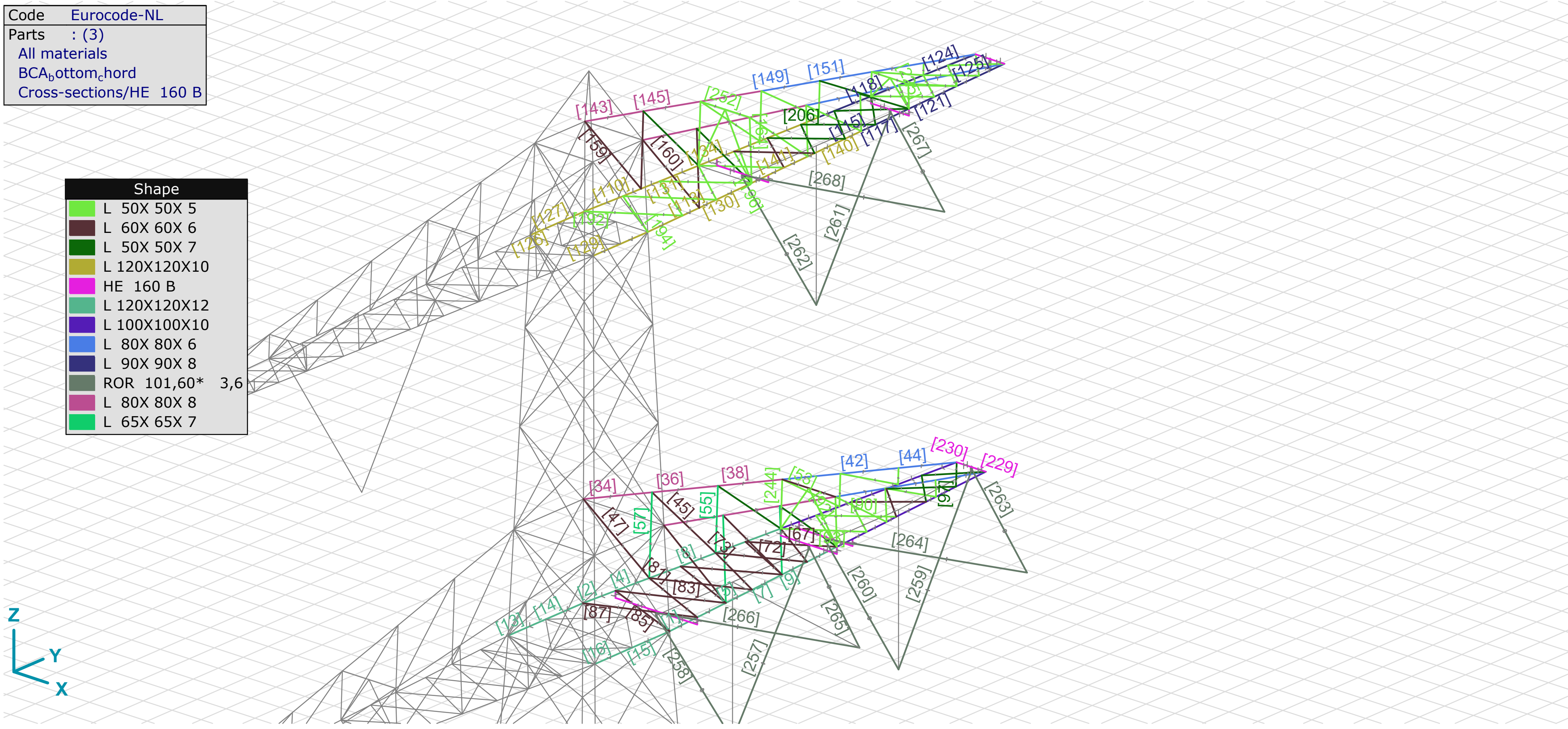
	Name	Ix [mm^4]	Iy [mm^4]	Iz [mm^4]	Iyz [mm^4]	I_1 [mm^4]	I_2 [mm^4]	α [°]	Iω [mm^6]	$W_{1,el,t}$ [mm^3]	$W_{1,el,b}$ [mm^3]	$W_{2,el,t}$ [mm^3]	$W_{2,el,b}$ [mm^3]
14	L 65X 65X 7	15488.8	334281.2	334281.2	−195612.7	529893.8	138668.5	45.00	4036559	11529.0	11529.0	6046.7	5310.0
15	L 90X 90X 8	32189.4	1043715.0	1043715.0	−612406.8	1656122.0	431308.0	45.00	1.7E+07	26023.4	26023.4	13599.0	12217.6
16	HE 160 B	317826.3	2.5E+07	8892444.0	0	2.5E+07	8892443.0	0	4.7E+10	311542.7	311542.7	111155.5	111155.5
17	ROR 101,60* 3,6	2663810.0	1328996.0	1328996.0	0	1328996.0	1328996.0	0	0	26161.3	26161.3	26161.3	26161.3

	Name	$W_{1,pl}$ [mm^3]	$W_{2,pl}$ [mm^3]	i_y [mm]	i_z [mm]	Hy [mm]	Hz [mm]	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
14	L 65X 65X 7	18413.0	9497.5	19.6	19.6	65.0	65.0	18.5	18.5	−14.2	−14.2	4
15	L 90X 90X 8	41166.2	21197.0	27.4	27.4	90.0	90.0	25.0	25.0	−20.2	−20.2	4
16	HE 160 B	354020.6	169972.2	67.8	40.5	160.0	160.0	80.0	80.0	0	0	9
17	ROR 101,60* 3,6	34524.1	34524.1	34.6	34.6	101.6	101.6	50.8	50.8	0	0	5

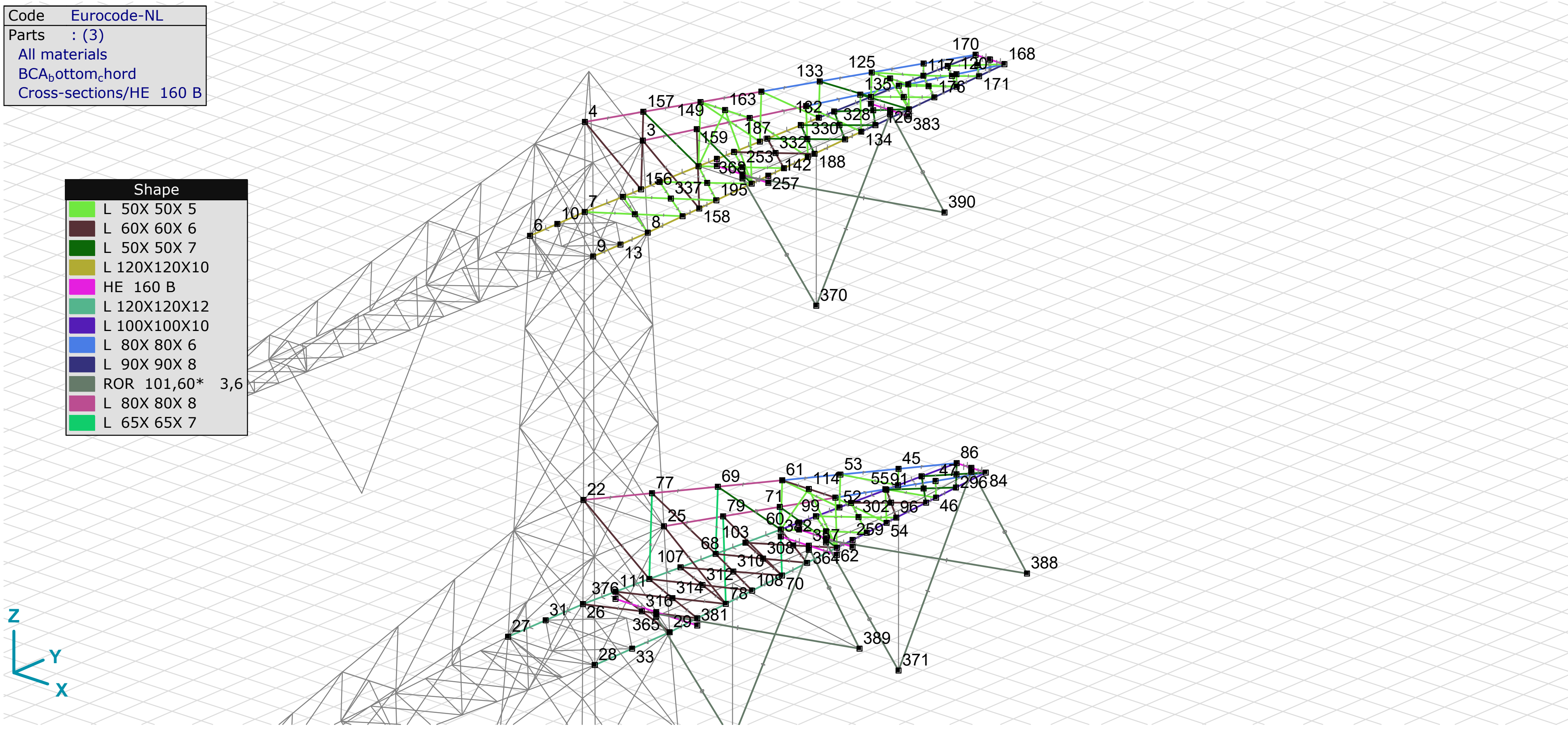
Name: Cross-section name; **Process:** Manufacturing process; **h:** Cross-section height; **b:** Cross-section width; **tw:** Web thickness; **tf:** Flange thickness; r_1, r_2, r_3: Rounding radius; **Ax:** Cross-section area; **Ay, Az:** Shear area; **Ix:** Torsional inertia; **Iy, Iz:** Flexural inertia; **Iyz:** Centrifugal inertia; I_1, I_2: Principal flexural inertia; **α:** Principal directions; **Iω:** Warping constant; $W_{1,el,t}$, $W_{1,el,b}$, $W_{2,el,t}$, $W_{2,el,b}$: Elastic modulus; $W_{1,pl}$, $W_{2,pl}$: Plastic modulus; i_y, i_z: Radius of inertia; **Hy:** Dimension in local y direction; **Hz:** Dimension in local z direction; y_G: y coordinate of the center of gravity; z_G: z coordinate of the center of gravity; y_s: y coordinate of the shear (torsion) center relative to the center of gravity; z_s: z coordinate of the shear (torsion) center relative to the center of gravity; **S.p.:** Stress calculation points;



cross_arm_details



model_beam_ID

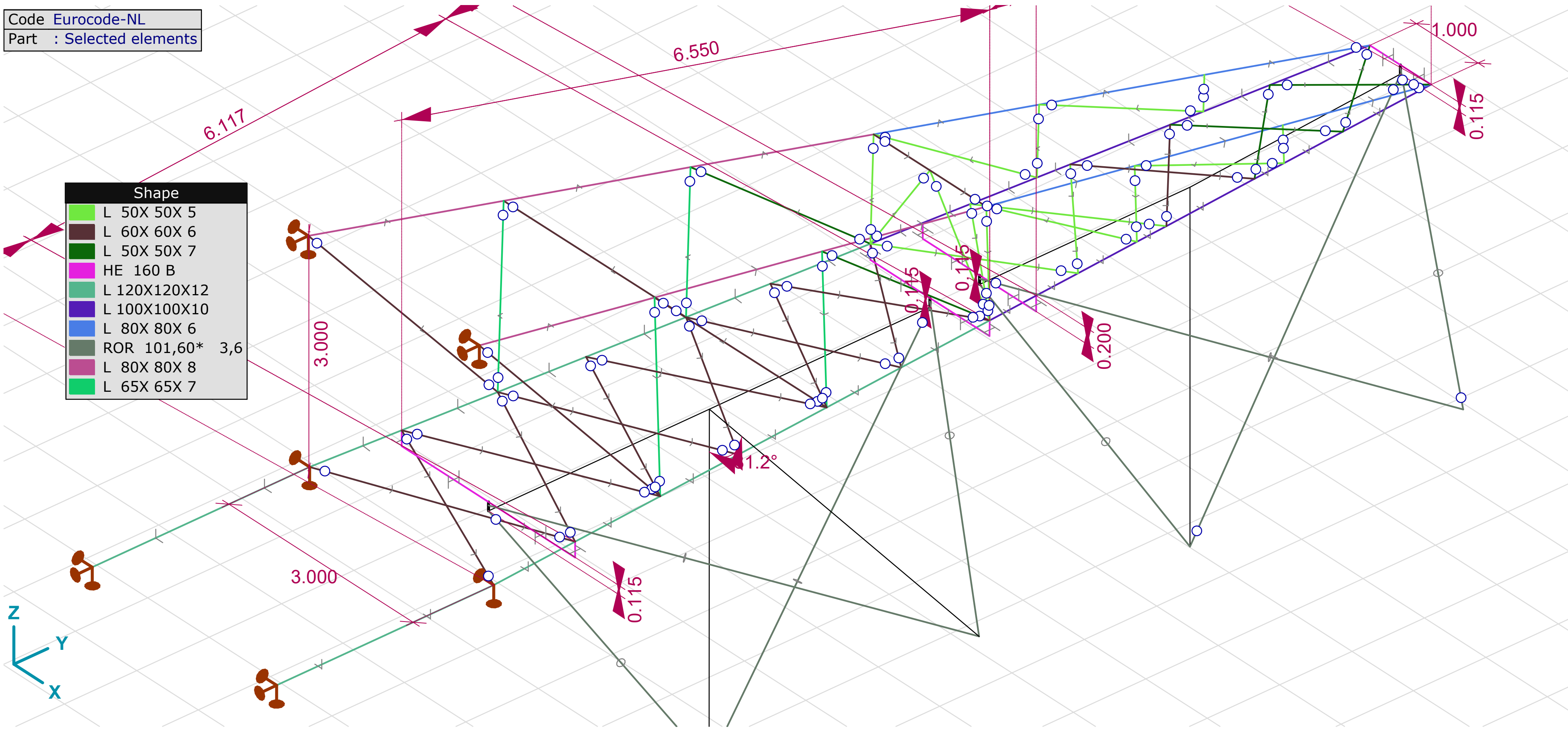


model_nodes

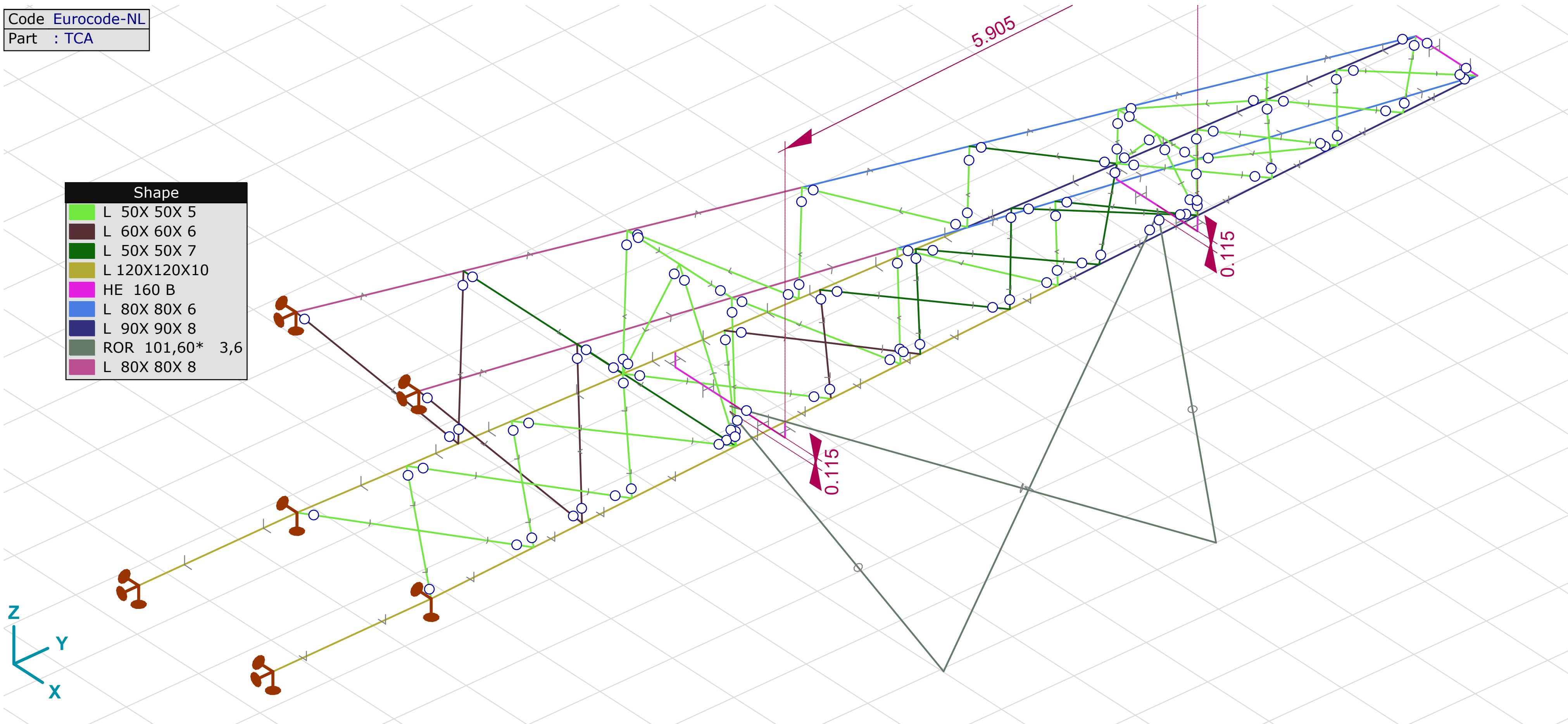
Spring characteristics

	Name	*Type*	*Degree of freedom*	*Model*	*K*	K_V
1	Soft - Translational	N-N	Translational	Linear	1E+0 kN/m	1E+0 kN/m
2	Rigid - Translational	N-N	Translational	Linear	1E+10 kN/m	1E+10 kN/m
3	Soft - Rotational	N-N	Rotational	Linear	1E+0 kNm/rad	1E+0 kNm/rad
4	Rigid - Rotational	N-N	Rotational	Linear	1E+10 kNm/rad	1E+10 kNm/rad

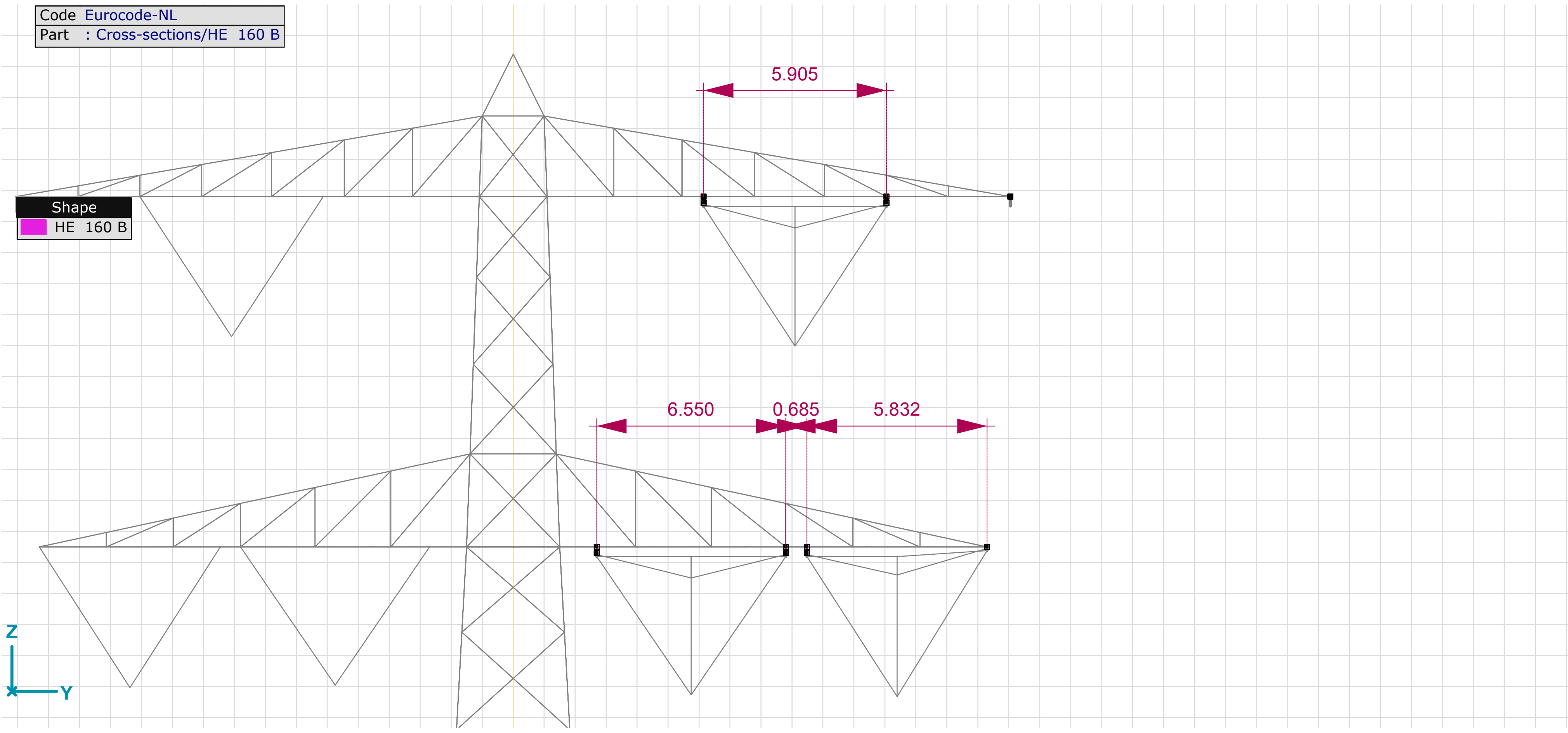
Name: Name of the spring characteristics; **Model:** Material model; **K:** Initial stiffness; **K_V:** Vibration stiffness;



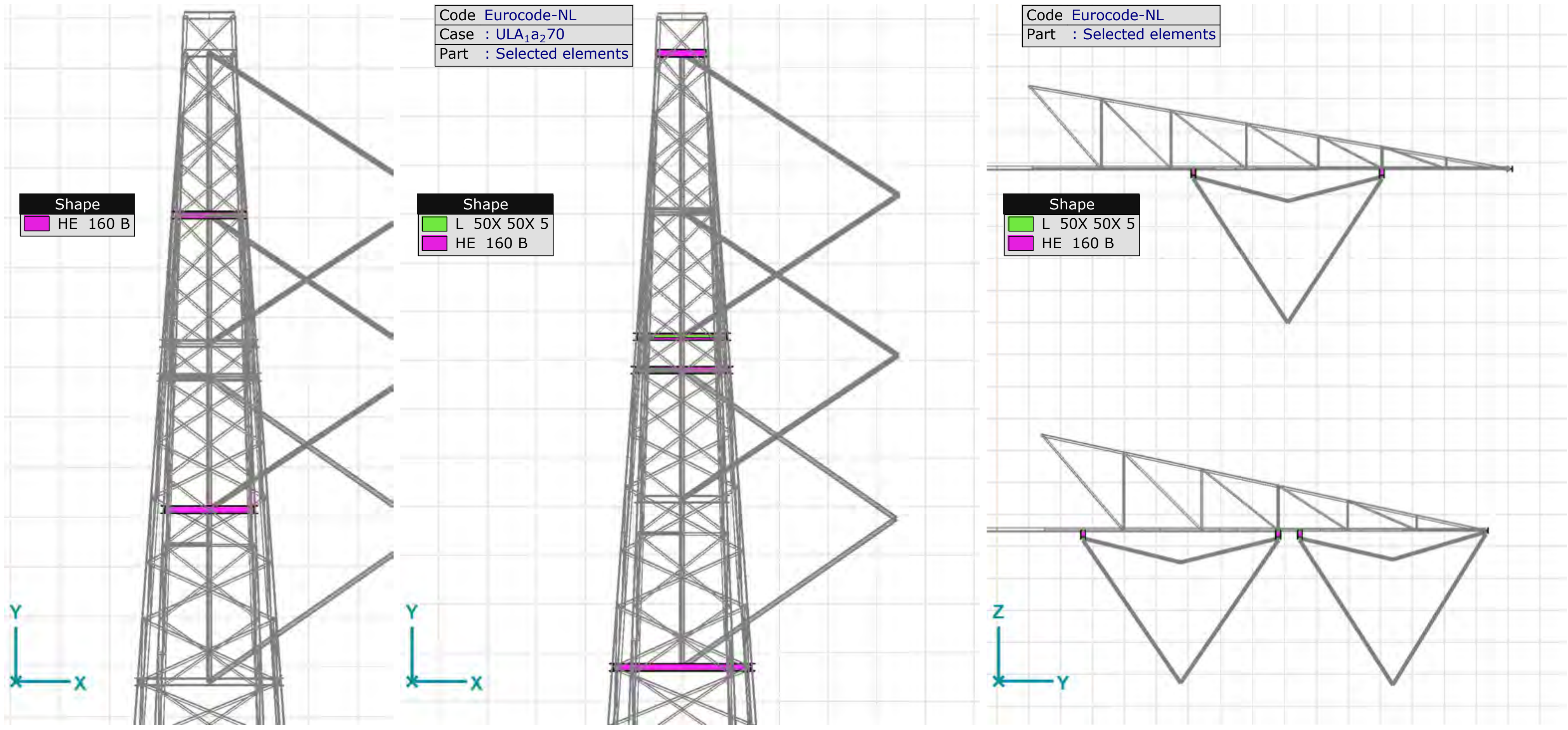
BCA_geometry_details



TCA_geometry_details



Location of added H beams housing insulators



Top and side view added members

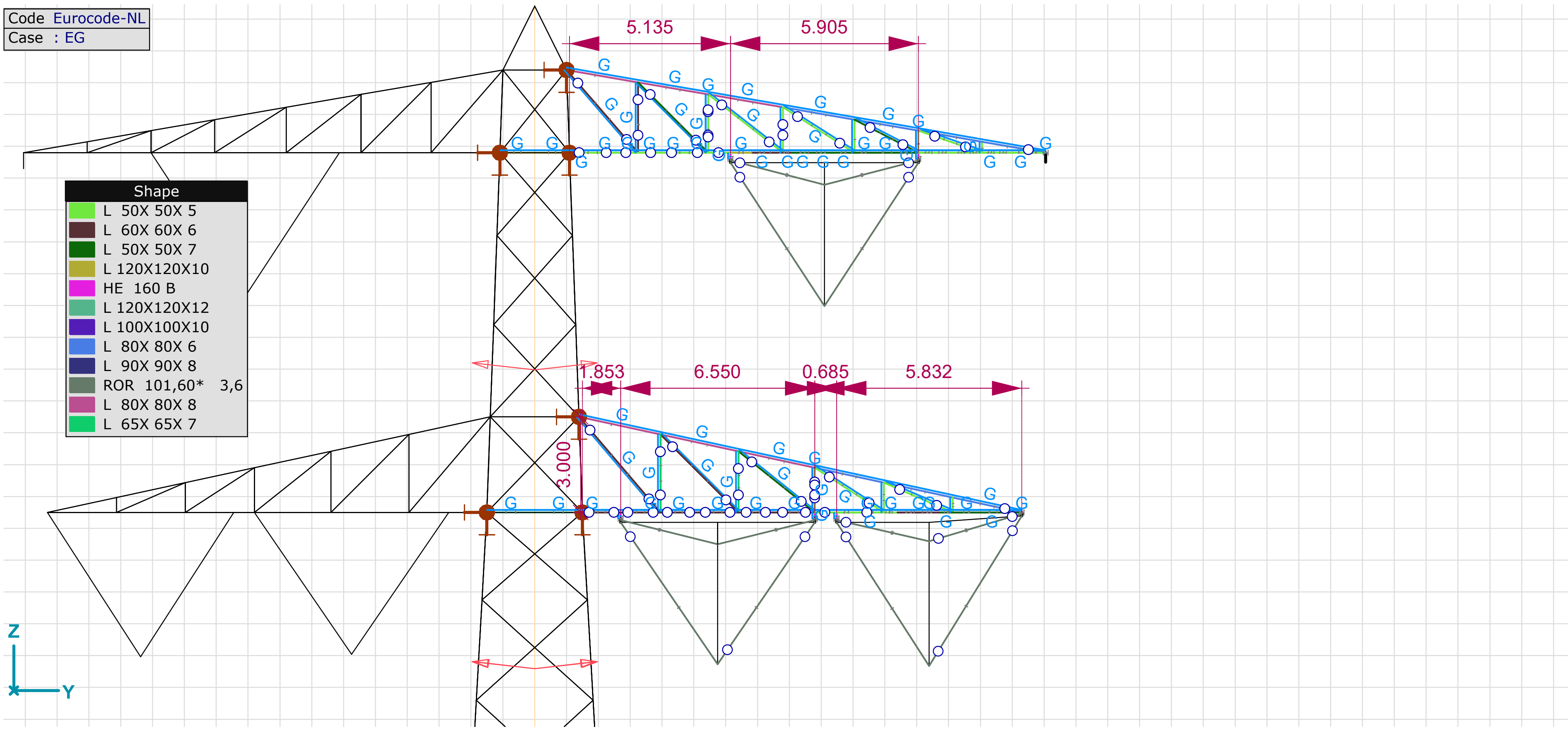
Nodal supports

	Node	X [m]	Y [m]	Z [m]
1	22	−1.392	1.392	30.500
2	25	1.392	1.392	30.500
3	3	1.000	1.000	41.400
4	4	−1.000	1.000	41.400
5	26	−1.500	1.500	27.500
6	29	1.500	1.500	27.500
7	7	−1.093	1.093	38.800
8	8	1.093	1.093	38.800
9	6	−1.093	−1.094	38.800
10	9	1.093	−1.094	38.800
11	27	−1.500	−1.500	27.500
12	28	1.500	−1.500	27.500

	Node	Type	$Name_x$	K_x [kN/m]	K_{xV} [kN/m]	$Name_y$	K_y [kN/m]	K_{yV} [kN/m]	$Name_z$	K_z [kN/m]	K_{zV} [kN/m]	$Name_{xx}$	K_{xx} [kNm/rad]	K_{xxV} [kNm/rad]
1	22	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
2	25	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
3	3	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
4	4	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
5	26	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
6	29	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
7	7	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
8	8	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
9	6	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
10	9	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
11	27	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
12	28	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–

	Node	$Name_{yy}$	K_{yy} [kNm/rad]	K_{yyV} [kNm/rad]	$Name_{zz}$	K_{zz} [kNm/rad]	K_{zzV} [kNm/rad]
1	22	—	–	–	—	–	–
2	25	—	–	–	—	–	–
3	3	—	–	–	—	–	–
4	4	—	–	–	—	–	–
5	26	—	–	–	—	–	–
6	29	—	–	–	—	–	–
7	7	—	–	–	—	–	–
8	8	—	–	–	—	–	–
9	6	—	–	–	—	–	–
10	9	—	–	–	—	–	–
11	27	—	–	–	—	–	–
12	28	—	–	–	—	–	–

Node: Supported node; **Type:** Support type; **$Name_x$:** Name of the spring characteristics; **K_x:** Initial stiffness; **K_{xV}:** Vibration stiffness; **$Name_y$:** Name of the spring characteristics; **K_y:** Initial stiffness; **K_{yV}:** Vibration stiffness; **$Name_z$:** Name of the spring characteristics; **K_z:** Initial stiffness; **K_{zV}:** Vibration stiffness; **$Name_{xx}$:** Name of the spring characteristics; **K_{xx}:** Initial stiffness; **K_{xxV}:** Vibration stiffness; **$Name_{yy}$:** Name of the spring characteristics; **K_{yy}:** Initial stiffness; **K_{yyV}:** Vibration stiffness; **$Name_{zz}$:** Name of the spring characteristics; **K_{zz}:** Initial stiffness; **K_{zzV}:** Vibration stiffness;

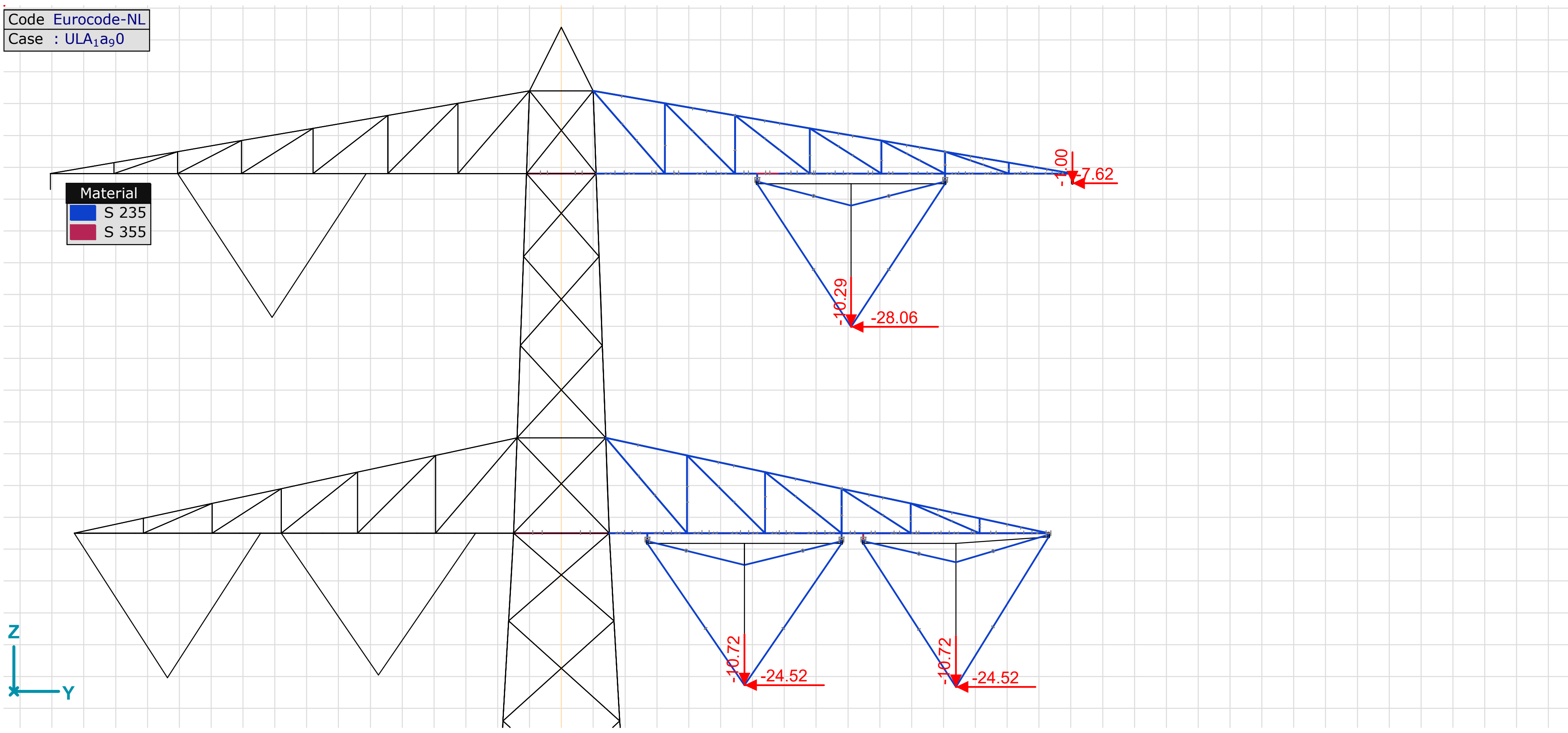


Load_self_weight

ULA_1a_90: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	−24.52	−10.72	0	0	0
264	Global	0	−7.62	−1.00	0	0	0
370	Global	0	−28.06	−10.29	0	0	0
371	Global	0	−24.52	−10.72	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

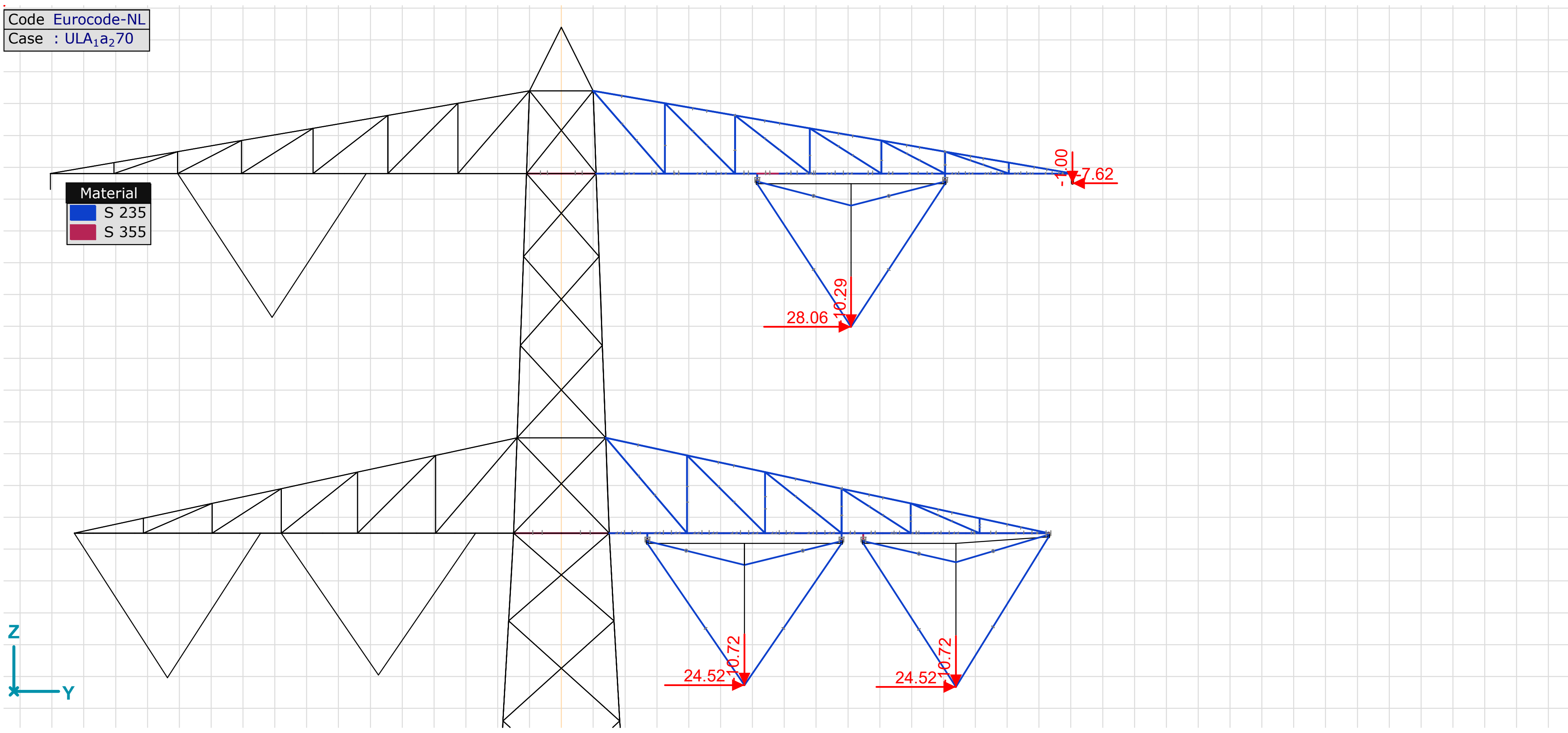


ULA_1a_90, Side view

ULA_1a_270: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	24.52	−10.72	0	0	0
264	Global	0	−7.62	−1.00	0	0	0
370	Global	0	28.06	−10.29	0	0	0
371	Global	0	24.52	−10.72	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

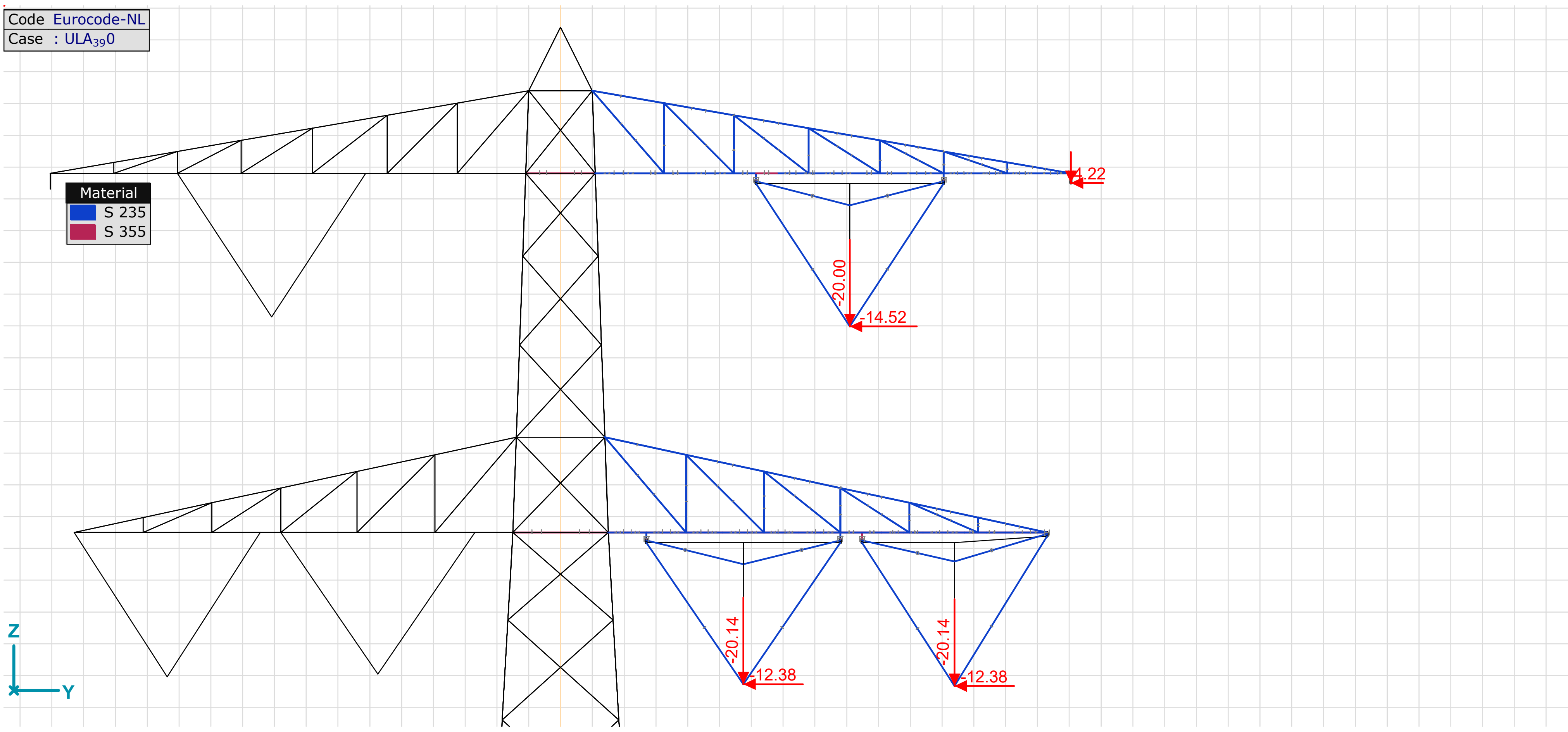


ULA_1a_270, Side view

ULA_3_90: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	−12.38	−20.14	0	0	0
264	Global	0	−4.22	−3.95	0	0	0
370	Global	0	−14.52	−20.00	0	0	0
371	Global	0	−12.38	−20.14	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

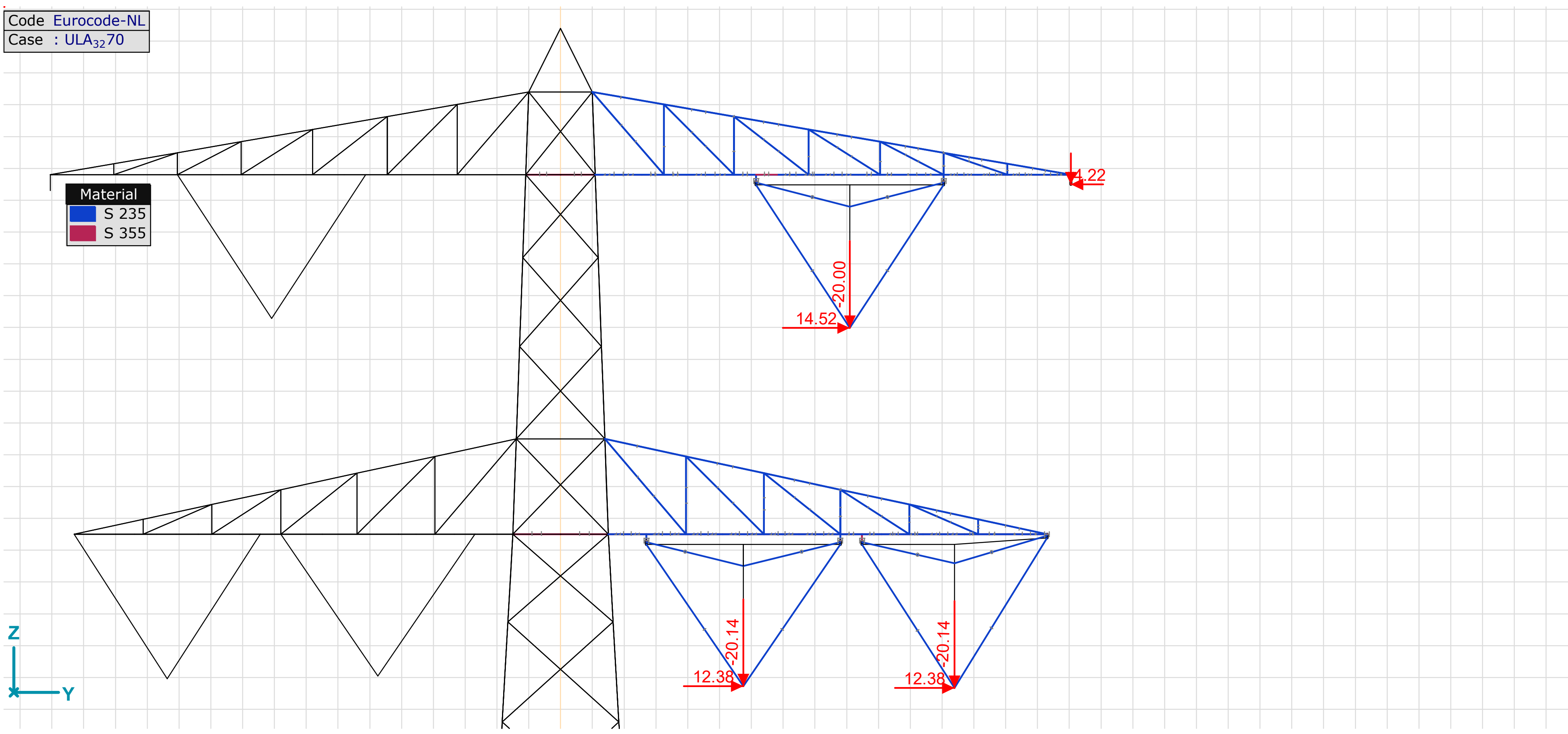


ULA_3_90, Side view

ULA_3_270: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	12.38	−20.14	0	0	0
264	Global	0	−4.22	−3.95	0	0	0
370	Global	0	14.52	−20.00	0	0	0
371	Global	0	12.38	−20.14	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

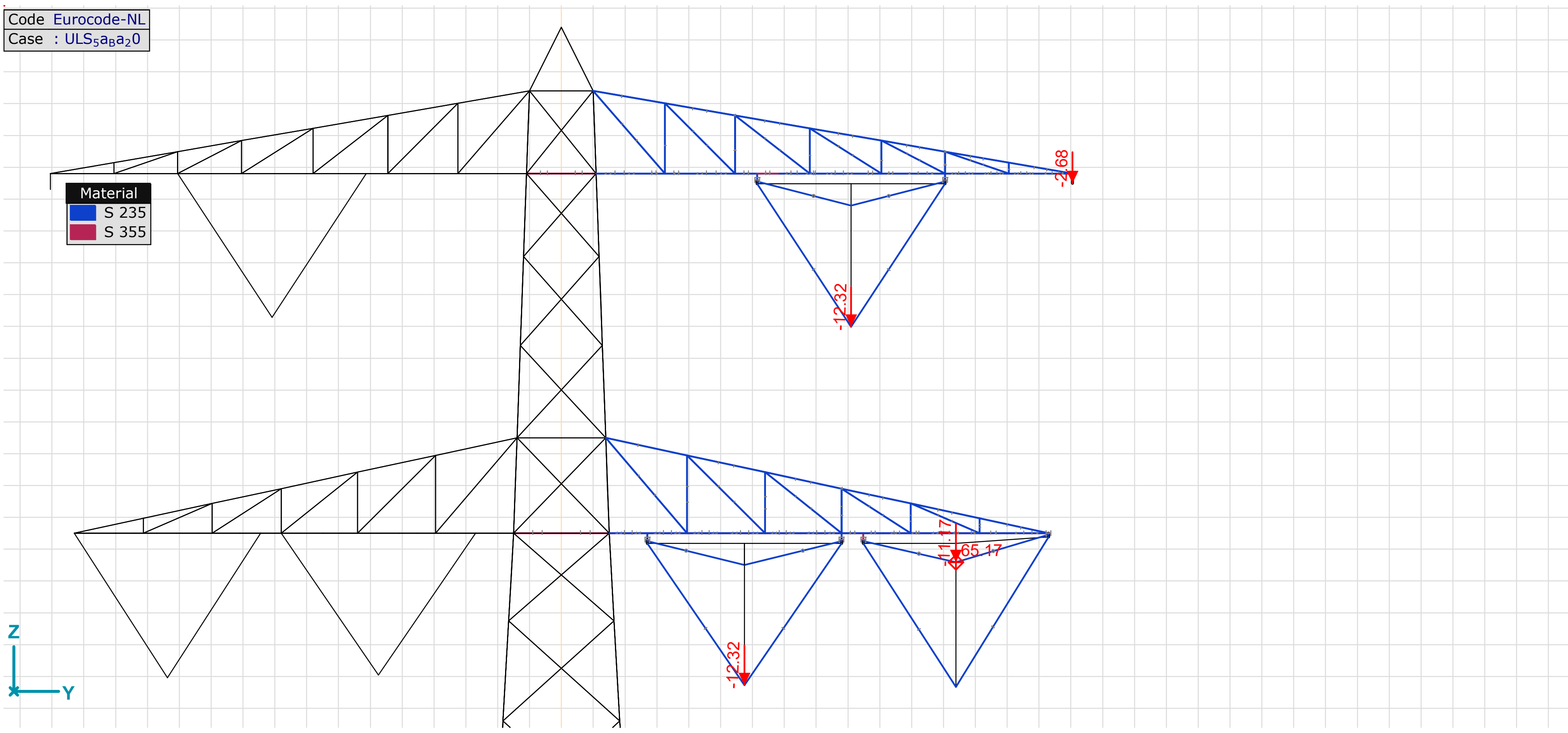


ULA_3_270, Side view

ULS_5a_Ba_20: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	0	−12.32	0	0	0
264	Global	0	0	−2.68	0	0	0
370	Global	0	0	−12.32	0	0	0
388	Global	65.17	0	−11.17	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

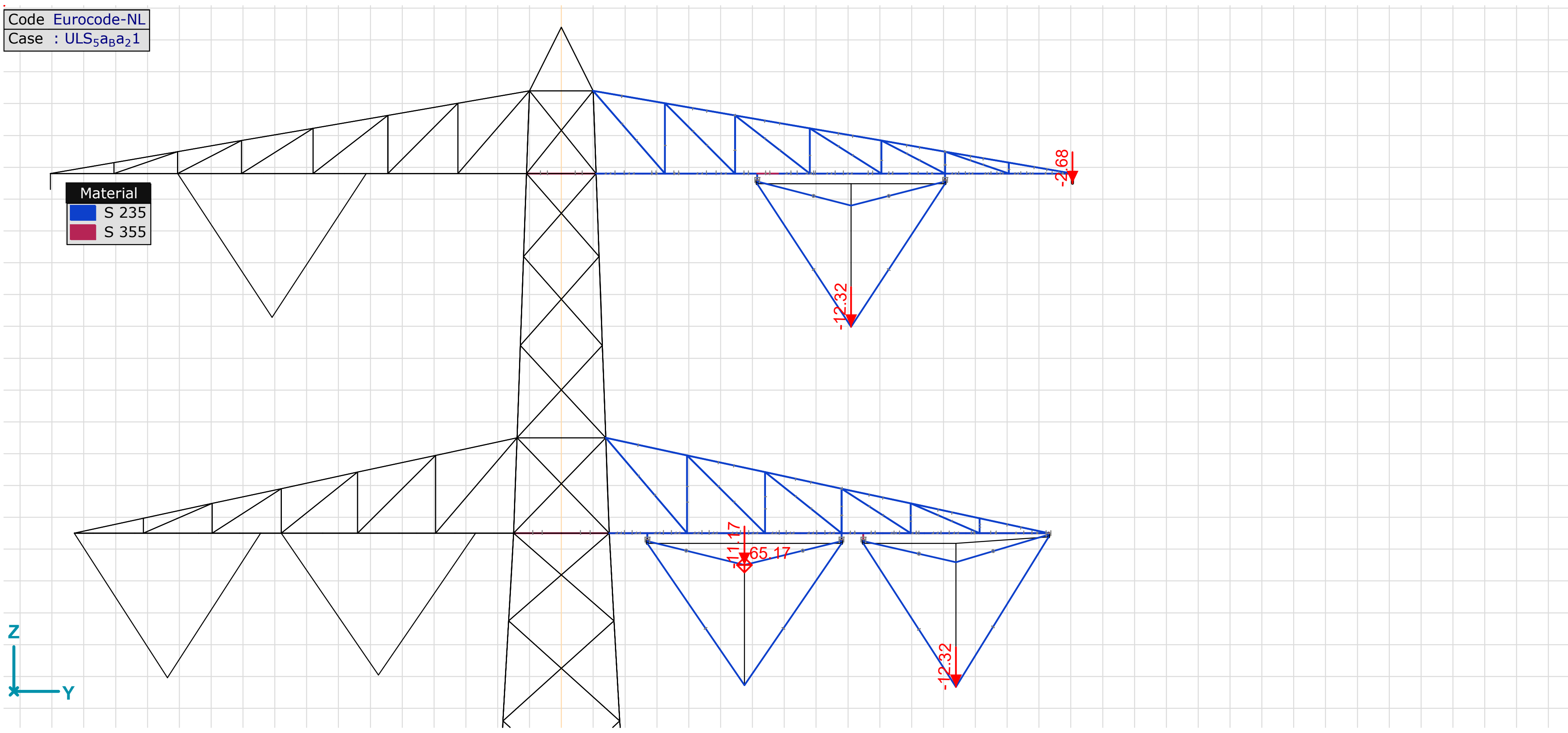


ULS_5a_Ba_20, Side view

ULS_5a_Ba_21: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
264	Global	0	0	−2.68	0	0	0
370	Global	0	0	−12.32	0	0	0
371	Global	0	0	−12.32	0	0	0
389	Global	65.17	0	−11.17	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

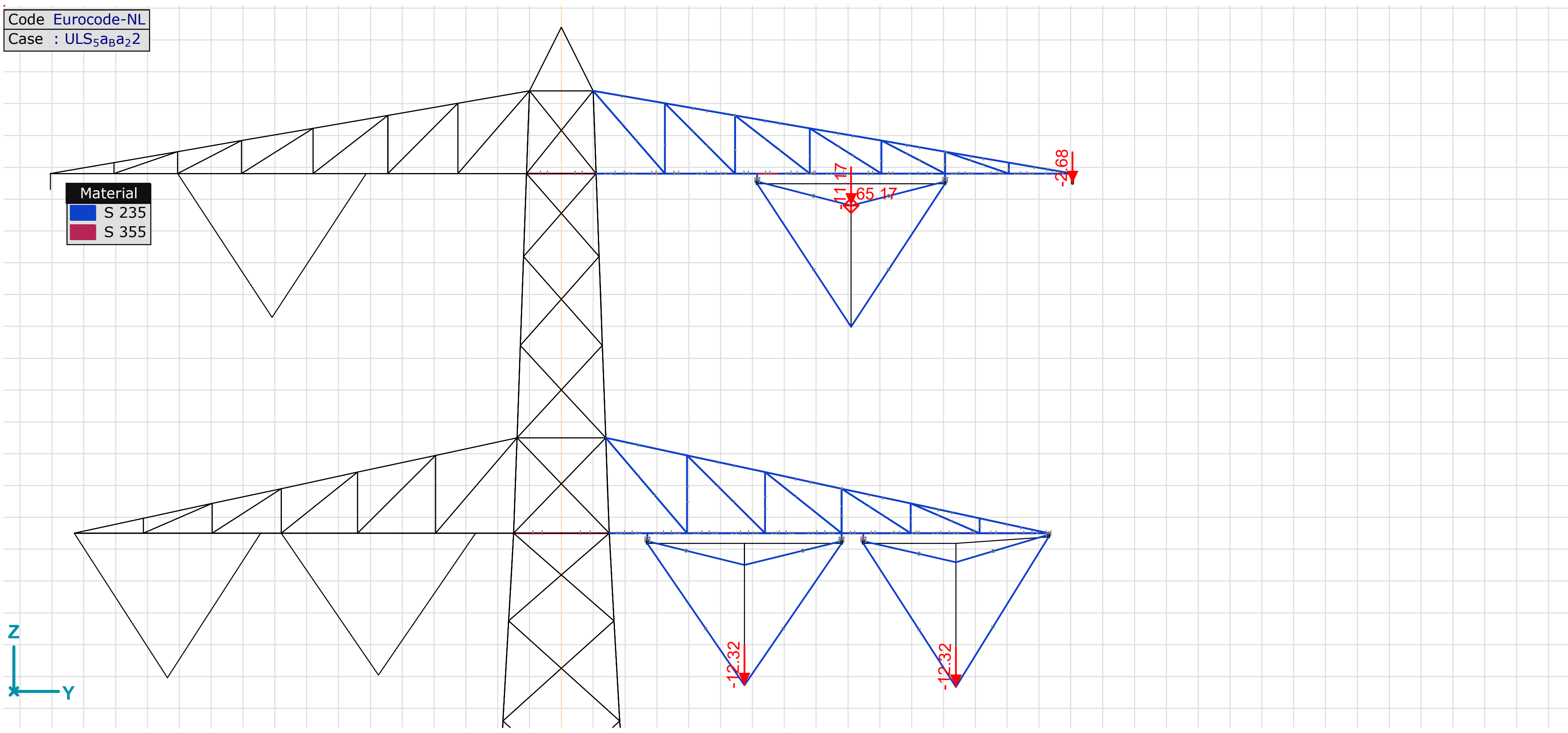


ULS_5a_Ba_21, Side view

ULS_5a_Ba_22: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	0	−12.32	0	0	0
264	Global	0	0	−2.68	0	0	0
371	Global	0	0	−12.32	0	0	0
390	Global	65.17	0	−11.17	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

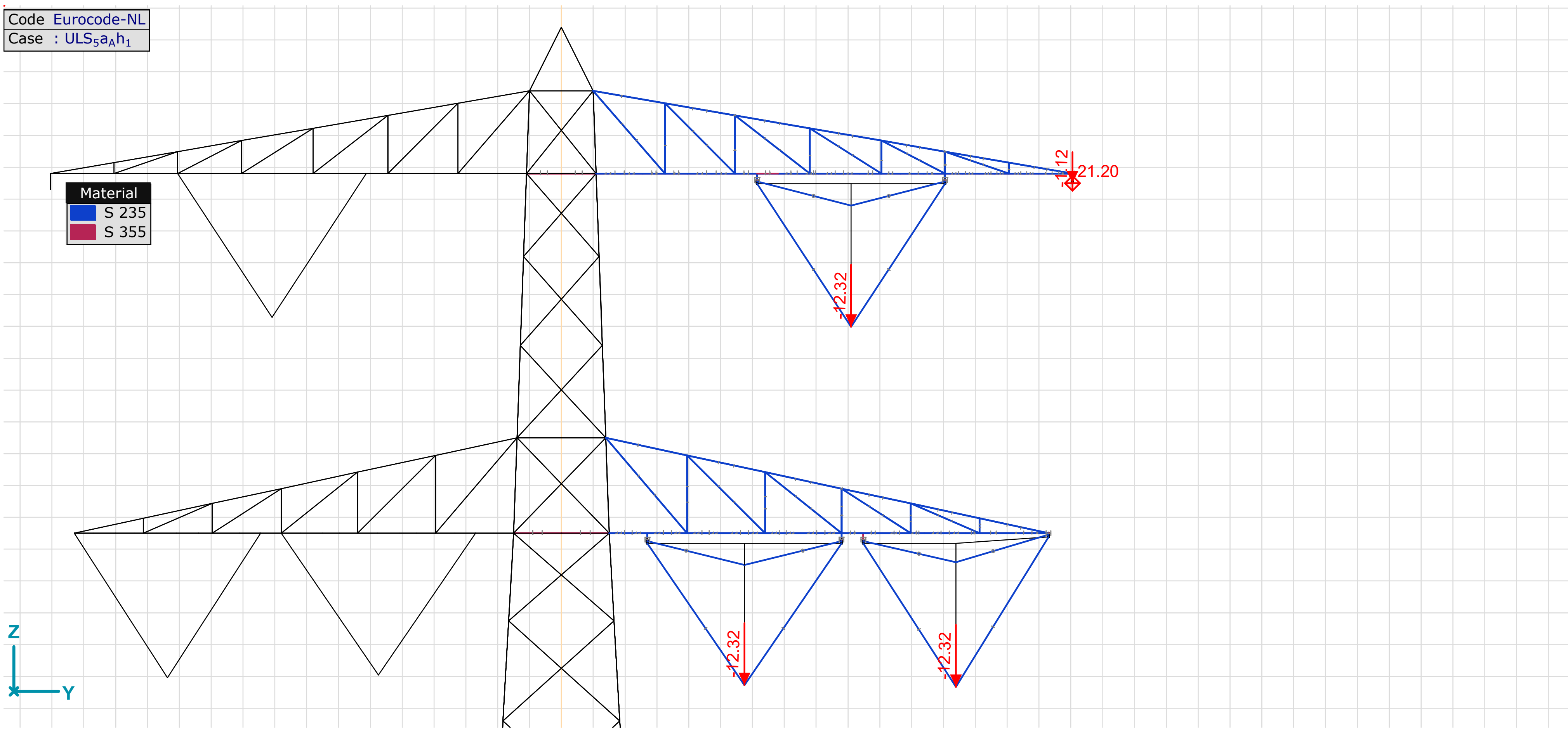


ULS_5a_Ba_22, Side view

ULS_5a_Ah_1: Nodal loads

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
251	Global	0	0	−12.32	0	0	0
264	Global	21.20	0	−1.12	0	0	0
370	Global	0	0	−12.32	0	0	0
371	Global	0	0	−12.32	0	0	0

Fx, Fy, Fz: Load force component; **Mx, My, Mz:** Load moment component;

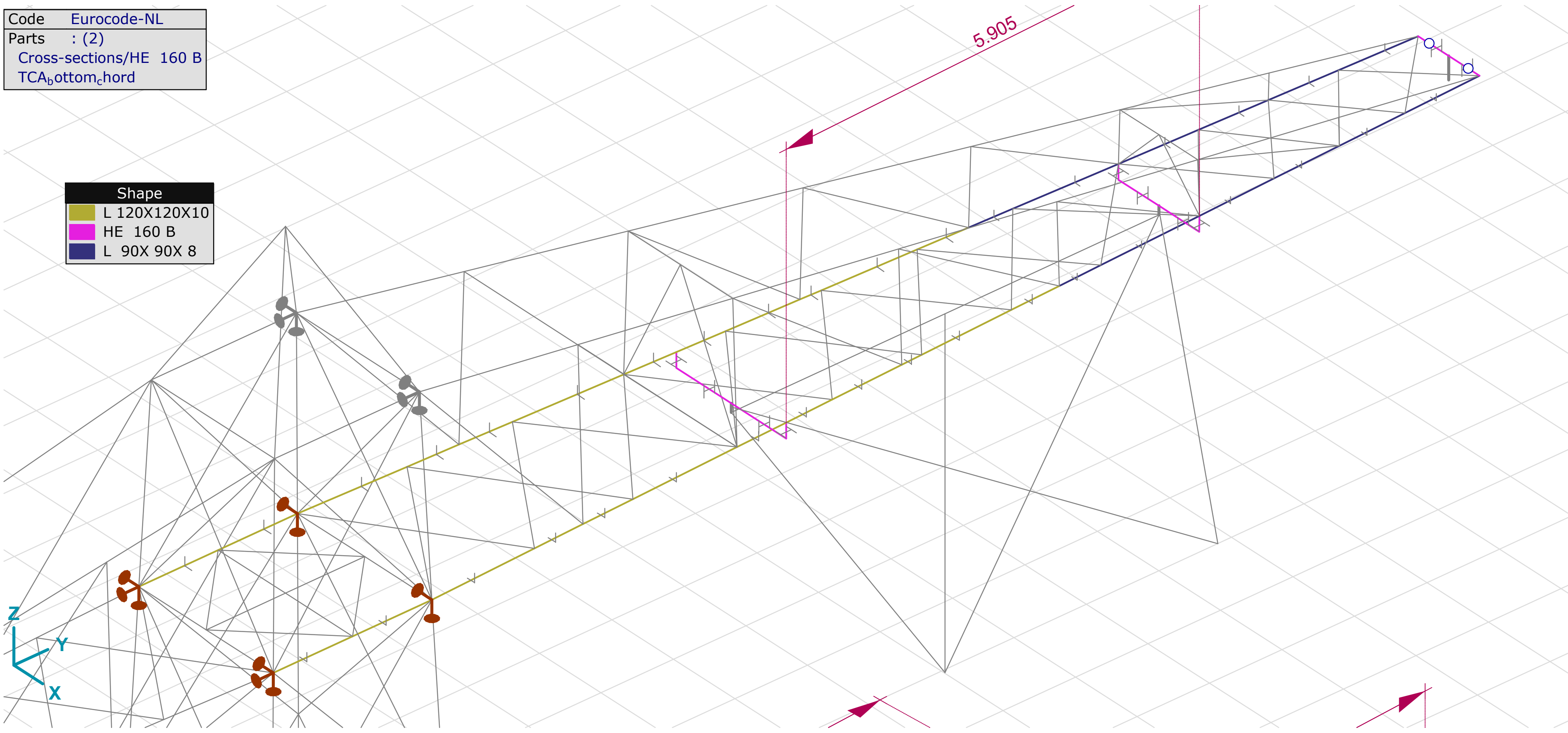


ULS_5a_Ah_1, Side view

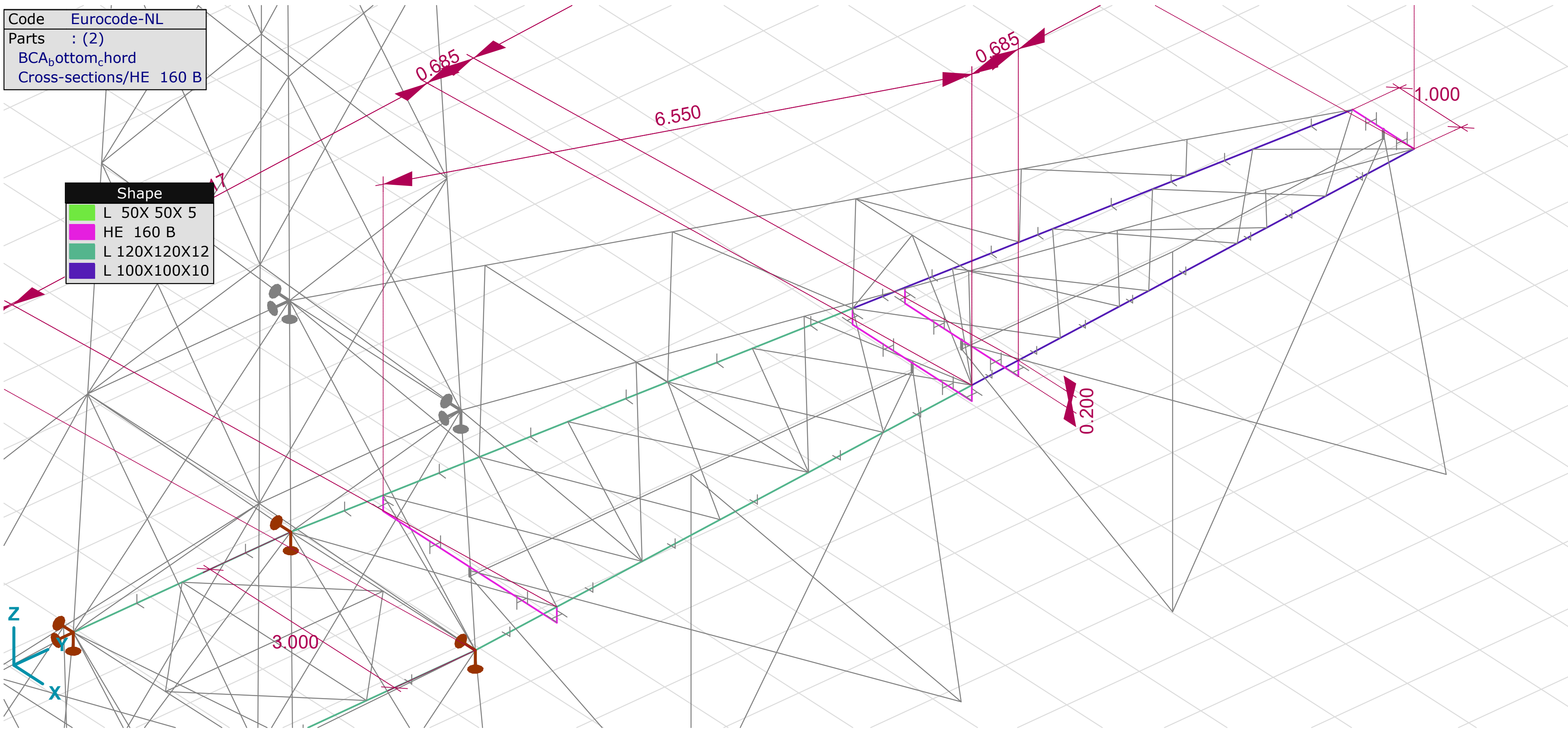
Custom load combinations by load cases

	Name	Type	EG	ULA_1a_90	ULA_1a_270	ULA_3_90	ULA_3_270	ULS_5a_Ba_20	ULS_5a_Ba_21	ULS_5a_Ba_22	ULS_5a_Ah_1	Comment
1	Co #1	ULS	1.00	1.00	0	0	0	0	0	0	0	
2	Co #2	ULS	1.00	0	0	1.00	0	0	0	0	0	
3	Co #3	ULS	1.00	0	0	0	0	1.00	0	0	0	
4	Co #4	ULS	1.00	0	0	0	0	0	1.00	0	0	
5	Co #5	ULS	1.00	0	0	0	0	0	0	1.00	0	
6	Co #6	ULS	1.00	0	0	0	0	0	0	0	1.00	
7	Co #1a	ULS	1.00	0	1.00	0	0	0	0	0	0	
8	Co #2a	ULS	1.00	0	0	0	1.00	0	0	0	0	

Name: Load combination name; **Type:** Load combination type; **EG, ULA$_1$a$_9$0, ULA$_1$a$_2$70, ULA$_{39}$0, ULA$_{32}$70, ULS$_5$a$_B$a$_2$0, ULS$_5$a$_B$a$_2$1, ULS$_5$a$_B$a$_2$2, ULS$_5$a$_A$h$_1$:** Factor;



TCA_bottom_chord_and_HEB_160_beams



BCA_bottom_chord_and_HEB_160_beams

APPENDIX G
Berekening klimladder

LADDER STRUCTURE S-6 MAST 28

Contents

1 INTRODUCTION

The following report contains structural calculations for the ladder in tower 28. The report also studies the platforms at the cross arms and plan brace at the third crossing of the tower diagonals. These additional built structures are required to access the tower for maintenance purposes. Tower 28 is of the type S-6. The tower provides the access to the crossarms from the third crossing diagonal.

Figure 1 shows the ladder embedded in the tower body. The ladder is supported on the existing members of the tower. The ladder is supported laterally at crossing of the tower diagonals by a new element between the horizontals in the tower body at that location. The ladder system is checked for wind loading as well as the live loading as per Eurocodes and TenneT recommendations. The efficacy of the structural system supporting the ladder is checked by comparing the stress developed in the model using a non-linear calculation with the allowable stress. Axis VM report is attached behind this report within appendix G.

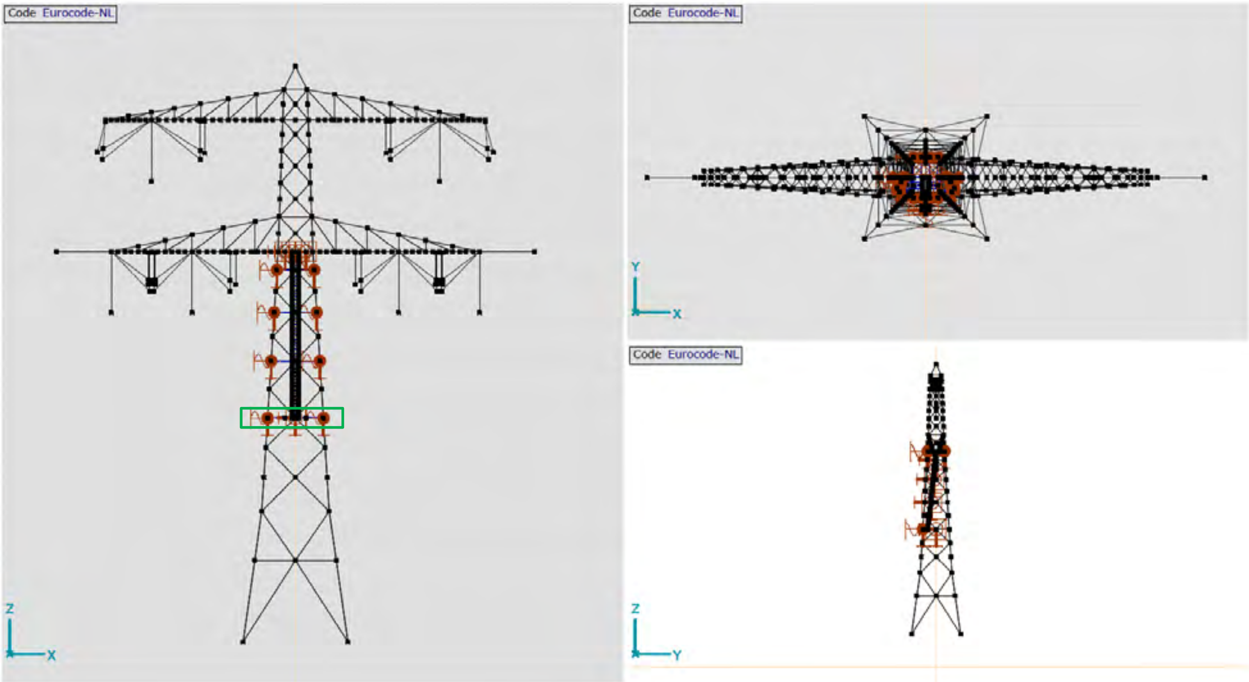


Figure 1 Location of ladder in the S-6 tower.

2 GEOMETRY

Stepping rungs have a width of 400mm, 20 mm diameter steel rods acts as rungs. The rungs are spaced at 300mm c/c along the length of the ladder. The platforms at the bottom and the top are 600mm x 600mm in size, this is based on NEN-EN 50341-2-15. The geometry of the ladder is shown in Figure 2. The chords of the ladder is L100x50x6. Furthermore, the chords of the ladder are supported in the horizontal at every in between crossing of the diagonals. The platforms both at top and bottom are supported by adding new elements to the exiting plan bracing of the tower. The majority of the new elements supporting platform are L80x80x8. An overview sketch is provided in Figure 2.

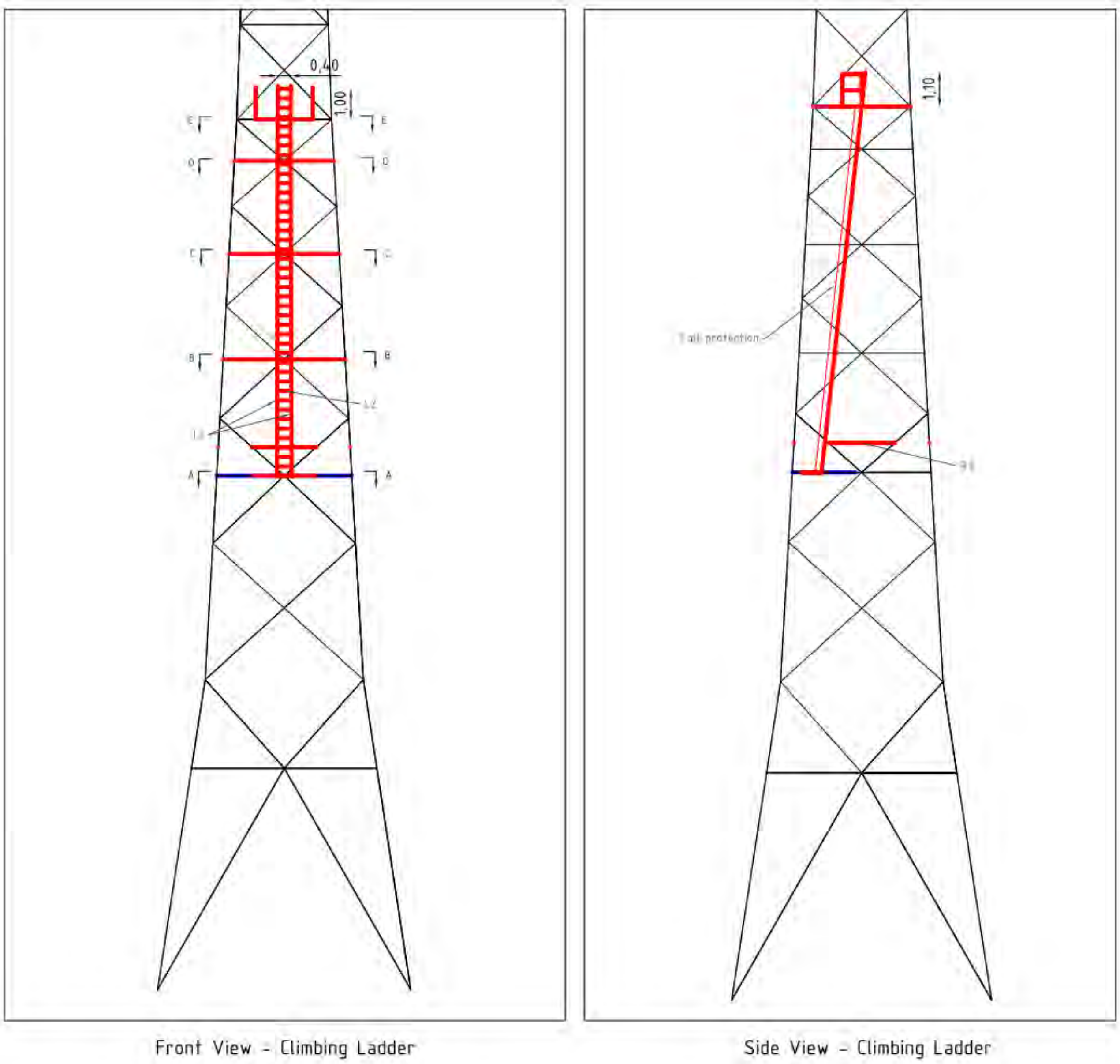


Figure 2a Overview sketch of ladder

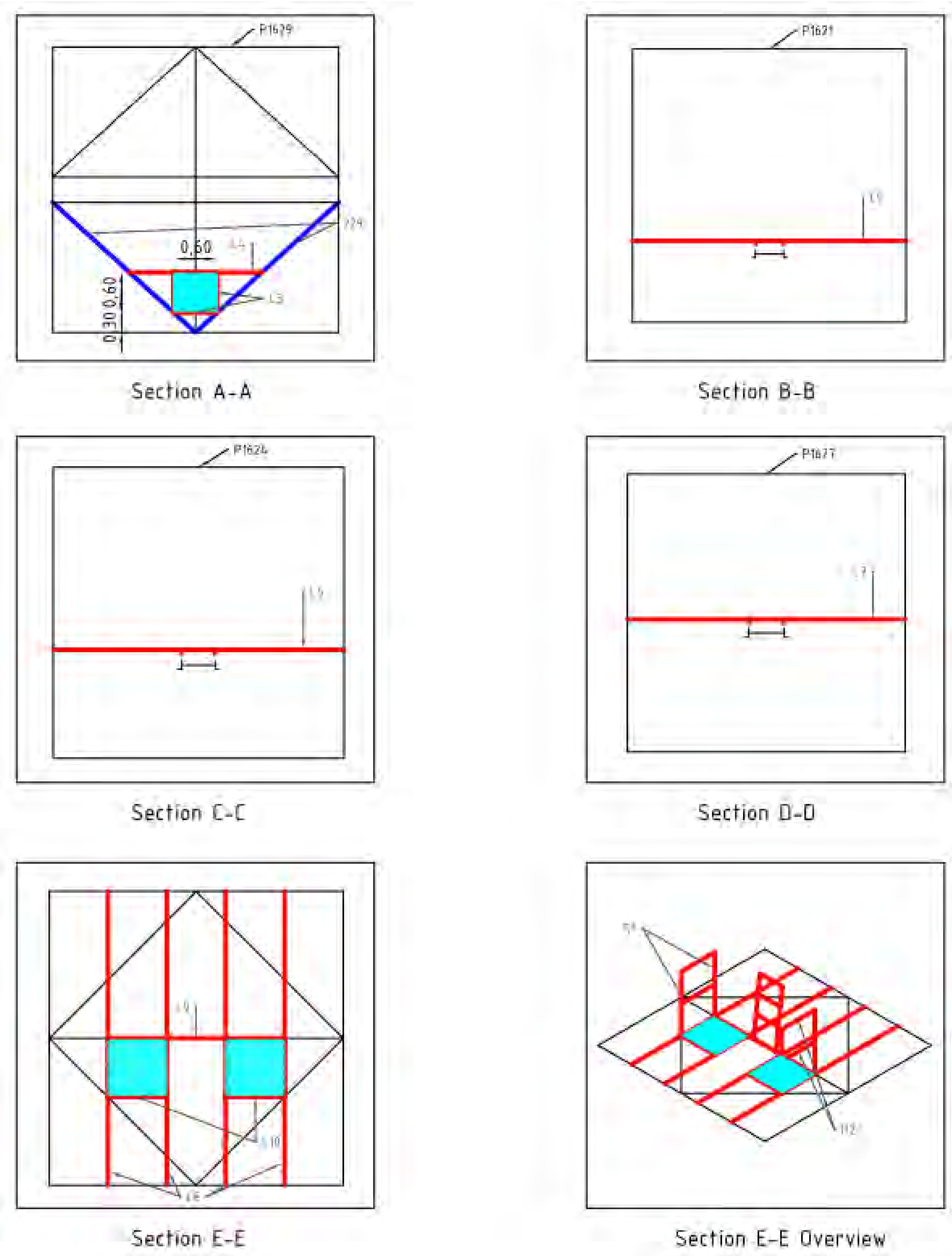


Figure 2b Overview sections of ladder

The details of the cross section are given in Figure 3.

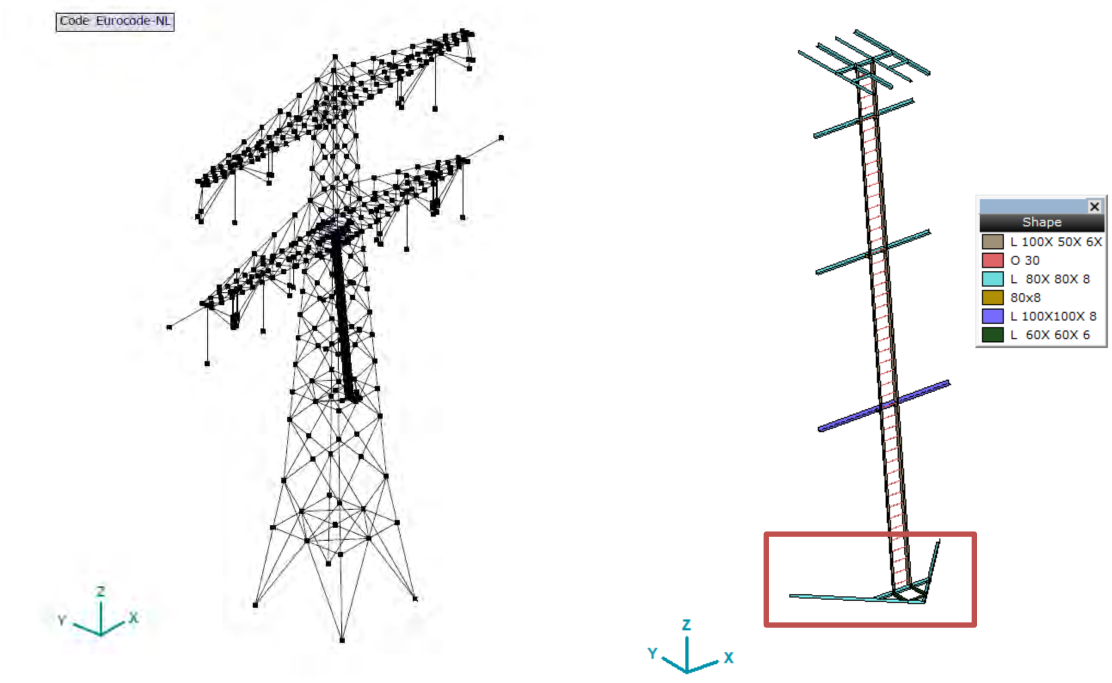


Figure 3 Geometry of the isolated ladder from the S-6 tower

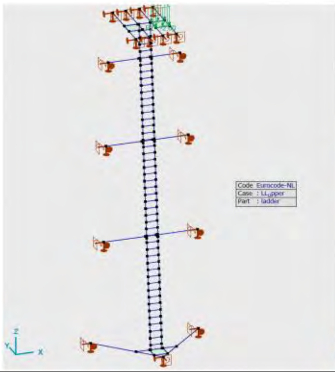
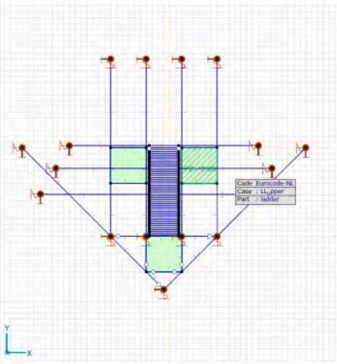
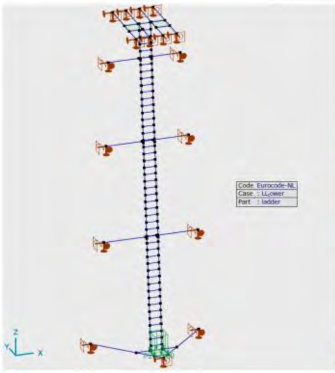
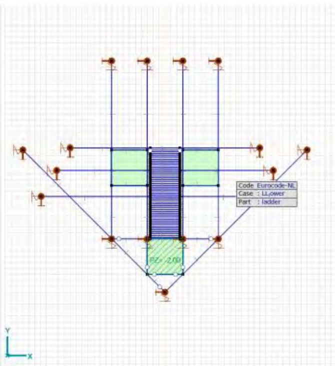
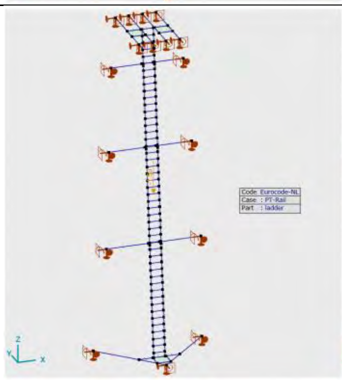
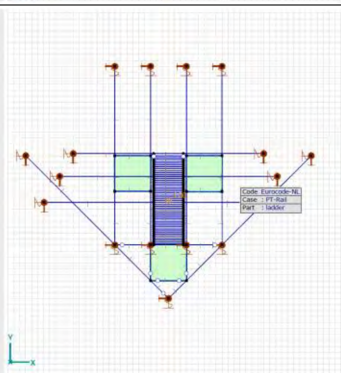
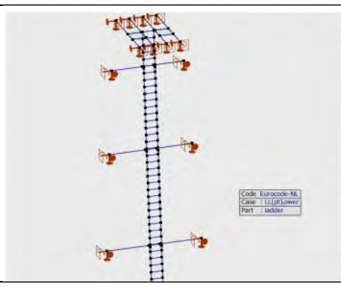
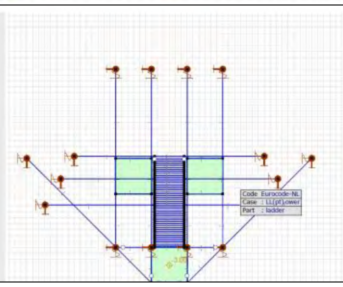
2.1 Supports

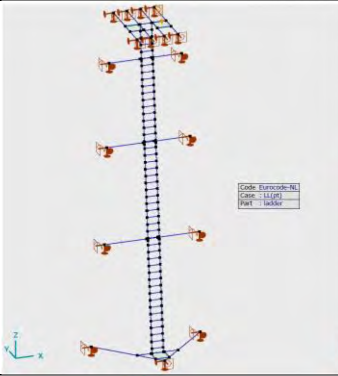
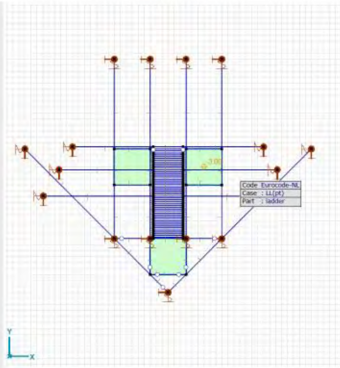
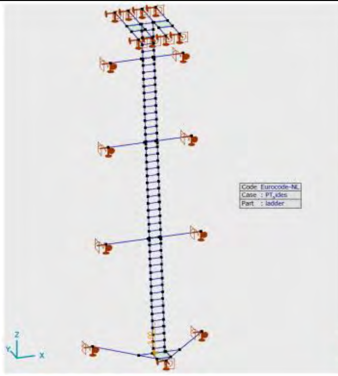
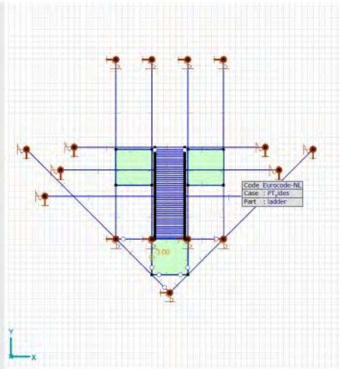
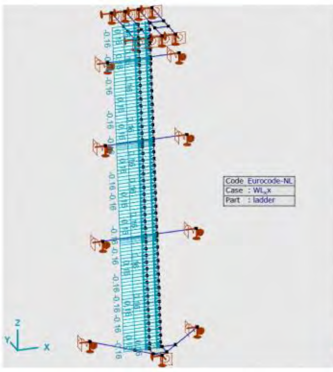
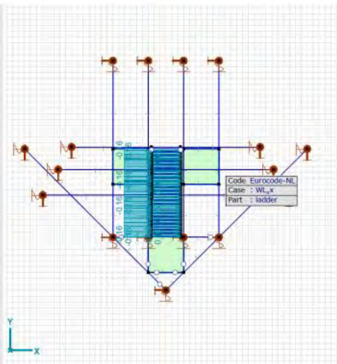
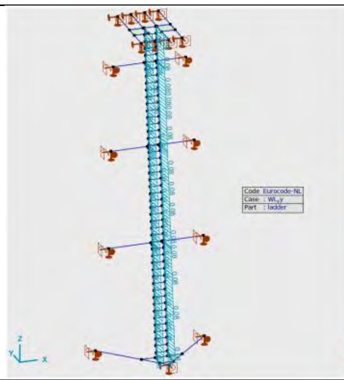
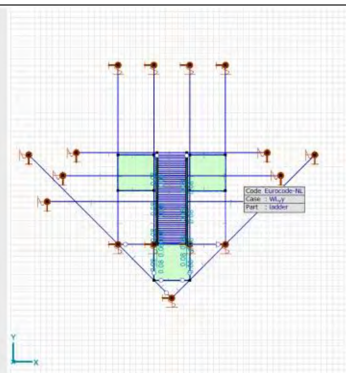
The elemets supporting the ladder and platforms are given hinged supports. The supports are the location where the new elements get integrated with the existing members of the tower. The exiting tower members are asuumed to be rigid compared to the new elements in translation. The connection are assumed to provided suffiencient torsional rigidity. The small elements of 80 x 8 mm flats are released at ends to transfer only horizontal force to the chord members of the ladder at intermidiate supporting points. The entire vertical load in ladder is taken by the members forming the bottom platform as marked in red box in Figure 3.

3 LOADING

The loading applied on the ladder is in accordance with the Eurocodes with preference to the TenneT recommendations. Live load applied on the platform and ladder is in accordance to NEN-EN 50341-2-15(2019) : Table 4.9/NL.1. The details of the loading are given in the table 1 below:

Table 1 Details of load cases

Sr. No.	Load Case	Particular	Load aplied in PLS tower model
1	LL_upper	Live load is applied to one of the platform taking advantage of the symetry. The applied load is 2kN/m^2.	 
2	LL_lower	The live load explained in the previous load case is applied at the bottom platform.	 
3	PT_Rail	A point load of 1.5kN is the middle of the middle span of the ladder. The middle span is chosen as it's the longest.	 
4	LL_pt_lower	3kN point load is applied on the middle of the lower platform.	 

5	LL_pt_upper	3kN point load is applied on the middle of the upper platform.	 
	PT_sides	Point load of 3kN is applied on the edge of the lower platform. This is simulates the case of heavy load kooked to the edge of the platform.	 
	Wind_xx	Wind load is applied as per the calculations in the Geleiderbealsting sheet for the corresponding tower. The pressure P_z = 1.6kN/m^2. The pressure is multiplied with the width of the crossection of the (100mm) and a drag factor of 1. The value of UDL applied is 0.16kN/m.	 
	Wind_yy	The loads are calculated as expalined for Wind_xx load case. The only difference is the width of the crossection (50 mm). Hence the applied UDL is 0.08kN/m.	 

	EG	Self weight is applied as shown on right.	

Load combination: The load combinations developed in the axis VM model is as per the TenneT recommendation defined in : page 73: PVE.05.000 Lijnen. The figure below shows the recommendation values for loads for verbouwniveau. The important load combinations are boxed in red.

4.13/NL.1 - Partial factors and combination factors (Ultimate Limit State, ULS) "Repair or Renewal" Verbouw/CC2/50j							
Nr	Loadcase	Temp [°C]	γg(1)	γq			γa
			Gk	Qpk	Qwk	Qik	Ak
1a	Wind	10	1,15	-	1,40	-	-
2	Not relevant	-	-	-	-	-	-
3	Wind + ice	-5	1,15	-	0,42	1,30	-
4	Min temp + wind	-20	1,15	-	0,28	-	-
5a	Torsional loads	10	1,0	1,0	-	-	1,0
5b	Longitudinal loads	10	1,0	-	-	-	1,0
6a	Construction + maintenance	5	1,15	1,3	0,28	-	-
6b	Weight of linesmen	5	1,15	1,3	0,28	-	-
7	Permanent	10	1,30	-	-	-	-
8	Special	10	1,0	-	-	-	1,0

4 RESULTS

The results from the axis VM are presented below and conclusions are laid out in the subsequent sections.

4.1 Deflection

The max deflection of 16 mm is observed in the ladder middle of the ladder, it is because the supporting beams act as flexible supports. This equates to a ratio of l/810. This is within the acceptable limit of l/250. The deflection in the post processing of Axis VM is shown in Figure 4.

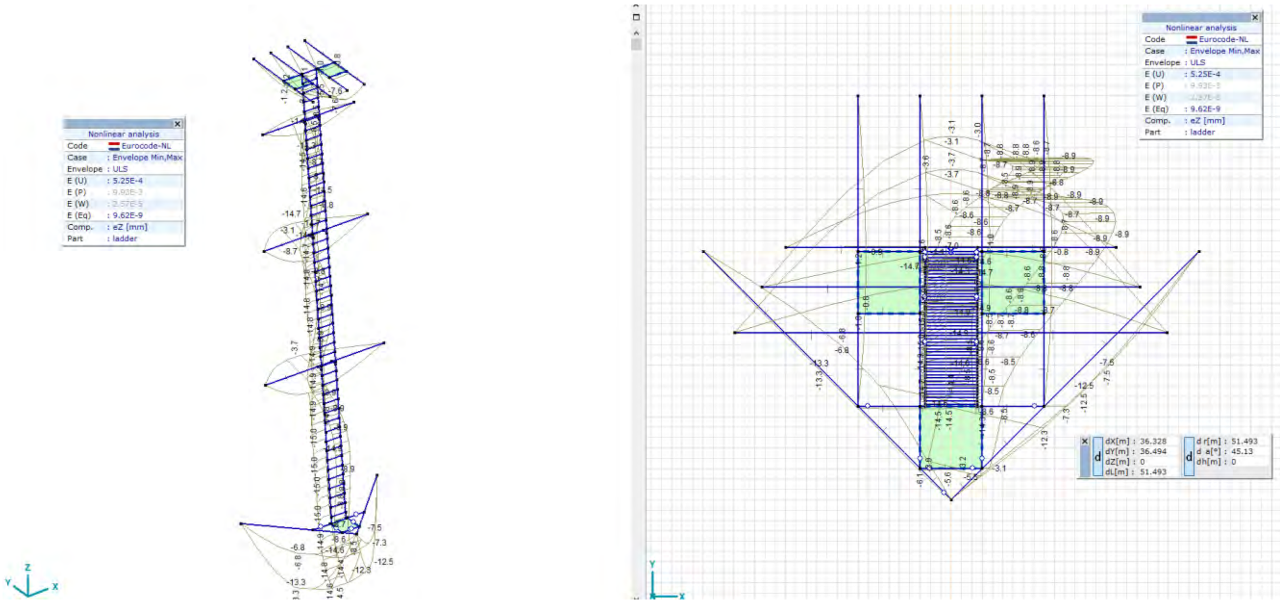


Figure 4 Deflection in the ladder

4.2 Internal forces

The internal forces in the ladder in shown in Figure 5. The chord members forming the ladder are loaded by axial force. The horizontal members have larger bending in both major and minor axis. The maximum internal forces in the ladder and platform is

N	(axial force)	− 11.4 kN (tension)	&	4.1 kN (compression)
Myy	(major axis moment)	- 2.1 kNm		
Mzz	(minor axis moment)	- 1.4 kNm		

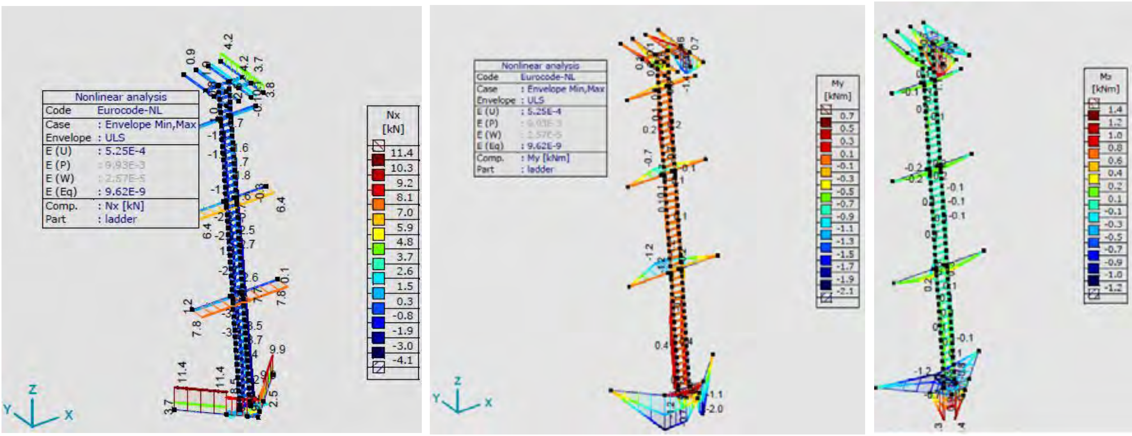


Figure 5 Internal forces in the ladder and platform.

4.3 Stability in vortex shedding and galloping

The natural frequency of the structure is calculated via the vibration analysis of the Axis VM. The natural frequency is the 4.7 Hz. This is used to calculate the critical velocity for vortex shedding. The natural frequency and the primary mode of deformation of the structure is shown in Figure 6.

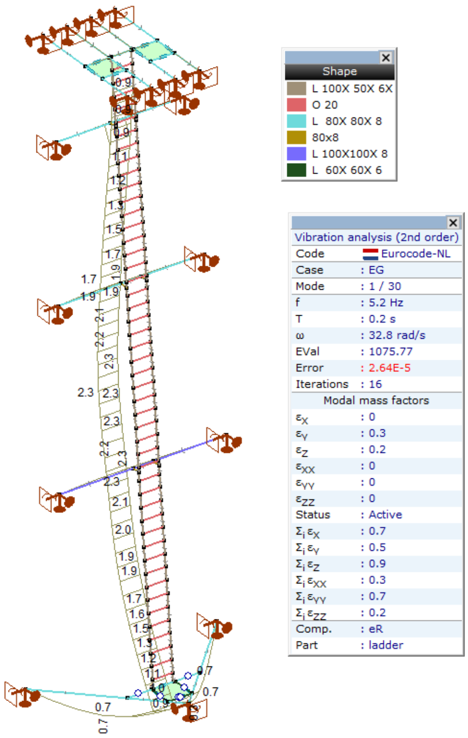


Figure 6 Primary mode of vibration of ladder.

The check for the dynamic stability of the ladder as is shown in the scanned images of calculations below:

(a) Check for Vortex shedding :- (Annex E)

(A) → Criteria for Vortex shedding

(1) $\frac{\text{Largest dimension}}{\text{Smallest dimension}} = \frac{15.3}{0.45} > 6$ — ✓ — E.1.2

(2) Porosity of structure < 8% — × — ICE recommendation

→ Structure not susceptible to vortex shedding
→ Initial indication of no vortex shedding

→ Mathematical criteria of vortex shedding

Equation E.1.2 — eq. — (E1)

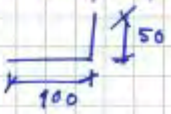
$V_{crit,i} > 1.25\, V_m$.

(B) Equation (E.3) — $V_{crit,i} = \frac{b}{S_t} n_{iy}$

| V_m – 10 min mean speed.
b – dimension of element
n_{iy} – Natural frequency
S_t – Strouhal no.

→ Referencing S_t (Strouhal no.) from table E.1

for d/b



$= \frac{100}{50} = 2$

$S_t = 0.07$

$b = 50$ mm.

n_{iy} (axis V_M calc.) $= 5.2$ Hz

$V_{mean} = 20 - 30$ m/sec.

$V_{crit,i} = \frac{50 \times 5.2}{1000 \times 0.07} = 4.0$ m/sec.

$\not> 1.5 \times 20$ — no lock in.

→ Critical wind velocity for structure doesn't occur.

(C) E.1.3.3 :- The susceptibility of vibration depends on structural damping and the ratio of structural mass to fluid mass.

Equation E.4 — $S_c = \frac{2\delta_s . m_{i,e}}{\rho . b^2}$

| δ_c – structural damping
$m_{i,e}$ – mass unit length

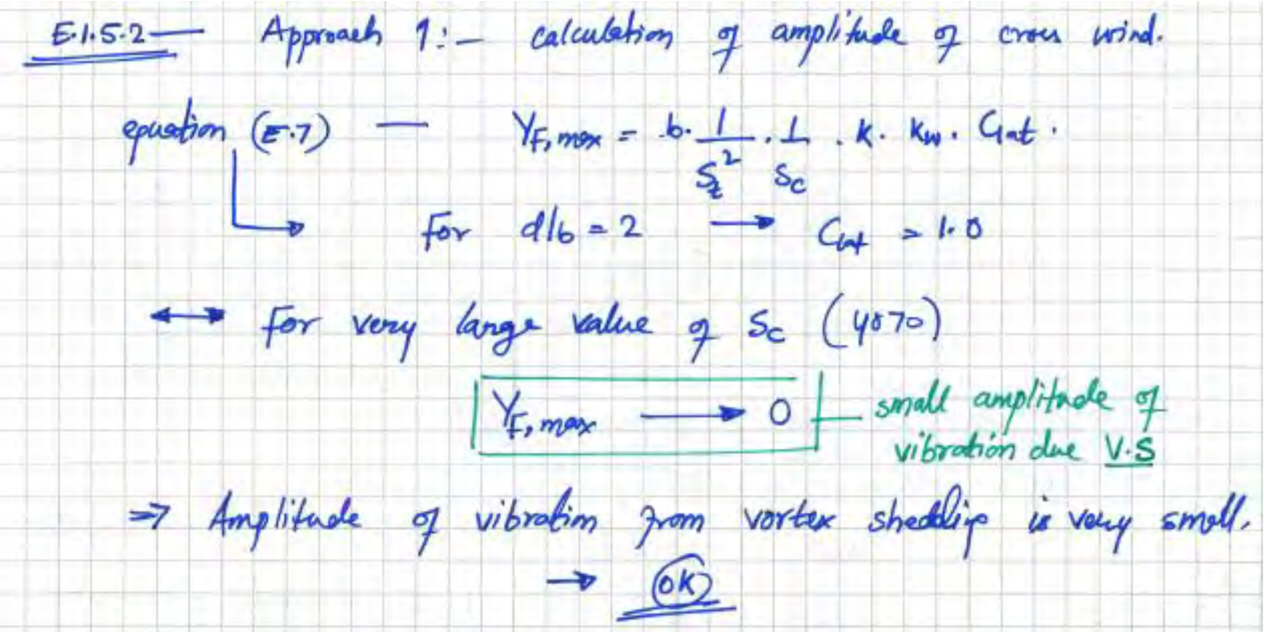
δ_c (for steel work) $= 0.012$.

$\Rightarrow S_c = \frac{2 \times 0.012 \times 530}{1.25 \times (0.05)^2}$

$= 4070 > V_{mean}$

For mode 1 :- $m_{i,e}$ (mass/unit length) $= \frac{2 \times (100 \times 50) \times 2 + \pi \cdot (20)^2 \times 450 \times 0.3}{10^6} \times 7850$

≈ 530 kg


E.1.5.2 — Approach 1: — calculation of amplitude of cross wind.

equation (E.7) — $Y_{F,max} = b \cdot \frac{1}{S_t^2} \cdot \frac{1}{S_c} \cdot K \cdot K_w \cdot C_{lat}$

→ For $d/b = 2$ → $C_{lat} = 1.0$

↔ For very large value of S_c (4870)

$Y_{F,max} \rightarrow 0$ — small amplitude of vibration due V.S

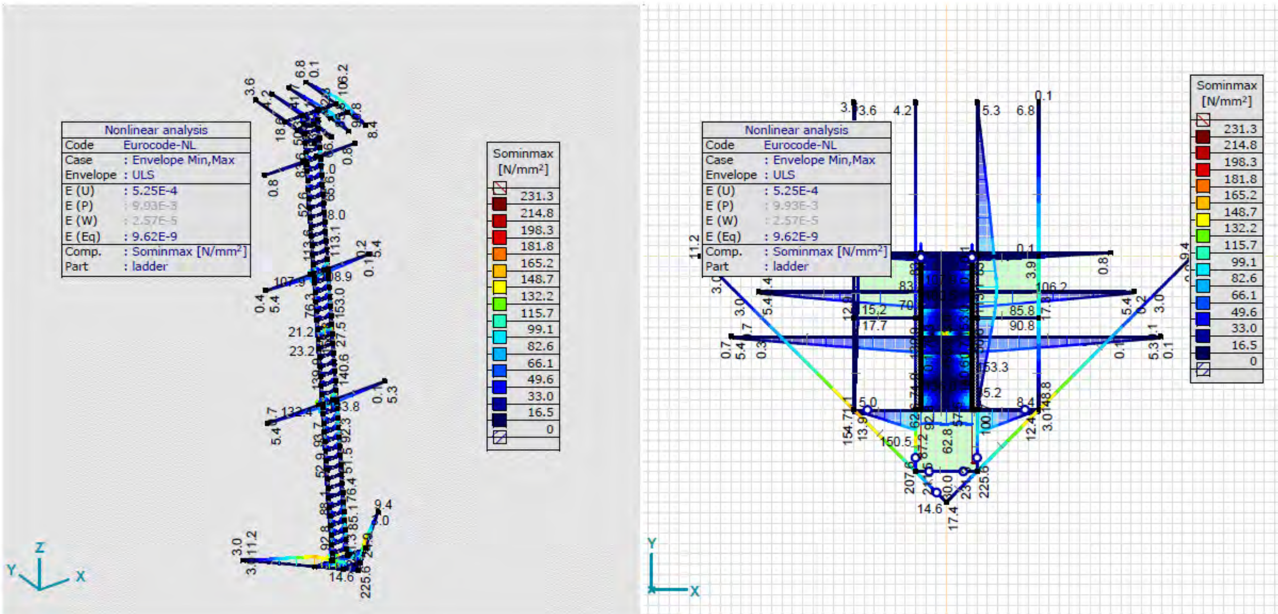
⇒ Amplitude of vibration from vortex shedding is very small.

→ OK

The structure is found immune to vortex shedding as shown above.

4.4 Check of members

The max stress observed in the structure is 173 MPa for the envelope of the ULS load combinations. This is considerably less than the yield limit of 355 MPa. This additional load carrying capacity should be enough for the losses due to effects in connections (bolt holes).



5 CONCLUSION

The system acting as ladder and supporting the platforms is found adequate in ULS loading. The efficacy is checked by comparing the stress in the structure due to loading to the permissible stress of S355 steel. Furthermore, the struture is found safe in dynamic stability check as per Eurocode.

6 BIJLAGE: UITVOER AXISVM.

Project

Analysis by

AxisVM X5 R4a · Registered to DNV GL - Energy
Model_ladder.axs

Report

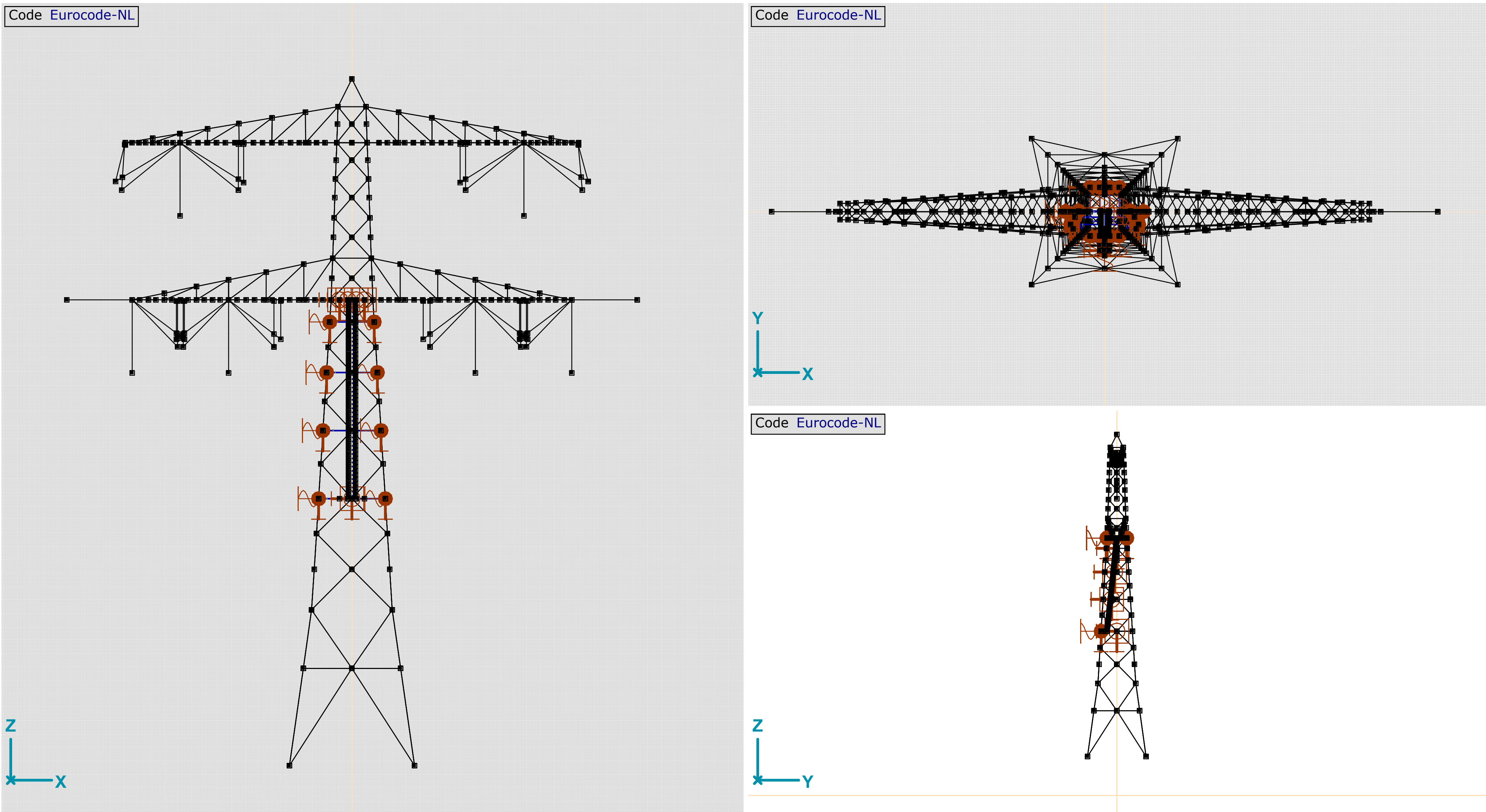
Report, Table of contents

Materials

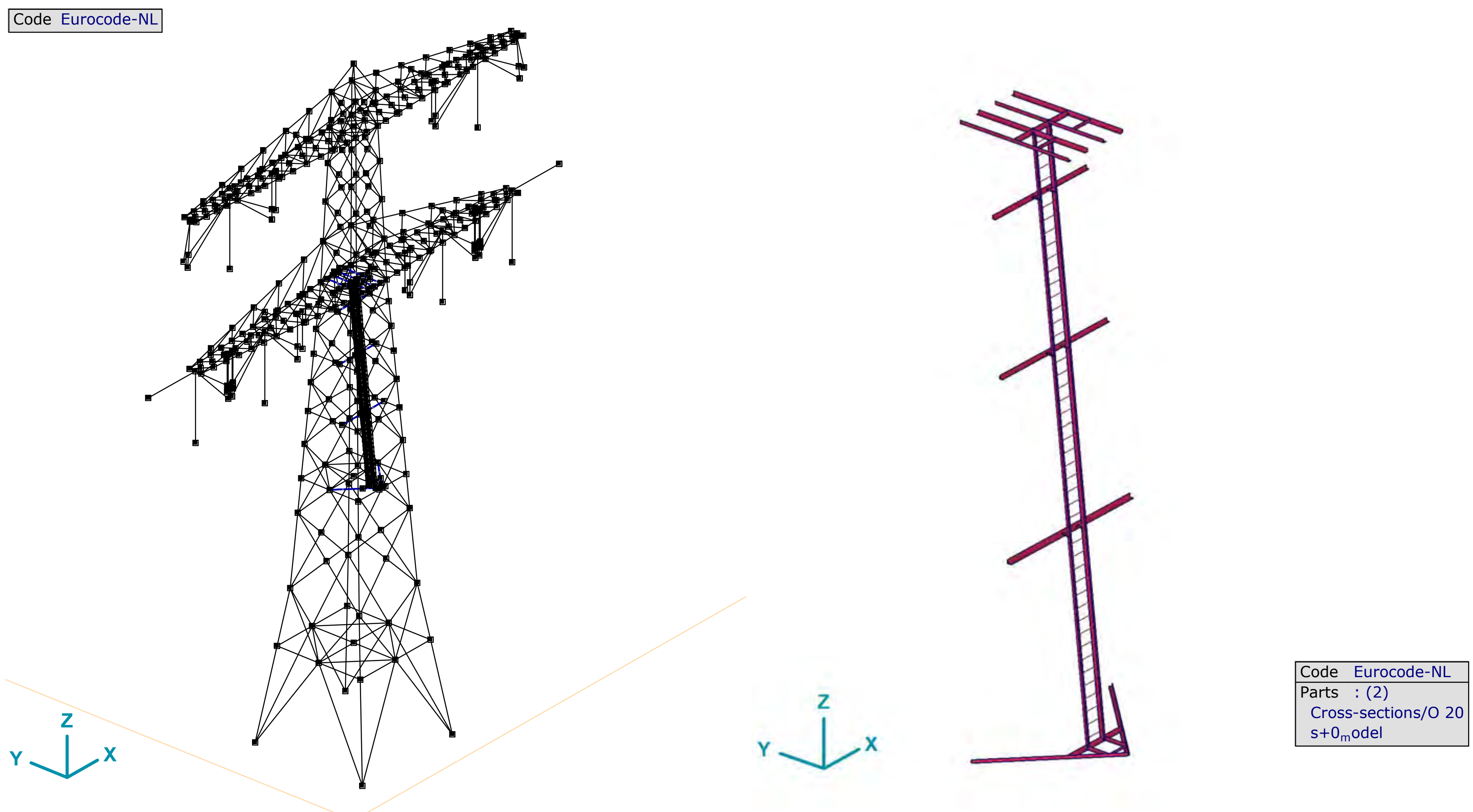
	Name	*Type*	*National design code*	*Material code*	*Model*	*E_x [N/mm^2]*	*E_y [N/mm^2]*	*ν*	*α_T [1/°C]*	*ρ [kg/m^3]*	*Material color*	*Contour color*	*Texture*	*P_1*
1	S 235	Steel	SIA 26x (Swiss)	SN EN 10025	Linear	210000	210000	0.30	1E-5	7850			Steel	f_y[N/mm^2] = 235.00
2	S 355	Steel	Eurocode-NL	10025-2	Linear	210000	210000	0.30	1.2E-5	7850			Steel	f_y[N/mm^2] = 355.00

	Name	*P_2*	*P_3*	*P_4*	*P_5*	*P_6*	*P_7*	*P_8*	*P_9*	*P_{10}*	*P_{11}*	*P_{12}*	*P_{13}*	*P_{14}*
1	S 235	f_u[N/mm^2] = 360.00	f_y^*[N/mm^2] = 215.00	f_u^*[N/mm^2] = 340.00										
2	S 355	f_u[N/mm^2] = 510.00	f_y^*[N/mm^2] = 335.00	f_u^*[N/mm^2] = 470.00										

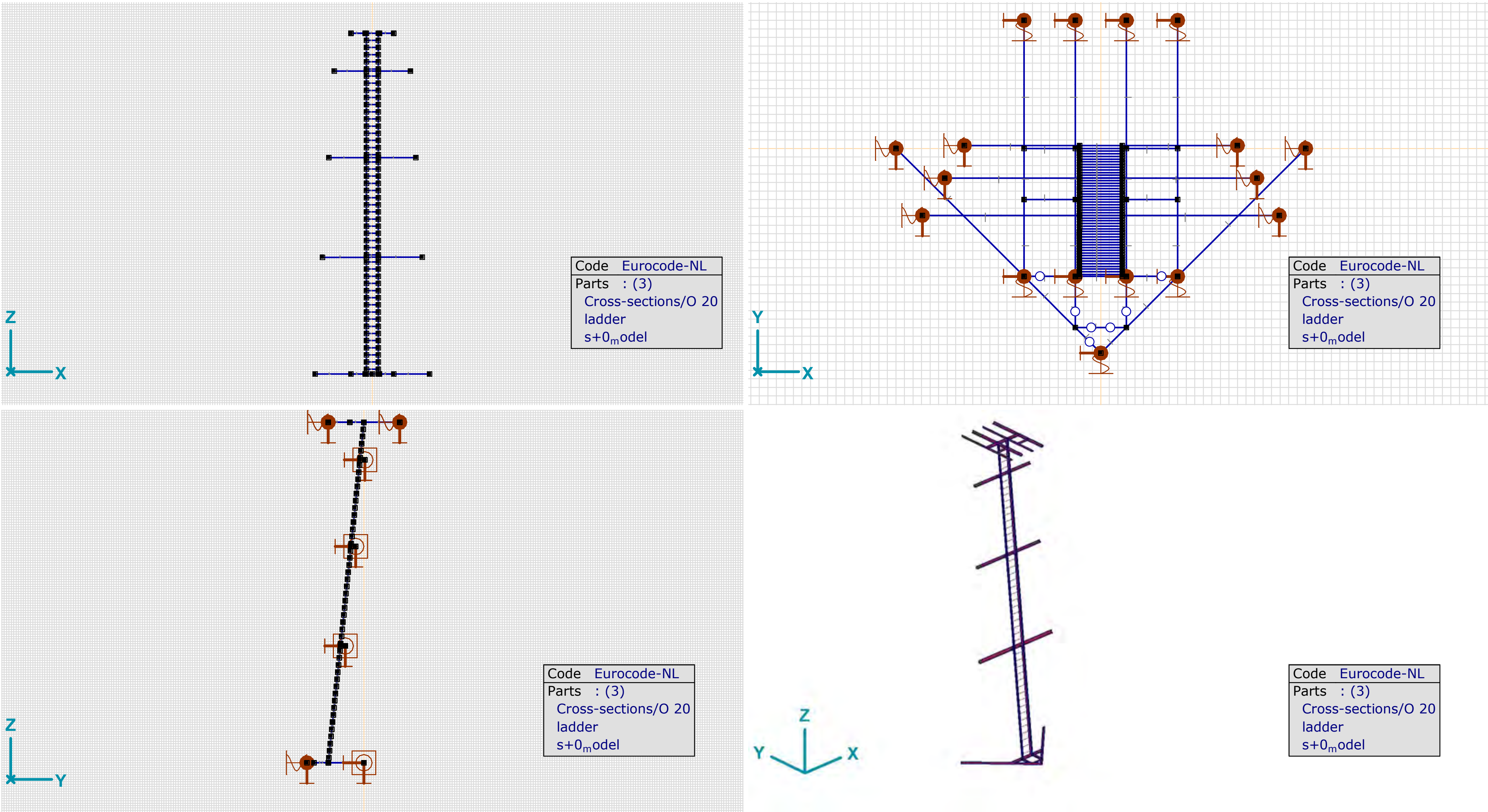
Name: Material name; **Type:** Type of material; **Model:** Material model; **E_x:** Young's modulus of elasticity in local x direction; **E_y:** Young's modulus of elasticity in local y direction; **ν:** Poisson's ratio; **α_T:** Thermal expansion coefficient; **ρ:** Density; **Contour color:** Material outline color; **P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}, P_{11}, P_{12}, P_{13}, P_{14}:** Design parameter;



S+0_model_ladder



ladder_3D



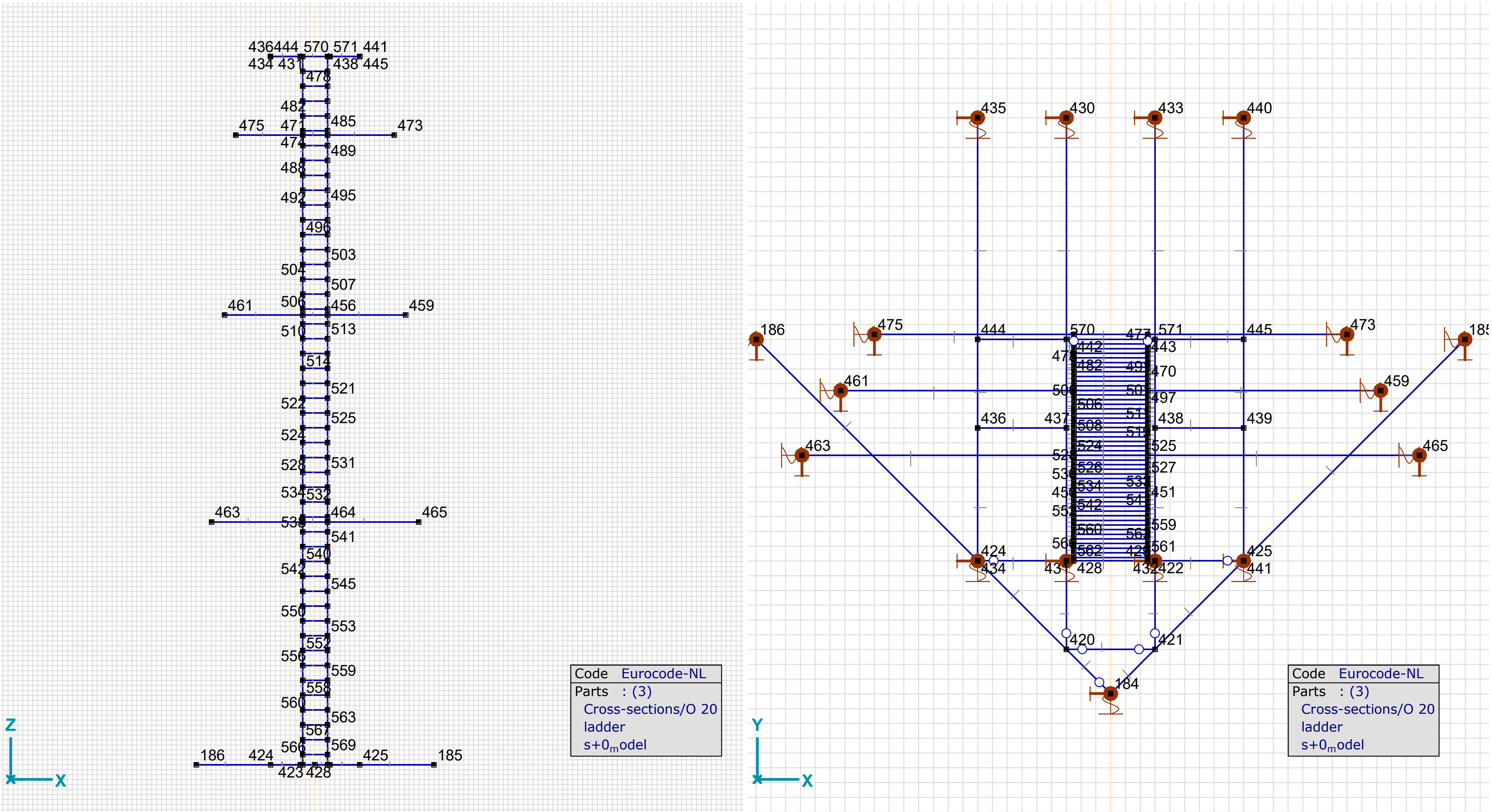
ladder_isolated_views

Nodes [ladder]

	X [m]	Y [m]	Z [m]	e_X	e_Y	e_Z	θ_X	θ_Y	θ_Z
184	0	−2.398	25.200	f	f	f	f	f	f
185	2.398	0	25.200	f	f	f	f	f	f
186	−2.398	0	25.200	f	f	f	f	f	f
420	−0.300	−2.098	25.200	f	f	f	f	f	f
421	0.300	−2.098	25.200	f	f	f	f	f	f
422	0.300	−1.498	25.200	f	f	f	f	f	f
423	−0.300	−1.498	25.200	f	f	f	f	f	f
424	−0.900	−1.498	25.200	f	f	f	f	f	f
425	0.900	−1.498	25.200	f	f	f	f	f	f
428	−0.250	−1.498	25.200	f	f	f	f	f	f
429	0.250	−1.498	25.200	f	f	f	f	f	f
430	−0.300	1.500	39.500	f	f	f	f	f	f
431	−0.300	−1.500	39.500	f	f	f	f	f	f
432	0.300	−1.500	39.500	f	f	f	f	f	f
433	0.300	1.500	39.500	f	f	f	f	f	f
434	−0.900	−1.500	39.500	f	f	f	f	f	f
435	−0.900	1.500	39.500	f	f	f	f	f	f
436	−0.900	−0.600	39.500	f	f	f	f	f	f
437	−0.300	−0.600	39.500	f	f	f	f	f	f
438	0.300	−0.600	39.500	f	f	f	f	f	f
439	0.900	−0.600	39.500	f	f	f	f	f	f
440	0.900	1.500	39.500	f	f	f	f	f	f
441	0.900	−1.500	39.500	f	f	f	f	f	f
442	−0.249	0	39.500	f	f	f	f	f	f
443	0.251	0	39.500	f	f	f	f	f	f
444	−0.900	0	39.500	f	f	f	f	f	f
445	0.900	0	39.500	f	f	f	f	f	f
450	−0.250	−0.985	30.100	f	f	f	f	f	f
451	0.250	−0.985	30.101	f	f	f	f	f	f
456	0.251	−0.547	34.281	f	f	f	f	f	f
457	−0.249	−0.547	34.281	f	f	f	f	f	f
458	0.251	−0.347	34.280	f	f	f	f	f	f
459	1.827	−0.347	34.280	f	f	f	f	f	f
460	−0.249	−0.347	34.280	f	f	f	f	f	f
461	−1.827	−0.347	34.280	f	f	f	f	f	f
462	−0.250	−0.785	30.100	f	f	f	f	f	f
463	−2.090	−0.785	30.100	f	f	f	f	f	f
464	0.250	−0.785	30.101	f	f	f	f	f	f
465	2.090	−0.785	30.102	f	f	f	f	f	f
470	0.251	−0.166	37.914	f	f	f	f	f	f
471	−0.249	−0.166	37.914	f	f	f	f	f	f
472	0.251	0.034	37.914	f	f	f	f	f	f
473	1.599	0.034	37.913	f	f	f	f	f	f
474	−0.249	0.034	37.914	f	f	f	f	f	f
475	−1.599	0.034	37.913	f	f	f	f	f	f
476	−0.249	−0.031	39.200	f	f	f	f	f	f
477	0.251	−0.031	39.200	f	f	f	f	f	f
478	−0.249	−0.063	38.900	f	f	f	f	f	f
479	0.251	−0.063	38.900	f	f	f	f	f	f
480	−0.249	−0.094	38.600	f	f	f	f	f	f
481	0.251	−0.094	38.600	f	f	f	f	f	f
482	−0.249	−0.126	38.301	f	f	f	f	f	f
483	0.251	−0.126	38.301	f	f	f	f	f	f
484	−0.249	−0.157	38.001	f	f	f	f	f	f
485	0.251	−0.157	38.001	f	f	f	f	f	f
486	−0.249	−0.188	37.701	f	f	f	f	f	f
487	0.251	−0.188	37.701	f	f	f	f	f	f
488	−0.249	−0.220	37.401	f	f	f	f	f	f
489	0.251	−0.220	37.401	f	f	f	f	f	f
490	−0.249	−0.251	37.101	f	f	f	f	f	f
491	0.251	−0.251	37.101	f	f	f	f	f	f
492	−0.249	−0.283	36.801	f	f	f	f	f	f
493	0.251	−0.283	36.801	f	f	f	f	f	f
494	−0.249	−0.314	36.501	f	f	f	f	f	f
495	0.251	−0.314	36.501	f	f	f	f	f	f
496	−0.249	−0.346	36.201	f	f	f	f	f	f
497	0.251	−0.346	36.201	f	f	f	f	f	f
498	−0.249	−0.377	35.902	f	f	f	f	f	f
499	0.251	−0.377	35.902	f	f	f	f	f	f
500	−0.249	−0.408	35.602	f	f	f	f	f	f
501	0.251	−0.408	35.602	f	f	f	f	f	f

	X [m]	Y [m]	Z [m]	e_X	e_Y	e_Z	θ_X	θ_Y	θ_Z
502	−0.249	−0.440	35.302	f	f	f	f	f	f
503	0.251	−0.440	35.302	f	f	f	f	f	f
504	−0.249	−0.471	35.002	f	f	f	f	f	f
505	0.251	−0.471	35.002	f	f	f	f	f	f
506	−0.249	−0.503	34.702	f	f	f	f	f	f
507	0.251	−0.503	34.702	f	f	f	f	f	f
508	−0.249	−0.534	34.402	f	f	f	f	f	f
509	0.251	−0.534	34.402	f	f	f	f	f	f
510	−0.249	−0.565	34.102	f	f	f	f	f	f
511	0.251	−0.565	34.102	f	f	f	f	f	f
512	−0.249	−0.597	33.802	f	f	f	f	f	f
513	0.251	−0.597	33.802	f	f	f	f	f	f
514	−0.249	−0.628	33.503	f	f	f	f	f	f
515	0.251	−0.628	33.503	f	f	f	f	f	f
516	−0.249	−0.660	33.203	f	f	f	f	f	f
517	0.251	−0.660	33.203	f	f	f	f	f	f
518	−0.249	−0.691	32.903	f	f	f	f	f	f
519	0.251	−0.691	32.903	f	f	f	f	f	f
520	−0.249	−0.722	32.603	f	f	f	f	f	f
521	0.251	−0.722	32.603	f	f	f	f	f	f
522	−0.249	−0.754	32.303	f	f	f	f	f	f
523	0.251	−0.754	32.303	f	f	f	f	f	f
524	−0.249	−0.785	32.003	f	f	f	f	f	f
525	0.251	−0.785	32.003	f	f	f	f	f	f
526	−0.249	−0.817	31.703	f	f	f	f	f	f
527	0.251	−0.817	31.703	f	f	f	f	f	f
528	−0.249	−0.848	31.404	f	f	f	f	f	f
529	0.251	−0.848	31.404	f	f	f	f	f	f
530	−0.249	−0.880	31.104	f	f	f	f	f	f
531	0.251	−0.880	31.104	f	f	f	f	f	f
532	−0.250	−0.911	30.804	f	f	f	f	f	f
533	0.250	−0.911	30.804	f	f	f	f	f	f
534	−0.250	−0.942	30.504	f	f	f	f	f	f
535	0.250	−0.942	30.504	f	f	f	f	f	f
536	−0.250	−0.974	30.204	f	f	f	f	f	f
537	0.250	−0.974	30.204	f	f	f	f	f	f
538	−0.250	−1.005	29.904	f	f	f	f	f	f
539	0.250	−1.005	29.904	f	f	f	f	f	f
540	−0.250	−1.037	29.604	f	f	f	f	f	f
541	0.250	−1.037	29.604	f	f	f	f	f	f
542	−0.250	−1.068	29.304	f	f	f	f	f	f
543	0.250	−1.068	29.304	f	f	f	f	f	f
544	−0.250	−1.099	29.005	f	f	f	f	f	f
545	0.250	−1.099	29.005	f	f	f	f	f	f
546	−0.250	−1.131	28.705	f	f	f	f	f	f
547	0.250	−1.131	28.705	f	f	f	f	f	f
548	−0.250	−1.162	28.405	f	f	f	f	f	f
549	0.250	−1.162	28.405	f	f	f	f	f	f
550	−0.250	−1.194	28.105	f	f	f	f	f	f
551	0.250	−1.194	28.105	f	f	f	f	f	f
552	−0.250	−1.225	27.805	f	f	f	f	f	f
553	0.250	−1.225	27.805	f	f	f	f	f	f
554	−0.250	−1.256	27.505	f	f	f	f	f	f
555	0.250	−1.256	27.505	f	f	f	f	f	f
556	−0.250	−1.288	27.205	f	f	f	f	f	f
557	0.250	−1.288	27.205	f	f	f	f	f	f
558	−0.250	−1.319	26.905	f	f	f	f	f	f
559	0.250	−1.319	26.905	f	f	f	f	f	f
560	−0.250	−1.351	26.606	f	f	f	f	f	f
561	0.250	−1.351	26.606	f	f	f	f	f	f
562	−0.250	−1.382	26.306	f	f	f	f	f	f
563	0.250	−1.382	26.306	f	f	f	f	f	f
564	−0.250	−1.414	26.006	f	f	f	f	f	f
565	0.250	−1.414	26.006	f	f	f	f	f	f
566	−0.250	−1.445	25.706	f	f	f	f	f	f
567	0.250	−1.445	25.706	f	f	f	f	f	f
568	−0.250	−1.476	25.406	f	f	f	f	f	f
569	0.250	−1.476	25.406	f	f	f	f	f	f
570	−0.300	0	39.500	f	f	f	f	f	f
571	0.300	0	39.500	f	f	f	f	f	f

e_X: Nodal DOF (translation constraint X); **e_Y:** Nodal DOF (translation constraint Y); **e_Z:** Nodal DOF (translation constraint Z); **θ_X:** Nodal DOF (rotation constraint about X-Axis); **θ_Y:** Nodal DOF (rotation constraint about Y-Axis); **θ_Z:** Nodal DOF (rotation constraint about Z-Axis);



ladder_nodes

Beams [ladder]

	Node i	*Node j*	*Length*	*Local x*	*Material*	*Start cross-section*	*End cross-section*	*Ref$_z$*	*ER$_{St}$*	*ER$_{End}$*
1	436	→ 437	0.60	i - j	S 355	8	8	Auto	.	.
2	438	→ 439	0.60	i - j	S 355	8	8	Auto	.	.
3	435	← 444	1.50	j - i	S 355	8	8	R1	.	.
4	443	→ 571	0.05	i - j	S 355	1	1	R1	.	.
5	440	← 445	1.50	j - i	S 355	8	8	Auto	.	.
6	439	← 441	0.90	j - i	S 355	8	8	Auto	.	.
7	420	→ 421	0.60	i - j	S 355	7	7	Auto	Hng-y	Hng-y
8	421	→ 422	0.60	i - j	S 355	7	7	Auto	Hng-y	.
9	420	→ 423	0.60	i - j	S 355	7	7	Auto	Hng-y	.
10	423	← 424	0.60	j - i	S 355	8	8	R1	Hng-y	.
11	422	→ 425	0.60	i - j	S 355	8	8	R1	.	Hng-y
12	458	→ 459	1.58	i - j	S 355	8	8	R1	.	.
13	460	← 461	1.58	j - i	S 355	8	8	R1	.	.
14	458	← 460	0.50	j - i	S 355	8	8	R1	.	.
15	457	→ 460	0.20	i - j	S 355	4	4	Auto	Hng-y	Hng-yz
16	456	→ 458	0.20	i - j	S 355	4	4	Auto	Hng-y	Hng-yz
17	462	← 463	1.84	j - i	S 355	1	1	R1	.	.
18	462	→ 464	0.50	i - j	S 355	1	1	R1	.	.
19	464	→ 465	1.84	i - j	S 355	1	1	R1	.	.
20	450	→ 462	0.20	i - j	S 355	4	4	Auto	Hng-y	Hng-yz
21	451	→ 464	0.20	i - j	S 355	4	4	Auto	Hng-y	Hng-yz
22	472	→ 473	1.35	i - j	S 355	8	8	R1	.	.
23	472	← 474	0.50	j - i	S 355	8	8	R1	.	.
24	474	← 475	1.35	j - i	S 355	8	8	R1	.	.
25	471	→ 474	0.20	i - j	S 355	4	4	Auto	Hng-y	Hng-yz
26	470	→ 472	0.20	i - j	S 355	4	4	Auto	Hng-y	Hng-yz
27	184	→ 421	0.42	i - j	S 355	8	8	Auto	.	.
28	185	← 425	2.12	j - i	S 355	8	8	Auto	.	.
29	184	← 420	0.42	j - i	S 355	8	8	Auto	.	Hng-yz
30	186	→ 424	2.12	i - j	S 355	8	8	Auto	.	.
31	442	→ 443	0.50	i - j	S 355	8	8	R1	.	.
32	476	→ 477	0.50	i - j	S 355	6	6	Auto	.	.
33	478	→ 479	0.50	i - j	S 355	6	6	Auto	.	.
34	480	→ 481	0.50	i - j	S 355	6	6	Auto	.	.
35	482	→ 483	0.50	i - j	S 355	6	6	Auto	.	.
36	484	→ 485	0.50	i - j	S 355	6	6	Auto	.	.
37	486	→ 487	0.50	i - j	S 355	6	6	Auto	.	.
38	488	→ 489	0.50	i - j	S 355	6	6	Auto	.	.
39	490	→ 491	0.50	i - j	S 355	6	6	Auto	.	.
40	492	→ 493	0.50	i - j	S 355	6	6	Auto	.	.
41	494	→ 495	0.50	i - j	S 355	6	6	Auto	.	.
42	496	→ 497	0.50	i - j	S 355	6	6	Auto	.	.
43	498	→ 499	0.50	i - j	S 355	6	6	Auto	.	.
44	500	→ 501	0.50	i - j	S 355	6	6	Auto	.	.
45	502	→ 503	0.50	i - j	S 355	6	6	Auto	.	.
46	504	→ 505	0.50	i - j	S 355	6	6	Auto	.	.
47	506	→ 507	0.50	i - j	S 355	6	6	Auto	.	.
48	508	→ 509	0.50	i - j	S 355	6	6	Auto	.	.

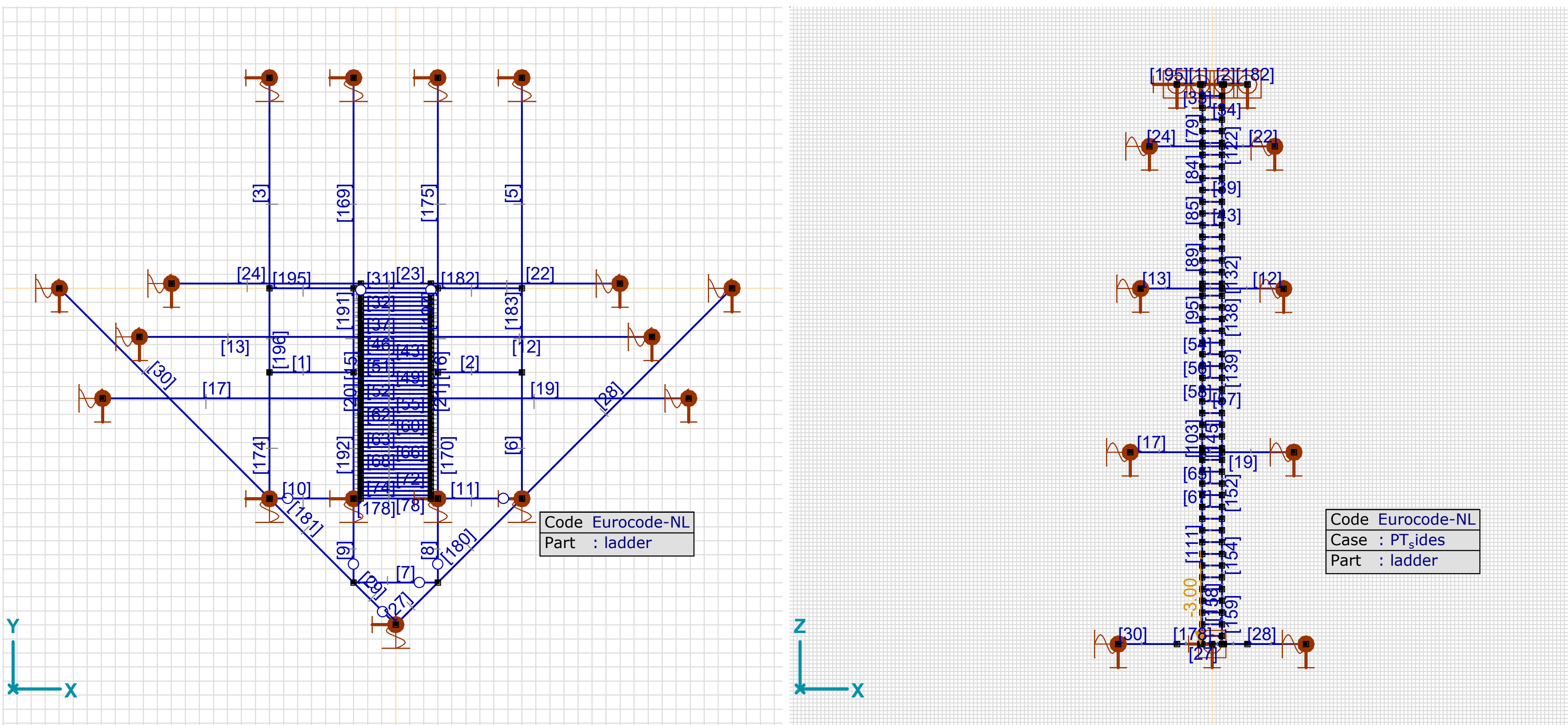
Beams [ladder]

	Node i	*Node j*	*Length*	*Local x*	*Material*	*Start cross-section*	*End cross-section*	*Ref_z*	*ER_{St}*	*ER_{End}*
49	510	→ 511	0.50	i - j	S 355	6	6	Auto	.	.
50	512	→ 513	0.50	i - j	S 355	6	6	Auto	.	.
51	514	→ 515	0.50	i - j	S 355	6	6	Auto	.	.
52	516	→ 517	0.50	i - j	S 355	6	6	Auto	.	.
53	518	→ 519	0.50	i - j	S 355	6	6	Auto	.	.
54	520	→ 521	0.50	i - j	S 355	6	6	Auto	.	.
55	522	→ 523	0.50	i - j	S 355	6	6	Auto	.	.
56	524	→ 525	0.50	i - j	S 355	6	6	Auto	.	.
57	526	→ 527	0.50	i - j	S 355	6	6	Auto	.	.
58	528	→ 529	0.50	i - j	S 355	6	6	Auto	.	.
59	530	→ 531	0.50	i - j	S 355	6	6	Auto	.	.
60	532	→ 533	0.50	i - j	S 355	6	6	Auto	.	.
61	534	→ 535	0.50	i - j	S 355	6	6	Auto	.	.
62	536	→ 537	0.50	i - j	S 355	6	6	Auto	.	.
63	538	→ 539	0.50	i - j	S 355	6	6	Auto	.	.
64	540	→ 541	0.50	i - j	S 355	6	6	Auto	.	.
65	542	→ 543	0.50	i - j	S 355	6	6	Auto	.	.
66	544	→ 545	0.50	i - j	S 355	6	6	Auto	.	.
67	546	→ 547	0.50	i - j	S 355	6	6	Auto	.	.
68	548	→ 549	0.50	i - j	S 355	6	6	Auto	.	.
69	550	→ 551	0.50	i - j	S 355	6	6	Auto	.	.
70	552	→ 553	0.50	i - j	S 355	6	6	Auto	.	.
71	554	→ 555	0.50	i - j	S 355	6	6	Auto	.	.
72	556	→ 557	0.50	i - j	S 355	6	6	Auto	.	.
73	558	→ 559	0.50	i - j	S 355	6	6	Auto	.	.
74	560	→ 561	0.50	i - j	S 355	6	6	Auto	.	.
75	562	→ 563	0.50	i - j	S 355	6	6	Auto	.	.
76	564	→ 565	0.50	i - j	S 355	6	6	Auto	.	.
77	566	→ 567	0.50	i - j	S 355	6	6	Auto	.	.
78	568	→ 569	0.50	i - j	S 355	6	6	Auto	.	.
79	478	→ 480	0.30	i - j	S 355	2	2	R3	.	.
80	480	→ 482	0.30	i - j	S 355	2	2	R3	.	.
81	471	← 484	0.09	j - i	S 355	2	2	R2	.	.
82	486	→ 488	0.30	i - j	S 355	2	2	R3	.	.
83	488	→ 490	0.30	i - j	S 355	2	2	R3	.	.
84	490	→ 492	0.30	i - j	S 355	2	2	R3	.	.
85	492	→ 494	0.30	i - j	S 355	2	2	R3	.	.
86	494	→ 496	0.30	i - j	S 355	2	2	R3	.	.
87	496	→ 498	0.30	i - j	S 355	2	2	R3	.	.
88	498	→ 500	0.30	i - j	S 355	2	2	R3	.	.
89	500	→ 502	0.30	i - j	S 355	2	2	R3	.	.
90	502	→ 504	0.30	i - j	S 355	2	2	R3	.	.
91	504	→ 506	0.30	i - j	S 355	2	2	R3	.	.
92	457	← 508	0.12	j - i	S 355	2	2	R2	.	.
93	510	→ 512	0.30	i - j	S 355	2	2	R3	.	.
94	512	→ 514	0.30	i - j	S 355	2	2	R3	.	.
95	514	→ 516	0.30	i - j	S 355	2	2	R3	.	.
96	516	→ 518	0.30	i - j	S 355	2	2	R3	.	.
97	518	→ 520	0.30	i - j	S 355	2	2	R3	.	.
98	520	→ 522	0.30	i - j	S 355	2	2	R3	.	.
99	522	→ 524	0.30	i - j	S 355	2	2	R3	.	.
100	524	→ 526	0.30	i - j	S 355	2	2	R3	.	.
101	526	→ 528	0.30	i - j	S 355	2	2	R3	.	.
102	528	→ 530	0.30	i - j	S 355	2	2	R3	.	.
103	530	→ 532	0.30	i - j	S 355	2	2	R3	.	.
104	532	→ 534	0.30	i - j	S 355	2	2	R3	.	.
105	450	← 536	0.11	j - i	S 355	2	2	R3	.	.
106	538	→ 540	0.30	i - j	S 355	2	2	R3	.	.
107	540	→ 542	0.30	i - j	S 355	2	2	R3	.	.
108	542	→ 544	0.30	i - j	S 355	2	2	R3	.	.
109	544	→ 546	0.30	i - j	S 355	2	2	R3	.	.
110	546	→ 548	0.30	i - j	S 355	2	2	R3	.	.
111	548	→ 550	0.30	i - j	S 355	2	2	R3	.	.
112	550	→ 552	0.30	i - j	S 355	2	2	R3	.	.
113	552	→ 554	0.30	i - j	S 355	2	2	R3	.	.
114	554	→ 556	0.30	i - j	S 355	2	2	R3	.	.
115	556	→ 558	0.30	i - j	S 355	2	2	R3	.	.
116	558	→ 560	0.30	i - j	S 355	2	2	R3	.	.
117	560	→ 562	0.30	i - j	S 355	2	2	R3	.	.
118	562	→ 564	0.30	i - j	S 355	2	2	R3	.	.
119	564	→ 566	0.30	i - j	S 355	2	2	R3	.	.
120	428	← 568	0.21	j - i	S 355	2	2	R3	.	.
121	479	← 481	0.30	j - i	S 355	2	2	R2	.	.
122	481	← 483	0.30	j - i	S 355	2	2	R2	.	.
123	470	→ 485	0.09	i - j	S 355	2	2	R3	.	.
124	487	← 489	0.30	j - i	S 355	2	2	R2	.	.
125	489	← 491	0.30	j - i	S 355	2	2	R2	.	.
126	491	← 493	0.30	j - i	S 355	2	2	R2	.	.
127	493	← 495	0.30	j - i	S 355	2	2	R2	.	.
128	495	← 497	0.30	j - i	S 355	2	2	R2	.	.
129	497	← 499	0.30	j - i	S 355	2	2	R2	.	.
130	499	← 501	0.30	j - i	S 355	2	2	R2	.	.
131	501	← 503	0.30	j - i	S 355	2	2	R2	.	.
132	503	← 505	0.30	j - i	S 355	2	2	R2	.	.
133	505	← 507	0.30	j - i	S 355	2	2	R2	.	.
134	456	→ 509	0.12	i - j	S 355	2	2	R2	.	.
135	511	← 513	0.30	j - i	S 355	2	2	R2	.	.
136	513	← 515	0.30	j - i	S 355	2	2	R2	.	.
137	515	← 517	0.30	j - i	S 355	2	2	R2	.	.
138	517	← 519	0.30	j - i	S 355	2	2	R2	.	.
139	519	← 521	0.30	j - i	S 355	2	2	R2	.	.
140	521	← 523	0.30	j - i	S 355	2	2	R2	.	.

Beams [ladder]

	Node i	Node j	Length	Local x	Material	Start cross-section	End cross-section	Ref_z	ER_{St}	ER_{End}
141	523	← 525	0.30	j - i	S 355	2	2	R2	.	.
142	525	← 527	0.30	j - i	S 355	2	2	R2	.	.
143	527	← 529	0.30	j - i	S 355	2	2	R2	.	.
144	529	← 531	0.30	j - i	S 355	2	2	R2	.	.
145	531	← 533	0.30	j - i	S 355	2	2	R2	.	.
146	533	← 535	0.30	j - i	S 355	2	2	R2	.	.
147	451	→ 537	0.10	i - j	S 355	2	2	R2	.	.
148	539	← 541	0.30	j - i	S 355	2	2	R2	.	.
149	541	← 543	0.30	j - i	S 355	2	2	R2	.	.
150	543	← 545	0.30	j - i	S 355	2	2	R2	.	.
151	545	← 547	0.30	j - i	S 355	2	2	R2	.	.
152	547	← 549	0.30	j - i	S 355	2	2	R2	.	.
153	549	← 551	0.30	j - i	S 355	2	2	R2	.	.
154	551	← 553	0.30	j - i	S 355	2	2	R2	.	.
155	553	← 555	0.30	j - i	S 355	2	2	R2	.	.
156	555	← 557	0.30	j - i	S 355	2	2	R2	.	.
157	557	← 559	0.30	j - i	S 355	2	2	R2	.	.
158	559	← 561	0.30	j - i	S 355	2	2	R2	.	.
159	561	← 563	0.30	j - i	S 355	2	2	R2	.	.
160	563	← 565	0.30	j - i	S 355	2	2	R2	.	.
161	565	← 567	0.30	j - i	S 355	2	2	R2	.	.
162	429	→ 569	0.21	i - j	S 355	2	2	R2	.	.
163	471	→ 486	0.21	i - j	S 355	2	2	R3	.	.
164	457	→ 510	0.18	i - j	S 355	2	2	R3	.	.
165	450	→ 538	0.20	i - j	S 355	2	2	R3	.	.
166	470	← 487	0.21	j - i	S 355	2	2	R2	.	.
167	456	← 511	0.18	j - i	S 355	2	2	R2	.	.
168	451	← 539	0.20	j - i	S 355	2	2	R2	.	.
169	430	← 570	1.50	j - i	S 355	8	8	Auto	.	.
170	432	→ 438	0.90	i - j	S 355	8	8	R1	.	.
171	442	→ 476	0.30	i - j	S 355	2	2	R3	100000	.
172	443	← 477	0.30	j - i	S 355	2	2	R2	.	100000
173	442	← 570	0.05	j - i	S 355	1	1	R1	.	.
174	434	→ 436	0.90	i - j	S 355	8	8	R1	.	.
175	433	← 571	1.50	j - i	S 355	8	8	R1	.	.
176	423	→ 428	0.05	i - j	S 355	8	8	R1	.	.
177	422	← 429	0.05	j - i	S 355	8	8	R1	.	.
178	428	→ 429	0.50	i - j	S 355	8	8	R1	.	.
179	566	→ 568	0.30	i - j	S 355	2	2	R3	.	.
180	421	→ 425	0.85	i - j	S 355	8	8	Auto	.	.
181	420	← 424	0.85	j - i	S 355	8	8	Auto	.	.
182	445	← 571	0.60	j - i	S 355	8	8	R1	.	.
183	439	→ 445	0.60	i - j	S 355	8	8	Auto	.	.
184	482	→ 484	0.30	i - j	S 355	2	2	R3	.	.
185	506	→ 508	0.30	i - j	S 355	2	2	R3	.	.
186	534	→ 536	0.30	i - j	S 355	2	2	R3	.	.
187	483	← 485	0.30	j - i	S 355	2	2	R2	.	.
188	507	← 509	0.30	j - i	S 355	2	2	R2	.	.
189	535	← 537	0.30	j - i	S 355	2	2	R2	.	.
190	567	← 569	0.30	j - i	S 355	2	2	R2	.	.
191	437	→ 570	0.60	i - j	S 355	8	8	Auto	.	.
192	431	→ 437	0.90	i - j	S 355	8	8	Auto	.	.
193	476	→ 478	0.30	i - j	S 355	2	2	R3	.	.
194	477	← 479	0.30	j - i	S 355	2	2	R2	.	.
195	444	→ 570	0.60	i - j	S 355	8	8	R1	.	.
196	436	→ 444	0.60	i - j	S 355	8	8	R1	.	.
197	438	→ 571	0.60	i - j	S 355	8	8	R1	.	.

Node i: Node at i end; **Node j:** Node at j end; **Length:** Beam length; **Local x:** Local x direction; $\mathbf{Ref_z}$: Reference for local z direction; $\mathbf{ER_{St}}$: End releases at start point; $\mathbf{ER_{End}}$: End releases at end point;



ladder_Beams

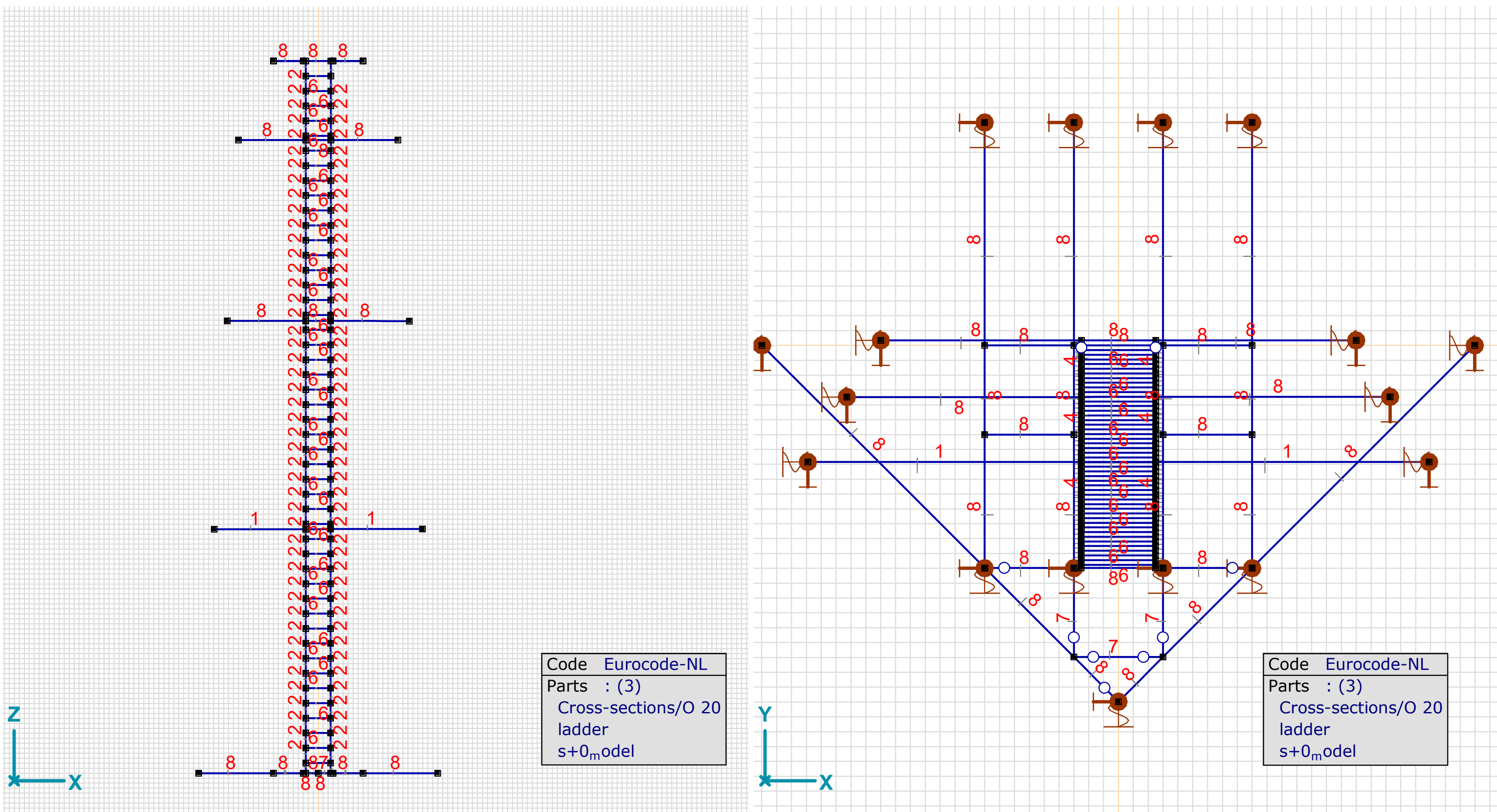
Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r_1 [mm]	r_2 [mm]	r_3 [mm]	Ax [mm^2]	Ay [mm^2]	Az [mm^2]	Ix [mm^4]	Iy [mm^4]	Iz [mm^4]
1	L 100X100X 8		Rolled	L	100.0	100.0	8.0	8.0	12.0	6.0	0	1551.52	669.67	678.46	36218.9	1448264.0	1448264.0
2	L 100X 50X 6X		Rolled	L	100.0	50.0	6.0	6.0	9.0	4.5	0	872.73	231.48	516.47	11460.0	897072.9	152537.5
3	L 120X120X10		Rolled	L	120.0	120.0	10.0	10.0	13.0	6.5	0	2318.22	1004.33	1014.85	82759.6	3129113.0	3129113.0
4	80x8		Rolled	Rect.	8.0	80.0	0	0	0	0	0	640.00	533.33	533.33	12791.5	3413.3	341333.3
5	L 55X 55X 6		Rolled	L	55.0	55.0	6.0	6.0	8.0	4.0	0	630.90	278.51	282.29	8324.3	172850.1	172850.2
6	O 20		Other	Round	20.0	20.0	0	0	0	0	0	314.10	269.22	269.22	15708.0	7850.8	7850.8
7	L 60X 60X 6		Rolled	L	60.0	60.0	6.0	6.0	8.0	4.0	0	690.90	302.80	306.64	9044.2	227898.9	227898.9
8	L 80X 80X 8		Rolled	L	80.0	80.0	8.0	8.0	10.0	5.0	0	1226.78	537.99	544.05	28221.9	722397.8	722397.8

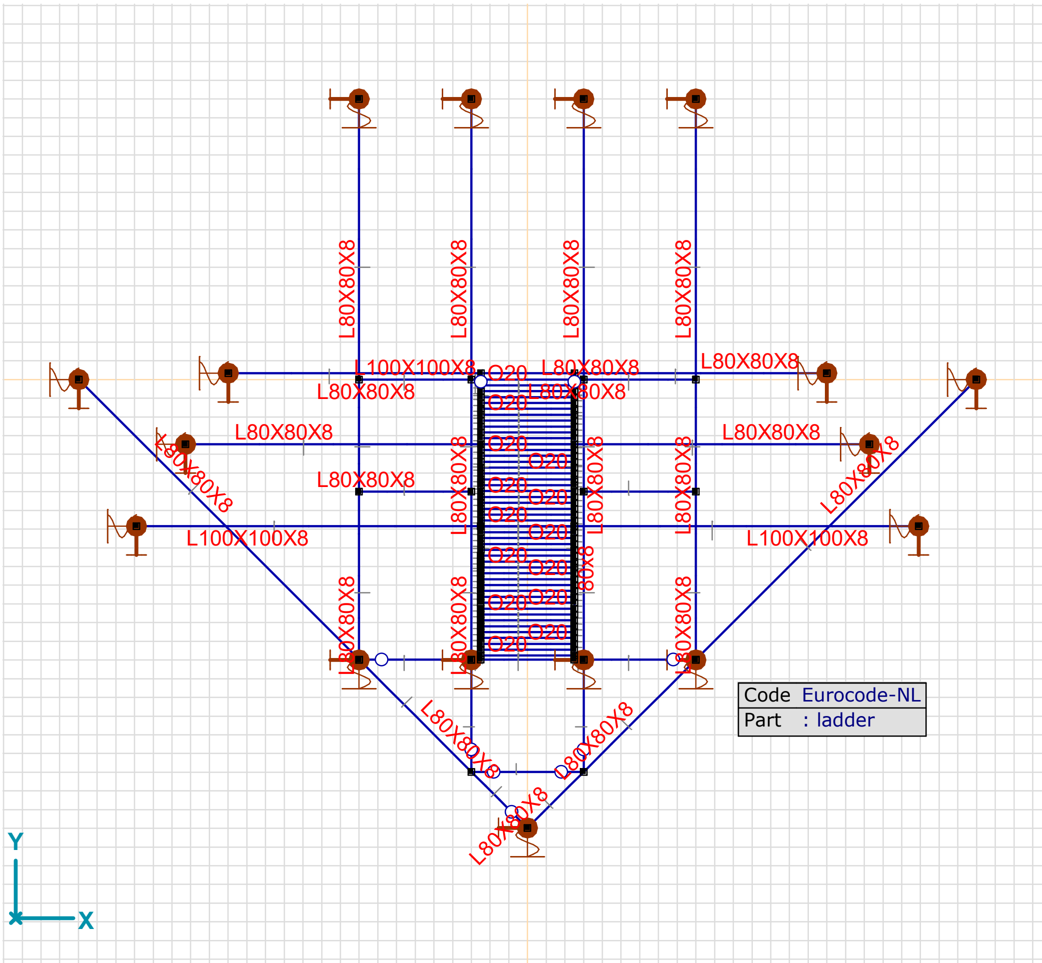
	Name	Iyz [mm^4]	I_1 [mm^4]	I_2 [mm^4]	α [°]	Iω [mm^6]	$W_{1,el,t}$ [mm^3]	$W_{1,el,b}$ [mm^3]	$W_{2,el,t}$ [mm^3]	$W_{2,el,b}$ [mm^3]	$W_{1,pl}$ [mm^3]	$W_{2,pl}$ [mm^3]	i_y [mm]	i_z [mm]	Hy [mm]	Hz [mm]
1	L 100X100X 8	−849655.4	2297919.0	598608.2	45.00	2.3E+07	32497.5	32497.5	17014.9	15467.6	51224.3	26412.7	30.6	30.6	100.0	100.0
2	L 100X 50X 6X	−207618.9	951054.9	98555.4	14.57	5624540	14496.4	21734.5	3281.0	5221.4	25285.3	7359.8	32.1	13.2	50.0	100.0
3	L 120X120X10	−1840138.0	4969251.0	1288975.0	45.00	7.9E+07	58563.2	58563.2	30420.2	27507.4	92246.3	47331.9	36.7	36.7	120.0	120.0
4	80x8	0	341333.3	3413.3	90.00	1736982	8533.3	8533.3	853.3	853.3	12800.0	1280.0	2.3	23.1	80.0	8.0
5	L 55X 55X 6	−101063.0	273913.2	71787.1	45.00	1527235	7043.1	7043.1	3705.3	3247.9	11266.6	5820.9	16.6	16.6	55.0	55.0
6	O 20	0	7850.8	7850.8	0	0	785.1	785.1	785.1	785.1	1332.9	1332.9	5.0	5.0	20.0	20.0
7	L 60X 60X 6	−133497.7	361396.6	94401.2	45.00	2037188	8518.2	8518.2	4463.6	3956.0	13554.5	6989.1	18.2	18.2	60.0	60.0
8	L 80X 80X 8	−423612.4	1146010.0	298785.4	45.00	1.2E+07	20258.8	20258.8	10570.7	9369.6	32196.1	16562.3	24.3	24.3	80.0	80.0

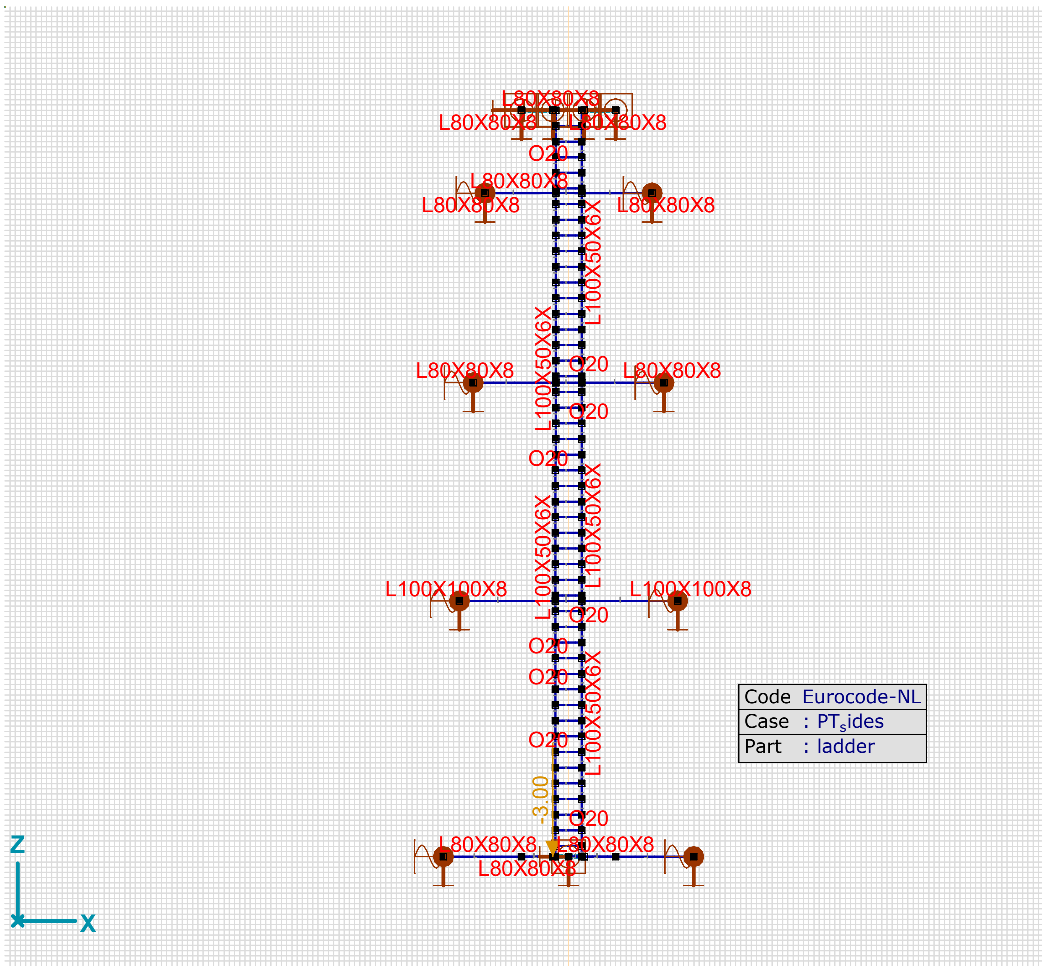
	Name	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
1	L 100X100X 8	27.4	27.4	−22.6	−22.6	4
2	L 100X 50X 6X	10.4	34.9	−7.3	−30.2	4
3	L 120X120X10	33.1	33.1	−27.3	−27.3	4
4	80x8	40.0	4.0	0	0	5
5	L 55X 55X 6	15.6	15.6	−12.0	−12.0	4
6	O 20	10.0	10.0	0	0	5
7	L 60X 60X 6	16.9	16.9	−13.3	−13.3	4
8	L 80X 80X 8	22.5	22.5	−17.8	−17.8	4

Name: Cross-section name; **Process:** Manufacturing process; **h:** Cross-section height; **b:** Cross-section width; **tw:** Web thickness; **tf:** Flange thickness; **r_1, r_2, r_3:** Rounding radius; **Ax:** Cross-section area; **Ay, Az:** Shear area; **Ix:** Torsional inertia; **Iy, Iz:** Flexural inertia; **Iyz:** Centrifugal inertia; **I_1, I_2:** Principal flexural inertia; **α:** Principal directions; **Iω:** Warping constant; **$W_{1,el,t}$, $W_{1,el,b}$, $W_{2,el,t}$, $W_{2,el,b}$:** Elastic modulus; **$W_{1,pl}$, $W_{2,pl}$:** Plastic modulus; **i_y, i_z:** Radius of inertia; **Hy:** Dimension in local y direction; **Hz:** Dimension in local z direction; **y_G:** y coordinate of the center of gravity; **z_G:** z coordinate of the center of gravity; **y_s:** y coordinate of the shear (torsion) center relative to the center of gravity; **z_s:** z coordinate of the shear (torsion) center relative to the center of gravity; **S.p.:** Stress calculation points;



ladder_cross_section





ladder_cross_section_name

Nodal supports [ladder]

	Node	X [m]	Y [m]	Z [m]
1	185	2.398	0	25.200
2	186	−2.398	0	25.200
3	430	−0.300	1.500	39.500
4	431	−0.300	−1.500	39.500
5	432	0.300	−1.500	39.500
6	433	0.300	1.500	39.500
7	434	−0.900	−1.500	39.500
8	435	−0.900	1.500	39.500
9	440	0.900	1.500	39.500
10	441	0.900	−1.500	39.500
11	459	1.827	−0.347	34.280
12	461	−1.827	−0.347	34.280
13	463	−2.090	−0.785	30.100
14	465	2.090	−0.785	30.102
15	473	1.599	0.034	37.913
16	475	−1.599	0.034	37.913
17	184	0	−2.398	25.200

	Node	Type	$Name_x$	K_x [kN/m]	K_{xV} [kN/m]	$Name_y$	K_y [kN/m]	K_{yV} [kN/m]	$Name_z$	K_z [kN/m]	K_{zV} [kN/m]	$Name_{xx}$	K_{xx} [kNm/rad]
1	185	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
2	186	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
3	430	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
4	431	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
5	432	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
6	433	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
7	434	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
8	435	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
9	440	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
10	441	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–
11	459	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
12	461	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
13	463	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
14	465	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
15	473	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
16	475	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Rotational	1E+10
17	184	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–

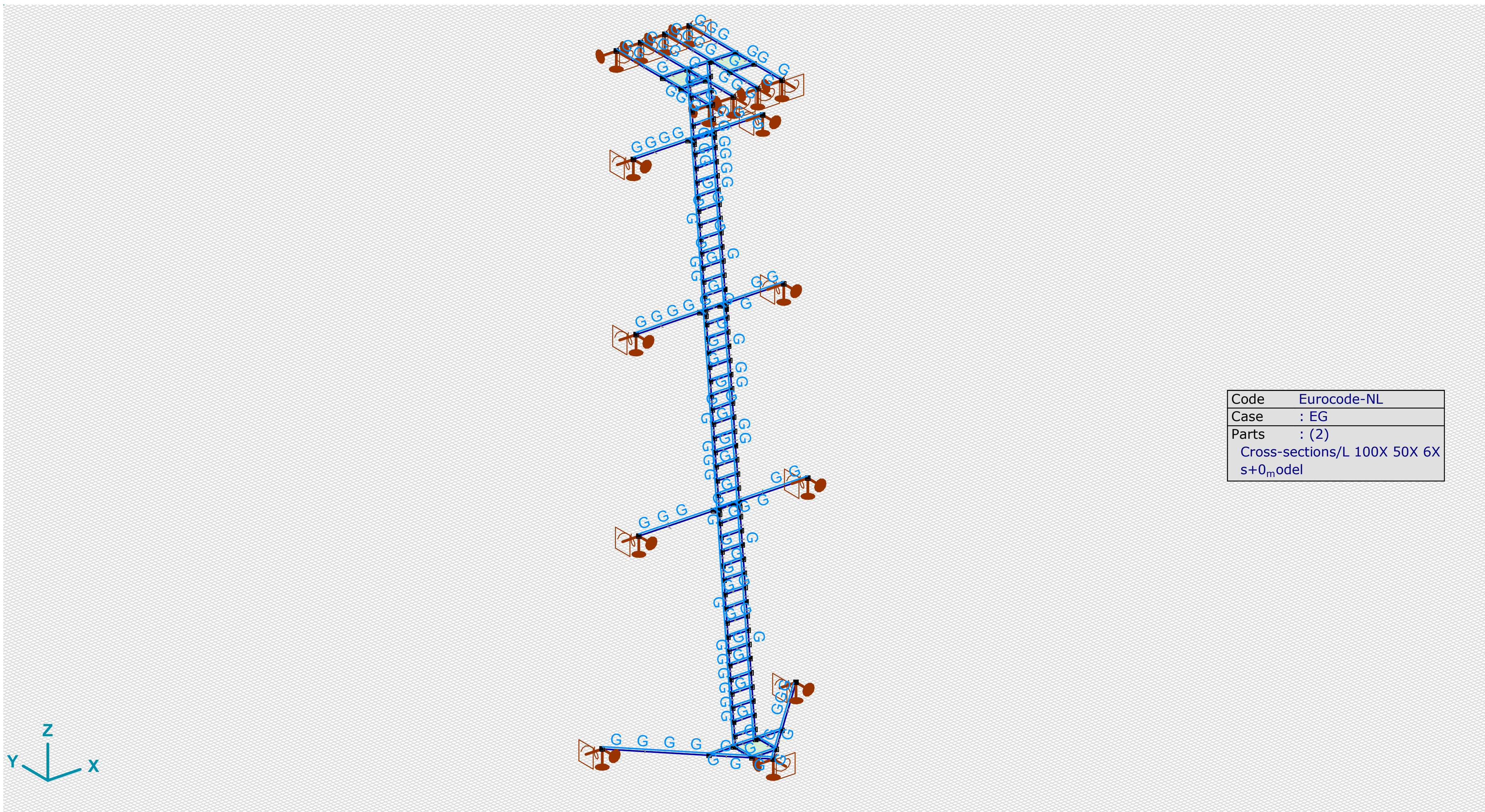
	Node	K_{xxV} [kNm/rad]	$Name_{yy}$	K_{yy} [kNm/rad]	K_{yyV} [kNm/rad]	$Name_{zz}$	K_{zz} [kNm/rad]	K_{zzV} [kNm/rad]
1	185	1E+10	—	–	–	—	–	–
2	186	1E+10	—	–	–	—	–	–
3	430	–	Rigid - Rotational	1E+10	1E+10	—	–	–
4	431	–	Rigid - Rotational	1E+10	1E+10	—	–	–
5	432	–	Rigid - Rotational	1E+10	1E+10	—	–	–
6	433	–	Rigid - Rotational	1E+10	1E+10	—	–	–
7	434	–	Rigid - Rotational	1E+10	1E+10	—	–	–
8	435	–	Rigid - Rotational	1E+10	1E+10	—	–	–
9	440	–	Rigid - Rotational	1E+10	1E+10	—	–	–
10	441	–	Rigid - Rotational	1E+10	1E+10	—	–	–
11	459	1E+10	—	–	–	—	–	–
12	461	1E+10	—	–	–	—	–	–
13	463	1E+10	—	–	–	—	–	–
14	465	1E+10	—	–	–	—	–	–
15	473	1E+10	—	–	–	—	–	–
16	475	1E+10	—	–	–	—	–	–
17	184	–	Rigid - Rotational	1E+10	1E+10	—	–	–

Node: Supported node; **Type:** Support type; **$Name_x$:** Name of the spring characteristics; **K_x:** Initial stiffness; **K_{xV}:** Vibration stiffness; **$Name_y$:** Name of the spring characteristics; **K_y:** Initial stiffness; **K_{yV}:** Vibration stiffness; **$Name_z$:** Name of the spring characteristics; **K_z:** Initial stiffness; **K_{zV}:** Vibration stiffness; **$Name_{xx}$:** Name of the spring characteristics; **K_{xx}:** Initial stiffness; **K_{xxV}:** Vibration stiffness; **$Name_{yy}$:** Name of the spring characteristics; **K_{yy}:** Initial stiffness; **K_{yyV}:** Vibration stiffness; **$Name_{zz}$:** Name of the spring characteristics; **K_{zz}:** Initial stiffness; **K_{zzV}:** Vibration stiffness;

EG: Beam self weight [ladder]

	Σ [kg]
1–452	615.009
Total	**615.009**

Σ: Total mass;

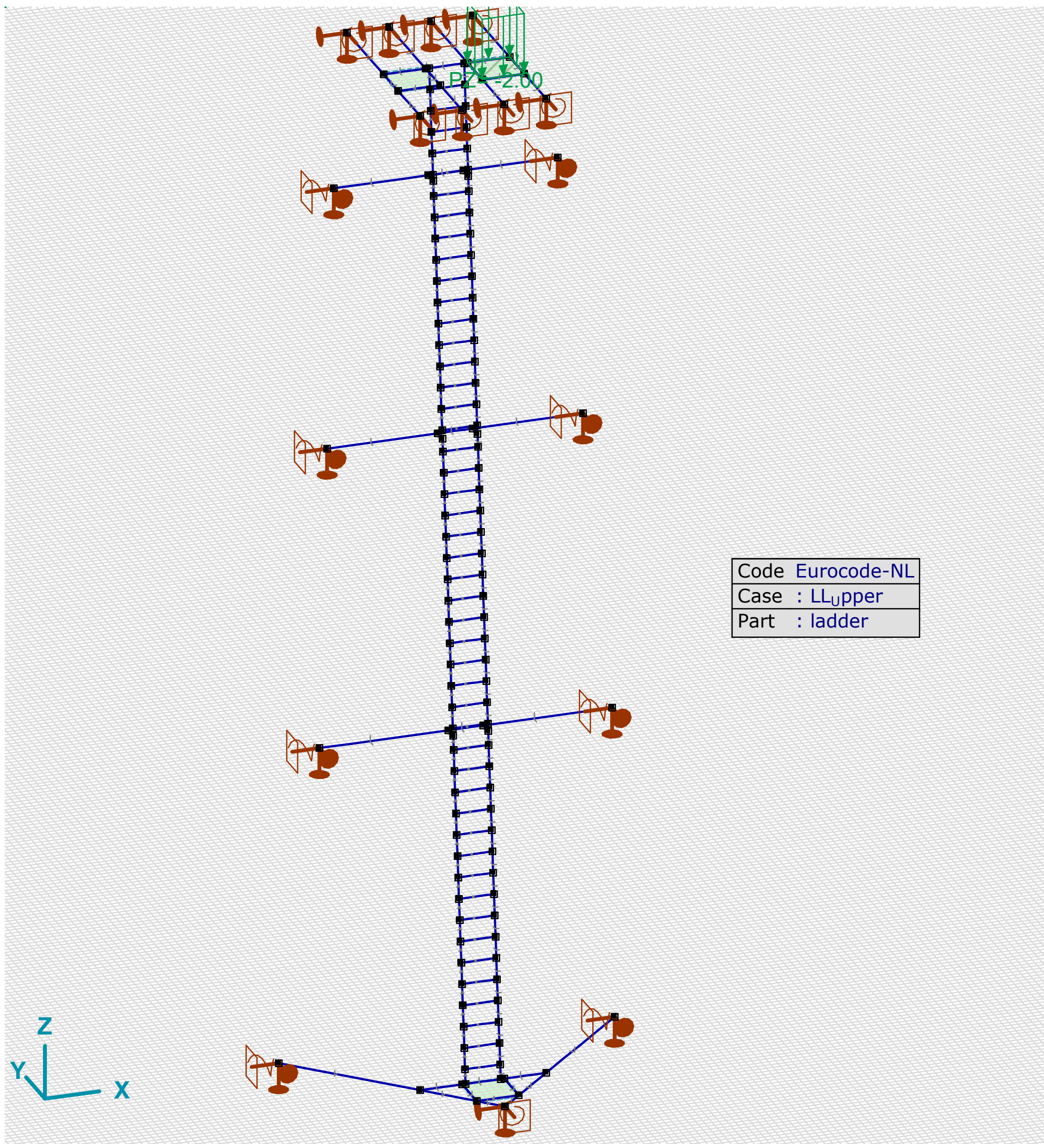


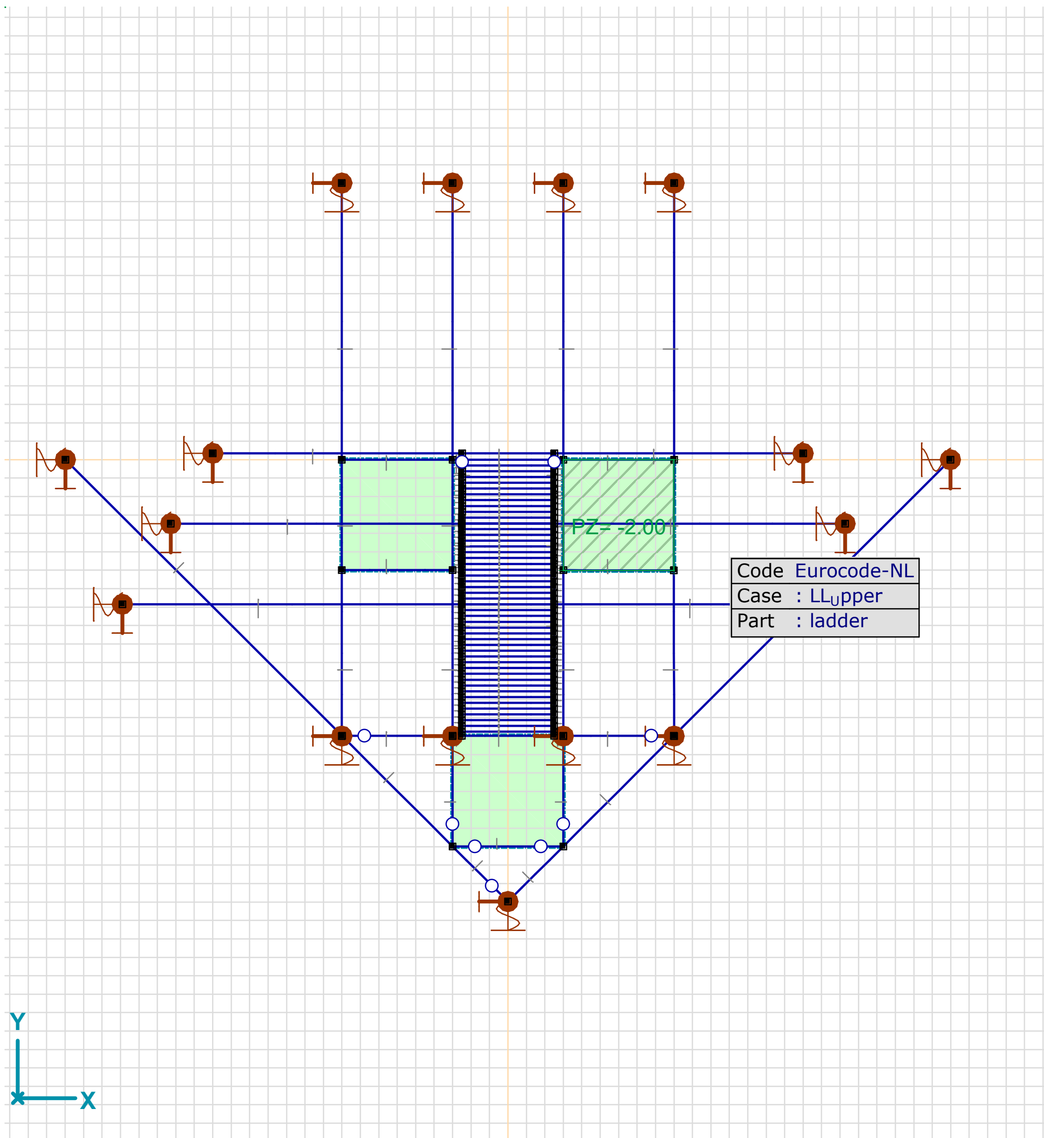
ladder_EG

LL_Upper: Domain area load [ladder]

	Element	*Index*	*Direction*	*Type*	*In hole*	*Comp.*	*Value [kN/m²]*	*X [m]*	*Y [m]*	*Z [m]*
	Panel*	1	Global	Constant	no	pX =	0	0.900	−0.600	39.500
						pY =	0	0.900	0	39.500
						pZ =	−2.00	0.300	0	39.500
								0.300	−0.600	39.500

In hole: Loads allowed on holes; **Comp.:** Component; **Value:** Load component value; **X:** X coordinate of the load polygon vertices; **Y:** Y coordinate of the load polygon vertices; **Z:** Z coordinate of the load polygon vertices;



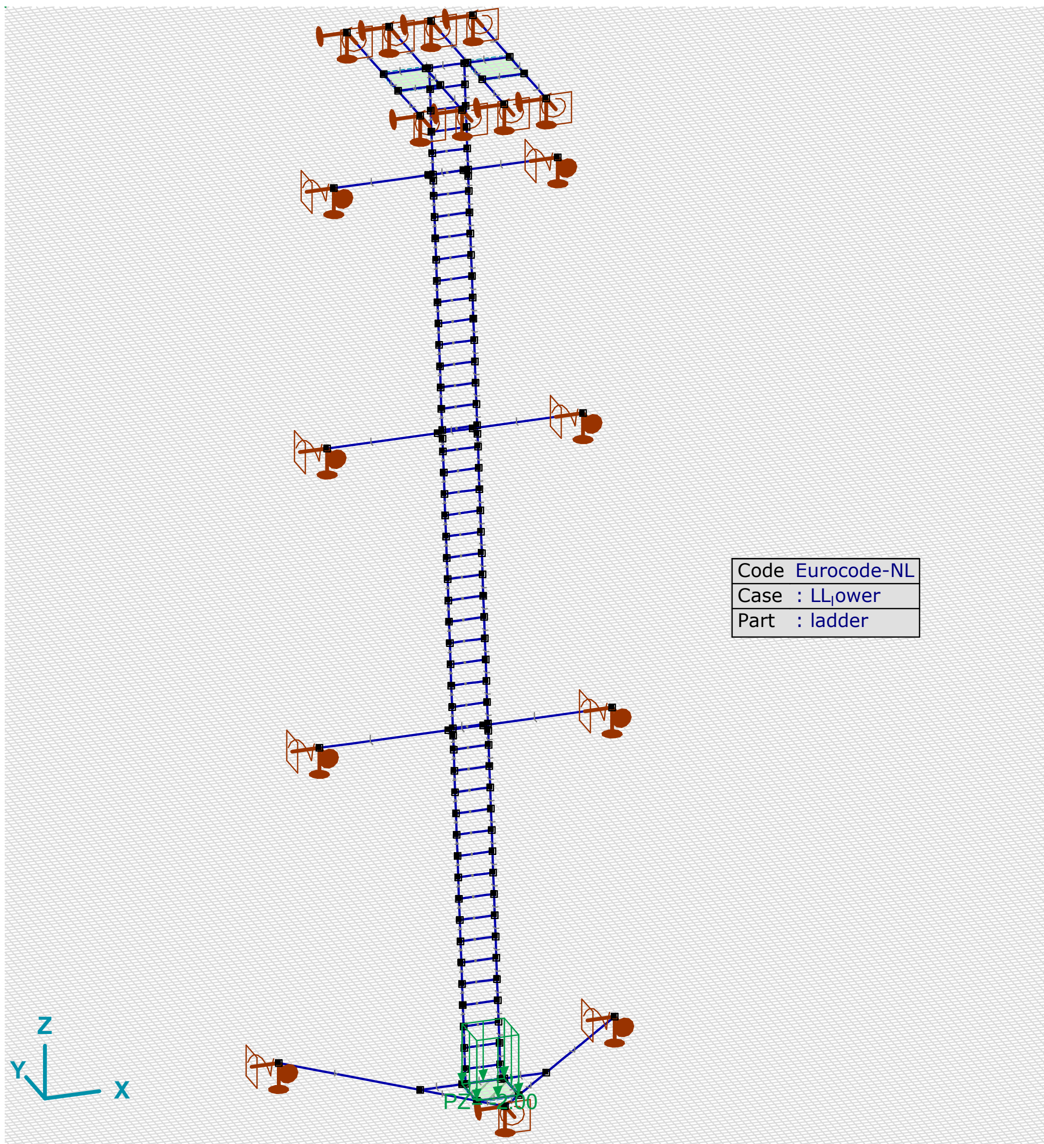


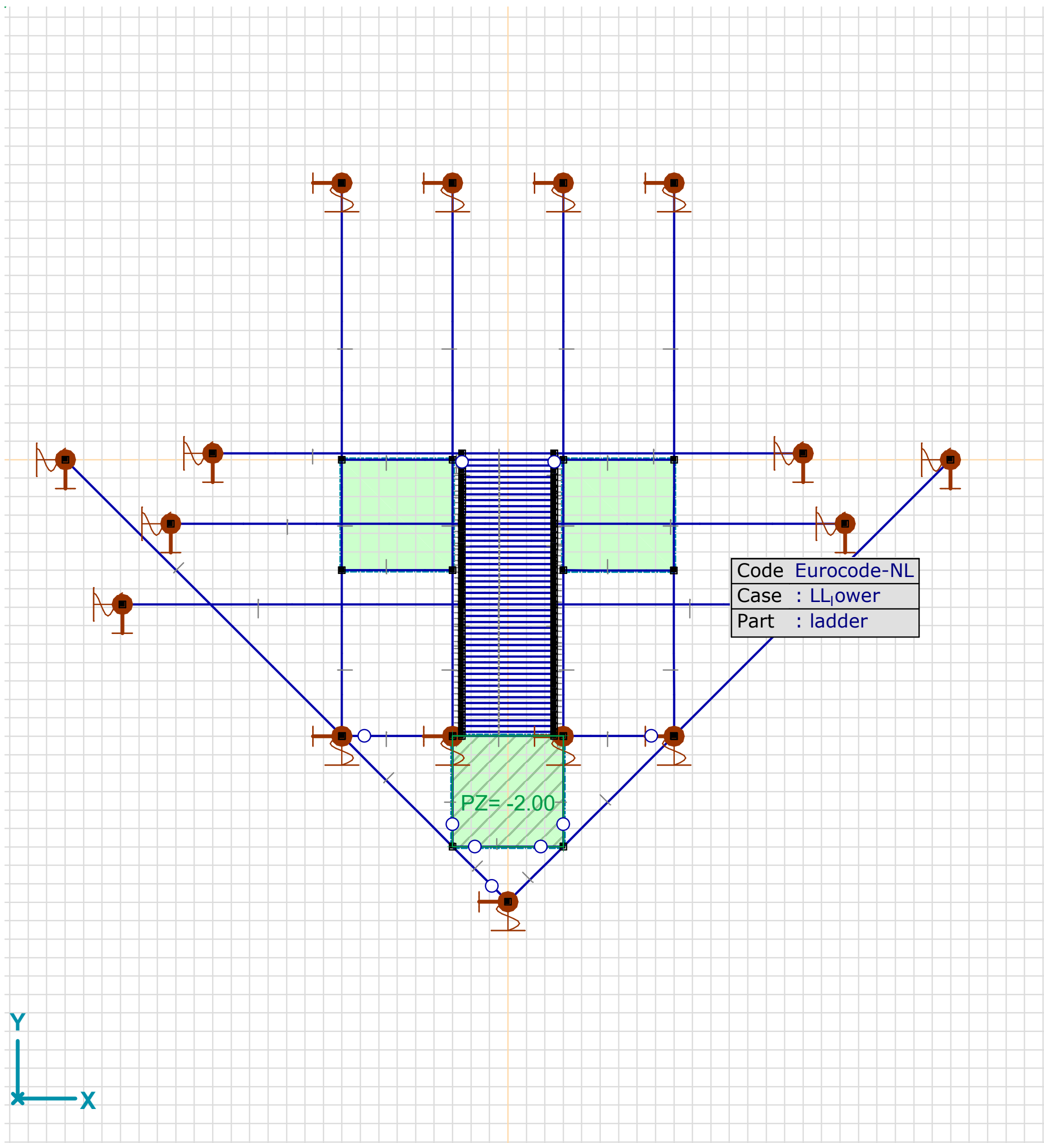
> ladder, LL_Upper

LL_lower: Domain area load [ladder]

	Element	Index	Direction	Type	In hole	Comp.	Value [kN/m²]	X [m]	Y [m]	Z [m]
	Panel*	3	Global	Constant	no	pX =	0	−0.300	−1.498	25.200
						pY =	0	−0.300	−2.098	25.200
						pZ =	−2.00	0.300	−2.098	25.200
								0.300	−1.498	25.200

In hole: Loads allowed on holes; **Comp.:** Component; **Value:** Load component value; **X:** X coordinate of the load polygon vertices; **Y:** Y coordinate of the load polygon vertices; **Z:** Z coordinate of the load polygon vertices;



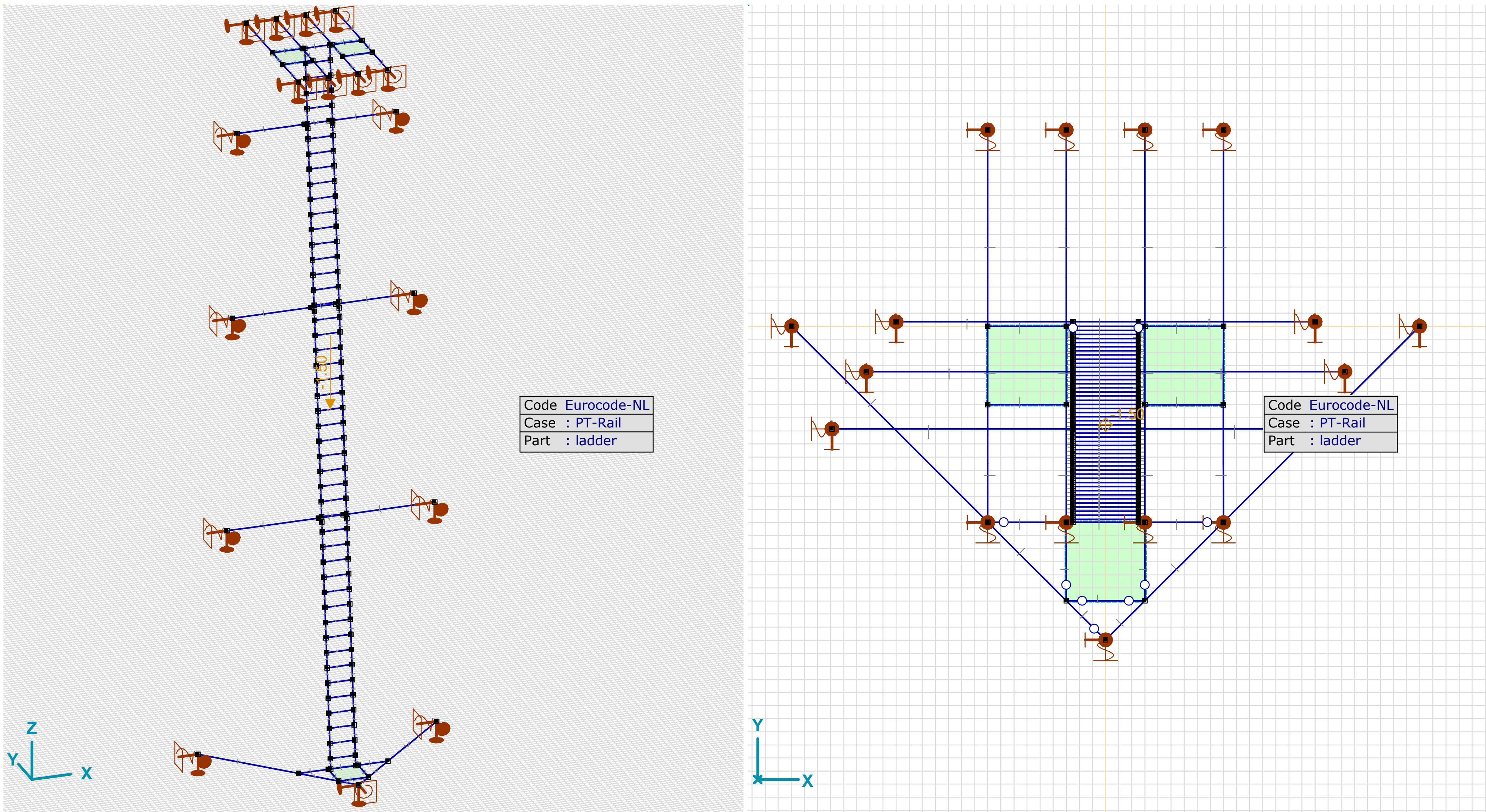


> ladder, LL_lower

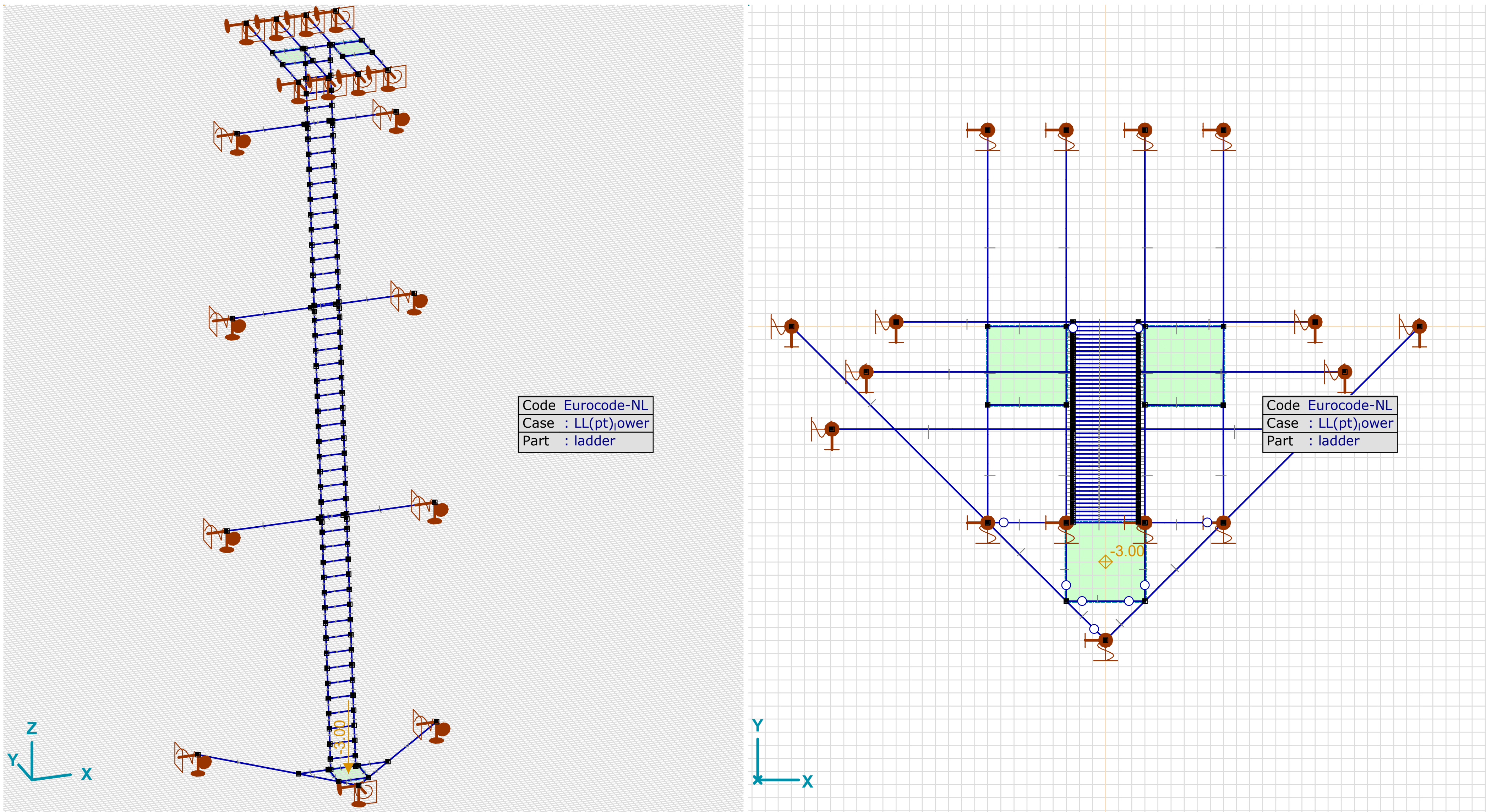
PT-Rail: Concentrated loads on beams [ladder]

	Type	Length [m]	a/d	Pos.	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
55	Beam G	0.50	a	0.500	0	0	−1.50	0	0	0

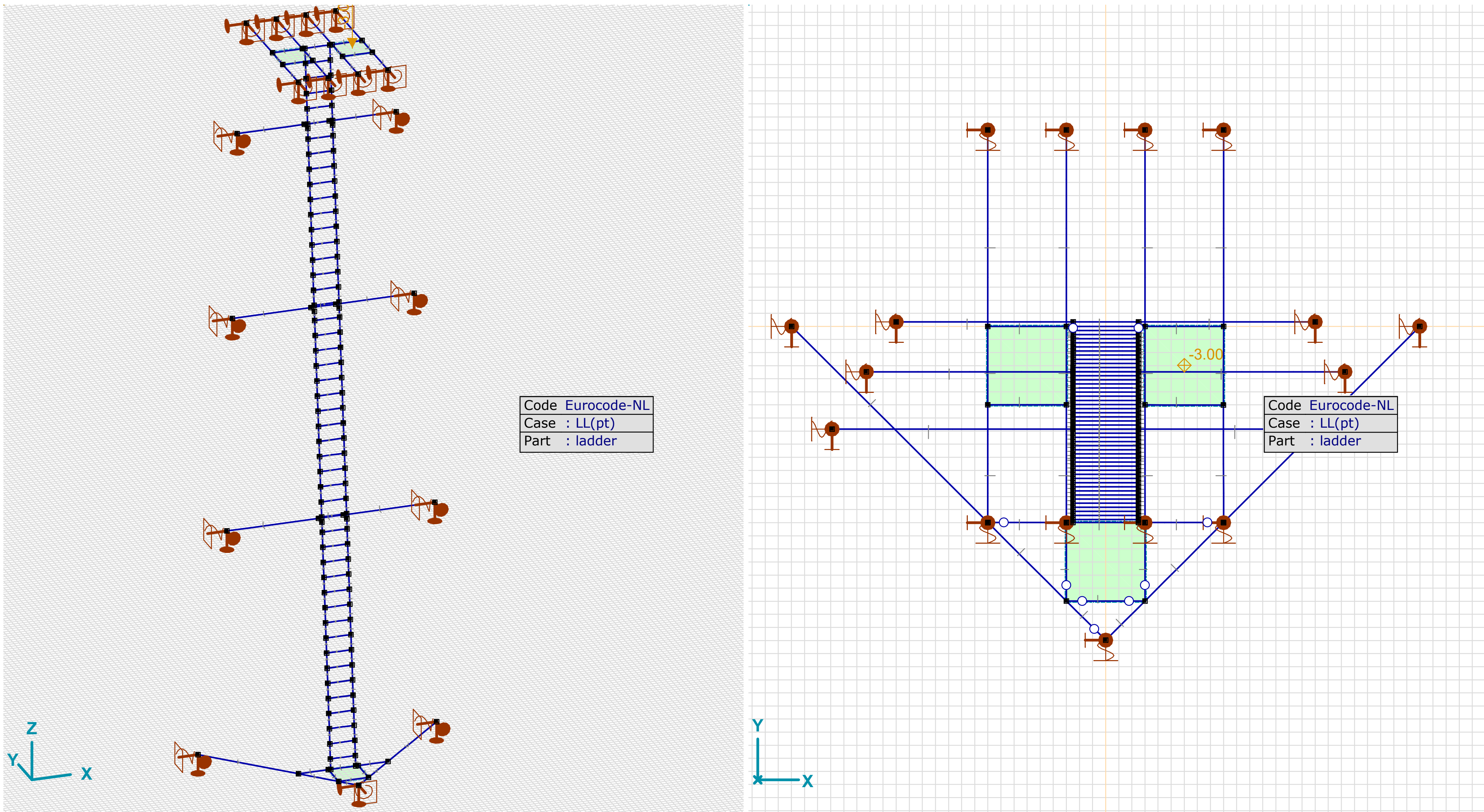
Type: Load type; **Length:** Beam length; **a/d:** Position by ratio(a) or by length(d); **Pos.:** Position; **Fx, Fy, Fz:** Load force component; **Mx, My, Mz:** Load moment component;



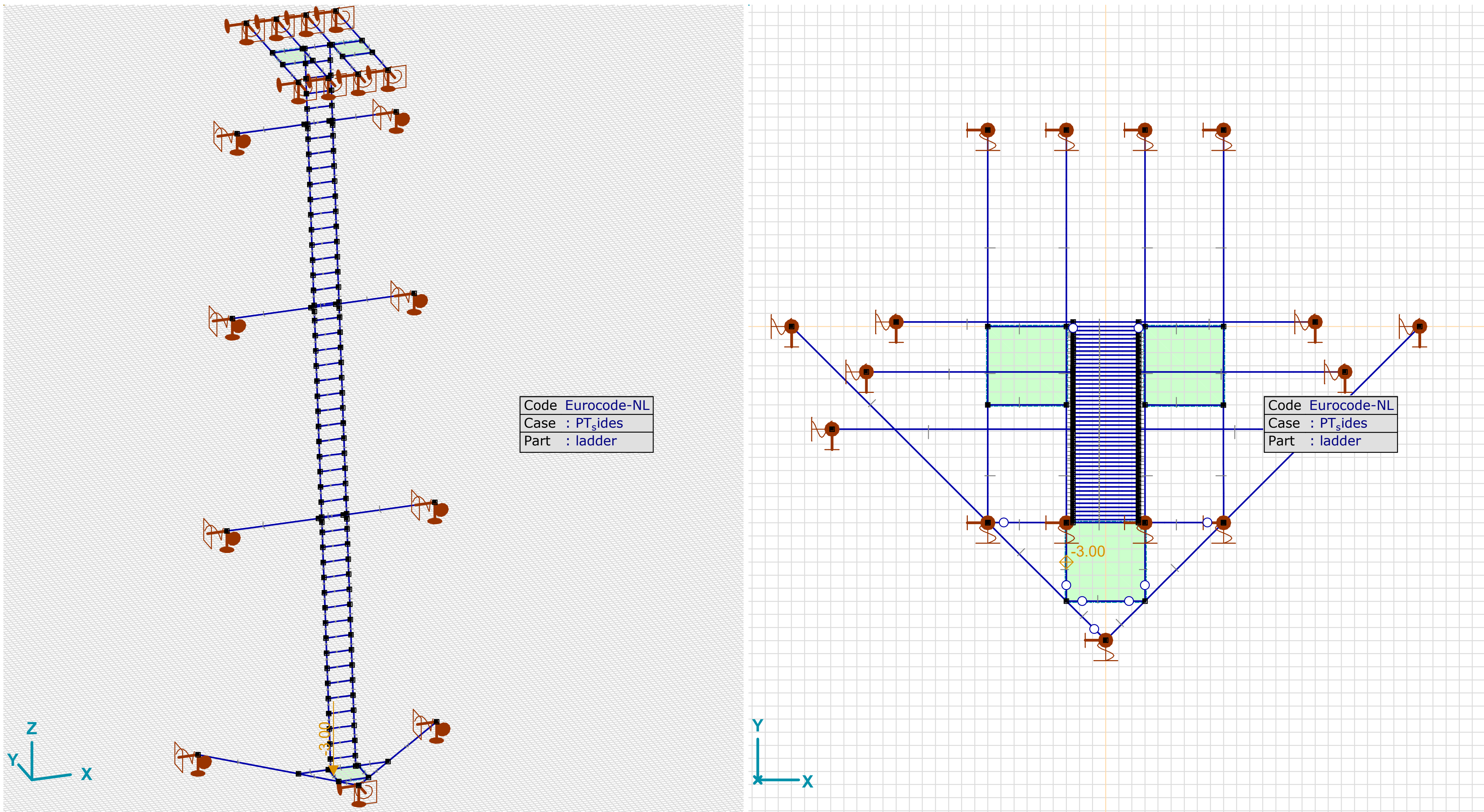
ladder, PT-Rail



ladder_LL(pt)_lower



ladder_LL(pt)



ladder_PT_sides

WL_xx: Distributed loads on beams and ribs [ladder]

	Type	Length [m]	a/d	Pos.	px [kN/m]	py [kN/m]	pz [kN/m]	m_{tor} [kNm/m]
79	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
80	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
81	Beam L	0.09	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
82	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0

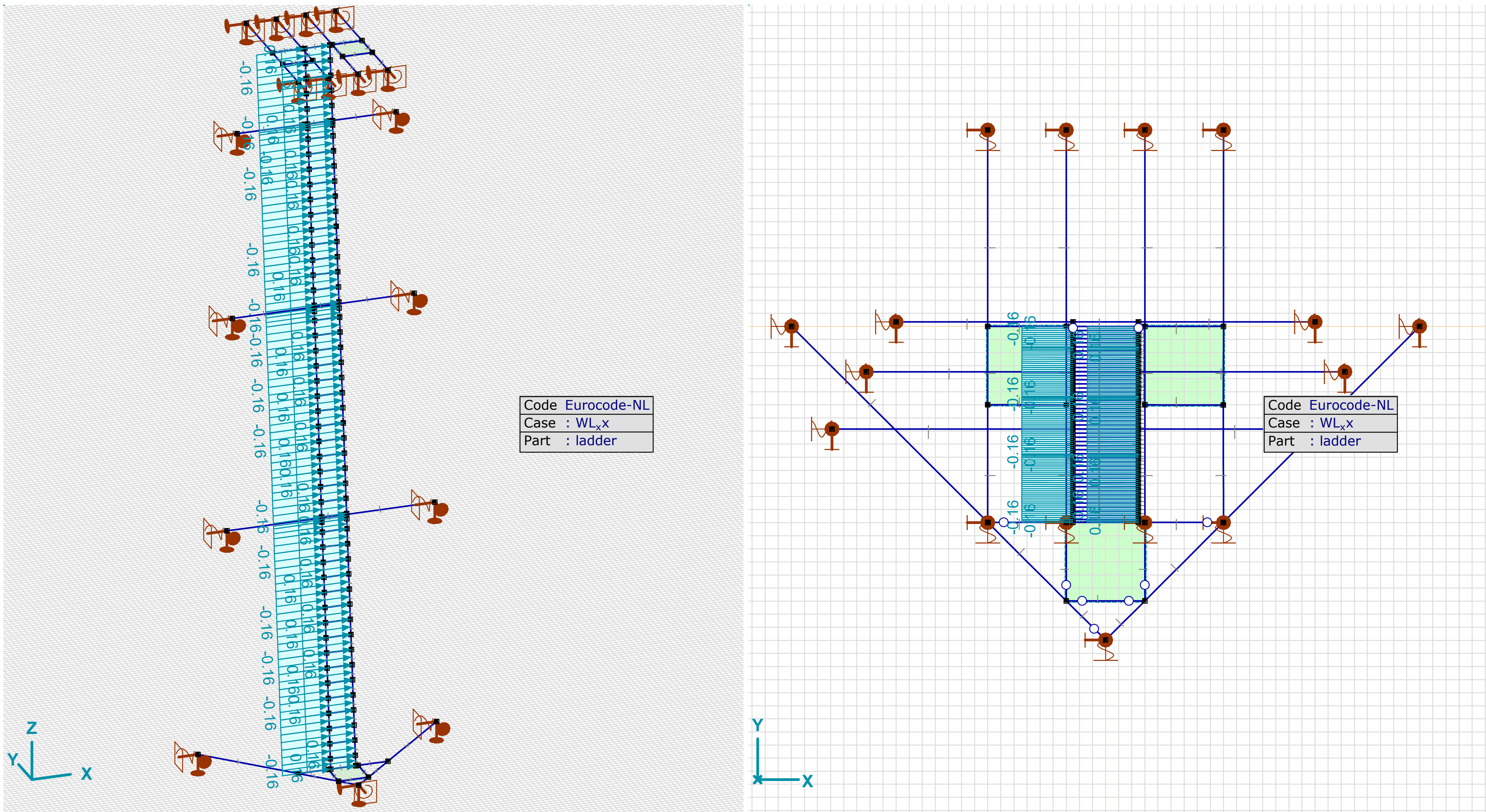
WL_xx: Distributed loads on beams and ribs [ladder]

	Type	Length [m]	a/d	Pos.	px [kN/m]	py [kN/m]	pz [kN/m]	m_{tor} [kNm/m]
83	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
84	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
85	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
86	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
87	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
88	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
89	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
90	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
91	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
92	Beam L	0.12	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
93	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
94	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
95	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
96	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
97	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
98	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
99	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
100	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
101	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
102	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
103	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
104	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
105	Beam L	0.11	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
106	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
107	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
108	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
109	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
110	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
111	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
112	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
113	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
114	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
115	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
116	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
117	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
118	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
119	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
120	Beam L	0.21	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
121	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
122	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
123	Beam L	0.09	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
124	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
125	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
126	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
127	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
128	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
129	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
130	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
131	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
132	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
133	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
134	Beam L	0.12	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
135	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
136	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
137	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
138	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
139	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
140	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
141	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
142	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
143	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
144	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
145	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
146	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
147	Beam L	0.10	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
148	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
149	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
150	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
151	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
152	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
153	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
154	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
155	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
156	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
157	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
158	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
159	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
160	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
161	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
162	Beam L	0.21	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
163	Beam L	0.21	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
164	Beam L	0.18	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
165	Beam L	0.20	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
166	Beam L	0.21	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
167	Beam L	0.18	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
168	Beam L	0.20	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
171	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
172	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
179	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
184	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
185	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
186	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0

WL_xx: Distributed loads on beams and ribs [ladder]

	Type	Length [m]	a/d	Pos.	px [kN/m]	py [kN/m]	pz [kN/m]	m_{tor} [kNm/m]
187	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
188	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
189	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
190	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0
193	Beam L	0.30	a	0	0	−0.16	0	0
				1.000	0	−0.16	0	0
194	Beam L	0.30	a	0	0	0.16	0	0
				1.000	0	0.16	0	0

Type: Load type; **Length:** Beam length; **a/d:** Position by ratio(a) or by length(d), * = throughout; **Pos.:** Position; **px, py, pz:** Load force component; m_{tor}**:** Load moment component;



ladder_WL_xx

WL_yy: Distributed loads on beams and ribs [ladder]

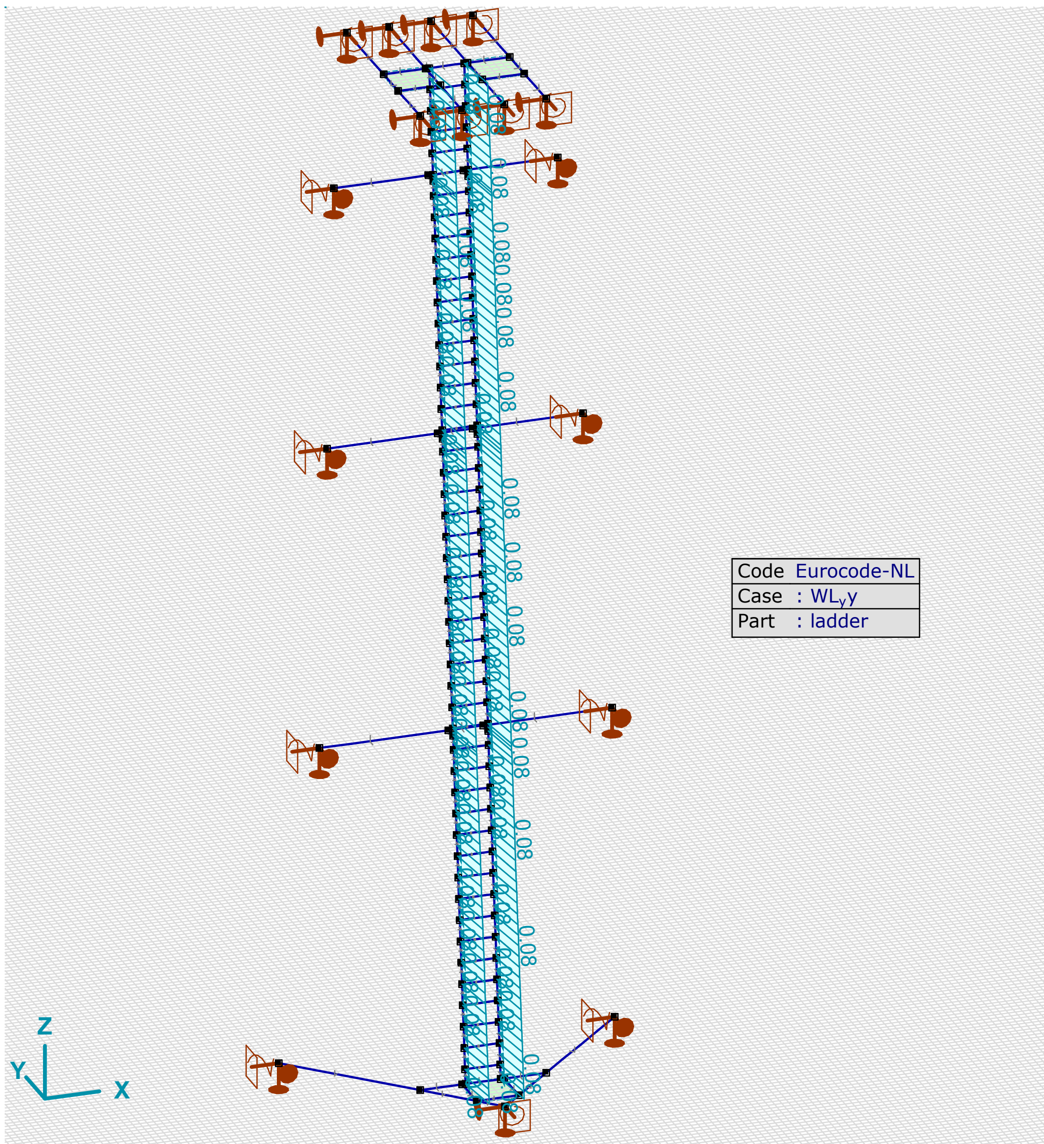
	Type	Length [m]	a/d	Pos.	px [kN/m]	py [kN/m]	pz [kN/m]	m_{tor} [kNm/m]
79	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
80	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
81	Beam L	0.09	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
82	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
83	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
84	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
85	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
86	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
87	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
88	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
89	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
90	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
91	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
92	Beam L	0.12	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
93	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
94	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
95	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
96	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
97	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
98	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
99	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
100	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
101	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
102	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
103	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
104	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
105	Beam L	0.11	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
106	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
107	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
108	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
109	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
110	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
111	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
112	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0

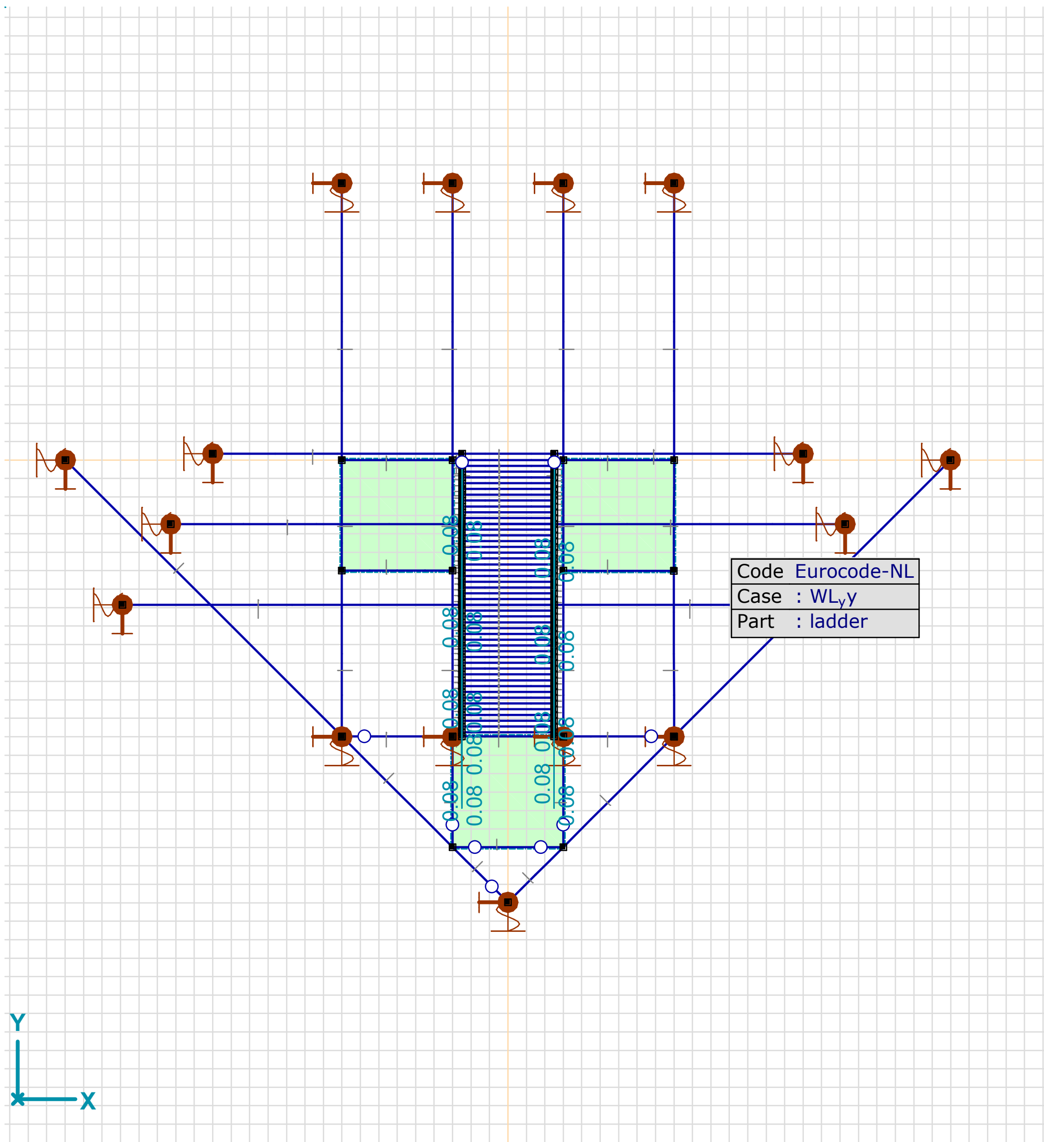
WL_yy: Distributed loads on beams and ribs [ladder]

	Type	*Length [m]*	*a/d*	*Pos.*	*px [kN/m]*	*py [kN/m]*	*pz [kN/m]*	*m_{tor} [kNm/m]*
113	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
114	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
115	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
116	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
117	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
118	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
119	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
120	Beam L	0.21	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
121	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
122	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
123	Beam L	0.09	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
124	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
125	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
126	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
127	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
128	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
129	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
130	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
131	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
132	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
133	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
134	Beam L	0.12	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
135	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
136	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
137	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
138	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
139	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
140	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
141	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
142	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
143	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
144	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
145	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
146	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0

	Type	*Length [m]*	*a/d*	*Pos.*	*px [kN/m]*	*py [kN/m]*	*pz [kN/m]*	*m_{tor} [kNm/m]*
147	Beam L	0.10	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
148	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
149	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
150	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
151	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
152	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
153	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
154	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
155	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
156	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
157	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
158	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
159	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
160	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
161	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
162	Beam L	0.21	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
163	Beam L	0.21	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
164	Beam L	0.18	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
165	Beam L	0.20	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
166	Beam L	0.21	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
167	Beam L	0.18	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
168	Beam L	0.20	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
171	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
172	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
179	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
184	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
185	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
186	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
187	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
188	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
189	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
190	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
193	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0
194	Beam L	0.30	a	0	0	0	0.08	0
				1.000	0	0	0.08	0

Type: Load type; **Length:** Beam length; **a/d:** Position by ratio(a) or by length(d), * = throughout; **Pos.:** Position; **px, py, pz:** Load force component; **m_{tor}:** Load moment component;





ladder_WL_yy

Custom load combinations by load cases

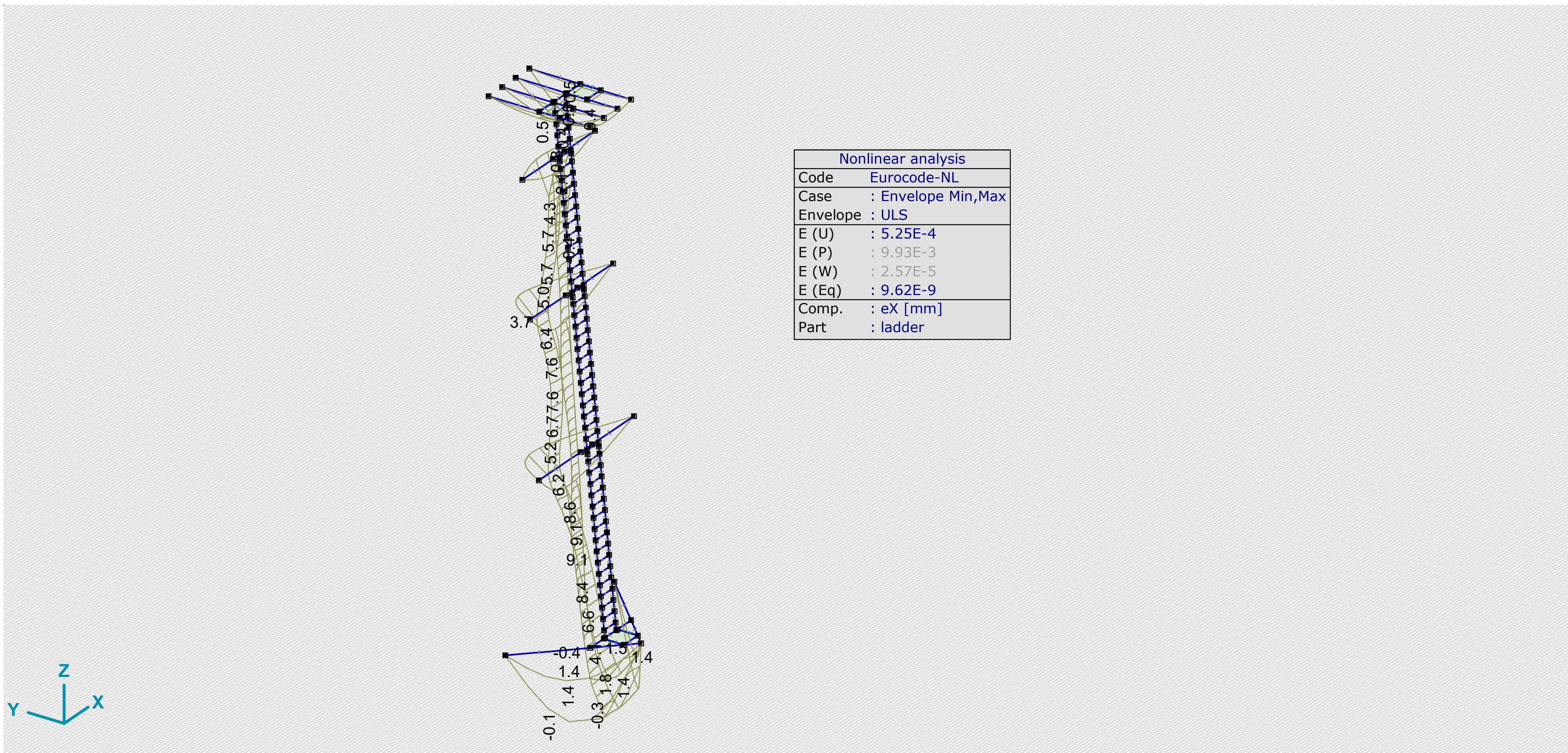
	Name	Type	EG	LL_Upper	LL(pt)	ladder_pt_Upper	LL_lower	LL(pt)_lower	PT-Rail	PT_sides	WL_xx	WL_yy	Comment
1	Co #1	ULS	1.15	1.30	0	0	0	0	0	0	0	0	
2	Co #2	ULS	1.15	0	1.30	0	0	0	0	0	0	0	
3	Co #3	ULS	1.15	0	0	1.30	0	0	0	0	0	0	
4	Co #4	ULS	1.15	0	0	0	1.30	0	0	0	0	0	
5	Co #5	ULS	1.15	0	0	0	0	1.30	0	0	0	0	
6	Co #6	ULS	1.15	0	0	0	0	0	1.30	0	0	0	
7	Co #7	ULS	1.15	0	0	0	0	0	0	1.30	0	0	
8	Co #8	ULS	1.15	0	0	0	0	0	0	0	1.40	0	
9	Co #9	ULS	1.15	0	0	0	0	0	0	0	0	1.40	

Name: Load combination name; **Type:** Load combination type; **EG, LL_Upper, LL(pt), ladder_pt_Upper, LL_lower, LL(pt)_lower, PT-Rail, PT_sides, WL_xx, WL_yy:** Factor;

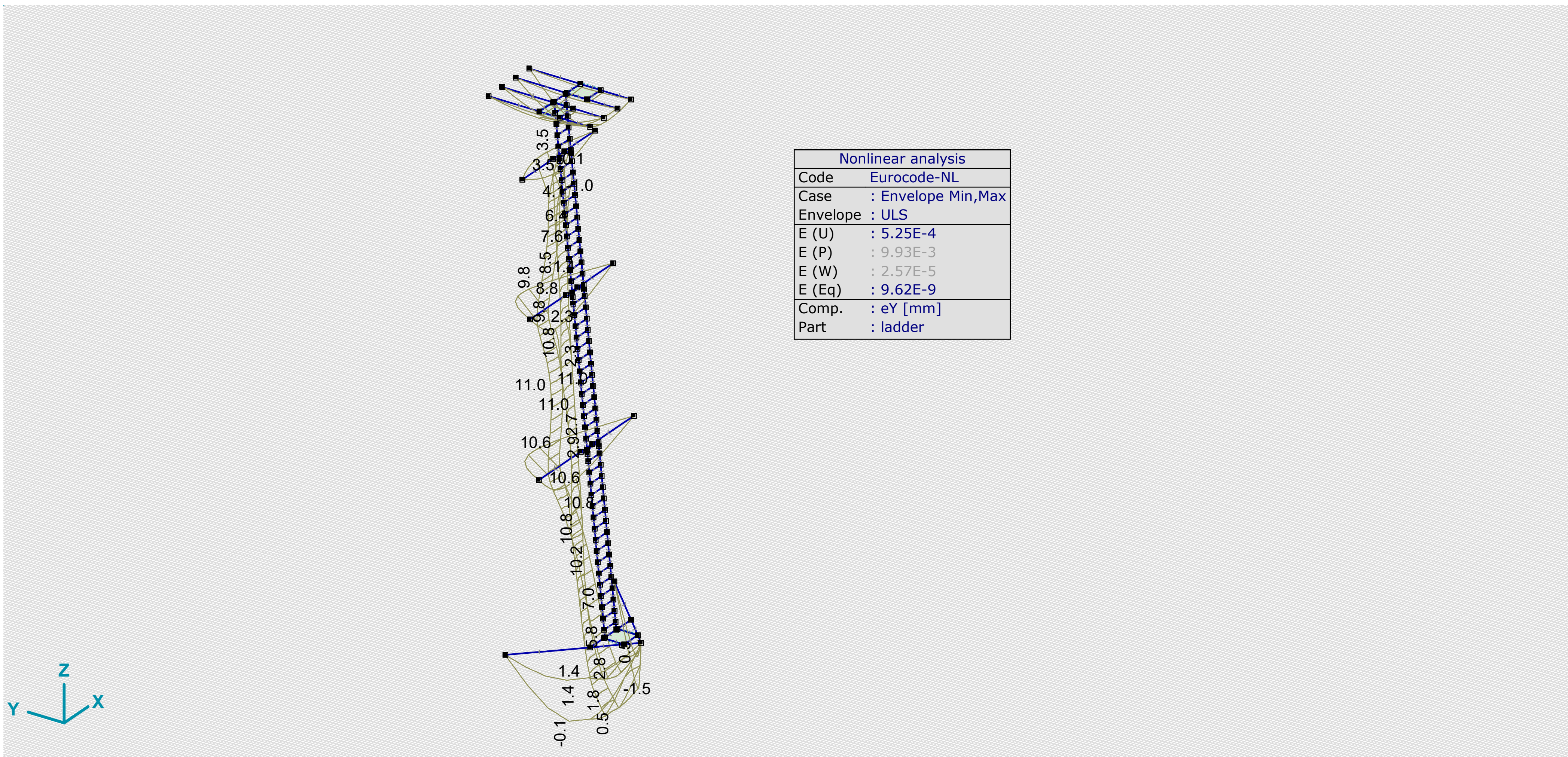
Nodal displacements [Nonlin., Envelope (ULS), ladder]

	C	*min. max.*	*Case*	*eX [mm]*	*eY [mm]*	*eZ [mm]*	*eR [mm]*	*fX [rad]*	*fY [rad]*	*fZ [rad]*	*fR [rad]*
Ext.											
480	eX	min	Co #2 [1] (1.000)	**−0.6**	0.4	−8.6	8.6	0	0	0	0
481		min	Co #2 [1] (1.000)	**−0.6**	0.2	−8.6	8.6	0	0	0	0
641		min	Co #2 [1] (1.000)	**−0.6**	0.3	−8.6	8.6	0	0	0	0
642		min	Co #2 [1] (1.000)	**−0.6**	0.3	−8.6	8.6	0	0	0	0
643		min	Co #2 [1] (1.000)	**−0.6**	0.3	−8.6	8.6	0	0	0	0
552		max	Co #8 [1] (1.000)	**9.1**	2.7	−8.7	12.8	0	0	0	0
553		max	Co #8 [1] (1.000)	**9.1**	4.8	−9.1	13.7	0	0	0	0
749		max	Co #8 [1] (1.000)	**9.1**	3.2	−8.8	13.0	0	0	0	0
750		max	Co #8 [1] (1.000)	**9.1**	3.7	−8.9	13.2	0	0	0	0
751		max	Co #8 [1] (1.000)	**9.1**	4.2	−9.0	13.5	0	0	0	0
817	eY	min	Co #8 [1] (1.000)	1.5	**−1.5**	−8.2	8.5	0	0	0	0
524		max	Co #9 [1] (1.000)	0	**11.0**	−11.0	15.6	0	0	0	0
525		max	Co #9 [1] (1.000)	0	**11.0**	−11.0	15.6	0	0	0	0
707		max	Co #9 [1] (1.000)	0	**11.0**	−11.0	15.6	0	0	0	0
708		max	Co #9 [1] (1.000)	0	**11.0**	−11.0	15.6	0	0	0	0
709		max	Co #9 [1] (1.000)	0	**11.0**	−11.0	15.6	0	0	0	0
546	eZ	min	Co #7 [1] (1.000)	−0.2	4.7	**−15.0**	15.7	0	0	0	0
548		min	Co #7 [1] (1.000)	−0.3	4.8	**−15.0**	15.8	0	0	0	0
550		min	Co #7 [1] (1.000)	−0.3	4.8	**−15.0**	15.8	0	0	0	0
552		min	Co #7 [1] (1.000)	−0.3	4.7	**−15.0**	15.7	0	0	0	0
554		min	Co #7 [1] (1.000)	−0.3	4.6	**−15.0**	15.7	0	0	0	0
184		max	Co #8 [1] (1.000)	0	0	**0**	0	0	0	0	0
184	eR	min	Co #3 [1] (1.000)	0	0	0	**0**	0	0	0	0
548		max	Co #7 [1] (1.000)	−0.3	4.8	−15.0	**15.8**	0	0	0	0
549		max	Co #5 [1] (1.000)	0	5.0	−14.9	**15.7**	0	0	0	0
550		max	Co #7 [1] (1.000)	−0.3	4.8	−15.0	**15.8**	0	0	0	0
551		max	Co #5 [1] (1.000)	0	5.1	−14.9	**15.8**	0	0	0	0
552		max	Co #7 [1] (1.000)	−0.3	4.7	−15.0	**15.7**	0	0	0	0
553		max	Co #5 [1] (1.000)	0	5.1	−14.9	**15.8**	0	0	0	0
743		max	Co #7 [1] (1.000)	−0.3	4.8	−15.0	**15.7**	0	0	0	0
744		max	Co #5 [1] (1.000)	0	5.0	−14.9	**15.7**	0	0	0	0
745		max	Co #5 [1] (1.000)	0	5.0	−14.9	**15.7**	0	0	0	0
746		max	Co #7 [1] (1.000)	−0.3	4.9	−15.0	**15.8**	0	0	0	0
747		max	Co #5 [1] (1.000)	0	5.1	−14.9	**15.8**	0	0	0	0
748		max	Co #5 [1] (1.000)	0	5.1	−14.9	**15.8**	0	0	0	0
749		max	Co #7 [1] (1.000)	−0.3	4.8	−15.0	**15.7**	0	0	0	0
750		max	Co #5 [1] (1.000)	0	5.1	−14.9	**15.8**	0	0	0	0
751		max	Co #5 [1] (1.000)	0	5.1	−14.9	**15.8**	0	0	0	0

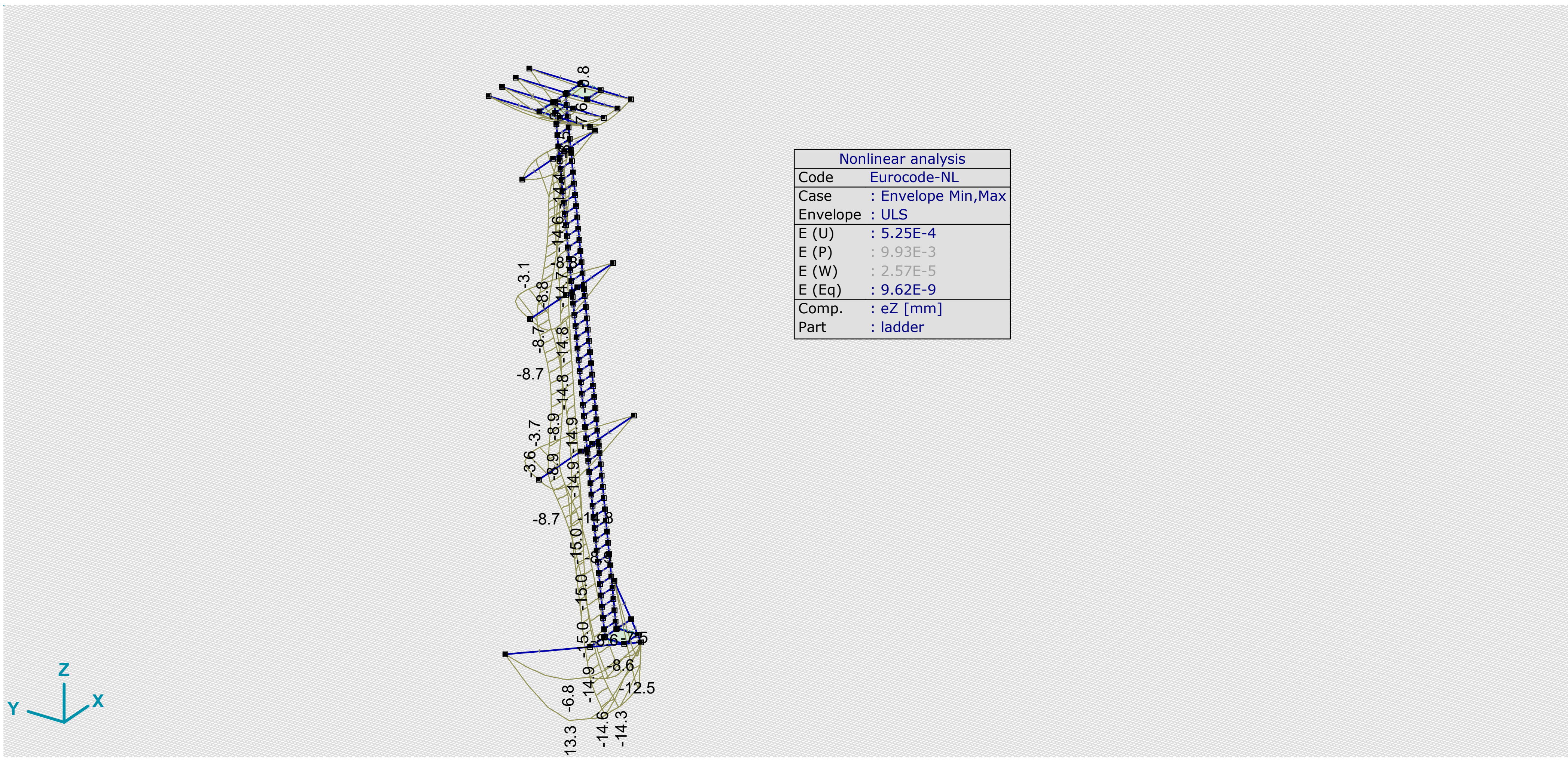
C: Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **eX:** Translation in X direction; **eY:** Translation in Y direction; **eZ:** Translation in Z direction; **eR:** Resultant translation; **fX:** Rotation in X direction; **fY:** Rotation in Y direction; **fZ:** Rotation in Z direction; **fR:** Resultant rotation;



[II], > ladder, Nonlin., Envelope (ULS), eX, Diagram



[II], > ladder, Nonlin., Envelope (ULS), eY, Diagram



[II], > ladder, Nonlin., Envelope (ULS), eZ, Diagram

Beam internal forces [Nonlin., Envelope (All ULS)]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
7	7	L 60X 60X 6	Nx	min	Co #9 [1] (1.000)	0	(420)	**−0.5**	0	0	0	0	0
8	7	L 60X 60X 6		max	Co #5 [1] (1.000)	0	(421)	**1.0**	0.1	−1.2	0	0	−0.1
9	7	L 60X 60X 6	My	min	Co #7 [1] (1.000)	0.30		0.9	0.2	1.4	0	**−0.7**	−0.3
8	7	L 60X 60X 6		max	Co #5 [1] (1.000)	0	(421)	1.0	0.1	−1.2	0	**0**	−0.1
9	7	L 60X 60X 6	Mz	min	Co #7 [1] (1.000)	0.60	(423)	0.9	0.2	1.4	0	−0.3	**−0.3**
7	7	L 60X 60X 6		max	Co #7 [1] (1.000)	0	(420)	0.4	0.2	0	0	0	**0.1**

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:** Flexural moment about local y axis; **Mz:** Flexural moment about local z axis;

Beam internal forces [Nonlin., Envelope (All ULS), L 80X 80X 8]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
22	8	L 80X 80X 8	Nx	min	Co #8 [1] (1.000)	0.34	(623)	**−0.5**	0.1	0	0	0	0.1
30	8	L 80X 80X 8		max	Co #7 [1] (1.000)	0	(186)	**11.4**	0.6	−1.0	0	0	0
30	8	L 80X 80X 8	My	min	Co #7 [1] (1.000)	2.12	(424)	11.4	0.6	−0.9	0	**−2.1**	−1.2
10	8	L 80X 80X 8		max	Co #7 [1] (1.000)	0.60	(423)	2.8	−1.7	1.2	0	**0.7**	1.0
30	8	L 80X 80X 8	Mz	min	Co #7 [1] (1.000)	2.12	(424)	11.4	0.6	−0.9	0	−2.1	**−1.2**
181	8	L 80X 80X 8		min	Co #7 [1] (1.000)	0	(424)	8.5	−0.5	0.7	0	−2.0	**−1.2**
177	8	L 80X 80X 8		max	Co #7 [1] (1.000)	0	(429)	2.6	2.7	0	−0.4	0.6	**1.4**

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:** Flexural moment about local y axis; **Mz:** Flexural moment about local z axis;

Beam internal forces [Nonlin., Envelope (All ULS), L 100X 50X 6X]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
113	2	L 100X 50X 6X	Nx	min	Co #8 [1] (1.000)	0.30	(554)	**−4.1**	0	0.1	0	0.2	0.1
154	2	L 100X 50X 6X		max	Co #8 [1] (1.000)	0.30	(551)	**1.7**	−0.1	0	0	0.1	0
147	2	L 100X 50X 6X	My	min	Co #9 [1] (1.000)	0	(451)	−1.0	0.1	0.3	0	**−0.2**	0
168	2	L 100X 50X 6X		min	Co #9 [1] (1.000)	0.20	(451)	−1.1	0.1	−0.4	0	**−0.2**	0
162	2	L 100X 50X 6X		max	Co #7 [1] (1.000)	0	(429)	−3.2	2.2	−0.1	0	**0.4**	0.5
105	2	L 100X 50X 6X	Mz	min	Co #8 [1] (1.000)	0.11	(450)	−2.4	0.4	0.5	−0.1	0	**−0.2**
162	2	L 100X 50X 6X		max	Co #8 [1] (1.000)	0	(429)	−0.2	1.9	0	0	0.2	**0.5**

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:** Flexural moment about local y axis; **Mz:** Flexural moment about local z axis;

Beam internal forces [Nonlin., Envelope (All ULS), L 100X100X 8]

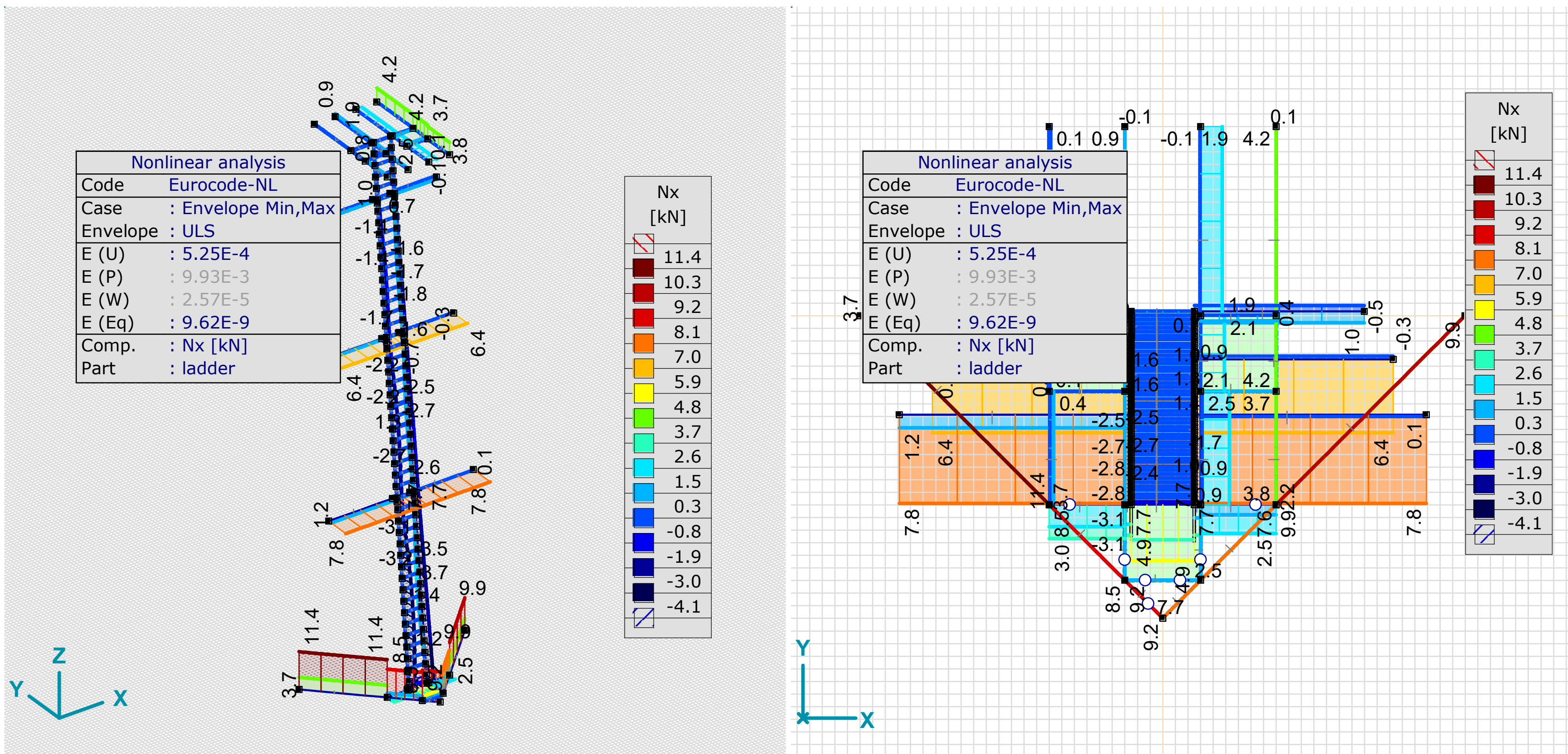
Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
4	1	L 100X100X 8	Nx	min	Co #8 [1] (1.000)	0	(443)	**−0.3**	0	0	0	0	−0.1
17	1	L 100X100X 8		max	Co #9 [1] (1.000)	0	(463)	**7.8**	−0.2	−0.6	0	0	0
18	1	L 100X100X 8		max	Co #9 [1] (1.000)	0.50	(464)	**7.7**	0	0	0	−1.2	0.2
19	1	L 100X100X 8		max	Co #9 [1] (1.000)	1.84	(465)	**7.8**	0.2	0.6	0	0	0
17	1	L 100X100X 8	My	min	Co #9 [1] (1.000)	1.84	(462)	7.7	0	−0.7	0	**−1.2**	0.2
18	1	L 100X100X 8		min	Co #9 [1] (1.000)	0	(462)	7.7	−0.1	0	0	**−1.2**	0.2
4	1	L 100X100X 8		max	Co #2 [1] (1.000)	0.05	(571)	−0.1	−0.5	0.2	0	**0**	0
4	1	L 100X100X 8	Mz	min	Co #8 [1] (1.000)	0	(443)	−0.3	0	0	0	0	**−0.1**
18	1	L 100X100X 8		max	Co #8 [1] (1.000)	0.13	(617)	1.1	0	−0.7	0	−0.1	**0.3**
19	1	L 100X100X 8		max	Co #8 [1] (1.000)	0	(464)	0.1	0	0.2	0	−0.4	**0.3**

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:** Flexural moment about local y axis; **Mz:** Flexural moment about local z axis;

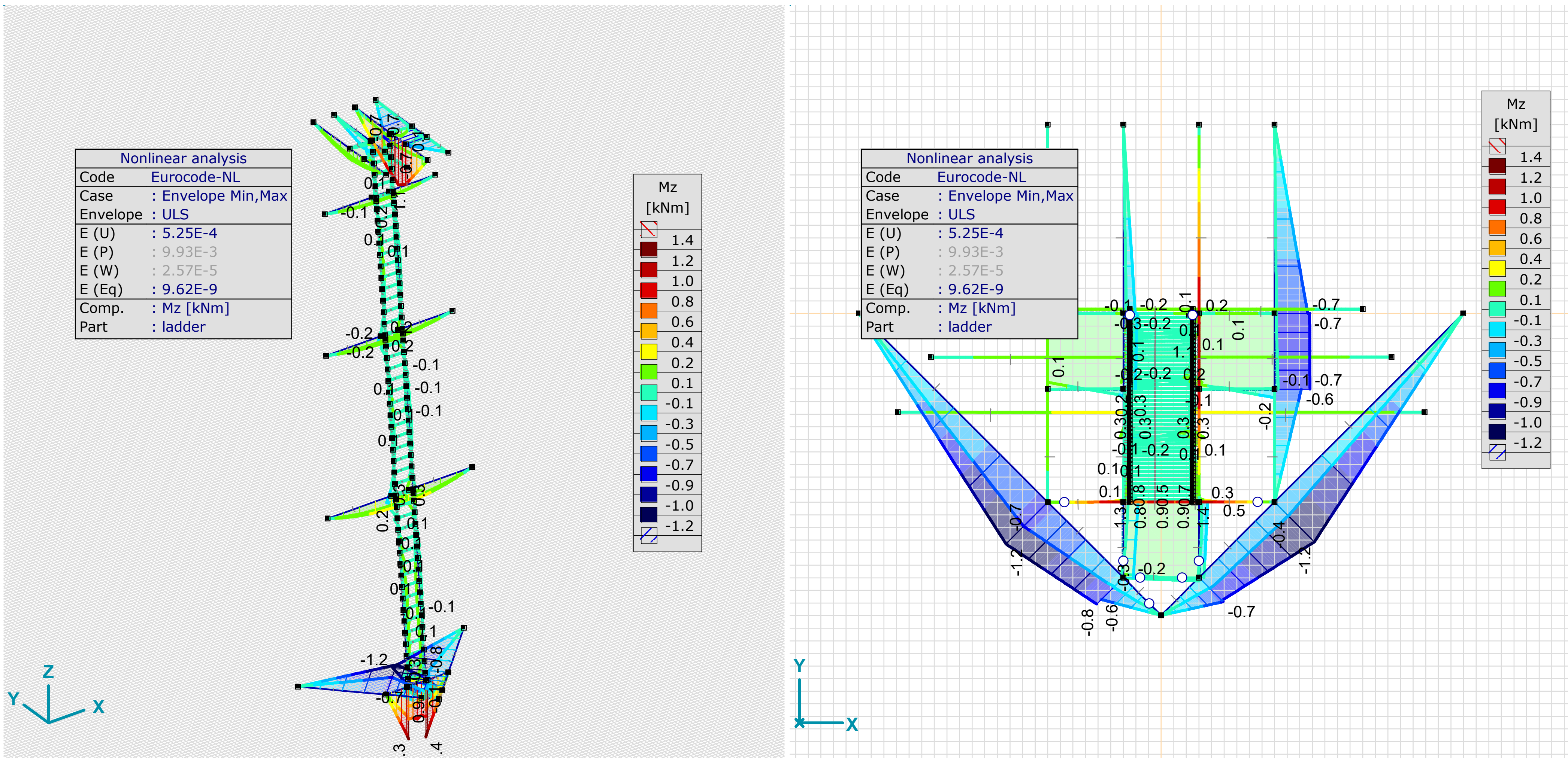
Beam internal forces [Nonlin., Envelope (All ULS), O 20]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
78	6	O 20	Nx	min	Co #5 [1] (1.000)	0.38	(775)	**−2.5**	0	0	0	0	0
77	6	O 20		max	Co #5 [1] (1.000)	0	(566)	**0.3**	0	0	0	0	0
55	6	O 20	My	min	Co #6 [1] (1.000)	0.25	(705)	0	0	1.0	0	**−0.1**	0
55	6	O 20		max	Co #6 [1] (1.000)	0	(522)	0	0	−1.0	0	**0.1**	0
62	6	O 20	Mz	min	Co #8 [1] (1.000)	0	(536)	0	−0.4	0	0	0	**−0.1**
62	6	O 20		max	Co #8 [1] (1.000)	0.50	(537)	0	−0.4	0	0	0	**0.1**

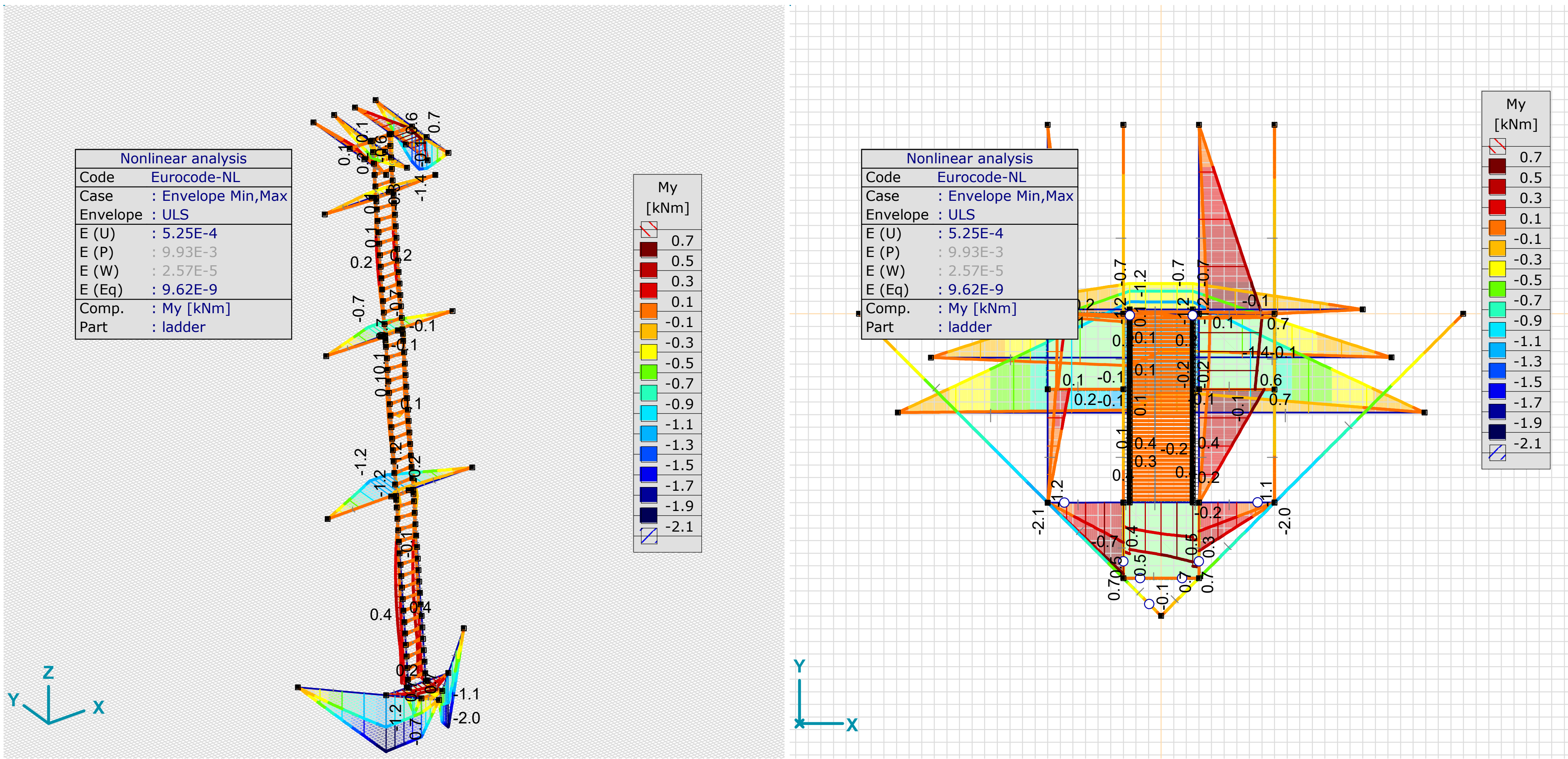
Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:** Flexural moment about local y axis; **Mz:** Flexural moment about local z axis;



[II], > ladder, Nonlin., Envelope (ULS), Nx, Filled diagram, x 2



[II], > ladder, Nonlin., Envelope (ULS), Mz, Filled diagram, x 2



[II], > ladder, Nonlin., Envelope (ULS), My, Filled diagram, x 2

Beam stresses [Nonlin., Envelope (All ULS)]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Smin [N/mm²]	Smax [N/mm²]	Vmin [N/mm²]	Vmax [N/mm²]	Somin [N/mm²]	Somax [N/mm²]	Vymean [N/mm²]	Vzmean [N/mm²]
9	7	L 60X 60X 6	Smin	min	Co #7 [1] (1.000)	0.30		**−150.5**	89.1	0	5.4	1.3	150.5	0.2	2.0
7	7	L 60X 60X 6		max	Co #7 [1] (1.000)	0.35		**0.1**	1.0	0	0.7	0.5	1.4	0.3	0
7	7	L 60X 60X 6	Smax	min	Co #9 [1] (1.000)	0.35		−1.2	**−0.5**	0	0.1	0.5	1.2	0	0
9	7	L 60X 60X 6		max	Co #7 [1] (1.000)	0.30		−150.5	**89.1**	0	5.4	1.3	150.5	0.2	2.0
7	7	L 60X 60X 6	Somin	min	Co #9 [1] (1.000)	0.41		−1.0	0	0	0.1	**0**	1.0	0	0
8	7	L 60X 60X 6		max	Co #5 [1] (1.000)	0	(421)	−17.5	24.8	0	4.0	**1.4**	24.9	0.2	−1.7
7	7	L 60X 60X 6	Somax	min	Co #3 [1] (1.000)	0.36		−0.5	0.5	0	0.1	0.1	**0.5**	0.1	0
9	7	L 60X 60X 6		max	Co #7 [1] (1.000)	0.30		−150.5	89.1	0	5.4	1.3	**150.5**	0.2	2.0

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Smin:** Axial stress cross-Section minimum; **Smax:** Axial stress cross-Section maximum; **Vmin:** Shear stress cross-section minimum; **Vmax:** Shear stress cross-section maximum; **Somin:** Von Mises stress cross-section minimum; **Somax:** Von Mises stress cross-section maximum; **Vymean:** Shear stress in local y direction; **Vzmean:** Shear stress in local z direction;

Beam stresses [Nonlin., Envelope (All ULS), L 100X 50X 6X]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Smin [N/mm²]	Smax [N/mm²]	Vmin [N/mm²]	Vmax [N/mm²]	Somin [N/mm²]	Somax [N/mm²]	Vymean [N/mm²]	Vzmean [N/mm²]
162	2	L 100X 50X 6X	Smin	min	Co #8 [1] (1.000)	0	(429)	**−153.3**	75.7	0	6.8	0.2	153.3	2.2	0
144	2	L 100X 50X 6X		max	Co #8 [1] (1.000)	0	(531)	**1.1**	1.3	0	1.9	1.2	3.5	0.3	0
107	2	L 100X 50X 6X	Smax	min	Co #8 [1] (1.000)	0.18		−3.6	**−2.7**	0	2.2	2.9	5.2	−0.5	0.1
162	2	L 100X 50X 6X		max	Co #8 [1] (1.000)	0	(429)	−153.3	**75.7**	0	6.8	0.2	153.3	2.2	0
171	2	L 100X 50X 6X	Somin	min	Co #2 [1] (1.000)	0	(442)	−26.3	53.1	0	1.2	**0**	53.1	−0.1	0.1
115	2	L 100X 50X 6X		max	Co #8 [1] (1.000)	0.30	(558)	−23.7	7.8	0	1.5	**4.6**	23.8	0.2	0.1
79	2	L 100X 50X 6X	Somax	min	Co #7 [1] (1.000)	0.12		−0.2	0.1	0	0.1	0	**0.2**	0	0.1
162	2	L 100X 50X 6X		max	Co #8 [1] (1.000)	0	(429)	−153.3	75.7	0	6.8	0.2	**153.3**	2.2	0

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Smin:** Axial stress cross-Section minimum; **Smax:** Axial stress cross-Section maximum; **Vmin:** Shear stress cross-section minimum; **Vmax:** Shear stress cross-section maximum; **Somin:** Von Mises stress cross-section minimum; **Somax:** Von Mises stress cross-section maximum; **Vymean:** Shear stress in local y direction; **Vzmean:** Shear stress in local z direction;

Beam stresses [Nonlin., Envelope (All ULS), L 80X 80X 8]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Smin [N/mm²]	Smax [N/mm²]	Vmin [N/mm²]	Vmax [N/mm²]	Somin [N/mm²]	Somax [N/mm²]	Vymean [N/mm²]	Vzmean [N/mm²]
181	8	L 80X 80X 8	Smin	min	Co #7 [1] (1.000)	0	(424)	**−154.7**	73.7	0	2.8	6.9	154.7	−0.4	0.6
30	8	L 80X 80X 8		max	Co #7 [1] (1.000)	0	(186)	**8.8**	10.0	0	4.0	9.3	11.2	0.5	−0.8
22	8	L 80X 80X 8	Smax	min	Co #8 [1] (1.000)	1.35	(473)	−0.4	**−0.4**	0	0.2	0.4	0.5	0.1	0
30	8	L 80X 80X 8		max	Co #7 [1] (1.000)	2.12	(424)	−153.8	**75.7**	0	2.0	9.3	153.8	0.5	−0.8
196	8	L 80X 80X 8	Somin	min	Co #8 [1] (1.000)	0	(436)	−15.2	6.3	0	0.4	**0**	15.2	−0.1	0.1
30	8	L 80X 80X 8		max	Co #7 [1] (1.000)	0	(186)	8.8	10.0	0	4.0	**9.3**	11.2	0.5	−0.8
31	8	L 80X 80X 8	Somax	min	Co #4 [1] (1.000)	0.01		−0.1	0	0	0	0	**0.1**	0	0
177	8	L 80X 80X 8		max	Co #7 [1] (1.000)	0	(429)	−109.4	56.0	0	121.0	2.1	**231.3**	2.2	0

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Smin:** Axial stress cross-Section minimum; **Smax:** Axial stress cross-Section maximum; **Vmin:** Shear stress cross-section minimum; **Vmax:** Shear stress cross-section maximum; **Somin:** Von Mises stress cross-section minimum; **Somax:** Von Mises stress cross-section maximum; **Vymean:** Shear stress in local y direction; **Vzmean:** Shear stress in local z direction;

Beam stresses [Nonlin., Envelope (All ULS), O 20]

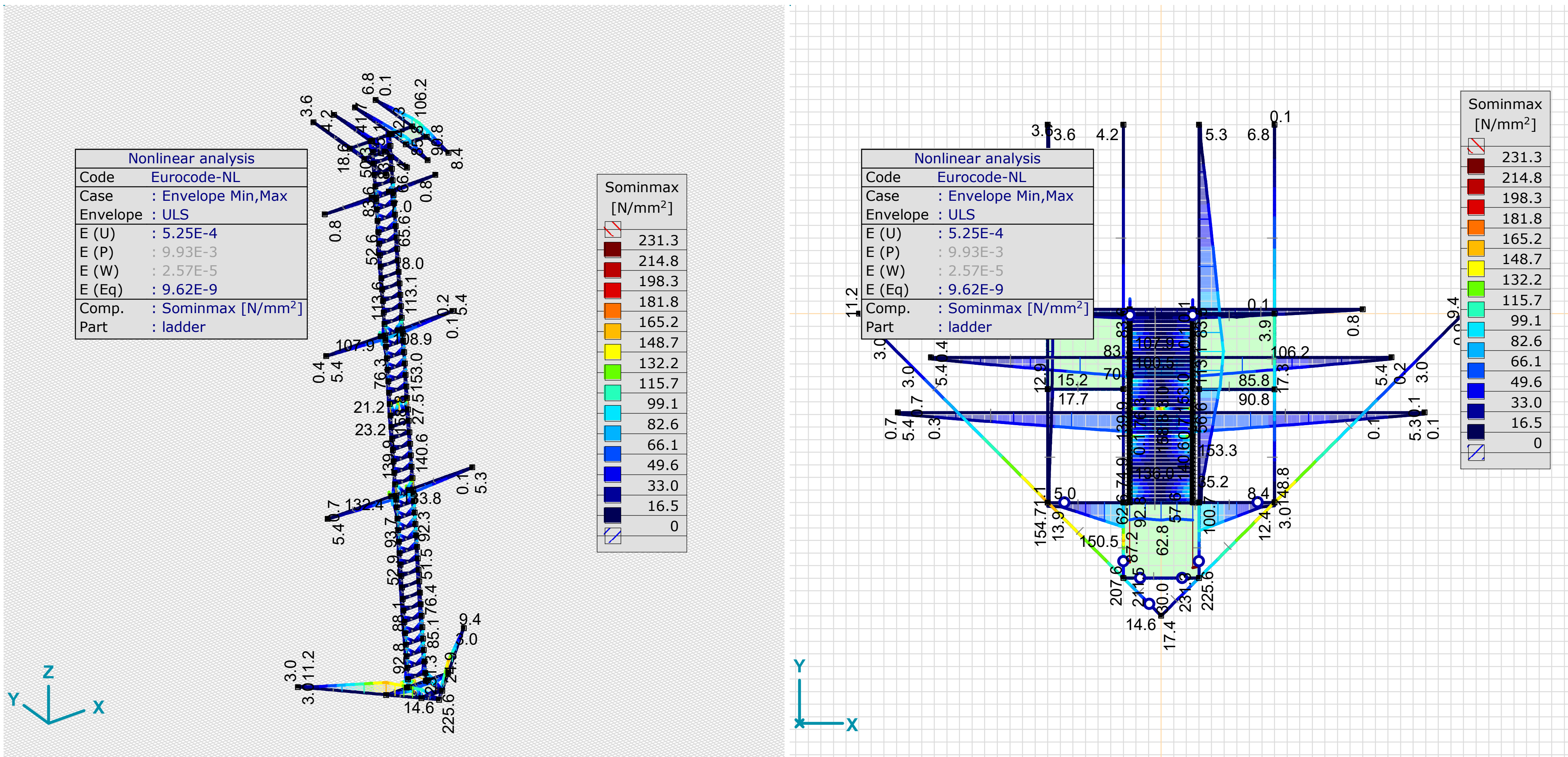
Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Smin [N/mm²]	Smax [N/mm²]	Vmin [N/mm²]	Vmax [N/mm²]	Somin [N/mm²]	Somax [N/mm²]	Vymean [N/mm²]	Vzmean [N/mm²]
55	6	O 20	Smin	min	Co #6 [1] (1.000)	0.25	(705)	**−158.5**	158.8	0	4.7	8.1	158.8	0	3.1
77	6	O 20		max	Co #5 [1] (1.000)	0.43		**1.0**	1.1	0	0	1.0	1.1	0	0
78	6	O 20	Smax	min	Co #7 [1] (1.000)	0.06		−7.8	**−7.3**	0	0.6	7.4	7.8	0	0
55	6	O 20		max	Co #6 [1] (1.000)	0.25	(705)	−158.5	**158.8**	0	4.7	8.1	158.8	0	3.1
42	6	O 20	Somin	min	Co #4 [1] (1.000)	0.10		−0.1	0.1	0	0	**0**	0.1	0	0
55	6	O 20		max	Co #6 [1] (1.000)	0	(522)	−152.8	153.1	0	4.7	**8.1**	153.1	0	−3.1
40	6	O 20	Somax	min	Co #1 [1] (1.000)	0.47		0	0	0	0	0	**0**	0	0
55	6	O 20		max	Co #6 [1] (1.000)	0.25	(705)	−158.5	158.8	0	4.7	8.1	**158.8**	0	3.1

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Smin:** Axial stress cross-Section minimum; **Smax:** Axial stress cross-Section maximum; **Vmin:** Shear stress cross-section minimum; **Vmax:** Shear stress cross-section maximum; **Somin:** Von Mises stress cross-section minimum; **Somax:** Von Mises stress cross-section maximum; **Vymean:** Shear stress in local y direction; **Vzmean:** Shear stress in local z direction;

Beam stresses [Nonlin., Envelope (All ULS), L 100X100X 8]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Smin [N/mm²]	Smax [N/mm²]	Vmin [N/mm²]	Vmax [N/mm²]	Somin [N/mm²]	Somax [N/mm²]	Vymean [N/mm²]	Vzmean [N/mm²]
19	1	L 100X100X 8	Smin	min	Co #9 [1] (1.000)	0	(464)	**−68.0**	68.7	0	0.9	5.0	68.8	0	0.4
17	1	L 100X100X 8		max	Co #9 [1] (1.000)	0	(463)	**5.0**	5.0	0	1.2	5.0	5.4	−0.2	−0.4
19	1	L 100X100X 8		max	Co #9 [1] (1.000)	1.84	(465)	**5.0**	5.0	0	1.0	5.0	5.3	0.2	0.4
19	1	L 100X100X 8	Smax	min	Co #8 [1] (1.000)	1.84	(465)	0.1	**0.1**	0	0.3	0.1	0.5	0.2	0.1
19	1	L 100X100X 8		max	Co #9 [1] (1.000)	0	(464)	−68.0	**68.7**	0	0.9	5.0	68.8	0	0.4
4	1	L 100X100X 8	Somin	min	Co #9 [1] (1.000)	0	(443)	−1.3	1.5	0	30.3	**0**	52.5	0	0.1
17	1	L 100X100X 8		max	Co #9 [1] (1.000)	0	(463)	5.0	5.0	0	1.2	**5.0**	5.4	−0.2	−0.4
18	1	L 100X100X 8		max	Co #9 [1] (1.000)	0.50	(464)	−67.9	68.5	0	0.9	**5.0**	68.5	0	0
19	1	L 100X100X 8		max	Co #9 [1] (1.000)	1.84	(465)	5.0	5.0	0	1.0	**5.0**	5.3	0.2	0.4
19	1	L 100X100X 8	Somax	min	Co #8 [1] (1.000)	1.84	(465)	0.1	0.1	0	0.3	0.1	**0.5**	0.2	0.1
19	1	L 100X100X 8		max	Co #9 [1] (1.000)	0	(464)	−68.0	68.7	0	0.9	5.0	**68.8**	0	0.4

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Smin:** Axial stress cross-Section minimum; **Smax:** Axial stress cross-Section maximum; **Vmin:** Shear stress cross-section minimum; **Vmax:** Shear stress cross-section maximum; **Somin:** Von Mises stress cross-section minimum; **Somax:** Von Mises stress cross-section maximum; **Vymean:** Shear stress in local y direction; **Vzmean:** Shear stress in local z direction;



[II], > ladder, Nonlin., Envelope (ULS), Sominmax, Filled diagram, x 2

About DNV

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Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

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TOETSING EN HERONTWERP MASTEN EN FUNDATIES BBB380

ENS-ZL380 – Rapportage masttype HB-3/R & HB-3/R_X

TenneT TSO B.V.

Rapport nr.: 22-0512, Rev. 0
Meridian doc.nr.: 002.515.40 1007988
Datum: 2022-04-01

Projectnaam:	Toetsing en herontwerp masten en fundaties BBB380	Energy Systems
Rapport titel:	ENS-ZL380 – Rapportage masttype HB-3/R & HB-3/R_X	DNV Netherlands B.V.
Klant:	TenneT TSO B.V.,	Utrechtseweg 310-B50
Contactpersoon klant:	P. v.d. Horst	6812 AR Arnhem
Datum uitgave:	2022-04-01	
Project nr.:	10166260	
Organisatie unit:	TDT	Tel: 026 356 9111
Meridian doc.nr..:	002.515.40 1007988	Handelsregister Arnhem 09006404
Rapport nr.:	22-0512, Rev. 0	

Geschreven door:	Beoordeeld door:	Goedgekeurd door:
M.H. Khan	A.J. Börger	C. Schutte

DNV Distributie:

☒ Open

☐ Intern

☐ Commercieel vertrouwelijk

☐ Vertrouwelijk

☐ Geheim

*Specificatie distributie: --

Rev.	Datum	Reden van uitgave	Auteur	Beoordeeld	Goedgekeurd
0	2022-04-01	Eerste uitgave	M.H. Khan	A.J. Börger	C. Schutte

Inhoudsopgave

1 INLEIDING

1.1 Inleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt.

Om die reden is de opdrachtgever (OG) voornemens de bestaande 380 kV-koppelnetring op te waarderen. Het opwaarderen van de bestaande verbindingen valt onder het programma “Beter benutten bestaande 380 kV-ring” en omvat de volgende deelprojecten:

- Opwaardering 380 kV-verbinding Lelystad – Ens (LLS-ENS380)
- Opwaardering 380 kV-verbinding Diemen – Lelystad (DIM-LLS380)
- Opwaardering 380 kV-verbinding Rilland – Zandvliet (RLL-ZVL380)
- Opwaardering 380 kV-verbinding Krimpen aan den IJssel - Geertruidenberg (KIJ-GT380)
- Opwaardering 380 kV-verbinding Ens - Zwolle (ENS-ZL380)
- Opwaardering 380 kV-verbinding Maasbracht - Eindhoven (MBT-EHV380)

Om te komen tot een DO waarmee de werkzaamheden kunnen worden gestart is door TenneT aan DNV opdracht verstrekt voor de volgende onderdelen:

1. In eerste fase het opstellen en creëren van:

1.1 E-studie deel 1

1.2 Uitgangspuntenrapporten ten behoeve van de constructieve analyse van masten en fundaties

1.3 Sonderingmodellen

1.4 Fundatiemodellen

1.5 Mastmodellen

2. In tweede fase de uitvoering van de DO-fase bevattende:

2.1 Toetsing conform het uitgangspuntenrapport van de bestaande fundaties

2.2 Globale specificatie van benodigde fundatieversterkingen ten behoeve van aanbesteding

2.3 Toetsing conform het uitgangspuntenrapport van de bestaande masten

2.4 Globale specificatie van benodigde mastversterkingen ten behoeve van aanbesteding

2.5 E-studie deel 2

1.2 Doel van dit rapport

In dit rapport wordt voor de hoogspanningslijn Ens - Zwolle de controle van de mastconstructie van masttype HB-3/R en HB-3/R_X gerapporteerd. Het doel is om te bepalen of de in dit rapport beschreven bestaande mast geschikt is om te worden uitgerust met de nieuwe ACCC-Warsaw geleider waarmee een hogere capaciteit kan worden gerealiseerd.

Nadat de wijzigingen zijn toegepast dient aantoonbaar geverifieerd te worden dat het systeem voldoet aan de vigerende eisen.

In de defintief-ontwerpfase zijn ten behoeve van de contractvorming Engelstalige rapporten geleverd. Het voorliggende rapport is bedoeld voor vergunningsaanvraag en is inhoudelijk ongewijzigd ten opzichte van de Engelse versie. Om deze reden zijn de bijlagen in dit rapport één op één overgenomen uit de Engelse versie. Hierdoor wijkt het revisienummer van de bijlagen af van het revisienummer van de rapportage.

1.3 Gerelateerde documenten

1.3.1 Verificatie & validatieplan

De door TenneT aangeleverde set met eisen is beoordeeld op relevantie en voor de relevante eisen is aangegeven in welk document wordt aangetoond dat er aan de eis wordt voldaan. De resultaten hiervan zijn opgenomen in het rapport “Verificatie & Validatieplan 380 kV verbinding Ens - Zwolle”.

1.3.2 E-studie deel 1

In de rapportage “ENS-ZL380 - E-studie deel 1” [1] is bepaald welke aanpassingen benodigd zijn om de ACCC-Warsaw geleider toe te passen binnen de verbinding Ens – Zwolle.

Uit de E-studie volgen de volgende zaken welke relevant zijn voor de constructie van masttype HB-3/R.

- Toepassen van een verticale ‘post-isolator’ aan de binnenzijde van de buitenste fase van e onderste traverse. De ‘post-isolator’ is benodigd bij de traverse aan de buitenzijde van de hoeklijn.
- Mast 6 zal worden omgebouwd tot “wisselmast” en aangeduid als HB-3/R_X.

De aanpassingen welke hierboven benoemd zijn, zijn de enige aanpassingen welke relevant zijn voor de structurele analyse in dit rapport. Een complete opsomming van de veranderingen gerelateerd aan HB-3/R is te vinden in “ENS-ZL380 – E-studie deel 1”.

1.3.3 Uitgangspuntendocument

De uitgangspunten op basis waarvan de berekeningen in deze rapportage zijn uitgevoerd zijn opgenomen in het rapport “Uitgangspuntenrapport 380kV verbinding Ens - Zwolle” [2].

2 EISEN

In onderstaande Tabel 1 zijn de eisen opgenomen die binnen deze rapportage worden getoetst.

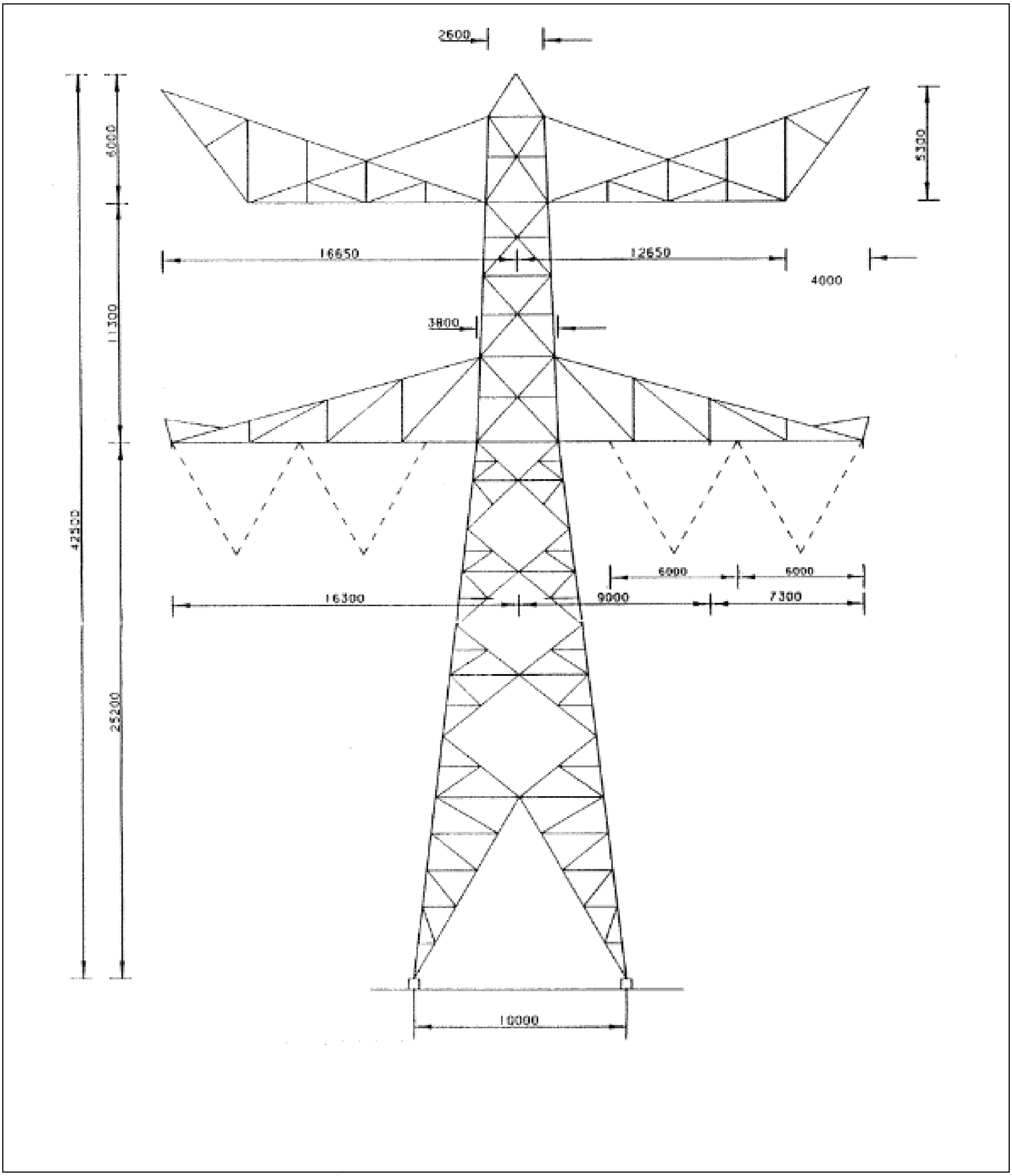
Tabel 1 Relevante eisen

Req. Id	Title	Req. text	Verification
BO Eis: H2.7-6	Omgeving, beperkingsf actoren	Het ontwerp dient geverifieerd te worden op de uitvoerbaarheid.	Tabel 7
PVE.05.001 5.14	Masten	Aanwijzingen t.a.v. klimvoorziening en valbeveiliging: Huidige klimweg blijft gehandhaafd en zal voldoen aan de eisen zoals opgenomen in de NEN 1060:1987. Valbeveiliging is/zal worden uitgevoerd in het type "latch way". Indien staaldelen in de nabijheid (aangrenzend profiel) van de klimweg gewijzigd worden, dient geverifieerd te worden dat de klimvoorziening in overeenstemming is met de NEN 1060:1987.	Tabel 7

3 BEREKENINGEN

3.1 Mastbeeld

Het mastbeeld op basis van de Asset-data is weergegeven in Figuur 1.



Figuur 1 Mastbeeld HB-3/R (beoogde fasewisseling niet weergegeven)

3.2 Missende 'as-built' gegevens

DNV heeft onvoldoende 'as-built' gegevens ontvangen met betrekking tot de blokdeuvels op de funderingspalen in de poer van mastnummer 40. Er is aangenomen dat het blokdeuvels vergelijkbaar zijn aan de blokdeuvels van enkele paalfunderingen. Aangezien twee palen in de poer worden ingebracht, is er met de helft van de blokdeuvels rekening gehouden.

3.3 Mastenlijst

In deze rapportage wordt masttype HB-3/R getoetst. Mast HB-3/R_X valt binnen windgebied II en HB-3/R valt onder windgebied III. De berekening is uitgevoerd voor windgebied II en windgebied III. De wind en weight span van de verschillende masten zijn in Tabel 2 weergegeven. De maatgevende mastnummers 6 (windgebied II) en 40 (windgebied III) zijn aangegeven. Bij zowel de masten in windgebied II als III is rekening gehouden met verhoogde windbelasting als gevolg van een hogere aangrenzende mast (hoger is een negatieve waarde).

De masten zijn vergeleken voor de maximale uitnutting en mast 40 is leidend. Ook is de hoek van de geleider het hoogst voor mast 40 waardoor deze leidend is.

Tabel 2 Mastnummers

Tower number	Tower type	Governing tower number	Wind span (m)	Weight span (m)	Height difference back (m)	Height difference ahead (m)
6	HB-3_R_X II	6	257	122	9.4	2.4
40	HB-3_R	40	319	346	0.0	-2.7
49	HB-3_R	40	335	371	-3.0	-2.8
51	HB-3_R	40	342	377	-2.7	-3.1

3.4 Uitgangspunten berekening

De berekening is uitgevoerd op basis van de uitgangspunten zoals opgenomen in het uitgangspuntenrapport [2]. Hierin is een volledig overzicht opgenomen van de belastingcombinaties en toegepaste belastingfactoren:

Tabel 3 Uitgangspunten berekening

Algemeen	Norm Windgebied Terreincategorie Reductiefactor cdir	NEN-EN50341-2-15:2019 II/III II (onbebouwde omgeving) 1,00
Situatie initieel	Gevolgklasse Betrouwbaarheidsniveau Referentieperiode	CC2-0 Afkeur CC2-0 30 jaar
Situatie na aanpassingen	Gevolgklasse Betrouwbaarheidsniveau Referentieperiode	CC2 Verbouw 50 jaar

3.5 Proces stappen

Het proces van het bepalen van eventueel benodigde verstevigingen bestaat uit de volgende stappen:

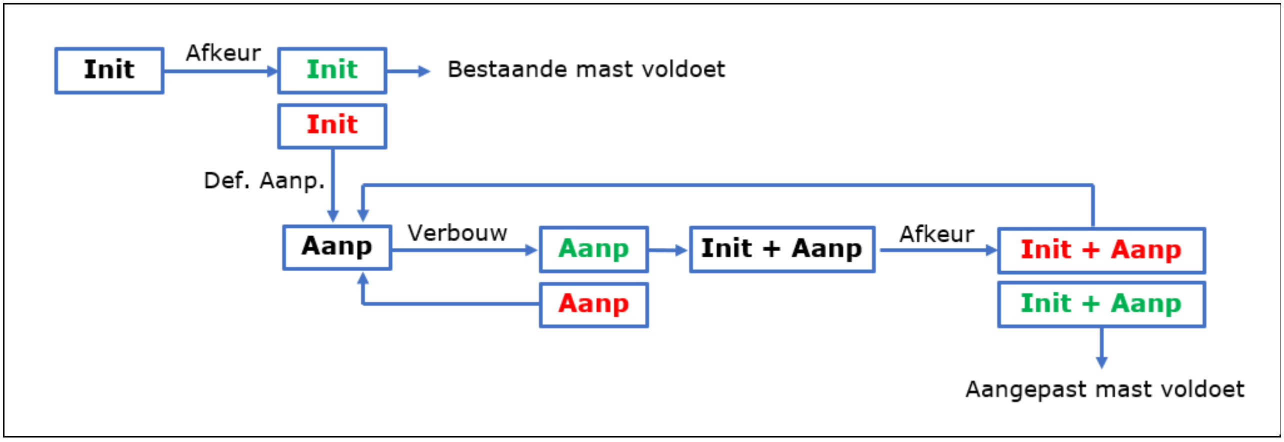
Stap 1: Toets bestaande (Init) mast op Afkeur

Stap 2: Definiëren benodigde aanpassingen indien initiële mast niet voldoet aan toets op Afkeur (Def. Aanp.)

Stap 3: Het toetsen van (alleen) de uitgewerkte aanpassingen (Aanp) op Verbouw

Stap 4: Het opnieuw toetsen van de complete mast inclusief aanpassingen (Initi + Aanp) op Afkeur

Het hierboven omschreven proces is in Figuur 2 weergegeven.



Figuur 2 Proces diagram

3.6 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV. In Appendix A zijn de resultaten van de geleiderbelastingen samengevat.

3.7 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma, zie ook Appendix A.

3.8 Modellering

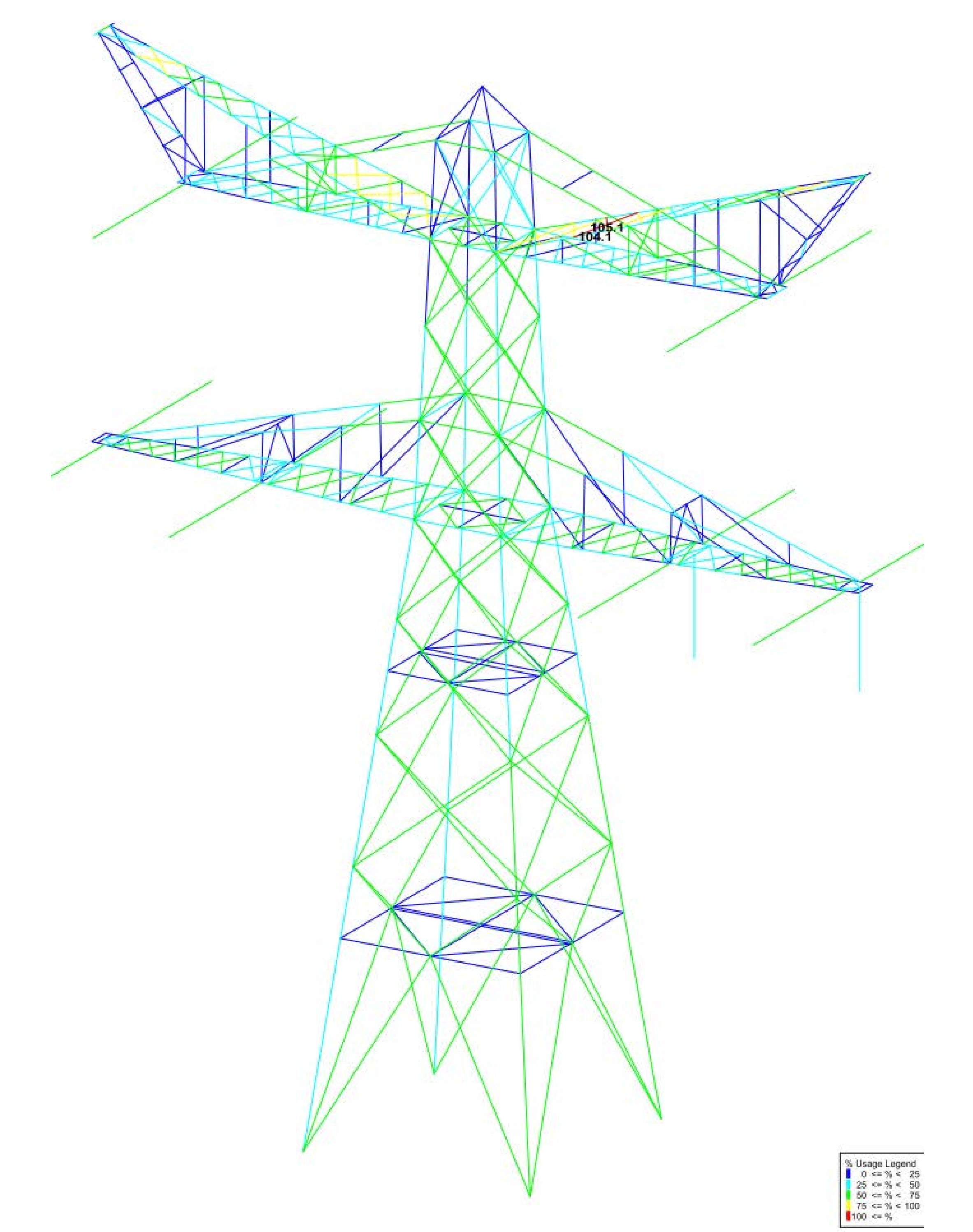
Op basis van de as-built tekeningen is de mast in PLS-TOWER ingevoerd. De hoofdelementen zijn gemodelleerd. Niet-dragende profielen als knikverkorters zijn weggelaten en worden separaat getoetst. De profielen inclusief de boutverbindingen zijn in PLS-TOWER ingevoerd en getoetst. Controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

De geleiderbelastingen vanuit het geleiderbelastingenprogramma zijn als invoer voor de belastingen gebruikt.

Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep en de toetsing wordt per staafgroep uitgevoerd. Ingeval dat een element uit een groep is overbelast, geldt dit voor alle elementen uit de betreffende groep.

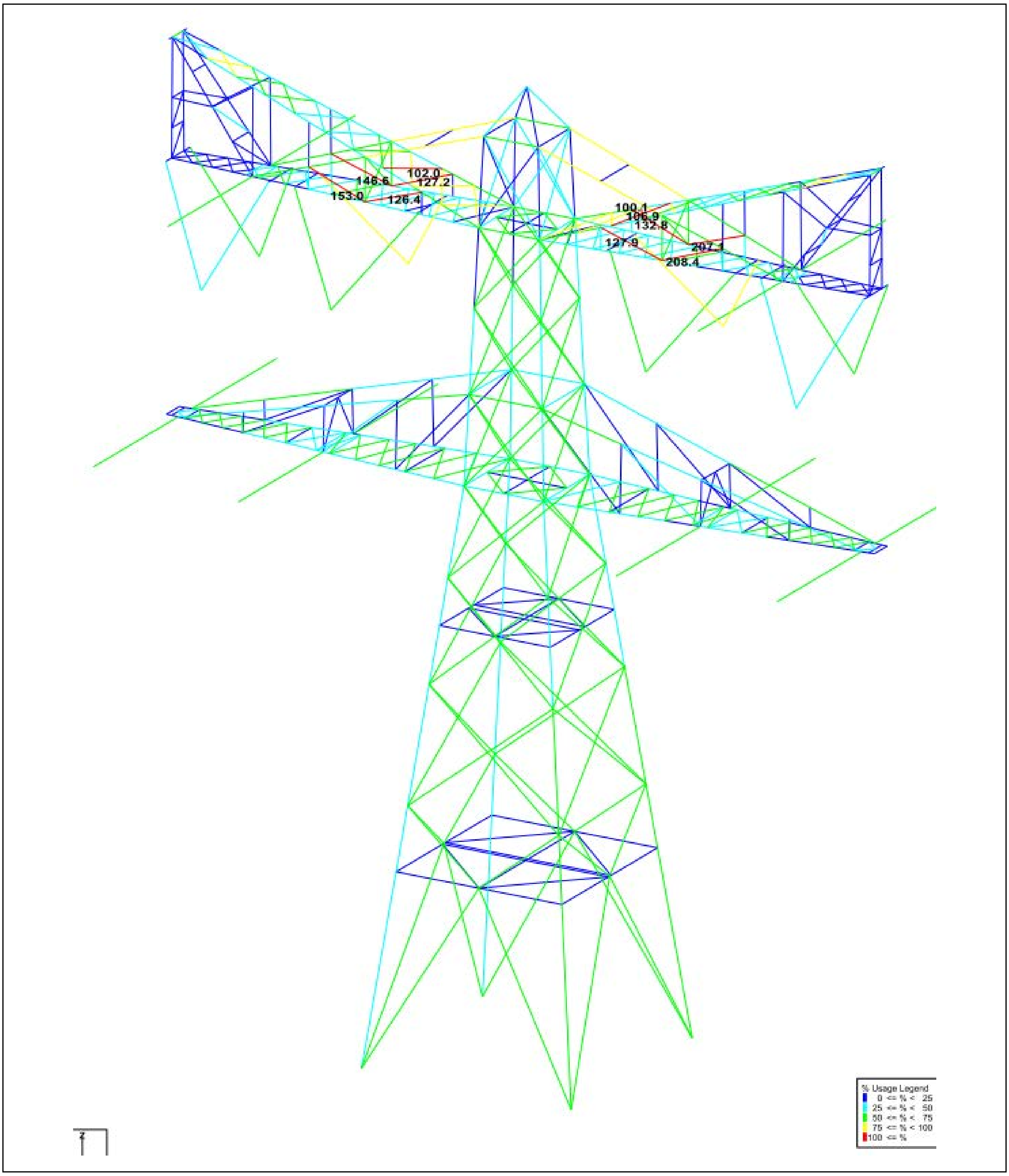
4 TOETSING MASTCONSTRUCTIE

Het resultaat van de controle van de mastconstructie type HB-3/R en HB-3/R_X met belastingen op afkeurniveau is weergegeven in Figuur 3 en Figuur 4.



Figuur 3 Resultaat PLS-TOWER HB-3/R (40)

De diagonalen in één paneel op de boventraverse falen vanwege een te kleine eindafstand van de enkele bout (22mm)



Figuur 4 Resultaat PLS-TOWER HB-3/R_X II (6)

De toegevoegde constructie van de faseomzetting resulteert in een overbelaste knikverkorter in de boventraverse. De hoofdprofielen hebben voldoende capaciteit.

De resultaten van de controles van profielen, knikverkorters en ankers randstijl zijn opgenomen in Tabel 4.

Tabel 4 Samenvatting controle

Controle van	Beoordeling		Referentie
Profielen		Voldoen niet	Figuur 3 Figuur 4 Appendix B
Knikverkorters	Voldoen		Appendix C
Blokdeuvels	Voldoen		Appendix D

5 AANPASSINGEN

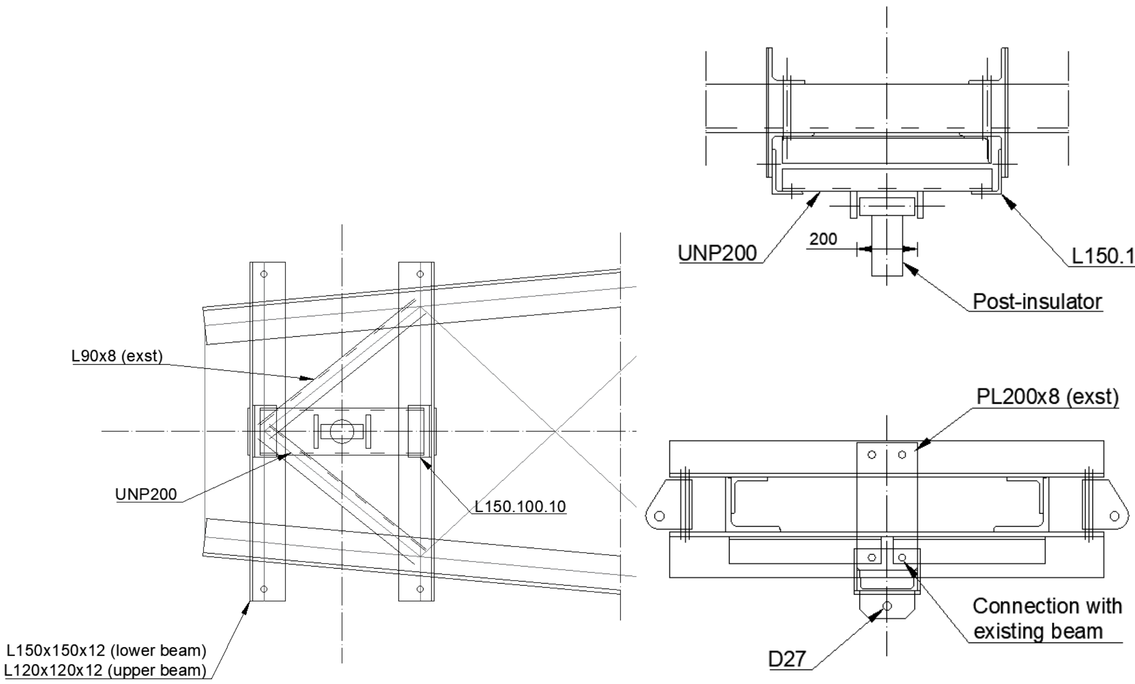
5.1 Inleiding

Een versterkingsvoorstel om de mast aan afkeurniveau te laten voldoen is uitgewerkt. Dit voorstel bevat de volgende maatregelen:

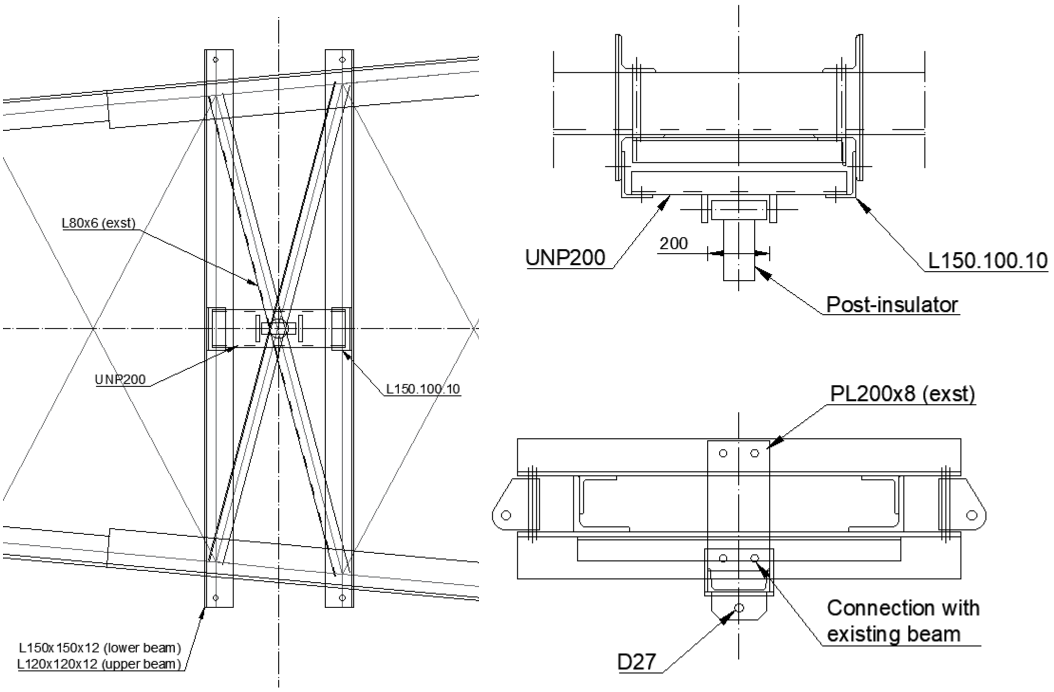
- Voorstel voor de verbinding van de ‘post-isolator’ (voor mast nummer 40)
- Vervangen van de horizontale diagonalen in de bovenzijde van de boventraverse (voor mastnummer 6 en 40)
- Vervangen van verschillende verticale verzwaringen in de boventraverse (enkel voor mast nummer 6)
- Extra profielen toevoegen voor het dragen van de fasewisseling (enkel voor mastnummer 6)
- Verlengen van het horizontale profiel in de boventraverse (enkel voor mast nummer 6)

5.2 Aanpassingen

Volgens de resultaten in Appendix B dienen de aanpassingen welke toegepast worden in dit hoofdstuk toegelicht te worden. DNV heeft een voorstel voorzien met betrekking tot de verbinding van de ‘post-isolators’ deze zijn weergegeven in Figuur 5 en Figuur 6.

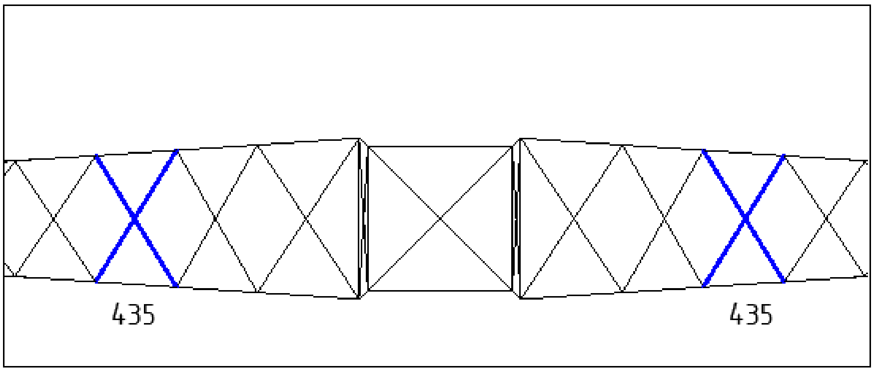


Figuur 5 Verbinding van de ‘post-isolator’ aan het einde van de traverse

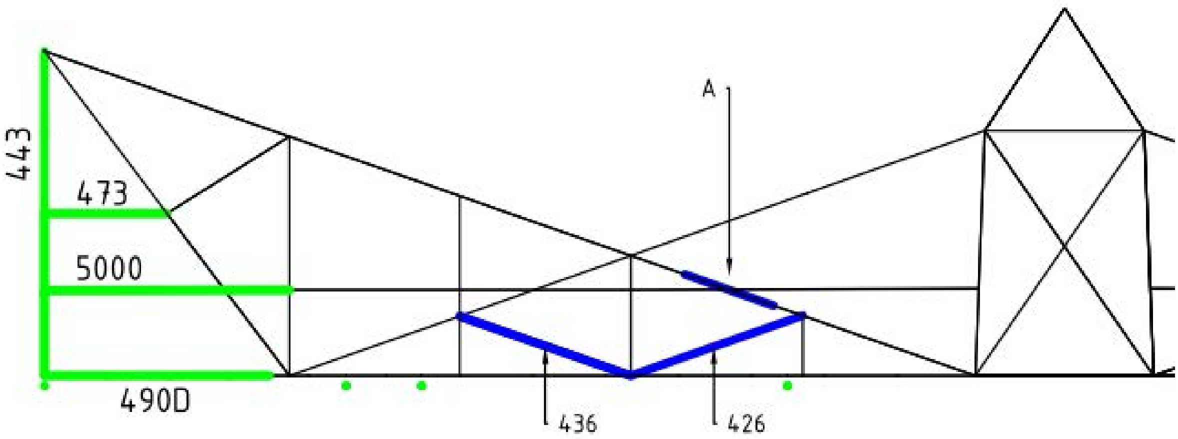


Figuur 6 Verbinding van de 'post-isolator' in het midden van de traverse

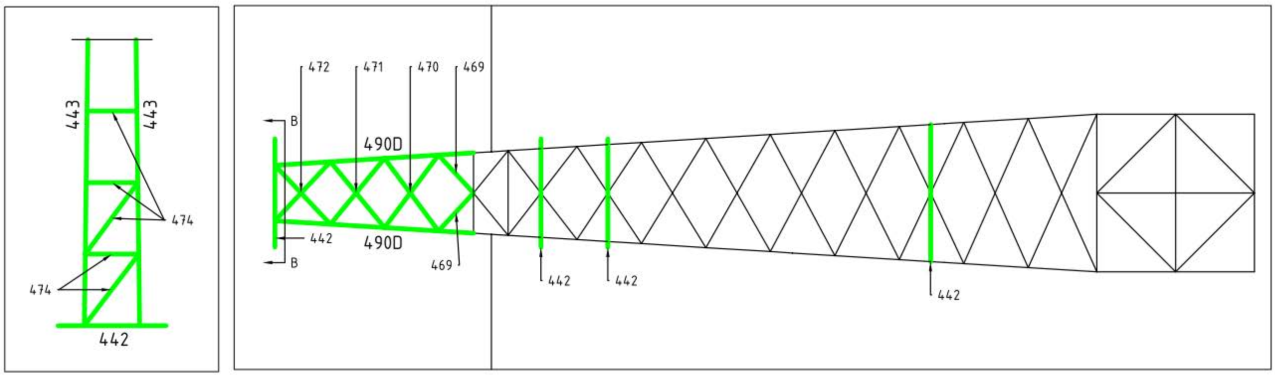
In de volgende figuur zijn de horizontale diagonalen weergegeven welke vervangen dienen te worden voor beide masten.



