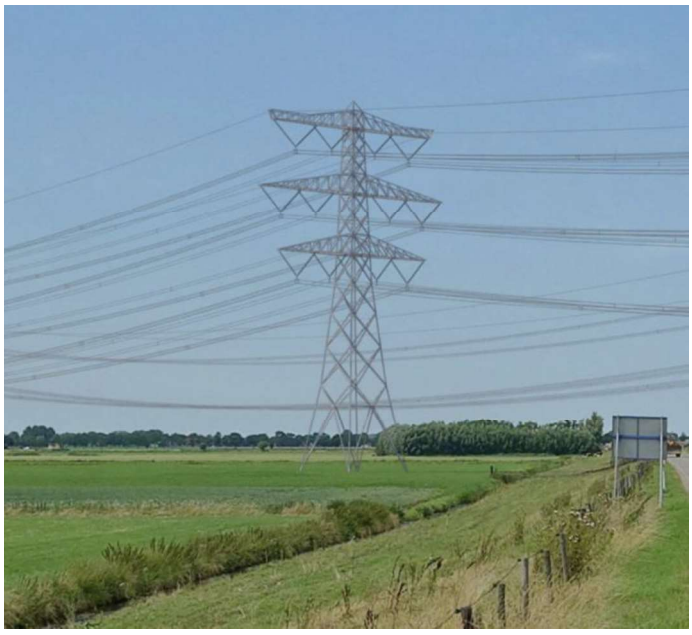
B.3 Mastrapportage steunmasten

ZUID-WEST 380 KV OOST VERBINDINGEN

Mastrapport combi-steunmasten

TenneT TSO B.V.

Meridian doc.nr.: 002.678.00.0927722
Rapport nr.: 21-0728, Rev. 1
Datum: 28-07-2021



Projectnaam:	Zuid-West 380 kV Oost Verbindingen	Energy Systems
Rapport titel:	Mastrapport combi-steunmasten	DNV Netherlands B.V.
Klant:	TenneT TSO B.V., Utrechtseweg 310, 6812 AR Arnhem	Utrechtseweg 310-B50
Contactpersoon klant:	[redacted]	6812 AR Arnhem
Datum uitgave:	28-07-2021	
Project nr.:	10124719	
Organisatie unit:	Transmission & Distribution Technology (TDT)	Tel: 026 356 9111
Meridian doc.nr..:	002.678.00.0927722	Handelsregister Arnhem 09006404
Rapport nr.:	21-0728, Rev. 1	

Geschreven door:	Beoordeeld door:	Goedgekeurd door:
[redacted]		

Copyright © DNV 2021. All rights reserved. Unless otherwise agreed in writing: (i) This publication or parts thereof may not be copied, reproduced or transmitted in any form, or by any means, whether digitally or otherwise; (ii) The content of this publication shall be kept confidential by the customer; (iii) No third party may rely on its contents; and (iv) DNV undertakes no duty of care toward any third party. Reference to part of this publication which may lead to misinterpretation is prohibited.

DNV Distributie:

☒ Open

☐ Intern

☐ Commercieel vertrouwelijk

☐ Vertrouwelijk

☐ Geheim

*Specificatie distributie: --

Trefwoorden:

[Trefwoorden]

Rev.	Datum	Reden van uitgave	Auteur	Beoordelaar	Goedkeuder
0	07-05-2021	Eerste uitgave	[redacted]		
0	28-07-2021	RFA-commentaar verwerkt			

Inhoudsopgave

1 INLEIDING 1

2 UITGANGSPUNTEN EN RANDVOORWAARDEN 2
2.1 Normen 2
2.2 TenneT-specificaties 2
2.3 Eisenverificatie 2
2.4 Ontwerprapporten 2
2.5 Materialen 2
2.6 Software 3

3 MASTONTWERP 4
3.1 Mastbeelden 4
3.2 Uitgangspunten berekening 11
3.3 Mastenlijst 11
3.4 Geleiderbelastingen 14
3.5 Reacties op de fundering 14
3.6 Modellering 14
3.7 Overige controles 14
3.8 Mastgewicht 14

4 TOETSING 15
4.1 Resultaat PLS-TOWER 15
4.2 Toetsing overige onderdelen 21

Appendix A Geleiderbelastingen
Appendix B Resultaten PLS-TOWER
Appendix C Knikverkorters
Appendix D Blokdeuvels
Appendix E Liggers
Appendix F Sterkte-coördinatie

1 INLEIDING

In het basisontwerp van de vakwerkmasten voor de verbinding RLL-TLB380 in het project Zuid-West 380 kV-Oost zijn voor het vaststellen van de haalbaarheid constructieve berekeningen uitgevoerd aan de masten en fundaties. In de Definitief Ontwerpfase, moeten berekeningen verder worden uitgewerkt om te kunnen dienen voor de benodigde vergunningsdocumentatie, voor de aanbesteding en als voorbereiding voor de uitvoeringsfase. Het DO omvat het ontwerp van de mastconstructies, de fundaties en de opstijgpunten in de verbinding.

Deze rapportage bevat de resultaten van de toetsing van alle masttypen binnen de groep van de combi-steunmasten, een masttype dat geschikt is voor twee circuits 380 kV en twee circuits 150 kV. Het ontwerp van de combi-steunmasten S-3/c t/m S+12/c is zodanig dat de “mastkop” gedeeld wordt binnen de groep van de combi-steunmasten, alleen de hoogte van het onderstuk verschilt.

In deze rapportage is de toetsing van de mastkop van de combi-steunmasten en de toetsing van alle onderstukken van de verschillende typen opgenomen. De toetsing bestaat uit controle van:

- de profielen en boutverbindingen onderdeel van de hoofddraagconstructie
- de knikverkorters
- de liggers voor de isolatorkettingen
- de verbinding met de fundatie via blokdeuvels
- aanvullende controle op sterkte-coördinatie

Buiten de scope van dit DO-rapport valt de controle van de schetsplaten en overige verbindingsdetails in de constructie. Dit moet in de UO-fase worden uitgewerkt. Ook de voorzieningen voor de high-step rail en bordessen vallen onder uitwerking in UO-fase.

In hoofdstuk 2 zijn de uitgangspunten en randvoorwaarden vanuit de van toepassing zijnde normen en TenneT-specificaties opgenomen. Hoofdstuk 3 beschrijft de gevolgde aanpak van de berekening. In hoofdstuk 4 is de toetsing opgenomen.

2 UITGANGSPUNTEN EN RANDVOORWAARDEN

2.1 Normen

Er is gebruik gemaakt van de normen volgens Tabel 1.

Tabel 1 Gebruikgemaakte normen, voorschriften en richtlijnen

Norm	Titel
NEN-EN 50341-1:2013	"Overhead electrical lines exceeding AC 1 kV - Part 1: General requirements – Common"
NEN-EN 50341-2-15:2019	"Overhead electrical lines exceeding AC 1 kV Part 2 National Normative Aspects (NNA) for THE NETHERLANDS"
NEN-EN 1990+A1+A1/C2:2019/NB:2019nl	"Grondslagen van het ontwerp"
NEN-EN 1991-1-4+A1+C2:2011/NB:2019+C1:2020	"Deel 1-4: Windbelasting op constructies"
NEN-EN 1992-1-1+C2:2011/NB:2016+A1:2020	"Eurocode 2: Ontwerp en berekening van betonconstructies, deel 1-1: algemene regels en regels voor gebouwen"
NEN-EN 1993-1-1+C2+A1:2016 nl	"Eurocode 3: Ontwerp en berekening van staalconstructies, deel 1-1: algemene regels en regels voor gebouwen"
NEN-EN 1993-3-1:2007/NB:2011 nl	"Deel 3-1: Torens, masten en schoorstenen - Torens en masten"
NEN-EN 1993-1-8+C2:2011/NB:2011 nl	"Ontwerp en berekening van staalconstructies, deel 1-8: ontwerp en berekening van verbindingen"

2.2 TenneT-specificaties

In Tabel 2 zijn de documenten opgenomen die relevant zijn voor de berekeningen en toetsingen die binnen dit project in de mastrapportage uitgevoerd zullen worden.

Tabel 2 Relevante documenten t.b.v. mechanische rapportages

Nummer	Onderwerp
PVE.05.000 v3.2	PvE Lijnen
sPVE.05.001	sPvE Lijnen
SPE.05.346 v1.3	Algemene specificatie stalen masten

2.3 Eisenverificatie

Voor de eisenverificatie wordt verwezen naar het rapport "Verificatierapport eisen DO Moldau", DNV GL rapport 21-0451, Meridiannummer 002.678.00 0910757.

2.4 Ontwerprapporten

Voor de achtergrond van het ontwerp wordt verwezen naar het uitgangspuntenrapport "Uitgangspunten definitief ontwerp Moldaumast", DNV GL rapport 21-0036, Meridiannummer 002.678.00 0876917.

2.5 Materialen

Voor het ontwerp van de mastconstructies en fundaties wordt uitgegaan van de eigenschappen volgens Tabel 3.

Tabel 3 Materialen aangepaste constructie

Staalsoort	S355J0 (t≤16 mm) S355J2 (16<t≤40 mm)
Boutkwaliteit	8.8 gerolde draad
Betonkwaliteit	C30/37
Wapeningsstaal	B500

Voor de constructie geldt conform TenneT-specificatie:

- Toe te passen bouten: M16/M20/M24;
- Voor hoekstaal is de minimale afmeting L50x5 mm;
- Minimale plaatdikte 6 mm.

Mocht het noodzakelijk zijn M30 toe te passen, bij grote plaatdiktes is dit als afwijking door TenneT toegestaan.

2.6 Software

De gebruikte software wordt benoemd in Tabel 4.

Tabel 4 Toegepaste software

Software		Versie
Mastontwerp	PLS-CADD	16.65
Mastberekeningen	PLS-TOWER	16.65
Constructieve analyse	AxisVM	X5 R4h

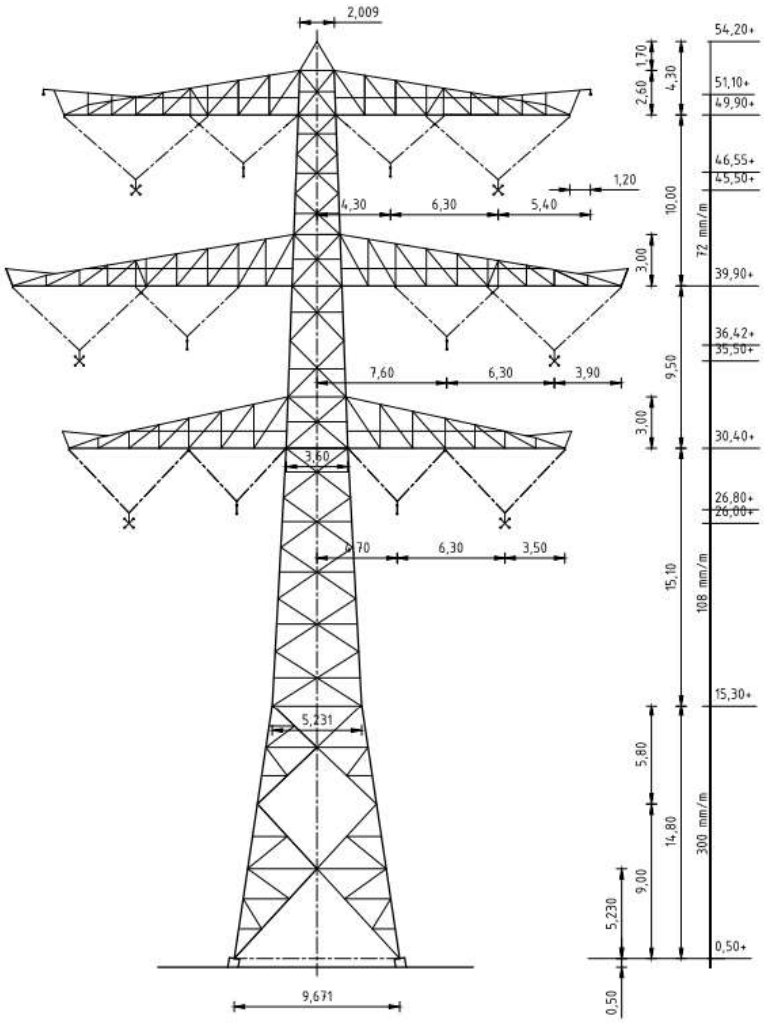
3 MASTONTWERP

3.1 Mastbeelden

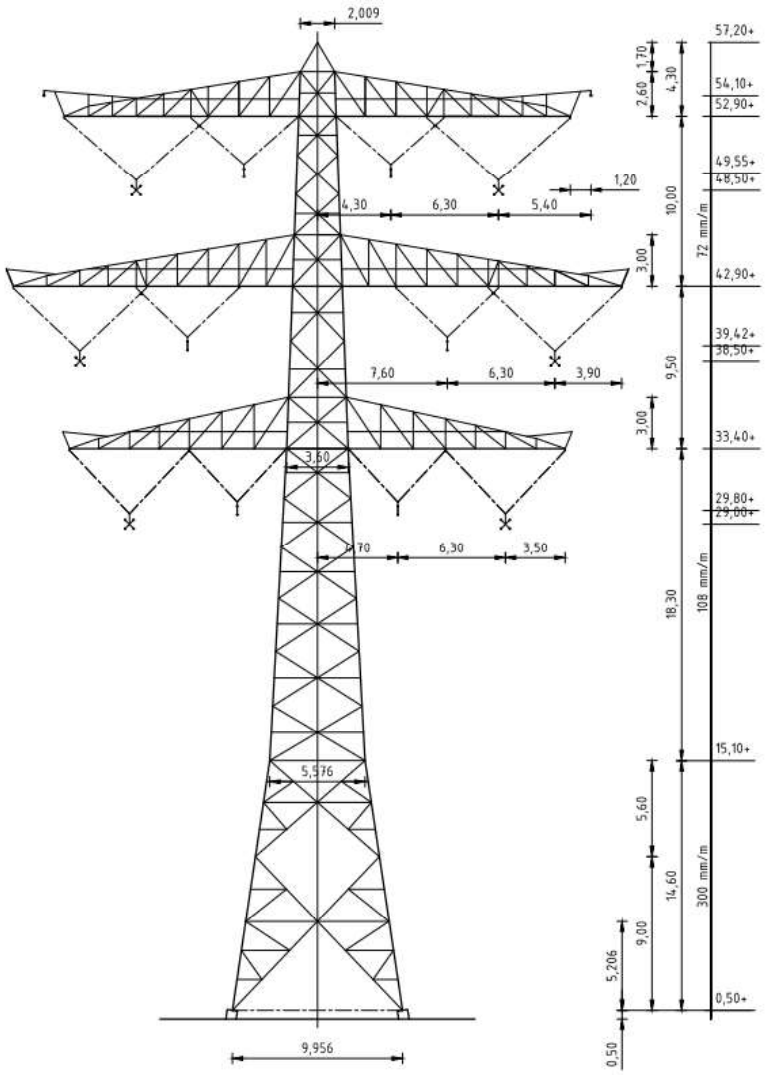
In dit hoofdstuk worden de mastbeelden weergegeven met de belangrijkste maatvoering, voor volledige tekeningen van de masttypen wordt verwezen naar onderstaande tekening:

- Mastbeeldtekening steunmasten, Meridiannummer 002.678.00 0890100
- Mastbeeldtekening S-3/c, Meridiannummer 002.678.00 0927444
- Mastbeeldtekening S+0/c, Meridiannummer 002.678.00 0901939
- Mastbeeldtekening S+3/c, Meridiannummer 002.678.00 0927446
- Mastbeeldtekening S+6/c, Meridiannummer 002.678.00 0927450
- Mastbeeldtekening S+9/c, Meridiannummer 002.678.00 0927458
- Mastbeeldtekening S+12/c, Meridiannummer 002.678.00 0927466

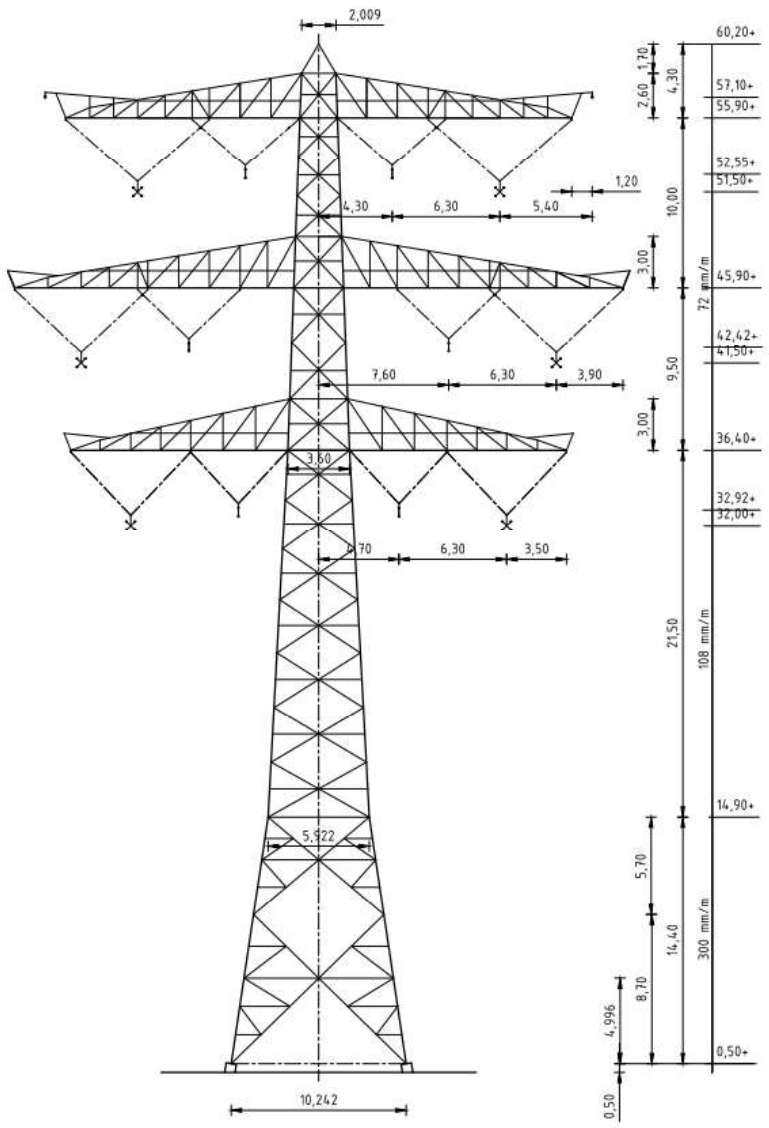
De combi-steunmasten voor twee circuits 380 kV en twee circuits 150kV zijn in oplopende hoogte in Figuur 1 weergegeven.



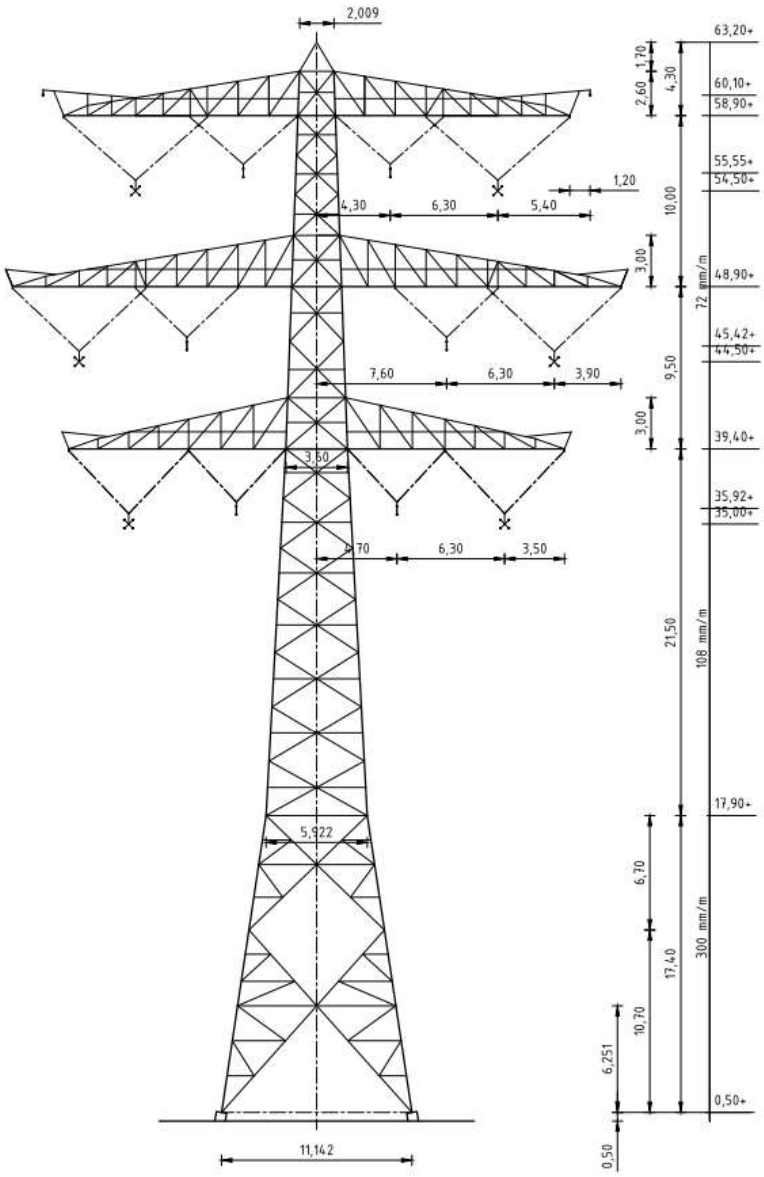
Mastbeeld S-3/c



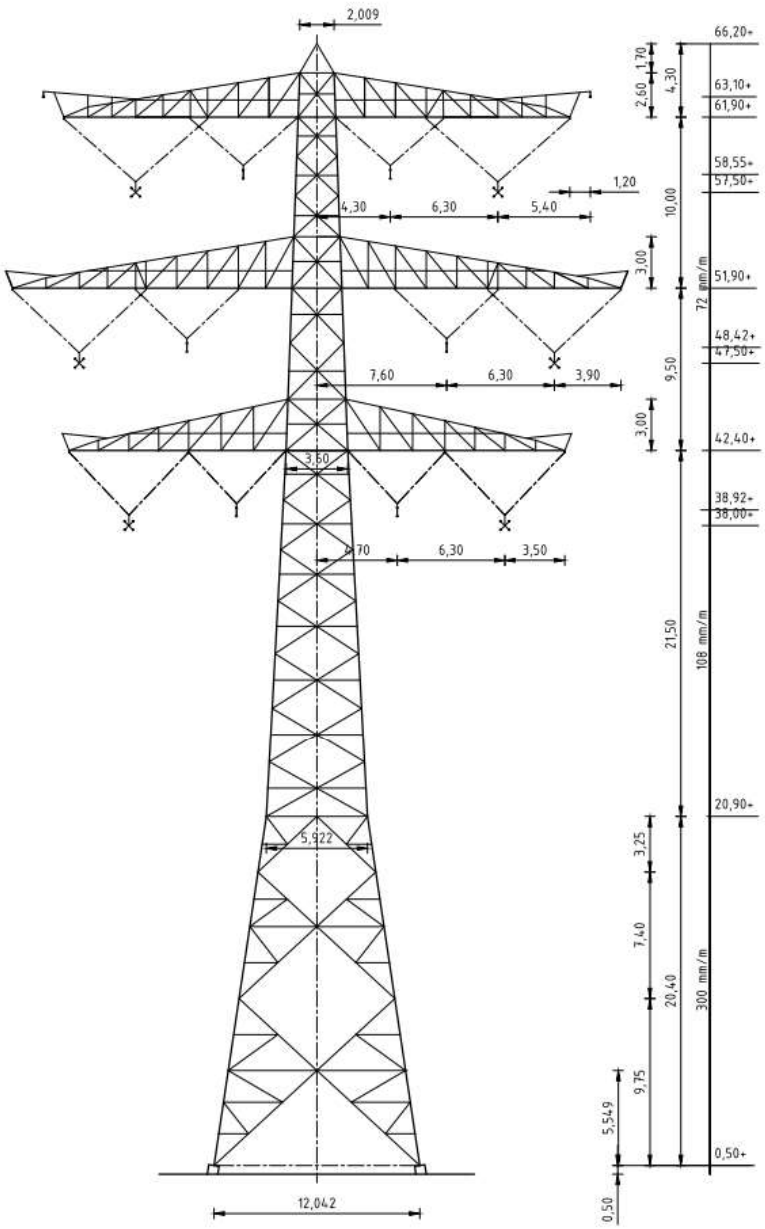
Mastbeeld S+0/c



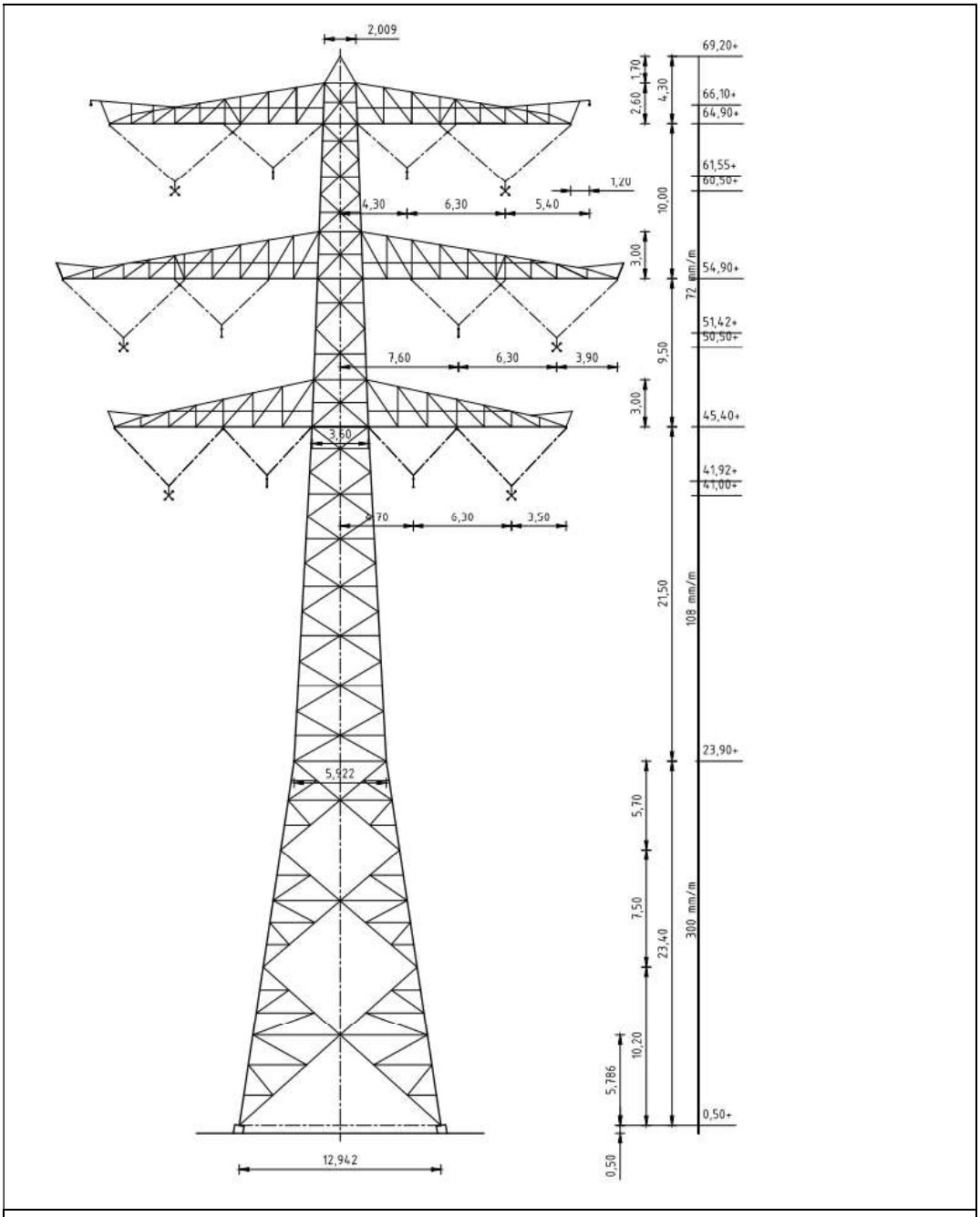
Mastbeeld S+3/c



Mastbeeld S+6/c



Mastbeeld S+9/c



Mastbeeld S+12/c

Figuur 1 Mastbeelden masttypes combi-steunmasten

3.2 Uitgangspunten berekening

De uitgangspunten volgens Tabel 5 zijn van toepassing.

Tabel 5 Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

3.3 Mastenlijst

De mastenlijst is gebaseerd op de “staking table” van het DO-uitgangspuntenrapport en benaamd als “VKA 1.1 Concept 20201112 1037-1044_1086-1094_1099-1105_1192-1204.xlsx”. De mastenlijst is vanwege lopende traceringsvraagstukken aan verandering onderhevig en is derhalve indicatief.

In Tabel 6 tot en met Tabel 11 zijn alle masten in het tracé van de type S-3/c t/m S+12/c opgenomen. De mast met grootste wind span is vetgedrukt aangegeven. Het masttype zal niet met deze wind en weight span worden berekend maar met generieke wind en weight span, zie uitgangspuntenrapport. In de tabellen zijn masttypes om praktische redenen aangeduid met “S_c” in plaats van “S/c”.

Tabel 6 Mastenlijst S-3/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1026	S-3_c	180,0	304,2	283,1	-3,6	-0,2	-3,3
1119	S-3_c	180,0	330,8	315,5	-2,8	-2,9	0,1
1120	S-3_c	180,0	326,3	323,5	-0,5	-0,1	-0,4
1121	S-3_c	180,0	320,4	306,4	-2,4	0,4	-2,9

Tabel 7 Mastenlijst S+0/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1028	S+0_c	180,0	299,0	306,9	1,2	0,3	0,9
1029	S+0_c	180,0	321,0	294,2	-5,2	-0,9	-4,3
1031	S+0_c	180,0	349,7	336,7	-2,5	-4,8	2,3
1032	S+0_c	180,0	349,7	322,4	-5,3	-2,3	-3,0
1034	S+0_c	180,0	349,7	343,5	-1,2	-0,1	-1,1
1035	S+0_c	180,0	349,7	337,6	-2,4	1,1	-3,4
1038	S+0_c	180,0	340,3	328,2	-2,4	-0,1	-2,3
1041	S+0_c	180,0	330,8	310,1	-3,5	-3,5	0,0
1042	S+0_c	180,0	359,9	343,5	-3,3	0,0	-3,2
1045	S+0_c	180,0	366,0	366,7	0,2	-0,7	0,9
1046	S+0_c	180,0	380,8	376,8	-0,8	-0,9	0,0
1047	S+0_c	180,0	380,1	383,9	0,8	0,0	0,8
1048	S+0_c	180,0	383,6	378,2	-1,1	-0,8	-0,3
1049	S+0_c	180,0	379,9	383,0	0,7	0,3	0,3

1050	S+0_c	180,0	376,5	373,7	-0,6	-0,3	-0,3
1084	S+0_c	180,0	351,1	333,2	-3,4	-3,6	0,2
1085	S+0_c	180,0	347,8	347,7	0,0	-0,2	0,2
1090	S+0_c	180,0	360,7	363,1	0,5	0,3	0,2
1091	S+0_c	180,0	377,7	376,5	-0,3	-0,2	0,0
1092	S+0_c	180,0	384,2	371,6	-2,8	0,0	-2,8
1096	S+0_c	180,0	369,6	354,3	-3,1	-2,9	-0,2
1097	S+0_c	180,0	379,2	380,5	0,3	0,2	0,0
1106	S+0_c	180,0	357,5	358,7	0,2	0,1	0,1
1107	S+0_c	180,0	361,6	359,9	-0,3	-0,1	-0,2
1108	S+0_c	180,0	389,8	390,7	0,2	0,2	0,0
1109	S+0_c	180,0	396,4	381,8	-3,2	0,0	-3,3
1112	S+0_c	180,0	384,5	385,2	0,1	-0,1	0,2
1113	S+0_c	180,0	343,8	325,6	-3,2	-0,2	-3,0
1122	S+0_c	180,0	323,2	342,9	3,5	2,9	0,6
1124	S+0_c	180,0	365,1	365,2	0,0	-0,1	0,1
1125	S+0_c	180,0	354,7	353,9	-0,2	-0,1	0,0
1126	S+0_c	180,0	365,2	366,6	0,3	0,0	0,3
1127	S+0_c	180,0	365,1	361,0	-0,8	-0,3	-0,6
1129	S+0_c	180,0	365,5	364,9	-0,1	-0,1	0,0
1132	S+0_c	180,0	233,1	224,3	-1,1	0,1	-1,2
1134	S+0_c	180,0	385,5	389,6	0,9	0,0	0,9
1135	S+0_c	180,0	385,0	379,4	-1,2	-0,9	-0,3
1136	S+0_c	180,0	376,6	377,8	0,3	0,3	-0,1
1140	S+0_c	180,0	377,5	362,5	-3,2	-3,1	-0,1
1141	S+0_c	180,0	364,9	365,2	0,1	0,1	0,0
1142	S+0_c	180,0	358,9	358,9	0,0	0,0	0,0
1143	S+0_c	180,0	361,4	361,9	0,1	0,0	0,1
1144	S+0_c	180,0	362,1	361,8	-0,1	-0,1	0,0
1145	S+0_c	180,0	362,6	363,7	0,2	0,0	0,2
1146	S+0_c	180,0	363,2	359,0	-0,9	-0,2	-0,6
1155	S+0_c	180,0	387,9	356,5	-6,8	-1,0	-5,8
1161	S+0_c	180,0	365,0	348,5	-3,5	-3,4	-0,1
1162	S+0_c	180,0	371,2	372,0	0,2	0,1	0,1
1164	S+0_c	180,0	375,1	345,1	-6,2	-0,3	-5,9
1170	S+0_c	180,0	334,4	316,3	-3,4	-3,0	-0,3
1171	S+0_c	180,0	344,2	345,2	0,2	0,3	-0,2
1172	S+0_c	180,0	369,8	371,0	0,2	0,2	0,1
1173	S+0_c	180,0	365,5	364,5	-0,2	-0,1	-0,1
1174	S+0_c	180,0	344,5	344,8	0,1	0,1	-0,1
1175	S+0_c	180,0	352,0	351,2	-0,1	0,1	-0,2
1176	S+0_c	180,0	367,5	370,2	0,6	0,2	0,3
1182	S+0_c	180,0	309,0	289,4	-3,4	-3,1	-0,3
1183	S+0_c	180,0	304,4	308,8	0,8	0,3	0,5
1189	S+0_c	180,0	339,6	339,7	0,0	0,5	-0,5
1190	S+0_c	180,0	339,6	339,4	0,0	0,5	-0,5
1191	S+0_c	180,0	337,9	339,1	0,2	0,5	-0,3
1195	S+0_c	180,0	350,4	319,9	-5,6	-5,0	-0,6
1201	S+0_c	180,0	332,4	316,4	-3,0	-3,0	0,1
1202	S+0_c	180,0	364,6	345,0	-3,6	-0,1	-3,5

Tabel 8 Mastenlijst S+3/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1030	S+3_c	180,0	360,7	406,3	9,1	4,3	4,8
1036	S+3_c	180,0	372,3	411,5	8,2	3,4	4,7
1039	S+3_c	180,0	342,2	362,1	3,8	2,3	1,5
1040	S+3_c	180,0	314,5	327,0	2,0	-1,5	3,5
1043	S+3_c	180,0	333,7	370,0	6,7	3,2	3,4
1070	S+3_c	180,0	325,3	320,6	-0,9	-2,5	1,6

1071	S+3_c	180,0	322,9	286,6	-6,5	-1,6	-4,9
1075	S+3_c	180,0	331,3	308,7	-2,8	2,5	-5,3
1083	S+3_c	180,0	330,9	336,4	1,2	-2,4	3,6
1093	S+3_c	180,0	399,0	410,4	2,5	2,8	-0,3
1104	S+3_c	180,0	400,0	382,2	-4,0	-6,8	2,9
1110	S+3_c	180,0	399,0	428,8	6,6	3,3	3,3
1138	S+3_c	180,0	361,9	379,0	3,5	3,5	0,0
1139	S+3_c	180,0	369,6	384,1	3,1	0,0	3,1
1160	S+3_c	180,0	385,0	416,6	6,8	3,4	3,4
1169	S+3_c	180,0	352,9	385,0	6,3	3,3	3,0
1178	S+3_c	180,0	400,0	413,5	3,0	3,3	-0,2
1179	S+3_c	180,0	400,0	399,4	-0,1	0,2	-0,4
1180	S+3_c	180,0	391,9	391,8	0,0	0,4	-0,4
1181	S+3_c	180,0	347,6	367,4	3,5	0,4	3,1
1185	S+3_c	180,0	328,1	358,3	5,0	4,7	0,3
1186	S+3_c	180,0	372,3	382,6	2,2	-0,3	2,5
1198	S+3_c	180,0	387,4	368,1	-4,3	-6,0	1,8
1200	S+3_c	180,0	362,2	388,3	5,6	2,6	3,0
1203	S+3_c	180,0	337,6	363,0	5,7	3,5	2,1

Tabel 9 Mastenlijst S+6/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1074	S+6_c	180,0	393,1	366,7	-5,8	-3,3	-2,5
1080	S+6_c	180,0	308,1	306,0	-0,3	-0,2	-0,2
1081	S+6_c	180,0	338,4	339,8	0,3	0,2	0,1
1082	S+6_c	180,0	316,1	329,1	2,3	-0,1	2,4
1087	S+6_c	180,0	391,0	406,8	3,2	6,1	-2,9
1100	S+6_c	180,0	399,0	411,0	2,7	3,0	-0,3
1101	S+6_c	180,0	398,6	388,5	-2,2	0,3	-2,6
1156	S+6_c	180,0	376,5	396,9	4,6	5,8	-1,3
1157	S+6_c	180,0	365,3	405,4	8,2	1,3	6,9
1165	S+6_c	180,0	367,3	397,2	6,1	5,9	0,3
1166	S+6_c	180,0	373,8	400,7	5,7	-0,3	6,0

Tabel 10 Mastenlijst S+9/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1072	S+9_c	180,0	361,6	386,6	4,4	4,9	-0,5
1073	S+9_c	180,0	400,0	416,8	3,7	0,5	3,3
1088	S+9_c	180,0	382,7	439,7	11,8	2,9	9,0
1102	S+9_c	180,0	399,5	405,3	1,3	2,6	-1,3
1103	S+9_c	180,0	400,0	436,5	8,1	1,3	6,8
1193	S+9_c	180,0	333,3	403,8	12,3	9,5	2,9
1197	S+9_c	180,0	270,7	328,7	9,3	9,7	-0,4

Tabel 11 Mastenlijst S+12/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1076	S+12_c	180,0	337,8	379,1	6,8	5,3	1,6
1077	S+12_c	180,0	399,1	418,2	4,2	-1,6	5,8
1115	S+12_c	180,0	269,8	355,0	10,2	9,6	0,6
1116	S+12_c	180,0	364,0	362,0	-0,3	-0,6	0,2
1117	S+12_c	180,0	398,1	451,4	11,8	-0,2	12,0

3.4 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV GL. De belastingen op de mastconstructie zijn bepaald op basis van de modellering in PLS-TOWER (staafoppervlaktes). Voor de toeslagen op eigen gewicht en windoppervlakte wordt verwezen naar het uitgangspuntenrapport. In Appendix A zijn de resultaten van de geleiderbelastingen samengevat.

3.5 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma. Zie Appendix A.

3.6 Modellering

Op basis van de ontwerptekeningen is de mast in PLS-TOWER ingevoerd. De toetsing wordt per staafgroep uitgevoerd. De hoofdelementen zijn gemodelleerd, niet-dragende profielen als knikverkorters zijn weggelaten, deze worden separaat getoetst. De profielen zijn in PLS-TOWER inclusief de boutverbindingen ingevoerd en getoetst, de controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

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

De gewichts- en windbelasting op de mastconstructie wordt door PLS-TOWER automatisch bepaald. Via toeslagfactoren wordt de invloed van niet gemodelleerde elementen als knikverkorters, bordesconstructies en klimvoorzieningen meegenomen. Voor schetsplaten, zinklaag en bouten is een aanvullende toeslag op het gewicht van 15% (*steunmast)* / 20% *(hoekmast)* toeslag gerekend.

Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep.

3.7 Overige controles

In PLS-TOWER zijn niet alle elementen getoetst. Knikverkorterprofielen en overige profielen voor beloopbaarheid worden separaat getoetst. In Appendix C is dit opgenomen. De verbinding met de fundatie bestaat uit ingestorte profielen voorzien van blokdeuvels. Dit is in Appendix D opgenomen. De liggers van isolatorkettingen vereisen een aanvullende controle op buiging. De toetsing is uitgevoerd met de software AxisVM en is beschreven in Appendix E. Appendix F omvat de toetsing op sterkte-coördinatie.

3.8 Mastgewicht

Het totale mastgewicht per masttype is met de uitgangspunten van paragraaf 3.6 bepaald op:

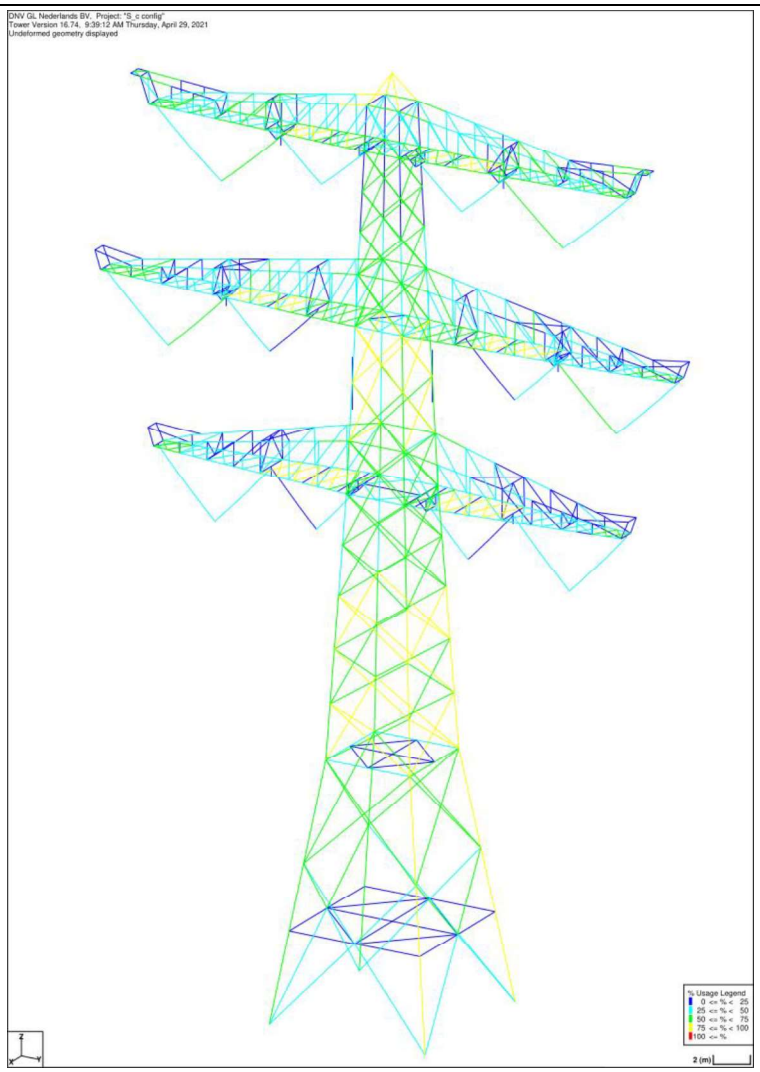
- Masttype S-3/c 42,6 ton
- Masttype S+0/c 45,0 ton
- Masttype S+3/c 46,7 ton
- Masttype S+6/c 49,2 ton
- Masttype S+9/c 52,2 ton
- Masttype S+12/c 59,2 ton

4 TOETSING

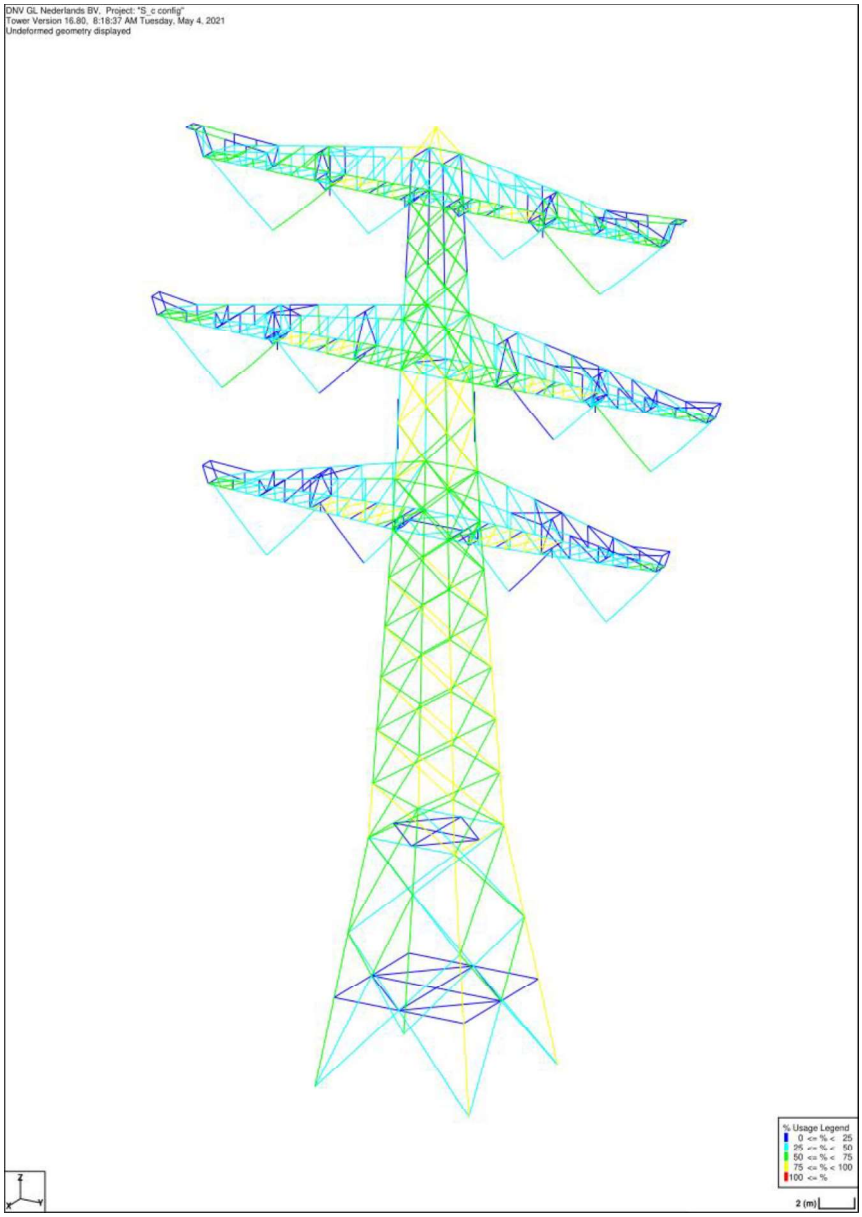
4.1 Resultaat PLS-TOWER

Het resultaat van de toetsing met PLS-TOWER is per masttype weergegeven in onderstaande Figuur 2. Voor elk masttype zijn de belastingen apart bepaald. Alléén voor masttype S+12/c, bepalend voor het ontwerp van de mastkop, zijn deze ook inclusief bouwfase (enkelzijdig belast) en hijslasten.

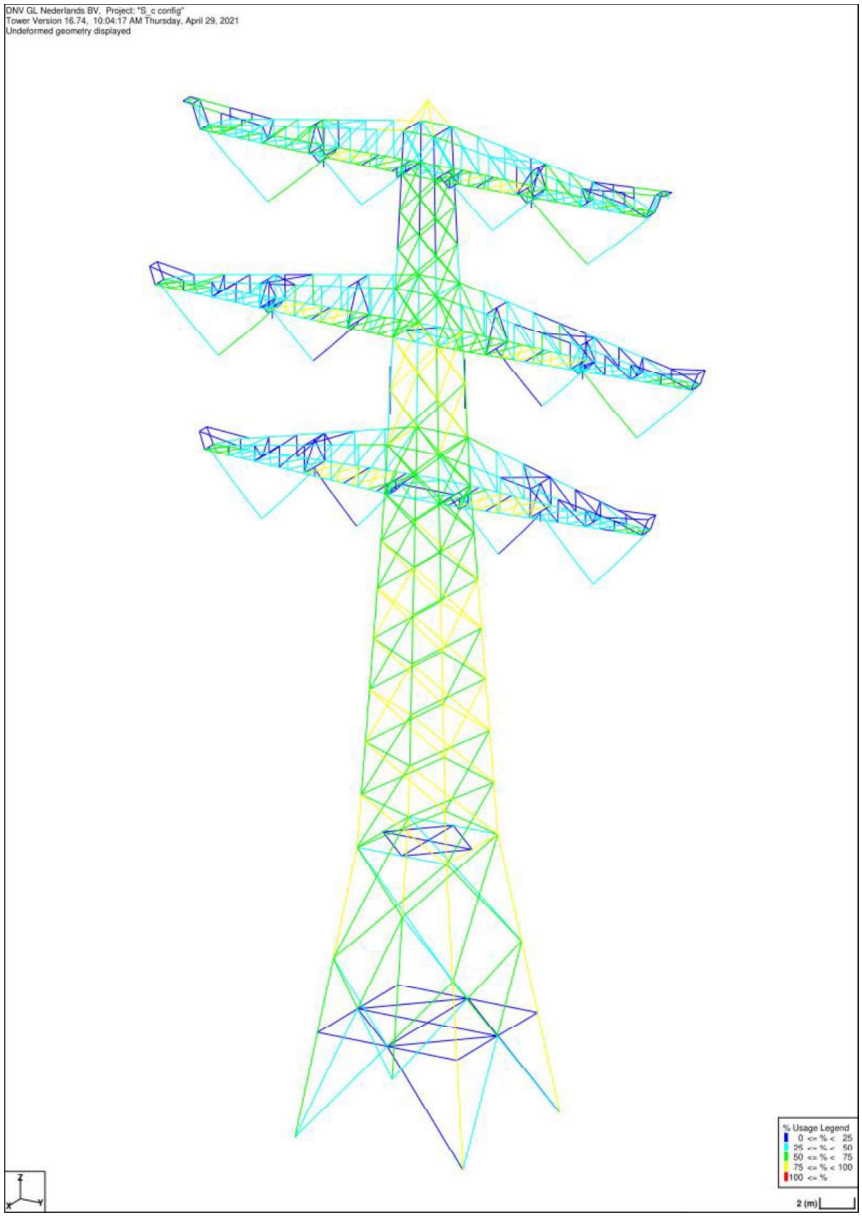
De uitnutting van de constructie loopt op van blauw (0-25%) tot geel (75-100%). Uit de figuur wordt geconcludeerd dat alle profielen en boutverbindingen voldoen.



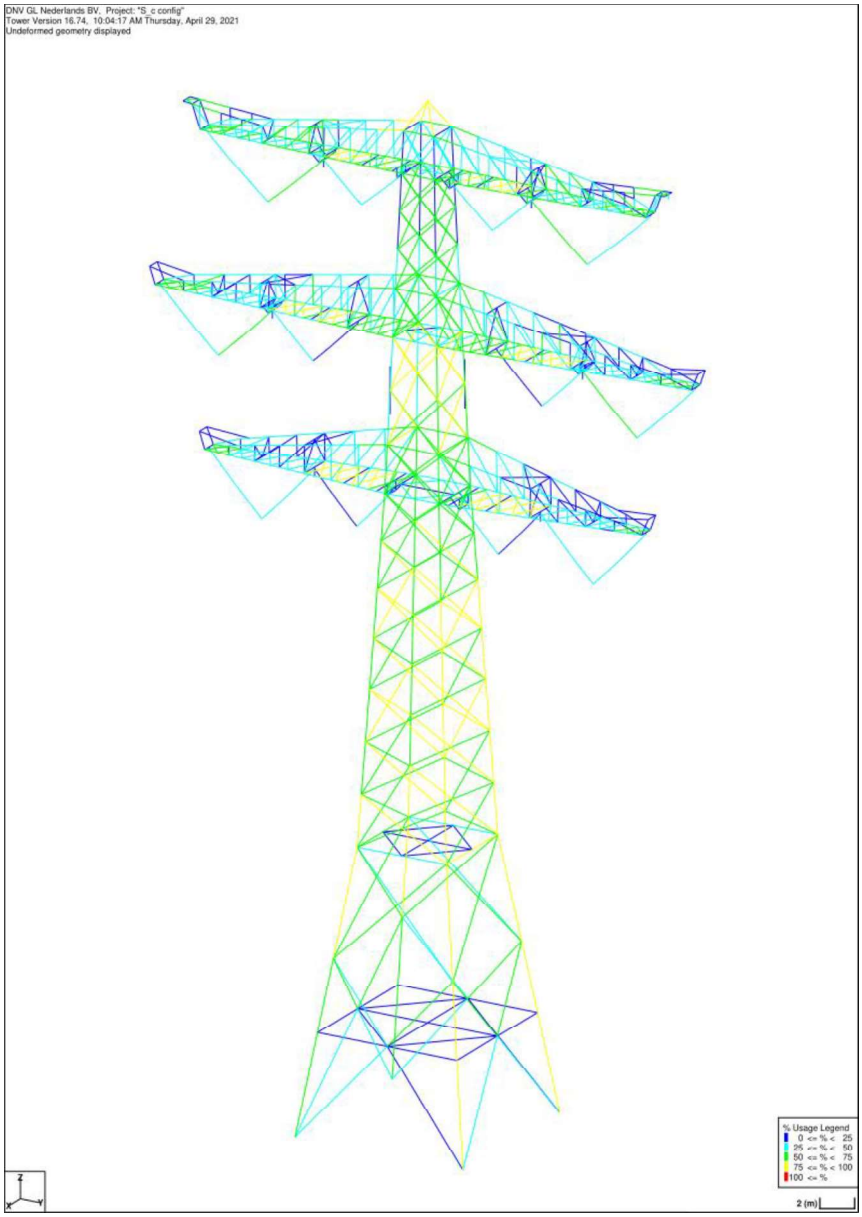
Resultaat masttype S-3/c



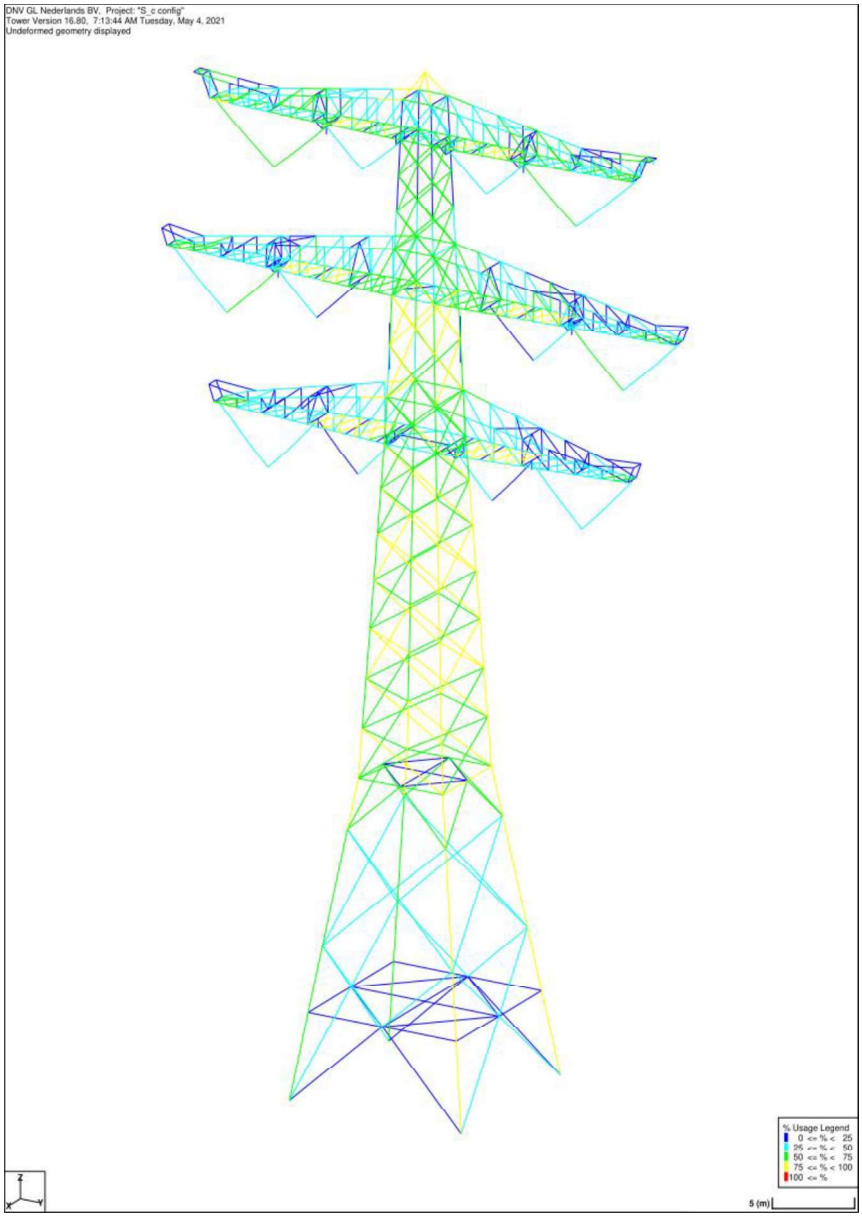
Resultaat masttype S+0/c



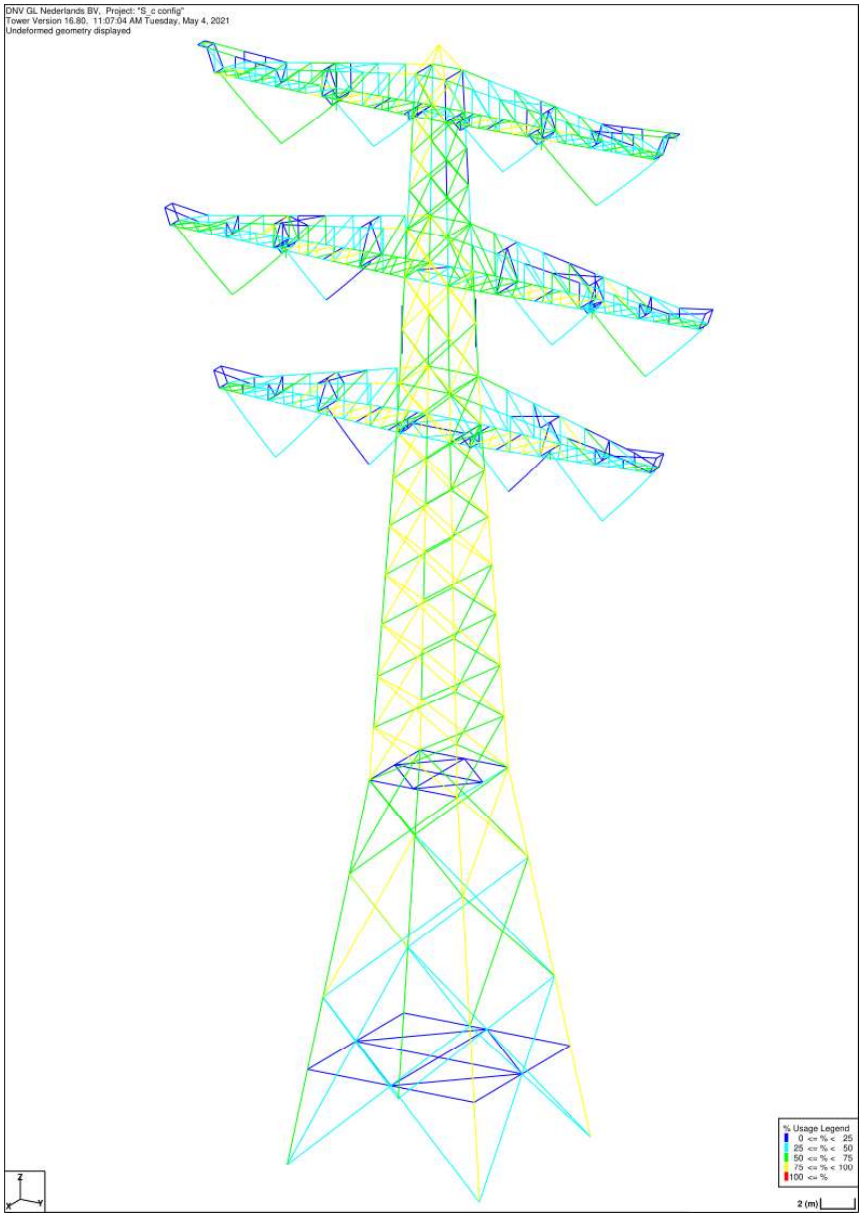
Resultaat masttype S+3/c



Resultaat masttype S+6/c



Resultaat masttype S+9/c



Resultaat masttype S+12/c

Figuur 2 Resultaat PLS-TOWER voor masttype S-3/c t/m S+12/c

4.2 Toetsing overige onderdelen

In Tabel 12 zijn de resultaten van de uitgevoerde toetsingen weergegeven.

Tabel 12 Samenvatting uitgevoerde controles

Controle van	Beoordeling	Referentie
Profielen	Voldoen	Figuur 2 Appendix B
Knikverkorters	Voldoen	Appendix C
Blokdeuvels randstijl	Voldoen	Appendix D
Liggers	Voldoen	Appendix E
Sterkte-coördinatie	Voldoet	Appendix F

APPENDIX A
Geleiderbelastingen

Geleiderbelastingen opgenomen:

- Masttype S-3/c
- Masttype S+0/c
- Masttype S+3/c
- Masttype S+6/c
- Masttype S+9/c
- Masttype S+12/c
- Masttype S+12/c bouwfase
- Hijslast liggers

Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	53,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	454 m
Min. Weight span	256 m
Max. Weight span	510 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S-3_c

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

Document name:

RLL-TLB380_S-3_c_1119_Report.pdf

Project number:

Project client number:

0.0											

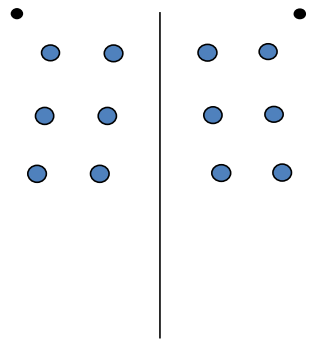
Project: RLL-TLB380
Tower: S-3_c
Number: 1119

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S-3_c
Masttype	Steunmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	4,50	4,50	2,00
Circuit 3	V-ketting	2,50	4,00	1,00
Circuit 4	V-ketting	2,50	4,00	1,00
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	25,4 m	29,9 m	11,3 m
Circuit 1	11	380ct1f2	34,9 m	39,4 m	14,0 m
Circuit 1	12	380ct1f3	44,9 m	49,4 m	10,3 m
Circuit 2	20	380ct2f1	25,4 m	29,9 m	-11,3 m
Circuit 2	21	380ct2f2	34,9 m	39,4 m	-14,0 m
Circuit 2	22	380ct2f3	44,9 m	49,4 m	-10,3 m
Circuit 3	30	150ct3f1	25,9 m	29,9 m	5,0 m
Circuit 3	31	150ct3f2	35,4 m	39,4 m	7,7 m
Circuit 3	32	150ct3f3	45,4 m	49,4 m	4,0 m
Circuit 4	40	150ct4f1	25,9 m	29,9 m	-5,0 m
Circuit 4	41	150ct4f2	35,4 m	39,4 m	-7,7 m
Circuit 4	42	150ct4f3	45,4 m	49,4 m	-4,0 m
Bliksemdraad 1	1	bl1	49,9 m	50,1 m	14,8 m
Bliksemdraad 2	3	bl2	49,9 m	50,1 m	-14,8 m

Project: RLL-TLB380
Tower: S-3_c
Number: 1119

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	6,0 m	6,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-6,0 m	-6,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

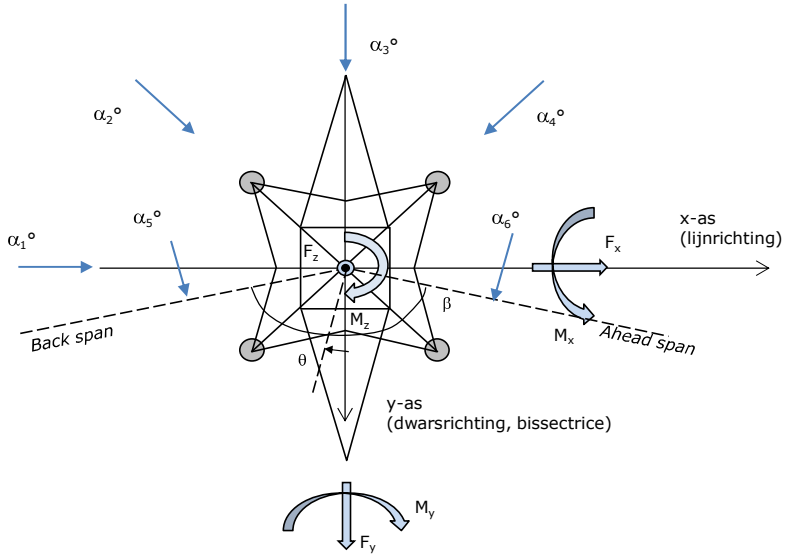
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	30	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	31	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	32	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	40	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	41	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	42	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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

Project: RLL-TLB380
Tower: S-3_c
Number: 1119

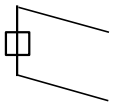
Geleiderafval

		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
Circuit 3	150ct3f1	1	0	1	0	0,8	0
Circuit 3	150ct3f2	1	0	1	0	0,8	0
Circuit 3	150ct3f3	1	0	1	0	0,8	0
Circuit 4	150ct4f1	0	1	1	0	0,8	0
Circuit 4	150ct4f2	0	1	1	0	0,8	0
Circuit 4	150ct4f3	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

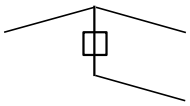
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

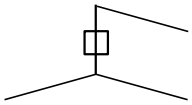
Principe belastingssituaties:



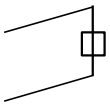
1. Ba All cts



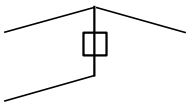
2. Ba ct1



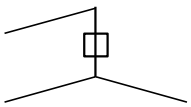
3. Ba ct2



4. Ah All cts



5. Ah ct1

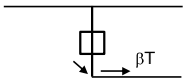


6. Ah ct2

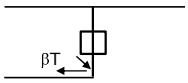
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S-3_c
Number: 1119

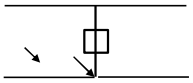
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

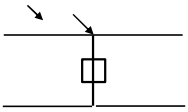
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

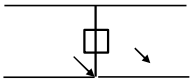
Principe belastingssituaties:



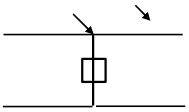
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

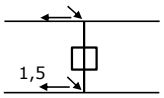
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

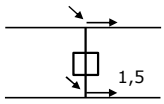
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S-3_c
Number: 1119

Mastconstructie

Eigenschappen

Masttype	Steunmast		
Mastbenaming	S-3_c		
Voetplaat t.o.v. maaiveld	0,5		m
Masthoogte t.o.v. voetplaat	53,7		m
Gewicht mast	418,0		kN
Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	9,67	9,67	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	14,80	9,67	5,23	14,80	0,150	110,27	18,67	0,17	3,07
Eerste tussenstuk	21,10	5,23	4,55	6,30	0,054	30,81	6,61	0,21	2,87
Tweede tussenstuk	29,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	39,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	52,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	53,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	29,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	39,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	49,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	14,80	9,67	5,23	14,80	0,150	110,27	18,67	0,17	3,07
Eerste tussenstuk	21,10	5,23	4,55	6,30	0,054	30,81	6,61	0,21	2,87
Tweede tussenstuk	29,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	39,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	52,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	53,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	29,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	39,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	49,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S-3_c
Number: 1119

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	14,8	1,5
Eerste tussenstuk	0,14	0,71	6,3	0,6
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	36,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	40,2	34,1	0,0	-34,1	7,4	297,2	252,2	0,0	-252,2
Eerste tussenstuk	0,85	16,1	13,7	0,0	-13,7	18,0	289,1	245,3	0,0	-245,3
Tweede tussenstuk	0,94	24,8	21,1	0,0	-21,1	25,5	633,1	537,2	0,0	-537,2
Bovenstuk 1	1,03	25,3	21,5	0,0	-21,5	34,7	878,2	745,2	0,0	-745,2
Bovenstuk 2	1,11	26,7	22,6	0,0	-22,6	45,7	1218,6	1034,0	0,0	-1034,0
Topstuk	1,15	1,1	0,9	0,0	-0,9	52,9	57,7	48,9	0,0	-48,9
Ondertraverse	1,00	25,8	15,3	0,0	-15,3	30,9	797,6	473,7	0,0	-473,7
Middentraverse	1,07	38,2	22,7	0,0	-22,7	40,4	1544,5	917,4	0,0	-917,4
Boventraverse	1,14	38,3	22,7	0,0	-22,7	50,3	1923,7	1142,6	0,0	-1142,6
Totaal		236,5	174,6	0,0	-174,6		7639,7	5396,6	0,0	-5396,6

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	34,1	40,2	34,1	7,4	0,0	252,2	297,2	252,2
Eerste tussenstuk	0,85	0,0	13,7	16,1	13,7	18,0	0,0	245,3	289,1	245,3
Tweede tussenstuk	0,94	0,0	21,1	24,8	21,1	25,5	0,0	537,2	633,1	537,2
Bovenstuk 1	1,03	0,0	21,5	25,3	21,5	34,7	0,0	745,2	878,2	745,2
Bovenstuk 2	1,11	0,0	22,6	26,7	22,6	45,7	0,0	1034,0	1218,6	1034,0
Topstuk	1,15	0,0	0,9	1,1	0,9	52,9	0,0	48,9	57,7	48,9
Ondertraverse	1,00	0,0	15,3	10,3	15,3	30,9	0,0	473,7	319,0	473,7
Middentraverse	1,07	0,0	22,7	15,3	22,7	40,4	0,0	917,4	617,8	917,4
Boventraverse	1,14	0,0	22,7	15,3	22,7	50,3	0,0	1142,6	769,5	1142,6
Totaal		0,0	174,6	175,1	174,6		0,0	5396,6	5080,2	5396,6

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	418	0	0	0
Windrichting 0°	244	0	0	0	7905	0
Windrichting 45°	180	180	0	5585	5585	0
Windrichting 90°	0	182	0	5346	0	0
Windrichting 135°	-180	180	0	5585	-5585	0

Project: RLL-TLB380
Tower: S-3_c
Number: 1119

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	28,15	0,97	1,2	2,33
380ct1f2	4,50	1	4,5	4,5	2,0	37,65	1,05	1,2	2,53
380ct1f3	4,50	1	4,5	4,5	2,0	47,65	1,12	1,2	2,69
380ct2f1	4,50	1	4,5	4,5	2,0	28,15	0,97	1,2	2,33
380ct2f2	4,50	1	4,5	4,5	2,0	37,65	1,05	1,2	2,53
380ct2f3	4,50	1	4,5	4,5	2,0	47,65	1,12	1,2	2,69
150ct3f1	2,50	1	2,5	4,0	1,0	28,40	0,97	1,2	1,17
150ct3f2	2,50	1	2,5	4,0	1,0	37,90	1,05	1,2	1,27
150ct3f3	2,50	1	2,5	4,0	1,0	47,90	1,12	1,2	1,35
150ct4f1	2,50	1	2,5	4,0	1,0	28,40	0,97	1,2	1,17
150ct4f2	2,50	1	2,5	4,0	1,0	37,90	1,05	1,2	1,27
150ct4f3	2,50	1	2,5	4,0	1,0	47,90	1,12	1,2	1,35
bl1	0,10	1	0,1	0,2	0,1	50,50	1,14	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	50,50	1,14	1,2	0,14

Project: RLL-TLB380
Tower: S-3_c
Number: 1119

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	21,5	0,90	0,55	0,55	1,04	33,37	68,4	68,4	51,8	122,9	122,9
380ct1f2	31,0	1,00	0,58	0,58	1,00	33,37	77,4	77,4	51,8	143,9	143,9
380ct1f3	41,0	1,08	0,60	0,60	0,98	33,37	84,6	84,6	51,8	161,3	161,3
380ct2f1	21,5	0,90	0,55	0,55	1,04	33,37	68,4	68,4	51,8	122,9	122,9
380ct2f2	31,0	1,00	0,58	0,58	1,00	33,37	77,4	77,4	51,8	143,9	143,9
380ct2f3	41,0	1,08	0,60	0,60	0,98	33,37	84,6	84,6	51,8	161,3	161,3
150ct3f1	22,0	0,90	0,55	0,55	1,03	33,37	34,5	34,5	51,8	62,1	62,1
150ct3f2	31,5	1,00	0,58	0,58	1,00	33,37	38,9	38,9	51,8	72,4	72,4
150ct3f3	41,5	1,08	0,60	0,60	0,98	33,37	42,5	42,5	51,8	81,0	81,0
150ct4f1	22,0	0,90	0,55	0,55	1,03	33,37	34,5	34,5	51,8	62,1	62,1
150ct4f2	31,5	1,00	0,58	0,58	1,00	33,37	38,9	38,9	51,8	72,4	72,4
150ct4f3	41,5	1,08	0,60	0,60	0,98	33,37	42,5	42,5	51,8	81,0	81,0
bl1	46,0	1,11	0,61	0,61	1,19	22,24	18,0	18,0	63,1	51,4	51,4
bl2	46,0	1,11	0,61	0,61	1,19	22,13	17,9	17,9	63,0	51,3	51,3

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	21,5	0,90	0,55	0,55	1,04	33,37	68,4	68,4	51,8	122,9	122,9
380ct1f2	31,0	1,00	0,58	0,58	1,00	33,37	77,4	77,4	51,8	143,9	143,9
380ct1f3	41,0	1,08	0,60	0,60	0,98	33,37	84,6	84,6	51,8	161,3	161,3
380ct2f1	21,5	0,90	0,55	0,55	1,04	33,37	68,4	68,4	51,8	122,9	122,9
380ct2f2	31,0	1,00	0,58	0,58	1,00	33,37	77,4	77,4	51,8	143,9	143,9
380ct2f3	41,0	1,08	0,60	0,60	0,98	33,37	84,6	84,6	51,8	161,3	161,3
150ct3f1	22,0	0,90	0,55	0,55	1,03	33,37	34,5	34,5	51,8	62,1	62,1
150ct3f2	31,5	1,00	0,58	0,58	1,00	33,37	38,9	38,9	51,8	72,4	72,4
150ct3f3	41,5	1,08	0,60	0,60	0,98	33,37	42,5	42,5	51,8	81,0	81,0
150ct4f1	22,0	0,90	0,55	0,55	1,03	33,37	34,5	34,5	51,8	62,1	62,1
150ct4f2	31,5	1,00	0,58	0,58	1,00	33,37	38,9	38,9	51,8	72,4	72,4
150ct4f3	41,5	1,08	0,60	0,60	0,98	33,37	42,5	42,5	51,8	81,0	81,0
bl1	46,0	1,11	0,61	0,61	1,19	22,24	18,0	18,0	63,1	51,4	51,4
bl2	46,0	1,11	0,61	0,61	1,19	22,13	17,9	17,9	63,0	51,3	51,3

Project: RLL-TLB380
Masttype: S-3_c
Mast: 1119

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	62
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	1022

Project: RLL-TLB380
Masttype: S-3_c
Mast: 1119

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 (Ba+Ah) in het globale assenstelsel 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

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	-65,8	65,8	5,5	5,5	10,5	10,5
380ct1f1	-256,2	256,2	22,3	22,3	36,6	36,6
380ct1f2	-260,3	260,3	25,1	25,1	36,7	36,7
380ct1f3	-264,1	264,1	27,4	27,4	36,7	36,7
380ct2f1	-256,2	256,2	22,3	22,3	36,6	36,6
380ct2f2	-260,3	260,3	25,1	25,1	36,7	36,7
380ct2f3	-264,1	264,1	27,4	27,4	36,7	36,7
150ct3f1	-128,2	128,2	11,2	11,2	18,8	18,8
150ct3f2	-130,2	130,2	12,6	12,6	18,8	18,8
150ct3f3	-132,1	132,1	13,7	13,7	18,8	18,8
150ct4f1	-128,2	128,2	11,2	11,2	18,8	18,8
150ct4f2	-130,2	130,2	12,6	12,6	18,8	18,8
150ct4f3	-132,1	132,1	13,7	13,7	18,8	18,8
bl2	-64,9	64,9	5,5	5,5	10,4	10,4

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	454,0	464,6	454,0
380ct1f1	454,0	463,6	454,0
380ct1f2	454,0	463,8	454,0
380ct1f3	454,0	464,0	454,0
380ct2f1	454,0	463,6	454,0
380ct2f2	454,0	463,8	454,0
380ct2f3	454,0	464,0	454,0
150ct3f1	454,0	463,6	454,0
150ct3f2	454,0	463,8	454,0
150ct3f3	454,0	464,0	454,0
150ct4f1	454,0	463,6	454,0
150ct4f2	454,0	463,8	454,0
150ct4f3	454,0	464,0	454,0
bl2	454,0	464,8	454,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	508,9	442,0
380ct1f1	473,3	451,1
380ct1f2	477,7	451,9
380ct1f3	481,2	452,7
380ct2f1	473,3	451,1
380ct2f2	477,7	451,9
380ct2f3	481,2	452,7
150ct3f1	473,5	451,1
150ct3f2	477,9	451,9
150ct3f3	481,4	452,7
150ct4f1	473,5	451,1
150ct4f2	477,9	451,9
150ct4f3	481,4	452,7
bl2	510,4	441,7

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	510,4 m	1,276 -
Min. weight span	256,4 m	0,641 -

Project: RLL-TLB380
Masttype: S-3_c
Mast: 1119

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	11,0	20,9	-65,8	65,8
380ct1f1	105,1	44,5	73,3	-256,2	256,2
380ct1f2	105,1	50,3	73,4	-260,3	260,3
380ct1f3	105,1	54,8	73,5	-264,1	264,1
380ct2f1	105,1	44,5	73,3	-256,2	256,2
380ct2f2	105,1	50,3	73,4	-260,3	260,3
380ct2f3	105,1	54,8	73,5	-264,1	264,1
150ct3f1	52,5	22,4	36,9	-128,2	128,2
150ct3f2	52,5	25,3	37,0	-130,2	130,2
150ct3f3	52,5	27,5	37,1	-132,1	132,1
150ct4f1	52,5	22,4	36,9	-128,2	128,2
150ct4f2	52,5	25,3	37,0	-130,2	130,2
150ct4f3	52,5	27,5	37,1	-132,1	132,1
bl2	25,1	11,0	20,7	-64,9	64,9