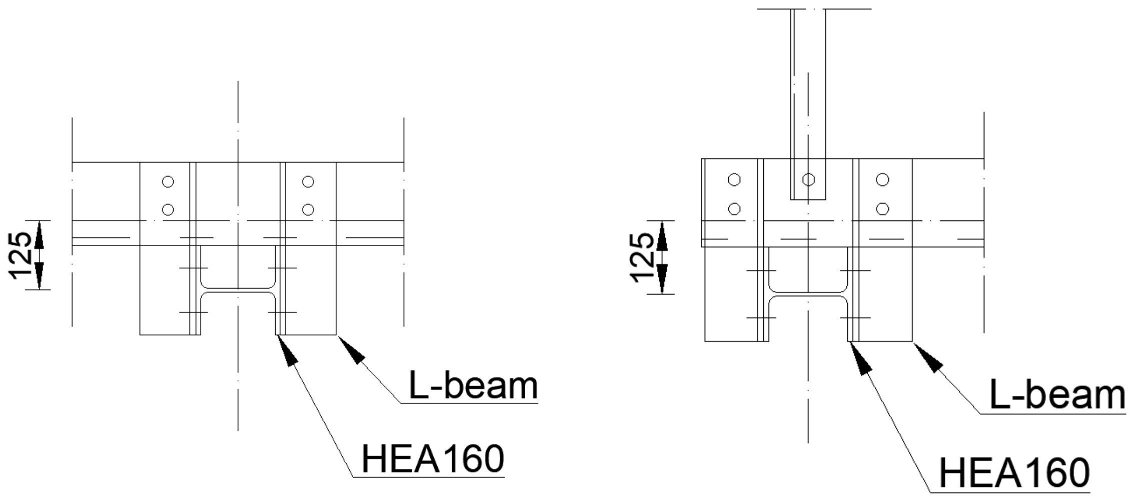
Figuur 7 Bovenaanzicht – boventraverse HB-3/R (40) en HB-3/R_X (6)

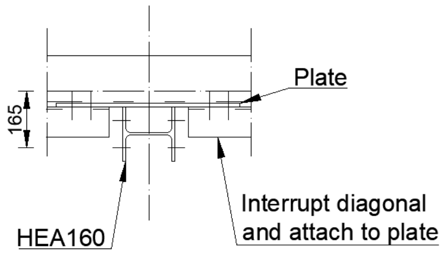


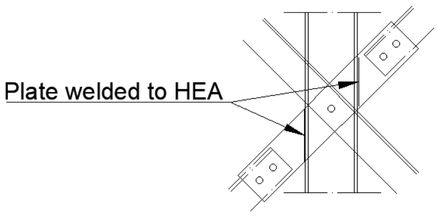
Figuur 8 Vooraanzicht – boventraverse van mast 6



Figuur 9 Bovenaanzicht – Boventraverse mast 6







Figuur 10 Principedetails voor mast 6

Informatie met betrekking tot de profielmaten en de boutmaten zijn de vinden in de tekeningen in Appendix E. De maten zijn weergegeven in Tabel 5 en Tabel 6. Het gewicht van eventueel benodigde schetsplaten en ander hulpstaal als onderdeel van de verbinding is niet meegenomen.

Tabel 5 Gewichten HB-3/R_X II (6) van toegevoegde knikverkorters en uitgewisselde profielen

Group Label	Profile ini.	Material ini.	Bolts ini.	Profile new	Material new	Bolts new	Mitigation	Number	Length (m)	Weight (kg)
435	L60x6	S235	1M16-8.8t	L60x6	S355	1M16-8.8t	Profile exchanged	4	2.83	61.3
426	L50x5	S235	1M16-8.8t	L70x7	S355	1M16-8.8t	Profile exchanged	4	2.98	88.0
436	L50x5	S235	1M16-8.8t	L70x7	S355	1M16-8.8t	Profile exchanged	4	2.96	87.4
490D				L150x14	S355	M20-8.8t	Profile added	4	3.67	463.9
469				L50x5	S355	M16-8.8t	Profile added	4	0.95	14.3
470				L50x5	S355	M16-8.8t	Profile added	4	1.67	25.2
471				L50x5	S355	M16-8.8t	Profile added	4	1.57	23.7
472				L50x5	S355	M16-8.8t	Profile added	4	1.49	22.5
473				L60x6	S355	M16-8.8t	Profile added	4	2.0	43.4
474				L50x5	S355	M16-8.8t	Profile added	10	1.32	49.7
442				HEA160	S355	M20-8.8t	Profile added	8	2.0	486.4
443				L60x6	S355	M16-8.8t	Profile added	4	5.3	114.9
5000				L60x6	S355	M16-8.8t	Profile added	4	4.0	86.7
									146.9	1567.5

Tabel 6 Gewichten HB-3/R (40) van toegevoegde knikverkorters en uitgewisselde profielen

Group Label	Profile ini.	Material ini.	Bolts ini.	Profile new	Material new	Bolts new	Mitigation	Number	Length (m)	Weight (kg)
435	L60x6	S235	1M16-8.8t	L60x6	S355	1M16-8.8t	Profile exchanged	4	2.83	61.3
									11.32	61.3

5.3 Eisenverificatie

De verificatie van de van toepassing zijnde eisen is uitgevoerd in onderstaande Tabel 7.

Tabel 7 Verificatie eisen

Eis Id	Eis Tekst	Ja	Nee	N.v.t.	Toelichting
BO Eis: H2.7-6	Aanpassingen uitvoerbaar?	X			De toe te voegen staalonderdelen zijn met geboute verbindingen te bevestigen. Dit is een bewezen methode.
PVE.05.001 5.14	Staaldelen in nabijheid van klimweg gewijzigd?			X	De wijzigingen in de nabijheid van de klimweg (knikverkorters) zijn in te passen zonder negatieve invloed op de begaanbaarheid.
	klimvoorziening nog in overeenstemming is met de NEN 1060:1987?			X	Geen wijzigingen

6 REFERENTIES

[1] „002.515.40 0825824 - 21-0462 - Verificatie & validatieplan 380kV verbinding Ens - Zwolle”.
[2] „002.515.40 0825812 - 20-1465 - E-studie deel 1 380kV verbinding Ens - Zwolle”.
[3] „002.515.40 0825820 - 20-1245 - Uitgangspuntenrapport 380kV verbinding Ens - Zwolle”.

APPENDIX A
Geleiderbelastingen

Content

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	III
Wind speed	24.5 m/s
Terrain categorie	II
Reduction factor Cdir	1.00
Ice region	B
Tower type	Hoekmast
Tower height	42.5 m
Max. Span	414.2 m
Line angle	146.1°
Catenary	1760 m
Wind span	319 m
EDS Weight span	259 m
Min. Weight span	181 m
Max. Weight span	263 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-02-25			

Client: TenneT Taking power further

DNV·GL

Title:

Berekening masttype HB-3_R

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_HB-3_R_40_Report.pdf

Project number:

Project client number:

0.0

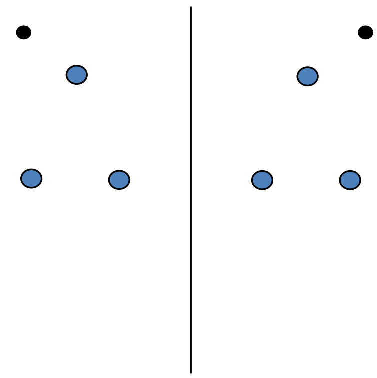
Project: ENS-ZL
Tower: HB-3_R
Number: 40

Conductor loads

Auteur: TBR
Versie: v11.6

General

Description	HB-3_R
Tower type	Hoekmast
Number of circuits	2
Configuration	2-circuit-donau
Number of earth wires	2



Configuratie geleiders

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	III
Terrain category	24.5 m/s
Reduction factor c_{dir}	II
Ice region phase conductor	1.00
Ice region earth conductor	B
	B

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area [m^2]
Circuit 1	Afspanketting	2.00	4.50	1.00
Circuit 2	Afspanketting	2.00	4.50	1.00
Bliksemdraad 1	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 2	Vast (Bliksemdraad)	0.10	0.30	0.10

1. Properties apply to the entire isolator set

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower Horizontal distance
Circuit 1	10	380ct1f1	25.2 m	25.2 m	-16.3 m
Circuit 1	11	380ct1f2	25.2 m	25.2 m	-9.0 m
Circuit 1	12	380ct1f3	36.5 m	36.5 m	-12.7 m
Circuit 2	21	380ct2f1	25.2 m	25.2 m	16.3 m
Circuit 2	20	380ct2f2	25.2 m	25.2 m	9.0 m
Circuit 2	22	380ct2f3	36.5 m	36.5 m	12.7 m
Bliksemdraad 1	1	bl1	41.5 m	41.8 m	-16.7 m
Bliksemdraad 2	3	bl2	41.5 m	41.8 m	16.7 m

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Height adjustment adjacent masts (wind and weight span adjustment)

	Back	Ahead	
Height increase for wind pressure	0.0 m	0.0 m	(positive: higher)
Height decrease for vertical load	0.0 m	0.0 m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

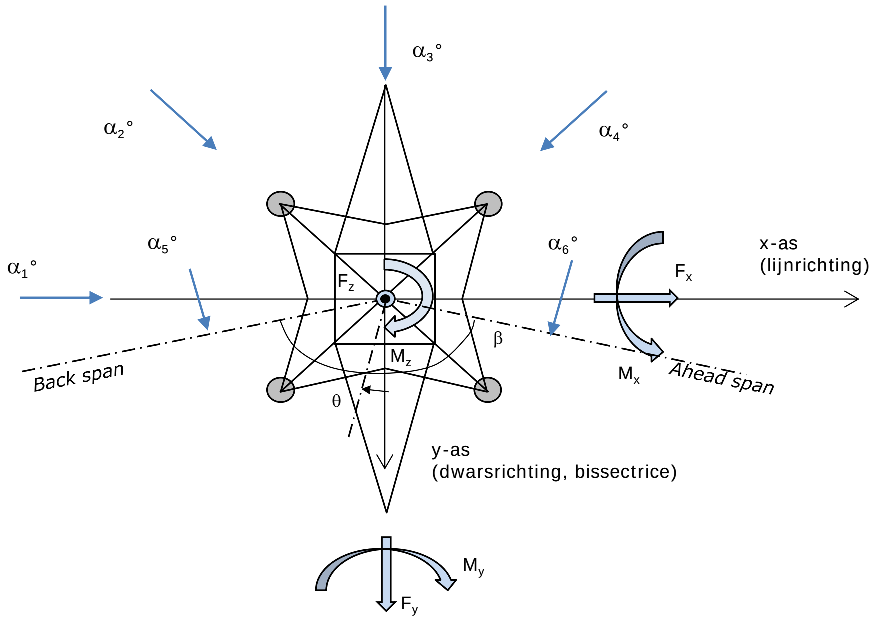
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	9.4	2.5 m	0.0	0.0 m
Circuit 1	11	380ct1f2	9.4	2.5 m	0.0	0.0 m
Circuit 1	12	380ct1f3	9.4	2.5 m	0.0	0.0 m
Circuit 2	21	380ct2f1	9.4	2.5 m	0.0	0.0 m
Circuit 2	20	380ct2f2	9.4	2.5 m	0.0	0.0 m
Circuit 2	22	380ct2f3	9.4	2.5 m	0.0	0.0 m
Bliksemdraad 1	1	bl1	9.4	2.5 m	0.0	0.0 m
Bliksemdraad 2	3	bl2	9.4	2.5 m	0.0	0.0 m

Line and tower data

		Back	Ahead
		414.2	222.9 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		443.5	338.9 m
Line angle	β	146.1 °	
Tower orientation with respect to bis	θ	0 °	
Section length		2214	2994 m
Height bottom of tower to ground level		0.5 m	
Wind directions considered	α_1	0 °	
Wind directions according to:	α_2	45 °	
Geleiderbelastingen	α_3	90 °	
	α_4	135 °	
	α_5	73.05 °	
	α_6	106.95 °	

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Project: ENS-ZL
Tower: HB-3_R
Number: 40

Considered number of wind directions

1a	6
3	6
4	1
6	1
Overig	1

Project: ENS-ZL
Tower: HB-3_R
Number: 40

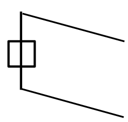
Absence of conductors

		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	1	0
Circuit 1	380ct1f2	1	0	1	0	1	0
Circuit 1	380ct1f3	1	0	1	0	1	0
Circuit 2	380ct2f1	0	1	1	0	1	0
Circuit 2	380ct2f2	0	1	1	0	1	0
Circuit 2	380ct2f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

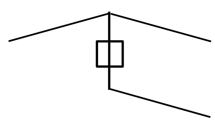
Load situations SPLS

Considered situations SPLS: 1 up to 6, All possible situations

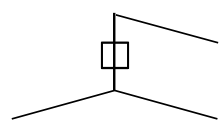
Principle of load situations:



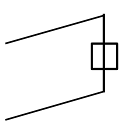
1. Ba All cts



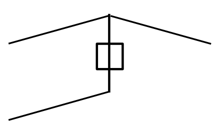
2. Ba ct1



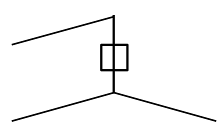
3. Ba ct2



4. Ah All cts



5. Ah ct1

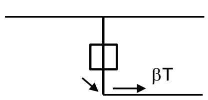


6. Ah ct2

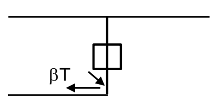
Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



1. Ba



2. Ah

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Load situations LC6. Construction and maintenance

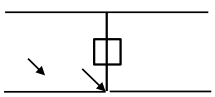
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

3.0 kN	2.0 kN
1.0 kN	1.0 kN

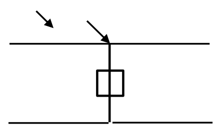
Considered situations construction and maintenance 6a: 1 up to 4, all possible situations

Presence line vehicle: Circuit, load present in all conductors of a circuit

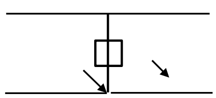
Principle of load situations:



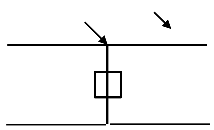
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

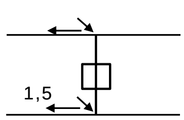
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0.866 W	1.5 W
Suspension tower earth	1.5 EDS	1.5 W
Strain tower phase and earth	1.5 EDS	1.5 W

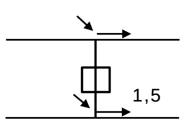
Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



1. Ba



2. Ah

Load combination 8. Galloping as a dynamic load

Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Tower structure

Properties

Tower type	Hoekmast		
Tower designation	HB-3_R		
Base plate w.r.t. ground level	0.5	m	
Tower height w.r.t. base plate	42.5	m	
Tower self weight	440.0	kN	

Width and slope at foundation	x-ri.	y-ri.	
Leg spread	10.00	10.00	m
Inclination of main leg	0.123	0.123	-
Horizontal force factor	1.3	1.3	-

Calculation Wind load

Dynamic factor G_T	1.00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross ar	0.4

Properties mast sections longitudinal direction (front view, yz plane)

Description	h	b_1	b_2	Δh	Δ_x	A_0	A_1	$\chi = A_1/A_0$	C_t
	[m]	[m]	[m]	[m]	[m]	[m^2]	[m^2]	[-]	
Broekstuk	11.36	10.00	7.21	11.36	0.123	97.72	16.23	0.17	3.08
Eerste tussenstuk	16.61	7.21	5.91	5.25	0.123	34.43	5.93	0.17	3.05
Tweede tussenstuk	25.20	5.91	3.80	8.59	0.123	41.72	10.36	0.25	2.73
Bovenstuk 1	33.00	3.80	3.19	7.80	0.039	27.25	6.48	0.24	2.77
Bovenstuk 2	40.50	3.19	2.60	7.50	0.039	21.70	5.22	0.24	2.76
Topstuk	42.50	2.60		2.00		2.60	0.40	0.15	3.14
Ondertraverse	25.20	14.40		4.00		28.80	6.32	0.22	2.85
Boventraverse	36.50	15.20		5.30		40.28	6.91	0.17	3.06

Properties tower sections transversal direction (side view, xz plane)

Description	h	b_1	b_2	Δh	Δ_x	A_0	A_1	$\chi = A_1/A_0$	C_t
	[m]	[m]	[m]	[m]	[m]	[m^2]	[m^2]	[-]	
Broekstuk	11.36	10.00	7.21	11.36	0.123	97.72	16.23	0.17	3.08
Eerste tussenstuk	16.61	7.21	5.91	5.25	0.123	34.43	5.93	0.17	3.05
Tweede tussenstuk	25.20	5.91	3.80	8.59	0.123	41.72	10.36	0.25	2.73
Bovenstuk 1	33.00	3.80	3.19	7.80	0.039	27.25	6.48	0.24	2.77
Bovenstuk 2	40.50	3.19	2.60	7.50	0.039	21.70	5.22	0.24	2.76
Topstuk	42.50	2.60		2.00		2.60	0.40	0.15	3.14
Ondertraverse	25.20	14.40		4.00		28.80	6.32	0.22	2.85
Boventraverse	36.50	15.20		5.30		40.28	6.91	0.17	3.06

Note: Surface transverse direction is reduced in calculation.

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Wind surface feeders telecom installations				
Part	A (m^2/m)	Factor	Δh	A_1
Broekstuk				
Eerste tussenstuk				
Tweede tussenstuk				
Bovenstuk 1				
Bovenstuk 2				

Input antennas			
Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	35.1	29.8	0.0	-29.8	5.7	199.3	169.1	0.0	-169.1
Eerste tussenstuk	0.78	14.2	12.1	0.0	-12.1	14.0	198.8	168.7	0.0	-168.7
Tweede tussenstuk	0.89	25.2	21.3	0.0	-21.3	20.9	525.8	446.2	0.0	-446.2
Bovenstuk 1	0.98	17.7	15.0	0.0	-15.0	29.1	514.6	436.7	0.0	-436.7
Bovenstuk 2	1.05	15.1	12.8	0.0	-12.8	36.8	553.8	469.9	0.0	-469.9
Topstuk	1.08	1.4	1.2	0.0	-1.2	41.5	56.3	47.8	0.0	-47.8
Ondertraverse	0.95	34.3	20.4	0.0	-20.4	26.5	911.4	541.3	0.0	-541.3
Boventraverse	1.06	44.7	26.5	0.0	-26.5	38.3	1710.0	1015.7	0.0	-1015.7
Totaal		187.6	139.1	0.0	-139.1		4670.0	3295.3	0.0	-3295.3

Tower section loads transversal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	0.0	29.8	35.1	29.8	5.7	0.0	169.1	199.3	169.1
Eerste tussenstuk	0.78	0.0	12.1	14.2	12.1	14.0	0.0	168.7	198.8	168.7
Tweede tussenstuk	0.89	0.0	21.3	25.2	21.3	20.9	0.0	446.2	525.8	446.2
Bovenstuk 1	0.98	0.0	15.0	17.7	15.0	29.1	0.0	436.7	514.6	436.7
Bovenstuk 2	1.05	0.0	12.8	15.1	12.8	36.8	0.0	469.9	553.8	469.9
Topstuk	1.08	0.0	1.2	1.4	1.2	41.5	0.0	47.8	56.3	47.8
Ondertraverse	0.95	0.0	20.4	13.7	20.4	26.5	0.0	541.3	364.5	541.3
Boventraverse	1.06	0.0	26.5	17.9	26.5	38.3	0.0	1015.7	684.0	1015.7
Total		0.0	139.1	140.2	139.1		0.0	3295.3	3097.2	3295.3

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	440	0	0	0
Windrichting 0°	188	0	0	0	4670	0
Windrichting 45°	139	139	0	3295	3295	0
Windrichting 90°	0	140	0	3097	0	0
Windrichting 135°	-139	139	0	3295	-3295	0

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm²]	G [N/m]	E [N/mm²]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm²]	G [N/m]	E [N/mm²]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m²]	Wind heigth [m]	Pressure [kN/m²]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct1f2	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct1f3	2.00	1	2	4.5	1.0	37.00	1.05	1.2	1.26
380ct2f1	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct2f2	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct2f3	2.00	1	2	4.5	1.0	37.00	1.05	1.2	1.26
bl1	0.10	0.5	0.05	0.3	0.1	42.00	1.08	1.2	0.13
bl2	0.10	0.5	0.05	0.3	0.1	42.00	1.08	1.2	0.13

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Wind load back

Conductor	Height wind [m]	Pressure [kN/m^2]	G_{c_dwars} [-]	G_{c_trek} [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	22.3	0.91	0.57	0.50	1.12	28.53	49.7	43.1	47.4	88.3	76.6
380ct1f2	22.3	0.91	0.57	0.50	1.12	28.53	49.7	43.1	47.4	88.3	76.6
380ct1f3	33.6	1.02	0.60	0.52	1.09	28.53	57.5	49.8	47.4	105.1	91.1
380ct2f1	22.3	0.91	0.57	0.50	1.12	28.53	49.7	43.1	47.4	88.3	76.6
380ct2f2	22.3	0.91	0.57	0.50	1.12	28.53	49.7	43.1	47.4	88.3	76.6
380ct2f3	33.6	1.02	0.60	0.52	1.09	28.53	57.5	49.8	47.4	105.1	91.1
bl1	39.9	1.07	0.62	0.54	1.20	22.35	17.7	15.4	41.8	33.2	28.7
bl2	39.9	1.07	0.62	0.54	1.20	22.35	17.7	15.4	41.8	33.2	28.7

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m^2]	G_{c_dwars} [-]	G_{c_trek} [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	24.6	0.93	0.58	0.49	1.11	28.53	51.5	43.6	47.4	92.1	77.9
380ct1f2	24.6	0.93	0.58	0.49	1.11	28.53	51.5	43.6	47.4	92.1	77.9
380ct1f3	35.9	1.04	0.61	0.51	1.09	28.53	58.8	49.6	47.4	108.0	91.1
380ct2f1	24.6	0.93	0.58	0.49	1.11	28.53	51.5	43.6	47.4	92.1	77.9
380ct2f2	24.6	0.93	0.58	0.49	1.11	28.53	51.5	43.6	47.4	92.1	77.9
380ct2f3	35.9	1.04	0.61	0.51	1.09	28.53	58.8	49.6	47.4	108.0	91.1
bl1	41.3	1.08	0.62	0.52	1.20	22.35	18.0	15.1	41.8	33.6	28.4
bl2	41.3	1.08	0.62	0.52	1.20	22.35	18.0	15.1	41.8	33.6	28.4

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Auteur: TBR
Versie: v11.6

Conductor loads

Starting points
Consequence class Afkeur CC2-0
Reference period 30 jaar

ULS	(strength)	NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.05	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.12	0.00	0.0
ULS 3	Wind+ice	-5°	1.05	1.05	0.00	0.34	0.97	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.05	0.00	0.34	0.97	0.0
ULS 4	Cold+wind	-20°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.05	0.00	0.22	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.05	1.05	1.20	0.22	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 7	Permanent	10°	1.15	1.15	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.05	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.05	1.05	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.05	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.05	1.05	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.05	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.05	1.05	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.05	1.05	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	0.94	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.28	0.88	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	54
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	5238

DNV·GL

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-36.8	38.2	14.5	12.1	4.8	3.6
380ct1f1	-128.1	126.5	45.9	42.6	14.9	9.8
380ct1f2	-128.1	126.5	45.9	42.6	14.9	9.8
380ct1f3	-130.0	128.1	49.4	43.7	14.9	9.8
380ct2f1	-128.1	126.5	45.9	42.6	14.9	9.8
380ct2f2	-128.1	126.5	45.9	42.6	14.9	9.8
380ct2f3	-130.0	128.1	49.4	43.7	14.9	9.8
bl2	-36.8	38.2	14.5	12.1	4.8	3.6
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar Combinatie1			
Geleider	SLS 1a	SLS 4	SLS 7
bl1	216.1	231.3	247.9
380ct1f1	245.4	251.0	259.3
380ct1f2	245.4	251.0	259.3
380ct1f3	241.6	250.7	259.3
380ct2f1	245.4	251.0	259.3
380ct2f2	245.4	251.0	259.3
380ct2f3	241.6	250.7	259.3
bl2	216.1	231.3	247.9
Post 1			
Post 2			

Max. Weight span (m)

Weight spar Combinatie1		
Geleider	ULS 1a	ULS 3
bl1	248.2	254.3
380ct1f1	259.6	261.4
380ct1f2	259.6	261.4
380ct1f3	259.5	261.4
380ct2f1	259.6	261.4
380ct2f2	259.6	261.4
380ct2f3	259.5	261.4
bl2	248.2	254.3
Post 1		
Post 2		

Envelop of weight span over all combinations (incl. 0,9 combinations) For all conductors		Wind / Weight span ratio
Max. weight span	261.4 m	0.821 -
Min. weight span	197.4 m	0.620 -

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	38.2	25.2	4.8	-39.2	40.1
380ct1f1	110.4	87.1	14.9	-135.9	133.4
380ct1f2	110.4	87.1	14.9	-135.9	133.4
380ct1f3	110.6	89.6	14.9	-138.3	135.3
380ct2f1	110.4	87.1	14.9	-135.9	133.4
380ct2f2	110.4	87.1	14.9	-135.9	133.4
380ct2f3	110.6	89.6	14.9	-138.3	135.3
bl2	38.2	25.2	4.8	-39.2	40.1
Post 1	2.5	2.5	4.0	0.0	
Post 2	2.5	2.5	4.0	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	20.3	6.2	1.7	-21.2	21.2
380ct1f1	77.9	23.8	9.7	-81.5	81.5
380ct1f2	77.9	23.8	9.7	-81.5	81.5
380ct1f3	77.9	23.8	9.7	-81.5	81.5
380ct2f1	77.9	23.8	9.7	-81.5	81.5
380ct2f2	77.9	23.8	9.7	-81.5	81.5
380ct2f3	77.9	23.8	9.7	-81.5	81.5
bl2	20.3	6.2	1.7	-21.2	21.2
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie1	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	0.0
	380ct1f1	0.0	0.0
	380ct1f2	0.0	0.0
	380ct1f3	0.0	0.0
	380ct2f1	0.0	0.0
	380ct2f2	0.0	0.0
	380ct2f3	0.0	0.0
	bl2	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	

Project: ENS-ZL
Tower: HB-3_R
Number: 40

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		-10	556	108	16906	-346	0
ULS 1a_0,9_0		6	327	113	9879	169	65
ULS 1a_0,9_0,9_90		-6	531	90	16182	-214	0
ULS 3_0		-11	495	162	14956	-338	20
SLS 7		0	310	108	9380	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

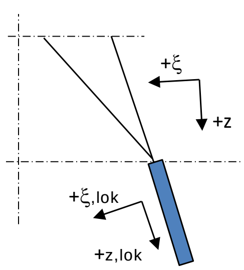
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-10	712	570	20365	-346	0
ULS 1a_0,9_0,9_90	-6	688	486	19640	-214	0
SLS 7	0	310	548	9380	0	0

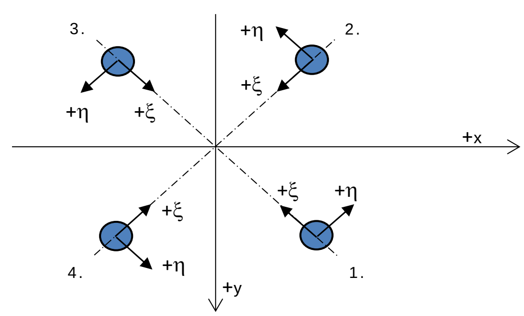
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-10	712	570	20365	-346	0
SPLS 3_0 Ba All Cts	725	199	529	6060	21422	21
SPLS 6a_90 Ah Ct1 Ah Ct2	-175	338	588	10284	-5139	4830
SPLS 3_73.05 Ah All Cts	-695	303	556	8820	-21105	6

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_106.95 Ba All Cts	263	263	1610	0	-372	-91	1634
2	SPLS 3_0 Ba All Cts	153	-143	900	-7	-210	-53	914
3	SPLS 3_135 Ah All Cts	-137	-124	803	9	-185	-46	815
4	SPLS 3_73.05 Ah All Cts	-266	267	1635	0	-377	-93	1660

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-96	-82	-542	-10	126	32	-550
2	SPLS 3_0,9_73.05 Ah All Cts	-225	225	-1373	0	318	79	-1394
3	SPLS 3_0,9_106.95 Ba All Cts	223	223	-1362	0	316	79	-1383
4	SPLS 3_0,9_0 Ba All Cts	115	-103	-653	9	154	40	-663

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_90 Ba Ct2 Ah Ct2	313	77	1190	167	-276	-69	1208
2	SPLS 6a_90 Ah Ct1 Ah Ct2	-223	-19	-624	171	145	36	-634
3	SPLS 6a_90 Ah Ct1 Ah Ct2	-106	141	-110	174	25	5	-112
4	SPLS 6a_90 Ba Ct2 Ah Ct2	113	137	65	176	-17	-6	66

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_90 Ah Ct2 Ah Ct1	-63	188	376	-177	-88	-23	381
2	SPLS 6a_90 Ah Ct2 Ah Ct1	23	223	-596	-174	141	38	-605
3	SPLS 6a_90 Ba Ct1 Ah Ct1	271	31	-926	-170	213	52	-940
4	SPLS 6a_90 Ah Ct2 Ah Ct1	-266	28	889	-168	-208	-53	903

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-96	-82	-542	-10	126	32	-550
2	SPLS 3_0,9_73.05 Ah Ct1	-278	58	-1031	155	238	58	-1047
3	SPLS 3_0,9_90 Ba Ct1	281	52	-1021	-162	235	58	-1036
4	SPLS 3_0,9_0 Ba All Cts	115	-103	-653	9	154	40	-663

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	97	99	606	-2	-139	-33	615
2	SLS 7	-53	56	-332	-2	77	19	-337
3	SLS 7	53	56	-332	2	77	19	-337
4	SLS 7	-97	99	606	2	-139	-33	615

Envelope of load combinations for all of the legs

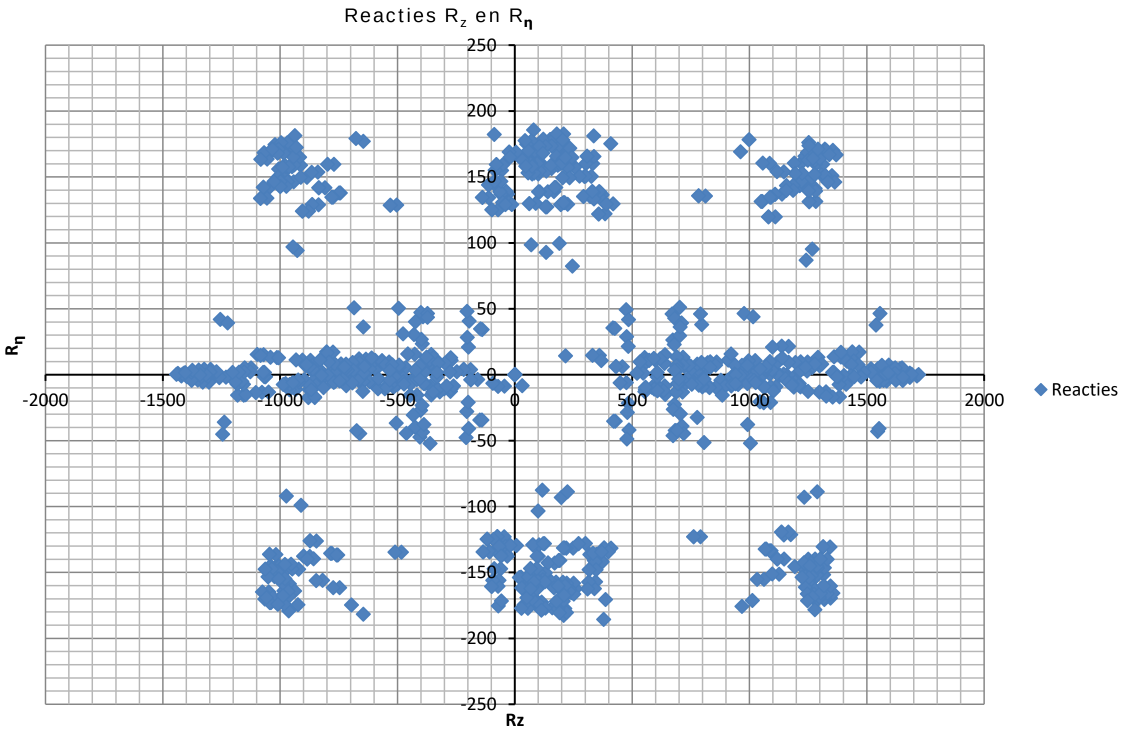
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	SPLS 3_73.05 Ah All Cts	-266	267	1635	0	-377	-93	1660
Max. tension	SPLS 3_0,9_73.05 Ah All Cts	-225	225	-1373	0	318	79	-1394
Max. pos. torsie	SPLS 6a_90 Ba Ct2 Ah Ct2	113	137	65	176	-17	-6	66
Max. neg. torsie	SPLS 6a_90 Ah Ct2 Ah Ct1	-63	188	376	-177	-88	-23	381
Comb. tension+torsie	SPLS 3_0,9_90 Ba Ct1	281	52	-1021	-162	235	58	-1036

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	97	99	606	-2	-139	-33	615
2	SLS 1a_90	-125	138	-782	-9	186	50	-794
3	SLS 1a_90	122	135	-763	9	182	49	-774
4	SLS 1a_0	-50	65	381	10	-81	-15	387

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_90	166	178	1034	-9	-243	-63	1050
2	SLS 1a_0	-9	18	-107	-6	19	1	-109
3	SLS 7	53	56	-332	2	77	19	-337
4	SLS 1a_90	-168	182	1054	9	-247	-64	1069


Reacties R_z en $R_η$
250
200
150
100
50
0
-50
-100
-150
-200
-250
-2000
-1500
-1000
-500
0
500
1000
1500
2000
$R_η$
Rz
Reacties

Auteur: TBR
Versie: v11.6

Conductor loads

Starting points
Consequence class Verbouw CC2
Reference period 50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.15	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.40	0.00	0.0
ULS 3	Wind+ice	-5°	1.15	1.15	0.00	0.42	1.30	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.15	0.00	0.42	1.30	0.0
ULS 4	Cold+wind	-20°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.15	0.00	0.28	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.15	1.15	1.30	0.28	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 7	Permanent	10°	1.30	1.30	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.15	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.15	1.15	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.15	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.15	1.15	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.15	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.15	1.15	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.15	1.15	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	1.00	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.30	1.00	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	54
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	5238

Project: ENS-ZL
Tower: HB-3_R
Number: 40

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-42.2	40.5	17.2	14.0	5.3	3.9
380ct1f1	-147.7	143.9	53.5	48.9	17.6	10.8
380ct1f2	-147.7	143.9	53.5	48.9	17.6	10.8
380ct1f3	-150.1	145.9	58.4	50.3	17.6	10.8
380ct2f1	-147.7	143.9	53.5	48.9	17.6	10.8
380ct2f2	-147.7	143.9	53.5	48.9	17.6	10.8
380ct2f3	-150.1	145.9	58.4	50.3	17.6	10.8
bl2	-42.2	40.5	17.2	14.0	5.3	3.9
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar Combinatie1			
Geleider	SLS 1a	SLS 4	SLS 7
bl1	213.2	231.1	247.9
380ct1f1	243.9	250.9	259.3
380ct1f2	243.9	250.9	259.3
380ct1f3	239.8	250.6	259.3
380ct2f1	243.9	250.9	259.3
380ct2f2	243.9	250.9	259.3
380ct2f3	239.8	250.6	259.3
bl2	213.2	231.1	247.9
Post 1			
Post 2			

Max. Weight span (m)

Weight spar Combinatie1		
Geleider	ULS 1a	ULS 3
bl1	249.6	257.9
380ct1f1	260.3	263.4
380ct1f2	260.3	263.4
380ct1f3	260.3	263.4
380ct2f1	260.3	263.4
380ct2f2	260.3	263.4
380ct2f3	260.3	263.4
bl2	249.6	257.9
Post 1		
Post 2		

Envelop of weight span over all combinations (incl. 0,9 combinations) For all conductors		Wind / Weight span ratio
Max. weight span	263.4 m	0.827 -
Min. weight span	180.6 m	0.567 -

Project: ENS-ZL
Tower: HB-3_R
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Maximum values back + ahead span / Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	39.3	29.4	5.3	-45.0	42.5
380ct1f1	115.9	100.7	17.6	-156.9	151.9
380ct1f2	115.9	100.7	17.6	-156.9	151.9
380ct1f3	116.0	103.9	17.6	-159.8	154.2
380ct2f1	115.9	100.7	17.6	-156.9	151.9
380ct2f2	115.9	100.7	17.6	-156.9	151.9
380ct2f3	116.0	103.9	17.6	-159.8	154.2
bl2	39.3	29.4	5.3	-45.0	42.5
Post 1	3.2	3.2	4.6	0.0	
Post 2	3.2	3.2	4.6	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	20.3	6.2	1.7	-21.2	21.2
380ct1f1	77.9	23.8	9.7	-81.5	81.5
380ct1f2	77.9	23.8	9.7	-81.5	81.5
380ct1f3	77.9	23.8	9.7	-81.5	81.5
380ct2f1	77.9	23.8	9.7	-81.5	81.5
380ct2f2	77.9	23.8	9.7	-81.5	81.5
380ct2f3	77.9	23.8	9.7	-81.5	81.5
bl2	20.3	6.2	1.7	-21.2	21.2
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie1	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	0.0
	380ct1f1	0.0	0.0
	380ct1f2	0.0	0.0
	380ct1f3	0.0	0.0
	380ct2f1	0.0	0.0
	380ct2f2	0.0	0.0
	380ct2f3	0.0	0.0
	bl2	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	

Project: ENS-ZL
Tower: HB-3_R
Number: 40

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		-19	647	117	19704	-630	0
ULS 1a_0,9_0		5	353	123	10667	106	82
ULS 1a_0,9_0,9_90		-12	612	87	18655	-424	0
ULS 3_0		-25	565	190	17062	-765	25
SLS 7		0	310	108	9380	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

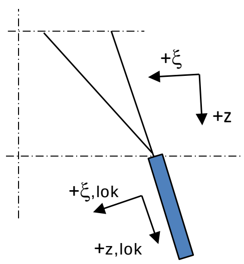
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-19	844	623	24040	-630	0
ULS 1a_0,9_0,9_90	-12	809	483	22991	-424	0
SLS 7	0	310	548	9380	0	0

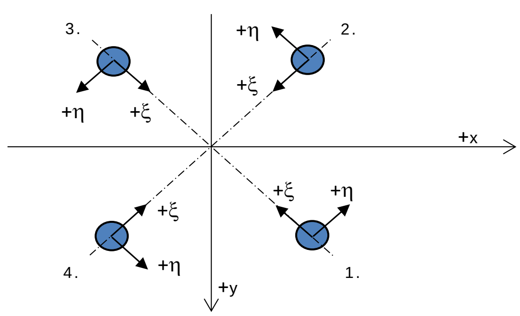
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-19	844	623	24040	-630	0
SPLS 3_0 Ba All Cts	763	210	579	6414	22553	21
SPLS 6a_90 Ba Ct1 Ah Ct1	387	352	629	10704	11717	-5055
SPLS 3_73.05 Ah All Cts	-732	314	608	9162	-22197	6

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_106.95 Ba All Cts	275	275	1686	0	-389	-96	1712
2	SPLS 3_0 Ba All Cts	162	-151	952	-8	-222	-56	966
3	SPLS 3_135 Ah All Cts	-147	-133	859	10	-198	-49	872
4	SPLS 3_73.05 Ah All Cts	-280	280	1720	0	-397	-97	1746

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-104	-88	-584	-11	136	34	-592
2	SPLS 3_0,9_73.05 Ah All Cts	-236	236	-1443	0	334	83	-1464
3	SPLS 3_0,9_106.95 Ba All Cts	234	233	-1424	0	330	82	-1445
4	SPLS 3_0,9_0 Ba All Cts	122	-109	-691	9	163	42	-702

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_90 Ba Ct2 Ah Ct2	330	80	1252	176	-290	-72	1270
2	SPLS 6a_90 Ah Ct1 Ah Ct2	-237	-16	-677	179	157	39	-687
3	SPLS 6a_90 Ah Ct1 Ah Ct2	-115	143	-88	182	19	4	-89
4	SPLS 6a_90 Ba Ct2 Ah Ct2	117	146	80	186	-21	-7	81

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_90 Ah Ct2 Ah Ct1	-69	194	378	-186	-89	-23	384
2	SPLS 6a_90 Ba Ct1 Ah Ct1	163	96	208	-183	-47	-11	211
3	SPLS 6a_90 Ba Ct1 Ah Ct1	284	30	-964	-179	222	54	-978
4	SPLS 6a_90 Ah Ct2 Ah Ct1	-284	35	967	-176	-226	-57	982

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Project: ENS-ZL
Tower: HB-3_R
Number: 40

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-104	-88	-584	-11	136	34	-592
2	SPLS 3_0,9_90 Ah Ct1	-294	56	-1069	168	247	61	-1085
3	SPLS 3_0,9_90 Ba Ct1	294	53	-1066	-170	246	60	-1082
4	SPLS 3_0,9_0 Ba All Cts	122	-109	-691	9	163	42	-702

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	97	99	606	-2	-139	-33	615
2	SLS 7	-53	56	-332	-2	77	19	-337
3	SLS 7	53	56	-332	2	77	19	-337
4	SLS 7	-97	99	606	2	-139	-33	615

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	SPLS 3_73.05 Ah All Cts	-280	280	1720	0	-397	-97	1746
Max. tension	SPLS 3_0,9_73.05 Ah All Cts	-236	236	-1443	0	334	83	-1464
Max. pos. torsie	SPLS 6a_90 Ba Ct2 Ah Ct2	117	146	80	186	-21	-7	81
Max. neg. torsie	SPLS 6a_90 Ah Ct2 Ah Ct1	-69	194	378	-186	-89	-23	384
Comb. tension+torsie	SPLS 3_0,9_90 Ba Ct1	294	53	-1066	-170	246	60	-1082

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	97	99	606	-2	-139	-33	615
2	SLS 1a_90	-130	144	-815	-10	194	52	-828
3	SLS 1a_90	127	141	-793	10	189	51	-805
4	SLS 1a_0	-48	63	368	11	-78	-14	373

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_90	170	184	1064	-10	-251	-65	1080
2	SLS 1a_0	-7	16	-94	-7	16	0	-95
3	SLS 7	53	56	-332	2	77	19	-337
4	SLS 1a_90	-174	188	1087	10	-255	-66	1103

Content

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-12-06			

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	II
Wind speed	25 m/s
Terrain categorie	II
Reduction factor Cdir	1.00
Ice region	B
Tower type	Hoekmast
Tower height	42.5 m
Max. Span	362.9 m
Line angle	157.3°
Catenary	1760 m
Wind span	256 m
EDS Weight span	134 m
Min. Weight span	-53 m
Max. Weight span	143 m

Client:

TenneT Taking power further

DNV·GL

Title:

Berekening masttype HB-3_R_X

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_HB-3_R_X_6_Report.pdf

Project number:

Project client number:

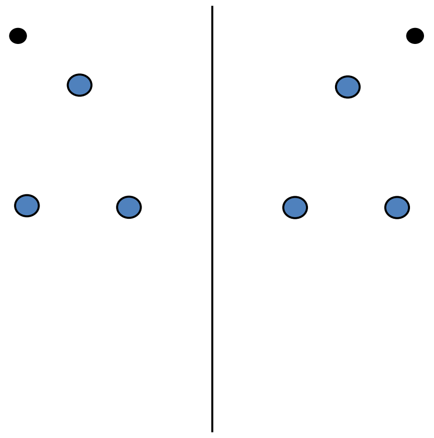
0.0

Conductor loads

Auteur: TBR
Versie: v11.7

General

Description	HB-3_R_X
Tower type	Hoekmast
Number of circuits	2
Configuration	2-circuit-donau
Number of earth wires	2



Configuratie geleiders

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	II
Wind speed (m/s)	25.0 m/s
Terrain category	II
Reduction factor c_{dir}	1.00
Ice region phase conductor	B
Ice region earth conductor	B

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area [m^2]
Circuit 1	Afspanketting	2.00	4.50	1.00
Circuit 2	Afspanketting	2.00	4.50	1.00
Bliksemdraad 1	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 2	Vast (Bliksemdraad)	0.10	0.30	0.10

1. Properties apply to the entire isolator set

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower Horizontal distance
Circuit 1	10	380ct1f1	25.2 m	25.2 m	-16.3 m
Circuit 1	11	380ct1f2	25.2 m	25.2 m	-9.0 m
Circuit 1	12	380ct1f3	36.5 m	36.5 m	-12.7 m
Circuit 2	21	380ct2f1	25.2 m	25.2 m	16.3 m
Circuit 2	20	380ct2f2	25.2 m	25.2 m	9.0 m
Circuit 2	22	380ct2f3	36.5 m	36.5 m	12.7 m
Bliksemdraad 1	1	bl1	41.5 m	41.8 m	-16.7 m
Bliksemdraad 2	3	bl2	41.5 m	41.8 m	16.7 m

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Height adjustment adjacent masts (wind and weight span adjustment)

	Back	Ahead	
Height increase for wind pressure	0.0 m	0.0 m	(positive: higher)
Height decrease for vertical load	0.0 m	0.0 m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

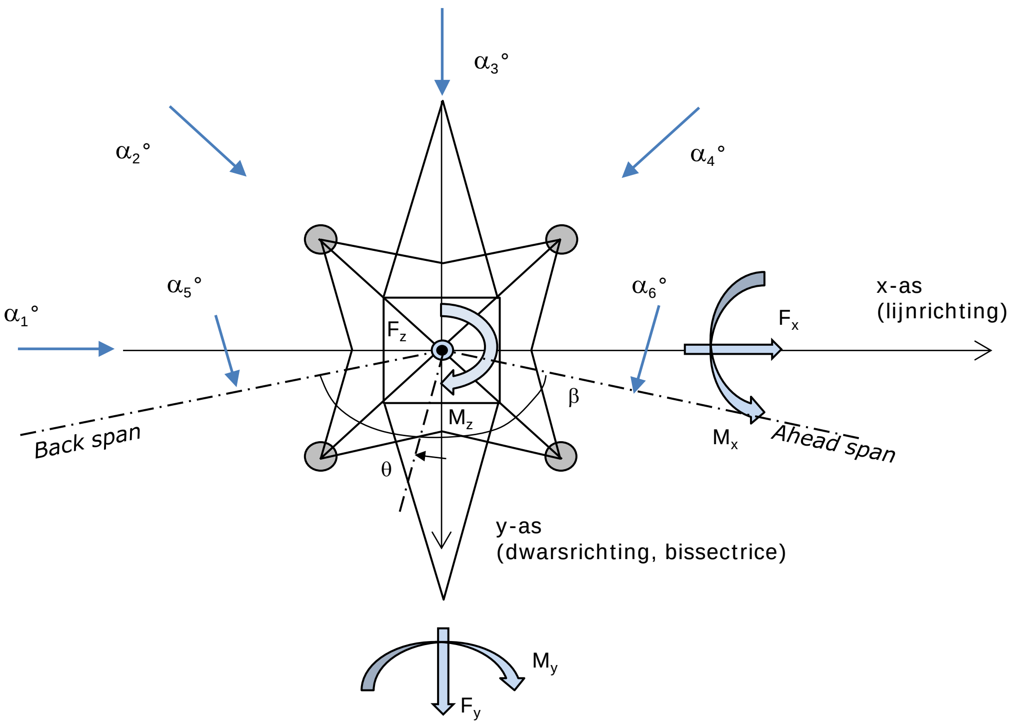
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	9.4	2.5 m	0.0	0.0 m
Circuit 1	11	380ct1f2	9.4	2.5 m	0.0	0.0 m
Circuit 1	12	380ct1f3	9.4	2.5 m	0.0	0.0 m
Circuit 2	21	380ct2f1	9.4	2.5 m	0.0	0.0 m
Circuit 2	20	380ct2f2	9.4	2.5 m	0.0	0.0 m
Circuit 2	22	380ct2f3	9.4	2.5 m	0.0	0.0 m
Bliksemdraad 1	1	bl1	9.4	2.5 m	0.0	0.0 m
Bliksemdraad 2	3	bl2	9.4	2.5 m	0.0	0.0 m

Line and tower data

		Back	Ahead
		150.0	362.9 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		383.2	400.3 m
Line angle	β	157.3 °	
Tower orientation with respect to bis	θ	0 °	
Section length		2076	1455 m
Height bottom of tower to ground level		0.5 m	
Wind directions considered	α_1	0 °	
Wind directions according to:	α_2	45 °	
Geleiderbelastingen	α_3	90 °	
	α_4	135 °	
	α_5	78.65 °	
	α_6	101.35 °	

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Considered number of wind directions	
1a	6
3	6
4	1
6	1
Overig	1

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

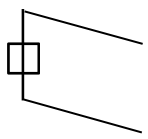
Absence of conductors

		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	1	0
Circuit 1	380ct1f2	1	0	1	0	1	0
Circuit 1	380ct1f3	1	0	1	0	1	0
Circuit 2	380ct2f1	0	1	1	0	1	0
Circuit 2	380ct2f2	0	1	1	0	1	0
Circuit 2	380ct2f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

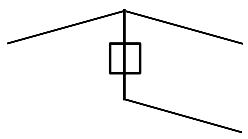
Load situations SPLS

Considered situations SPLS: 1 up to 6, All possible situations

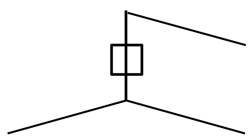
Principle of load situations:



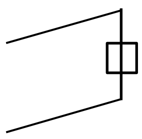
1. Ba All cts



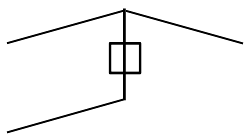
2. Ba ct1



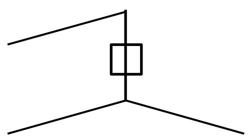
3. Ba ct2



4. Ah All cts



5. Ah ct1

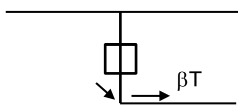


6. Ah ct2

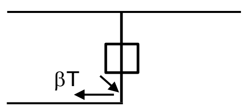
Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



1. Ba



2. Ah

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

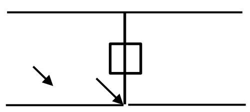
Load situations LC6. Construction and maintenance
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

	Phase	Earth
Line vehicle	3.0 kN	2.0 kN
Concentrated load cross arm	1.0 kN	1.0 kN

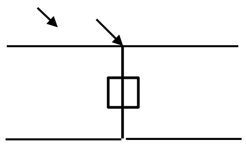
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

Presence line vehicle: Circuit, belasting tegelijk aanwezig in alle geleiders per circuit.

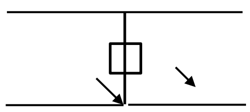
Principle of load situations:



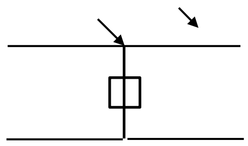
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

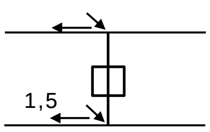
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0.866 W	1.5 W
Suspension tower earth	1.5 EDS	1.5 W
Strain tower phase and earth	1.5 EDS	1.5 W

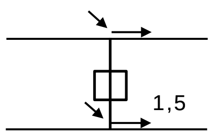
Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



1. Ba



2. Ah

Load combination 8. Galloping as a dynamic load
Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Tower structure

Properties

Tower type	Hoekmast		
Tower designation	HB-3_R_X		
Base plate w.r.t. ground level	0.5	m	
Tower height w.r.t. base plate	42.5	m	
Tower self weight	484.0	kN	
Width and slope at foundation	x-ri.	y-ri.	
Leg spread	10.00	10.00	m
Inclination of main leg	0.123	0.123	-
Horizontal force factor	1.3	1.3	-

Calculation Wind load

Dynamic factor G_T	1.00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross a	0.4

Properties mast sections longitudinal direction (front view, yz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	11.36	10.00	7.21	11.36	0.123	97.72	16.18	0.17	3.09
Eerste tussenstuk	16.61	7.21	5.91	5.25	0.123	34.43	5.95	0.17	3.05
Tweede tussenstuk	25.20	5.91	3.80	8.59	0.123	41.72	10.35	0.25	2.73
Bovenstuk 1	33.00	3.80	3.19	7.80	0.039	27.25	6.37	0.23	2.79
Bovenstuk 2	40.50	3.19	2.60	7.50	0.039	21.70	5.23	0.24	2.76
Topstuk	42.50	2.60		2.00		2.60	0.38	0.15	3.17
Ondertraverse	25.20	14.40		4.00		28.80	6.32	0.22	2.85
Boventraverse	36.50	15.20		5.30		40.28	7.88	0.20	2.95

Properties tower sections transversal direction (side view, xz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	11.36	10.00	7.21	11.36	0.123	97.72	16.18	0.17	3.09
Eerste tussenstuk	16.61	7.21	5.91	5.25	0.123	34.43	5.95	0.17	3.05
Tweede tussenstuk	25.20	5.91	3.80	8.59	0.123	41.72	10.35	0.25	2.73
Bovenstuk 1	33.00	3.80	3.19	7.80	0.039	27.25	6.37	0.23	2.79
Bovenstuk 2	40.50	3.19	2.60	7.50	0.039	21.70	5.23	0.24	2.76
Topstuk	42.50	2.60		2.00		2.60	0.38	0.15	3.17
Ondertraverse	25.20	14.40		4.00		28.80	6.32	0.22	2.85
Boventraverse	36.50	15.20		5.30		40.28	7.88	0.20	2.95

Note: Surface transverse direction is reduced in calculation.

DNV·GL

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Wind surface feeders telecom installations				
Part	A (m^2/m)	Factor	Δh	A_1
Broekstuk				
Eerste tussenstuk				
Tweede tussenstuk				
Bovenstuk 1				
Bovenstuk 2				

Input antennas			
Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.73	36.5	31.0	0.0	-31.0	5.7	207.2	175.9	0.0	-175.9
Eerste tussenstuk	0.82	14.9	12.6	0.0	-12.6	14.0	207.8	176.3	0.0	-176.3
Tweede tussenstuk	0.93	26.2	22.2	0.0	-22.2	20.9	548.0	465.0	0.0	-465.0
Bovenstuk 1	1.03	18.2	15.5	0.0	-15.5	29.1	530.2	449.9	0.0	-449.9
Bovenstuk 2	1.09	15.7	13.3	0.0	-13.3	36.8	578.0	490.4	0.0	-490.4
Topstuk	1.13	1.4	1.2	0.0	-1.2	41.5	56.7	48.1	0.0	-48.1
Ondertraverse	0.99	35.8	21.3	0.0	-21.3	26.5	950.2	564.4	0.0	-564.4
Boventraverse	1.10	51.2	30.4	0.0	-30.4	38.3	1960.9	1164.7	0.0	-1164.7
Totaal		199.9	147.5	0.0	-147.5		5039.0	3534.7	0.0	-3534.7

Tower section loads transversal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.73	0.0	31.0	36.5	31.0	5.7	0.0	175.9	207.2	175.9
Eerste tussenstuk	0.82	0.0	12.6	14.9	12.6	14.0	0.0	176.3	207.8	176.3
Tweede tussenstuk	0.93	0.0	22.2	26.2	22.2	20.9	0.0	465.0	548.0	465.0
Bovenstuk 1	1.03	0.0	15.5	18.2	15.5	29.1	0.0	449.9	530.2	449.9
Bovenstuk 2	1.09	0.0	13.3	15.7	13.3	36.8	0.0	490.4	578.0	490.4
Topstuk	1.13	0.0	1.2	1.4	1.2	41.5	0.0	48.1	56.7	48.1
Ondertraverse	0.99	0.0	21.3	14.3	21.3	26.5	0.0	564.4	380.1	564.4
Boventraverse	1.10	0.0	30.4	20.5	30.4	38.3	0.0	1164.7	784.3	1164.7
Total		0.0	147.5	147.7	147.5		0.0	3534.7	3292.3	3534.7

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	484	0	0	0
Windrichting 0°	200	0	0	0	5039	0
Windrichting 45°	147	147	0	3535	3535	0
Windrichting 90°	0	148	0	3292	0	0
Windrichting 135°	-147	147	0	3535	-3535	0

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m^2]	Wind heigth [m]	Pressure [kN/m^2]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct1f2	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct1f3	2.00	1	2	4.5	1.0	37.00	1.09	1.2	1.31
380ct2f1	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct2f2	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct2f3	2.00	1	2	4.5	1.0	37.00	1.09	1.2	1.31
bl1	0.10	0.5	0.05	0.3	0.1	42.00	1.13	1.2	0.14
bl2	0.10	0.5	0.05	0.3	0.1	42.00	1.13	1.2	0.14

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Wind load back

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	29.3	1.02	0.61	0.52	1.09	28.53	58.4	49.4	47.4	106.8	90.4
380ct1f2	29.3	1.02	0.61	0.52	1.09	28.53	58.4	49.4	47.4	106.8	90.4
380ct1f3	40.6	1.12	0.64	0.54	1.06	28.53	65.1	55.1	47.4	122.0	103.2
380ct2f1	29.3	1.02	0.61	0.52	1.09	28.53	58.4	49.4	47.4	106.8	90.4
380ct2f2	29.3	1.02	0.61	0.52	1.09	28.53	58.4	49.4	47.4	106.8	90.4
380ct2f3	40.6	1.12	0.64	0.54	1.06	28.53	65.1	55.1	47.4	122.0	103.2
bl1	45.8	1.16	0.65	0.55	1.18	22.35	19.8	16.8	41.8	37.6	31.8
bl2	45.8	1.16	0.65	0.55	1.18	22.35	19.8	16.8	41.8	37.6	31.8

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	20.7	0.92	0.58	0.51	1.12	28.53	51.4	45.2	47.4	91.8	80.6
380ct1f2	20.7	0.92	0.58	0.51	1.12	28.53	51.4	45.2	47.4	91.8	80.6
380ct1f3	32.0	1.05	0.62	0.54	1.08	28.53	60.1	52.8	47.4	110.7	97.1
380ct2f1	20.7	0.92	0.58	0.51	1.12	28.53	51.4	45.2	47.4	91.8	80.6
380ct2f2	20.7	0.92	0.58	0.51	1.12	28.53	51.4	45.2	47.4	91.8	80.6
380ct2f3	32.0	1.05	0.62	0.54	1.08	28.53	60.1	52.8	47.4	110.7	97.1
bl1	38.0	1.10	0.63	0.56	1.19	22.35	18.6	16.3	41.8	35.0	30.7
bl2	38.0	1.10	0.63	0.56	1.19	22.35	18.6	16.3	41.8	35.0	30.7

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Conductor loads

Auteur: TBR
Versie: v11.7

Starting points

Consequence class	Afkeur CC2-0
Reference period	30 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.05	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.12	0.00	0.0
ULS 3	Wind+ice	-5°	1.05	1.05	0.00	0.34	0.97	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.05	0.00	0.34	0.97	0.0
ULS 4	Cold+wind	-20°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.05	0.00	0.22	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.05	1.05	1.20	0.22	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 7	Permanent	10°	1.15	1.15	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.05	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.05	1.05	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.05	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.05	1.05	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.05	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.05	1.05	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.05	1.05	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	0.94	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.28	0.88	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	54
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	5820

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-38.8	38.5	8.9	11.0	1.3	5.1
380ct1f1	-133.4	131.8	29.9	34.3	3.3	15.1
380ct1f2	-133.4	131.8	29.9	34.3	3.3	15.1
380ct1f3	-135.5	134.2	31.5	37.7	3.3	15.1
380ct2f1	-133.4	131.8	29.9	34.3	3.3	15.1
380ct2f2	-133.4	131.8	29.9	34.3	3.3	15.1
380ct2f3	-135.5	134.2	31.5	37.7	3.3	15.1
bl2	-38.8	38.5	8.9	11.0	1.3	5.1
Post 40	0.0	0.0	0.0	0.0	0.0	
Post 41	0.0	0.0	0.0	0.0	0.0	
Post 42	0.0	0.0	0.0	0.0	0.0	
Post 43	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	29.9	73.3	110.8
380ct1f1	94.8	115.4	134.4
380ct1f2	94.8	115.4	134.4
380ct1f3	86.9	114.9	134.4
380ct2f1	94.8	115.4	134.4
380ct2f2	94.8	115.4	134.4
380ct2f3	86.9	114.9	134.4
bl2	29.9	73.3	110.8
Post 40			
Post 41			
Post 42			
Post 43			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	112.4	125.0
380ct1f1	135.3	139.0
380ct1f2	135.3	139.0
380ct1f3	135.2	139.0
380ct2f1	135.3	139.0
380ct2f2	135.3	139.0
380ct2f3	135.2	139.0
bl2	112.4	125.0
Post 40		
Post 41		
Post 42		
Post 43		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	139.0 m	0.542 -
Min. weight span	-15.3 m	-0.060 -

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Maximum values back + ahead span / Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	38.8	19.4	5.1	-39.7	39.4
380ct1f1	113.5	62.5	15.1	-136.7	135.7
380ct1f2	113.5	62.5	15.1	-136.7	135.7
380ct1f3	116.6	67.5	15.1	-138.9	138.3
380ct2f1	113.5	62.5	15.1	-136.7	135.7
380ct2f2	113.5	62.5	15.1	-136.7	135.7
380ct2f3	116.6	67.5	15.1	-138.9	138.3
bl2	38.8	19.4	5.1	-39.7	39.4
Post 40	1.9	1.9	5.8	0.0	
Post 41	1.9	1.9	5.8	0.0	
Post 42	1.9	1.9	5.8	0.0	
Post 43	1.9	1.9	5.8	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	20.8	4.2	1.7	-21.2	21.2
380ct1f1	79.9	16.0	9.8	-81.5	81.5
380ct1f2	79.9	16.0	9.8	-81.5	81.5
380ct1f3	79.9	16.0	9.8	-81.5	81.5
380ct2f1	79.9	16.0	9.8	-81.5	81.5
380ct2f2	79.9	16.0	9.8	-81.5	81.5
380ct2f3	79.9	16.0	9.8	-81.5	81.5
bl2	20.8	4.2	1.7	-21.2	21.2
Post 40	0.0	0.0	5.0	0.0	
Post 41	0.0	0.0	5.0	0.0	
Post 42	0.0	0.0	5.0	0.0	
Post 43	0.0	0.0	5.0	0.0	

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	-0.9	0.0
	380ct1f1	-0.4	0.0
	380ct1f2	-0.4	0.0
	380ct1f3	-0.4	0.0
	380ct2f1	-0.4	0.0
	380ct2f2	-0.4	0.0
	380ct2f3	-0.4	0.0
	bl2	-0.9	0.0
	Post 40	0.0	
	Post 41	0.0	
	Post 42	0.0	
	Post 43	0.0	

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x	F_y	F_z	M_x	M_y	M_z
		[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
ULS 1a_90		-27	431	72	12903	-761	0
ULS 1a_0,9_0		9	216	85	6295	315	-83
ULS 1a_0,9_0,9_90		-29	417	57	12498	-836	0
ULS 3_0		5	332	115	9755	169	-25
SLS 7		0	209	84	6054	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

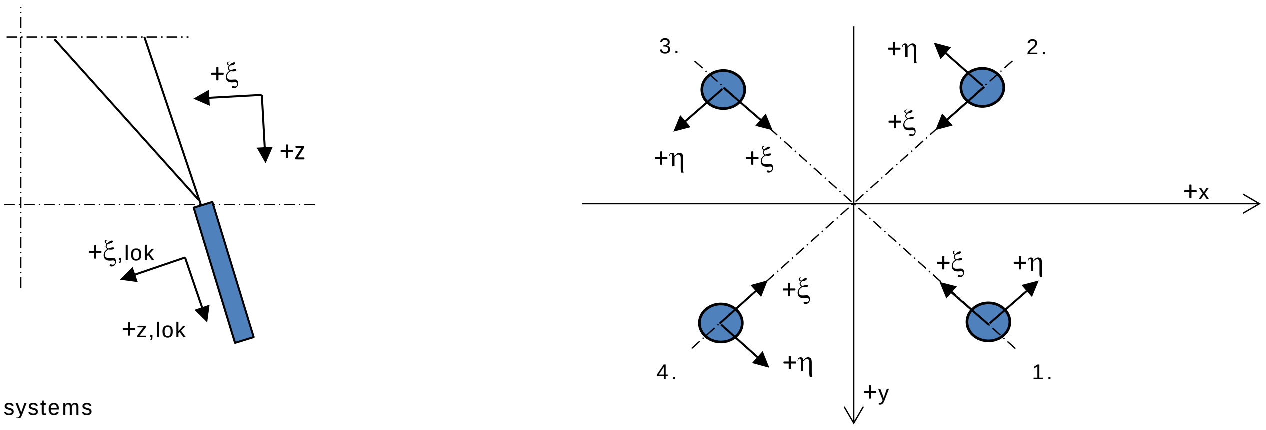
Combination	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
ULS 1a_90	-27	598	580	16604	-761	0
ULS 1a_0,9_0,9_90	-29	583	492	16199	-836	0
SLS 7	0	209	568	6054	0	0

Foundation loads, selection of load combinations based on greatest value

Combination	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
ULS 1a_0,9_90	-27	598	505	16636	-761	0
SPLS 3_90 Ah All Cts	-748	221	535	6046	-22553	0
SPLS 3_78.65 Ba Ct1	355	308	608	8535	10618	-4907
SPLS 3_0,9_78.65 Ah All Cts	-742	224	459	6157	-22474	-5

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
		[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 3_90 Ba All Cts	259	260	1580	0	-367	-92	1604
2	SPLS 3_0 Ba All Cts	181	-167	1065	-10	-246	-60	1081
3	SPLS 3_90 Ah All Cts	-160	-146	959	10	-217	-50	973
4	SPLS 3_90 Ah All Cts	-257	257	1564	0	-363	-91	1587

Maximum tension load

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
		[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 3_0,9_90 Ah All Cts	-120	-107	-709	-9	160	37	-720
2	SPLS 3_0,9_78.65 Ah All Cts	-216	218	-1317	-1	307	78	-1337
3	SPLS 3_0,9_90 Ba All Cts	213	213	-1292	0	301	77	-1311
4	SPLS 3_0,9_0 Ba All Cts	133	-121	-773	8	180	45	-785

Maximum torsional load (positive)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
		[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 3_0,9_78.65 Ba Ct2	303	61	1106	171	-257	-65	1122
2	SPLS 6a_90 Ah Ct1 Ba Ct1	-250	7	-784	172	182	45	-796
3	SPLS 6a_90 Ah Ct1 Ba Ct1	-182	68	357	177	-80	-18	362
4	SPLS 3_78.65 Ba Ct2	117	139	61	181	-16	-5	62

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_90 Ah Ct2 Ba Ct2	-140	115	-98	-181	18	1	-100
2	SPLS 3_78.65 Ba Ct1	167	91	256	-182	-54	-10	260
3	SPLS 3_0,9_78.65 Ba Ct1	259	18	-826	-170	196	52	-839
4	SPLS 6a_90 Ah Ct2 Ba Ct2	-291	54	1042	-168	-244	-63	1058

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_90 Ah All Cts Ba Ct2	-133	-61	-607	-51	137	32	-616
2	SPLS 3_0,9_90 Ah Ct1	-267	29	-904	168	210	53	-918
3	SPLS 3_0,9_90 Ba Ct2	19	265	-858	174	201	51	-871
4	SPLS 3_0,9_0 Ba All Cts	133	-121	-773	8	180	45	-785

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	71	75	445	-3	-103	-26	451
2	SLS 7	-26	30	-161	-3	39	11	-163
3	SLS 7	26	30	-161	3	39	11	-163
4	SLS 7	-71	75	445	3	-103	-26	451

Envelope of load combinations for all of the legs

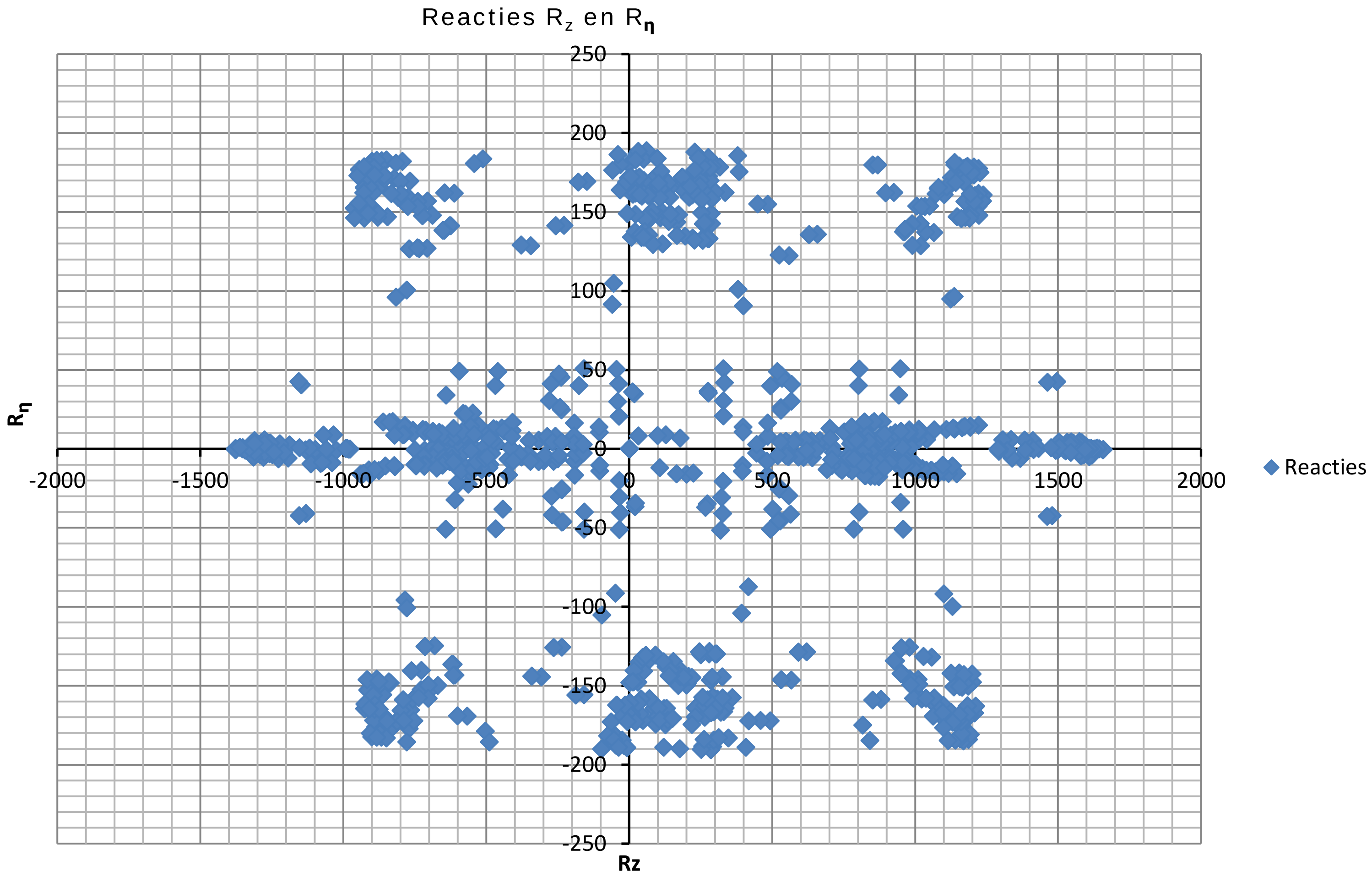
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	SPLS 3_90 Ba All Cts	259	260	1580	0	-367	-92	1604
Max. tension	SPLS 3_0,9_78.65 Ah All Cts	-216	218	-1317	-1	307	78	-1337
Max. pos. torsie	SPLS 3_78.65 Ba Ct2	117	139	61	181	-16	-5	62
Max. neg. torsie	SPLS 3_78.65 Ba Ct1	167	91	256	-182	-54	-10	260
Comb. tension+torsie	SPLS 3_0,9_90 Ah Ct1	-267	29	-904	168	210	53	-918

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	71	75	445	-3	-103	-26	451
2	SLS 1a_90	-100	114	-621	-10	151	43	-631
3	SLS 1a_90	89	103	-557	10	136	39	-566
4	SLS 1a_0	-24	33	192	7	-40	-6	195

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_90	133	148	835	-10	-199	-53	847
2	SLS 1a_0	25	-9	91	-11	-24	-8	93
3	SLS 7	26	30	-161	3	39	11	-163
4	SLS 1a_90	-144	158	899	10	-214	-57	912


Reacties R_z en R_η
R_η
Rz
250
200
150
100
50
0
-50
-100
-150
-200
-250
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Reacties

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Auteur: TBR
Versie: v11.7

Conductor loads

Starting points

Consequence class	Verbouw CC2
Reference period	50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.15	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.40	0.00	0.0
ULS 3	Wind+ice	-5°	1.15	1.15	0.00	0.42	1.30	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.15	0.00	0.42	1.30	0.0
ULS 4	Cold+wind	-20°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.15	0.00	0.28	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.15	1.15	1.30	0.28	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 7	Permanent	10°	1.30	1.30	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS (strength, for angle towers: absence of conductors)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.15	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.15	1.15	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.15	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.15	1.15	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.15	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.15	1.15	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.15	1.15	0.0	0.24	0.0	0.0
SLS (deformations, fatigue, EDS)								
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	1.00	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.30	1.00	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	54
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	5820

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Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-43.2	43.1	10.4	13.0	1.3	5.5
380ct1f1	-153.0	151.3	34.6	40.4	3.5	17.7
380ct1f2	-153.0	151.3	34.6	40.4	3.5	17.7
380ct1f3	-155.5	154.2	36.8	44.6	3.5	17.7
380ct2f1	-153.0	151.3	34.6	40.4	3.5	17.7
380ct2f2	-153.0	151.3	34.6	40.4	3.5	17.7
380ct2f3	-155.5	154.2	36.8	44.6	3.5	17.7
bl2	-43.2	43.1	10.4	13.0	1.3	5.5
Post 40	0.0	0.0	0.0	0.0	0.0	
Post 41	0.0	0.0	0.0	0.0	0.0	
Post 42	0.0	0.0	0.0	0.0	0.0	
Post 43	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	23.0	72.7	110.8
380ct1f1	90.8	115.1	134.4
380ct1f2	90.8	115.1	134.4
380ct1f3	82.3	114.6	134.4
380ct2f1	90.8	115.1	134.4
380ct2f2	90.8	115.1	134.4
380ct2f3	82.3	114.6	134.4
bl2	23.0	72.7	110.8
Post 40			
Post 41			
Post 42			
Post 43			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	115.8	132.6
380ct1f1	137.0	143.4
380ct1f2	137.0	143.4
380ct1f3	137.0	143.4
380ct2f1	137.0	143.4
380ct2f2	137.0	143.4
380ct2f3	137.0	143.4
bl2	115.8	132.6
Post 40		
Post 41		
Post 42		
Post 43		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	143.4 m	0.559 -
Min. weight span	-53.2 m	-0.207 -

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Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	40.0	22.8	5.5	-44.3	44.5
380ct1f1	119.0	73.1	17.7	-156.8	155.8
380ct1f2	119.0	73.1	17.7	-156.8	155.8
380ct1f3	121.9	79.3	17.7	-159.5	159.1
380ct2f1	119.0	73.1	17.7	-156.8	155.8
380ct2f2	119.0	73.1	17.7	-156.8	155.8
380ct2f3	121.9	79.3	17.7	-159.5	159.1
bl2	40.0	22.8	5.5	-44.3	44.5
Post 40	2.4	2.4	6.5	0.0	
Post 41	2.4	2.4	6.5	0.0	
Post 42	2.4	2.4	6.5	0.0	
Post 43	2.4	2.4	6.5	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	20.8	4.2	1.7	-21.2	21.2
380ct1f1	79.9	16.0	9.8	-81.5	81.5
380ct1f2	79.9	16.0	9.8	-81.5	81.5
380ct1f3	79.9	16.0	9.8	-81.5	81.5
380ct2f1	79.9	16.0	9.8	-81.5	81.5
380ct2f2	79.9	16.0	9.8	-81.5	81.5
380ct2f3	79.9	16.0	9.8	-81.5	81.5
bl2	20.8	4.2	1.7	-21.2	21.2
Post 40	0.0	0.0	5.0	0.0	
Post 41	0.0	0.0	5.0	0.0	
Post 42	0.0	0.0	5.0	0.0	
Post 43	0.0	0.0	5.0	0.0	

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	-0.9	0.0
	380ct1f1	-0.4	0.0
	380ct1f2	-0.4	0.0
	380ct1f3	-0.5	0.0
	380ct2f1	-0.4	0.0
	380ct2f2	-0.4	0.0
	380ct2f3	-0.5	0.0
	bl2	-0.9	0.0
	Post 40	0.0	
	Post 41	0.0	
	Post 42	0.0	
	Post 43	0.0	

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		-32	506	76	15160	-919	0
ULS 1a_0,9_0		12	233	92	6796	410	-103
ULS 1a_0,9_0,9_90		-37	485	50	14588	-1040	0
ULS 3_0		8	379	135	11145	268	-31
SLS 7		0	209	84	6054	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

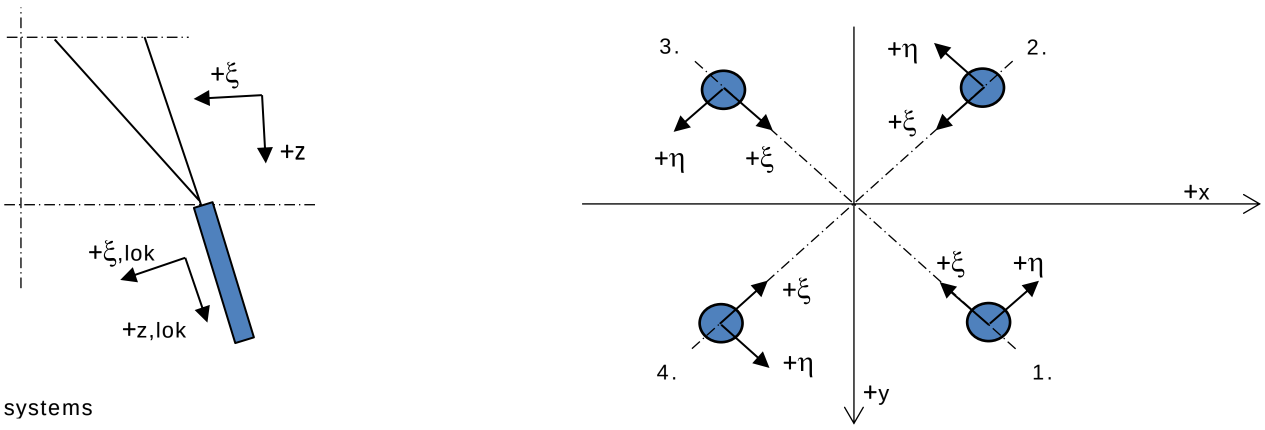
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-32	713	633	19769	-919	0
ULS 1a_0,9_0,9_90	-37	691	485	19198	-1040	0
SLS 7	0	209	568	6054	0	0

Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_90	-32	713	507	19823	-919	0
SPLS 3_90 Ah All Cts	-783	228	588	6230	-23578	0
SPLS 6a_90 Ba Ct2 Ba Ct1	211	260	677	7411	6230	5140
SPLS 3_0,9_90 Ah All Cts	-783	228	462	6284	-23578	0

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_90 Ba All Cts	272	272	1658	0	-385	-97	1683
2	SPLS 3_0 Ba All Cts	192	-177	1131	-11	-261	-64	1148
3	SPLS 3_90 Ah All Cts	-169	-155	1014	10	-229	-53	1030
4	SPLS 3_90 Ah All Cts	-269	269	1637	0	-380	-96	1662

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_90 Ah All Cts	-127	-113	-749	-10	170	39	-761
2	SPLS 3_0,9_90 Ah All Cts	-227	227	-1378	0	321	82	-1398
3	SPLS 3_0,9_90 Ba All Cts	223	223	-1354	0	316	80	-1374
4	SPLS 3_0,9_0 Ba All Cts	141	-129	-821	9	191	48	-834

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_90 Ba Ct2 Ah Ct2	313	59	1139	180	-263	-65	1156
2	SPLS 6a_90 Ah Ct1 Ba Ct1	-262	6	-816	181	189	47	-829
3	SPLS 6a_90 Ah Ct1 Ba Ct1	-192	71	379	186	-86	-20	385
4	SPLS 3_78.65 Ba Ct2	122	145	61	189	-16	-5	62

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_90 Ah Ct2 Ba Ct2	-147	122	-97	-190	17	1	-98
2	SPLS 3_78.65 Ba Ct1	178	92	285	-191	-61	-11	290
3	SPLS 6a_90 Ba Ct1 Ba Ct2	212	-41	-503	-179	121	33	-511
4	SPLS 6a_90 Ah Ct2 Ba Ct2	-307	57	1099	-177	-258	-66	1116

DNV·GL

Project: ENS-ZL
Tower: HB-3_R_X
Number: 6

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_90 Ah All Cts Ba Ct2	-139	-67	-642	-51	145	34	-652
2	SPLS 3_0,9_90 Ah Ct1	-280	30	-945	177	219	55	-959
3	SPLS 3_0,9_90 Ba Ct2	20	278	-900	182	211	54	-913
4	SPLS 3_0,9_0 Ba All Cts	141	-129	-821	9	191	48	-834

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	71	75	445	-3	-103	-26	451
2	SLS 7	-26	30	-161	-3	39	11	-163
3	SLS 7	26	30	-161	3	39	11	-163
4	SLS 7	-71	75	445	3	-103	-26	451

Envelope of load combinations for all of the legs

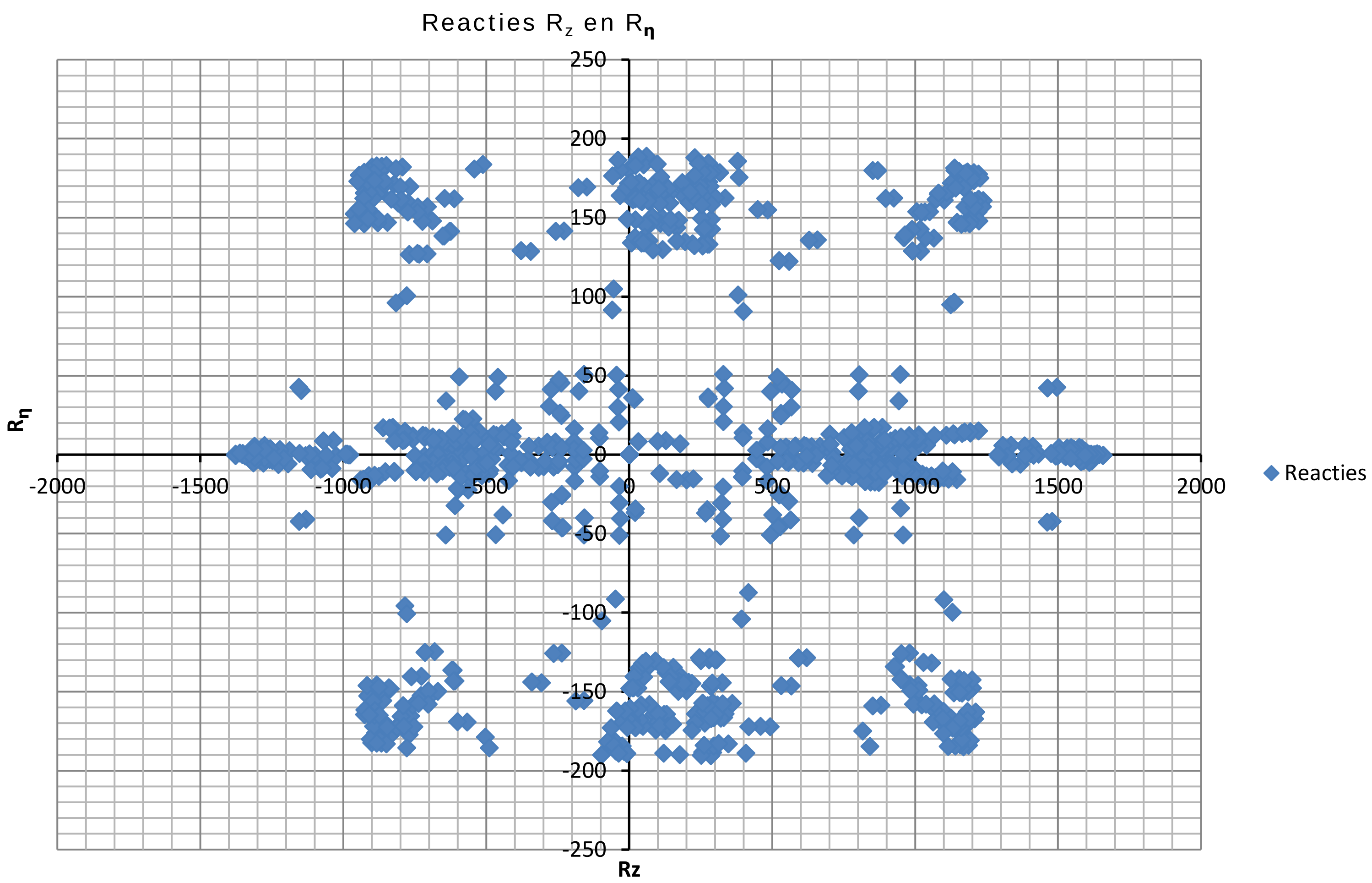
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	SPLS 3_90 Ba All Cts	272	272	1658	0	-385	-97	1683
Max. tension	SPLS 3_0,9_90 Ah All Cts	-227	227	-1378	0	321	82	-1398
Max. pos. torsie	SPLS 3_78.65 Ba Ct2	122	145	61	189	-16	-5	62
Max. neg. torsie	SPLS 3_78.65 Ba Ct1	178	92	285	-191	-61	-11	290
Comb. tension+torsie	SPLS 3_0,9_90 Ah Ct1	-280	30	-945	177	219	55	-959

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	71	75	445	-3	-103	-26	451
2	SLS 1a_90	-105	120	-654	-10	159	45	-664
3	SLS 1a_90	93	109	-585	11	143	41	-594
4	SLS 1a_0	-21	30	177	7	-36	-5	180

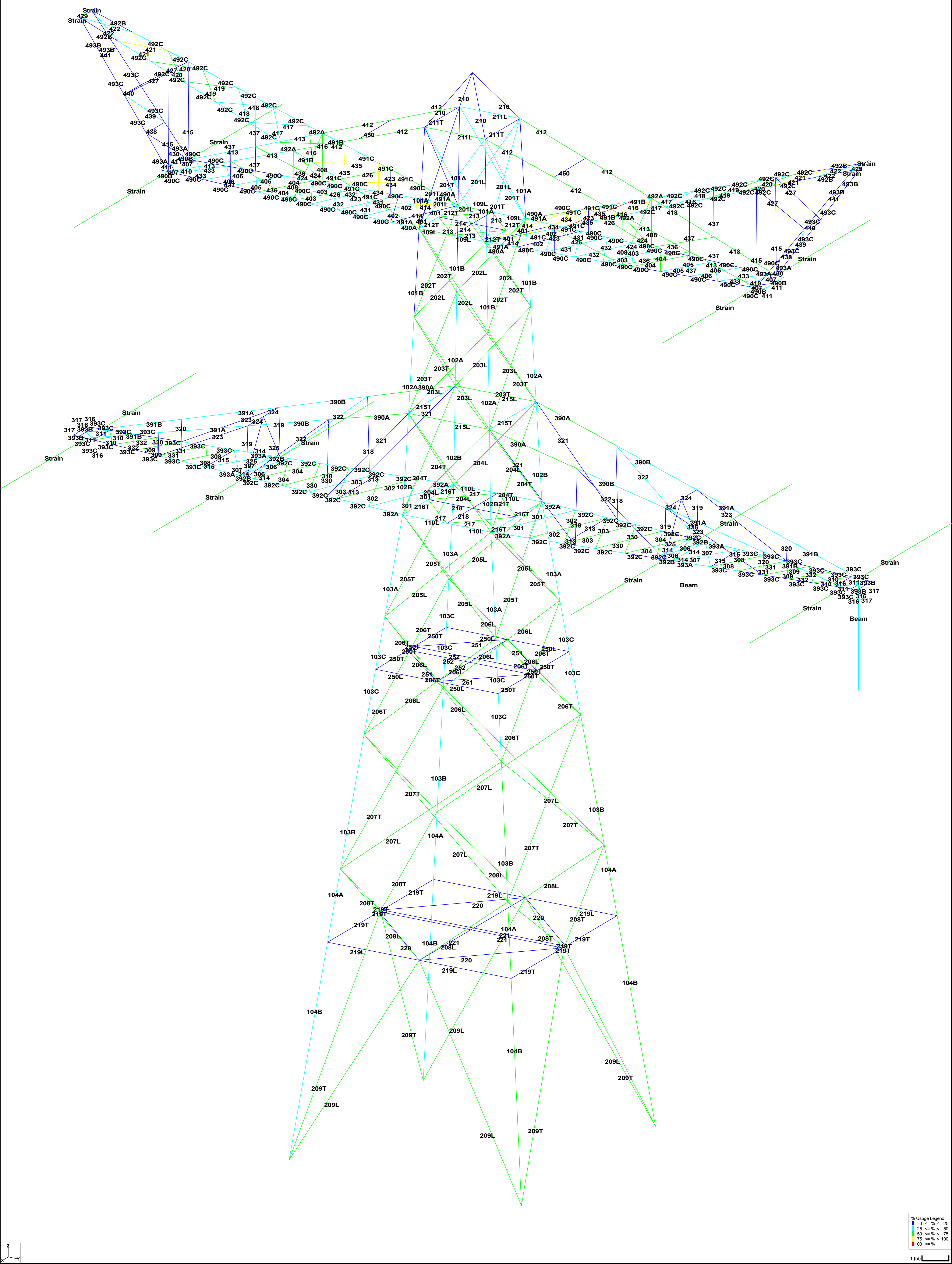
Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_90	137	153	862	-11	-205	-55	875
2	SLS 1a_0	28	-11	107	-12	-28	-9	108
3	SLS 7	26	30	-161	3	39	11	-163
4	SLS 1a_90	-149	164	931	10	-221	-60	945


Reacties R_z en R_η
250
200
150
100
50
0
-50
-100
-150
-200
-250
-2000
-1500
-1000
-500
0
500
1000
1500
2000
R_η
Rz
Reacties

APPENDIX B
Uitvoer PLS-TOWER

DNV GL Nederlands BV, Project: "HB-3_R ini"
Tower Version 16.63, 14:53:28 Thursday, 25 February, 2021
Undeformed geometry displayed



Assessment of groups for initial mast (afkeur level)

Date 25-02-21
Author MKh
Version 1.0

ENS-ZL 380
HB-3 R
40

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101A	Leg	120x120x10	S355	7M24-8.8t	0.52	0.52	0.52	88	-66.1	SPLS 6a_90 Ba Ct1 Ah Ct2	462.0	945.9	1234.8	0.14		31.7	3_0,9_106.95 Ba All Cts	635.0	945.9	1160.9	0.05	
101B	Leg	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	77	-178.4	SPLS 6a_90 Ah All Cts Ba Ct2	538.8	1084.4	1411.2	0.33		149.5	SPLS 3_0,9_90 Ba Ct1	635.0	1084.4	1326.8	0.24	
102A	Leg	150x150x14	S355	8M24-8.8t	0.52	0.52	0.52	67	-455.6	SPLS 3_90 Ah All Cts	1038.6	1084.4	1975.7	0.44		371.1	S 3_0,9_73.05 Ah All Cts	1159.3	1084.4	1857.5	0.34	
102B	Leg	150x150x14	S355	11M24-8.8t	0.52	0.52	0.52	71	-409.4	SPLS 3_73.05 Ah All Cts	1001.6	2910.7	2716.6	0.41		319.2	S 3_0,9_73.05 Ah All Cts	1159.3	2910.7	2461.2	0.28	
103A	Leg	200x200x20	S355	8M24-8.8t	0.28	0.28	0.28	29	-905.0	SPLS 3_73.05 Ah All Cts	2574.7	2168.8	2822.4	0.42		740.6	SPLS 3_0,9_90 Ah All Cts	2328.5	2168.8	2653.5	0.34	
103B	Leg	200x200x20	S355	10M24-8.8t	0.28	0.28	0.28	38	-1359.7	SPLS 3_73.05 Ah All Cts	2458.4	2660.2	3528.0	0.55		1144.4	S 3_0,9_73.05 Ah All Cts	2328.5	2660.2	3528.0	0.49	
103C	Leg	200x200x20	S355		0.52	0.52	0.52	34	-1123.8	SPLS 3_73.05 Ah All Cts	2507.1	0.0	0.0	0.45		943.8	S 3_0,9_73.05 Ah All Cts	2712.2	0.0	0.0	0.35	
104A	Leg	250x250x18#	S355	12M24-8.8t	0.55	0.55	0.55	32	-1467.9	SPLS 3_90 Ah All Cts	2823.6	2975.4	3810.2	0.52		1243.0	SPLS 3_0,9_90 Ah All Cts	2763.8	2975.4	3810.2	0.45	
104B	Leg	250x250x18#	S355	12M24-8.8t	0.20	0.20	0.20	35	-1472.6	SPLS 3_90 Ah All Cts	2788.0	2975.4	3810.2	0.53		1236.4	SPLS 3_0,9_90 Ah All Cts	2763.8	2975.4	3582.3	0.45	
392A	Onderregel eerste dwarsarm	200x200x16	S355	13M24-8.8t	2.26	1.00	1.00	56	-724.9	SPLS 6a_90 Ba Ct1 Ah Ct1	1764.6	1696.1	3669.1	0.43		531.2	PLS 6a_90 Ba Ct2 Ah Ct2	1886.8	1696.1	3449.6	0.31	
392B	Onderregel eerste dwarsarm	200x200x16	S355	6M24-8.8t	12.18	2.00	1.00	66	-386.6	SPLS 6a_90 Ba Ct1 Ah Ct1	1622.8	813.3	1693.4	0.48		274.9	PLS 3_0,9_106.95 Ba Ct2	1886.8	813.3	1592.1	0.34	
392C	Onderregel eerste dwarsarm	200x200x16	S355		2.38	1.00	1.00	56	-679.1	SPLS 6a_90 Ba Ct1 Ah Ct1	1764.7	0.0	0.0	0.38		484.5	PLS 6a_90 Ba Ct2 Ah Ct2	2193.9	0.0	0.0	0.22	
393A	Onderregel eerste dwarsarm	160x160x15#	S355	6M24-8.8t	2.59	1.00	1.00	82	-357.5	SPLS 6a_90 Ba Ct1 Ah Ct1	1015.5	813.3	1587.6	0.44		243.6	PLS 3_0,9_106.95 Ba Ct2	1372.7	813.3	1370.5	0.30	
393B	Onderregel eerste dwarsarm	160x160x15#	S355		2.32	1.00	1.00	12	-1.7	ULS 3_90	1658.2	0.0	0.0	0.00		0.2	SPLS 1a_0,9_0 Ah Ct1	1658.2	0.0	0.0	0.00	
393C	Onderregel eerste dwarsarm	160x160x15#	S355		3.62	1.00	1.00	82	-323.5	SPLS 6a_90 Ah Ct1 Ba Ct1	1014.6	0.0	0.0	0.32		207.4	PLS 3_0,9_106.95 Ba Ct2	1658.2	0.0	0.0	0.13	
490A	Onderregel tweede dwarsarm	150x150x14	S355	15M24-8.8t	2.22	1.00	1.00	62	-405.9	SPLS 6a_90 Ba Ct1 Ah Ct1	1096.6	1918.9	3704.4	0.37		304.0	PLS 3_0,9_106.95 Ba Ct2	1159.3	1918.9	3704.4	0.26	
490B	Onderregel tweede dwarsarm	150x150x14	S355		1.00	1.95	1.00	14	0.0		1425.0	0.0	0.0	0.00		12.5	ULS 3_106.95	1425.0	0.0	0.0	0.01	
490C	Onderregel tweede dwarsarm	150x150x14	S355		2.36	1.00	1.00	62	-390.0	SPLS 6a_90 Ba Ct1 Ah Ct1	1096.7	0.0	0.0	0.36		286.9	PLS 3_0,9_106.95 Ba Ct2	1425.0	0.0	0.0	0.20	
390A	Bovenregel eerste dwarsarm	90x90x8	S235	4M24-8.8t	2.01	1.00	1.00	275	0.0		47.2	542.2	414.7	0.00		120.1	SPLS 3_0 Ba Ct1	185.9	542.2	357.1	0.65	
390B	Bovenregel eerste dwarsarm	90x90x8	S235	4M20-8.8t	2.00	1.00	1.00	277	0.0		46.8	376.3	345.6	0.00		91.1	SPLS 3_0 Ba Ct1	269.1	376.3	314.2	0.34	
391A	Bovenregel eerste dwarsarm	80x80x8	S235	4M20-8.8t	1.82	1.00	1.00	313	-1.4	SPLS 3_0,9_106.95 Ba All Cts	34.3	376.3	345.6	0.04		78.5	SPLS 3_0 Ba Ct1	227.6	376.3	314.2	0.34	
391B	Bovenregel eerste dwarsarm	80x80x8	S235	4M20-8.8t	2.23	1.00	1.00	313	-1.4	SPLS 3_0,9_106.95 Ba All Cts	34.3	376.3	345.6	0.04		78.5	SPLS 3_0 Ba Ct1	168.3	376.3	304.4	0.47	
491A	Bovenregel tweede dwarsarm	120x120x10	S355	3M24-8.8t	1.54	1.00	1.00	82	-256.9	SPLS 6a_90 Ba All Cts Ah Ct1	419.0	406.7	529.2	0.63		232.1	S 6a_90 Ba All Cts Ah Ct2	441.0	406.7	493.6	0.57	
491B	Bovenregel tweede dwarsarm	120x120x10	S355	5M24-8.8t	1.65	3.19	1.00	81	-173.3	SPLS 6a_90 Ba Ct1 Ah Ct1	418.9	677.8	882.0	0.41		152.9	PLS 6a_90 Ba Ct2 Ah Ct2	635.0	677.8	829.2	0.24	
491C	Bovenregel tweede dwarsarm	120x120x10	S355		1.49	2.87	1.00	81	-232.0	SPLS 6a_90 Ba All Cts Ah Ct1	419.0	0.0	0.0	0.55		207.8	S 6a_90 Ba All Cts Ah Ct2	823.6	0.0	0.0	0.25	
492A	Bovenregel tweede dwarsarm	120x120x10	S355	5M24-8.8t	2.54	4.87	1.00	81	-201.5	SPLS 6a_90 Ba All Cts Ah Ct1	421.9	677.8	882.0	0.48		203.4	S 6a_90 Ba All Cts Ah Ct2	635.0	677.8	829.2	0.32	
492B	Bovenregel tweede dwarsarm	120x120x10	S355	4M24-8.8t	2.33	1.00	1.00	116	-45.3	SPLS 6a_90 Ba All Cts Ah Ct1	294.4	542.2	705.6	0.15		36.5	S 6a_90 Ba All Cts Ah Ct2	635.0	542.2	663.4	0.07	
492C	Bovenregel tweede dwarsarm	120x120x10	S355		1.92	1.00	1.00	81	-184.1	SPLS 6a_90 Ba All Cts Ah Ct1	421.6	0.0	0.0	0.44		184.5	S 6a_90 Ba All Cts Ah Ct2	823.6	0.0	0.0	0.22	
493A	Tussenregel tweede dwarsarm	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-22.3	ULS 5a Ah 22	156.1	188.2	172.8	0.14		10.5	3_0,9_106.95 Ba All Cts	187.5	188.2	172.8	0.06	
493B	Tussenregel tweede dwarsarm	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-15.5	SPLS 6a_90 Ba Ct1 Ba Ct2	156.1	188.2	172.8	0.10		7.3	3_0,9_106.95 Ba All Cts	168.5	188.2	172.8	0.04	
493C	Tussenregel tweede dwarsarm	90x90x8	S235		2.00	1.00	1.00	121	-21.0	ULS 5a Ah 22	156.1	0.0	0.0	0.13		10.2	3_0,9_106.95 Ba All Cts	326.7	0.0	0.0	0.03	
201L	Diagonaal	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	131	-64.4	SPLS 3_106.95 Ba Ct1	150.4	188.2	172.8	0.43		47.0	PLS 6a_90 Ba Ct1 Ba Ct2	190.7	188.2	157.1	0.30	
201T	Diagonaal	100x100x8	S235	1M24-8.8t	0.53	0.53	0.53	131	-31.5	SPLS 6a_90 Ba Ct1 Ba Ct2	120.3	135.6	103.7	0.30		22.0	SPLS 3_0,9_73.05 Ba Ct1	170.5	135.6	97.5	0.23	
202L	Diagonaal	160x160x15#	S235	4M24-8.8t	0.53	0.53	0.53	78	-347.8	SPLS 6a_90 Ba Ct1 Ah Ct1	702.9	542.2	777.6	0.64		304.4	PLS 6a_90 Ba Ct2 Ah Ct2	673.4	542.2	691.1	0.56	
202T	Diagonaal	150x150x12	S235	4M24-8.8t	0.53	0.53	0.53	83	-297.8	SPLS 6a_90 Ba Ct1 Ah Ct1	502.9	542.2	622.1	0.59		307.1	PLS 6a_90 Ba Ct1 Ah Ct1	498.3	542.2	535.6	0.62	
203L	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-277.9	SPLS 6a_90 Ba Ct2 Ah Ct2	480.6	542.2	622.1	0.58		316.3	PLS 6a_90 Ba Ct1 Ah Ct1	498.3	542.2	535.6	0.63	
203T	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-280.1	SPLS 6a_90 Ba Ct1 Ah Ct1	480.6	542.2	622.1	0.58		270.6	PLS 6a_90 Ba Ct1 Ah Ct1	498.3	542.2	535.6	0.54	
204L	Diagonaal	160x160x17#	S235	4M24-8.8t	0.52	0.52	0.52	90	-382.5	SPLS 6a_90 Ba Ct1 Ah Ct1	714.2	542.2	881.3	0.71		329.8	PLS 6a_90 Ba Ct2 Ah Ct2	746.8	542.2	783.2	0.61	
204T	Diagonaal	160x160x17#	S235	4M24-8.8t	0.52	0.52	0.52	90	-333.0	SPLS 6a_90 Ba Ct2 Ah Ct2	714.2	542.2	881.3	0.61		310.9	SPLS 3_0,9_90 Ba Ct1	746.8	542.2	783.2	0.57	
205L	Diagonaal	180x180x16#	S235	5M24-8.8t	0.28	0.56	0.28	60	-468.5	SPLS 6a_90 Ah Ct2 Ah Ct1	906.7	677.8	1036.8	0.69		456.3	PLS 6a_90 Ba Ct1 Ah Ct1	783.3	677.8	867.4	0.67	
205T	Diagonaal	180x180x16#	S235	5M24-8.8t	0.28	0.56	0.28	60	-482.9	SPLS 6a_90 Ba Ct1 Ah Ct1	906.7	677.8	1036.8	0.71		469.7	PLS 6a_90 Ba Ct2 Ah Ct2	783.3	677.8	867.4	0.69	
206L	Diagonaal	160x160x17#	S235	4M24-8.8t	0.55	1.00	0.55	65	-363.5	SPLS 6a_90 Ba Ct1 Ah Ct1	819.3	542.2	881.3	0.67		364.7	PLS 6a_90 Ah Ct2 Ah Ct1	725.8	542.2	736.4	0.67	
206T	Diagonaal	160x160x17#	S235	4M24-8.8t	0.55	1.00	0.55	80	-379.8	SPLS 6a_90 Ba Ct2 Ah Ct2	729.6	542.2	881.3	0.70		377.4	PLS 6a_90 Ba Ct1 Ah Ct1	725.8	542.2	736.4	0.70	
207L	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-288.4	SPLS 3_0,9_73.05 Ba Ct2	475.0	406.7	544.3	0.71		286.9	PLS 6a_90 Ba Ct1 Ah Ct1	557.9	406.7	453.9	0.71	
207T	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-298.9	SPLS 6a_90 Ba Ct1 Ah Ct1	475.0	406.7	544.3	0.73		299.5	PLS 6a_90 Ba Ct2 Ah Ct2	557.9	406.7	453.9	0.74	
208L	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-244.2	SPLS 6a_90 Ba Ct1 Ah Ct1	415.0	406.7	466.6	0.60		239.6	SPLS 3_0,9_73.05 Ba Ct2	498.3	406.7	405.3	0.59	
208T	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-251.9	SPLS 6a_90 Ba Ct2 Ah Ct2	415.0	406.7	466.6	0.62		246.4	PLS 6a_90 Ba Ct1 Ah Ct1	498.3	406.7	405.3	0.61	
209L	Diagonaal	160x160x15#	S235	4M24-8.8t	0.20	0.20	0.20	63	-371.2	SPLS 3_106.95 Ah Ct1	782.1	542.2	777.6	0.68		363.1	SPLS 3_0,9_73.05 Ba Ct2	673.4	542.2	680.3	0.67	
209T	Diagonaal	160x160x15#	S235	4M24-8.8t	0.20	0.20	0.20	63	-379.3	SPLS 6a_90 Ba Ct2 Ah Ct2	782.1	542.2	777.6	0.70		361.9	PLS 6a_90 Ba Ct1 Ah Ct1	673.4	542.2	680.3	0.67	
210	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	174	-19.8	SPLS 3_106.95 Ah Ct1	84.7	188.2	172.8	0.23		19.7	PLS 3_0,9_106.95 Ah Ct1	146.3	188.2	157.1	0.13	
211L	Tweede dwarsarm in tower	90x90x8	S235	3M24-8.8t	1.00	1.00	1.00	148	-0.2	SPLS 3_0,9_106.95 Ba All Cts	117.9	406.7	311.0	0.00		95.4	S 6a_90 Ah All Cts Ba Ct2	185.9	406.7	270.2	0.51	
211T	Tweede dwarsarm in tower	70x70x7	S235	1M16-8.8t	1.00	1.00	1.00	191	-4.1	ULS 1a_0,9_90	45.6	60.3	60.5	0.09		6.3	PLS 6a_90 Ba Ct1 Ba Ct2	92.7	60.3	52.3	0.12	
109L	Tweede dwarsarm in tower	150x150x14	S355	15M24-8.8t	1.00	2.00	1.00	64	-543.7	SPLS 3_73.05 Ah All Cts	1076.4	1918.9	3704.4	0.51		465.3	3_0,9_106.95 Ba All Cts	1159.3	1918.9	3482.8	0.40	
212T	Tweede dwarsarm in tower	120x120x10	S235	6M24-8.8t	1.00	2.00	1.00	79	-125.0	SPLS 6a_90 Ah Ct1 Ah Ct2	328.5	813.3	777.6	0.38		137.5	PLS 6a_90 Ah Ct1 Ah Ct2	466.6	813.3	731.1	0.29	
213	Tweede dwarsarm in tower	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-180.6	SPLS 6a_90 Ba Ct1 Ah Ct1	325.4	406.7	388.8	0.56		180.7	PLS 6a_90 Ba Ct1 Ah Ct1	324.0	406.7	359.4	0.56	
214	Tweede dwarsarm in tower	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.2	ULS 3_0	31.9	60.3	43.2	0.01		0.1	PLS 6a_90 Ah Ct2 Ah Ct1	46.1	60.3	32.7	0.00	
215L	Eerste dwarsarm in tower	120x120x10	S235	4M24-8.8t	1.00	1.00	1.00	148	-42.1	SPLS 3_0,9_90 Ba All Cts	196.8	542.2	518.4	0.21		185.1	SPLS 3_90 Ah All Cts	324.0	542.2	467.9	0.57	
215T	Eerste dwarsarm in tower	150x150x12	S235	2M24-8.8t	1.00	1.00	1.00	118	-94.7	ULS 1a_0,9_90	377.6	271.1	311.0	0.35		116.8	ULS 1a_90	638.7	271.1	292.4	0.43	
110L	Eerste dwarsarm in tower	200x200x16	S355	13M24-8.8t	1.00	2.00	1.00	62	-572.9	SPLS 3_73.05 Ah All Cts	1686.0	1696.1	3669.1	0.34		430.3	3_0,9_106.95 Ba All Cts	1886.8	1696.1	3449.6	0.25	
216T	Eerste dwarsarm in tower	120x120x10	S235	5M24-8.8t	1.00	2.00	1.00	104	-125.8	SPLS 3_0,9_73.05 Ba Ct1	269.2	677.8	648.0	0.47		153.4	PLS 6a_90 Ba Ct1 Ah Ct1	466.6	677.8	609.2	0.33	
217	Eerste dwarsarm in tower	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-181.7	SPLS 6a_90 Ba Ct1 Ah Ct1	261.1	406.7	388.8	0.70		182.3	PLS 6a_90 Ba Ct1 Ah Ct1	324.0	406.7	359.4	0.56	
218	Eerste dwarsarm in tower	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.6	ULS 3_0	29.9	60.3	60.5	0.02		0.7	ULS 3_0	64.5	60.3	45.8	0.01	
219L	Onderstuk in tower	80x80x8	S235	2M16-8.8t	1.00	1.00	1.00	253	-10.0	SPLS 3_0,9_90 Ah All Cts	49.4	120.6	138.2	0.20		5.4	1a_0,9_106.95 Ah All Cts	177.2	120.6	119.5	0.05	
219T	Onderstuk in tower	80x80x8	S235	2M16-8.8t	1.00	1.03	1.00	247	-7.6	SPLS 1a_106.95 Ah Ct2	51.5	120.6	138.2	0.15		5.1	ULS 1a_0,9_45	177.2	120.6	119.5	0.04	
220	Onderstuk in tower	80x80x8	S235	1M16-8.8t	1.00	0.50	0.50	227	-5.2	ULS 1a_45	38.5	60.3	69.1	0.13		4.1	ULS 1a_0,9_135	142.8	60.3	59.7	0.07	
221	Onderstuk in tower	80x80x8	S235	1M16-8.8t	0.50	0.50	0.50	253	-1.5	ULS 1a_0	39.5	60.3	69.1	0.04		0.2	ULS 1a_0,9_0,9_0	142.8	60.3	59.7	0.00	
301	Diagonaal onderregel eerste dwarsarm	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	140	-54.9	SPLS 6a_90 Ba All Cts Ah Ct2	111.3	188.2	172.8	0.49		60.0	S 6a_90 Ba All Cts Ah Ct2	149.6	188.2	139.6	0.43	
302	Diagonaal onderregel eerste dwarsarm	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	130	-68.5	SPLS 6a_90 Ba Ct2 Ah Ct2	120.9	188.2	172.8	0.57		65.1	PLS 6a_90 Ba Ct2 Ah Ct2	151.2	188.2	139.6	0.47	
303	Diagonaal onderregel eerste dwarsarm	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	120	-69.5	SPLS 6a_90 Ba All Cts Ah Ct2	131.9	188.2	172.8	0.53		70.3	S 6a_90 Ba All Cts Ah Ct2	149.6	188.2	139.6	0.50	
304	Diagonaal onderregel eerste dwarsarm	90x90x8	S235	2M24-8.8t	0.55	0.55	0.55	93	-88.9	SPLS 6a_90 Ba All Cts Ah Ct2	186.3	271.1	207.4	0.48		91.0	S 6a_90 Ba All Cts Ah Ct2	150.3	271.1	141.8	0.64	
306	Diagonaal onderregel eerste dwarsarm	80x80x6#	S235	2M24-8.8t	0.53	0.53	0.53	86	-37.9	SPLS 6a_90 Ba All Cts Ah Ct2	133.0	271.1	155.5	0.29		51.3	S 6a_90 Ba All Cts Ah Ct2	99.7	271.1	124.3	0.51	
307	Diagonaal onderregel eerste dwarsarm	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	112	-35.2	SPLS 6a_90 Ba All Cts Ah Ct1	107.5	188.2	151.2	0.33		35.5	S 6a_90 Ba All Cts Ah Ct2	114.0	188.2	116.0	0.31	
308	Diagonaal onderregel eerste dwarsarm	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	110	-34.6	SPLS 6a_90 Ba All Cts Ah Ct2	80.5	120.6	103.7	0.43		34.0	S 6a_90 Ba All Cts Ah Ct2	67.0	120.6	56.7	0.60	
309	Diagonaal onderregel eerste dwarsarm	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	79	-47.1	SPLS 6a_90 Ba All Cts Ah Ct2	140.3	188.2	151.2	0.34		48.1	S 6a_90 Ba All Cts Ah Ct2	90.5	188.2	82.6	0.58	
310	Diagonaal onderregel eerste dwarsarm	90x90x8	S235	2M20-8.8t	0.55	0.55	0.55	49	-62.1	SPLS 6a_90 Ba Ct2 Ah Ct2	252.8	188.2	172.8	0.36		59.3	S 6a_90 Ba All Cts Ah Ct2	139.9	188.2	99.5	0.60	
311	Diagonaal onderregel eerste dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	51	-38.5	SPLS 6a_90 Ba Ct1 Ah Ct1	250.3	271.1	207.4	0.19		28.8	SPLS 3_0,9_90 Ba Ct2	136.2	271.1	104.6	0.28	
313	Dwarsligger onderregel eerste dwarsarm	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	82	0.0		570.7	188.2	216.0	0.00		3.6	ULS 3_73.05	766.1	188.2	0.0	0.02	
314	Dwarsligger onderregel eerste dwarsarm	120x120x12	S355	2M20-8.8t	2.00	2.00	2.00	104	0.0		416.8	188.2	352.8	0.00		51.3	ULS 3_90	389.8	188.2	203.1	0.27	
315	Dwarsligger onderregel eerste dwarsarm	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	54	-5.0	ULS 3_0,9_90	689.5	188.2	216.0	0.03		2.8	ULS 5a Ah 11	766.1	188.2	0.0	0.01	
316	Dwarsligger onderregel eerste dwarsarm	150x150x12(	S355	2M24-8.8t	2.00	1.00	1.00	24	0.0		2047.8	542.2	846.7	0.00		87.3	ULS 3_90	1904.3	542.2	369.1	0.24	
317	Dwarsligger onderregel eerste dwarsarm	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	26	-17.9	ULS 3_90	790.1	188.2	216.0	0.09		0.0		766.1	188.2	0.0	0.00	
318	Verticaal eerste dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	171	-17.8	ULS 3_0	98.0	271.1	207.4	0.18		0.0		159.7	271.1	183.4	0.00	
319	Verticaal eerste dwarsarm	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	172	-3.8	SPLS 1a_45 Ah Ct2	38.8	60.3	51.8	0.10		0.0		48.4	60.3	33.7	0.00	
320	Verticaal eerste dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	93	-1.0	SPLS 6a_90 Ba Ct1 Ba Ct2	51.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00	

DNV·GL

Assessment of groups for initial mast (afkeur level)

Date 25-02-21
Author MKh
Version 1.0

ENS-ZL 380
HB-3 R
40

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
321	Diagonaal eerste dwarsarm	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	345	**0.0**		30.1	188.2	172.8	0.00		**26.5**	PLS 6a_90 Ba Ct1 Ba Ct2	162.8	188.2	157.1	0.17	
322	Diagonaal eerste dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	269	**0.0**		50.9	271.1	207.4	0.00		**39.8**	ULS 3_0	136.2	271.1	161.3	0.29	
323	Diagonaal eerste dwarsarm	70x70x7	S235	1M20-8.8t	1.00	1.00	1.00	331	**0.0**		19.8	94.1	75.6	0.00		**15.0**	SPLS 1a_45 Ah Ct2	84.7	94.1	65.2	0.23	
324	Dwarsligger bovenregel eerste dwarsarm	70x70x7	S235	1M20-8.8t	1.00	2.00	1.00	110	**-0.8**	ULS 1a_0	93.2	94.1	75.6	0.01		**0.7**	ULS 1a_0,9_0	84.7	94.1	65.2	0.01	
325	Tussen diagonaal eerste dwarsarm	80x80x8	S235	1M20-8.8t	1.00	1.00	1.00	151	**-2.2**	ULS 1a_0	81.0	94.1	86.4	0.03		**1.4**	ULS 1a_0,9_0	133.6	94.1	78.5	0.02	
401	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.53	0.53	0.53	121	**-18.8**	SPLS 3_0,9_90 Ba Ct1	99.6	188.2	151.2	0.19		**18.8**	SPLS 3_90 Ba All Cts	90.5	188.2	91.6	0.21	
402	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	112	**-22.7**	SPLS 3_90 Ba Ct2	107.3	188.2	151.2	0.21		**22.8**	SPLS 3_90 Ba Ct2	90.5	188.2	100.8	0.25	
403	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	97	**-32.9**	SPLS 3_106.95 Ba Ct2	121.9	188.2	151.2	0.27		**32.9**	PLS 3_0,9_106.95 Ba Ct2	90.5	188.2	100.8	0.36	
404	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	92	**-48.1**	SPLS 6a_90 Ba All Cts Ah Ct2	126.9	188.2	151.2	0.38		**47.1**	S 6a_90 Ba All Cts Ah Ct2	90.5	188.2	117.6	0.52	
405	Diagonaal onderregel tweede dwarsarm	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	67	**-50.6**	SPLS 6a_90 Ba All Cts Ah Ct2	226.0	271.1	207.4	0.24		**52.6**	S 6a_90 Ba All Cts Ah Ct2	136.2	271.1	141.8	0.39	
406	Diagonaal onderregel tweede dwarsarm	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	64	**-57.3**	SPLS 6a_90 Ba All Cts Ah Ct2	231.6	271.1	207.4	0.28		**55.2**	S 6a_90 Ba All Cts Ah Ct2	139.3	271.1	124.1	0.44	
407	Diagonaal onderregel tweede dwarsarm	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	65	**-39.2**	SPLS 6a_90 Ba Ct1 Ah Ct1	203.3	271.1	207.4	0.19		**27.7**	PLS 6a_90 Ba Ct1 Ah Ct1	117.7	271.1	124.1	0.24	
408	Diagonaal onderregel tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	202	**-9.7**	SPLS 3_0,9_73.05 Ah All Cts	21.5	60.3	43.2	0.45		**18.7**	S 6a_90 Ah All Cts Ba Ct2	46.1	60.3	32.7	0.57	
410	Dwarsligger onderregel tweede dwarsarm	150x150x12	S355	2M20-8.8t	1.00	1.00	1.00	53	**0.0**		867.3	188.2	352.8	0.00		**79.8**	ULS 3_90	504.3	188.2	217.4	0.42	
411	Dwarsligger onderregel tweede dwarsarm	150x150x12	S355	2M24-8.8t	2.00	1.00	1.00	32	**0.0**		971.1	271.1	423.4	0.00		**66.0**	ULS 3_0,9_73.05	496.7	271.1	220.7	0.30	
437		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	203	**-1.9**	SPLS 6a_90 Ah Ct2 Ba Ct2	24.2	60.3	43.2	0.08		**3.2**	PLS 6a_90 Ah Ct2 Ba Ct2	46.1	60.3	32.7	0.10	
412	Bovenregel tweede dwarsarm	90x90x8	S235	3M24-8.8t	2.00	2.00	2.00	349	**-25.1**	SPLS 3_0,9_106.95 Ba All Cts	33.6	406.7	311.0	0.75		**128.3**	S 6a_90 Ah All Cts Ba Ct2	185.9	406.7	270.2	0.69	
413	Bovenregel tweede dwarsarm	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	189	**-2.4**	SPLS 3_0,9_106.95 Ba All Cts	76.0	376.3	345.6	0.03		**87.4**	PLS 6a_90 Ba Ct1 Ba Ct2	151.8	376.3	261.3	0.58	
414	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	160	**-24.0**	SPLS 6a_90 Ba All Cts Ah Ct2	42.5	60.3	51.8	0.57		**24.0**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.85	
415	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	334	**-2.9**	SPLS 1a_106.95 Ba All Cts	14.3	60.3	51.8	0.20		**0.0**		48.4	60.3	33.7	0.00	
416	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	126	**-24.1**	SPLS 6a_90 Ba All Cts Ah Ct2	56.2	60.3	51.8	0.47		**22.0**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.78	
417	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	118	**-10.1**	SPLS 6a_90 Ba Ct2 Ah Ct2	59.8	60.3	51.8	0.19		**9.7**	PLS 6a_90 Ba Ct2 Ah Ct2	72.6	60.3	28.2	0.34	
418	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	111	**-13.9**	SPLS 6a_90 Ba All Cts Ah Ct2	63.5	60.3	51.8	0.27		**14.2**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.50	
419	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	105	**-16.3**	SPLS 6a_90 Ba All Cts Ah Ct2	66.8	60.3	51.8	0.31		**15.6**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.55	
420	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	97	**-18.8**	SPLS 6a_90 Ba All Cts Ah Ct2	71.3	60.3	51.8	0.36		**19.5**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.69	
421	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	92	**-25.6**	SPLS 6a_90 Ba All Cts Ah Ct2	74.4	60.3	51.8	0.49		**24.1**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.85	
422	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	98	**-35.0**	SPLS 6a_90 Ba All Cts Ah Ct1	89.0	120.6	103.7	0.39		**37.8**	S 6a_90 Ba All Cts Ah Ct2	78.2	120.6	76.8	0.49	
423	Verticaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	101	**-0.6**	ULS 5a Ba 12	48.1	60.3	43.2	0.01		**2.7**	ULS 5a Ba 12	46.1	60.3	32.7	0.08	
424	Verticaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	152	**-21.2**	SPLS 6a_90 Ah All Cts Ba Ct2	31.6	60.3	43.2	0.67		**21.5**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.66	
426	Diagonaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	308	**-7.1**	ULS 5a Ba 12	11.4	60.3	43.2	0.62		**0.0**		46.1	60.3	25.2	0.00	
427	Diagonaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	244	**0.0**		16.4	60.3	43.2	0.00		**1.1**	ULS 1a_106.95	46.1	60.3	20.5	0.05	
429	Dwarsligger bovenregel tweede dwarsarm	UNP160	S235	1M16-8.8t	1.00	1.00	1.00	47	**0.0**		279.0	60.3	64.8	0.00		**35.2**	ULS 3_0,9_90	90.7	60.3	64.8	0.58	
430	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	**-2.0**	SPLS 1a_0,9_135 Ba All Cts	18.2	60.3	43.2	0.11		**2.5**	SPLS 1a_0,9_0 Ah All Cts	46.1	60.3	32.7	0.08	
438	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	**-2.6**	SPLS 1a_0 Ah All Cts	34.4	60.3	43.2	0.07		**2.3**	LS 1a_0,9_135 Ba All Cts	46.1	60.3	32.7	0.07	
439	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	**-6.4**	ULS 5a Ba 12	19.5	60.3	43.2	0.33		**7.3**	ULS 5a Ah 12	46.1	60.3	32.7	0.22	
440	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	**-2.4**	ULS 5a Ah 12	39.5	60.3	43.2	0.06		**2.0**	ULS 5a Ba 12	46.1	60.3	32.7	0.06	
441	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	**0.0**	SPLS 6a_90 Ah Ct2 Ba Ct2	45.3	60.3	43.2	0.00		**0.0**	ULS 3_0,9_90	46.1	60.3	32.7	0.00	
431		70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	107	**-24.0**	SPLS 3_106.95 Ba Ct2	112.0	188.2	151.2	0.21		**23.8**	SPLS 3_106.95 Ba Ct2	90.5	188.2	100.8	0.26	
432		70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	102	**-24.7**	SPLS 3_106.95 Ba Ct2	116.9	188.2	151.2	0.21		**24.6**	SPLS 3_106.95 Ba Ct2	90.5	188.2	100.8	0.27	
433		90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	63	**-69.0**	SPLS 6a_90 Ba All Cts Ah Ct2	233.3	271.1	207.4	0.33		**66.6**	S 3_0,9_106.95 Ba All Cts	144.0	271.1	159.5	0.46	
434		60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	141	**-25.0**	SPLS 6a_90 Ba All Cts Ah Ct2	49.5	60.3	51.8	0.51		**24.6**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.87	
435		60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	133	**-29.1**	SPLS 6a_90 Ba All Cts Ah Ct2	52.8	60.3	51.8	0.56		**29.6**	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	1.05	stuik
436		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	305	**-8.3**	SPLS 6a_90 Ah Ct1 Ba Ct1	11.5	60.3	43.2	0.72		**0.0**		46.1	60.3	32.7	0.00	
330		80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	111	**-77.6**	SPLS 6a_90 Ba All Cts Ah Ct2	141.9	188.2	172.8	0.55		**74.7**	S 6a_90 Ba All Cts Ah Ct2	149.6	188.2	139.6	0.54	
331		60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	100	**-40.6**	SPLS 6a_90 Ba All Cts Ah Ct2	87.4	120.6	103.7	0.46		**40.5**	S 6a_90 Ba All Cts Ah Ct2	67.0	120.6	56.7	0.71	
332		70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	73	**-54.7**	SPLS 6a_90 Ba All Cts Ah Ct2	147.1	188.2	151.2	0.37		**52.8**	S 6a_90 Ba All Cts Ah Ct2	90.5	188.2	82.6	0.64	
250L		80x80x6#	S235	2M16-8.8t	1.00	1.00	1.00	166	**-6.2**	SPLS 3_0,9_73.05 Ah All Cts	68.8	120.6	103.7	0.09		**4.6**	S 3_0,9_73.05 Ah All Cts	111.8	120.6	89.6	0.05	
250T		80x80x6#	S235		11.75	2.00	1.00	107	**-7.3**	SPLS 1a_45 Ba Ct1	105.9	0.0	0.0	0.07		**2.6**	SPLS 1a_0,9_45 Ba Ct1	111.8	120.6	89.6	0.03	
251		90x90x8	S235	1M20-8.8t	1.00	1.00	1.00	204	**-6.1**	SPLS 1a_73.05 Ba Ct1	61.8	94.1	86.4	0.10		**5.2**	PLS 1a_0,9_73.05 Ba Ct2	156.7	94.1	78.5	0.07	
252		60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	226	**-0.9**	SPLS 1a_0 Ah Ct2	26.4	94.1	64.8	0.03		**0.2**	SPLS 1a_0,9_0 Ah All Cts	65.7	94.1	44.4	0.00	
450		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	**-0.1**	SPLS 1a_135 Ba All Cts	16.2	60.3	43.2	0.00		**0.0**	SPLS 1a_0,9_0 Ba All Cts	46.1	60.3	32.7	0.00	

Assessment of groups for strenghthened mast (afkeur level)

Date 25-02-21
Author MKh
Version 1.0

ENS-ZL 380
HB-3 R
40

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
101A	Leg	120x120x10	S355	7M24-8.8t	0.52	0.52	0.52	88	-66.1	SPLS 6a_90 Ba Ct1 Ah	462.0	945.9	1234.8	0.14		31.7	SPLS 3_0,9_106.95 Ba	635.0	945.9	1160.9	0.05
101B	Leg	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	77	-178.4	SPLS 6a_90 Ah All Cts	538.8	1084.4	1411.2	0.33		149.5	SPLS 3_0,9_90 Ba Ct1	635.0	1084.4	1326.8	0.24
102A	Leg	150x150x14	S355	8M24-8.8t	0.52	0.52	0.52	67	-455.6	SPLS 3_90 Ah All Cts	1038.6	1084.4	1975.7	0.44		371.1	SPLS 3_0,9_73.05 Ah /	1159.3	1084.4	1857.5	0.34
102B	Leg	150x150x14	S355	11M24-8.8t	0.52	0.52	0.52	71	-409.4	SPLS 3_73.05 Ah All Ct	1001.6	2910.7	2716.6	0.41		319.2	SPLS 3_0,9_73.05 Ah /	1159.3	2910.7	2461.2	0.28
103A	Leg	200x200x20	S355	8M24-8.8t	0.28	0.28	0.28	29	-905.0	SPLS 3_73.05 Ah All Ct	2574.7	2168.8	2822.4	0.42		740.6	SPLS 3_0,9_90 Ah All (	2328.5	2168.8	2653.5	0.34
103B	Leg	200x200x20	S355	10M24-8.8t	0.28	0.28	0.28	38	-1359.7	SPLS 3_73.05 Ah All Ct	2458.4	2660.2	3528.0	0.55		1144.4	SPLS 3_0,9_73.05 Ah /	2328.5	2660.2	3528.0	0.49
103C	Leg	200x200x20	S355		0.52	0.52	0.52	34	-1123.8	SPLS 3_73.05 Ah All Ct	2507.1	0.0	0.0	0.45		943.8	SPLS 3_0,9_73.05 Ah /	2712.2	0.0	0.0	0.35
104A	Leg	250x250x18#	S355	12M24-8.8t	0.55	0.55	0.55	32	-1467.9	SPLS 3_90 Ah All Cts	2823.6	2975.4	3810.2	0.52		1243.0	SPLS 3_0,9_90 Ah All (	2763.8	2975.4	3810.2	0.45
104B	Leg	250x250x18#	S355	12M24-8.8t	0.20	0.20	0.20	35	-1472.6	SPLS 3_90 Ah All Cts	2788.0	2975.4	3810.2	0.53		1236.4	SPLS 3_0,9_90 Ah All (	2763.8	2975.4	3582.3	0.45
392A	Onderregel eers	200x200x16	S355	13M24-8.8t	2.26	1.00	1.00	56	-724.9	SPLS 6a_90 Ba Ct1 Ah	1764.6	1696.1	3669.1	0.43		531.2	SPLS 6a_90 Ba Ct2 Ah	1886.8	1696.1	3449.6	0.31
392B	Onderregel eers	200x200x16	S355	6M24-8.8t	12.18	2.00	1.00	66	-386.6	SPLS 6a_90 Ba Ct1 Ah	1622.8	813.3	1693.4	0.48		274.9	SPLS 3_0,9_106.95 Ba	1886.8	813.3	1592.1	0.34
392C	Onderregel eers	200x200x16	S355		2.38	1.00	1.00	56	-679.1	SPLS 6a_90 Ba Ct1 Ah	1764.7	0.0	0.0	0.38		484.5	SPLS 6a_90 Ba Ct2 Ah	2193.9	0.0	0.0	0.22
393A	Onderregel eers	160x160x15#	S355	6M24-8.8t	2.59	1.00	1.00	82	-357.5	SPLS 6a_90 Ba Ct1 Ah	1015.5	813.3	1587.6	0.44		243.6	SPLS 3_0,9_106.95 Ba	1372.7	813.3	1370.5	0.30
393B	Onderregel eers	160x160x15#	S355		2.32	1.00	1.00	12	-1.7	ULS 3_90	1658.2	0.0	0.0	0.00		0.2	SPLS 1a_0,9_0 Ah Ct1	1658.2	0.0	0.0	0.00
393C	Onderregel eers	160x160x15#	S355		3.62	1.00	1.00	82	-323.5	SPLS 6a_90 Ah Ct1 Ba	1014.6	0.0	0.0	0.32		207.4	SPLS 3_0,9_106.95 Ba	1658.2	0.0	0.0	0.13
490A	Onderregel twe	150x150x14	S355	15M24-8.8t	2.22	1.00	1.00	62	-405.9	SPLS 6a_90 Ba Ct1 Ah	1096.6	1918.9	3704.4	0.37		304.0	SPLS 3_0,9_106.95 Ba	1159.3	1918.9	3704.4	0.26
490B	Onderregel twe	150x150x14	S355		1.00	1.95	1.00	14	0.0		1425.0	0.0	0.0	0.00		12.5	ULS 3_106.95	1425.0	0.0	0.0	0.01
490C	Onderregel twe	150x150x14	S355		2.36	1.00	1.00	62	-390.0	SPLS 6a_90 Ba Ct1 Ah	1096.7	0.0	0.0	0.36		286.9	SPLS 3_0,9_106.95 Ba	1425.0	0.0	0.0	0.20
390A	Bovenregel eers	90x90x8	S235	4M24-8.8t	2.01	1.00	1.00	275	0.0		47.2	542.2	414.7	0.00		120.1	SPLS 3_0 Ba Ct1	185.9	542.2	357.1	0.65
390B	Bovenregel eers	90x90x8	S235	4M20-8.8t	2.00	1.00	1.00	277	0.0		46.8	376.3	345.6	0.00		91.1	SPLS 3_0 Ba Ct1	269.1	376.3	314.2	0.34
391A	Bovenregel eers	80x80x8	S235	4M20-8.8t	1.82	1.00	1.00	313	-1.4	SPLS 3_0,9_106.95 Ba	34.3	376.3	345.6	0.04		78.5	SPLS 3_0 Ba Ct1	227.6	376.3	314.2	0.34
391B	Bovenregel eers	80x80x8	S235	4M20-8.8t	2.23	1.00	1.00	313	-1.4	SPLS 3_0,9_106.95 Ba	34.3	376.3	345.6	0.04		78.5	SPLS 3_0 Ba Ct1	168.3	376.3	304.4	0.47
491A	Bovenregel twe	120x120x10	S355	3M24-8.8t	1.54	1.00	1.00	82	-256.9	SPLS 6a_90 Ba All Cts	419.0	406.7	529.2	0.63		232.1	SPLS 6a_90 Ba All Cts	441.0	406.7	493.6	0.57
491B	Bovenregel twe	120x120x10	S355	5M24-8.8t	1.65	3.19	1.00	81	-173.3	SPLS 6a_90 Ba Ct1 Ah	418.9	677.8	882.0	0.41		152.9	SPLS 6a_90 Ba Ct2 Ah	635.0	677.8	829.2	0.24
491C	Bovenregel twe	120x120x10	S355		1.49	2.87	1.00	81	-232.0	SPLS 6a_90 Ba All Cts	419.0	0.0	0.0	0.55		207.8	SPLS 6a_90 Ba All Cts	823.6	0.0	0.0	0.25
492A	Bovenregel twe	120x120x10	S355	5M24-8.8t	2.54	4.87	1.00	81	-201.5	SPLS 6a_90 Ba All Cts	421.9	677.8	882.0	0.48		203.4	SPLS 6a_90 Ba All Cts	635.0	677.8	829.2	0.32
492B	Bovenregel twe	120x120x10	S355	4M24-8.8t	2.33	1.00	1.00	116	-45.3	SPLS 6a_90 Ba All Cts	294.4	542.2	705.6	0.15		36.5	SPLS 6a_90 Ba All Cts	635.0	542.2	663.4	0.07
492C	Bovenregel twe	120x120x10	S355		1.92	1.00	1.00	81	-184.1	SPLS 6a_90 Ba All Cts	421.6	0.0	0.0	0.44		184.5	SPLS 6a_90 Ba All Cts	823.6	0.0	0.0	0.22
493A	Tussenregel tw	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-22.3	ULS 5a Ah 22	156.1	188.2	172.8	0.14		10.5	SPLS 3_0,9_106.95 Ba	187.5	188.2	172.8	0.06
493B	Tussenregel tw	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-15.5	SPLS 6a_90 Ba Ct1 Ba	156.1	188.2	172.8	0.10		7.3	SPLS 3_0,9_106.95 Ba	168.5	188.2	172.8	0.04
493C	Tussenregel tw	90x90x8	S235		2.00	1.00	1.00	121	-21.0	ULS 5a Ah 22	156.1	0.0	0.0	0.13		10.2	SPLS 3_0,9_106.95 Ba	326.7	0.0	0.0	0.03
201L	Diagonaal	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	131	-64.4	SPLS 3_106.95 Ba Ct1	150.4	188.2	172.8	0.43		47.0	SPLS 6a_90 Ba Ct1 Ba	190.7	188.2	157.1	0.30
201T	Diagonaal	100x100x8	S235	1M24-8.8t	0.53	0.53	0.53	131	-31.5	SPLS 6a_90 Ba Ct1 Ba	120.3	135.6	103.7	0.30		22.0	SPLS 3_0,9_73.05 Ba (	170.5	135.6	97.5	0.23
202L	Diagonaal	160x160x15#	S235	4M24-8.8t	0.53	0.53	0.53	78	-347.8	SPLS 6a_90 Ba Ct1 Ah	702.9	542.2	777.6	0.64		304.4	SPLS 6a_90 Ba Ct2 Ah	673.4	542.2	691.1	0.56
202T	Diagonaal	150x150x12	S235	4M24-8.8t	0.53	0.53	0.53	83	-297.8	SPLS 6a_90 Ba Ct1 Ah	502.9	542.2	622.1	0.59		307.1	SPLS 6a_90 Ba Ct1 Ah	498.3	542.2	535.6	0.62
203L	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-277.9	SPLS 6a_90 Ba Ct2 Ah	480.6	542.2	622.1	0.58		316.3	SPLS 6a_90 Ba Ct1 Ah	498.3	542.2	535.6	0.63
203T	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-280.1	SPLS 6a_90 Ba Ct1 Ah	480.6	542.2	622.1	0.58		270.6	SPLS 6a_90 Ba Ct1 Ah	498.3	542.2	535.6	0.54
204L	Diagonaal	160x160x17#	S235	4M24-8.8t	0.52	0.52	0.52	90	-382.5	SPLS 6a_90 Ba Ct1 Ah	714.2	542.2	881.3	0.71		329.8	SPLS 6a_90 Ba Ct2 Ah	746.8	542.2	783.2	0.61
204T	Diagonaal	160x160x17#	S235	4M24-8.8t	0.52	0.52	0.52	90	-333.0	SPLS 6a_90 Ba Ct2 Ah	714.2	542.2	881.3	0.61		310.9	SPLS 3_0,9_90 Ba Ct1	746.8	542.2	783.2	0.57
205L	Diagonaal	180x180x16#	S235	5M24-8.8t	0.28	0.56	0.28	60	-468.5	SPLS 6a_90 Ah Ct2 Ah	906.7	677.8	1036.8	0.69		456.3	SPLS 6a_90 Ba Ct1 Ah	783.3	677.8	867.4	0.67
205T	Diagonaal	180x180x16#	S235	5M24-8.8t	0.28	0.56	0.28	60	-482.9	SPLS 6a_90 Ba Ct1 Ah	906.7	677.8	1036.8	0.71		469.7	SPLS 6a_90 Ba Ct2 Ah	783.3	677.8	867.4	0.69
206L	Diagonaal	160x160x17#	S235	4M24-8.8t	0.55	1.00	0.55	65	-363.5	SPLS 6a_90 Ba Ct1 Ah	819.3	542.2	881.3	0.67		364.7	SPLS 6a_90 Ah Ct2 Ah	725.8	542.2	736.4	0.67
206T	Diagonaal	160x160x17#	S235	4M24-8.8t	0.55	1.00	0.55	80	-379.8	SPLS 6a_90 Ba Ct2 Ah	729.6	542.2	881.3	0.70		377.4	SPLS 6a_90 Ba Ct1 Ah	725.8	542.2	736.4	0.70
207L	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-288.4	SPLS 3_0,9_73.05 Ba (	475.0	406.7	544.3	0.71		286.9	SPLS 6a_90 Ba Ct1 Ah	557.9	406.7	453.9	0.71
207T	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-298.9	SPLS 6a_90 Ba Ct1 Ah	475.0	406.7	544.3	0.73		299.5	SPLS 6a_90 Ba Ct2 Ah	557.9	406.7	453.9	0.74
208L	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-244.2	SPLS 6a_90 Ba Ct1 Ah	415.0	406.7	466.6	0.60		239.6	SPLS 3_0,9_73.05 Ba (	498.3	406.7	405.3	0.59
208T	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-251.9	SPLS 6a_90 Ba Ct2 Ah	415.0	406.7	466.6	0.62		246.4	SPLS 6a_90 Ba Ct1 Ah	498.3	406.7	405.3	0.61
209L	Diagonaal	160x160x15#	S235	4M24-8.8t	0.20	0.20	0.20	63	-371.2	SPLS 3_106.95 Ah Ct1	782.1	542.2	777.6	0.68		363.1	SPLS 3_0,9_73.05 Ba (	673.4	542.2	680.3	0.67
209T	Diagonaal	160x160x15#	S235	4M24-8.8t	0.20	0.20	0.20	63	-379.3	SPLS 6a_90 Ba Ct2 Ah	782.1	542.2	777.6	0.70		361.9	SPLS 6a_90 Ba Ct1 Ah	673.4	542.2	680.3	0.67
210	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	174	-19.8	SPLS 3_106.95 Ah Ct1	84.7	188.2	172.8	0.23		19.7	SPLS 3_0,9_106.95 Ah	146.3	188.2	157.1	0.13
211L	Tweede dwarsa	90x90x8	S235	3M24-8.8t	1.00	1.00	1.00	148	-0.2	SPLS 3_0,9_106.95 Ba	117.9	406.7	311.0	0.00		95.4	SPLS 6a_90 Ah All Cts	185.9	406.7	270.2	0.51
211T	Tweede dwarsa	70x70x7	S235	1M16-8.8t	1.00	1.00	1.00	191	-4.1	ULS 1a_0,9_90	45.6	60.3	60.5	0.09		6.3	SPLS 6a_90 Ba Ct1 Ba	92.7	60.3	52.3	0.12
109L	Tweede dwarsa	150x150x14	S355	15M24-8.8t	1.00	2.00	1.00	64	-543.7	SPLS 3_73.05 Ah All Ct	1076.4	1918.9	3704.4	0.51		465.3	SPLS 3_0,9_106.95 Ba	1159.3	1918.9	3482.8	0.40
212T	Tweede dwarsa	120x120x10	S235	6M24-8.8t	1.00	2.00	1.00	79	-125.0	SPLS 6a_90 Ah Ct1 Ah	328.5	813.3	777.6	0.38		137.5	SPLS 6a_90 Ah Ct1 Ah	466.6	813.3	731.1	0.29
213	Tweede dwarsa	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-180.6	SPLS 6a_90 Ba Ct1 Ah	325.4	406.7	388.8	0.56		180.7	SPLS 6a_90 Ba Ct1 Ah	324.0	406.7	359.4	0.56
214	Tweede dwarsa	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.2	ULS 3_0	31.9	60.3	43.2	0.01		0.1	SPLS 6a_90 Ah Ct2 Ah	46.1	60.3	32.7	0.00
215L	Eerste dwarsarr	120x120x10	S235	4M24-8.8t	1.00	1.00	1.00	148	-42.1	SPLS 3_0,9_90 Ba All (	196.8	542.2	518.4	0.21		185.1	SPLS 3_90 Ah All Cts	324.0	542.2	467.9	0.57
215T	Eerste dwarsarr	150x150x12	S235	2M24-8.8t	1.00	1.00	1.00	118	-94.7	ULS 1a_0,9_90	377.6	271.1	311.0	0.35		116.8	ULS 1a_90	638.7	271.1	292.4	0.43
110L	Eerste dwarsarr	200x200x16	S355	13M24-8.8t	1.00	2.00	1.00	62	-572.9	SPLS 3_73.05 Ah All Ct	1686.0	1696.1	3669.1	0.34		430.3	SPLS 3_0,9_106.95 Ba	1886.8	1696.1	3449.6	0.25
216T	Eerste dwarsarr	120x120x10	S235	5M24-8.8t	1.00	2.00	1.00	104	-125.8	SPLS 3_0,9_73.05 Ba (	269.2	677.8	648.0	0.47		153.4	SPLS 6a_90 Ba Ct1 Ah	466.6	677.8	609.2	0.33
217	Eerste dwarsarr	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-181.7	SPLS 6a_90 Ba Ct1 Ah	261.1	406.7	388.8	0.70		182.3	SPLS 6a_90 Ba Ct1 Ah	324.0	406.7	359.4	0.56
218	Eerste dwarsarr	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.6	ULS 3_0	29.9	60.3	60.5	0.02		0.7	ULS 3_0	64.5	60.3	45.8	0.01
219L	Onderstuk in to	80x80x8	S235	2M16-8.8t	1.00	1.00	1.00	253	-10.0	SPLS 3_0,9_90 Ah All (	49.4	120.6	138.2	0.20		5.4	SPLS 1a_0,9_106.95 A	177.2	120.6	119.5	0.05
219T	Onderstuk in to	80x80x8	S235	2M16-8.8t	1.00	1.03	1.00	247	-7.6	SPLS 1a_106.95 Ah Ct.	51.5	120.6	138.2	0.15		5.1	ULS 1a_0,9_45	177.2	120.6	119.5	0.04
220	Onderstuk in to	80x80x8	S235	1M16-8.8t	1.00	0.50	0.50	227	-5.2	ULS 1a_45	38.5	60.3	69.1	0.13		4.1	ULS 1a_0,9_135	142.8	60.3	59.7	0.07
221	Onderstuk in to	80x80x8	S235	1M16-8.8t	0.50	0.50	0.50	253	-1.5	ULS 1a_0	39.5	60.3	69.1	0.04		0.2	ULS 1a_0,9_0	142.8	60.3	59.7	0.00
301	Diagonaal onde	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	140	-54.9	SPLS 6a_90 Ba All Cts	111.3	188.2	172.8	0.49		60.0	SPLS 6a_90 Ba All Cts	149.6	188.2	139.6	0.43
302	Diagonaal onde	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	130	-68.5	SPLS 6a_90 Ba Ct2 Ah	120.9	188.2	172.8	0.57		65.1	SPLS 6a_90 Ba Ct2 Ah	151.2	188.2	139.6	0.47
303	Diagonaal onde	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	120	-69.5	SPLS 6a_90 Ba All Cts	131.9	188.2	172.8	0.53		70.3	SPLS 6a_90 Ba All Cts	149.6	188.2	139.6	0.50
304	Diagonaal onde	90x90x8	S235	2M24-8.8t	0.55	0.55	0.55	93	-88.9	SPLS 6a_90 Ba All Cts	186.3	271.1	207.4	0.48		91.0	SPLS 6a_90 Ba All Cts	150.3	271.1	141.8	0.64
306	Diagonaal onde	80x80x6#	S235	2M24-8.8t	0.53	0.53	0.53	86	-37.9	SPLS 6a_90 Ba All Cts	133.0	271.1	155.5	0.29		51.3	SPLS 6a_90 Ba All Cts	99.7	271.1	124.3	0.51
307	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	112	-35.2	SPLS 6a_90 Ba All Cts	107.5	188.2	151.2	0.33		35.5	SPLS 6a_90 Ba All Cts	114.0	188.2	116.0	0.31
308	Diagonaal onde	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	110	-34.6	SPLS 6a_90 Ba All Cts	80.5	120.6	103.7	0.43		34.0	SPLS 6a_90 Ba All Cts	67.0	120.6	56.7	0.60
309	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	79	-47.1	SPLS 6a_90 Ba All Cts	140.3	188.2	151.2	0.34		48.1	SPLS 6a_90 Ba All Cts	90.5	188.2	82.6	0.58
310	Diagonaal onde	90x90x8	S235	2M20-8.8t	0.55	0.55	0.55	49	-62.1	SPLS 6a_90 Ba Ct2 Ah	252.8	188.2	172.8	0.36		59.3	SPLS 6a_90 Ba All Cts	139.9	188.2	99.5	0.60
311	Diagonaal onde	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	51	-38.5	SPLS 6a_90 Ba Ct1 Ah	250.3	271.1	207.4	0.19		28.8	SPLS 3_0,9_90 Ba Ct2	136.2	271.1	104.6	0.28
313	Dwarsligger onc	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	82	0.0		570.7	188.2	216.0	0.00		3.6	ULS 3_73.05	766.1	188.2	0.0	0.02
314	Dwarsligger onc	120x120x12	S355	2M20-8.8t	2.00	2.00	2.00	104	0.0		416.8	188.2	352.8	0.00		51.3	ULS 3_90	389.8	188.2	203.1	0.27
315	Dwarsligger onc	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	54	-5.0	ULS 3_0,9_90	689.5	188.2	216.0	0.03		2.8	ULS 5a Ah 11	766.1	188.2	0.0	0.01
316	Dwarsligger onc	150x150x12(12	S355	2M24-8.8t	2.00	1.00	1.00	24	0.0		2047.8	542.2	846.7	0.00		87.3	ULS 3_90	1904.3	542.2	369.1	0.24
317	Dwarsligger onc	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	26	-17.9	ULS 3_90	790.1	188.2	216.0	0.09		0.0		766.1	188.2	0.0	0.00

Assessment of groups for strengthened mast (afkeur level)

Date 25-02-21
Author MKh
Version 1.0

ENS-ZL 380
HB-3 R
40

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
318	Verticaal eerste	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	171	-17.8	ULS 3_0	98.0	271.1	207.4	0.18		0.0		159.7	271.1	183.4	0.00
319	Verticaal eerste	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	172	-3.8	SPLS 1a_45 Ah Ct2	38.8	60.3	51.8	0.10		0.0		48.4	60.3	33.7	0.00
320	Verticaal eerste	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	93	-1.0	SPLS 6a_90 Ba Ct1 Ba	51.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00
321	Diagonaal eerst	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	345	0.0		30.1	188.2	172.8	0.00		26.5	SPLS 6a_90 Ba Ct1 Ba	162.8	188.2	157.1	0.17
322	Diagonaal eerst	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	269	0.0		50.9	271.1	207.4	0.00		39.8	ULS 3_0	136.2	271.1	161.3	0.29
323	Diagonaal eerst	70x70x7	S235	1M20-8.8t	1.00	1.00	1.00	331	0.0		19.8	94.1	75.6	0.00		15.0	SPLS 1a_45 Ah Ct2	84.7	94.1	65.2	0.23
324	Dwarsligger bov	70x70x7	S235	1M20-8.8t	1.00	2.00	1.00	110	-0.8	ULS 1a_0	93.2	94.1	75.6	0.01		0.7	ULS 1a_0,9_0	84.7	94.1	65.2	0.01
325	Tussen diagona	80x80x8	S235	1M20-8.8t	1.00	1.00	1.00	151	-2.2	ULS 1a_0	81.0	94.1	86.4	0.03		1.4	ULS 1a_0,9_0	133.6	94.1	78.5	0.02
401	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.53	0.53	0.53	121	-18.8	SPLS 3_0,9_90 Ba Ct1	99.6	188.2	151.2	0.19		18.8	SPLS 3_90 Ba All Cts	90.5	188.2	91.6	0.21
402	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	112	-22.7	SPLS 3_90 Ba Ct2	107.3	188.2	151.2	0.21		22.8	SPLS 3_90 Ba Ct2	90.5	188.2	100.8	0.25
403	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	97	-32.9	SPLS 3_106.95 Ba Ct2	121.9	188.2	151.2	0.27		32.9	SPLS 3_0,9_106.95 Ba	90.5	188.2	100.8	0.36
404	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	92	-48.1	SPLS 6a_90 Ba All Cts	126.9	188.2	151.2	0.38		47.1	SPLS 6a_90 Ba All Cts	90.5	188.2	117.6	0.52
405	Diagonaal onde	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	67	-50.6	SPLS 6a_90 Ba All Cts	226.0	271.1	207.4	0.24		52.6	SPLS 6a_90 Ba All Cts	136.2	271.1	141.8	0.39
406	Diagonaal onde	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	64	-57.3	SPLS 6a_90 Ba All Cts	231.6	271.1	207.4	0.28		55.2	SPLS 6a_90 Ba All Cts	139.3	271.1	124.1	0.44
407	Diagonaal onde	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	65	-39.2	SPLS 6a_90 Ba Ct1 Ah	203.3	271.1	207.4	0.19		27.7	SPLS 6a_90 Ba Ct1 Ah	117.7	271.1	124.1	0.24
408	Diagonaal onde	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	202	-9.7	SPLS 3_0,9_73.05 Ah	21.5	60.3	43.2	0.45		18.7	SPLS 6a_90 Ah All Cts	46.1	60.3	32.7	0.57
410	Dwarsligger onc	150x150x12	S355	2M20-8.8t	1.00	1.00	1.00	53	0.0		867.3	188.2	352.8	0.00		79.8	ULS 3_90	504.3	188.2	217.4	0.42
411	Dwarsligger onc	150x150x12	S355	2M24-8.8t	2.00	1.00	1.00	32	0.0		971.1	271.1	423.4	0.00		66.0	ULS 3_0,9_73.05	496.7	271.1	220.7	0.30
437	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	203	-1.9	SPLS 6a_90 Ah Ct2 Ba	24.2	60.3	43.2	0.08		3.2	SPLS 6a_90 Ah Ct2 Ba	46.1	60.3	32.7	0.10
412	Bovenregel twe	90x90x8	S235	3M24-8.8t	2.00	2.00	2.00	349	-25.1	SPLS 3_0,9_106.95 Ba	33.6	406.7	311.0	0.75		128.3	SPLS 6a_90 Ah All Cts	185.9	406.7	270.2	0.69
413	Bovenregel twe	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	189	-2.4	SPLS 3_0,9_106.95 Ba	76.0	376.3	345.6	0.03		87.4	SPLS 6a_90 Ba Ct1 Ba	151.8	376.3	261.3	0.58
414	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	160	-24.0	SPLS 6a_90 Ba All Cts	42.5	60.3	51.8	0.57		24.0	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.85
415	Diagonaal bove	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	334	-2.9	SPLS 1a_106.95 Ba All	14.3	60.3	51.8	0.20		0.0		48.4	60.3	33.7	0.00
416	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	126	-24.1	SPLS 6a_90 Ba All Cts	56.2	60.3	51.8	0.47		22.0	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.78
417	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	118	-10.1	SPLS 6a_90 Ba Ct2 Ah	59.8	60.3	51.8	0.19		9.7	SPLS 6a_90 Ba Ct2 Ah	72.6	60.3	28.2	0.34
418	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	111	-13.9	SPLS 6a_90 Ba All Cts	63.5	60.3	51.8	0.27		14.2	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.50
419	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	105	-16.3	SPLS 6a_90 Ba All Cts	66.8	60.3	51.8	0.31		15.6	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.55
420	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	97	-18.8	SPLS 6a_90 Ba All Cts	71.3	60.3	51.8	0.36		19.5	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.69
421	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	92	-25.6	SPLS 6a_90 Ba All Cts	74.4	60.3	51.8	0.49		24.1	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.85
422	Diagonaal bove	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	98	-35.0	SPLS 6a_90 Ba All Cts	89.0	120.6	103.7	0.39		37.8	SPLS 6a_90 Ba All Cts	78.2	120.6	76.8	0.49
423	Verticaal tweed	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	101	-0.6	ULS 5a Ba 12	48.1	60.3	43.2	0.01		2.7	ULS 5a Ba 12	46.1	60.3	32.7	0.08
424	Verticaal tweed	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	152	-21.2	SPLS 6a_90 Ah All Cts	31.6	60.3	43.2	0.67		21.5	SPLS 6a_90 Ba All Cts	46.1	60.3	32.7	0.66
426	Diagonaal twee	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	308	-7.1	ULS 5a Ba 12	11.4	60.3	43.2	0.62		0.0		46.1	60.3	25.2	0.00
427	Diagonaal twee	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	244	0.0		16.4	60.3	43.2	0.00		1.1	ULS 1a_106.95	46.1	60.3	20.5	0.05
429	Dwarsligger bov	UNP160	S235	1M16-8.8t	1.00	1.00	1.00	47	0.0		279.0	60.3	64.8	0.00		35.2	ULS 3_0,9_90	90.7	60.3	64.8	0.58
430	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-2.0	SPLS 1a_0,9_135 Ba A	18.2	60.3	43.2	0.11		2.5	SPLS 1a_0,9_0 Ah All (	46.1	60.3	32.7	0.08
438	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-2.6	SPLS 1a_0 Ah All Cts	34.4	60.3	43.2	0.07		2.3	SPLS 1a_0,9_135 Ba A	46.1	60.3	32.7	0.07
439	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	-6.4	ULS 5a Ba 12	19.5	60.3	43.2	0.33		7.3	ULS 5a Ah 12	46.1	60.3	32.7	0.22
440	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-2.4	ULS 5a Ah 12	39.5	60.3	43.2	0.06		2.0	ULS 5a Ba 12	46.1	60.3	32.7	0.06
441	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 6a_90 Ah Ct2 Ba	45.3	60.3	43.2	0.00		0.0	ULS 3_0,9_90	46.1	60.3	32.7	0.00
431	0	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	107	-24.0	SPLS 3_106.95 Ba Ct2	112.0	188.2	151.2	0.21		23.8	SPLS 3_106.95 Ba Ct2	90.5	188.2	100.8	0.26
432	0	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	102	-24.7	SPLS 3_106.95 Ba Ct2	116.9	188.2	151.2	0.21		24.6	SPLS 3_106.95 Ba Ct2	90.5	188.2	100.8	0.27
433	0	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	63	-69.0	SPLS 6a_90 Ba All Cts	233.3	271.1	207.4	0.33		66.6	SPLS 3_0,9_106.95 Ba	144.0	271.1	159.5	0.46
434	0	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	141	-25.0	SPLS 6a_90 Ba All Cts	49.5	60.3	51.8	0.51		24.6	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.87
435	0	60x60x6	**S355**	1M16-8.8t	0.55	0.55	0.55	133	-29.1	SPLS 6a_90 Ba All Cts	62.2	60.3	70.6	0.48		29.6	SPLS 6a_90 Ba All Cts	98.8	60.3	38.3	0.77
436	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	305	-8.3	SPLS 6a_90 Ah Ct1 Ba	11.5	60.3	43.2	0.72		0.0		46.1	60.3	32.7	0.00
330	0	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	111	-77.6	SPLS 6a_90 Ba All Cts	141.9	188.2	172.8	0.55		74.7	SPLS 6a_90 Ba All Cts	149.6	188.2	139.6	0.54
331	0	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	100	-40.6	SPLS 6a_90 Ba All Cts	87.4	120.6	103.7	0.46		40.5	SPLS 6a_90 Ba All Cts	67.0	120.6	56.7	0.71
332	0	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	73	-54.7	SPLS 6a_90 Ba All Cts	147.1	188.2	151.2	0.37		52.8	SPLS 6a_90 Ba All Cts	90.5	188.2	82.6	0.64
250L	0	80x80x6#	S235	2M16-8.8t	1.00	1.00	1.00	166	-6.2	SPLS 3_0,9_73.05 Ah	68.8	120.6	103.7	0.09		4.6	SPLS 3_0,9_73.05 Ah	111.8	120.6	89.6	0.05
250T	0	80x80x6#	S235		11.75	2.00	1.00	107	-7.3	SPLS 1a_45 Ba Ct1	105.9	0.0	0.0	0.07		2.6	SPLS 1a_0,9_45 Ba Ct	111.8	120.6	89.6	0.03
251	0	90x90x8	S235	1M20-8.8t	1.00	1.00	1.00	204	-6.1	SPLS 1a_73.05 Ba Ct1	61.8	94.1	86.4	0.10		5.2	SPLS 1a_0,9_73.05 Ba	156.7	94.1	78.5	0.07
252	0	60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	226	-0.9	SPLS 1a_0 Ah Ct2	26.4	94.1	64.8	0.03		0.2	SPLS 1a_0,9_0 Ah All (	65.7	94.1	44.4	0.00
450	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	-0.1	SPLS 1a_135 Ba All Cts	16.2	60.3	43.2	0.00		0.0	SPLS 1a_0,9_0 Ba All (	46.1	60.3	32.7	0.00

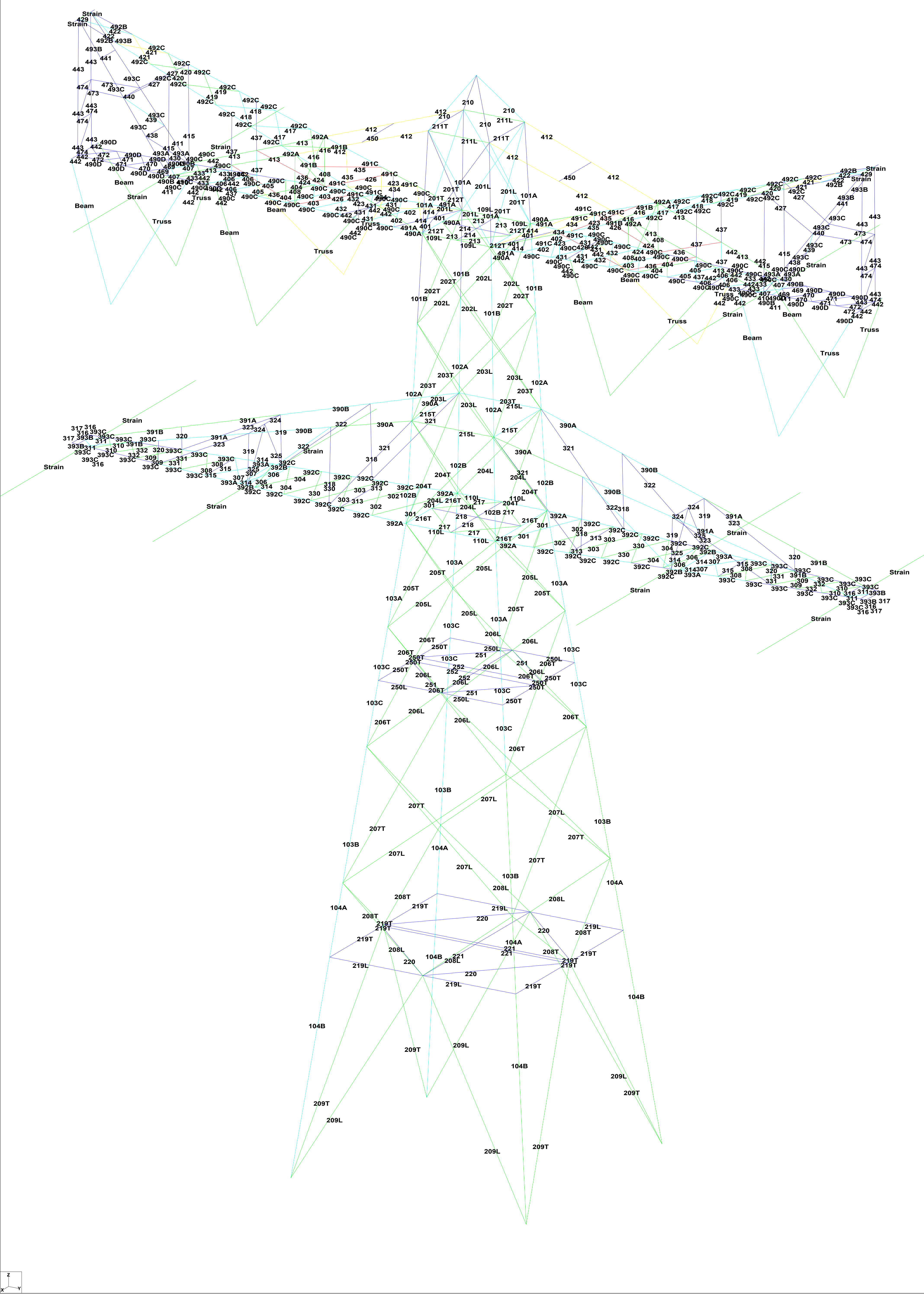
Assessment of groups for strengthened mast (verbouw level)

Date 25-02-21
Author MKh
Version 1.0

ENS-ZL 380
HB-3 R
40

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
435		60x60x6	**S355**	1M16-8.8t	0.55	0.55	0.55	133	**-30.3**	SPLS 6a_90 Ba All Cts	62.2	60.3	70.6	0.50		**30.7**	SPLS 6a_90 Ba All Cts	98.8	60.3	38.3	0.80

DNV GL Nederlands BV, Project: "HB-3_R_X.ini"
Tower Version 16.86, 15:08:02 Monday, 25 October, 2021
Undeformed geometry displayed



% Usage Legend
0 <= % < 25
25 <= % < 50
50 <= % < 75
75 <= % < 100
100 <= %

1 (m)

Assessment of groups for initial mast (afkeur level)

Date 25-10-21
Author KCh
Version 1.0

ENS-ZL 380
HB-3 R X
6

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101A	Leg	120x120x10	S355	7M24-8.8t	0.52	0.52	0.52	88	-70.1	SPLS 6a_90 Ba All Cts Ah Ct2	462.0	945.9	1234.8	0.15		25.4	SPLS 3_0,9_90 Ah All Cts	635.0	945.9	1160.9	0.04	
101B	Leg	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	77	-183.2	SPLS 6a_90 Ba All Cts Ah Ct2	538.8	1084.4	1411.2	0.34		128.6	SPLS 3_0,9_90 Ah Ct1	635.0	1084.4	1326.8	0.20	
102A	Leg	150x150x14	S355	8M24-8.8t	0.52	0.52	0.52	67	-464.4	SPLS 3_90 Ba All Cts	1038.6	1084.4	1975.7	0.45		348.7	SPLS 3_0,9_90 Ah All Cts	1159.3	1084.4	1857.5	0.32	
102B	Leg	150x150x14	S355	11M24-8.8t	0.52	0.52	0.52	71	-401.9	SPLS 3_90 Ba All Cts	1001.6	2910.7	2716.6	0.40		298.9	SPLS 3_0,9_90 Ah All Cts	1159.3	2910.7	2461.2	0.26	
103A	Leg	200x200x20	S355	8M24-8.8t	0.28	0.28	0.28	29	-888.7	SPLS 3_90 Ba All Cts	2574.7	2168.8	2822.4	0.41		708.5	SPLS 3_0,9_90 Ah All Cts	2328.5	2168.8	2653.5	0.33	
103B	Leg	200x200x20	S355	10M24-8.8t	0.28	0.28	0.28	38	-1334.0	SPLS 3_90 Ba All Cts	2458.4	2660.2	3528.0	0.54		1106.6	SPLS 3_0,9_90 Ah All Cts	2328.5	2660.2	3528.0	0.48	
103C	Leg	200x200x20	S355		0.52	0.52	0.52	34	-1103.7	SPLS 3_90 Ba All Cts	2507.1	0.0	0.0	0.44		912.4	SPLS 3_0,9_90 Ah All Cts	2712.2	0.0	0.0	0.34	
104A	Leg	250x250x18	S355	12M24-8.8t	0.55	0.55	0.55	32	-1441.6	SPLS 3_90 Ba All Cts	2823.6	2975.4	3810.2	0.51		1206.2	SPLS 3_0,9_90 Ah All Cts	2763.8	2975.4	3810.2	0.44	
104B	Leg	250x250x18	S355	12M24-8.8t	0.20	0.20	0.20	35	-1446.5	SPLS 3_90 Ba All Cts	2788.0	2975.4	3810.2	0.52		1199.5	SPLS 3_0,9_90 Ah All Cts	2763.8	2975.4	3582.3	0.43	
392A	Onderregel eerste dwarsarm	200x200x16	S355	13M24-8.8t	2.26	1.00	1.00	56	-734.2	SPLS 6a_90 Ba Ct1 Ah Ct1	1764.6	1696.1	3669.1	0.43		570.4	SPLS 3_0,9_78.65 Ah Ct2	1886.8	1696.1	3449.6	0.34	
392B	Onderregel eerste dwarsarm	200x200x16	S355	6M24-8.8t	###	2.00	1.00	66	-393.7	SPLS 6a_90 Ba Ct1 Ah Ct1	1622.8	813.3	1693.4	0.48		301.0	SPLS 3_0,9_78.65 Ah Ct2	1886.8	813.3	1592.1	0.37	
392C	Onderregel eerste dwarsarm	200x200x16	S355		2.38	1.00	1.00	56	-687.1	SPLS 6a_90 Ba Ct1 Ah Ct1	1764.7	0.0	0.0	0.39		522.2	SPLS 3_0,9_78.65 Ah Ct2	2193.9	0.0	0.0	0.24	
393A	Onderregel eerste dwarsarm	160x160x15	S355	6M24-8.8t	2.59	1.00	1.00	82	-364.2	SPLS 6a_90 Ba Ct1 Ah Ct1	1015.5	813.3	1587.6	0.45		268.0	SPLS 3_0,9_78.65 Ah Ct2	1372.7	813.3	1370.5	0.33	
393B	Onderregel eerste dwarsarm	160x160x15	S355		2.32	1.00	1.00	12	-1.7	ULS 3_0	1658.2	0.0	0.0	0.00		0.2	SPLS 1a_0,9_0 Ah Ct1	1658.2	0.0	0.0	0.00	
393C	Onderregel eerste dwarsarm	160x160x15	S355		3.62	1.00	1.00	82	-328.3	SPLS 6a_90 Ba Ct1 Ah Ct1	1014.6	0.0	0.0	0.32		230.2	SPLS 3_0,9_78.65 Ah Ct2	1658.2	0.0	0.0	0.14	
490A	Onderregel tweede dwarsarm	150x150x14	S355	15M24-8.8t	2.22	1.00	1.00	62	-451.9	SPLS 6a_90 Ba Ct1 Ah Ct1	1096.6	1918.9	3704.4	0.41		313.2	SPLS 3_0,9_90 Ah Ct2	1159.3	1918.9	3704.4	0.27	
490B	Onderregel tweede dwarsarm	150x150x14	S355		1.95	###	1.00	87	-8.0	SPLS 1a_0 Ah Ct1	810.2	0.0	0.0	0.01		15.0	ULS 1a_0,9_0	1425.0	0.0	0.0	0.01	
490C	Onderregel tweede dwarsarm	150x150x14	S355		2.36	1.00	1.00	62	-435.4	SPLS 6a_90 Ba Ct1 Ah Ct1	1096.7	0.0	0.0	0.40		290.9	SPLS 3_0,9_90 Ah Ct2	1425.0	0.0	0.0	0.20	
390A	Bovenregel eerste dwarsarm	90x90x8	S235	4M24-8.8t	2.01	1.00	1.00	275	-7.9	SPLS 3_0,9_78.65 Ah All Cts	47.2	542.2	414.7	0.17		103.7	PLS 6a_90 Ah Ct1 Ah Ct2	185.9	542.2	357.1	0.56	
390B	Bovenregel eerste dwarsarm	90x90x8	S235	4M20-8.8t	2.00	1.00	1.00	277	-15.9	SPLS 3_0,9_78.65 Ah All Cts	46.8	376.3	345.6	0.34		80.0	6a_90 Ba All Cts Ah Ct1	269.1	376.3	314.2	0.30	
391A	Bovenregel eerste dwarsarm	80x80x8	S235	4M20-8.8t	1.82	1.00	1.00	313	-22.3	SPLS 3_0,9_78.65 Ah All Cts	34.3	376.3	345.6	0.65		70.5	6a_90 Ba All Cts Ah Ct1	227.6	376.3	314.2	0.31	
391B	Bovenregel eerste dwarsarm	80x80x8	S235	4M20-8.8t	2.23	1.00	1.00	313	-22.3	SPLS 3_0,9_78.65 Ah All Cts	34.3	376.3	345.6	0.65		70.5	6a_90 Ba All Cts Ah Ct1	168.3	376.3	304.4	0.42	
491A	Bovenregel tweede dwarsarm	120x120x10	S355	3M24-8.8t	1.54	1.00	1.00	82	-260.2	SPLS 6a_90 Ba All Cts Ah Ct1	419.0	406.7	529.2	0.64		233.0	6a_90 Ba All Cts Ah Ct2	441.0	406.7	493.6	0.57	
491B	Bovenregel tweede dwarsarm	120x120x10	S355	5M24-8.8t	1.65	3.19	1.00	81	-168.7	SPLS 6a_90 Ah Ct1 Ba Ct1	418.9	677.8	882.0	0.40		157.9	PLS 6a_90 Ba Ct2 Ah Ct2	635.0	677.8	829.2	0.25	
491C	Bovenregel tweede dwarsarm	120x120x10	S355		1.49	2.87	1.00	81	-234.3	SPLS 6a_90 Ba All Cts Ah Ct1	419.0	0.0	0.0	0.56		212.8	6a_90 Ba All Cts Ah Ct2	823.6	0.0	0.0	0.26	
492A	Bovenregel tweede dwarsarm	120x120x10	S355	5M24-8.8t	2.54	4.87	1.00	81	-192.3	SPLS 6a_90 Ba All Cts Ah Ct1	421.9	677.8	882.0	0.46		210.4	6a_90 Ba All Cts Ah Ct2	635.0	677.8	829.2	0.33	
492B	Bovenregel tweede dwarsarm	120x120x10	S355	4M24-8.8t	2.33	1.00	1.00	116	-35.9	SPLS 6a_90 Ah All Cts Ba Ct1	294.4	542.2	705.6	0.12		42.8	6a_90 Ba All Cts Ah Ct2	635.0	542.2	663.4	0.08	
492C	Bovenregel tweede dwarsarm	120x120x10	S355		1.92	1.00	1.00	81	-174.8	SPLS 6a_90 Ba All Cts Ah Ct1	421.6	0.0	0.0	0.41		191.1	6a_90 Ba All Cts Ah Ct2	823.6	0.0	0.0	0.23	
493A	Tussenregel tweede dwarsarm	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-29.7	ULS 5a Ba 22	138.8	188.2	172.8	0.21		3.6	ULS 5a Ba 12	187.5	188.2	172.8	0.02	
493B	Tussenregel tweede dwarsarm	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-23.9	ULS 5a Ba 22	138.8	188.2	172.8	0.17		0.0	PLS 3_0,9_135 Ah All Cts	168.5	188.2	172.8	0.00	
493C	Tussenregel tweede dwarsarm	90x90x8	S235		2.00	1.00	1.00	121	-27.2	ULS 5a Ah 22	138.8	0.0	0.0	0.20		3.2	ULS 5a Ba 12	326.7	0.0	0.0	0.01	
201L	Diagonaal	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	131	-59.9	SPLS 3_90 Ah Ct1	150.4	188.2	172.8	0.40		51.4	PLS 6a_90 Ba Ct2 Ah Ct2	190.7	188.2	157.1	0.33	
201T	Diagonaal	100x100x8	S235	1M24-8.8t	0.53	0.53	0.53	131	-35.1	SPLS 6a_90 Ba Ct2 Ah Ct2	120.3	135.6	103.7	0.34		19.6	LS 3_0,9_101.35 Ah Ct1	170.5	135.6	97.5	0.20	
202L	Diagonaal	160x160x15	S235	4M24-8.8t	0.53	0.53	0.53	78	-346.3	SPLS 6a_90 Ba Ct1 Ah Ct1	702.9	542.2	777.6	0.64		298.7	LS 3_0,9_101.35 Ah Ct2	673.4	542.2	691.1	0.55	
202T	Diagonaal	150x150x12	S235	4M24-8.8t	0.53	0.53	0.53	83	-307.2	SPLS 6a_90 Ba Ct1 Ah Ct1	502.9	542.2	622.1	0.61		310.3	PLS 6a_90 Ah Ct1 Ba Ct1	498.3	542.2	535.6	0.62	
203L	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-273.4	SPLS 3_0,9_101.35 Ah Ct2	480.6	542.2	622.1	0.57		314.7	PLS 6a_90 Ba Ct1 Ah Ct1	498.3	542.2	535.6	0.63	
203T	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-283.2	SPLS 6a_90 Ah Ct1 Ba Ct1	480.6	542.2	622.1	0.59		279.1	PLS 6a_90 Ba Ct1 Ah Ct1	498.3	542.2	535.6	0.56	
204L	Diagonaal	160x160x17	S235	4M24-8.8t	0.52	0.52	0.52	90	-380.8	SPLS 6a_90 Ah Ct1 Ba Ct1	714.2	542.2	881.3	0.70		342.5	SPLS 3_0,9_90 Ba Ct2	746.8	542.2	783.2	0.63	
204T	Diagonaal	160x160x17	S235	4M24-8.8t	0.52	0.52	0.52	90	-341.0	SPLS 3_78.65 Ba Ct2	714.2	542.2	881.3	0.63		304.5	LS 3_0,9_101.35 Ah Ct1	746.8	542.2	783.2	0.56	
205L	Diagonaal	180x180x16	S235	5M24-8.8t	0.28	0.56	0.28	60	-467.4	SPLS 3_78.65 Ba Ct1	906.7	677.8	1036.8	0.69		462.4	SPLS 3_0,9_78.65 Ba Ct1	783.3	677.8	867.4	0.68	
205T	Diagonaal	180x180x16	S235	5M24-8.8t	0.28	0.56	0.28	60	-484.7	SPLS 3_78.65 Ba Ct1	906.7	677.8	1036.8	0.72		474.4	SPLS 3_0,9_78.65 Ba Ct2	783.3	677.8	867.4	0.70	
206L	Diagonaal	160x160x17	S235	4M24-8.8t	0.55	1.00	0.55	65	-368.4	SPLS 3_78.65 Ba Ct1	819.3	542.2	881.3	0.68		362.9	SPLS 3_101.35 Ah Ct2	725.8	542.2	736.4	0.67	
206T	Diagonaal	160x160x17	S235	4M24-8.8t	0.55	1.00	0.55	80	-384.0	SPLS 3_78.65 Ba Ct2	729.6	542.2	881.3	0.71		378.2	SPLS 3_78.65 Ba Ct1	725.8	542.2	736.4	0.70	
207L	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-286.8	SPLS 3_0,9_101.35 Ah Ct2	475.0	406.7	544.3	0.71		291.6	SPLS 3_78.65 Ba Ct1	557.9	406.7	453.9	0.72	
207T	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-299.7	SPLS 3_0,9_78.65 Ba Ct1	475.0	406.7	544.3	0.74		303.0	SPLS 3_78.65 Ba Ct2	557.9	406.7	453.9	0.75	
208L	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-248.6	SPLS 3_78.65 Ba Ct1	415.0	406.7	466.6	0.61		239.2	LS 3_0,9_101.35 Ah Ct2	498.3	406.7	405.3	0.59	
208T	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-255.0	SPLS 3_78.65 Ba Ct2	415.0	406.7	466.6	0.63		247.0	SPLS 3_0,9_78.65 Ba Ct1	498.3	406.7	405.3	0.61	
209L	Diagonaal	160x160x15	S235	4M24-8.8t	0.20	0.20	0.20	63	-379.6	SPLS 3_78.65 Ba Ct1	782.1	542.2	777.6	0.70		361.3	LS 3_0,9_101.35 Ah Ct2	673.4	542.2	680.3	0.67	
209T	Diagonaal	160x160x15	S235	4M24-8.8t	0.20	0.20	0.20	63	-385.9	SPLS 3_78.65 Ba Ct2	782.1	542.2	777.6	0.71		365.4	SPLS 3_0,9_78.65 Ba Ct1	673.4	542.2	680.3	0.67	
210	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	174	-21.6	SPLS 3_78.65 Ba Ct1	84.7	188.2	172.8	0.25		21.4	SPLS 3_78.65 Ba Ct1	146.3	188.2	157.1	0.15	
211L	Tweede dwarsarm in tower	90x90x8	S235	3M24-8.8t	1.00	1.00	1.00	148	0.0		117.9	406.7	311.0	0.00		136.2	6a_90 Ba All Cts Ah Ct2	185.9	406.7	270.2	0.73	
211T	Tweede dwarsarm in tower	70x70x7	S235	1M16-8.8t	1.00	1.00	1.00	191	-2.8	SPLS 3_0,9_78.65 Ah Ct1	45.6	60.3	60.5	0.06		5.8	PLS 6a_90 Ah Ct1 Ah Ct2	92.7	60.3	52.3	0.11	
109L	Tweede dwarsarm in tower	150x150x14	S355	15M24-8.8t	1.00	2.00	1.00	64	-599.7	SPLS 3_90 Ba All Cts	1076.4	1918.9	3704.4	0.56		476.0	SPLS 3_0,9_90 Ah All Cts	1159.3	1918.9	3482.8	0.41	
212T	Tweede dwarsarm in tower	120x120x10	S235	6M24-8.8t	1.00	2.00	1.00	79	-123.1	SPLS 6a_90 Ah Ct1 Ah Ct2	328.5	813.3	777.6	0.37		143.6	PLS 6a_90 Ah Ct1 Ba Ct1	466.6	813.3	731.1	0.31	
213	Tweede dwarsarm in tower	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-183.7	SPLS 6a_90 Ba Ct1 Ah Ct1	325.4	406.7	388.8	0.56		183.7	PLS 6a_90 Ba Ct1 Ah Ct1	324.0	406.7	359.4	0.57	
214	Tweede dwarsarm in tower	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.5	SPLS 6a_90 Ba Ct2 Ah Ct1	31.9	60.3	43.2	0.02		0.4	PLS 6a_90 Ba Ct2 Ah Ct2	46.1	60.3	32.7	0.01	
215L	Eerste dwarsarm in tower	120x120x10	S235	4M24-8.8t	1.00	1.00	1.00	148	-56.4	SPLS 3_0,9_90 Ah All Cts	196.8	542.2	518.4	0.29		189.9	SPLS 3_0 Ba All Cts	324.0	542.2	467.9	0.59	
215T	Eerste dwarsarm in tower	150x150x12	S235	2M24-8.8t	1.00	1.00	1.00	118	-78.0	ULS 1a_0,9_90	377.6	271.1	311.0	0.29		102.2	ULS 1a_90	638.7	271.1	292.4	0.38	
110L	Eerste dwarsarm in tower	200x200x16	S355	13M24-8.8t	1.00	2.00	1.00	62	-585.3	SPLS 3_101.35 Ba All Cts	1686.0	1696.1	3669.1	0.35		466.5	S 3_0,9_78.65 Ah All Cts	1886.8	1696.1	3449.6	0.28	
216T	Eerste dwarsarm in tower	120x120x10	S235	5M24-8.8t	1.00	2.00	1.00	104	-128.8	SPLS 3_0,9_101.35 Ah Ct1	269.2	677.8	648.0	0.48		151.3	PLS 6a_90 Ah Ct1 Ah Ct2	466.6	677.8	609.2	0.32	
217	Eerste dwarsarm in tower	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-183.8	SPLS 3_0,9_78.65 Ba Ct1	261.1	406.7	388.8	0.70		184.6	SPLS 3_78.65 Ba Ct1	324.0	406.7	359.4	0.57	
218	Eerste dwarsarm in tower	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.5	SPLS 6a_90 Ba Ct2 Ah Ct1	29.9	60.3	60.5	0.02		0.6	PLS 6a_90 Ba Ct2 Ah Ct2	64.5	60.3	45.8	0.01	
219L	Onderstuk in tower	80x80x8	S235	2M16-8.8t	1.00	1.00	1.00	253	-10.1	SPLS 3_0,9_90 Ah All Cts	49.4	120.6	138.2	0.20		5.7	1a_0,9_101.35 Ah All Cts	177.2	120.6	119.5	0.05	
219T	Onderstuk in tower	80x80x8	S235	2M16-8.8t	1.00	1.03	1.00	247	-7.1	SPLS 1a_0,9_78.65 Ba Ct2	51.5	120.6	138.2	0.14		4.6	ULS 1a_0,9_135	177.2	120.6	119.5	0.04	
220	Onderstuk in tower	80x80x8	S235	1M16-8.8t	1.00	0.50	0.50	227	-5.2	ULS 1a_45	38.5	60.3	69.1	0.14		4.5	ULS 1a_0,9_135	142.8	60.3	59.7	0.08	
221	Onderstuk in tower	80x80x8	S235	1M16-8.8t	0.50	0.50	0.50	253	-1.6	ULS 1a_0	39.5	60.3	69.1	0.04		0.2	ULS 1a_0,9_0,9_0	142.8	60.3	59.7	0.00	
301	Diagonaal onderregel eerste dwarsarm	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	140	-57.5	SPLS 3_0,9_78.65 Ah All Cts	111.3	188.2	172.8	0.52		61.1	SPLS 3_78.65 Ah All Cts	149.6	188.2	139.6	0.44	
302	Diagonaal onderregel eerste dwarsarm	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	130	-69.1	SPLS 3_78.65 Ah Ct2	120.9	188.2	172.8	0.57		66.9	SPLS 3_0,9_78.65 Ah Ct2	151.2	188.2	139.6	0.48	
303	Diagonaal onderregel eerste dwarsarm	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	120	-70.5	SPLS 3_78.65 Ah All Cts	131.9	188.2	172.8	0.53		71.9	S 3_0,9_78.65 Ah All Cts	149.6	188.2	139.6	0.51	
304	Diagonaal onderregel eerste dwarsarm	90x90x8	S235	2M24-8.8t	0.55	0.55	0.55	93	-90.1	SPLS 3_78.65 Ah All Cts	186.3	271.1	207.4	0.48		93.2	S 3_0,9_78.65 Ah All Cts	150.3	271.1	141.8	0.66	
306	Diagonaal onderregel eerste dwarsarm	80x80x6#	S235	2M24-8.8t	0.53	0.53	0.53	86	-38.5	SPLS 3_78.65 Ah All Cts	133.0	271.1	155.5	0.29		52.2	SPLS 3_78.65 Ah All Cts	99.7	271.1	124.3	0.52	
307	Diagonaal onderregel eerste dwarsarm	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	112	-35.7	SPLS 6a_90 Ba All Cts Ah Ct1	107.5	188.2	151.2	0.33		37.4	S 3_0,9_78.65 Ah All Cts	114.0	188.2	116.0	0.33	
308	Diagonaal onderregel eerste dwarsarm	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	110	-35.0	SPLS 3_78.65 Ah All Cts	80.5	120.6	103.7	0.44		34.8	S 3_0,9_78.65 Ah All Cts	67.0	120.6	56.7	0.61	
309	Diagonaal onderregel eerste dwarsarm	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	79	-47.9	SPLS 3_78.65 Ah All Cts	140.3	188.2	151.2	0.34		49.0	S 3_0,9_78.65 Ah All Cts	90.5	188.2	82.6	0.59	
310	Diagonaal onderregel eerste dwarsarm	90x90x8	S235	2M20-8.8t	0.55	0.55	0.55	49	-63.2	SPLS 3_78.65 Ah Ct2	252.8	188.2	172.8	0.37		61.5	S 3_0,9_78.65 Ah All Cts	139.9	188.2	99.5	0.62	
311	Diagonaal onderregel eerste dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	51	-39.1	SPLS 3_0,9_78.65 Ah All Cts	250.3	271.1	207.4	0.19		29.6	SPLS 3_0,9_78.65 Ah Ct2	136.2	271.1	104.6	0.28	
313	Dwarsligger onderregel eerste dwarsarm	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	82	-0.1	ULS 1a_0,9_0,9_78.65	570.7	188.2	216.0	0.00		2.7	PLS 6a_90 Ah Ct2 Ah Ct1	766.1	188.2	0.0	0.01	
314	Dwarsligger onderregel eerste dwarsarm	120x120x12	S355	2M20-8.8t	2.00	2.00	2.00	104	0.0		416.8	188.2	352.8	0.00		53.0	ULS 3_90	389.8	188.2	203.1	0.28	
315	Dwarsligger onderregel eerste dwarsarm	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	54	-5.6	ULS 3_0,9_90	689.5	188.2	216.0	0.03		1.7	ULS 5a Ba 11	766.1	188.2	0.0	0.01	
316	Dwarsligger onderregel eerste dwarsarm	150x150x12	S355	2M24-8.8t	2.00	1.00	1.00	24	0.0		2047.8	542.2	846.7	0.00		90.4	ULS 3_78.65	1904.3	542.2	369.1	0.24	
317	Dwarsligger onderregel eerste dwarsarm	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	26	-16.8	ULS 3_0,9_90	790.1	188.2	216.0	0.09		0.0		766.1	188.2	0.0	0.00	
318	Verticaal eerste dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	171	-16.8	SPLS 6a_90 Ba Ct2 Ah Ct2	98.0	271.1	207.4	0.17		0.0		159.7	271.1	183.4	0.00	
319	Verticaal eerste dwarsarm	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	172	-3.7	SPLS 6a_90 Ba Ct1 Ah Ct1	38.8	60.3	51.8	0.10		0.0		48.4	60.3	33.7	0.00	
320	Verticaal eerste dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	93	-1.0	SPLS 6a_90 Ah Ct2 Ah Ct1	51.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00	

Assessment of groups for initial mast (afkeur level)

Date 25-10-21
Author KCh
Version 1.0

ENS-ZL 380
HB-3 R X
6

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
321	Diagonaal eerste dwarsarm	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	345	0.0		30.1	188.2	172.8	0.00		27.4	PLS 6a_90 Ah Ct2 Ah Ct1	162.8	188.2	157.1	0.17	
322	Diagonaal eerste dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	269	0.0		50.9	271.1	207.4	0.00		37.6	PLS 6a_90 Ba Ct2 Ah Ct2	136.2	271.1	161.3	0.28	
323	Diagonaal eerste dwarsarm	70x70x7	S235	1M20-8.8t	1.00	1.00	1.00	331	0.0		19.8	94.1	75.6	0.00		14.0	PLS 6a_90 Ah Ct2 Ah Ct1	84.7	94.1	65.2	0.21	
324	Dwarsligger bovenregel eerste dwarsarm	70x70x7	S235	1M20-8.8t	1.00	2.00	1.00	110	-0.8	ULS 1a_0	93.2	94.1	75.6	0.01		0.7	ULS 1a_0,9_0,9_0	84.7	94.1	65.2	0.01	
325	Tussen diagonaal eerste dwarsarm	80x80x8	S235	1M20-8.8t	1.00	1.00	1.00	151	-2.2	ULS 1a_0	81.0	94.1	86.4	0.03		1.4	ULS 1a_0,9_0,9_0	133.6	94.1	78.5	0.02	
401	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.53	0.53	0.53	121	-23.9	SPLS 3_135 Ah Ct2	99.6	188.2	151.2	0.24		21.7	SPLS 1a_0 Ba Ct1	90.5	188.2	91.6	0.24	
402	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	112	-25.6	SPLS 3_135 Ah Ct1	107.3	188.2	151.2	0.24		31.4	SPLS 3_101.35 Ah Ct2	90.5	188.2	100.8	0.35	
403	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	97	-37.0	SPLS 3_90 Ah Ct1	121.9	188.2	151.2	0.30		37.8	SPLS 3_90 Ah Ct2	90.5	188.2	100.8	0.42	
404	Diagonaal onderregel tweede dwarsarm	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	92	-50.2	SPLS 3_78.65 Ah All Cts	126.9	188.2	151.2	0.40		52.2	SPLS 3_90 Ah Ct1	90.5	188.2	117.6	0.58	
405	Diagonaal onderregel tweede dwarsarm	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	67	-59.7	SPLS 3_90 Ah Ct1	226.0	271.1	207.4	0.29		53.5	S 3_0,9_78.65 Ah All Cts	136.2	271.1	141.8	0.39	
406	Diagonaal onderregel tweede dwarsarm	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	59	-62.6	SPLS 3_78.65 Ah Ct1	239.1	271.1	207.4	0.30		57.7	SPLS 3_78.65 Ah Ct1	139.3	271.1	124.1	0.46	
407	Diagonaal onderregel tweede dwarsarm	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	65	-40.2	SPLS 3_90 Ah Ct1	203.3	271.1	207.4	0.20		31.2	S 3_0,9_78.65 Ah All Cts	117.7	271.1	124.1	0.26	
408	Diagonaal onderregel tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	202	-7.7	SPLS 3_0,9_90 Ba All Cts	21.5	60.3	43.2	0.36		19.8	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.60	
410	Dwarsligger onderregel tweede dwarsarm	150x150x12	S355	2M20-8.8t	1.00	1.00	1.00	53	0.0		867.3	188.2	352.8	0.00		75.1	ULS 3_0,9_90	504.3	188.2	217.4	0.40	
411	Dwarsligger onderregel tweede dwarsarm	150x150x12	S355	2M24-8.8t	2.00	1.00	1.00	32	0.0		971.1	271.1	423.4	0.00		73.6	ULS 3_78.65	496.7	271.1	220.7	0.33	
437		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	203	-1.7	SPLS 6a_90 Ba Ct1 Ah Ct1	24.2	60.3	43.2	0.07		14.4	SPLS 1a_0 Ah Ct2	46.1	60.3	32.7	0.44	
412	Bovenregel tweede dwarsarm	90x90x8	S235	3M24-8.8t	2.00	2.00	2.00	349	-9.8	SPLS 3_0,9_90 Ah All Cts	33.6	406.7	311.0	0.29		170.8	S 6a_90 Ba All Cts Ah Ct2	185.9	406.7	270.2	0.92	
413	Bovenregel tweede dwarsarm	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	189	0.0		76.0	376.3	345.6	0.00		119.6	PLS 6a_90 Ah Ct1 Ah Ct2	168.3	376.3	310.2	0.71	
414	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	160	-24.1	SPLS 6a_90 Ba All Cts Ah Ct2	42.5	60.3	51.8	0.57		24.4	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.87	
415	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	334	-2.7	SPLS 1a_78.65 Ah All Cts	14.3	60.3	51.8	0.19		0.0		48.4	60.3	33.7	0.00	
416	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	126	-25.0	SPLS 6a_90 Ba All Cts Ah Ct2	56.2	60.3	51.8	0.48		21.6	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.77	
417	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	118	-10.0	SPLS 6a_90 Ba Ct2 Ah Ct2	59.8	60.3	51.8	0.19		9.7	PLS 6a_90 Ba Ct2 Ah Ct2	72.6	60.3	28.2	0.34	
418	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	111	-13.8	SPLS 6a_90 Ba All Cts Ah Ct2	63.5	60.3	51.8	0.27		14.4	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.51	
419	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	105	-16.4	SPLS 6a_90 Ba All Cts Ah Ct2	66.8	60.3	51.8	0.32		15.5	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.55	
420	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	97	-18.6	SPLS 6a_90 Ba All Cts Ah Ct2	71.3	60.3	51.8	0.36		19.7	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.70	
421	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	92	-25.9	SPLS 6a_90 Ba All Cts Ah Ct2	74.4	60.3	51.8	0.50		23.9	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.85	
422	Diagonaal bovenregel tweede dwarsarm	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	98	-34.6	SPLS 6a_90 Ba All Cts Ah Ct1	89.0	120.6	103.7	0.39		38.2	S 6a_90 Ba All Cts Ah Ct2	78.2	120.6	76.8	0.50	
423	Verticaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	101	-1.1	ULS 1a_0,9_0	48.1	60.3	43.2	0.03		8.7	ULS 1a_0	46.1	60.3	32.7	0.27	
424	Verticaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	152	-21.6	SPLS 6a_90 Ba All Cts Ah Ct2	31.6	60.3	43.2	0.68		22.0	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.67	
426	Diagonaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	308	-15.1	SPLS 1a_0 Ah Ct2	11.4	60.3	43.2	1.33	knik	0.1	SPLS 1a_0,9_0 Ah Ct2	46.1	60.3	25.2	0.00	
427	Diagonaal tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	244	0.0		16.4	60.3	43.2	0.00		1.0	ULS 1a_78.65	46.1	60.3	20.5	0.05	
429	Dwarsligger bovenregel tweede dwarsarı	UNP160	S235	1M16-8.8t	1.00	1.00	1.00	47	0.0		279.0	60.3	64.8	0.00		36.9	ULS 3_0,9_90	90.7	60.3	64.8	0.61	
430	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-2.0	ULS 1a_135	18.2	60.3	43.2	0.11		2.1	SPLS 1a_0 Ah All Cts	46.1	60.3	32.7	0.06	
438	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-2.5	SPLS 1a_0 Ah All Cts	34.4	60.3	43.2	0.07		2.9	SPLS 1a_135 Ba All Cts	46.1	60.3	32.7	0.09	
439	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	-7.3	SPLS 1a_135 Ba All Cts	19.5	60.3	43.2	0.38		6.7	SPLS 1a_0 Ah All Cts	46.1	60.3	32.7	0.20	
440	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-2.2	SPLS 1a_0 Ah All Cts	39.5	60.3	43.2	0.06		2.3	SPLS 1a_135 Ba All Cts	46.1	60.3	32.7	0.07	
441	Dwarsligger ladder tweede dwarsarm	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 1a_135 Ah Ct1	45.3	60.3	43.2	0.00		0.0	ULS 3_0,9_90	46.1	60.3	32.7	0.00	
431		70x70x7	S235	2M20-8.8t	1.00	1.00	1.00	106	-34.0	SPLS 3_135 Ah Ct2	113.1	188.2	151.2	0.30		29.9	SPLS 3_101.35 Ah Ct2	90.5	188.2	100.8	0.33	
432		70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	102	-33.5	SPLS 3_90 Ah Ct2	116.9	188.2	151.2	0.29		28.6	SPLS 3_135 Ah Ct1	90.5	188.2	100.8	0.32	
433		90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	62	-64.9	SPLS 3_90 Ah All Cts	234.4	271.1	207.4	0.31		77.7	SPLS 3_78.65 Ah Ct1	144.0	271.1	159.5	0.54	
434		60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	141	-25.4	SPLS 6a_90 Ba All Cts Ah Ct2	49.5	60.3	51.8	0.51		24.9	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	0.88	
435		60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	133	-29.4	SPLS 6a_90 Ba All Cts Ah Ct2	52.8	60.3	51.8	0.57		30.1	S 6a_90 Ba All Cts Ah Ct2	72.6	60.3	28.2	1.07	stuik
436		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	305	-24.0	SPLS 1a_135 Ba Ct2	11.5	60.3	43.2	2.08	knik	1.2	SPLS 1a_0,9_0 Ah Ct1	46.1	60.3	32.7	0.04	
442	Dwarsligger onderregel dwarsarm WB m	HEA160	S235	2M20-5.6t	2.00	2.00	2.00	5	-4.6	ULS 1a_0	839.3	117.6	216.0	0.04		3.6	S 6a_90 Ba All Cts Ah Ct1	766.1	117.6	0.0	0.03	
443		60x60x6	S355	1M16-8.8t	2.00	1.00	1.00	146	-0.9	ULS 1a_0	59.3	60.3	70.6	0.01		12.4	ULS 1a_45	98.8	60.3	61.0	0.21	
330		80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	111	-79.4	SPLS 3_0,9_78.65 Ah All Cts	141.9	188.2	172.8	0.56		75.8	SPLS 3_78.65 Ah All Cts	149.6	188.2	139.6	0.54	
331		60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	100	-41.3	SPLS 3_78.65 Ah All Cts	87.4	120.6	103.7	0.47		41.1	SPLS 3_78.65 Ah All Cts	67.0	120.6	56.7	0.72	
332		70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	73	-55.8	SPLS 3_0,9_78.65 Ah All Cts	147.1	188.2	151.2	0.38		53.5	SPLS 3_78.65 Ah All Cts	90.5	188.2	82.6	0.65	
250L		80x80x6#	S235	2M16-8.8t	1.00	1.00	1.00	166	-6.3	SPLS 3_0,9_90 Ah All Cts	68.8	120.6	103.7	0.09		4.8	PLS 1a_0,9_90 Ba All Cts	111.8	120.6	89.6	0.05	
250T		80x80x6#	S235		###	2.00	1.00	107	-7.1	SPLS 1a_135 Ah Ct1	105.9	0.0	0.0	0.07		2.5	SPLS 1a_0,9_135 Ah Ct1	111.8	120.6	89.6	0.03	
251		90x90x8	S235	1M20-8.8t	1.00	1.00	1.00	204	-6.3	SPLS 1a_90 Ah Ct2	61.8	94.1	86.4	0.10		5.4	LS 1a_0,9_101.35 Ah Ct2	156.7	94.1	78.5	0.07	
252		60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	226	-0.9	SPLS 1a_135 Ba Ct2	26.4	94.1	64.8	0.03		0.2	SPLS 1a_0,9_0 Ah All Cts	65.7	94.1	44.4	0.00	
450		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	-0.1	SPLS 1a_45 Ah All Cts	16.2	60.3	43.2	0.00		0.0	SPLS 1a_0,9_0 Ba All Cts	46.1	60.3	32.7	0.00	

DNV·GL

Assessment of groups for strengthened mast (afkeur level)

Date	25-10-21
Author	KCh
Version	1.0

ENS-ZL 380
HB-3 R X
6

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
101A	Leg	120x120x10	S355	7M24-8.8t	0.52	0.52	0.52	88	-70.3	SPLS 6a_90 Ba All Cts	462.0	945.9	1234.8	0.15		25.2	SPLS 3_0,9_90 Ah All (	635.0	945.9	1160.9	0.04
101B	Leg	120x120x10	S355	8M24-8.8t	0.52	0.52	0.52	77	-183.4	SPLS 6a_90 Ba All Cts	538.8	1084.4	1411.2	0.34		128.4	SPLS 3_0,9_90 Ah Ct1	635.0	1084.4	1326.8	0.20
102A	Leg	150x150x14	S355	8M24-8.8t	0.52	0.52	0.52	67	-464.9	SPLS 3_90 Ba All Cts	1038.6	1084.4	1975.7	0.45		348.5	SPLS 3_0,9_90 Ah All (	1159.3	1084.4	1857.5	0.32
102B	Leg	150x150x14	S355	11M24-8.8t	0.52	0.52	0.52	71	-402.2	SPLS 3_90 Ba All Cts	1001.6	2910.7	2716.6	0.40		298.9	SPLS 3_0,9_90 Ah All (	1159.3	2910.7	2461.2	0.26
103A	Leg	200x200x20	S355	8M24-8.8t	0.28	0.28	0.28	29	-889.2	SPLS 3_90 Ba All Cts	2574.7	2168.8	2822.4	0.41		708.5	SPLS 3_0,9_90 Ah All (	2328.5	2168.8	2653.5	0.33
103B	Leg	200x200x20	S355	10M24-8.8t	0.28	0.28	0.28	38	-1334.5	SPLS 3_90 Ba All Cts	2458.4	2660.2	3528.0	0.54		1106.6	SPLS 3_0,9_90 Ah All (	2328.5	2660.2	3528.0	0.48
103C	Leg	200x200x20	S355		0.52	0.52	0.52	34	-1104.2	SPLS 3_90 Ba All Cts	2507.1	0.0	0.0	0.44		912.3	SPLS 3_0,9_90 Ah All (	2712.2	0.0	0.0	0.34
104A	Leg	250x250x18#	S355	12M24-8.8t	0.55	0.55	0.55	32	-1442.1	SPLS 3_90 Ba All Cts	2823.6	2975.4	3810.2	0.51		1206.2	SPLS 3_0,9_90 Ah All (	2763.8	2975.4	3810.2	0.44
104B	Leg	250x250x18#	S355	12M24-8.8t	0.20	0.20	0.20	35	-1447.0	SPLS 3_90 Ba All Cts	2788.0	2975.4	3810.2	0.52		1199.4	SPLS 3_0,9_90 Ah All (	2763.8	2975.4	3582.3	0.43
392A	Onderregel eers	200x200x16	S355	13M24-8.8t	2.26	1.00	1.00	56	-734.2	SPLS 6a_90 Ba Ct1 Ah	1764.6	1696.1	3669.1	0.43		570.4	SPLS 3_0,9_78.65 Ah (	1886.8	1696.1	3449.6	0.34
392B	Onderregel eers	200x200x16	S355	6M24-8.8t	12.18	2.00	1.00	66	-393.7	SPLS 6a_90 Ba Ct1 Ah	1622.8	813.3	1693.4	0.48		301.0	SPLS 3_0,9_78.65 Ah (	1886.8	813.3	1592.1	0.37
392C	Onderregel eers	200x200x16	S355		2.38	1.00	1.00	56	-687.1	SPLS 6a_90 Ba Ct1 Ah	1764.7	0.0	0.0	0.39		522.2	SPLS 3_0,9_78.65 Ah (	2193.9	0.0	0.0	0.24
393A	Onderregel eers	160x160x15#	S355	6M24-8.8t	2.59	1.00	1.00	82	-364.2	SPLS 6a_90 Ba Ct1 Ah	1015.5	813.3	1587.6	0.45		268.0	SPLS 3_0,9_78.65 Ah (	1372.7	813.3	1370.5	0.33
393B	Onderregel eers	160x160x15#	S355		2.32	1.00	1.00	12	-1.7	ULS 3_0	1658.2	0.0	0.0	0.00		0.2	SPLS 1a_0,9_0 Ah Ct1	1658.2	0.0	0.0	0.00
393C	Onderregel eers	160x160x15#	S355		3.62	1.00	1.00	82	-328.3	SPLS 6a_90 Ba Ct1 Ah	1014.6	0.0	0.0	0.32		230.2	SPLS 3_0,9_78.65 Ah (	1658.2	0.0	0.0	0.14
490A	Onderregel twe	150x150x14	S355	15M24-8.8t	2.22	1.00	1.00	62	-452.0	SPLS 6a_90 Ba Ct1 Ah	1096.6	1918.9	3704.4	0.41		313.0	SPLS 3_0,9_90 Ah Ct2	1159.3	1918.9	3704.4	0.27
490B	Onderregel twe	150x150x14	S355		1.95	12.10	1.00	87	-8.1	SPLS 1a_0 Ah Ct1	810.2	0.0	0.0	0.01		15.2	ULS 1a_0,9_0	1425.0	0.0	0.0	0.01
490C	Onderregel twe	150x150x14	S355		2.36	1.00	1.00	62	-435.6	SPLS 6a_90 Ba Ct1 Ah	1096.7	0.0	0.0	0.40		290.7	SPLS 3_0,9_90 Ah Ct2	1425.0	0.0	0.0	0.20
390A	Bovenregel eers	90x90x8	S235	4M24-8.8t	2.01	1.00	1.00	275	-7.9	SPLS 3_0,9_78.65 Ah ,	47.2	542.2	414.7	0.17		103.7	SPLS 6a_90 Ah Ct1 Ah	185.9	542.2	357.1	0.56
390B	Bovenregel eers	90x90x8	S235	4M20-8.8t	2.00	1.00	1.00	277	-15.9	SPLS 3_0,9_78.65 Ah ,	46.8	376.3	345.6	0.34		80.0	SPLS 6a_90 Ba All Cts	269.1	376.3	314.2	0.30
391A	Bovenregel eers	80x80x8	S235	4M20-8.8t	1.82	1.00	1.00	313	-22.3	SPLS 3_0,9_78.65 Ah ,	34.3	376.3	345.6	0.65		70.5	SPLS 6a_90 Ba All Cts	227.6	376.3	314.2	0.31
391B	Bovenregel eers	80x80x8	S235	4M20-8.8t	2.23	1.00	1.00	313	-22.3	SPLS 3_0,9_78.65 Ah ,	34.3	376.3	345.6	0.65		70.5	SPLS 6a_90 Ba All Cts	168.3	376.3	304.4	0.42
491A	Bovenregel twe	120x120x10	S355	3M24-8.8t	1.54	1.00	1.00	82	-260.7	SPLS 6a_90 Ba All Cts	419.0	406.7	529.2	0.64		232.5	SPLS 6a_90 Ba All Cts	441.0	406.7	493.6	0.57
491B	Bovenregel twe	120x120x10	S355	5M24-8.8t	1.65	3.19	1.00	81	-168.6	SPLS 6a_90 Ah Ct1 Ba	418.9	677.8	882.0	0.40		157.9	SPLS 6a_90 Ba Ct2 Ah	635.0	677.8	829.2	0.25
491C	Bovenregel twe	120x120x10	S355		1.49	2.87	1.00	81	-234.9	SPLS 6a_90 Ba All Cts	419.0	0.0	0.0	0.56		212.8	SPLS 6a_90 Ba All Cts	823.6	0.0	0.0	0.26
492A	Bovenregel twe	120x120x10	S355	5M24-8.8t	2.54	4.87	1.00	81	-192.1	SPLS 6a_90 Ba All Cts	421.9	677.8	882.0	0.46		210.4	SPLS 6a_90 Ba All Cts	635.0	677.8	829.2	0.33
492B	Bovenregel twe	120x120x10	S355	4M24-8.8t	2.33	1.00	1.00	116	-35.8	SPLS 6a_90 Ah All Cts	294.4	542.2	705.6	0.12		42.8	SPLS 6a_90 Ba All Cts	635.0	542.2	663.4	0.08
492C	Bovenregel twe	120x120x10	S355		1.92	1.00	1.00	81	-174.6	SPLS 6a_90 Ba All Cts	421.6	0.0	0.0	0.41		191.1	SPLS 6a_90 Ba All Cts	823.6	0.0	0.0	0.23
493A	Tussenregel tw	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-29.9	ULS 5a Ba 22	138.8	188.2	172.8	0.22		3.5	ULS 5a Ba 12	187.5	188.2	172.8	0.02
493B	Tussenregel tw	90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-24.0	ULS 5a Ba 22	138.8	188.2	172.8	0.17		0.0		168.5	188.2	172.8	0.00
493C	Tussenregel tw	90x90x8	S235		2.00	1.00	1.00	121	-27.3	ULS 5a Ah 22	138.8	0.0	0.0	0.20		3.0	ULS 5a Ba 12	326.7	0.0	0.0	0.01
201L	Diagonaal	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	131	-59.8	SPLS 3_90 Ah Ct1	150.4	188.2	172.8	0.40		51.3	SPLS 6a_90 Ba Ct2 Ah	190.7	188.2	157.1	0.33
201T	Diagonaal	100x100x8	S235	1M24-8.8t	0.53	0.53	0.53	131	-35.2	SPLS 6a_90 Ba Ct2 Ah	120.3	135.6	103.7	0.34		19.5	SPLS 3_0,9_101.35 Ah	170.5	135.6	97.5	0.20
202L	Diagonaal	160x160x15#	S235	4M24-8.8t	0.53	0.53	0.53	78	-346.3	SPLS 6a_90 Ba Ct1 Ah	702.9	542.2	777.6	0.64		298.7	SPLS 3_0,9_101.35 Ah	673.4	542.2	691.1	0.55
202T	Diagonaal	150x150x12	S235	4M24-8.8t	0.53	0.53	0.53	83	-307.3	SPLS 6a_90 Ba Ct1 Ah	502.9	542.2	622.1	0.61		310.3	SPLS 6a_90 Ah Ct1 Ba	498.3	542.2	535.6	0.62
203L	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-273.4	SPLS 3_0,9_101.35 Ah	480.6	542.2	622.1	0.57		314.8	SPLS 6a_90 Ba Ct1 Ah	498.3	542.2	535.6	0.63
203T	Diagonaal	150x150x12	S235	4M24-8.8t	0.52	0.52	0.52	89	-283.2	SPLS 6a_90 Ah Ct1 Ba	480.6	542.2	622.1	0.59		279.1	SPLS 6a_90 Ba Ct1 Ah	498.3	542.2	535.6	0.56
204L	Diagonaal	160x160x17#	S235	4M24-8.8t	0.52	0.52	0.52	90	-380.9	SPLS 6a_90 Ah Ct1 Ba	714.2	542.2	881.3	0.70		342.5	SPLS 3_0,9_90 Ba Ct2	746.8	542.2	783.2	0.63
204T	Diagonaal	160x160x17#	S235	4M24-8.8t	0.52	0.52	0.52	90	-341.2	SPLS 3_78.65 Ba Ct2	714.2	542.2	881.3	0.63		304.5	SPLS 3_0,9_101.35 Ah	746.8	542.2	783.2	0.56
205L	Diagonaal	180x180x16#	S235	5M24-8.8t	0.28	0.56	0.28	60	-467.4	SPLS 3_78.65 Ba Ct1	906.7	677.8	1036.8	0.69		462.4	SPLS 3_0,9_78.65 Ba (	783.3	677.8	867.4	0.68
205T	Diagonaal	180x180x16#	S235	5M24-8.8t	0.28	0.56	0.28	60	-484.7	SPLS 3_78.65 Ba Ct1	906.7	677.8	1036.8	0.72		474.4	SPLS 3_0,9_78.65 Ba (	783.3	677.8	867.4	0.70
206L	Diagonaal	160x160x17#	S235	4M24-8.8t	0.55	1.00	0.55	65	-368.4	SPLS 3_78.65 Ba Ct1	819.3	542.2	881.3	0.68		362.9	SPLS 3_101.35 Ah Ct2	725.8	542.2	736.4	0.67
206T	Diagonaal	160x160x17#	S235	4M24-8.8t	0.55	1.00	0.55	80	-384.1	SPLS 3_78.65 Ba Ct2	729.6	542.2	881.3	0.71		378.2	SPLS 3_78.65 Ba Ct1	725.8	542.2	736.4	0.70
207L	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-286.8	SPLS 3_0,9_101.35 Ah	475.0	406.7	544.3	0.71		291.7	SPLS 3_78.65 Ba Ct1	557.9	406.7	453.9	0.72
207T	Diagonaal	150x150x14	S235	3M24-8.8t	0.27	0.55	0.27	101	-299.7	SPLS 3_0,9_78.65 Ba (	475.0	406.7	544.3	0.74		303.0	SPLS 3_78.65 Ba Ct2	557.9	406.7	453.9	0.75
208L	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-248.7	SPLS 3_78.65 Ba Ct1	415.0	406.7	466.6	0.61		239.2	SPLS 3_0,9_101.35 Ah	498.3	406.7	405.3	0.59
208T	Diagonaal	150x150x12	S235	3M24-8.8t	0.55	1.00	0.55	100	-255.1	SPLS 3_78.65 Ba Ct2	415.0	406.7	466.6	0.63		247.0	SPLS 3_0,9_78.65 Ba (	498.3	406.7	405.3	0.61
209L	Diagonaal	160x160x15#	S235	4M24-8.8t	0.20	0.20	0.20	63	-379.6	SPLS 3_78.65 Ba Ct1	782.1	542.2	777.6	0.70		361.3	SPLS 3_0,9_101.35 Ah	673.4	542.2	680.3	0.67
209T	Diagonaal	160x160x15#	S235	4M24-8.8t	0.20	0.20	0.20	63	-385.9	SPLS 3_78.65 Ba Ct2	782.1	542.2	777.6	0.71		365.4	SPLS 3_0,9_78.65 Ba (	673.4	542.2	680.3	0.67
210	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	174	-21.6	SPLS 3_78.65 Ba Ct1	84.7	188.2	172.8	0.25		21.4	SPLS 3_78.65 Ba Ct1	146.3	188.2	157.1	0.15
211L	Tweede dwarsa	90x90x8	S235	3M24-8.8t	1.00	1.00	1.00	148	0.0		117.9	406.7	311.0	0.00		136.7	SPLS 6a_90 Ba All Cts	185.9	406.7	270.2	0.74
211T	Tweede dwarsa	70x70x7	S235	1M16-8.8t	1.00	1.00	1.00	191	-2.8	SPLS 3_0,9_78.65 Ah (	45.6	60.3	60.5	0.06		5.8	SPLS 6a_90 Ah Ct1 Ah	92.7	60.3	52.3	0.11
109L	Tweede dwarsa	150x150x14	S355	15M24-8.8t	1.00	2.00	1.00	64	-600.4	SPLS 3_90 Ba All Cts	1076.4	1918.9	3704.4	0.56		475.6	SPLS 3_0,9_90 Ah All (	1159.3	1918.9	3482.8	0.41
212T	Tweede dwarsa	120x120x10	S235	6M24-8.8t	1.00	2.00	1.00	79	-123.0	SPLS 6a_90 Ah Ct1 Ah	328.5	813.3	777.6	0.37		143.7	SPLS 6a_90 Ah Ct1 Ba	466.6	813.3	731.1	0.31
213	Tweede dwarsa	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-183.7	SPLS 6a_90 Ba Ct1 Ah	325.4	406.7	388.8	0.56		183.7	SPLS 6a_90 Ba Ct1 Ah	324.0	406.7	359.4	0.57
214	Tweede dwarsa	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.5	SPLS 6a_90 Ba Ct2 Ah	31.9	60.3	43.2	0.02		0.5	SPLS 6a_90 Ba Ct2 Ah	46.1	60.3	32.7	0.01
215L	Eerste dwarsarı	120x120x10	S235	4M24-8.8t	1.00	1.00	1.00	148	-56.4	SPLS 3_0,9_90 Ah All (	196.8	542.2	518.4	0.29		190.0	SPLS 3_0 Ba All Cts	324.0	542.2	467.9	0.59
215T	Eerste dwarsarı	150x150x12	S235	2M24-8.8t	1.00	1.00	1.00	118	-78.1	ULS 1a_0,9_90	377.6	271.1	311.0	0.29		102.4	ULS 1a_90	638.7	271.1	292.4	0.38
110L	Eerste dwarsarı	200x200x16	S355	13M24-8.8t	1.00	2.00	1.00	62	-585.3	SPLS 3_101.35 Ba All (	1686.0	1696.1	3669.1	0.35		466.6	SPLS 3_0,9_78.65 Ah ,	1886.8	1696.1	3449.6	0.28
216T	Eerste dwarsarı	120x120x10	S235	5M24-8.8t	1.00	2.00	1.00	104	-128.8	SPLS 3_0,9_101.35 Ah	269.2	677.8	648.0	0.48		151.4	SPLS 6a_90 Ah Ct1 Ah	466.6	677.8	609.2	0.32
217	Eerste dwarsarı	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-183.7	SPLS 3_0,9_78.65 Ba (	261.1	406.7	388.8	0.70		184.6	SPLS 3_78.65 Ba Ct1	324.0	406.7	359.4	0.57
218	Eerste dwarsarı	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.5	SPLS 6a_90 Ba Ct2 Ah	29.9	60.3	60.5	0.02		0.6	SPLS 6a_90 Ba Ct2 Ah	64.5	60.3	45.8	0.01
219L	Onderstuk in to	80x80x8	S235	2M16-8.8t	1.00	1.00	1.00	253	-10.1	SPLS 3_0,9_90 Ah All (	49.4	120.6	138.2	0.20		5.7	SPLS 1a_0,9_101.35 A	177.2	120.6	119.5	0.05
219T	Onderstuk in to	80x80x8	S235	2M16-8.8t	1.00	1.03	1.00	247	-7.1	SPLS 1a_0,9_78.65 Ba	51.5	120.6	138.2	0.14		4.6	ULS 1a_0,9_135	177.2	120.6	119.5	0.04
220	Onderstuk in to	80x80x8	S235	1M16-8.8t	1.00	0.50	0.50	227	-5.2	ULS 1a_45	38.5	60.3	69.1	0.14		4.5	ULS 1a_0,9_135	142.8	60.3	59.7	0.08
221	Onderstuk in to	80x80x8	S235	1M16-8.8t	0.50	0.50	0.50	253	-1.6	ULS 1a_0	39.5	60.3	69.1	0.04		0.2	ULS 1a_0,9_0,9_0	142.8	60.3	59.7	0.00
301	Diagonaal onde	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	140	-57.5	SPLS 3_0,9_78.65 Ah ,	111.3	188.2	172.8	0.52		61.1	SPLS 3_78.65 Ah All C	149.6	188.2	139.6	0.44
302	Diagonaal onde	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	130	-69.1	SPLS 3_78.65 Ah Ct2	120.9	188.2	172.8	0.57		66.9	SPLS 3_0,9_78.65 Ah (	151.2	188.2	139.6	0.48
303	Diagonaal onde	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	120	-70.5	SPLS 3_78.65 Ah All C	131.9	188.2	172.8	0.53		71.9	SPLS 3_0,9_78.65 Ah ,	149.6	188.2	139.6	0.51
304	Diagonaal onde	90x90x8	S235	2M24-8.8t	0.55	0.55	0.55	93	-90.1	SPLS 3_78.65 Ah All C	186.3	271.1	207.4	0.48		93.2	SPLS 3_0,9_78.65 Ah ,	150.3	271.1	141.8	0.66
306	Diagonaal onde	80x80x6#	S235	2M24-8.8t	0.53	0.53	0.53	86	-38.5	SPLS 3_78.65 Ah All C	133.0	271.1	155.5	0.29		52.2	SPLS 3_78.65 Ah All C	99.7	271.1	124.3	0.52
307	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	112	-35.7	SPLS 6a_90 Ba All Cts	107.5	188.2	151.2	0.33		37.4	SPLS 3_0,9_78.65 Ah ,	114.0	188.2	116.0	0.33
308	Diagonaal onde	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	110	-35.0	SPLS 3_78.65 Ah All C	80.5	120.6	103.7	0.44		34.8	SPLS 3_0,9_78.65 Ah ,	67.0	120.6	56.7	0.61
309	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	79	-47.9	SPLS 3_78.65 Ah All C	140.3	188.2	151.2	0.34		49.0	SPLS 3_0,9_78.65 Ah ,	90.5	188.2	82.6	0.59
310	Diagonaal onde	90x90x8	S235	2M20-8.8t	0.55	0.55	0.55	49	-63.2	SPLS 3_78.65 Ah Ct2	252.8	188.2	172.8	0.37		61.5	SPLS 3_0,9_78.65 Ah ,	139.9	188.2	99.5	0.62
311	Diagonaal onde	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	51	-39.1	SPLS 3_0,9_78.65 Ah ,	250.3	271.1	207.4	0.19		29.6	SPLS 3_0,9_78.65 Ah (	136.2	271.1	104.6	0.28
313	Dwarsligger onc	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	82	-0.1	ULS 1a_0,9_0,9_78.65	570.7	188.2	216.0	0.00		2.7	SPLS 6a_90 Ah Ct2 Ah	766.1	188.2	0.0	0.01
314	Dwarsligger onc	120x120x12	S355	2M20-8.8t	2.00	2.00	2.00	104	0.0		416.8	188.2	352.8	0.00		53.0	ULS 3_90	389.8	188.2	203.1	0.28
315	Dwarsligger onc	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	54	-5.6	ULS 3_0,9_90	689.5	188.2	216.0	0.03		1.7	ULS 5a Ba 11	766.1	188.2	0.0	0.01
316	Dwarsligger onc	150x150x12(1:	S355	2M24-8.8t	2.00	1.00	1.00	24	0.0		2047.8	542.2	846.7	0.00		90.4	ULS 3_78.65	1904.3	542.2	369.1	0.24
317	Dwarsligger onc	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	26	-16.8	ULS 3_0,9_90	790.1	188.2	216.0	0.09		0.0		766.1	188.2	0.0	0.00

Assessment of groups for strengthened mast (afkeur level)

Date 25-10-21
Author KCh
Version 1.0

ENS-ZL 380
HB-3 R X
6

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
318	Verticaal eerste	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	171	-16.8	SPLS 6a_90 Ba Ct2 Ah	98.0	271.1	207.4	0.17		0.0		159.7	271.1	183.4	0.00
319	Verticaal eerste	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	172	-3.7	SPLS 6a_90 Ba Ct1 Ah	38.8	60.3	51.8	0.10		0.0		48.4	60.3	33.7	0.00
320	Verticaal eerste	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	93	-1.0	SPLS 6a_90 Ah Ct2 Ah	51.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00
321	Diagonaal eerst	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	345	0.0		30.1	188.2	172.8	0.00		27.4	SPLS 6a_90 Ah Ct2 Ah	162.8	188.2	157.1	0.17
322	Diagonaal eerst	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	269	0.0		50.9	271.1	207.4	0.00		37.6	SPLS 6a_90 Ba Ct2 Ah	136.2	271.1	161.3	0.28
323	Diagonaal eerst	70x70x7	S235	1M20-8.8t	1.00	1.00	1.00	331	0.0		19.8	94.1	75.6	0.00		14.0	SPLS 6a_90 Ah Ct2 Ah	84.7	94.1	65.2	0.21
324	Dwarsligger bov	70x70x7	S235	1M20-8.8t	1.00	2.00	1.00	110	-0.8	ULS 1a_0	93.2	94.1	75.6	0.01		0.7	ULS 1a_0,9_0,9_0	84.7	94.1	65.2	0.01
325	Tussen diagona	80x80x8	S235	1M20-8.8t	1.00	1.00	1.00	151	-2.2	ULS 1a_0	81.0	94.1	86.4	0.03		1.4	ULS 1a_0,9_0,9_0	133.6	94.1	78.5	0.02
401	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.53	0.53	0.53	121	-23.9	SPLS 3_135 Ah Ct2	99.6	188.2	151.2	0.24		21.7	SPLS 1a_0 Ba Ct1	90.5	188.2	91.6	0.24
402	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	112	-25.6	SPLS 3_135 Ah Ct1	107.3	188.2	151.2	0.24		31.4	SPLS 3_101.35 Ah Ct2	90.5	188.2	100.8	0.35
403	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	97	-37.0	SPLS 3_90 Ah Ct1	121.9	188.2	151.2	0.30		37.8	SPLS 3_90 Ah Ct2	90.5	188.2	100.8	0.42
404	Diagonaal onde	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	92	-50.2	SPLS 3_78.65 Ah All Ct	126.9	188.2	151.2	0.40		52.2	SPLS 3_90 Ah Ct1	90.5	188.2	117.6	0.58
405	Diagonaal onde	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	67	-59.7	SPLS 3_90 Ah Ct1	226.0	271.1	207.4	0.29		53.5	SPLS 3_0,9_78.65 Ah /	136.2	271.1	141.8	0.39
406	Diagonaal onde	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	59	-62.6	SPLS 3_78.65 Ah Ct1	239.1	271.1	207.4	0.30		57.6	SPLS 3_78.65 Ah Ct1	139.3	271.1	124.1	0.46
407	Diagonaal onde	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	65	-40.2	SPLS 3_90 Ah Ct1	203.3	271.1	207.4	0.20		31.2	SPLS 3_0,9_78.65 Ah /	117.7	271.1	124.1	0.26
408	Diagonaal onde	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	202	-7.6	SPLS 3_0,9_90 Ba All (	21.5	60.3	43.2	0.35		19.9	SPLS 6a_90 Ba All Cts	46.1	60.3	32.7	0.61
410	Dwarsligger onc	150x150x12	S355	2M20-8.8t	1.00	1.00	1.00	53	0.0		867.3	188.2	352.8	0.00		75.1	ULS 3_0,9_90	504.3	188.2	217.4	0.40
411	Dwarsligger onc	150x150x12	S355	2M24-8.8t	2.00	1.00	1.00	32	0.0		971.1	271.1	423.4	0.00		73.6	ULS 3_78.65	496.7	271.1	220.7	0.33
437	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	203	-1.8	SPLS 6a_90 Ba Ct1 Ah	24.2	60.3	43.2	0.08		15.1	SPLS 1a_0 Ah Ct2	46.1	60.3	32.7	0.46
412	Bovenregel twe	90x90x8	S235	3M24-8.8t	2.00	2.00	2.00	349	-9.3	SPLS 3_0,9_90 Ah All (	33.6	406.7	311.0	0.28		171.4	SPLS 6a_90 Ba All Cts	185.9	406.7	270.2	0.92
413	Bovenregel twe	80x80x8	S235	4M20-8.8t	1.00	1.00	1.00	189	0.0		76.0	376.3	345.6	0.00		120.2	SPLS 6a_90 Ah Ct1 Ah	168.3	376.3	310.2	0.71
414	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	160	-24.2	SPLS 6a_90 Ba All Cts	42.5	60.3	51.8	0.57		24.4	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.87
415	Diagonaal bove	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	334	-2.6	SPLS 1a_78.65 Ah All (	14.3	60.3	51.8	0.18		0.0		48.4	60.3	33.7	0.00
416	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	126	-25.0	SPLS 6a_90 Ba All Cts	56.2	60.3	51.8	0.48		21.6	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.77
417	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	118	-10.0	SPLS 6a_90 Ba Ct2 Ah	59.8	60.3	51.8	0.19		9.7	SPLS 6a_90 Ba Ct2 Ah	72.6	60.3	28.2	0.34
418	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	111	-13.8	SPLS 6a_90 Ba All Cts	63.5	60.3	51.8	0.27		14.4	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.51
419	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	105	-16.4	SPLS 6a_90 Ba All Cts	66.8	60.3	51.8	0.32		15.4	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.55
420	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	97	-18.6	SPLS 6a_90 Ba All Cts	71.3	60.3	51.8	0.36		19.7	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.70
421	Diagonaal bove	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	92	-25.9	SPLS 6a_90 Ba All Cts	74.4	60.3	51.8	0.50		23.8	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.85
422	Diagonaal bove	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	98	-34.6	SPLS 6a_90 Ba All Cts	89.0	120.6	103.7	0.39		38.2	SPLS 6a_90 Ba All Cts	78.2	120.6	76.8	0.50
423	Verticaal tweed	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	101	-1.0	ULS 1a_0,9_0	48.1	60.3	43.2	0.02		9.3	ULS 1a_0	46.1	60.3	32.7	0.28
424	Verticaal tweed	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	152	-21.6	SPLS 6a_90 Ba All Cts	31.6	60.3	43.2	0.68		22.0	SPLS 6a_90 Ba All Cts	46.1	60.3	32.7	0.67
426	Diagonaal twee	70x70x7	S355	1M16-8.8t	1.00	1.00	1.00	219	-16.1	SPLS 1a_0 Ah Ct2	41.5	60.3	82.3	0.39		0.1	SPLS 1a_0,9_0 Ah Ct2	87.8	60.3	48.1	0.00
427	Diagonaal twee	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	244	0.0		16.4	60.3	43.2	0.00		1.0	ULS 1a_78.65	46.1	60.3	20.5	0.05
429	Dwarsligger bov	UNP160	S235	1M16-8.8t	1.00	1.00	1.00	47	0.0		279.0	60.3	64.8	0.00		36.9	ULS 3_0,9_90	90.7	60.3	64.8	0.61
430	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-2.0	ULS 1a_135	18.2	60.3	43.2	0.11		2.1	SPLS 1a_0 Ah All Cts	46.1	60.3	32.7	0.06
438	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-2.5	SPLS 1a_0 Ah All Cts	34.4	60.3	43.2	0.07		2.9	SPLS 1a_135 Ba All Cts	46.1	60.3	32.7	0.09
439	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	-7.3	SPLS 1a_135 Ba All Cts	19.5	60.3	43.2	0.37		6.6	SPLS 1a_0 Ah All Cts	46.1	60.3	32.7	0.20
440	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-2.2	SPLS 1a_0 Ah All Cts	39.5	60.3	43.2	0.06		2.3	SPLS 1a_135 Ba All Cts	46.1	60.3	32.7	0.07
441	Dwarsligger lad	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 1a_135 Ah Ct1	45.3	60.3	43.2	0.00		0.0	ULS 3_0,9_90	46.1	60.3	32.7	0.00
431	0	70x70x7	S235	2M20-8.8t	1.00	1.00	1.00	106	-34.0	SPLS 3_135 Ah Ct2	113.1	188.2	151.2	0.30		29.9	SPLS 3_101.35 Ah Ct2	90.5	188.2	100.8	0.33
432	0	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	102	-33.5	SPLS 3_90 Ah Ct2	116.9	188.2	151.2	0.29		28.6	SPLS 3_135 Ah Ct1	90.5	188.2	100.8	0.32
433	0	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	62	-64.9	SPLS 3_90 Ah All Cts	234.4	271.1	207.4	0.31		77.6	SPLS 3_78.65 Ah Ct1	144.0	271.1	159.5	0.54
434	0	60x60x6	S235	1M16-8.8t	0.55	0.55	0.55	141	-25.4	SPLS 6a_90 Ba All Cts	49.5	60.3	51.8	0.51		24.9	SPLS 6a_90 Ba All Cts	72.6	60.3	28.2	0.88
435	0	60x60x6	S355	1M16-8.8t	0.55	0.55	0.55	133	-29.4	SPLS 6a_90 Ba All Cts	62.2	60.3	70.6	0.49		30.1	SPLS 6a_90 Ba All Cts	98.8	60.3	38.3	0.79
436	0	70x70x7	S355	1M16-8.8t	1.00	1.00	1.00	218	-25.5	SPLS 1a_135 Ba Ct2	41.9	60.3	82.3	0.61		1.4	SPLS 1a_0,9_0 Ah Ct1	87.8	60.3	62.3	0.02
442	Dwarsligger onc	HEA160	S235	2M20-5.6t	2.00	2.00	2.00	5	-4.6	ULS 1a_0	839.3	117.6	216.0	0.04		3.6	SPLS 6a_90 Ba All Cts	766.1	117.6	0.0	0.03
443	0	60x60x6	S355	1M16-8.8t	2.00	1.00	1.00	146	-0.9	ULS 1a_0	59.3	60.3	70.6	0.01		12.5	ULS 1a_45	98.8	60.3	61.0	0.21
330	0	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	111	-79.4	SPLS 3_0,9_78.65 Ah /	141.9	188.2	172.8	0.56		75.8	SPLS 3_78.65 Ah All Ct	149.6	188.2	139.6	0.54
331	0	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	100	-41.3	SPLS 3_78.65 Ah All Ct	87.4	120.6	103.7	0.47		41.1	SPLS 3_78.65 Ah All Ct	67.0	120.6	56.7	0.72
332	0	70x70x7	S235	2M20-8.8t	0.55	0.55	0.55	73	-55.8	SPLS 3_0,9_78.65 Ah /	147.1	188.2	151.2	0.38		53.5	SPLS 3_78.65 Ah All Ct	90.5	188.2	82.6	0.65
250L	0	80x80x6#	S235	2M16-8.8t	1.00	1.00	1.00	166	-6.3	SPLS 3_0,9_90 Ah All (	68.8	120.6	103.7	0.09		4.8	SPLS 1a_0,9_90 Ba All	111.8	120.6	89.6	0.05
250T	0	80x80x6#	S235		11.75	2.00	1.00	107	-7.1	SPLS 1a_135 Ah Ct1	105.9	0.0	0.0	0.07		2.6	SPLS 1a_0,9_135 Ah C	111.8	120.6	89.6	0.03
251	0	90x90x8	S235	1M20-8.8t	1.00	1.00	1.00	204	-6.3	SPLS 1a_90 Ah Ct2	61.8	94.1	86.4	0.10		5.4	SPLS 1a_0,9_101.35 A	156.7	94.1	78.5	0.07
252	0	60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	226	-0.9	SPLS 1a_135 Ba Ct2	26.4	94.1	64.8	0.03		0.2	SPLS 1a_0,9_0 Ah All (	65.7	94.1	44.4	0.00
450	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	-0.1	SPLS 1a_45 Ah All Cts	16.2	60.3	43.2	0.00		0.0	SPLS 1a_0,9_0 Ba All (	46.1	60.3	32.7	0.00
490D	490D	150x150x14	S355		1.00	6.20	1.00	87	-11.6	ULS 1a_0	808.6	0.0	0.0	0.01		8.4	8.376	ULS 1a_0,9_(	1425.0	0.0	0.01
469	469	50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	98	-4.4	ULS 1a_0	61.6	60.3	58.8	0.07		4.0	3.962	ULS 1a_0,9_(	51.0	35.0	0.11
470	470	50x50x5	S355	1M16-8.8t	0.53	0.53	0.53	91	-5.9	ULS 1a_0,9_0	66.1	60.3	58.8	0.10		3.6	3.637	ULS 1a_0,9_(	51.0	35.0	0.10
471	471	50x50x5	S355	1M16-8.8t	0.53	0.53	0.53	86	-6.1	ULS 1a_0	69.9	60.3	58.8	0.10		4.8	4.803	ULS 1a_0,9_(	51.0	35.0	0.14
472	472	50x50x5	S355	1M16-8.8t	0.53	0.53	0.53	82	-4.4	ULS 1a_0	73.1	60.3	58.8	0.08		1.1	1.056	ULS 1a_0,9_1	51.0	35.0	0.03
473	473	60x60x6	S355	1M16-8.8t	1.00	1.00	1.00	171	-0.2	ULS 1a_0,9_0,9_135	44.2	60.3	70.6	0.00		0.2	0.202	ULS 1a_0,9_1	61.2	42.0	0.00
474	474	50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	172	-2.2	ULS 1a_0	30.6	60.3	58.8	0.07		1.9	1.852	ULS 1a_135	51.0	35.0	0.05

Assessment of groups for strengthened mast (verbouw level)

Date	25-10-21
Author	KCh
Version	1.0

ENS-ZL 380
HB-3_R_X
6

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
426	Diagonaal twee	70x70x7	S355	1M16-8.8t	1.00	1.00	1.00	219	-18.0	ULS 1a_0	41.5	60.3	82.3	0.44		1.4	ULS 1a_0,9_0	87.8	60.3	48.1	0.03
435		60x60x6	S355	1M16-8.8t	0.55	0.55	0.55	133	-30.7	SPLS 6a_90 Ba All Cts	62.2	60.3	70.6	0.51		31.4	SPLS 6a_90 Ba All Cts	98.8	60.3	38.3	0.82
436		70x70x7	S355	1M16-8.8t	1.00	1.00	1.00	218	-27.4	SPLS 1a_135 Ba Ct2	41.9	60.3	82.3	0.65		1.7	SPLS 1a_0,9_0 Ah Ct1	87.8	60.3	62.3	0.03
490D	Onderregel twe	150x150x14	S355		1.00	6.20	1.00	87	-14.3	ULS 1a_0	808.6	0.0	0.0	0.02		10.8	ULS 1a_0,9_0,9_0	1425.0	0.0	0.0	0.01
469		50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	98	-5.4	ULS 1a_0	61.6	60.3	58.8	0.09		5.0	ULS 1a_0,9_0,9_0	51.0	60.3	35.0	0.14
470		50x50x5	S355	1M16-8.8t	0.53	0.53	0.53	91	-7.2	ULS 1a_0,9_0	66.1	60.3	58.8	0.12		4.8	ULS 1a_0,9_0,9_0	51.0	60.3	35.0	0.14
471		50x50x5	S355	1M16-8.8t	0.53	0.53	0.53	86	-7.5	ULS 1a_0	69.9	60.3	58.8	0.13		6.2	ULS 1a_0,9_0	51.0	60.3	35.0	0.18
472		50x50x5	S355	1M16-8.8t	0.53	0.53	0.53	82	-5.2	ULS 1a_0	73.1	60.3	58.8	0.09		1.3	ULS 1a_135	51.0	60.3	35.0	0.04
473		60x60x6	S355	1M16-8.8t	1.00	1.00	1.00	171	-0.3	ULS 1a_135	44.2	60.3	70.6	0.01		0.3	ULS 1a_0,9_101.35	61.2	60.3	42.0	0.01
474		50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	172	-2.8	ULS 1a_0	30.6	60.3	58.8	0.09		2.3	ULS 1a_135	51.0	60.3	35.0	0.07

APPENDIX C
Toetsing knikverkorters

Knikverkorters initial construction (afkeur)

Date: 2021-12-10
Author: K H Chan
Version: 1.8

ENS - ZL
HB-3_R
Masts: 6/40

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
3558	Broekstuk	Enkele staaf	L50.5	S235	M16	8.8	0.652	0	67	28.2	0.16	59.6	60.3	30.3	31.7	0.72	0.93		
3557	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	1.82	71	156	28.2	0.00	43.9	60.3	38.4	72.6	1.24	0.74		
3556	Broekstuk	Enkele staaf	L50.5	S235	M16	8.8	1.44	0	148	28.2	0.36	32.4	60.3	30.3	31.7	0.72	0.93		
3555	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	2.14	53	183	28.2	0.00	35.6	60.3	38.4	72.6	1.24	0.79		
3554	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	2.23	0	191	28.2	0.56	33.6	60.3	38.4	72.6	1.24	0.84		
3553	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	2.67	40	170	28.2	0.00	53.3	60.3	38.4	107.1	2.25	0.74		
3552	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	3.02	0	192	28.2	0.76	45.0	60.3	38.4	107.1	2.25	0.74		
3551	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	3.31	30	210	28.2	0.72	39.7	60.3	38.4	107.1	2.25	0.74		
3550	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	2.49	29	158	28.2	0.54	58.4	60.3	38.4	107.1	2.25	0.74		
3549	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	1.92	0	164	28.2	0.48	41.0	60.3	38.4	72.6	1.24	0.74		
3544	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	0.92	0	94	7.8	0.23	51.0	60.3	30.3	31.7	0.72	0.32		
3548	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.01	77	207	7.8	0.00	20.9	60.3	30.3	31.7	0.72	0.37		
3543	Pootverband	Kniksteun en verticale steur	L60.6	S235	M16	8.8	2.03	0	112	7.8	0.25	48.8	60.3	38.4	72.6	0.93	0.28		
3547	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.19	62	225	7.8	0.00	18.5	60.3	30.3	31.7	0.72	0.42		
3542	Pootverband	Kniksteun en verticale steur	L60.6	S235	M16	8.8	3.15	0	174	7.8	0.39	30.5	60.3	38.4	72.6	0.93	0.44		
3546	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.49	51	256	7.8	0.00	15.2	60.3	30.3	31.7	0.72	0.51		
3541	Pootverband	Kniksteun en verticale steur	L80.6	S235	M16	8.8	4.27	0	175	7.8	0.53	40.9	60.3	38.4	107.1	1.77	0.32		
3545	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.82	41	290	7.8	0.00	12.5	60.3	30.3	31.7	0.72	0.62		
3538	Tussenschot	Kniksteun en verticale steur	L80.8	S235	M16	8.8	5.33	0	220	0.5	0.67	40.2	60.3	51.2	142.8	2.20	0.31		
3537	Tussenschot	Kruisende staaf halverwege	L80.8	S235	M16	8.8	7.73	0	319	0.5	0.97	23.7	60.3	51.2	142.8	2.95	0.33		
3599	Eerste TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.57	0	161	24.6	0.39	29.2	60.3	30.3	31.7	0.72	0.84		
3598	Eerste TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	2.03	45	174	24.6	0.00	38.1	60.3	38.4	72.6	1.24	0.65		
3597	Eerste TSNSTK	Enkele staaf	L80.6	S235	M16	8.8	3.24	0	206	24.6	0.81	40.8	60.3	38.4	107.1	2.25	0.64		
3596	Eerste TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	2.02	33	173	24.6	0.00	38.4	60.3	38.4	72.6	1.2	0.64		
3595	Eerste TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.54	0	158	24.6	0.39	29.9	60.3	30.3	31.7	0.72	0.82		
3594	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.24	0	127	25.9	0.31	38.6	60.3	30.3	31.7	0.72	0.85		
3593	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.70	49	175	25.9	0.00	26.3	60.3	30.3	31.7	0.72	0.98		
3592	Tweede TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	1.67	39	143	25.9	0.00	48.9	60.3	38.4	72.6	1.24	0.67		
3591	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.24	0	127	25.9	0.31	38.6	60.3	30.3	31.7	0.72	0.85		
3590	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	0.97	0	99	25.9	0.24	48.8	60.3	30.3	31.7	0.72	0.85		
3589	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.42	53	146	25.9	0.00	33.1	60.3	30.3	31.7	0.7	0.85		
3588	Tweede TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	2.11	0	181	25.9	0.53	36.2	60.3	38.4	72.6	1.2	0.71		
3587	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.36	35	139	25.9	0.00	34.9	60.3	30.3	31.7	0.72	0.85		
3586	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	0.99	0	102	25.9	0.25	47.8	60.3	30.3	31.7	0.72	0.85		
3600	Tussenschot	Enkele staaf	L80.6	S235	M16	8.8	2.48	0	158	25.9	0.62	58.6	60.3	38.4	107.1	2.2	0.67		
3601	Tussenschot	Enkele staaf	L90.8	S235	M16	8.8	3.56	0	202	0.8	0.89	62.4	60.3	51.2	165.9	3.77	0.24		
3602	Tussenschot	Kruisende staaf halverwege	L60.6	S235	M16	8.8	5.39	0	297	0.8	0.67	14.8	60.3	38.4	72.6	1.24	0.54		
2575	Bovenstuk 1	Enkele staaf	L50.5	S235	M16	8.8	1.86	0	191	10.4	0.47	23.3	60.3	30.3	31.7	0.7	0.65		
2572	Bovenstuk 1	Enkele staaf	L50.5	S235	M16	8.8	1.71	0	176	10.4	0.43	26.1	60.3	30.3	31.7	0.7	0.60		
2571	Bovenstuk 2	Enkele staaf	L50.5	S235	M16	8.8	1.60	0	164	5.4	0.40	28.6	60.3	30.3	31.7	0.7	0.56		
2570	Bovenstuk 2	Enkele staaf	L50.5	S235	M16	8.8	1.41	0	145	5.4	0.35	33.3	60.3	30.3	31.7	0.7	0.49		

Knikverkorters initial construction (afkeur)

Date: 2021-12-10
Author: K H Chan
Version: 1.8

ENS - ZL
HB-3_R
Masts: 6/40

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
5000	Boventraverse	Kniksteun op 0,5L	L60.6	S355	M16	8.8	4.00	0	220	1.5	1.00	25.5	60.3	52.3	98.8	1.9	0.53		

APPENDIX D
Toetsing blokdeuvels

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2021-10-29
Auteur: TBR
Versie: 1.4

Load				**Results**			
Compression	$F_{Ed,c}$	1592	kN	Compression	U.C.	0.66	< 1,00 OK
Tension	$F_{Ed,t}$	1347	kN	Tension	U.C.	0.60	< 1,00 OK

Main leg

Profile		L250.18	
Steel material		S355	
Cross section		8719	mm^2
Axial capacity	N_{pl}	3095	kN
Width	b	250	mm
Thickness	t	18	mm
Length in concrete		1800	mm

Shear blocks main leg

Width	b	50	mm
Thickness	h	30	mm
Length	L	260	mm
Welds	a	7	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	12	-
Number for tension	n_t	12	-

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	6	mm

Pile

Name		Buispaal	
Diameter		914	mm
Thickness		10	mm
Cross section		28400	mm^2
Steel material		S235	
Capacity		6674	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	1300	mm
Welds	a	5	mm
c.t.c. separation	s	360	mm
Number for compr.	n_c	6	-
Number for tension	n_t	6	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	490	N/mm^2

Capacity shear blocks main leg

A_{f1} =	7800	mm^2
A_{f2} =	23800	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.75	
$f_{jd} = C_A \times f_{cd}$ =	18.6	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	1744	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	1744	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	63	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,c}$ =	36487	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	674	kN
$A_{p,t}$ =	27768	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	513	kN

Capacities

$F_{rd,c,plate}$ =	674	kN
$F_{rd,blocks,c}$ =	1744	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	2418	kN
U.C. compression	0.66	< 1,00 OK
Welds foot plate (see next page)	1454	kN
$F_{rd,t}$ = min. (welds / foot plate) =	513	kN
$F_{rd,blocks,t}$ =	1744	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	2257	kN
U.C. tension	0.60	< 1,00 OK
U.C. welds	0.25	< 1,00 OK

Capacity shear blocks pile

A_{f1} =	39000	mm^2
A_{f2} =	117000	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	4323	kN
U.C. compression	0.37	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	4323	kN
U.C. tension	0.31	< 1,00 OK
U.C. welds	0.34	< 1,00 OK

"Splitting" of pile

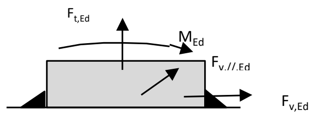
Spread of forces		45	°
Length force flow		1353	mm
Splitting force		498	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.11	< 1,00 OK

Project: ENS-ZL380
Mast: HB-3 R_X II (6)

Welds of shear blocks of main leg

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	7	mm
Grade	S355		l =	250	mm
f_{yd} =	355	N/mm²	β_w =	0.9	-
f_u =	490	N/mm²	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 4al$ =	0	N/mm²
$F_{t,Ed}$ =	0	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 4al$ =	35	N/mm²
$F_{v,Ed} = F_{rd,c} / n$ =	174	kN		35	N/mm²
$F_{v//,Ed}$ =	0	kN	$b^* = b + 2/3a\sqrt{2}$	56.6	mm
$M_{Ed} = 1/2\ b / h \times F_{v,Ed}$ =	2.62	kNm	$\sigma_1 = \tau_1 = 0{,}706 M_{Ed} / al\ b^*$ =	19	N/mm²
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm²
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	108	N/mm²

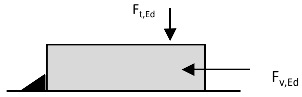
Check

$\sigma_{vw,Ed}$ =	108	N/mm²	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm²	U.C. =	0.25 OK
σ_1 =	54	N/mm²	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm²	U.C. =	0.15 OK

Welds of shear blocks of pile

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S235		l =	1300	mm
f_{yd} =	235	N/mm²	β_w =	0.8	-
f_u =	360	N/mm²	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 2al$ =	14	N/mm²
$F_{t,Ed} = 1/2\ b / h \times F_{v,Ed}$ =	259	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 2al$ =	47	N/mm²
$F_{v,Ed}$ =	865	kN		61	N/mm²
$F_{v//,Ed}$ =	0	kN			
M_{Ed} =	0.00	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm²
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	122	N/mm²

Check

$\sigma_{vw,Ed}$ =	122	N/mm²	≤	$f_u / \beta_w \gamma_{M2}$ =	360	N/mm²	U.C. =	0.34 OK
σ_1 =	61	N/mm²	≤	$0{,}9 f_u / \gamma_{M2}$ =	259	N/mm²	U.C. =	0.24 OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm²
Weld size	a =	6	mm
Length	l = 2b+ 2b - t =	964	mm
Capacity	$F_{Rd} = a \times l \times f_{w,d} / \sqrt{3}$ =	1454	kN

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2021-02-25
Auteur: TBR
Versie: 1.4

Load				**Results**			
Compression	$F_{Ed,c}$	**1660**	kN	Compression	U.C.	0.77	< 1,00 OK
Tension	$F_{Ed,t}$	**1394**	kN	Tension	U.C.	0.64	< 1,00 OK

Main leg

Profile		**L250.18**	
Steel material		S355	
Cross section		8719	mm^2
Axial capacity	N_{pl}	3095	kN
Width	b	250	mm
Thickness	t	18	mm
Length in concrete		1800	mm

Shear blocks main leg

Width	b	50	mm
Thickness	h	30	mm
Length	L	260	mm
Welds	a	7	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	12	-
Number for tension	n_t	12	-

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	6	mm

Pile

Name		Buispaal	
Diameter		609	mm
Thickness		10	mm
Cross section		18818	mm^2
Steel material		S235	
Capacity		4422	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	1300	mm
Welds	a	5	mm
c.t.c. separation	s	360	mm
Number for compr.	n_c	3	-
Number for tension	n_t	3	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	490	N/mm^2

Capacity shear blocks main leg

A_{f1} =	7800	mm^2
A_{f2} =	23800	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.75	
$f_{jd} = C_A \times f_{cd}$ =	18.6	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	1744	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	1744	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	63	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,c}$ =	36487	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	674	kN
$A_{p,t}$ =	27768	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	513	kN

Capacities

$F_{rd,c,plate}$ =	674	kN
$F_{rd,blocks,c}$ =	1744	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**2418**	kN
U.C. compression	0.69	< 1,00 OK
Welds foot plate (see next page)	1454	kN
$F_{rd,t}$ = min. (welds / foot plate) =	513	kN
$F_{rd,blocks,t}$ =	1744	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**2257**	kN
U.C. tension	0.62	< 1,00 OK
U.C. welds	0.25	< 1,00 OK

Capacity shear blocks pile

A_{f1} =	39000	mm^2
A_{f2} =	117000	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	**2162**	kN
U.C. compression	0.77	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	**2162**	kN
U.C. tension	0.64	< 1,00 OK
U.C. welds	0.34	< 1,00 OK

"Splitting" of pile

Spread of forces		45	°
Length force flow		1506	mm
Splitting force		463	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.10	< 1,00 OK

Project: ENS-ZL380
Mast: HB-3 R (40)

Welds of shear blocks of main leg

Out-of-plane loading

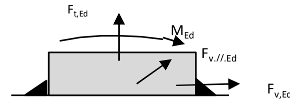


Plate			***Welds***		
t =	50	mm	a =	7	mm
Grade	S355		l =	250	mm
f_{yd} =	355	N/mm^2	β_w =	0.9	-
f_u =	490	N/mm^2	γ_{M2} =	1.25	-

Member forces			***Stress components***		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 4al$ =	35	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**174**	kN		35	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	56.6	mm
M_{Ed} = 1/2 b / h x $F_{v,Ed}$ =	**2.62**	kNm	$\sigma_1 = \tau_1 = 0{,}706M_{Ed} / al\ b^*$ =	19	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	108	N/mm^2

Check

$\sigma_{vw,Ed}$ =	108	N/mm^2	≤	$f_u / \beta_w\gamma_{M2}$ =	436	N/mm^2	U.C. =	**0.25** OK
σ_1 =	54	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0.15** OK

Welds of shear blocks of pile

Out-of-plane loading

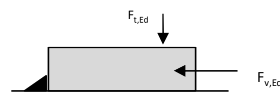


Plate			***Welds***		
t =	50	mm	a =	5	mm
Grade	S235		l =	1300	mm
f_{yd} =	235	N/mm^2	β_w =	0.8	-
f_u =	360	N/mm^2	γ_{M2} =	1.25	-

Member forces			***Stress components***		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 2al$ =	14	N/mm^2
$F_{t,Ed}$ = 1/2 b / h x $F_{v,Ed}$ =	**259**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 2al$ =	47	N/mm^2
$F_{v,Ed}$ =	**865**	kN		61	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0.00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	122	N/mm^2

Check

$\sigma_{vw,Ed}$ =	122	N/mm^2	≤	$f_u / \beta_w\gamma_{M2}$ =	360	N/mm^2	U.C. =	**0.34** OK
σ_1 =	61	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	259	N/mm^2	U.C. =	**0.24** OK

Welds of foot plate

$f_u / \beta_w\gamma_{M2}$ =		436	N/mm^2
Weld size	a =	6	mm
Length	l = 2b+ 2b - t =	964	mm
Capacity	F_{Rd} = a x l x $f_{w,d}$ / √3 =	**1454**	kN

CALCULATION OF POST INSULATOR LOADS

The following parameters are calculated:

- The forces on the insulator attachment due to wind loading and weight
- The required measurements of the components

The diagram below is a representation of the loads on the insulator:

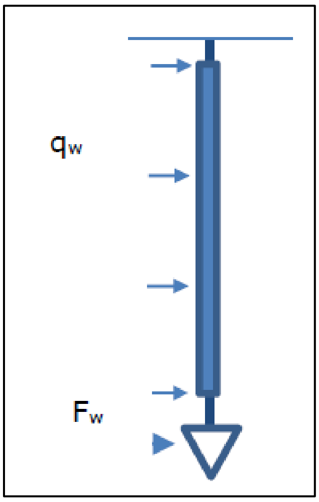


Figure 1: Diagrammatic representation of the loads on the post insulator

Forces on the insulator attachment

Wind pressure based on non-urban terrain in wind zone II at a height of 36,5 m: q_h = 1,26 kN/m^2

Wind load per meter based on an insulator diameter of 0,2 m and a drag factor of 1,2:

q_w = 1,2 x 0,2 x 1,26 = 0,30 kN/m

F_w = 2 x 4 m x 0,30 kN/m = 2,4 kN

Conductor with C_c = 0,9:

F_w based on a supported length of 9 m and a structural factor of 1:
F_w = 9 x 1 x 0,9 x 3 x 0,036 x 1,26 = 1,1 kN

Invoer geleiderbelastingen:

Wind area = 2 x 4 m x 0,2 m = 1,6 m^2

Conductor wind area: 9 m x 3 x 0,036 = 1,0 m^2

Total wind area for geleiderbelasting sheet: 2,6 m^2

Calculation of vertical weight

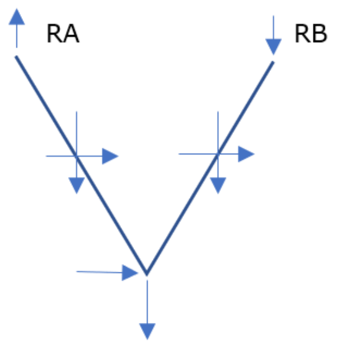
$F_{insulator}$ = 2 x 2,0 kN = 4 kN

$F_{conductor}$ = 9 m x 3 x 0,024 = 0,7 kN

Reaction Force

$\Sigma M_B = 0$: -RA x 5 + 4 x 2,5 + 0,7 x 2,5 + 2,4 x 2 + 1,1 x 4 = 0

RA = 20,95 / 5 = 4,2 kN



Relatively small forces, pin connections based short circuit requirement suffices.

Check for bending of beams HEA160

M = 0,6 x 4,2 = 2,52 kNm

M_{Rd} = 51,7 kNm

U.C = 2,52 / 51,7 = 0,1 < 1,0 OK.

CALCULATION OF POST INSULATOR LOADS

The following parameters are calculated:

- The forces on the insulator attachment due to wind loading and weight
- The required measurements of the components

The diagram below is a representation of the loads on the insulator:

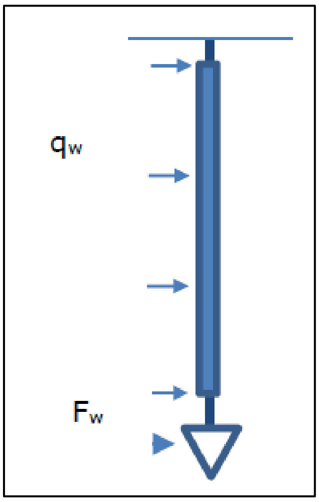


Figure 1: Diagrammatic representation of the loads on the post insulator

1. Forces on the insulator attachment

Wind pressure based on non-urban terrain in wind zone II at a height of 25.2 m: q_h = 1.14 kN/m^2

Wind load per meter based on an insulator diameter of 0.2 m and a drag factor of 1.2:

$\underline{q_w}$ = 1.2 x 0.2 x 1.14 = <u>0.27 kN/m</u>

Then calculate F_w based on a supported length of 9 m, a dragfactor of 0,9 and a structural factor of 1,0:

F_w = 9 x 0.9 x 1.0 x 3 x 0.036 x 1.14 = 0.99 kN

Calculate the moment based on the wind loading and the point load:

M_w = 0.5 x 0.24 x 4^2 + 4 x 0.99 = 5.88 kNm

Design values:

M_{ED} = 1.4 x 5.88 = 8.23 kNm

V_{ED} = 1.4 x (0.99 + 3.5 x 0.24) = 2.56 kN

2. Assessment of the pin

The figure below is a sketch of the insulator attachment mechanism indicating the location of the pin.

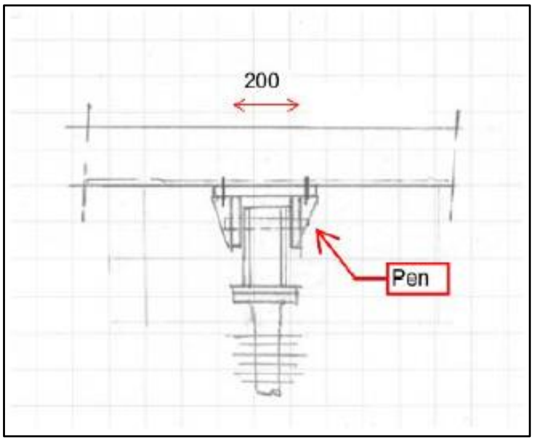


Figure 2: Post insulator attachment mechanism

Calculation of the shear force on the pin:

Assuming a total vertical weight of 5 kN and an attachment fit of 200 mm:

F_V = 8.23 /0.2 + 5/2 = 43.65 kN

Using a pin with a diameter of 25 mm is sufficient; see the attached spreadsheet calculation at the end of this appendix. A minimum flange thickness of 15 mm is required.

3. Console thickness

This will be determined in the subsequent design phases.

4. Attachment to the crossarm

The figure below depicts the additional members required for attachment to the crossarm.

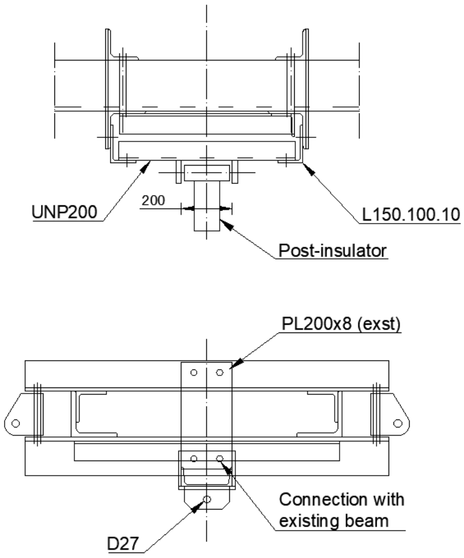


Figure 3: Overview of the new members required for attachment

M = 0.5 x 8.23 + 0.25 x 5 x 0.66 = 4.94 kNm

Proposition: 1 x UNP200: M_{rd} = 26900 x 355 = 9.55 kNm

U.C. = 4.94/ 9.55 = 0.51 < 1 OK

Project: BBB - ENS-ZL
Mast: HB-3_R

DNV·GL

Pen-gatverbinding

Datum: 2021-02-25
Auteur: MKh
Versie: 1.3

Onderwerp	Post Insulator Attachment	Toetsing sterkte	0.59 < 1,0 OK

Input

Dikte	15	mm
Gat	27	mm
Pendiameter	25	mm
Ringdikte	5	mm
Eindafstand	40	mm
Randafstand	35	mm
Staalsoort	S235	
Kwaliteit pen	8.8	

Belasting

F_{Ed} = 43.7 kN

$\gamma_{m0,staal}$	1.20
$\gamma_{m0,pen}$	1.00
γ_{m2}	1.25
$\gamma_{m6,ser}$	1.00

Toetsing

Afstanden

Randafstand	OK
Eindafstand	OK
Dikte	OK

Sterkte-eisen

Afschuifsterkte pen	0.23	< 1,0 OK
Buigsterkte pen	0.59	< 1,0 OK
Combinatie M + V	0.41	< 1,0 OK
Stuik plaat	0.40	< 1,0 OK

Berekeningen

Controle eind- en randafstand

Aan de eisen van óf A óf B moet voldaan worden

Type A

Rand	$a > F_{Ed}\ \gamma_{m0}$ / $2tf_y$ + 2 d0/3 =	25 mm	OK
Eind	$c > F_{Ed}\ \gamma_{m0}$ / $2tf_y$ + d0/3 =	16 mm	OK

Type B

Min. eindafstand	$e > 1{,}6d_0$ =	43 mm	Niet OK
Min. randafstand	$e > 1{,}25d_0$ =	34 mm	OK
Min. dikte	$t > 0{,}7\sqrt{(F_{Ed}\ \gamma_{m0} / f_y)}$ =	10 mm	OK

Pen

A = 491 mm^2

W_{el} = 1534 mm^2

Excentriciteit

e = (132-102)+t*clip*/2 = 20 mm

Materiaalsterktes

$f_y = \min(f_{y,staal},\ f_{yp})$ =	235	N/mm^2
f_{yp} =	640	N/mm^2
f_{up} =	800	N/mm^2
$f_{y,staal}$	235	N/mm^2
$f_{t,staal}$	360	N/mm^2

Afschuiving

$F_{v,Rd} = 0{,}6A\ f_{up} / \gamma_{m2}$ = 188 kN

U.C. 0.23 < 1,0 OK

Stuik

$F_{b,Rd} = 1{,}5\ t\ d\ f_y / \gamma_{m0}$ = 110 kN

U.C. 0.40 < 1,0 OK

Buigweerstand

$M_{Ed} = F_{Ed}\ e$ = 0.87 kNm

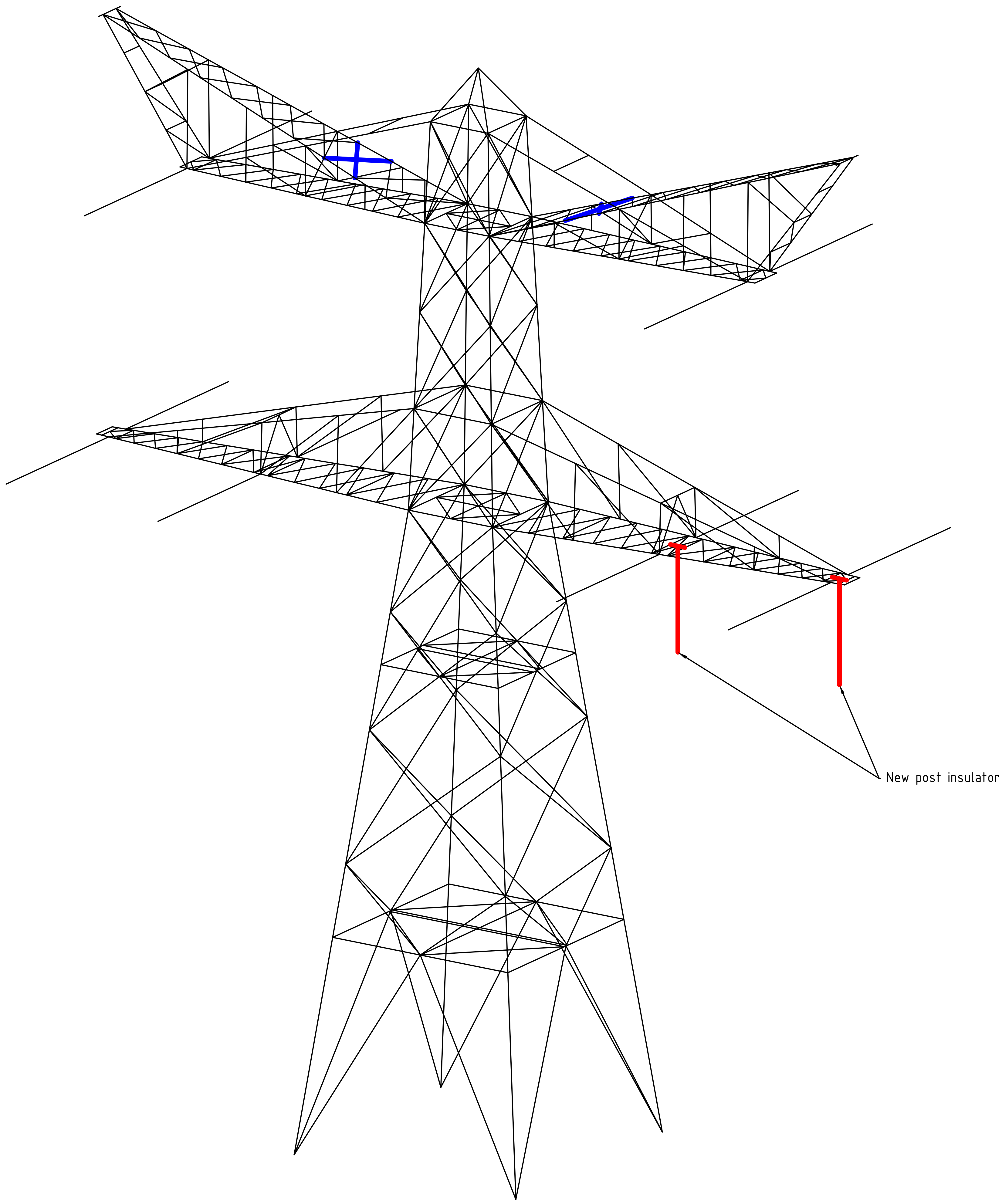
$M_{Rd} = 1{,}5\ W_{el}\ f_{yp} / \gamma_{m0}$ = 1.47 kNm

U.C. = 0.59 < 1,0 OK

$(M_{Ed} / M_{Rd})2 + (F_{v,Ed} / F_{v,Rd})^2$ = 0.41 < 1,0 OK

APPENDIX E
Tekeningen

Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
435	EA	L60x6	S235 t=<40	M16-8.8t-NEN2012	EA	L60x6	S355 t=<40	M16-8.8t-NEN2012



Overview

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality $t \leq 16$mm S355J0
- Material quality $t > 16$mm S355J2
- Bolt quality 8.8 rolled

New profile/insulator
Profile exchanged
New redundant
Bolt exchanged

Revision	Date	Description
01	25-02-2021	Dimension added
00	8-01-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-048

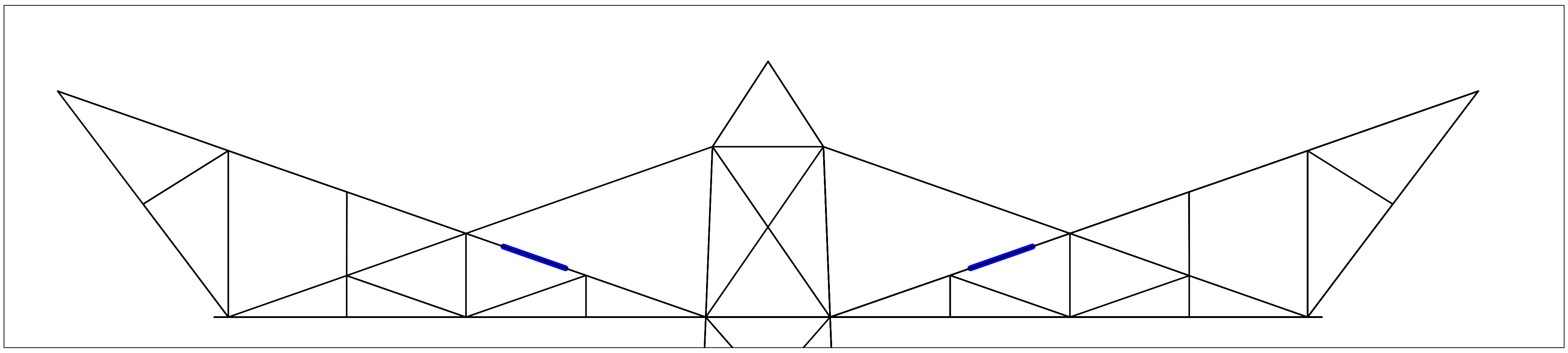
Design state: FINAL
Scale: -
Drawn by: KCh 25-02-2021
Units: m
Checked by: TBR 25-02-2021
Project no: 10166260
Approved by: JHu 25-02-2021
Company: TenneT

Description: Modifications overview for mast type HB-3_R (Mast 40) page 1 of 3

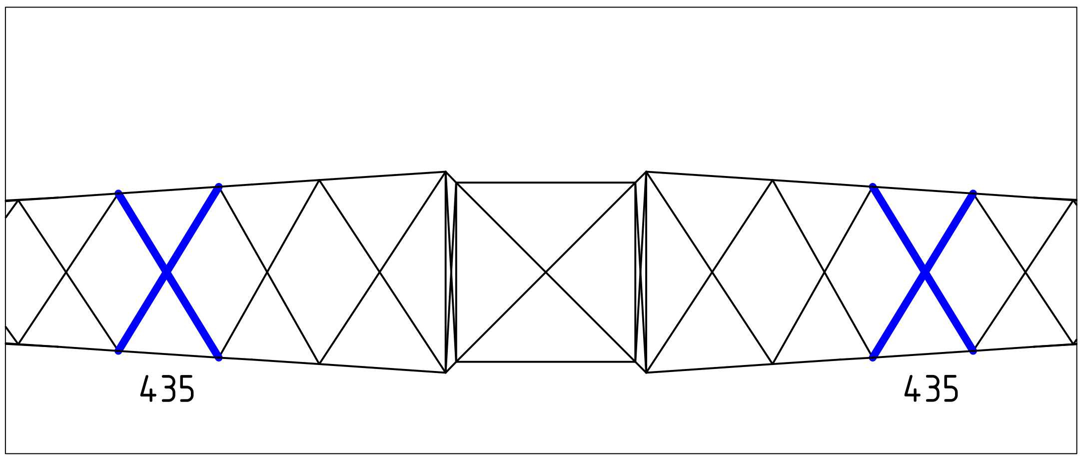
Revision: 01

Format: A2

DNV GL Energy & Sustainability, Utrechtseweg 310, 6812 AR Arnhem, tel: +31 26 3 56 91 11, www.dnvgl.com



Front View - Upper Crossarm



Top View - Upper Crossarm

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

New profile/insulator
Profile exchanged
New redundant
Bolt exchanged

01	25-02-2021	Dimension added
00	8-01-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-048

Design state: FINAL		Scale: -	Description: Modifications overview for mast type HB-3_R (Mast 40) page 2 of 3	Revision: 01
Drawn by: KCh	25-02-2021	Units: m		
Checked by: TBR	25-02-2021	Project no: 10166260		Format: A2
Approved by: JHu	25-02-2021	Company: TenneT		

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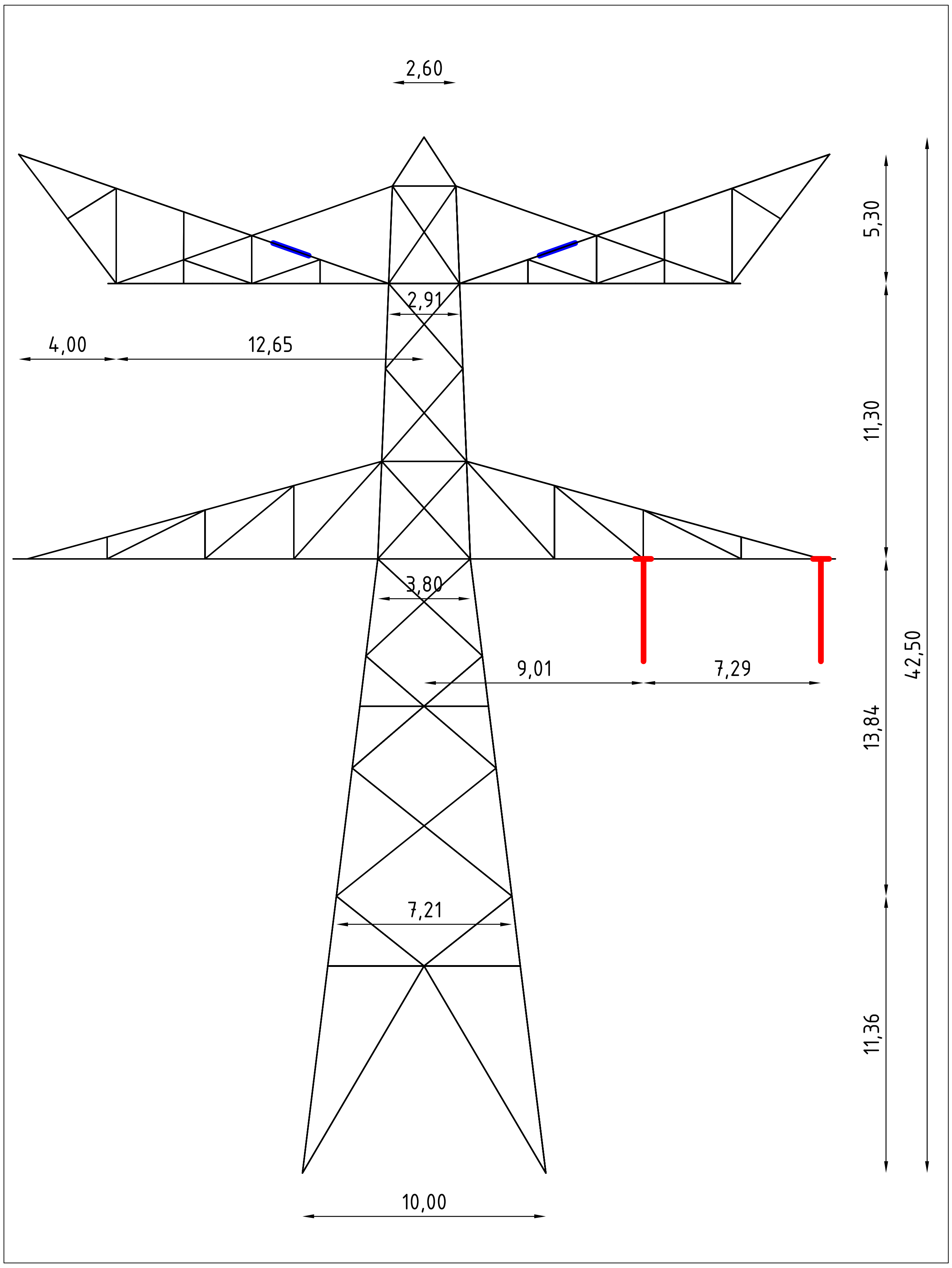
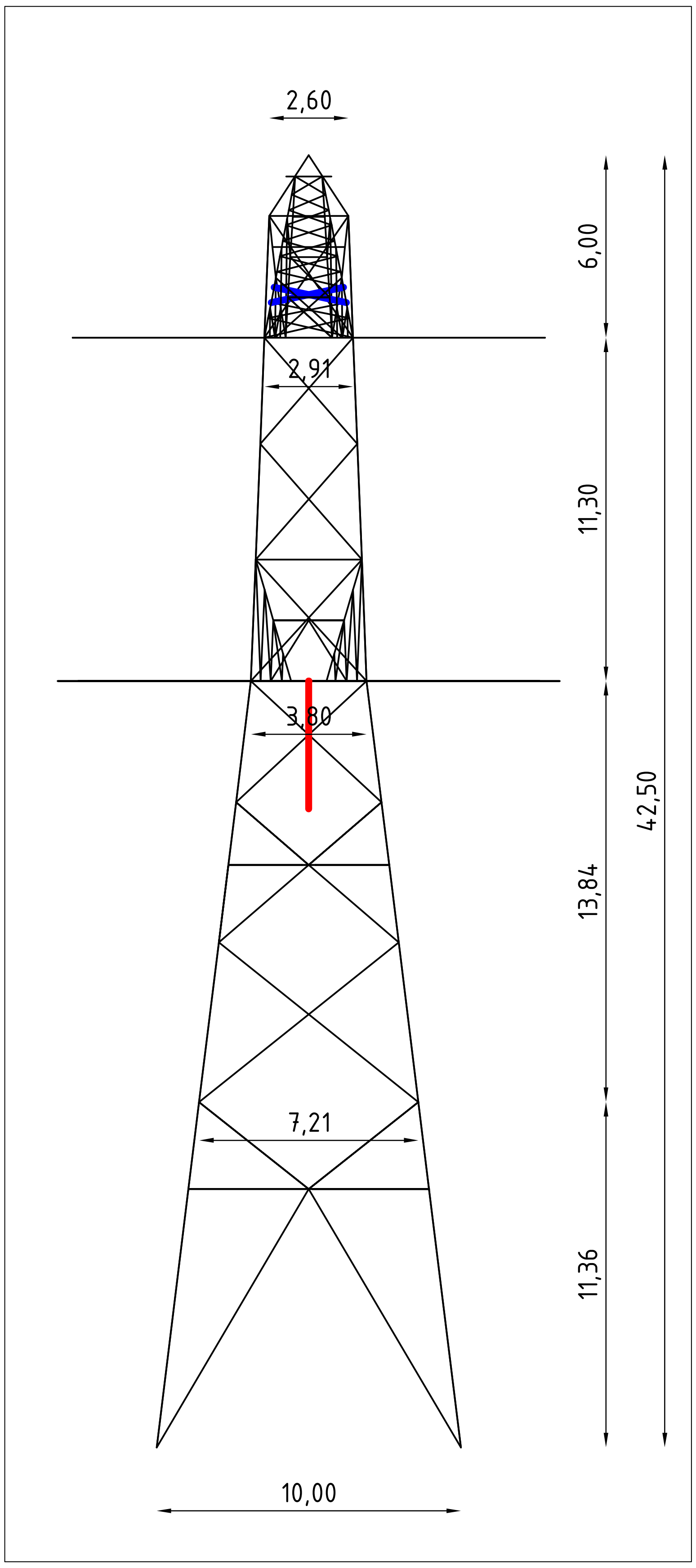


Front View



Side View

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

New profile/insulator (red line)
Profile exchanged (blue line)
New redundant (green line)
Bolt exchanged (red dot)

01	25-02-2021	Dimension added
00	8-01-2021	Version 1.0

DNV·GL

Projectname:	Mast constructions ENS - ZL 380 kV
Third angle projection:	
Drawing no.:	10166260-048
Design state:	FINAL
Scale:	-
Drawn by:	KCh 25-02-2021
Units:	m
Checked by:	TBR 25-02-2021
Project no:	10166260
Approved by:	JHu 25-02-2021
Company:	TenneT
Description:	Modifications overview for mast type HB-3_R (Mast 40) page 3 of 3
Revision:	01
Format:	A2

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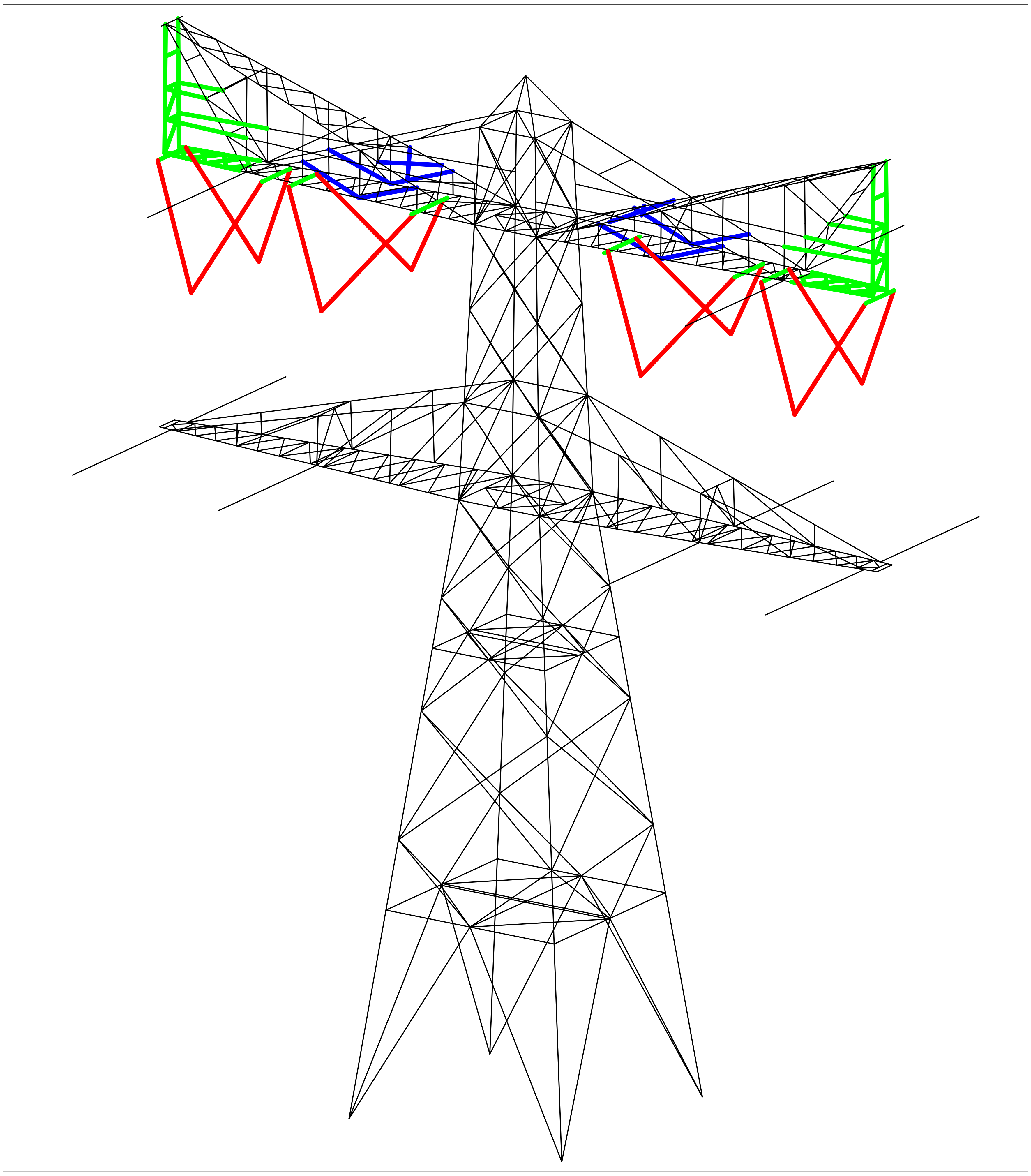
Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
426	EA	L50x5	S235 t<=40	M16-8.8t-NEN2012	EA	L70x7	S355 t<=40	M16-8.8t-NEN2012
435	EA	L60x6	S235 t<=40	M16-8.8t-NEN2012	EA	L60x6	S355 t<=40	M16-8.8t-NEN2012
436	EA	L50x5	S235 t<=40	M16-8.8t-NEN2012	EA	L70x7	S355 t<=40	M16-8.8t-NEN2012
490D					EA	L150x14	S355 t<=40	M20-8.8t-NEN2012
469					EA	L50x5	S355 t<=40	M16-8.8t-NEN2012
470					EA	L50x5	S355 t<=40	M16-8.8t-NEN2012
471					EA	L50x5	S355 t<=40	M16-8.8t-NEN2012
472					EA	L50x5	S355 t<=40	M16-8.8t-NEN2012
473					EA	L60x6	S355 t<=40	M16-8.8t-NEN2012
474					EA	L50x5	S355 t<=40	M16-8.8t-NEN2012
442					HEA	HEA160	S355 t<=40	M20-8.8t-NEN2012
443					EA	L60x6	S355 t<=40	M16-8.8t-NEN2012
5000					EA	L60x6	S355 t<=40	M16-8.8t-NEN2012



Overview

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

New profile/insulator
Profile exchanged
New redundant
Bolt exchanged

Rev.	Date	Description
02	29-10-2021	Phase Transposition
03	6-12-2021	Phase Transposition

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

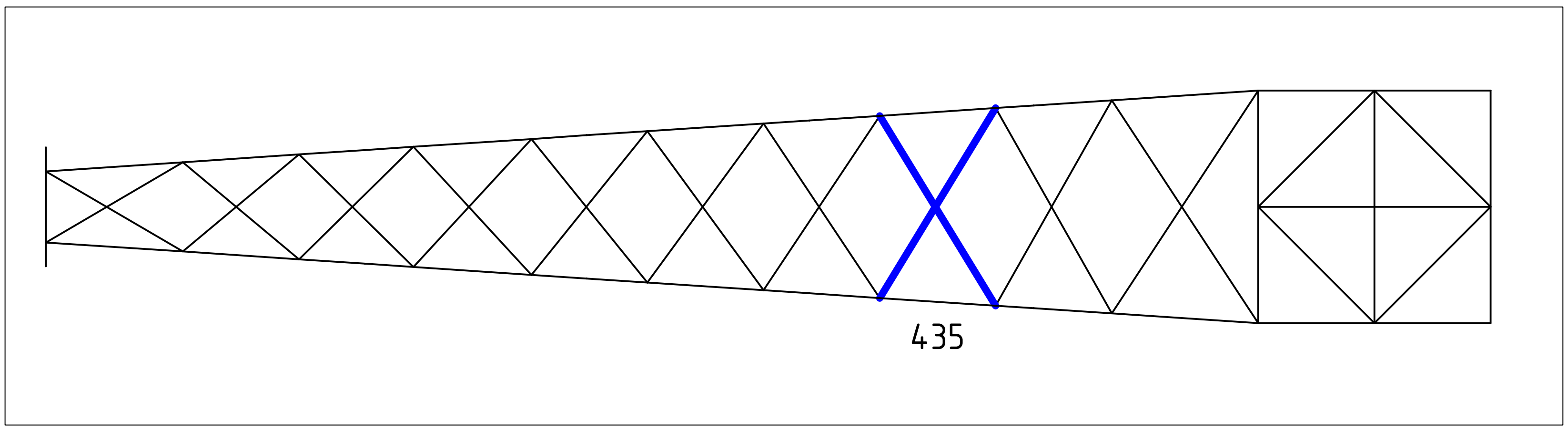
Drawing no.: 10166260-047

Design state: FINAL		Scale: -		
Drawn by: KCh	6-12-2021	Units: m		
Checked by: TBR	6-12-2021	Project no: 10166260		
Approved by: JHu	6-12-2021	Company: TenneT		

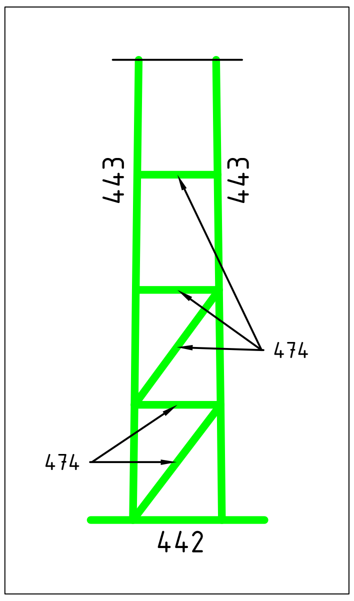
Description: Modifications overview for mast type HB-3_R_X (Mast 6) page 1 of 3

Revision: 03

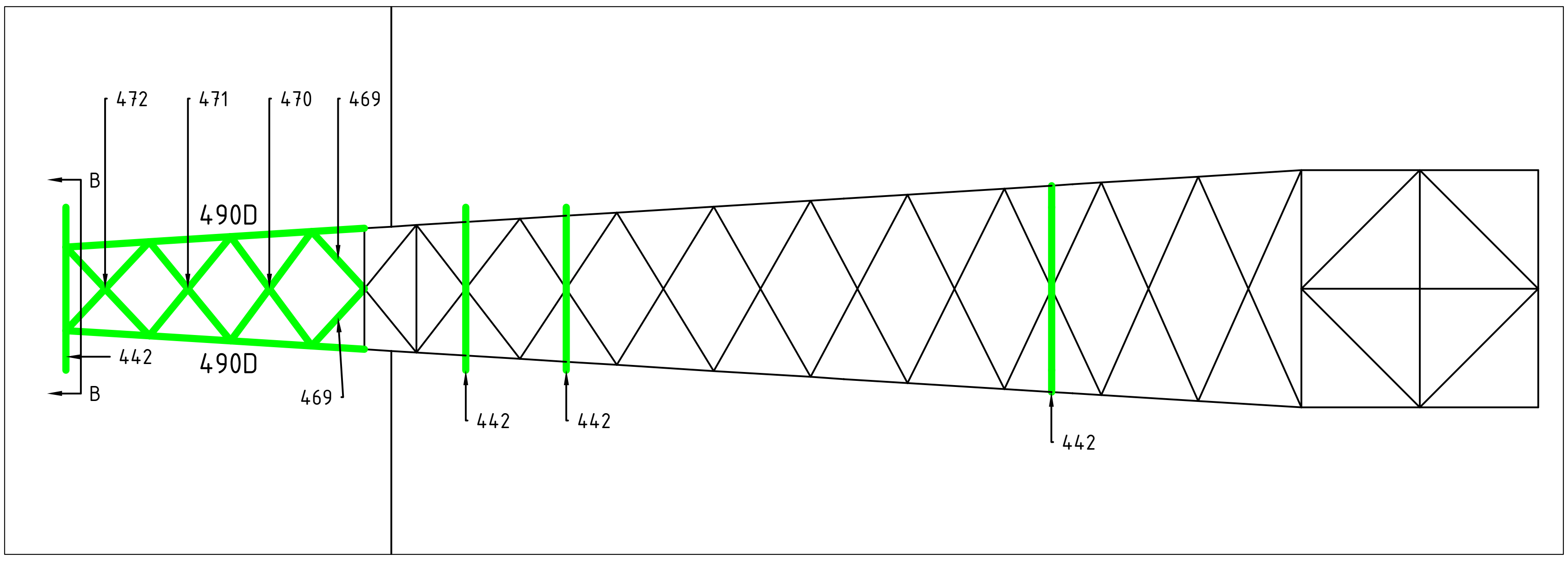
Format: A2



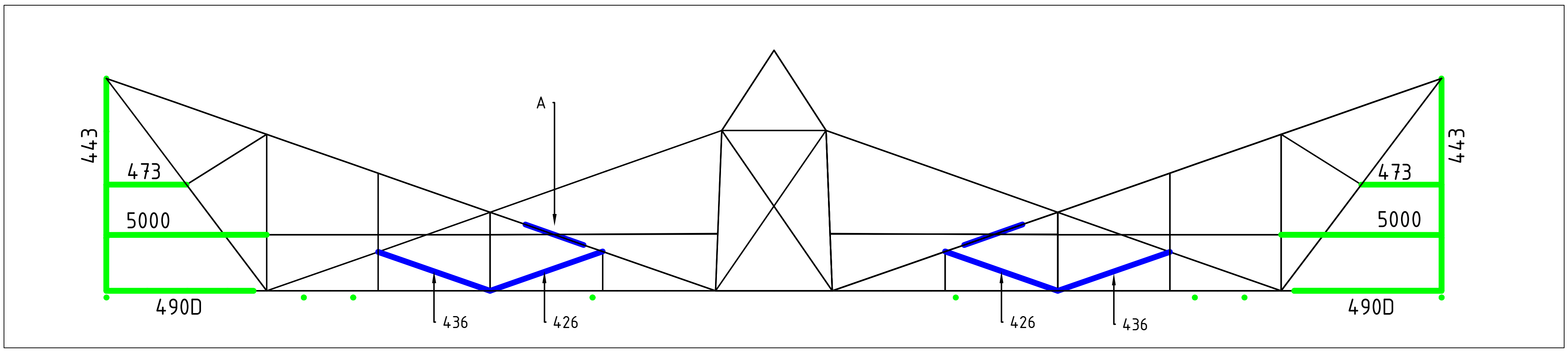
View on Arrow A



View on Section B



Top View - Lower Part of Upper Crossarm



Front View - Upper Crossarm

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

New profile/insulator
Profile exchanged
New redundant
Bolt exchanged

02	29-10-2021	Phase Transposition
03	6-12-2021	Phase Transposition

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV				
Third angle projection:	Drawing no.: 10166260-047			
Design state: FINAL		Scale: -	Description: Modifications overview for mast type HB-3_R_X (Mast 6) page 2 of 3	Revision: 03
Drawn by: KCh	6-12-2021	Units: m		
Checked by: TBR	6-12-2021	Project no: 10166260		Format: A2
Approved by: JHu	6-12-2021	Company: TenneT		

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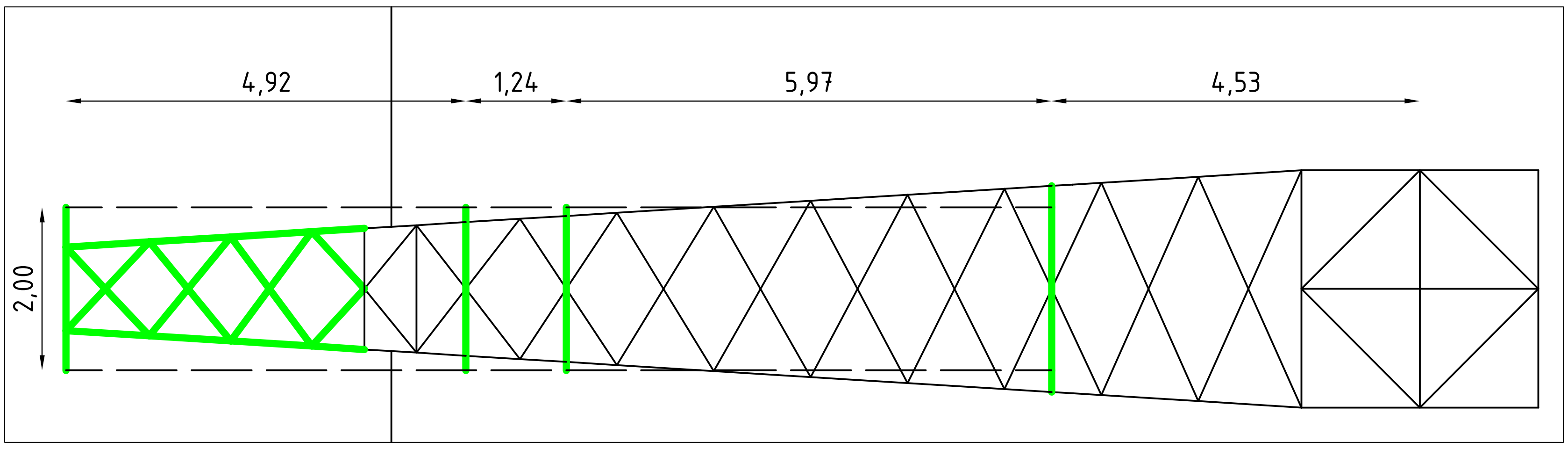
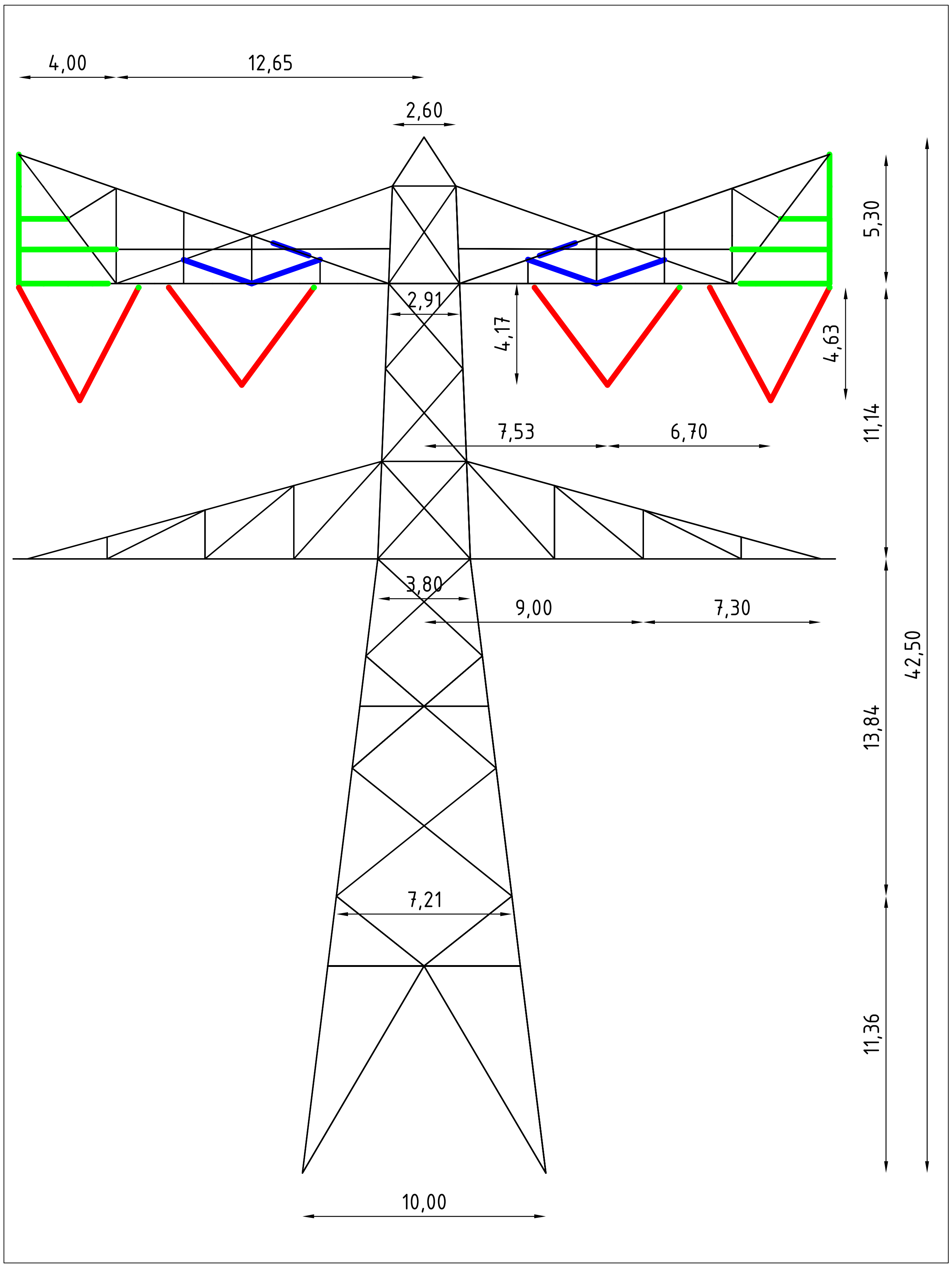
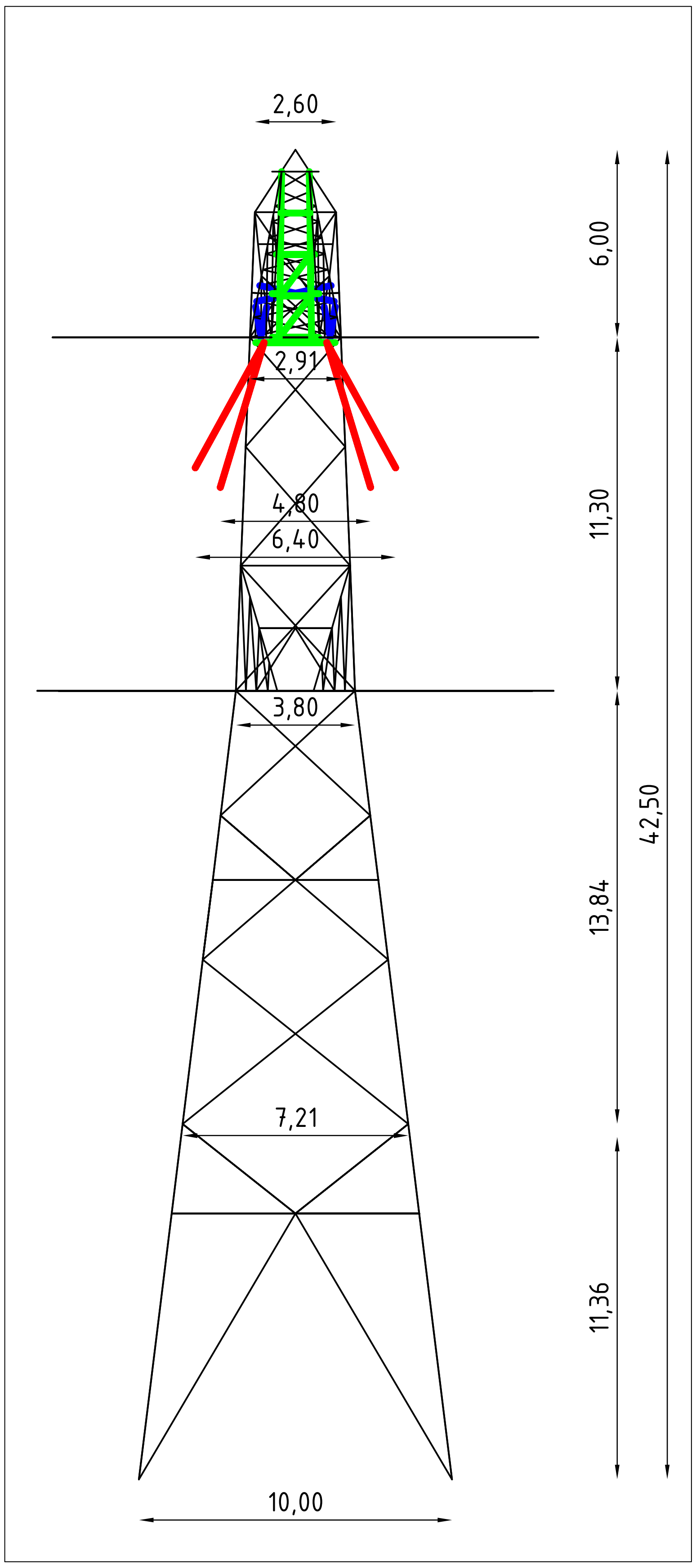


Top View - Lower Part of Upper Crossarm



Front View



Side View

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

New profile/insulator
Profile exchanged
New redundant
Bolt exchanged

02	29-10-2021	Phase Transposition
03	6-12-2021	Phase Transposition

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-047

Design state:	FINAL		Scale:	-
Drawn by:	KCh	6-12-2021	Units:	m
Checked by:	TBR	6-12-2021	Project no:	10166260
Approved by:	JHu	6-12-2021	Company:	TenneT

Description: Modifications overview for mast type HB-3_R_X (Mast 6) page 3 of 3

Revision: 03

Format: A2

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Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company’s supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world’s most successful and forward-thinking companies.

TOETSING EN HERONTWERP MASTEN EN FUNDATIES BBB380

ENS-ZL380 – Rapportage masttype HA-6/RC

TenneT TSO B.V.

Rapport nr.: 22-0509, Rev. 0
Meridian doc.nr.: 002.515.40 - 1007981
Datum: 2022-04-01

Projectnaam:	Toetsing en herontwerp masten en fundaties BBB380	Energy Systems
Rapport titel:	ENS-ZL380 – Rapportage masttype HA-6/RC	DNV Netherlands B.V.
Klant:	TenneT TSO B.V.,	Utrechtseweg 310-B50
Contactpersoon klant:	P. v.d. Horst	6812 AR Arnhem
Datum uitgave:	2022-04-01	
Project nr.:	10166260	
Organisatie unit:	TDT	Tel: 026 356 9111
Meridian doc.nr..:	002.515.40 - 1007981	Handelsregister Arnhem 09006404
Rapport nr.:	22-0509, Rev. 0	

Geschreven door:	Beoordeeld door:	Goedgekeurd door:
M.H. Khan	A.J. Börger	C. Schutte

DNV Distributie:

☒ Open

☐ Intern

☐ Commercieel vertrouwelijk

☐ Vertrouwelijk

☐ Geheim

*Specificatie distributie: --

Rev.	Datum	Reden van uitgave	Auteur	Beoordeeld	Goedgekeurd
0	2022-04-01	Eerste uitgave	M.H. Khan	A.J. Börger	C. Schutte

Inhoudsopgave

1 INLEIDING

1.1 Inleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt.

Om die reden is de opdrachtgever (OG) voornemens de bestaande 380 kV-koppelnetring op te waarderen. Het opwaarderen van de bestaande verbindingen valt onder het programma “Beter benutten bestaande 380 kV-ring” en omvat de volgende deelprojecten:

- Opwaardering 380 kV-verbinding Lelystad – Ens (LLS-ENS380)
- Opwaardering 380 kV-verbinding Diemen – Lelystad (DIM-LLS380)
- Opwaardering 380 kV-verbinding Rilland – Zandvliet (RLL-ZVL380)
- Opwaardering 380 kV-verbinding Krimpen aan den IJssel - Geertruidenberg (KIJ-GT380)
- Opwaardering 380 kV-verbinding Ens - Zwolle (ENS-ZL380)
- Opwaardering 380 kV-verbinding Maasbracht - Eindhoven (MBT-EHV380)

Om te komen tot een DO waarmee de werkzaamheden kunnen worden gestart is door TenneT aan DNV opdracht verstrekt voor de volgende onderdelen:

1. In eerste fase het opstellen en creëren van:

1.1 E-studie deel 1

1.2 Uitgangspuntenrapporten ten behoeve van de constructieve analyse van masten en fundaties

1.3 Sonderingmodellen

1.4 Fundatiemodellen

1.5 Mastmodellen

2. In tweede fase de uitvoering van de DO-fase bevattende:

2.1 Toetsing conform het uitgangspuntenrapport van de bestaande fundaties

2.2 Globale specificatie van benodigde fundatieversterkingen ten behoeve van aanbesteding

2.3 Toetsing conform het uitgangspuntenrapport van de bestaande masten

2.4 Globale specificatie van benodigde mastversterkingen ten behoeve van aanbesteding

2.5 E-studie deel 2

1.2 Doel van dit rapport

In dit rapport wordt voor de hoogspanningslijn Ens - Zwolle de controle van de mastconstructie van masttype HA-6/RC gerapporteerd. Het doel is om te bepalen of de in dit rapport beschreven bestaande mast geschikt is om te worden uitgerust met de nieuwe ACCC-Warsaw geleider waarmee een hogere capaciteit kan worden gerealiseerd.

Nadat de wijzigingen zijn toegepast dient aantoonbaar geverifieerd te worden dat het systeem voldoet aan de vigerende eisen.

In de defintief-ontwerpfase zijn ten behoeve van de contractvorming Engelstalige rapporten geleverd. Het voorliggende rapport is bedoeld voor vergunningsaanvraag en is inhoudelijk ongewijzigd ten opzichte van de Engelse versie. Om deze reden zijn de bijlagen in dit rapport één op één overgenomen uit de Engelse versie. Hierdoor wijkt het revisienummer van de bijlagen af van het revisienummer van de rapportage.

1.3 Gerelateerde documenten

1.3.1 Verificatie & validatieplan

De door TenneT aangeleverde set met eisen is beoordeeld op relevantie en voor de relevante eisen is aangegeven in welk document wordt aangetoond dat er aan de eis wordt voldaan. De resultaten hiervan zijn opgenomen in het rapport “Verificatie & Validatieplan 380 kV verbinding Ens - Zwolle”.

1.3.2 E-studie deel 1

In de rapportage “ENS-ZL380 - E-studie deel 1” [1] is bepaald welke aanpassingen benodigd zijn om de ACCC-Warsaw geleider toe te passen binnen de verbinding Ens – Zwolle.

Uit de E-studie volgen de volgende zaken die relevant zijn voor de constructie van masttyppe HA-6/RC:

- Toepassen van verticale ‘post-isolators’

1.3.3 Uitgangspuntendocument

De uitgangspunten op basis waarvan de berekeningen in deze rapportage zijn uitgevoerd zijn opgenomen in het rapport “Uitgangspuntenrapport 380kV verbinding Ens - Zwolle” [2].

2 EISEN

In onderstaande Tabel 1 zijn de eisen opgenomen die binnen deze rapportage worden getoetst.

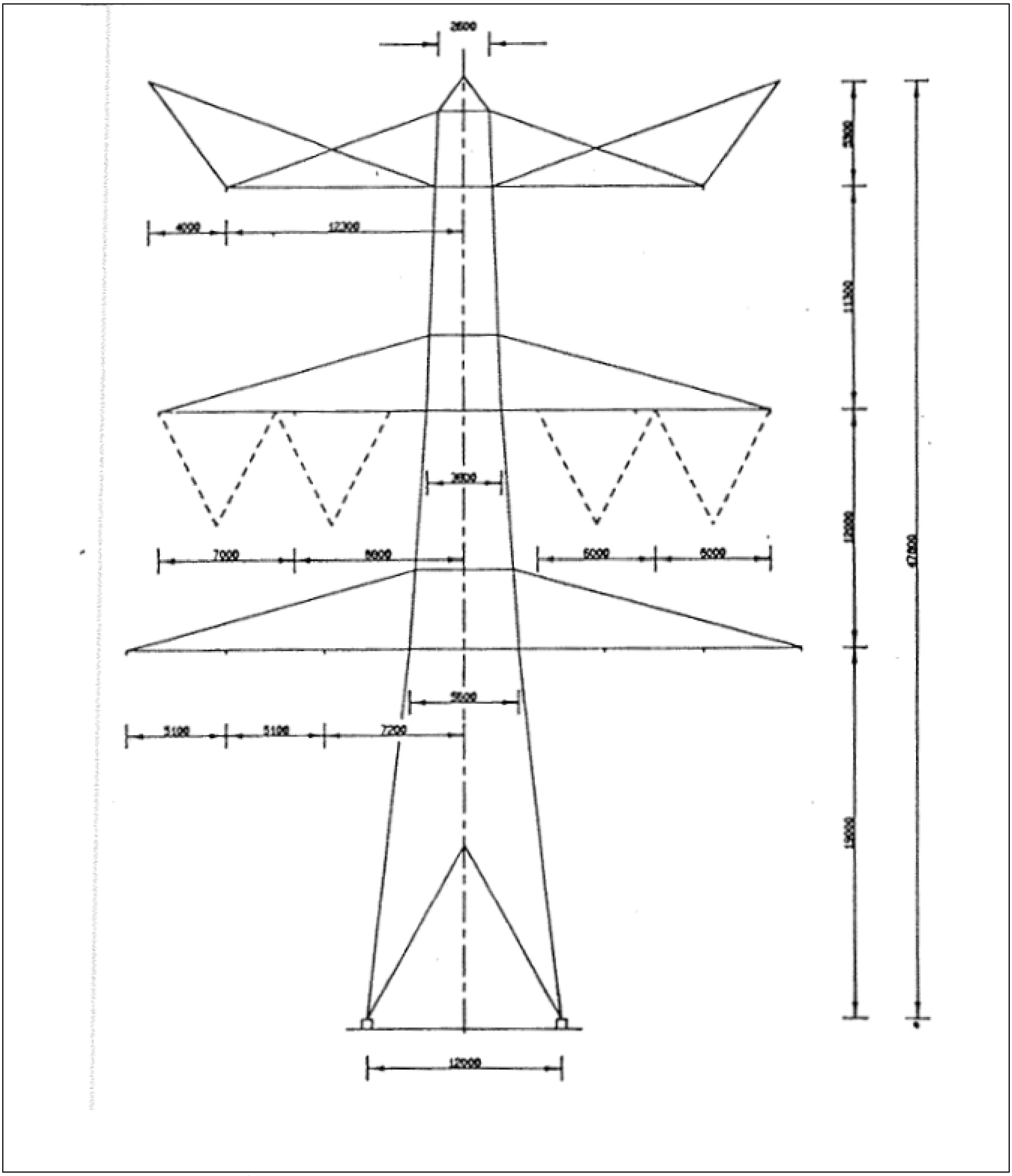
Tabel 1 Relevante eisen

Req. Id	Title	Req. text	Verification
BO Eis: H2.7-6	Omgeving, beperkingsf actoren	Het ontwerp dient geverifieerd te worden op de uitvoerbaarheid.	Tabel 6
PVE.05.001 5.14	Masten	Aanwijzingen t.a.v. klimvoorziening en valbeveiliging: Huidige klimweg blijft gehandhaafd en zal voldoen aan de eisen zoals opgenomen in de NEN 1060:1987. Valbeveiliging is/zal worden uitgevoerd in het type "latch way". Indien staaldelen in de nabijheid (aangrenzend profiel) van de klimweg gewijzigd worden, dient geverifieerd te worden dat de klimvoorziening in overeenstemming is met de NEN 1060:1987.	Tabel 6

3 BEREKENINGEN

3.1 Mastbeeld

Het mastbeeld op basis van de Asset-data is weergegeven in Figuur 1.



Figuur 1 Mastbeeld HA-6/RC

3.2 Mastenlijst

In deze rapportage wordt masttype HA-6/RC getoetst. Er zijn twee HA-6/RC en beide masten vallen binnen windgebied III. De berekening is uitgevoerd voor windgebied III. De wind en weight span van de verschillende masten zijn in Tabel 2 Mastnummers weergegeven. Het maatgevende mastnummer 82 (windgebied II) is aangegeven. Bij de masten in windgebied III is rekening gehouden met verhoogde windbelasting als gevolg van een hogere aangrenzende mast (hoger is een negatieve waarde).

De masten zijn vergeleken voor de maximale uitnutting en mast 82 is leidend. Beide masten hebben een verticale post-isolator nodig als aanpassing aan één zijde. De hoek van de geleider is het grootst voor mast 82 waardoor mast 82 leidend is.

Tabel 2 Mastnummers

Tower number	Tower type	Governing tower number	Wind span (m)	Weight span (m)	Height difference back (m)	Height difference ahead (m)
82	HA-6_RC	82	346	379	-4.4	-4.2
88	HA-6_RC	82	396	358	-4.3	11.9

3.3 Uitgangspunten berekening

De berekening is uitgevoerd op basis van de uitgangspunten zoals opgenomen in het uitgangspuntenrapport [3]. Hierin is een volledig overzicht opgenomen van de belastingcombinaties en toegepaste belastingfactoren:

Tabel 3 Uitgangspunten berekening

Algemeen	Norm	NEN-EN50341-2-15:2019
	Windgebied	II/III
	Terreincategorie	II (onbebouwde omgeving)
	Reductiefactor cdir	1,00
Situatie initieel	Gevolgklasse	CC2-0
	Betrouwbaarheidsniveau	Afkeur CC2-0
	Referentieperiode	30 jaar
Situatie na aanpassingen	Gevolgklasse	CC2
	Betrouwbaarheidsniveau	Verbouw
	Referentieperiode	50 jaar

3.4 Proces stappen

Het proces van het bepalen van eventueel benodigde verzwaringen bestaat uit de volgende stappen:

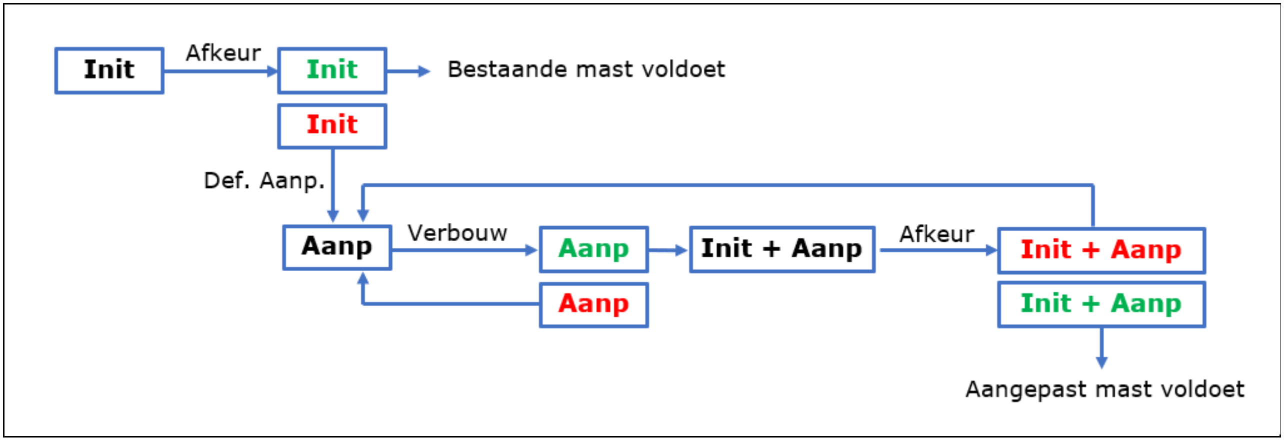
Stap 1: Toets bestaande (Init) mast op Afkeur.

Stap 2: Definiëren benodigde aanpassingen indien initiële mast niet voldoet aan toets op Afkeur (Def. Aanp.).

Stap 3: Het toetsen van (alleen) de uitgewerkte aanpassingen (Aanp) op Verbouw.

Stap 4: Het opnieuw toetsen van de complete mast inclusief aanpassingen (Initi + Aanp) op Afkeur.

Het hierboven omschreven proces is in Figuur 2 weergegeven.



Figuur 2 Proces diagram

3.5 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV. In Appendix A zijn de resultaten van de geleiderbelastingen samengevat.

3.6 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma, zie ook Appendix A.

3.7 Modellering

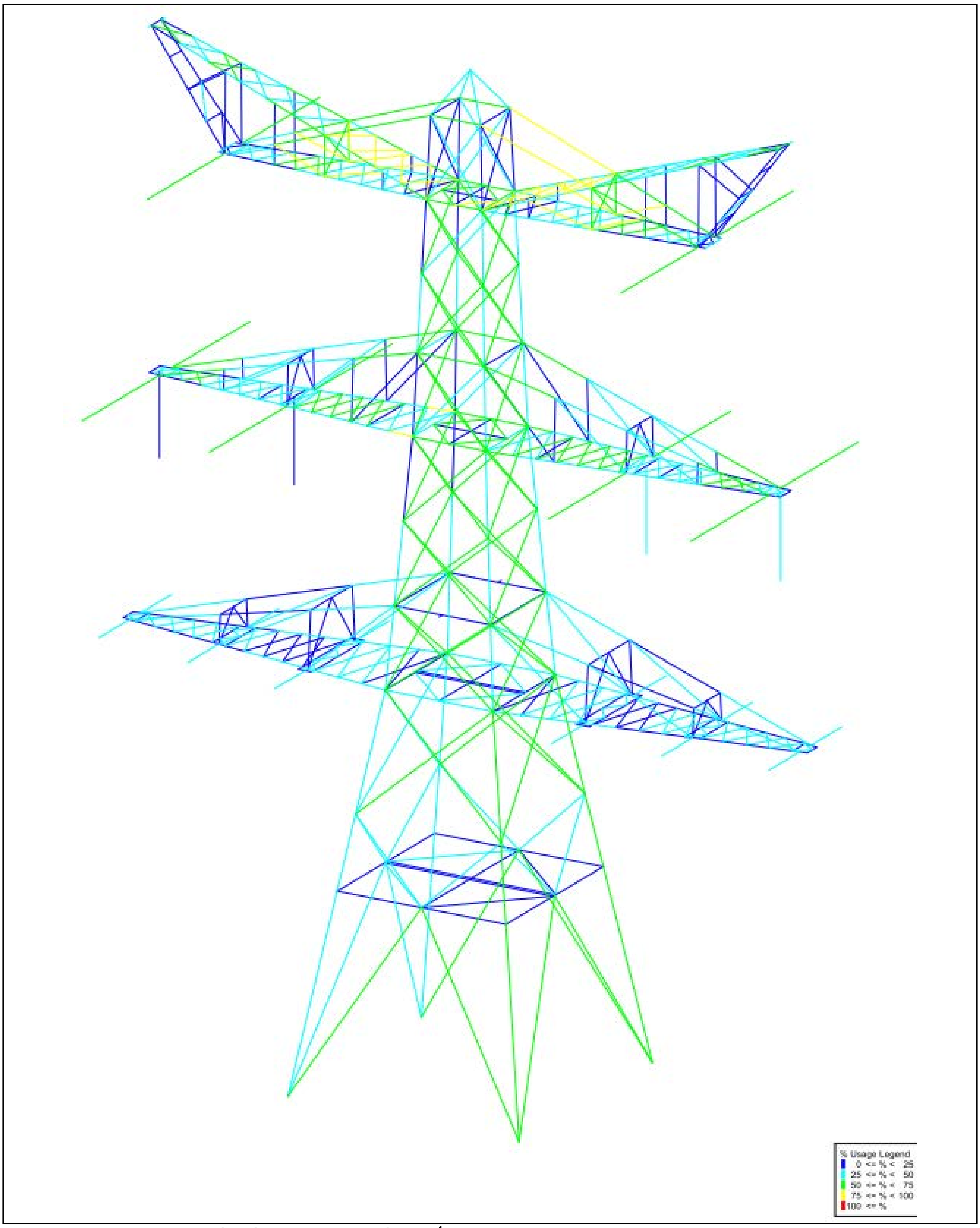
Op basis van de as-built tekeningen is de mast in PLS-TOWER ingevoerd. De hoofdelementen zijn gemodelleerd. Niet-dragende profielen als knikverkorters zijn weggelaten en worden separaat getoetst. De profielen inclusief de boutverbindingen zijn in PLS-TOWER ingevoerd en getoetst. Controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

De geleiderbelastingen vanuit het geleiderbelastingenprogramma zijn als invoer voor de belastingen gebruikt.

Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep en de toetsing wordt per staafgroep uitgevoerd. Ingeval dat een element uit een groep is overbelast, geldt dit voor alle elementen uit de betreffende groep.

4 TOETSING MASTCONSTRUCTIE

Het resultaat van de controle van de mastconstructie type HA-6/RC met belastingen op afkeurniveau is weergegeven in Figuur 3.



Figuur 3 Resultaat PLS-TOWER HA-6/RC (82)[1]

---

1 De post-isolatoren zijn zichtbaar in het model aan beide zijden. In de berekeningen zijn deze aan één zijde voorzien van belastingen omdat per mast deze slechts aan één zijde voorkomen.

De resultaten van de controles van profielen, knikverkorters en randstijl ankers zijn opgenomen in Tabel 4.

Sommige knikverkorters falen door knik vanwege het overschrijden van het 1% criterium voor drukkracht weerstand van het hoofdprofiel. Daarom dienen deze profielen vervangen te worden.

Tabel 4 Samenvatting controle

Controle van	Beoordeling		Referentie
Profielen	Voldoen		Figuur 3 Appendix B
Knikverkorters		Voldoen niet	Appendix C
Blokdeuvels	Voldoen		Appendix D

5 AANPASSINGEN

5.1 Inleiding

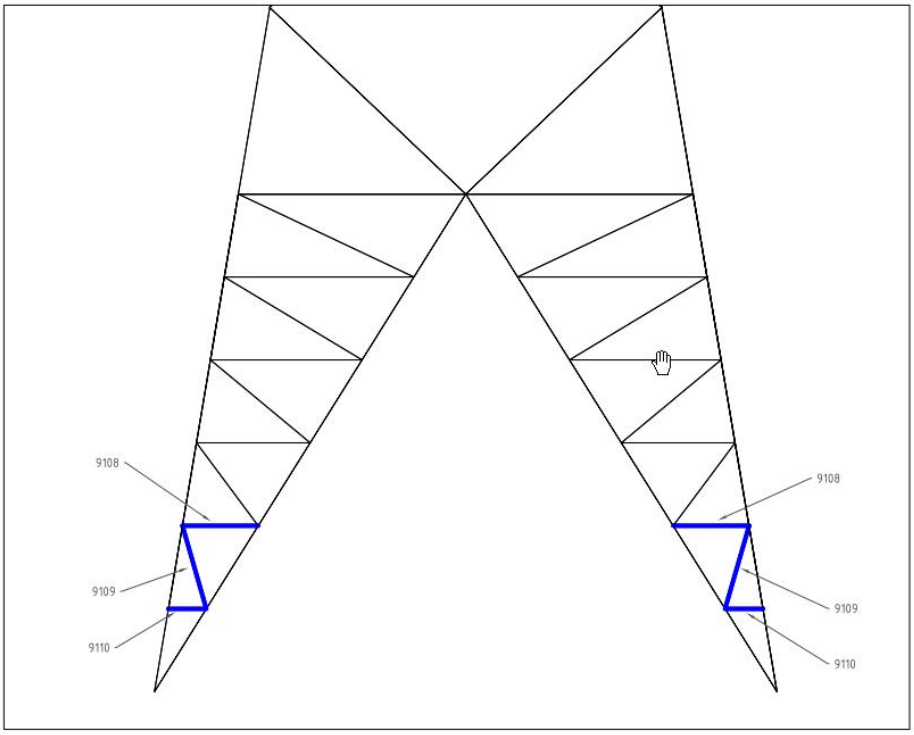
Een versterkingsvoorstel om de mast aan afkeurniveau te laten voldoen is uitgewerkt. Dit voorstel bevat de volgende maatregelen:

- Knikverkorters vervangen in de onderste randstijlsectie
- Voorstel voor de verbinding van de post-isolator

5.2 Aanpassingen

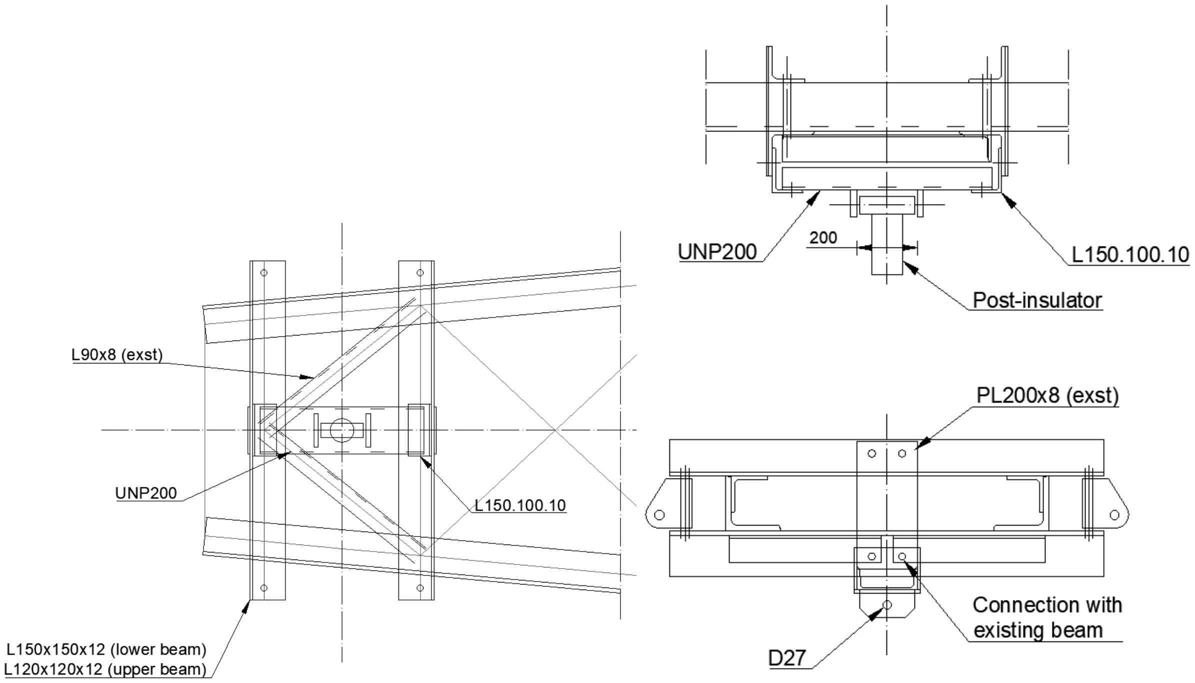
Gebleken uit de resultaten van Appendix B dienen de aanpassingen die toegepast worden in dit hoofdstuk behandeld te worden.

Knikverkorters welke vervangen dienen te worden zijn weergegeven in figuur 4.

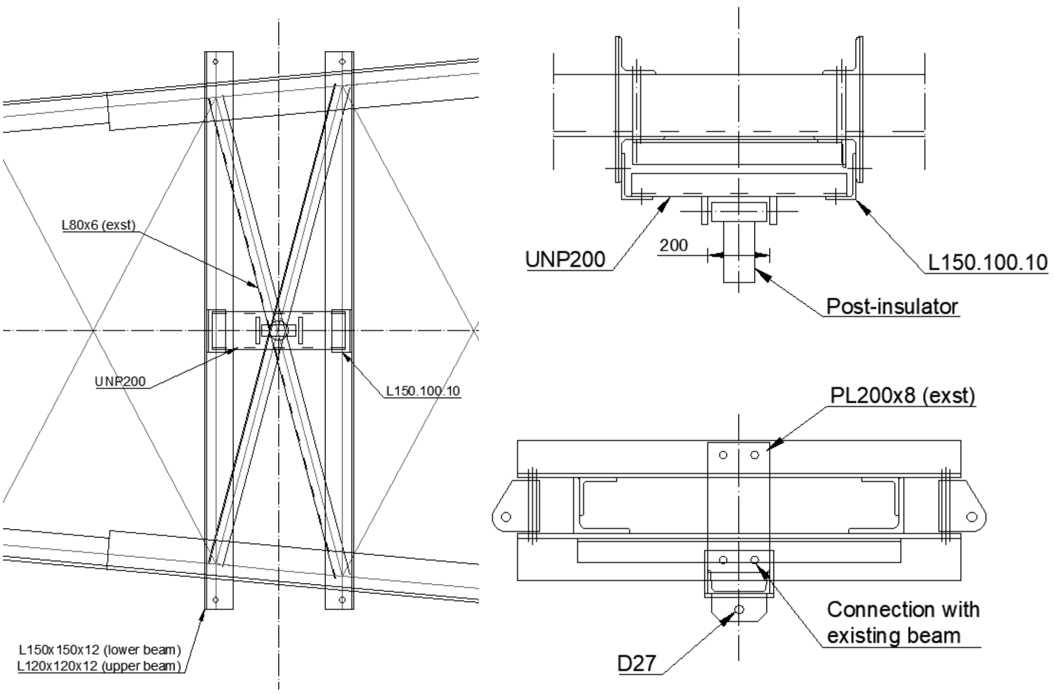


Figuur 4 Vooraanzicht- onderste randstijlsectie

DNV heeft een voorstel voorzien voor de verbinding van de post-isolator, deze zijn weergegeven in figuur 5 en 6.



Figuur 5 Verticale post-isolators aan het uiteinde van de traverse



Figuur 6 Verbinding van de post-isolator in het midden van de traverse.

Informatie met betrekking tot de profielmaten en de boutmaten zijn te vinden in Appendix E. Een overzicht van het nettogewicht van de profielen die nodig zijn voor de versterkingen/aanpassingen is gegeven in tabel 5.

Het gewicht van eventueel benodigde schetsplaten en ander hulpstaal als onderdeel van de verbinding is niet meegenomen.

Tabel 5 Gewichten HA-6/RC van toegevoegde knikverkorters en uitgewisselde profielen

Group Label	Profile ini.	Material ini.	Bolts ini.	Profile new	Material new	Bolts new	Mitigation	Number	Length (m)	Weight (kg)
Pos 9110	L50.5	S235	1M16-8.8t	**L50.5**	**S355**	**1M16-8.8t**	Profile exchanged	8	0.47	14.28
Pos 9109	L50.7	S235	1M16-8.8t	**L60.6**	**S355**	**1M16-8.8t**	Profile exchanged	8	1.71	75.80
Pos 9108	L50.5	S235	1M16-8.8t	**L50.5**	**S355**	**1M16-8.8t**	Profile exchanged	8	1.33	40.92
									28.08	131.0

5.3 Eisenverificatie

De verificatie van de van toepassing zijnde eisen is uitgevoerd in onderstaande Tabel 6.

Tabel 6 Verificatie eisen

Eis Id	Eis Tekst	Ja	Nee	N.v.t.	toelichting
BO Eis: H2.7-6	Aanpassingen uitvoerbaar?	X			De toe te voegen staalonderdelen zijn met geboute verbindingen te bevestigen. Dit is een bewezen methode.
PVE.05.001 5.14	Staaldelen in nabijheid van klimweg gewijzigd?		X		De wijzigingen in de nabijheid van de klimweg (knikverkorters) zijn in te passen zonder negatieve invloed op de begaanbaarheid.
	klimvoorziening nog in overeenstemming is met de NEN 1060:1987?			X	Geen wijzigingen

6 REFERENTIES

[1] „002.515.40 0825824 - 21-0462 - Verificatie & validatieplan 380kV verbinding Ens - Zwolle”.
[2] „002.515.40 0825812 - 20-1465 - E-studie deel 1 380kV verbinding Ens - Zwolle”.
[3] „002.515.40 0825820 - 20-1245 - Uitgangspuntenrapport 380kV verbinding Ens - Zwolle”.

APPENDIX A
Geleiderbelastingen

Content

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-01-15			

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	III
Wind speed	24.5 m/s
Terrain categorie	II
Reduction factor Cdir	1.00
Ice region	B
Tower type	Hoekmast
Tower height	48.3 m
Max. Span	354.9 m
Line angle	156.7°
Catenary	2100 m
Wind span	346 m
EDS Weight span	398 m
Min. Weight span	346 m
Max. Weight span	448 m

Client: TenneT Taking power further

DNV·GL

Title:

Berekening masttype HA-6 RC

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_HA-6 RC_82_Report.pdf

Project number:

Project client number:

0.0

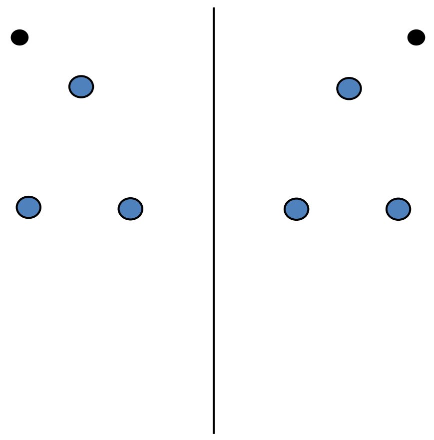
Project: ENS-ZL
Tower: HA-6 RC
Number: 82

Conductor loads

Auteur: TBR
Versie: v11.5

General

Description	HA-6 RC
Tower type	Hoekmast
Number of circuits	4
Configuration	4-circuit-verticaal-vlak
Number of earth wires	3



Configuratie geleiders

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	III
Terrain category	24.5 m/s
Reduction factor c_{dir}	II
Ice region phase conductor	1.00
Ice region earth conductor	B
	B

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 3	110 kV	AAAC IJSSEL	1	B	3 %	3 %	2100
Circuit 4	110 kV	AAAC IJSSEL	1	B	3 %	3 %	2100
Bliksemdraad 1		B232 HAWK	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 3		OPGW 96 Fibral	1	B	3 %	3 %	2100

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 3	110 kV	AAAC IJSSEL	1	B	3 %	3 %	2100
Circuit 4	110 kV	AAAC IJSSEL	1	B	3 %	3 %	2100
Bliksemdraad 1		B232 HAWK	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 3		OPGW 96 Fibral	1	B	3 %	3 %	2100

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area $[m^2]$
Circuit 1	Afspanketting	2.00	4.50	1.00
Circuit 2	Afspanketting	2.00	4.50	1.00
Circuit 3	Afspanketting	1.00	1.59	0.50
Circuit 4	Afspanketting	1.00	1.59	0.50
Bliksemdraad 1	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 2	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 3	Vast (Bliksemdraad)	0.10	0.30	0.10

1. *Properties apply to the entire isolator set*

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower (3) Horizontal distance
Circuit 1	10	380ct1f1	31.0 m	31.0 m	-15.8 m
Circuit 1	11	380ct1f2	31.0 m	31.0 m	-8.8 m
Circuit 1	12	380ct1f3	42.3 m	42.3 m	-12.3 m
Circuit 2	21	380ct2f1	31.0 m	31.0 m	15.8 m
Circuit 2	20	380ct2f2	31.0 m	31.0 m	8.8 m
Circuit 2	22	380ct2f3	42.3 m	42.3 m	12.3 m
Circuit 3	30	110ct3f1	19.0 m	19.0 m	-17.4 m
Circuit 3	31	110ct3f2	19.0 m	19.0 m	-12.3 m
Circuit 3	32	110ct3f3	19.0 m	19.0 m	-7.2 m
Circuit 4	42	110ct4f1	19.0 m	19.0 m	17.4 m
Circuit 4	41	110ct4f2	19.0 m	19.0 m	12.3 m
Circuit 4	40	110ct4f3	19.0 m	19.0 m	7.2 m
Bliksemdraad 1	1	bl1	47.3 m	47.6 m	-16.3 m
Bliksemdraad 2	3	bl2	47.3 m	47.6 m	16.3 m
Bliksemdraad 3	2	bl3	22.7 m	23.0 m	0.0 m

1. *Positive = adjacent mast higher*
2. *Positive = in direction of rotation coordinate system x => y*

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Height adjustment adjacent masts (wind and weight span adjustment)

	Back	Ahead	
Height increase for wind pressure	0.0 m	0.0 m	(positive: higher)
Height decrease for vertical load	0.0 m	0.0 m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

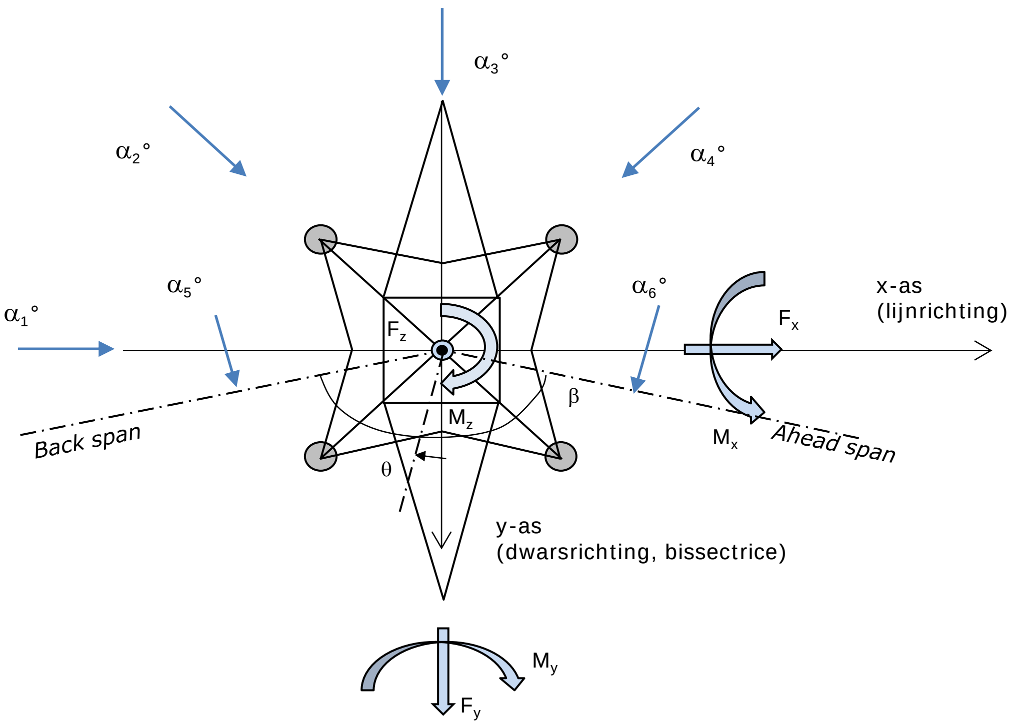
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	-4.4	-4.2 m	0.0	0.0 m
Circuit 1	11	380ct1f2	-4.4	-4.2 m	0.0	0.0 m
Circuit 1	12	380ct1f3	-4.4	-4.2 m	0.0	0.0 m
Circuit 2	21	380ct2f1	-4.4	-4.2 m	0.0	0.0 m
Circuit 2	20	380ct2f2	-4.4	-4.2 m	0.0	0.0 m
Circuit 2	22	380ct2f3	-4.4	-4.2 m	0.0	0.0 m
Circuit 3	30	110ct3f1	0.0	0.0 m	0.0	0.0 m
Circuit 3	31	110ct3f2	0.0	0.0 m	0.0	0.0 m
Circuit 3	32	110ct3f3	0.0	0.0 m	0.0	0.0 m
Circuit 4	42	110ct4f1	0.0	0.0 m	0.0	0.0 m
Circuit 4	41	110ct4f2	0.0	0.0 m	0.0	0.0 m
Circuit 4	40	110ct4f3	0.0	0.0 m	0.0	0.0 m
Bliksemdraad 1	1	bl1	-4.4	-4.2 m	0.0	0.0 m
Bliksemdraad 2	3	bl2	-4.4	-4.2 m	0.0	0.0 m
Bliksemdraad 3	2	bl3	-4.4	-4.2 m	0.0	0.0 m

Line and tower data

		Back	Ahead
		354.9	336.5 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		359.2	341.8 m
Line angle	β	156.7 °	
Tower orientation with respect to bis	θ	0 °	
Section length		3225	2049 m
Height bottom of tower to ground level		0.5 m	
Wind directions considered	α_1	0 °	
Wind directions according to:	α_2	45 °	
Geleiderbelastingen	α_3	90 °	
	α_4	135 °	
	α_5	78.35 °	
	α_6	101.65 °	

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Considered number of wind directions	
1a	6
3	6
4	1
6	1
Overig	1

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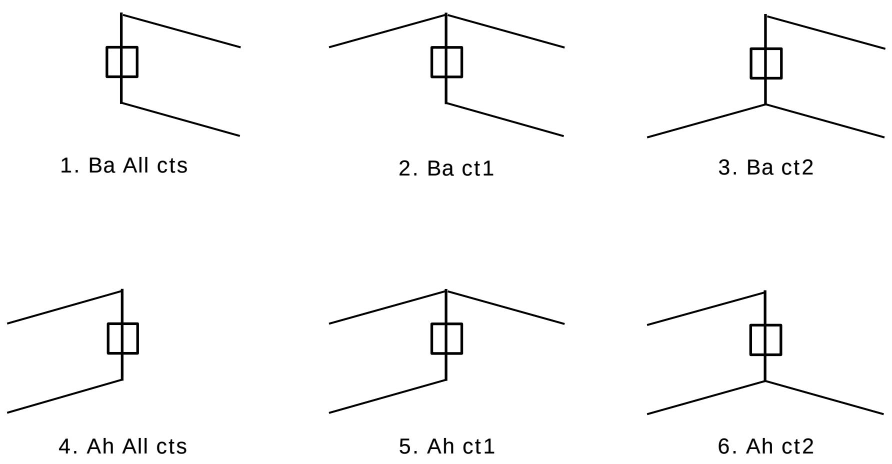
Absence of conductors

		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	1	0
Circuit 1	380ct1f2	1	0	1	0	1	0
Circuit 1	380ct1f3	1	0	1	0	1	0
Circuit 2	380ct2f1	0	1	1	0	1	0
Circuit 2	380ct2f2	0	1	1	0	1	0
Circuit 2	380ct2f3	0	1	1	0	1	0
Circuit 3	110ct3f1	1	0	1	0	1	0
Circuit 3	110ct3f2	1	0	1	0	1	0
Circuit 3	110ct3f3	1	0	1	0	1	0
Circuit 4	110ct4f1	0	1	1	0	1	0
Circuit 4	110ct4f2	0	1	1	0	1	0
Circuit 4	110ct4f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0
Bliksemdraad 3	bl3	0	1	1	0	1	0

Load situations SPLS

Considered situations SPLS: 1 up to 6, All possible situations

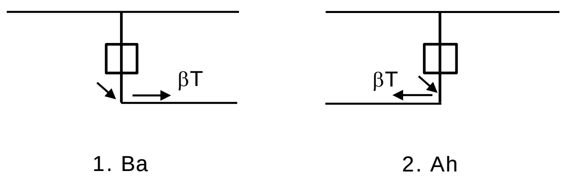
Principle of load situations:



Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



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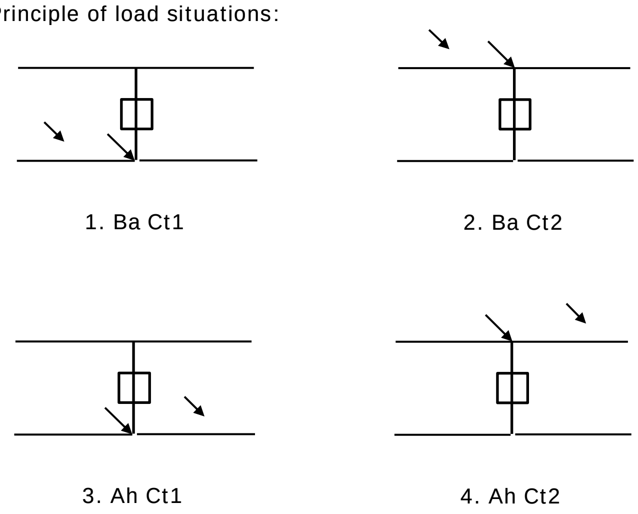
Load situations LC6. Construction and maintenance
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

3.0 kN	2.0 kN
1.0 kN	1.0 kN

Considered situations construction and maintenance 6a: 1 up to 4, all possible situations

Presence line vehicle: Circuit, load present in all conductors of a circuit

Principle of load situations:



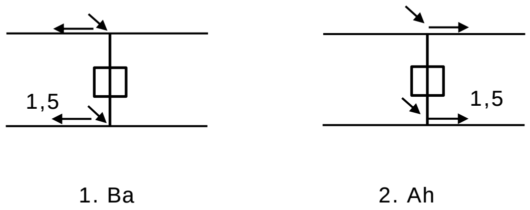
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0.866 W	1.5 W
Suspension tower earth	1.5 EDS	1.5 W
Strain tower phase and earth	1.5 EDS	1.5 W

Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



Load combination 8. Galloping as a dynamic load
Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

Tower structure

0.06

Properties

Tower type	Hoekmast		
Tower designation	HA-6 RC		
Base plate w.r.t. ground level	0.5 m		
Tower height w.r.t. base plate	48.3 m		
Tower self weight	590.0 kN		
Width and slope at foundation	x-ri.	y-ri.	
Leg spread	12.00	12.00	m
Inclination of main leg	0.168	0.168	-
Horizontal force factor	1.3	1.3	-

Calculation Wind load

Dynamic factor G_T	1.00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross a	0.4

Properties mast sections line direction (front view, yz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	9.60	12.00	8.77	9.60	0.168	99.68	14.80	0.15	3.17
Eerste tussenstuk	19.00	8.77	5.60	9.40	0.168	67.52	12.49	0.18	3.00
Tweede tussenstuk	31.00	5.60	3.80	12.00	0.075	56.40	15.26	0.27	2.64
Bovenstuk 1	38.80	3.80	3.19	7.80	0.039	27.26	6.34	0.23	2.79
Bovenstuk 2	46.30	3.19	2.60	7.50	0.039	21.71	5.18	0.24	2.77
Topstuk	48.30	2.60		2.00		2.60	0.40	0.15	3.14
Ondertraverse	19.00	14.60		4.00		29.20	5.71	0.20	2.95
Boventraverse	42.30	14.84		5.30		39.33	6.77	0.17	3.06
Midtraverse	31.00	13.90		4.00		27.80	5.79	0.21	2.89

Properties tower sections transverse direction (side view, xz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	9.60	12.00	8.77	9.60	0.168	99.68	14.80	0.15	3.17
Eerste tussenstuk	19.00	8.77	5.60	9.40	0.168	67.52	12.49	0.18	3.00
Tweede tussenstuk	31.00	5.60	3.80	12.00	0.075	56.40	15.26	0.27	2.64
Bovenstuk 1	38.80	3.80	3.19	7.80	0.039	27.26	6.34	0.23	2.79
Bovenstuk 2	46.30	3.19	2.60	7.50	0.039	21.71	5.18	0.24	2.77
Topstuk	48.30	2.60		2.00		2.60	0.40	0.15	3.14
Ondertraverse	19.00	14.60		4.00		29.20	5.71	0.20	2.95
Boventraverse	42.30	14.84		5.30		39.33	6.77	0.17	3.06
Midtraverse	31.00	13.90		4.00		27.80	5.79	0.21	2.89

Note: Surface transverse direction is reduced in calculation.

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Wind surface feeders telecom installations			
Part	A (m^2/m)	Δh	A_1
Broekstuk			
Eerste tussenstuk			
Tweede tussenstuk			
Bovenstuk 1			
Bovenstuk 2			

Input antennas			
Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m²]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	32.8	27.9	0.0	-27.9	4.8	157.7	133.8	0.0	-133.8
Eerste tussenstuk	0.80	29.9	25.4	0.0	-25.4	14.3	427.7	362.9	0.0	-362.9
Tweede tussenstuk	0.94	37.8	32.1	0.0	-32.1	25.0	945.6	802.4	0.0	-802.4
Bovenstuk 1	1.04	18.3	15.6	0.0	-15.6	34.9	639.7	542.8	0.0	-542.8
Bovenstuk 2	1.09	15.6	13.2	0.0	-13.2	42.6	663.6	563.0	0.0	-563.0
Topstuk	1.12	1.4	1.2	0.0	-1.2	47.3	66.7	56.6	0.0	-56.6
Ondertraverse	0.88	29.7	17.7	0.0	-17.7	20.3	604.4	359.0	0.0	-359.0
Boventraverse	1.10	45.4	27.0	0.0	-27.0	44.1	2001.2	1188.6	0.0	-1188.6
Midtraverse	1.01	33.8	20.1	0.0	-20.1	32.3	1093.9	649.8	0.0	-649.8
Totaal		244.9	180.1	0.0	-180.1		6600.5	4659.0	0.0	-4659.0

Tower section loads longitudinal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m²]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	0.0	27.9	32.8	27.9	4.8	0.0	133.8	157.7	133.8
Eerste tussenstuk	0.80	0.0	25.4	29.9	25.4	14.3	0.0	362.9	427.7	362.9
Tweede tussenstuk	0.94	0.0	32.1	37.8	32.1	25.0	0.0	802.4	945.6	802.4
Bovenstuk 1	1.04	0.0	15.6	18.3	15.6	34.9	0.0	542.8	639.7	542.8
Bovenstuk 2	1.09	0.0	13.2	15.6	13.2	42.6	0.0	563.0	663.6	563.0
Topstuk	1.12	0.0	1.2	1.4	1.2	47.3	0.0	56.6	66.7	56.6
Ondertraverse	0.88	0.0	17.7	11.9	17.7	20.3	0.0	359.0	241.8	359.0
Boventraverse	1.10	0.0	27.0	18.2	27.0	44.1	0.0	1188.6	800.5	1188.6
Midtraverse	1.01	0.0	20.1	13.5	20.1	32.3	0.0	649.8	437.6	649.8
Total		0.0	180.1	179.5	180.1		0.0	4659.0	4380.8	4659.0

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	590	0	0	0
Windrichting 0°	245	0	0	0	6601	0
Windrichting 45°	180	180	0	4659	4659	0
Windrichting 90°	0	180	0	4381	0	0
Windrichting 135°	-180	180	0	4659	-4659	0

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Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 3	AAAC IJSSEL	21.8	282.9	8.00	56500	2.30E-05
Circuit 4	AAAC IJSSEL	21.8	282.9	8.00	56500	2.30E-05
Bliksemdraad 1	B232 HAWK	21.8	281.0	9.70	74000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 3	OPGW 96 Fibral	15.8	116.0	4.85	85366	1.72E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 3	AAAC IJSSEL	21.8	282.9	8.00	56500	2.30E-05
Circuit 4	AAAC IJSSEL	21.8	282.9	8.00	56500	2.30E-05
Bliksemdraad 1	B232 HAWK	21.8	281.0	9.70	74000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 3	OPGW 96 Fibral	15.8	116.0	4.85	85366	1.72E-05

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 3	1	3	8.2	B	4+0,2d	8.4	8.4
Circuit 4	1	3	8.2	B	4+0,2d	8.4	8.4
Bliksemdraad 1	1	3	10.0	B	4+0,2d	8.4	8.4
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 3	1	3	5.0	B	4+0,2d	7.2	7.2

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 3	1	3	8.2	B	4+0,2d	8.4	8.4
Circuit 4	1	3	8.2	B	4+0,2d	8.4	8.4
Bliksemdraad 1	1	3	10.0	B	4+0,2d	8.4	8.4
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 3	1	3	5.0	B	4+0,2d	7.2	7.2

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m^2]	Wind heigth [m]	Pressure [kN/m^2]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	2.00	1	2	4.5	1.0	31.50	1.00	1.2	1.20
380ct1f2	2.00	1	2	4.5	1.0	31.50	1.00	1.2	1.20
380ct1f3	2.00	1	2	4.5	1.0	42.80	1.09	1.2	1.31
380ct2f1	2.00	1	2	4.5	1.0	31.50	1.00	1.2	1.20
380ct2f2	2.00	1	2	4.5	1.0	31.50	1.00	1.2	1.20
380ct2f3	2.00	1	2	4.5	1.0	42.80	1.09	1.2	1.31
110ct3f1	1.00	1	1	1.6	0.5	19.50	0.87	1.2	0.52
110ct3f2	1.00	1	1	1.6	0.5	19.50	0.87	1.2	0.52
110ct3f3	1.00	1	1	1.6	0.5	19.50	0.87	1.2	0.52
110ct4f1	1.00	1	1	1.6	0.5	19.50	0.87	1.2	0.52
110ct4f2	1.00	1	1	1.6	0.5	19.50	0.87	1.2	0.52
110ct4f3	1.00	1	1	1.6	0.5	19.50	0.87	1.2	0.52
bl1	0.10	0.5	0.05	0.3	0.1	47.80	1.12	1.2	0.13
bl2	0.10	0.5	0.05	0.3	0.1	47.80	1.12	1.2	0.13
bl3	0.10	0.5	0.05	0.3	0.1	23.20	0.92	1.2	0.11

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Wind load back

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	23.3	0.92	0.57	0.48	1.12	28.53	50.0	42.5	47.4	89.1	75.7
380ct1f2	23.3	0.92	0.57	0.48	1.12	28.53	50.0	42.5	47.4	89.1	75.7
380ct1f3	34.6	1.03	0.60	0.51	1.09	28.53	57.5	48.7	47.4	105.3	89.3
380ct2f1	23.3	0.92	0.57	0.48	1.12	28.53	50.0	42.5	47.4	89.1	75.7
380ct2f2	23.3	0.92	0.57	0.48	1.12	28.53	50.0	42.5	47.4	89.1	75.7
380ct2f3	34.6	1.03	0.60	0.51	1.09	28.53	57.5	48.7	47.4	105.3	89.3
110ct3f1	14.5	0.79	0.53	0.45	1.20	22.50	11.3	9.7	42.0	21.2	18.0
110ct3f2	14.5	0.79	0.53	0.45	1.20	22.50	11.3	9.7	42.0	21.2	18.0
110ct3f3	14.5	0.79	0.53	0.45	1.20	22.50	11.3	9.7	42.0	21.2	18.0
110ct4f1	14.5	0.79	0.53	0.45	1.20	22.50	11.3	9.7	42.0	21.2	18.0
110ct4f2	14.5	0.79	0.53	0.45	1.20	22.50	11.3	9.7	42.0	21.2	18.0
110ct4f3	14.5	0.79	0.53	0.45	1.20	22.50	11.3	9.7	42.0	21.2	18.0
bl1	40.6	1.07	0.61	0.52	1.20	22.45	17.7	15.0	41.9	33.1	28.1
bl2	40.6	1.07	0.61	0.52	1.20	22.35	17.7	15.0	41.8	33.1	28.0
bl3	16.0	0.82	0.54	0.46	1.20	16.23	8.6	7.3	36.6	19.3	16.4

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	24.0	0.93	0.57	0.50	1.12	28.53	50.6	44.7	47.4	90.3	79.8
380ct1f2	24.0	0.93	0.57	0.50	1.12	28.53	50.6	44.7	47.4	90.3	79.8
380ct1f3	35.3	1.03	0.60	0.53	1.09	28.53	57.9	51.1	47.4	106.2	93.7
380ct2f1	24.0	0.93	0.57	0.50	1.12	28.53	50.6	44.7	47.4	90.3	79.8
380ct2f2	24.0	0.93	0.57	0.50	1.12	28.53	50.6	44.7	47.4	90.3	79.8
380ct2f3	35.3	1.03	0.60	0.53	1.09	28.53	57.9	51.1	47.4	106.2	93.7
110ct3f1	15.0	0.80	0.53	0.47	1.20	22.50	11.5	10.2	42.0	21.5	19.0
110ct3f2	15.0	0.80	0.53	0.47	1.20	22.50	11.5	10.2	42.0	21.5	19.0
110ct3f3	15.0	0.80	0.53	0.47	1.20	22.50	11.5	10.2	42.0	21.5	19.0
110ct4f1	15.0	0.80	0.53	0.47	1.20	22.50	11.5	10.2	42.0	21.5	19.0
110ct4f2	15.0	0.80	0.53	0.47	1.20	22.50	11.5	10.2	42.0	21.5	19.0
110ct4f3	15.0	0.80	0.53	0.47	1.20	22.50	11.5	10.2	42.0	21.5	19.0
bl1	41.2	1.08	0.61	0.54	1.20	22.45	17.8	15.7	41.9	33.3	29.4
bl2	41.2	1.08	0.61	0.54	1.20	22.35	17.7	15.7	41.8	33.3	29.3
bl3	16.6	0.83	0.54	0.48	1.20	16.23	8.7	7.7	36.6	19.6	17.4

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Auteur: TBR
Versie: v11.5

Conductor loads

Starting points

Consequence class	Afkeur CC2-0
Reference period	30 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.05	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.12	0.00	0.0
ULS 3	Wind+ice	-5°	1.05	1.05	0.00	0.34	0.97	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.05	0.00	0.34	0.97	0.0
ULS 4	Cold+wind	-20°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.05	0.00	0.22	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.05	1.05	1.20	0.22	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 7	Permanent	10°	1.15	1.15	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.05	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.05	1.05	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.05	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.05	1.05	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.05	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.05	1.05	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.05	1.05	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	0.94	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.28	0.88	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	72
Number of load combinations for SPLS	246
Number of load combinations for SLS	15
Number of concentrated loads	10656

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Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-38.6	38.8	10.3	10.3	6.0	5.9
bl2	-38.9	39.2	10.4	10.3	6.0	5.9
380ct1f1	-129.9	129.9	33.4	33.4	17.3	16.6
380ct1f2	-129.9	129.9	33.4	33.4	17.3	16.6
380ct1f3	-131.6	131.7	36.2	36.0	17.3	16.6
380ct2f1	-129.9	129.9	33.4	33.4	17.3	16.6
380ct2f2	-129.9	129.9	33.4	33.4	17.3	16.6
380ct2f3	-131.6	131.7	36.2	36.0	17.3	16.6
110ct3f1	-40.4	40.6	8.9	8.9	7.3	7.2
110ct3f2	-40.4	40.6	8.9	8.9	7.3	7.2
110ct3f3	-40.4	40.6	8.9	8.9	7.3	7.2
110ct4f1	-40.4	40.6	8.9	8.9	7.3	7.2
110ct4f2	-40.4	40.6	8.9	8.9	7.3	7.2
110ct4f3	-40.4	40.6	8.9	8.9	7.3	7.2
bl3	-25.6	25.8	5.7	5.7	4.9	4.8
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	398.1	413.0	398.1
bl2	398.1	413.1	398.1
380ct1f1	389.6	397.4	389.6
380ct1f2	389.6	397.4	389.6
380ct1f3	389.6	397.6	389.6
380ct2f1	389.6	397.4	389.6
380ct2f2	389.6	397.4	389.6
380ct2f3	389.6	397.6	389.6
110ct3f1	345.7	345.7	345.7
110ct3f2	345.7	345.7	345.7
110ct3f3	345.7	345.7	345.7
110ct4f1	345.7	345.7	345.7
110ct4f2	345.7	345.7	345.7
110ct4f3	345.7	345.7	345.7
bl3	398.1	408.7	398.1
Post 1			
Post 2			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	424.9	395.6
bl2	424.5	395.8
380ct1f1	402.2	389.3
380ct1f2	402.2	389.3
380ct1f3	405.3	389.9
380ct2f1	402.2	389.3
380ct2f2	402.2	389.3
380ct2f3	405.3	389.9
110ct3f1	345.7	345.7
110ct3f2	345.7	345.7
110ct3f3	345.7	345.7
110ct4f1	345.7	345.7
110ct4f2	345.7	345.7
110ct4f3	345.7	345.7
bl3	423.6	389.4
Post 1		
Post 2		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	435.6 m	1.260 -
Min. weight span	345.7 m	1.000 -

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Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	38.8	20.0	6.0	-39.5	39.8
bl2	39.2	20.1	6.0	-39.9	40.1
380ct1f1	113.0	65.2	17.3	-133.8	133.8
380ct1f2	113.0	65.2	17.3	-133.8	133.8
380ct1f3	113.5	70.4	17.3	-135.7	135.8
380ct2f1	113.0	65.2	17.3	-133.8	133.8
380ct2f2	113.0	65.2	17.3	-133.8	133.8
380ct2f3	113.5	70.4	17.3	-135.7	135.8
110ct3f1	40.6	15.2	7.3	-41.3	41.5
110ct3f2	40.6	15.2	7.3	-41.3	41.5
110ct3f3	40.6	15.2	7.3	-41.3	41.5
110ct4f1	40.6	15.2	7.3	-41.3	41.5
110ct4f2	40.6	15.2	7.3	-41.3	41.5
110ct4f3	40.6	15.2	7.3	-41.3	41.5
bl3	25.8	10.8	4.9	-26.2	26.4
Post 1	2.7	2.7	4.0	0.0	
Post 2	2.7	2.7	4.0	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	20.5	4.2	2.1	-21.0	21.0
bl2	20.8	4.3	2.1	-21.2	21.2
380ct1f1	79.8	16.5	11.2	-81.5	81.5
380ct1f2	79.8	16.5	11.2	-81.5	81.5
380ct1f3	79.8	16.5	11.2	-81.5	81.5
380ct2f1	79.8	16.5	11.2	-81.5	81.5
380ct2f2	79.8	16.5	11.2	-81.5	81.5
380ct2f3	79.8	16.5	11.2	-81.5	81.5
110ct3f1	16.9	3.5	2.5	-17.3	17.3
110ct3f2	16.9	3.5	2.5	-17.3	17.3
110ct3f3	16.9	3.5	2.5	-17.3	17.3
110ct4f1	16.9	3.5	2.5	-17.3	17.3
110ct4f2	16.9	3.5	2.5	-17.3	17.3
110ct4f3	16.9	3.5	2.5	-17.3	17.3
bl3	10.3	2.1	1.1	-10.5	10.5
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	0.0
	bl2	0.0	0.0
	380ct1f1	0.0	0.0
	380ct1f2	0.0	0.0
	380ct1f3	0.0	0.0
	380ct2f1	0.0	0.0
	380ct2f2	0.0	0.0
	380ct2f3	0.0	0.0
	110ct3f1	0.0	0.0
	110ct3f2	0.0	0.0
	110ct3f3	0.0	0.0
	110ct4f1	0.0	0.0
	110ct4f2	0.0	0.0
	110ct4f3	0.0	0.0
	bl3	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	

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ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		13	548	192	18159	413	0
ULS 1a_0,9_0		6	271	186	8994	201	66
ULS 1a_0,9_0,9_90		15	530	166	17555	499	0
ULS 3_0		-2	420	277	13809	-63	20
SLS 7		0	261	179	8655	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

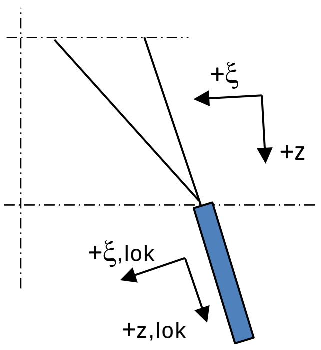
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	13	748	812	23051	413	0
ULS 1a_0,9_0,9_90	15	730	697	22447	499	0
SLS 7	0	261	769	8655	0	0

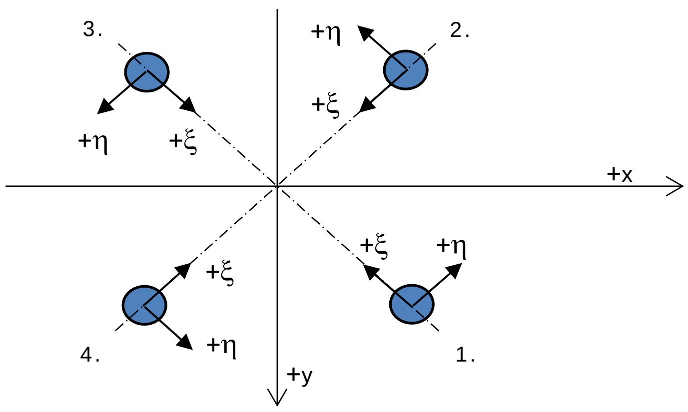
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	13	748	812	23051	413	0
SPLS 3_0 Ba All Cts	914	169	750	5620	29422	26
SPLS 3_101.65 Ah Ct2	-447	383	797	11606	-14452	-5572
SPLS 3_90 Ba All Cts	895	284	751	8858	29413	4

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_90 Ba All Cts	346	380	1782	-24	-513	-89	1832
2	SPLS 3_0 Ba All Cts	218	-268	1179	35	-343	-62	1212
3	SPLS 3_135 Ah All Cts	-193	-243	1066	-35	-308	-54	1096
4	SPLS 3_90 Ah All Cts	-345	379	1775	24	-511	-89	1824

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-117	-164	-712	34	199	29	-732
2	SPLS 3_0,9_90 Ah All Cts	-266	301	-1419	-24	401	63	-1459
3	SPLS 3_0,9_90 Ba All Cts	268	303	-1429	25	404	64	-1469
4	SPLS 3_0,9_0 Ba All Cts	142	-190	-827	-34	234	37	-850

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_90 Ah Ct1	168	-104	141	193	-45	-12	145
2	SPLS 6a_90 Ba Ct2 Ah Ct2	-42	-222	443	187	-127	-22	455
3	SPLS 6a_90 Ba Ct2 Ah Ct2	44	286	-836	171	233	34	-859
4	SPLS 6a_90 Ah Ct1 Ba Ct1	-136	373	1253	167	-359	-61	1288

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_90 Ba Ct1 Ah Ct1	137	374	1261	-168	-361	-61	1296
2	SPLS 3_0,9_101.65 Ah Ct2	-63	305	-908	-171	260	44	-934
3	SPLS 6a_90 Ah Ct2 Ba Ct2	43	-220	435	-186	-125	-22	448
4	SPLS 3_90 Ba Ct1	-165	-106	129	-192	-42	-11	132

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Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-117	-164	-712	34	199	29	-732
2	SPLS 3_0,9_90 Ah All Cts	-266	301	-1419	-24	401	63	-1459
3	SPLS 3_0,9_90 Ba All Cts	268	303	-1429	25	404	64	-1469
4	SPLS 3_0,9_0 Ba All Cts	142	-190	-827	-34	234	37	-850

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	121	107	553	10	-161	-30	568
2	SLS 7	-37	23	-168	10	42	2	-173
3	SLS 7	37	23	-168	-10	42	2	-173
4	SLS 7	-121	107	553	-10	-161	-30	568

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	SPLS 3_90 Ba All Cts	346	380	1782	-24	-513	-89	1832
Max. tension	SPLS 3_0,9_90 Ba All Cts	268	303	-1429	25	404	64	-1469
Max. pos. torsie	SPLS 3_90 Ah Ct1	168	-104	141	193	-45	-12	145
Max. neg. torsie	SPLS 3_90 Ba Ct1	-165	-106	129	-192	-42	-11	132
Comb. tension+torsie	SPLS 3_0,9_90 Ba All Cts	268	303	-1429	25	404	64	-1469

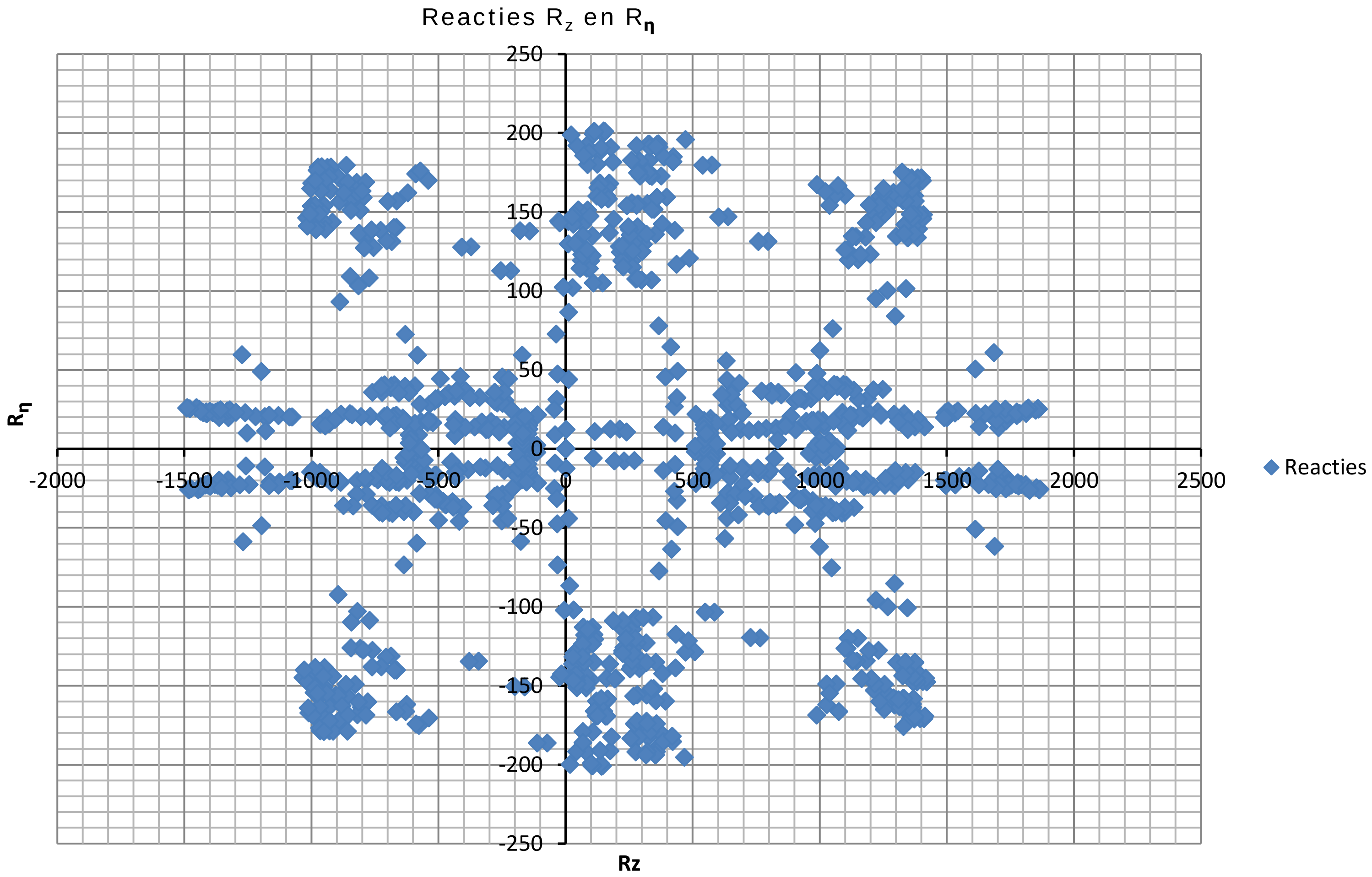
Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	121	107	553	10	-161	-30	568
2	SLS 1a_90	-141	119	-641	15	184	31	-659
3	SLS 1a_90	146	126	-671	-15	193	33	-690
4	SLS 1a_0	-61	50	286	-8	-78	-10	294

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_90	231	210	1057	15	-312	-60	1087
2	SLS 1a_0	21	-36	98	11	-41	-17	101
3	SLS 7	37	23	-168	-10	42	2	-173
4	SLS 1a_90	-225	204	1027	-15	-304	-59	1056

Project: ENS-ZL
Tower: HA-6 RC
Number: 82



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Project: ENS-ZL
Tower: HA-6 RC
Number: 82

Auteur: TBR
Versie: v11.5

Conductor loads

Starting points

Consequence class	Verbouw CC2
Reference period	50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.15	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.40	0.00	0.0
ULS 3	Wind+ice	-5°	1.15	1.15	0.00	0.42	1.30	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.15	0.00	0.42	1.30	0.0
ULS 4	Cold+wind	-20°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.15	0.00	0.28	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.15	1.15	1.30	0.28	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 7	Permanent	10°	1.30	1.30	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.15	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.15	1.15	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.15	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.15	1.15	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.15	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.15	1.15	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.15	1.15	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	1.00	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.30	1.00	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	72
Number of load combinations for SPLS	246
Number of load combinations for SLS	15
Number of concentrated loads	10656

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Project: ENS-ZL
Tower: HA-6 RC
Number: 82

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-41.1	41.1	12.2	12.1	6.5	6.4
bl2	-41.4	41.5	12.2	12.1	6.5	6.4
380ct1f1	-148.2	147.9	39.3	39.2	20.3	19.4
380ct1f2	-148.2	147.9	39.3	39.2	20.3	19.4
380ct1f3	-150.3	150.1	42.8	42.5	20.3	19.4
380ct2f1	-148.2	147.9	39.3	39.2	20.3	19.4
380ct2f2	-148.2	147.9	39.3	39.2	20.3	19.4
380ct2f3	-150.3	150.1	42.8	42.5	20.3	19.4
110ct3f1	-42.7	42.9	9.5	9.5	8.0	7.9
110ct3f2	-42.7	42.9	9.5	9.5	8.0	7.9
110ct3f3	-42.7	42.9	9.5	9.5	8.0	7.9
110ct4f1	-42.7	42.9	9.5	9.5	8.0	7.9
110ct4f2	-42.7	42.9	9.5	9.5	8.0	7.9
110ct4f3	-42.7	42.9	9.5	9.5	8.0	7.9
bl3	-27.1	27.2	6.4	6.3	5.3	5.2
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	398.1	413.1	398.1
bl2	398.1	413.2	398.1
380ct1f1	389.6	397.5	389.6
380ct1f2	389.6	397.5	389.6
380ct1f3	389.6	397.7	389.6
380ct2f1	389.6	397.5	389.6
380ct2f2	389.6	397.5	389.6
380ct2f3	389.6	397.7	389.6
110ct3f1	345.7	345.7	345.7
110ct3f2	345.7	345.7	345.7
110ct3f3	345.7	345.7	345.7
110ct4f1	345.7	345.7	345.7
110ct4f2	345.7	345.7	345.7
110ct4f3	345.7	345.7	345.7
bl3	398.1	408.9	398.1
Post 1			
Post 2			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	428.1	392.6
bl2	427.7	392.9
380ct1f1	404.2	387.6
380ct1f2	404.2	387.6
380ct1f3	407.9	388.3
380ct2f1	404.2	387.6
380ct2f2	404.2	387.6
380ct2f3	407.9	388.3
110ct3f1	345.7	345.7
110ct3f2	345.7	345.7
110ct3f3	345.7	345.7
110ct4f1	345.7	345.7
110ct4f2	345.7	345.7
110ct4f3	345.7	345.7
bl3	426.6	386.4
Post 1		
Post 2		

Envelop of weight span over all combinations (incl. 0,9 combinations)		
For all conductors		Wind / Weight span ratio
Max. weight span	447.5 m	1.295 -
Min. weight span	345.7 m	1.000 -

Project: ENS-ZL
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Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	39.8	23.6	6.5	-42.4	42.2
bl2	40.2	23.6	6.5	-42.8	42.6
380ct1f1	118.7	76.4	20.3	-152.8	152.4
380ct1f2	118.7	76.4	20.3	-152.8	152.4
380ct1f3	118.9	83.0	20.3	-155.2	154.9
380ct2f1	118.7	76.4	20.3	-152.8	152.4
380ct2f2	118.7	76.4	20.3	-152.8	152.4
380ct2f3	118.9	83.0	20.3	-155.2	154.9
110ct3f1	41.3	17.7	8.0	-43.7	43.9
110ct3f2	41.3	17.7	8.0	-43.7	43.9
110ct3f3	41.3	17.7	8.0	-43.7	43.9
110ct4f1	41.3	17.7	8.0	-43.7	43.9
110ct4f2	41.3	17.7	8.0	-43.7	43.9
110ct4f3	41.3	17.7	8.0	-43.7	43.9
bl3	26.2	12.6	5.3	-27.8	27.9
Post 1	3.4	3.4	4.6	0.0	
Post 2	3.4	3.4	4.6	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	20.5	4.2	2.1	-21.0	21.0
bl2	20.8	4.3	2.1	-21.2	21.2
380ct1f1	79.8	16.5	11.2	-81.5	81.5
380ct1f2	79.8	16.5	11.2	-81.5	81.5
380ct1f3	79.8	16.5	11.2	-81.5	81.5
380ct2f1	79.8	16.5	11.2	-81.5	81.5
380ct2f2	79.8	16.5	11.2	-81.5	81.5
380ct2f3	79.8	16.5	11.2	-81.5	81.5
110ct3f1	16.9	3.5	2.5	-17.3	17.3
110ct3f2	16.9	3.5	2.5	-17.3	17.3
110ct3f3	16.9	3.5	2.5	-17.3	17.3
110ct4f1	16.9	3.5	2.5	-17.3	17.3
110ct4f2	16.9	3.5	2.5	-17.3	17.3
110ct4f3	16.9	3.5	2.5	-17.3	17.3
bl3	10.3	2.1	1.1	-10.5	10.5
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	0.0
	bl2	0.0	0.0
	380ct1f1	0.0	0.0
	380ct1f2	0.0	0.0
	380ct1f3	0.0	0.0
	380ct2f1	0.0	0.0
	380ct2f2	0.0	0.0
	380ct2f3	0.0	0.0
	110ct3f1	0.0	0.0
	110ct3f2	0.0	0.0
	110ct3f3	0.0	0.0
	110ct4f1	0.0	0.0
	110ct4f2	0.0	0.0
	110ct4f3	0.0	0.0
	bl3	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	

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ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		14	643	211	21337	471	0
ULS 1a_0,9_0		7	291	203	9657	222	82
ULS 1a_0,9_0,9_90		18	618	169	20471	607	0
ULS 3_0		-5	476	325	15666	-169	25
SLS 7		0	261	179	8655	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

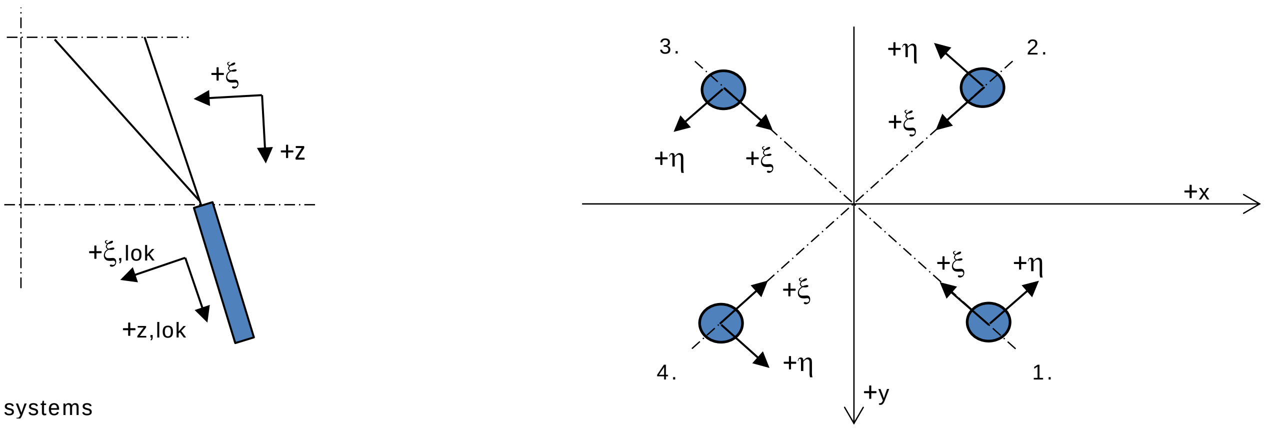
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	14	895	890	27470	471	0
ULS 1a_0,9_0,9_90	18	869	700	26604	607	0
SLS 7	0	261	769	8655	0	0

Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	14	895	890	27470	471	0
SPLS 3_0 Ba All Cts	959	178	820	5941	30940	26
SPLS 3_101.65 Ah Ct2	-469	396	870	11993	-15207	-5811
SPLS 3_90 Ba All Cts	934	292	820	9135	30713	5

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_90 Ba All Cts	362	398	1865	-25	-537	-93	1918
2	SPLS 3_0 Ba All Cts	230	-283	1247	38	-363	-66	1281
3	SPLS 3_135 Ah All Cts	-206	-258	1134	-37	-328	-58	1166
4	SPLS 3_90 Ah All Cts	-361	397	1860	25	-536	-93	1912

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-125	-175	-760	36	212	31	-782
2	SPLS 3_0,9_90 Ah All Cts	-279	315	-1484	-26	420	66	-1526
3	SPLS 3_0,9_90 Ba All Cts	280	317	-1492	26	422	66	-1533
4	SPLS 3_0,9_0 Ba All Cts	150	-201	-875	-36	248	39	-899

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_90 Ah Ct1	176	-108	149	201	-48	-12	154
2	SPLS 6a_90 Ba Ct2 Ah Ct2	-42	-235	472	196	-136	-24	485
3	SPLS 6a_90 Ba Ct2 Ah Ct2	43	298	-864	180	241	35	-888
4	SPLS 6a_90 Ah Ct1 Ba Ct1	-144	392	1323	175	-380	-64	1360

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_90 Ba Ct1 Ah Ct1	145	394	1329	-176	-381	-64	1366
2	SPLS 3_0,9_101.65 Ah Ct2	-66	319	-952	-179	272	46	-979
3	SPLS 6a_90 Ah Ct2 Ba Ct2	43	-233	467	-195	-135	-23	480
4	SPLS 3_90 Ba Ct1	-174	-110	140	-201	-45	-12	144

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Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_0,9_135 Ah All Cts	-125	-175	-760	36	212	31	-782
2	SPLS 3_0,9_90 Ah All Cts	-279	315	-1484	-26	420	66	-1526
3	SPLS 3_0,9_90 Ba All Cts	280	317	-1492	26	422	66	-1533
4	SPLS 3_0,9_0 Ba All Cts	150	-201	-875	-36	248	39	-899

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	121	107	553	10	-161	-30	568
2	SLS 7	-37	23	-168	10	42	2	-173
3	SLS 7	37	23	-168	-10	42	2	-173
4	SLS 7	-121	107	553	-10	-161	-30	568

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	SPLS 3_90 Ba All Cts	362	398	1865	-25	-537	-93	1918
Max. tension	SPLS 3_0,9_90 Ba All Cts	280	317	-1492	26	422	66	-1533
Max. pos. torsie	SPLS 3_90 Ah Ct1	176	-108	149	201	-48	-12	154
Max. neg. torsie	SPLS 3_90 Ba Ct1	-174	-110	140	-201	-45	-12	144
Comb. tension+torsie	SPLS 3_0,9_90 Ba All Cts	280	317	-1492	26	422	66	-1533

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	121	107	553	10	-161	-30	568
2	SLS 1a_90	-148	126	-673	16	194	33	-692
3	SLS 1a_90	154	133	-706	-15	203	35	-725
4	SLS 1a_0	-57	47	270	-7	-73	-9	278

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_90	239	217	1092	15	-322	-62	1123
2	SLS 1a_0	25	-40	114	11	-46	-18	117
3	SLS 7	37	23	-168	-10	42	2	-173
4	SLS 1a_90	-233	210	1059	-16	-313	-61	1089

Project: ENS-ZL
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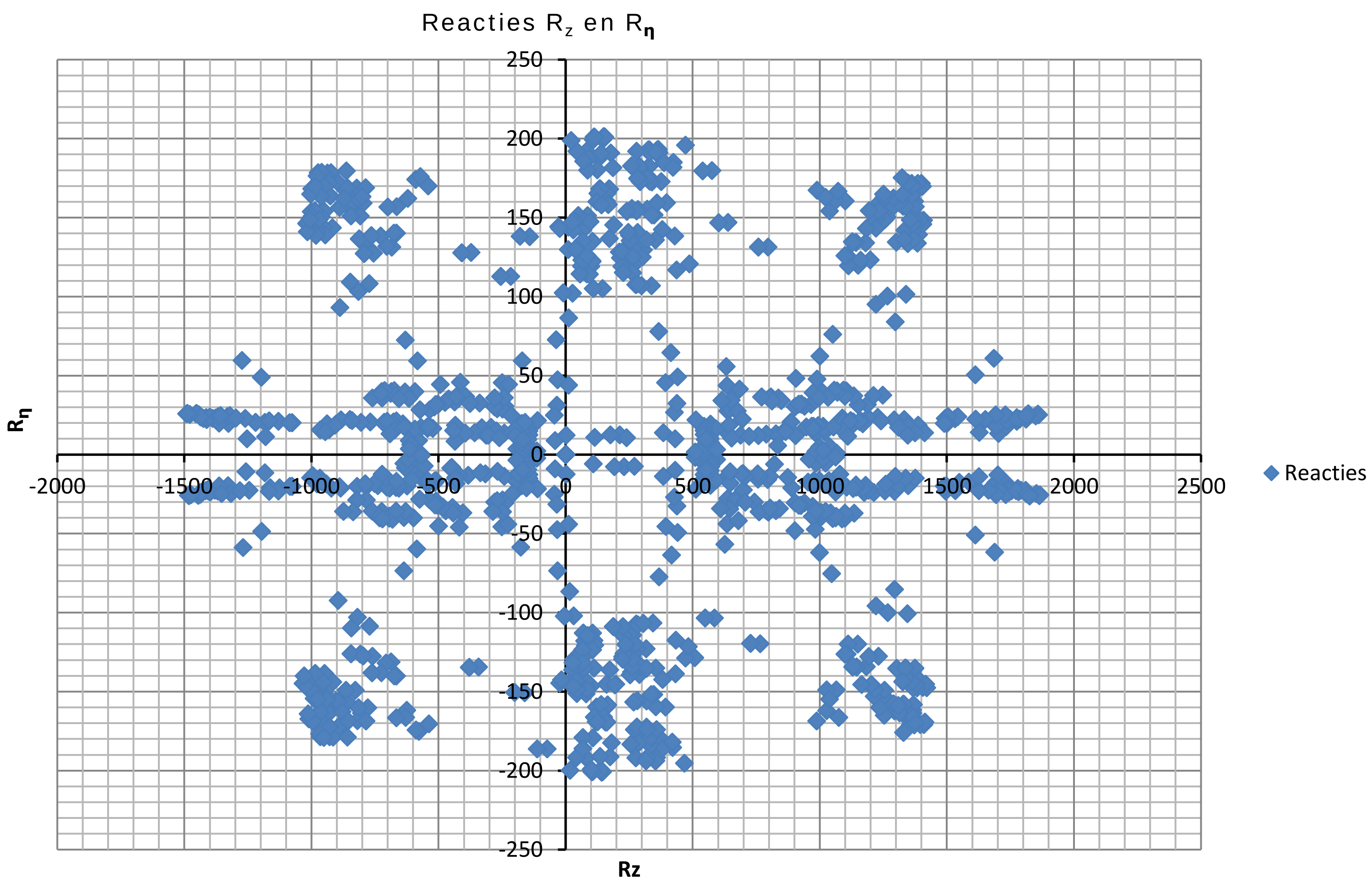
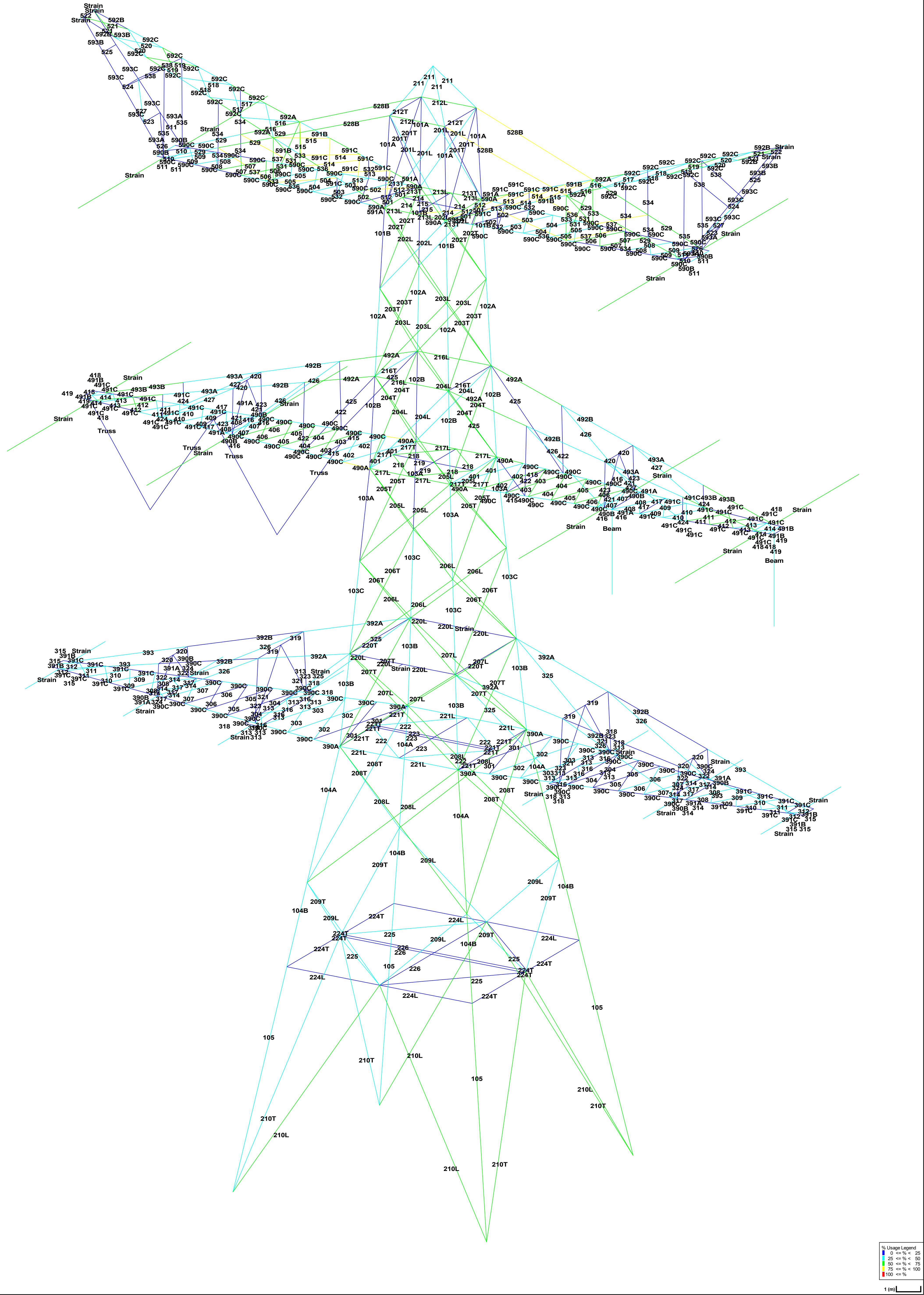
Number: 82



APPENDIX B
Uitvoer PLS-TOWER

DNV GL Nederlands BV, Project: "HA-6_RC ini"
Tower Version 16.63, 11:30:14 Friday, 15 January, 2021
Undeformed geometry displayed



DNV·GL

Assessment of groups for initial mast (afkeur level)

Date	18-01-21
Author	MKh
Version	1.0

ENS-ZL 380
HA-6 RC
82

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101A	Leg	120x120x10	S355	8M24-8.8t	0.50	0.50	0.50	85	**-72.2**	SPLS 6a_90 Ba Ct1 Ah Ct2	485.4	1074.8	1411.2	0.15		**25.4**	3_0,9_101.65 Ba All Cts	635.0	1074.8	1326.8	0.04	
101B	Leg	120x120x10	S355	9M24-8.8t	0.50	0.50	0.50	74	**-169.7**	SPLS 6a_90 Ba All Cts Ah Ct2	557.9	1214.9	1587.6	0.30		**141.3**	SPLS 3_0,9_90 Ba Ct1	635.0	1214.9	1492.6	0.22	
102A	Leg	160x160x15#	S355	8M24-8.8t	0.50	0.50	0.50	60	**-449.3**	SPLS 3_90 Ba All Cts	1288.7	1084.4	2116.8	0.41		**356.8**	SPLS 3_0,9_90 Ba All Cts	1372.7	1084.4	1990.2	0.33	
102B	Leg	160x160x15#	S355	10M24-8.8t	0.50	0.50	0.50	64	**-423.6**	SPLS 3_90 Ba All Cts	1252.5	1355.5	2646.0	0.34		**318.7**	SPLS 3_0,9_90 Ba All Cts	1372.7	1355.5	2058.0	0.24	
103A	Leg	250x250x18#	S355	12M24-8.8t	0.52	0.52	0.52	42	**-839.3**	SPLS 3_90 Ba All Cts	2680.5	2975.4	3810.2	0.31		**686.7**	SPLS 3_0,9_90 Ba All Cts	2763.8	2975.4	3582.3	0.25	
103B	Leg	250x250x18#	S355	16M24-8.8t	0.50	0.50	0.50	41	**-1313.7**	SPLS 3_90 Ba All Cts	2705.0	3646.3	5080.3	0.49		**1107.7**	SPLS 3_0,9_90 Ba All Cts	2763.8	3646.3	5080.3	0.40	
103C	Leg	250x250x18#	S355		0.50	0.50	0.50	41	**-1238.3**	SPLS 3_90 Ba All Cts	2705.0	0.0	0.0	0.46		**1040.7**	SPLS 3_0,9_90 Ba All Cts	3113.4	0.0	0.0	0.33	
104A	Leg	250x250x24#	S355	16M24-8.8t	0.50	0.50	0.50	61	**-1743.2**	SPLS 3_90 Ba All Cts	3165.5	3646.3	6773.8	0.55		**1438.3**	SPLS 3_0,9_90 Ba All Cts	3614.1	3646.3	6368.5	0.40	
104B	Leg	250x250x24#	S355	14M24-8.8t	0.50	0.50	0.50	38	**-1684.3**	SPLS 3_90 Ba All Cts	3707.0	3309.2	5927.0	0.51		**1389.7**	SPLS 3_0,9_90 Ba All Cts	3614.1	3309.2	5572.4	0.42	
105	Leg	250x250x24#	S355	12M24-8.8t	0.17	0.17	0.17	34	**-1695.1**	SPLS 3_90 Ba All Cts	3775.4	3049.9	5080.3	0.56		**1377.1**	SPLS 3_0,9_90 Ba All Cts	3614.1	3049.9	4776.4	0.45	
201L	CD	100x100x8	S235	2M24-8.8t	0.53	0.53	0.53	131	**-61.7**	SPLS 3_90 Ba Ct1	150.4	271.1	207.4	0.41		**46.5**	PLS 6a_90 Ba Ct1 Ba Ct2	181.4	271.1	189.2	0.26	
201T	CD	100x100x8	S235	2M24-8.8t	0.53	0.53	0.53	131	**-34.7**	SPLS 6a_90 Ah Ct1 Ah Ct2	150.4	271.1	207.4	0.23		**21.7**	SPLS 3_0,9_78.35 Ba Ct1	181.4	271.1	189.2	0.12	
202L	CD	150x150x18#	S235	5M24-8.8t	0.53	0.53	0.53	84	**-348.4**	SPLS 6a_90 Ba Ct1 Ah Ct1	733.6	677.8	1166.4	0.51		**296.4**	PLS 6a_90 Ba Ct2 Ah Ct2	687.5	677.8	901.1	0.44	
202T	CD	150x150x12	S235	4M24-8.8t	0.53	0.53	0.53	83	**-292.7**	SPLS 6a_90 Ba Ct2 Ah Ct2	502.8	542.2	622.1	0.58		**306.7**	PLS 6a_90 Ba Ct1 Ah Ct1	470.2	542.2	486.8	0.65	
203L	CD	150x150x12	S235	5M24-8.8t	0.53	0.53	0.53	91	**-270.6**	SPLS 6a_90 Ba Ct2 Ah Ct2	474.0	677.8	777.6	0.57		**316.9**	PLS 6a_90 Ba Ct1 Ah Ct1	470.2	677.8	600.7	0.67	
203T	CD	150x150x12	S235	4M24-8.8t	0.53	0.53	0.53	91	**-279.5**	SPLS 6a_90 Ba Ct1 Ah Ct1	474.0	542.2	622.1	0.59		**265.9**	PLS 6a_90 Ba Ct1 Ah Ct1	470.2	542.2	486.8	0.57	
204L	CD	150x150x18#	S235	5M24-8.8t	0.53	0.53	0.53	98	**-353.3**	SPLS 6a_90 Ba Ct1 Ah Ct1	656.1	677.8	1166.4	0.54		**317.0**	PLS 6a_90 Ba Ct2 Ah Ct2	687.5	677.8	901.1	0.47	
204T	CD	150x150x18#	S235	4M24-8.8t	0.53	0.53	0.53	98	**-305.0**	SPLS 6a_90 Ba Ct2 Ah Ct2	656.1	542.2	933.1	0.56		**275.1**	SPLS 3_0,9_90 Ba Ct1	687.5	542.2	730.1	0.51	
205L	CD	160x160x15#	S355	6M24-8.8t	0.54	0.27	0.27	63	**-531.8**	SPLS 6a_90 Ba Ct1 Ah Ct1	1013.3	810.8	1587.6	0.66		**484.2**	PLS 3_0,9_101.65 Ah Ct2	890.7	810.8	1430.8	0.60	
205T	CD	160x160x15#	S355	6M24-8.8t	0.54	0.27	0.27	63	**-502.0**	SPLS 6a_90 Ba Ct1 Ah Ct1	1013.3	810.8	1587.6	0.62		**508.8**	PLS 6a_90 Ba Ct1 Ah Ct1	890.7	810.8	1430.8	0.63	
206L	CD	160x160x15#	S355	5M24-8.8t	0.54	0.27	0.27	68	**-399.0**	SPLS 3_0,9_101.65 Ah Ct2	966.4	677.8	1323.0	0.59		**432.5**	PLS 6a_90 Ba Ct1 Ah Ct1	890.7	677.8	1200.2	0.64	
206T	CD	160x160x15#	S355	5M24-8.8t	0.54	0.27	0.27	68	**-417.5**	SPLS 6a_90 Ba Ct1 Ah Ct1	966.4	677.8	1323.0	0.62		**414.3**	PLS 6a_90 Ba Ct1 Ah Ct1	890.7	677.8	1200.2	0.61	
207L	CD	160x160x15#	S355	5M24-8.8t	0.53	0.27	0.27	72	**-431.8**	SPLS 6a_90 Ba Ct1 Ah Ct1	930.5	677.8	1323.0	0.64		**380.3**	PLS 6a_90 Ba Ct2 Ah Ct2	890.7	677.8	1200.2	0.56	
207T	CD	160x160x15#	S355	5M24-8.8t	0.53	0.27	0.27	72	**-420.4**	SPLS 6a_90 Ba Ct2 Ah Ct2	930.5	677.8	1323.0	0.62		**390.1**	SPLS 3_0,9_90 Ba Ct1	890.7	677.8	1200.2	0.58	
208L	CD	180x180x16#	S355	5M24-8.8t	0.58	0.29	0.29	93	**-346.8**	SPLS 3_0,9_101.65 Ah Ct2	887.6	677.8	1411.2	0.51		**340.8**	SPLS 3_101.65 Ah Ct1	1066.1	677.8	1295.9	0.50	
208T	CD	180x180x16#	S355	5M24-8.8t	0.58	0.29	0.29	93	**-338.6**	SPLS 3_0,9_101.65 Ah Ct1	887.6	677.8	1411.2	0.50		**345.3**	SPLS 3_101.65 Ah Ct2	1066.1	677.8	1295.9	0.51	
209L	CD	160x160x17#	S355	4M24-8.8t	1.00	0.50	0.50	108	**-268.7**	SPLS 3_101.65 Ah Ct1	714.2	542.2	1199.5	0.50		**268.5**	PLS 3_0,9_101.65 Ah Ct2	987.9	542.2	1098.9	0.50	
209T	CD	160x160x17#	S355	4M24-8.8t	1.00	0.50	0.50	108	**-268.2**	SPLS 3_101.65 Ah Ct2	714.2	542.2	1199.5	0.49		**262.2**	PLS 3_0,9_101.65 Ah Ct1	987.9	542.2	1098.9	0.48	
210L	CD	150x150x14	S355	5M24-8.8t	0.17	0.17	0.17	66	**-358.1**	SPLS 3_101.65 Ah Ct1	891.0	677.8	1234.8	0.53		**348.2**	PLS 3_0,9_101.65 Ah Ct2	759.4	677.8	1106.5	0.51	
210T	CD	150x150x14	S355	5M24-8.8t	0.17	0.17	0.17	66	**-363.2**	SPLS 3_101.65 Ah Ct2	891.0	677.8	1234.8	0.54		**331.6**	PLS 3_0,9_101.65 Ah Ct1	759.4	677.8	1106.5	0.49	
211	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	174	**-21.6**	SPLS 3_101.65 Ah Ct1	84.7	188.2	172.8	0.25		**21.5**	PLS 3_0,9_101.65 Ah Ct1	146.3	188.2	157.1	0.15	
212L		90x90x8	S235	4M24-8.8t	1.00	1.00	1.00	148	**0.0**		117.9	542.2	414.7	0.00		**95.7**	S 6a_90 Ah All Cts Ba Ct2	185.9	542.2	357.1	0.51	
212T		80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	164	**-3.5**	SPLS 6a_90 Ba Ct1 Ah Ct2	70.3	188.2	129.6	0.05		**6.2**	PLS 6a_90 Ba Ct1 Ba Ct2	112.1	188.2	117.8	0.06	
213L		150x150x14	S355	7M24-8.8t	1.00	2.00	1.00	64	**-539.6**	SPLS 6a_90 Ba All Cts Ah Ct1	1076.0	889.6	1728.7	0.61		**455.3**	3_0,9_101.65 Ba All Cts	913.5	889.6	1625.3	0.51	
213T		100x100x8	S235	6M24-8.8t	1.00	2.00	1.00	95	**-124.1**	SPLS 6a_90 Ah Ct1 Ah Ct2	192.8	813.3	622.1	0.64		**137.1**	PLS 6a_90 Ah Ct1 Ah Ct2	293.9	813.3	537.0	0.47	
214	Diagonal	100x100x10	S235	3M24-8.8t	1.00	1.00	1.00	106	**-173.9**	SPLS 6a_90 Ba Ct1 Ah Ct1	231.5	406.7	388.8	0.75		**174.2**	PLS 6a_90 Ba Ct1 Ah Ct1	239.0	406.7	302.4	0.73	
215	Diagonal	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	**-0.2**	ULS 3_0	31.9	60.3	43.2	0.01		**0.2**	PLS 6a_90 Ah Ct1 Ah Ct2	46.1	60.3	32.7	0.01	
216L		100x100x10	S235	5M24-8.8t	1.00	1.00	1.00	179	**-31.3**	SPLS 3_0,9_90 Ba All Cts	127.7	677.8	648.0	0.25		**165.0**	SPLS 3_90 Ah All Cts	275.8	677.8	609.2	0.60	
216T		120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	148	**-56.9**	ULS 1a_0,9_90	196.7	406.7	388.8	0.29		**76.2**	ULS 1a_90	333.2	406.7	365.5	0.23	
217L		180x180x16#	S355	8M24-8.8t	1.00	2.00	1.00	69	**-500.4**	SPLS 3_101.65 Ba All Cts	1409.8	960.2	2257.9	0.52		**376.9**	3_0,9_101.65 Ba All Cts	1406.0	960.2	2122.8	0.39	
217T		120x120x10	S235	6M24-8.8t	1.00	2.00	1.00	104	**-134.2**	SPLS 3_0,9_101.65 Ah Ct1	269.2	813.3	777.6	0.50		**168.1**	PLS 6a_90 Ah Ct1 Ah Ct2	466.6	813.3	598.2	0.36	
218	Diagonal	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	**-178.2**	SPLS 6a_90 Ba Ct1 Ah Ct1	261.1	406.7	388.8	0.68		**179.9**	PLS 6a_90 Ba Ct1 Ah Ct1	324.0	406.7	359.4	0.56	
219	Diagonal	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	**-1.8**	ULS 3_90	29.9	60.3	60.5	0.06		**2.1**	ULS 3_90	64.5	60.3	45.8	0.05	
220L		150x150x12	S355	5M24-8.8t	2.00	2.00	2.00	169	**-67.3**	SPLS 3_0,9_90 Ba All Cts	282.6	655.2	1058.4	0.24		**163.2**	S 6a_90 Ah All Cts Ba Ct3	869.3	655.2	995.1	0.25	
220T		160x160x17#	S355	4M24-8.8t	1.00	1.00	1.00	159	**-89.5**	ULS 1a_0,9_90	460.5	542.2	1199.5	0.19		**118.0**	ULS 1a_90	1073.8	542.2	1127.8	0.22	
221L		180x180x16#	S355	7M24-8.8t	1.00	2.00	1.00	102	**-247.4**	SPLS 6a_90 Ba All Cts Ah Ct3	897.5	824.3	1975.7	0.30		**113.8**	S 6a_90 Ba All Cts Ah Ct3	1406.0	824.3	1857.5	0.14	
221T		150x150x12	S235	6M24-8.8t	2.08	1.00	1.00	122	**-42.9**	SPLS 6a_90 Ba Ct1 Ah Ct3	346.1	813.3	933.1	0.12		**53.5**	PLS 6a_90 Ba Ct1 Ah Ct3	740.3	813.3	877.3	0.07	
222	Diagonal	120x120x10	S235	1M24-8.8t	1.00	1.00	1.00	165	**-47.9**	SPLS 6a_90 Ba Ct1 Ah Ct3	137.4	135.6	129.6	0.37		**49.2**	PLS 6a_90 Ba Ct1 Ah Ct3	270.7	135.6	121.8	0.40	
223	Diagonal	70x70x7	S235	1M24-8.8t	0.50	0.50	0.50	206	**-2.6**	SPLS 6a_90 Ba All Cts Ah Ct3	41.1	135.6	90.7	0.06		**1.4**	ULS 3_0,9_90	76.6	135.6	59.6	0.02	
224L		90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	249	**-11.9**	SPLS 1a_90 Ba All Cts	57.4	271.1	207.4	0.21		**5.5**	PLS 1a_0,9_78.35 Ba Ct2	151.9	271.1	178.0	0.04	
224T		90x90x8	S235	2M24-8.8t	1.03	1.00	1.00	243	**-10.4**	SPLS 1a_135 Ah Ct2	59.7	271.1	207.4	0.17		**10.8**	ULS 1a_0,9_45	326.7	0.0	0.0	0.03	
225	Diagonal	80x80x6#	S235	1M20-8.8t	1.00	0.50	0.50	248	**-7.7**	ULS 1a_135	26.1	94.1	64.8	0.30		**6.4**	ULS 1a_0,9_45	100.2	94.1	58.9	0.11	
226	Diagonal	100x100x8	S235	1M20-8.8t	1.00	0.50	0.50	286	**-0.9**	ULS 1a_0	15.8	94.1	86.4	0.06		**0.1**	ULS 1a_0,9_0,9_0	179.7	94.1	78.5	0.00	
590A	BT onderregel	150x150x14	S355	7M24-8.8t	1.00	2.00	1.00	51	**-412.6**	SPLS 6a_90 Ba Ct1 Ah Ct1	1191.3	889.6	1728.7	0.46		**290.8**	PLS 3_0,9_101.65 Ba Ct2	913.5	889.6	1625.3	0.33	
590B	BT onderregel	150x150x14	S355		2.00	1.00	1.00	14	**0.0**		1425.0	0.0	0.0	0.00		**10.8**	ULS 3_101.65	1425.0	0.0	0.0	0.01	
590C	BT onderregel	150x150x14	S355		1.00	2.68	1.00	69	**-380.1**	SPLS 6a_90 Ba Ct1 Ah Ct1	1025.8	0.0	0.0	0.37		**275.0**	PLS 3_0,9_101.65 Ba Ct2	1425.0	0.0	0.0	0.19	
501	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	117	**-17.9**	SPLS 3_0,9_90 Ba All Cts	102.7	188.2	151.2	0.17		**18.7**	SPLS 3_90 Ba All Cts	90.5	188.2	101.5	0.21	
502	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	112	**-22.4**	SPLS 3_90 Ba Ct2	107.3	188.2	151.2	0.21		**22.7**	SPLS 3_0,9_90 Ba Ct1	90.5	188.2	101.5	0.25	
503	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	107	**-23.4**	SPLS 3_0,9_90 Ba Ct2	112.2	188.2	151.2	0.21		**23.3**	SPLS 3_90 Ba Ct2	90.5	188.2	101.5	0.26	
504	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	102	**-24.1**	SPLS 3_0,9_90 Ba Ct2	117.1	188.2	151.2	0.21		**24.1**	SPLS 3_90 Ba Ct2	90.5	188.2	101.5	0.27	
505	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	97	**-32.3**	SPLS 3_101.65 Ba Ct2	122.2	188.2	151.2	0.26		**32.1**	PLS 3_0,9_101.65 Ba Ct2	90.5	188.2	108.7	0.35	
506	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	92	**-49.3**	SPLS 6a_90 Ba All Cts Ah Ct2	127.3	188.2	151.2	0.39		**48.2**	S 6a_90 Ba All Cts Ah Ct2	90.5	188.2	111.6	0.53	
507	CD	70x70x7	S235	2M20-8.8t	0.52	0.52	0.52	87	**-50.0**	SPLS 6a_90 Ba All Cts Ah Ct2	132.5	188.2	151.2	0.38		**52.3**	3_0,9_101.65 Ba All Cts	90.5	188.2	111.6	0.58	
508	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	64	**-59.6**	SPLS 3_0,9_101.65 Ba All Cts	230.5	271.1	207.4	0.29		**56.6**	S 6a_90 Ba All Cts Ah Ct2	136.2	271.1	161.3	0.42	
509	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	61	**-66.8**	SPLS 6a_90 Ba All Cts Ah Ct2	236.1	271.1	207.4	0.32		**65.3**	3_0,9_101.65 Ba All Cts	136.2	271.1	161.3	0.48	
510	CD	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	58	**-36.6**	SPLS 3_101.65 Ba Ct1	239.8	271.1	207.4	0.18		**27.8**	PLS 3_0,9_101.65 Ba Ct1	136.2	271.1	161.3	0.20	
511	Hor. onderregel	120x120x12	S235	2M24-8.8t	1.00	2.00	1.00	41	**0.0**		505.4	271.1	311.0	0.00		**81.0**	ULS 3_90	280.9	271.1	162.2	0.50	
591A	BT bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.71	1.00	68	**-257.0**	SPLS 6a_90 Ba All Cts Ah Ct1	480.9	813.3	1058.4	0.53		**240.6**	S 6a_90 Ba All Cts Ah Ct2	403.8	813.3	823.2	0.60	
591B	BT bovenregel	120x120x10	S355	6M24-8.8t	1.00	2.29	1.00	91	**-174.3**	SPLS 6a_90 Ba Ct1 Ah Ct1	379.8	813.3	1058.4	0.46		**164.2**	PLS 6a_90 Ba Ct2 Ah Ct2	635.0	813.3	823.2	0.26	
591C	BT bovenregel	120x120x10	S355		1.00	2.29	1.00	91	**-203.9**	SPLS 6a_90 Ba Ct1 Ah Ct1	379.7	0.0	0.0	0.54		**219.7**	S 6a_90 Ba All Cts Ah Ct2	823.6	0.0	0.0	0.27	
592A	BT bovenregel	120x120x10	S235	6M24-8.8t	1.00	1.73	1.00	78	**-184.8**	SPLS 6a_90 Ba All Cts Ah Ct1	330.7	813.3	777.6	0.56		**192.5**	S 6a_90 Ba All Cts Ah Ct2	259.2	813.3	554.5	0.74	
592B	BT bovenregel	120x120x10	S235	4M24-8.8t	1.00	2.56	1.00	116	**-37.6**	SPLS 6a_90 Ba All Cts Ah Ct1	242.3	542.2	518.4	0.16		**35.8**	S 6a_90 Ba All Cts Ah Ct2	466.6	542.2	487.4	0.08	
592C	BT bovenregel	120x120x10	S235		2.37	1.37	1.00	79	**-169.0**	SPLS 6a_90 Ba All Cts Ah Ct1	330.6	0.0	0.0	0.51		**175.1**	S 6a_90 Ba All Cts Ah Ct2	545.2	0.0	0.0	0.32	
512	CD bovenregel	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	170	**-22.3**	SPLS 6a_90 Ba All Cts Ah Ct2	27.3	60.3	43.2	0.82		**23.1**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.71	
513	CD bovenregel	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	161	**-26.3**	SPLS 6a_90 Ba All Cts Ah Ct2	29.2	60.3	43.2	0.90		**24.8**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.76	
514	CD bovenregel	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	153	**-27.0**	SPLS 6a_90 Ba All Cts Ah Ct2	31.3	60.3	43.2	0.86		**28.7**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.88	
515	CD bovenregel	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	147	**-31.8**	SPLS 6a_90 Ba All Cts Ah Ct2	32.8	60.3	43.2	0.97		**29.1**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.89	
516	CD bovenregel	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	145	**-13.0**	SPLS 6a_90 Ba All Cts Ah Ct2	33.4	60.3	43.2	0.39		**11.6**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.36	
517	CD bovenregel	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	136	**-13.4**	SPLS 6a_90 Ba All Cts Ah Ct2	35.9	60.3	43.2	0.37		**14.1**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.43	
518	CD bovenregel	50x50x5	S235	1M16-8.8t	0.54	0.54	0.54	130	**-16.9**	SPLS 6a_90 Ba All Cts Ah Ct2	37.8	60.3	43.2	0.45		**16.1**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.49	
519	CD bovenregel	50x50x5	S235	1M16-8.8t	0.54	0.54	0.54	122	**-19.9**	SPLS 6a_90 Ba All Cts Ah Ct2	40.5	60.3	43.2	0.49		**20.6**	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.63	
520	CD bovenregel	60x60x6	S235	2M16-8.8t	0.55	0.55	0.55	97	**-27.7**	SPLS 6a_90 Ba All Cts Ah Ct2	89.8	120.6	103.7	0.31		**26.4**	S 6a_90 Ba All Cts Ah Ct2	68.2	120.6	62.5	0.42	
521	CD bovenregel	60x60x6	S235	2M16-8.8t	0.60	0.60	0.60	99	**-34.0**	SPLS 6a_90 Ba All Cts Ah Ct2	87.8	120.6	103.7	0.39		**36.2**	S 6a_90 Ba All Cts Ah Ct2	67.0	120.6	60.6	0.60	
522	Hor. bovenregel	UNP160	S235	3M20-8.8t	1.00	1.00	1.00	47	**0.0**		409.5	282.2	243.0	0.00		**35.7**	ULS 3_0,9_90	243.2	282.2	208.0	0.17	

Assessment of groups for initial mast (afkeur level)

Date 18-01-21
Author MKh
Version 1.0

ENS-ZL 380
HA-6 RC
82

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
593A		90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-23.3	ULS 5a Ba 22	138.8	188.2	172.8	0.17		8.9	S 3_0,9_78.35 Ah All Cts	139.9	188.2	134.4	0.07	
593B		90x90x8	S235	2M20-8.8t	2.00	1.00	1.00	121	-18.9	SPLS 6a_90 Ah Ct1 Ah Ct4	138.8	188.2	172.8	0.14		4.9	PLS 1a_0,9_90 Ba All Cts	139.9	188.2	134.4	0.04	
593C		90x90x8	S235		2.00	1.00	1.00	121	-21.9	ULS 5a Ba 22	138.8	0.0	0.0	0.16		8.4	S 3_0,9_78.35 Ah All Cts	326.7	0.0	0.0	0.03	
523		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-2.6	SPLS 1a_135 Ba All Cts	34.4	60.3	43.2	0.08		2.7	SPLS 1a_0,9_0 Ah All Cts	46.1	60.3	32.7	0.08	
524		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-2.3	ULS 5a Ba 12	39.5	60.3	43.2	0.06		2.3	ULS 5a Ah 12	46.1	60.3	32.7	0.07	
525		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 6a_90 Ba Ct2 Ah Ct4	45.3	60.3	43.2	0.00		0.0	ULS 3_0,9_90	46.1	60.3	32.7	0.00	
526		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-2.5	SPLS 1a_0,9_0 Ah All Cts	18.2	60.3	43.2	0.14		2.5	LS 1a_0,9_135 Ba All Cts	46.1	60.3	23.3	0.11	
527		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	-7.2	ULS 5a Ah 12	19.5	60.3	43.2	0.37		7.0	ULS 5a Ba 12	46.1	60.3	23.3	0.30	
528B		90x90x8	S235	4M24-8.8t	1.00	1.00	1.00	340	-7.7	SPLS 3_0,9_101.65 Ba All Cts	34.9	542.2	414.7	0.22		129.3	S 6a_90 Ah All Cts Ba Ct2	170.2	542.2	308.2	0.76	
529		80x80x8	S235	4M20-8.8t	2.00	1.00	1.00	234	0.0		53.5	376.3	345.6	0.00		103.0	PLS 6a_90 Ba Ct1 Ba Ct2	151.8	376.3	261.3	0.68	
531	CD	50x50x5	S235	1M16-8.8t	0.51	0.51	0.51	154	-22.3	SPLS 6a_90 Ba All Cts Ah Ct2	30.9	60.3	43.2	0.72		23.2	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.71	
532	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	86	-1.1	ULS 5a Ba 12	54.3	60.3	43.2	0.03		2.7	ULS 5a Ba 12	46.1	60.3	32.7	0.08	
533	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	201	-10.6	SPLS 6a_90 Ba All Cts Ah Ct2	21.7	60.3	43.2	0.49		19.3	S 6a_90 Ba All Cts Ah Ct2	46.1	60.3	32.7	0.59	
534	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	201	-2.0	SPLS 6a_90 Ah Ct2 Ba Ct2	24.4	60.3	43.2	0.08		3.7	PLS 6a_90 Ah Ct2 Ba Ct2	46.1	60.3	32.7	0.11	
535	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	331	-3.0	SPLS 1a_101.65 Ba All Cts	14.5	60.3	51.8	0.21		0.0		48.4	60.3	33.7	0.00	
536	Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	335	-8.0	ULS 5a Ba 12	9.9	60.3	43.2	0.81		0.7	ULS 5a Ba 22	46.1	60.3	32.7	0.02	
537	Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	297	-9.4	SPLS 6a_90 Ah Ct2 Ba Ct2	12.0	60.3	43.2	0.78		0.0		46.1	60.3	32.7	0.00	
538	Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	242	0.0		16.6	60.3	43.2	0.00		1.2	ULS 1a_101.65	46.1	60.3	20.5	0.06	
490A	MT onderregel	180x180x16#	S355	8M24-8.8t	2.50	1.00	1.00	61	-729.3	SPLS 6a_90 Ba Ct1 Ah Ct1	1519.3	960.2	2257.9	0.76		525.1	PLS 3_0,9_101.65 Ba Ct2	1406.0	960.2	2122.8	0.55	
490B	MT onderregel	180x180x16#	S355	8M24-8.8t	10.61	2.00	1.00	64	-392.8	SPLS 6a_90 Ba Ct1 Ah Ct1	1481.9	1084.4	2257.9	0.36		272.2	PLS 3_0,9_101.65 Ba Ct2	1661.0	1084.4	2122.8	0.25	
490C	MT onderregel	180x180x16#	S355		2.93	1.00	1.00	61	-692.7	SPLS 6a_90 Ba Ct1 Ah Ct1	1519.5	0.0	0.0	0.46		489.5	PLS 3_0,9_101.65 Ba Ct2	1966.7	0.0	0.0	0.25	
491A	MT onderregel	150x150x15	S355	8M24-8.8t	2.80	1.00	1.00	77	-368.3	SPLS 6a_90 Ba Ct1 Ah Ct1	1002.3	1084.4	2116.8	0.37		246.7	PLS 3_0,9_101.65 Ba Ct2	1241.9	1084.4	1990.2	0.23	
491B	MT onderregel	150x150x15	S355		2.32	1.00	1.00	13	-2.0	ULS 1a_90	1526.5	0.0	0.0	0.00		0.7	PLS 3_0,9_101.65 Ba Ct1	1526.5	0.0	0.0	0.00	
491C	MT onderregel	150x150x15	S355		3.33	1.00	1.00	77	-337.9	SPLS 6a_90 Ba Ct1 Ah Ct1	1002.4	0.0	0.0	0.34		216.2	PLS 3_0,9_101.65 Ba Ct2	1526.5	0.0	0.0	0.14	
401	CD	80x80x8	S235	2M20-8.8t	0.52	0.52	0.52	130	-52.5	SPLS 3_0,9_90 Ba All Cts	120.6	188.2	172.8	0.44		57.5	S 6a_90 Ba All Cts Ah Ct2	139.6	188.2	153.9	0.41	
402	CD	80x80x8	S235	2M20-8.8t	0.52	0.52	0.52	120	-65.9	SPLS 6a_90 Ba Ct2 Ah Ct2	131.0	188.2	172.8	0.50		60.3	PLS 6a_90 Ba Ct2 Ah Ct2	139.6	188.2	153.9	0.43	
403	CD	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	110	-62.3	SPLS 6a_90 Ba All Cts Ah Ct2	109.1	188.2	129.6	0.57		61.8	S 6a_90 Ba All Cts Ah Ct2	107.0	188.2	115.4	0.58	
404	CD	80x80x6#	S235	2M20-8.8t	0.52	0.52	0.52	104	-68.5	SPLS 6a_90 Ba All Cts Ah Ct2	114.9	188.2	129.6	0.60		70.4	S 6a_90 Ba All Cts Ah Ct2	107.0	188.2	115.4	0.66	
405	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	88	-80.4	SPLS 6a_90 Ba All Cts Ah Ct2	193.2	271.1	207.4	0.42		76.5	S 6a_90 Ba All Cts Ah Ct2	139.3	271.1	141.8	0.55	
406	CD	90x90x8	S235	2M20-8.8t	0.52	0.52	0.52	83	-83.5	SPLS 6a_90 Ba All Cts Ah Ct2	201.9	188.2	172.8	0.48		84.9	S 6a_90 Ba All Cts Ah Ct2	162.7	188.2	139.6	0.61	
407	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	75	-42.5	SPLS 6a_90 Ba All Cts Ah Ct2	214.4	271.1	207.4	0.20		60.5	S 6a_90 Ba All Cts Ah Ct2	137.7	271.1	141.8	0.44	
408	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	117	-29.0	SPLS 6a_90 Ba All Cts Ah Ct2	75.7	120.6	103.7	0.38		29.1	S 6a_90 Ba All Cts Ah Ct2	70.4	120.6	66.3	0.44	
409	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	104	-32.2	SPLS 6a_90 Ba All Cts Ah Ct2	84.7	120.6	103.7	0.38		31.6	S 6a_90 Ba All Cts Ah Ct2	70.4	120.6	66.3	0.48	
410	CD	70x70x7	S235	2M16-8.8t	0.53	0.53	0.53	82	-40.4	SPLS 6a_90 Ba All Cts Ah Ct2	137.3	120.6	121.0	0.34		40.0	S 6a_90 Ba All Cts Ah Ct2	106.3	120.6	104.5	0.38	
411	CD	70x70x7	S235	2M20-8.8t	0.54	0.54	0.54	77	-45.0	SPLS 6a_90 Ba All Cts Ah Ct2	143.1	188.2	151.2	0.31		46.7	S 6a_90 Ba All Cts Ah Ct2	90.5	188.2	101.5	0.52	
412	CD	70x70x7	S235	2M20-8.8t	0.54	0.54	0.54	70	-55.4	SPLS 6a_90 Ba All Cts Ah Ct2	150.2	188.2	151.2	0.37		52.2	S 6a_90 Ba All Cts Ah Ct2	93.0	188.2	117.4	0.56	
413	CD	90x90x8	S235	2M20-8.8t	0.55	0.55	0.55	47	-66.0	SPLS 6a_90 Ba All Cts Ah Ct2	255.7	188.2	172.8	0.38		64.0	S 6a_90 Ba All Cts Ah Ct2	139.9	188.2	134.4	0.48	
414	CD	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	56	-41.2	SPLS 6a_90 Ba Ct1 Ah Ct1	215.5	271.1	207.4	0.20		38.1	SPLS 1a_90 Ba Ct2	117.7	271.1	141.8	0.32	
415	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	83	0.0		564.1	188.2	216.0	0.00		3.2	ULS 3_101.65	766.1	188.2	0.0	0.02	
416	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	101	0.0		427.5	188.2	352.8	0.00		48.9	ULS 3_90	389.8	188.2	167.5	0.29	
417	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	54	-4.9	ULS 3_0,9_90	691.4	188.2	216.0	0.03		1.2	ULS 5a Ah 11	766.1	188.2	0.0	0.01	
418	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	2.00	1.00	27	0.0		791.0	188.2	352.8	0.00		88.6	ULS 3_90	389.8	188.2	238.8	0.47	
419	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	24	-22.7	ULS 1a_90	797.8	188.2	216.0	0.12		0.0		766.1	188.2	0.0	0.00	
492A	MT bovenregel	80x80x8	S235	4M20-8.8t	2.01	1.00	1.00	303	0.0		36.0	376.3	345.6	0.00		128.2	ULS 3_0	179.4	376.3	345.6	0.71	
492B	MT bovenregel	80x80x8	S235	4M20-8.8t	1.99	1.00	1.00	303	0.0		36.0	376.3	345.6	0.00		97.7	SPLS 3_0 Ba Ct1	227.6	376.3	314.2	0.43	
493A	MT bovenregel	80x80x8	S235	4M20-8.8t	2.00	1.00	1.00	301	0.0		36.5	376.3	345.6	0.00		88.2	SPLS 3_0 Ba Ct1	227.6	376.3	314.2	0.39	
493B	MT bovenregel	80x80x8	S235	4M20-8.8t	2.00	1.00	1.00	301	0.0		36.5	376.3	345.6	0.00		88.2	SPLS 3_0 Ba Ct1	151.8	376.3	261.3	0.58	
420	Hor. bovenregel	70x70x7	S235	1M20-8.8t	1.00	2.00	1.00	107	-0.8	ULS 1a_0	95.2	94.1	75.6	0.01		0.7	ULS 1a_0,9_0	84.7	94.1	50.7	0.01	
421		80x80x8	S235	1M20-8.8t	1.00	1.00	1.00	150	-2.0	ULS 1a_0	82.0	94.1	86.4	0.02		1.4	ULS 1a_0,9_0	133.6	94.1	78.5	0.02	
422	Vertical	90x90x8	S235	1M24-8.8t	1.00	1.00	1.00	171	-18.4	SPLS 6a_90 Ah Ct2 Ba Ct2	78.6	135.6	103.7	0.23		0.0		147.5	135.6	97.5	0.00	
423	Vertical	80x80x6#	S235	1M16-8.8t	1.00	1.00	1.00	125	-3.9	SPLS 1a_45 Ah Ct2	76.8	60.3	51.8	0.08		0.0		96.8	60.3	44.8	0.00	
424	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	103	-1.0	SPLS 6a_90 Ba Ct1 Ba Ct2	47.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00	
425	Diagonal	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	335	0.0		24.3	188.2	129.6	0.00		28.0	PLS 6a_90 Ba Ct1 Ba Ct2	115.9	188.2	117.8	0.24	
426	Diagonal	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	293	0.0		30.1	188.2	129.6	0.00		41.3	PLS 6a_90 Ah Ct2 Ba Ct2	112.1	188.2	117.8	0.37	
427	Diagonal	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	345	0.0		13.6	60.3	51.8	0.00		12.8	SPLS 1a_45 Ah Ct2	48.4	60.3	33.7	0.38	
390A	OT onderregel	160x160x15#	S355	7M24-8.8t	1.00	3.26	1.00	91	-304.1	SPLS 6a_90 Ba Ct1 Ah Ct3	896.7	824.3	1852.2	0.37		153.0	PLS 6a_90 Ba Ct2 Ah Ct4	1174.7	824.3	1852.2	0.19	
390B	OT onderregel	160x160x15#	S355	4M24-8.8t	2.00	14.57	1.00	105	-111.5	SPLS 6a_90 Ba Ct1 Ah Ct3	715.7	542.2	1058.4	0.21		55.8	PLS 6a_90 Ba Ct2 Ah Ct4	1372.7	542.2	995.1	0.10	
390C	OT onderregel	160x160x15#	S355		1.00	3.26	1.00	91	-287.7	SPLS 6a_90 Ba Ct1 Ah Ct3	896.7	0.0	0.0	0.32		136.1	PLS 6a_90 Ba Ct2 Ah Ct4	1658.2	0.0	0.0	0.08	
391A	OT onderregel	150x150x12	S355	4M24-8.8t	1.00	4.64	1.00	112	-111.7	SPLS 6a_90 Ba Ct1 Ah Ct3	476.4	542.2	846.7	0.23		51.5	PLS 6a_90 Ba Ct2 Ah Ct4	1007.6	542.2	796.1	0.10	
391B	OT onderregel	150x150x12	S355		2.00	1.00	1.00	15	0.0		1235.4	0.0	0.0	0.00		5.7	PLS 6a_90 Ah Ct1 Ah Ct4	1235.4	0.0	0.0	0.00	
391C	OT onderregel	150x150x12	S355		1.00	4.64	1.00	112	-102.1	SPLS 6a_90 Ba Ct1 Ah Ct3	476.4	0.0	0.0	0.21		41.4	PLS 6a_90 Ba Ct2 Ah Ct4	1235.4	0.0	0.0	0.03	
301	CD	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	150	-29.9	SPLS 6a_90 Ba All Cts Ah Ct4	128.9	188.2	172.8	0.23		25.3	PLS 6a_90 Ba Ct1 Ah Ct3	158.3	188.2	122.2	0.21	
302	CD	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	139	-35.1	SPLS 6a_90 Ba All Cts Ah Ct4	141.2	188.2	172.8	0.25		34.8	PLS 6a_90 Ba Ct2 Ah Ct4	158.3	188.2	122.2	0.29	
303	CD	100x100x8	S235	2M20-8.8t	0.53	0.53	0.53	128	-35.3	SPLS 6a_90 Ba Ct2 Ah Ct4	154.9	188.2	172.8	0.23		39.0	S 6a_90 Ba All Cts Ah Ct4	158.3	188.2	122.2	0.32	
304	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	136	-18.5	SPLS 6a_90 Ba All Cts Ah Ct4	87.8	188.2	129.6	0.21		20.4	S 6a_90 Ba All Cts Ah Ct4	93.1	188.2	91.6	0.22	
305	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	125	-22.0	SPLS 6a_90 Ba All Cts Ah Ct4	96.4	188.2	129.6	0.23		21.8	S 6a_90 Ba All Cts Ah Ct4	93.1	188.2	91.6	0.24	
306	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	114	-25.1	SPLS 6a_90 Ba All Cts Ah Ct4	105.8	188.2	129.6	0.24		23.7	S 6a_90 Ba All Cts Ah Ct4	94.4	188.2	91.6	0.26	
307	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	103	-27.3	SPLS 6a_90 Ba All Cts Ah Ct4	116.0	188.2	129.6	0.24		28.4	S 6a_90 Ba All Cts Ah Ct4	94.4	188.2	91.6	0.31	
308	CD	50x50x5	S235	1M16-8.8t	0.54	0.54	0.54	143	-9.3	SPLS 6a_90 Ba All Cts Ah Ct4	33.9	60.3	43.2	0.27		9.2	S 6a_90 Ba All Cts Ah Ct4	46.1	60.3	32.7	0.28	
309	CD	50x50x5	S235	1M16-8.8t	0.55	0.55	0.55	128	-12.6	SPLS 6a_90 Ba All Cts Ah Ct4	38.4	60.3	43.2	0.33		12.4	S 6a_90 Ba All Cts Ah Ct4	46.1	60.3	32.7	0.38	
310	CD	50x50x5	S235	2M16-8.8t	0.56	0.56	0.56	113	-16.1	SPLS 6a_90 Ba All Cts Ah Ct4	54.4	120.6	86.4	0.30		15.6	S 6a_90 Ba All Cts Ah Ct4	47.9	120.6	65.4	0.33	
311	CD	50x50x5	S235	2M16-8.8t	0.57	0.57	0.57	99	-22.6	SPLS 6a_90 Ba All Cts Ah Ct4	61.2	120.6	86.4	0.37		21.2	S 6a_90 Ba All Cts Ah Ct4	49.4	120.6	65.4	0.43	
312	CD	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	76	-17.1	SPLS 6a_90 Ba All Cts Ah Ct4	82.0	60.3	51.8	0.33		12.9	S 6a_90 Ba All Cts Ah Ct4	72.6	60.3	44.8	0.29	
313	Hor. onderregel	100x100x10	S355		1.00	4.00	1.00	135	-19.5	SPLS 6a_90 Ba Ct2 Ah Ct4	202.3	0.0	0.0	0.10		21.7	PLS 6a_90 Ba Ct2 Ah Ct4	486.1	241.2	48.0	0.45	
314	Hor. onderregel	100x100x10	S355	2M20-8.8t	1.00	4.00	1.00	82	-8.6	SPLS 6a_90 Ba Ct2 Ah Ct4	344.8	188.2	294.0	0.05		29.8	PLS 6a_90 Ba Ct2 Ah Ct4	266.6	188.2	228.7	0.16	
315	Hor. onderregel	100x100x10	S355	2M20-8.8t	1.00	2.00	1.00	29	-0.2	SPLS 1a_135 Ah All Cts	547.4	188.2	294.0	0.00		19.6	PLS 6a_90 Ba Ct1 Ah Ct4	288.4	188.2	264.3	0.10	
316	Diagonalen Detail 3	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	114	-17.0	SPLS 6a_90 Ba Ct1 Ah Ct3	62.0	60.3	51.8	0.33		16.7	PLS 6a_90 Ba Ct1 Ah Ct3	72.6	60.3	44.8	0.37	
317	Diagonalen Detail 2	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	87	-14.9	SPLS 6a_90 Ba Ct2 Ah Ct4	77.8	60.3	51.8	0.29		14.0	PLS 6a_90 Ba Ct2 Ah Ct4	72.6	60.3	44.8	0.31	
318		200x100x10	S235	2M16-8.8t	2.00	2.00	2.00	33	-1.6	SPLS 1a_78.35 Ah Ct1	637.9	120.6	172.8	0.01		15.6	PLS 6a_90 Ba Ct1 Ah Ct4	584.6	120.6	82.6	0.19	
392A	OT bovenregel	100x100x8	S235	4M24-8.8t	1.00	1.00	1.00	250	0.0		63.4	542.2	414.7	0.00		70.2	PLS 6a_90 Ba Ct1 Ba Ct4	211.1	542.2	362.8	0.33	
392B	OT bovenregel	100x100x8	S235	4M20-8.8t	1.00	1.00	1.00	272	0.0		55.9	376.3	345.6	0.00		49.1	PLS 6a_90 Ba Ct1 Ah Ct4	310.5	376.3	314.2	0.16	
393	OT bovenregel	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	335	0.0		24.2	188.2	129.6	0.00		48.9	PLS 6a_90 Ba Ct2 Ah Ct3	124.8	188.2	117.8	0.41	
319	Hor. bovenregel B-B	80x80x6#	S235	1M20-8.8t	2.00	1.00	1.00	151	-0.6	SPLS 6a_90 Ba Ct2 Ah Ct2	66.1	94.1	64.8	0.01		0.3	SPLS 1a_0,9_0 Ah Ct2	100.2	94.1	58.9	0.00	
320	Hor. bovenregel A-A	60x60x6	S235	1M16-8.8t	2.00	1.00	1.00	130	-0.3	ULS 1a_0	57.7	60.3	51.8	0.01		0.3	ULS 1a_0,9_0	72.6	60.3	44.8	0.01	
321	Diagonal B-B	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	295	-1.2	SPLS 1a_0 Ah Ct2	17.5	60.3	51.8	0.07		0.4	SPLS 1a_0,9_0 Ah Ct2	48.4	60.3	33.7	0.01	

DNV·GL

Assessment of groups for initial mast (afkeur level)

Date	18-01-21
Author	MKh
Version	1.0

ENS-ZL 380
HA-6 RC
82

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
322	Diagonal A-A	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	195	**-1.0**	ULS 1a_0	22.7	60.3	43.2	0.05		**0.3**	ULS 1a_0,9_0	46.1	60.3	32.7	0.01	
323	Vertical	80x80x6#	S235	1M20-8.8t	1.00	1.00	1.00	173	**-7.9**	SPLS 6a_90 Ah All Cts Ba Ct4	52.3	94.1	64.8	0.15		**0.0**		100.2	94.1	52.4	0.00	
324	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	142	**-0.7**	SPLS 6a_90 Ba Ct2 Ba Ct3	34.2	60.3	43.2	0.02		**0.0**		46.1	60.3	32.7	0.00	
325	Diagonal	90x90x8	S235	2M20-8.8t	1.00	1.00	1.00	351	**0.0**		33.1	188.2	172.8	0.00		**33.6**	PLS 6a_90 Ba Ct2 Ba Ct3	168.5	188.2	122.2	0.28	
326	Diagonal	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	497	**0.0**		9.1	120.6	103.7	0.00		**30.6**	S 6a_90 Ah All Cts Ba Ct4	78.2	120.6	67.3	0.46	

APPENDIX C
Toetsing knikverkorters

Knikverkorters initial construction (afkeur)

Date: 2022-02-23
Author: K H Chan
Version: 1.8

ENS - ZL
HA-6_RC
Mast: 88

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
9110	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	0.465	0	48	**37.8**	**0.12**	64.9	60.3	35.9	46.1	0.72	1.05	Bearing	
9109	Onderstuk	Enkele staaf	L50.7	S235	M16	8.8	1.714	71	179	**37.8**	**0.00**	34.9	60.3	42.5	44.4	0.98	1.08	Buckling	
9108	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.332	0	137	**37.8**	**0.33**	35.6	60.3	35.9	46.1	0.72	1.06	Buckling Bearing	
9107	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	1.972	55	169	**37.8**	**0.00**	39.7	60.3	38.4	72.6	1.24	0.98		
9106	Onderstuk	Enkele staaf	L80.6	S235	M16	8.8	2.063	0	131	**37.8**	**0.52**	72.7	60.3	38.4	107.1	2.25	0.98		
9105	Onderstuk	Enkele staaf	L80.6	S235	M16	8.8	2.437	42	155	**37.8**	**0.00**	59.8	60.3	38.4	107.1	2.25	0.98		
9104	Onderstuk	Enkele staaf	L80.6	S235	M16	8.8	2.793	0	178	**37.8**	**0.70**	50.2	60.3	38.4	107.1	2.25	0.98		
9103	Onderstuk	Enkele staaf	L80.6	S235	M16	8.8	3.012	33	191	**37.8**	**0.00**	45.3	60.3	38.4	107.1	2.25	0.98		
9102	Onderstuk	Enkele staaf	L80.8	S235	M16	8.8	3.524	0	226	**37.8**	**0.88**	46.9	60.3	51.2	142.8	2.95	0.80		
9101	Onderstuk	Enkele staaf	L80.8	S235	M16	8.8	3.429	27	220	**37.8**	**0.77**	48.9	60.3	51.2	142.8	2.95	0.77		
9115	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	0.854	0	88	**8.9**	**0.21**	53.6	60.3	30.3	31.7	0.72	0.30		
9114	Pootverband	Kniksteun en verticale steur	L50.7	S235	M16	8.8	1.894	0	127	**8.9**	**0.24**	41.0	60.3	42.5	44.4	0.68	0.35		
9113	Pootverband	Kniksteun en verticale steur	L60.6	S235	M16	8.8	2.932	0	161	**8.9**	**0.37**	33.3	60.3	38.4	72.6	0.93	0.41		
9112	Pootverband	Kniksteun en verticale steur	L80.6	S235	M16	8.8	3.972	0	163	**8.9**	**0.50**	44.7	60.3	38.4	107.1	1.77	0.29		
9111	Pootverband	Kniksteun en verticale steur	L80.6	S235	M16	8.8	5.010	0	205	**8.9**	**0.63**	33.5	60.3	38.4	107.1	1.77	0.37		
9120	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	1.936	77	199	**8.9**	**0.00**	22.0	60.3	30.3	31.7	0.72	0.40		
9119	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.095	63	215	**8.9**	**0.00**	19.7	60.3	30.3	31.7	0.72	0.45		
9118	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.365	52	243	**8.9**	**0.00**	16.4	60.3	30.3	31.7	0.72	0.54		
9117	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.711	43	279	**8.9**	0.00	13.3	60.3	30.3	31.7	0.7	0.67		
9116	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	3.064	35	315	**8.9**	0.00	11.0	60.3	30.3	31.7	0.7	0.81		
9098	Tussenschot	Enkele staaf	L90.8	S235	M24	8.8	4.151	0	236	**37.8**	**1.04**	49.9	135.6	88.6	147.5	3.77	0.76		
9100	Tussenschot	Kniksteun en verticale steur	L80.6	S235	M20	8.8	5.929	0	243	**0.6**	**0.74**	26.7	94.1	52.4	100.2	1.77	0.44		
9097	Tussenschot	Kruisende staaf halverwege	L100.8	S235	M20	8.8	8.578	0	279	**0.6**	**1.07**	36.4	94.1	69.8	179.7	4.76	0.23		
9270	1e tussenstuk	Enkele staaf	L80.6	S235	M16	8.8	2.824	36	180	**31.7**	**0.00**	49.4	60.3	38.4	107.1	2.25	0.82		
9269	1e tussenstuk	Enkele staaf	L80.6	S235	M16	8.8	2.110	0	134	**31.7**	**0.53**	70.9	60.3	38.4	107.1	2.25	0.82		
9268	1e tussenstuk	Enkele staaf	L50.7	S235	M16	8.8	1.514	0	158	**31.7**	**0.38**	41.0	60.3	42.5	44.4	1.0	0.77		
9267	1e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.122	54	182	**31.7**	**0.00**	36.0	60.3	38.4	72.6	1.24	0.88		
9266	1e tussenstuk	Enkele staaf	L80.6	S235	M16	8.8	3.210	0	204	**31.7**	0.80	41.4	60.3	38.4	107.1	2.2	0.82		
9265	1e tussenstuk	Enkele staaf	L80.6	S235	M16	8.8	2.068	33	131	**31.7**	0.00	72.5	60.3	38.4	107.1	2.2	0.82		
9311	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.576	40	162	**27.1**	0.00	29.1	60.3	30.3	31.7	0.7	0.93		
9310	2e tussenstuk	Enkele staaf	L80.6	S235	M16	8.8	2.636	0	168	**27.1**	0.66	54.2	60.3	38.4	107.1	2.2	0.70		
9312	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.565	32	161	**27.1**	0.00	29.3	60.3	30.3	31.7	0.7	0.92		
9313	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.490	43	153	**27.1**	0.00	31.2	60.3	30.3	31.7	0.7	0.89		
9309	2e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.334	0	200	**27.1**	**0.58**	31.6	60.3	38.4	72.6	1.24	0.86		
9314	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.446	35	149	**27.1**	**0.00**	32.3	60.3	30.3	31.7	0.72	0.89		
9315	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.409	49	145	**27.1**	**0.00**	33.4	60.3	30.3	31.7	0.72	0.89		
9308	2e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.027	0	173	**27.1**	**0.51**	38.3	60.3	38.4	72.6	1.24	0.71		
9316	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.330	38	137	**27.1**	**0.00**	35.7	60.3	30.3	31.7	0.72	0.89		
8019	Bovenstuk 1	Enkele staaf	L50.5	S235	M16	8.8	1.861	0	191	**12.9**	0.47	23.3	60.3	30.3	31.7	0.7	0.65		
8020	Bovenstuk 1	Enkele staaf	L50.5	S235	M16	8.8	1.708	0	175	**12.9**	0.43	26.2	60.3	30.3	31.7	0.7	0.59		

Knikverkorters initial construction (afkeur)

Date: 2022-02-23
Author: K H Chan
Version: 1.8

ENS - ZL
HA-6_RC
Mast: 88

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
8021	Bovenstuk 2	Enkele staaf	L50.5	S235	M16	8.8	1.609	0	165	**5.6**	0.40	28.3	60.3	30.3	31.7	0.7	0.56		
8023	Bovenstuk 2	Enkele staaf	L50.5	S235	M16	8.8	1.428	0	147	**5.6**	**0.36**	32.8	60.3	30.3	31.7	0.72	0.50		

Knikverkorters adjusted construction (verbouw)

Date: 2022-02-23
Author: K H Chan
Version: 1.8

ENS - ZL
HA-6_RC
Mast: 88

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness (-)	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Block Tearing Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Mitigation
9110	Onderstuk	Enkele staaf	L50.5	**S355**	M16	8.8	0.47	0	48	**37.8**	**0.15**	93.5	60.3	43.6	51.0	1.08	0.87		Profile exchanged
9109	Onderstuk	Enkele staaf	**L60.6**	**S355**	M16	8.8	1.71	71	147	**37.8**	0.00	54.9	60.3	52.3	98.8	1.88	0.72		Profile exchanged
9108	Onderstuk	Enkele staaf	L50.5	**S355**	M16	8.8	1.33	0	137	**37.8**	**0.43**	41.8	60.3	43.6	51.0	1.08	0.90		Profile exchanged

APPENDIX D
Toetsing blokdeuvels

Project: ENS-ZL380
Mast: HA-6 RC (82)

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2021-01-18
Auteur: TBR
Versie: 1.4

Load				***Results***			
Compression	$F_{Ed,c}$	**1832**	kN	Compression	U.C.	0.69	< 1,00 OK
Tension	$F_{Ed,t}$	**1469**	kN	Tension	U.C.	0.58	< 1,00 OK

Main leg

Profile		**L250.24**	
Steel material		S355	
Cross section		11467	mm^2
Axial capacity	N_{pl}	4071	kN
Width	b	250	mm
Thickness	t	24	mm
Length in concrete		2000	mm

Shear blocks main leg

Width	b	50	mm
Thickness	h	30	mm
Length	L	260	mm
Welds	a	5	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	14	-
Number for tension	n_t	14	-

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Pile

Name		Buispaal	
Diameter		559	mm
Thickness		10	mm
Cross section		17241	mm^2
Steel material		S235	
Capacity		4052	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	1200	mm
Welds	a	5	mm
c.t.c. separation	s	500	mm
Number for compr.	n_c	4	-
Number for tension	n_t	4	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	490	N/mm^2

Capacity shear blocks main leg

A_{f1} =	7800	mm^2
A_{f2} =	23800	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.75	
$f_{jd} = C_A \times f_{cd}$ =	18.6	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	2035	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	2035	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	63	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,c}$ =	39379	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	728	kN
$A_{p,t}$ =	27912	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	516	kN

Capacities

$F_{rd,c,plate}$ =	728	kN	
$F_{rd,blocks,c}$ =	2035	kN	
$F_{rd,c} = F_{rd,blck}+F_{rd,footplate}$ =	**2762**	kN	
U.C. compression	0.66	<	1,00 OK
Welds foot plate (see next page)	1197	kN	
$F_{rd,t}$ = min. (welds / foot plate) =	516	kN	
$F_{rd,blocks,t}$ =	2035	kN	
$F_{rd,t} = F_{rd,blck}+F_{rd,footplate}$ =	**2550**	kN	
U.C. tension	0.58	<	1,00 OK
U.C. welds	0.35	<	1,00 OK

Capacity shear blocks pile

A_{f1} =	36000	mm^2	
A_{f2} =	108000	mm^2	
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-	
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2	
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	**2660**	kN	
U.C. compression	0.69	<	1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	**2660**	kN	
U.C. tension	0.55	<	1,00 OK
U.C. welds	0.34	<	1,00 OK

"Splitting" of pile

Spread of forces		45	°
Length force flow		1731	mm
Splitting force		424	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.09	< 1,00 OK

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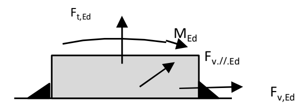
Project: ENS-ZL380
Mast: HA-6 RC (82)

Welds of shear blocks of main leg

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S355		l =	250	mm
f_{yd} =	355	N/mm^2	β_w =	0.9	-
f_u =	490	N/mm^2	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 4al$ =	49	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**174**	kN		49	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54.7	mm
M_{Ed} = 1/2 b / h x $F_{v,Ed}$ =	**2.62**	kNm	$\sigma_1 = \tau_1 = 0{,}706 M_{Ed} / al\ b^*$ =	27	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	153	N/mm^2

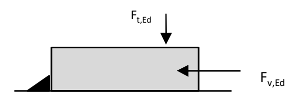
Check

$\sigma_{vw,Ed}$ =	153 N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0.35**	OK
σ_1 =	76 N/mm^2	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0.22**	OK

Welds of shear blocks of pile

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S235		l =	1200	mm
f_{yd} =	235	N/mm^2	β_w =	0.8	-
f_u =	360	N/mm^2	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 2al$ =	14	N/mm^2
$F_{t,Ed}$ = 1/2 b / h x $F_{v,Ed}$ =	**239**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 2al$ =	47	N/mm^2
$F_{v,Ed}$ =	**798**	kN		61	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0.00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	122	N/mm^2

Check

$\sigma_{vw,Ed}$ =	122 N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	360	N/mm^2	U.C. =	**0.34**	OK
σ_1 =	61 N/mm^2	≤	$0{,}9 f_u / \gamma_{M2}$ =	259	N/mm^2	U.C. =	**0.24**	OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm^2
Weld size	a =	5	mm
Length	l = 2b+ 2b - t =	952	mm
Capacity	F_{Rd} = a x l x $f_{w,d}$ / √3 =	**1197**	kN

CALCULATION OF POST INSULATOR LOADS

The following parameters are calculated:

- The forces on the insulator attachment due to wind loading and weight
- The required measurements of the components

The diagram below is a representation of the loads on the insulator:

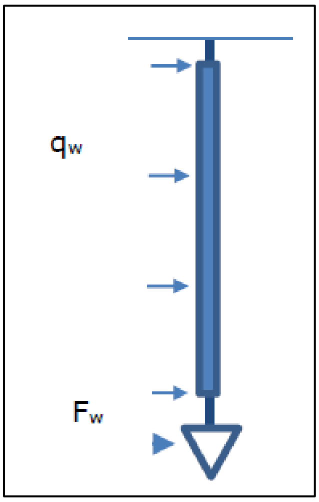


Figure 1: Diagrammatic representation of the loads on the post insulator

1. Forces on the insulator attachment

Wind pressure based on non-urban terrain in wind zone III at a height of 31 m: q_h = 1.0 kN/m^2

Wind load per meter based on an insulator diameter of 0.2 m and a drag factor of 1.2:

$\underline{q_w}$ = 1.2 x 0.2 x 1.0 = $\underline{0.24\ kN/m}$

Then calculate F_w based on a supported length of 9 m, a dragfactor of 0,9 and a structural factor of 1,0:

F_w = 9 x 0.9 x 1.0 x 3 x 0.036 x 1.0 = 0.87 kN

Calculate the moment based on the wind loading and the point load:

M_w = 0.5 x 0.24 x 4^2 + 4 x 0.87 = 5.4 kNm

Design values:

M_{ED} = 1.4 x 5.4 = 7.56 kNm

V_{ED} = 1.4 x (0.87 + 3.5 x 0.24) = 2.4 kN

2. Assessment of the pin

The figure below is a sketch of the insulator attachment mechanism indicating the location of the pin.

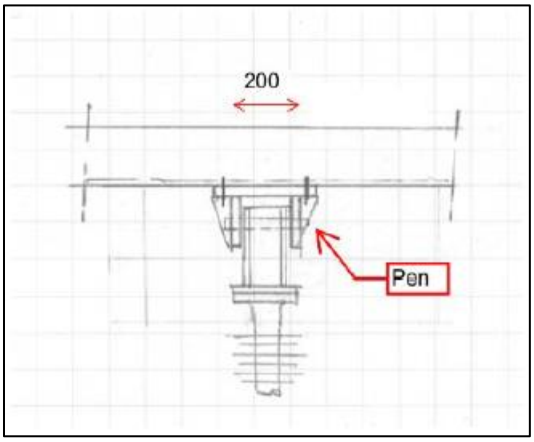


Figure 2: Post insulator attachment mechanism

Calculation of the shear force on the pin:

Assuming a total vertical weight of 5 kN and an attachment fit of 200 mm:

F_V = 7.56 /0.2 + 5/2 = 40.3 kN

Using a pin with a diameter of 25 mm is sufficient; see the attached spreadsheet calculation at the end of this appendix. A minimum flange thickness of 15 mm is required.

3. Console thickness

This will be determined in the subsequent design phases.

4. Attachment to the crossarm

The figure below depicts the additional members required for attachment to the crossarm.

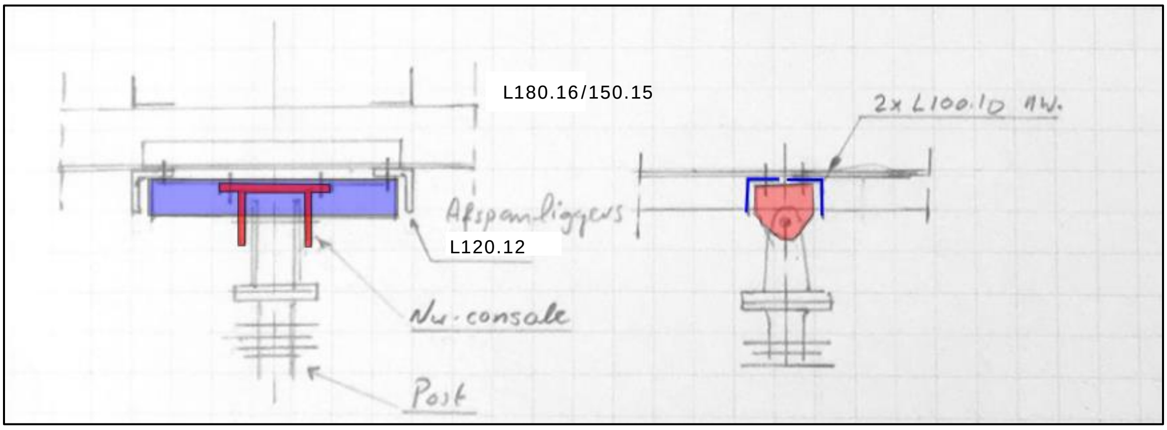


Figure 3: Overview of the new members reqpuired for attachment

M = 0.5 x 7.56 + 0.25 x 5 x 0.66 = 4.6 kNm

Proposition: 2 x L100.10: M_{rd} = 2 x 24750 x 355 x 10^{-3} = 17.5 kNm

U.C. = 4.6/ 17.5 = 0.26 < 1 OK

Pen-gatverbinding

Datum: 2021-01-18
Auteur: MKh
Versie: 1.3

Onderwerp	Post Insulator Attachment	Toetsing sterkte	0.55 < 1,0 OK

Input

Dikte	15	mm
Gat	27	mm
Pendiameter	25	mm
Ringdikte	5	mm
Eindafstand	40	mm
Randafstand	35	mm
Staalsoort	S235	
Kwaliteit pen	8.8	

Toetsing

Afstanden

Randafstand	OK
Eindafstand	OK
Dikte	OK

Sterkte-eisen

Afschuifsterkte pen	0.21	< 1,0 OK
Buigsterkte pen	0.55	< 1,0 OK
Combinatie M + V	0.35	< 1,0 OK
Stuik plaat	0.37	< 1,0 OK

Belasting

F_{Ed} = 40.3 kN

$\gamma_{m0,staal}$	1.20
$\gamma_{m0,pen}$	1.00
γ_{m2}	1.25
$\gamma_{m6,ser}$	1.00

Berekeningen

Controle eind- en randafstand
Aan de eisen van óf A óf B moet voldaan worden

Type A

Rand	$a > F_{Ed}\ \gamma_{m0}$ / $2tf_y$ + 2 d0/3 =	25 mm	OK
Eind	$c > F_{Ed}\ \gamma_{m0}$ / $2tf_y$ + d0/3 =	16 mm	OK

Type B

Min. eindafstand	$e > 1{,}6d_0$ =	43 mm	Niet OK
Min. randafstand	$e > 1{,}25d_0$ =	34 mm	OK
Min. dikte	$t > 0{,}7\sqrt{(F_{Ed}\ \gamma_{m0}\ /\ f_y)}$ =	10 mm	OK

Pen

A = 491 mm^2
W_{el} = 1534 mm^2
Excentriciteit
e = (132-102)+t*clip*/2 — 20 mm

Materiaalsterktes

$f_y = \min(f_{y,staal},\ f_{yp})$ = 235 N/mm^2
f_{yp} = 640 N/mm^2
f_{up} = 800 N/mm^2
$f_{y,staal}$ 235 N/mm^2
$f_{t,staal}$ 360 N/mm^2

Afschuiving

$F_{v,Rd} = 0{,}6A\ f_{up}\ /\ \gamma_{m2}$ = 188 kN
U.C. 0.21 < 1,0 OK

Stuik

$F_{b,Rd} = 1{,}5\ t\ d\ f_y\ /\ \gamma_{m0}$ = 110 kN
U.C. 0.37 < 1,0 OK

Buigweerstand

$M_{Ed} = F_{Ed}\ e$ = 0.81 kNm
$M_{Rd} = 1{,}5\ W_{el}\ f_{yp}\ /\ \gamma_{m0}$ = 1.47 kNm

U.C. = 0.55 < 1,0 OK

$(M_{Ed}\ /\ M_{Rd})2 + (F_{v,Ed}\ /\ F_{v,Rd})^2$ = 0.35 < 1,0 OK

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Project: ENS-ZL380
Mast: HA-6 RC (82)

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2021-01-18
Auteur: TBR
Versie: 1.4

Load				***Results***			
Compression	$F_{Ed,c}$	**1832**	kN	Compression	U.C.	0.69	< 1,00 OK
Tension	$F_{Ed,t}$	**1469**	kN	Tension	U.C.	0.58	< 1,00 OK

Main leg

Profile		**L250.24**	
Steel material		S355	
Cross section		11467	mm^2
Axial capacity	N_{pl}	4071	kN
Width	b	250	mm
Thickness	t	24	mm
Length in concrete		2000	mm

Shear blocks main leg

Width	b	50	mm
Thickness	h	30	mm
Length	L	260	mm
Welds	a	5	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	14	-
Number for tension	n_t	14	-

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Pile

Name		Buispaal	
Diameter		559	mm
Thickness		10	mm
Cross section		17241	mm^2
Steel material		S235	
Capacity		4052	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	1200	mm
Welds	a	5	mm
c.t.c. separation	s	500	mm
Number for compr.	n_c	4	-
Number for tension	n_t	4	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	490	N/mm^2

Capacity shear blocks main leg

A_{f1} =	7800	mm^2
A_{f2} =	23800	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.75	
$f_{jd} = C_A \times f_{cd}$ =	18.6	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	2035	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	2035	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	63	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,c}$ =	39379	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	728	kN
$A_{p,t}$ =	27912	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	516	kN

Capacities

$F_{rd,c,plate}$ =	728	kN
$F_{rd,blocks,c}$ =	2035	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**2762**	kN
U.C. compression	0.66	< 1,00 OK
Welds foot plate (see next page)	1197	kN
$F_{rd,t}$ = min. (welds / foot plate) =	516	kN
$F_{rd,blocks,t}$ =	2035	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**2550**	kN
U.C. tension	0.58	< 1,00 OK
U.C. welds	0.35	< 1,00 OK

Capacity shear blocks pile

A_{f1} =	36000	mm^2
A_{f2} =	108000	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	**2660**	kN
U.C. compression	0.69	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	**2660**	kN
U.C. tension	0.55	< 1,00 OK
U.C. welds	0.34	< 1,00 OK

"Splitting" of pile

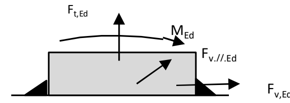
Spread of forces		45	°
Length force flow		1731	mm
Splitting force		424	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.09	< 1,00 OK

Project: ENS-ZL380
Mast: HA-6 RC (82)

Welds of shear blocks of main leg

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S355		l =	250	mm
f_{yd} =	355	N/mm²	β_w =	0.9	-
f_u =	490	N/mm²	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 4al$ =	0	N/mm²
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 4al$ =	49	N/mm²
$F_{v,Ed} = F_{rd,c} / n$ =	**174**	kN		49	N/mm²
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54.7	mm
M_{Ed} = 1/2 b / h x $F_{v,Ed}$ =	**2.62**	kNm	$\sigma_1 = \tau_1 = 0{,}706 M_{Ed} / al\, b^*$ =	27	N/mm²
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm²
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	153	N/mm²

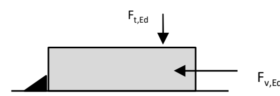
Check

$\sigma_{vw,Ed}$ =	153	N/mm²	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm²	U.C. =	**0.35**	OK
σ_1 =	76	N/mm²	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm²	U.C. =	**0.22**	OK

Welds of shear blocks of pile

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S235		l =	1200	mm
f_{yd} =	235	N/mm²	β_w =	0.8	-
f_u =	360	N/mm²	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 2al$ =	14	N/mm²
$F_{t,Ed}$ = 1/2 b / h x $F_{v,Ed}$ =	**239**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 2al$ =	47	N/mm²
$F_{v,Ed}$ =	**798**	kN		61	N/mm²
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0.00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm²
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	122	N/mm²

Check

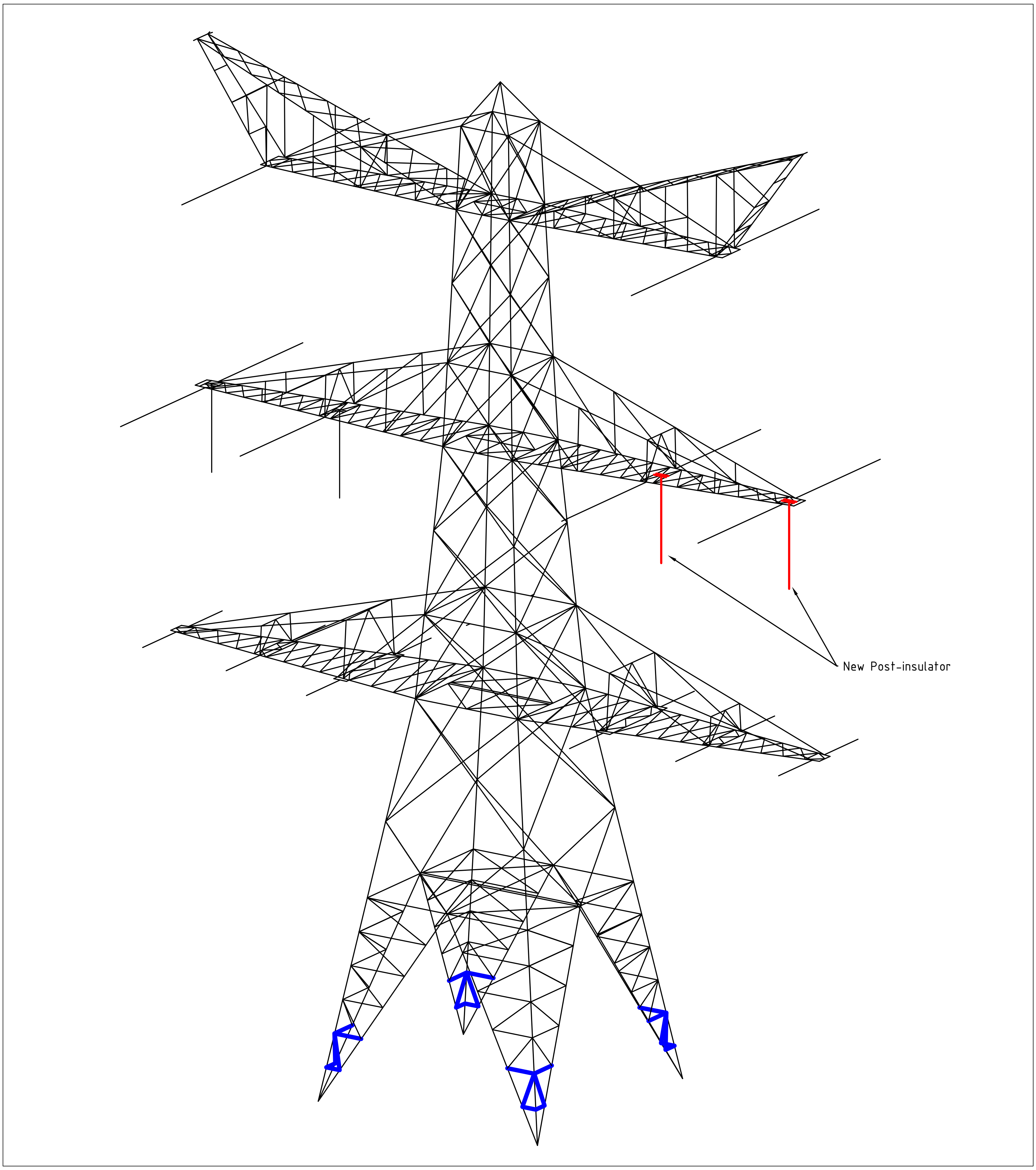
$\sigma_{vw,Ed}$ =	122	N/mm²	≤	$f_u / \beta_w \gamma_{M2}$ =	360	N/mm²	U.C. =	**0.34**	OK
σ_1 =	61	N/mm²	≤	$0{,}9 f_u / \gamma_{M2}$ =	259	N/mm²	U.C. =	**0.24**	OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm²
Weld size	a =	5	mm
Length	l = 2b+ 2b - t =	952	mm
Capacity	F_{Rd} = a x l x $f_{w,d}$ / √3 =	**1197**	kN

APPENDIX E
Tekeningen

Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
Pos 9110	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L50x5	S355 t=<40	M16-8.8t-NEN2012
Pos 9109	EA	L50x7	S235 t=<40	M16-8.8t-NEN2012	EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
Pos 9108	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L50x5	S355 t=<40	M16-8.8t-NEN2012
BR1 & BR2					EA	L100x10	S355 t=<40	M24-8.8t-NEN2012



Overview

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

New profile/insulator
Profile exchanged
New redundant
Bolt exchanged

00	18-1-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-053

Design state: FINAL | Scale: -

Drawn by: MuK 18-1-2021 | Units: m

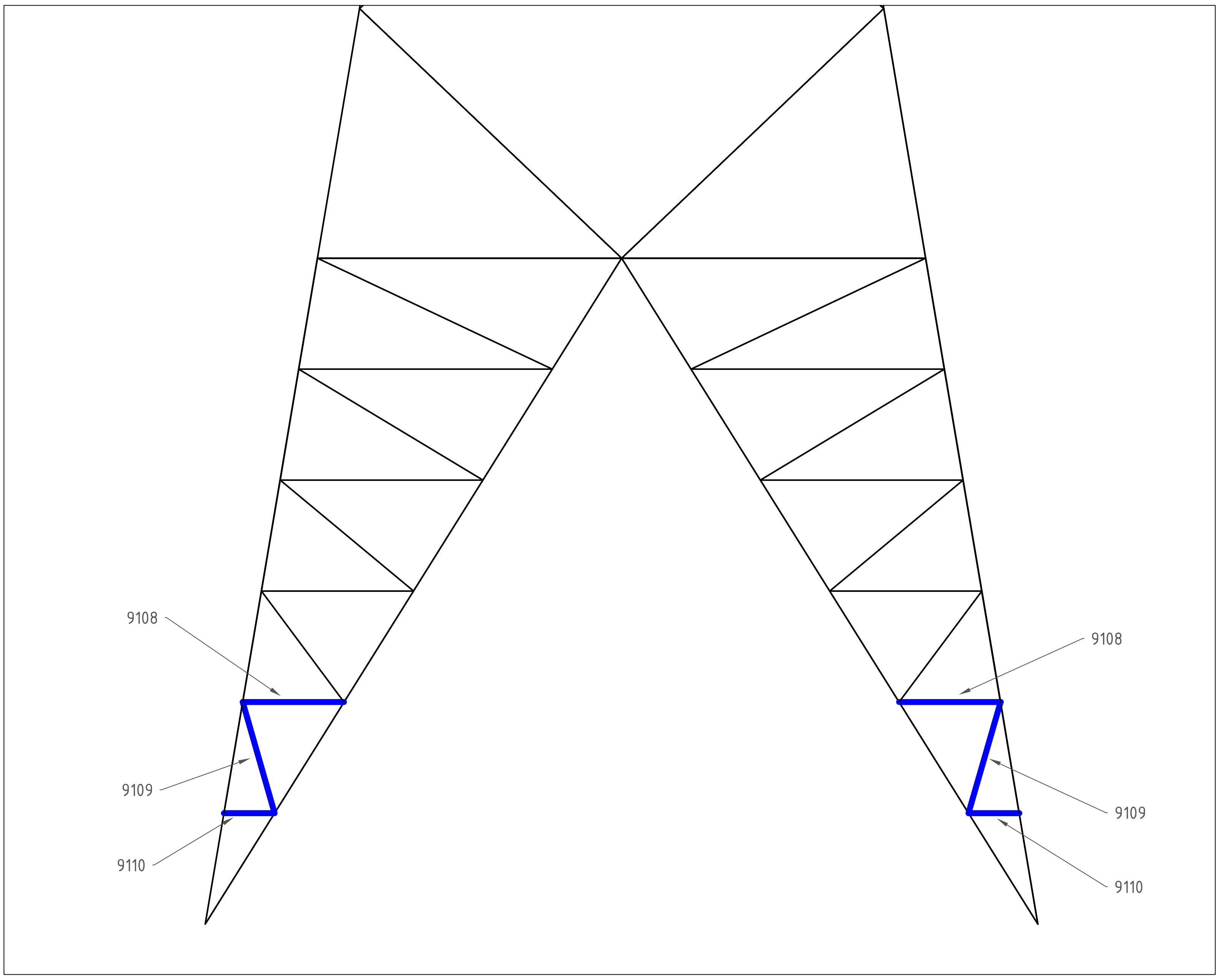
Checked by: TBR 18-1-2021 | Project no: 10166260

Approved by: JHu 18-1-2021 | Company: TenneT

Description: Modifications overview for mast type HA-6_RC (Mast 82) page 1 of 3

Revision: 00

Format: A2



Front View - Lower Leg Section

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

Profile exchanged
New redundant
Bolt exchanged

00	18-1-2021	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-053

Design state: FINAL		Scale: -		
Drawn by: MuK	18-1-2021	Units: m		
Checked by: TBR	18-1-2021	Project no: 10166260		
Approved by: JHu	18-1-2021	Company: TenneT		

Description: Modifications overview for mast type HA-6_RC (Mast 82) page 2 of 3

Revision: 00

Format: A2

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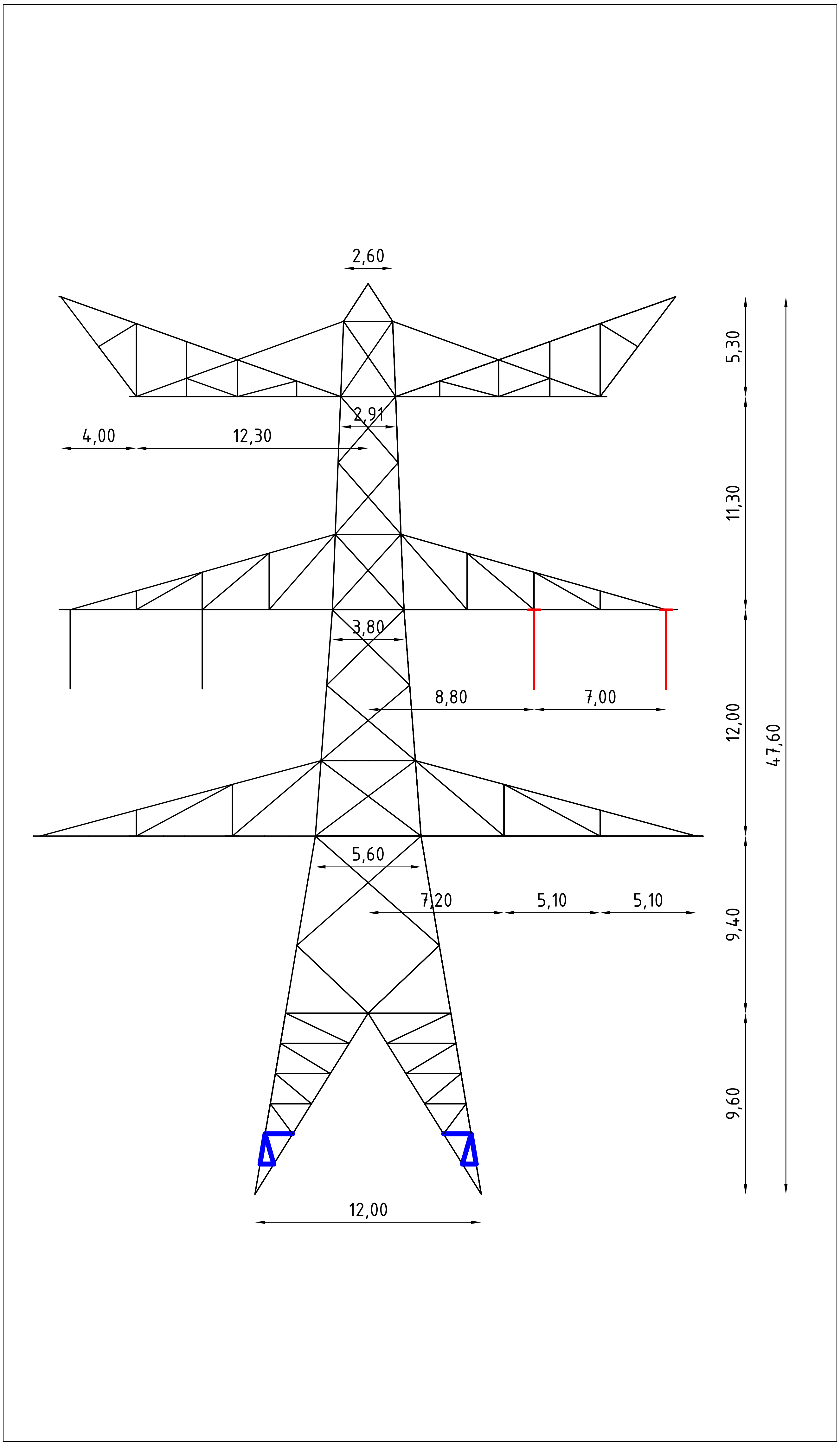
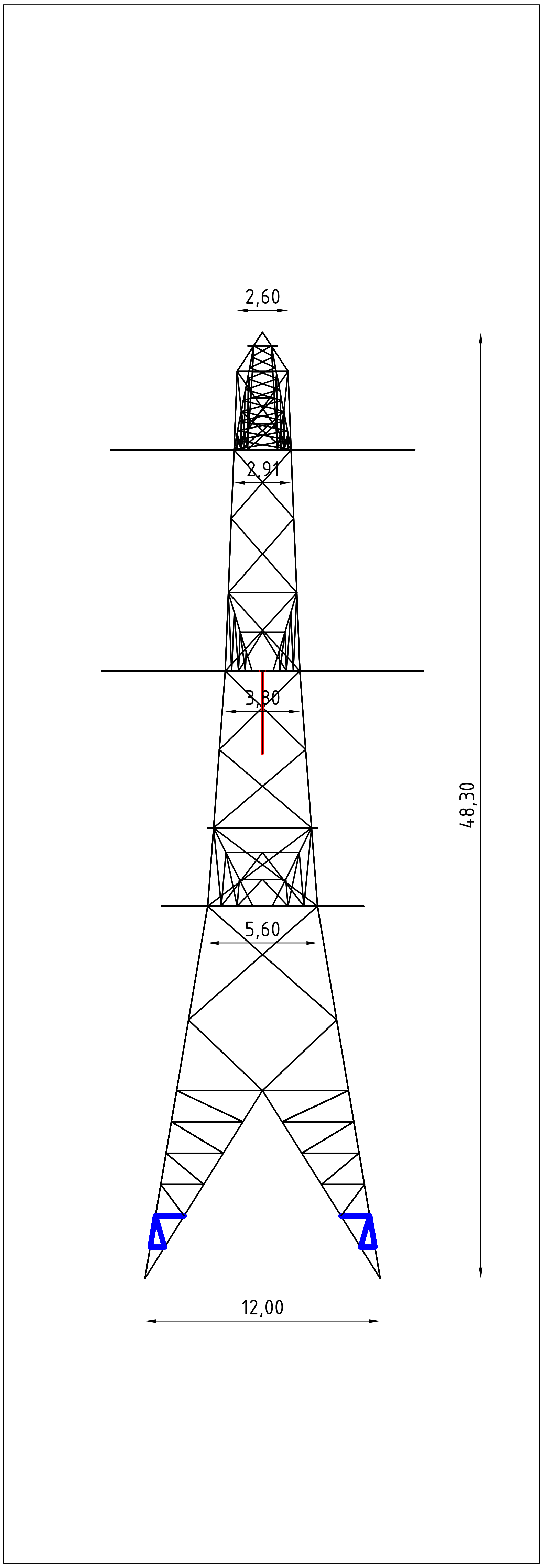


Front View



Side View

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

Profile exchanged
New redundant
Bolt exchanged

00	18-1-2021	Version 1.0	
DNV·GL		Projectname: Mast constructions ENS - ZL 380 kV	
		Third angle projection:	Drawing no.: 10166260-053
Design state: FINAL	Scale: -	Description: Modifications overview for mast type HA-6_RC (Mast 82) page 3 of 3	Revision: 00
Drawn by: MuK 18-1-2021	Units: m		
Checked by: TBR 18-1-2021	Project no: 10166260		Format: A2
Approved by: JHu 18-1-2021	Company: TenneT		

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TOETSING EN HERONTWERP MASTEN EN FUNDATIES BBB380

ENS-ZL380 – Rapportage masttype S+15/R

TenneT TSO B.V.

Rapport nr.: 22-0494, Rev. 0
Meridian doc.nr.: 002.515.40 1007976
Datum: 2022-03-30

Projectnaam:	Toetsing en herontwerp masten en fundaties BBB380	Energy Systems
Rapport titel:	ENS-ZL380 – Rapportage masttype S+15/R	DNV Netherlands B.V.
Klant:	TenneT TSO B.V.,	Utrechtseweg 310-B50
Contactpersoon klant:	P. v.d. Horst	6812 AR Arnhem
Datum uitgave:	2022-03-30	
Project nr.:	10166260	
Organisatie unit:	TDT	Tel: 026 356 9111
Meridian doc.nr..:	002.515.40 1007976	Handelsregister Arnhem 09006404
Rapport nr.:	22-0494, Rev. 0	

Geschreven door:	Beoordeeld door:	Goedgekeurd door:
M.H. Khan	A.J. Börger	C. Schutte

DNV Distributie:

☐ Open

☐ Intern

☐ Commercieel vertrouwelijk

☒ Vertrouwelijk

☐ Geheim

*Specificatie distributie: --

Rev.	Datum	Reden van uitgave	Auteur	Beoordeeld	Goedgekeurd
0	2022-03-30	Eerste uitgave	M.H. Khan	A.J. Börger	C. Schutte

Inhoudsopgave

1 INLEIDING

1.1 Inleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt.

Om die reden is de opdrachtgever (OG) voornemens de bestaande 380 kV-koppelnetring op te waarderen. Het opwaarderen van de bestaande verbindingen valt onder het programma “Beter benutten bestaande 380 kV-ring” en omvat de volgende deelprojecten:

- Opwaardering 380 kV-verbinding Lelystad – Ens (LLS-ENS380)
- Opwaardering 380 kV-verbinding Diemen – Lelystad (DIM-LLS380)
- Opwaardering 380 kV-verbinding Rilland – Zandvliet (RLL-ZVL380)
- Opwaardering 380 kV-verbinding Krimpen aan den IJssel - Geertruidenberg (KIJ-GT380)
- Opwaardering 380 kV-verbinding Ens - Zwolle (ENS-ZL380)
- Opwaardering 380 kV-verbinding Maasbracht - Eindhoven (MBT-EHV380)

Om te komen tot een DO waarmee de werkzaamheden kunnen worden gestart is door TenneT aan DNV opdracht verstrekt voor de volgende onderdelen:

1. In eerste fase het opstellen en creëren van:

1.1 E-studie deel 1

1.2 Uitgangspuntenrapporten ten behoeve van de constructieve analyse van masten en fundaties

1.3 Sonderingmodellen

1.4 Fundatiemodellen

1.5 Mastmodellen

2. In tweede fase de uitvoering van de DO-fase bevattende:

2.1 Toetsing conform het uitgangspuntenrapport van de bestaande fundaties

2.2 Globale specificatie van benodigde fundatieversterkingen ten behoeve van aanbesteding

2.3 Toetsing conform het uitgangspuntenrapport van de bestaande masten

2.4 Globale specificatie van benodigde mastversterkingen ten behoeve van aanbesteding

2.5 E-studie deel 2

1.2 Doel van dit rapport

In dit rapport wordt voor de hoogspanningslijn Ens - Zwolle de controle van de mastconstructie van masttype S+15/R gerapporteerd. Het doel is om te bepalen of de in dit rapport beschreven bestaande mast geschikt is om te worden uitgerust met de nieuwe ACCC-Warsaw geleider waarmee een hogere capaciteit kan worden gerealiseerd.

Nadat de wijzigingen zijn toegepast dient aantoonbaar geverifieerd te worden dat het systeem voldoet aan de vigerende eisen.

In de defintief-ontwerpfase zijn ten behoeve van de contractvorming Engelstalige rapporten geleverd. Het voorliggende rapport is bedoeld voor vergunningsaanvraag en is inhoudelijk ongewijzigd ten opzichte van de Engelse versie. Om deze reden zijn de bijlagen in dit rapport één op één overgenomen uit de Engelse versie. Hierdoor wijkt het revisienummer van de bijlagen af van het revisienummer van de rapportage.

1.3 Gerelateerde documenten

1.3.1 Verificatie & validatieplan

De door TenneT aangeleverde set met eisen is beoordeeld op relevantie en voor de relevante eisen is aangegeven in welk document wordt aangetoond dat er aan de eis wordt voldaan. De resultaten hiervan zijn opgenomen in het rapport “Verificatie & Validatieplan 380 kV verbinding Ens - Zwolle”.

1.3.2 E-studie deel 1

In de rapportage “ENS-ZL380 - E-studie deel 1” [1] is bepaald welke aanpassingen benodigd zijn om de ACCC-Warsaw geleider toe te passen binnen de verbinding Ens – Zwolle.

Uit de E-studie volgen geen zaken die relevant zijn voor de constructie van masttype S+15/R.

1.3.3 Uitgangspuntendocument

De uitgangspunten op basis waarvan de berekeningen in deze rapportage zijn uitgevoerd zijn opgenomen in het rapport “Uitgangspuntenrapport 380kV verbinding Ens - Zwolle” [2].

2 EISEN

In onderstaande Tabel 1 zijn de eisen opgenomen die binnen deze rapportage worden getoetst.

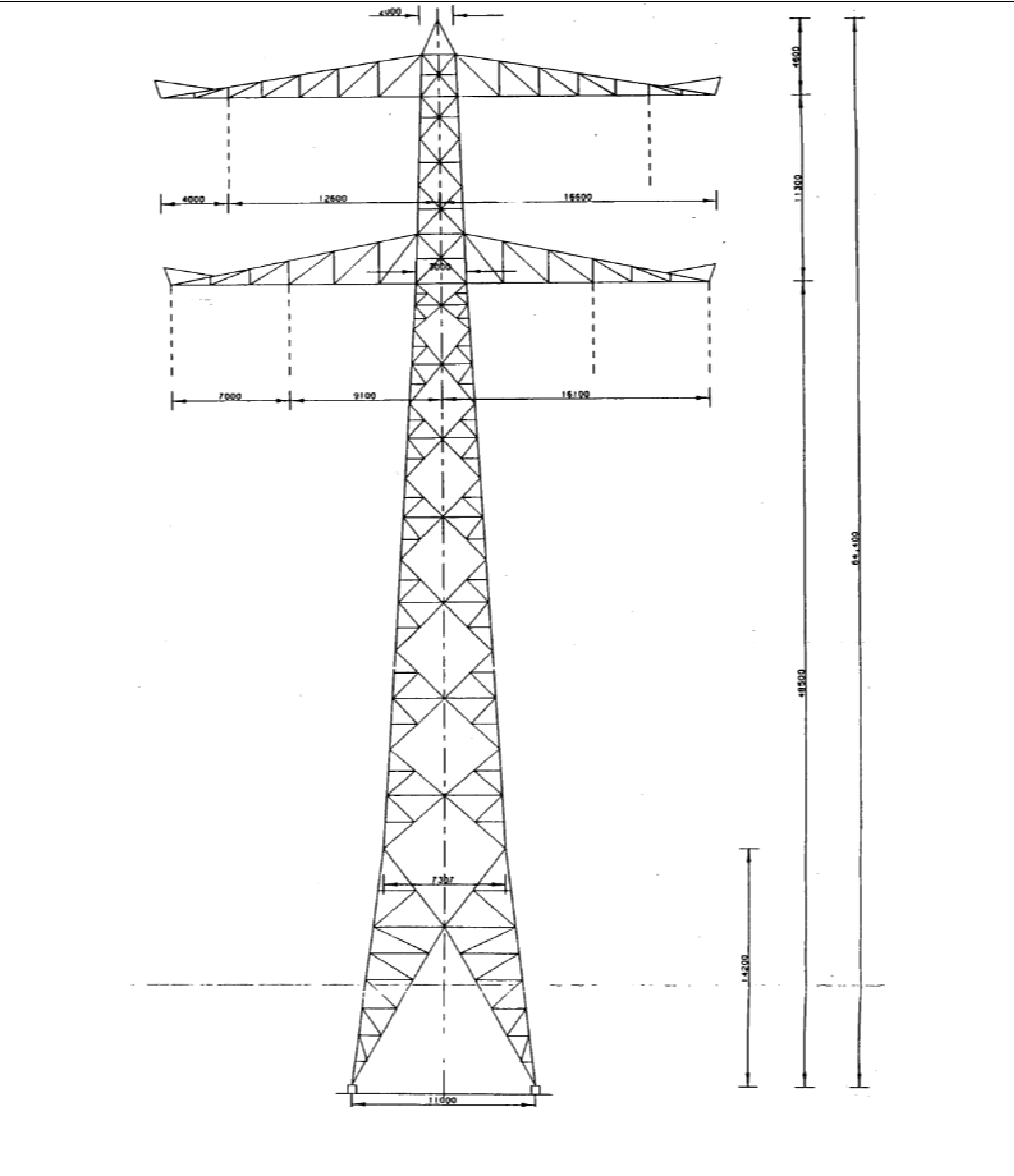
Tabel 1 Relevante eisen

Req. Id	Title	Req. text	Verification
BO Eis: H2.7-6	Omgeving, beperkingsfactoren	Het ontwerp dient geverifieerd te worden op de uitvoerbaarheid.	Tabel 5
PVE.05.001 5.14	Masten	Aanwijzingen t.a.v. klimvoorziening en valbeveiliging: Huidige klimweg blijft gehandhaafd en zal voldoen aan de eisen zoals opgenomen in de NEN 1060:1987. Valbeveiliging is/zal worden uitgevoerd in het type "latch way". Indien staaldelen in de nabijheid (aangrenzend profiel) van de klimweg gewijzigd worden, dient geverifieerd te worden dat de klimvoorziening in overeenstemming is met de NEN 1060:1987.	Tabel 5

3 BEREKENINGEN

3.1 Mastbeeld

Het mastbeeld op basis van de Asset-data is weergegeven in Figuur 1.



Figuur 1 Mastbeeld S+15 R

3.2 Mastenlijst

In deze rapportage wordt masttype S+15/R getoetst. De S+15/R mast valt onder windgebied III. Bij het bepalen van de conductor belastingen is rekening gehouden met verhoogde windbelasting als gevolg van een hogere aangrenzende mast (hoger is een negatieve waarde). De wind en weight span van de verschillende masten zijn in Tabel 2 weergegeven.

De overschrijding van de profiel capaciteit wordt veroorzaakt door de steile aflopende helling naar mast nummer 90.

Tabel 2 Mastnummers

Tower number	Tower type	Governing tower number	Wind span (m)	Weight span (m)	Height difference back (m)	Height difference ahead (m)
89	S+15_R	89	258	799	-11.9	-17.5

3.3 Uitgangspunten berekening

De berekening is uitgevoerd op basis van de uitgangspunten zoals opgenomen in het uitgangspuntenrapport [2]. Hierin is een volledig overzicht opgenomen van de belastingcombinaties en toegepaste belastingfactoren

Tabel 3 Uitgangspunten berekening

Algemeen	Norm	NEN-EN50341-2-15:2019
	Windgebied	II/III
	Terreincategorie	II (onbebouwde omgeving)
	Reductiefactor cdir	1,00
Situatie initieel	Gevolgklasse	CC2-0
	Betrouwbaarheidsniveau	Afkeur CC2-0
	Referentieperiode	30 jaar
Situatie na aanpassingen	Gevolgklasse	CC2
	Betrouwbaarheidsniveau	Verbouw
	Referentieperiode	50 jaar

3.4 Proces stappen

Het proces van het bepalen van eventueel benodigde verstevigingen bestaat uit de volgende stappen:

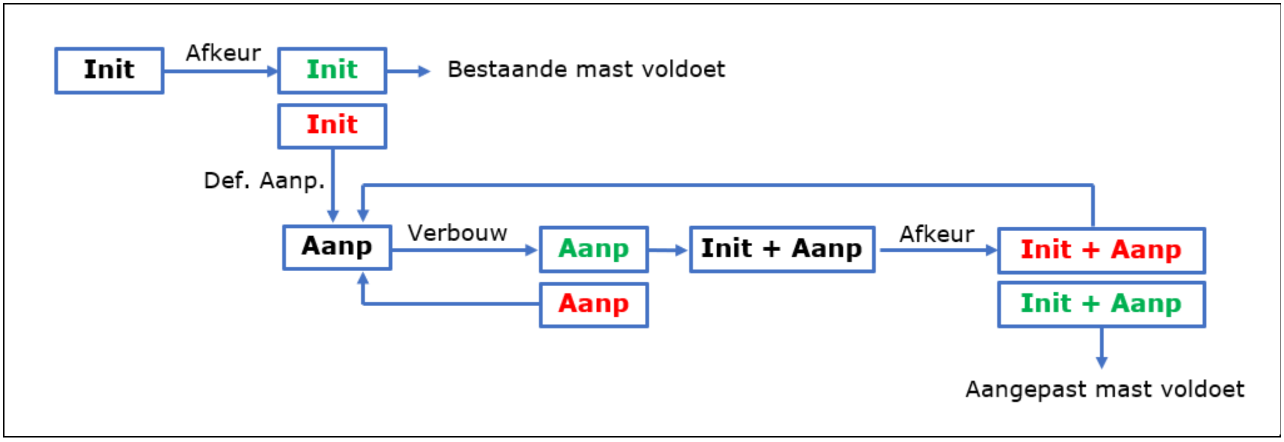
Stap 1: Toets bestaande (Init) mast op Afkeur

Stap 2: Definiëren benodigde aanpassingen indien initiële mast niet voldoet aan toets op Afkeur (Def. Aanp.)

Stap 3: Het toetsen van (alleen) de uitgewerkte aanpassingen (Aanp) op Verbouw

Stap 4: Het opnieuw toetsen van de complete mast inclusief aanpassingen (Initi + Aanp) op Afkeur

Het hierboven omschreven proces is in Figuur 2 weergegeven.



Figuur 2 Proces diagram

3.5 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV. In Appendix A zijn de resultaten van de geleiderbelastingen samengevat.

3.6 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma, zie ook Appendix A

3.7 Modellering

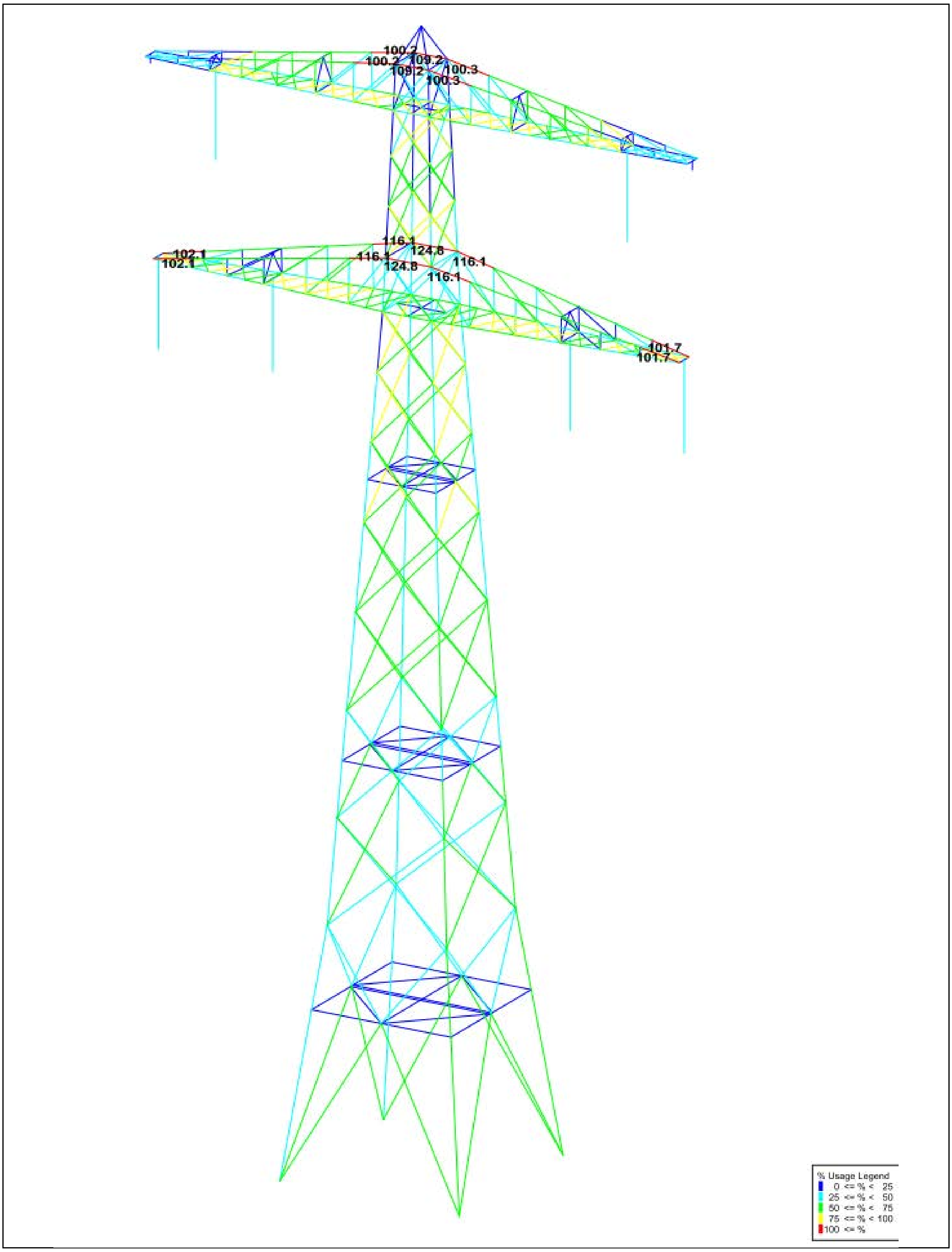
Op basis van de as-built tekeningen is de mast in PLS-TOWER ingevoerd. De hoofdelementen zijn gemodelleerd. Niet-dragende profielen als knikverkorters zijn weggelaten en worden separaat getoetst. De profielen inclusief de boutverbindingen zijn in PLS-TOWER ingevoerd en getoetst. Controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

De geleiderbelastingen vanuit het geleiderbelastingenprogramma zijn als invoer voor de belastingen gebruikt.

Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep en de toetsing wordt per staafgroep uitgevoerd. Ingeval dat een element uit een groep is overbelast, geldt dit voor alle elementen uit de betreffende groep.

4 TOETSING MASTCONSTRUCTIE

Het resultaat van de controle van de mastconstructie type S+15 R met belastingen op afkeurniveau is weergegeven in Figuur 3.



Figuur 3 Resultaat PLS-TOWER S+15 R (89)

De resultaten van de controles van profielen, knikverkorters en ankers randstijl zijn opgenomen in Tabel 4.

Verschillende profielen in PLS-TOWER zijn op een conservatieve manier berekend met betrekking tot de breekcapaciteit. Daarom heeft DNV de trek capaciteit aan de hand van handmatige berekeningen overschreven voor deze profielen (groep 305 en 306). De berekeningen zijn opgenomen in Appendix D.

Tabel 4 Samenvatting controle

Controle van	Beoordeling		Referentie
Profielen		Voldoen niet	Figuur 3 Appendix B
Knikverkorters	Voldoen		Appendix C
Blokdeuvels	Voldoen		Appendix D

5 AANPASSINGEN

5.1 Inleiding

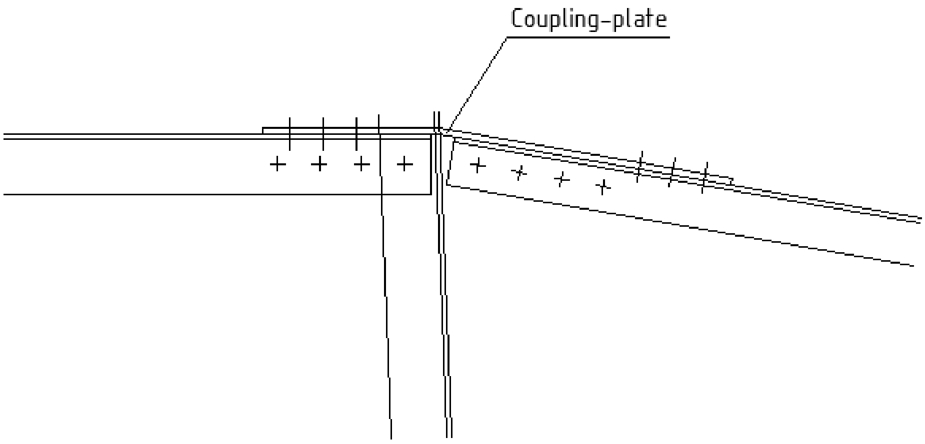
Een versterkingsvoorstel om de mast aan afkeurniveau te laten voldoen is uitgewerkt. Dit voorstel bevat de volgende maatregelen:

- Toevoegen van een koppelplaat om de hoofdprofielen aan de bovenzijde van de traverse en de horizontale profielen in het mastlichaam met toevoeging van boutverbindingen te verbinden. (Voor beide traversen)
- Toevoegen van een hoekplaat om de capaciteit van de boutverbinding aan het einde van de bovenrand van de onderste traverse te verhogen.

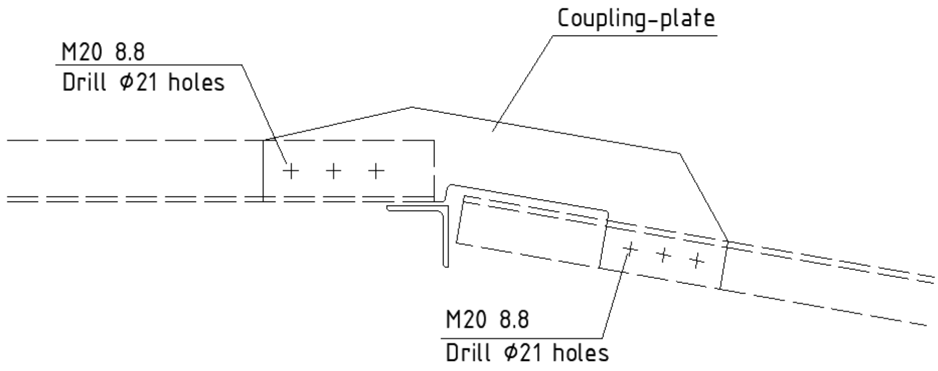
5.2 Aanpassingen

Zoals in de resultaten in Appendix B is te zien zijn de aanpassingen eerder beschreven in dit hoofdstuk.

Een koppelplaat wordt verbonden met een nieuwe boutverbinding op de bovenzijde van de flens op het bestaande profiel om zo de doorsnede capaciteit te verhogen, weergeven in figuur 5 en 6. De doorsnede capaciteit van deze verbinding is significant hoger als beide profielen in deze hoek verbonden zijn. Deze principe aanpassing dient toegepast te worden voor zowel de onderste als de bovenste traversen.

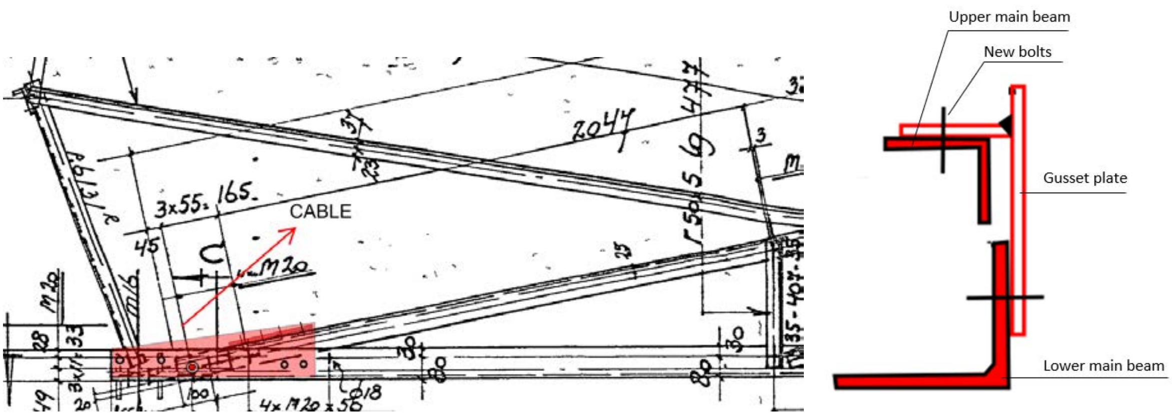


Figuur 4 Principe aanpassing/toevoeging tussen de traverse en het mastlichaam (zijaanzicht).



Figuur 5 Principe aanpassing/toevoeging tussen de traverse en het mastlichaam (Boven aanzicht).

Voor de tip van de onderste traverse is een hoekplaat benodigd om zo een boutverbinding te creëren op de top flens van het bovendeel van het profiel. Een tijdelijke tui kan in staat zijn om de benodigde ondersteuning te bieden voor de bestaande belastingen op de onderste traverse wanneer de bouten worden vervangen. (Dient opgelost te worden in het veld).



Figuur 7 Principe aanpassing/toevoeging van het staart-eind van de onderste traverse.

Meer informatie met betrekking tot de locatie en de tekeningen van deze aanpassingen is weergegeven in Appendix E.

5.3 Eisenverificatie

De verificatie van de van toepassing zijnde eisen is uitgevoerd in onderstaande Tabel 5.

Tabel 5 Verificatie eisen

Eis Id	Eis Tekst	Ja	Nee	N.v.t.	toelichting
BO Eis: H2.7-6	Aanpassingen uitvoerbaar?	X			De toe te voegen staalonderdelen zijn met geboute verbindingen te bevestigen. Dit is een bewezen methode.
PVE.05.001 5.14	Staaldelen in nabijheid van klimweg gewijzigd?			X	De wijzigingen in de nabijheid van de klimweg (knikverkorters) zijn in te passen zonder negatieve invloed op de begaanbaarheid.
	klimvoorziening nog in overeenstemming is met de NEN 1060:1987?			X	Geen wijzigingen

6 REFERENTIES

„002.515.40 0825824 - 21-0462 - Verificatie & validatieplan 380kV verbinding Ens - Zwolle”.
„002.515.40 0825812 - 20-1465 - E-studie deel 1 380kV verbinding Ens - Zwolle”.
„002.515.40 0825820 - 20-1245 - Uitgangspuntenrapport 380kV verbinding Ens - Zwolle”.

APPENDIX A
Geleiderbelastingen

Content

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	III
Wind speed	24,5 m/s
Terrain categorie	II
Reduction factor C_{dir}	1,00
Ice region	B
Tower type	Steunmast
Tower height	64,4 m
Max. Span	444,6 m
Line angle	180°
Catenary	1760 m
Wind span	257 m
EDS Weight span	850 m
Min. Weight span	721 m
Max. Weight span	1706 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2020-11-30			

Client:

Title:

Berekening masttype S+15_R

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_S+15_R_89_Report.pdf

Project number:

Project client number:

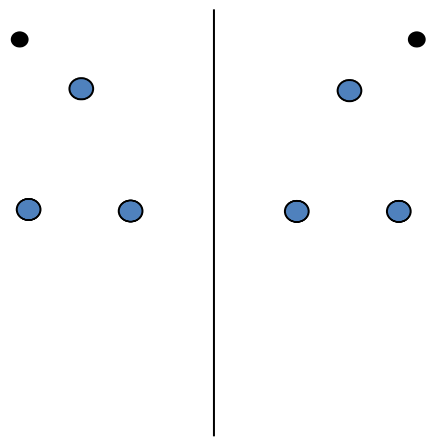
0.0

Conductor loads

Auteur: TBR
Versie: v11.3

General

Description	S+15_R
Tower type	Steunmast
Number of circuits	2
Configuration	2-circuit-donau
Number of earth wires	2



Configuratie geleiders

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	III
Wind speed	24,5 m/s
Terrain category	II
Reduction factor c_{dir}	1,00
Ice region phase conductor	B
Ice region earth conductor	B

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area [m^2]
Circuit 1	Halfverankering	2,00	4,50	1,00
Circuit 2	Halfverankering	2,00	4,50	1,00
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,30	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,30	0,10

1. *Properties apply to the entire isolator set*

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower (3) Horizontal distance
Circuit 1	10	380ct1f1	44,0 m	48,5 m	-16,1 m
Circuit 1	11	380ct1f2	44,0 m	48,5 m	-9,1 m
Circuit 1	12	380ct1f3	55,3 m	59,8 m	-12,6 m
Circuit 2	20	380ct2f1	44,0 m	48,5 m	16,1 m
Circuit 2	21	380ct2f2	44,0 m	48,5 m	9,1 m
Circuit 2	22	380ct2f3	55,3 m	59,8 m	12,6 m
Bliksemdraad 1	1	bl1	59,5 m	59,8 m	-16,6 m
Bliksemdraad 2	3	bl2	59,5 m	59,8 m	16,6 m

1. *Positive = adjacent mast higher*
2. *Positive = in direction of rotation coordinate system x => y*

Project: ENS-ZL
Tower: S+15_R
Number: 89

Height adjustment adjacent masts (wind and weight span adjustment)

	Back		Ahead		
Height increase for wind pressure	0,0	m	0,0	m	(positive: higher)
Height decrease for vertical load	0,0	m	0,0	m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

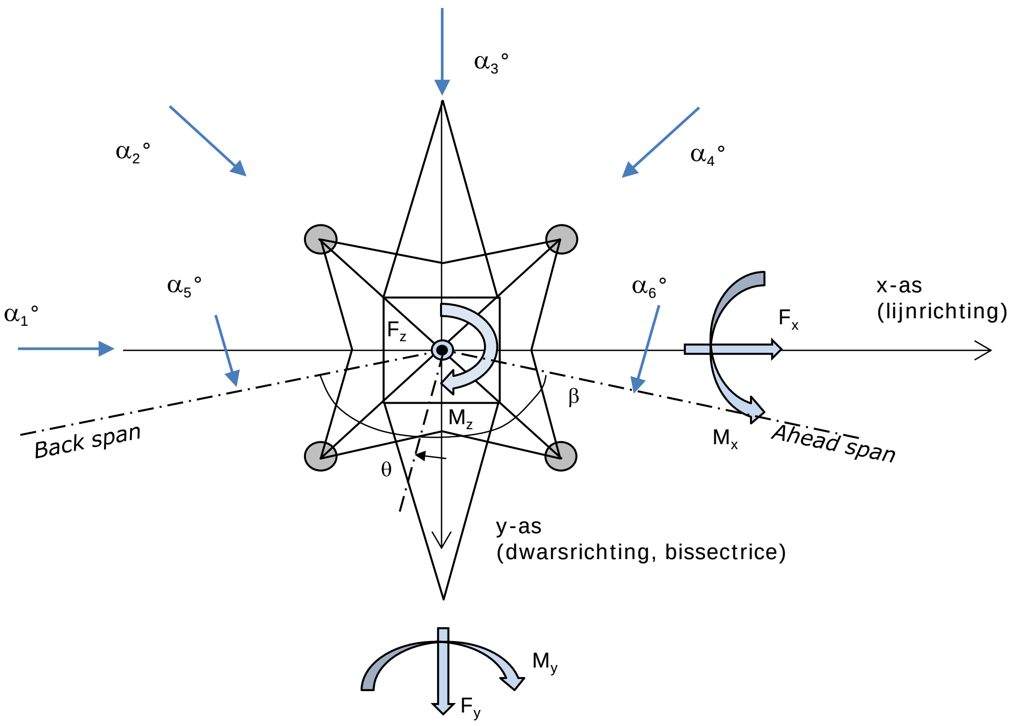
Circuits	Aanduiding	Nummer	Hoogteverschil Δh_back	Δh_ahead		Richtingsverandering Δy_back	Δy_ahead	
Circuit 1	10	380ct1f1	-11,9	-17,5	m	0,0	0,0	m
Circuit 1	11	380ct1f2	-11,9	-17,5	m	0,0	0,0	m
Circuit 1	12	380ct1f3	-11,9	-17,5	m	0,0	0,0	m
Circuit 2	20	380ct2f1	-11,9	-17,5	m	0,0	0,0	m
Circuit 2	21	380ct2f2	-11,9	-17,5	m	0,0	0,0	m
Circuit 2	22	380ct2f3	-11,9	-17,5	m	0,0	0,0	m
Bliksemdraad 1	1	bl1	-11,9	-17,5	m	0,0	0,0	m
Bliksemdraad 2	3	bl2	-11,9	-17,5	m	0,0	0,0	m

Line and tower data

		Back	Ahead	
		444,6	68,5	m
Ruling span $\sqrt{\Sigma L^3/\Sigma L}$		414,6	414,6	m
Line angle	β	180 °		
Tower orientation with respect to bi:	θ	0 °		
Section length		513	513	m
Height bottom of tower to ground level		0,5 m		
Wind directions considered	α_1	0 °		
Wind directions according to:	α_2	45 °		
Geleiderbelastingen	α_3	90 °		
	α_4	135 °		
	α_5	- °		
	α_6	- °		

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Considered number of wind directions

1a	4
3	4
4	1
6	1
Overig	1

Project: ENS-ZL
Tower: S+15_R
Number: 89

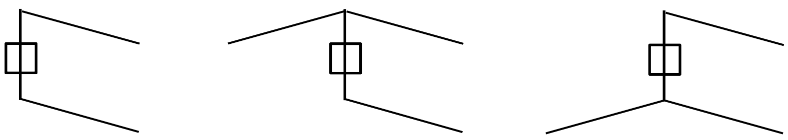
Absence of conductors

		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	0,8	0
Circuit 1	380ct1f2	1	0	1	0	0,8	0
Circuit 1	380ct1f3	1	0	1	0	0,8	0
Circuit 2	380ct2f1	0	1	1	0	0,8	0
Circuit 2	380ct2f2	0	1	1	0	0,8	0
Circuit 2	380ct2f3	0	1	1	0	0,8	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

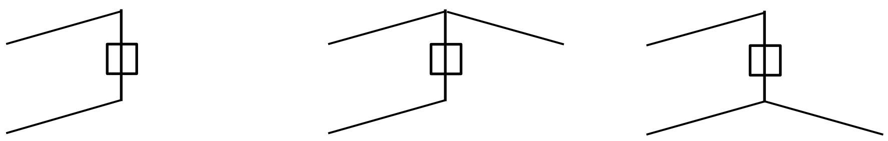
Load situations SPLS

Considered situations SPLS: SPLS for suspension tower not applicable

Principle of load situations:



1. Ba All cts   2. Ba ct1   3. Ba ct2

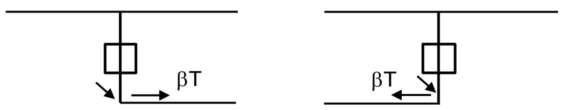


4. Ah All cts   5. Ah ct1   6. Ah ct2

Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



1. Ba   2. Ah

Project: ENS-ZL
Tower: S+15_R
Number: 89

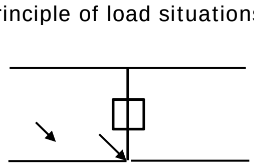
Load situations LC6. Construction and maintenance
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

3,0 kN	2,0 kN
1,0 kN	1,0 kN

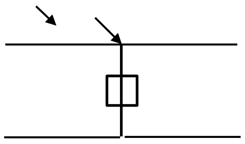
Considered situations construction and maintenance 6a: 1 up to 4, all possible situations

Presence line vehicle: Circuit, load present in all conductors of a circuit

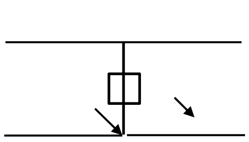
Principle of load situations:



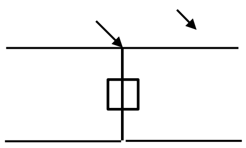
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

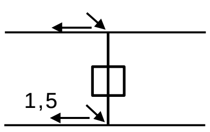
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0,866 W	1,5 W
Suspension tower earth	1,5 EDS	1,5 W
Strain tower phase and earth	1,5 EDS	1,5 W

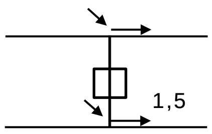
Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



1. Ba



2. Ah

Load combination 8. Galloping as a dynamic load
Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

Project: ENS-ZL
Tower: S+15_R
Number: 89

Tower structure

Properties

Tower type	Steunmast	
Tower designation	S+15_R	
Base plate w.r.t. ground level	0,5	m
Tower height w.r.t. base plate	64,4	m
Tower self weight	330,0	kN

Width and slope at foundation	x-ri.	y-ri.	
Leg spread	11,00	11,00	m
Inclination of main leg	0,130	0,130	-
Horizontal force factor	1,3	1,3	-

Calculation Wind load

Dynamic factor G_T	1,00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross a	0,4

Properties mast sections line direction (front view, yz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	14,20	11,00	7,31	14,20	0,130	129,98	15,50	0,12	3,31
Eerste tussenstuk	26,20	7,31	5,80	12,00	0,063	78,64	9,79	0,12	3,28
Tweede tussenstuk	36,70	5,80	4,48	10,50	0,063	53,98	7,92	0,15	3,17
Bovenstuk 1	48,50	4,48	3,00	11,80	0,063	44,14	8,63	0,20	2,95
Bovenstuk 2	62,40	3,00	2,00	13,90	0,036	34,75	8,26	0,24	2,77
Topstuk	64,40	2,00		2,00		2,00	0,36	0,18	3,02
Ondertraverse	48,50	14,60		3,00		21,90	5,21	0,24	2,77
Boventraverse	59,80	15,50		2,60		20,15	5,20	0,26	2,69

Properties tower sections transverse direction (side view, xz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	14,20	11,00	7,31	14,20	0,130	129,98	15,50	0,12	3,31
Eerste tussenstuk	26,20	7,31	5,80	12,00	0,063	78,64	9,79	0,12	3,28
Tweede tussenstuk	36,70	5,80	4,48	10,50	0,063	53,98	7,92	0,15	3,17
Bovenstuk 1	48,50	4,48	3,00	11,80	0,063	44,14	8,63	0,20	2,95
Bovenstuk 2	62,40	3,00	2,00	13,90	0,036	34,75	8,26	0,24	2,77
Topstuk	64,40	2,00		2,00		2,00	0,36	0,18	3,02
Ondertraverse	48,50	14,60		3,00		21,90	5,21	0,24	2,77
Boventraverse	59,80	15,50		2,60		20,15	5,20	0,26	2,69

Note: Surface transverse direction is reduced in calculation.

Project: ENS-ZL
Tower: S+15_R
Number: 89

Wind surface feeders telecom installations

Part	A (m^2/m)	Δh	A_1
Broekstuk			
Eerste tussenstuk			
Tweede tussenstuk			
Bovenstuk 1			
Bovenstuk 2			

Input antennas

Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0,70	36,0	30,5	0,0	-30,5	7,1	255,3	216,6	0,0	-216,6
Eerste tussenstuk	0,88	28,3	24,0	0,0	-24,0	20,2	571,4	484,9	0,0	-484,9
Tweede tussenstuk	1,00	25,2	21,4	0,0	-21,4	31,5	791,8	671,9	0,0	-671,9
Bovenstuk 1	1,09	27,7	23,5	0,0	-23,5	42,6	1180,3	1001,6	0,0	-1001,6
Bovenstuk 2	1,17	26,7	22,7	0,0	-22,7	55,5	1480,4	1256,2	0,0	-1256,2
Topstuk	1,21	1,3	1,1	0,0	-1,1	63,4	82,8	70,3	0,0	-70,3
Ondertraverse	1,13	32,7	19,4	0,0	-19,4	49,5	1619,5	961,9	0,0	-961,9
Boventraverse	1,19	33,4	19,8	0,0	-19,8	60,7	2026,6	1203,7	0,0	-1203,7
Totaal		211,3	162,4	0,0	-162,4		8008,2	5867,1	0,0	-5867,1

Tower section loads longitudinal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0,70	0,0	30,5	36,0	30,5	7,1	0,0	216,6	255,3	216,6
Eerste tussenstuk	0,88	0,0	24,0	28,3	24,0	20,2	0,0	484,9	571,4	484,9
Tweede tussenstuk	1,00	0,0	21,4	25,2	21,4	31,5	0,0	671,9	791,8	671,9
Bovenstuk 1	1,09	0,0	23,5	27,7	23,5	42,6	0,0	1001,6	1180,3	1001,6
Bovenstuk 2	1,17	0,0	22,7	26,7	22,7	55,5	0,0	1256,2	1480,4	1256,2
Topstuk	1,21	0,0	1,1	1,3	1,1	63,4	0,0	70,3	82,8	70,3
Ondertraverse	1,13	0,0	19,4	13,1	19,4	49,5	0,0	961,9	647,8	961,9
Boventraverse	1,19	0,0	19,8	13,4	19,8	60,7	0,0	1203,7	810,6	1203,7
Total		0,0	162,4	171,6	162,4		0,0	5867,1	5820,6	5867,1

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	330	0	0	0
Windrichting 0°	211	0	0	0	8008	0
Windrichting 45°	162	162	0	5867	5867	0
Windrichting 90°	0	172	0	5821	0	0
Windrichting 135°	-162	162	0	5867	-5867	0

Project: ENS-ZL
Tower: S+15_R
Number: 89

Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Circuit 2	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Bliksemdraad 1	OPGW 226	21,7	264,0	9,80	81000	2,30E-05
Bliksemdraad 2	OPGW 226	21,7	264,0	9,80	81000	2,30E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Circuit 2	ACCCZ-Warsaw	27,7	571,0	14,98	62700	1,88E-05
Bliksemdraad 1	OPGW 226	21,7	264,0	9,80	81000	2,30E-05
Bliksemdraad 2	OPGW 226	21,7	264,0	9,80	81000	2,30E-05

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46,3	B	4+0,2d	9,5	28,6
Circuit 2	3	3	46,3	B	4+0,2d	9,5	28,6
Bliksemdraad 1	1	3	10,1	B	4+0,2d	8,3	8,3
Bliksemdraad 2	1	3	10,1	B	4+0,2d	8,3	8,3

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46,3	B	4+0,2d	9,5	28,6
Circuit 2	3	3	46,3	B	4+0,2d	9,5	28,6
Bliksemdraad 1	1	3	10,1	B	4+0,2d	8,3	8,3
Bliksemdraad 2	1	3	10,1	B	4+0,2d	8,3	8,3

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m^2]	Wind heigth [m]	Pressure [kN/m^2]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	2,00	1	2	4,5	1,0	46,75	1,12	1,2	1,34
380ct1f2	2,00	1	2	4,5	1,0	46,75	1,12	1,2	1,34
380ct1f3	2,00	1	2	4,5	1,0	58,05	1,18	1,2	1,42
380ct2f1	2,00	1	2	4,5	1,0	46,75	1,12	1,2	1,34
380ct2f2	2,00	1	2	4,5	1,0	46,75	1,12	1,2	1,34
380ct2f3	2,00	1	2	4,5	1,0	58,05	1,18	1,2	1,42
bl1	0,10	1	0,1	0,3	0,1	60,15	1,19	1,2	0,14
bl2	0,10	1	0,1	0,3	0,1	60,15	1,19	1,2	0,14

Project: ENS-ZL
Tower: S+15_R
Number: 89

Wind load back

Conductor	Height wind [m]	Pressure [kN/m²]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	29,2	0,98	0,61	0,61	1,10	28,53	56,5	56,5	47,4	102,2	102,2
380ct1f2	29,2	0,98	0,61	0,61	1,10	28,53	56,5	56,5	47,4	102,2	102,2
380ct1f3	40,5	1,07	0,64	0,64	1,08	28,53	63,1	63,1	47,4	116,9	116,9
380ct2f1	29,2	0,98	0,61	0,61	1,10	28,53	56,5	56,5	47,4	102,2	102,2
380ct2f2	29,2	0,98	0,61	0,61	1,10	28,53	56,5	56,5	47,4	102,2	102,2
380ct2f3	40,5	1,07	0,64	0,64	1,08	28,53	63,1	63,1	47,4	116,9	116,9
bl1	46,2	1,11	0,65	0,65	1,19	22,35	19,2	19,2	41,8	36,2	36,2
bl2	46,2	1,11	0,65	0,65	1,19	22,35	19,2	19,2	41,8	36,2	36,2

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m²]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	35,5	1,04	0,63	0,63	1,09	28,53	60,4	60,4	47,4	110,9	110,9
380ct1f2	35,5	1,04	0,63	0,63	1,09	28,53	60,4	60,4	47,4	110,9	110,9
380ct1f3	46,8	1,12	0,65	0,65	1,06	28,53	66,1	66,1	47,4	123,7	123,7
380ct2f1	35,5	1,04	0,63	0,63	1,09	28,53	60,4	60,4	47,4	110,9	110,9
380ct2f2	35,5	1,04	0,63	0,63	1,09	28,53	60,4	60,4	47,4	110,9	110,9
380ct2f3	46,8	1,12	0,65	0,65	1,06	28,53	66,1	66,1	47,4	123,7	123,7
bl1	51,0	1,14	0,66	0,66	1,19	22,35	19,9	19,9	41,8	37,7	37,7
bl2	51,0	1,14	0,66	0,66	1,19	22,35	19,9	19,9	41,8	37,7	37,7

Starting points

Consequence class Afkeur CC2-0
Reference period 30 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1,05	1,05	0,00	1,12	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0,90	1,05	0,00	1,12	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0,90	0,90	0,00	1,12	0,00	0,0
ULS 3	Wind+ice	-5°	1,05	1,05	0,00	0,34	0,97	0,0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0,90	1,05	0,00	0,34	0,97	0,0
ULS 4	Cold+wind	-20°	1,05	1,05	0,00	0,22	0,00	0,0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0,90	1,05	0,00	0,22	0,00	0,0
ULS 5a	Torsional loads	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinal loads	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Construction + maintenance	5°	1,05	1,05	1,20	0,22	0,00	0,0
ULS 6_0,9	Construction + maintenance	5°	1,05	1,05	0,00	0,22	0,00	0,0
ULS 7	Permanent	10°	1,15	1,15	0,00	0,00	0,00	0,0
ULS 8	Special	10°	1,00	1,00	0,00	0,00	0,00	1,0
SPLS (strength, for angle towers: absence of conductors)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1,05	1,05	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,05	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	1,05	0,0	0,78	0,00	0,0
SPLS 3	Wind+ice	-5°	1,05	1,05	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ice 0,9	-5°	0,90	1,05	0,0	0,36	0,34	0,0
SPLS 4	Cold+wind	-20°	1,05	1,05	0,0	0,24	0,00	0,0
SPLS 4_0,9	Cold+wind 0,9	-20°	0,90	1,05	0,0	0,24	0,00	0,0
SPLS 6	Maintenance	5°	1,05	1,05	1,2	0,24	0,0	0,0
SPLS 6_0,9	Maintenance	5°	1,05	1,05	0,0	0,24	0,0	0,0
SLS (deformations, fatigue, EDS)								
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1,00	1,00	0,0	0,94	0,0	0,0
SLS 3	Wind+ice	-5°	1,00	1,00	0,0	0,28	0,88	0,0
SLS 4	Wind	-20°	1,00	1,00	0,0	0,19	0,0	0,0
SLS 6	Maintenance	5°	1,00	1,00	0,0	0,19	0,0	0,0
SLS 7	EDS, no wind	10°	1,00	1,00	0,0	0,00	0,0	0,0

Number of wind directions	4
Number of load combinations for ULS	44
Number of load combinations for SPLS	0
Number of load combinations for SLS	11
Number of concentrated loads	440

Project: ENS-ZL
Tower: S+15_R
Number: 89

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-40,8	40,8	4,9	0,8	6,6	11,5
bl2	-40,8	40,8	4,9	0,8	6,6	11,5
380ct1f1	-140,4	140,4	14,8	3,1	21,7	39,8
380ct1f2	-140,4	140,4	14,8	3,1	21,7	39,8
380ct1f3	-143,1	143,1	16,5	3,3	21,8	40,5
380ct2f1	-140,4	140,4	14,8	3,1	21,7	39,8
380ct2f2	-140,4	140,4	14,8	3,1	21,7	39,8
380ct2f3	-143,1	143,1	16,5	3,3	21,8	40,5

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	849,9	998,3	849,9
bl2	849,9	998,3	849,9
380ct1f1	753,9	827,3	753,9
380ct1f2	753,9	827,3	753,9
380ct1f3	753,9	830,0	753,9
380ct2f1	753,9	827,3	753,9
380ct2f2	753,9	827,3	753,9
380ct2f3	753,9	830,0	753,9

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	1352,2	872,7
bl2	1352,2	872,7
380ct1f1	1028,0	779,0
380ct1f2	1028,0	779,0
380ct1f3	1068,2	788,8
380ct2f1	1028,0	779,0
380ct2f2	1028,0	779,0
380ct2f3	1068,2	788,8

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors			Wind / Weight span ratio	
Max. weight span	1511,5	m	5,892	-
Min. weight span	736,9	m	2,872	-

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Project: ENS-ZL
Tower: S+15_R
Number: 89

Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	21,2	5,7	16,4	-40,4	41,2
bl2	21,2	5,7	16,4	-40,4	41,2
380ct1f1	65,2	17,8	61,5	-139,5	141,2
380ct1f2	65,2	17,8	61,5	-139,5	141,2
380ct1f3	65,2	19,8	62,3	-142,4	143,8
380ct2f1	65,2	17,8	61,5	-139,5	141,2
380ct2f2	65,2	17,8	61,5	-139,5	141,2
380ct2f3	65,2	19,8	62,3	-142,4	143,8

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	8,7	-21,2	21,2
bl2	0,0	0,0	8,7	-21,2	21,2
380ct1f1	0,0	0,0	36,9	-81,5	81,5
380ct1f2	0,0	0,0	36,9	-81,5	81,5
380ct1f3	0,0	0,0	36,9	-81,5	81,5
380ct2f1	0,0	0,0	36,9	-81,5	81,5
380ct2f2	0,0	0,0	36,9	-81,5	81,5
380ct2f3	0,0	0,0	36,9	-81,5	81,5

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	3,0	7,2
	bl2	3,0	7,2
	380ct1f1	13,8	26,5
	380ct1f2	13,8	26,5
	380ct1f3	13,8	26,6
	380ct2f1	13,8	26,5
	380ct2f2	13,8	26,5
	380ct2f3	13,8	26,6

Project: ENS-ZL
Tower: S+15_R
Number: 89

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	122	345	6505	0	0
ULS 1a_0,9_90		0	122	345	6505	0	0
ULS 3_90		0	65	403	3459	0	0
ULS 3_0,9_90		0	65	403	3459	0	0
SLS 7		0	0	239	0	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

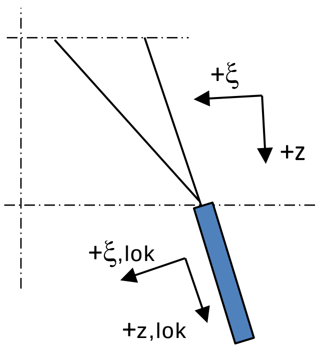
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	314	692	13005	0	0
ULS 3_90	0	122	750	5409	0	0
SLS 7	0	0	569	0	0	0

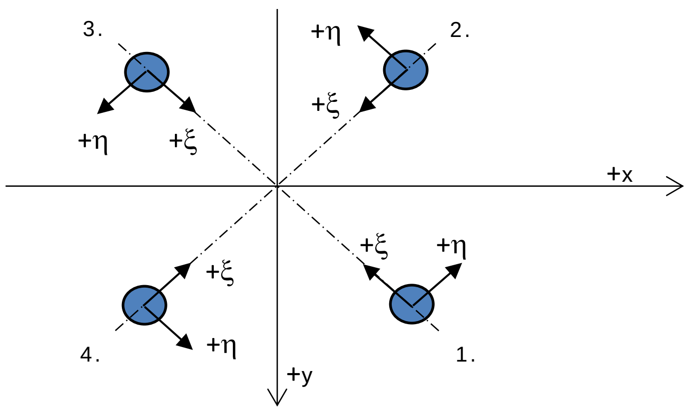
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	314	692	13005	0	0
ULS 1a_0	239	0	596	0	9082	0
ULS 5a Ba 10	65	0	564	201	3161	-1049
ULS 1a_45	183	244	627	9908	6650	0

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_45	148	139	909	7	-203	-36	925
2	ULS 1a_0	85	-95	562	7	-127	-24	571
3	ULS 5a Ah 22	-23	-72	329	-35	-67	-7	334
4	ULS 1a_135	-148	139	909	-7	-203	-36	925

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 22	-14	12	-51	-18	1	-8	-52
2	ULS 1a_0,9_0,9_135	-99	89	-615	7	133	20	-625
3	ULS 1a_0,9_0,9_45	99	89	-615	-7	133	20	-625
4	ULS 1a_0,9_0,9_0	38	-48	-284	-7	61	9	-289

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 10	34	-25	11	41	-6	-4	12
2	ULS 5a Ba 20	18	-72	294	38	-64	-9	299
3	ULS 5a Ba 20	-33	24	7	40	-6	-5	7
4	ULS 5a Ah 10	-19	72	299	37	-64	-9	304

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	ULS 5a Ba 10	18	72	294	-38	-64	-9	299
2	ULS 5a Ah 20	34	25	11	-41	-6	-4	12
3	ULS 5a Ah 20	-19	-72	299	-37	-64	-9	304
4	ULS 5a Ba 10	-33	-24	7	-40	-6	-5	7

Project: ENS-ZL
Tower: S+15_R
Number: 89

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 12	28	-25	-26	38	-2	-7	-26
2	ULS 1a_0,9_0,9_135	-99	89	-615	7	133	20	-625
3	ULS 1a_0,9_0,9_45	99	89	-615	-7	133	20	-625
4	ULS 1a_0,9_0,9_0	38	-48	-284	-7	61	9	-289

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	24	24	142	0	-34	-8	145
2	SLS 7	24	-24	142	0	-34	-8	145
3	SLS 7	-24	-24	142	0	-34	-8	145
4	SLS 7	-24	24	142	0	-34	-8	145

Envelope of load combinations for all of the legs

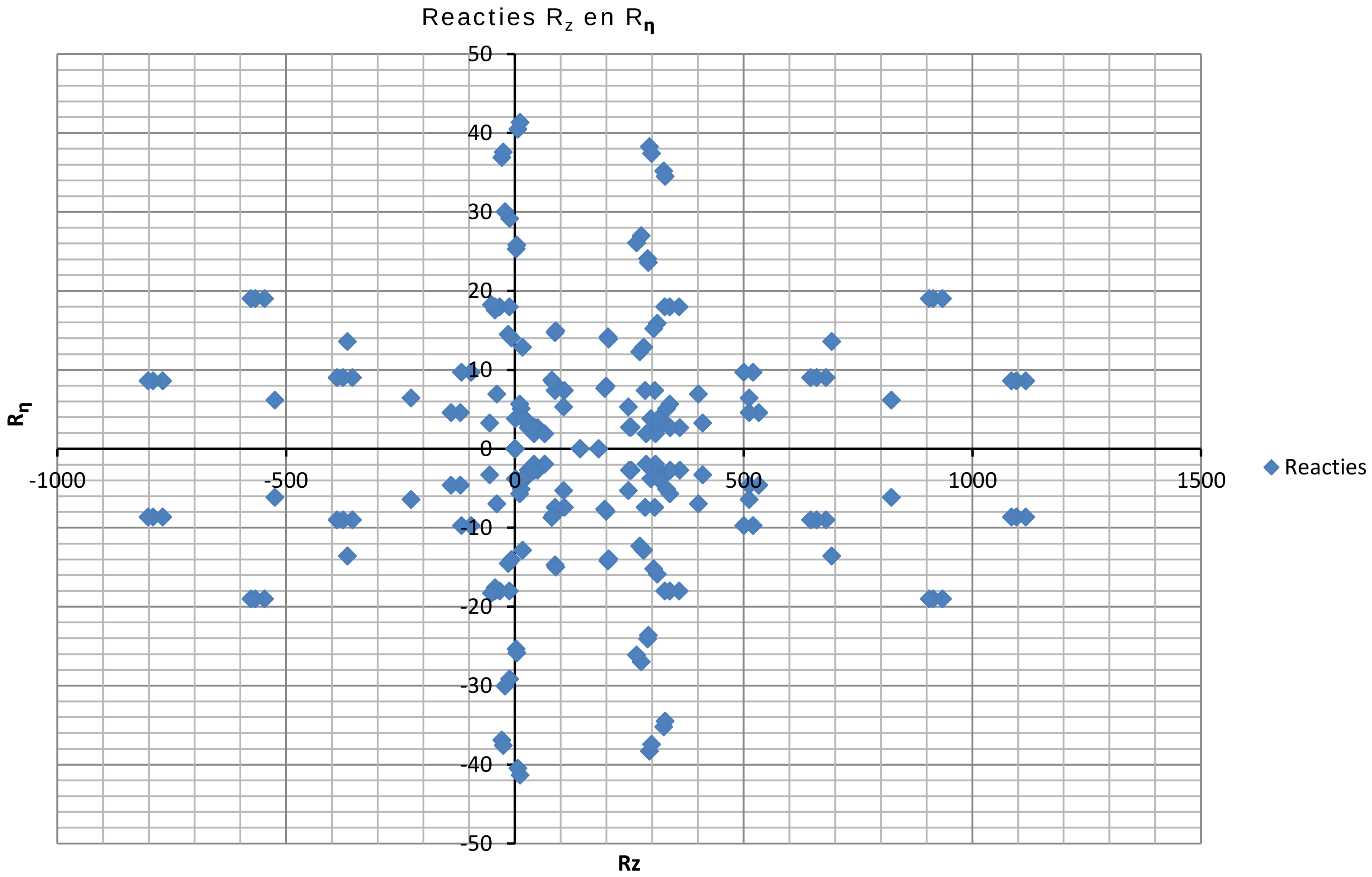
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_135	-148	139	909	-7	-203	-36	925
Max. tension	ULS 1a_0,9_0,9_135	-99	89	-615	7	133	20	-625
Max. pos. torsie	ULS 5a Ah 10	34	-25	11	41	-6	-4	12
Max. neg. torsie	ULS 5a Ah 20	34	25	11	-41	-6	-4	12
Comb. tension+torsie	ULS 1a_135	-99	89	-615	7	133	20	-625

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	24	24	142	0	-34	-8	145
2	SLS 1a_135	-78	70	-487	6	104	15	-496
3	SLS 1a_45	78	70	-487	-6	104	15	-496
4	SLS 1a_0	26	-35	-207	-6	43	5	-210

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_45	128	120	784	6	-175	-31	797
2	SLS 1a_0	74	-83	491	6	-111	-21	499
3	SLS 7	-24	-24	142	0	-34	-8	145
4	SLS 1a_135	-128	120	784	-6	-175	-31	797


Reacties R_z en R_η
50
40
30
20
10
0
-10
-20
-30
-40
-50
-1000
-500
0
500
1000
1500
R_η
Rz
Reacties

Conductor loads

Auteur: TBR
Versie: v11.3

Starting points

Consequence class	Verbouw CC2
Reference period	50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1,15	1,15	0,00	1,40	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0,90	1,15	0,00	1,40	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0,90	0,90	0,00	1,40	0,00	0,0
ULS 3	Wind+ice	-5°	1,15	1,15	0,00	0,42	1,30	0,0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0,90	1,15	0,00	0,42	1,30	0,0
ULS 4	Cold+wind	-20°	1,15	1,15	0,00	0,28	0,00	0,0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0,90	1,15	0,00	0,28	0,00	0,0
ULS 5a	Torsional loads	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinal loads	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Construction + maintenance	5°	1,15	1,15	1,30	0,28	0,00	0,0
ULS 6_0,9	Construction + maintenance	5°	1,15	1,15	0,00	0,28	0,00	0,0
ULS 7	Permanent	10°	1,30	1,30	0,00	0,00	0,00	0,0
ULS 8	Special	10°	1,00	1,00	0,00	0,00	0,00	1,0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1,15	1,15	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,15	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	1,15	0,0	0,78	0,00	0,0
SPLS 3	Wind+ice	-5°	1,15	1,15	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ice 0,9	-5°	0,90	1,15	0,0	0,36	0,34	0,0
SPLS 4	Cold+wind	-20°	1,15	1,15	0,0	0,24	0,00	0,0
SPLS 4_0,9	Cold+wind 0,9	-20°	0,90	1,15	0,0	0,24	0,00	0,0
SPLS 6	Maintenance	5°	1,15	1,15	1,2	0,24	0,0	0,0
SPLS 6_0,9	Maintenance	5°	1,15	1,15	0,0	0,24	0,0	0,0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1,00	1,00	0,0	1,00	0,0	0,0
SLS 3	Wind+ice	-5°	1,00	1,00	0,0	0,30	1,00	0,0
SLS 4	Wind	-20°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 6	Maintenance	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	EDS, no wind	10°	1,00	1,00	0,0	0,00	0,0	0,0

Number of wind directions	4
Number of load combinations for ULS	44
Number of load combinations for SPLS	0
Number of load combinations for SLS	11
Number of concentrated loads	440

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Project: ENS-ZL
Tower: S+15_R
Number: 89

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift
Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-47,2	47,2	6,1	1,1	7,2	12,8
bl2	-47,2	47,2	6,1	1,1	7,2	12,8
380ct1f1	-162,0	162,0	18,5	3,8	25,5	46,0
380ct1f2	-162,0	162,0	18,5	3,8	25,5	46,0
380ct1f3	-165,4	165,4	20,6	4,2	25,6	46,8
380ct2f1	-162,0	162,0	18,5	3,8	25,5	46,0
380ct2f2	-162,0	162,0	18,5	3,8	25,5	46,0
380ct2f3	-165,4	165,4	20,6	4,2	25,6	46,8

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	849,9	1001,9	849,9
bl2	849,9	1001,9	849,9
380ct1f1	753,9	829,0	753,9
380ct1f2	753,9	829,0	753,9
380ct1f3	753,9	831,9	753,9
380ct2f1	753,9	829,0	753,9
380ct2f2	753,9	829,0	753,9
380ct2f3	753,9	831,9	753,9

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	1415,5	844,3
bl2	1415,5	844,3
380ct1f1	1074,2	765,2
380ct1f2	1074,2	765,2
380ct1f3	1119,7	775,5
380ct2f1	1074,2	765,2
380ct2f2	1074,2	765,2
380ct2f3	1119,7	775,5

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors			Wind / Weight span ratio	
Max. weight span	1706,1	m	6,650	-
Min. weight span	720,7	m	2,809	-

Project: ENS-ZL
Tower: S+15_R
Number: 89

Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	21,2	7,1	19,1	-46,7	47,7
bl2	21,2	7,1	19,1	-46,7	47,7
380ct1f1	65,2	22,4	71,5	-161,0	163,0
380ct1f2	65,2	22,4	71,5	-161,0	163,0
380ct1f3	65,2	24,8	72,4	-164,5	166,2
380ct2f1	65,2	22,4	71,5	-161,0	163,0
380ct2f2	65,2	22,4	71,5	-161,0	163,0
380ct2f3	65,2	24,8	72,4	-164,5	166,2

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	8,7	-21,2	21,2
bl2	0,0	0,0	8,7	-21,2	21,2
380ct1f1	0,0	0,0	36,9	-81,5	81,5
380ct1f2	0,0	0,0	36,9	-81,5	81,5
380ct1f3	0,0	0,0	36,9	-81,5	81,5
380ct2f1	0,0	0,0	36,9	-81,5	81,5
380ct2f2	0,0	0,0	36,9	-81,5	81,5
380ct2f3	0,0	0,0	36,9	-81,5	81,5

1 Control uplift SLS-wind

Combinatie	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	3,0	7,2
	bl2	3,0	7,2
	380ct1f1	13,8	26,6
	380ct1f2	13,8	26,6
	380ct1f3	13,8	26,7
	380ct2f1	13,8	26,6
	380ct2f2	13,8	26,6
	380ct2f3	13,8	26,7

Project: ENS-ZL
Tower: S+15_R
Number: 89

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	153	395	8155	0	0
ULS 1a_0,9_90		0	153	395	8155	0	0
ULS 3_90		0	81	469	4336	0	0
ULS 3_0,9_90		0	81	469	4336	0	0
SLS 7		0	0	239	0	0	0

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

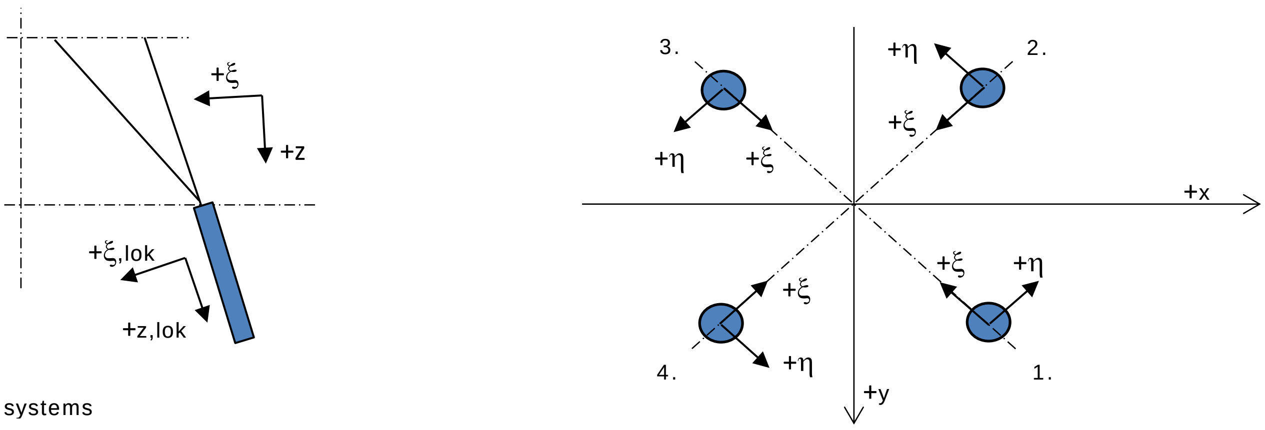
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	393	774	16304	0	0
ULS 3_90	0	153	849	6781	0	0
SLS 7	0	0	569	0	0	0

Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	393	774	16304	0	0
ULS 1a_0	299	0	650	0	11386	0
ULS 5a Ba 10	65	0	564	201	3161	-1049
ULS 1a_45	230	306	693	12421	8337	0

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_45	182	170	1117	9	-249	-44	1135
2	ULS 1a_0	102	-115	680	9	-154	-29	692
3	ULS 5a Ah 22	-23	-72	329	-35	-67	-7	334
4	ULS 1a_135	-182	170	1117	-9	-249	-44	1135

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 22	-14	12	-51	-18	1	-8	-52
2	ULS 1a_0,9_0,9_135	-129	117	-802	9	174	26	-815
3	ULS 1a_0,9_0,9_45	129	117	-802	-9	174	26	-815
4	ULS 1a_0,9_0,9_0	53	-66	-389	-9	84	12	-396

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 10	34	-25	11	41	-6	-4	12
2	ULS 5a Ba 20	18	-72	294	38	-64	-9	299
3	ULS 5a Ba 20	-33	24	7	40	-6	-5	7
4	ULS 5a Ah 10	-19	72	299	37	-64	-9	304

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	ULS 5a Ba 10	18	72	294	-38	-64	-9	299
2	ULS 5a Ah 20	34	25	11	-41	-6	-4	12
3	ULS 5a Ah 20	-19	-72	299	-37	-64	-9	304
4	ULS 5a Ba 10	-33	-24	7	-40	-6	-5	7

Project: ENS-ZL
Tower: S+15_R
Number: 89

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 5a Ah 12	28	-25	-26	38	-2	-7	-26
2	ULS 1a_0,9_0,9_135	-129	117	-802	9	174	26	-815
3	ULS 1a_0,9_0,9_45	129	117	-802	-9	174	26	-815
4	ULS 1a_0,9_0,9_0	53	-66	-389	-9	84	12	-396

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	24	24	142	0	-34	-8	145
2	SLS 7	24	-24	142	0	-34	-8	145
3	SLS 7	-24	-24	142	0	-34	-8	145
4	SLS 7	-24	24	142	0	-34	-8	145

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_45	182	170	1117	9	-249	-44	1135
Max. tension	ULS 1a_0,9_0,9_45	129	117	-802	-9	174	26	-815
Max. pos. torsie	ULS 5a Ah 10	34	-25	11	41	-6	-4	12
Max. neg. torsie	ULS 5a Ah 20	34	25	11	-41	-6	-4	12
Comb. tension+torsie	ULS 1a_45	129	117	-802	-9	174	26	-815

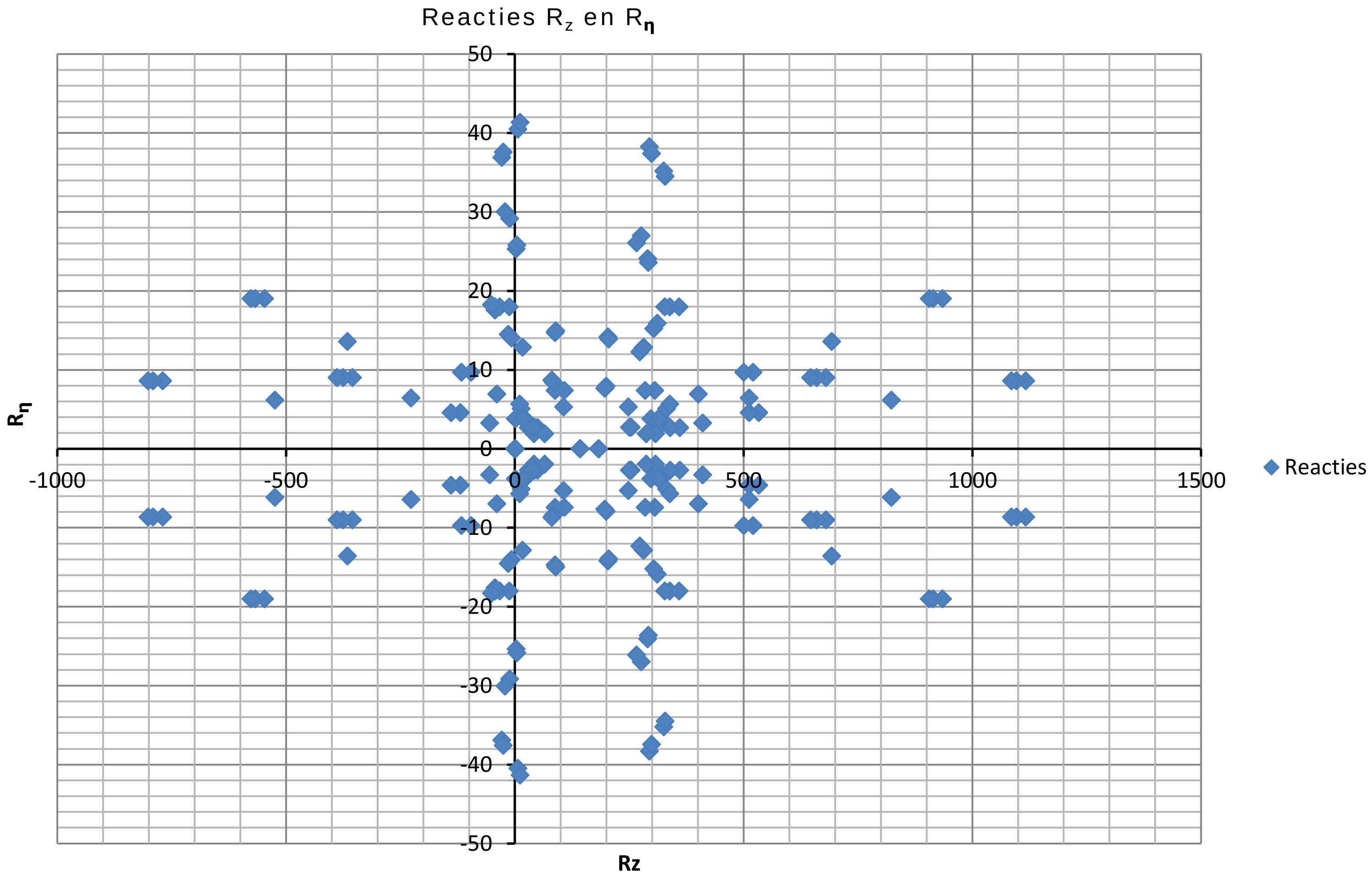
Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	24	24	142	0	-34	-8	145
2	SLS 1a_135	-84	75	-525	6	113	16	-534
3	SLS 1a_45	84	75	-525	-6	113	16	-534
4	SLS 1a_0	29	-38	-227	-6	48	6	-231

Maximum compression load - SLS

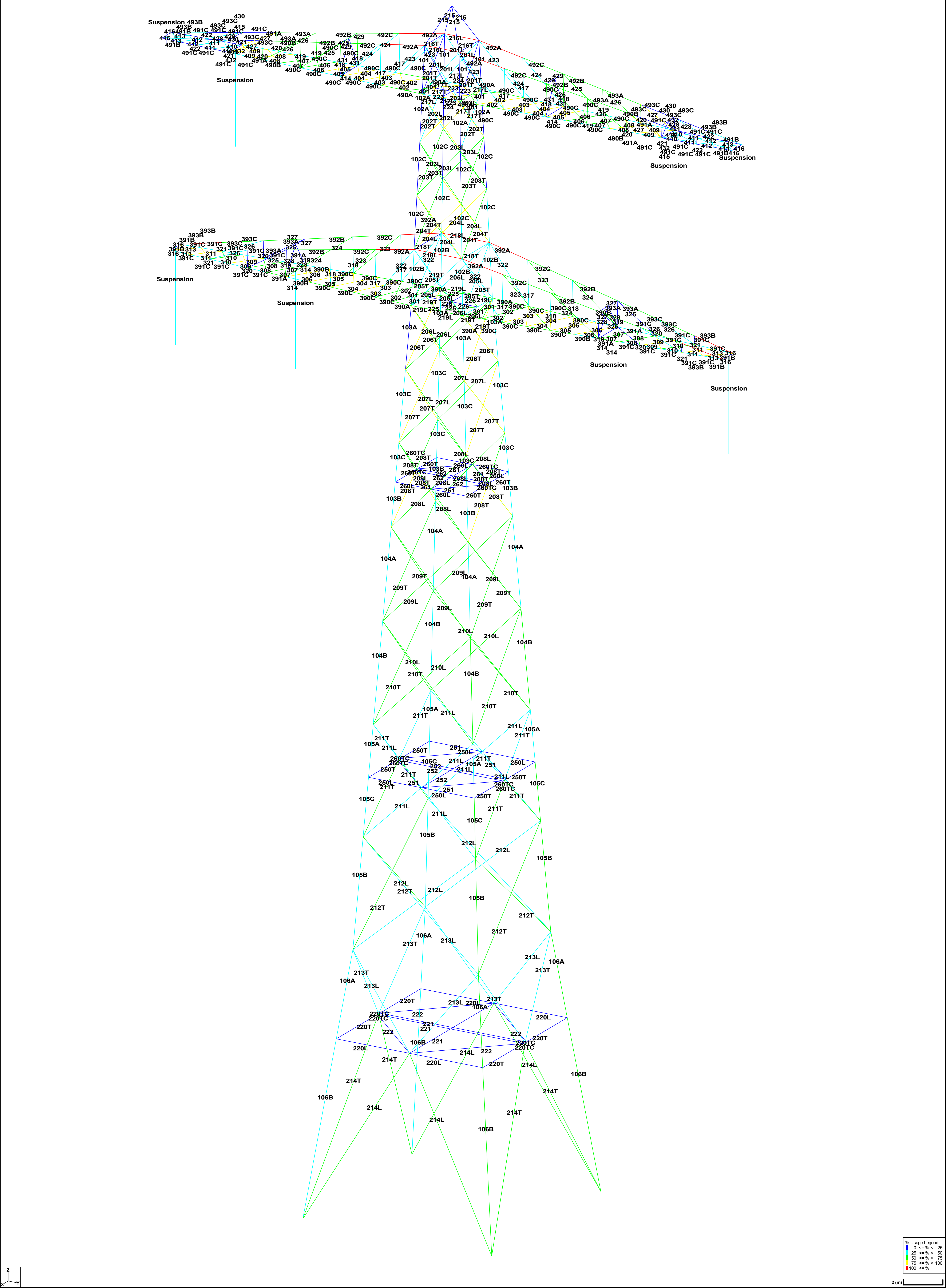
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 1a_45	134	126	823	6	-184	-33	837
2	SLS 1a_0	77	-87	512	6	-116	-22	520
3	SLS 7	-24	-24	142	0	-34	-8	145
4	SLS 1a_135	-134	126	823	-6	-184	-33	837

Project: ENS-ZL
Tower: S+15_R
Number: 89



APPENDIX B
Uitvoer PLS-TOWER

DNV GL Nederlands BV, Project: "S+15_R ini"
Tower Version 16.63, 10:23:45 Wednesday, 24 February, 2021
Undeformed geometry displayed



DNV·GL

Assessment of groups for initial mast (afkeur level)

Date 24-02-21
Author MKh
Version 1.0

ENS-ZL 380
S+15_R
89

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101	Leg	100x100x8	S355	4M24-8.8t	0.50	0.50	0.50	66	**-67.7**	ULS 5a Ah 12	404.6	542.2	564.5	0.17		**8.4**	ULS 5a Ah 22	400.1	542.2	564.5	0.02	
102A	Leg	120x120x10	S355	4M24-8.8t	0.50	0.50	0.50	55	**-93.0**	ULS 5a Ah 22	668.2	542.2	705.6	0.17		**48.2**	ULS 5a Ah 22	635.0	542.2	663.4	0.09	
102B	Leg	120x120x10	S355	8M24-8.8t	0.50	0.50	0.50	64	**-222.2**	ULS 1a_45	621.8	1084.4	1411.2	0.36		**80.6**	ULS 1a_0,9_0,9_135	635.0	1084.4	1411.2	0.13	
102C	Leg	120x120x10	S355		0.50	0.50	0.50	62	**-179.8**	ULS 1a_45	633.9	0.0	0.0	0.28		**94.8**	ULS 1a_0,9_0,9_135	823.6	0.0	0.0	0.12	
103A	Leg	150x150x12	S355	8M24-8.8t	0.50	0.50	0.50	58	**-362.0**	ULS 1a_45	981.0	2168.8	1693.4	0.37		**171.6**	ULS 1a_0,9_0,9_135	1007.6	2168.8	1592.1	0.17	
103B	Leg	150x150x12	S355	8M24-8.8t	0.54	0.54	0.54	44	**-521.0**	ULS 1a_45	1081.4	2168.8	1693.4	0.48		**318.5**	ULS 1a_0,9_0,9_45	1007.6	2168.8	1592.1	0.32	
103C	Leg	150x150x12	S355		0.50	0.50	0.50	66	**-444.2**	ULS 1a_45	908.9	0.0	0.0	0.49		**319.9**	ULS 1a_0,9_0,9_135	1235.4	0.0	0.0	0.26	
104A	Leg	150x150x15	S355	8M24-8.8t	0.27	0.27	0.27	46	**-609.5**	ULS 1a_45	1318.6	2168.8	2116.8	0.46		**381.4**	ULS 1a_0,9_0,9_135	1241.9	2168.8	1990.2	0.31	
104B	Leg	150x150x15	S355	8M24-8.8t	0.27	0.27	0.27	51	**-692.8**	ULS 1a_135	1278.3	2168.8	2116.8	0.54		**470.5**	ULS 1a_0,9_0,9_135	1241.9	2168.8	1990.2	0.38	
105A	Leg	160x160x17#	S355	8M24-8.8t	0.54	0.54	0.54	49	**-768.1**	ULS 1a_45	1566.9	2168.8	2399.0	0.49		**525.8**	ULS 1a_0,9_0,9_135	1519.2	2168.8	2255.5	0.35	
105B	Leg	160x160x17#	S355	8M24-8.8t	0.27	0.27	0.27	52	**-868.4**	ULS 1a_135	1532.9	2168.8	2399.0	0.57		**610.9**	ULS 1a_0,9_0,9_135	1519.2	2168.8	2255.5	0.40	
105C	Leg	160x160x17#	S355		0.54	0.54	0.54	55	**-770.4**	ULS 1a_45	1497.2	0.0	0.0	0.51		**523.6**	ULS 1a_0,9_0,9_135	1842.5	0.0	0.0	0.28	
106A	Leg	160x160x17#	S355	8M24-8.8t	0.33	0.33	0.33	50	**-821.9**	ULS 1a_45	1550.0	2168.8	2399.0	0.53		**595.5**	ULS 1a_0,9_0,9_45	1519.2	2168.8	2255.5	0.39	
106B	Leg	160x160x17#	S355	8M24-8.8t	0.17	0.17	0.17	52	**-826.7**	ULS 1a_45	1527.3	2168.8	2399.0	0.54		**591.2**	ULS 1a_0,9_0,9_135	1519.2	2168.8	2255.5	0.39	
201L	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	113	**-56.5**	ULS 5a Ah 22	138.9	188.2	172.8	0.41		**38.9**	ULS 5a Ah 12	146.3	188.2	157.1	0.27	
201T	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	113	**-23.9**	ULS 5a Ah 22	138.9	188.2	172.8	0.17		**11.2**	ULS 5a Ah 22	146.3	188.2	157.1	0.08	
202L	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	104	**-141.6**	ULS 5a Ba 12	169.7	271.1	207.4	0.83		**151.4**	ULS 5a Ah 12	159.7	271.1	183.4	0.95	
202T	CD	120x120x10	S235	3M24-8.8t	0.53	0.53	0.53	78	**-159.1**	ULS 5a Ba 12	350.3	406.7	388.8	0.45		**160.7**	ULS 5a Ah 22	324.0	406.7	359.4	0.50	
203L	CD	100x100x8	S235	2M24-8.8t	0.53	0.53	0.53	101	**-140.9**	ULS 5a Ah 22	194.2	271.1	207.4	0.73		**129.0**	ULS 5a Ba 22	181.4	271.1	189.2	0.71	
203T	CD	120x120x10	S235	2M24-8.8t	0.53	0.53	0.53	84	**-147.3**	ULS 5a Ah 22	333.9	271.1	259.2	0.57		**146.0**	ULS 5a Ba 22	278.4	271.1	243.7	0.60	
204L	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	119	**-115.3**	ULS 5a Ba 22	149.8	271.1	207.4	0.77		**127.0**	ULS 5a Ah 22	159.7	271.1	183.4	0.80	
204T	CD	120x120x10	S235	2M24-8.8t	0.53	0.53	0.53	89	**-132.0**	ULS 5a Ba 22	321.6	271.1	259.2	0.51		**132.3**	ULS 5a Ah 12	278.4	271.1	243.7	0.54	
205L	CD	120x120x10	S235	3M24-8.8t	0.53	0.53	0.53	94	**-133.4**	ULS 5a Ba 22	309.2	406.7	388.8	0.43		**125.1**	ULS 5a Ah 22	324.0	406.7	359.4	0.39	
205T	CD	120x120x10	S235	3M24-8.8t	0.53	0.53	0.53	94	**-133.1**	ULS 5a Ba 22	309.2	406.7	388.8	0.43		**109.2**	ULS 5a Ah 22	324.0	406.7	359.4	0.34	
206L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	83	**-129.5**	ULS 5a Ah 21	213.8	271.1	207.4	0.62		**122.4**	ULS 5a Ah 21	181.4	271.1	189.2	0.68	
206T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	83	**-139.0**	ULS 5a Ba 21	213.8	271.1	207.4	0.67		**140.4**	ULS 5a Ah 21	181.4	271.1	189.2	0.77	
207L	CD	90x90x8	S235	2M24-8.8t	0.54	0.27	0.27	106	**-108.6**	ULS 5a Ah 21	158.4	271.1	207.4	0.69		**113.4**	ULS 5a Ah 10	183.3	271.1	195.0	0.62	
207T	CD	90x90x8	S235	2M24-8.8t	0.54	0.27	0.27	106	**-123.3**	ULS 5a Ah 10	158.4	271.1	207.4	0.78		**122.2**	ULS 5a Ba 10	183.3	271.1	195.0	0.67	
208L	CD	90x90x8	S235	2M24-8.8t	1.00	0.54	0.54	120	**-98.2**	ULS 5a Ah 10	140.3	271.1	207.4	0.70		**92.1**	ULS 5a Ah 10	159.7	271.1	183.4	0.58	
208T	CD	90x90x8	S235	2M24-8.8t	1.00	0.54	0.54	120	**-112.6**	ULS 5a Ba 10	140.3	271.1	207.4	0.80		**107.3**	ULS 5a Ah 21	159.7	271.1	183.4	0.67	
209L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	122	**-80.1**	ULS 5a Ah 21	153.4	271.1	207.4	0.52		**84.5**	ULS 5a Ah 10	181.4	271.1	189.2	0.47	
209T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	122	**-93.2**	ULS 5a Ah 21	153.4	271.1	207.4	0.61		**96.6**	ULS 5a Ba 10	181.4	271.1	189.2	0.53	
210L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	137	**-73.4**	ULS 5a Ah 21	136.0	271.1	207.4	0.54		**68.6**	ULS 5a Ah 21	181.4	271.1	189.2	0.38	
210T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	137	**-83.7**	ULS 5a Ba 10	136.0	271.1	207.4	0.62		**80.1**	ULS 5a Ah 10	181.4	271.1	189.2	0.44	
211L	CD	100x100x8	S235	2M24-8.8t	1.00	0.54	0.54	149	**-61.4**	ULS 5a Ah 10	122.8	271.1	207.4	0.50		**61.6**	ULS 5a Ah 10	234.9	271.1	141.8	0.43	
211T	CD	100x100x8	S235	2M24-8.8t	1.00	0.54	0.54	149	**-75.0**	ULS 5a Ba 10	122.8	271.1	207.4	0.61		**67.1**	ULS 5a Ba 21	234.9	271.1	141.8	0.47	
212L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	162	**-52.4**	ULS 5a Ah 21	111.4	271.1	207.4	0.47		**51.4**	ULS 5a Ah 10	217.0	271.1	141.8	0.36	
212T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	162	**-57.0**	ULS 5a Ba 21	111.4	271.1	207.4	0.51		**62.9**	ULS 5a Ba 10	217.0	271.1	141.8	0.44	
213L	CD	150x150x12	S235	2M24-8.8t	1.00	0.33	0.33	130	**-76.3**	ULS 5a Ba 10	322.8	271.1	311.0	0.28		**57.6**	ULS 5a Ah 10	428.1	271.1	292.4	0.21	
213T	CD	150x150x12	S235	2M24-8.8t	1.00	0.33	0.33	130	**-81.0**	ULS 1a_90	322.8	271.1	311.0	0.30		**51.9**	ULS 1a_0,9_0,9_90	428.1	271.1	292.4	0.19	
214L	CD	90x90x8	S235	2M24-8.8t	0.17	0.17	0.17	107	**-87.1**	ULS 5a Ba 21	166.2	271.1	207.4	0.52		**66.9**	ULS 5a Ah 21	159.7	271.1	183.4	0.42	
214T	CD	90x90x8	S235	2M24-8.8t	0.17	0.17	0.17	107	**-91.6**	ULS 5a Ah 10	166.2	271.1	207.4	0.55		**45.4**	ULS 5a Ba 10	159.7	271.1	183.4	0.28	
215	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	157	**-13.0**	ULS 5a Ba 12	96.8	188.2	172.8	0.13		**12.9**	ULS 5a Ba 12	146.3	188.2	157.1	0.09	
216L		100x100x8	S235	4M24-8.8t	1.00	1.00	1.00	102	**0.0**		192.7	542.2	414.7	0.00		**217.4**	ULS 3_90	199.2	542.2	319.0	1.09	nettodsn.
216T		60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	171	**-4.8**	ULS 5a Ah 22	39.0	60.3	51.8	0.12		**5.2**	ULS 5a Ah 12	72.6	60.3	44.8	0.12	
217L		130x130x11	S355	8M24-8.8t	1.00	2.00	1.00	55	**-344.9**	ULS 5a Ba 12	796.4	1023.4	1552.3	0.43		**106.3**	ULS 5a Ah 22	494.8	1023.4	1552.3	0.21	
217T		70x70x7	S235	4M20-8.8t	0.50	1.00	0.50	52	**-80.0**	ULS 5a Ah 12	162.2	376.3	302.4	0.49		**89.6**	ULS 5a Ah 22	163.8	376.3	260.9	0.55	
218L		100x100x8	S235	4M24-8.8t	1.00	1.00	1.00	142	**0.0**		137.7	542.2	414.7	0.00		**256.0**	ULS 3_90	205.1	542.2	346.5	1.25	nettodsn.
218T		100x100x8	S235	1M24-8.8t	1.00	1.00	1.00	142	**-25.7**	ULS 1a_0,9_0,9_90	110.2	135.6	103.7	0.25		**42.7**	ULS 1a_90	170.5	135.6	97.5	0.44	
219L		130x130x11	S355	8M24-8.8t	1.00	2.00	1.00	75	**-342.9**	ULS 5a Ba 10	655.5	928.5	1552.3	0.52		**67.7**	ULS 5a Ah 10	600.4	928.5	1552.3	0.11	
219T		80x80x8	S235	4M20-8.8t	1.00	2.00	1.00	123	**-54.2**	ULS 5a Ah 10	120.6	376.3	345.6	0.45		**93.2**	ULS 5a Ah 21	227.6	376.3	314.2	0.41	
220L		80x80x6#	S235	1M20-8.8t	1.00	1.00	1.00	268	**-3.7**	ULS 1a_45	31.1	94.1	64.8	0.12		**1.0**	ULS 1a_0,9_135	100.2	94.1	58.9	0.02	
220T		80x80x6#	S235	1M20-8.8t	1.03	1.00	1.00	261	**-3.8**	ULS 1a_135	32.5	94.1	64.8	0.12		**1.2**	ULS 1a_0,9_0,9_0	100.2	94.1	58.9	0.02	
220TC		80x80x6#	S235		35.54	2.00	1.00	173	**-8.6**	ULS 1a_135	62.2	0.0	0.0	0.14		**5.7**	ULS 1a_0,9_0,9_45	220.9	0.0	0.0	0.03	
221		80x80x8	S235	1M20-8.8t	0.50	0.50	0.50	273	**-1.4**	ULS 1a_0	35.2	94.1	86.4	0.04		**0.2**	ULS 1a_0,9_0,9_0	133.6	94.1	78.5	0.00	
222		70x70x7	S235	1M20-8.8t	0.50	1.00	0.50	281	**-4.5**	ULS 1a_45	21.8	94.1	75.6	0.21		**4.9**	ULS 1a_0,9_0,9_45	84.7	94.1	50.7	0.10	
223	Bovenstuk	80x80x6#	S235	3M20-8.8t	1.00	1.00	1.00	97	**-101.5**	ULS 5a Ba 22	121.6	282.2	194.4	0.83		**98.4**	ULS 5a Ah 12	129.0	282.2	175.7	0.76	
224	Bovenstuk	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	113	**-5.5**	ULS 3_90	43.6	60.3	43.2	0.13		**2.6**	ULS 3_90	46.1	60.3	32.7	0.08	
225	Derde TSNSTK	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	121	**-95.4**	ULS 5a Ba 21	147.8	271.1	207.4	0.65		**95.6**	ULS 5a Ba 10	159.7	271.1	183.4	0.60	
226	Derde TSNSTK	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	155	**-0.8**	ULS 3_90	30.8	60.3	43.2	0.03		**0.9**	ULS 3_90	46.1	60.3	32.7	0.03	
490A	Tweede DWSRM onderregel	130x130x11	S355	8M24-8.8t	1.00	2.00	1.00	48	**-433.4**	ULS 5a Ba 12	835.1	1023.4	1552.3	0.52		**234.5**	ULS 5a Ah 22	494.8	1023.4	1459.4	0.47	
490B	Tweede DWSRM onderregel	130x130x11	S355	4M24-8.8t	2.35	1.55	1.00	57	**-174.1**	ULS 5a Ba 1	786.2	542.2	776.2	0.32		**12.4**	ULS 5a Ah 12	771.9	542.2	729.7	0.02	
490C	Tweede DWSRM onderregel	130x130x11	S355		1.00	2.00	1.00	78	**-407.8**	ULS 5a Ba 22	636.6	0.0	0.0	0.64		**201.8**	ULS 5a Ah 22	979.8	0.0	0.0	0.21	
491A	Tweede DWSRM onderregel	100x100x8	S355	4M24-8.8t	3.84	2.84	1.00	65	**-147.5**	ULS 5a Ba 3	408.3	542.2	564.5	0.36		**24.4**	ULS 5a Ah 22	400.1	542.2	530.7	0.06	
491B	Tweede DWSRM onderregel	100x100x8	S355		1.00	2.00	1.00	65	**-50.8**	ULS 3_90	408.6	0.0	0.0	0.12		**0.0**		550.3	0.0	0.0	0.00	
491C	Tweede DWSRM onderregel	100x100x8	S355		1.00	1.35	1.00	75	**-127.5**	ULS 5a Ba 1	367.6	0.0	0.0	0.35		**25.9**	ULS 5a Ah 1	550.3	0.0	0.0	0.05	
492A	Tweede DWSRM bovenregel	80x80x10	S235	4M20-8.8t	1.92	1.00	1.00	210	**0.0**		76.5	376.3	432.0	0.00		**206.6**	ULS 3_90	206.0	376.3	387.7	1.00	nettodsn.
492B	Tweede DWSRM bovenregel	80x80x10	S235	4M20-8.8t	2.83	1.00	1.00	280	**0.0**		50.1	376.3	432.0	0.00		**164.3**	ULS 3_90	277.3	376.3	392.7	0.59	
492C	Tweede DWSRM bovenregel	80x80x10	S235		2.08	1.00	1.00	211	**0.0**		76.4	0.0	0.0	0.00		**188.8**	ULS 3_90	354.9	0.0	0.0	0.53	
493A	Tweede DWSRM bovenregel	80x80x8	S235	4M20-8.8t	2.96	1.00	1.00	277	**0.0**		41.3	376.3	345.6	0.00		**124.8**	ULS 3_90	227.6	376.3	314.2	0.55	
493B	Tweede DWSRM bovenregel	80x80x8	S235	3M20-8.8t	2.00	1.00	1.00	167	**0.0**		85.0	282.2	259.2	0.00		**51.2**	ULS 3_90	151.8	282.2	201.6	0.34	
493C	Tweede DWSRM bovenregel	80x80x8	S235		2.00	1.00	1.00	167	**0.0**		85.0	0.0	0.0	0.00		**59.0**	ULS 3_90	289.1	0.0	0.0	0.20	
401	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	**-22.8**	ULS 5a Ba 12	32.7	60.3	43.2	0.70		**15.0**	ULS 5a Ah 22	46.1	60.3	32.7	0.46	
402	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	138	**-25.8**	ULS 5a Ah 12	35.3	60.3	43.2	0.73		**29.0**	ULS 5a Ba 12	46.1	60.3	32.7	0.89	
403	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	123	**-25.5**	ULS 5a Ah 22	40.1	60.3	43.2	0.64		**24.8**	ULS 5a Ba 12	46.1	60.3	32.7	0.76	
404	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	119	**-28.5**	ULS 5a Ba 22	41.5	60.3	43.2	0.68		**26.6**	ULS 5a Ah 22	46.1	60.3	32.7	0.81	
405	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	114	**-29.8**	ULS 5a Ba 22	43.3	60.3	43.2	0.69		**27.6**	ULS 5a Ah 22	46.1	60.3	32.7	0.85	
406	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	112	**-30.5**	ULS 5a Ah 12	60.0	60.3	60.5	0.51		**32.1**	ULS 5a Ba 12	64.5	60.3	45.8	0.70	
407	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	112	**-36.1**	ULS 5a Ba 12	60.1	60.3	60.5	0.60		**33.5**	ULS 5a Ah 12	64.5	60.3	45.8	0.73	
408	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	114	**-38.9**	ULS 5a Ah 12	58.8	60.3	60.5	0.66		**43.3**	ULS 5a Ba 12	64.5	60.3	45.8	0.95	
409	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	110	**-49.1**	ULS 5a Ba 12	61.0	60.3	60.5	0.81		**42.7**	ULS 5a Ah 22	64.5	60.3	45.8	0.93	
410	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	87	**-10.7**	ULS 5a Ba 1	54.2	60.3	43.2	0.25		**10.0**	ULS 5a Ah 1	46.1	60.3	32.7	0.31	
411	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	83	**-11.8**	ULS 5a Ba 3	55.1	60.3	43.2	0.27		**11.7**	ULS 5a Ba 1	46.1	60.3	32.7	0.36	
412	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	80	**-12.7**	ULS 5a Ah 3	55.9	60.3	43.2	0.29		**13.3**	ULS 5a Ba 3	46.1	60.3	32.7	0.41	

DNV·GL

Assessment of groups for initial mast (afkeur level)

Date 24-02-21
Author MKh
Version 1.0

ENS-ZL 380
S+15_R
89

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
413	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	77	**-14.1**	ULS 5a Ba 1	56.8	60.3	43.2	0.33		**12.9**	ULS 5a Ah 3	46.1	60.3	32.7	0.40	
414	Hor. onderregel	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	187	**0.0**		24.1	60.3	43.2	0.00		**5.0**	ULS 3_90	46.1	60.3	32.7	0.15	
415	Hor. onderregel	HEB160	S355	2M20-8.8t	2.00	2.00	2.00	32	**-30.0**	ULS 5a Ah 12	1470.4	188.2	235.2	0.16		**35.9**	ULS 5a Ba 22	1739.7	188.2	0.0	0.19	
416	Hor. onderregel	HEB160	S355	2M20-8.8t	2.00	2.00	2.00	25	**-10.3**	ULS 5a Ah 3	1530.7	188.2	235.2	0.05		**11.2**	ULS 5a Ba 1	1739.7	188.2	0.0	0.06	
417	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	185	**-13.7**	ULS 3_45	35.0	60.3	51.8	0.39		**0.0**		48.4	60.3	33.7	0.00	
418	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	182	**-14.9**	ULS 3_90	24.9	60.3	43.2	0.60		**0.0**		46.1	60.3	32.7	0.00	
419	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	142	**-17.9**	ULS 3_90	34.2	60.3	43.2	0.52		**0.0**		46.1	60.3	32.7	0.00	
420	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	103	**-22.5**	ULS 3_90	47.3	60.3	43.2	0.52		**0.0**		46.1	60.3	32.7	0.00	
421	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	69	**-1.3**	ULS 3_90	59.1	60.3	43.2	0.03		**0.0**		46.1	60.3	32.7	0.00	
422	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	34	**-1.0**	ULS 3_90	68.4	60.3	43.2	0.02		**0.0**		46.1	60.3	32.7	0.00	
423	Vertical Diagonal	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	314	**0.0**		19.7	120.6	103.7	0.00		**19.5**	ULS 3_45	71.5	120.6	86.5	0.27	
424	Vertical Diagonal	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	333	**0.0**		12.5	120.6	86.4	0.00		**23.8**	ULS 3_45	50.2	120.6	65.4	0.47	
425	Vertical Diagonal	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	303	**0.0**		14.6	120.6	86.4	0.00		**30.4**	ULS 3_90	53.9	120.6	65.4	0.56	
426	Vertical Diagonal	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	225	**0.0**		33.1	120.6	103.7	0.00		**45.7**	ULS 3_90	68.2	120.6	83.2	0.67	
427	Vertical Diagonal	70x70x7	S235	2M20-8.8t	1.00	1.00	1.00	164	**0.0**		69.8	188.2	151.2	0.00		**72.7**	ULS 3_90	90.5	188.2	111.6	0.80	
428	Vertical Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	**0.0**		19.4	60.3	43.2	0.00		**8.3**	ULS 3_90	46.1	60.3	32.7	0.25	
429	Hor. bovenregel	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	111	**-1.0**	ULS 1a_0	47.0	60.3	43.2	0.02		**0.9**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.03	
430	Hor. bovenregel	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	83	**-0.9**	ULS 1a_0,9_0,9_0	59.3	60.3	43.2	0.02		**0.9**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.03	
431	C-C Diagonal	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	170	**-2.8**	ULS 1a_0	39.3	60.3	51.8	0.07		**2.3**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.07	
432	B-B Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	96	**-1.8**	ULS 1a_0	50.1	60.3	43.2	0.04		**1.3**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.04	
390A	Eerste DWSRM onderregel	120x120x12	S355	8M24-8.8t	1.00	2.00	1.00	60	**-427.5**	ULS 5a Ba 21	758.7	928.5	1693.4	0.56		**179.8**	ULS 5a Ah 21	583.4	928.5	1693.4	0.31	
390B	Eerste DWSRM onderregel	120x120x12	S355	5M24-8.8t	1.00	2.00	1.00	74	**-324.5**	ULS 5a Ba 21	662.2	677.8	1058.4	0.49		**140.8**	ULS 5a Ah 21	750.1	677.8	995.1	0.21	
390C	Eerste DWSRM onderregel	120x120x12	S355		1.00	2.00	1.00	74	**-396.2**	ULS 5a Ba 21	662.2	0.0	0.0	0.60		**171.7**	ULS 5a Ah 21	976.3	0.0	0.0	0.18	
391A	Eerste DWSRM onderregel	110x110x10	S355	5M24-8.8t	1.00	2.00	1.00	69	**-271.6**	ULS 5a Ba 21	535.1	677.8	882.0	0.51		**147.7**	ULS 5a Ah 10	561.7	677.8	829.2	0.26	
391B	Eerste DWSRM onderregel	110x110x10	S355		1.00	4.00	1.00	69	**-150.9**	ULS 3_90	534.9	0.0	0.0	0.28		**0.0**		749.8	0.0	0.0	0.00	
391C	Eerste DWSRM onderregel	110x110x10	S355		1.00	2.00	1.00	69	**-248.6**	ULS 5a Ba 10	535.1	0.0	0.0	0.46		**123.8**	ULS 5a Ah 21	749.8	0.0	0.0	0.17	
392A	Eerste DWSRM bovenregel	100x100x8	S235	4M24-8.8t	3.34	1.00	1.00	257	**0.0**		58.4	542.2	414.7	0.00		**245.1**	ULS 3_90	211.1	542.2	362.8	1.16	nettodsn.
392B	Eerste DWSRM bovenregel	100x100x8	S235	4M20-8.8t	2.86	1.00	1.00	258	**0.0**		58.4	376.3	345.6	0.00		**168.6**	ULS 3_90	310.5	376.3	314.2	0.54	
392C	Eerste DWSRM bovenregel	100x100x8	S235		2.86	1.00	1.00	258	**0.0**		58.4	0.0	0.0	0.00		**216.2**	ULS 3_90	364.3	0.0	0.0	0.59	
393A	Eerste DWSRM bovenregel	80x80x8	S235	4M20-8.8t	3.00	1.00	1.00	295	**0.0**		37.7	376.3	345.6	0.00		**164.6**	ULS 3_90	227.6	376.3	314.2	0.72	
393B	Eerste DWSRM bovenregel	80x80x8	S235	4M20-8.8t	3.00	1.00	1.00	295	**0.0**		37.7	376.3	345.6	0.00		**154.9**	ULS 3_90	151.8	376.3	261.3	1.02	nettodsn.
393C	Eerste DWSRM bovenregel	80x80x8	S235		3.00	1.00	1.00	295	**0.0**		37.7	0.0	0.0	0.00		**154.6**	ULS 3_90	289.1	0.0	0.0	0.53	
301	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	142	**-21.0**	ULS 5a Ah 20	49.2	60.3	51.8	0.43		**23.1**	ULS 5a Ba 11	48.4	60.3	33.7	0.69	
302	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	135	**-25.5**	ULS 5a Ba 20	51.9	60.3	51.8	0.49		**24.5**	ULS 5a Ah 20	48.4	60.3	33.7	0.73	
303	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	133	**-27.2**	ULS 5a Ah 11	52.9	60.3	51.8	0.52		**28.0**	ULS 5a Ba 11	48.4	60.3	33.7	0.83	
304	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	126	**-30.8**	ULS 5a Ba 11	56.3	60.3	51.8	0.59		**29.4**	ULS 5a Ah 20	48.4	60.3	33.7	0.87	
305	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	118	**-32.3**	ULS 5a Ah 11	59.8	60.3	51.8	0.62		**35.0**	ULS 5a Ba 11	48.4	60.3	33.7	0.85	stuik
306	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	111	**-38.7**	ULS 5a Ba 11	63.5	60.3	51.8	0.75		**33.8**	ULS 5a Ah 20	48.4	60.3	33.7	0.82	stuik
307	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	121	**-20.7**	ULS 5a Ba 10	40.7	60.3	43.2	0.51		**19.2**	ULS 5a Ah 10	46.1	60.3	32.7	0.59	
308	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	114	**-23.1**	ULS 5a Ah 10	43.3	60.3	43.2	0.53		**23.4**	ULS 5a Ba 10	46.1	60.3	32.7	0.72	
309	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	106	**-25.9**	ULS 5a Ah 10	46.0	60.3	43.2	0.60		**26.2**	ULS 5a Ba 21	46.1	60.3	32.7	0.80	
310	CD	50x50x7	S235	1M16-8.8t	0.53	0.53	0.53	102	**-31.3**	ULS 5a Ba 10	65.4	60.3	60.5	0.52		**30.0**	ULS 5a Ah 21	64.5	60.3	45.8	0.66	
311	CD	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	97	**-35.8**	ULS 5a Ah 10	68.1	60.3	60.5	0.59		**38.4**	ULS 5a Ba 10	64.5	60.3	45.8	0.84	
313	CD	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	90	**-45.4**	ULS 5a Ba 10	71.8	60.3	60.5	0.75		**41.1**	ULS 5a Ah 10	64.5	60.3	45.8	0.90	
314	Hor. onderregel	HEB160	S355	2M20-8.8t	2.00	2.00	2.00	48	**-29.0**	ULS 5a Ba 20	1325.2	188.2	235.2	0.15		**36.3**	ULS 5a Ba 11	1739.7	188.2	0.0	0.19	
316	Hor. onderregel	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	25	**-31.5**	ULS 5a Ah 10	1067.2	188.2	172.8	0.18		**35.1**	ULS 5a Ba 21	1278.1	188.2	0.0	0.20	
317	Vertical	80x80x6#	S235	1M16-8.8t	1.00	1.00	1.00	159	**-21.5**	ULS 3_90	65.4	60.3	51.8	0.41		**0.0**		107.1	60.3	51.8	0.00	
318	Vertical	70x70x7	S235	1M20-8.8t	1.00	1.00	1.00	146	**-25.6**	ULS 3_90	73.0	94.1	75.6	0.35		**0.0**		84.7	94.1	65.2	0.00	
319	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	**-2.5**	ULS 5a Ah 10	32.7	60.3	43.2	0.08		**0.0**		46.1	60.3	32.7	0.00	
320	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	98	**-2.7**	ULS 3_90	49.3	60.3	43.2	0.06		**0.0**		46.1	60.3	32.7	0.00	
321	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	49	**-2.2**	ULS 3_90	64.5	60.3	43.2	0.05		**0.0**		46.1	60.3	32.7	0.00	
322	Vertical Diagonal	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	324	**0.0**		18.8	120.6	103.7	0.00		**27.1**	ULS 3_90	78.2	120.6	67.3	0.40	
323	Vertical Diagonal	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	316	**0.0**		19.5	120.6	103.7	0.00		**39.0**	ULS 3_90	78.2	120.6	67.3	0.58	
324	Vertical Diagonal	70x70x7	S235	2M20-8.8t	1.00	1.00	1.00	246	**0.0**		39.5	188.2	151.2	0.00		**57.9**	ULS 3_90	95.5	188.2	119.9	0.61	
325	Vertical Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	282	**0.0**		13.1	60.3	43.2	0.00		**6.4**	ULS 5a Ba 10	46.1	60.3	32.7	0.20	
326	Vertical Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	260	**0.0**		14.8	60.3	43.2	0.00		**11.7**	ULS 5a Ba 21	46.1	60.3	32.7	0.36	
327	Hor. Bovenregel	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	102	**-1.3**	ULS 1a_0	73.2	60.3	51.8	0.02		**1.1**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.03	
328	B-B Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	179	**-2.8**	ULS 1a_0	25.6	60.3	43.2	0.11		**2.2**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.07	
250L		60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	263	**-2.3**	ULS 1a_0,9_0,9_135	23.6	60.3	51.8	0.10		**1.5**	ULS 1a_0,9_90	48.4	60.3	33.7	0.04	
250T		60x60x6	S235	1M16-8.8t	1.05	1.00	1.00	250	**-2.4**	ULS 1a_0,9_0,9_135	25.5	60.3	51.8	0.09		**1.5**	ULS 1a_0,9_0	48.4	60.3	33.7	0.04	
251		70x70x7	S235	1M16-8.8t	1.00	1.00	1.00	312	**-2.8**	ULS 1a_45	21.8	60.3	60.5	0.13		**3.5**	ULS 1a_0,9_45	92.7	60.3	52.3	0.07	
252		70x70x7	S235	1M16-8.8t	0.50	0.50	0.50	226	**-0.7**	ULS 1a_0	35.8	60.3	60.5	0.02		**0.5**	ULS 1a_0,9_0	92.7	60.3	52.3	0.01	
260L		60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	179	**-2.6**	ULS 1a_0,9_0,9_135	41.3	60.3	51.8	0.06		**1.9**	ULS 1a_0,9_0,9_45	48.4	60.3	33.7	0.06	
260T		60x60x6	S235	1M16-8.8t	1.08	1.00	1.00	166	**-2.5**	ULS 1a_0,9_0,9_45	45.6	60.3	51.8	0.06		**2.4**	ULS 1a_0,9_45	48.4	60.3	33.7	0.07	
260TC		60x60x6	S235		20.51	2.00	1.00	175	**-5.4**	ULS 1a_0,9_0,9_45	45.0	0.0	0.0	0.12		**5.0**	ULS 1a_0,9_45	162.2	0.0	0.0	0.03	
261		60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	244	**-2.4**	ULS 5a Ah 21	23.5	60.3	51.8	0.10		**2.6**	ULS 1a_0,9_45	48.4	60.3	33.7	0.08	
262		50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	220	**-0.6**	ULS 1a_0	26.1	60.3	60.5	0.02		**0.4**	ULS 1a_0,9_0	64.5	60.3	45.8	0.01	

Assessment of groups for strengthened mast (afkeur level)

Date	24-02-21
Author	MKh
Version	1.0

ENS-ZL 380
S+15_R
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Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
101	Leg	100x100x8	S355	4M24-8.8t	0.50	0.50	0.50	66	**-67.6**	ULS 5a Ah 12	404.6	542.2	564.5	0.17		**8.3**	ULS 5a Ah 22	400.1	542.2	564.5	0.02
102A	Leg	120x120x10	S355	4M24-8.8t	0.50	0.50	0.50	55	**-93.0**	ULS 5a Ah 22	668.2	542.2	705.6	0.17		**48.1**	ULS 5a Ah 22	635.0	542.2	663.4	0.09
102B	Leg	120x120x10	S355	8M24-8.8t	0.50	0.50	0.50	64	**-222.2**	ULS 1a_45	621.8	1084.4	1411.2	0.36		**80.6**	ULS 1a_0,9_0,9_135	635.0	1084.4	1411.2	0.13
102C	Leg	120x120x10	S355		0.50	0.50	0.50	62	**-179.8**	ULS 1a_45	633.9	0.0	0.0	0.28		**94.8**	ULS 1a_0,9_0,9_135	823.6	0.0	0.0	0.12
103A	Leg	150x150x12	S355	8M24-8.8t	0.50	0.50	0.50	58	**-362.0**	ULS 1a_45	981.0	2168.8	1693.4	0.37		**171.6**	ULS 1a_0,9_0,9_135	1007.6	2168.8	1592.1	0.17
103B	Leg	150x150x12	S355	8M24-8.8t	0.54	0.54	0.54	44	**-521.0**	ULS 1a_45	1081.4	2168.8	1693.4	0.48		**318.5**	ULS 1a_0,9_0,9_135	1007.6	2168.8	1592.1	0.32
103C	Leg	150x150x12	S355		0.50	0.50	0.50	66	**-444.2**	ULS 1a_45	908.9	0.0	0.0	0.49		**319.9**	ULS 1a_0,9_0,9_135	1235.4	0.0	0.0	0.26
104A	Leg	150x150x15	S355	8M24-8.8t	0.27	0.27	0.27	46	**-609.5**	ULS 1a_45	1318.6	2168.8	2116.8	0.46		**381.4**	ULS 1a_0,9_0,9_135	1241.9	2168.8	1990.2	0.31
104B	Leg	150x150x15	S355	8M24-8.8t	0.27	0.27	0.27	51	**-692.8**	ULS 1a_45	1278.3	2168.8	2116.8	0.54		**470.5**	ULS 1a_0,9_0,9_135	1241.9	2168.8	1990.2	0.38
105A	Leg	160x160x17#	S355	8M24-8.8t	0.54	0.54	0.54	49	**-768.1**	ULS 1a_135	1566.9	2168.8	2399.0	0.49		**525.8**	ULS 1a_0,9_0,9_135	1519.2	2168.8	2255.5	0.35
105B	Leg	160x160x17#	S355	8M24-8.8t	0.27	0.27	0.27	52	**-868.4**	ULS 1a_135	1532.9	2168.8	2399.0	0.57		**610.9**	ULS 1a_0,9_0,9_135	1519.2	2168.8	2255.5	0.40
105C	Leg	160x160x17#	S355		0.54	0.54	0.54	55	**-770.4**	ULS 1a_45	1497.2	0.0	0.0	0.51		**523.6**	ULS 1a_0,9_0,9_135	1842.5	0.0	0.0	0.28
106A	Leg	160x160x17#	S355	8M24-8.8t	0.33	0.33	0.33	50	**-821.9**	ULS 1a_45	1550.0	2168.8	2399.0	0.53		**595.5**	ULS 1a_0,9_0,9_135	1519.2	2168.8	2255.5	0.39
106B	Leg	160x160x17#	S355	8M24-8.8t	0.17	0.17	0.17	52	**-826.7**	ULS 1a_45	1527.3	2168.8	2399.0	0.54		**591.2**	ULS 1a_0,9_0,9_45	1519.2	2168.8	2255.5	0.39
201L	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	113	**-56.8**	ULS 5a Ah 22	138.9	188.2	172.8	0.41		**38.4**	ULS 5a Ah 22	146.3	188.2	157.1	0.26
201T	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	113	**-24.4**	ULS 5a Ah 22	138.9	188.2	172.8	0.18		**11.8**	ULS 5a Ah 12	146.3	188.2	157.1	0.08
202L	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	104	**-141.6**	ULS 5a Ba 12	169.7	271.1	207.4	0.83		**151.4**	ULS 5a Ah 12	159.7	271.1	183.4	0.95
202T	CD	120x120x10	S235	3M24-8.8t	0.53	0.53	0.53	78	**-159.2**	ULS 5a Ba 12	350.3	406.7	388.8	0.45		**160.7**	ULS 5a Ah 12	324.0	406.7	359.4	0.50
203L	CD	100x100x8	S235	2M24-8.8t	0.53	0.53	0.53	101	**-140.9**	ULS 5a Ah 22	194.2	271.1	207.4	0.73		**129.0**	ULS 5a Ba 22	181.4	271.1	189.2	0.71
203T	CD	120x120x10	S235	2M24-8.8t	0.53	0.53	0.53	84	**-147.3**	ULS 5a Ah 12	333.9	271.1	259.2	0.57		**146.0**	ULS 5a Ba 12	278.4	271.1	243.7	0.60
204L	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	119	**-115.3**	ULS 5a Ba 22	149.8	271.1	207.4	0.77		**126.9**	ULS 5a Ah 22	159.7	271.1	183.4	0.79
204T	CD	120x120x10	S235	2M24-8.8t	0.53	0.53	0.53	89	**-132.0**	ULS 5a Ba 22	321.6	271.1	259.2	0.51		**132.4**	ULS 5a Ah 12	278.4	271.1	243.7	0.54
205L	CD	120x120x10	S235	3M24-8.8t	0.53	0.53	0.53	94	**-133.3**	ULS 5a Ba 22	309.2	406.7	388.8	0.43		**124.9**	ULS 5a Ah 22	324.0	406.7	359.4	0.39
205T	CD	120x120x10	S235	3M24-8.8t	0.53	0.53	0.53	94	**-132.9**	ULS 5a Ba 22	309.2	406.7	388.8	0.43		**109.1**	ULS 5a Ah 12	324.0	406.7	359.4	0.34
206L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	83	**-129.5**	ULS 5a Ah 21	213.8	271.1	207.4	0.62		**122.4**	ULS 5a Ah 10	181.4	271.1	189.2	0.68
206T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	83	**-139.0**	ULS 5a Ba 21	213.8	271.1	207.4	0.67		**140.3**	ULS 5a Ah 21	181.4	271.1	189.2	0.77
207L	CD	90x90x8	S235	2M24-8.8t	0.54	0.27	0.27	106	**-108.6**	ULS 5a Ah 21	158.4	271.1	207.4	0.69		**113.4**	ULS 5a Ah 21	183.3	271.1	195.0	0.62
207T	CD	90x90x8	S235	2M24-8.8t	0.54	0.27	0.27	106	**-123.3**	ULS 5a Ah 10	158.4	271.1	207.4	0.78		**122.2**	ULS 5a Ba 10	183.3	271.1	195.0	0.67
208L	CD	90x90x8	S235	2M24-8.8t	1.00	0.54	0.54	120	**-98.2**	ULS 5a Ah 10	140.3	271.1	207.4	0.70		**92.1**	ULS 5a Ah 21	159.7	271.1	183.4	0.58
208T	CD	90x90x8	S235	2M24-8.8t	1.00	0.54	0.54	120	**-112.6**	ULS 5a Ba 21	140.3	271.1	207.4	0.80		**107.2**	ULS 5a Ah 10	159.7	271.1	183.4	0.67
209L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	122	**-80.1**	ULS 5a Ah 21	153.4	271.1	207.4	0.52		**84.5**	ULS 5a Ah 21	181.4	271.1	189.2	0.47
209T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	122	**-93.2**	ULS 5a Ah 10	153.4	271.1	207.4	0.61		**96.6**	ULS 5a Ba 10	181.4	271.1	189.2	0.53
210L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	137	**-73.4**	ULS 5a Ah 21	136.0	271.1	207.4	0.54		**68.6**	ULS 5a Ah 21	181.4	271.1	189.2	0.38
210T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	137	**-83.7**	ULS 5a Ba 10	136.0	271.1	207.4	0.62		**80.1**	ULS 5a Ah 10	181.4	271.1	189.2	0.44
211L	CD	100x100x8	S235	2M24-8.8t	1.00	0.54	0.54	149	**-61.4**	ULS 5a Ah 21	122.8	271.1	207.4	0.50		**61.6**	ULS 5a Ah 21	234.9	271.1	141.8	0.43
211T	CD	100x100x8	S235	2M24-8.8t	1.00	0.54	0.54	149	**-75.0**	ULS 5a Ba 10	122.8	271.1	207.4	0.61		**67.1**	ULS 5a Ba 10	234.9	271.1	141.8	0.47
212L	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	162	**-52.4**	ULS 5a Ah 21	111.4	271.1	207.4	0.47		**51.4**	ULS 5a Ah 10	217.0	271.1	141.8	0.36
212T	CD	100x100x8	S235	2M24-8.8t	0.54	0.27	0.27	162	**-57.0**	ULS 5a Ba 10	111.4	271.1	207.4	0.51		**62.8**	ULS 5a Ba 10	217.0	271.1	141.8	0.44
213L	CD	150x150x12	S235	2M24-8.8t	1.00	0.33	0.33	130	**-76.3**	ULS 5a Ba 10	322.8	271.1	311.0	0.28		**57.6**	ULS 5a Ah 10	428.1	271.1	292.4	0.21
213T	CD	150x150x12	S235	2M24-8.8t	1.00	0.33	0.33	130	**-81.0**	ULS 1a_90	322.8	271.1	311.0	0.30		**51.9**	ULS 1a_0,9_0,9_90	428.1	271.1	292.4	0.19
214L	CD	90x90x8	S235	2M24-8.8t	0.17	0.17	0.17	107	**-87.1**	ULS 5a Ba 21	166.2	271.1	207.4	0.52		**66.9**	ULS 5a Ah 21	159.7	271.1	183.4	0.42
214T	CD	90x90x8	S235	2M24-8.8t	0.17	0.17	0.17	107	**-91.6**	ULS 5a Ah 21	166.2	271.1	207.4	0.55		**45.4**	ULS 5a Ba 10	159.7	271.1	183.4	0.28
215	Top	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	157	**-12.8**	ULS 5a Ba 22	96.8	188.2	172.8	0.13		**12.7**	ULS 5a Ba 12	146.3	188.2	157.1	0.09
216L	0	100x100x8	S235	**7M20-8.8t**	1.00	1.00	1.00	102	**0.0**		220.4	658.6	604.8	0.00		**217.4**	ULS 3_90	310.5	658.6	549.8	0.70
216T	0	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	171	**-4.8**	ULS 5a Ah 22	39.0	60.3	51.8	0.12		**5.2**	ULS 5a Ah 22	72.6	60.3	44.8	0.12
217L	0	130x130x11	S355	8M24-8.8t	1.00	2.00	1.00	55	**-344.4**	ULS 5a Ba 12	796.4	1023.4	1552.3	0.43		**105.9**	ULS 5a Ah 12	494.8	1023.4	1552.3	0.21
217T	0	70x70x7	S235	4M20-8.8t	0.50	1.00	0.50	52	**-79.7**	ULS 5a Ah 22	162.2	376.3	302.4	0.49		**89.3**	ULS 5a Ah 22	163.8	376.3	260.9	0.55
218L	0	100x100x8	S235	**7M20-8.8t**	1.00	1.00	1.00	142	**0.0**		133.2	658.6	604.8	0.00		**256.0**	ULS 3_90	310.5	658.6	604.8	0.82
218T	0	100x100x8	S235	1M24-8.8t	1.00	1.00	1.00	142	**-25.7**	ULS 1a_0,9_0,9_90	110.2	135.6	103.7	0.25		**42.7**	ULS 1a_90	170.5	135.6	97.5	0.44
219L	0	130x130x11	S355	8M24-8.8t	1.00	2.00	1.00	75	**-342.7**	ULS 5a Ba 10	655.5	928.5	1552.3	0.52		**67.5**	ULS 5a Ah 10	600.4	928.5	1552.3	0.11
219T	0	80x80x8	S235	4M20-8.8t	1.00	2.00	1.00	123	**-54.1**	ULS 5a Ah 10	120.6	376.3	345.6	0.45		**93.0**	ULS 5a Ah 21	227.6	376.3	314.2	0.41
220L	0	80x80x6#	S235	1M20-8.8t	1.00	1.00	1.00	268	**-3.7**	ULS 1a_135	31.1	94.1	64.8	0.12		**1.0**	ULS 1a_0,9_135	100.2	94.1	58.9	0.02
220T	0	80x80x6#	S235	1M20-8.8t	1.03	1.00	1.00	261	**-3.8**	ULS 1a_135	32.5	94.1	64.8	0.12		**1.2**	ULS 1a_0,9_0,9_0	100.2	94.1	58.9	0.02
220TC	0	80x80x6#	S235		35.54	2.00	1.00	173	**-8.6**	ULS 1a_135	62.2	0.0	0.0	0.14		**5.7**	ULS 1a_0,9_0,9_45	220.9	0.0	0.0	0.03
221	0	80x80x8	S235	1M20-8.8t	0.50	0.50	0.50	273	**-1.4**	ULS 1a_0	35.2	94.1	86.4	0.04		**0.2**	ULS 1a_0,9_0,9_0	133.6	94.1	78.5	0.00
222	0	70x70x7	S235	1M20-8.8t	0.50	1.00	0.50	281	**-4.5**	ULS 1a_135	21.8	94.1	75.6	0.21		**4.9**	ULS 1a_0,9_0,9_45	84.7	94.1	50.7	0.10
223	Bovenstuk	80x80x6#	S235	3M20-8.8t	1.00	1.00	1.00	97	**-101.1**	ULS 5a Ba 12	121.6	282.2	194.4	0.83		**98.1**	ULS 5a Ah 12	129.0	282.2	175.7	0.76
224	Bovenstuk	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	113	**-5.5**	ULS 3_90	43.6	60.3	43.2	0.13		**2.6**	ULS 3_90	46.1	60.3	32.7	0.08
225	Derde TSNSTK	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	121	**-95.2**	ULS 5a Ah 10	147.8	271.1	207.4	0.64		**95.3**	ULS 5a Ba 10	159.7	271.1	183.4	0.60
226	Derde TSNSTK	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	155	**-0.8**	ULS 3_90	30.8	60.3	43.2	0.03		**0.9**	ULS 3_90	46.1	60.3	32.7	0.03
490A	Tweede DWSR	130x130x11	S355	8M24-8.8t	1.00	2.00	1.00	48	**-432.7**	ULS 5a Ba 22	835.1	1023.4	1552.3	0.52		**233.9**	ULS 5a Ah 22	494.8	1023.4	1459.4	0.47
490B	Tweede DWSR	130x130x11	S355	4M24-8.8t	2.35	1.55	1.00	57	**-174.1**	ULS 5a Ba 3	786.2	542.2	776.2	0.32		**12.4**	ULS 5a Ah 22	771.9	542.2	729.7	0.02
490C	Tweede DWSR	130x130x11	S355		1.00	2.00	1.00	78	**-407.3**	ULS 5a Ba 22	636.6	0.0	0.0	0.64		**201.4**	ULS 5a Ah 22	979.8	0.0	0.0	0.21
491A	Tweede DWSR	100x100x8	S355	4M24-8.8t	3.84	2.84	1.00	65	**-147.6**	ULS 5a Ba 3	408.3	542.2	564.5	0.36		**24.5**	ULS 5a Ah 22	400.1	542.2	530.7	0.06
491B	Tweede DWSR	100x100x8	S355		1.00	2.00	1.00	65	**-50.8**	ULS 3_90	408.6	0.0	0.0	0.12		**0.0**		550.3	0.0	0.0	0.00
491C	Tweede DWSR	100x100x8	S355		1.00	1.35	1.00	75	**-127.5**	ULS 5a Ba 1	367.6	0.0	0.0	0.35		**25.9**	ULS 5a Ah 3	550.3	0.0	0.0	0.05
492A	Tweede DWSR	80x80x10	S235	**7M20-8.8t**	1.92	1.00	1.00	210	**0.0**		60.6	658.6	756.0	0.00		**206.6**	ULS 3_90	277.3	658.6	687.3	0.74
492B	Tweede DWSR	80x80x10	S235	4M20-8.8t	2.83	1.00	1.00	280	**0.0**		50.1	376.3	432.0	0.00		**164.3**	ULS 3_90	277.3	376.3	392.7	0.59
492C	Tweede DWSR	80x80x10	S235		2.08	1.00	1.00	211	**0.0**		76.4	0.0	0.0	0.00		**188.8**	ULS 3_90	354.9	0.0	0.0	0.53
493A	Tweede DWSR	80x80x8	S235	4M20-8.8t	2.96	1.00	1.00	277	**0.0**		41.3	376.3	345.6	0.00		**124.8**	ULS 3_90	227.6	376.3	314.2	0.55
493B	Tweede DWSR	80x80x8	S235	3M20-8.8t	2.00	1.00	1.00	167	**0.0**		85.0	282.2	259.2	0.00		**51.2**	ULS 3_90	151.8	282.2	201.6	0.34
493C	Tweede DWSR	80x80x8	S235		2.00	1.00	1.00	167	**0.0**		85.0	0.0	0.0	0.00		**59.0**	ULS 3_90	289.1	0.0	0.0	0.20
401	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	**-22.6**	ULS 5a Ba 22	32.7	60.3	43.2	0.69		**14.8**	ULS 5a Ah 22	46.1	60.3	32.7	0.45
402	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	138	**-25.7**	ULS 5a Ah 12	35.3	60.3	43.2	0.73		**28.9**	ULS 5a Ba 12	46.1	60.3	32.7	0.88
403	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	123	**-25.4**	ULS 5a Ah 12	40.1	60.3	43.2	0.63		**24.7**	ULS 5a Ba 22	46.1	60.3	32.7	0.75
404	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	119	**-28.4**	ULS 5a Ba 22	41.5	60.3	43.2	0.68		**26.5**	ULS 5a Ah 12	46.1	60.3	32.7	0.81
405	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	114	**-29.8**	ULS 5a Ba 22	43.3	60.3	43.2	0.69		**27.6**	ULS 5a Ah 12	46.1	60.3	32.7	0.85
406	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	112	**-30.5**	ULS 5a Ah 12	60.0	60.3	60.5	0.51		**32.1**	ULS 5a Ba 12	64.5	60.3	45.8	0.70
407	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	112	**-36.1**	ULS 5a Ba 22	60.1	60.3	60.5	0.60		**33.5**	ULS 5a Ah 22	64.5	60.3	45.8	0.73
408	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	114	**-38.9**	ULS 5a Ah 12	58.8	60.3	60.5	0.66		**43.3**	ULS 5a Ba 12	64.5	60.3	45.8	0.95
409	CD	50x50x7	S235	1M16-8.8t	0.52	0.52	0.52	110	**-49.1**	ULS 5a Ba 22	61.0	60.3	60.5	0.81		**42.8**	ULS 5a Ah 22	64.5	60.3	45.8	0.93

DNV·GL

Assessment of groups for strenghtened mast (afkeur level)

Date	24-02-21
Author	MKh
Version	1.0

ENS-ZL 380
S+15_R
89

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
410	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	87	**-10.7**	ULS 5a Ba 3	54.2	60.3	43.2	0.25		**10.0**	ULS 5a Ah 3	46.1	60.3	32.7	0.31
411	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	83	**-11.8**	ULS 5a Ba 3	55.1	60.3	43.2	0.27		**11.7**	ULS 5a Ba 1	46.1	60.3	32.7	0.36
412	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	80	**-12.7**	ULS 5a Ah 3	55.9	60.3	43.2	0.29		**13.3**	ULS 5a Ba 1	46.1	60.3	32.7	0.41
413	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	77	**-14.1**	ULS 5a Ba 1	56.8	60.3	43.2	0.33		**12.9**	ULS 5a Ah 1	46.1	60.3	32.7	0.40
414	Hor. onderregel	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	187	**0.0**		24.1	60.3	43.2	0.00		**5.0**	ULS 3_90	46.1	60.3	32.7	0.15
415	Hor. onderregel	HEB160	S355	2M20-8.8t	2.00	2.00	2.00	32	**-30.0**	ULS 5a Ah 22	1470.4	188.2	235.2	0.16		**35.9**	ULS 5a Ba 22	1739.7	188.2	0.0	0.19
416	Hor. onderregel	HEB160	S355	2M20-8.8t	2.00	2.00	2.00	25	**-10.3**	ULS 5a Ah 1	1530.7	188.2	235.2	0.05		**11.2**	ULS 5a Ba 3	1739.7	188.2	0.0	0.06
417	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	185	**-13.7**	ULS 3_45	35.0	60.3	51.8	0.39		**0.0**		48.4	60.3	33.7	0.00
418	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	182	**-14.9**	ULS 3_90	24.9	60.3	43.2	0.60		**0.0**		46.1	60.3	32.7	0.00
419	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	142	**-17.9**	ULS 3_90	34.2	60.3	43.2	0.52		**0.0**		46.1	60.3	32.7	0.00
420	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	103	**-22.5**	ULS 3_90	47.3	60.3	43.2	0.52		**0.0**		46.1	60.3	32.7	0.00
421	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	69	**-1.3**	ULS 3_90	59.1	60.3	43.2	0.03		**0.0**		46.1	60.3	32.7	0.00
422	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	34	**-1.0**	ULS 3_90	68.4	60.3	43.2	0.02		**0.0**		46.1	60.3	32.7	0.00
423	Vertical Diagona	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	314	**0.0**		19.7	120.6	103.7	0.00		**19.5**	ULS 3_135	71.5	120.6	86.5	0.27
424	Vertical Diagona	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	333	**0.0**		12.5	120.6	86.4	0.00		**23.8**	ULS 3_45	50.2	120.6	65.4	0.47
425	Vertical Diagona	50x50x5	S235	2M16-8.8t	1.00	1.00	1.00	303	**0.0**		14.6	120.6	86.4	0.00		**30.4**	ULS 3_90	53.9	120.6	65.4	0.56
426	Vertical Diagona	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	225	**0.0**		33.1	120.6	103.7	0.00		**45.7**	ULS 3_90	68.2	120.6	83.2	0.67
427	Vertical Diagona	70x70x7	S235	2M20-8.8t	1.00	1.00	1.00	164	**0.0**		69.8	188.2	151.2	0.00		**72.7**	ULS 3_90	90.5	188.2	111.6	0.80
428	Vertical Diagona	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	**0.0**		19.4	60.3	43.2	0.00		**8.3**	ULS 3_90	46.1	60.3	32.7	0.25
429	Hor. bovenrege	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	111	**-1.0**	ULS 1a_0	47.0	60.3	43.2	0.02		**0.9**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.03
430	Hor. bovenrege	50x50x5	S235	1M16-8.8t	1.00	2.00	1.00	83	**-0.9**	ULS 1a_0,9_0,9_0	59.3	60.3	43.2	0.02		**0.9**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.03
431	C-C Diagonal	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	170	**-2.8**	ULS 1a_0	39.3	60.3	51.8	0.07		**2.3**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.07
432	B-B Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	96	**-1.8**	ULS 1a_0	50.1	60.3	43.2	0.04		**1.3**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.04
390A	Eerste DWSRM	120x120x12	S355	8M24-8.8t	1.00	2.00	1.00	60	**-427.2**	ULS 5a Ba 21	758.7	928.5	1693.4	0.56		**179.5**	ULS 5a Ah 21	583.4	928.5	1693.4	0.31
390B	Eerste DWSRM	120x120x12	S355	5M24-8.8t	1.00	2.00	1.00	74	**-324.4**	ULS 5a Ba 21	662.2	677.8	1058.4	0.49		**140.7**	ULS 5a Ah 21	750.1	677.8	995.1	0.21
390C	Eerste DWSRM	120x120x12	S355		1.00	2.00	1.00	74	**-395.9**	ULS 5a Ba 10	662.2	0.0	0.0	0.60		**171.4**	ULS 5a Ah 21	976.3	0.0	0.0	0.18
391A	Eerste DWSRM	110x110x10	S355	5M24-8.8t	1.00	2.00	1.00	69	**-271.6**	ULS 5a Ba 10	535.1	677.8	882.0	0.51		**147.8**	ULS 5a Ah 10	561.7	677.8	829.2	0.26
391B	Eerste DWSRM	110x110x10	S355		1.00	4.00	1.00	69	**-150.9**	ULS 3_90	534.9	0.0	0.0	0.28		**0.0**		749.8	0.0	0.0	0.00
391C	Eerste DWSRM	110x110x10	S355		1.00	2.00	1.00	69	**-248.6**	ULS 5a Ba 21	535.1	0.0	0.0	0.46		**123.9**	ULS 5a Ah 21	749.8	0.0	0.0	0.17
392A	Eerste DWSRM	100x100x8	S235	**7M20-8.8t**	3.34	1.00	1.00	257	**0.0**		42.9	658.6	604.8	0.00		**245.1**	ULS 3_90	310.5	658.6	604.8	0.79
392B	Eerste DWSRM	100x100x8	S235	4M20-8.8t	2.86	1.00	1.00	258	**0.0**		58.4	376.3	345.6	0.00		**168.6**	ULS 3_90	310.5	376.3	314.2	0.54
392C	Eerste DWSRM	100x100x8	S235		2.86	1.00	1.00	258	**0.0**		58.4	0.0	0.0	0.00		**216.2**	ULS 3_90	364.3	0.0	0.0	0.59
393A	Eerste DWSRM	80x80x8	S235	4M20-8.8t	3.00	1.00	1.00	295	**0.0**		37.7	376.3	345.6	0.00		**164.6**	ULS 3_90	227.6	376.3	314.2	0.72
393B	Eerste DWSRM	80x80x8	S235	**7M20-8.8t**	3.00	1.00	1.00	295	**0.0**		26.4	658.6	604.8	0.00		**154.9**	ULS 3_90	227.6	658.6	470.4	0.68
393C	Eerste DWSRM	80x80x8	S235		3.00	1.00	1.00	295	**0.0**		37.7	0.0	0.0	0.00		**154.6**	ULS 3_90	289.1	0.0	0.0	0.53
301	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	142	**-20.9**	ULS 5a Ah 11	49.2	60.3	51.8	0.42		**23.0**	ULS 5a Ba 11	48.4	60.3	33.7	0.68
302	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	135	**-25.5**	ULS 5a Ba 20	51.9	60.3	51.8	0.49		**24.5**	ULS 5a Ah 11	48.4	60.3	33.7	0.73
303	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	133	**-27.2**	ULS 5a Ah 11	52.9	60.3	51.8	0.52		**27.9**	ULS 5a Ba 11	48.4	60.3	33.7	0.83
304	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	126	**-30.8**	ULS 5a Ba 20	56.3	60.3	51.8	0.59		**29.4**	ULS 5a Ah 20	48.4	60.3	33.7	0.87
305	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	118	**-32.3**	ULS 5a Ah 20	59.8	60.3	51.8	0.62		**35.0**	ULS 5a Ba 11	48.4	60.3	33.7	0.85
306	CD	60x60x6	S235	1M16-8.8t	0.53	0.53	0.53	111	**-38.7**	ULS 5a Ba 20	63.5	60.3	51.8	0.75		**33.7**	ULS 5a Ah 20	48.4	60.3	33.7	0.82
307	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	121	**-20.7**	ULS 5a Ba 21	40.7	60.3	43.2	0.51		**19.2**	ULS 5a Ah 21	46.1	60.3	32.7	0.59
308	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	114	**-23.1**	ULS 5a Ah 10	43.3	60.3	43.2	0.54		**23.4**	ULS 5a Ba 10	46.1	60.3	32.7	0.72
309	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	106	**-25.9**	ULS 5a Ah 10	46.0	60.3	43.2	0.60		**26.2**	ULS 5a Ba 10	46.1	60.3	32.7	0.80
310	CD	50x50x7	S235	1M16-8.8t	0.53	0.53	0.53	102	**-31.3**	ULS 5a Ba 10	65.4	60.3	60.5	0.52		**30.0**	ULS 5a Ah 21	64.5	60.3	45.8	0.66
311	CD	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	97	**-35.8**	ULS 5a Ah 21	68.1	60.3	60.5	0.59		**38.4**	ULS 5a Ba 21	64.5	60.3	45.8	0.84
313	CD	50x50x7	S235	1M16-8.8t	0.54	0.54	0.54	90	**-45.4**	ULS 5a Ba 10	71.8	60.3	60.5	0.75		**41.1**	ULS 5a Ah 10	64.5	60.3	45.8	0.90
314	Hor. onderregel	HEB160	S355	2M20-8.8t	2.00	2.00	2.00	48	**-29.0**	ULS 5a Ba 20	1325.2	188.2	235.2	0.15		**36.3**	ULS 5a Ba 11	1739.7	188.2	0.0	0.19
316	Hor. onderregel	HEB160	S235	2M20-8.8t	2.00	2.00	2.00	25	**-31.5**	ULS 5a Ah 10	1067.2	188.2	172.8	0.18		**35.1**	ULS 5a Ba 21	1278.1	188.2	0.0	0.20
317	Vertical	80x80x6#	S235	1M16-8.8t	1.00	1.00	1.00	159	**-21.5**	ULS 3_90	65.4	60.3	51.8	0.41		**0.0**		107.1	60.3	51.8	0.00
318	Vertical	70x70x7	S235	1M20-8.8t	1.00	1.00	1.00	146	**-25.6**	ULS 3_90	73.0	94.1	75.6	0.35		**0.0**		84.7	94.1	65.2	0.00
319	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	147	**-2.5**	ULS 5a Ah 21	32.7	60.3	43.2	0.08		**0.0**		46.1	60.3	32.7	0.00
320	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	98	**-2.7**	ULS 3_90	49.3	60.3	43.2	0.06		**0.0**		46.1	60.3	32.7	0.00
321	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	49	**-2.2**	ULS 3_90	64.5	60.3	43.2	0.05		**0.0**		46.1	60.3	32.7	0.00
322	Vertical Diagona	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	324	**0.0**		18.8	120.6	103.7	0.00		**27.1**	ULS 3_90	78.2	120.6	67.3	0.40
323	Vertical Diagona	60x60x6	S235	2M16-8.8t	1.00	1.00	1.00	316	**0.0**		19.5	120.6	103.7	0.00		**39.0**	ULS 3_90	78.2	120.6	67.3	0.58
324	Vertical Diagona	70x70x7	S235	2M20-8.8t	1.00	1.00	1.00	246	**0.0**		39.5	188.2	151.2	0.00		**57.9**	ULS 3_90	95.5	188.2	119.9	0.61
325	Vertical Diagona	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	282	**0.0**		13.1	60.3	43.2	0.00		**6.4**	ULS 5a Ba 10	46.1	60.3	32.7	0.20
326	Vertical Diagona	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	260	**0.0**		14.8	60.3	43.2	0.00		**11.7**	ULS 5a Ba 21	46.1	60.3	32.7	0.36
327	Hor. Bovenrege	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	102	**-1.2**	ULS 1a_0	73.2	60.3	51.8	0.02		**1.1**	ULS 1a_0,9_0,9_0	48.4	60.3	33.7	0.03
328	B-B Diagonal	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	179	**-2.8**	ULS 1a_0	25.6	60.3	43.2	0.11		**2.2**	ULS 1a_0,9_0,9_0	46.1	60.3	32.7	0.07
250L	0	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	263	**-2.3**	ULS 1a_0,9_0,9_135	23.6	60.3	51.8	0.10		**1.5**	ULS 1a_0,9_90	48.4	60.3	33.7	0.04
250T	0	60x60x6	S235	1M16-8.8t	1.05	1.00	1.00	250	**-2.4**	ULS 1a_0,9_0,9_45	25.5	60.3	51.8	0.09		**1.5**	ULS 1a_0,9_0	48.4	60.3	33.7	0.04
251	0	70x70x7	S235	1M16-8.8t	1.00	1.00	1.00	312	**-2.8**	ULS 1a_45	21.8	60.3	60.5	0.13		**3.5**	ULS 1a_0,9_45	92.7	60.3	52.3	0.07
252	0	70x70x7	S235	1M16-8.8t	0.50	0.50	0.50	226	**-0.7**	ULS 1a_0	35.8	60.3	60.5	0.02		**0.5**	ULS 1a_0,9_0	92.7	60.3	52.3	0.01
260L	0	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	179	**-2.6**	ULS 1a_0,9_0,9_135	41.3	60.3	51.8	0.06		**1.9**	ULS 1a_0,9_0,9_45	48.4	60.3	33.7	0.06
260T	0	60x60x6	S235	1M16-8.8t	1.08	1.00	1.00	166	**-2.5**	ULS 1a_0,9_0,9_45	45.6	60.3	51.8	0.06		**2.4**	ULS 1a_0,9_45	48.4	60.3	33.7	0.07
260TC	0	60x60x6	S235		20.51	2.00	1.00	175	**-5.4**	ULS 1a_0,9_0,9_45	45.0	0.0	0.0	0.12		**5.0**	ULS 1a_0,9_45	162.2	0.0	0.0	0.03
261	0	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	244	**-2.4**	ULS 5a Ah 10	23.5	60.3	51.8	0.10		**2.6**	ULS 1a_0,9_135	48.4	60.3	33.7	0.08
262	0	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	220	**-0.6**	ULS 1a_0	26.1	60.3	60.5	0.02		**0.4**	ULS 1a_0,9_0	64.5	60.3	45.8	0.01

DNV·GL

Assessment of groups for strengthened mast (verbouw level)

Date 24-02-21
Author MKh
Version 1.0

ENS-ZL 380
S+15_R
89

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
216L		100x100x8	S235	**7M20-8.8t**	1.00	1.00	1.00	102	**0.0**		220.4	658.6	604.8	0.00		**250.8**	ULS 3_90	310.5	658.6	549.8	0.81
218L		100x100x8	S235	**7M20-8.8t**	1.00	1.00	1.00	142	**0.0**		133.2	658.6	604.8	0.00		**295.6**	ULS 3_90	310.5	658.6	604.8	0.95
492A	Tweede DWSRM	80x80x10	S235	**7M20-8.8t**	1.92	1.00	1.00	210	**0.0**		60.6	658.6	756.0	0.00		**238.5**	ULS 3_90	277.3	658.6	687.3	0.86
392A	Eerste DWSRM	100x100x8	S235	**7M20-8.8t**	3.34	1.00	1.00	257	**0.0**		42.9	658.6	604.8	0.00		**283.3**	ULS 3_90	310.5	658.6	604.8	0.91
393B	Eerste DWSRM	80x80x8	S235	**7M20-8.8t**	3.00	1.00	1.00	295	**0.0**		26.4	658.6	604.8	0.00		**179.8**	ULS 3_90	227.6	658.6	470.4	0.79

APPENDIX C
Toetsing knikverkorters

DNV·GL

Knikverkorters initial construction (afkeur)

Date: 2020-12-04
Author: K H Chan
Version: 1.8

ENS - ZL
S+15_R
Mast: 89

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
6197	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	0.642	0	66	**15.5**	**0.16**	59.9	60.3	30.3	31.7	0.72	0.51		
6198	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.69	72	174	**15.5**	**0.00**	26.5	60.3	30.3	31.7	0.72	0.59		
6199	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.35	0	139	**15.5**	**0.34**	35.0	60.3	30.3	31.7	0.72	0.51		
6200	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.99	54	204	**15.5**	**0.00**	21.2	60.3	30.3	31.7	0.72	0.73		
6201	Onderstuk	Enkele staaf	L50.7	S235	M16	8.8	2.06	0	215	**15.5**	**0.52**	26.9	60.3	42.5	44.4	0.98	0.58		
6202	Onderstuk	Enkele staaf	L50.7	S235	M16	8.8	2.46	41	257	**15.5**	**0.00**	20.6	60.3	42.5	44.4	0.98	0.75		
6203	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	2.78	0	237	**15.5**	**0.69**	24.5	60.3	38.4	72.6	1.24	0.63		
6204	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	3.02	32	259	**15.5**	**0.00**	21.5	60.3	38.4	72.6	1.24	0.72		
6205	Onderstuk	Enkele staaf	L80.6	S235	M16	8.8	3.50	0	222	**15.5**	**0.87**	36.6	60.3	38.4	107.1	2.25	0.42		
6243	Onderstuk	Enkele staaf	L80.6	S235	M16	8.8	3.68	26	234	**15.5**	**0.83**	33.9	60.3	38.4	107.1	2.25	0.46		
6207	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	3.36	25	288	**15.5**	**0.76**	18.2	60.3	38.4	72.6	1.24	0.85		
6208	Onderstuk	Enkele staaf	L60.6	S235	M16	8.8	2.82	0	241	**15.5**	**0.70**	24.0	60.3	38.4	72.6	1.24	0.65		
6209	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	2.27	45	233	**15.5**	**0.00**	17.6	60.3	30.3	31.7	0.72	0.88		
6210	Onderstuk	Enkele staaf	L50.5	S235	M16	8.8	1.40	0	143	**15.5**	**0.35**	33.8	60.3	30.3	31.7	0.72	0.51		
6225	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	0.83	0	85	**1.7**	**0.21**	54.7	60.3	30.3	31.7	0.72	0.29		
6220	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	1.87	77	192	**1.7**	**0.00**	23.1	60.3	30.3	31.7	0.72	0.07		
6224	Pootverband	Kniksteun en verticale steun	L50.7	S235	M16	8.8	1.83	0	123	**1.7**	**0.23**	42.5	60.3	42.5	44.4	0.68	0.34		
6219	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.03	63	208	**1.7**	**0.00**	20.7	60.3	30.3	31.7	0.72	0.08		
6223	Pootverband	Kniksteun en verticale steun	L60.6	S235	M16	8.8	2.84	0	156	**1.7**	**0.35**	34.6	60.3	38.4	72.6	0.93	0.39		
6218	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.29	52	235	**1.7**	**0.00**	17.3	60.3	30.3	31.7	0.72	0.10		
6222	Pootverband	Kniksteun en verticale steun	L80.6	S235	M16	8.8	3.84	0	157	**1.7**	**0.48**	46.4	60.3	38.4	107.1	1.77	0.28		
6217	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.62	43	269	**1.7**	**0.00**	14.1	60.3	30.3	31.7	0.72	0.12		
6221	Pootverband	Kniksteun en verticale steun	L80.6	S235	M16	8.8	4.85	0	198	**1.7**	**0.61**	35.0	60.3	38.4	107.1	1.77	0.36		
6216	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.94	34	302	**1.7**	**0.00**	11.7	60.3	30.3	31.7	0.7	0.14		
6212	Tussenschot	Enkele staaf	L80.6	S235	M20	8.8	4.23	0	269	**0.3**	**1.06**	27.4	94.1	52.4	100.2	2.25	0.47		
6213	Tussenschot	Kniksteun en verticale steun	L70.7	S235	M20	8.8	5.76	0	271	**0.3**	**0.72**	22.9	94.1	61.1	96.8	1.48	0.51		
6214	Tussenschot	Kruisende staaf halverwege	L80.8	S235	M20	8.8	8.38	0	346	**0.3**	**1.05**	20.9	94.1	69.8	133.6	2.95	0.35		
6060	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.72	0	177	**15.7**	**0.43**	25.9	60.3	30.3	31.7	0.72	0.61		
6061	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	2.30	44	236	**15.7**	**0.00**	17.2	60.3	30.3	31.7	0.72	0.91		
6055	1e tussenstuk	Enkele staaf	L70.7	S235	M16	8.8	3.45	0	253	**15.7**	**0.86**	30.3	60.3	44.8	104.8	1.98	0.52		
6062	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	2.24	38	230	**15.7**	**0.00**	17.9	60.3	30.3	31.7	0.7	0.88		
6060	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.72	0	177	**15.7**	**0.43**	25.9	60.3	30.3	31.7	0.7	0.61		
6063	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.53	0	157	**15.7**	**0.38**	30.1	60.3	30.3	31.7	0.72	0.53		
6064	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	2.18	48	223	**15.7**	**0.00**	18.6	60.3	30.3	31.7	0.72	0.84		
6065	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	2.10	43	215	**15.7**	**0.00**	19.7	60.3	30.3	31.7	0.72	0.80		
6066	1e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.57	0	161	**15.7**	**0.39**	29.3	60.3	30.3	31.7	0.72	0.54		
6056	Tussenschot	Enkele staaf	L60.6	S235	M16	8.8	2.93	0	251	**15.7**	**0.73**	22.6	60.3	38.4	72.6	1.2	0.69		
6059	Tussenschot	Enkele staaf	L70.7	S235	M16	8.8	4.24	0	311	**0.3**	**1.06**	21.9	60.3	44.8	104.8	2.0	0.54		
6058	Tussenschot	Kruisende staaf halverwege	L70.7	S235	M16	8.8	6.21	0	292	**0.3**	**0.78**	20.5	60.3	44.8	104.8	2.0	0.39		
553	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.31	0	135	**13.2**	**0.33**	36.2	60.3	30.3	31.7	0.7	0.46		
552	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.96	48	201	**13.2**	**0.00**	21.7	60.3	30.3	31.7	0.7	0.61		

DNV·GL

Knikverkorters initial construction (afkeur)

Date: 2020-12-04
Author: K H Chan
Version: 1.8

ENS - ZL
S+15_R
Mast: 89

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slender ness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
6081	2e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.71	0	232	**13.2**	**0.68**	25.4	60.3	38.4	72.6	1.2	0.54		
551	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.87	42	192	**13.2**	**0.00**	23.1	60.3	30.3	31.7	0.7	0.57		
550	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.35	0	139	**13.2**	**0.34**	35.1	60.3	30.3	31.7	0.7	0.47		
548	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.19	0	122	**13.2**	**0.30**	40.3	60.3	30.3	31.7	0.7	0.43		
546	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.75	50	180	**13.2**	0.00	25.3	60.3	30.3	31.7	0.7	0.52		
6078	2e tussenstuk	Enkele staaf	L60.6	S235	M16	8.8	2.37	0	203	**13.2**	0.59	30.8	60.3	38.4	72.6	1.2	0.48		
545	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.66	42	170	**13.2**	0.00	27.2	60.3	30.3	31.7	0.7	0.48		
544	2e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.15	0	118	**13.2**	0.29	41.8	60.3	30.3	31.7	0.7	0.43		
586	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.07	0	110	**11.2**	0.27	44.7	60.3	30.3	31.7	0.7	0.37		
585	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.56	49	161	**11.2**	0.00	29.3	60.3	30.3	31.7	0.7	0.38		
584	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.47	48	151	**11.2**	0.00	31.7	60.3	30.3	31.7	0.7	0.37		
593	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.04	0	106	**11.2**	0.26	46.0	60.3	30.3	31.7	0.7	0.37		
581	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	0.90	0	93	**11.2**	0.23	51.5	60.3	30.3	31.7	0.7	0.37		
582	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.35	50	139	**11.2**	0.00	35.1	60.3	30.3	31.7	0.7	0.37		
580	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.81	0	186	**11.2**	0.45	24.2	60.3	30.3	31.7	0.7	0.63		
579	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.26	43	129	**11.2**	0.00	38.0	60.3	30.3	31.7	0.7	0.37		
576	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.19	51	122	**11.2**	0.00	40.2	60.3	30.3	31.7	0.7	0.37		
577	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.58	0	163	**11.2**	0.40	28.9	60.3	30.3	31.7	0.7	0.55		
575	3e tussenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.09	44	112	**11.2**	0.00	43.9	60.3	30.3	31.7	0.7	0.37		
6084	Tussenschot	Enkele staaf	L60.6	S235	M16	8.8	1.95	0	167	**11.2**	0.49	40.2	60.3	38.4	72.6	1.2	0.39		
570	Tussenschot	Enkele staaf	L60.6	S235	M16	8.8	2.86	0	245	**0.5**	0.72	23.4	60.3	38.4	72.6	1.2	0.58		
6083	Tussenschot	Kruisende staaf halverwege	L50.7	S235	M16	8.8	4.22	0	283	**0.5**	0.53	15.0	60.3	42.5	44.4	1.0	0.54		
107	Bovenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.49	0	154	**6.7**	0.37	31.1	60.3	30.3	31.7	0.7	0.52		
108	Bovenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.39	0	143	**6.7**	0.35	34.0	60.3	30.3	31.7	0.7	0.48		
6097	Bovenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.29	0	132	**6.7**	0.32	37.1	60.3	30.3	31.7	0.7	0.45		
6098	Bovenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.19	0	122	**6.7**	0.30	40.3	60.3	30.3	31.7	0.7	0.41		
111	Bovenstuk	Enkele staaf	L50.5	S235	M16	8.8	1.10	0	113	**4.1**	**0.27**	43.6	60.3	30.3	31.7	0.7	0.38		

APPENDIX D
Toetsing blokdeuvels

Project: ENS-ZL380
Mast: S+15 R (89)

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2020-12-04
Auteur: TBR
Versie: 1.3

Load				**Results**			
Compression	$F_{Ed,druk}$	925	kN	Compression	U.C.	0.57	< 1,00 OK
Tension	$F_{Ed,trek}$	625	kN	Tension	U.C.	0.41	< 1,00 OK

Hoekstijl

Profile		**L160.17**	
Steel material		S355	
Cross section		5182	mm^2
Axial capacity	N_{pl}	1840	kN
Width	b	160	mm
Thickness	t	17	mm
Length in concrete		1700	mm

Blokdeuvels randstijl

Width	b	50	mm
Thickness	h	30	mm
Length	L	170	mm
Welds	a	5	mm
c.t.c. separation	s	250	mm
Number for compr.	n	12	-
Number for tension	n	12	-

Foot plate

Thickness	t	20	mm
Ext. length	m	30	mm
Welds	a	5	mm

Pile

Name		Buispaal	
Diameter		588	mm
Thickness		10	mm
Cross section		18158	mm^2
Steel material		S235	
Capacity		4267	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	1784	mm
Welds	a	5	mm
c.t.c. separation	s	525	mm
Number for compr.	n	4	-
Number for tension	n	4	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	510	N/mm^2

Capacity shear blocks main leg

A_{f1} =	5100	mm^2
A_{f2} =	17500	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.85	
$f_{jd} = C_A \times f_{cd}$ =	19.8	N/mm^2
$F_{Rd,c} = n \times A_{f1} \times f_{jd}$ =	1209	kN
$F_{Rd,t} = n \times A_{f1} \times f_{jd}$ =	1209	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	49	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,trek}$ =	16958	mm^2
$F_{Rd} = A_{p,trek} \times f_{jd}$ =	313	kN
Welds foot plate	793	kN
$A_{p,druk}$ =	22140	mm^2
$F_{Rd} = A_{p,druk} \times f_{jd}$ =	409	kN

Capacity shear blocks pile

A_{f1} =	53533	mm^2
A_{f2} =	160598	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,c} = n \times A_{f1} \times f_{jd}$ =	3956	kN
$F_{Rd,t} = n \times A_{f1} \times f_{jd}$ =	3956	kN

"Splitting" of pile

Spread of forces		45	°
Length force flow		1416	mm
Splitting force		221	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.05	< 1,00 OK

Capacities

Main leg for tension	1523	kN
Tubular pile for tension	3956	kN
Main leg for compression	1618	kN
Tubular pile for compression	3956	kN

Check of welds

Shear block main leg	0.36	< 1,00 OK
Shear block pile	0.40	< 1,00 OK

Project: ENS-ZL380
Mast: 89

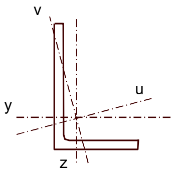
DNV·GL

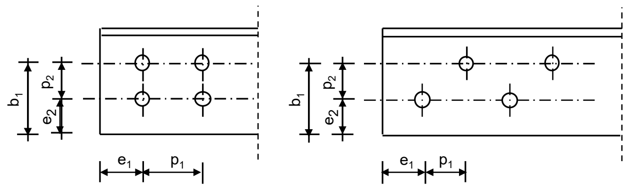
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-12-03
Auteur: TBR
Versie: 2.7

Member name	**G139**	***Conclusion***			
Section	**L60.6**	U.C.	(compression)	**0.62**	**< 1,0 OK**
		U.C.	(tension)	**0.87**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-33**	kN
Tensile force		**36**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**36**	kN
Max. comp. force diagonal 1	**-33**	kN
Position crossing diagonal y-axis	1.38	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.61	m
System length z-axis	$L_{z,buc}$ =	1.38	m
System length v-axis	$L_{v,buc}$ =	1.38	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	23	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	120	mm	OK
	t_p =	12	mm	OK
	e_2 =	35	mm	OK

A		691	mm^2
G		5.5	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	118	-
Allowed:		180	**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.98 kNm
U.C. = **0.79** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi Af_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.38	m	0.81	0,4+0,7 l	0.97	0.62	0.9	90	0.37
$L_{z,buc}$ =	1.38	m	0.81	0,4+0,7 l	0.97	0.62	0.9	90	0.37
$L_{v,buc}$ =	1.38	m	1.26	0,35+0,70 l	1.23	0.46	0.9	67	0.49

Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	162	0.20	
Cross section tie plate	$F_{u;Rd}$ =	338	0.10	
Shear strength	$F_{v;Rd}$ =	60	0.55	
Bearing strength	$F_{b;Rd}$ =	53	0.62	
Combined effect	$F_{v;Rd}$ =	53	0.62	plastisch

Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	48	0.74	
Net section tie plate	$F_{u;Rd}$ =	317	0.11	
Block shear	$F_{u;Rd}$ =	50	0.72	
Shear strength	$F_{v;Rd}$ =	60	0.60	
Bearing strength	$F_{b;Rd}$ =	41	0.87	
Combined effect	$F_{v;Rd}$ =	41	0.87	plastisch

Project: ENS-ZL380
Mast: 89

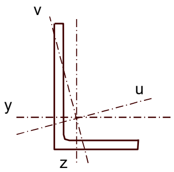
DNV·GL

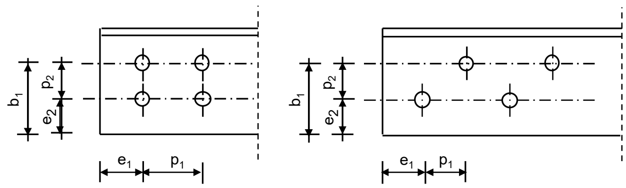
Angle check

NEN-EN1993-1-1 and EN1993-3-1

Datum: 2020-12-03
Auteur: TBR
Versie: 2.7

Member name	**G140**	***Conclusion***		
Section	**L60.6**	U.C. (compression)	**0.73**	**< 1,0 OK**
		U.C. (tension)	**0.82**	**< 1,0 OK**





Steel grade **S235**

Member loads

Compressive force	N_{Ed} =	**-39**	kN
Tensile force		**34**	kN

Crossing diagonal loads

Applicable:	**Yes**	
Min. tensile force diagonal 2	**34**	kN
Max. comp. force diagonal 1	**-39**	kN
Position crossing diagonal y-axis	1.30	m

Construction loads

Vertical construction load	**1.0**	kN
Member angle to horizontal	**0**	°
Bending around axis	y-axis	

Geometry

System length y-axis	$L_{y,buc}$ =	2.46	m
System length z-axis	$L_{z,buc}$ =	1.30	m
System length v-axis	$L_{v,buc}$ =	1.30	m

Member type	**Other**
Type bracing	Non staggered

End conditions

Begin	One bolt
End	Continuous
Restraint code TOWER	C5

Bolted connection

Bolt type		M16		
Bolt class		8.8		
Number of bolts per leg		1		
Shearplane through		Thread		
Boltpattern		Line		
Boltpattern (leg-member only)		Non staggered		
End distance	e_1 =	35	mm	Ok
Separation distance //	p_1 =	55	mm	Ok
Separation distance |	p_2 =	0	mm	Ok
End distance ┘	e_2 =	23	mm	Ok
Double strap or single strap		Single		
Tie plate	b_p =	120	mm	OK
	t_p =	12	mm	OK
	e_2 =	35	mm	OK

A		691	mm^2
G		5.5	kg/m
Partial safety factor	$\gamma_{f;Q}$ =	1.50	
Material factors	γ_{M0} =	1.00	
	γ_{M1} =	1.00	
	γ_{M2} =	1.25	
Shear strength bolt	$F_{v;b;Rd}$ =	60.3	kN

Slenderness	λ_{max} = L / i	111	-
Allowed:		180	**OK**

Bending due to vertical construction load

$M_{y,Ed}$ = 1/4 F_{Ed} L_{pr} = 0.92 kNm
U.C. = **0.74** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd}$ = $\eta\chi A f_y$ / γ_{M1}	
$L_{y,buc}$ =	1.30	m	0.76	0,4+0,7 l	0.93	0.64	0.9	93	0.42
$L_{z,buc}$ =	1.30	m	0.76	0,4+0,7 l	0.93	0.64	0.9	93	0.42
$L_{v,buc}$ =	1.30	m	1.19	0,35+0,70 l	1.18	0.49	0.9	72	0.55

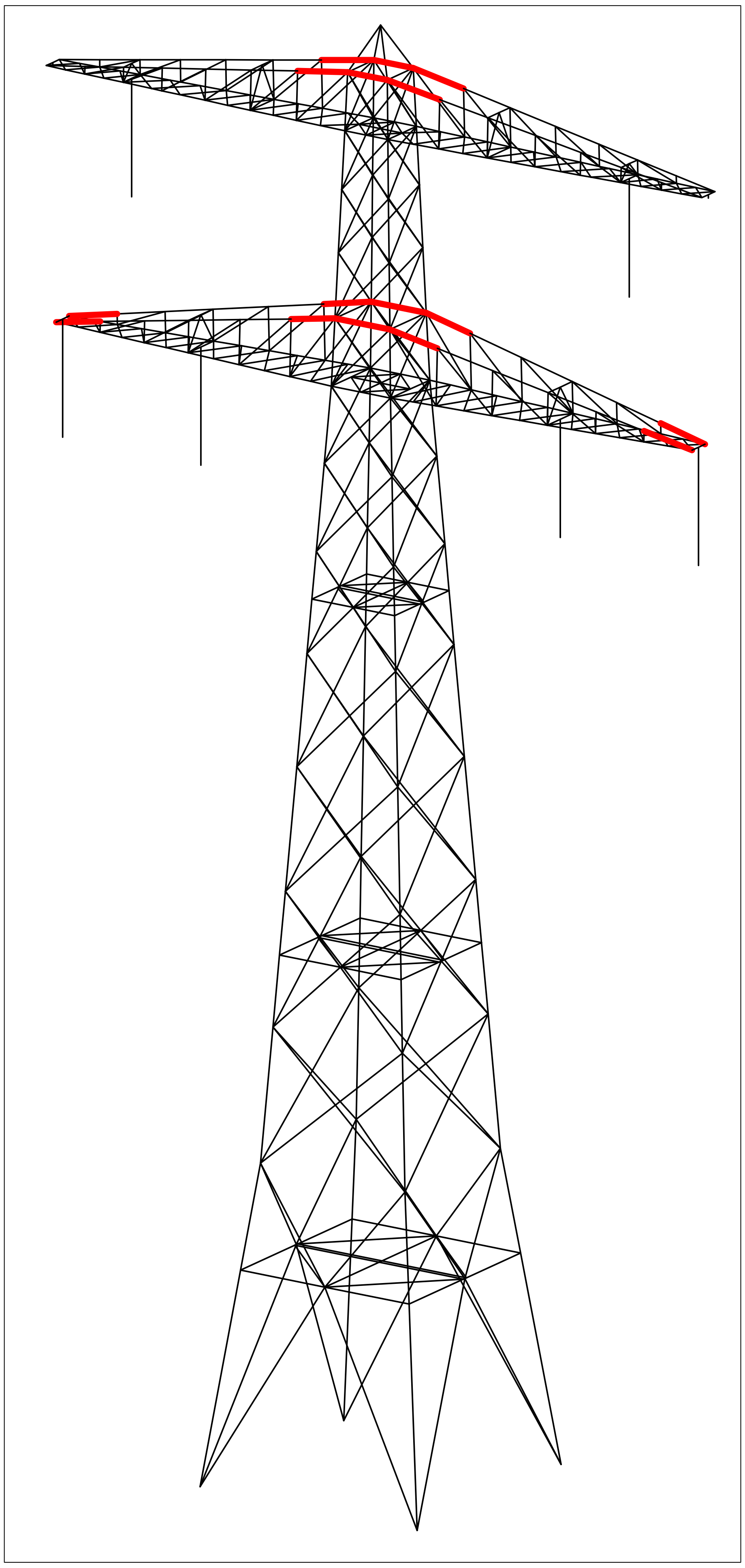
Bolted connection

Compression		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	162	0.24	
Cross section tie plate	$F_{u;Rd}$ =	338	0.12	
Shear strength	$F_{v;Rd}$ =	60	0.65	
Bearing strength	$F_{b;Rd}$ =	53	0.73	
Combined effect	$F_{v;Rd}$ =	53	0.73	plastisch

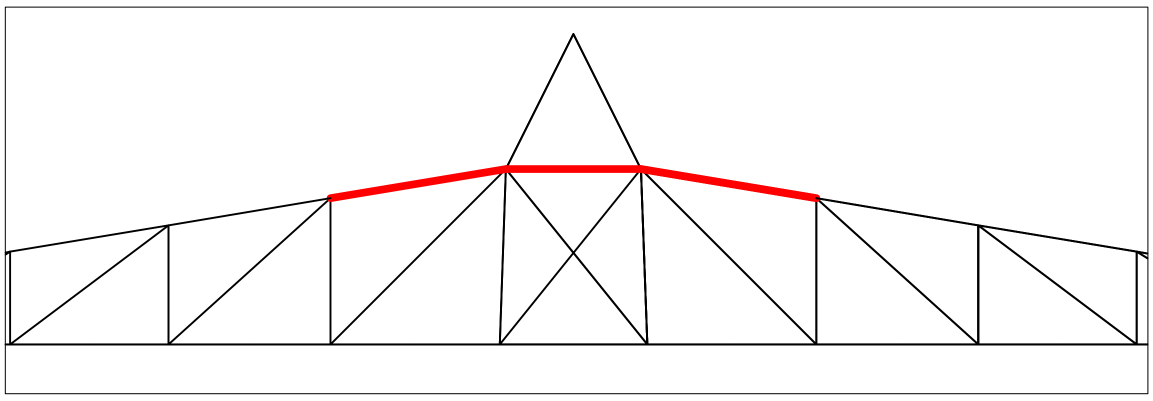
Tension		F_{Rd} (kN)	U.C.	
Net section angle	$F_{u;Rd}$ =	48	0.70	
Net section tie plate	$F_{u;Rd}$ =	317	0.11	
Block shear	$F_{u;Rd}$ =	50	0.68	
Shear strength	$F_{v;Rd}$ =	60	0.56	
Bearing strength	$F_{b;Rd}$ =	41	0.82	
Combined effect	$F_{v;Rd}$ =	41	0.82	plastisch

APPENDIX E
Tekeningen

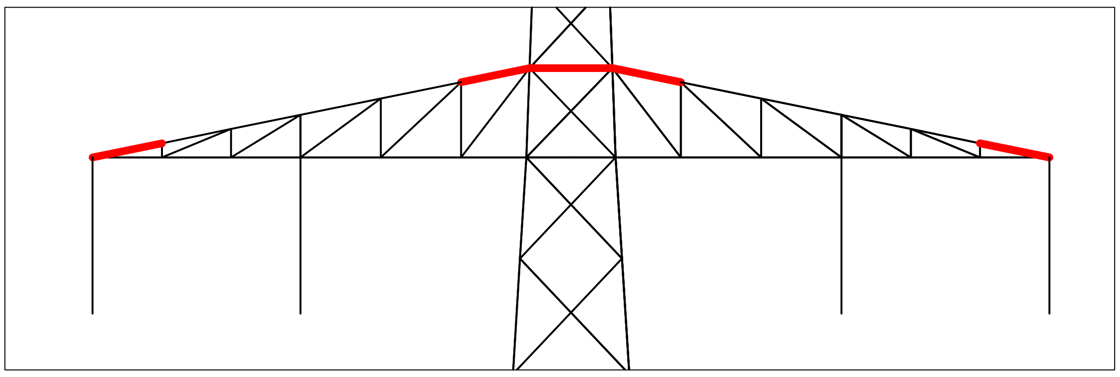
Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)



Overview



Side view upper crossarm



Side view lower crossarm

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Addition of bolt connections with plate
Profile exchanged
New redundant
Bolt exchanged

01	24-02-2021	Dimension added
00	07-12-2020	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-043

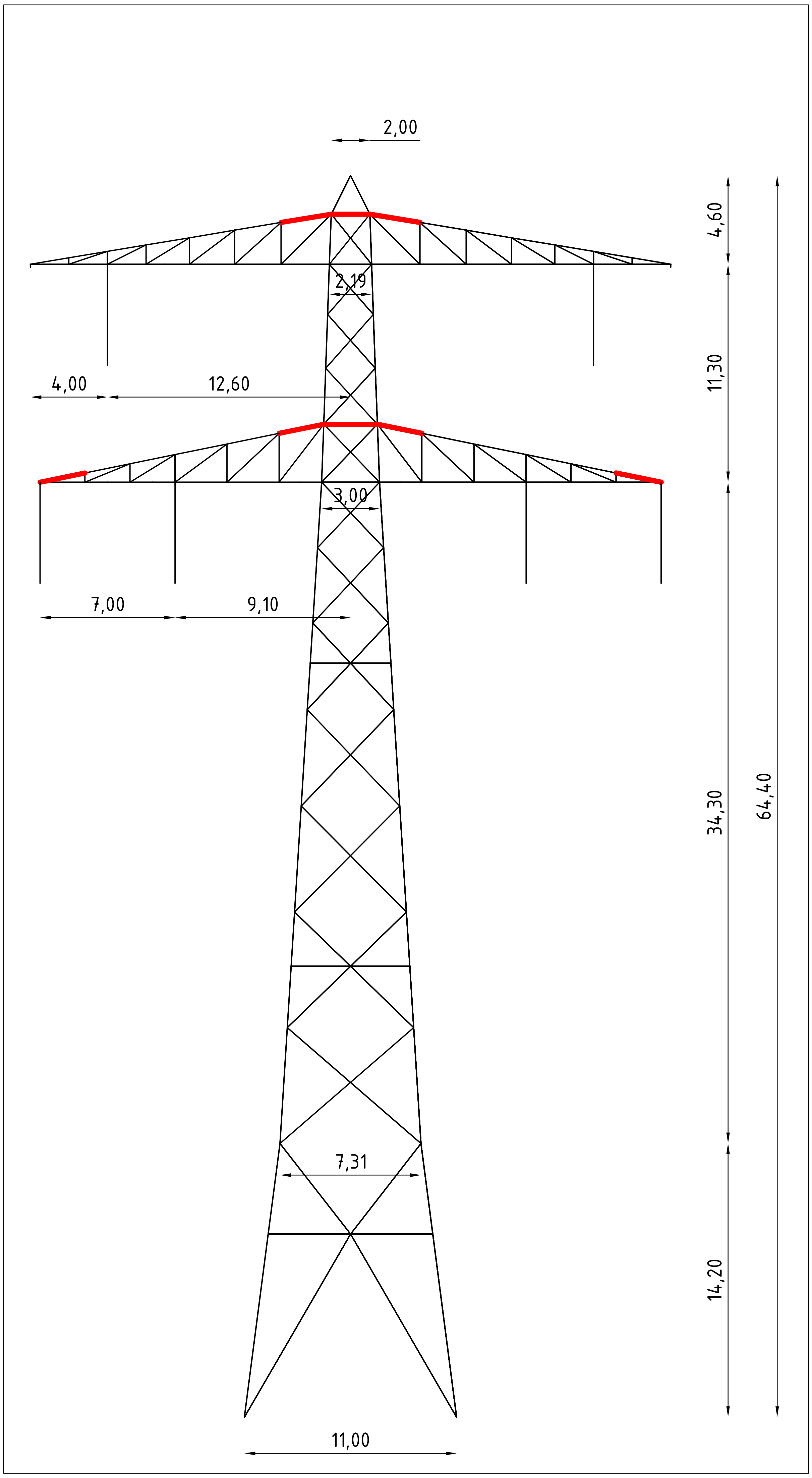
Design state: FINAL		Scale: -		
Drawn by: KCh	24-02-2021	Units: m		
Checked by: TBR	24-02-2021	Project no: 10166260		
Approved by: JHu	24-02-2021	Company: TenneT		

Description: Modifications overview for mast type S+15_R (Mast 89) page 1 of 2

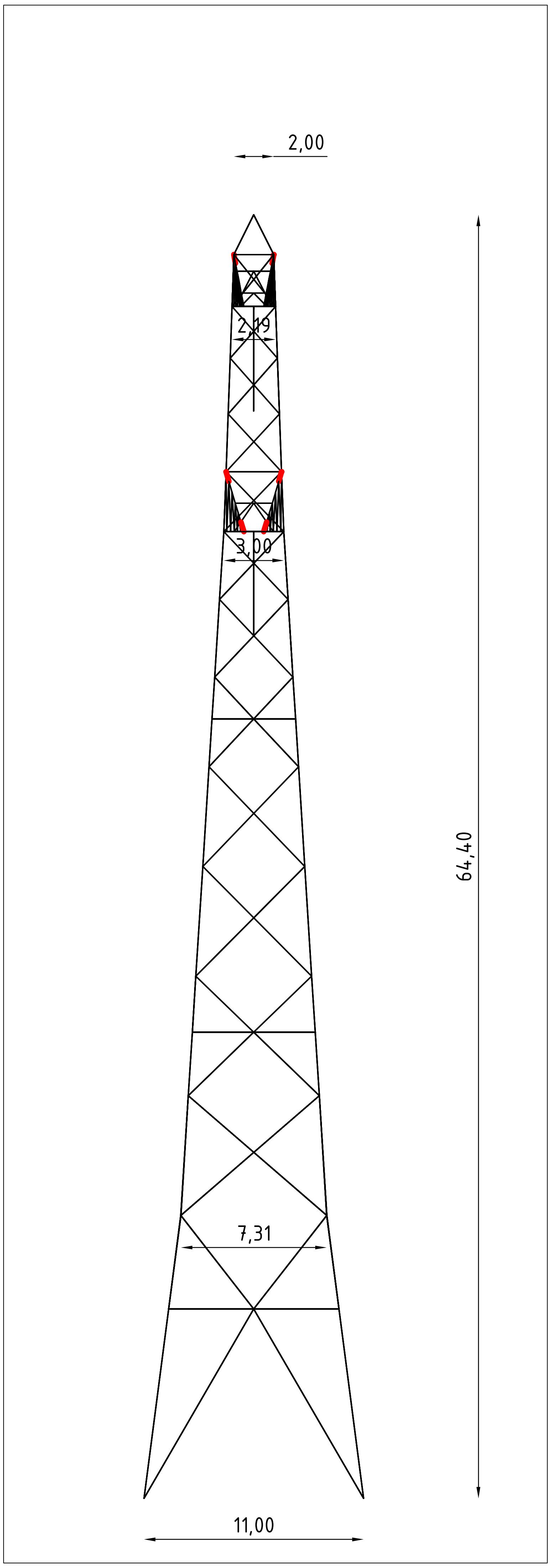
Revision: 01

Format: A2

DNV GL Energy & Sustainability, Utrechtseweg 310, 6812 AR Arnhem, tel: +31 26 3 56 91 11, www.dnvgl.com



Front View



Side View

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

Addition of bolt connections with plate (red line)
Profile exchanged (blue line)
New redundant (green line)
Bolt exchanged (red dot)

01	24-02-2021	Dimension added
00	07-12-2020	Version 1.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-043

Design state: FINAL		Scale: -	Description: Modifications overview for mast type S+15_R (Mast 89) page 2 of 2	Revision: 01
Drawn by: KCh	24-02-2021	Units: m		
Checked by: TBR	24-02-2021	Project no: 10166260		Format: A2
Approved by: JHu	24-02-2021	Company: TenneT		

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About DNV

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Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

TOETSING EN HERONTWERP MASTEN EN FUNDATIES BBB380

ENS-ZL380 – Rapportage masttype EC-3/R

TenneT TSO B.V.