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	4,4	-17,2	17,2
380ct1f1	0,0	0,0	37,6	-131,3	131,3
380ct1f2	0,0	0,0	37,6	-131,3	131,3
380ct1f3	0,0	0,0	37,6	-131,3	131,3
380ct2f1	0,0	0,0	37,6	-131,3	131,3
380ct2f2	0,0	0,0	37,6	-131,3	131,3
380ct2f3	0,0	0,0	37,6	-131,3	131,3
150ct3f1	0,0	0,0	19,1	-65,7	65,7
150ct3f2	0,0	0,0	19,1	-65,7	65,7
150ct3f3	0,0	0,0	19,1	-65,7	65,7
150ct4f1	0,0	0,0	19,1	-65,7	65,7
150ct4f2	0,0	0,0	19,1	-65,7	65,7
150ct4f3	0,0	0,0	19,1	-65,7	65,7
bl2	0,0	0,0	4,3	-16,8	16,8

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,3	2,3
	380ct1f1	19,2	19,2
	380ct1f2	19,2	19,2
	380ct1f3	19,2	19,2
	380ct2f1	19,2	19,2
	380ct2f2	19,2	19,2
	380ct2f3	19,2	19,2
	150ct3f1	9,7	9,7
	150ct3f2	9,7	9,7
	150ct3f3	9,7	9,7
	150ct4f1	9,7	9,7
	150ct4f2	9,7	9,7
	150ct4f3	9,7	9,7
	bl2	2,2	2,2

Project: RLL-TLB380
Masttype: S-3_c
Mast: 1119

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	471	438	19183	0	0
ULS 1a_0,9_90		0	471	311	19183	0	0
ULS 3_90		0	261	704	10714	0	0
ULS 3_0,9_90		0	261	556	10713	0	0
SLS 7		0	0	349	2	0	0

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

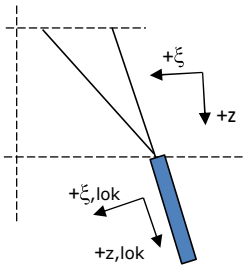
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	745	940	27202	0	0
ULS 3_90	0	343	1206	13120	0	0
SLS 7	0	0	767	2	0	0

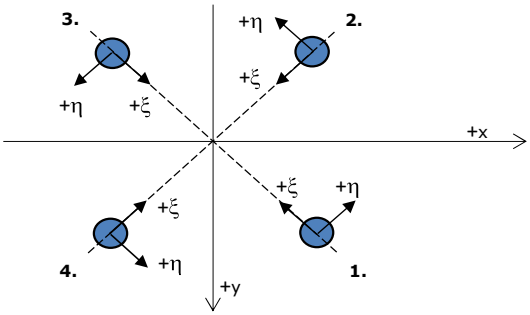
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	745	940	**27202**	0	0
ULS 8 Ah	309	0	920	3	**12769**	10
ULS 5a Ba 11	105	0	764	-230	4140	**1471**
ULS 1a_90	0	745	940	**27202**	**0**	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_90	271	225	**1641**	32	-351	-2	1678
2	ULS 8 Ah	115	-147	**890**	23	-185	3	910
3	ULS 8 Ba	-115	-147	**890**	-23	-185	3	910
4	ULS 1a_90	-271	225	**1641**	-32	-351	-2	1678

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 8 Ba	-40	-71	**-430**	22	78	-13	-440
2	ULS 1a_0,9_0,9_90	-207	162	**-1257**	32	261	-6	-1285
3	ULS 1a_0,9_0,9_90	207	162	**-1257**	-32	261	-6	-1285
4	ULS 1a_0,9_0,9_0	70	-81	**-493**	-8	107	2	-504

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 21	45	-42	-11	**62**	-2	-5	-11
2	ULS 5a Ba 11	22	-105	417	**59**	-90	-1	426
3	ULS 5a Ba 11	-45	42	-11	**62**	-2	-5	-11
4	ULS 5a Ah 21	-22	105	417	**59**	-90	-1	426

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 Ba 21	22	105	417	**-59**	-90	-1	426
2	ULS 5a Ah 11	45	42	-11	**-62**	-2	-5	-11
3	ULS 5a Ah 11	-22	-105	417	**-59**	-90	-1	426
4	ULS 5a Ba 21	-45	-42	-11	**-62**	-2	-5	-11

Project: RLL-TLB380
Masttype: S-3_c
Mast: 1119

Combinatie Ftrek+Fhor

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 8 Ba	-40	-71	**-430**	**22**	78	-13	-440
2	ULS 1a_0,9_0,9_90	-207	162	**-1257**	**32**	261	-6	-1285
3	ULS 1a_0,9_0,9_90	207	162	**-1257**	**-32**	261	-6	-1285
4	ULS 1a_0,9_0,9_0	70	-81	**-493**	**-8**	107	2	-504

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	32	32	192	0	-45	-4	196
2	SLS 7	32	-32	192	0	-45	-4	196
3	SLS 7	-32	-32	192	0	-45	-4	196
4	SLS 7	-32	32	192	0	-45	-4	196

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_90	271	225	**1641**	32	-351	-2	1678
Max. trek	ULS 1a_0,9_0,9_90	-207	162	**-1257**	32	261	-6	-1285
Max. pos. torsie	ULS 5a Ah 21	45	-42	-11	**62**	-2	-5	-11
Max. neg. torsie	ULS 5a Ba 21	-45	-42	-11	**-62**	-2	-5	-11
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-207	162	**-1257**	**32**	261	-6	-1285

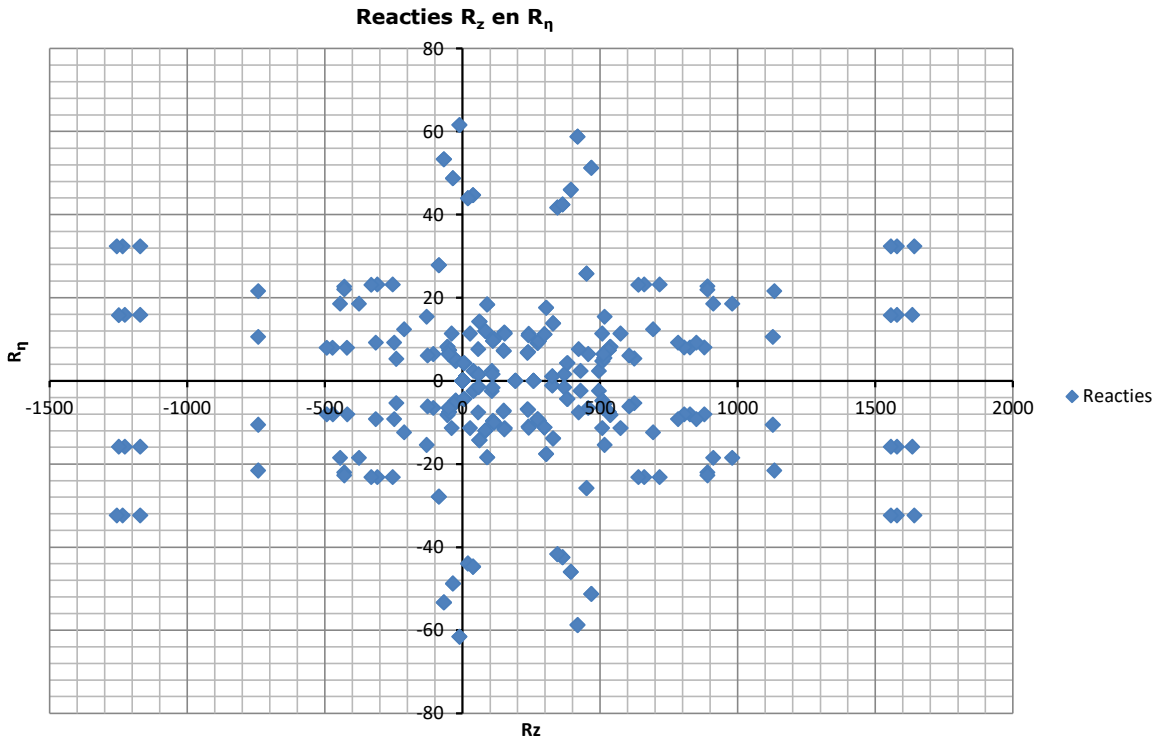
Maximale trekbelasting SLS

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	32	32	**192**	0	-45	-4	196
2	SLS 1a_90	-123	92	**-743**	22	152	-6	-759
3	SLS 1a_90	123	92	**-743**	-22	152	-6	-759
4	SLS 1a_0	32	-40	**-241**	-5	51	0	-246

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_90	187	156	**1133**	22	-243	-2	1158
2	SLS 1a_0	95	-103	**625**	5	-140	-8	638
3	SLS 7	-32	-32	**192**	0	-45	-4	196
4	SLS 1a_90	-187	156	**1133**	-22	-243	-2	1158

Project: RLL-TLB380
Masttype: S-3_c
Mast: 1119



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	56,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	454 m
Min. Weight span	254 m
Max. Weight span	512 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S+0_c

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

Document name:

RLL-TLB380_S+0_c_1111_Report.pdf

Project number:

Project client number:

0.0											

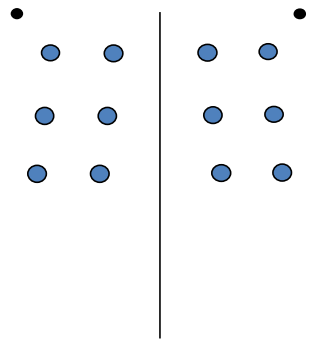
Project: RLL-TLB380
Tower: S+0_c
Number: 1111

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S+0_c
Masttype	Steunmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	4,50	4,50	2,00
Circuit 3	V-ketting	2,50	4,00	1,40
Circuit 4	V-ketting	2,50	4,00	1,40
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	28,4 m	32,9 m	11,0 m
Circuit 1	11	380ct1f2	37,9 m	42,4 m	14,0 m
Circuit 1	12	380ct1f3	47,9 m	52,4 m	10,6 m
Circuit 2	20	380ct2f1	28,4 m	32,9 m	-11,0 m
Circuit 2	21	380ct2f2	37,9 m	42,4 m	-14,0 m
Circuit 2	22	380ct2f3	47,9 m	52,4 m	-10,6 m
Circuit 3	30	150ct3f1	28,9 m	32,9 m	4,7 m
Circuit 3	31	150ct3f2	38,4 m	42,4 m	7,6 m
Circuit 3	32	150ct3f3	48,4 m	52,4 m	4,3 m
Circuit 4	40	150ct4f1	28,9 m	32,9 m	-4,7 m
Circuit 4	41	150ct4f2	38,4 m	42,4 m	-7,6 m
Circuit 4	42	150ct4f3	48,4 m	52,4 m	-4,3 m
Bliksemdraad 1	1	bl1	53,7 m	53,9 m	16,0 m
Bliksemdraad 2	3	bl2	53,7 m	53,9 m	-16,0 m

Project: RLL-TLB380
Tower: S+0_c
Number: 1111

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	6,0 m	6,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-6,0 m	-6,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

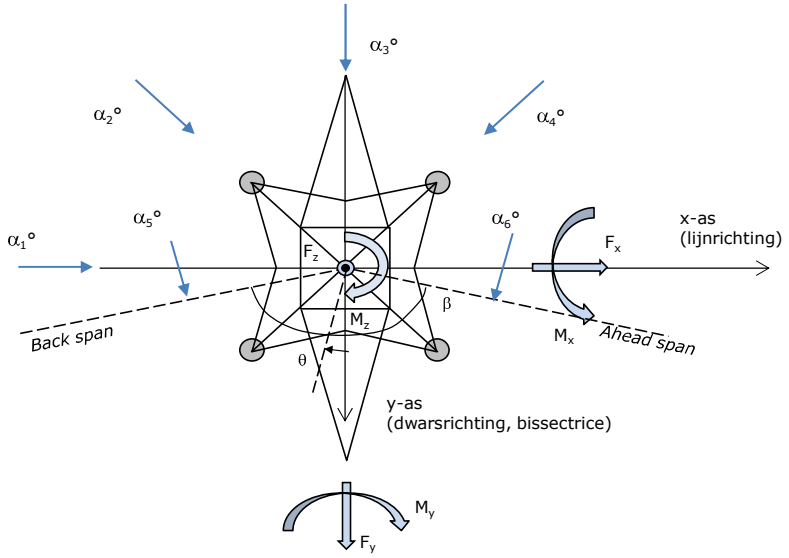
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	30	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	31	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	32	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	40	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	41	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	42	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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

Project: RLL-TLB380
Tower: S+0_c
Number: 1111

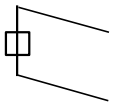
Geleiderafval

		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
Circuit 3	150ct3f1	1	0	1	0	0,8	0
Circuit 3	150ct3f2	1	0	1	0	0,8	0
Circuit 3	150ct3f3	1	0	1	0	0,8	0
Circuit 4	150ct4f1	0	1	1	0	0,8	0
Circuit 4	150ct4f2	0	1	1	0	0,8	0
Circuit 4	150ct4f3	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

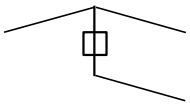
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

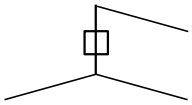
Principe belastingssituaties:



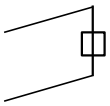
1. Ba All cts



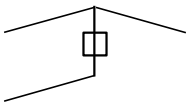
2. Ba ct1



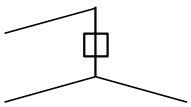
3. Ba ct2



4. Ah All cts



5. Ah ct1

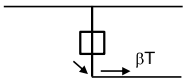


6. Ah ct2

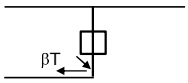
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S+0_c
Number: 1111

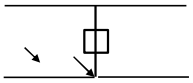
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

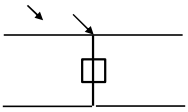
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

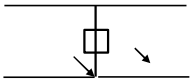
Principe belastingssituaties:



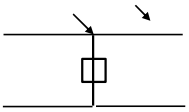
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

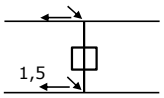
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

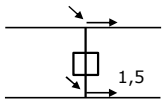
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S+0_c
Number: 1111

Mastconstructie

Eigenschappen

Masttype	Steunmast		
Mastbenaming	S+0_c		
Voetplaat t.o.v. maaiveld	0,5	m	
Masthoogte t.o.v. voetplaat	56,7	m	
Gewicht mast	442,0	kN	
Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	9,96	9,96	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	14,60	9,96	5,58	14,60	0,150	113,44	16,37	0,14	3,19
Eerste tussenstuk	24,10	5,58	4,55	9,50	0,054	48,12	9,90	0,21	2,91
Tweede tussenstuk	32,90	4,55	3,60	8,80	0,054	35,86	9,77	0,27	2,64
Bovenstuk 1	42,40	3,60	2,92	9,50	0,036	30,97	9,60	0,31	2,50
Bovenstuk 2	55,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	56,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	32,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	42,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	52,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	14,60	9,96	5,58	14,60	0,150	113,44	16,37	0,14	3,19
Eerste tussenstuk	24,10	5,58	4,55	9,50	0,054	48,12	9,90	0,21	2,91
Tweede tussenstuk	32,90	4,55	3,60	8,80	0,054	35,86	9,77	0,27	2,64
Bovenstuk 1	42,40	3,60	2,92	9,50	0,036	30,97	9,60	0,31	2,50
Bovenstuk 2	55,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	56,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	32,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	42,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	52,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S+0_c
Number: 1111

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	14,6	1,4
Eerste tussenstuk	0,14	0,71	9,5	0,9
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	39,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	36,6	31,0	0,0	-31,0	7,3	266,8	226,4	0,0	-226,4
Eerste tussenstuk	0,87	25,0	21,2	0,0	-21,2	19,4	483,7	410,5	0,0	-410,5
Tweede tussenstuk	0,97	25,1	21,3	0,0	-21,3	28,5	714,8	606,5	0,0	-606,5
Bovenstuk 1	1,06	25,3	21,5	0,0	-21,5	37,7	954,4	809,8	0,0	-809,8
Bovenstuk 2	1,13	27,1	23,0	0,0	-23,0	48,7	1320,5	1120,5	0,0	-1120,5
Topstuk	1,17	1,1	0,9	0,0	-0,9	55,9	61,8	52,4	0,0	-52,4
Ondertraverse	1,02	26,5	15,7	0,0	-15,7	33,9	898,0	533,4	0,0	-533,4
Middentraverse	1,09	39,0	23,1	0,0	-23,1	43,4	1691,4	1004,7	0,0	-1004,7
Boventraverse	1,15	38,8	23,1	0,0	-23,1	53,3	2069,4	1229,2	0,0	-1229,2
Totaal		244,5	180,9	0,0	-180,9		8460,8	5993,3	0,0	-5993,3

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	31,0	36,6	31,0	7,3	0,0	226,4	266,8	226,4
Eerste tussenstuk	0,87	0,0	21,2	25,0	21,2	19,4	0,0	410,5	483,7	410,5
Tweede tussenstuk	0,97	0,0	21,3	25,1	21,3	28,5	0,0	606,5	714,8	606,5
Bovenstuk 1	1,06	0,0	21,5	25,3	21,5	37,7	0,0	809,8	954,4	809,8
Bovenstuk 2	1,13	0,0	23,0	27,1	23,0	48,7	0,0	1120,5	1320,5	1120,5
Topstuk	1,17	0,0	0,9	1,1	0,9	55,9	0,0	52,4	61,8	52,4
Ondertraverse	1,02	0,0	15,7	10,6	15,7	33,9	0,0	533,4	359,2	533,4
Middentraverse	1,09	0,0	23,1	15,6	23,1	43,4	0,0	1004,7	676,6	1004,7
Boventraverse	1,15	0,0	23,1	15,5	23,1	53,3	0,0	1229,2	827,8	1229,2
Totaal		0,0	180,9	181,9	180,9		0,0	5993,3	5665,6	5993,3

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	442	0	0	0
Windrichting 0°	252	0	0	0	8755	0
Windrichting 45°	186	186	0	6201	6201	0
Windrichting 90°	0	189	0	5960	0	0
Windrichting 135°	-186	186	0	6201	-6201	0

Project: RLL-TLB380
Tower: S+0_c
Number: 1111

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	31,15	1,00	1,2	2,40
380ct1f2	4,50	1	4,5	4,5	2,0	40,65	1,07	1,2	2,58
380ct1f3	4,50	1	4,5	4,5	2,0	50,65	1,14	1,2	2,73
380ct2f1	4,50	1	4,5	4,5	2,0	31,15	1,00	1,2	2,40
380ct2f2	4,50	1	4,5	4,5	2,0	40,65	1,07	1,2	2,58
380ct2f3	4,50	1	4,5	4,5	2,0	50,65	1,14	1,2	2,73
150ct3f1	2,50	1	2,5	4,0	1,4	31,40	1,00	1,2	1,68
150ct3f2	2,50	1	2,5	4,0	1,4	40,90	1,08	1,2	1,81
150ct3f3	2,50	1	2,5	4,0	1,4	50,90	1,14	1,2	1,92
150ct4f1	2,50	1	2,5	4,0	1,4	31,40	1,00	1,2	1,68
150ct4f2	2,50	1	2,5	4,0	1,4	40,90	1,08	1,2	1,81
150ct4f3	2,50	1	2,5	4,0	1,4	50,90	1,14	1,2	1,92
bl1	0,10	1	0,1	0,2	0,1	54,30	1,16	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	54,30	1,16	1,2	0,14

Project: RLL-TLB380
Tower: S+0_c
Number: 1111

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	24,5	0,93	0,56	0,56	1,02	33,37	71,6	71,6	51,8	130,2	130,2
380ct1f2	34,0	1,02	0,59	0,59	0,99	33,37	79,8	79,8	51,8	149,5	149,5
380ct1f3	44,0	1,10	0,61	0,61	0,97	33,37	86,4	86,4	51,8	165,9	165,9
380ct2f1	24,5	0,93	0,56	0,56	1,02	33,37	71,6	71,6	51,8	130,2	130,2
380ct2f2	34,0	1,02	0,59	0,59	0,99	33,37	79,8	79,8	51,8	149,5	149,5
380ct2f3	44,0	1,10	0,61	0,61	0,97	33,37	86,4	86,4	51,8	165,9	165,9
150ct3f1	25,0	0,94	0,56	0,56	1,02	33,37	36,0	36,0	51,8	65,7	65,7
150ct3f2	34,5	1,03	0,59	0,59	0,99	33,37	40,1	40,1	51,8	75,2	75,2
150ct3f3	44,5	1,10	0,61	0,61	0,97	33,37	43,4	43,4	51,8	83,3	83,3
150ct4f1	25,0	0,94	0,56	0,56	1,02	33,37	36,0	36,0	51,8	65,7	65,7
150ct4f2	34,5	1,03	0,59	0,59	0,99	33,37	40,1	40,1	51,8	75,2	75,2
150ct4f3	44,5	1,10	0,61	0,61	0,97	33,37	43,4	43,4	51,8	83,3	83,3
bl1	49,8	1,13	0,62	0,62	1,19	22,24	18,4	18,4	63,1	53,0	53,0
bl2	49,8	1,13	0,62	0,62	1,19	22,13	18,4	18,4	63,0	52,9	52,9

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	24,5	0,93	0,56	0,56	1,02	33,37	71,6	71,6	51,8	130,2	130,2
380ct1f2	34,0	1,02	0,59	0,59	0,99	33,37	79,8	79,8	51,8	149,5	149,5
380ct1f3	44,0	1,10	0,61	0,61	0,97	33,37	86,4	86,4	51,8	165,9	165,9
380ct2f1	24,5	0,93	0,56	0,56	1,02	33,37	71,6	71,6	51,8	130,2	130,2
380ct2f2	34,0	1,02	0,59	0,59	0,99	33,37	79,8	79,8	51,8	149,5	149,5
380ct2f3	44,0	1,10	0,61	0,61	0,97	33,37	86,4	86,4	51,8	165,9	165,9
150ct3f1	25,0	0,94	0,56	0,56	1,02	33,37	36,0	36,0	51,8	65,7	65,7
150ct3f2	34,5	1,03	0,59	0,59	0,99	33,37	40,1	40,1	51,8	75,2	75,2
150ct3f3	44,5	1,10	0,61	0,61	0,97	33,37	43,4	43,4	51,8	83,3	83,3
150ct4f1	25,0	0,94	0,56	0,56	1,02	33,37	36,0	36,0	51,8	65,7	65,7
150ct4f2	34,5	1,03	0,59	0,59	0,99	33,37	40,1	40,1	51,8	75,2	75,2
150ct4f3	44,5	1,10	0,61	0,61	0,97	33,37	43,4	43,4	51,8	83,3	83,3
bl1	49,8	1,13	0,62	0,62	1,19	22,24	18,4	18,4	63,1	53,0	53,0
bl2	49,8	1,13	0,62	0,62	1,19	22,13	18,4	18,4	63,0	52,9	52,9

Project: RLL-TLB380
Masttype: S+0_c
Mast: 1111

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	62
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	1022

Project: RLL-TLB380
Masttype: S+0_c
Mast: 1111

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 (Ba+Ah) in het globale assenstelsel 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

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	-66,1	66,1	5,6	5,6	10,5	10,5
380ct1f1	-257,5	257,5	23,3	23,3	36,7	36,7
380ct1f2	-261,5	261,5	25,9	25,9	36,7	36,7
380ct1f3	-265,1	265,1	28,0	28,0	36,8	36,8
380ct2f1	-257,5	257,5	23,3	23,3	36,7	36,7
380ct2f2	-261,5	261,5	25,9	25,9	36,7	36,7
380ct2f3	-265,1	265,1	28,0	28,0	36,8	36,8
150ct3f1	-128,9	128,9	12,1	12,1	18,8	18,8
150ct3f2	-130,8	130,8	13,4	13,4	18,8	18,8
150ct3f3	-132,7	132,7	14,4	14,4	18,8	18,8
150ct4f1	-128,9	128,9	12,1	12,1	18,8	18,8
150ct4f2	-130,8	130,8	13,4	13,4	18,8	18,8
150ct4f3	-132,7	132,7	14,4	14,4	18,8	18,8
bl2	-65,2	65,2	5,6	5,6	10,4	10,4

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	454,0	464,8	454,0
380ct1f1	454,0	463,7	454,0
380ct1f2	454,0	463,9	454,0
380ct1f3	454,0	464,1	454,0
380ct2f1	454,0	463,7	454,0
380ct2f2	454,0	463,9	454,0
380ct2f3	454,0	464,1	454,0
150ct3f1	454,0	463,7	454,0
150ct3f2	454,0	463,9	454,0
150ct3f3	454,0	464,1	454,0
150ct4f1	454,0	463,7	454,0
150ct4f2	454,0	463,9	454,0
150ct4f3	454,0	464,1	454,0
bl2	454,0	465,0	454,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	510,8	442,2
380ct1f1	474,8	451,4
380ct1f2	478,9	452,1
380ct1f3	482,2	452,9
380ct2f1	474,8	451,4
380ct2f2	478,9	452,1
380ct2f3	482,2	452,9
150ct3f1	475,1	451,4
150ct3f2	479,0	452,2
150ct3f3	482,3	452,9
150ct4f1	475,1	451,4
150ct4f2	479,0	452,2
150ct4f3	482,3	452,9
bl2	512,3	441,9

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	512,3 m	1,281 -
Min. weight span	253,8 m	0,634 -

Project: RLL-TLB380
Masttype: S+0_c
Mast: 1111

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	11,3	20,9	-66,1	66,1
380ct1f1	105,1	46,5	73,3	-257,5	257,5
380ct1f2	105,1	51,7	73,4	-261,5	261,5
380ct1f3	105,1	56,0	73,5	-265,1	265,1
380ct2f1	105,1	46,5	73,3	-257,5	257,5
380ct2f2	105,1	51,7	73,4	-261,5	261,5
380ct2f3	105,1	56,0	73,5	-265,1	265,1
150ct3f1	52,5	24,1	37,0	-128,9	128,9
150ct3f2	52,5	26,8	37,0	-130,8	130,8
150ct3f3	52,5	28,9	37,1	-132,7	132,7
150ct4f1	52,5	24,1	37,0	-128,9	128,9
150ct4f2	52,5	26,8	37,0	-130,8	130,8
150ct4f3	52,5	28,9	37,1	-132,7	132,7
bl2	25,1	11,2	20,8	-65,2	65,2

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	4,4	-17,2	17,2
380ct1f1	0,0	0,0	37,6	-131,3	131,3
380ct1f2	0,0	0,0	37,6	-131,3	131,3
380ct1f3	0,0	0,0	37,6	-131,3	131,3
380ct2f1	0,0	0,0	37,6	-131,3	131,3
380ct2f2	0,0	0,0	37,6	-131,3	131,3
380ct2f3	0,0	0,0	37,6	-131,3	131,3
150ct3f1	0,0	0,0	19,1	-65,7	65,7
150ct3f2	0,0	0,0	19,1	-65,7	65,7
150ct3f3	0,0	0,0	19,1	-65,7	65,7
150ct4f1	0,0	0,0	19,1	-65,7	65,7
150ct4f2	0,0	0,0	19,1	-65,7	65,7
150ct4f3	0,0	0,0	19,1	-65,7	65,7
bl2	0,0	0,0	4,3	-16,8	16,8

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,3	2,3
	380ct1f1	19,2	19,2
	380ct1f2	19,2	19,2
	380ct1f3	19,2	19,2
	380ct2f1	19,2	19,2
	380ct2f2	19,2	19,2
	380ct2f3	19,2	19,2
	150ct3f1	9,7	9,7
	150ct3f2	9,7	9,7
	150ct3f3	9,7	9,7
	150ct4f1	9,7	9,7
	150ct4f2	9,7	9,7
	150ct4f3	9,7	9,7
	bl2	2,2	2,2

Project: RLL-TLB380
Masttype: S+0_c
Mast: 1111

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	491	439	21415	0	0
ULS 1a_0,9_90		0	491	310	21415	0	0
ULS 3_90		0	272	704	11997	0	0
ULS 3_0,9_90		0	272	555	11996	0	0
SLS 7		0	0	349	2	0	0

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

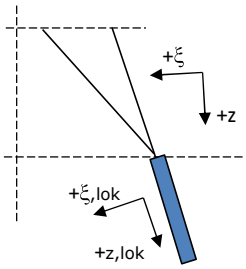
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	775	970	30355	0	0
ULS 3_90	0	357	1235	14679	0	0
SLS 7	0	0	791	2	0	0

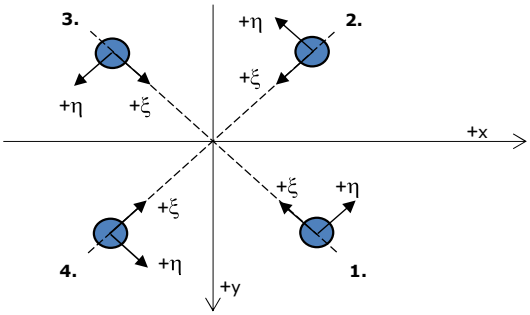
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	775	970	**30355**	0	0
ULS 1a_0	398	0	948	2	**14001**	0
ULS 5a Ba 11	105	0	788	-230	4455	**1471**
ULS 1a_90	0	775	970	**30355**	**0**	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_90	291	234	**1766**	41	-371	3	1806
2	ULS 1a_0	139	-155	**940**	12	-208	-8	961
3	ULS 8 Ba	-116	-153	**926**	-26	-190	6	946
4	ULS 1a_90	-291	234	**1766**	-41	-371	3	1806

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 8 Ba	-39	-75	**-453**	25	80	-16	-463
2	ULS 1a_0,9_0,9_90	-226	168	**-1369**	41	279	-12	-1400
3	ULS 1a_0,9_0,9_90	226	168	**-1369**	-41	279	-12	-1400
4	ULS 1a_0,9_0,9_0	73	-89	**-541**	-12	115	0	-553

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 21	45	-41	-15	**61**	-3	-6	-15
2	ULS 5a Ba 11	24	-106	432	**58**	-92	0	442
3	ULS 5a Ba 11	-45	41	-15	**61**	-3	-6	-15
4	ULS 5a Ah 21	-24	106	432	**58**	-92	0	442

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 Ba 21	24	106	432	**-58**	-92	0	442
2	ULS 5a Ah 11	45	41	-15	**-61**	-3	-6	-15
3	ULS 5a Ah 11	-24	-106	432	**-58**	-92	0	442
4	ULS 5a Ba 21	-45	-41	-15	**-61**	-3	-6	-15

Project: RLL-TLB380
Masttype: S+0_c
Mast: 1111

Combinatie Ftrek+Fhor

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 8 Ba	-39	-75	**-453**	**25**	80	-16	-463
2	ULS 1a_0,9_0,9_90	-226	168	**-1369**	**41**	279	-12	-1400
3	ULS 1a_0,9_0,9_90	226	168	**-1369**	**-41**	279	-12	-1400
4	ULS 1a_0,9_0,9_0	73	-89	**-541**	**-12**	115	0	-553

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	33	33	198	0	-46	-4	202
2	SLS 7	33	-33	198	0	-46	-4	202
3	SLS 7	-33	-33	198	0	-46	-4	202
4	SLS 7	-33	33	198	0	-46	-4	202

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_90	291	234	**1766**	41	-371	3	1806
Max. trek	ULS 1a_0,9_0,9_90	-226	168	**-1369**	41	279	-12	-1400
Max. pos. torsie	ULS 5a Ah 21	45	-41	-15	**61**	-3	-6	-15
Max. neg. torsie	ULS 5a Ba 21	-45	-41	-15	**-61**	-3	-6	-15
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-226	168	**-1369**	**41**	279	-12	-1400

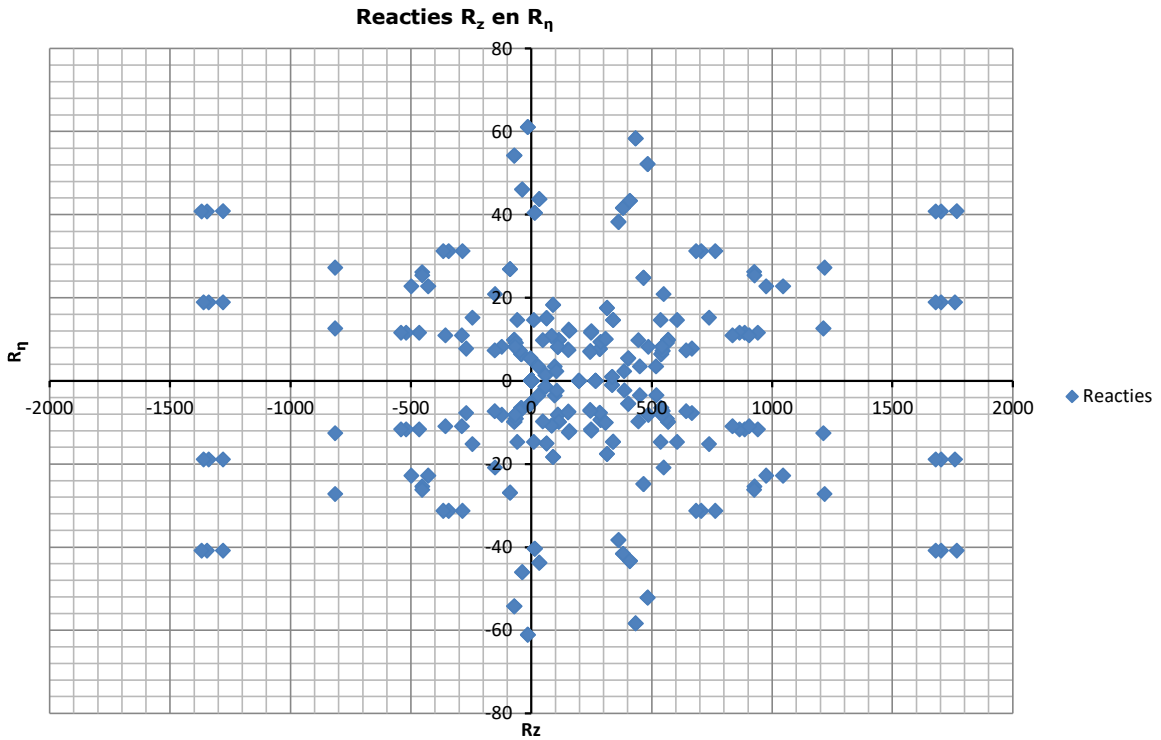
Maximale trekbelasting SLS

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	33	33	**198**	0	-46	-4	202
2	SLS 1a_90	-134	96	**-815**	27	163	-10	-833
3	SLS 1a_90	134	96	**-815**	-27	163	-10	-833
4	SLS 1a_0	34	-45	**-271**	-8	55	-2	-277

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_90	201	162	**1217**	27	-257	1	1244
2	SLS 1a_0	99	-110	**666**	8	-148	-6	681
3	SLS 7	-33	-33	**198**	0	-46	-4	202
4	SLS 1a_90	-201	162	**1217**	-27	-257	1	1244

Project: RLL-TLB380
Masttype: S+0_c
Mast: 1111



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	59,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	454 m
Min. Weight span	252 m
Max. Weight span	514 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S+3_c

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

Document name:

RLL-TLB380_S+3_c_1104_Report.pdf

Project number:

Project client number:

0.0											

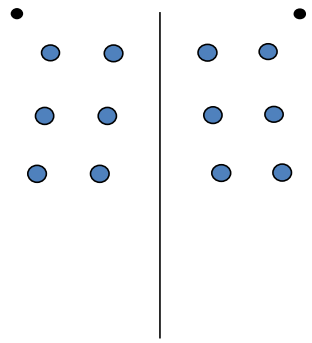
Project: RLL-TLB380
Tower: S+3_c
Number: 1104

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S+3_c
Masttype	Steunmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	4,50	4,50	2,00
Circuit 3	V-ketting	2,50	4,00	1,00
Circuit 4	V-ketting	2,50	4,00	1,00
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	31,4 m	35,9 m	11,3 m
Circuit 1	11	380ct1f2	40,9 m	45,4 m	14,0 m
Circuit 1	12	380ct1f3	50,9 m	55,4 m	10,3 m
Circuit 2	20	380ct2f1	31,4 m	35,9 m	-11,3 m
Circuit 2	21	380ct2f2	40,9 m	45,4 m	-14,0 m
Circuit 2	22	380ct2f3	50,9 m	55,4 m	-10,3 m
Circuit 3	30	150ct3f1	31,9 m	35,9 m	5,0 m
Circuit 3	31	150ct3f2	41,4 m	45,4 m	7,7 m
Circuit 3	32	150ct3f3	51,4 m	55,4 m	4,0 m
Circuit 4	40	150ct4f1	31,9 m	35,9 m	-5,0 m
Circuit 4	41	150ct4f2	41,4 m	45,4 m	-7,7 m
Circuit 4	42	150ct4f3	51,4 m	55,4 m	-4,0 m
Bliksemdraad 1	1	bl1	56,7 m	56,9 m	16,0 m
Bliksemdraad 2	3	bl2	56,7 m	56,9 m	-16,0 m

Project: RLL-TLB380
Tower: S+3_c
Number: 1104

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	6,0 m	6,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-6,0 m	-6,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

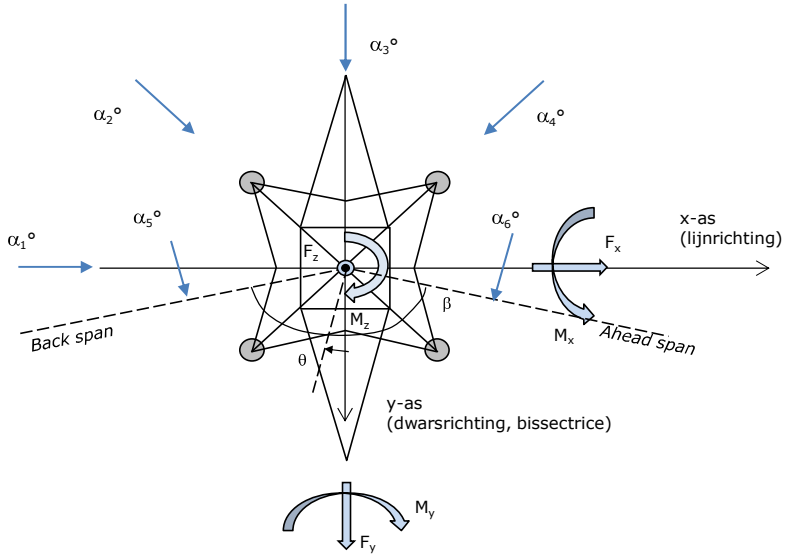
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	30	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	31	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	32	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	40	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	41	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	42	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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

Project: RLL-TLB380
Tower: S+3_c
Number: 1104

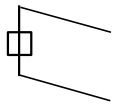
Geleiderafval

		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
Circuit 3	150ct3f1	1	0	1	0	0,8	0
Circuit 3	150ct3f2	1	0	1	0	0,8	0
Circuit 3	150ct3f3	1	0	1	0	0,8	0
Circuit 4	150ct4f1	0	1	1	0	0,8	0
Circuit 4	150ct4f2	0	1	1	0	0,8	0
Circuit 4	150ct4f3	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

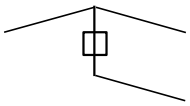
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

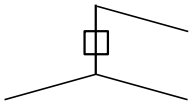
Principe belastingssituaties:



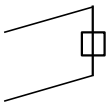
1. Ba All cts



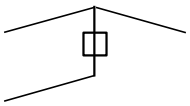
2. Ba ct1



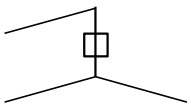
3. Ba ct2



4. Ah All cts



5. Ah ct1

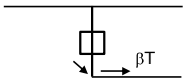


6. Ah ct2

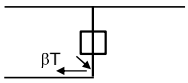
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S+3_c
Number: 1104

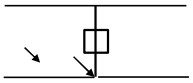
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

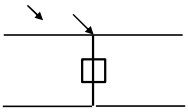
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

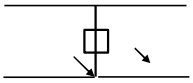
Principe belastingssituaties:



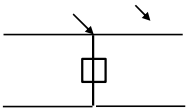
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

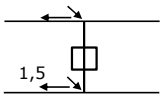
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

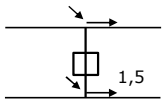
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S+3_c
Number: 1104

Mastconstructie

Eigenschappen

Masttype	Steunmast	
Mastbenaming	S+3_c	
Voetplaat t.o.v. maaiveld	0,5	m
Masthoogte t.o.v. voetplaat	59,7	m
Gewicht mast	458,0	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	10,24	10,24	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	14,40	10,24	5,92	14,40	0,150	116,38	18,75	0,16	3,11
Eerste tussenstuk	27,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	35,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	45,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	58,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	59,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	35,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	45,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	55,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	14,40	10,24	5,92	14,40	0,150	116,38	18,75	0,16	3,11
Eerste tussenstuk	27,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	35,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	45,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	58,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	59,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	35,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	45,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	55,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S+3_c
Number: 1104

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	14,4	1,4
Eerste tussenstuk	0,14	0,71	12,7	1,3
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	42,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	40,8	34,6	0,0	-34,6	7,2	293,9	249,4	0,0	-249,4
Eerste tussenstuk	0,89	36,1	30,6	0,0	-30,6	20,8	749,3	635,8	0,0	-635,8
Tweede tussenstuk	1,00	26,4	22,4	0,0	-22,4	31,5	830,7	704,9	0,0	-704,9
Bovenstuk 1	1,08	26,5	22,4	0,0	-22,4	40,7	1075,5	912,6	0,0	-912,6
Bovenstuk 2	1,15	27,5	23,4	0,0	-23,4	51,7	1423,9	1208,2	0,0	-1208,2
Topstuk	1,18	1,1	1,0	0,0	-1,0	58,9	66,0	56,0	0,0	-56,0
Ondertraverse	1,05	27,1	16,1	0,0	-16,1	36,9	1000,5	594,3	0,0	-594,3
Middentraverse	1,11	39,7	23,6	0,0	-23,6	46,4	1840,7	1093,3	0,0	-1093,3
Boventraverse	1,17	39,4	23,4	0,0	-23,4	56,3	2217,0	1316,8	0,0	-1316,8
Totaal		264,6	197,5	0,0	-197,5		9497,5	6771,3	0,0	-6771,3

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	34,6	40,8	34,6	7,2	0,0	249,4	293,9	249,4
Eerste tussenstuk	0,89	0,0	30,6	36,1	30,6	20,8	0,0	635,8	749,3	635,8
Tweede tussenstuk	1,00	0,0	22,4	26,4	22,4	31,5	0,0	704,9	830,7	704,9
Bovenstuk 1	1,08	0,0	22,4	26,5	22,4	40,7	0,0	912,6	1075,5	912,6
Bovenstuk 2	1,15	0,0	23,4	27,5	23,4	51,7	0,0	1208,2	1423,9	1208,2
Topstuk	1,18	0,0	1,0	1,1	1,0	58,9	0,0	56,0	66,0	56,0
Ondertraverse	1,05	0,0	16,1	10,8	16,1	36,9	0,0	594,3	400,2	594,3
Middentraverse	1,11	0,0	23,6	15,9	23,6	46,4	0,0	1093,3	736,3	1093,3
Boventraverse	1,17	0,0	23,4	15,8	23,4	56,3	0,0	1316,8	886,8	1316,8
Totaal		0,0	197,5	200,9	197,5		0,0	6771,3	6462,6	6771,3

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	458	0	0	0
Windrichting 0°	272	0	0	0	9821	0
Windrichting 45°	203	203	0	7000	7000	0
Windrichting 90°	0	209	0	6786	0	0
Windrichting 135°	-203	203	0	7000	-7000	0

Project: RLL-TLB380
Tower: S+3_c
Number: 1104

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	34,15	1,02	1,2	2,46
380ct1f2	4,50	1	4,5	4,5	2,0	43,65	1,10	1,2	2,63
380ct1f3	4,50	1	4,5	4,5	2,0	53,65	1,16	1,2	2,78
380ct2f1	4,50	1	4,5	4,5	2,0	34,15	1,02	1,2	2,46
380ct2f2	4,50	1	4,5	4,5	2,0	43,65	1,10	1,2	2,63
380ct2f3	4,50	1	4,5	4,5	2,0	53,65	1,16	1,2	2,78
150ct3f1	2,50	1	2,5	4,0	1,0	34,40	1,03	1,2	1,23
150ct3f2	2,50	1	2,5	4,0	1,0	43,90	1,10	1,2	1,32
150ct3f3	2,50	1	2,5	4,0	1,0	53,90	1,16	1,2	1,39
150ct4f1	2,50	1	2,5	4,0	1,0	34,40	1,03	1,2	1,23
150ct4f2	2,50	1	2,5	4,0	1,0	43,90	1,10	1,2	1,32
150ct4f3	2,50	1	2,5	4,0	1,0	53,90	1,16	1,2	1,39
bl1	0,10	1	0,1	0,2	0,1	57,30	1,18	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	57,30	1,18	1,2	0,14

Project: RLL-TLB380
Tower: S+3_c
Number: 1104

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	27,5	0,96	0,57	0,57	1,01	33,37	74,4	74,4	51,8	136,8	136,8
380ct1f2	37,0	1,05	0,59	0,59	0,99	33,37	81,9	81,9	51,8	154,8	154,8
380ct1f3	47,0	1,12	0,61	0,61	0,97	33,37	88,1	88,1	51,8	170,2	170,2
380ct2f1	27,5	0,96	0,57	0,57	1,01	33,37	74,4	74,4	51,8	136,8	136,8
380ct2f2	37,0	1,05	0,59	0,59	0,99	33,37	81,9	81,9	51,8	154,8	154,8
380ct2f3	47,0	1,12	0,61	0,61	0,97	33,37	88,1	88,1	51,8	170,2	170,2
150ct3f1	28,0	0,97	0,57	0,57	1,01	33,37	37,4	37,4	51,8	68,9	68,9
150ct3f2	37,5	1,05	0,59	0,59	0,99	33,37	41,1	41,1	51,8	77,8	77,8
150ct3f3	47,5	1,12	0,61	0,61	0,96	33,37	44,2	44,2	51,8	85,5	85,5
150ct4f1	28,0	0,97	0,57	0,57	1,01	33,37	37,4	37,4	51,8	68,9	68,9
150ct4f2	37,5	1,05	0,59	0,59	0,99	33,37	41,1	41,1	51,8	77,8	77,8
150ct4f3	47,5	1,12	0,61	0,61	0,96	33,37	44,2	44,2	51,8	85,5	85,5
bl1	52,8	1,15	0,62	0,62	1,18	22,24	18,8	18,8	63,1	54,2	54,2
bl2	52,8	1,15	0,62	0,62	1,18	22,13	18,8	18,8	63,0	54,2	54,2

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	27,5	0,96	0,57	0,57	1,01	33,37	74,4	74,4	51,8	136,8	136,8
380ct1f2	37,0	1,05	0,59	0,59	0,99	33,37	81,9	81,9	51,8	154,8	154,8
380ct1f3	47,0	1,12	0,61	0,61	0,97	33,37	88,1	88,1	51,8	170,2	170,2
380ct2f1	27,5	0,96	0,57	0,57	1,01	33,37	74,4	74,4	51,8	136,8	136,8
380ct2f2	37,0	1,05	0,59	0,59	0,99	33,37	81,9	81,9	51,8	154,8	154,8
380ct2f3	47,0	1,12	0,61	0,61	0,97	33,37	88,1	88,1	51,8	170,2	170,2
150ct3f1	28,0	0,97	0,57	0,57	1,01	33,37	37,4	37,4	51,8	68,9	68,9
150ct3f2	37,5	1,05	0,59	0,59	0,99	33,37	41,1	41,1	51,8	77,8	77,8
150ct3f3	47,5	1,12	0,61	0,61	0,96	33,37	44,2	44,2	51,8	85,5	85,5
150ct4f1	28,0	0,97	0,57	0,57	1,01	33,37	37,4	37,4	51,8	68,9	68,9
150ct4f2	37,5	1,05	0,59	0,59	0,99	33,37	41,1	41,1	51,8	77,8	77,8
150ct4f3	47,5	1,12	0,61	0,61	0,96	33,37	44,2	44,2	51,8	85,5	85,5
bl1	52,8	1,15	0,62	0,62	1,18	22,24	18,8	18,8	63,1	54,2	54,2
bl2	52,8	1,15	0,62	0,62	1,18	22,13	18,8	18,8	63,0	54,2	54,2

Project: RLL-TLB380
Masttype: S+3_c
Mast: 1104

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	62
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	1022

Project: RLL-TLB380
Masttype: S+3_c
Mast: 1104

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 (Ba+Ah) in het globale assenstelsel 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

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	-66,4	66,4	5,7	5,7	10,5	10,5
380ct1f1	-258,8	258,8	24,2	24,2	36,7	36,7
380ct1f2	-262,6	262,6	26,6	26,6	36,7	36,7
380ct1f3	-266,2	266,2	28,5	28,5	36,8	36,8
380ct2f1	-258,8	258,8	24,2	24,2	36,7	36,7
380ct2f2	-262,6	262,6	26,6	26,6	36,7	36,7
380ct2f3	-266,2	266,2	28,5	28,5	36,8	36,8
150ct3f1	-129,5	129,5	12,2	12,2	18,8	18,8
150ct3f2	-131,4	131,4	13,3	13,3	18,8	18,8
150ct3f3	-133,2	133,2	14,3	14,3	18,8	18,8
150ct4f1	-129,5	129,5	12,2	12,2	18,8	18,8
150ct4f2	-131,4	131,4	13,3	13,3	18,8	18,8
150ct4f3	-133,2	133,2	14,3	14,3	18,8	18,8
bl2	-65,4	65,4	5,7	5,7	10,4	10,4

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	454,0	464,9	454,0
380ct1f1	454,0	463,7	454,0
380ct1f2	454,0	463,9	454,0
380ct1f3	454,0	464,1	454,0
380ct2f1	454,0	463,7	454,0
380ct2f2	454,0	463,9	454,0
380ct2f3	454,0	464,1	454,0
150ct3f1	454,0	463,8	454,0
150ct3f2	454,0	464,0	454,0
150ct3f3	454,0	464,1	454,0
150ct4f1	454,0	463,8	454,0
150ct4f2	454,0	464,0	454,0
150ct4f3	454,0	464,1	454,0
bl2	454,0	465,1	454,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	512,2	442,3
380ct1f1	476,2	451,6
380ct1f2	479,9	452,4
380ct1f3	483,0	453,1
380ct2f1	476,2	451,6
380ct2f2	479,9	452,4
380ct2f3	483,0	453,1
150ct3f1	476,4	451,7
150ct3f2	480,1	452,4
150ct3f3	483,2	453,1
150ct4f1	476,4	451,7
150ct4f2	480,1	452,4
150ct4f3	483,2	453,1
bl2	513,8	442,0

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	513,8 m	1,284 -
Min. weight span	251,8 m	0,629 -

Project: RLL-TLB380
Masttype: S+3_c
Mast: 1104

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	11,5	20,9	-66,4	66,4
380ct1f1	105,1	48,3	73,3	-258,8	258,8
380ct1f2	105,1	53,1	73,5	-262,6	262,6
380ct1f3	105,1	57,1	73,6	-266,2	266,2
380ct2f1	105,1	48,3	73,3	-258,8	258,8
380ct2f2	105,1	53,1	73,5	-262,6	262,6
380ct2f3	105,1	57,1	73,6	-266,2	266,2
150ct3f1	52,5	24,3	37,0	-129,5	129,5
150ct3f2	52,5	26,7	37,0	-131,4	131,4
150ct3f3	52,5	28,6	37,1	-133,2	133,2
150ct4f1	52,5	24,3	37,0	-129,5	129,5
150ct4f2	52,5	26,7	37,0	-131,4	131,4
150ct4f3	52,5	28,6	37,1	-133,2	133,2
bl2	25,1	11,5	20,8	-65,4	65,4

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	4,4	-17,2	17,2
380ct1f1	0,0	0,0	37,6	-131,3	131,3
380ct1f2	0,0	0,0	37,6	-131,3	131,3
380ct1f3	0,0	0,0	37,6	-131,3	131,3
380ct2f1	0,0	0,0	37,6	-131,3	131,3
380ct2f2	0,0	0,0	37,6	-131,3	131,3
380ct2f3	0,0	0,0	37,6	-131,3	131,3
150ct3f1	0,0	0,0	19,1	-65,7	65,7
150ct3f2	0,0	0,0	19,1	-65,7	65,7
150ct3f3	0,0	0,0	19,1	-65,7	65,7
150ct4f1	0,0	0,0	19,1	-65,7	65,7
150ct4f2	0,0	0,0	19,1	-65,7	65,7
150ct4f3	0,0	0,0	19,1	-65,7	65,7
bl2	0,0	0,0	4,3	-16,8	16,8

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,3	2,3
	380ct1f1	19,2	19,2
	380ct1f2	19,2	19,2
	380ct1f3	19,2	19,2
	380ct2f1	19,2	19,2
	380ct2f2	19,2	19,2
	380ct2f3	19,2	19,2
	150ct3f1	9,7	9,7
	150ct3f2	9,7	9,7
	150ct3f3	9,7	9,7
	150ct4f1	9,7	9,7
	150ct4f2	9,7	9,7
	150ct4f3	9,7	9,7
	bl2	2,2	2,2

Project: RLL-TLB380
Masttype: S+3_c
Mast: 1104

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	499	440	23261	0	0
ULS 1a_0,9_90		0	499	309	23260	0	0
ULS 3_90		0	280	705	13169	0	0
ULS 3_0,9_90		0	280	555	13168	0	0
SLS 7		0	0	349	2	0	0

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

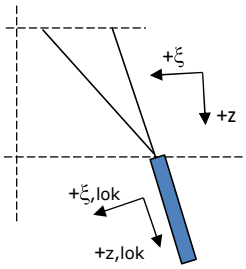
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	812	990	33439	0	0
ULS 3_90	0	374	1254	16223	0	0
SLS 7	0	0	807	2	0	0

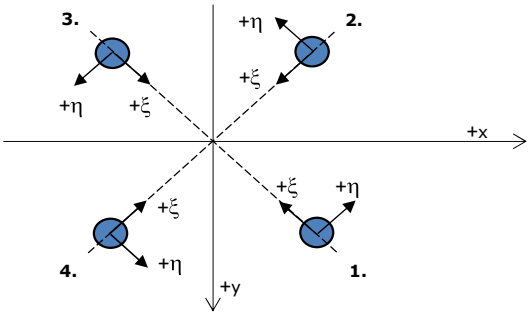
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	812	990	**33439**	0	0
ULS 1a_0	427	0	967	2	**15569**	0
ULS 5a Ba 11	105	0	804	-230	4770	**1471**
ULS 1a_45	317	561	974	**22473**	**11092**	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	301	270	**1882**	22	-403	-4	1924
2	ULS 1a_0	146	-165	**1002**	13	-220	-8	1024
3	ULS 8 Ba	-117	-158	**956**	-29	-194	9	977
4	ULS 1a_135	-301	270	**1882**	-22	-403	-4	1924

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 8 Ba	-38	-78	**-476**	29	82	-19	-486
2	ULS 1a_0,9_0,9_135	-234	203	**-1476**	22	309	-5	-1509
3	ULS 1a_0,9_0,9_45	234	203	**-1476**	-22	309	-5	-1509
4	ULS 1a_0,9_0,9_0	79	-98	**-595**	-13	126	-1	-608

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 21	45	-41	-20	**61**	-3	-7	-21
2	ULS 5a Ba 11	25	-108	445	**58**	-94	0	455
3	ULS 5a Ba 11	-45	41	-21	**61**	-2	-7	-21
4	ULS 5a Ah 21	-25	108	445	**58**	-94	0	455

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 Ba 21	25	108	445	**-58**	-94	0	455
2	ULS 5a Ah 11	45	41	-21	**-61**	-2	-7	-21
3	ULS 5a Ah 11	-25	-108	445	**-58**	-94	0	455
4	ULS 5a Ba 21	-45	-41	-20	**-61**	-3	-7	-21

Project: RLL-TLB380
Masttype: S+3_c
Mast: 1104

Combinatie Ftrek+Fhor

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 8 Ba	-38	-78	**-476**	**29**	82	-19	-486
2	ULS 1a_0,9_0,9_90	-243	177	**-1474**	**47**	297	-16	-1507
3	ULS 1a_0,9_0,9_90	243	177	**-1474**	**-47**	297	-16	-1507
4	ULS 1a_0,9_0,9_0	79	-98	**-595**	**-13**	126	-1	-608

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	33	33	202	0	-47	-4	206
2	SLS 7	33	-33	202	0	-47	-4	206
3	SLS 7	-33	-33	202	0	-47	-4	206
4	SLS 7	-33	33	202	0	-47	-4	206

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	301	270	**1882**	22	-403	-4	1924
Max. trek	ULS 1a_0,9_0,9_45	234	203	**-1476**	-22	309	-5	-1509
Max. pos. torsie	ULS 5a Ah 21	45	-41	-20	**61**	-3	-7	-21
Max. neg. torsie	ULS 5a Ba 21	-45	-41	-20	**-61**	-3	-7	-21
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-243	177	**-1474**	**47**	297	-16	-1507

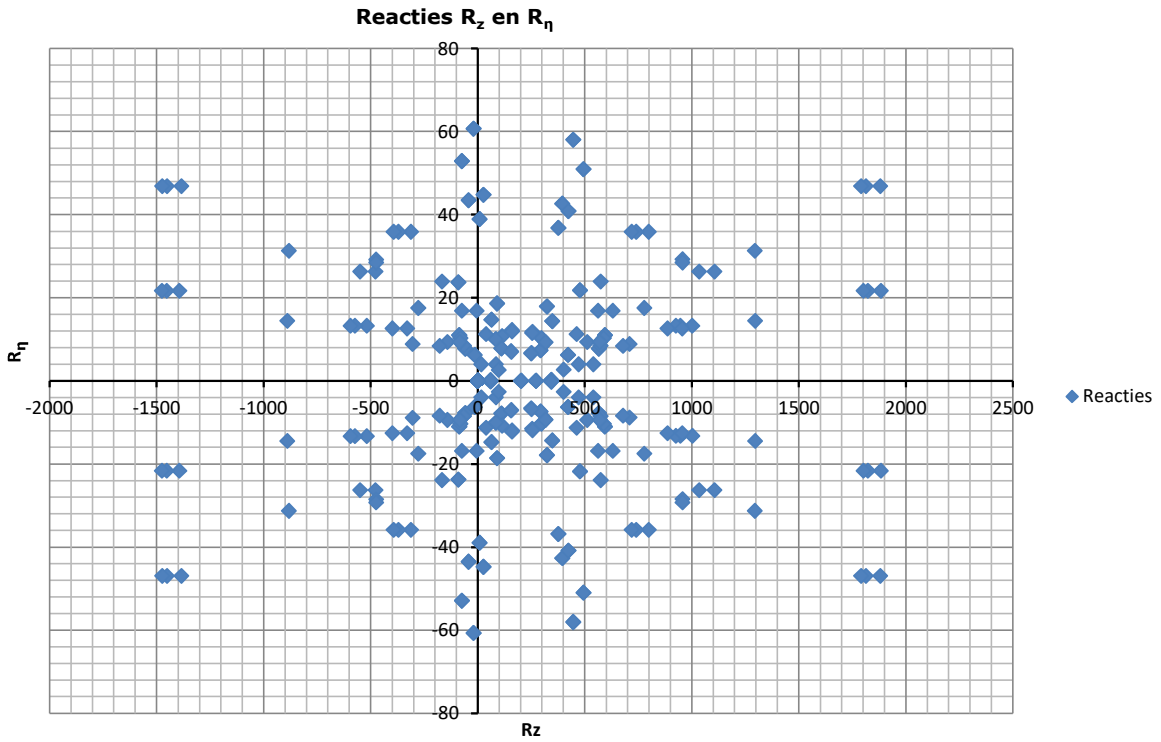
Maximale trekbelasting SLS

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	33	33	**202**	0	-47	-4	206
2	SLS 1a_135	-140	120	**-890**	14	184	-5	-909
3	SLS 1a_45	140	120	**-890**	-14	184	-5	-909
4	SLS 1a_0	38	-50	**-305**	-9	62	-2	-312

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	207	187	**1295**	14	-278	-4	1324
2	SLS 1a_0	104	-117	**708**	9	-156	-6	724
3	SLS 7	-33	-33	**202**	0	-47	-4	206
4	SLS 1a_135	-207	187	**1295**	-14	-278	-4	1324

Project: RLL-TLB380
Masttype: S+3_c
Mast: 1104



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	62,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	454 m
Min. Weight span	250 m
Max. Weight span	515 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S+6_c

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

Document name:

RLL-TLB380_S+6_c_1101_Report.pdf

Project number:

Project client number:

0.0											

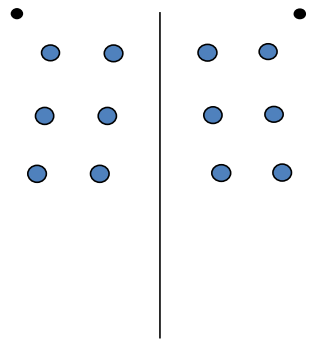
Project: RLL-TLB380
Tower: S+6_c
Number: 1101

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S+6_c
Masttype	Steunmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	4,50	4,50	2,00
Circuit 3	V-ketting	2,50	4,00	1,00
Circuit 4	V-ketting	2,50	4,00	1,00
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	34,4 m	38,9 m	11,3 m
Circuit 1	11	380ct1f2	43,9 m	48,4 m	14,0 m
Circuit 1	12	380ct1f3	53,9 m	58,4 m	10,3 m
Circuit 2	20	380ct2f1	34,4 m	38,9 m	-11,3 m
Circuit 2	21	380ct2f2	43,9 m	48,4 m	-14,0 m
Circuit 2	22	380ct2f3	53,9 m	58,4 m	-10,3 m
Circuit 3	30	150ct3f1	34,9 m	38,9 m	5,0 m
Circuit 3	31	150ct3f2	44,4 m	48,4 m	7,7 m
Circuit 3	32	150ct3f3	54,4 m	58,4 m	4,0 m
Circuit 4	40	150ct4f1	34,9 m	38,9 m	-5,0 m
Circuit 4	41	150ct4f2	44,4 m	48,4 m	-7,7 m
Circuit 4	42	150ct4f3	54,4 m	58,4 m	-4,0 m
Bliksemdraad 1	1	bl1	59,7 m	59,9 m	16,0 m
Bliksemdraad 2	3	bl2	59,7 m	59,9 m	-16,0 m

Project: RLL-TLB380
Tower: S+6_c
Number: 1101

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	6,0 m	6,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-6,0 m	-6,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

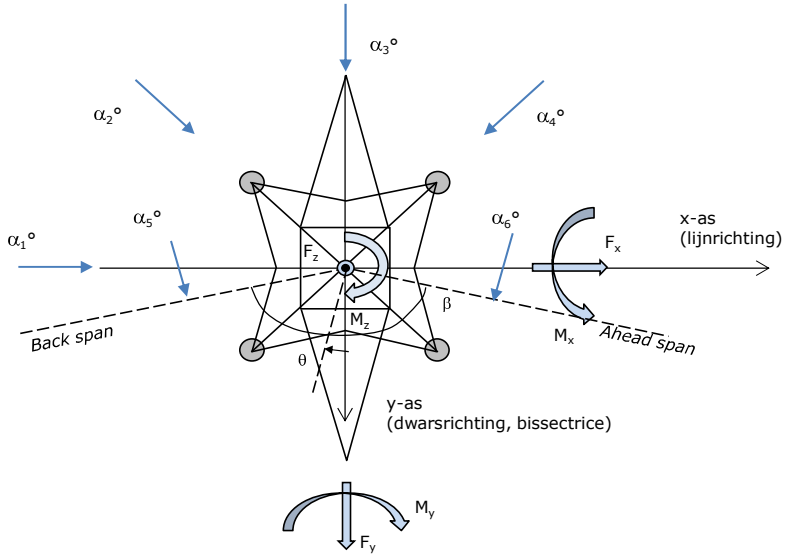
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	30	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	31	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	32	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	40	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	41	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	42	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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

Project: RLL-TLB380
Tower: S+6_c
Number: 1101

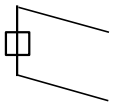
Geleiderafval

		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
Circuit 3	150ct3f1	1	0	1	0	0,8	0
Circuit 3	150ct3f2	1	0	1	0	0,8	0
Circuit 3	150ct3f3	1	0	1	0	0,8	0
Circuit 4	150ct4f1	0	1	1	0	0,8	0
Circuit 4	150ct4f2	0	1	1	0	0,8	0
Circuit 4	150ct4f3	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

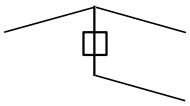
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

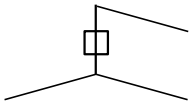
Principe belastingssituaties:



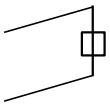
1. Ba All cts



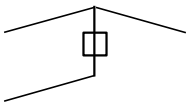
2. Ba ct1



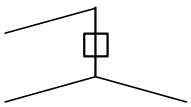
3. Ba ct2



4. Ah All cts



5. Ah ct1

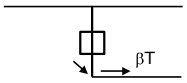


6. Ah ct2

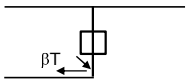
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S+6_c
Number: 1101

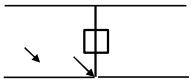
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

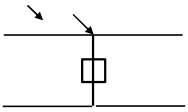
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

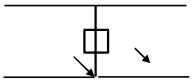
Principe belastingssituaties:



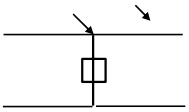
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

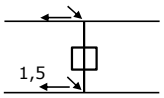
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

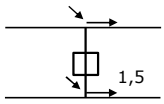
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S+6_c
Number: 1101

Mastconstructie

Eigenschappen

Masttype	Steunmast		
Mastbenaming	S+6_c		
Voetplaat t.o.v. maaiveld	0,5	m	
Masthoogte t.o.v. voetplaat	62,7	m	
Gewicht mast	482,0	kN	
Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	11,14	11,14	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	17,40	11,14	5,92	17,40	0,150	148,46	21,82	0,15	3,17
Eerste tussenstuk	30,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	38,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	48,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	61,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	62,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	38,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	48,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	58,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	17,40	11,14	5,92	17,40	0,150	148,46	21,82	0,15	3,17
Eerste tussenstuk	30,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	38,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	48,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	61,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	62,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	38,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	48,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	58,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S+6_c
Number: 1101

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	17,4	1,7
Eerste tussenstuk	0,14	0,71	12,7	1,3
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	45,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	48,5	41,2	0,0	-41,2	8,7	422,2	358,3	0,0	-358,3
Eerste tussenstuk	0,92	37,6	31,9	0,0	-31,9	23,8	892,8	757,5	0,0	-757,5
Tweede tussenstuk	1,03	27,0	23,0	0,0	-23,0	34,5	933,1	791,8	0,0	-791,8
Bovenstuk 1	1,10	27,0	22,9	0,0	-22,9	43,7	1176,8	998,5	0,0	-998,5
Bovenstuk 2	1,16	27,9	23,7	0,0	-23,7	54,7	1528,7	1297,1	0,0	-1297,1
Topstuk	1,20	1,1	1,0	0,0	-1,0	61,9	70,2	59,6	0,0	-59,6
Ondertraverse	1,07	27,7	16,5	0,0	-16,5	39,9	1105,1	656,4	0,0	-656,4
Middentraverse	1,13	40,3	24,0	0,0	-24,0	49,4	1992,2	1183,3	0,0	-1183,3
Boventraverse	1,19	39,9	23,7	0,0	-23,7	59,3	2366,4	1405,6	0,0	-1405,6
Totaal		277,2	207,7	0,0	-207,7		10487,6	7508,2	0,0	-7508,2

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	41,2	48,5	41,2	8,7	0,0	358,3	422,2	358,3
Eerste tussenstuk	0,92	0,0	31,9	37,6	31,9	23,8	0,0	757,5	892,8	757,5
Tweede tussenstuk	1,03	0,0	23,0	27,0	23,0	34,5	0,0	791,8	933,1	791,8
Bovenstuk 1	1,10	0,0	22,9	27,0	22,9	43,7	0,0	998,5	1176,8	998,5
Bovenstuk 2	1,16	0,0	23,7	27,9	23,7	54,7	0,0	1297,1	1528,7	1297,1
Topstuk	1,20	0,0	1,0	1,1	1,0	61,9	0,0	59,6	70,2	59,6
Ondertraverse	1,07	0,0	16,5	11,1	16,5	39,9	0,0	656,4	442,0	656,4
Middentraverse	1,13	0,0	24,0	16,1	24,0	49,4	0,0	1183,3	796,9	1183,3
Boventraverse	1,19	0,0	23,7	16,0	23,7	59,3	0,0	1405,6	946,6	1405,6
Totaal		0,0	207,7	212,4	207,7		0,0	7508,2	7209,3	7508,2

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	482	0	0	0
Windrichting 0°	285	0	0	0	10840	0
Windrichting 45°	213	213	0	7757	7757	0
Windrichting 90°	0	220	0	7562	0	0
Windrichting 135°	-213	213	0	7757	-7757	0

Project: RLL-TLB380
Tower: S+6_c
Number: 1101

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	37,15	1,05	1,2	2,52
380ct1f2	4,50	1	4,5	4,5	2,0	46,65	1,12	1,2	2,68
380ct1f3	4,50	1	4,5	4,5	2,0	56,65	1,17	1,2	2,81
380ct2f1	4,50	1	4,5	4,5	2,0	37,15	1,05	1,2	2,52
380ct2f2	4,50	1	4,5	4,5	2,0	46,65	1,12	1,2	2,68
380ct2f3	4,50	1	4,5	4,5	2,0	56,65	1,17	1,2	2,81
150ct3f1	2,50	1	2,5	4,0	1,0	37,40	1,05	1,2	1,26
150ct3f2	2,50	1	2,5	4,0	1,0	46,90	1,12	1,2	1,34
150ct3f3	2,50	1	2,5	4,0	1,0	56,90	1,17	1,2	1,41
150ct4f1	2,50	1	2,5	4,0	1,0	37,40	1,05	1,2	1,26
150ct4f2	2,50	1	2,5	4,0	1,0	46,90	1,12	1,2	1,34
150ct4f3	2,50	1	2,5	4,0	1,0	56,90	1,17	1,2	1,41
bl1	0,10	1	0,1	0,2	0,1	60,30	1,19	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	60,30	1,19	1,2	0,14

Project: RLL-TLB380
Tower: S+6_c
Number: 1101

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	30,5	0,99	0,58	0,58	1,00	33,37	77,0	77,0	51,8	143,0	143,0
380ct1f2	40,0	1,07	0,60	0,60	0,98	33,37	84,0	84,0	51,8	159,7	159,7
380ct1f3	50,0	1,14	0,62	0,62	0,96	33,37	89,8	89,8	51,8	174,4	174,4
380ct2f1	30,5	0,99	0,58	0,58	1,00	33,37	77,0	77,0	51,8	143,0	143,0
380ct2f2	40,0	1,07	0,60	0,60	0,98	33,37	84,0	84,0	51,8	159,7	159,7
380ct2f3	50,0	1,14	0,62	0,62	0,96	33,37	89,8	89,8	51,8	174,4	174,4
150ct3f1	31,0	1,00	0,58	0,58	1,00	33,37	38,7	38,7	51,8	72,0	72,0
150ct3f2	40,5	1,07	0,60	0,60	0,98	33,37	42,1	42,1	51,8	80,3	80,3
150ct3f3	50,5	1,14	0,62	0,62	0,96	33,37	45,0	45,0	51,8	87,5	87,5
150ct4f1	31,0	1,00	0,58	0,58	1,00	33,37	38,7	38,7	51,8	72,0	72,0
150ct4f2	40,5	1,07	0,60	0,60	0,98	33,37	42,1	42,1	51,8	80,3	80,3
150ct4f3	50,5	1,14	0,62	0,62	0,96	33,37	45,0	45,0	51,8	87,5	87,5
bl1	55,8	1,17	0,63	0,63	1,18	22,24	19,2	19,2	63,1	55,4	55,4
bl2	55,8	1,17	0,63	0,63	1,18	22,13	19,1	19,1	63,0	55,3	55,3

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	30,5	0,99	0,58	0,58	1,00	33,37	77,0	77,0	51,8	143,0	143,0
380ct1f2	40,0	1,07	0,60	0,60	0,98	33,37	84,0	84,0	51,8	159,7	159,7
380ct1f3	50,0	1,14	0,62	0,62	0,96	33,37	89,8	89,8	51,8	174,4	174,4
380ct2f1	30,5	0,99	0,58	0,58	1,00	33,37	77,0	77,0	51,8	143,0	143,0
380ct2f2	40,0	1,07	0,60	0,60	0,98	33,37	84,0	84,0	51,8	159,7	159,7
380ct2f3	50,0	1,14	0,62	0,62	0,96	33,37	89,8	89,8	51,8	174,4	174,4
150ct3f1	31,0	1,00	0,58	0,58	1,00	33,37	38,7	38,7	51,8	72,0	72,0
150ct3f2	40,5	1,07	0,60	0,60	0,98	33,37	42,1	42,1	51,8	80,3	80,3
150ct3f3	50,5	1,14	0,62	0,62	0,96	33,37	45,0	45,0	51,8	87,5	87,5
150ct4f1	31,0	1,00	0,58	0,58	1,00	33,37	38,7	38,7	51,8	72,0	72,0
150ct4f2	40,5	1,07	0,60	0,60	0,98	33,37	42,1	42,1	51,8	80,3	80,3
150ct4f3	50,5	1,14	0,62	0,62	0,96	33,37	45,0	45,0	51,8	87,5	87,5
bl1	55,8	1,17	0,63	0,63	1,18	22,24	19,2	19,2	63,1	55,4	55,4
bl2	55,8	1,17	0,63	0,63	1,18	22,13	19,1	19,1	63,0	55,3	55,3

Project: RLL-TLB380
Masttype: S+6_c
Mast: 1101

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	62
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	1022

Project: RLL-TLB380
Masttype: S+6_c
Mast: 1101

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 (Ba+Ah) in het globale assenstelsel 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

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	-66,6	66,6	5,9	5,9	10,5	10,5
380ct1f1	-260,1	260,1	25,0	25,0	36,7	36,7
380ct1f2	-263,7	263,7	27,2	27,2	36,7	36,7
380ct1f3	-267,2	267,2	29,0	29,0	36,8	36,8
380ct2f1	-260,1	260,1	25,0	25,0	36,7	36,7
380ct2f2	-263,7	263,7	27,2	27,2	36,7	36,7
380ct2f3	-267,2	267,2	29,0	29,0	36,8	36,8
150ct3f1	-130,1	130,1	12,6	12,6	18,8	18,8
150ct3f2	-132,0	132,0	13,6	13,6	18,8	18,8
150ct3f3	-133,7	133,7	14,6	14,6	18,8	18,8
150ct4f1	-130,1	130,1	12,6	12,6	18,8	18,8
150ct4f2	-132,0	132,0	13,6	13,6	18,8	18,8
150ct4f3	-133,7	133,7	14,6	14,6	18,8	18,8
bl2	-65,6	65,6	5,8	5,8	10,4	10,4

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	454,0	465,1	454,0
380ct1f1	454,0	463,8	454,0
380ct1f2	454,0	464,0	454,0
380ct1f3	454,0	464,2	454,0
380ct2f1	454,0	463,8	454,0
380ct2f2	454,0	464,0	454,0
380ct2f3	454,0	464,2	454,0
150ct3f1	454,0	463,8	454,0
150ct3f2	454,0	464,0	454,0
150ct3f3	454,0	464,2	454,0
150ct4f1	454,0	463,8	454,0
150ct4f2	454,0	464,0	454,0
150ct4f3	454,0	464,2	454,0
bl2	454,0	465,2	454,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	513,5	442,4
380ct1f1	477,5	451,9
380ct1f2	480,9	452,6
380ct1f3	483,8	453,3
380ct2f1	477,5	451,9
380ct2f2	480,9	452,6
380ct2f3	483,8	453,3
150ct3f1	477,7	451,9
150ct3f2	481,1	452,6
150ct3f3	484,0	453,3
150ct4f1	477,7	451,9
150ct4f2	481,1	452,6
150ct4f3	484,0	453,3
bl2	515,1	442,2

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	515,1 m	1,288 -
Min. weight span	249,9 m	0,625 -

Project: RLL-TLB380
Masttype: S+6_c
Mast: 1101

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	11,7	20,9	-66,6	66,6
380ct1f1	105,1	50,0	73,4	-260,1	260,1
380ct1f2	105,1	54,4	73,5	-263,7	263,7
380ct1f3	105,1	58,1	73,6	-267,2	267,2
380ct2f1	105,1	50,0	73,4	-260,1	260,1
380ct2f2	105,1	54,4	73,5	-263,7	263,7
380ct2f3	105,1	58,1	73,6	-267,2	267,2
150ct3f1	52,5	25,1	37,0	-130,1	130,1
150ct3f2	52,5	27,3	37,0	-132,0	132,0
150ct3f3	52,5	29,1	37,1	-133,7	133,7
150ct4f1	52,5	25,1	37,0	-130,1	130,1
150ct4f2	52,5	27,3	37,0	-132,0	132,0
150ct4f3	52,5	29,1	37,1	-133,7	133,7
bl2	25,1	11,7	20,8	-65,6	65,6

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	4,4	-17,2	17,2
380ct1f1	0,0	0,0	37,6	-131,3	131,3
380ct1f2	0,0	0,0	37,6	-131,3	131,3
380ct1f3	0,0	0,0	37,6	-131,3	131,3
380ct2f1	0,0	0,0	37,6	-131,3	131,3
380ct2f2	0,0	0,0	37,6	-131,3	131,3
380ct2f3	0,0	0,0	37,6	-131,3	131,3
150ct3f1	0,0	0,0	19,1	-65,7	65,7
150ct3f2	0,0	0,0	19,1	-65,7	65,7
150ct3f3	0,0	0,0	19,1	-65,7	65,7
150ct4f1	0,0	0,0	19,1	-65,7	65,7
150ct4f2	0,0	0,0	19,1	-65,7	65,7
150ct4f3	0,0	0,0	19,1	-65,7	65,7
bl2	0,0	0,0	4,3	-16,8	16,8

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,3	2,3
	380ct1f1	19,2	19,2
	380ct1f2	19,2	19,2
	380ct1f3	19,2	19,2
	380ct2f1	19,2	19,2
	380ct2f2	19,2	19,2
	380ct2f3	19,2	19,2
	150ct3f1	9,7	9,7
	150ct3f2	9,7	9,7
	150ct3f3	9,7	9,7
	150ct4f1	9,7	9,7
	150ct4f2	9,7	9,7
	150ct4f3	9,7	9,7
	bl2	2,2	2,2

Project: RLL-TLB380
Masttype: S+6_c
Mast: 1101

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	511	441	25339	0	0
ULS 1a_0,9_90		0	511	309	25339	0	0
ULS 3_90		0	289	705	14431	0	0
ULS 3_0,9_90		0	289	555	14430	0	0
SLS 7		0	0	349	2	0	0

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

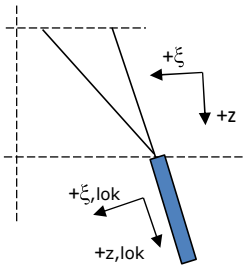
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	842	1020	36682	0	0
ULS 3_90	0	388	1283	17833	0	0
SLS 7	0	0	831	2	0	0