Rapport nr.: 22-0526, Rev. 0
Meridian doc.nr.: 002.515.40 1007991
Datum: 2022-03-31

Projectnaam:	Toetsing en herontwerp masten en fundaties BBB380	Energy Systems
Rapport titel:	ENS-ZL380 – Rapportage masttype EC-3/R	DNV Netherlands B.V.
Klant:	TenneT TSO B.V.,	Utrechtseweg 310-B50
Contactpersoon klant:	P. v.d. Horst	6812 AR Arnhem
Datum uitgave:	2022-03-31	
Project nr.:	10166260	
Organisatie unit:	TDT	Tel: 026 356 9111
Meridian doc.nr..:	002.515.40 1007991	Handelsregister Arnhem 09006404
Rapport nr.:	22-0526, Rev. 0	

Geschreven door:	Beoordeeld door:	Goedgekeurd door:
M.H. Khan	A.J. Börger	C. Schutte

DNV Distributie: :

☒ Open
☐ Intern
☐ Commercieel vertrouwelijk
☐ Vertrouwelijk
☐ Geheim

*Specificatie distributie: --

Rev.	Datum	Reden van uitgave	Auteur	Beoordeeld	Goedgekeurd
0	2022-03-31	Eerste uitgave	M.H. Khan	A.J. Börger	C. Schutte

Inhoudsopgave

1 INLEIDING

1.1 Inleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt.

Om die reden is de opdrachtgever (OG) voornemens de bestaande 380 kV-koppelnetring op te waarderen. Het opwaarderen van de bestaande verbindingen valt onder het programma “Beter benutten bestaande 380 kV-ring” en omvat de volgende deelprojecten:

- Opwaardering 380 kV-verbinding Lelystad – Ens (LLS-ENS380)
- Opwaardering 380 kV-verbinding Diemen – Lelystad (DIM-LLS380)
- Opwaardering 380 kV-verbinding Rilland – Zandvliet (RLL-ZVL380)
- Opwaardering 380 kV-verbinding Krimpen aan den IJssel - Geertruidenberg (KIJ-GT380)
- Opwaardering 380 kV-verbinding Ens - Zwolle (ENS-ZL380)
- Opwaardering 380 kV-verbinding Maasbracht - Eindhoven (MBT-EHV380)

Om te komen tot een DO waarmee de werkzaamheden kunnen worden gestart is door TenneT aan DNV opdracht verstrekt voor de volgende onderdelen:

1. In eerste fase het opstellen en creëren van:

1.1 E-studie deel 1

1.2 Uitgangspuntenrapporten ten behoeve van de constructieve analyse van masten en fundaties

1.3 Sonderingmodellen

1.4 Fundatiemodellen

1.5 Mastmodellen

2. In tweede fase de uitvoering van de DO-fase bevattende:

2.1 Toetsing conform het uitgangspuntenrapport van de bestaande fundaties

2.2 Globale specificatie van benodigde fundatieversterkingen ten behoeve van aanbesteding

2.3 Toetsing conform het uitgangspuntenrapport van de bestaande masten

2.4 Globale specificatie van benodigde mastversterkingen ten behoeve van aanbesteding

2.5 E-studie deel 2

1.2 Doel van dit rapport

In dit rapport wordt voor de hoogspanningslijn Ens - Zwolle de controle van de mastconstructie van masttype EC-3/R gerapporteerd. Het doel is om te bepalen of de in dit rapport beschreven bestaande mast geschikt is om te worden uitgerust met de nieuwe ACCC-Warsaw geleider waarmee een hogere capaciteit kan worden gerealiseerd.

Nadat de wijzigingen zijn toegepast dient aantoonbaar geverifieerd te worden dat het systeem voldoet aan de vigerende eisen.

In de defintief-ontwerpfase zijn ten behoeve van de contractvorming Engelstalige rapporten geleverd. Het voorliggende rapport is bedoeld voor vergunningsaanvraag en is inhoudelijk ongewijzigd ten opzichte van de Engelse versie. Om deze reden zijn de bijlagen in dit rapport één op één overgenomen uit de Engelse versie. Hierdoor wijkt het revisienummer van de bijlagen af van het revisienummer van de rapportage.

1.3 Gerelateerde documenten

1.3.1 Verificatie & validatieplan

De door TenneT aangeleverde set met eisen is beoordeeld op relevantie en voor de relevante eisen is aangegeven in welk document wordt aangetoond dat er aan de eis wordt voldaan. De resultaten hiervan zijn opgenomen in het rapport "Verificatie & Validatieplan 380 kV verbinding Ens - Zwolle".

1.3.2 E-studie deel 1

In de rapportage "ENS-ZL380 - E-studie deel 1" [1] is bepaald welke aanpassingen benodigd zijn om de ACCC-Warsaw geleider toe te passen binnen de verbinding Ens – Zwolle.

Voor masttype EC-3/R zijn de volgende aanpassingen voorgesteld uit de E-studie deel 1:

- Mast 1: Aanbrengen van een verticale post-isolator aan de buitenste fase en twee verticale post-isolatoren aan de binnenste fase van de onderste traverse. De post-isolatoren zijn vereist bij de traverse aan de buitenzijde van de lijnhoek.

- Mast 90: Aanbrengen van een verticale post-isolator aan de buitenste fase en twee verticale post-isolatoren aan de binnenste fase van de onderste traverse. De post-isolatoren zijn vereist bij de traverse aan de buitenzijde van de lijnhoek.

Bovenstaande wijzigingen zijn slechts de wijzigingen die het meest relevant zijn voor de structuuranalyse in dit rapport. Raadpleeg "ENS-ZL380 – E-studie deel 1" voor een volledige lijst van wijzigingen met betrekking tot de EC-3/R.

1.3.3 Uitgangspuntendocument

De uitgangspunten op basis waarvan de berekeningen in deze rapportage zijn uitgevoerd zijn opgenomen in het rapport "Uitgangspuntenrapport 380kV verbinding Ens - Zwolle" [2].

2 EISEN

In onderstaande Tabel 1 zijn de eisen opgenomen die binnen deze rapportage worden getoetst.

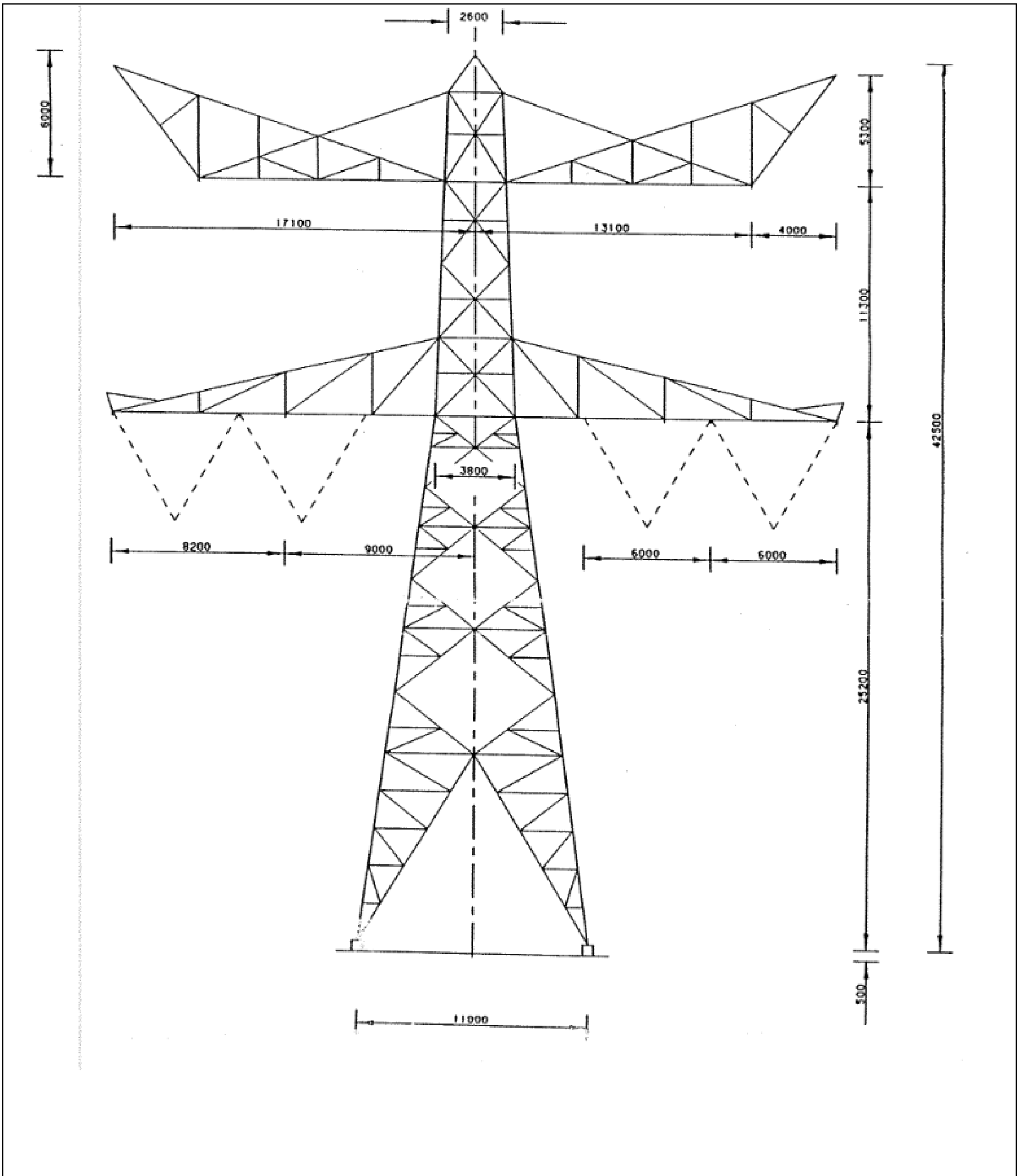
Tabel 1 Relevante eisen

Req. Id	Title	Req. text	Verification
BO Eis: H2.7-6	Omgeving, beperkingsfactoren	Het ontwerp dient geverifieerd te worden op de uitvoerbaarheid.	Tabel 6
PVE.05.001 5.14	Masten	Aanwijzingen t.a.v. klimvoorziening en valbeveiliging: Huidige klimweg blijft gehandhaafd en zal voldoen aan de eisen zoals opgenomen in de NEN 1060:1987. Valbeveiliging is/zal worden uitgevoerd in het type "latch way". Indien staaldelen in de nabijheid (aangrenzend profiel) van de klimweg gewijzigd worden, dient geverifieerd te worden dat de klimvoorziening in overeenstemming is met de NEN 1060:1987.	Tabel 6

3 BEREKENINGEN

3.1 Mastbeeld

Het mastbeeld op basis van de Asset-data is weergegeven in Figuur 1.



Figuur 1 Mastbeeld EC-3/R

3.2 Ontbrekende as-built gegevens

Met de meegeleverde tekeningen (90_TNNT001580-00022, 90_TNNT001580-00023 en 23712-50-023) heeft DNV de afschuifblokken van masten nummer 1 en 90 berekend. Alleen de afmetingen van de gelaste blokdeuvels op de hoofdstijlen van de masten ontbreken op de tekeningen. De maataanduiding op de tekening over de gelaste blokdeuvels op de hoofdstijlen is gelijk aan de blokdeuvels van masttype HA-3/R en HA+0/R.

3.3 Mastenlijst

Dit rapport beschrijft masttype EC-3/R. Er is één EC-3/R mast die binnen windzone II valt en één andere masten die binnen windzone III valt. Beide masten zijn identiek maar hebben een verschillende belastingssituatie. Voor beide windzones zijn berekeningen uitgevoerd volgens de wind- en gewichtsoverspanningsparameters in Tabel 2. De windbelasting wordt aangepast op basis van de toegenomen hoogte van aangrenzende masten (positieve waarden geven een hoogteverhoging aan).

Tabel 2 Mastnummers

Tower number	Tower type	Governing tower number	Wind span (m)	Weight span (m)	Height difference back (m)	Height difference ahead (m)
1	EC-3_R	1	267	320	-9.4	-0.1
90	EC-3_R	90	101	223	17.5	-20.9

3.4 Uitgangspunten berekening

De berekening is uitgevoerd op basis van de uitgangspunten zoals opgenomen in het uitgangspuntenrapport [2]. Hierin is een volledig overzicht opgenomen van de belastingcombinaties en toegepaste belastingfactoren

Tabel 3 Uitgangspunten berekening

Algemeen	Norm Windgebied Terreincategorie Reductiefactor cdir	NEN-EN50341-2-15:2019 II/III II (onbebouwde omgeving) 1,00
Situatie initieel	Gevolgklasse Betrouwbaarheidsniveau Referentieperiode	CC2-0 Afkeur CC2-0 30 jaar
Situatie na aanpassingen	Gevolgklasse Betrouwbaarheidsniveau Referentieperiode	CC2 Verbouw 50 jaar

3.5 Proces stappen

Het proces van het bepalen van eventueel benodigde verstevigingen bestaat uit de volgende stappen:

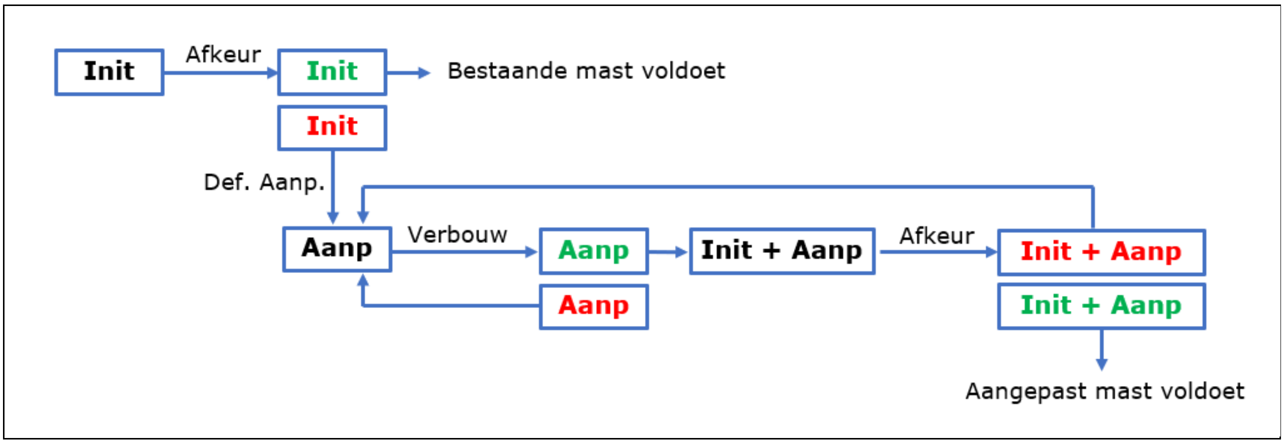
Stap 1: Toets bestaande (Init) mast op Afkeur

Stap 2: Definiëren benodigde aanpassingen indien initiële mast niet voldoet aan toets op Afkeur (Def. Aanp.)

Stap 3: Het toetsen van (alleen) de uitgewerkte aanpassingen (Aanp) op Verbouw

Stap 4: Het opnieuw toetsen van de complete mast inclusief aanpassingen (Initi + Aanp) op Afkeur

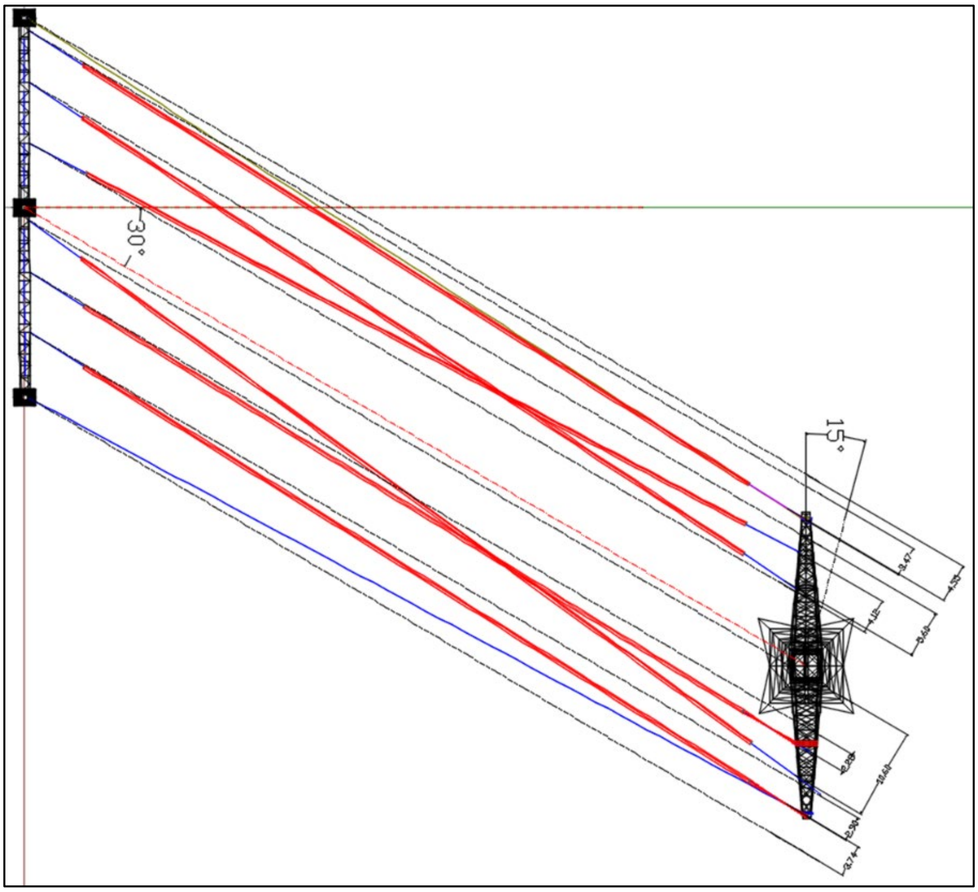
Het hierboven omschreven proces is in Figuur 2 weergegeven.



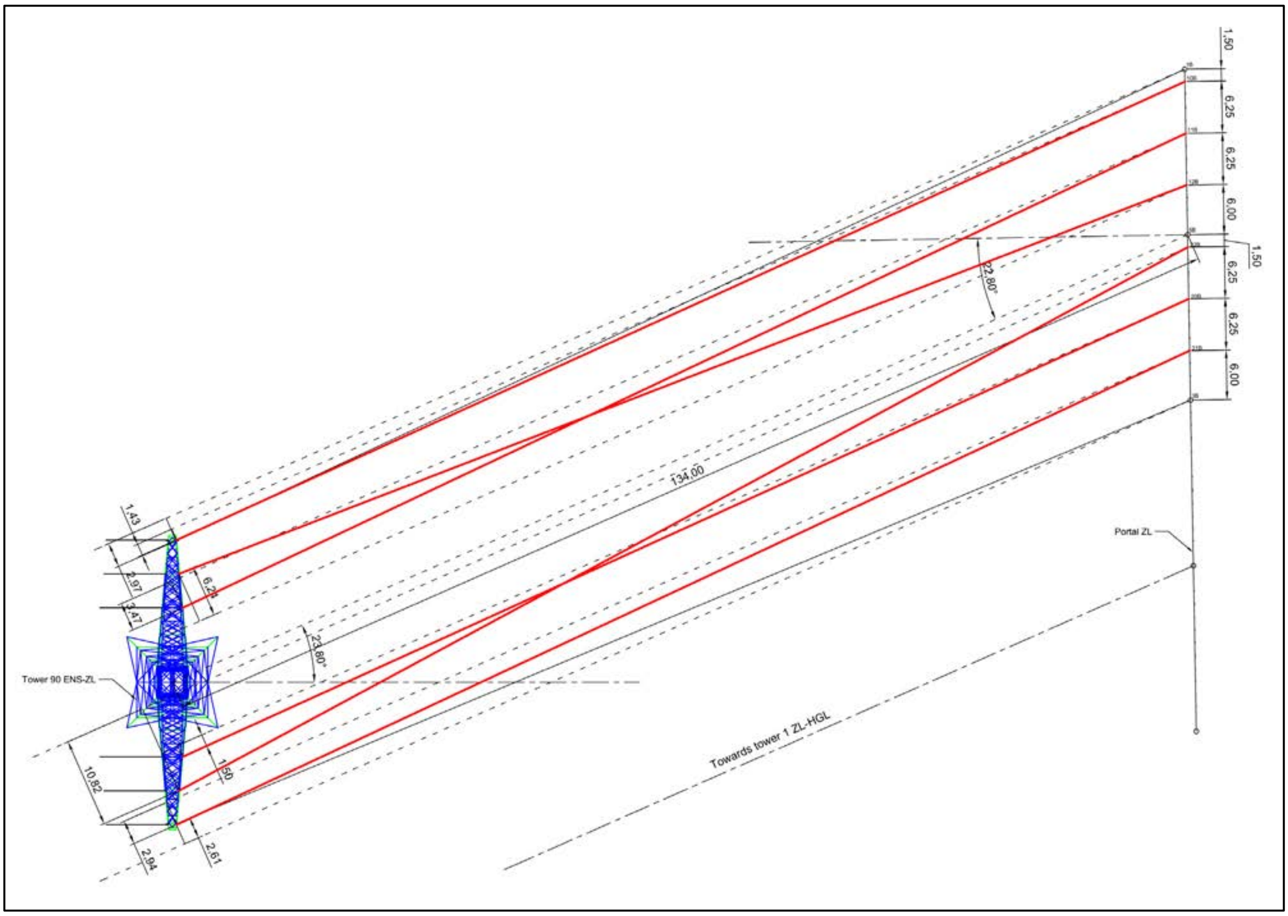
Figuur 2 Proces diagram

3.6 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV. Appendix A zijn de resultaten van de geleiderbelastingen samengevat. De bijzondere situatie met wisselende geleiderposities in de eerste overspanning van portaal ENS naar mast 1 en van mast 90 naar portaal ZL is gemeten vanuit het PLS-CADD profiel en in acht genomen in de geleiderbelastingenspreadsheet. Zie Figuur 3 en Figuur 4.



Figuur 3 Situatie bij portaal ENS



Figuur 4 Mast 90 richting Portal ZL

3.7 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma, zie ook Appendix A

3.8 Modellering

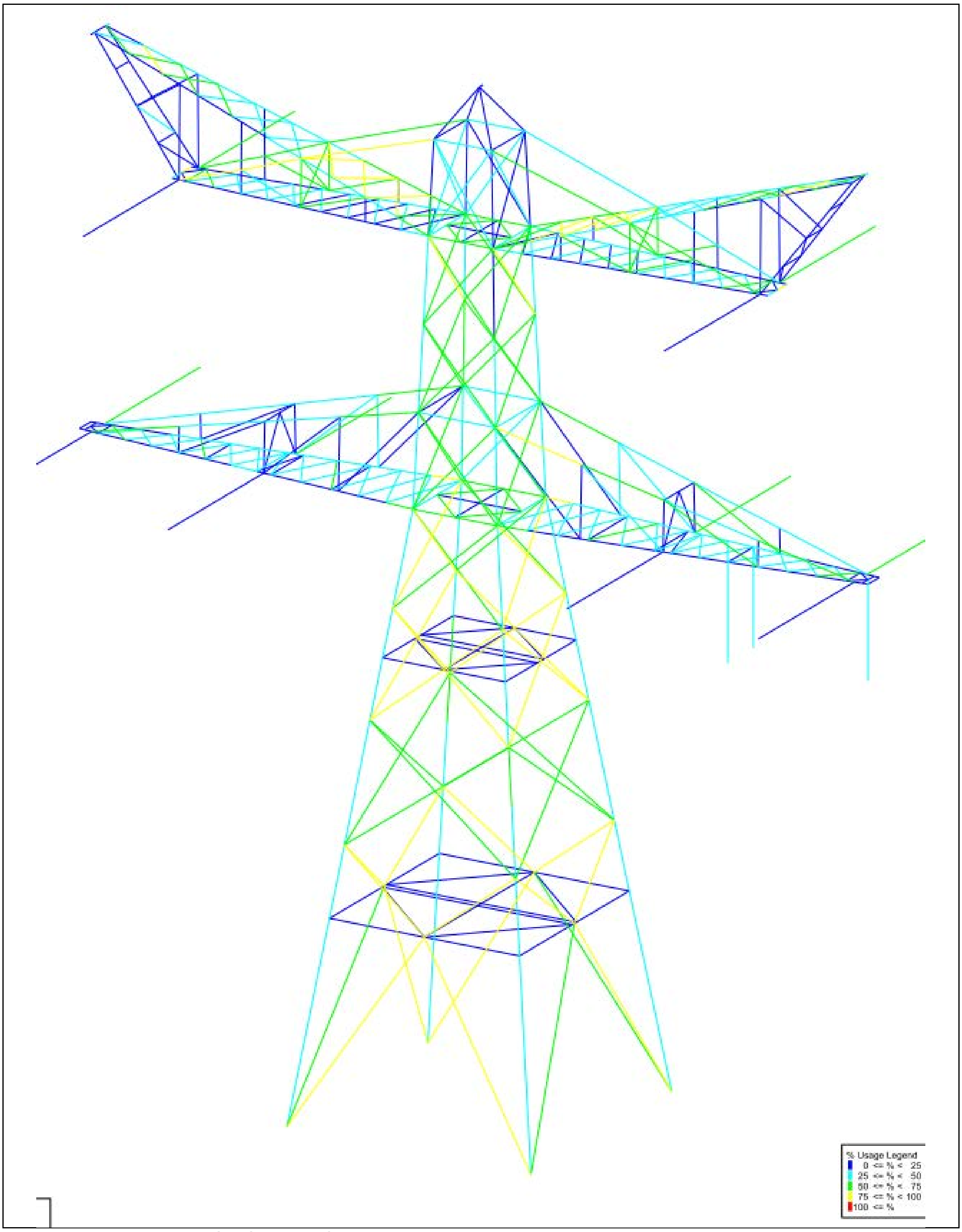
Op basis van de as-built tekeningen is de mast in PLS-TOWER ingevoerd. De hoofdelementen zijn gemodelleerd. Niet-dragende profielen als knikverkorters zijn weggelaten en worden separaat getoetst. De profielen inclusief de boutverbindingen zijn in PLS-TOWER ingevoerd en getoetst. Controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

De geleiderbelastingen vanuit het geleiderbelastingenprogramma zijn als invoer voor de belastingen gebruikt.

Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep en de toetsing wordt per staafgroep uitgevoerd. Ingeval dat een element uit een groep is overbelast, geldt dit voor alle elementen uit de betreffende groep.

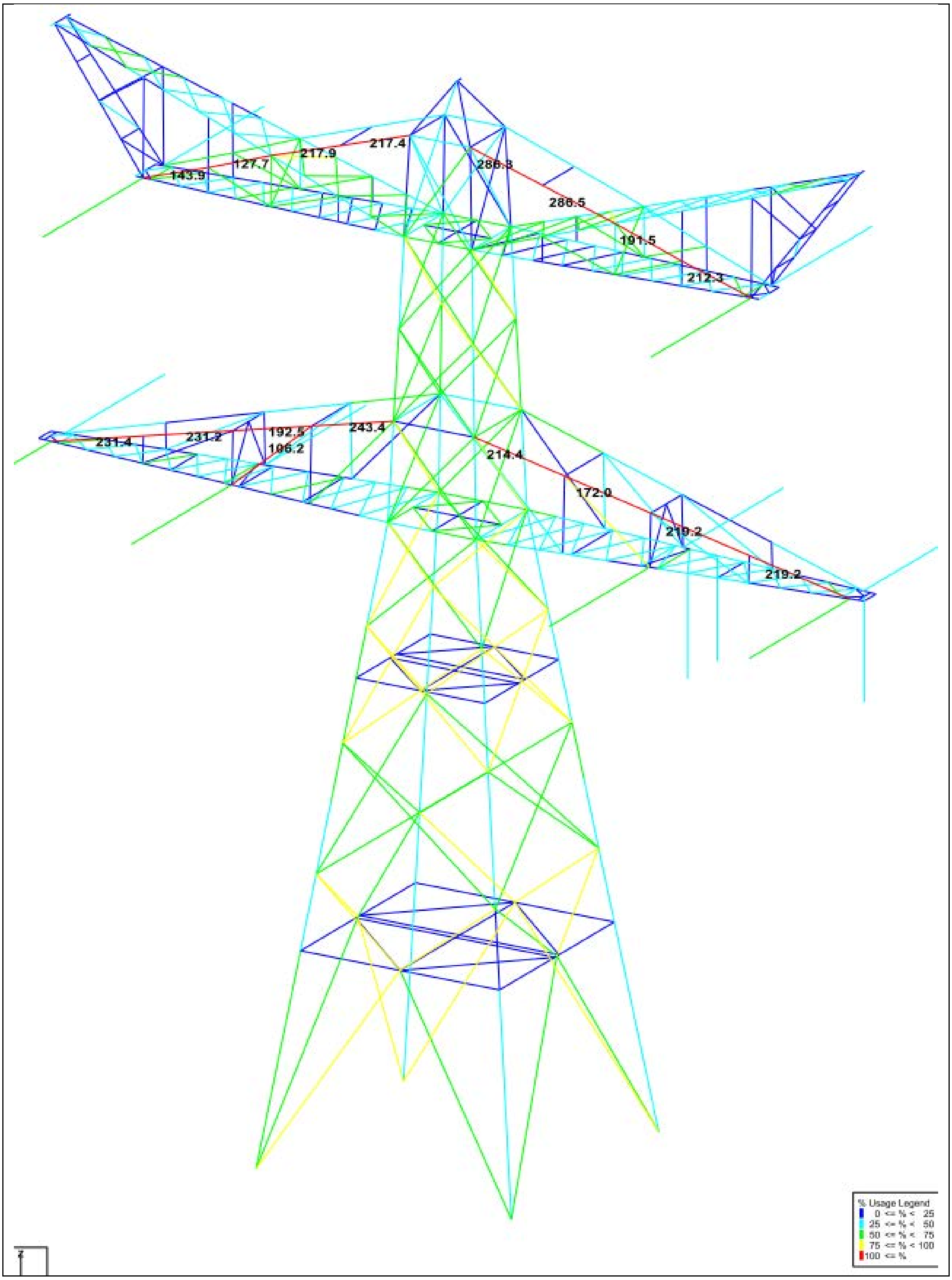
4 TOETSING MASTCONSTRUCTIE

Het resultaat van de controle van de mastconstructie type EC-3/R met belastingen op afkeurniveau is weergegeven in Figuur 5 en Figuur 6. Mast 1 vertoont geen overschrijdingen.



Figuur 5 Resultaat PLS-TOWER EC-3/R (1)

Bij mast 90 veroorzaakt de nabijheid van de hogere mast 89 drukkrachten in de bovenste rand van beide traverses, hetgeen overbelasting veroorzaakt in staven die alleen voor trek zijn ontworpen.



Figuur 6 Resultaat PLS-TOWER the EC-3/R (90)

De resultaten van de controles van profielen, knikverkorters en ankers randstijl zijn opgenomen in Tabel 4.

Tabel 4   Samenvatting controle

Controle van	Beoordeling		Referentie
Profielen van EC-3/R (1)	Voldoen		Figuur 5 Appendix B
Profielen van EC-E/R (90)		Voldoen niet	Figuur 6 Appendix B
Knikverkorters	Voldoen		Appendix C
Blokdeuvels	Voldoen		Appendix D

5 AANPASSINGEN

5.1 Inleiding

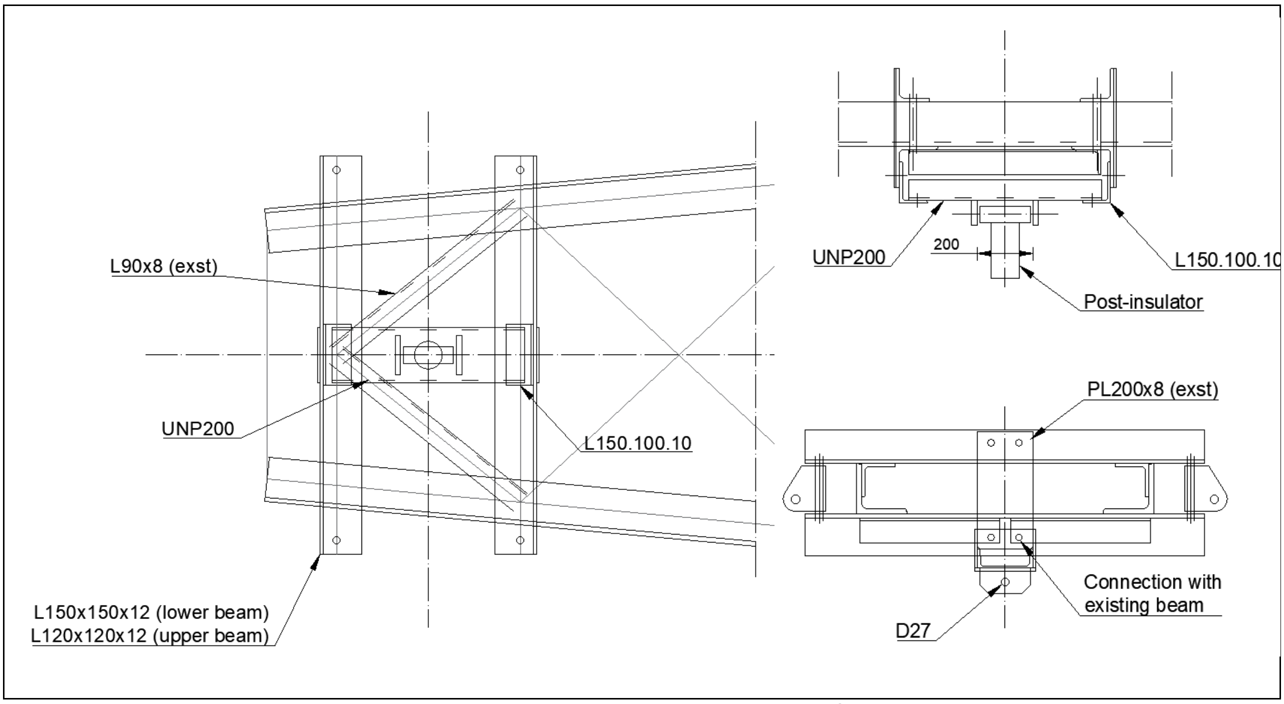
In deze paragraaf worden mastversterkingen voorgesteld om ervoor te zorgen dat de masten aan de eisen van het “afkeurniveau” voldoet. Het voorstel bevat de volgende maatregelen:

- Uitwisselen van diagonalen aan één zijde van de onderste traverse (Mast 90)
- Toevoeging van een horizontaal steungevend verband in het bovenvlak van de onderste traverse (Mast 90)
- Toevoeging van profielen in de bovenste traverse (Mast 90)
- Toevoeging van een extra profiel aan één zijde van de onderste en bovenste traverse (Mast 90)

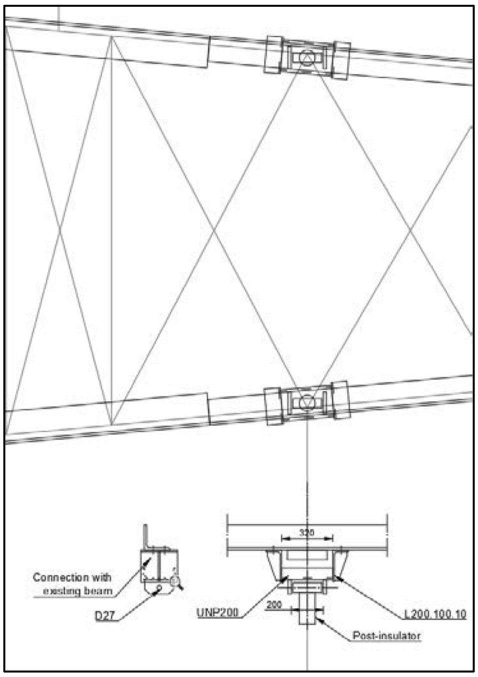
Aangezien de situatie van mast 90 sterk locatie-afhankelijk is, is het voorstel alleen gericht op het versterken van de zijde van de mast tegenover mast 89. Maatregelen aan de onderstationszijde van de mast worden niet effectief of noodzakelijk geacht en daarmee buiten beschouwing gelaten.

5.2 Aanpassingen

DNV heeft een voorgestelde aansluiting voor de nieuwe post-isolatoren geleverd. Zie Figuur 7.



Figuur 7 Aansluiting van post-isolator aan einde van traverse (Masten 1&90)



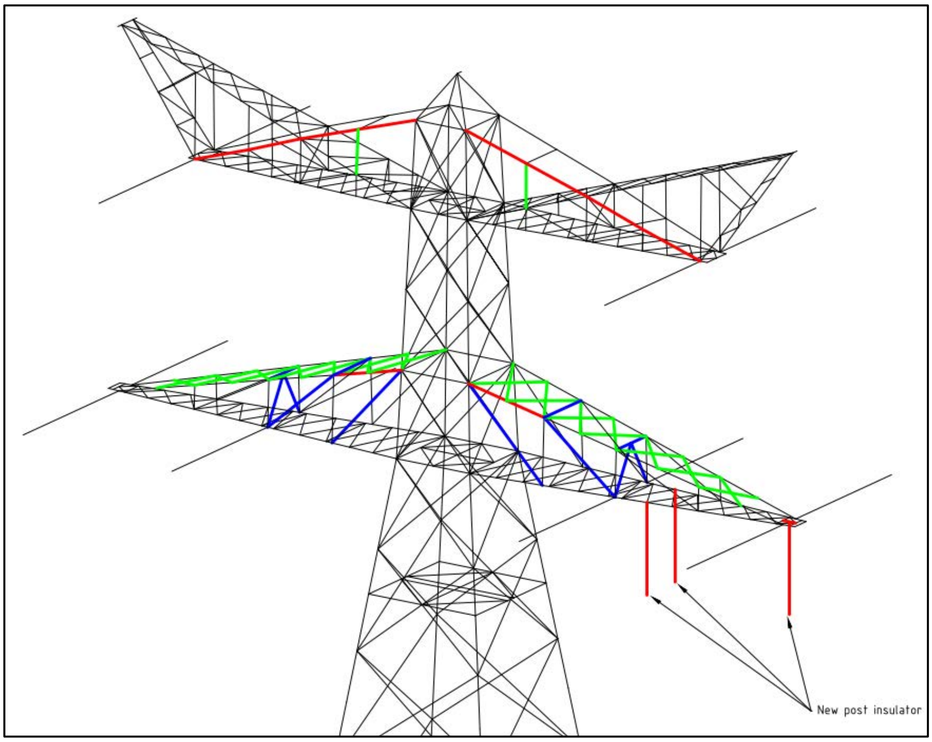
Figuur 8 Aansluiting van post-isolator op binnenste fase (mast 1&90)

5.2.1 Mast 1

Er zijn geen verdere wijzigingen nodig voor mast 1 afgezien van de wijziging van de post-isolator

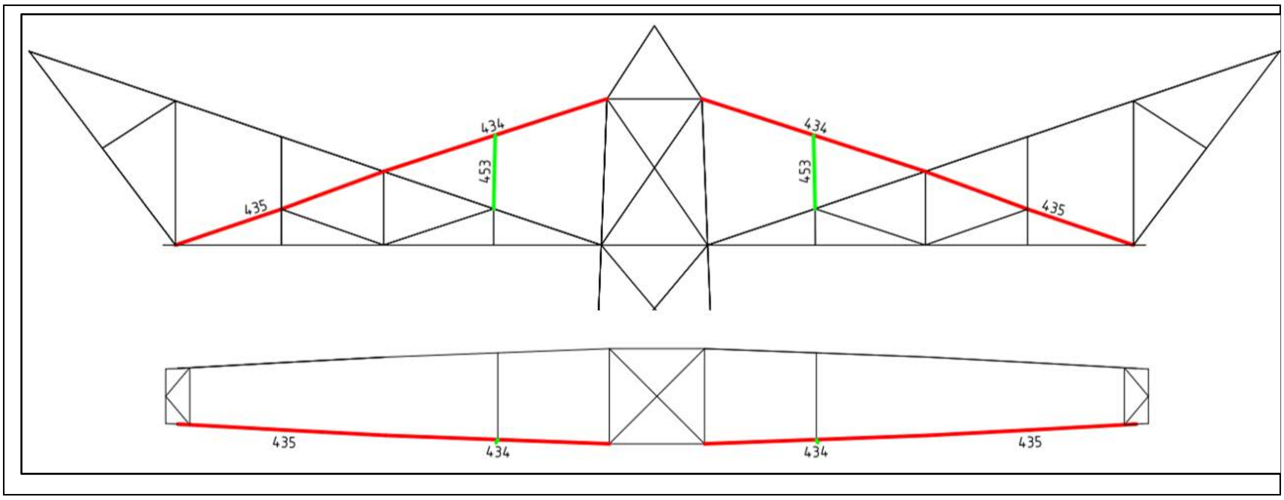
5.2.2 Mast 90

Overeenkomstig de resultaten in Appendix B moeten de eerder in dit hoofdstuk beschreven wijzigingen worden toegepast.



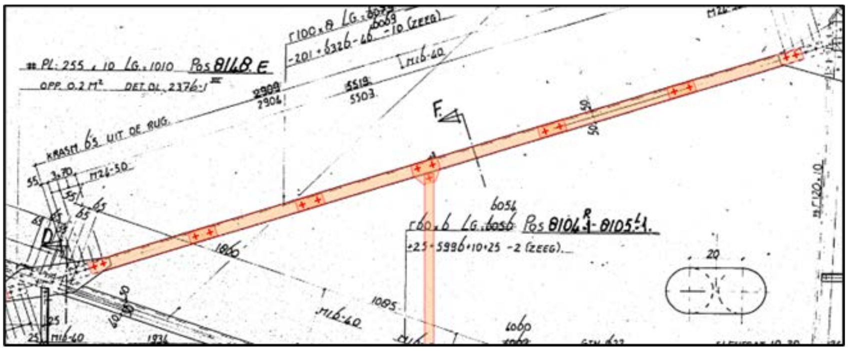
Figuur 9 Isometrische weergave

De extra profielen (groen) en extra verzwaringen (rood) worden weergegeven in de onderstaande afbeelding. Zie Figuur 10.

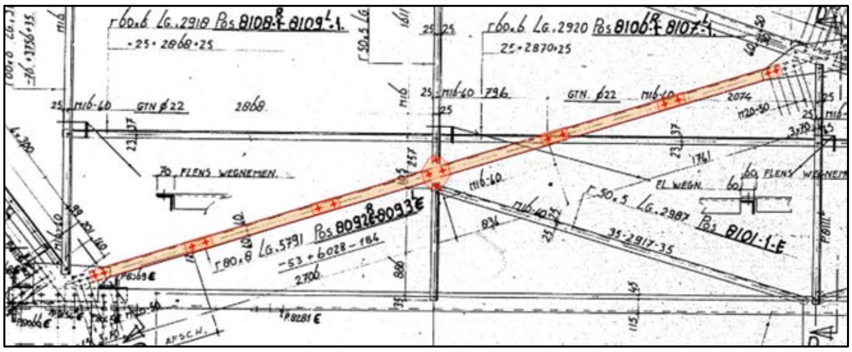


Figuur 10 Voor- en bovenaanzicht - Bovenste traverse

De extra profielen aan de bestaande constructie worden bevestigd door slechts twee van de vier bouten aan elke kant te verwisselen. Om de samenwerking tussen de twee profielen te garanderen, moet de verbinding tussen de profielen worden gemaakt zoals weergegeven op de onderstaande afbeeldingen.



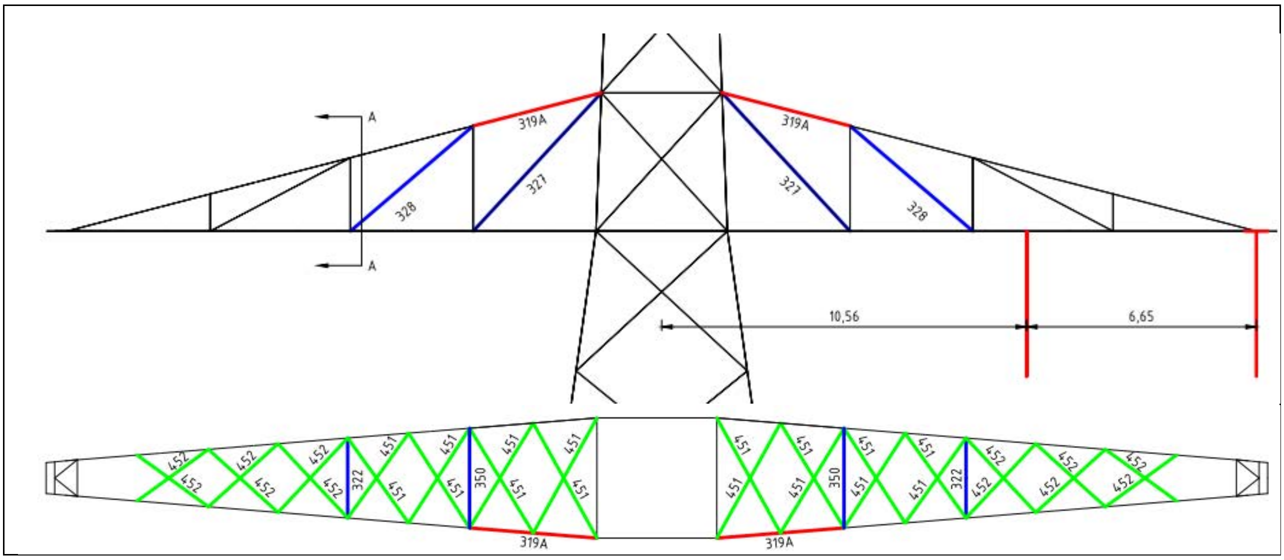
Figuur 11 Toegevoegde profielgroep 434



Figuur 12 Toegevoegde profielgroep 435

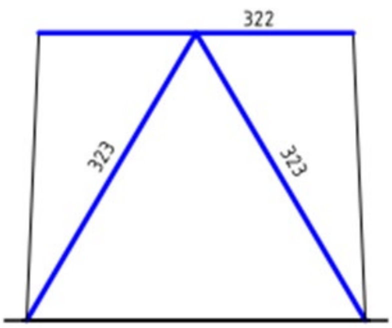
De toegevoegde profielen (groen), verzwaarde profielen (rood) en uitgewisselde profielen (blauw) worden weergegeven in de onderstaande afbeelding.

DNV



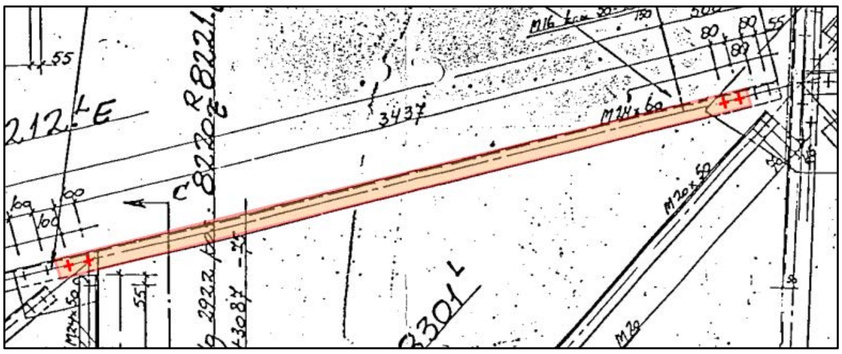
Figuur 13 Voor- en bovenaanzicht - Bovenzijde Onderste traverse

Het K-frame halverwege de traverse heeft een toename van krachten als de diagonalen in het bovenvlak worden opgeteld. Om die reden zullen de diagonaal en de bovenste horizontaal uitgewisseld moeten worden. Zie Figuur 14.



Figuur 14 Sectie A-A Onderste traverse

De extra profielen aan de bovenrand kunnen aan de bestaande staaf worden bevestigd door slechts twee van de vier bouten aan elke kant te verwisselen.



Figuur 15 Toegevoegde profielgroep 319A

Voor informatie over profielafmeting en boutmaten, zie tekening in Appendix E. De afmetingen zijn weergegeven in Tabel 5. Extra gewichten voor bouten en platen in de verbindingen zijn niet inbegrepen.

Tabel 5 Gewicht van profielen vereist voor aanpassingen aan mast EC-3/R (90).

Group Label	Profile ini.	Material ini.	Bolts ini.	Profile new	Material new	Bolts new	Mitigation	Number	Length (m)	Weight (kg)
319A	L90.8	S235	4M24-8.8t	L90.8	S355	2M24-8.8t	Extra profile added	2	3.84	85.2
327	L90.8	S235	M20-8.8t	L100.10	S355	M20-8.8t	Profile exchanged	2	5.46	167.1
328	L80.8	S235	2M20-8.8t	L100.10	S355	2M20-8.8t	Profile exchanged	2	4.68	143.2
434	L100.8	S235	4M24-8.8t	L100.8	S355	2M24-8.8t	Extra profile added	1	6.43	79.7
435	L80.8	S235	4M20-8.8t	L80.8	S355	2M20-8.8t	Extra profile added	1	6.05	59.4
451				L70.7	S355	1M16-8.8t	Profile added	16	3.45	415.1
452				L60.6	S355	1M16-8.8t	Profile added	12	2.8	185.8
453				L50.5	S355	1M16-8.8t	Profile added	2	2.01	15.4
322	L60.6	S235	M16-8.8t	L60.6	S355	M16-8.8t	Profile exchanged	2	2.32	25.7
323	L50.5	S235	M16-8.8t	L70.7	S355	M16-8.8t	Profile exchanged	4	2.46	74.0
350	L50.5	S235	M16-8.8t	L50.5	S355	M16-8.8t	Profile exchanged	2	2.89	22.2
									Total:	1272.8

Opmerking: de lengte van de profielen van groep 451 tot 454 is gebaseerd op de gemiddelde lengte van de profielen binnen de groep

6 EISENVERIFICATIE

De verificatie van de van toepassing zijnde eisen is uitgevoerd in onderstaande Tabel 1.

Tabel 6 Verificatie eisen

Eis Id	Eis Tekst	Ja	Nee	N.v.t.	toelichting
BO Eis: H2.7-6	Aanpassingen uitvoerbaar?	X			De toe te voegen staalonderdelen zijn met geboute verbindingen te bevestigen. Dit is een bewezen methode.
PVE.05.001 5.14	Staaldelen in nabijheid van klimweg gewijzigd?		X		De wijzigingen in de nabijheid van de klimweg (knikverkorters) zijn in te passen zonder negatieve invloed op de begaanbaarheid.
	klimvoorziening nog in overeenstemming is met de NEN 1060:1987?			X	Geen wijzigingen

7 REFERENTIES

[1] „002.515.40 0825824 - 21-0462 - Verificatie & validatieplan 380kV verbinding Ens - Zwolle”.
[2] „002.515.40 0825812 - 20-1465 - E-studie deel 1 380kV verbinding Ens - Zwolle”.
[3] „002.515.40 0825820 - 20-1245 - Uitgangspuntenrapport 380kV verbinding Ens - Zwolle”.

APPENDIX A
Geleiderbelastingen

Content

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-12-03			

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	II
Wind speed	25 m/s
Terrain categorie	II
Reduction factor Cdir	1.00
Ice region	B
Tower type	Hoekmast
Tower height	42.5 m
Max. Span	428 m
Line angle	210.5°
Catenary	1760 m
Wind span	267 m
EDS Weight span	378 m
Min. Weight span	309 m
Max. Weight span	599 m

Client:

Title:

Berekening masttype EC-3_R

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_EC-3_R_1_Report.pdf

Project number:

Project client number:

0.0

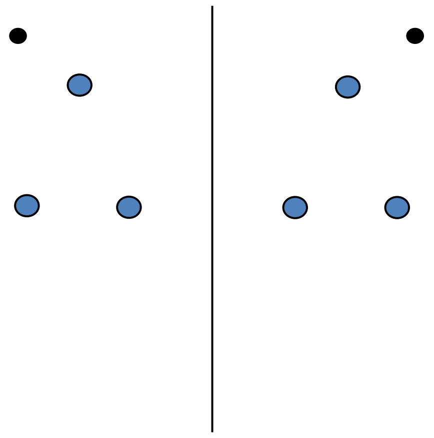
Project: ENS-ZL
Tower: EC-3_R
Number: 1

Auteur: TBR
Versie: v11.7

Conductor loads

General

Description	EC-3_R
Tower type	Hoekmast
Number of circuits	2
Configuration	2-circuit-donau
Number of earth wires	2



Configuratie geleiders

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	II
Wind speed (m/s)	25.0 m/s
Terrain category	II
Reduction factor c_{dir}	1.00
Ice region phase conductor	B
Ice region earth conductor	B

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	500
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	500
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	600
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	600

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area [m^2]
Circuit 1	Afspanketting	2.00	4.50	1.00
Circuit 2	Afspanketting	2.00	4.50	1.00
Bliksemdraad 1	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 2	Vast (Bliksemdraad)	0.10	0.30	0.10

1. Properties apply to the entire isolator set

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower Horizontal distance
Circuit 1	10	380ct1f1	25.2 m	25.2 m	-17.2 m
Circuit 1	11	380ct1f2	25.2 m	25.2 m	-9.0 m
Circuit 1	12	380ct1f3	36.5 m	36.5 m	-13.1 m
Circuit 2	21	380ct2f1	25.2 m	25.2 m	17.2 m
Circuit 2	20	380ct2f2	25.2 m	25.2 m	9.0 m
Circuit 2	22	380ct2f3	36.5 m	36.5 m	13.1 m
Bliksemdraad 1	1	bl1	41.5 m	41.8 m	-17.1 m
Bliksemdraad 2	3	bl2	41.5 m	41.8 m	17.1 m

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Height adjustment adjacent masts (wind and weight span adjustment)

	Back		Ahead		
Height increase for wind pressure	0.0	m	0.0	m	(positive: higher)
Height decrease for vertical load	0.0	m	0.0	m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

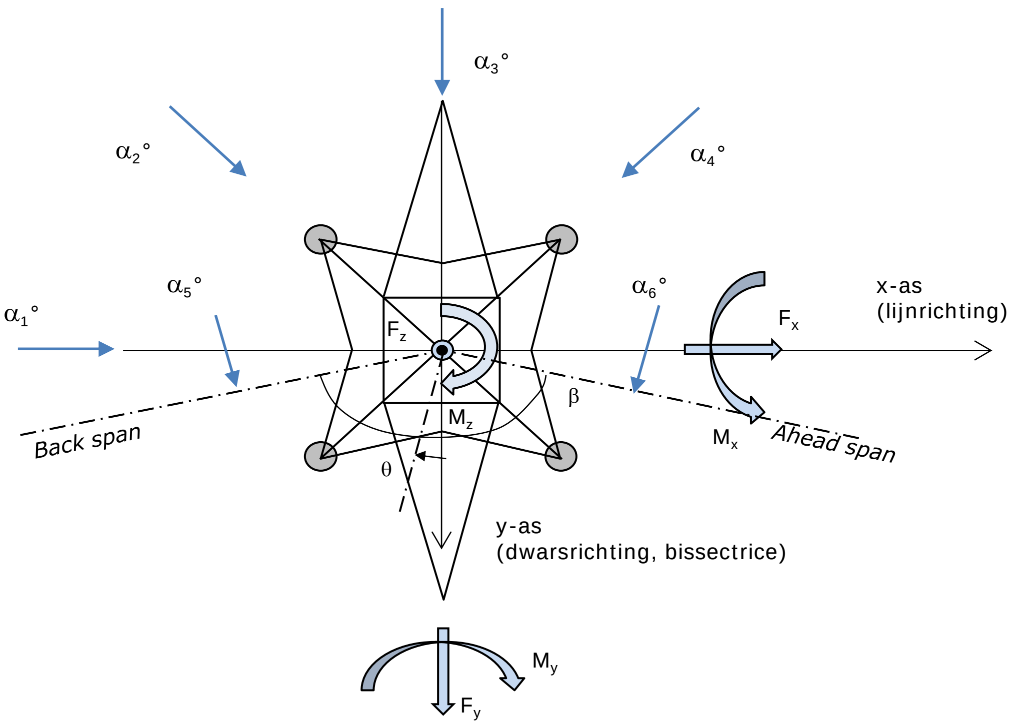
			Hoogteverschil			Richtingsverandering		
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead		Δy_back	Δy_ahead	
Circuit 1	10	380ct1f1	-0.1	-9.4	m	0.0	-3.5	m
Circuit 1	11	380ct1f2	-0.1	-9.4	m	0.0	-5.6	m
Circuit 1	12	380ct1f3	-0.1	-20.7	m	0.0	4.1	m
Circuit 2	21	380ct2f1	-0.1	-9.4	m	0.0	-2.9	m
Circuit 2	20	380ct2f2	-0.1	-9.4	m	0.0	-2.3	m
Circuit 2	22	380ct2f3	-0.1	-20.7	m	0.0	-10.6	m
Bliksemdraad 1	1	bl1	-0.1	-19.5	m	0.0	-4.6	m
Bliksemdraad 2	3	bl2	-0.1	-19.5	m	0.0	3.7	m

Line and tower data

		Back		Ahead	
		428.0		105.0	m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		383.2		105.0	m
Line angle	β	210.5	°		
Tower orientation with respect to bis	θ	15.25	°		
Section length		2076		105	m
Height bottom of tower to ground level		0.5	m		
Wind directions considered	α_1	180	°		
Wind directions according to:	α_2	225	°		
Geleiderbelastingen	α_3	270	°		
	α_4	315	°		
	α_5	240	°		
	α_6	255	°		

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Considered number of wind directions	
1a	6
3	6
4	1
6	1
Overig	1

Project: ENS-ZL
Tower: EC-3_R
Number: 1

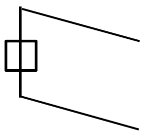
Absence of conductors

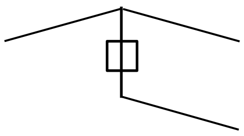
		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	1	0
Circuit 1	380ct1f2	1	0	1	0	1	0
Circuit 1	380ct1f3	1	0	1	0	1	0
Circuit 2	380ct2f1	0	1	1	0	1	0
Circuit 2	380ct2f2	0	1	1	0	1	0
Circuit 2	380ct2f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

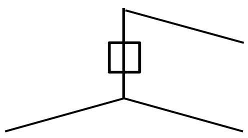
Load situations SPLS

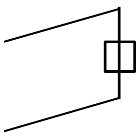
Considered situations SPLS: 1 up to 6, All possible situations

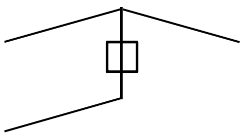
Principle of load situations:

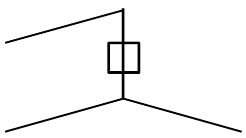

1. Ba All cts


2. Ba ct1


3. Ba ct2


4. Ah All cts

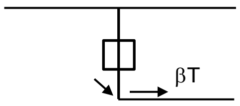

5. Ah ct1


6. Ah ct2

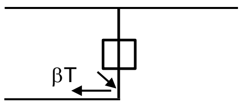
Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



1. Ba



2. Ah

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Load situations LC6. Construction and maintenance

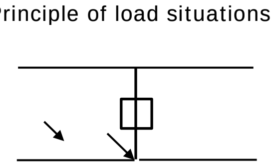
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

	Phase	Earth
Line vehicle	3.0 kN	2.0 kN
Concentrated load cross arm	1.0 kN	1.0 kN

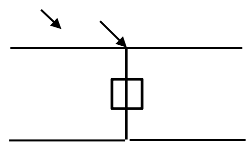
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

Presence line vehicle: Circuit, belasting tegelijk aanwezig in alle geleiders per circuit.

Principle of load situations:



1. Ba Ct1



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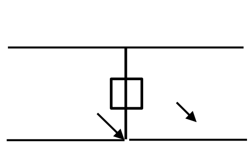
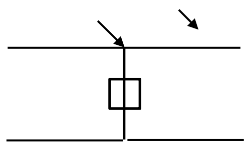


3. Ah Ct1



4. Ah Ct2

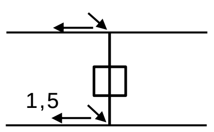
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0.866 W	1.5 W
Suspension tower earth	1.5 EDS	1.5 W
Strain tower phase and earth	1.5 EDS	1.5 W

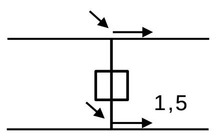
Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



1. Ba



2. Ah

Load combination 8. Galloping as a dynamic load

Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

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Project: ENS-ZL
Tower: EC-3_R
Number: 1

Tower structure

Properties

Tower type	Hoekmast		
Tower designation	EC-3_R		
Base plate w.r.t. ground level	0.5		m
Tower height w.r.t. base plate	42.5		m
Tower self weight	415.0		kN
Width and slope at foundation	x-ri.	y-ri.	
Leg spread	11.00	11.00	m
Inclination of main leg	0.143	0.143	-
Horizontal force factor	1.3	1.3	-

Calculation Wind load

Dynamic factor G_T	1.00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross a	0.4

Properties mast sections longitudinal direction (front view, yz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	11.50	11.00	7.71	11.50	0.143	107.61	14.80	0.14	3.22
Eerste tussenstuk	16.59	7.71	6.26	5.09	0.143	35.56	6.05	0.17	3.06
Tweede tussenstuk	25.20	6.26	3.80	8.61	0.143	43.31	10.02	0.23	2.80
Bovenstuk 1	32.85	3.80	3.20	7.65	0.039	26.78	6.17	0.23	2.80
Bovenstuk 2	40.50	3.20	2.60	7.65	0.039	22.19	5.39	0.24	2.75
Topstuk	42.50	2.60		2.00		2.60	0.50	0.19	2.96
Ondertraverse	25.20	15.30		4.00		30.60	6.72	0.22	2.85
Boventraverse	36.50	15.64		5.30		41.45	7.30	0.18	3.04

Properties tower sections transversal direction (side view, xz plane)

Description	h [m]	b_1 [m]	b_2 [m]	Δh [m]	Δ_x [m]	A_0 [m^2]	A_1 [m^2]	$\chi = A_1/A_0$ [-]	C_t
Broekstuk	11.50	11.00	7.71	11.50	0.143	107.61	14.80	0.14	3.22
Eerste tussenstuk	16.59	7.71	6.26	5.09	0.143	35.56	6.05	0.17	3.06
Tweede tussenstuk	25.20	6.26	3.80	8.61	0.143	43.31	10.02	0.23	2.80
Bovenstuk 1	32.85	3.80	3.20	7.65	0.039	26.78	6.17	0.23	2.80
Bovenstuk 2	40.50	3.20	2.60	7.65	0.039	22.19	5.39	0.24	2.75
Topstuk	42.50	2.60		2.00		2.60	0.50	0.19	2.96
Ondertraverse	25.20	15.30		4.00		30.60	6.72	0.22	2.85
Boventraverse	36.50	15.64		5.30		41.45	7.30	0.18	3.04

Note: Surface transverse direction is reduced in calculation.

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Wind surface feeders telecom installations				
Part	A (m^2/m)	Factor	Δh	A_1
Broekstuk				
Eerste tussenstuk				
Tweede tussenstuk				
Bovenstuk 1				
Bovenstuk 2				

Input antennas			
Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.73	-34.8	-29.5	0.0	29.5	5.8	-200.2	-169.8	0.0	169.8
Eerste tussenstuk	0.82	-15.2	-12.9	0.0	12.9	14.0	-213.1	-180.8	0.0	180.8
Tweede tussenstuk	0.93	-26.0	-22.1	0.0	22.1	20.9	-543.1	-460.9	0.0	460.9
Bovenstuk 1	1.03	-17.7	-15.0	0.0	15.0	29.0	-514.6	-436.7	0.0	436.7
Bovenstuk 2	1.09	-16.1	-13.7	0.0	13.7	36.7	-592.1	-502.4	0.0	502.4
Topstuk	1.13	-1.7	-1.4	0.0	1.4	41.5	-69.3	-58.8	0.0	58.8
Ondertraverse	0.99	-38.0	-22.6	0.0	22.6	26.5	-1009.4	-599.5	0.0	599.5
Boventraverse	1.10	-48.9	-29.0	0.0	29.0	38.3	-1870.7	-1111.1	0.0	1111.1
Totaal		-198.5	-146.3	0.0	146.3		-5012.6	-3520.1	0.0	3520.1

Tower section loads transversal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.73	0.0	-29.5	-34.8	-29.5	5.8	0.0	-169.8	-200.2	-169.8
Eerste tussenstuk	0.82	0.0	-12.9	-15.2	-12.9	14.0	0.0	-180.8	-213.1	-180.8
Tweede tussenstuk	0.93	0.0	-22.1	-26.0	-22.1	20.9	0.0	-460.9	-543.1	-460.9
Bovenstuk 1	1.03	0.0	-15.0	-17.7	-15.0	29.0	0.0	-436.7	-514.6	-436.7
Bovenstuk 2	1.09	0.0	-13.7	-16.1	-13.7	36.7	0.0	-502.4	-592.1	-502.4
Topstuk	1.13	0.0	-1.4	-1.7	-1.4	41.5	0.0	-58.8	-69.3	-58.8
Ondertraverse	0.99	0.0	-22.6	-15.2	-22.6	26.5	0.0	-599.5	-403.8	-599.5
Boventraverse	1.10	0.0	-29.0	-19.6	-29.0	38.3	0.0	-1111.1	-748.3	-1111.1
Total		0.0	-146.3	-146.3	-146.3		0.0	-3520.1	-3284.5	-3520.1

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	415	0	0	0
Windrichting 180°	-198	0	0	0	-5013	0
Windrichting 225°	-146	-146	0	-3520	-3520	0
Windrichting 270°	0	-146	0	-3285	0	0
Windrichting 315°	146	-146	0	-3520	3520	0

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm²]	G [N/m]	E [N/mm²]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm²]	G [N/m]	E [N/mm²]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]	Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46.3	B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3	B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1	B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1	B	4+0,2d	8.3	8.3

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m²]	Wind heigth [m]	Pressure [kN/m²]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct1f2	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct1f3	2.00	1	2	4.5	1.0	37.00	1.09	1.2	1.31
380ct2f1	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct2f2	2.00	1	2	4.5	1.0	25.70	0.99	1.2	1.18
380ct2f3	2.00	1	2	4.5	1.0	37.00	1.09	1.2	1.31
bl1	0.10	0.5	0.05	0.3	0.1	42.00	1.13	1.2	0.14
bl2	0.10	0.5	0.05	0.3	0.1	42.00	1.13	1.2	0.14

Project: ENS-ZL
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Wind load back

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	17.0	0.87	0.56	0.48	1.13	28.53	47.4	40.4	47.4	83.4	71.1
380ct1f2	17.0	0.87	0.56	0.48	1.13	28.53	47.4	40.4	47.4	83.4	71.1
380ct1f3	28.3	1.01	0.60	0.51	1.09	28.53	57.3	48.8	47.4	104.6	89.0
380ct2f1	17.0	0.87	0.56	0.48	1.13	28.53	47.4	40.4	47.4	83.4	71.1
380ct2f2	17.0	0.87	0.56	0.48	1.13	28.53	47.4	40.4	47.4	83.4	71.1
380ct2f3	28.3	1.01	0.60	0.51	1.09	28.53	57.3	48.8	47.4	104.6	89.0
bl1	34.7	1.07	0.62	0.53	1.20	22.35	17.9	15.2	41.8	33.5	28.5
bl2	34.7	1.07	0.62	0.53	1.20	22.35	17.9	15.2	41.8	33.5	28.5

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	19.2	0.90	0.57	0.74	1.12	28.53	49.7	64.2	47.4	88.2	113.9
380ct1f2	19.2	0.90	0.57	0.74	1.12	28.53	49.7	64.2	47.4	88.2	113.9
380ct1f3	24.8	0.98	0.59	0.76	1.10	28.53	54.7	70.2	47.4	98.9	126.8
380ct2f1	19.2	0.90	0.57	0.74	1.12	28.53	49.7	64.2	47.4	88.2	113.9
380ct2f2	19.2	0.90	0.57	0.74	1.12	28.53	49.7	64.2	47.4	88.2	113.9
380ct2f3	24.8	0.98	0.59	0.76	1.10	28.53	54.7	70.2	47.4	98.9	126.8
bl1	30.7	1.04	0.61	0.78	1.20	22.35	17.0	21.7	41.8	31.9	40.6
bl2	30.7	1.04	0.61	0.78	1.20	22.35	17.0	21.7	41.8	31.9	40.6

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Project: ENS-ZL
Tower: EC-3_R
Number: 1

Auteur: TBR
Versie: v11.7

Conductor loads

Starting points
Consequence class Afkeur CC2-0
Reference period 30 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.05	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.12	0.00	0.0
ULS 3	Wind+ice	-5°	1.05	1.05	0.00	0.34	0.97	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.05	0.00	0.34	0.97	0.0
ULS 4	Cold+wind	-20°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.05	0.00	0.22	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.05	1.05	1.20	0.22	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 7	Permanent	10°	1.15	1.15	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS (strength, for angle towers: absence of conductors)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.05	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.05	1.05	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.05	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.05	1.05	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.05	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.05	1.05	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.05	1.05	0.0	0.24	0.0	0.0
SLS (deformations, fatigue, EDS)								
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	0.94	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.28	0.88	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	54
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	5529

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Project: ENS-ZL
Tower: EC-3_R
Number: 1

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-39.6	22.0	0.0	0.0	6.2	9.1
380ct1f1	-133.9	46.7	0.0	0.0	18.5	14.4
380ct1f2	-133.9	46.1	0.0	0.0	18.5	14.4
380ct1f3	-136.5	48.8	0.0	0.0	18.5	20.5
380ct2f1	-133.9	46.9	0.0	0.0	18.5	14.4
380ct2f2	-133.9	47.1	0.0	0.0	18.5	14.4
380ct2f3	-136.5	44.6	0.0	0.0	18.5	20.4
bl2	-39.6	23.1	0.0	0.0	6.2	9.1
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	
Post 3	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	378.9	423.5	378.4
380ct1f1	311.5	320.5	311.4
380ct1f2	311.5	320.4	311.4
380ct1f3	366.2	386.2	365.5
380ct2f1	311.6	320.5	311.4
380ct2f2	311.6	320.5	311.4
380ct2f3	365.6	385.4	365.5
bl2	379.8	424.5	378.4
Post 1			
Post 2			
Post 3			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	512.7	404.2
380ct1f1	343.1	318.0
380ct1f2	343.0	318.0
380ct1f3	445.6	382.5
380ct2f1	343.1	318.0
380ct2f2	343.2	318.0
380ct2f3	444.3	382.2
bl2	513.0	404.3
Post 1		
Post 2		
Post 3		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	549.0 m	2.060 -
Min. weight span	309.2 m	1.160 -

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Maximum values back + ahead span / Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	39.6	15.4	9.1	-39.6	26.3
380ct1f1	114.0	36.2	18.5	-133.9	55.8
380ct1f2	114.0	36.6	18.5	-133.9	55.7
380ct1f3	115.8	38.0	20.5	-136.5	55.8
380ct2f1	114.0	36.1	18.5	-133.9	55.8
380ct2f2	114.0	36.0	18.5	-133.9	55.8
380ct2f3	115.8	41.1	20.4	-136.5	55.7
bl2	39.6	13.6	9.1	-39.6	26.3
Post 1	1.9	0.0	4.0	0.0	
Post 2	1.9	0.0	4.0	0.0	
Post 3	1.9	0.0	4.0	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	5.1	0.0	2.2	-21.2	6.1
380ct1f1	19.5	0.0	11.9	-81.5	23.1
380ct1f2	19.3	0.0	11.9	-81.5	23.1
380ct1f3	20.4	0.0	11.9	-81.5	23.1
380ct2f1	19.6	0.0	11.9	-81.5	23.1
380ct2f2	19.7	0.0	11.9	-81.5	23.1
380ct2f3	18.7	0.0	11.9	-81.5	23.1
bl2	5.3	0.0	2.2	-21.2	6.1
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	
Post 3	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	0.0
	380ct1f1	0.0	0.0
	380ct1f2	0.0	0.0
	380ct1f3	0.0	0.0
	380ct2f1	0.0	0.0
	380ct2f2	0.0	0.0
	380ct2f3	0.0	0.0
	bl2	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	
	Post 3	0.0	

Project: ENS-ZL
Tower: EC-3_R
Number: 1

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270		-561	-239	151	-7075	-17032	-41
ULS 1a_0,9_180		-419	-99	141	-2849	-12525	-111
ULS 1a_0,9_0,9_270		-532	-232	132	-6893	-16178	-42
ULS 3_180		-627	-144	203	-4172	-18803	-53
SLS 7		-404	-80	134	-2274	-12102	-14

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

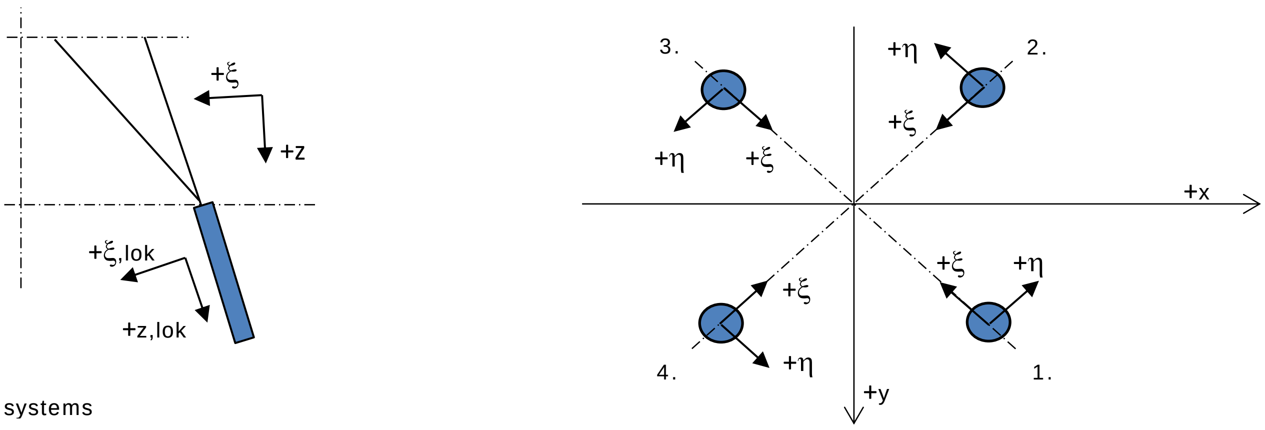
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270	-561	-403	586	-10766	-17032	-41
ULS 1a_0,9_0,9_270	-532	-396	505	-10585	-16178	-42
SLS 7	-404	-80	549	-2274	-12102	-14

Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_240	-557	-427	529	-11545	-16099	-82
SPLS 3_255 Ah All Cts	-753	-86	553	-2043	-22606	-8
SPLS 6a_270 Ba Ct1 Ah Ct1	-56	-198	591	-5522	-1553	-5180
ULS 1a_0,9_255	-563	-426	527	-11473	-16697	-66

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ba All Cts Ah Ct2	71	9	235	43	-56	-9	240
2	SPLS 6a_270 Ba All Cts Ah Ct1	162	-103	721	-41	-188	-42	736
3	ULS 1a_255	-263	-276	1427	-9	-382	-93	1456
4	SPLS 3_180 Ah All Cts	-217	214	1160	-2	-304	-70	1184

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_0,9_255	-215	-221	-1149	5	308	76	-1172
2	SPLS 3_0,9_180 Ah All Cts	-167	167	-899	0	236	54	-917
3	-	0	0	0	0	0	0	0
4	SPLS 1a_0,9_315 Ba All Cts	88	-88	-443	0	124	35	-452

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ba Ct2 Ah Ct2	82	-152	-183	166	50	13	-186
2	SPLS 6a_270 Ba Ct2 Ah Ct2	-55	-181	334	167	-88	-21	341
3	SPLS 6a_270 Ba Ct2 Ba Ct1	-242	-7	683	166	-176	-38	697
4	SPLS 6a_270 Ba Ct2 Ba Ct1	67	171	280	168	-74	-18	285

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_270 Ba Ct1 Ah Ct1	-151	83	-174	-165	48	13	-177
2	SPLS 6a_270 Ba Ct1 Ah Ct1	178	54	328	-164	-88	-21	335
3	SPLS 6a_270 Ba Ct1 Ba Ct2	4	-242	623	-174	-169	-43	636
4	SPLS 6a_270 Ba Ct1 Ba Ct2	-179	-63	339	-171	-82	-13	346

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_0,9_255	-215	-221	-1149	5	308	76	-1172
2	SPLS 3_0,9_180 Ah All Cts	-167	167	-899	0	236	54	-917
3	SPLS 6a_270 Ba All Cts Ah Ct2	-39	15	44	38	-17	-8	45
4	SPLS 6a_270 Ba All Cts Ah Ct1	51	-111	-442	-43	114	25	-451

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-95	-96	-516	1	135	31	-527
2	SLS 7	-56	57	-310	-1	80	17	-316
3	SLS 7	-145	-148	791	-2	-207	-48	807
4	SLS 7	-108	107	584	0	-152	-34	596

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_255	-263	-276	1427	-9	-382	-93	1456
Max. tension	ULS 1a_0,9_255	-215	-221	-1149	5	308	76	-1172
Max. pos. torsie	SPLS 6a_270 Ba Ct2 Ba Ct1	67	171	280	168	-74	-18	285
Max. neg. torsie	SPLS 6a_270 Ba Ct1 Ba Ct2	4	-242	623	-174	-169	-43	636
Comb. tension+torsie	ULS 1a_0,9_255	-215	-221	-1149	5	308	76	-1172

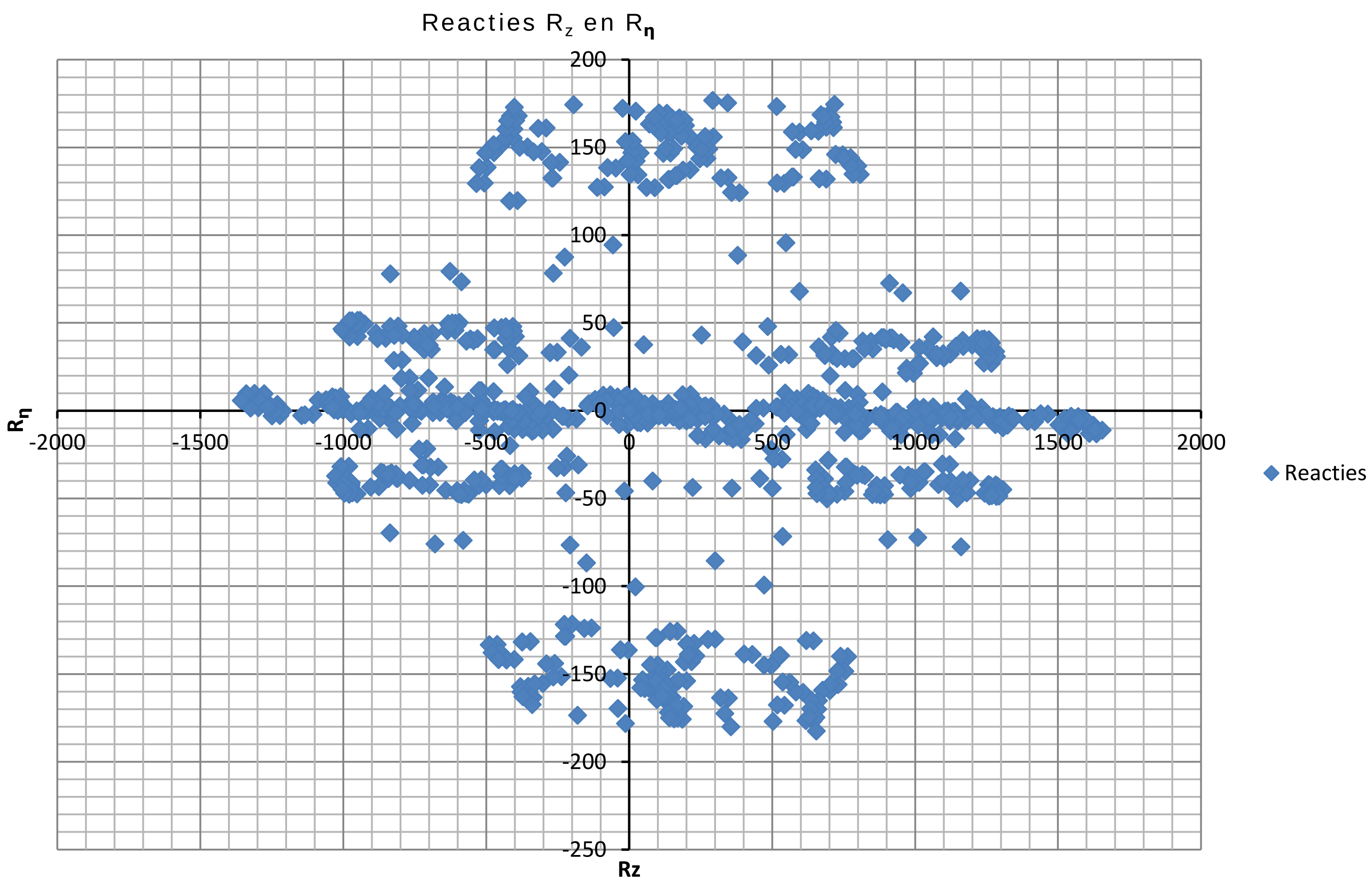
Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-95	-96	-516	1	135	31	-527
2	SLS 7	-56	57	-310	-1	80	17	-316
3	SLS 7	-145	-148	791	-2	-207	-48	807
4	SLS 7	-108	107	584	0	-152	-34	596

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-95	-96	-516	1	135	31	-527
2	SLS 7	-56	57	-310	-1	80	17	-316
3	SLS 7	-145	-148	791	-2	-207	-48	807
4	SLS 7	-108	107	584	0	-152	-34	596

Project: ENS-ZL
Tower: EC-3_R
Number: 1



Project: ENS-ZL
Tower: EC-3_R
Number: 1

Auteur: TBR
Versie: v11.7

Conductor loads

Starting points

Consequence class	Verbouw CC2
Reference period	50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.15	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.40	0.00	0.0
ULS 3	Wind+ice	-5°	1.15	1.15	0.00	0.42	1.30	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.15	0.00	0.42	1.30	0.0
ULS 4	Cold+wind	-20°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.15	0.00	0.28	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.15	1.15	1.30	0.28	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 7	Permanent	10°	1.30	1.30	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS (strength, for angle towers: absence of conductors)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.15	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.15	1.15	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.15	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.15	1.15	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.15	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.15	1.15	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.15	1.15	0.0	0.24	0.0	0.0
SLS (deformations, fatigue, EDS)								
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	1.00	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.30	1.00	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	54
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	5529

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-43.6	23.4	0.0	0.0	6.8	9.8
380ct1f1	-153.3	50.4	0.0	0.0	21.7	15.6
380ct1f2	-153.3	49.7	0.0	0.0	21.7	15.6
380ct1f3	-156.5	52.6	0.0	0.0	21.7	22.2
380ct2f1	-153.3	50.5	0.0	0.0	21.7	15.6
380ct2f2	-153.3	50.7	0.0	0.0	21.7	15.6
380ct2f3	-156.5	48.0	0.0	0.0	21.7	22.1
bl2	-43.6	24.6	0.0	0.0	6.8	9.8
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	
Post 3	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	378.9	424.1	378.4
380ct1f1	311.6	320.6	311.4
380ct1f2	311.5	320.5	311.4
380ct1f3	366.3	386.5	365.5
380ct2f1	311.6	320.6	311.4
380ct2f2	311.6	320.6	311.4
380ct2f3	365.6	385.6	365.5
bl2	380.0	425.2	378.4
Post 1			
Post 2			
Post 3			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	531.9	400.3
380ct1f1	349.0	317.5
380ct1f2	348.9	317.5
380ct1f3	460.1	381.5
380ct2f1	349.1	317.5
380ct2f2	349.1	317.5
380ct2f3	458.6	381.2
bl2	532.3	400.4
Post 1		
Post 2		
Post 3		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	599.1 m	2.248 -
Min. weight span	308.9 m	1.159 -

DNV·GL

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	40.8	16.5	9.8	-43.6	28.1
380ct1f1	120.1	43.6	21.7	-153.3	60.1
380ct1f2	120.1	44.1	21.7	-153.3	60.1
380ct1f3	121.4	46.1	22.2	-156.5	60.2
380ct2f1	120.1	43.5	21.7	-153.3	60.1
380ct2f2	120.1	43.4	21.7	-153.3	60.1
380ct2f3	121.4	49.6	22.1	-156.5	60.1
bl2	40.8	14.7	9.8	-43.6	28.1
Post 1	2.3	0.0	4.6	0.0	
Post 2	2.3	0.0	4.6	0.0	
Post 3	2.3	0.0	4.6	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	5.1	0.0	2.2	-21.2	6.1
380ct1f1	19.5	0.0	11.9	-81.5	23.1
380ct1f2	19.3	0.0	11.9	-81.5	23.1
380ct1f3	20.4	0.0	11.9	-81.5	23.1
380ct2f1	19.6	0.0	11.9	-81.5	23.1
380ct2f2	19.7	0.0	11.9	-81.5	23.1
380ct2f3	18.7	0.0	11.9	-81.5	23.1
bl2	5.3	0.0	2.2	-21.2	6.1
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	
Post 3	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	0.0
	380ct1f1	0.0	0.0
	380ct1f2	0.0	0.0
	380ct1f3	0.0	0.0
	380ct2f1	0.0	0.0
	380ct2f2	0.0	0.0
	380ct2f3	0.0	0.0
	bl2	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	
	Post 3	0.0	

Project: ENS-ZL
Tower: EC-3_R
Number: 1

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270		-635	-287	167	-8531	-19265	-51
ULS 1a_0,9_180		-449	-111	154	-3216	-13392	-134
ULS 1a_0,9_0,9_270		-592	-277	136	-8270	-18037	-52
ULS 3_180		-710	-168	237	-4881	-21283	-64
SLS 7		-404	-80	134	-2274	-12102	-14

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

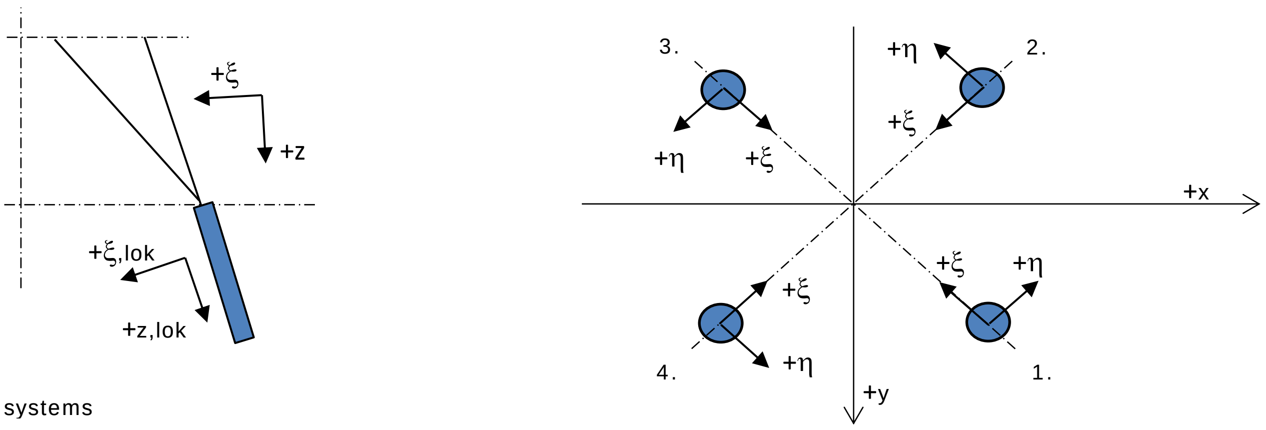
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270	-635	-492	644	-13130	-19265	-51
ULS 1a_0,9_0,9_270	-592	-482	510	-12868	-18037	-52
SLS 7	-404	-80	549	-2274	-12102	-14

Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_240	-627	-522	546	-14119	-18031	-101
SPLS 3_255 Ah All Cts	-790	-86	604	-2029	-23713	-8
SPLS 6a_270 Ba Ct1 Ah Ct1	-66	-205	643	-5673	-1852	-5454
ULS 1a_0,9_255	-636	-521	544	-14028	-18823	-82

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg



Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ba All Cts Ah Ct2	74	13	253	43	-61	-10	258
2	SPLS 6a_270 Ba All Cts Ah Ct1	168	-110	757	-41	-197	-44	773
3	ULS 1a_255	-305	-321	1654	-11	-443	-109	1688
4	SPLS 3_180 Ah All Cts	-230	227	1231	-2	-323	-74	1256

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_0,9_255	-254	-262	-1357	6	365	91	-1385
2	SPLS 3_0,9_180 Ah All Cts	-177	177	-954	0	250	57	-973
3	-	0	0	0	0	0	0	0
4	SPLS 1a_0,9_315 Ba All Cts	93	-92	-468	0	131	36	-478

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ba Ct2 Ah Ct2	86	-161	-194	174	53	13	-198
2	SPLS 6a_270 Ba Ct2 Ah Ct2	-60	-188	344	175	-91	-21	351
3	SPLS 6a_270 Ba Ct2 Ba Ct1	-254	-8	717	174	-185	-40	732
4	SPLS 6a_270 Ba Ct2 Ba Ct1	70	180	291	177	-77	-18	297

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_270 Ba Ct1 Ah Ct1	-158	87	-181	-174	51	14	-185
2	SPLS 6a_270 Ba Ct1 Ah Ct1	185	59	334	-172	-90	-22	341
3	SPLS 6a_270 Ba Ct1 Ba Ct2	4	-254	654	-182	-177	-45	667
4	SPLS 6a_270 Ba Ct1 Ba Ct2	-188	-67	355	-180	-86	-14	362

Project: ENS-ZL
Tower: EC-3_R
Number: 1

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	ULS 1a_0,9_255	-254	-262	-1357	6	365	91	-1385
2	SPLS 3_0,9_180 Ah All Cts	-177	177	-954	0	250	57	-973
3	SPLS 6a_270 Ba All Cts Ah Ct2	-40	14	50	38	-18	-8	51
4	SPLS 6a_270 Ba All Cts Ah Ct1	53	-113	-454	-43	117	26	-463

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-95	-96	-516	1	135	31	-527
2	SLS 7	-56	57	-310	-1	80	17	-316
3	SLS 7	-145	-148	791	-2	-207	-48	807
4	SLS 7	-108	107	584	0	-152	-34	596

Envelope of load combinations for all of the legs

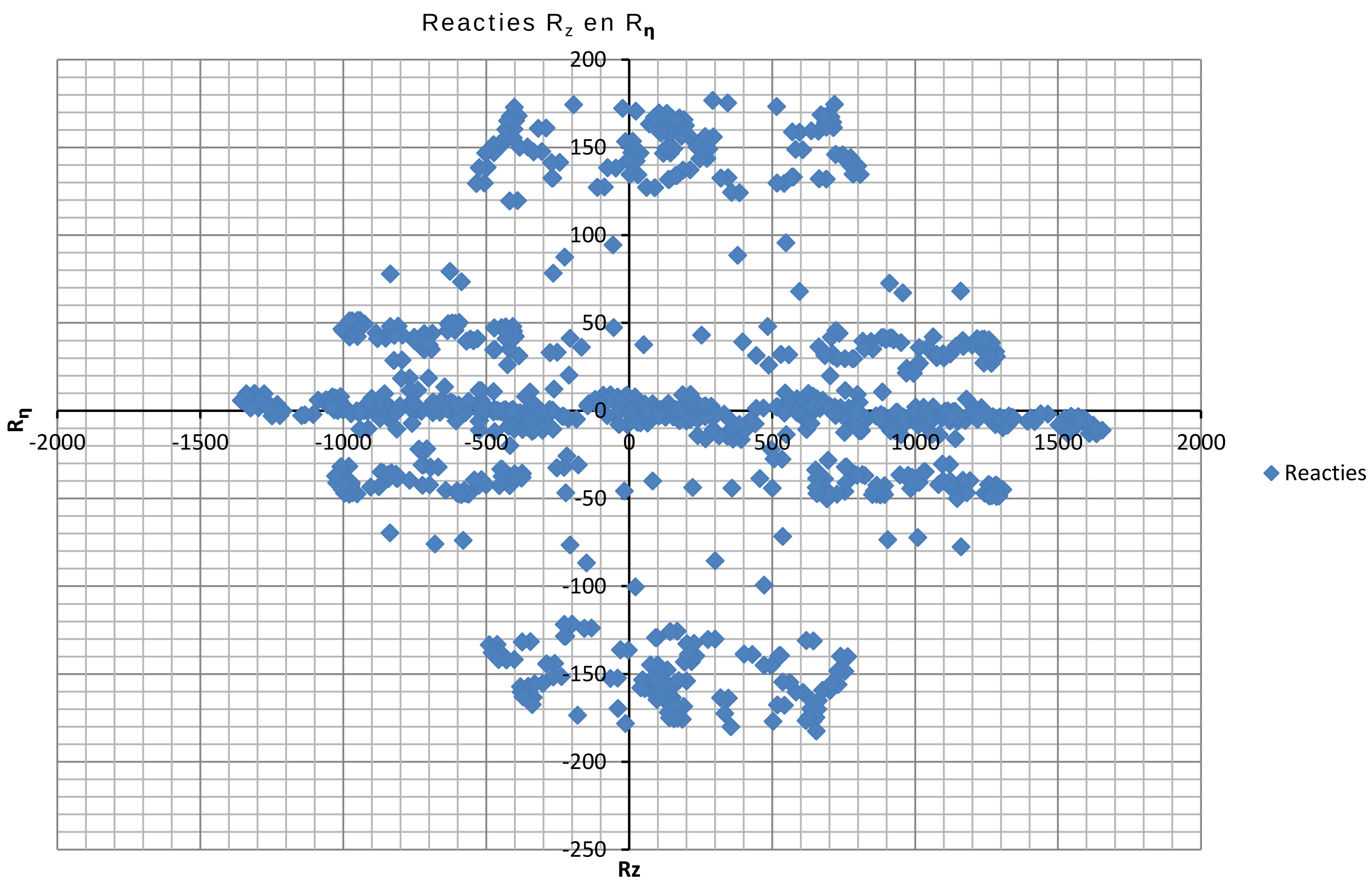
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_255	-305	-321	1654	-11	-443	-109	1688
Max. tension	ULS 1a_0,9_255	-254	-262	-1357	6	365	91	-1385
Max. pos. torsie	SPLS 6a_270 Ba Ct2 Ba Ct1	70	180	291	177	-77	-18	297
Max. neg. torsie	SPLS 6a_270 Ba Ct1 Ba Ct2	4	-254	654	-182	-177	-45	667
Comb. tension+torsie	ULS 1a_0,9_255	-254	-262	-1357	6	365	91	-1385

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-95	-96	-516	1	135	31	-527
2	SLS 7	-56	57	-310	-1	80	17	-316
3	SLS 7	-145	-148	791	-2	-207	-48	807
4	SLS 7	-108	107	584	0	-152	-34	596

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-95	-96	-516	1	135	31	-527
2	SLS 7	-56	57	-310	-1	80	17	-316
3	SLS 7	-145	-148	791	-2	-207	-48	807
4	SLS 7	-108	107	584	0	-152	-34	596


Reacties Rz en Rη
200
150
100
50
0
-50
-100
-150
-200
-250
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Rη
Rz
Reacties

Content

Data

Norm	NEN-EN50341-2-15:2019
Initial	
Consequence class	CC2-0
Reliability level	Afkeur
Reference period	30 jaar
After adjustment	
Consequence class	CC2
Reliability level	Verbouw
Reference period	50 jaar
Wind zone	III
Wind speed	24.5 m/s
Terrain categorie	II
Reduction factor Cdir	1.00
Ice region	B
Tower type	Hoekmast
Tower height	42.5 m
Max. Span	134 m
Line angle	227.6°
Catenary	1760 m
Wind span	101 m
EDS Weight span	220 m
Min. Weight span	-988 m
Max. Weight span	458 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-11-26			

Client: TenneT Taking power further

DNV·GL

Title:

Berekening masttype EC-3_R

JOB No.	-	DATE	-
DRAWN	-	CHKD	-
DESIGN	-	APPD	-

Document name:

ENS-ZL_EC-3_R_90_Report.pdf

Project number:

Project client number:

0.0

Project: ENS-ZL
Tower: EC-3_R
Number: 90

Conductor loads

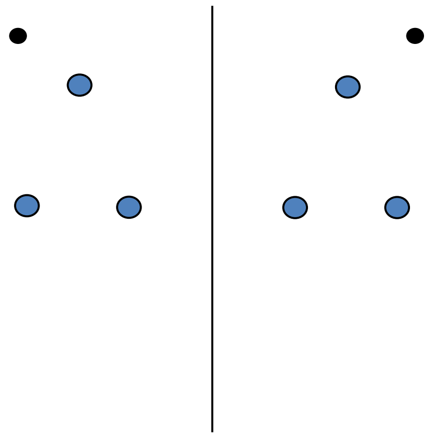
Auteur: TBR
Versie: v11.7

General

Description	EC-3_R
Tower type	Hoekmast
Number of circuits	2
Configuration	2-circuit-donau
Number of earth wires	3

Starting points

Norm	NEN-EN50341-2-15:2019
Consequence class	CC2-0
Reliability level initial	Afkeur CC2-0
Reference period intial	30 jaar
Consequence class modified	CC2
Reliability level modified	Verbouw
Reference period modified	50 jaar
Wind zone	III
Wind speed (m/s)	24.5 m/s
Terrain category	II
Reduction factor c_{dir}	1.00
Ice region phase conductor	B
Ice region earth conductor	B



Configuratie geleiders

Conductors back

Description	Voltage	Conductor Back	Bundle Ba	Ice region	Additional weight	Additional diameter	Catenary P_{back}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1000
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1000
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	1000
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	1000
Bliksemdraad 3		OPGW AFL-226/38	1	B	3 %	3 %	1000

Conductors ahead

Description	Voltage	Conductor Ahead	Bundle Ah	Ice region	Additional weight	Additional diameter	Catenary P_{ahead}
Circuit 1	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Circuit 2	380 kV	ACCCZ-Warsaw	3	B	3 %	3 %	1760
Bliksemdraad 1		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 2		OPGW 226	1	B	3 %	3 %	2100
Bliksemdraad 3		Niet aanwezig	1	B	3 %	3 %	2100

Insulators *(1)*

Description	Suspension	Weight [kN]	Length [m]	Wind area [m^2]
Circuit 1	Afspanketting	2.00	4.50	1.00
Circuit 2	Afspanketting	2.00	4.50	1.00
Bliksemdraad 1	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 2	Vast (Bliksemdraad)	0.10	0.30	0.10
Bliksemdraad 3	Vast (Bliksemdraad)	0.10	0.30	0.10

1. Properties apply to the entire isolator set

Suspension height and position in mast

Circuits	Designation	Number	Suspension height	Attach point	Position in tower Horizontal distance
Circuit 1	10	380ct1f1	25.2 m	25.2 m	-17.2 m
Circuit 1	11	380ct1f2	25.2 m	25.2 m	-9.0 m
Circuit 1	12	380ct1f3	36.5 m	36.5 m	-13.1 m
Circuit 2	21	380ct2f1	25.2 m	25.2 m	17.2 m
Circuit 2	20	380ct2f2	25.2 m	25.2 m	9.0 m
Circuit 2	22	380ct2f3	36.5 m	36.5 m	13.1 m
Bliksemdraad 1	1	bl1	41.5 m	41.8 m	-17.1 m
Bliksemdraad 2	3	bl2	41.5 m	41.8 m	17.1 m
Bliksemdraad 3	5	bl3	42.2 m	42.5 m	0.0 m

Project: ENS-ZL
Tower: EC-3_R
Number: 90

Height adjustment adjacent masts (wind and weight span adjustment)

	Back		Ahead		
Height increase for wind pressure	0.0	m	0.0	m	(positive: higher)
Height decrease for vertical load	0.0	m	0.0	m	(negative: decrease, more weight span)

Decrease: Niet in 0,9EG-combinaties

Height difference adjacent tower and change of direction with respect to Line direction

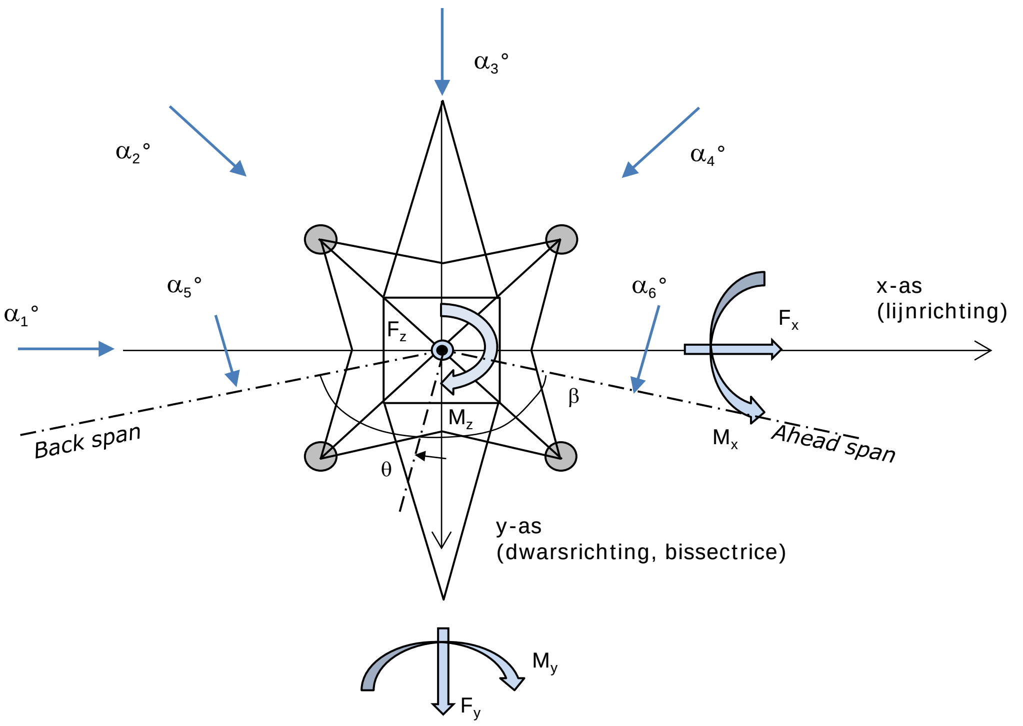
			Hoogteverschil			Richtingsverandering		
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead		Δy_back	Δy_ahead	
Circuit 1	10	380ct1f1	-9.2	17.5	m	-1.4	0.0	m
Circuit 1	11	380ct1f2	-9.2	17.5	m	-3.5	0.0	m
Circuit 1	12	380ct1f3	-20.5	17.5	m	6.2	0.0	m
Circuit 2	21	380ct2f1	-9.2	17.5	m	-2.9	0.0	m
Circuit 2	20	380ct2f2	-9.2	17.5	m	-1.5	0.0	m
Circuit 2	22	380ct2f3	-20.5	17.5	m	-10.8	0.0	m
Bliksemdraad 1	1	bl1	-19.8	17.5	m	-3.0	0.0	m
Bliksemdraad 2	3	bl2	-19.8	17.5	m	2.6	0.0	m
Bliksemdraad 3	5	bl3	-20.5	0.0	m	0.0	0.0	m

Line and tower data

		Back		Ahead	
		134.0		68.5	m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		134.0		414.6	m
Line angle	β	227.6	°		
Tower orientation with respect to bis	θ	0	°		
Section length		134		513	m
Height bottom of tower to ground level		0.5	m		
Wind directions considered	α_1	180	°		
Wind directions according to:	α_2	225	°		
Geleiderbelastingen	α_3	270	°		
	α_4	315	°		
	α_5	246.2	°		
	α_6	293.8	°		

Wind directions apply to the main direction of mast construction, not to the bisector.

Windrichtingen en positieve richtingen belastingen



Considered number of wind directions

1a	6
3	6
4	1
6	1
Overig	1

Project: ENS-ZL
Tower: EC-3_R
Number: 90

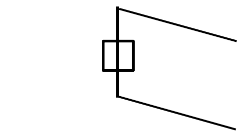
Absence of conductors

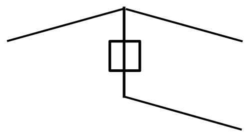
		SPLS - torsie		SPLS - Enkelzijdige trek		5a - geleiderbreuk	
		Aanw.	Afw.	Aanw.	Afw.	Aanw.	Afw.
Circuit 1	380ct1f1	1	0	1	0	1	0
Circuit 1	380ct1f2	1	0	1	0	1	0
Circuit 1	380ct1f3	1	0	1	0	1	0
Circuit 2	380ct2f1	0	1	1	0	1	0
Circuit 2	380ct2f2	0	1	1	0	1	0
Circuit 2	380ct2f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0
Bliksemdraad 3	bl3	0	1	1	0	1	0

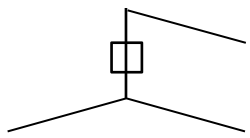
Load situations SPLS

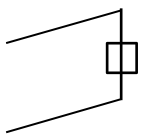
Considered situations SPLS: 1 up to 6, All possible situations

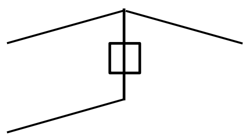
Principle of load situations:

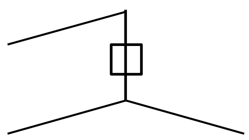

1. Ba All cts


2. Ba ct1


3. Ba ct2


4. Ah All cts

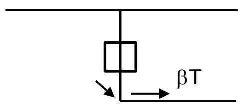

5. Ah ct1


6. Ah ct2

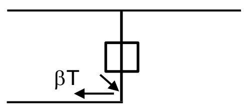
Load situation 5a. Conductor failure

Considered situations conductor failure 5a: 1 and 2, all possible situations

Principle of load situations:



1. Ba



2. Ah

Project: ENS-ZL
Tower: EC-3_R
Number: 90

Load situations LC6. Construction and maintenance

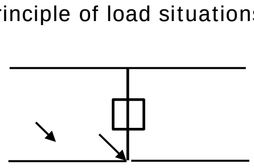
Under 6a, the load due to the presence of a line verhicle or line bicycle in combination with point load on the traverse is assesed.
Combination 6b does not contain any loads in conductor or on traverse. This combination has been added to be able to combine with separate control platforms, etc. The situations are applied in ULS and in every SPLS situation (in case of angle tower).

	Phase	Earth
Line vehicle	3.0 kN	2.0 kN
Concentrated load cross arm	1.0 kN	1.0 kN

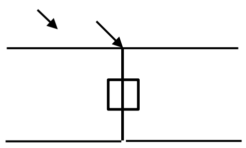
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

Presence line vehicle: Circuit, belasting tegelijk aanwezig in alle geleiders per circuit.

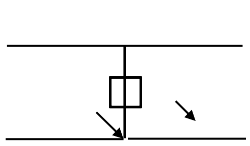
Principle of load situations:



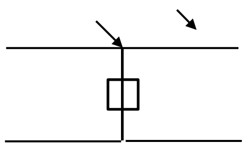
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

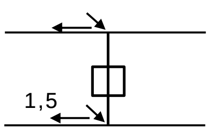
Load situations 8. Galloping as a static load

Conductor		
Suspension tower phase	0.866 W	1.5 W
Suspension tower earth	1.5 EDS	1.5 W
Strain tower phase and earth	1.5 EDS	1.5 W

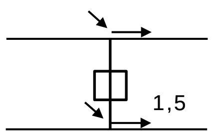
Considered situations galloping 8: None (existing structure)

Belasting tegelijk aanwezig in alle geleiders van het circuit.

Principle of load situations:



1. Ba



2. Ah

Load combination 8. Galloping as a dynamic load

Only applies to tension towers
Load consists of EDS tensile load in one of the conductors on one side of the tower
Can be converted by user to fatigue spectrum via the load spectrum of table 4.11 / NL.1

Project: ENS-ZL
Tower: EC-3_R
Number: 90

Tower structure

Properties

Tower type	Hoekmast		
Tower designation	EC-3_R		
Base plate w.r.t. ground level	0.5	m	
Tower height w.r.t. base plate	42.5	m	
Tower self weight	425.0	kN	

Width and slope at foundation	x-ri.	y-ri.	
Leg spread	11.00	11.00	m
Inclination of main leg	0.143	0.143	-
Horizontal force factor	1.3	1.3	-

Calculation Wind load

Dynamic factor G_T	1.00 *(Masthoogte < 60 m)*
Wind load diagonally to tower body proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Wind load diagonally on traverse proportional to:	(A1C1sin^2(phi)+A2C2cos^2(phi))
Magnification factor diagonal wind to tower body	(1+0,2sin^2(2phi))
Magnification factor diagonal wind to cross arm	(1+0,2sin^2(2phi))
Magnification factor wind parallel to perpendicular to cross a	0.4

Properties mast sections longitudinal direction (front view, yz plane)

Description	h	b_1	b_2	Δh	Δ_x	A_0	A_1	$\chi = A_1/A_0$	C_t
	[m]	[m]	[m]	[m]	[m]	[m^2]	[m^2]	[-]	
Broekstuk	11.50	11.00	7.71	11.50	0.143	107.61	14.80	0.14	3.22
Eerste tussenstuk	16.59	7.71	6.26	5.09	0.143	35.56	6.05	0.17	3.06
Tweede tussenstuk	25.20	6.26	3.80	8.61	0.143	43.31	10.02	0.23	2.80
Bovenstuk 1	32.85	3.80	3.20	7.65	0.039	26.78	6.17	0.23	2.80
Bovenstuk 2	40.50	3.20	2.60	7.65	0.039	22.19	5.39	0.24	2.75
Topstuk	42.50	2.60		2.00		2.60	0.50	0.19	2.96
Ondertraverse	25.20	15.30		4.00		30.60	6.72	0.22	2.85
Boventraverse	36.50	15.64		5.30		41.45	7.30	0.18	3.04

Properties tower sections transversal direction (side view, xz plane)

Description	h	b_1	b_2	Δh	Δ_x	A_0	A_1	$\chi = A_1/A_0$	C_t
	[m]	[m]	[m]	[m]	[m]	[m^2]	[m^2]	[-]	
Broekstuk	11.50	11.00	7.71	11.50	0.143	107.61	14.80	0.14	3.22
Eerste tussenstuk	16.59	7.71	6.26	5.09	0.143	35.56	6.05	0.17	3.06
Tweede tussenstuk	25.20	6.26	3.80	8.61	0.143	43.31	10.02	0.23	2.80
Bovenstuk 1	32.85	3.80	3.20	7.65	0.039	26.78	6.17	0.23	2.80
Bovenstuk 2	40.50	3.20	2.60	7.65	0.039	22.19	5.39	0.24	2.75
Topstuk	42.50	2.60		2.00		2.60	0.50	0.19	2.96
Ondertraverse	25.20	15.30		4.00		30.60	6.72	0.22	2.85
Boventraverse	36.50	15.64		5.30		41.45	7.30	0.18	3.04

Note: Surface transverse direction is reduced in calculation.

Project: ENS-ZL
Tower: EC-3_R
Number: 90

Wind surface feeders telecom installations

Part	A (m^2/m)	Factor	Δh	A_1
Broekstuk				
Eerste tussenstuk				
Tweede tussenstuk				
Bovenstuk 1				
Bovenstuk 2				

Input antennas

Description	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.			

Tower section loads longitudinal (x-direction) per wind direction

Description	p_w	F_{x1}	F_{x2}	F_{x3}	F_{x4}	h_{ef}	M_{y1}	M_{y2}	M_{y3}	M_{y4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	-33.4	-28.3	0.0	28.3	5.8	-192.0	-162.9	0.0	162.9
Eerste tussenstuk	0.79	-14.6	-12.4	0.0	12.4	14.0	-204.5	-173.5	0.0	173.5
Tweede tussenstuk	0.89	-24.9	-21.2	0.0	21.2	20.9	-521.0	-442.1	0.0	442.1
Bovenstuk 1	0.98	-17.0	-14.4	0.0	14.4	29.0	-493.7	-418.9	0.0	418.9
Bovenstuk 2	1.05	-15.5	-13.1	0.0	13.1	36.7	-568.0	-482.0	0.0	482.0
Topstuk	1.08	-1.6	-1.4	0.0	1.4	41.5	-66.5	-56.4	0.0	56.4
Ondertraverse	0.95	-36.5	-21.7	0.0	21.7	26.5	-968.3	-575.2	0.0	575.2
Boventraverse	1.06	-46.9	-27.9	0.0	27.9	38.3	-1794.6	-1065.9	0.0	1065.9
Totaal		-190.4	-140.3	0.0	140.3		-4808.6	-3376.9	0.0	3376.9

Tower section loads transversal (y-direction) per wind direction

Description	p_w	F_{y1}	F_{y2}	F_{y3}	F_{x4}	h_{ef}	M_{x1}	M_{x2}	M_{x3}	M_{x4}
	[kN/m^2]	[kN]	[kN]	[kN]	[kN]	[m]	[kNm]	[kNm]	[kNm]	[kNm]
Broekstuk	0.70	0.0	-28.3	-33.4	-28.3	5.8	0.0	-162.9	-192.0	-162.9
Eerste tussenstuk	0.79	0.0	-12.4	-14.6	-12.4	14.0	0.0	-173.5	-204.5	-173.5
Tweede tussenstuk	0.89	0.0	-21.2	-24.9	-21.2	20.9	0.0	-442.1	-521.0	-442.1
Bovenstuk 1	0.98	0.0	-14.4	-17.0	-14.4	29.0	0.0	-418.9	-493.7	-418.9
Bovenstuk 2	1.05	0.0	-13.1	-15.5	-13.1	36.7	0.0	-482.0	-568.0	-482.0
Topstuk	1.08	0.0	-1.4	-1.6	-1.4	41.5	0.0	-56.4	-66.5	-56.4
Ondertraverse	0.95	0.0	-21.7	-14.6	-21.7	26.5	0.0	-575.2	-387.3	-575.2
Boventraverse	1.06	0.0	-27.9	-18.8	-27.9	38.3	0.0	-1065.9	-717.8	-1065.9
Total		0.0	-140.3	-140.3	-140.3		0.0	-3376.9	-3150.9	-3376.9

Resulting loads from mast construction incl. Antenna without conductors level foundation (char. Value)

Load / wind direction	F_x	F_y	F_z	M_x	M_y	M_z
	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
Permanente belasting	0	0	425	0	0	0
Windrichting 180°	-190	0	0	0	-4809	0
Windrichting 225°	-140	-140	0	-3377	-3377	0
Windrichting 270°	0	-140	0	-3151	0	0
Windrichting 315°	140	-140	0	-3377	3377	0

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Intermediate results for conductor loads

Conductors back

Circuit	Geleider	Diameter [mm]	A [mm²]	G [N/m]	E [N/mm²]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 3	OPGW AFL-226/38	21.7	264.0	9.13	72000	1.98E-05

Conductors ahead

Circuit	Geleider	Diameter [mm]	A [mm²]	G [N/m]	E [N/mm²]	αT [-]
Circuit 1	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Circuit 2	ACCCZ-Warsaw	27.7	571.0	14.98	62700	1.88E-05
Bliksemdraad 1	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 2	OPGW 226	21.7	264.0	9.80	81000	2.30E-05
Bliksemdraad 3	Niet aanwezig					

Vertical load back

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]		Ice region	Formula	$w_{z,ijs}$ [N/m]	$w_{z,ijs,bundel}$ [N/m]
Circuit 1	3	3	46.3		B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3		B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1		B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1		B	4+0,2d	8.3	8.3
Bliksemdraad 3	1	3	9.4		B	4+0,2d	8.3	8.3

Vertical load ahead

Circuit	Bundle [-]	Additional [%]	$w_{z,G}$ [N/m]		Ice region	Formula	[N/m]	[N/m]
Circuit 1	3	3	46.3		B	4+0,2d	9.5	28.6
Circuit 2	3	3	46.3		B	4+0,2d	9.5	28.6
Bliksemdraad 1	1	3	10.1		B	4+0,2d	8.3	8.3
Bliksemdraad 2	1	3	10.1		B	4+0,2d	8.3	8.3
Bliksemdraad 3	1	3			B	4+0,2d		

Insulators

Conductor	$G_{isolator}$ [kN]	Number -	$F_{v,iso}$ [kN]	Length [m]	Wind surf. [m²]	Wind heigth [m]	Pressure [kN/m²]	Drag factor [-]	$F_{h,iso}$ [kN]
380ct1f1	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct1f2	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct1f3	2.00	1	2	4.5	1.0	37.00	1.05	1.2	1.26
380ct2f1	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct2f2	2.00	1	2	4.5	1.0	25.70	0.95	1.2	1.13
380ct2f3	2.00	1	2	4.5	1.0	37.00	1.05	1.2	1.26
bl1	0.10	0.5	0.05	0.3	0.1	42.00	1.08	1.2	0.13
bl2	0.10	0.5	0.05	0.3	0.1	42.00	1.08	1.2	0.13
bl3	0.10	0.5	0.05	0.3	0.1	42.70	1.09	1.2	0.13

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Wind load back

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	19.6	0.87	0.67	0.71	1.13	28.53	56.4	60.3	47.4	99.2	106.1
380ct1f2	19.6	0.87	0.67	0.71	1.13	28.53	56.4	60.3	47.4	99.2	106.1
380ct1f3	25.3	0.94	0.69	0.74	1.11	28.53	61.8	65.9	47.4	110.7	118.1
380ct2f1	19.6	0.87	0.67	0.71	1.13	28.53	56.4	60.3	47.4	99.2	106.1
380ct2f2	19.6	0.87	0.67	0.71	1.13	28.53	56.4	60.3	47.4	99.2	106.1
380ct2f3	25.3	0.94	0.69	0.74	1.11	28.53	61.8	65.9	47.4	110.7	118.1
bl1	30.6	0.99	0.71	0.75	1.20	22.35	18.8	20.1	41.8	35.3	37.6
bl2	30.6	0.99	0.71	0.75	1.20	22.35	18.8	20.1	41.8	35.3	37.6
bl3	31.0	1.00	0.71	0.75	1.20	22.35	18.9	20.2	41.8	35.4	37.7

Wind load ahead

Conductor	Height wind [m]	Pressure [kN/m^2]	$G_{c\ dwars}$ [-]	$G_{c\ trek}$ [-]	C_c [-]	$d_{additional}$ [mm]	w_y [N/m]	$w_{y,section}$ [N/m]	$D_{ijs,additional}$ [mm]	$w_{y,ijs}$ [N/m]	$w_{y,ijs,section}$ [N/m]
380ct1f1	34.2	1.03	0.72	0.62	1.09	28.53	68.5	59.7	47.4	125.4	109.2
380ct1f2	34.2	1.03	0.72	0.62	1.09	28.53	68.5	59.7	47.4	125.4	109.2
380ct1f3	45.5	1.11	0.74	0.65	1.07	28.53	75.0	65.5	47.4	140.1	122.4
380ct2f1	34.2	1.03	0.72	0.62	1.09	28.53	68.5	59.7	47.4	125.4	109.2
380ct2f2	34.2	1.03	0.72	0.62	1.09	28.53	68.5	59.7	47.4	125.4	109.2
380ct2f3	45.5	1.11	0.74	0.65	1.07	28.53	75.0	65.5	47.4	140.1	122.4
bl1	50.6	1.14	0.75	0.66	1.19	22.35	22.7	19.8	41.8	42.9	37.5
bl2	50.6	1.14	0.75	0.66	1.19	22.35	22.7	19.8	41.8	42.9	37.5
bl3	42.5	1.09	0.74	0.64							

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Project: ENS-ZL
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Number: 90

Auteur: TBR
Versie: v11.7

Conductor loads

Starting points

Consequence class	Afkeur CC2-0
Reference period	30 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.05	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.05	0.00	1.12	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.12	0.00	0.0
ULS 3	Wind+ice	-5°	1.05	1.05	0.00	0.34	0.97	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.05	0.00	0.34	0.97	0.0
ULS 4	Cold+wind	-20°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.05	0.00	0.22	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.05	1.05	1.20	0.22	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.05	1.05	0.00	0.22	0.00	0.0
ULS 7	Permanent	10°	1.15	1.15	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS (strength, for angle towers: absence of conductors)				γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.05	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.05	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.05	1.05	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.05	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.05	1.05	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.05	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.05	1.05	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.05	1.05	0.0	0.24	0.0	0.0
SLS (deformations, fatigue, EDS)								
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	0.94	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.28	0.88	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.19	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	56
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	6153

Project: ENS-ZL
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Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-28.4	37.2	0.0	0.0	9.0	1.3
380ct1f1	-79.3	128.1	0.1	0.0	16.2	3.3
380ct1f2	-78.7	128.1	0.1	0.0	16.2	3.3
380ct1f3	-81.3	130.5	0.2	0.0	23.5	3.3
380ct2f1	-78.8	128.1	0.1	0.0	16.2	3.3
380ct2f2	-79.2	128.1	0.1	0.0	16.2	3.3
380ct2f3	-76.6	130.5	0.1	0.0	23.6	3.3
bl2	-29.0	37.2	0.0	0.0	9.0	1.3
bl3	-27.4	0.0	0.0	0.0	8.9	1.3
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	
Post 3	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	-652.4	-329.3	-288.4
380ct1f1	-482.5	-313.0	-280.5
380ct1f2	-482.1	-313.0	-280.5
380ct1f3	-422.1	-192.8	-196.2
380ct2f1	-482.2	-313.0	-280.5
380ct2f2	-482.5	-313.0	-280.5
380ct2f3	-411.8	-192.2	-196.2
bl2	-657.6	-329.7	-288.4
bl3	223.9	291.8	220.0
Post 1			
Post 2			
Post 3			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	-194.9	-231.2
380ct1f1	-257.0	-262.1
380ct1f2	-257.5	-262.2
380ct1f3	-128.0	-170.9
380ct2f1	-257.3	-262.2
380ct2f2	-257.0	-262.1
380ct2f3	-138.7	-172.8
bl2	-190.4	-230.4
bl3	361.4	231.4
Post 1		
Post 2		
Post 3		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	405.1 m	4.001 -
Min. weight span	-832.9 m	-8.226 -

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Maximum values back + ahead span | Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	35.9	25.4	9.0	-31.5	41.1
380ct1f1	110.5	92.1	16.2	-87.5	140.9
380ct1f2	110.5	93.2	16.2	-87.5	140.9
380ct1f3	114.0	89.1	23.5	-87.5	143.5
380ct2f1	110.5	92.9	16.2	-87.5	140.9
380ct2f2	110.5	92.1	16.2	-87.5	140.9
380ct2f3	114.0	98.9	23.6	-87.6	143.5
bl2	35.9	24.5	9.0	-31.5	41.1
bl3	27.4	12.4	8.9	-30.1	0.0
Post 1	1.8	0.0	4.0	0.0	
Post 2	1.8	0.0	4.0	0.0	
Post 3	1.8	0.0	4.0	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	19.4	-4.3	2.2	-10.1	21.2
380ct1f1	74.5	-19.1	8.3	-46.3	81.5
380ct1f2	74.5	-19.8	8.3	-46.3	81.5
380ct1f3	74.5	-16.7	12.2	-46.3	81.5
380ct2f1	74.5	-19.6	8.3	-46.3	81.5
380ct2f2	74.5	-19.2	8.3	-46.3	81.5
380ct2f3	74.5	-22.0	12.2	-46.3	81.5
bl2	19.4	-3.9	2.2	-10.1	21.2
bl3	0.0	0.0	2.1	-9.4	0.0
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	
Post 3	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	-6.3
	380ct1f1	0.0	-20.2
	380ct1f2	0.0	-20.2
	380ct1f3	0.0	-20.3
	380ct2f1	0.0	-20.2
	380ct2f2	0.0	-20.2
	380ct2f3	0.0	-20.3
	bl2	0.0	-6.3
	bl3	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	
	Post 3	0.0	

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ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270		330	-576	-91	-17294	9855	18
ULS 1a_0,9_180		211	-363	-45	-10809	6300	-52
ULS 1a_0,9_0,9_270		313	-554	-93	-16654	9360	13
ULS 3_180		309	-557	-78	-16640	9175	23
SLS 7		207	-343	-39	-10166	6142	31

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

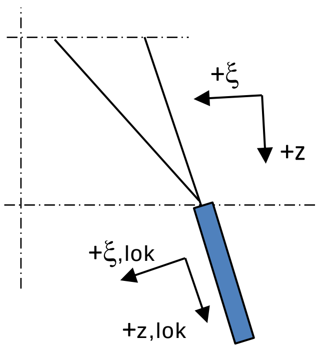
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270	330	-733	355	-20813	9855	18
ULS 1a_0,9_0,9_270	313	-710	289	-20172	9360	13
SLS 7	207	-343	386	-10166	6142	31

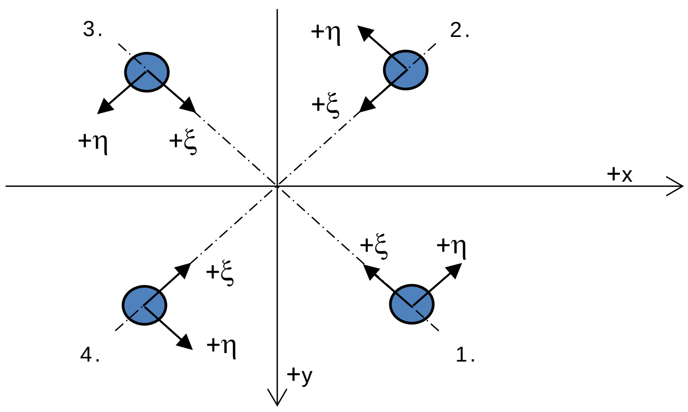
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_270	330	-733	290	-20833	9855	18
SPLS 3_246.2 Ba All Cts	711	-391	289	-11268	21642	-13
SPLS 6a_270 Ah Ct1 Ba Ct1	-180	-365	524	-12001	-5800	5182
ULS 1a_0,9_246.2	395	-730	260	-20732	12482	-36

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_315 Ba All Cts	105	101	559	3	-145	-32	571
2	ULS 1a_246.2	290	-302	1590	9	-418	-97	1622
3	SPLS 6a_270 Ah All Cts Ba Ct1	-239	-168	1115	50	-288	-63	1137
4	SPLS 1a_180 Ah All Cts	-105	99	541	-4	-145	-35	552

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ah All Cts Ba Ct1	-110	-187	-818	55	210	45	-835
2	SPLS 1a_0,9_180 Ah All Cts	-57	54	-288	2	78	20	-294
3	SPLS 3_0,9_270 Ba All Cts	75	75	-420	0	106	21	-429
4	ULS 1a_0,9_246.2	261	-277	-1445	-11	380	88	-1474

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ah Ct1 Ba Ct1	-4	-234	-678	162	168	31	-692
2	SPLS 6a_270 Ah Ct1 Ba Ct1	-37	-184	413	156	-104	-21	421
3	SPLS 6a_270 Ah Ct1 Ba Ct1	-288	-47	940	171	-237	-47	959
4	SPLS 6a_270 Ah Ct1 Ba Ct1	150	100	-151	177	35	5	-154

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_270 Ah Ct2 Ba Ct2	-216	0	-563	-153	153	39	-574
2	SPLS 6a_270 Ah Ct2 Ba Ct2	176	48	303	-158	-91	-29	309
3	SPLS 6a_270 Ah Ct2 Ba Ct2	-33	-281	825	-175	-222	-55	842
4	SPLS 6a_270 Ah Ct2 Ba Ct2	-104	-135	-41	-169	22	13	-42

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Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ah Ct1 Ba Ct1	-4	-234	-678	162	168	31	-692
2	SPLS 6a_270 Ah All Cts Ba Ct2	10	61	-160	-50	36	3	-164
3	SPLS 6a_270 Ba All Cts Ah Ct1	89	36	-356	-37	88	16	-363
4	SPLS 3_0,9_246.2 Ba Ct2	297	-183	-1308	81	339	75	-1334

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-15	-17	-86	1	23	5	-88
2	SLS 7	155	-156	838	1	-220	-51	855
3	SLS 7	-53	-51	279	1	-73	-17	285
4	SLS 7	120	-119	-645	1	169	39	-658

Envelope of load combinations for all of the legs

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_246.2	290	-302	1590	9	-418	-97	1622
Max. tension	ULS 1a_0,9_246.2	261	-277	-1445	-11	380	88	-1474
Max. pos. torsie	SPLS 6a_270 Ah Ct1 Ba Ct1	150	100	-151	177	35	5	-154
Max. neg. torsie	SPLS 6a_270 Ah Ct2 Ba Ct2	-33	-281	825	-175	-222	-55	842
Comb. tension+torsie	SPLS 3_0,9_246.2 Ba Ct2	297	-183	-1308	81	339	75	-1334

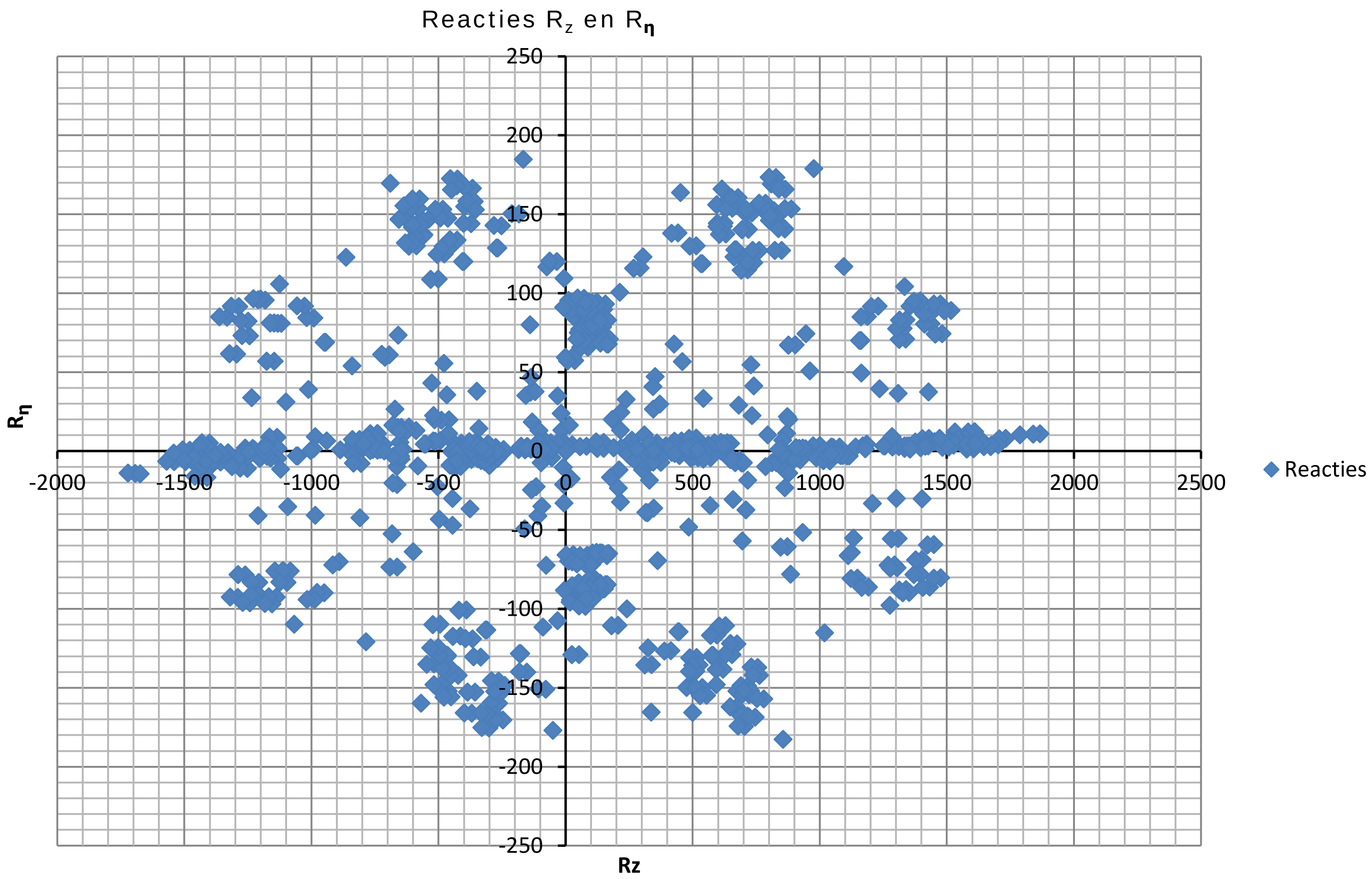
Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-15	-17	-86	1	23	5	-88
2	SLS 7	155	-156	838	1	-220	-51	855
3	SLS 7	-53	-51	279	1	-73	-17	285
4	SLS 7	120	-119	-645	1	169	39	-658

Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-15	-17	-86	1	23	5	-88
2	SLS 7	155	-156	838	1	-220	-51	855
3	SLS 7	-53	-51	279	1	-73	-17	285
4	SLS 7	120	-119	-645	1	169	39	-658

Project: ENS-ZL
Tower: EC-3_R
Number: 90



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Project: ENS-ZL
Tower: EC-3_R
Number: 90

Auteur: TBR
Versie: v11.7

Conductor loads

Starting points

Consequence class	Verbouw CC2
Reference period	50 jaar

ULS (strength)		NEN-EN50341-2-15:2019						
Load case	description	Temp	γ_G	γ_G		γ_Q		γ_a
		°C	$G_{k,mast}$	$G_{k,geleider}$	Q_{pk}	Q_{wk}	Q_{ik}	A_k
ULS 1a	Wind	10°	1.15	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk only tower	10°	0.90	1.15	0.00	1.40	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk conductors too	10°	0.90	0.90	0.00	1.40	0.00	0.0
ULS 3	Wind+ice	-5°	1.15	1.15	0.00	0.42	1.30	0.0
ULS 3_0,9	Wind+ice 0,9Gk	-5°	0.90	1.15	0.00	0.42	1.30	0.0
ULS 4	Cold+wind	-20°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 4_0,9	Cold+wind 0,9Gk	-20°	0.90	1.15	0.00	0.28	0.00	0.0
ULS 5a	Torsional loads	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinal loads	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Construction + maintenance	5°	1.15	1.15	1.30	0.28	0.00	0.0
ULS 6_0,9	Construction + maintenance	5°	1.15	1.15	0.00	0.28	0.00	0.0
ULS 7	Permanent	10°	1.30	1.30	0.00	0.00	0.00	0.0
ULS 8	Special	10°	1.00	1.00	0.00	0.00	0.00	1.0
SPLS	(strength, for angle towers: absence of conductors)			γ_G	γ_Q			
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SPLS 1a	Wind	10°	1.15	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	1.15	0.0	0.78	0.00	0.0
SPLS 3	Wind+ice	-5°	1.15	1.15	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ice 0,9	-5°	0.90	1.15	0.0	0.36	0.34	0.0
SPLS 4	Cold+wind	-20°	1.15	1.15	0.0	0.24	0.00	0.0
SPLS 4_0,9	Cold+wind 0,9	-20°	0.90	1.15	0.0	0.24	0.00	0.0
SPLS 6	Maintenance	5°	1.15	1.15	1.2	0.24	0.0	0.0
SPLS 6_0,9	Maintenance	5°	1.15	1.15	0.0	0.24	0.0	0.0
SLS	(deformations, fatigue, EDS)							
				G_k	Q_{pk}	Q_{wk}	Q_{ik}	A_k
SLS 1a	Wind	10°	1.00	1.00	0.0	1.00	0.0	0.0
SLS 3	Wind+ice	-5°	1.00	1.00	0.0	0.30	1.00	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 6	Maintenance	5°	1.00	1.00	0.0	0.20	0.0	0.0
SLS 7	EDS, no wind	10°	1.00	1.00	0.0	0.00	0.0	0.0

Number of wind directions	6
Number of load combinations for ULS	56
Number of load combinations for SPLS	222
Number of load combinations for SLS	15
Number of concentrated loads	6153

Project: ENS-ZL
Tower: EC-3_R
Number: 90

Summary table - Conductor loads

The four tables below show:
- The maximum conductor load in the global axis system, split into proportion of back and ahead span
- The combined conductor load (Ba+Ah) in the global axis system with the maximum tensile force in the local axes. Components Fx and Fy as absolute values
- The everyday (EDS) values of the combined conductor loads (Ba+Ah) with corresponding tensile forces
- Check for uplift, where a negative value indicates uplift

Note: Maximum values for Fx, Fy and Fz do not necessarily belong to the same load combination.

Maximum values for back and ahead span

Geleider	Fx_ba [kN]	Fx_ah [kN]	Fy_ba [kN]	Fy_ah [kN]	Fz_ba [kN]	Fz_ah [kN]
bl1	-30.1	43.1	0.0	0.0	9.7	1.3
380ct1f1	-84.3	147.9	0.1	0.0	17.5	3.5
380ct1f2	-83.7	147.9	0.1	0.0	17.5	3.5
380ct1f3	-86.4	150.8	0.2	0.0	25.3	3.5
380ct2f1	-83.8	147.9	0.1	0.0	17.5	3.5
380ct2f2	-84.3	147.9	0.1	0.0	17.5	3.5
380ct2f3	-81.4	150.8	0.1	0.0	25.3	3.5
bl2	-30.7	43.1	0.0	0.0	9.7	1.3
bl3	-29.0	0.0	0.0	0.0	9.6	1.4
Post 1	0.0	0.0	0.0	0.0	0.0	
Post 2	0.0	0.0	0.0	0.0	0.0	
Post 3	0.0	0.0	0.0	0.0	0.0	

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	-680.6	-331.0	-288.4
380ct1f1	-501.4	-313.9	-280.5
380ct1f2	-500.9	-313.8	-280.5
380ct1f3	-442.3	-193.7	-196.2
380ct2f1	-501.0	-313.9	-280.5
380ct2f2	-501.4	-313.9	-280.5
380ct2f3	-431.1	-193.0	-196.2
bl2	-686.3	-331.4	-288.4
bl3	224.4	292.5	220.0
Post 1			
Post 2			
Post 3			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	-174.1	-213.6
380ct1f1	-248.9	-251.0
380ct1f2	-249.5	-251.1
380ct1f3	-113.7	-164.0
380ct2f1	-249.3	-251.1
380ct2f2	-248.9	-251.0
380ct2f3	-125.8	-165.9
bl2	-169.1	-212.8
bl3	378.4	222.4
Post 1		
Post 2		
Post 3		

Envelop of weight span over all combinations (incl. 0,9 combinations)

For all conductors		Wind / Weight span ratio
Max. weight span	457.8 m	4.521 -
Min. weight span	-988.0 m	-9.758 -

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Project: ENS-ZL
Tower: EC-3_R
Number: 90

Maximum values back + ahead span — Maximum tension in conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	37.0	29.1	9.7	-33.4	47.6
380ct1f1	115.4	105.7	17.5	-93.1	162.6
380ct1f2	115.4	107.0	17.5	-93.1	162.6
380ct1f3	118.7	102.4	25.3	-93.6	165.9
380ct2f1	115.4	106.6	17.5	-93.1	162.6
380ct2f2	115.4	105.7	17.5	-93.1	162.6
380ct2f3	118.7	113.6	25.3	-93.6	165.9
bl2	37.0	28.2	9.7	-33.4	47.6
bl3	29.0	13.2	9.6	-31.9	0.0
Post 1	2.2	0.0	4.6	0.0	
Post 2	2.2	0.0	4.6	0.0	
Post 3	2.2	0.0	4.6	0.0	

EDS-loads conductor

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	19.4	-4.3	2.2	-10.1	21.2
380ct1f1	74.5	-19.1	8.3	-46.3	81.5
380ct1f2	74.5	-19.8	8.3	-46.3	81.5
380ct1f3	74.5	-16.7	12.2	-46.3	81.5
380ct2f1	74.5	-19.6	8.3	-46.3	81.5
380ct2f2	74.5	-19.2	8.3	-46.3	81.5
380ct2f3	74.5	-22.0	12.2	-46.3	81.5
bl2	19.4	-3.9	2.2	-10.1	21.2
bl3	0.0	0.0	2.1	-9.4	0.0
Post 1	0.0	0.0	3.5	0.0	
Post 2	0.0	0.0	3.5	0.0	
Post 3	0.0	0.0	3.5	0.0	

1 Control uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	0.0	-6.3
	380ct1f1	0.0	-20.2
	380ct1f2	0.0	-20.2
	380ct1f3	0.0	-20.3
	380ct2f1	0.0	-20.2
	380ct2f2	0.0	-20.2
	380ct2f3	0.0	-20.3
	bl2	0.0	-6.3
	bl3	0.0	0.0
	Post 1	0.0	
	Post 2	0.0	
	Post 3	0.0	

Project: ENS-ZL
Tower: EC-3_R
Number: 90

ULS foundation loads for LC 1 and 3, wind purpendicular to the line or bisector and EDS, from conductors

Combination	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270		386	-668	-110	-20063	11530	18
ULS 1a_0,9_180		230	-394	-49	-11722	6869	-69
ULS 1a_0,9_0,9_270		362	-636	-115	-19166	10823	11
ULS 3_180		364	-633	-90	-18920	10802	23
SLS 7		207	-343	-39	-10166	6142	31

ULS foundation loads, LC 1 and 3, wind purpendicular to the line or bisector and EDS, total conductors and tower

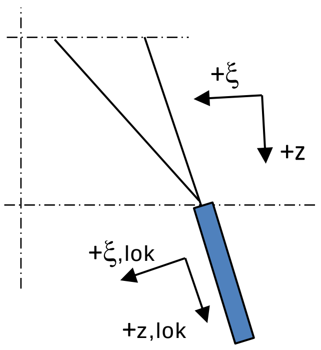
Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_270	386	-864	379	-24474	11530	18
ULS 1a_0,9_0,9_270	362	-833	267	-23577	10823	11
SLS 7	207	-343	386	-10166	6142	31

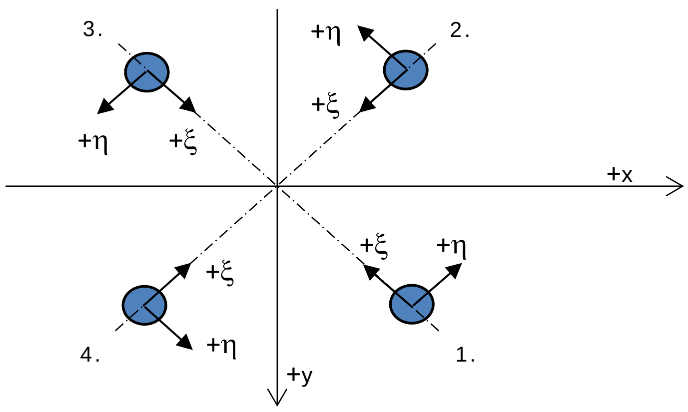
Foundation loads, selection of load combinations based on greatest value

Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_270	386	-864	270	-24508	11530	18
SPLS 3_246.2 Ba All Cts	742	-405	327	-11657	22555	-13
SPLS 6a_270 Ah Ct1 Ba Ct1	-178	-382	569	-12563	-5761	5421
ULS 1a_0,9_246.2	469	-860	233	-24357	14835	-52

Note: Largest values can appear in multiple combinations, one combination is displayed.

Support reactions per leg





Axis systems

Maximum compression load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 3_315 Ba All Cts	112	108	599	3	-155	-34	611
2	ULS 1a_246.2	340	-355	1865	11	-491	-114	1903
3	SPLS 6a_270 Ah All Cts Ba Ct1	-247	-178	1163	49	-301	-66	1186
4	SPLS 1a_180 Ah All Cts	-110	105	570	-4	-152	-37	582

Maximum tension load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ah All Cts Ba Ct1	-115	-191	-841	54	216	46	-858
2	SPLS 1a_0,9_180 Ah All Cts	-59	56	-302	2	82	21	-308
3	SPLS 3_0,9_270 Ba All Cts	80	80	-447	0	113	23	-456
4	ULS 1a_0,9_246.2	311	-331	-1723	-14	454	105	-1758

Maximum torsional load (positive)

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ah Ct1 Ba Ct1	-1	-241	-691	170	171	31	-705
2	SPLS 6a_270 Ah Ct1 Ba Ct1	-35	-196	451	164	-114	-23	461
3	SPLS 6a_270 Ah Ct1 Ba Ct1	-300	-47	975	179	-246	-49	995
4	SPLS 6a_270 Ah Ct1 Ba Ct1	158	103	-167	185	39	5	-170

Maximum torsional load (negative)

Index	Combination	R_x	R_y	R_z	R_η	R_ξ	$R_{\xi,lok}$	$R_{z,lok}$
Index	Combination	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
1	SPLS 6a_270 Ah Ct2 Ba Ct2	-223	3	-570	-160	155	40	-581
2	SPLS 6a_270 Ah Ct2 Ba Ct2	187	47	336	-166	-100	-32	343
3	SPLS 6a_270 Ah Ct2 Ba Ct2	-34	-292	854	-183	-230	-58	872
4	SPLS 6a_270 Ah Ct2 Ba Ct2	-108	-143	-51	-177	25	15	-52

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Project: ENS-ZL
Tower: EC-3_R
Number: 90

Combination Ftensile+Fhor

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SPLS 6a_270 Ah Ct1 Ba Ct1	-1	-241	-691	170	171	31	-705
2	SPLS 6a_270 Ah All Cts Ba Ct2	9	60	-162	-49	36	3	-165
3	SPLS 6a_270 Ba All Cts Ah Ct1	92	40	-376	-37	94	18	-384
4	ULS 1a_0,9_246.2	311	-331	-1723	-14	454	105	-1758

Permanent load

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-15	-17	-86	1	23	5	-88
2	SLS 7	155	-156	838	1	-220	-51	855
3	SLS 7	-53	-51	279	1	-73	-17	285
4	SLS 7	120	-119	-645	1	169	39	-658

Envelope of load combinations for all of the legs

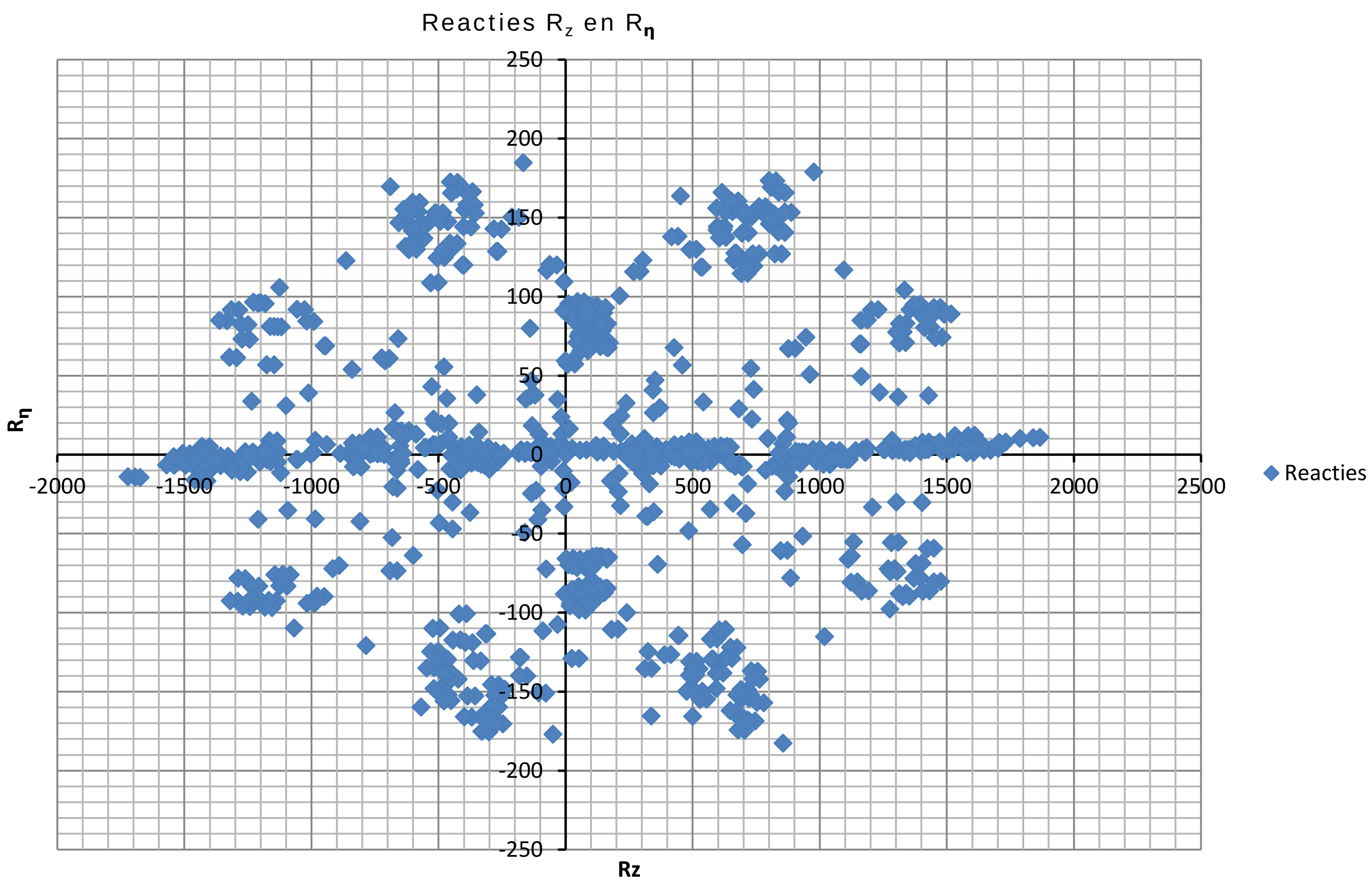
Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. pressure	ULS 1a_246.2	340	-355	1865	11	-491	-114	1903
Max. tension	ULS 1a_0,9_246.2	311	-331	-1723	-14	454	105	-1758
Max. pos. torsie	SPLS 6a_270 Ah Ct1 Ba Ct1	158	103	-167	185	39	5	-170
Max. neg. torsie	SPLS 6a_270 Ah Ct2 Ba Ct2	-34	-292	854	-183	-230	-58	872
Comb. tension+torsie	ULS 1a_0,9_246.2	311	-331	-1723	-14	454	105	-1758

Maximum tension load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-15	-17	-86	1	23	5	-88
2	SLS 7	155	-156	838	1	-220	-51	855
3	SLS 7	-53	-51	279	1	-73	-17	285
4	SLS 7	120	-119	-645	1	169	39	-658

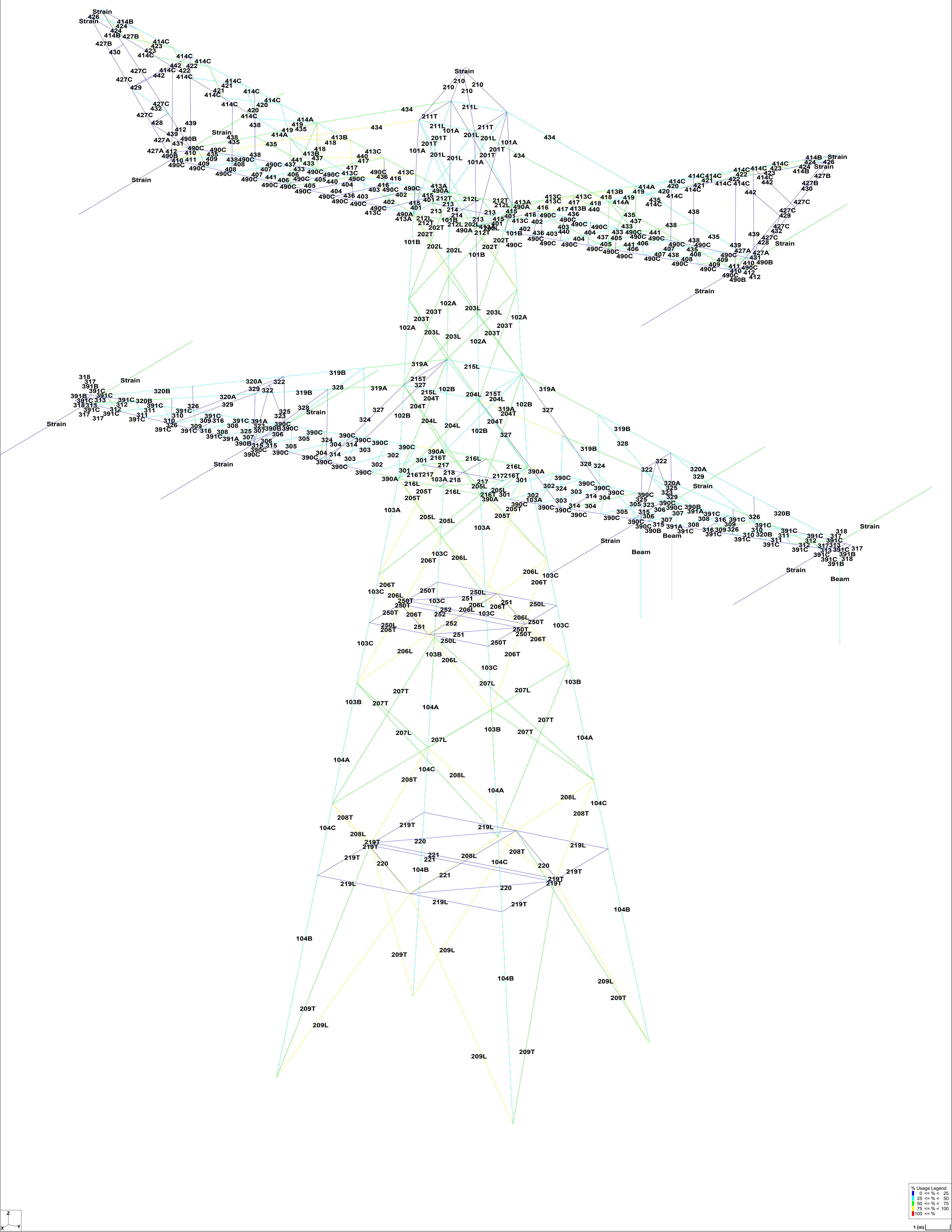
Maximum compression load - SLS

Index	Combination	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
1	SLS 7	-15	-17	-86	1	23	5	-88
2	SLS 7	155	-156	838	1	-220	-51	855
3	SLS 7	-53	-51	279	1	-73	-17	285
4	SLS 7	120	-119	-645	1	169	39	-658


Reacties R_z en R_η
250
200
150
100
50
0
-50
-100
-150
-200
-250
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
R_η
Rz
Reacties

APPENDIX B
Uitvoer PLS-TOWER

DNV GL Nederlands BV, Project: "EC-3_R (1) ini"
Tower Version 16.86, 13:35:14 Friday, 3 December, 2021
Undeformed geometry displayed



Assessment of groups for initial mast (afkeur level)

Date	03-12-21
Author	MRE
Version	1.0

ENS-ZL 380
EC-3 / R
1

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101A	Leg	120x120x10	S355	7M24-8.8t	0.50	0.50	0.50	85	-76.8	SPLS 6a_270 Ah Ct2 Ah Ct1	485.4	937.0	1234.8	0.16		24.5	.S 6a_270 Ah Ct2 Ah Ct1	635.0	937.0	1234.8	0.04	
101B	Leg	120x120x10	S355	8M24-8.8t	0.50	0.50	0.50	77	-180.1	ULS 1a_255	537.3	1084.4	1411.2	0.34		141.0	SPLS 1a_0,9_255 Ah Ct2	635.0	1084.4	1326.8	0.22	
102A	leg	150x150x14	S355	6M24-8.8t	0.50	0.50	0.50	62	-445.1	ULS 1a_255	1090.3	813.3	1481.8	0.55		342.3	ULS 1a_0,9_255	1159.3	813.3	1393.1	0.42	
102B	leg	150x150x14	S355	8M24-8.8t	0.50	0.50	0.50	68	-442.3	ULS 1a_255	1030.1	2168.8	1975.7	0.43		318.5	ULS 1a_0,9_255	1159.3	2168.8	1925.0	0.27	
103A	Leg	200x200x16	S355	10M24-8.8t	0.26	0.26	0.26	27	-835.3	ULS 1a_255	2098.3	2711.0	2822.4	0.40		650.6	ULS 1a_0,9_255	1886.8	2711.0	2653.5	0.34	
103B	Leg	200x200x16	S355	12M24-8.8t	0.53	0.53	0.53	31	-1202.6	ULS 1a_255	2058.7	3124.5	3386.9	0.58		977.5	ULS 1a_0,9_255	1886.8	3124.5	3184.2	0.52	
103C	Leg	200x200x16	S355		0.52	0.52	0.52	34	-1030.7	ULS 1a_255	2028.2	0.0	0.0	0.51		825.2	ULS 1a_0,9_255	2193.9	0.0	0.0	0.38	
104A	Leg	200x200x24	S355	12M24-8.8t	0.53	0.53	0.53	39	-1206.3	ULS 1a_255	2901.1	3124.5	5080.3	0.42		974.8	ULS 1a_0,9_255	2756.1	3124.5	4776.4	0.35	
104B	Leg	200x200x24	S355	12M24-8.8t	0.20	0.20	0.20	44	-1312.6	ULS 1a_255	2809.5	3236.3	5080.3	0.47		1063.7	ULS 1a_0,9_255	2756.1	3236.3	4385.6	0.39	
104C	Leg	200x200x24	S355		0.50	0.50	0.50	39	-1308.5	ULS 1a_255	2896.6	0.0	0.0	0.45		1068.9	ULS 1a_0,9_255	3216.3	0.0	0.0	0.33	
201L	CD	100x100x8	S355	2M24-8.8t	0.53	0.53	0.53	131	-62.3	SPLS 6a_270 Ba Ct2 Ah Ct1	177.8	271.1	282.2	0.35		64.3	.S 6a_270 Ba Ct2 Ah Ct1	246.8	271.1	265.4	0.26	
201T	CD	90x90x8	S355	1M24-8.8t	1.00	0.53	0.53	177	-33.6	SPLS 6a_270 Ba Ct2 Ah Ct1	103.2	135.6	141.1	0.33		14.6	SPLS 3_0,9_270 Ba Ct2	200.7	135.6	132.7	0.11	
202L	CD	150x150x12	S355	4M24-8.8t	0.53	0.53	0.53	86	-336.5	SPLS 6a_270 Ba Ct1 Ba Ct2	636.5	542.2	846.7	0.62		291.7	.S 6a_270 Ba Ct2 Ah Ct2	659.1	542.2	763.9	0.54	
202T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	86	-316.0	SPLS 6a_270 Ba Ct1 Ba Ct1	636.5	406.7	635.0	0.78		301.2	.S 6a_270 Ba Ct1 Ba Ct2	659.1	406.7	579.5	0.74	
203L	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	89	-254.9	SPLS 6a_270 Ba Ct2 Ah Ct2	614.6	406.7	635.0	0.63		293.0	.S 6a_270 Ba Ct1 Ba Ct2	659.1	406.7	579.5	0.72	
203T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	89	-262.1	SPLS 6a_270 Ba Ct1 Ba Ct2	614.6	406.7	635.0	0.64		274.5	.S 6a_270 Ba Ct2 Ba Ct1	659.1	406.7	579.5	0.68	
204L	CD	150x150x14	S355	4M24-8.8t	0.53	0.53	0.53	98	-263.4	SPLS 6a_270 Ah Ct2 Ba Ct2	648.2	542.2	987.8	0.49		295.2	.S 6a_270 Ba Ct2 Ba Ct1	759.4	542.2	891.2	0.54	
204T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	97	-303.2	SPLS 6a_270 Ba Ct2 Ba Ct1	563.9	406.7	635.0	0.75		224.7	.S 6a_270 Ba Ct1 Ah Ct1	659.1	406.7	579.5	0.55	
205L	CD	150x150x14	S355	5M24-8.8t	0.57	0.28	0.28	75	-467.8	SPLS 6a_270 Ba Ct2 Ah Ct2	777.4	677.8	1234.8	0.69		453.0	.S 6a_270 Ba Ct2 Ah Ct2	759.4	677.8	1106.5	0.67	
205T	CD	150x150x12	S355	4M24-8.8t	0.57	0.28	0.28	74	-446.8	SPLS 6a_270 Ba Ct1 Ba Ct2	676.2	542.2	846.7	0.82		446.6	.S 6a_270 Ba Ct2 Ba Ct1	659.1	542.2	763.9	0.82	
206L	CD	150x150x12	S355	3M24-8.8t	1.00	0.56	0.56	70	-337.6	SPLS 6a_270 Ba Ct2 Ah Ct2	707.3	406.7	635.0	0.83		345.1	.S 6a_270 Ba Ct2 Ah Ct2	659.1	406.7	579.5	0.85	
206T	CD	150x150x12	S235	3M24-8.8t	1.00	0.56	0.56	88	-343.0	SPLS 6a_270 Ba Ct2 Ba Ct1	459.3	406.7	466.6	0.84		330.5	.S 6a_270 Ba Ct1 Ba Ct2	484.3	406.7	389.1	0.85	
207L	CD	150x150x12	S355	3M24-8.8t	0.56	0.28	0.28	106	-261.4	SPLS 6a_270 Ba Ct2 Ah Ct2	488.9	406.7	635.0	0.64		256.1	.S 6a_270 Ba Ct2 Ah Ct2	678.2	406.7	434.2	0.63	
207T	CD	150x150x12	S355	3M24-8.8t	0.56	0.28	0.28	106	-253.9	SPLS 6a_270 Ba Ct1 Ba Ct2	488.9	406.7	635.0	0.62		262.7	.S 6a_270 Ba Ct2 Ba Ct1	678.2	406.7	434.2	0.65	
208L	CD	150x150x12	S235	2M24-8.8t	1.00	0.50	0.50	107	-219.2	SPLS 6a_270 Ba Ct1 Ba Ct2	393.3	271.1	311.0	0.81		216.0	.S 6a_270 Ba Ct2 Ah Ct2	428.1	271.1	292.4	0.80	
208T	CD	150x150x12	S235	2M24-8.8t	1.00	0.50	0.50	107	-221.9	SPLS 6a_270 Ba Ct2 Ba Ct1	393.3	271.1	311.0	0.82		209.3	.S 6a_270 Ba Ct1 Ba Ct2	428.1	271.1	292.4	0.77	
209L	CD	120x120x12	S355	3M24-8.8t	0.20	0.20	0.20	87	-316.4	SPLS 6a_270 Ba Ct1 Ba Ct2	496.8	406.7	635.0	0.78		309.8	.S 6a_270 Ba Ct2 Ah Ct2	507.3	406.7	591.2	0.76	
209T	CD	120x120x12	S355	3M24-8.8t	0.20	0.20	0.20	87	-324.0	SPLS 6a_270 Ba Ct2 Ba Ct1	496.8	406.7	635.0	0.80		293.8	.S 6a_270 Ba Ct1 Ba Ct2	507.3	406.7	591.2	0.72	
210	Top	90x90x8	S355	2M20-8.8t	1.00	1.00	1.00	154	-18.1	SPLS 3_270 Ba Ct1	128.8	188.2	235.2	0.14		17.9	SPLS 3_0,9_270 Ba Ct1	229.3	188.2	213.8	0.10	
211L		100x100x8	S355	4M24-8.8t	1.00	1.00	1.00	133	0.0		175.7	542.2	564.5	0.00		136.4	ULS 3_255	287.3	542.2	530.7	0.47	
211T		100x100x8	S355	1M24-8.8t	1.00	1.00	1.00	133	-5.7	SPLS 6a_270 Ba Ct2 Ah Ct1	140.6	135.6	141.1	0.04		7.4	.S 6a_270 Ba Ct2 Ah Ct1	232.1	135.6	132.7	0.06	
212L		200x200x16	S355	8M24-8.8t	1.00	2.00	1.00	47	-613.4	SPLS 3_270 Ah All Cts	1882.3	991.8	2257.9	0.62		512.7	PLS 3_0,9_270 Ah All Cts	1442.6	991.8	2122.8	0.52	
212T		120x120x10	S235	4M24-8.8t	1.00	2.00	1.00	79	-138.9	SPLS 6a_270 Ba Ct2 Ba Ct1	328.3	542.2	518.4	0.42		151.8	.S 6a_270 Ba Ct2 Ba Ct1	466.6	542.2	447.5	0.34	
213		120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-193.8	SPLS 6a_270 Ba Ct2 Ah Ct2	325.2	406.7	388.8	0.60		193.3	.S 6a_270 Ba Ct2 Ah Ct2	296.6	406.7	302.4	0.65	
214		50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.3	ULS 3_240	31.9	60.3	43.2	0.01		0.2	ULS 6a_270 Ah Ct1	46.1	60.3	32.7	0.01	
215L		120x120x10	S355	5M24-8.8t	1.00	1.00	1.00	148	-16.6	SPLS 3_0,9_270 Ah All Cts	228.2	677.8	882.0	0.07		206.7	ULS 3_270	441.0	677.8	829.2	0.47	
215T		100x100x8	S355	2M24-8.8t	1.00	1.00	1.00	178	-31.3	ULS 1a_0,9_255	117.4	271.1	282.2	0.27		43.7	ULS 1a_255	368.2	271.1	265.4	0.16	
216L		200x200x16	S355	9M24-8.8t	1.00	2.00	1.00	62	-647.7	SPLS 3_270 Ah All Cts	1686.0	915.0	2540.2	0.71		465.0	PLS 3_0,9_270 Ah All Cts	1581.6	915.0	2388.2	0.51	
216T		120x120x10	S235	4M24-8.8t	1.00	2.00	1.00	104	-129.3	SPLS 6a_270 Ba Ct2 Ba Ct1	269.2	542.2	518.4	0.48		151.4	.S 6a_270 Ba Ct2 Ba Ct1	466.6	542.2	487.4	0.32	
217		120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-194.3	SPLS 6a_270 Ba Ct2 Ah Ct2	261.1	406.7	388.8	0.74		194.3	.S 6a_270 Ba Ct2 Ah Ct2	324.0	406.7	359.4	0.60	
218		50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.7	ULS 3_240	29.9	60.3	60.5	0.02		0.8	ULS 3_240	64.5	60.3	45.8	0.02	
219L		90x90x8	S235	2M16-8.8t	1.00	1.00	1.00	244	-5.7	SPLS 1a_255 Ah All Cts	59.4	120.6	138.2	0.10		5.6	ULS 1a_0,9_255	229.7	120.6	119.5	0.05	
219T		90x90x8	S235	4M20-8.8t	27.30	2.00	1.00	156	-8.8	ULS 1a_225	104.2	376.3	345.6	0.08		8.2	ULS 1a_0,9_225	269.1	376.3	314.2	0.03	
220		80x80x8	S235	2M20-8.8t	1.00	0.50	0.50	245	-5.1	ULS 1a_240	50.0	188.2	172.8	0.10		4.6	ULS 1a_0,9_240	146.3	188.2	157.1	0.03	
221		80x80x8	S235	1M20-8.8t	0.50	0.50	0.50	275	-1.6	ULS 1a_315	34.9	94.1	86.4	0.05		0.2	ULS 1a_0,9_315	133.6	94.1	78.5	0.00	
490A	Tweede DWSRM onderregel	160x160x15	S355	8M24-8.8t	1.00	2.27	1.00	60	-439.6	SPLS 6a_270 Ah Ct2 Ba Ct2	1293.6	991.8	2116.8	0.44		320.4	SPLS 3_0,9_270 Ah Ct1	1071.4	991.8	1990.2	0.32	
490B	Tweede DWSRM onderregel	160x160x15	S355		2.00	1.00	1.00	13	0.0		1658.2	0.0	0.0	0.00		7.8	ULS 3_270	1658.2	0.0	0.0	0.00	
490C	Tweede DWSRM onderregel	160x160x15	S355		1.00	2.37	1.00	60	-424.0	SPLS 6a_270 Ah Ct2 Ba Ct2	1293.3	0.0	0.0	0.33		303.4	SPLS 3_0,9_270 Ah Ct1	1658.2	0.0	0.0	0.18	
401	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	104	-18.3	SPLS 3_0,9_255 Ah All Cts	115.0	188.2	129.6	0.16		18.7	SPLS 3_255 Ah All Cts	93.1	188.2	91.6	0.20	
402	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	99	-22.2	SPLS 3_255 Ah Ct1	120.2	188.2	129.6	0.18		22.6	SPLS 3_0,9_255 Ah Ct2	94.4	188.2	78.5	0.29	
403	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	94	-23.3	SPLS 3_255 Ah Ct1	124.7	188.2	129.6	0.19		23.2	SPLS 3_0,9_255 Ah Ct1	95.6	188.2	91.6	0.25	
404	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	90	-24.1	SPLS 3_0,9_270 Ah Ct1	129.2	188.2	129.6	0.19		24.1	SPLS 3_270 Ah Ct1	95.6	188.2	91.6	0.26	
405	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	85	-31.5	SPLS 3_270 Ah Ct1	133.7	188.2	129.6	0.24		31.4	SPLS 3_0,9_270 Ah Ct1	96.9	188.2	108.7	0.32	
406	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	81	-49.6	SPLS 3_270 Ah All Cts	138.3	188.2	129.6	0.38		48.5	PLS 3_0,9_270 Ah All Cts	98.2	188.2	109.7	0.49	
407	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	78	-52.6	SPLS 3_270 Ah Ct1	184.6	188.2	172.8	0.30		54.5	SPLS 3_0,9_270 Ah Ct1	129.7	188.2	147.4	0.42	
408	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	74	-59.7	SPLS 3_0,9_270 Ah Ct1	190.6	188.2	172.8	0.35		57.4	SPLS 3_270 Ah Ct1	138.0	188.2	139.6	0.42	
409	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	64	-70.7	SPLS 3_270 Ah Ct1	231.7	271.1	207.4	0.34		68.8	SPLS 3_0,9_270 Ah Ct1	136.2	271.1	161.3	0.51	
410	CD	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	66	-35.8	SPLS 3_270 Ah Ct1	202.3	271.1	207.4	0.18		28.8	SPLS 3_0,9_270 Ah Ct1	117.7	271.1	161.3	0.24	
411	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	67	0.0		607.6	188.2	352.8	0.00		53.4	ULS 3_255	692.3	188.2	89.9	0.59	
412	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	2.00	1.00	41	-0.2	SPLS 1a_315 Ba Ct2	723.3	188.2	352.8	0.00		62.8	ULS 3_0,9_270	692.3	188.2	64.6	0.97	
413A	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.98	1.00	85	-265.9	SPLS 6a_270 Ah Ct2 Ba Ct2	404.5	813.3	1058.4	0.66		243.9	6a_270 Ah All Cts Ba Ct1	403.8	813.3	823.2	0.60	
413B	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	2.02	1.00	87	-173.8	SPLS 6a_270 Ah Ct2 Ba Ct2	396.2	813.3	1058.4	0.44		161.1	.S 6a_270 Ah Ct1 Ba Ct1	352.8	813.3	823.2	0.46	
413C	Bovenregel	120x120x10	S355		1.00	2.02	1.00	85	-241.5	SPLS 6a_270 Ah Ct2 Ba Ct2	404.7	0.0	0.0	0.60		220.4	6a_270 Ah All Cts Ba Ct1	823.6	0.0	0.0	0.27	
414A	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.73	1.00	81	-185.6	SPLS 6a_270 Ah All Cts Ba Ct2	422.2	813.3	1058.4	0.44		197.7	6a_270 Ah All Cts Ba Ct1	635.0	813.3	823.2	0.31	
414B	Bovenregel	120x120x10	S355	4M24-8.8t	2.48	1.00	1.00	115	-28.2	SPLS 6a_270 Ah All Cts Ba Ct2	295.6	542.2	705.6	0.10		37.7	ULS 3_255	635.0	542.2	663.4	0.07	
414C	Bovenregel	120x120x10	S355		3.73	6.69	1.00	83	-169.3	SPLS 6a_270 Ah All Cts Ba Ct2	409.9	0.0	0.0	0.41		179.7	6a_270 Ah All Cts Ba Ct1	823.6	0.0	0.0	0.22	
415	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	173	-22.5	SPLS 6a_270 Ah All Cts Ba Ct1	30.0	60.3	43.2	0.75		23.1	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.71	
416	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	163	-26.2	SPLS 6a_270 Ah All Cts Ba Ct1	32.4	60.3	43.2	0.81		25.1	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.77	
417	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	156	-27.6	SPLS 6a_270 Ah All Cts Ba Ct1	34.1	60.3	43.2	0.81		29.3	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.90	
418	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	150	-32.5	SPLS 6a_270 Ah All Cts Ba Ct1	36.1	60.3	43.2	0.90		30.0	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.92	
419	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	145	-13.0	SPLS 6a_270 Ah All Cts Ba Ct1	33.2	60.3	43.2	0.39		11.8	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.36	
420	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	137	-13.6	SPLS 6a_270 Ah All Cts Ba Ct1	35.7	60.3	43.2	0.38		14.4	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.44	
421	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	129	-17.1	SPLS 6a_270 Ah All Cts Ba Ct1	38.2	60.3	43.2	0.45		16.5	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.51	
422	CD	50x50x5	S235	1M16-8.8t	0.54	0.54	0.54	123	-20.3	SPLS 6a_270 Ah All Cts Ba Ct1	39.9	60.3	43.2	0.51		20.9	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.64	
423	CD	60x60x6	S235	1M16-8.8t	0.56	0.56	0.56	100	-28.0	SPLS 6a_270 Ah All Cts Ba Ct1	69.8	60.3	51.8	0.54		27.1	6a_270 Ah All Cts Ba Ct1	48.4	60.3	33.7	0.80	
424	CD	60x60x6	S235	2M16-8.8t	0.57	0.57	0.57	96	-35.1	SPLS 6a_270 Ah All Cts Ba Ct1	90.0	120.6	103.7	0.39		36.7	6a_270 Ah All Cts Ba Ct1	72.6	120.6	67.3	0.54	
426	Hor. bovenregel	UNP160	S235		1.00	1.00	1.00	47	0.0		369.8	0.0	0.0	0.00		24.2	ULS 3_0,9_255	564.0	0.0	0.0	0.04	
427A	Ladderregel	90x90x8	S235	2M24-8.8t	1.00	2.00	1.00	121	-24.2	SPLS 6a_270 Ah Ct2 Ah Ct1	156.1	271.1	207.4	0.16		4.5	ULS 5a Ba 3	136.2	271.1	156.3	0.03	
427B	Ladderregel	90x90x8	S235	2M24-8.8t	1.00	2.00	1.00	121	-24.0	SPLS 6a_270 Ah Ct2 Ah Ct1	156.1	271.1	207.4	0.15		1.6	ULS 5a Ba 3	136.2	271.1	156.3	0.01	
427C	Ladderregel	90x90x8	S235		1.00	2.00	1.00	121	-24.4	SPLS 6a_270 Ah Ct2 Ah Ct1	156.1	0.0	0.0	0.16		2.0	ULS 5a Ba 22	326.7	0.0	0.0	0.01	
428		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-2.6	SPLS 1a_315 Ah All Cts	34.4	60.3	43.2	0.07		2.2	6a_270 Ba All Cts Ah Ct1	46.1	60.3	32.7	0.07	
429		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-2.1	SPLS 3_0,9_315 Ah All Cts	39.5	60.3	43.2	0.05		2.1	6a_270 Ba All Cts Ah Ct1	46.1	60.3	32.7	0.06	
430		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 6a_270 Ba Ct1 Ah Ct1	45.3	60.3	43.2	0.00		0.0		46.1	60.3	32.7	0.00	
431	Ladder CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-2.3	SPLS 1a_180 Ba All Cts	18.2	60.3	43.2	0.13		2.8	ULS 1a_0,9_315	46.1	60.3	32.7	0.09	
432	Ladder CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	-6.3	SPLS 6a_270 Ba All Cts Ah Ct1	19.5	60.3	43.2	0.32		6.4	PLS 3_0,9_315 Ah All Cts	46.1	60.3	32.7	0.19	
433	D-D CD	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	153	-22.8	SPLS 6a_270 Ah All Cts Ba Ct1	31.2	60.3	43.2	0.73		23.8	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.73	
434	Bovenregel	100x100x8	S235	4M24-8.8t	1.00	1.00	1.00	328	0.0		41.4	542.2	414.7	0.00		162.3	ULS 3_255	199.2	542.2	330.3	0.81	

Assessment of groups for initial mast (afkeur level)

Date 03-12-21
Author MRE
Version 1.0

ENS-ZL 380
EC-3 / R
1

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
435	Bovenregel	80x80x8	S235	4M20-8.8t	1.00	2.00	1.00	252	0.0		47.9	376.3	345.6	0.00		136.9	-S 6a_270 Ah Ct2 Ah Ct1	168.3	376.3	310.2	0.81	
436	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	103	-0.4	ULS 5a Ba 1	47.5	60.3	43.2	0.01		3.2	ULS 5a Ba 3	46.1	60.3	32.7	0.10	
437	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	208	-11.8	SPLS 6a_270 Ah All Cts Ba Ct1	20.7	60.3	43.2	0.57		19.0	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.58	
438	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	204	-2.4	SPLS 6a_270 Ba Ct2 Ba Ct1	23.9	60.3	43.2	0.10		4.4	-S 6a_270 Ah Ct2 Ba Ct2	46.1	60.3	32.7	0.13	
439	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	337	-3.0	ULS 1a_270	14.1	60.3	51.8	0.21		0.0		48.4	60.3	33.7	0.00	
440	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	327	-7.3	ULS 5a Ba 3	10.3	60.3	43.2	0.71		0.0		46.1	60.3	32.7	0.00	
441	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	306	-8.2	SPLS 6a_270 Ah Ct2 Ba Ct2	11.5	60.3	43.2	0.71		1.1	PLS 3_0,9_270 Ah All Cts	46.1	60.3	32.7	0.03	
442	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	0.0		16.2	60.3	43.2	0.00		1.3	ULS 1a_255	46.1	60.3	32.7	0.04	
390A	Eerste DWSRM onderregel	200x200x16	S355	9M24-8.8t	1.00	2.73	1.00	58	-773.1	SPLS 6a_270 Ah Ct2 Ba Ct2	1741.8	915.0	2540.2	0.84		551.2	SPLS 3_0,9_270 Ah Ct1	1581.6	915.0	2388.2	0.60	
390B	Eerste DWSRM onderregel	200x200x16	S355	8M24-8.8t	2.00	6.62	2.00	66	-412.0	SPLS 6a_270 Ah Ct2 Ba Ct2	1619.0	1078.8	2257.9	0.38		271.7	SPLS 3_0,9_270 Ah Ct1	1886.8	1078.8	2007.0	0.25	
390C	Eerste DWSRM onderregel	200x200x16	S355		1.00	2.75	1.00	58	-732.7	SPLS 6a_270 Ah Ct2 Ba Ct2	1741.9	0.0	0.0	0.42		511.9	SPLS 3_0,9_270 Ah Ct1	2193.9	0.0	0.0	0.23	
391A	Eerste DWSRM onderregel	160x160x15	S355	8M24-8.8t	2.00	6.62	2.00	83	-412.0	SPLS 6a_270 Ah Ct2 Ba Ct2	1005.6	1084.4	2116.8	0.41		271.7	SPLS 3_0,9_270 Ah Ct1	1372.7	1084.4	1827.3	0.25	
391B	Eerste DWSRM onderregel	160x160x15	S355		1.00	2.32	1.00	12	-1.3	ULS 1a_0,9_315	1658.2	0.0	0.0	0.00		0.3	SPLS 1a_180 Ba Ct2	1658.2	0.0	0.0	0.00	
391C	Eerste DWSRM onderregel	160x160x15	S355		1.00	3.31	1.00	83	-383.0	SPLS 6a_270 Ah Ct2 Ba Ct2	1004.7	0.0	0.0	0.38		245.6	SPLS 3_0,9_270 Ah Ct1	1658.2	0.0	0.0	0.15	
301	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	115	-50.8	SPLS 3_0,9_255 Ah All Cts	154.5	271.1	207.4	0.33		53.5	6a_270 Ah All Cts Ba Ct1	136.2	271.1	157.7	0.39	
302	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	109	-63.6	SPLS 6a_270 Ah Ct1 Ba Ct1	163.4	271.1	207.4	0.39		63.0	-S 6a_270 Ah Ct1 Ba Ct1	136.2	271.1	161.3	0.46	
303	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	102	-65.9	SPLS 6a_270 Ah All Cts Ba Ct1	172.6	271.1	207.4	0.38		64.5	6a_270 Ah All Cts Ba Ct1	136.2	271.1	161.3	0.47	
304	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	99	-74.9	SPLS 6a_270 Ah Ct1 Ba Ct1	177.0	271.1	207.4	0.42		70.1	-S 6a_270 Ah Ct1 Ba Ct1	136.2	271.1	161.3	0.51	
305	CD	100x100x10	S235	2M24-8.8t	0.53	0.53	0.53	83	-86.9	SPLS 6a_270 Ah All Cts Ba Ct1	278.2	271.1	259.2	0.34		87.5	-S 6a_270 Ah Ct1 Ba Ct1	193.4	271.1	206.0	0.45	
306	CD	100x100x10	S235	2M24-8.8t	0.52	0.52	0.52	69	-39.7	SPLS 6a_270 Ah All Cts Ba Ct2	308.7	271.1	259.2	0.15		61.7	6a_270 Ah All Cts Ba Ct1	191.2	271.1	197.2	0.32	
307	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	119	-26.5	SPLS 6a_270 Ah All Cts Ba Ct1	74.2	120.6	103.7	0.36		26.3	6a_270 Ah All Cts Ba Ct1	73.8	120.6	67.3	0.39	
308	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	110	-32.7	SPLS 6a_270 Ah All Cts Ba Ct2	80.0	120.6	103.7	0.41		28.1	6a_270 Ah All Cts Ba Ct1	73.8	120.6	67.3	0.42	
309	CD	60x60x6	S235	2M16-8.8t	0.54	0.54	0.54	105	-36.3	SPLS 6a_270 Ah All Cts Ba Ct2	83.9	120.6	103.7	0.43		34.1	6a_270 Ah All Cts Ba Ct1	76.0	120.6	67.3	0.51	
310	CD	80x80x6#	S235	2M20-8.8t	0.54	0.54	0.54	71	-44.0	SPLS 6a_270 Ah All Cts Ba Ct1	149.4	188.2	129.6	0.34		45.4	6a_270 Ah All Cts Ba Ct1	93.1	188.2	100.8	0.49	
311	CD	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	67	-55.8	SPLS 6a_270 Ah All Cts Ba Ct1	200.5	188.2	172.8	0.32		55.8	6a_270 Ah All Cts Ba Ct2	121.4	188.2	130.9	0.46	
312	CD	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	61	-73.3	SPLS 6a_270 Ah All Cts Ba Ct2	208.7	188.2	172.8	0.42		66.8	6a_270 Ah All Cts Ba Ct1	121.4	188.2	134.4	0.55	
313	CD	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	48	-43.1	SPLS 6a_270 Ah All Cts Ba Ct2	254.4	271.1	207.4	0.21		30.6	6a_270 Ah All Cts Ba Ct1	136.2	271.1	161.3	0.23	
314	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	78	0.0		588.7	188.2	216.0	0.00		5.7	ULS 3_255	766.1	188.2	0.0	0.03	
315	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	104	0.0		416.1	188.2	352.8	0.00		28.2	ULS 3_255	692.3	188.2	60.7	0.47	
316	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	50	0.0		705.6	188.2	216.0	0.00		5.3	ULS 3_255	766.1	188.2	0.0	0.03	
317	Hor. onderregel	120x120x12(	S355	2M24-8.8t	2.00	2.00	2.00	26	0.0		1598.5	542.2	423.4	0.00		74.7	ULS 3_0,9_270	1017.6	542.2	423.4	0.18	
318	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	22	-9.3	ULS 3_0,9_255	802.5	188.2	216.0	0.05		0.0		766.1	188.2	0.0	0.00	
319A	Eerste DWSRM bovenregel	90x90x8	S235	4M24-8.8t	1.00	1.96	1.00	274	0.0		47.5	542.2	414.7	0.00		149.1	ULS 3_180	185.9	542.2	351.3	0.80	
319B	Eerste DWSRM bovenregel	90x90x8	S235	4M24-8.8t	1.00	2.04	1.00	274	0.0		47.5	542.2	414.7	0.00		126.3	ULS 3_180	252.5	542.2	389.9	0.50	
320A	Eerste DWSRM bovenregel	90x90x8	S235	4M24-8.8t	2.02	1.00	1.00	310	0.0		39.3	542.2	414.7	0.00		116.0	ULS 3_225	252.5	542.2	389.9	0.46	
320B	Eerste DWSRM bovenregel	90x90x8	S235	3M24-8.8t	1.98	1.00	1.00	310	0.0		39.2	406.7	311.0	0.00		116.0	ULS 3_225	185.9	406.7	264.5	0.62	
322	Hor. bovenregel	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	127	-0.9	ULS 1a_180	58.9	60.3	51.8	0.02		0.8	ULS 1a_0,9_0,9_180	48.4	60.3	33.7	0.02	
323	B-B CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	254	-2.5	ULS 1a_180	15.4	60.3	43.2	0.16		1.7	ULS 1a_0,9_0,9_180	46.1	60.3	32.7	0.05	
324	Vertical	90x90x8	S235	1M24-8.8t	1.00	1.00	1.00	173	-23.7	ULS 3_315	77.3	135.6	103.7	0.31		0.0		147.5	135.6	97.5	0.00	
325	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	182	-5.3	ULS 1a_315	36.0	60.3	51.8	0.15		0.0		48.4	60.3	33.7	0.00	
326	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	111	-1.0	ULS 7	44.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00	
327	CD	90x90x8	S235	2M20-8.8t	1.00	1.00	1.00	310	0.0		40.7	188.2	172.8	0.00		34.5	ULS 3_315	168.5	188.2	157.1	0.22	
328	CD	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	300	0.0		37.9	188.2	172.8	0.00		50.5	ULS 3_315	146.3	188.2	157.1	0.35	
329	CD	80x80x6#	S235	1M20-8.8t	1.00	1.00	1.00	288	-1.9	SPLS 1a_0,9_180 Ba Ct2	24.7	94.1	64.8	0.08		19.0	ULS 1a_180	100.2	94.1	58.9	0.32	
250L		80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	174	-5.1	SPLS 3_0,9_255 Ah All Cts	64.8	188.2	129.6	0.08		6.4	ULS 3_255	93.1	188.2	91.6	0.07	
250T		80x80x6#	S235		11.53	2.00	1.00	112	-5.5	ULS 1a_225	101.5	0.0	0.0	0.05		3.6	ULS 1a_0,9_240	93.1	188.2	91.6	0.04	
251		100x100x8	S235	1M20-8.8t	1.00	1.00	1.00	191	-6.8	SPLS 1a_270 Ba Ct2	75.3	94.1	86.4	0.09		6.4	SPLS 1a_0,9_255 Ba Ct2	179.7	94.1	78.5	0.08	
252		60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	236	-0.9	ULS 1a_315	24.6	94.1	64.8	0.04		0.3	ULS 1a_0,9_315	41.5	94.1	25.7	0.01	

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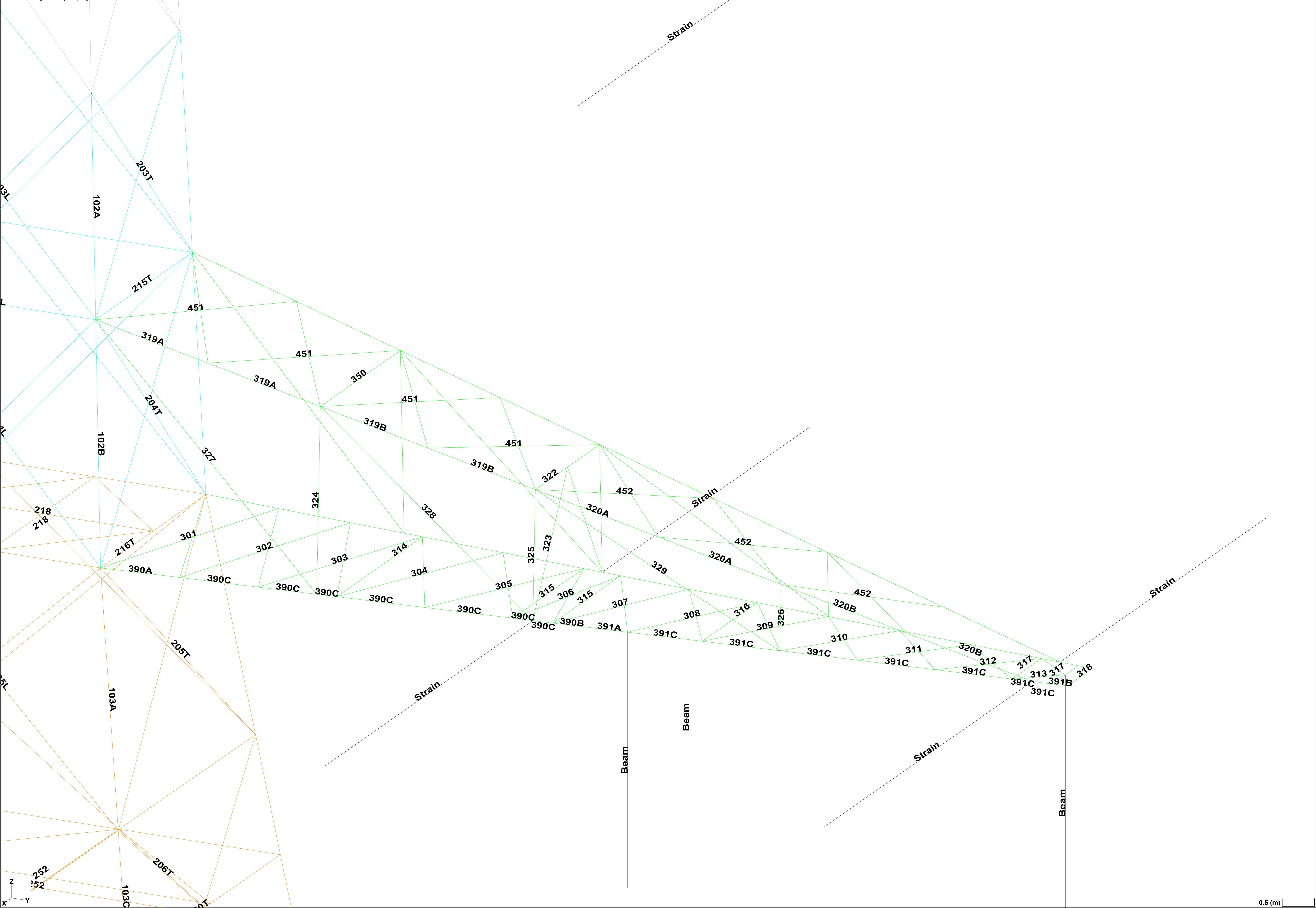
Tower Version 16.86, 16:16:40 Friday, 26 November, 2021
Undeformed geometry displayed



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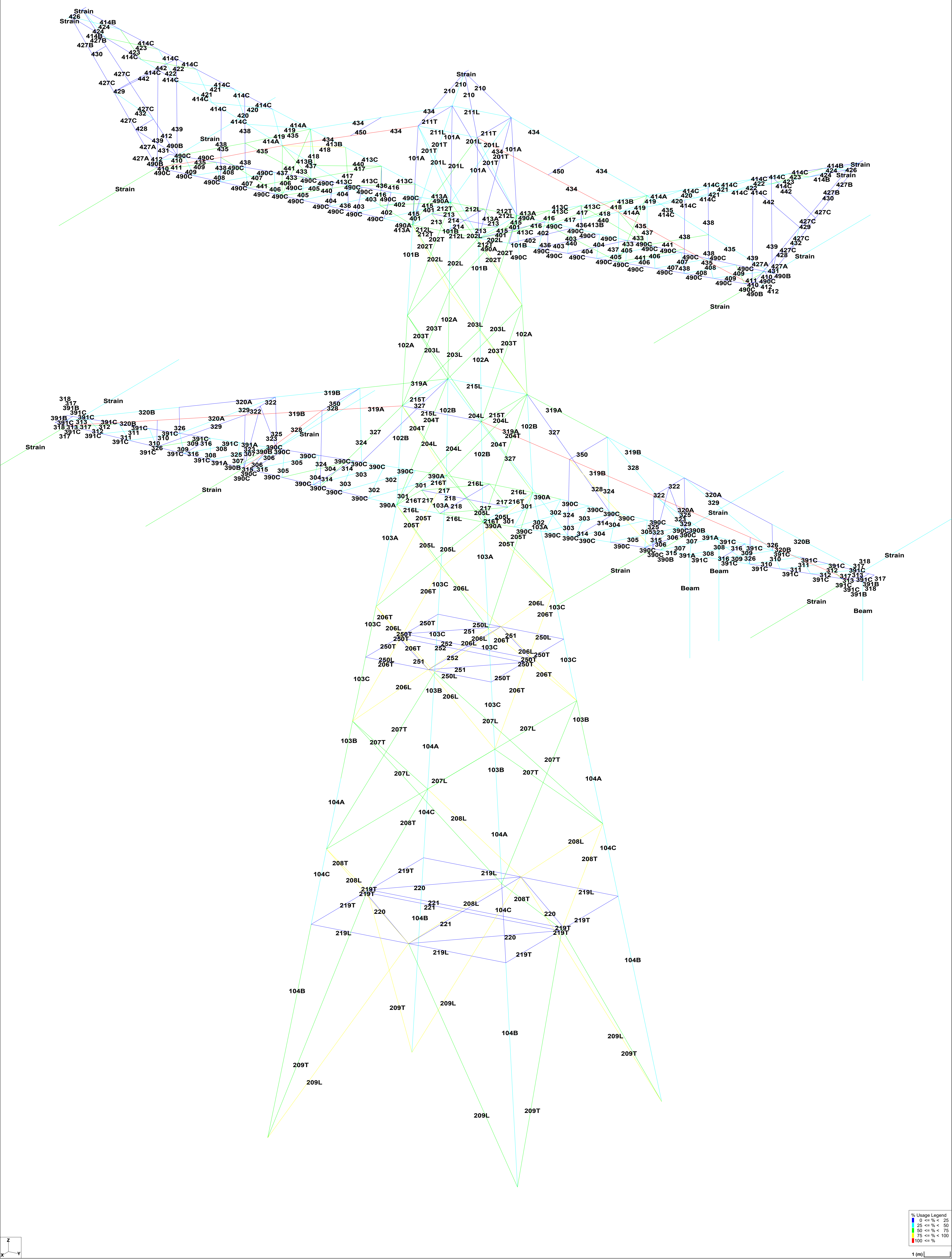


Assessment of groups for initial mast (afkeur level)

Date	26-11-21
Author	KCh
Version	1.0

ENS-ZL 380
EC-3 / R
90

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
101A	Leg	120x120x10	S355	7M24-8.8t	0.50	0.50	0.50	85	-93.4	SPLS 6a_270 Ah Ct1 Ba Ct1	485.4	937.0	1234.8	0.19		61.8	PLS 3_0,9_246.2 Ah Ct1	635.0	937.0	1234.8	0.10	
101B	Leg	120x120x10	S355	8M24-8.8t	0.50	0.50	0.50	77	-266.7	SPLS 6a_270 Ah Ct1 Ba Ct1	537.3	1084.4	1411.2	0.50		196.7	PLS 3_0,9_246.2 Ba Ct2	635.0	1084.4	1326.8	0.31	
102A	leg	150x150x14	S355	6M24-8.8t	0.50	0.50	0.50	62	-458.3	SPLS 6a_270 Ah Ct1 Ba Ct1	1090.3	813.3	1481.8	0.56		430.8	S 3_0,9_246.2 Ba All Cts	1159.3	813.3	1393.1	0.53	
102B	leg	150x150x14	S355	8M24-8.8t	0.50	0.50	0.50	68	-447.4	SPLS 6a_270 Ah Ct1 Ba Ct1	1030.1	2168.8	1975.7	0.43		397.8	PLS 3_0,9_246.2 Ba Ct2	1159.3	2168.8	1925.0	0.34	
103A	Leg	200x200x16	S355	10M24-8.8t	0.26	0.26	0.26	27	-849.0	SPLS 3_246.2 Ba All Cts	2098.3	2711.0	2822.4	0.40		819.4	S 3_0,9_246.2 Ba All Cts	1886.8	2711.0	2653.5	0.43	
103B	Leg	200x200x16	S355	12M24-8.8t	0.53	0.53	0.53	31	-1295.2	SPLS 3_246.2 Ba All Cts	2058.7	3124.5	3386.9	0.63		1225.0	S 3_0,9_246.2 Ba All Cts	1886.8	3124.5	3184.2	0.65	
103C	Leg	200x200x16	S355		0.52	0.52	0.52	34	-1090.3	SPLS 3_246.2 Ba All Cts	2028.2	0.0	0.0	0.54		1046.3	S 3_0,9_246.2 Ba All Cts	2193.9	0.0	0.0	0.48	
104A	Leg	200x200x24	S355	12M24-8.8t	0.53	0.53	0.53	39	-1298.7	SPLS 3_246.2 Ba All Cts	2901.1	3124.5	5080.3	0.45		1222.1	S 3_0,9_246.2 Ba All Cts	2756.1	3124.5	4776.4	0.44	
104B	Leg	200x200x24	S355	12M24-8.8t	0.20	0.20	0.20	44	-1420.5	SPLS 3_246.2 Ba All Cts	2809.5	3236.3	5080.3	0.51		1319.7	S 3_0,9_246.2 Ba All Cts	2756.1	3236.3	4385.6	0.48	
104C	Leg	200x200x24	S355		0.50	0.50	0.50	39	-1415.7	SPLS 3_246.2 Ba All Cts	2896.6	0.0	0.0	0.49		1325.9	S 3_0,9_246.2 Ba All Cts	3216.3	0.0	0.0	0.41	
201L	CD	100x100x8	S355	2M24-8.8t	0.53	0.53	0.53	131	-98.9	SPLS 3_246.2 Ah Ct1	177.8	271.1	282.2	0.56		108.8	LS 6a_270 Ah Ct1 Ba Ct1	246.8	271.1	265.4	0.44	
201T	CD	90x90x8	S355	1M24-8.8t	0.53	0.53	0.53	146	-55.2	SPLS 6a_270 Ah Ct1 Ba Ct1	110.8	135.6	141.1	0.50		30.8	PLS 3_0,9_246.2 Ah Ct1	200.7	135.6	132.7	0.23	
202L	CD	150x150x12	S355	4M24-8.8t	0.53	0.53	0.53	86	-363.8	SPLS 6a_270 Ah Ct2 Ba Ct2	636.5	542.2	846.7	0.67		327.7	LS 6a_270 Ah Ct1 Ba Ct1	659.1	542.2	763.9	0.60	
202T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	86	-335.1	SPLS 6a_270 Ah Ct1 Ba Ct1	636.5	406.7	635.0	0.82		293.5	LS 6a_270 Ah Ct2 Ba Ct2	659.1	406.7	579.5	0.72	
203L	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	89	-286.5	SPLS 6a_270 Ah Ct1 Ba Ct1	614.6	406.7	635.0	0.70		316.3	LS 6a_270 Ah Ct2 Ba Ct2	659.1	406.7	579.5	0.78	
203T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	89	-255.9	SPLS 6a_270 Ah Ct2 Ba Ct2	614.6	406.7	635.0	0.63		290.6	LS 6a_270 Ah Ct1 Ba Ct1	659.1	406.7	579.5	0.71	
204L	CD	150x150x14	S355	4M24-8.8t	0.53	0.53	0.53	98	-327.9	SPLS 6a_270 Ah Ct1 Ah Ct2	648.2	542.2	987.8	0.60		364.5	LS 6a_270 Ah Ct1 Ba Ct1	759.4	542.2	891.2	0.67	
204T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	97	-359.7	SPLS 6a_270 Ah Ct1 Ba Ct1	563.9	406.7	635.0	0.88		305.2	PLS 3_0,9_246.2 Ah Ct1	659.1	406.7	579.5	0.75	
205L	CD	150x150x14	S355	5M24-8.8t	0.57	0.28	0.28	75	-520.2	SPLS 6a_270 Ah Ct2 Ba Ct2	777.4	677.8	1234.8	0.77		500.4	LS 6a_270 Ah Ct2 Ba Ct2	759.4	677.8	1106.5	0.74	
205T	CD	150x150x12	S355	4M24-8.8t	0.57	0.28	0.28	74	-439.9	SPLS 6a_270 Ah Ct2 Ba Ct2	676.2	542.2	846.7	0.81		425.8	LS 6a_270 Ah Ct1 Ba Ct1	659.1	542.2	763.9	0.79	
206L	CD	150x150x12	S355	3M24-8.8t	1.00	0.56	0.56	70	-376.8	SPLS 6a_270 Ah Ct2 Ba Ct2	707.3	406.7	635.0	0.93		380.4	LS 6a_270 Ah Ct2 Ba Ct2	659.1	406.7	579.5	0.94	
206T	CD	150x150x12	S235	3M24-8.8t	1.00	0.56	0.56	88	-329.7	SPLS 6a_270 Ah Ct1 Ba Ct1	459.3	406.7	466.6	0.81		326.6	LS 6a_270 Ah Ct2 Ba Ct2	484.3	406.7	389.1	0.84	
207L	CD	150x150x12	S355	3M24-8.8t	0.56	0.28	0.28	106	-287.9	SPLS 6a_270 Ah Ct2 Ba Ct2	488.9	406.7	635.0	0.71		286.8	LS 6a_270 Ah Ct2 Ba Ct2	678.2	406.7	434.2	0.71	
207T	CD	150x150x12	S355	3M24-8.8t	0.56	0.28	0.28	106	-251.8	SPLS 6a_270 Ah Ct2 Ba Ct2	488.9	406.7	635.0	0.62		252.4	LS 6a_270 Ah Ct1 Ba Ct1	678.2	406.7	434.2	0.62	
208L	CD	150x150x12	S235	2M24-8.8t	1.00	0.50	0.50	107	-244.1	SPLS 6a_270 Ah Ct2 Ba Ct2	393.3	271.1	311.0	0.90		235.9	LS 6a_270 Ah Ct2 Ba Ct2	428.1	271.1	292.4	0.87	
208T	CD	150x150x12	S235	2M24-8.8t	1.00	0.50	0.50	107	-215.3	SPLS 6a_270 Ah Ct1 Ba Ct1	393.3	271.1	311.0	0.79		209.4	LS 6a_270 Ah Ct2 Ba Ct2	428.1	271.1	292.4	0.77	
209L	CD	120x120x12	S355	3M24-8.8t	0.20	0.20	0.20	87	-354.5	SPLS 6a_270 Ah Ct2 Ba Ct2	496.8	406.7	635.0	0.87		342.5	LS 6a_270 Ah Ct2 Ba Ct2	507.3	406.7	591.2	0.84	
209T	CD	120x120x12	S355	3M24-8.8t	0.20	0.20	0.20	87	-310.6	SPLS 6a_270 Ah Ct1 Ba Ct1	496.8	406.7	635.0	0.76		287.1	LS 6a_270 Ah Ct2 Ba Ct2	507.3	406.7	591.2	0.71	
210	Top	90x90x8	S355	2M20-8.8t	1.00	1.00	1.00	154	-42.9	SPLS 6a_270 Ah Ct1 Ba Ct1	128.8	188.2	235.2	0.33		35.9	LS 6a_270 Ah Ct2 Ba Ct2	229.3	188.2	213.8	0.19	
211L		100x100x8	S355	4M24-8.8t	1.00	1.00	1.00	133	-87.4	SPLS 3_0,9_246.2 Ba All Cts	175.7	542.2	564.5	0.50		93.6	6a_270 Ah All Cts Ba Ct1	287.3	542.2	530.7	0.33	
211T		100x100x8	S355	1M24-8.8t	1.00	1.00	1.00	133	-11.5	SPLS 6a_270 Ah Ct1 Ba Ct1	140.6	135.6	141.1	0.09		15.9	LS 6a_270 Ah Ct1 Ba Ct1	232.1	135.6	132.7	0.12	
212L		200x200x16	S355	8M24-8.8t	1.00	2.00	1.00	47	-518.9	SPLS 3_246.2 Ba All Cts	1882.3	991.8	2257.9	0.52		565.3	S 3_0,9_246.2 Ba All Cts	1442.6	991.8	2122.8	0.57	
212T		120x120x10	S235	4M24-8.8t	1.00	2.00	1.00	79	-157.3	SPLS 6a_270 Ah Ct1 Ba Ct1	328.3	542.2	518.4	0.48		168.7	LS 6a_270 Ah Ct1 Ba Ct1	466.6	542.2	447.5	0.38	
213		120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-196.3	SPLS 6a_270 Ah Ct1 Ba Ct1	325.2	406.7	388.8	0.60		196.1	LS 6a_270 Ah Ct1 Ba Ct1	296.6	406.7	302.4	0.66	
214		50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.2	SPLS 6a_270 Ah All Cts Ba Ct2	31.9	60.3	43.2	0.01		0.2	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.01	
215L		120x120x10	S355	5M24-8.8t	1.00	1.00	1.00	148	-52.0	SPLS 3_0,9_246.2 Ba All Cts	228.2	677.8	882.0	0.23		161.7	6a_270 Ah All Cts Ba Ct2	441.0	677.8	829.2	0.37	
215T		100x100x8	S355	2M24-8.8t	1.00	1.00	1.00	178	-67.9	ULS 1a_0,9_270	117.4	271.1	282.2	0.58		73.3	ULS 1a_270	368.2	271.1	265.4	0.28	
216L		200x200x16	S355	9M24-8.8t	1.00	2.00	1.00	62	-466.7	SPLS 3_246.2 Ba All Cts	1686.0	915.0	2540.2	0.51		510.7	S 3_0,9_246.2 Ba All Cts	1581.6	915.0	2388.2	0.56	
216T		120x120x10	S235	4M24-8.8t	1.00	2.00	1.00	104	-135.7	SPLS 6a_270 Ah Ct2 Ba Ct2	269.2	542.2	518.4	0.50		149.5	LS 6a_270 Ah Ct2 Ba Ct2	466.6	542.2	487.4	0.32	
217		120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-186.3	SPLS 6a_270 Ah Ct2 Ba Ct2	261.1	406.7	388.8	0.71		187.0	LS 6a_270 Ah Ct2 Ba Ct2	324.0	406.7	359.4	0.58	
218		50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.6	SPLS 6a_270 Ah All Cts Ba Ct2	29.9	60.3	60.5	0.02		0.6	6a_270 Ah All Cts Ba Ct2	64.5	60.3	45.8	0.01	
219L		90x90x8	S235	2M16-8.8t	1.00	1.00	1.00	244	-8.1	SPLS 3_0,9_246.2 Ba All Cts	59.4	120.6	138.2	0.14		3.0	S 3_0,9_246.2 Ba All Cts	229.7	120.6	119.5	0.03	
219T		90x90x8	S235	2M16-8.8t	1.00	1.04	1.00	235	-6.6	SPLS 3_270 Ba Ct1	62.8	120.6	138.2	0.10		3.6	ULS 1a_0,9_225	229.7	120.6	119.5	0.03	
220		80x80x8	S235	2M20-8.8t	1.00	0.50	0.50	245	-5.2	ULS 1a_246.2	50.0	188.2	172.8	0.10		4.5	ULS 1a_0,9_293.8	146.3	188.2	157.1	0.03	
221		80x80x8	S235	1M20-8.8t	0.50	0.50	0.50	275	-1.6	ULS 1a_180	34.9	94.1	86.4	0.05		0.2	ULS 1a_0,9_180	133.6	94.1	78.5	0.00	
490A	Tweede DWSRM onderregel	160x160x15	S355	8M24-8.8t	1.00	2.27	1.00	60	-357.9	SPLS 6a_270 Ah Ct2 Ba Ct2	1293.6	991.8	2116.8	0.36		406.1	PLS 3_0,9_246.2 Ba Ct1	1071.4	991.8	1990.2	0.41	
490B	Tweede DWSRM onderregel	160x160x15	S355		2.00	1.00	1.00	13	0.0		1658.2	0.0	0.0	0.00		11.6	ULS 3_246.2	1658.2	0.0	0.0	0.01	
490C	Tweede DWSRM onderregel	160x160x15	S355		1.00	2.37	1.00	60	-348.2	SPLS 6a_270 Ah Ct2 Ba Ct2	1293.3	0.0	0.0	0.27		385.3	PLS 3_0,9_246.2 Ba Ct1	1658.2	0.0	0.0	0.23	
401	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	104	-22.5	SPLS 3_0,9_246.2 Ba All Cts	115.0	188.2	129.6	0.20		23.7	SPLS 3_246.2 Ba All Cts	93.1	188.2	91.6	0.26	
402	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	99	-27.9	SPLS 3_246.2 Ba Ct1	120.2	188.2	129.6	0.23		27.6	PLS 3_0,9_246.2 Ba Ct2	94.4	188.2	78.5	0.35	
403	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	94	-28.8	SPLS 3_246.2 Ba Ct1	124.7	188.2	129.6	0.23		28.9	SPLS 3_246.2 Ba Ct1	95.6	188.2	91.6	0.32	
404	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	90	-30.6	SPLS 3_246.2 Ba Ct1	129.2	188.2	129.6	0.24		30.6	SPLS 3_246.2 Ba Ct1	95.6	188.2	91.6	0.33	
405	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	85	-37.0	SPLS 3_246.2 Ba Ct1	133.7	188.2	129.6	0.29		36.5	PLS 3_0,9_246.2 Ba Ct1	96.9	188.2	108.7	0.38	
406	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	81	-50.6	SPLS 3_246.2 Ba All Cts	138.3	188.2	129.6	0.39		49.1	S 3_0,9_246.2 Ba All Cts	98.2	188.2	109.7	0.50	
407	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	78	-53.3	SPLS 3_246.2 Ba All Cts	184.6	188.2	172.8	0.31		56.6	S 3_0,9_246.2 Ba All Cts	129.7	188.2	147.4	0.44	
408	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	74	-62.8	SPLS 3_0,9_246.2 Ba All Cts	190.6	188.2	172.8	0.36		57.0	SPLS 3_246.2 Ba All Cts	138.0	188.2	139.6	0.41	
409	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	64	-68.6	SPLS 3_246.2 Ba All Cts	231.7	271.1	207.4	0.33		74.1	S 3_0,9_246.2 Ba All Cts	136.2	271.1	161.3	0.54	
410	CD	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	66	-40.0	SPLS 3_246.2 Ba All Cts	202.3	271.1	207.4	0.20		30.4	S 3_0,9_246.2 Ba All Cts	117.7	271.1	161.3	0.26	
411	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	67	0.0		607.6	188.2	352.8	0.00		55.5	ULS 3_246.2	692.3	188.2	89.9	0.62	
412	Hor. onderregel	120x120x12(	S355	2M20-8.8t	1.00	2.00	1.00	29	0.0		1563.6	188.2	352.8	0.00		70.1	ULS 3_246.2	1036.4	188.2	352.8	0.37	
413A	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.98	1.00	85	-236.7	SPLS 6a_270 Ba Ct2 Ah Ct2	404.5	813.3	1058.4	0.59		201.3	6a_270 Ba All Cts Ah Ct1	403.8	813.3	823.2	0.50	
413B	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	2.02	1.00	87	-175.1	SPLS 6a_270 Ba Ct2 Ah Ct2	396.2	813.3	1058.4	0.44		141.6	LS 6a_270 Ba Ct1 Ah Ct1	352.8	813.3	823.2	0.40	
413C	Bovenregel	120x120x10	S355		1.00	2.02	1.00	85	-221.6	SPLS 6a_270 Ba Ct2 Ah Ct2	404.7	0.0	0.0	0.55		184.2	6a_270 Ba All Cts Ah Ct1	823.6	0.0	0.0	0.22	
414A	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.73	1.00	81	-178.1	SPLS 6a_270 Ba All Cts Ah Ct2	422.2	813.3	1058.4	0.42		164.1	6a_270 Ba All Cts Ah Ct1	635.0	813.3	823.2	0.26	
414B	Bovenregel	120x120x10	S355	4M24-8.8t	2.48	1.00	1.00	115	-52.3	SPLS 6a_270 Ba All Cts Ah Ct2	295.6	542.2	705.6	0.18		29.2	6a_270 Ah All Cts Ba Ct1	635.0	542.2	663.4	0.05	
414C	Bovenregel	120x120x10	S355		2.10	5.20	1.00	115	-125.9	SPLS 6a_270 Ba All Cts Ah Ct2	295.4	0.0	0.0	0.43		149.4	6a_270 Ba All Cts Ah Ct1	823.6	0.0	0.0	0.18	
415	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	173	-17.3	SPLS 6a_270 Ah All Cts Ba Ct1	26.7	60.3	43.2	0.65		18.6	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.57	
416	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	163	-21.2	SPLS 6a_270 Ah All Cts Ba Ct1	28.8	60.3	43.2	0.73		19.4	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.59	
417	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	156	-21.5	SPLS 6a_270 Ah All Cts Ba Ct1	30.4	60.3	43.2	0.71		23.5	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.72	
418	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	150	-26.2	SPLS 6a_270 Ah All Cts Ba Ct1	32.1	60.3	43.2	0.81		23.4	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.71	
419	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	145	-10.5	SPLS 6a_270 Ba All Cts Ah Ct1	33.2	60.3	43.2	0.32		10.1	6a_270 Ba All Cts Ah Ct1	46.1	60.3	32.7	0.31	
420	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	137	-11.7	SPLS 6a_270 Ba All Cts Ah Ct1	35.7	60.3	43.2	0.33		11.8	6a_270 Ba All Cts Ah Ct1	46.1	60.3	32.7	0.36	
421	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	129	-14.4	SPLS 6a_270 Ba All Cts Ah Ct1	38.2	60.3	43.2	0.38		14.0	6a_270 Ba All Cts Ah Ct1	46.1	60.3	32.7	0.43	
422	CD	50x50x5	S235	1M16-8.8t	0.54	0.54	0.54	123	-17.2	SPLS 6a_270 Ba All Cts Ah Ct1	39.9	60.3	43.2	0.43		17.7	6a_270 Ba All Cts Ah Ct1	46.1	60.3	32.7	0.54	
423	CD	60x60x6	S235	1M16-8.8t	0.56	0.56	0.56	100	-23.5	SPLS 6a_270 Ba All Cts Ah Ct1	69.8	60.3	51.8	0.45		22.4	6a_270 Ba All Cts Ah Ct1	48.4	60.3	33.7	0.67	
424	CD	60x60x6	S235	2M16-8.8t	0.57	0.57	0.57	96	-30.6	SPLS 6a_270 Ba All Cts Ah Ct1	90.0	120.6	103.7	0.34		32.4	6a_270 Ba All Cts Ah Ct1	72.6	120.6	67.3	0.48	
426	Hor. bovenregel	UNP160	S235		1.00	1.00	1.00	47	0.0		369.8	0.0	0.0	0.00		26.9	ULS 3_0,9_246.2	564.0	0.0	0.0	0.05	
427A	Ladderregel	90x90x8	S235	2M24-8.8t	1.00	2.00	1.00	121	-20.6	SPLS 6a_270 Ah Ct2 Ba Ct1	156.1	271.1	207.4	0.13		16.2	ULS 3_0,9_246.2	136.2	271.1	156.3	0.12	
427B	Ladderregel	90x90x8	S235	2M24-8.8t	1.00	2.00	1.00	121	-17.0	SPLS 6a_270 Ah Ct1 Ba Ct1	156.1	271.1	207.4	0.11		16.0	S 3_0,9_246.2 Ba All Cts	136.2	271.1	156.3	0.12	
427C	Ladderregel	90x90x8	S235		1.00	2.00	1.00	121	-18.5	SPLS 6a_270 Ah Ct2 Ba Ct1	156.1	0.0	0.0	0.12		15.6	S 3_0,9_246.2 Ba All Cts	326.7	0.0	0.0	0.05	
428		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-4.0	ULS 3_315	34.4	60.3	43.2	0.12		0.1	LS 1a_0,9_180 Ba All Cts	46.1	60.3	32.7	0.00	
429		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-3.6	ULS 3_0,9_270	39.5	60.3	43.2	0.09		0.0		46.1	60.3	32.7	0.00	
430		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 6a_270 Ah Ct1 Ba Ct1	45.3	60.3	43.2	0.00		0.0	ULS 3_0,9_180	46.1	60.3	32.7	0.00	
431	Ladder CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-1.0	SPLS 1a_180 Ba All Cts	18.2	60.3	43.2	0.06		3.7	ULS 1a_0,9_315	46.1	60.3	32.7	0.11	
432	Ladder CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	0.0		19.5	60.3	43.2	0.00		11.1	ULS 3_0,9_270	46.1	60.3	32.7	0.34	
433	D-D CD	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	153	-18.7	SPLS 6a_270 Ah All Cts Ba Ct1	31.2	60.3	43.2	0.60		19.1	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.59	
434	Bovenregel	100x100x8	S235	4M22-8.8t	2.00	2.00	2.00	328	-118.6	SPLS 3_0,9_246.2 Ba All Cts	41.4	1861.6	380.2	2.86	knik	136.9	6a_270 Ah All Cts Ba Ct1	211.1	2168.8	362.8	0.65	

DNV·GL

Assessment of groups for initial mast (afkeur level)

Date 26-11-21
Author KCh
Version 1.0

ENS-ZL 380
EC-3 / R
90

Group Label	Description	Profile	Steel Quality	Bolts	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	Bearing (Comp)	U.C. (Comp)	Exceedance (Comp)	Tension	Load Case (Tension)	Net Section	Shear (Tens)	Bearing (Tens)	U.C. (Tens)	Exceedance (Tens)
435	Bovenregel	80x80x8	S235	4M20-8.8t	1.00	2.00	1.00	252	-101.7	SPLS 3_0,9_246.2 Ba All Cts	47.9	376.3	345.6	2.12	knik	108.6	LS 6a_270 Ah Ct1 Ba Ct1	168.3	376.3	310.2	0.65	
436	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	103	-0.7	SPLS 3_0,9_246.2 Ba Ct1	47.5	60.3	43.2	0.02		2.9	SPLS 3_246.2 Ah Ct1	46.1	60.3	32.7	0.09	
437	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	208	-9.5	SPLS 6a_270 Ah All Cts Ba Ct1	20.7	60.3	43.2	0.46		16.4	6a_270 Ah All Cts Ba Ct1	46.1	60.3	32.7	0.50	
438	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	204	-2.0	SPLS 6a_270 Ah Ct1 Ba Ct1	23.9	60.3	43.2	0.08		4.4	LS 6a_270 Ah Ct1 Ba Ct1	46.1	60.3	32.7	0.13	
439	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	337	-3.2	SPLS 1a_246.2 Ba All Cts	14.1	60.3	51.8	0.23		0.0		48.4	60.3	33.7	0.00	
440	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	327	-7.0	SPLS 3_246.2 Ba Ct2	10.3	60.3	43.2	0.68		0.8	SPLS 3_0,9_246.2 Ba Ct1	46.1	60.3	32.7	0.02	
441	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	306	-8.2	SPLS 3_246.2 Ba Ct2	11.5	60.3	43.2	0.72		0.5	SPLS 3_0,9_246.2 Ba Ct1	46.1	60.3	32.7	0.01	
442	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	0.0		16.2	60.3	43.2	0.00		1.1	SPLS 1a_293.8 Ah All Cts	46.1	60.3	32.7	0.03	
390A	Eerste DWSRM onderregel	200x200x16	S355	9M24-8.8t	1.00	2.73	1.00	58	-638.6	SPLS 6a_270 Ah Ct2 Ba Ct2	1741.8	915.0	2540.2	0.70		617.2	SPLS 3_0,9_246.2 Ba Ct1	1581.6	915.0	2388.2	0.67	
390B	Eerste DWSRM onderregel	200x200x16	S355	8M24-8.8t	2.00	6.62	2.00	66	-347.3	SPLS 6a_270 Ah Ct2 Ba Ct2	1619.0	1078.8	2257.9	0.32		336.1	SPLS 3_0,9_246.2 Ba Ct1	1886.8	1078.8	2007.0	0.31	
390C	Eerste DWSRM onderregel	200x200x16	S355		1.00	2.75	1.00	58	-611.7	SPLS 6a_270 Ah Ct2 Ba Ct2	1741.9	0.0	0.0	0.35		576.9	SPLS 3_0,9_246.2 Ba Ct1	2193.9	0.0	0.0	0.26	
391A	Eerste DWSRM onderregel	160x160x15;	S355	8M24-8.8t	2.00	6.62	2.00	83	-347.3	SPLS 6a_270 Ah Ct2 Ba Ct2	1005.6	1084.4	2116.8	0.35		336.0	SPLS 3_0,9_246.2 Ba Ct1	1372.7	1084.4	1827.3	0.31	
391B	Eerste DWSRM onderregel	160x160x15;	S355		1.00	2.32	1.00	12	-1.7	ULS 1a_0,9_246.2	1658.2	0.0	0.0	0.00		0.3	SPLS 1a_0,9_180 Ba Ct2	1658.2	0.0	0.0	0.00	
391C	Eerste DWSRM onderregel	160x160x15;	S355		1.00	3.31	1.00	83	-327.2	SPLS 6a_270 Ah Ct2 Ba Ct2	1004.7	0.0	0.0	0.33		308.8	SPLS 3_0,9_246.2 Ba Ct1	1658.2	0.0	0.0	0.19	
301	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	115	-53.8	SPLS 3_0,9_246.2 Ba All Cts	154.5	271.1	207.4	0.35		54.2	SPLS 3_246.2 Ba All Cts	136.2	271.1	157.7	0.40	
302	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	109	-64.2	SPLS 3_246.2 Ba Ct1	163.4	271.1	207.4	0.39		63.5	SPLS 3_0,9_246.2 Ba Ct1	136.2	271.1	161.3	0.47	
303	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	102	-64.9	SPLS 3_246.2 Ba All Cts	172.6	271.1	207.4	0.38		67.1	S 3_0,9_246.2 Ba All Cts	136.2	271.1	161.3	0.49	
304	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	99	-75.5	SPLS 3_246.2 Ba All Cts	177.0	271.1	207.4	0.43		71.1	S 3_0,9_246.2 Ba All Cts	136.2	271.1	161.3	0.52	
305	CD	100x100x10	S235	2M24-8.8t	0.53	0.53	0.53	83	-86.1	SPLS 3_246.2 Ba All Cts	278.2	271.1	259.2	0.33		90.8	S 3_0,9_246.2 Ba All Cts	193.4	271.1	206.0	0.47	
306	CD	100x100x10	S235	2M24-8.8t	0.52	0.52	0.52	69	-39.1	SPLS 3_246.2 Ba All Cts	308.7	271.1	259.2	0.15		63.6	S 3_0,9_246.2 Ba All Cts	191.2	271.1	197.2	0.33	
307	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	119	-26.5	SPLS 3_246.2 Ba All Cts	74.2	120.6	103.7	0.36		26.9	S 3_0,9_246.2 Ba All Cts	73.8	120.6	67.3	0.40	
308	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	110	-31.3	SPLS 3_246.2 Ba All Cts	80.0	120.6	103.7	0.39		29.5	S 3_0,9_246.2 Ba All Cts	73.8	120.6	67.3	0.44	
309	CD	60x60x6	S235	2M16-8.8t	0.54	0.54	0.54	105	-35.2	SPLS 3_246.2 Ba All Cts	83.9	120.6	103.7	0.42		35.7	S 3_0,9_246.2 Ba All Cts	76.0	120.6	67.3	0.53	
310	CD	80x80x6#	S235	2M20-8.8t	0.54	0.54	0.54	71	-44.1	SPLS 3_246.2 Ba All Cts	149.4	188.2	129.6	0.34		45.7	SPLS 3_246.2 Ba All Cts	93.1	188.2	100.8	0.49	
311	CD	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	67	-58.3	SPLS 3_0,9_246.2 Ba All Cts	200.5	188.2	172.8	0.34		53.9	SPLS 3_246.2 Ba All Cts	121.4	188.2	130.9	0.44	
312	CD	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	61	-68.0	SPLS 3_246.2 Ba Ct1	208.7	188.2	172.8	0.39		72.8	S 3_0,9_246.2 Ba All Cts	121.4	188.2	134.4	0.60	
313	CD	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	48	-38.4	SPLS 3_246.2 Ba Ct1	254.4	271.1	207.4	0.19		34.7	SPLS 3_0,9_246.2 Ba Ct1	136.2	271.1	161.3	0.25	
314	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	78	-0.5	SPLS 3_0,9_246.2 Ba Ct1	588.7	188.2	216.0	0.00		4.7	LS 6a_270 Ba Ct1 Ba Ct2	766.1	188.2	0.0	0.03	
315	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	104	0.0		416.1	188.2	352.8	0.00		32.1	ULS 3_246.2	692.3	188.2	60.7	0.53	
316	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	50	-0.5	SPLS 3_0,9_246.2 Ba All Cts	705.6	188.2	216.0	0.00		4.1	LS 6a_270 Ah Ct1 Ba Ct2	766.1	188.2	0.0	0.02	
317	Hor. onderregel	120x120x12(	S355	2M24-8.8t	2.00	2.00	2.00	26	0.0		1598.5	542.2	423.4	0.00		51.4	ULS 3_246.2	1036.4	188.2	352.8	0.27	
318	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	22	-13.0	ULS 3_0,9_246.2	802.5	188.2	216.0	0.07		0.0		766.1	188.2	0.0	0.00	
319A	Eerste DWSRM bovenregel	90x90x8	S235	4M24-8.8t	1.00	1.96	1.00	274	-115.7	SPLS 3_0,9_246.2 Ba All Cts	47.5	542.2	414.7	2.43	knik	109.9	LS 6a_270 Ah Ct2 Ba Ct2	185.9	542.2	351.3	0.59	
319B	Eerste DWSRM bovenregel	90x90x8	S235	4M24-8.8t	1.00	2.04	1.00	274	-91.5	SPLS 3_0,9_246.2 Ba All Cts	47.5	542.2	414.7	1.93	knik	92.6	6a_270 Ah All Cts Ba Ct2	252.5	542.2	389.9	0.37	
320A	Eerste DWSRM bovenregel	90x90x8	S235	4M24-8.8t	2.02	1.00	1.00	310	-90.7	SPLS 3_0,9_246.2 Ba All Cts	39.3	542.2	414.7	2.31	knik	82.6	6a_270 Ah All Cts Ba Ct2	252.5	542.2	389.9	0.33	
320B	Eerste DWSRM bovenregel	90x90x8	S235	3M24-8.8t	1.98	1.00	1.00	310	-90.8	SPLS 3_0,9_246.2 Ba All Cts	39.2	406.7	311.0	2.31	knik	82.6	6a_270 Ah All Cts Ba Ct2	185.9	406.7	264.5	0.44	
322	Hor. bovenregel	60x60x6	S235	1M16-8.8t	1.00	2.00	1.00	127	-0.9	ULS 1a_180	58.9	60.3	51.8	0.02		0.8	ULS 1a_0,9_180	48.4	60.3	33.7	0.02	
323	B-B CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	254	-2.5	ULS 1a_180	15.4	60.3	43.2	0.16		1.7	ULS 1a_0,9_180	46.1	60.3	32.7	0.05	
324	Vertical	90x90x8	S235	1M24-8.8t	1.00	1.00	1.00	173	-21.4	SPLS 6a_270 Ah Ct2 Ba Ct2	77.3	135.6	103.7	0.28		17.6	ULS 3_0,9_246.2	147.5	135.6	97.5	0.18	
325	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	182	-7.5	ULS 1a_315	36.0	60.3	51.8	0.21		0.6	ULS 1a_0,9_315	48.4	60.3	33.7	0.02	
326	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	111	-1.0	SPLS 6a_270 Ah Ct1 Ba Ct1	44.4	60.3	43.2	0.02		0.0		46.1	60.3	32.7	0.00	
327	CD	90x90x8	S235	2M20-8.8t	1.00	1.00	1.00	310	-26.6	ULS 3_0,9_246.2	40.7	188.2	172.8	0.65		34.2	LS 6a_270 Ba Ct1 Ba Ct2	168.5	188.2	157.1	0.22	
328	CD	80x80x8	S235	2M20-8.8t	1.00	1.00	1.00	300	-40.3	ULS 3_0,9_246.2	37.9	188.2	172.8	1.06	knik	45.2	LS 6a_270 Ba Ct1 Ba Ct2	146.3	188.2	157.1	0.31	
329	CD	80x80x6#	S235	1M20-8.8t	1.00	1.00	1.00	288	-5.4	ULS 1a_0,9_315	24.7	94.1	64.8	0.22		27.4	ULS 1a_315	100.2	94.1	58.9	0.47	
250L		80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	174	-7.7	SPLS 3_0,9_246.2 Ba All Cts	64.8	188.2	129.6	0.12		4.3	6a_270 Ah All Cts Ba Ct1	93.1	188.2	91.6	0.05	
250T		80x80x6#	S235	2M20-8.8t	1.00	1.10	1.00	159	-5.5	SPLS 6a_270 Ah Ct1 Ba Ct1	72.9	188.2	129.6	0.08		3.5	SPLS 3_0,9_246.2 Ah Ct1	93.1	188.2	91.6	0.04	
251		100x100x8	S235	1M20-8.8t	1.00	1.00	1.00	191	-6.5	SPLS 6a_270 Ah Ct1 Ba Ct1	75.3	94.1	86.4	0.09		5.5	PLS 1a_0,9_246.2 Ah Ct1	179.7	94.1	78.5	0.07	
252		60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	236	-0.9	ULS 1a_180	24.6	94.1	64.8	0.04		0.2	ULS 1a_0,9_180	41.5	94.1	25.7	0.01	
450		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	245	-4.2	ULS 1a_180	16.3	60.3	43.2	0.25		4.2	ULS 1a_180	46.1	60.3	32.7	0.13	
350		50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	298	-0.1	ULS 1a_225	12.0	60.3	43.2	0.01		0.1	ULS 1a_0,9_315	46.1	60.3	32.7	0.00	

DNV·GL

Assessment of groups for strengthened mast (afkeur level)

Date 26-11-21
Author KCh
Version 1.0

ENS-ZL 380
EC-3 / R
90

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
101A	Leg	120x120x10	S355	7M24-8.8t	0.50	0.50	0.50	85	-102.9	SPLS 6a_270 Ah Ct1 B	485.4	937.0	1234.8	0.21		63.9	ULS 1a_0,9_246.2	635.0	937.0	1234.8	0.10
101B	Leg	120x120x10	S355	8M24-8.8t	0.50	0.50	0.50	77	-266.5	SPLS 6a_270 Ah Ct1 B	537.3	1084.4	1411.2	0.50		199.7	SPLS 3_0,9_246.2 Ba	635.0	1084.4	1326.8	0.31
102A	leg	150x150x14	S355	6M24-8.8t	0.50	0.50	0.50	62	-449.5	SPLS 3_246.2 Ba Ct2	1090.3	813.3	1481.8	0.55		419.9	SPLS 3_0,9_246.2 Ba	1159.3	813.3	1393.1	0.52
102B	leg	150x150x14	S355	8M24-8.8t	0.50	0.50	0.50	68	-434.7	SPLS 6a_270 Ah Ct1 B	1030.1	2168.8	1975.7	0.42		383.6	ULS 1a_0,9_246.2	1159.3	2168.8	1925.0	0.33
103A	Leg	200x200x16	S355	10M24-8.8t	0.26	0.26	0.26	27	-859.8	SPLS 3_246.2 Ba All Ct	2098.3	2711.0	2822.4	0.41		821.8	SPLS 3_0,9_246.2 Ba	1886.8	2711.0	2653.5	0.44
103B	Leg	200x200x16	S355	12M24-8.8t	0.53	0.53	0.53	31	-1305.8	SPLS 3_246.2 Ba All Ct	2058.7	3124.5	3386.9	0.63		1226.4	SPLS 3_0,9_246.2 Ba	1886.8	3124.5	3184.2	0.65
103C	Leg	200x200x16	S355		0.52	0.52	0.52	34	-1095.5	SPLS 3_246.2 Ba All Ct	2028.2	0.0	0.0	0.54		1042.3	SPLS 3_0,9_246.2 Ba	2193.9	0.0	0.0	0.48
104A	Leg	200x200x24*	S355	12M24-8.8t	0.53	0.53	0.53	39	-1309.3	SPLS 3_246.2 Ba All Ct	2901.1	3124.5	5080.3	0.45		1223.4	SPLS 3_0,9_246.2 Ba	2756.1	3124.5	4776.4	0.44
104B	Leg	200x200x24*	S355	12M24-8.8t	0.20	0.20	0.20	44	-1428.5	SPLS 3_246.2 Ba All Ct	2809.5	3236.3	5080.3	0.51		1318.5	SPLS 3_0,9_246.2 Ba	2756.1	3236.3	4385.6	0.48
104C	Leg	200x200x24*	S355		0.50	0.50	0.50	39	-1423.7	SPLS 3_246.2 Ba All Ct	2896.6	0.0	0.0	0.49		1324.6	SPLS 3_0,9_246.2 Ba	3216.3	0.0	0.0	0.41
201L	CD	100x100x8	S355	2M24-8.8t	0.53	0.53	0.53	131	-100.3	SPLS 3_246.2 Ah Ct1	177.8	271.1	282.2	0.56		109.4	SPLS 6a_270 Ah Ct1 B	246.8	271.1	265.4	0.44
201T	CD	90x90x8	S355	1M24-8.8t	0.53	0.53	0.53	146	-60.7	SPLS 6a_270 Ah Ct1 B	110.8	135.6	141.1	0.55		37.4	SPLS 3_0,9_246.2 Ah	200.7	135.6	132.7	0.28
202L	CD	150x150x12	S355	4M24-8.8t	0.53	0.53	0.53	86	-370.5	SPLS 6a_270 Ah Ct2 B	636.5	542.2	846.7	0.68		333.4	SPLS 6a_270 Ah Ct1 B	659.1	542.2	763.9	0.61
202T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	86	-321.8	SPLS 6a_270 Ah Ct1 B	636.5	406.7	635.0	0.79		280.8	SPLS 6a_270 Ah Ct2 B	659.1	406.7	579.5	0.69
203L	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	89	-291.0	SPLS 6a_270 Ah Ct1 B	614.6	406.7	635.0	0.72		322.0	SPLS 6a_270 Ah Ct2 B	659.1	406.7	579.5	0.79
203T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	89	-245.0	SPLS 6a_270 Ah Ct2 B	614.6	406.7	635.0	0.60		279.0	SPLS 6a_270 Ah Ct1 B	659.1	406.7	579.5	0.69
204L	CD	150x150x14	S355	4M24-8.8t	0.53	0.53	0.53	98	-291.4	SPLS 6a_270 Ba Ct2 A	648.2	542.2	987.8	0.54		294.2	SPLS 6a_270 Ah Ct1 B	759.4	542.2	891.2	0.54
204T	CD	150x150x12	S355	3M24-8.8t	0.53	0.53	0.53	97	-352.0	SPLS 6a_270 Ah Ct1 B	563.9	406.7	635.0	0.87		274.1	SPLS 3_0,9_270 Ba Ct	659.1	406.7	579.5	0.67
205L	CD	150x150x14	S355	5M24-8.8t	0.57	0.28	0.28	75	-523.7	SPLS 6a_270 Ah Ct2 B	777.4	677.8	1234.8	0.77		511.1	SPLS 6a_270 Ah Ct2 B	759.4	677.8	1106.5	0.75
205T	CD	150x150x12	S355	4M24-8.8t	0.57	0.28	0.28	74	-433.3	SPLS 6a_270 Ah Ct2 B	676.2	542.2	846.7	0.80		419.2	SPLS 6a_270 Ah Ct1 B	659.1	542.2	763.9	0.77
206L	CD	150x150x12	S355	3M24-8.8t	1.00	0.56	0.56	70	-384.5	SPLS 6a_270 Ah Ct2 B	707.3	406.7	635.0	0.95		383.8	SPLS 6a_270 Ah Ct2 B	659.1	406.7	579.5	0.94
206T	CD	150x150x12	S235	3M24-8.8t	1.00	0.56	0.56	88	-326.0	SPLS 6a_270 Ah Ct1 B	459.3	406.7	466.6	0.80		321.6	SPLS 6a_270 Ah Ct2 B	484.3	406.7	389.1	0.83
207L	CD	150x150x12	S355	3M24-8.8t	0.56	0.28	0.28	106	-289.6	SPLS 6a_270 Ah Ct2 B	488.9	406.7	635.0	0.71		291.8	SPLS 6a_270 Ah Ct2 B	678.2	406.7	434.2	0.72
207T	CD	150x150x12	S355	3M24-8.8t	0.56	0.28	0.28	106	-248.8	SPLS 6a_270 Ah Ct2 B	488.9	406.7	635.0	0.61		249.6	SPLS 6a_270 Ah Ct1 B	678.2	406.7	434.2	0.61
208L	CD	150x150x12	S235	2M24-8.8t	1.00	0.50	0.50	107	-248.2	SPLS 6a_270 Ah Ct2 B	393.3	271.1	311.0	0.92		237.4	SPLS 6a_270 Ah Ct2 B	428.1	271.1	292.4	0.88
208T	CD	150x150x12	S235	2M24-8.8t	1.00	0.50	0.50	107	-213.0	SPLS 6a_270 Ah Ct1 B	393.3	271.1	311.0	0.79		206.9	SPLS 6a_270 Ah Ct2 B	428.1	271.1	292.4	0.76
209L	CD	120x120x12	S355	3M24-8.8t	0.20	0.20	0.20	87	-358.1	SPLS 6a_270 Ah Ct2 B	496.8	406.7	635.0	0.88		344.2	SPLS 6a_270 Ah Ct2 B	507.3	406.7	591.2	0.85
209T	CD	120x120x12	S355	3M24-8.8t	0.20	0.20	0.20	87	-308.6	SPLS 6a_270 Ah Ct1 B	496.8	406.7	635.0	0.76		285.0	SPLS 6a_270 Ah Ct2 B	507.3	406.7	591.2	0.70
210	Top	90x90x8	S355	2M20-8.8t	1.00	1.00	1.00	154	-49.7	SPLS 6a_270 Ah Ct1 B	128.8	188.2	235.2	0.39		42.7	SPLS 6a_270 Ah Ct2 B	229.3	188.2	213.8	0.23
211L	0	100x100x8	S355	4M24-8.8t	1.00	1.00	1.00	133	-106.0	SPLS 3_0,9_246.2 Ba	175.7	542.2	564.5	0.60		102.5	SPLS 6a_270 Ah All Ct	287.3	542.2	530.7	0.36
211T	0	100x100x8	S355	1M24-8.8t	1.00	1.00	1.00	133	-11.5	SPLS 6a_270 Ah Ct1 B	140.6	135.6	141.1	0.09		15.9	SPLS 6a_270 Ah Ct1 B	232.1	135.6	132.7	0.12
212L	0	200x200x16	S355	8M24-8.8t	1.00	2.00	1.00	47	-510.1	SPLS 3_246.2 Ba All Ct	1882.3	991.8	2257.9	0.51		551.2	SPLS 3_0,9_246.2 Ba	1442.6	991.8	2122.8	0.56
212T	0	120x120x10	S235	4M24-8.8t	1.00	2.00	1.00	79	-145.7	SPLS 6a_270 Ah Ct1 B	328.3	542.2	518.4	0.44		157.7	SPLS 6a_270 Ah Ct1 B	466.6	542.2	447.5	0.35
213	0	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	87	-180.7	SPLS 6a_270 Ah Ct1 B	325.2	406.7	388.8	0.56		180.4	SPLS 6a_270 Ah Ct1 B	296.6	406.7	302.4	0.61
214	0	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	150	-0.2	SPLS 6a_270 Ah All Ct	31.9	60.3	43.2	0.01		0.2	SPLS 6a_270 Ah All Ct	46.1	60.3	32.7	0.01
215L	0	120x120x10	S355	5M24-8.8t	1.00	1.00	1.00	148	-93.2	SPLS 3_0,9_246.2 Ba	228.2	677.8	882.0	0.41		130.4	SPLS 6a_270 Ah All Ct	441.0	677.8	829.2	0.30
215T	0	100x100x8	S355	2M24-8.8t	1.00	1.00	1.00	178	-64.4	ULS 1a_0,9_270	117.4	271.1	282.2	0.55		70.1	ULS 1a_270	368.2	271.1	265.4	0.26
216L	0	200x200x16	S355	9M24-8.8t	1.00	2.00	1.00	62	-364.1	SPLS 3_246.2 Ba All Ct	1686.0	915.0	2540.2	0.40		397.8	SPLS 3_0,9_246.2 Ba	1581.6	915.0	2388.2	0.43
216T	0	120x120x10	S235	4M24-8.8t	1.00	2.00	1.00	104	-138.8	SPLS 6a_270 Ah Ct2 B	269.2	542.2	518.4	0.52		154.8	SPLS 6a_270 Ah Ct2 B	466.6	542.2	487.4	0.33
217	0	120x120x10	S235	3M24-8.8t	1.00	1.00	1.00	114	-191.6	SPLS 6a_270 Ah Ct2 B	261.1	406.7	388.8	0.73		192.4	SPLS 6a_270 Ah Ct2 B	324.0	406.7	359.4	0.59
218	0	50x50x7	S235	1M16-8.8t	0.50	0.50	0.50	200	-0.6	SPLS 6a_270 Ah All Ct	29.9	60.3	60.5	0.02		0.7	SPLS 6a_270 Ah All Ct	64.5	60.3	45.8	0.02
219L	0	90x90x8	S235	2M16-8.8t	1.00	1.00	1.00	244	-8.0	SPLS 3_0,9_246.2 Ba	59.4	120.6	138.2	0.13		2.9	SPLS 3_0,9_246.2 Ba	229.7	120.6	119.5	0.02
219T	0	90x90x8	S235	2M16-8.8t	1.00	1.04	1.00	235	-6.5	ULS 1a_270	62.8	120.6	138.2	0.10		3.7	ULS 1a_0,9_225	229.7	120.6	119.5	0.03
220	0	80x80x8	S235	2M20-8.8t	1.00	0.50	0.50	245	-5.3	ULS 1a_246.2	50.0	188.2	172.8	0.11		4.3	ULS 1a_0,9_293.8	146.3	188.2	157.1	0.03
221	0	80x80x8	S235	1M20-8.8t	0.50	0.50	0.50	275	-1.6	ULS 1a_180	34.9	94.1	86.4	0.05		0.2	ULS 1a_0,9_180	133.6	94.1	78.5	0.00
490A	Tweede DWSRI	160x160x15#	S355	8M24-8.8t	1.00	2.27	1.00	60	-355.8	SPLS 6a_270 Ah Ct2 B	1293.6	991.8	2116.8	0.36		380.0	SPLS 3_0,9_246.2 Ba	1071.4	991.8	1990.2	0.38
490B	Tweede DWSRI	160x160x15#	S355		2.00	1.00	1.00	13	0.0		1658.2	0.0	0.0	0.00		11.3	ULS 3_246.2	1658.2	0.0	0.0	0.01
490C	Tweede DWSRI	160x160x15#	S355		1.00	2.37	1.00	60	-346.5	SPLS 6a_270 Ah Ct2 B	1293.3	0.0	0.0	0.27		361.1	SPLS 3_0,9_246.2 Ba	1658.2	0.0	0.0	0.22
401	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	104	-20.4	SPLS 3_0,9_246.2 Ba	115.0	188.2	129.6	0.18		21.3	SPLS 3_246.2 Ba All Ct	93.1	188.2	91.6	0.23
402	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	99	-25.5	SPLS 3_246.2 Ba Ct1	120.2	188.2	129.6	0.21		25.2	SPLS 3_0,9_246.2 Ba	94.4	188.2	78.5	0.32
403	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	94	-26.4	SPLS 3_246.2 Ba Ct1	124.7	188.2	129.6	0.21		26.4	SPLS 3_246.2 Ba Ct1	95.6	188.2	91.6	0.29
404	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	90	-27.8	SPLS 3_0,9_246.2 Ba	129.2	188.2	129.6	0.21		27.8	SPLS 3_246.2 Ba Ct1	95.6	188.2	91.6	0.30
405	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	85	-34.8	SPLS 3_246.2 Ba Ct1	133.7	188.2	129.6	0.27		34.2	SPLS 3_0,9_246.2 Ba	96.9	188.2	108.7	0.35
406	CD	80x80x6#	S235	2M20-8.8t	0.53	0.53	0.53	81	-50.6	SPLS 3_246.2 Ba All Ct	138.3	188.2	129.6	0.39		49.0	SPLS 3_0,9_246.2 Ba	98.2	188.2	109.7	0.50
407	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	78	-52.9	SPLS 3_246.2 Ba All Ct	184.6	188.2	172.8	0.31		56.3	SPLS 3_0,9_246.2 Ba	129.7	188.2	147.4	0.43
408	CD	80x80x8	S235	2M20-8.8t	0.53	0.53	0.53	74	-62.6	SPLS 3_0,9_246.2 Ba	190.6	188.2	172.8	0.36		56.8	SPLS 3_246.2 Ba All Ct	138.0	188.2	139.6	0.41
409	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	64	-68.4	SPLS 3_246.2 Ba All Ct	231.7	271.1	207.4	0.33		73.7	SPLS 3_0,9_246.2 Ba	136.2	271.1	161.3	0.54
410	CD	80x80x8	S235	2M24-8.8t	1.00	1.00	1.00	66	-39.5	SPLS 3_246.2 Ba All Ct	202.3	271.1	207.4	0.20		29.8	SPLS 3_0,9_246.2 Ba	117.7	271.1	161.3	0.25
411	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	67	0.0		607.6	188.2	352.8	0.00		55.6	ULS 3_246.2	692.3	188.2	89.9	0.62
412	Hor. onderregel	120x120x12(12	S355	2M20-8.8t	1.00	2.00	1.00	29	0.0		1563.6	188.2	352.8	0.00		69.6	ULS 3_246.2	1036.4	188.2	352.8	0.37
413A	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.98	1.00	85	-246.6	SPLS 6a_270 Ba All Ct	404.5	813.3	1058.4	0.61		206.6	SPLS 6a_270 Ba All Ct	403.8	813.3	823.2	0.51
413B	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	2.02	1.00	87	-175.9	SPLS 6a_270 Ba Ct2 A	396.2	813.3	1058.4	0.44		139.6	SPLS 6a_270 Ba Ct1 A	352.8	813.3	823.2	0.40
413C	Bovenregel	120x120x10	S355		1.00	2.02	1.00	85	-228.6	SPLS 6a_270 Ba Ct2 A	404.7	0.0	0.0	0.56		186.9	SPLS 6a_270 Ba All Ct	823.6	0.0	0.0	0.23
414A	Bovenregel	120x120x10	S355	6M24-8.8t	1.00	1.73	1.00	81	-182.7	SPLS 6a_270 Ba All Ct	422.2	813.3	1058.4	0.43		168.3	SPLS 6a_270 Ba All Ct	635.0	813.3	823.2	0.27
414B	Bovenregel	120x120x10	S355	4M24-8.8t	2.48	1.00	1.00	115	-53.7	SPLS 6a_270 Ba All Ct	295.6	542.2	705.6	0.18		29.5	SPLS 6a_270 Ah All Ct	635.0	542.2	663.4	0.05
414C	Bovenregel	120x120x10	S355		2.10	5.20	1.00	115	-129.2	SPLS 6a_270 Ba All Ct	295.4	0.0	0.0	0.44		153.3	SPLS 6a_270 Ba All Ct	823.6	0.0	0.0	0.19
415	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	173	-19.0	SPLS 3_246.2 Ba All Ct	26.7	60.3	43.2	0.71		20.2	SPLS 6a_270 Ah All Ct	46.1	60.3	32.7	0.62
416	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	163	-22.9	SPLS 6a_270 Ah All Ct	28.8	60.3	43.2	0.80		21.1	SPLS 6a_270 Ah All Ct	46.1	60.3	32.7	0.65
417	CD	50x50x5	S235	1M16-8.8t	0.52	0.52	0.52	156	-23.4	SPLS 3_0,9_246.2 Ba	30.4	60.3	43.2	0.77		25.5	SPLS 6a_270 Ah All Ct	46.1	60.3	32.7	0.78
418	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	150	-28.4	SPLS 6a_270 Ah All Ct	32.1	60.3	43.2	0.88		25.6	SPLS 3_0,9_246.2 Ba	46.1	60.3	32.7	0.78
419	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	145	-10.8	SPLS 6a_270 Ba All Ct	33.2	60.3	43.2	0.32		10.3	SPLS 6a_270 Ba All Ct	46.1	60.3	32.7	0.31
420	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	137	-11.9	SPLS 6a_270 Ba All Ct	35.7	60.3	43.2	0.33		12.1	SPLS 6a_270 Ba All Ct	46.1	60.3	32.7	0.37
421	CD	50x50x5	S235	1M16-8.8t	0.53	0.53	0.53	129	-14.7	SPLS 6a_270 Ba All Ct	38.2	60.3	43.2	0.39		14.3	SPLS 6a_270 Ba All Ct	46.1	60.3	32.7	0.44
422	CD	50x50x5	S235	1M16-8.8t	0.54	0.54	0.54	123	-17.6	SPLS 6a_270 Ba All Ct	39.9	60.3	43.2	0.44		18.1	SPLS 6a_270 Ba All Ct	46.1	60.3	32.7	0.55
423	CD	60x60x6	S235	1M16-8.8t	0.56	0.56	0.56	100	-24.0	SPLS 6a_270 Ba All Ct	69.8	60.3	51.8	0.46		22.9	SPLS 6a_270 Ba All Ct	48.4	60.3	33.7	0.68
424	CD	60x60x6	S235	2M16-8.8t	0.57	0.57	0.57	96	-31.0	SPLS 6a_270 Ba All Ct	90.0	120.6	103.7	0.34		32.8	SPLS 6a_270 Ba All Ct	72.6	120.6	67.3	0.49
426	Hor. bovenrege	UNP160	S235		1.00	1.00	1.00	47	0.0		369.8	0.0	0.0	0.00		26.9	ULS 3_0,9_246.2	564.0	0.0	0.0	0.05
427A	Ladderregel	90x90x8	S235	2M24-8.8t	1.00	2.00	1.00	121	-20.1	SPLS 6a_270 Ah All Ct	156.1	271.1	207.4	0.13		15.2	SPLS 3_0,9_246.2 Ba	136.2	271.1	156.3	0.11
427B	Ladderregel	90x90x8	S235	2M24-8.8t	1.00	2.00	1.00	121	-17.3	SPLS 6a_270 Ah Ct1 B	156.1	271.1	207.4	0.11		18.7	SPLS 3_0,9_246.2 Ba	136.2	271.1	156.3	0.14
427C	Ladderregel	90x90x8	S235		1.00	2.00	1.00	121	-18.6	SPLS 6a_270 Ah All Ct	156.1	0.0	0.0	0.12		18.2	SPLS 3_0,9_246.2 Ba	326.7	0.0	0.0	0.06
428	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	141	-3.3	ULS 3_315	34.4	60.3	43.2	0.10		0.7	SPLS 1a_0,9_180 Ba A	46.1	60.3	32.7	0.02

DNV·GL

Assessment of groups for strengthened mast (afkeur level)

Date	26-11-21
Author	KCh
Version	1.0

ENS-ZL 380
EC-3 / R
90

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
429	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	125	-2.8	ULS 3_0,9_270	39.5	60.3	43.2	0.07		0.2	SPLS 1a_180 Ba All Ct	46.1	60.3	32.7	0.01
430	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	108	0.0	SPLS 6a_270 Ah Ct1 B	45.3	60.3	43.2	0.00		0.0		46.1	60.3	32.7	0.00
431	Ladder CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	227	-1.4	SPLS 1a_180 Ba All Ct	18.2	60.3	43.2	0.08		3.5	ULS 1a_0,9_315	46.1	60.3	32.7	0.11
432	Ladder CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	217	-0.8	SPLS 1a_180 Ba All Ct	19.5	60.3	43.2	0.04		8.7	ULS 3_0,9_270	46.1	60.3	32.7	0.27
433	D-D CD	50x50x5	S235	1M16-8.8t	0.50	0.50	0.50	153	-21.0	SPLS 6a_270 Ah All Ct	31.2	60.3	43.2	0.67		21.7	SPLS 6a_270 Ah All Ct	46.1	60.3	32.7	0.66
434	Bovenregel	100x100x8(1	S235	4M24-8.8t	1.00	2.00	1.00	156	-139.2	SPLS 3_0,9_246.2 Ba	232.6	2168.8	414.7	0.60		146.4	SPLS 6a_270 Ah All Ct	602.5	2168.8	378.3	0.39
435	Bovenregel	80x80x8(12,0	S235	4M20-8.8t	1.00	2.00	1.00	181	-117.1	SPLS 3_0,9_246.2 Ba	153.0	376.3	345.6	0.77		113.1	SPLS 6a_270 Ah Ct1 B	473.5	376.3	314.2	0.36
436	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	103	-0.3	ULS 5a Ah 12	47.5	60.3	43.2	0.01		2.9	ULS 5a Ah 3	46.1	60.3	32.7	0.09
437	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	208	-10.3	SPLS 6a_270 Ah All Ct	20.7	60.3	43.2	0.50		18.5	SPLS 6a_270 Ah All Ct	46.1	60.3	32.7	0.57
438	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	204	-2.2	SPLS 6a_270 Ah Ct1 B	23.9	60.3	43.2	0.09		4.0	SPLS 6a_270 Ah Ct1 B	46.1	60.3	32.7	0.12
439	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	337	-3.5	SPLS 1a_246.2 Ba All	14.1	60.3	51.8	0.25		0.0		48.4	60.3	33.7	0.00
440	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	327	-8.1	ULS 5a Ah 3	10.3	60.3	43.2	0.79		0.0		46.1	60.3	32.7	0.00
441	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	306	-10.4	SPLS 3_246.2 Ba All C	11.5	60.3	43.2	0.91		0.6	SPLS 3_0,9_246.2 Ba	46.1	60.3	32.7	0.02
442	CD	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	246	0.0		16.2	60.3	43.2	0.00		1.1	ULS 1a_293.8	46.1	60.3	32.7	0.03
390A	Eerste DWSRM	200x200x16	S355	9M24-8.8t	1.00	2.73	1.00	58	-632.3	SPLS 6a_270 Ah Ct2 B	1741.8	915.0	2540.2	0.69		567.9	SPLS 3_0,9_246.2 Ba	1581.6	915.0	2388.2	0.62
390B	Eerste DWSRM	200x200x16	S355	8M24-8.8t	2.00	6.62	2.00	66	-340.4	SPLS 6a_270 Ah Ct2 B	1619.0	1078.8	2257.9	0.32		334.1	SPLS 3_0,9_246.2 Ba	1886.8	1078.8	2007.0	0.31
390C	Eerste DWSRM	200x200x16	S355		1.00	2.75	1.00	58	-605.6	SPLS 6a_270 Ah Ct2 B	1741.9	0.0	0.0	0.35		530.9	SPLS 3_0,9_246.2 Ba	2193.9	0.0	0.0	0.24
391A	Eerste DWSRM	160x160x15#	S355	8M24-8.8t	2.00	6.62	2.00	83	-340.3	SPLS 6a_270 Ah Ct2 B	1005.6	1084.4	2116.8	0.34		334.0	SPLS 3_0,9_246.2 Ba	1372.7	1084.4	1827.3	0.31
391B	Eerste DWSRM	160x160x15#	S355		1.00	2.32	1.00	12	-1.9	ULS 1a_0,9_246.2	1658.2	0.0	0.0	0.00		0.2	SPLS 1a_180 Ba Ct2	1658.2	0.0	0.0	0.00
391C	Eerste DWSRM	160x160x15#	S355		1.00	3.31	1.00	83	-321.1	SPLS 6a_270 Ah Ct2 B	1004.7	0.0	0.0	0.32		306.9	SPLS 3_0,9_246.2 Ba	1658.2	0.0	0.0	0.19
301	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	115	-47.1	SPLS 3_0,9_246.2 Ba	154.5	271.1	207.4	0.31		47.2	SPLS 3_246.2 Ba Ct1	136.2	271.1	157.7	0.35
302	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	109	-59.0	SPLS 3_246.2 Ba Ct1	163.4	271.1	207.4	0.36		58.2	SPLS 3_0,9_246.2 Ba	136.2	271.1	161.3	0.43
303	CD	90x90x8	S235	2M24-8.8t	0.52	0.52	0.52	102	-59.3	SPLS 3_246.2 Ba Ct1	172.6	271.1	207.4	0.34		61.4	SPLS 3_0,9_246.2 Ba	136.2	271.1	161.3	0.45
304	CD	90x90x8	S235	2M24-8.8t	0.53	0.53	0.53	99	-69.4	SPLS 3_246.2 Ba Ct1	177.0	271.1	207.4	0.39		65.0	SPLS 3_246.2 Ba Ct1	136.2	271.1	161.3	0.48
305	CD	100x100x10	S235	2M24-8.8t	0.53	0.53	0.53	83	-78.7	SPLS 3_246.2 Ba Ct1	278.2	271.1	259.2	0.30		83.3	SPLS 3_0,9_246.2 Ba	193.4	271.1	206.0	0.43
306	CD	100x100x10	S235	2M24-8.8t	0.52	0.52	0.52	69	-36.0	SPLS 3_246.2 Ba Ct1	308.7	271.1	259.2	0.14		60.4	SPLS 3_0,9_246.2 Ba	191.2	271.1	197.2	0.32
307	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	119	-26.3	SPLS 3_246.2 Ba All C	74.2	120.6	103.7	0.35		26.7	SPLS 3_0,9_246.2 Ba	73.8	120.6	67.3	0.40
308	CD	60x60x6	S235	2M16-8.8t	0.53	0.53	0.53	110	-31.2	SPLS 3_246.2 Ba All C	80.0	120.6	103.7	0.39		29.3	SPLS 3_0,9_246.2 Ba	73.8	120.6	67.3	0.44
309	CD	60x60x6	S235	2M16-8.8t	0.54	0.54	0.54	105	-35.0	SPLS 3_246.2 Ba Ct1	83.9	120.6	103.7	0.42		35.5	SPLS 3_0,9_246.2 Ba	76.0	120.6	67.3	0.53
310	CD	80x80x6#	S235	2M20-8.8t	0.54	0.54	0.54	71	-43.8	SPLS 3_0,9_246.2 Ba	149.4	188.2	129.6	0.34		45.4	SPLS 3_246.2 Ba All C	93.1	188.2	100.8	0.49
311	CD	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	67	-57.8	SPLS 3_0,9_246.2 Ba	200.5	188.2	172.8	0.33		53.4	SPLS 3_246.2 Ba Ct1	121.4	188.2	130.9	0.44
312	CD	80x80x8	S235	2M20-8.8t	0.55	0.55	0.55	61	-67.7	SPLS 3_246.2 Ba Ct1	208.7	188.2	172.8	0.39		72.4	SPLS 3_0,9_246.2 Ba	121.4	188.2	134.4	0.60
313	CD	90x90x8	S235	2M24-8.8t	1.00	1.00	1.00	48	-38.9	SPLS 3_246.2 Ba All C	254.4	271.1	207.4	0.19		35.1	SPLS 3_0,9_246.2 Ba	136.2	271.1	161.3	0.26
314	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	78	-0.4	SPLS 3_0,9_246.2 Ba	588.7	188.2	216.0	0.00		4.8	SPLS 6a_270 Ba Ct1 B	766.1	188.2	0.0	0.03
315	Hor. onderregel	120x120x12	S355	2M20-8.8t	1.00	1.00	1.00	104	0.0		416.1	188.2	352.8	0.00		32.1	ULS 3_246.2	692.3	188.2	60.7	0.53
316	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	50	-0.4	SPLS 3_0,9_246.2 Ba	705.6	188.2	216.0	0.00		4.2	SPLS 6a_270 Ah Ct1 B	766.1	188.2	0.0	0.02
317	Hor. onderregel	120x120x12(1	S355	2M24-8.8t	2.00	2.00	2.00	26	0.0		1598.5	542.2	423.4	0.00		51.8	ULS 3_246.2	1036.4	188.2	352.8	0.28
318	Hor. onderregel	HEA160	S235	2M20-8.8t	2.00	2.00	2.00	22	-13.0	ULS 3_0,9_246.2	802.5	188.2	216.0	0.07		0.0		766.1	188.2	0.0	0.00
319A	Eerste DWSRM	90x90x8(12,0	S235	4M24-8.8t	1.00	2.00	1.00	118	-211.1	SPLS 3_0,9_246.2 Ba	286.1	542.2	414.7	0.74		210.5	SPLS 6a_270 Ah All Ct	536.3	542.2	355.3	0.59
319B	Eerste DWSRM	90x90x8	S235	4M24-8.8t	1.00	2.00	1.00	134	-115.2	SPLS 3_0,9_246.2 Ba	124.6	542.2	414.7	0.92		123.2	SPLS 6a_270 Ah All Ct	252.5	542.2	389.9	0.49
320A	Eerste DWSRM	90x90x8	S235	4M24-8.8t	1.00	2.00	1.00	153	-79.8	SPLS 3_0,9_246.2 Ba	106.8	542.2	414.7	0.75		80.4	SPLS 6a_270 Ah All Ct	252.5	542.2	389.9	0.32
320B	Eerste DWSRM	90x90x8	S235	3M24-8.8t	1.00	2.00	1.00	157	-78.6	SPLS 3_0,9_246.2 Ba	104.0	406.7	311.0	0.76		74.4	SPLS 6a_270 Ah All Ct	185.9	406.7	264.5	0.40
322	Hor. bovenrege	60x60x6	S355	1M16-8.8t	1.00	2.00	1.00	127	-21.9	SPLS 6a_270 Ah Ct1 B	70.2	60.3	70.6	0.36		20.9	SPLS 6a_270 Ah Ct2 B	65.9	60.3	45.8	0.46
323	B-B CD	70x70x7	S355	1M16-8.8t	1.00	1.00	1.00	181	-41.9	SPLS 6a_270 Ah Ct2 B	55.5	60.3	82.3	0.76		41.1	SPLS 6a_270 Ah Ct2 B	87.8	60.3	62.3	0.68
324	Vertical	90x90x8	S235	1M24-8.8t	1.00	1.00	1.00	173	-34.2	SPLS 6a_270 Ba Ct1 A	77.3	135.6	103.7	0.44		33.3	SPLS 3_0,9_246.2 Ba	147.5	135.6	97.5	0.34
325	Vertical	60x60x6	S235	1M16-8.8t	1.00	1.00	1.00	182	-8.8	ULS 1a_315	36.0	60.3	51.8	0.25		0.0		48.4	60.3	33.7	0.00
326	Vertical	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	111	-1.9	ULS 7	44.4	60.3	43.2	0.04		0.0		46.1	60.3	32.7	0.00
327	CD	100x100x10	S355	2M20-8.8t	1.00	1.00	1.00	280	-48.0	SPLS 3_0,9_246.2 Ba	71.6	188.2	294.0	0.67		52.7	SPLS 6a_270 Ah All Ct	321.1	188.2	267.3	0.28
328	CD	100x100x10	S355	2M20-8.8t	1.00	1.00	1.00	240	-76.3	SPLS 3_0,9_246.2 Ba	91.9	188.2	294.0	0.83		71.7	SPLS 6a_270 Ba Ct1 A	321.1	188.2	267.3	0.38
329	CD	80x80x6#	S235	1M20-8.8t	1.00	1.00	1.00	288	-3.3	ULS 1a_0,9_315	24.7	94.1	64.8	0.13		29.5	ULS 1a_315	100.2	94.1	58.9	0.50
250L	0	80x80x6#	S235	2M20-8.8t	1.00	1.00	1.00	174	-7.2	SPLS 3_0,9_246.2 Ba	64.8	188.2	129.6	0.11		4.0	SPLS 6a_270 Ah All Ct	93.1	188.2	91.6	0.04
250T	0	80x80x6#	S235	2M20-8.8t	1.00	1.10	1.00	159	-5.2	SPLS 6a_270 Ah Ct1 B	72.9	188.2	129.6	0.07		3.4	SPLS 3_0,9_246.2 Ah	93.1	188.2	91.6	0.04
251	0	100x100x8	S235	1M20-8.8t	1.00	1.00	1.00	191	-7.8	SPLS 1a_246.2 Ah Ct2	75.3	94.1	86.4	0.10		6.8	SPLS 1a_0,9_246.2 Ah	179.7	94.1	78.5	0.09
252	0	60x60x6	S235	1M20-8.8t	0.50	0.50	0.50	236	-0.9	ULS 1a_180	24.6	94.1	64.8	0.04		0.3	ULS 1a_0,9_180	41.5	94.1	25.7	0.01
450	0	50x50x5	S235	1M16-8.8t	1.00	1.00	1.00	245	-4.9	ULS 1a_180	16.3	60.3	43.2	0.30		4.9	ULS 1a_180	46.1	60.3	32.7	0.15
350	0	50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	298	-4.0	ULS 1a_0,9_270	12.9	60.3	58.8	0.31		4.2	ULS 1a_270	62.7	60.3	44.5	0.10
451	451	70x70x7	S355	1M16-8.8t	0.53	0.53	0.53	120	-25.3	SPLS 6a_270 Ah Ct2 B	96.9	60.3	82.3	0.42		25.8	25.803	SPLS 6a_270	87.8	62.3	0.43
452	452	60x60x6	S355	1M16-8.8t	0.54	0.54	0.54	121	-3.4	SPLS 6a_270 Ah All Ct	70.4	60.3	70.6	0.06		4.1	4.075	SPLS 6a_270	75.3	53.4	0.08
453	453	50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	208	-1.0	SPLS 6a_270 Ah Ct1 B	23.1	60.3	58.8	0.04		0.0	0.014	SPLS 3_0,9_2	62.7	44.5	0.00

Assessment of groups for strengthened mast (verbouw level)

Date 26-11-21
Author KCh
Version 1.0

ENS-ZL 380
EC-3 / R
90

Staafgroep	Omschrijving	Profiel	Staalsoort	Bouten	RLX	RLY	RLZ	Slankheid	Druk	Combinatie druk	Knik	Afschuiving	Stuik (druk)	U.C. (druk)	Opm.	Trek	Combinatie trek	Nettodsn.	Afschuif	Stuik (trek)	U.C. (trek)
434	Bovenregel	100x100x8(12,0.2)	S235	4M24-8.8t	1.00	2.00	1.00	156	-145.4	SPLS 3_0,9_246.2 Ba /	232.6	2168.8	414.7	0.63		153.7	SPLS 6a_270 Ah All Ct:	602.5	2168.8	378.3	0.41
435	Bovenregel	80x80x8(12,0.2)	S235	4M20-8.8t	1.00	2.00	1.00	181	-133.0	ULS 1a_0,9_246.2	153.0	376.3	345.6	0.87		118.1	SPLS 6a_270 Ah Ct1 B:	473.5	376.3	314.2	0.38
319A	Eerste DWSRM	90x90x8(12,0.33)	S235	4M24-8.8t	1.00	2.00	1.00	118	-221.3	SPLS 3_0,9_246.2 Ba /	286.1	542.2	414.7	0.77		222.5	SPLS 6a_270 Ah All Ct:	536.3	542.2	355.3	0.63
319B	Eerste DWSRM	90x90x8	S235	4M24-8.8t	1.00	2.00	1.00	134	-120.9	SPLS 3_0,9_246.2 Ba /	124.6	542.2	414.7	0.97		130.8	SPLS 6a_270 Ah All Ct:	252.5	542.2	389.9	0.52
320A	Eerste DWSRM	90x90x8	S235	4M24-8.8t	1.00	2.00	1.00	153	-83.6	SPLS 3_0,9_246.2 Ba /	106.8	542.2	414.7	0.78		85.2	SPLS 6a_270 Ah All Ct:	252.5	542.2	389.9	0.34
320B	Eerste DWSRM	90x90x8	S235	3M24-8.8t	1.00	2.00	1.00	157	-86.4	ULS 1a_0,9_246.2	104.0	406.7	311.0	0.83		78.9	SPLS 6a_270 Ah All Ct:	185.9	406.7	264.5	0.42
322	Hor. bovenrege	60x60x6	S355	1M16-8.8t	1.00	2.00	1.00	127	-22.8	SPLS 6a_270 Ah Ct1 B:	70.2	60.3	70.6	0.38		21.7	SPLS 6a_270 Ah Ct2 B:	65.9	60.3	45.8	0.47
323	B-B CD	70x70x7	S355	1M16-8.8t	1.00	1.00	1.00	181	-43.5	SPLS 6a_270 Ah Ct2 B:	55.5	60.3	82.3	0.78		42.5	SPLS 6a_270 Ah Ct2 B:	87.8	60.3	62.3	0.71
327	CD	100x100x10	S355	2M20-8.8t	1.00	1.00	1.00	280	-50.5	SPLS 3_0,9_246.2 Ba /	71.6	188.2	294.0	0.71		55.9	SPLS 6a_270 Ba Ct1 Al	321.1	188.2	267.3	0.30
328	CD	100x100x10	S355	2M20-8.8t	1.00	1.00	1.00	240	-80.0	SPLS 3_0,9_246.2 Ba /	91.9	188.2	294.0	0.87		76.4	SPLS 6a_270 Ba Ct1 Al	321.1	188.2	267.3	0.41
350		50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	298	-4.8	ULS 1a_0,9_270	12.9	60.3	58.8	0.37		5.0	ULS 1a_270	62.7	60.3	44.5	0.11
451		70x70x7	S355	1M16-8.8t	0.53	0.53	0.53	120	-26.3	SPLS 6a_270 Ah Ct2 B:	96.9	60.3	82.3	0.44		26.8	SPLS 6a_270 Ah Ct1 B:	87.8	60.3	62.3	0.44
452		60x60x6	S355	1M16-8.8t	0.54	0.54	0.54	121	-3.5	SPLS 6a_270 Ah All Ct:	70.4	60.3	70.6	0.06		4.2	SPLS 6a_270 Ah All Ct:	75.3	60.3	53.4	0.08
453		50x50x5	S355	1M16-8.8t	1.00	1.00	1.00	208	-1.1	SPLS 6a_270 Ah Ct1 B:	23.1	60.3	58.8	0.05		0.0	SPLS 3_0,9_246.2 Ba (	62.7	60.3	44.5	0.00

APPENDIX C
Toetsing knikverkorters

DNV·GL

Knikverkorters initial construction (afkeur)

Date: 2021-01-15
Author: M Rekers
Version: 1.8

ENS - ZL
EC-3/R
Masts: 1/90

Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Exceedance Type	Notes
93-1-E	Broekstuk	Enkele staaf	L50.5	S235	M16	8.8	0.64	0	66	**29.0**	**0.16**	59.9	60.3	30.3	31.7	0.72	0.95		
92E	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	1.85	80	158	**29.0**	**0.00**	43.1	60.3	38.4	72.6	1.24	0.75		
91E	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	1.59	0	136	**29.0**	**0.40**	51.8	60.3	38.4	72.6	1.24	0.75		
90E	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	2.22	55	190	**29.0**	**0.00**	33.9	60.3	38.4	72.6	1.24	0.85		
89-1	Broekstuk	Enkele staaf	L70.6	S235	M16	8.8	2.45	0	179	**29.0**	**0.61**	43.3	60.3	38.4	89.9	1.71	0.75		
88E	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	2.82	40	179	**29.0**	**0.00**	49.6	60.3	38.4	107.1	2.25	0.75		
87E	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	3.31	0	211	**29.0**	**0.83**	39.6	60.3	38.4	107.1	2.25	0.75		
86E	Broekstuk	Enkele staaf	L80.6	S235	M16	8.8	3.53	30	225	**29.0**	**0.76**	36.0	60.3	38.4	107.1	2.25	0.80		
85E	Broekstuk	Enkele staaf	L70.6	S235	M16	8.8	2.71	30	197	**29.0**	**0.59**	37.7	60.3	38.4	89.9	1.71	0.77		
84E	Broekstuk	Enkele staaf	L60.6	S235	M16	8.8	2.10	0	179	**29.0**	**0.52**	36.6	60.3	38.4	72.6	1.24	0.79		
75E	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	0.92	0	94	**4.1**	**0.23**	51.0	60.3	30.3	31.7	0.72	0.32		
79E	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.01	77	207	**4.1**	**0.00**	20.9	60.3	30.3	31.7	0.72	0.19		
74-1	Pootverband	Kniksteun en verticale steun	L60.6	S235	M16	8.8	2.03	0	112	**4.1**	**0.25**	48.8	60.3	38.4	72.6	0.93	0.28		
78E	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.19	62	225	**4.1**	**0.00**	18.5	60.3	30.3	31.7	0.72	0.22		
73E	Pootverband	Kniksteun en verticale steun	L70.6	S235	M16	8.8	3.15	0	148	**4.1**	**0.39**	43.2	60.3	38.4	89.9	1.32	0.31		
77E	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.49	51	256	**4.1**	**0.00**	15.2	60.3	30.3	31.7	0.72	0.27		
72-1	Pootverband	Kniksteun en verticale steun	L80.6	S235	M16	8.8	4.27	0	175	**4.1**	**0.53**	40.9	60.3	38.4	107.1	1.77	0.32		
76E	Pootverband	Enkele staaf	L50.5	S235	M16	8.8	2.82	41	290	**4.1**	**0.00**	12.5	60.3	30.3	31.7	0.72	0.32		
68E	Tussenschot	Kniksteun en verticale steun	L80.8	S235	M16	8.8	5.80	0	239	**0.7**	**0.73**	35.8	60.3	51.2	142.8	2.20	0.34		
115E	Tussenschot	Kruisende staaf halverwege	L80.8	S235	M16	8.8	4.14	0	171	**0.7**	**0.52**	55.4	60.3	51.2	142.8	2.95	0.18		
83E	Eerste TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	1.64	0	140	**29.0**	**0.41**	49.8	60.3	38.4	72.6	1.24	0.76		
82E	Eerste TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	1.88	45	160	**4.1**	**0.00**	42.3	60.3	38.4	72.6	1.24	0.11		
71E	Eerste TSNSTK	Enkele staaf	L80.8	S235	M16	8.8	3.36	0	216	**29.0**	**0.84**	50.3	60.3	51.2	142.8	2.95	0.58		
81E	Eerste TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	1.97	30	168	**4.1**	**0.43**	39.9	60.3	38.4	72.6	1.24	0.34		
80E	Eerste TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	1.64	0	140	**29.0**	**0.41**	49.8	60.3	38.4	72.6	1.24	0.76		
146E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.30	0	133	**29.0**	**0.32**	36.7	60.3	30.3	31.7	0.72	0.96		
145E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.73	50	178	**4.1**	**0.00**	25.7	60.3	30.3	31.7	0.7	0.16		
137E	Tweede TSNSTK	Enkele staaf	L80.6	S235	M16	8.8	2.59	0	164	**29.0**	**0.65**	55.5	60.3	38.4	107.1	2.25	0.76		
144E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.72	35	176	**4.1**	**0.00**	26.0	60.3	30.3	31.7	0.72	0.16		
143E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.30	0	133	**21.0**	**0.32**	36.7	60.3	30.3	31.7	0.72	0.69		
140E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.30	0	134	**21.0**	**0.33**	36.6	60.3	30.3	31.7	0.72	0.69		
142E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.45	60	149	**6.8**	**0.00**	32.2	60.3	30.3	31.7	0.72	0.22		
139E	Tweede TSNSTK	Enkele staaf	L60.6	S235	M16	8.8	2.14	0	183	**21.0**	**0.53**	35.7	60.3	38.4	72.6	1.24	0.59		
141E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	1.38	40	142	**6.8**	**0.00**	34.2	60.3	30.3	31.7	0.7	0.22		
140E	Tweede TSNSTK	Enkele staaf	L50.5	S235	M16	8.8	0.99	0	102	**21.0**	**0.25**	47.8	60.3	30.3	31.7	0.7	0.69		
137E	Tussenschot	Enkele staaf	L80.6	S235	M16	8.8	2.59	0	164	**16.9**	0.65	55.5	60.3	38.4	107.1	2.2	0.44		
136E	Tussenschot	Enkele staaf	L100.8	S235	M16	8.8	3.72	0	189	**16.9**	**0.93**	76.6	60.3	51.2	188.9	4.76	0.33		
138-1-E	Tussenschot	Kruisende staaf halverwege	L60.6	S235	M16	8.8	2.82	0	155	**16.9**	**0.35**	34.8	60.3	38.4	72.6	1.24	0.48		
187E	Bovenstuk 1	Enkele staaf	L50.5	S235	M16	8.8	1.86	0	191	**10.9**	**0.47**	23.3	60.3	30.3	31.7	0.7	0.65		
188E	Bovenstuk 1	Enkele staaf	L50.5	S235	M16	8.8	1.71	0	176	**10.9**	**0.43**	26.1	60.3	30.3	31.7	0.7	0.60		
189E	Bovenstuk 2	Enkele staaf	L50.5	S235	M16	8.8	1.61	0	166	**5.4**	**0.40**	28.2	60.3	30.3	31.7	0.7	0.56		
190E	Bovenstuk 2	Enkele staaf	L50.5	S235	M16	8.8	1.43	0	147	**5.4**	**0.36**	32.8	60.3	30.3	31.7	0.7	0.50		

APPENDIX D
Toetsing blokdeuvels

DNV·GL

Project: ENS-ZL380
Mast: EC-3/R (1&90)

Shear blocks

NEN-EN 1993-1-1 en NEN-EN 1994-1-1

Datum: 2021-04-06
Auteur: TBR
Versie: 1.4

Load				**Results**			
Compression	$F_{Ed,c}$	**1628**	kN	Compression	U.C.	0.81	< 1,00 OK
Tension	$F_{Ed,t}$	**1475**	kN	Tension	U.C.	0.80	< 1,00 OK

Main leg

Profile		**L200.24**	
Steel material		S355	
Cross section		9059	mm^2
Axial capacity	N_{pl}	3216	kN
Width	b	200	mm
Thickness	t	24	mm
Length in concrete		1800	mm

Shear blocks main leg

Width	b	50	mm
Thickness	h	30	mm
Length	L	210	mm
Welds	a	5	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	12	-
Number for tension	n_t	12	-

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Pile

Name		Buispaal	
Diameter		914	mm
Thickness		10	mm
Cross section		28400	mm^2
Steel material		S235	
Capacity		6674	kN
Concrete strength		C20/25	

Shear blocks pile

Width	b	20	mm
Thickness	h	20	mm
Length	L	2746	mm
Welds	a	5	mm
c.t.c. separation	s	950	mm
Number for compr.	n_c	3	-
Number for tension	n_t	2	-

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.25	-
f_{cd} =		10.7	N/mm^2

Steel tower stub

Yield strength	f_{yd} =	355	N/mm^2
Tensile strength	f_{ud} =	490	N/mm^2

Capacity shear blocks main leg

A_{f1} =	6300	mm^2
A_{f2} =	20300	mm^2
Slope	1:	5
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.80	
$f_{jd} = C_A \times f_{cd}$ =	19.1	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	1448	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	1448	kN

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	18.5	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	62	mm
$m^* = \min(c,m)$ =	30	mm
Type foot plate	Diagonally cut	
Effective for	Compr. and tension	
$A_{p,c}$ =	30971	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	572	kN
$A_{p,t}$ =	21912	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	405	kN

Capacities

$F_{rd,c,plate}$ =	572	kN	
$F_{rd,blocks,c}$ =	1448	kN	
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**2020**	kN	
U.C. compression	0.81	< 1,00 OK	
Welds foot plate (see next page)	946	kN	
$F_{rd,t}$ = min. (welds / foot plate) =	405	kN	
$F_{rd,blocks,t}$ =	1448	kN	
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**1852**	kN	
U.C. tension	0.80	< 1,00 OK	
U.C. welds	0.36	< 1,00 OK	

Capacity shear blocks pile

A_{f1} =	54915	mm^2
A_{f2} =	164745	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.73	-
$f_{jd} = k_d \times f_{cd}$ =	18.5	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	**3044**	kN
U.C. compression	0.53	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	**2029**	kN
U.C. tension	0.73	< 1,00 OK
U.C. welds	0.26	< 1,00 OK

"Splitting" of pile

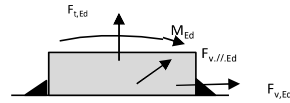
Spread of forces		45	°
Length force flow		1353	mm
Splitting force		545	kN/m
Yield strength wall	f_{yd} =	235	N/mm^2
Capacity tubular pile		4700	kN/m
U.C.		0.12	< 1,00 OK

Project: ENS-ZL380
Mast: EC-3/R (1&90)

Welds of shear blocks of main leg

Out-of-plane loading

Plate			**Welds**		
t =	50	mm	a =	5	mm
Grade	S355		l =	200	mm
f_{yd} =	355	N/mm^2	β_w =	0.9	-
f_u =	490	N/mm^2	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 4al$ =	51	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**145**	kN		51	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54.7	mm
$M_{Ed} = 1/2\ b / h \times F_{v,Ed}$ =	**2.17**	kNm	$\sigma_1 = \tau_1 = 0{,}706 M_{Ed} / al\ b^*$ =	28	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	158	N/mm^2

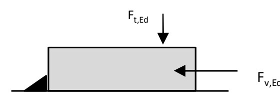
Check

$\sigma_{vw,Ed}$ =	158	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0.36** OK
σ_1 =	79	N/mm^2	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0.22** OK

Welds of shear blocks of pile

Out-of-plane loading

Plate			**Welds**		
t =	20	mm	a =	5	mm
Grade	S235		l =	2746	mm
f_{yd} =	235	N/mm^2	β_w =	0.8	-
f_u =	360	N/mm^2	γ_{M2} =	1.25	-



Member forces			**Stress components**		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 2al$ =	16	N/mm^2
$F_{t,Ed} = 1/2\ b / h \times F_{v,Ed}$ =	**609**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 2al$ =	31	N/mm^2
$F_{v,Ed}$ =	**1217**	kN		47	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0.00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	94	N/mm^2

Check

$\sigma_{vw,Ed}$ =	94	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	360	N/mm^2	U.C. =	**0.26** OK
σ_1 =	47	N/mm^2	≤	$0{,}9 f_u / \gamma_{M2}$ =	259	N/mm^2	U.C. =	**0.18** OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm^2
Weld size	a =	5	mm
Length	l = 2b+ 2b - t =	752	mm
Capacity	$F_{Rd} = a \times l \times f_{w,d} / \sqrt{3}$ =	**946**	kN

CALCULATION OF POST INSULATOR LOADS

The following parameters are calculated:

- The forces on the insulator attachment due to wind loading and weight
- The required measurements of the components

The diagram below is a representation of the loads on the insulator:

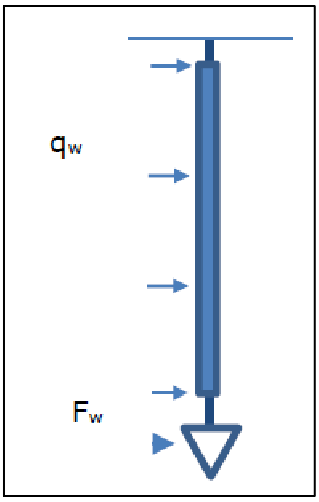


Figure 1: Diagrammatic representation of the loads on the post insulator

1. Forces on the insulator attachment

Wind pressure based on non-urban terrain in wind zone II at a height of 25.2 m: q_h = 1.14 kN/m^2

Wind load per meter based on an insulator diameter of 0.2 m and a drag factor of 1.2:

q_w = 1.2 x 0.2 x 1.14 = 0.27 kN/m

Then calculate F_w based on a supported length of 9 m, a dragfactor of 0,9 and a structural factor of 1,0:

F_w = 9 x 0.9 x 1.0 x 3 x 0.036 x 1.14 = 0.99 kN

Calculate the moment based on the wind loading and the point load:

M_w = 0.5 x 0.24 x 4^2 + 4 x 0.99 = 5.88 kNm

Design values:

M_{ED} = 1.4 x 5.88 = 8.23 kNm

V_{ED} = 1.4 x (0.99 + 3.5 x 0.24) = 2.56 kN

2. Assessment of the pin

The figure below is a sketch of the insulator attachment mechanism indicating the location of the pin.

Calculation of the shear force on the pin:

Assuming a total vertical weight of 5 kN and an attachment fit of 200 mm:

F_V = 8.23 /0.2 + 5/2 = 43.65 kN

Using a pin with a diameter of 24 mm is sufficient; see the attached spreadsheet calculation at the end of this appendix. A minimum flange thickness of 15 mm is required.

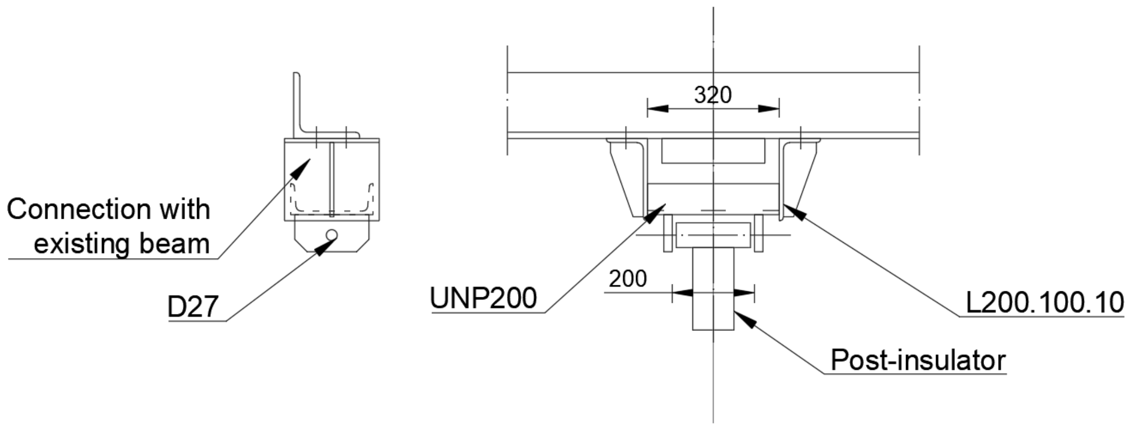


Figure 2: Overview of the new members required for attachment – inner phase

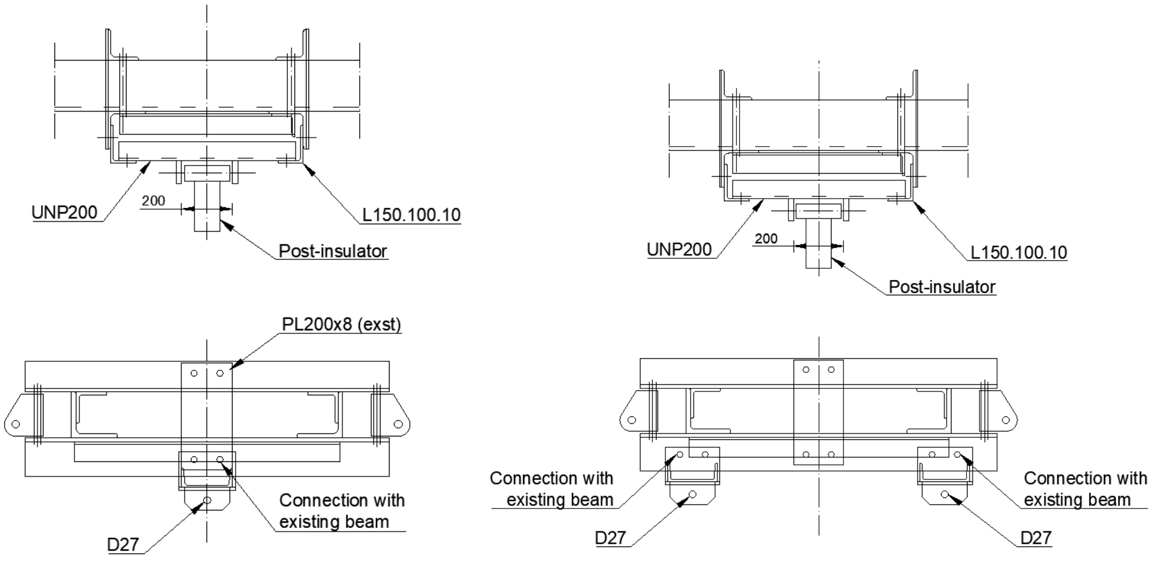


Figure 3: Overview of the new members required for attachment – outer phase

3. Console thickness

This will be determined in the subsequent design phases.

4. Attachment to the crossarm

Check of UNP200 profile (outer phase is ruling):

M = 0.5 x 8.23 + 0.25 x 5 x 0.66 = 4.94 kNm

Proposition: 1 x UNP200: M_{rd} = 26900 x 355 = 9.55 kNm

U.C. = 4.94/ 9.55 = 0.51 < 1 OK

Force on the bolts (inner phase):

F_{bolt} = 8.23 / 0.42 + 5 / 2 = 22.1 kN. Some prying effect can occur, so the total force can be around 30kN → 15 kN per bolt. Boltdiameter M16 (8.8) → capacity: $F_{T,Rd}$ = 90.4kN.

U.C. = 15 / 90.4 = 0,17.

Project:	BBB - ENS-ZL
Mast:	EC-3

DNV·GL

Pen-gatverbinding

Datum:	2021-03-10
Auteur:	MRE
Versie:	1.3

Onderwerp	Post Insulator Attachment	Toetsing sterkte	0.67 < 1,0 OK

Input

Dikte	15	mm
Gat	27	mm
Pendiameter	24	mm
Ringdikte	5	mm
Eindafstand	45	mm
Randafstand	35	mm
Staalsoort	S235	
Kwaliteit pen	8.8	

Belasting

F_{Ed} = 43.7 kN

$\gamma_{m0,staal}$	1.20
$\gamma_{m0,pen}$	1.00
γ_{m2}	1.25
$\gamma_{m6,ser}$	1.00

Toetsing

Afstanden

Randafstand	OK
Eindafstand	OK
Dikte	OK

Sterkte-eisen

Afschuifsterkte pen	0.25	< 1,0 OK
Buigsterkte pen	0.67	< 1,0 OK
Combinatie M + V	0.51	< 1,0 OK
Stuik plaat	0.41	< 1,0 OK

Berekeningen

Controle eind- en randafstand

Aan de eisen van óf A óf B moet voldaan worden

Type A

Rand	$a > F_{Ed}\,\gamma_{m0} / 2tf_y + 2\,d0/3$ =	25 mm	OK
Eind	$c > F_{Ed}\,\gamma_{m0} / 2tf_y + d0/3$ =	16 mm	OK

Type B

Min. eindafstand	$e > 1{,}6d_0$ =	43 mm	OK
Min. randafstand	$e > 1{,}25d_0$ =	34 mm	OK
Min. dikte	$t > 0{,}7\sqrt{(F_{Ed}\,\gamma_{m0} / f_y)}$ =	10 mm	OK

Pen

A =	452	mm^2
W_{el} =	1357	mm^2

Excentriciteit

$e = (132-102)+t_{clip}/2$ = 20 mm

Materiaalsterktes

$f_y = \min(f_{y,staal}, f_{yp})$ =	235	N/mm^2
f_{yp} =	640	N/mm^2
f_{up} =	800	N/mm^2
$f_{y,staal}$	235	N/mm^2
$f_{t,staal}$	360	N/mm^2

Afschuiving

$F_{v,Rd} = 0{,}6A\,f_{up} / \gamma_{m2}$ = 174 kN

U.C. 0.25 < 1,0 OK

Stuik

$F_{b,Rd} = 1{,}5\,t\,d\,f_y / \gamma_{m0}$ = 106 kN

U.C. 0.41 < 1,0 OK

Buigweerstand

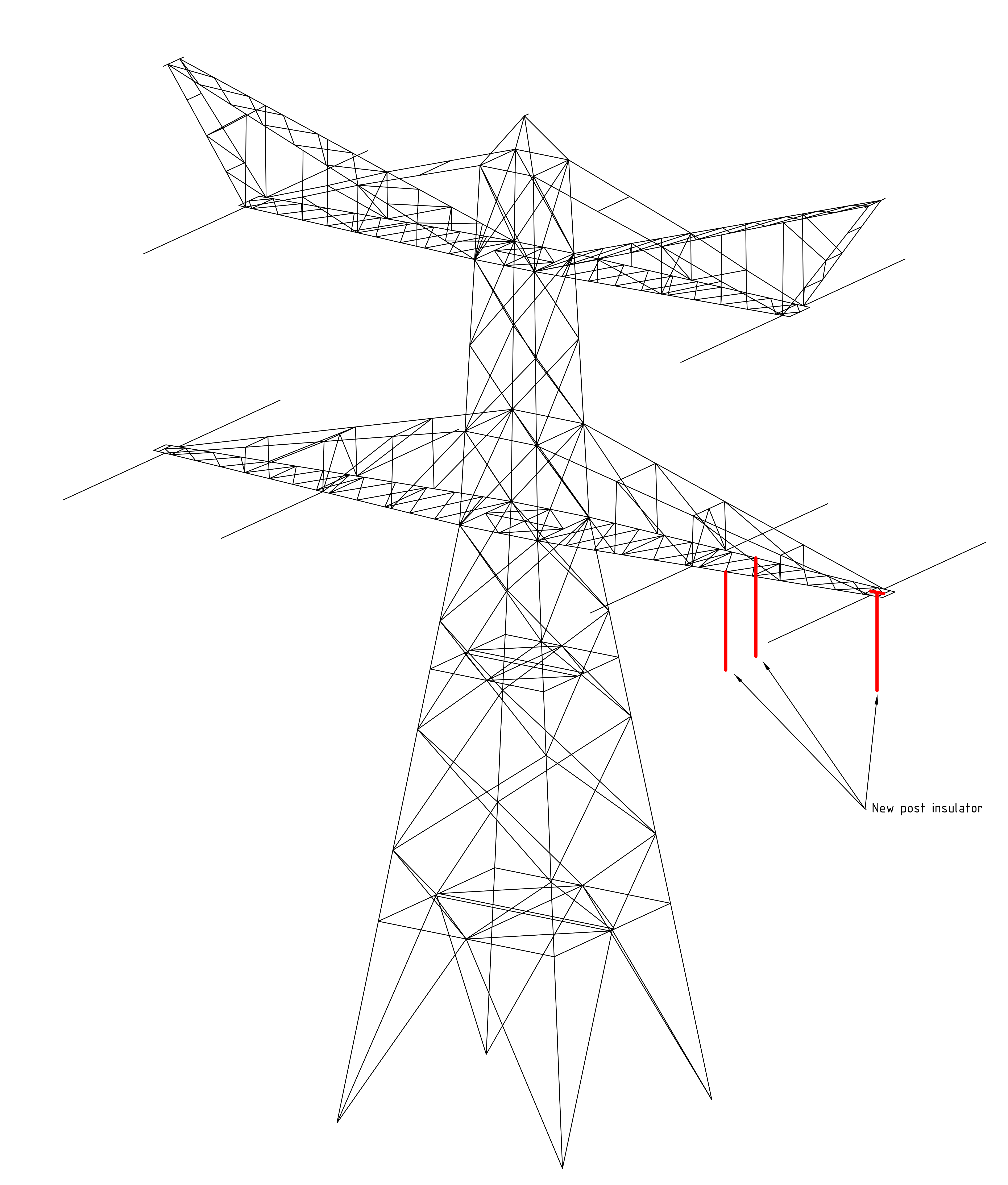
$M_{Ed} = F_{Ed}\,e$ = 0.87 kNm

$M_{Rd} = 1{,}5\,W_{el}\,f_{yp} / \gamma_{m0}$ = 1.30 kNm

U.C. = 0.67 < 1,0 OK

$(M_{Ed} / M_{Rd})2 + (F_{v,Ed} / F_{v,Rd})^2$ = 0.51 < 1,0 OK

APPENDIX E
Tekeningen



Overview

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5 unless otherwise indicated
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Added profile to existing
Profile exchanged
New redundant
Bolt exchanged

01	10-3-2021	Version 2.0
02	29-11-2021	Version 3.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-051

Design state: FINAL		Scale: -		
Drawn by: KCh	29-11-2021	Units: m		
Checked by: TBR	29-11-2021	Project no: 10166260		
Approved by: JHu	29-11-2021	Company: TenneT		

Description: Modifications overview for mast type EC-3_R (Mast 1) page 1 of 2

Revision: 02

Format: A2

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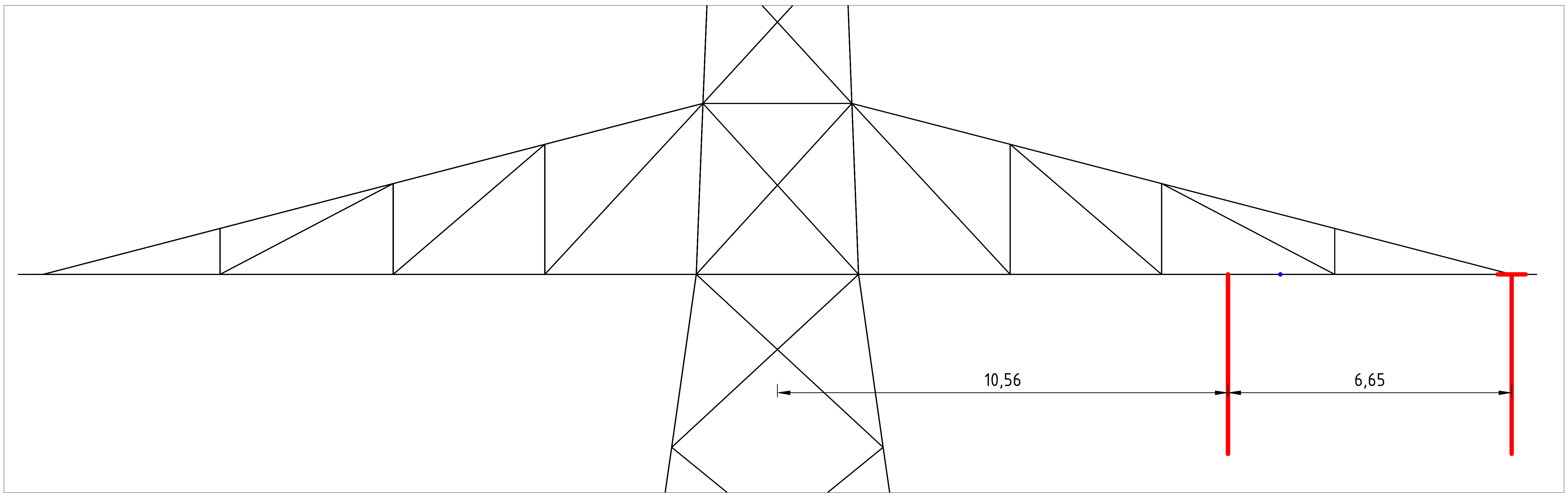


Front View - Lower Crossarm

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5 unless otherwise indicated
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Added profile to existing
Profile exchanged
New redundant
Bolt exchanged

01	10-3-2021	Version 2.0
02	29-11-2021	Version 3.0

Projectname: Mast constructions ENS - ZL 380 kV

DNV·GL

Third angle projection:

Drawing no.: 10166260-051

Design state:	FINAL		Scale:	-
Drawn by:	KCh	29-11-2021	Units:	m
Checked by:	TBR	29-11-2021	Project no:	10166260
Approved by:	JHu	29-11-2021	Company:	TenneT

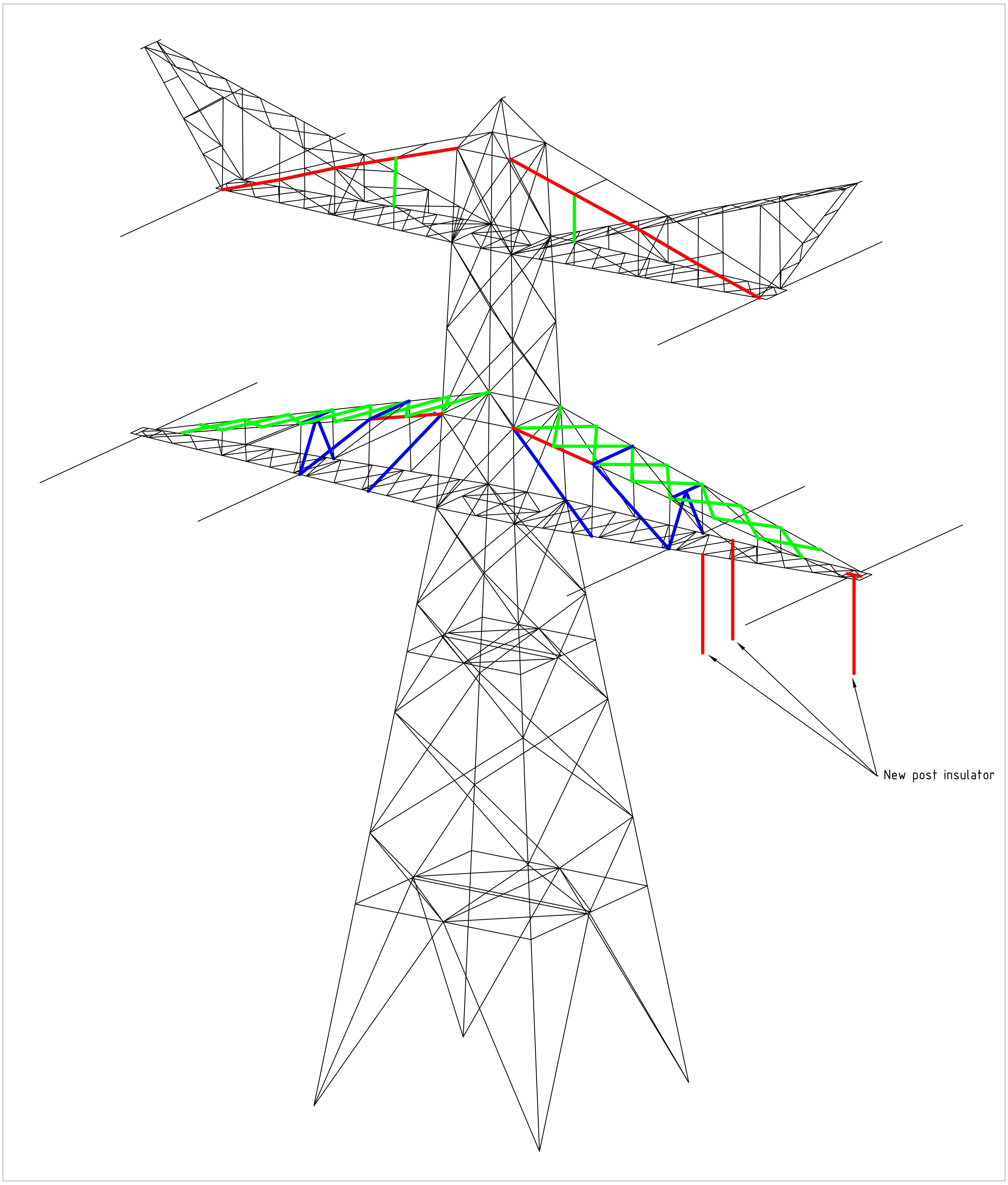
Description: Modifications overview for mast type EC-3_R (Mast 1) page 2 of 2

Revision: 02

Format: A2

DNV GL Energy & Sustainability, Utrechtseweg 310, 6812 AR Arnhem, tel: +31 26 3 56 91 11, www.dnvgl.com

Initial Profiles and Bolts					Final Profiles and Bolts			
Group label	Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
319A	EA	L90x8	S235 t=<40	M16-8.8t-NEN2012	DEA	L90x8	S355 t=<40	M16-8.8t-NEN2012
327	EA	L90x8	S235 t=<40	M20-8.8t-NEN2012	EA	L100x10	S355 t=<40	M20-8.8t-NEN2012
328	EA	L80x8	S235 t=<40	M24-8.8t-NEN2012	EA	L100x10	S355 t=<40	M20-8.8t-NEN2012
434	EA	L100x8	S235 t=<40	M24-8.8t-NEN2012	DEA	L100x8	S355 t=<40	M24-8.8t-NEN2012
435	EA	L80x8	S235 t=<40	M20-8.8t-NEN2012	DEA	L80x8	S355 t=<40	M20-8.8t-NEN2012
451					EA	L70x7	S355 t=<40	M16-8.8t-NEN2012
452					EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
453					EA	L50x5	S355 t=<40	M16-8.8t-NEN2012
322	EA	L60x6	S235 t=<40	M16-8.8t-NEN2012	EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
323	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L70x7	S355 t=<40	M16-8.8t-NEN2012
350	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L50x5	S355 t=<40	M16-8.8t-NEN2012



Overview

Notes and legend:

- **New redundants according to drawing**
- **Size for new redundants is L50x50x5 unless otherwise indicated**
- **Other changes according to the table**
- **All changes are symmetrical unless otherwise indicated**
- **Material quality t ≤ 16mm S355J0**
- **Material quality t > 16mm S355J2**
- **Bolt quality 8.8 rolled**

Added profile to existing (red line)
Profile exchanged (blue line)
New redundant (green line)
Bolt exchanged (red dot)

01	10-3-2021	Version 2.0
02	29-11-2021	Version 3.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-052

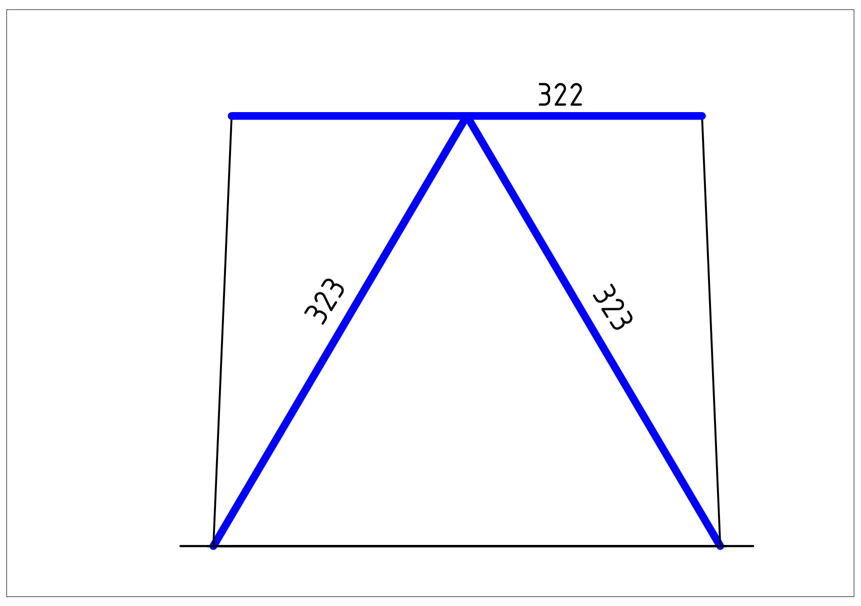
Design state: FINAL		Scale: -		
Drawn by: KCh	29-11-2021	Units: m		
Checked by: TBR	29-11-2021	Project no: 10166260		
Approved by: JHu	29-11-2021	Company: TenneT		

Description: Modifications overview for mast type EC-3_R (Mast 90) page 1 of 2

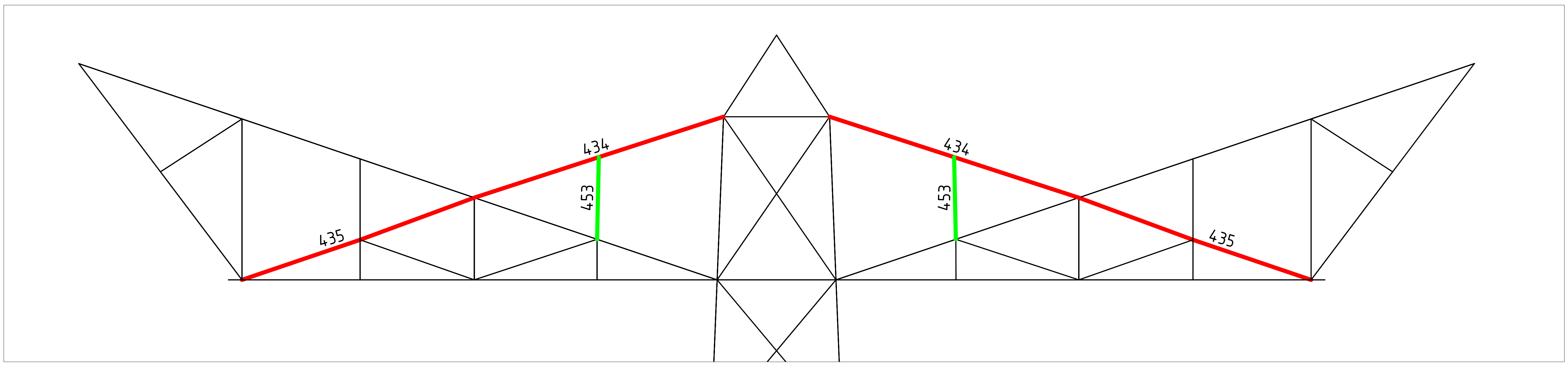
Revision: 02

Format: A2

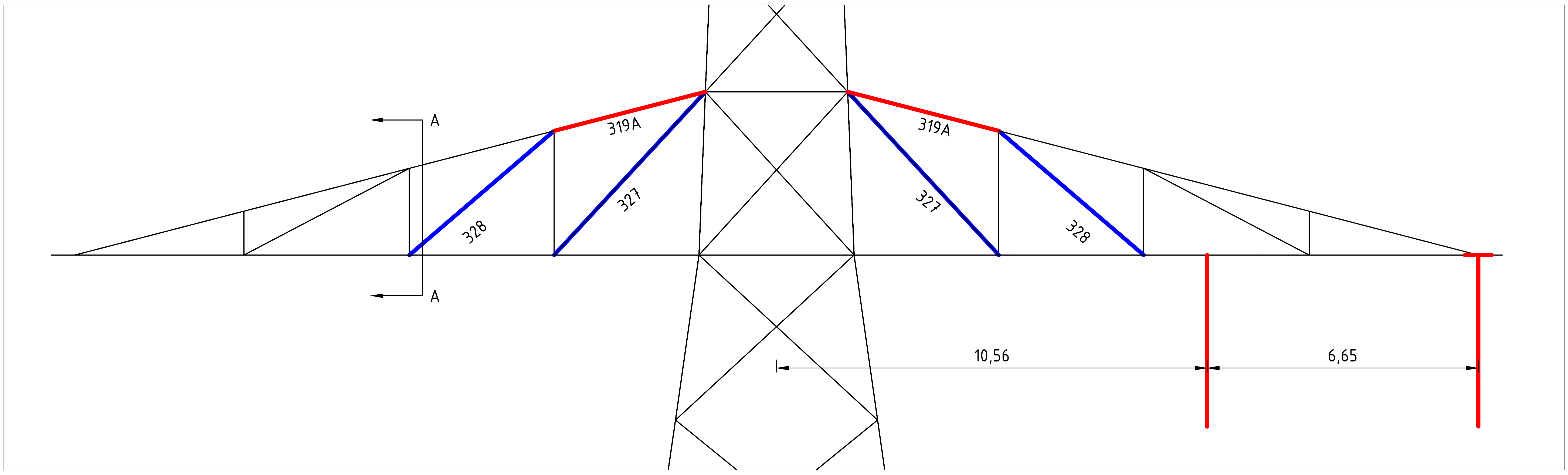
Group label	Initial Profiles and Bolts: Profile type (ini)	Profile size (ini)	Steel quality (ini)	Bolt size and quality (ini)	Final Profiles and Bolts: Profile type (new)	Profile size (new)	Steel quality (new)	Bolt size and quality (new)
319A	EA	L90x8	S235 t=<40	M16-8.8t-NEN2012	DEA	L90x8	S355 t=<40	M16-8.8t-NEN2012
327	EA	L90x8	S235 t=<40	M20-8.8t-NEN2012	EA	L100x10	S355 t=<40	M20-8.8t-NEN2012
328	EA	L80x8	S235 t=<40	M24-8.8t-NEN2012	EA	L100x10	S355 t=<40	M20-8.8t-NEN2012
434	EA	L100x8	S235 t=<40	M24-8.8t-NEN2012	DEA	L100x8	S355 t=<40	M24-8.8t-NEN2012
435	EA	L80x8	S235 t=<40	M20-8.8t-NEN2012	DEA	L80x8	S355 t=<40	M20-8.8t-NEN2012
451					EA	L70x7	S355 t=<40	M16-8.8t-NEN2012
452					EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
453					EA	L50x5	S355 t=<40	M16-8.8t-NEN2012
322	EA	L60x6	S235 t=<40	M16-8.8t-NEN2012	EA	L60x6	S355 t=<40	M16-8.8t-NEN2012
323	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L70x7	S355 t=<40	M16-8.8t-NEN2012
350	EA	L50x5	S235 t=<40	M16-8.8t-NEN2012	EA	L50x5	S355 t=<40	M16-8.8t-NEN2012



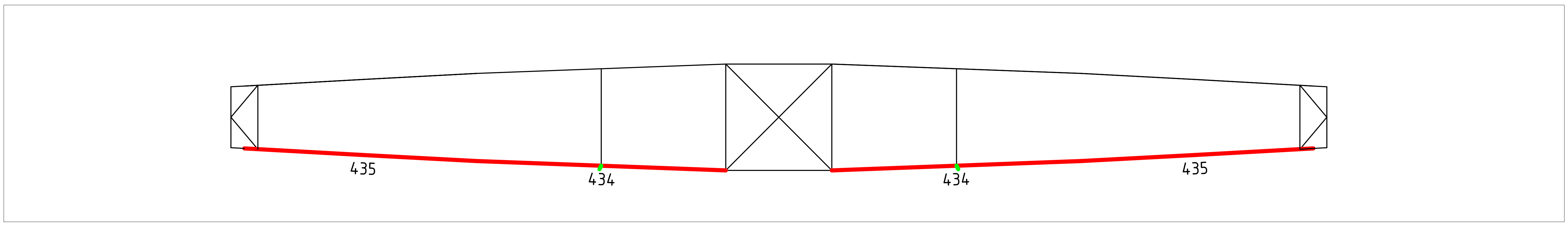
Section A-A



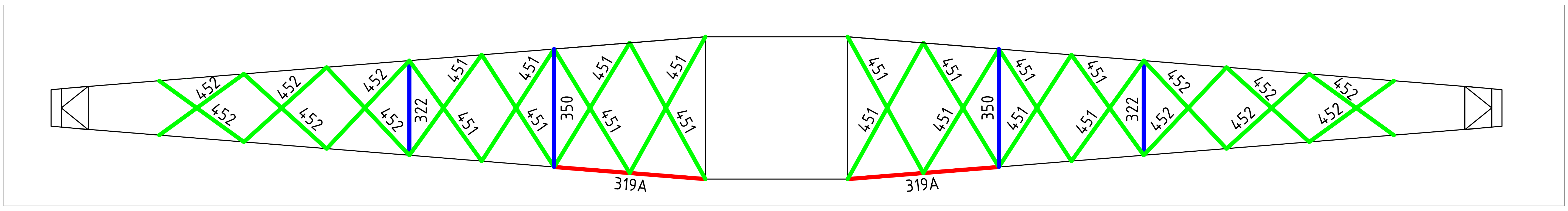
Front View - Upper Crossarm



Front View - Lower Crossarm



Top View - Upper Crossarm



Top View - Lower Crossarm

Notes and legend:

- New redundants according to drawing
- Size for new redundants is L50x50x5 unless otherwise indicated
- Other changes according to the table
- All changes are symmetrical unless otherwise indicated
- Material quality t ≤ 16mm S355J0
- Material quality t > 16mm S355J2
- Bolt quality 8.8 rolled

Added profile to existing
Profile exchanged
New redundant
Bolt exchanged

01	10-3-2021	Version 2.0
02	29-11-2021	Version 3.0

DNV·GL

Projectname: Mast constructions ENS - ZL 380 kV

Third angle projection:

Drawing no.: 10166260-052

Design state: FINAL		Scale:	-
Drawn by: KCh	29-11-2021	Units:	m
Checked by: TBR	29-11-2021	Project no:	10166260
Approved by: JHu	29-11-2021	Company:	TenneT

Description: Modifications overview for mast type EC-3_R (Mast 90) page 2 of 2

Revision: 02

Format: A2

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

Bijlage 5

Gegevens UO per masttype

Ingenieursbureau
Aafjes b.v.

Ohmstraat 1
8013 PZ Zwolle
T. 038-460 88 60
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Projectnummer Aafjes: **21-187**

Documentnummer: **00974-01-02800**

Projectnummer TenneT: **002.515**

Meridian nummer: **002.515.40 0994434**

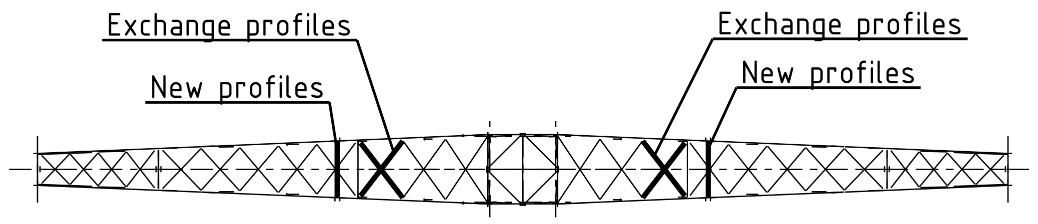
Opdrachtgever: **TenneT**

Project: **Opwaardering ENS-ZL380**

Onderdeel: **Masttype S-6_R, Mast 28 - Overzichtstekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		10-03-2022
Validatie Aafjes	Niels Verhaar	System Engineer		10-03-2022
Vrijgegeven	Bart Aafjes	Projectleider		10-03-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	10-03-2022	1e versie ter review



Section A - A
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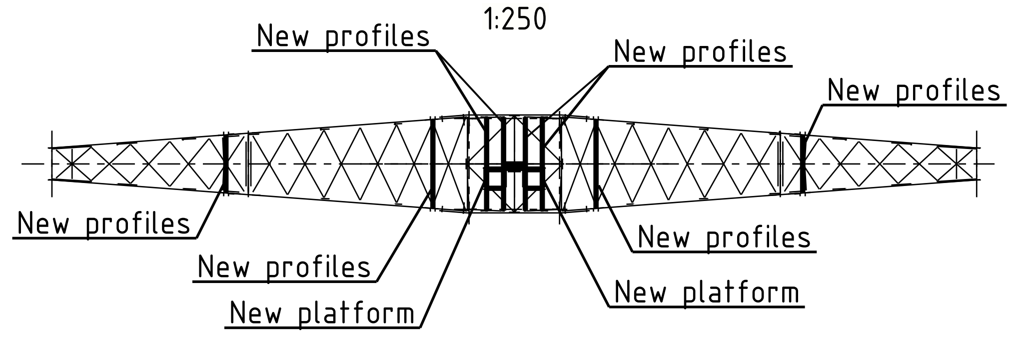

Section B - B
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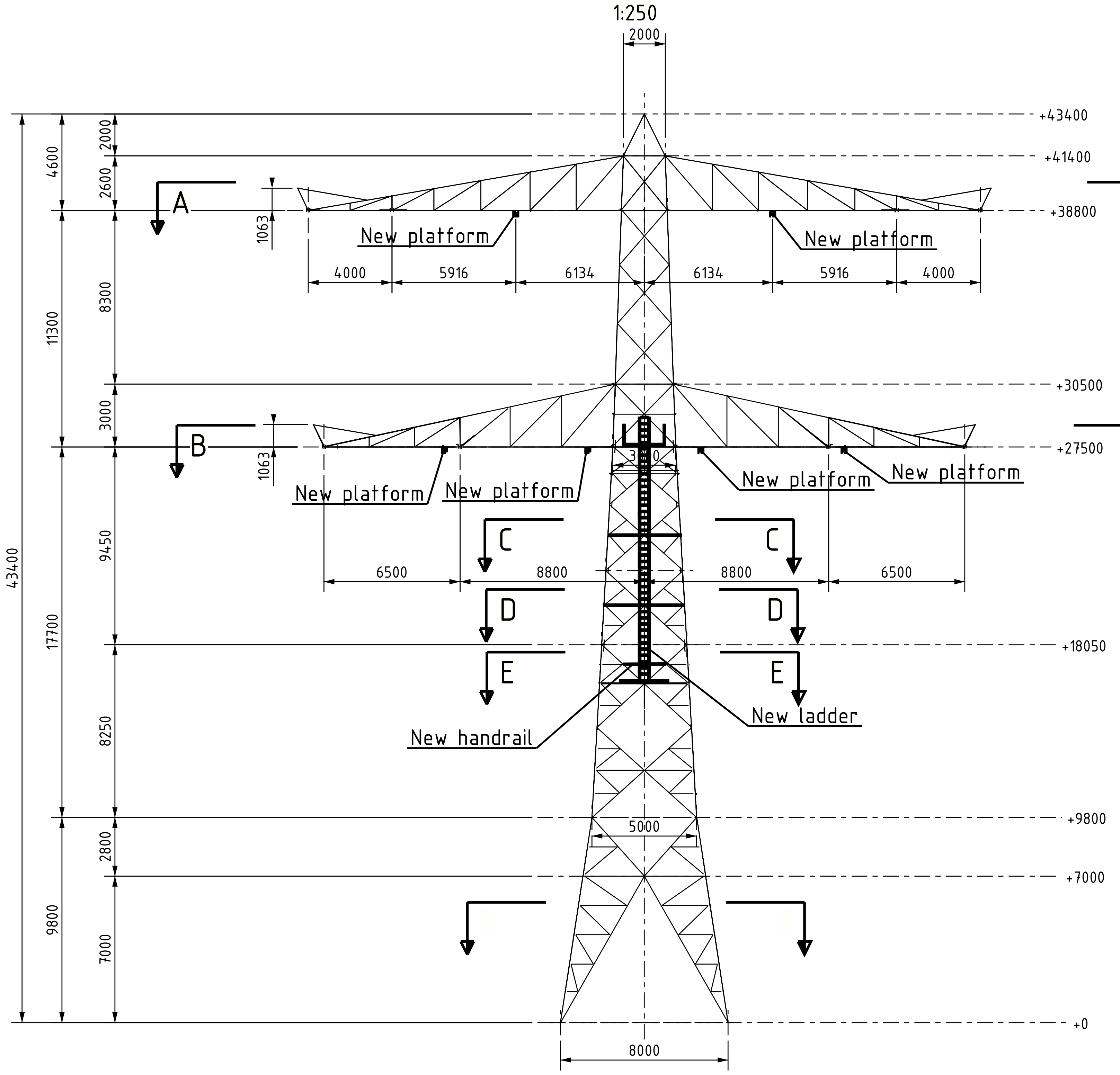
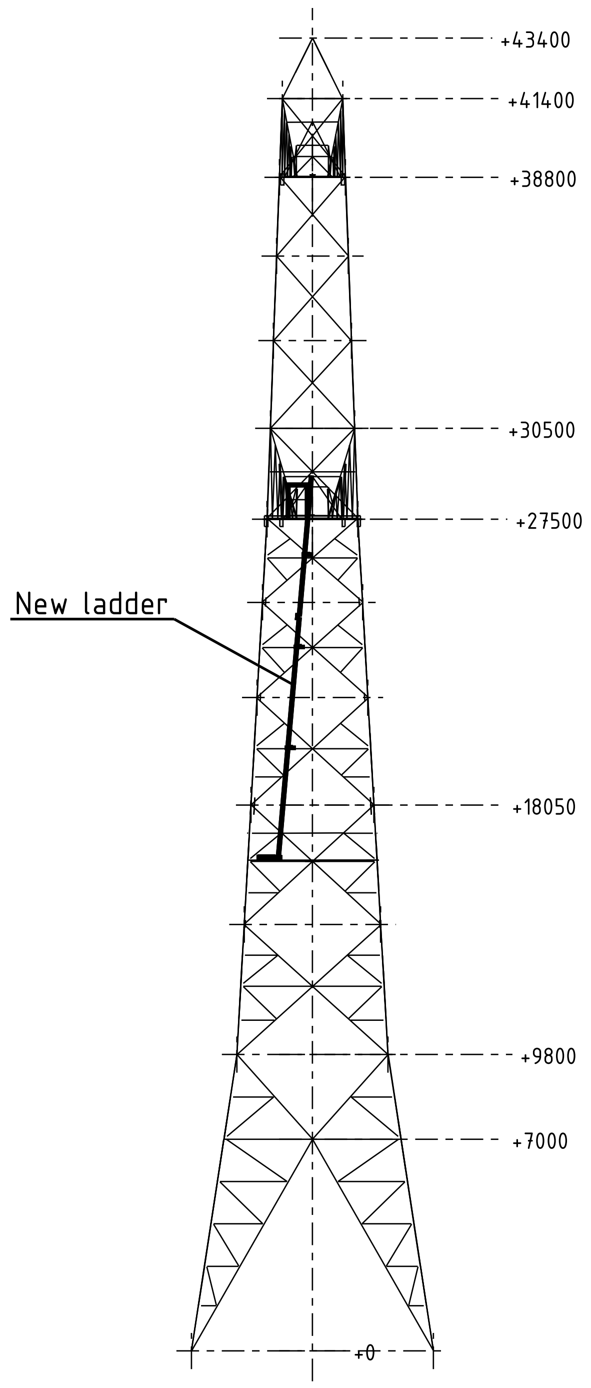
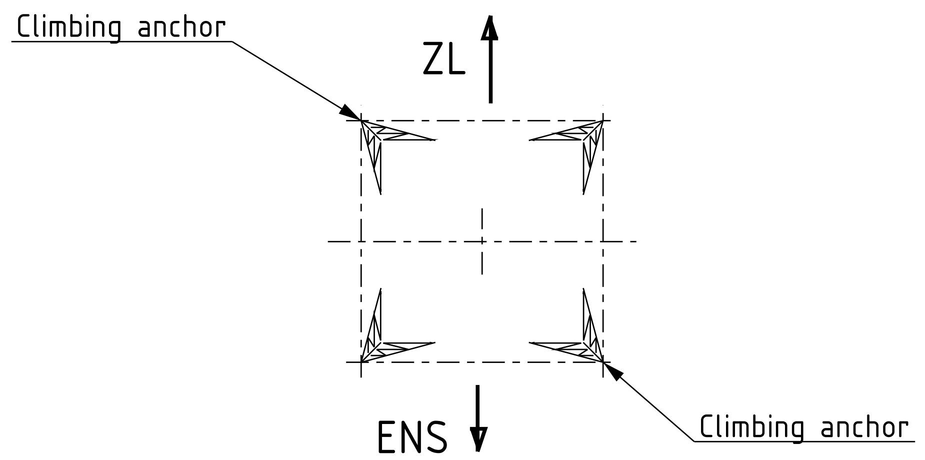


Transverse face
1:250



Longitudinal face
1:250



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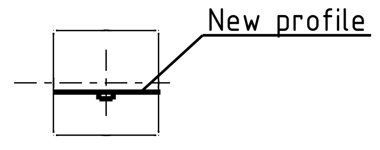

Section C - C
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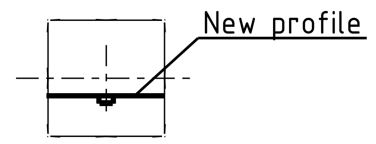

Section D - D
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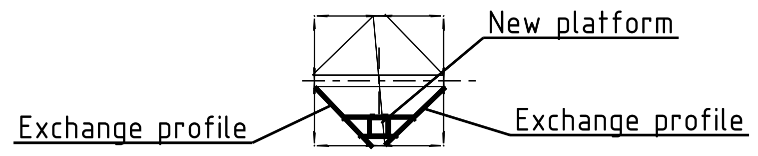


Section E - E
1:250

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

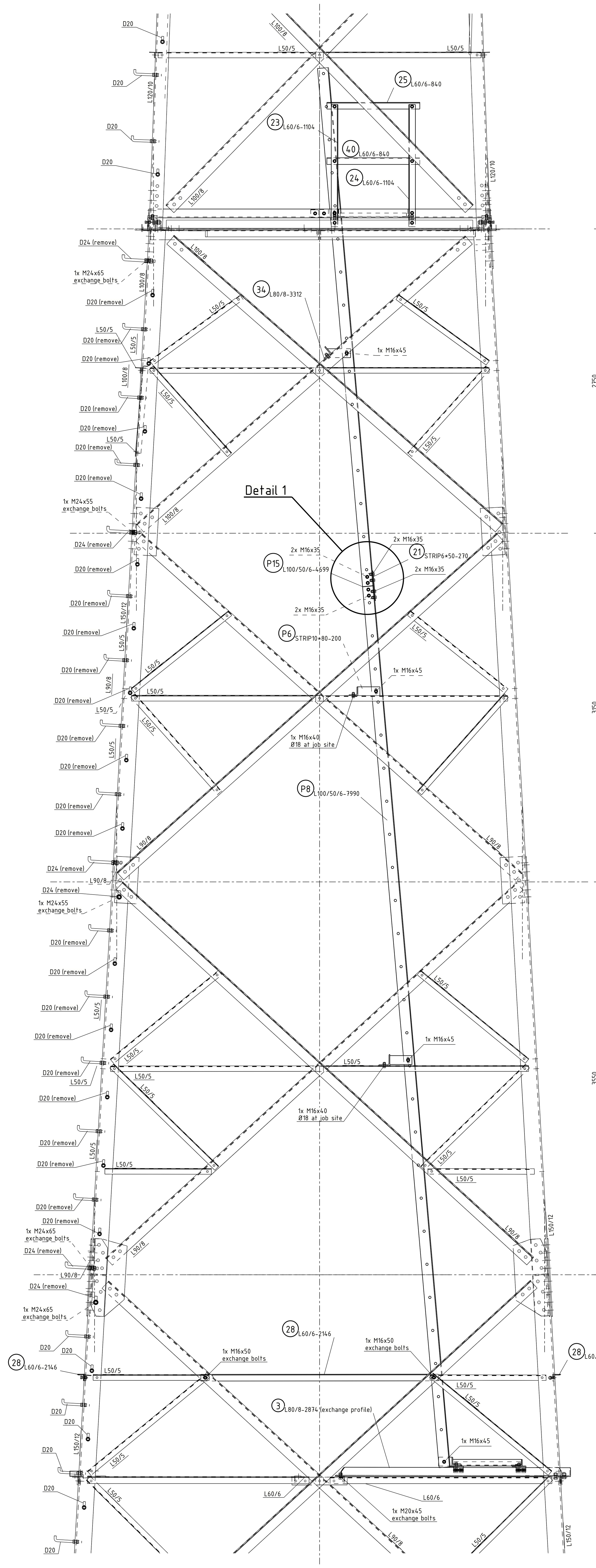
Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

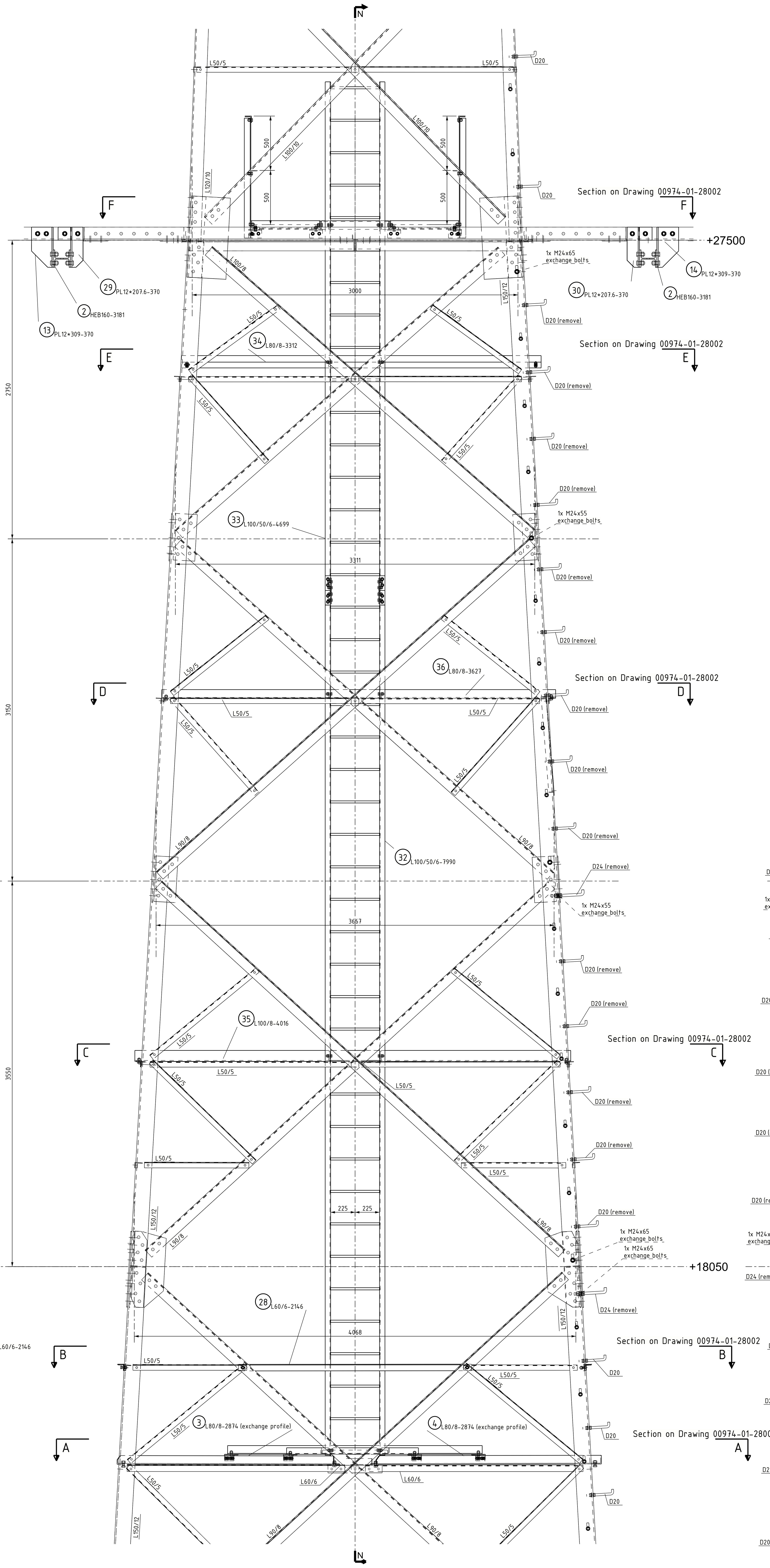
- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:250	594x420

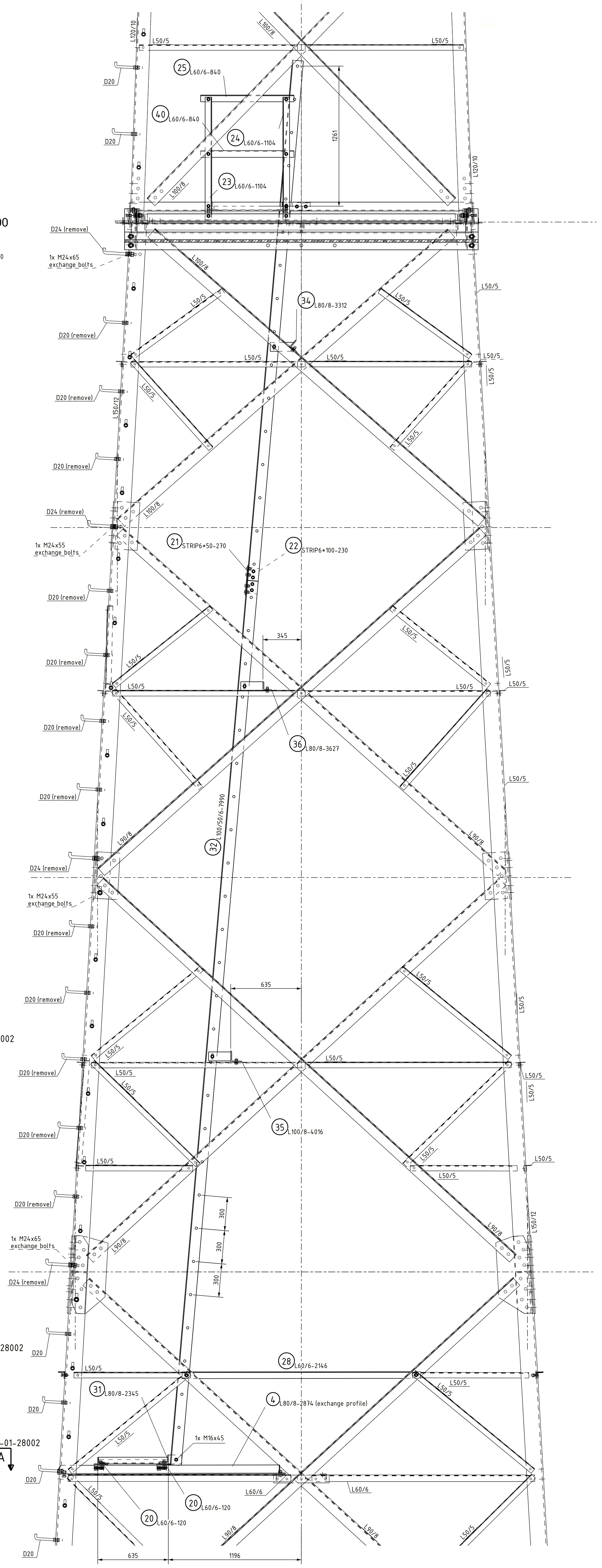
Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
	Object ID	ENS-ZL380
Oud tekeningnummer:	Omschrijving:	Masttype S-6_R, Mast 28 - Overzicht
TenneT Taking power further	Documentnummer:	00974-01-28001



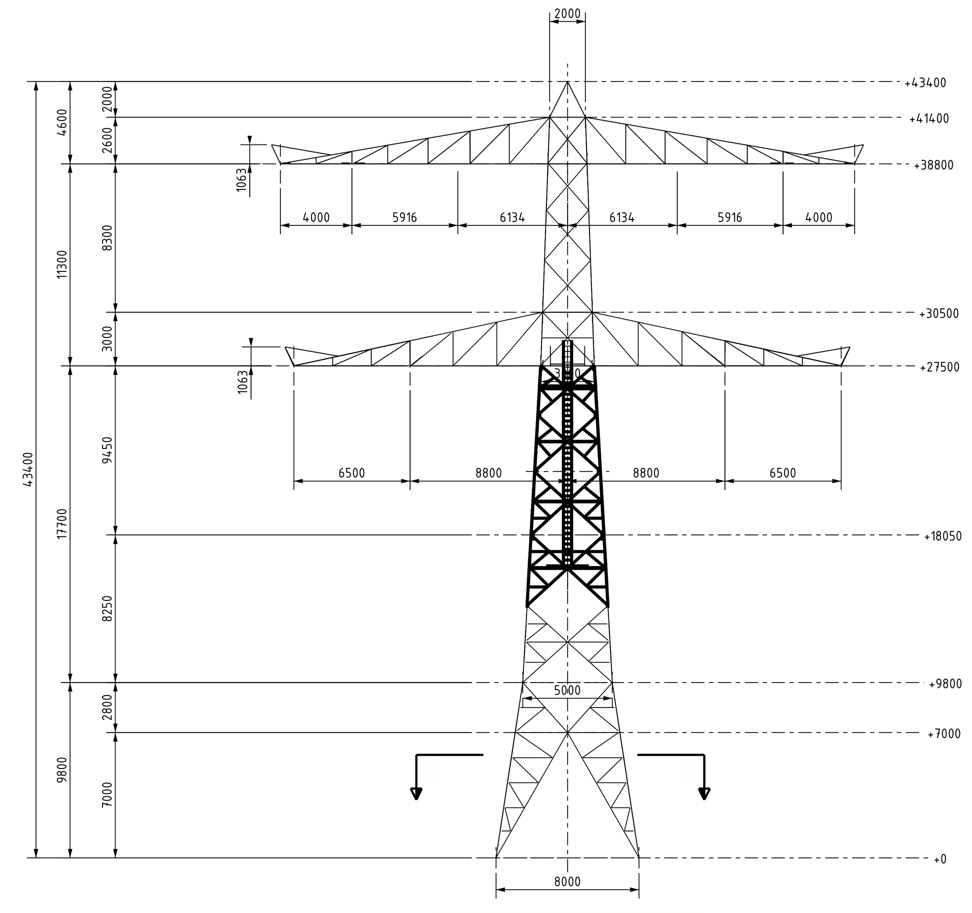
dsn N-N, 1:20



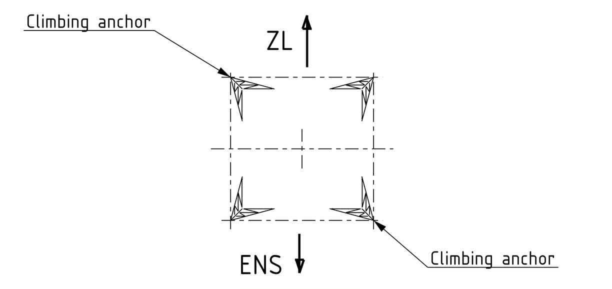
Transversal Face Middle Part
1:20



Longitudinal left Face Middle Part
1:20



Transverse face
1:250



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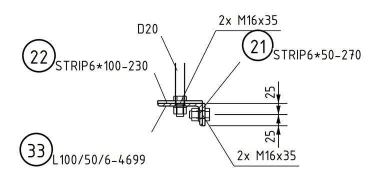
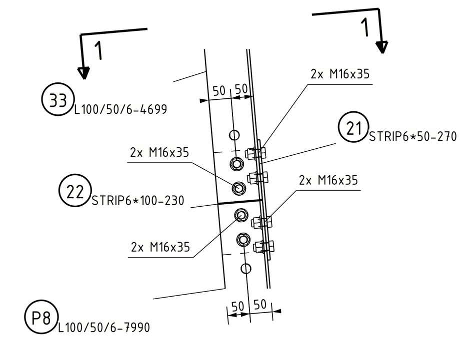
1:250



Section 1 - 1
1:10



Detail 1
1:10

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

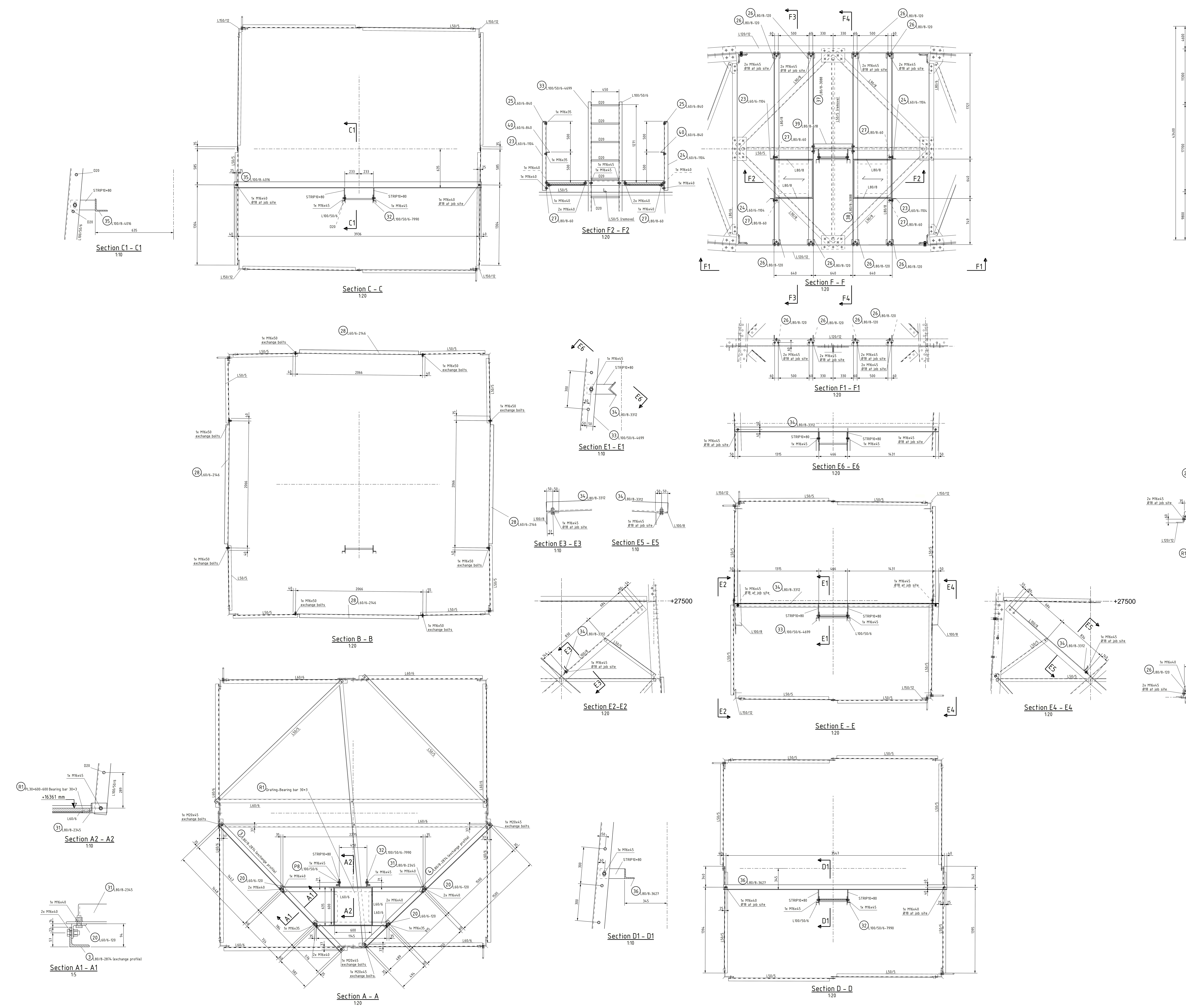
Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

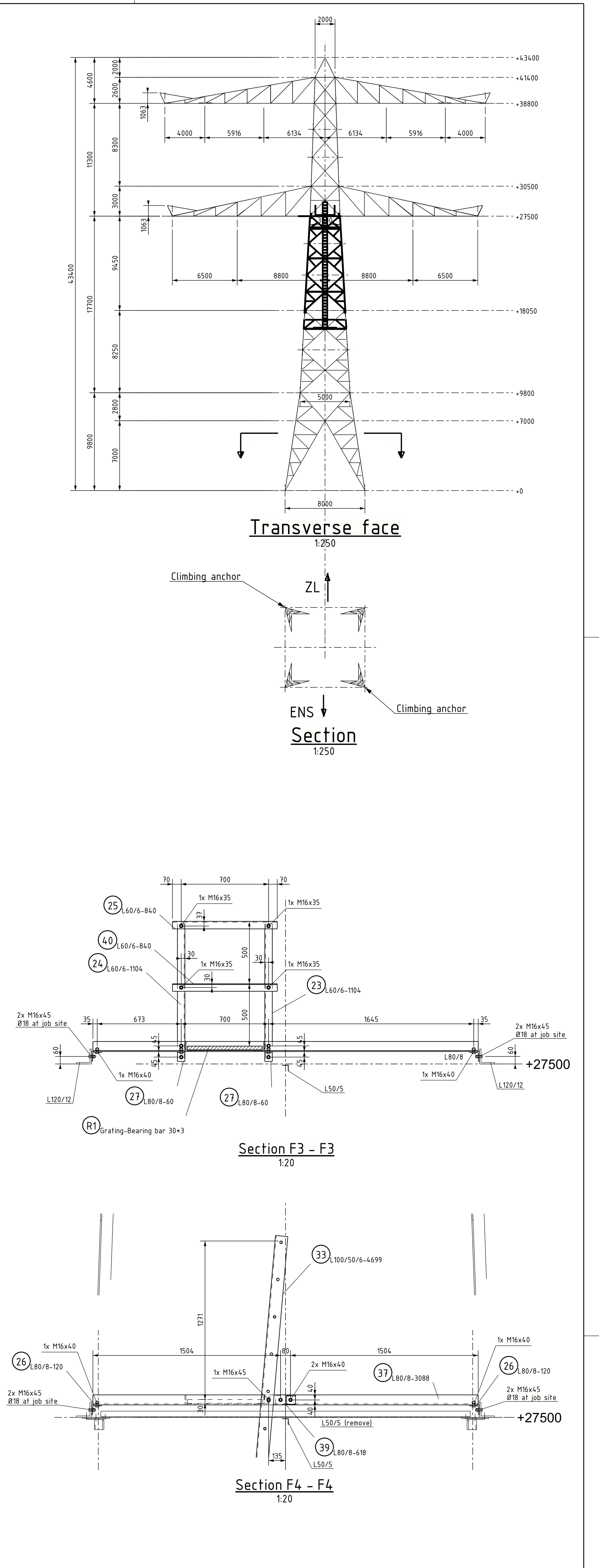
- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380
Omschrijving:	Masttype S-6_R, Mast 28 - Tussenstuk
Documentnummer:	00974-01-28002

TenneT Taking power further





All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5 1:10	A0

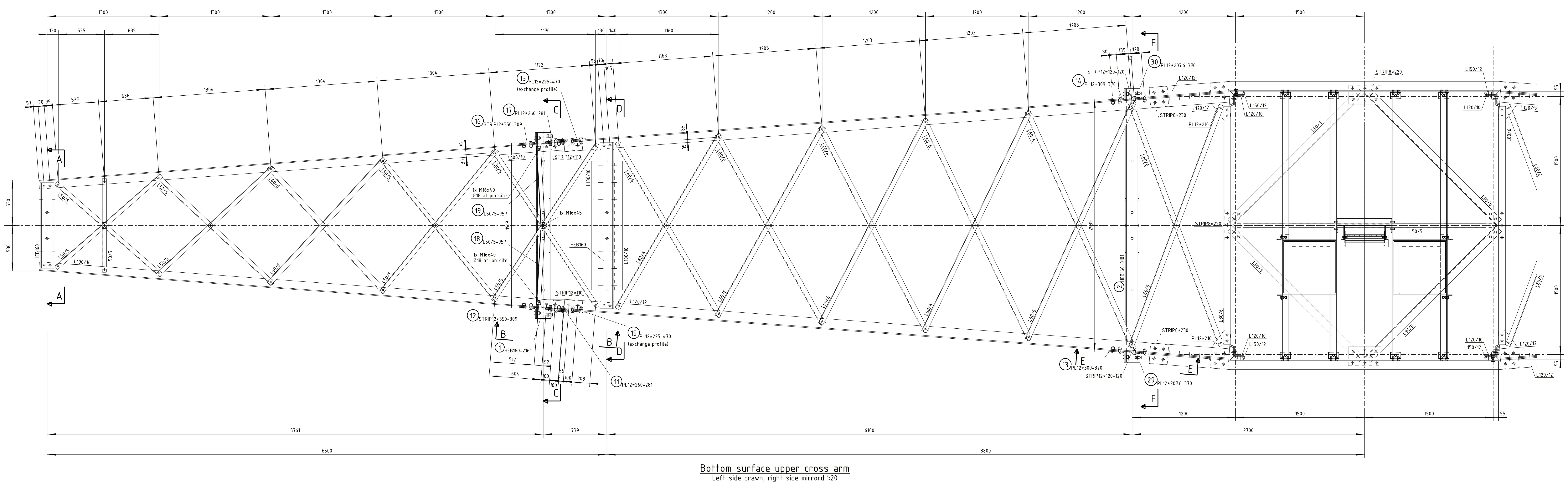
Relatie

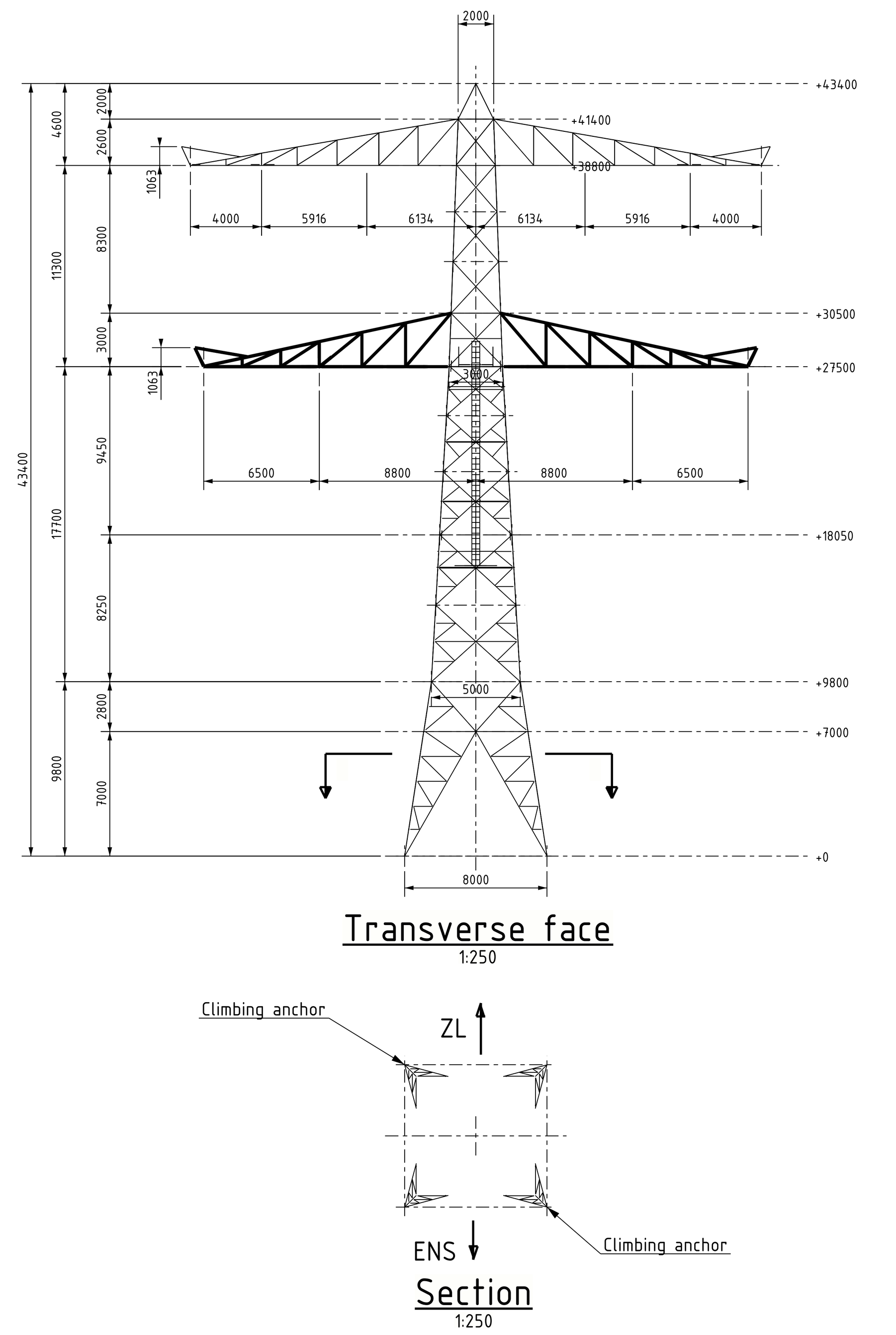
Oud tekeningnummer:

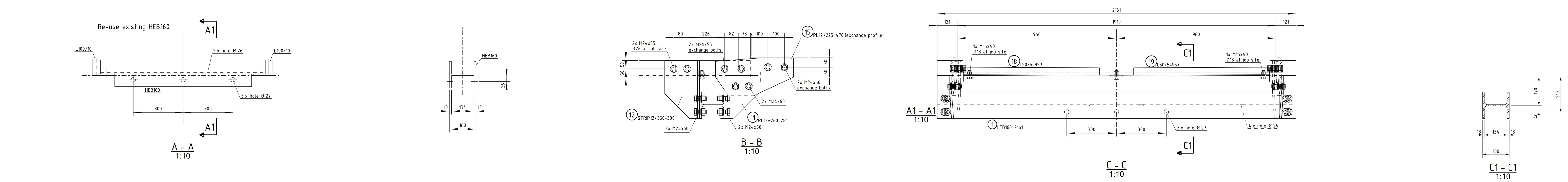
TenneT Taking power further

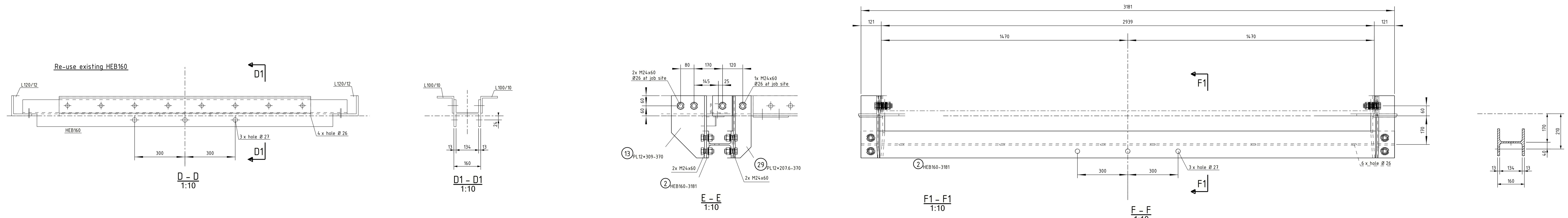
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Masttype S-6_R, Mast 28 - Tussenstuk bordes en ladder
Documentnummer:	00974-01-28003

Tekla Structures









All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

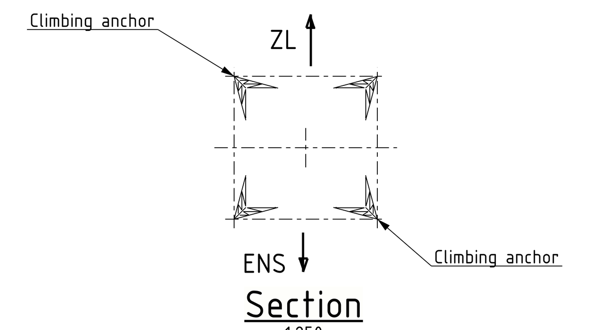
Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

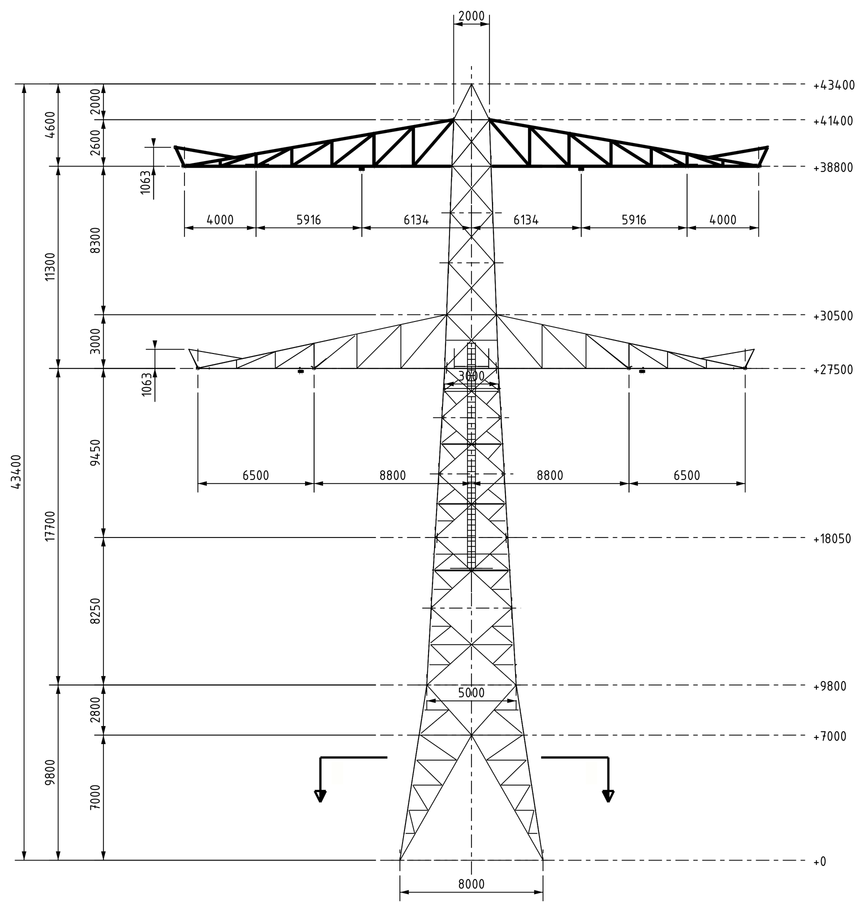
Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Masttype S-6_R, Mast 28 - Ondertraverse
Documentnummer:	00974-01-28004

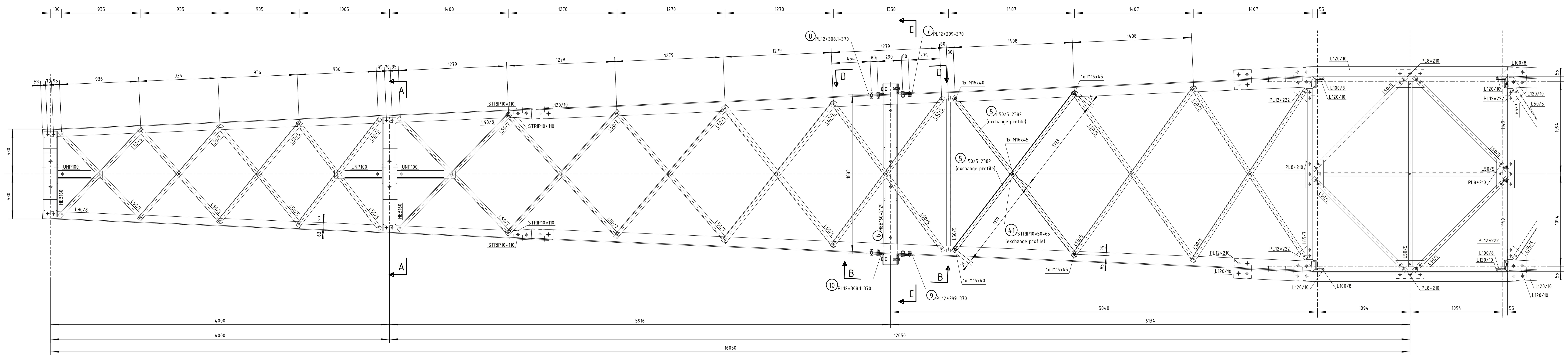
TenneT
Taking power further



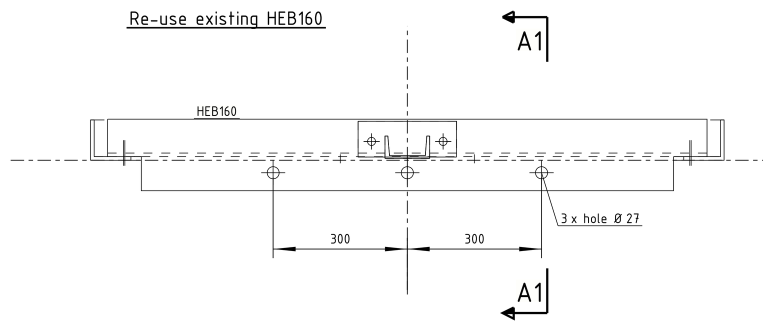
Section
1:250



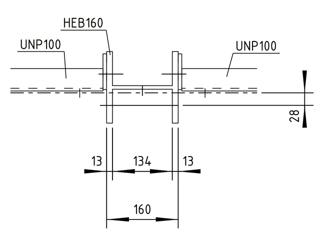
Transverse face
1:250



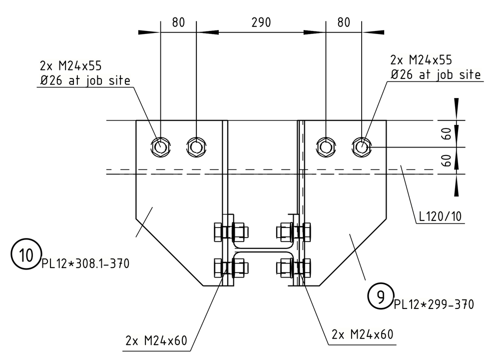
Bottom surface lower cross arm
Left side drawn, right side mirrord 1:20



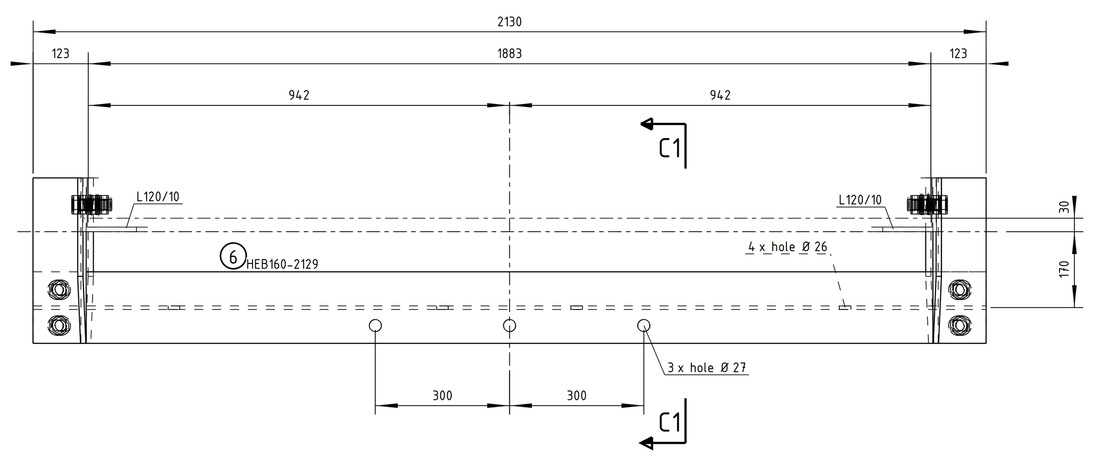
Section A - A
1:10



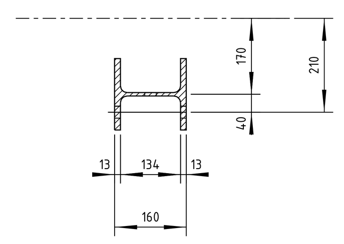
Section A1 - A1
1:10



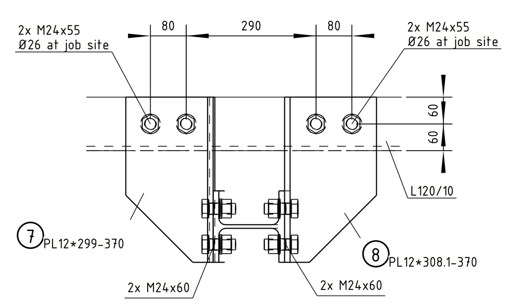
Section B - B
1:10



Section C - C
1:10



Section C1 - C1
1:10



Section D - D
1:10

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380
Omschrijving:	Masttype S-6_R, Mast 28 - Boventraverse
Documentnummer:	00974-01-280045

TenneT Taking power further

Tekla Structures

Ingenieursbureau
Aafjes b.v.

Ohmstraat 1
8013 PZ Zwolle
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Projectnummer Aafjes: **21-187**

Documentnummer: **00974-01-02810**

Projectnummer TenneT: **002.515**

Meridian nummer: **002.515.40 0994435**

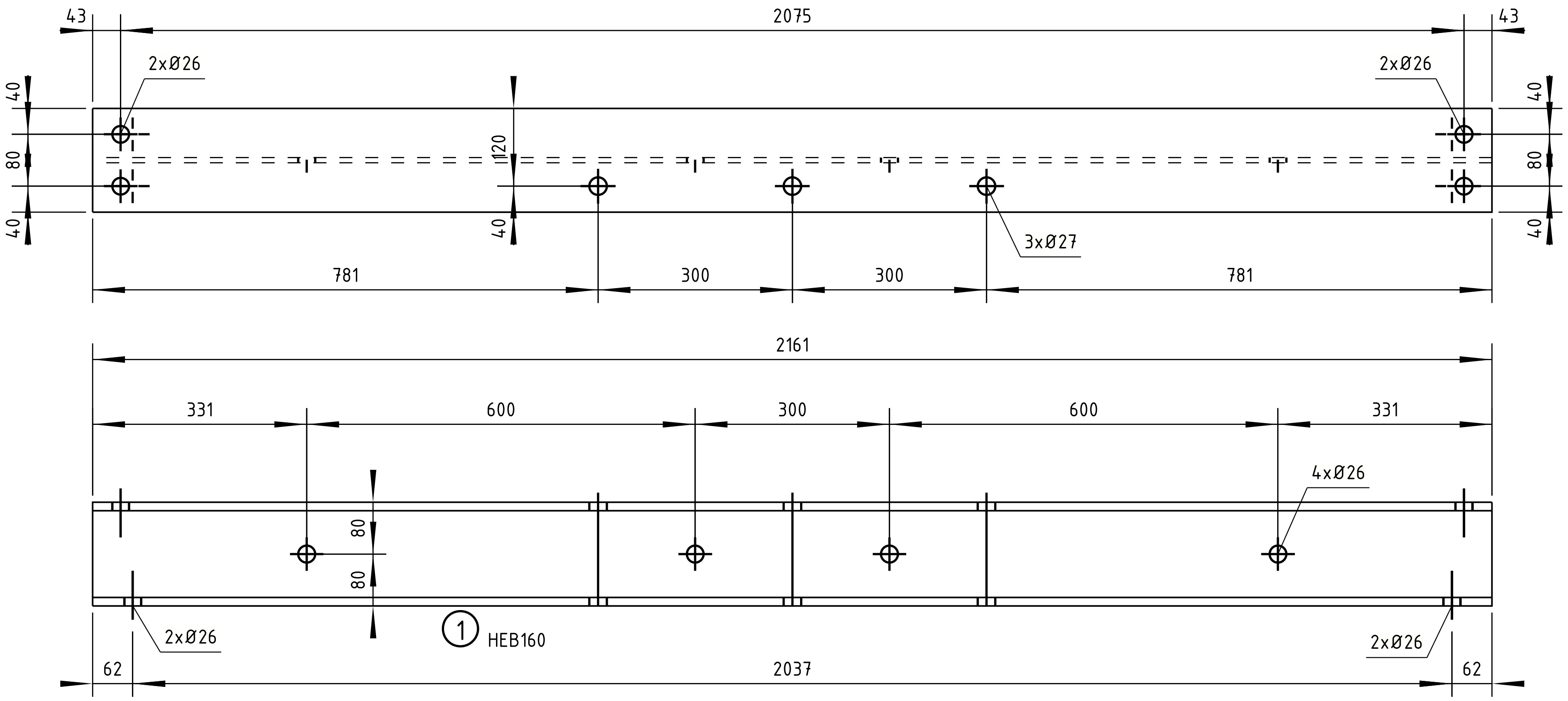
Opdrachtgever: **TenneT**

Project: **Opwaardering ENS-ZL380**

Onderdeel: **Masttype S-6_R, Mast 28- Onderdeeltekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		10-03-2022
Validatie Aafjes	Niels Verhaar	System Engineer		10-03-2022
Vrijgegeven	Bart Aafjes	Projectleider		10-03-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	10-03-2022	1e versie ter review

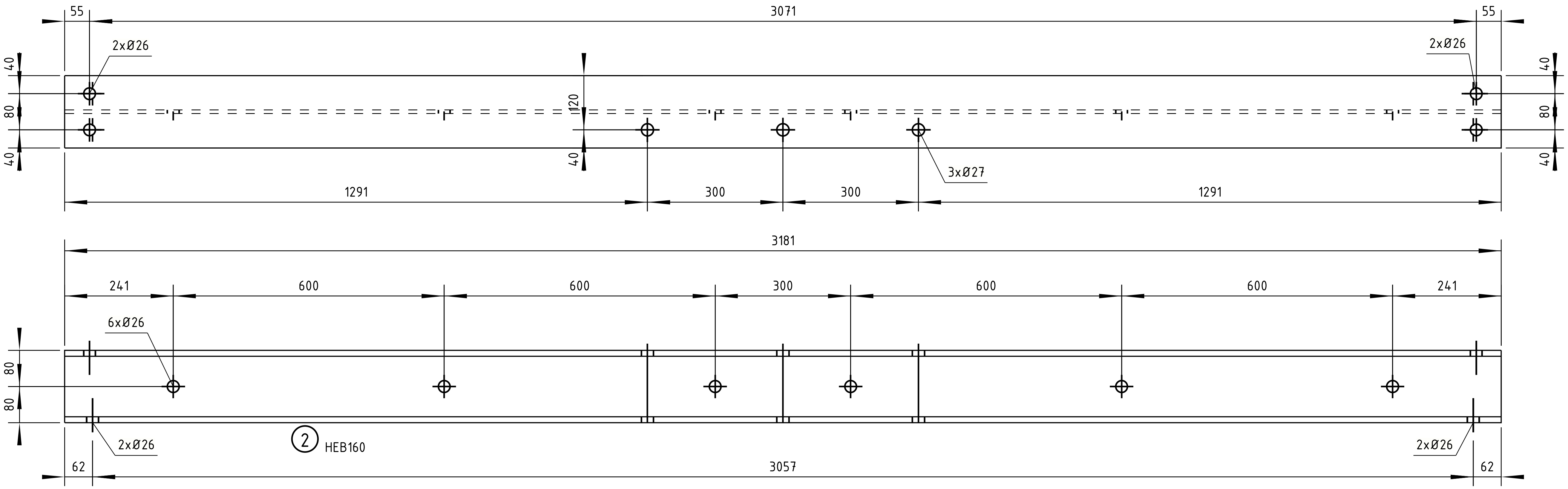


Pos	Profile	Number	Grade	Length	Area (m^2)
1	HEB160	2	S355J0	2161	1.99

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig
Rev.	0.1
Datum revisie	10.03.2022
Omschrijving revisie	1e versie ter review
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	A3
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [1]
Documentnummer:	

TenneT Taking power further

Tekla Structures

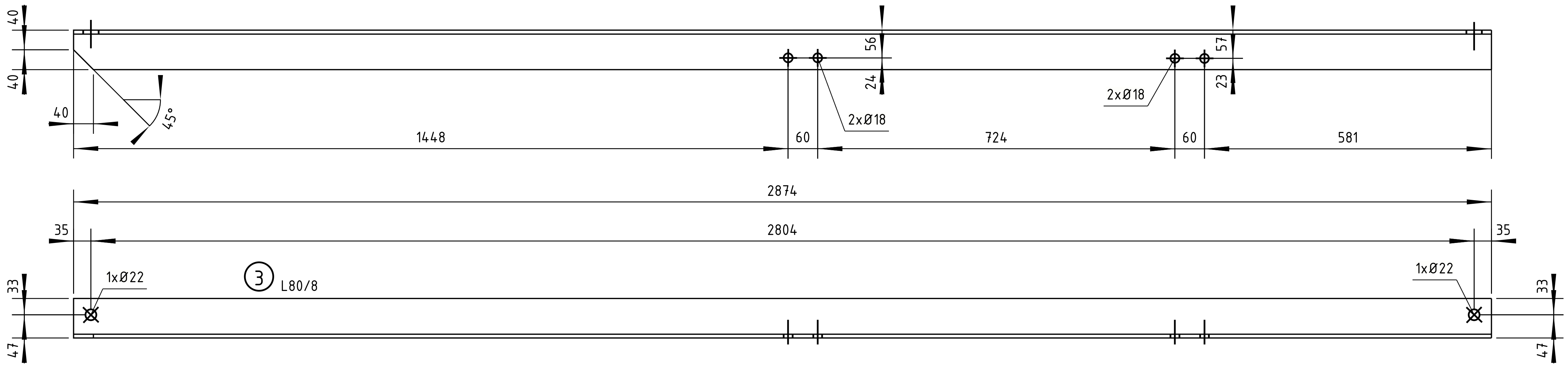


Pos	Profile	Number	Grade	Length	Area (m^2)
2	HEB160	2	S355J0	3181	2.93

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig
Rev.	0.1
Datum revisie	10.03.2022
Omschrijving revisie	1e versie ter review
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	A3
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [2]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
3	L80/8	1	S355J0	2874	0.92

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

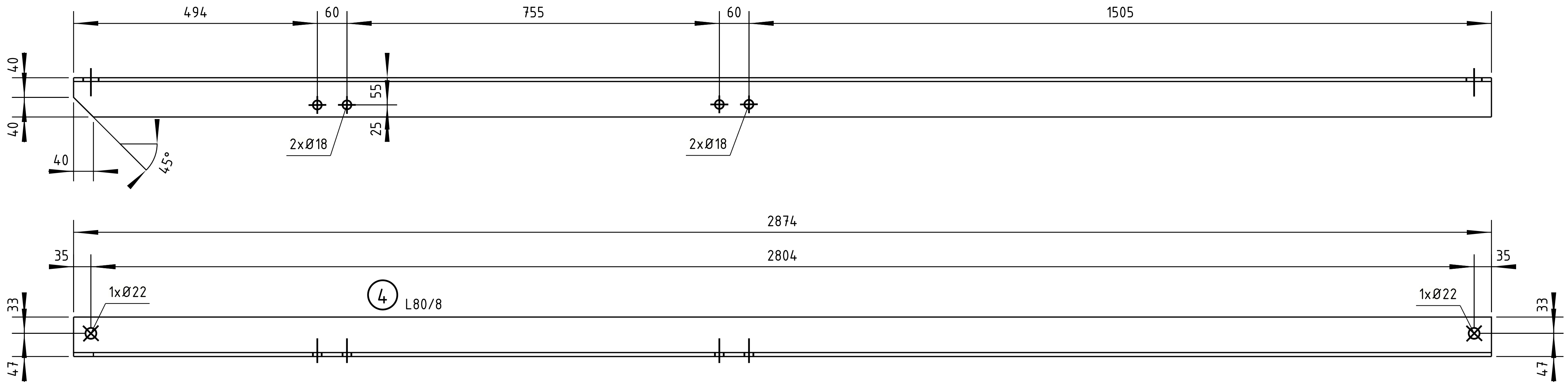
Documentcode: Constructietekening

Object ID: ENS-ZL380

Omschrijving: Te vervangen staal - onderdeel [3]

Documentnummer:

TenneT Taking power further



Pos	Profile	Number	Grade	Length	Area (m^2)
4	L80/8	1	S355J0	2874	0.92

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

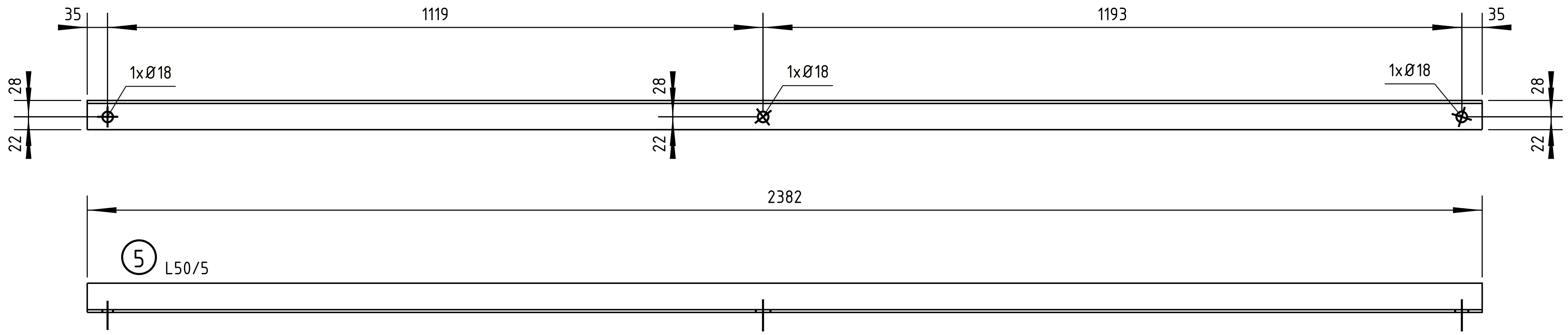
Object ID: ENS-ZL380

Omschrijving: Te vervangen staal - onderdeel [4]

Documentnummer:

TenneT Taking power further

Tekla Structures



5	L50/5	4	S355J0	2382	0.48
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

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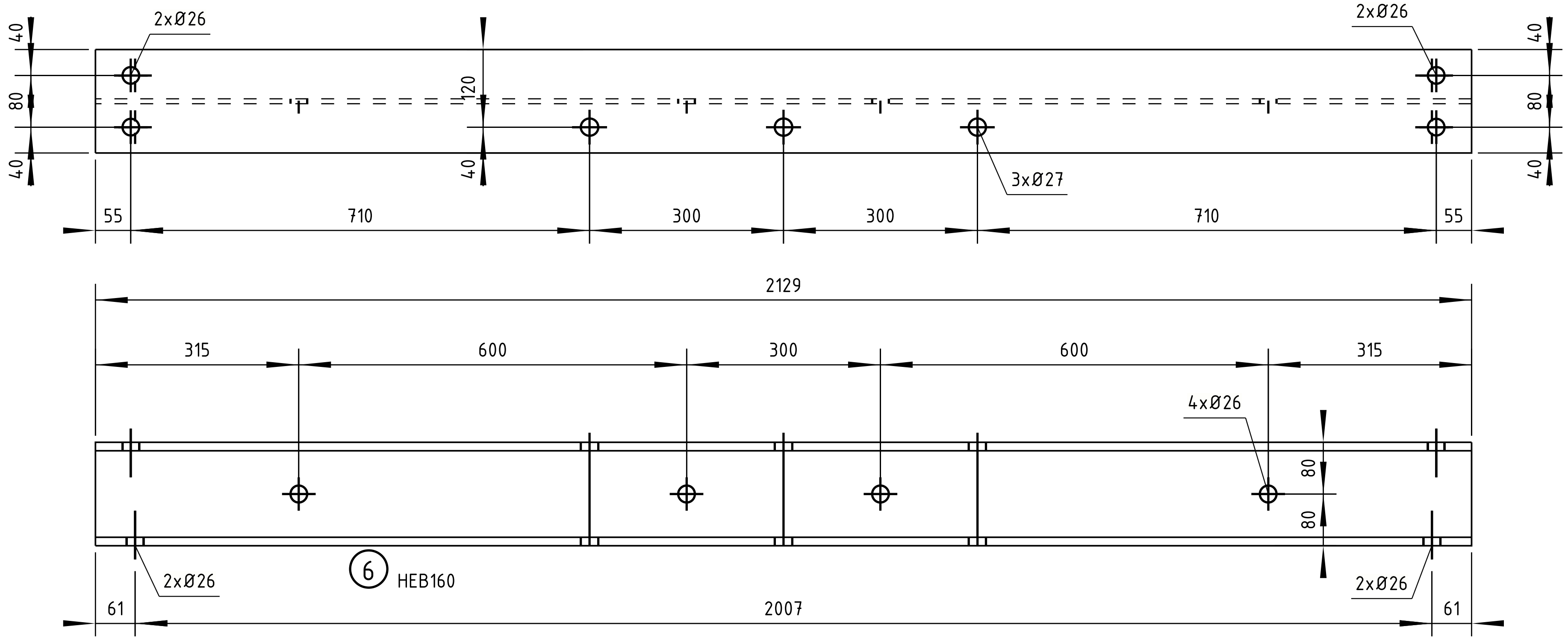
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380

Omschrijving: Te vervangen staal - onderdeel [5]

Documentnummer:



6	HEB160	2	S355J0	2129	1.96
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus	Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat	
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3	

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

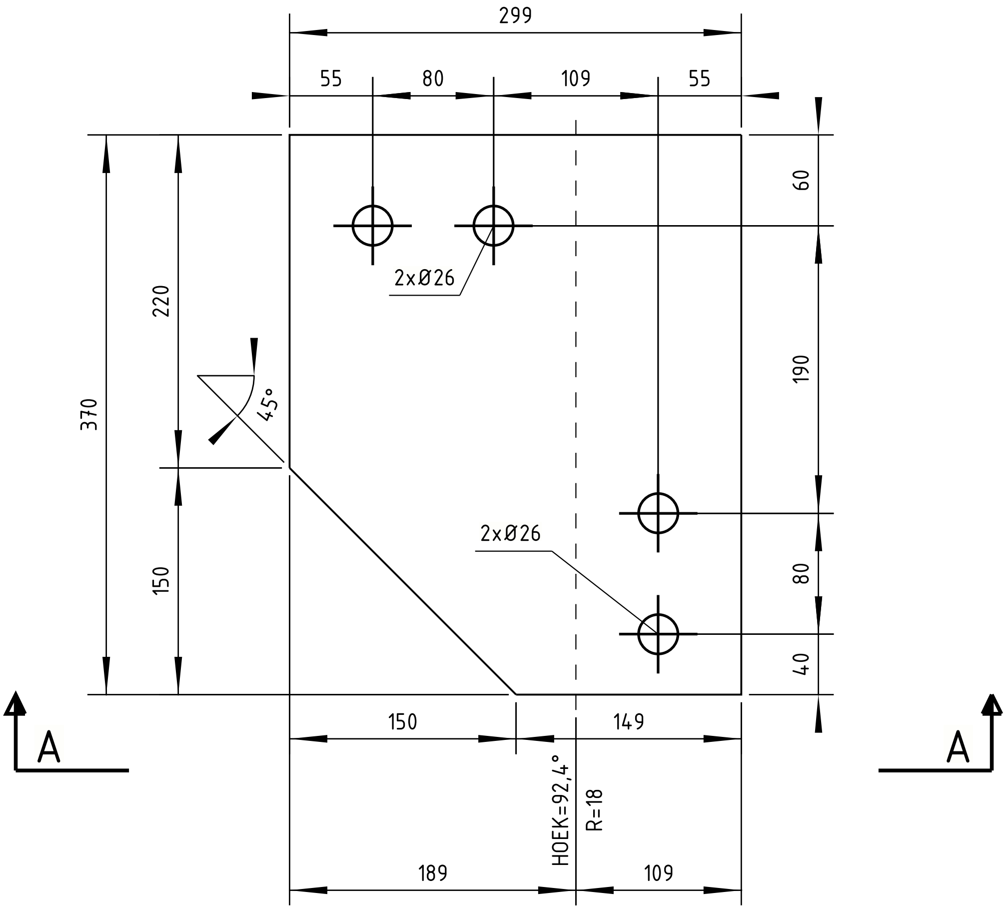
Object ID: ENS-ZL380

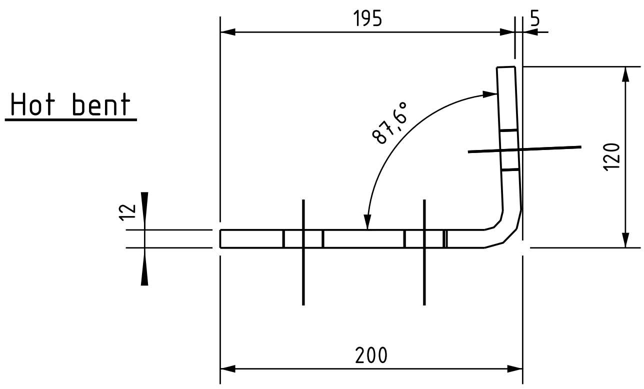
Omschrijving: Nieuw staal - onderdeel [6]

Documentnummer:

TenneT Taking power further

Tekla Structures





A - A
1:5

Pos	Profile	Number	Grade	Length	Area (m²)
7	PL12*299	2	S355J0	370	0.21

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380

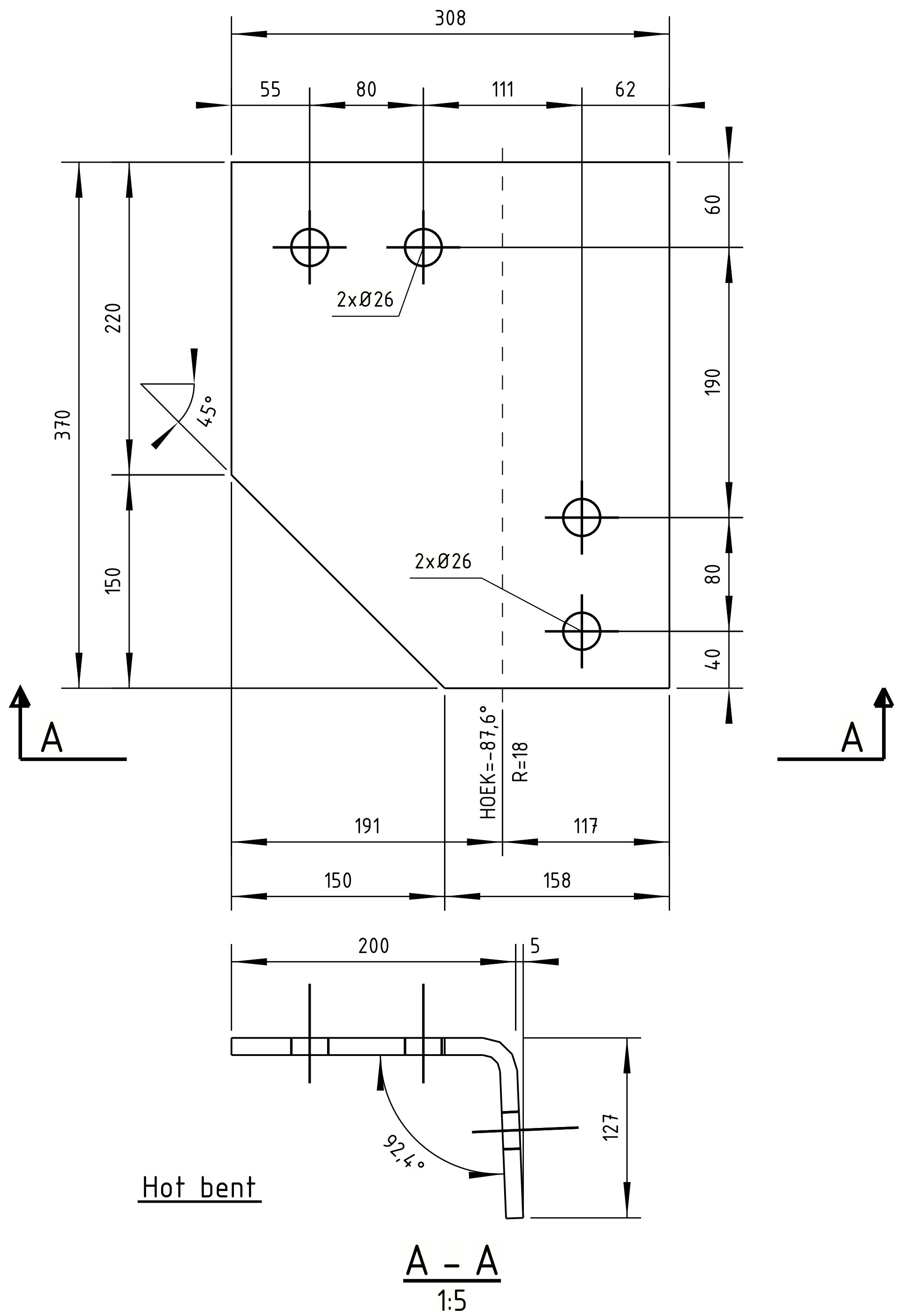
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [7]

Documentnummer:

Taking power further

Tekla Structures



A - A
1:5

8	PL12*308.1	2	S355J0	370	0.22
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

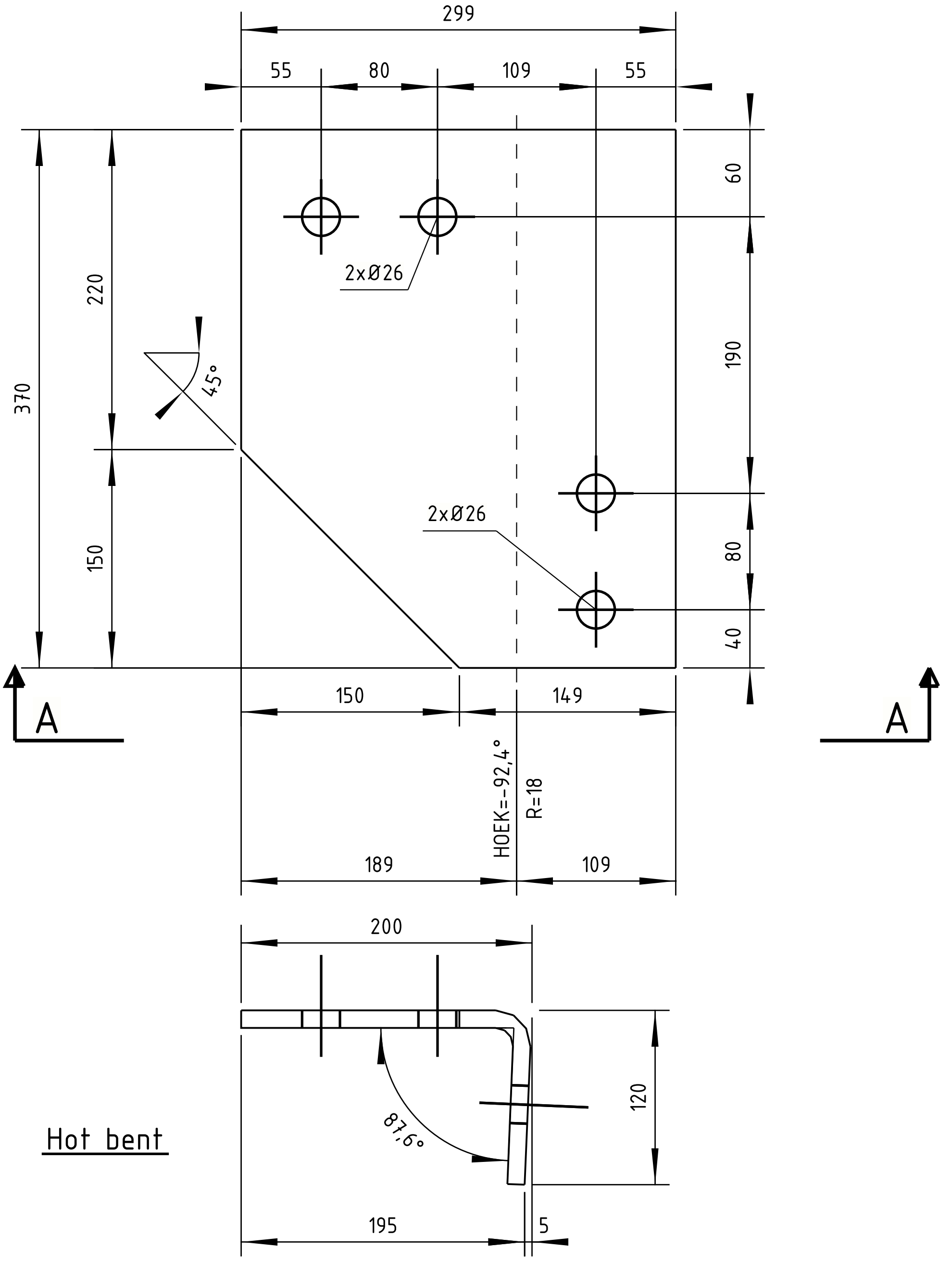
Oud tekeningnummer:

Omschrijving:
Nieuw staal - onderdeel [8]

Documentnummer:

Tennet Taking power further

Tekla Structures

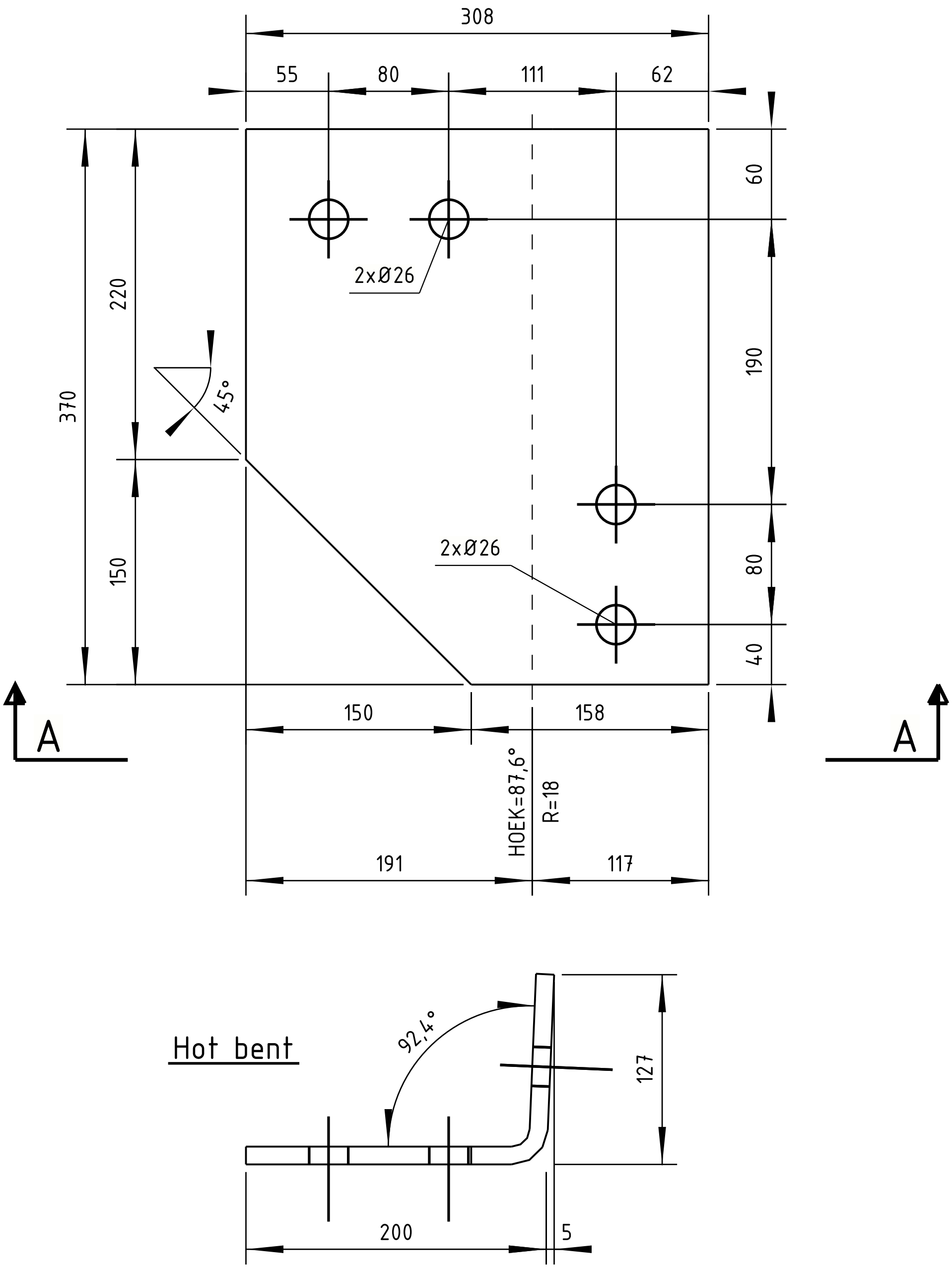


A - A
1:5

Pos	Profile	Number	Grade	Length	Area (m²)
9	PL12*299	2	S355J0	370	0.21

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380
TenneT Taking power further	Omschrijving:	Nieuw staal - onderdeel [9]
	Documentnummer:	



A - A
1:5

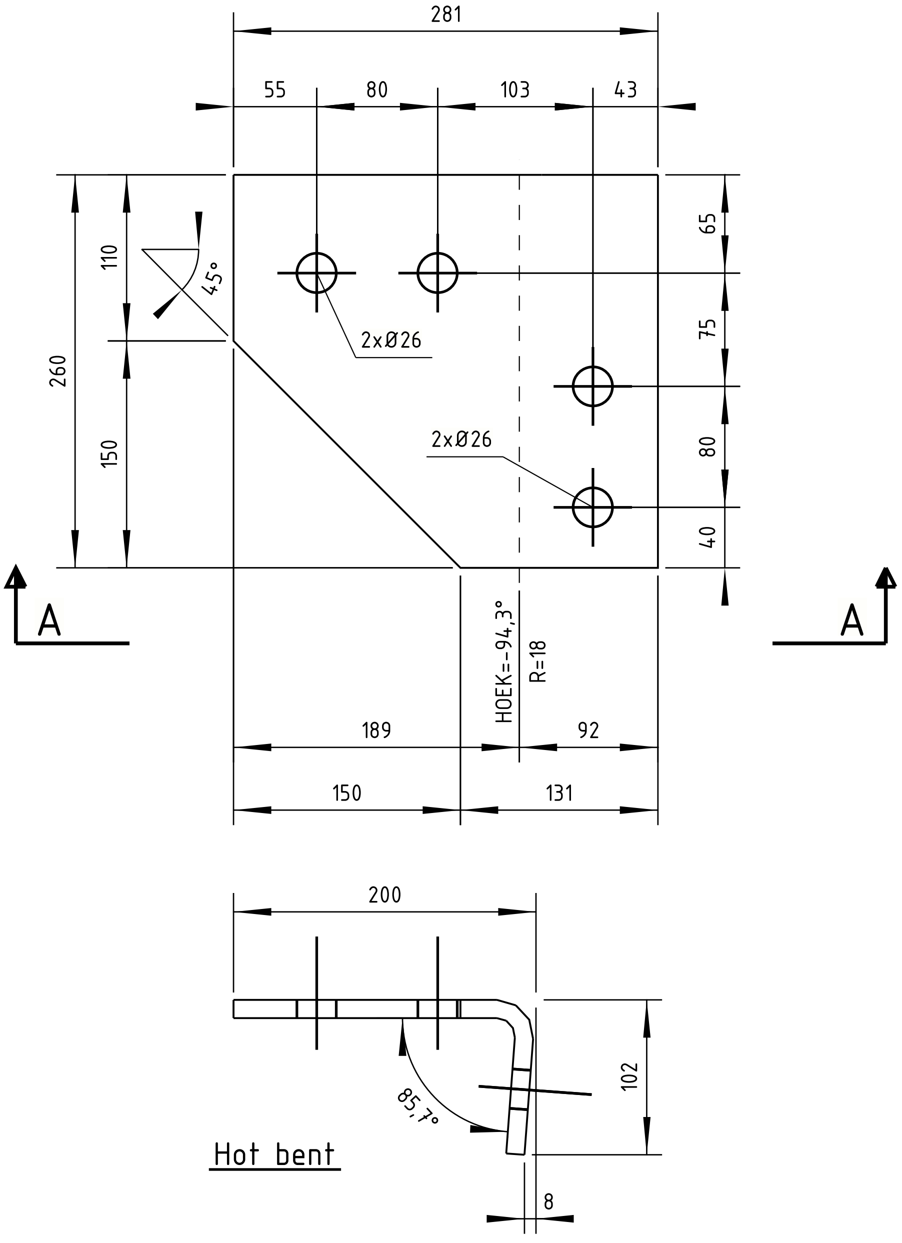
Pos	Profile	Number	Grade	Length	Area (m^2)
10	PL12*308.1	2	S355J0	370	0.22

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [10]
Documentnummer:	

TenneT Taking power further

Tekla Structures



A - A
1:5

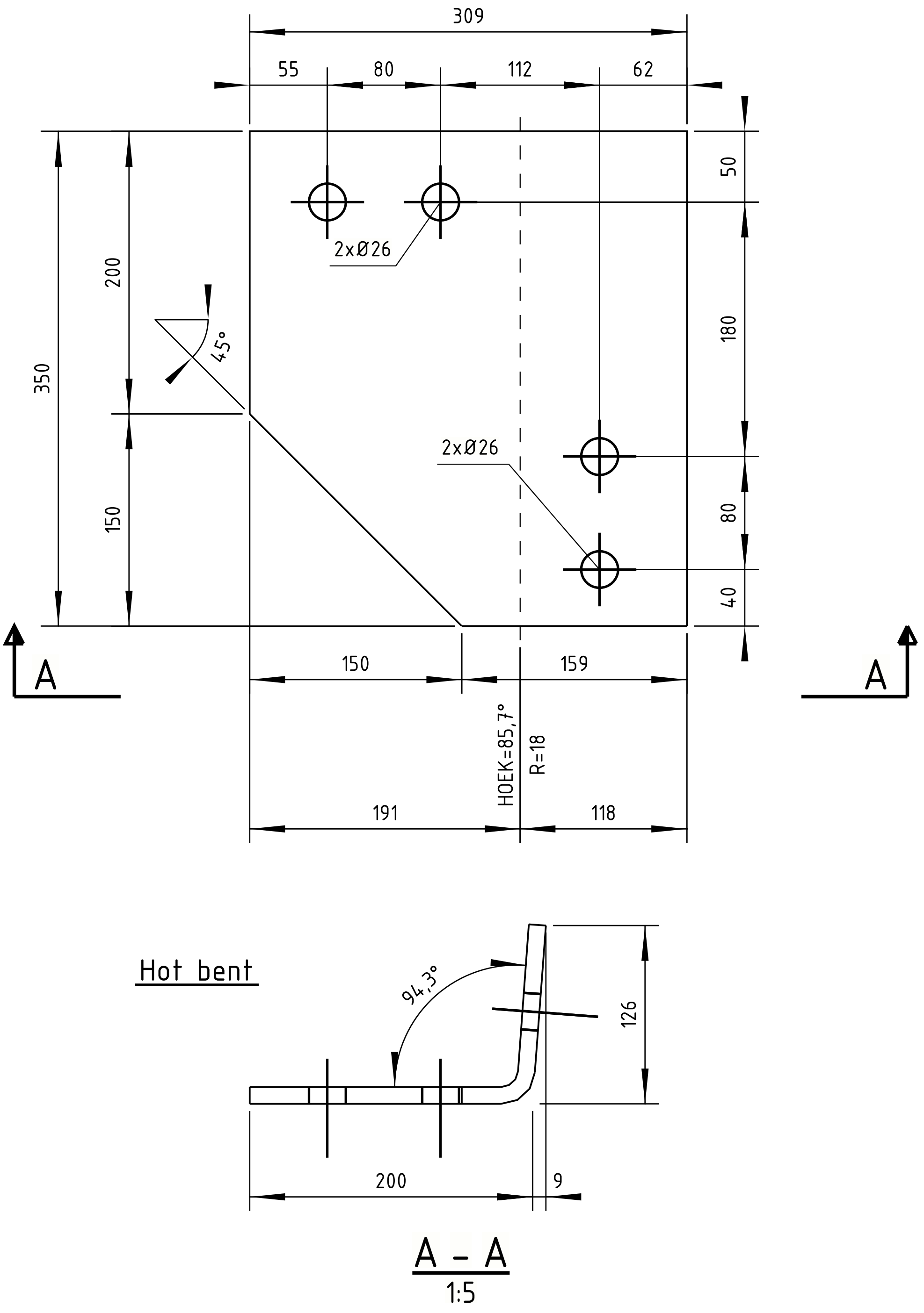
Pos	Profile	Number	Grade	Length	Area (m²)
11	PL12*260	2	S355J0	281	0.14

Naam						Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle						Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [11]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



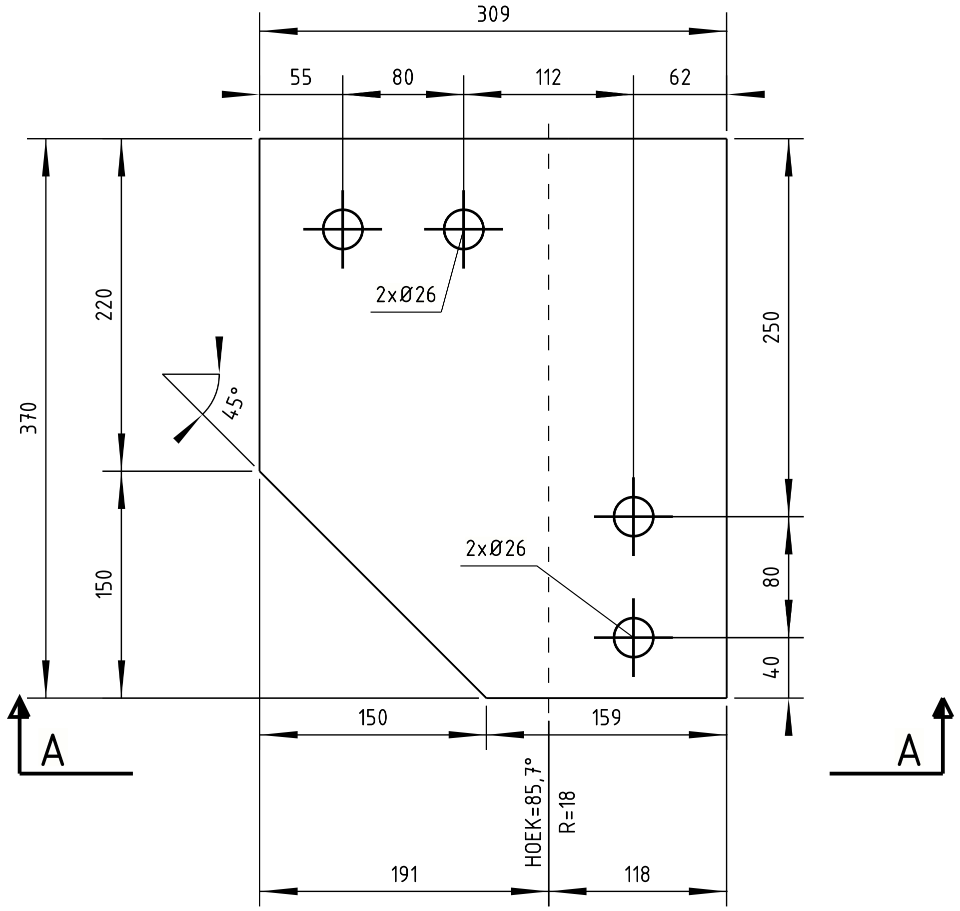
12	STRIP12*350	2	S355J0	309	0.21
Pos	Profile	Number	Grade	Length	Area (m^2)

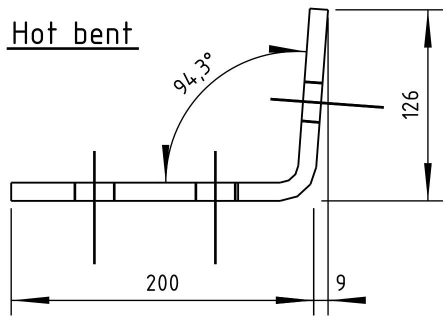
Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [12]
Documentnummer:	

TenneT
Taking power further

Tekla Structures





A – A
1:5

13	PL12*309	2	S355J0	370	0.22
Pos	Profile	Number	Grade	Length	Area (m²)

Naam				Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380
TenneT Taking power further	Omschrijving:	Nieuw staal - onderdeel [13]
	Documentnummer:	

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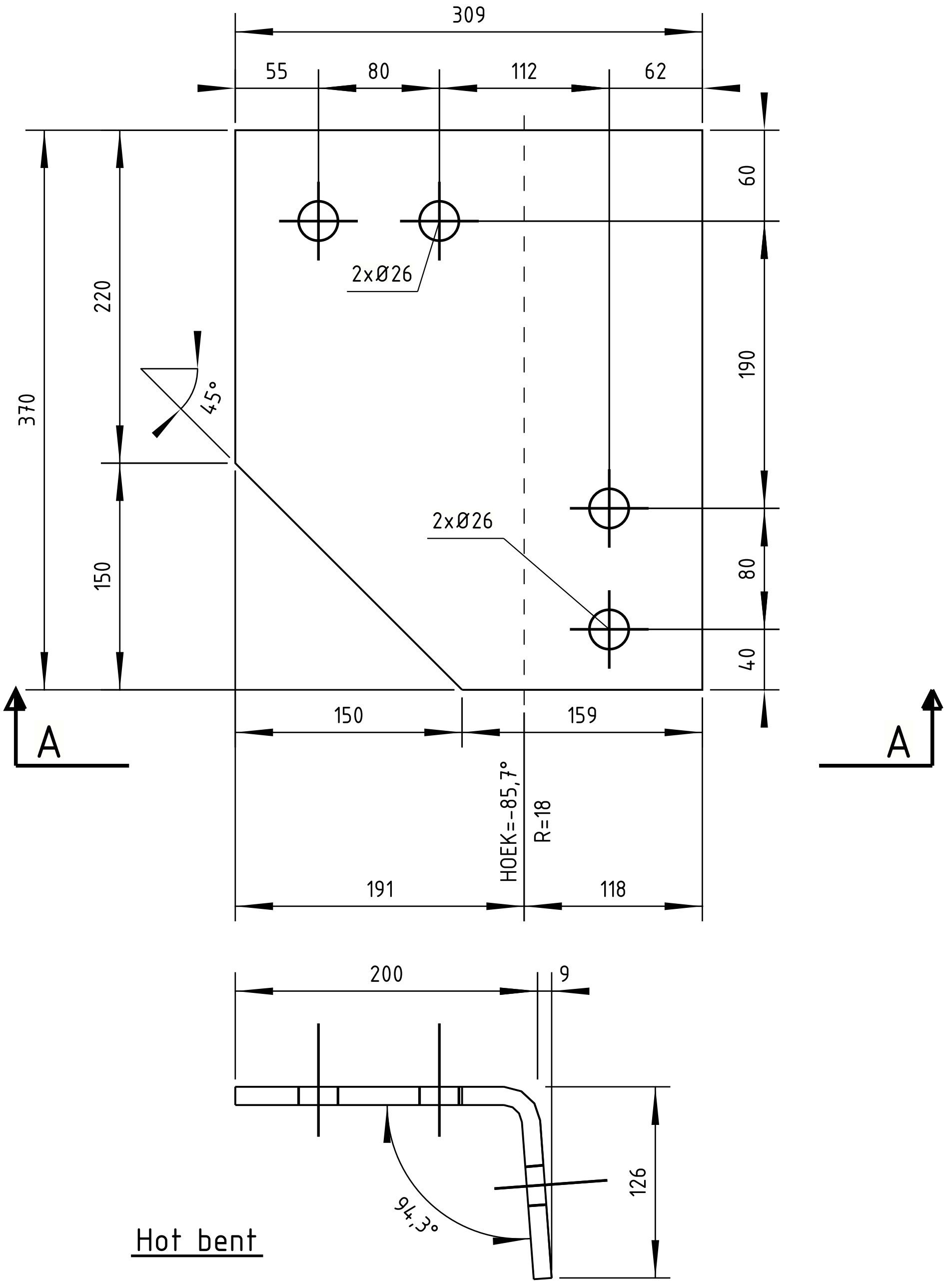

A - A
1:5

14	PL12*309	2	S355J0	370	0.22
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [14]
Documentnummer:	

TenneT
Taking power further

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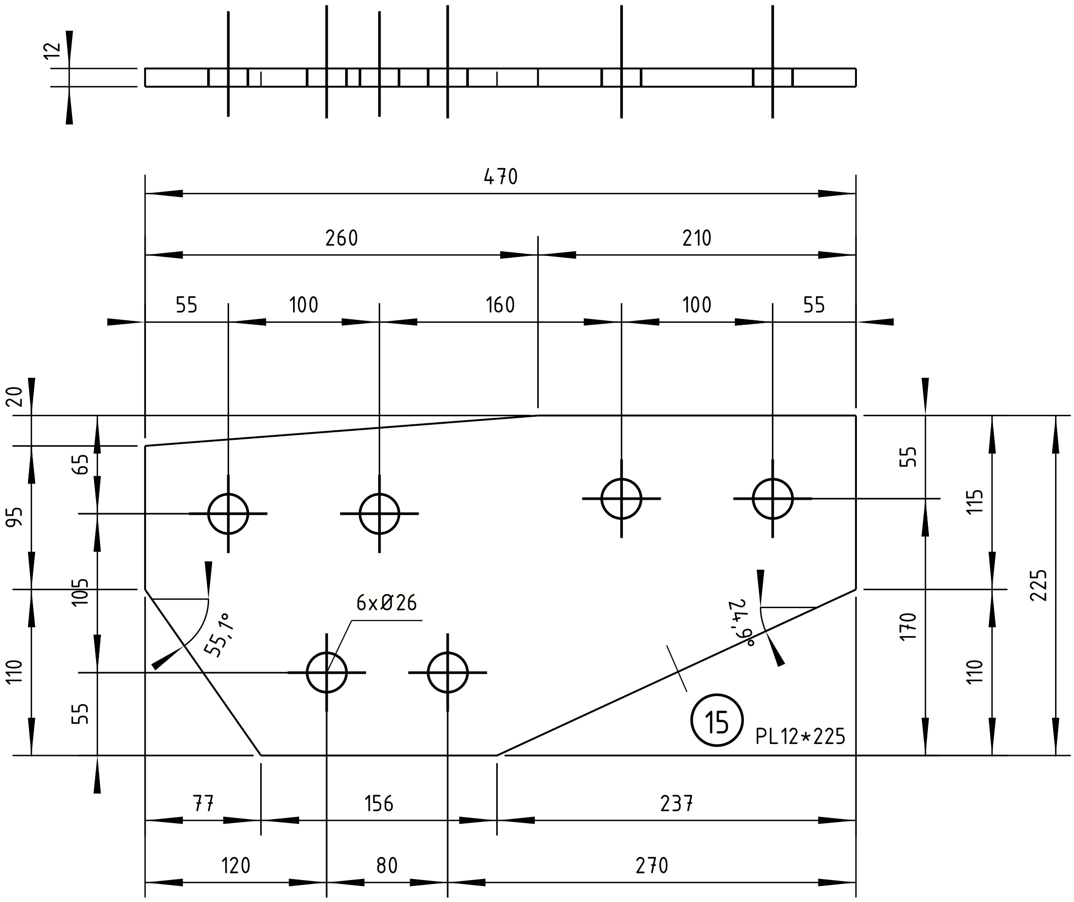

15	PL12*225	4	S355J0	470	0.19
Pos	Profile	Number	Grade	Length	Area (m²)

Naam Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
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Oud tekeningnummer:	Omschrijving:	Te vervangen staal - onderdeel [15]
TenneT Taking power further	Documentnummer:	

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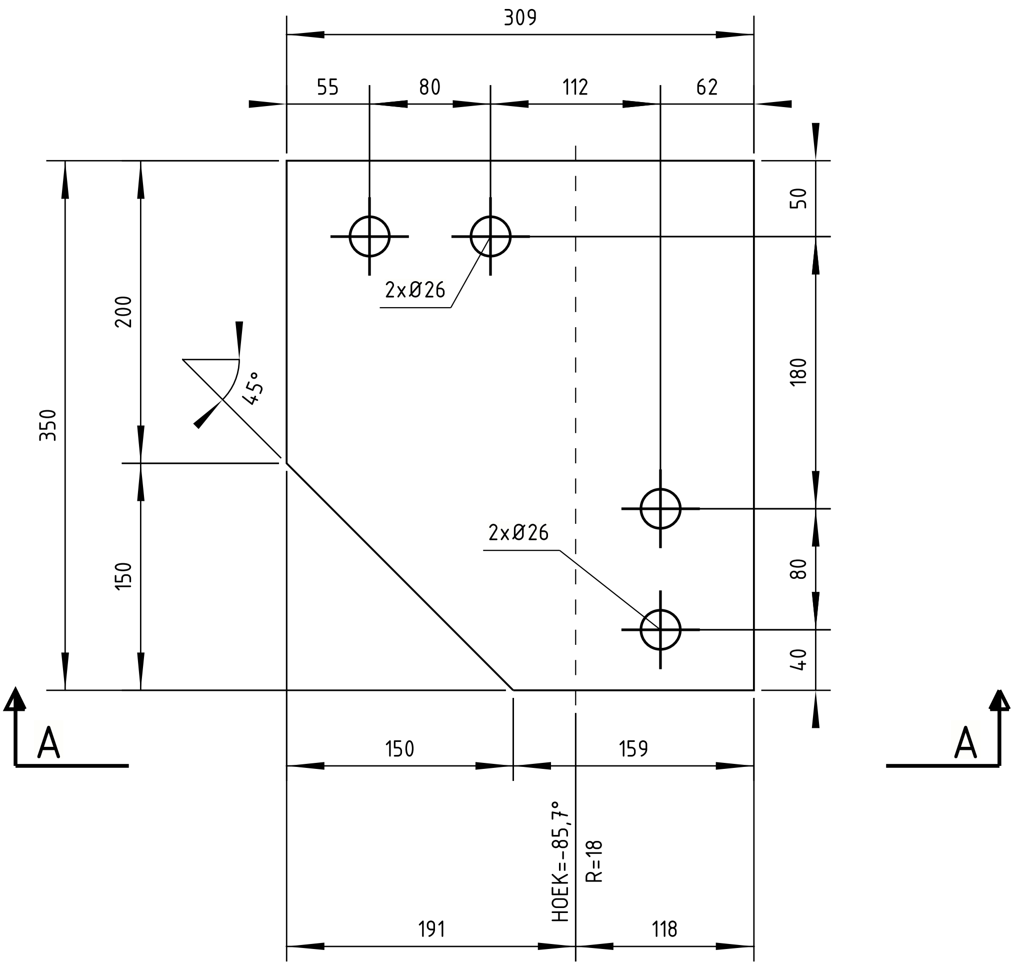
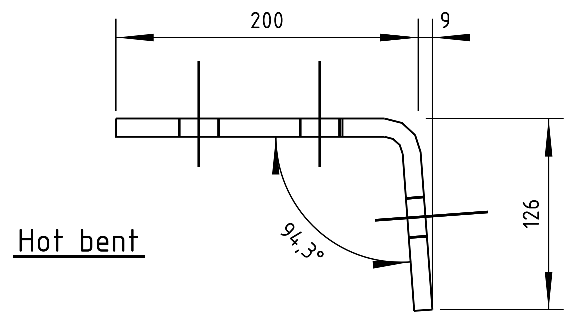




A - A

1:5

16	STRIP12*350	2	S355J0	309	0.21
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID

ENS-ZL380

Oud tekeningnummer:

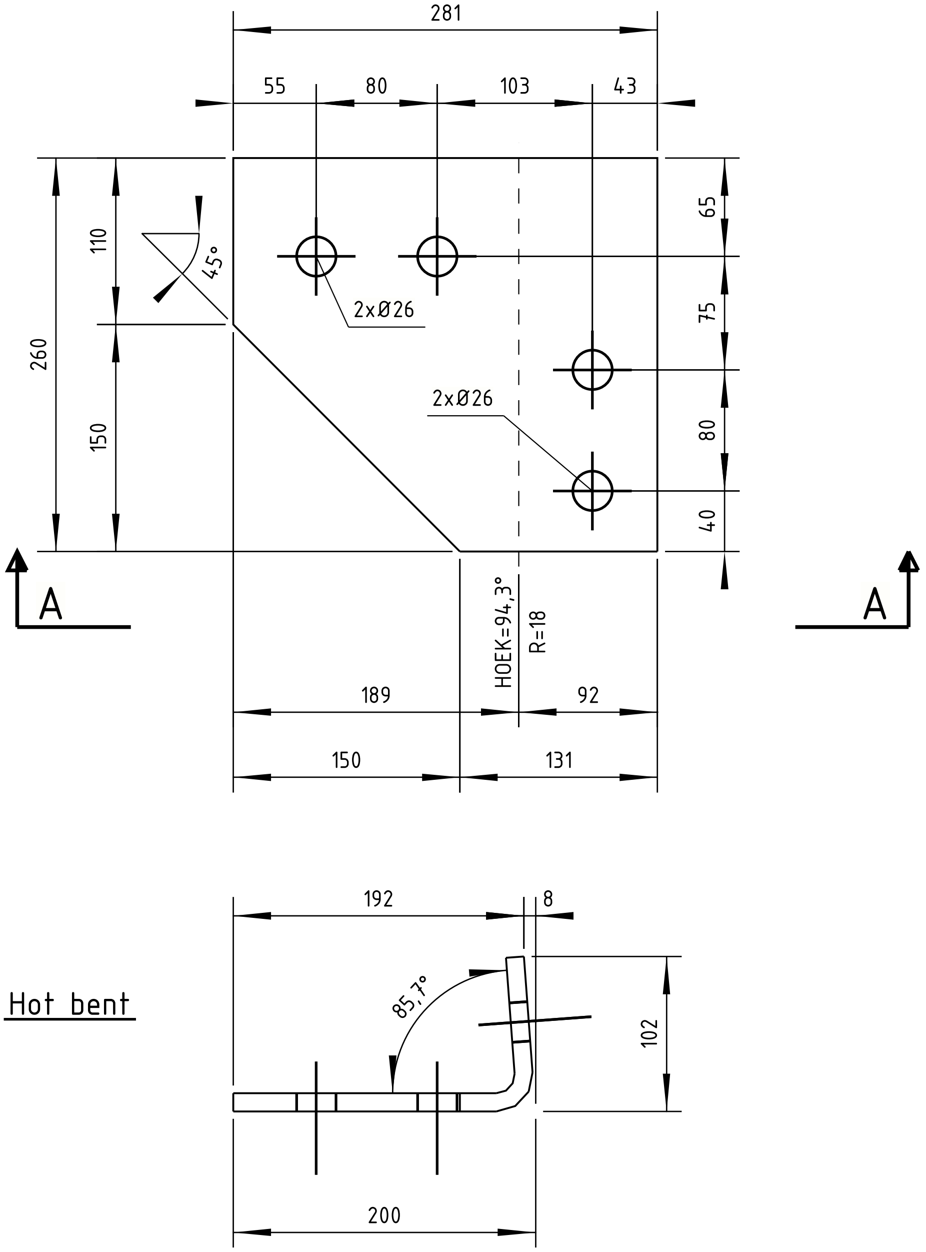
Omschrijving:

Nieuw staal - onderdeel [16]

Documentnummer:

TenneT Taking power further

Tekla Structures



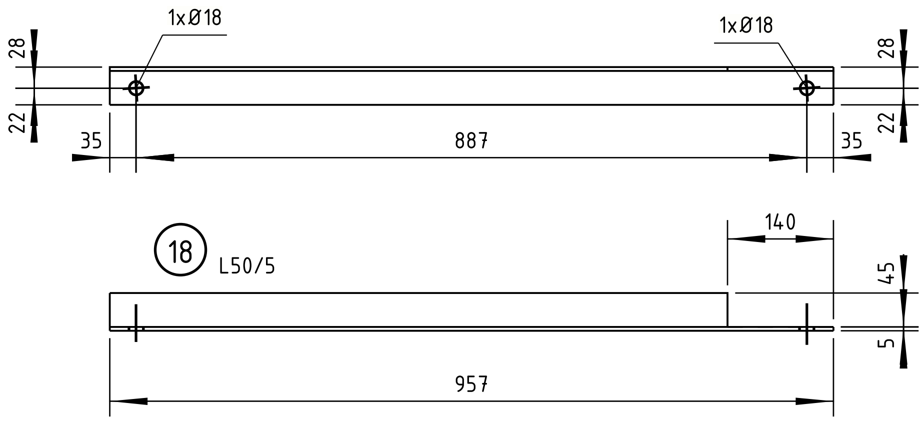
A - A
1:5

Pos	Profile	Number	Grade	Length	Area (m²)
17	PL12*260	2	S355J0	281	0.14

Naam					Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [17]
Documentnummer:	

TenneT
Taking power further



18	L50/5	2	S355J0	957	0.19
Pos	Profile	Number	Grade	Length	Area (m²)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID
ENS-ZL380

Oud tekeningnummer:

Omschrijving:
Nieuw staal - onderdeel [18]

Documentnummer:

TenneT Taking power further

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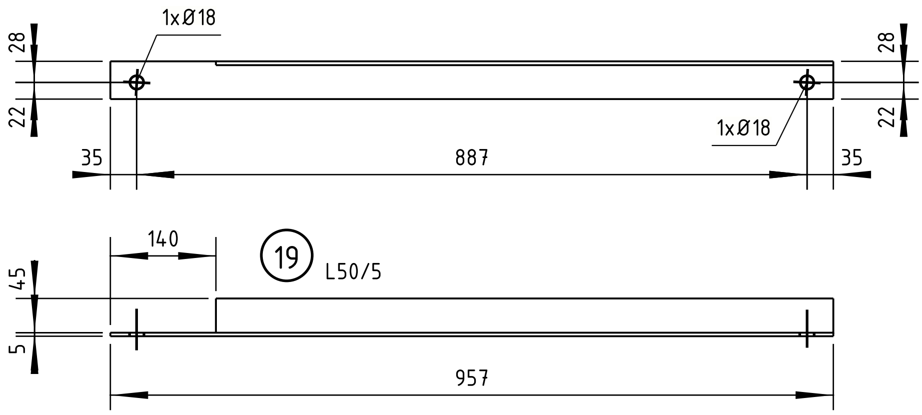

19	L50/5	2	S355J0	957	0.19
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
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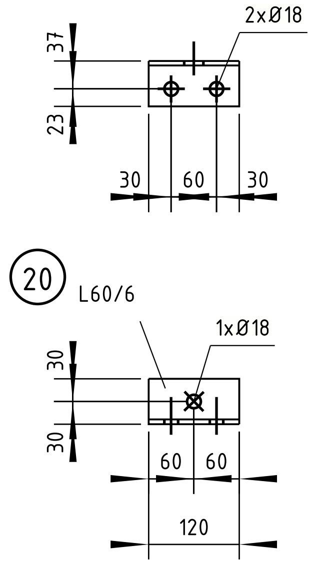
Omschrijving:	Nieuw staal - onderdeel [19]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
20	L60/6	4	S355J0	120	0.03

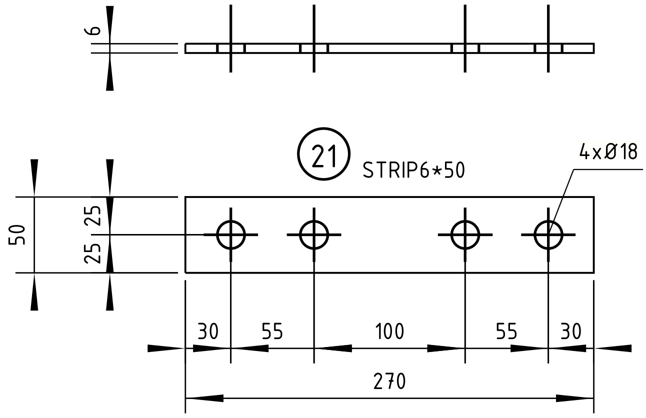
Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [20]
Documentnummer:	

Oud tekeningnummer:

Taking power further

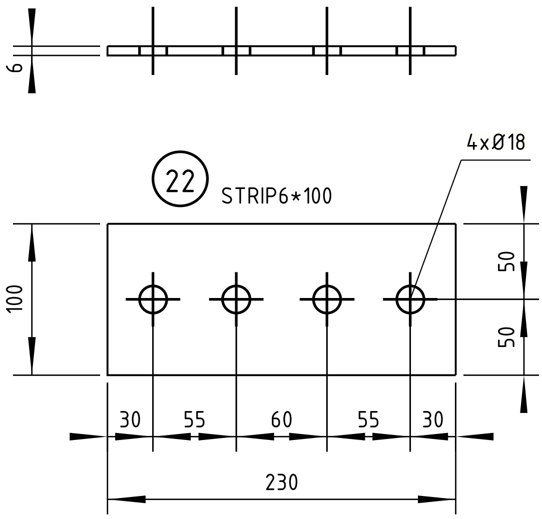


21	STRIP6*50	2	S355J0	270	0.03
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [21]
Documentnummer:	

TenneT
Taking power further



22	STRIP6*100	2	S355J0	230	0.05
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

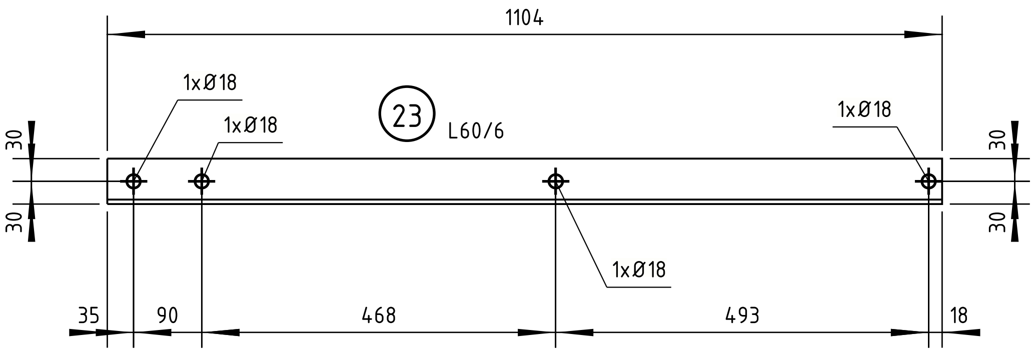
Object ID: ENS-ZL380

Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [22]

Documentnummer:

TenneT Taking power further



23	L60/6	2	S355J0	1104	0.26
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

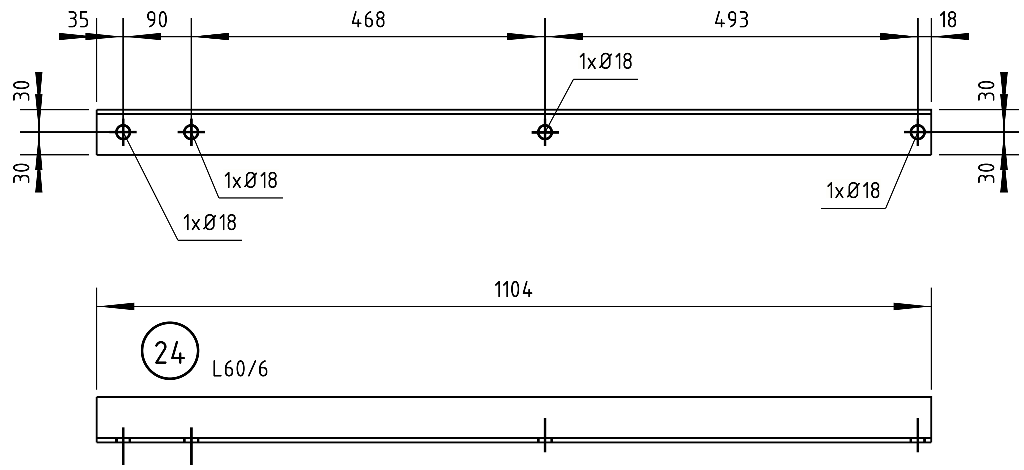
Oud tekeningnummer:

Omschrijving:
Nieuw staal - onderdeel [23]

Documentnummer:

TenneT
Taking power further

Tekla Structures

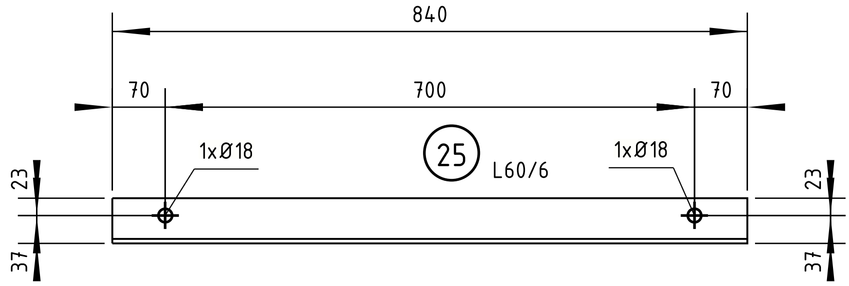


24	L60/6	2	S355J0	1104	0.26
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [24]
Documentnummer:	

Taking power further



25	L60/6	2	S355J0	840	0.20
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380

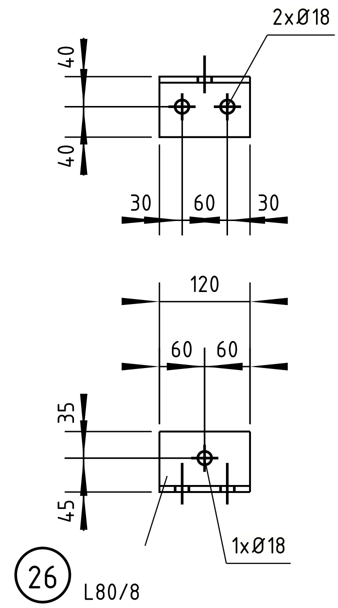
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [25]

Documentnummer:

Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
26	L80/8	8	S355J0	120	0.04

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380

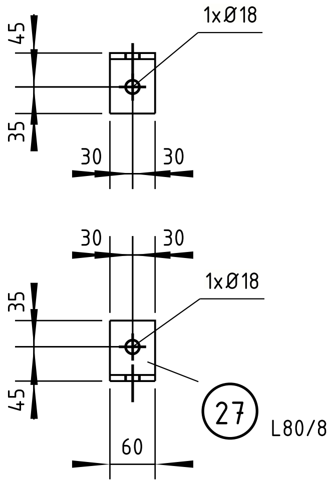
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [26]

Documentnummer:

TenneT Taking power further

Tekla Structures



27	L80/8	4	S355J0	60	0.02
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Voorlopig		

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Oud tekeningnummer:

Taking power further

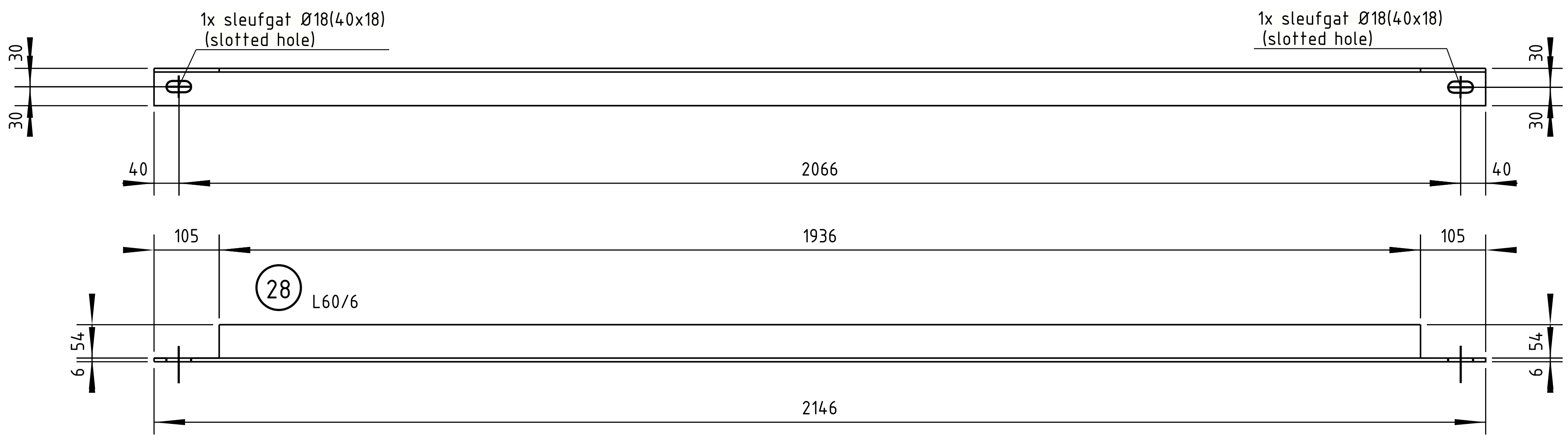
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [27]

Documentnummer:

Tekla Structures



28	L60/6	4	S355J0	2146	0.52
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend		Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.			1:10	A3

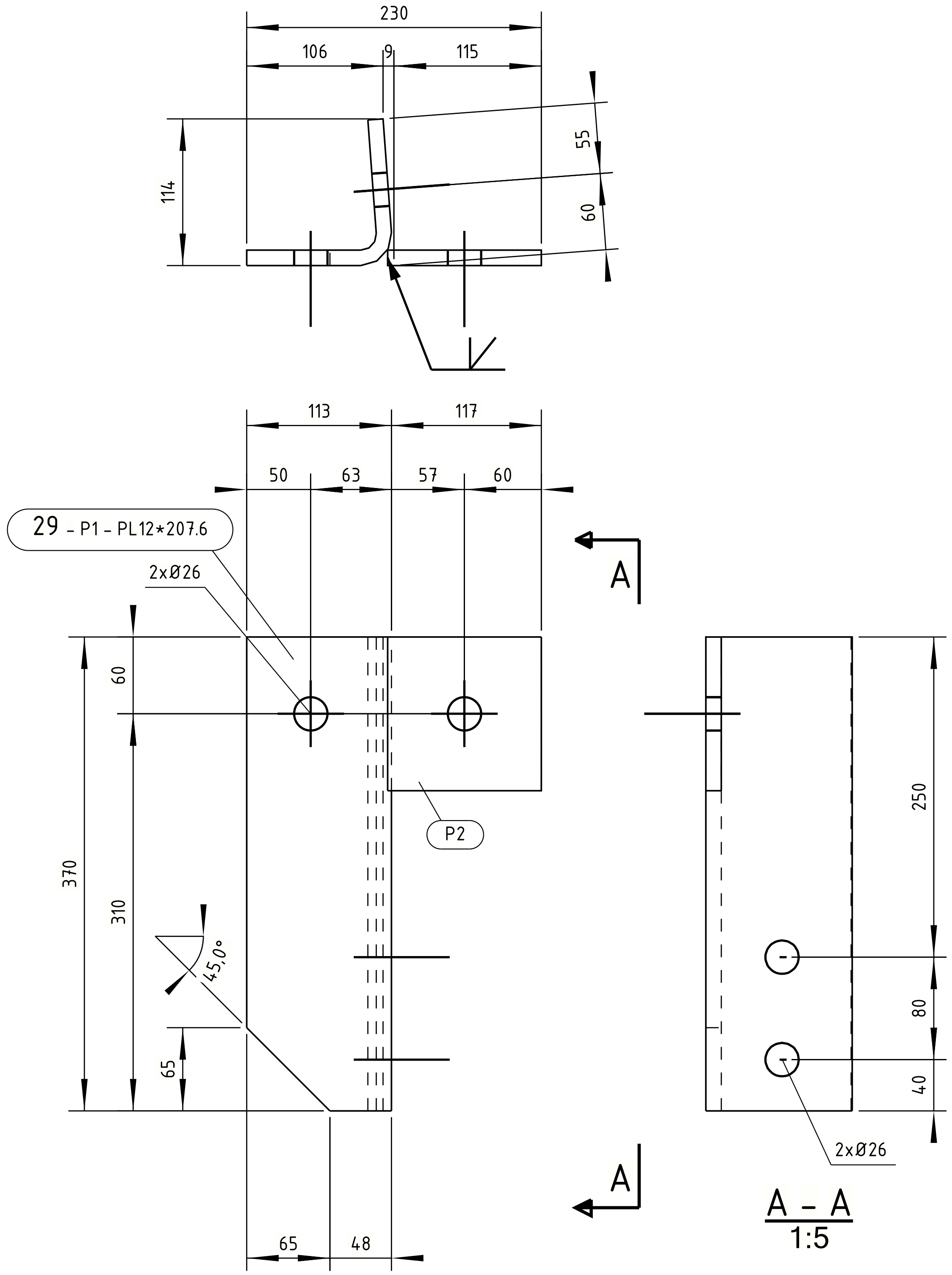
Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [28]
Documentnummer:	

Tekla Structures



ASSEMBLY

Mark: 29 length (mm): 230 Number: 2

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P1	PL12*207.6	S355J0	1	370	7.1	0.16
P2	STRIP12*120	S355J0	1	120	1.4	0.03
				Total of one mark	8.5	0.20

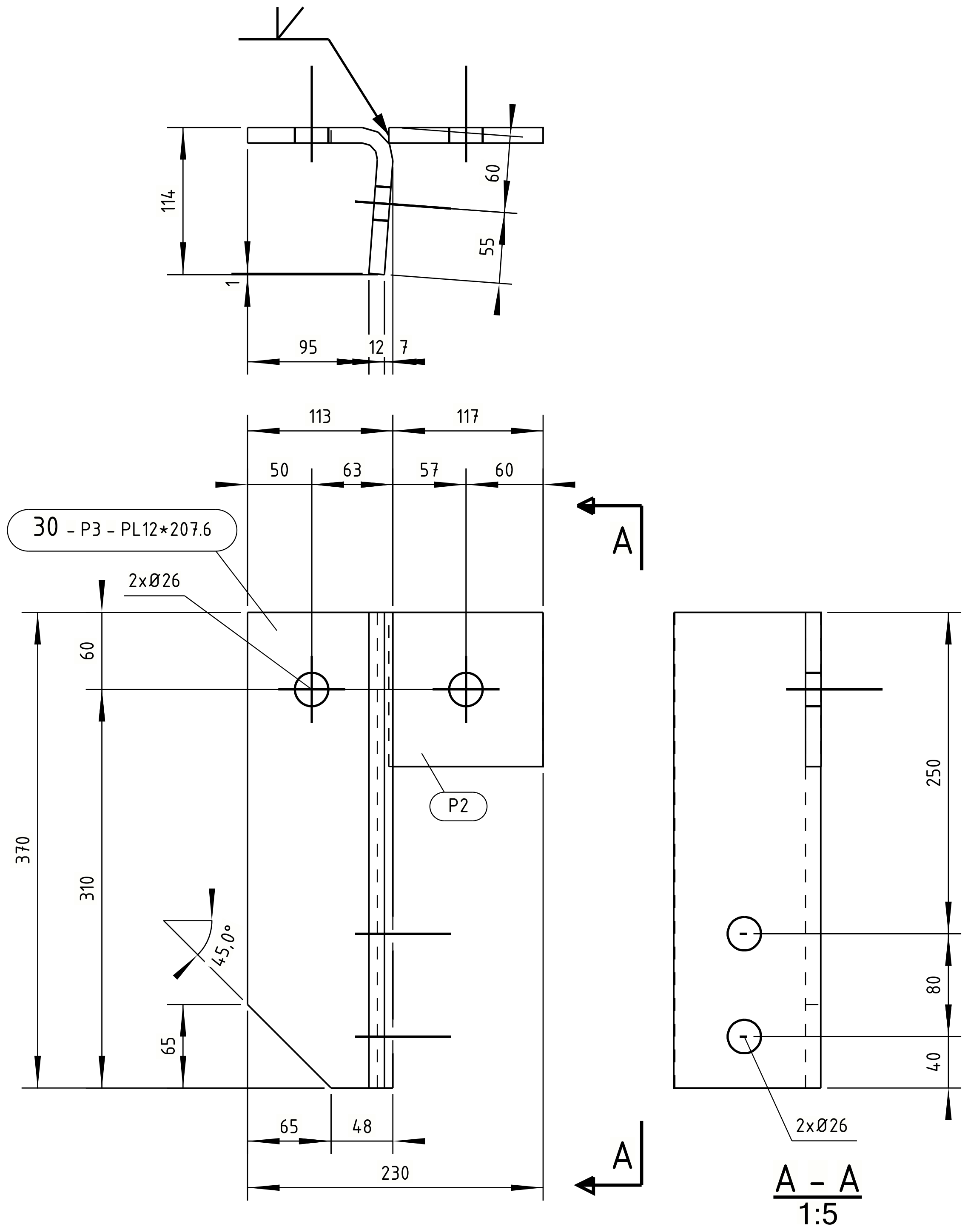
Naam					Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [29]
Documentnummer:	



ASSEMBLY

Mark: 30 length (mm): 230 Number: 2

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P2	STRIP12*120	S355J0	1	120	1.4	0.03
P3	PL12*207.6	S355J0	1	370	7.1	0.16
				Total of one mark	8.5	0.20

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
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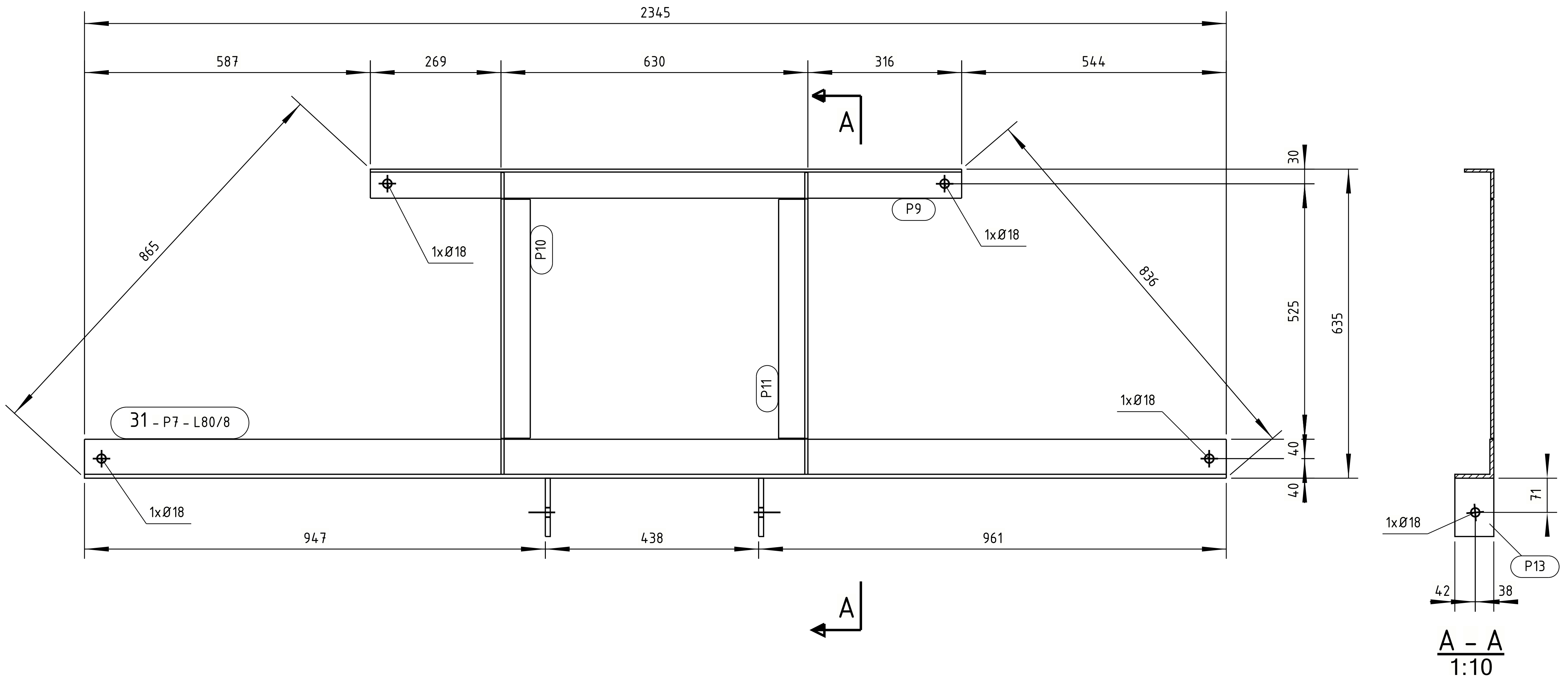
Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [30]
Documentnummer:	

Tekla Structures



Welds a=4, all round

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [31]
Documentnummer:	

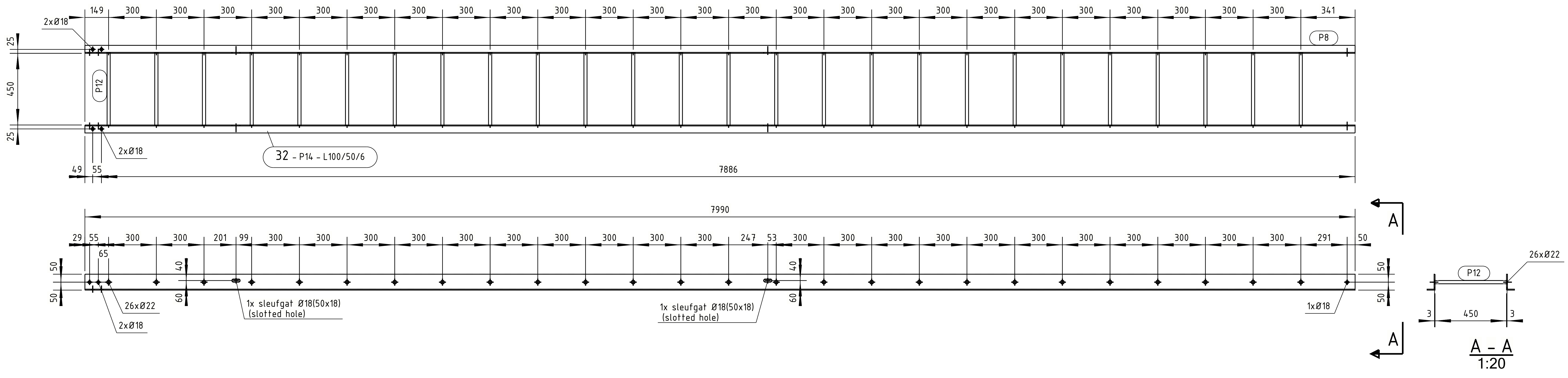
TenneT Taking power further

ASSEMBLY

Mark: 31 length (mm): 2345 Number: 1

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P7	L80/8	S355J0	1	2345	23.0	0.75
P9	L60/6	S355J0	1	1215	6.7	0.29
P10	L60/6	S355J0	1	620	3.4	0.15
P11	L60/6	S355J0	1	620	3.4	0.15
P13	STRIP10*80	S355J0	2	120	1.5	0.05
				Total of one mark	38.1	1.39

Tekla Structures



Welds a=4, all round

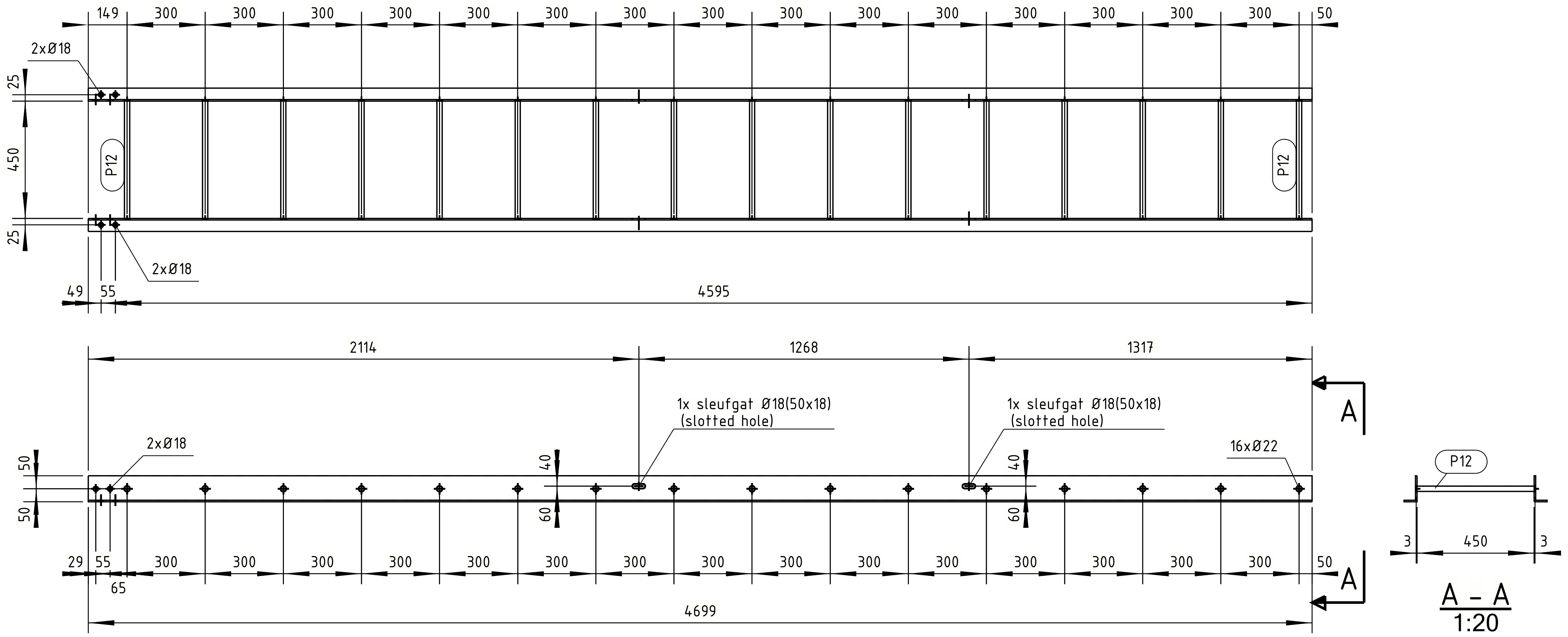
ASSEMBLY						
Mark: 32		length (mm): 7990		Number: 1		
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P8	L100/50/6	S355J0	1	7990	55.2	2.40
P12	D20	S355J2	26	456	26.8	0.74
P14	L100/50/6	S355J0	1	7990	55.2	2.40
			Total of one mark		137.3	5.53

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:20	594x420

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [32]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



Welds a=4, all round

ASSEMBLY						
Mark: 33		length (mm): 4699		Number: 1		
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P12	D20	S355J2	16	456	16.5	0.46
P15	L100/50/6	S355J0	1	4699	32.5	1.41
P16	L100/50/6	S355J0	1	4699	32.5	1.41
				Total of one mark	81.5	3.28

Naam						Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle						Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:20	A3

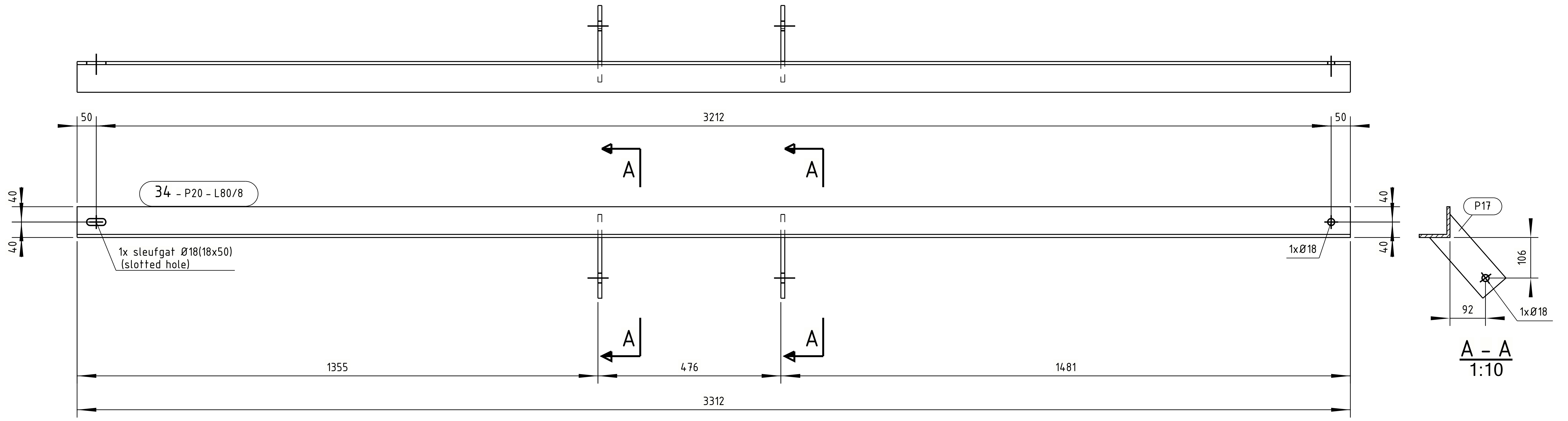
Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [33]
Documentnummer:	

Tekla Structures



ASSEMBLY						
Mark: 34		length (mm): 3312			Number: 1	
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P17	STRIP10*80	S355J0	2	220	2.5	0.08
P20	L80/8	S355J0	1	3312	32.5	1.06
			Total of one mark		35.0	1.13

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

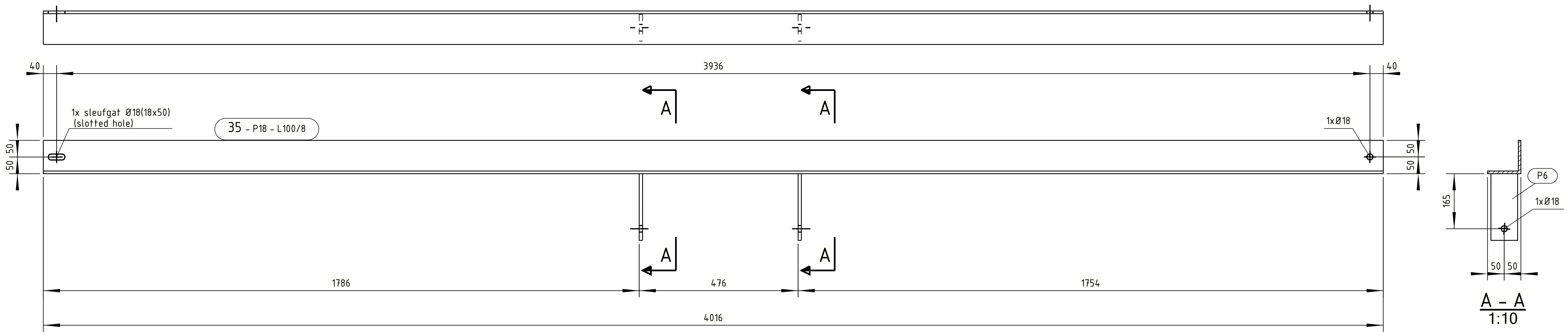
Relatie

Oud tekeningnummer:

TenneT
Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [34]
Documentnummer:	

Tekla Structures



Welds a=4, all round

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

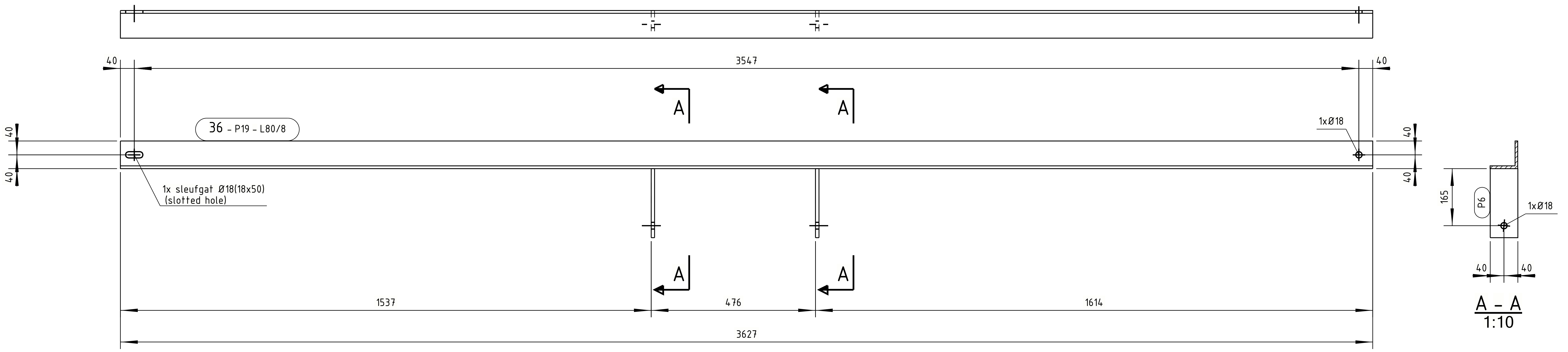
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [35]
Documentnummer:	

TenneT Taking power further

ASSEMBLY

Mark: 35 length (mm): 4016 Number: 1

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P6	STRIP10*80	S355J0	2	200	2.6	0.08
P18	L100/8	S355J0	1	4016	49.8	1.61
				Total of one mark	52.4	1.68



Welds a=4, all round

ASSEMBLY						
Mark: 36		length (mm): 3627			Number: 1	
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P6	STRIP10*80	S355J0	2	200	2.6	0.08
P19	L80/8	S355J0	1	3627	35.6	1.16
			Total of one mark		38.1	1.24

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

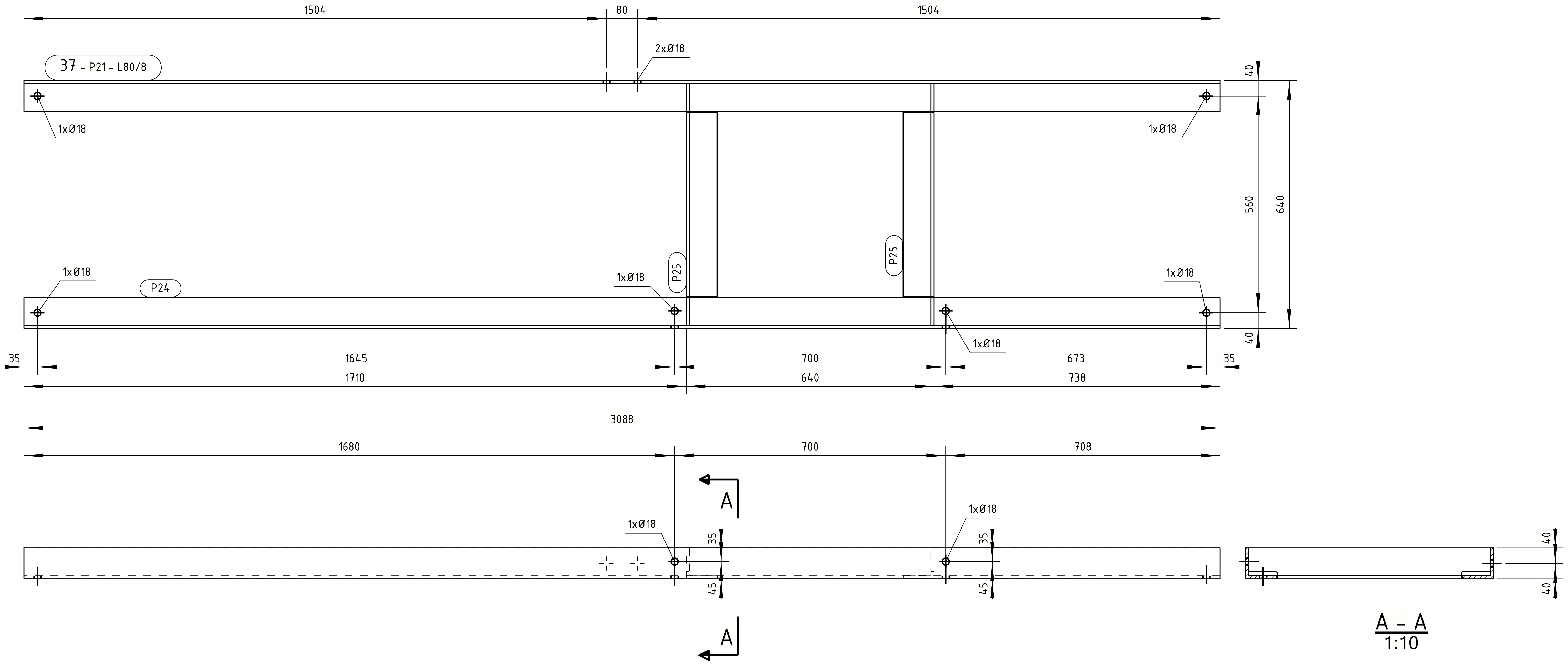
Relatie

Oud tekeningnummer:

TenneT
Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [36]
Documentnummer:	

Tekla Structures



Welds a=4, all round

ASSEMBLY						
Mark: 37		length (mm): 3088			Number: 1	
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P21	L80/8	S355J0	1	3088	30.3	0.99
P24	L80/8	S355J0	1	3088	30.3	0.99
P25	L80/8	S355J0	2	624	12.2	0.40
				Total of one mark	72.8	2.38

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

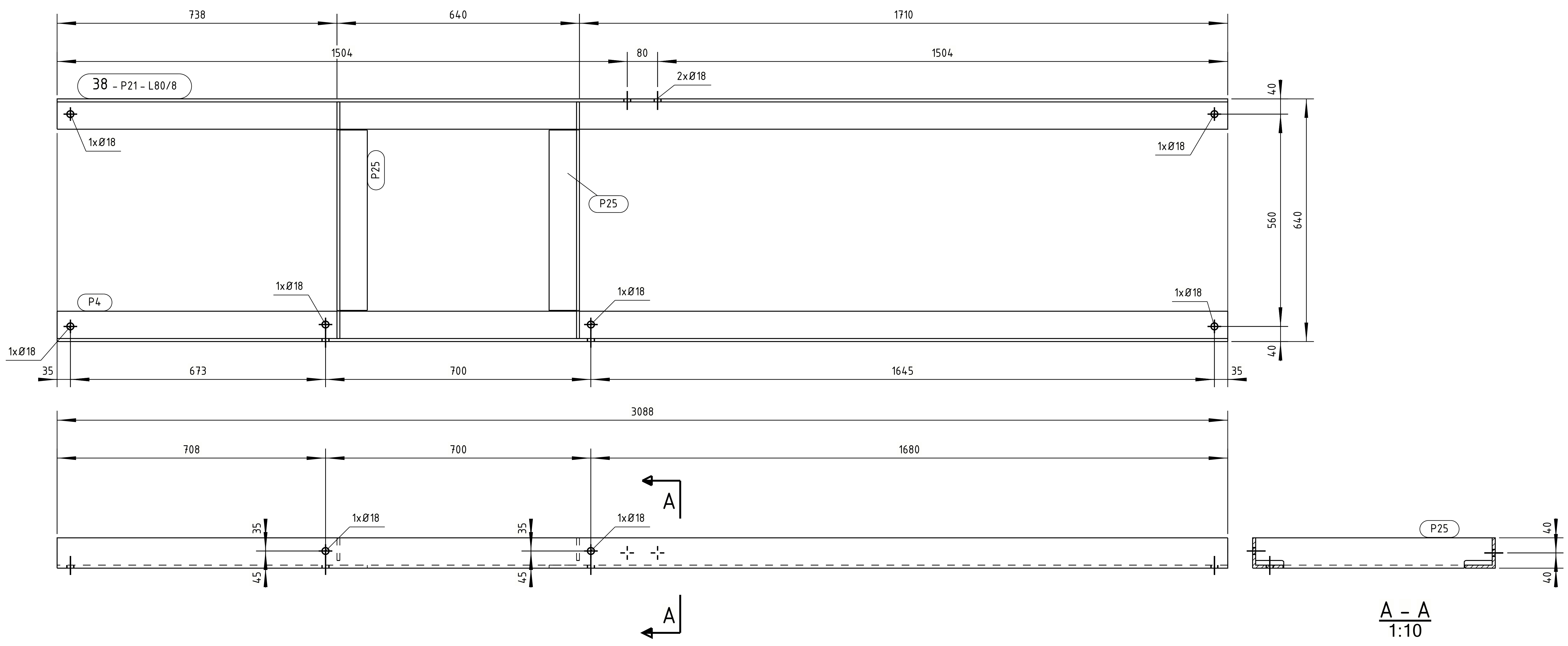
Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [37]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Welds a=4, all round

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus: Voorlopig
Rev.: 0.1	Datum revisie: 10.03.2022	Omschrijving revisie: 1e versie ter review	Getekend: Ing. bureau Aafjes b.v.
Datum As-Built:	Schaal: 1:10	Formaat: 594x420	
Relatie:			
Thema: Verbinding			
Categorie: Algemeen			
Documentcode: Constructietekening			
Oud tekeningnummer:	Object ID: ENS-ZL380		
Omschrijving: Nieuw staal - onderdeel [38]			
Documentnummer:			

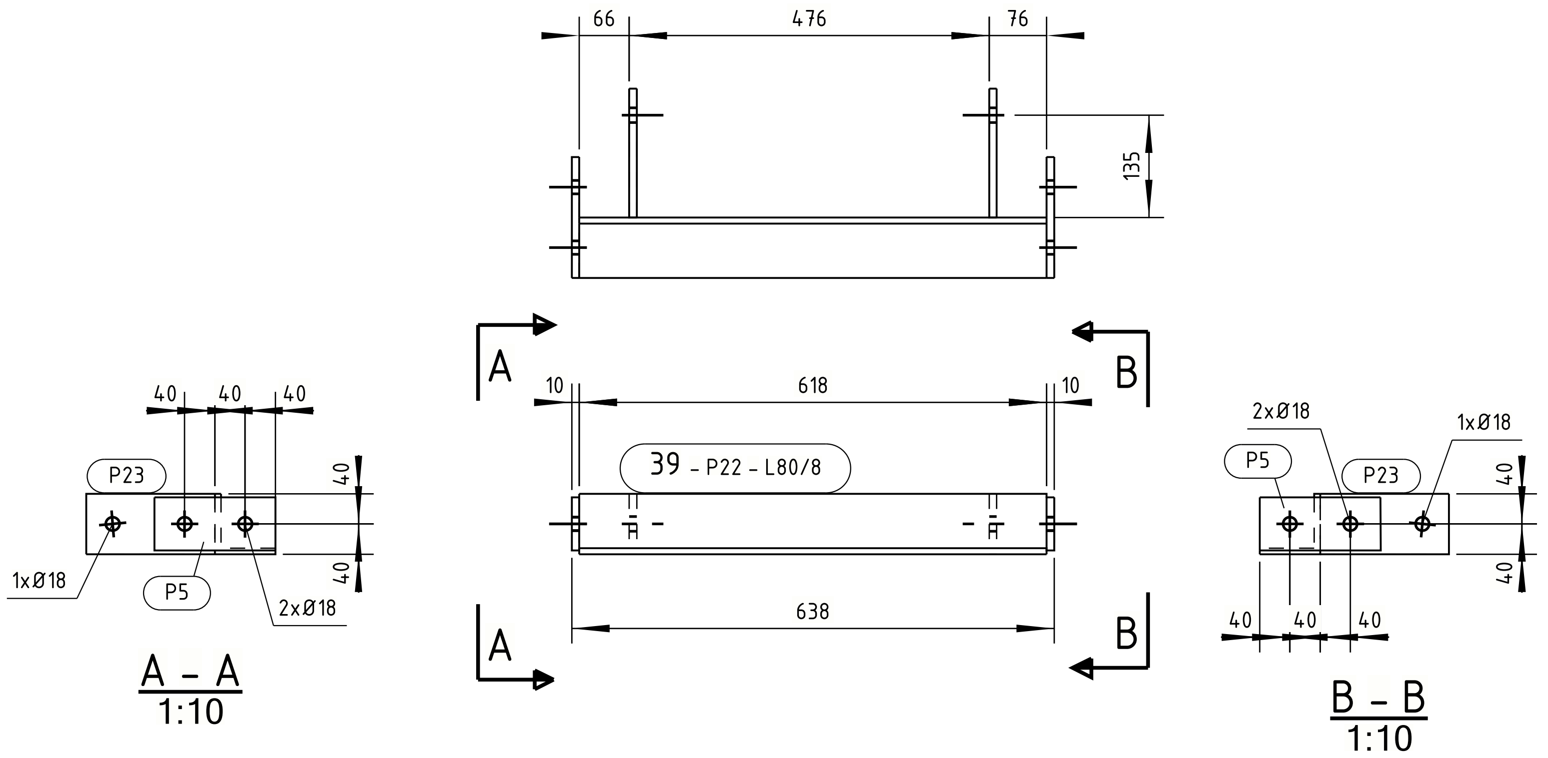
TenneT Taking power further

ASSEMBLY

Mark: 38 length (mm): 3088 Number: 1

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P4	L80/8	S355J0	1	3088	30.3	0.99
P21	L80/8	S355J0	1	3088	30.3	0.99
P25	L80/8	S355J0	2	624	12.2	0.40
			Total of one mark		72.8	2.38

Tekla Structures



Welds a=4, all round

ASSEMBLY

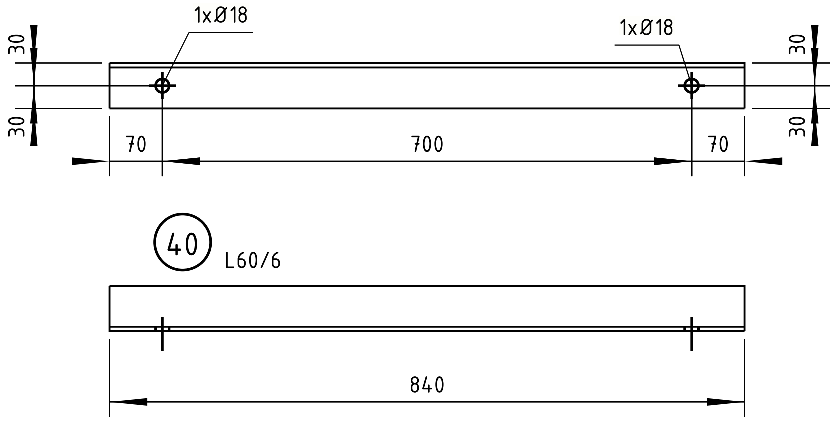
Mark: 39 length (mm): 638 Number: 1

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m²)
P5	STRIP10*70	S355J0	2	160	1.8	0.05
P22	L80/8	S355J0	1	618	6.1	0.20
P23	STRIP10*80	S355J0	2	170	2.2	0.06
				Total of one mark	10.0	0.32

Naam					Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat	
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3	

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380
TenneT Taking power further	Omschrijving:	Nieuw staal - onderdeel [39]
	Documentnummer:	

Tekla Structures



40	L60/6	2	S355J0	840	0.20
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

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Oud tekeningnummer:

TenneT Taking power further

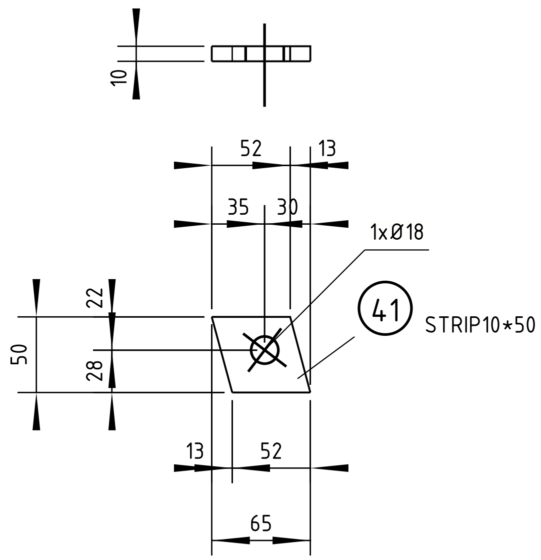
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [40]

Documentnummer:

Tekla Structures



41	STRIP10*50	2	S355J0	65	0.01
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
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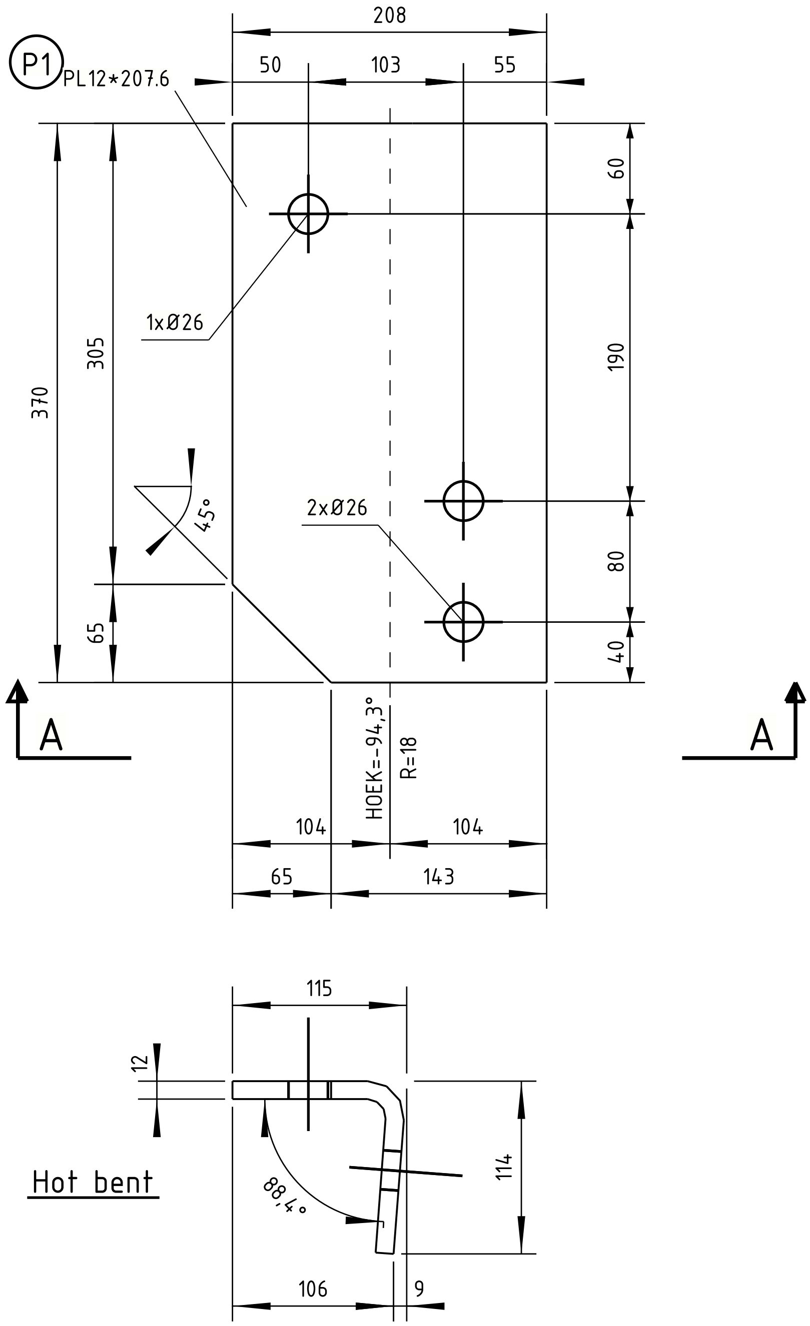
Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Te vervangen staal - onderdeel [41]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Doorsnede A - A

1:5

P1	PL12*207.6	2	S355J0	370	0.16
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

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Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

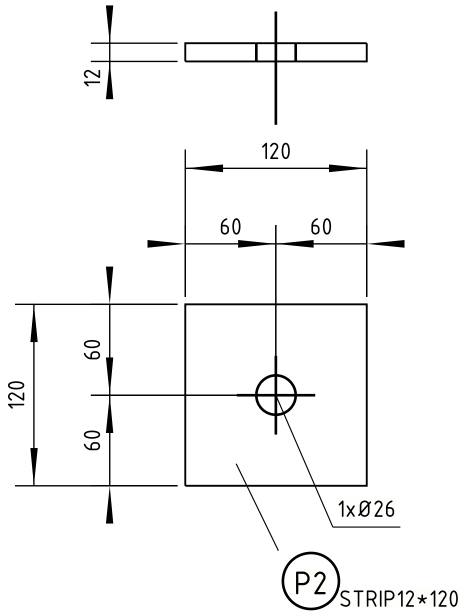
Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [P1]

Documentnummer:

TenneT Taking power further

Tekla Structures



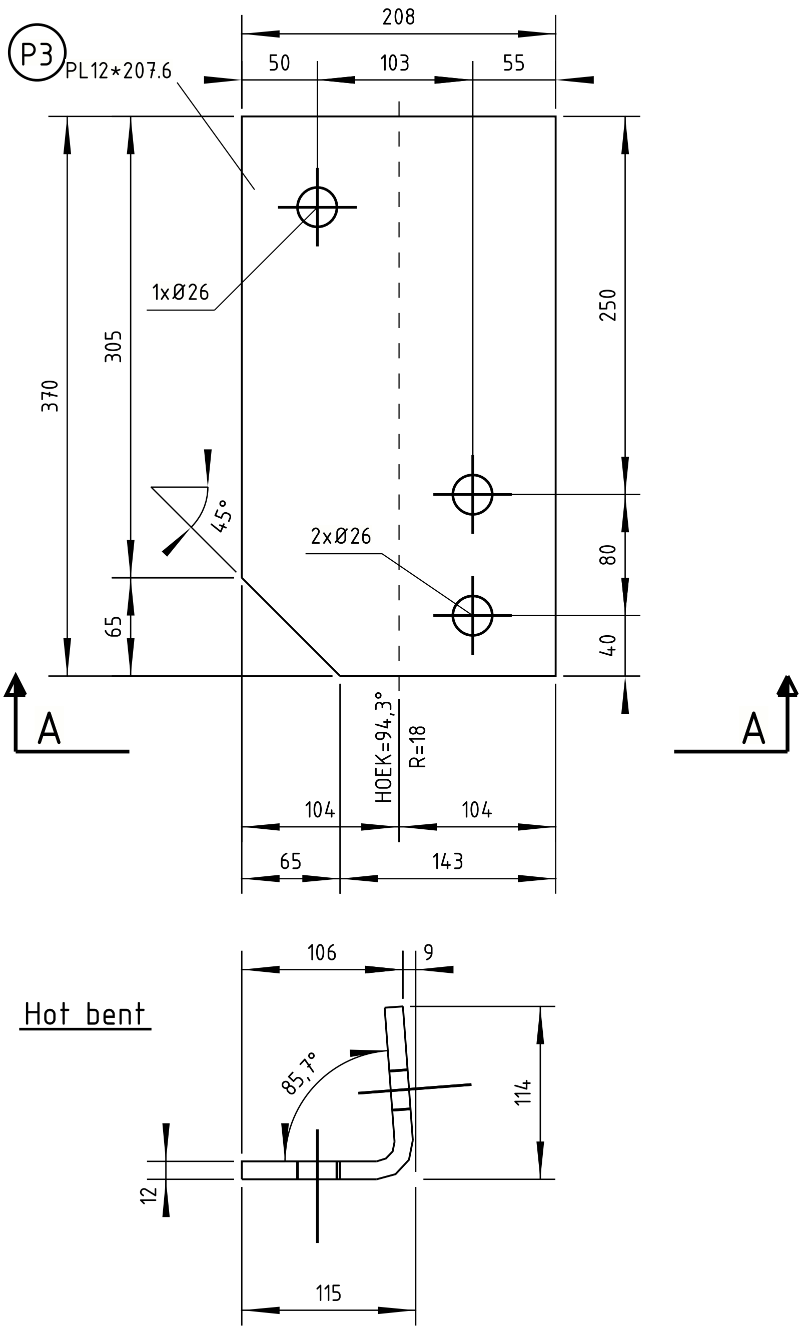
P2	STRIP12*120	4	S355J0	120	0.03
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P2]
Documentnummer:	

Taking power further

Tekla Structures



Doorsnede A - A

1:5

P3	PL12*207.6	2	S355J0	370	0.16
Pos	Profile	Number	Grade	Length	Area (m²)

Naam				Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie		
	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
	Object ID	ENS-ZL380
Oud tekeningnummer:	Omschrijving:	Nieuw staal - onderdeel [P3]
TenneT Taking power further	Documentnummer:	

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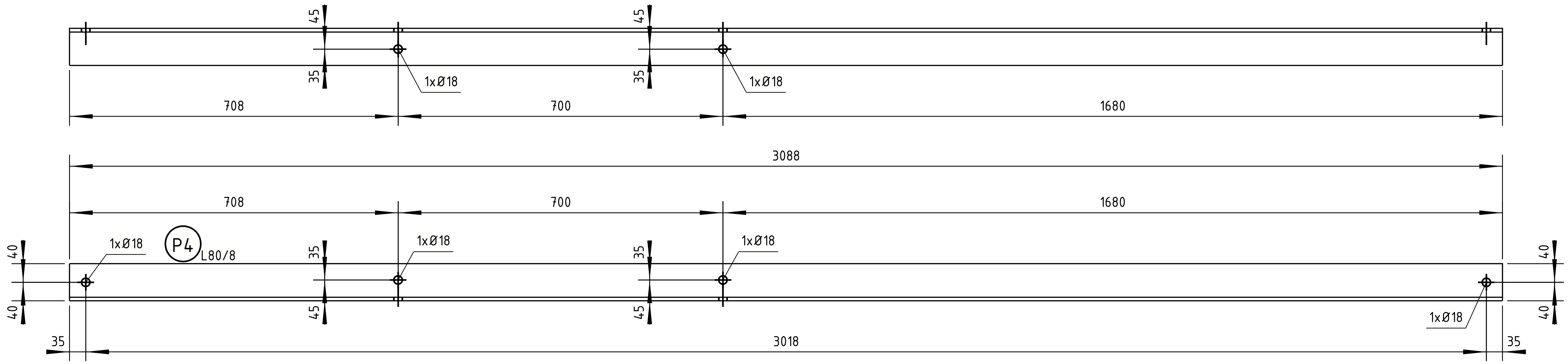

Pos	Profile	Number	Grade	Length	Area (m^2)
P4	L80/8	1	S355J0	3088	0.99

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

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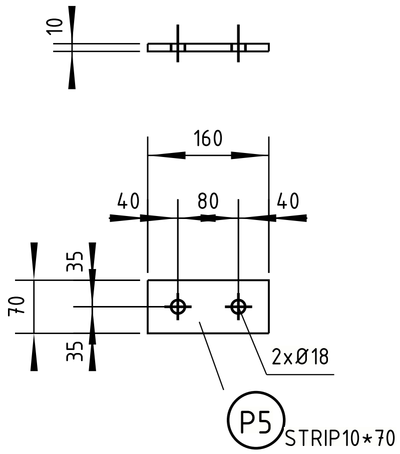
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [P4]
Documentnummer:	

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
P5	STRIP10*70	2	S355J0	160	0.03

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

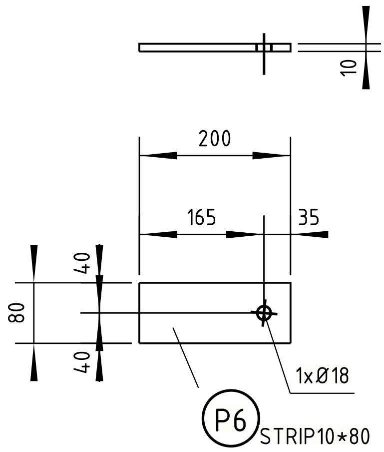
Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [P5]

Documentnummer:

TenneT Taking power further

Tekla Structures



P6	STRIP10*80	4	S355J0	200	0.04
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [P6]

Documentnummer:

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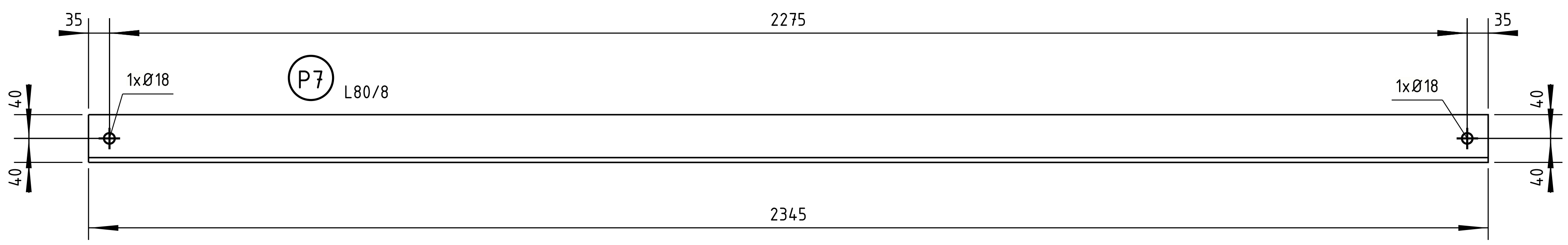


P7	L80/8	1	S355J0	2345	0.75
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

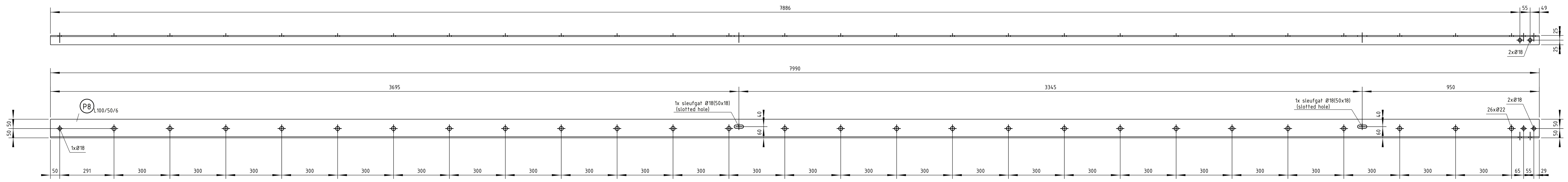
Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [P7]
Documentnummer:	

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
P8	L100/50/6	1	S355J0	7990	2.40

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A0
Relatie		Thema	Verbinding			
		Categorie	Algemeen			
		Documentcode	Constructietekening			
Oud tekeningnummer:		Object ID: ENS-ZL380				
TenneT Taking power further		Omschrijving: Nieuw staal - onderdeel [P8]				
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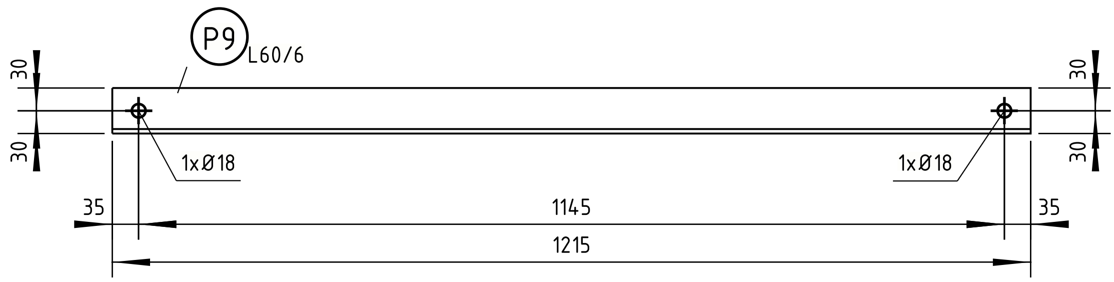


P9	L60/6	1	S355J0	1215	0.29
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

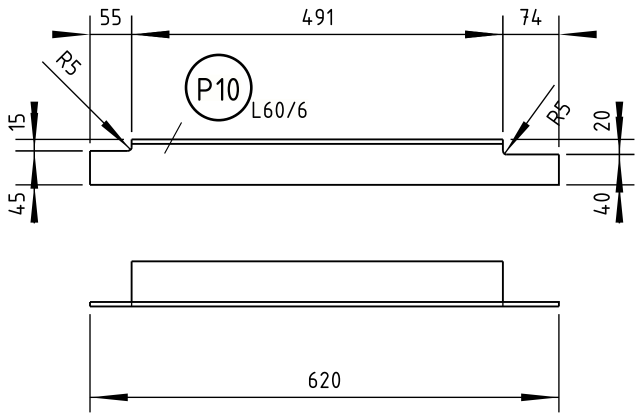
Oud tekeningnummer:

Omschrijving:
Nieuw staal - onderdeel [P9]

Documentnummer:

TenneT
Taking power further

Tekla Structures



P10	L60/6	1	S355J0	620	0.15
Pos	Profile	Number	Grade	Length	Area (m²)

Naam						Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle						Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380

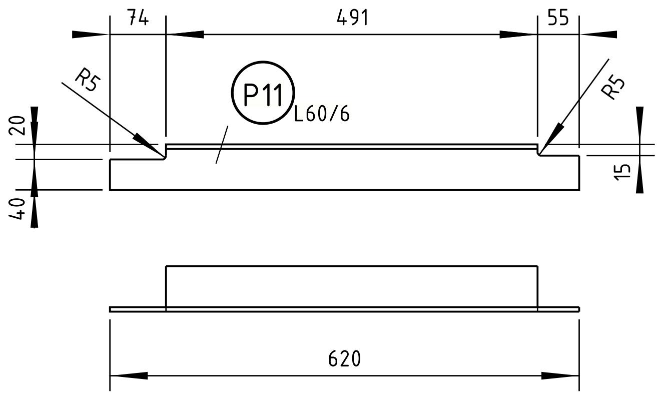
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [P10]

Documentnummer:

TenneT Taking power further

Tekla Structures



P11	L60/6	1	S355J0	620	0.15
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Oud tekeningnummer:

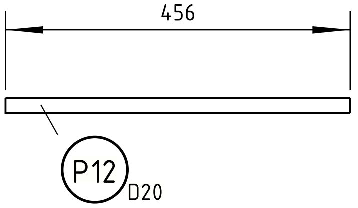
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [P11]

Documentnummer:

Taking power further



P12	D20	42	S355J2	456	0.03
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380
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	Documentnummer:	

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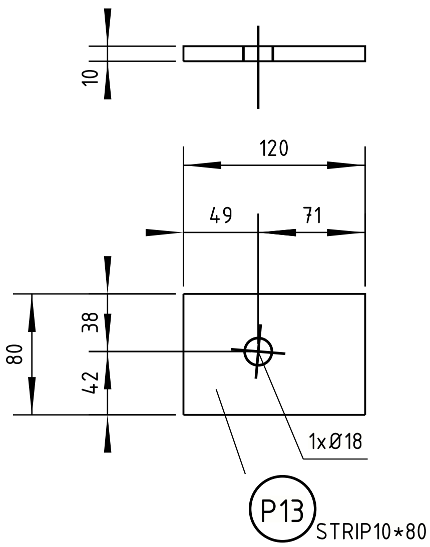


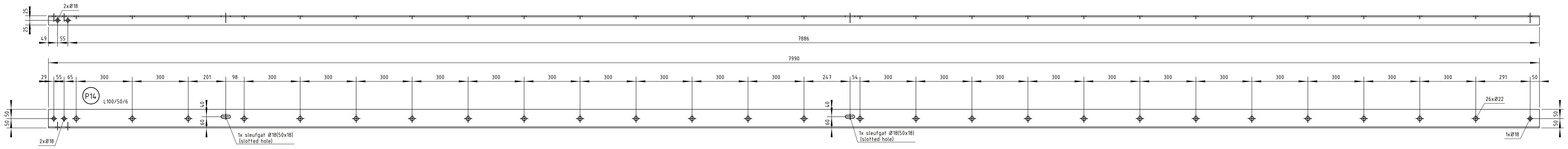
P13	STRIP10*80	2	S355J0	120	0.02
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P13]
Documentnummer:	

TenneT
Taking power further

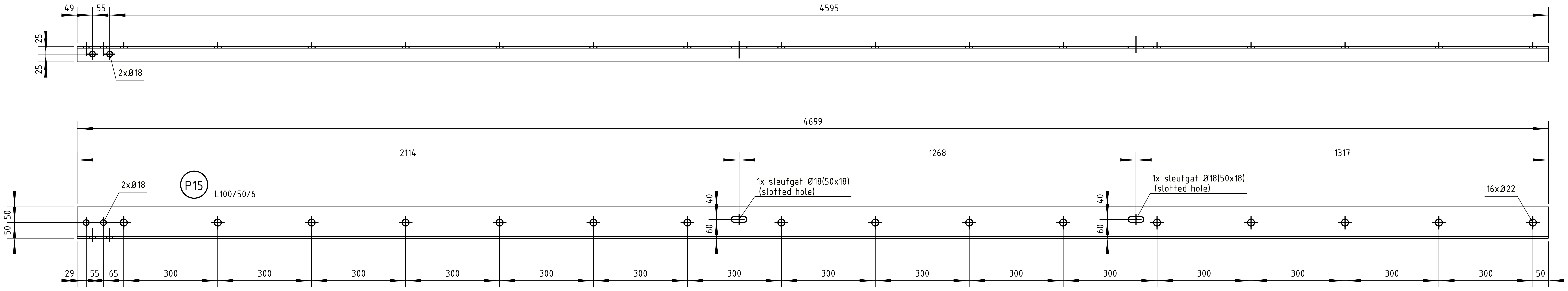
Tekla Structures



P14	L100/50/6	1	S355J0	7990	2.40
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A0
Relatie			Thema	Verbinding		
			Categorie	Algemeen		
			Documentcode	Constructietekening		
Oud tekeningnummer:			Object ID: ENS-ZL380			
			Omschrijving: Nieuw staal - onderdeel [P14]			
Taking power further			Documentnummer:			

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
P15	L100/50/6	1	S355J0	4699	1.41

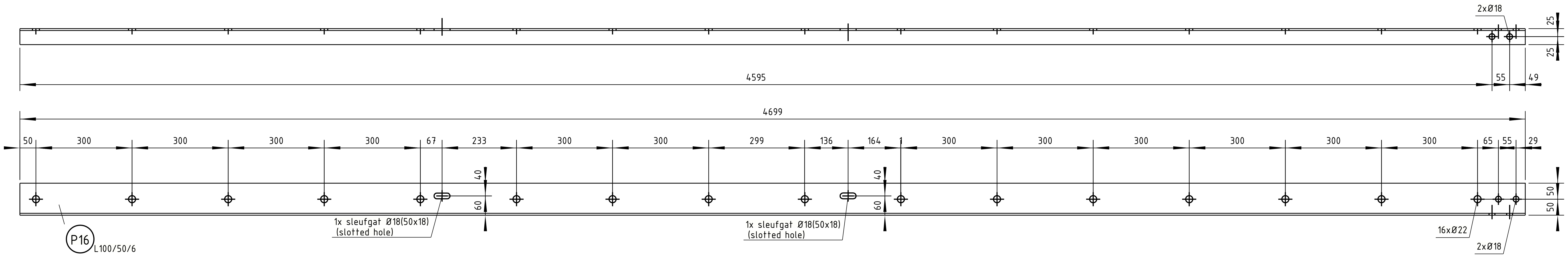
Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P15]
Documentnummer:	

Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
P16	L100/50/6	1	S355J0	4699	1.41

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380

Omschrijving: Nieuw staal - onderdeel [P16]

Documentnummer:

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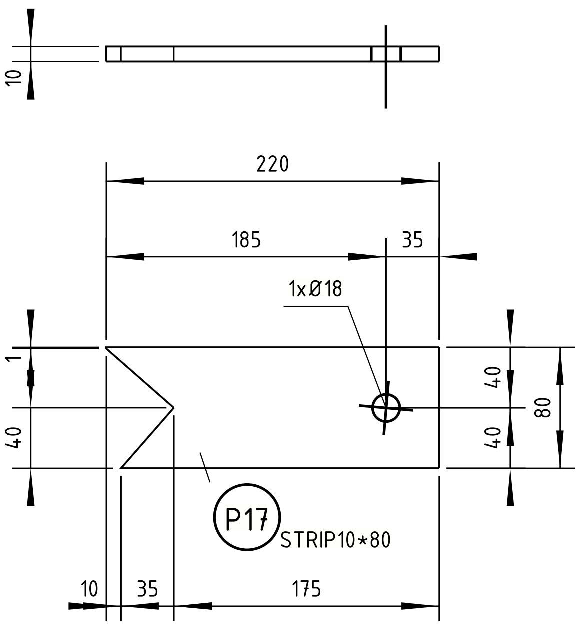


P17	STRIP10*80	2	S355J0	220	0.04
Pos	Profile	Number	Grade	Length	Area (m²)

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380

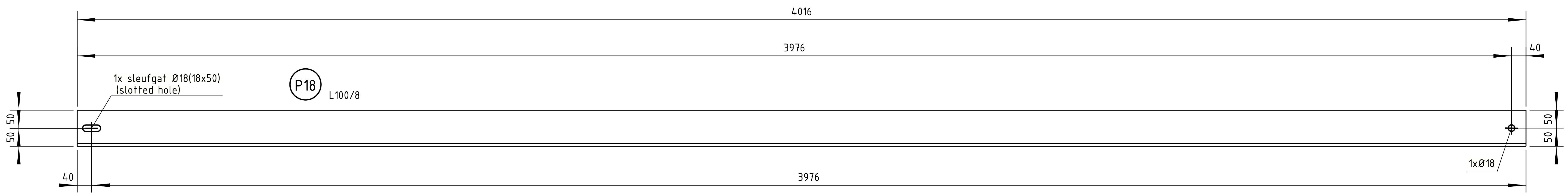
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [P17]

Documentnummer:

TenneT Taking power further

Tekla Structures



P18	L100/8	1	S355J0	4016	1.61
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle	Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

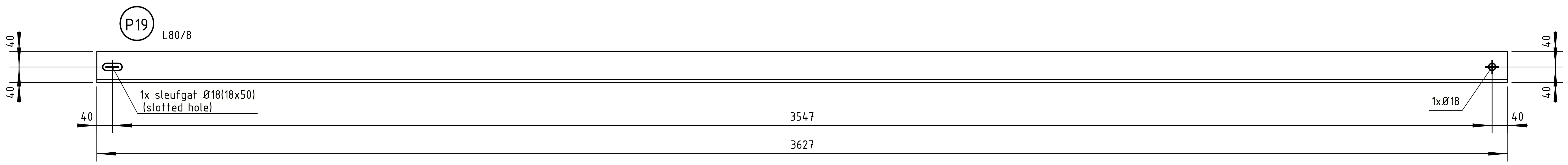
Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [P18]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
P19	L80/8	1	S355J0	3627	1.16

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380

Omschrijving: Nieuw staal - onderdeel [P19]

Documentnummer:

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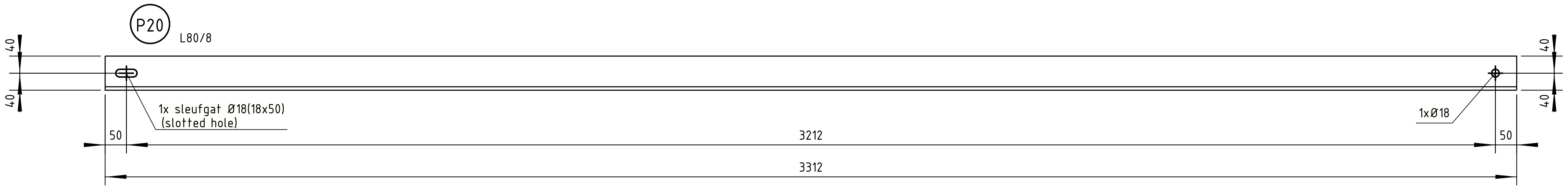

Pos	Profile	Number	Grade	Length	Area (m^2)
P20	L80/8	1	S355J0	3312	1.06

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
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Omschrijving:	Nieuw staal - onderdeel [P20]
Documentnummer:	

TenneT Taking power further

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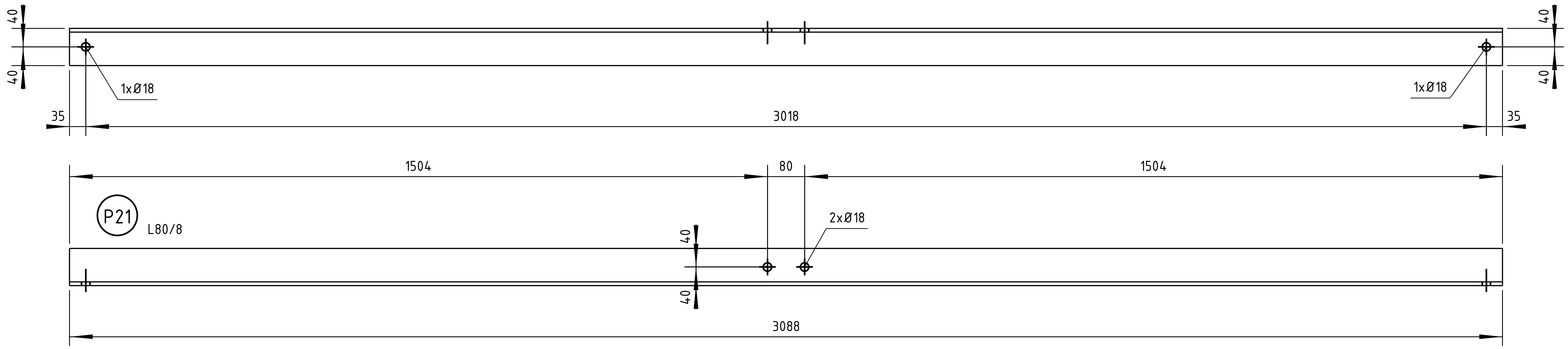

P21	L80/8	2	S355J0	3088	0.99
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [P21]

Documentnummer:

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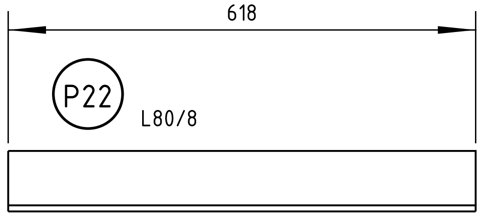

P22	L80/8	1	S355J0	618	0.20
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Omschrijving:	Nieuw staal - onderdeel [P22]
Documentnummer:	

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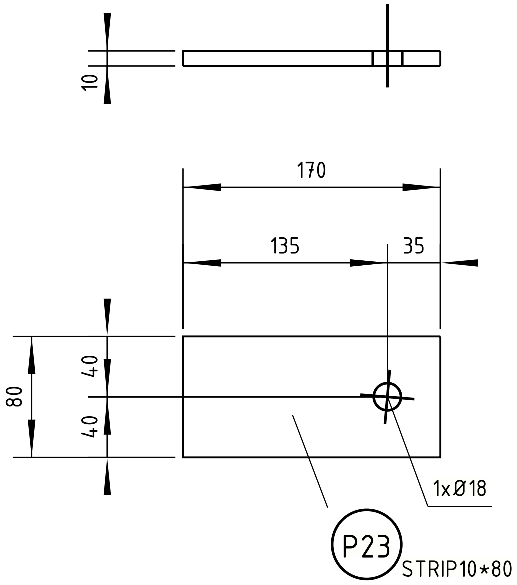

P23	STRIP10*80	2	S355J0	170	0.03
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam				Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
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Omschrijving:
Nieuw staal - onderdeel [P23]

Documentnummer:

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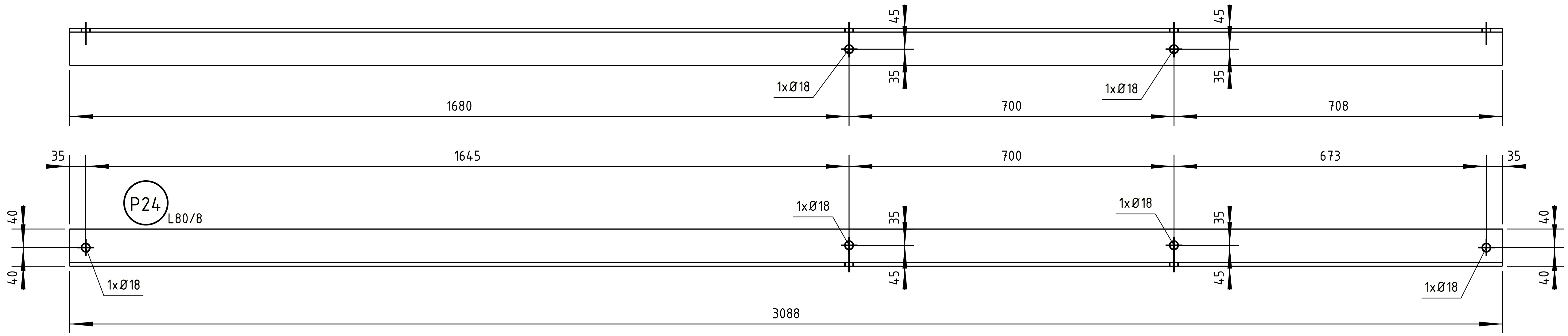


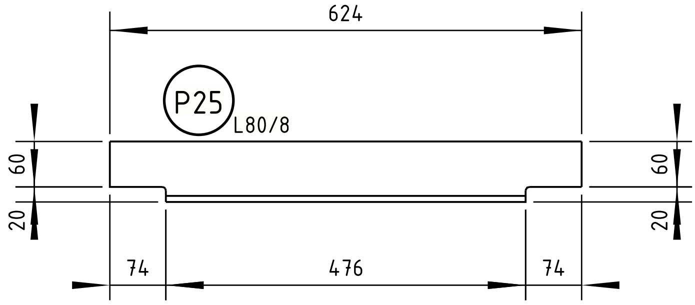
P24	L80/8	1	S355J0	3088	0.99
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat	
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3	

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P24]
Documentnummer:	

TenneT Taking power further

Tekla Structures



P25	L80/8	4	S355J0	624	0.20
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Oud tekeningnummer:

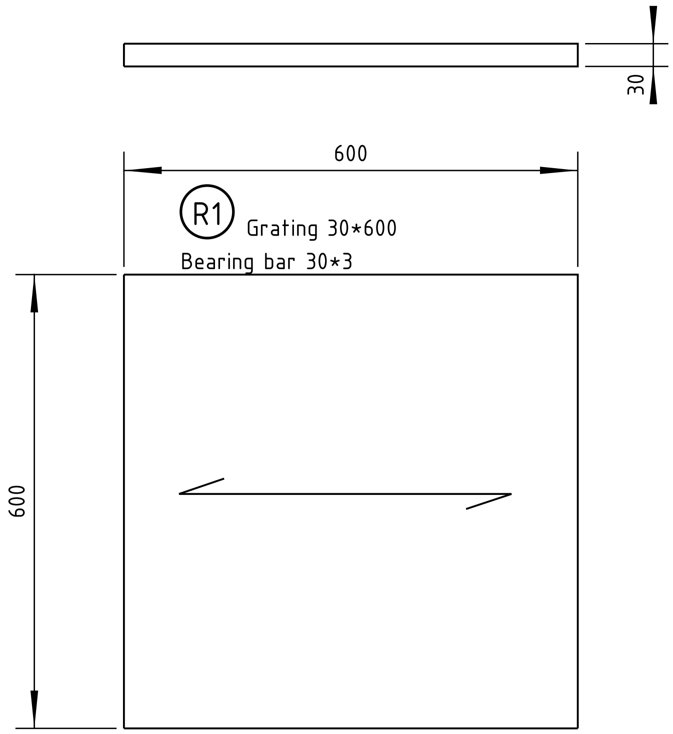
Object ID
ENS-ZL380

Omschrijving:
Nieuw staal - onderdeel [P25]

Documentnummer:

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
R1	PL30*600	3	S235JR	600	0.79

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380

Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [R1]

TenneT Taking power further

Documentnummer:

Tekla Structures

Ingenieursbureau
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8013 PZ Zwolle
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Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-02820**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994436**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**Masttype S-6_R, Mast 28 - Lijsten**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		10-03-2022
Validatie Aafjes	Niels Verhaar	System Engineer		10-03-2022
Vrijgegeven	Bart Aafjes	Projectleider		10-03-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	10-03-2022	1e versie ter review

BOUTEN-, MOEREN-, RINGENLIJST   Pagina: 1

ENS-ZL380   Datum: 09.03.2022
Masttype S-6_R
t.b.v. Mast 28

Naam	Type	Kwal.	Aantal
BOUT-M16*35	4017	8.8	26
BOUT-M16*40	4017	8.8	46
BOUT-M16*45	4017	8.8	36
BOUT-M16*50	4014	8.8	8
BOUT-M20*45	4017	8.8	4
BOUT-M24*55	4017	8.8	38
BOUT-M24*60	4017	8.8	80
BOUT-M24*65	4017	8.8	6
MOER-M16	4032		116
MOER-M20	4032		4
MOER-M24	4032		124
RING-M16	7091		16
RING-M16	7091		116
RING-M20	7091		4
RING-M24	7091		124

MATERIAALLIJST | Pagina: 1

ENS-ZL380 | Datum: 09.03.2022

Masttype S-6_R

t.b.v. Mast 28

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
D20	P12	S355J2	42	456	0.03	1.0
				19152	1.20	43.3
HEB160	1	S355J0	2	2161	1.99	93.8
HEB160	2	S355J0	2	3181	2.93	138.1
HEB160	6	S355J0	2	2129	1.96	92.4
				14943	13.75	648.5
L50/5	5	S355J0	4	2382	0.48	9.2
L50/5	18	S355J0	2	957	0.19	3.7
L50/5	19	S355J0	2	957	0.19	3.7
				13358	2.67	51.3
L60/6	20	S355J0	4	120	0.03	0.7
L60/6	23	S355J0	2	1104	0.26	6.1
L60/6	24	S355J0	2	1104	0.26	6.1
L60/6	25	S355J0	2	840	0.20	4.6
L60/6	28	S355J0	4	2146	0.52	11.9
L60/6	40	S355J0	2	840	0.20	4.6
L60/6	P9	S355J0	1	1215	0.29	6.7
L60/6	P10	S355J0	1	620	0.15	3.4
L60/6	P11	S355J0	1	620	0.15	3.4
				19294	4.63	106.6
L80/8	3	S355J0	1	2874	0.92	28.2
L80/8	4	S355J0	1	2874	0.92	28.2
L80/8	26	S355J0	8	120	0.04	1.2
L80/8	27	S355J0	4	60	0.02	0.6
L80/8	P4	S355J0	1	3088	0.99	30.3
L80/8	P7	S355J0	1	2345	0.75	23.0
L80/8	P19	S355J0	1	3627	1.16	35.6
L80/8	P20	S355J0	1	3312	1.06	32.5
L80/8	P21	S355J0	2	3088	0.99	30.3
L80/8	P22	S355J0	1	618	0.20	6.1
L80/8	P24	S355J0	1	3088	0.99	30.3
L80/8	P25	S355J0	4	624	0.20	6.1
				31698	10.14	310.9
L100/8	P18	S355J0	1	4016	1.61	49.8
				4016	1.61	49.8
L100/50/6	P8	S355J0	1	7990	2.40	55.2
L100/50/6	P14	S355J0	1	7990	2.40	55.2

MATERIAALLIJST   Pagina: 2

ENS-ZL380   Datum: 09.03.2022
Masttype S-6_R
t.b.v. Mast 28

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
L100/50/6	P15	S355J0	1	4699	1.41	32.5
L100/50/6	P16	S355J0	1	4699	1.41	32.5
				25378	7.61	175.4
PL12*207.6	P1	S355J0	2	370	0.16	7.1
PL12*207.6	P3	S355J0	2	370	0.16	7.1
				1480	0.65	28.5
PL12*225	15	S355J0	4	470	0.19	8.2
				1880	0.75	33.0
PL12*260	11	S355J0	2	281	0.14	5.9
PL12*260	17	S355J0	2	281	0.14	5.9
				1122	0.54	23.5
PL12*299	7	S355J0	2	370	0.21	9.5
PL12*299	9	S355J0	2	370	0.21	9.5
				1480	0.85	38.0
PL12*308.1	8	S355J0	2	370	0.22	9.8
PL12*308.1	10	S355J0	2	370	0.22	9.8
				1480	0.88	39.3
PL12*309	13	S355J0	2	370	0.22	9.9
PL12*309	14	S355J0	2	370	0.22	9.9
				1480	0.88	39.4
PL30*600	R1	S235JR	3	600	0.79	86.4
				1800	2.38	259.2
STRIP6*50	21	S355J0	2	270	0.03	0.6
				540	0.06	1.3
STRIP6*100	22	S355J0	2	230	0.05	1.1
				460	0.10	2.2
STRIP10*50	41	S355JO	2	65	0.01	0.2

MATERIAALLIJST Pagina: 3

ENS-ZL380 Datum: 09.03.2022
Masttype S-6_R
t.b.v. Mast 28

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
				130	0.01	0.4
STRIP10*70	P5	S355J0	2	160	0.03	0.9
				320	0.05	1.8
STRIP10*80	P6	S355J0	4	200	0.04	1.3
STRIP10*80	P13	S355J0	2	120	0.02	0.8
STRIP10*80	P17	S355J0	2	220	0.04	1.3
STRIP10*80	P23	S355J0	2	170	0.03	1.1
				1821	0.34	11.3
STRIP12*120	P2	S355J0	4	120	0.03	1.4
				480	0.14	5.5
STRIP12*350	12	S355J0	2	309	0.21	9.3
STRIP12*350	16	S355J0	2	309	0.21	9.3
				1236	0.83	37.1
				Totaal:	50.08	1906.5

TEKLA STRUCTURES MERKENLIJST Pagina: 1

ENS-ZL380 Datum: 09.03.2022
Masttype S-6_R
t.b.v. Mast 28

Merk	Aantal	Profiel	Lengte	Opp.(m2)	Gewicht (kg)
1	2	HEB160	2161	1.99	93.8
2	2	HEB160	3181	2.93	138.1
3	1	L80/8	2874	0.92	28.2
4	1	L80/8	2874	0.92	28.2
5	4	L50/5	2382	0.48	9.2
6	2	HEB160	2129	1.96	92.4
7	2	PL12*299	199	0.21	9.5
8	2	PL12*308.1	205	0.22	9.8
9	2	PL12*299	199	0.21	9.5
10	2	PL12*308.1	205	0.22	9.8
11	2	PL12*260	198	0.14	5.9
12	2	STRIP12*350	209	0.21	9.3
13	2	PL12*309	209	0.22	9.9
14	2	PL12*309	209	0.22	9.9
15	4	PL12*225	470	0.19	8.2
16	2	STRIP12*350	209	0.21	9.3
17	2	PL12*260	198	0.14	5.9
18	2	L50/5	957	0.19	3.7
19	2	L50/5	957	0.19	3.7
20	4	L60/6	120	0.03	0.7
21	2	STRIP6*50	270	0.03	0.6
22	2	STRIP6*100	230	0.05	1.1
23	2	L60/6	1104	0.26	6.1
24	2	L60/6	1104	0.26	6.1
25	2	L60/6	840	0.20	4.6
26	8	L80/8	120	0.04	1.2
27	4	L80/8	60	0.02	0.6
28	4	L60/6	2146	0.52	11.9
29	2	PL12*207.6	230	0.20	8.5
30	2	PL12*207.6	230	0.20	8.5
31	1	L80/8	2345	1.39	38.1
32	1	L100/50/6	7990	5.53	137.3
33	1	L100/50/6	4699	3.28	81.5
34	1	L80/8	3312	1.13	35.0
35	1	L100/8	4016	1.68	52.4
36	1	L80/8	3627	1.24	38.1
37	1	L80/8	3088	2.38	72.8
38	1	L80/8	3088	2.38	72.8
39	1	L80/8	638	0.32	10.0
40	2	L60/6	840	0.20	4.6
41	2	STRIP10*50	65	0.01	0.2
R1	3	PL30*600	600	0.79	86.4
Totaal	90	merk(en)		50.08	1906.5

Masttype: Masttype S-6_R Mast 28
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekening omschrijving	Tekeningnummer	Rev.	Datum	Tek.	formaat
Masttype S-6_R, Mast 28 - Overzicht	00974-01-02801	0.1	10.03.2022	A2	594x420
Masttype S-6_R, Mast 28 - Tussenstuk	00974-01-02802	0.1	10.03.2022	A0	1189x841
Masttype S-6_R, Mast 28 - Tussenstuk bordes en ladder	00974-01-02803	0.1	10.03.2022	A0	1189x841
Masttype S-6_R, Mast 28 - Ondertraverse	00974-01-02804	0.1	10.03.2022	A0	1189x841
Masttype S-6_R, Mast 28 - Boventraverse	00974-01-02805	0.1	10.03.2022	A0	1189x841
S-6_R, Mast 28 - Onderdeeltekeningen	00974-01-02810	0.1	10.03.2022	A2/A3/A4	

Lijsten	Documentnummer		Datum
bouten-moeren-ringenlijst	00974-01-02820	0.1	09.03.2022
materiaallijst	00974-01-02820	0.1	09.03.2022
merkenlijst	00974-01-02820	0.1	09.03.2022
Documentenlijst	00974-01-02820	0.1	09.03.2022

Detailberekeningen	Documentnummer		Datum
Masttype S-6-R, Mast 28	00974-01-02830	0.1	10.03.2022

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"REVIEW AND RE-DESIGN TOWERS BBB380"

ENS-ZL380 – Tower S-6_R Mast 28

TenneT TSO B.V.

Detail Calculation

Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-02830**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994437**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**S-3_R Mast 28 - Detailberekeningen**

	[signature]	[signature]	[signature]		
1e versie ter review	G. Pieper	R.Hol	B. Aafjes	10-03-2022	0.1
	Author	Checked	Approved	date	revision

Content

1 Introduction

This report contains the detail calculations of the reinforcements of towertype S-6/R windzone III.

It concerns tower number: Tower 28

To increase the future capacity of electricity transmission, it is necessary to upgrade the transmission grid by building new and modifying existing high voltage connections.

It is for this reason the client (OG) intends to upgrade part the existing 380kV grid. This upgrading is part of the program “Beter Benutten Bestaande 380kV” and consists of the following subprojects:

- Upgrading of the 380 kV-connection Lelystad – Ens (LLS-ENS380).
- Upgrading of the 380 kV-connection Diemen – Lelystad (DIM-LLS380).
- Upgrading of the 380 kV-connection Rilland – Zandvliet (RLL-ZVL380).
- Upgrading of the 380 kV-connection Krimpen aan de IJssel – Geertruidenberg (KIJ-GT380).
- Upgrading of the 380 kV-connection Ens – Zwolle (ENS-ZL380).
- Upgrading of the 380 kV-connection Maasbracht – Eindhoven (MBT-EHV380).

DNV GL has calculated the existing tower for the new situation on behalf of Tennet. On the instructions of DNV GL, the reinforcements mainly consist of the exchange of bolts and profiles and the reinforcement of profiles and the application of redundant members.

DNV GL has tested the profiles and bolts. In this report only the detail calculations are made of the specified reinforcements (bolts are specified by DNV GL).

2 General Data

2.1 Principal constructor

DNV GL – Energy

2.2 Principal calculation and related documents

- ENS-ZL380 – Tower S-6/R
  Reportnr.: 20-1505 Rev 1
  Date: 2021-03-23

- Uitgangspuntenrapport 380kV verbinding Ens – Zwolle
  Reportnr.: 20-1245 Rev.3
  Date: 2021-06-09

2.3 Material- and bolt quality

Materials excisting construction

	Signification 1969	Current startingpoint
Steeltype	St.37	S235JR
	St.52	S355JO
Bolt quality	bolt class 8.8	8.8 rolled thread
Concrete quality	K225	Min. C16/20
Reinforcing steel	Qr24, Qr40	B220, B400

Materials modified construction

Steeltype	S355JO (t ≦ 16 mm)
	S355J2 (16 < t ≦ 40 mm)
Bolt quality	8.8 rolled thread

2.4 Applicable standards

Mainly used:
- NEN-EN 1993-1-8+C2 :2011/NB:2011 nl

Also used:
- NEN-EN 50341-2-15: 2019
- NEN-EN 8700: 2011
- NEN-EN 8701: 2011
- Eurocode reeks

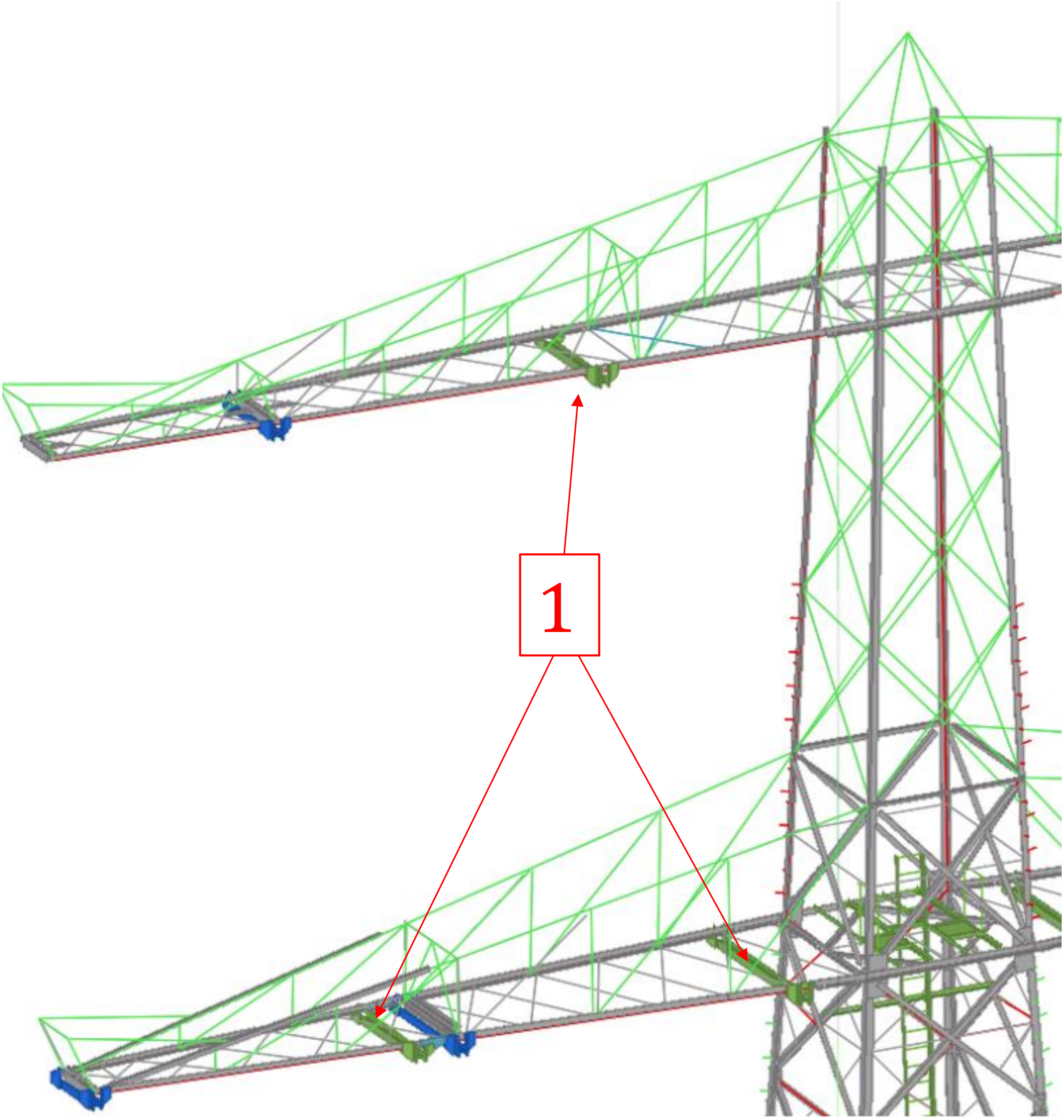
2.5 Tennet specifications

- SPE. 05. 346. v 2.0 algemene specificatie stalen masten

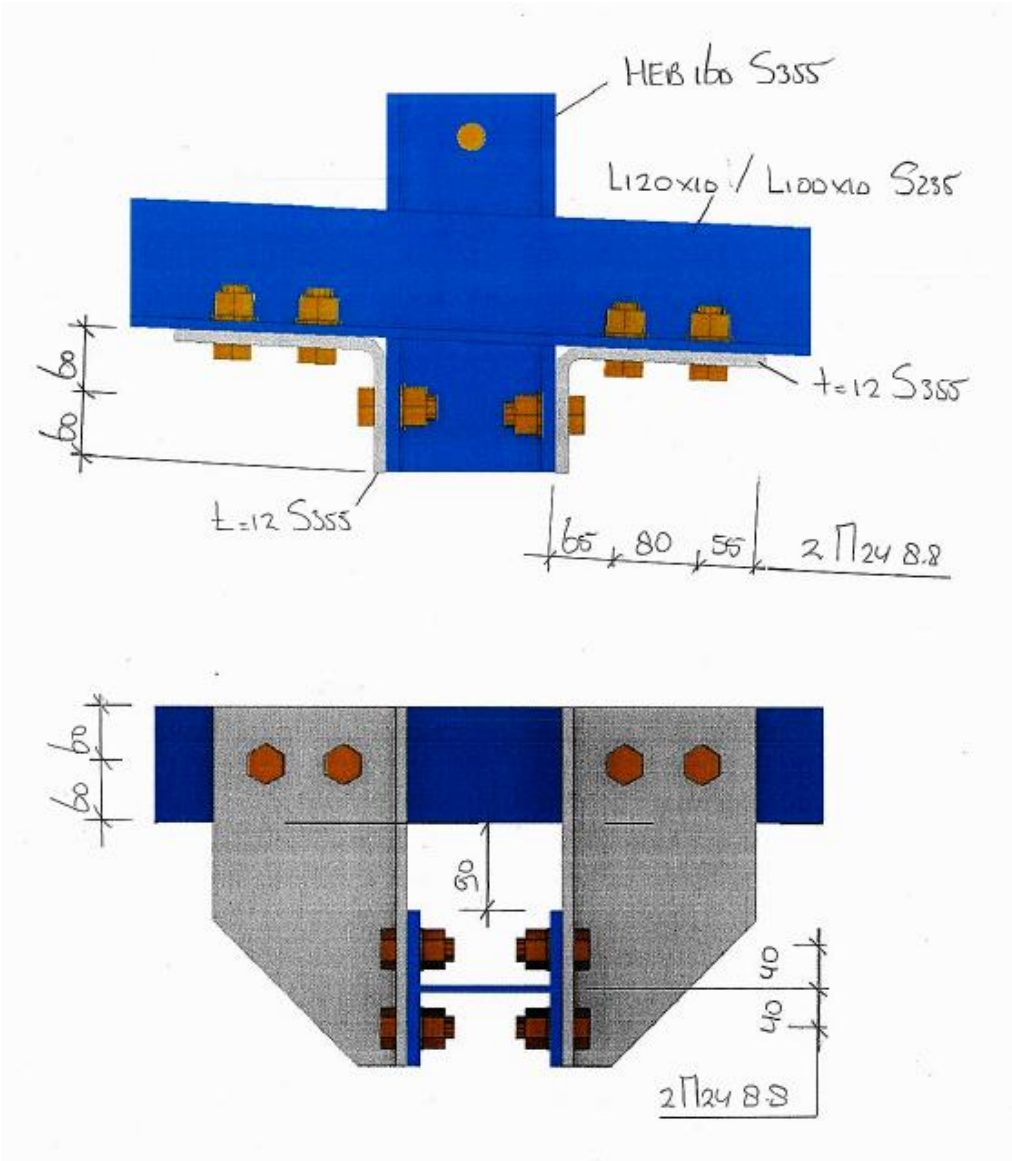
3 Calculations

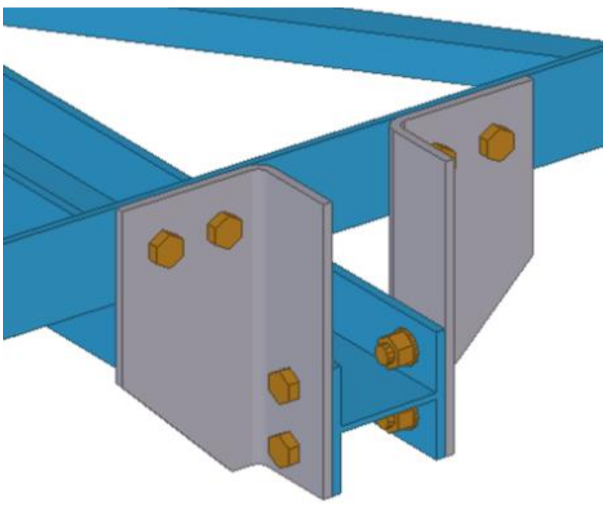
3.1 Connections

3.1.1 Overview



3.1.2 Detail 1


HEB 160 S355
L120x10 / L100x10 S235
t=12 S355
80
60
t=12 S355
65
80
55
2M24 8.8
60
60
30
40
40
2M24 8.8



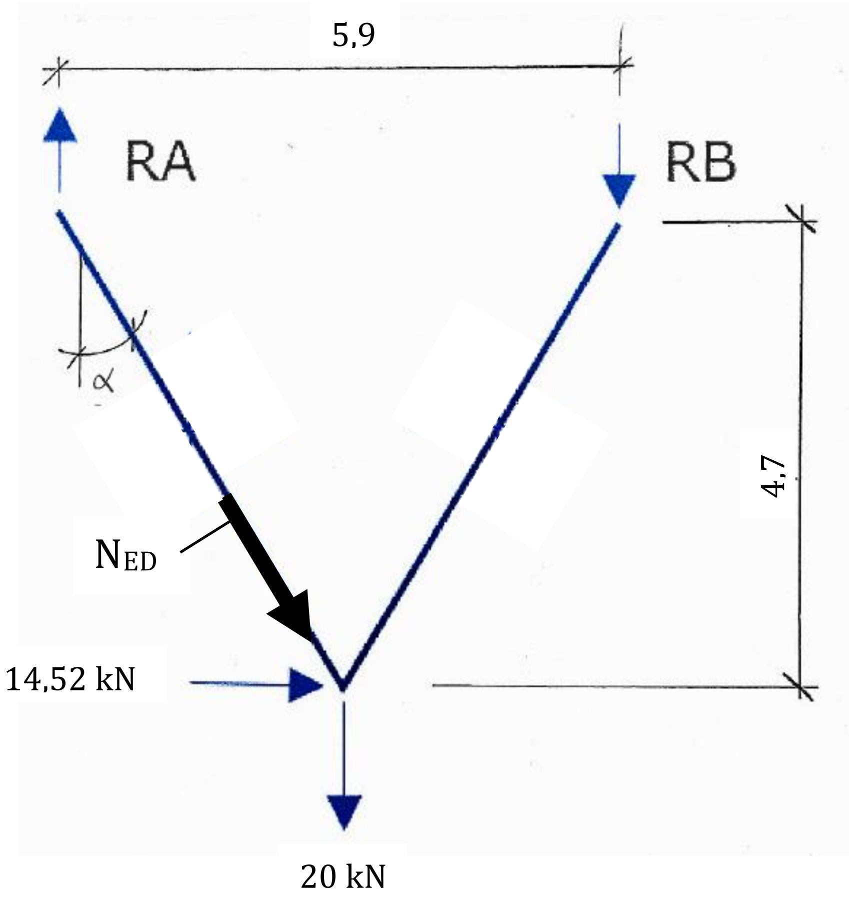
3.1.3 Loads

Loads from report:

ENS-ZL380 – Tower S-6/R

Report nr.: 20-1505 Rev 1
Date: 2021-03-23

Page 125



$$RA = \frac{14{,}52 \text{ x } 4{,}7 + 20 \text{ x } 2{,}95}{5{,}9} = 21{,}56 \text{ kN}$$

$\alpha = 32°$

$N_{ED} = 21{,}56 / \cos 32° = 25{,}43$ kN

3.1.4 Calculation

3.1.4.1 IDEA calculation

Project data

Project name	ENS-ZL380 S-6_R mast 28
Project number	21-187
Author	G.P.
Description	Detail 1
Date	3/8/2022
Design code	EN

Material

Steel	S 355, S 235

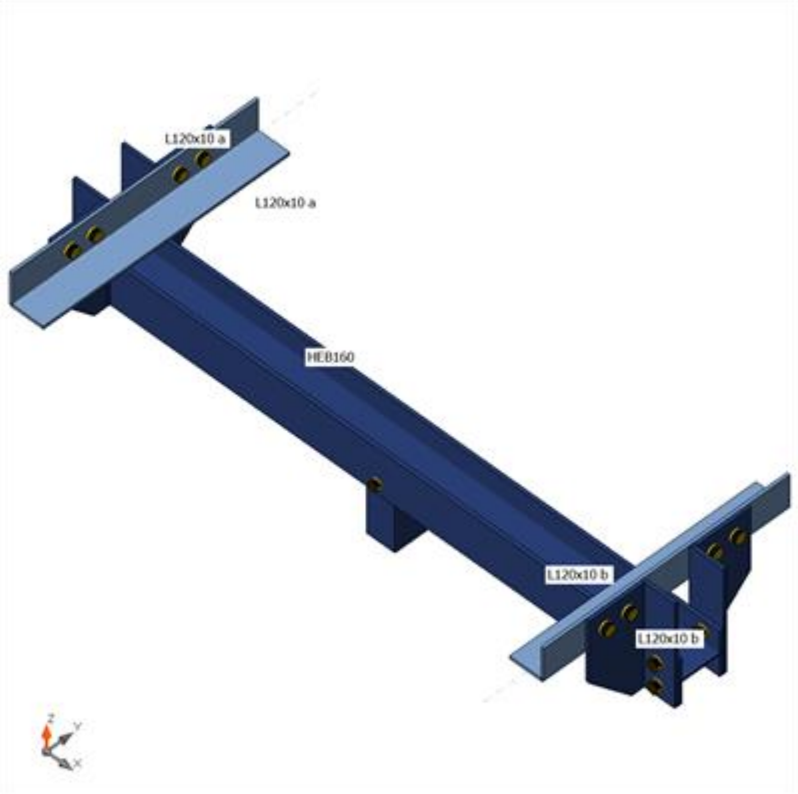
Project item Detail 1

Design

Name	Detail 1
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
Dummy	5 - CHS40,3	90.0	58.0	0.0	0	0	-61	Node
L120x10 a	6 - L120/10	-90.0	0.0	0.0	0	-912	203	Bolts
L120x10 b	6 - L120/10	90.0	0.0	0.0	0	-912	203	Bolts



Cross-sections

Name	Material
5 - CHS40,3	S 355
6 - L120/10	S 235
1 - HEB160	S 355

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M20 8.8	M20 8.8	20	800.0	314
M24 8.8	M24 8.8	24	800.0	452

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	Dummy	26.0	0.0	0.0	0.0	0.0	0.0
	L120x10 a	6.9	0.0	5.5	0.0	-1.1	0.0
	L120x10 a	0.0	0.0	5.5	0.0	-1.1	0.0
	L120x10 b	0.0	0.0	5.5	0.0	1.1	0.0
	L120x10 b	-6.9	0.0	5.5	0.0	1.1	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	29.7 < 100%	OK
Buckling	38.61	

Plates

Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
Dummy	S 355	3.0	LE1	98.6	0.0	0.0	OK
L120x10 a-bfl 1	S 235	10.0	LE1	88.6	0.0	0.0	OK
L120x10 a-w 1	S 235	10.0	LE1	129.0	0.0	4.2	OK
L120x10 b-bfl 1	S 235	10.0	LE1	82.9	0.0	0.0	OK
L120x10 b-w 1	S 235	10.0	LE1	117.2	0.0	4.2	OK
HEB160-bfl 1	S 355	13.0	LE1	100.0	0.0	5.9	OK
HEB160-tfl 1	S 355	13.0	LE1	203.3	0.0	7.3	OK
HEB160-w 1	S 355	8.0	LE1	62.6	0.0	0.0	OK
Dummy	S 355 - 1	134.0	LE1	8.0	0.0	7.3	OK
SP10	S 355	12.0	LE1	13.5	0.0	3.1	OK
SP11	S 355	12.0	LE1	57.6	0.0	4.0	OK
SP8	S 355	12.0	LE1	95.2	0.0	4.5	OK
SP12	S 355	12.0	LE1	61.7	0.0	4.2	OK
SP6	S 355	12.0	LE1	48.4	0.0	3.5	OK
SP7	S 355	12.0	LE1	14.5	0.0	3.2	OK
SP13	S 355	12.0	LE1	59.8	0.0	4.2	OK
SP14	S 355	12.0	LE1	96.3	0.0	4.3	OK

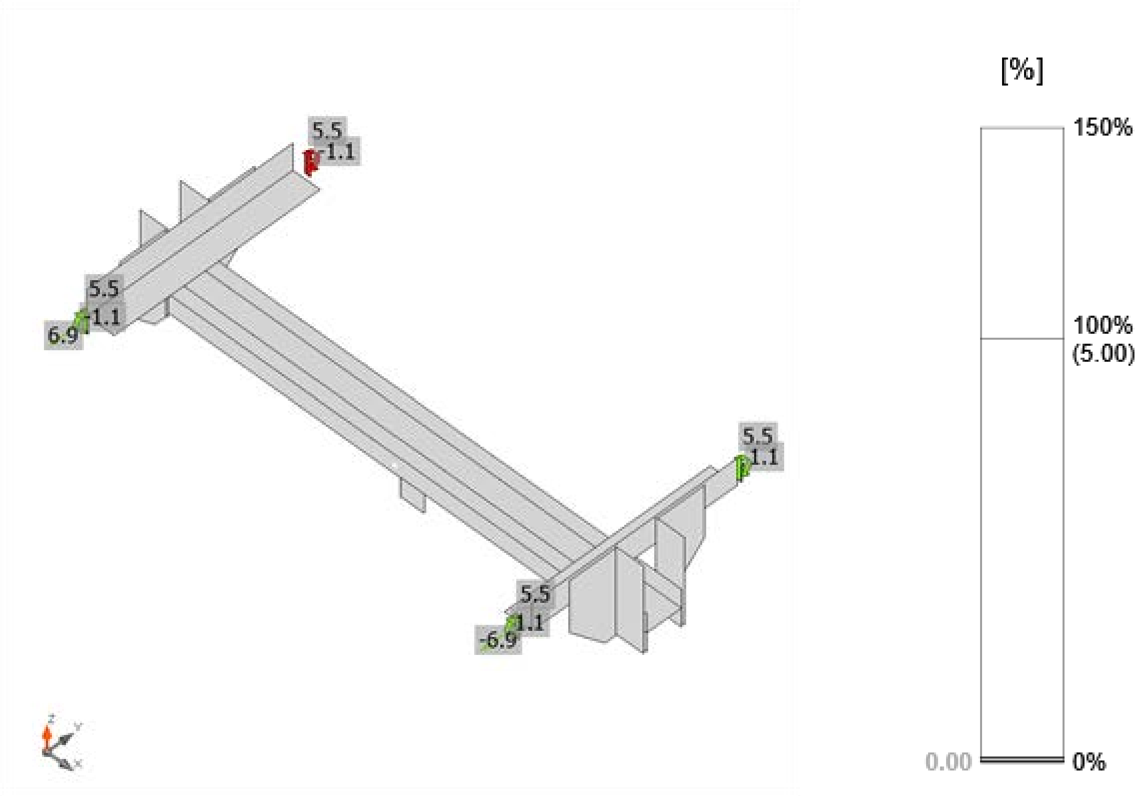
Design data

Material	f_y [MPa]	ε_{lim} [%]
S 355	355.0	5.0
S 235	235.0	5.0
S 355 - 1	335.0	5.0

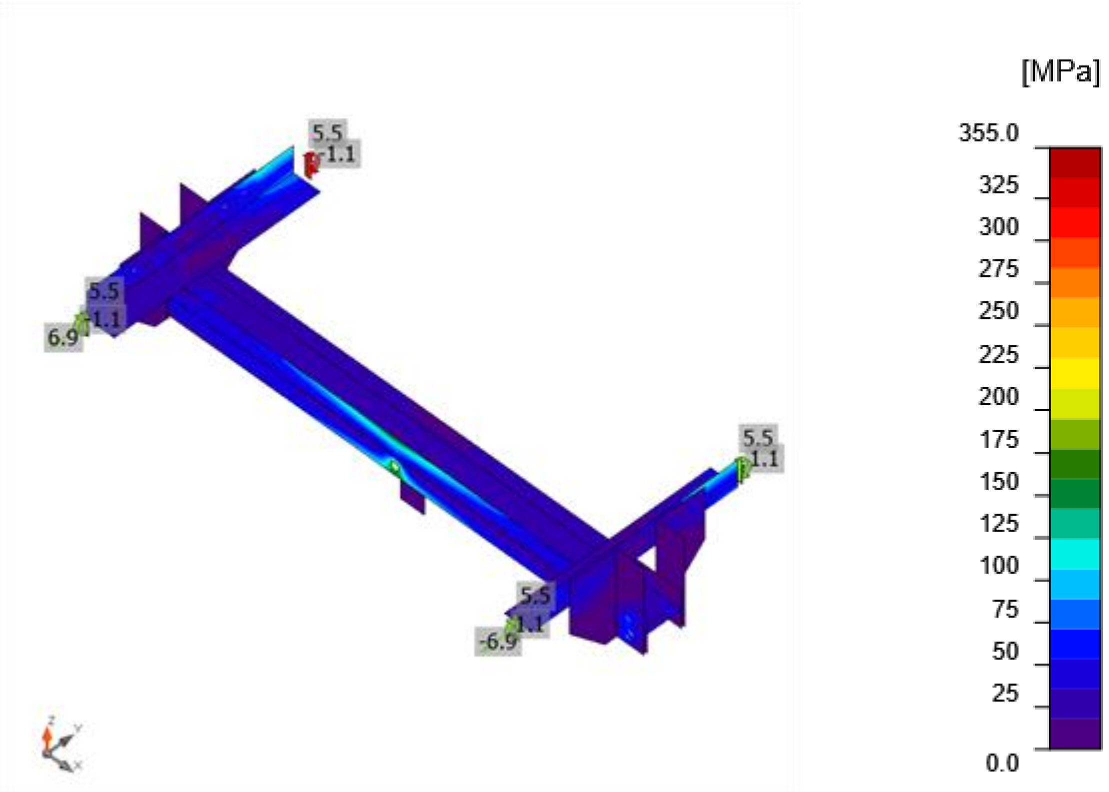
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
σc_{Ed}	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

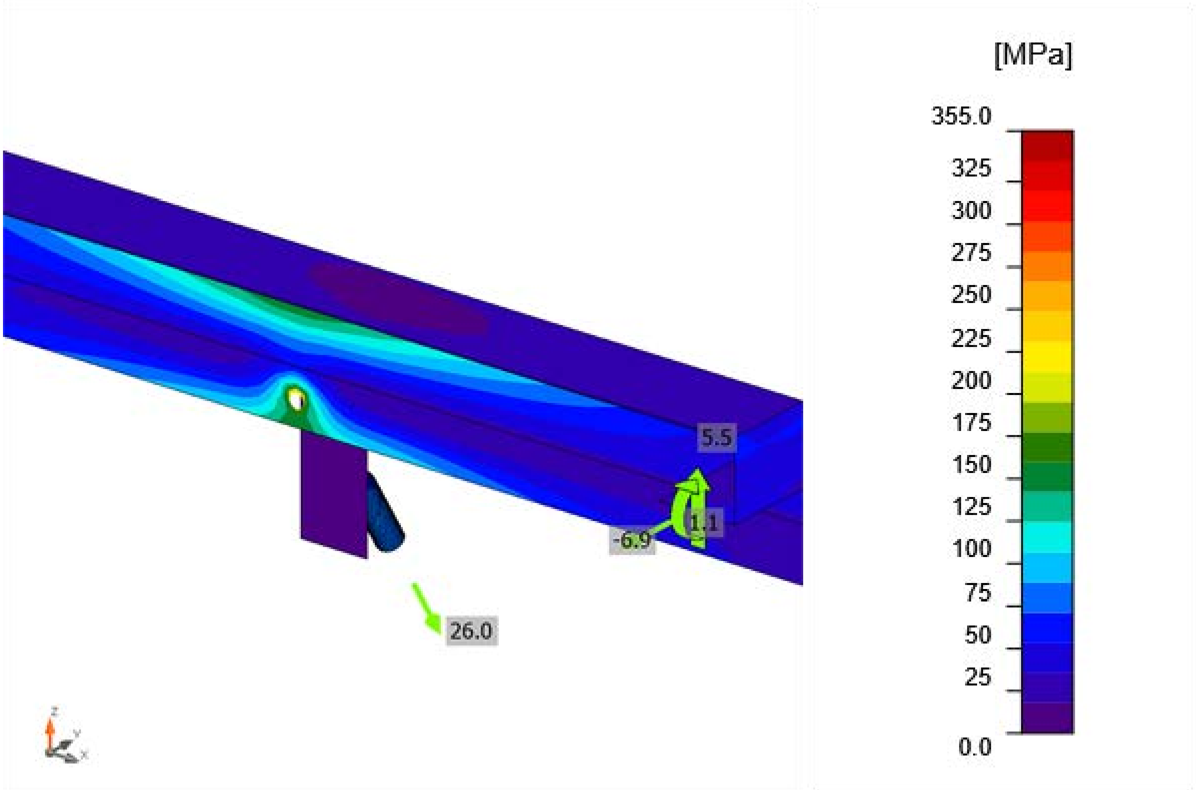
Overall check, LE1



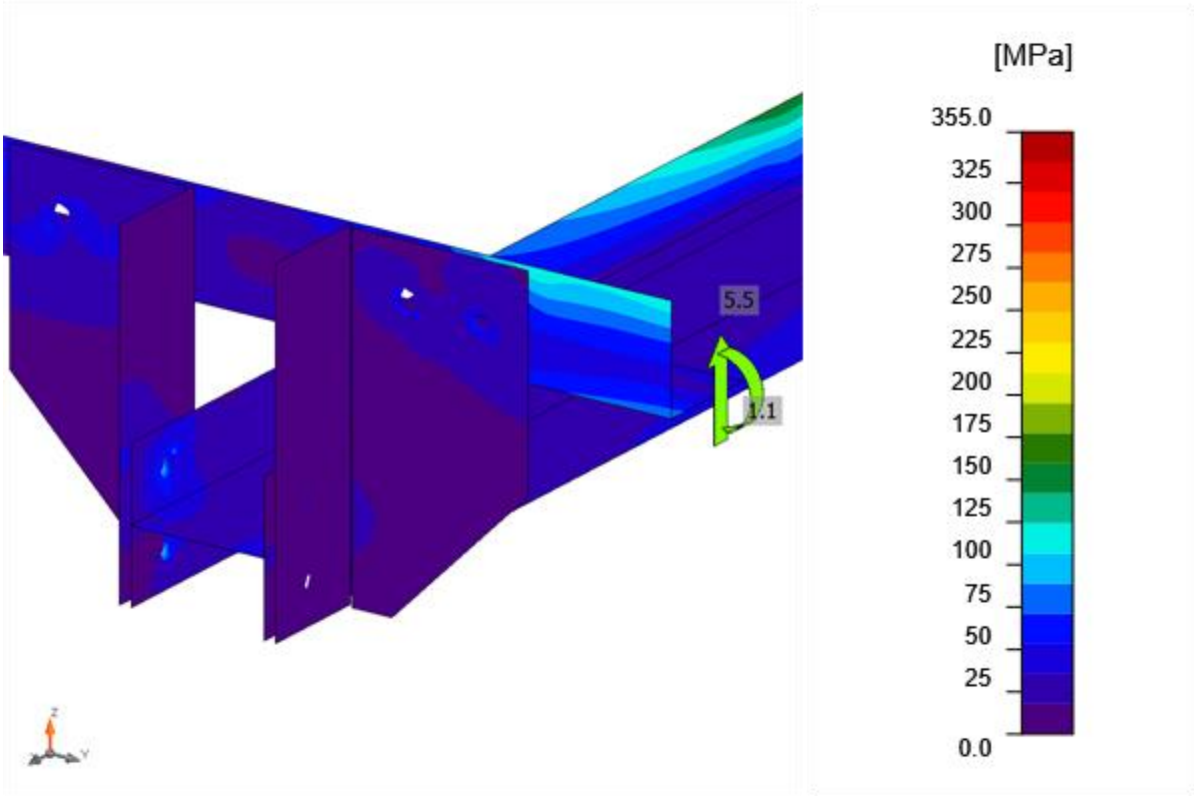
Strain check, LE1



Equivalent stress, LE1

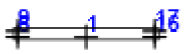
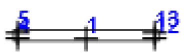
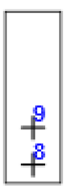


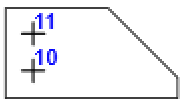
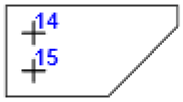
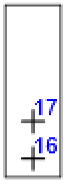
Equivalent stress, LE1



Equivalent stress, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M20 8.8 - 1	LE1	18.3	19.2	13.0	135.1	20.4	29.7	OK
	B2	M24 8.8 - 2	LE1	6.4	6.4	3.2	122.1	5.2	7.0	OK
	B3	M24 8.8 - 2	LE1	7.0	5.7	3.4	132.6	4.3	6.6	OK
	B6	M24 8.8 - 2	LE1	2.3	4.8	1.1	122.6	3.9	4.3	OK
	B7	M24 8.8 - 2	LE1	5.9	6.9	2.9	122.1	5.7	7.2	OK
	B4	M24 8.8 - 3	LE1	1.3	1.1	0.6	196.1	0.8	1.3	OK
	B5	M24 8.8 - 3	LE1	0.9	0.4	0.4	156.8	0.3	0.6	OK
	B12	M24 8.8 - 3	LE1	1.3	1.1	0.6	185.9	0.8	1.2	OK
	B13	M24 8.8 - 3	LE1	1.1	0.5	0.5	156.8	0.4	0.7	OK
	B8	M24 8.8 - 3	LE1	9.5	13.3	4.7	185.7	9.8	13.2	OK
	B9	M24 8.8 - 3	LE1	7.9	14.6	3.9	198.3	10.8	13.5	OK

	B10	M24 8.8 - 2	LE1	5.8	6.4	2.8	122.1	5.2	6.7	OK
	B11	M24 8.8 - 2	LE1	6.2	5.5	3.0	132.6	4.1	6.2	OK
	B14	M24 8.8 - 2	LE1	1.9	4.6	0.9	122.9	3.8	4.1	OK
	B15	M24 8.8 - 2	LE1	5.5	6.9	2.7	122.1	5.6	7.0	OK
	B16	M24 8.8 - 3	LE1	9.1	12.7	4.5	184.5	9.4	12.6	OK
	B17	M24 8.8 - 3	LE1	8.9	13.9	4.4	196.9	10.3	13.4	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M20 8.8 - 1	141.1	302.6	94.1
M24 8.8 - 2	203.3	206.3	135.6
M24 8.8 - 3	203.3	336.9	135.6

Symbol explanation

$F_{t,Rd}$ Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$ Tension force
$B_{p,Rd}$ Punching shear resistance
V Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$ Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$ Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t Utilization in tension
Ut_s Utilization in shear

Buckling

Loads	Shape	Factor [-]
LE1	1	38.61
	2	38.95
	3	47.63
	4	48.05
	5	55.79
	6	56.31

Code settings

Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_{C}	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

4 Summary U.C. 's

4.1.1 Connections

Detail 1

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	29.7 < 100%	OK
Buckling	38.61	

5 Conclusion

5.1.1 Connections

Connection has sufficient strength.

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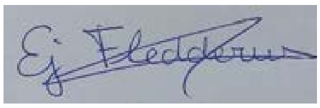
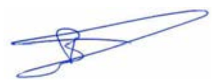
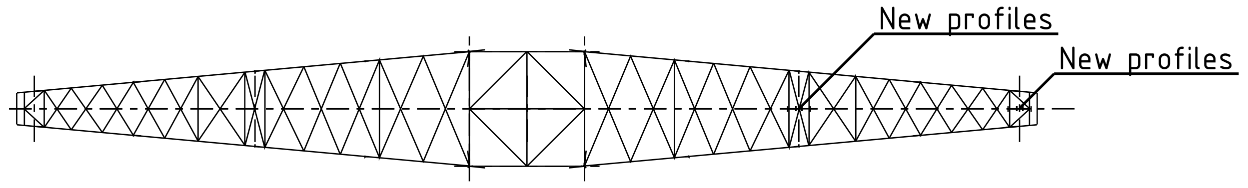
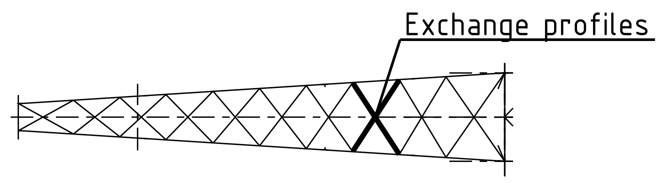
Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-04000**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994408**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**Masttype HB-3_R, Mast 40, 49 en 51 - Overzichtstekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Erik-Jan Fledderus	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

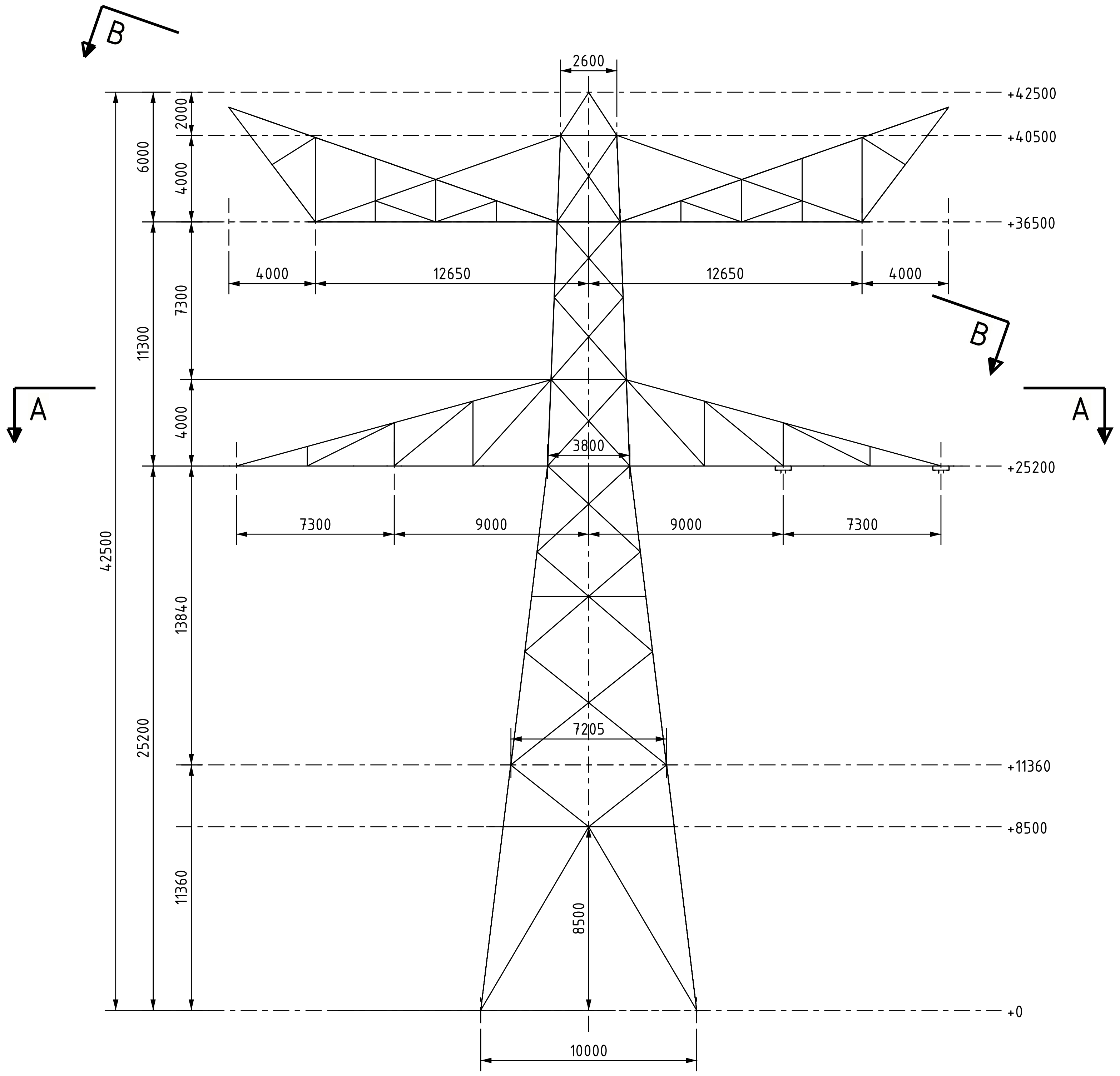
Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	18-02-2022	1^{e} versie ter review



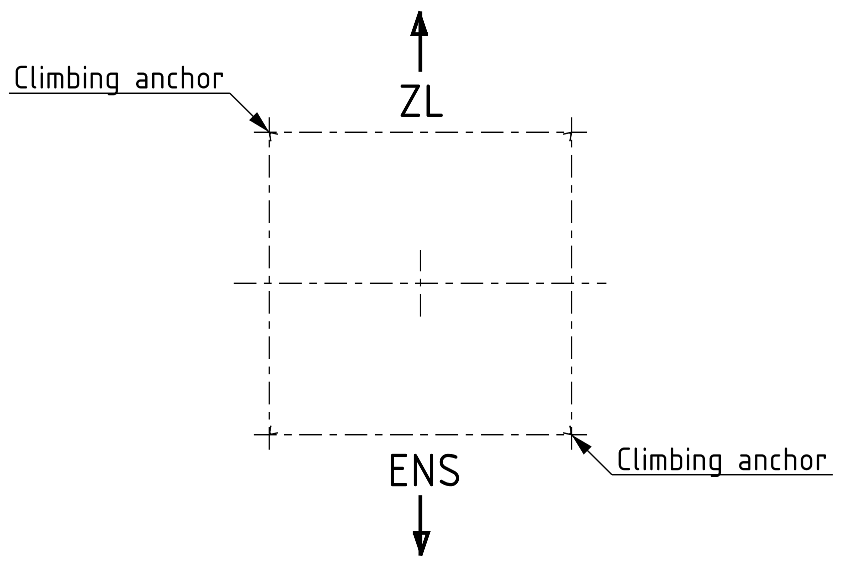
Section A - A
1:250



Section B - B
1:250



Transverse face
1:250



Section
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All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam			Getekend	Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:250	594x420

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 HB-3_R Mast 40, 49 en 51
Omschrijving:	Masttype HB-3 R, Mast 40, 49 en 51 - Overzicht
Documentnummer:	00974-01-04001

TenneT
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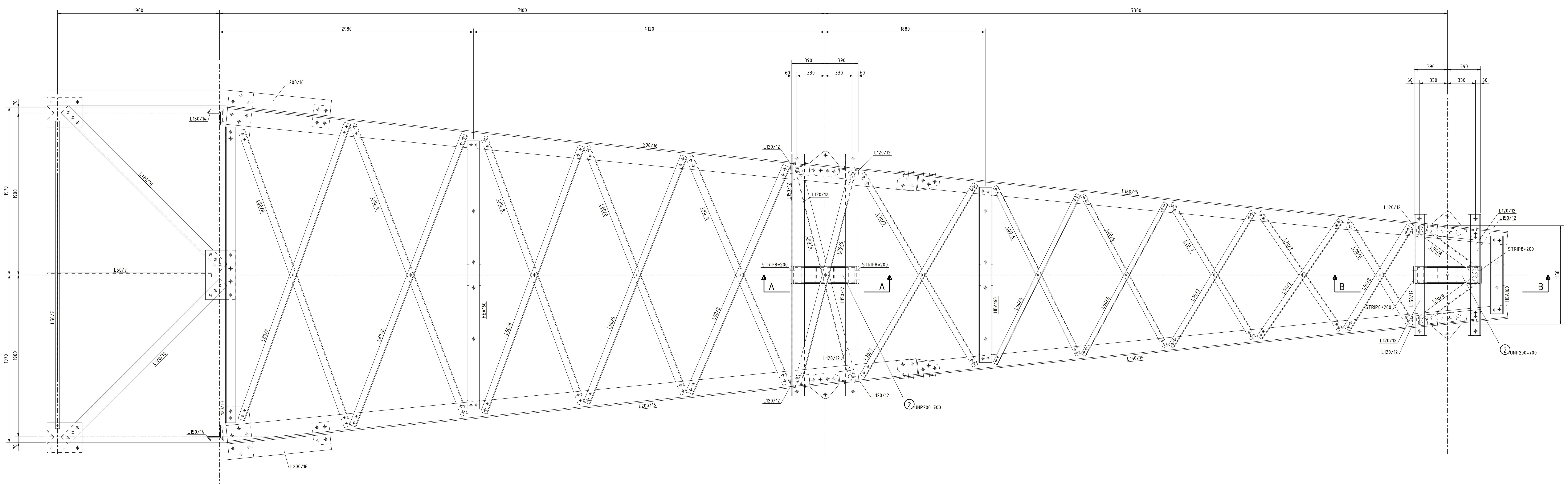
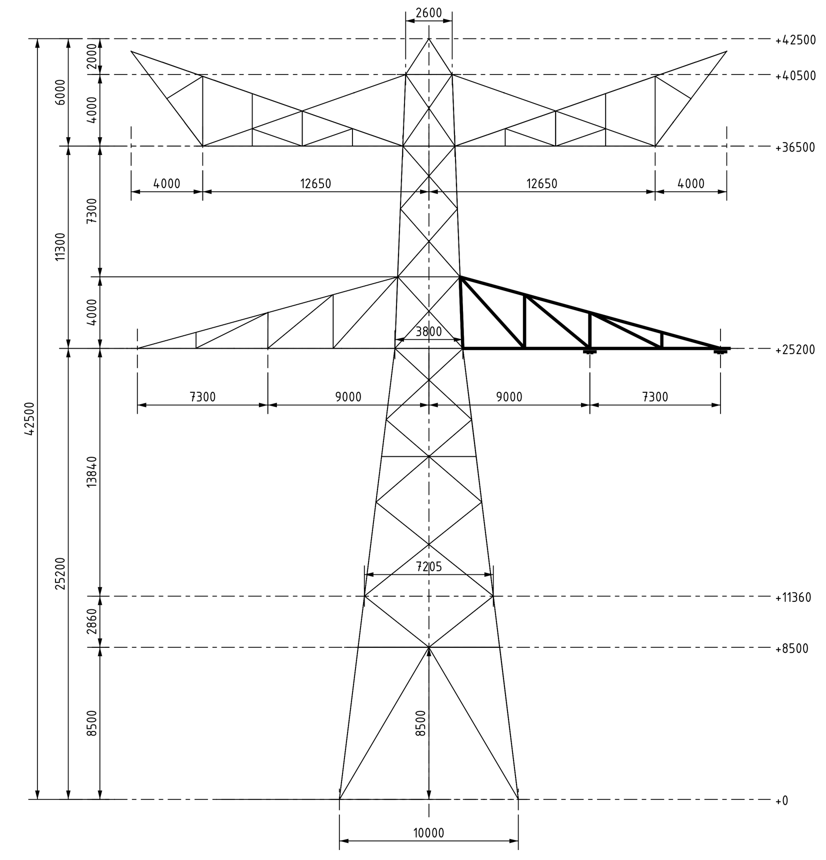
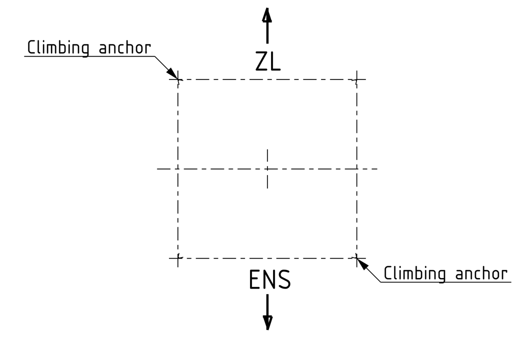


Bottom Surface Lower Cross Arm
1:20



Transverse face
1:250



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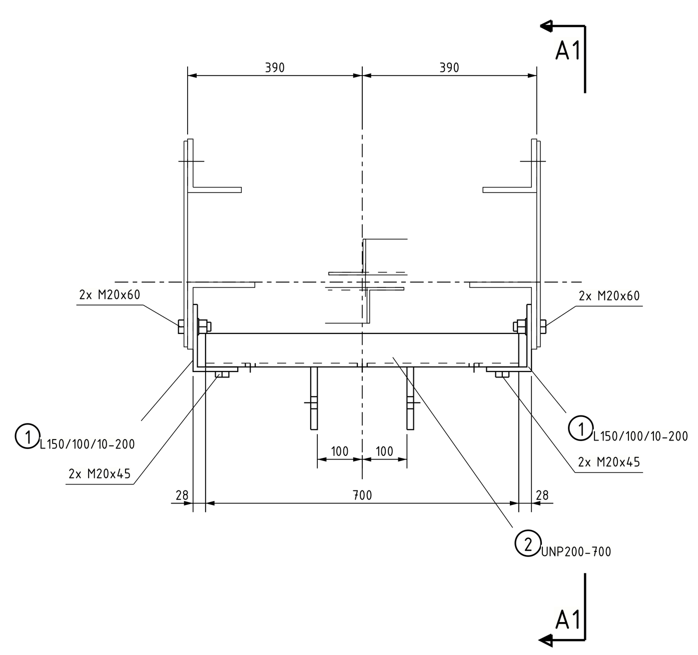
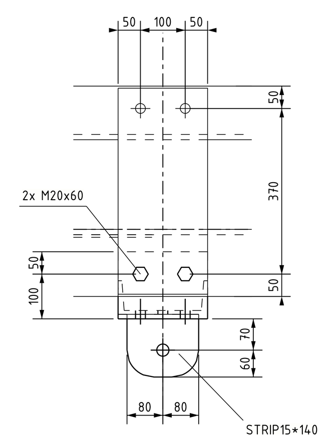
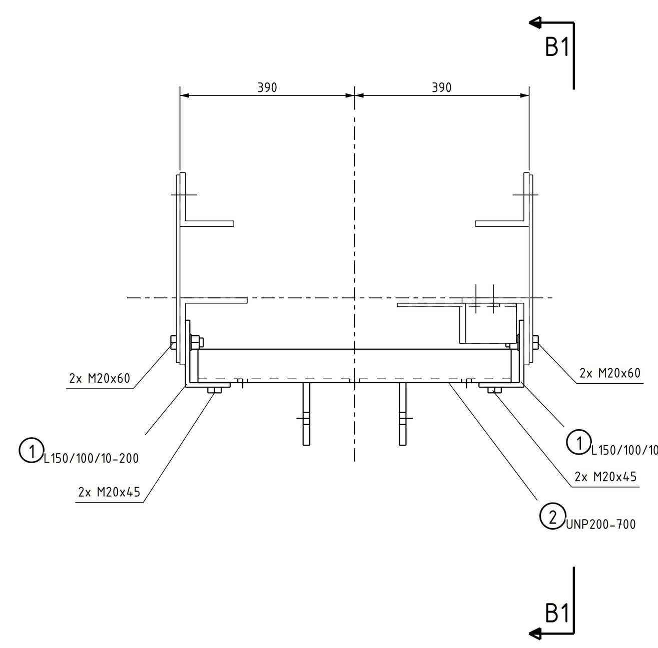


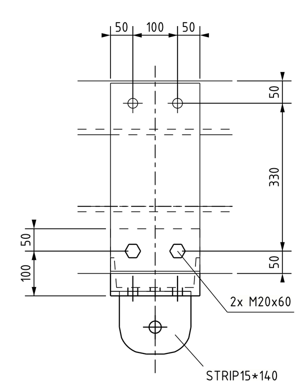
Section A - A
1:10



Section A1 - A1
1:10



Section B - B
1:10



Section B1 - B1
1:10

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
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- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

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Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

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Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

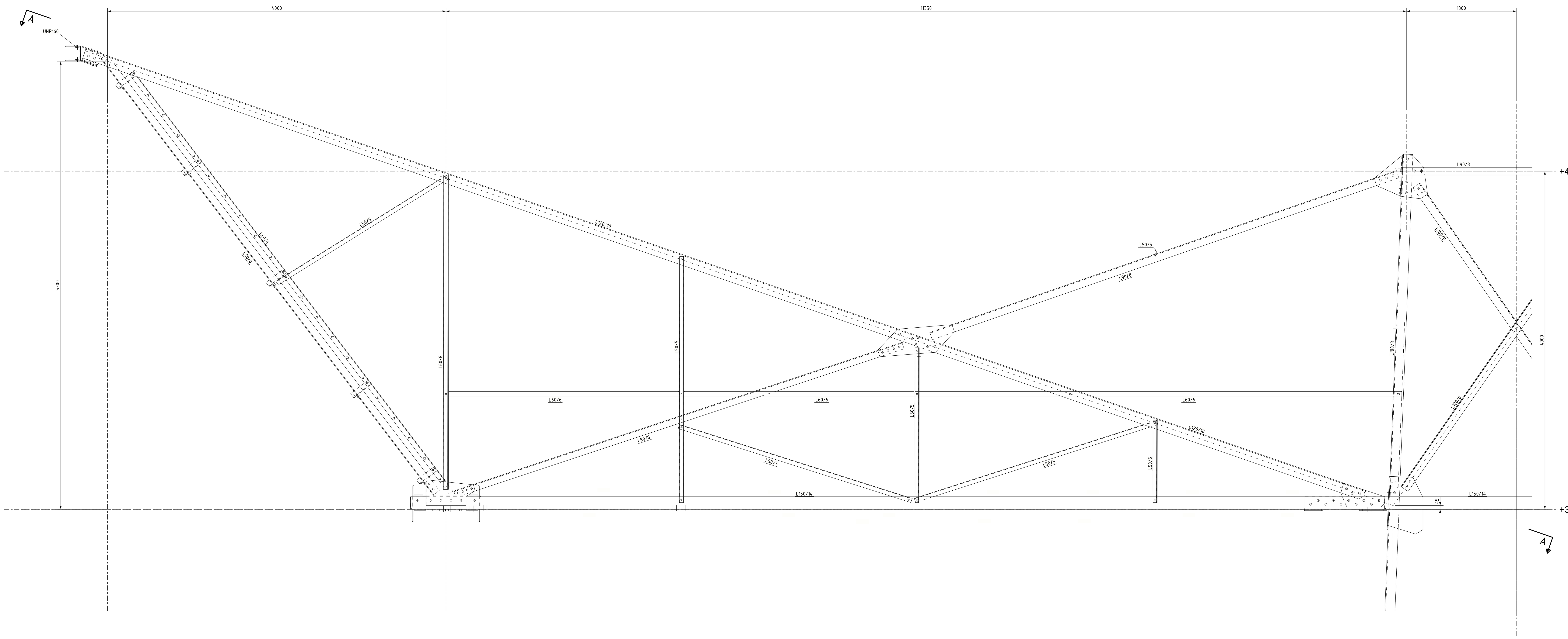
- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

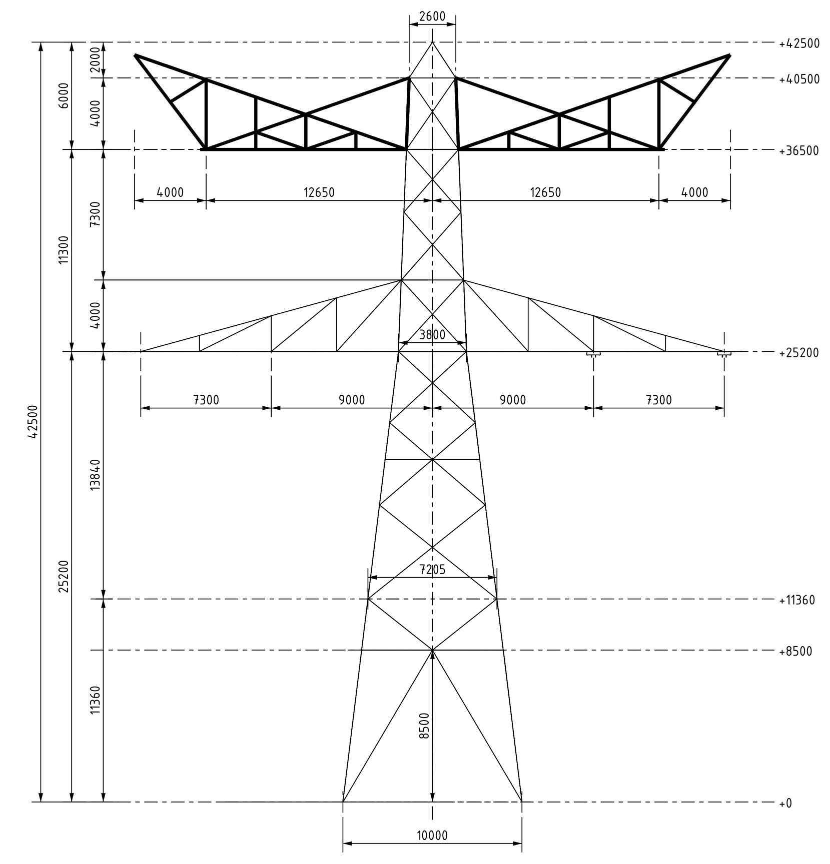
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 HB-3_R Mast 40, 49 en 51
Omschrijving:	Masttype HB-3 R, Mast 40, 49 en 51 - Ondertraverse
Documentnummer:	00974-01-04002

TenneT Taking power further

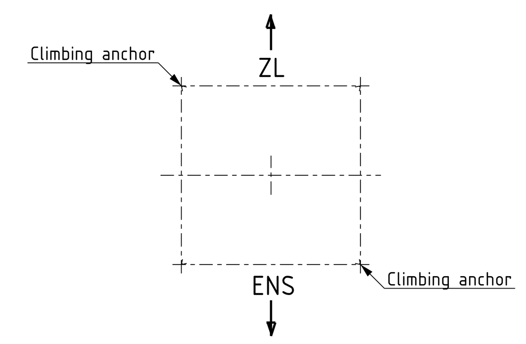
Tekla Structures



Front Face Upper Cross Arm
1:20



Transverse face
1:250



Section
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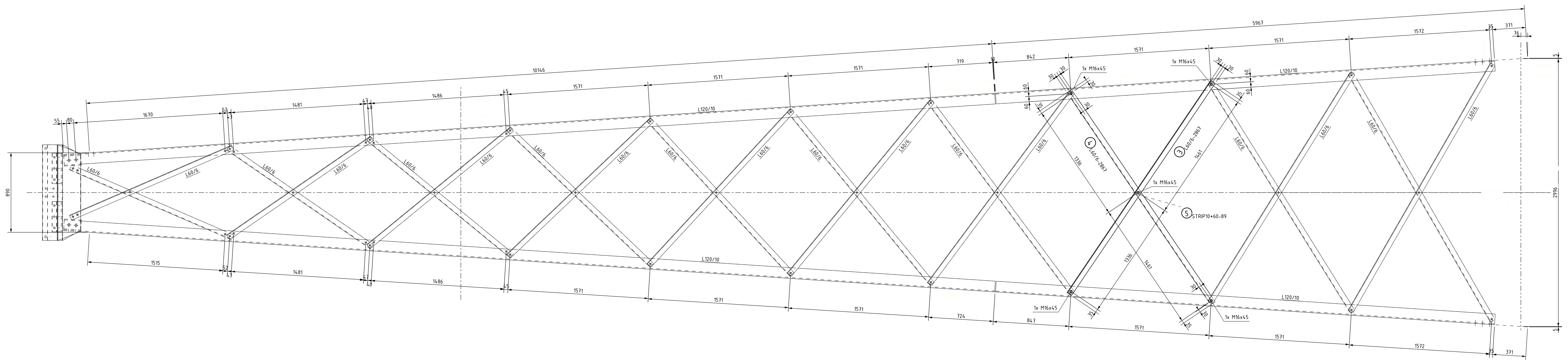

Section A - A
1:20

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

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Nuts	ISO 4032
Washers	ISO 7091
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Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:20 1:250	A0
Relatie			Thema	Verbinding		
			Categorie	Algemeen		
			Documentcode	Constructietekening		
Oud tekeningnummer:			Object ID	ENS-ZL380 HB-3_R Mast 40, 49 en 51		
TenneT Taking power further			Omschrijving:	Masttype HB-3 R, Mast 40, 49 en 51 - Boventraverse		
			Documentnummer:	00974-01-04003		

Tekla Structures

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Aafjes b.v.