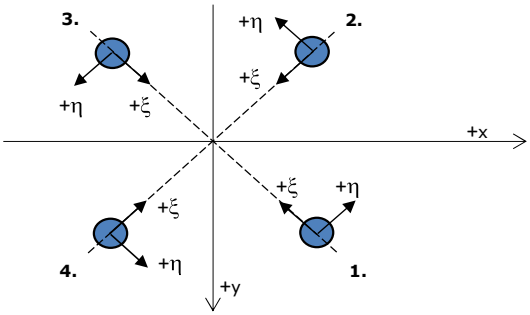
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	842	1020	**36682**	0	0
ULS 1a_0	446	0	996	2	**17168**	0
ULS 5a Ba 11	105	0	828	-230	5085	**1471**
ULS 1a_45	333	583	1004	**24677**	**12278**	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	307	278	**1909**	21	-414	-9	1952
2	ULS 1a_0	153	-168	**1019**	11	-227	-11	1042
3	ULS 8 Ba	-118	-156	**946**	-27	-194	7	967
4	ULS 1a_135	-307	278	**1909**	-21	-414	-9	1952

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 8 Ba	-37	-75	**-453**	27	79	-17	-464
2	ULS 1a_0,9_0,9_135	-238	209	**-1491**	21	316	0	-1524
3	ULS 1a_0,9_0,9_45	238	209	**-1491**	-21	316	0	-1524
4	ULS 1a_0,9_0,9_0	83	-99	**-600**	-11	129	2	-613

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 21	43	-36	-11	**56**	-4	-7	-11
2	ULS 5a Ba 11	29	-105	446	**54**	-95	0	456
3	ULS 5a Ba 11	-43	36	-11	**56**	-4	-7	-11
4	ULS 5a Ah 21	-29	105	446	**54**	-95	0	456

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 Ba 21	29	105	446	**-54**	-95	0	456
2	ULS 5a Ah 11	43	36	-11	**-56**	-4	-7	-11
3	ULS 5a Ah 11	-29	-105	446	**-54**	-95	0	456
4	ULS 5a Ba 21	-43	-36	-11	**-56**	-4	-7	-11

Project: RLL-TLB380
Masttype: S+6_c
Mast: 1101

Combinatie Ftrek+Fhor

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 8 Ba	-37	-75	**-453**	**27**	79	-17	-464
2	ULS 1a_0,9_0,9_90	-245	184	**-1483**	**43**	303	-12	-1516
3	ULS 1a_0,9_0,9_90	245	184	**-1483**	**-43**	303	-12	-1516
4	ULS 1a_0,9_0,9_0	83	-99	**-600**	**-11**	129	2	-613

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	34	34	208	0	-48	-4	212
2	SLS 7	34	-34	208	0	-48	-4	212
3	SLS 7	-34	-34	208	0	-48	-4	212
4	SLS 7	-34	34	208	0	-48	-4	212

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	307	278	**1909**	21	-414	-9	1952
Max. trek	ULS 1a_0,9_0,9_45	238	209	**-1491**	-21	316	0	-1524
Max. pos. torsie	ULS 5a Ah 21	43	-36	-11	**56**	-4	-7	-11
Max. neg. torsie	ULS 5a Ba 21	-43	-36	-11	**-56**	-4	-7	-11
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-245	184	**-1483**	**43**	303	-12	-1516

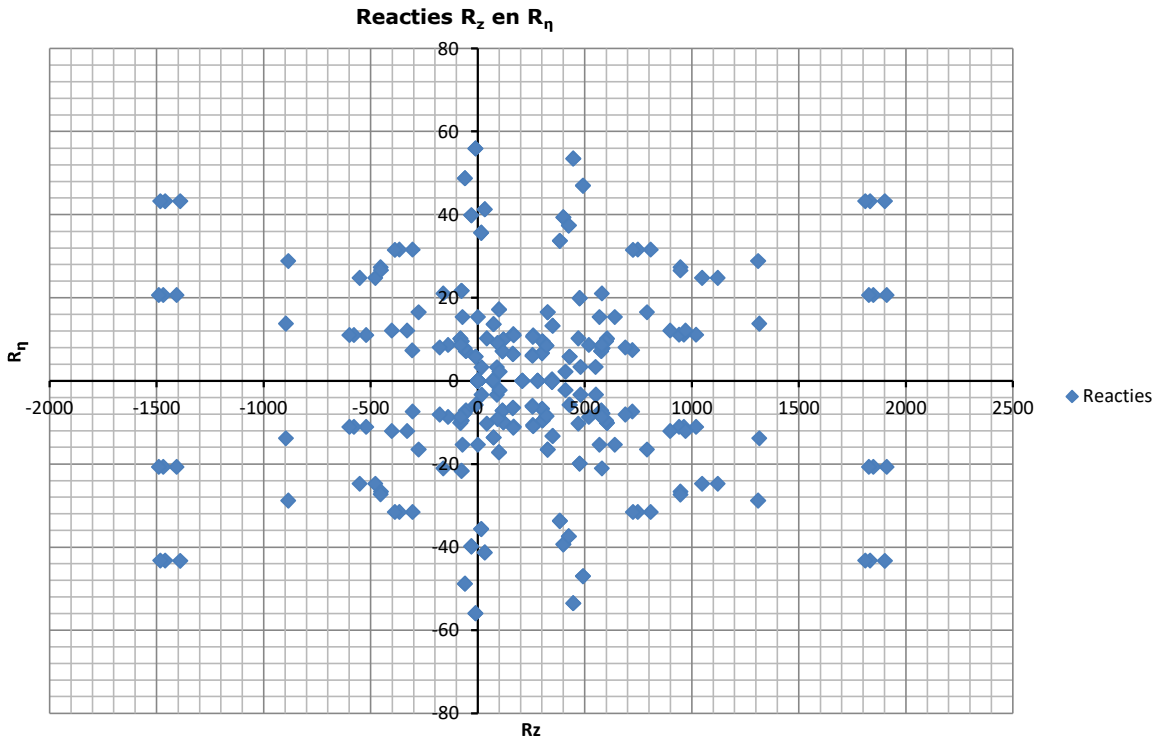
Maximale trekbelasting SLS

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	34	34	**208**	0	-48	-4	212
2	SLS 1a_135	-143	123	**-897**	14	188	-2	-917
3	SLS 1a_45	143	123	**-897**	-14	188	-2	-917
4	SLS 1a_0	40	-50	**-306**	-7	64	-1	-313

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	212	192	**1314**	14	-286	-7	1344
2	SLS 1a_0	109	-119	**721**	7	-161	-8	737
3	SLS 7	-34	-34	**208**	0	-48	-4	212
4	SLS 1a_135	-212	192	**1314**	-14	-286	-7	1344

Project: RLL-TLB380
Masttype: S+6_c
Mast: 1101



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	65,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	481 m
Min. Weight span	324 m
Max. Weight span	574 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S+9_c

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

Document name:

RLL-TLB380_S+9_c_1073_Report.pdf

Project number:

Project client number:

0.0											

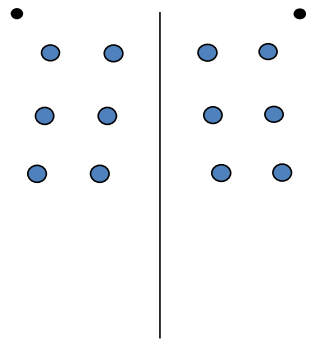
Project: RLL-TLB380
Tower: S+9_c
Number: 1073

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S+9_c
Masttype	Steunmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	4,50	4,50	2,00
Circuit 3	V-ketting	2,50	4,00	1,00
Circuit 4	V-ketting	2,50	4,00	1,00
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	37,4 m	41,9 m	11,3 m
Circuit 1	11	380ct1f2	46,9 m	51,4 m	14,0 m
Circuit 1	12	380ct1f3	56,9 m	61,4 m	10,3 m
Circuit 2	20	380ct2f1	37,4 m	41,9 m	-11,3 m
Circuit 2	21	380ct2f2	46,9 m	51,4 m	-14,0 m
Circuit 2	22	380ct2f3	56,9 m	61,4 m	-10,3 m
Circuit 3	30	150ct3f1	37,9 m	41,9 m	5,0 m
Circuit 3	31	150ct3f2	47,4 m	51,4 m	7,7 m
Circuit 3	32	150ct3f3	57,4 m	61,4 m	4,0 m
Circuit 4	40	150ct4f1	37,9 m	41,9 m	-5,0 m
Circuit 4	41	150ct4f2	47,4 m	51,4 m	-7,7 m
Circuit 4	42	150ct4f3	57,4 m	61,4 m	-4,0 m
Bliksemdraad 1	1	bl1	62,7 m	62,9 m	16,0 m
Bliksemdraad 2	3	bl2	62,7 m	62,9 m	-16,0 m

Project: RLL-TLB380
Tower: S+9_c
Number: 1073

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	-9,0 m	-9,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

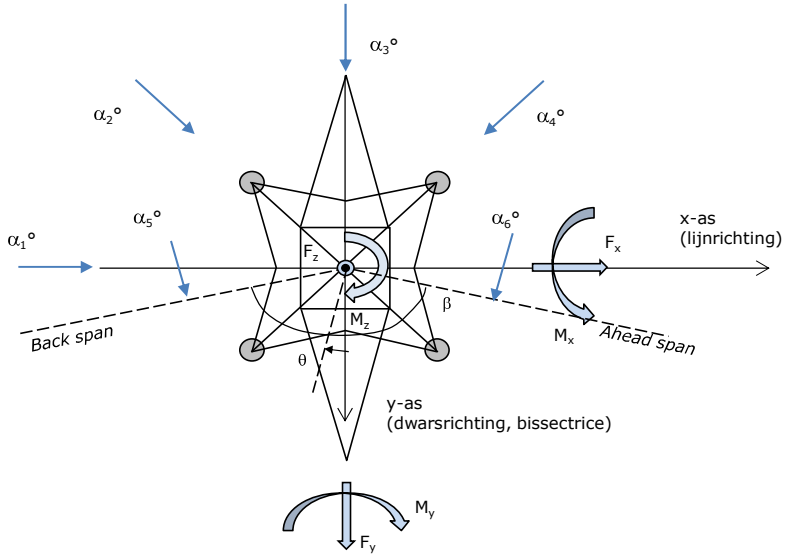
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	30	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	31	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	32	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	40	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	41	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	42	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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

Project: RLL-TLB380
Tower: S+9_c
Number: 1073

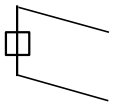
Geleiderafval

		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
Circuit 3	150ct3f1	1	0	1	0	0,8	0
Circuit 3	150ct3f2	1	0	1	0	0,8	0
Circuit 3	150ct3f3	1	0	1	0	0,8	0
Circuit 4	150ct4f1	0	1	1	0	0,8	0
Circuit 4	150ct4f2	0	1	1	0	0,8	0
Circuit 4	150ct4f3	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

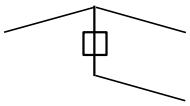
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

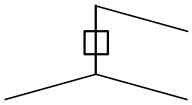
Principe belastingssituaties:



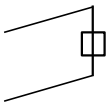
1. Ba All cts



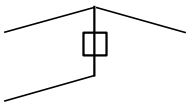
2. Ba ct1



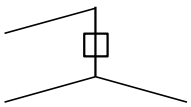
3. Ba ct2



4. Ah All cts



5. Ah ct1

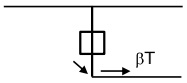


6. Ah ct2

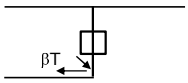
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S+9_c
Number: 1073

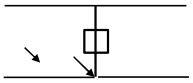
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

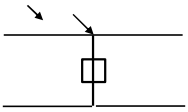
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

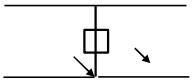
Principe belastingssituaties:



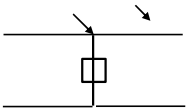
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

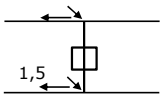
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

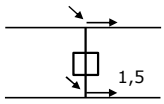
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S+9_c
Number: 1073

Mastconstructie

Eigenschappen

Masttype	Steunmast		
Mastbenaming	S+9_c		
Voetplaat t.o.v. maaiveld	0,5	m	
Masthoogte t.o.v. voetplaat	65,7	m	
Gewicht mast	512,0	kN	
Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	12,04	12,04	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	20,40	12,04	5,92	20,40	0,150	183,23	25,18	0,14	3,22
Eerste tussenstuk	33,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	41,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	51,40	3,60	2,92	9,50	0,036	30,97	8,66	0,28	2,61
Bovenstuk 2	64,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	65,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	41,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	51,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	61,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	20,40	12,04	5,92	20,40	0,150	183,23	25,18	0,14	3,22
Eerste tussenstuk	33,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	41,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	51,40	3,60	2,92	9,50	0,036	30,97	8,66	0,28	2,61
Bovenstuk 2	64,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	65,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	41,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	51,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	61,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S+9_c
Number: 1073

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	20,4	2,0
Eerste tussenstuk	0,14	0,71	12,7	1,3
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1				
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	48,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	0,71	57,2	48,5	0,0	-48,5	10,2	583,5	495,1	0,0	-495,1
Eerste tussenstuk	0,96	38,9	33,0	0,0	-33,0	26,8	1041,0	883,3	0,0	-883,3
Tweede tussenstuk	1,05	27,7	23,5	0,0	-23,5	37,5	1037,8	880,6	0,0	-880,6
Bovenstuk 1	1,12	25,3	21,4	0,0	-21,4	46,7	1178,3	999,8	0,0	-999,8
Bovenstuk 2	1,18	28,3	24,0	0,0	-24,0	57,7	1634,8	1387,1	0,0	-1387,1
Topstuk	1,21	1,1	1,0	0,0	-1,0	64,9	74,5	63,3	0,0	-63,3
Ondertraverse	1,09	28,2	16,8	0,0	-16,8	42,9	1211,6	719,6	0,0	-719,6
Middentraverse	1,15	41,0	24,3	0,0	-24,3	52,4	2145,9	1274,6	0,0	-1274,6
Boventraverse	1,20	40,4	24,0	0,0	-24,0	62,3	2517,5	1495,3	0,0	-1495,3
Totaal		288,2	216,6	0,0	-216,6		11424,8	8198,8	0,0	-8198,8

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	0,71	0,0	48,5	57,2	48,5	10,2	0,0	495,1	583,5	495,1
Eerste tussenstuk	0,96	0,0	33,0	38,9	33,0	26,8	0,0	883,3	1041,0	883,3
Tweede tussenstuk	1,05	0,0	23,5	27,7	23,5	37,5	0,0	880,6	1037,8	880,6
Bovenstuk 1	1,12	0,0	21,4	25,3	21,4	46,7	0,0	999,8	1178,3	999,8
Bovenstuk 2	1,18	0,0	24,0	28,3	24,0	57,7	0,0	1387,1	1634,8	1387,1
Topstuk	1,21	0,0	1,0	1,1	1,0	64,9	0,0	63,3	74,5	63,3
Ondertraverse	1,09	0,0	16,8	11,3	16,8	42,9	0,0	719,6	484,6	719,6
Middentraverse	1,15	0,0	24,3	16,4	24,3	52,4	0,0	1274,6	858,4	1274,6
Boventraverse	1,20	0,0	24,0	16,2	24,0	62,3	0,0	1495,3	1007,0	1495,3
Totaal		0,0	216,6	222,4	216,6		0,0	8198,8	7899,8	8198,8

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	512	0	0	0
Windrichting 0°	296	0	0	0	11807	0
Windrichting 45°	222	222	0	8469	8469	0
Windrichting 90°	0	230	0	8282	0	0
Windrichting 135°	-222	222	0	8469	-8469	0

Project: RLL-TLB380
Tower: S+9_c
Number: 1073

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	40,15	1,07	1,2	2,57
380ct1f2	4,50	1	4,5	4,5	2,0	49,65	1,13	1,2	2,72
380ct1f3	4,50	1	4,5	4,5	2,0	59,65	1,19	1,2	2,85
380ct2f1	4,50	1	4,5	4,5	2,0	40,15	1,07	1,2	2,57
380ct2f2	4,50	1	4,5	4,5	2,0	49,65	1,13	1,2	2,72
380ct2f3	4,50	1	4,5	4,5	2,0	59,65	1,19	1,2	2,85
150ct3f1	2,50	1	2,5	4,0	1,0	40,40	1,07	1,2	1,29
150ct3f2	2,50	1	2,5	4,0	1,0	49,90	1,14	1,2	1,36
150ct3f3	2,50	1	2,5	4,0	1,0	59,90	1,19	1,2	1,43
150ct4f1	2,50	1	2,5	4,0	1,0	40,40	1,07	1,2	1,29
150ct4f2	2,50	1	2,5	4,0	1,0	49,90	1,14	1,2	1,36
150ct4f3	2,50	1	2,5	4,0	1,0	59,90	1,19	1,2	1,43
bl1	0,10	1	0,1	0,2	0,1	63,30	1,21	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	63,30	1,21	1,2	0,14

Project: RLL-TLB380
Tower: S+9_c
Number: 1073

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	32,0	1,01	0,58	0,58	1,00	33,37	78,2	78,2	51,8	145,8	145,8
380ct1f2	41,5	1,08	0,60	0,60	0,98	33,37	84,9	84,9	51,8	162,1	162,1
380ct1f3	51,5	1,14	0,62	0,62	0,96	33,37	90,5	90,5	51,8	176,4	176,4
380ct2f1	32,0	1,01	0,58	0,58	1,00	33,37	78,2	78,2	51,8	145,8	145,8
380ct2f2	41,5	1,08	0,60	0,60	0,98	33,37	84,9	84,9	51,8	162,1	162,1
380ct2f3	51,5	1,14	0,62	0,62	0,96	33,37	90,5	90,5	51,8	176,4	176,4
150ct3f1	32,5	1,01	0,58	0,58	1,00	33,37	39,3	39,3	51,8	73,4	73,4
150ct3f2	42,0	1,08	0,60	0,60	0,98	33,37	42,6	42,6	51,8	81,4	81,4
150ct3f3	52,0	1,15	0,62	0,62	0,96	33,37	45,4	45,4	51,8	88,5	88,5
150ct4f1	32,5	1,01	0,58	0,58	1,00	33,37	39,3	39,3	51,8	73,4	73,4
150ct4f2	42,0	1,08	0,60	0,60	0,98	33,37	42,6	42,6	51,8	81,4	81,4
150ct4f3	52,0	1,15	0,62	0,62	0,96	33,37	45,4	45,4	51,8	88,5	88,5
bl1	57,3	1,18	0,63	0,63	1,18	22,24	19,3	19,3	63,1	55,9	55,9
bl2	57,3	1,18	0,63	0,63	1,18	22,13	19,3	19,3	63,0	55,9	55,9

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	32,0	1,01	0,58	0,58	1,00	33,37	78,2	78,2	51,8	145,8	145,8
380ct1f2	41,5	1,08	0,60	0,60	0,98	33,37	84,9	84,9	51,8	162,1	162,1
380ct1f3	51,5	1,14	0,62	0,62	0,96	33,37	90,5	90,5	51,8	176,4	176,4
380ct2f1	32,0	1,01	0,58	0,58	1,00	33,37	78,2	78,2	51,8	145,8	145,8
380ct2f2	41,5	1,08	0,60	0,60	0,98	33,37	84,9	84,9	51,8	162,1	162,1
380ct2f3	51,5	1,14	0,62	0,62	0,96	33,37	90,5	90,5	51,8	176,4	176,4
150ct3f1	32,5	1,01	0,58	0,58	1,00	33,37	39,3	39,3	51,8	73,4	73,4
150ct3f2	42,0	1,08	0,60	0,60	0,98	33,37	42,6	42,6	51,8	81,4	81,4
150ct3f3	52,0	1,15	0,62	0,62	0,96	33,37	45,4	45,4	51,8	88,5	88,5
150ct4f1	32,5	1,01	0,58	0,58	1,00	33,37	39,3	39,3	51,8	73,4	73,4
150ct4f2	42,0	1,08	0,60	0,60	0,98	33,37	42,6	42,6	51,8	81,4	81,4
150ct4f3	52,0	1,15	0,62	0,62	0,96	33,37	45,4	45,4	51,8	88,5	88,5
bl1	57,3	1,18	0,63	0,63	1,18	22,24	19,3	19,3	63,1	55,9	55,9
bl2	57,3	1,18	0,63	0,63	1,18	22,13	19,3	19,3	63,0	55,9	55,9

Project: RLL-TLB380
Masttype: S+9_c
Mast: 1073

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	62
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	1022

Project: RLL-TLB380
Masttype: S+9_c
Mast: 1073

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 (Ba+Ah) in het globale assenstelsel 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

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	-66,7	66,7	5,9	5,9	11,0	11,0
380ct1f1	-260,7	260,7	25,4	25,4	38,7	38,7
380ct1f2	-264,3	264,3	27,5	27,5	38,7	38,7
380ct1f3	-267,6	267,6	29,3	29,3	38,8	38,8
380ct2f1	-260,7	260,7	25,4	25,4	38,7	38,7
380ct2f2	-264,3	264,3	27,5	27,5	38,7	38,7
380ct2f3	-267,6	267,6	29,3	29,3	38,8	38,8
150ct3f1	-130,4	130,4	12,8	12,8	19,7	19,7
150ct3f2	-132,2	132,2	13,8	13,8	19,7	19,7
150ct3f3	-133,9	133,9	14,7	14,7	19,7	19,7
150ct4f1	-130,4	130,4	12,8	12,8	19,7	19,7
150ct4f2	-132,2	132,2	13,8	13,8	19,7	19,7
150ct4f3	-133,9	133,9	14,7	14,7	19,7	19,7
bl2	-65,7	65,7	5,9	5,9	10,9	10,9

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	481,0	497,7	481,0
380ct1f1	481,0	495,8	481,0
380ct1f2	481,0	496,0	481,0
380ct1f3	481,0	496,3	481,0
380ct2f1	481,0	495,8	481,0
380ct2f2	481,0	496,0	481,0
380ct2f3	481,0	496,3	481,0
150ct3f1	481,0	495,8	481,0
150ct3f2	481,0	496,1	481,0
150ct3f3	481,0	496,3	481,0
150ct4f1	481,0	495,8	481,0
150ct4f2	481,0	496,1	481,0
150ct4f3	481,0	496,3	481,0
bl2	481,0	498,0	481,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	571,2	463,8
380ct1f1	517,1	478,0
380ct1f2	522,1	479,0
380ct1f3	526,3	480,1
380ct2f1	517,1	478,0
380ct2f2	522,1	479,0
380ct2f3	526,3	480,1
150ct3f1	517,4	478,0
150ct3f2	522,3	479,1
150ct3f3	526,5	480,1
150ct4f1	517,4	478,0
150ct4f2	522,3	479,1
150ct4f3	526,5	480,1
bl2	573,7	463,4

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	573,7 m	1,434 -
Min. weight span	324,5 m	0,811 -

Project: RLL-TLB380
Masttype: S+9_c
Mast: 1073

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	11,8	21,9	-66,7	66,7
380ct1f1	105,1	50,8	77,3	-260,7	260,7
380ct1f2	105,1	55,0	77,5	-264,3	264,3
380ct1f3	105,1	58,6	77,6	-267,6	267,6
380ct2f1	105,1	50,8	77,3	-260,7	260,7
380ct2f2	105,1	55,0	77,5	-264,3	264,3
380ct2f3	105,1	58,6	77,6	-267,6	267,6
150ct3f1	52,5	25,5	39,0	-130,4	130,4
150ct3f2	52,5	27,6	39,0	-132,2	132,2
150ct3f3	52,5	29,4	39,1	-133,9	133,9
150ct4f1	52,5	25,5	39,0	-130,4	130,4
150ct4f2	52,5	27,6	39,0	-132,2	132,2
150ct4f3	52,5	29,4	39,1	-133,9	133,9
bl2	25,1	11,8	21,8	-65,7	65,7

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	4,7	-17,2	17,2
380ct1f1	0,0	0,0	39,6	-131,3	131,3
380ct1f2	0,0	0,0	39,6	-131,3	131,3
380ct1f3	0,0	0,0	39,6	-131,3	131,3
380ct2f1	0,0	0,0	39,6	-131,3	131,3
380ct2f2	0,0	0,0	39,6	-131,3	131,3
380ct2f3	0,0	0,0	39,6	-131,3	131,3
150ct3f1	0,0	0,0	20,0	-65,7	65,7
150ct3f2	0,0	0,0	20,0	-65,7	65,7
150ct3f3	0,0	0,0	20,0	-65,7	65,7
150ct4f1	0,0	0,0	20,0	-65,7	65,7
150ct4f2	0,0	0,0	20,0	-65,7	65,7
150ct4f3	0,0	0,0	20,0	-65,7	65,7
bl2	0,0	0,0	4,6	-16,8	16,8

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,4	2,4
	380ct1f1	20,3	20,3
	380ct1f2	20,3	20,3
	380ct1f3	20,4	20,4
	380ct2f1	20,3	20,3
	380ct2f2	20,3	20,3
	380ct2f3	20,4	20,4
	150ct3f1	10,3	10,3
	150ct3f2	10,3	10,3
	150ct3f3	10,3	10,3
	150ct4f1	10,3	10,3
	150ct4f2	10,3	10,3
	150ct4f3	10,3	10,3
	bl2	2,4	2,4

Project: RLL-TLB380
Masttype: S+9_c
Mast: 1073

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	517	475	27182	0	0
ULS 1a_0,9_90		0	517	342	27181	0	0
ULS 3_90		0	293	743	15516	0	0
ULS 3_0,9_90		0	293	592	15515	0	0
SLS 7		0	0	367	2	0	0

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

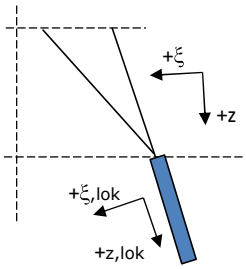
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	863	1089	39605	0	0
ULS 3_90	0	397	1357	19243	0	0
SLS 7	0	0	879	2	0	0

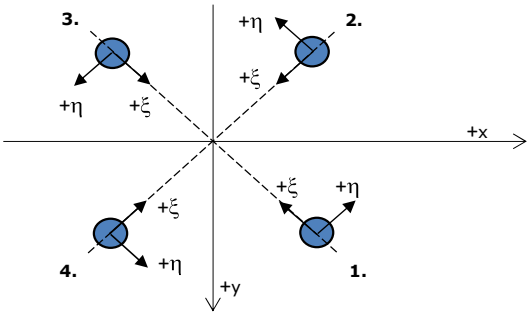
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	863	1089	**39605**	0	0
ULS 1a_0	463	0	1053	2	**18689**	0
ULS 5a Ba 11	105	0	876	-244	5401	**1471**
ULS 1a_45	347	600	1065	**26695**	**13396**	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	313	286	**1931**	20	-424	-14	1974
2	ULS 1a_0	159	-171	**1039**	9	-234	-13	1062
3	ULS 8 Ba	-124	-162	**979**	-27	-202	6	1001
4	ULS 1a_135	-313	286	**1931**	-20	-424	-14	1974

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 8 Ba	-38	-75	**-458**	26	80	-17	-468
2	ULS 1a_0,9_0,9_135	-240	212	**-1485**	20	320	5	-1518
3	ULS 1a_0,9_0,9_45	240	212	**-1485**	-20	320	5	-1518
4	ULS 1a_0,9_0,9_0	86	-98	**-595**	-9	130	4	-608

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 21	42	-31	5	**52**	-8	-6	5
2	ULS 5a Ba 11	34	-104	453	**50**	-97	-1	463
3	ULS 5a Ba 11	-42	31	5	**52**	-8	-7	5
4	ULS 5a Ah 21	-34	104	453	**50**	-97	-1	464

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 Ba 21	34	104	453	**-50**	-97	-1	464
2	ULS 5a Ah 11	42	31	5	**-52**	-8	-7	5
3	ULS 5a Ah 11	-34	-104	453	**-50**	-97	-1	463
4	ULS 5a Ba 21	-42	-31	5	**-52**	-8	-6	5

Project: RLL-TLB380
Masttype: S+9_c
Mast: 1073

Combinatie Ftrek+Fhor

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 8 Ba	-38	-75	**-458**	**26**	80	-17	-468
2	ULS 1a_0,9_0,9_90	-242	186	**-1467**	**39**	303	-8	-1499
3	ULS 1a_0,9_0,9_90	242	186	**-1467**	**-39**	303	-8	-1499
4	ULS 1a_0,9_0,9_0	86	-98	**-595**	**-9**	130	4	-608

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	36	36	220	0	-51	-5	225
2	SLS 7	36	-36	220	0	-51	-5	225
3	SLS 7	-36	-36	220	0	-51	-5	225
4	SLS 7	-36	36	220	0	-51	-5	225

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	313	286	**1931**	20	-424	-14	1974
Max. trek	ULS 1a_0,9_0,9_45	240	212	**-1485**	-20	320	5	-1518
Max. pos. torsie	ULS 5a Ah 21	42	-31	5	**52**	-8	-6	5
Max. neg. torsie	ULS 5a Ba 21	-42	-31	5	**-52**	-8	-6	5
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-242	186	**-1467**	**39**	303	-8	-1499

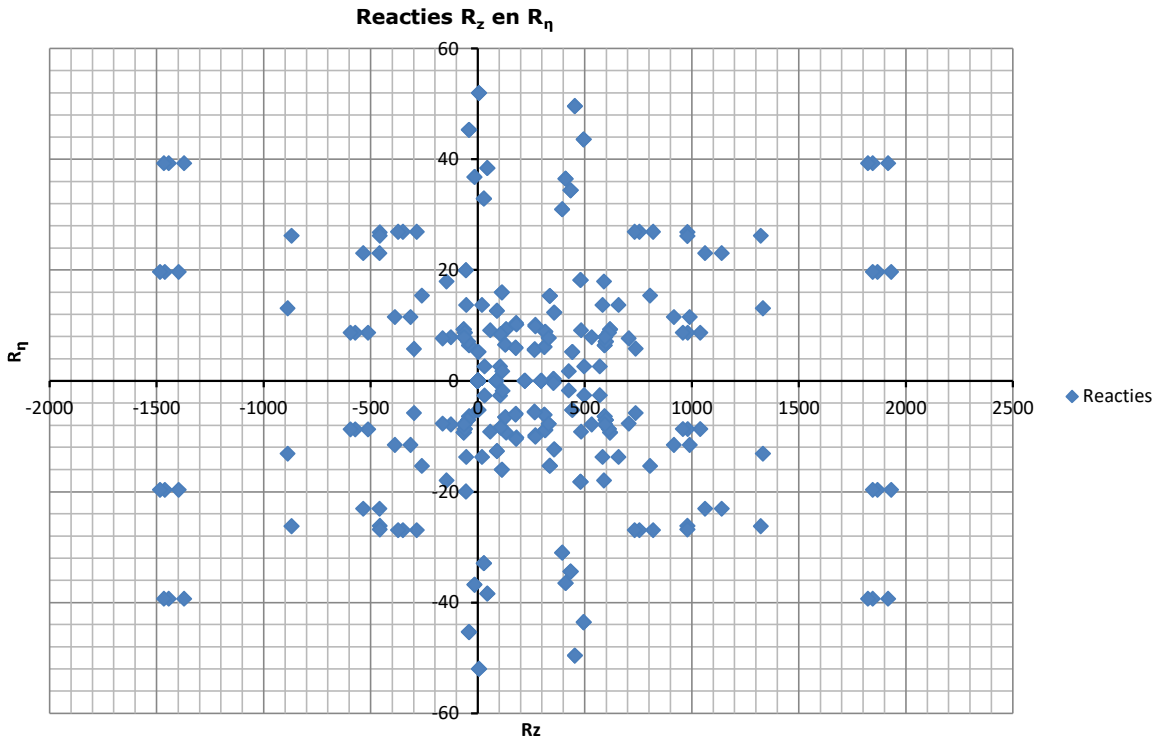
Maximale trekbelasting SLS

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	36	36	**220**	0	-51	-5	225
2	SLS 1a_135	-143	125	**-888**	13	189	1	-908
3	SLS 1a_45	143	125	**-888**	-13	189	1	-908
4	SLS 1a_0	41	-49	**-297**	-6	64	1	-304

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	216	198	**1331**	13	-293	-10	1361
2	SLS 1a_0	113	-122	**737**	6	-166	-10	753
3	SLS 7	-36	-36	**220**	0	-51	-5	225
4	SLS 1a_135	-216	198	**1331**	-13	-293	-10	1361

Project: RLL-TLB380
Masttype: S+9_c
Mast: 1073



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	68,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	508 m
Min. Weight span	400 m
Max. Weight span	633 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S+12_c

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

Document name:

RLL-TLB380_S+12_c_1077_Report.pdf

Project number:

Project client number:

0.0											

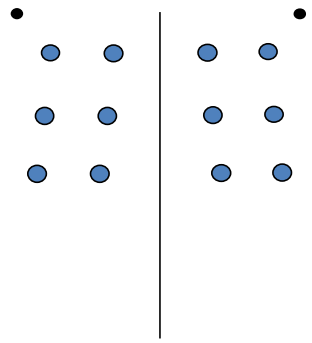
Project: RLL-TLB380
Tower: S+12_c
Number: 1077

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S+12_c
Masttype	Steunmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	4,50	4,50	2,00
Circuit 3	V-ketting	2,50	4,00	1,40
Circuit 4	V-ketting	2,50	4,00	1,40
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10
Bliksemdraad 2	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	40,4 m	44,9 m	11,0 m
Circuit 1	11	380ct1f2	49,9 m	54,4 m	14,0 m
Circuit 1	12	380ct1f3	59,9 m	64,4 m	10,6 m
Circuit 2	20	380ct2f1	40,4 m	44,9 m	-11,0 m
Circuit 2	21	380ct2f2	49,9 m	54,4 m	-14,0 m
Circuit 2	22	380ct2f3	59,9 m	64,4 m	-10,6 m
Circuit 3	30	150ct3f1	40,9 m	44,9 m	4,7 m
Circuit 3	31	150ct3f2	50,4 m	54,4 m	7,6 m
Circuit 3	32	150ct3f3	60,4 m	64,4 m	4,3 m
Circuit 4	40	150ct4f1	40,9 m	44,9 m	-4,7 m
Circuit 4	41	150ct4f2	50,4 m	54,4 m	-7,6 m
Circuit 4	42	150ct4f3	60,4 m	64,4 m	-4,3 m
Bliksemdraad 1	1	bl1	65,7 m	65,9 m	16,0 m
Bliksemdraad 2	3	bl2	65,7 m	65,9 m	-16,0 m

Project: RLL-TLB380
Tower: S+12_c
Number: 1077

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	0,0 m	0,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-12,0 m	-12,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

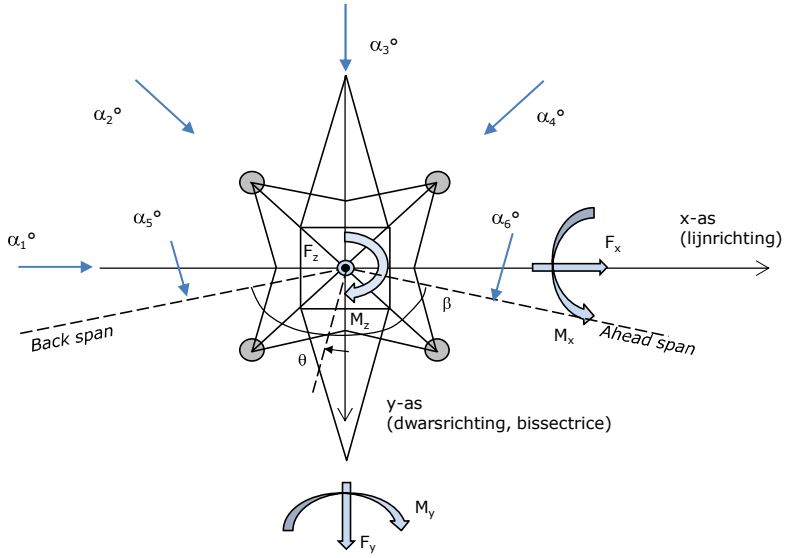
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	30	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	31	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	32	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	40	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	41	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	42	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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

Project: RLL-TLB380
Tower: S+12_c
Number: 1077

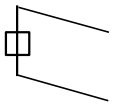
Geleiderafval

		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
Circuit 3	150ct3f1	1	0	1	0	0,8	0
Circuit 3	150ct3f2	1	0	1	0	0,8	0
Circuit 3	150ct3f3	1	0	1	0	0,8	0
Circuit 4	150ct4f1	0	1	1	0	0,8	0
Circuit 4	150ct4f2	0	1	1	0	0,8	0
Circuit 4	150ct4f3	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

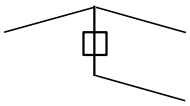
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

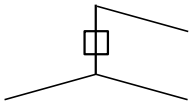
Principe belastingssituaties:



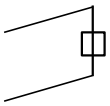
1. Ba All cts



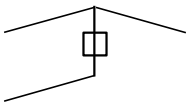
2. Ba ct1



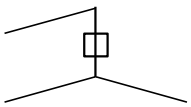
3. Ba ct2



4. Ah All cts



5. Ah ct1

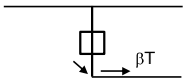


6. Ah ct2

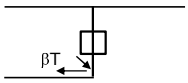
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S+12_c
Number: 1077

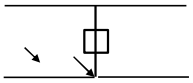
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

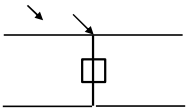
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

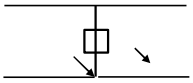
Principe belastingssituaties:



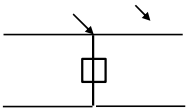
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

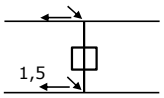
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

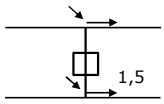
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S+12_c
Number: 1077

Mastconstructie

Eigenschappen

Masttype	Steunmast	
Mastbenaming	S+12_c	
Voetplaat t.o.v. maaiveld	0,5	m
Masthoogte t.o.v. voetplaat	68,7	m
Gewicht mast	581,0	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	12,94	12,94	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	23,40	12,94	5,92	23,40	0,150	220,71	32,90	0,15	3,16
Eerste tussenstuk	36,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	44,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	54,40	3,60	2,92	9,50	0,036	30,97	8,66	0,28	2,61
Bovenstuk 2	67,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	68,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	44,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	54,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	64,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	23,40	12,94	5,92	23,40	0,150	220,71	32,90	0,15	3,16
Eerste tussenstuk	36,10	5,92	4,55	12,70	0,054	66,50	14,15	0,21	2,88
Tweede tussenstuk	44,90	4,55	3,60	8,80	0,054	35,86	10,13	0,28	2,60
Bovenstuk 1	54,40	3,60	2,92	9,50	0,036	30,97	8,66	0,28	2,61
Bovenstuk 2	67,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	68,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	44,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	54,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	64,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S+12_c
Number: 1077

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	23,4	2,3
Eerste tussenstuk	0,14	0,71	12,7	1,3
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1				
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	51,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	0,74	77,0	65,3	0,0	-65,3	11,7	900,5	764,1	0,0	-764,1
Eerste tussenstuk	0,99	40,1	34,0	0,0	-34,0	29,8	1193,4	1012,7	0,0	-1012,7
Tweede tussenstuk	1,07	28,3	24,0	0,0	-24,0	40,5	1144,4	971,1	0,0	-971,1
Bovenstuk 1	1,14	25,7	21,8	0,0	-21,8	49,7	1274,5	1081,4	0,0	-1081,4
Bovenstuk 2	1,19	28,7	24,4	0,0	-24,4	60,7	1742,1	1478,2	0,0	-1478,2
Topstuk	1,23	1,2	1,0	0,0	-1,0	67,9	78,9	66,9	0,0	-66,9
Ondertraverse	1,11	28,8	17,1	0,0	-17,1	45,9	1319,8	783,9	0,0	-783,9
Middentraverse	1,17	41,5	24,7	0,0	-24,7	55,4	2301,6	1367,1	0,0	-1367,1
Boventraverse	1,22	40,9	24,3	0,0	-24,3	65,3	2670,3	1586,1	0,0	-1586,1
Totaal		312,1	236,5	0,0	-236,5		12625,4	9111,5	0,0	-9111,5

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	0,74	0,0	65,3	77,0	65,3	11,7	0,0	764,1	900,5	764,1
Eerste tussenstuk	0,99	0,0	34,0	40,1	34,0	29,8	0,0	1012,7	1193,4	1012,7
Tweede tussenstuk	1,07	0,0	24,0	28,3	24,0	40,5	0,0	971,1	1144,4	971,1
Bovenstuk 1	1,14	0,0	21,8	25,7	21,8	49,7	0,0	1081,4	1274,5	1081,4
Bovenstuk 2	1,19	0,0	24,4	28,7	24,4	60,7	0,0	1478,2	1742,1	1478,2
Topstuk	1,23	0,0	1,0	1,2	1,0	67,9	0,0	66,9	78,9	66,9
Ondertraverse	1,11	0,0	17,1	11,5	17,1	45,9	0,0	783,9	527,9	783,9
Middentraverse	1,17	0,0	24,7	16,6	24,7	55,4	0,0	1367,1	920,6	1367,1
Boventraverse	1,22	0,0	24,3	16,4	24,3	65,3	0,0	1586,1	1068,1	1586,1
Totaal		0,0	236,5	245,4	236,5		0,0	9111,5	8850,5	9111,5

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	581	0	0	0
Windrichting 0°	320	0	0	0	13038	0
Windrichting 45°	242	242	0	9403	9403	0
Windrichting 90°	0	253	0	9263	0	0
Windrichting 135°	-242	242	0	9403	-9403	0

Project: RLL-TLB380
Tower: S+12_c
Number: 1077

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	43,15	1,09	1,2	2,62
380ct1f2	4,50	1	4,5	4,5	2,0	52,65	1,15	1,2	2,76
380ct1f3	4,50	1	4,5	4,5	2,0	62,65	1,20	1,2	2,89
380ct2f1	4,50	1	4,5	4,5	2,0	43,15	1,09	1,2	2,62
380ct2f2	4,50	1	4,5	4,5	2,0	52,65	1,15	1,2	2,76
380ct2f3	4,50	1	4,5	4,5	2,0	62,65	1,20	1,2	2,89
150ct3f1	2,50	1	2,5	4,0	1,4	43,40	1,09	1,2	1,84
150ct3f2	2,50	1	2,5	4,0	1,4	52,90	1,15	1,2	1,94
150ct3f3	2,50	1	2,5	4,0	1,4	62,90	1,20	1,2	2,02
150ct4f1	2,50	1	2,5	4,0	1,4	43,40	1,09	1,2	1,84
150ct4f2	2,50	1	2,5	4,0	1,4	52,90	1,15	1,2	1,94
150ct4f3	2,50	1	2,5	4,0	1,4	62,90	1,20	1,2	2,02
bl1	0,10	1	0,1	0,2	0,1	66,30	1,22	1,2	0,15
bl2	0,10	1	0,1	0,2	0,1	66,30	1,22	1,2	0,15

Project: RLL-TLB380
Tower: S+12_c
Number: 1077

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	33,5	1,02	0,59	0,59	1,00	33,37	79,4	79,4	51,8	148,6	148,6
380ct1f2	43,0	1,09	0,61	0,61	0,97	33,37	85,8	85,8	51,8	164,4	164,4
380ct1f3	53,0	1,15	0,62	0,62	0,95	33,37	91,3	91,3	51,8	178,3	178,3
380ct2f1	33,5	1,02	0,59	0,59	1,00	33,37	79,4	79,4	51,8	148,6	148,6
380ct2f2	43,0	1,09	0,61	0,61	0,97	33,37	85,8	85,8	51,8	164,4	164,4
380ct2f3	53,0	1,15	0,62	0,62	0,95	33,37	91,3	91,3	51,8	178,3	178,3
150ct3f1	34,0	1,02	0,59	0,59	0,99	33,37	39,9	39,9	51,8	74,8	74,8
150ct3f2	43,5	1,09	0,61	0,61	0,97	33,37	43,1	43,1	51,8	82,6	82,6
150ct3f3	53,5	1,16	0,62	0,62	0,95	33,37	45,8	45,8	51,8	89,5	89,5
150ct4f1	34,0	1,02	0,59	0,59	0,99	33,37	39,9	39,9	51,8	74,8	74,8
150ct4f2	43,5	1,09	0,61	0,61	0,97	33,37	43,1	43,1	51,8	82,6	82,6
150ct4f3	53,5	1,16	0,62	0,62	0,95	33,37	45,8	45,8	51,8	89,5	89,5
bl1	58,8	1,18	0,63	0,63	1,18	22,24	19,5	19,5	63,1	56,5	56,5
bl2	58,8	1,18	0,63	0,63	1,18	22,13	19,4	19,4	63,0	56,4	56,4

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	33,5	1,02	0,59	0,59	1,00	33,37	79,4	79,4	51,8	148,6	148,6
380ct1f2	43,0	1,09	0,61	0,61	0,97	33,37	85,8	85,8	51,8	164,4	164,4
380ct1f3	53,0	1,15	0,62	0,62	0,95	33,37	91,3	91,3	51,8	178,3	178,3
380ct2f1	33,5	1,02	0,59	0,59	1,00	33,37	79,4	79,4	51,8	148,6	148,6
380ct2f2	43,0	1,09	0,61	0,61	0,97	33,37	85,8	85,8	51,8	164,4	164,4
380ct2f3	53,0	1,15	0,62	0,62	0,95	33,37	91,3	91,3	51,8	178,3	178,3
150ct3f1	34,0	1,02	0,59	0,59	0,99	33,37	39,9	39,9	51,8	74,8	74,8
150ct3f2	43,5	1,09	0,61	0,61	0,97	33,37	43,1	43,1	51,8	82,6	82,6
150ct3f3	53,5	1,16	0,62	0,62	0,95	33,37	45,8	45,8	51,8	89,5	89,5
150ct4f1	34,0	1,02	0,59	0,59	0,99	33,37	39,9	39,9	51,8	74,8	74,8
150ct4f2	43,5	1,09	0,61	0,61	0,97	33,37	43,1	43,1	51,8	82,6	82,6
150ct4f3	53,5	1,16	0,62	0,62	0,95	33,37	45,8	45,8	51,8	89,5	89,5
bl1	58,8	1,18	0,63	0,63	1,18	22,24	19,5	19,5	63,1	56,5	56,5
bl2	58,8	1,18	0,63	0,63	1,18	22,13	19,4	19,4	63,0	56,4	56,4

Project: RLL-TLB380
Masttype: S+12_c
Mast: 1077

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	4
Aantal belastingcombinaties ULS	62
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	11
Aantal knooplasten	1022

Project: RLL-TLB380
Masttype: S+12_c
Mast: 1077

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 (Ba+Ah) in het globale assenstelsel 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

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	-66,8	66,8	6,0	6,0	11,5	11,5
380ct1f1	-261,3	261,3	25,8	25,8	40,6	40,6
380ct1f2	-264,8	264,8	27,8	27,8	40,7	40,7
380ct1f3	-268,1	268,1	29,6	29,6	40,8	40,8
380ct2f1	-261,3	261,3	25,8	25,8	40,6	40,6
380ct2f2	-264,8	264,8	27,8	27,8	40,7	40,7
380ct2f3	-268,1	268,1	29,6	29,6	40,8	40,8
150ct3f1	-130,7	130,7	13,3	13,3	20,5	20,5
150ct3f2	-132,5	132,5	14,4	14,4	20,5	20,5
150ct3f3	-134,1	134,1	15,2	15,2	20,6	20,6
150ct4f1	-130,7	130,7	13,3	13,3	20,5	20,5
150ct4f2	-132,5	132,5	14,4	14,4	20,5	20,5
150ct4f3	-134,1	134,1	15,2	15,2	20,6	20,6
bl2	-65,8	65,8	5,9	5,9	11,4	11,4

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	508,0	530,3	508,0
380ct1f1	508,0	527,7	508,0
380ct1f2	508,0	528,1	508,0
380ct1f3	508,0	528,4	508,0
380ct2f1	508,0	527,7	508,0
380ct2f2	508,0	528,1	508,0
380ct2f3	508,0	528,4	508,0
150ct3f1	508,0	527,8	508,0
150ct3f2	508,0	528,1	508,0
150ct3f3	508,0	528,4	508,0
150ct4f1	508,0	527,8	508,0
150ct4f2	508,0	528,1	508,0
150ct4f3	508,0	528,4	508,0
bl2	508,0	530,7	508,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	629,6	485,1
380ct1f1	557,3	504,2
380ct1f2	563,7	505,6
380ct1f3	569,2	506,9
380ct2f1	557,3	504,2
380ct2f2	563,7	505,6
380ct2f3	569,2	506,9
150ct3f1	557,7	504,3
150ct3f2	564,0	505,7
150ct3f3	569,5	507,0
150ct4f1	557,7	504,3
150ct4f2	564,0	505,7
150ct4f3	569,5	507,0
bl2	632,9	484,6

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	632,9 m	1,582 -
Min. weight span	400,0 m	1,000 -

Project: RLL-TLB380
Masttype: S+12_c
Mast: 1077

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	11,9	22,9	-66,8	66,8
380ct1f1	105,1	51,6	81,3	-261,3	261,3
380ct1f2	105,1	55,6	81,5	-264,8	264,8
380ct1f3	105,1	59,1	81,7	-268,1	268,1
380ct2f1	105,1	51,6	81,3	-261,3	261,3
380ct2f2	105,1	55,6	81,5	-264,8	264,8
380ct2f3	105,1	59,1	81,7	-268,1	268,1
150ct3f1	52,5	26,7	40,9	-130,7	130,7
150ct3f2	52,5	28,7	41,0	-132,5	132,5
150ct3f3	52,5	30,5	41,1	-134,1	134,1
150ct4f1	52,5	26,7	40,9	-130,7	130,7
150ct4f2	52,5	28,7	41,0	-132,5	132,5
150ct4f3	52,5	30,5	41,1	-134,1	134,1
bl2	25,1	11,9	22,7	-65,8	65,8

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	5,0	-17,2	17,2
380ct1f1	0,0	0,0	41,6	-131,3	131,3
380ct1f2	0,0	0,0	41,6	-131,3	131,3
380ct1f3	0,0	0,0	41,6	-131,3	131,3
380ct2f1	0,0	0,0	41,6	-131,3	131,3
380ct2f2	0,0	0,0	41,6	-131,3	131,3
380ct2f3	0,0	0,0	41,6	-131,3	131,3
150ct3f1	0,0	0,0	21,0	-65,7	65,7
150ct3f2	0,0	0,0	21,0	-65,7	65,7
150ct3f3	0,0	0,0	21,0	-65,7	65,7
150ct4f1	0,0	0,0	21,0	-65,7	65,7
150ct4f2	0,0	0,0	21,0	-65,7	65,7
150ct4f3	0,0	0,0	21,0	-65,7	65,7
bl2	0,0	0,0	4,8	-16,8	16,8

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,6	2,6
	380ct1f1	21,5	21,5
	380ct1f2	21,5	21,5
	380ct1f3	21,5	21,5
	380ct2f1	21,5	21,5
	380ct2f2	21,5	21,5
	380ct2f3	21,5	21,5
	150ct3f1	10,9	10,9
	150ct3f2	10,9	10,9
	150ct3f3	10,9	10,9
	150ct4f1	10,9	10,9
	150ct4f2	10,9	10,9
	150ct4f3	10,9	10,9
	bl2	2,5	2,5

Project: RLL-TLB380
Masttype: S+12_c
Mast: 1077

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	528	509	29322	0	0
ULS 1a_0,9_90		0	528	375	29321	0	0
ULS 3_90		0	299	781	16703	0	0
ULS 3_0,9_90		0	299	630	16702	0	0
SLS 7		0	0	385	2	0	0

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

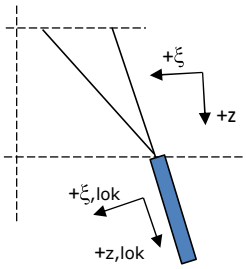
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	908	1206	43216	0	0
ULS 3_90	0	413	1478	20871	0	0
SLS 7	0	0	966	2	0	0

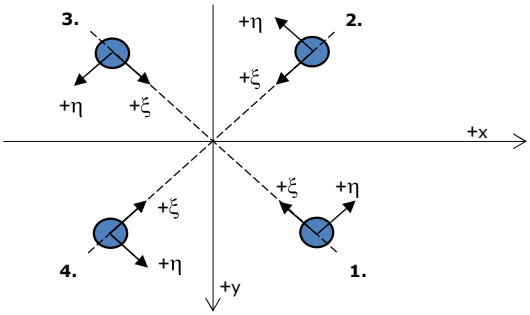
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	908	1206	**43216**	0	0
ULS 1a_0	502	0	1157	2	**20744**	0
ULS 5a Ba 11	105	0	962	-257	5716	**1471**
ULS 1a_45	379	636	1173	**29253**	**14944**	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	329	303	**2001**	19	-447	-23	2045
2	ULS 1a_0	173	-180	**1090**	5	-250	-18	1115
3	ULS 8 Ba	-132	-169	**1023**	-26	-213	4	1046
4	ULS 1a_135	-329	303	**2001**	-19	-447	-23	2045

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 8 Ba	-38	-75	**-454**	26	80	-16	-464
2	ULS 1a_0,9_0,9_135	-248	221	**-1506**	19	332	12	-1540
3	ULS 1a_0,9_0,9_45	248	221	**-1506**	-19	332	12	-1540
4	ULS 1a_0,9_0,9_0	92	-99	**-600**	-5	135	8	-614

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 21	43	-25	30	**49**	-13	-7	30
2	ULS 5a Ba 11	39	-105	471	**46**	-102	-2	482
3	ULS 5a Ba 11	-43	25	30	**49**	-13	-7	30
4	ULS 5a Ah 21	-39	105	471	**46**	-102	-2	482

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 Ba 21	39	105	471	**-46**	-102	-2	482
2	ULS 5a Ah 11	43	25	30	**-49**	-13	-7	30
3	ULS 5a Ah 11	-39	-105	471	**-46**	-102	-2	482
4	ULS 5a Ba 21	-43	-25	30	**-49**	-13	-7	30

Project: RLL-TLB380
Masttype: S+12_c
Mast: 1077

Combinatie Ftrek+Fhor

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 8 Ba	-38	-75	**-454**	**26**	80	-16	-464
2	ULS 1a_0,9_0,9_90	-242	194	**-1469**	**34**	308	-3	-1501
3	ULS 1a_0,9_0,9_90	242	194	**-1469**	**-34**	308	-3	-1501
4	ULS 1a_0,9_0,9_0	92	-99	**-600**	**-5**	135	8	-614

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	40	40	242	0	-56	-5	247
2	SLS 7	40	-40	242	0	-56	-5	247
3	SLS 7	-40	-40	242	0	-56	-5	247
4	SLS 7	-40	40	242	0	-56	-5	247

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	329	303	**2001**	19	-447	-23	2045
Max. trek	ULS 1a_0,9_0,9_45	248	221	**-1506**	-19	332	12	-1540
Max. pos. torsie	ULS 5a Ah 21	43	-25	30	**49**	-13	-7	30
Max. neg. torsie	ULS 5a Ba 21	-43	-25	30	**-49**	-13	-7	30
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-242	194	**-1469**	**34**	308	-3	-1501

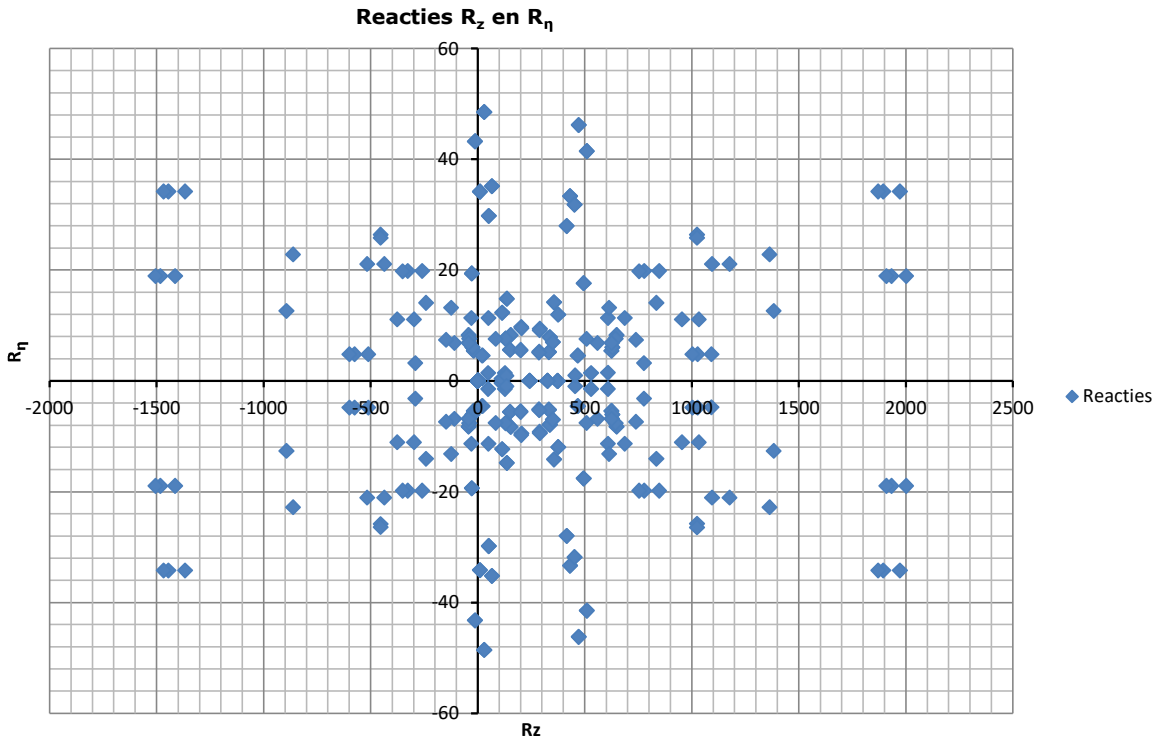
Maximale trekbelasting SLS

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	40	40	**242**	0	-56	-5	247
2	SLS 1a_135	-147	129	**-894**	13	195	6	-914
3	SLS 1a_45	147	129	**-894**	-13	195	6	-914
4	SLS 1a_0	44	-48	**-293**	-3	65	3	-299

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	228	210	**1382**	13	-309	-16	1413
2	SLS 1a_0	123	-128	**776**	3	-178	-13	793
3	SLS 7	-40	-40	**242**	0	-56	-5	247
4	SLS 1a_135	-228	210	**1382**	-13	-309	-16	1413

Project: RLL-TLB380
Masttype: S+12_c
Mast: 1077



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	15 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Steunmast
Masthoogte	68,7 m
Max. veldlengte	400 m
Lijnhoek	180°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	508 m
Min. Weight span	400 m
Max. Weight span	605 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-05-04			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype S+12_c - bouwfase

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

Document name:

RLL-TLB380_S+12_c - bouwfase_1077_Report.pdf

Project number:

Project client number:

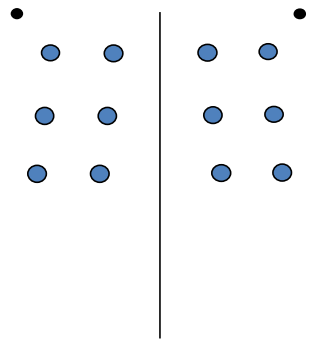
0.0											

Geleiderbelastingen

Auteur: TBR
Versie: v11.8

Algemeen

Benaming	S+12_c - bouwfase
Masttype	Steunmast
Aantal circuits	2
Configuratie	2-circuit-verticaal
Aantal bliksemgeleiders	1



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	15 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	V-ketting	4,50	4,50	2,00
Circuit 2	V-ketting	2,50	4,00	1,40
Bliksemdraad 1	Vast (Bliksemdraad)	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	40,4 m	44,9 m	11,0 m
Circuit 1	11	380ct1f2	49,9 m	54,4 m	14,0 m
Circuit 1	12	380ct1f3	59,9 m	64,4 m	10,6 m
Circuit 2	20	150ct2f1	40,9 m	44,9 m	4,7 m
Circuit 2	21	150ct2f2	50,4 m	54,4 m	7,6 m
Circuit 2	22	150ct2f3	60,4 m	64,4 m	4,3 m
Bliksemdraad 1	1	bl1	65,7 m	65,9 m	-16,0 m

Project: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	0,0 m	0,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-12,0 m	-12,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

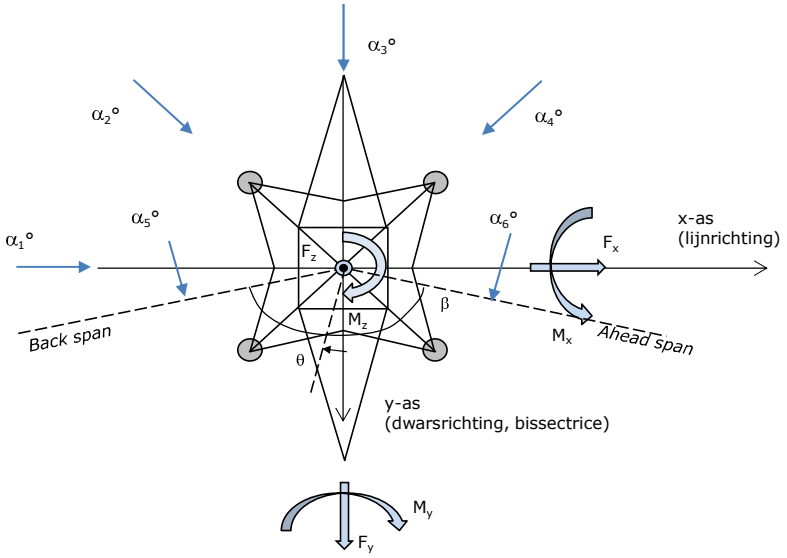
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	20	150ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	21	150ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	22	150ct2f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	180 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		800	800 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	225 °	
	α_6	270 °	

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

Windrichtingen en positieve richtingen belastingen



Beschouwd aantal windrichtingen

1a	6
3	6
4	1
6	1
Overig	1

Project: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

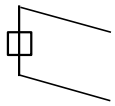
Geleiderafval

		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	150ct2f1	0	1	1	0	0,8	0
Circuit 2	150ct2f2	0	1	1	0	0,8	0
Circuit 2	150ct2f3	0	1	1	0	0,8	0
Bliksemdraad 1	bl1	1	0	1	0	1	0

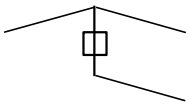
Belastingsituaties SPLS

Beschouwde situaties SPLS: SPLS voor steunmast niet van toepassing

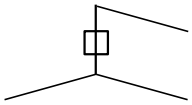
Principe belastingssituaties:



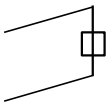
1. Ba All cts



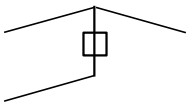
2. Ba ct1



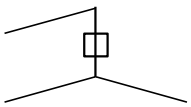
3. Ba ct2



4. Ah All cts



5. Ah ct1

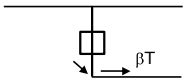


6. Ah ct2

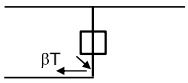
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

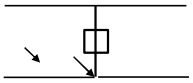
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht. Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

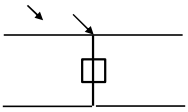
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

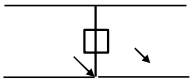
Principe belastingssituaties:



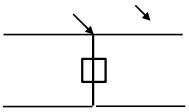
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

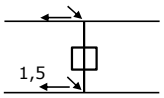
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

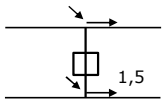
Considered situations galloping 8: 1 and 2, all possible situations

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: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

Mastconstructie

Eigenschappen

Masttype	Steunmast	
Mastbenaming	S+12_c - bouwfase	
Voetplaat t.o.v. maaiveld	0,5	m
Masthoogte t.o.v. voetplaat	68,7	m
Gewicht mast	581,0	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	12,94	12,94	m
Helling van de randstijl	0,150	0,150	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	23,40	12,94	5,92	23,40	0,150	220,71	32,90	0,15	3,16
Eerste tussenstuk	36,10	5,92	3,90	12,70	0,079	62,40	14,15	0,23	2,82
Tweede tussenstuk	44,90	3,90	3,60	8,80	0,017	33,02	10,13	0,31	2,51
Bovenstuk 1	54,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	67,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	68,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	44,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	54,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	64,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

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	23,40	12,94	5,92	23,40	0,150	220,71	32,90	0,15	3,16
Eerste tussenstuk	36,10	5,92	3,90	12,70	0,079	62,40	14,15	0,23	2,82
Tweede tussenstuk	44,90	3,90	3,60	8,80	0,017	33,02	10,13	0,31	2,51
Bovenstuk 1	54,40	3,60	2,92	9,50	0,036	30,97	9,99	0,32	2,46
Bovenstuk 2	67,00	2,92	2,01	12,60	0,036	31,06	9,61	0,31	2,50
Topstuk	68,70	2,01		1,70		1,71	0,32	0,18	3,00
Ondertraverse	44,90	12,70		3,00		19,05	4,75	0,25	2,72
Middentraverse	54,40	16,34		3,00		24,51	6,81	0,28	2,62
Boventraverse	64,40	13,70	1,00	2,60		24,66	6,19	0,25	2,72

NB: oppervlakte traverse dwarsrichting wordt in berekening gereduceerd.

Project: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	23,4	2,3
Eerste tussenstuk	0,14	0,71	12,7	1,3
Tweede tussenstuk	0,14	0,71	8,8	0,9
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	51,2	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	0,74	77,0	65,3	0,0	-65,3	11,7	900,5	764,1	0,0	-764,1
Eerste tussenstuk	0,99	39,3	33,3	0,0	-33,3	29,8	1169,1	992,0	0,0	-992,0
Tweede tussenstuk	1,07	27,3	23,2	0,0	-23,2	40,5	1105,8	938,3	0,0	-938,3
Bovenstuk 1	1,14	27,9	23,7	0,0	-23,7	49,7	1384,2	1174,6	0,0	-1174,6
Bovenstuk 2	1,19	28,7	24,4	0,0	-24,4	60,7	1742,1	1478,2	0,0	-1478,2
Topstuk	1,23	1,2	1,0	0,0	-1,0	67,9	78,9	66,9	0,0	-66,9
Ondertraverse	1,11	28,8	17,1	0,0	-17,1	45,9	1319,8	783,9	0,0	-783,9
Middentraverse	1,17	41,5	24,7	0,0	-24,7	55,4	2301,6	1367,1	0,0	-1367,1
Boventraverse	1,22	40,9	24,3	0,0	-24,3	65,3	2670,3	1586,1	0,0	-1586,1
Totaal		312,5	236,9	0,0	-236,9		12672,2	9151,1	0,0	-9151,1

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	0,74	0,0	65,3	77,0	65,3	11,7	0,0	764,1	900,5	764,1
Eerste tussenstuk	0,99	0,0	33,3	39,3	33,3	29,8	0,0	992,0	1169,1	992,0
Tweede tussenstuk	1,07	0,0	23,2	27,3	23,2	40,5	0,0	938,3	1105,8	938,3
Bovenstuk 1	1,14	0,0	23,7	27,9	23,7	49,7	0,0	1174,6	1384,2	1174,6
Bovenstuk 2	1,19	0,0	24,4	28,7	24,4	60,7	0,0	1478,2	1742,1	1478,2
Topstuk	1,23	0,0	1,0	1,2	1,0	67,9	0,0	66,9	78,9	66,9
Ondertraverse	1,11	0,0	17,1	11,5	17,1	45,9	0,0	783,9	527,9	783,9
Middentraverse	1,17	0,0	24,7	16,6	24,7	55,4	0,0	1367,1	920,6	1367,1
Boventraverse	1,22	0,0	24,3	16,4	24,3	65,3	0,0	1586,1	1068,1	1586,1
Totaal		0,0	236,9	245,8	236,9		0,0	9151,1	8897,2	9151,1

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	581	0	0	0
Windrichting 0°	321	0	0	0	13085	0
Windrichting 45°	243	243	0	9443	9443	0
Windrichting 90°	0	254	0	9310	0	0
Windrichting 135°	-243	243	0	9443	-9443	0

Project: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7

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	4,50	1	4,5	4,5	2,0	43,15	1,09	1,2	2,62
380ct1f2	4,50	1	4,5	4,5	2,0	52,65	1,15	1,2	2,76
380ct1f3	4,50	1	4,5	4,5	2,0	62,65	1,20	1,2	2,89
150ct2f1	2,50	1	2,5	4,0	1,4	43,40	1,09	1,2	1,84
150ct2f2	2,50	1	2,5	4,0	1,4	52,90	1,15	1,2	1,94
150ct2f3	2,50	1	2,5	4,0	1,4	62,90	1,20	1,2	2,02
bl1	0,10	1	0,1	0,2	0,1	66,30	1,22	1,2	0,15

Project: RLL-TLB380
Tower: S+12_c - bouwfase
Number: 1077

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	33,5	1,02	0,59	0,59	1,00	33,37	79,4	79,4	51,8	148,6	148,6
380ct1f2	43,0	1,09	0,61	0,61	0,97	33,37	85,8	85,8	51,8	164,4	164,4
380ct1f3	53,0	1,15	0,62	0,62	0,95	33,37	91,3	91,3	51,8	178,3	178,3
150ct2f1	34,0	1,02	0,59	0,59	0,99	33,37	39,9	39,9	51,8	74,8	74,8
150ct2f2	43,5	1,09	0,61	0,61	0,97	33,37	43,1	43,1	51,8	82,6	82,6
150ct2f3	53,5	1,16	0,62	0,62	0,95	33,37	45,8	45,8	51,8	89,5	89,5
bl1	58,8	1,18	0,63	0,63	1,18	22,24	19,5	19,5	63,1	56,5	56,5

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	33,5	1,02	0,59	0,59	1,00	33,37	79,4	79,4	51,8	148,6	148,6
380ct1f2	43,0	1,09	0,61	0,61	0,97	33,37	85,8	85,8	51,8	164,4	164,4
380ct1f3	53,0	1,15	0,62	0,62	0,95	33,37	91,3	91,3	51,8	178,3	178,3
150ct2f1	34,0	1,02	0,59	0,59	0,99	33,37	39,9	39,9	51,8	74,8	74,8
150ct2f2	43,5	1,09	0,61	0,61	0,97	33,37	43,1	43,1	51,8	82,6	82,6
150ct2f3	53,5	1,16	0,62	0,62	0,95	33,37	45,8	45,8	51,8	89,5	89,5
bl1	58,8	1,18	0,63	0,63	1,18	22,24	19,5	19,5	63,1	56,5	56,5

Project: RLL-TLB380
Masttype: S+12_c - bouwfase
Mast: 1077

Auteur: TBR
Versie: v11.8

Geleiderbelastingen

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw CC2
Referentieperiode	15 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°	1,20	1,20	0,00	1,25	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,25	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,25	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,38	1,07	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,38	1,07	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,25	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,25	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,25	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,25	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	0,87	0,0	0,0
SLS 3	Wind+ijs	-5°	1,00	1,00	0,0	0,26	0,71	0,0
SLS 4	Wind	-20°	1,00	1,00	0,0	0,17	0,0	0,0
SLS 6	Bouw en onderhoud	5°	1,00	1,00	0,0	0,17	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	6
Aantal belastingcombinaties ULS	54
Aantal belastingcombinaties SPLS	0
Aantal belastingcombinaties SLS	15
Aantal knooplasten	483

Project: RLL-TLB380
Masttype: S+12_c - bouwfase
Mast: 1077

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 (Ba+Ah) in het globale assenstelsel 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

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	-54,5	54,5	5,0	5,0	8,6	8,6
380ct1f1	-236,3	236,3	21,5	21,5	36,3	36,3
380ct1f2	-239,2	239,2	23,2	23,2	36,4	36,4
380ct1f3	-242,0	242,0	24,7	24,7	36,5	36,5
150ct2f1	-118,2	118,2	11,1	11,1	20,5	20,5
150ct2f2	-119,7	119,7	12,0	12,0	20,5	20,5
150ct2f3	-121,1	121,1	12,7	12,7	20,5	20,5

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	508,0	528,6	508,0
380ct1f1	508,0	527,2	508,0
380ct1f2	508,0	527,5	508,0
380ct1f3	508,0	527,7	508,0
150ct2f1	508,0	527,2	508,0
150ct2f2	508,0	527,5	508,0
150ct2f3	508,0	527,7	508,0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	604,6	495,3
380ct1f1	544,6	507,0
380ct1f2	549,8	508,4
380ct1f3	554,2	509,6
150ct2f1	544,9	507,1
150ct2f2	550,0	508,4
150ct2f3	554,4	509,7

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	604,6 m	1,512 -
Min. weight span	400,0 m	1,000 -

Project: RLL-TLB380
Masttype: S+12_c - bouwfase
Mast: 1077

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	25,8	10,0	17,1	-54,5	54,5
380ct1f1	105,1	43,1	72,6	-236,3	236,3
380ct1f2	105,1	46,5	72,7	-239,2	239,2
380ct1f3	105,1	49,4	72,9	-242,0	242,0
150ct2f1	52,5	22,3	36,6	-118,2	118,2
150ct2f2	52,5	24,0	36,7	-119,7	119,7
150ct2f3	52,5	25,5	36,8	-121,1	121,1

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	0,0	0,0	5,0	-17,2	17,2
380ct1f1	0,0	0,0	41,6	-131,3	131,3
380ct1f2	0,0	0,0	41,6	-131,3	131,3
380ct1f3	0,0	0,0	41,6	-131,3	131,3
150ct2f1	0,0	0,0	21,0	-65,7	65,7
150ct2f2	0,0	0,0	21,0	-65,7	65,7
150ct2f3	0,0	0,0	21,0	-65,7	65,7

Controle uplift SLS-wind

Combinatie:	Geleider	Fz_ba [kN]	Fz_ah [kN]
SLS 4	bl1	2,6	2,6
	380ct1f1	21,5	21,5
	380ct1f2	21,5	21,5
	380ct1f3	21,5	21,5
	150ct2f1	10,9	10,9
	150ct2f2	10,9	10,9
	150ct2f3	10,9	10,9

Project: RLL-TLB380
Masttype: S+12_c - bouwfase
Mast: 1077

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		0	221	249	14489	0	0
ULS 1a_0,9_0		9	0	188	1704	496	79
ULS 1a_0,9_0,9_90		0	221	141	13525	0	0
ULS 3_0		3	0	340	2885	149	24
SLS 7		0	0	193	1750	0	0

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

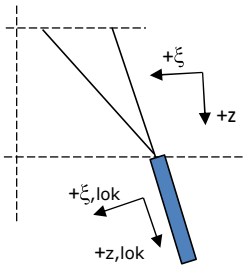
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	539	946	26154	0	0
ULS 1a_0,9_0,9_90	0	539	664	25191	0	0
SLS 7	0	0	774	1750	0	0

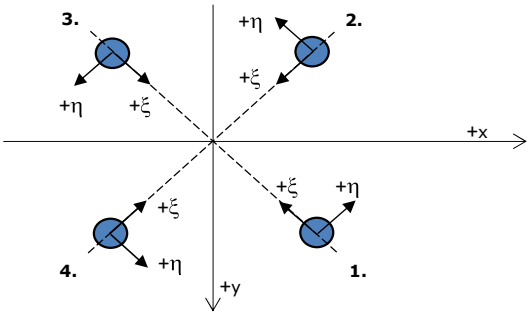
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	0	539	946	**26154**	0	0
ULS 1a_0,9_0,9_0	411	0	664	1278	**16892**	79
ULS 5a Ba 11	105	0	762	1526	5716	**1471**
ULS 1a_45	310	418	933	**20292**	**12183**	56

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	246	220	**1488**	19	-330	-14	1521
2	ULS 1a_270	177	-174	**1074**	-2	-248	-20	1098
3	ULS 1a_225	-217	-222	**1323**	-3	-310	-30	1353
4	ULS 1a_135	-246	220	**1488**	-19	-330	-14	1521

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 1a_0,9_0,9_225	-159	-154	**-957**	-4	221	18	-978
2	ULS 1a_0,9_135	-174	154	**-1060**	14	232	7	-1084
3	ULS 1a_0,9_45	174	154	**-1060**	-14	232	7	-1084
4	ULS 1a_0,9_0,9_270	117	-107	**-709**	7	159	8	-724

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 Ba 11	96	39	470	**40**	-96	4	481
2	ULS 5a Ba 11	20	-96	352	**54**	-82	-7	360
3	ULS 5a Ba 11	-24	33	-89	**40**	7	-12	-91
4	ULS 5a Ba 11	14	23	29	**26**	-7	-1	29

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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 11	-14	23	29	**-26**	-7	-1	29
2	ULS 5a Ah 11	24	33	-89	**-40**	7	-12	-91
3	ULS 5a Ah 11	-20	-96	352	**-54**	-82	-7	360
4	ULS 5a Ah 11	-96	39	470	**-40**	-96	4	481

Project: RLL-TLB380
Masttype: S+12_c - bouwfase
Mast: 1077

Combinatie Ftrek+Fhor

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_0,9_0,9_225	-159	-154	**-957**	**-4**	221	18	-978
2	ULS 1a_0,9_135	-174	154	**-1060**	**14**	232	7	-1084
3	ULS 1a_0,9_45	174	154	**-1060**	**-14**	232	7	-1084
4	ULS 1a_0,9_0,9_270	117	-107	**-709**	**7**	159	8	-724

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	43	32	261	8	-53	2	267
2	SLS 7	21	-32	126	8	-37	-11	129
3	SLS 7	-21	-32	126	-8	-37	-11	129
4	SLS 7	-43	32	261	-8	-53	2	267

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	246	220	**1488**	19	-330	-14	1521
Max. trek	ULS 1a_0,9_45	174	154	**-1060**	-14	232	7	-1084
Max. pos. torsie	ULS 5a Ba 11	20	-96	352	**54**	-82	-7	360
Max. neg. torsie	ULS 5a Ah 11	-20	-96	352	**-54**	-82	-7	360
Comb. trek+torsie	ULS 1a_0,9_45	174	154	**-1060**	**-14**	232	7	-1084

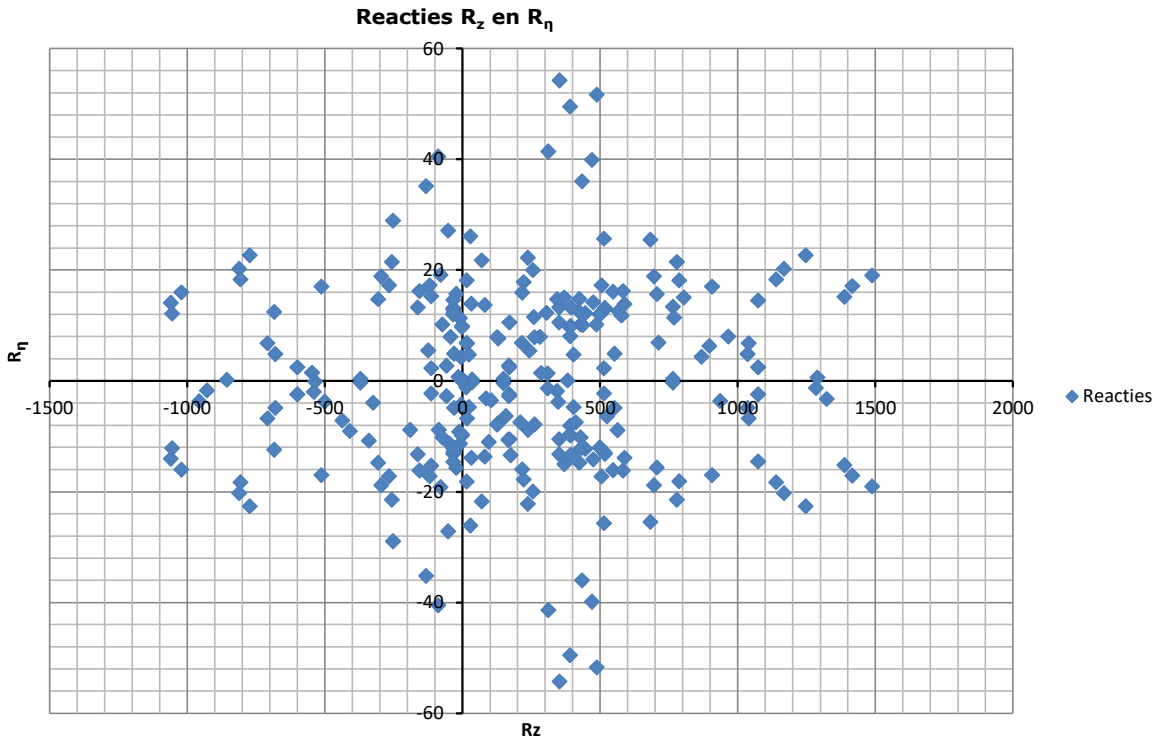
Maximale trekbelasting SLS

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	43	32	**261**	8	-53	2	267
2	SLS 1a_135	-112	95	**-685**	12	146	1	-700
3	SLS 1a_45	112	95	**-685**	-12	146	1	-700
4	SLS 1a_0	29	-41	**-190**	-9	50	9	-194

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	178	157	**1073**	15	-237	-9	1097
2	SLS 1a_0	91	-107	**577**	12	-140	-18	590
3	SLS 7	-21	-32	**126**	-8	-37	-11	129
4	SLS 1a_135	-178	157	**1073**	-15	-237	-9	1097

Project: RLL-TLB380
Masttype: S+12_c - bouwfase
Mast: 1077



Hoisting load

Date: 2021-02-22
Author: TBR
Version: 1.1

RLL-TLB
S+0_c

Uitvoer geleiderbelastingen

Belastingcombi	nummer	Fxtotaal	Fytotaal	Fztotaal	Ftrekahead	Ftrekback
ULS 6b_90	10	**0.0**	**10.3**	**50.0**	159.9	-159.9
	11	**0.0**	**11.1**	**50.1**	160.6	-160.6
	12	**0.0**	**11.8**	**50.1**	161.3	-161.3
	20	**0.0**	**10.3**	**50.0**	159.9	-159.9
	21	**0.0**	**11.1**	**50.1**	160.6	-160.6
	22	**0.0**	**11.8**	**50.1**	161.3	-161.3
	30	**0.0**	**5.3**	**25.3**	80.0	-80.0
	31	**0.0**	**5.7**	**25.3**	80.3	-80.3
	32	**0.0**	**6.1**	**25.4**	80.6	-80.6
	40	**0.0**	**5.3**	**25.3**	80.0	-80.0
	41	**0.0**	**5.7**	**25.3**	80.3	-80.3
	42	**0.0**	**6.1**	**25.4**	80.6	-80.6
	1	**0.0**	**2.4**	**6.0**	22.3	-22.3
	3	**0.0**	**2.4**	**5.9**	21.8	-21.8

Extra belastingfactor voor hijsen:	$\gamma_{f,dyn}$ =	1.2	kN
Extra belasting voor hijsmiddelen	F_{kar} =	1	kN
Rekenwaarde	F_{Ed} =	1.2	kN

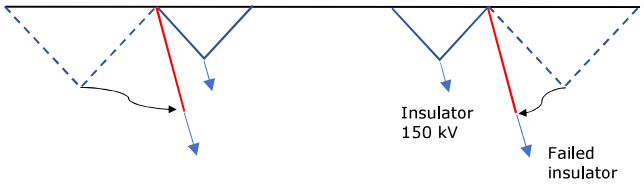
Invoer in PLS-TOWER

Load Case	Joint Label	Vertical Load (N)	Transverse Load (N)	Longitudinal Load (N)	Load Comment
Hoisting load	4P_84SF0.50S	10315	61459	0	
Hoisting load	4P_84SF0.50X	11128	61511	0	
Hoisting load	7P_51SF0.50S	11822	61559	0	
Hoisting load	7P_51SF0.50X	10315	61459	0	
Hoisting load	10P_27SF0.50S	11128	61511	0	
Hoisting load	10P_27SF0.50X	11822	61559	0	
Hoisting load	0i0.52E33S	5338	31811	0	
Hoisting load	0i0.52E33X	5749	31837	0	
Hoisting load	0i0.51E42S	6100	31860	0	
Hoisting load	0i0.51E42X	5338	31811	0	
Hoisting load	1i0.51E52S	5749	31837	0	
Hoisting load	1i0.51E52X	6100	31860	0	

Insulator failure case

Date: 2021-02-22
Author: TBR
Version: 1.1

RLL-TLB
S+0_c



Uitvoer geleiderbelastingen

Belastingcombi	nummer	Fxtotaal	Fytotaal	Fztotaal	Ftrekahead	Ftrekback
SLS 1a_90	10	**0.0**	**34.4**	**44.5**	179.6	-179.6
	11	**0.0**	**37.1**	**44.8**	185.8	-185.8
	12	**0.0**	**39.4**	**45.2**	191.3	-191.3
	20	**0.0**	**34.4**	**44.5**	179.6	-179.6
	21	**0.0**	**37.1**	**44.8**	185.8	-185.8
	22	**0.0**	**39.4**	**45.2**	191.3	-191.3
	30	**0.0**	**17.8**	**22.5**	90.0	-90.0
	31	**0.0**	**19.2**	**22.7**	93.1	-93.1
	32	**0.0**	**20.3**	**22.8**	95.8	-95.8
	40	**0.0**	**17.8**	**22.5**	90.0	-90.0
	41	**0.0**	**19.2**	**22.7**	93.1	-93.1
	42	**0.0**	**20.3**	**22.8**	95.8	-95.8
	1	**0.0**	**7.9**	**5.9**	33.1	-33.1
	3	**0.0**	**7.9**	**5.8**	32.7	-32.7
SLS 3_90	10	**0.0**	**18.6**	**63.1**	210.6	-210.6
	11	**0.0**	**20.6**	**63.2**	212.9	-212.9
	12	**0.0**	**22.3**	**63.4**	215.1	-215.1
	20	**0.0**	**18.6**	**63.1**	210.6	-210.6
	21	**0.0**	**20.6**	**63.2**	212.9	-212.9
	22	**0.0**	**22.3**	**63.4**	215.1	-215.1
	30	**0.0**	**9.5**	**31.8**	105.4	-105.4
	31	**0.0**	**10.5**	**31.9**	106.5	-106.5
	32	**0.0**	**11.3**	**31.9**	107.6	-107.6
	40	**0.0**	**9.5**	**31.8**	105.4	-105.4
	41	**0.0**	**10.5**	**31.9**	106.5	-106.5
	42	**0.0**	**11.3**	**31.9**	107.6	-107.6
	1	**0.0**	**6.8**	**16.5**	51.5	-51.5
	3	**0.0**	**6.8**	**16.3**	50.8	-50.8

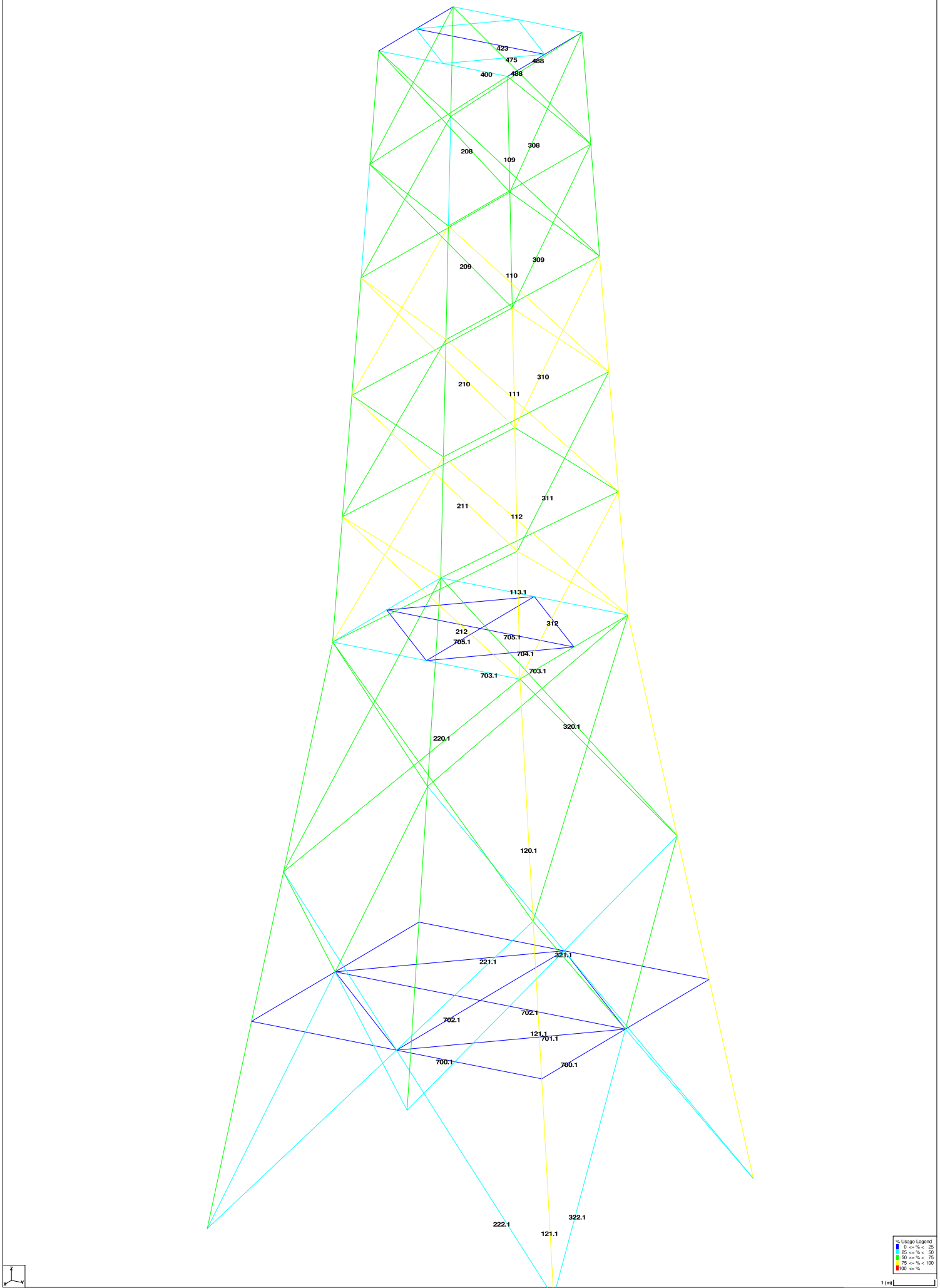
APPENDIX B
Resultaten PLS-TOWER

Deze Appendix bevat de resultaten uit PLS-TOWER voor de verschillende masttypen. De samenstelling van de bovenstukken zijn voor alle masttypen gelijk. De resultaten van het bovenstuk zijn dan ook alleen opgenomen van het maatgevende masttype S+12/c. De resultaten van het onderstuk zijn voor alle masten opgenomen.