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Projectnummer Aafjes: **21-187**

Documentnummer: **00974-01-04010**

Projectnummer TenneT: **002.515**

Meridian nummer: **002.515.40 0994409**

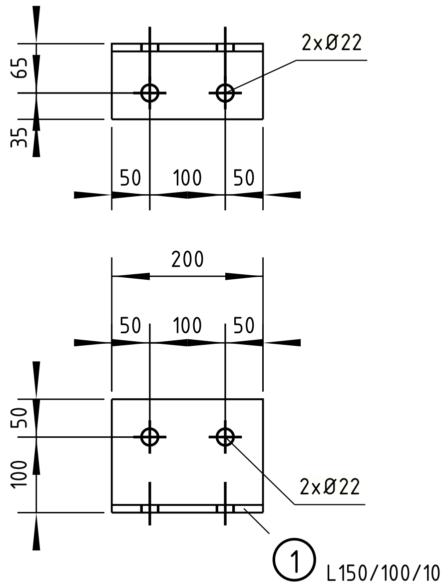
Opdrachtgever: **TenneT**

Project: **Opwaardering ENS-ZL380**

Onderdeel: **Masttype HB-3_R, Mast 40, 49 en 51- Onderdeeltekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Erik Jan Fledderus	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	18-02-2022	1e versie ter review



Pos	Profile	Number	Grade	Length	Area (m^2)
1	L150/100/10	4	S355J0	200	0.10

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus:

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie:

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

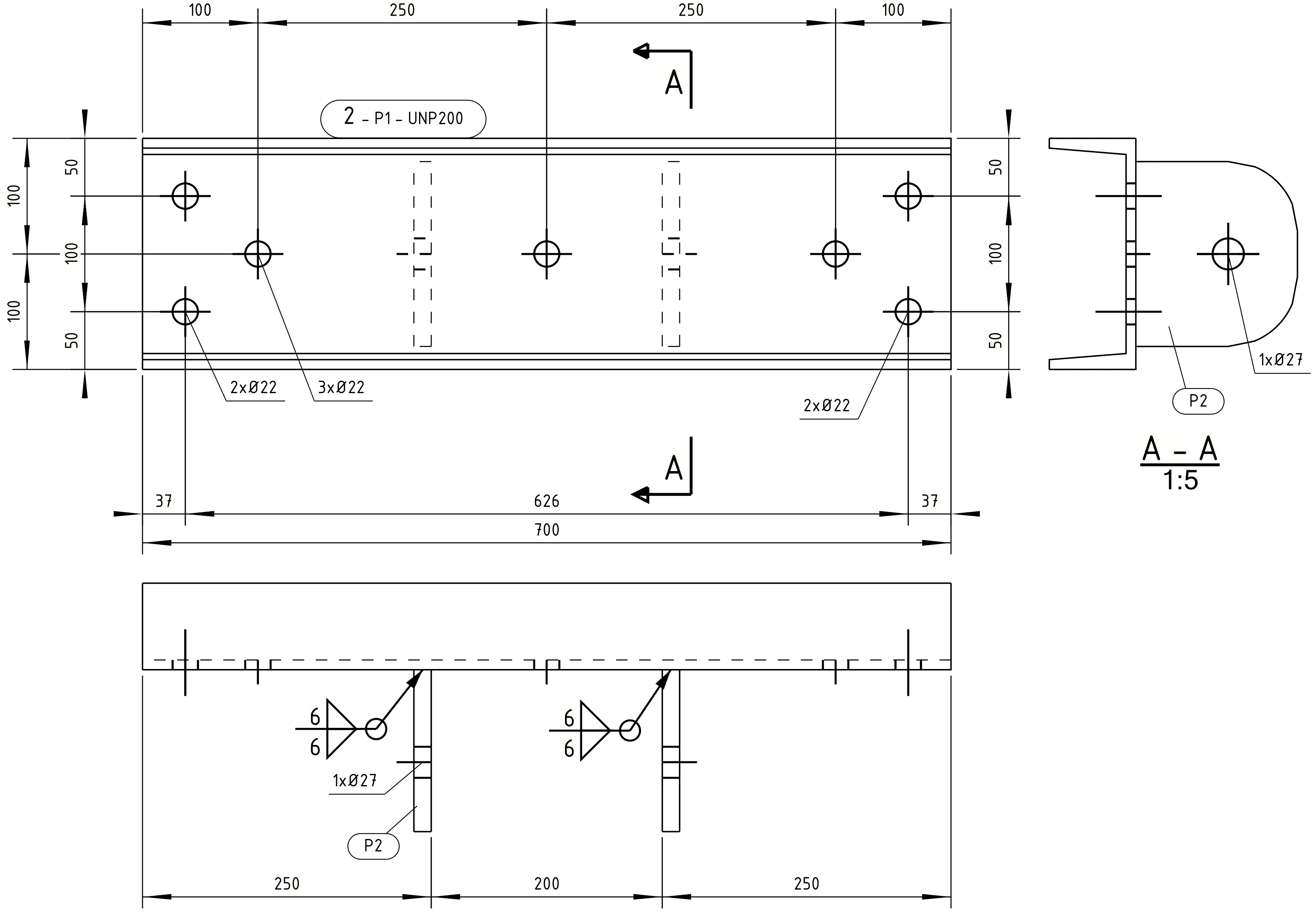
Object ID: ENS-ZL380 HB-3_R Mast 40, 49 en 51

Omschrijving: Nieuw staal - onderdeel [1]

Documentnummer:

TenneT Taking power further

Tekla Structures



ASSEMBLY

Mark: 2 length (mm): 700 Number: 2

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P1	UNP200	S355J0	1	700	18.0	0.46
P2	STRIP15*140	S355J0	2	160	5.0	0.10
				Total of one mark	23.0	0.56

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus:

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

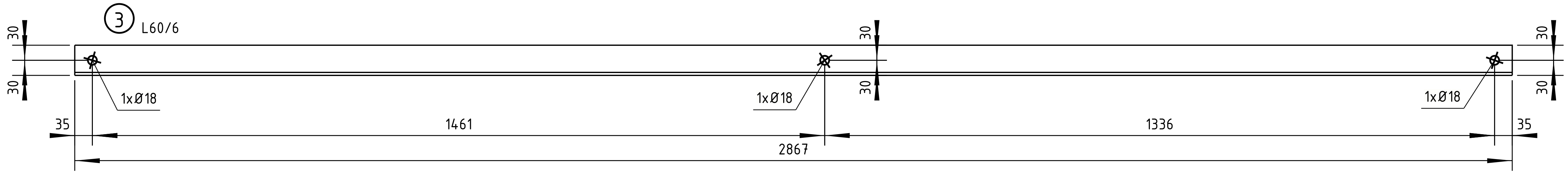
Object ID: ENS-ZL380 HB-3_R Mast 40, 49 en 51

Omschrijving: Nieuw staal - onderdeel [2]

Documentnummer:

Taking power further

Tekla Structures



3	L60/6	2	S355J0	2867	0.69
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

Taking power further

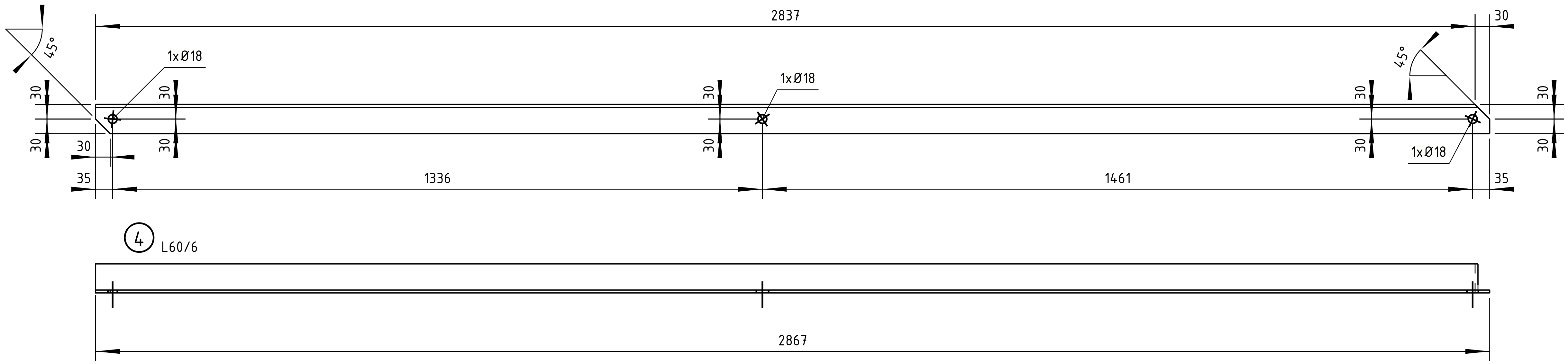
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 HB-3_R Mast 40, 49 en 51

Omschrijving:
Te vervangen staal - onderdeel [3]

Documentnummer:

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
4	L60/6	2	S355J0	2867	0.69

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus:

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

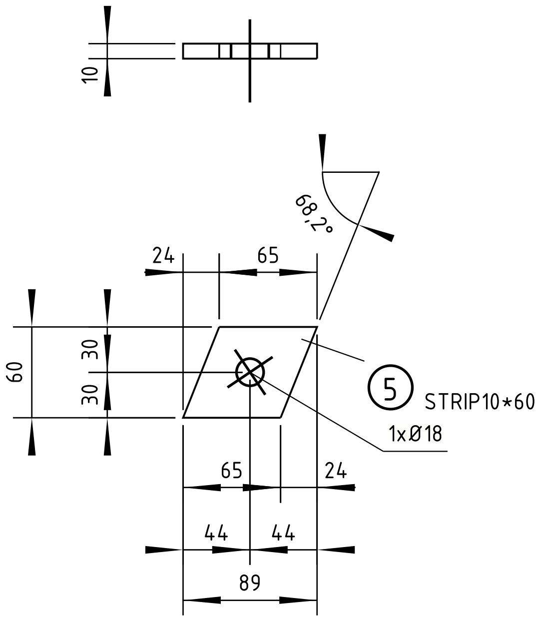
Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 HB-3_R Mast 40, 49 en 51
Omschrijving:	Te vervangen staal - onderdeel [4]
Documentnummer:	

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
5	STRIP10*60	2	S355J0	89	0.01

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 HB-3_R Mast 40, 49 en 51

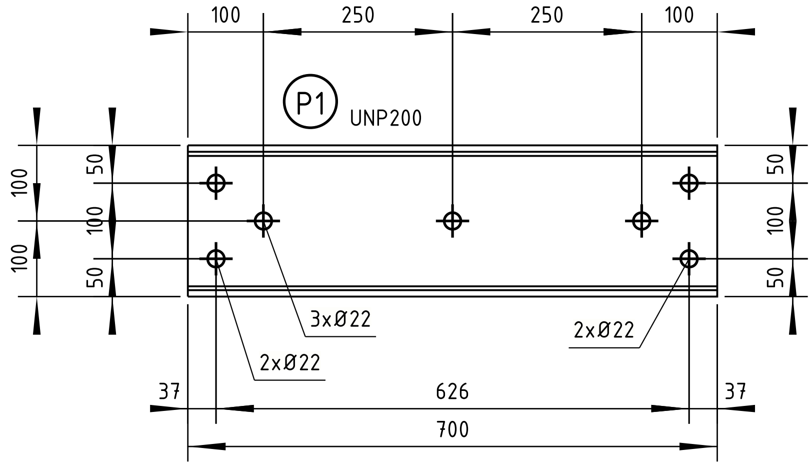
Oud tekeningnummer:

Omschrijving:
Te vervangen staal - onderdeel [5]

Documentnummer:

TenneT Taking power further

Tekla Structures



P1	UNP200	2	S355J0	700	0.46
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	210x297

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380 HB-3_R Mast 40, 49 en 51

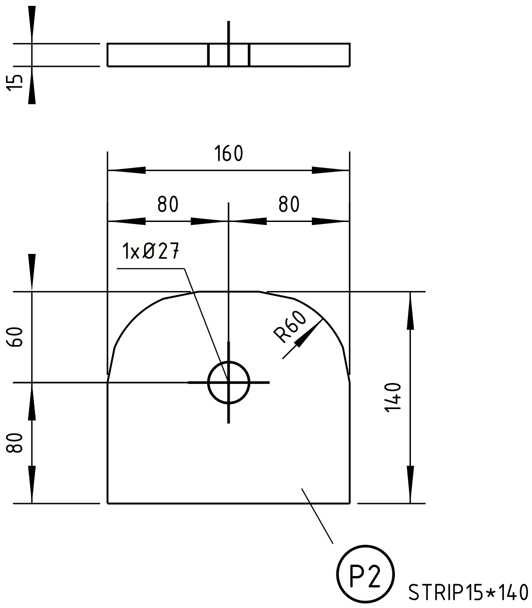
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [P1]

Documentnummer:

TenneT Taking power further

Tekla Structures



P2	STRIP15*140	4	S355J0	160	0.05
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380 HB-3_R Mast 40, 49 en 51
TenneT Taking power further	Omschrijving:	Nieuw staal - onderdeel [P2]
	Documentnummer:	

Tekla Structures

Ingenieursbureau
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Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-04020**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994410**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**Masttype HB-3_R, Mast 40, 49 en 51 - Lijsten**

	Naam	Functie	Handtekening	Datum
Opgesteld	Erik Jan Fledderus	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	18-02-2022	1e versie ter review

BOUTEN-, MOEREN-, RINGENLIJST   Pagina: 1

ENS-ZL380   Datum: 12.02.2022
Masttype HB-3 R
t.b.v. 1 mast

Naam	Type	Kwal.	Aantal
BOUT-M16*45	4017	8.8	10
BOUT-M20*45	4017	8.8	8
BOUT-M20*60	4017	8.8	8
MOER-M16	4032		10
MOER-M20	4032		16
RING-M16	7091		10
RING-M20	7091		16

MATERIAALLIJST

Pagina: 1

ENS-ZL380
Masttype HB-3 R
t.b.v. 1 mast

Datum: 13.02.2022

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
L60/6	3	S355J0	2	2867	0.69	15.8
L60/6	4	S355J0	2	2867	0.69	15.8
				11470	2.75	63.4
L150/100/10	1	S355J0	4	200	0.10	3.8
				800	0.40	15.4
STRIP10*60	5	S355J0	2	89	0.01	0.3
				177	0.02	0.6
STRIP15*140	P2	S355J0	4	160	0.05	2.5
				640	0.20	9.9
UNP200	P1	S355J0	2	700	0.46	18.0
				1400	0.92	36.0
				Totaal:	4.30	125.4

TEKLA STRUCTURES MERKENLIJST Pagina: 1

ENS-ZL380 Datum: 12.02.2022
Masttype HB-3 R
t.b.v. 1 mast

Merk	Aantal	Profiel	Lengte	Opp.(m2)	Gewicht (kg)
1	4	L150/100/10	200	0.10	3.8
2	2	UNP200	700	0.56	23.0
3	2	L60/6	2867	0.69	15.8
4	2	L60/6	2867	0.69	15.8
5	2	STRIP10*60	89	0.01	0.3
Totaal	12	merk(en)		4.30	125.4

Masttype: Masttype HB-3_R_X, Mast 40, 49 en51
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekening omschrijving	Tekeningnummer	Rev.	Datum	Tek.	formaat
Masttype HB-3 R, Mast 40, 49 en 51 - Overzicht	00974-01-04001	0.1	18.02.2022	A2	594x420
Masttype HB-3 R, Mast 40, 49 en 51 - Ondertraverse	00974-01-04002	0.1	18.02.2022	A0	1189x841
Masttype HB-3 R, Mast 40, 49 en 51 - Boventraverse	00974-01-04003	0.1	18.02.2022	A0	1189x841
HB-3 R, Mast 40, 49 en 51 - Onderdeeltekeningen	00974-01-04010	0.1	18.02.2022	A3/A4	

Lijsten	Documentnummer		Datum
bouten-moeren-ringenlijst	00974-01-04020	0.1	14.02.2022
materiaallijst	00974-01-04020	0.1	14.02.2022
merkenlijst	00974-01-04020	0.1	14.02.2022
Documentenlijst	00974-01-04020	0.1	18.02.2022

Detailberekeningen	Documentnummer		Datum
Masttype HB-3 R, Mast 40, 49 en 51	00974-01-04030	0.1	18.02.2022

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"REVIEW AND RE-DESIGN TOWERS BBB380"

ENS-ZL380 – Tower HB-3/R

TenneT TSO B.V.

Detail Calculation

Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-04030**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994411**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**HB-3_R Mast 40,49,51 - Detailberekeningen**

1e versie ter review	G. Pieper	R.Hol	B. Aafjes	18-02-2022	0.1
	Author	Checked	Approved	date	revision

Content

1 Introduction

This report contains the detail calculations of the reinforcements of towertype HB-3/R windzone III.

It concerns tower number: Tower 40,49 and 51

To increase the future capacity of electricity transmission, it is necessary to upgrade the transmission grid by building new and modifying existing high voltage connections.

It is for this reason the client (OG) intends to upgrade part the existing 380kV grid. This upgrading is part of the program “Beter Benutten Bestaande 380kV” and consists of the following subprojects:

- Upgrading of the 380 kV-connection Lelystad – Ens (LLS-ENS380).
- Upgrading of the 380 kV-connection Diemen – Lelystad (DIM-LLS380).
- Upgrading of the 380 kV-connection Rilland – Zandvliet (RLL-ZVL380).
- Upgrading of the 380 kV-connection Krimpen aan de IJssel – Geertruidenberg (KIJ-GT380).
- Upgrading of the 380 kV-connection Ens – Zwolle (ENS-ZL380).
- Upgrading of the 380 kV-connection Maasbracht – Eindhoven (MBT-EHV380).

DNV GL has calculated the existing tower for the new situation on behalf of Tennet. On the instructions of DNV GL, the reinforcements mainly consist of the exchange of bolts and profiles and the reinforcement of profiles and the application of redundant members.

DNV GL has tested the profiles and bolts. In this report only the detail calculations are made of the specified reinforcements (bolts are specified by DNV GL).

2 General Data

2.1 Principal constructor

DNV GL – Energy

2.2 Principal calculation and related documents

- ENS-ZL380 – Tower HB-3/R and HB-3/R_X
  Reportnr.: 21-0050 Rev 3
  Date: 2021-12-20

- Uitgangspuntenrapport 380kV verbinding Ens – Zwolle
  Reportnr.: 20-1245 Rev.3
  Date: 2021-06-09

2.3 Material- and bolt quality

Materials excisting construction

	Signification 1969	Current startingpoint
Steeltype	St.37	S235JR
	St.52	S355JO
Bolt quality	bolt class 5	5.6 rolled thread
Concrete quality	K225	Min. C16/20
Reinforcing steel	Qr24, Qr40	B220, B400

Materials modified construction

Steeltype	S355JO (t ≦ 16 mm)
	S355J2 (16 < t ≦ 40 mm)
Bolt quality	8.8 rolled thread

2.4 Applicable standards

Mainly used:
- NEN-EN 1993-1-8+C2 :2011/NB:2011 nl

Also used:
- NEN-EN 50341-2-15: 2019
- NEN-EN 8700: 2011
- NEN-EN 8701: 2011
- Eurocode reeks

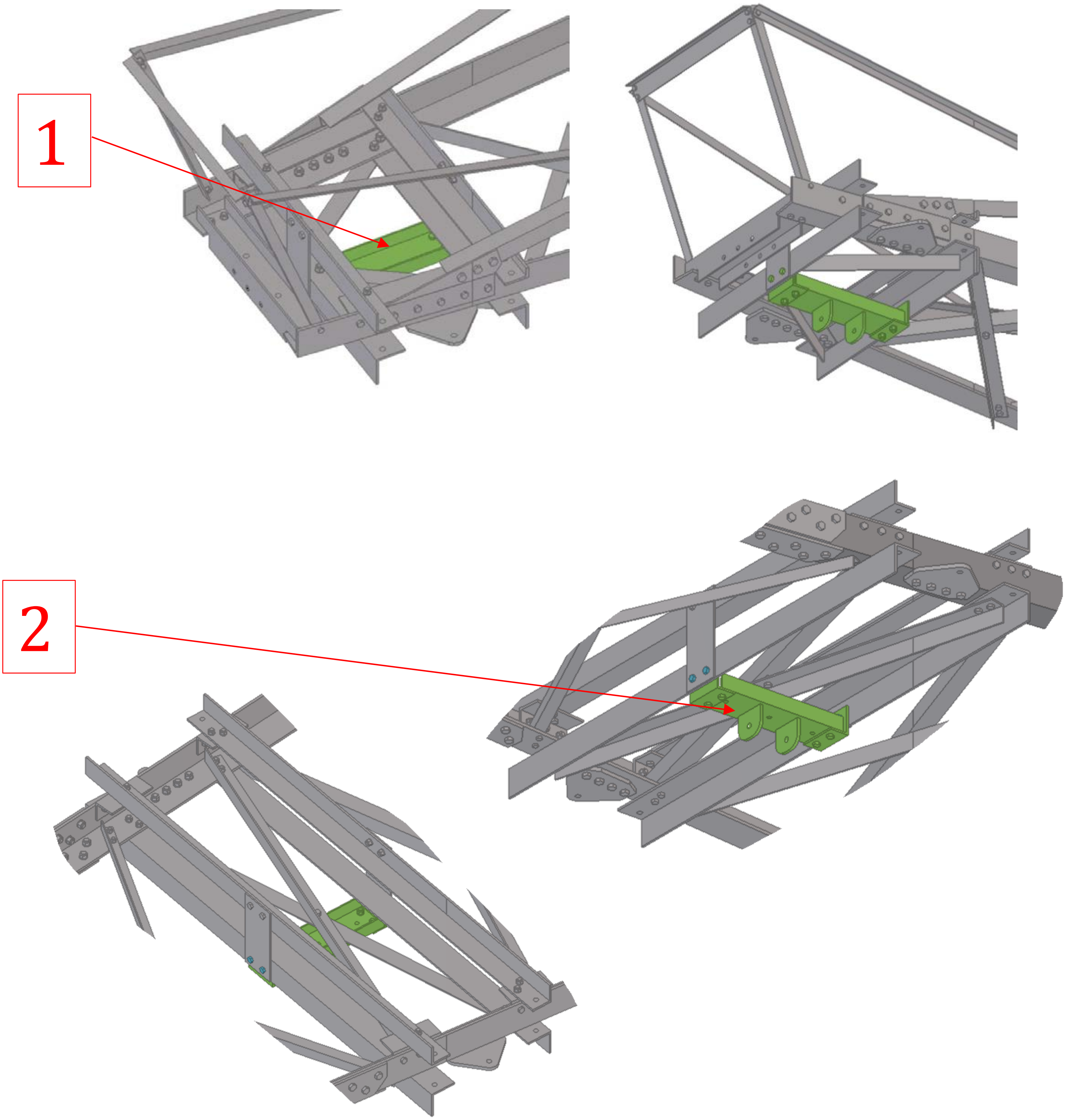
2.5 Tennet specifications

- SPE. 05. 346. v 2.0 algemene specificatie stalen masten

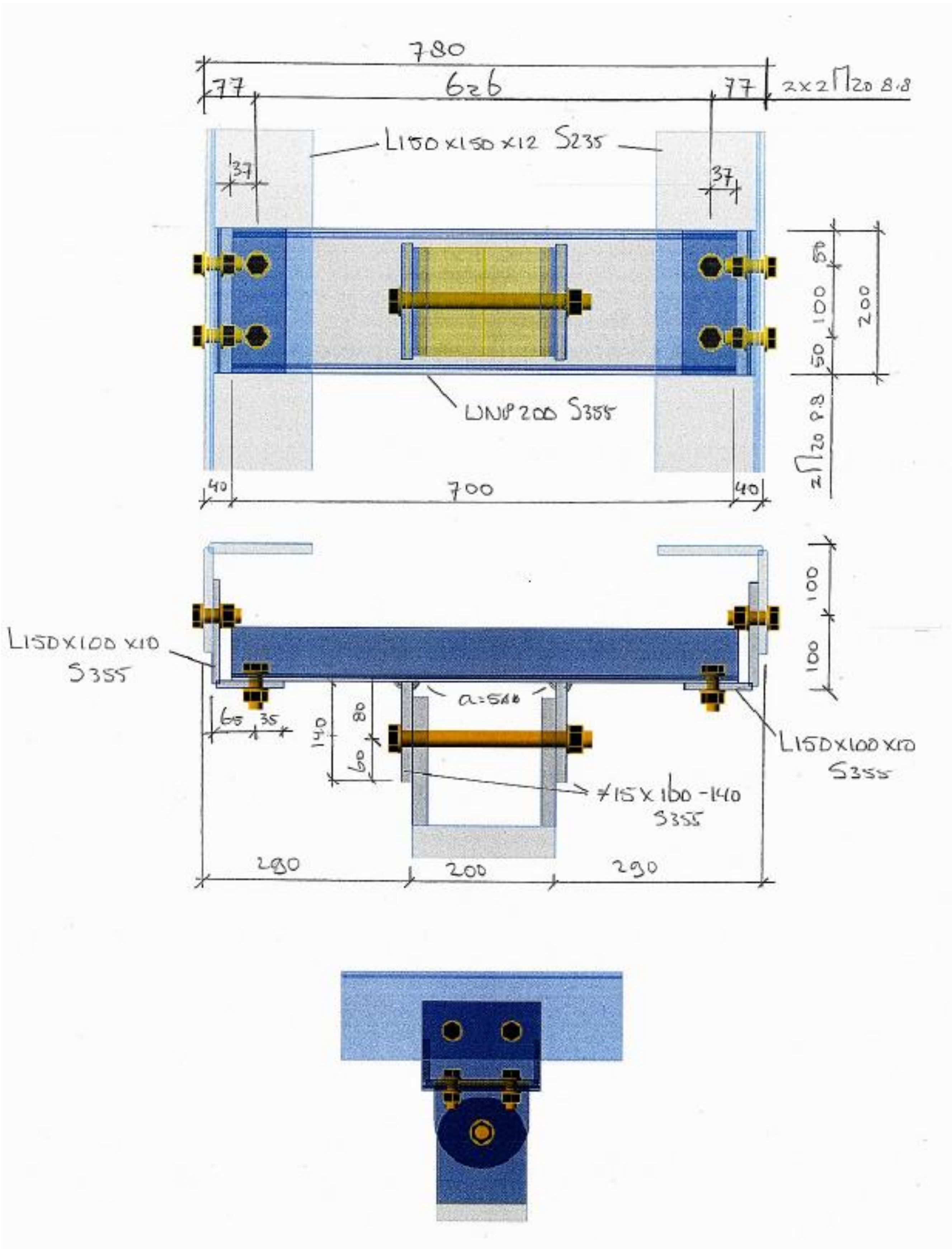
3 Calculations

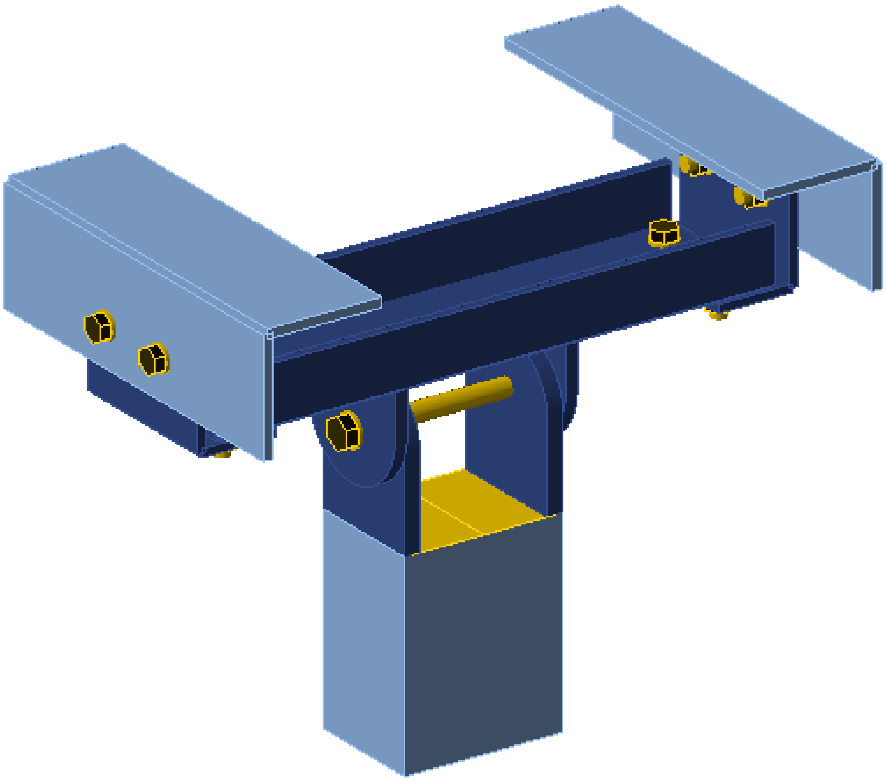
3.1 Connection of post insulators to the lower crossarm

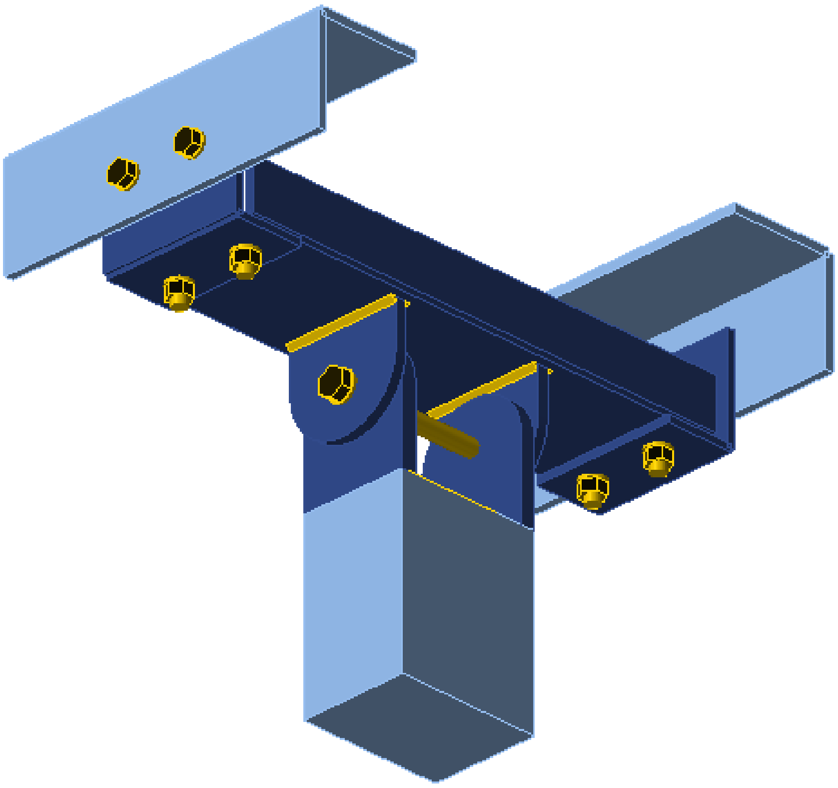
3.1.1 Overview



3.1.2 Detail 1


780
77
626
77
2x2 M20 8.8
L150x150x12 S235
37
37
50
100
50
200
UNP200 S355
2 M20 8.8
40
700
40
100
100
L150x100x10
S355
a=5
65
35
140
80
60
L150x100x10
S355
#15x160-140
S355
290
200
290





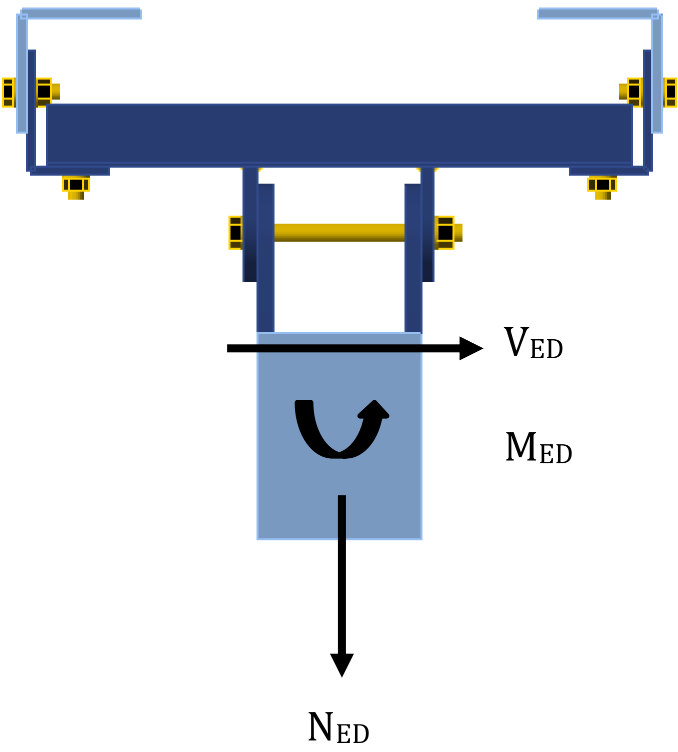
3.1.3 Loads

Loads from report:

ENS-ZL380 – Tower HB-3/R and HB-3/R_X

Report nr.: 21-0050 Rev 3
Date: 2021-12-20

Page 84 / 85



$V_{ED} = 2{,}56$ kN

$M_{ED} = 8{,}23$ kNm

$N_{ED} = 5$ kN

3.1.4 Calculation

3.1.4.1 IDEA calculation

Project data

Project name	ENS-ZL380 HB-3/R Tower 40
Project number	21-187
Author	G.P.
Description	Detail 1
Date	2/17/2022
Design code	EN

Material

Steel	S 235, S 355

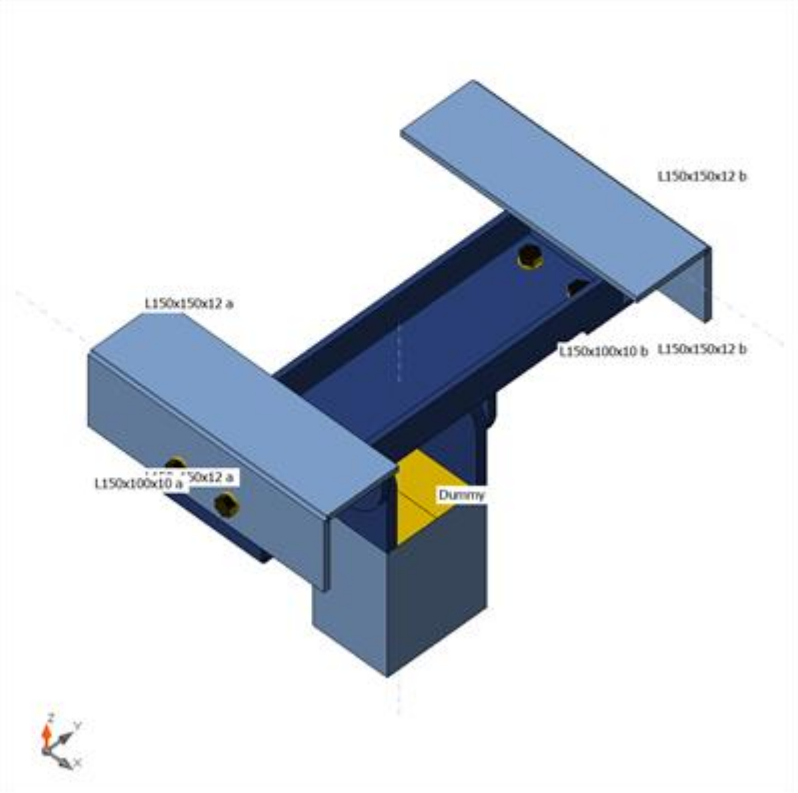
Project item Detail 1

Design

Name	Detail 1
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
L150x150x12 a	3 - HFLeq150x150x12	0.0	0.0	-90.0	0	0	-349	Node
L150x150x12 b	3 - HFLeq150x150x12	180.0	0.0	-90.0	0	0	-349	Bolts
Dummy	5 - Plaat 200, 150	0.0	90.0	90.0	0	0	0	Node



Cross-sections

Name	Material
3 - HFLeq150x150x12	S 235
5 - Plaat 200, 150	S 355
10 - UNP200	S 355
9 - HFLue150x100x10	S 355

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm²]
M24 8.8	M24 8.8	24	800.0	452
M20 8.8	M20 8.8	20	800.0	314

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	L150x150x12 a	0.0	-7.1	-0.6	0.0	0.0	0.0
	L150x150x12 a	0.0	-7.1	-0.6	0.0	0.0	0.0
	L150x150x12 b	0.0	4.6	0.6	0.0	0.0	0.0
	L150x150x12 b	0.0	4.6	0.6	0.0	0.0	0.0
	Dummy	5.0	0.0	-2.6	0.0	8.2	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	30.3 < 100%	OK
Welds	98.0 < 100%	OK
Buckling	84.44	

Plates

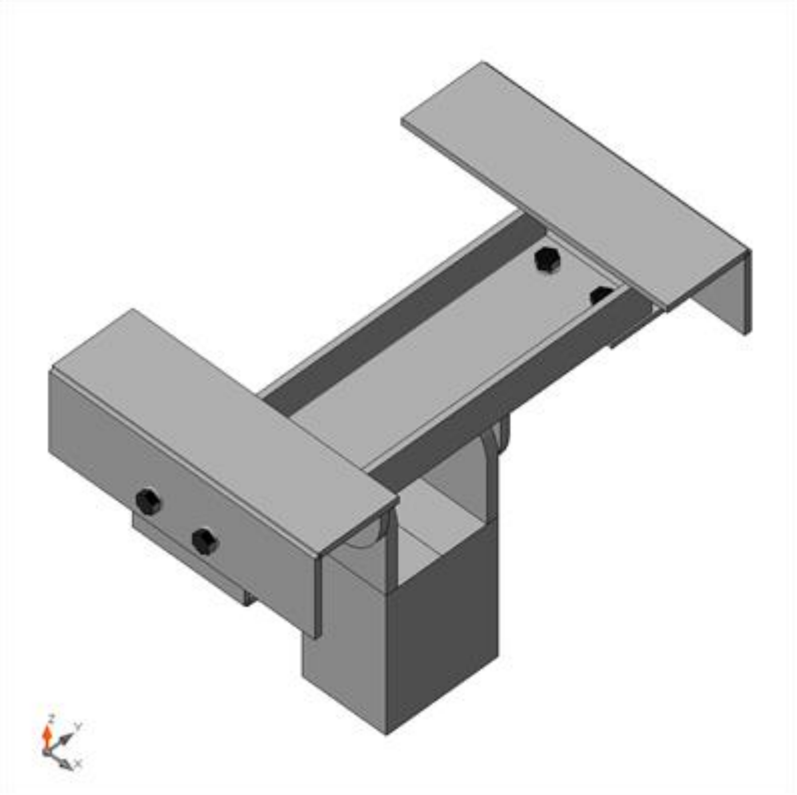
Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
L150x150x12 a-bfl 1	S 235	12.0	LE1	111.2	0.0	12.7	OK
L150x150x12 a-w 1	S 235	12.0	LE1	30.0	0.0	0.0	OK
L150x150x12 b-bfl 1	S 235	12.0	LE1	49.0	0.0	5.8	OK
L150x150x12 b-w 1	S 235	12.0	LE1	19.7	0.0	0.0	OK
Dummy-bfl 1	S 355	200.0	LE1	7.8	0.0	0.0	OK
UNP200-bfl 1	S 355 - 1	11.5	LE1	94.0	0.0	0.0	OK
UNP200-tfl 1	S 355 - 1	11.5	LE1	93.9	0.0	0.0	OK
UNP200-w 1	S 355 - 1	8.5	LE1	131.7	0.0	25.4	OK
L150x100x10 a-bfl 1	S 355 - 1	10.0	LE1	121.1	0.0	25.4	OK
L150x100x10 a-w 1	S 355 - 1	10.0	LE1	194.1	0.0	12.7	OK
L150x100x10 b-bfl 1	S 355 - 1	10.0	LE1	97.7	0.0	8.6	OK
L150x100x10 b-w 1	S 355 - 1	10.0	LE1	126.7	0.0	5.8	OK
SP2	S 355 - 1	15.0	LE1	134.8	0.0	18.9	OK
SP1	S 355 - 1	15.0	LE1	152.0	0.0	11.2	OK
dummy1	S 355 - 1	20.0	LE1	66.1	0.0	18.9	OK
dummy2	S 355 - 1	20.0	LE1	85.2	0.0	11.2	OK

Design data

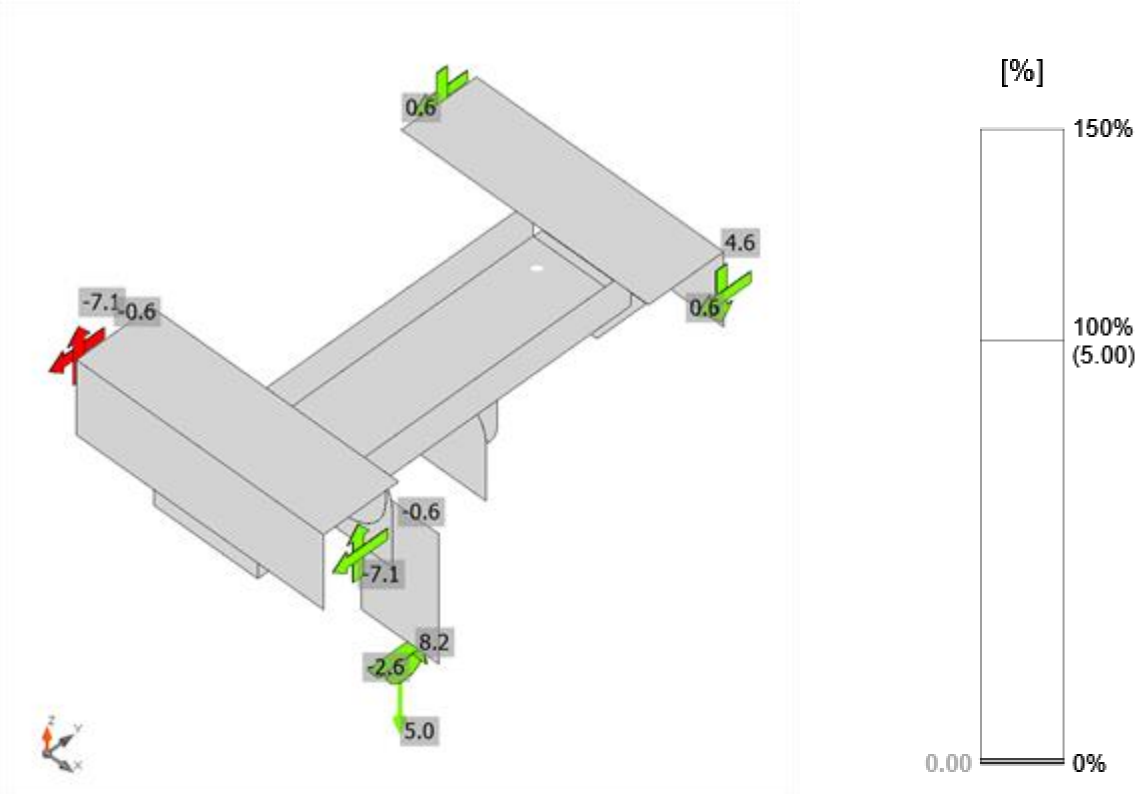
Material	f_y [MPa]	ε_{lim} [%]
S 235	235.0	5.0
S 355	335.0	5.0
S 355 - 1	355.0	5.0

Symbol explanation

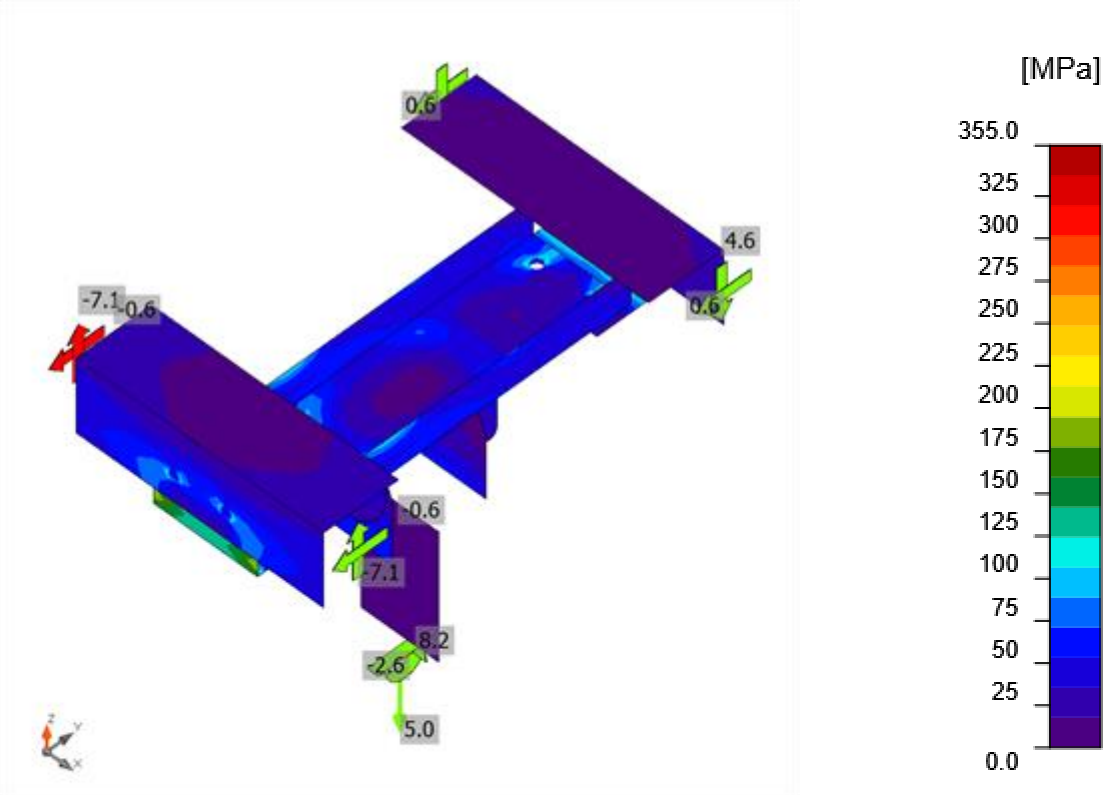
ε_{Pl}	Strain
σ_{Ed}	Eq. stress
σc_{Ed}	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain



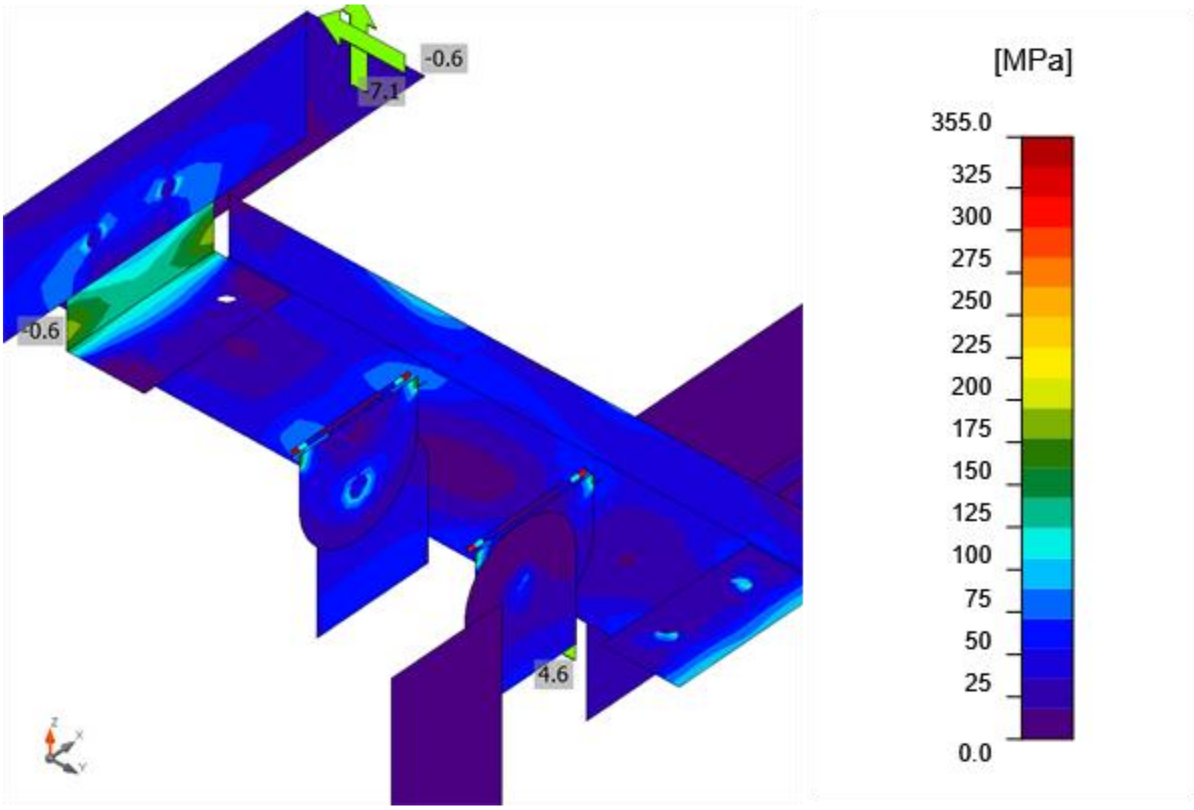
Overall check, LE1



Strain check, LE1

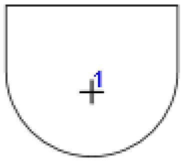
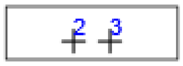
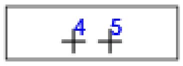


Equivalent stress, LE1



Equivalent stress, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	6.1	38.2	3.0	271.1	28.2	30.3	OK
	B2	M20 8.8 - 2	LE1	7.0	4.7	5.0	172.8	4.9	8.5	OK
	B3	M20 8.8 - 2	LE1	7.1	4.7	5.0	172.8	4.9	8.5	OK
	B4	M20 8.8 - 2	LE1	6.9	7.2	4.9	130.3	7.6	11.1	OK
	B5	M20 8.8 - 2	LE1	6.9	7.2	4.9	130.3	7.6	11.1	OK
	B6	M20 8.8 - 3	LE1	13.0	1.1	9.2	149.1	1.2	7.8	OK
	B7	M20 8.8 - 3	LE1	13.0	1.1	9.2	149.1	1.2	7.8	OK
	B8	M20 8.8 - 3	LE1	0.3	0.9	0.2	97.0	1.0	1.1	OK
	B9	M20 8.8 - 3	LE1	0.3	0.9	0.2	97.0	1.0	1.1	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203.3	421.2	135.6
M20 8.8 - 2	141.1	205.2	94.1
M20 8.8 - 3	141.1	197.8	94.1

Symbol explanation

$F_{t,Rd}$ Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$ Tension force
$B_{p,Rd}$ Punching shear resistance
V Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$ Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$ Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t Utilization in tension
Ut_s Utilization in shear

Welds (Plastic redistribution)

Item	Edge	Material	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
Dummy-bfl 1	dummy1	S 235	20.0	150	LE1								OK
Dummy-bfl 1	dummy2	S 235	20.0	150	LE1								OK
UNP200-w 1	SP1	S 355	◢5.0◣	160	LE1	426.9	0.0	144.5	189.4	133.9	98.0	19.7	OK
		S 355	◢5.0◣	160	LE1	417.2	0.0	122.4	-186.5	-135.0	95.8	20.3	OK

UNP200-w 1	SP2	S 355	◢5.0◣	160	LE1	326.9	0.0	-95.6	-147.3	-104.4	75.1	16.2	OK
		S 355	◢5.0◣	160	LE1	361.5	0.0	-120.0	162.6	111.0	83.0	17.0	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0.80	360.0	259.2
S 355	0.90	435.6	352.8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Buckling

Loads	Shape	Factor [-]
LE1	1	84.44
	2	84.59
	3	90.57
	4	92.38
	5	149.71
	6	157.20

Code settings

Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_{C}	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5

Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

3.1.5 Detail 2

Detail 2 is equal to detail 1.

Loads detail 2 are equal to detail 1.

Check connection is the same as detail 1.

4 Summary U.C. ‘s

4.1.1 Connection of post insulators to the lower crossarm

Detail 1

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	30.3 < 100%	OK
Welds	98.0 < 100%	OK
Buckling	84.44	

5 Conclusion

5.1.1 Connection of post insulators to the lower crossarm

Both connections have sufficient strength.

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Projectnummer Aafjes: **21-187**

Documentnummer: **00974-01-08200**

Projectnummer TenneT: **002.515**

Meridian nummer: **002.515.40 0994396**

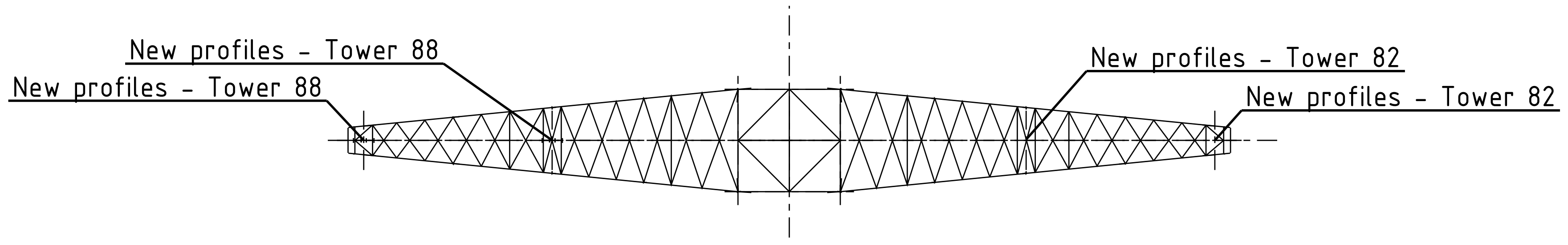
Opdrachtgever: **TenneT**

Project: **Opwaardering ENS-ZL380**

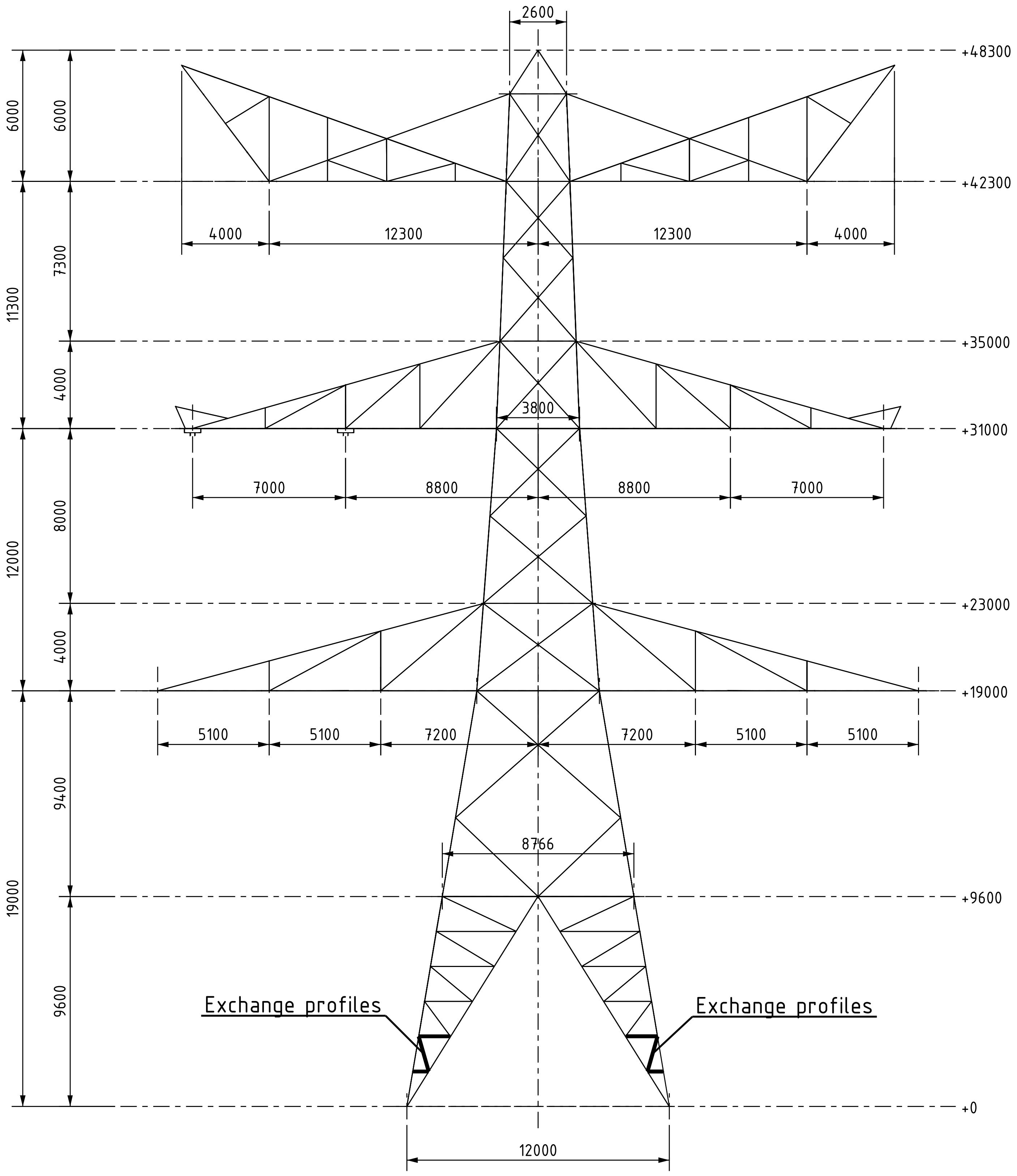
Onderdeel: **HA-6RC Mast 82 en 88 - Overzichtstekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Erik Jan Fledderus	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

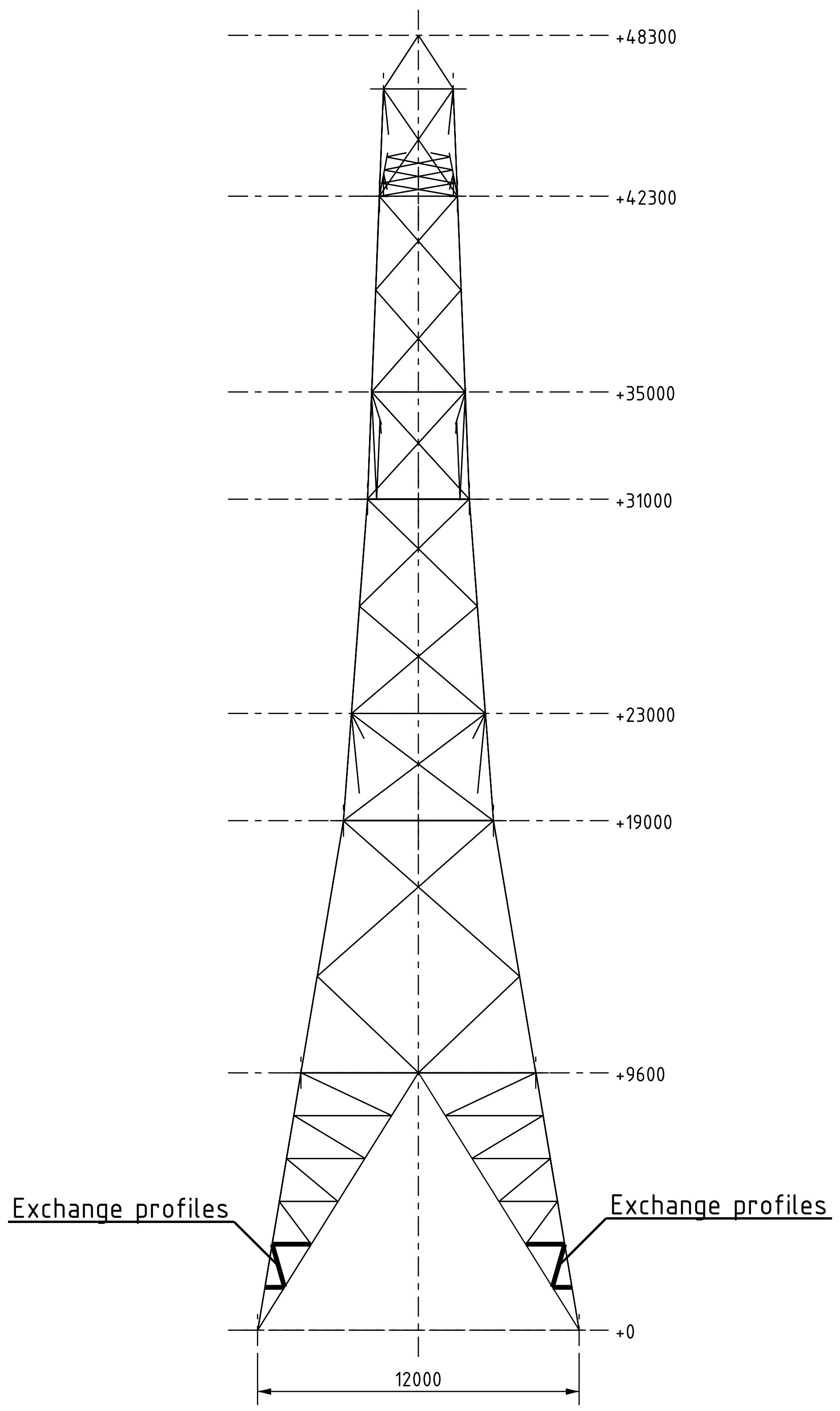
Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	18-02-2022	1^{e} versie ter review



Section A - A
1:250



Transverse face
1:250



Longitudinal face
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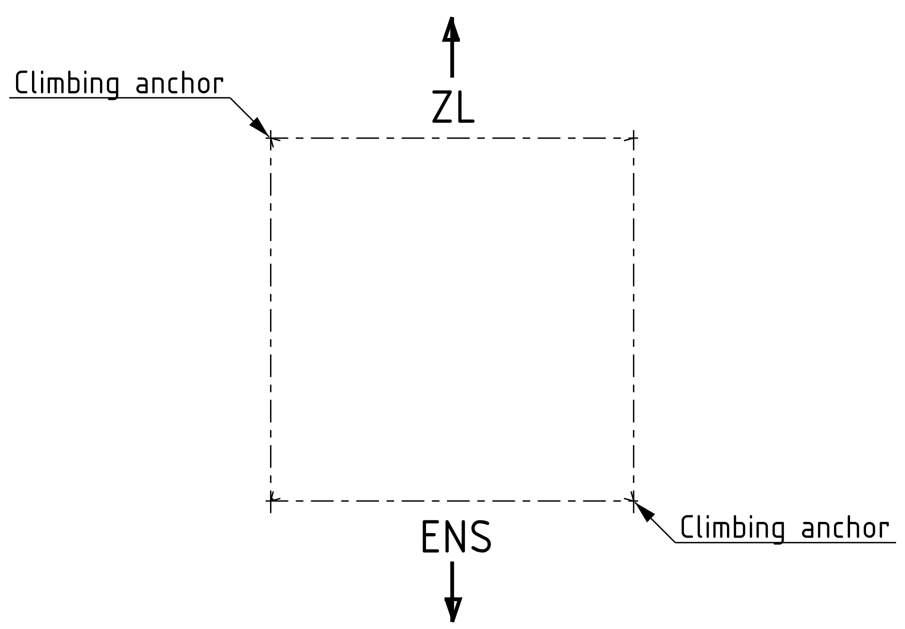

Section
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All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:250	A2

Relatie

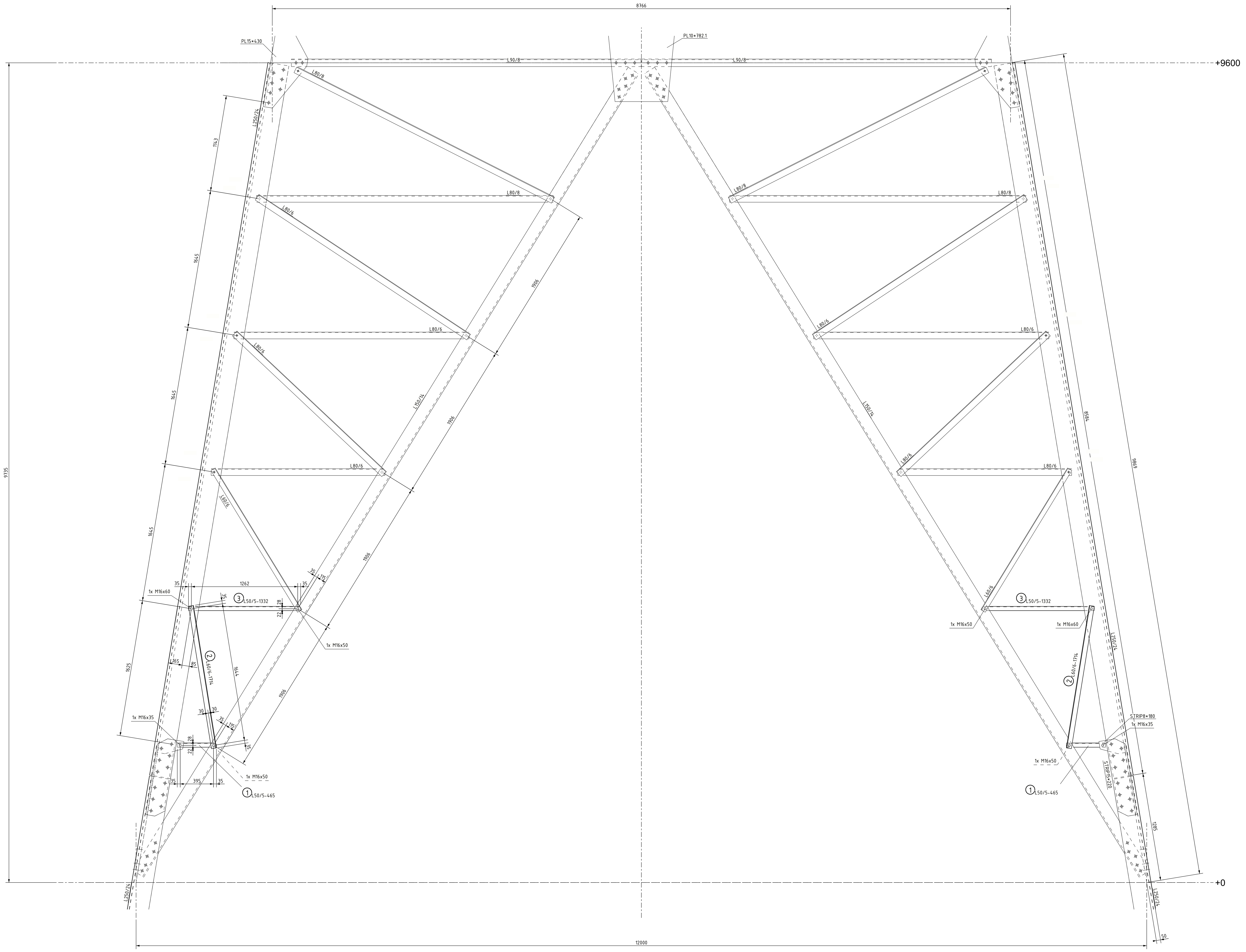
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Omschrijving:	Masttype HA-3 RC, Mast 85 en 88 - Overzicht
Documentnummer:	00974-01-08201

Oud tekeningnummer:

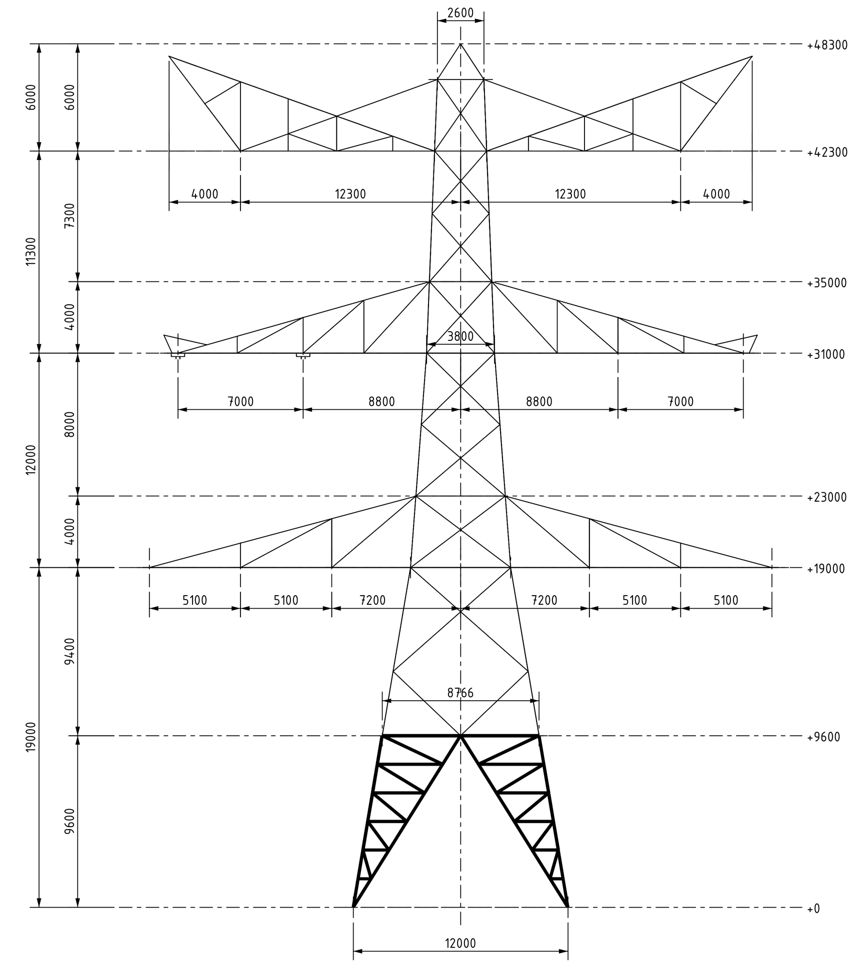
TenneT Taking power further

Tekla Structures

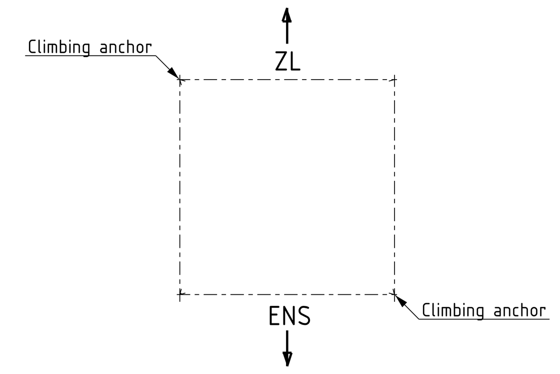
Apply to all sides



Side Face Bottom Part
1:20



Transverse face
1:250



Section
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All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

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Welds	NEN-EN 15607

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Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

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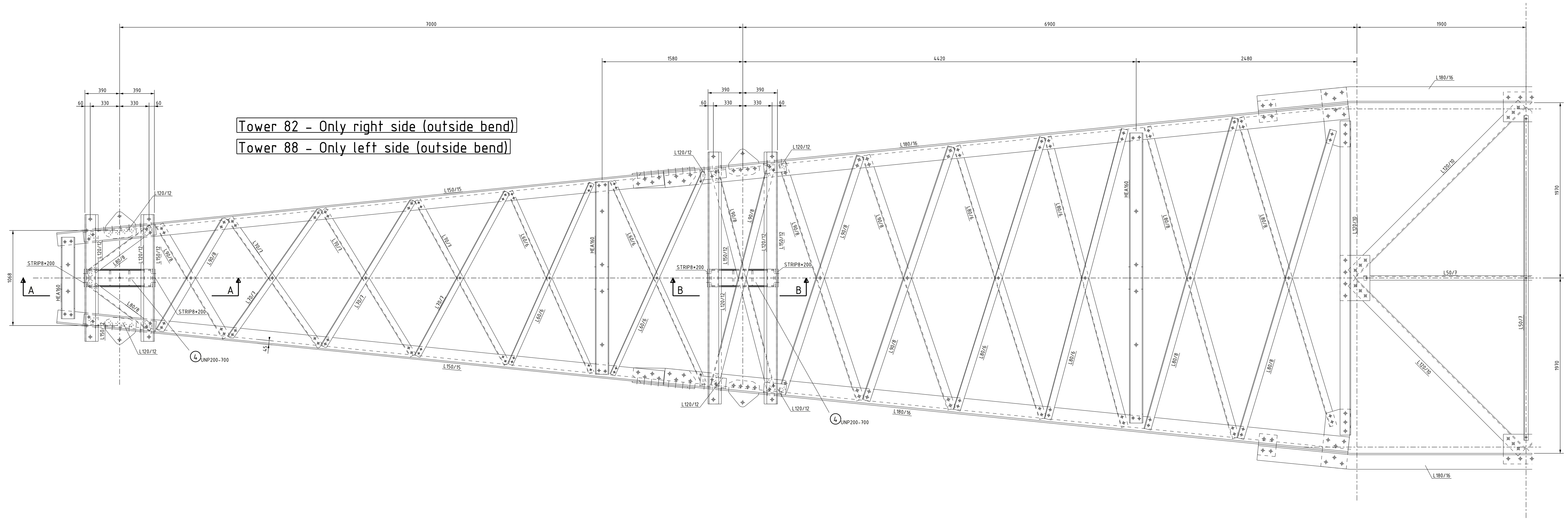
- If a profile needs to be replaced, always use new bolts.

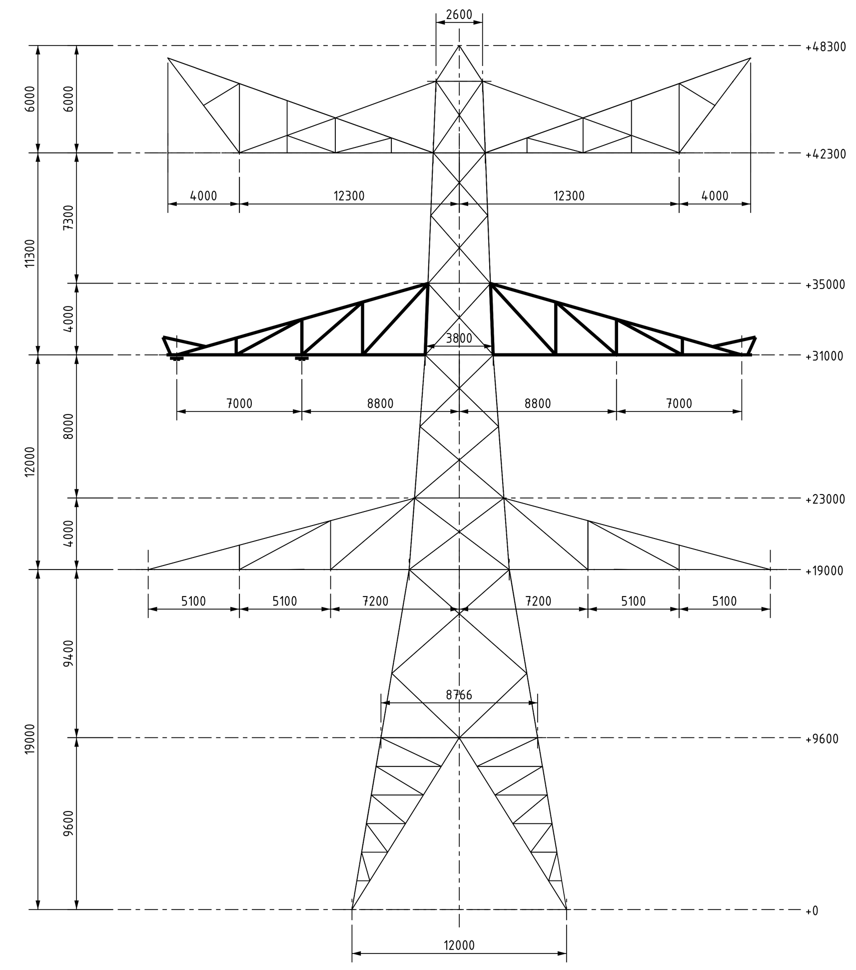
Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:20 1:250	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Omschrijving:	Masttype HA-3 RC, Mast 82 en 88 - Broekstuk
Documentnummer:	00974-01-08202

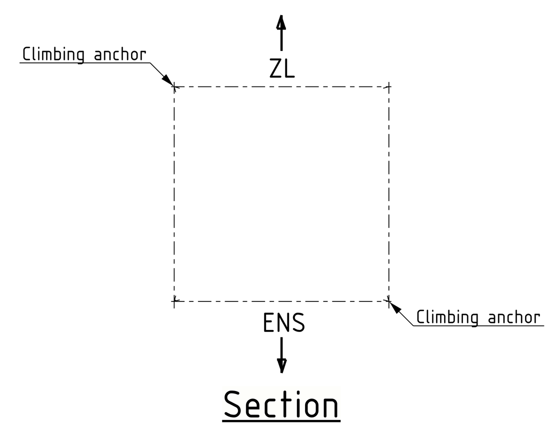
TenneT Taking power further



Bottom Surface Middle Cross Arm
1:20



Transverse face
1:250



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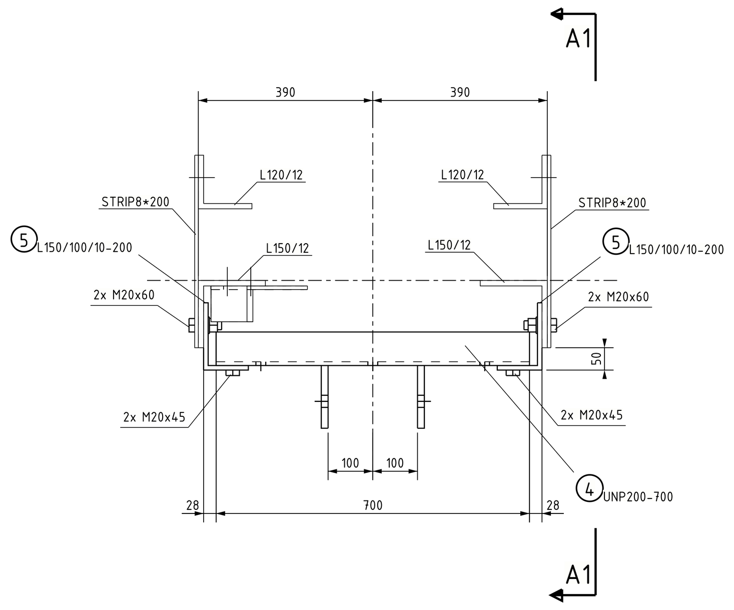

Section A - A
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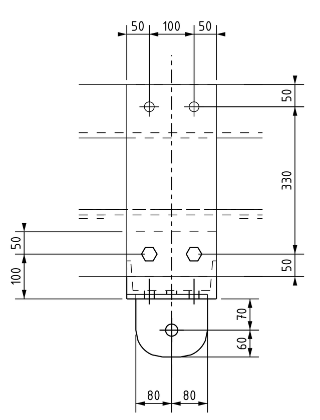

Section A1 - A1
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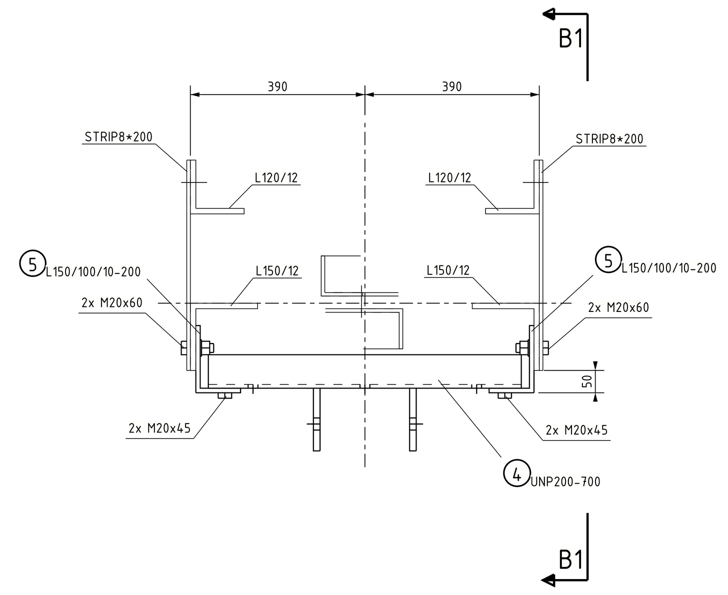

Section B - B
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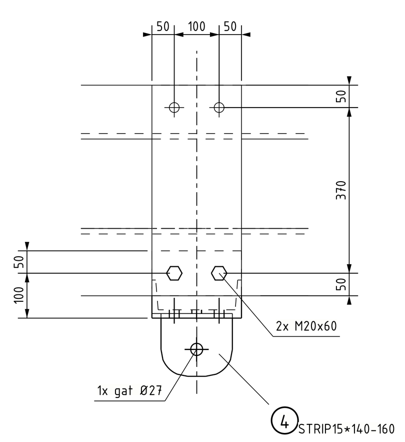

Section B1 - B1
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All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

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Welds	NEN-EN 15607

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Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Omschrijving:	Masttype HA-3 RC, Mast 82 en 88 - Middentraverse
Documentnummer:	00974-01-08203

TenneT
Taking power further

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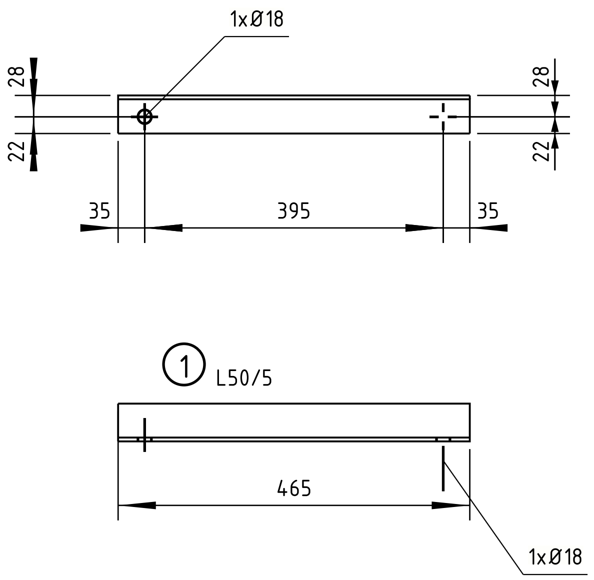
Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-08210**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994397**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**HA-6RC Mast 82 en 88 - Onderdeeltekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Erik Jan Fledderus	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	18-02-2022	1e versie ter review



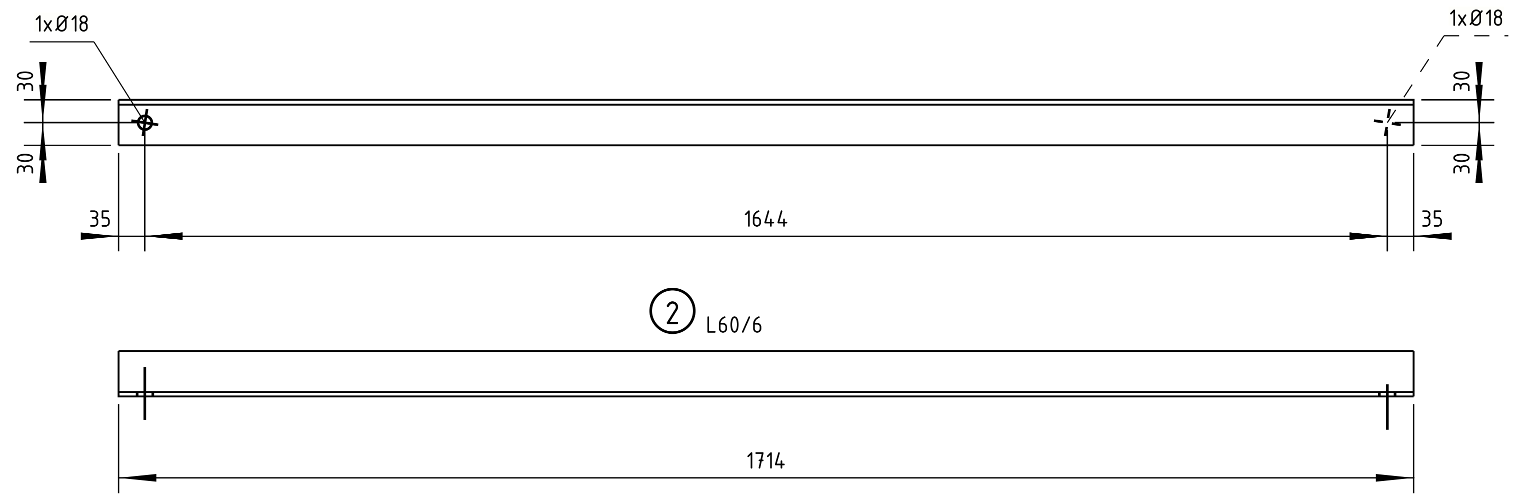
Pos	Profile	Number	Grade	Length	Area (m^2)
1	L50/5	8	S355J0	465	0.09

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus	Voorlopig
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Oud tekeningnummer:	
Omschrijving:	Te vervangen staal - onderdeel [1]
Documentnummer:	

TenneT Taking power further

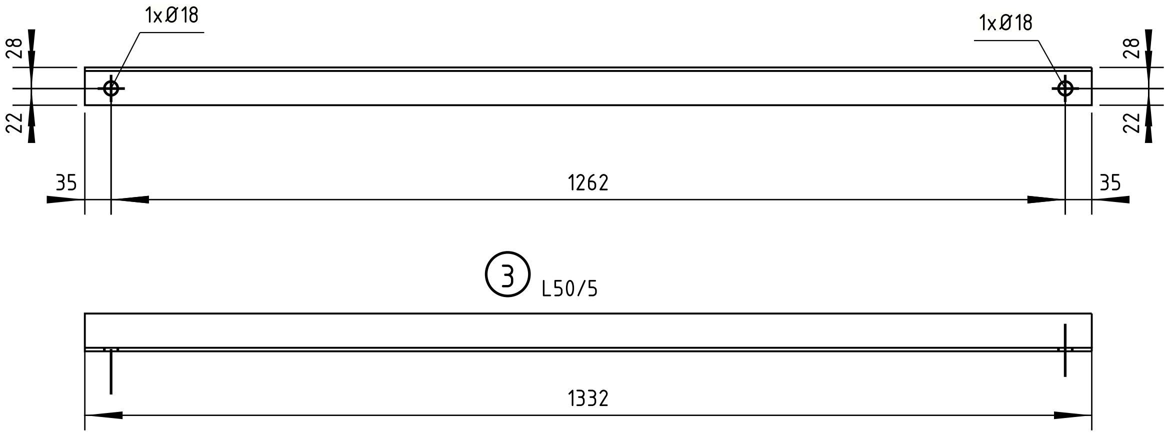
Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
2	L60/6	8	S355J0	1714	0.41

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig
Rev.	0.1
Datum revisie	18.02.2022
Omschrijving revisie	1e versie ter review
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	A3
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Omschrijving:	Te vervangen staal - onderdeel [2]
Documentnummer:	

TenneT Taking power further



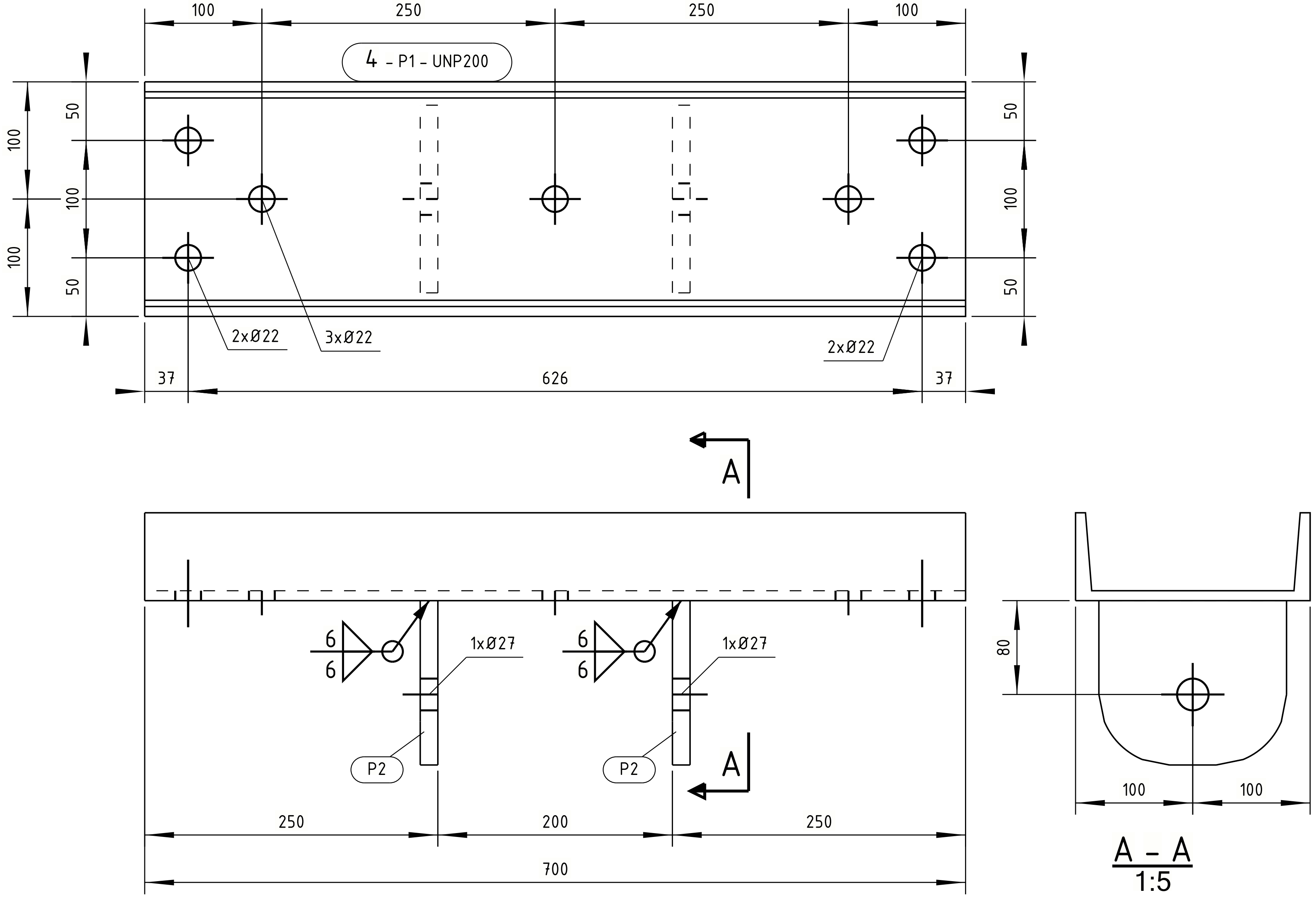
Pos	Profile	Number	Grade	Length	Area (m²)
3	L50/5	8	S355J0	1332	0.27

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Oud tekeningnummer:	
Omschrijving:	Te vervangen staal - onderdeel [3]
Documentnummer:	

TenneT Taking power further

Tekla Structures

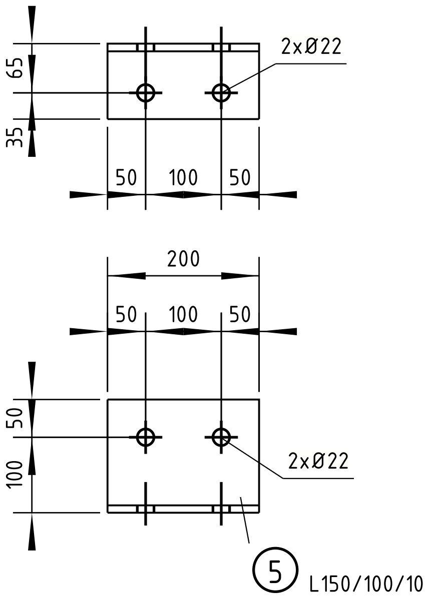


ASSEMBLY						
Mark: 4		length (mm): 700			Number: 2	
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P1	UNP200	S355J0	1	700	18.0	0.46
P2	STRIP15*140	S355J0	2	160	5.0	0.10
				Total of one mark	23.0	0.56

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [4]
Documentnummer:	

TenneT Taking power further



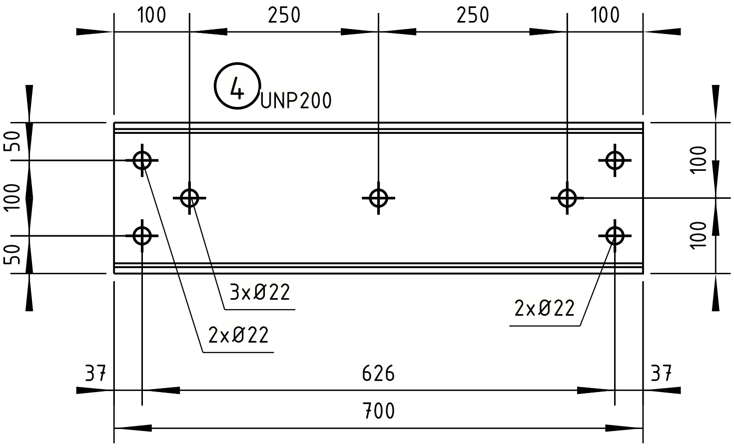
5	L150/100/10	4	S355J0	200	0.10
Pos	Profile	Number	Grade	Length	Area (m²)

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [5]
Documentnummer:	

TenneT Taking power further

Tekla Structures



P1	UNP200	2	S355J0	700	0.46
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A4

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88

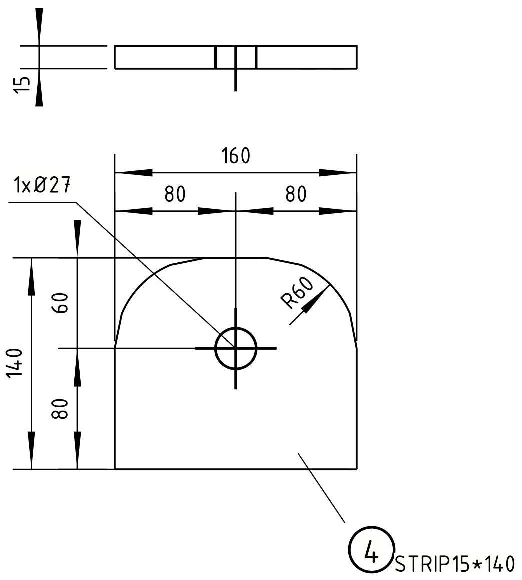
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [P1]

Documentnummer:

TenneT
Taking power further

Tekla Structures



P2	STRIP15*140	4	S355J0	160	0.05
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	18.02.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A4

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380 Masttype HA-3 RC, Mast 82 en 88

Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [P2]

Documentnummer:

TenneT Taking power further

Tekla Structures

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Projectnummer Aafjes: **21-187**

Documentnummer: **00974-01-08220**

Projectnummer TenneT: **002.515**

Meridian nummer: **002.515.40 0994398**

Opdrachtgever: **TenneT**

Project: **Opwaardering ENS-ZL380**

Onderdeel: **HA-6RC Mast 82 en 88 - Lijsten**

	Naam	Functie	Handtekening	Datum
Opgesteld	Erik Jan Fledderus	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	18-02-2022	1e versie ter review

BOUTEN-, MOEREN-, RINGENLIJST

ENS-ZL380

Datum: 14.02.2022

Masttype HA-6_RC

t.b.v. 1 mast

Naam	Type	Kwal.	Aantal
BOUT-M16*35	4017	8.8	8
BOUT-M16*50	4014	8.8	16
BOUT-M16*60	4014	8.8	8
BOUT-M20*45	4017	8.8	8
BOUT-M20*60	4017	8.8	8
MOER-M16	4032		32
MOER-M20	4032		16
RING-M16	7091		32
RING-M20	7091		16

MATERIAALLIJST

ENS-ZL380 Datum: 14.02.2022
Masttype HA-6_RC
t.b.v. 1 mast

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
L50/5	1	S355J0	8	465	0.09	1.8
L50/5	3	S355J0	8	1332	0.27	5.1
				14376	2.88	55.2
L60/6	2	S355J0	8	1714	0.41	9.5
				13709	3.29	75.8
L150/100/10	5	S355J0	4	200	0.10	3.8
				800	0.40	15.4
STRIP15*140	P2	S355JO	4	160	0.05	2.5
				640	0.20	9.9
UNP200	P1	S355J0	2	700	0.46	18.0
				1400	0.92	36.0
				Totaal:	7.69	192.3

TEKLA STRUCTURES MERKENLIJST — Pagina: 1

ENS-ZL380 — Datum: 14.02.2022

Masttype HA-6_RC

t.b.v. 1 mast

Merk	Aantal	Profiel	Lengte	Opp.(m2)	Gewicht (kg)
1	8	L50/5	465	0.09	1.8
2	8	L60/6	1714	0.41	9.5
3	8	L50/5	1332	0.27	5.1
4	2	UNP200	700	0.56	23.0
5	4	L150/100/10	200	0.10	3.8
Totaal	30	merk(en)		7.69	192.3

Masttype: HA-6RC Mast 82 en 88
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekening omschrijving	Tekeningnummer	Rev.	Datum	Tek.	formaat
Masttype HA-3 RC, Mast 85 en 88 - Overzicht	00974-01-08201	0.1	18.02.2022	A2	594x420
Masttype HA-3 RC, Mast 82 en 88 - Broekstuk	00974-01-08202	0.1	18.02.2022	A0	1189x841
Masttype HA-3 RC, Mast 82 en 88 - Middentraverse	00974-01-08203	0.1	18.02.2022	A0	1189x841
HA-3_R Mast 14 - Onderdeeltekeningen	00974-01-08210	0.1	18.02.2022	A3/A4	

Lijsten	Documentnummer		Datum
bouten-moeren-ringenlijst	00974-01-08220	0.1	18.02.2022
materiaallijst	00974-01-08220	0.1	18.02.2022
merkenlijst	00974-01-08220	0.1	18.02.2022
Documentenlijst	00974-01-08220	0.1	18.02.2022

Detailberekeningen	Documentnummer		Datum
HA-6RC Mast 82 en 88	00974-01-08230	0.1	18.02.2022

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"REVIEW AND RE-DESIGN TOWERS BBB380"

ENS-ZL380 – Tower HA-6/RC

TenneT TSO B.V.

Detail Calculation

Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-08230**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994399**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**HA-6_RC_ Mast 82 - Detailberekeningen**

1e versie ter review	G. Pieper	R.Hol	B. Aafjes	18-02-2022	0.1
	Author	Checked	Approved	date	revision

Content

1 Introduction

This report contains the detail calculations of the reinforcements of towertype HA-6/RC windzone III.

It concerns tower number: Tower 82 and 88

To increase the future capacity of electricity transmission, it is necessary to upgrade the transmission grid by building new and modifying existing high voltage connections.

It is for this reason the client (OG) intends to upgrade part the existing 380kV grid. This upgrading is part of the program "Beter Benutten Bestaande 380kV" and consists of the following subprojects:

- Upgrading of the 380 kV-connection Lelystad – Ens (LLS-ENS380).
- Upgrading of the 380 kV-connection Diemen – Lelystad (DIM-LLS380).
- Upgrading of the 380 kV-connection Rilland – Zandvliet (RLL-ZVL380).
- Upgrading of the 380 kV-connection Krimpen aan de IJssel – Geertruidenberg (KIJ-GT380).
- Upgrading of the 380 kV-connection Ens – Zwolle (ENS-ZL380).
- Upgrading of the 380 kV-connection Maasbracht – Eindhoven (MBT-EHV380).

DNV GL has calculated the existing tower for the new situation on behalf of Tennet. On the instructions of DNV GL, the reinforcements mainly consist of the exchange of bolts and profiles and the reinforcement of profiles and the application of redundant members.

DNV GL has tested the profiles and bolts. In this report only the detail calculations are made of the specified reinforcements (bolts are specified by DNV GL).

2 General Data

2.1 Principal constructor

DNV GL – Energy

2.2 Principal calculation and related documents

- ENS-ZL380 – Tower HA-6/RC
  Reportnr.: 21-0134 Rev 1
  Date: 2021-03-23

- Uitgangspuntenrapport 380kV verbinding Ens – Zwolle
  Reportnr.: 20-1245 Rev.3
  Date: 2021-06-09

2.3 Material- and bolt quality

Materials excisting construction

	Signification 1969	Current startingpoint
Steeltype	St.37	S235JR
	St.52	S355JO
Bolt quality	bolt class 5	5.6 rolled thread
Concrete quality	K225	Min. C16/20
Reinforcing steel	Qr24, Qr40	B220, B400

Materials modified construction

Steeltype	S355JO ($t \leqq 16$ mm)
	S355J2 ($16 < t \leqq 40$ mm)
Bolt quality	8.8 rolled thread

2.4 Applicable standards

Mainly used:
- NEN-EN 1993-1-8+C2 :2011/NB:2011 nl

Also used:
- NEN-EN 50341-2-15: 2019
- NEN-EN 8700: 2011
- NEN-EN 8701: 2011
- Eurocode reeks

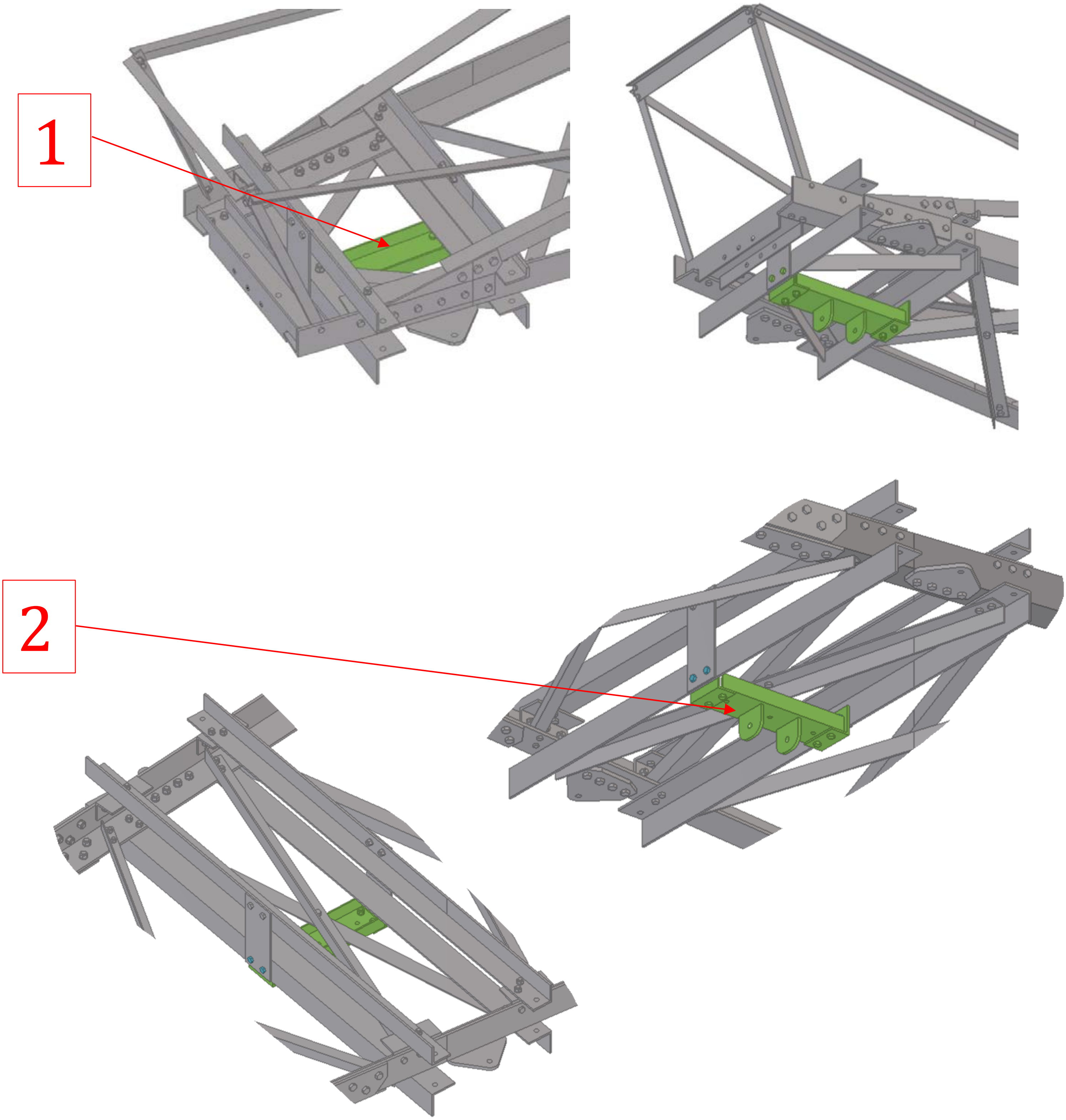
2.5 Tennet specifications

- SPE. 05. 346. v 2.0 algemene specificatie stalen masten

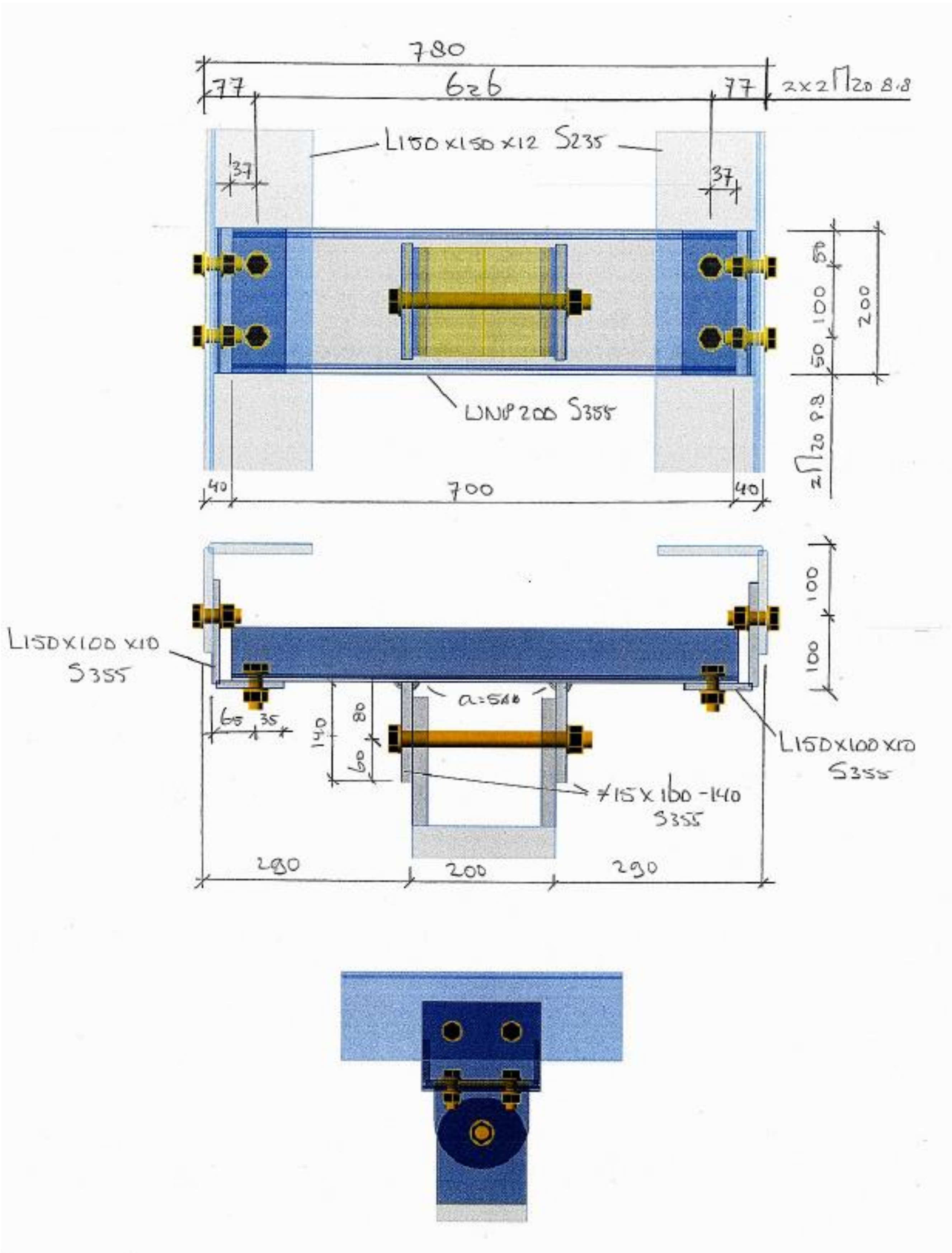
3 Calculations

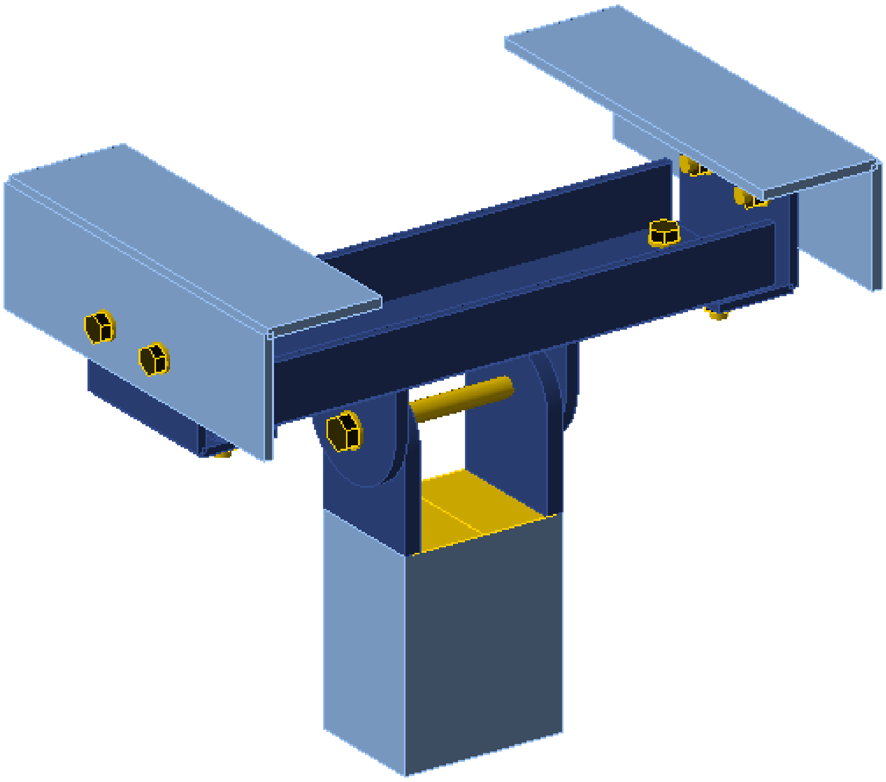
3.1 Connection of post insulators to the lower crossarm

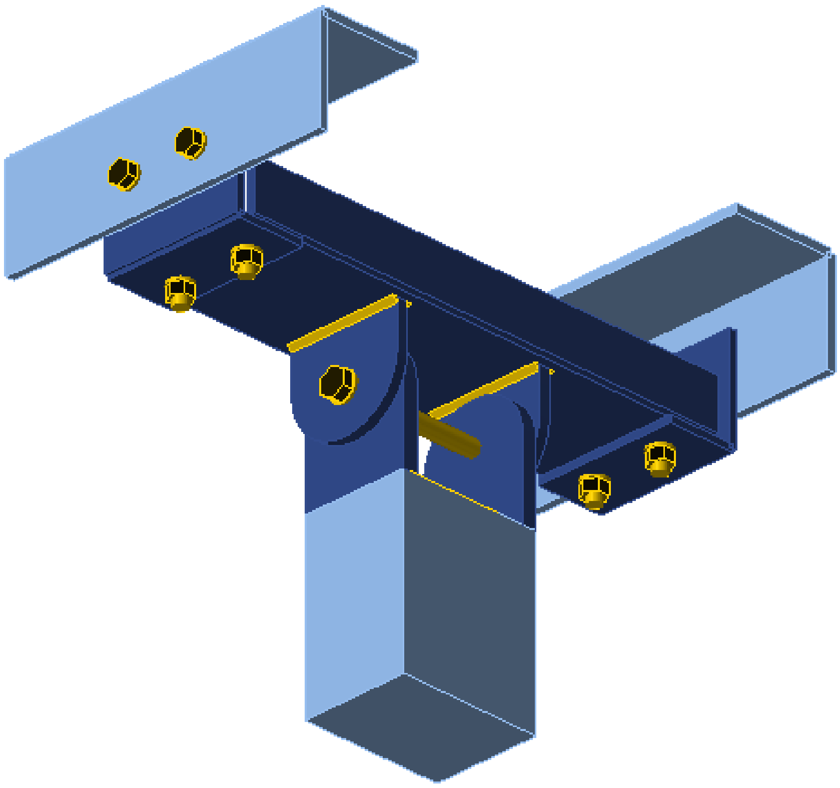
3.1.1 Overview



3.1.2 Detail 1


780
77
626
77
2x2 M20 8.8
L150x150x12 S235
37
37
50
100
50
200
UNP200 S355
2 M20 8.8
40
700
40
100
100
L150x100x10
S355
65
35
140
80
60
L150x100x10
S355
15x160-140
S355
290
200
290





3.1.3 Loads

Loads from report:

ENS-ZL380 – Tower HA-6/RC

Report nr.: 21-0134 Rev 1
Date: 2021-03-23

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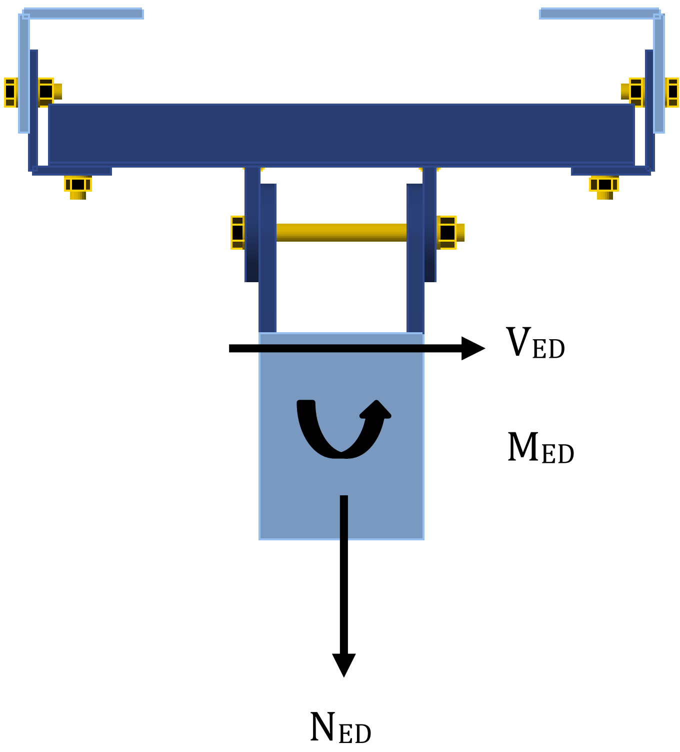


V_{ED} = 2,4 kN

M_{ED} = 7,56 kNm

N_{ED} = 5 kN

3.1.4 Calculation

3.1.4.1 IDEA calculation

Project data

Project name	ENS-ZL380 HA-6/RC Tower 82
Project number	21-187
Author	G.P.
Description	Detail 1
Date	2/17/2022
Design code	EN

Material

Steel	S 235, S 355

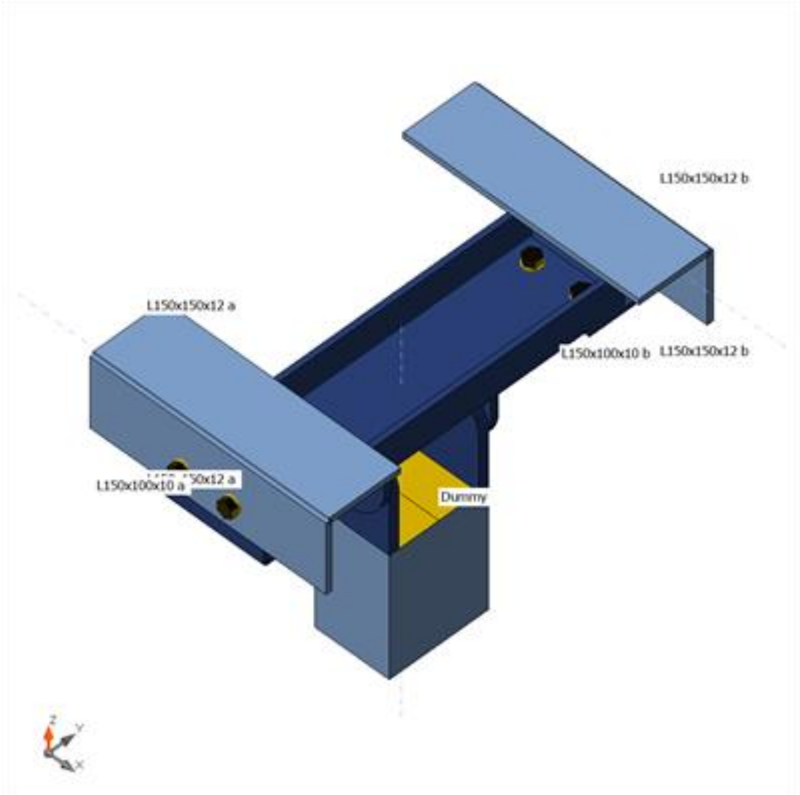
Project item Detail 1

Design

Name	Detail 1
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
L150x150x12 a	3 - HFLeq150x150x12	0.0	0.0	-90.0	0	0	-349	Node
L150x150x12 b	3 - HFLeq150x150x12	180.0	0.0	-90.0	0	0	-349	Bolts
Dummy	5 - Plaat 200, 150	0.0	90.0	90.0	0	0	0	Node



Cross-sections

Name	Material
3 - HFLeq150x150x12	S 235
5 - Plaat 200, 150	S 355
10 - UNP200	S 355
9 - HFLue150x100x10	S 355

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M24 8.8	M24 8.8	24	800.0	452
M20 8.8	M20 8.8	20	800.0	314

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	L150x150x12 a	0.0	-6.7	-0.6	0.0	0.0	0.0
	L150x150x12 a	0.0	-6.7	-0.6	0.0	0.0	0.0
	L150x150x12 b	0.0	4.2	0.6	0.0	0.0	0.0
	L150x150x12 b	0.0	4.2	0.6	0.0	0.0	0.0
	Dummy	5.0	0.0	-2.4	0.0	7.6	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	28.0 < 100%	OK
Welds	94.8 < 100%	OK
Buckling	90.44	

Plates

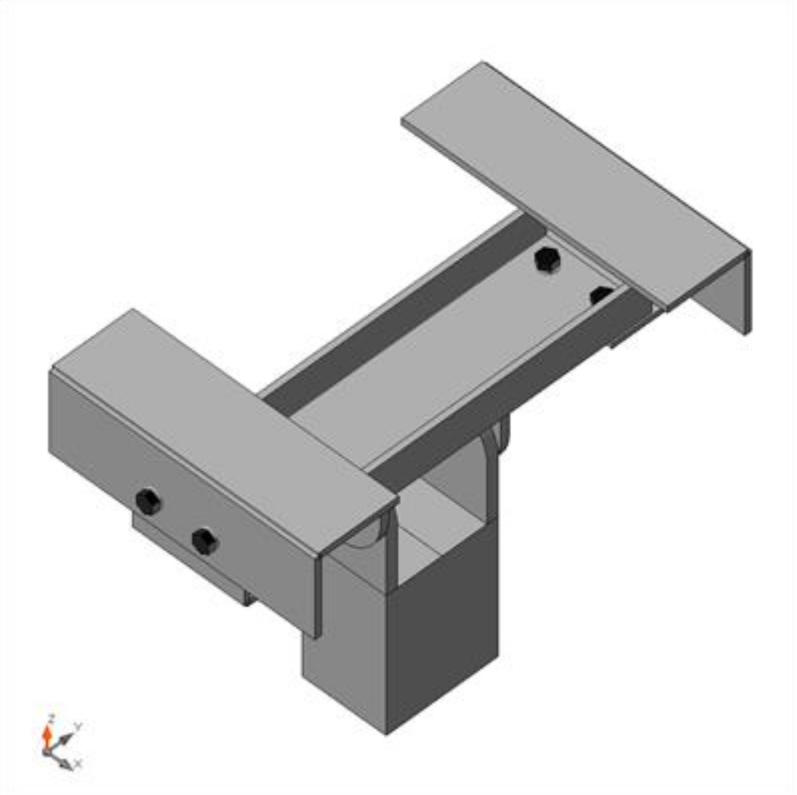
Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
L150x150x12 a-bfl 1	S 235	12.0	LE1	103.8	0.0	11.9	OK
L150x150x12 a-w 1	S 235	12.0	LE1	28.0	0.0	0.0	OK
L150x150x12 b-bfl 1	S 235	12.0	LE1	43.9	0.0	5.2	OK
L150x150x12 b-w 1	S 235	12.0	LE1	17.6	0.0	0.0	OK
Dummy-bfl 1	S 355	200.0	LE1	7.1	0.0	0.0	OK
UNP200-bfl 1	S 355 - 1	11.5	LE1	87.2	0.0	0.0	OK
UNP200-tfl 1	S 355 - 1	11.5	LE1	87.1	0.0	0.0	OK
UNP200-w 1	S 355 - 1	8.5	LE1	116.3	0.0	23.6	OK
L150x100x10 a-bfl 1	S 355 - 1	10.0	LE1	113.4	0.0	23.6	OK
L150x100x10 a-w 1	S 355 - 1	10.0	LE1	181.5	0.0	11.9	OK
L150x100x10 b-bfl 1	S 355 - 1	10.0	LE1	89.7	0.0	7.6	OK
L150x100x10 b-w 1	S 355 - 1	10.0	LE1	114.8	0.0	5.2	OK
SP2	S 355 - 1	15.0	LE1	122.8	0.0	17.3	OK
SP1	S 355 - 1	15.0	LE1	147.7	0.0	10.2	OK
dummy1	S 355 - 1	20.0	LE1	60.2	0.0	17.3	OK
dummy2	S 355 - 1	20.0	LE1	78.3	0.0	10.2	OK

Design data

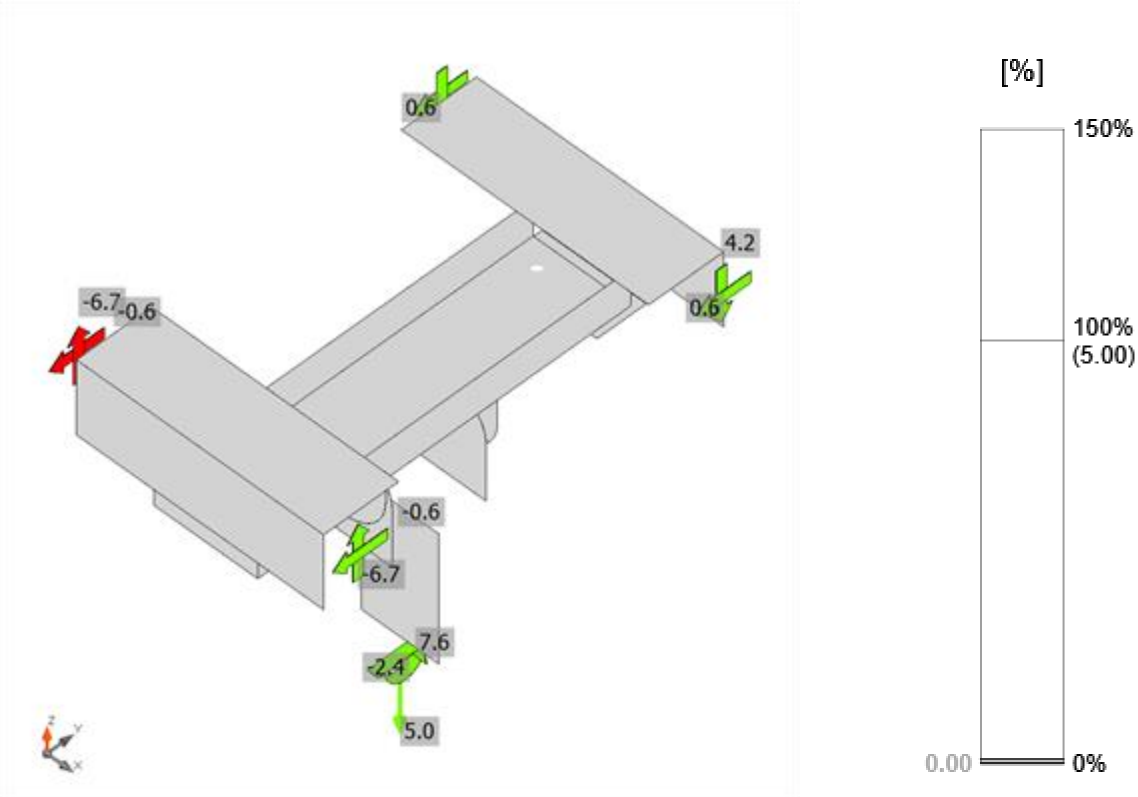
Material	f_y [MPa]	ε_{lim} [%]
S 235	235.0	5.0
S 355	335.0	5.0
S 355 - 1	355.0	5.0

Symbol explanation

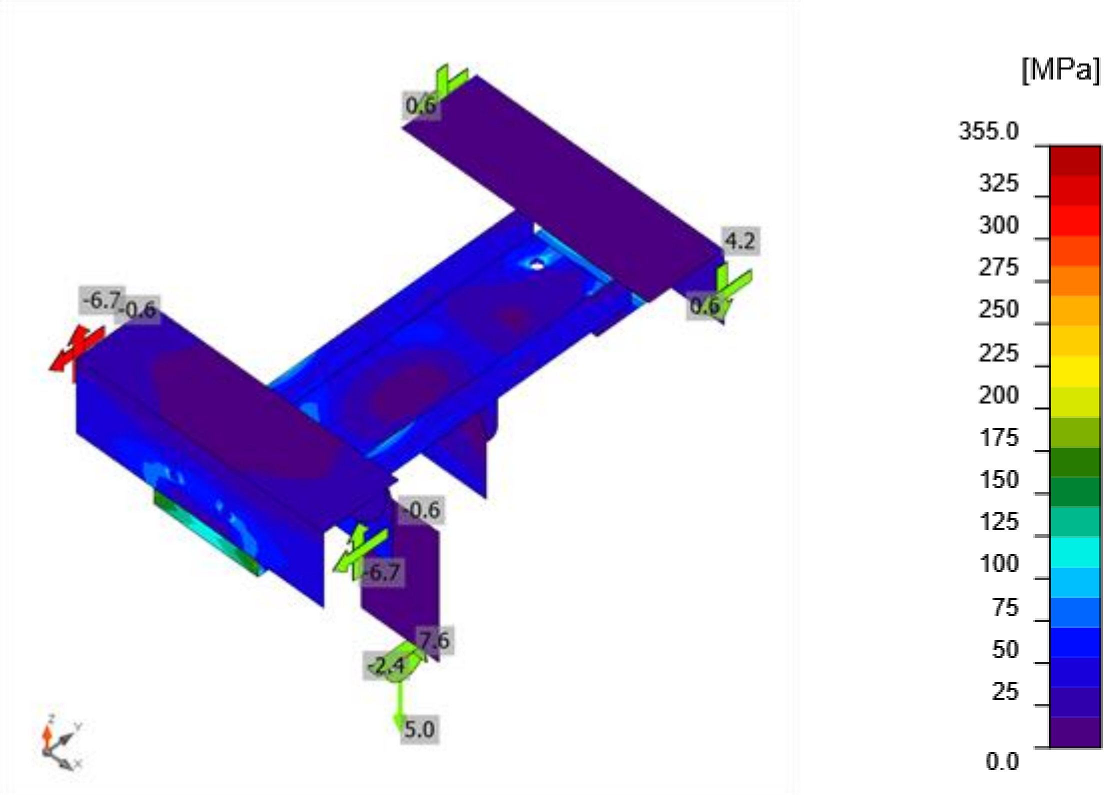
ε_{Pl}	Strain
σ_{Ed}	Eq. stress
σc_{Ed}	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain



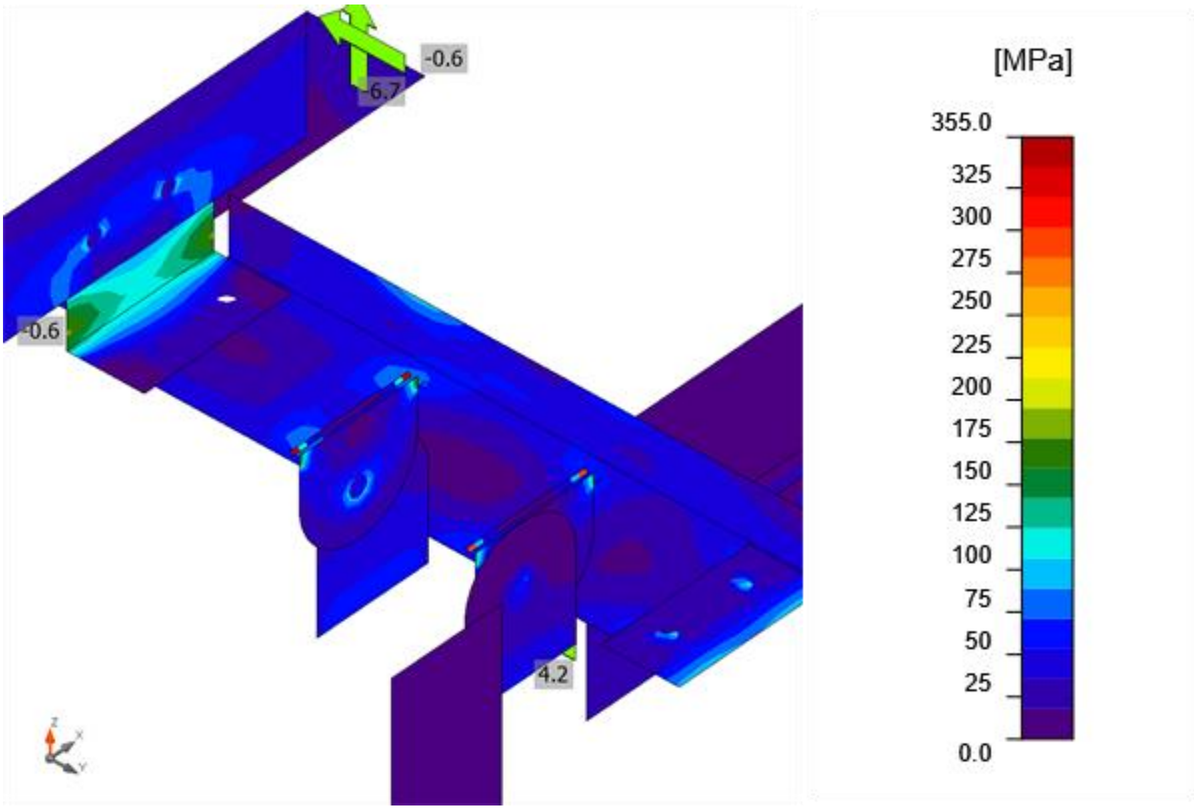
Overall check, LE1



Strain check, LE1

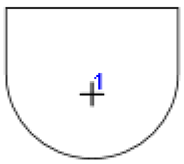
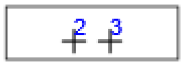
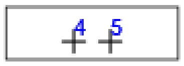


Equivalent stress, LE1



Equivalent stress, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	5.6	35.3	2.8	271.1	26.0	28.0	OK
	B2	M20 8.8 - 2	LE1	6.4	4.2	4.5	172.8	4.4	7.7	OK
	B3	M20 8.8 - 2	LE1	6.4	4.2	4.5	172.8	4.4	7.7	OK
	B4	M20 8.8 - 2	LE1	6.4	6.7	4.6	130.3	7.1	10.4	OK
	B5	M20 8.8 - 2	LE1	6.4	6.7	4.6	130.3	7.1	10.4	OK
	B6	M20 8.8 - 3	LE1	11.5	1.0	8.2	149.6	1.1	6.9	OK
	B7	M20 8.8 - 3	LE1	11.5	1.0	8.2	149.6	1.1	6.9	OK
	B8	M20 8.8 - 3	LE1	0.3	0.9	0.2	97.1	0.9	1.0	OK
	B9	M20 8.8 - 3	LE1	0.3	0.9	0.2	97.1	0.9	1.0	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203.3	421.2	135.6
M20 8.8 - 2	141.1	205.2	94.1
M20 8.8 - 3	141.1	197.8	94.1

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear

Welds (Plastic redistribution)

Item	Edge	Material	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\|\|}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
Dummy-bfl 1	dummy1	S 235	20.0	150	LE1								OK
Dummy-bfl 1	dummy2	S 235	20.0	150	LE1								OK
UNP200-w 1	SP1	S 355	◢5.0◣	160	LE1	412.8	0.0	140.2	185.4	126.0	94.8	18.6	OK
		S 355	◢5.0◣	160	LE1	374.9	0.0	107.0	-168.3	-121.2	86.1	18.5	OK
UNP200-w 1	SP2	S 355	◢5.0◣	160	LE1	299.0	0.0	-87.5	-134.8	-95.4	68.6	14.8	OK
		S 355	◢5.0◣	160	LE1	330.0	0.0	-109.3	148.6	101.2	75.8	15.5	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0.80	360.0	259.2
S 355	0.90	435.6	352.8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\|\|}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Buckling

Loads	Shape	Factor [-]
LE1	1	90.44
	2	90.59
	3	96.98
	4	98.90
	5	160.76
	6	168.16

Code settings

Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_{C}	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1

Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

3.1.5 Detail 2

Detail 2 is equal to detail 1.

Loads detail 2 are equal to detail 1.

Check connection is the same as detail 1.

4 Summary U.C. 's

4.1.1 Connection of post insulators to the lower crossarm

Detail 1

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	28.0 < 100%	OK
Welds	94.8 < 100%	OK
Buckling	90.44	

5 Conclusion

5.1.1 Connection of post insulators to the lower crossarm

Both connections have sufficient strength.

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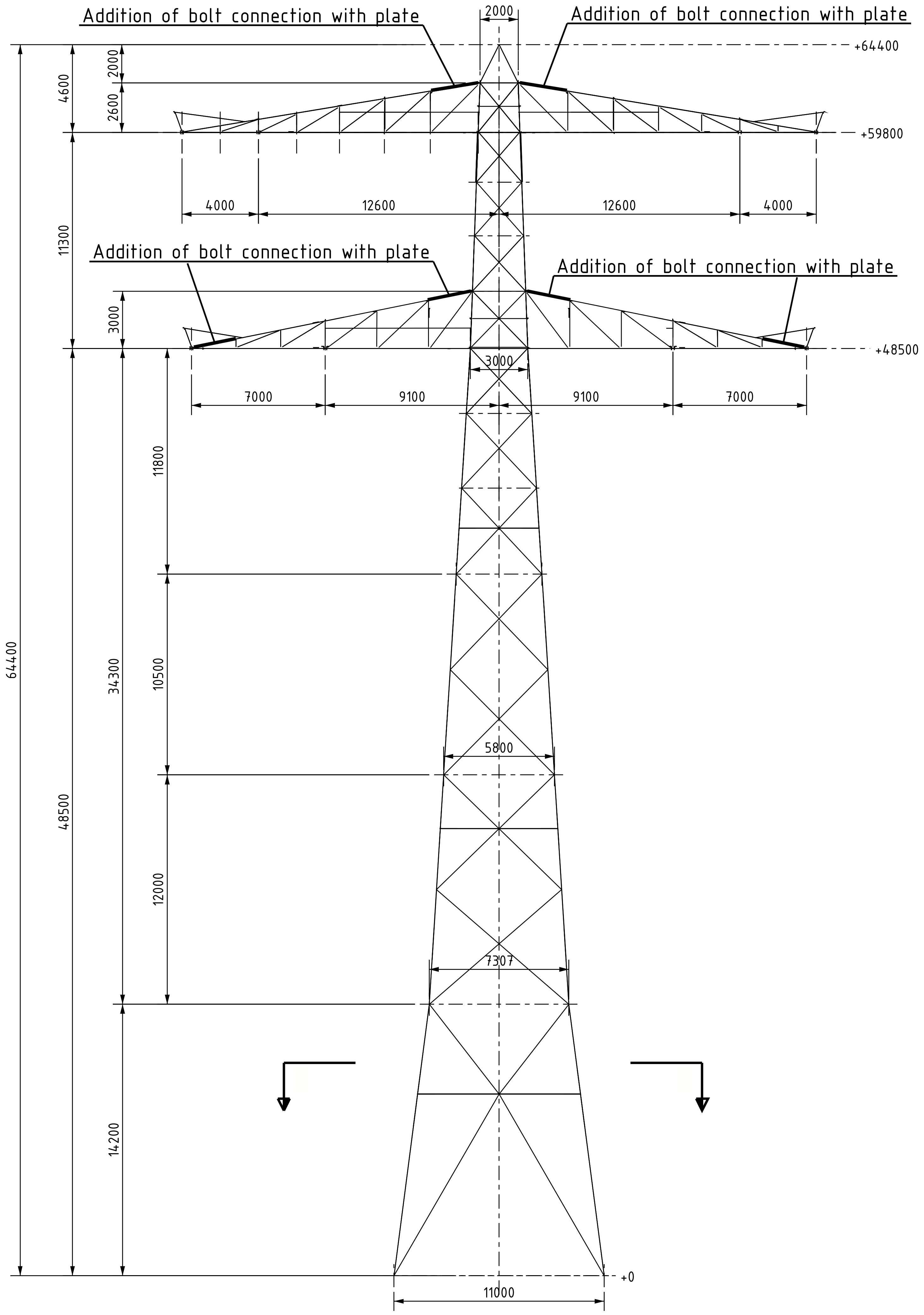
Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-08900**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994430**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**Masttype S+15_R, Mast 89 - Overzichtstekeningen**

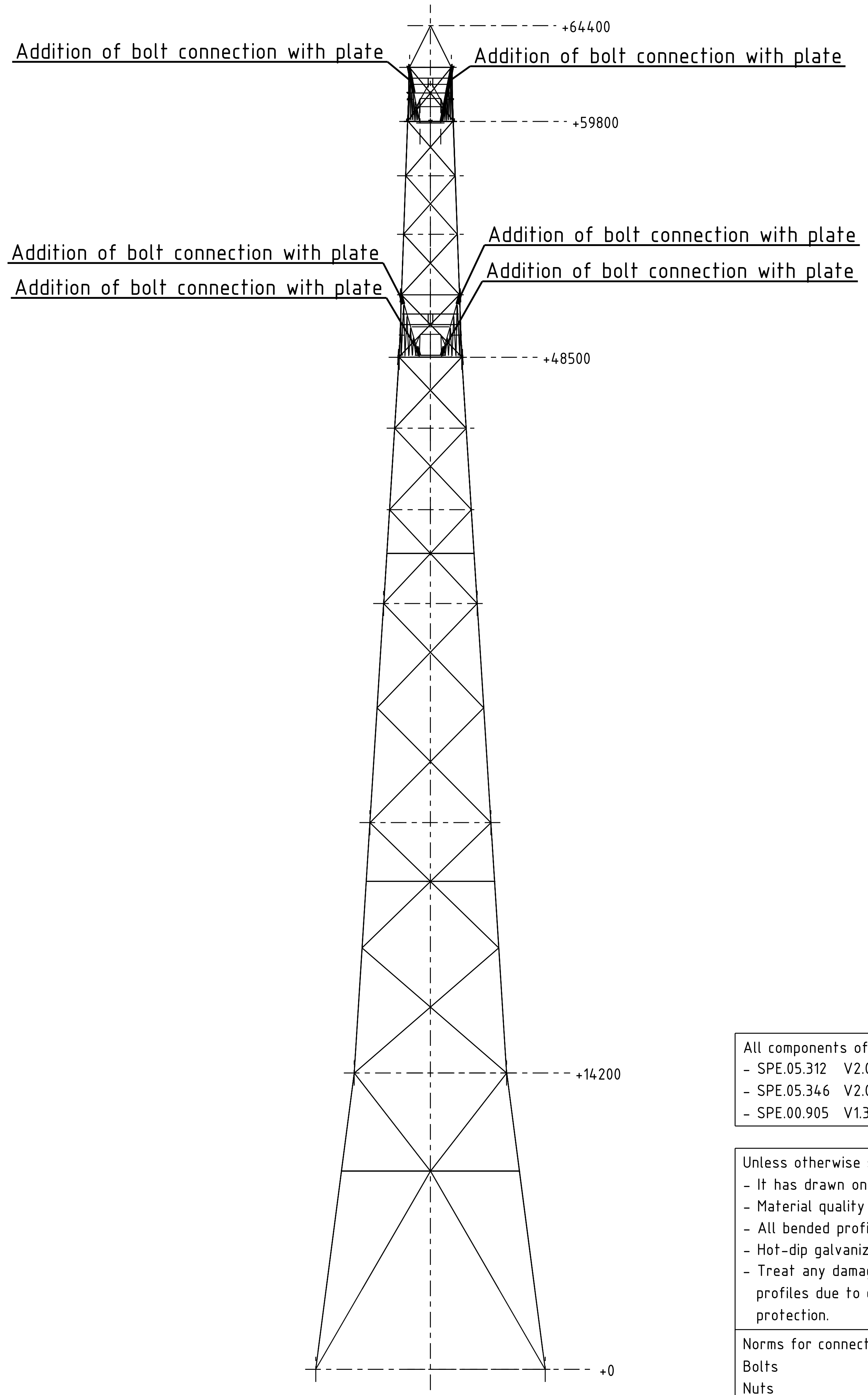
	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		10-03-2022
Validatie Aafjes	Niels Verhaar	System Engineer		10-03-2022
Vrijgegeven	Bart Aafjes	Projectleider		10-03-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	10-03-2022	1e versie ter review



Transverse face

1:250



Longitudinal face

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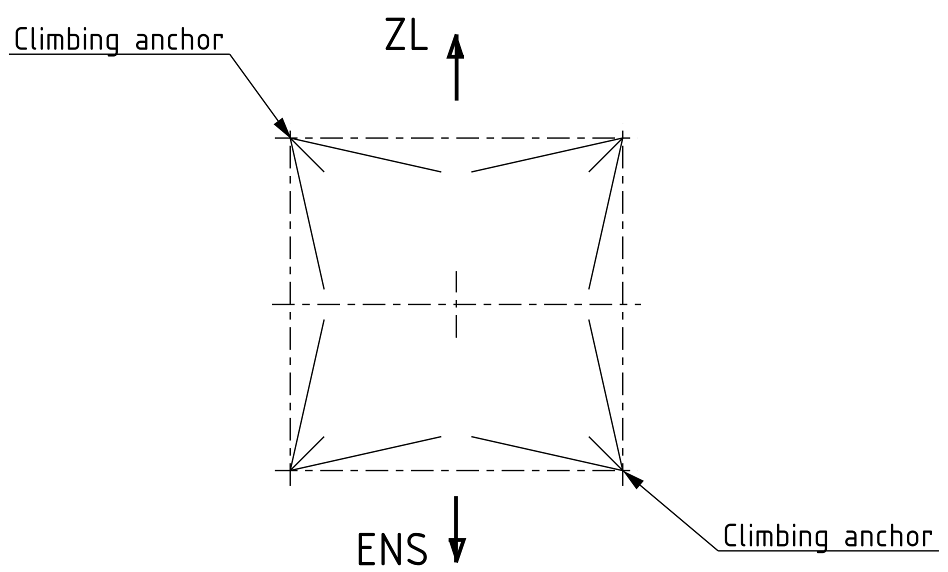


Section

1:250

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

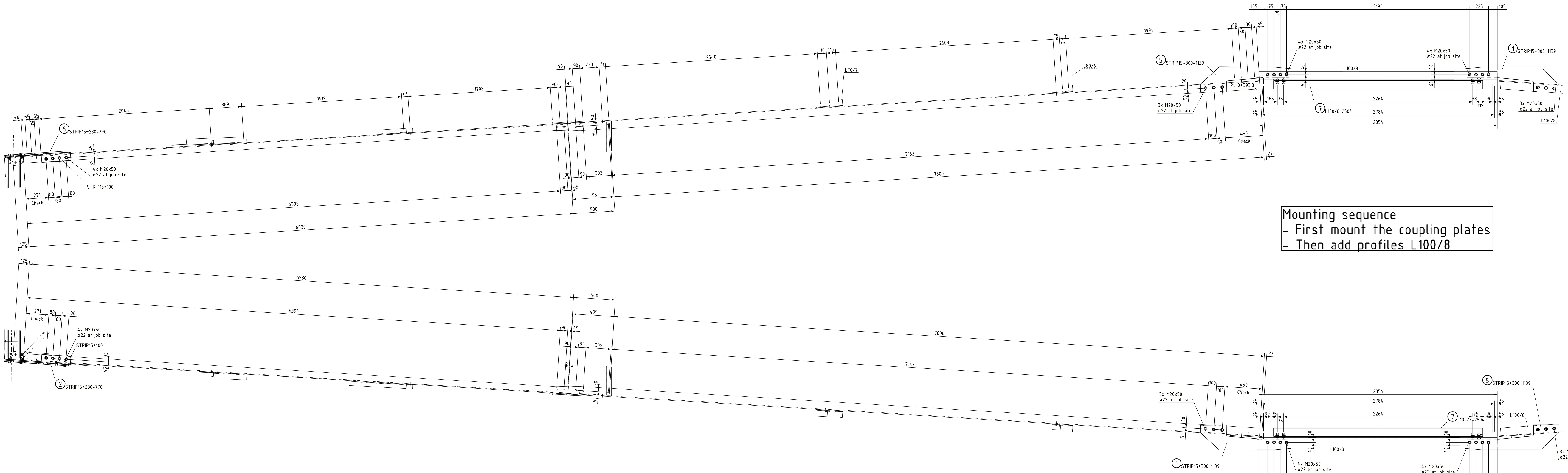
- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam			Getekend	Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:250	594x420

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Masttype S+15_R, Mast 89 - Overzicht
Documentnummer:	00974-01-89001

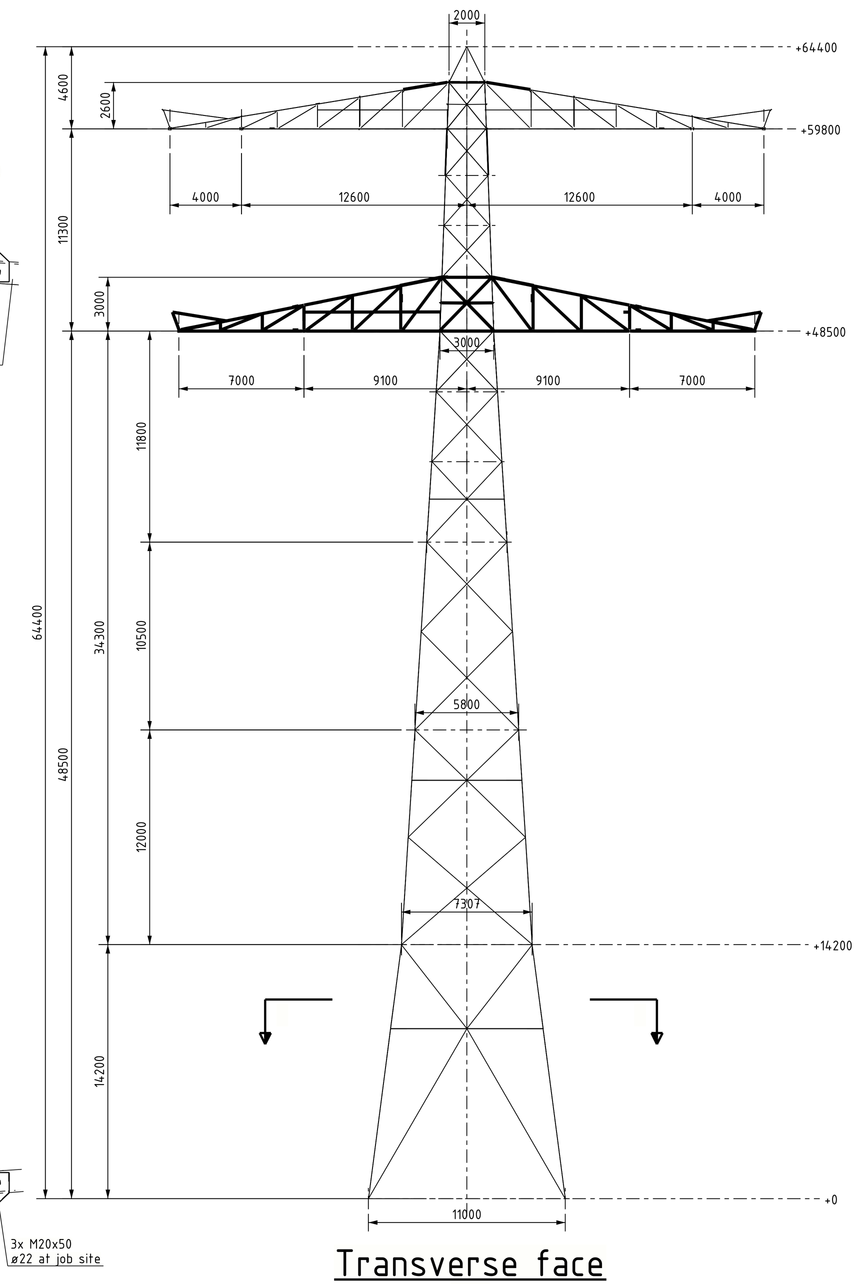
TenneT Taking power further

Tekla Structures



Section A - A
1:20

Section B-B
1:20



Transverse face
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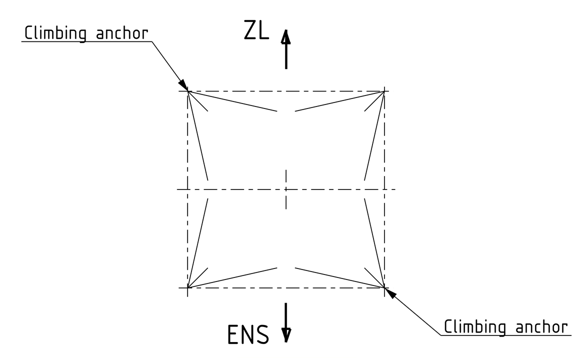
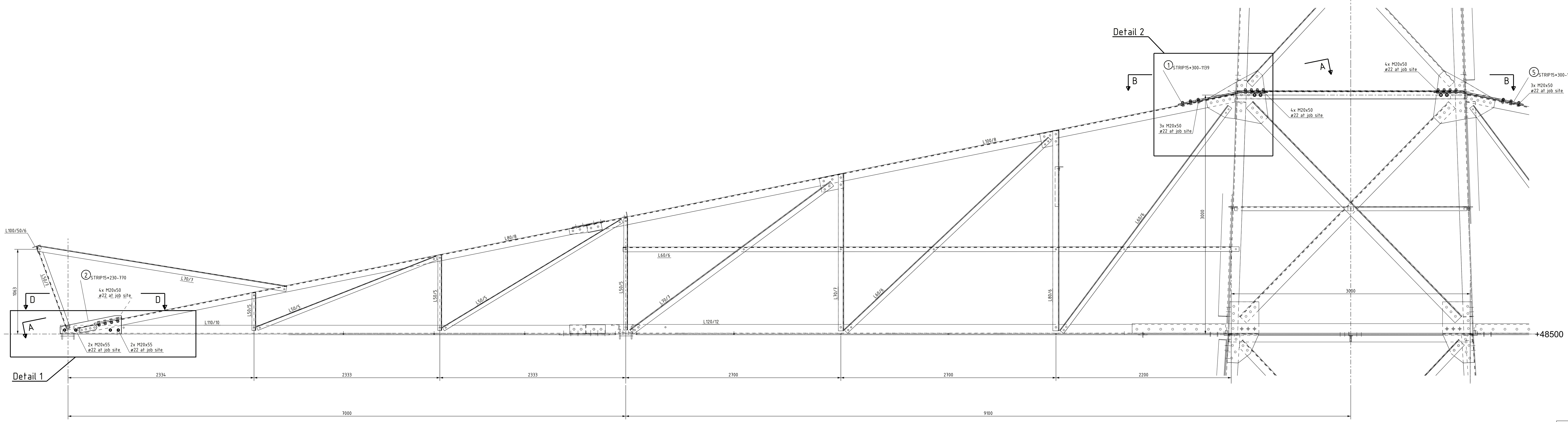
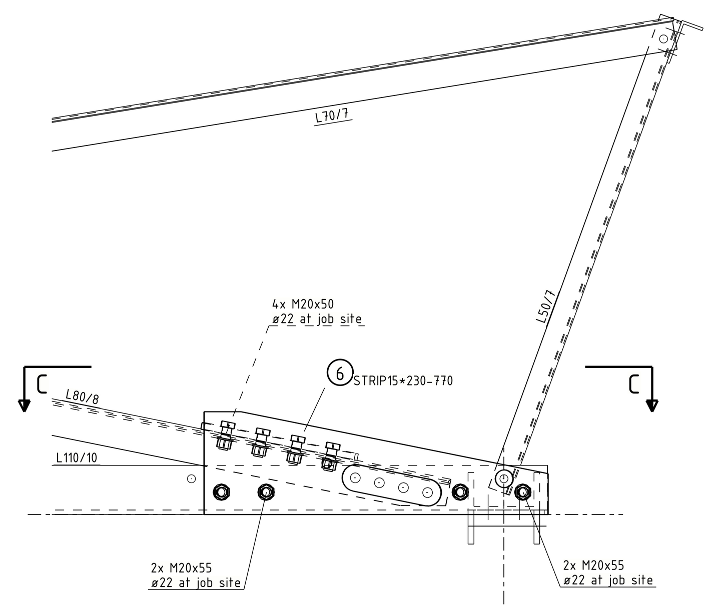


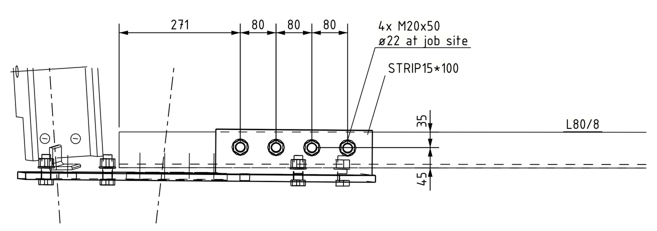
Section
1:250



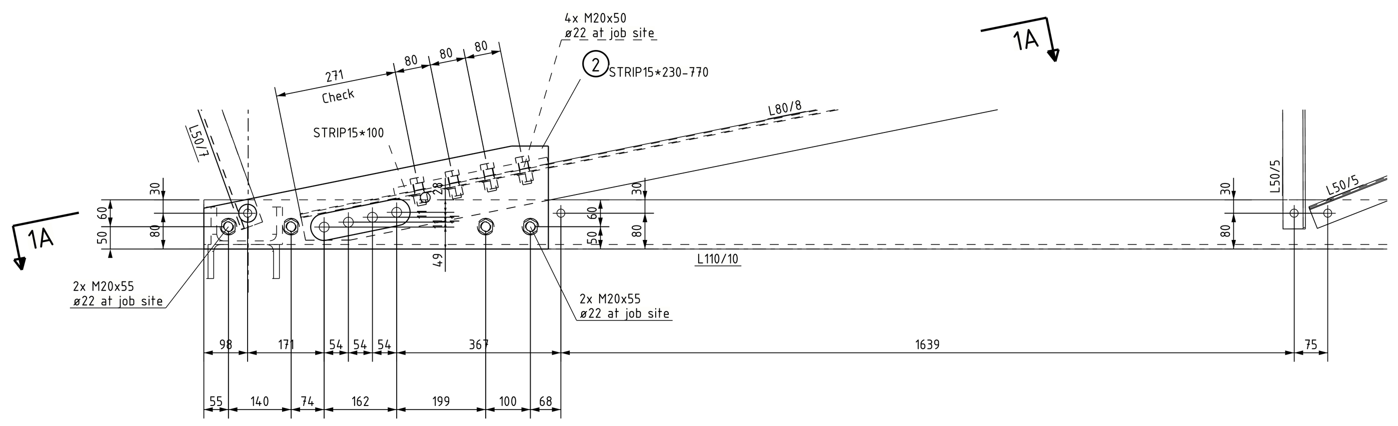
Front Face Lower Cross Arm
1:20



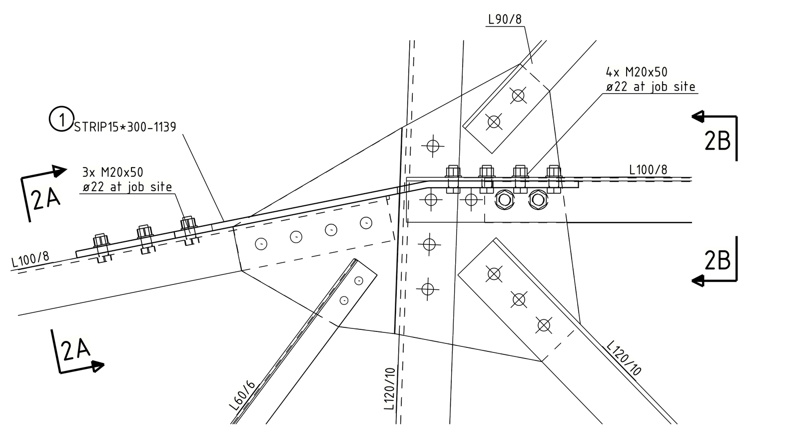
Front Face Lower Cross Arm
1:10



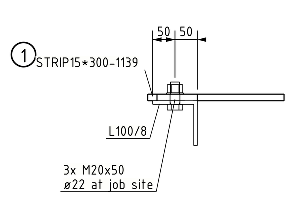
Section 1A - 1A
1:10



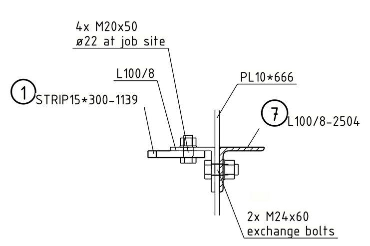
Detail 1
1:10



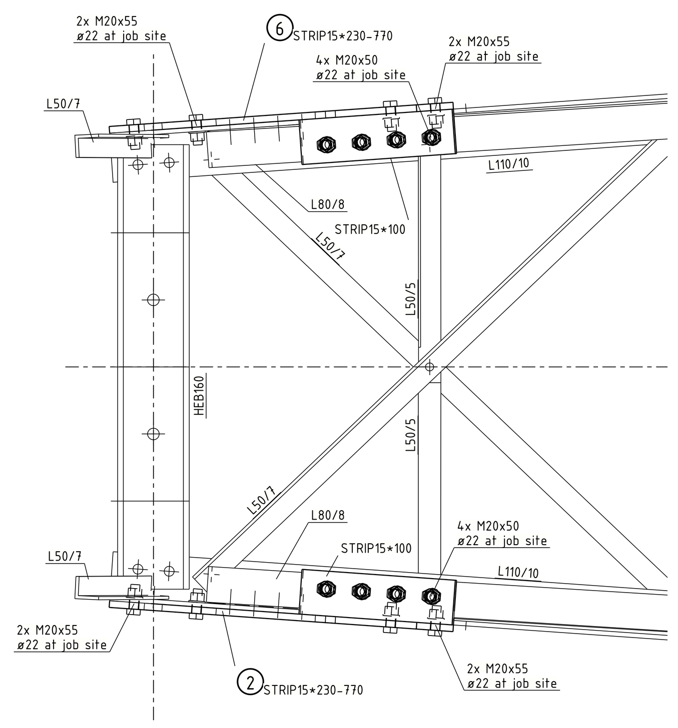
Detail 2
1:10



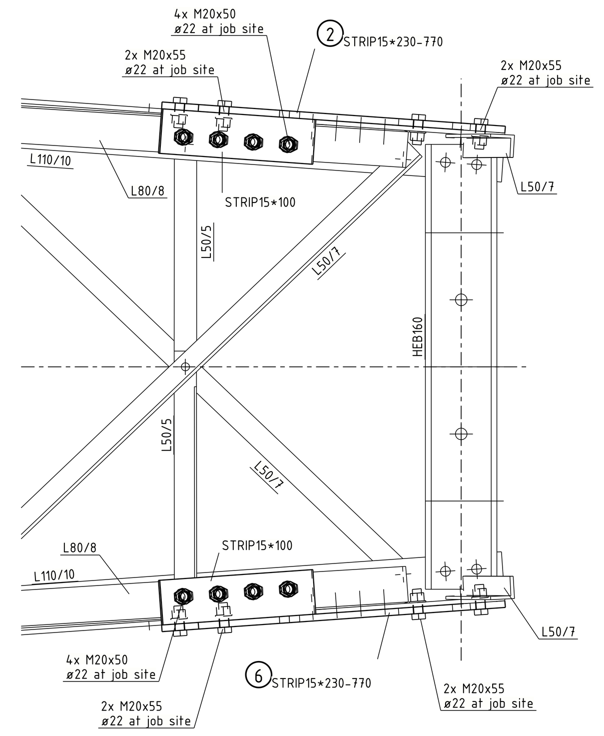
Section 2A - 2A
1:10



Section 2B - 2B
1:10



Section D - D
1:10



Section C - C
1:10

Checking feasibility through zero assessment

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

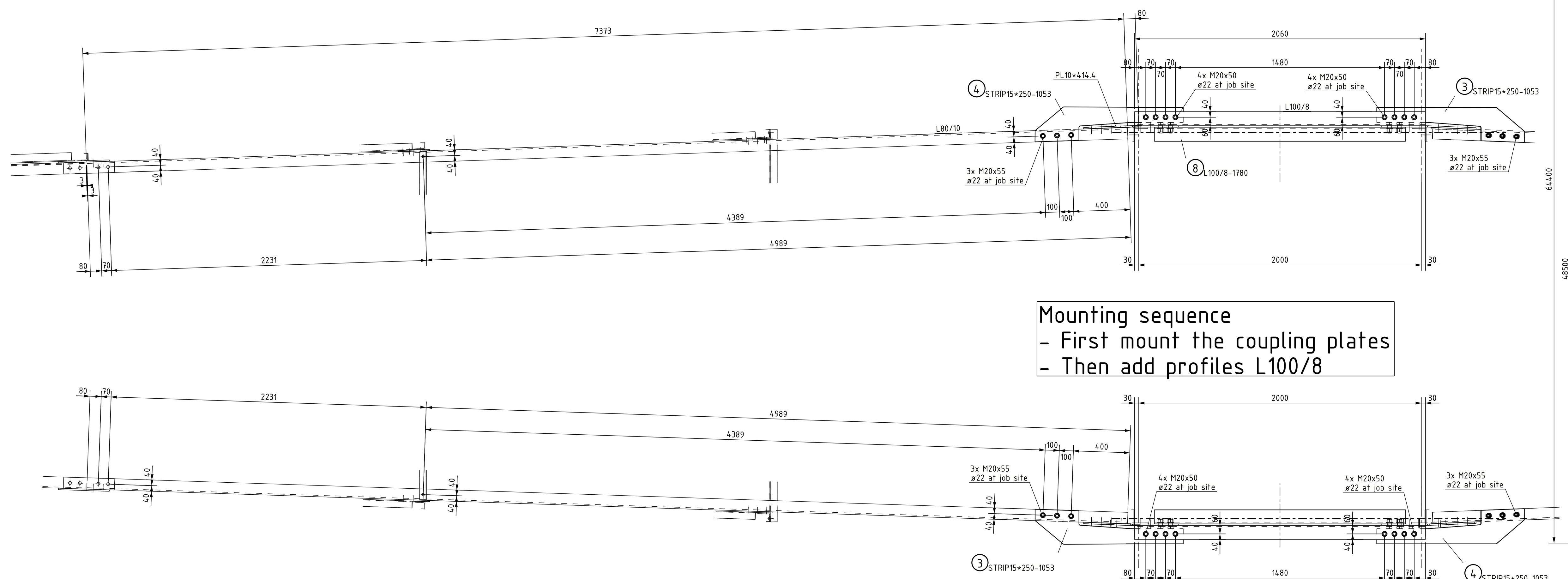
Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie

Oud tekeningnummer:

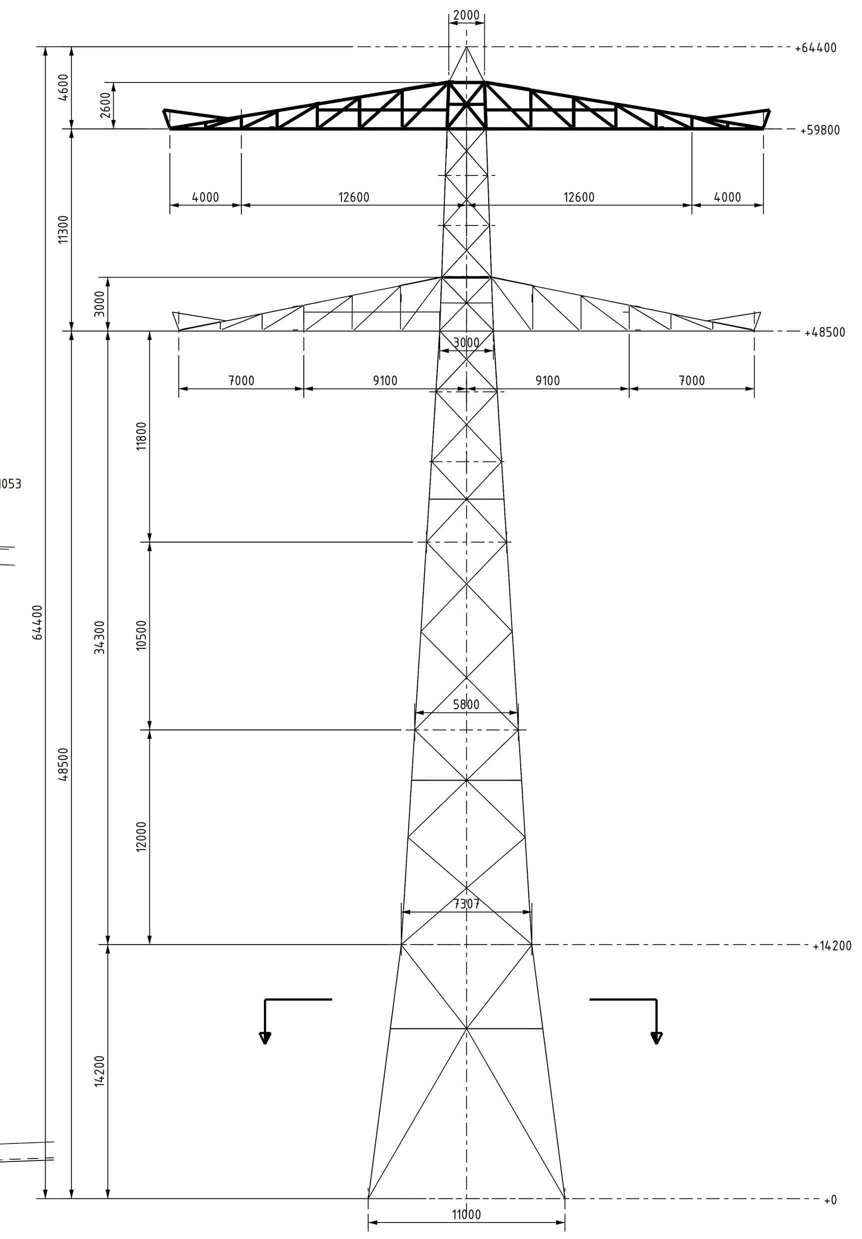
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Masttype S+15_R, Mast 89 - Ondertraverse
Documentnummer:	00974-01-90002

TenneT Taking power further

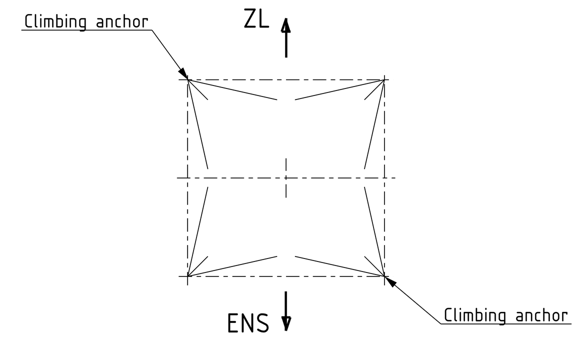


Section A-A
1:20

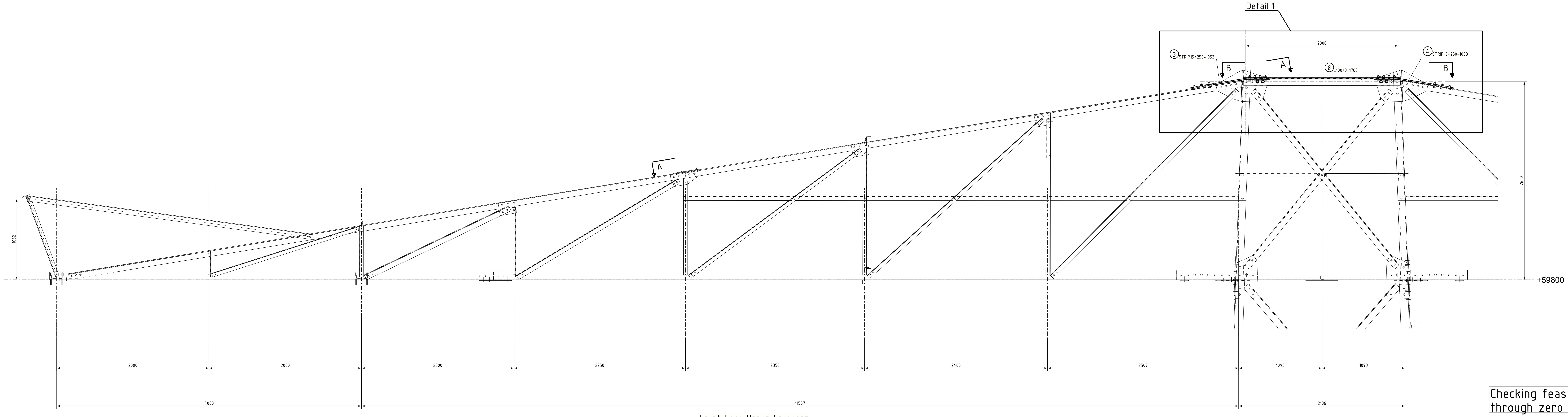
Section B-B
1:20



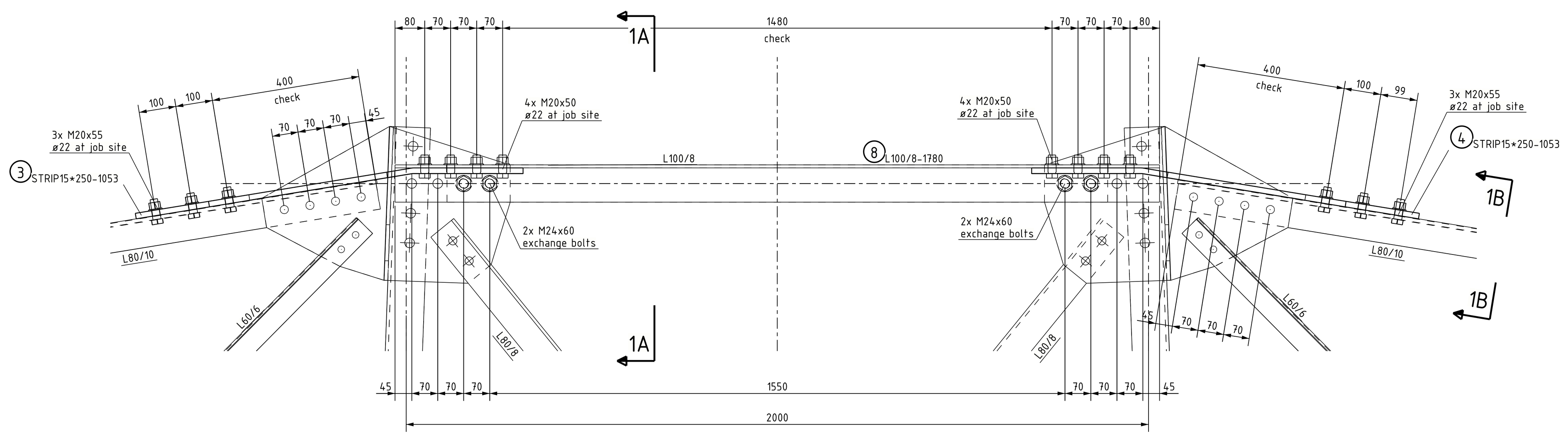
Transverse face
1:250



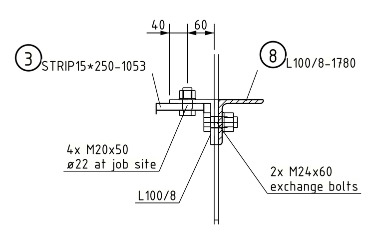
Section
1:250



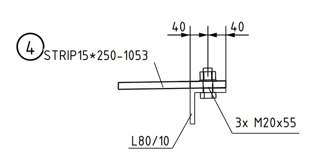
Front Face Upper Crossarm
1:20



Detail 1
1:10



Section 1A - 1A
1:10



Section 1B - 1B
1:10

Checking feasibility
through zero assessment

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
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Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

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Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam					Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle					Voorlopig	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380 S+15_R Mast 89
	Omschrijving:	Masttype S+15_R, Mast 89 - Boventraverse
TenneT Taking power further	Documentnummer:	00974-01-90003

Ingenieursbureau
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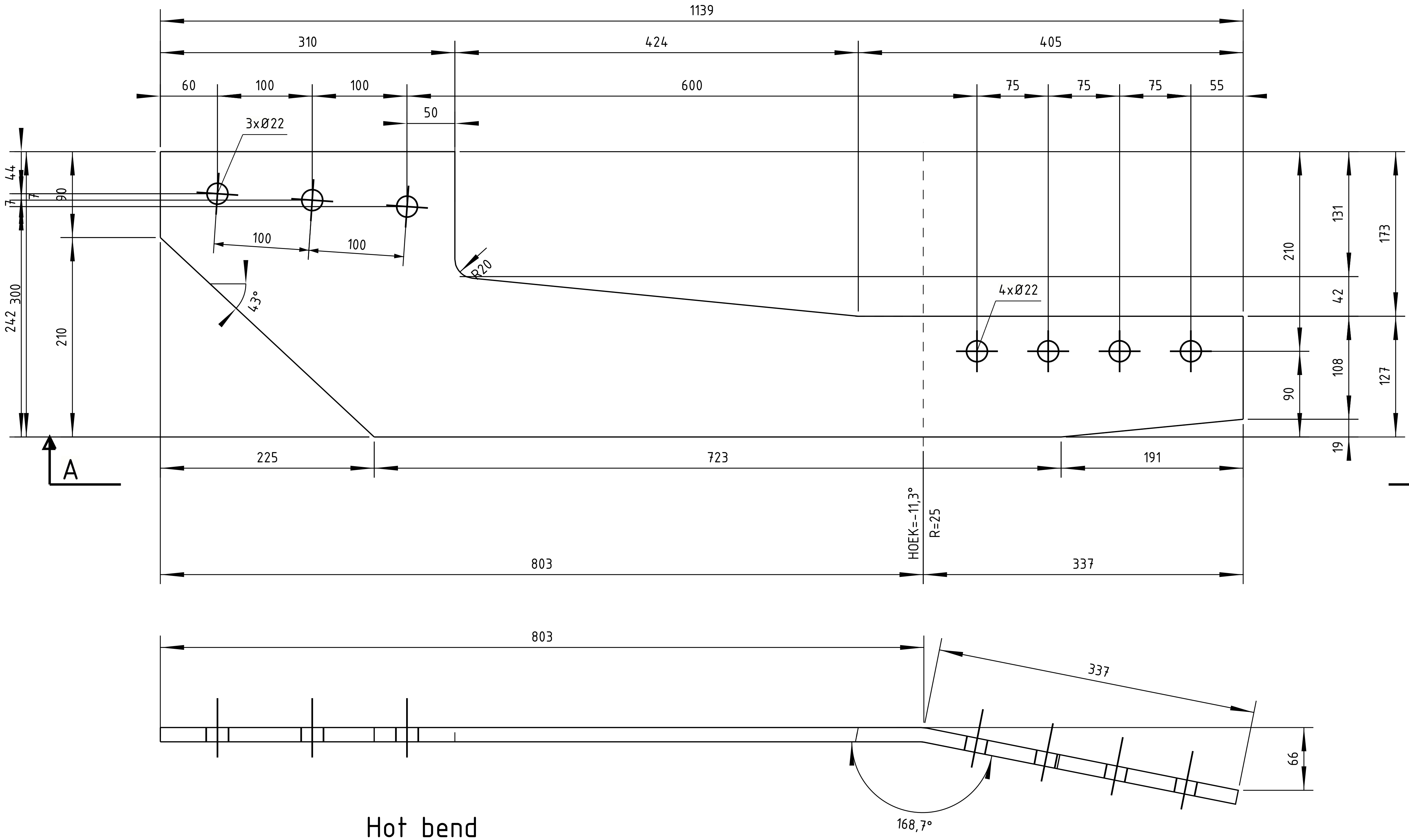
Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-08910**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994431**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**Masttype S+15_R, Mast 89- Onderdeeltekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		10-03-2022
Validatie Aafjes	Niels Verhaar	System Engineer		10-03-2022
Vrijgegeven	Bart Aafjes	Projectleider		10-03-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	10-03-2022	1e versie ter review



A - A
1:5

1	STRIP15*300	2	S355J2	1139	0.40
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

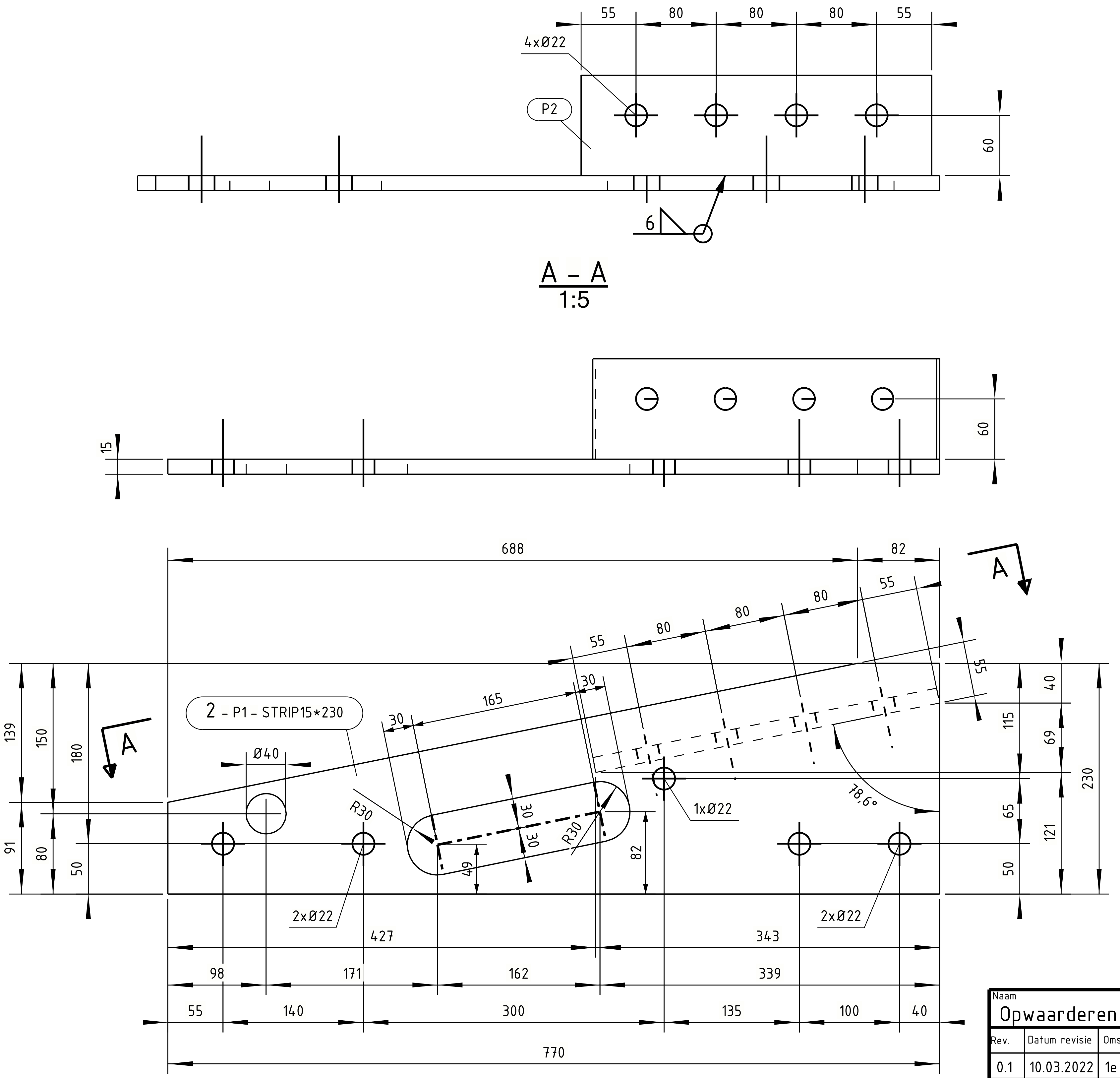
Object ID: ENS-ZL380 S+15_R Mast 89

Omschrijving: Nieuw staal - onderdeel [1]

Documentnummer:

TenneT Taking power further

Tekla Structures



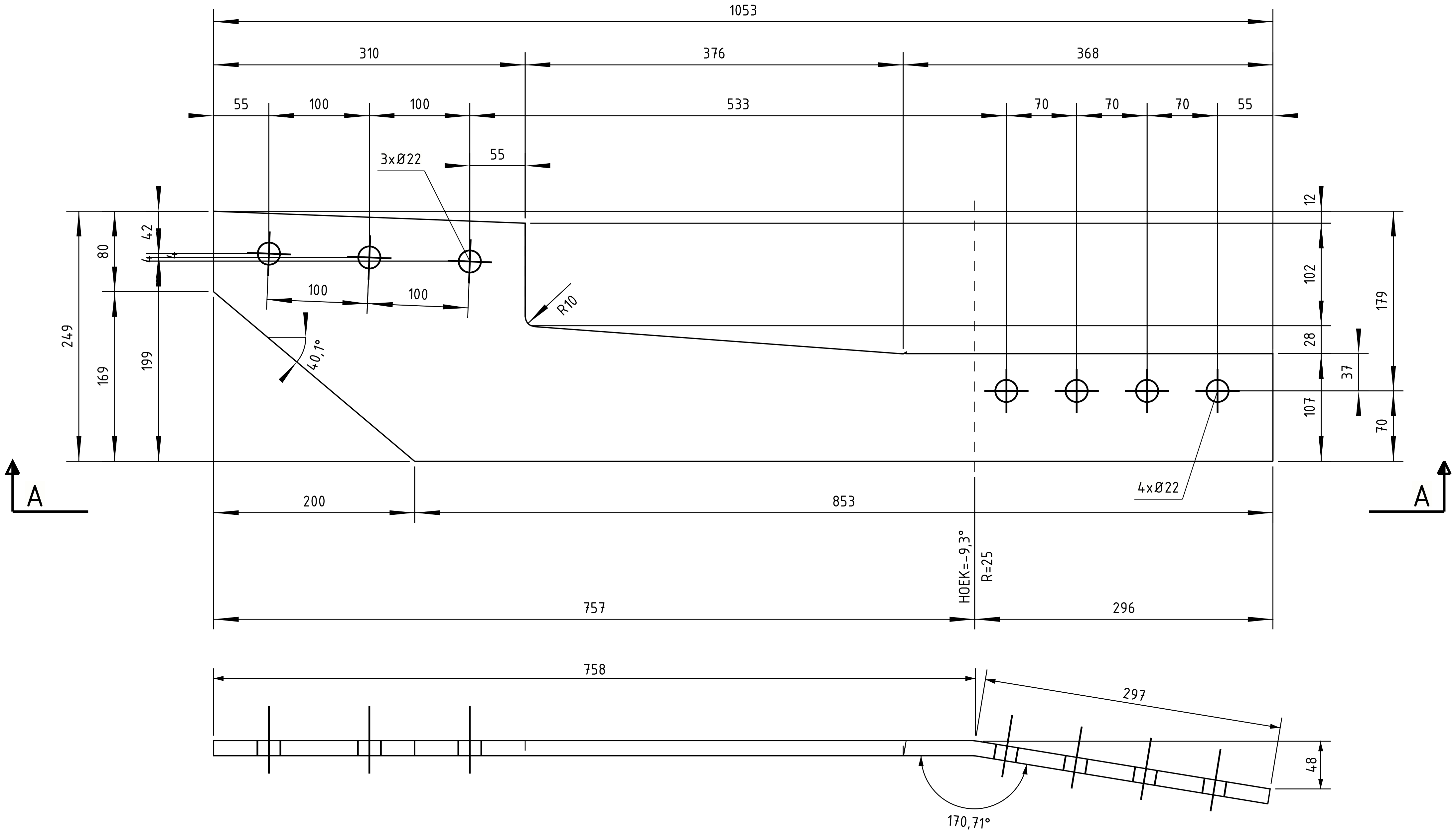
ASSEMBLY						
Mark: 2		length (mm): 770		Number: 2		
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P1	STRIP15*230	S355J2	1	770	13.9	0.27
P2	STRIP15*100	S355J2	1	350	4.2	0.08
			Total of one mark		18.1	0.35

Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Nieuw staal - onderdeel [2]
Documentnummer:	

TenneT Taking power further

Tekla Structures



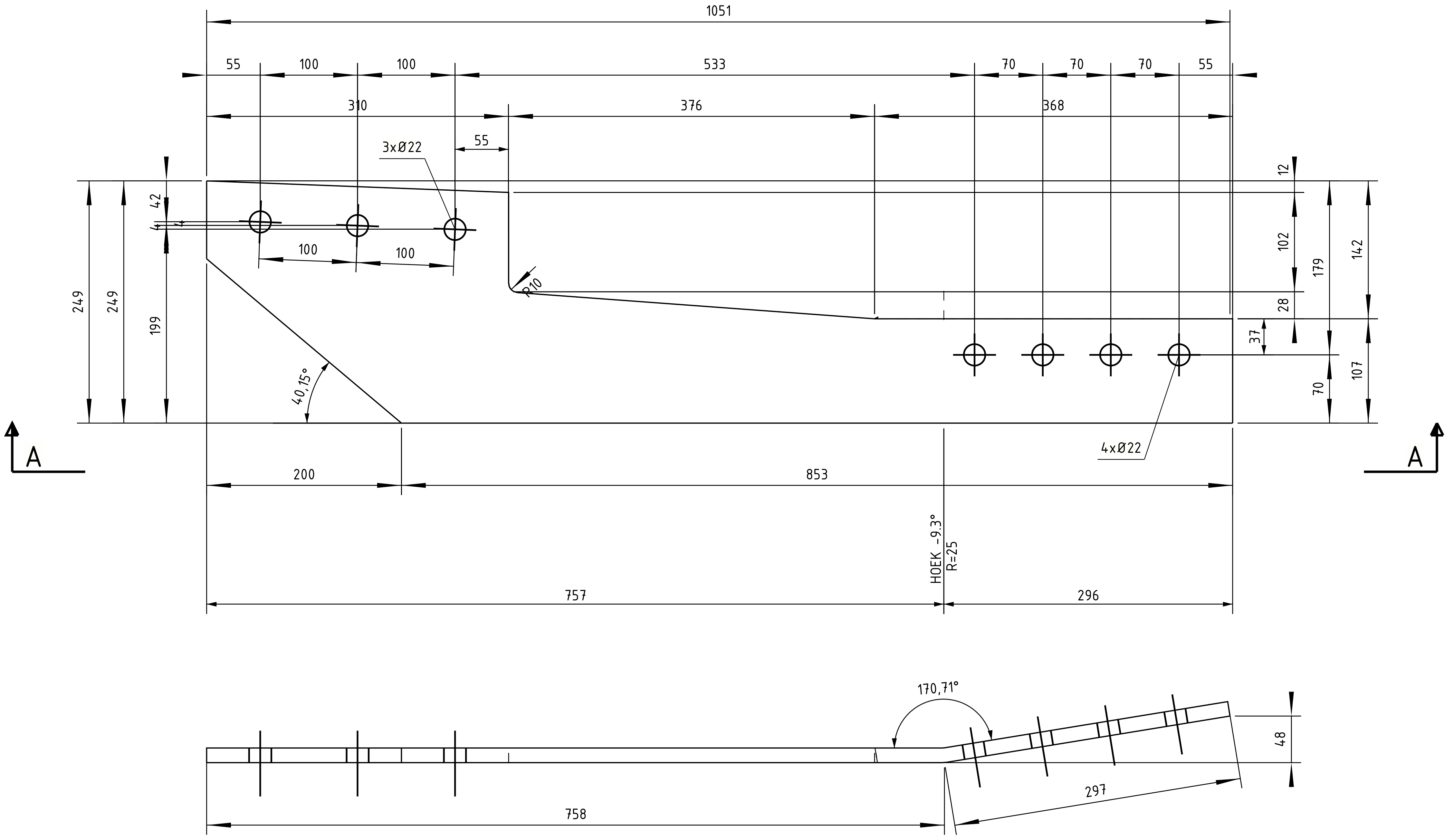
Hot bend

A - A
1:5

Pos	Profile	Number	Grade	Length	Area (m²)
3	STRIP15*250	2	S355J2	1053	0.32

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig
Rev.	0.1
Datum revisie	10.03.2022
Omschrijving revisie	1e versie ter review
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:5
Formaat	A3
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Nieuw staal - onderdeel [3]
Documentnummer:	

TenneT
Taking power further



Hot bend

A - A
1:5

Pos	Profile	Number	Grade	Length	Area (m²)
4	STRIP15*250	2	S355J2	1053	0.32

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

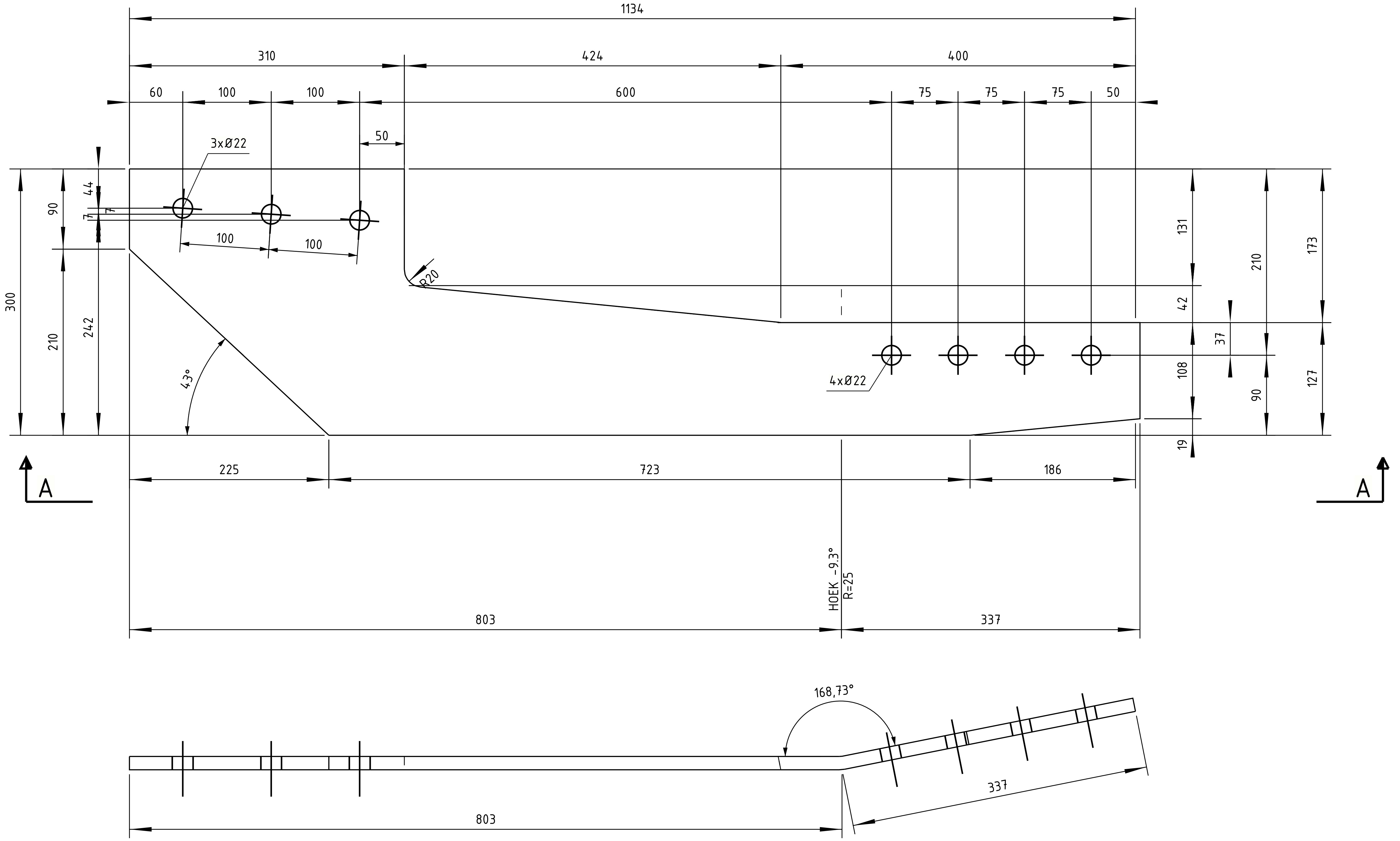
Relatie

Oud tekeningnummer:

TenneT
Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Nieuw staal - onderdeel [4]
Documentnummer:	

Tekla Structures



Hot bend

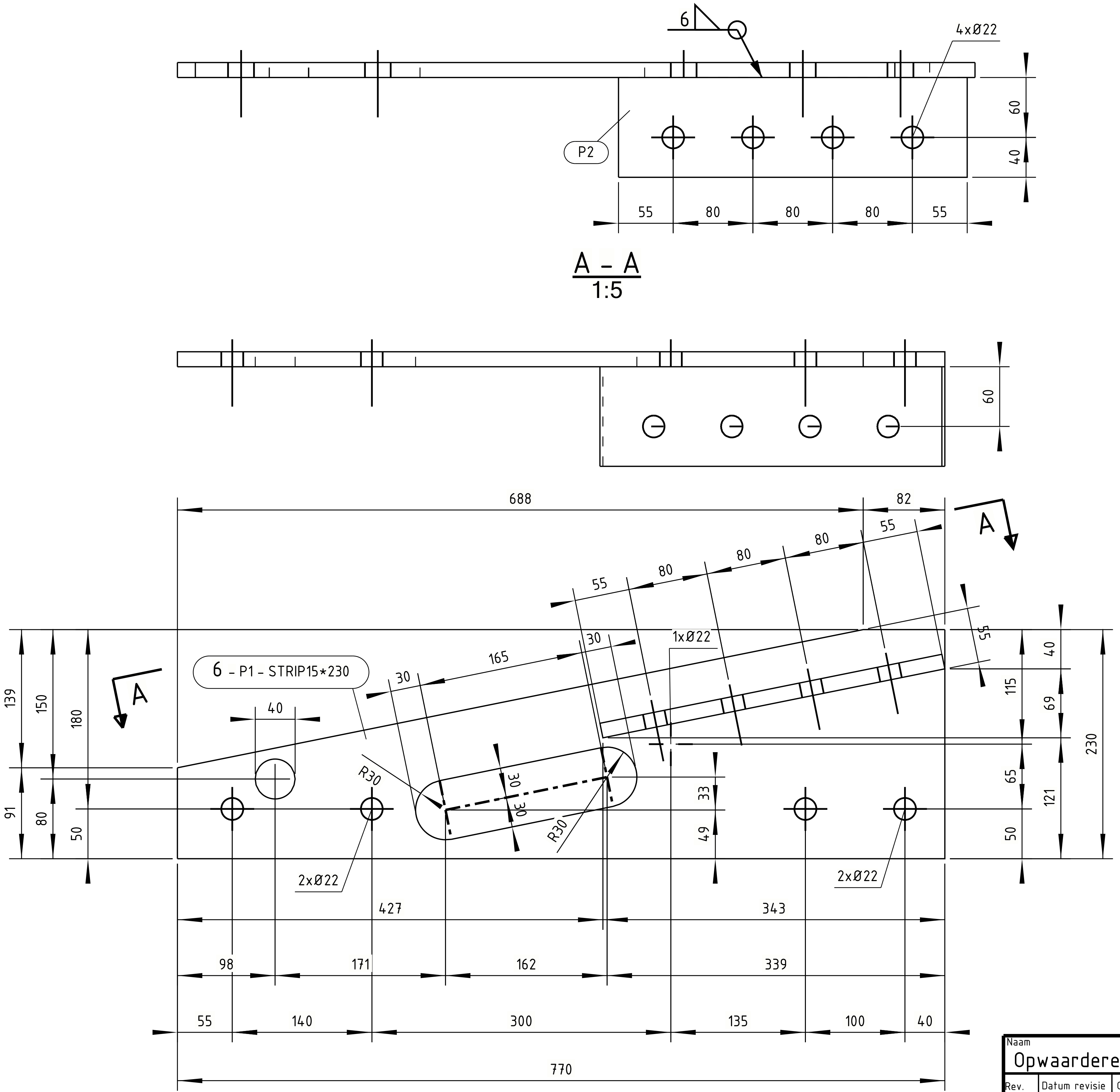
A - A
1:5

Pos	Profile	Number	Grade	Length	Area (m²)
5	STRIP15*300	2	S355J2	1139	0.40

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Voorlopig
Rev.	0.1
Datum revisie	10.03.2022
Omschrijving revisie	1e versie ter review
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:5
Formaat	A3
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Nieuw staal - onderdeel [5]
Documentnummer:	

TenneT Taking power further

Tekla Structures

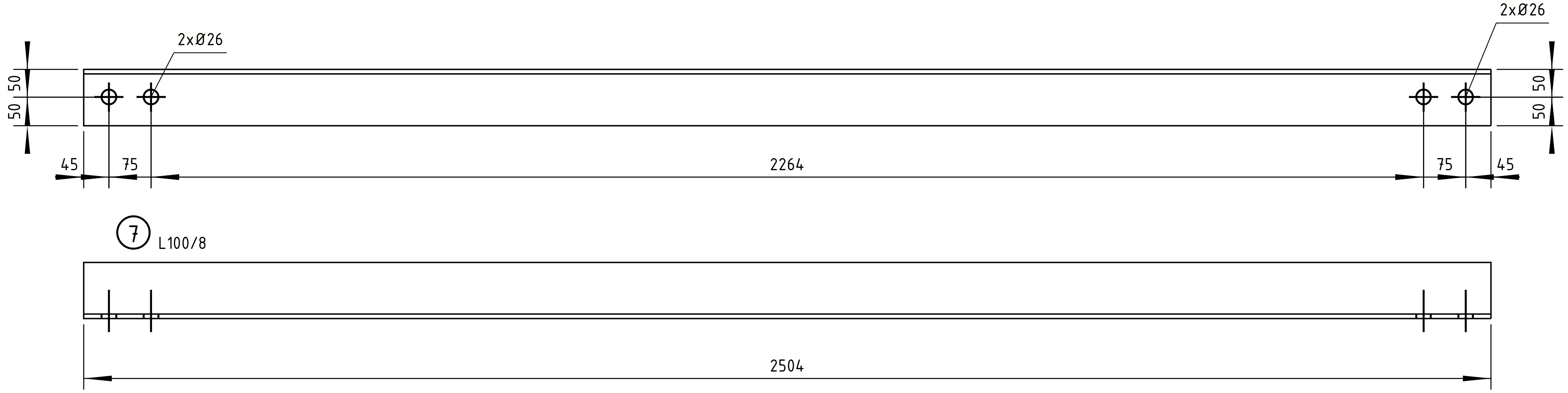


ASSEMBLY						
Mark: 6		length (mm): 770		Number: 2		
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P1	STRIP15*230	S355J2	1	770	13.9	0.27
P2	STRIP15*100	S355J2	1	350	4.2	0.08
				Total of one mark	18.1	0.35

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 S+15_R Mast 89
Omschrijving:	Nieuw staal - onderdeel [6]
Documentnummer:	

TenneT
Taking power further



Pos	Profile	Number	Grade	Length	Area (m²)
7	L100/8	2	S355J2	2504	1.00

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

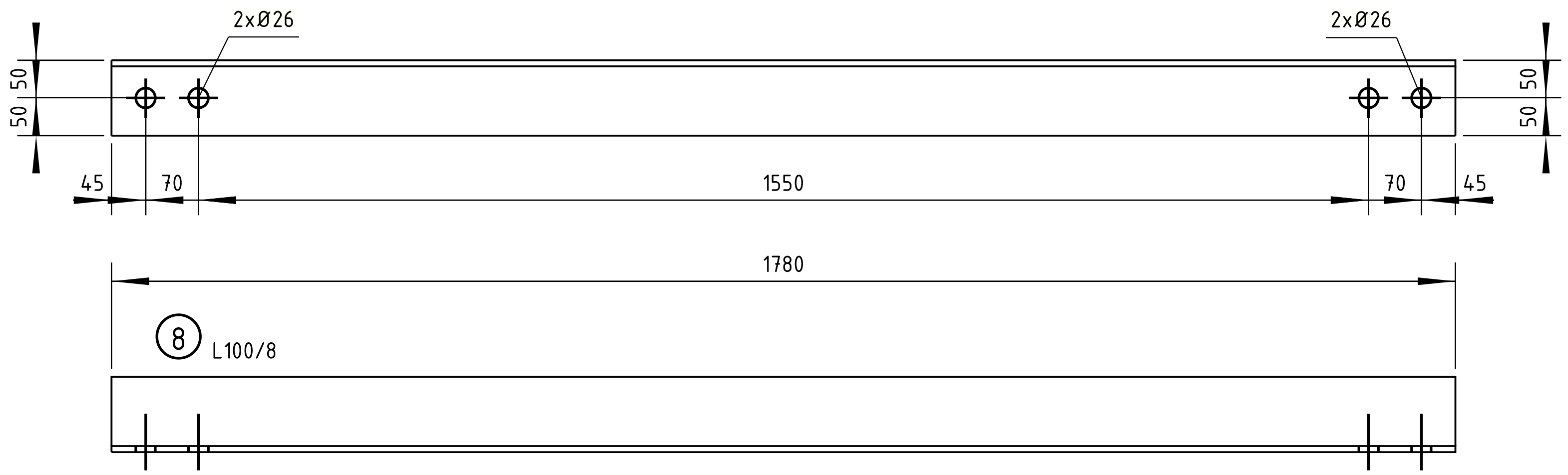
Object ID: ENS-ZL380 S+15_R Mast 89

Omschrijving: Nieuw staal - onderdeel [7]

Documentnummer:

TenneT Taking power further

Tekla Structures



8	L100/8	2	S355J2	1780	0.71
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Voorlopig

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:10	A3

Relatie

Oud tekeningnummer:

TenneT Taking power further

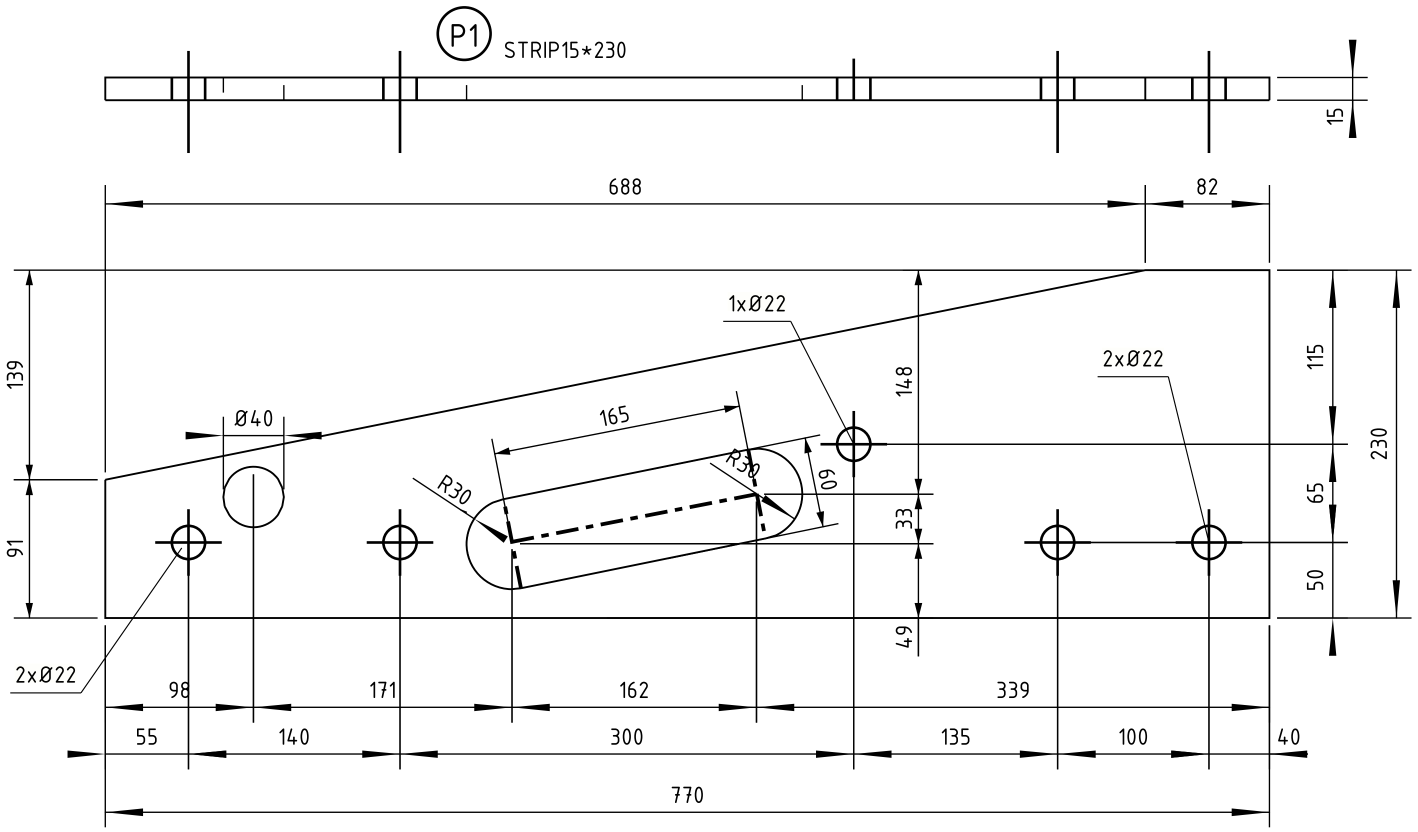
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 S+15_R Mast 89

Omschrijving:
Nieuw staal - onderdeel [8]

Documentnummer:

Tekla Structures



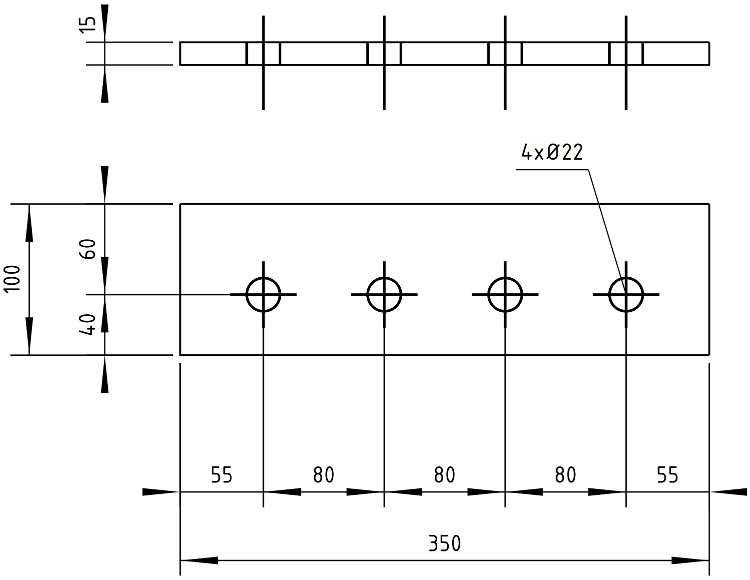
Pos	Profile	Number	Grade	Length	Area (m^2)
P1	STRIP15*230	4	S355J2	770	0.27

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	A3

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 S+15_R Mast 89
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P1]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



P2	STRIP15*100	4	S355J2	350	0.08
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus: Voorlopig		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
0.1	10.03.2022	1e versie ter review	Ing. bureau Aafjes b.v.		1:5	210x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 S+15_R Mast 89
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P2]
Documentnummer:	

TenneT Taking power further

Tekla Structures

Ingenieursbureau
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Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-08920**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994432**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**Masttype S+15_R, Mast 89 - Lijsten**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		10-03-2022
Validatie Aafjes	Niels Verhaar	System Engineer		10-03-2022
Vrijgegeven	Bart Aafjes	Projectleider		10-03-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	10-03-2022	1e versie ter review

BOUTEN-, MOEREN-, RINGENLIJST Pagina: 1

ENS-ZL380 Datum: 07.03.2022
Masttype S+15_R
t.b.v. mast 89

Naam	Type	Kwal.	Aantal
BOUT-M20*50	4017	8.8	60
BOUT-M20*55	4017	8.8	28
BOUT-M24*60	4017	8.8	16
MOER-M20	4032		88
MOER-M24	4032		16
RING-M20	7091		88
RING-M24	7091		16

MATERIAALLIJST

Pagina: 1

ENS-ZL380

Datum: 07.03.2022

Masttype S+15_R
t.b.v. mast 89

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
L100/8	7	S355J2	2	2504	1.00	31.1
L100/8	8	S355J2	2	1780	0.71	22.1
				8568	3.43	106.3
STRIP15*100	P2	S355J2	4	350	0.08	4.2
				1400	0.33	16.8
STRIP15*230	P1	S355J2	4	770	0.27	13.9
				3080	1.07	55.4
STRIP15*250	3	S355J2	2	1053	0.32	17.2
STRIP15*250	4	S355J2	2	1053	0.32	17.2
				4214	1.29	68.7
STRIP15*300	1	S355J2	2	1139	0.40	21.8
STRIP15*300	5	S355J2	2	1139	0.40	21.8
				4556	1.62	87.3
				Totaal:	7.74	334.5

TEKLA STRUCTURES MERKENLIJST Pagina: 1

ENS-ZL380 Datum: 07.03.2022
Masttype S+15_R
t.b.v. mast 89

Merk	Aantal	Profiel	Lengte	Opp.(m2)	Gewicht (kg)
1	2	STRIP15*300	1134	0.40	21.8
2	2	STRIP15*230	770	0.35	18.1
3	2	STRIP15*250	1051	0.32	17.2
4	2	STRIP15*250	1051	0.32	17.2
5	2	STRIP15*300	1134	0.40	21.8
6	2	STRIP15*230	770	0.35	18.1
7	2	L100/8	2504	1.00	31.1
8	2	L100/8	1780	0.71	22.1
Totaal	16	merk(en)		7.74	334.5

Masttype: Masttype S+15_R Mast 89
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekening omschrijving	Tekeningnummer	Rev.	Datum	Tek.	formaat
Masttype S+15_R, Mast 89 - Overzicht	00974-01-08901	0.1	10.03.2022	A2	594x420
Masttype S+15_R, Mast 89 - Ondertraverse	00974-01-08902	0.1	10.03.2022	A0	1189x841
Masttype S+15_R, Mast 89 - Boventraverse	00974-01-08903	0.1	10.03.2022	A0	1189x841
S+15_R, Mast 89 - Onderdeeltekeningen	00974-01-08910	0.1	10.03.2022	A3/A4	

Lijsten	Documentnummer		Datum
bouten-moeren-ringenlijst	00974-01-08920	0.1	07.03.2022
materiaallijst	00974-01-08920	0.1	07.03.2022
merkenlijst	00974-01-08920	0.1	07.03.2022
Documentenlijst	00974-01-08920	0.1	07.03.2022

Detailberekeningen	Documentnummer		Datum
Masttype S+15-R, Mast 89	00974-01-08930	0.1	10.03.2022

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"REVIEW AND RE-DESIGN TOWERS BBB380"

ENS-ZL380 – Tower S+15_R Mast 89

TenneT TSO B.V.

Detail Calculation

Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-08930**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994433**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**S+15_R Mast 89 - Detailberekeningen**

1e versie ter review	G. Pieper	R.Hol	B. Aafjes	10-03-2022	0.1
	Author	Checked	Approved	date	revision

Content

1 Introduction

This report contains the detail calculations of the reinforcements of towertype S+15/R windzone III.

It concerns tower number: Tower 89

To increase the future capacity of electricity transmission, it is necessary to upgrade the transmission grid by building new and modifying existing high voltage connections.

It is for this reason the client (OG) intends to upgrade part the existing 380kV grid. This upgrading is part of the program "Beter Benutten Bestaande 380kV" and consists of the following subprojects:

- Upgrading of the 380 kV-connection Lelystad – Ens (LLS-ENS380).
- Upgrading of the 380 kV-connection Diemen – Lelystad (DIM-LLS380).
- Upgrading of the 380 kV-connection Rilland – Zandvliet (RLL-ZVL380).
- Upgrading of the 380 kV-connection Krimpen aan de IJssel – Geertruidenberg (KIJ-GT380).
- Upgrading of the 380 kV-connection Ens – Zwolle (ENS-ZL380).
- Upgrading of the 380 kV-connection Maasbracht – Eindhoven (MBT-EHV380).

DNV GL has calculated the existing tower for the new situation on behalf of Tennet. On the instructions of DNV GL, the reinforcements mainly consist of the exchange of bolts and profiles and the reinforcement of profiles and the application of redundant members.

DNV GL has tested the profiles and bolts. In this report only the detail calculations are made of the specified reinforcements (bolts are specified by DNV GL).

2 General Data

2.1 Principal constructor

DNV GL – Energy

2.2 Principal calculation and related documents

- ENS-ZL380 – Tower S+15 R
  Reportnr.: 21-1725 Rev 1
  Date: 2021-03-23

- Uitgangspuntenrapport 380kV verbinding Ens – Zwolle
  Reportnr.: 20-1245 Rev.3
  Date: 2021-06-09

2.3 Material- and bolt quality

Materials excisting construction

	Signification 1969	Current startingpoint
Steeltype	St.37	S235JR
	St.52	S355JO
Bolt quality	bolt class 8.8	8.8 rolled thread
Concrete quality	K225	Min. C16/20
Reinforcing steel	Qr24, Qr40	B220, B400

Materials modified construction

Steeltype	S355JO ($t \leqq 16$ mm)
	S355J2 ($16 < t \leqq 40$ mm)
Bolt quality	8.8 rolled thread

2.4 Applicable standards

Mainly used:
- NEN-EN 1993-1-8+C2 :2011/NB:2011 nl

Also used:
- NEN-EN 50341-2-15: 2019
- NEN-EN 8700: 2011
- NEN-EN 8701: 2011
- Eurocode reeks

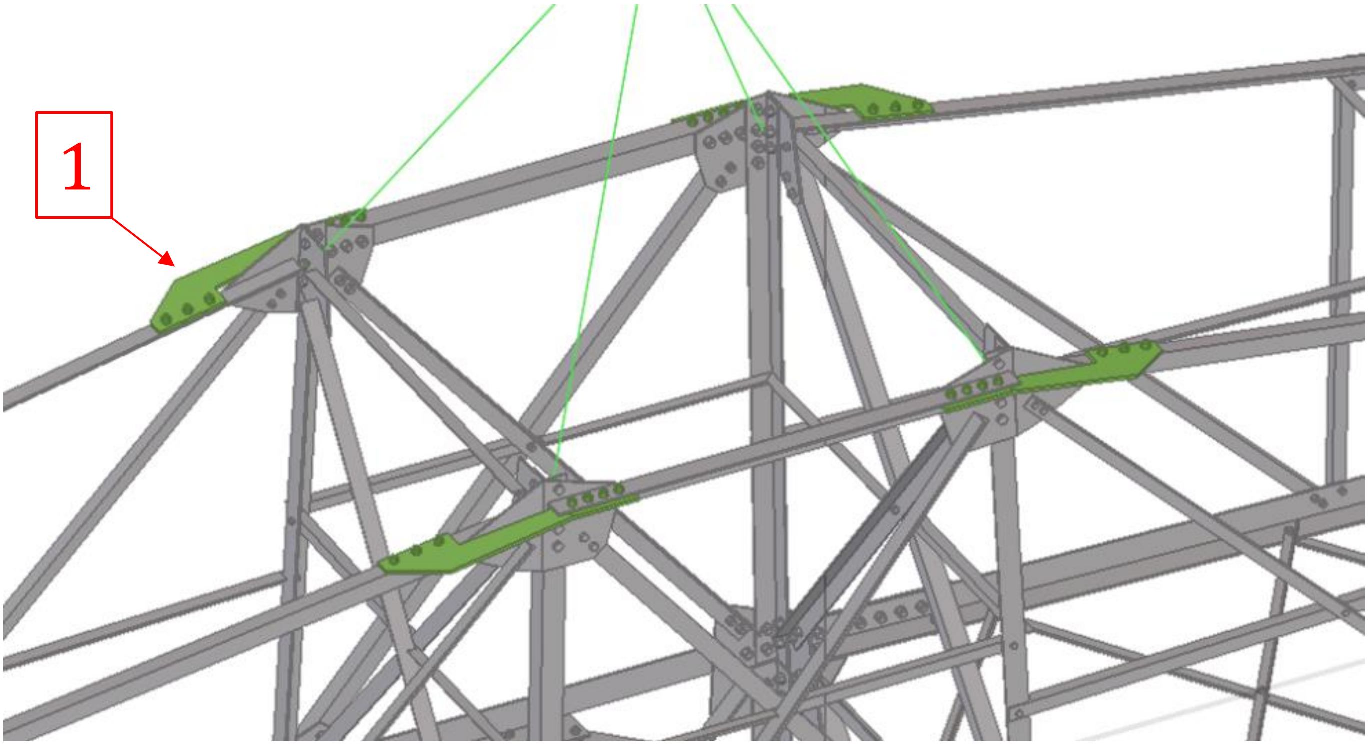
2.5 Tennet specifications

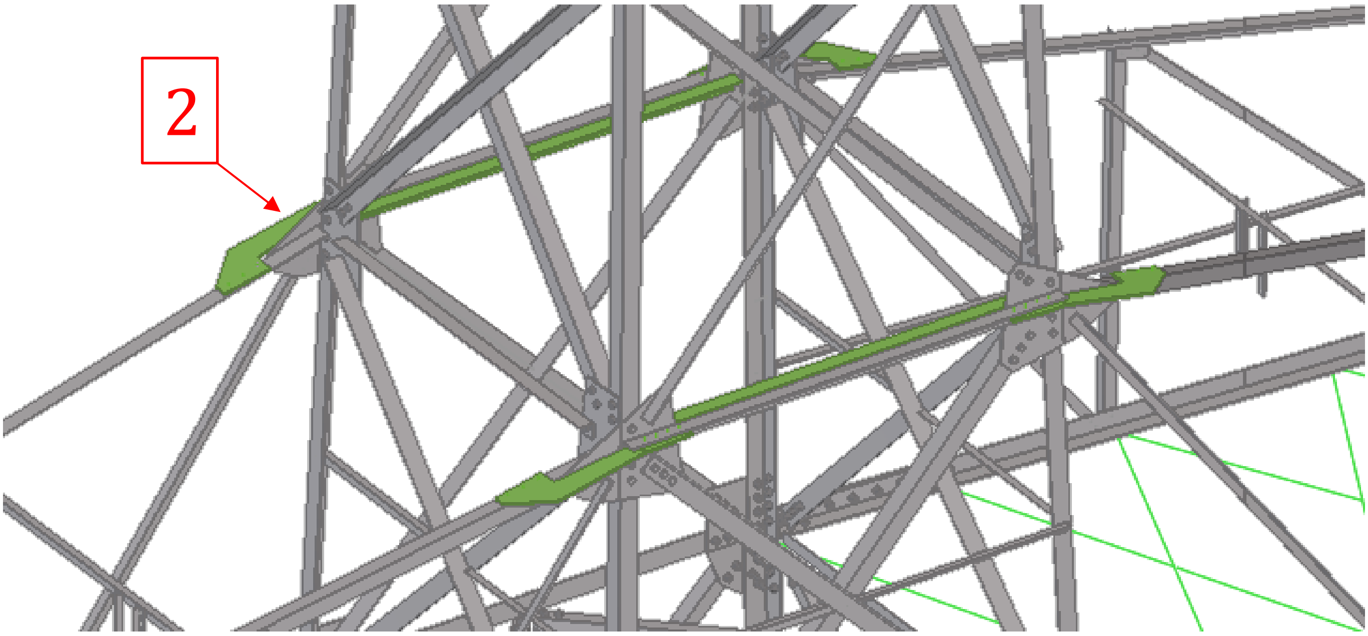
- SPE. 05. 346. v 2.0 algemene specificatie stalen masten

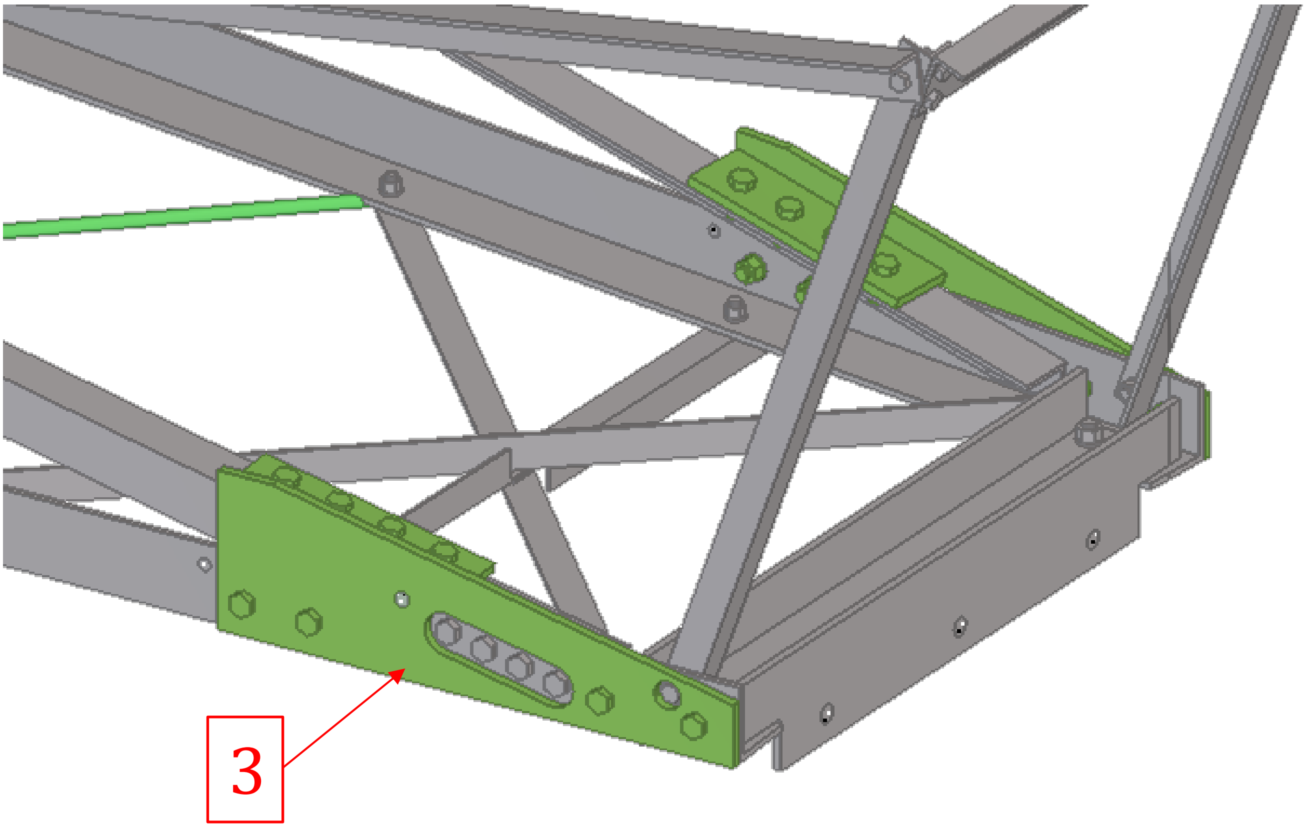
3 Calculations

3.1 Connections

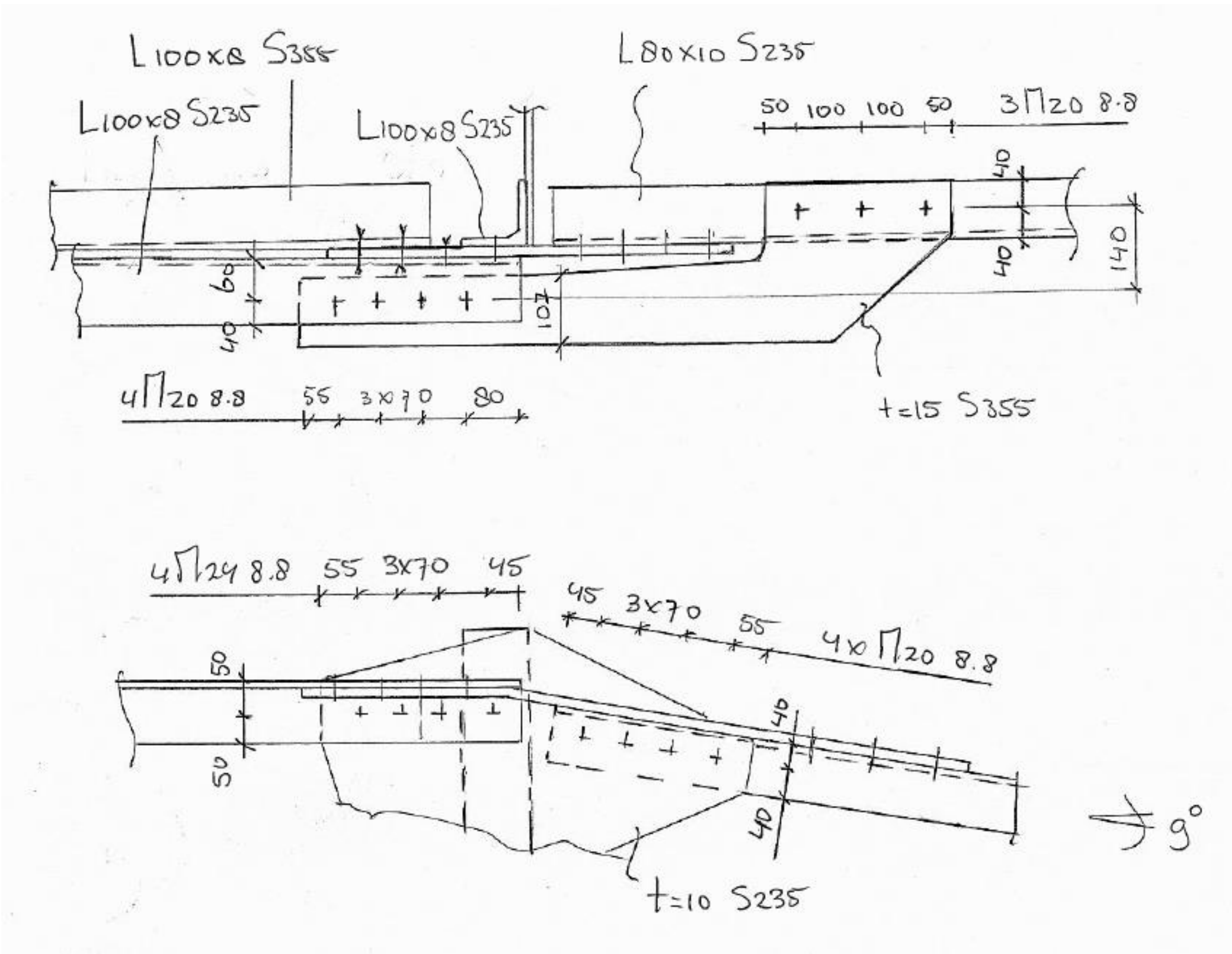
3.1.1 Overview

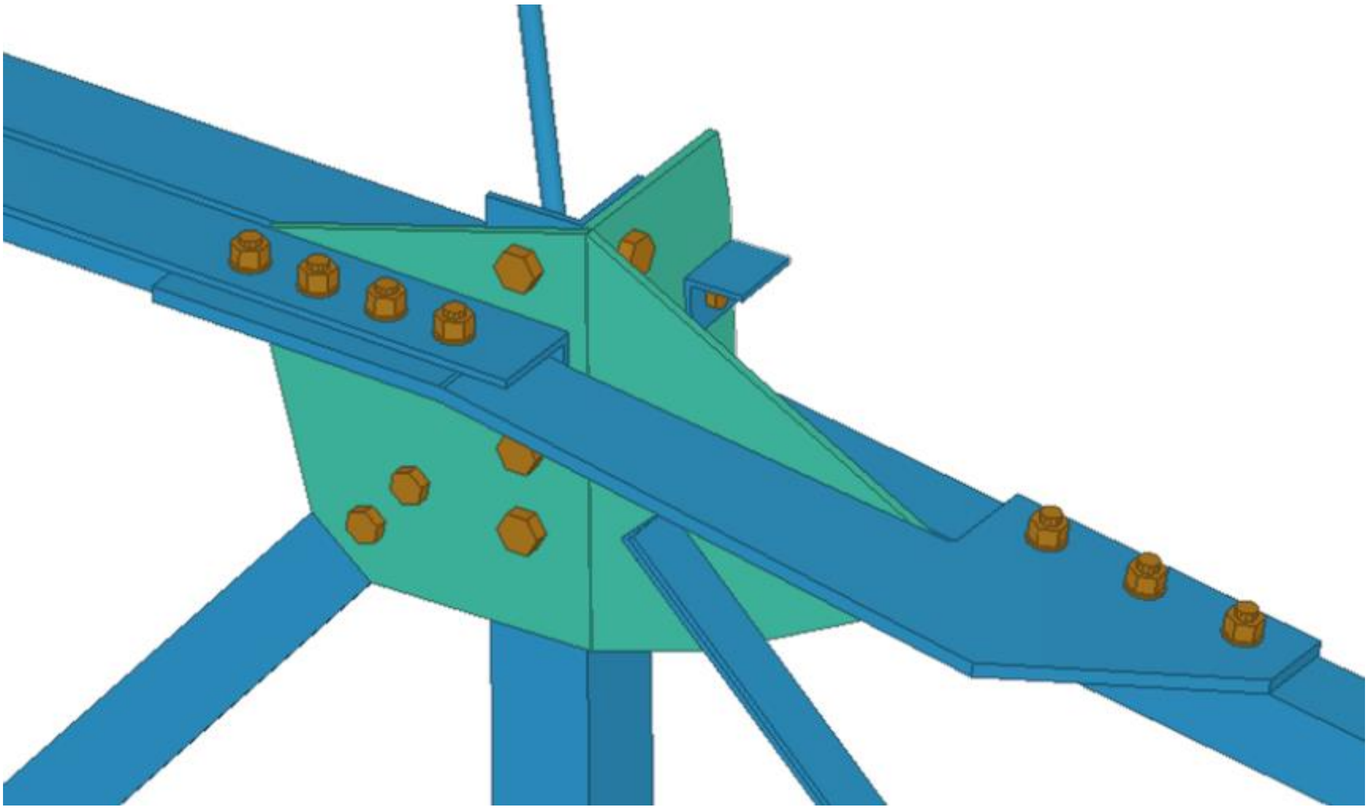


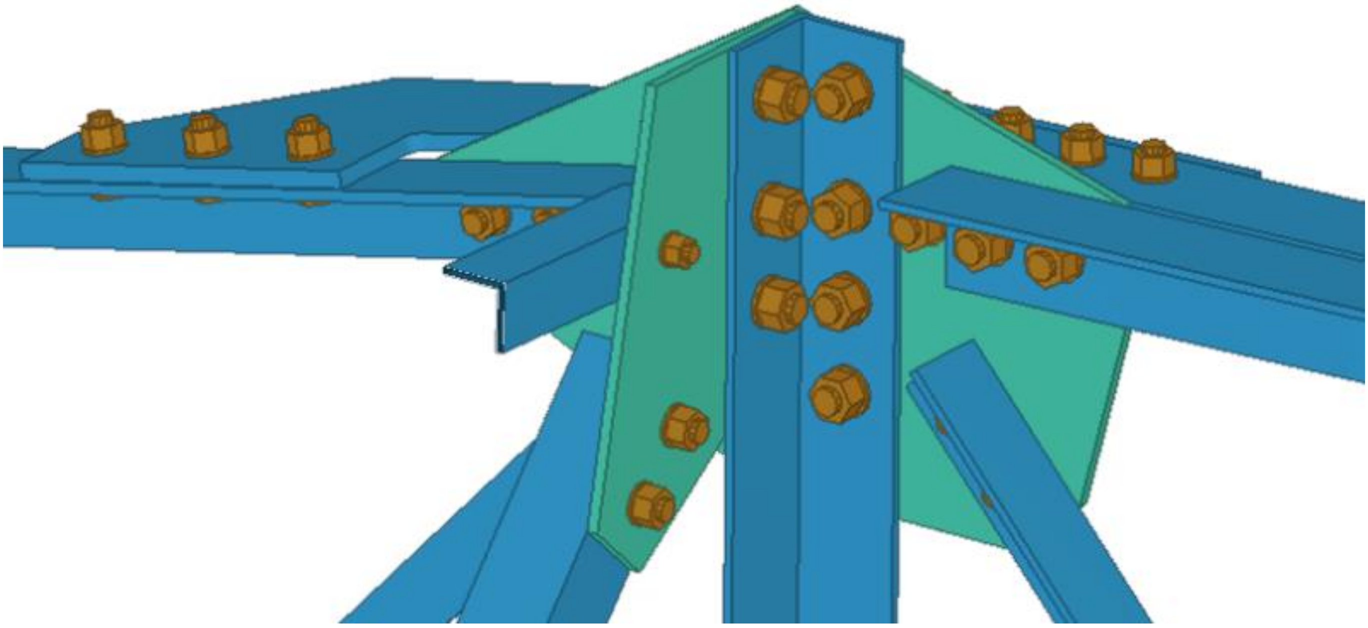



3

3.1.2 Detail 1


L100x8 S355
L100x8 S235
L100x8 S235
L80x10 S235
50 100 100 50
3 M20 8.8
40
40
140
60
40
107
4 M20 8.8
55 3x70 80
t=15 S355
4 M24 8.8
55 3x70 45
45 3x70 55
4x M20 8.8
50
50
40
40
9°
t=10 S235





3.1.3 Loads

Loads from report:

ENS-ZL380 – Tower S+15 R

Report nr.: 21-1725 Rev 1
Date: 2021-03-23

Page 41

Member: 492A L80x80x10 S235

N_{ED} = 0 kN compression N_{ED} = 238,5 kN tension

Page 41

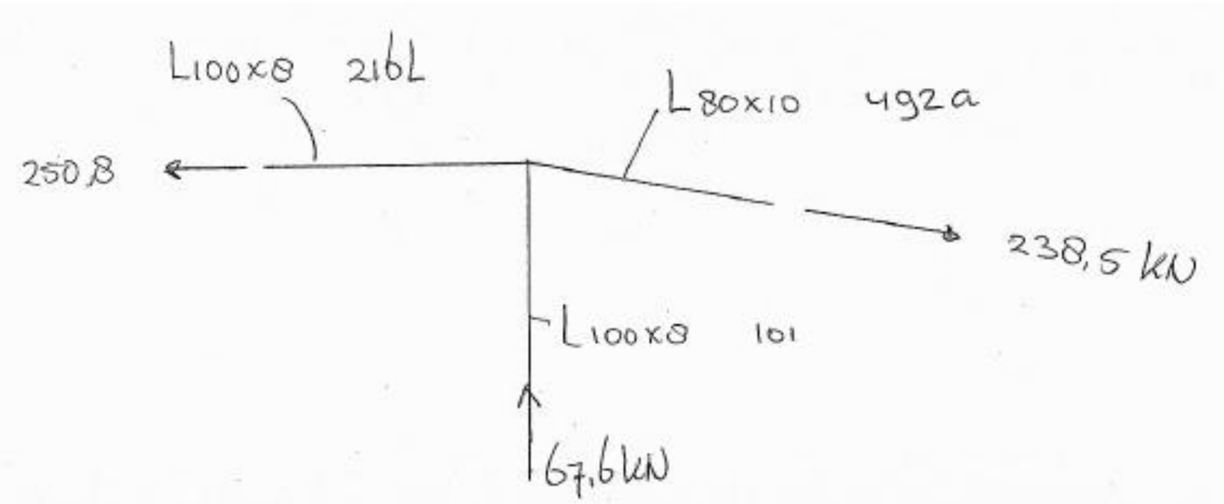
Member: 216L L100x100x8 S235

N_{ED} = 0 kN compression N_{ED} = 250,8 kN tension

Page 39

Member: 101 L100x100x8 S235

N_{ED} = 67,6 kN compression N_{ED} = 8,3 kN tension



L80x10

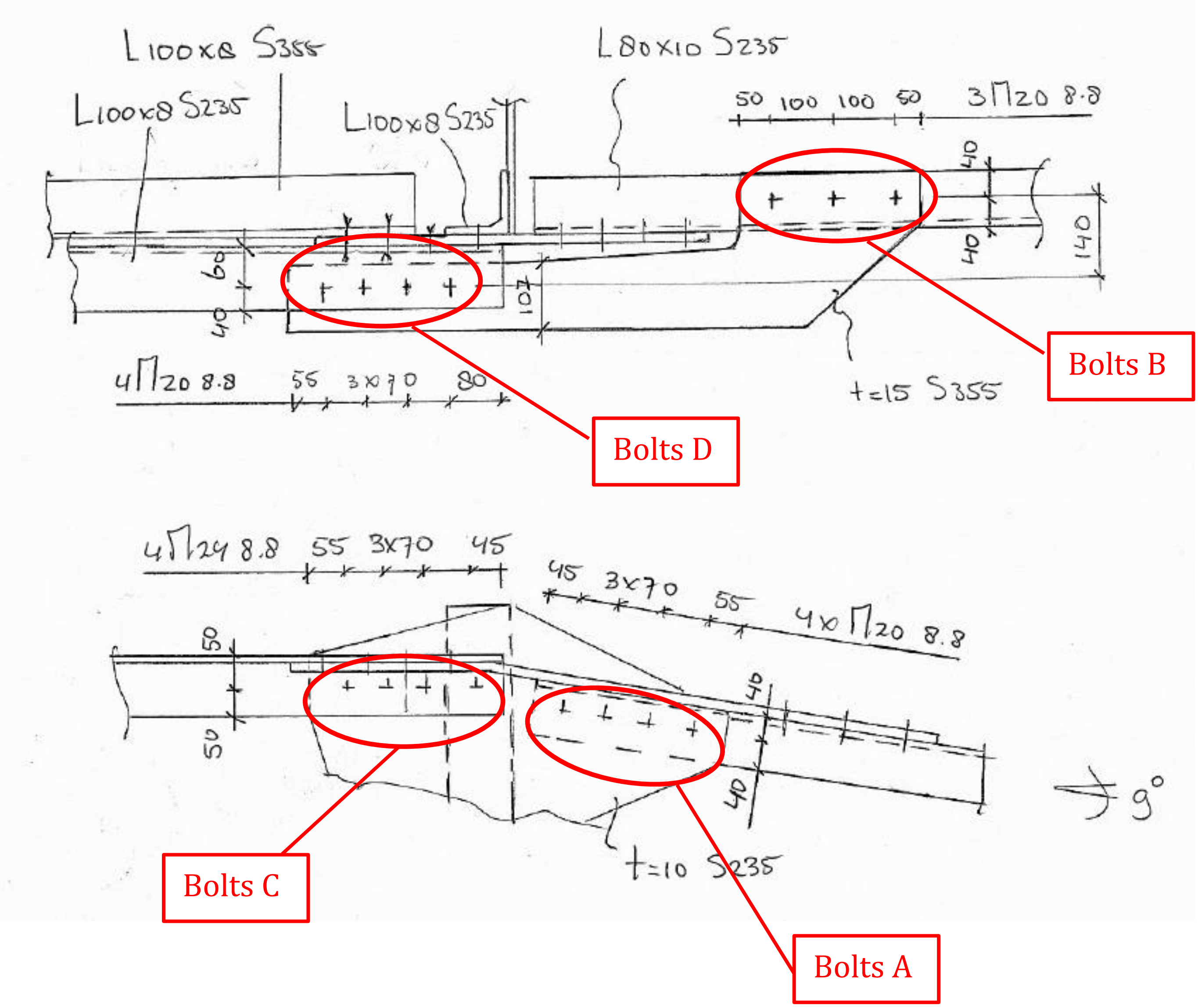
N_{ED} = 238,5 kN tension F= 203,5kN through bolts A and plate t=10mm S235

F= 35 kN through bolts B and plate t=15mm S355

L100x8

N_{ED} = 250,8 kN tension F= 215,8kN through bolts C and plate t=10mm S235

F= 35 kN through bolts D and plate t=15mm S355



3.1.4 Calculation L80x10

3.1.4.1 Check Bolts

Bolts A: 4 x M20 8.8

F_{shear} max = 203,5 kN

$$U.C. = \frac{FvEd}{FvRd} = \frac{203{,}5}{4x94} = 0{,}54 < 1$$ O.K.

$F_{bearing}$ max = 203,5 kN

L80x10 S235

e_1 = 45 mm e_2 = 40 mm   s1= 70 mm

$$k_1 = 2{,}8 \text{ x } \frac{40}{22} - 1{,}7 = 3{,}39 \rightarrow k_1 = 2{,}5$$

$$\alpha_b = \frac{45}{3x22} = 0{,}68$$

$$F_{b,Rd} = \frac{2{,}5 \text{ x } 0{,}68 \text{ x } 360 \text{ x } 20 \text{ x } 10}{1{,}25} = 98 \text{ kN}$$

$$U.C. = \frac{Fb,Ed}{Fb,Rd} = \frac{203{,}5}{4x98} = 0{,}52 < 1$$ O.K.

3.1.4.2 Check profile

L80x10 S235:

$$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0{,}55 \text{ x } 1290 \text{ x } 360}{1{,}25} = 206 \text{ kN}$$

$$U.C. = \frac{203{,}5}{206} = 0{,}99 < 1$$ O.K

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} / \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} / \Upsilon_{m0}$$

A_{nt} = (40 – 11) x 10 = 290 mm^2

A_{nv} = ((45 – 11) + (3 x 70 - 3 x 22)) x 10 = 1780 mm^2

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 360 \text{ x } 290 / 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 1780 / 1 = 283 \text{ kN}$$

$$U.C. = \frac{203{,}5}{283} = 0{,}72 < 1$$ O.K.

Bolts B: 3 x M20 8.8

F_{shear} max = 35 kN

U.C. = $\frac{FvEd}{FvRd} = \frac{35}{3x94} = 0{,}13 < 1$ O.K.

$F_{bearing}$ max = 35 kN

L80x10 S235

$e_2 = 40$ mm s1= 100 mm

$k_1 = 2{,}8 \text{ x } \frac{40}{22} - 1{,}7 = 3{,}39 \rightarrow k_1 = 2{,}5$

$\alpha_b = \frac{100}{3x22} - 0{,}25 = 1{,}26$ $\alpha_b = 1$

$F_{b,Rd} = \frac{2{,}5 \text{ x } 1 \text{ x } 360 \text{ x } 20 \text{ x } 10}{1{,}25} = 144$ kN

U.C. = $\frac{Fb,Ed}{Fb,Rd} = \frac{35}{3x144} = 0{,}1 < 1$ O.K.

3.1.4.3 Check profile

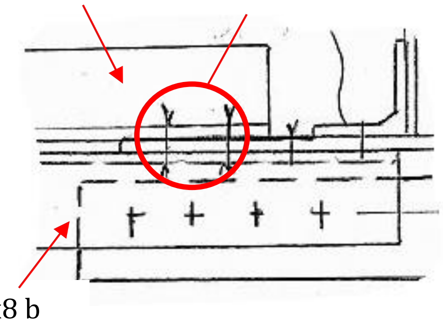
L80x10 S235:

$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\gamma_{m2}} = \frac{0{,}55 \text{ x } 1290 \text{ x } 360}{1{,}25} = 247$ kN

U.C. = $\frac{35}{247} = 0{,}11 < 1$ O.K

3.1.5 Calculation L100x8

3.1.5.1 Check Bolts



Bolts C: 4 x M24 8.8

F= 1/2 x 215,8 = 108 kN through L100x8 a

F= 1/2 x 215,8 = 108 kN through L100x8 b

Bolts C1 (governing)

$F_{shear}\,max = 108 + \frac{108}{2} = 162\ kN$

$U.C. = \frac{FvEd}{FvRd} = \frac{162}{2x2x135} = 0{,}3 < 1$ O.K.

$F_{bearing}\,max = 162\ kN$

Plate t = 10 mm S235

$e_1 = 55\ mm$ $e_2 = 60\ mm$ $s1 = 70\ mm$

$k_1 = 2{,}8\ x\ \frac{60}{26} - 1{,}7 = 4{,}76 \rightarrow k_1 = 2{,}5$

$\alpha_b = \frac{55}{3x26} = 0{,}7$ $\alpha_b = \frac{70}{3x26} - 0{,}25 = 0{,}65$

$F_{b,Rd} = \frac{2{,}5\ x\ 0{,}65\ x\ 360\ x\ 24\ x\ 10}{1{,}25} = 112\ kN$

$U.C. = \frac{Fb,Ed}{Fb,Rd} = \frac{162}{2x112} = 0{,}72 < 1$ O.K.

3.1.5.2 Check profile

L100x8a S355:

$$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\gamma_{m2}} = \frac{0{,}423 \text{ x } 1342 \text{ x } 490}{1{,}25} = 223 \text{ kN}$$

$$\text{U.C.} = \frac{108}{223} = 0{,}49 < 1 \quad \text{O.K}$$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} \,/\, \gamma_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} \,/\, \gamma_{m0}$$

$A_{nt} = (50 - 13) \text{ x } 8 = 296 \text{ mm}^2$

$A_{nv} = ((45 - 13) + (70 - 26)) \text{ x } 8 = 608 \text{ mm}^2$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 490 \text{ x } 296 \,/\, 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 35 \text{ x } 608 \,/\, 1 = 183 \text{ kN}$$

$$\text{U.C.} = \frac{108}{183} = 0{,}59 < 1 \quad \text{O.K.}$$

L100x8b S235:

L100x8: $A = 1550 \text{ mm}^2$

One flange: $A = \frac{1550}{2} = 775 \text{ mm}^2$

F = 108 kN

$$N_{u,Rd} = \frac{0{,}9 \text{ x Anet x fu}}{\gamma_{m2}} = \frac{0{,}9 \text{ x } 567 \text{ x } 360}{1{,}25} = 147 \text{ kN}$$

$$\text{U.C.} = \frac{108}{147} = 0{,}73 < 1 \quad \text{O.K}$$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} \,/\, \gamma_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} \,/\, \gamma_{m0}$$

$A_{nt} = (50 - 13) \text{ x } 8 = 296 \text{ mm}^2$

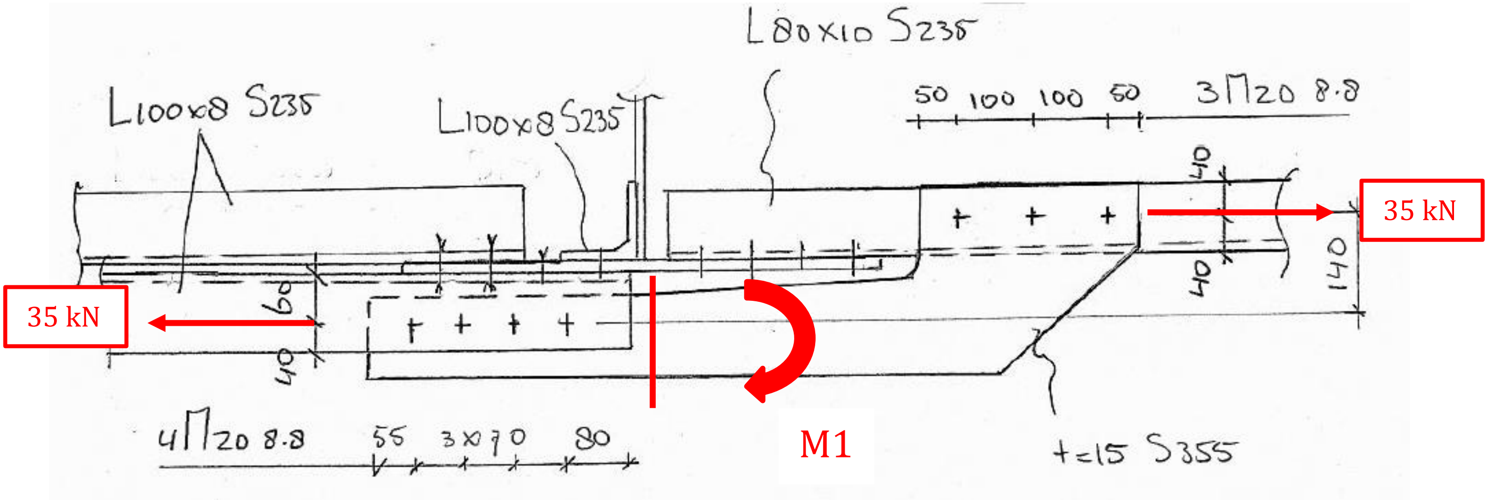
$A_{nv} = ((45 - 13) + (3\text{x}70 - 3\text{x}26)) \text{ x } 8 = 1312 \text{ mm}^2$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 360 \text{ x } 296 \,/\, 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 1312 \,/\, 1 = 221 \text{ kN}$$

$$\text{U.C.} = \frac{108}{221} = 0{,}49 < 1 \quad \text{O.K.}$$

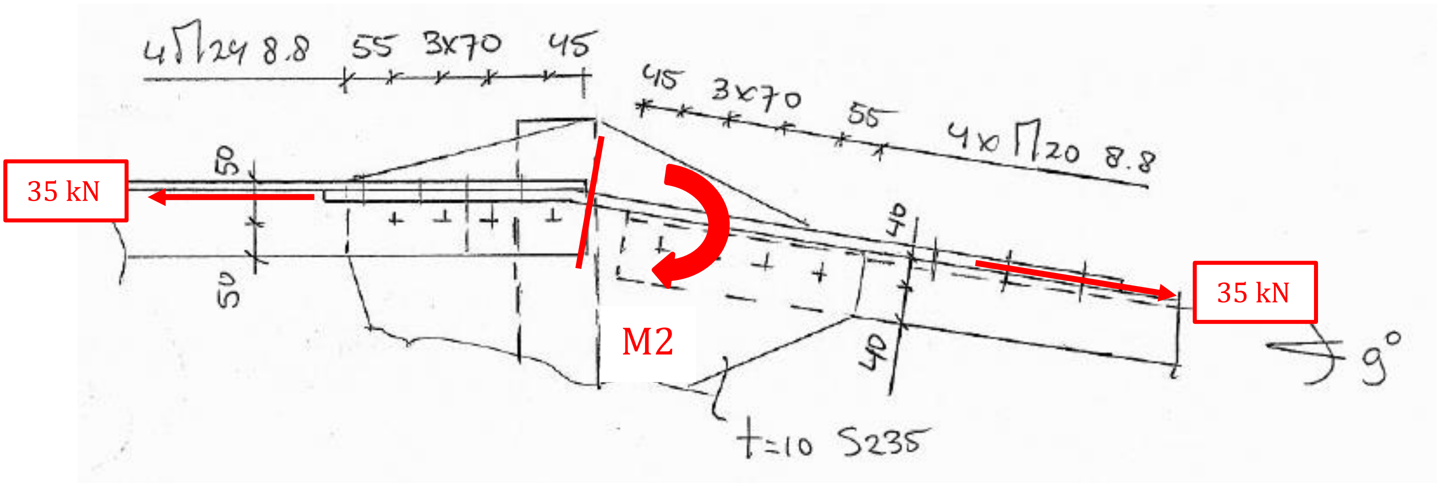
3.1.5.3 Check profile

Plate t = 15 mm S355



M1 = 35 x 0,07 = 2,45 kNm

$$\sigma = \frac{2{,}45 \text{ x } 10^6}{\frac{1}{6} \text{ x } 15 \text{ x } 107^2} = 86 \text{ N/mm}^2$$



M2 = 56 N/mm² See IDEA calculation

M_{total} = 86 + 56 = 142 N/mm²

$$\text{U.C.} = \frac{142}{355} = 0{,}4 < 1$$ O.K.

3.1.5.4 Check Bolts

Bolts D: 4 x M20 8.8

F_{shear} max = 35 kN

$U.C. = \frac{FvEd}{FvRd} = \frac{35}{4x94} = 0,1 < 1$ O.K.

One flange: $A = \frac{1550}{2} = 775\ mm^2$

F = 35 kN

$N_{u,Rd} = \frac{0,9 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0,9 \text{ x } 567 \text{ x } 360}{1,25} = 147\ kN$

$U.C. = \frac{35}{147} = 0,25 < 1$ O.K

$V_{eff,2,Rd} = 0,5 \text{ x } f_u \text{ x } A_{nt} / \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} / \Upsilon_{m0}$

$A_{nt} = (40 - 11) \text{ x } 8 = 232\ mm^2$

$A_{nv} = ((80 - 11) + (3x70 - 3x22)) \text{ x } 8 = 1704\ mm^2$

$V_{eff,2,Rd} = 0,5 \text{ x } 360 \text{ x } 232 / 1,25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 1704 / 1 = 265\ kN$

$U.C. = \frac{35}{265} = 0,13 < 1$ O.K.

3.1.5.5 IDEA calculation

Project data

Project name	ENS-ZL380 S+15 R mast 89
Project number	21-222
Author	G.P.
Description	Detail 1
Date	3/7/2022
Design code	EN

Material

Steel	S 235, S 355

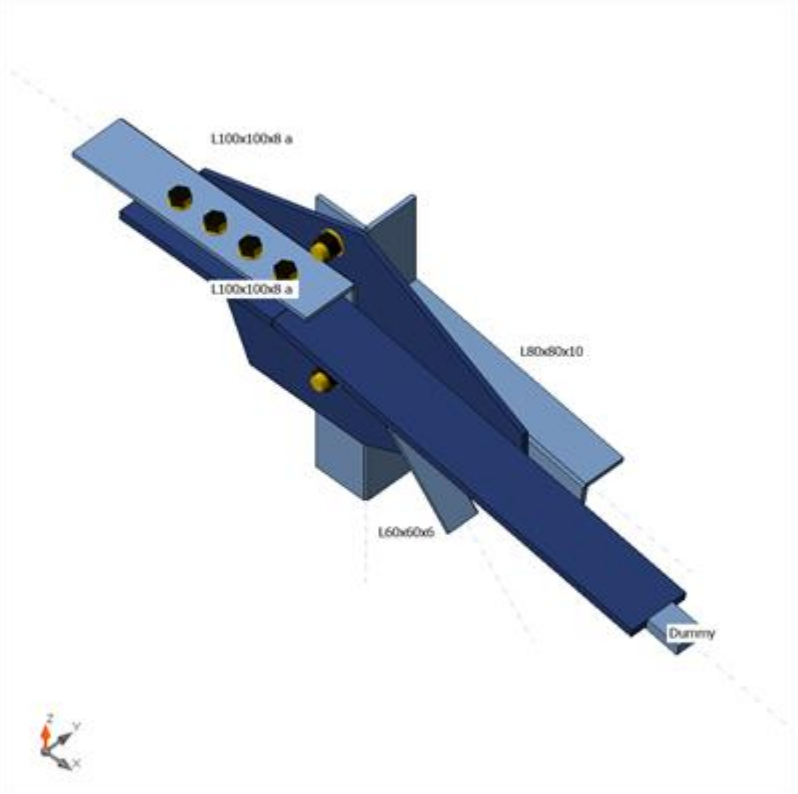
Project item Detail 1 check t=15mm

Design

Name	Detail 1 check t=15mm
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in	X [mm]
L100x100x8 a	3 - HFLeq100x100x8	180.0	0.0	-90.0	-18	0	32	Node	0
L100x100x8 b	3 - HFLeq100x100x8	0.0	90.0	-90.0	0	0	32	Bolts	58
L80x80x10	4 - HFLeq80x80x10	0.0	9.0	-90.0	49	22	28	Node	0
L60x60x6	5 - HFLeq60x60x6	0.0	47.0	180.0	155	22	0	Node	0
Dummy	6 - FLA50/20	0.0	9.0	0.0	600	-80	7	Node	0



Cross-sections

Name	Material
3 - HFLeq100x100x8	S 235
4 - HFLeq80x80x10	S 235
5 - HFLeq60x60x6	S 235
6 - FLA50/20	S 235

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M24 8.8	M24 8.8	24	800.0	452
M20 8.8	M20 8.8	20	800.0	314
M16 8.8	M16 8.8	16	800.0	201

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	L100x100x8 a	0.0	0.0	0.0	0.0	0.0	0.0
	L100x100x8 b	-5.5	0.0	0.0	0.0	0.0	0.0
	L80x80x10	0.0	0.0	0.0	0.0	0.0	0.0
	L60x60x6	0.0	0.0	0.0	0.0	0.0	0.0
	Dummy	35.0	0.0	0.0	0.0	0.0	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	17.4 < 100%	OK

Plates

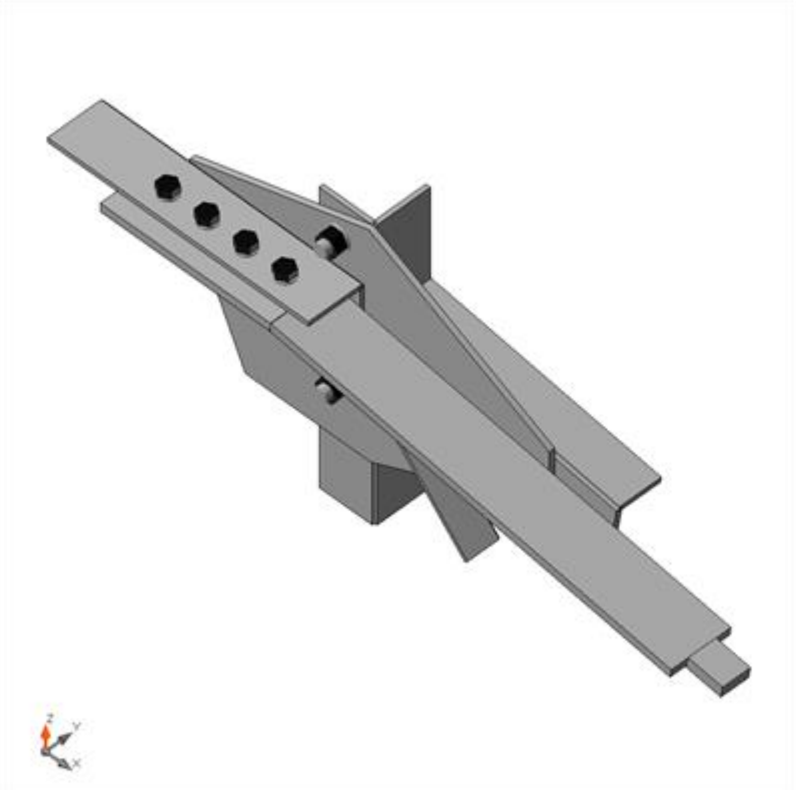
Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
L100x100x8 a-bfl 1	S 235	8.0	LE1	83.6	0.0	5.0	OK
L100x100x8 a-w 1	S 235	8.0	LE1	160.5	0.0	10.9	OK
L100x100x8 b-bfl 1	S 235	8.0	LE1	31.7	0.0	2.4	OK
L100x100x8 b-w 1	S 235	8.0	LE1	12.2	0.0	0.0	OK
L80x80x10-bfl 1	S 235	10.0	LE1	35.7	0.0	4.8	OK
L80x80x10-w 1	S 235	10.0	LE1	28.6	0.0	0.0	OK
L60x60x6-bfl 1	S 235	6.0	LE1	120.7	0.0	0.0	OK
L60x60x6-w 1	S 235	6.0	LE1	95.4	0.0	64.7	OK
Dummy-bfl 1	S 235	20.0	LE1	107.0	0.0	0.0	OK
SP1	S 235	10.0	LE1	79.9	0.0	64.7	OK
SP2	S 355	15.0	LE1	124.1	0.0	10.9	OK
SP5	S 355	15.0	LE1	56.3	0.0	0.0	OK

Design data

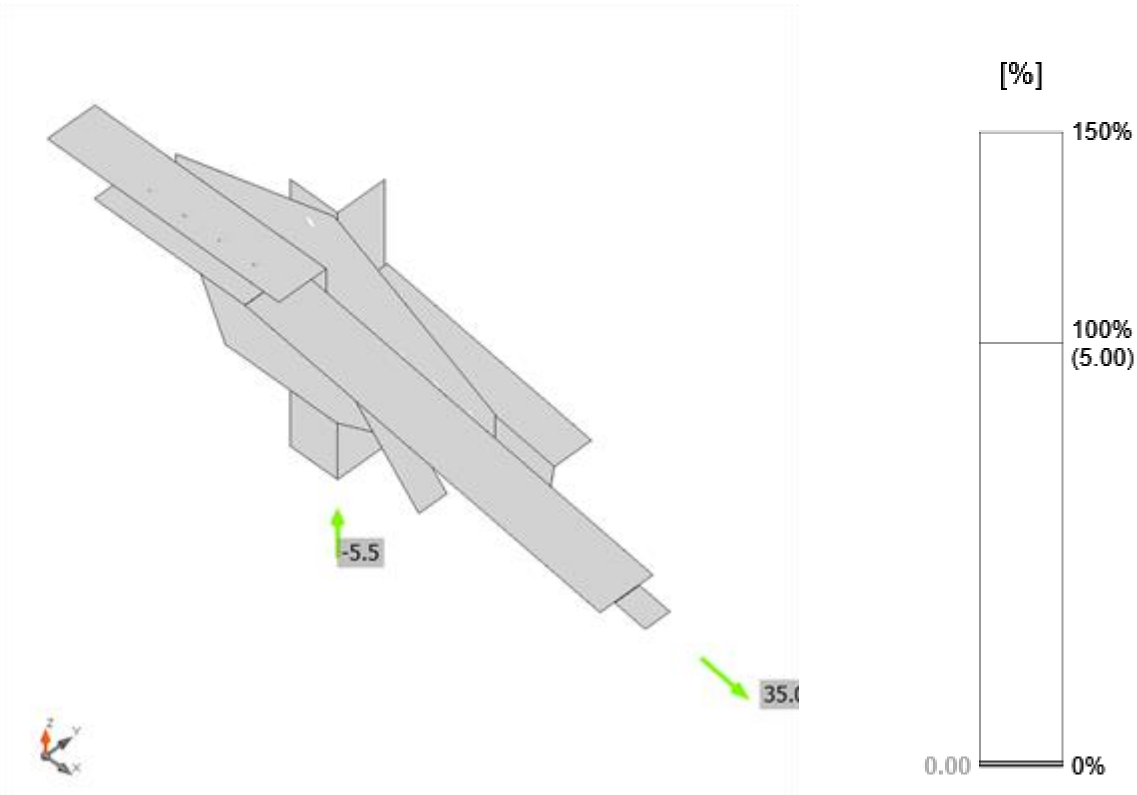
Material	f_y [MPa]	ε_{lim} [%]
S 235	235.0	5.0
S 355	355.0	5.0

Symbol explanation

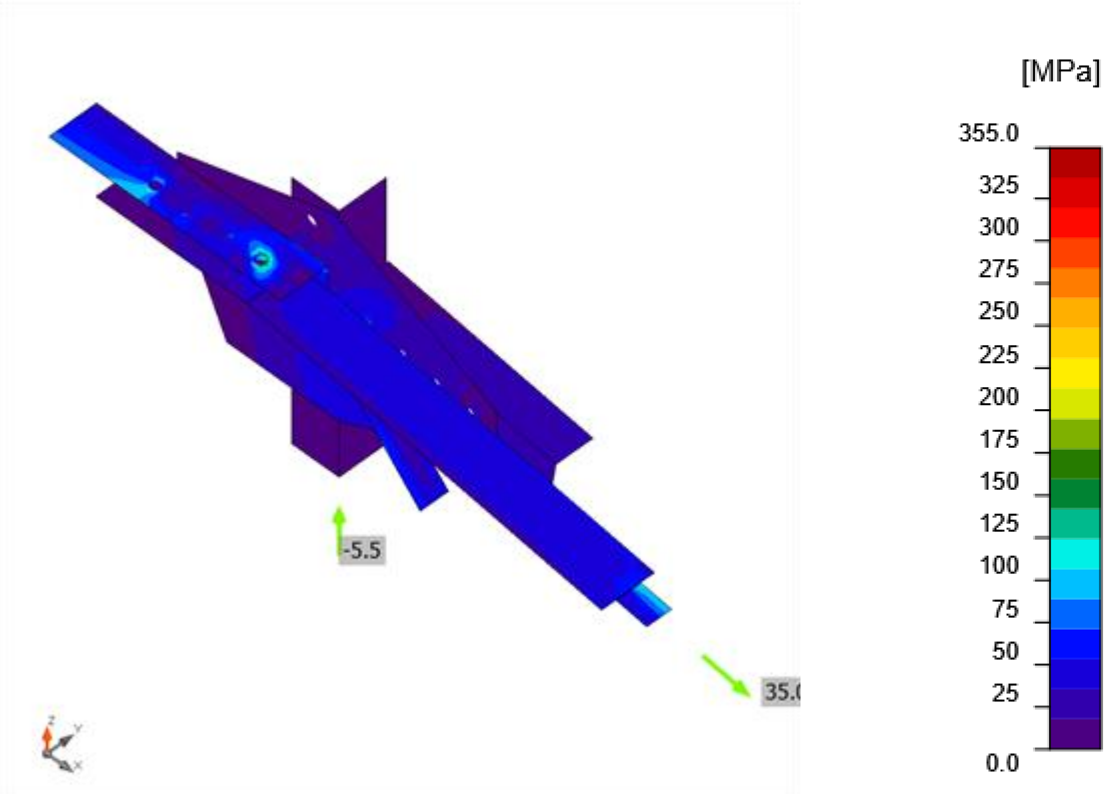
ε_{Pl} Strain
σ_{Ed} Eq. stress
σc_{Ed} Contact stress
f_y Yield strength
ε_{lim} Limit of plastic strain



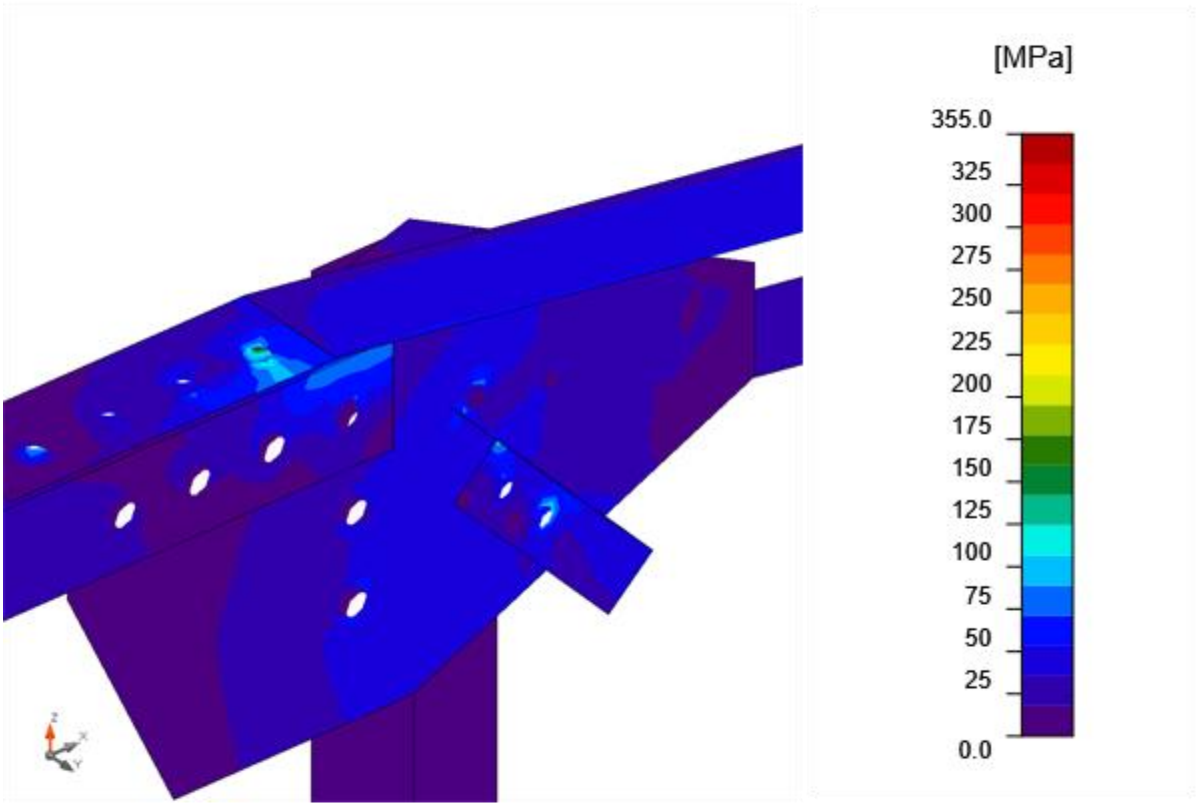
Overall check, LE1



Strain check, LE1

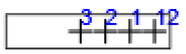
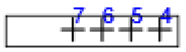
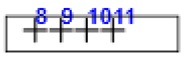
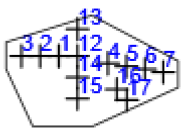


Equivalent stress, LE1



Equivalent stress, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	4.1	2.1	2.5	69.5	3.0	3.0	OK
	B2	M24 8.8 - 1	LE1	2.8	0.4	1.7	83.9	0.5	1.3	OK
	B3	M24 8.8 - 1	LE1	2.1	1.1	1.3	71.3	1.6	1.6	OK
	B12	M24 8.8 - 1	LE1	2.5	4.2	1.5	69.5	6.1	4.0	OK
	B4	M20 8.8 - 2	LE1	5.6	0.8	4.0	91.1	0.8	3.6	OK
	B5	M20 8.8 - 2	LE1	0.4	0.2	0.3	91.9	0.2	0.4	OK
	B6	M20 8.8 - 2	LE1	0.9	0.2	0.6	85.2	0.2	0.6	OK
	B7	M20 8.8 - 2	LE1	1.9	0.7	1.4	72.8	1.0	1.7	OK
	B8	M20 8.8 - 3	LE1	15.3	9.1	11.2	115.2	9.7	17.4	OK
	B9	M20 8.8 - 3	LE1	2.5	8.5	1.8	93.4	9.1	10.3	OK
	B10	M20 8.8 - 3	LE1	0.9	8.3	0.7	93.4	8.9	9.3	OK
	B11	M20 8.8 - 3	LE1	1.7	8.7	1.2	93.4	9.3	10.1	OK
	B13	M24 8.8 - 1	LE1	1.1	1.4	0.6	65.1	2.1	1.4	OK
	B14	M24 8.8 - 1	LE1	1.5	1.4	0.9	107.2	1.3	1.6	OK
	B15	M24 8.8 - 1	LE1	7.0	1.7	4.2	107.6	1.6	3.7	OK
	B16	M16 8.8 - 4	LE1	2.5	0.7	3.1	34.4	2.0	3.1	OK
	B17	M16 8.8 - 4	LE1	6.5	0.7	8.0	38.6	1.8	6.3	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203.3	165.0	135.6
M20 8.8 - 2	141.1	171.0	94.1
M20 8.8 - 3	141.1	136.8	94.1
M16 8.8 - 4	90.4	81.4	60.3

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear

Welds (Maximal value used, plastic redistribution recommended)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	$\sigma_\perp$ [MPa]	$\tau_{\|\|}$ [MPa]	$\tau_\perp$ [MPa]	Ut [%]	Status
SP5	SP2	15.0	107	LE1						OK
SP5	Dummy-bfl 1	20.0	50	LE1						OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0.80	360.0	259.2

Symbol explanation

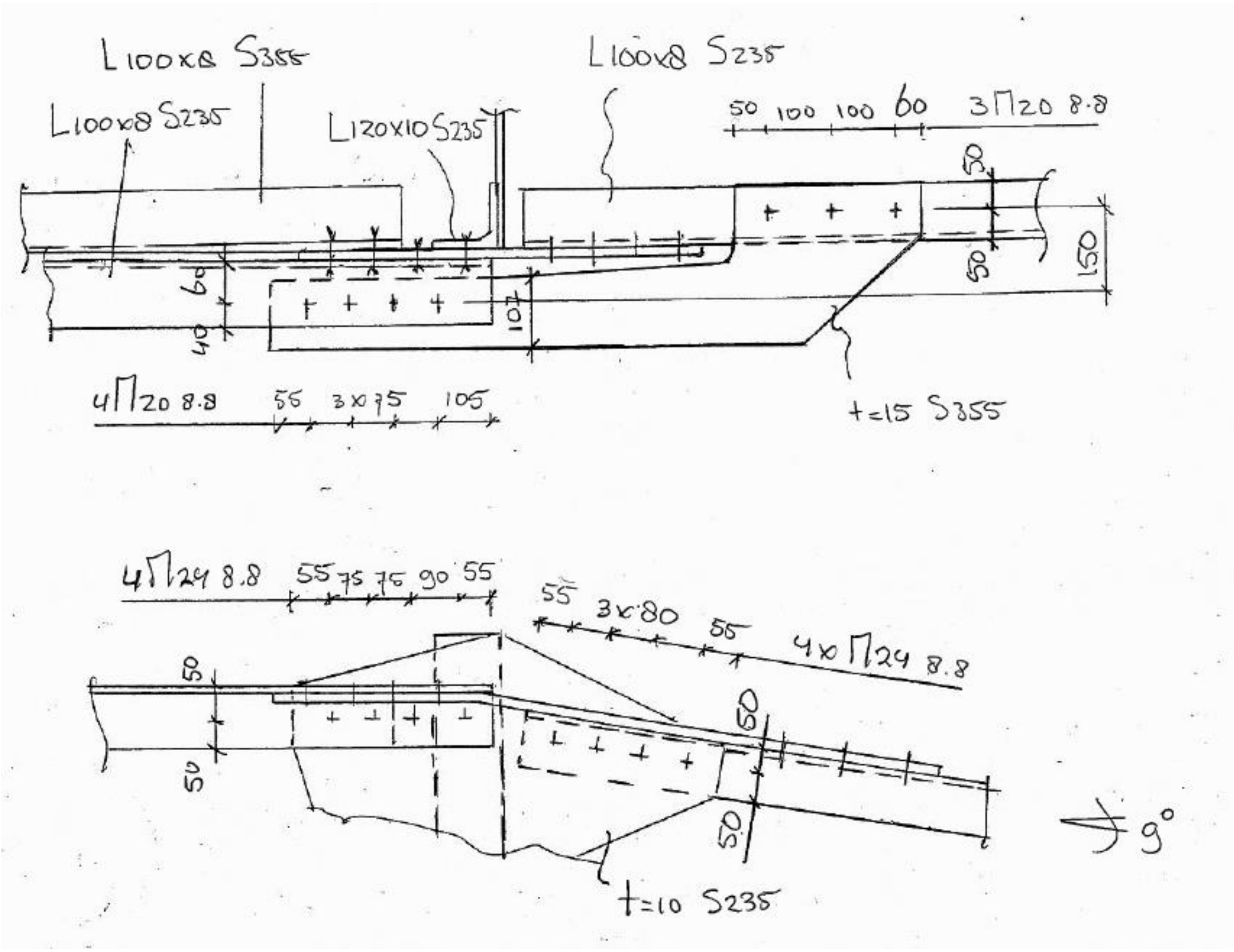
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_\perp$	Perpendicular stress
$\tau_{\|\|}$	Shear stress parallel to weld axis
$\tau_\perp$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

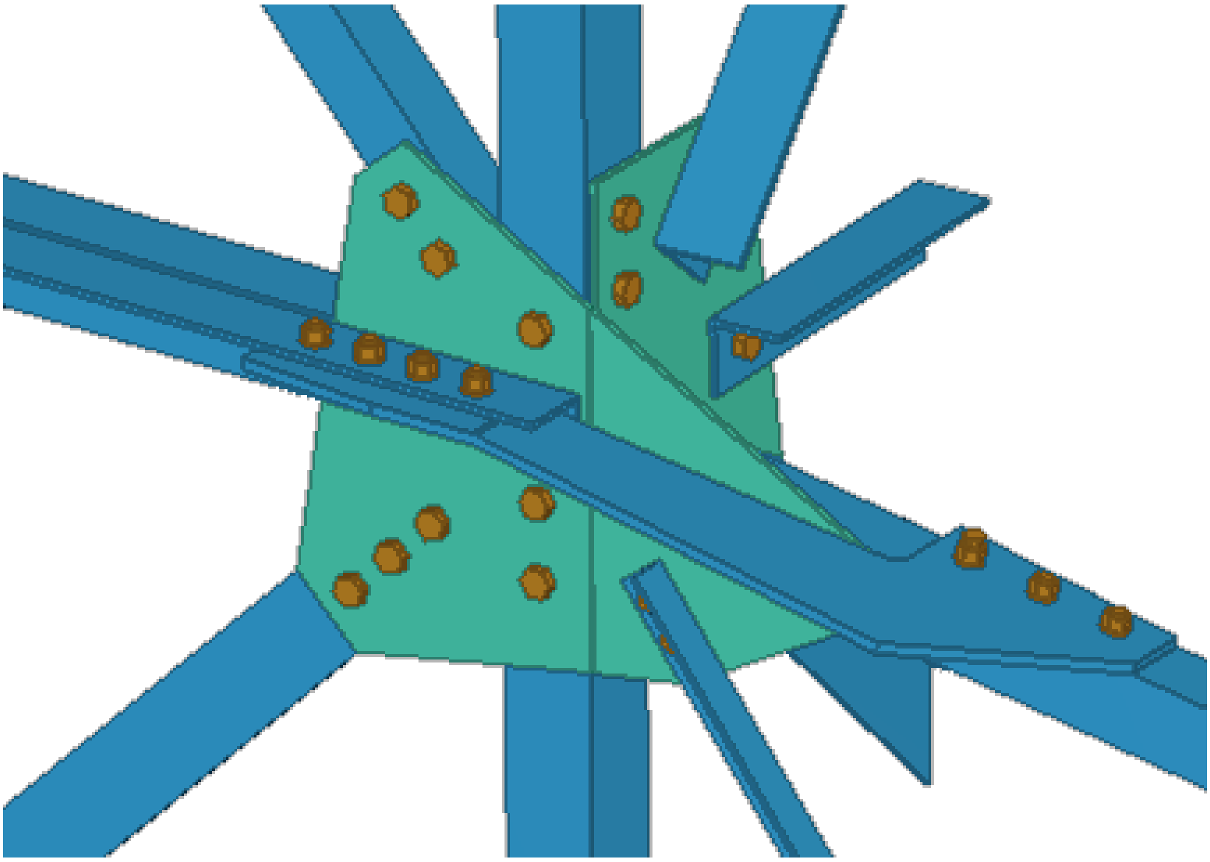
Code settings

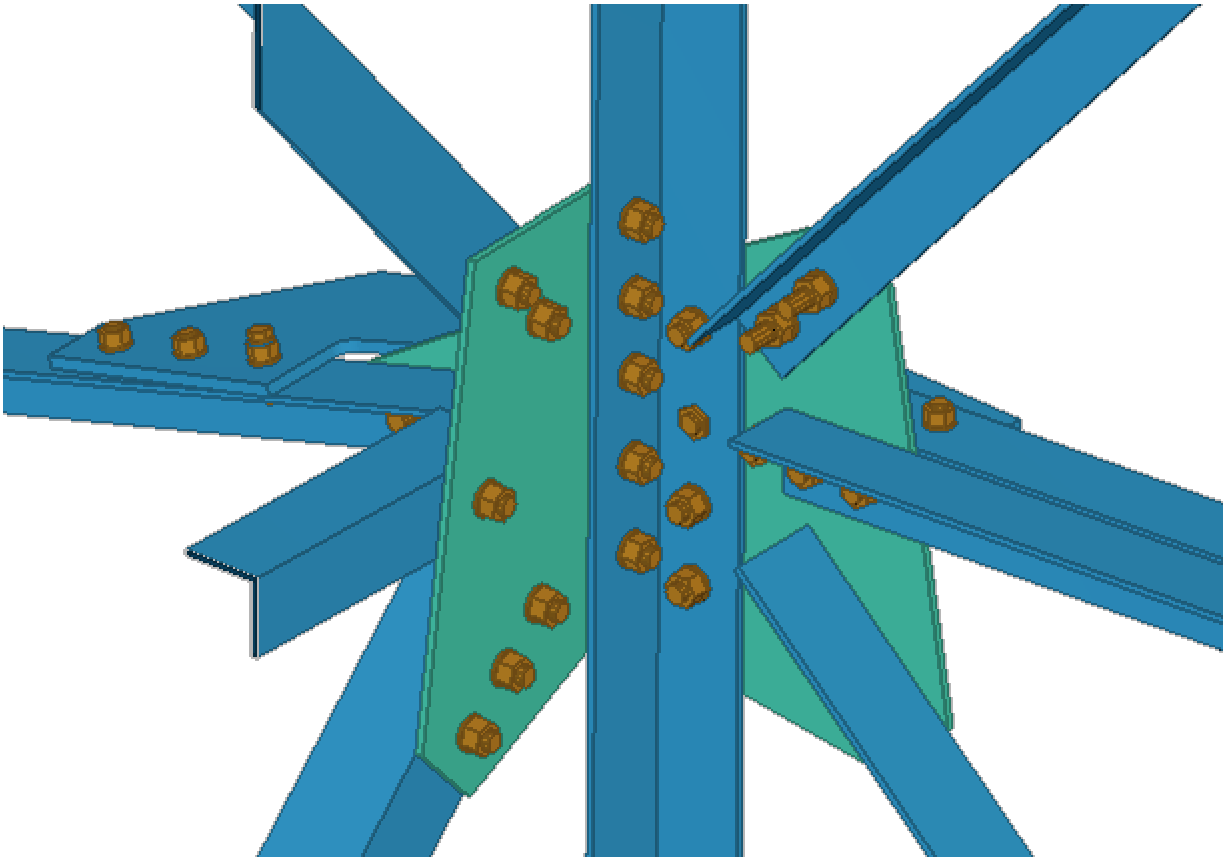
Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_C	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4

Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

3.1.6 Detail 2


L100x8 S355
L100x8 S235
L120x10 S235
L100x8 S235
50 100 100 60 3M20 8.8
4M20 8.8 55 3x75 105
t=15 S355
150
4M24 8.8 55 75 75 90 55
55 3x80 55 4xM24 8.8
t=10 S235
9°





3.1.7 Loads

Loads from report:

ENS-ZL380 – Tower S+15 R

Report nr.: 21-1725 Rev 1
Date: 2021-03-23

Page 41

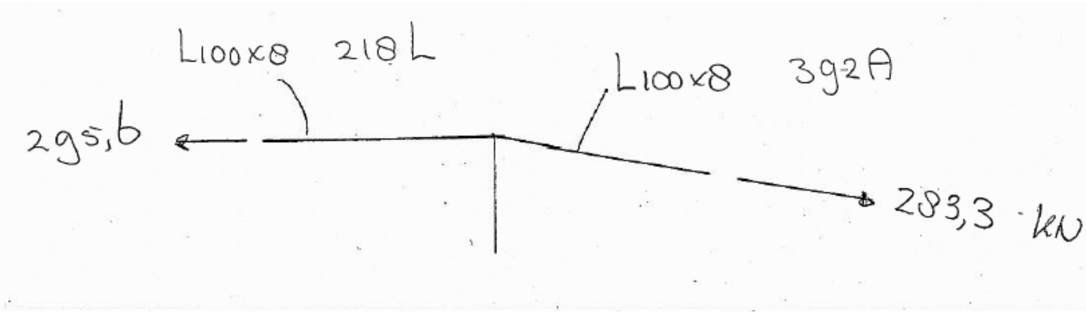
Member: 392A L100x100x8 S235

N_{ED} = 0 kN compression N_{ED} = 283,3 kN tension

Page 41

Member: 218L L100x100x8 S235

N_{ED} = 0 kN compression N_{ED} = 295,6 kN tension



L100x8 392A

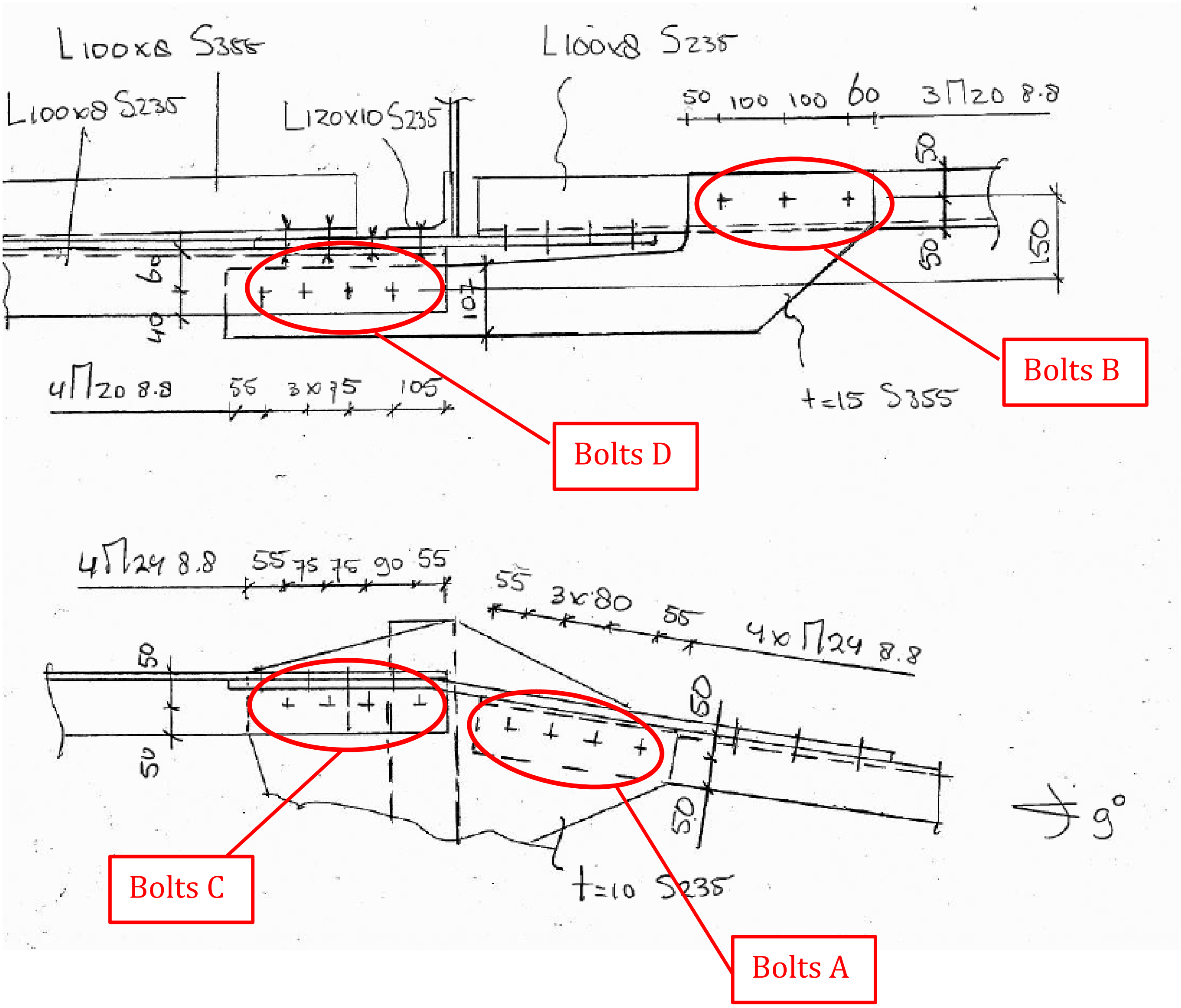
N_{ED} = 283,3 kN tension F= 210,3 kN through bolts A and plate t=10mm S235

F= 73 kN through bolts B and plate t=15mm S355

L100x8 218L

N_{ED} = 295,6 kN tension F= 222,6 kN through bolts C and plate t=10mm S235

F= 73 kN through bolts D and plate t=15mm S355



3.1.8 Calculation L100x8 392A

3.1.8.1 Check Bolts

Bolts A: 4 x M24 8.8

F_{shear} max = 210,3 kN

U.C. = $\frac{FvEd}{FvRd} = \frac{210,3}{4x135} = 0,4 < 1$ O.K.

$F_{bearing}$ max = 210,3 kN

L100x8 S235

$e_1 = 55$ mm $e_2 = 50$ mm s1= 80 mm

$k_1 = 2,8 \text{ x } \frac{50}{26} - 1,7 = 3,68 \rightarrow k_1 = 2,5$

$\alpha_b = \frac{55}{3x26} = 0,71$ $\alpha_b = \frac{80}{3x26} - 0,25 = 0,78$

$F_{b,Rd} = \frac{2,5 \text{ x } 0,71 \text{ x } 360 \text{ x } 24 \text{ x } 8}{1,25} = 98$ kN

U.C. = $\frac{Fb,Ed}{Fb,Rd} = \frac{210,3}{4x98} = 0,54 < 1$ O.K.

3.1.8.2 Check profile

L100x8 S235:

$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0,55 \text{ x } 1342 \text{ x } 360}{1,25} =211$ kN

U.C. = $\frac{210}{211} = 0,99 < 1$ O.K

$V_{eff,2,Rd} = 0,5 \text{ x } f_u \text{ x } A_{nt} / \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} / \Upsilon_{m0}$

$A_{nt} = (50 - 13) \text{ x } 8 = 296 \text{ mm}^2$

$A_{nv} = ((55 - 13) + (3 \text{ x } 80 - 3 \text{ x } 26)) \text{ x } 8 = 1632 \text{ mm}^2$

$V_{eff,2,Rd} = 0,5 \text{ x } 360 \text{ x } 296 / 1,25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 1632 / 1 = 264$ kN

U.C. = $\frac{211}{264} = 0,8 < 1$ O.K.

Bolts B: 3 x M20 8.8

F_{shear} max = 73 kN

U.C. = $\frac{FvEd}{FvRd} = \frac{73}{3x94}$ = 0,26 < 1 O.K.

$F_{bearing}$ max = 73 kN

L100x8 S235

e_2 = 50 mm s1= 100 mm

$k_1 = 2,8 \text{ x } \frac{50}{22} - 1,7 = 4,66 \rightarrow k_1 = 2,5$

$\alpha_b = \frac{100}{3x22} - 0,25 = 1,26$ $\alpha_b = 1$

$F_{b,Rd} = \frac{2,5 \text{ x } 1 \text{ x } 360 \text{ x } 20 \text{ x } 8}{1,25} = 115 \text{ kN}$

U.C. = $\frac{Fb,Ed}{Fb,Rd} = \frac{35}{3x117}$ = 0,1 < 1 O.K.

3.1.8.3 Check profile

L100x8 S235:

$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0,55 \text{ x } 1290 \text{ x } 360}{1,25}$ =263 kN

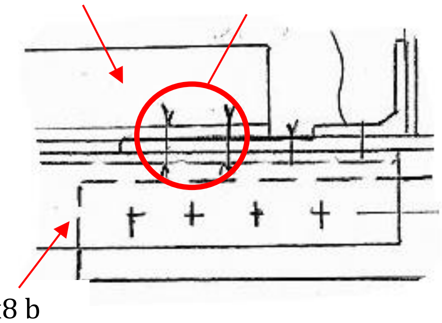
U.C. = $\frac{73}{263}$ = 0,28 < 1 O.K

3.1.9 Calculation L100x8

3.1.9.1 Check Bolts

L100x8 a

bolts C1



L100x8 b

Bolts C: 4 x M24 8.8

F= 1/2 x 222,6 = 111,3 kN through L100x8 a

F= 1/2 x 222,6 = 111,3 kN through L100x8 b

Bolts C1 (governing)

$$F_{shear}\,max = 111{,}3 + \frac{111{,}3}{2} = 167\ kN$$

$$U.C. = \frac{FvEd}{FvRd} = \frac{167}{2x2x135} = 0{,}31 < 1\ \ O.K.$$

$$F_{bearing}\,max = 167\ kN$$

Plate t = 10 mm S235

$e_1 = 55$ mm $e_2 = 60$ mm s1= 75 mm

$$k_1 = 2{,}8 \text{ x } \frac{60}{26} - 1{,}7 = 4{,}76 \rightarrow k_1 = 2{,}5$$

$$\alpha_b = \frac{55}{3x26} = 0{,}7 \qquad \alpha_b = \frac{75}{3x26} - 0{,}25 = 0{,}71$$

$$F_{b,Rd} = \frac{2{,}5 \text{ x } 0{,}7 \text{ x } 360 \text{ x } 24 \text{ x } 10}{1{,}25} = 122\ kN$$

$$U.C. = \frac{Fb,Ed}{Fb,Rd} = \frac{167}{2x122} = 0{,}68 < 1\ \ O.K.$$

3.1.9.2 Check profile

L100x8a S355:

$$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\gamma_{m2}} = \frac{0{,}446 \text{ x } 1342 \text{ x } 490}{1{,}25} = 235 \text{ kN}$$

$$U.C. = \frac{111{,}3}{235} = 0{,}47 < 1 \quad \text{O.K}$$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} \ / \ \gamma_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} \ / \ \gamma_{m0}$$

$A_{nt} = (50 - 13) \text{ x } 8 = 296 \text{ mm}^2$

$A_{nv} = ((45 - 13) + (77 - 26)) \text{ x } 8 = 648 \text{ mm}^2$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 490 \text{ x } 296 \ / \ 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 35 \text{ x } 608 \ / \ 1 = 191 \text{ kN}$$

$$U.C. = \frac{111{,}3}{191} = 0{,}58 < 1 \quad \text{O.K.}$$

L100x8b S235:

L100x8: $A = 1550 \text{ mm}^2$

One flange: $A = \frac{1550}{2} = 775 \text{ mm}^2$

$F = 111{,}3 \text{ kN}$

$$N_{u,Rd} = \frac{0{,}9 \text{ x Anet x fu}}{\gamma_{m2}} = \frac{0{,}9 \text{ x } 567 \text{ x } 360}{1{,}25} = 147 \text{ kN}$$

$$U.C. = \frac{111{,}3}{147} = 0{,}76 < 1 \quad \text{O.K}$$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} \ / \ \gamma_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} \ / \ \gamma_{m0}$$

$A_{nt} = (50 - 13) \text{ x } 8 = 296 \text{ mm}^2$

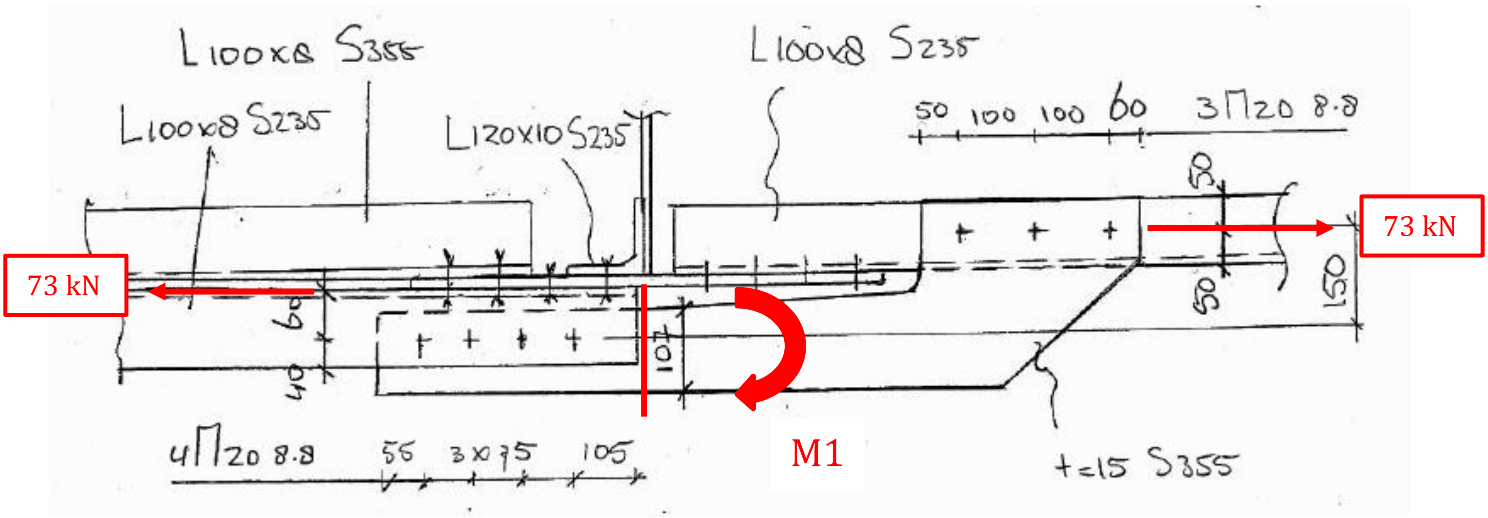
$A_{nv} = ((55 - 13) + (3\text{x}75 - 3\text{x}26)) \text{ x } 8 = 1512 \text{ mm}^2$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 360 \text{ x } 296 \ / \ 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 1512 \ / \ 1 = 290 \text{ kN}$$

$$U.C. = \frac{111{,}3}{290} = 0{,}38 < 1 \quad \text{O.K.}$$

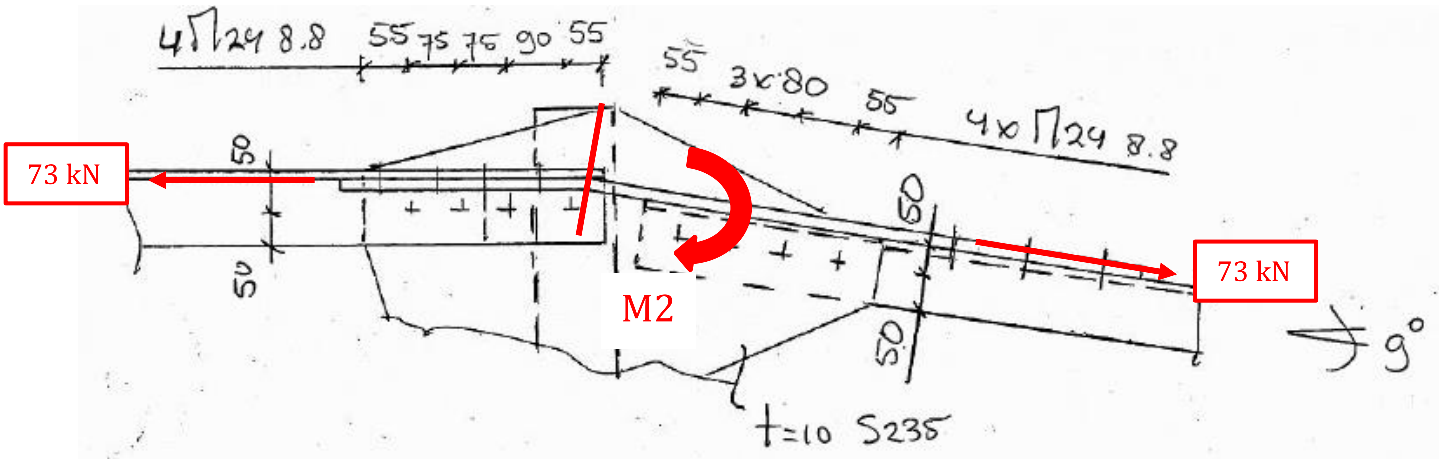
3.1.9.3 Check profile

Plate t = 15 mm S355



M1 = 73 x 0,075 = 5,47 kNm

$$\sigma = \frac{5{,}47 \times 10^6}{\frac{1}{6} \times 15 \times 107^2} = 191 \text{ N/mm}^2$$



M2 = 117 N/mm² See IDEA calculation

M_{total} = 191 + 117 = 308 N/mm²

$$\text{U.C.} = \frac{308}{355} = 0{,}87 < 1$$ O.K.

3.1.9.4 Check Bolts

Bolts D: 4 x M20 8.8

F_{shear} max = 73 kN

$$U.C. = \frac{FvEd}{FvRd} = \frac{73}{4x94} = 0,2 < 1$$ O.K.

One flange: $A = \frac{1550}{2} = 775\ mm^2$

F = 73 kN

$$N_{u,Rd} = \frac{0,9 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0,9 \text{ x } 567 \text{ x } 360}{1,25} = 147 \text{ kN}$$

$$U.C. = \frac{73}{147} = 0,5 < 1$$ O.K

$$V_{eff,2,Rd} = 0,5 \text{ x } f_u \text{ x } A_{nt} / \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} / \Upsilon_{m0}$$

$A_{nt} = (40 – 11) \text{ x } 8 = 232\ mm^2$

$A_{nv} = ((105 – 11) + (3x75 – 3x22)) \text{ x } 8 = 2024\ mm^2$

$$V_{eff,2,Rd} = 0,5 \text{ x } 360 \text{ x } 232 / 1,25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 2024 / 1 = 308 \text{ kN}$$

$$U.C. = \frac{73}{308} = 0,24 < 1$$ O.K.

3.1.9.5 IDEA calculation

Project data

Project name	ENS-ZL380 S+15 R mast 89
Project number	21-222
Author	G.P.
Description	Detail 1
Date	3/7/2022
Design code	EN

Material

Steel	S 235, S 355

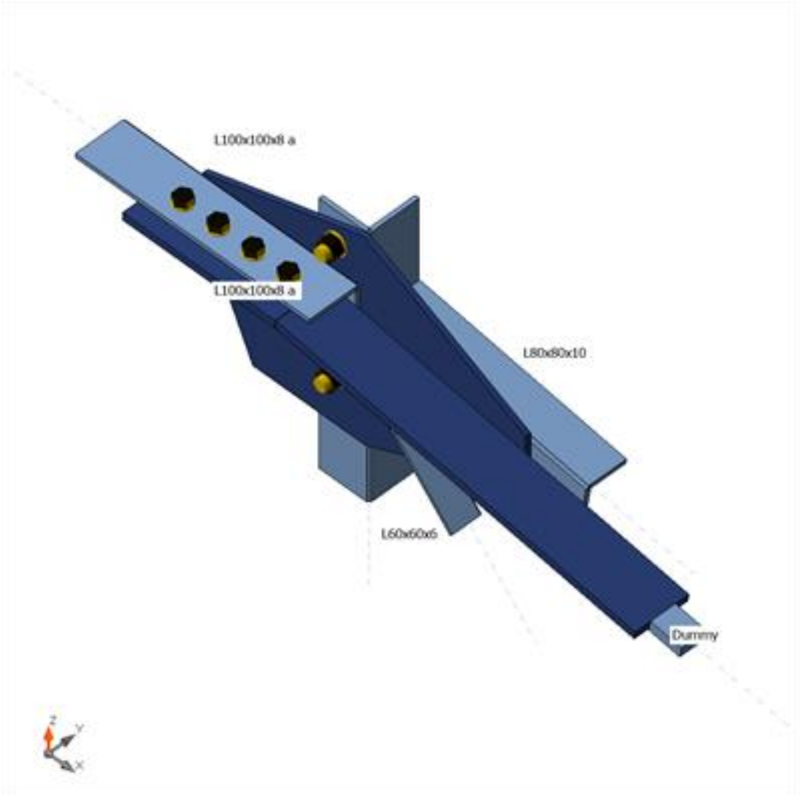
Project item Detail 1 check t=15mm

Design

Name	Detail 1 check t=15mm
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in	X [mm]
L100x100x8 a	3 - HFLeq100x100x8	180.0	0.0	-90.0	-18	0	32	Node	0
L100x100x8 b	3 - HFLeq100x100x8	0.0	90.0	-90.0	0	0	32	Bolts	58
L80x80x10	4 - HFLeq80x80x10	0.0	9.0	-90.0	49	22	28	Node	0
L60x60x6	5 - HFLeq60x60x6	0.0	47.0	180.0	155	22	0	Node	0
Dummy	6 - FLA50/20	0.0	9.0	0.0	600	-80	7	Node	0



Cross-sections

Name	Material
3 - HFLeq100x100x8	S 235
4 - HFLeq80x80x10	S 235
5 - HFLeq60x60x6	S 235
6 - FLA50/20	S 235

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M24 8.8	M24 8.8	24	800.0	452
M20 8.8	M20 8.8	20	800.0	314
M16 8.8	M16 8.8	16	800.0	201

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	L100x100x8 a	0.0	0.0	0.0	0.0	0.0	0.0
	L100x100x8 b	-11.4	0.0	0.0	0.0	0.0	0.0
	L80x80x10	0.0	0.0	0.0	0.0	0.0	0.0
	L60x60x6	0.0	0.0	0.0	0.0	0.0	0.0
	Dummy	73.0	0.0	0.0	0.0	0.0	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.1 < 5.0%	OK
Bolts	36.3 < 100%	OK

Plates

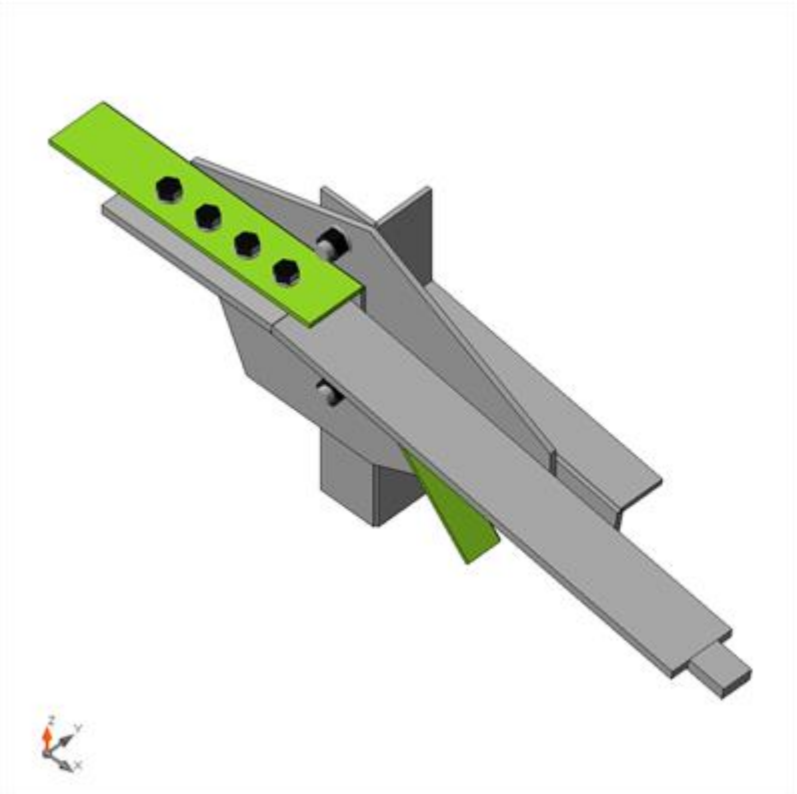
Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
L100x100x8 a-bfl 1	S 235	8.0	LE1	175.1	0.0	10.4	OK
L100x100x8 a-w 1	S 235	8.0	LE1	235.1	0.1	23.0	OK
L100x100x8 b-bfl 1	S 235	8.0	LE1	66.4	0.0	5.0	OK
L100x100x8 b-w 1	S 235	8.0	LE1	25.4	0.0	0.0	OK
L80x80x10-bfl 1	S 235	10.0	LE1	74.2	0.0	10.0	OK
L80x80x10-w 1	S 235	10.0	LE1	59.5	0.0	0.0	OK
L60x60x6-bfl 1	S 235	6.0	LE1	212.5	0.0	0.0	OK
L60x60x6-w 1	S 235	6.0	LE1	187.8	0.0	134.0	OK
Dummy-bfl 1	S 235	20.0	LE1	222.6	0.0	0.0	OK
SP1	S 235	10.0	LE1	166.6	0.0	134.0	OK
SP2	S 355	15.0	LE1	258.2	0.0	23.0	OK
SP5	S 355	15.0	LE1	117.4	0.0	0.0	OK

Design data

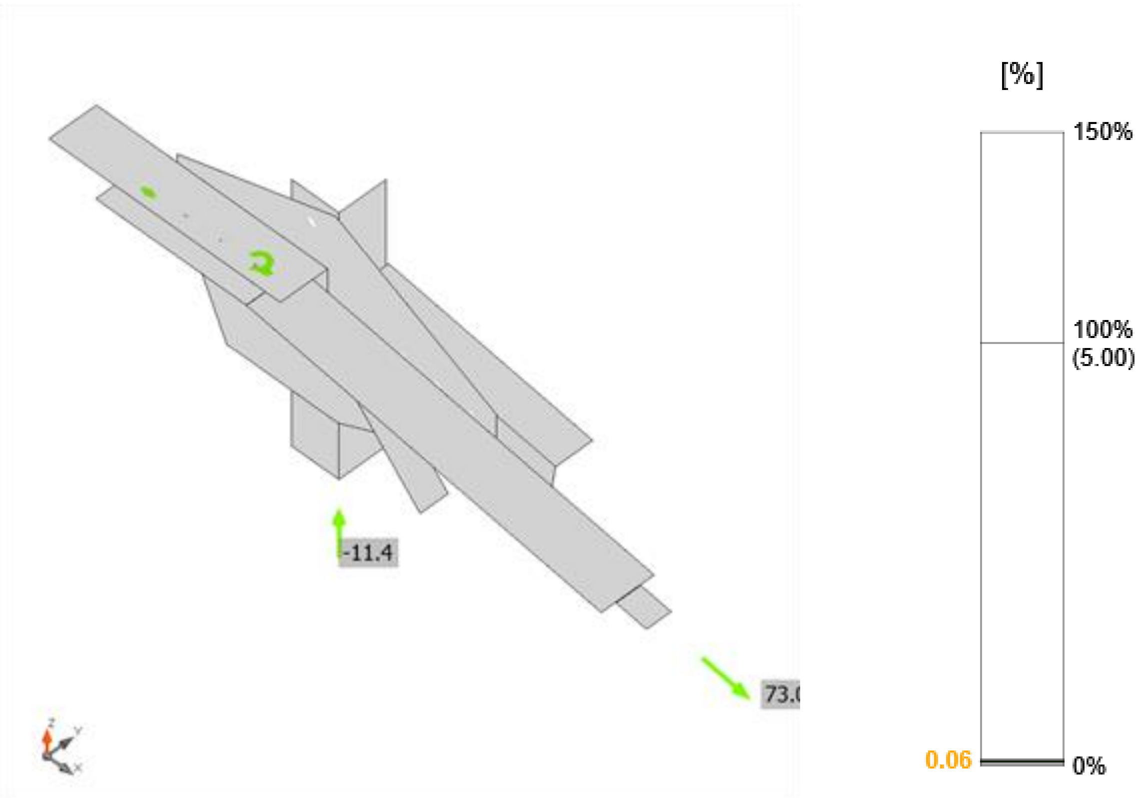
Material	f_y [MPa]	ε_{lim} [%]
S 235	235.0	5.0
S 355	355.0	5.0

Symbol explanation

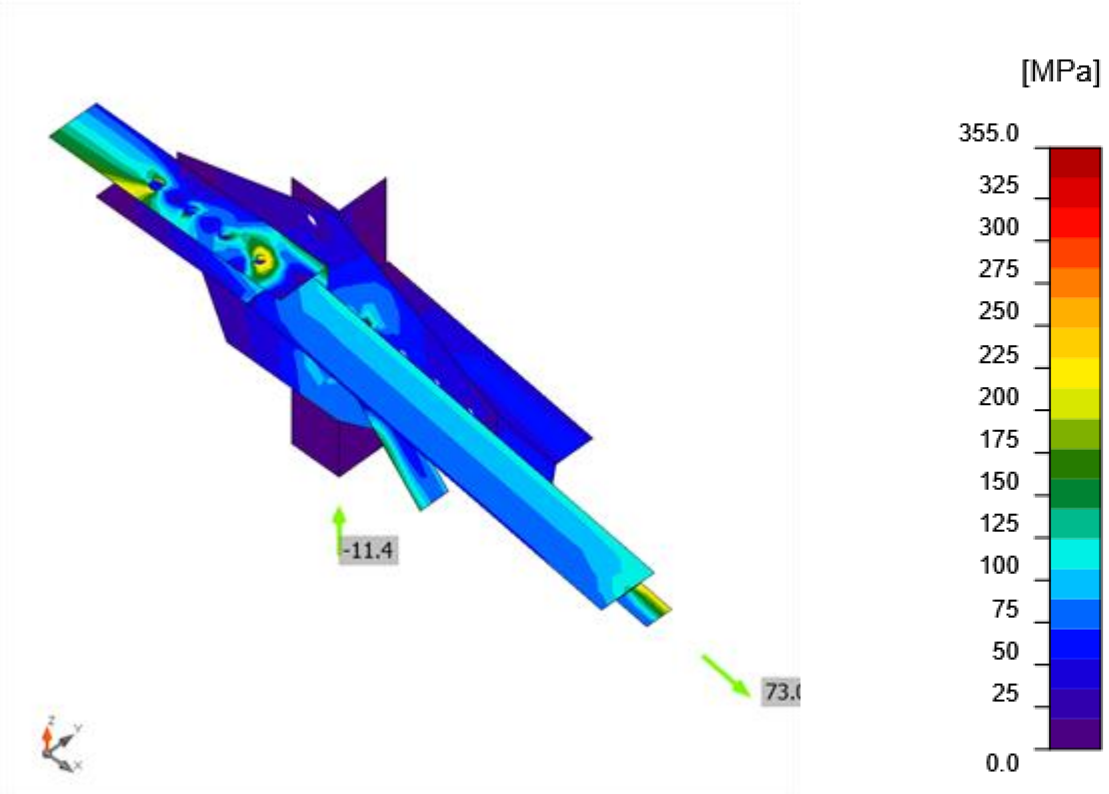
ε_{Pl}	Strain
σ_{Ed}	Eq. stress
σc_{Ed}	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain



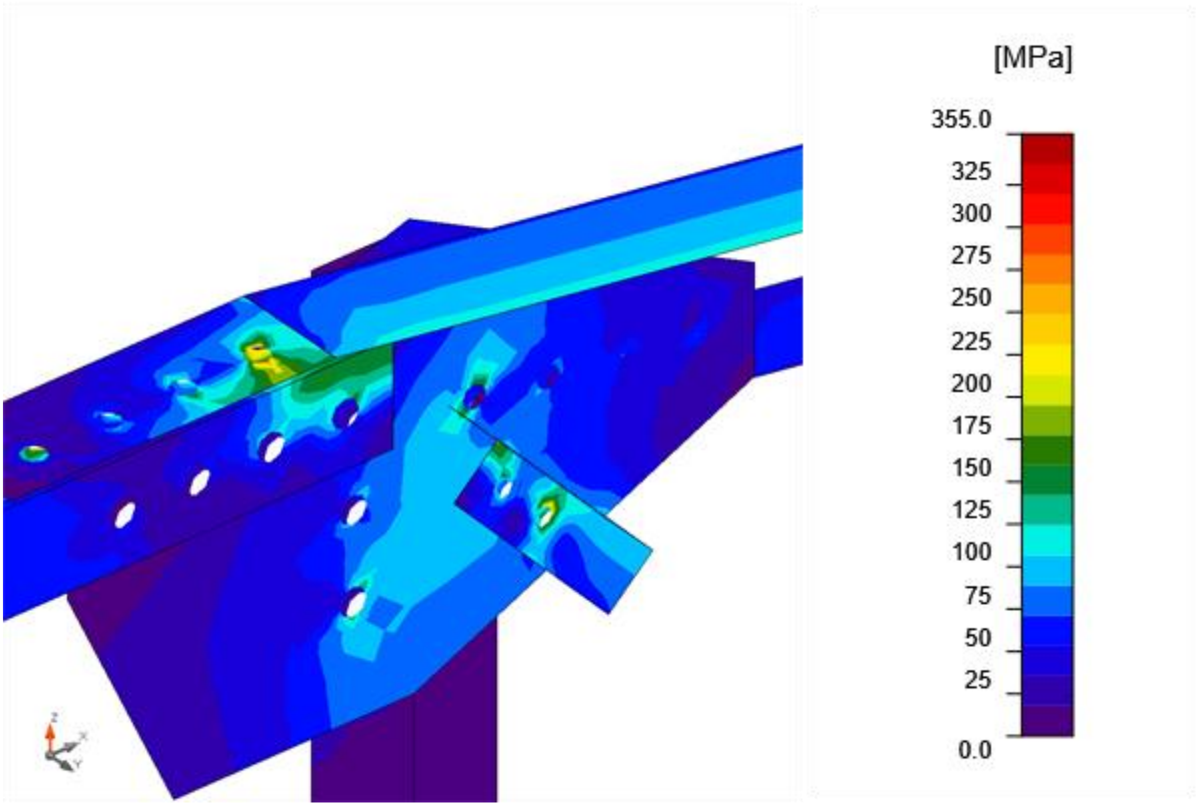
Overall check, LE1



Strain check, LE1

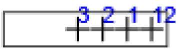
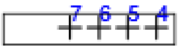
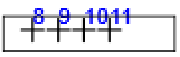
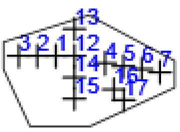


Equivalent stress, LE1



Equivalent stress, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	8.6	4.3	5.2	69.5	6.2	6.2	OK
	B2	M24 8.8 - 1	LE1	5.9	0.8	3.6	83.9	0.9	2.6	OK
	B3	M24 8.8 - 1	LE1	4.4	2.4	2.7	71.3	3.4	3.4	OK
	B12	M24 8.8 - 1	LE1	5.3	8.8	3.2	69.5	12.6	8.3	OK
	B4	M20 8.8 - 2	LE1	11.6	1.6	8.2	91.3	1.7	7.5	OK
	B5	M20 8.8 - 2	LE1	0.9	0.4	0.6	92.3	0.4	0.9	OK
	B6	M20 8.8 - 2	LE1	1.9	0.4	1.3	86.4	0.4	1.3	OK
	B7	M20 8.8 - 2	LE1	4.0	1.4	2.9	72.8	2.0	3.6	OK
	B8	M20 8.8 - 3	LE1	31.9	19.0	23.3	115.2	20.2	36.3	OK
	B9	M20 8.8 - 3	LE1	5.2	17.8	3.8	93.4	19.0	21.5	OK
	B10	M20 8.8 - 3	LE1	1.9	17.3	1.4	93.4	18.5	19.4	OK
	B11	M20 8.8 - 3	LE1	3.5	18.1	2.6	93.4	19.4	21.0	OK
	B13	M24 8.8 - 1	LE1	2.2	2.8	1.3	65.1	4.3	2.8	OK
	B14	M24 8.8 - 1	LE1	3.2	2.9	1.9	107.2	2.7	3.3	OK
	B15	M24 8.8 - 1	LE1	14.6	3.5	8.9	107.6	3.3	7.7	OK
	B16	M16 8.8 - 4	LE1	5.2	1.5	6.3	34.4	4.3	6.6	OK
	B17	M16 8.8 - 4	LE1	13.6	1.5	16.7	38.6	3.9	13.2	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203.3	165.0	135.6
M20 8.8 - 2	141.1	171.0	94.1
M20 8.8 - 3	141.1	136.8	94.1
M16 8.8 - 4	90.4	81.4	60.3

Symbol explanation

$F_{t,Rd}$ Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$ Tension force
$B_{p,Rd}$ Punching shear resistance
V Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$ Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$ Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t Utilization in tension
Ut_s Utilization in shear

Welds (Maximal value used, plastic redistribution recommended)

Item	Edge	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	$\sigma_\perp$ [MPa]	$\tau_{\|\|}$ [MPa]	$\tau_\perp$ [MPa]	Ut [%]	Status
SP5	SP2	15.0	107	LE1						OK
SP5	Dummy-bfl 1	20.0	50	LE1						OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0.80	360.0	259.2

Symbol explanation

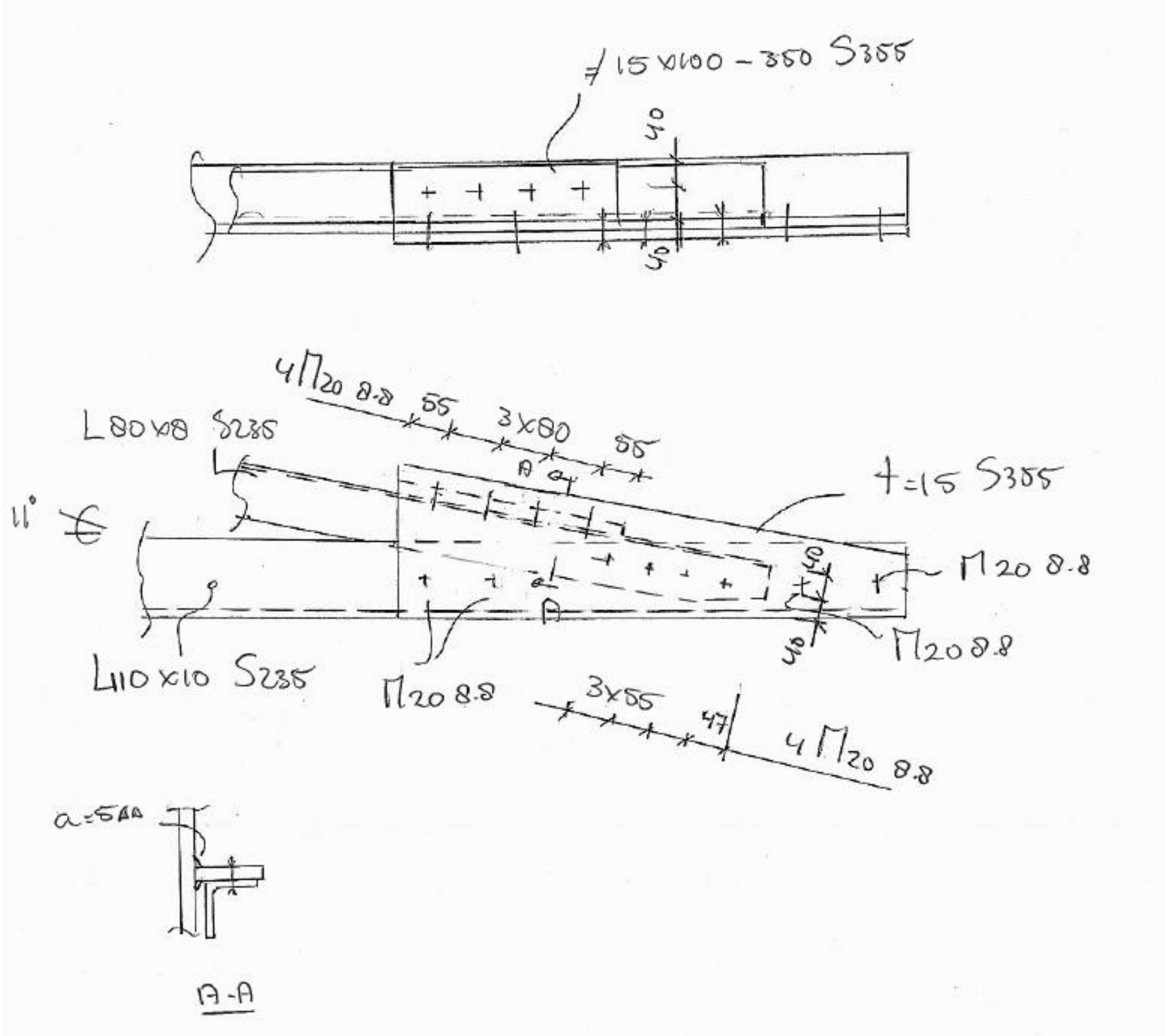
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_\perp$	Perpendicular stress
$\tau_{\|\|}$	Shear stress parallel to weld axis
$\tau_\perp$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

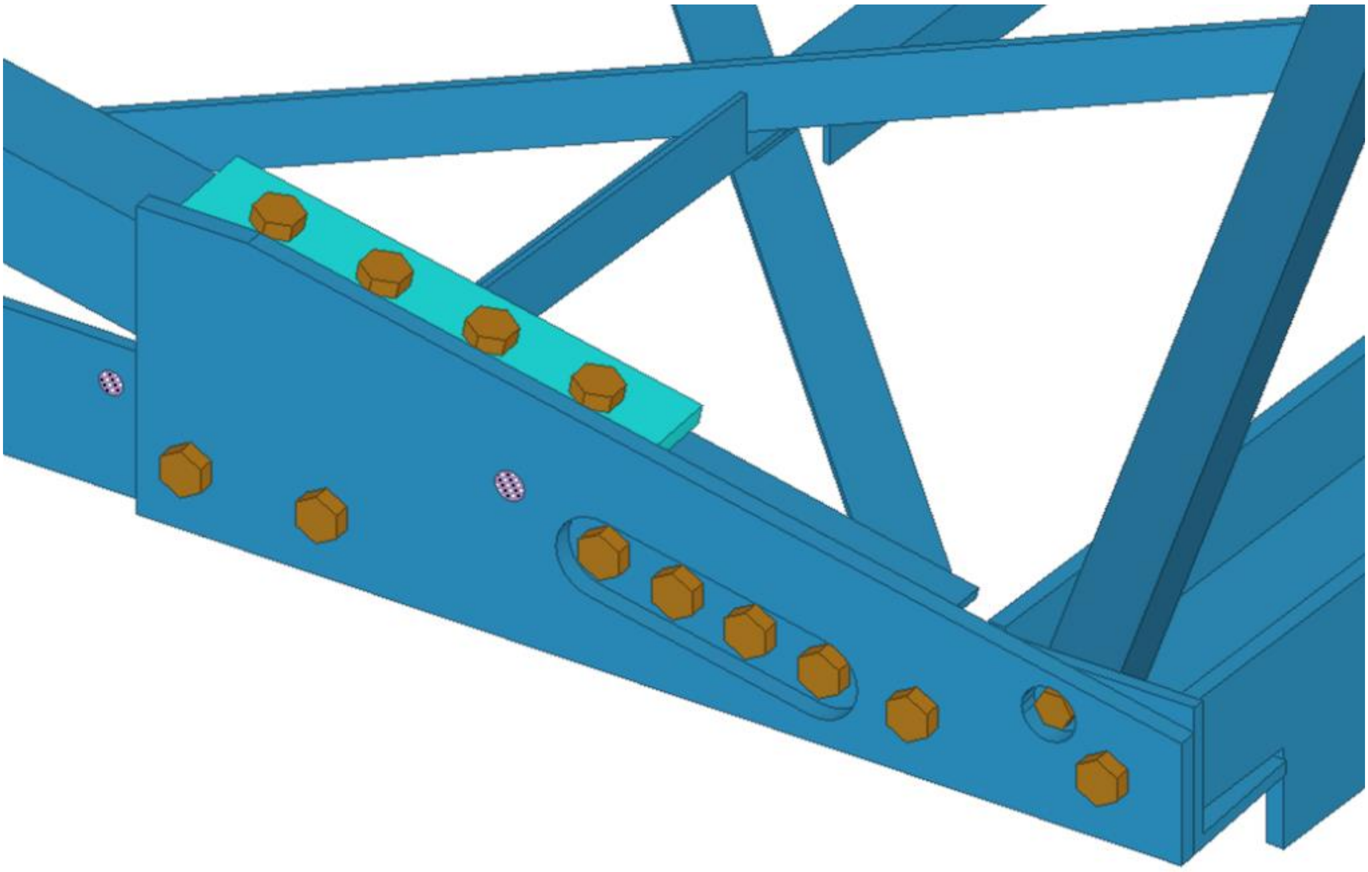
Code settings

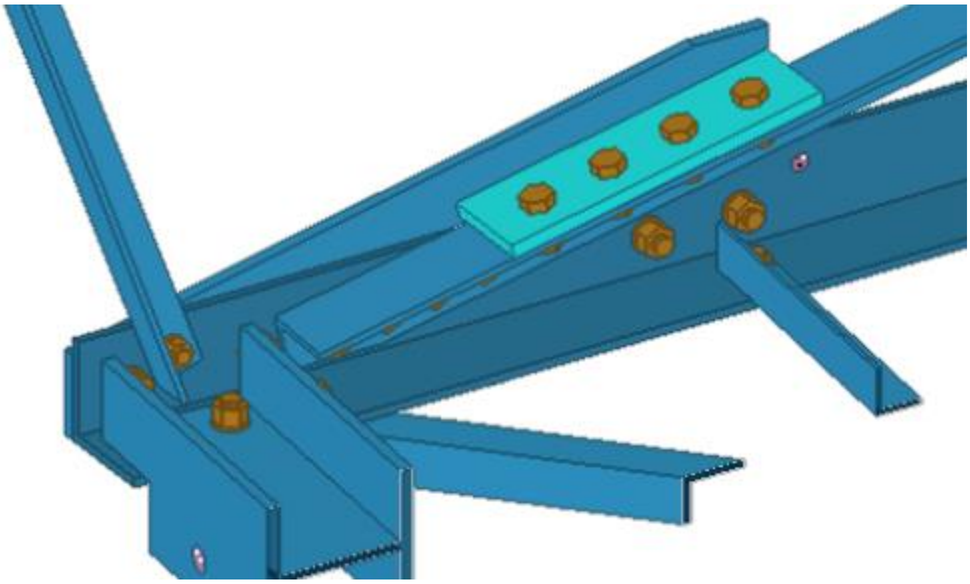
Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_C	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1

Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

3.1.10 Detail 3







3.1.11 Loads

Loads from report:

ENS-ZL380 – Tower S+15 R

Report nr.: 21-1725 Rev 1
Date: 2021-03-23

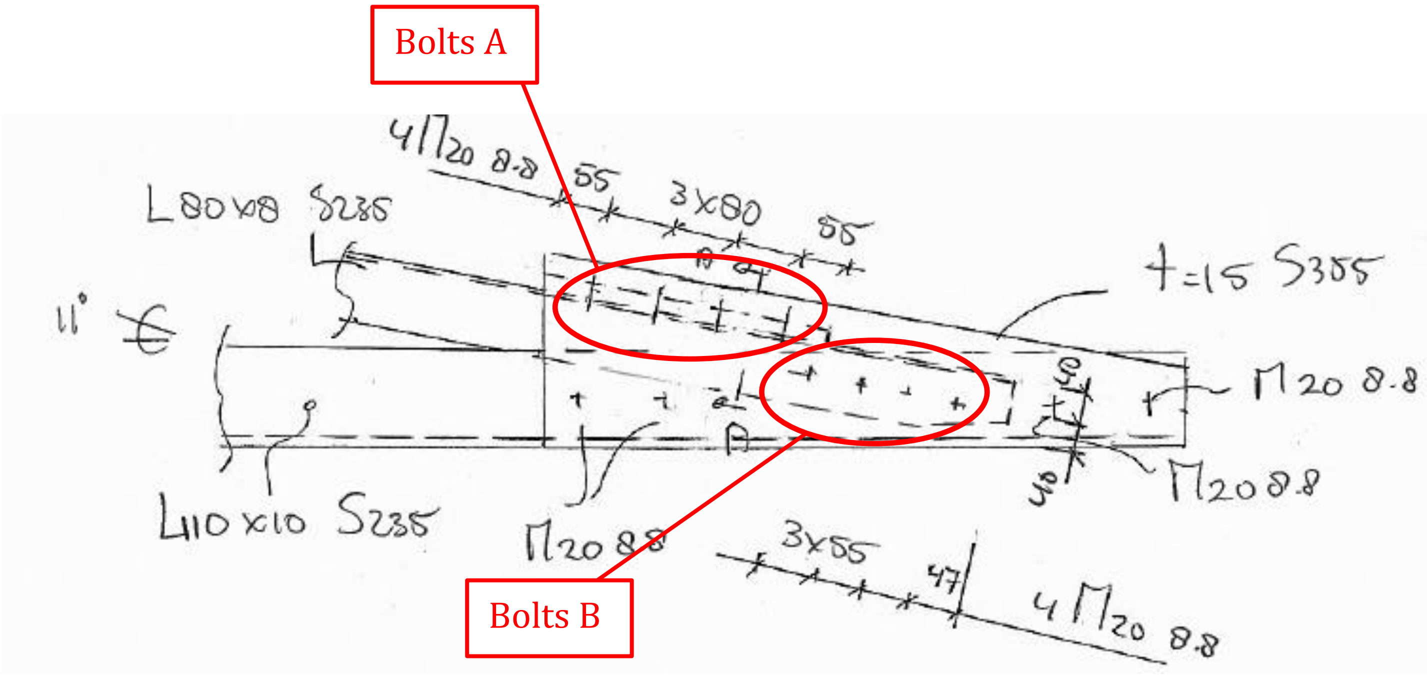
Page 41

Member: 393B L80x80x8 S235

N_{ED} = 0 kN compression N_{ED} = 179,8 kN tension

N_{ED} = 179,8 kN tension F= 90 kN through bolts A and plate t=15mm S355

F= 90 kN through bolts B and plate t=15mm S355



3.1.12 Calculation L80x8

3.1.12.1 Check Bolts

Bolts A: 4 x M20 8.8

F_{shear} max = 90 kN

$$U.C. = \frac{FvEd}{FvRd} = \frac{90}{4x94} = 0{,}24 < 1$$ O.K.

$F_{bearing}$ max = 90 kN

L80x8 S235

e_2 = 40 mm s1= 80 mm

$$k_1 = 2{,}8 \text{ x } \frac{40}{22} - 1{,}7 = 3{,}39 \rightarrow k_1 = 2{,}5$$

$$\alpha_b = \frac{45}{3x22} = 0{,}68 \qquad \alpha_b = \frac{80}{3x22} - 0{,}25 = 0{,}96$$

$$F_{b,Rd} = \frac{2{,}5 \text{ x } 0{,}96 \text{ x } 360 \text{ x } 20 \text{ x } 8}{1{,}25} = 111 \text{ kN}$$

$$U.C. = \frac{Fb,Ed}{Fb,Rd} = \frac{90}{4x111} = 0{,}2 < 1$$ O.K.

3.1.12.2 Check profile

L80x8 S235:

$$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0{,}59 \text{ x } 1054 \text{ x } 360}{1{,}25} = 179 \text{ kN}$$

$$U.C. = \frac{90}{179} = 0{,}5 < 1$$ O.K

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} / \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} / \Upsilon_{m0}$$
Not governing

3.1.13 Calculation L80x8

3.1.13.1 Check Bolts

Bolts B: 4 x M20 8.8

F_{shear} max = 90 kN

$$U.C. = \frac{FvEd}{FvRd} = \frac{90}{4x94} = 0{,}24 < 1$$ O.K.

$F_{bearing}$ max = 90 kN

L80x8 S235

E_1 = 47 mm e_2 = 40 mm s1= 55 mm

$$k_1 = 2{,}8 \text{ x } \frac{40}{22} - 1{,}7 = 3{,}39 \rightarrow k_1 = 2{,}5$$

$$\alpha_b = \frac{47}{3x22} = 0{,}71 \qquad \alpha_b = \frac{55}{3x22} - 0{,}25 = 0{,}58$$

$$F_{b,Rd} = \frac{2{,}5 \text{ x } 0{,}58 \text{ x } 360 \text{ x } 20 \text{ x } 8}{1{,}25} = 67 \text{ kN}$$

$$U.C. = \frac{Fb,Ed}{Fb,Rd} = \frac{90}{4x67} = 0{,}34 < 1$$ O.K.

3.1.13.2 Check profile

L80x8 S235:

$$N_{u,Rd} = \frac{\beta 3 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0{,}5 \text{ x } 1054 \text{ x } 360}{1{,}25} = 152 \text{ kN}$$

$$U.C. = \frac{90}{152} = 0{,}59 < 1$$ O.K

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} / \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} / \Upsilon_{m0}$$

A_{nt} = (40 – 11) x 8 = 232 mm^2

A_{nv} = ((47 – 11) + (3 x 55 - 3 x 22)) x 10 = 1080 mm^2

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 360 \text{ x } 232 / 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 235 \text{ x } 1080 / 1 = 180 \text{ kN}$$

$$U.C. = \frac{90}{180} = 0{,}5 < 1$$ O.K.

3.1.14 Calculation L110 x 10

Connection is not governing

3.1.15 Calculation Plate t = 15 mm S355

Connection is not governing

4 Summary U.C. 's

4.1.1 Connections

Detail 1

Bolts: U.C. = 0,72

Profile: U.C. = 0,99

Detail 2

Bolts: U.C. = 0,68

Profile: U.C. = 0,99

Detail 3

Bolts: U.C. = 0,34

Profile: U.C. = 0,59

5 Conclusion

5.1.1 Connections

All connections have sufficient strength.

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Projectnummer Aafjes:	**21-187**
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Meridian nummer:	**002.515.40 0994386**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**EC-3_R_X Mast 90 - Overzichtstekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
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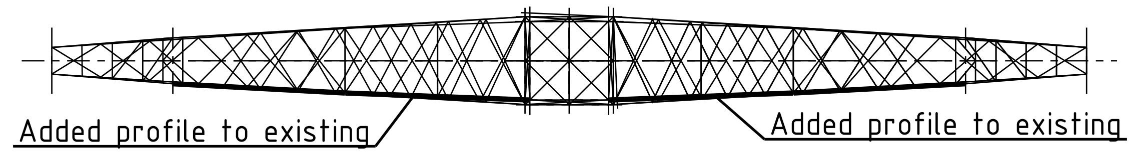
1.0	Definitief	18-02-2022	Document goedgekeurd



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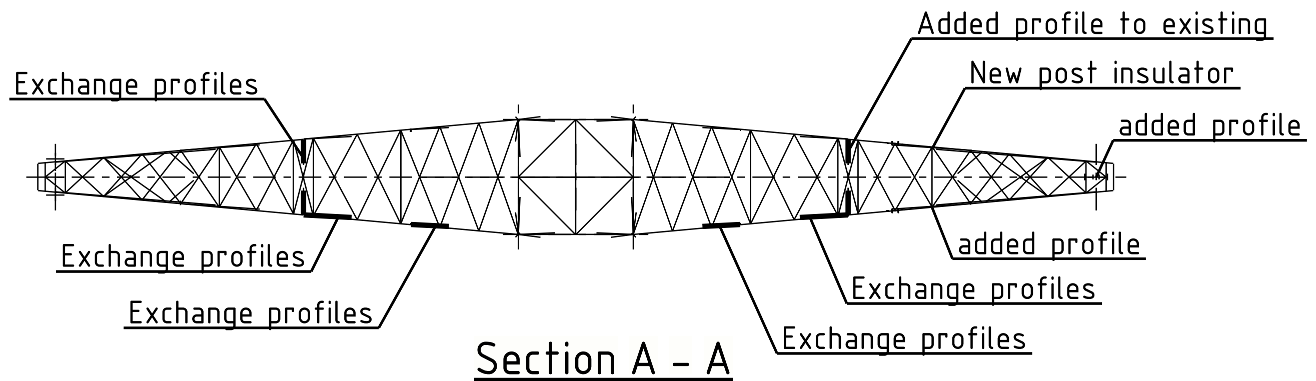

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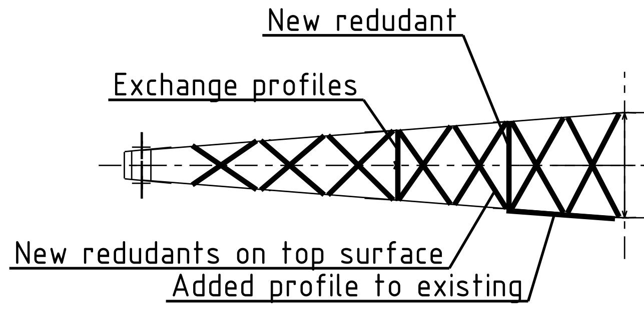

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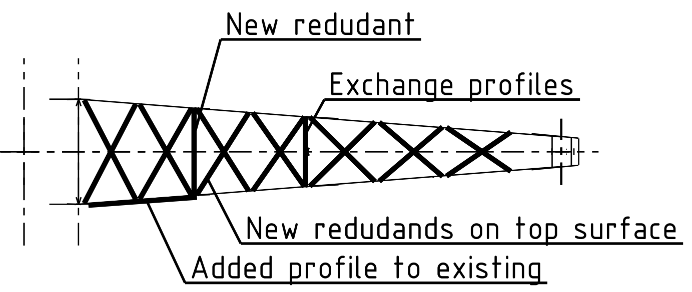

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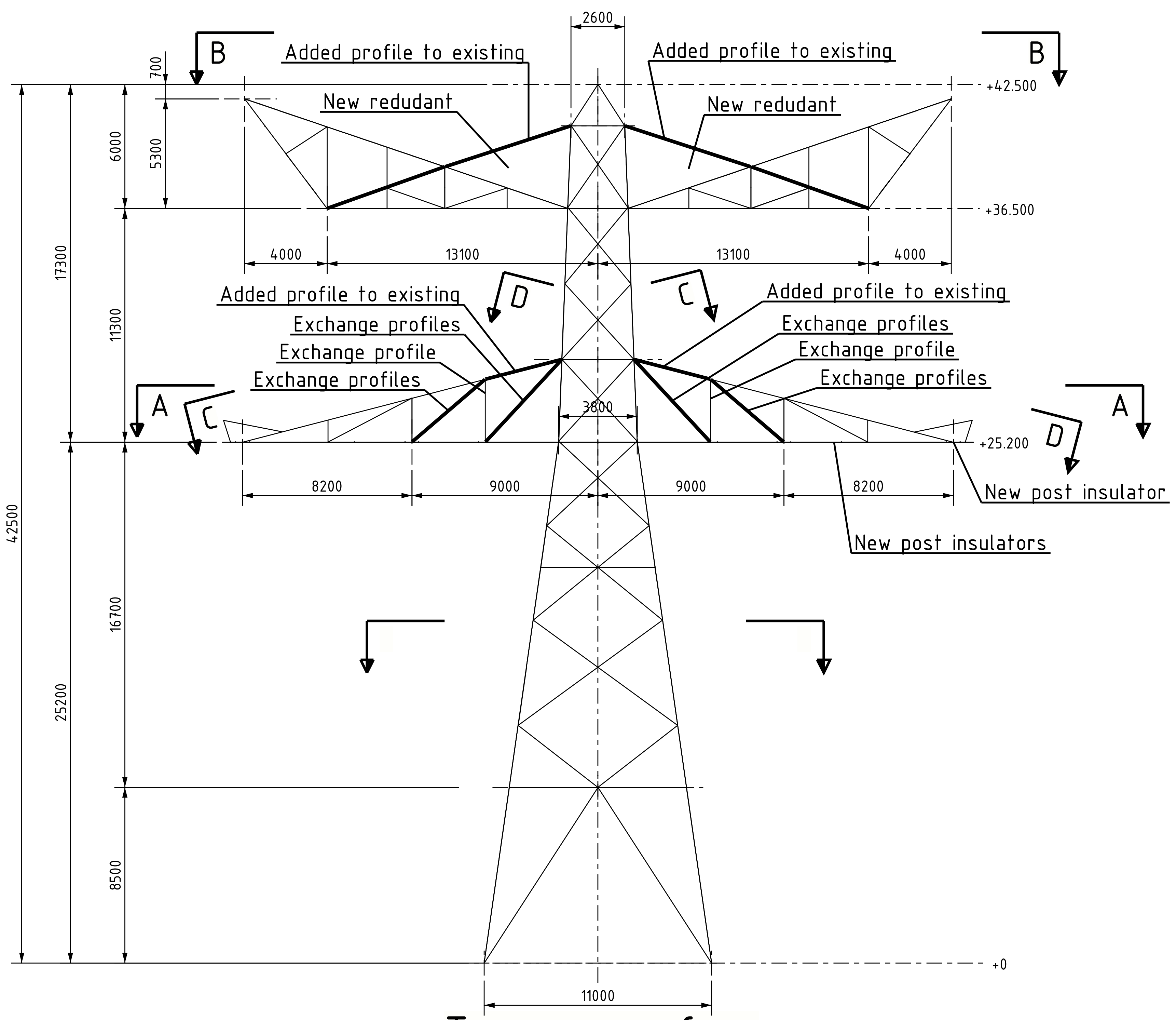

Transverse face
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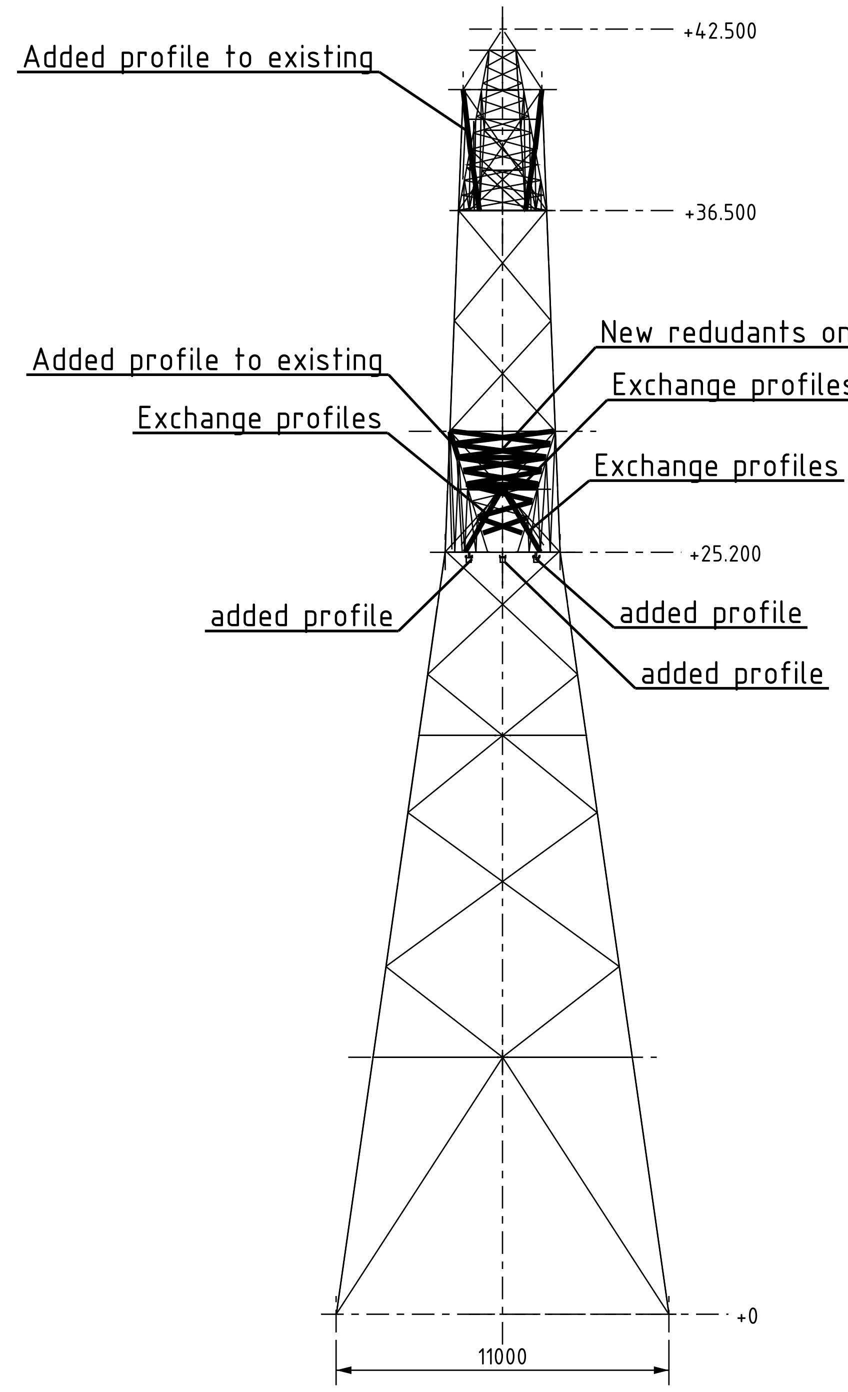

Longitudinal face
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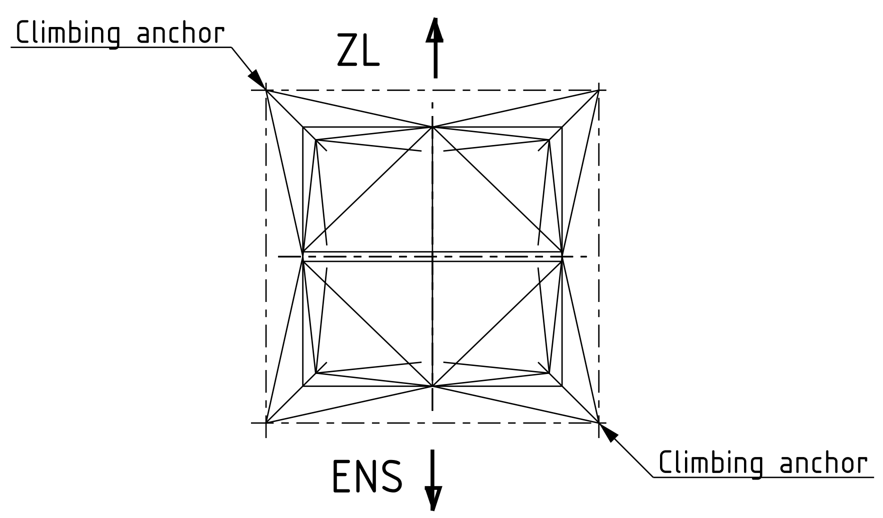

Section
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All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

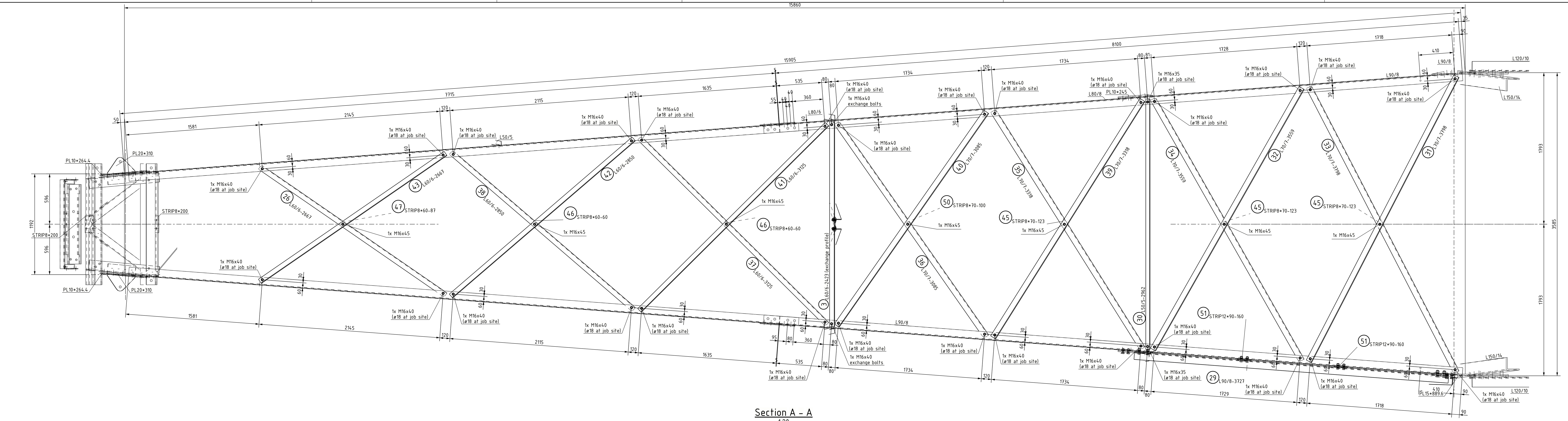
- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:250	594x420

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Masttype EC-3_R_X, Mast 90 - Overzicht
Documentnummer:	00974-01-09001

TenneT
Taking power further

Tekla Structures



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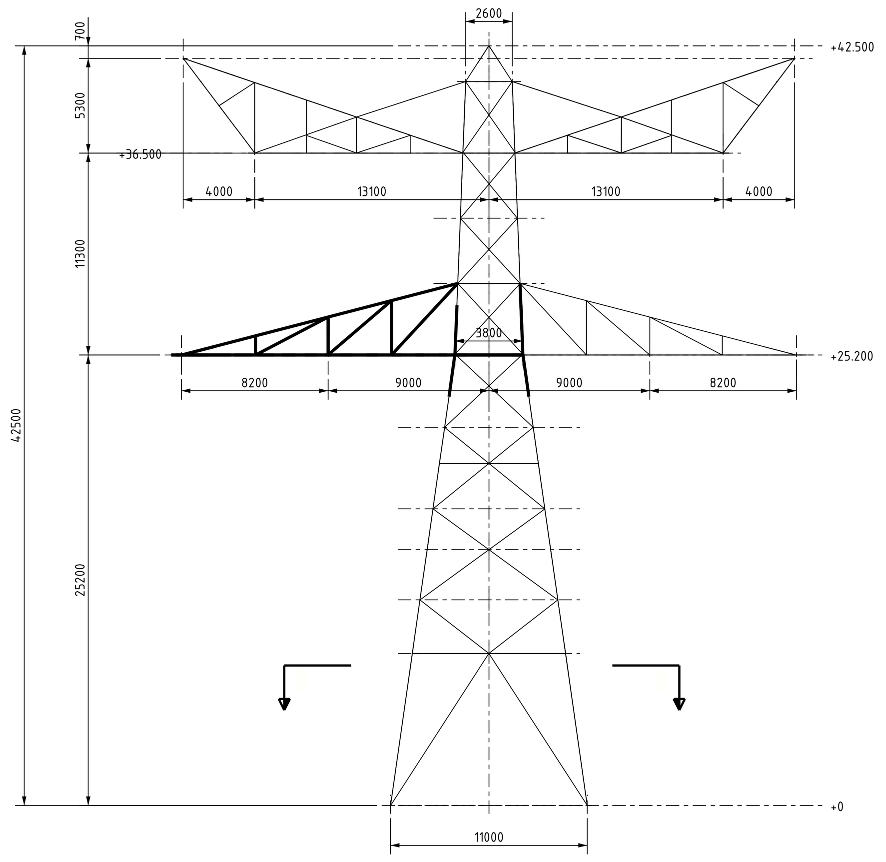
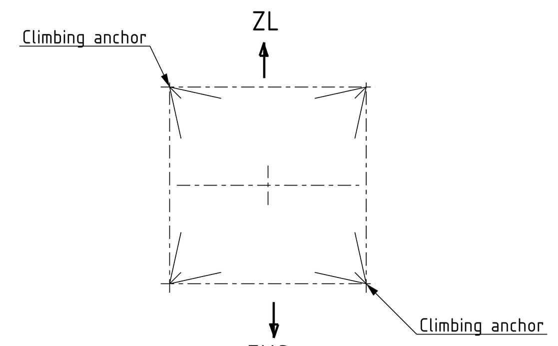


Transverse face
1:250



ENS
Section
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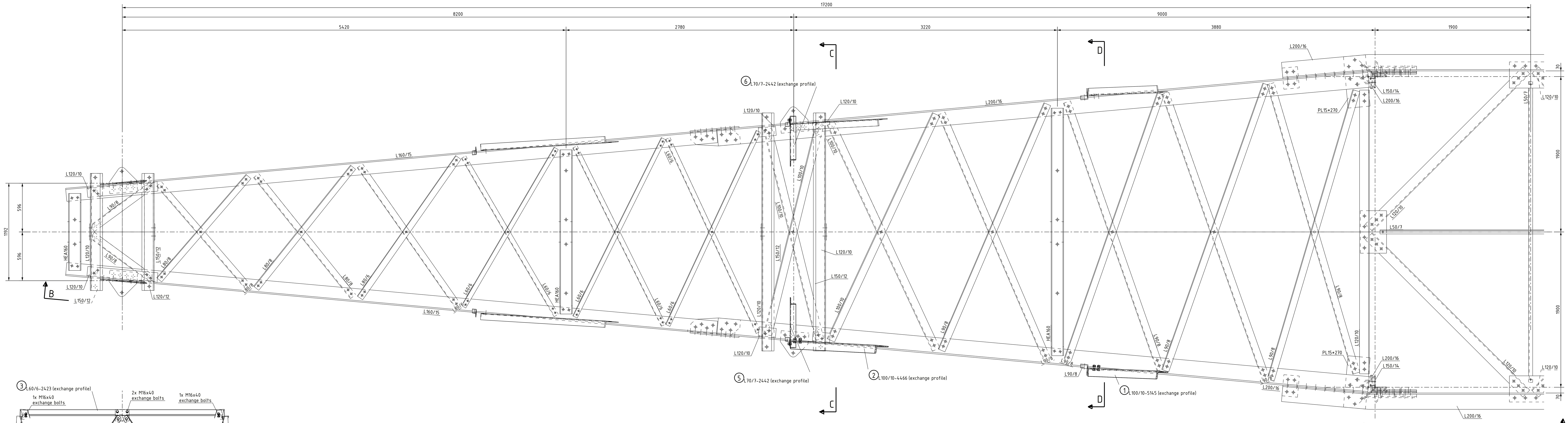
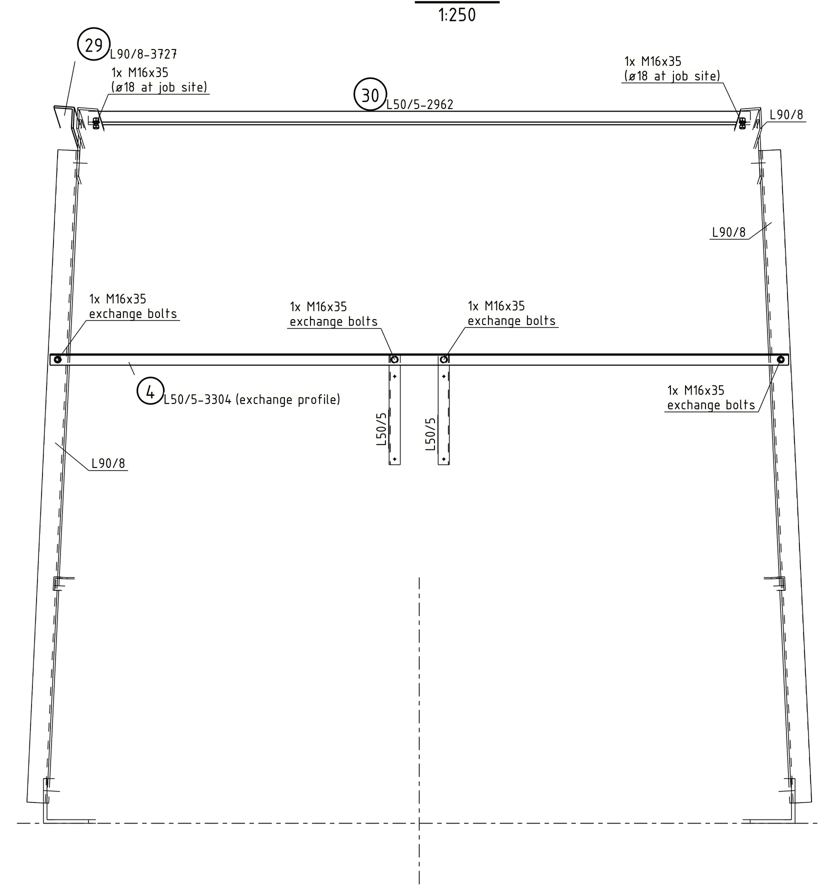


Bottom Surface Lower Cross Arm
1:20



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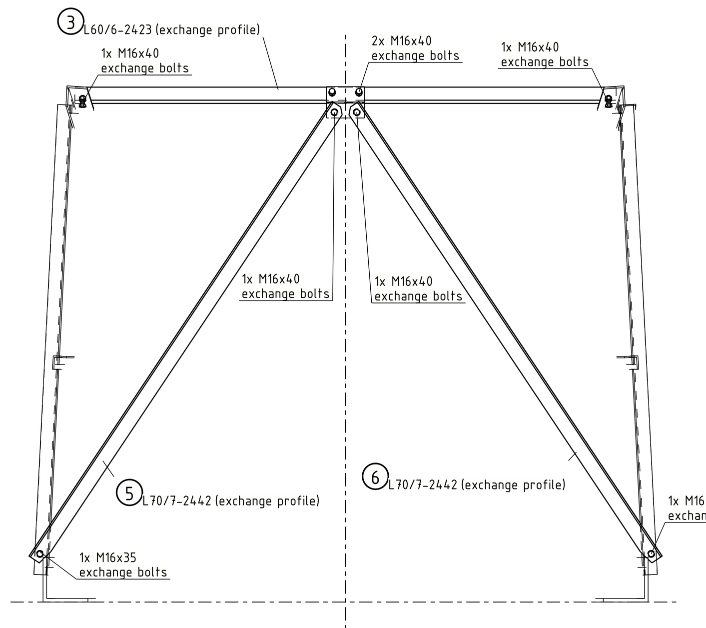

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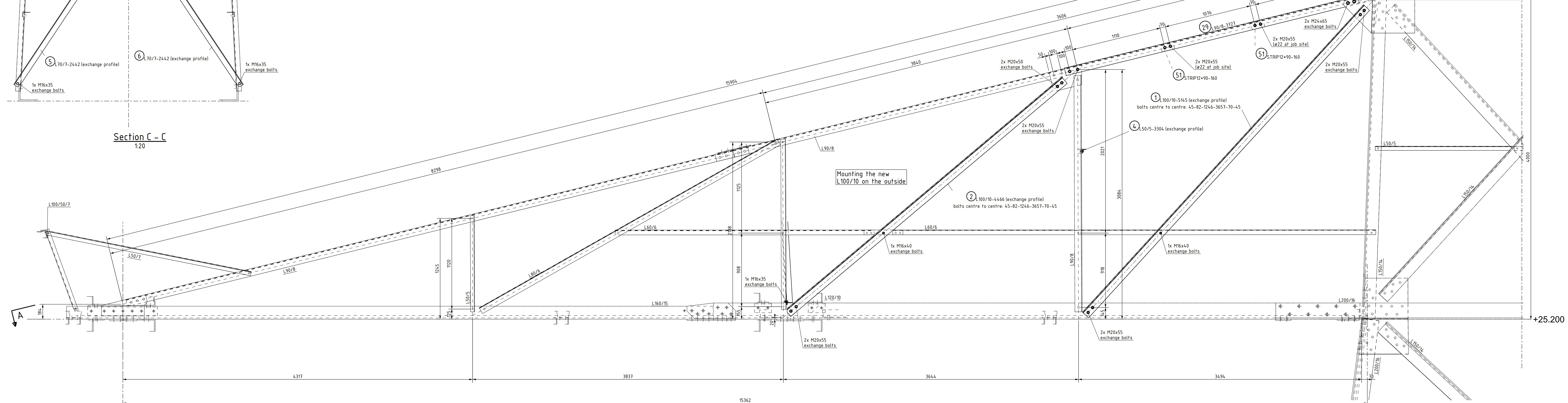

Section B - B
1:20

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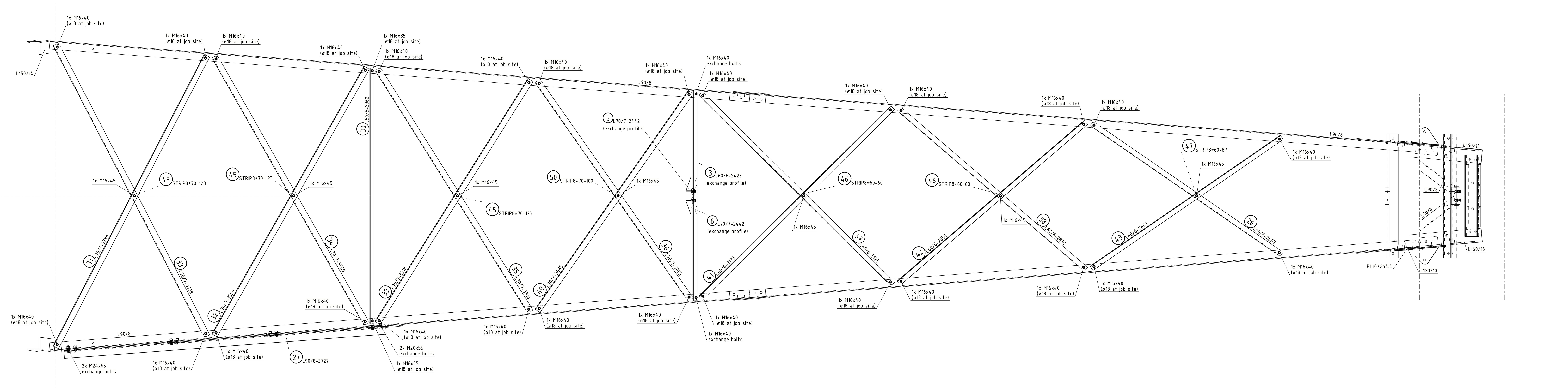
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:20 1:250	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Masttype EC-3_R_X, Mast 90 - Ondertraverse links
Documentnummer:	00974-01-09002

TenneT Taking power further

Tekla Structures



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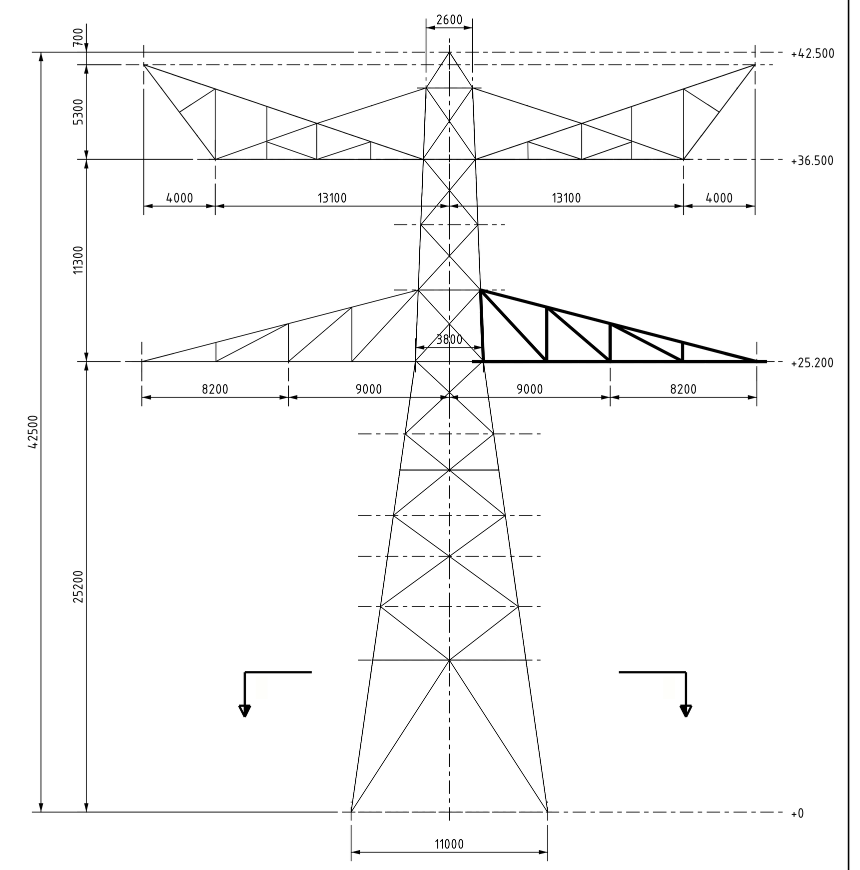
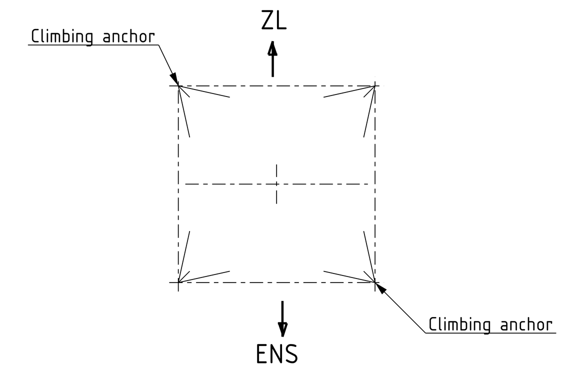


Transverse face
1:250



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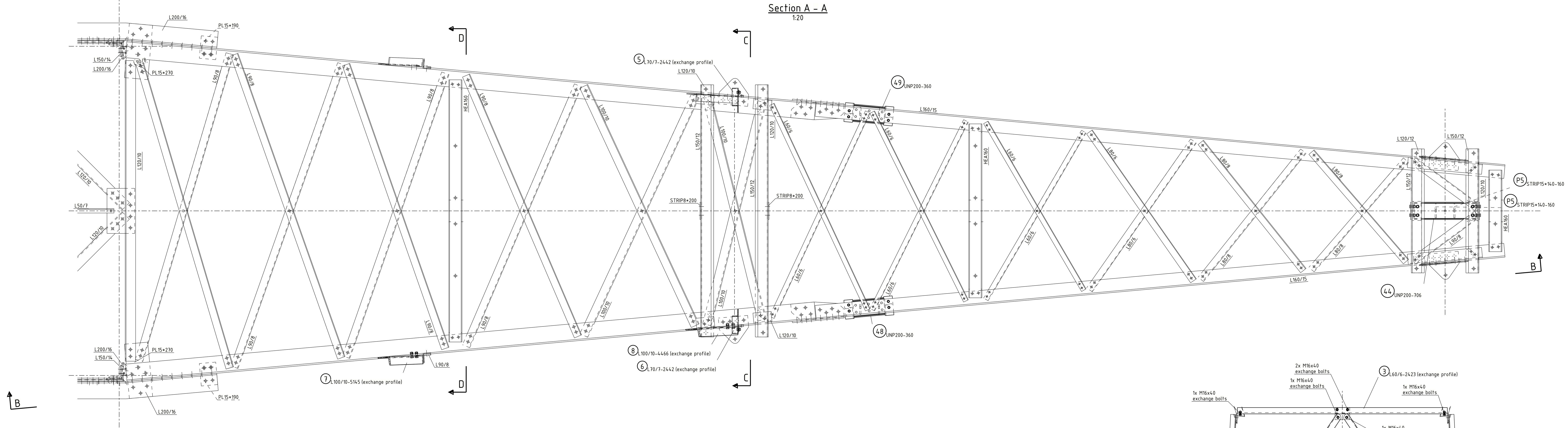
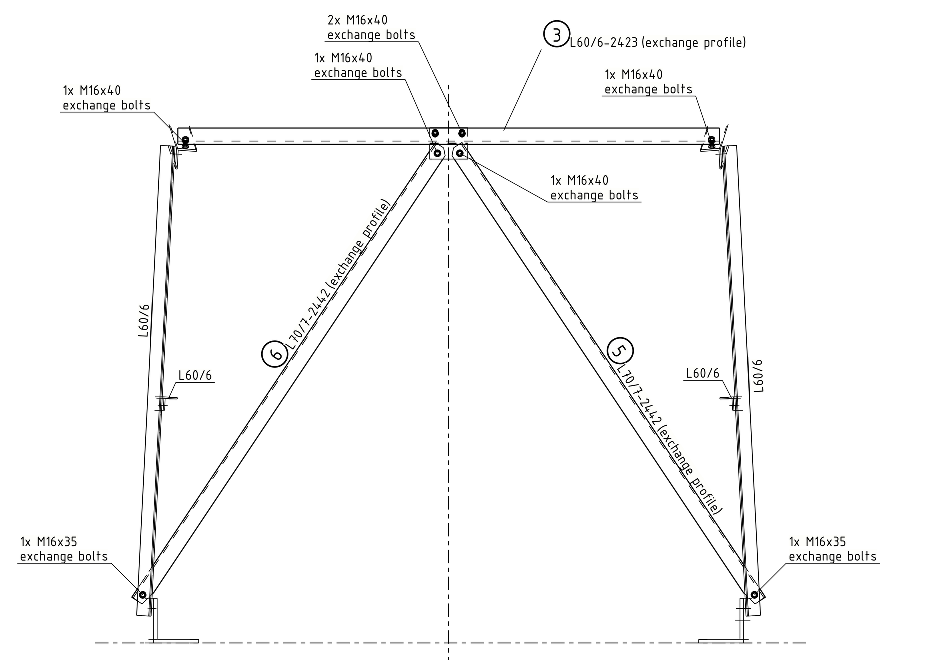


Bottom Surface Lower Cross Arm
1:20



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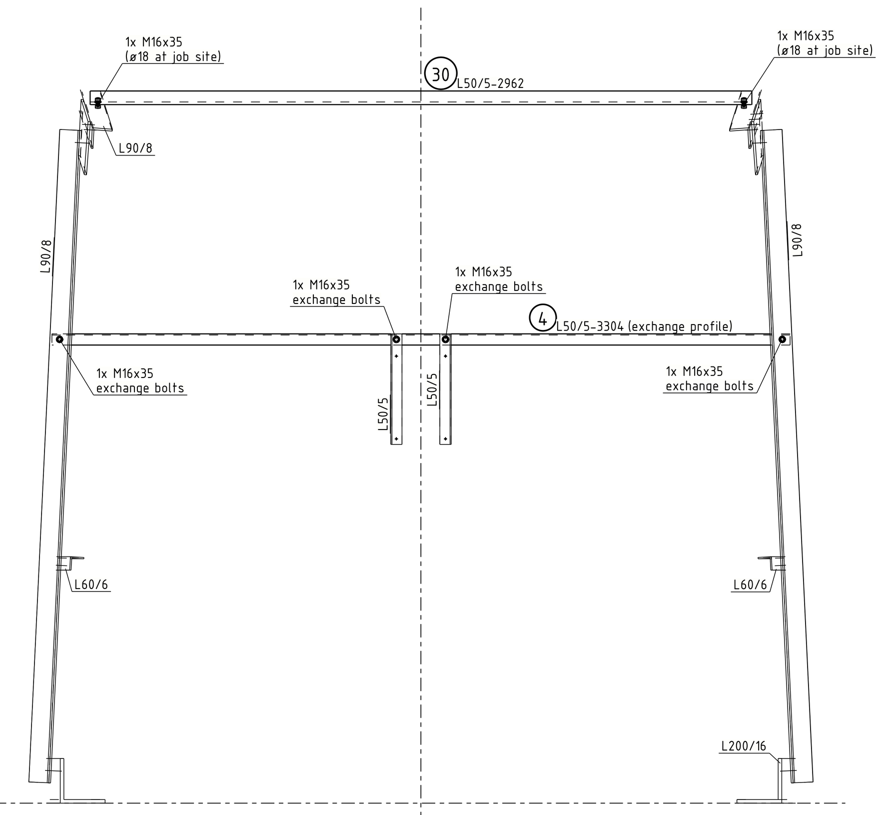

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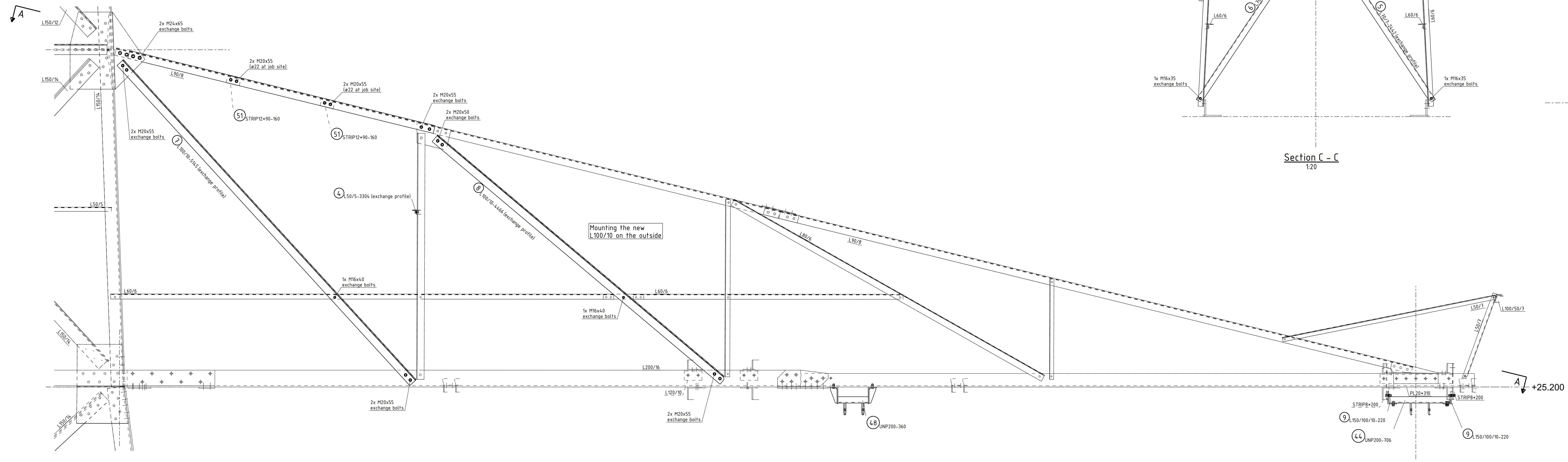

Section B - B
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- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

For details and dimensions see drawing 00974-01-09002 and 00974-01-09004

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:20 1:250	A0

Relatie

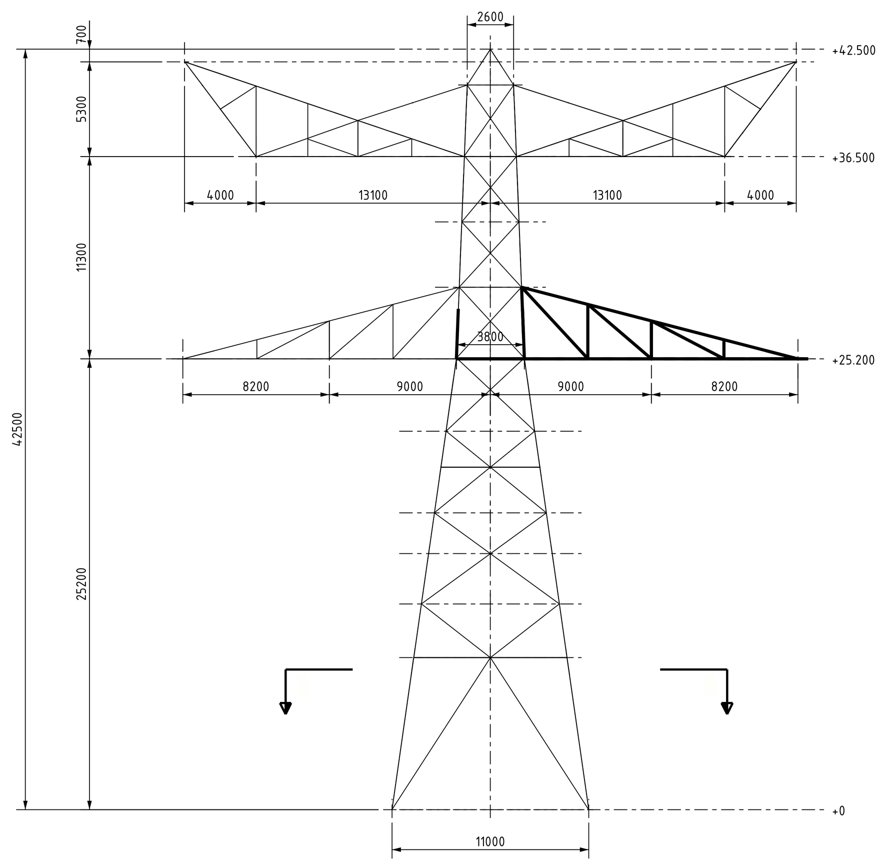
Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

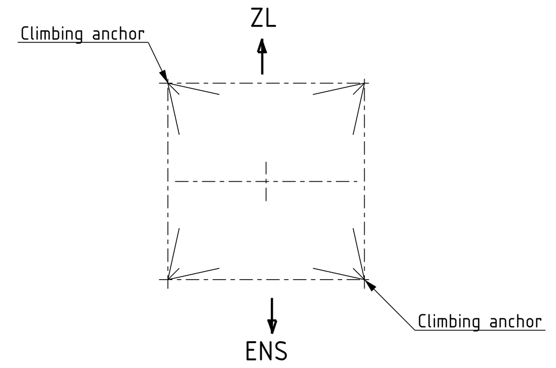
Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Masttype EC-3_R_X, Mast 90 - Ondertraverse rechts

Documentnummer: 00974-01-09003



Transverse face
1:250



Section
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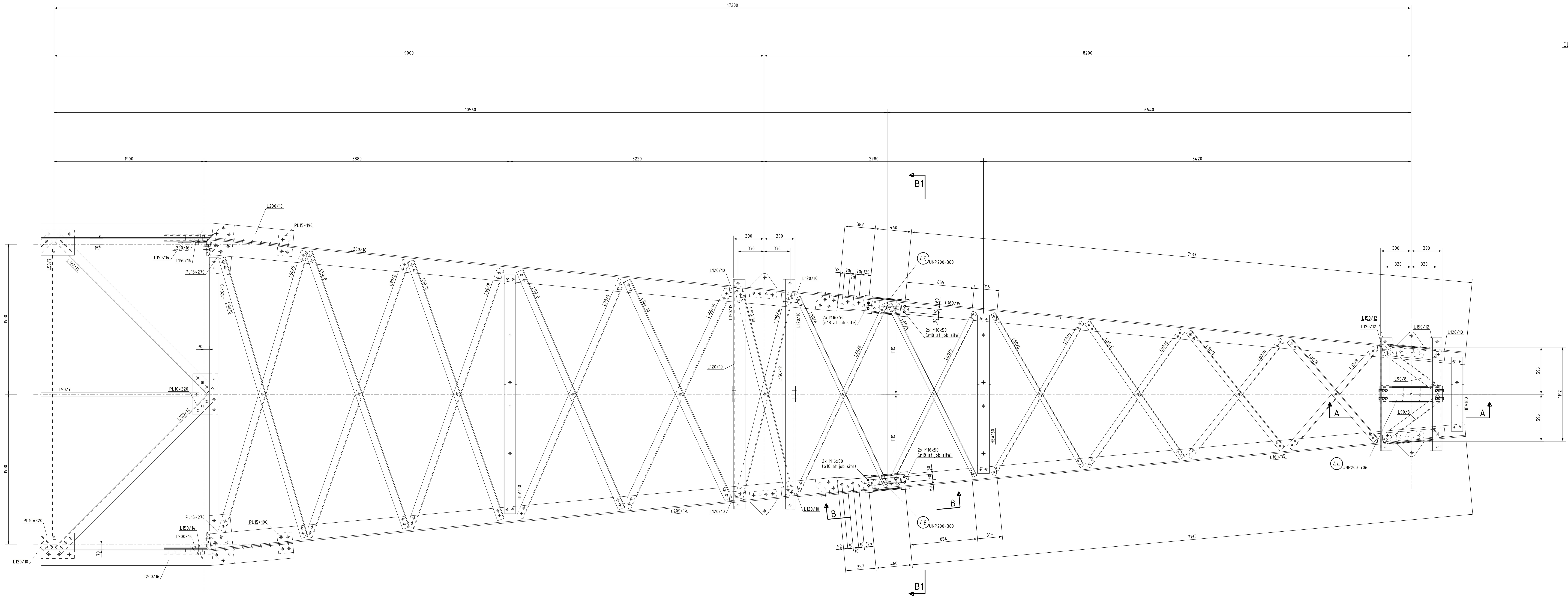
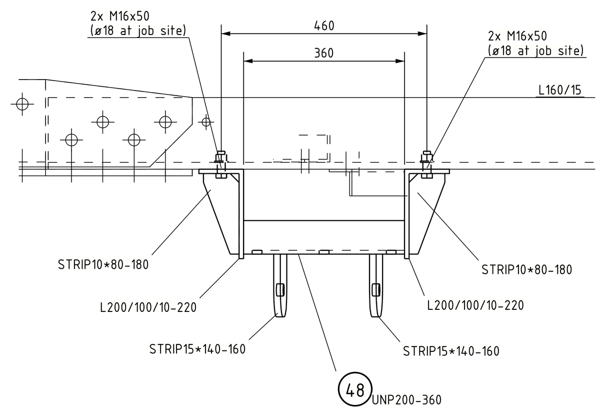
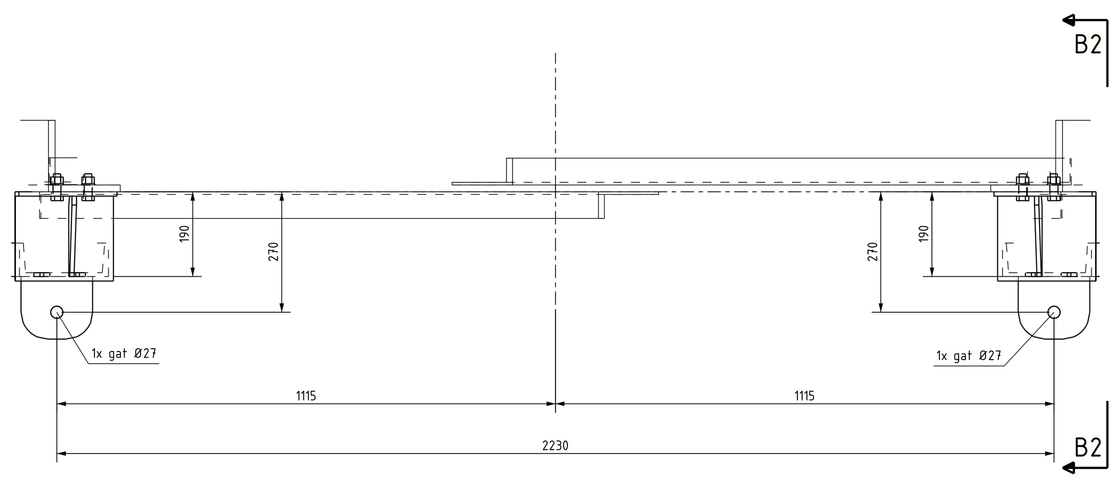


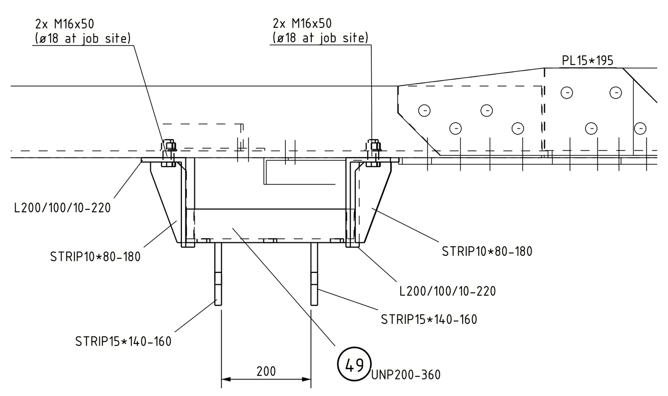
Bottom Surface Lower Cross Arm
1:20



Section B - B
1:10



Section B1 - B1
1:10



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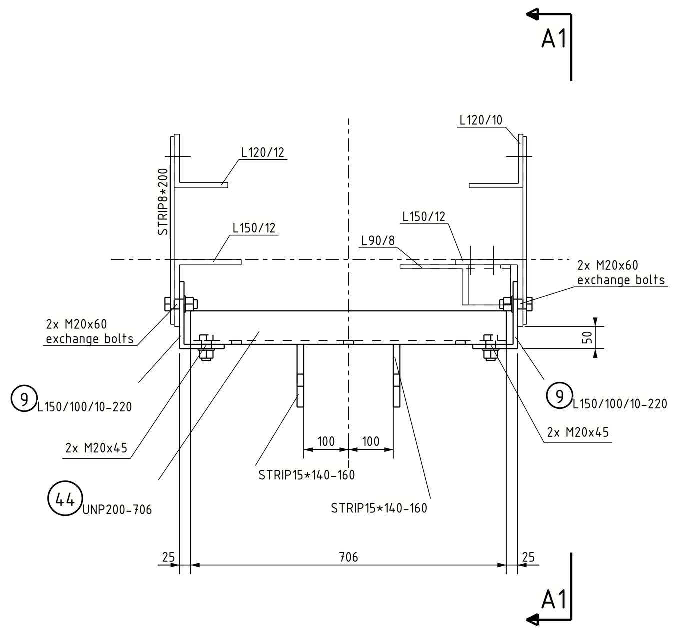
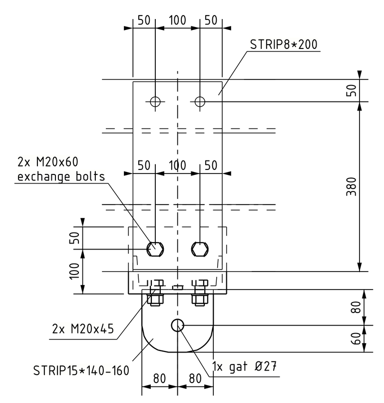


Section A - A
1:10



Section A1 - A1
1:10

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

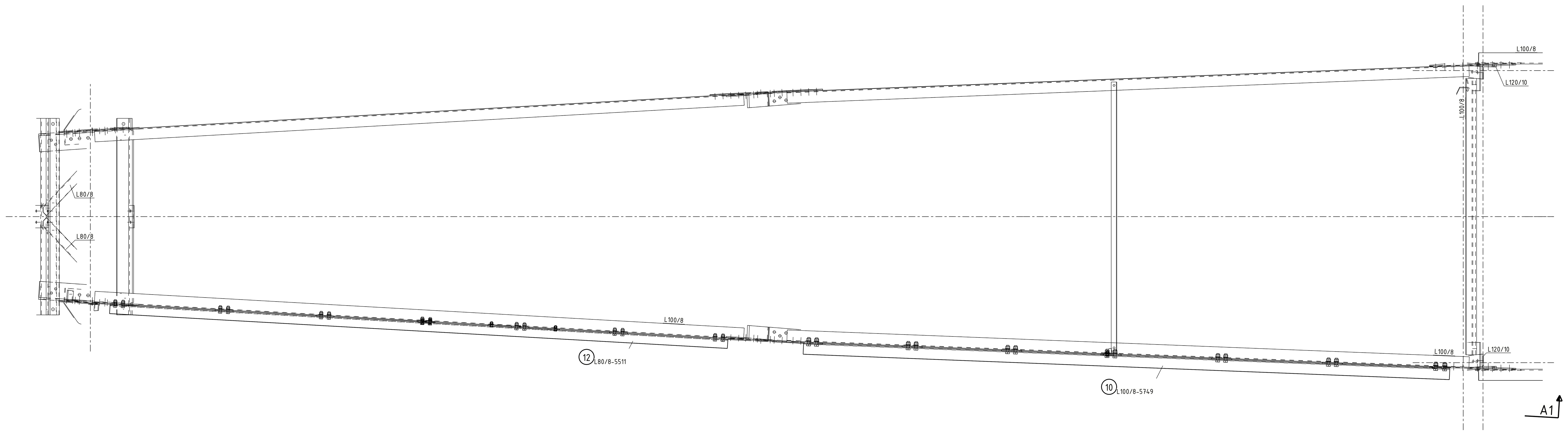
Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

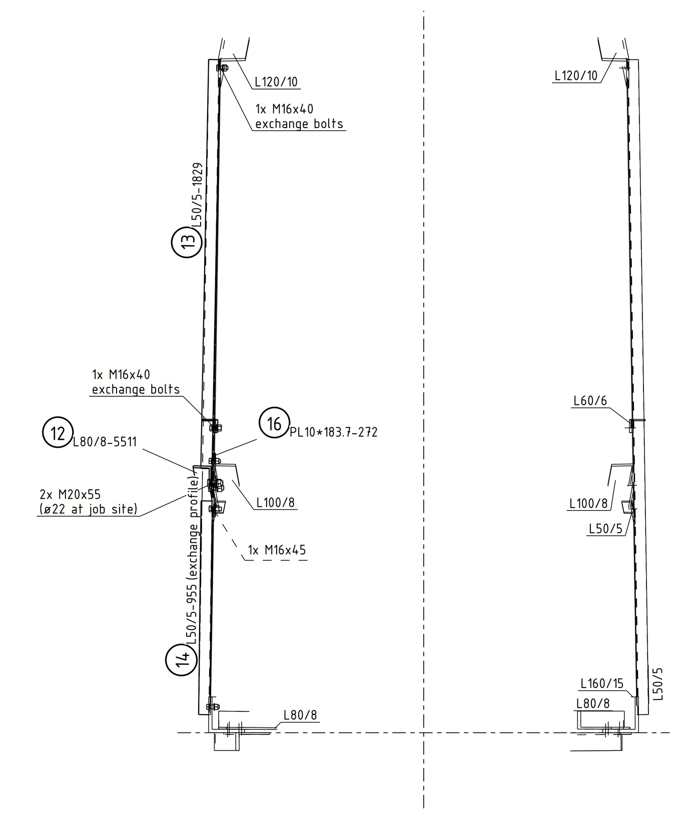
Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Masttype EC-3_R_X, Mast 90 - Ondertraverse rechts
Documentnummer:	00974-01-09004

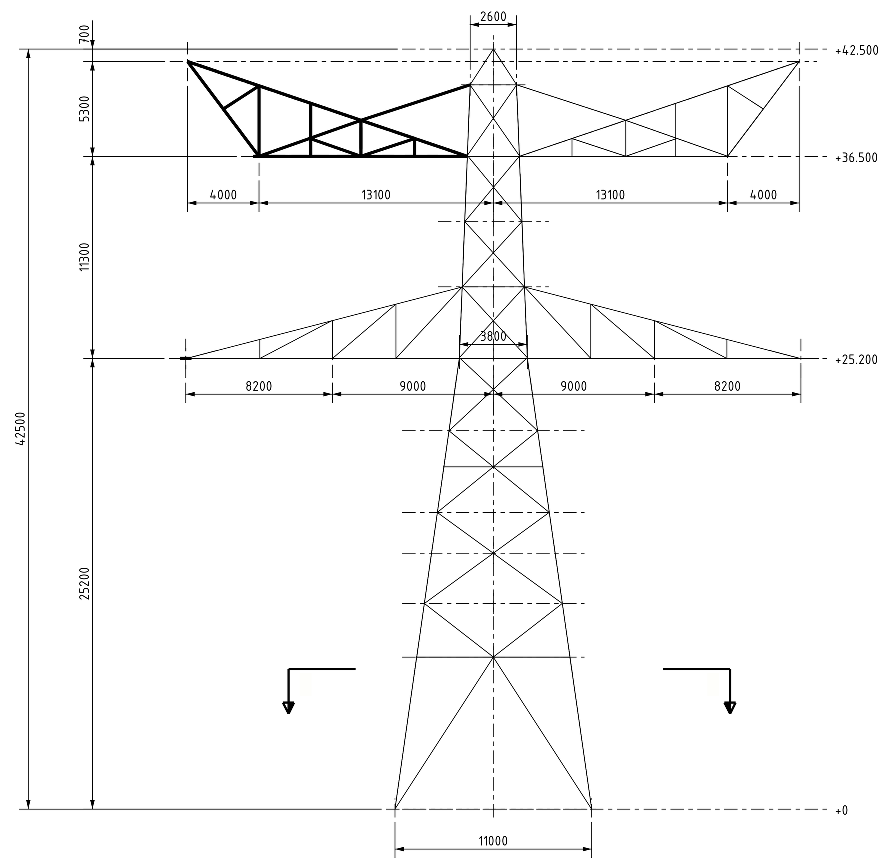
TenneT Taking power further



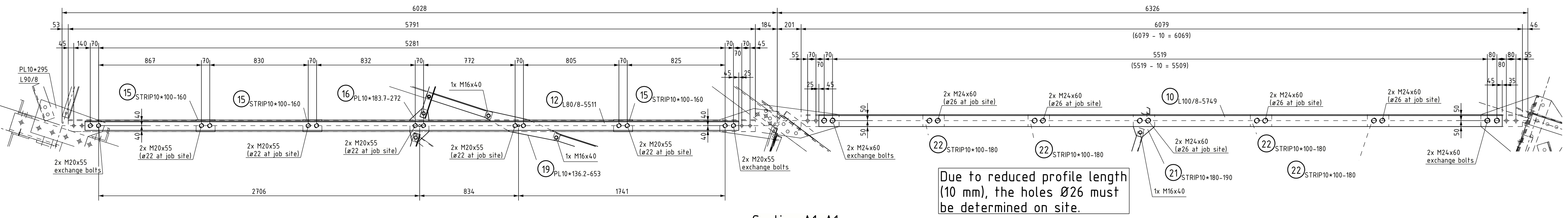
Section A - A
1:20



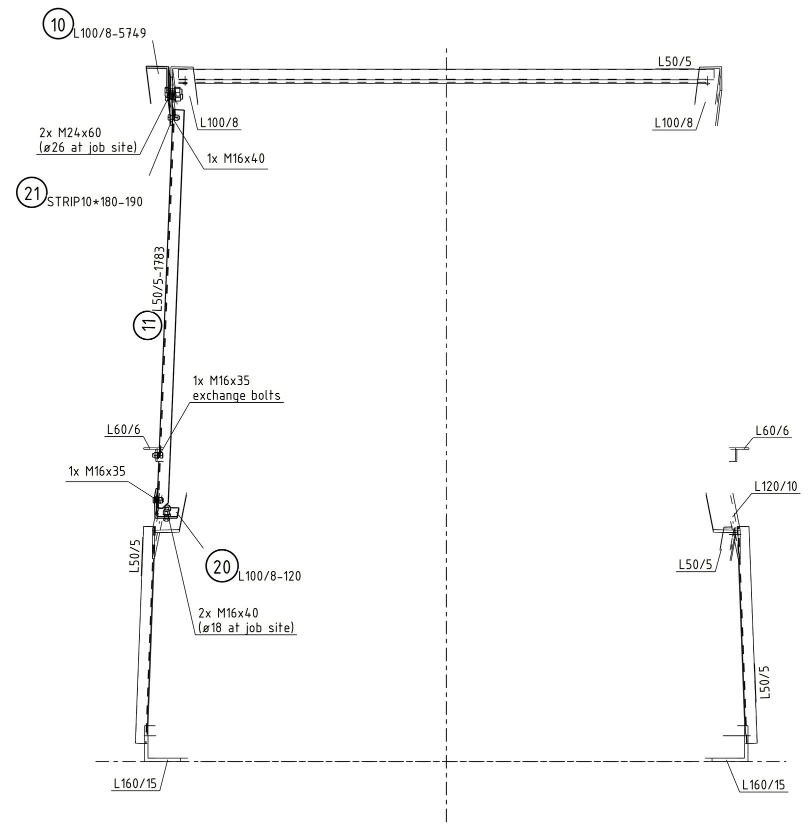
Section C - C
1:20



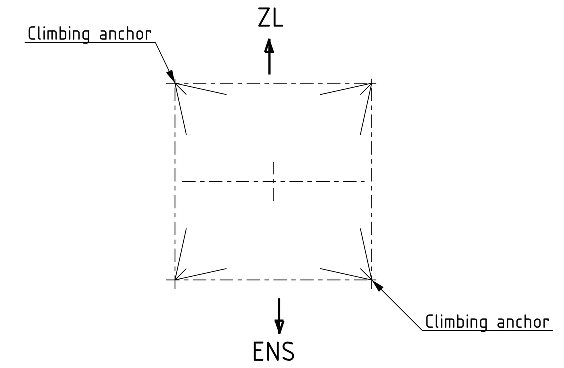
Transverse face
1:250



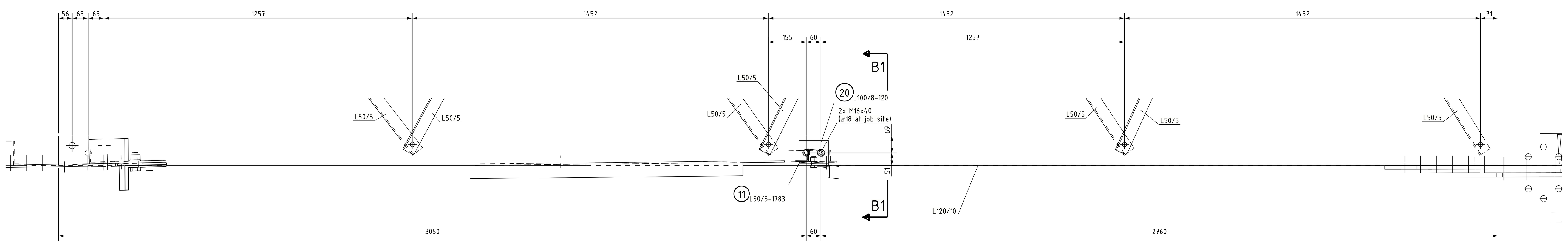
Section A1-A1
1:20



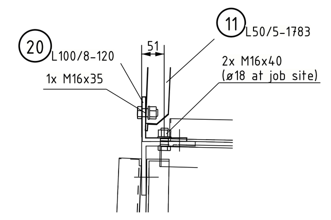
Section D - D
1:20



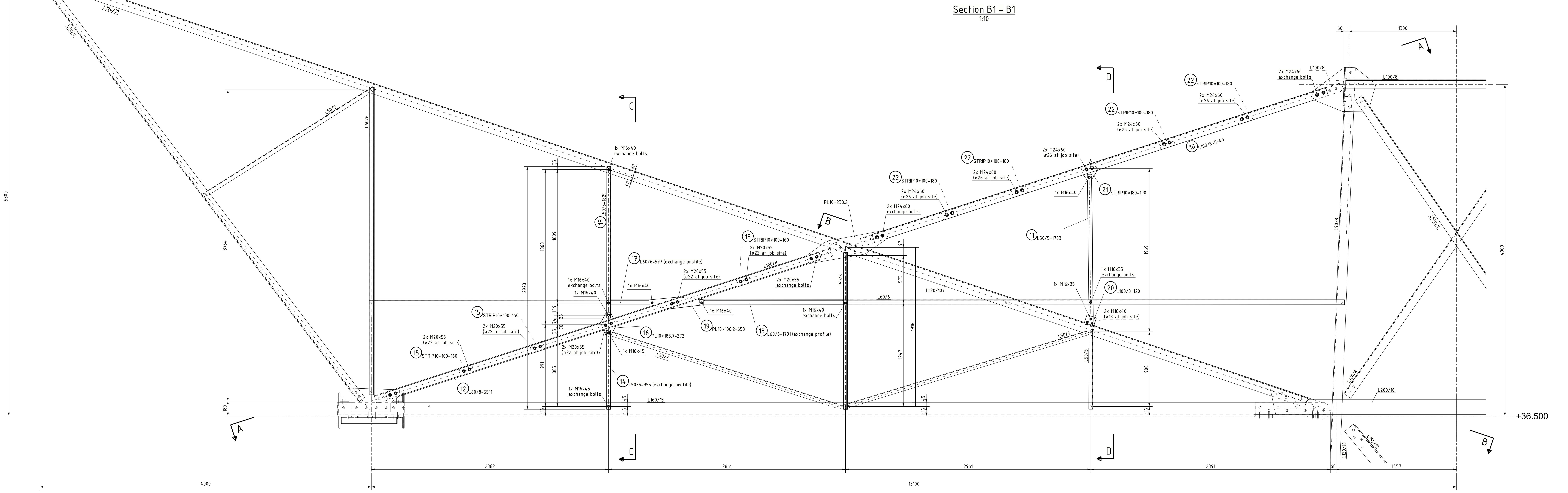
Section
1:250



Section B-B
1:10



Section B1 - B1
1:10



Front Face Upper Cross Arm Left
1:20

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

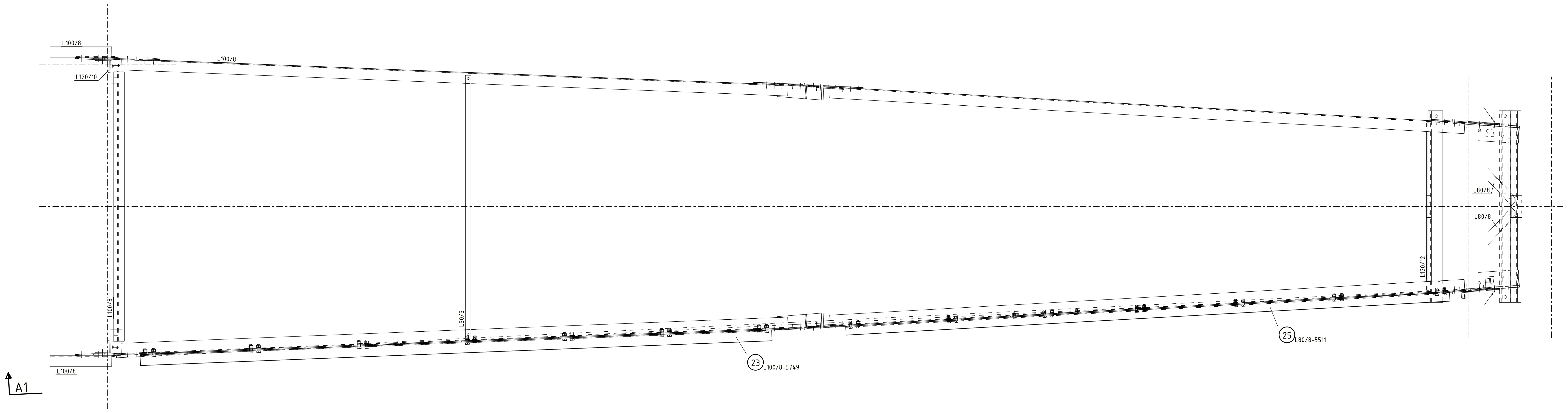
Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

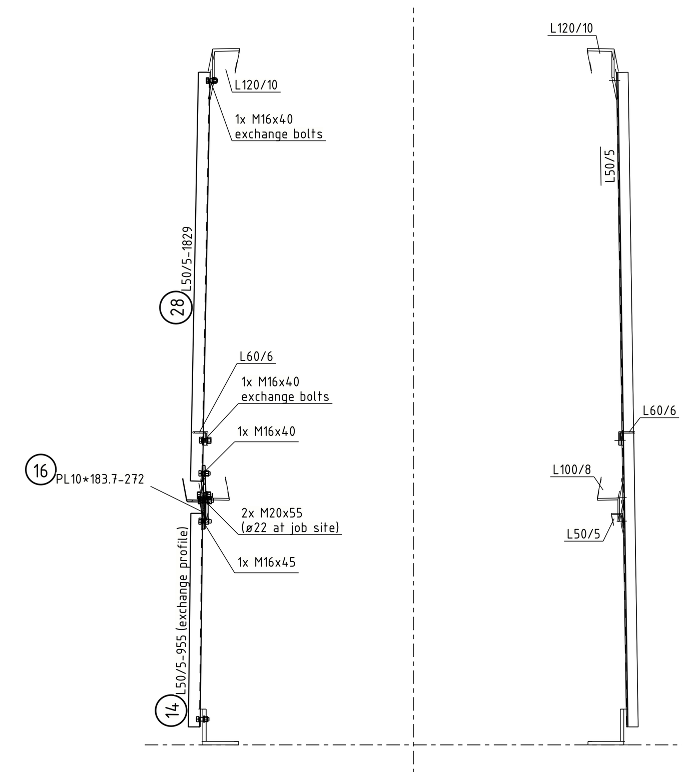
Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Masttype EC-3_R_X, Mast 90 - Boventraverse links
Documentnummer:	00974-01-09005

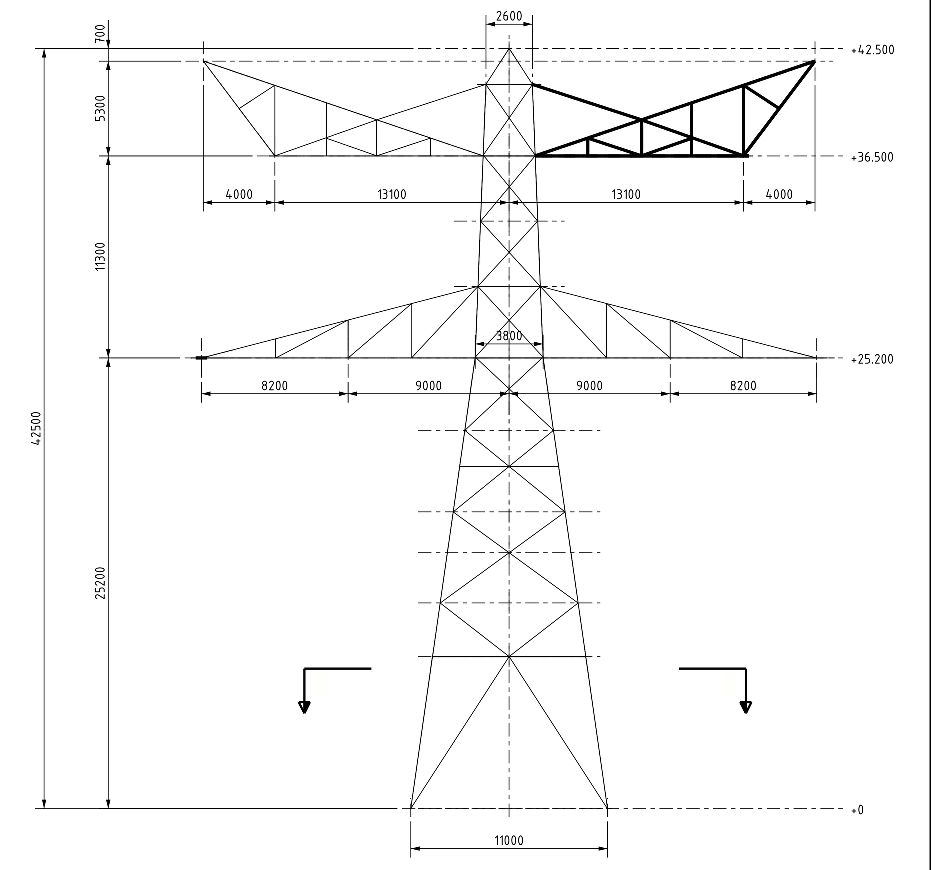
TenneT Taking power further



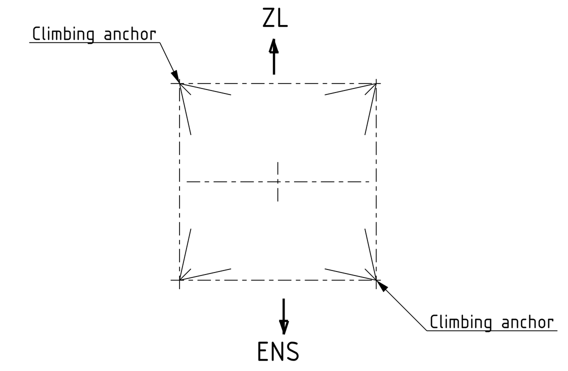
Section A - A
1:20



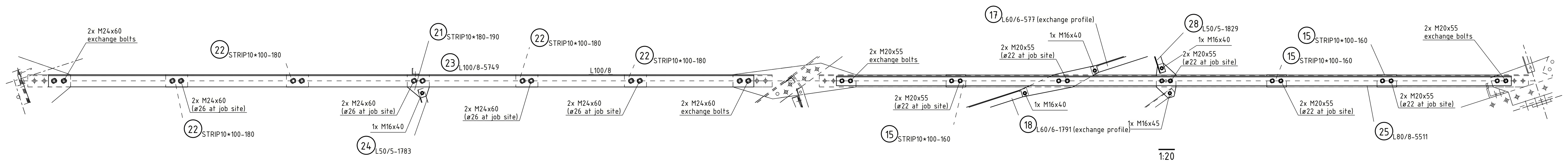
Section C - C
1:20



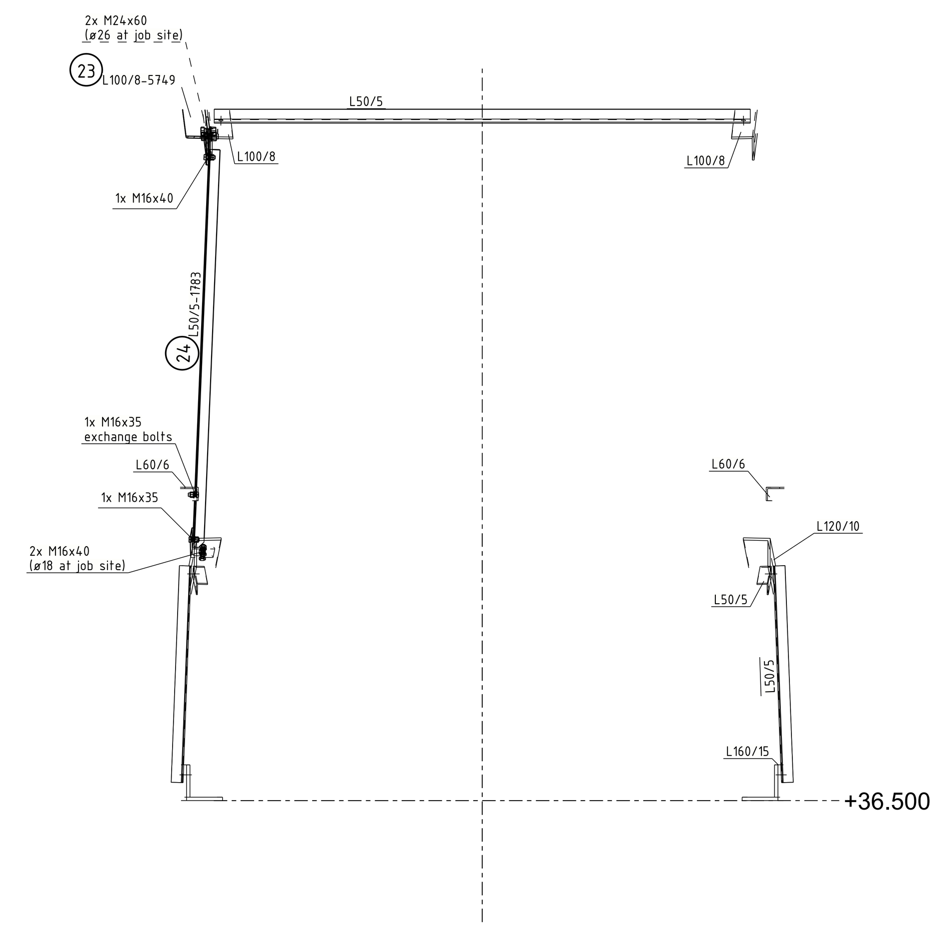
Transverse face
1:250



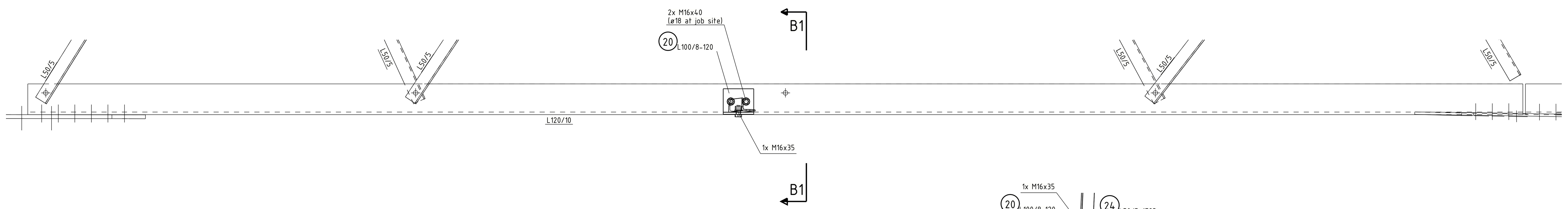
Section
1:250



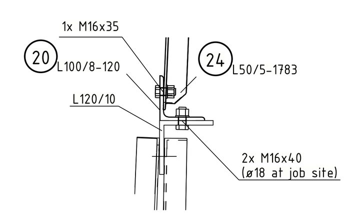
Section A1-A1
1:20



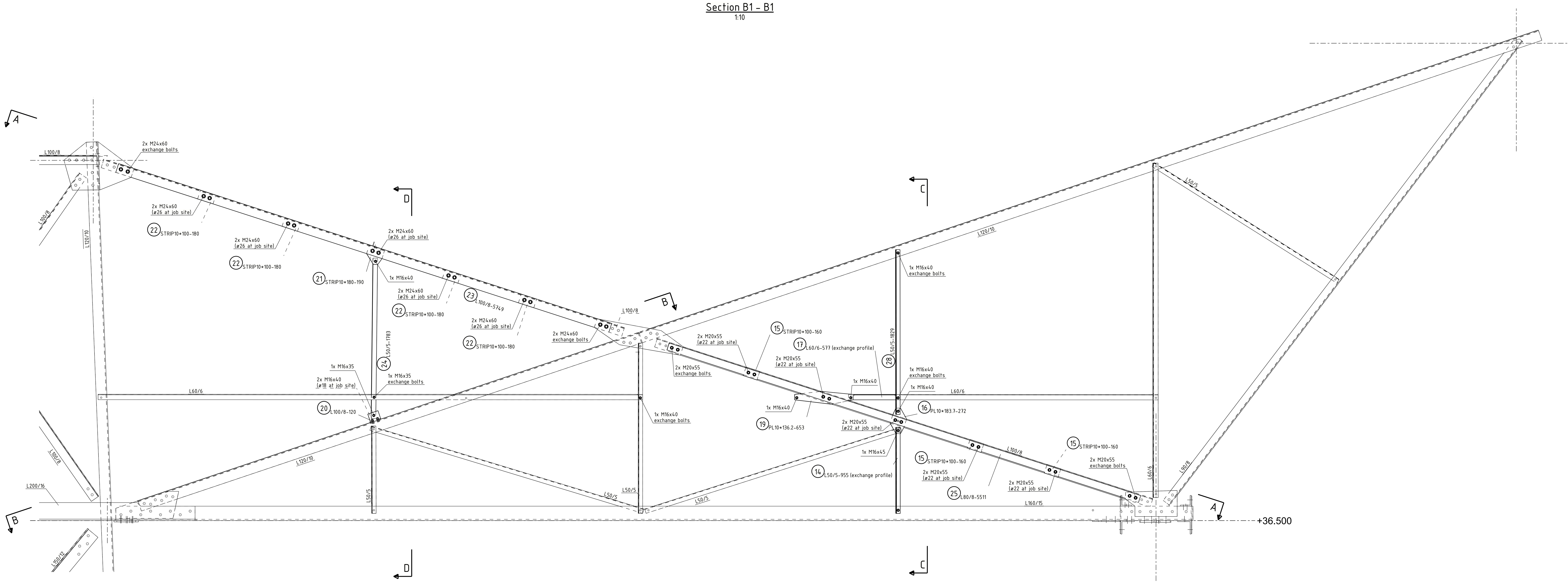
Section D - D
1:20



Section B - B
1:10



Section B1 - B1
1:10



Front Face Upper Cross Arm Right
1:20

All components of manufacture and finishing according to implementation of TenneT specifications below:
- SPE.05.312 V2.0 Algemene specificatie transport montage staalconstructies HS-stations, HS-lijnen
- SPE.05.346 V2.0 Algemene specificatie stalen HS masten
- SPE.00.905 V1.3 Conservering Mastverzwaring

Unless otherwise specified:
- It has drawn on the right side.
- Material quality S355J0 (t<=16mm), S355J2 (16<t<=40mm)
- All bended profiles and plates "HOT BENDING".
- Hot-dip galvanization according to NEN-EN-ISO 1461.
- Treat any damage of the zinc layer on the existing profiles due to drilling/grinding for corrosion protection.

Norms for connection components:

Bolts	ISO 4014
Nuts	ISO 4032
Washers	ISO 7091
Welds	NEN-EN 15607

Quality of connection components:

Bolts	: Quality 8.8 - HDG oversized
Nuts	: Quality 8 - HDG oversized
Washers	: St. -HDG oversized

- Place a washer under each nut.
- Length of bolts after mounting must be minimum 1 thread and maximum 4 threads.
- If a profile needs to be replaced, always use new bolts.

For details and dimensions see drawing 00974-01-9005

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10 1:20	A0

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Masttype EC-3_R_X, Mast 90 - Boventraverse rechts
Documentnummer:	00974-01-09006

TenneT Taking power further

Ingenieursbureau
Aafjes b.v.

Ohmstraat 1
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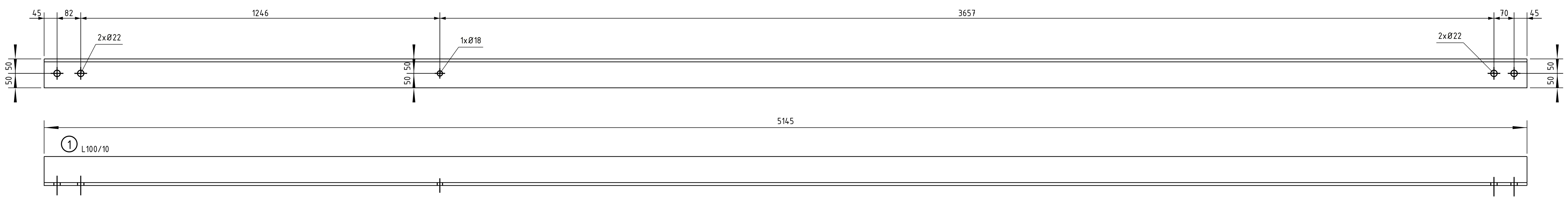
T. 038-460 88 60
M. info@jaapaafje

Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-09010**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994387**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**EC-3_R_X Mast 90 - Onderdeeltekeningen**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	02-02-2022	1e versie ter review
1.0	Definitief	18-02-2022	Document goedgekeurd

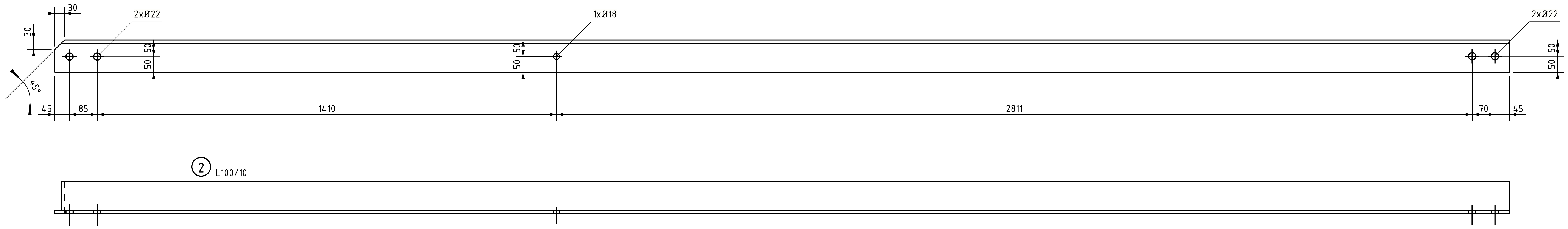


Pos	Profile	Number	Grade	Length	Area (m^2)
1	L100/10	1	S355J2	5145	2.06

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief
Rev.	1.0
Datum revisie	18.02.2022
Omschrijving revisie	Document goedgekeurd
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	A1
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [1]
Documentnummer:	

TenneT Taking power further

Tekla Structures



2	L100/10	1	S355J2	4466	1.79
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

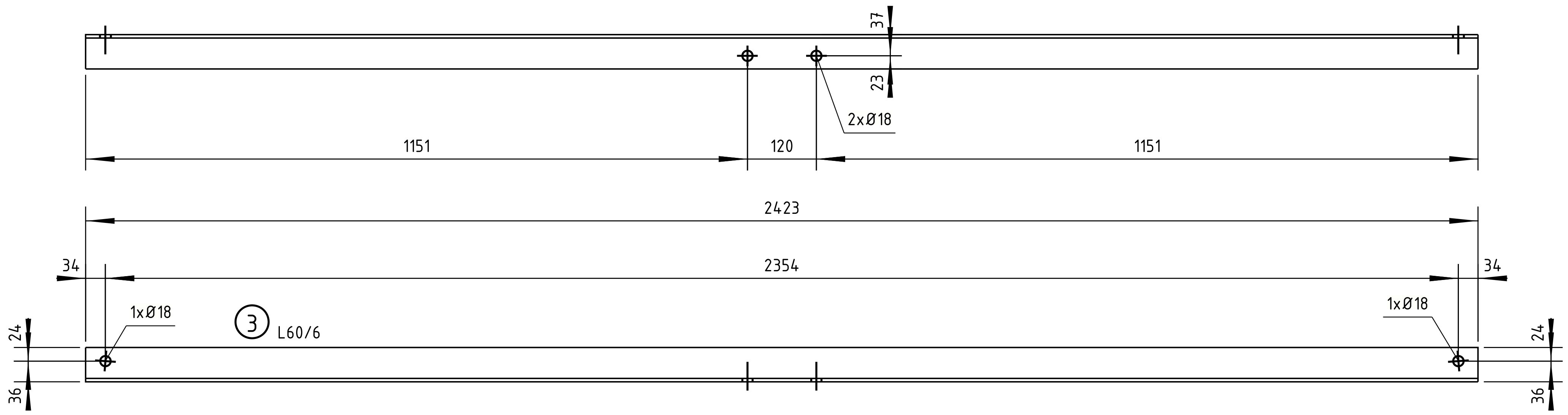
Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Te vervangen staal - onderdeel [2]

Documentnummer:

TenneT Taking power further

Tekla Structures

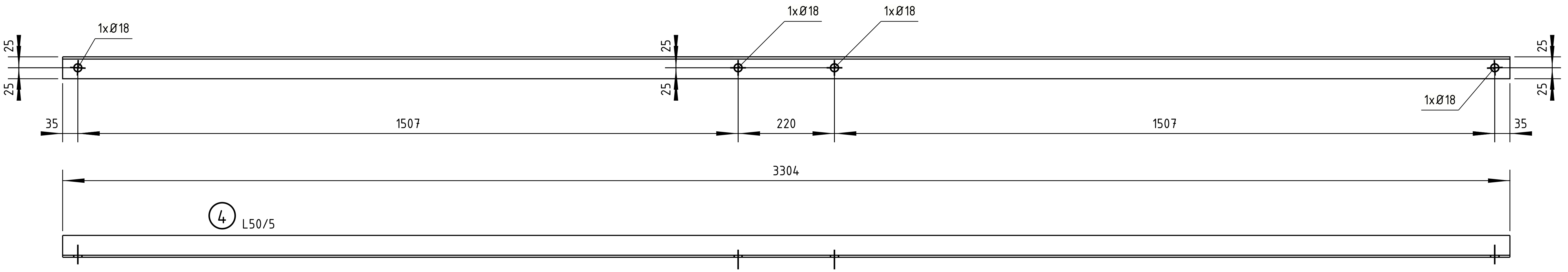


Pos	Profile	Number	Grade	Length	Area (m^2)
3	L60/6	2	S355J0	2423	0.58

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief
Rev.	1.0
Datum revisie	18.02.2022
Omschrijving revisie	Document goedgekeurd
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	420x297
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [3]
Documentnummer:	

TenneT Taking power further

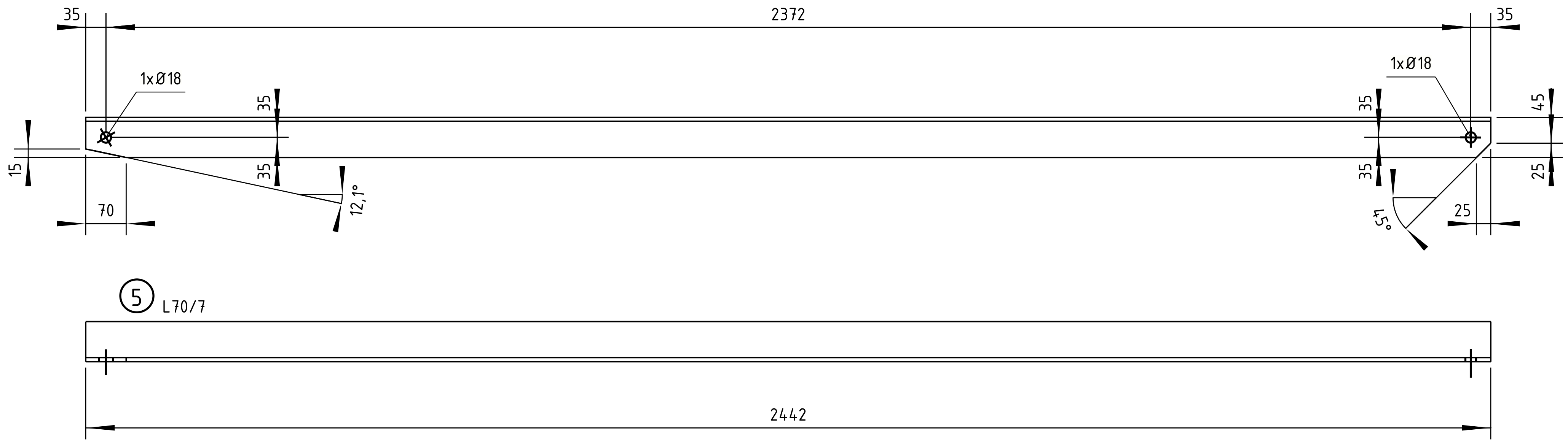
Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
4	L50/5	2	S355J0	3304	0.66

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief
Rev.	1.0
Datum revisie	18.02.2022
Omschrijving revisie	Document goedgekeurd
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	420x297
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [4]
Documentnummer:	

TenneT Taking power further



5	L70/7	2	S355J0	2442	0.68
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Definitief
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

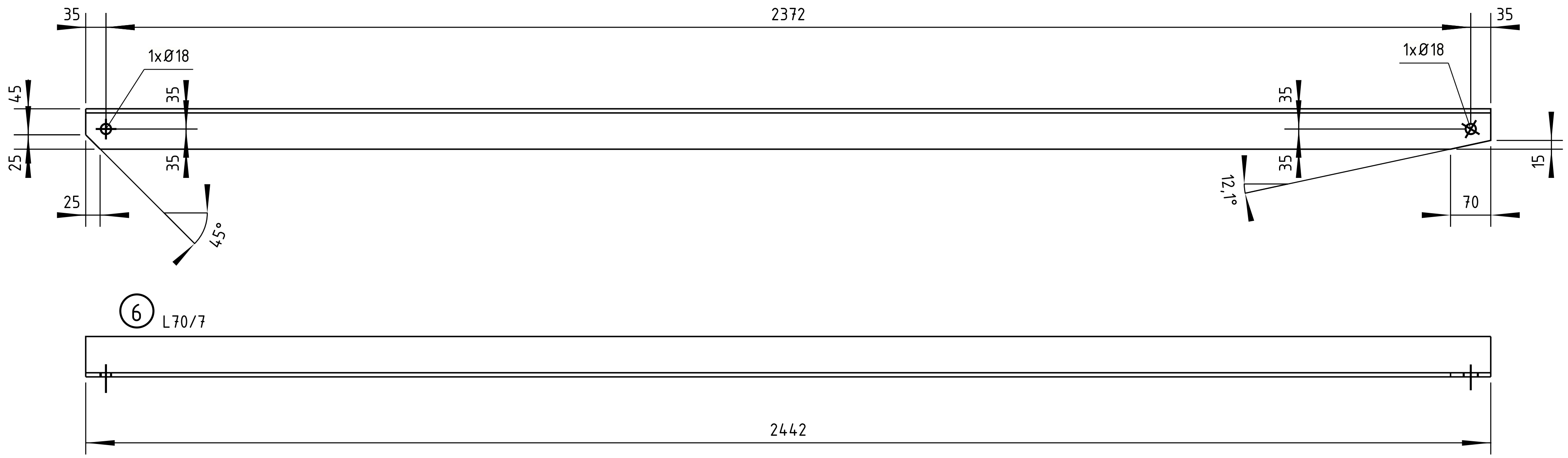
Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [5]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
6	L70/7	2	S355J0	2442	0.68

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

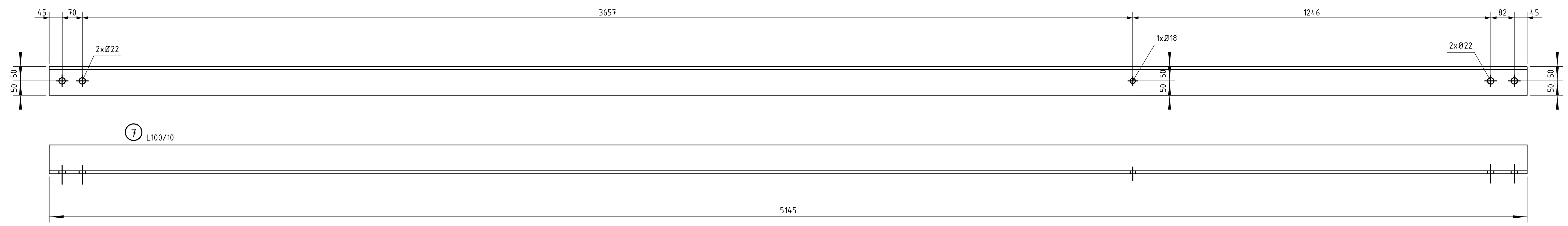
Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [6]
Documentnummer:	

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
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Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief
Rev.	1.0
Datum revisie	18.02.2022
Omschrijving revisie	Document goedgekeurd
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	A1
Relatie	
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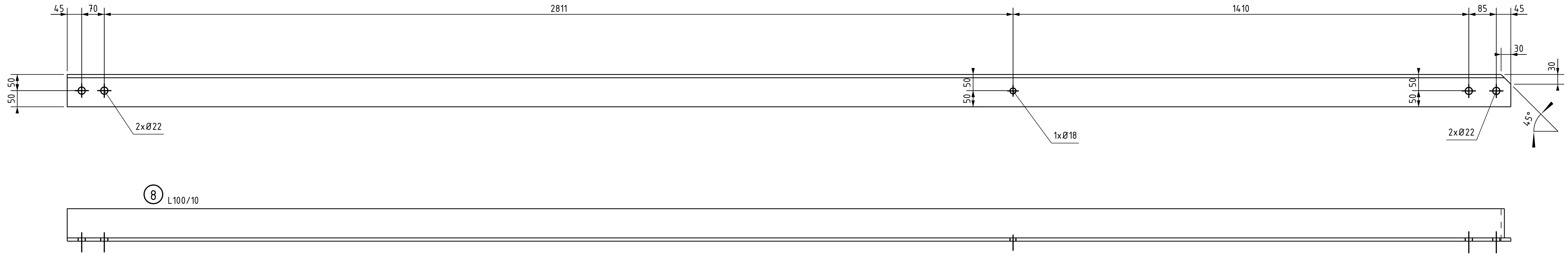
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [7]
Documentnummer:	

TenneT Taking power further

Tekla Structures



8	L100/10	1	S355J2	4466	1.79
Pos	Profile	Number	Grade	Length	Area (m²)

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus	Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	594x420

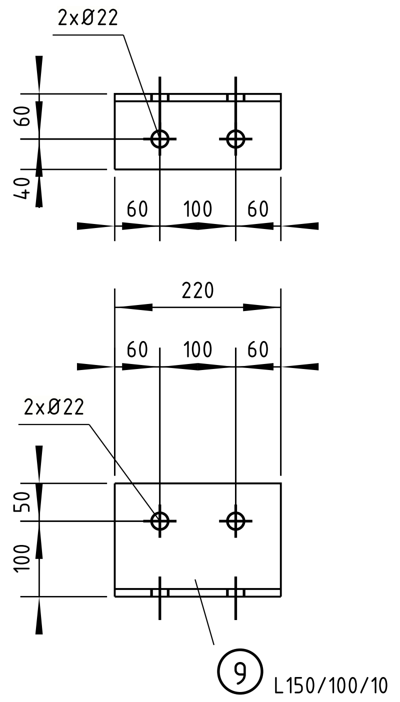
Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [8]
Documentnummer:	

Tekla Structures

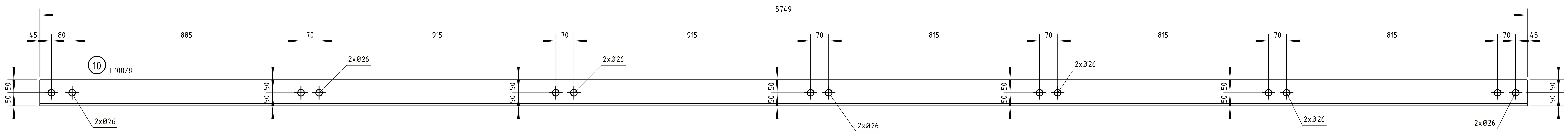


9	L150/100/10	2	S355J0	220	0.11
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
	Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	Omschrijving:	Nieuw staal - onderdeel [9]
Taking power further	Documentnummer:	

Tekla Structures



10	L100/8	1	S355J2	5749	2.30
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A1

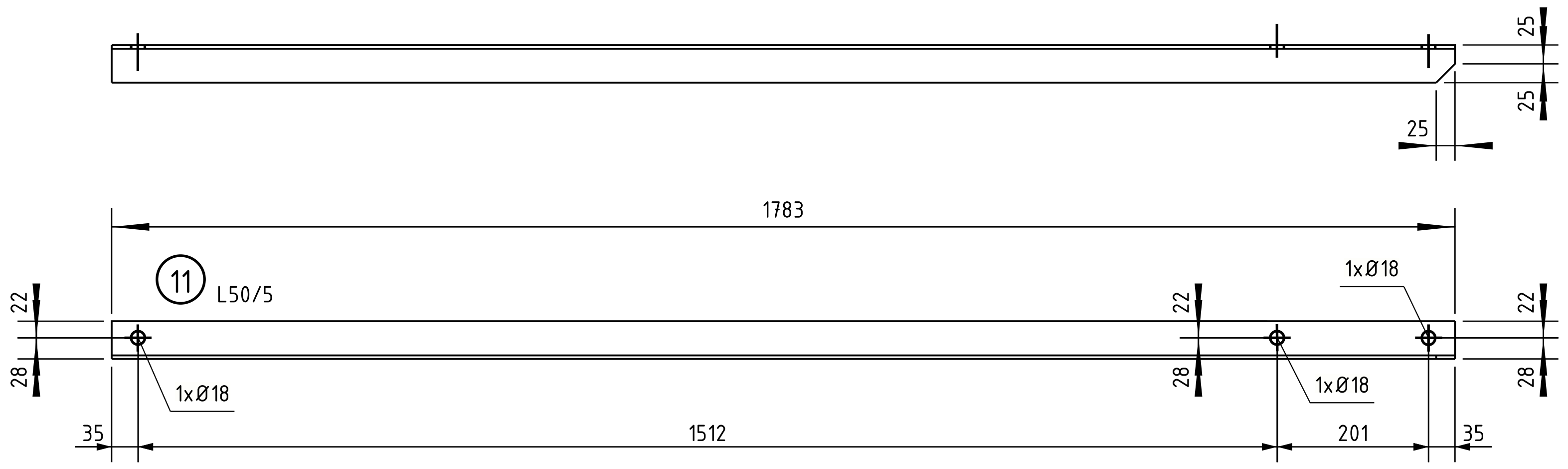
Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [10]
Documentnummer:	

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
11	L50/5	1	S355J0	1783	0.36

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

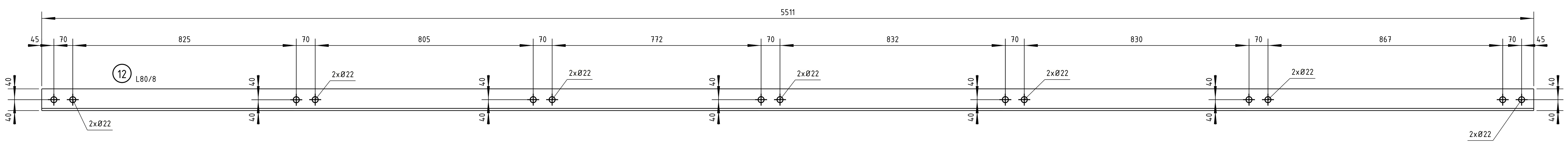
Documentcode: Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [11]

Documentnummer:

TenneT Taking power further



12	L80/8	1	S355J2	5511	1.76
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A1

Relatie

Oud tekeningnummer:

TenneT Taking power further

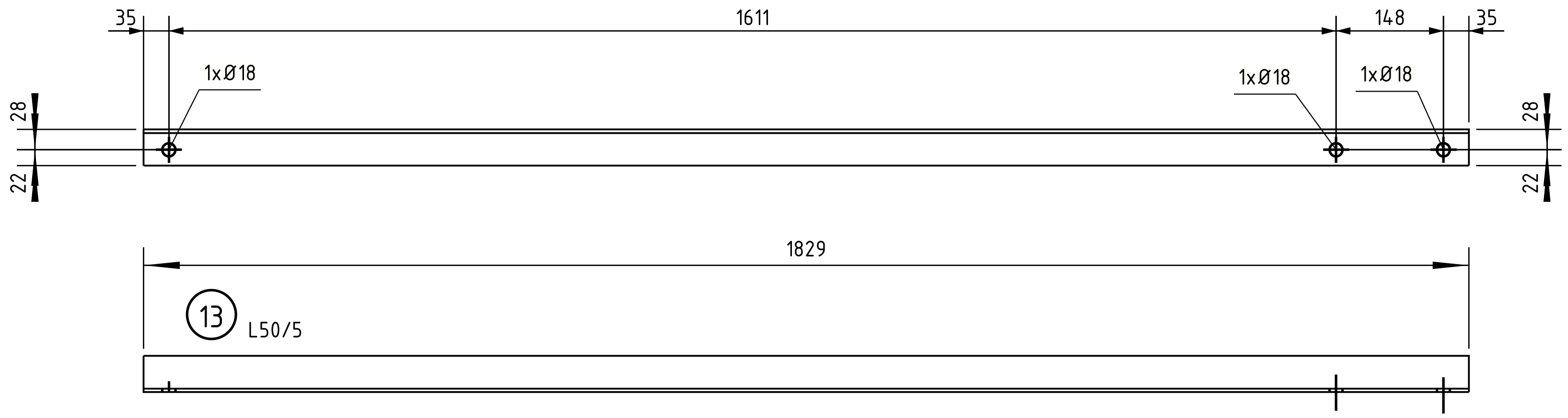
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [12]

Documentnummer:

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
13	L50/5	1	S355J0	1829	0.37

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

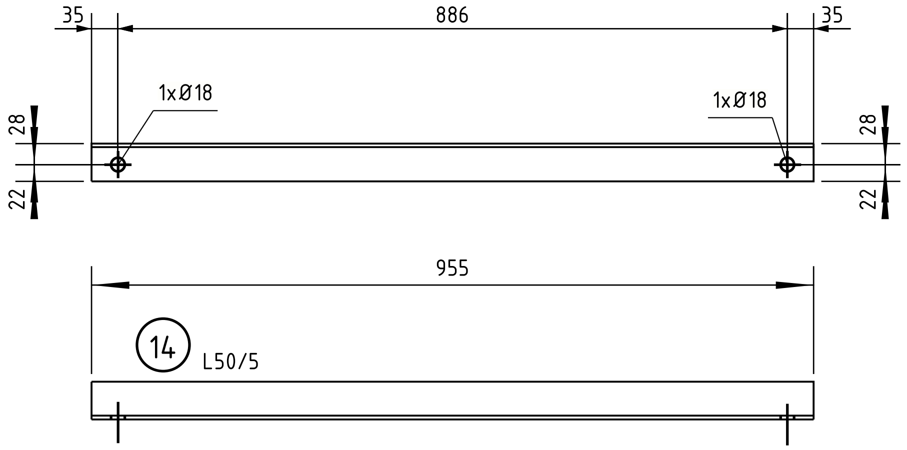
Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [13]

Documentnummer:

Taking power further

Tekla Structures

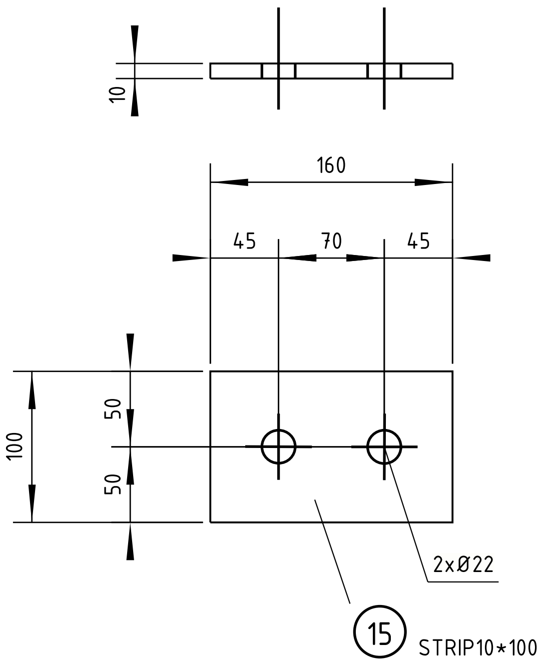


Pos	Profile	Number	Grade	Length	Area (m^2)
14	L50/5	2	S355J0	955	0.19

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus	Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380 EC-3_R_X Mast 90
TenneT Taking power further	Omschrijving:	Te vervangen staal - onderdeel [14]
	Documentnummer:	

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
15	STRIP10*100	6	S355J0	160	0.04

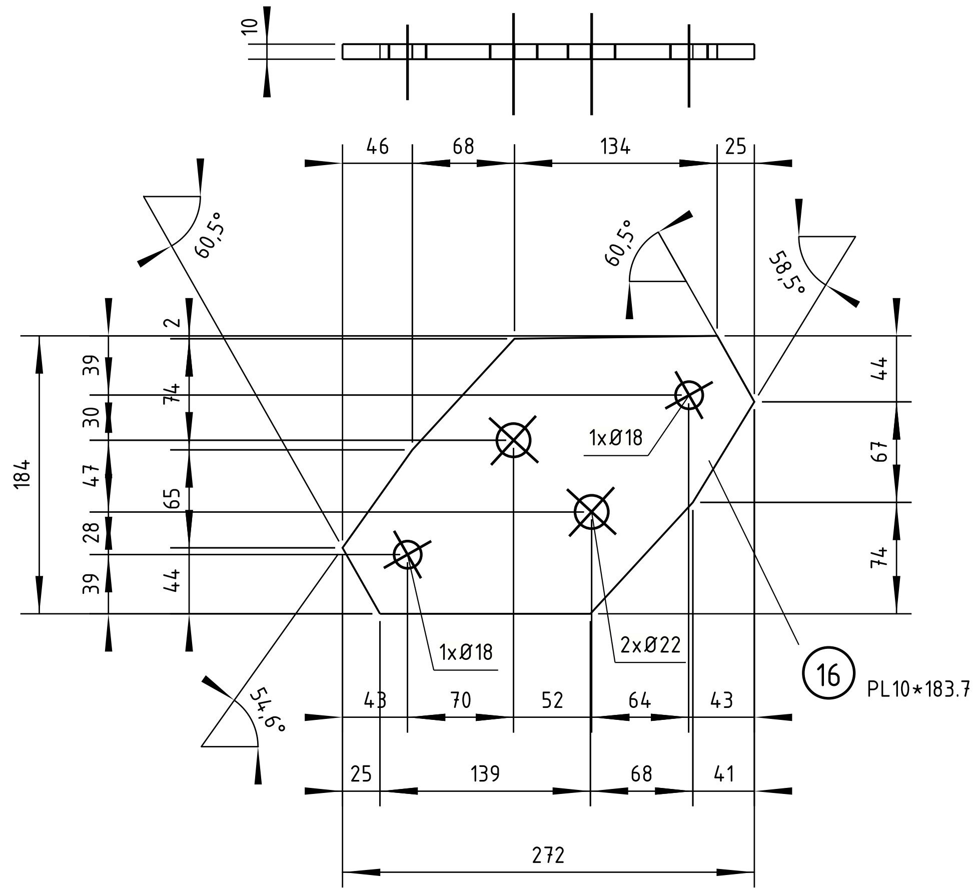
Naam			Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle			Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [15]
Documentnummer:	

TenneT Taking power further

Tekla Structures

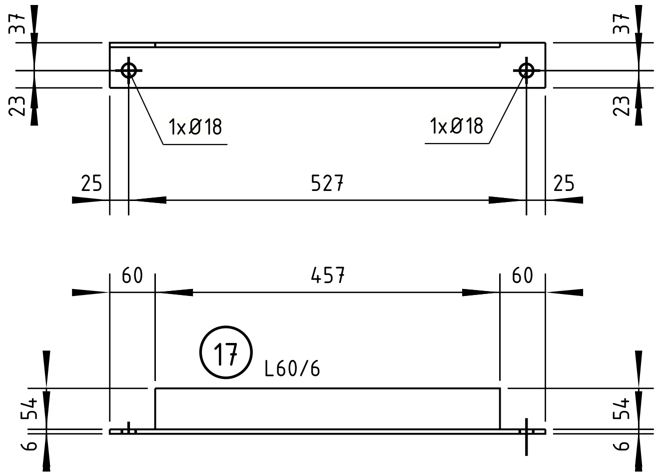


16	PL10*183.7	2	S355J0	272	0.08
Pos	Profile	Number	Grade	Length	Area (m²)

Naam					Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat	
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4	

Relatie		
	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
	Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	Omschrijving:	Nieuw staal - onderdeel [16]
TenneT Taking power further	Documentnummer:	

Tekla Structures



17	L60/6	2	S355J0	577	0.14
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie

Oud tekeningnummer:

TenneT
Taking power further

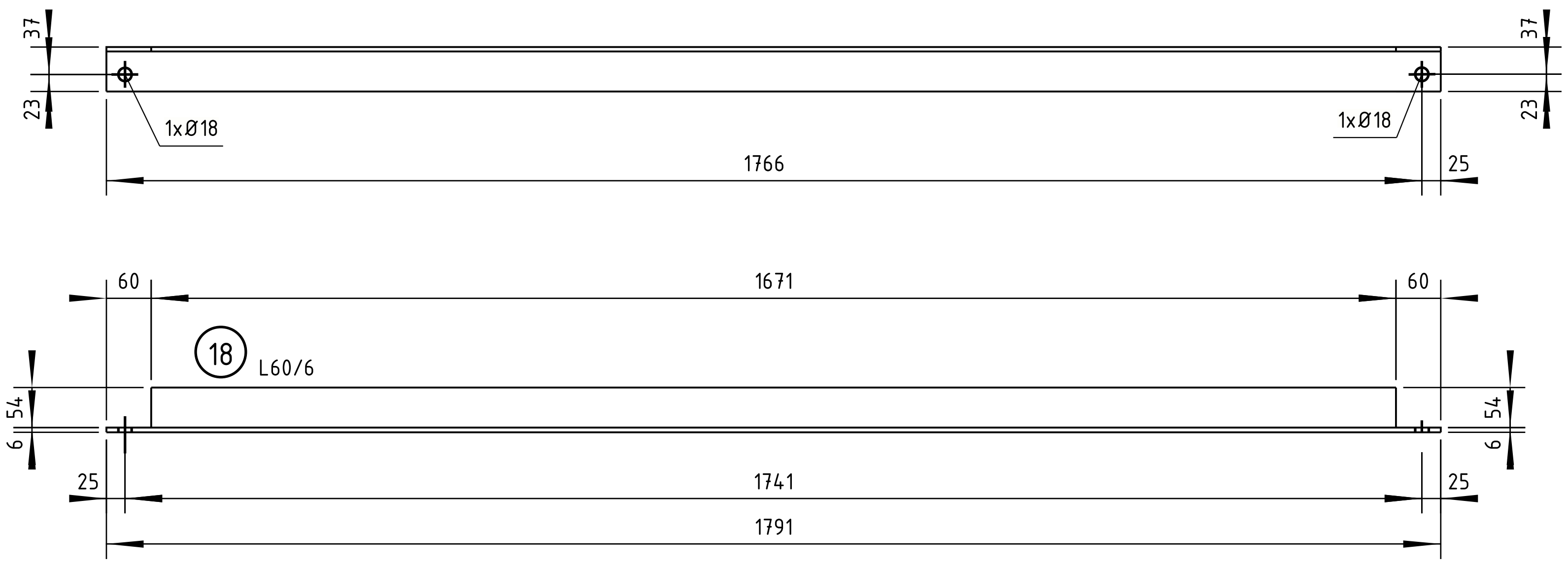
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Te vervangen staal - onderdeel [17]

Documentnummer:

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
18	L60/6	2	S355J0	1791	0.43

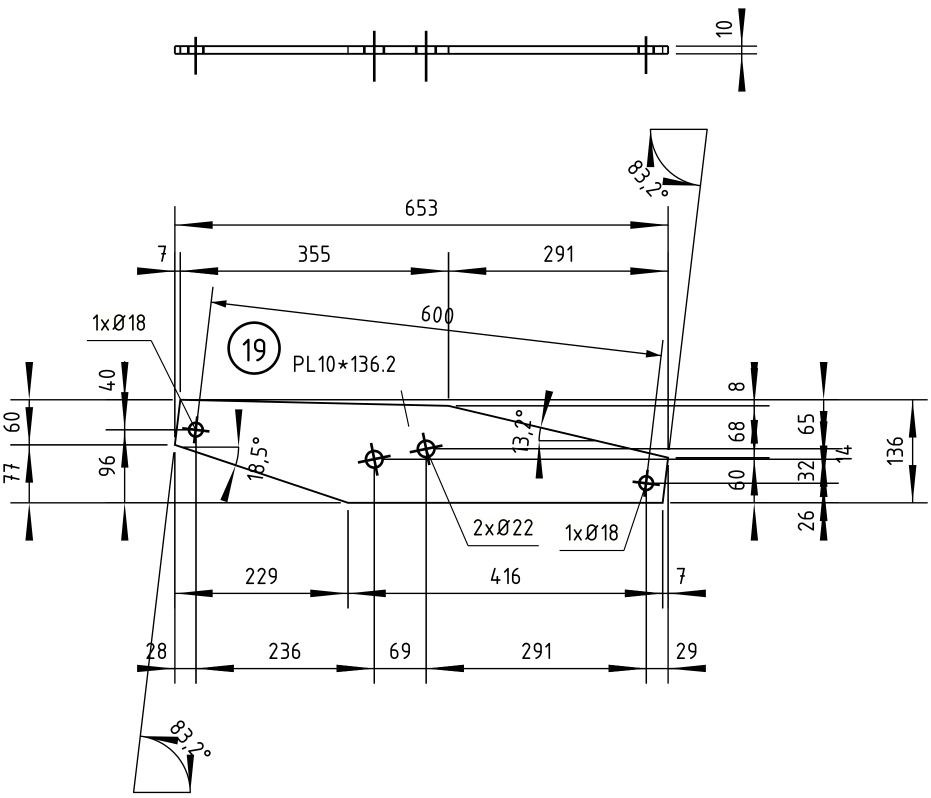
Naam	Opwaarderen 380 kV verbinding Ens - Zwolle				Tekeningstatus	Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat	
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297	

Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Te vervangen staal - onderdeel [18]
Documentnummer:	



19	PL10*136.2	2	S355J0	653	0.15
Pos	Profile	Number	Grade	Length	Area (m²)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 EC-3_R_X Mast 90

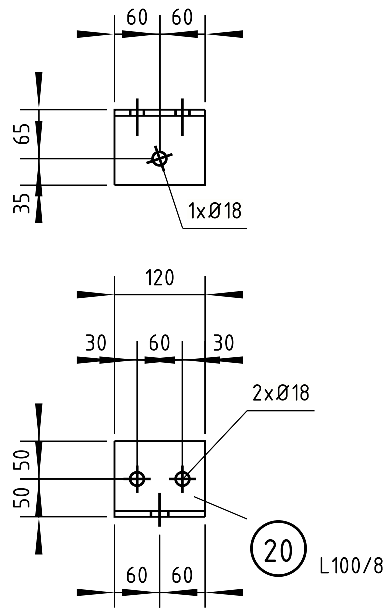
Oud tekeningnummer:

Omschrijving:
Nieuw staal - onderdeel [19]

TenneT Taking power further

Documentnummer:

Tekla Structures



20	L100/8	2	S355J0	120	0.05
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema: Verbinding

Categorie: Algemeen

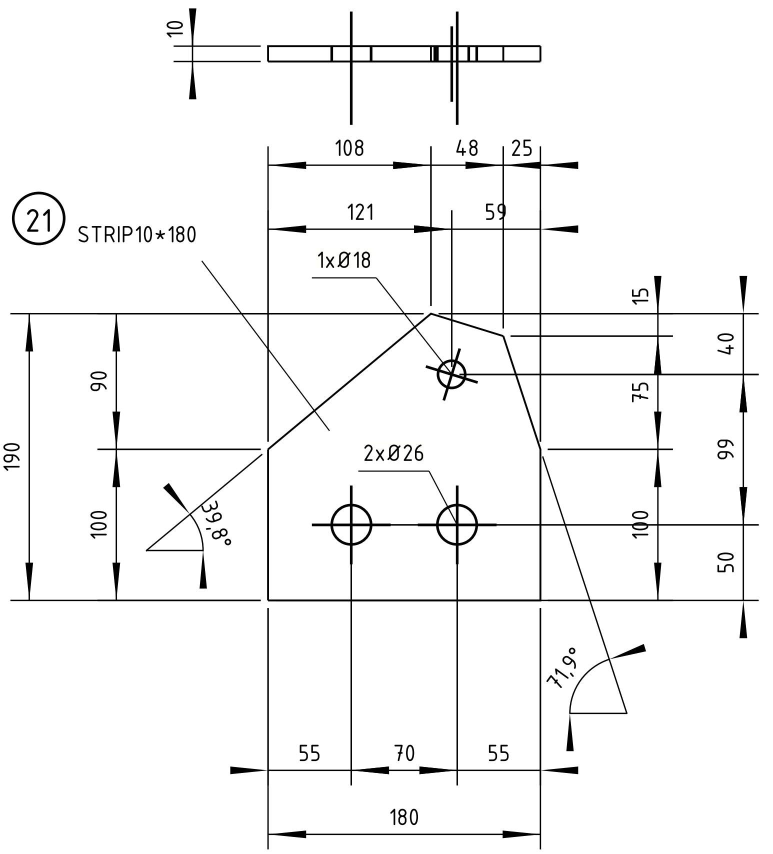
Documentcode: Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [20]

Documentnummer:

Tekla Structures



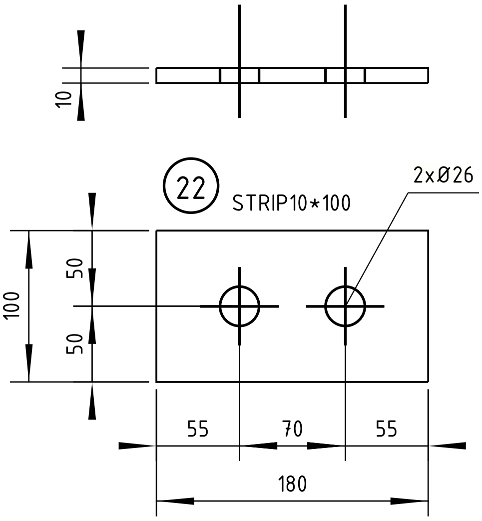
21	STRIP10*180	2	S355J0	190	0.06
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [21]
Documentnummer:	

Taking power further

Tekla Structures



22	STRIP10*100	8	S355J0	180	0.04
Pos	Profile	Number	Grade	Length	Area (m²)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie

Oud tekeningnummer:

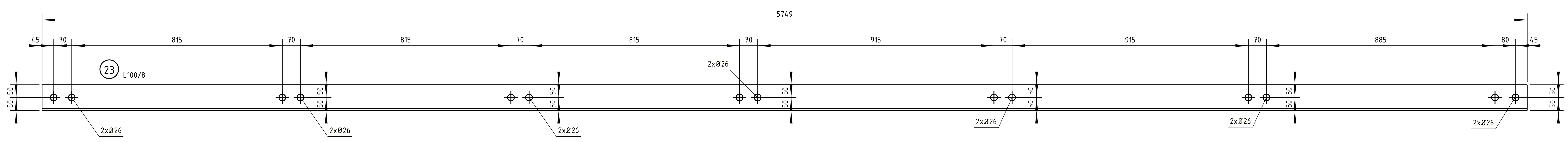
Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Nieuw staal - onderdeel [22]

Documentnummer:



Pos	Profile	Number	Grade	Length	Area (m²)
23	L100/8	1	S355J2	5749	2.30

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A1

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

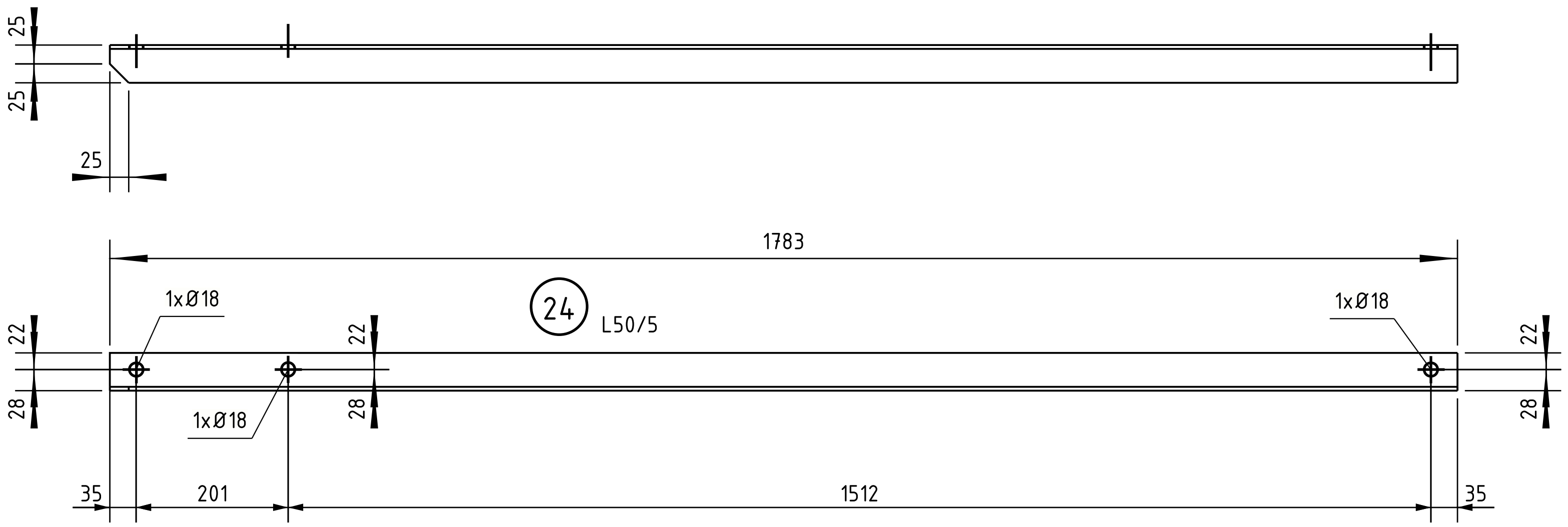
Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [23]

Documentnummer:

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
24	L50/5	1	S355J0	1783	0.36

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

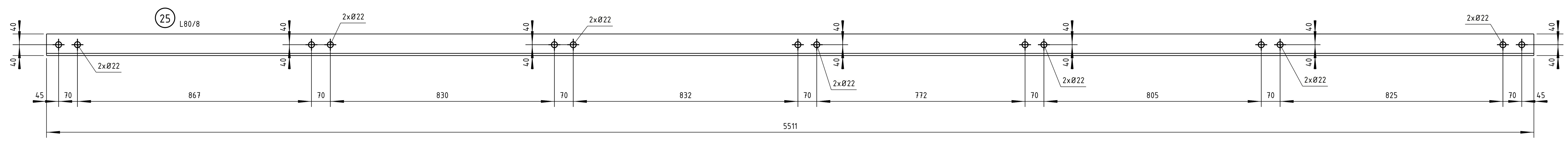
Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Nieuw staal - onderdeel [24]

Documentnummer:

Taking power further

Tekla Structures

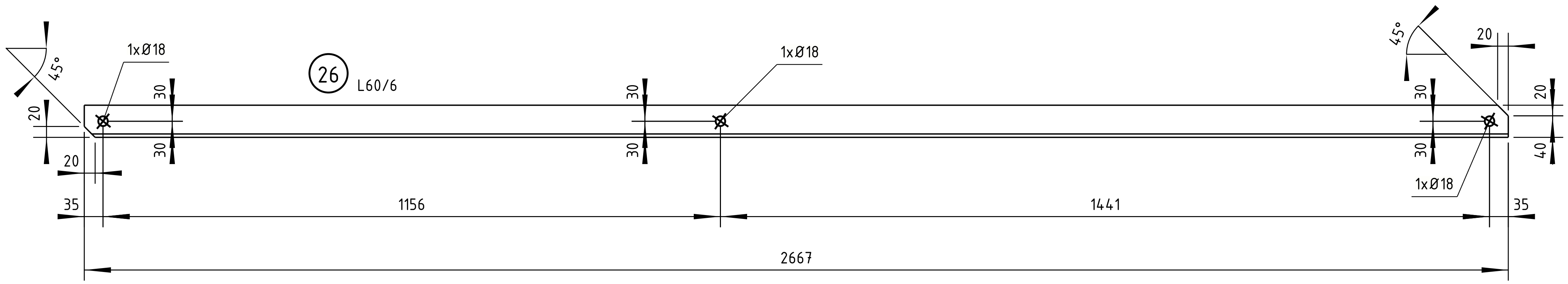


25	L80/8	1	S355J2	5511	1.76
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A1

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380 EC-3_R_X Mast 90
	Omschrijving:	Nieuw staal - onderdeel [25]
TenneT Taking power further	Documentnummer:	

Tekla Structures



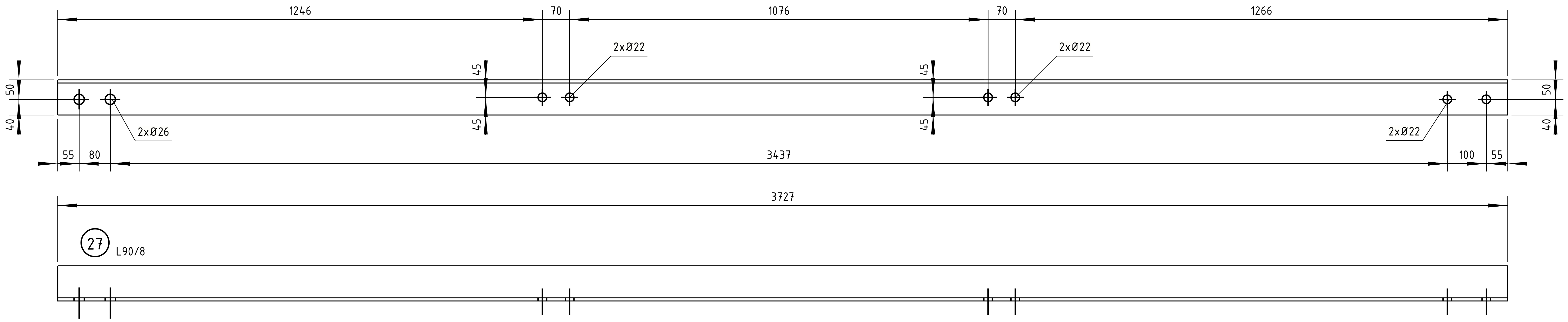
Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [26]
Documentnummer:	

TenneT Taking power further

26	L60/6	2	S355J0	2667	0.64
Pos	Profile	Number	Grade	Length	Area (m^2)

Tekla Structures

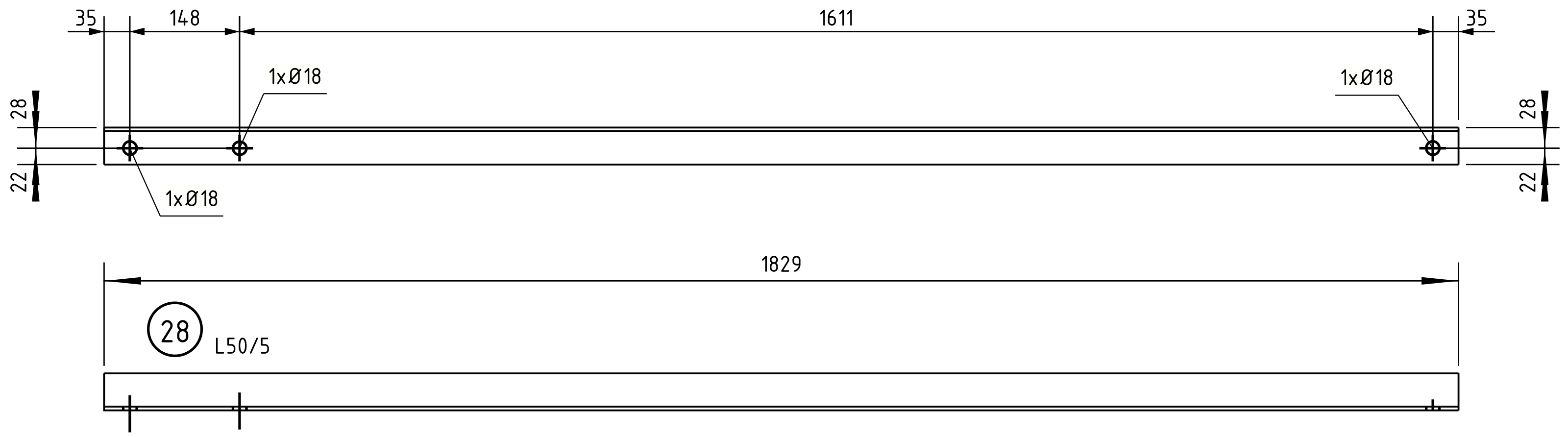


27	L90/8	1	S355J2	3727	1.34
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle						Tekeningstatus: Definitief
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Oud tekeningnummer:	
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [27]
Documentnummer:	

TenneT Taking power further



Pos	Profile	Number	Grade	Length	Area (m^2)
28	L50/5	1	S355J0	1829	0.37

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

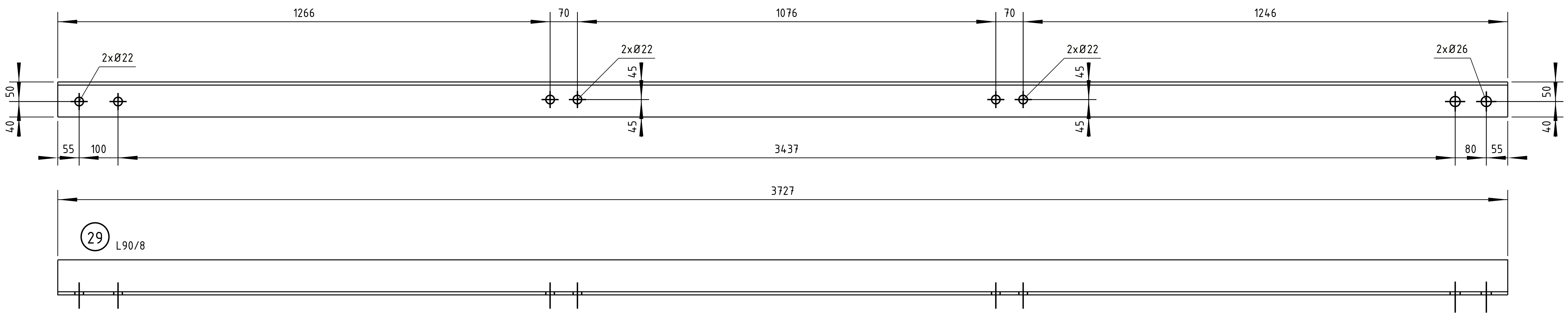
Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Nieuw staal - onderdeel [28]

Documentnummer:

TenneT Taking power further

Tekla Structures



29	L90/8	1	S355J2	3727	1.34
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

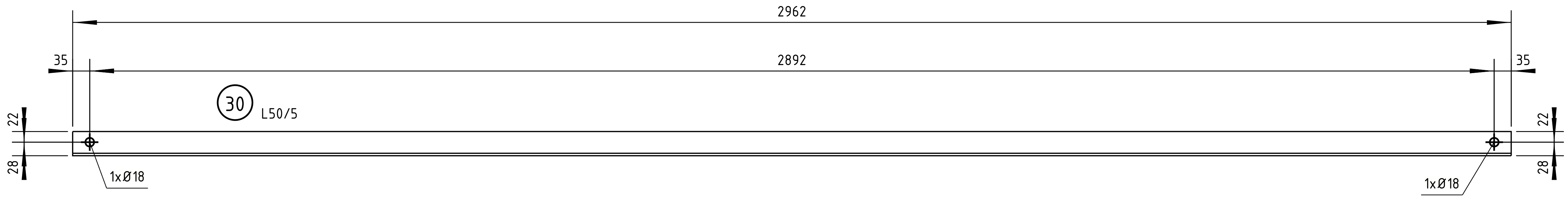
Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [29]

Documentnummer:

TenneT Taking power further

Tekla Structures

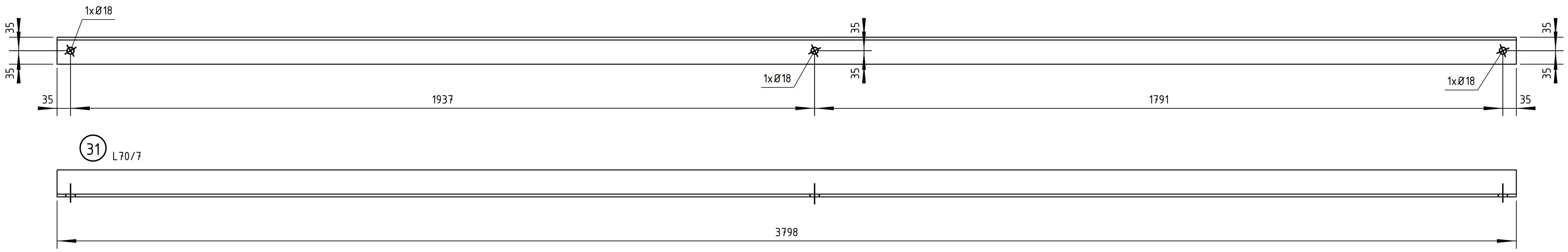


Pos	Profile	Number	Grade	Length	Area (m^2)
30	L50/5	2	S355J0	2962	0.59

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief
Rev.	1.0
Datum revisie	18.02.2022
Omschrijving revisie	Document goedgekeurd
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	420x297
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [30]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



31	L70/7	2	S355J0	3798	1.06
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	594x420

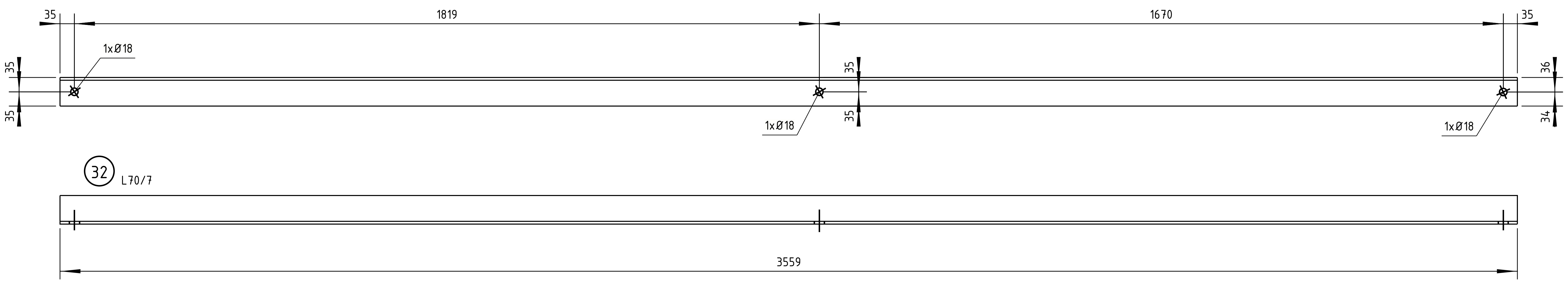
Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [31]
Documentnummer:	

TenneT Taking power further

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m²)
32	L70/7	2	S355J0	3559	1.00

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	594x420

Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema: Verbinding

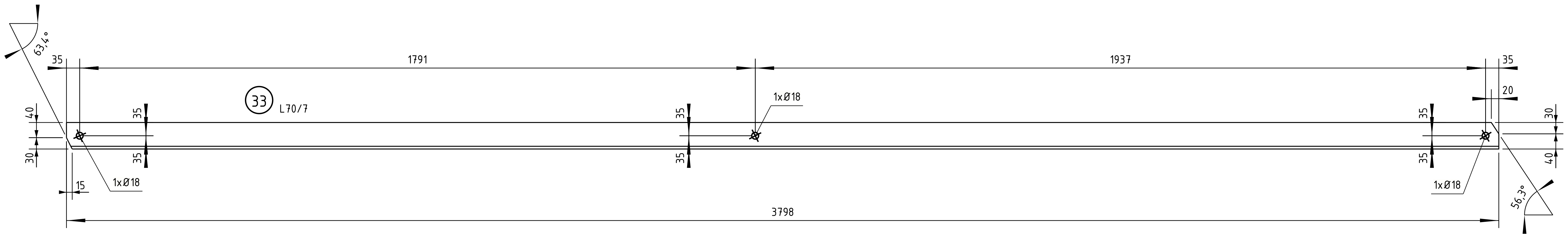
Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [32]

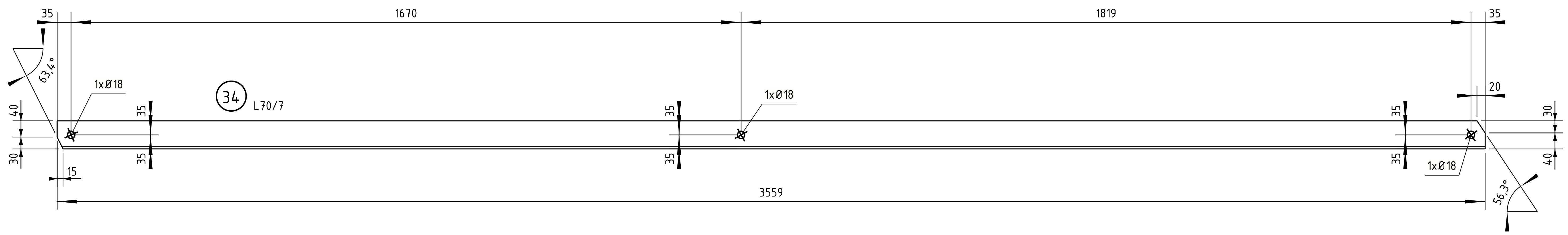
Documentnummer:



33	L70/7	2	S355J0	3798	1.06
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built / Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.	1:10	594x420

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
Oud tekeningnummer:	Object ID	ENS-ZL380 EC-3_R_X Mast 90
TenneT Taking power further	Omschrijving:	Nieuw staal - onderdeel [33]
	Documentnummer:	

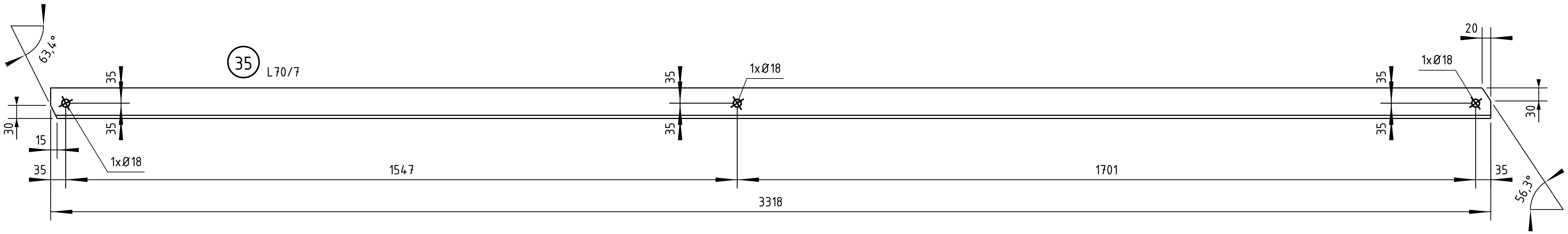


Pos	Profile	Number	Grade	Length	Area (m²)
34	L70/7	2	S355J0	3559	1.00

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief
Rev.	1.0
Datum revisie	18.02.2022
Omschrijving revisie	Document goedgekeurd
Getekend	Ing. bureau Aafjes b.v.
Datum As-Built	
Schaal	1:10
Formaat	594x420
Relatie	
Oud tekeningnummer:	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [34]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



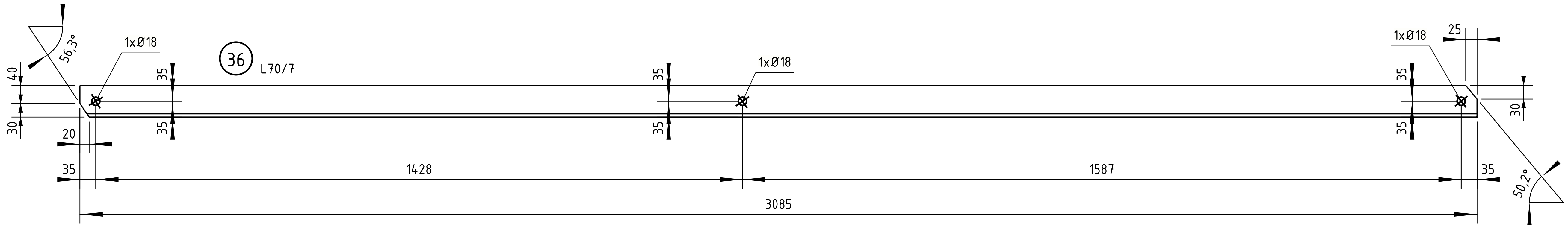
Pos	Profile	Number	Grade	Length	Area (m^2)
35	L70/7	2	S355J0	3318	0.93

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [35]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



36	L70/7	2	S355J0	3085	0.86
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Taking power further

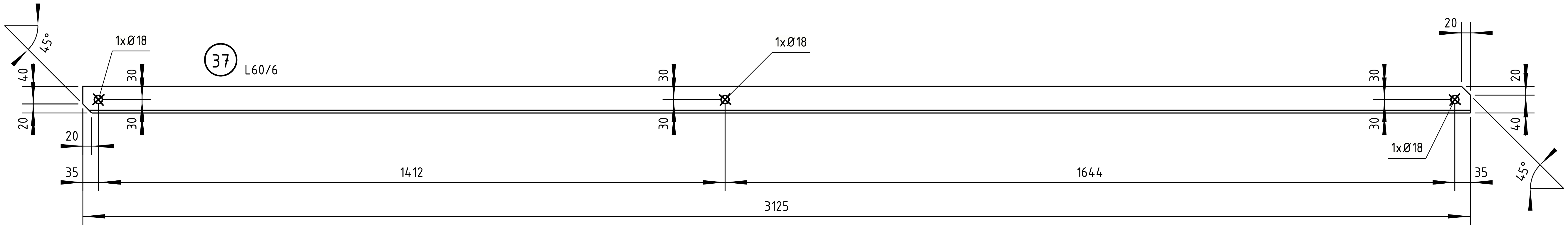
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Nieuw staal - onderdeel [36]

Documentnummer:

Tekla Structures



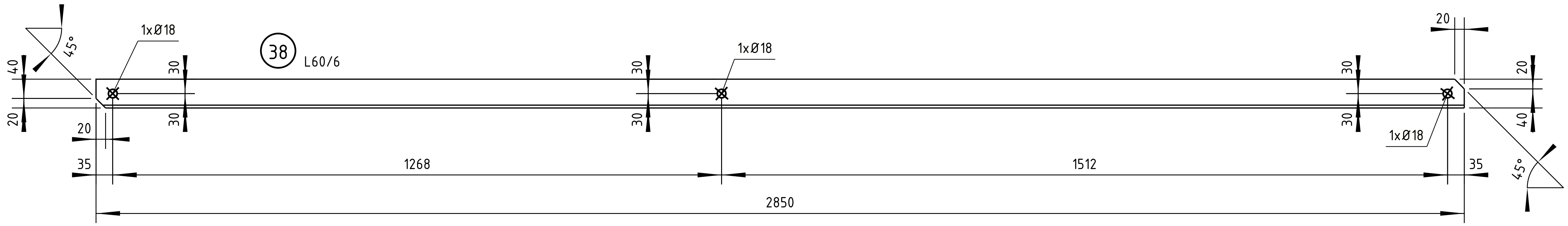
37	L60/6	2	S355J0	3125	0.75
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle					Tekeningstatus: Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [37]
Documentnummer:	

TenneT Taking power further

Tekla Structures



38	L60/6	2	S355J0	2850	0.68
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

TenneT Taking power further

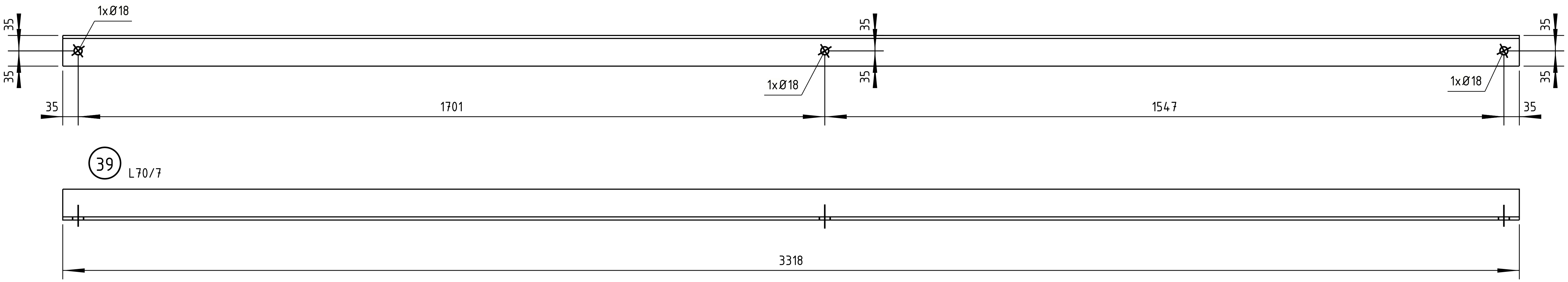
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [38]

Documentnummer:

Tekla Structures



Pos	Profile	Number	Grade	Length	Area (m^2)
39	L70/7	2	S355J0	3318	0.93

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Definitief

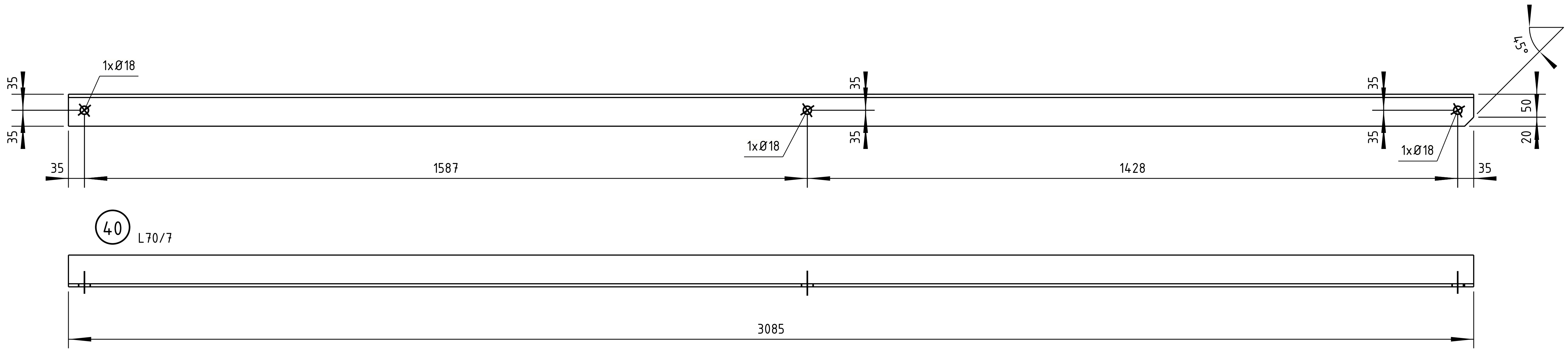
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [39]
Documentnummer:	



40	L70/7	2	S355J0	3085	0.86
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Opwaarderen 380 kV verbinding Ens - Zwolle
Tekeningstatus	Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

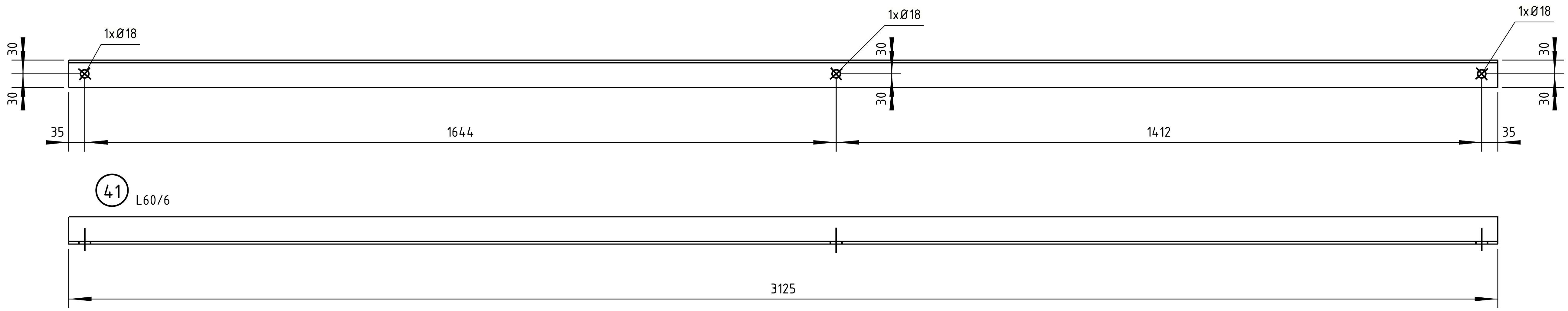
Relatie

Oud tekeningnummer:

TenneT Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [40]
Documentnummer:	

Tekla Structures



41	L60/6	2	S355J0	3125	0.75
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

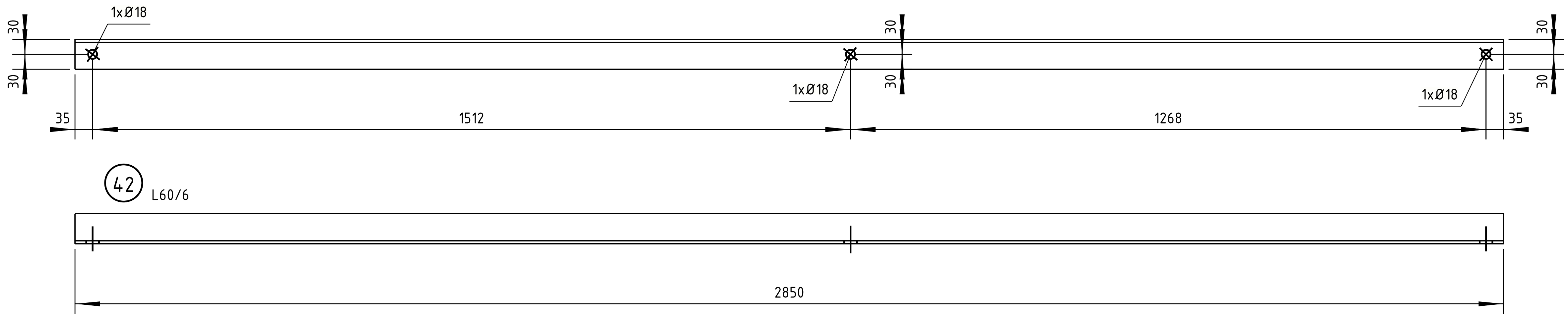
Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [41]

Documentnummer:

TenneT Taking power further

Tekla Structures



42	L60/6	2	S355J0	2850	0.68
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

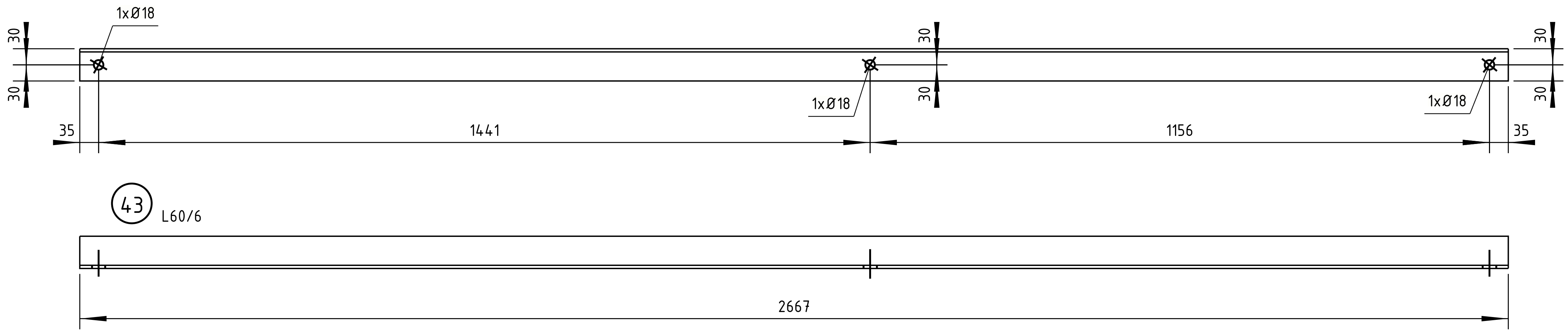
Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [42]
Documentnummer:	

Tekla Structures



43	L60/6	2	S355J0	2667	0.64
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	420x297

Relatie

Oud tekeningnummer:

TenneT Taking power further

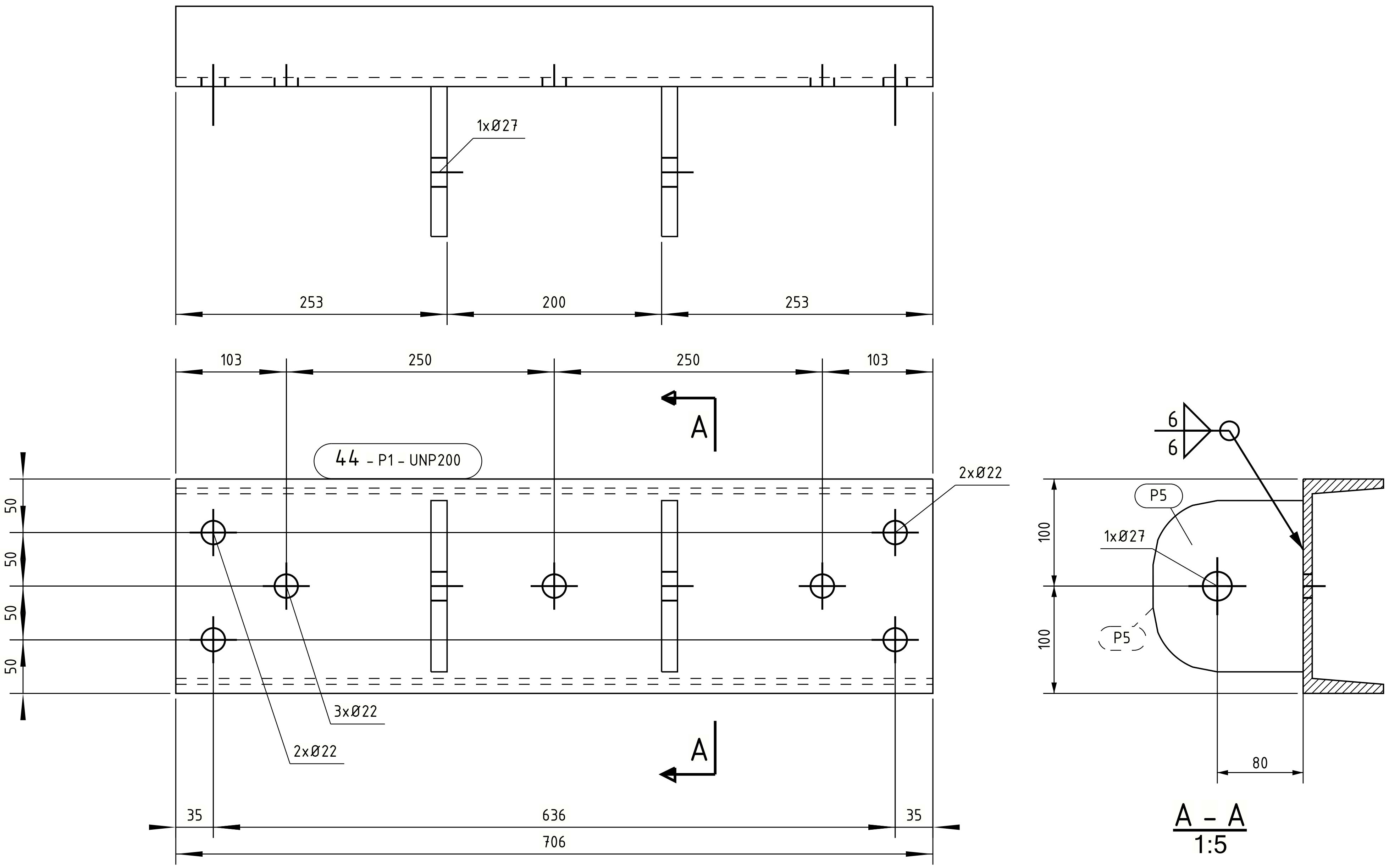
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Nieuw staal - onderdeel [43]

Documentnummer:

Tekla Structures



ASSEMBLY

Mark: 44 — length (mm): 706 — Number: 1

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P1	UNP200	S355J0	1	706	18.2	0.47
P5	STRIP15*140	S355J0	2	160	5.0	0.10
				Total of one mark	23.1	0.57

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	420x297

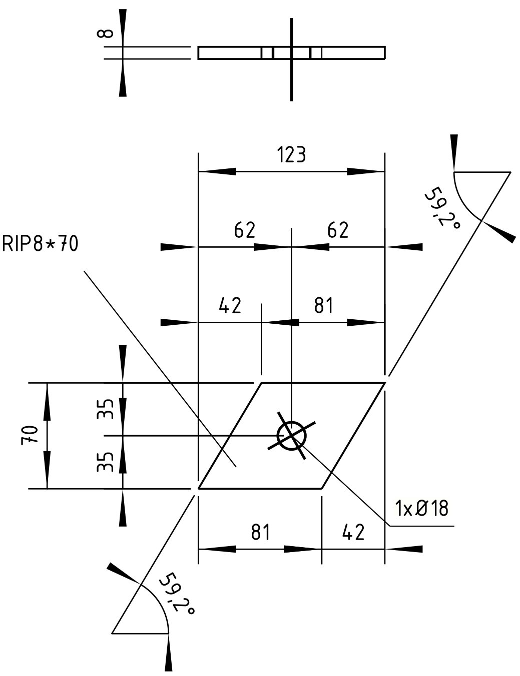
Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [44]
Documentnummer:	

TenneT — Taking power further

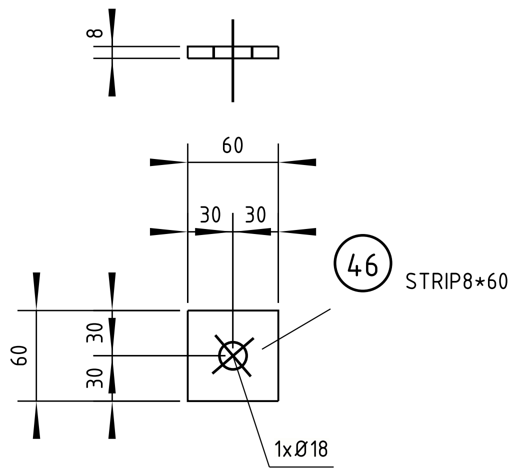
Tekla Structures



45	STRIP8*70	6	S355J0	123	0.01
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam						Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle						Definitief
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie	Thema	Verbinding
	Categorie	Algemeen
	Documentcode	Constructietekening
	Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	Omschrijving:	Nieuw staal - onderdeel [45]
TenneT Taking power further	Documentnummer:	



46	STRIP8*60	4	S355J0	60	0.01
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID

ENS-ZL380 EC-3_R_X Mast 90

Oud tekeningnummer:

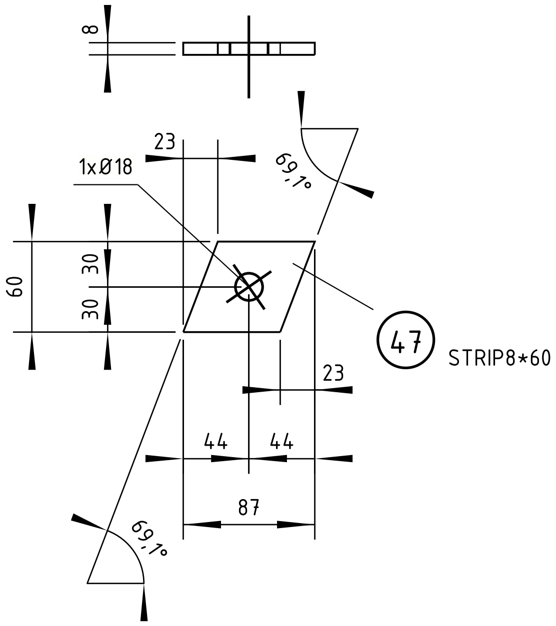
Omschrijving:

Nieuw staal - onderdeel [46]

Taking power further

Documentnummer:

Tekla Structures



47	STRIP8*60	2	S355J0	87	0.01
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekeningstatus
Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie

Oud tekeningnummer:

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

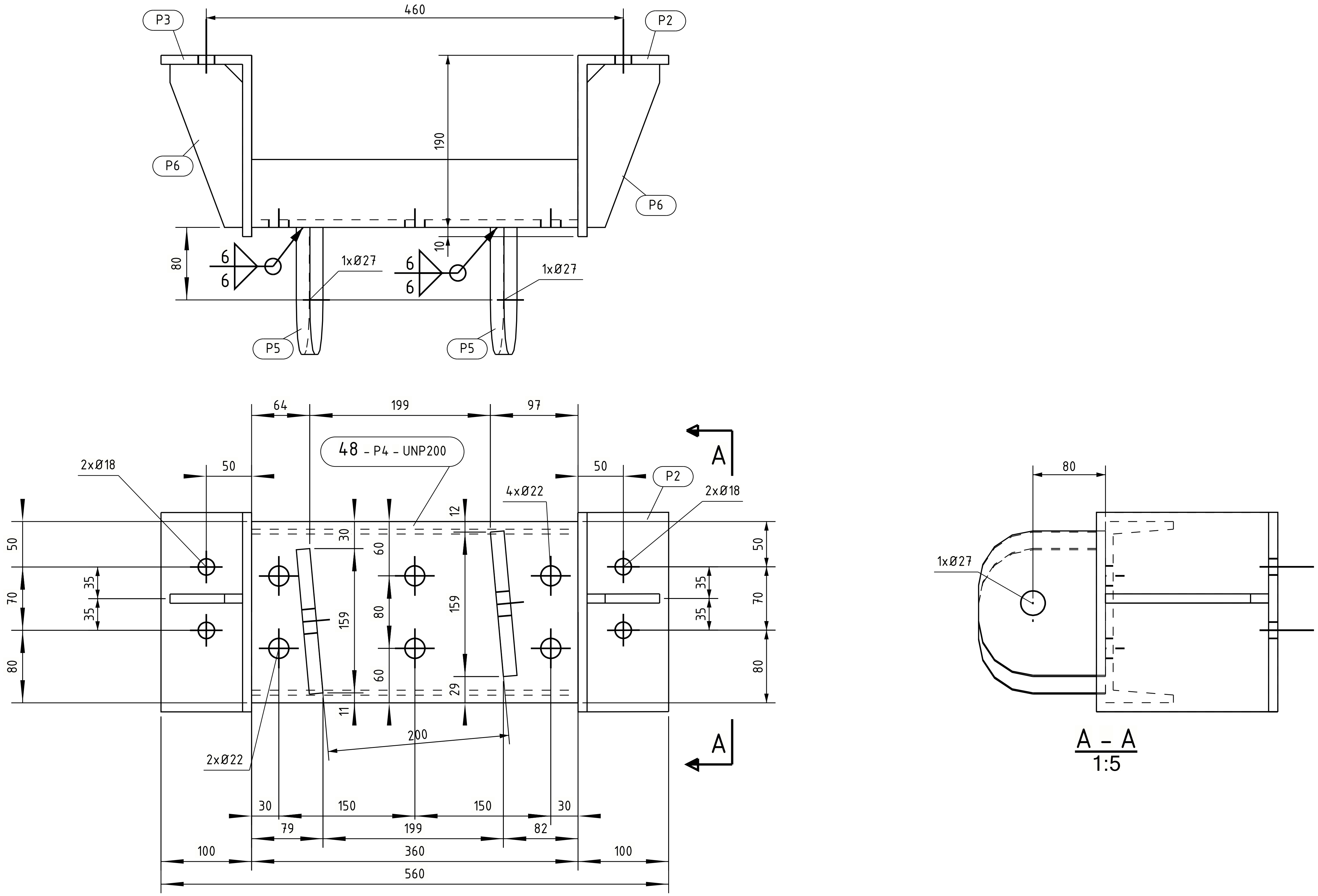
Object ID
ENS-ZL380 EC-3_R_X Mast 90

Omschrijving:
Nieuw staal - onderdeel [47]

Documentnummer:

TenneT Taking power further

Tekla Structures



Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	420x297

Relatie

Oud tekeningnummer:

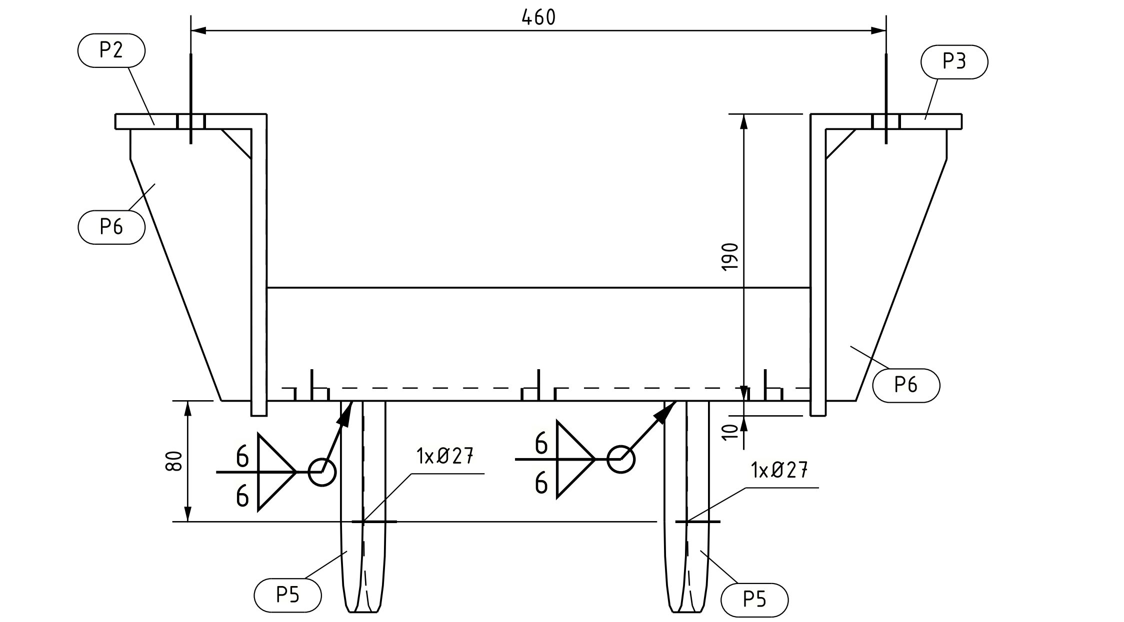
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [48]
Documentnummer:	

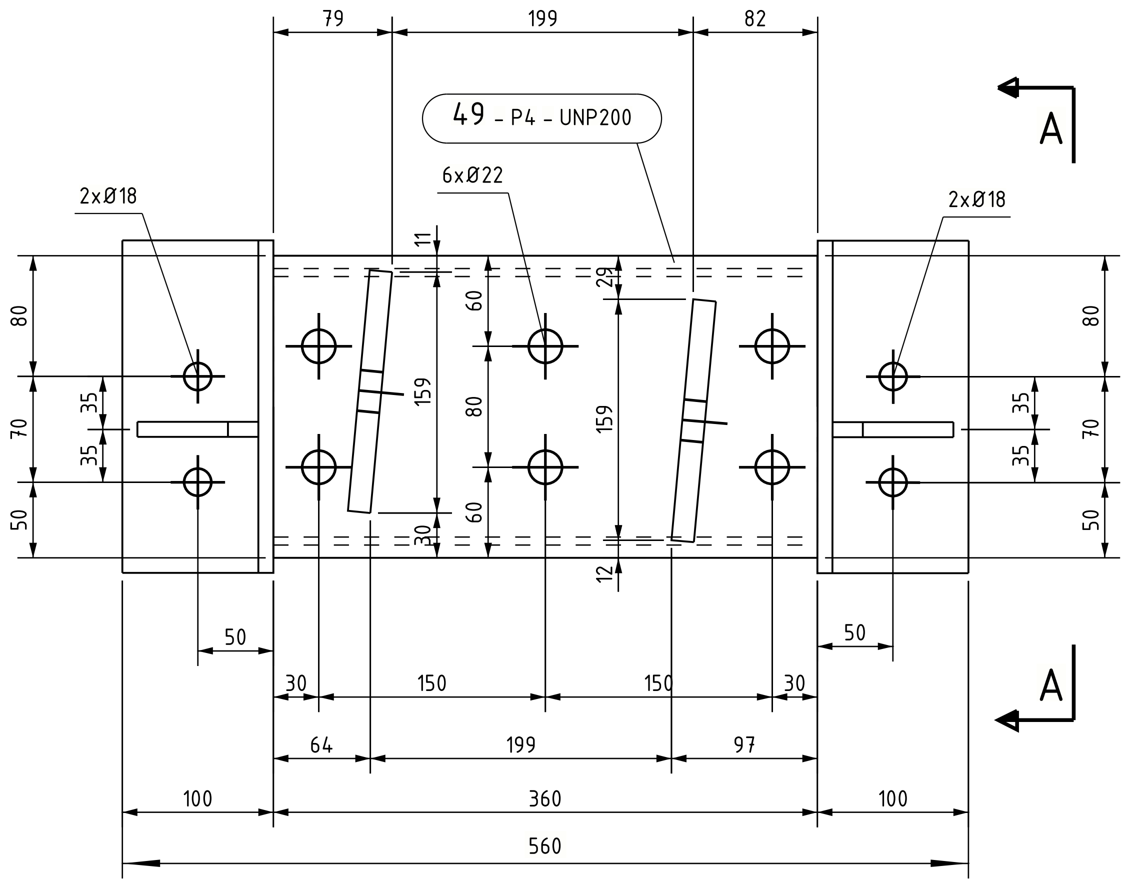
TenneT Taking power further

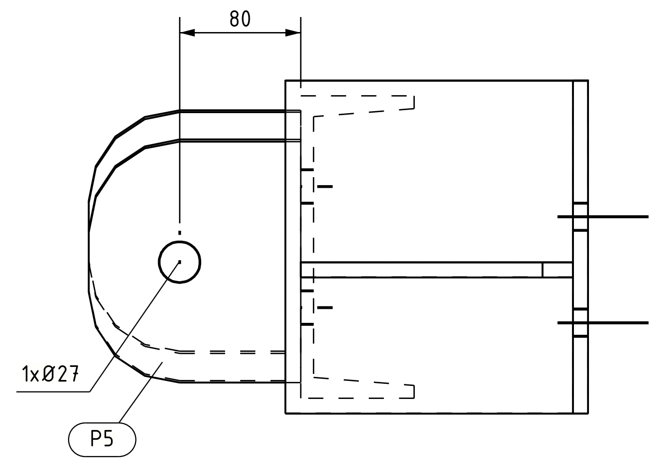
ASSEMBLY

Mark: 48 length (mm): 560 Number: 1

Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P2	L200/100/10	S355J0	1	220	5.1	0.13
P3	L200/100/10	S355J0	1	220	5.1	0.13
P4	UNP200	S355J0	1	360	9.3	0.24
P5	STRIP15*140	S355J0	2	160	5.0	0.10
P6	STRIP10*80	S355J0	2	180	1.5	0.05
				Total of one mark	26.0	0.65







A - A
1:5

ASSEMBLY						
Mark: 49		length (mm): 560		Number: 1		
Pos	Profile	Grade	Number	Length (mm)	Weight (kg)	Area (m^2)
P2	L200/100/10	S355J0	1	220	5.1	0.13
P3	L200/100/10	S355J0	1	220	5.1	0.13
P4	UNP200	S355J0	1	360	9.3	0.24
P5	STRIP15*140	S355J0	2	160	5.0	0.10
P6	STRIP10*80	S355J0	2	180	1.5	0.05
				Total of one mark	26.0	0.65

Naam			Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle			Definitief		

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	420x297

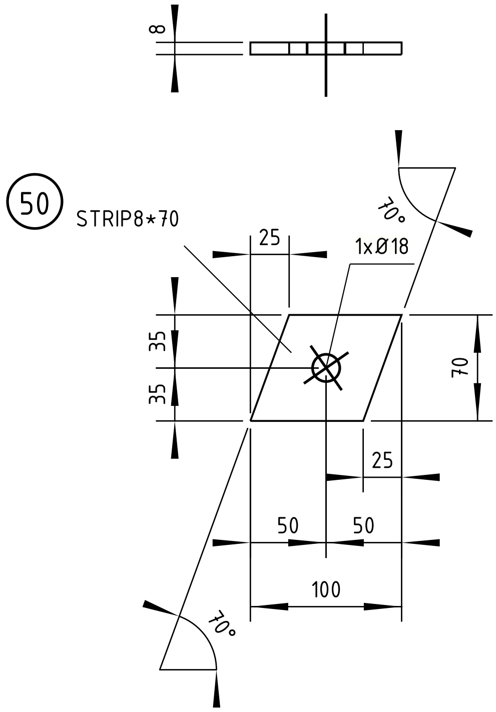
Relatie

Oud tekeningnummer:

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [49]
Documentnummer:	

TenneT
Taking power further

Tekla Structures



50	STRIP8*70	2	S355J0	100	0.01
Pos	Profile	Number	Grade	Length	Area (m^2)

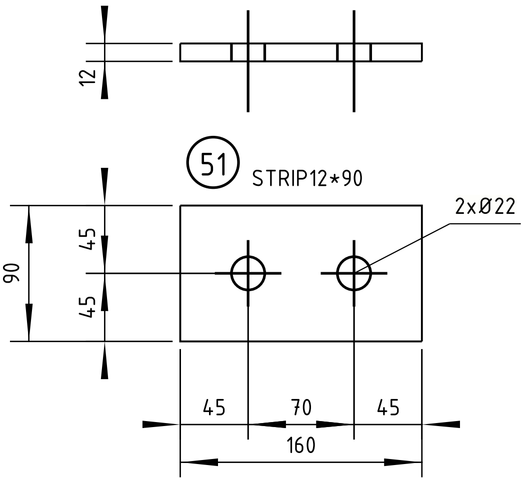
Naam	Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle	Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [50]
Documentnummer:	

TenneT Taking power further

Tekla Structures

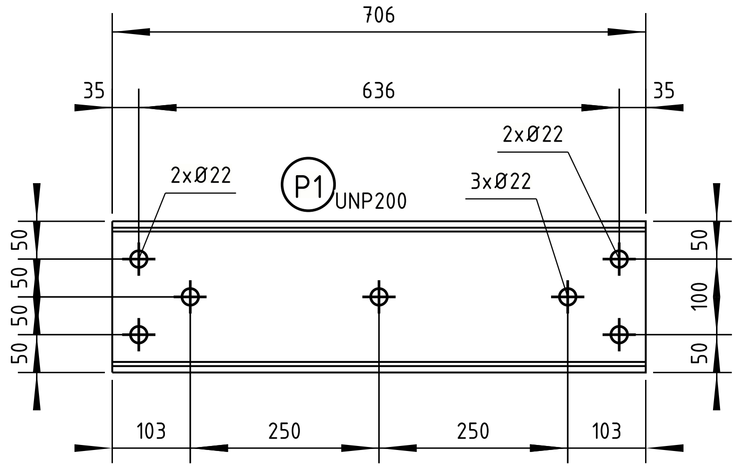


51	STRIP12*90	4	S355J0	160	0.03
Pos	Profile	Number	Grade	Length	Area (m²)

Naam				Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [51]
Documentnummer:	

Taking power further



P1	UNP200	1	S355J0	706	0.47
Pos	Profile	Number	Grade	Length	Area (m^2)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID

ENS-ZL380 EC-3_R_X Mast 90

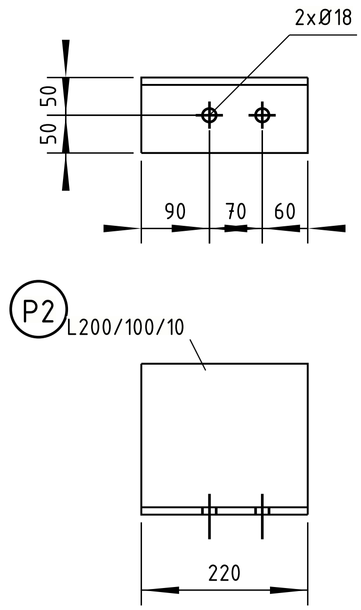
Oud tekeningnummer:

Omschrijving:

Nieuw staal - onderdeel [P1]

TenneT
Taking power further

Documentnummer:



P2	L200/100/10	2	S355J0	220	0.13
Pos	Profile	Number	Grade	Length	Area (m²)

Naam					Tekeningstatus
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

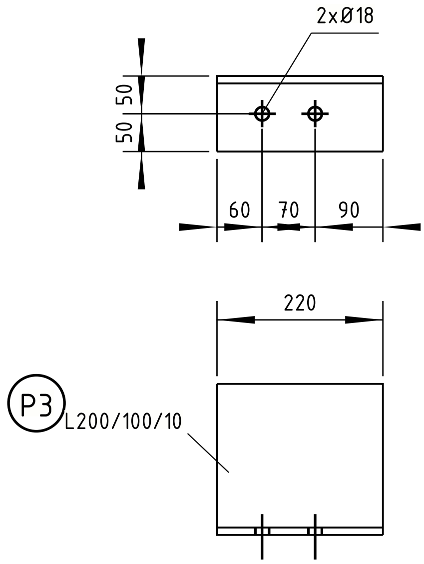
Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [P2]
Documentnummer:	

Tekla Structures



P3	L200/100/10	2	S355J0	220	0.13
Pos	Profile	Number	Grade	Length	Area (m²)

Naam					Tekeningstatus		
Opwaarderen 380 kV verbinding Ens - Zwolle					Definitief		
Rev.	Datum revisie	Omschrijving revisie	Getekend		Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.			1:10	A4

Relatie

Thema: Verbinding

Categorie: Algemeen

Documentcode: Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

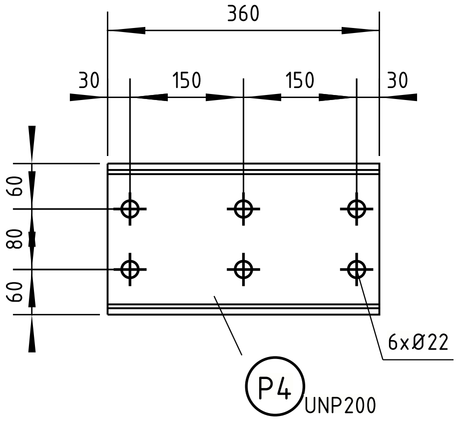
Oud tekeningnummer:

Omschrijving: Nieuw staal - onderdeel [P3]

Documentnummer:

TenneT Taking power further

Tekla Structures



P4	UNP200	2	S355J0	360	0.24
Pos	Profile	Number	Grade	Length	Area (m²)

Naam: Opwaarderen 380 kV verbinding Ens - Zwolle	Tekeningstatus: Definitief

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:10	A4

Relatie

Oud tekeningnummer:

Taking power further

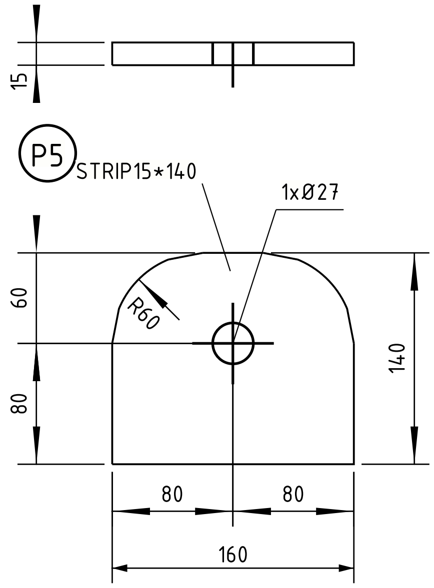
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening

Object ID: ENS-ZL380 EC-3_R_X Mast 90

Omschrijving: Nieuw staal - onderdeel [P4]

Documentnummer:

Tekla Structures



P5	STRIP15*140	6	S355J0	160	0.05
Pos	Profile	Number	Grade	Length	Area (m^2)

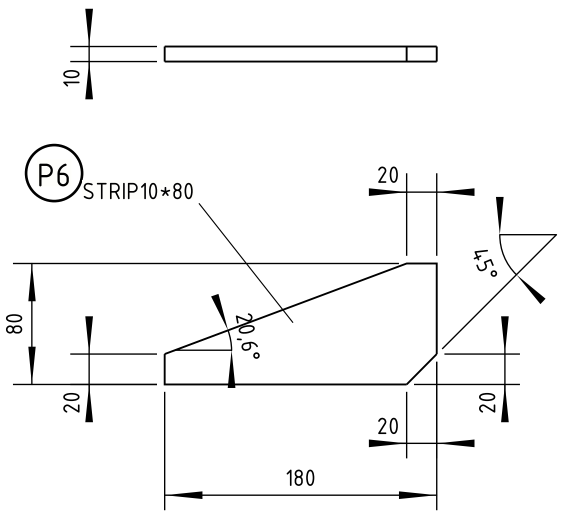
Naam	Opwaarderen 380 kV verbinding Ens - Zwolle			Tekeningstatus	Definitief	
Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie

Oud tekeningnummer:

Taking power further

Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Omschrijving:	Nieuw staal - onderdeel [P5]
Documentnummer:	



P6	STRIP10*80	4	S355J0	180	0.02
Pos	Profile	Number	Grade	Length	Area (m²)

Naam				Tekeningstatus	
Opwaarderen 380 kV verbinding Ens - Zwolle				Definitief	

Rev.	Datum revisie	Omschrijving revisie	Getekend	Datum As-Built	Schaal	Formaat
1.0	18.02.2022	Document goedgekeurd	Ing. bureau Aafjes b.v.		1:5	A4

Relatie	
Thema	Verbinding
Categorie	Algemeen
Documentcode	Constructietekening
Object ID	ENS-ZL380 EC-3_R_X Mast 90
Oud tekeningnummer:	
Omschrijving:	Nieuw staal - onderdeel [P6]
Documentnummer:	

TenneT Taking power further

Tekla Structures

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Projectnummer Aafjes: **21-187**

Documentnummer: **00974-01-09020**

Projectnummer TenneT: **002.515**

Meridian nummer: **002.515.40 0994388**

Opdrachtgever: **TenneT**

Project: **Opwaardering ENS-ZL380**

Onderdeel: **EC-3_R_X Mast 90 - Lijsten**

	Naam	Functie	Handtekening	Datum
Opgesteld	Rogier Hol	Tekenaar		18-02-2022
Validatie Aafjes	Niels Verhaar	System Engineer		18-02-2022
Vrijgegeven	Bart Aafjes	Projectleider		18-02-2022

Revisie	Documentstatus	Datum	Reden van uitgifte
0.1	Voorlopig	02-02-2022	1e versie ter review
1.0	Definitief	18-02-2022	Document goedgekeurd

BOUTEN-, MOEREN-, RINGENLIJST

ENS-ZL380

Datum: 18.02.2022

Masttype EC-3_R_X

t.b.v. mast 90

Naam	Type	Kwal.	Aantal
BOUT-M16*35	4017	8.8	20
BOUT-M16*40	4017	8.8	90
BOUT-M16*45	4017	8.8	18
BOUT-M16*50	4014	8.8	8
BOUT-M20*45	4017	8.8	4
BOUT-M20*50	4017	8.8	4
BOUT-M20*55	4017	8.8	52
BOUT-M20*60	4017	8.8	4
BOUT-M24*60	4017	8.8	28
BOUT-M24*65	4017	8.8	4
MOER-M16	4032		136
MOER-M20	4032		64
MOER-M24	4032		32
RING-M16	7091		136
RING-M20	7091		64
RING-M24	7091		32

MATERIAALLIJST   Pagina: 1

ENS-ZL380   Datum: 18.02.2022
Masttype EC-3_R_X
t.b.v. mast 90

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
L50/5	4	S355JO	2	3304	0.66	12.7
L50/5	11	S355JO	1	1783	0.36	6.8
L50/5	13	S355JO	1	1829	0.37	7.0
L50/5	14	S355JO	2	955	0.19	3.7
L50/5	24	S355JO	1	1783	0.36	6.8
L50/5	28	S355JO	1	1829	0.37	7.0
L50/5	30	S355JO	2	2962	0.59	11.4
				21665	4.33	83.2
L60/6	3	S355JO	2	2423	0.58	13.4
L60/6	17	S355JO	2	577	0.14	3.2
L60/6	18	S355JO	2	1791	0.43	9.9
L60/6	26	S355JO	2	2667	0.64	14.7
L60/6	37	S355JO	2	3125	0.75	17.3
L60/6	38	S355JO	2	2850	0.68	15.8
L60/6	41	S355JO	2	3125	0.75	17.3
L60/6	42	S355JO	2	2850	0.68	15.8
L60/6	43	S355JO	2	2667	0.64	14.7
				44152	10.60	244.0
L70/7	5	S355JO	2	2442	0.68	18.4
L70/7	6	S355JO	2	2442	0.68	18.4
L70/7	31	S355JO	2	3798	1.06	28.5
L70/7	32	S355JO	2	3559	1.00	26.8
L70/7	33	S355JO	2	3798	1.06	28.5
L70/7	34	S355JO	2	3559	1.00	26.8
L70/7	35	S355JO	2	3318	0.93	24.9
L70/7	36	S355JO	2	3085	0.86	23.2
L70/7	39	S355JO	2	3318	0.93	24.9
L70/7	40	S355JO	2	3085	0.86	23.2
				64806	18.15	487.1
L80/8	12	S355J2	1	5511	1.76	54.1
L80/8	25	S355J2	1	5511	1.76	54.1
				11022	3.53	108.1
L90/8	27	S355J2	1	3727	1.34	41.0
L90/8	29	S355J2	1	3727	1.34	41.0
				7454	2.68	82.1
L100/8	10	S355J2	1	5749	2.30	71.3
				5749	2.30	71.3

MATERIAALLIJST Pagina: 2

ENS-ZL380 Datum: 18.02.2022
Masttype EC-3_R_X
t.b.v. mast 90

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
L100/8	20	S355JO	2	120	0.05	1.5
				240	0.10	3.0
L100/8	23	S355J2	1	5749	2.30	71.3
				5749	2.30	71.3
L100/10	1	S355J2	1	5145	2.06	78.8
L100/10	2	S355J2	1	4466	1.79	68.4
L100/10	7	S355J2	1	5145	2.06	78.8
L100/10	8	S355J2	1	4466	1.79	68.4
				19222	7.69	294.5
L150/100/10	9	S355JO	2	220	0.11	4.2
				440	0.22	8.4
L200/100/10	P2	S355JO	2	220	0.13	5.1
L200/100/10	P3	S355JO	2	220	0.13	5.1
				880	0.53	20.4
PL10*136.2	19	S355JO	2	653	0.15	5.3
				1305	0.29	10.5
PL10*183.7	16	S355JO	2	272	0.08	2.8
				544	0.15	5.5
STRIP8*60	46	S355JO	4	60	0.01	0.2
STRIP8*60	47	S355JO	2	87	0.01	0.2
				414	0.06	1.4
STRIP8*70	45	S355JO	6	123	0.01	0.4
STRIP8*70	50	S355JO	2	100	0.01	0.3
				939	0.11	2.9
STRIP10*80	P6	S355JO	4	180	0.02	0.8
				720	0.09	3.0
STRIP10*100	15	S355JO	6	160	0.04	1.3
STRIP10*100	22	S355JO	8	180	0.04	1.4

ENS-ZL380 Datum: 18.02.2022
Masttype EC-3_R_X
t.b.v. mast 90

Profiel	Pos	Kwaliteit	Aantal	Lengte(mm)	Opp.(m2)	Gewicht(kg)
				2400	0.56	19.2
STRIP10*180	21	S355JO	2	190	0.06	2.2
				379	0.12	4.4
STRIP12*90	51	S355JO	4	160	0.03	1.4
				640	0.14	5.5
STRIP15*140	P5	S355JO	6	160	0.05	2.5
				960	0.30	14.9
UNP200	P1	S355JO	1	706	0.47	18.2
UNP200	P4	S355JO	2	360	0.24	9.3
				1426	0.94	36.7
				Totaal:	55.18	1577.6

TEKLA STRUCTURES MERKENLIJST   Pagina: 1

ENS-ZL380   Datum: 18.02.2022
Masttype EC-3_R_X
t.b.v. mast 90

Merk	Aantal	Profiel	Lengte	Opp.(m2)	Gewicht (kg)
1	1	L100/10	5145	2.06	78.8
2	1	L100/10	4466	1.79	68.4
3	2	L60/6	2423	0.58	13.4
4	2	L50/5	3304	0.66	12.7
5	2	L70/7	2442	0.68	18.4
6	2	L70/7	2442	0.68	18.4
7	1	L100/10	5145	2.06	78.8
8	1	L100/10	4466	1.79	68.4
9	2	L150/100/10	220	0.11	4.2
10	1	L100/8	5749	2.30	71.3
11	1	L50/5	1783	0.36	6.8
12	1	L80/8	5511	1.76	54.1
13	1	L50/5	1829	0.37	7.0
14	2	L50/5	955	0.19	3.7
15	6	STRIP10*100	160	0.04	1.3
16	2	PL10*183.7	272	0.08	2.8
17	2	L60/6	577	0.14	3.2
18	2	L60/6	1791	0.43	9.9
19	2	PL10*136.2	653	0.15	5.3
20	2	L100/8	120	0.05	1.5
21	2	STRIP10*180	190	0.06	2.2
22	8	STRIP10*100	180	0.04	1.4
23	1	L100/8	5749	2.30	71.3
24	1	L50/5	1783	0.36	6.8
25	1	L80/8	5511	1.76	54.1
26	2	L60/6	2667	0.64	14.7
27	1	L90/8	3727	1.34	41.0
28	1	L50/5	1829	0.37	7.0
29	1	L90/8	3727	1.34	41.0
30	2	L50/5	2962	0.59	11.4
31	2	L70/7	3798	1.06	28.5
32	2	L70/7	3559	1.00	26.8
33	2	L70/7	3798	1.06	28.5
34	2	L70/7	3559	1.00	26.8
35	2	L70/7	3318	0.93	24.9
36	2	L70/7	3085	0.86	23.2
37	2	L60/6	3125	0.75	17.3
38	2	L60/6	2850	0.68	15.8
39	2	L70/7	3318	0.93	24.9
40	2	L70/7	3085	0.86	23.2
41	2	L60/6	3125	0.75	17.3
42	2	L60/6	2850	0.68	15.8
43	2	L60/6	2667	0.64	14.7
44	1	UNP200	706	0.57	23.1
45	6	STRIP8*70	123	0.01	0.4
46	4	STRIP8*60	60	0.01	0.2
47	2	STRIP8*60	87	0.01	0.2
48	1	UNP200	560	0.65	26.0
49	1	UNP200	560	0.65	26.0

ENS-ZL380 Datum: 18.02.2022
Masttype EC-3_R_X
t.b.v. mast 90

Merk	Aantal	Profiel	Lengte	Opp.(m2)	Gewicht (kg)
50	2	STRIP8*70	100	0.01	0.3
51	4	STRIP12*90	160	0.03	1.4
Totaal	103	merk(en)		55.18	1577.6

Masttype: EC-3_R_X, Mast 90
Opwaarderen 380 kV verbinding Ens - Zwolle

Tekening omschrijving	Tekeningnummer	Rev.	Datum	Tek.	formaat
Masttype EC-3_R_X, Mast 90 - Overzicht	00974-01-09001	1.0	18.02.2022	A2	594x420
Masttype EC-3_R_X, Mast 90 - Ondertraverse links	00974-01-09002	1.0	18.02.2022	A0	1189x841
Masttype EC-3_R_X, Mast 90 - Ondertraverse rechts	00974-01-09003	1.0	18.02.2022	A0	1189x841
Masttype EC-3_R_X, Mast 90 - Ondertraverse rechts	00974-01-09004	1.0	18.02.2022	A0	1189x841
Masttype EC-3_R_X, Mast 90 - Boventraverse links	00974-01-09005	1.0	18.02.2022	A0	1189x841
Masttype EC-3_R_X, Mast 90 - Boventraverse rechts	00974-01-09006	1.0	18.02.2022	A0	1189x841
EC-3_R_X, Mast 90 - Onderdeeltekeningen	00974-01-09010	1.0	18.02.2022	A1/2/3/4	

Lijsten	Documentnummer		Datum
bouten-moeren-ringenlijst	00974-01-09020	1.0	18.02.2022
materiaallijst	00974-01-09020	1.0	18.02.2022
merkenlijst	00974-01-09020	1.0	18.02.2022
Documentenlijst	00974-01-09020	1.0	18.02.2022

Detailberekeningen	Documentnummer		Datum
EC-3_R_X Mast 90	00974-01-09030	1.0	18.02.2022

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"REVIEW AND RE-DESIGN TOWERS BBB380"

ENS-ZL380 – Tower EC-3_R_X Mast 90

TenneT TSO B.V.

Detail Calculation

Projectnummer Aafjes:	**21-187**
Documentnummer:	**00974-01-09030**
Projectnummer TenneT:	**002.515**
Meridian nummer:	**002.515.40 0994389**
Opdrachtgever:	**TenneT**
Project:	**Opwaardering ENS-ZL380**
Onderdeel:	**EC-3_R_X Mast 90 - Detailberekeningen**

Definitief – Document goedgekeurd	G. Pieper	R.Hol	B. Aafjes	18-02-2022	1.0
1st edition	G. Pieper	R.Hol	B. Aafjes	02-02-2022	0.1
	Author	Checked	Approved	date	revision

Content

1 Introduction

This report contains the detail calculations of the reinforcements of towertype EC-3/R windzone II.

It concerns tower number: Tower 90

To increase the future capacity of electricity transmission, it is necessary to upgrade the transmission grid by building new and modifying existing high voltage connections.

It is for this reason the client (OG) intends to upgrade part the existing 380kV grid. This upgrading is part of the program “Beter Benutten Bestaande 380kV” and consists of the following subprojects:

- Upgrading of the 380 kV-connection Lelystad – Ens (LLS-ENS380).
- Upgrading of the 380 kV-connection Diemen – Lelystad (DIM-LLS380).
- Upgrading of the 380 kV-connection Rilland – Zandvliet (RLL-ZVL380).
- Upgrading of the 380 kV-connection Krimpen aan de IJssel – Geertruidenberg (KIJ-GT380).
- Upgrading of the 380 kV-connection Ens – Zwolle (ENS-ZL380).
- Upgrading of the 380 kV-connection Maasbracht – Eindhoven (MBT-EHV380).

DNV GL has calculated the existing tower for the new situation on behalf of Tennet. On the instructions of DNV GL, the reinforcements mainly consist of the exchange of bolts and profiles and the reinforcement of profiles and the application of redundant members.

DNV GL has tested the profiles and bolts. In this report only the detail calculations are made of the specified reinforcements (bolts are specified by DNV GL).

2 General Data

2.1 Principal constructor

DNV GL – Energy

2.2 Principal calculation and related documents

- ENS-ZL380 – Tower EC-3/R
  Reportnr.: 21-0093 Rev 4
  Date: 2021-12-22

- Uitgangspuntenrapport 380kV verbinding Ens – Zwolle
  Reportnr.: 20-1245 Rev.3
  Date: 2021-06-09

2.3 Material- and bolt quality

Materials excisting construction

	Signification 1969	Current startingpoint
Steeltype	St.37	S235JR
	St.52	S355JO
Bolt quality	bolt class 8.8	8.8 rolled thread
Concrete quality	K225	Min. C16/20
Reinforcing steel	Qr24, Qr40	B220, B400

Materials modified construction

Steeltype	S355JO ($t \leqq 16$ mm)
	S355J2 ($16 < t \leqq 40$ mm)
Bolt quality	8.8 rolled thread

2.4 Applicable standards

Mainly used:
- NEN-EN 1993-1-8+C2 :2011/NB:2011 nl

Also used:
- NEN-EN 50341-2-15: 2019
- NEN-EN 8700: 2011
- NEN-EN 8701: 2011
- Eurocode reeks

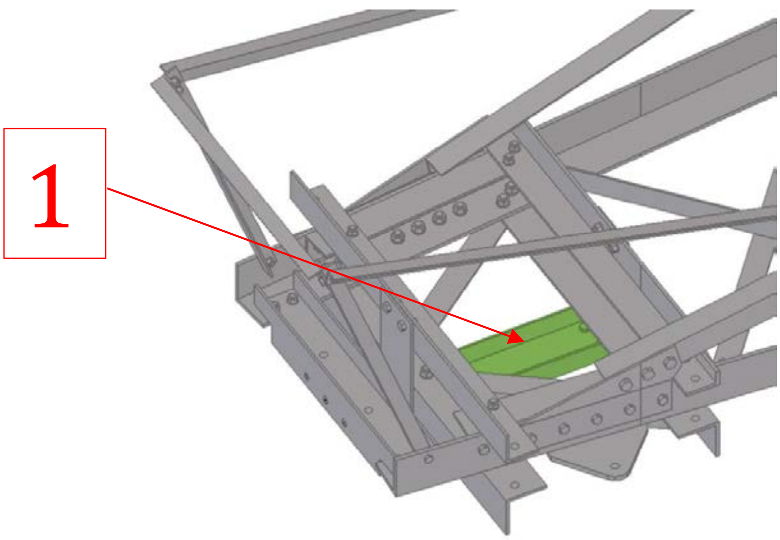
2.5 Tennet specifications

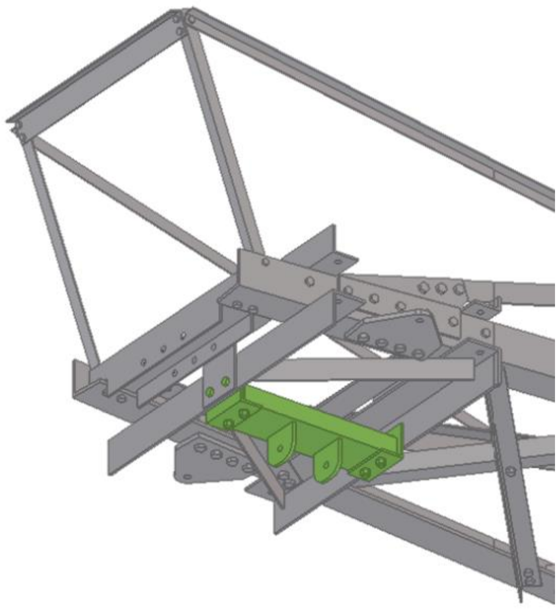
- SPE. 05. 346. v 2.0 algemene specificatie stalen masten

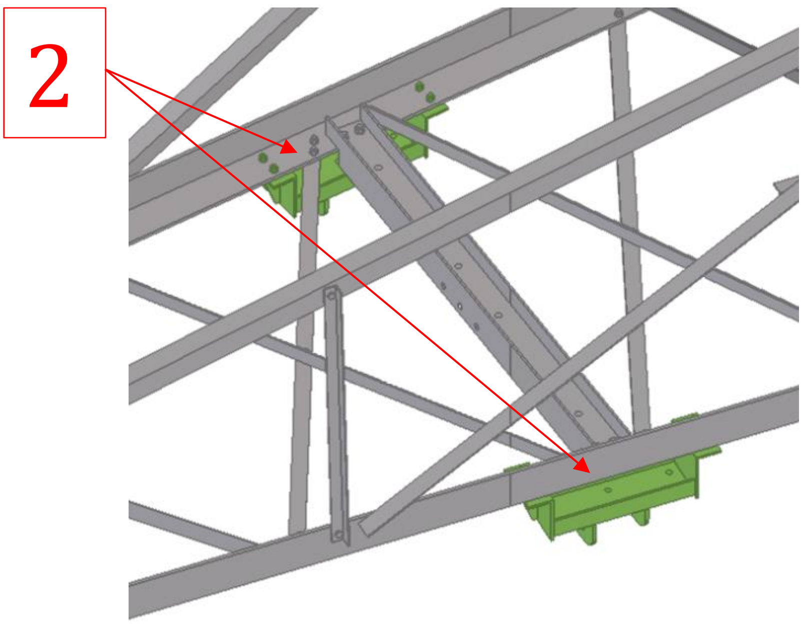
3 Calculations

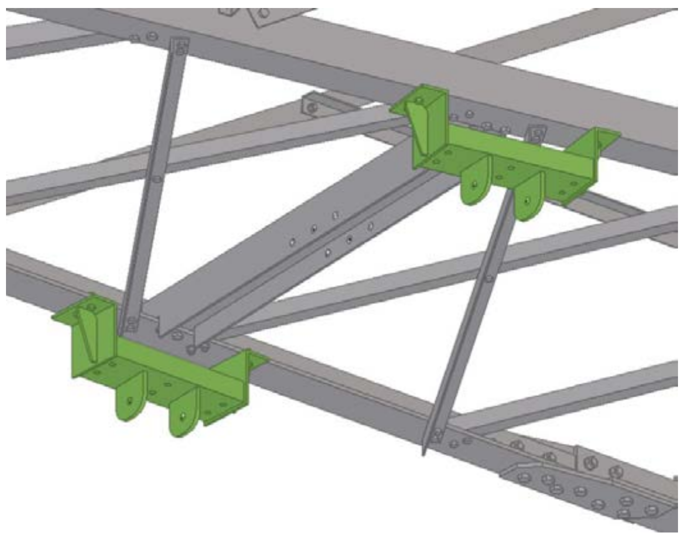
3.1 Connection of post insulators to the lower crossarm

3.1.1 Overview

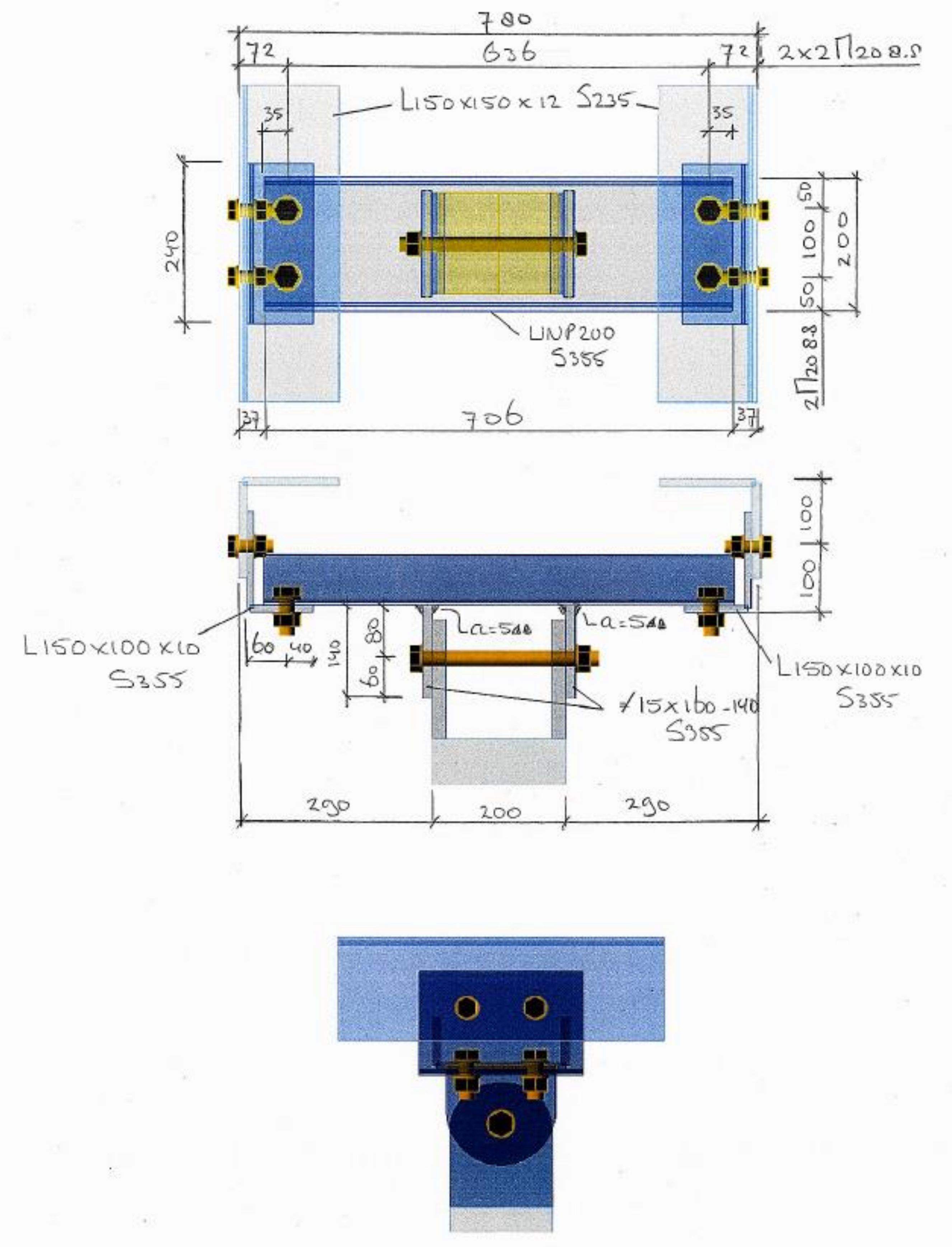








3.1.2 Detail 1


780
72
636
72
2x2M20 8.8
L150x150x12 S235
35
35
240
50
100
50
200
UNP200
S355
2M20 8.8
37
706
37
100
100
L150x100x10
S355
La=5
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60
40
140
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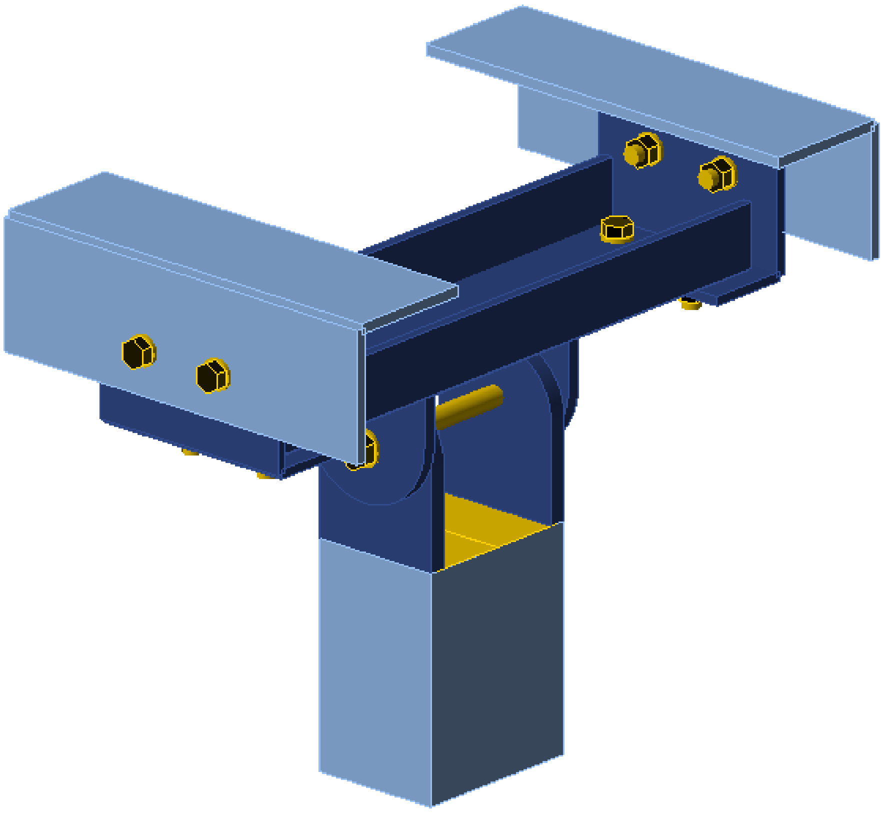
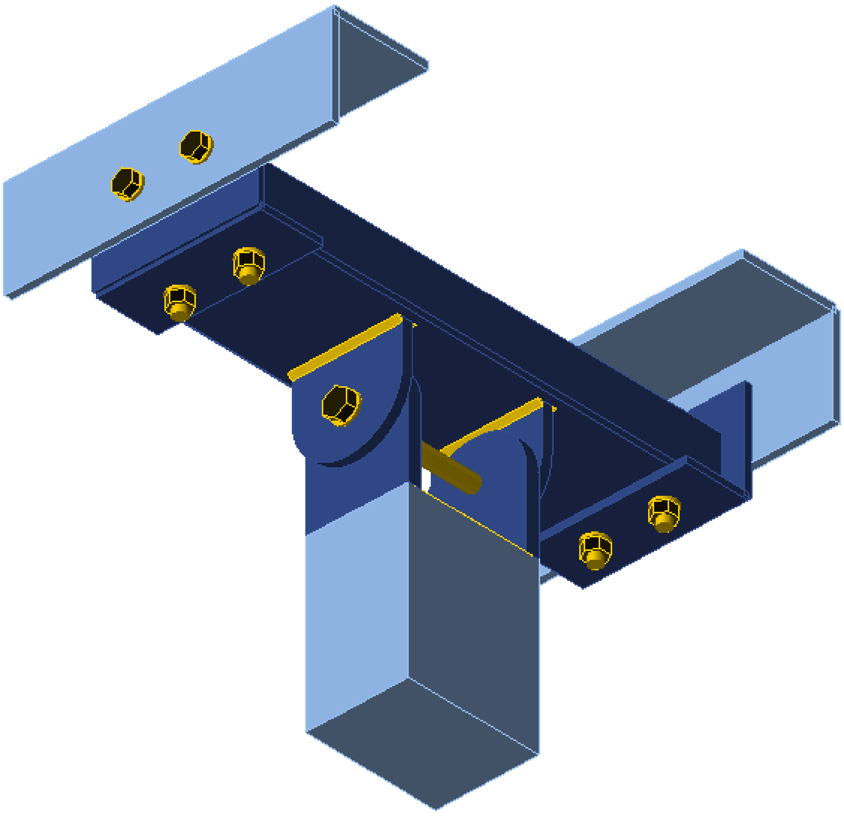
S355
15x160-140
S355
290
200
290





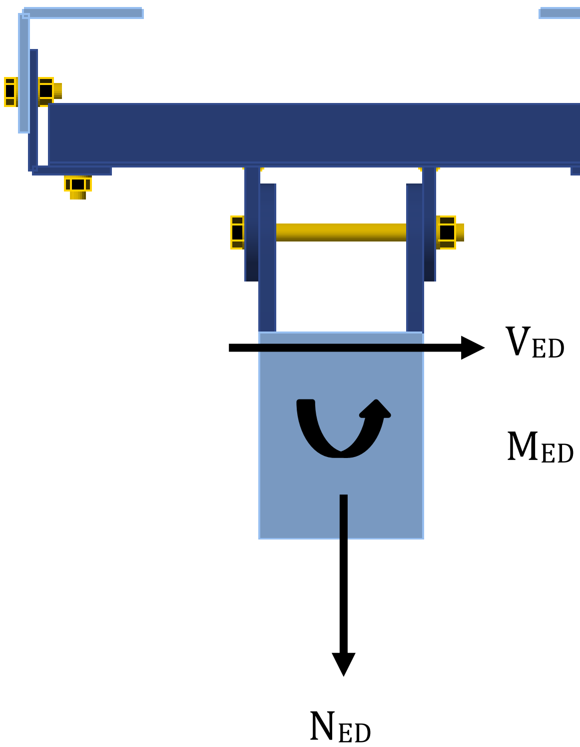
3.1.3 Loads

Loads from report:

ENS-ZL380 – Tower EC-3/R

Report nr.: 21-0093 Rev 4
Date: 2021-12-22

Page 80 / 81



V_{ED} = 2,56 kN

M_{ED} = 8,23 kNm

N_{ED} = 5 kN

3.1.4 Calculation

3.1.4.1 IDEA calculation

Project data

Project name	ENS-ZL380 EC-3/R Tower 90
Project number	21-187
Author	G.P.
Description	Detail 1
Date	1/24/2022
Design code	EN

Material

Steel	S 235, S 355

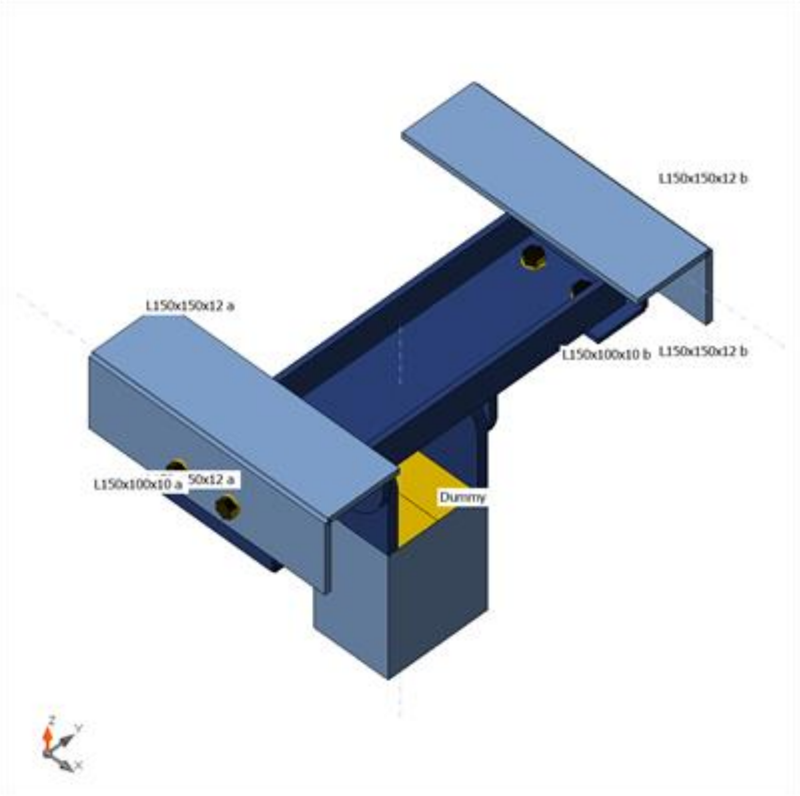
Project item Detail 1

Design

Name	Detail 1
Description	
Analysis	Stress, strain/ loads in equilibrium

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
L150x150x12 a	3 - HFLeq150x150x12	0.0	0.0	-90.0	0	0	-349	Node
L150x150x12 b	3 - HFLeq150x150x12	180.0	0.0	-90.0	0	0	-349	Bolts
Dummy	5 - Plaat 200, 150	0.0	90.0	90.0	0	0	0	Node



Cross-sections

Name	Material
3 - HFLeq150x150x12	S 235
5 - Plaat 200, 150	S 355
10 - UNP200	S 355
9 - HFLue150x100x10	S 355

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M24 8.8	M24 8.8	24	800.0	452
M20 8.8	M20 8.8	20	800.0	314

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	L150x150x12 a	0.0	-7.2	-0.6	0.0	0.0	0.0
	L150x150x12 a	0.0	-7.2	-0.6	0.0	0.0	0.0
	L150x150x12 b	0.0	4.7	0.6	0.0	0.0	0.0
	L150x150x12 b	0.0	4.7	0.6	0.0	0.0	0.0
	Dummy	5.0	0.0	-2.6	0.0	8.2	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	30.3 < 100%	OK
Welds	98.0 < 100%	OK
Buckling	85.57	

Plates

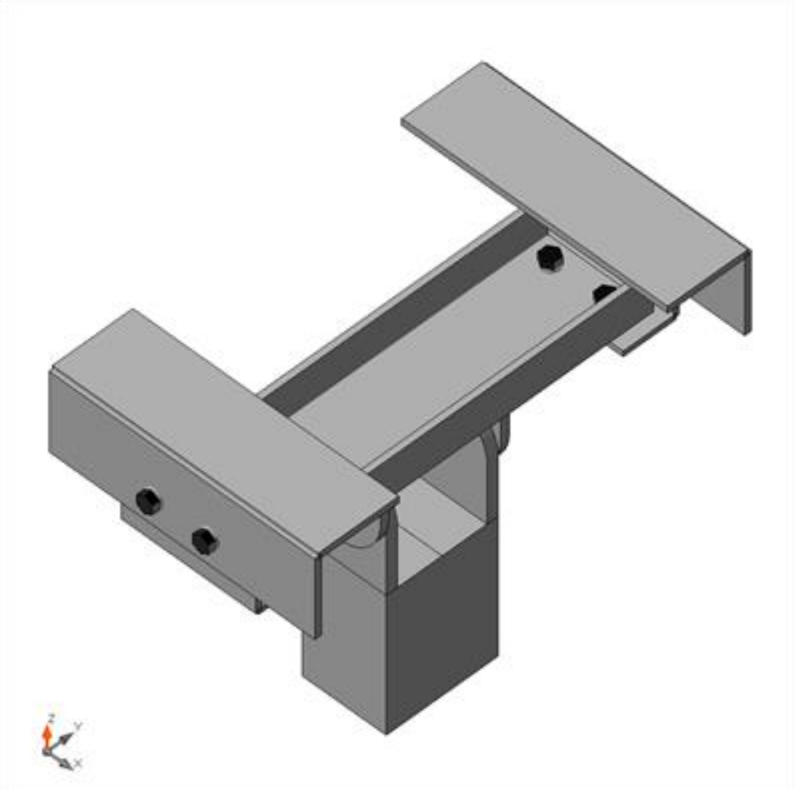
Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
L150x150x12 a-bfl 1	S 235	12.0	LE1	111.1	0.0	10.6	OK
L150x150x12 a-w 1	S 235	12.0	LE1	32.7	0.0	0.0	OK
L150x150x12 b-bfl 1	S 235	12.0	LE1	47.6	0.0	5.4	OK
L150x150x12 b-w 1	S 235	12.0	LE1	19.8	0.0	0.0	OK
Dummy-bfl 1	S 355	200.0	LE1	7.8	0.0	0.0	OK
UNP200-bfl 1	S 355 - 1	11.5	LE1	93.0	0.0	0.0	OK
UNP200-tfl 1	S 355 - 1	11.5	LE1	92.9	0.0	0.0	OK
UNP200-w 1	S 355 - 1	8.5	LE1	123.6	0.0	17.8	OK
L150x100x10 a-bfl 1	S 355 - 1	10.0	LE1	112.4	0.0	17.8	OK
L150x100x10 a-w 1	S 355 - 1	10.0	LE1	153.9	0.0	10.6	OK
L150x100x10 b-bfl 1	S 355 - 1	10.0	LE1	86.0	0.0	8.1	OK
L150x100x10 b-w 1	S 355 - 1	10.0	LE1	107.4	0.0	5.4	OK
SP2	S 355 - 1	15.0	LE1	136.1	0.0	18.8	OK
SP1	S 355 - 1	15.0	LE1	151.8	0.0	11.1	OK
dummy1	S 355 - 1	20.0	LE1	66.1	0.0	18.8	OK
dummy2	S 355 - 1	20.0	LE1	85.1	0.0	11.1	OK

Design data

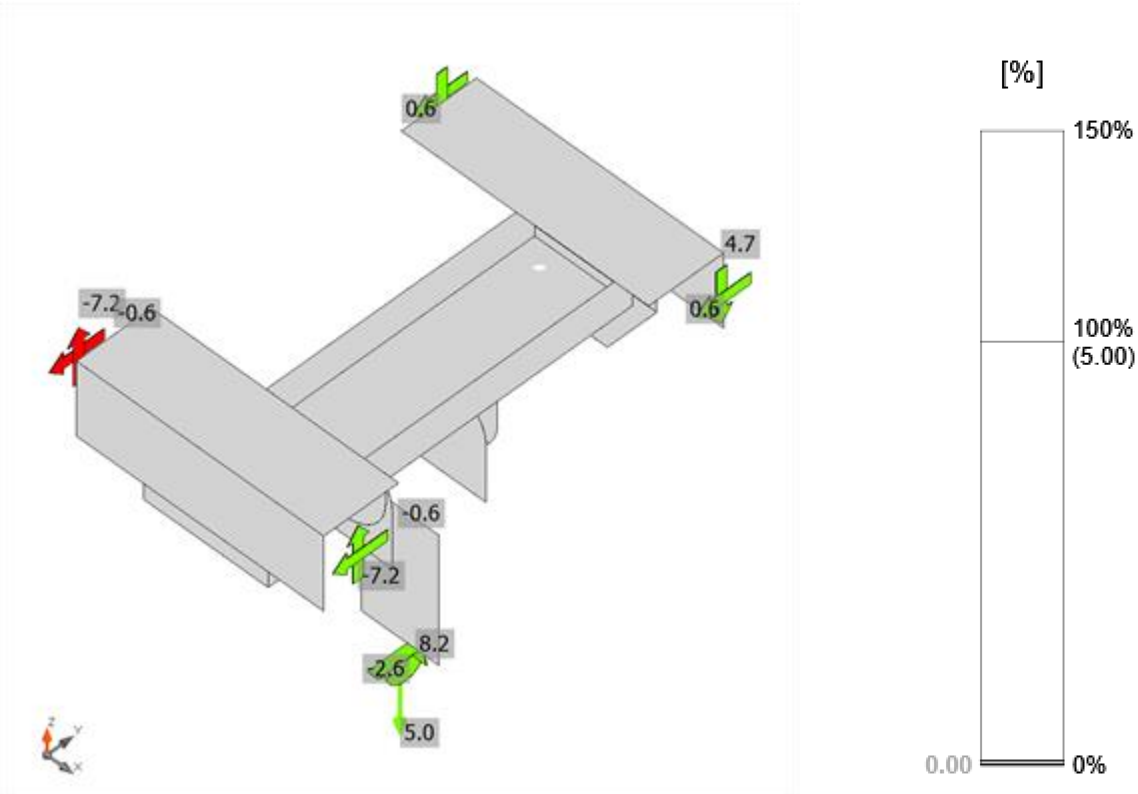
Material	f_y [MPa]	ε_{lim} [%]
S 235	235.0	5.0
S 355	335.0	5.0
S 355 - 1	355.0	5.0

Symbol explanation

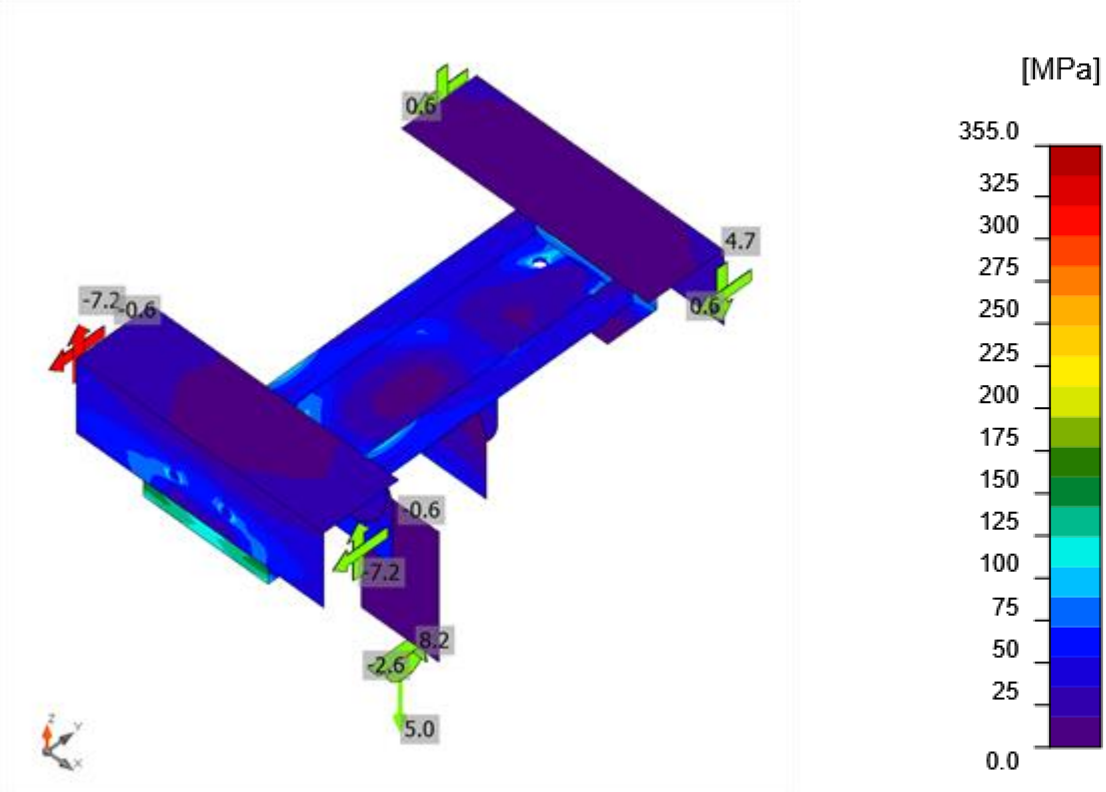
ε_{Pl}	Strain
σ_{Ed}	Eq. stress
σc_{Ed}	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain



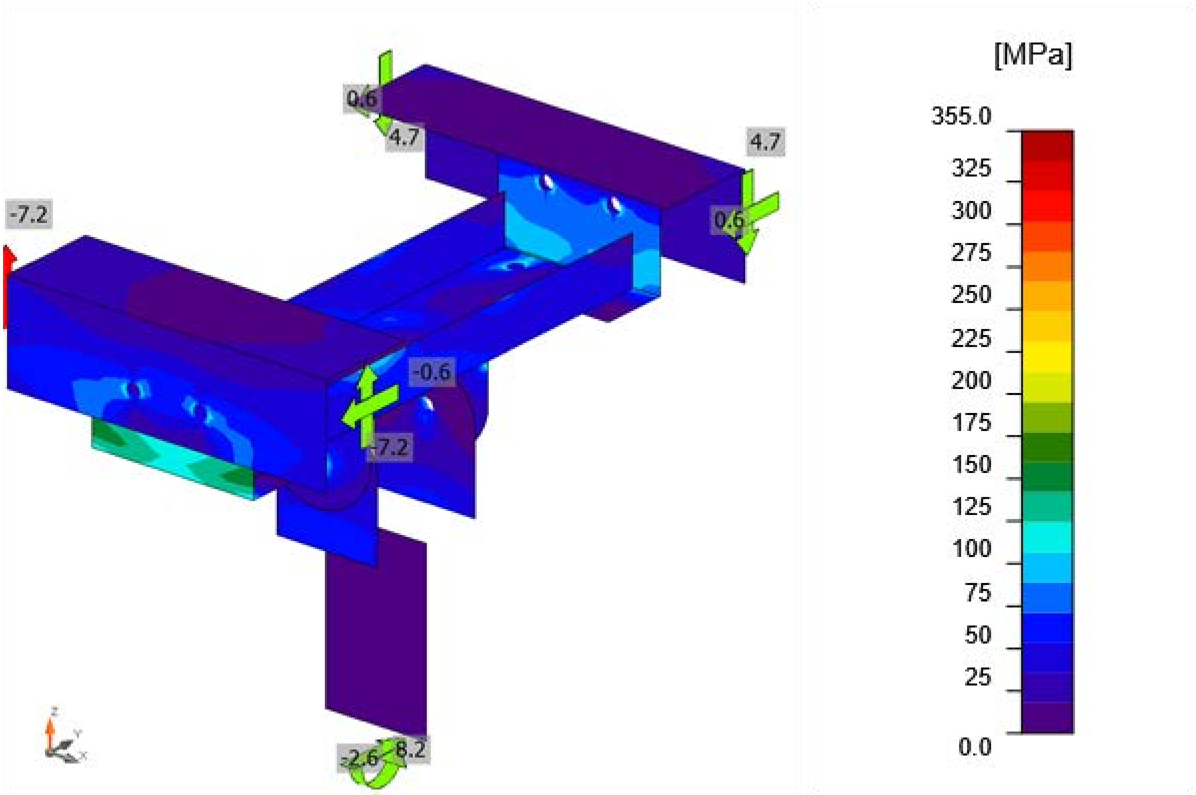
Overall check, LE1



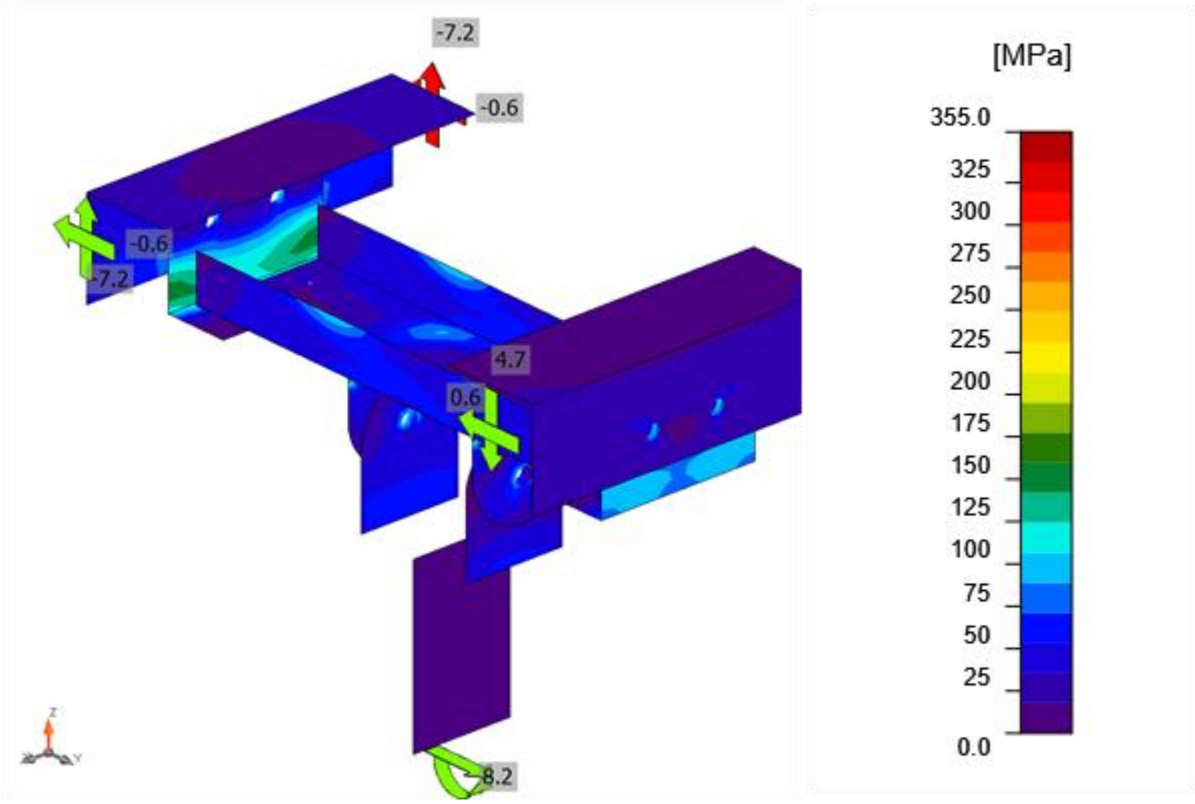
Strain check, LE1



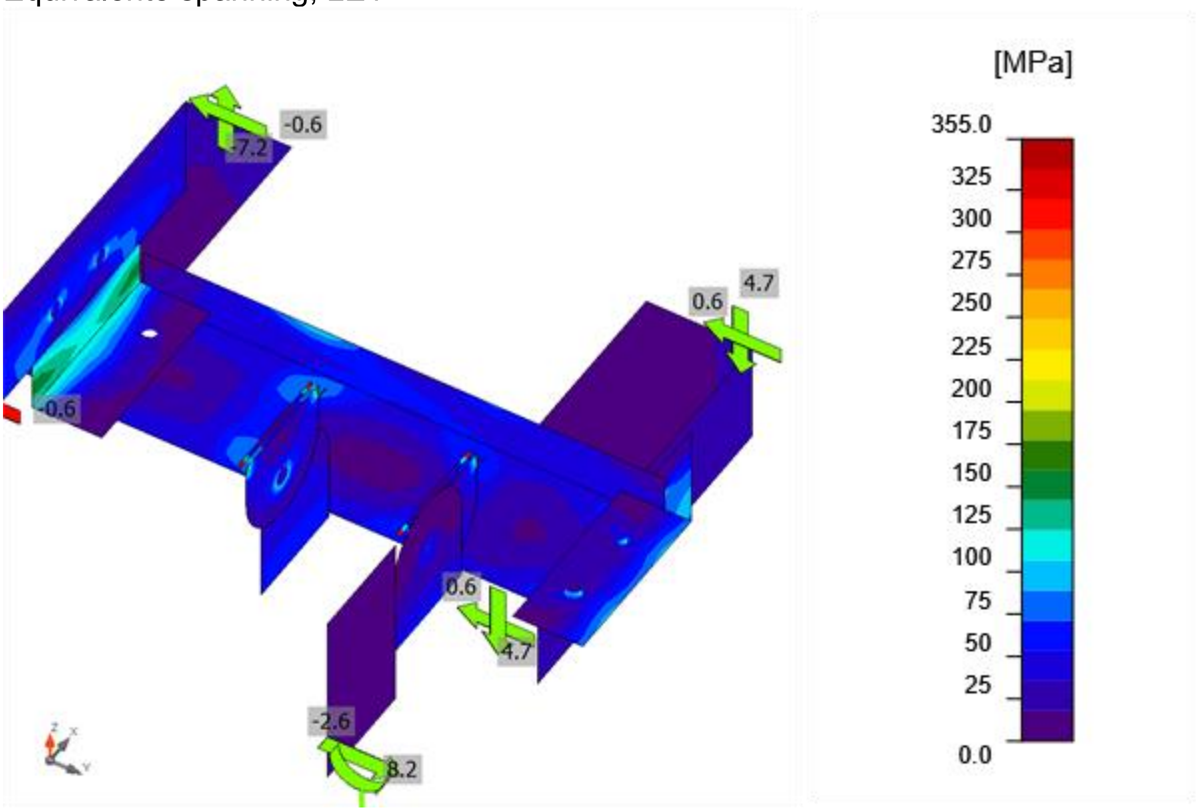
Equivalent stress, LE1



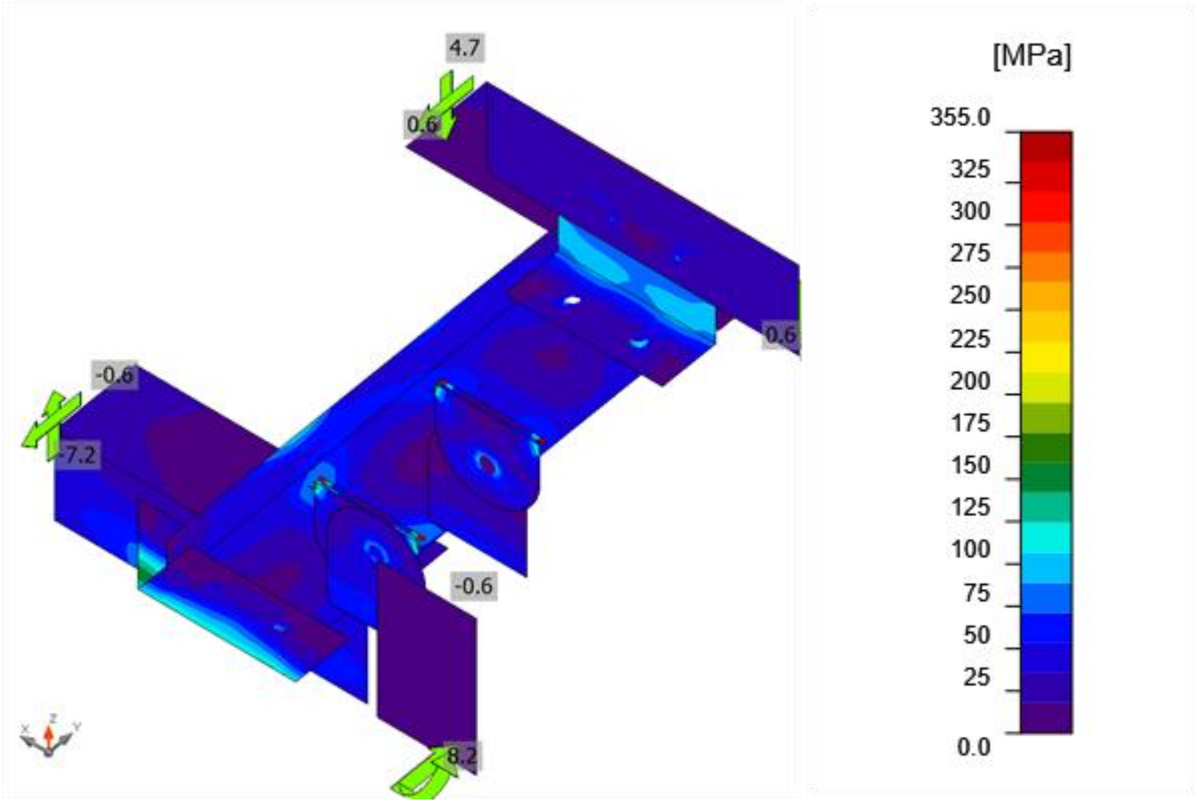
Equivalente spanning, LE1



Equivalente spanning, LE1

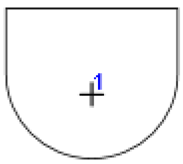
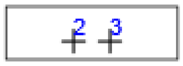
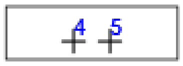


Equivalente spanning, LE1



Equivalente spanning, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	6.0	38.2	3.0	271.1	28.2	30.3	OK
	B2	M20 8.8 - 2	LE1	6.4	4.7	4.5	172.8	5.0	8.2	OK
	B3	M20 8.8 - 2	LE1	6.4	4.7	4.5	172.8	5.0	8.2	OK
	B4	M20 8.8 - 2	LE1	8.0	7.2	5.7	130.3	7.6	11.7	OK
	B5	M20 8.8 - 2	LE1	8.3	7.2	5.9	130.3	7.6	11.9	OK
	B6	M20 8.8 - 3	LE1	12.7	1.0	9.0	166.6	1.0	7.5	OK
	B7	M20 8.8 - 3	LE1	12.7	1.0	9.0	166.6	1.0	7.5	OK
	B8	M20 8.8 - 3	LE1	0.5	0.8	0.3	89.4	0.9	1.1	OK
	B9	M20 8.8 - 3	LE1	0.5	0.8	0.3	89.4	0.9	1.1	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203.3	421.2	135.6
M20 8.8 - 2	141.1	205.2	94.1
M20 8.8 - 3	141.1	197.8	94.1

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear

Welds (Plastic redistribution)

Item	Edge	Material	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
Dummy-bfl 1	dummy1	S 235	20.0	150	LE1								OK
Dummy-bfl 1	dummy2	S 235	20.0	150	LE1								OK
UNP200-w 1	SP1	S 355	◢5.0◣	160	LE1	426.9	0.0	144.2	189.8	133.4	98.0	19.9	OK
		S 355	◢5.0◣	160	LE1	420.5	0.0	122.3	-188.6	-135.6	96.6	20.5	OK
UNP200-w 1	SP2	S 355	◢5.0◣	160	LE1	327.1	0.0	-94.1	-147.8	-104.2	75.1	16.4	OK
		S 355	◢5.0◣	160	LE1	363.5	0.0	-121.0	164.1	110.6	83.5	17.2	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0.80	360.0	259.2
S 355	0.90	435.6	352.8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

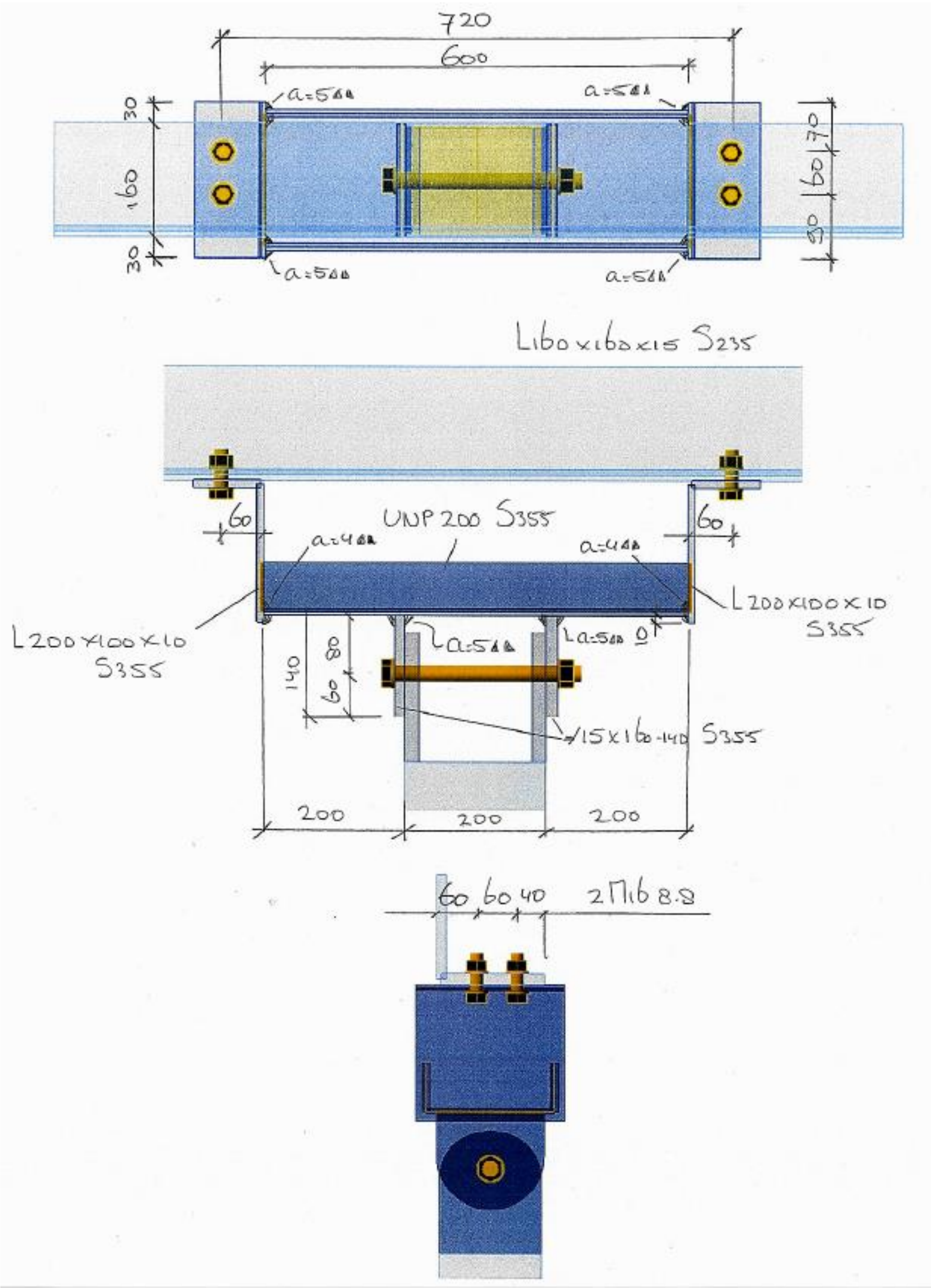
Buckling

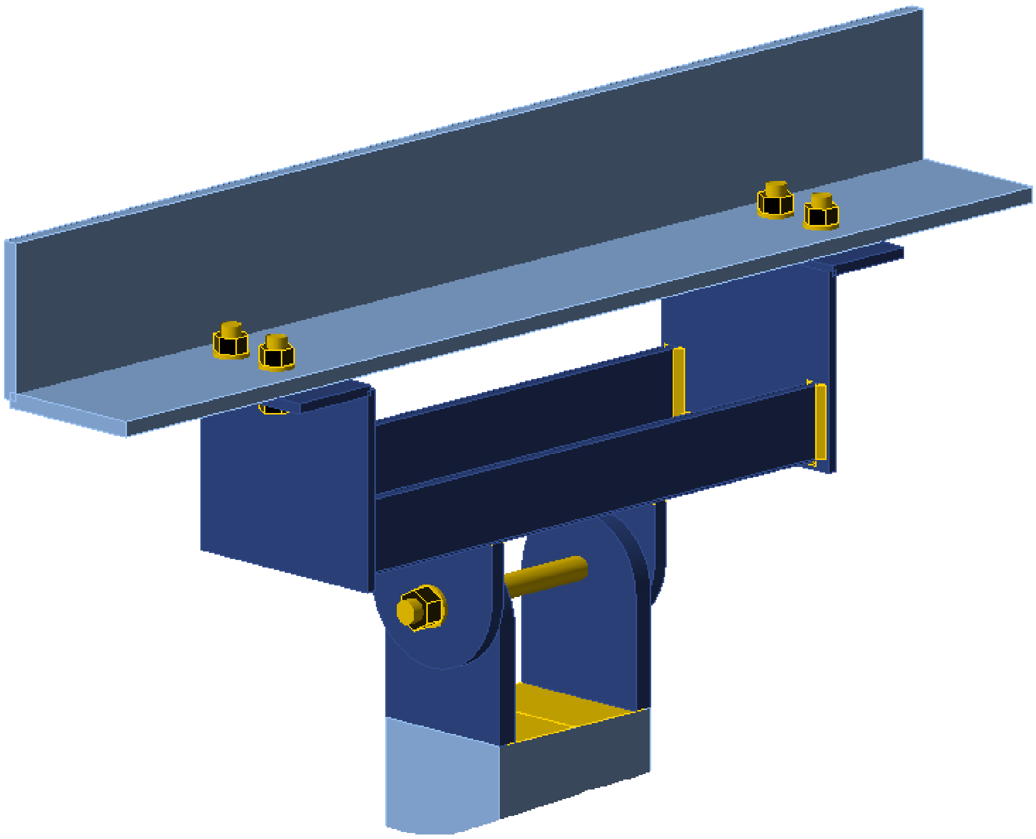
Loads	Shape	Factor [-]
LE1	1	85.57
	2	85.70
	3	91.68
	4	93.65
	5	154.53
	6	161.94

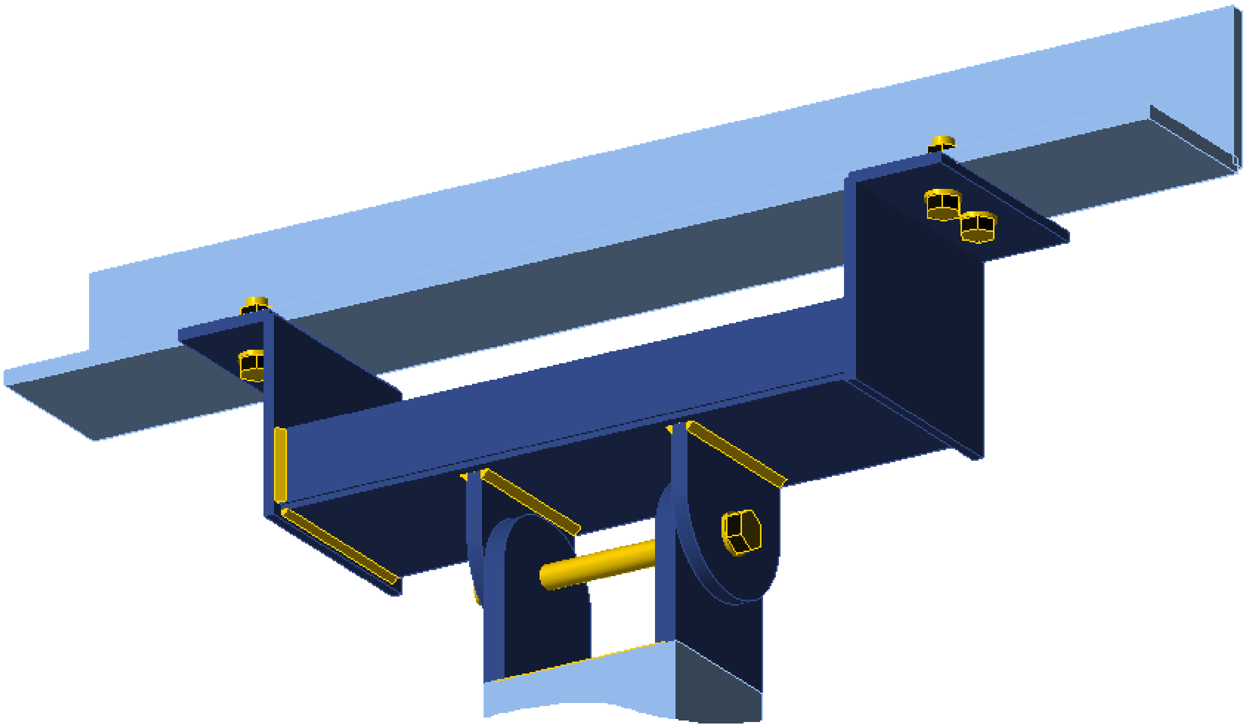
Code settings

Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_{C}	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

3.1.5 Detail 2


720
600
a=5
30
160
30
70
60
L160x160x15 S235
UNP 200 S355
a=4
60
L200x100x10
S355
140
80
60
a=5
15x160-140 S355
200
200
200
60 60 40
2M16 8.8





3.1.6 Loads

Loads from report:

ENS-ZL380 – Tower EC-3/R

Report nr.: 21-0093 Rev 4
Date: 2021-12-22

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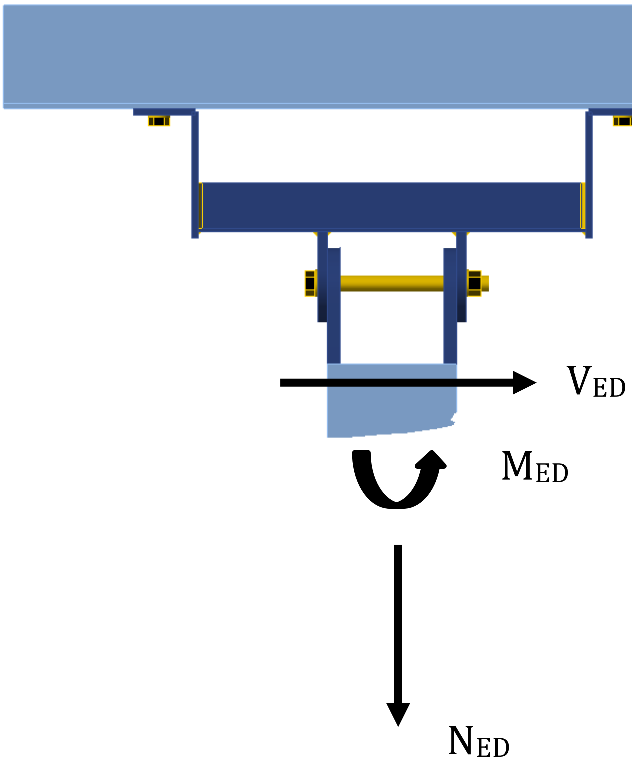


$V_{ED} = 2{,}56$ kN

$M_{ED} = 8{,}23$ kNm

$N_{ED} = 5$ kN

3.1.7 Calculation

3.1.7.1 IDEA calculation

Project data

Project name	ENS-ZL380 EC-3/R Tower 90
Project number	21-187
Author	G.P.
Description	Detail 2
Date	1/24/2022
Design code	EN

Material

Steel	S 235, S 355

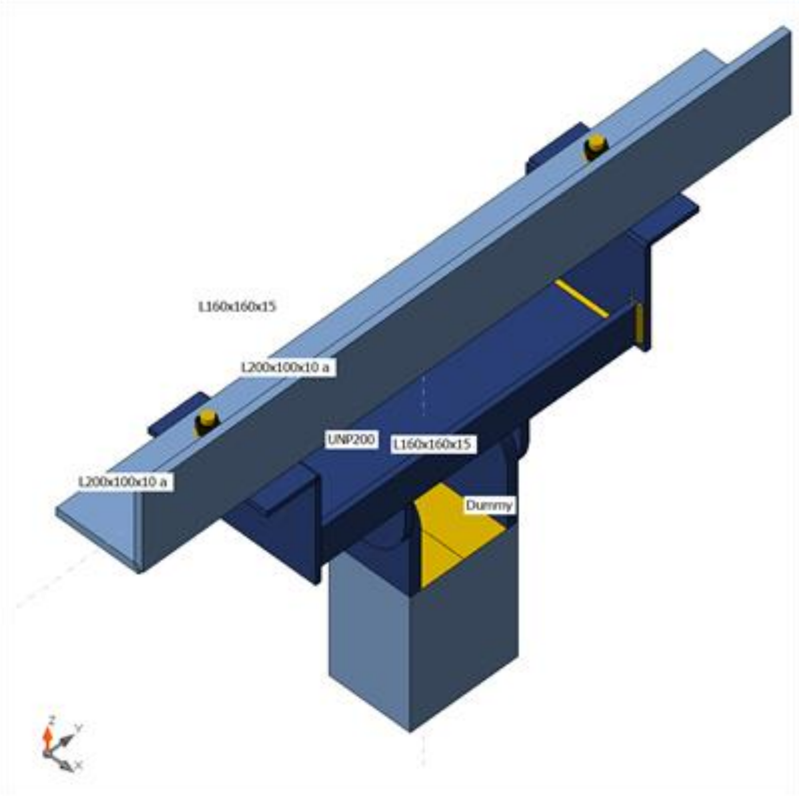
Project item Detail 2

Design

Name	Detail 2
Description	
Analysis	Stress, strain/ simplified loading

Beams and columns

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
L160x160x15	3 - HFLeq160x160x15	90.0	0.0	0.0	0	0	0	Node
Dummy	5 - Plaat 200, 150	0.0	90.0	90.0	0	-35	0	Node



Cross-sections

Name	Material
3 - HFLeq160x160x15	S 235
5 - Plaat 200, 150	S 355
10 - UNP200	S 355
9 - HFLue200x100x10	S 355

Bolts

Name	Bolt assembly	Diameter [mm]	fu [MPa]	Gross area [mm^2]
M24 8.8	M24 8.8	24	800.0	452
M20 8.8	M20 8.8	20	800.0	314

Load effects (equilibrium not required)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	Dummy	5.0	0.0	-2.6	0.0	8.2	0.0

Check

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	29.6 < 100%	OK
Welds	98.0 < 100%	OK
Buckling	106.12	

Plates

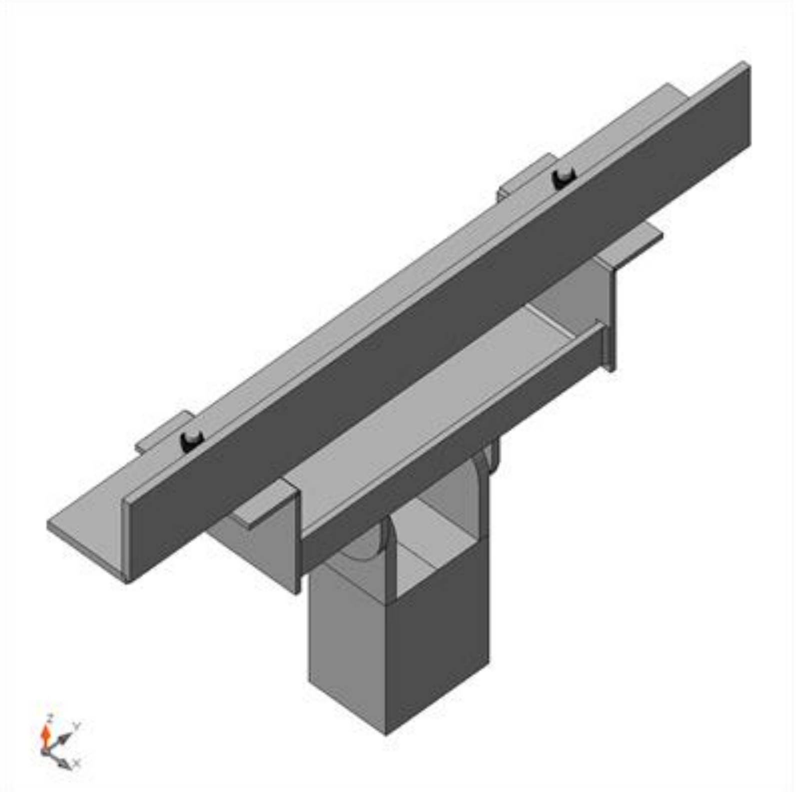
Name	Material	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Status
L160x160x15-bfl 1	S 235	15.0	LE1	133.6	0.0	16.9	OK
L160x160x15-w 1	S 235	15.0	LE1	60.8	0.0	0.0	OK
Dummy-bfl 1	S 355	200.0	LE1	7.7	0.0	0.0	OK
UNP200-bfl 1	S 355 - 1	11.5	LE1	83.7	0.0	0.0	OK
UNP200-tfl 1	S 355 - 1	11.5	LE1	82.0	0.0	0.0	OK
UNP200-w 1	S 355 - 1	8.5	LE1	109.1	0.0	0.0	OK
L200x100x10 a-bfl 1	S 355 - 1	10.0	LE1	225.4	0.0	16.9	OK
L200x100x10 a-w 1	S 355 - 1	10.0	LE1	140.3	0.0	0.0	OK
L200x100x10 b-bfl 1	S 355 - 1	10.0	LE1	31.2	0.0	10.8	OK
L200x100x10 b-w 1	S 355 - 1	10.0	LE1	68.3	0.0	0.0	OK
SP2	S 355 - 1	15.0	LE1	158.0	0.0	13.1	OK
SP1	S 355 - 1	15.0	LE1	160.1	0.0	10.3	OK
dummy1	S 355 - 1	20.0	LE1	65.2	0.0	13.1	OK
dummy2	S 355 - 1	20.0	LE1	81.2	0.0	10.3	OK

Design data

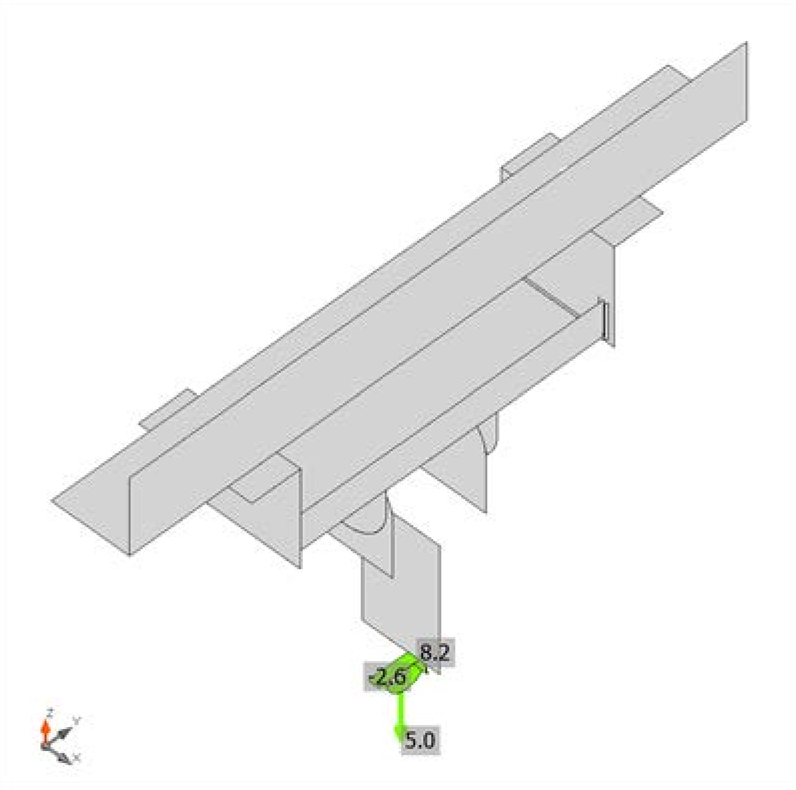
Material	f_y [MPa]	ε_{lim} [%]
S 235	235.0	5.0
S 355	335.0	5.0
S 355 - 1	355.0	5.0

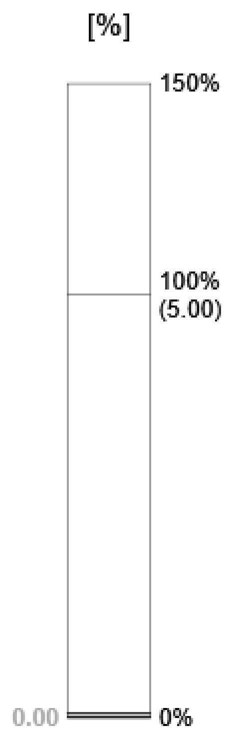
Symbol explanation

ε_{Pl}	Strain
σ_{Ed}	Eq. stress
σc_{Ed}	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

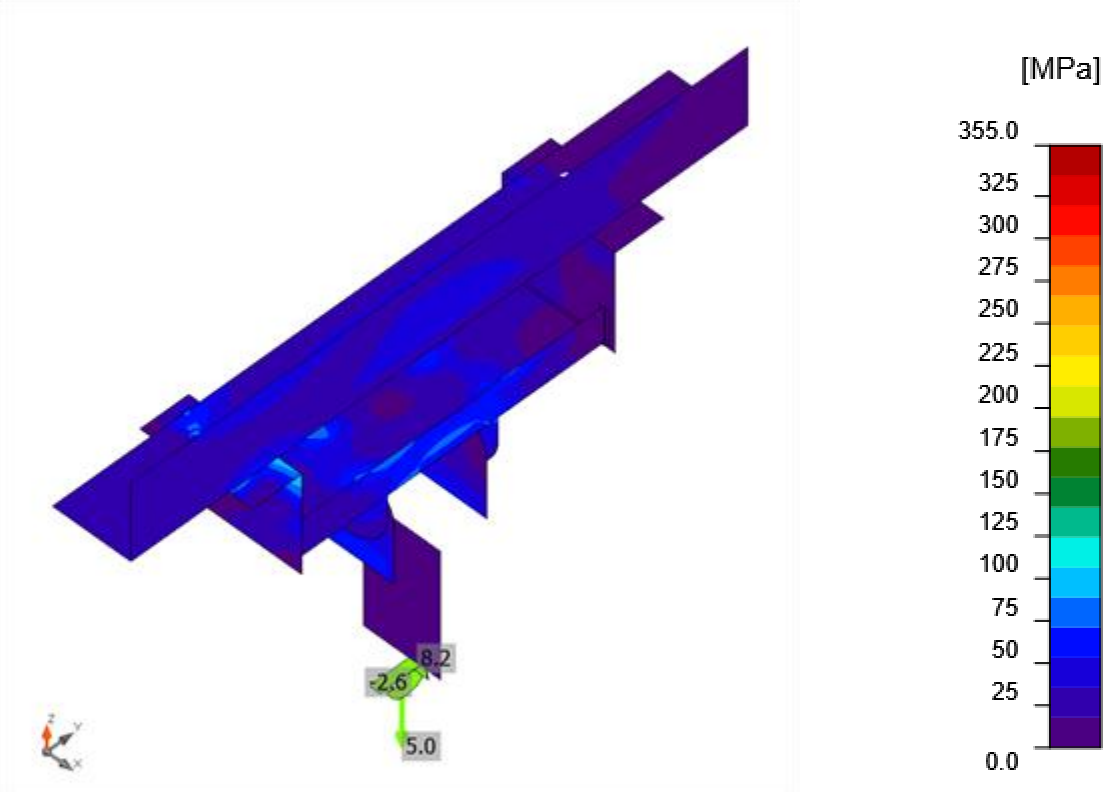


Overall check, LE1

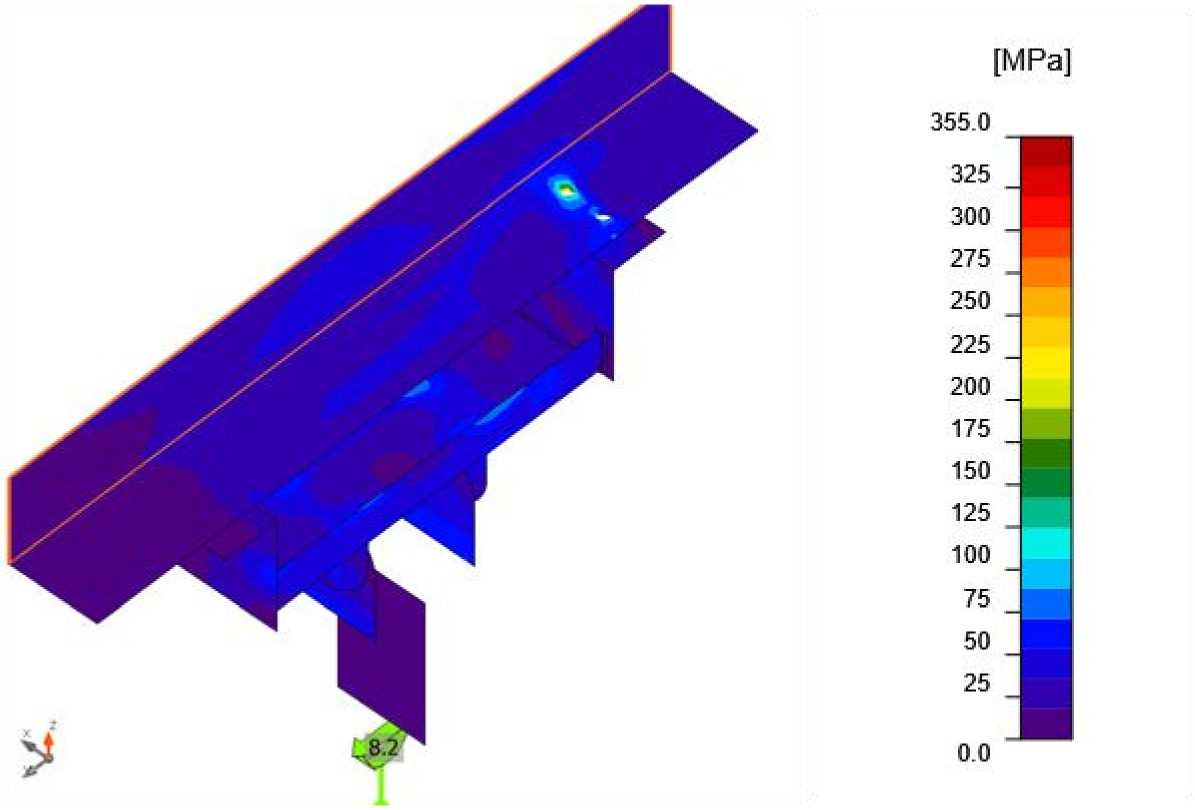




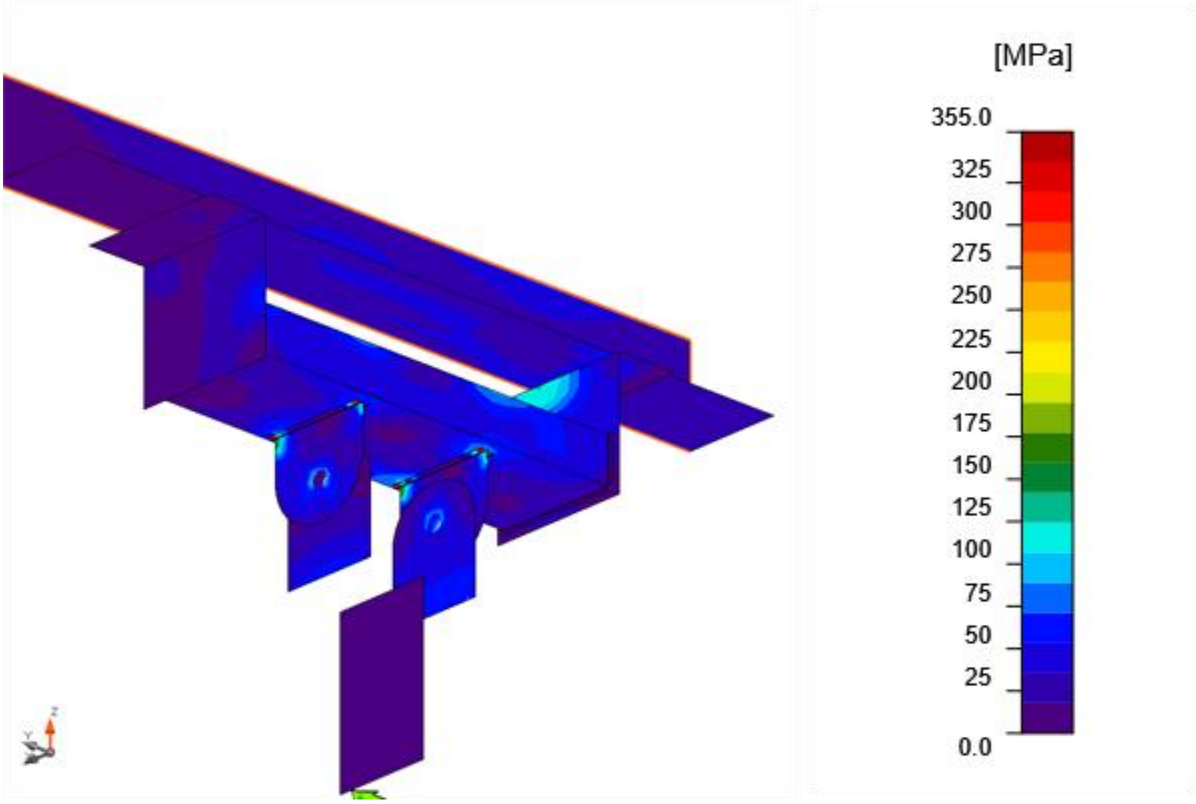
Strain check, LE1



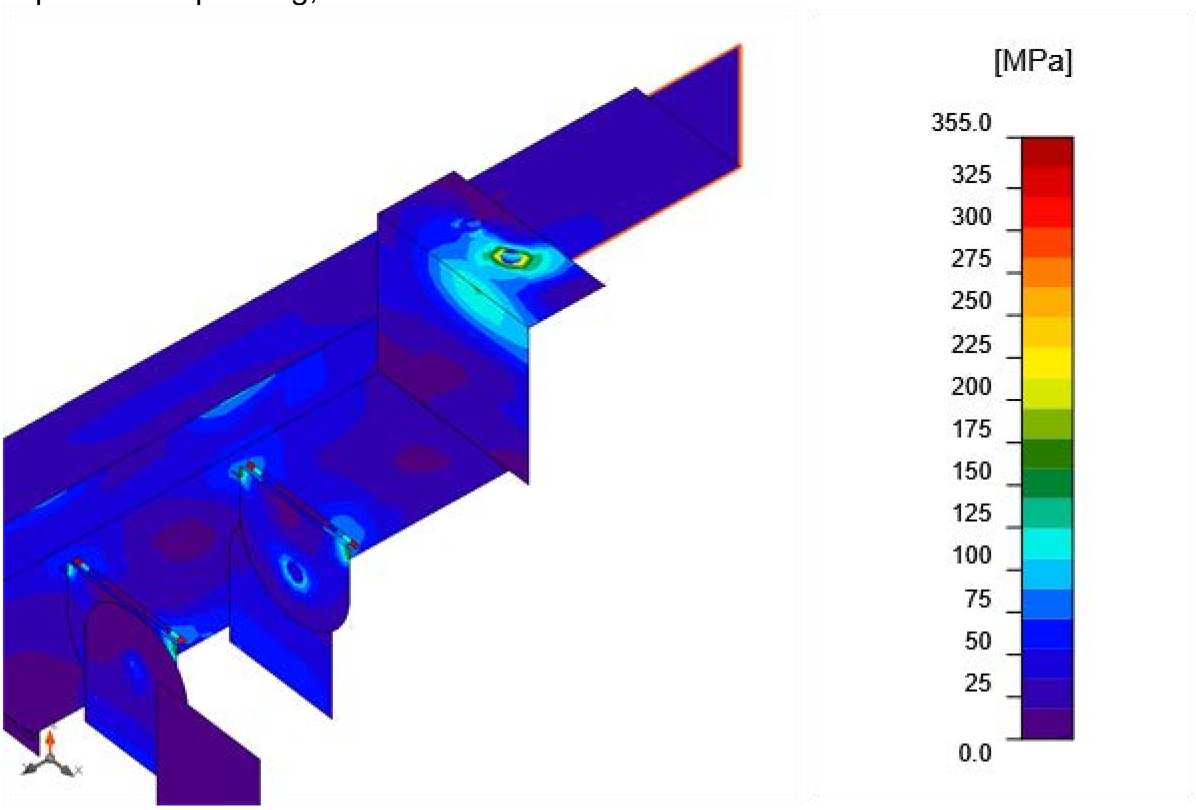
Equivalent stress, LE1



Equivalente spanning, LE1

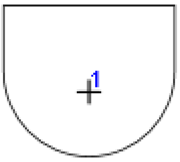
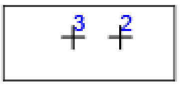
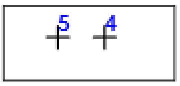


Equivalente spanning, LE1



Equivalente spanning, LE1

Bolts

	Name	Grade	Loads	$F_{t,Ed}$ [kN]	V [kN]	Ut_t [%]	$F_{b,Rd}$ [kN]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	6.1	37.3	3.0	271.1	27.5	29.6	OK
	B2	M20 8.8 - 2	LE1	2.3	3.7	1.6	100.3	3.9	5.0	OK
	B3	M20 8.8 - 2	LE1	0.7	2.6	0.5	138.7	2.8	3.1	OK
	B4	M20 8.8 - 2	LE1	30.1	6.2	21.3	100.3	6.5	21.8	OK
	B5	M20 8.8 - 2	LE1	10.2	2.5	7.2	138.7	2.7	7.9	OK

Design data

Name	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203.3	421.2	135.6
M20 8.8 - 2	141.1	232.8	94.1

Symbol explanation

$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 tab. 3.4
$F_{t,Ed}$	Tension force
$B_{p,Rd}$	Punching shear resistance
V	Resultant of shear forces Vy, Vz in bolt
$F_{v,Rd}$	Bolt shear resistance EN_1993-1-8 table 3.4
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear

Welds (Plastic redistribution)

Item	Edge	Material	Throat th. [mm]	Length [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_{\perp}$ [MPa]	$\tau_{\parallel}$ [MPa]	$\tau_{\perp}$ [MPa]	Ut [%]	Ut_c [%]	Status
Dummy-bfl 1	dummy1	S 235	20.0	150	LE1								OK
Dummy-bfl 1	dummy2	S 235	20.0	150	LE1								OK
UNP200-w 1	SP1	S 355	◢5.0◣	160	LE1	426.9	0.1	149.4	186.5	136.2	98.0	19.7	OK
		S 355	◢5.0◣	160	LE1	412.3	0.0	138.5	181.8	-131.3	94.7	19.8	OK
UNP200-w 1	SP2	S 355	◢5.0◣	160	LE1	339.6	0.0	-116.5	150.2	-106.6	78.0	16.8	OK
		S 355	◢5.0◣	160	LE1	395.5	0.0	-142.9	173.9	122.9	90.8	17.4	OK

L200x100x10 b-w 1	UNP200-bfl 1	S 355	◢5.0◣	71	LE1	62.3	0.0	32.4	-23.5	19.8	14.3	8.9	OK
		S 355	◢5.0◣	71	LE1	57.1	0.0	-4.1	-32.4	5.6	13.1	7.8	OK
L200x100x10 b-w 1	UNP200-tfl 1	S 355	◢5.0◣	71	LE1	17.4	0.0	2.6	9.9	-0.7	4.0	2.1	OK
		S 355	◢5.0◣	71	LE1	24.4	0.0	-3.4	-13.9	0.2	5.6	3.9	OK
L200x100x10 b-w 1	UNP200-w 1	S 355	◢4.0◣	189	LE1	21.9	0.0	-4.7	11.8	-3.6	5.0	3.3	OK
		S 355	◢4.0◣	189	LE1	22.5	0.0	1.3	12.8	-1.8	5.2	4.2	OK
L200x100x10 a-w 1	UNP200-bfl 1	S 355	◢5.0◣	71	LE1	35.0	0.0	-5.6	19.1	-5.7	8.0	6.4	OK
		S 355	◢5.0◣	71	LE1	22.5	0.0	3.2	-12.5	-3.3	5.2	3.5	OK
L200x100x10 a-w 1	UNP200-tfl 1	S 355	◢5.0◣	71	LE1	42.5	0.0	-3.3	22.7	9.2	9.7	6.8	OK
		S 355	◢5.0◣	71	LE1	74.7	0.0	21.2	-40.4	-8.7	17.2	8.3	OK
L200x100x10 a-w 1	UNP200-w 1	S 355	◢4.0◣	189	LE1	20.7	0.0	8.5	9.0	6.2	4.8	3.9	OK
		S 355	◢4.0◣	189	LE1	28.2	0.0	-3.4	15.7	3.8	6.5	4.4	OK

Design data

	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0.80	360.0	259.2
S 355	0.90	435.6	352.8

Symbol explanation

ε_{Pl}	Strain
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
$\sigma_{\perp}$	Perpendicular stress
$\tau_{\parallel}$	Shear stress parallel to weld axis
$\tau_{\perp}$	Shear stress perpendicular to weld axis
0.9 σ	Perpendicular stress resistance - 0.9*fu/γM2
β_w	Corelation factor EN 1993-1-8 tab. 4.1
Ut	Utilization
Utc	Weld capacity utilization

Buckling

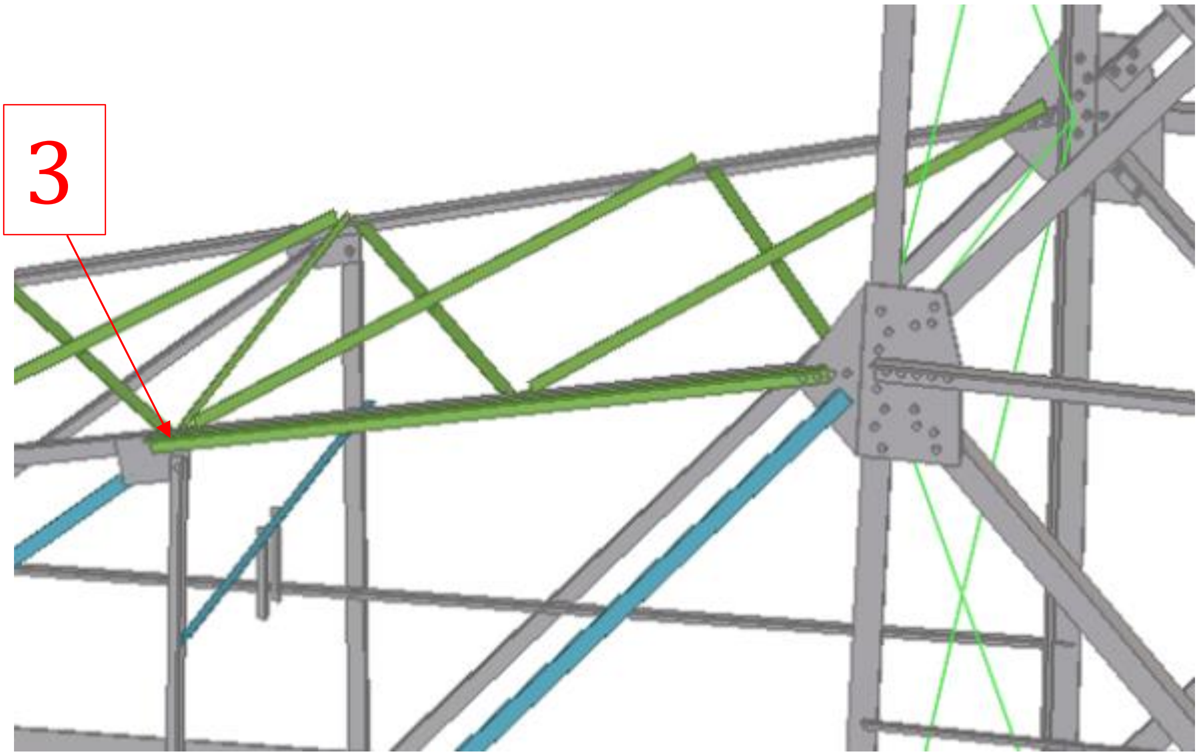
Loads	Shape	Factor [-]
LE1	1	106.12
	2	112.85
	3	116.17
	4	124.05
	5	185.68
	6	219.72

Code settings

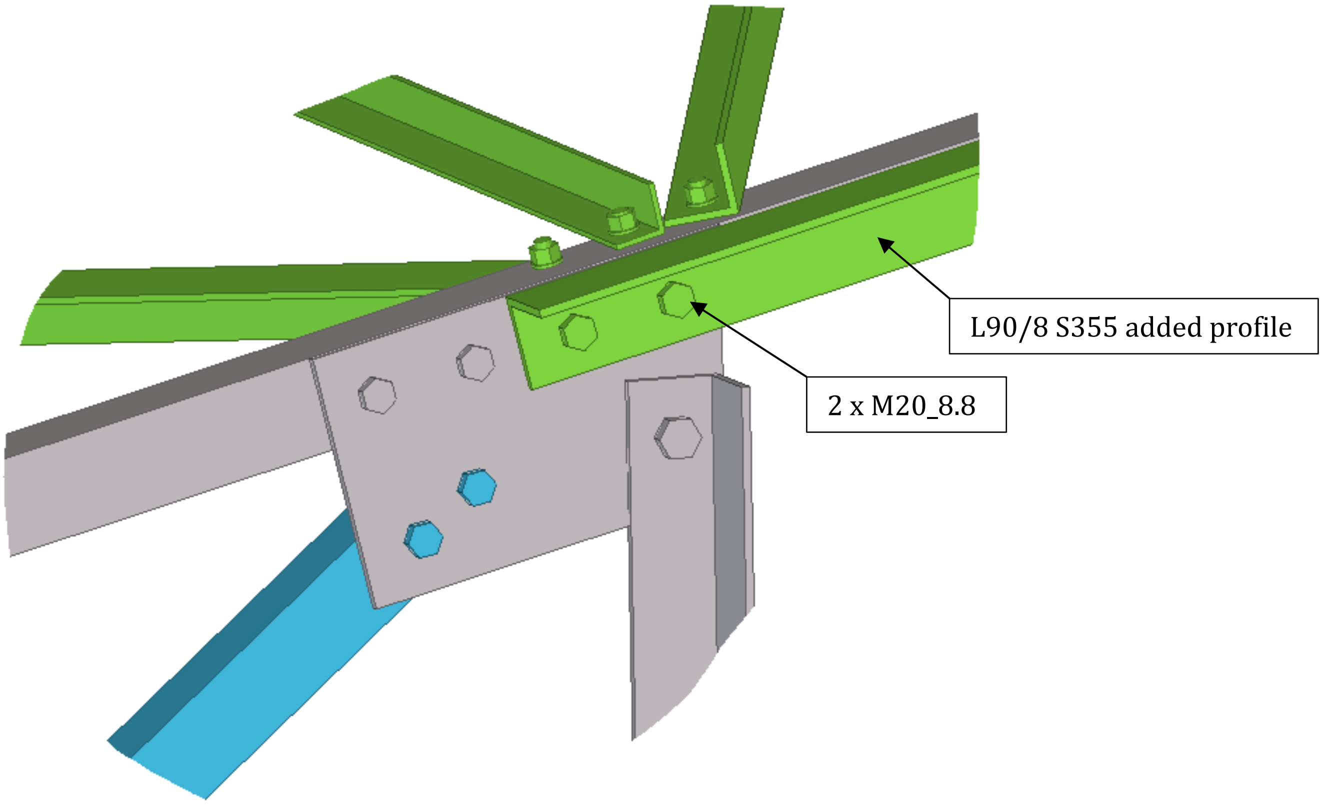
Item	Value	Unit	Reference
γ_{M0}	1.00	-	EN 1993-1-1: 6.1
γ_{M1}	1.00	-	EN 1993-1-1: 6.1
γ_{M2}	1.25	-	EN 1993-1-1: 6.1
γ_{M3}	1.25	-	EN 1993-1-8: 2.2
γ_{C}	1.50	-	EN 1992-1-1: 2.4.2.4
γ_{Inst}	1.20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0.67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0.10	-	
Friction coefficient - concrete	0.25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0.30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0.05	-	EN 1993-1-5
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1.20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints
Braced system	No		EN 1993-1-8: 5.2.2.5

3.2 Connection of additional profile to the lower crossarm

3.2.1 Overview



3.2.2 Detail 3



3.2.3 Loads

Loads from report:

ENS-ZL380 – Tower EC-3/R

Report nr.: 21-0093 Rev 4
Date: 2021-12-22

Page 73

rod 319A L90x90x8 S355 and L90x90x8 S235

Nd = -211,1 kN compression Nd = 210,5 kN tension

Forces in L90x90x8 S355:

Nd = 0,5 x -211,1 = 105,6 kN compression

Nd = 0,5 x 210,5 = 105,3 kN tension

3.2.4 Calculation

3.2.4.1 Check Bolts

F_{shear} max = 105,6 kN

2 x Bolt M20 8.8

$U.C. = \frac{FvEd}{FvRd} = \frac{105,6}{2x94} = 0,56 < 1$ O.K.