Resultaten opgenomen voor:

- Masttype S-3/c
- Masttype S+0/c
- Masttype S+3/c
- Masttype S+6/c
- Masttype S+9/c
- Masttype S+12/c

DNV GL Nederlands BV. Project: "S_c config"
Tower Version 16.80, 8:15:01 AM Tuesday, May 4, 2021
Undeformed geometry displayed



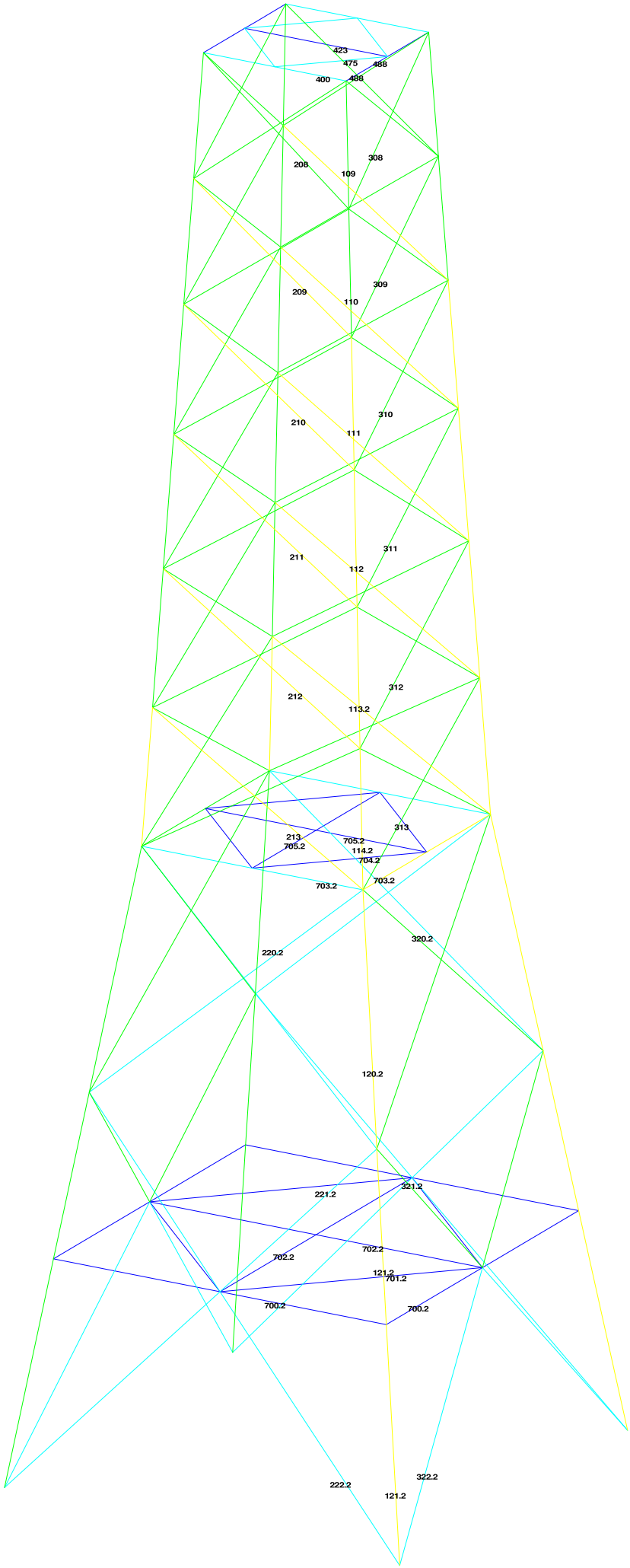
Assessment of angle groups - Tower footage

Date	5/4/2021
Author	TBR
Version	1,0

RLL-TLB
S-3_c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
109	Main leg	EA	180x180x16	S355	6M24-8.8t	2		55	40	80	0.52	0.52	0.52	43	**-1046.1**	ULS 1a_135	1734.9	1626.6	1693.4	0.64	**800.1**	ULS 1a_0_9_0_9_90	1661.0	1626.6	1592.1	0.50
110	Main leg	EA	180x180x16	S355							0.52	0.52	0.52	43	**-1253.0**	ULS 1a_135	1734.9	0.0	0.0	0.72	**980.9**	ULS 1a_0_9_0_9_90	1966.7	0.0	0.0	0.50
111	Main leg	EA	180x180x16	S355	8M24-8.8t	2		55	40	80	0.52	0.52	0.52	44	**-1356.8**	ULS 1a_135	1719.5	2168.8	2257.9	0.79	**1105.0**	ULS 1a_0_9_0_9_90	1661.0	2168.8	2122.8	0.67
112	Main leg	EA	180x180x18	S355							0.50	0.50	0.50	44	**-1529.8**	ULS 1a_135	1923.2	0.0	0.0	0.80	**1250.7**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.57
208	Diag front face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	127	**-161.4**	ULS 1a_90	230.8	271.1	352.8	0.70	**137.5**	ULS 1a_90	305.3	271.1	329.6	0.51
209	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	133	**-128.1**	ULS 1a_90	175.7	271.1	282.2	0.73	**143.7**	ULS 1a_90	246.8	271.1	263.7	0.58
210	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	141	**-133.4**	ULS 1a_90	162.1	271.1	282.2	0.82	**117.9**	ULS 1a_90	246.8	271.1	263.7	0.48
211	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	150	**-114.3**	ULS 1a_90	149.6	271.1	282.2	0.76	**124.0**	ULS 1a_90	246.8	271.1	263.7	0.50
212	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	159	**-117.9**	ULS 1a_90	138.0	271.1	282.2	0.85	**102.1**	ULS 1a_90	246.8	271.1	263.7	0.41
308	Diag side face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	127	**-146.8**	ULS 5a Ah 11	230.8	271.1	352.8	0.64	**145.6**	ULS 5a Ah 11	305.3	271.1	329.6	0.54
309	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	133	**-129.8**	ULS 5a Ah 11	175.7	271.1	282.2	0.74	**134.2**	ULS 5a Ah 11	246.8	271.1	263.7	0.54
310	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	141	**-123.3**	ULS 5a Ah 11	162.1	271.1	282.2	0.76	**117.8**	ULS 5a Ah 11	246.8	271.1	263.7	0.48
311	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	150	**-108.3**	ULS 5a Ah 11	149.6	271.1	282.2	0.72	**113.5**	ULS 5a Ah 11	246.8	271.1	263.7	0.46
312	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	159	**-105.7**	ULS 5a Ah 11	138.0	271.1	282.2	0.77	**98.0**	ULS 5a Ah 11	246.8	271.1	263.7	0.40
703.1	Hor plan bracing tussenstuk	EA	110x110x10	S355	2M24-8.8t	1		45	35	70	2.00	1.00	1.00	155	**-132.5**	ULS 1a_90	185.0	271.1	352.8	0.72	**95.8**	ULS 1a_0_9_0_9_90	307.1	271.1	224.6	0.43
704.1	Diag plan bracing tussenstuk	EA	80x80x6	S355	1M20-8.8t	1		45	35		1.00	1.00	1.00	233	**-2.6**	ULS 1a_135	37.8	94.1	88.2	0.07	**4.5**	ULS 1a_135	112.9	94.1	80.2	0.06
705.1	Mid hor plan bracing tussenstuk	DEA	60x60x6 (not cou	S355	1M20-8.8t	1		45	35		0.50	0.50	0.50	224	**-0.1**	ULS 1a_90	66.5	94.1	88.2	0.00	**0.0**		112.9	94.1	80.2	0.00
120.1	Main leg	EA	180x180x18	S355	10M24-8.8t	2		55	40	80	0.29	0.29	0.29	49	**-1694.5**	ULS 1a_45	1866.2	2711.0	3175.2	0.91	**1381.0**	ULS 1a_0_9_0_9_90	1853.6	2711.0	2985.2	0.75
121.1	Main leg	EA	200x200x18	S355	10M24-8.8t	2		55	40	80	0.50	0.50	0.50	49	**-1632.9**	ULS 1a_45	2075.3	2711.0	3175.2	0.79	**1296.0**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.61
220.1	Diag front face	EA	100x100x10	S355	2M24-8.8t	1		55	50	80	0.58	0.29	0.29	161	**-86.3**	ULS 5a Ba 21	159.4	271.1	352.8	0.54	**88.5**	ULS 5a Ba 21	305.3	271.1	331.7	0.33
221.1	Diag front face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	1.00	0.50	0.50	170	**-70.2**	ULS 5a Ba 21	148.4	271.1	352.8	0.47	**67.9**	ULS 5a Ba 21	305.3	271.1	329.6	0.25
222.1	Diag front face	EA	130x130x12	S355	2M24-8.8t	1		55	40	80	1.00	0.33	0.33	181	**-72.9**	ULS 5a Ba 21	212.8	271.1	423.4	0.34	**64.7**	ULS 5a Ba 21	494.4	271.1	395.5	0.24
320.1	Diag side face	EA	100x100x10	S355	2M24-8.8t	1		55	50	80	0.58	0.29	0.29	161	**-97.3**	ULS 5a Ah 21	159.4	271.1	352.8	0.61	**96.1**	ULS 5a Ba 11	305.3	271.1	331.7	0.35
321.1	Diag side face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	1.00	0.50	0.50	170	**-77.9**	ULS 5a Ba 11	148.4	271.1	352.8	0.53	**75.5**	ULS 5a Ah 21	305.3	271.1	329.6	0.28
322.1	Diag side face	EA	130x130x12	S355	2M24-8.8t	1		55	40	80	1.00	0.33	0.33	181	**-79.8**	ULS 5a Ba 11	212.8	271.1	423.4	0.38	**71.6**	ULS 5a Ah 21	494.4	271.1	395.5	0.26
700.1	Hor plan bracing broekstuk	EA	90x90x8	S355	1M20-8.8t	1		45	35		1.00	1.00	1.00	230	**-9.7**	ULS 1a_0_9_0_9_45	64.0	94.1	117.6	0.15	**3.5**	ULS 1a_0_9_0_9_135	150.5	94.1	106.9	0.04
701.1	Diag plan bracing broekstuk	EA	80x80x8	S355	1M20-8.8t	1		45	35		1.00	0.50	0.50	236	**-3.0**	ULS 1a_135	41.2	94.1	117.6	0.07	**4.1**	ULS 1a_0_9_0_9_45	150.5	94.1	106.9	0.04
702.1	Mid hor plan bracing broekstuk	DEA	90x90x8 (not cou	S355	1M16-8.8t	1		35	40		0.50	0.50	0.50	230	**-0.6**	ULS 1a_90	127.9	60.3	94.1	0.01	**0.0**		194.4	60.3	81.3	0.00
113.1	Main leg	EA	180x180x18	S355	10M24-8.8t	2		55	40	80	0.52	0.52	0.52	47	**-1611.8**	ULS 1a_45	1884.0	2711.0	3175.2	0.86	**1344.8**	ULS 1a_0_9_0_9_90	1853.6	2711.0	2985.2	0.73

DNV GL Nederlands BV. Project: "S_c config"
Tower Version 16.80, 8:16:47 AM Tuesday, May 4, 2021
Undeformed geometry displayed



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

1 (m)

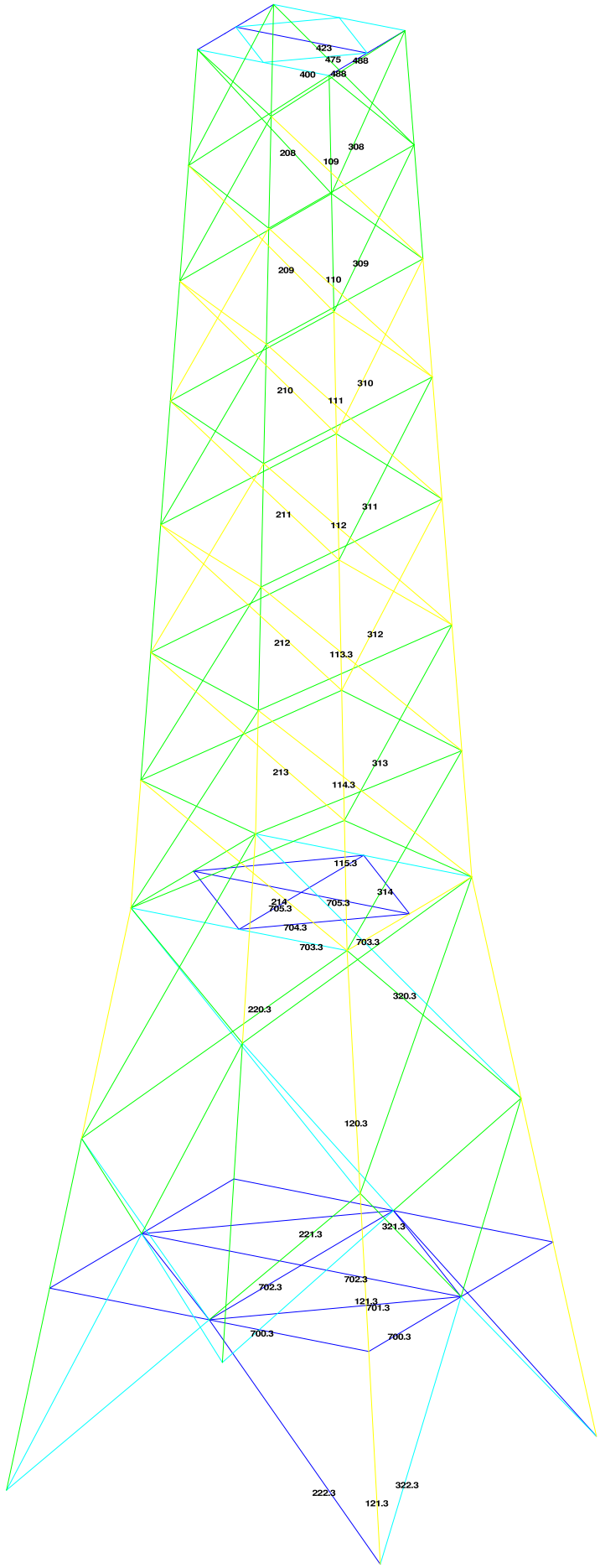
Assessment of angle groups - Tower footage

Date	5/4/2021
Author	TBR
Version	1,0

RLL-TLB
S+0_c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
109	Main leg	EA	180x180x16	S355	6M24-8.8t	2		55	40	80	0.52	0.52	0.52	43	**-1080.3**	ULS 1a_135	1734.9	1626.6	1693.4	0.66	**840.1**	ULS 1a_0_9_0_9_90	1661.0	1626.6	1592.1	0.53
110	Main leg	EA	180x180x16	S355							0.52	0.52	0.52	43	**-1265.9**	ULS 1a_135	1734.9	0.0	0.0	0.73	**1013.0**	ULS 1a_0_9_0_9_90	1966.7	0.0	0.0	0.52
111	Main leg	EA	180x180x16	S355	8M24-8.8t	2		55	40	80	0.52	0.52	0.52	44	**-1405.4**	ULS 1a_135	1719.5	2168.8	2257.9	0.82	**1160.0**	ULS 1a_0_9_0_9_90	1661.0	2168.8	2122.8	0.70
112	Main leg	EA	180x180x18	S355							0.50	0.50	0.50	44	**-1546.1**	ULS 1a_135	1923.2	0.0	0.0	0.80	**1286.5**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.59
120.2	Main leg	EA	200x200x18	S355	10M24-8.8t	2		55	40	80	0.28	0.28	0.28	41	**-1873.8**	ULS 1a_90	2186.1	2711.0	3175.2	0.86	**1547.3**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.73
121.2	Main leg	EA	200x200x18	S355	10M24-8.8t	2		55	40	80	0.50	0.50	0.50	50	**-1756.3**	ULS 1a_90	2070.8	2711.0	3175.2	0.85	**1418.8**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.67
208	Diag front face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	127	**-165.3**	ULS 1a_90	230.8	271.1	352.8	0.72	**144.9**	ULS 1a_90	305.3	271.1	329.6	0.53
209	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	133	**-135.5**	ULS 1a_90	175.7	271.1	282.2	0.77	**146.7**	ULS 1a_90	246.8	271.1	263.7	0.59
210	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	141	**-135.4**	ULS 1a_90	162.1	271.1	282.2	0.84	**125.5**	ULS 1a_90	246.8	271.1	263.7	0.51
211	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	150	**-123.2**	ULS 1a_90	149.6	271.1	282.2	0.82	**124.4**	ULS 1a_90	246.8	271.1	263.7	0.50
212	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	159	**-117.6**	ULS 1a_90	138.0	271.1	282.2	0.85	**115.0**	ULS 1a_90	246.8	271.1	263.7	0.47
213	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	167	**-110.9**	ULS 1a_90	128.9	271.1	282.2	0.86	**103.7**	ULS 1a_90	246.8	271.1	263.7	0.42
220.2	Diag front face	EA	100x100x10	S355	2M24-8.8t	1		55	50	80	0.56	0.28	0.28	158	**-81.2**	ULS 1a_0_9_0_9_90	164.7	271.1	352.8	0.49	**81.6**	ULS 1a_0_9_0_9_90	305.3	271.1	331.7	0.30
221.2	Diag front face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	1.00	0.50	0.50	174	**-69.8**	ULS 1a_0_9_0_9_90	143.9	271.1	352.8	0.49	**65.6**	ULS 5a Ba 21	305.3	271.1	329.6	0.24
222.2	Diag front face	EA	130x130x12	S355	2M24-8.8t	1		55	40	80	1.00	0.33	0.33	183	**-68.7**	ULS 5a Ah 11	209.4	271.1	423.4	0.33	**61.9**	ULS 5a Ba 21	494.4	271.1	395.5	0.23
308	Diag side face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	127	**-145.4**	ULS 5a Ah 11	230.8	271.1	352.8	0.63	**146.6**	ULS 5a Ah 11	305.3	271.1	329.6	0.54
309	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	133	**-131.0**	ULS 5a Ah 11	175.7	271.1	282.2	0.75	**132.5**	ULS 5a Ah 11	246.8	271.1	263.7	0.54
310	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	141	**-121.3**	ULS 5a Ah 11	162.1	271.1	282.2	0.75	**119.6**	ULS 5a Ah 11	246.8	271.1	263.7	0.48
311	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	150	**-110.8**	ULS 5a Ah 11	149.6	271.1	282.2	0.74	**110.4**	ULS 5a Ah 11	246.8	271.1	263.7	0.45
312	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	159	**-101.4**	ULS 5a Ah 11	138.0	271.1	282.2	0.73	**102.9**	ULS 5a Ah 11	246.8	271.1	263.7	0.42
313	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	167	**-95.8**	ULS 5a Ah 11	128.9	271.1	282.2	0.74	**90.9**	ULS 5a Ah 11	246.8	271.1	263.7	0.37
320.2	Diag side face	EA	100x100x10	S355	2M24-8.8t	1		55	50	80	0.56	0.28	0.28	158	**-89.5**	ULS 5a Ah 21	164.7	271.1	352.8	0.54	**93.2**	ULS 5a Ba 11	305.3	271.1	331.7	0.34
321.2	Diag side face	EA	100x100x10	S355	2M24-8.8t	1		55	40	80	1.00	0.50	0.50	174	**-78.7**	ULS 5a Ba 11	143.9	271.1	352.8	0.55	**72.2**	ULS 5a Ba 11	305.3	271.1	329.6	0.27
322.2	Diag side face	EA	130x130x12	S355	2M24-8.8t	1		55	40	80	1.00	0.33	0.33	183	**-81.0**	ULS 5a Ba 11	209.4	271.1	423.4	0.39	**68.0**	ULS 5a Ba 11	494.4	271.1	395.5	0.25
700.2	Hor plan bracing broekstuk	EA	100x100x8	S355	1M20-8.8t	1		45	35		1.00	1.00	1.00	214	**-10.3**	ULS 1a_0_9_0_9_135	79.9	94.1	117.6	0.13	**3.5**	ULS 1a_0_9_0_9_135	150.5	94.1	106.9	0.04
701.2	Diag plan bracing broekstuk	EA	80x80x8	S355	1M20-8.8t	1		45	35		1.00	0.50	0.50	244	**-2.5**	ULS 1a_135	39.1	94.1	117.6	0.06	**3.8**	ULS 1a_0_9_0_9_45	150.5	94.1	106.9	0.04
702.2	Mid hor plan bracing broekstuk	DEA	90x90x8 (not cou	S355	1M16-8.8t	1		35	40		0.50	0.50	0.50	238	**-0.6**	ULS 1a_90	121.0	60.3	94.1	0.01	**0.0**		194.4	60.3	81.3	0.00
703.2	Hor plan bracing tussenstuk	EA	120x120x10	S355	2M24-8.8t	1		45	35	70	2.00	1.00	1.00	152	**-177.0**	ULS 1a_90	209.2	271.1	352.8	0.85	**128.5**	ULS 1a_0_9_0_9_90	341.6	271.1	224.6	0.57
704.2	Diag plan bracing tussenstuk	EA	80x80x6	S355	1M20-8.8t	1		45	35		1.00	1.00	1.00	248	**-3.2**	ULS 1a_135	34.1	94.1	88.2	0.09	**5.5**	ULS 1a_135	112.9	94.1	80.2	0.07
705.2	Mid hor plan bracing tussenstuk	DEA	70x70x6 (not cou	S355	1M20-8.8t	1		45	35		0.50	0.50	0.50	204	**-0.1**	ULS 1a_90	90.3	94.1	88.2	0.00	**0.0**		112.9	94.1	80.2	0.00
113.2	Main leg	EA	180x180x18	S355							0.52	0.52	0.52	47	**-1688.6**	ULS 1a_90	1884.1	0.0	0.0	0.90	**1419.9**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.65
114.2	Main leg	EA	180x180x18	S355	10M24-8.8t	2		55	40	80	0.52	0.52	0.52	47	**-1791.5**	ULS 1a_90	1884.1	2711.0	3175.2	0.95	**1512.1**	ULS 1a_0_9_0_9_90	1853.6	2711.0	2985.2	0.82

DNV GL Nederlands BV. Project: "S_c config"
Tower Version 16.80, 9:10:51 AM Tuesday, May 4, 2021
Undeformed geometry displayed



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

1 (m)

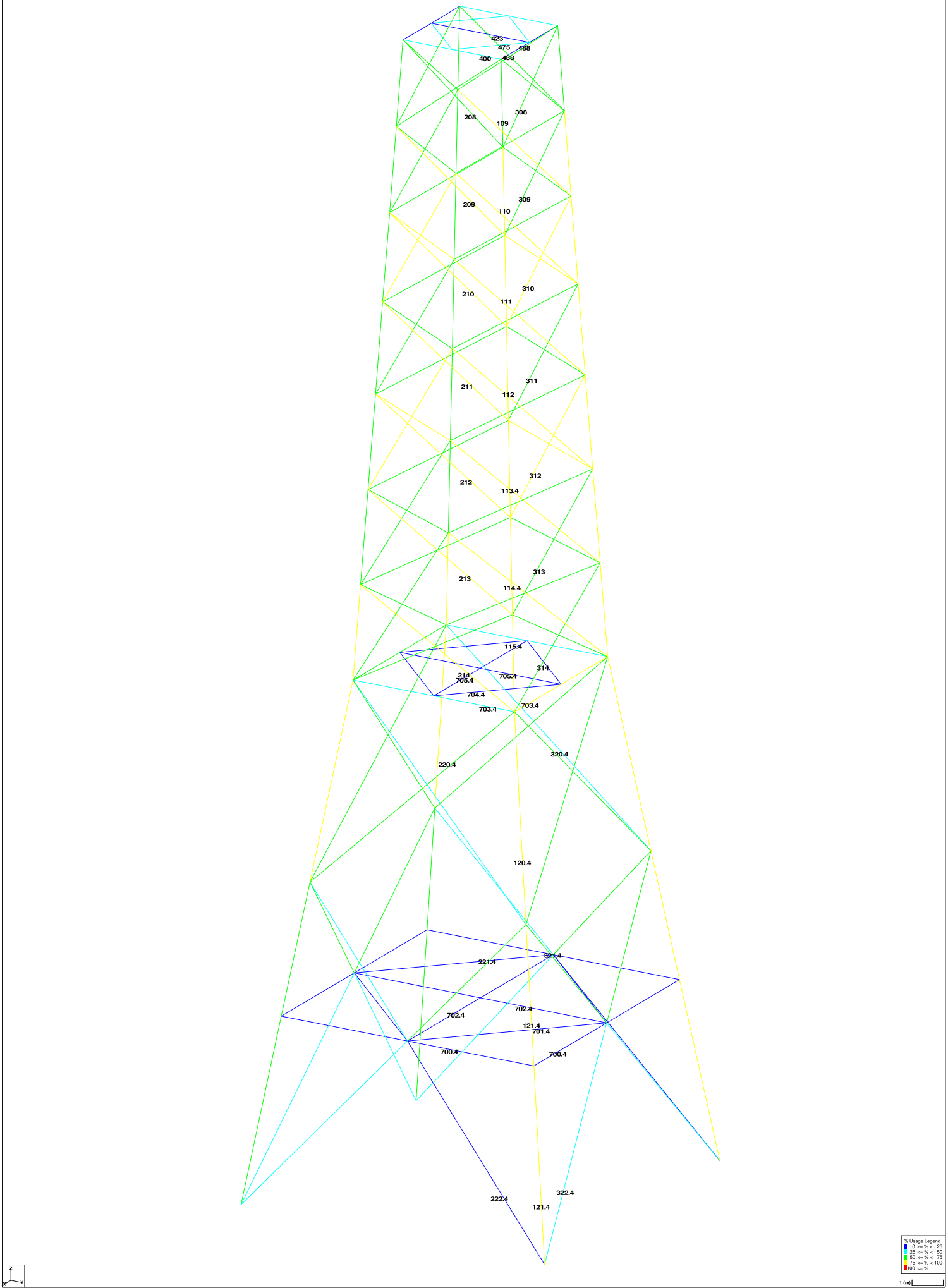
Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+3_c

Group Label	Description	Type	Profile	Steel Qual	Bolts	#sh.pl	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
109	Main leg	EA	180x180x16	S355	6M24-8.8t	2	55	40	80	0.52	0.52	0.52	43	**-1081.3**	ULS 1a_135	1734.9	1626.6	1693.4	0.66	**841.1**	ULS 1a_0,9_0,9_90	1661.0	1626.6	1592.1	0.53
110	Main leg	EA	180x180x16	S355						0.52	0.52	0.52	43	**-1288.0**	ULS 1a_135	1734.9	0.0	0.0	0.74	**1024.5**	ULS 1a_0,9_0,9_90	1966.7	0.0	0.0	0.52
111	Main leg	EA	180x180x16	S355	8M24-8.8t	2	55	40	80	0.52	0.52	0.52	44	**-1409.5**	ULS 1a_135	1719.5	2168.8	2257.9	0.82	**1160.9**	ULS 1a_0,9_0,9_90	1661.0	2168.8	2122.8	0.70
112	Main leg	EA	180x180x18	S355						0.50	0.50	0.50	44	**-1578.4**	ULS 1a_135	1923.2	0.0	0.0	0.82	**1304.1**	ULS 1a_0,9_0,9_90	2197.5	0.0	0.0	0.59
208	Diag front face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	127	**-167.1**	ULS 1a_90	230.8	271.1	352.8	0.72	**144.9**	ULS 1a_90	305.3	271.1	329.6	0.53
209	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	133	**-135.2**	ULS 1a_90	175.7	271.1	282.2	0.77	**148.6**	ULS 1a_90	246.8	271.1	263.7	0.60
210	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	141	**-137.7**	ULS 1a_90	162.1	271.1	282.2	0.85	**124.8**	ULS 1a_90	246.8	271.1	263.7	0.51
211	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	150	**-122.3**	ULS 1a_90	149.6	271.1	282.2	0.82	**127.8**	ULS 1a_90	246.8	271.1	263.7	0.52
212	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	159	**-122.1**	ULS 1a_90	138.0	271.1	282.2	0.89	**112.7**	ULS 1a_90	246.8	271.1	263.7	0.46
213	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	167	**-108.2**	ULS 1a_90	128.9	271.1	282.2	0.84	**112.9**	ULS 1a_90	246.8	271.1	263.7	0.46
308	Diag side face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	127	**-145.9**	ULS 5a Ah 11	230.8	271.1	352.8	0.63	**145.7**	ULS 5a Ah 11	305.3	271.1	329.6	0.54
309	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	133	**-130.0**	ULS 5a Ah 11	175.7	271.1	282.2	0.74	**133.2**	ULS 5a Ah 11	246.8	271.1	263.7	0.54
310	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	141	**-122.2**	ULS 5a Ah 11	162.1	271.1	282.2	0.75	**118.3**	ULS 5a Ah 11	246.8	271.1	263.7	0.48
311	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	150	**-109.2**	ULS 5a Ah 11	149.6	271.1	282.2	0.73	**111.9**	ULS 5a Ah 11	246.8	271.1	263.7	0.45
312	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	159	**-103.6**	ULS 5a Ah 11	138.0	271.1	282.2	0.75	**100.1**	ULS 5a Ah 11	246.8	271.1	263.7	0.41
313	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	167	**-91.8**	ULS 5a Ah 11	128.9	271.1	282.2	0.71	**95.6**	ULS 5a Ah 11	246.8	271.1	263.7	0.39
214	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	175	**-109.4**	ULS 1a_90	120.6	271.1	282.2	0.91	**96.1**	ULS 1a_90	246.8	271.1	263.7	0.39
314	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	175	**-89.8**	ULS 5a Ah 11	120.6	271.1	282.2	0.74	**82.6**	ULS 5a Ah 11	246.8	271.1	263.7	0.33
703.3	Hor plan bracing tussenstuk	EA	120x120x10	S355	2M24-8.8t	1	55	50	80	1.00	2.00	1.00	161	**-169.9**	ULS 1a_90	192.8	271.1	352.8	0.88	**125.8**	ULS 1a_0,9_0,9_90	341.6	271.1	224.6	0.56
704.3	Diag plan bracing tussenstuk	EA	90x90x8	S355	1M20-8.8t	1	45	35		1.00	1.00	1.00	238	**-3.9**	ULS 1a_135	54.0	94.1	117.6	0.07	**6.6**	ULS 1a_135	150.5	94.1	106.9	0.07
705.3	Mid hor plan bracing tussenstuk	DEA	70x70x6 (not cou	S355	1M20-8.8t	1	45	35		0.50	0.50	0.50	216	**-0.1**	ULS 1a_90	82.3	94.1	88.2	0.00	**0.0**		112.9	94.1	80.2	0.00
120.3	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.29	0.29	0.29	43	**-1986.1**	ULS 1a_45	2157.7	2711.0	3175.2	0.92	**1643.1**	ULS 1a_0,9_0,9_90	2107.6	2711.0	2985.2	0.78
121.3	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.50	0.50	0.50	49	**-1879.9**	ULS 1a_45	2087.5	2711.0	3175.2	0.90	**1513.7**	ULS 1a_0,9_0,9_90	2107.6	2711.0	2985.2	0.72
220.3	Diag front face	EA	100x100x10	S355	2M24-8.8t	1	55	50	80	0.57	0.29	0.29	167	**-93.8**	ULS 1a_0,9_0,9_90	152.3	271.1	352.8	0.62	**92.9**	ULS 1a_0,9_0,9_90	305.3	271.1	331.7	0.34
221.3	Diag front face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	1.00	0.50	0.50	176	**-78.3**	ULS 1a_0,9_0,9_90	141.3	271.1	352.8	0.55	**72.9**	ULS 1a_0,9_0,9_90	305.3	271.1	329.6	0.27
222.3	Diag front face	EA	140x140x13	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	167	**-68.6**	ULS 1a_0,9_0,9_90	278.2	271.1	458.6	0.25	**57.5**	ULS 1a_0,9_0,9_90	585.4	271.1	428.5	0.21
320.3	Diag side face	EA	100x100x10	S355	2M24-8.8t	1	55	50	80	0.57	0.29	0.29	167	**-87.1**	ULS 5a Ah 21	152.3	271.1	352.8	0.57	**89.0**	ULS 5a Ba 11	305.3	271.1	331.7	0.33
321.3	Diag side face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	1.00	0.50	0.50	176	**-74.7**	ULS 5a Ba 11	141.3	271.1	352.8	0.53	**69.7**	ULS 5a Ah 21	305.3	271.1	329.6	0.26
322.3	Diag side face	EA	140x140x13	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	167	**-77.4**	ULS 5a Ba 11	278.2	271.1	458.6	0.29	**65.9**	ULS 5a Ah 21	585.4	271.1	428.5	0.24
700.3	Hor plan bracing broekstuk	EA	90x90x8	S355	1M20-8.8t	1	45	35		1.00	1.00	1.00	248	**-11.2**	ULS 1a_0,9_0,9_135	56.7	94.1	117.6	0.20	**4.0**	ULS 1a_0,9_0,9_135	150.5	94.1	106.9	0.04
701.3	Diag plan bracing broekstuk	EA	90x90x8	S355	1M20-8.8t	1	45	35		1.00	0.50	0.50	226	**-3.2**	ULS 1a_135	49.6	94.1	117.6	0.06	**4.2**	ULS 1a_0,9_0,9_45	150.5	94.1	106.9	0.04
702.3	Mid hor plan bracing broekstuk	DEA	90x90x8 (not cou	S355	1M16-8.8t	1	35	40		0.50	0.50	0.50	248	**-0.6**	ULS 1a_90	113.3	60.3	94.1	0.01	**0.0**		194.4	60.3	81.3	0.00
113.3	Main leg	EA	180x180x18	S355						0.52	0.52	0.52	47	**-1686.1**	ULS 1a_135	1884.1	0.0	0.0	0.89	**1415.4**	ULS 1a_0,9_0,9_90	2197.5	0.0	0.0	0.64
114.3	Main leg	EA	200x200x18	S355						0.52	0.52	0.52	43	**-1832.6**	ULS 1a_135	2164.6	0.0	0.0	0.85	**1542.7**	ULS 1a_0,9_0,9_90	2453.1	0.0	0.0	0.63
115.3	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.52	0.52	0.52	43	**-1909.9**	ULS 1a_45	2164.6	2711.0	3175.2	0.88	**1621.6**	ULS 1a_0,9_0,9_90	2107.6	2711.0	2985.2	0.77

DNV GL Nederlands BV, Project: *S_c config*
Tower Version 16.80, 10:07:47 AM Tuesday, May 4, 2021
Undeformed geometry displayed



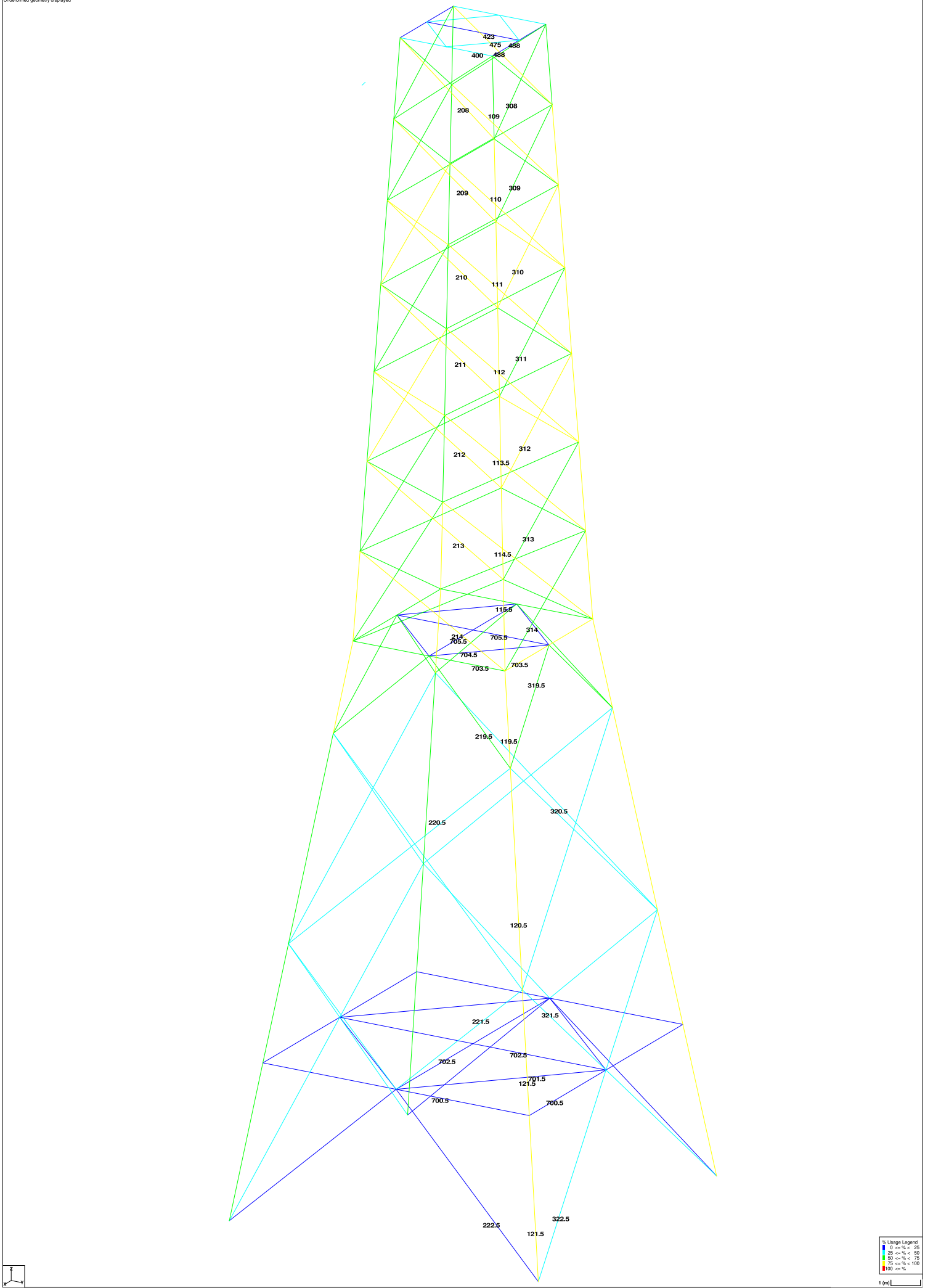
Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+6_c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.pl	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
109	Main leg	EA	180x180x16	S355	6M24-8.8t	2	55	40	80	0.52	0.52	0.52	43	**-1096.5**	ULS 1a_135	1734.9	1626.6	1693.4	0.67	**862.5**	ULS 1a_0_9_0_9_90	1661.0	1626.6	1592.1	0.54
110	Main leg	EA	180x180x16	S355						0.52	0.52	0.52	43	**-1307.7**	ULS 1a_135	1734.9	0.0	0.0	0.75	**1050.6**	ULS 1a_0_9_0_9_90	1966.7	0.0	0.0	0.53
111	Main leg	EA	180x180x16	S355	8M24-8.8t	2	55	40	80	0.52	0.52	0.52	44	**-1432.0**	ULS 1a_135	1719.5	2168.8	2257.9	0.83	**1190.1**	ULS 1a_0_9_0_9_90	1661.0	2168.8	2122.8	0.72
112	Main leg	EA	180x180x18	S355						0.50	0.50	0.50	44	**-1604.7**	ULS 1a_135	1923.2	0.0	0.0	0.83	**1337.0**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.61
208	Diag front face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	127	**-170.8**	ULS 1a_90	230.8	271.1	352.8	0.74	**148.6**	ULS 1a_90	305.3	271.1	329.6	0.55
209	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	133	**-138.6**	ULS 1a_90	175.7	271.1	282.2	0.79	**151.9**	ULS 1a_90	246.8	271.1	263.7	0.62
210	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	141	**-140.9**	ULS 1a_90	162.1	271.1	282.2	0.87	**127.9**	ULS 1a_90	246.8	271.1	263.7	0.52
211	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	150	**-125.3**	ULS 1a_90	149.6	271.1	282.2	0.84	**130.8**	ULS 1a_90	246.8	271.1	263.7	0.53
212	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	159	**-125.1**	ULS 1a_90	138.0	271.1	282.2	0.91	**115.4**	ULS 1a_90	246.8	271.1	263.7	0.47
213	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	167	**-110.9**	ULS 1a_90	128.9	271.1	282.2	0.86	**115.7**	ULS 1a_90	246.8	271.1	263.7	0.47
308	Diag side face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	127	**-145.9**	ULS 5a Ah 11	230.8	271.1	352.8	0.63	**145.7**	ULS 5a Ah 11	305.3	271.1	329.6	0.54
309	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	133	**-130.0**	ULS 5a Ah 11	175.7	271.1	282.2	0.74	**133.2**	ULS 5a Ah 11	246.8	271.1	263.7	0.54
310	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	141	**-122.2**	ULS 5a Ah 11	162.1	271.1	282.2	0.75	**118.3**	ULS 5a Ah 11	246.8	271.1	263.7	0.48
311	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	150	**-109.1**	ULS 5a Ah 11	149.6	271.1	282.2	0.73	**111.9**	ULS 5a Ah 11	246.8	271.1	263.7	0.45
312	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	159	**-103.6**	ULS 5a Ah 11	138.0	271.1	282.2	0.75	**100.1**	ULS 5a Ah 11	246.8	271.1	263.7	0.41
313	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	167	**-91.8**	ULS 5a Ah 11	128.9	271.1	282.2	0.71	**95.7**	ULS 5a Ah 11	246.8	271.1	263.7	0.39
214	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	175	**-112.4**	ULS 1a_90	120.6	271.1	282.2	0.93	**98.5**	ULS 1a_90	246.8	271.1	263.7	0.40
314	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	175	**-89.9**	ULS 5a Ah 11	120.6	271.1	282.2	0.75	**82.5**	ULS 5a Ah 11	246.8	271.1	263.7	0.33
120.4	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.29	0.29	0.29	51	**-2028.2**	ULS 1a_45	2053.5	2711.0	3175.2	0.99	**1680.9**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.80
121.4	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.33	0.33	0.33	54	**-1904.3**	ULS 1a_45	2006.9	2711.0	3175.2	0.95	**1527.3**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.72
220.4	Diag front face	EA	110x110x10	S355	2M24-8.8t	1	55	50	80	0.58	0.29	0.29	167	**-99.0**	ULS 1a_0_9_0_9_90	167.6	271.1	352.8	0.59	**99.9**	ULS 1a_0_9_0_9_90	340.7	271.1	331.7	0.37
221.4	Diag front face	EA	110x110x10	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	178	**-80.5**	ULS 1a_0_9_0_9_90	152.9	271.1	352.8	0.53	**72.5**	ULS 1a_0_9_0_9_90	340.7	271.1	329.6	0.27
222.4	Diag front face	EA	160x160x15	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	172	**-69.6**	ULS 1a_0_9_0_9_90	356.1	271.1	529.2	0.26	**56.7**	ULS 5a Ba 21	787.4	271.1	494.4	0.21
320.4	Diag side face	EA	110x110x10	S355	2M24-8.8t	1	55	50	80	0.58	0.29	0.29	167	**-90.0**	ULS 5a Ah 21	167.6	271.1	352.8	0.54	**94.6**	ULS 5a Ba 11	340.7	271.1	331.7	0.35
321.4	Diag side face	EA	110x110x10	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	178	**-77.0**	ULS 5a Ba 11	152.9	271.1	352.8	0.50	**69.7**	ULS 5a Ah 21	340.7	271.1	329.6	0.26
322.4	Diag side face	EA	160x160x15	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	172	**-80.5**	ULS 5a Ba 11	356.1	271.1	529.2	0.30	**65.5**	ULS 5a Ah 21	787.4	271.1	494.4	0.24
700.4	Hor plan bracing broekstuk	EA	100x100x8	S355	1M20-8.8t	1	45	35		1.00	1.00	1.00	236	**-11.5**	ULS 1a_0_9_0_9_135	68.4	94.1	117.6	0.17	**3.3**	ULS 1a_0_9_0	150.5	94.1	106.9	0.04
701.4	Diag plan bracing broekstuk	EA	90x90x8	S355	1M20-8.8t	1	45	35		1.00	0.50	0.50	239	**-3.9**	ULS 1a_135	45.6	94.1	117.6	0.08	**5.1**	ULS 1a_0_9_0_9_45	150.5	94.1	106.9	0.05
702.4	Mid hor plan bracing broekstuk	DEA	100x100x10 (not	S355	1M16-8.8t	1	35	40		0.50	0.50	0.50	238	**-0.9**	ULS 1a_90	168.0	60.3	117.6	0.01	**0.0**		243.0	60.3	101.6	0.00
703.4	Hor plan bracing tussenstuk	EA	120x120x10	S355	2M24-8.8t	1	55	50	80	1.00	2.00	1.00	161	**-184.0**	ULS 1a_90	192.8	271.1	352.8	0.95	**134.6**	ULS 1a_0_9_0_9_90	341.6	271.1	224.6	0.60
704.4	Diag plan bracing tussenstuk	EA	90x90x8	S355	1M20-8.8t	1	45	35		1.00	1.00	1.00	238	**-4.3**	ULS 1a_135	54.0	94.1	117.6	0.08	**7.1**	ULS 1a_135	150.5	94.1	106.9	0.08
705.4	Mid hor plan bracing tussenstuk	DEA	70x70x6 (not cou	S355	1M20-8.8t	1	45	35		0.50	0.50	0.50	216	**-0.1**	ULS 1a_90	82.3	94.1	88.2	0.00	**0.0**		112.9	94.1	80.2	0.00
113.4	Main leg	EA	180x180x18	S355						0.52	0.52	0.52	47	**-1715.4**	ULS 1a_90	1884.1	0.0	0.0	0.91	**1450.8**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.66
114.4	Main leg	EA	200x200x18	S355						0.52	0.52	0.52	43	**-1868.3**	ULS 1a_90	2164.6	0.0	0.0	0.86	**1581.6**	ULS 1a_0_9_0_9_90	2453.1	0.0	0.0	0.64
115.4	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.52	0.52	0.52	43	**-1949.6**	ULS 1a_90	2164.6	2711.0	3175.2	0.90	**1662.2**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.79

DNV GL Nederlands BV, Project: *S_c config*
Tower Version 16.80, 10:21:26 AM Tuesday, May 4, 2021
Undeformed geometry displayed



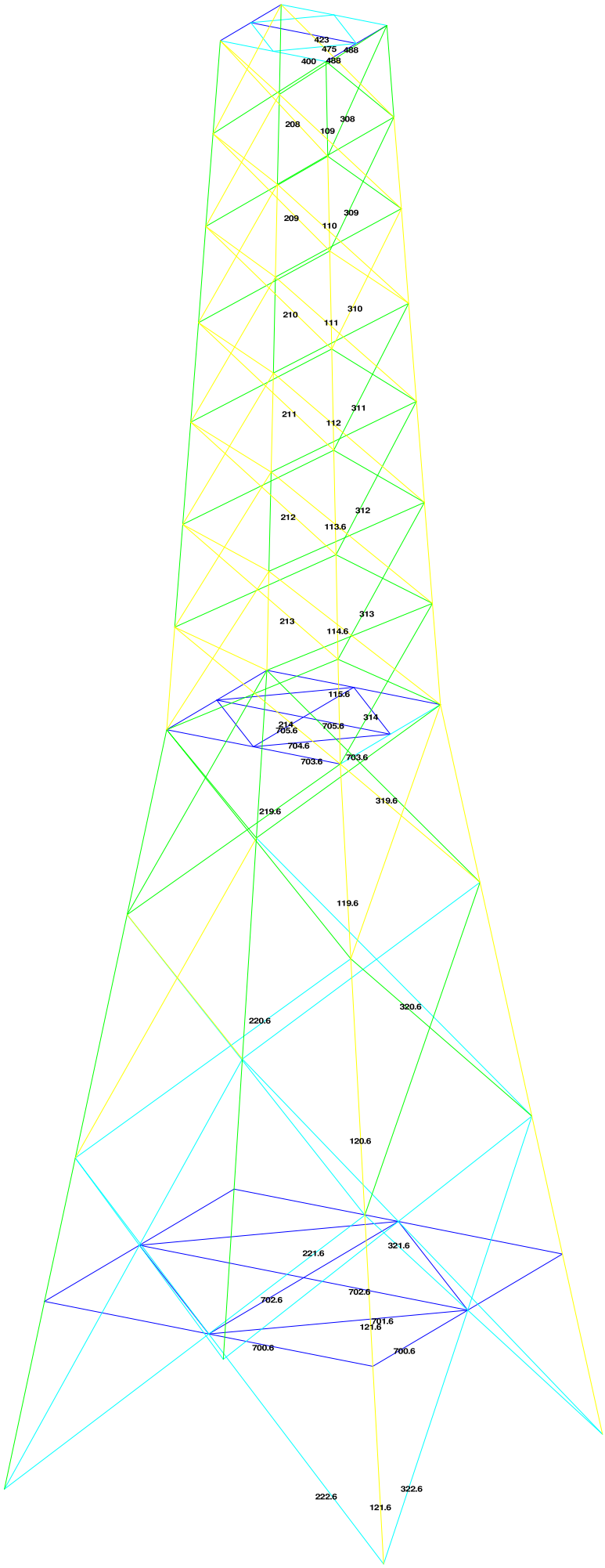
Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+9_c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.	pl e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
109	Main leg	EA	180x180x16	S355	6M24-8.8t	2	55	40	80	0.52	0.52	0.52	43	**-1114.1**	ULS 1a_135	1734.9	1626.6	1693.4	0.68	**854.8**	ULS 1a_0_9_0_9_90	1661.0	1626.6	1592.1	0.54
110	Main leg	EA	180x180x16	S355						0.52	0.52	0.52	43	**-1330.0**	ULS 1a_135	1734.9	0.0	0.0	0.77	**1046.1**	ULS 1a_0_9_0_9_90	1966.7	0.0	0.0	0.53
111	Main leg	EA	180x180x16	S355	8M24-8.8t	2	55	40	80	0.52	0.52	0.52	44	**-1454.6**	ULS 1a_135	1719.5	2168.8	2257.9	0.85	**1188.6**	ULS 1a_0_9_0_9_90	1661.0	2168.8	2122.8	0.72
112	Main leg	EA	180x180x18	S355						0.50	0.50	0.50	44	**-1631.7**	ULS 1a_135	1923.2	0.0	0.0	0.85	**1338.6**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.61
208	Diag front face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	127	**-174.6**	ULS 1a_90	230.8	271.1	352.8	0.76	**150.9**	ULS 1a_90	305.3	271.1	329.6	0.56
209	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	133	**-140.8**	ULS 1a_90	175.7	271.1	282.2	0.80	**155.3**	ULS 1a_90	246.8	271.1	263.7	0.63
210	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	141	**-144.0**	ULS 1a_90	162.1	271.1	282.2	0.89	**129.9**	ULS 1a_90	246.8	271.1	263.7	0.53
211	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	150	**-127.3**	ULS 1a_90	149.6	271.1	282.2	0.85	**133.7**	ULS 1a_90	246.8	271.1	263.7	0.54
212	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	159	**-127.9**	ULS 1a_90	138.0	271.1	282.2	0.93	**117.2**	ULS 1a_90	246.8	271.1	263.7	0.47
213	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	167	**-113.0**	ULS 1a_90	128.9	271.1	282.2	0.88	**118.5**	ULS 1a_90	246.8	271.1	263.7	0.48
308	Diag side face	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	127	**-146.0**	ULS 5a Ah 11	230.8	271.1	352.8	0.63	**145.7**	ULS 5a Ah 11	305.3	271.1	329.6	0.54
309	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	133	**-129.9**	ULS 5a Ah 11	175.7	271.1	282.2	0.74	**133.4**	ULS 5a Ah 11	246.8	271.1	263.7	0.54
310	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	141	**-122.4**	ULS 5a Ah 11	162.1	271.1	282.2	0.76	**118.1**	ULS 5a Ah 11	246.8	271.1	263.7	0.48
311	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	150	**-108.9**	ULS 5a Ah 11	149.6	271.1	282.2	0.73	**112.1**	ULS 5a Ah 11	246.8	271.1	263.7	0.45
312	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	159	**-103.9**	ULS 5a Ah 11	138.0	271.1	282.2	0.75	**99.9**	ULS 5a Ah 11	246.8	271.1	263.7	0.40
313	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	167	**-91.6**	ULS 5a Ah 11	128.9	271.1	282.2	0.71	**95.8**	ULS 5a Ah 11	246.8	271.1	263.7	0.39
214	Diag front face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	175	**-112.4**	ULS 1a_90	120.6	271.1	282.2	0.93	**99.9**	ULS 1a_90	246.8	271.1	263.7	0.40
314	Diag side face	EA	100x100x8	S355	2M24-8.8t	1	55	40	80	0.52	0.52	0.52	175	**-89.3**	ULS 5a Ah 11	120.6	271.1	282.2	0.74	**83.4**	ULS 5a Ah 11	246.8	271.1	263.7	0.34
119.5	Main leg	EA	200x200x20	S355	10M24-8.8t	2	55	40	80	0.50	0.50	0.50	42	**-2095.1**	ULS 1a_45	2399.2	2711.0	3528.0	0.87	**1755.6**	ULS 1a_0_9_0_9_90	2328.5	2711.0	3316.9	0.75
120.5	Main leg	EA	200x200x20	S355	10M24-8.8t	2	55	40	80	0.29	0.29	0.29	56	**-2018.3**	ULS 1a_45	2186.7	2711.0	3528.0	0.92	**1614.5**	ULS 1a_0_9_0_9_90	2328.5	2711.0	3316.9	0.69
121.5	Main leg	EA	200x200x20	S355	10M24-8.8t	2	55	40	80	0.50	0.50	0.50	55	**-1946.3**	ULS 1a_45	2207.0	2711.0	3528.0	0.88	**1526.0**	ULS 1a_0_9_0_9_135	2328.5	2711.0	3316.9	0.66
219.5	Diag front face	EA	100x100x10	S355	2M24-8.8t	1	55	50	80	1.00	0.50	0.50	157	**-110.6**	ULS 1a_0_9_0_9_90	166.1	271.1	352.8	0.67	**100.3**	ULS 1a_0_9_0_9_90	305.3	271.1	331.7	0.37
220.5	Diag front face	EA	120x120x10	S355	2M24-8.8t	1	55	50	80	0.57	0.29	0.29	170	**-77.9**	ULS 1a_0_9_0_9_90	178.9	271.1	352.8	0.44	**79.9**	ULS 1a_0_9_0_9_90	378.9	271.1	331.7	0.29
221.5	Diag front face	EA	120x120x10	S355	2M24-8.8t	1	55	40	80	1.00	0.50	0.50	170	**-60.0**	ULS 1a_0_9_0_9_90	179.6	271.1	352.8	0.33	**52.8**	ULS 1a_0_9_0_9_90	378.9	271.1	329.6	0.19
222.5	Diag front face	EA	150x150x12	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	179	**-57.0**	ULS 5a Ba 21	250.0	271.1	423.4	0.23	**42.8**	ULS 5a Ba 21	582.7	271.1	395.5	0.16
319.5	Diag side face	EA	100x100x10	S355	2M24-8.8t	1	55	50	80	1.00	0.50	0.50	157	**-109.3**	ULS 5a Ah 21	166.1	271.1	352.8	0.66	**97.4**	ULS 5a Ah 21	305.3	271.1	331.7	0.36
320.5	Diag side face	EA	120x120x10	S355	2M24-8.8t	1	55	50	80	0.57	0.29	0.29	170	**-75.0**	ULS 5a Ah 21	178.9	271.1	352.8	0.42	**81.7**	ULS 5a Ah 21	378.9	271.1	331.7	0.30
321.5	Diag side face	EA	120x120x10	S355	2M24-8.8t	1	55	40	80	1.00	0.50	0.50	170	**-63.0**	ULS 5a Ah 21	179.6	271.1	352.8	0.35	**55.2**	ULS 5a Ah 21	378.9	271.1	329.6	0.20
322.5	Diag side face	EA	150x150x12	S355	2M24-8.8t	1	55	40	80	1.00	0.33	0.33	179	**-66.6**	ULS 5a Ah 21	250.0	271.1	423.4	0.27	**51.1**	ULS 5a Ah 21	582.7	271.1	395.5	0.19
700.5	Hor plan bracing broekstuk	EA	110x110x10	S355	1M20-8.8t	1	45	35		1.00	1.00	1.00	240	**-9.3**	ULS 1a_0_9_0_9_135	90.8	94.1	147.0	0.10	**2.8**	ULS 1a_0_9_0	188.2	94.1	133.6	0.03
701.5	Diag plan bracing broekstuk	EA	100x100x8	S355	1M20-8.8t	1	45	35		1.00	0.50	0.50	240	**-3.3**	ULS 1a_135	50.6	94.1	117.6	0.07	**4.3**	ULS 1a_0_9_45	150.5	94.1	106.9	0.05
702.5	Mid hor plan bracing broekstuk	DEA	110x110x10 (not	S355	1M16-8.8t	1	35	40		0.50	0.50	0.50	240	**-0.7**	ULS 1a_90	181.7	60.3	117.6	0.01	**0.0**		243.0	60.3	101.6	0.00
703.5	Hor plan bracing tussenstuk	EA	100x100x10	S355	2M24-8.8t	1	45	35	70	1.00	1.00	1.00	152	**-170.4**	ULS 1a_90	181.9	271.1	352.8	0.94	**131.3**	ULS 1a_0_9_0_9_90	275.3	271.1	224.6	0.58
704.5	Diag plan bracing tussenstuk	EA	90x90x8	S355	1M20-8.8t	1	45	35		1.00	1.00	1.00	238	**-5.5**	ULS 1a_135	54.0	94.1	117.6	0.10	**10.9**	ULS 1a_0_9_135	150.5	94.1	106.9	0.12
705.5	Mid hor plan bracing tussenstuk	DEA	70x70x6 (not cou	S355	1M20-8.8t	1	45	35		0.50	0.50	0.50	216	**-0.8**	ULS 7	82.3	94.1	88.2	0.01	**0.0**		112.9	94.1	80.2	0.00
113.5	Main leg	EA	180x180x18	S355						0.52	0.52	0.52	47	**-1741.6**	ULS 1a_135	1884.1	0.0	0.0	0.92	**1454.4**	ULS 1a_0_9_0_9_90	2197.5	0.0	0.0	0.66
114.5	Main leg	EA	200x200x18	S355						0.52	0.52	0.52	43	**-1895.9**	ULS 1a_135	2164.6	0.0	0.0	0.88	**1588.7**	ULS 1a_0_9_0_9_90	2453.1	0.0	0.0	0.65
115.5	Main leg	EA	200x200x18	S355	10M24-8.8t	2	55	40	80	0.52	0.52	0.52	43	**-1976.5**	ULS 1a_45	2164.6	2711.0	3175.2	0.91	**1669.9**	ULS 1a_0_9_0_9_90	2107.6	2711.0	2985.2	0.79

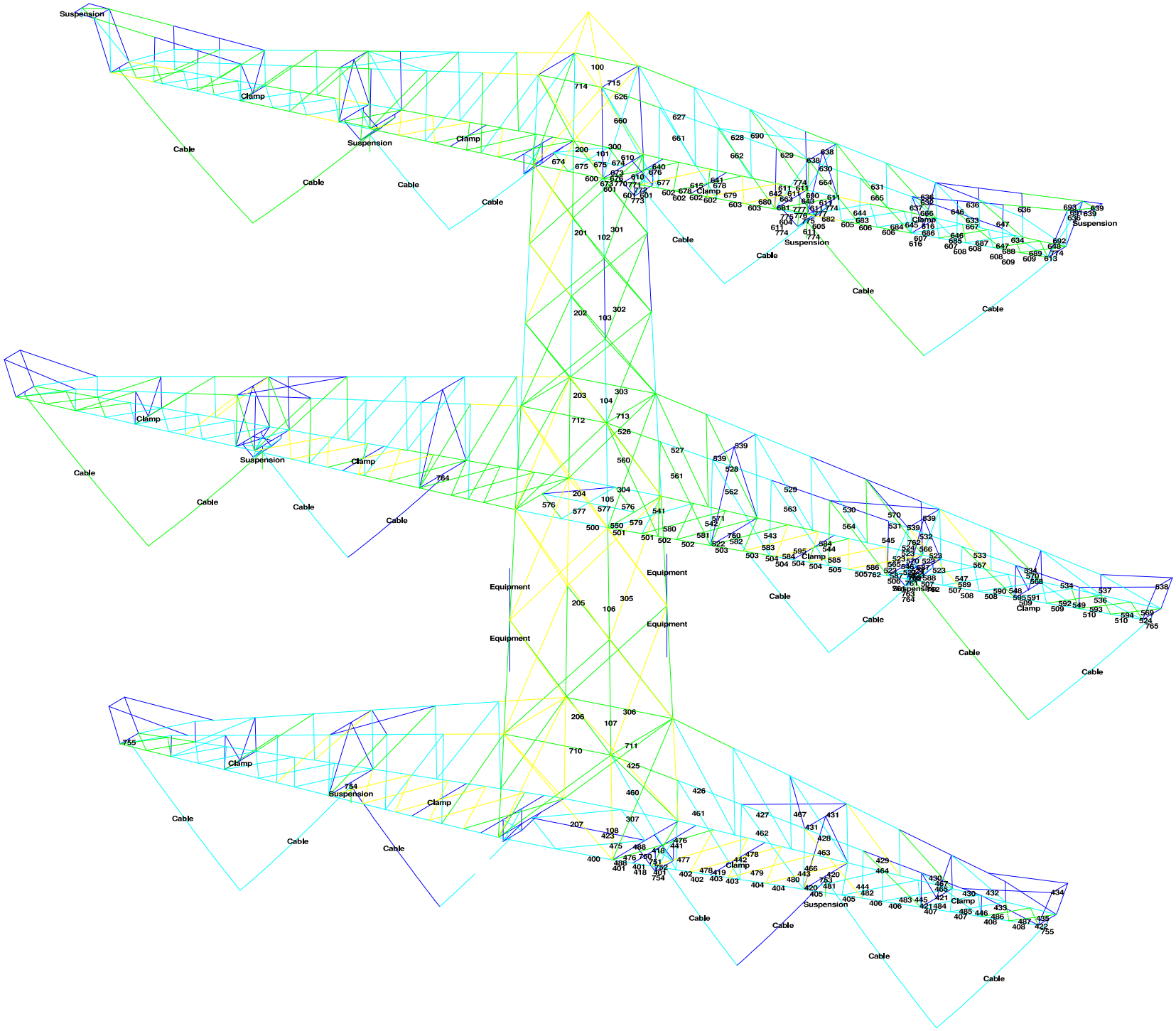
DNV GL Nederlands BV. Project: "S_c config"
Tower Version 16.80, 8:52:49 AM Tuesday, May 4, 2021
Undeformed geometry displayed



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

1 (m)

DNV GL Nederlands BV , Project: "S_c config"
Tower Version 16.80 , 7:46:16 AM Tuesday, May 4, 2021
Undeformed geometry displayed



Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+12_c(full_summary)

Group Label	Description	Type	Profile	Steel	Quali	Bolts	#sh	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
109	Main leg	EA	180x180x16	S355		6M24-8.8t	2	55	40	80		0.52	0.52	0.52	43	**-1162.2**	ULS 1a_135	1734.9	1626.6	1693.4	0.71	**860.3**	ULS 1a_0,9_0,9_90	1661.0	1626.6	1592.1	0.54
110	Main leg	EA	180x180x16	S355								0.52	0.52	0.52	43	**-1384.6**	ULS 1a_135	1734.9	0.0	0.0	0.80	**1056.0**	ULS 1a_0,9_0,9_90	1966.7	0.0	0.0	0.54
111	Main leg	EA	180x180x16	S355		8M24-8.8t	2	55	40	80		0.52	0.52	0.52	44	**-1519.3**	ULS 1a_135	1719.5	2168.8	2257.9	0.88	**1205.5**	ULS 1a_0,9_0,9_90	1661.0	2168.8	2122.8	0.73
112	Main leg	EA	180x180x18	S355								0.50	0.50	0.50	44	**-1700.1**	ULS 1a_135	1923.2	0.0	0.0	0.88	**1358.6**	ULS 1a_0,9_0,9_90	2197.5	0.0	0.0	0.62
208	Diag front face	EA	100x100x10	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	127	**-189.4**	ULS 8 Ah_bouwfase	230.8	271.1	352.8	0.82	**163.9**	ULS 8 Ah_bouwfase	305.3	271.1	329.6	0.60
209	Diag front face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	133	**-150.8**	ULS 8 Ah_bouwfase	175.7	271.1	282.2	0.86	**168.7**	ULS 8 Ah_bouwfase	246.8	271.1	263.7	0.68
210	Diag front face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	141	**-153.5**	ULS 8 Ah_bouwfase	162.1	271.1	282.2	0.95	**139.3**	ULS 8 Ah_bouwfase	246.8	271.1	263.7	0.56
211	Diag front face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	150	**-132.4**	ULS 1a_90	149.6	271.1	282.2	0.89	**140.3**	ULS 8 Ah_bouwfase	246.8	271.1	263.7	0.57
212	Diag front face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	159	**-132.0**	ULS 1a_90	138.0	271.1	282.2	0.96	**122.5**	ULS 1a_90	246.8	271.1	263.7	0.50
213	Diag front face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	167	**-118.3**	ULS 1a_90	128.9	271.1	282.2	0.92	**121.8**	ULS 1a_90	246.8	271.1	263.7	0.49
300	Diag side face	EA	70x70x6	S355		2M20-8.8t	1	45	35	70		1.00	0.52	0.52	157	**-39.1**	ULS 3_90_bouwfase	69.5	188.2	176.4	0.56	**35.9**	ULS 5a Ah 12	128.1	188.2	160.4	0.28
308	Diag side face	EA	100x100x10	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	127	**-194.5**	ULS 8 Ba_bouwfase	230.8	271.1	352.8	0.84	**182.1**	ULS 8 Ah_bouwfase	305.3	271.1	329.6	0.67
309	Diag side face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	133	**-163.7**	ULS 8 Ba_bouwfase	175.7	271.1	282.2	0.93	**176.1**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.71
310	Diag side face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	141	**-160.4**	ULS 8 Ba_bouwfase	162.1	271.1	282.2	0.99	**149.6**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.61
311	Diag side face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	150	**-138.1**	ULS 8 Ba_bouwfase	149.6	271.1	282.2	0.92	**146.4**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.59
312	Diag side face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	159	**-134.9**	ULS 8 Ba_bouwfase	138.0	271.1	282.2	0.98	**127.0**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.51
313	Diag side face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	167	**-116.6**	ULS 8 Ba_bouwfase	128.9	271.1	282.2	0.90	**124.1**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.50
214	Diag front face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	175	**-118.2**	ULS 1a_90	120.6	271.1	282.2	0.98	**106.8**	ULS 1a_90	246.8	271.1	263.7	0.43
314	Diag side face	EA	100x100x8	S355		2M24-8.8t	1	55	40	80		0.52	0.52	0.52	175	**-114.9**	ULS 8 Ba_bouwfase	120.6	271.1	282.2	0.95	**106.1**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.43
119.6	Main leg	EA	200x200x20	S355		10M24-8.8t	2	55	40	80		0.29	0.29	0.29	43	**-2039.2**	ULS 1a_45	2388.8	2711.0	3528.0	0.85	**1663.1**	ULS 1a_0,9_0,9_135	2328.5	2711.0	3316.9	0.71
120.6	Main leg	EA	200x200x20	S355		10M24-8.8t	2	55	40	80		0.22	0.22	0.22	43	**-2170.9**	ULS 1a_45	2389.9	2711.0	3528.0	0.91	**1709.6**	ULS 1a_0,9_0,9_135	2328.5	2711.0	3316.9	0.73
121.6	Main leg	EA	200x200x20	S355		10M24-8.8t	2	55	40	80		0.33	0.33	0.33	50	**-1984.8**	ULS 1a_45	2288.8	2711.0	3528.0	0.87	**1546.4**	ULS 1a_0,9_0,9_135	2328.5	2711.0	3316.9	0.66
219.6	Diag front face	EA	130x130x12	S355		2M24-8.8t	1	55	50	80		0.29	0.57	0.29	128	**-167.4**	ULS 8 Ah_bouwfase	338.3	271.1	423.4	0.62	**93.5**	ULS 8 Ah_bouwfase	494.4	271.1	398.0	0.35
220.6	Diag front face	EA	130x130x12	S355		2M24-8.8t	1	55	50	80		1.00	0.57	0.22	292	**-43.5**	ULS 1a_0,9_0,9_0	101.3	271.1	423.4	0.43	**130.5**	ULS 8 Ah_bouwfase	494.4	271.1	398.0	0.48
221.6	Diag front face	EA	130x130x12	S355		2M24-8.8t	1	55	40	80		0.33	1.00	0.33	168	**-102.7**	ULS 8 Ah_bouwfase	236.1	271.1	423.4	0.43	**57.0**	ULS 8 Ah_bouwfase	494.4	271.1	395.5	0.21
222.6	Diag front face	EA	160x160x15	S355		2M24-8.8t	1	55	40	80		0.33	1.00	0.33	178	**-102.4**	ULS 8 Ah_bouwfase	339.0	271.1	529.2	0.38	**56.8**	ULS 8 Ah_bouwfase	787.4	271.1	494.4	0.21
319.6	Diag side face	EA	130x130x12	S355		2M24-8.8t	1	55	50	80		1.00	0.57	0.29	224	**-151.9**	ULS 1a_90	154.1	271.1	423.4	0.99	**131.4**	ULS 8 Ba_bouwfase	494.4	271.1	398.0	0.48
320.6	Diag side face	EA	130x130x12	S355		2M24-8.8t	1	55	50	80		1.00	0.57	0.22	292	**-95.7**	ULS 1a_0,9_0,9_90	101.2	271.1	423.4	0.95	**117.3**	ULS 1a_90	494.4	271.1	398.0	0.43
321.6	Diag side face	EA	130x130x12	S355		2M24-8.8t	1	55	40	80		0.33	1.00	0.33	168	**-91.7**	ULS 1a_90	236.1	271.1	423.4	0.39	**80.6**	ULS 8 Ba_bouwfase	494.4	271.1	395.5	0.30
322.6	Diag side face	EA	160x160x15	S355		2M24-8.8t	1	55	40	80		0.33	1.00	0.33	178	**-99.6**	ULS 1a_90	339.0	271.1	529.2	0.37	**79.8**	ULS 8 Ah_bouwfase	787.4	271.1	494.4	0.29
700.6	Hor plan bracing broekstuk	EA	120x120x10	S355		1M20-8.8t	1	45	35			1.00	1.00	1.00	237	**-11.6**	ULS 1a_0,9_0,9_90	101.6	94.1	147.0	0.12	**5.1**	ULS 1a_0,9_0,9_0	188.2	94.1	133.6	0.05
701.6	Diag plan bracing broekstuk	EA	110x110x10	S355		1M20-8.8t	1	45	35			1.00	0.50	0.50	235	**-6.8**	ULS 1a_135	71.0	94.1	147.0	0.10	**7.9**	ULS 1a_0,9_0,9_45	188.2	94.1	133.6	0.08
702.6	Mid hor plan bracing broekstuk	DEA	120x120x10 (not	S355		1M16-8.8t	1	35	40			0.50	0.50	0.50	237	**-1.1**	ULS 1a_90	203.3	60.3	117.6	0.02	**0.0**		243.0	60.3	101.6	0.00
703.6	Hor plan bracing tussenstuk	EA	120x120x10	S355		2M24-8.8t	1	55	50	80		1.00	2.00	1.00	161	**-54.3**	ULS 1a_90	192.8	271.1	352.8	0.28	**39.9**	ULS 1a_0,9_0,9_90	341.6	271.1	224.6	0.18
704.6	Diag plan bracing tussenstuk	EA	90x90x8	S355		1M20-8.8t	1	45	35			1.00	1.00	1.00	238	**-5.1**	ULS 1a_135	54.0	94.1	117.6	0.09	**8.3**	ULS 1a_135	150.5	94.1	106.9	0.09
705.6	Mid hor plan bracing tussenstuk	DEA	70x70x6 (not co	S355		1M20-8.8t	1	45	35			0.50	0.50	0.50	216	**0.0**	ULS 1a_90	82.3	94.1	88.2	0.00	**0.0**	ULS 1a_0,9_0,9_90	112.9	94.1	80.2	0.00
113.6	Main leg	EA	180x180x18	S355								0.52	0.52	0.52	47	**-1822.4**	ULS 1a_135	1884.1	0.0	0.0	0.97	**1482.6**	ULS 1a_0,9_0,9_90	2197.5	0.0	0.0	0.67
114.6	Main leg	EA	200x200x18	S355								0.52	0.52	0.52	43	**-1976.8**	ULS 1a_135	2164.6	0.0	0.0	0.91	**1616.9**	ULS 1a_0,9_0,9_90	2453.1	0.0	0.0	0.66
115.6	Main leg	EA	200x200x18	S355		10M24-8.8t	2	55	40	80		0.52	0.52	0.52	43	**-2072.5**	ULS 1a_45	2164.6	2711.0	3175.2	0.96	**1710.8**	ULS 1a_0,9_0,9_90	2107.6	2711.0	2985.2	0.81

Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+12_c(full_summary)

Group Label	Description	Type	Profile	Steel	Quali	Bolts	#sh	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
100	Main leg	EA	80x80x6	S355		1M16-8.8t	1		35	30		1.00	1.00	1.00	139	**-47.0**	ULS 5a Ba 12_bouwfase	100.0	60.3	70.6	0.78	**47.0**	ULS 5a Ba 12_bouwfase	98.8	60.3	61.0	0.76
101	Main leg	EA	100x100x10	S355		4M24-8.8t	1		55	40		0.52	0.52	0.52	69	**-172.4**	ULS 3_90_bouwfase	486.3	542.2	705.6	0.35	**104.5**	ULS 3_90_bouwfase	493.9	542.2	663.4	0.21
102	Main leg	EA	120x120x12	S355		4M24-8.8t	1		55	40		0.52	0.52	0.52	51	**-316.9**	ULS 3_90_bouwfase	817.1	542.2	846.7	0.58	**215.3**	ULS 3_90_bouwfase	750.1	542.2	796.1	0.40
103	Main leg	EA	120x120x12	S355								0.52	0.52	0.52	51	**-342.5**	ULS 3_225_bouwfase	817.1	0.0	0.0	0.42	**225.6**	ULS 3_225_bouwfase	976.3	0.0	0.0	0.23
104	Main leg	EA	120x120x12	S355								0.52	0.52	0.52	53	**-336.2**	ULS 1a_225_bouwfase	804.0	0.0	0.0	0.42	**243.4**	ULS 1a_225_bouwfase	976.3	0.0	0.0	0.25
105	Main leg	EA	120x120x12	S355		6M24-8.8t	1		55	40	80	0.52	0.52	0.52	66	**-426.9**	ULS 1a_225_bouwfase	717.5	813.3	1270.1	0.60	**297.5**	ULS 1a_225_bouwfase	750.1	813.3	1194.1	0.40
106	Main leg	EA	150x150x14	S355		6M24-8.8t	1		55	40	80	0.52	0.52	0.52	57	**-663.8**	ULS 1a_225_bouwfase	1142.4	813.3	1481.8	0.82	**495.8**	ULS 1a_225_bouwfase	1159.3	813.3	1393.1	0.61
107	Main leg	EA	150x150x14	S355								0.52	0.52	0.52	58	**-802.3**	ULS 1a_225_bouwfase	1126.0	0.0	0.0	0.71	**599.0**	ULS 1a_225_bouwfase	1425.0	0.0	0.0	0.42
108	Main leg	EA	150x150x14	S355		6M24-8.8t	2		55	40	80	0.52	0.52	0.52	53	**-897.5**	ULS 1a_135	1174.0	1626.6	1481.8	0.76	**670.6**	ULS 1a_225_bouwfase	1159.3	1626.6	1393.1	0.58
109	Main leg	EA	180x180x16	S355		6M24-8.8t	2		55	40	80	0.52	0.52	0.52	43	**-1162.2**	ULS 1a_135	1734.9	1626.6	1693.4	0.71	**860.3**	ULS 1a_0,9_0,9_90	1661.0	1626.6	1592.1	0.54
110	Main leg	EA	180x180x16	S355								0.52	0.52	0.52	43	**-1384.6**	ULS 1a_135	1734.9	0.0	0.0	0.80	**1056.0**	ULS 1a_0,9_0,9_90	1966.7	0.0	0.0	0.54
111	Main leg	EA	180x180x16	S355		8M24-8.8t	2		55	40	80	0.52	0.52	0.52	44	**-1519.3**	ULS 1a_135	1719.5	2168.8	2257.9	0.88	**1205.5**	ULS 1a_0,9_0,9_90	1661.0	2168.8	2122.8	0.73
112	Main leg	EA	180x180x18	S355								0.50	0.50	0.50	44	**-1700.1**	ULS 1a_135	1923.2	0.0	0.0	0.88	**1358.6**	ULS 1a_0,9_0,9_90	2197.5	0.0	0.0	0.62
200	Diag front face	EA	90x90x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	99	**-179.2**	ULS 3_90_bouwfase	221.6	271.1	282.2	0.81	**165.8**	ULS 3_90_bouwfase	217.4	271.1	263.7	0.76
201	Diag front face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	86	**-190.0**	ULS 5a Ba 12_bouwfase	348.3	271.1	352.8	0.70	**186.7**	ULS 5a Ah 12	305.3	271.1	329.6	0.69
202	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	89	**-170.7**	ULS 5a Ah 12	273.4	271.1	282.2	0.63	**170.4**	ULS 5a Ba 12_bouwfase	246.8	271.1	263.7	0.69
203	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	94	**-156.8**	ULS 5a Ba 12_bouwfase	259.3	271.1	282.2	0.60	**157.9**	ULS 5a Ah 12	246.8	271.1	263.7	0.64
204	Diag front face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	110	**-180.2**	ULS 8 Ba_bouwfase	273.8	271.1	352.8	0.66	**240.5**	ULS 8 Ah_bouwfase	305.3	271.1	329.6	0.89
205	Diag front face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	118	**-208.4**	ULS 5a Ba 11_bouwfase	252.5	271.1	352.8	0.83	**171.6**	ULS 5a Ba 11_bouwfase	305.3	271.1	329.6	0.63
206	Diag front face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	124	**-158.2**	ULS 5a Ba 11_bouwfase	237.2	271.1	352.8	0.67	**188.9**	ULS 5a Ba 11_bouwfase	305.3	271.1	329.6	0.70
207	Diag front face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	123	**-157.7**	ULS 5a Ba 11_bouwfase	239.6	271.1	352.8	0.66	**214.8**	ULS 8 Ba_bouwfase	305.3	271.1	329.6	0.79
208	Diag front face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	127	**-189.4**	ULS 8 Ah_bouwfase	230.8	271.1	352.8	0.82	**163.9**	ULS 8 Ah_bouwfase	305.3	271.1	329.6	0.60
209	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	133	**-150.8**	ULS 8 Ah_bouwfase	175.7	271.1	282.2	0.86	**168.7**	ULS 8 Ah_bouwfase	246.8	271.1	263.7	0.68
210	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	141	**-153.5**	ULS 8 Ah_bouwfase	162.1	271.1	282.2	0.95	**139.3**	ULS 8 Ah_bouwfase	246.8	271.1	263.7	0.56
211	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	150	**-132.4**	ULS 1a_90	149.6	271.1	282.2	0.89	**140.3**	ULS 8 Ah_bouwfase	246.8	271.1	263.7	0.57
212	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	159	**-132.0**	ULS 1a_90	138.0	271.1	282.2	0.96	**122.5**	ULS 1a_90	246.8	271.1	263.7	0.50
213	Diag front face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	167	**-118.3**	ULS 1a_90	128.9	271.1	282.2	0.92	**121.8**	ULS 1a_90	246.8	271.1	263.7	0.49
300	Diag side face	EA	70x70x6	S355		2M20-8.8t	1		45	35	70	1.00	0.52	0.52	157	**-39.1**	ULS 3_90_bouwfase	69.5	188.2	176.4	0.56	**35.9**	ULS 5a Ah 12	128.1	188.2	160.4	0.28
301	Diag side face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	86	**-208.2**	ULS 5a Ba 12_bouwfase	348.3	271.1	352.8	0.77	**199.6**	ULS 5a Ba 22	305.3	271.1	329.6	0.74
302	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	89	**-180.3**	ULS 5a Ba 22	273.4	271.1	282.2	0.66	**188.2**	ULS 5a Ba 12_bouwfase	246.8	271.1	263.7	0.76
303	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	94	**-173.9**	ULS 5a Ba 12_bouwfase	259.3	271.1	282.2	0.67	**165.9**	ULS 5a Ba 22	246.8	271.1	263.7	0.67
304	Diag side face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	110	**-208.3**	ULS 5a Ah 12_bouwfase	273.8	271.1	352.8	0.77	**152.0**	ULS 5a Ba 22	305.3	271.1	329.6	0.56
305	Diag side face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	118	**-204.7**	ULS 8 Ah_bouwfase	252.5	271.1	352.8	0.81	**205.9**	ULS 5a Ah 11	305.3	271.1	329.6	0.76
306	Diag side face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	124	**-187.5**	ULS 5a Ah 11	237.2	271.1	352.8	0.79	**185.6**	ULS 8 Ah_bouwfase	305.3	271.1	329.6	0.68
307	Diag side face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	123	**-214.8**	ULS 8 Ah_bouwfase	239.6	271.1	352.8	0.90	**140.2**	ULS 5a Ba 21	305.3	271.1	329.6	0.52
308	Diag side face	EA	100x100x10	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	127	**-194.5**	ULS 8 Ba_bouwfase	230.8	271.1	352.8	0.84	**182.1**	ULS 8 Ah_bouwfase	305.3	271.1	329.6	0.67
309	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	133	**-163.7**	ULS 8 Ba_bouwfase	175.7	271.1	282.2	0.93	**176.1**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.71
310	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	141	**-160.4**	ULS 8 Ba_bouwfase	162.1	271.1	282.2	0.99	**149.6**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.61
311	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	150	**-138.1**	ULS 8 Ba_bouwfase	149.6	271.1	282.2	0.92	**146.4**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.59
312	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	159	**-134.9**	ULS 8 Ba_bouwfase	138.0	271.1	282.2	0.98	**127.0**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.51
313	Diag side face	EA	100x100x8	S355		2M24-8.8t	1		55	40	80	0.52	0.52	0.52	167	**-116.6**	ULS 8 Ba_bouwfase	128.9	271.1	282.2	0.90	**124.1**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.50
400	Horizontal lower ca. tower body	EA	130x130x12	S355		8M24-8.8t	2		55	40	80	2.00	1.00	1.00	91	**-220.1**	ULS 5a Ba 10	491.7	2168.8	1693.4	0.45	**105.0**	ULS 5a Ba 10_bouwfase	838.3	2168.8	1592.1	0.13
401	Lower chord lower ca.	EA	120x120x12	S355		8M24-8.8t	2		55	40	80	3.41	1.00	1.00	54	**-300.8**	ULS 5a Ba 10	649.1	2168.8	1693.4	0.46	**152.7**	ULS 5a Ba 10_bouwfase	750.1	2168.8	1592.1	0.20
402	Lower chord lower ca.	EA	120x120x12	S355								4.47	1.00	1.00	52	**-274.9**	ULS 5a Ba 10	658.1	0.0	0.0	0.42	**142.8**	ULS 5a Ba 10	976.3	0.0	0.0	0.15
403	Lower chord lower ca.	EA	120x120x12	S355			1					3.41	1.00	1.00	51	**-253.6**	ULS 5a Ba 10_bouwfase	664.5	0.0	0.0	0.38	**120.1**	ULS 5a Ba 10	976.3	0.0	0.0	0.12
404	Lower chord lower ca.	EA	120x120x12	S355		4M24-8.8t	1		55	40	80	2.45	1.00	1.00	53	**-219.3**	ULS 5a Ba 10	656.5	542.2	846.7	0.40	**110.0**	ULS 5a Ba 10_bouwfase	860.1	542.2	796.1	0.20
405	Lower chord lower ca.	EA	100x100x10	S355		4M24-8.8t	1		55	40	80	1.52	1.00	1.00	59	**-180.6**	ULS 5a Ba 10	437.6	542.2	705.6	0.41	**54.7**	ULS 5a Ba 10	585.6	542.2	663.4	0.10
406	Lower chord lower ca.	EA	100x100x10	S355								2.88	1.00	1.00	57	**-165.7**	ULS 5a Ah 20	440.3	0.0	0.0	0.38	**45.4**	ULS 5a Ba 10	681.6	0.0	0.0	0.07
407	Lower chord lower ca.	EA	100x100x10	S355								2.00	1.00	1.00	61	**-134.9**	ULS 3_90	424.1	0.0	0.0	0.32	**18.1**	ULS 5a Ba 10	681.6	0.0	0.0	0.03
408	Lower chord lower ca.	EA	100x100x10	S355		2M20-8.8t	1		45	35	70	2.00	1.00	1.00	55	**-114.4**	ULS 3_90	450.8	188.2	294.0	0.61	**7.7**	ULS 8 Ba_bouwfase	321.1	188.2	267.3	0.04
417	Fictive	EA	45x45x5	S355								1.00	1.00	1.00	123	**0.0**	Hoisting load	53.6	0.0	0.0	0.00	**0.0**	Hoisting load	152.7	0.0	0.0	0.00
418	Beam lower ca.	HEA	HEA160	S355								1.00	1.00	1.00	13	**-4.5**	ULS 5a Ah 20_bouwfase	1107.4	0.0	0.0	0.00	**12.6**	ULS 5a Ah 30	1384.5	0.0	0.0	0.01
419	Beam lower ca.	HEA	HEA140	S355								1.00	1.00	1.00	43	**-0.3**	ULS 1a_0,9_225_bouwfase	693.9	0.0	0.0	0.00	**2.2**	Hoisting load	1114.7	0.0	0.0	0.00
420	Beam lower ca.	HEB	HEB220	S355								2.00	1.00	1.00	26	**-20.5**	ULS 5a Ba 10_bouwfase	2601.3	0.0	0.0	0.01	**32.6**	ULS 5a Ba 10_bouwfase	3231.9	0.0	0.0	0.01
421	Beam lower ca.	HEA	HEA140	S355								1.00	1.00	1.00	24	**-0.8**	SLS 1a_90_isolator falen	762.1	0.0	0.0	0.00	**4.3**	ULS 3_90	1114.7	0.0	0.0	0.00
422	Beam lower ca.	HEB	HEB180	S355								2.00	1.00	1.00	13	**-28.3**	ULS 5a Ah 10_bouwfase	1726.7	0.0	0.0	0.02	**24.0**	ULS 5a Ba 20	2318.2	0.0	0.0	0.01
423	Upper chord lower ca.	EA	70x70x7	S355		2M16-8.8t	1		35	35	55	0.50	0.50	0.50	132	**-2.8**	Hoisting load	106.9	120.6	164.6	0.03	**11.8**	ULS 5a Ba 30	148.9	120.6	142.3	0.10
425	Upper chord lower ca.	EA	80x80x8	S355		4M20-8.8t	1		45	35	70	2.00	1.00	1.00	170	**-11.6**	ULS 8 Ba_bouwfase	95.1	376.3	470.4	0.12	**184.5**	ULS 3_90	229.1	376.3	427.6	0.81
426	Upper chord lower ca.	EA	80x80x8	S355								2.00	1.00	1.00	161	**-11.3**	ULS 8 Ba_bouwfase	102.9	0.0	0.0	0.11	**161.8**	ULS 3_90	436.7	0.0	0.0	0.37
427	Upper chord lower ca.	EA	80x80x8	S355		4M20-8.8t	1		45	35	70	2.00	1.00	1.00	161	**-9.5**	ULS 8 Ba_bouwfase	102.8	376.3	470.4	0.09	**130.6**	ULS 3_90	371.9	376.3	427.6	0.35
428	Upper chord lower ca.	EA	70x70x7	S355		4M20-8.8t	1		45	35	70	2.00	1.00	1.00	170	**-8.7**	ULS 8 Ba_bouwfase	72.8	376.3	411.6	0.12	**122.4**	ULS 3_90	277.3	376.3	374.2	0.44
429	Upper chord lower ca.	EA	70x70x7	S355								2.00	1.00	1.00	170	**-8.6**	ULS 8 Ba_bouwfase	72.9	0.0	0.0	0.12	**110.8**	ULS 3_90	333.7	0.0	0.0	0.33
430	Upper chord lower ca.	EA	70x70x7	S355		4M20-8.8t	1		45	35	70	2.00	1.00	1.00	120	**-8.2**	ULS 8 Ba_bouwfase	114.8	376.3	411.6	0.07	**88.0**	ULS 3_90	277.3	376.3	374.2	0.32
431	Stab. bracing lower ca.	EA	60x60x6	S355		1M16-8.8t	1		30	30		2.00	1.00	1.00	126	**-1.0**	ULS 1a_0	52.6	60.3	70.6	0.02	**0.9**	ULS 1a_0,9_0,9_0	98.8	60.3	52.3	0.02
432	Hand rail	EA	70x70x7	S355		1M16-8.8t	1		35	30		1.00	1.00	1.00	198	**-0.9**	ULS 8 Ba_bouwfase	48.5	60.3	82.3	0.02	**1.5**	ULS 5a Ba 20	115.2	60.3	71.1	0.03
433	Upper chord lower ca.	EA	70x70x7	S355		4M20-8.8t	1		45	35	70	2.00	1.00	1.00	171	**-7.5**	ULS 8 Ba_bouwfase	72.2	376.3	411.6	0.10	**90.5**	ULS 3_90	277.3	376.3	374.2	0.33
434	Hand rail	UA	100x50x6	S355		1M16-8.8t	1		35	25		1.00	1.00	1.00	80	**-0.2**	ULS 1a_90	112.2	60.3	70.6	0.00	**0.0**	ULS 1a_0,9_90	75.3	60.3	53.4	0.00
435	Hand rail	EA	60x60x6	S355		1M16-8.8t	1		35	30		1.00	1.00	1.00	92	**-1.1**	ULS 5a Ba 20	94.2	60.3	70.6	0.02	**0.5**	ULS 8 Ba_bouwfase	98.8	60.3	61.0	0.01
441	Vertical side face lower ca.	EA	70x70x6	S355		1M20-8.8t	1		45	35	70	1.00	1.00	0.61	121	**-32.3**	SLS 3_90_isolator falen	65.0	94.1	88.2	0.50	**0.4**	ULS 8 Ba_bouwfase	112.9	94.1	80.2	0.00
442	Vertical side face lower ca.	EA	70x70x6	S355		1M20-8.8t	1		35	35		1.00	1.00	0.54	101	**-37.6**	SLS 3_90_isolator falen	78.1	94.1	88.2	0.48	**0.9**	ULS 8 Ba_bouwfase	112.9	94.1	62.4	0.01
443	Vertical side face lower ca.	EA	60x60x6	S355		1M16-8.8t	1		30	30		1.00	1.00	0.57	96	**-20.4**	Hoisting load	70.1	60.3	70.6	0.34	**0.1**	ULS 8 Ba_bouwfase	98.8	60.3	52.3	0.00
444	Vertical side face lower ca.	EA	55x55x6	S355		1M16-8.8t	1		35	25	55	1.00	1.00	0.73	94	**-24.0**	Hoisting load	69.9	60.3	70.6	0.40	**0.1**	ULS 8 Ba_bouwfase	75.3	60.3	53.4	0.00
445	Vertical side face lower ca.	EA	50x50x5	S355		1M16-8.8t	1		35	25		1.00	1.00	1.00	102	**-8.1**	ULS 3_90	59.2	60.3	58.8	0.14	**0.2**	ULS 8 Ba_bouwfase	62.7	60.3	44.5	0.00
446	Vertical side face lower ca.	EA	50x50x5	S355		1M16-8.8t	1		35	25		1.00	1.00	1.00	62	**-12.3**	ULS 3_90	86.2	60.3	58.8	0.21	**0.5**	ULS 8 Ba_bouwfase	62.7	60.3	44.5	0.01
460	Diag side face lower ca.	EA	70x70x6	S355		1M20-8.8t	1		45	35		1.00	1.00	0.66	174	**-1.1**	ULS 8 Ba_bouwfase	42.9	94.1	88.2	0.03	**40.8**	SLS 3_90_isolator falen	112.9	94.1	80.2	0.51
461	Diag side face lower ca.	EA	60x60x6	S355		2M16-8.8t	1		35	30		1.00	1.00	0.61	175	**-0.5**	ULS 8 Ba_bouwfase	34.9	120.6	141.1	0.01	**47.4**	SLS 3_90_isolator falen	98.9	120.6	122.0	0.48
462	Diag side face lower ca.	EA	60x60x6	S355		2M16-8.8t	1		35	30	55	1.00	1.00	0.55	158	**-1.6**	ULS 8 Ba_bouwfase	59.0	120.6	141.1	0.03	**61.1**	SLS 3_90_isolator falen	106.5	120.6	122.0	0.57
463	Diag side face lower ca.	EA	55x55x6	S355		1M16-8.8t	1		30	25		1.00	1.00	0.57	149	**-0.2**	ULS 8 Ba_bouwfase	37.5	60.3	70.6	0.00	**36.3**	Hoisting load	75.3	60.3	45.8	0.79
464	Diag side face lower ca.	EA	55x55x6	S355		2M16-8.8t	1		30	25		1.00	1.00	0.73	153	**-0.1**	ULS 8 Ba_bouwfase	56.2	120.6	141.1	0.00	**52.8**	Hoisting load	83.6	120.6	91.5	0.63
465	Diag side face lower ca.	EA	60x60x6	S355		1M16-8.8t	1		35	25		1.00	1.00	1.00	176	**-0.4**	ULS 8 Ba_bouwfase	42.5	60.3	70.6	0.01	**25.5**	ULS 3_90	75.3	60.3	53.4	0.48
466	Diag lower plane lower ca.	EA	60x60x6	S355		1M16-8.8t	1		30	30		1.00	1.00	1.00	182	**-2.2**	ULS 1a_0	40.5	60.3	70.6	0.05	**1.8**	ULS 1a_0,9_0,9_0	98.8	60.3	52.3	0.03

Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+12_c(full_summary)

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	aring (Tens)	U.C. (Tens)
467	Diag side face lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.50	1.00	0.50	208	**-1.6**	ULS 5a Ah 11_bouwfase	24.8	60.3	58.8	0.06	**1.8**	ULS 5a Ba 11_bouwfase	62.7	60.3	44.5	0.04
475	Diag Plan bracing mid ca.	EA	90x90x9	S355	2M24-8.8t	1		55	40	80	1.00	1.00	1.00	145	**-72.3**	ULS 5a Ba 10_bouwfase	155.8	271.1	317.5	0.46	**71.1**	ULS 5a Ba 10_bouwfase	240.0	271.1	296.7	0.30
476	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	183	**-24.5**	ULS 5a Ah 20	34.9	60.3	58.8	0.70	**25.0**	ULS 5a Ba 10_bouwfase	62.7	60.3	44.5	0.56
477	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	184	**-30.9**	ULS 5a Ba 10_bouwfase	31.0	60.3	58.8	1.00	**29.0**	ULS 5a Ah 20	62.7	60.3	44.5	0.65
478	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	172	**-29.6**	ULS 5a Ah 10	30.5	60.3	58.8	0.97	**30.3**	ULS 5a Ba 10_bouwfase	62.7	60.3	44.5	0.68
479	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	161	**-37.1**	ULS 5a Ah 10_bouwfase	37.9	60.3	58.8	0.98	**34.4**	ULS 5a Ba 10	62.7	60.3	44.5	0.77
480	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	149	**-39.6**	ULS 5a Ba 10	41.9	60.3	58.8	0.94	**33.3**	ULS 5a Ah 10	62.7	60.3	44.5	0.75
481	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	139	**-11.6**	ULS 5a Ah 20	46.3	60.3	58.8	0.25	**13.3**	ULS 5a Ba 20	62.7	60.3	44.5	0.30
482	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.53	0.53	0.53	131	**-13.3**	ULS 5a Ba 10_bouwfase	49.8	60.3	58.8	0.27	**16.2**	ULS 5a Ba 10_bouwfase	62.7	60.3	44.5	0.36
483	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.53	0.53	0.53	118	**-18.9**	ULS 5a Ah 20	56.4	60.3	58.8	0.34	**14.1**	ULS 5a Ah 20	62.7	60.3	44.5	0.32
484	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.54	0.54	0.54	103	**-17.8**	ULS 5a Ba 20	66.0	60.3	58.8	0.30	**17.7**	ULS 5a Ba 20	62.7	60.3	44.5	0.40
485	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.54	0.54	0.54	95	**-22.4**	ULS 5a Ah 10_bouwfase	71.3	60.3	58.8	0.38	**21.3**	ULS 5a Ba 20	62.7	60.3	44.5	0.48
486	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.54	0.54	0.54	84	**-24.2**	ULS 5a Ah 10_bouwfase	80.3	60.3	58.8	0.41	**26.6**	ULS 5a Ah 10_bouwfase	62.7	60.3	44.5	0.60
487	Diag lower plane lower ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.55	0.55	0.55	79	**-30.5**	ULS 5a Ah 20	84.3	60.3	58.8	0.52	**28.0**	ULS 5a Ah 20	62.7	60.3	44.5	0.63
488	Beam lower ca. tower body	HEA	HEA160	S355							1.00	1.00	1.00	33	**-60.6**	ULS 5a Ba 10_bouwfase	1010.7	0.0	0.0	0.06	**83.2**	ULS 1a_90	1384.5	0.0	0.0	0.06
500	Lower chord mid ca. tower body	EA	150x150x12	S355	8M24-8.8t	2		55	40	80	2.00	1.00	1.00	63	**-352.2**	ULS 5a Ah 11	752.7	2168.8	1693.4	0.47	**183.0**	ULS 5a Ba 11_bouwfase	1007.6	2168.8	1592.1	0.18
501	Lower chord mid ca.	EA	120x120x12	S355	8M24-8.8t	2		55	40	80	2.00	1.00	1.00	57	**-466.6**	ULS 5a Ba 11_bouwfase	628.9	2168.8	1693.4	0.74	**242.9**	ULS 5a Ah 11	750.1	2168.8	1592.1	0.32
502	Lower chord mid ca.	EA	120x120x12	S355							2.88	1.00	1.00	44	**-438.0**	ULS 5a Ah 21	705.9	0.0	0.0	0.62	**236.8**	ULS 5a Ah 11_bouwfase	976.3	0.0	0.0	0.24
503	Lower chord mid ca.	EA	120x120x12	S355							1.80	1.00	1.00	49	**-386.9**	ULS 5a Ba 21	675.1	0.0	0.0	0.57	**198.0**	ULS 5a Ba 11_bouwfase	976.3	0.0	0.0	0.20
504	Lower chord mid ca.	EA	120x120x12	S355							9.00	1.00	1.00	49	**-356.7**	ULS 5a Ba 21	675.1	0.0	0.0	0.53	**190.9**	ULS 5a Ba 11_bouwfase	976.3	0.0	0.0	0.20
505	Lower chord mid ca.	EA	120x120x12	S355							3.00	1.00	1.00	49	**-287.0**	ULS 5a Ba 21	675.3	0.0	0.0	0.43	**149.4**	ULS 5a Ba 21	976.3	0.0	0.0	0.15
506	Lower chord mid ca.	EA	120x120x12	S355	4M24-8.8t	1		55	40	80	1.00	1.00	1.00	26	**-219.8**	ULS 5a Ah 21	824.8	542.2	846.7	0.41	**89.4**	ULS 5a Ba 21	860.1	542.2	796.1	0.17
507	Lower chord mid ca.	EA	100x100x10	S355	4M24-8.8t	1		55	40	80	1.00	1.00	1.00	57	**-217.9**	ULS 5a Ah 21	464.7	542.2	705.6	0.47	**67.4**	ULS 5a Ba 21	585.6	542.2	663.4	0.12
508	Lower chord mid ca.	EA	100x100x10	S355							3.00	1.00	1.00	54	**-198.6**	ULS 5a Ah 21	451.4	0.0	0.0	0.44	**55.3**	ULS 5a Ba 21	681.6	0.0	0.0	0.08
509	Lower chord mid ca.	EA	100x100x10	S355							2.00	1.00	1.00	65	**-157.2**	ULS 3_90	410.5	0.0	0.0	0.38	**20.8**	ULS 5a Ba 21	681.6	0.0	0.0	0.03
510	Lower chord mid ca.	EA	100x100x10	S355	2M20-8.8t	1		45	35	70	2.00	1.00	1.00	64	**-128.1**	ULS 3_90	413.0	188.2	294.0	0.68	**5.4**	ULS 8 Ah_bouwfase	321.1	188.2	267.3	0.03
521	Fictive	EA	45x45x5	S355							1.00	1.00	1.00	201	**0.0**	Hoisting load	27.2	0.0	0.0	0.00	**0.0**	Hoisting load	152.7	0.0	0.0	0.00
522	Beam mid ca.	HEB	HEB180	S355							2.00	1.00	1.00	33	**-9.0**	ULS 5a Ah 21_bouwfase	1559.7	0.0	0.0	0.01	**15.4**	ULS 5a Ba 31	2318.2	0.0	0.0	0.01
523	Beam mid ca.	HEB	HEB160	S355							2.00	1.00	1.00	13	**-31.3**	ULS 5a Ba 11_bouwfase	1459.4	0.0	0.0	0.02	**25.8**	ULS 5a Ah 11_bouwfase	1927.7	0.0	0.0	0.01
524	Beam mid ca.	HEB	HEB180	S355							1.00	1.00	1.00	6	**-29.2**	SLS 3_90_isolator falen	1792.0	0.0	0.0	0.02	**23.0**	ULS 5a Ah 21	2318.2	0.0	0.0	0.01
526	Upper chord mid ca.	EA	100x100x10	S355	4M24-8.8t	2		55	40	80	2.00	1.00	1.00	110	**-16.1**	ULS 8 Ah_bouwfase	257.6	1084.4	705.6	0.06	**273.9**	ULS 3_90	355.4	1084.4	657.6	0.77
527	Upper chord mid ca.	EA	100x100x10	S355							2.00	1.00	1.00	107	**-15.8**	ULS 8 Ah_bouwfase	266.3	0.0	0.0	0.06	**253.0**	ULS 3_90	681.6	0.0	0.0	0.37
528	Upper chord mid ca.	EA	100x100x10	S355							2.00	1.00	1.00	120	**-14.9**	ULS 8 Ah_bouwfase	233.1	0.0	0.0	0.06	**230.2**	ULS 3_90	681.6	0.0	0.0	0.34
529	Upper chord mid ca.	EA	100x100x10	S355							2.00	1.00	1.00	120	**-14.2**	ULS 8 Ah_bouwfase	233.1	0.0	0.0	0.06	**202.1**	ULS 3_90	681.6	0.0	0.0	0.30
530	Upper chord mid ca.	EA	100x100x10	S355							1.50	1.00	1.00	94	**-11.7**	ULS 8 Ah_bouwfase	316.4	0.0	0.0	0.04	**165.3**	ULS 3_90	681.6	0.0	0.0	0.24
531	Upper chord mid ca.	EA	100x100x10	S355	4M20-8.8t	1		45	35	70	2.00	1.00	1.00	40	**-11.7**	ULS 8 Ah_bouwfase	507.5	376.3	588.0	0.03	**165.3**	ULS 3_90	599.8	376.3	534.5	0.44
532	Upper chord mid ca.	EA	80x80x6	S355	4M20-8.8t	1		45	35	70	2.00	1.00	1.00	136	**-7.1**	ULS 8 Ah_bouwfase	98.2	376.3	352.8	0.07	**144.6**	ULS 3_90	285.1	376.3	320.7	0.51
533	Upper chord mid ca.	EA	80x80x6	S355							2.00	1.00	1.00	135	**-6.5**	ULS 8 Ah_bouwfase	98.6	0.0	0.0	0.07	**129.2**	ULS 3_90	333.7	0.0	0.0	0.39
534	Upper chord mid ca.	EA	80x80x6	S355	4M20-8.8t	1		45	35	70	3.00	1.00	1.00	169	**-5.7**	ULS 8 Ah_bouwfase	73.3	376.3	352.8	0.08	**98.0**	ULS 3_90	285.1	376.3	320.7	0.34
536	Upper chord mid ca.	EA	80x80x6	S355	4M20-8.8t	1		45	35	70	2.00	1.00	1.00	166	**-5.3**	ULS 8 Ah_bouwfase	75.3	376.3	352.8	0.07	**100.6**	ULS 3_90	285.1	376.3	320.7	0.35
537	Hand rail	EA	70x70x7	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	176	**-0.7**	ULS 5a Ba 11	58.1	60.3	82.3	0.01	**2.1**	ULS 5a Ah 11_bouwfase	87.8	60.3	62.3	0.03
538	Hand rail	UA	100x50x6	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	80	**-0.3**	ULS 1a_90	112.2	60.3	70.6	0.00	**0.0**		75.3	60.3	53.4	0.00
539	Stab. bracing mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		2.00	1.00	1.00	156	**-1.6**	ULS 1a_135	28.3	60.3	58.8	0.06	**1.4**	ULS 1a_0	62.7	60.3	44.5	0.03
541	Vertical side face mid ca.	EA	80x80x6	S355	1M20-8.8t	1		45	40		1.00	1.00	0.54	111	**-41.8**	ULS 3_90	82.8	94.1	88.2	0.50	**0.9**	ULS 8 Ah_bouwfase	136.4	94.1	80.2	0.01
542	Vertical side face mid ca.	EA	80x80x6	S355	1M20-8.8t	1		45	40		1.00	1.00	0.54	100	**-33.2**	Hoisting load	91.9	94.1	88.2	0.38	**0.6**	ULS 8 Ah_bouwfase	136.4	94.1	80.2	0.01
543	Vertical side face mid ca.	EA	70x70x6	S355	1M20-8.8t	1		45	30		1.00	1.00	0.54	102	**-34.8**	SLS 3_90_isolator falen	77.6	94.1	88.2	0.45	**0.8**	ULS 8 Ah_bouwfase	89.4	94.1	67.9	0.01
544	Vertical side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1		35	30		1.00	1.00	0.54	103	**-38.4**	SLS 3_90_isolator falen	65.4	60.3	70.6	0.64	**0.9**	ULS 8 Ah_bouwfase	98.8	60.3	61.0	0.01
545	Vertical side face mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	0.54	104	**-0.8**	ULS 1a_90	44.9	60.3	58.8	0.02	**0.3**	ULS 1a_0,9_90	62.7	60.3	44.5	0.01
546	Vertical side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1		35	30		1.00	1.00	0.68	86	**-14.7**	ULS 5a Ah 11_bouwfase	81.5	60.3	70.6	0.24	**32.8**	SLS 3_90_isolator falen	98.8	60.3	61.0	0.54
547	Vertical side face mid ca.	EA	55x55x6	S355	1M16-8.8t	1		35	25		1.00	1.00	0.83	94	**-25.7**	Hoisting load	77.4	60.3	70.6	0.43	**0.4**	ULS 8 Ah_bouwfase	75.3	60.3	53.4	0.01
548	Vertical side face mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	96	**-10.7**	ULS 3_90	62.9	60.3	58.8	0.18	**0.5**	ULS 8 Ah_bouwfase	62.7	60.3	44.5	0.01
549	Vertical side face mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	63	**-15.0**	ULS 3_90	85.6	60.3	58.8	0.25	**0.5**	ULS 8 Ah_bouwfase	62.7	60.3	44.5	0.01
550	Vertical side face mid ca.	EA	80x80x8	S355	2M20-8.8t	1		45	35	70	2.00	1.00	1.00	120	**-90.8**	ULS 5a Ba 11_bouwfase	149.5	188.2	235.2	0.61	**118.1**	ULS 5a Ah 11_bouwfase	199.1	188.2	213.8	0.63
560	Diag side face mid ca.	EA	70x70x6	S355	1M20-8.8t	1		45	35		1.00	1.00	0.66	164	**0.0**		46.0	94.1	88.2	0.00	**46.6**	ULS 3_90	112.9	94.1	80.2	0.58
561	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1		35	30		1.00	1.00	0.66	177	**-0.8**	ULS 8 Ba_bouwfase	35.4	120.6	141.1	0.02	**53.6**	ULS 3_90	98.9	120.6	122.0	0.54
562	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1		35	25		1.00	1.00	0.60	168	**-1.0**	ULS 8 Ah_bouwfase	37.1	120.6	141.1	0.03	**45.9**	Hoisting load	98.9	120.6	106.8	0.46
563	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1		35	30	55	1.00	1.00	0.53	155	**-1.1**	ULS 8 Ah_bouwfase	41.1	120.6	141.1	0.03	**51.6**	SLS 3_90_isolator falen	106.5	120.6	122.0	0.48
564	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1		35	30	55	1.00	1.00	0.53	143	**-1.6**	ULS 8 Ah_bouwfase	45.5	120.6	141.1	0.04	**62.7**	SLS 3_90_isolator falen	106.5	120.6	122.0	0.59
565	Diag side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1		35	30		1.00	1.00	0.69	94	**-37.2**	SLS 3_90_isolator falen	76.2	60.3	70.6	0.62	**11.8**	ULS 5a Ah 11_bouwfase	98.8	60.3	61.0	0.20
566	Diag side face mid ca.	EA	55x55x6	S355	1M16-8.8t	1		35	25		1.00	1.00	0.69	143	**-0.6**	ULS 8 Ah_bouwfase	42.9	60.3	70.6	0.01	**40.8**	Hoisting load	75.3	60.3	53.4	0.77
567	Diag side face mid ca.	EA	55x55x6	S355	2M16-8.8t	1		35	25		1.00	1.00	0.84	162	**-0.7**	ULS 8 Ah_bouwfase	41.7	120.6	141.1	0.02	**55.3**	Hoisting load	83.6	120.6	106.8	0.66
568	Diag side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	185	**-0.8**	ULS 8 Ah_bouwfase	39.5	60.3	70.6	0.02	**34.2**	ULS 3_90	75.3	60.3	53.4	0.64
569	Hand rail	EA	60x60x6	S355	1M16-8.8t	1		35	30		1.00	1.00	1.00	92	**-1.5**	ULS 5a Ba 11	94.2	60.3	70.6	0.02	**0.3**	ULS 8 Ah_bouwfase	98.8	60.3	61.0	0.01
570	Stab. bracing mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.50	1.00	0.50	202	**-2.4**	ULS 5a Ba 11	25.9	60.3	58.8	0.09	**3.7**	ULS 5a Ah 11	62.7	60.3	44.5	0.08
571	Stab. bracing mid ca.	EA	60x60x6	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	237	**-4.1**	ULS 1a_0	26.9	60.3	70.6	0.15	**3.6**	ULS 1a_0	75.3	60.3	53.4	0.07
576	Diag Plan bracing mid ca.	EA	120x120x10	S355	3M24-8.8t	1		55	40	80	1.00	1.00	1.00	87	**-227.6**	ULS 5a Ba 21	416.5	406.7	529.2	0.56	**227.3**	ULS 5a Ba 11_bouwfase	441.0	406.7	493.6	0.56
577	Hor Plan bracing mid ca.	EA	110x110x10	S355	3M24-8.8t	1		55	40	80	1.00	0.50	0.50	87	**-151.6**	ULS 5a Ba 11_bouwfase	364.9	406.7	529.2	0.42	**151.8**	ULS 5a Ah 11_bouwfase	396.5	406.7	493.6	0.38
579	Diag lower plane mid ca.	EA	55x55x6	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	149	**-26.9**	ULS 5a Ah 11	52.4	60.3	70.6	0.51	**30.8**	ULS 5a Ba 11_bouwfase	75.3	60.3	53.4	0.58
580	Diag lower plane mid ca.	EA	55x55x6	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	144	**-33.8**	ULS 5a Ah 11_bouwfase	55.2	60.3	70.6	0.61	**33.0**	ULS 5a Ah 21	75.3	60.3	53.4	0.62
581	Diag lower plane mid ca.	EA	55x55x6	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	138	**-33.1**	ULS 5a Ba 11	58.2	60.3	70.6	0.57	**30.2**	ULS 5a Ah 11_bouwfase	75.3	60.3	53.4	0.57
582	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	144	**-30.9**	ULS 5a Ba 21	44.1	60.3	58.8	0.70	**31.3**	ULS 5a Ah 21	62.7	60.3	44.5	0.70
583	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	138	**-35.3**	ULS 5a Ba 11_bouwfase	46.5	60.3	58.8	0.76	**36.0**	ULS 5a Ah 11_bouwfase	62.7	60.3	44.5	0.81
584	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	131	**-35.4**	ULS 5a Ah 21	44.4	60.3	58.8	0.80	**33.7**	ULS 5a Ba 21	62.7	60.3	44.5	0.76
585	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	131	**-42.4**	ULS 5a Ah 11_bouwfase	49.9	60.3	58.8	0.85	**42.8**	ULS 5a Ba 11_bouwfase	62.7	60.3	44.5	0.96
586	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	124	**-44.3**	ULS 5a Ba 21	53.1	60.3	58.8	0.83	**41.6**	ULS 5a Ah 21	62.7	60.3	44.5	0.93
587	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		1.00	1.00	1.00	100	**-12.5**	ULS 5a Ah 21	60.6	60.3	58.8	0.21	**14.8**	ULS 5a Ba 21	62.7	60.3	44.5	0.33
588	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	112	**-16.6**	ULS 5a Ah 21	60.0	60.3	58.8	0.28	**14.3**	ULS 5a Ba 21	62.7	60.3	44.5	0.32
589	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	106	**-16.1**	ULS 5a Ba 11_bouwfase	63.7	60.3	58.8	0.27	**19.3**	ULS 5a Ba 11_bouwfase	62.7	60.3	44.5	0.43
590	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	101	**-21.1**	ULS 5a Ah 21	67.6	60.3	58.8	0.36	**16.6**	ULS 5a Ah 21	62.7	60.3	44.5	0.37
591	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	91	**-21.0**	ULS 5a Ah 21	74.4	60.3	58.8	0.36	**20.0**	ULS 5a Ah 21	62.7	60.3	44.5	0.45
592	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	87	**-24.3**	ULS 5a Ah 11_bouwfase	78.1	60.3	58.8	0.41	**23.6**	ULS 5a Ah 11_bouwfase	62.7	60.3	44.5	0.53
593	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	82	**-26.5**	ULS 5a Ah 11_bouwfase	82.3	60.3	58.8	0.45	**28.7**	ULS 5a Ah 11_bouwfase	62.7	60.3	44.5	0.65
594	Diag lower plane mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	77	**-31.0**	ULS 5a Ah 21	86.0	60.3	58.8	0.53	**28.5**	ULS 5a Ah 21	62.7	60.3	44.5	0.64

Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+12_c(full_summary)

Group Label	Description	Type	Profile	Steel	Quali	Bolts	#sh.	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	ring (Tens)	U.C. (Tens)
595	Beam mid ca.	HEA	HEA140	S355								1.00	1.00	1.00	32	**-1.3**	ULS 5a Ah 11_bouwfase	735.2	0.0	0.0	0.00	**6.6**	ULS 3_90	1114.7	0.0	0.0	0.01
600	Lower chord top ca. tower body	EA	150x150x12	S355	8M24-8.8t		2	55	40	80		2.00	1.00	1.00	48	**-505.1**	ULS 8 Ba	866.2	2168.8	1693.4	0.58	**167.8**	ULS 5a Ba 12_bouwfase	1007.6	2168.8	1592.1	0.17
601	Lower chord top ca.	EA	120x120x12	S355	8M24-8.8t		2	55	40	80		2.00	1.00	1.00	36	**-536.4**	ULS 8 Ba	750.7	2168.8	1693.4	0.71	**225.3**	ULS 5a Ba 22	750.1	2168.8	1592.1	0.30
602	Lower chord top ca.	EA	120x120x12	S355								3.82	1.00	1.00	49	**-502.1**	ULS 8 Ba	676.2	0.0	0.0	0.74	**207.0**	ULS 5a Ba 22	976.3	0.0	0.0	0.21
603	Lower chord top ca.	EA	120x120x12	S355								2.11	1.00	1.00	49	**-436.7**	ULS 8 Ah	676.4	0.0	0.0	0.65	**150.7**	ULS 5a Ba 22	976.3	0.0	0.0	0.15
604	Lower chord top ca.	EA	120x120x12	S355								1.00	1.00	1.00	43	**-368.4**	ULS 8 Ah	742.5	0.0	0.0	0.50	**112.8**	ULS 8 Ba_bouwfase	976.3	0.0	0.0	0.12
605	Lower chord top ca.	EA	100x100x10	S355								1.52	1.00	1.00	54	**-350.9**	ULS 8 Ah	458.7	0.0	0.0	0.77	**89.6**	ULS 8 Ba_bouwfase	585.6	542.2	361.8	0.25
606	Lower chord top ca.	EA	100x100x10	S355								2.90	1.00	1.00	52	**-310.7**	ULS 8 Ah	460.2	0.0	0.0	0.68	**78.7**	ULS 8 Ba_bouwfase	681.6	0.0	0.0	0.12
607	Lower chord top ca.	EA	100x100x10	S355								1.65	1.00	1.00	46	**-236.3**	ULS 8 Ah	484.0	0.0	0.0	0.49	**30.2**	ULS 8 Ba_bouwfase	681.6	0.0	0.0	0.04
608	Lower chord top ca.	EA	100x100x10	S355								6.00	1.00	1.00	55	**-190.5**	ULS 3_90	448.2	0.0	0.0	0.43	**18.4**	ULS 8 Ba_bouwfase	681.6	0.0	0.0	0.03
609	Lower chord top ca.	EA	100x100x10	S355	2M20-8.8t		1	45	35	70		2.40	1.00	1.00	44	**-153.7**	ULS 3_90	491.4	188.2	294.0	0.82	**0.4**	ULS 8 Ah_bouwfase	321.1	188.2	267.3	0.00
610	Beam top ca.	HEA	HEA160	S355								1.00	1.00	1.00	14	**-11.4**	ULS 8 Ah_bouwfase	1102.6	0.0	0.0	0.01	**16.0**	ULS 5a Ah 12	1384.5	0.0	0.0	0.01
611	Beam top ca.	HEB	HEB160	S355								1.00	1.00	1.00	9	**-14.8**	ULS 5a Ba 22	1508.9	0.0	0.0	0.01	**27.9**	ULS 8 Ba	1927.7	0.0	0.0	0.01
613	Beam top ca.	HEB	HEB180	S355								2.00	1.00	1.00	13	**-23.5**	ULS 5a Ba 22	1726.7	0.0	0.0	0.01	**23.1**	ULS 5a Ah 12	2318.2	0.0	0.0	0.01
614	Fictive	EA	45x45x5	S355								1.00	1.00	1.00	264	**0.0**	Hoisting load	17.7	0.0	0.0	0.00	**0.0**	Hoisting load	152.7	0.0	0.0	0.00
615	Beam top ca.	HEA	HEA140	S355								1.00	1.00	1.00	28	**-1.0**	ULS 5a Ah 22	750.1	0.0	0.0	0.00	**5.7**	ULS 8 Ah	1114.7	0.0	0.0	0.01
616	Beam top ca.	HEA	HEA140	S355								1.00	1.00	1.00	19	**-0.8**	ULS 1a_0,9_0_bouwfase	778.5	0.0	0.0	0.00	**10.0**	ULS 3_90	1114.7	0.0	0.0	0.01
626	Upper chord top ca.	EA	100x100x10	S355	4M24-8.8t		1	55	40	80		2.00	1.00	1.00	120	**-4.6**	ULS 8 Ah_bouwfase	234.0	542.2	705.6	0.02	**300.7**	ULS 3_90	355.4	542.2	657.6	0.85
627	Upper chord top ca.	EA	100x100x10	S355								2.00	1.00	1.00	120	**-4.0**	ULS 8 Ah_bouwfase	233.4	0.0	0.0	0.02	**271.5**	ULS 3_90	681.6	0.0	0.0	0.40
628	Upper chord top ca.	EA	100x100x10	S355								2.00	1.00	1.00	120	**-2.8**	ULS 8 Ah_bouwfase	233.4	0.0	0.0	0.01	**234.2**	ULS 3_90	681.6	0.0	0.0	0.34
629	Upper chord top ca.	EA	100x100x10	S355	4M20-8.8t		1	45	35	70		2.00	1.00	1.00	67	**-2.8**	ULS 8 Ah_bouwfase	402.2	376.3	588.0	0.01	**234.2**	ULS 3_90	599.8	376.3	534.5	0.62
630	Upper chord top ca.	EA	90x90x9	S355	4M20-8.8t		1	45	35	70		2.00	1.00	1.00	119	**-1.4**	ULS 8 Ah_bouwfase	189.3	376.3	529.2	0.01	**203.4**	ULS 3_90	473.1	376.3	481.1	0.54
631	Upper chord top ca.	EA	90x90x9	S355			1					1.00	1.00	1.00	92	**-1.4**	ULS 8 Ah_bouwfase	262.9	0.0	0.0	0.01	**182.7**	ULS 3_90	546.3	0.0	0.0	0.33
632	Upper chord top ca.	EA	90x90x9	S355								3.00	1.00	1.00	156	**-0.9**	ULS 8 Ah_bouwfase	134.1	0.0	0.0	0.01	**151.4**	ULS 3_90	546.3	0.0	0.0	0.28
633	Upper chord top ca.	EA	90x90x9	S355	4M20-8.8t		1	45	35	70		2.00	1.00	1.00	104	**-0.7**	ULS 8 Ah_bouwfase	219.9	376.3	529.2	0.00	**114.5**	ULS 3_90	473.1	376.3	481.1	0.30
634	Upper chord top ca.	EA	90x90x9	S355	4M20-8.8t		1	45	35	70		2.00	1.00	1.00	112	**-0.7**	ULS 8 Ah_bouwfase	203.4	376.3	529.2	0.00	**122.6**	ULS 3_90	473.1	376.3	481.1	0.33
636	Chord earth peak	EA	120x120x12	S355	1M20-8.8t		1	45	40	70		1.00	2.42	1.00	132	**-48.8**	ULS 8 Ah_bouwfase	199.3	94.1	176.4	0.52	**53.1**	ULS 8 Ba	225.8	94.1	160.4	0.56
637	Stab bracing top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	1.00	127	**-4.5**	ULS 8 Ah	45.9	60.3	58.8	0.10	**2.9**	ULS 1a_0,9_0,9_0	62.7	60.3	44.5	0.07
638	Stab bracing top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			2.00	1.00	1.00	101	**-2.8**	ULS 8 Ah_bouwfase	46.3	60.3	58.8	0.06	**2.0**	ULS 8 Ba_bouwfase	62.7	60.3	44.5	0.04
639	Beam earth wire	UNP	UNP120	S355								2.00	1.00	1.00	25	**-15.1**	ULS 8 Ba	433.8	0.0	0.0	0.03	**13.5**	ULS 8 Ba	603.5	0.0	0.0	0.02
640	Vert side face top ca.	EA	70x70x6	S355	1M20-8.8t		1	45	30			1.00	1.00	0.54	109	**-36.4**	SLS 3_90_isolator falen	72.8	94.1	88.2	0.50	**0.6**	ULS 8 Ah_bouwfase	89.4	94.1	67.9	0.01
641	Vert side face top ca.	EA	70x70x6	S355	1M20-8.8t		1	45	30			1.00	1.00	0.54	95	**-39.2**	SLS 3_90_isolator falen	83.2	94.1	88.2	0.47	**0.4**	ULS 8 Ah_bouwfase	89.4	94.1	67.9	0.01
642	Vert side face top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	0.64	115	**-2.2**	ULS 8 Ba	40.7	60.3	58.8	0.05	**0.1**	ULS 1a_0,9_90	62.7	60.3	44.5	0.00
643	Vert side face top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	0.64	104	**-15.4**	ULS 8 Ah_bouwfase	45.1	60.3	58.8	0.34	**32.4**	SLS 3_90_isolator falen	62.7	60.3	44.5	0.73
644	Vert side face top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	25	55		1.00	1.00	0.64	79	**-27.4**	Hoisting load	72.5	60.3	70.6	0.45	**12.1**	ULS 8 Ba_bouwfase	75.3	60.3	53.4	0.23
645	Vert side face top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	0.64	70	**-29.2**	ULS 8 Ah	63.8	60.3	58.8	0.50	**11.6**	ULS 8 Ba_bouwfase	62.7	60.3	44.5	0.26
646	Vert side face top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	0.64	55	**-20.7**	ULS 3_90	74.5	60.3	58.8	0.35	**2.6**	ULS 8 Ba_bouwfase	62.7	60.3	44.5	0.06
647	Vert side face top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	0.64	40	**-22.6**	ULS 3_90	86.2	60.3	58.8	0.38	**6.9**	ULS 3_0	62.7	60.3	44.5	0.16
648	Main diag earth peak	EA	60x60x6	S355	2M20-8.8t		1	45	35	70		1.00	1.00	1.00	133	**-13.8**	ULS 3_90	77.6	188.2	176.4	0.18	**3.0**	ULS 8 Ba_bouwfase	105.4	188.2	160.4	0.03
660	Diag side face top ca.	EA	60x60x6	S355	2M16-8.8t		1	35	30	55		1.00	1.00	0.61	174	**0.0**		35.4	120.6	141.1	0.00	**44.4**	Hoisting load	106.5	120.6	122.0	0.42
661	Diag side face top ca.	EA	60x60x6	S355	2M16-8.8t		1	35	30	55		1.00	1.00	0.57	161	**-0.9**	ULS 8 Ah_bouwfase	39.1	120.6	141.1	0.02	**52.5**	SLS 3_90_isolator falen	106.5	120.6	122.0	0.49
662	Diag side face top ca.	EA	60x60x6	S355	2M16-8.8t		1	35	30	55		1.00	1.00	0.51	149	**-1.2**	ULS 5a Ba 22	43.2	120.6	141.1	0.03	**60.6**	SLS 3_90_isolator falen	106.5	120.6	122.0	0.57
663	Diag side face top ca.	EA	60x60x6	S355								1.00	1.00	0.64	102	**-41.8**	SLS 3_90_isolator falen	100.2	0.0	0.0	0.42	**5.9**	ULS 5a Ba 22	245.0	0.0	0.0	0.02
664	Diag side face top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	30	55		1.00	1.00	0.64	135	**-15.1**	ULS 8 Ba_bouwfase	42.3	60.3	70.6	0.36	**40.9**	Hoisting load	98.8	60.3	61.0	0.68
665	Diag side face top ca.	EA	55x55x6	S355	2M16-8.8t		1	35	25	55		1.00	1.00	0.77	150	**-22.3**	ULS 8 Ba_bouwfase	46.2	120.6	141.1	0.48	**52.7**	Hoisting load	90.0	120.6	106.8	0.59
666	Diag side face top ca.	EA	50x50x5	S355	2M16-8.8t		1	35	25	55		1.00	1.00	1.00	180	**-0.2**	ULS 8 Ah_bouwfase	28.5	120.6	117.6	0.01	**36.7**	ULS 3_90	71.3	120.6	89.0	0.51
667	Diag side face top ca.	EA	50x50x5	S355	2M16-8.8t		1	35	25	55		1.00	1.00	1.00	168	**-4.6**	ULS 8 Ba_bouwfase	31.7	120.6	117.6	0.14	**49.1**	ULS 8 Ah	71.3	120.6	89.0	0.69
673	Beam top ca.	HEA	HEA160	S355								1.00	1.00	1.00	15	**-76.0**	ULS 5a Ba 12	1100.0	0.0	0.0	0.07	**107.7**	ULS 8 Ba_bouwfase	1384.5	0.0	0.0	0.08
674	Diag plan bracing top ca.	EA	100x100x8	S355	2M24-8.8t		1	55	40	80		1.00	1.00	1.00	79	**-175.2**	ULS 5a Ah 12_bouwfase	302.5	271.1	282.2	0.65	**173.4**	ULS 5a Ba 12	246.8	271.1	263.7	0.70
675	Hor Plan bracing top ca.	EA	90x90x9	S355	2M24-8.8t		1	55	40	80		1.00	0.50	0.50	80	**-88.6**	ULS 5a Ba 12_bouwfase	289.0	271.1	317.5	0.33	**83.4**	ULS 5a Ah 12	240.0	271.1	296.7	0.35
676	Hor Plan bracing top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	25			1.00	1.00	1.00	120	**-38.2**	ULS 5a Ba 12	61.4	60.3	70.6	0.63	**32.3**	ULS 5a Ah 12_bouwfase	75.3	60.3	53.4	0.61
677	Diag lower plane top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	25			0.51	0.51	0.51	110	**-41.0**	ULS 5a Ba 22	76.5	60.3	70.6	0.68	**40.7**	ULS 5a Ah 22	75.3	60.3	53.4	0.76
678	Diag lower plane top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	25			1.00	1.00	1.00	107	**-41.0**	ULS 5a Ah 22	70.4	60.3	70.6	0.68	**39.6**	ULS 5a Ba 22	75.3	60.3	53.4	0.74
679	Diag lower plane top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	108	**-48.2**	ULS 5a Ba 12_bouwfase	78.7	60.3	70.6	0.80	**46.8**	ULS 5a Ah 22	75.3	60.3	53.4	0.88
680	Diag lower plane top ca.	EA	55x55x6	S355	1M16-8.8t		1	35	25			0.51	0.51	0.51	97	**-45.4**	ULS 5a Ah 22	87.9	60.3	70.6	0.75	**42.1**	ULS 5a Ba 22	75.3	60.3	53.4	0.79
681	Diag lower plane top ca.	EA	60x60x6	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	87	**-34.6**	ULS 8 Ba	111.6	60.3	70.6	0.57	**18.3**	ULS 8 Ba	75.3	60.3	53.4	0.34
682	Diag lower plane top ca.	EA	60x60x6	S355	1M16-8.8t		1	35	30			0.52	0.52	0.52	85	**-19.4**	ULS 5a Ah 12	114.2	60.3	70.6	0.32	**15.1**	ULS 5a Ba 22	98.8	60.3	61.0	0.25
683	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	100	**-16.9**	ULS 5a Ah 12_bouwfase	68.1	60.3	58.8	0.29	**21.4**	ULS 5a Ah 12_bouwfase	62.7	60.3	44.5	0.48
684	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	94	**-22.7**	ULS 5a Ah 12	72.1	60.3	58.8	0.39	**17.1**	ULS 5a Ba 22	62.7	60.3	44.5	0.39
685	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	81	**-20.7**	ULS 5a Ah 12_bouwfase	83.0	60.3	58.8	0.35	**22.9**	ULS 5a Ah 12_bouwfase	62.7	60.3	44.5	0.51
686	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	85	**-21.0**	ULS 5a Ba 22	79.8	60.3	58.8	0.36	**17.7**	ULS 5a Ba 22	62.7	60.3	44.5	0.40
687	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	78	**-24.3**	ULS 5a Ah 22	85.6	60.3	58.8	0.41	**22.1**	ULS 5a Ah 22	62.7	60.3	44.5	0.50
688	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	75	**-24.6**	ULS 5a Ah 12_bouwfase	88.3	60.3	58.8	0.42	**27.5**	ULS 5a Ah 12_bouwfase	62.7	60.3	44.5	0.62
689	Diag lower plane top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	72	**-27.4**	ULS 5a Ba 22	91.0	60.3	58.8	0.47	**25.2**	ULS 5a Ba 22	62.7	60.3	44.5	0.57
690	Stab bracing top ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			1.00	1.00	0.64	217	**-10.4**	ULS 8 Ah_bouwfase	23.3	60.3	58.8	0.45	**11.4**	ULS 8 Ah_bouwfase	62.7	60.3	44.5	0.26
691	K bracing earth peak	EA	50x50x5	S355	2M16-8.8t		1	35	25	55		1.00	1.00	1.00	78	**-48.3**	ULS 8 Ba	76.1	120.6	117.6	0.64	**49.3**	ULS 8 Ba	71.3	120.6	89.0	0.69
692	Stab bracing earth peak	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.50	0.50	0.50	93	**-18.8**	ULS 8 Ah	72.8	60.3	58.8	0.32	**11.7**	ULS 8 Ba_bouwfase	62.7	60.3	44.5	0.26
693	Hor earth peak	EA	70x70x7	S355	1M16-8.8t		1	35	30			2.00	1.00	1.00	40	**-2.7**	ULS 1a_0,9_0,9_90	168.5	60.3	82.3	0.04	**6.3**	ULS 3_90	115.2	60.3	71.1	0.10
710	Hor tower body lower ca.	EA	100x100x8	S355	4M20-8.8t		1	45	35	70		1.00	1.00	1.00	173	**0.0**		122.6	376.3	470.4	0.00	**173.5**	ULS 3_0	298.7	376.3	427.6	0.58
711	Hor tower body lower ca.	EA	90x90x8	S355	2M20-8.8t		1	45	35	70		1.00	1.00	1.00	192	**-86.9**	ULS 1a_0,9_0,9_90	93.8	188.2	235.2	0.93	**98.4**	ULS 1a_0,9_0,9_90	229.3	188.2	213.8	0.52
712	Hor tower body mid ca.	EA	110x110x10	S355	4M24-8.8t		2	55	40	80		1.00	1.00	1.00	125	**0.0**		257.9	1084.4	705.6	0.00	**281.0**	ULS 3_0	396.5	1084.4	657.6	0.71
713	Hor tower body mid ca.	EA	80x80x6	S355	2M20-8.8t		1	45	35	70		1.00	1.00	1.00	170	**-51.6**	ULS 3_270_bouwfase	76.1	188.2	176.4	0.68	**69.0**	ULS 3_270_bouwfase	152.6	188.2	160.4	0.45
714	Hor tower body top ca.	EA	110x110x10	S355	4M24-8.8t		1	55	40	80		1.00	1.00	1.00	93	**0.0**		357.7	542.2	705.6	0.00	**290.7**	ULS 3_45	396.5	542.2	657.6	0.73
715	Hor tower body top ca.	EA	70x70x6	S355	2M20-8.8t		1	45	35	70		1.00	1.00	1.00	147	**-16.7**	ULS 3_90_bouwfase	80.5	188.2	176.4	0.21	**13.0**	ULS 3_90_bouwfase	128.1	188.2	160.4	0.10
750	Insulator substructure lower ca.	EA	60x60x6	S355								1.00	1.00	1.00	75	**0.0**		140.9	0.0	0.0	0.00	**19.5**	ULS 1a_90	245.0	0.0	0.0	0.08
751	Insulator substructure lower ca.	UNP	UNP120	S355								1.00	1.00	1.00	40	**-19.9**	ULS 5a Ba 20_bouwfase	396.8	0.0	0.0	0.05	**1.9**	ULS 8 Ba_bouwfase	603.5	0.0	0.0	0.00
752	Insulator substructure lower ca.	EA	50x50x5	S355	1M16-8.8t		1	35	25			0.52	0.52	0.52	64	**-19.1**	ULS 5a Ah 20_bouwfase	98.2	60.3	58.8	0.32	**17.8**	ULS 5a Ba 20_bouwfase	62.7	60.3	44.5	0.40
753	Fictive beam	HEB	HEB160	S355								1.00	1.00	1.00	2	**0.0**		1531.6	0.0	0.0	0.00	**73.6**	SLS 3_90_isolator falen	1927.7	0.0	0.0	0.04
754	Fictive beam	HEB	HEB160	S355								1.00	1.00	1.00	12	**-15.0**	ULS 5a Ba 20_bouwfase	1497.1	0.0	0.0	0.01	**84.0**	SLS 3_90_isolator falen	1927.7	0.0	0.0	0.04
755	Fictive beam	HEB	HEB160	S355								1.00	1.00	1.00	2	**-0.3**	ULS 1a_0,9_0,9_90	1531.6	0.0	0.0	0.00	**55.8**	ULS 3_90	1927.7	0.0	0.0	0.03
760	Fictive beam	UNP	UNP200	S355								1.00	1.00	1.00	5	**0.0**	ULS 1a_270_bouwfase	770.0	0.0	0.0	0.00	**28.1**	ULS 3_90	1168.0	0.0	0.0	0.02
761	Insulator substructure mid ca.	UNP	UNP120	S355								1.00	1.00	1.00	26	**-13.7**	ULS 5a Ah 11_bouwfase	431.1	0.0	0.0	0.03	**42.0**	SLS 3_90_isolator falen	603.5	0.0	0.0	0.07
762	Insulator substructure mid ca.	EA	100x100x10	S355								1.00	1.00	1.00	5	**-13.3**	ULS 5a Ba 11_bouwfase	622.9	0.0	0.0	0.02	**31.1**	SLS 3_90_isolator falen	681.6	0.0	0.0	0.05

Assessment of angle groups - Lower structure

Date	5/4/2021
Author	TBR
Version	1.0

RLL-TLB
S+12_c(full_summary)

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.	plane	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compression)	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	ring (Tens)	U.C. (Tens)
763	Insulator substructure mid ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	58	**-14.5**	ULS 5a Ah 11_bouwfase	103.2	60.3	58.8	0.25	**20.4**	ULS 5a Ah 21	62.7	60.3	44.5	0.46
764	Fictive beam	HEA	HEA220	S355							1.00	1.00	1.00	9	**-32.6**	ULS 5a Ah 11_bouwfase	1607.5	0.0	0.0	0.02	**24.7**	ULS 3_270_bouwfase	2284.1	0.0	0.0	0.01
765	Fictive beam	HEB	HEB160	S355							1.00	1.00	1.00	2	**-0.3**	ULS 1a_0,9_0,9_90	1531.6	0.0	0.0	0.00	**55.8**	ULS 3_90	1927.7	0.0	0.0	0.03
770	Insulator substructure 1 top ca.	EA	60x60x6	S355							1.00	1.00	1.00	75	**0.0**		140.7	0.0	0.0	0.00	**21.6**	ULS 3_90	245.0	0.0	0.0	0.09
771	Insulator substructure 1 top ca.	UNP	UNP120	S355							2.00	2.00	2.00	74	**-18.3**	ULS 5a Ba 42	198.1	0.0	0.0	0.09	**1.1**	ULS 8 Ah	603.5	0.0	0.0	0.00
772	Insulator substructure 1 top ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	62	**-16.0**	ULS 5a Ah 42	99.5	60.3	58.8	0.27	**15.1**	ULS 5a Ba 42	62.7	60.3	44.5	0.34
773	Insulator substructure 1 top ca.	HEB	HEB160	S355							1.00	1.00	1.00	12	**-13.0**	ULS 5a Ba 42	1497.1	0.0	0.0	0.01	**13.9**	ULS 5a Ah 42	1927.7	0.0	0.0	0.01
774	Insulator substructure 2 top ca.	HEB	HEB160	S355							1.00	1.00	1.00	2	**-14.1**	ULS 5a Ba 22	1531.5	0.0	0.0	0.01	**55.9**	ULS 3_90	1927.7	0.0	0.0	0.03
775	Insulator substructure 2 top ca.	UNP	UNP120	S355							1.00	1.00	1.00	42	**-13.7**	ULS 5a Ba 22	392.5	0.0	0.0	0.03	**42.3**	SLS 3_90_isolator falen	603.5	0.0	0.0	0.07
776	Insulator substructure 2 top ca.	HEB	HEB160	S355							1.00	1.00	1.00	12	**-32.8**	ULS 5a Ba 12_bouwfase	1497.1	0.0	0.0	0.02	**26.2**	ULS 5a Ba 22	1927.7	0.0	0.0	0.01
777	Insulator substructure 2 top ca.	EA	50x50x5	S355	1M16-8.8t	1		35	25		0.52	0.52	0.52	65	**-19.5**	ULS 5a Ah 12_bouwfase	97.3	60.3	58.8	0.33	**29.7**	ULS 5a Ah 12_bouwfase	62.7	60.3	44.5	0.67
214	Diag front face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	175	**-118.2**	ULS 1a_90	120.6	271.1	282.2	0.98	**106.8**	ULS 1a_90	246.8	271.1	263.7	0.43
314	Diag side face	EA	100x100x8	S355	2M24-8.8t	1		55	40	80	0.52	0.52	0.52	175	**-114.9**	ULS 8 Ba_bouwfase	120.6	271.1	282.2	0.95	**106.1**	ULS 8 Ba_bouwfase	246.8	271.1	263.7	0.43
119.6	Main leg	EA	200x200x20	S355	10M24-8.8t	2		55	40	80	0.29	0.29	0.29	43	**-2039.2**	ULS 1a_45	2388.8	2711.0	3528.0	0.85	**1663.1**	ULS 1a_0,9_0,9_135	2328.5	2711.0	3316.9	0.71
120.6	Main leg	EA	200x200x20	S355	10M24-8.8t	2		55	40	80	0.22	0.22	0.22	43	**-2170.9**	ULS 1a_45	2389.9	2711.0	3528.0	0.91	**1709.6**	ULS 1a_0,9_0,9_135	2328.5	2711.0	3316.9	0.73
121.6	Main leg	EA	200x200x20	S355	10M24-8.8t	2		55	40	80	0.33	0.33	0.33	50	**-1984.8**	ULS 1a_45	2288.8	2711.0	3528.0	0.87	**1546.4**	ULS 1a_0,9_0,9_135	2328.5	2711.0	3316.9	0.66
219.6	Diag front face	EA	130x130x12	S355	2M24-8.8t	1		55	50	80	0.29	0.57	0.29	128	**-167.4**	ULS 8 Ah_bouwfase	338.3	271.1	423.4	0.62	**93.5**	ULS 8 Ah_bouwfase	494.4	271.1	398.0	0.35
220.6	Diag front face	EA	130x130x12	S355	2M24-8.8t	1		55	50	80	1.00	0.57	0.22	292	**-43.5**	ULS 1a_0,9_0,9_0	101.3	271.1	423.4	0.43	**130.5**	ULS 8 Ah_bouwfase	494.4	271.1	398.0	0.48
221.6	Diag front face	EA	130x130x12	S355	2M24-8.8t	1		55	40	80	0.33	1.00	0.33	168	**-102.7**	ULS 8 Ah_bouwfase	236.1	271.1	423.4	0.43	**57.0**	ULS 8 Ah_bouwfase	494.4	271.1	395.5	0.21
222.6	Diag front face	EA	160x160x15	S355	2M24-8.8t	1		55	40	80	0.33	1.00	0.33	178	**-102.4**	ULS 8 Ah_bouwfase	339.0	271.1	529.2	0.38	**56.8**	ULS 8 Ah_bouwfase	787.4	271.1	494.4	0.21
319.6	Diag side face	EA	130x130x12	S355	2M24-8.8t	1		55	50	80	1.00	0.57	0.29	224	**-151.9**	ULS 1a_90	154.1	271.1	423.4	0.99	**131.4**	ULS 8 Ba_bouwfase	494.4	271.1	398.0	0.48
320.6	Diag side face	EA	130x130x12	S355	2M24-8.8t	1		55	50	80	1.00	0.57	0.22	292	**-95.7**	ULS 1a_0,9_0,9_90	101.2	271.1	423.4	0.95	**117.3**	ULS 1a_90	494.4	271.1	398.0	0.43
321.6	Diag side face	EA	130x130x12	S355	2M24-8.8t	1		55	40	80	0.33	1.00	0.33	168	**-91.7**	ULS 1a_90	236.1	271.1	423.4	0.39	**80.6**	ULS 8 Ba_bouwfase	494.4	271.1	395.5	0.30
322.6	Diag side face	EA	160x160x15	S355	2M24-8.8t	1		55	40	80	0.33	1.00	0.33	178	**-99.6**	ULS 1a_90	339.0	271.1	529.2	0.37	**79.8**	ULS 8 Ah_bouwfase	787.4	271.1	494.4	0.29
700.6	Hor plan bracing broekstuk	EA	120x120x10	S355	1M20-8.8t	1		45	35		1.00	1.00	1.00	237	**-11.6**	ULS 1a_0,9_0,9_90	101.6	94.1	147.0	0.12	**5.1**	ULS 1a_0,9_0,9_0	188.2	94.1	133.6	0.05
701.6	Diag plan bracing broekstuk	EA	110x110x10	S355	1M20-8.8t	1		45	35		1.00	0.50	0.50	235	**-6.8**	ULS 1a_135	71.0	94.1	147.0	0.10	**7.9**	ULS 1a_0,9_0,9_45	188.2	94.1	133.6	0.08
702.6	Mid hor plan bracing broekstuk	DEA	120x120x10 (not	S355	1M16-8.8t	1		35	40		0.50	0.50	0.50	237	**-1.1**	ULS 1a_90	203.3	60.3	117.6	0.02	**0.0**		243.0	60.3	101.6	0.00
703.6	Hor plan bracing tussenstuk	EA	120x120x10	S355	2M24-8.8t	1		55	50	80	1.00	2.00	1.00	161	**-54.3**	ULS 1a_90	192.8	271.1	352.8	0.28	**39.9**	ULS 1a_0,9_0,9_90	341.6	271.1	224.6	0.18
704.6	Diag plan bracing tussenstuk	EA	90x90x8	S355	1M20-8.8t	1		45	35		1.00	1.00	1.00	238	**-5.1**	ULS 1a_135	54.0	94.1	117.6	0.09	**8.3**	ULS 1a_135	150.5	94.1	106.9	0.09
705.6	Mid hor plan bracing tussenstuk	DEA	70x70x6 (not co	S355	1M20-8.8t	1		45	35		0.50	0.50	0.50	216	**0.0**	ULS 1a_90	82.3	94.1	88.2	0.00	**0.0**	ULS 1a_0,9_0,9_90	112.9	94.1	80.2	0.00
113.6	Main leg	EA	180x180x18	S355							0.52	0.52	0.52	47	**-1822.4**	ULS 1a_135	1884.1	0.0	0.0	0.97	**1482.6**	ULS 1a_0,9_0,9_90	2197.5	0.0	0.0	0.67
114.6	Main leg	EA	200x200x18	S355							0.52	0.52	0.52	43	**-1976.8**	ULS 1a_135	2164.6	0.0	0.0	0.91	**1616.9**	ULS 1a_0,9_0,9_90	2453.1	0.0	0.0	0.66
115.6	Main leg	EA	200x200x18	S355	10M24-8.8t	2		55	40	80	0.52	0.52	0.52	43	**-2072.5**	ULS 1a_45	2164.6	2711.0	3175.2	0.96	**1710.8**	ULS 1a_0,9_0,9_90	2107.6	2711.0	2985.2	0.81

APPENDIX C
Knikverkorters

Niet in PLS-TOWER gemodelleerde elementen in de constructie worden aanvullend getoetst. Hieronder vallen de knikverkorters van de randstijl en profielen onderdeel van stabiliteitsverbanden. De staven worden getoetst op:

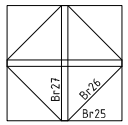
- voldoende trek- of druksterkte als steungevend profiel voor randstijl, 1% van de knikcapaciteit van de randstijl;
- slankheid;
- klimbelasting

Voor de beloopbaarheid zijn staven in de traverse aanwezig. Deze zijn niet constructief (voorzien van slobgaten) en worden enkel getoetst op de klimbelasting van 1,0 kN. Zie hoofdstuk 4.2.5 en 5.7.2. van het uitgangspuntenrapport.

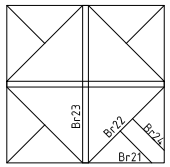
De knikverkorters van het tussenstuk en bovenstuk zijn voor alle masttypen in de groep van combi-steunmasten gelijk. Om deze reden worden alléén voor masttype S+12/c de knikverkorters van het bovenstuk en het onderstuk en de stapstaven in de traverse getoetst. Voor de overige masttypen worden alleen de knikverkorters van het onderstuk getoetst.

Profielen uit horizontaalverbanden van het onderstuk zijn in PLS-TOWER aanwezig maar worden in deze Appendix aanvullend getoetst op buiging. Profielafmeting en boutverbinding uit PLS-TOWER is leidend.