$F_{bearing}$ max = 105,6 kN

L90x90x8 S235

$e_1 = 55$ mm

$e_2 = 40$ mm

$k_1 = 2,8 \text{ x } \frac{40}{22} - 1,7 = 3,39 \rightarrow k_1 = 2,5$

$\alpha_b = \frac{55}{3x22} = 0,83$ or $\alpha_b = \frac{100}{3x22} - 0,25 = 1,26 \rightarrow \alpha_b = 0,83$

$F_{b,Rd} = \frac{2,5 \text{ x } 0,83 \text{ x } 490 \text{ x } 20 \text{ x } 8}{1,25} = 130$ kN

$U.C. = \frac{Fb,Ed}{Fb,Rd} = \frac{105,6}{2x130} = 0,4 < 1$ O.K.

3.2.4.2 Check profile

L90x90x8 S335:

$$N_{u,Rd} = \frac{\beta 2 \text{ x Anet x fu}}{\Upsilon_{m2}} = \frac{0{,}645 \text{ x } 1214 \text{ x } 490}{1{,}25} = 307 \text{ kN}$$

$$\text{U.C.} = \frac{105{,}6}{307} = 0{,}34 > 1$$ O.K

$$V_{eff,2,Rd} = 0{,}5 \text{ x } f_u \text{ x } A_{nt} \,/\, \Upsilon_{m2} + \frac{1}{\sqrt{3}} \text{ x } f_y \text{ x } A_{nv} \,/\, \Upsilon_{m0}$$

$A_{nt} = (40 - 11) \text{ x } 8 = 232 \text{ mm}^2$

$A_{nv} = ((55 - 11) + (100\text{-}22)) \text{ x } 8 = 976 \text{ mm}^2$

$$V_{eff,2,Rd} = 0{,}5 \text{ x } 490 \text{ x } 232 \,/\, 1{,}25 + \frac{1}{\sqrt{3}} \text{ x } 355 \text{ x } 976 \,/\, 1 = 245 \text{ kN}$$

$$\text{U.C.} = \frac{105{,}6}{245} = 0{,}43 < 1$$ O.K.

4 Summary U.C. 's

4.1.1 Connection of post insulators to the lower crossarm

Detail 1

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	30.3 < 100%	OK
Welds	98.0 < 100%	OK
Buckling	85.57	

Detail 2

Summary

Name	Value	Status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	29.6 < 100%	OK
Welds	98.0 < 100%	OK
Buckling	106.12	

4.1.2 Connection of additional profile to the lower crossarm

Detail 2

Bolts: U.C. = 0,56 <1

Profile: U.C. = 0,43 <1

5 Conclusion

5.1.1 Connection of post insulators to the lower crossarm

Both connections have sufficient strength.

5.1.2 Connection of additional profile to the lower crossarm

Connection has sufficient strength.

Bijlage 6

Archeologisch onderzoek

RAAP

RAAP-RAPPORT 5493

Opwaardering 380 kV Ens-Zwolle

Gemeente Zwolle
Archeologisch vooronderzoek: een bureauonderzoek

Colofon

Titel: Onderzoeksgebied Opwaardering 380 kV Ens Zwolle te Zwolle, gemeente Zwolle; archeologisch vooronderzoek: een bureauonderzoek

Versie: 13-12-2021

Auteur: H.B.G. Scholte Lubberink

Projectcode: ZWEN

Bestandsnaam: RAAPrap_5493_ZWEN_20211213

Autorisatie: E. Boshoven

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Samenvatting

In opdracht van Arcadis heeft RAAP van 19-10-2021 tot 19-11-2021 een archeologisch vooronderzoek in de vorm van een bureauonderzoek uitgevoerd voor het onderzoeksgebied Opwaardering 380 kV Ens-Zwolle in de gemeente Zwolle. Het onderzoek vond plaats in het kader van een omgevingsvergunning.

Verspreid binnen het plangebied worden bouwwegen en werkterreinen aangelegd en weer verwijderd, waarna het terrein cultuurtechnisch wordt hersteld. Bij een deel van de hoogspanningsmasten wordt de fundering versterkt. De exacte omvang en diepte van de ingrepen is vooralsnog onbekend.

Op grond van de onderzoeksresultaten en onder verwijzing naar de doelstellingen, kunnen de volgende uitspraken worden gedaan (zie ook bijlage 9):

Op afgedekt dekzandreliëf (> 40 cm -mv) in de polder Mastenbroek en op dekzandkoppen in het Haersterbroek (vanaf het maaiveld) komen mogelijk archeologische resten voor uit de steen- en bronstijd. In het betreffende gebied in Mastenbroek en op enkele dekzandkoppen in het Haersterbroek zijn werkzaamheden gepland aan hoogspanningsmasten en zijn bouwwegen voorzien.

Archeologische resten uit de late middeleeuwen en nieuwe tijd worden verwacht ter hoogte van twee oude bewoningslinten in de polder Mastenbroek en ter hoogte van bedrijventerrein Hessenpoort (De Blekhuizen). In Mastenbroek worden twee bewoningslinten doorsneden. Op of in de directe nabijheid van twee huisterpen (erven Appel en Blankvoort) zijn werkzaamheden gepland. Het gaat hierbij om archeologisch waardevolle gebieden met een hoge kans op het aantreffen van archeologische resten en lage vrijstellingsgrenzen voor archeologisch onderzoek (100 m^2, diepte tot 50 cm). Een hoge archeologische verwachting en lage vrijstellingsgrenzen gelden ook voor de locatie van de voormalige Blekhuizen in bedrijventerrein Hessenpoort. Deze locatie valt samen met de plaats van een hoogspanningsmast waar eventueel werkzaamheden uitgevoerd gaan worden.

Elders in het plangebied worden is de kans op archeologische resten (zeer) klein.

Op basis van de resultaten van het onderzoek blijkt dat in het plangebied (mogelijk) archeologische resten bedreigd worden door de voorgenomen bodemingrepen. Daarom wordt geadviseerd om de plannen zodanig aan te passen (graafwerkzaamheden tot een minimum beperken) en om mitigerende maatregelen te treffen (bijvoorbeeld gebruik van rijplaten voor werkwegen in bewoningslinten in de polder Mastenbroek) dat verstoring wordt voorkomen/tot een minimum wordt beperkt.
Voor de Blekhuizen wordt geadviseerd wordt om eventuele archeologische resten *in situ* te beschermen. Om verstoring te voorkomen wordt/worden de volgende maatregelen geadviseerd: een maximale verstoringsdiepte van de bovengrond van 40 cm -mv (onder voorbehoud van de aanwezigheid van een eventueel ophogingspakket).

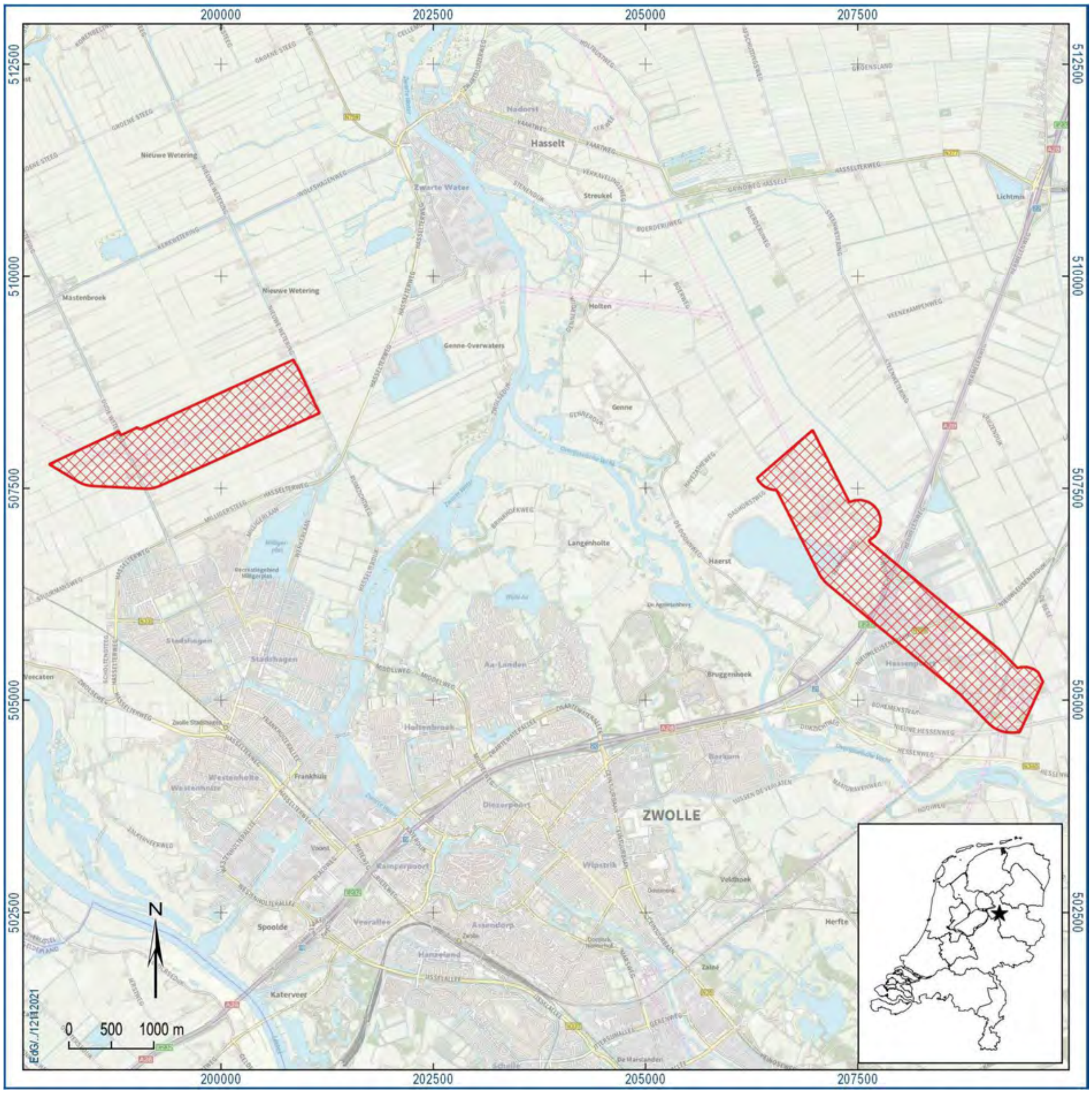
Indien en waar dit niet mogelijk is, wordt aanbevolen in het kader van de bestaande planvorming onderstaande vervolgstap uit het proces van de Archeologische Monumentenzorg (AMZ) te nemen.

In zones met dekzandreliëf op een geringe diepte in de polder Mastenbroek en op dekzandkoppen in het Haersterbroek wordt archeologisch vervolgonderzoek aanbevolen om een beter beeld te krijgen van de (kans op de) aan- of afwezigheid van archeologische resten. Hierbij moet in eerste instantie geacht

worden aan een verkennend of inventariserend booronderzoek op locaties waar binnen die zones ingrepen zijn gepland.

In het overige deel van het plangebied wordt in het kader van de voorgenomen bodemingrepen geen archeologisch vervolgonderzoek aanbevolen. Indien bij de uitvoering van de werkzaamheden onverwacht archeologische resten worden aangetroffen, dan is conform artikel 5.10 van de Erfgoedwet aanmelding van de desbetreffende vondsten bij de Minister van Onderwijs, Cultuur en Wetenschap c.q. de Rijksdienst voor het Cultureel Erfgoed verplicht (vondstmelding via ARCHIS).

Inhoud



Figuur 1. Aanduiding onderzoeksgebied. Inzet: ligging in Nederland (ster).

1 Inleiding

1.1 Kader

Aanleiding

In opdracht van Arcadis heeft RAAP van 19-10-2021 tot 19-11-2021 een archeologisch vooronderzoek in de vorm van een bureauonderzoek uitgevoerd voor het onderzoeksgebied Opwaardering 380 kV Ens-Zwolle in de gemeente Zwolle (figuur 1 en bijlage 5). Het onderzoek vond plaats in het kader van een omgevingsvergunning.

Voor de opwaardering van de bestaande 380 kV verbinding Ens-Zwolle moeten diverse werkzaamheden worden uitgevoerd. In de basis betreft dit het ophangen van nieuwe geleiders met een hogere transportcapaciteit dan de huidige geleiders. De nieuwe geleiders zijn qua omvang en aantal gelijk aan de bestaande, maar kunnen meer stroom transporteren doordat ze hogere temperaturen kunnen weerstaan zonder te ver door te gaan hangen. De huidige hoogspanningsverbinding is bovendien inmiddels bijna 35 jaar oud. Om deze reden worden ook andere onderdelen, zoals de isolatorkettingen en bliksemdraden als levensduurverlengende activiteit vervangen. Daarnaast worden de masten opnieuw constructief beschouwd en moet bij een aantal masten de fundering en/of het mastlichaam versterkt worden.

In de kaartbijlagen bij deze rapportage zijn de locaties van ingrepen/werkzaamheden weergegeven waarvan eventueel schade aan archeologische resten zijn te verwachten. Het gebruik van bestaande (verharde) wegen is bij de beoordeling van de effecten en in het kaartbeeld achterwege gelaten.

Juridisch en beleidskader

Het uitgangspunt voor dit onderzoek wordt gevormd door het wettelijk en beleidsmatig kader voor de ruimtelijke ordening en monumentenzorg. De gemeente is de bevoegde overheid die een besluit zal nemen over hoe om te gaan met de eventueel aanwezige archeologische waarden.

Op de archeologische verwachtingskaart van de gemeente Zwolle zijn binnen het onderzoeksgebied twee zones met een verschillende archeologische verwachting onderscheiden: 10%- en 50%-gebieden. In een 10% gebied zijn de archeologische waarden onbekend. Op basis van de geomorfologische kaart en de Bodemkaart van Nederland wordt een lage verwachting vermoed. Er kunnen echter wel belangrijke archeologische waarden in de grond aanwezig zijn. Daarom wordt een proefonderzoek aanbevolen. Een 50% gebied is archeologisch waardevol met een hoge archeologische verwachting. De kans op, vaak prehistorische of vroegmiddeleeuwse, archeologische sporen is 1:2. Meestal zijn dit gebieden die op de geomorfologische en Bodemkaart van Nederland gekarteerd zijn als dekzandruggen en rivierduinen. Een Inventariserend Veldonderzoek dient plaats te vinden. Op basis van dit onderzoek wordt beoordeeld of er een volledig archeologisch onderzoek moet worden verricht.[1]

Bovenstaande voorschriften zijn verankerd in bestemmingsplan Buitengebied - Haerst, Tolhuislanden (2012-11-27; NL.IMRO.0193.BP10016-0004), bestemmingsplan Hessenpoort (2012-10-02;

[1] Anoniem 2008.

NL.IMRO.0193.BP11015-0004) en in het bestemmingsplan Nationaal Landschap IJsseldelta (2014-05-28; NL.IMRO.0193.BP11010-0005).

Wat betreft de 50%-gebieden is de omvang van de bodemingrepen groter dan de vrijstellingsgrens (oppervlak ingreep 100 m^2 en de diepte van de ingrepen bedraagt 50 cm -mv). Een archeologische onderbouwing met betrekking tot de eventuele aanwezigheid van archeologische waarden is daarom verplicht conform het vigerend beleid (bijlage 6).

Kwaliteitsborging

De werkzaamheden zijn uitgevoerd onder certificaat BRL4000, conform artikel 5.4 van de Erfgoedwet. Het onderzoek is uitgevoerd volgens de normen van de archeologische beroepsgroep. De Kwaliteitsnorm Nederlandse Archeologie (KNA, versie 4.1), beheerd door de Stichting Infrastructuur Kwaliteitsborging Bodembeheer (SIKB; www.sikb.nl), is door de minister aangewezen als norm.

RAAP is gecertificeerd voor de protocollen 4001 Programma van Eisen, 4002 Bureauonderzoek, 4003 Inventariserend veldonderzoek (landbodems), onderdelen proefsleuven en overig, alsmede 4004 Opgraven (landbodems).

Zie bijlage 1 voor de dateringen van de in dit rapport genoemde archeologische perioden.

1.2 Administratieve gegevens

Type onderzoek	Bureauonderzoek
Opdrachtgever	Arcadis
Bevoegde overheid	Gemeente Zwolle
Plaats	Zwolle
Gemeente	Zwolle
Provincie	Overijssel
Centrumcoördinaten (X/Y)	207.817/506.719
Toponiem	380 kV Ens Zwolle
Oppervlakte onderzoeksgebied	506 ha
Afbakening onderzoeksgebied	Tijdens onderhavig onderzoek is het plangebied inclusief een zone van 200 m rondom het plangebied onderzocht.
Onderzoeksperiode	19-09-2021 tot 19-11-2021
Uitvoerder	RAAP Oost
Projectleider	H.B.G. Scholte Lubberink
Projectmedewerkers	E. Witmer
RAAP-projectcode	ZWEN
ARCHIS-onderzoeksmeldingsnummer	5129133100
Beheer en plaats documentatie	RAAP Oost-Nederland

Tabel 1. Administratieve gegevens.

1.3 Doel- en vraagstelling

De doelstelling van het archeologisch vooronderzoek is het vaststellen van de archeologische waarde van het terrein, dan wel de archeologische vindplaats. Daartoe wordt informatie verzameld over bekende en verwachte archeologische resten teneinde een gespecificeerde archeologische verwachting op te stellen. Hiertoe is een aantal onderzoeksvragen geformuleerd:

- Hoe ziet de geo(morfo)logische en/of bodemkundige opbouw van het onderzoeksgebied eruit?
- Welke gegevens met betrekking tot archeologische complexen in en rond onderzoeksgebied zijn reeds bekend?
- Wat was het historisch landgebruik van het onderzoeksgebied en wat is het landgebruik nu en wat is de invloed daarvan op de (verwachte) archeologie en (bodem)gaafheid?
- Wat is de gespecificeerde verwachting ten aanzien van nog onbekende archeologische waarden in het gebied? En wat zijn hiervan de prospectiekenmerken?

Algemeen

- Wat is de invloed van de toekomstige inrichting op eventuele archeologische resten?
- Op welke wijze kan bij de planvorming met archeologische resten worden omgegaan?
- Met de inzet van welke zoekmethoden kunnen verwachte resten systematisch opgespoord worden (zoeksleuven, booronderzoek, veldkartering, geofysisch etc.)?

2 Bureauonderzoek

2.1 Methode

Het bureauonderzoek dient ervoor om – op basis van verschillende bronnen – inzicht te krijgen in de genese van het landschap, de bodemopbouw en de sporen die het menselijk gebruik in de loop van de tijd heeft achtergelaten. Met behulp van deze gegevens wordt een gespecificeerde archeologische verwachting opgesteld.

Naast de conform de KNA verplichte bronnen is door de gebiedsexperts van RAAP een beredeneerde keuze gemaakt uit betrouwbare bronnen die voor de archeologische verwachting relevante informatie bevatten (zie bijlage 2 voor de motivering). Daarvoor is gebruik gemaakt van de landelijk en voor RAAP digitaal beschikbare archieven. Voor de beschrijving van de historische situatie is gebruik gemaakt van hiervoor relevante informatiedragers. Voor de actuele metadata van de verzamelde gegevens (gemeente, plaats, etc.) wordt verwezen naar het van toepassing zijnde data-archief.

2.2 Aardkundige situatie (bijlage 7)

De geologische ondergrond van het in de polder Mastenbroek gelegen deel van de gemeente Zwolle is onderdeel van een in noordoostelijke richting hellend dekzandplateau dat door riviergeulen is versneden. Plaatselijk zijn op dit plateau hogere zandkoppen opgestoven die tegenwoordig nog boven het maaiveld uitsteken. Door de stijging van de zee- en grondwaterspiegel gedurende het holoceen is het dekzandplateau vernat, waarna sprake was van veengroei. In de polder Mastenbroek nam de veengroei omstreeks 1600 voor Chr. een aanvang en zette zich voort tot rond het begin van onze jaartelling. Het uitgestrekte veengebied werd toentertijd ontwaterd door geulen die tegenwoordig nog in het landschap zichtbaar zijn. Op de best ontwaterde delen kwam een moerasbos tot ontwikkeling. Rond het begin van de vroege middeleeuwen nam de waterafvoer via de IJssel toe. De regelmatig buiten zijn oevers tredende rivier heeft op het veen in Mastenbroek circa een halve meter klei afgezet. In de lage broek en veengebieden ten oosten van de Vecht ontbreekt een dikke(re) kleilaag en ligt veen of dekzand vrijwel aan de oppervlakte (bijlage 7).[2]

In geomorfologisch opzicht bestaat het Zwolse deel van de polder Mastenbroek uit een rivierkomvlakte waarin afzettingen van de Vecht en IJssel zijn afgezet op veen. Lokaal is in de ondergrond sprake van dekzandreliëf dat overwegend dieper ligt dan 80 cm -mv. De hoogste toppen bevinden zich echter al binnen 40 cm -mv.[3] In Haerst en Hessenpoort is voornamelijk sprake van reliëfarme dekzandvlakten met kleine dekzandkoppen,[4] met aan de randen daarvan een enkele grotere dekzandwelving en -rug (bijlage 7).

De geologische en geomorfologische situatie weerspiegeld zich in de bodemgesteldheid. In Mastenbroek is uitsluitend sprake van waardveengronden met een dun kleidek op zand beginnend ondieper van 120 cm. Te Haerst en Hessenpoort komen hoofdzakelijk bodems voor met een venige bovengrond, terwijl lage dekzandwelvingen sprake is van gooreerd-, beekeerd- en vlakvaaggronden.

---

[2] Clevis, Klomp & Kranenborg 2009, 34-36.
[3] Bles, Groot Obbink & Rutten 1970: bijlage 4: zanddieptekaart.
[4] Van Liere 1950.

Op dekzandkoppen en hogere dekzandruggen langs de randen van het onderzoeksgebied is sprake van veldpodzolen al dan niet met een dun cultuurdek (laarpodzolen; bijlage 7).

Geologische situatie (Weerts e.a., 2006)	Mastenbroek: -Formatie van Echtend op Formatie van Boxtel; rivierklei en-zand met inschakelingen van veen op zand. Haerst en Hessenpoort: -Formatie van Nieuwkoop (veen); -Formatie van Boxtel met een dek van het Laagpakket van Wierden: fluvioperiglaciale afzettingen (leem en zand) met een zanddek; -Laagpakket van Wierden (dekzand).
Geomorfologische situatie (Koomen & Maas, 2004)	Mastenbroek: -rivierkomvlakte (M46). Haerst en Hessenpoort -vlakte van ten dele verspoelde dekzanden of löss (M53); -dekzandwelvingen (L51); -dekzandrug (B53).
Ouderdom geomorfologische structuur	laat-pleistoceen en holoceen
Bodemkundige situatie	Mastenbroek: waardveengronden op zand, beginnend ondieper van 120 cm (kVz). Haerst en Hessenpoort: koopveengronden op zand, beginnend ondieper dan 120 cm (hVz); moerige eerdgronden met een moerige bovengrond op zand (vWz); beekeerdgronden; leemarm en/of (zwak) lemig fijn zand (pZg21/23); gooreerdgronden; leemarm en zwak lemig fijn zand (pZn21); vlakvaagronden; lemig fijn zand (Zn23); veldpodzolgronden; leemarm en zwak lemig fijn zand (Hn21); laatpodzolgronden; lemig fijn zand (cHn23).
Verwachte diepteligging van archeologisch relevante lagen	direct onder het maaiveld of onder de moderne bouwvoor op een diepte van circa 40 cm -mv. In gebieden met veen (kVz, hVz en Vwz) of met een cultuurdek (cHn23) mogelijk één tot enkele decimeters dieper.

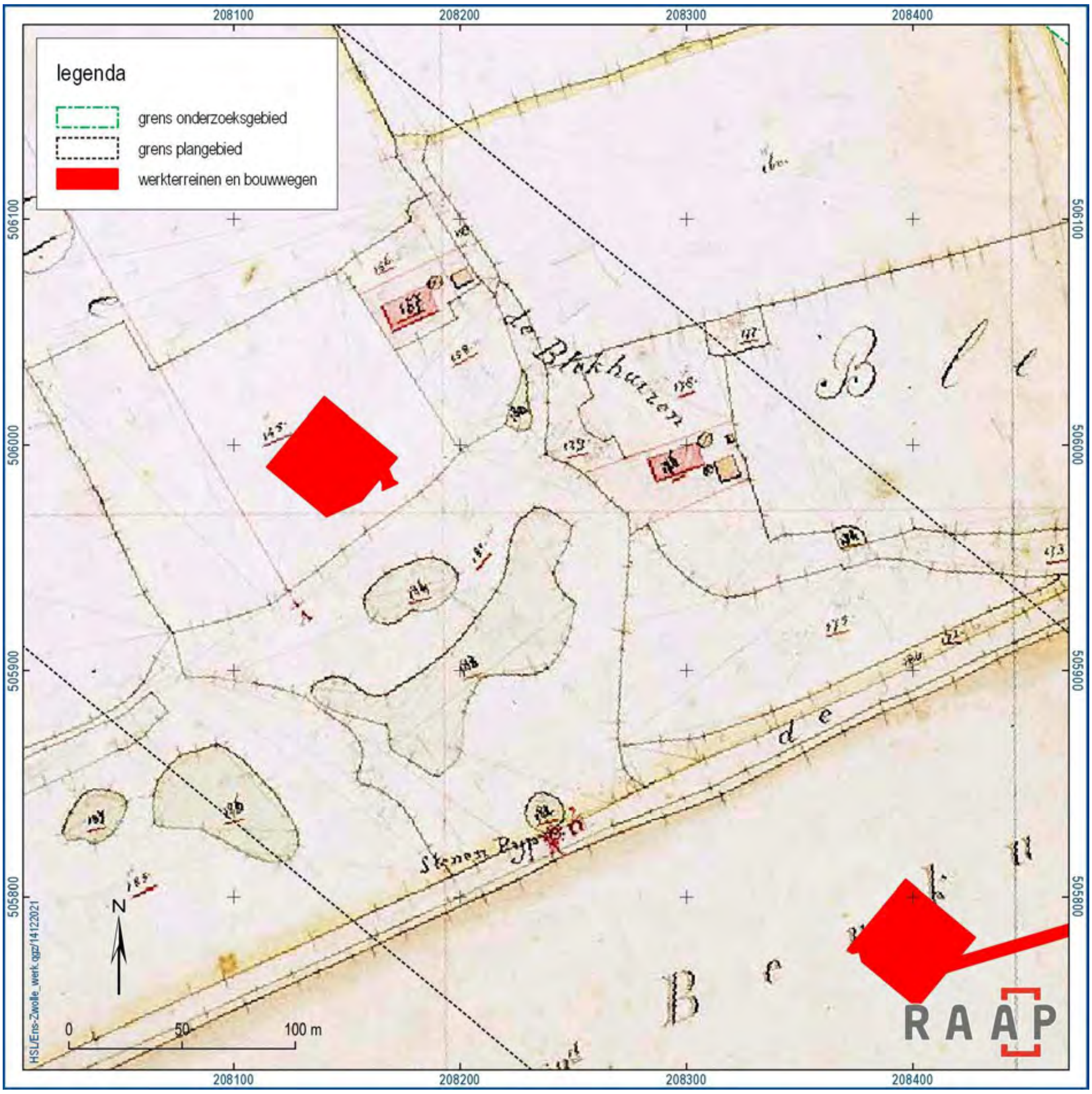
Tabel 2. Overzicht van geraadpleegde geologische, geomorfologische en bodemkundige kenmerken van het onderzoeksgebied en de directe omgeving.

2.3 Archeologische gegevens

Gemeentelijk archeologiebeleid (bijlage 6)

Bestemmingsplan Nationaal landschap IJsseldelta (NL.IMRO.0193.BP11010-0005) Bestemmingsplan Hessenpoort (NL.IMRO.0193.BP11015-0004) Bestemmingsplan Buitengebied - Haerst, Tolhuislanden (NL.IMRO.0193.BP11010-0005)	Dubbelbestemming 'waarde-archeologie ' Aanduiding: in het onderzoeksgebied liggen twee gebieden met een archeologische waarde van 50 %. Dubbelbestemming 'waarde-archeologie ' Aanduiding: binnen bedrijventerrein de Hessenpoort ligt een gebied met een archeologische waarde van 50 %. In de toelichtingen bij deze bestemmingsplannen is opgenomen dat in afwijking van het bepaalde bij de andere bestemmingen mag op of in deze gronden niet anders worden gebouwd ten behoeve van deze bestemmingen dan overeenkomstig de volgende regels, indien door de bouw de bodem op een grotere diepte dan 0,5 meter en over een grotere oppervlakte dan 100 m² zal kunnen worden verstoord: De aanvrager van een omgevingsvergunning dient in het belang van de archeologische monumentenzorg een rapport over te leggen waarin de archeologische waarden van het terrein, dat blijkens de aanvraag zal worden verstoord, naar het oordeel van het bevoegd gezag in voldoende mate zijn vastgesteld; Aan een omgevingsvergunning kunnen in het belang van de archeologische monumentenzorg in ieder geval de volgende regels worden verbonden: -de verplichting tot het treffen van technische maatregelen waardoor monumenten in de bodem kunnen worden behouden; -de verplichting tot het doen van opgravingen; -de verplichting de activiteit die tot bodemverstoring leidt te laten begeleiden door een deskundige op het terrein van de archeologische monumentenzorg die voldoet aan bij de vergunning te stellen kwalificaties. Geen dubbelbestemming archeologie, geen beperkingen
Gemeentelijke archeologische verwachtingskaart	In de polder Mastenbroek zijn twee stroken in de oude bewoningslinten langs de Oude Wetering en de Nieuwe Wetering aangeduid als gebied met een archeologische waarde van 50%. Het gaat om gebieden met de nummers 266 en 270. Binnen bedrijventerrein Hessenpoort ligt een gebied met een archeologische waarde van 50%. Dit gebied is op de verwachtingskaart aangegeven met nummer 260 en verwijst naar de locatie van een oud boerenerf met de naam Het Blik. In 1832 liggen op deze locatie al twee erven met de namen Het Blekken en Blekhuizen (figuur 2). Deze boerderijen gaan dus mogelijk tot in de late middeleeuwen terug (bijlage 8).

Tabel 3. Overzicht van het geldende archeologiebeleid en achterliggende verwachtingskaart.



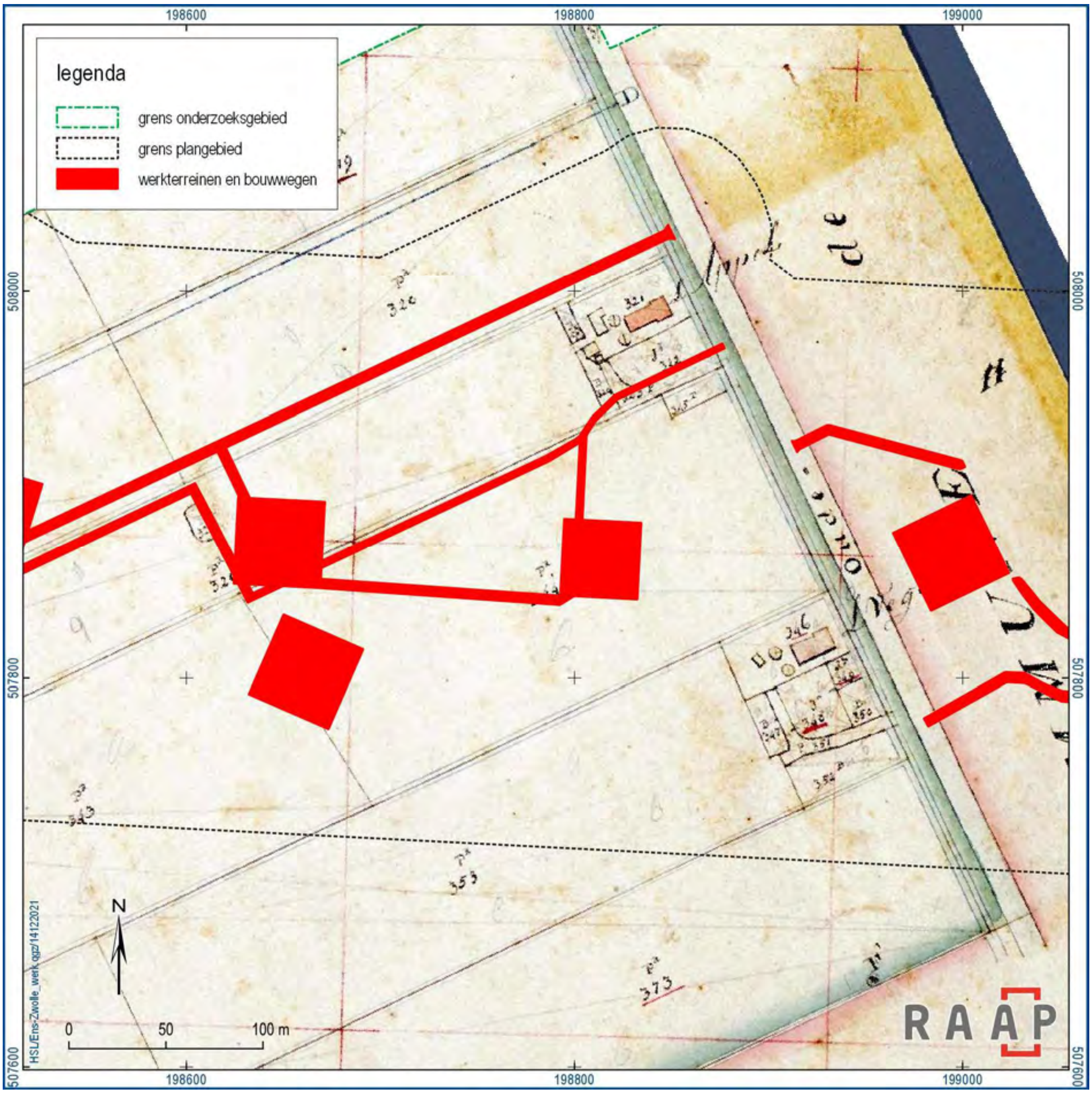
Figuur 2. De Blekhuizen ter hoogte van bedrijventerrein Hessenpoort aangegeven op de kadastrale minuut van 1811-1832.

Terreinen met een archeologische waarde en vondstmeldingen (bijlage 8)

Zaakidentificatienr.	Ligging	Complex	Datering	Materiaal	Diepte	Verzamelwijze
2762679100	onder humuslaag in het schone zand	losse vondst	midden-/laat-neolithicum	vuurstenen bijl (Flint-Rechteickbeil)	onbekend	graafwerkzaamheden in een bouwput

Tabel 4. Overzicht van de bekende archeologische vondstlocaties in en rond het onderzoeksgebied.

Binnen het onderzoeksgebied is slechts één archeologische vindplaats bekend: een losse vondst van een neolithische vuurstenen bijl (tabel 4). Wanneer de vindplaats en zijn landschappelijke inbedding bekeken worden in vergelijking met de situering van het onderzoeksgebied, dan blijkt dat er geen directe relatie is tussen de vindplaats en de landschappelijke ligging van de vondstlocatie. Het gaat om een losse vondst, mogelijk een rituele depositie, in een laaggelegen nat gebied.



Figuur 3. Historische erven, De Appel (boven) en De Vegt (onder) ter hoogte van de Oude Wetering, op de kadastrale minuut van 1811-1832.

Eerder in de omgeving uitgevoerd onderzoek volgens ARCHIS3 (bijlage 8)

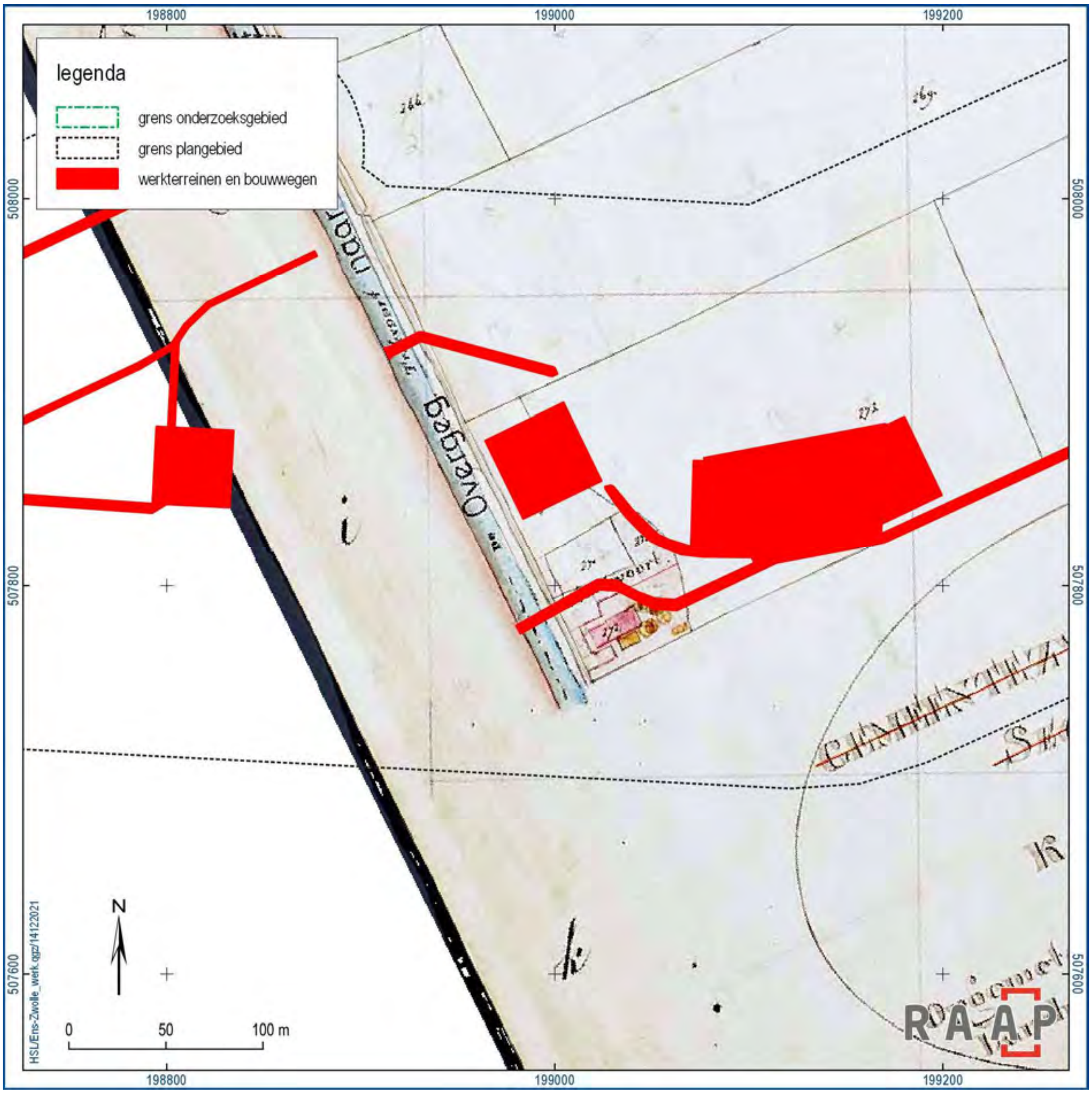
Zaakidentificatienummer	Aard	Opmerking
4927452100	bureauonderzoek	zie bijlage 3 (Bakker 2011)
4871238100	bureauonderzoek	zie bijlage 3 (Bakker 2020)
4772912100	bureauonderzoek	zie bijlage 3

Tabel 5. Overzicht van eerder archeologisch onderzoek in en rond het onderzoeksgebied (voor locatie zie bijlage 8).

Bekende archeologische gegevens uit andere bronnen (bijlage 8)

Op de archeologische verwachtingskaart van de gemeente Zwolle staan in de polder Mastenbroek twee oude bewoningslinten aangeduid langs de Oude Wetering (nr. 266) en de Nieuwe Wetering (nr. 270). Beide weteringen zijn ontsluitingswegen van de Mastenbroekerpolder ten noorden van de Milligersteeg. Aan weerszijden daarvan liggen huisterpen. De polder Mastenbroek werd verdeeld in de tweede helft van de veertiende eeuw. Tot hoe ver deze oude huisterpen terug gaan is onbekend (figuur 3, figuur 4, figuur 5 en bijlage 8).

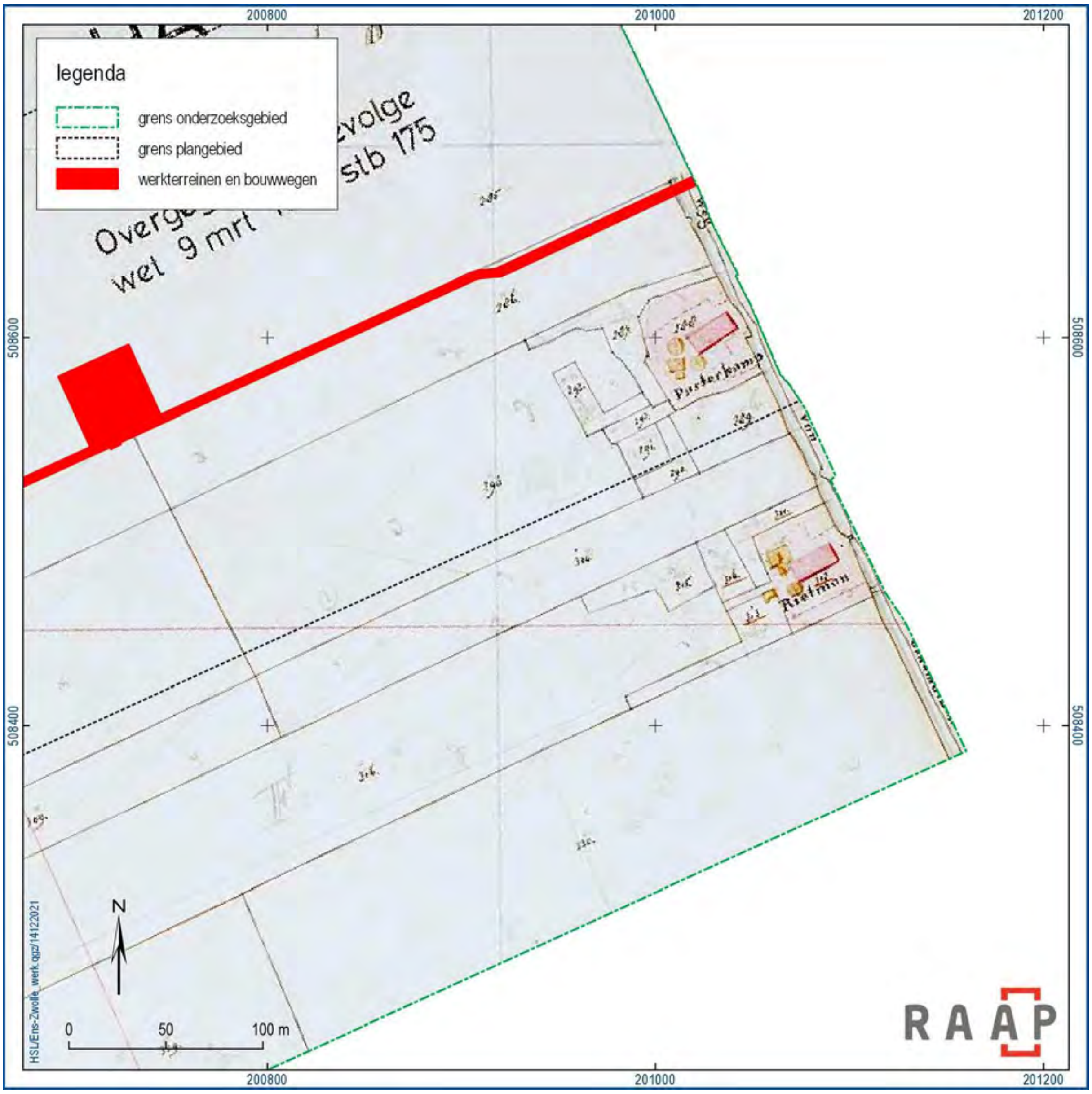
Op de archeologische verwachtingskaart van de gemeente Zwolle staat in bedrijventerrein Hessenpoort een oude woonlocatie aangeduid (nr. 260), waarop een boerderij Het Blik gevestigd was (figuur 2 en bijlage 8).



Figuur 4. Historische erf Blankvoort ter hoogte van de Oude Wetering op de kadastrale minuut van 1811-1832.

2.4 Cultuurhistorische gegevens (bijlage 8)

Op basis van historische kaarten kan inzicht worden verkregen in het historisch gebruik van een gebied van na de late middeleeuwen tot begin twintigste eeuw. In die periode was men veel meer dan nu gebonden aan de (on)mogelijkheden die het natuurlijke landschap bood voor bewoning en andere vormen van landgebruik. Het historisch gebruik zegt daarmee iets over de archeologische potentie van het gebied. Daarnaast kan het informatie leveren over eventuele bodemverstoringen die in het verleden hebben plaatsgevonden.



Figuur 5. Historische erven, Pasterkamp (boven) en Rietman (onder) ter hoogte van de Nieuwe Wetering, op de kadastrale minuut van 1811-1832.

Uit bestudeerde historische kaarten blijkt dat daar waar het onderzoeksgebied de Oude Wetering snijdt drie historische erven op huisterpen liggen/lagen: erve Appel, erve De Vegt en erve Blankvoort. Deze erven staan aangegeven op de kadastrale minuut van 1811-1832. Ter plaatse van Nieuwe Wetering liggen nog eens twee historische erven op huisterpen: erve Pasterkamp en erve Rietman. Erve De Vegt is verdwenen, de overige erven bestaan nog (figuur 3, figuur 4, figuur 5 en bijlage 8). De erven Appel en Blankvoort worden door geplande bouwwegen doorsneden.

Verder lagen ter hoogte van bedrijventerrein Hessenpoort twee historische erven de zogenaamde Blekhuizen (zie 2.3; figuur 2 en bijlage 8).

Binnen het onderzoeksgebied zijn geen bouwkundige waarden geregistreerd.

2.5 Huidige situatie

Aan de hand van actuele gegevens van recente luchtfoto's, Google Street View, locatiebezoek en navraag bij de opdrachtgever zijn de onderstaande zaken over de huidige situatie te melden (bijlage 5).

Huidig grondgebruik	agrarisch (vooral grasland) en bedrijventerrein
Hoogteligging maaiveld	1 m -NAP tot 2 m +NAP
Grondwatertrap of -stand	IIb; gemiddeld hoogste grondwaterstand 25-40 cm, gemiddeld laagste grondwaterstand 50-80 cm -mv; IV: gemiddeld hoogste grondwaterstand > 40, gemiddeld laagste grondwaterstand > 80-120 cm -mv; VII: gemiddeld hoogste grondwaterstand > 80 40.
Milieutechnische condities	ter plaatse van de mastlocaties en werkterreinen zal milieuhygiënisch onderzoek verricht worden
Aanwezige constructies (funderingen, kelders e.d.)	onbekend

Tabel 6. Overzicht van de huidige situatie van het onderzoeksgebied.

2.6 Toekomstige situatie

Uit aangeleverde informatie van de opdrachtgever is het volgende gebleken over de toekomstige situatie:

Aard	er worden bouwwegen en werkterreinen aangelegd en weer verwijderd, waarna het terrein cultuurtechnisch wordt hersteld. Bij een deel van de hoogspanningsmasten wordt de fundering versterkt
Omvang en diepte	de exacte omvang en diepte van de ingrepen is vooralsnog onbekend
Invloed op maaiveld en grondwater	er worden bouwwegen en werkterreinen aangelegd en weer verwijderd, waarna het terrein cultuurtechnisch wordt hersteld.
Toekomstig gebruik	agrarisch en hoogspanningsmasten

Tabel 7. De toekomstige situatie.

3 Gespecificeerde archeologische verwachting

Op basis van de tijdens het bureauonderzoek verzamelde gegevens is een gespecificeerde archeologische verwachting opgesteld. Deze geeft inzicht in de aard en de ouderdom (inclusief omvang en uiterlijke kenmerken), (diepte)ligging, en gaafheid van eventueel aanwezige archeologische resten.

Aard en ouderdom

Het verspreidingspatroon van archeologische vindplaatsen is voor een groot deel gerelateerd aan de fysieke eisen die de mens stelde aan de leef- en woonomgeving. Het meest markant zijn de verschillen tussen jager-verzamelaars enerzijds en landbouwers anderzijds.

Jager-verzamelaars
In de steentijd (paleolithicum t/m neolithicum) leefden de mensen voornamelijk van de jacht, visvangst en het verzamelen van eetbare planten en vruchten. Deze zogenaamde jager-verzamelaars trokken door het landschap en verbleven alleen tijdelijk op een plek. Uit de verspreiding van vindplaatsen uit deze periode blijkt dat hun kampementen in vrijwel alle gevallen waren gesitueerd op hoge zandruggen/koppen op de overgang van nat naar droog. Op dergelijke locaties waren namelijk veel voedselbronnen voorhanden en was (drink)water eenvoudig bereikbaar. Vindplaatsen uit deze periode kenmerken zich doorgaans door een (oppervlakkige) concentratie van vuurstenen werktuigen en afval en een beperkt aantal grondsporen (haardkuilen, kuilen en eventueel graven).

In het onderzoeksgebied komen vrijwel geen grotere zandkoppen of -ruggen voor op de bestudeerde kaarten met landschappelijke gegevens en recente hoogtekaarten. Een uitzondering vormen enkele zones met afgedekt dekzandreliëf in de polder Mastenbroek, kleine dekzandkoppen in het Haersterbroek en de flank van een langs de Vecht gelegen dekzandrug die nog net binnen het onderzoeksgebied valt. De overige delen van het onderzoeksgebied bestaan uit reliëfarme veengebieden en dekzandvlakten.

Op grond van de landschappelijke gegevens is de kans klein dat zich binnen de grenzen van het onderzoeksgebied (intacte) kampementen van jager-verzamelaars bevinden, met uitzondering van de hoge delen van dekzandreliëf in de polder Mastenbroek, dekzandkoppen in het Haersterbroek en de voornoemde dekzandrug langs de Vecht. Het gebied met afgedekt dekzandreliëf in de polder Mastenbroek wordt doorsneden door bouwwegen. Onbekend is of bij dergelijke oppervlakkige ingrepen de hogere delen van het dekzandreliëf bereikt worden. Op enkele dekzandkoppen in het Haersterbroek zijn werkzaamheden gepland, op de dekzandrug langs de Vecht zijn in het kader van het onderhavige project geen ingrepen voorzien.

Landbouwers
Met de introductie van de landbouw (vanaf het neolithicum) werd de mate waarin gronden geschikt waren om te beakkeren een steeds belangrijker factor in de locatiekeuze van de mensen. De eerste

akkergronden werden aangelegd op de van nature vruchtbaarste gronden. Bovendien moesten de gronden goed ontwaterd zijn.

Het onderzoeksgebied kenmerkt zich door overwegend door vrij laaggelegen en reliëfarme veengebieden en dekzandvlakten. Incidenteel is sprake van dekzandreliëf. Of op het afgedekte dekzandlandschap in de polder Mastenbroek resten uit het neolithicum of de vroege bronstijd verwacht mogen worden, is onbekend. Onduidelijk is of dit gebied, dat vanaf omstreeks 1600 voor Chr. geleidelijk bedekt is geraakt met veen, ooit geschikt was voor bewoning en/of agrarische activiteiten. Op dekzandhoogten in Mastenbroek zouden in theorie archeologische resten van voor die tijd aangetroffen kunnen worden. Op door (agrarisch gebruik afgetopte restanten) van dekzandkoppen en -welvingen in het Haersterbroek bestaat kans op de aanwezigheid van kampementen uit het neolithicum en eventueel nog de bronstijd. Vanwege hun geringe omvang wordt de kans op nederzettingsterrein en grafvelden op deze dekzandkoppen gering ingeschat. De flank van een grotere en hogere dekzandrug valt in het uiterste zuiden nog net binnen de grens van het onderzoeksgebied. Met uitzondering van deze dekzandrug worden in het onderzoeksgebied geen resten verwacht van (grotere) agrarische nederzettingen en grafvelden uit de tijdspanne van het neolithicum tot en met de vroege middeleeuwen.

Op basis van het historisch kaartmateriaal blijkt dat er in de nieuwe tijd wel bewoning in het onderzoeksgebied heeft plaatsgevonden. In de polder Mastenbroek valt een viertal binnen twee bewoningslinten gelegen oude huisterpen binnen het onderzoeksgebied. De polder Mastenbroek werd verdeeld en ontgonnen in de tweede helft van de veertiende eeuw. Tot hoe ver deze huisterpen terug gaan is onbekend. Verder bevindt zich in bedrijventerrein Hessenpoort een oude woonlocatie waarop (vanaf de late middeleeuwen/vroege nieuwe tijd?) enkele boerderijen De Blik- of Blekhuizen gevestigd waren.

Zodoende worden in het onderzoeksgebied archeologische resten van huisplaatsen uit de late middeleeuwen en nieuwe tijd verwacht. De omvang van dergelijke vindplaatsen kan één tot enkele hectares bedragen, De huisterpen in Mastenbroek kenmerken zich door ophogingslagen rijk aan archeologisch materiaal (aardewerk, keramisch bouwmateriaal, hout, bot, metaal, glas, etc.) funderingsresten, resten van vloeren, paalsporen, houten palen, beerputten, waterputten, kuilen, en rond de terp gelegen sloten.
Eventuele resten van de Blekhuizen zullen bestaan uit funderingsresten, maar hoofdzakelijk uit grondsporen (paalsporen, kuilen, waterputten etc.).

(Diepte)ligging

Het dekzandreliëf in de polder Mastenbroek ligt overwegend dieper dan 80 cm -mv. De hoogste toppen bevinden zich echter al binnen 40 cm -mv.[5] Op dekzandkoppen en ruggetjes in het Haersterbroek worden archeologische resten direct onder het maaiveld verwacht. Op de huisterpen in de polder Mastenbroek worden archeologische resten verwacht vanaf het maaiveld, dat wil zeggen direct onder de moderne bouwvoor met een dikte van circa 30 tot 40 cm. De verwachte diepte van archeologische resten ter plaatse van de voormalige Blekhuizen is onduidelijk. Het terrein van bedrijventerrein Hesspoort lijkt op basis van de huidige maaiveldhoogte te zijn opgehoogd. Het derhalve mogelijk dat eventuele archeologische resten, die normaal gesproken direct onder de moderne bouwvoor worden verwacht, zich tegenwoordig op een grotere diepte onder het maaiveld bevinden.

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[5] Bles, Groot Obbink & Rutten 1970: bijlage 4: zanddieptekaart.

Fysieke kwaliteit

Eventuele archeologische vindplaatsen in het Haersterbroek zullen vanwege hun oppervlakkige ligging en grote kwetsbaarheid in een meer of mindere mate zijn aangetast door agrarisch gebruik. Op en rond de huisterpen in de polder Mastenbroek daarentegen worden goed tot zeer goed geconserveerde archeologisch resten verwacht. Hierbij moet echter de kanttekening gemaakt worden dat een deel van de vondstlagen is verstoord geraakt door moderne bebouwing die zich tegenwoordig op het merendeel van de huisterpen bevindt. Daarbuiten en in diepere grondsporen (bijv. opgevulde sloten) moet rekening gehouden worden met een uitstekende conservering.

Het is aannemelijk dat de Blekhuizen op een hogere zandige welving in laaggelegen gebied van de Haerster Markte/Berkummer broek zijn gebouwd. De veldnaam blik of blek duidt soms op hoger gelegen aan- of opgewassen grond. Misschien betreft het overslagmateriaal dat hier bij overstromingen van de Vecht is afgezet. De naam kan echter ook op hogere, schrale grond wijzen, bijvoorbeeld een dekzandwelving/rug in een lager gelegen gebied.[6]

Gezien het verwachte zandige karakter van de bodem zijn organische resten daar vermoedelijk alleen te verwachten in diepere, met waterverzadigde grondsporen. De conservering van grondsporen en andere archeologische resten is waarschijnlijk normaal voor de oostelijke zandgronden. Of eventuele resten van de Blekhuizen zijn aangetast tijdens de aanleg van bedrijventerrein Hessenpoort is onbekend.

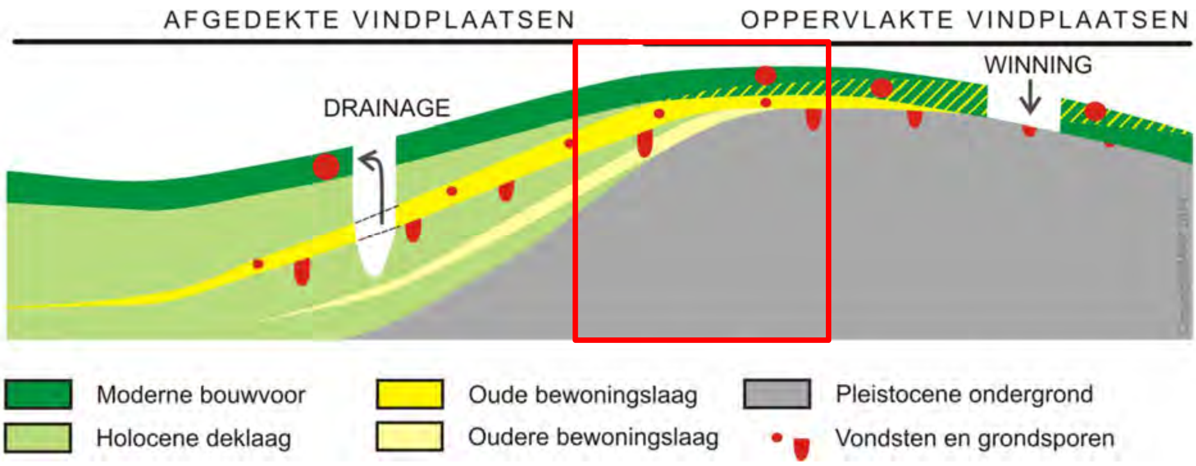
Overzicht

De archeologische verwachting en de verschillende deelaspecten daarvan, zoals hiervoor beschreven, zijn samengevat in tabel 8. Daarnaast zijn de prospectiekenmerken met betrekking tot de verwachte archeologische resten in figuur 6 schematisch verbeeld.

Archeologische periode	Complextype	Omvang	Kenmerken	Diepteligging	Gaafheid
mesolithicum - vroege bronstijd	kampementen/ nederzettingen (Mastenbroek)	5-2000 m^2	oppervlakkige spreiding van vondstmateriaal, eventueel sporen van gebouwen en bouwwerken, kuilen en haardkuilen	> 40 cm -mv	vermoedelijk goed door afdekking met veen en klei
meso-/neolithicum	kampementen (Haersterbroek)	5-100 m^2	oppervlakkige spreiding van vondstmateriaal, eventueel haardkuilen	vanaf het maaiveld	slecht, vermoedelijk afgetopt door modern agrarisch gebruik
late middeleeuwen /nieuwe tijd	huisterp (Mastenbroek)	> 1 ha	vondstrijke ophogingslagen met grondsporen en hout, veel sloten	vanaf het maaiveld	vermoedelijk goed, m.u.v. de locaties van moderne bebouwing
late middeleeuwen /nieuwe tijd	agrarische nederzetting (Blekhuizen)	> 1 ha	grondsporen	vanaf het maaiveld, mogelijk onder ophogingslaag	middelmatig, normaal voor de Oost-Nederlandse zandgronden

[6] Schönfeld 1980, 51-52.

Tabel 8. Samenvatting van de gespecificeerde archeologische verwachting voor het onderzoeksgebied.



Figuur 6. Diagram voor archeologische vondst- en spoorcomplexen. Rode kader: aanduiding van de situatie in het onderzoeksgebied.

4 Conclusies en advies

4.1 Conclusie

Op grond van de onderzoeksresultaten en onder verwijzing naar de doelstellingen, kunnen de volgende uitspraken worden gedaan (zie ook bijlage 9):

Op afgedekt dekzandreliëf (> 40 cm -mv) in de polder Mastenbroek en op dekzandkoppen in het Haersterbroek (vanaf het maaiveld) komen mogelijk archeologische resten voor uit de steen- en bronstijd. In het betreffende gebied in Mastenbroek en op enkele dekzandkoppen in het Haersterbroek zijn werkzaamheden gepland aan hoogspanningsmasten en zijn bouwwegen voorzien.

Archeologische resten uit de late middeleeuwen en nieuwe tijd worden verwacht ter hoogte van twee oude bewoningslinten in de polder Mastenbroek en ter hoogte van bedrijventerrein Hessenpoort (De Blekhuizen). In Mastenbroek worden twee bewoningslinten doorsneden. Op of in de directe nabijheid van twee huisterpen (erven Appel en Blankvoort) zijn werkzaamheden gepland. Het gaat hierbij om archeologisch waardevolle gebieden met een hoge kans op het aantreffen van archeologische resten en lage vrijstellingsgrenzen voor archeologisch onderzoek (100 m^2, diepte tot 50 cm). Een hoge archeologische verwachting en lage vrijstellingsgrenzen gelden ook voor de locatie van de voormalige Blekhuizen in bedrijventerrein Hessenpoort. Deze locatie valt samen met de plaats van een hoogspanningsmast waar eventueel werkzaamheden uitgevoerd gaan worden.

Elders in het plangebied worden is de kans op archeologische resten (zeer) klein.

4.2 Advies

Op basis van de resultaten van het onderzoek blijkt dat in het plangebied (mogelijk) archeologische resten bedreigd worden door de voorgenomen bodemingrepen (bijlage 9). Daarom wordt geadviseerd om de plannen zodanig aan te passen (graafwerkzaamheden tot een minimum beperken) en om mitigerende maatregelen te treffen (bijvoorbeeld gebruik van rijplaten voor werkwegen in bewoningslinten in de polder Mastenbroek) dat verstoring wordt voorkomen/tot een minimum wordt beperkt.

Voor de Blekhuizen wordt geadviseerd wordt om eventuele archeologische resten *in situ* te beschermen. Om verstoring te voorkomen wordt/worden de volgende maatregelen geadviseerd: een maximale verstoringsdiepte van de bovengrond van 40 cm -mv (onder voorbehoud van de aanwezigheid van een eventueel ophogingspakket).

Indien en waar dit niet mogelijk is, wordt aanbevolen in het kader van de bestaande planvorming onderstaande vervolgstap uit het proces van de Archeologische Monumentenzorg (AMZ) te nemen.

In zones met dekzandreliëf op een geringe diepte in de polder Mastenbroek en op dekzandkoppen in het Haersterbroek wordt archeologisch vervolgonderzoek aanbevolen om een beter beeld te krijgen van de (kans op de) aan- of afwezigheid van archeologische resten. Hierbij moet in eerste instantie geacht worden aan een verkennend of inventariserend booronderzoek op locaties waar binnen die zones ingrepen zijn gepland.

In het overige deel van het plangebied wordt in het kader van de voorgenomen bodemingrepen geen archeologisch vervolgonderzoek aanbevolen. Indien bij de uitvoering van de werkzaamheden onverwacht archeologische resten worden aangetroffen, dan is conform artikel 5.10 van de Erfgoedwet aanmelding van de desbetreffende vondsten bij de Minister van Onderwijs, Cultuur en Wetenschap c.q. de Rijksdienst voor het Cultureel Erfgoed verplicht (vondstmelding via ARCHIS).

4.3 Tot slot

Dit rapport geeft (selectie)adviezen. Het is aan de bevoegde overheid, de gemeente Zwolle, deze al dan niet over te nemen in de vorm van een (selectie)besluit.

Literatuur

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Overzicht van figuren, tabellen, bijlagen en appendices

Figuren:

Tabellen:

Bijlagen:

Bijlage 1. Tijdschaal

Archeologische perioden

Tijdperk			Datering
Recente tijd			1945
Nieuwe tijd	C		1850
	B		1650
	A		1500
Middeleeuwen	Laat B		1250
	Laat A		1050
	Vroeg	D: Ottoonse tijd	900
		C: Karolingische tijd	725
		B: Merovingische tijd	525
		A: Volksverhuizingstijd	450
Romeinse tijd	Laat		270
	Midden		70 na Chr.
	Vroeg		15 voor Chr.
Prehistorie: **IJzertijd**	Laat		250
	Midden		500
	Vroeg		800
Prehistorie: **Bronstijd**	Laat		1100
	Midden		1800
	Vroeg		2000
Prehistorie: **Neolithicum** (Nieuwe Steentijd)	Laat		2850
	Midden		4200
	Vroeg		4900/5300
Prehistorie: **Mesolithicum** (Midden Steentijd)	Laat		6450
	Midden		8640
	Vroeg		9700
Prehistorie: **Paleolithicum** (Oude Steentijd)	Laat		12.500
	Jong B		16.000
	Jong A		35.000
	Midden		250.000
	Oud		

tabel1_standaard_Archeologisch_RAAP_2014

Bijlage 2. Motivatie geraadpleegde bronnen

LS03 en LS04, motivatie voor de keuze van de geraadpleegde bronnen (+ indien van toepassing)

Bron	Geraadpleegd en afgebeeld/beschreven	Geraadpleegd, niet afgebeeld	Niet beschikbaar voor dit plan-/onderzoeksgebied	Bevat geen (nieuwe) relevante informatie	Opmerking
Bodemkaart van NL	x				
Geologische kaart van NL	x				
Geomorfologische kaart van NL	x				
Gedetailleerde bodemkaarten	x				
Actueel Hoogtebestand Nederland	x				
Lucht- en satellietfoto's	x				
Topografische kaart van Nederland	x				
Oud(st)e kadasterkaarten	x				
Archeologische en cultuurhistorische rapportages	x				
Eigenaar en gebruiker	x				
AMK	x				
ARCHIS	x				
Literatuur (arch./aardwet.)		x			
Gemeentelijke waarden- of verwachtingskaart	x				

Bijlage 3. Onderzoeksmeldingen

Zaakidentificatie:	**4927452100**
Zaaktype:	Registratie niet-rapportplichtige onderzoeksmelding
Voorafgaand onderzoek:	-
Archis2 Onderzoeksmeldingsnr:	-
Naam onderzoek:	Enexis Zwolle Bomhofsplas
Eigen kenmerk project:	20192605
Verwerving:	archeologisch: bureauonderzoek
Uitvoerder:	Salisbury Archeologie b.v.
Bevoegd gezag:	gemeente
Provincie:	Overijssel
Gemeente:	Zwolle
Plaats:	Zwolle
Toponiem:	-
X coördinaat:	207436
Y coördinaat:	506335
Startdatum veldwerk:	01-12-2020
Verwachte einddatum veldwerk:	04-12-2020
Meldingsdatum:	06-12-2020
Omschrijving:	Op basis van de waarderingskaart van de gemeente Zwolle wordt in de zones met 0% of 10% gebieden weergegeven, waar geen archeologische resten meer worden verwacht. Het betreft hier lagergelegen gebieden in een vlakte van ten dele verspoelde dekzanden. Op de hoger gelegen delen binnen dit landschap, die wel nog voor kunnen komen en bestaan uit dekzandopduikingen, kunnen echter nog wel bewoningsresten aanwezig zijn. Uit vondstmeldingen uit de omgeving blijkt dit ook het geval te zijn. Vondsten vanaf het Midden Paleolithicum worden in het onderzoeksgebied aangetroffen. Vanaf het Neolithicum raakt het gebied overdekt met veen. Bewoning in het onderzoeksgebied is dan over het algemeen niet meer mogelijk. Vondsten uit deze periode aangetroffen in het onderzoeksgebied liggen over het algemeen op hoger gelegen rivierduinen. Deze worden in het plangebied niet verwacht. Vervolgens is het veen door ontginning in de Nieuwe tijd grotendeels verdwenen. De bodem werd op de dekzandruggen vruchtbaar gemaakt met schapenmest en heideplaggen waardoor essen of enken zijn ontstaan. Een afdekkende esdek kan circa 50 tot 100 cm dik zijn. In het noorden van locatie 1 lijkt een esdek te liggen. Eventueel onderliggend dekzand kan hier nog intact zijn. Op basis van het bureauonderzoek kan de lage verwachting naar middelhoog worden bijgesteld voor de periode Paleolithicum - Mesolithicum. Voor de resterende perioden blijft de verwachting laag.
Status zaak:	Onderzoek afgemeld op 19-01-2021
(Eerste) bevindingen:	
Literatuur:	Bakker 2011

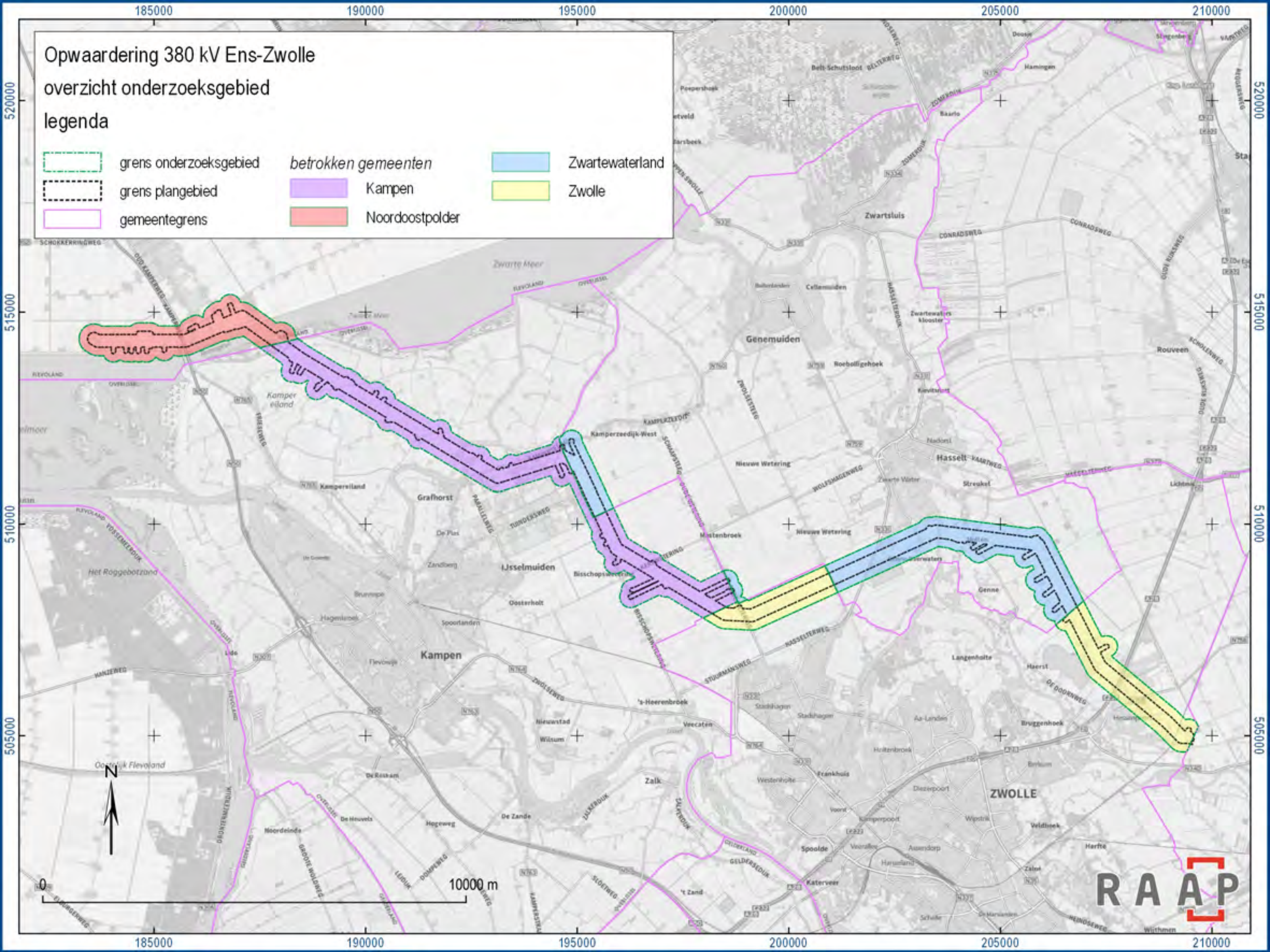
Zaakidentificatie:	**4871238100**
Zaaktype:	Registratie niet-rapportplichtige onderzoeksmelding
Voorafgaand onderzoek:	-
Archis2 Onderzoeksmeldingsnr:	-
Naam onderzoek:	Middenspanningsroute Bomhofsplas te Zwolle
Eigen kenmerk project:	20192605
Verwerving:	archeologisch: bureauonderzoek
Uitvoerder:	Salisbury Archeologie b.v.
Bevoegd gezag:	gemeente
Provincie:	Overijssel
Gemeente:	Zwolle
Plaats:	Zwolle
Toponiem:	-
X coördinaat:	207421
Y coördinaat:	506361
Startdatum veldwerk:	23-06-2020
Verwachte einddatum veldwerk:	23-06-2020
Meldingsdatum:	23-06-2020
Omschrijving:	Op basis van de waarderingskaart van de gemeente Zwolle wordt in de zones met 0% of 10% gebieden weergegeven, waar geen archeologische resten meer worden verwacht. Het betreft hier lagergelegen gebieden in een vlakte van ten dele verspoelde dekzanden. Op de hoger gelegen delen binnen dit landschap, die wel nog voor kunnen komen en bestaan uit dekzandopduikingen, kunnen echter nog wel bewoningsresten aanwezig zijn. Uit vondstmeldingen uit de omgeving blijkt dit ook het geval te zijn. Vondsten vanaf het Midden Paleolithicum worden in het onderzoeksgebied aangetroffen. Vanaf het Neolithicum raakt het gebied overdekt met veen. Bewoning in het onderzoeksgebied is dan over het algemeen niet meer mogelijk. Vondsten uit deze periode aangetroffen in het onderzoeksgebied liggen over het algemeen op hoger gelegen rivierduinen. Deze worden in het plangebied niet verwacht. Vervolgens is het veen door ontginning in de Nieuwe tijd grotendeels verdwenen. De bodem werd op de dekzandruggen vruchtbaar gemaakt met schapenmest en heideplaggen waardoor essen of enken zijn ontstaan. Een afdekkende esdek kan circa 50 tot 100 cm dik zijn. In het noorden van locatie 1 lijkt een esdek te liggen. Eventueel onderliggend dekzand kan hier nog intact zijn. Op basis van het bureauonderzoek kan de lage verwachting naar middelhoog worden bijgesteld voor de periode Paleolithicum - Mesolithicum. Voor de resterende perioden blijft de verwachting laag.
Status zaak:	Onderzoek afgemeld op 23-06-2020
(Eerste) bevindingen:	
Literatuur:	Bakker 2020.

Zaakidentificatie:	**4772912100**
Zaaktype:	Registratie niet-rapportplichtige onderzoeksmelding
Voorafgaand onderzoek:	-
Archis2 Onderzoeksmeldingsnr:	-
Naam onderzoek:	BO Berkummerbroekweg Zwolle
Eigen kenmerk project:	459543
Verwerving:	archeologisch: bureauonderzoek
Uitvoerder:	Antea Group Archeologie
Bevoegd gezag:	gemeente
Provincie:	Overijssel
Gemeente:	Zwolle
Plaats:	Zwolle
Toponiem:	-
X coördinaat:	209542
Y coördinaat:	505141
Startdatum veldwerk:	10-02-2020
Verwachte einddatum veldwerk:	07-02-2022
Meldingsdatum:	07-02-2020
Omschrijving:	Nog geen gegevens beschikbaar
Status zaak:	Onderzoek aangemeld op 07-02-2020
(Eerste) bevindingen:	
Literatuur:	

Bijlage 4. Vondstmeldingen

Zaakidentificatie:	**2762679100**
Zaaktype:	Registratie archeologische vondstmelding
Voorafgaand onderzoek:	-
Archis2-waarnemingsnr:	12931
Naam onderzoek:	-
Verwerving:	niet-archeologisch: graafwerk
Vinder:	-
Provincie:	Overijssel
Gemeente:	Zwolle
Plaats:	Berkumerbroek
Toponiem:	Berkumerbroek
X coördinaat:	208870
Y coördinaat:	505240
Vondstdatum:	08-12-1967
Meldingsdatum:	20-12-1967
Omschrijving:	-
Status zaak:	Vondstmelding afgemeld op 27-06-2015
(Eerste) bevindingen:	Vuurstenen bijl (Flint-Rechteickbeil) gevonden tijdens graafwerkzaamheden in bouwput onder humuslaag in het schone zand.
Literatuur:	

Bijlage 5. Huidige situatie



Opwaardering 380 kV Ens-Zwolle
overzicht onderzoeksgebied
legenda
grens onderzoeksgebied
grens plangebied
gemeentegrens
betrokken gemeenten
Kampen
Noordoostpolder
Zwartewaterland
Zwolle
185000
190000
195000
200000
205000
210000
520000
515000
510000
505000
0
10000 m
N
Genemuiden
Zwartsluis
Hasselt
IJsselmuiden
Kampen
ZWOLLE
Zalk
RAAP


Opwaardering 380 kV Ens-Zwolle
huidige situatie (luchtfoto) Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
N
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1000 m
RAAP
197000
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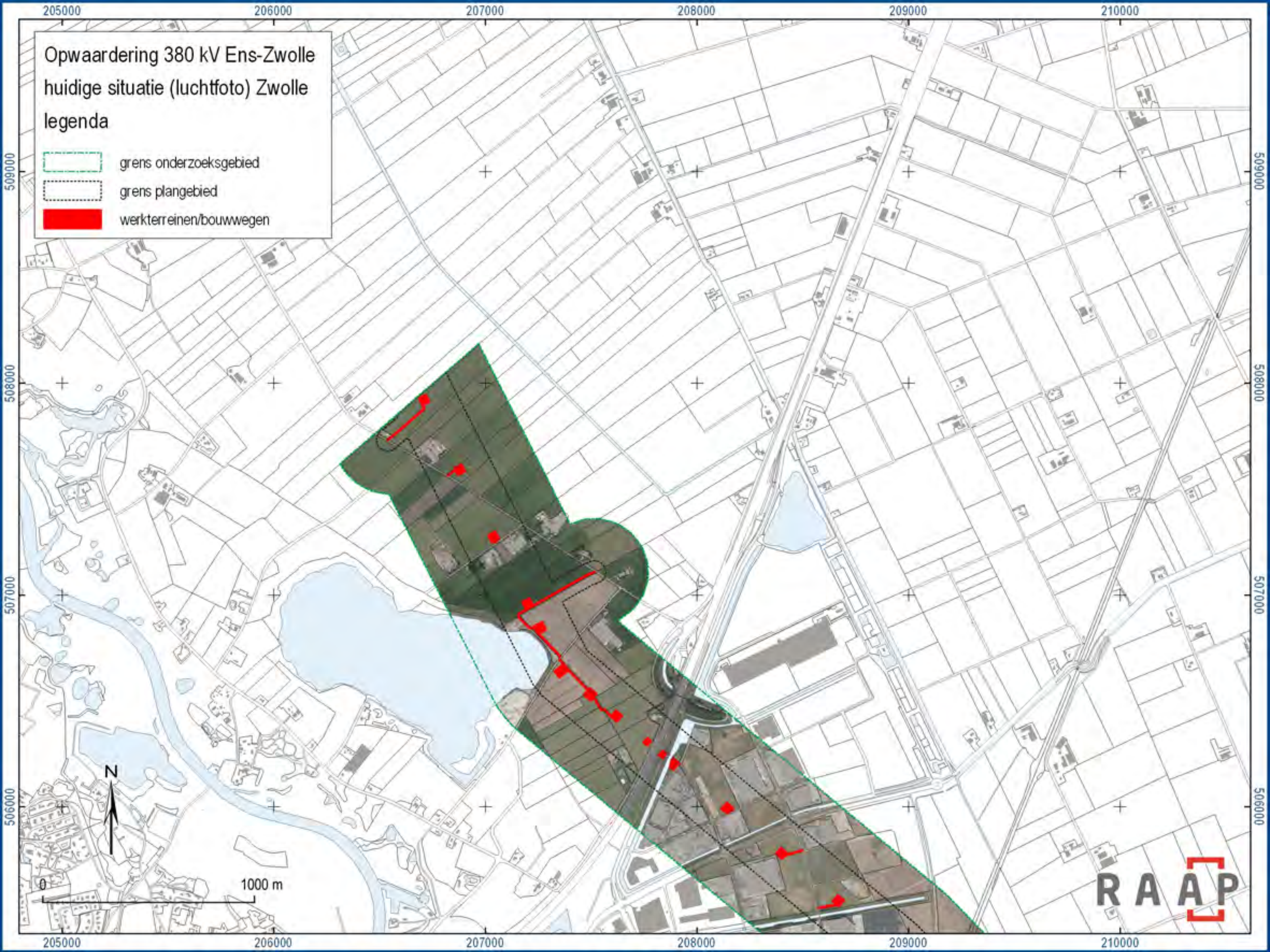
Opwaardering 380 kV Ens-Zwolle
huidige situatie (luchtfoto) Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
205000
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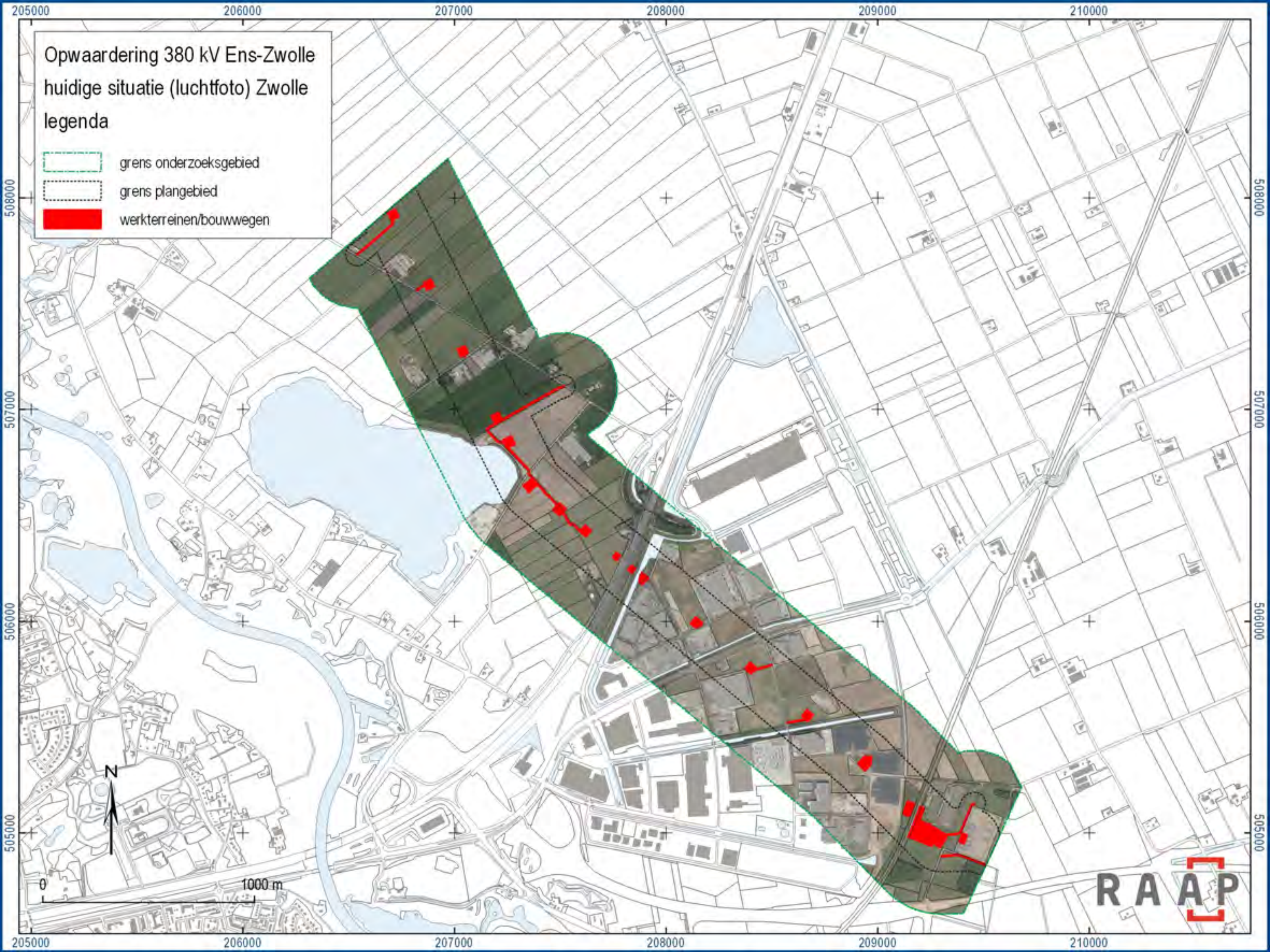
1000 m
RAAP



Opwaardering 380 kV Ens-Zwolle
huidige situatie (luchtfoto) Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
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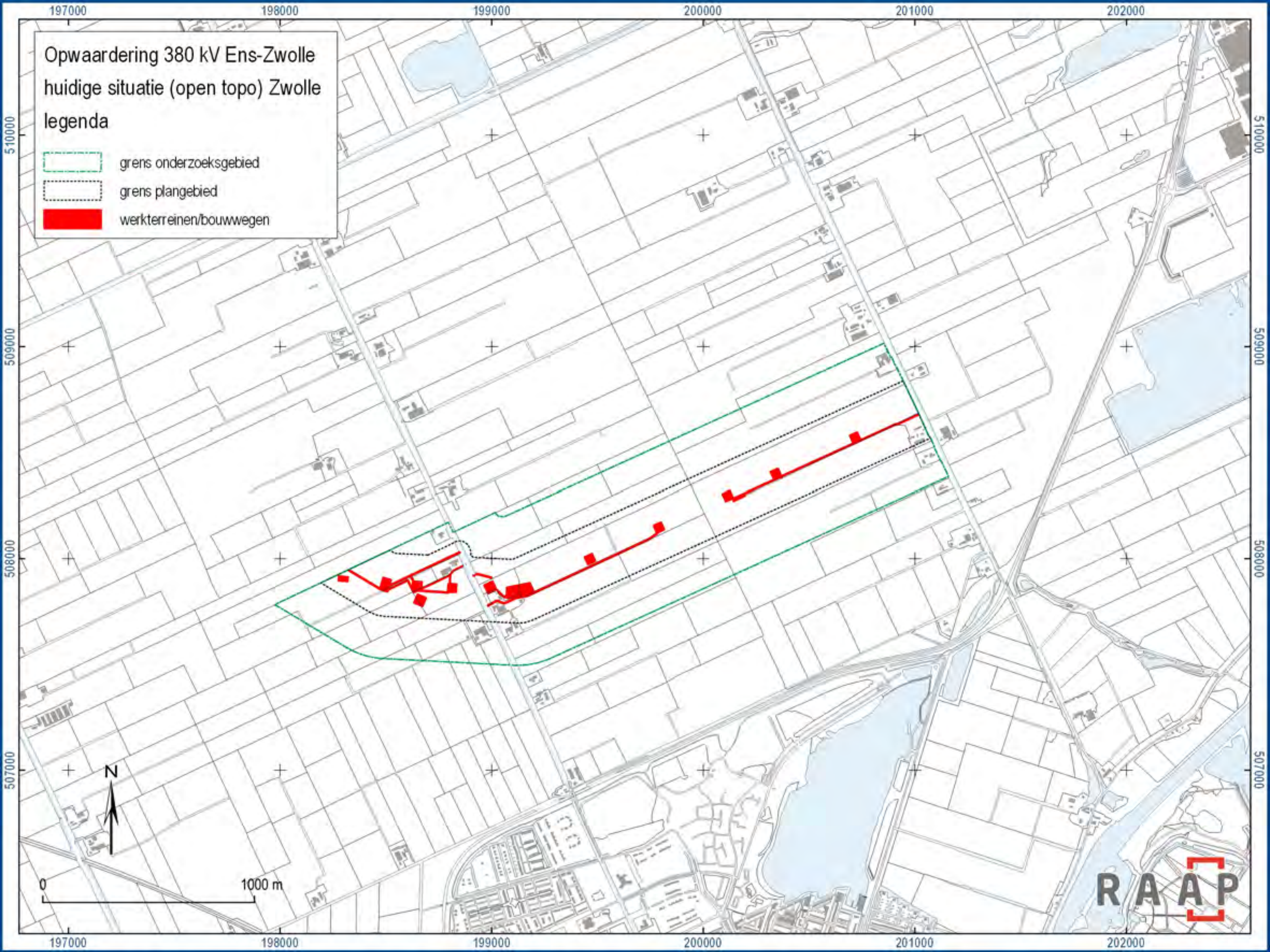
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
huidige situatie (open topo) Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
197000
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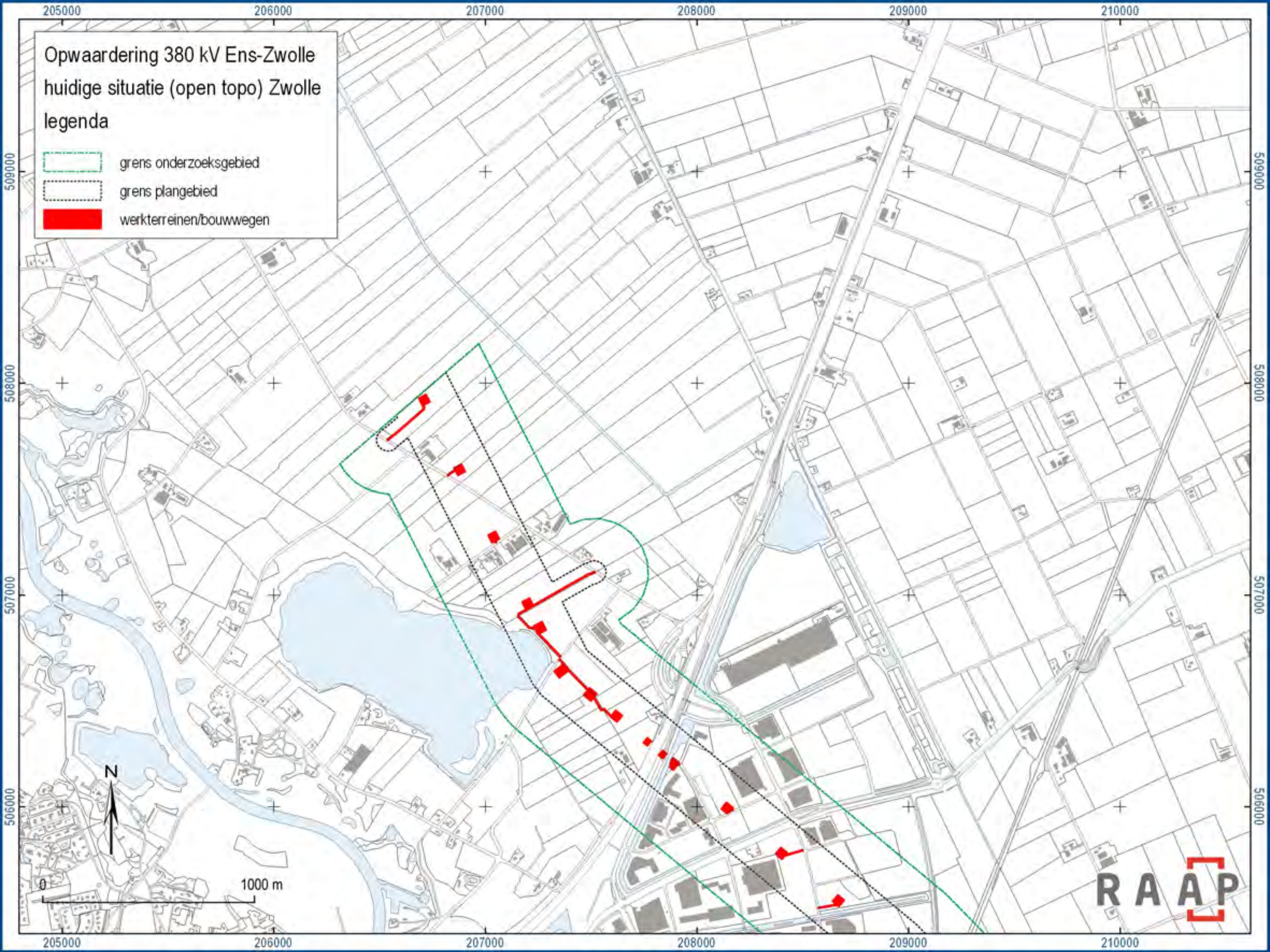
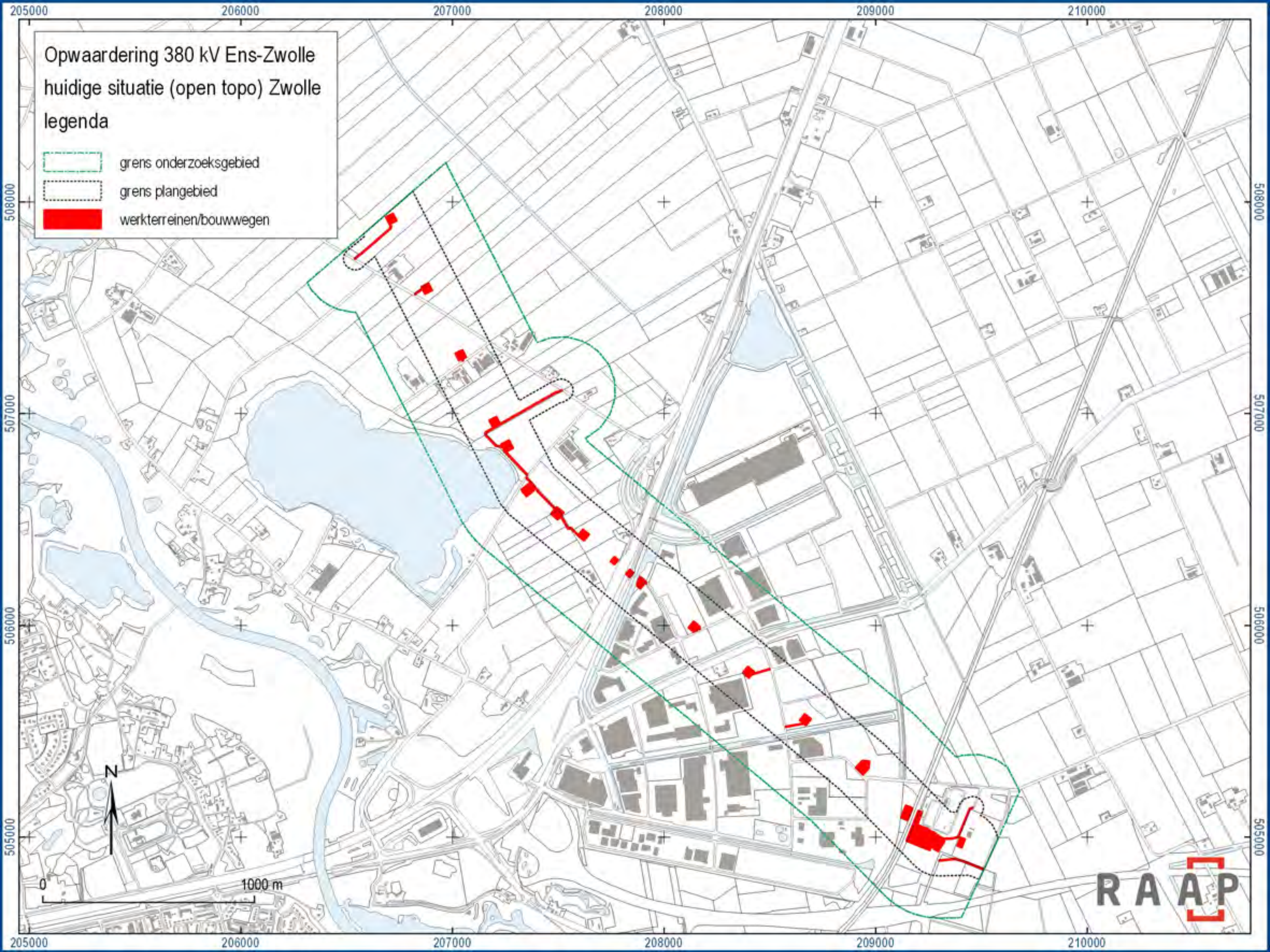
202000
510000
509000
508000
507000
N
0
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
huidige situatie (open topo) Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
205000
206000
207000
208000
209000
210000
509000
508000
507000
506000
N
0
1000 m
RAAP



Opwaardering 380 kV Ens-Zwolle
huidige situatie (open topo) Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
205000
206000
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506000
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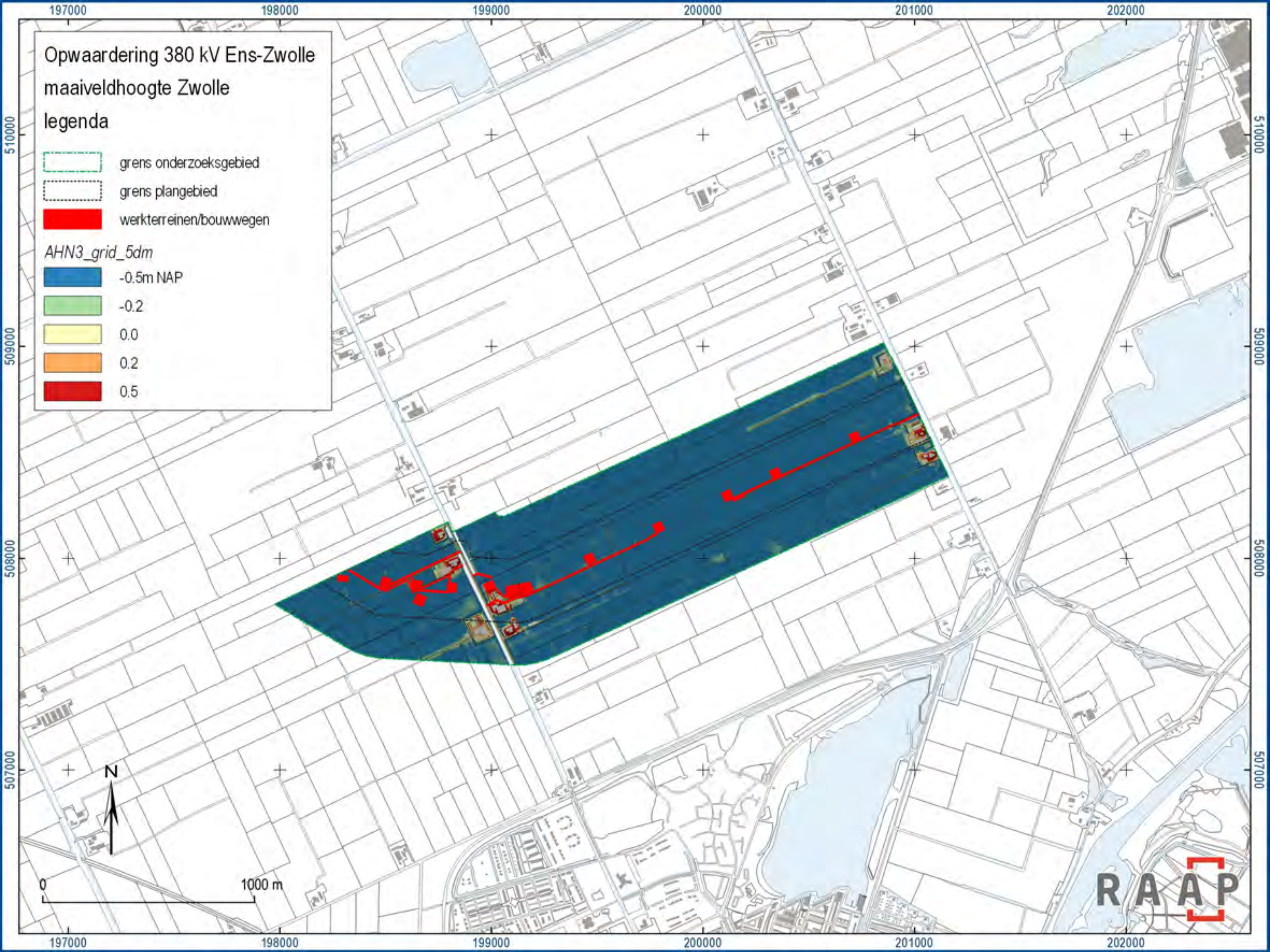
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
maaiveldhoogte Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
AHN3_grid_5dm
-0.5m NAP
-0.2
0.0
0.2
0.5
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201000
202000
510000
509000
508000
507000
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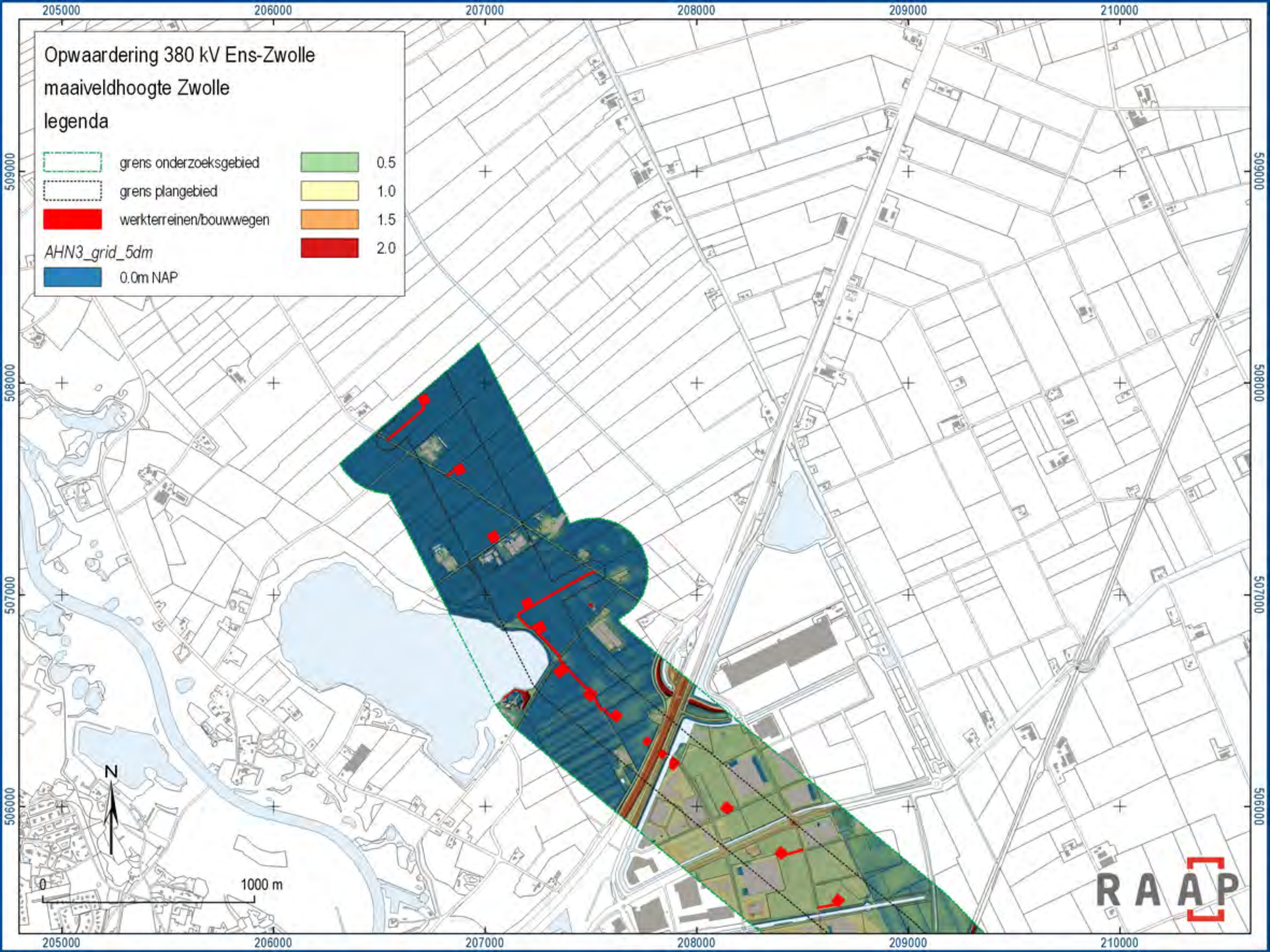
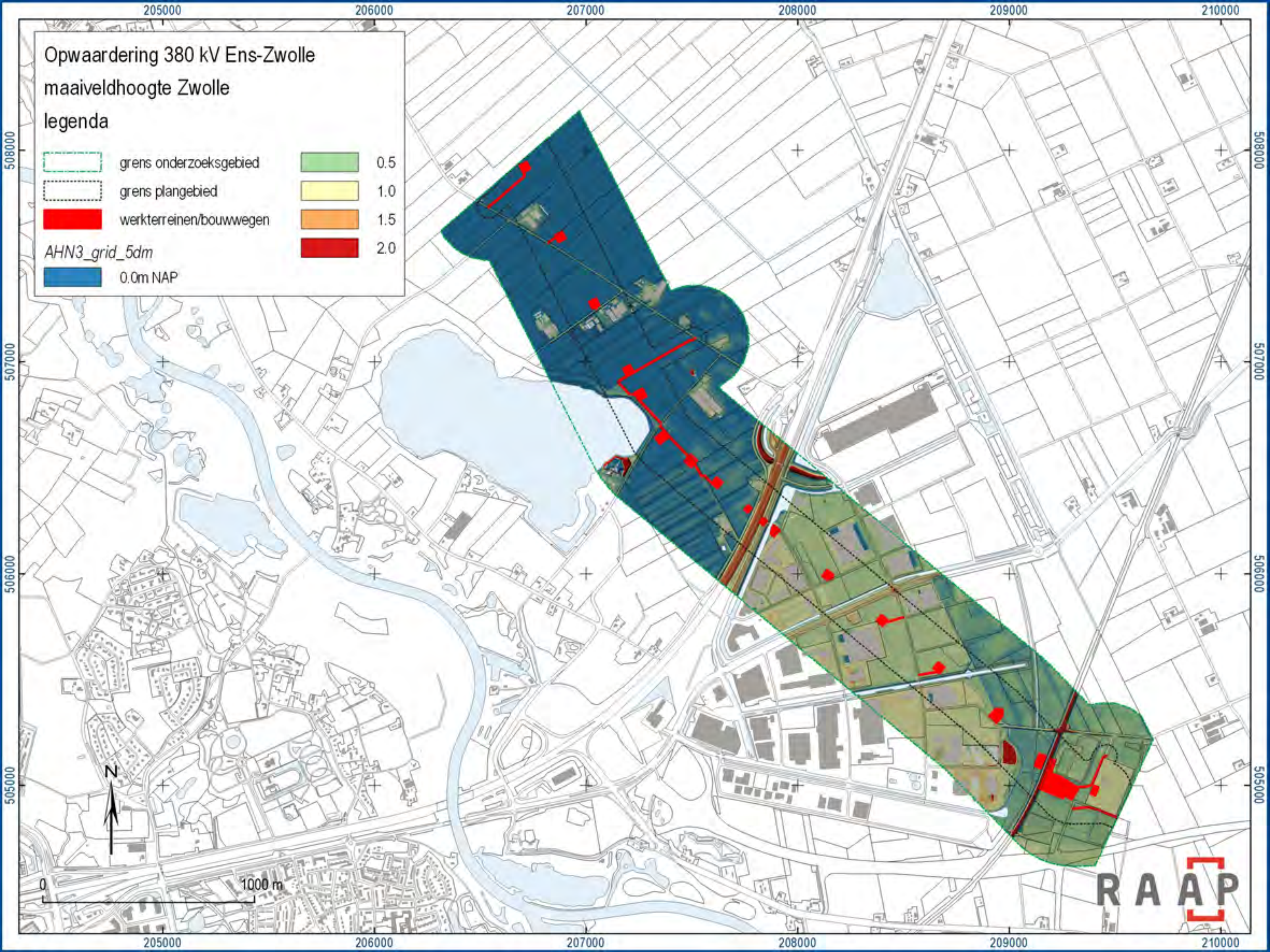
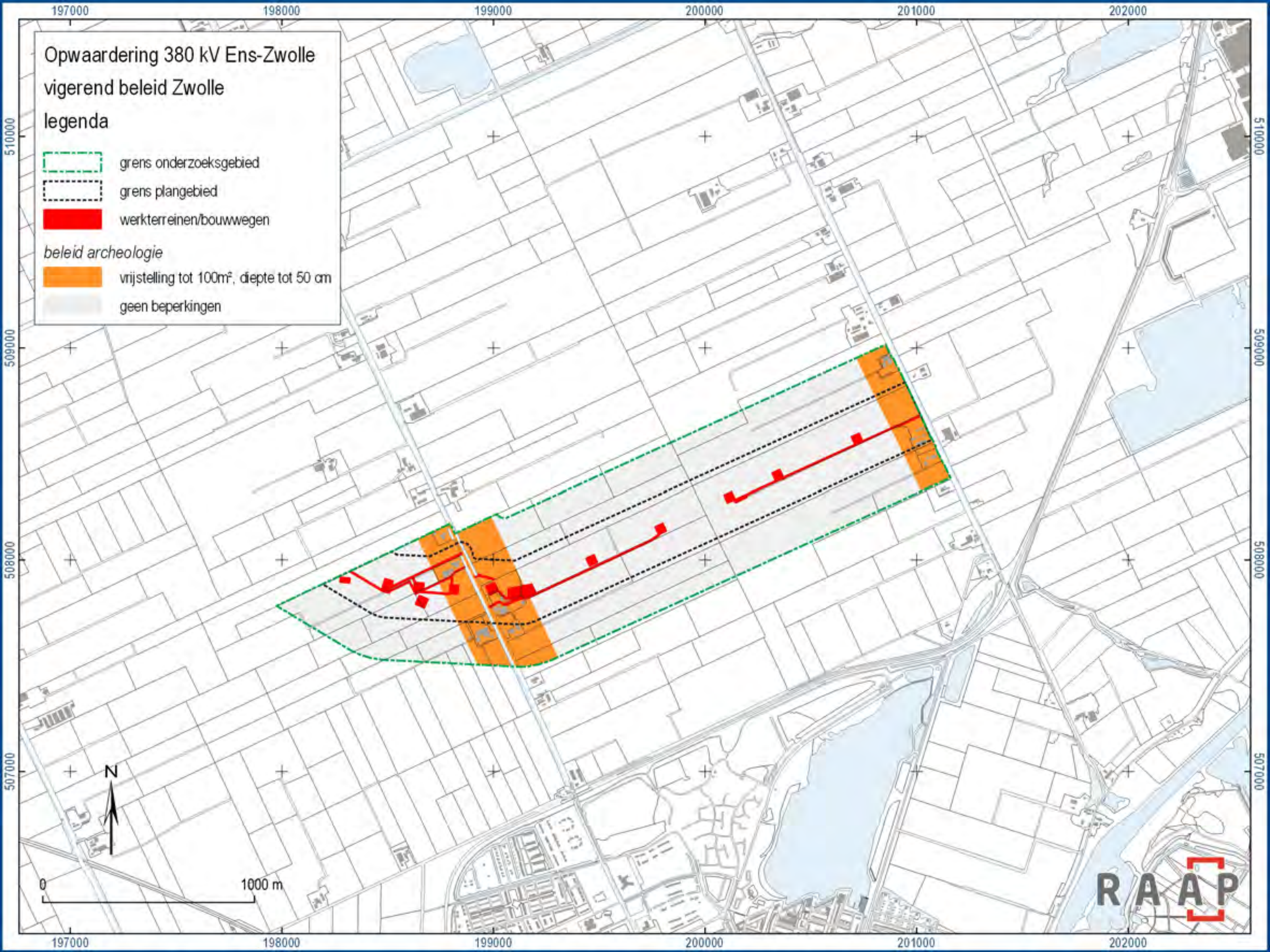
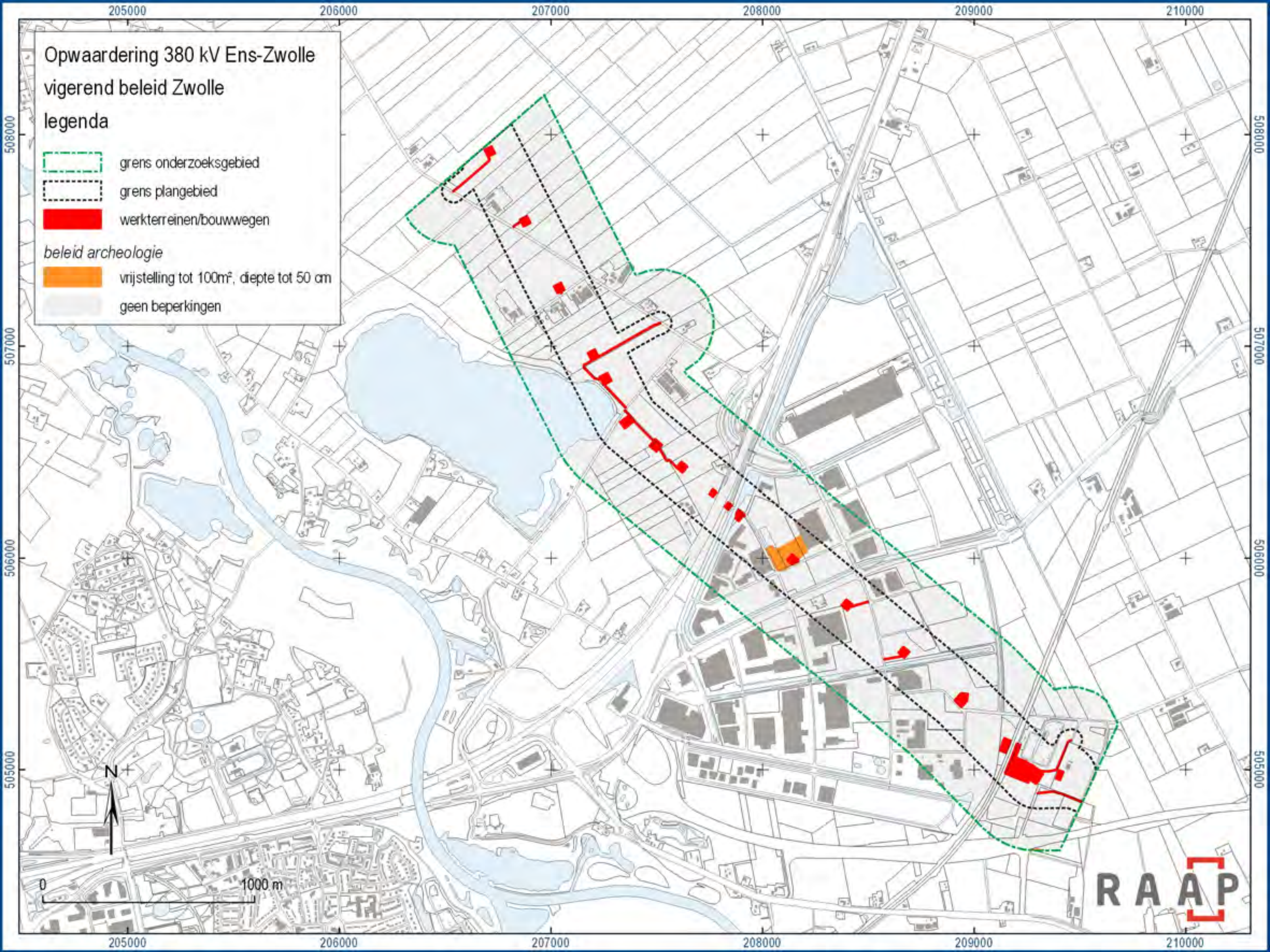
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
maaiveldhoogte Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
AHN3_grid_5dm
0.0m NAP
0.5
1.0
1.5
2.0
205000
206000
207000
208000
209000
210000
509000
508000
507000
506000
N
0
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
maaiveldhoogte Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
AHN3_grid_5dm
0.0m NAP
0.5
1.0
1.5
2.0
205000
206000
207000
208000
209000
210000
508000
507000
506000
505000
N
0
1000 m
RAAP

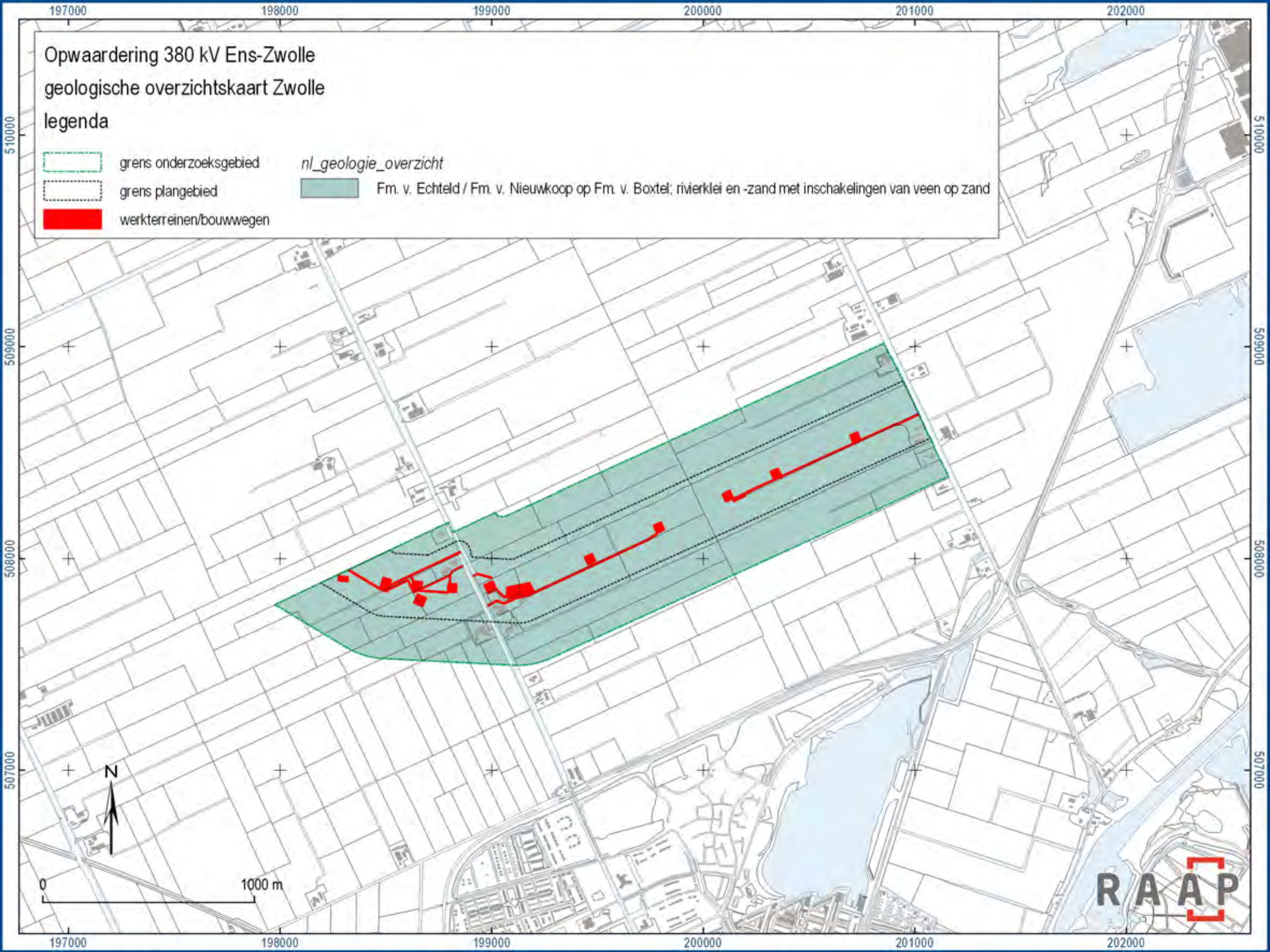
Bijlage 6. Vigerend beleid

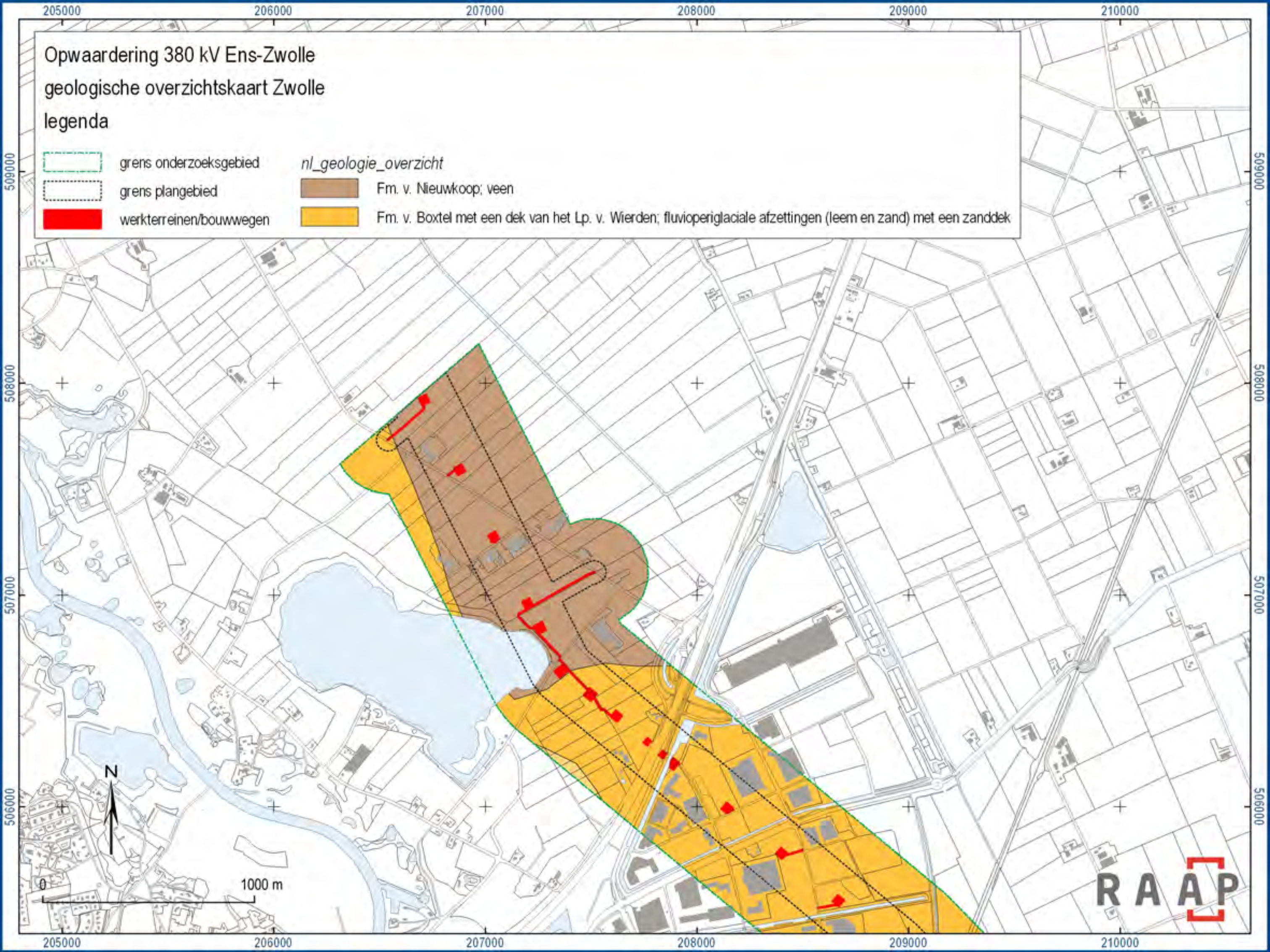

Opwaardering 380 kV Ens-Zwolle
vigerend beleid Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
beleid archeologie
vrijstelling tot 100m², diepte tot 50 cm
geen beperkingen
197000
198000
199000
200000
201000
202000
510000
509000
508000
507000
N
0
1000 m
RAAP

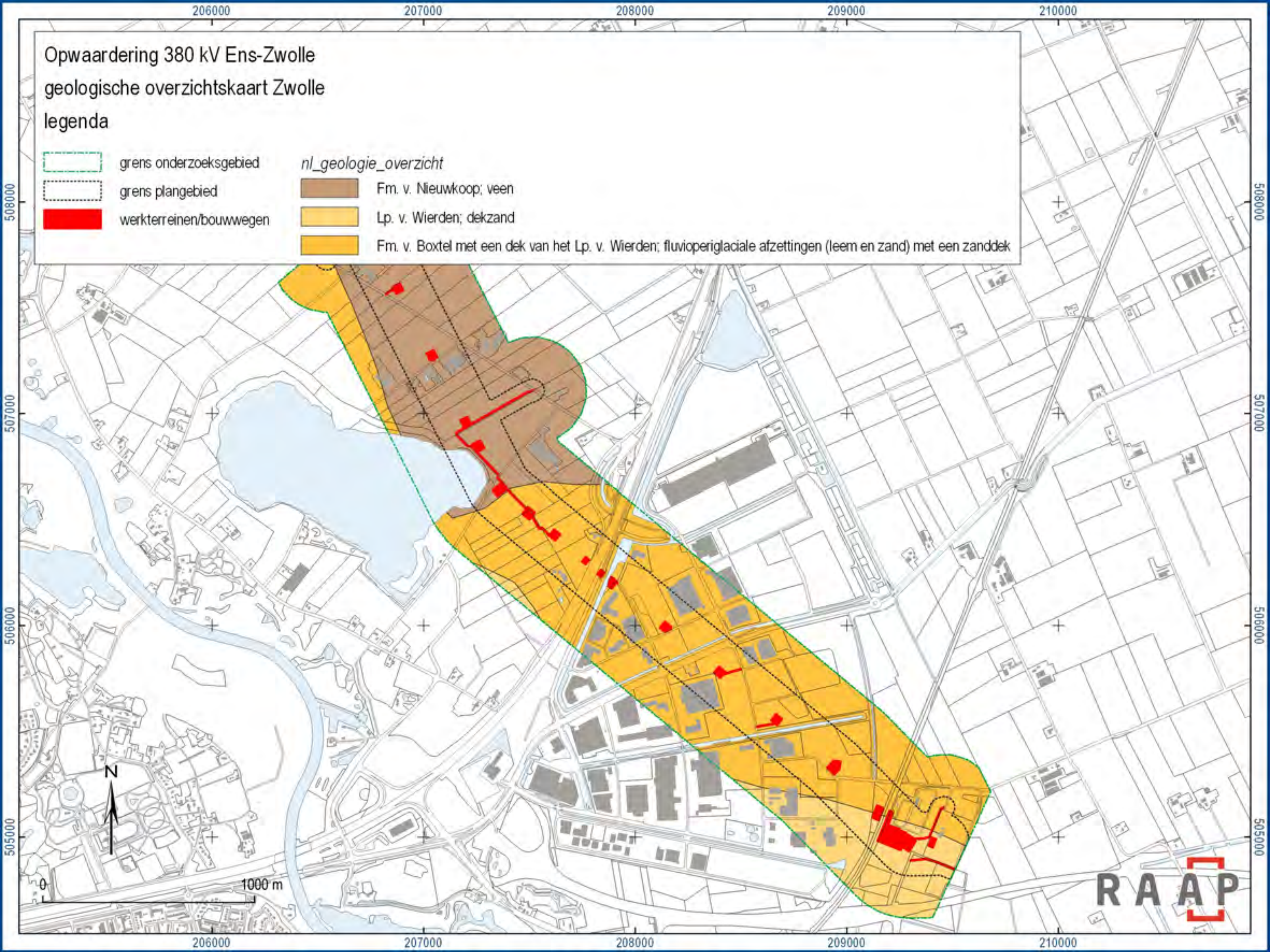


Opwaardering 380 kV Ens-Zwolle
vigerend beleid Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
beleid archeologie
vrijstelling tot 100m², diepte tot 50 cm
geen beperkingen
205000
206000
207000
208000
209000
210000
508000
507000
506000
505000
N
0
1000 m
RAAP

Bijlage 7. Landschap


Opwaardering 380 kV Ens-Zwolle
geologische overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
nl_geologie_overzicht
Fm. v. Echteld / Fm. v. Nieuwkoop op Fm. v. Boxtel; rivierklei en -zand met inschakelingen van veen op zand
197000
198000
199000
200000
201000
202000
510000
509000
508000
507000
N
0
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
geologische overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
nl_geologie_overzicht
Fm. v. Nieuwkoop; veen
Fm. v. Boxtel met een dek van het Lp. v. Wierden; fluvioperiglaciale afzettingen (leem en zand) met een zanddek
205000
206000
207000
208000
209000
210000
509000
508000
507000
506000
N
0
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
geologische overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
nl_geologie_overzicht
Fm. v. Nieuwkoop; veen
Lp. v. Wierden; dekzand
Fm. v. Boxtel met een dek van het Lp. v. Wierden; fluvioperiglaciale afzettingen (leem en zand) met een zanddek
206000
207000
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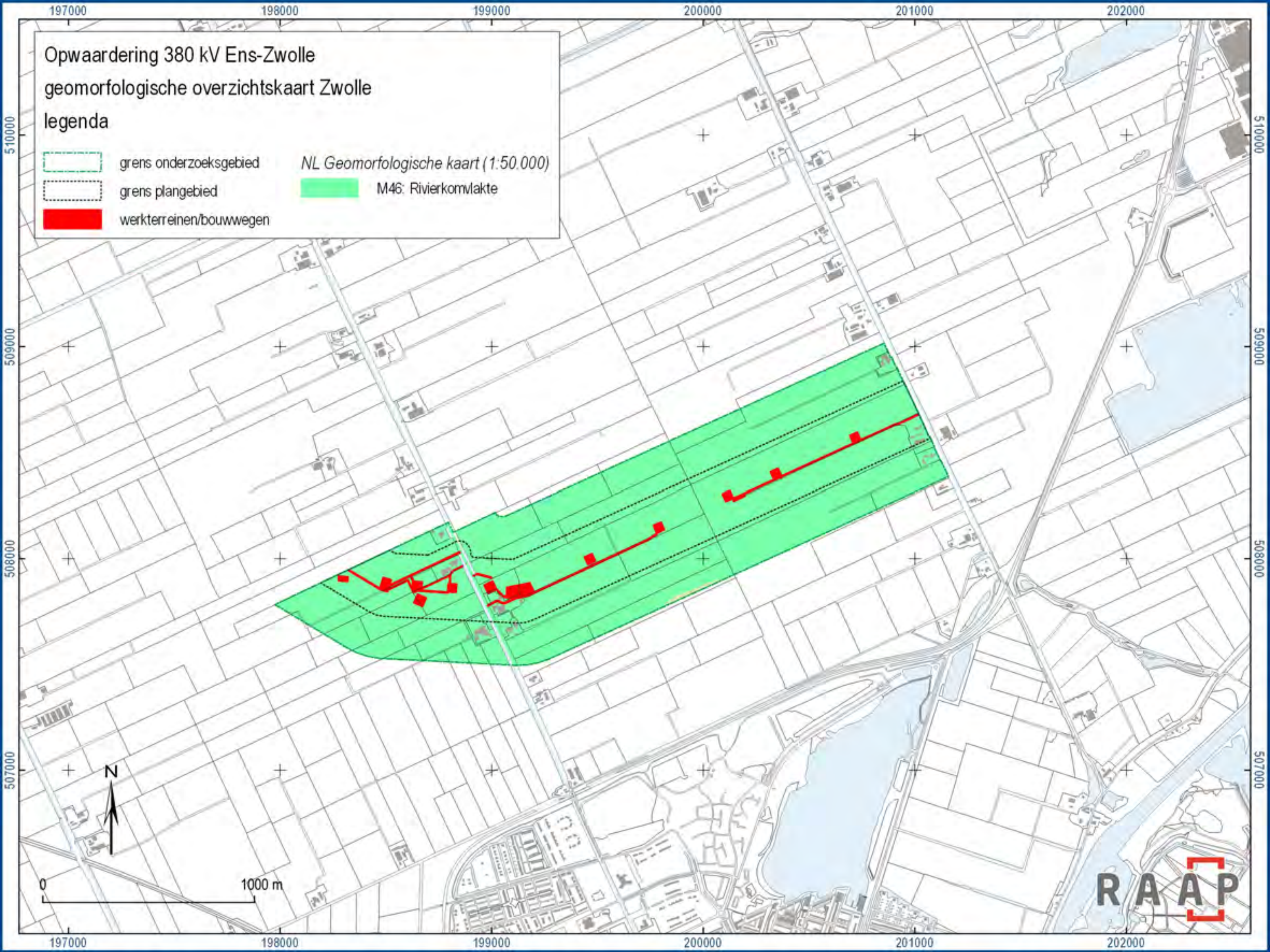
1000 m
RAAP


Opwaardering 380 kV Ens-Zwolle
geomorfologische overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
NL Geomorfologische kaart (1:50.000)
M46: Rivierkomvlakte
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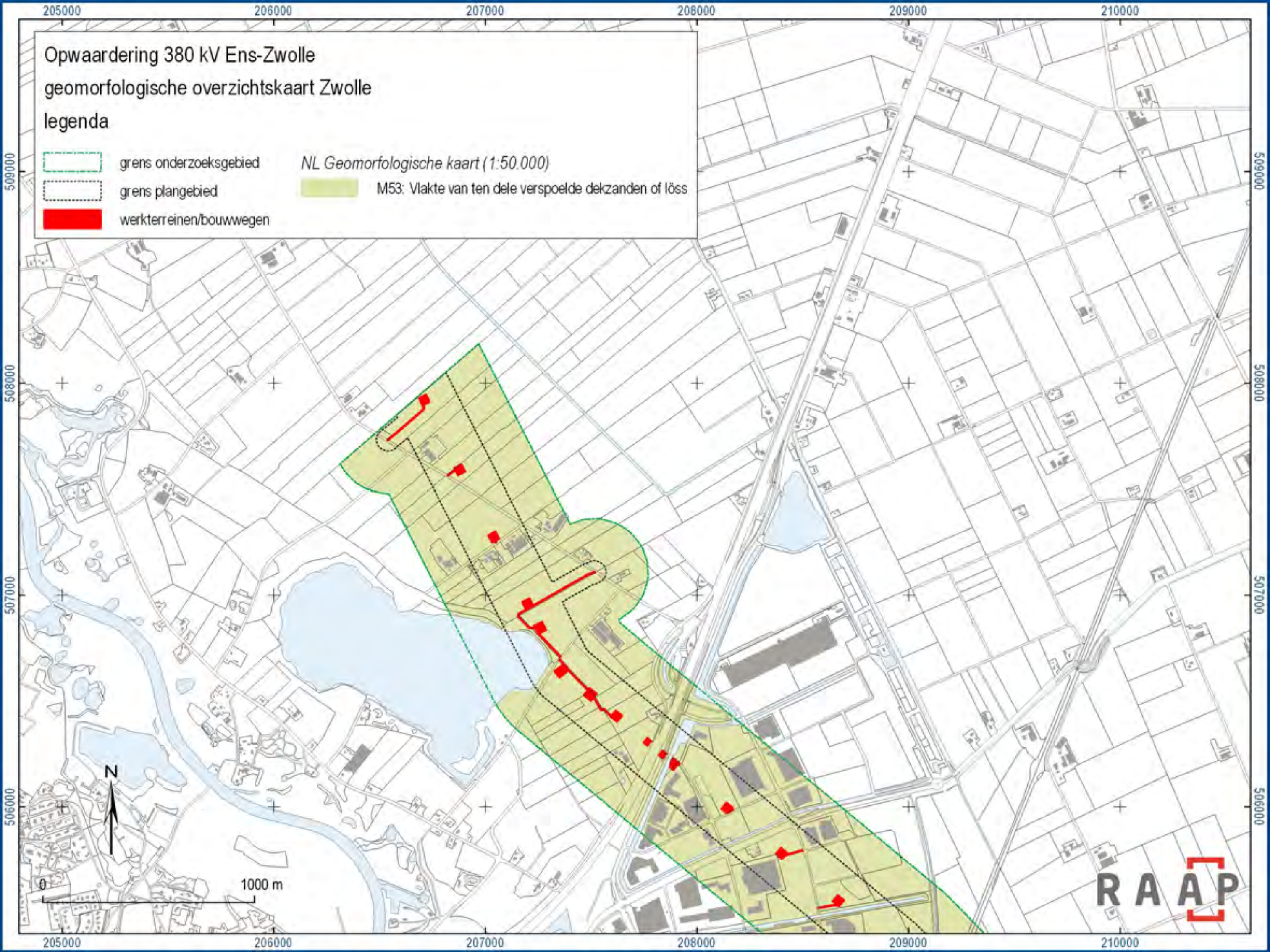
198000
199000
200000
201000
202000
510000
509000
508000
507000
N
0
1000 m
RAAP



Opwaardering 380 kV Ens-Zwolle
geomorfologische overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
NL Geomorfologische kaart (1:50.000)
M53: Vlakte van ten dele verspoelde dekzanden of löss
205000
206000
207000
208000
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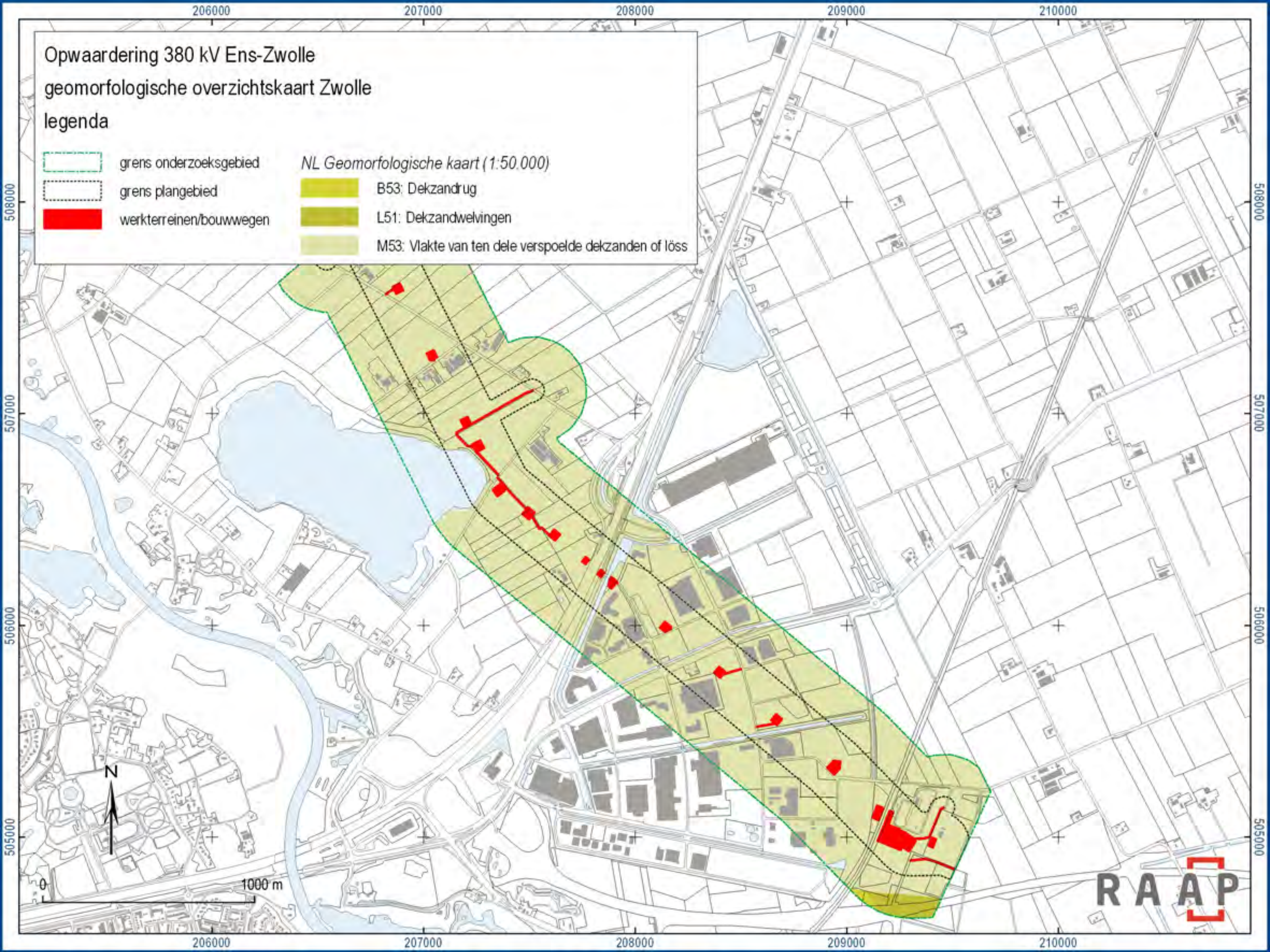
Opwaardering 380 kV Ens-Zwolle
geomorfologische overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
NL Geomorfologische kaart (1:50.000)
B53: Dekzandrug
L51: Dekzandwelvingen
M53: Vlakte van ten dele verspoelde dekzanden of löss
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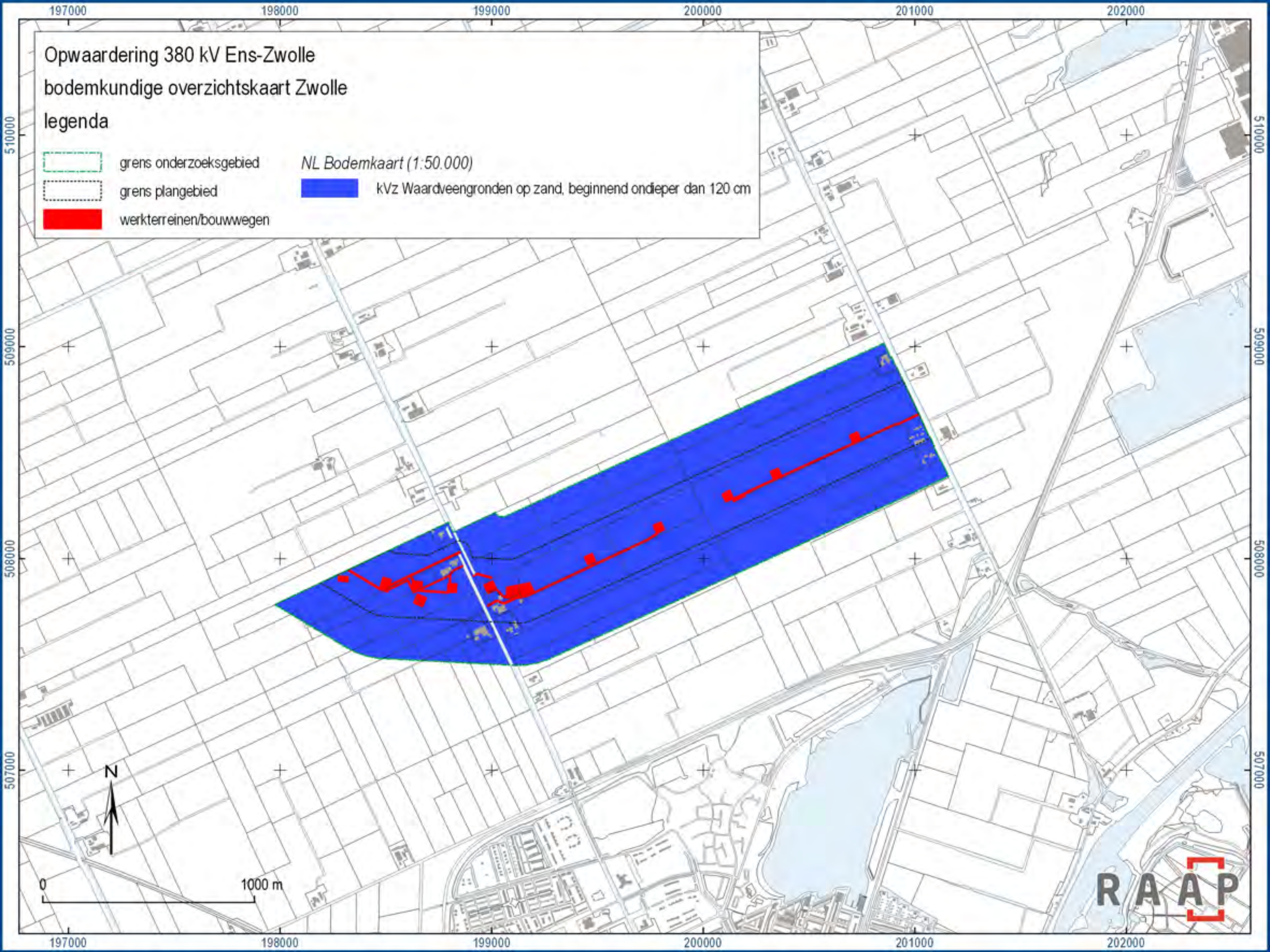

Opwaardering 380 kV Ens-Zwolle
bodemkundige overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
NL Bodemkaart (1:50.000)
kVz Waardveengronden op zand, beginnend ondieper dan 120 cm
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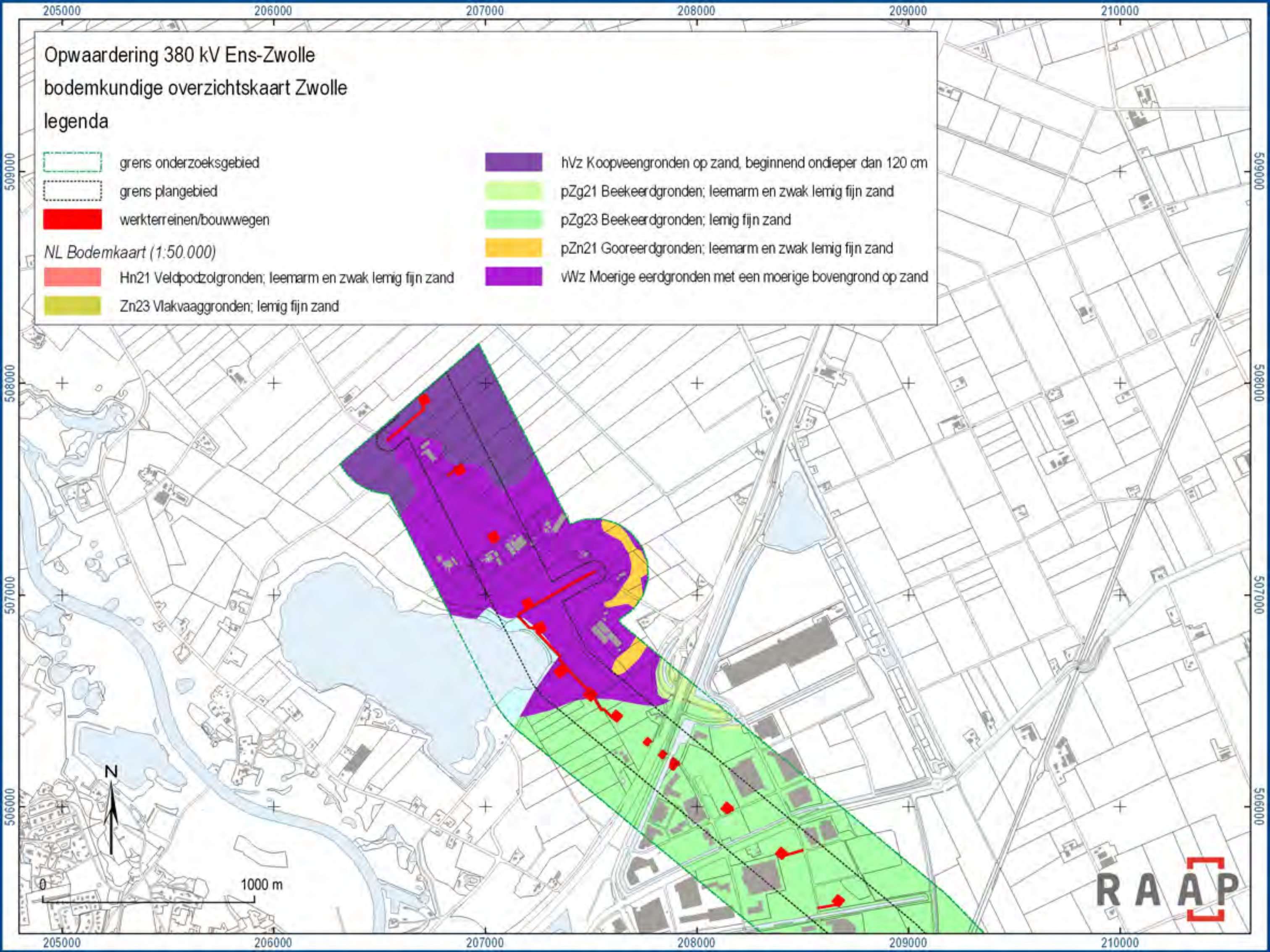
Opwaardering 380 kV Ens-Zwolle
bodemkundige overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
NL Bodemkaart (1:50.000)
Hn21 Veldpodzolgronden; leemarm en zwak lemig fijn zand
Zn23 Vlakvaaggronden; lemig fijn zand
hVz Koopveengronden op zand, beginnend ondieper dan 120 cm
pZg21 Beekeerdgronden; leemarm en zwak lemig fijn zand
pZg23 Beekeerdgronden; lemig fijn zand
pZn21 Gooreerdgronden; leemarm en zwak lemig fijn zand
vWz Moerige eerdgronden met een moerige bovengrond op zand
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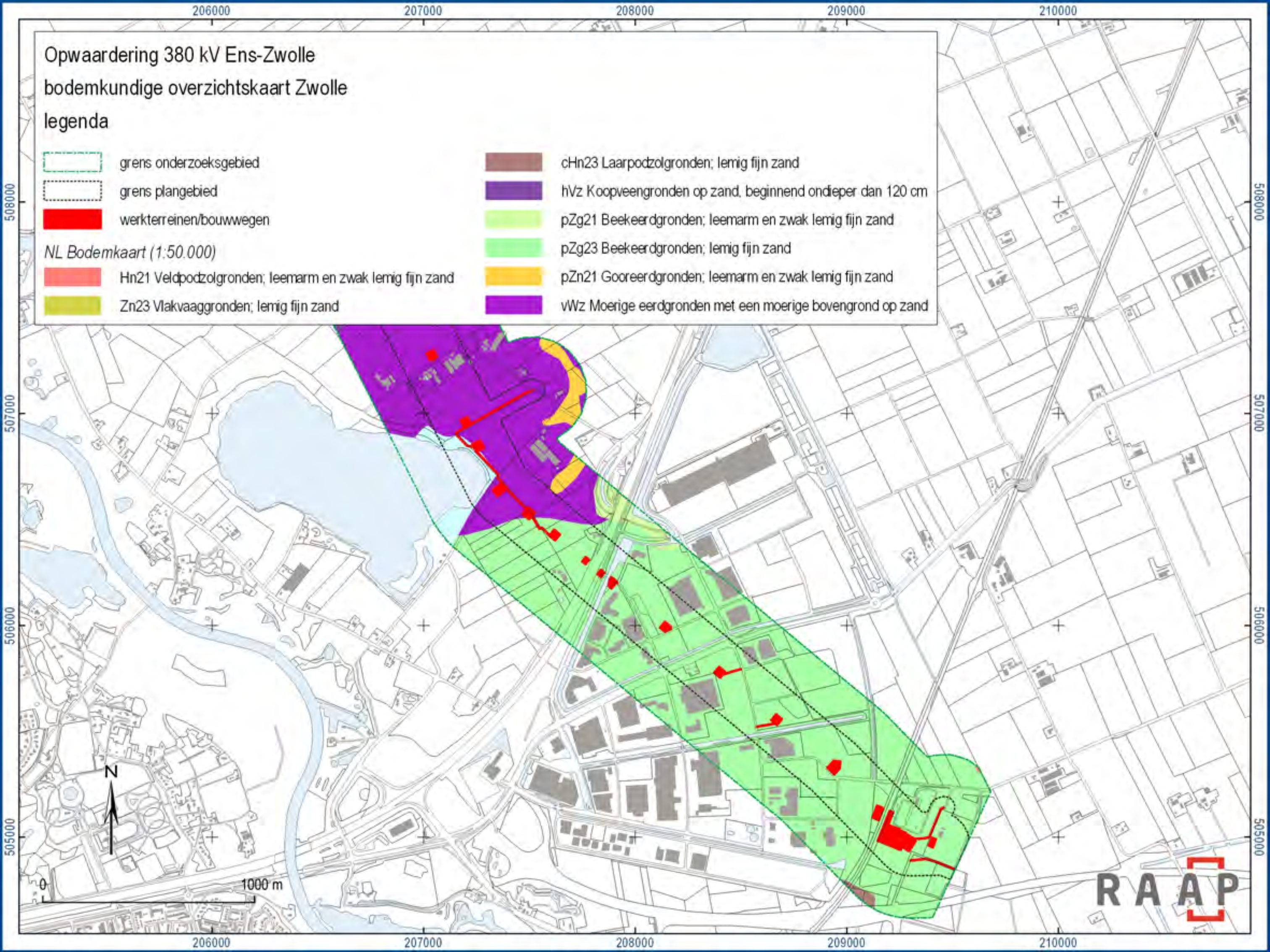
Opwaardering 380 kV Ens-Zwolle
bodemkundige overzichtskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
NL Bodemkaart (1:50.000)
Hn21 Veldpodzolgronden; leemarm en zwak lemig fijn zand
Zn23 Vlakvaaggronden; lemig fijn zand
cHn23 Laarpodzolgronden; lemig fijn zand
hVz Koopveengronden op zand, beginnend ondieper dan 120 cm
pZg21 Beekeerdgronden; leemarm en zwak lemig fijn zand
pZg23 Beekeerdgronden; lemig fijn zand
pZn21 Gooreerdgronden; leemarm en zwak lemig fijn zand
vWz Moerige eerdgronden met een moerige bovengrond op zand
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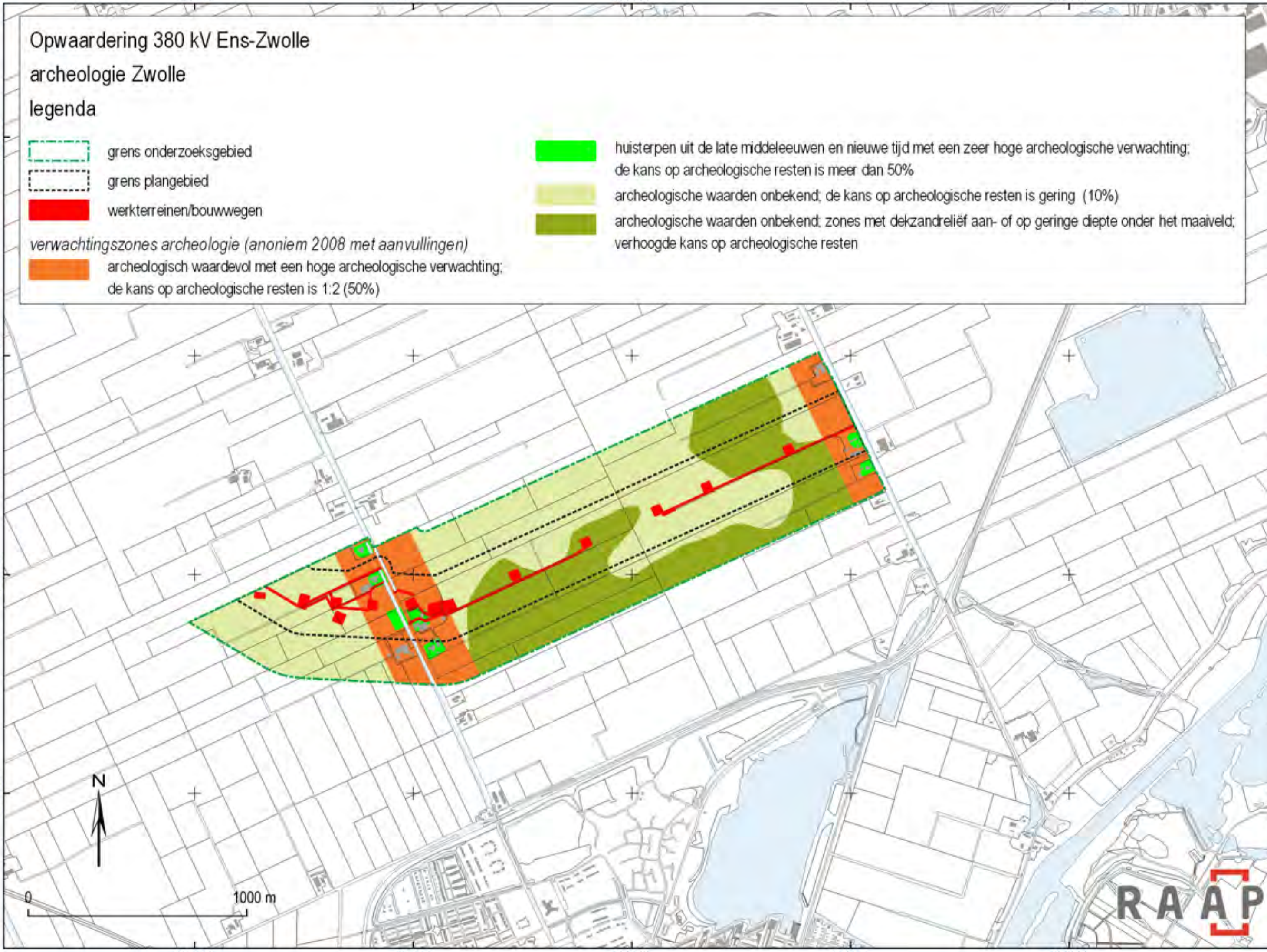
Bijlage 8. Archeologie en cultuurhistorie


Opwaardering 380 kV Ens-Zwolle
archeologie Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
verwachtingszones archeologie (anoniem 2008 met aanvullingen)
archeologisch waardevol met een hoge archeologische verwachting; de kans op archeologische resten is 1:2 (50%)
huisterpen uit de late middeleeuwen en nieuwe tijd met een zeer hoge archeologische verwachting; de kans op archeologische resten is meer dan 50%
archeologische waarden onbekend; de kans op archeologische resten is gering (10%)
archeologische waarden onbekend; zones met dekzandreliëf aan- of op geringe diepte onder het maaiveld; verhoogde kans op archeologische resten
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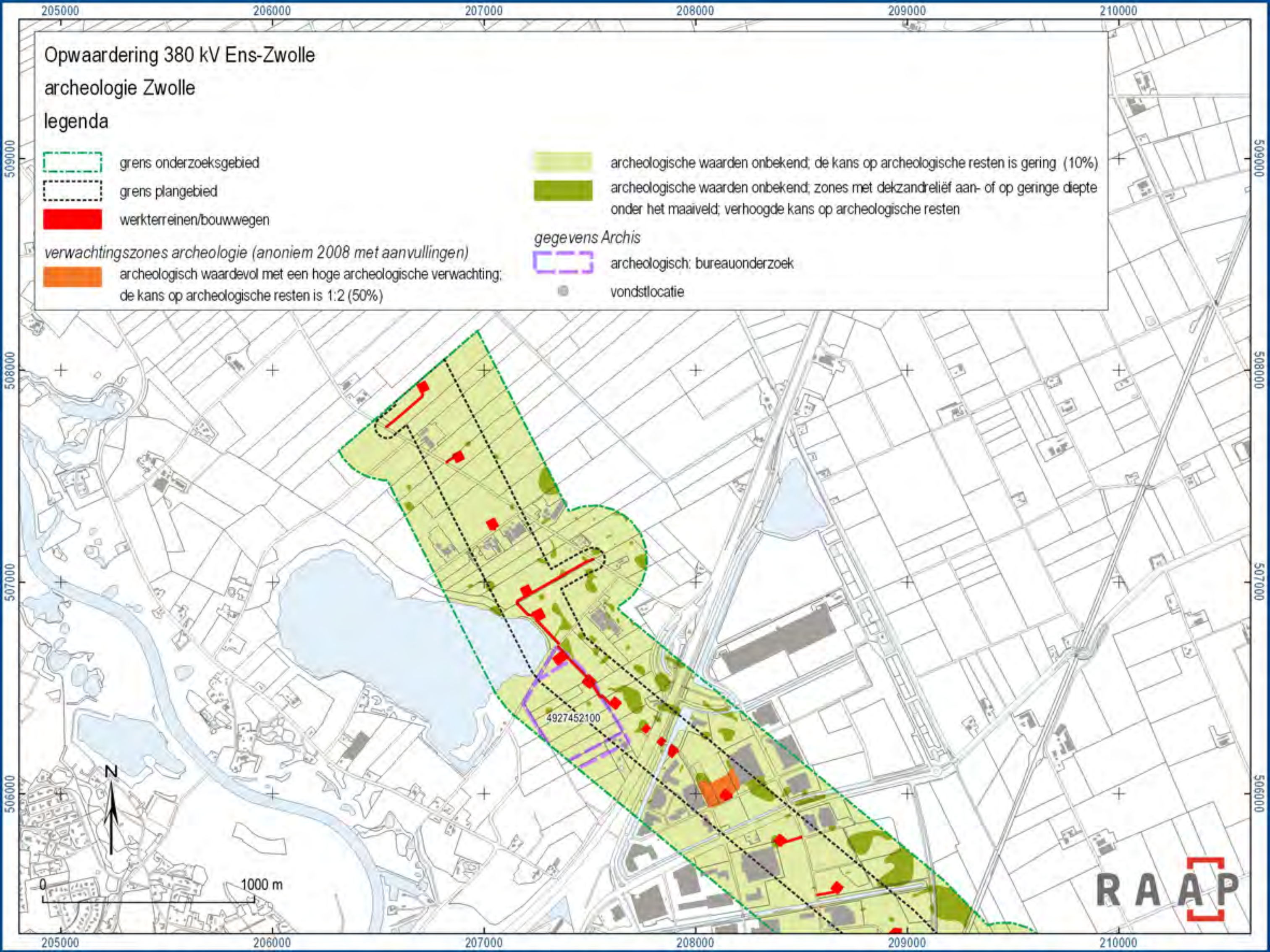

Opwaardering 380 kV Ens-Zwolle
archeologie Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
verwachtingszones archeologie (anoniem 2008 met aanvullingen)
archeologisch waardevol met een hoge archeologische verwachting; de kans op archeologische resten is 1:2 (50%)
archeologische waarden onbekend; de kans op archeologische resten is gering (10%)
archeologische waarden onbekend; zones met dekzandreliëf aan- of op geringe diepte onder het maaiveld; verhoogde kans op archeologische resten
gegevens Archis
archeologisch: bureauonderzoek
vondstlocatie
4927452100
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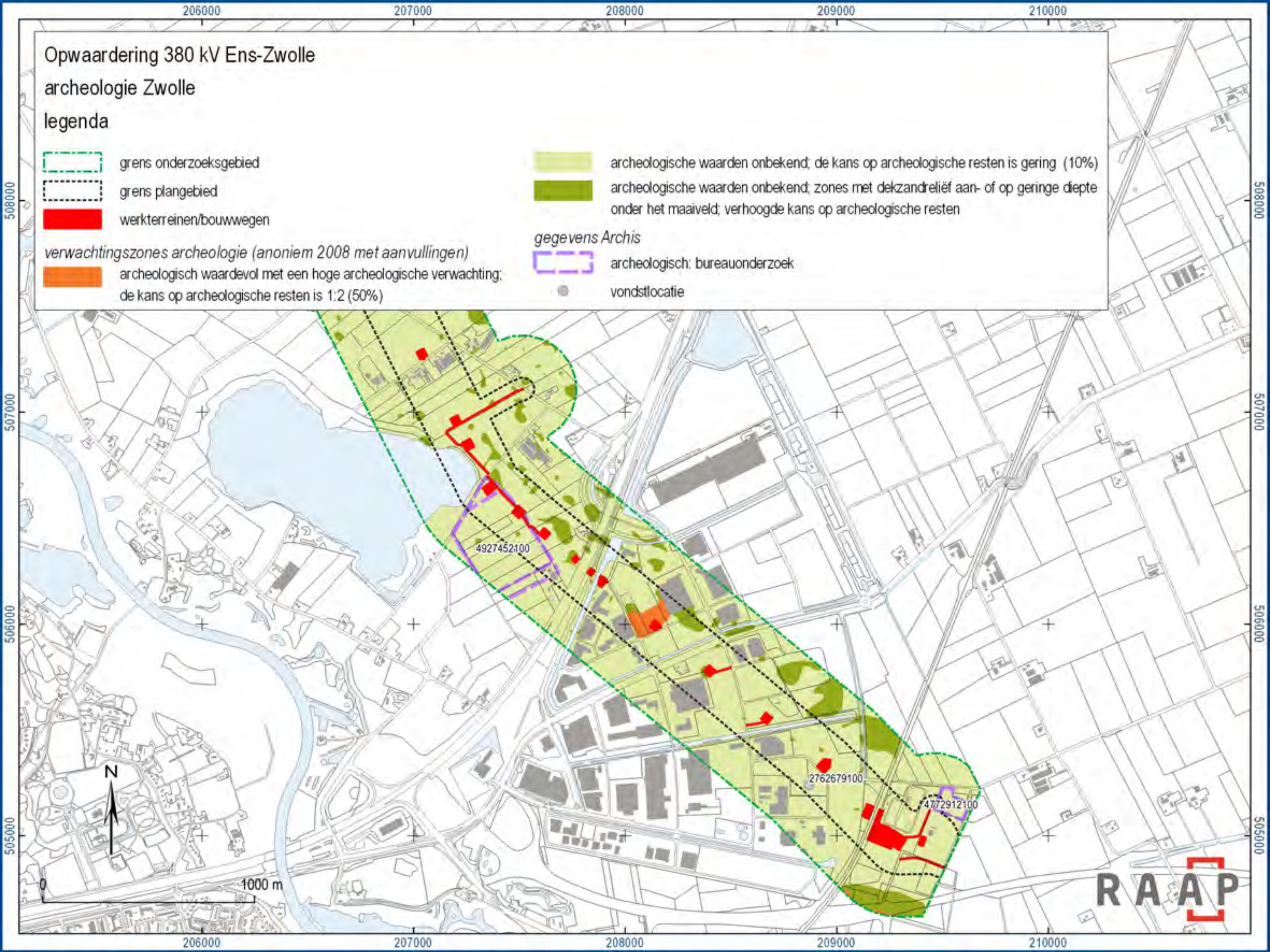

Opwaardering 380 kV Ens-Zwolle
archeologie Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
verwachtingszones archeologie (anoniem 2008 met aanvullingen)
archeologisch waardevol met een hoge archeologische verwachting; de kans op archeologische resten is 1:2 (50%)
archeologische waarden onbekend; de kans op archeologische resten is gering (10%)
archeologische waarden onbekend; zones met dekzandreliëf aan- of op geringe diepte onder het maaiveld; verhoogde kans op archeologische resten
gegevens Archis
archeologisch: bureauonderzoek
vondstlocatie
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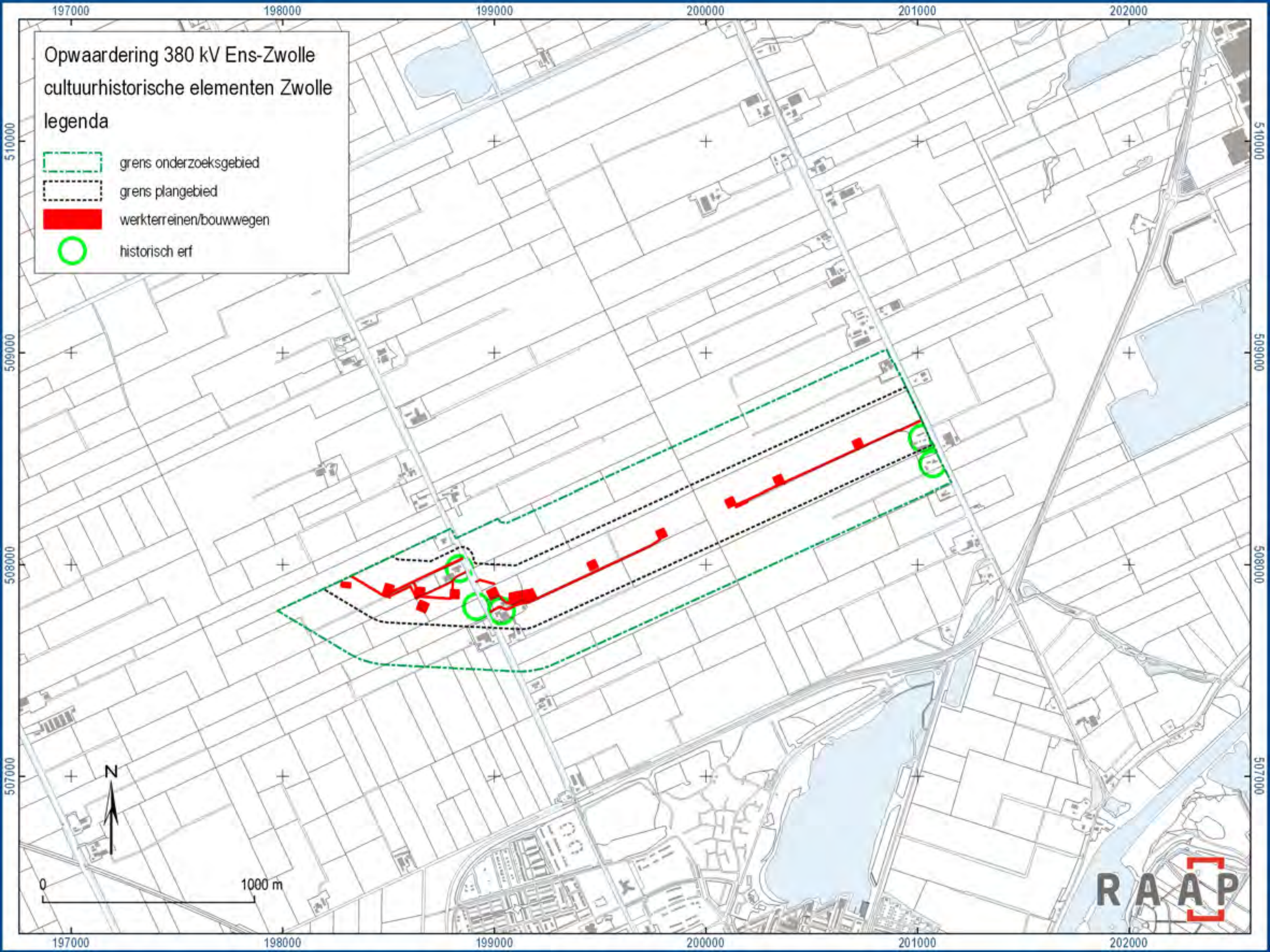

Opwaardering 380 kV Ens-Zwolle
cultuurhistorische elementen Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
historisch erf
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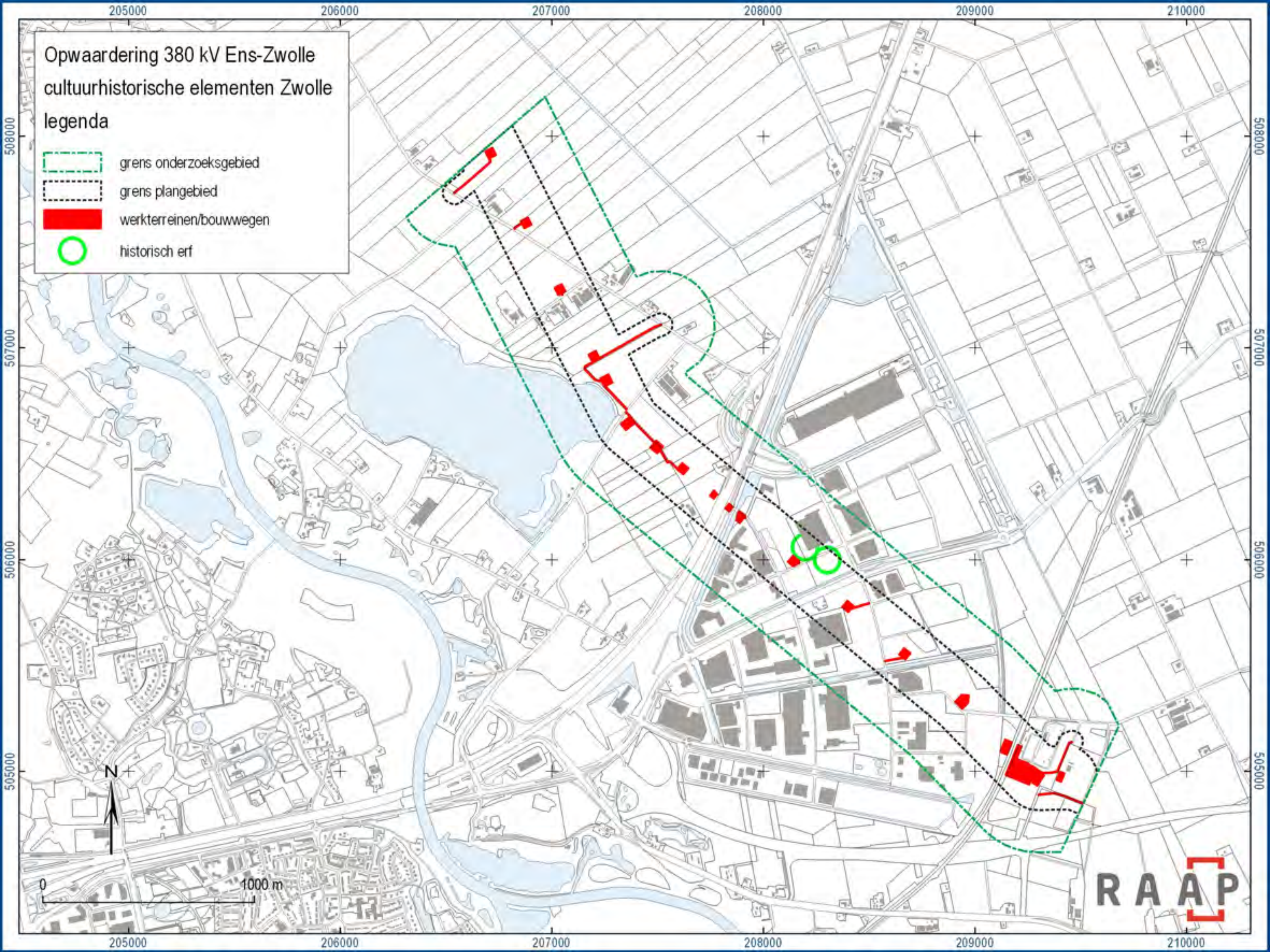
Opwaardering 380 kV Ens-Zwolle
cultuurhistorische elementen Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
historisch erf
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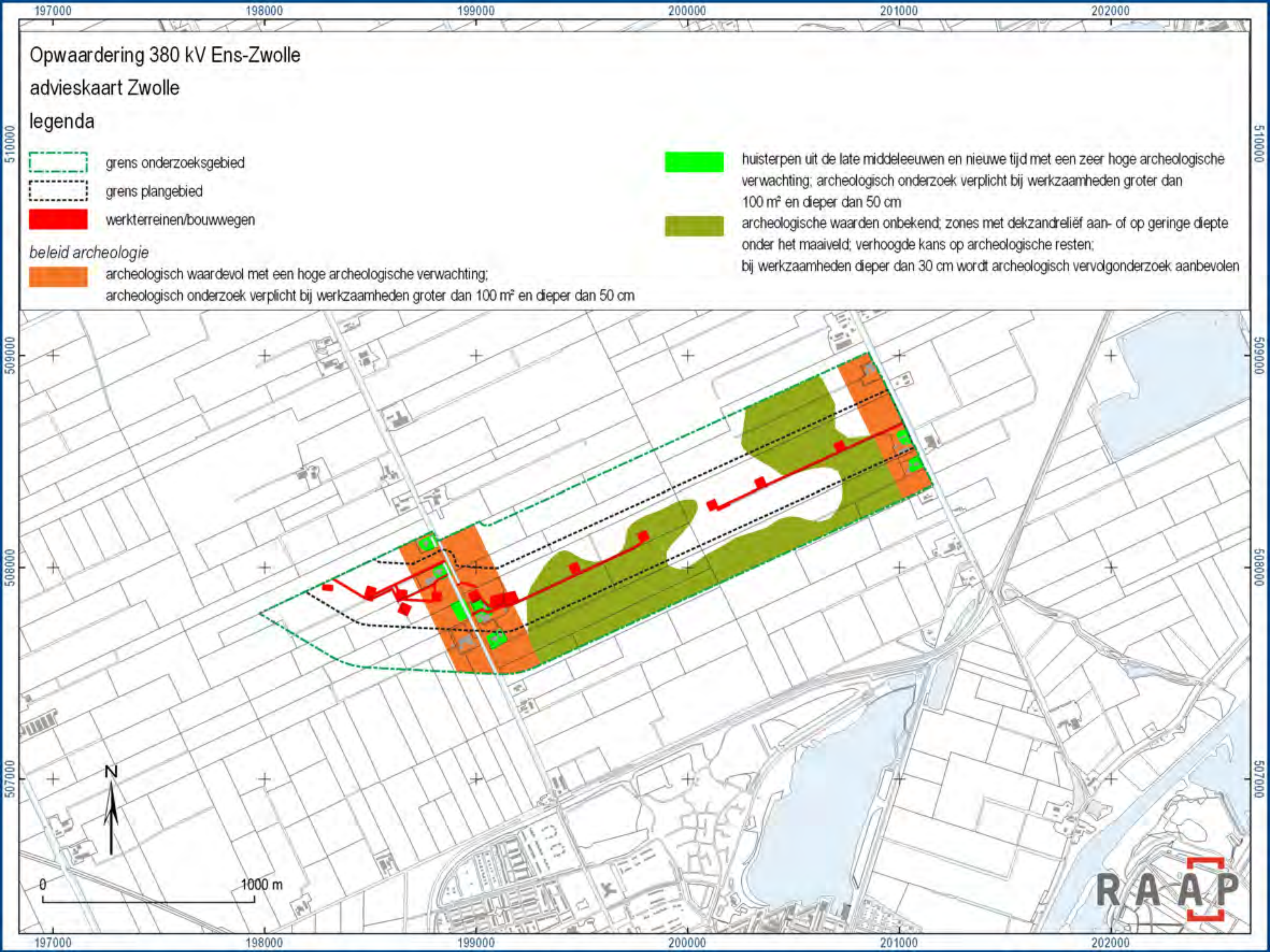
Bijlage 9. Advies


Opwaardering 380 kV Ens-Zwolle
advieskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
beleid archeologie
archeologisch waardevol met een hoge archeologische verwachting; archeologisch onderzoek verplicht bij werkzaamheden groter dan 100 m² en dieper dan 50 cm
huisterpen uit de late middeleeuwen en nieuwe tijd met een zeer hoge archeologische verwachting; archeologisch onderzoek verplicht bij werkzaamheden groter dan 100 m² en dieper dan 50 cm
archeologische waarden onbekend; zones met dekzandreliëf aan- of op geringe diepte onder het maaiveld; verhoogde kans op archeologische resten; bij werkzaamheden dieper dan 30 cm wordt archeologisch vervolgonderzoek aanbevolen
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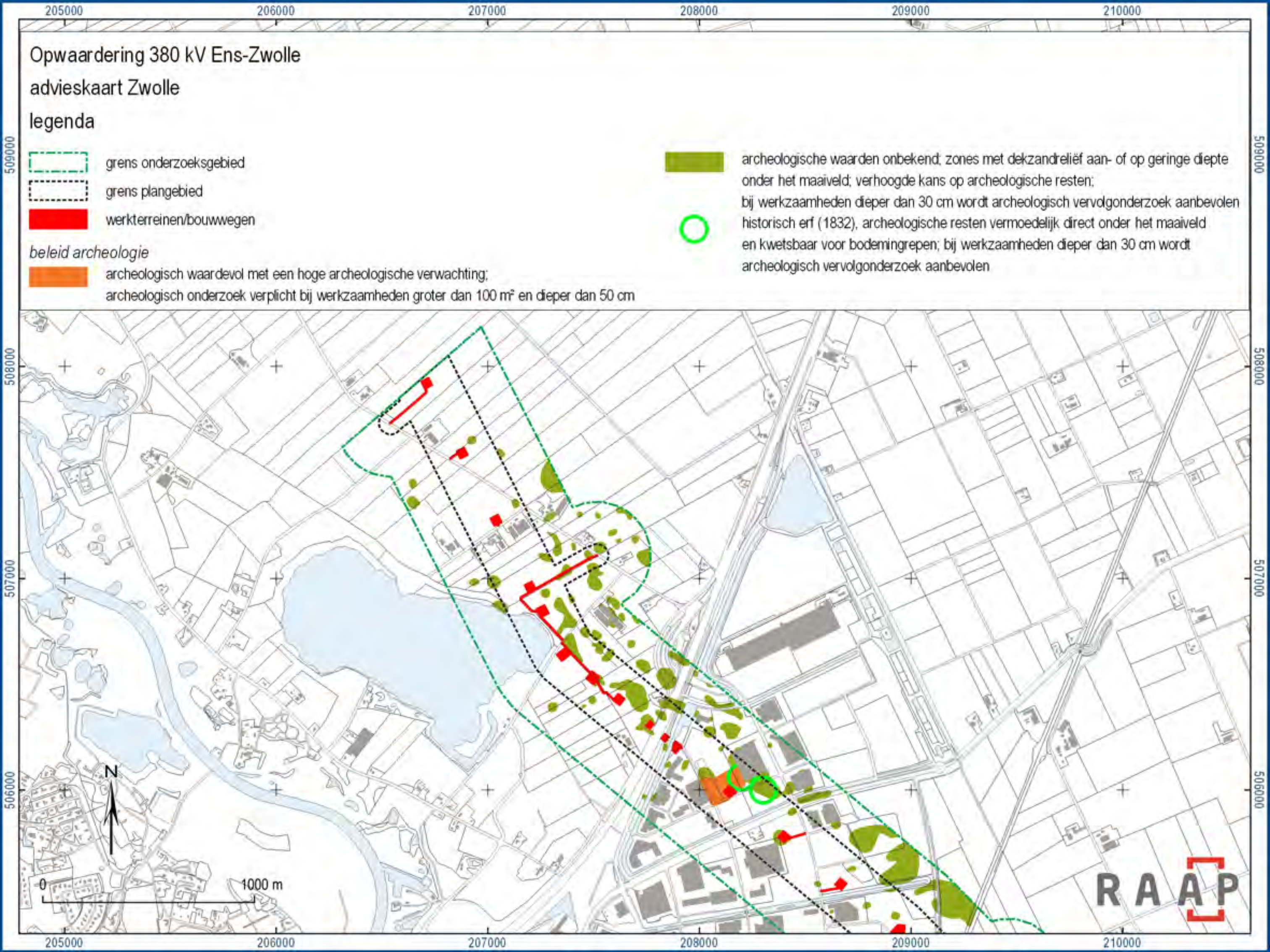
Opwaardering 380 kV Ens-Zwolle
advieskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
beleid archeologie
archeologisch waardevol met een hoge archeologische verwachting;
archeologisch onderzoek verplicht bij werkzaamheden groter dan 100 m² en dieper dan 50 cm
archeologische waarden onbekend; zones met dekzandreliëf aan- of op geringe diepte
onder het maaiveld; verhoogde kans op archeologische resten;
bij werkzaamheden dieper dan 30 cm wordt archeologisch vervolgonderzoek aanbevolen
historisch erf (1832), archeologische resten vermoedelijk direct onder het maaiveld
en kwetsbaar voor bodemingrepen; bij werkzaamheden dieper dan 30 cm wordt
archeologisch vervolgonderzoek aanbevolen
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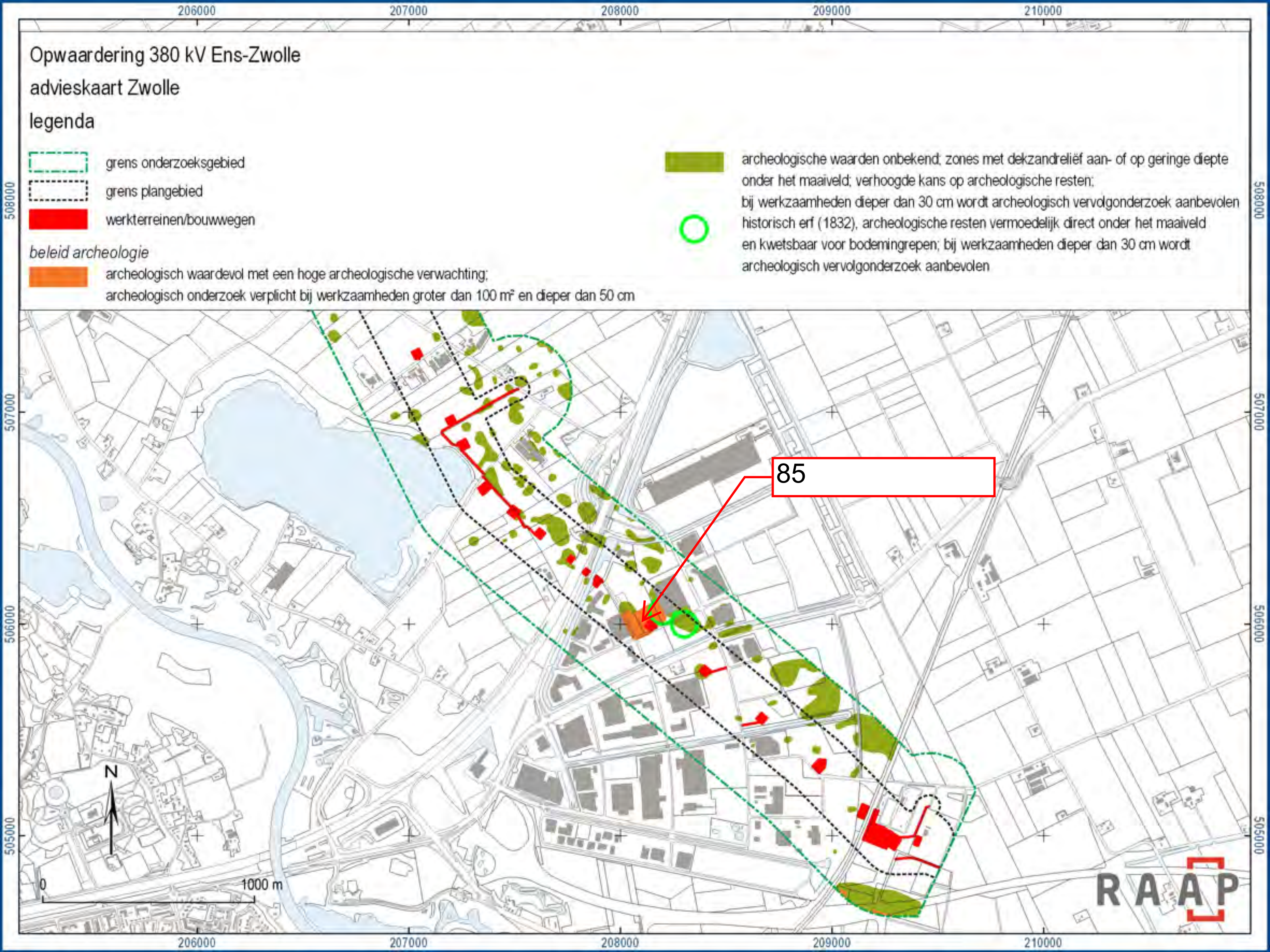
Opwaardering 380 kV Ens-Zwolle
advieskaart Zwolle
legenda
grens onderzoeksgebied
grens plangebied
werkterreinen/bouwwegen
beleid archeologie
archeologisch waardevol met een hoge archeologische verwachting;
archeologisch onderzoek verplicht bij werkzaamheden groter dan 100 m² en dieper dan 50 cm
archeologische waarden onbekend; zones met dekzandreliëf aan- of op geringe diepte
onder het maaiveld; verhoogde kans op archeologische resten;
bij werkzaamheden dieper dan 30 cm wordt archeologisch vervolgonderzoek aanbevolen
historisch erf (1832), archeologische resten vermoedelijk direct onder het maaiveld
en kwetsbaar voor bodemingrepen; bij werkzaamheden dieper dan 30 cm wordt
archeologisch vervolgonderzoek aanbevolen
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Bijlage 7

Natuuronderzoek, verkennend

Rapport

Projectnummer: 375014
Referentienummer: NL21-648800269-11542
Datum: 02-12-2021

Verkennend natuuronderzoek opwaardering 380 kV Ens - Zwolle

Oriënterend natuuronderzoek in het kader van de wet- en regelgeving voor natuur

Status definitief

Opdrachtgever:
TenneT TSO BV
Utrechtseweg 310
6812 AR ARNHEM

Sweco
Rozenburglaan 11
9727 DL Groningen
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9701 JB Groningen

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Groningen
Handelsregister 30129769
Statutair gevestigd te De Bilt

Rietje Klous
Adviseur Ecologie en Milieu

M +31 6 20 13 47 40

SWECO

Verantwoording

Titel	Verkennend natuuronderzoek opwaardering 380 kV Ens - Zwolle
Subtitel	Oriënterend natuuronderzoek in het kader van de wet- en regelgeving voor natuur
Projectnummer	375014/ 51002704
Referentienummer	NL21-648800269-11542
Revisie	D1
Datum	02-12-2021
Auteur	Rietje Klous & Germ Zeephat
E-mailadres	rietje.klous@sweco.nl
Gecontroleerd door	Germ Zeephat
Paraaf gecontroleerd	
Goedgekeurd door	Tim Verver
Paraaf goedgekeurd	

Inhoudsopgave

1 Inleiding

1.1 Aanleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspanningsverbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt. Om die reden is TenneT voornemens de bestaande landelijke 380 kV-ring, de 'ruggengraat' van het landelijk hoogspanningsnet, op te waarderen (programma Beter Benutten Bestaande 380 kV). Binnen het betreffende programma valt ook het deelproject Opwaardering 380 kV-verbinding Ens - Zwolle.

1.2 Kader van het onderzoek

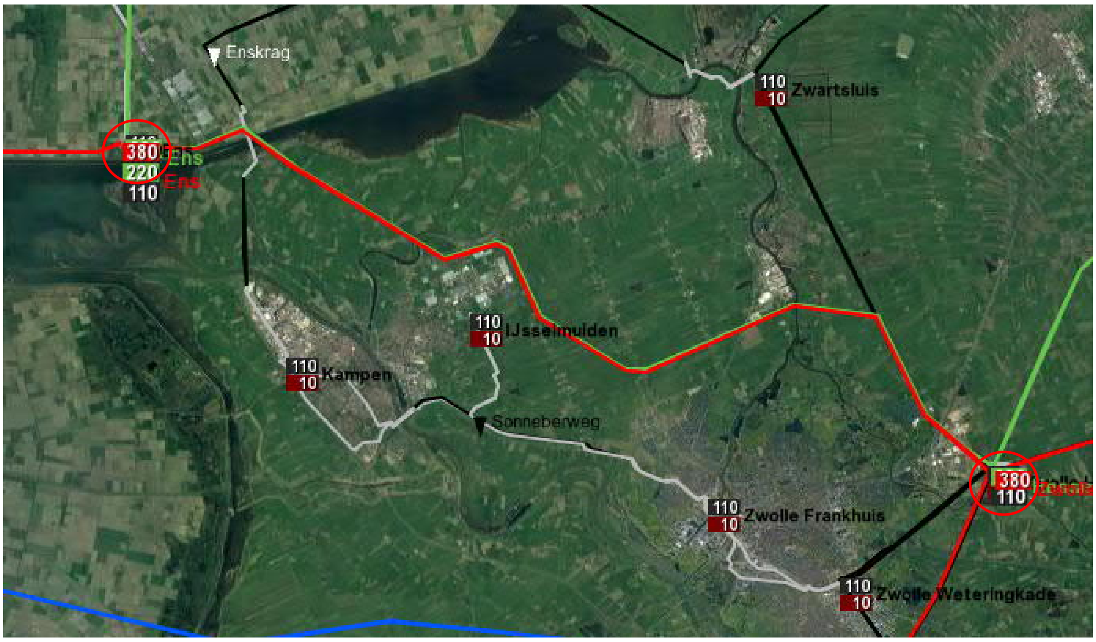
We toetsen de voorgenomen werkzaamheden aan de wet- en regelgeving voor natuur binnen de volgende kaders:

- Wet natuurbescherming:
  - Natura 2000-gebieden;
  - Soorten.
- Provinciaal beleid
  - Natuurnetwerk Nederland (NNN);
  - eventueel gebieden buiten het NNN.

Het verkennend natuuronderzoek is erop gericht een eerste inzicht te krijgen in de mogelijke effecten op beschermde natuurwaarden in en om het projectgebied en de mogelijke vervolgstappen die moeten worden genomen met betrekking tot aanvullend veldonderzoek, nader effectonderzoek en nadere procedures. Het verkennend onderzoek is de eerste stap in de procedure. Afhankelijk van het resultaat, moeten de navolgende stappen al dan niet worden doorlopen. Welke stappen dit zijn, staat beschreven in de effectenanalyse en conclusie van elk hoofdstuk. De resultaten van eventuele vervolgonderzoeken zijn, voor zover al uitgevoerd in deze rapportage verwerkt.

1.3 Ligging en beschrijving plangebied

De scope van de werkzaamheden betreft de bestaande 380 kV hoogspanningsverbinding tussen Zwolle en Ens (figuur 1.1). Onderdeel van de scope zijn 91 mastlocaties, werkterreinen, lierlocaties en aanrijroutes behorend bij de op te waarderen hoogspanningsmasten van het tracé Ens - Zwolle.



Figuur 1.1 De 380 Kv-verbinding Ens-Zwolle (in rood, Ens en Zwolle omcirkeld)

1.4 Voorgenomen ontwikkelingen

Voor de opwaardering van de bestaande 380 kV-verbinding Zwolle-Ens moeten diverse werkzaamheden worden uitgevoerd. In de basis betreft dit het ophangen van nieuwe geleiders met een hogere transportcapaciteit dan de huidige geleiders. De nieuwe geleiders zijn qua omvang en aantal gelijk aan de bestaande maar kunnen meer stroom transporteren doordat ze hogere temperaturen kunnen weerstaan zonder te ver door te gaan hangen. De huidige hoogspanningsverbinding is bovendien inmiddels bijna 35 jaar oud. Om deze reden worden ook andere onderdelen, zoals de isolatorkettingen en bliksemdraden als levensduur verlengende activiteit vervangen. Daarnaast zijn de masten constructief beschouwd en moet bij een aantal masten de fundering versterkt worden.

SWECO

2 Wet natuurbescherming: Natura 2000-gebieden

2.1 Toetsingskader

Bescherming van Natura 2000-gebieden vindt plaats op grond van de Wet natuurbescherming. Onder Natura 2000-gebieden vallen de gebieden die op grond van de Europese Vogelrichtlijn en/of Habitatrichtlijn zijn aangewezen. De essentie van het beschermingsregime voor deze gebieden is dat de duurzame instandhouding van soorten en habitats binnen de Europese Unie wordt gewaarborgd. Daarbij zijn instandhoudingsdoelstellingen geformuleerd voor natuurlijke habitats en/of soorten. Dit kunnen behoudsdoelstellingen zijn voor habitats en leefgebieden van soorten die zich al op het gewenste niveau (kwalitatief en kwantitatief) bevinden of uitbreidings- of verbeterdoelstellingen voor habitats en leefgebieden van soorten die zich nog niet op het gewenste niveau bevinden.

Om dit toetsbaar te maken, kent de Wet natuurbescherming (Wnb) een goedkeuringsvereiste voor plannen die significante gevolgen voor de betreffende gebieden zouden kunnen hebben (artikel 2.7, eerste lid, Wnb), en een vergunningsplicht voor projecten en andere handelingen die (significant) negatieve gevolgen voor de betreffende gebieden zouden kunnen hebben (artikel 2.7, tweede lid, Wnb). De goedkeuring of de vergunning wordt alleen verleend wanneer voldoende zeker is dat de instandhoudingsdoelstellingen voor het betreffende Natura 2000-gebied niet in het geding zijn. Wanneer significante gevolgen voor Natura 2000-gebieden op grond van een passende beoordeling niet kunnen worden uitgesloten, kan alleen goedkeuring aan het plan of een vergunning voor het project worden verleend indien de ADC-toets met succes doorlopen kan worden (artikel 2.8, vierde lid, Wnb). Dat betekent dat het project nodig is omwille van een dwingende reden van groot openbaar belang, er geen alternatief mag zijn met minder grote effecten op Natura 2000 en de nodige compenserende maatregelen worden getroffen.

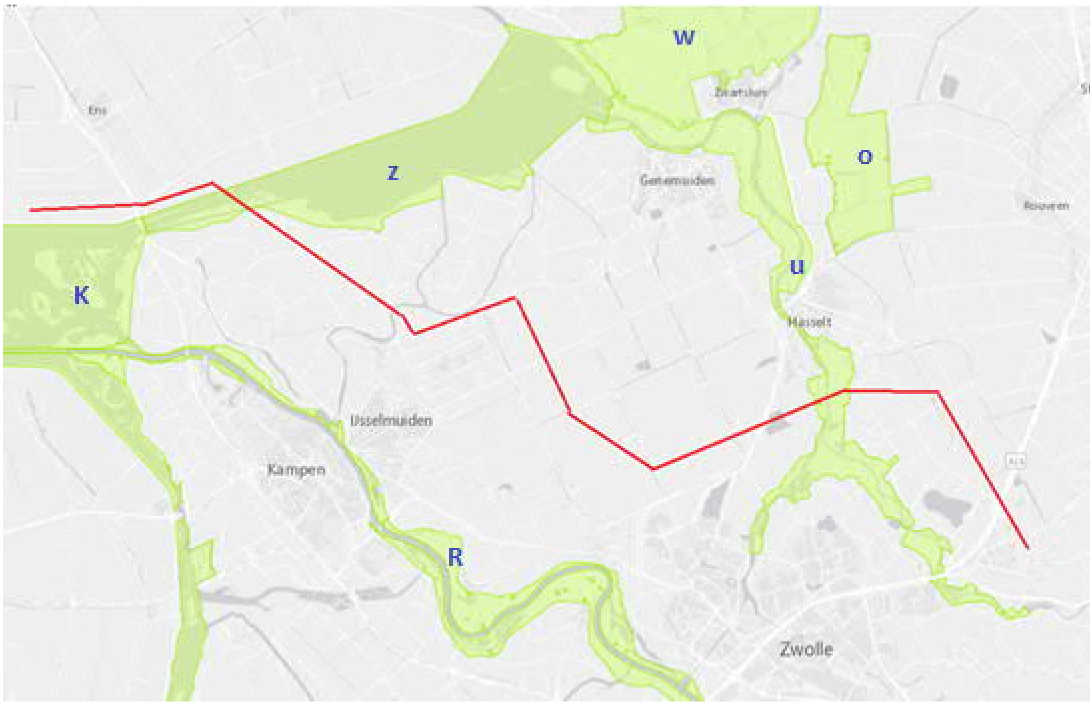
In de navolgende paragrafen is beoordeeld of er effecten op kunnen treden op Natura 2000-gebieden en zo ja, wat de benodigde vervolgstappen zijn.

2.2 Inventarisatie

Voor de inventarisatie van Natura 2000-gebieden is gebruik gemaakt van de Natura 2000-kaart van het ministerie van LNV. Het plangebied ligt grotendeels buiten de begrenzing van Natura 2000-gebieden. De dichtstbijzijnde Natura-2000 gebieden Zwarte meer, Ketelmeer & Vossemeer (HR- en VR-gebied), Rijntakken (HR- en VR-gebied) en Uiterwaarden Zwarte Water en Vecht (HR en VR-gebied) liggen allen binnen enkele km van een deel van het tracé. Een aantal masten ligt binnen of zeer nabij een Natura 2000-gebied (Zwarte meer en Uiterwaarden Zwarte Water en Vecht). In tabel 2.1 is een overzicht van deze afstanden gegeven. In figuur 2.1 is de globale ligging van het tracé ten opzichte van de Natura 2000-gebieden te zien. Op iets grotere afstand liggen HR-gebied Olde Maten & Veerslootslanden (minimaal 3,8 km) en HR en VR-gebied De Wieden (minimaal 6 km).

Tabel 2.1 Afstand van het plangebied tot Natura 2000-gebieden

Natura-2000 gebied	Mast nr.	Afstand
Zwarte meer	12	0 m
	13	35 m
	11	50 m
	6- 10	200 m
Ketelmeer & Vossemeer	1 – 6a	350 m
Rijntakken	49 - 50	3 km
Uiterwaarden Zwarte Water en Vecht	64 - 67	0 m
	63	120 m
	68	150 m



Figuur 2.1 Ligging van het tracé ten opzichte van Natura 2000-gebieden Globaal van links naar rechts: Ketelmeer & Vossemeer (K) Zwarte meer (Z), Rijntakken (R), Uiterwaarden Zwarte Water en Vecht, De Wieden (W) en Olde Maten & Veerslootslanden (O) (transparant groen met blauwe letter).

2.3 Analyse van de mogelijke effecten

2.3.1 Natura 2000-gebied Zwarte meer

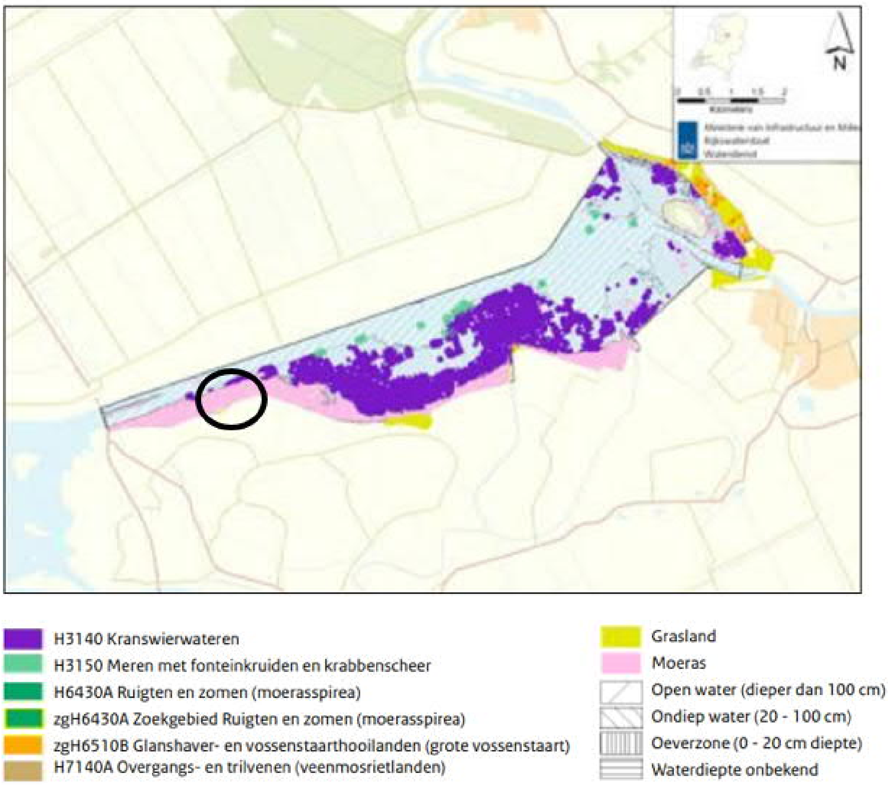
Oppervlakteverlies en versnippering
Mast 12 bevindt zich binnen de begrenzing van Natura 2000-gebied Zwarte meer en is deels gelegen in habtattype H3140 Kranswierwateren en deels in moeras (zie afbeelding 2.2). Omdat de mast vanwege het rietmoeras rondom niet bereikbaar is met materieel, is het nodig om voorafgaande aan de werkzaamheden aan de mast een zandpad aan te leggen. Hierdoor kan mogelijk een deel van het habitattype H3140 Kranswierwateren verloren gaan. Met uitzondering van het aan te leggen pad wordt het werkgebied weer in de oorspronkelijke staat terug gebracht. Van het gedeelte waar het pad wordt aangelegd dient onderzocht te worden of (significant) negatieve effecten op het aangewezen habittatype kunnen optreden.

Verstoring
Verstoring van verstoringsgevoelige dieren door beweging, geluid, trilling en licht gedurende de realisatiefase en gebruiksfase reikt tot maximaal enkele honderden meters ver. De masten 6 t/m 13 bevinden zich op een afstand van nul tot 200 m van Natura 2000 gebied Zwarte meer en staan niet in het water. Verstoring op de aangewezen vissen kan worden uitgesloten, er van uitgaande dat geen trillingen plaatsvinden. Wel kan verstoring van meervleermuis, broedvogels en niet-broedvogels plaatsvinden.

Door de werkzaamheden overdag uit te voeren en geen gebruik te maken van kunstlicht worden negatieve effecten op meervleermuis voorkomen.
Voor de broedvogels geldt dat deze voornamelijk de aanwezige rietvelden zullen gebruiken als broedplaats. Om negatieve effecten op deze soorten te voorkomen dienen de

werkzaamheden buiten het broedseizoen plaats te vinden. In een aanvullende toets moet worden vastgesteld of ook (potentieel) broedgebied verloren gaat door de aanleg van het zandpad.

Verstoring van niet-broedvogels in een klein deel van Natura 2000-gebied Zwarte meer is niet geheel uit te sluiten. Maar omdat de werkzaamheden tijdelijk zijn is er geen sprake van structurele verstoring dat verlies van leefgebied tot gevolg kan hebben. Bij mogelijke verstoring is aan de oostzijde van het plangebied een groot areaal aan geschikt gebied aanwezig, waar rustende vogels gebruik van kunnen maken als tijdelijk alternatief. De omvang van de verstoring ten opzichte van de omvang van het Natura 2000-gebied is erg beperkt. Hierdoor zullen de werkzaamheden waarschijnlijk niet leiden tot significant negatieve effecten op de niet-broedvogels, zeker als de werkzaamheden zoveel mogelijk uitgevoerd worden buiten de kwetsbare periodes (broedseizoen en winterrustseizoen). Maar om uit te sluiten dat significant negatieve effecten op de instandhoudingsdoelen van de niet-broedvogels optreden een aanvullende toets te worden uitgevoerd.

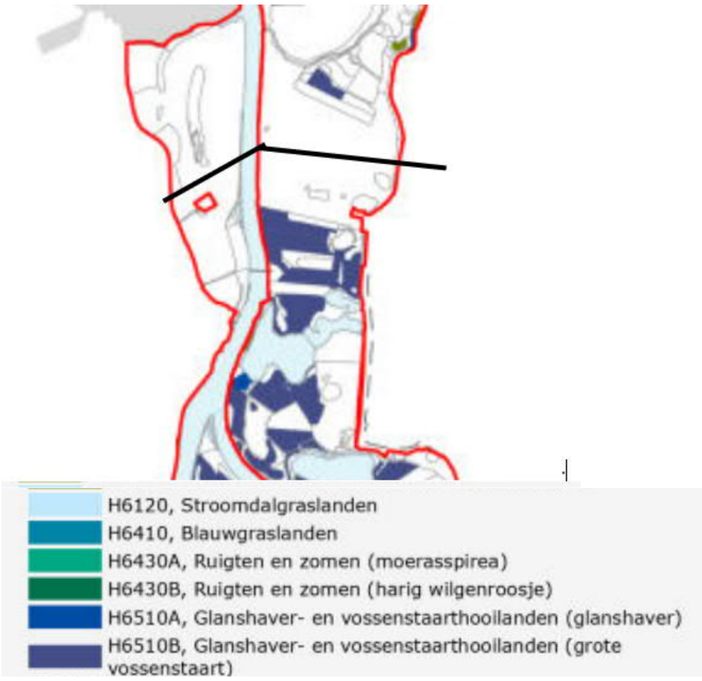


Afbeelding 2.2: habitattypenkaart Natura 2000-gebied Zwarte meer met plangebied zwart omcirkeld.

2.3.2 Natura 2000-gebied Uiterwaarden Zwarte water en Vecht

Oppervlakteverlies en versnippering

De masten 64 t/m 67 bevinden zich binnen de begrenzing van Natura 2000-gebied. Voor deze masten geldt dat na de werkzaamheden de oorspronkelijke situatie weer is hersteld. Rond de masten 64 t/m 67 is bovendien geen habitattype aangewezen (zie afbeelding 2.3). Er is geen sprake van versnippering en oppervlakteverlies ten gevolge van de werkzaamheden.



Afbeelding 2.3: Habitattypenkaart Uiterwaarden Zwarte water en Vecht met het hoogspanningstracé zwart ingetekend.

Verstoring

De masten 64, 65, 66 en 67 bevinden zich binnen de begrenzing van Natura 2000-gebied Uiterwaarden Zwarte water en Vecht en mast 63 en 68 bevinden zich op ruim 100 m afstand van de begrenzing van dit gebied. Tussen de begrenzing van het Natura 2000-gebied en deze masten ligt een weg vanwaar uit structurele verstoring plaatsvindt op het Natura 2000-gebied.
De habitatrichtlijnsoorten, een 4-tal vissoorten (bittervoorn, grote modderkruiper, kleine modderkruiper en rivierdonderpad) zullen geen negatieve effecten ondervinden van de werkzaamheden, aangezien niet in open water wordt gewerkt en geen trillingen ontstaan die negatief effect kunnen veroorzaken.

Wel kan mogelijk verstoring ontstaan voor broedvogels en niet-broedvogels. Om verstoring van broedvogels tegen te gaan wordt gewerkt buiten het broedseizoen (halverwege maart tot halverwege augustus). Verstoring van niet-broedvogels kan niet geheel worden uitgesloten. Maar omdat de werkzaamheden aan de vier masten binnen de begrenzing tijdelijk zijn, is er waarschijnlijk geen sprake van structurele verstoring en daardoor geen verlies van leefgebied. Er is nabij het plangebied een groot areaal aan graslanden, uiterwaarden en rietmoeras aanwezig, dat als alternatief kan dienen, voor rustende of foeragerende vogels. Het mogelijk verstoorde areaal rond de masten in het plangebied is dermate klein ten opzichte van de omvang van het Natura 2000-gebied dat de werkzaamheden waarschijnlijk niet zullen leiden tot significant negatieve effecten op de niet-broedvogels, uitgaande van uitvoering van de werkzaamheden buiten de kwetsbare periodes (broedseizoen en winterrustseizoen).
Voor de masten 63 en 68 die buiten de begrenzing van het Natura 2000-gebied staan geldt bovendien dat de tussen de masten en het Natura 2000-gebied aanwezige weg al zorgt voor een zeker geluidsniveau dat door de werkzaamheden niet permanent zal worden overstegen. De aanvullende verstoring ten gevolge van de werkzaamheden aan de masten 63 en 68 is naar verwachting gering en zal waarschijnlijk niet tot significant negatieve effecten leiden op niet-broedvogels.

Om uit te kunnen sluiten of significant negatieve effecten op de instandhoudingsdoelen van de niet-broedvogels optreden dient een aanvullende toets te worden uitgevoerd

2.3.3 Stikstofdepositie

Bij de uitvoering van de werkzaamheden wordt gebruik gemaakt van verschillend materieel dat gepaard gaat met stikstofemissie, zoals kranen en lierwagens. Stikstofdepositie als gevolg van de inzet van werktuigen is naar verwachting erg beperkt, gezien de tijdelijke aard van de werkzaamheden. Per 1 juli 2021 voorziet de Wet stikstofreductie en natuurverbetering in een partiële vrijstelling van de vergunningplicht voor stikstofemissies afkomstig van bouw- en sloopwerkzaamheden. De werkzaamheden aan de masten kunnen conform de huidige wetgeving vanaf die datum buiten beschouwing worden gelaten voor de beoordeling van de vergunningplicht. In de nieuwe situatie vindt geen stikstofuitstoot plaats.

2.4 Conclusie

Voor de werkzaamheden bij mast 12 dient een nadere toets uitgevoerd te worden om vast te stellen of de aanleg van het zandpad om de mast te bereiken leidt tot significant negatieve effecten op aangewezen habitattypen, broedareaal voor de aangewezen broedvogels en verstoring van niet-broedvogels.

Voor alle masten in of nabij de Natura 2000-gebieden Zwarte meer en Uiterwaarden Zwarte water en Vecht is het uitgangspunt dat de werkzaamheden uitgevoerd worden buiten het broedseizoen. Voor mogelijk significante verstoring van niet-broedvogels in deze Natura 2000-gebieden een aanvullende toets te worden uitgevoerd om uit te kunnen sluiten of significant negatieve effecten op de instandhoudingsdoelen van de niet-broedvogels optreden.

3 Wet natuurbescherming: soortenbescherming

3.1 Toetsingskader

In de Wet natuurbescherming (Wnb) is de soortenbescherming in Nederland geregeld. Hierbij worden drie verschillende beschermingsregimes gehanteerd waaraan verschillende verbodsbepalingen zijn gekoppeld:

Soorten Vogelrichtlijn (artikel 3.1 e.v.):

- lid 1) Het is verboden opzettelijk van nature in Nederland in het wild levende vogels van soorten als bedoeld in artikel 1 van de Vogelrichtlijn te doden of te vangen;
- lid 2) Het is verboden opzettelijk nesten, rustplaatsen en eieren van vogels als bedoeld in het eerste lid te vernielen of te beschadigen, of nesten van vogels weg te nemen;
- lid 3) Het is verboden eieren van vogels als bedoeld in het eerste lid te rapen en deze onder zich te hebben;
- lid 4) Het is verboden vogels als bedoeld in het eerste lid opzettelijk te storen;
- lid 5) Het verbod, bedoeld in het vierde lid, is niet van toepassing indien de storing niet van wezenlijke invloed is op de staat van instandhouding van de desbetreffende vogelsoort.

Soorten Habitatrichtlijn (artikel 3.5 e.v.):

- lid 1) Het is verboden in het wild levende dieren van soorten, genoemd in bijlage IV, onderdeel a, bij de Habitatrichtlijn, bijlage II bij het Verdrag van Bern of bijlage I bij het Verdrag van Bonn, in hun natuurlijk verspreidingsgebied opzettelijk te doden of te vangen;
- lid 2) Het is verboden dieren als bedoeld in het eerste lid opzettelijk te verstoren;
- lid 3) Het is verboden eieren van dieren als bedoeld in het eerste lid in de natuur opzettelijk te vernielen of te rapen;
- lid 4) Het is verboden de voortplantingsplaatsen of rustplaatsen van dieren als bedoeld in het eerste lid te beschadigen of te vernielen;
- lid 5) Het is verboden planten van soorten, genoemd in bijlage IV, onderdeel b, bij de Habitatrichtlijn of bijlage I bij het Verdrag van Bern, in hun natuurlijke verspreidingsgebied opzettelijk te plukken en te verzamelen, af te snijden, te ontwortelen of te vernielen.

Andere soorten (artikel 3.10 e.v.):

- lid 1) Onverminderd artikel 3.5, eerste, vierde en vijfde lid, is het verboden:
    - onderdeel a. in het wild levende zoogdieren, amfibieën, reptielen, vissen, dagvlinders, libellen en kevers van de soorten, genoemd in de bijlage, onderdeel A, bij deze wet, opzettelijk te doden of te vangen;
    - onderdeel b. de voortplantingsplaatsen of rustplaatsen van dieren als bedoeld in onderdeel a opzettelijk te beschadigen of te vernielen, of
    - onderdeel c. vaatplanten van de soorten, genoemd in de bijlage, onderdeel B, bij deze wet, in hun natuurlijke verspreidingsgebied opzettelijk te plukken en te verzamelen, af te snijden, te ontwortelen of te vernielen.

Voor *Vogelrichtlijn- en Habitatrichtlijnsoorten* geldt dat voortplantings- en rustplaatsen (inclusief functionele leefomgeving) van beschermde soorten niet opzettelijk verstoord of vernietigd mogen worden en dat exemplaren van beschermde soorten niet opzettelijk mogen worden gedood of verwond.
Voor *Andere soorten* geldt dat voortplantingsplaatsen en rustplaatsen (inclusief functionele leefomgeving) van beschermde soorten niet (opzettelijk) vernietigd mogen worden en dat exemplaren van beschermde soorten niet (opzettelijk) mogen worden gedood of verwond.

Verbodsbepalingen ten aanzien van de verstoring zijn niet van toepassing op deze soorten. Ten aanzien van de andere beschermde soorten geldt dat het bevoegd gezag (provincies c.q. ministerie van LNV) de vrijheid hebben om soorten binnen deze categorie vrij te stellen van de verbodsbepalingen uit artikel 3.10 Wet Natuurbescherming.

Voor beschermde soorten die niet zijn vrijgesteld en de voorgenomen activiteiten strijdig zijn met de bepalingen in de wet, geldt een ontheffingsplicht. Een ontheffing kan alleen worden verleend, indien de gunstige staat van instandhouding niet in het geding is. Voor vogels geldt in afwijking hierop dat voor verstoring geen ontheffing nodig is, indien de gunstige staat van instandhouding niet in het geding is. Het is mogelijk om ten aanzien van Andere soorten te werken volgens een goedgekeurde gedragscode die is afgestemd op de Wnb, mits de voorgenomen activiteit als zodanig in de gedragscode is beschreven. Er is dan geen ontheffingsplicht van toepassing.

Naast bepalingen voor specifiek aangewezen soorten geldt krachtens artikel 1.11 (lid 1 & 2) van de Wet natuurbescherming, de algemene zorgplicht voor alle in het wild levende dieren en planten alsmede voor hun directe leefomgeving. Via deze wet wordt eenieder medeverantwoordelijk gesteld voor de zorg en bescherming van flora en fauna.

3.2 Methode

De inventarisatie betreft een onderzoek naar de actueel en potentieel voorkomende beschermde soorten in het tracé. Hierbij maken we onderscheid tussen het bronnenonderzoek en een verkennend veldbezoek. Tijdens het laatste vindt tevens een habitatgeschiktheidsbeoordeling plaats.

Bronnenonderzoek

Het bronnenonderzoek heeft als doel een overzicht te verkrijgen van de beschikbare informatie met betrekking tot het voorkomen van beschermde soorten in het plangebied en omgeving. Hiervoor zijn de volgende bronnen gebruikt:

- landelijke (digitale) verspreidingsatlassen (waaronder de NDFF, periode 2016-2021);
- regionale verspreidingsatlassen.

Habitatgeschiktheidsbeoordeling

Op basis van een oriënterend veldbezoek is de geschiktheid van biotopen voor beschermde soorten beoordeeld. Deze beoordeling brengt samen met het bronnenonderzoek de beschermde soorten(groepen) in beeld die in het tracé (kunnen) voorkomen. De veldbezoeken hebben plaats gevonden in november en december 2020 en zijn uitgevoerd door Rietje Klous en Germ Zeephat, beide deskundig ecologen van Sweco. Uitgangspunt bij de inventarisatie is geweest dat, waar mogelijk de omliggende sloten intact blijven en de werkzaamheden vanaf de droge percelen worden uitgevoerd. In enkele gevallen kan, bijvoorbeeld ten behoeve van een tijdelijke bouwweg, een tijdelijke dam met duiker nodig zijn. Voor deze gevallen wordt vooraf beoordeeld of nader onderzoek nodig is of dat werken volgens voorgeschreven maatregelen (ecologisch werkprotocol) afdoende is.

Analyse en toetsing van mogelijke effecten

Op basis van het bronnenonderzoek en de habitatgeschiktheidsbeoordeling wordt een inschatting gemaakt in hoeverre de te verwachten soort(groepen)en en/of het geschikte biotoop beïnvloed wordt door de voorgenomen activiteit. Hieruit wordt duidelijk voor welke soort(groepen) er nader (veld)onderzoek en eventueel ontheffingsplicht in kader van de Wnb noodzakelijk is. Het onderzoek beperkt zich tot op grond van de Wnb beschermde planten- en diersoorten. Niet-beschermde Rode lijst-soorten die in het plangebied (kunnen) voorkomen zoals diverse soorten paddenstoelen en vaatplanten worden niet in het onderzoek betrokken, omdat deze soorten niet relevant zijn voor toetsing aan de Wnb.

Leeswijzer resultaten
Om de resultaten overzichtelijk te maken en de leesbaarheid te bewaren zijn de resultaten van het onderdeel soortenbescherming in paragraaf 3.2 weergegeven in een tabel (3.1). in de tabel wordt per locatie aangegeven:

- wat het ecotoop is,
- of er waarnemingen bekend zijn van beschermde soorten,
- of deze, of andere, beschermde soorten hier te verwachten zijn aan de hand van het aanwezige ecotoop en,
- of er nader onderzoek noodzakelijk is naar de aanwezigheid van deze soorten (betreffende masten zijn rood gemarkeerd).

Uitgevoerd aanvullend onderzoek is beschreven in paragraaf 3.4.

In de tabel zijn ook lierlocaties vermeld. Omdat de lierlocaties in het door TenneT aangeleverde mastenboek ongenummerd zijn, zijn ze vermeld bij het dichtstbijzijnde mastnummer.

Binnen de scope van het verkennend onderzoek vallen ook de toegangswegen naar de mast- en lierlocaties. Resultaten hiervan worden meegenomen in de beoordeling van de locaties zelf en worden niet apart beschreven.

De aangeleverde werkvlakken vallen in een aantal gevallen over een sloot of moerasgebied heen. Uitgangspunt hierbij is dat de werkzaamheden zoveel mogelijk uitgevoerd zullen worden vanaf de droge percelen rondom de hoogspanningsmast. Als dit niet kan en een tijdelijke demping moet plaatsvinden, wordt vooraf beoordeeld of nader onderzoek nodig is of dat werken volgens voorgeschreven maatregelen (ecologisch werkprotocol) afdoende is.

3.3 Resultaten

Tabel 3.1 Resultaten veld-en bronnenonderzoek masten- en lierlocaties (in rood de masten waar een nest is aangetroffen)

Locatie	Ecotoop	Veldwaarnemingen	Nader onderzoek	Bekende waarnemingen	Geschikt habitat
Mast 1+lier	Grasland + Akkerland	-	Nee	Gewone- ruige- en kleine dwergvleermuis, rosse vleermuis, bever, otter. Boomvalk, buizerd, gierzwaluw, havik, huismus, kerkuil, ransuil, roek, sperwer, rugstreeppad, grote modderkruiper	Vleermuizen, vogels
Mast 2	Agrarisch grasland	Slechtvalk	Nee		
Mast 3	Akkerland	Nest, 2e traverse noordzijde	Ja, gebruik nest		
Mast 4	Akkerland	-	Nee		
Mast 5	Akkerland	Buizerd	Nee		
Mast 5a+lier	Verruigd grasland	Nest, 2e traverse zuidzijde	Ja, gebruik nest		
Mast 6a+lier	Gemaaid grasland	-	Nee		
Mast 7	Agrarisch grasland	-	Nee		
Mast 8	Agrarisch grasland	Slechtvalk	Nee		
Mast 9+lier	Agrarisch grasland	-	Nee		
Mast 10	Agrarisch grasland	-	Nee		
Mast 11+lier	Agrarisch grasland	-	Nee		
Mast 12	Ruigte, boschages en riet	Aalscholvers aanwezig, zie ook 3.4.2	Nee	Vleermuizen. Wezel, bunzing, bever, otter, woelrat, boomvalk, buizerd, havik, kerkuil, ooievaar, ransuil, roek, slechtvalk.	Vleermuizen, vogels, poelkikker, otter (uitsluitend bij mast 12 en 27)
Mast 13+lier	Agrarisch grasland	-	Nee		
Mast 14+lier	Agrarisch grasland	-	Nee		
Mast 15+lier	Agrarisch grasland	-	Nee		
Mast 16	Agrarisch grasland	-	Nee		
Mast 17	Agrarisch grasland/ ruigte	Nest, 2e traverse zuidzijde	Ja, gebruik nest		
Mast 18	Agrarisch grasland	Nest, 1e traverse noordoostzijde	Ja, gebruik nest		
Mast 19	Agrarisch grasland	-	Nee		
Mast 20	Agrarisch grasland & riet	-	Nee		
Mast 21	Agrarisch grasland	-	Nee		
Mast 22	Agrarisch grasland	-	Nee		
Mast 23	Agrarisch grasland	Nest, 2e traverse zuidzijde	Ja, gebruik nest		
Mast 24	Agrarisch grasland	-	Nee		

Mast 25	Agrarisch grasland	-	Nee		
Mast 26	Akkerland	-	Nee		
Mast 27	Graskade nabij rietoever	Aalscholver aanwezig	Nee[1]		
Mast 28	Agrarisch grasland	-	Nee		
Mast 29+lier	Agrarisch akker- en grasland	-	Nee		
Mast 30+lier	Grasland en nat rietland	-	Nee	Vleermuizen. Bunzing, otter, woelrat. Boomvalk, buizerd, grote gele kwikstaart, havik, huismus, ooievaar slechtvalk, rugstreeppad	Vleermuizen, vogels, amfibieën
Mast 31	Grasland omringd door bomen	Nest, traverse noordzijde	Ja, gebruik nest		
Mast 32	Schapenweide	-	Nee		
Mast 33+lier	Nat agrarisch grasland	-	Nee		
Mast 34 +lier	Ruigte (voedselrijk)	Nest, 2e traverse zuidzijde	Ja, gebruik nest		
Mast 35+lier	Akkerland	-	Nee	Vleermuizen, woelrat, wezel, hermelijn, boomvalk, buizerd, gierzwaluw, grote gele kwikstaart, havik, huismus, kerkuil, ooievaar, roek, slechtvalk, sperwer, wespendief	Vleermuizen, vogels
Mast 36	Agrarisch grasland	-	Nee		
Mast 37	Agrarisch grasland	-	Nee		
Mast 38	Agrarisch grasland	Nest, 2e traverse noordoostzijde	Ja, gebruik nest		
Mast 39	Agrarisch grasland	-	Nee		
Mast 40	Agrarisch grasland	-	Nee		
Mast 41+lier	Agrarisch grasland	-	Nee		
Mast 42	Agrarisch grasland	-	Nee		
Mast 43	Agrarisch grasland	-	Nee		
Mast 44	Agrarisch grasland	-	Nee		
Mast 45	Agrarisch grasland				
Mast 46	Agrarisch grasand	-	Nee		
Mast 47	Agrarisch grasland	Werkterrein over sloot	Nee		
Mast 48+lier	Agrarisch grasland	Aanrijroute tussen 48 en 49 passeert 3x landbouwsloot	Nee		
Mast 49+lier	Agrarisch grasland	Aanrijroute tussen 48 en 49 passeert 3x landbouwsloot	Nee	Vleermuizen, wezel, hermelijn, buizerd, gierzwaluw, grote gele kwikstaart, huismus, ooievaar,	Vleermuizen, vogels, waterspitsmuis
Mast 50+lier	Agrarisch grasland	Nest, 2e traverse zuidzijde	Ja, gebruik nest		
Mast 51+lier	Begroeide landbouw sloot	Mast over sloot	Nee[1]		

Mast 52	Mast over sloot	Voedselrijke landbouw sloot	Nee[1]	ransuil, roek slechtvalk, sperwer, torenvalk, steenarend	
Mast 53	Agrarisch grasland	-	Nee		
Mast 54	Agrarisch grasland	-	Nee		
Mast 55	Agrarisch grasland	-	Nee		
Madt 56	Agrarisch grasland	-	Nee		
Mast 57	Agrarisch grasland	-	Nee		
Mast 58	Akkerland (mais)	-	Nee		
Mast 59	Agrarisch grasland	-	Nee		
Werkroute 59	Sloot/dam	Aanrijroute over/door weg en sloot. Maar ook aanrijroute via andere kant over particulier pad	Nee[1]		
Mast 60	Agrarisch grasland.	aanrijroute over/door sloot	Nee[1]		
Mast 61	Agrarisch grasland Grasdam over sloot	-	Nee		
Mast 62	Verruigd grasland	-	Nee		
Mast 63	Grasland met riet en ruigte	Toegang via bestaande weg en via dam grasland in	Nee		
Mast 64+lier	Grasland, riet, bosschages, dunne bomen	Geen nesten of holtes aanwezig	Nee		
Mast 65	Agrarisch grasland	Aanrijroute door riet en over sloot	Nee[1]	Vleermuizen, wezel, hermelijn, otter. Boerenzwaluw, buizerd, huismus, huiszwaluw, kerkuil, ooievaar, slechtvalk, sperwer, torenvalk, zeearend.	Vleermuizen, vogels. amfibieën (mast 66, 67), otter (mast 66, 67)
Mast 66+lier	Grasland, sloot	Werkterrein valt over sloot Binnen verspreidingsgebied poelkikker en otter. Geen otterverblijf aangetroffen.	Nee[1]		
Mast 67	Grasland, sloot	Werkterrein valt over sloot.Binnen verspreidingsgebied poelkikker en otter. Geen otterverblijf aangetroffen	Nee[1]		
Mast 68	Agrarisch grasland	-	Nee		
Mast 69	Agrarisch grasland	-	Nee		
Mast 70	Agrarisch grasland	-	Nee		
Mast 71	Grasland, sloot	Mast over sloot	Nee[1]		
Mast 72+lier	Agrarisch grasland	-	Nee		

Mast 73+lier	Agrarisch grasland	-	Nee	Vleermuizen, bunzing, steenmarter, otter, egel. Boerenzwaluw, boomvalk, buizerd, havik, huismus, huiszwaluw, roek, ooievaar, slechtvalk, sperwer, torenvalk, zwarte wouw	Vleermuizen, vogels
Mast 74	Agrarisch grasland	-	Nee		
Mast 75	Agrarisch grasland	-	Nee		
Mast 76	Agrarisch grasland	-	Nee		
Mast 77	Agrarisch grasland	Kraaien nabij mast	Nee		
Mast 78	Agrarisch grasland	-	Nee		
Mast 79	Agrarisch grasland	-	Nee		
Mast 80	Agrarisch grasland	Nest, 2e traverse noordoostzijde	Ja, gebruik nest		
Mast 81	Agrarisch grasland	-	Nee		
Mast 82+lier	Grasland, bosschage, landbouwsloot	-	Nee		
Mast 83+lier	Agrarisch grasland	-	Nee	Vleermuizen. Grote modderkruiper, beekrombout. Boerenzwaluw, boomvalk, buizerd, havik, huismus, ,roek, ooievaar, slechtvalk, sperwer, torenvalk.	Vleermuizen, vogels, amfibieën (mast 88), otter (mast 88)
Mast 84	Hoog gras, riet	Mogelijk nest	Ja, gebruik nest		
Mast 85	Grasland met schapen	-	Nee		
Mast 86	Grasland	-	Nee		
Mast 87	Grasland en graspad	-	Nee		
Mast 88+lier	Gras, ruigte, bosschage	Nest, 2e traverse noordoostzijde	Ja, gebruik nest		
Werkroute	Zandberm, sloot met brede oeverzone	Geen beschermde soorten. In sloot mogelijk amfibieën. Binnen verspreidingsgebied poelkikker en otter. Geen otterverblijf aangetroffen.	Nee[1]		
Mast 89+lier	Grasland	-	Nee		
Mast 90+lier	Grasland	-	Nee		

[1] *In de leeswijzer is het uitgangspunt opgenomen dat de werkzaamheden (zoveel mogelijk) uitgevoerd zullen worden vanaf de droge percelen rondom de hoogspanningsmast.*

3.4 Resultaten aanvullend onderzoek

3.4.1 Aanvullend onderzoek nesten

Van een aantal vogelsoorten zijn binnen de wet natuurbescherming de nesten niet alleen beschermd als er gebroed wordt, maar zijn deze nestplaatsen jaarrond beschermd. Dit is met name voor soorten die niet zelf een nest (kunnen) bouwen, of afhankelijk zijn van bebouwing (zoals hoogspanningsmasten). De soorten waarvan de nesten jaarrond beschermd zijn, mogelijk in een hoogspanningsmast aangetroffen kunnen worden en voor kunnen komen binnen het plangebied zijn: slechtvalk, boomvalk, buizerd, havik, ransuil, sperwer, ekster en torenvalk.
In onderstaande tabel 3.2 is een overzicht gegeven van alle aangetroffen nesten in de hoogspanningsmasten. Deze nesten zijn, afhankelijk van het gebruik, mogelijk jaarrond beschermd. Als jaarrond beschermde nesten door de werkzaamheden worden geschaad, vindt overtreding van de Wet natuurbescherming plaats. De traverse nummering is overgenomen uit de methodiek van Tennet en begint bij de bovenste traverse met 1.

Om voor de nesten in de masten vermeldt in tabel 3.2 te achterhalen of deze in gebruik zijn als jaarrond beschermd nest, is aanvullend onderzoek uitgevoerd. Dit onderzoek bestond uit 4 rondes in de periode april t/m juni 2021 conform de protocollen die vanuit de overheid hiervoor zijn opgesteld. De resultaten zijn samengevat in tabel 3.2 en de uitgebreide resultaten per ronde zijn opgenomen in Bijlage 1.

Tabel 3.2 Traverse waar te onderzoeken nest is aangetroffen en een samenvatting van het resultaat

Mastnummer	Traverse	Zijde	Samenvatting 4 rondes
3	2e traverse	Noord	Geen nest meer aanwezig
5	2e traverse	Zuid	Kraai (niet jaarrond beschermd)
17	2e traverse	Zuid	Kraai (niet jaarrond beschermd)
18	1e traverse	Noord-oost	Kraai (niet jaarrond beschermd)
23	2e traverse	Zuid	Geen nest meer aanwezig
31	2e traverse	Noord	Geen nest meer aanwezig
34	2e traverse	Zuid	Nest 4 rondes niet in gebruik
38	2e traverse	Noord-oost	Nest 4 rondes niet in gebruik
50	2e traverse	Zuid	In gebruik door slechtvalk
80	2e traverse	Noord-oost	Nest 4 rondes niet in gebruik
84	1e traverse	Midden mast	Geen nest meer aanwezig
88	2e traverse	Noord-oost	Nest 4 rondes niet in gebruik

3.4.2 Aanvullend onderzoek mast 12

Mast 12 staat in moerasgebied staat en was niet zonder meer bereikbaar. Omdat de mast nabij de oever van het Zwarte meer staat en is omringd door Natura 2000-gebied was het van belang om hier wel aanvullend een veldonderzoek te doen. Op 22 april 2021 is samen met Koops grondmechanica een veldbezoek aan mast 12 gebracht.
Een luchtfoto van deze locatie is weergegeven in afbeelding 3.1. Binnen het werkgebied van mast 12 kunnen potentieel vleermuizen, vogels, wezel, bunzing, bever, otter, woelrat en poelkikker (telmee.nl) aanwezig zijn.
Tijdens het veldbezoek zijn geen (jaarrond beschermde) nesten direct langs de werkstrook en/ of onder de mast aangetroffen. Wel waren er grote aantallen van diverse soorten vogels aanwezig in het gebied. Als het gebied binnen het broedseizoen wordt betreden met machines valt verstoring van broedvogels niet uit te sluiten. Door het dichte rietland zijn nesten, van met name kleinere zangvogels, binnen de verstoringsafstand niet uit te sluiten.

Onder de mast was vooral ruigte aanwezig in de vorm van brandnetels en braam. Onder de mast op het verhoogde deel waren holen te zien. Op basis van de predatiesporen, uitwerpselen, gebiedseigenschappen en de vorm van de holen, wordt aangenomen dat dit van een vos is. De vos is nationaal beschermd, maar door de provincie vrijgesteld. Onder de hoogspanningsmast naast (oostelijk van) mast 12 zijn diverse knaagsporen van bever aangetroffen. Er is geen burcht waargenomen, dus waarschijnlijk wordt dit deel van het rietland gebruikt om te foerageren.

3.5 Toetsing soortenbescherming

Uit de tabel met resultaten van het bronnen- en veldonderzoek blijkt dat bij het grootste deel van masten geen negatieve effecten op beschermde soorten zijn te verwachten. Er zijn bij de meeste masten geen beschermde verblijfplaatsen aangetroffen en geen beschermde planten en als de zorgplicht in acht wordt genomen zijn negatieve effecten uitgesloten.

Bij de masten 27, 30, 34, 51, 52, 59, 60, 65, 66, 67, 71 en 88/89 valt het werkgebied en /of de toerit deels in rietoevers of sloten. Uitgaande van het voornemen de masten zoveel mogelijk over land te benaderen worden geen negatieve effecten op soorten die in de sloten voorkomen verwacht. Mocht het plaatselijk toch noodzakelijk zijn een sloot (deels) te dempen of anderzins te beïnvloeden, dient alsnog beoordeeld te worden of sprake kan zijn van negatieve effecten, en dienen mogelijk maatregelen te worden genomen om negatieve effecten te voorkomen. Voorbeelden hiervan zijn: werken buiten het voortplantingseizoen van amfibien en vissen, het vooraf kaal maken, het een kant op werken etc. Voor in riet broedende vogels geldt dat buiten het broedseizoen wordt gewerkt. Waar en wanneer maatregelen nodig zijn zal worden opgenomen in een ecologisch werkprotcol.

Bij mast 12 is het onvermijdelijk om het rietmoeras te betreden. Er zijn echter geen beschermde rust en verblijfplaatsen en jaarrond beschermde nesten aanwezig. Wel wordt het gebied rond mast 12 gebruikt door vos, bever en broedvogels. Voor vos geldt dat deze is vrijgesteld in de provincie Overijssel. Bever gebruikt de omgeving als foerageergebied en dit is in ruime mate aanwezig. Bovendien komt het plangebied na de werkzaamheden weer in de oude situatie beschikbaar. Tijdens de werkzaamheden kan bever het plangebied gemakkelijk mijden en geldt, voor alle soorten, de zorgplicht. Dit houdt in dat dieren de gelegenheid moet worden geboden het plangebied tijdens de werkzaamheden te verlaten Negatieve effecten op bever en andere soorten worden niet verwacht. Voor vogels worden negatieve effecten voorkomen door buiten het broedseizoen de werkzaamheden te verrichten.

In de masten 3, 5, 17, 18, 23, 31, 34, 38, 50, 80, 84 en 88 zijn in 2020 nesten waargenomen die mogelijk jaarrond beschermd zijn. Deze zijn in het voorjaar 2021 nader onderzocht en in één van de masten, mast 50 blijkt een jaarrond beschermd nest aanwezig te zijn dat in gebruik is door een slechtvalk. De overige nesten zijn of niet meer aanwezig of niet in gebruik door een juridisch zwaarder beschermde vogelsoort. Als het nest in mast 50 door de werkzaamheden verloren kan gaan, beschadigd wordt of wordt verstoord, dient ontheffing aangevraagd te worden bij het bevoegd gezag (provincie). Aan de ontheffingsaanvraag dient een activiteitenplan ter grondslag te liggen waarin de werkzaamheden zijn beschreven (inclusief planning en periode), de mitigerende maatregelen en het maatschappelijke belang van de ingreep. Als de werkzaamheden na het broedseizien van 2022 gaan plaatsvinden dient opnieuw onderzocht te worden of in de masten jaarrond beschermde nesten in gebruik zijn.

Afbeelding 3.1: Bovenaanzicht van mast 12 in Natura 2000-gebied Zwarte meer.

Gedragscode/zorgplicht
In acht neming van de zorgplicht geldt voor de werkzaamheden bij alle masten. Dit houdt in dat voor een aantal soortgroepen mitigerende maatregelen genomen dienen te worden. In deze paragraaf worden de mitigerende maatregelen ten behoeve van de zorgplicht per soortgroep toegelicht.

Vogels
Het werk dient buiten het broedseizoen plaats te vinden. Het broedseizoen loopt globaal van halverwege maart tot begin augustus afhankelijk van de vogelsoort. Als werken binnen het broedseizoen niet te vermijden is dient voorafgaand aan de werkzaamheden een inspectie uitgevoerd te worden door een deskundig ecoloog, naar de aanwezigheid van broedende vogels binnen het plangebied. Als deze aanwezig zijn, dient gewacht te worden met het uitvoeren van de werkzaamheden tot de jongen uitgevlogen zijn. Om te voorkomen dat vogels gaan broeden binnen het plangebied kan voorafgaand aan het broedseizoen in de directe omgeving van het plangebied ruigte te worden verwijderd, gras kort gemaaid, werkzaamheden (inclusief de verstoring) voorafgaand aan het broedseizoen op te starten of voorafgaand aan het broedseizoen verstoring aan te brengen binnen het plangebied.

Vleermuizen
Om verstoring van migrerende, foeragerende of overvliegende vleermuizen te voorkomen dient in de actieve periode (maart tot en met oktober) geen gebruik gemaakt te worden van kunstlicht. Er wordt gewerkt tussen zonsopkomst en zonsondergang. Indien niet gewerkt kan worden zonder kunstlicht (bijvoorbeeld bij slecht weer vanwege de veiligheid) dient dit zo afgesteld te zijn dat deze geen omliggende bosschages of gebouwen kunnen beschijnen.

Amfibieën
Daar waar gewerkt wordt in oevers dient de voortplantingsperiode gemeden te worden. Deze periode loopt van april tot en met augustus. Indien niet te vermijden is om in deze periode werk uit te voeren zullen de werkzaamheden zo uitgevoerd moeten worden dat mogelijk aanwezige amfibieën geen hinder ondervinden. Bij aanwezigheid moeten de dieren de gelegenheid worden geboden het plangebied te kunnen verlaten.

Zoogdieren
De werkzaamheden dienen op dusdanige wijze uitgevoerd te worden dat mogelijk aanwezige dieren het plangebied ongestoord kunnen verlaten. Dit betekend veelal één kant op werken, naar de richting van geschikt habitat (ruigte).

Draadslachtoffers
Het optreden van een stijging van het aantal draadslachtoffers door de werkzaamheden wordt uitgesloten omdat de configuratie van de lijnen niet verandert ten opzichte van de huidige configuratie. Verder worden over de gehele verbinging varkenskrullen aangebracht. De bliksemdraden en de nieuwe geleiders komen op dezelfde positie te hangen als in de huidige situatie. Het type geleider is wel verschillend in materiaal, maar de omvang (diameter) is gelijk. Dat het verschil in het materiaal van de geleider niet leidt tot een hogere aanvaringskans, wordt hieronder nader onderbouwd.
Het materiaal bepaalt de maximale temperatuur (weerstandsafhankelijk) die in de geleider mag optreden. Dit bepaalt de maximale doorhang van de geleider en de maximale transportcapaciteit van de hoogspanningsverbinding. De nieuwe geleider heeft een maximaal toelaatbare temperatuur van 175 graden Celsius, waar de huidige geleider een temperatuur heeft van 70 graden Celsius. Hierdoor kan er dus ook meer stroom over de nieuwe geleider. Een toename van stroom doet de geleiders lichtelijk uitzetten, waardoor de doorhang zeer beperkt toeneemt bij de toepassing van dit nieuwe type geleider (wat uiteraard ook samenhangt met de omgevingstemperatuur). De huidige geleider, type ACSR 48/7, heeft een maximaal toelaatbare geleidertemperatuur van 70 graden Celsius en zet dan 16,51 meter uit over een nominale veldlengte van 400 meter. De toekomstige geleider, type ACCCZ Midal, heeft een maximaal toelaatbare geleidertemperatuur van 175 graden Celsius, en zet dan 16,71 meter uit over een nominale veldlengte van 400 meter. Dit betekent dat bij een maximale belasting een extra uitzetting in de lengte van 20 centimeter over 400 meter (0,0005 centimeter per meter) ten opzichte van de huidige situatie. In praktijk zal dit echter zelden gebeuren, omdat slechts zelden de maximale transportcapaciteit wordt gebruikt.
Bij dezelfde transportcapaciteit heeft de nieuwe geleider minder uitzetting per meter dan de huidige geleider. De nieuwe geleiders vertonen daardoor minder variatie in doorhang ten opzichte van de huidige geleiders. Verschillen in doorhang zijn dusdanig klein dat hier niet gesproken kan worden over een veranderende configuratie of positionering van de geleiders. Een negatief effect zoals het verwonden of doden van vogels door de incidenteel hogere geleidertemperaturen is uitgesloten. In de huidige situatie kan de temperatuur van de geleiders al oplopen tot 70 graden Celsius, ongeschikt voor vogels om op te rusten. Ook bij hogere temperaturen zijn vogels in staat om dit aan te voelen en niet te landen of direct weer los te laten.

3.6 Conclusie
Op de meeste soortgroepen treden ten gevolge van de werkzaamheden geen negatieve effecten op. Het uitgangspunt is hierbij dat gewerkt wordt buiten het broedseizoen en dat de werkzaamheden (zoveel mogelijk) uitgevoerd zullen worden vanaf de droge percelen rondom de hoogspanningsmast. Als wel sloten worden vergraven of (deels) gedempt zal voor betreffende locatie mogelijke vervolgonderzoek moeten worden verricht. Van de in

2020 in de masten waargenomen mogelijk jaarrond beschermde nesten is er in 2021 één in gebruik gebleken door slechtvalk. Dit nest is daarmee jaarrond beschermd en als door de werkzaamheden beschadiging van dit nest niet kan worden uitgesloten, dient ontheffing te worden aangevraagd. Als de werkzaamheden pas na het broedseizoen 2022 worden utigevoerd, moet opnieuw onderzoek naar mogelijk aarrond beschermde nesten in alle masten worden gedaan.

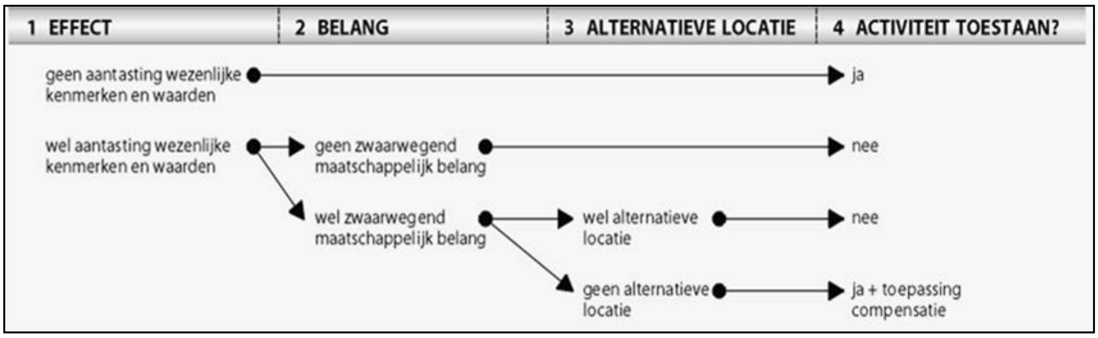
4 Provinciaal natuurbeleid

4.1 Toetsingskader

Het beleidskader van de overheid dat niet in wetgeving is vastgelegd, bestaat uit:

- Provinciaal beleid:
  - Natuurnetwerk Nederland (NNN): Flevoland en Overijssel.

De afweging voor ingrepen in het NNN gaat volgens het 'nee, tenzij-principe'. In figuur 4.1 is dit stapsgewijs weergegeven. Ingrepen met een significant negatieve invloed op de wezenlijke kenmerken en waarden mogen niet plaatsvinden, tenzij er sprake is van een zwaarwegend maatschappelijk belang en indien er geen alternatieven zijn. Indien bij een ingreep schade wordt aangericht aan een NNN-gebied, dient dit in ieder geval gemitigeerd te worden. De resteffecten aan verlies van kwaliteit en/of oppervlakte dient te worden gecompenseerd. Daarnaast kan salderen van positieve en negatieve effecten op het NNN uitkomst bieden om projecten in het NNN te realiseren.

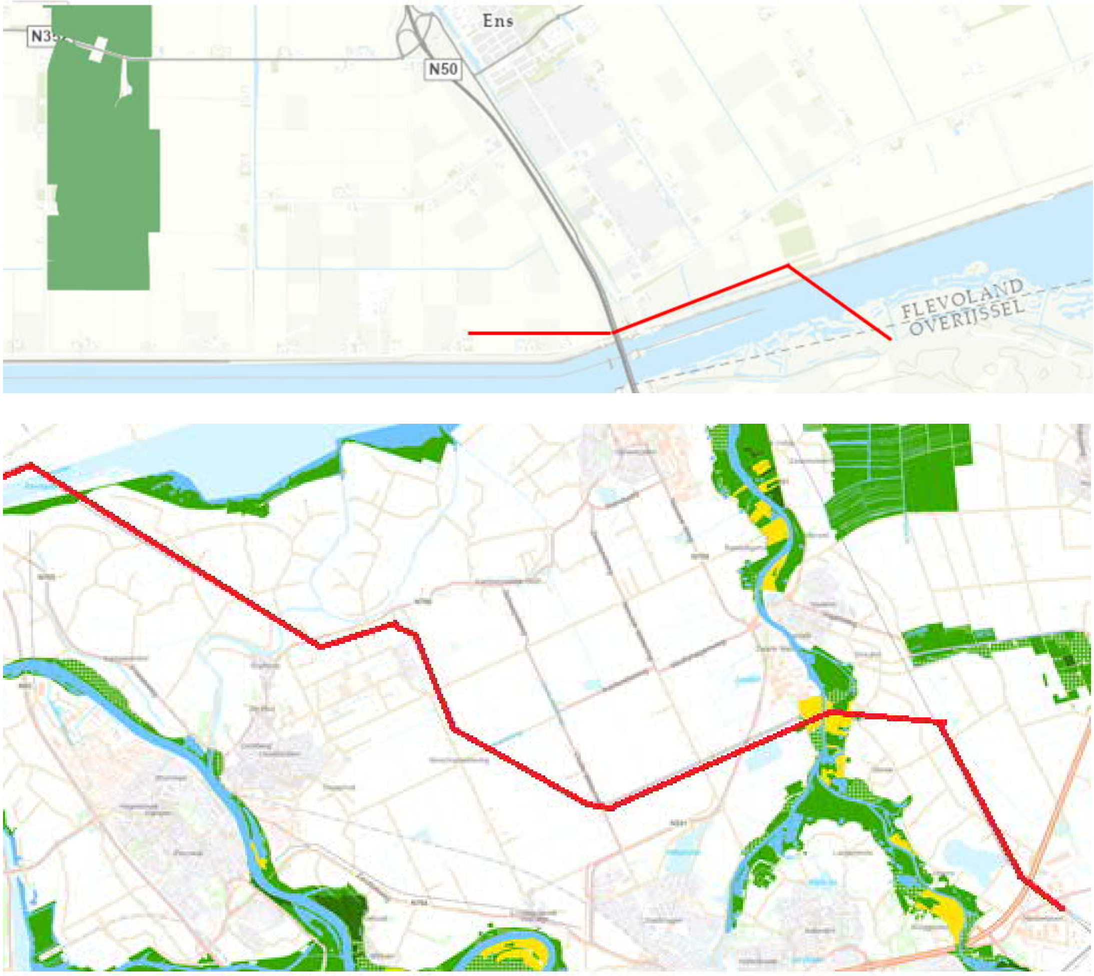


Figuur 4.1 Het 'nee, tenzij'-principe van het compensatiebeginsel.

Het verkennend natuuronderzoek geeft inzicht in de ligging van NNN-gebieden in de omgeving van het tracé en de noodzaak voor het doorlopen van 'nee, tenzij'-procedure. Een 'nee, tenzij'-toets behoeft alleen te worden doorlopen, indien er sprake is van een RO-procedure met betrekking tot wijziging van de bestemming van het plangebied. In provincie Flevoland zijn ook effecten vanuit externe werking op het NNN van toepassing, in de provincie Overijssel niet.

4.2 Inventarisatie

Op twee plaatsen in Overijssel doorsnijdt het tracé gebieden die zijn aangewezen als NNN. Betreffende gebieden liggen tevens binnen Natura 2000-gebied (Zwarte meer en Uiterwaarden Zwarte Water en Vecht). Op beide locaties wordt de oorspronkelijke situatie weer hersteld. De ligging van het tracé ten opzichte van de NNN gebieden is weergegeven in figuur 4.2.



Figuur 4.2 De ligging van het tracé (in rood) ten opzichte van Natuurnetwerk Nederland. Boven Flevoland en onder Overijssel (groen is NNN, geel is uitwerkingsgebied ontwikkelopgave Natura 2000).

4.3 Analyse van de mogelijke effecten

Op twee plaatsen doorsnijdt het tracé het NNN Overijssel. Omdat de oorspronkelijke situatie wordt hersteld is er geen sprake van negatieve effecten op de kernwaarden van NNN. In Flevoland liggen de masten buiten NNN. In Flevoland dient ook externe werking te worden getoetst. Daarvan is echter geen sprake omdat er geen bestemmingswijziging met bijbehorende RO-procedure gaat plaatsvinden Er is hierdoor geen noodzaak tot een nadere beschouwing van de effecten in de vorm van een ‘Nee, tenzij’-toets en er zijn geen belemmeringen vanuit provinciaal beleid.

4.4 Conclusie

Er is met de voorgenomen ontwikkeling geen sprake van een RO-procedure met betrekking tot het wijzigen van bestemmingen binnen het tracé. Er is hierdoor geen noodzaak tot een nadere beschouwing van de effecten in de vorm van een ‘Nee, tenzij’-toets en er zijn geen belemmeringen vanuit provinciaal beleid.

5 Conclusies

Op basis van het verkennend natuuronderzoek en het aanvullend onderzoek wordt het volgende geconcludeerd:

Gebiedsbescherming
Voor de werkzaamheden bij mast 12 dient een nadere toets uitgevoerd te worden om vast te stellen of de aanleg van het zandpad om de mast te bereiken leidt tot significant negatieve effecten op aangewezen habitattypen, broedareaal voor de aangewezen broedvogels en verstoring van niet-broedvogels. Er wordt bij alle masten buiten het broedseizoen gewerkt zodat verstoring van aangewezen broedvogels niet aan de orde is. Ook voor de werkzaamheden aan alle andere masten in of nabij de Natura 2000-gebieden Zwarte meer en Uiterwaarden Zwarte water en Vecht is het uitgangspunt dat geen verstoring op aangewezen broedvogels plaatsvindt. Om mogelijk significant negatieve effecten door verstoring van niet-broedvogels in beide Natura 2000-gebieden uit te kunnen sluiten dient aanvullende toets te worden uitgevoerd.

Soortenbescherming
Op de meeste soortgroepen treden ten gevolge van de werkzaamheden geen negatieve effecten op. Het uitgangspunt is hierbij dat gewerkt wordt buiten het broedseizoen en dat de werkzaamheden (zoveel mogelijk) uitgevoerd zullen worden vanaf de droge percelen rondom de hoogspanningsmast. Als wel sloten worden vergraven of (deels) gedempt dient te worden beoordeeld of voor betreffende locatie vervolgonderzoek nodig is of dat werken volgens voorgeschreven maatregelen (ecologisch werkprotocol) afdoende is. Van de in 2020 in de masten waargenomen mogelijk jaarrond beschermde nesten is er in 2021 één in gebruik gebleken door slechtvalk. Dit nest is daarmee jaarrond beschermd en als door de werkzaamheden beschadiging van dit nest niet kan worden uitgesloten, dient ontheffing te worden aangevraagd. Omdat de werkzaamheden pas na het broedseizoen 2022 worden utigevoerd, wordt in 2022 opnieuw onderzoek naar mogelijk jaarrond beschermde nesten in alle masten uitgevoerd.

Natuurnetwerk Nederland
Er is met de voorgenomen ontwikkeling geen sprake van een RO-procedure met betrekking tot het wijzigen van bestemmingen binnen het tracé. Er is hierdoor geen noodzaak tot een nadere beschouwing van de effecten in de vorm van een ‘Nee, tenzij’-toets en er zijn geen belemmeringen vanuit provinciaal beleid.

Bijlage 1 Resultaten aanvullend nestonderzoek

Nr.	Datum	Bevindingen 1e ronde	Opmerking	Bevindingen 2e ronde 27-5-2021	Opmerking	Bevindingen 3e ronde 08-06-2021	Opmerking	Bevindingen 4e ronde 24-6-2021	vervolg
3	22-4-2021	Nest niet teruggevonden	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
5a	22-4-2021	Gebruik door kraai	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
17	22-4-2021	Gebruik door kraai	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
18	22-4-2021	Gebruik door kraai	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
23	22-4-2021	Niet in gebruik	Veldbezoek continueren	nest niet teruggevonden	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
31	22-4-2021	Niet in gebruik	Veldbezoek continueren	nest niet teruggevonden	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
34	22-4-2021	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	niet in gebruik	geen
38	22-4-2021	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	niet in gebruik	geen
50	7-5-2021	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	Gebruik door slechtvalk	Geen vervolg nodig	nvt	Mogelijk ontheffi ng nodig
80	7-5-2021	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	niet in gebruik	geen
84	7-5-2021	Nest niet teruggevonden	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	Geen vervolg nodig	nvt	geen
88	7-5-2021	Niet in gebruik	Veldbezoek continueren	Niet in gebruik	Veldbezoek continueren	Niet in gebruik, wel kraai in mast	Veldbezoek continueren	niet in gebruik	geen

Voor de nesten die niet in gebruik waren gedurende de 4 inventarisatierondes geldt in de meeste gevallen dat het nest geen volledige opbouw heeft en mogelijk deels verwaait is.

Bijlage 8

Natuuronderzoek, voortoets

Voortoets werkzaamheden aan hoogspanningsmasten tracé Zwolle-Ens

Beoordeling van de gevolgen van de voorgenomen activiteit(en) op Natura 2000-gebieden

SWECO

Verantwoording

Titel:	Voortoets werkzaamheden aan hoogspanningsmasten tracé Zwolle-Ens
Onderwerp:	Voortoets
Projectnummer:	51002704
Klant:	TenneT TSO BV
Referentienummer:	NL22-648800269-19681
Versie:	D1
Datum:	31-03-2022
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Vrijgegeven door:	Tim Verver
Paraaf vrijgegeven:	

Inhoudsopgave

1 Inleiding

1.1 Aanleiding

Om in de toekomst meer elektriciteit te kunnen transporteren is het noodzakelijk om naast de nieuwbouw van verbindingen bestaande hoogspannings-verbindingen aan te passen zodat er een grotere transportcapaciteit mogelijk wordt gemaakt. Om die reden is TenneT voornemens de bestaande landelijke 380 kV-ring, de 'ruggengraat' van het landelijk hoogspanningsnet, op te waarderen (programma Beter Benutten Bestaande 380 kV). Binnen het betreffende programma valt ook het deelproject Opwaardering 380 kV-verbinding Ens – Zwolle. Een aantal van deze masten ligt in of nabij Natura 2000-gebied Zwarte meer of Uiterwaarden Zwarte Water en Vecht. Om vast te kunnen stellen of de geplande werkzaamheden aan deze masten leiden tot negatieve effecten op de instandhoudingsdoelstellingen van deze Natura 2000-gebieden is voorliggende voortoets opgesteld.

1.1 Werkzaamheden

De werkzaamheden betreffen het opwaarderen van de masten, het aanpassen van de geleiders. Bij een aantal masten moet ook de fundering worden aangepast worden. Van de masten binnen Natura 2000-gebied is mast 64 de enige waarvan zowel de geleiders worden vervangen, aanpassingen in de mast plaatsvinden en waar de fundering wordt aangepast. In hoofdstuk 2 worden de werkzaamheden verder toegelicht samen met de ligging van het plangebied ten opzichte van de omliggende Natura 2000-gebieden.

1.2 Doel voorliggend rapport

Dit rapport geeft inzicht in de aanwezigheid van wettelijk en beleidsmatig beschermde natuurwaarden in de Natura 2000-gebieden (Zwarte meer en Uiterwaarden zwarte water en Vecht) binnen de invloedssfeer van de werkzaamheden bij de masten 6 t/m 13 en 63 t/m 68. Het rapport gaat in verstorende effecten die de werkzaamheden kunnen hebben op de aangewezen niet-broedvogels. Beoordeeld is of significante effecten kunnen worden uitgesloten.
Overige effecten zijn in eerder onderzoek uitgesloten. In het verkennend natuur onderzoek (Sweco, ref NL21-648800269-11542, december 2021) zijn negatieve effecten op habitattypen en habitatsoorten van Uiterwaarden Zwarte Water en Vecht al uitgesloten en voor Zwarte meer is dit uitgesloten in een voortoets (opgesteld voor de aanleg van een onverhard toegangspad, Sweco , ref NL22-648800269-18292). Effecten op aangewezen broedvogels zijn niet aan de orde omdat de werkzaamheden in Natura 2000-gebied buiten het broedseizoen worden uitgevoerd.

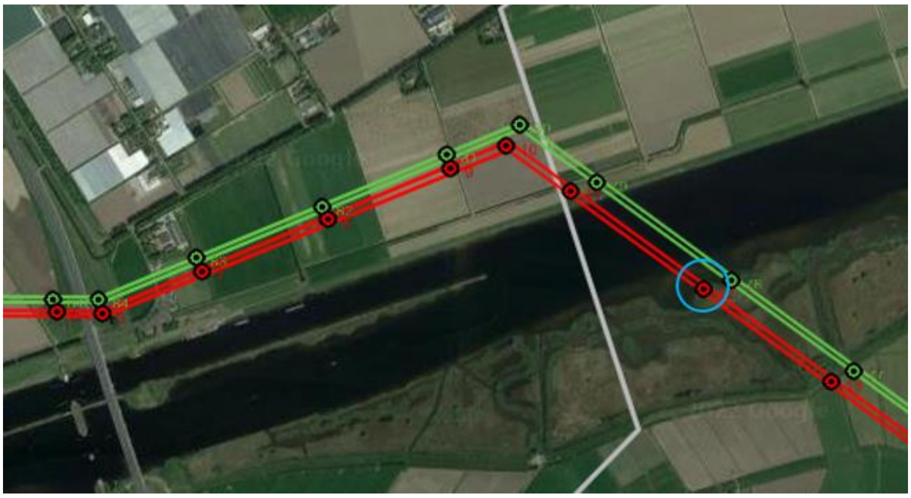
1.3 Leeswijzer

In het voorliggend rapport zijn in hoofdstuk 1 de aanleiding en doelstelling omschreven. Een beschrijving van het planvoornemen volgt in hoofdstuk 2. Vervolgens is het wettelijk kader in hoofdstuk 3 nader toegelicht. Hoofdstuk 4 behandelt de afbakening van effectindicatoren en hoofdstuk 5 de toetsing hiervan. In hoofdstuk 6 staan de conclusies.

2 Plangebied en werkzaamheden

2.1 Ligging en begrenzing plangebied

De masten 6 t/m 13 en 63 t/m 68 vormen het plangebied dat binnen Natura 2000-gebieden ligt. De masten 6 t/m 13 liggen binnen of nabij de begrenzing van Natura 2000-gebied Zwarte meer. De masten 63 t/m 68 liggen binnen of nabij de begrenzing van Natura 2000-gebied Uiterwaarden Zwarte Water en Vecht (zie figuur 2.1).



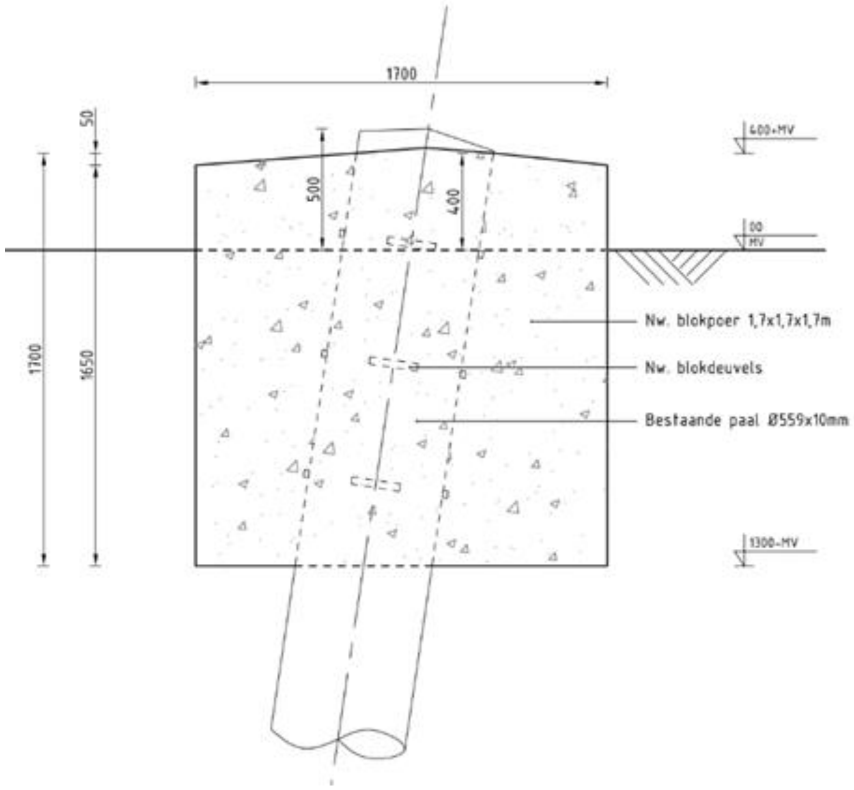
Figuur 2.1 Ligging masten 6 t/m 13 (rood) plangebied binnen (blauw omcirkeld) en nabij Zwarte meer.

Figuur 2.2 Ligging masten 63 t/m 68 (rood) binnen (blauw omcirkeld) en nabij Uiterwaarden Zwarte Water en Vecht.

2.2 Werkzaamheden

De beoogd uit te voeren werkzaamheden betreffen:

- Aanpassen mast: bij aanpassing van de masten worden stalen profielen/bouten vervangen. Het te gebruiken materieel bestaat uit een hoogwerker en een wagen om materiaal aan te voeren. In het geval dat een mast moeilijker bereikbaar is (zoals mast 12) zal het materieel beperkt blijven tot een tractor met platte kar. Er wordt dan in de mast geklommen en benodigde materialen worden opgehesen. Duur van deze werkzaamheden betreft enkele werkdagen per mast.
- Lierlocaties: op tussenliggende lierlocaties worden de geleiders binnen de vakken getrokken (deel tussen twee hoek/trekmasten). De lierlocaties zijn enkele weken aanwezig, maar het lieren zelf neemt een paar dagen in beslag;
- Aanpassen fundering: bij mast 64 wordt naast de mast en de geleiders ook de fundering aangepast (zie figuur 2.3). De werkzaamheden bestaan uit het aanbrengen van een extra klomp beton per poer. Er komen geen palen bij. Er zal ca 1 dag een graafmachine werkzaam zijn, daarna een paar dagen mensen die een bekisting maken waarna de kist wordt gestort. Tenslotte wordt er gedurende enkele uren een kraan ingezet ter afwerking. Totale duur 5 werkdagen verspreid over 2 weken.



Figuur 2.3 Doorsnede fundatieversterking

2.3 Doelstelling Zwarte meer en Uiterwaarden Zwarte Water en vecht

In deze voortoets worden alleen de Natura 2000-gebieden beschouwd die binnen de verstoringsafstand van de geplande werkzaamheden liggen. Negatieve effecten op instandhoudingsdoelstellingen van Natura 200-gebieden die verder dan enkele honderenden meters af liggen, kunnen gezien de beperkte duur en intensiteit van de werkzaamheden op voorhand worden uitgesloten.

Verder wordt alleen getoetst op de instandhoudingsdoelstellingen van niet-broedvogels omdat de doelstellingen van overige soorten/habitattypen reeds zijn getoetst en negatieve effecten zijn uitgesloten.

De aangewezen niet-broedvogels voor Zwarte meer staan in tabel 2.1 en die voor Uiterwaarden Zwarte Water en Vecht in tabel 2.2.

Tabel 2.1.Niet broedvogels Natura 2000-gebied Zwarte Meer met instandhoudingsdoelstelling en functie

Soort		LSVI[2]	doelstelling Opp	doelstelling kwal	Functie[3]
A005	**Fuut**	**-**	**=**	**=**	**foer**
A017	Aalscholver	+	=	=	foer
A034	Lepelaar	+	=	=	foer
A037	Kleine zwaan	--	=	=	Slaaprust/foer
A041	kolgans	+	=	=	Slaaprust foer
A043	Grauwe gans	+	=	=	Slaaprust foer
A050	Smient	-	=	=	slaaprust
A051	Krakeend	+	=	=	Foer
A052	Wintertaling	+	=	=	Foer
A054	Pijlstaart	+	=	=	Foer
A056	Slobeend	+	=	=	Foer
A059	Tafeleend	--	=	=	Foer
A061	Kuifeend	-	=	=	Foer
A125	Meerkoet	-	=	=	Foer
A156	Grutto	--	=	=	slaaprust
A197	Zwarte stern	--	=	=	Foer
A702	Toendrarietgans	+	=	=	slaaprust

Tabel 2.2. Niet broedvogels Natura 2000-gebied Uiterwaarden Zwarte Water en Vecht met instandhoudingsdoelstelling en functie

Soort		LSVI[2]	doelstelling[1] opp	doelstelling[1] kwal	Functie[3]
A037	Kleine zwaan	--	=	=	foer
A041	kolgans	+	=(<)	=	foer
A050	Smient	-	=(<)	=	Slaaprust foer
A054	Pijlstaart	+	=	=	Foer
A056	Slobeend	+	=	=	Foer
A125	Meerkoet	-	=	=	Foer
A156	Grutto	--	=	=	Slaaprust foer

[1] doelstelling:
Broedvogels, niet-broedvogels: doelstelling voor leefgebied en/of omvang populatie

- = behoud
- > uitbreiding

[2] LSVI landelijke staat van instandhouding

- \+ gunstig
- \- matig ongunstig
- -- zeer ongunstig

[3] functie foer = foerageergebied, slaaprust = slaap of rustplaatsen

3 Wettelijk kader

3.1 Wet natuurbescherming: onderdeel Natura 2000-gebieden

De Wet natuurbescherming heeft als doel het beschermen van Natura 2000-gebieden (Vogel- en Habitatrichtlijn) in Nederland. Projecten die, gelet op de instandhoudingsdoelen, leiden tot significante verstoring van kwalificerende soorten of verslechtering van habitats (van soorten), zijn in beginsel niet toegestaan (zonder vergunning).

Bij toetsing aan Natura 2000 doelstellingen kunnen de volgende stappen aan de orde zijn:

- Geen nader onderzoek: effecten kunnen op voorhand en zonder enig nader onderzoek worden uitgesloten (er zijn geen Natura 2000-gebieden in de omgeving aanwezig die beïnvloed kunnen worden door de werkzaamheden).
- Voortoets: effecten kunnen niet op voorhand en zonder enig onderzoek worden uitgesloten.
- Passende beoordeling: significantie van effecten kan op basis van de Voortoets niet worden uitgesloten en mitigerende maatregelen zijn nodig effect te voorkomen.
- ADC-toets: indien aantasting van de natuurlijke kenmerken van het gebied niet kan worden uitgesloten. Aangetoond dient te worden dat er geen alternatieven zijn met minder effecten, er sprake is dwingende redenen van groot openbaar belang en in compensatie is voorzien.

De voorliggende studie richt zich op de vraag: ‘Wat zijn de effecten van de werkzaamheden op de kwalificerende niet-broedvogelsoorten en wat zijn de gevolgen voor de instandhoudingsdoelstellingen?’ Indien significante verstoring of significante verslechtering van het Natura 2000-gebied niet is uit te sluiten, is een vergunning noodzakelijk op grond van artikel 2.7 Wet natuurbescherming. Indien significante effecten in relatie tot de instandhoudingsdoelstellingen niet zijn uit te sluiten kan een vergunning alleen verleend worden indien voldaan wordt aan de ADC-criteria.

3.2 Algemeen kader instandhoudingsdoelstellingen

De effecten van de ingreep worden getoetst aan de instandhoudingsdoelstellingen die gelden voor de niet-broedvogelsoorten en de waarvoor de Natura 2000-gebieden Zwarte meer en Uiterwaarden Zwarte Water en Vecht zijn aangewezen. Daarbij wordt onderscheid gemaakt tussen een significante verslechtering van de kwaliteit van habitattypen en habitats van soorten en een significante verstoring van soorten conform artikel 2.7 lid 2 Wet natuurbescherming.

3.3 Significantie

Voor het begrip significantie bestaat geen juridische (of ecologische) definitie. De Europese Commissie laat de interpretatie van dit begrip over aan de lidstaten. Tot op heden wordt in de jurisprudentie teruggegrepen op een uitspraak van het Europese Hof van Justitie uit 2004.

In het Kokkelvisserij-arrest is significantie door het Europese Hof van Justitie als volgt omschreven:

‘Een plan of project dat niet direct verband houdt met of nodig is voor het beheer van een gebied moet worden beschouwd als een plan of project dat significante gevolgen kan hebben voor het betrokken gebied, wanneer de instandhoudingsdoelstellingen daarvan in gevaar dreigen te komen.’ Ook het ministerie van LNV neemt de instandhoudingsdoelen als referentie voor het bepalen van significante effecten; ‘indien als gevolg van een ingreep de toekomstige oppervlakte habitat of leefgebied, aantal van een soort dan wel kwaliteit van een habitat lager zal worden dan zoals bedoeld in de instandhoudingsdoelstelling, dan kan sprake zijn van significante gevolgen’ (Steunpunt Natura 2000, 2010).

4 Afbakening effectindicatoren Natura 2000

4.1 Relevante effecttypen

Voor de effectanalyse is het van belang om eerst de relevante storingsfactoren in beeld te brengen die de werkzaamheden met zich meebrengen. Het gaat hierbij alleen om tijdelijke effecten voor de Natura 2000-gebieden binnen de reikwijdte van het effect. De werkzaamheden aan de masten zijn per mast relatief beperkt en kortdurend (enkele dagen en bij mast 64 iets langer). De reikwijdte beperkt zich tot het Natura 2000-gebied Zwarte meer voor de masten 6 t/m 13 en tot het Natura 2000-gebied Uiterwaarden Zwarte Water en Vecht voor de masten 63 t/m 68.

De mogelijke significante effectindicatoren van de geplande werkzaamheden op het Natura 2000-gebied zijn uitgewerkt aan de hand van de zogenoemde ‘effectenindicator’ (LNV, 2014).

De effectenindicator is een instrument om een eerste indruk te kunnen geven van de mogelijk optredende effecten bij een specifieke activiteit. De effectenindicator biedt een selectie aan activiteiten (zoals woningbouw, recreatie, etc.). Hierbij zijn de gangbare effecten vanuit de geselecteerde activiteit in relatie gebracht met de gevoeligheid van de aangewezen habitats en soorten voor de betreffende effecten. De meest passende activiteit die gekozen kan worden is ‘weg’. De masten worden voor het onderhoud bereikt via aanrijroutes (mogelijk met rijplaten) op het maaiveld. Omdat een weg intensiever is dan een tijdelijke betreding betreft het een worst case. De volgende effectindicatoren zijn van toepassing:

- Oppervlakteverlies en versnippering.
- Verontreiniging.
- Verdroging.
- Verstoring door licht, geluid en trillingen.
- Optische verstoring.
- Verstoring door mechanische effecten.
- Vermesting en verzuring door stikstofdepositie.

Per effectindicator is in de navolgende paragrafen een korte omschrijving opgenomen.

4.2 Ruimtebeslag en versnippering

Verlies van oppervlakte kan leiden tot verkleining en in sommige gevallen ook tot versnippering van het leefgebied van kwalificerende soorten. Een kleiner gebied heeft bovendien meer te lijden van randinvloeden: vaak is de kwaliteit van het leefmilieu aan de rand minder goed dan in het centrum van het gebied. Op deze manier leidt verlies van oppervlakte mogelijk ook tot een grotere gevoeligheid voor bijvoorbeeld verdroging, verzuring of vermesting (Broekmeyer et al, 2005).

Er is geen sprake van versnippering en oppervlakteverlies door de tijdelijke werkzaamheden aan de masten.

4.3 Verontreiniging

De werkzaamheden aan de masten veroorzaken geen verontreiniging en effecten door verontreiniging zijn daarom niet aan de orde. Verontreiniging heeft namelijk betrekking op afstroming van water ('run-off') met daarin bijvoorbeeld zware metalen, organische stoffen of strooizout. Deze stoffen kunnen een negatief effect hebben op habitattypen en (leefgebieden van) kwalificerende soorten op een zeer korte afstand tot de bron.

4.4 Verdroging

De werkzaamheden aan de masten hebben geen invloed op de waterhuishouding in het plangebied en omgeving. Effecten door verdroging zijn niet aan de orde. De waterhuishouding op regionale schaal, bijvoorbeeld van verschillende beeksystemen, werkt door in de aanvoer van grondwater naar diverse gebieden en de kwaliteit daarvan. Dit kan leiden tot verdroging en als gevolg daarvan tot verzuring. Verzuring treedt op door een vergrote invloed van regenwater in de wortelzone, ten koste van het meer gebufferde grondwater.

4.5 Verstoring door licht, geluid en trillingen

Door lichtverstoring bestaat de kans dat kwalificerende soorten een verlicht gebied gaan ontwijken waardoor het leefgebied afneemt. Lichthinder op fauna kan doorgaans tot honderden meters van de bron meetbaar zijn (Molenaar, 2003) en in uitzonderlijke gevallen leiden tot effecten op 1.000 meter afstand van leefgebieden (Arcadis, 2014).

De werkzaamheden voor de aanleg en ook het gebruik vinden plaats bij daglicht en er wordt geen kunstlicht gebruikt. Verstoring door licht is niet aan de orde. Bij de werkzaamheden aan de masten en funderingen worden geen heipalen gezet. De werkzaamheden worden voornamelijk uitgevoerd door relatief licht materieel zoals een kraan, vrachtwagen en hoogwerker. Het gebruikte materieel veroorzaakt geen tot nauwelijks trillingen die niet verder reiken dan het werkgebied. Verstoring door trillingen is niet aan de orde.

Verstoring van geluid kan optreden door onnatuurlijke geluidsbronnen. Deze verstoring kan tijdelijk of permanent zijn. Permanent zoals geluid van bijvoorbeeld wegverkeer dan wel tijdelijk zoals geluidsbelasting tijdens de realisatiefase. Geluid is een hoorbare trilling, gekenmerkt door geluidsdruk en frequentie. Geluid kan de vocale communicatie maskeren en op korte afstand voor schrikreacties zorgen voor soorten. Met name broedvogels zijn gevoelig en de effecten kunnen tot op grotere afstand doorwerken. Trillingen en geluid kunnen vooral ontstaan bij zwaardere werkzaamheden zoals bijvoorbeeld heien.

Voor de niet-broedvogels moeten de mogelijke effecten door de tijdelijke geluidverstoring nader worden beschouwd.

4.6 Optische verstoring

Met optische verstoring wordt bedoeld een toename van het aantal mensen of verkeersbewegingen door de aanleg van de benodigde infrastructuur waardoor de druk op Natura 2000-gebieden toeneemt. Optische verstoring kan optreden door de aanwezigheid en/of beweging van mensen dan wel voorwerpen die niet thuishoren in het natuurlijke systeem.

Volgens Arcadis (2014) kunnen in uiterste gevallen nog effecten optreden tot een afstand van 1.200 meter voor kwalificerende visueel verstoringsgevoelige soorten (met name vogels) bij een zeer intensieve uitloop van menselijke activiteiten en zonder enige tussenliggende afscherming.

Door de werkzaamheden zal de menselijke aanwezigheid tijdelijk toenemen. Voor de aangewezen niet-broedvogels zijn negatieve effecten op de instandhoudingsdoelstellingen niet op voorhand uit te sluiten en worden in hoofdstuk 5 mogelijke effecten nader beschouwd.

4.7 Verstoring door mechanische effecten

Onder mechanische effecten vallen verstoring door betreding, golfslag, luchtwervelingen etc. die optreden ten gevolge van menselijke activiteiten. De oorzaken en gevolgen zijn bij deze storende factor zeer divers.

De werkzaamheden aan de masten zijn niet zodanig intensief dat hierdoor mechanische effecten zijn te verwachten. Dit geldt ook voor het aanbrengen van beton bij mast 64. Negatieve effecten door verstoring door mechanische effecten zijn niet aan de orde.

4.8 Verzuring en vermesting door stikstofdepositie

Als er stoffen in het milieu terecht komen die leiden tot het zuurder worden van de lucht, neerslag, bodem, oppervlaktewater of grondwater spreken we van verzuring. Dit leidt tot een directe of indirecte afname van de buffercapaciteit (het neutralisatievermogen) van bodem of water. Op termijn resulteert dit proces in een daling van de zuurgraad. Hierdoor zullen voor verzuring gevoelige soorten verdwijnen, wat kan resulteren in een verandering van het habitattype en daarmee mogelijk het verdwijnen van typische (dier)soorten. Vermesting betreft elke extra aanvoer van voedingsstoffen, met name stikstof en fosfaat. Het kan gaan om aanvoer door de lucht (droge en natte neerslag van ammoniak en stikstofoxiden) of nitraat- en fosfaataanvoer door het oppervlaktewater. Ook verhoogde mineralisatie, dat wil zeggen de omzetting van plantenresten en humus tot voedingsstoffen en CO2, leidt tot vermesting.

De werkzaamheden leiden tot een geringe extra stikstofuitstoot. Per 1 juli 2021 is echter de Wet stikstofreductie natuurverbetering in werking is getreden en geldt er een partiële vrijstelling voor de bouwsector, waardoor de stikstofemissies (en de bijhorende stikstofdepositie) in de aanlegfase niet meer leiden tot een vergunningplicht op grond van de Wet natuurbescherming. Stikstof uitstoot in de eindfase is niet aan de orde. De werkzaamheden vallen onder een eenmalige tijdelijke activiteit ten behoeve van de opwaardering van het hoogspanningstracé. In de nieuwe situatie zal de stikstofuitstoot en depositie niet toenemen. De werkzaamheden vallen hiermee onder de partiele vrijstelling. Deze vrijstelling is echter nog niet juridisch houdbaar gebleken. Hier schuilt dus een risico. Door toch voor de werkzaamheden een Aeriusberekening uit te voeren kan hier indien nodig later op worden terug gegrepen. Negatieve effecten door stikstofdepositie hoeven niet te worden getoetst.

5 Effectbeoordeling Natura 2000

5.1 Effectbeoordeling

In dit hoofdstuk zijn de mogelijke effecten beschreven op de instandhoudingsdoelen van habitattypen en kwalificerende soorten van Natura 2000-gebied Zwarte meer. De hoofdvraag hierbij is of significante verslechtering op de doelen van kwalificerende soorten, en significante verslechtering van habitattypen en habitats van soorten (leefgebied), op voorhand zijn uitgesloten.

In de onderstaande paragrafen worden de effectindicatoren behandeld die in hoofdstuk 4 als relevant en nader te toetsen zijn beoordeeld. Bepaald wordt in hoeverre significante effecten op de geformuleerde instandhoudingsdoelstellingen optreden.

Voor de onderstaande effectindicatoren is in hoofdstuk 4 geconcludeerd dat geen nadere toetsing nodig is:

- Oppervlakteverlies en versnippering
- Verontreiniging.
- Verdroging.
- Verstoring door licht en trillingen.
- Verstoring door mechanische effecten.
- Verzuring en vermesting door stikstofdepositie.

Mogelijke effecten van verstoring door geluid en optische verstoring worden in paragraaf 5.2 getoetst.

5.2 Verstoring door geluid en optische verstoring

De werkzaamheden per mast en per lierlocatie duren enkele dagen. Bij mast 64 is dat iets langer (max. 5 werkdagen, verdeeld over 2 weken). Er wordt niet gelijktijdig aan alle masten gewerkt waardoor het verstoorde oppervlakte zich elke keer beperkt tot de omgeving van één mast/lierlocatie.

Voor de niet-broedvogels kunnen effecten van verstoring door geluid en optische verstoring niet worden uitgesloten. Voor alle aangewezen niet-broedvogels geldt voor zowel kwaliteit als omvang van het leefgebied een behoudsdoelstelling.

In tabel 5.1 en 5.2 is voor respectievelijk de Natura 2000-gebieden Zwarte meer en Uiterwaarden Zwarte Water en Vecht een overzicht opgenomen van de aangewezen niet-broedvogels en hun staat van instandhouding, de doelstelling en de huidige aantallen. Vervolgens vindt per soort een toetsing plaats. Voor de waarnemingen per soort is gebruik gemaakt van NDFF (2017-2022).

Tabel 5.1. Niet broedvogels Natura 2000-gebied Zwarte Meer met instandhoudingsdoelstelling en huidige aantallen. De aantallen betreffen seizoensgemiddelden. Aantallen in rood zijn aantallen onder instandhoudingsdoelstelling

Soort		LSVI[2]	doelstelling Opp	kwal	Functie[4]	Draagkracht Aantal paren	Aantal vogels	Huidig [3] aantal paren	aantal vogels
A005	**Fuut**	**-**	**=**	**=**	**foer**		**170**		**103**
A017	Aalscholver	+	=	=	foer		330		263
A034	Lepelaar	+	=	=	foer		3		2
A037	Kleine zwaan	--	=	=	Slaaprust /foer		2		0
A041	kolgans	+	=	=	Slaaprust foer		740		343
A043	Grauwe gans	+	=	=	Slaaprust foer		630		822
A050	Smient	-	=	=	slaaprust		1.300		610
A051	Krakeend	+	=	=	Foer		90		1123
A052	Wintertaling	+	=	=	Foer		470		71
A054	Pijlstaart	+	=	=	Foer		10		1
A056	Slobeend	+	=	=	Foer		10		13
A059	Tafeleend	--	=	=	Foer		240		69
A061	Kuifeend	-	=	=	Foer		1.700		1464
A125	Meerkoet	-	=	=	Foer		1.800		1.521
A156	Grutto	--	=	=	slaaprust		Behoud		583
A197	Zwarte stern	--	=	=	Foer		10 (max)		1
A702	Toendrarietgans	+	=	=	slaaprust		behoud		1030[1]

Tabel 5.2. Niet broedvogels Natura 2000-gebied Uiterwaarden Zwarte Water en Vecht met instandhoudingsdoelstelling en huidige aantallen. De aantallen betreffen seizoensgemiddelden. Aantallen in rood zijn aantallen onder instandhoudingsdoelstelling

Soort		**LSVI[2]**	**doelstelling[1] opp**	**kwal**	**Functie[4]**	**draagkracht aantal paren**	**aantal vogels**	**Huidige aantallen[3] Aantal paren**	**Aantal vogels**
A037	Kleine zwaan	--	=	=	foer		4		1
A041	kolgans	+	=(<)	=	foer		2.100		1265
A050	Smient	-	=(<)	=	Slaaprust foer		570		368
A054	Pijlstaart	+	=	=	Foer		20		1
A056	Slobeend	+	=	=	Foer		10		8
A125	Meerkoet	-	=	=	Foer		320		193
A156	Grutto	--	=	=	Slaaprust foer		80		10

[1] doelstelling:
Broedvogels, niet-broedvogels: doelstelling voor leefgebied en/of omvang populatie

= behoud
> uitbreiding

[2] LSVI landelijke staat van instandhouding

+ gunstig
- matig ongunstig
-- zeer ongunstig

[3] * huidige aantallen betreffen het gemiddelde van seizoenen 2015 t/m 2019 voor broedvogels, en seizoenen 2014/2015 t/m 2018/2019 voor niet-broedvogels (Bron:Sovon)

[4] functie foer = foerageergebied, slaaprust = slaap of rustplaatsen

Fuut

De aantallen voor fuut liggen beneden het instandhoudingsdoel voor Zwarte Meer en de landelijke staat van instandhouding is matig ongunstig. Fuut komt jaarrond verspreid voor in het hele Zwarte Meer. Buiten de broedperiode is de fuut beperkt gevoelig voor verstoring (Platteeuw and Henkens 1997, Platteeuw and Beekman 1994). De territoria liggen in het rietmoeras langs de gehele zuidoever van het Zwarte meer, ook nabij mast 12. De overige masten liggen buiten de verstoringsafstand van het foerageergebied. Bij de werkzaamheden aan mast 12 kan verstoring optreden op fuut, maar er zijn voldoende uitwijkmogelijkheden waar geen verstoring door de werkzaamheden optreedt (zie figuur 5.1). Omdat slechts een gering deel van het totale beschikbare foerageergebied (tot mogelijk 1 kortdurend wordt verstoord en er eenvoudig uitgeweken kan worden naar alternatief foerageergebied, zijn significant negatieve effecten van verstoring door de werkzaamheden op het instandhoudingsdoel van fuut uitgesloten.

Figuur 5.1 Ligging werkgebied (masten 12 en 13) met globale verstoringsgrens binnen alternatief foerageergebied

Aalscholver

De aalscholver komt jaarrond verspreid voor in het gebied Zwarte Meer. In of nabij de masten binnen Natura 2000-gebieden zijn geen aalscholverkolonies waargenomen. Het aantal aalscholvers (263) bevindt zich momenteel beneden het instandhoudingsdoel van Zwarte Meer (330). Buiten de broedperiode is de aalscholver beperkt gevoelig voor verstoring. Bovendien maken ze gebruik van een groot foerageergebied. Wanneer er wel verstoring optreedt, wijken foeragerende aalscholvers daarbij uit om elders te foerageren, zonder dat daar meetbare effecten op voedselinname waarneembaar zijn (Madsen et al. 1992). Omdat door de werkzaamheden aan de masten slechts een klein deel van het aanwezige foerageergebied van de aalscholver verstoord kan worden, er eenvoudig kan worden uitgeweken naar alternatief foerageergebied en de landelijke staat van instandhouding gunstig is, worden significant negatieve effecten op de aalscholver uitgesloten.

Lepelaar

Lepelaar is meer dan 1 km oostelijk en meer dan 2 km westelijk van mast 12 foeragerend waargenomen langs de oever van het Zwarte Meer. De gebieden in Zwarte Meer zijn aangewezen als foerageergebied. Lepelaars zijn ook buiten de broedtijd gevoelig voor verstoring en kiezen voor weinig verstoorde foerageergebieden. Concrete verstoringsafstanden zijn weinig bekend, wel genoemd wordt een gemiddelde verstoringsafstand van 113 m voor wandelaars (Krijgsveld, Smits, and van der Winden 2008). Het aantal lepelaars (2) bevindt zich momenteel iets beneden het instandhoudingsdoel van Zwarte Meer (3). Van het in Zwarte Meer aanwezige foerageergebied ligt slechts een klein deel mogelijk binnen de verstoringsafstand van lepelaar (zie figuur 5.1). Daarnaast is de landelijke staat van instandhouding gunstig. De verstoring door de kortdurende werkzaamheden aan de dichtstbijzijnde masten 12 en 13 hebben geen significant negatieve effecten voor lepelaar tot gevolg.

Kleine zwaan

In het Zwarte Meer zijn in de omgeving van de masten weinig waarnemingen van foeragerende kleine zwanen bekend. In en in de omgeving van Uiterwaarden Zwarte Water en Vecht wordt kleine zwaan veel meer waargenomen. De soort foerageert op het water maar ook op graslanden en akkers. De waarnemingen die er zijn, zijn verspreid over het gebied. Omdat de werkzaamheden per mast plaatsvinden en zo steeds slechts een klein deel van het aanwezige foerageergebied van de kleine zwaan verstoord kan worden, kan er eenvoudig worden uitgeweken naar alternatief foerageergebied (zie figuren 5.1 en 5.2).

Het aantal kleine zwanen bevindt zich momenteel voor beide Natura 2000-gebieden beneden het instandhoudingsdoel en de landelijke staat van instandhouding is zeer ongunstig. Maar omdat beurtelings slechts een zeer klein deel van mogelijk foerageergebied van kleine zwaan wordt verstoord, kunnen significant negatieve effecten van de verstoring door de werkzaamheden worden uitgesloten.

Figuur 5.2 De ligging van de masten in het agrarisch gebied met blauw omcirkelde de masten nabij Natura 2000-gebied Zwarte meer en groen nabij Uiterwaarden Zwarte Water en Vecht

Kolgans

De kolgans is van oktober tot maart aanwezig in Nederland, vooral in open agrarische gebieden. Langs de noordoever van het Zwarte Meer (Flevoland) worden door Sovon en NEM (Netwerk Ecologische Monitoring) diverse tellingen gedaan. Op deze locaties, maar ook langs de zuid- en oostoever van het Zwarte Meer zijn veel kolganzen waargenomen. Het aantal kolganzen bevindt zich momenteel beneden het instandhoudingsdoel van Zwarte Meer en Uiterwaarden Zwarte Water en Vecht, maar de landelijke staat van instandhouding is gunstig. De werkzaamheden aan de masten zijn plaatselijk (per mast) en tijdelijk. De kolganzen die mogelijk foerageren in het agrarische gebied waar de masten zich bevinden, zullen omdat het agrarisch gebied hier omvangrijk is, altijd voldoende alternatief in de directe omgeving hebben (zie figuur 5.2). Significant negatieve effecten van de verstoring door de werkzaamheden aan de masten kunnen worden uitgesloten.

Grauwe gans

De grauwe gans komt jaarrond voor in Nederland, maar de piek ligt in de winter. In het gehele gebied Zwarte Meer komt de soort voor, vooral in de oeverzone. Het aantal grauwe ganzen bevindt zich momenteel boven het instandhoudingsdoel van Zwarte Meer en ook de landelijke staat van instandhouding is goed. De grauwe gans is vergeleken met andere ganzensoorten relatief beperkt gevoelig voor verstoring. Grauwe gans kan in geval van verstoring eenvoudig uitwijken naar alternatieve foerageergebieden. Omdat door de werkzaamheden per mast slechts een beperkt oppervlakte tijdelijk verstoord kan worden zijn significant negatieve effecten van verstoring door de werkzaamheden op de grauwe gans uitgesloten.

Smient

De smient komt verspreid voor in het Zwarte Meer en is vooral aanwezig tussen november en maart. Het aantal smienten bevindt zich momenteel beneden het instandhoudingsdoel van vooral Zwarte Meer maar ook van Zwarte Water en Vecht. Voor beide gebieden is de functie rust- en slaapgebied en dat is voor smient met name overdag en op het water. De landelijke staat van instandhouding is matig ongunstig. Vergeleken met andere grasland-gebonden soorten is de smient is relatief gevoelig voor verstoring (Kleyheeg and van den Bremer 2018, Madsen 1998). Bij verstoring zullen de smienten het verstoorde gebied mijden om elders te rusten of foerageren wanneer uitwijkmogelijkheden aanwezig zijn (Kleyheeg and van den Bremer 2018). Omdat de smient vooral overdag rust en de werkzaamheden overdag plaatsvinden, kan verstoring van de rustgebieden aan de orde zijn bij werk aan de masten nabij water. Dit betreft slechts enkele masten (11,12, 65 en 66) waardoor voldoende niet verstoorde rustplaatsen overblijven (zie figuren 5.1 en 5.2). Het leidt ook niet direct tot verlies van voedselgebied, omdat dit ‘s nachts onverstoord is. Omdat per mast wordt gewerkt en steeds een beperkt oppervlakte (gedurende enkele dagen) wordt verstoord kan smient voor rustplaatsen ook gemakkelijk uitwijken naar onverstoorde locaties op korte afstand. Er zijn veel graslanden waar gefoerageerd kan worden aanwezig in de omgeving van de masten waar gewerkt gaat worden. Significant negatieve effecten van de verstoring door de werkzaamheden op de instandhoudingsdoelstellingen voor smient kunnen worden uitgesloten.

Krakeend

Krakeend komt verspreid voor in de omgeving van de masten en is het hele jaar aanwezig, maar het meest in de winter. Hoewel de krakeend verstoord kan worden door bijvoorbeeld waterrecreatie, is de soort de afgelopen jaren sterk in aantal toegenomen ondanks de eveneens toegenomen waterrecreatie. Verder komt de krakeend steeds vaker voor binnen de stedelijke omgeving wat ook wijst op een beperkte gevoeligheid voor verstoring. Het aantal krakeenden bevindt zich momenteel ruim boven het instandhoudingsdoel van Zwarte Meer en ook de landelijke staat van instandhouding is goed. Op basis van de aanwezigheid van krakeend langs de gehele zuidkant van het Zwarte meer lijkt het erop dat er voldoende uitwijkmogelijkheden aanwezig zijn. Bovendien wordt door de werkzaamheden slechts tijdelijk en per mast een gebied rond deze mast verstoord. Significant negatieve effecten van de verstoring door de werkzaamheden op de instandhoudingsdoelstellingen voor de krakeend kunnen worden uitgesloten.

Wintertaling

Wintertaling komt verspreid voor langs de noord- en zuidoever van het Zwarte Meer. Wintertaling is het gehele jaar in Nederland aanwezig, maar de aantallen zijn het hoogst van september t/m november. Wintertaling is gevoelig voor verstoring door water- en oeverrecreatie. Het aantal wintertalingen bevindt zich momenteel ruim beneden het instandhoudingsdoel van Zwarte Meer, maar de landelijke staat van instandhouding is goed. De foerageergebieden bevinden zich in en rond de wateren waar wintertaling verblijft. Bij de werkzaamheden aan mast 12 kan verstoring optreden op wintertaling, maar er zijn voldoende uitwijkmogelijkheden (zie figuur 5.1) waar geen verstoring door de werkzaamheden optreedt. Omdat slechts een gering deel van het totale beschikbare foerageergebied kortdurend wordt verstoord en er eenvoudig uitgeweken kan worden naar alternatief foerageergebied, zijn significant negatieve effecten van verstoring door de werkzaamheden op het instandhoudingsdoel van wintertaling uitgesloten.

Pijlstaart

Pijlstaart komt verspreid voor langs de zuidoever van het Zwarte Meer en ook langs de noordoostoevers. Pijlstaart is het gehele jaar in Nederland aanwezig, maar de aantallen zijn het hoogst van oktober t/m februari. Pijlstaart foerageert voornamelijk ’s nachts, waardoor geschikte foerageergebieden niet worden verstoord door de werkzaamheden. Bovendien zijn er langs de hele Zwarte Meer kust geschikte alternatieven waarnaar uitgeweken kan worden (zie figuur 5.1). Het aantal pijlstaarten bevindt zich momenteel onder het instandhoudingsdoel van Zwarte Meer en Zwarte Water en Vecht, maar de landelijke staat van instandhouding is goed. Vanwege het ’s nachts foerageren worden de foerageergebieden door de werkzaamheden niet verstoord. Significant negatieve effecten op de instandhoudings-doelstellingen van pijlstaart zijn uitgesloten.

Slobeend

Slobeend komt gedurende het gehele jaar verspreid voor langs de zuid- en noord oever van het Zwarte Meer. Slobeend foerageert bij voorkeur in ondiepere en beschutte wateren en is vooral gevoelig voor waterrecreatie. Nabij mast 12 ligt geschikt foerageerwater, maar ook in de directe omgeving, buiten de verstoringsafstand van het werk aan mast 12 is geschikt foerageergebied aanwezig (zie figuur 5.1). Voor Uiterwaarden Zwarte Water en Vecht liggen de geschikte foerageergebieden buiten de verstoringsafstand. Het aantal slobeenden bevindt zich momenteel boven het instandhoudingsdoel van Zwarte Meer en iets beneden dat van Uiterwaarden Zwarte Water en Vecht. Bovendien is de landelijke staat van instandhouding goed. Significant negatieve effecten van verstoring door de kortdurende werkzaamheden, uitgevoerd op een beperkt oppervlakte per dag, op de instandhoudingsdoelstellingen voor de slobeend kunnen daarom worden uitgesloten.

Tafeleend

Tafeleend komt gedurende het gehele jaar verspreid voor langs de zuid- en noordoevers van het Zwarte Meer. Tafeleend bevindt zich overdag op beschutte rustplaatsen, langs de oeverzone en eilandjes, terwijl er ’s nachts veelal op meerdere kilometers afstand van de rustplaatsen en vooral op het open water gefoerageerd wordt op waterplanten en macrofauna. Tafeleend is zeer gevoelig voor waterrecreatie.

De dichtstbijzijnde mast bij rustplaatsen is mast 12, maar omdat de hele oeverzone geschikt is als rustplaats kan tijdens de kortdurende (enkele dagen) werkzaamheden bij mast 12 worden uitgeweken naar de directe omgeving (zie figuur 5.1). De foerageergebieden worden niet verstoord omdat het werk overdag plaatsvindt. Het aantal tafeleenden bevindt zich momenteel beneden het instandhoudingsdoel van Zwarte Meer, en ook is de landelijke staat van instandhouding zeer ongunstig. De kortdurende en zeer plaatselijke (alleen mast 12 bevindt zich in rustgebied) werkzaamheden leiden niet tot significant negatieve effecten van verstoring op de instandhoudingsdoelstellingen van tafeleend.

Kuifeend

Kuifeend komt gedurende het gehele jaar verspreid voor langs de zuid- en noordoostoevers van het Zwarte Meer. Kuifeend bevindt zich overdag vaak op de rustplaatsen, terwijl er met name ’s nachts veelal op meerdere kilometers afstand van de rustplaatsen en vooral op het open water gefoerageerd wordt op driehoeksmosselen en andere macrofauna. Kuifeend is gevoelig voor waterrecreatie, maar ook recreatie op oevers kan verstorend werken. De dichtstbijzijnde mast bij rustplaatsen is mast 12, maar omdat de hele oeverzone geschikt is als rustplaats kan tijdens de kortdurende (enkele dagen) werkzaamheden bij mast 12 worden uitgeweken naar de directe omgeving (zie figuur 5.1). De foerageergebieden worden niet verstoord omdat het werk overdag plaatsvindt. Het aantal kuifeenden (1464) bevindt zich momenteel beneden het instandhoudingsdoel van Zwarte Meer (1700) en de landelijke staat van instandhouding is matig ongunstig. De kortdurende en zeer plaatselijke (alleen mast 12 bevindt zich in rustgebied) werkzaamheden leiden niet tot significant negatieve effecten van verstoring op de instandhoudingsdoelstellingen van kuifeend omdat de soort niet erg verstoringsgevoelig is, de foerageergebieden op beperkte afstand liggen, er voldoende uitwijkmogelijkheden zijn en foerageren vooral ’s nachts plaatsvindt.

Meerkoet

De meerkoet komt jaarrond verspreid voor in het Zwarte Meer. Zowel nabij mast 12 als bij mast 13 zijn territoria aanwezig. Voor Uiterwaarden Zwarte Water en Vecht geldt dat de masten buiten de verstoringsafstand van de territoria liggen. De vluchtafstanden bij water- en oeverrecreatie zijn ongeveer 50 m en de maximale verstoringsafstand is ongeveer 130 m. Meerkoet is daarmee beperkt gevoelig voor verstoring en komt dan ook veelvuldig voor binnen de stedelijke omgeving en gebieden met veel waterrecreatie (Platteeuw and Beekman 1994). Het aantal meerkoeten bevindt zich momenteel beneden het instandhoudingsdoel van Zwarte Meer en Uiterwaarden Zwarte Water en Vecht en de landelijke staat van instandhouding is matig ongunstig Vanwege de beperkte verstoringsgevoeligheid, de korte duur, het werken per mast en de alternatieve foerageerlocaties nabij mast 12 en 13 (zie figuur 5.1) worden significant negatieve effecten van de werkzaamheden aan de masten voor de meerkoet uitgesloten.

Grutto

Grutto is waargenomen in de omgeving van de masten bij beide Natura 2000-gebieden. Er bevinden zich slaapplaatsen op een beperkt aantal km afstand van het plangebied (Meetnet NEM, via NDFF). Slaapplaatsen worden niet verstoord omdat overdag wordt gewerkt.

Voor foerageergebieden kan gemakkelijk worden uitgeweken omdat per mast wordt gewerkt en het verstoorde oppervlakte daarom zowel beperkt als tijdelijk is. De landelijke staat van instandhouding is zeer ongunstig, maar het aantal grutto's (583) bevindt zich momenteel boven het instandhoudingsdoel van Zwarte Meer (behoud) en beneden dat van Uiterwaarden Zwarte Water en Vecht (aantal 10, doel 80). Vanwege de korte duur en het beperkte oppervlak van verstoring en daarmee de uitwijkmogelijkheden bij foerageren worden significant negatieve effecten door de werkzaamheden op de instandhoudingsdoelstellingen voor grutto uitgesloten.

Zwarte stern

Zwarte stern is niet in de omgeving van de masten waargenomen. Het aantal zwarte sterns in Zwarte Meer (1) ligt beneden het instandhoudingsdoel (10) De landelijke staat van instandhouding is zeer ongunstig. Op basis van de afstand van de waargenomen zwarte sterns tot het plangebied, de gemiddelde verstoringsgevoeligheid van de soort en de uitwijkmogelijkheden naar alternatief geschikt foerageergebied worden significant negatieve effecten van de van de beoogd uit te voeren werkzaamheden op de instandhoudingsdoelstellingen voor de zwarte stern uitgesloten.

Toendrarietgans

Toendrarietgans verblijft van oktober tot maart in Nederland en komt verspreid op het land langs de oevers van het Zwarte Meer voor. Dit betreffen echter losse waarnemingen. De soort slaapt op water, maar zal dan niet worden verstoord omdat overdag wordt gewerkt. Foerageren gebeurt op akkers en graslanden die in de wijde omgeving van de masten aanwezig zijn. Gedurende het werk aan een mast is er voldoende alternatief niet verstoord foerageergebied beschikbaar (zie figuur 5.2). Het aantal toendrarietganzen bevindt zich momenteel boven het instandhoudingsdoel van Zwarte Meer en ook de landelijke staat van instandhouding is gunstig. Significant negatieve effecten van werkzaamheden aan de masten op de instandhoudingsdoelstellingen voor toendrarietgans worden uitgesloten.

Voor alle niet-broedvogels kunnen negatieve effecten, en zeker significant negatieve effecten door optische verstoring en verstoring door geluid worden uitgesloten.

6 Conclusie

Uit de voortoets gericht op niet-broedvogels is gebleken dat de per mastlocatie kortdurende werkzaamheden niet leidt tot effecten op de instandhoudingsdoelstellingen van Natura 2000-gebied Zwarte meer en Uiterwaarden Zwarte Water en Vecht.

Er is geen sprake van effecten van:

- Oppervlakteverlies en versnippering.
- Verontreiniging.
- Verdroging.
- Verstoring door licht en trillingen.
- Verstoring door mechanische effecten.
- Verzuring en vermesting door stikstofdepositie.

De volgende mogelijke effecten zijn nader getoetst:

- Verstoring door geluid.
- Optische verstoring.

Uit de effectbeoordeling is gebleken dat de werkzaamheden aan de masten niet zal leiden tot significant negatieve effecten op de instandhoudingsdoelstellingen van niet-broedvogels. Deze conclusie dient te worden besproken met het bevoegd gezag (LNV).

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