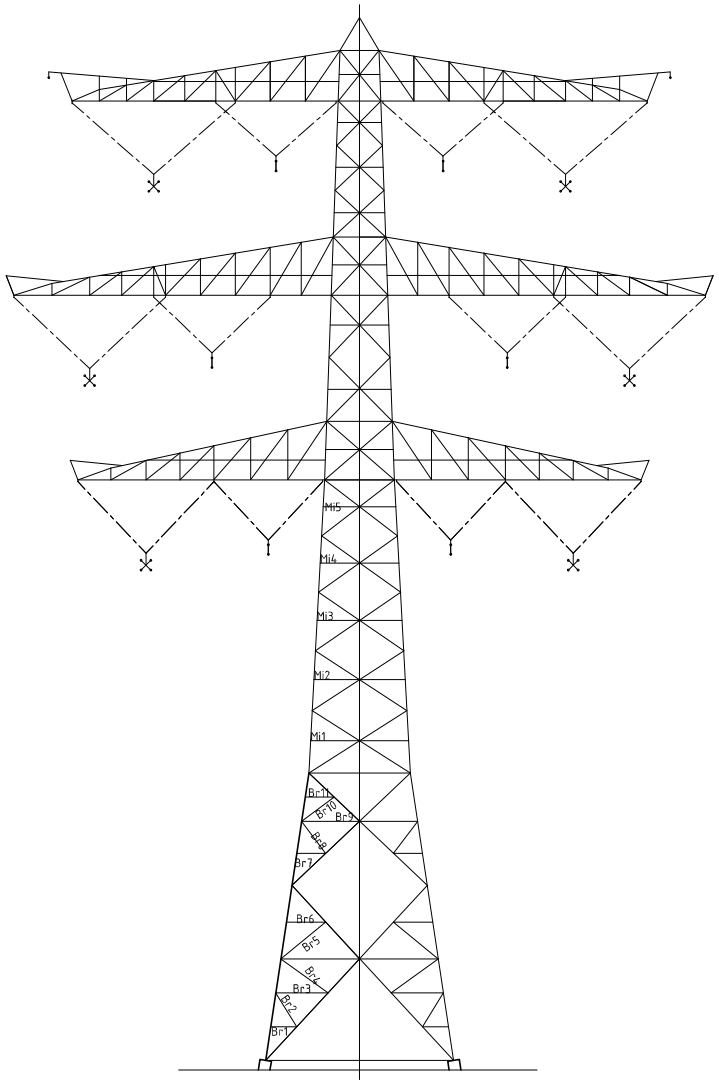
Overzicht knikverkorters - S-3/c



Tussenschot +15,3m



Tussenschot +5,73m



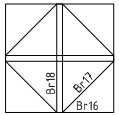
Redundant members

Date: 2021-07-27
Author: TBR
Version: 1.9

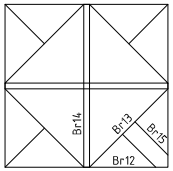
RLL-TLB
S-3_c

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.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,49	0	153	**20,1**	**0,56**	36,1	60,3	41,3	43,1	0,81	0,71	Bending	
Br2	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	2,06	58	212	**20,1**	**0,00**	22,4	60,3	41,3	43,1	0,81	0,90	Buckling	
Br3	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	2,93	0	214	**20,1**	**1,10**	37,4	60,3	52,3	122,3	1,99	0,58	Bending	
Br4	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3,15	36	230	**20,1**	**0,00**	33,4	60,3	52,3	122,3	1,99	0,60	Buckling	
Br5	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3,09	39	225	**22,1**	**0,00**	34,5	60,3	52,3	122,3	1,99	0,64	Buckling	
Br6	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,18	0	187	**22,1**	**0,82**	39,0	60,3	52,3	98,8	1,40	0,60	Bending	
Br7	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,67	0	172	**22,1**	**0,63**	30,6	60,3	41,3	43,1	0,81	0,80	Bending	
Br8	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	2,15	53	221	**20,5**	**0,00**	21,0	60,3	41,3	43,1	0,81	0,98	Buckling	
Br9	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3,33	0	243	**20,5**	**1,25**	30,5	60,3	52,3	122,3	1,99	0,67	Buckling	
Br10	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,23	36	191	**20,5**	**0,00**	37,7	60,3	52,3	98,8	1,40	0,54	Buckling	
Br11	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,66	0	171	**20,5**	**0,62**	30,9	60,3	41,3	43,1	0,81	0,79	Bending	
Br21	Tussenschot +5,06m	Enkele staaf	L90x8	S355J0	M16	8.8	4,05	0	230	**22,1**	**1,52**	57,0	60,3	69,7	225,8	4,34	0,39	Buckling	
Br22	Tussenschot +5,06m	Kniksteun op 0,5L	L80x8	S355J0	M16	8.8	5,75	0	237	**22,1**	**2,16**	40,8	60,3	69,7	194,4	4,46	0,54	Buckling	
Br23	Tussenschot +5,06m	Kruisende staaf halverwege	L90x8	S355J0	M16	8.8	8,10	0	230	**22,1**	**1,52**	57,0	60,3	69,7	225,8	5,70	0,39	Buckling	
Br24	Tussenschot +5,06m	Enkele staaf	L60x6	S355J0	M16	8.8	2,88	0	246	**22,1**	**1,08**	25,4	60,3	52,3	98,8	1,40	0,87	Buckling	
Br25	Tussenschot +14,6m	Enkele staaf	L110x10	S355J0	M16	8.8	2,62	0	121	**20,5**	**0,98**	214,4	60,3	87,1	360,6	8,04	0,34	shear	
Br26	Tussenschot +14,6m	Enkele staaf	L80x6	S355J0	M16	8.8	3,71	0	236	**20,5**	**1,39**	36,7	60,3	52,3	145,8	2,68	0,56	Buckling	
Br27	Tussenschot +14,6m	Kruisende staaf halverwege	L60x6	S355J0	M16	8.8	5,23	0	224	**20,5**	**0,98**	29,6	60,3	52,3	98,8	1,88	0,69	Buckling	

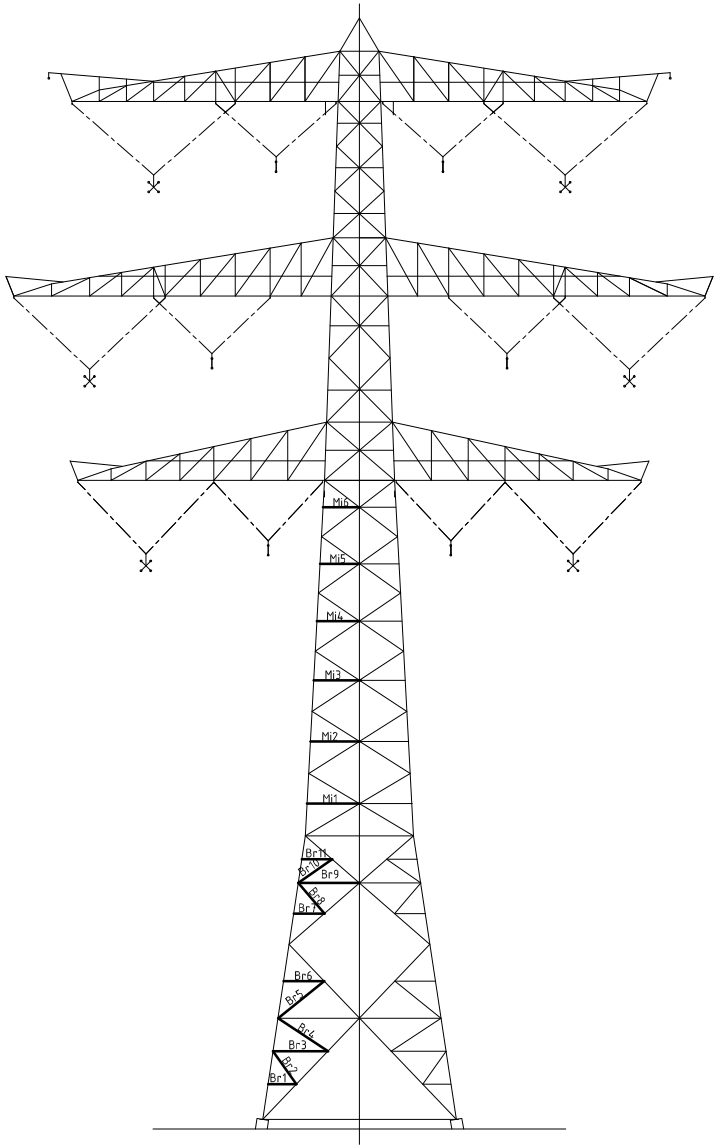
Overzicht knikverkorters - S+0/c



Tussenschot +14,5m



Tussenschot +5,7m



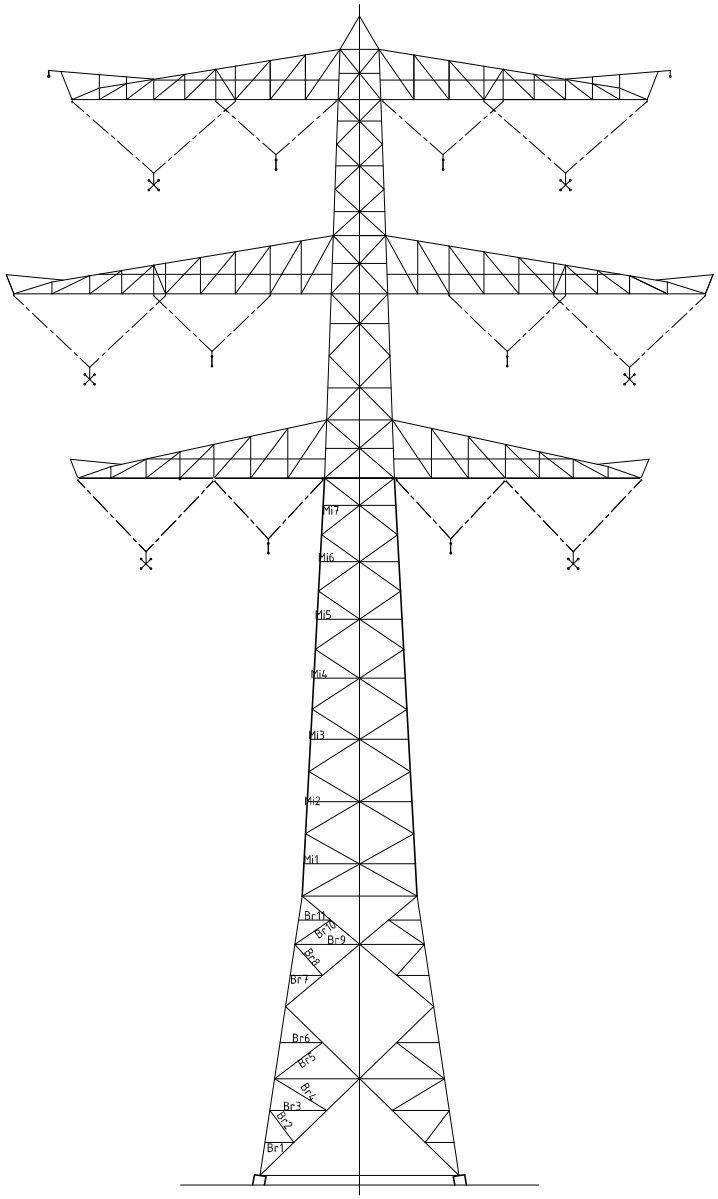
Redundant members

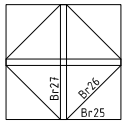
Date: 2021/05/05
Author: TBR
Version: 1.9

RLL-TLB
S+0_c

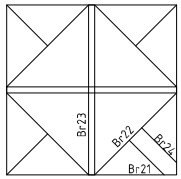
Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.45	0	149	**22.0**	**0.54**	37.3	60.3	41.3	43.1	0.81	0.69	Bending	
Br2	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	2.08	55	214	**22.0**	**0.00**	22.1	60.3	41.3	43.1	0.81	1.00	Buckling	
Br3	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.82	0	241	**22.0**	**1.06**	26.2	60.3	52.3	98.8	1.40	0.84	Buckling	
Br4	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.08	41	225	**22.0**	**0.00**	34.6	60.3	52.3	122.3	1.99	0.64	Buckling	
Br5	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.05	39	222	**22.0**	**0.00**	35.1	60.3	52.3	122.3	1.99	0.63	Buckling	
Br6	Broekstuk	Enkele staaf	L55x6	S355J0	M16	8.8	2.10	0	196	**22.0**	**0.79**	33.1	60.3	51.5	75.3	1.15	0.71	Bending	
Br7	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.58	0	162	**22.0**	**0.59**	33.2	60.3	41.3	43.1	0.81	0.76	Bending	
Br8	Broekstuk	Enkele staaf	L55x6	S355J0	M16	8.8	2.07	41	193	**22.0**	**0.00**	33.8	60.3	51.5	75.3	1.15	0.65	Buckling	
Br9	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.15	0	230	**22.0**	**1.18**	33.3	60.3	52.3	122.3	1.99	0.66	Buckling	
Br10	Broekstuk	Enkele staaf	L55x6	S355J0	M16	8.8	2.13	35	199	**22.0**	**0.00**	32.4	60.3	51.5	75.3	1.15	0.68	Buckling	
Br11	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.57	0	161	**22.0**	**0.59**	33.5	60.3	41.3	43.1	0.81	0.75	Bending	
Br12	Tussenschot +5,06m	Enkele staaf	L90x8	S355J0	M16	8.8	4.20	0	238	**22.0**	**1.58**	53.8	60.3	69.7	225.8	4.34	0.41	Buckling	1
Br13	Tussenschot +5,06m	Kniksteun op 0,5L	L80x8	S355J0	M16	8.8	5.88	0	243	**22.0**	**2.21**	39.5	60.3	69.7	194.4	4.46	0.56	Buckling	1
Br14	Tussenschot +5,06m	Kruisende staaf halverwege	L90x8	S355J0	M16	8.8	8.40	0	238	**22.0**	**1.58**	53.8	60.3	69.7	225.8	5.70	0.41	Buckling	1
Br15	Tussenschot +5,06m	Enkele staaf	L70x6	S355J0	M16	8.8	2.94	0	214	**2.0**	**1.10**	37.2	60.3	52.3	122.3	1.99	0.58	Bending	
Br16	Tussenschot +14,5m	Kniksteun op 0,5L	L110x10	S355J0	M16	8.8	5.57	0	166	**22.0**	**2.09**	115.4	60.3	87.1	360.6	10.69	0.36	shear	1
Br17	Tussenschot +14,5m	Enkele staaf	L80x6	S355J0	M16	8.8	3.90	0	248	**22.0**	**1.46**	34.0	60.3	52.3	145.8	2.68	0.65	Buckling	1
Br18	Tussenschot +14,5m	Kruisende staaf halverwege	L80x6	S355J0	M16	8.8	5.57	0	177	**22.0**	**1.04**	57.0	60.3	52.3	145.8	3.40	0.42	Bearing	1
1)	Also checked in PLS - Tower																		

Overzicht knikverkorters - S+3/c





Tussenschot +14.9m



Tussenschot +5,45m

Redundant members

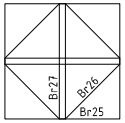
Date: 2021/05/05
Author: TBR
Version: 1.9

RLL-TLB
S+3_c

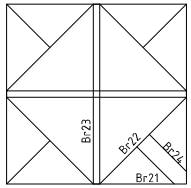
Posnr.	Section	Schematization	Profile	Steel Quality	Bolt	Quality	Length (m)	Angle (°)	Slenderness	Normal Force (kN)	Moment (kNm)	Buckling Cap. (kN)	Shear Cap. Bolt (kN)	Bearing Cap. (kN)	Net Section Cap. (kN)	Moment Cap. (kNm)	Highest U.C.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.49	0	153	**20.1**	**0.56**	36.1	60.3	41.3	43.1	0.81	0.71	Bending	
Br2	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	2.06	53	212	**20.1**	**0.00**	22.4	60.3	41.3	43.1	0.81	0.90	Buckling	
Br3	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	2.93	0	214	**20.1**	**1.10**	37.4	60.3	52.3	122.3	1.99	0.58	Bending	
Br4	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.15	31	230	**20.1**	**0.00**	33.4	60.3	52.3	122.3	1.99	0.60	Buckling	
Br5	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.09	0	225	**22.1**	**1.16**	34.5	60.3	52.3	122.3	1.99	0.64	Buckling	
Br6	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.18	0	187	**22.1**	**0.82**	39.0	60.3	52.3	98.8	1.40	0.60	Bending	
Br7	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.67	48	172	**22.1**	**0.00**	30.6	60.3	41.3	43.1	0.81	0.72	Buckling	
Br8	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.15	0	184	**20.5**	**0.81**	39.9	60.3	52.3	98.8	1.40	0.59	Bending	
Br9	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.33	34	243	**20.5**	**0.00**	30.5	60.3	52.3	122.3	1.99	0.67	Buckling	
Br10	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.23	0	191	**20.5**	**0.84**	37.7	60.3	52.3	98.8	1.40	0.62	Bending	
Br11	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.66	0	171	**20.5**	**0.62**	30.9	60.3	41.3	43.1	0.81	0.79	Bending	
Br21	Tussenschot +5,06m	Enkele staaf	L90x8	S355J0	M16	8.8	4.37	0	248	**22.1**	**1.64**	50.5	60.3	69.7	225.8	4.34	0.44	Buckling	1
Br22	Tussenschot +5,06m	Kniksteun op 0,5L	L90x8	S355J0	M16	8.8	6.21	0	226	**22.1**	**2.33**	49.3	60.3	69.7	225.8	5.70	0.45	Buckling	1
Br23	Tussenschot +5,06m	Kruisende staaf halverwege	L90x8	S355J0	M16	8.8	8.74	0	248	**22.1**	**1.64**	50.5	60.3	69.7	225.8	5.70	0.44	Buckling	1
Br24	Tussenschot +5,06m	Enkele staaf	L70x6	S355J0	M16	8.8	3.10	0	226	**22.1**	**1.16**	34.2	60.3	52.3	122.3	1.99	0.65	Buckling	
Br25	Tussenschot +14,6m	Enkele staaf	L120x10	S355J0	M16	8.8	3.33	0	140	**20.5**	**1.25**	195.9	60.3	87.1	399.8	9.77	0.34	shear	1
Br26	Tussenschot +14,6m	Enkele staaf	L100x8	S355J0	M16	8.8	4.73	0	240	**20.5**	**1.77**	59.3	60.3	69.7	257.2	5.49	0.35	Buckling	1
Br27	Tussenschot +14,6m	Kruisende staaf halverwege	L70x6	S355J0	M16	8.8	6.66	0	243	**20.5**	**1.25**	30.6	60.3	52.3	122.3	2.58	0.67	Buckling	1
Mi1	Middenstuk1	Enkele staaf	L60x6	S355J0	M16	8.8	2.89	0	247	**19.1**	1.08	25.2	60.3	52.3	98.8	1.4	0.80	Bending	

1) Also checked in PLS-TOWER

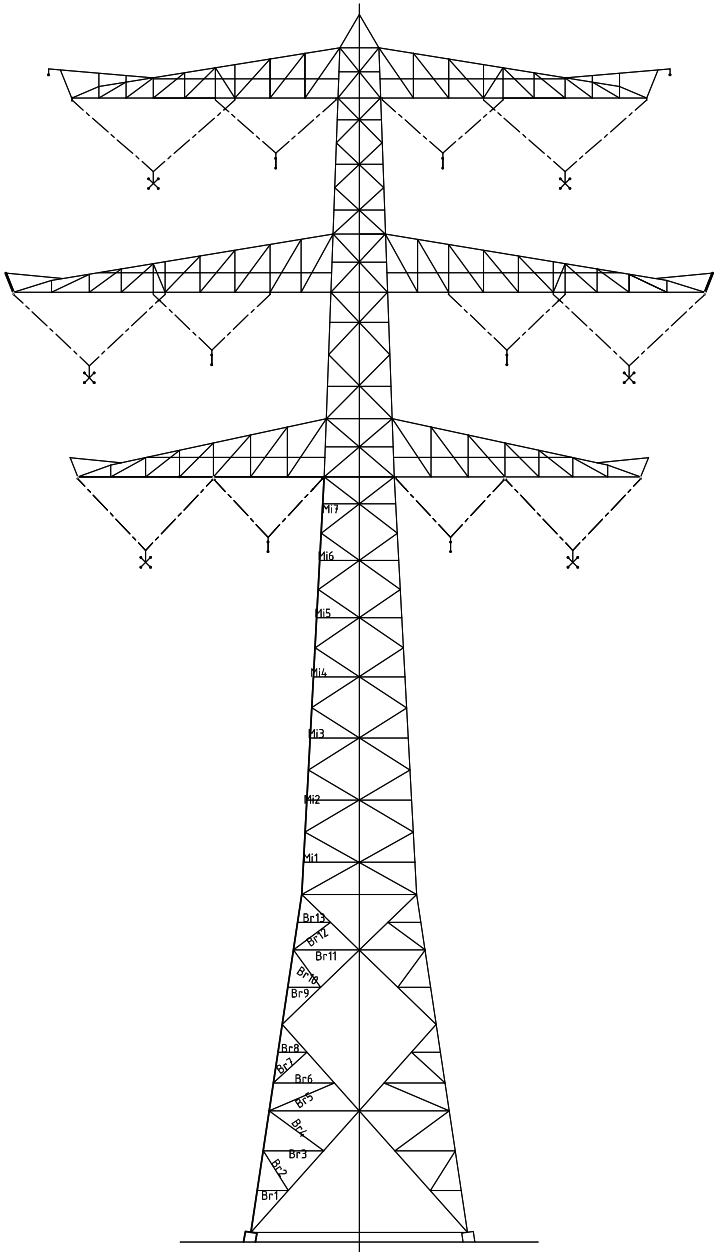
Overzicht knikverkorters - S+6/c



Tussenschot +17,9m



Tussenschot +6,75m



Redundant members

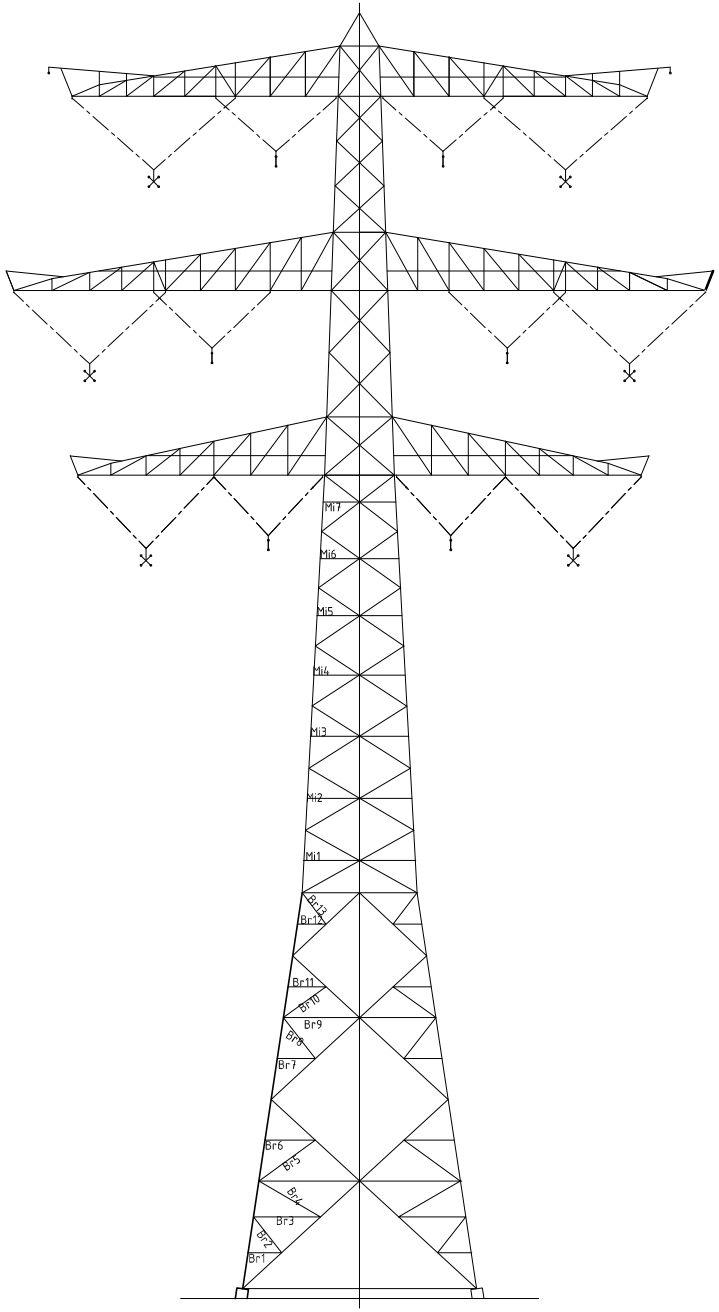
Date: 2021/05/05
Author: TBR
Version: 1.9

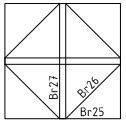
RLL-TLB
S+6_c

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.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.59	0	164	**20.1**	**0.60**	32.8	60.3	41.3	43.1	0.81	0.76	Bending	
Br2	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.42	58	207	**20.1**	**0.00**	33.3	60.3	52.3	98.8	1.40	0.60	Buckling	
Br3	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.11	0	227	**20.1**	**1.17**	34.0	60.3	52.3	122.3	1.99	0.61	Bending	
Br4	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3.47	36	221	**20.1**	**0.00**	40.8	60.3	52.3	145.8	2.68	0.49	Buckling	
Br5	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3.65	23	232	**22.1**	**1.26**	37.8	60.3	52.3	145.8	2.68	0.59	Buckling	
Br6	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.14	0	229	**22.1**	**1.18**	33.5	60.3	52.3	122.3	1.99	0.66	Buckling	
Br7	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.34	43	200	**22.1**	**0.00**	35.1	60.3	52.3	98.8	1.40	0.63	Buckling	
Br8	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.49	0	153	**22.1**	**0.56**	36.0	60.3	41.3	43.1	0.81	0.71	Bending	
Br9	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.69	0	174	**20.5**	**0.63**	30.1	60.3	41.3	43.1	0.81	0.81	Bending	
Br10	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.38	54	204	**20.5**	**0.00**	34.2	60.3	52.3	98.8	1.40	0.60	Buckling	
Br11	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3.39	0	247	**20.5**	**1.27**	29.7	60.3	52.3	122.3	1.99	0.69	Buckling	
Br12	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.39	37	204	**20.5**	**0.00**	34.1	60.3	52.3	98.8	1.40	0.60	Buckling	
Br13	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.69	0	174	**20.5**	**0.64**	30.0	60.3	41.3	43.1	0.81	0.81	Bending	1
Br21	Tussenschot +5,06m	Enkele staaf	L100x8	S355J0	M16	8.8	4.63	0	235	**22.1**	**1.74**	61.3	60.3	69.7	257.2	5.49	0.37	shear	1
Br22	Tussenschot +5,06m	Kniksteun op 0,5L	L90x8	S355J0	M16	8.8	6.57	0	240	**22.1**	**2.47**	45.3	60.3	69.7	225.8	5.70	0.49	Buckling	1
Br23	Tussenschot +5,06m	Kruisende staaf halverwege	L120x10	S355J0	M16	8.8	9.26	0	195	**22.1**	**1.74**	122.8	60.3	87.1	399.8	12.83	0.37	shear	1
Br24	Tussenschot +5,06m	Enkele staaf	L70x6	S355J0	M16	8.8	3.29	0	240	**22.1**	**1.23**	31.2	60.3	52.3	122.3	1.99	0.71	Buckling	
Br25	Tussenschot +14,6m	Enkele staaf	L120x10	S355J0	M16	8.8	2.96	0	125	**20.5**	**1.11**	227.6	60.3	87.1	399.8	9.77	0.34	shear	1
Br26	Tussenschot +14,6m	Enkele staaf	L90x8	S355J0	M16	8.8	4.20	0	239	**20.5**	**1.58**	53.7	60.3	69.7	225.8	4.34	0.38	Buckling	1
Br27	Tussenschot +14,6m	Kruisende staaf halverwege	L70x6	S355J0	M16	8.8	5.92	0	216	**20.5**	**1.11**	36.8	60.3	52.3	122.3	2.58	0.56	Buckling	1
Mi1	Middenstuk1	Enkele staaf	L60x6	S355J0	M16	8.8	2.89	0	247	**19.5**	1.08	25.2	60.3	52.3	98.8	1.4	0.80	Bending	

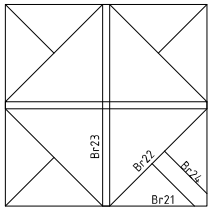
1) Also checked in PLS-TOWER

Overzicht knikverkorters - S+9/c





Tussenschot +20,9m



Tussenschot +6,04m

Redundant members

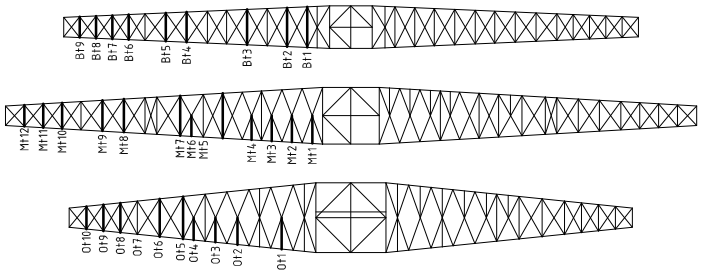
Date: 2021/05/05
Author: TBR
Version: 1.9

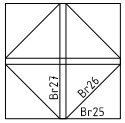
RLL-TLB
S+9_c

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.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.76	0	181	**23.3**	**0.66**	28.4	60.3	41.3	43.1	0.81	0.84	Bending	
Br2	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.35	52	201	**23.3**	**0.00**	34.8	60.3	52.3	98.8	1.40	0.67	Buckling	
Br3	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3.46	0	220	**23.3**	**1.30**	41.1	60.3	52.3	145.8	2.68	0.57	Buckling	
Br4	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3.68	30	234	**23.3**	**1.20**	37.3	60.3	52.3	145.8	2.68	0.62	Buckling	
Br5	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3.59	36	228	**22.1**	**0.00**	38.8	60.3	52.3	145.8	2.68	0.57	Buckling	
Br6	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.59	0	222	**22.1**	**0.97**	30.0	60.3	52.3	98.8	1.40	0.74	Buckling	
Br7	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.96	0	202	**21.9**	**0.74**	24.1	60.3	41.3	43.1	0.81	0.94	Bending	
Br8	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.67	52	229	**21.9**	**0.00**	28.5	60.3	52.3	98.8	1.40	0.77	Buckling	
Br9	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3.93	0	250	**21.9**	**1.47**	33.6	60.3	52.3	145.8	2.68	0.65	Buckling	
Br10	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2.72	36	233	**21.9**	**0.00**	27.8	60.3	52.3	98.8	1.40	0.79	Buckling	
Br11	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.96	0	202	**21.9**	**0.74**	24.1	60.3	41.3	43.1	0.81	0.94	Bending	
Br12	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1.48	0	152	**21.7**	**0.55**	36.3	60.3	41.3	43.1	0.81	0.71	Bending	
Br13	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	2.04	53	210	**21.7**	**0.00**	22.7	60.3	41.3	43.1	0.81	0.95	Buckling	
Br21	Tussenschot +5,06m	Enkele staaf	L110x10	S355J0	M16	8.8	5.19	0	241	**23.3**	**1.95**	80.6	60.3	87.1	360.6	8.04	0.39	shear	1
Br22	Tussenschot +5,06m	Kniksteun op 0,5L	L100x8	S355J0	M16	8.8	7.37	0	239	**23.3**	**2.76**	50.7	60.3	69.7	257.2	7.19	0.46	Buckling	1
Br23	Tussenschot +5,06m	Kruisende staaf halverwege	L110x10	S355J0	M16	8.8	10.38	0	241	**23.3**	**1.95**	80.6	60.3	87.1	360.6	10.69	0.39	shear	1
Br24	Tussenschot +5,06m	Enkele staaf	L80x6	S355J0	M16	8.8	3.68	0	234	**23.3**	**1.38**	37.2	60.3	52.3	145.8	2.68	0.63	Buckling	
Br25	Tussenschot +14,6m	Enkele staaf	L110x10	S355J0	M16	8.8	2.80	0	130	**21.7**	**1.05**	197.1	60.3	87.1	360.6	8.04	0.36	shear	1
Br26	Tussenschot +14,6m	Enkele staaf	L90x8	S355J0	M16	8.8	3.98	0	226	**21.7**	**1.49**	58.6	60.3	69.7	225.8	4.34	0.37	Buckling	1
Br27	Tussenschot +14,6m	Kruisende staaf halverwege	L70x6	S355J0	M16	8.8	5.60	0	204	**21.7**	**1.05**	40.1	60.3	52.3	122.3	2.58	0.54	Buckling	1
MI1	Middenstuk1	Enkele staaf	L60x6	S355J0	M16	8.8	2.89	0	247	**19.5**	1.08	25.2	60.3	52.3	98.8	1.4	0.80	Bending	

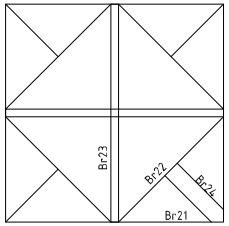
1) Also checked in PLS-TOWER

Overzicht knikverkorters - S+12/c

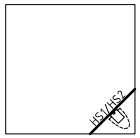




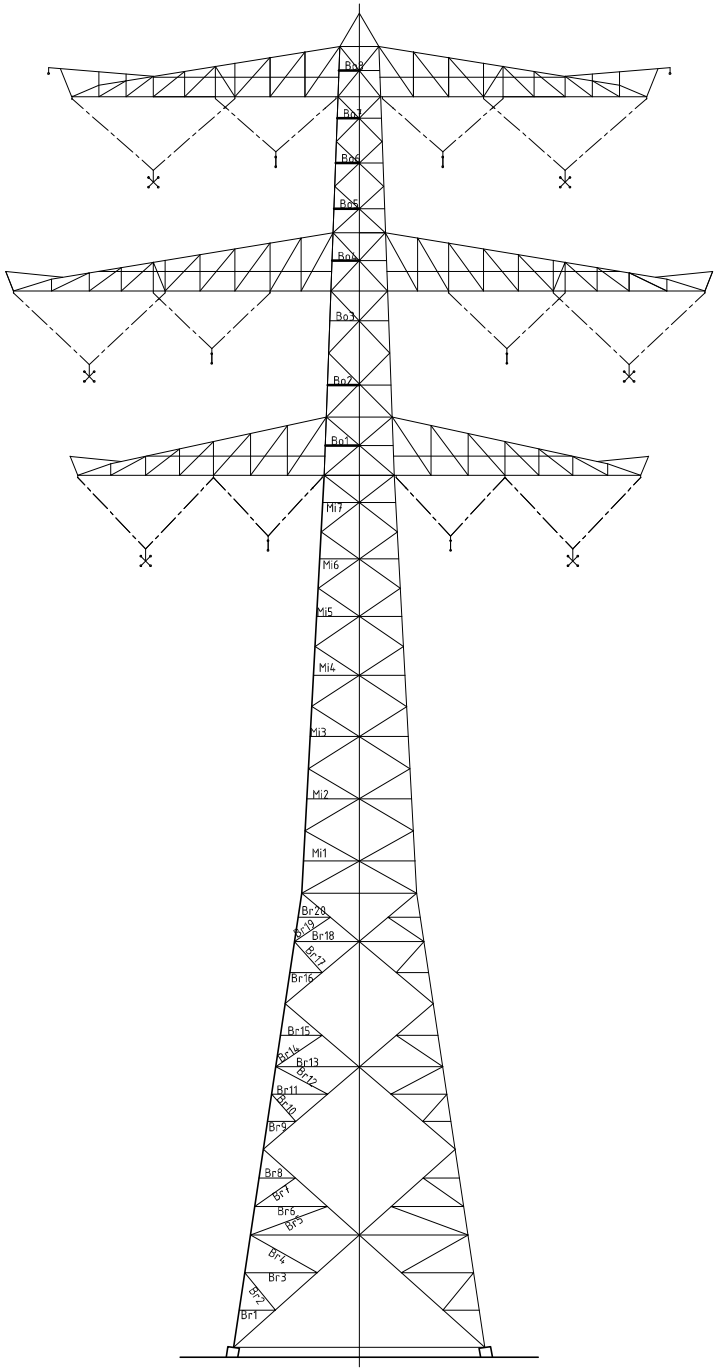
Tussenschot +23,9m



Tussenschot +6,28m



Standaard frame



Redundant members

Date: 2021-07-27
Author: TBR
Version: 1.9

RLL-TLB
S+12_c

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.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,87	0	192	**20,7**	**0,70**	26,0	60,3	41,3	43,1	0,81	0,89	Bending	
Br2	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,49	51	213	**20,7**	**0,00**	31,9	60,3	52,3	98,8	1,40	0,65	Buckling	
Br3	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3,73	0	237	**20,7**	**1,40**	36,4	60,3	52,3	145,8	2,68	0,57	Buckling	
Br4	Broekstuk	Enkele staaf	L90x6	S355J0	M16	8.8	3,95	29	222	**20,7**	**0,00**	45,7	60,3	52,3	169,3	3,48	0,45	Buckling	
Br5	Broekstuk	Enkele staaf	L90x6	S355J0	M16	8.8	4,22	20	238	**22,2**	**0,00**	41,1	60,3	52,3	169,3	3,48	0,54	Buckling	
Br6	Broekstuk	Enkele staaf	L80x6	S355J0	M16	8.8	3,74	0	238	**22,2**	**1,40**	36,4	60,3	52,3	145,8	2,68	0,61	Buckling	
Br7	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,56	35	219	**22,2**	**0,79**	30,6	60,3	52,3	98,8	1,40	0,73	Buckling	
Br8	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,87	0	193	**22,2**	**0,00**	25,9	60,3	41,3	43,1	0,81	0,86	Buckling	
Br9	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,45	0	149	**21,6**	**0,54**	37,3	60,3	41,3	43,1	0,81	0,69	Bending	
Br10	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,88	49	193	**21,6**	**0,00**	25,8	60,3	41,3	43,1	0,81	0,84	Buckling	
Br11	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,89	0	247	**21,6**	**1,08**	25,3	60,3	52,3	98,8	1,40	0,85	Buckling	
Br12	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3,02	28	220	**21,6**	**1,00**	35,6	60,3	52,3	122,3	1,99	0,61	Buckling	
Br13	Broekstuk	Enkele staaf	L90x6	S355J0	M16	8.8	4,30	0	242	**21,6**	**1,61**	39,9	60,3	52,3	169,3	3,48	0,54	Buckling	
Br14	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,90	34	248	**21,6**	**0,90**	25,1	60,3	52,3	98,8	1,40	0,86	Buckling	
Br15	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,16	0	185	**21,6**	**0,81**	39,6	60,3	52,3	98,8	1,40	0,60	Bending	
Br16	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,67	0	171	**21,6**	**0,63**	30,7	60,3	41,3	43,1	0,81	0,80	Bending	
Br17	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,15	48	184	**21,6**	**0,54**	40,0	60,3	52,3	98,8	1,40	0,54	Buckling	
Br18	Broekstuk	Enkele staaf	L70x6	S355J0	M16	8.8	3,33	0	243	**21,6**	**1,25**	30,5	60,3	52,3	122,3	1,99	0,71	Buckling	
Br19	Broekstuk	Enkele staaf	L60x6	S355J0	M16	8.8	2,23	34	191	**21,6**	**0,69**	37,7	60,3	52,3	98,8	1,40	0,57	Buckling	
Br20	Broekstuk	Enkele staaf	L50x5	S355J0	M16	8.8	1,67	0	171	**17,2**	**0,63**	30,7	60,3	41,3	43,1	0,81	0,80	Bending	
Br21	Tussenschot +5,06m	Enkele staaf	L120x10	S355J0	M16	8.8	5,60	0	236	**22,0**	**2,10**	91,4	60,3	87,1	399,8	9,77	0,36	shear	1
Br22	Tussenschot +5,06m	Kniksteun op 0,5L	L110x10	S355J0	M16	8.8	7,95	0	237	**22,0**	**2,98**	70,4	60,3	87,1	360,6	10,69	0,36	shear	1
Br23	Tussenschot +5,06m	Kruisende staaf halverwege	L70x6	S355J0	M16	8.8	5,60	0	204	**22,0**	**1,05**	40,1	60,3	52,3	122,3	2,58	0,55	Buckling	1
Br24	Tussenschot +5,06m	Enkele staaf	L50x5	S355J0	M16	8.8	1,99	0	204	**17,2**	**0,75**	23,6	60,3	41,3	43,1	0,81	0,95	Bending	
Br25	Tussenschot +14,6m	Enkele staaf	L120x10	S355J0	M16	8.8	2,80	0	118	**17,2**	**1,05**	243,4	60,3	87,1	399,8	9,8	0,29	shear	1
Br26	Tussenschot +14,6m	Enkele staaf	L90x8	S355J0	M16	8.8	3,98	0	226	**17,2**	**1,49**	58,6	60,3	69,7	225,8	4,3	0,36	Bending	1
Br27	Tussenschot +14,6m	Kruisende staaf halverwege	L50x5	S355J0	M16	8.8	2,80	0	144	**17,2**	**0,53**	39,2	60,3	41,3	43,1	1,1	0,48	Bending	1
Mi1	Middenstuk1	Enkele staaf	L60x6	S355J0	M16	8.8	2,70	0	231	**19,0**	**1,01**	28,1	60,3	52,3	98,8	1,4	0,75	Bending	
Mi2	Middenstuk1	Enkele staaf	L55x6	S355J0	M16	8.8	2,52	0	235	**19,0**	**0,95**	24,9	60,3	51,5	75,3	1,2	0,85	Bending	
Mi3	Middenstuk1	Enkele staaf	L55x6	S355J0	M16	8.8	2,36	0	220	**19,0**	**0,89**	27,7	60,3	51,5	75,3	1,2	0,79	Bending	
Mi4	Middenstuk2	Enkele staaf	L55x6	S355J0	M16	8.8	2,19	0	204	**14,0**	**0,82**	31,1	60,3	51,5	75,3	1,2	0,73	Bending	
Mi5	Middenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	2,03	0	209	**14,0**	**0,76**	22,9	60,3	41,3	43,1	0,8	0,97	Bending	
Mi6	Middenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1,88	0	193	**14,0**	**0,71**	25,7	60,3	41,3	43,1	0,8	0,90	Bending	
Bo1	Bovenstuk1	Enkele staaf	L50x5	S355J0	M16	8.8	1,74	0	179	**14,0**	**0,65**	28,8	60,3	41,3	43,1	0,8	0,83	Bending	
Bo2	Bovenstuk1	Enkele staaf	L50x5	S355J0	M16	8.8	1,63	0	167	**11,3**	**0,61**	31,8	60,3	41,3	43,1	0,8	0,78	Bending	
Bo3	Bovenstuk1	Enkele staaf	L50x5	S355J0	M16	8.8	1,51	0	155	**11,3**	**0,57**	35,4	60,3	41,3	43,1	0,8	0,72	Bending	
Bo4	Bovenstuk1	Enkele staaf	L50x5	S355J0	M16	8.8	1,40	0	144	**11,3**	**0,53**	39,0	60,3	41,3	43,1	0,8	0,67	Bending	
Bo5	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1,30	0	134	**3,8**	**0,49**	43,0	60,3	41,3	43,1	0,8	0,62	Bending	
Bo6	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1,21	0	125	**3,8**	**0,45**	47,1	60,3	41,3	43,1	0,8	0,58	Bending	
Bo7	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1,13	0	116	**3,8**	**0,42**	51,1	60,3	41,3	43,1	0,8	0,54	Bending	
Bo8	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1,05	0	107	**3,8**	**0,39**	56,0	60,3	41,3	43,1	0,8	0,50	Bending	
Ot1	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,61	0	165	**3,3**	**0,60**	32,3	60,3	41,3	43,1	0,8	0,77	Bending	
Ot2	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,39	0	143	**3,3**	**0,52**	39,5	60,3	41,3	43,1	0,8	0,66	Bending	
Ot3	Ondertraverse	Enkele staaf	L60x6	S355J0	M16	8.8	1,26	0	108	**3,3**	**0,47**	80,3	60,3	52,3	98,8	1,4	0,35	Bending	
Ot4	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,15	0	118	**3,3**	**0,43**	50,2	60,3	41,3	43,1	0,8	0,55	Bending	
Ot5	Ondertraverse	Enkele staaf	L55x6	S355J0	M16	8.8	2,20	0	205	**3,3**	**0,83**	30,8	60,3	51,5	75,3	1,2	0,74	Bending	
Ot6	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,95	0	200	**3,3**	**0,73**	24,4	60,3	41,3	43,1	0,8	0,93	Bending	
Ot7	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,72	0	177	**3,3**	**0,65**	29,4	60,3	41,3	43,1	0,8	0,82	Bending	

Redundant members

Date: 2021-07-27
Author: TBR
Version: 1.9

RLL-TLB
S+12_c

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.	Max. usage	Notes
Ot8	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,54	0	158	**3,3**	**0,58**	34,4	60,3	41,3	43,1	0,8	0,74	Bending	
Ot9	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,35	0	139	**3,3**	**0,51**	41,1	60,3	41,3	43,1	0,8	0,65	Bending	
Ot10	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,17	0	120	**3,3**	**0,44**	49,2	60,3	41,3	43,1	0,8	0,56	Bending	
Mt1	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,46	0	150	**3,3**	**0,55**	37,0	60,3	41,3	43,1	0,8	0,70	Bending	
Mt2	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,37	0	141	**3,3**	**0,51**	40,3	60,3	41,3	43,1	0,8	0,65	Bending	
Mt3	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,30	0	134	**4,0**	**0,49**	43,1	60,3	41,3	43,1	0,8	0,62	Bending	
Mt4	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,24	0	127	**4,0**	**0,47**	45,8	60,3	41,3	43,1	0,8	0,59	Bending	
Mt5	Middentraverse	Enkele staaf	L55x6	S355J0	M16	8.8	2,31	0	216	**4,0**	**0,87**	28,6	60,3	51,5	75,3	1,2	0,78	Bending	
Mt6	Middentraverse	Enkele staaf	L55x6	S355J0	M16	8.8	1,06	0	99	**4,0**	**0,40**	80,4	60,3	51,5	75,3	1,2	0,36	Bending	
Mt7	Middentraverse	Enkele staaf	L55x6	S355J0	M16	8.8	2,05	0	191	**4,0**	**0,77**	34,3	60,3	51,5	75,3	1,2	0,69	Bending	
Mt8	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,72	0	177	**4,0**	**0,65**	29,4	60,3	41,3	43,1	0,8	0,82	Bending	
Mt9	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,58	0	162	**4,0**	**0,59**	33,2	60,3	41,3	43,1	0,8	0,76	Bending	
Mt10	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,34	0	138	**4,0**	**0,50**	41,5	60,3	41,3	43,1	0,8	0,64	Bending	
Mt11	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,23	0	126	**4,0**	**0,46**	46,3	60,3	41,3	43,1	0,8	0,59	Bending	
Mt12	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,11	0	114	**4,3**	**0,42**	52,3	60,3	41,3	43,1	0,8	0,53	Bending	
Bt1	Boventraverse	Enkele staaf	L55x6	S355J0	M16	8.8	2,10	0	196	**4,3**	**0,79**	33,1	60,3	51,5	75,3	1,2	0,71	Bending	
Bt2	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	2,01	0	207	**4,3**	**0,75**	23,2	60,3	41,3	43,1	0,8	0,96	Bending	
Bt3	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,82	0	187	**4,3**	**0,68**	27,0	60,3	41,3	43,1	0,8	0,87	Bending	
Bt4	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,55	0	159	**4,3**	**0,58**	34,1	60,3	41,3	43,1	0,8	0,74	Bending	
Bt5	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,46	0	150	**4,3**	**0,55**	37,0	60,3	41,3	43,1	0,8	0,70	Bending	
Bt6	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,29	0	133	**4,3**	**0,48**	43,6	60,3	41,3	43,1	0,8	0,62	Bending	
Bt7	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,22	0	125	**4,3**	**0,46**	46,7	60,3	41,3	43,1	0,8	0,58	Bending	
Bt8	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,15	0	118	**4,3**	**0,43**	50,2	60,3	41,3	43,1	0,8	0,55	Bending	
Bt9	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1,07	0	110	**4,3**	**0,40**	54,6	60,3	41,3	43,1	0,8	0,51	Bending	
HS1	High Step	Enkele staaf	L80x6	S355J0	M16	8.8	3,25	0	207	**0,0**	**2,44**	45,2	60,3	52,3	145,8	2,7	0,95	Bending	
HS2	High Step	Enkele staaf	L70x7	S355J0	M16	8.8	2,80	0	205	**0,0**	**2,10**	46,0	60,3	61,0	142,7	2,2	0,97	Bending	
1)	Also checked in PLS-TOWER																		

APPENDIX D
Blokdeuvels

Belasting

De belastingen op de fundatie uit Appendix A zijn uitgangspunt voor de berekening van de ingestorte rand met blokdeuvels. De belastingen in de richting van de randstijl zijn van toepassing. In de tabellen is dit opgenomen in de laatste kolom $R_{z,lok}$. De controles zijn uitgevoerd met een spreadsheet. Vanwege de helling van de drukdiagonaal wordt per krachtsrichting bepaald hoeveel deuvels effectief zijn.

Voor de berekening van de blokdeuvels zijn de masttypen als volgt samengevoegd:

- Masttype S-3/c en S+0/c
- Masttype S+3/c en S+6/c
- Masttype S+9/c en S+12/c

De blokdeuvels worden getoetst op de maatgevende belasting per samenvoeging van masttypen (hoogste mast is maatgevend). De belastingen waaraan getoetst worden zijn onderstaand weergegeven.

Masttype S-3/c en S+0/c

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_90	291	234	**1766**	41	-371	3	1806
Max. trek	ULS 1a_0,9_0,9_90	-226	168	**-1369**	41	279	-12	-1400
Max. pos. torsie	ULS 5a Ah 21	45	-41	-15	**61**	-3	-6	-15
Max. neg. torsie	ULS 5a Ba 21	-45	-41	-15	**-61**	-3	-6	-15
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-226	168	**-1369**	**41**	279	-12	-1400

Masttype S+3/c en S+6/c

Omhullenden ongeacht stijl

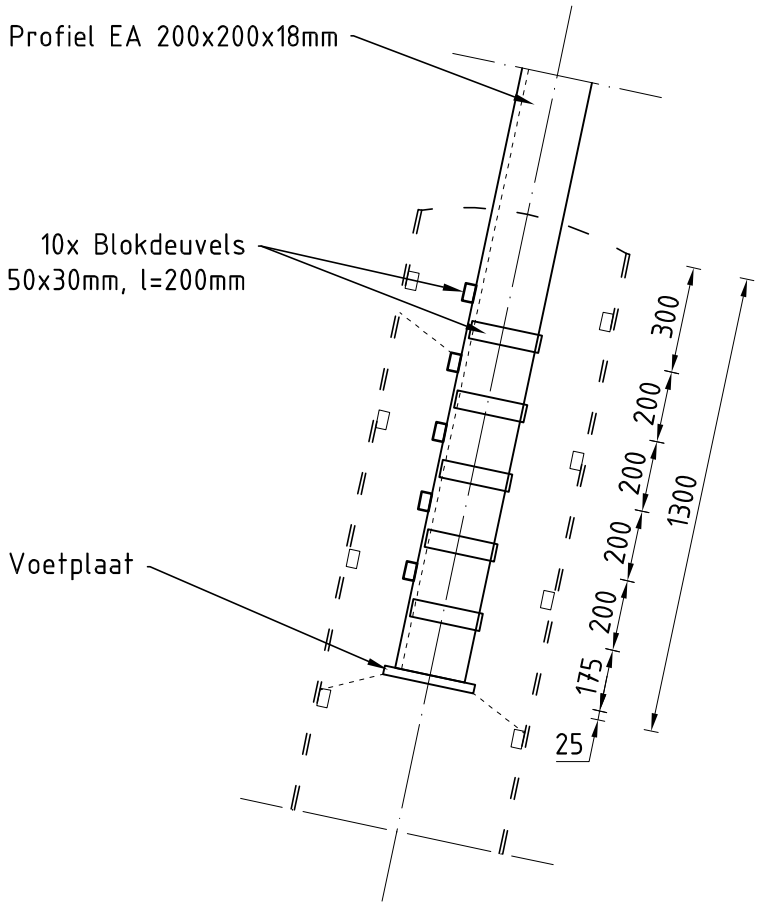
Belasting	Combinatie	R_x [kN]	R_y [kN]	R_z [kN]	R_η [kN]	R_ξ [kN]	$R_{\xi,lok}$ [kN]	$R_{z,lok}$ [kN]
Max. druk	ULS 1a_45	307	278	**1909**	21	-414	-9	1952
Max. trek	ULS 1a_0,9_0,9_45	238	209	**-1491**	-21	316	0	-1524
Max. pos. torsie	ULS 5a Ah 21	43	-36	-11	**56**	-4	-7	-11
Max. neg. torsie	ULS 5a Ba 21	-43	-36	-11	**-56**	-4	-7	-11
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-245	184	**-1483**	**43**	303	-12	-1516

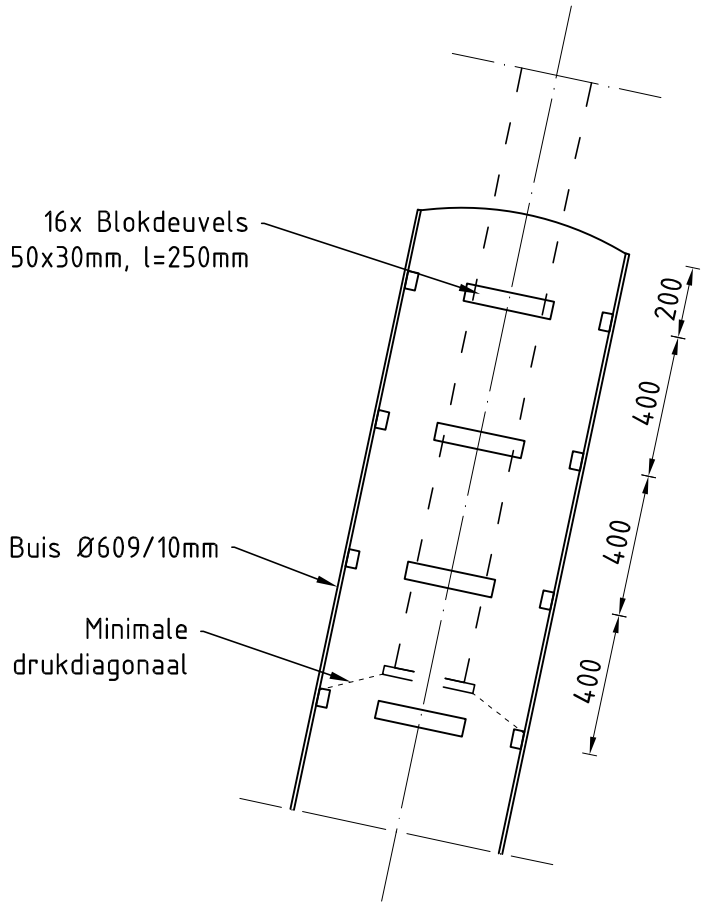
Masttype S+9/c en S+12/c

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	329	303	**2001**	19	-447	-23	2045
Max. trek	ULS 1a_0,9_0,9_45	248	221	**-1506**	-19	332	12	-1540
Max. pos. torsie	ULS 5a Ah 21	43	-25	30	**49**	-13	-7	30
Max. neg. torsie	ULS 5a Ba 21	-43	-25	30	**-49**	-13	-7	30
Comb. trek+torsie	ULS 1a_0,9_0,9_90	-242	194	**-1469**	**34**	308	-3	-1501

Principe blokdeuvels - S+0/c & S-3/c





Algemene opmerkingen

- Aarding niet aangegeven
- Spiraalwapening niet aangegeven

Project: RLL-TBG
Mast: S-3/c & S+0/c

Shear blocks

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

Datum: 2021-07-27
Auteur: TBR
Versie: 1.5

Load				***Results***			
Compression	$F_{Ed,c}$	**1806**	kN	Compression	U.C.	0,92	< 1,00 OK
Tension	$F_{Ed,t}$	**1401**	kN	Tension	U.C.	0,75	< 1,00 OK

Main leg

Profile		**L200x18**	
Type		Single	
Steel material		S355	
Cross section		6911	mm^2
Axial capacity	N_{pl}	2453	kN
Width	b	200	mm
Thickness	t	18	mm
Length in concrete		1300	mm

Capacity shear blocks main leg

$A_{f1} = A_{f1,out} + A_{f1,in}$ =	6000	mm^2
$A_{f2} = A_{f2,out} + A_{f2,in}$ =	15400	mm^2
Slope	1: 5	
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1,60	
$f_{jd} = C_A \times f_{cd}$ =	24,1	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	1156	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	1156	kN

Shear blocks main leg

Sides		1 (outside)	
Width	b	50	mm
Thickness	h	30	mm
Length - outside	L_{out}	200	mm
Length - inside	L_{in}		mm
Eccentricity	e	-10	mm
Welds	a	5	mm
c.t.c. separation	s	200	mm
Number for compr.	n_c	8	-
Number for tension	n_t	8	-

Capacity foot plate

k_d =	1,73	-
$f_{jd} = C_A \times f_{cd}$ =	26,0	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	53	mm
m* = min(c,m) =	30	mm
Type foot plate	Extending	
Effective for	Compr. and tension	
$A_{p,c}$ =	34511	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	899	kN
$A_{p,t}$ =	27600	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	719	kN

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Capacities

$F_{rd,c,plate}$ =	899	kN
$F_{rd,blocks,c}$ =	1156	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**2055**	kN
U.C. compression	0,88	< 1,00 OK
Welds foot plate (see next page)	961	kN
$F_{rd,t}$ = min. (welds / foot plate) =	719	kN
$F_{rd,blocks,t}$ =	1156	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**1875**	kN
U.C. tension	0,75	< 1,00 OK
U.C. welds	0,44	< 1,00 OK

Pile

Name	Buispaal	
Diameter	609	mm
Thickness	10	mm
Cross section	18818	mm^2
Steel material	S355	
Capacity	6680	kN
Concrete strength	C30/37	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	250	mm
Welds	a	5	mm
c.t.c. separation	s	350	mm
Number for compr.	n_c	12	-
Number for tension	n_t	12	-
Blocks per row	n_{bl}	4	-
Effectivity of total	c_{red}	75%	-

Capacity shear blocks pile

A_{f1} =	7500	mm^2
A_{f2} =	28212	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1,94	-
$f_{jd} = k_d \times f_{cd}$ =	29,2	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd} \times c_{red}$ =	**1969**	kN
U.C. compression	0,92	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd} \times c_{red}$ =	**1969**	kN
U.C. tension	0,71	< 1,00 OK
U.C. welds	0,44	< 1,00 OK

Design value concrete strength

Material factor	γ_c	1,5	
Add. mat. factor	γ_m	1,33	-
f_{cd} =		15,0	N/mm^2

Steel tower stub

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

"Splitting" of pile

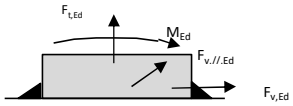
Spread of forces		45	°
Length force flow		1006	mm
Splitting force		697	kN/m
Yield strength wall	f_{yd} =	355	N/mm^2
Capacity tubular pile		7100	kN/m
U.C.		0,10	< 1,00 OK

Project: RLL-TBG
Mast: S-3/c & S+0/c

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	-



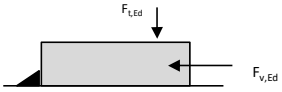
Member forces			***Stress components***		
Factor	1,2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 4al$ =	61	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**173**	kN		61	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54,7	mm
$M_{Ed} = 1/2\ b / h \times F_{v,Ed}$ =	**2,60**	kNm	$\sigma_1 = \tau_1 = 0{,}706 M_{Ed} / al\ b^*$ =	34	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	190	N/mm^2

Check								
$\sigma_{vw,Ed}$ =	190	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0,44** OK
σ_1 =	95	N/mm^2	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0,27** OK

Welds of shear blocks of pile

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	-



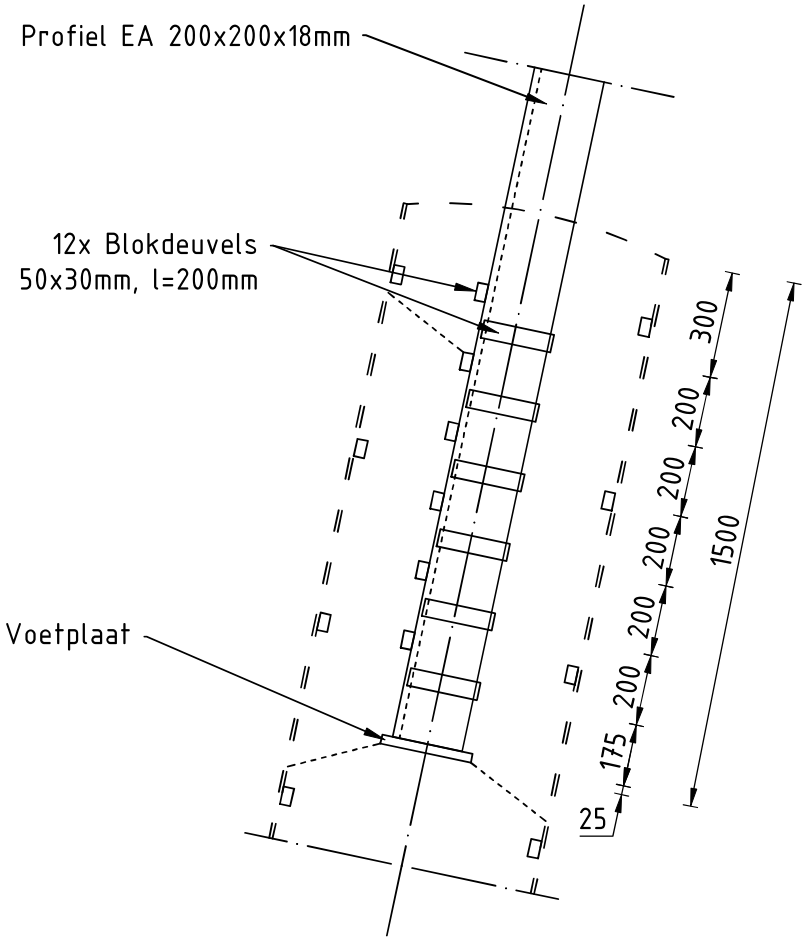
Member forces			***Stress components***		
Factor	1,2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 2al$ =	22	N/mm^2
$F_{t,Ed} = 1/2\ b / h \times F_{v,Ed}$ =	**79**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 2al$ =	74	N/mm^2
$F_{v,Ed}$ =	**262**	kN		97	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0,00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	193	N/mm^2

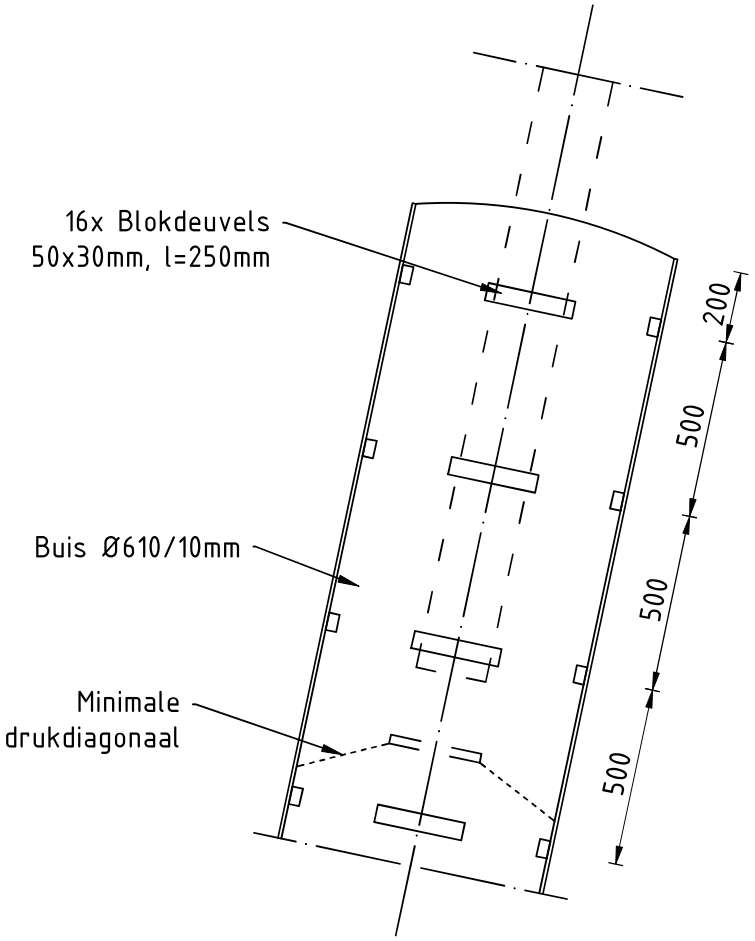
Check								
$\sigma_{vw,Ed}$ =	193	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0,44** OK
σ_1 =	97	N/mm^2	≤	$0{,}9 f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0,27** OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm^2
Weld size	a =	5	mm
Length	l = 2b+ 2b - t =	764	mm
Capacity	$F_{Rd} = a \times l \times f_{w,d} / \sqrt{3}$ =	**961**	kN

Principe blokdeuvels - S+3/c en S+6/c





Algemene opmerkingen

- Aarding niet aangegeven
- Spiraalwapening niet aangegeven

Project: RLL-TBG
Mast: S+3/c & S+6/c

Shear blocks

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

Datum: 2021-07-27
Auteur: TBR
Versie: 1.5

Load				***Results***			
Compression	$F_{Ed,c}$	**1952**	kN	Compression	U.C.	0,83	< 1,00 OK
Tension	$F_{Ed,t}$	**1524**	kN	Tension	U.C.	0,70	< 1,00 OK

Main leg

Profile		**L200x18**	
Type		Single	
Steel material		S355	
Cross section		6911	mm^2
Axial capacity	N_{pl}	2453	kN
Width	b	200	mm
Thickness	t	18	mm
Length in concrete		1500	mm

Capacity shear blocks main leg

$A_{f1} = A_{f1,out} + A_{f1,in}$ =	6000	mm^2
$A_{f2} = A_{f2,out} + A_{f2,in}$ =	15400	mm^2
Slope	1: 5	
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1,60	
$f_{jd} = C_A \times f_{cd}$ =	24,1	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	1445	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	1445	kN

Shear blocks main leg

Sides		1 (outside)	
Width	b	50	mm
Thickness	h	30	mm
Length - outside	L_{out}	200	mm
Length - inside	L_{in}		mm
Eccentricity	e	-10	mm
Welds	a	5	mm
c.t.c. separation	s	200	mm
Number for compr.	n_c	10	-
Number for tension	n_t	10	-

Capacity foot plate

k_d =	1,73	-
$f_{jd} = C_A \times f_{cd}$ =	26,0	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	53	mm
m* = min(c,m) =	30	mm
Type foot plate	Extending	
Effective for	Compr. and tension	
$A_{p,c}$ =	34511	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	899	kN
$A_{p,t}$ =	27600	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	719	kN

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Capacities

$F_{rd,c,plate}$ =	899	kN
$F_{rd,blocks,c}$ =	1445	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**2344**	kN
U.C. compression	0,83	< 1,00 OK
Welds foot plate (see next page)	961	kN
$F_{rd,t}$ = min. (welds / foot plate) =	719	kN
$F_{rd,blocks,t}$ =	1445	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**2164**	kN
U.C. tension	0,70	< 1,00 OK
U.C. welds	0,44	< 1,00 OK

Pile

Name	Buispaal	
Diameter	609	mm
Thickness	10	mm
Cross section	18818	mm^2
Steel material	S355	
Capacity	6680	kN
Concrete strength	C30/37	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	250	mm
Welds	a	5	mm
c.t.c. separation	s	500	mm
Number for compr.	n_c	12	-
Number for tension	n_t	12	-
Blocks per row	n_{bl}	4	-
Effectivity of total	c_{red}	75%	-

Capacity shear blocks pile

A_{f1} =	7500	mm^2
A_{f2} =	41087	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	2,34	-
$f_{jd} = k_d \times f_{cd}$ =	35,2	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd} \times c_{red}$ =	**2376**	kN
U.C. compression	0,82	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd} \times c_{red}$ =	**2376**	kN
U.C. tension	0,64	< 1,00 OK
U.C. welds	0,53	< 1,00 OK

Design value concrete strength

Material factor	γ_c	1,5	
Add. mat. factor	γ_m	1,33	-
f_{cd} =		15,0	N/mm^2

Steel tower stub

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

"Splitting" of pile

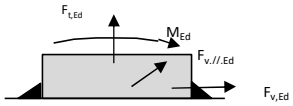
Spread of forces		45	°
Length force flow		1206	mm
Splitting force		632	kN/m
Yield strength wall	f_{yd} =	355	N/mm^2
Capacity tubular pile		7100	kN/m
U.C.		0,09	< 1,00 OK

Project: RLL-TBG
Mast: S+3/c & S+6/c

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	-



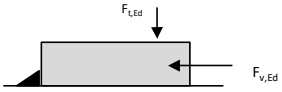
Member forces			***Stress components***		
Factor	1,2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 4al$ =	61	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**173**	kN		61	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54,7	mm
M_{Ed} = 1/2 b / h x $F_{v,Ed}$ =	**2,60**	kNm	$\sigma_1 = \tau_1 = 0{,}706M_{Ed} / al\, b^*$ =	34	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	190	N/mm^2

Check								
$\sigma_{vw,Ed}$ =	190	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0,44** OK
σ_1 =	95	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0,27** OK

Welds of shear blocks of pile

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	-



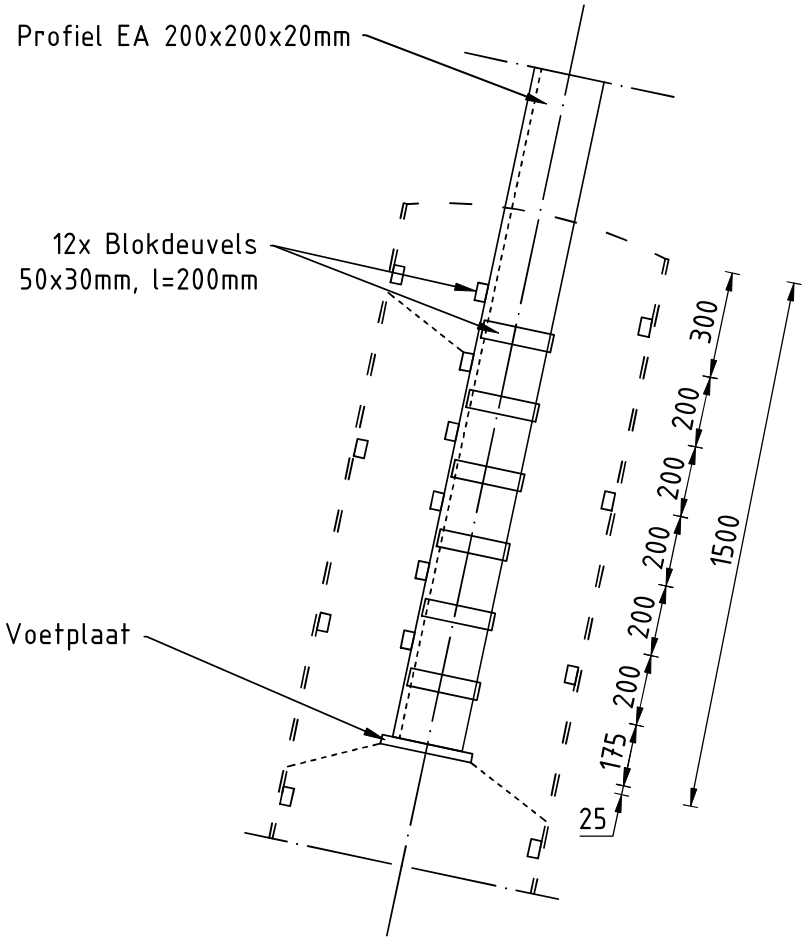
Member forces			***Stress components***		
Factor	1,2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 2al$ =	27	N/mm^2
$F_{t,Ed}$ = 1/2 b / h x $F_{v,Ed}$ =	**95**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 2al$ =	90	N/mm^2
$F_{v,Ed}$ =	**317**	kN		116	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0,00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	233	N/mm^2

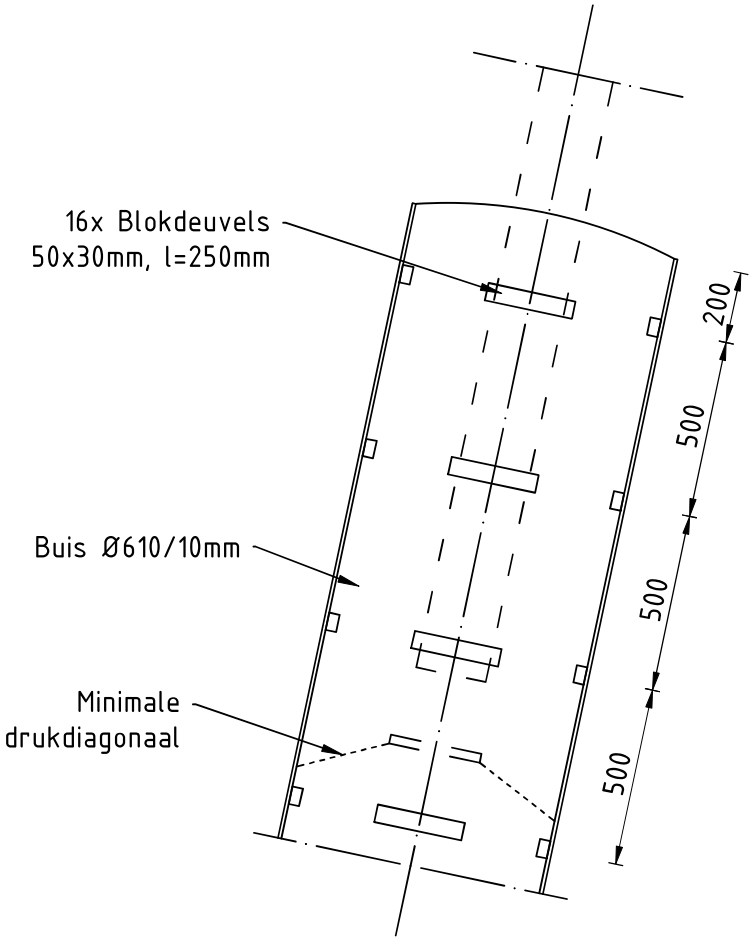
Check								
$\sigma_{vw,Ed}$ =	233	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0,53** OK
σ_1 =	116	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0,33** OK

Welds of foot plate

$f_u / \beta_w \gamma_{M2}$ =		436	N/mm^2
Weld size	a =	5	mm
Length	l = 2b+ 2b - t =	764	mm
Capacity	$F_{Rd} = a \times l \times f_{w,d} / \sqrt{3}$ =	**961**	kN

Principe blokdeuvels - S+9/c & S+12/c





Algemene opmerkingen

- Aarding niet aangegeven
- Spiraalwapening niet aangegeven

Project: RLL-TBG
Mast: S+9/c & S+12/c

Shear blocks

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

Datum: 2021-07-27
Auteur: TBR
Versie: 1.5

Load				***Results***			
Compression	$F_{Ed,c}$	**2046**	kN	Compression	U.C.	0,87	< 1,00 OK
Tension	$F_{Ed,t}$	**1540**	kN	Tension	U.C.	0,71	< 1,00 OK

Main leg

Profile		**L200x20**	
Type		Single	
Steel material		S355	
Cross section		7635	mm^2
Axial capacity	N_{pl}	2710	kN
Width	b	200	mm
Thickness	t	20	mm
Length in concrete		1500	mm

Capacity shear blocks main leg

$A_{f1} = A_{f1,out} + A_{f1,in}$ =	6000	mm^2
$A_{f2} = A_{f2,out} + A_{f2,in}$ =	15400	mm^2
Slope	1: 5	
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1,60	
$f_{jd} = C_A \times f_{cd}$ =	24,1	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	1445	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	1445	kN

Shear blocks main leg

Sides		1 (outside)	
Width	b	50	mm
Thickness	h	30	mm
Length - outside	L_{out}	200	mm
Length - inside	L_{in}		mm
Eccentricity	e	-10	mm
Welds	a	5	mm
c.t.c. separation	s	200	mm
Number for compr.	n_c	10	-
Number for tension	n_t	10	-

Capacity foot plate

k_d =	1,73	-
$f_{jd} = C_A \times f_{cd}$ =	26,0	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	53	mm
m* = min(c,m) =	30	mm
Type foot plate	Extending	
Effective for	Compr. and tension	
$A_{p,c}$ =	35235	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	918	kN
$A_{p,t}$ =	27600	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	719	kN

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Capacities

$F_{rd,c,plate}$ =	918	kN
$F_{rd,blocks,c}$ =	1445	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**2363**	kN
U.C. compression	0,87	< 1,00 OK
Welds foot plate (see next page)	956	kN
$F_{rd,t}$ = min. (welds / foot plate) =	719	kN
$F_{rd,blocks,t}$ =	1445	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**2164**	kN
U.C. tension	0,71	< 1,00 OK
U.C. welds	0,44	< 1,00 OK

Pile

Name	Buispaal	
Diameter	609	mm
Thickness	10	mm
Cross section	18818	mm^2
Steel material	S355	
Capacity	6680	kN
Concrete strength	C30/37	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	250	mm
Welds	a	5	mm
c.t.c. separation	s	500	mm
Number for compr.	n_c	12	-
Number for tension	n_t	12	-
Blocks per row	n_{bl}	4	-
Effectivity of total	c_{red}	75%	-

Capacity shear blocks pile

A_{f1} =	7500	mm^2
A_{f2} =	41087	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	2,34	-
$f_{jd} = k_d \times f_{cd}$ =	35,2	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd} \times c_{red}$ =	**2376**	kN
U.C. compression	0,86	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd} \times c_{red}$ =	**2376**	kN
U.C. tension	0,65	< 1,00 OK
U.C. welds	0,53	< 1,00 OK

Design value concrete strength

Material factor	γ_c	1,5	
Add. mat. factor	γ_m	1,33	-
f_{cd} =		15,0	N/mm^2

Steel tower stub

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

"Splitting" of pile

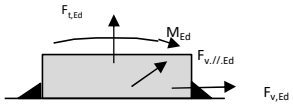
Spread of forces		45	°
Length force flow		1206	mm
Splitting force		639	kN/m
Yield strength wall	f_{yd} =	355	N/mm^2
Capacity tubular pile		7100	kN/m
U.C.		0,09	< 1,00 OK

Project: RLL-TBG
Mast: S+9/c & S+12/c

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	-



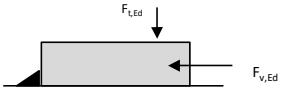
Member forces			***Stress components***		
Factor	1,2		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 4al$ =	61	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**173**	kN		61	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54,7	mm
M_{Ed} = 1/2 b / h x $F_{v,Ed}$ =	**2,60**	kNm	$\sigma_1 = \tau_1 = 0{,}706M_{Ed} / al\, b^*$ =	34	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	190	N/mm^2

Check								
$\sigma_{vw,Ed}$ =	190	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0,44** OK
σ_1 =	95	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0,27** OK

Welds of shear blocks of pile

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		$\sigma_1 = \tau_1 = F_{t,Ed} \sqrt{2} / 2al$ =	27	N/mm^2
$F_{t,Ed}$ = 1/2 b / h x $F_{v,Ed}$ =	**95**	kN	$\sigma_1 = \tau_1 = F_{v,Ed} \sqrt{2} / 2al$ =	90	N/mm^2
$F_{v,Ed}$ =	**317**	kN		116	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0,00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	233	N/mm^2

Check								
$\sigma_{vw,Ed}$ =	233	N/mm^2	≤	$f_u / \beta_w \gamma_{M2}$ =	436	N/mm^2	U.C. =	**0,53** OK
σ_1 =	116	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0,33** 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 =	760	mm
Capacity	$F_{Rd} = a \times l \times f_{w,d} / \sqrt{3}$ =	**956**	kN

APPENDIX E
Liggers

CHECK OF BEAMS COMBI-SUSPENSION TOWERS

1 INTRODUCTION

The following report studies the members subjected to bending forces in the S+0 C (combi) tower. Figure 1 shows the outline of the tower. The members subjected to large bending and torsion forces are highlighted in yellow and blocked in red rectangles. These members are studied in detail via this report.

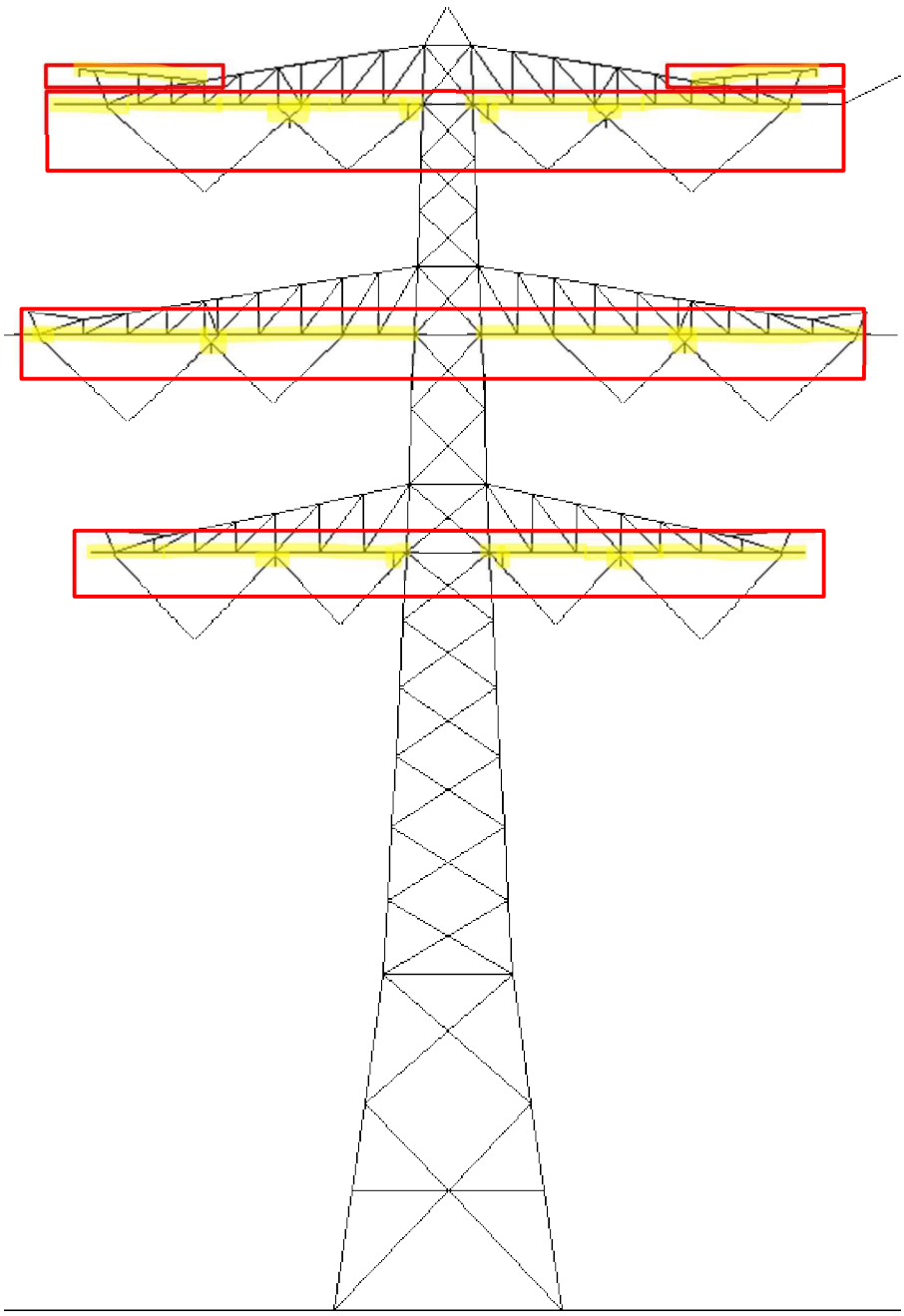


Figure 1 Front view of the S-c tower in PLS tower

The following are the aim of the current study:

1. To understand the structural efficacy of the H – Beams supporting the insulator assembly. The insulator assembly are attached the H beams eccentrically. Subsequently, the H – beams develop bi-axial bending and torsion. PLS tower, the application primarily used for the analysis of the towers is inept at checking structures for bending as well as torsion. Thus, the structures nesting the insulator assemblies are modelled and checked in AxisVM application.
2. The bottom chord of the cross arm develops bending moments due to the loading from the insulators. The moments are large enough, that they cannot be neglected and thus required to be checked in AxisVM.

1.1 Modelling and Geometry:

The geometry from PLS tower is exported and further developed in AxisVM. Figure 2 shows the cross – arms (referred as lower cross arm – LCA, Mid cross arm – MCA and Upper cross arm – UCA, here forth in this report) of the tower as modelled in AxisVM. The details of the profiles used is also visible. The nomenclature for the attachment points is given in Figure 2. The details of the beams nesting the insulator assembly is given in Figure 3.

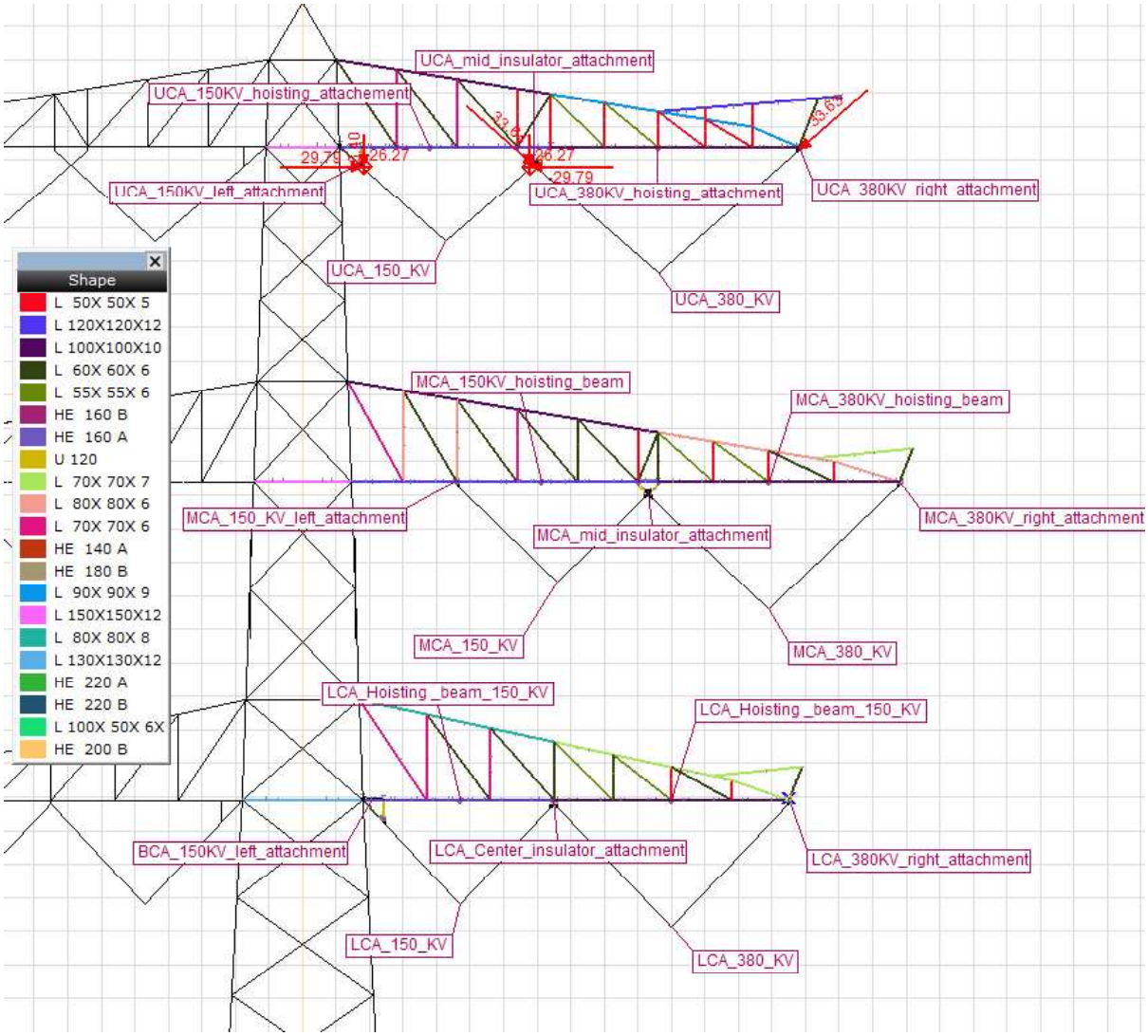
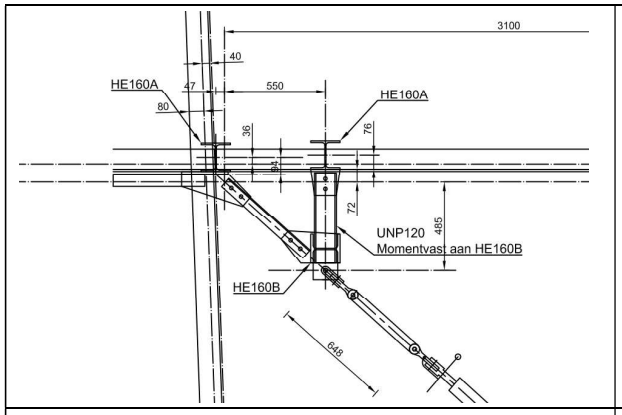
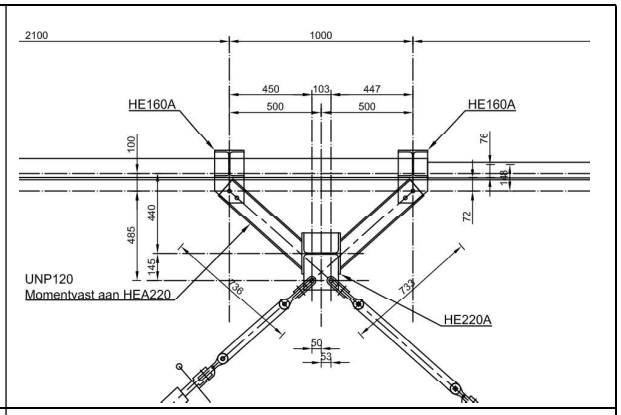


Figure 2 Geometry of cross arms in AxisVM.

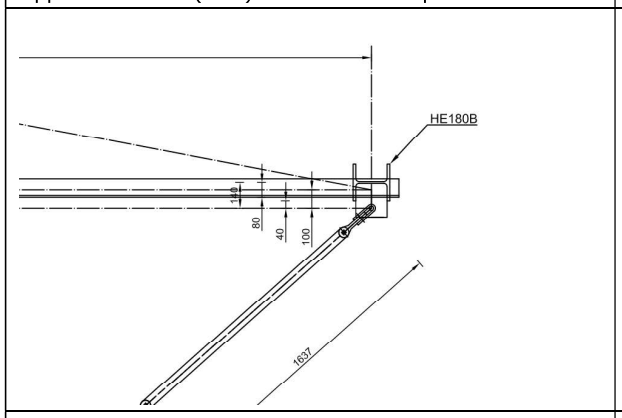
The details of the beam systems nesting the insulator assembly in the tower are shown in Figure 3. The size along with the location of the H beams are marked in the figure. The dimension marking the eccentricity in the system have been modelled in AxisVM to capture the torsion in the system.



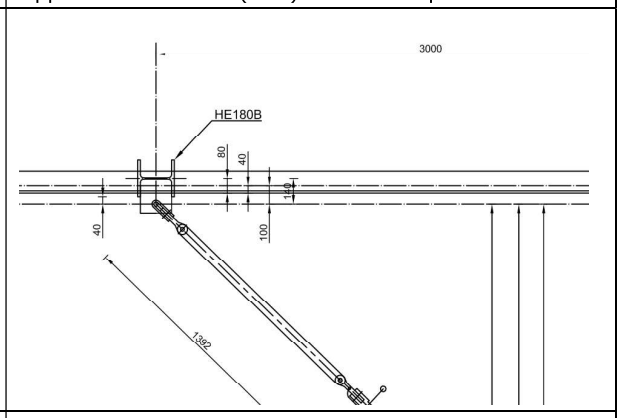
Upper cross arm (UCA) left attachment point



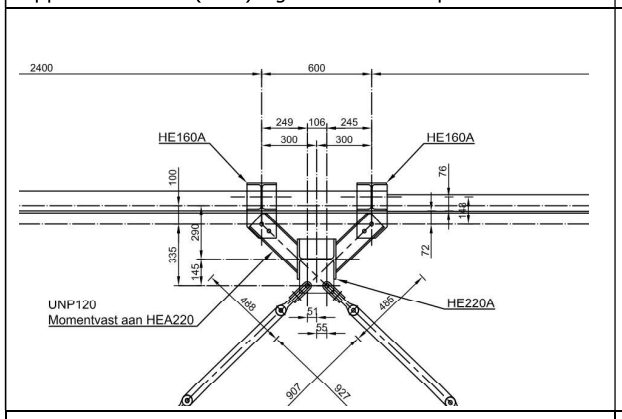
Upper cross arm mid (UCA) attachment point



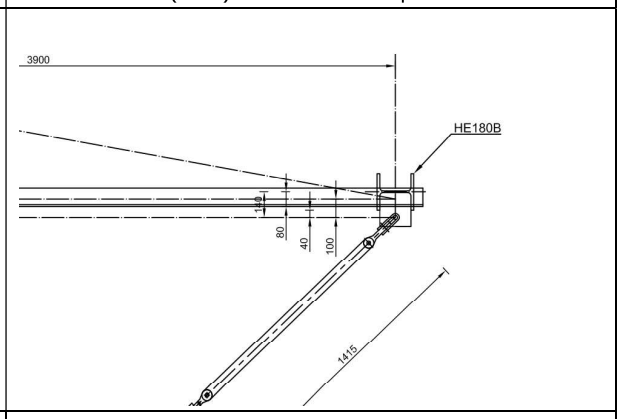
Upper cross arm (UCA) right attachment point



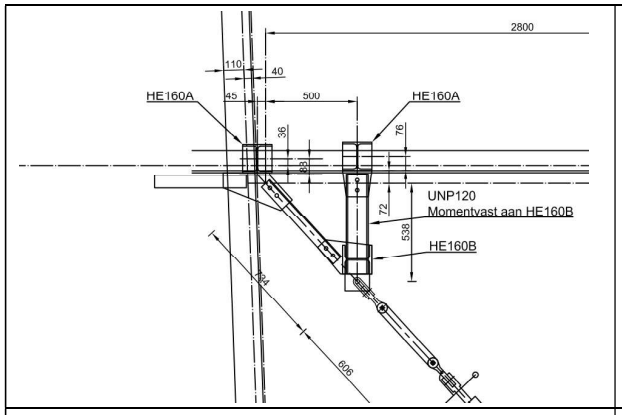
Mid cross arm (MCA) left attachment point



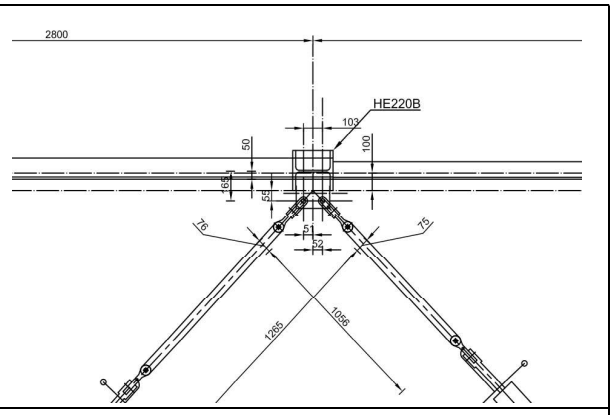
Mid cross arm (MCA) mid attachment point



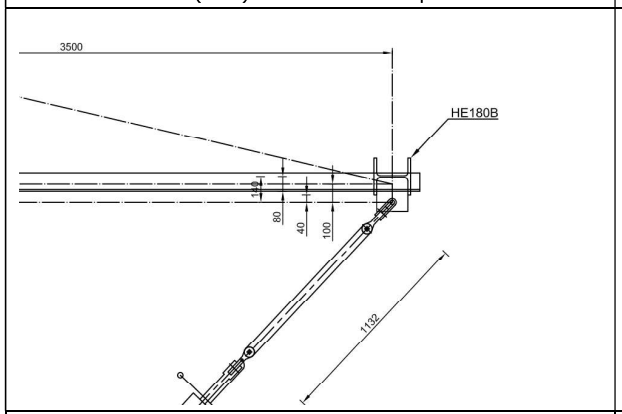
Mid cross arm (MCA) right attachment point



Lower cross arm (LCA) left attachment point



Lower cross arm (LCA) mid attachment point



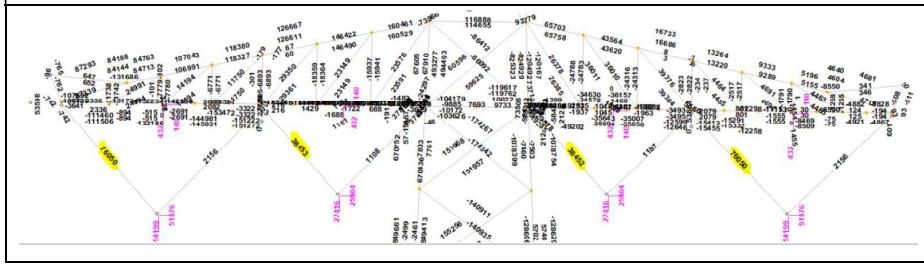
Lower cross arm (LCA) right attachment point

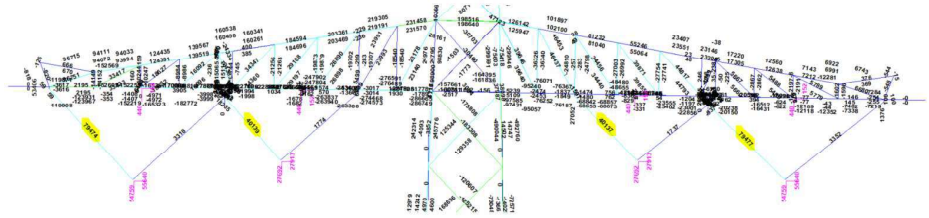
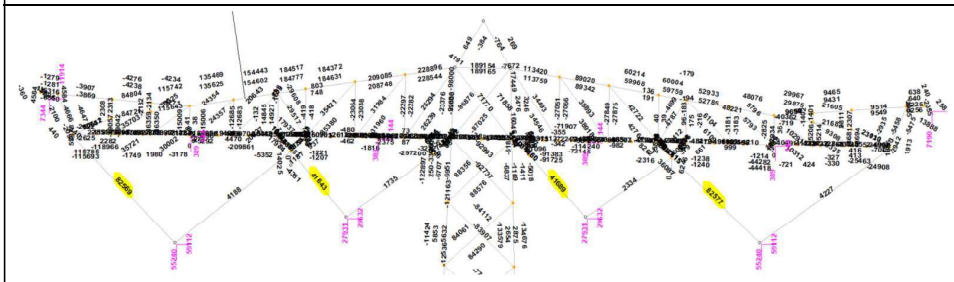
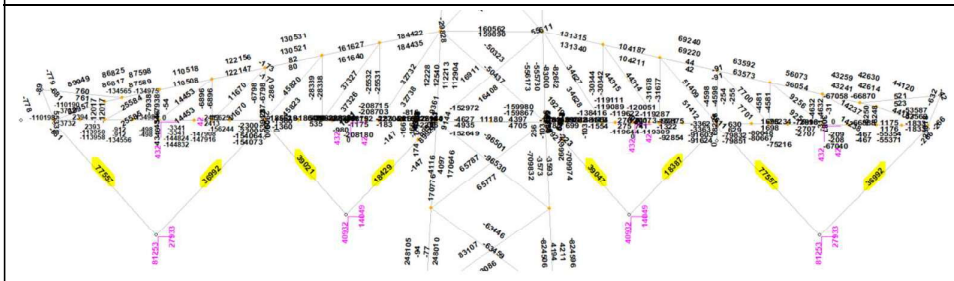
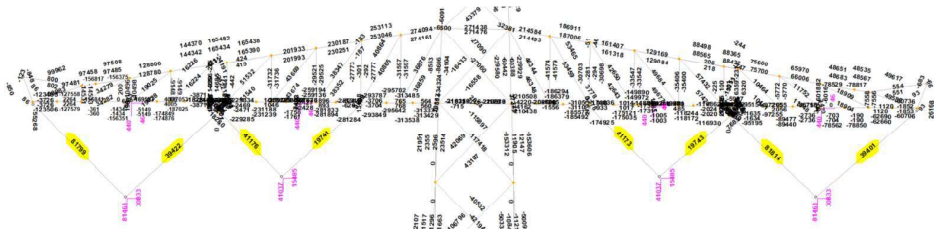
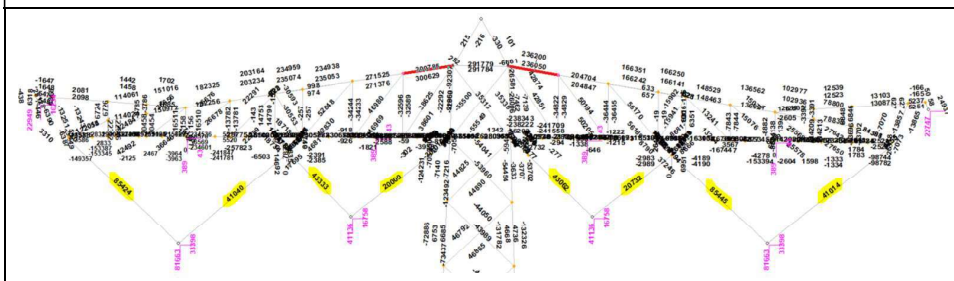
Figure 3 details of beam supporting the insulators

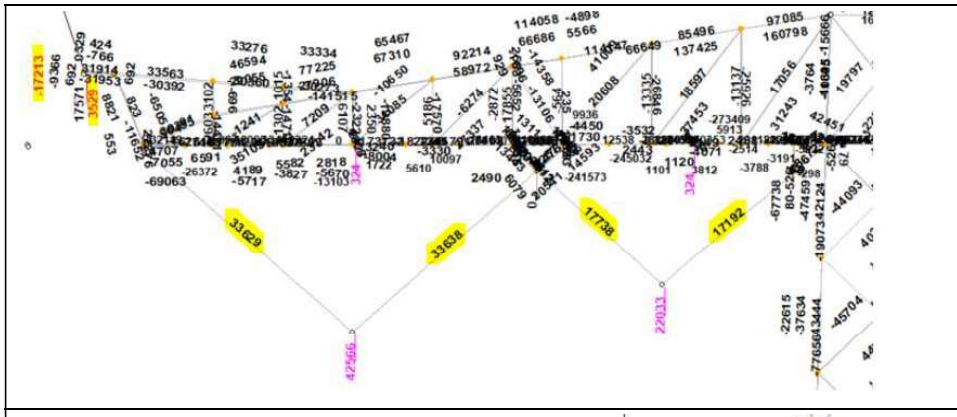
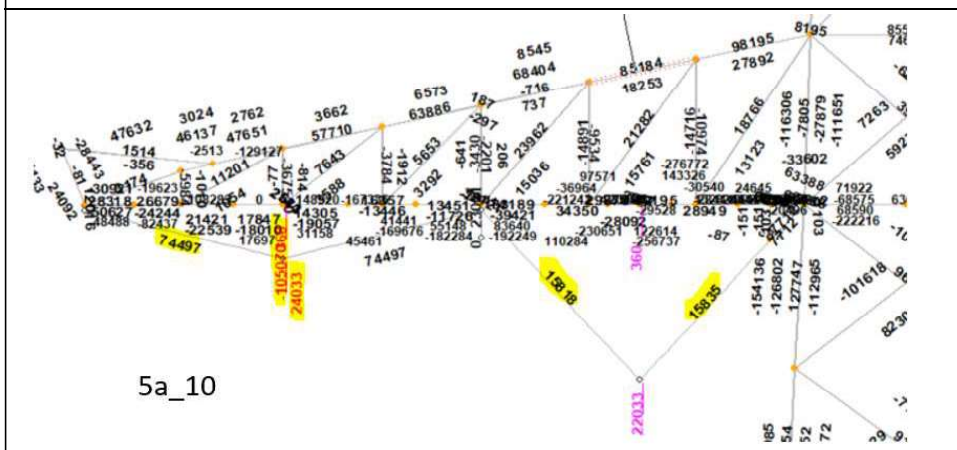
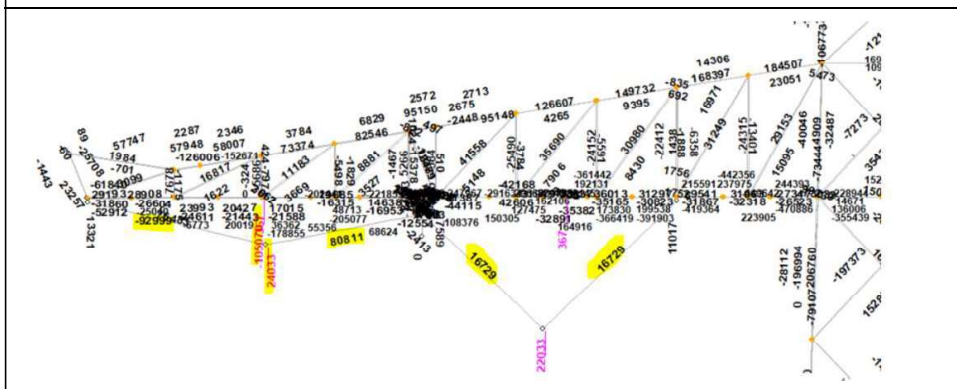
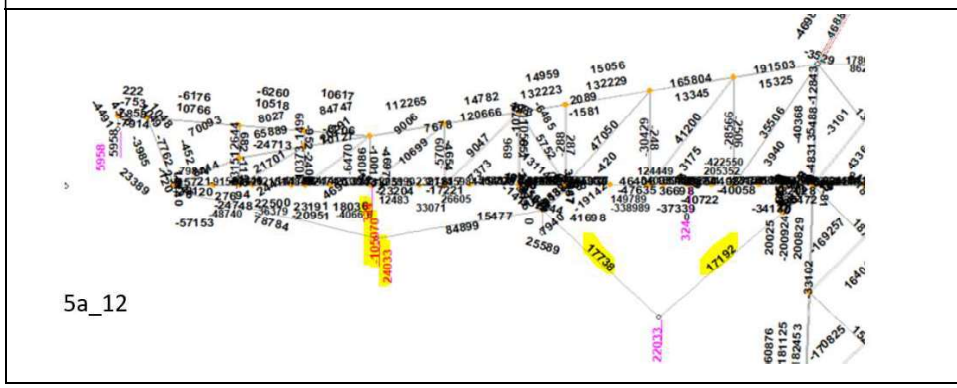
1.2 Loading

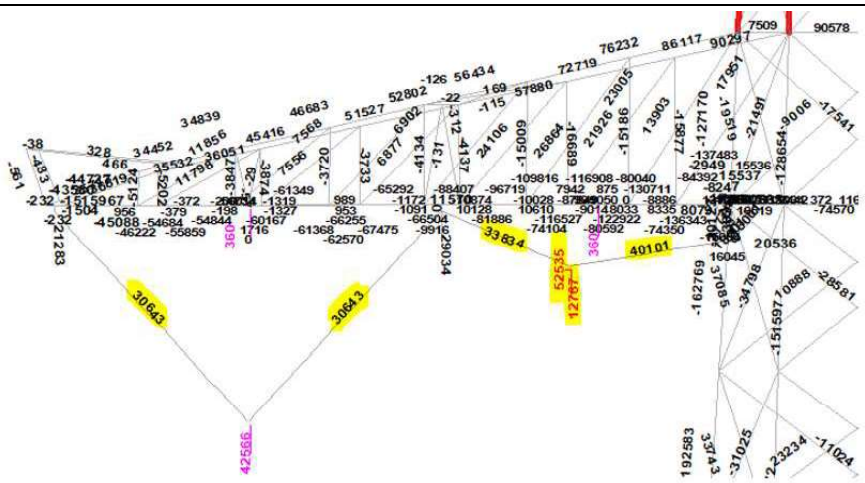
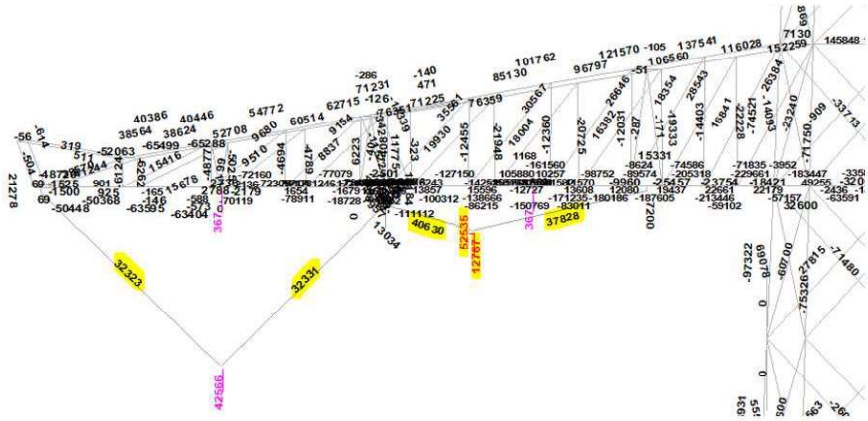
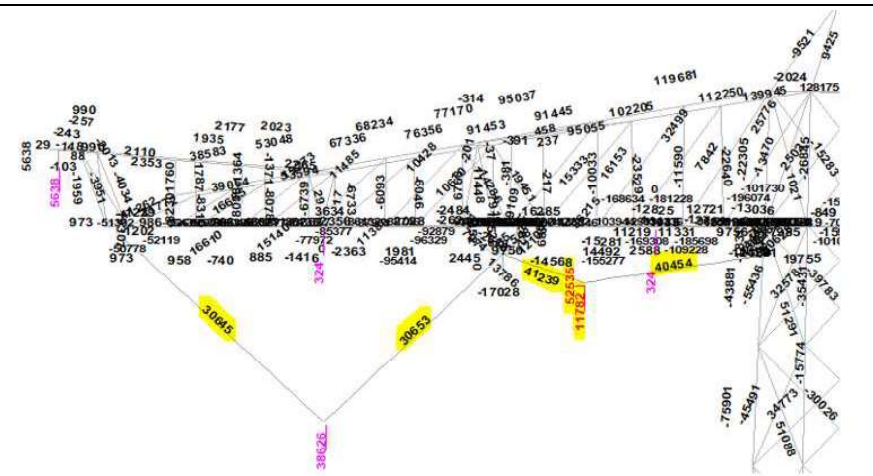
The loading is taken from the PLS tower. The following load cases are replicated in AxisVM. The details of the loads applied in PLS tower can be looked in the main report supplemented by "Geleiderbealsting calculation". Table 1 shows the details of the loads applied in AxisVM. The relevant loads are highlighted in yellow. The location of the load application is given along with Load case ID in the column – "Particulars". For load cases 1a_90 to 3_90, the loads are applied as point loads applied in the direction of the insulators. The value of the loads corresponds to the member forces in the insulators of the PLS tower output. The load cases 5a, 144 and 145 correspond to conductor and isolator failure. A load case for the loads coming on the tower during the hoisting of the isolators has been simulated.

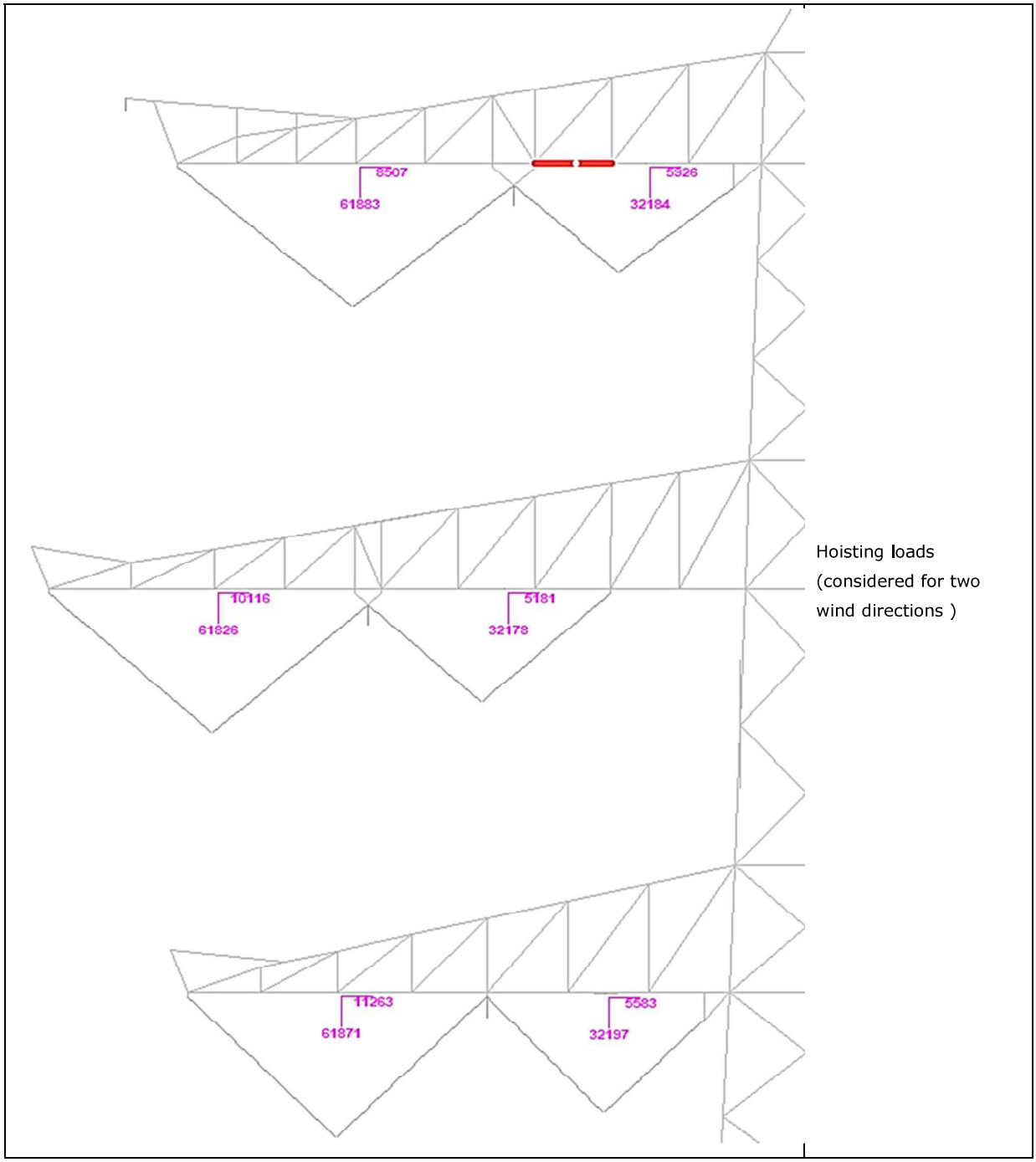
Table 1 Loading applied in AxisVM for various load cases

	Particulars
	ULS_1a_90 - LCA

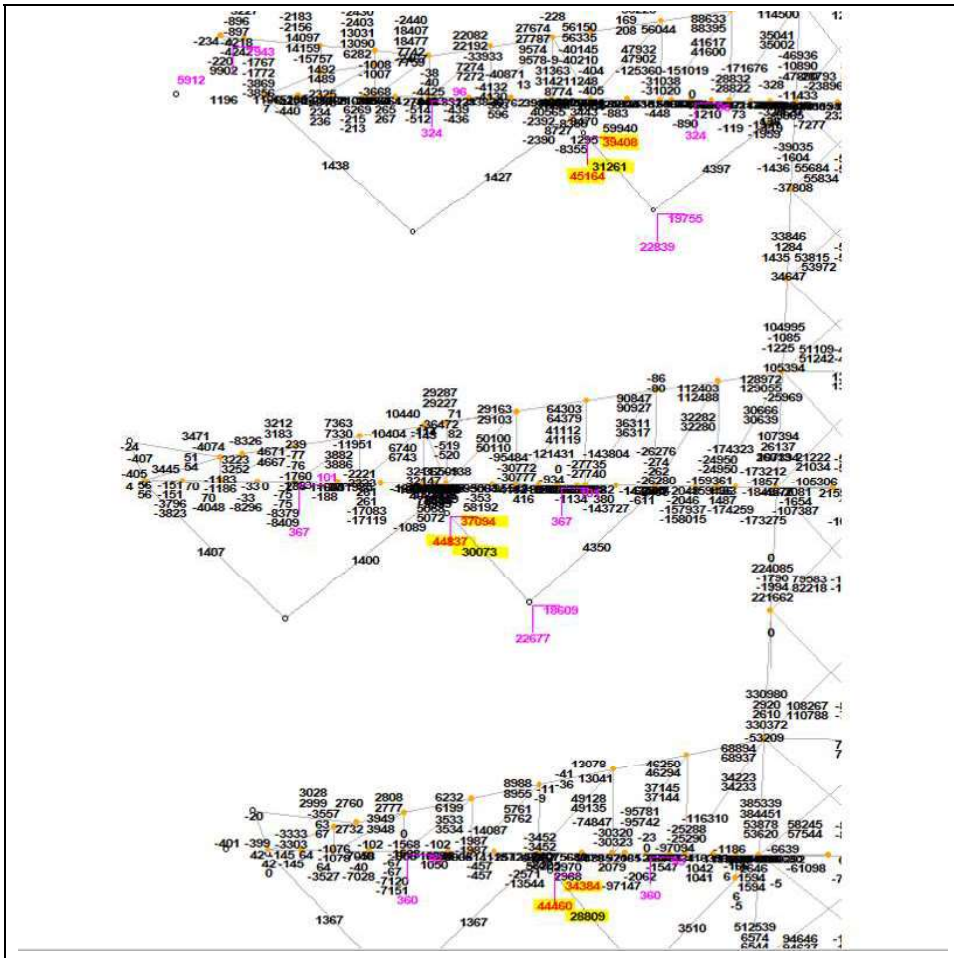
	ULS_1a_90 - MCA
	ULS_1a_90 - UCA
	ULS_3_90 - LCA
	ULS_3_90 - MCA
	ULS_3_90 - UCA

	ULS_5a_1 - UCA
	ULS_5a_10 - LCA
	ULS_5a_11 - MCA
	ULS_5a_12 - UCA

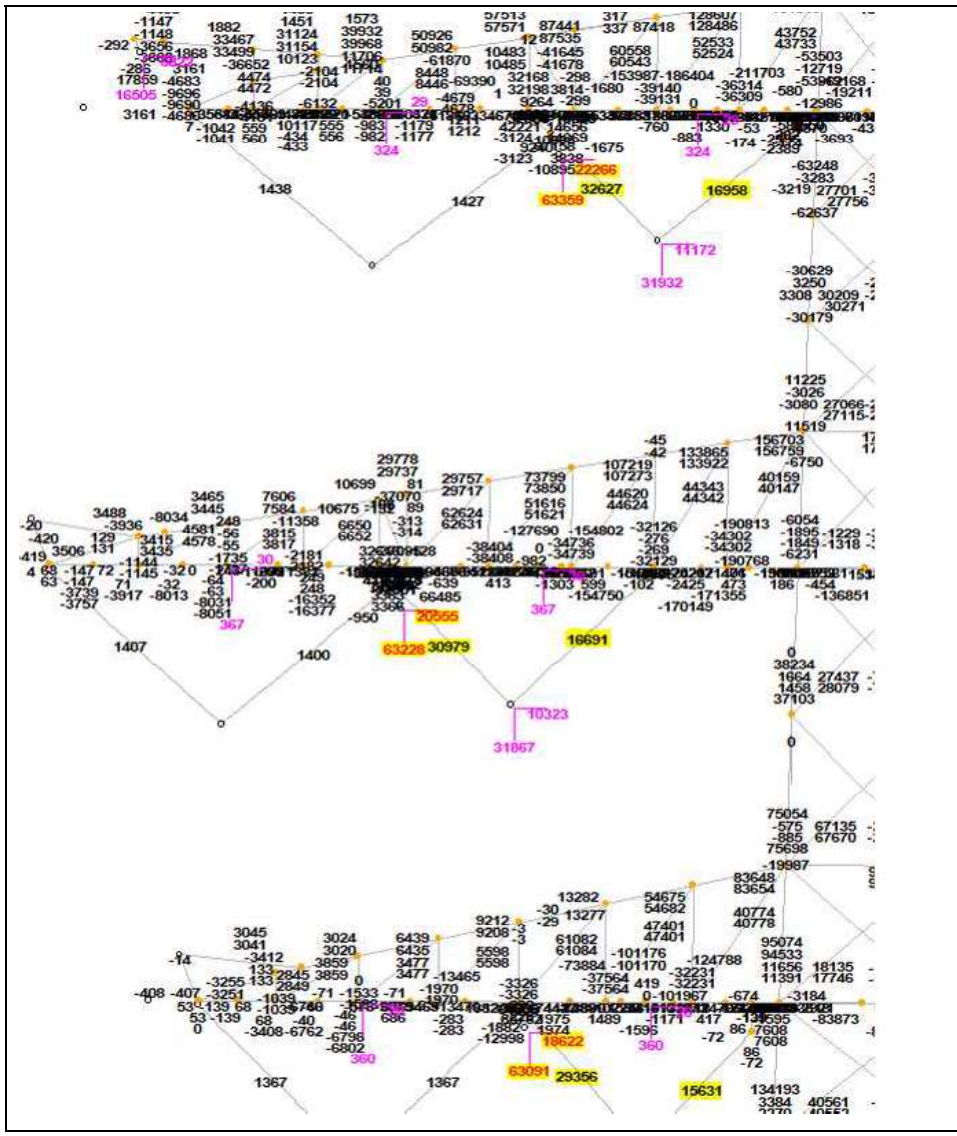
	ULS_5a_30 - LCA
	ULS_5a_31 - MCA
	ULS_5a_32 - UCA



Hoisting loads (considered for two wind directions)



144 SLS
1a_90_isolator_failure
(two wind directions considered)



145 SLS
3_90_isolator_failure
(two wind directions considered)

The failure of conductor on one side results in unbalanced forces on the insulator. The insulator swings out of the plane about the out of plane hinge, as marked in figure 4. The green arrows show the direction of insulator during load case 5a and the direction for rest of the load cases is marked in blue arrow. The part of load of insulator between the two hinges remains aligned the normal direction even during the conductor failure. This part has been shown in green dashed lines. The point of application of load during load case 5a thus changes from the in-plane hinge to the out of plane hinge

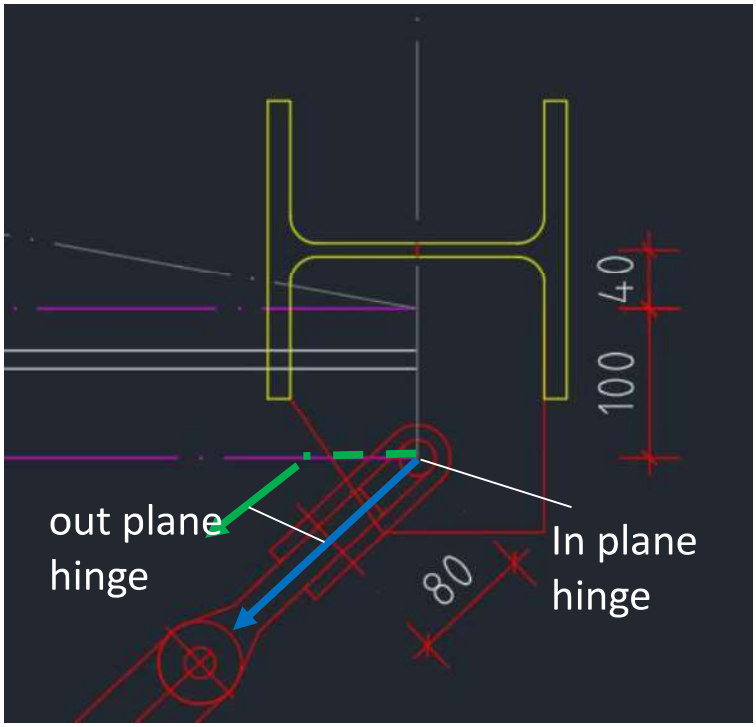


Figure 4 Out of plane hinge in the insulator.

Figure 5 shows the load application points for the right insulator attachment of the MCA in AxisVM model. The figure on right shows the load application for load case 3_90 (generic load case) at the in-plane hinge. The figure on right shows the load application for 5a_11 load case. The point of application has shifted the out of plane hinge. The out of plane hinge has swung to a horizontal position.

Figure 5 Load application points for load case 5a

The insulator is no longer in the vertical plane, when the conductor fails. Thus, the forces can no longer be applied along the determinate directions of insulators. The positions of the insulator are not determined. Forces to be applied at the vertical hinge is determined by evaluating the X and Y component of the force seen in the insulator in the PLS tower post processing. Table 2 and Table 3 gives the X & Y component for the load cases 5a as explained above.

Table 2 Horizontal loads for the 5a_10, 5a_11 & 5a_12

		5a_10 (LCA)	5a_11 (MCA)	5a_12 (UCA)
transverse	X	52.54	52.54	52.54
longitudinal	Y	49.85	55.55	60.01
Load from conductor		105.07	105.07	105.07
angle with vertical		43.50	46.60	48.80

Table 3 Horizontal loads for the 5a_30, 5a_31 & 5a_32

		5a_30 (LCA)	5a_31 (MCA)	5a_32 (UCA)
transverse	X	26.27	26.27	26.27
longitudinal	Y	24.41	27.49	29.79
Load from conductor		52.54	52.54	52.54
angle with vertical		42.90	46.30	48.60

The vertical force gets equally distributed at both the attachment point of the conductor.

1.3 Results

The internal forces in the beam assembly supporting the insulators is taken from AxisVM and checked via excel calculation for bending and torsion. The resulting stresses are compared against the yield limit. The detailed results from AxisVM can be found in the appendix – AxisVM report. The AxisVM package does not calculate the warping moment M_{wEd}. Hence, the beams with torsion is checked via excel calculation. Figure 5 to 8 gives the calculation for the H-beams in the LCA, MCA and UCA in the tower.

The stress in the beams due to combination of the internal forces is found to be within the yield limit.

Axis VM ID		10,11,12	70,71	13,14,15	541	1,2	546	3,4	
Beam Location		left_top_l	left_top_r	left_bot	hoisting beam	mid	hoisting beam	right	
Profile of beam		HEA 160	HEA 160	HEB 160	HEA 140	HEB220	HEA 140	HEA 220	
$M_{w,Ed}$ =									
$M_{y,Ed}$ =		4.5	16.6	7.2	24.5	35.4	26.6	14.6	*kNm*
$M_{z,Ed}$ =		3.8	0.4	7.3	0.5	35.4	4.8	14.2	*kNm*
Torsion =		1	0	2.1	0.3	5.4	0.6	7	*kNm*
Orientation of beam		y-as	y-as	z-as	y-as	z-as	y-as	z-as	
Torsional moment	T	1.00	0.00	2.10	0.30	5.40	0.60	7.00	*kNm*
Beams									
Beam length	L	3600	987	3748	3000	2430	1716	1000	*mm*
Yield stress	f_y	355	355	355	355	355	355	355	*Mpa*
Elastic modulus	E	210000	210000	210000	210000	210000	210000	210000	*Mpa*
Shear modulus	G	81000	81000	81000	81000	81000	81000	81000	*Mpa*
Profile		HEA 140	HEA 160	HEB 160	HEA 140	HEB 220	HEA 140	HEA 220	
		HEA140	HEA160	HEB160	HEA140	HEB220	HEA140	HEA220	
Height	h	133	152	160	133	220	133	210	*mm*
Width	b	140	160	160	140	220	140	220	*mm*
Web thickness	t_w	5.5	6.0	8.0	5.5	9.5	5.5	7.0	*mm*
Flange thickness	t_f	8.5	9.0	13.0	8.5	16.0	8.5	11.0	*mm*
Torsional constant	I_t	8	12	31	8	77	8	28	mm^4
Warping constant	I_{wa}	15064	31410	47943	15064	295418	15064	193266	mm^6
Moment of inertia	I_y	1033	1673	2492	1033	8091	1033	5410	mm^4
	I_z	389	616	889	389	2843	389	1955	mm^4
Flange stiffness	$I_f = I_z / 2$ =	195	308	445	195	1422	195	977	mm^3
Moment of resistance	$W_{y,el}$	155	220	311	155	736	155	515	mm^3
	$W_{z,el}$	56	77	111	56	258	56	178	mm^3
Torsional bending constant	d	697	829	630	697	997	697	1335	*mm*
	L/d	5.2	1.2	5.9	4.3	2.4	2.5	0.7	
	α	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Acting moments:									
$M_{w,Ed} = E \cdot I_f \cdot (h-t_f) \cdot \phi'' / 2$ =		2.8	0.0	4.5	0.8	11.1	1.4	8.4	*kNm*
$M_{y,Ed} = 1/4 \cdot F \cdot L$ =		4.5	16.6	7.2	24.5	35.4	26.6	14.6	*kNm*
$M_{z,Ed} = 1/4 \cdot F \cdot L$ =		3.8	0.4	7.3	0.5	35.4	4.8	14.2	*kNm*
Capacities of beams:									
$M_{w,Rd} = W_{z,el} \cdot f_y / 2$ =		9.9	13.7	19.7	9.9	45.9	9.9	31.5	*kNm*
$M_{y,Rd} = W_{y,el} \cdot f_y$ =		55.2	78.1	110.6	55.2	261.1	55.2	182.9	*kNm*
$M_{z,Rd} = W_{z,el} \cdot f_y$ =		19.7	27.3	39.5	19.7	91.8	19.7	63.1	*kNm*
Combined check of beam:									
UC		0.55	0.23	0.48	0.55	0.76	0.87	0.57	
Displacements:									
Factor F_{ed} / F_k		1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Displacement y-direction	u_y	1.58	0.01	1.36	0.14	0.85	0.45	0.09	*mm*
Relative displacement	rel.	2284	128143	2754	20828	2844	3793	11520	-
Displacement z-direction	u_z	4.95	0.87	3.76	18.73	2.43	6.65	0.25	*mm*
Relative displacement	rel.	727	1136	996	160	1000	258	4048	-

Axis VM ID		5,545	542	.6,17,18,1	49,50	0,21,22,54	547	6,7	
Beam Location		left	hoisting beam	mid_top_l	mid_bot	mid_top_r	hoisting beam	right	
Profile of beam		HEB 180	HEA 140	HEB 160	HEA 220	HEB 160	HEA 140	HEA 180	
From AxisVM Analysis									
$M_{w,Ed}$ =									
$M_{y,Ed}$ =		15.2	18.3	14.2	14.7	15.8	22.6	16	*kNm*
$M_{z,Ed}$ =		17.8	0.7	6.3	21.2	6.9	3.7	14.1	*kNm*
Torsion =		2.1	0.3	1.2	4.9	1.3	0.5	5.5	*kNm*
Orientation of beam		z-as	y-as	y-as	z-as	y-as	y-as	z-as	
Beams									
Beam length	L	2548	2252	1910	1000	1840	1458	1000	*mm*
Yield stress	f_y	355	355	355	355	355	355	355	*Mpa*
Elastic modulus	E	210000	210000	210000	210000	210000	210000	210000	*Mpa*
Shear modulus	G	81000	81000	81000	81000	81000	81000	81000	*Mpa*
Profile		HEB 180	HEA 140	HEB 160	HEA 220	HEB 160	HEA 140	HEA 180	
		HEB180	HEA140	HEB160	HEA220	HEB160	HEA140	HEA180	
Height	h	180	133	160	210	160	133	171	*mm*
Width	b	180	140	160	220	160	140	180	*mm*
Web thickness	t_w	8.5	5.5	8.0	7.0	8.0	5.5	6.0	*mm*
Flange thickness	t_f	14.0	8.5	13.0	11.0	13.0	8.5	9.5	*mm*
Torsional constant	I_t	42	8	31	28	31	8	15	mm^4
Warping constant	I_{wa}	93746	15064	47943	193266	47943	15064	60211	mm^6
Moment of inertia	I_y	3831	1033	2492	5410	2492	1033	2510	mm^4
	I_z	1363	389	889	1955	889	389	925	mm^4
Flange stiffness	$I_f = I_z / 2$ =	681	195	445	977	445	195	462	mm^3
Moment of resistance	$W_{y,el}$	426	155	311	515	311	155	294	mm^3
	$W_{z,el}$	151	56	111	178	111	56	103	mm^3
Torsional bending constant	d	759	697	630	1335	630	697	1032	*mm*
	L/d	3.4	3.2	3.0	0.7	2.9	2.1	1.0	
	α	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Acting moments:									
$M_{w,Ed} = E \cdot I_f \cdot (h-t_f) \cdot \phi'' / 2$ =		4.5	0.8	2.3	5.9	2.5	1.1	7.9	*kNm*
$M_{y,Ed} = 1/4 \cdot F \cdot L$ =		15.2	18.3	14.2	14.7	15.8	22.6	16.0	*kNm*
$M_{z,Ed} = 1/4 \cdot F \cdot L$ =		17.8	0.7	6.3	21.2	6.9	3.7	14.1	*kNm*
Capacities of beams:									
$M_{w,Rd} = W_{z,el} \cdot f_y / 2$ =		26.9	9.9	19.7	31.5	19.7	9.9	18.2	*kNm*
$M_{y,Rd} = W_{y,el} \cdot f_y$ =		151.1	55.2	110.6	182.9	110.6	55.2	104.2	*kNm*
$M_{z,Rd} = W_{z,el} \cdot f_y$ =		53.8	19.7	39.5	63.1	39.5	19.7	36.5	*kNm*
Combined check of beam:									
UC		0.60	0.45	0.41	0.60	0.44	0.71	0.97	
Displacements:									
Factor F_{ed}/ F_k		1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Displacement y-direction	u_y	1.00	0.11	0.30	0.13	0.31	0.25	0.19	*mm*
Relative displacement	rel.	2554	19818	6263	7716	5936	5791	5384	-
Displacement z-direction	u_z	2.39	7.88	1.93	0.25	1.99	4.08	0.57	*mm*
Relative displacement	rel.	1064	286	991	4021	925	357	1748	-

Steel beams in torsion

Calculation of unrestrained beams with eccentric load - Upper cross arm

Datum: Datum: Datum: 2021/02/22
Auteur: Auteur: Auteur: RSH
Versie: Versie: Versie: 1.1

Axis VM ID		23,24,25	60,61	26,27,28	543	29,30,31	51,52	32,524,525	548	8,9	
Beam Location		left_top_l	left_bot	left_top_r	hoisting	mid_top_l	mid_bot	mid_top_r	hoisting	right	
Profile of beam		HEA 160	HEB 160	HEA 160	HEA 140	HEB 160	HEA 220	HEB 160	HEA 140	HEB180	
From AxisVM Analysis											
$M_{w,Ed}$ =											
$M_{y,Ed}$ =		3.1	8.5	9.3	15.9	10.5	15.7	10.6	21	17.1	*kNm*
$M_{z,Ed}$ =		4.5	7.2	0.6	0.5	4.9	21.3	5.8	2.9	14.2	*kNm*
Torsion =		0.9	1.9	0	0.3	2.3	5.2	2.7	0.5	4.7	*kNm*
Orientation of beam		y-as	z-as	y-as	y-as	y-as	z-as	y-as	y-as	z-as	
Beams											
Beam length	L	2196	1000	2140	1960	1730	1000	1642	1366	1000	*mm*
Yield stress	f_y	355	355	355	355	355	355	355	355	355	*Mpa*
Elastic modulus	E	210000	210000	210000	210000	210000	210000	210000	210000	210000	*Mpa*
Shear modulus	G	81000	81000	81000	81000	81000	81000	81000	81000	81000	*Mpa*
Profile		HEA 160	HEA 160	HEB 160	HEA 140	HEB 160	HEA 220	HEB 160	HEA 140	HEA 180	
		HEA160	HEA160	HEB160	HEA140	HEB160	HEA220	HEB160	HEA140	HEA180	
Height	h	152	152	160	133	160	210	160	133	171	*mm*
Width	b	160	160	160	140	160	220	160	140	180	*mm*
Web thickness	t_w	6.0	6.0	8.0	5.5	8.0	7.0	8.0	5.5	6.0	*mm*
Flange thickness	t_f	9.0	9.0	13.0	8.5	13.0	11.0	13.0	8.5	9.5	*mm*
Torsional constant	I_t	12	12	31	8	31	28	31	8	15	mm^4
Warping constant	I_{wa}	31410	31410	47943	15064	47943	193266	47943	15064	60211	mm^6
Moment of inertia	I_y	1673	1673	2492	1033	2492	5410	2492	1033	2510	mm^4
	I_z	616	616	889	389	889	1955	889	389	925	mm^4
Flange stiffness	$I_f = I_z / 2$ =	308	308	445	195	445	977	445	195	462	mm^3
Moment of resistance	$W_{y,el}$	220	220	311	155	311	515	311	155	294	mm^3
	$W_{z,el}$	77	77	111	56	111	178	111	56	103	mm^3
Torsional bending constant	d	829	829	630	697	630	1335	630	697	1032	*mm*
	L/d	2.6	1.2	3.4	2.8	2.7	0.7	2.6	2.0	1.0	
	α	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Acting moments:											
$M_{w,Ed} = E \cdot I_f \cdot (h-t_f) \cdot \phi'' / 2$ =		2.3	3.0	0.0	0.7	4.3	6.3	5.0	1.1	6.8	*kNm*
$M_{y,Ed} = 1/4 \cdot F \cdot L$ =		3.1	8.5	9.3	15.9	10.5	15.7	10.6	21.0	17.1	*kNm*
$M_{z,Ed} = 1/4 \cdot F \cdot L$ =		4.5	7.2	0.6	0.5	4.9	21.3	5.8	2.9	14.2	*kNm*
Capacities of beams:											
$M_{w,Rd} = W_{z,el} \cdot f_y / 2$ =		13.7	13.7	19.7	9.9	19.7	31.5	19.7	9.9	18.2	*kNm*
$M_{y,Rd} = W_{y,el} \cdot f_y$ =		78.1	78.1	110.6	55.2	110.6	182.9	110.6	55.2	104.2	*kNm*
$M_{z,Rd} = W_{z,el} \cdot f_y$ =		27.3	27.3	39.5	19.7	39.5	63.1	39.5	19.7	36.5	*kNm*
Combined check of beam:											
UC		0.37	0.59	0.10	0.39	0.44	0.62	0.50	0.63	0.92	
Displacements:											
Factor F_{ed} / F_k		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Displacement y-direction	u_y	0.43	0.14	0.04	0.06	0.19	0.13	0.21	0.17	0.19	*mm*
Relative displacement	rel.	5119	7026	58690	31879	8890	7680	7913	7887	5346	-
Displacement z-direction	u_z	0.80	0.46	1.58	5.19	1.17	0.27	1.06	3.33	0.61	*mm*
Relative displacement	rel.	2734	2190	1351	378	1480	3765	1545	410	1635	-

The unsupported lengths for the HEB beams are small, as a result of which stability is not governing. Thus, for the purpose of conciseness stability calculation was done roughly for H beams and not shown in this report.

The bottom chords of the cross arms are checked for bending. The figures and tables for the internal forces can be found in the above-mentioned appendix. The torsion in the bottom chord, shown in figure 6 is less than 0.8 and can be neglected. Therefore, stress check in AxisVM is acceptable.

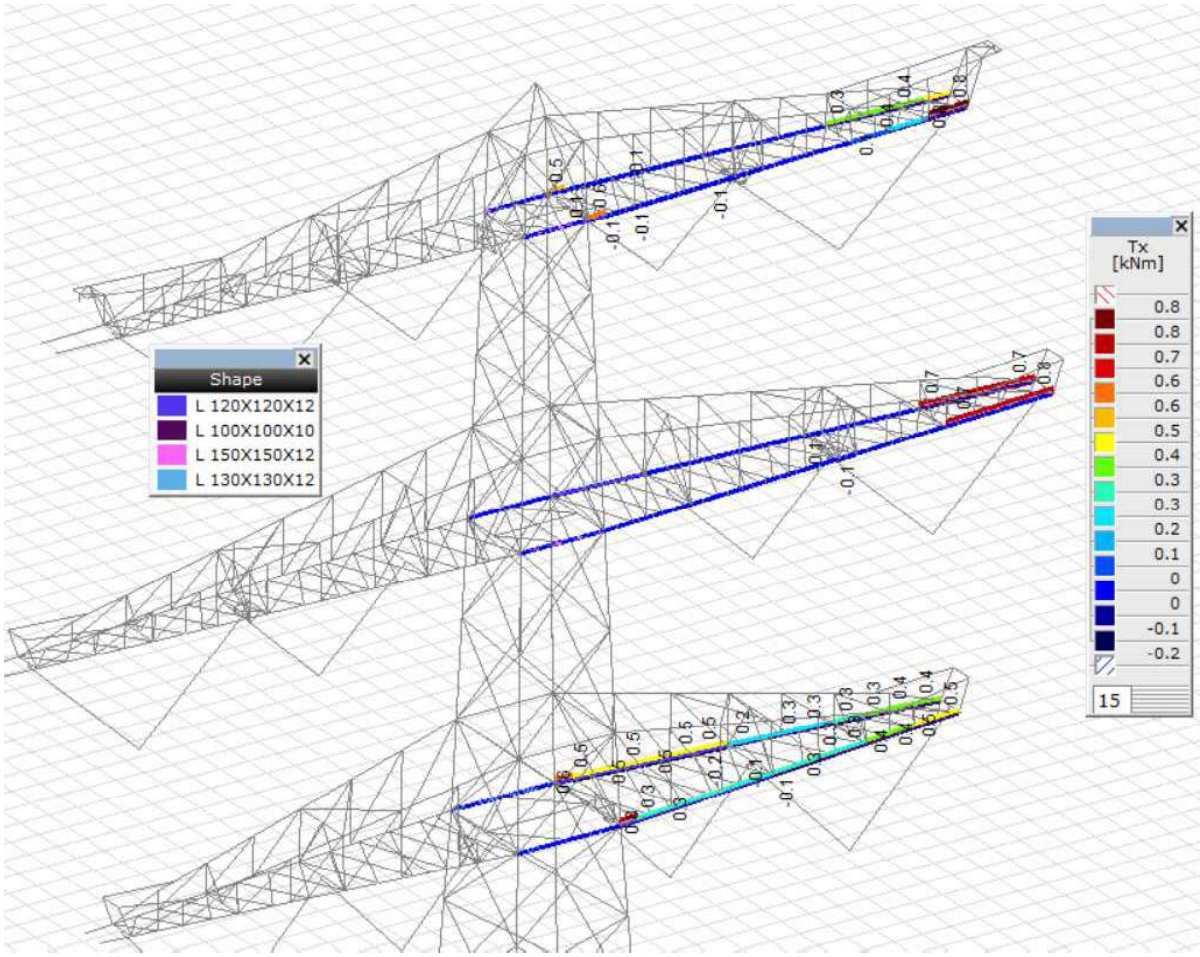


Figure 6 Torsion in bottom chord of the cross arms

The maximum stress in the bottom chord members is 274 N/mm^2. This occurs in the low cross arm. The max stress is within the yield limit of 355 N/mm^2 for S355 grade steel. PLS tower showed a utility ratio of around 50% for a section of 100x100x10 profiles as the bottom chord of the LCA. However, this profile was not adequate as the combined stress including the effects of bending exceed the yield limit. Thus, the size was increases to 120x120x12 angle profile. The stress in the bottom chord is shown in Figure 7. The stresses are considered to have a safe margin below the yield limit.

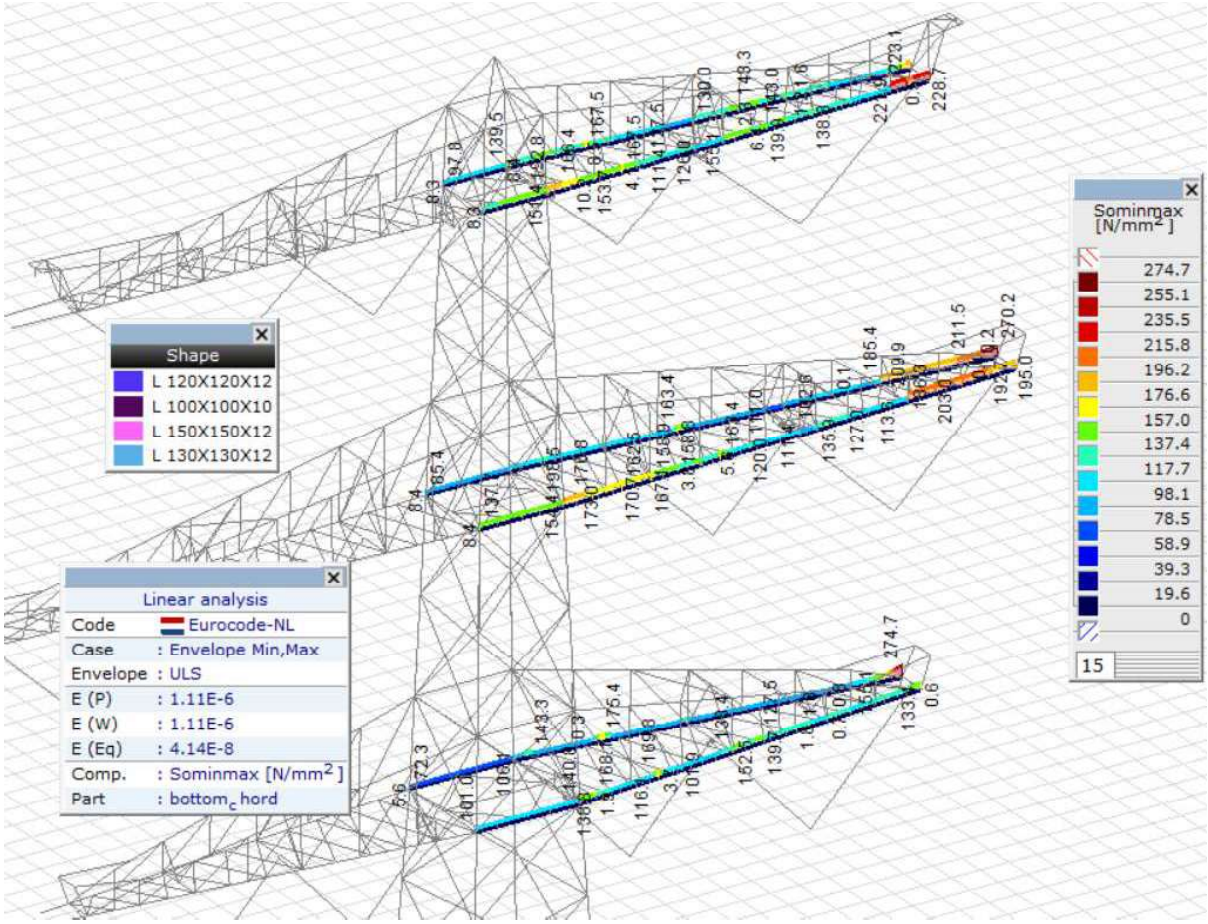


Figure 7 stress in the bottom chord for envelop of forces.

1.4 Conclusion:

Load scenarios impose torsional load in the structure. PLS tower is incapable of checking for torsion and bending. The beams supporting the insulators and the bottom chord of the cross arms are checked for bending and torsion in AxisVM application. The loads are taken from PLS tower. The results of the analysis in AxisVM post processing show large torsion in beams for hoisting and the beams of the insulator assembly. Furthermore, the stress calculation of Axis does not consider the warping moment due to torsion. Therefore, excel calculation is made to check the beams with considerable torsion. All the HEB- and HEA-beams are found to have stresses within the permissible limit of yield stress.

The profiles for the H beams housing the insulator assemblies are adequate and shown in figure 8.

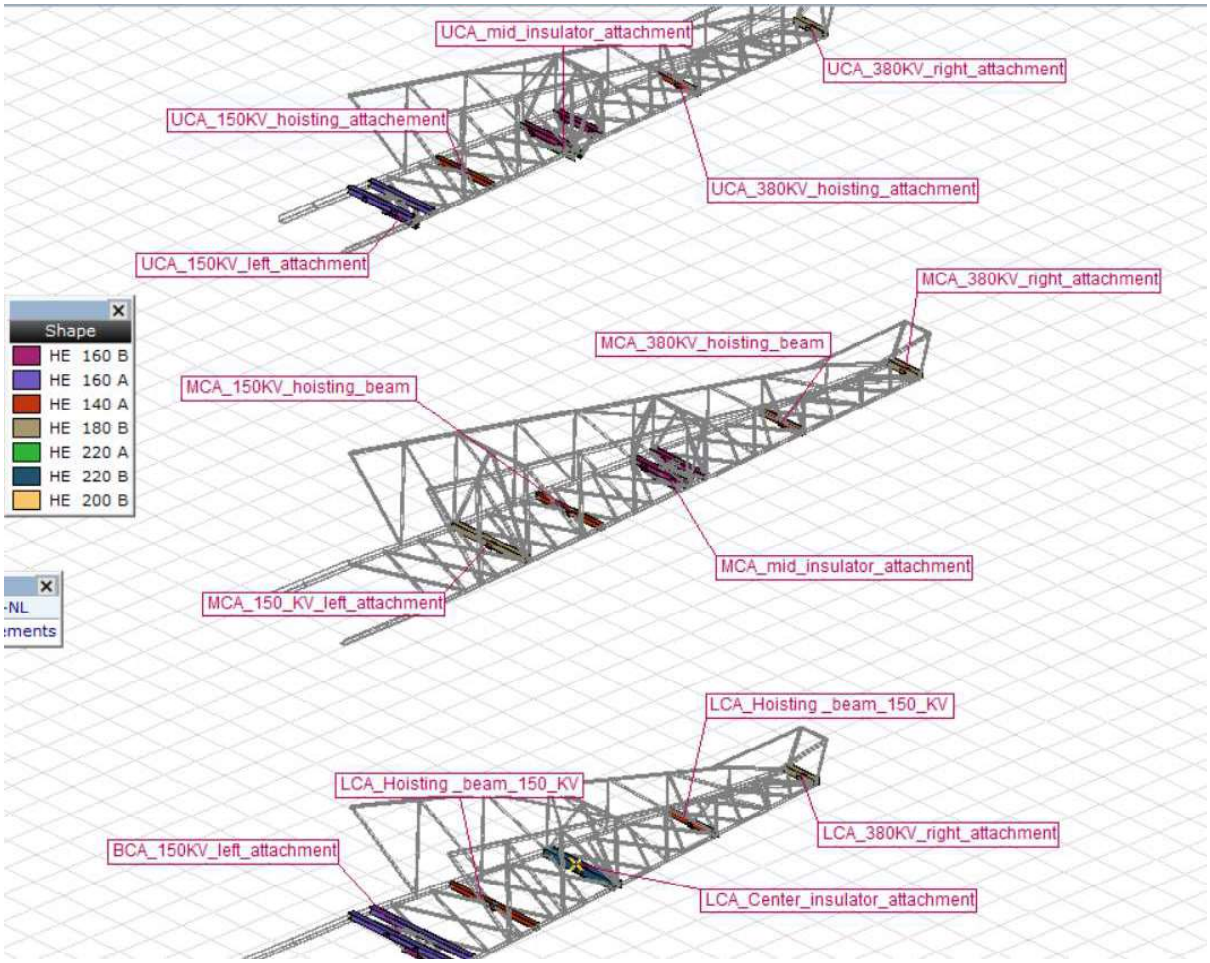


Figure 8 Profiles for the H beams

The bottom chord members do not develop torsion. Therefore, stresses calculated by AxisVM are accurate. The stress in the bottom chord from AxisVM post processing are below the yield limit. The utility ratio for the bottom chord is less than 0.70. The reserve capacity is adequate for stability considerations.

Appendix: report AxisVM

Project

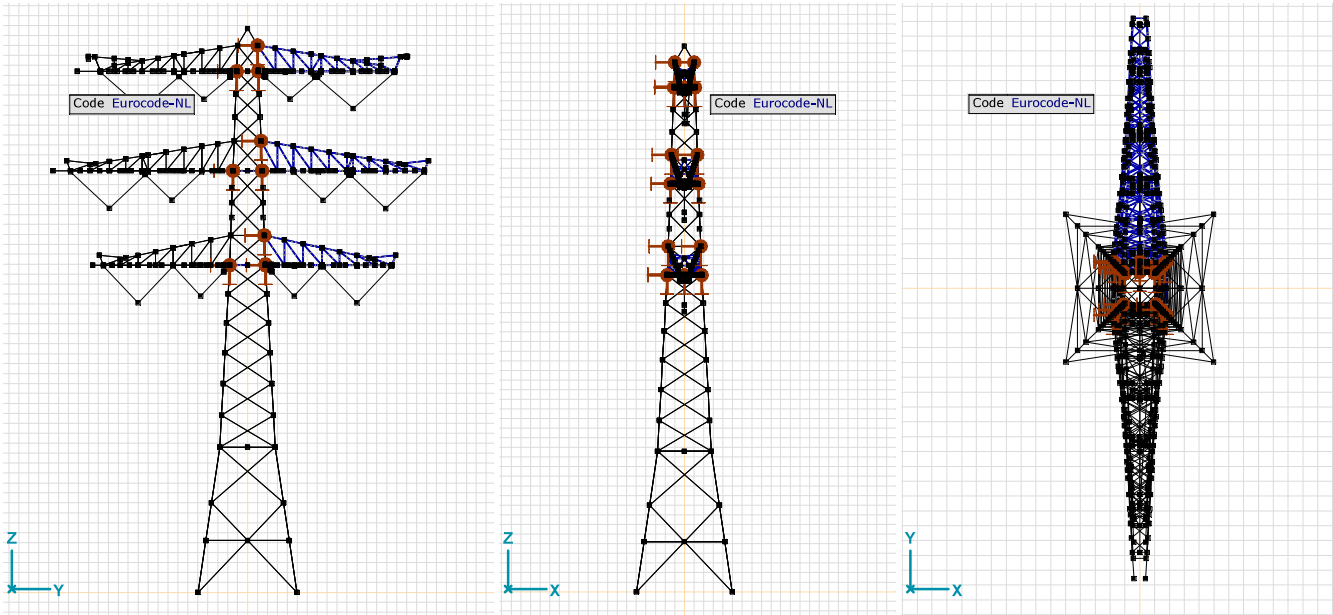
Analysis by

AxisVM X5 R4h - Registered to DNV GL - Energy
S+0_combi.axs

Report

Item	Page
model_views	4
Materials	4
Cross-sections	4
3D view and cross_section_detail	6
Spring characteristics	6
Nodal supports [Insultors_assembly]	7
Lower_cross_arm_details_with_dimensions	8
LCA_left_150KV	8
LCA_Mid_150_380_KV	9
LCA_right_380_KV	9
Mid_cross_arm_details	10
MCA_150KV_left_attachement	10
MCA_380KV_right_attachement	11
MCA_mid_attachement_(1)_cross-section_orientation_(2)_dimension	11
Upper_cross_arms_details	12
UCA_150_KV_left_attachement_(1)crossection_shape_(2)dimensions	12
UCA_150KV_hoisting_beam_details	13
UCA_mid_attachement_(1)crossection_shape_(2)dimensions	13
UCA_380KV_right_attachement_detils	14
> Load nodes_ID	15
1a_90: Nodal loads [Load nodes]	15
> Load nodes, 1a_90, Side view	15
1a_270: Nodal loads [Load nodes]	15
> Load nodes, 1a_270, Side view	16
3_90: Nodal loads [Load nodes]	16
> Load nodes, 3_90, Side view	16
3_270: Nodal loads [Load nodes]	16
> Load nodes, 3_270, Side view	17
5a_01: Nodal loads [Load nodes]	17
> Load nodes, 5a_01, Side view	17
5a_10: Nodal loads [Load nodes]	17
> Load nodes, 5a_10, Side view	18
5a_11: Nodal loads [Load nodes]	18
> Load nodes, 5a_11, Side view	18
5a_12: Nodal loads [Load nodes]	18
> Load nodes, 5a_12, Side view	19
5a_30: Nodal loads [Load nodes]	19
> Load nodes, 5a_30, Side view	19
5a_31: Nodal loads [Load nodes]	19
> Load nodes, 5a_31, Side view	20
5a_32: Nodal loads [Load nodes]	20
> Load nodes, 5a_32, Side view	20
hoisting_Load: Nodal loads [Load nodes]	20
> Load nodes, hoisting_Load, Side view	21
hoisting_Load_reverse: Nodal loads [Load nodes]	21
> Load nodes, hoisting_Load_reverse, Side view	21
144_SLS_1a_90_1: Nodal loads [Load nodes]	21
> Load nodes, 144_SLS_1a_90_1, Side view	22
144_SLS_1a_270_1: Nodal loads [Load nodes]	22
> Load nodes, 144_SLS_1a_270_1, Side view	22
145_SLS_3_90: Nodal loads [Load nodes]	23
> Load nodes, 145_SLS_3_90, Side view	23
145_SLS_3_270: Nodal loads [Load nodes]	23
> Load nodes, 145_SLS_3_270, Side view	23
Custom load combinations by load cases	24
> bottom_chord	25
Nodal displacements [Linear, Envelope (Default), LCA]	25
LCA_bottom_chord, Linear, Envelope (Default), eZ [mm], Diagram	25
Beam internal forces [Linear, Envelope (Default), LCA]	26
LCA_bottom_chord, Linear, Envelope (Default), Nx [kN], Filled diagram	26
LCA_bottom_chord, Linear, Envelope (Default), My [kNm], Filled diagram	26
LCA_bottom_chord, Linear, Envelope (Default), Mz [kNm], Filled diagram	27
LCA_bottom_chord, Linear, Envelope (ULS), Vz [kN], Filled diagram	27
Beam stresses [Linear, Envelope (Default), LCA]	28
LCA_bottom_chord, Linear, Envelope (Default), Sominmax [N/mm^2], Filled diagram	28
Nodal displacements [Linear, Envelope (Default), MCA]	28
MCA_bottom_chord, Linear, Envelope (Default), eZ [mm], Diagram	29
Beam internal forces [Linear, Envelope (Default), MCA]	29
MCA_bottom_chord, Linear, Envelope (Default), Nx [kN], Filled diagram	29
MCA_ bottom_chord, Linear, Envelope (Default), My [kNm], Filled diagram	30
MCA_bottom_chord, Linear, Envelope (Default), Mz [kNm], Filled diagram	30
MCA_bottom_chord, Linear, Envelope (ULS), Vz [kN], Filled diagram	31
Beam stresses [Linear, Envelope (Default), MCA]	31
MCA_bottom_chord, Linear, Envelope (Default), Sominmax [N/mm^2], Filled diagram	32
Nodal displacements [Linear, Envelope (Default), UCA]	32
UCA_bottom_chord, Linear, Envelope (Default), eZ [mm], Diagram	32
Beam internal forces [Linear, Envelope (Default), UCA]	33
UCA_bottom_chord, Linear, Envelope (Default), Nx [kN], Filled diagram	33
UCA_bottom_chord, Linear, Envelope (Default), My [kNm], Filled diagram	33
UCA_bottom_chord, Linear, Envelope (Default), Mz [kNm], Filled diagram	34
UCA_bottom_chord, Linear, Envelope (ULS), Vz [kN], Filled diagram	34
Beam stresses [Linear, Envelope (Default), UCA]	35
UCA_bottom_chord, Linear, Envelope (Default), Sominmax [N/mm^2], Filled diagram	35
Beam internal forces [Linear, Envelope (Default), Insultors_assembly]	36
BCA_150KV_left_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	46
BCA_150KV_left_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	47
BCA_150KV_left_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	47
BCA_Center_insulator_attachment_Linear, Envelope (Default), My [kNm], Filled diagram	48
BCA_Center_insulator_attachment_Linear, Envelope (Default), Mz [kNm], Filled diagram	48
BCA_Center_insulator_attachment_Linear, Envelope (Default), Tx [kNm], Filled diagram	49
BCA_380KV_right_attachment_Linear, Envelope (Default), My [kNm], Filled diagram	49
BCA_380KV_right_attachment_Linear, Envelope (Default), Mz [kNm], Filled diagram	50
BCA_380KV_right_attachment_LLinear, Envelope (Default), Tx [kNm], Filled diagram	50
MCA_150_KV_left_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	51
MCA_150_KV_left_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	51
MCA_150_KV_left_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	52
MCA_mid_insulator_attachment_ Linear, Envelope (Default), My [kNm], Filled diagram	52

Item	*Page*
MCA_mid_insulator_attachment_Linear, Envelope (Default), Mz [kNm], Filled diagram	53
MCA_mid_insulator_attachment_Linear, Envelope (Default), Tx [kNm], Filled diagram	53
MCA_380KV_right_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	54
MCA_380KV_right_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	54
MCA_380KV_right_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	55
UCA_150KV_left_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	55
UCA_150KV_left_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	56
UCA_150KV_left_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	56
UCA_150KV_hoisting_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	57
UCA_150KV_hoisting_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	57
UCA_150KV_hoisting_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	58
UCA_mid_insulator_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	58
UCA_mid_insulator_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	59
UCA_mid_insulator_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	59
UCA_380KV_right_attachement_Linear, Envelope (Default), My [kNm], Filled diagram	60
UCA_380KV_right_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram	60
UCA_380KV_right_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram	61



model_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 355	Steel	Eurocode-NL	10025-2	Plastic	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 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;

Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r_1 [mm]	r_2 [mm]	r_3 [mm]	Ax [mm²]	Ay [mm²]	Az [mm²]	Ix [mm⁴]	Iy [mm⁴]	Iz [mm⁴]
1	HE 160 A		Rolled	I	152.0	160.0	6.0	9.0	15.0	0	0	3878.04	2636.55	888.57	121366.2	1.7E+07	6155809.0
2	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
3	U 120		Rolled	U	120.0	55.0	7.0	9.0	9.0	4.5	0	1698.73	617.80	752.09	41830.7	3643327.0	430614.1
4	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	4408.9	109629.1	109629.1
5	HE 220 A		Rolled	I	210.0	220.0	7.0	11.0	18.0	0	0	6435.42	4367.99	1424.01	287198.6	5.4E+07	2E+07

	Name	Iyz [mm⁴]	I_1 [mm⁴]	I_2 [mm⁴]	α [°]	Iω [mm⁶]	$W_{1,el,t}$ [mm³]	$W_{1,el,b}$ [mm³]	$W_{2,el,t}$ [mm³]	$W_{2,el,b}$ [mm³]	$W_{1,pl}$ [mm³]	$W_{2,pl}$ [mm³]	i_y [mm]	i_z [mm]
1	HE 160 A	0	1.7E+07	6155809.0	0	3.1E+10	220173.4	220173.4	76947.6	76947.6	245202.6	117640.1	65.7	39.8
2	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
3	U 120	0	3643327.0	430614.1	0	8.9E+08	60722.1	60722.1	11058.3	26813.4	72702.6	21257.6	46.3	15.9
4	L 50X 50X 5	−64162.8	173791.9	45466.3	45.00	678722	4915.6	4915.6	2584.4	2290.7	7830.3	4045.4	15.1	15.1
5	HE 220 A	0	5.4E+07	2E+07	0	1.9E+11	515304.0	515304.0	177688.9	177688.9	568570.3	270607.6	91.7	55.1

	Name	Hy [mm]	Hz [mm]	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
1	HE 160 A	160.0	152.0	80.0	76.0	0	0	9
2	L 60X 60X 6	60.0	60.0	16.9	16.9	−13.3	−13.3	4
3	U 120	55.0	120.0	16.1	60.0	−29.6	0	8
4	L 50X 50X 5	50.0	50.0	14.0	14.0	−11.0	−11.0	4
5	HE 220 A	220.0	210.0	110.0	105.0	0	0	9

Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r_1 [mm]	r_2 [mm]	r_3 [mm]	Ax [mm²]	Ay [mm²]	Az [mm²]	Ix [mm⁴]	Iy [mm⁴]	Iz [mm⁴]
6	L 120X120X12		Rolled	L	120.0	120.0	12.0	12.0	13.0	6.5	0	2754.22	1208.71	1219.23	139579.2	3676399.0	3676399.0
7	HE 200 B		Rolled	I	200.0	200.0	9.0	15.0	18.0	0	0	7809.42	5398.31	1742.91	606300.8	5.7E+07	2E+07
8	L 100X100X10		Rolled	L	100.0	100.0	10.0	10.0	12.0	6.0	0	1915.52	840.25	849.06	68400.0	1766604.0	1766604.0
9	L 70X 70X 7		Rolled	L	70.0	70.0	7.0	7.0	9.0	4.5	0	939.73	412.00	416.89	16632.0	422933.4	422933.4
10	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
11	L 70X 70X 6		Rolled	L	70.0	70.0	6.0	6.0	9.0	4.5	0	812.73	352.06	356.95	10739.9	368795.6	368795.6
12	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
13	HE 140 A		Rolled	I	133.0	140.0	5.5	8.5	12.0	0	0	3142.19	2147.66	704.86	81932.8	1E+07	3893251.0
14	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	12473.9	558166.2	558166.2
15	HE 180 B		Rolled	I	180.0	180.0	8.5	14.0	15.0	0	0	6526.04	4497.99	1465.41	428543.6	3.8E+07	1.4E+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	317826.3	2.5E+07	8892444.0
17	L 45X 45X 5		Rolled	L	45.0	45.0	5.0	5.0	7.0	3.5	0	430.28	190.17	193.02	3992.0	78398.8	78398.7
18	L 90X 90X 9		Rolled	L	90.0	90.0	9.0	9.0	11.0	5.5	0	1552.04	680.71	688.10	45021.7	1158223.0	1158223.0

	Name	Iyz [mm⁴]	I_1 [mm⁴]	I_2 [mm⁴]	α [°]	Iω [mm⁶]	$W_{1,el,t}$ [mm³]	$W_{1,el,b}$ [mm³]	$W_{2,el,t}$ [mm³]	$W_{2,el,b}$ [mm³]	$W_{1,pl}$ [mm³]	$W_{2,pl}$ [mm³]	i_y [mm]	i_z [mm]
6	L 120X120X12	−2160249.0	5836648.0	1516150.0	45.00	1.3E+08	68785.5	68785.5	35578.9	31565.4	109074.8	55859.7	36.5	36.5
7	HE 200 B	0	5.7E+07	2E+07	0	1.7E+11	569697.5	569697.5	200338.9	200338.9	642648.6	305826.5	85.4	50.6
8	L 100X100X10	−1036581.0	2803186.0	730023.0	45.00	4.4E+07	39643.0	39643.0	20631.6	18290.5	62957.8	32342.2	30.4	30.4
9	L 70X 70X 7	−247895.0	670828.4	175038.4	45.00	5155803	13552.8	13552.8	7084.6	6279.1	21550.0	11096.7	21.2	21.2
10	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
11	L 70X 70X 6	−216123.7	584919.3	152671.9	45.00	3333474	11817.2	11817.2	6203.4	5599.5	18692.5	9653.0	21.3	21.3
12	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
13	HE 140 A	0	1E+07	3893251.0	0	1.5E+10	155382.8	155382.8	55617.9	55617.9	173525.9	84852.6	57.3	35.2
14	L 80X 80X 6	−326876.9	885043.1	231289.3	45.00	5085144	15645.5	15645.5	8233.3	7546.6	24644.0	12753.5	24.4	24.4
15	HE 180 B	0	3.8E+07	1.4E+07	0	9.2E+10	425731.4	425731.4	151428.6	151428.6	481510.9	231022.2	76.6	45.7
16	HE 160 B	0	2.5E+07	8892443.0	0	4.7E+10	311542.7	311542.7	111155.5	111155.5	354020.6	169972.2	67.8	40.5
17	L 45X 45X 5	−45786.5	124185.2	32612.3	45.00	478168	3902.8	3902.8	2062.0	1802.8	6258.0	3240.6	13.5	13.5
18	L 90X 90X 9	−679416.3	1837639.0	478806.7	45.00	2.3E+07	28875.7	28875.7	15045.3	13336.8	45872.2	23579.5	27.3	27.3

	Name	Hy [mm]	Hz [mm]	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
6	L 120X120X12	120.0	120.0	34.0	34.0	−27.0	−27.0	4
7	HE 200 B	200.0	200.0	100.0	100.0	0	0	9
8	L 100X100X10	100.0	100.0	28.2	28.2	−22.3	−22.3	4
9	L 70X 70X 7	70.0	70.0	19.7	19.7	−15.5	−15.5	4
10	L 80X 80X 8	80.0	80.0	22.5	22.5	−17.8	−17.8	4
11	L 70X 70X 6	70.0	70.0	19.3	19.3	−15.7	−15.7	4
12	L 55X 55X 6	55.0	55.0	15.6	15.6	−12.0	−12.0	4
13	HE 140 A	140.0	133.0	70.0	66.5	0	0	9
14	L 80X 80X 6	80.0	80.0	21.7	21.7	−18.1	−18.1	4
15	HE 180 B	180.0	180.0	90.0	90.0	0	0	9
16	HE 160 B	160.0	160.0	80.0	80.0	0	0	9
17	L 45X 45X 5	45.0	45.0	12.8	12.8	−9.7	−9.7	4
18	L 90X 90X 9	90.0	90.0	25.4	25.4	−20.0	−20.0	4

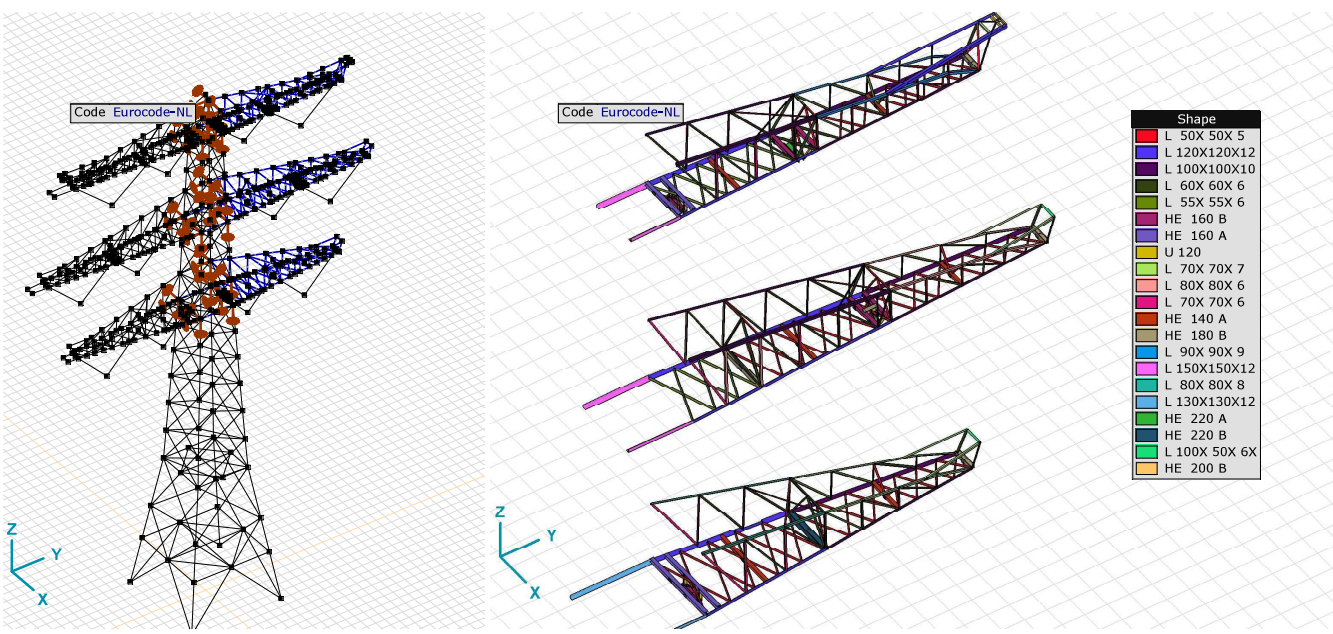
Cross-sections

	Name	Drawing	Process	Shape	h [mm]	b [mm]	tw [mm]	tf [mm]	r_1 [mm]	r_2 [mm]	r_3 [mm]	Ax [mm²]	Ay [mm²]	Az [mm²]	Ix [mm⁴]	Iy [mm⁴]	Iz [mm⁴]
19	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
20	L 150X150X12		Rolled	L	150.0	150.0	12.0	12.0	16.0	8.0	0	3483.60	1505.64	1521.61	179274.1	7368515.0	7368513.0
21	L 130X130X12		Rolled	L	130.0	130.0	12.0	12.0	14.0	7.0	0	2997.13	1307.44	1319.65	152690.7	4721381.0	4721382.0
22	U 160_double		Rolled	Custom	160.0	264.0	7.5	10.5	10.5	5.5	0	5472.91	896.17	1978.17	141469.7	1.8E+07	3.8E+07
23	HE 220 B		Rolled	I	220.0	220.0	9.5	16.0	18.0	0	0	9105.42	6276.26	2008.65	781768.1	8.1E+07	2.8E+07

	Name	Iyz [mm⁴]	I_1 [mm⁴]	I_2 [mm⁴]	α [°]	$I\omega$ [mm⁶]	$W_{1,el,t}$ [mm³]	$W_{1,el,b}$ [mm³]	$W_{2,el,t}$ [mm³]	$W_{2,el,b}$ [mm³]	$W_{1,pl}$ [mm³]	$W_{2,pl}$ [mm³]	i_y [mm]	i_z [mm]
19	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
20	L 150X150X12	−4334081.0	1.2E+07	3034433.0	45.00	2.7E+08	110333.1	110333.1	57321.5	52048.1	173526.6	89044.1	46.0	46.0
21	L 130X130X12	−2776282.0	7497663.0	1945100.0	45.00	1.7E+08	81563.8	81563.8	42243.5	37794.8	128920.4	66052.0	39.7	39.7
22	U 160_double	0	3.8E+07	1.8E+07	90.00	4.9E+10	285822.3	285822.3	231205.9	231205.9	432594.1	275916.0	58.1	83.0
23	HE 220 B	0	8.1E+07	2.8E+07	0	2.9E+11	735632.5	735632.5	258480.6	258480.6	827160.4	393895.7	94.3	55.9

	Name	Hy [mm]	Hz [mm]	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
19	L 100X 50X 6X	50.0	100.0	10.4	34.9	−7.3	−30.2	4
20	L 150X150X12	150.0	150.0	41.2	41.2	−34.2	−34.2	4
21	L 130X130X12	130.0	130.0	36.4	36.4	−29.4	−29.4	4
22	U 160_double	264.0	160.0	132.0	80.0	0	0	9
23	HE 220 B	220.0	220.0	110.0	110.0	0	0	9

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;



3D view and cross_section_detail

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;

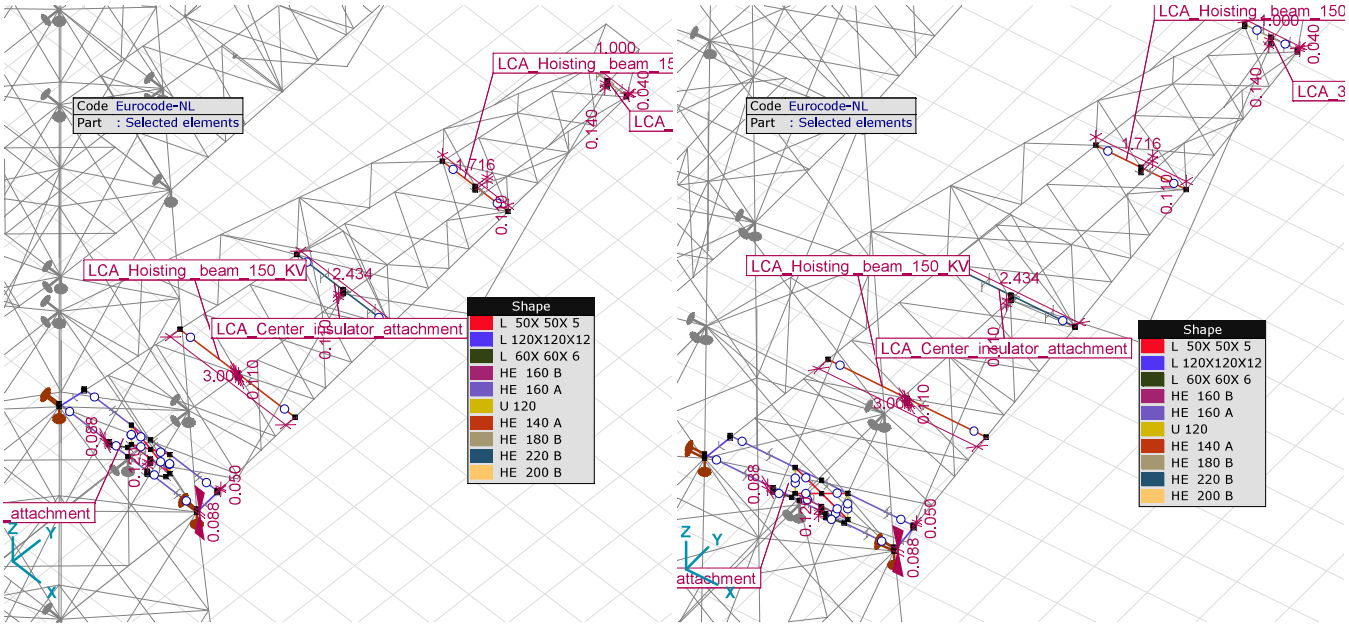
Nodal supports [Insultors_assembly]

	Node	X [m]	Y [m]	Z [m]
1	60	1.458	1.458	42.400
2	63	−1.458	1.458	42.400
3	56	1.350	1.350	45.400
4	59	−1.350	1.350	45.400
5	66	1.692	1.692	35.900
6	69	−1.692	1.692	35.900
7	39	1.004	1.004	55.000
8	43	−1.004	1.004	55.000
9	44	1.098	1.098	52.400
10	47	−1.098	1.098	52.400
11	70	1.800	1.800	32.900
12	73	−1.800	1.800	32.900
13	110	0	1.800	32.900
14	433	0	1.098	52.400
15	45	1.098	−1.098	52.400
16	46	−1.098	−1.098	52.400
17	61	1.458	−1.458	42.400
18	62	−1.458	−1.458	42.400
19	71	1.800	−1.800	32.900
20	72	−1.800	−1.800	32.900
21	624	1.098	1.098	52.494
22	625	−1.098	1.098	52.494
23	647	1.800	1.800	32.988
24	648	−1.800	1.800	32.988

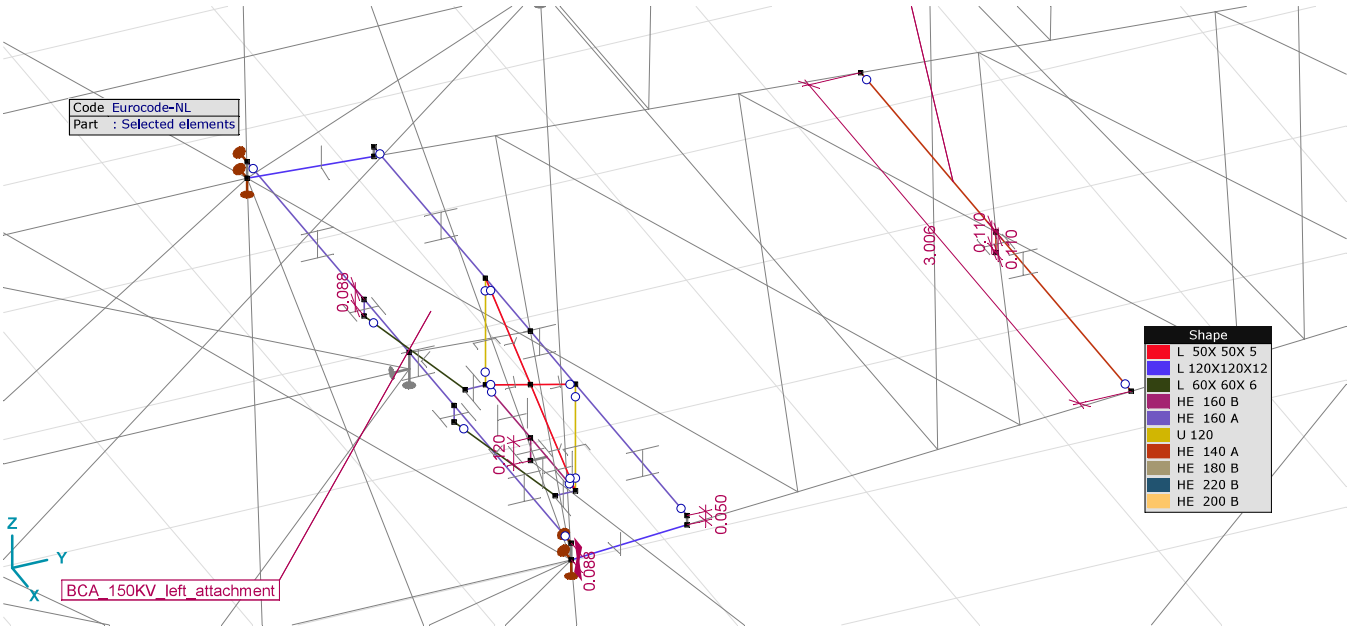
	Node	Type	$Name_x$	K_x [kN/m]	K_{xV} [kN/m]	$Name_y$	K_y [kN/m]	K_{yV} [kN/m]	$Name_z$	K_z [kN/m]	K_{zV} [kN/m]	$Name_{xx}$	K_{xx} [kNm/rad]	K_{xxV} [kNm/rad]
1	60	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
2	63	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
3	56	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
4	59	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
5	66	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
6	69	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
7	39	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
8	43	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
9	44	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
10	47	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
11	70	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
12	73	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	Rigid - Translational	1E+10	1E+10	—	–	–
13	110	Glob.	—	–	–	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
14	433	Glob.	—	–	–	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
15	45	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
16	46	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
17	61	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
18	62	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
19	71	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
20	72	Glob.	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	Rigid - Translational	1E+10	1E+10	—	–	–
21	624	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	—	–	–	—	–	–
22	625	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	—	–	–	—	–	–
23	647	Glob.	Rigid - Translational	1E+10	1E+10	—	–	–	—	–	–	—	–	–
24	648	Glob.	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	60	—	–	–	—	–	–
2	63	—	–	–	—	–	–
3	56	—	–	–	—	–	–
4	59	—	–	–	—	–	–
5	66	—	–	–	—	–	–
6	69	—	–	–	—	–	–
7	39	—	–	–	—	–	–
8	43	—	–	–	—	–	–
9	44	—	–	–	—	–	–
10	47	—	–	–	—	–	–
11	70	—	–	–	—	–	–
12	73	—	–	–	—	–	–
13	110	—	–	–	—	–	–
14	433	—	–	–	—	–	–
15	45	—	–	–	—	–	–
16	46	—	–	–	—	–	–
17	61	—	–	–	—	–	–
18	62	—	–	–	—	–	–
19	71	—	–	–	—	–	–
20	72	—	–	–	—	–	–
21	624	—	–	–	—	–	–
22	625	—	–	–	—	–	–
23	647	—	–	–	—	–	–
24	648	—	–	–	—	–	–

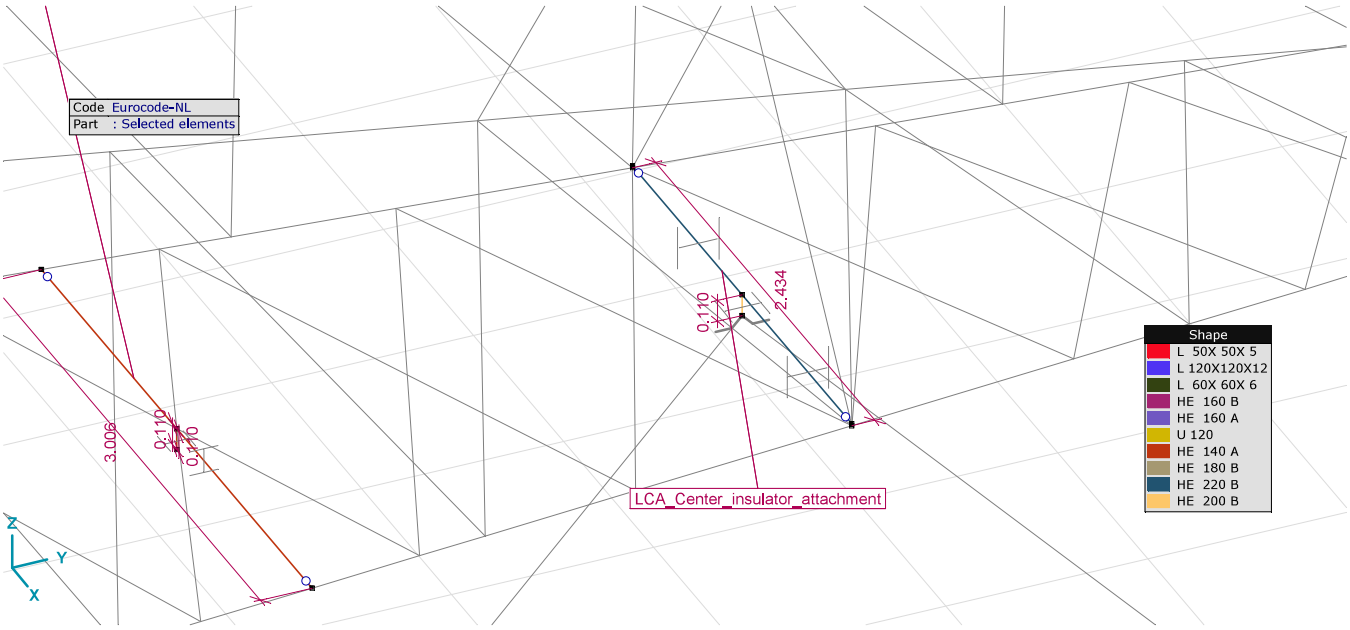
Node: Supported node; **Type:** Support type; **$Name_x$:** Name of the spring characteristics; **K_x: Initial** stiffness; **K_{xV}:** Vibration stiffness; **$Name_y$:** Name of the spring characteristics; **K_y: Initial** stiffness; **K_{yV}:** Vibration stiffness; **$Name_z$:** Name of the spring 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;



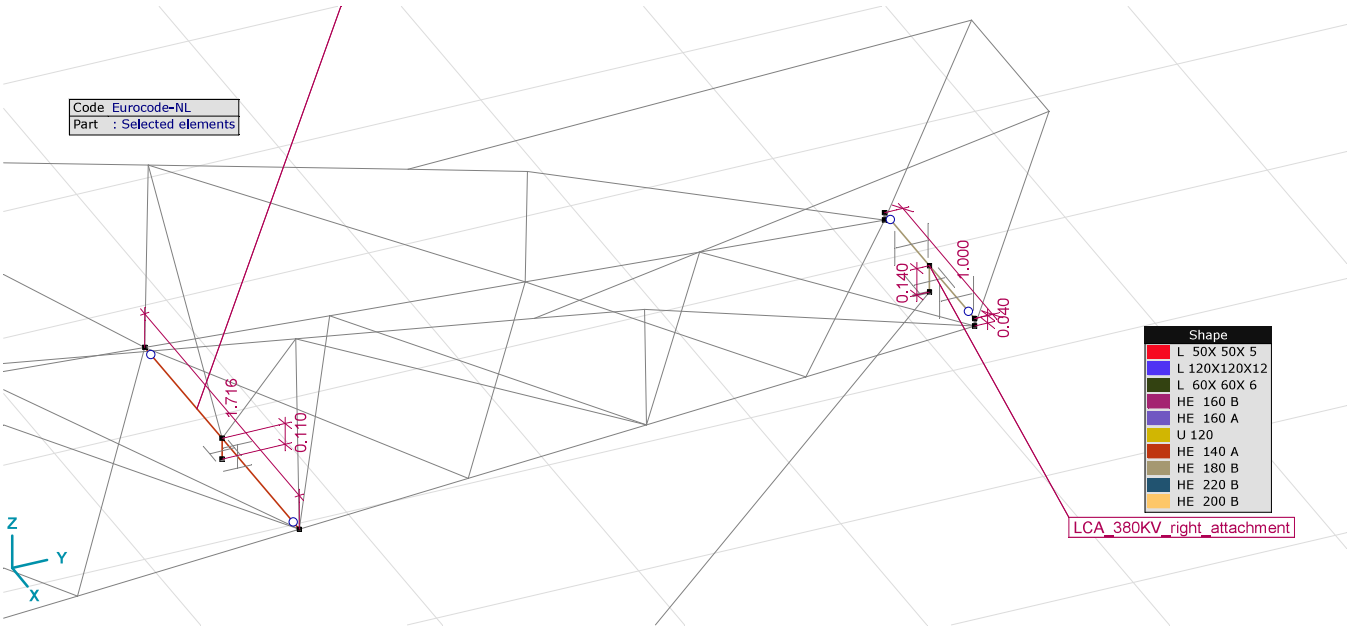
Lower_cross_arm_details_with_dimensions



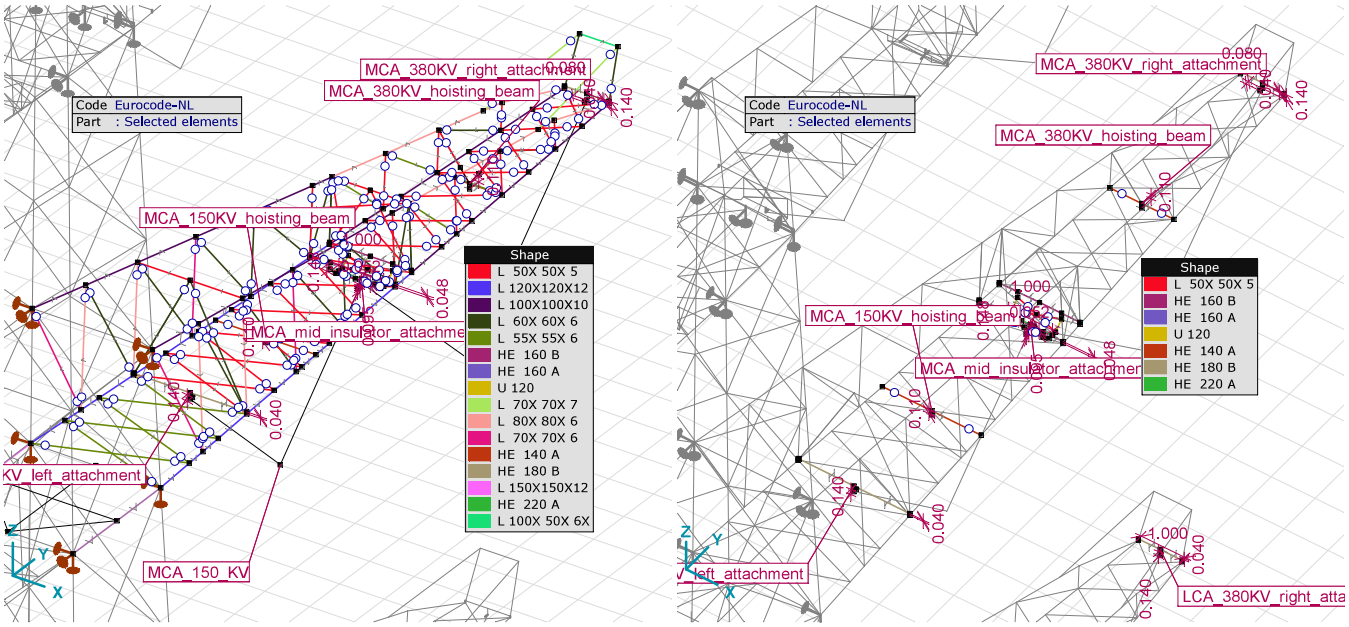
LCA_left_150KV



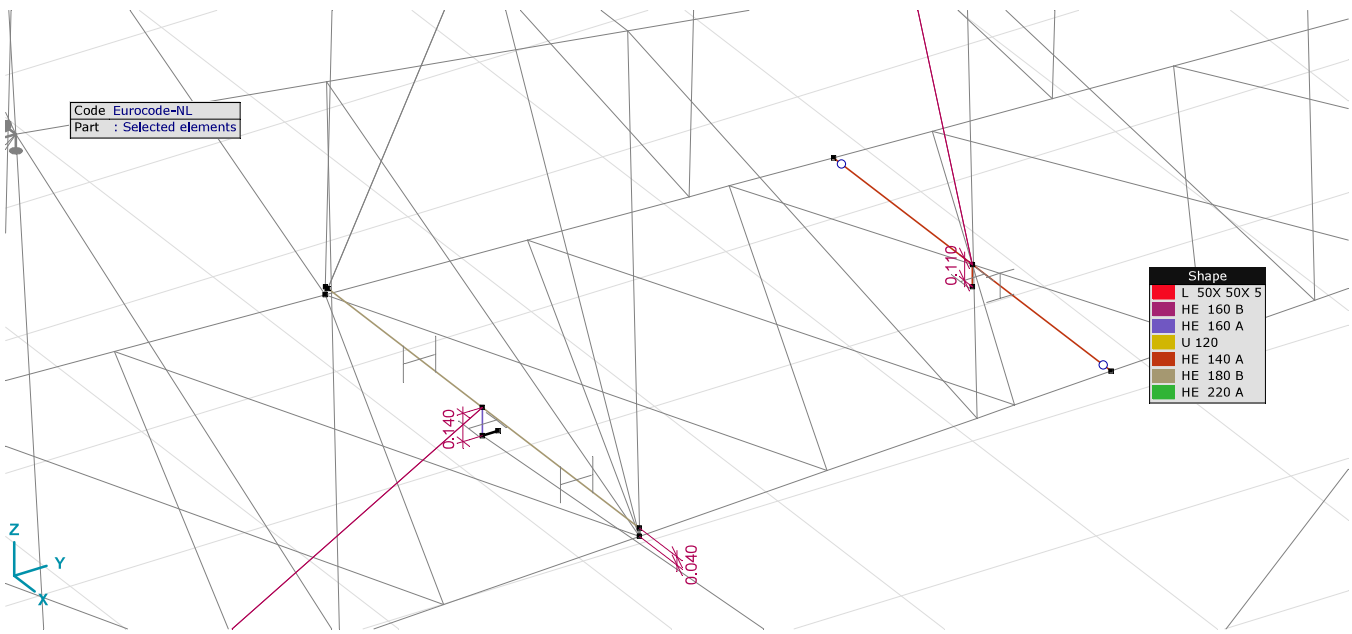
LCA_Mid_150_380_KV



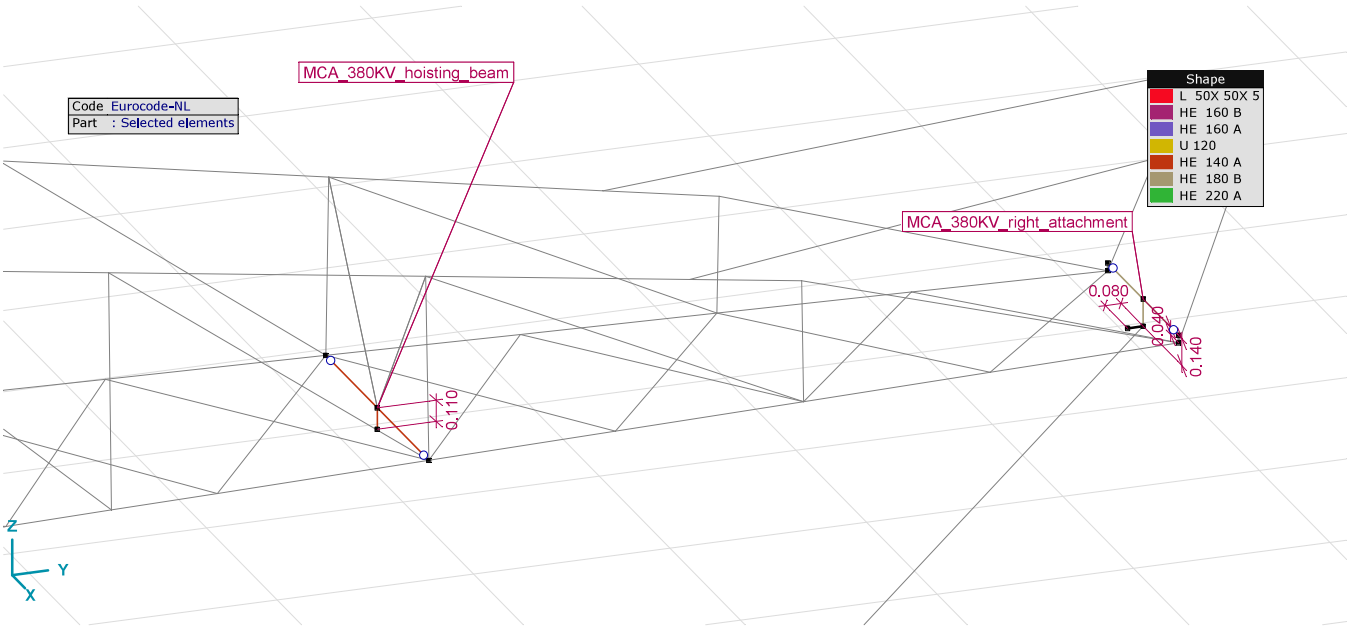
LCA_right_380_KV



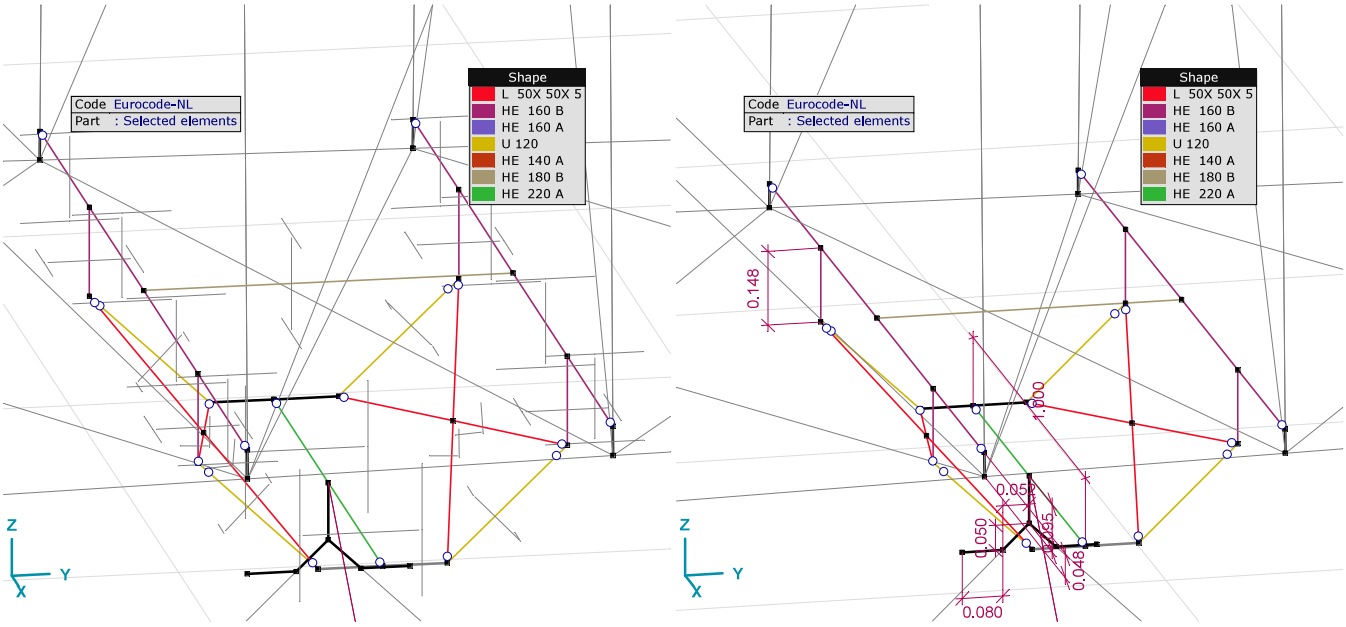
Mid_cross_arm_details



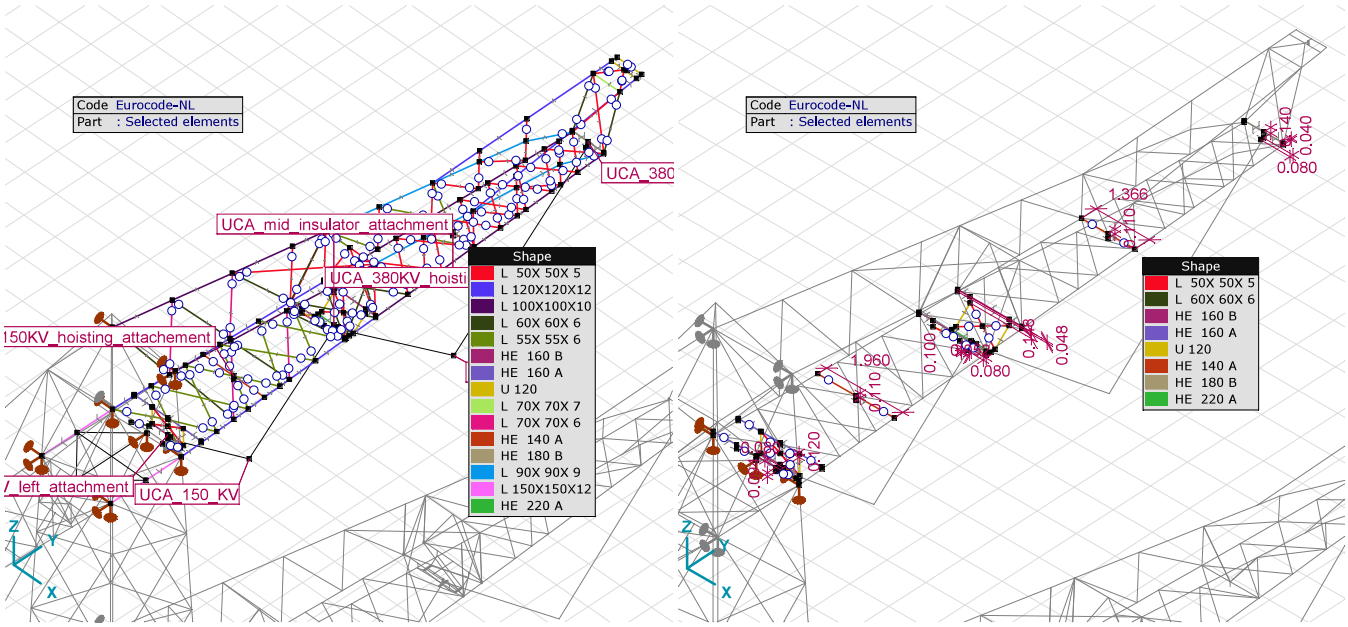
MCA_150KV_left_attachement



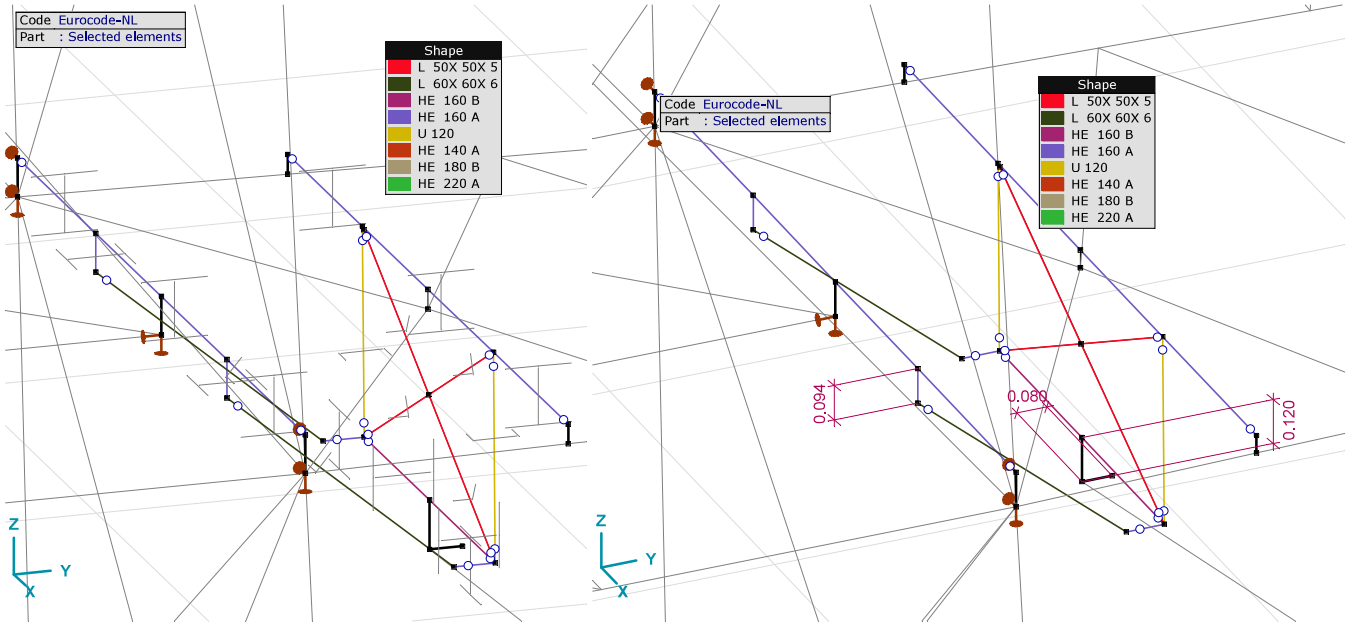
MCA_380KV_right_attachement



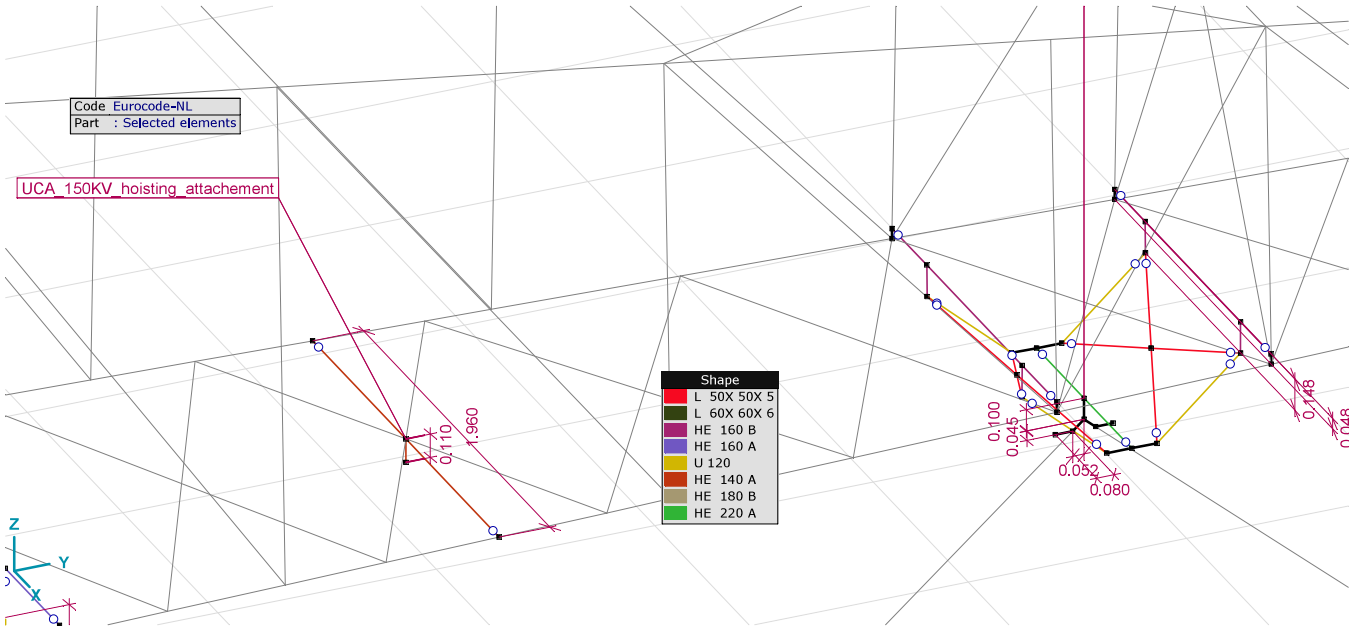
MCA_mid_attachement_(1)_cross-section_orientation_(2)_dimension



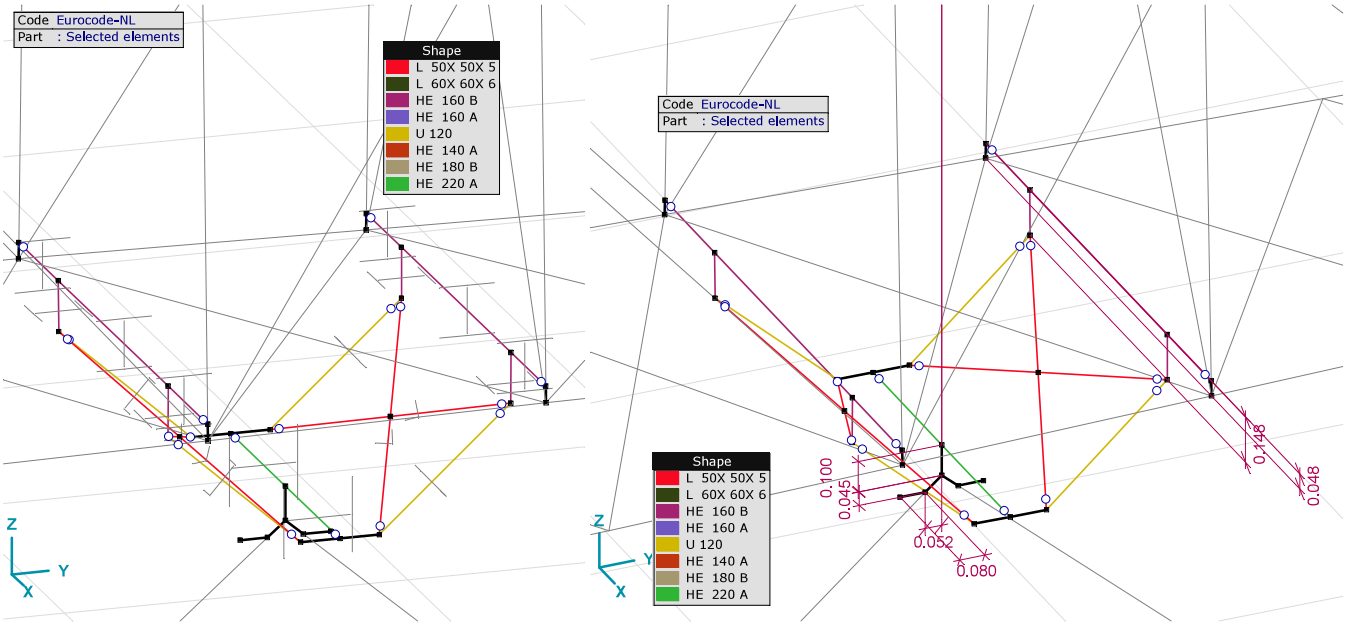
Upper_cross_arms_details



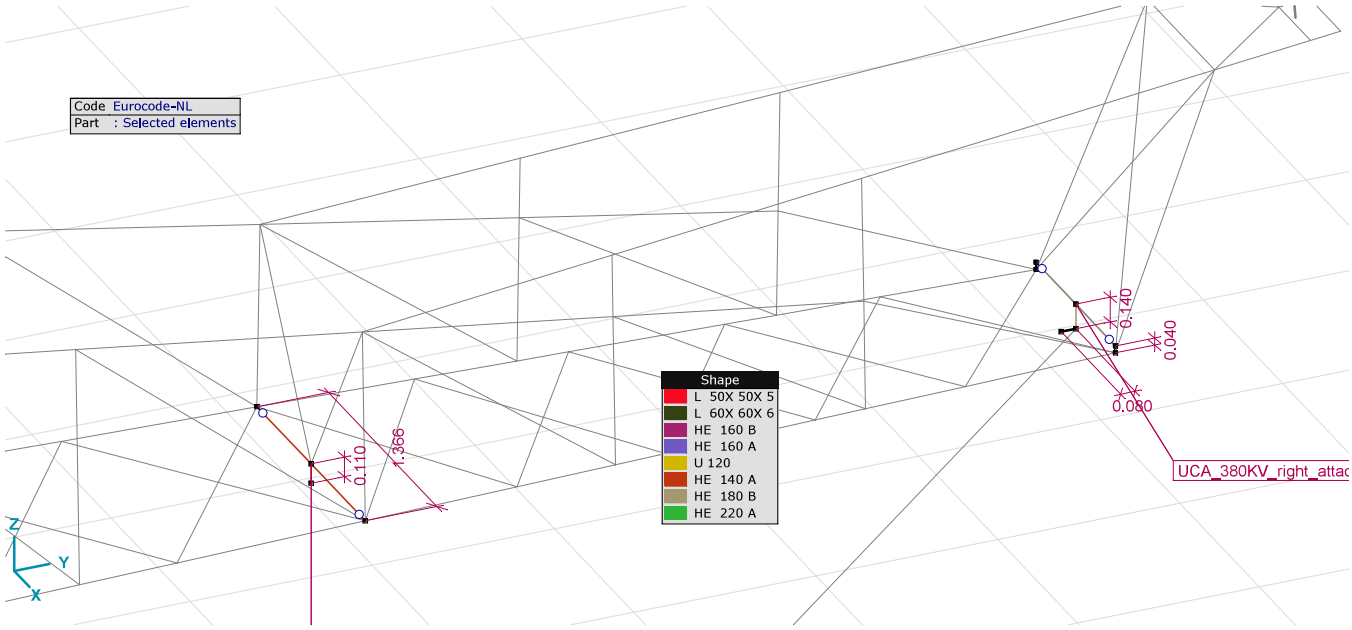
UCA_150_KV_left_attachement_(1)crossection_shape_(2)dimensions



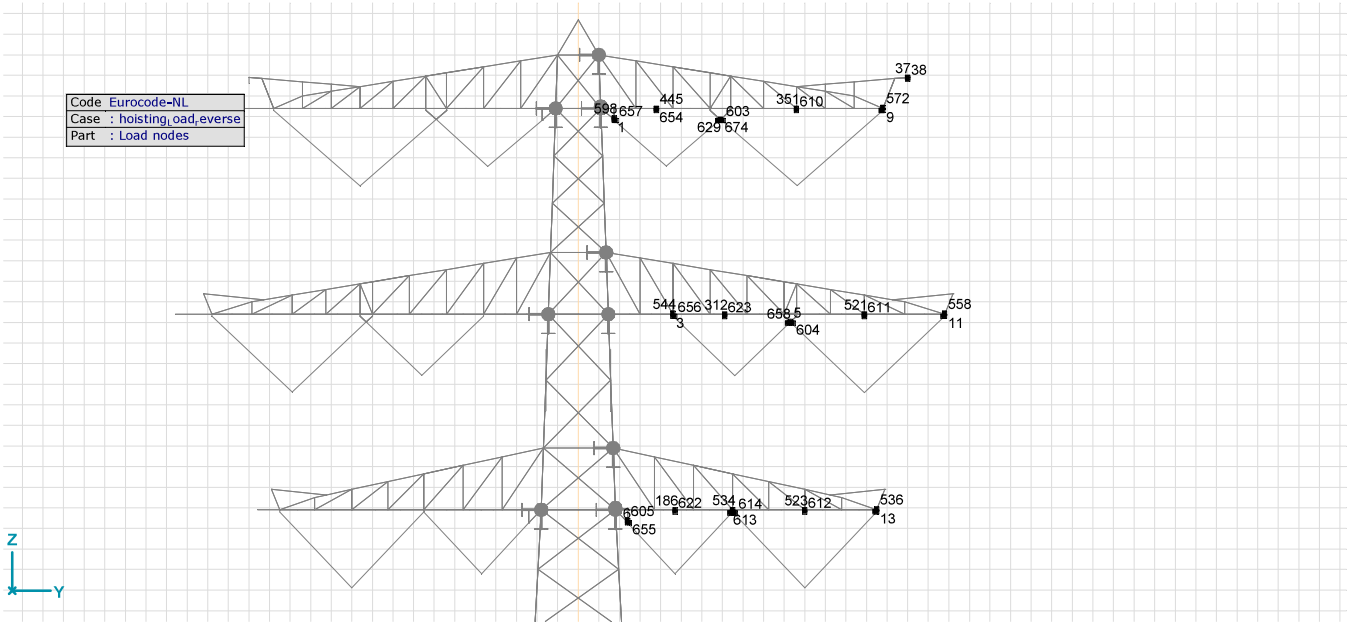
UCA_150KV_hoisting_beam_details



UCA_mid_attachement_(1)crossection_shape_(2)dimensions



UCA_380KV_right_attachement_detils

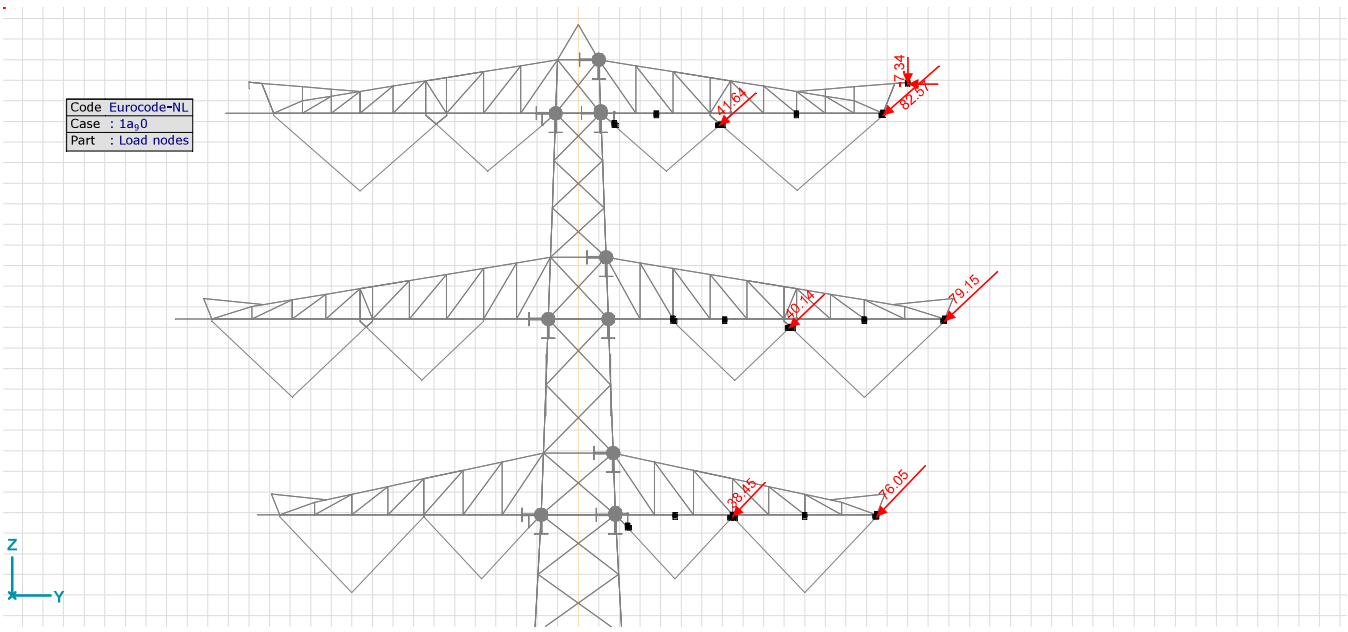


> Load nodes_ID

1a_90: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
38	Global	0	−11.91	−7.34	0	0	0
8	R16	38.45			0		
13	R16	76.05			0		
11	R14	79.15			0		
621	R12	40.14			0		
9	R10	82.57			0		
675	R8	41.64			0		

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

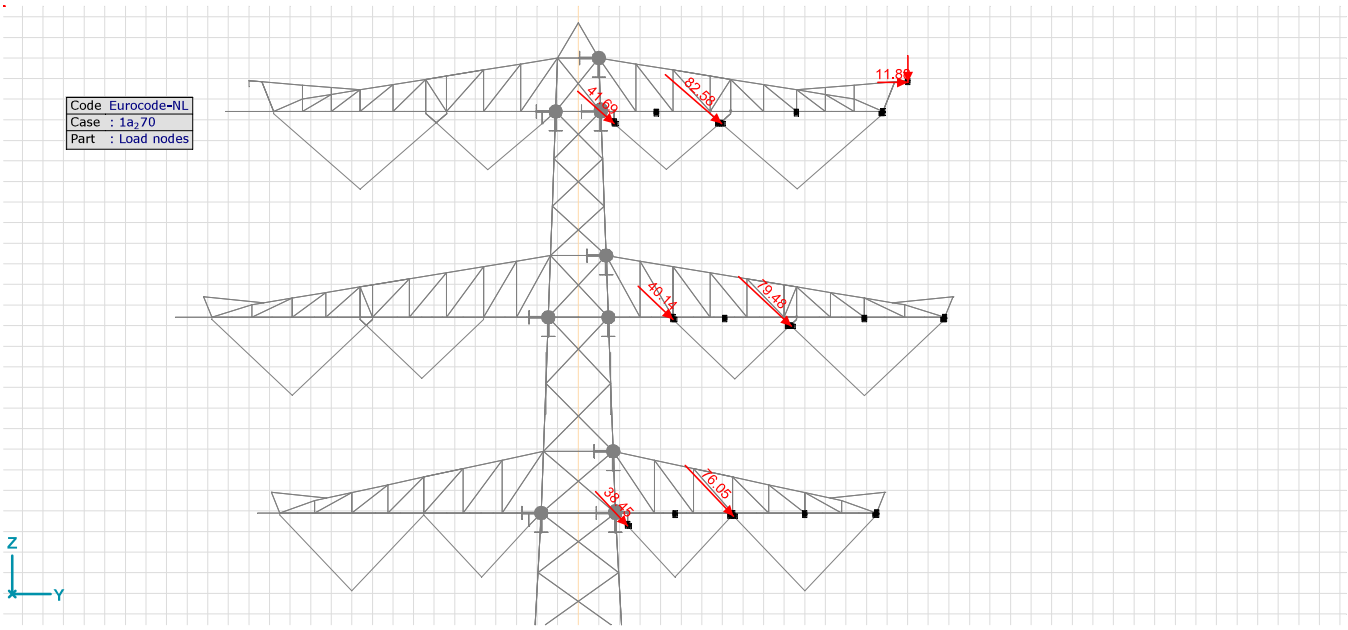


> Load nodes, 1a_90, Side view

1a_270: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
38	Global	0	11.88	−7.19	0	0	0
670	R17	76.05			0		
6	R15	38.45			0		
620	R13	79.48			0		
3	R11	40.14			0		
674	R9	82.58			0		
1	R7	41.69			0		

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



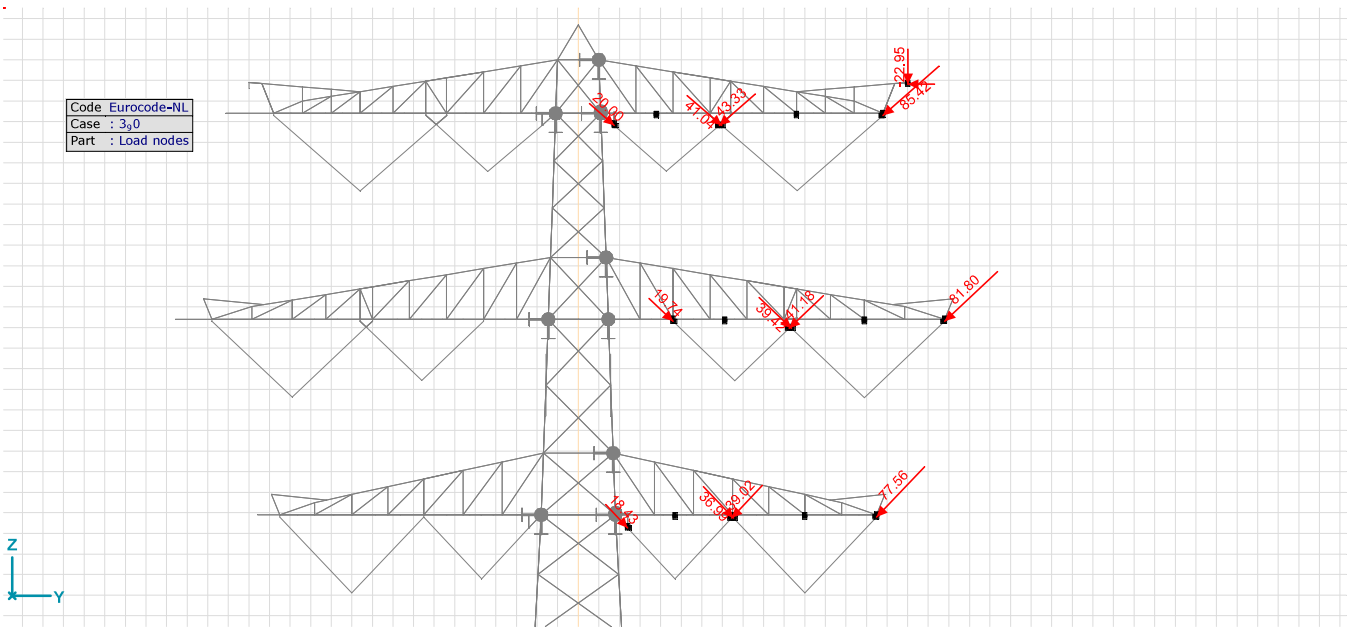
> Load nodes, 1a_270, Side view

3_90: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
38	Global	0	−10.23	−22.95	0	0	0
670	R17	36.99			0		
671	R16	39.02			0		
13	R16	77.56			0		
6	R15	18.43			0		
11	R14	81.80			0		
620	R13	39.42			0		

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
621	R12	41.18			0		
3	R11	19.74			0		
9	R10	85.42			0		
674	R9	41.04			0		
675	R8	43.33			0		
1	R7	20.00			0		

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



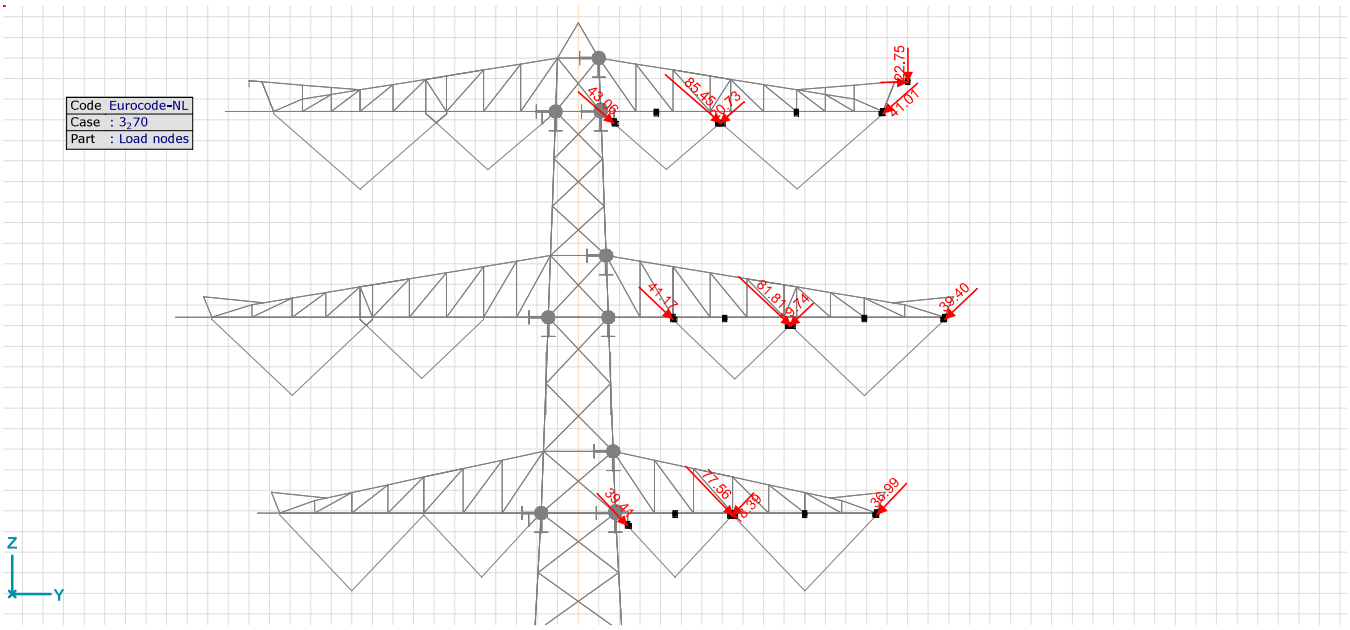
> Load nodes, 3_90, Side view

3_270: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
38	Global	0	10.22	−22.75	0	0	0
670	R17	77.56			0		
671	R16	18.39			0		
13	R16	36.99			0		
6	R15	39.41			0		
11	R14	39.40			0		
620	R13	81.81			0		

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
621	R12	19.74			0		
3	R11	41.17			0		
9	R10	41.01			0		
674	R9	85.45			0		
675	R8	20.73			0		
1	R7	43.06			0		

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

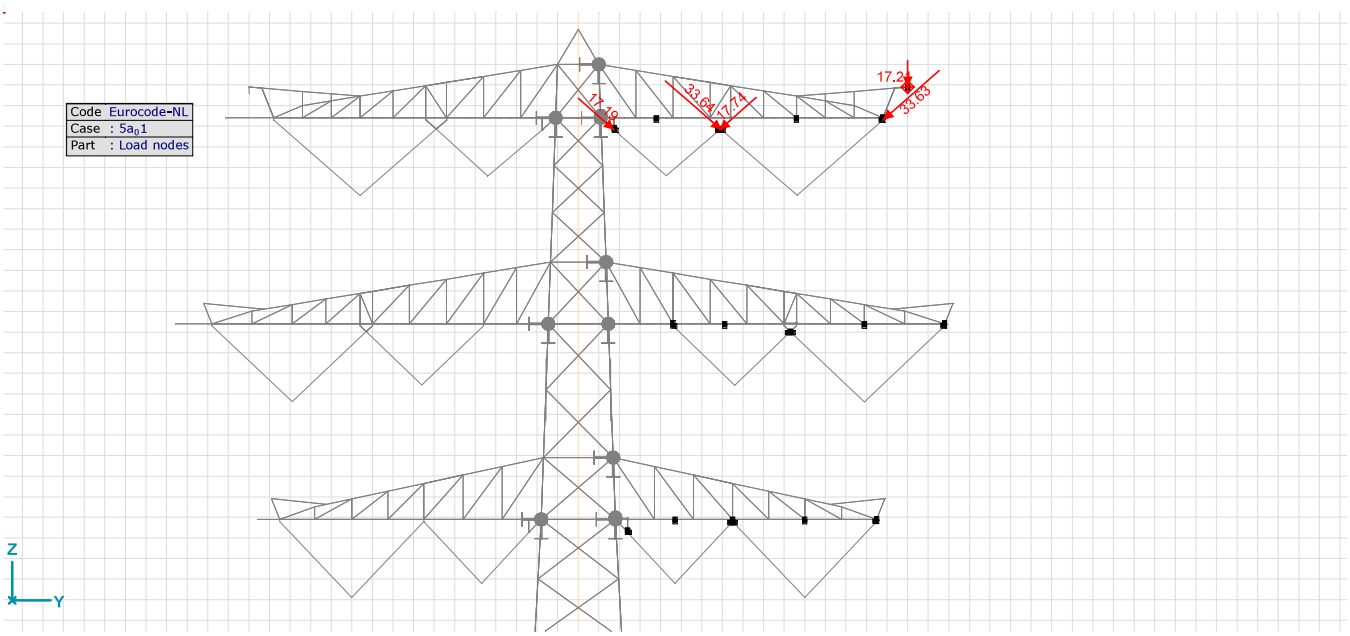


> Load nodes, 3_270, Side view

5a_01: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
37	Global	17.21	0	−3.53	0	0	0
9	R10	33.63			0		
674	R9	33.64			0		
675	R8	17.74			0		
1	R7	17.19			0		

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

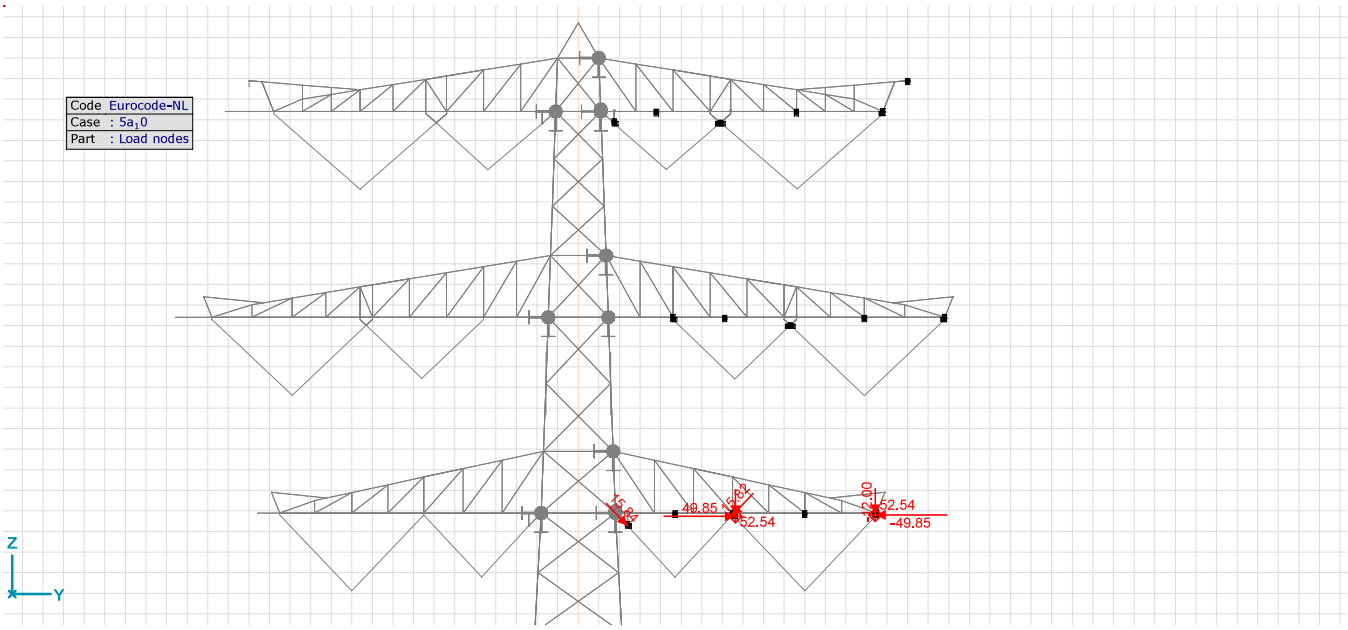


> Load nodes, 5a_01, Side view

5a_10: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
617	Global	52.54	−49.85	−12.00	0	0	0
614	Global	52.54	49.85	−12.00	0	0	0
671	R16	15.82			0		
6	R15	15.84			0		

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

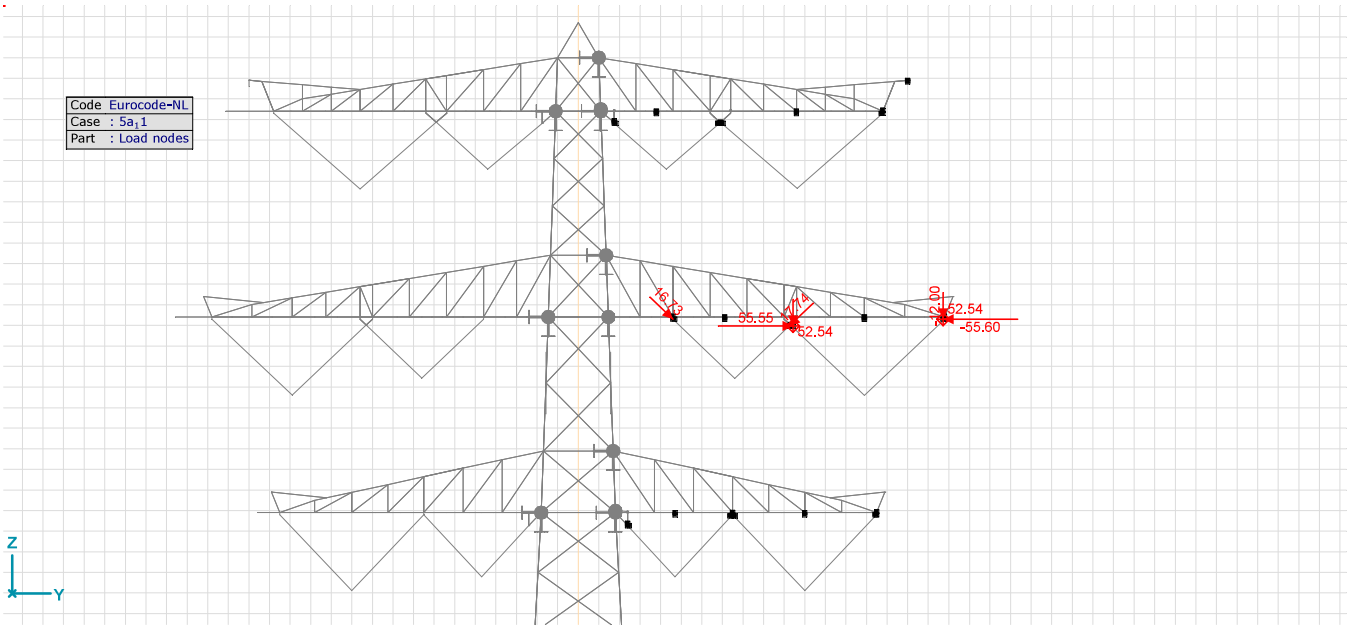


> Load nodes, 5a_10, Side view

5a_11: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
604	Global	52.54	55.55	−12.00	0	0	0
615	Global	52.54	−55.60	−12.00	0	0	0
621	R12	17.74			0		
3	R11	16.73			0		

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

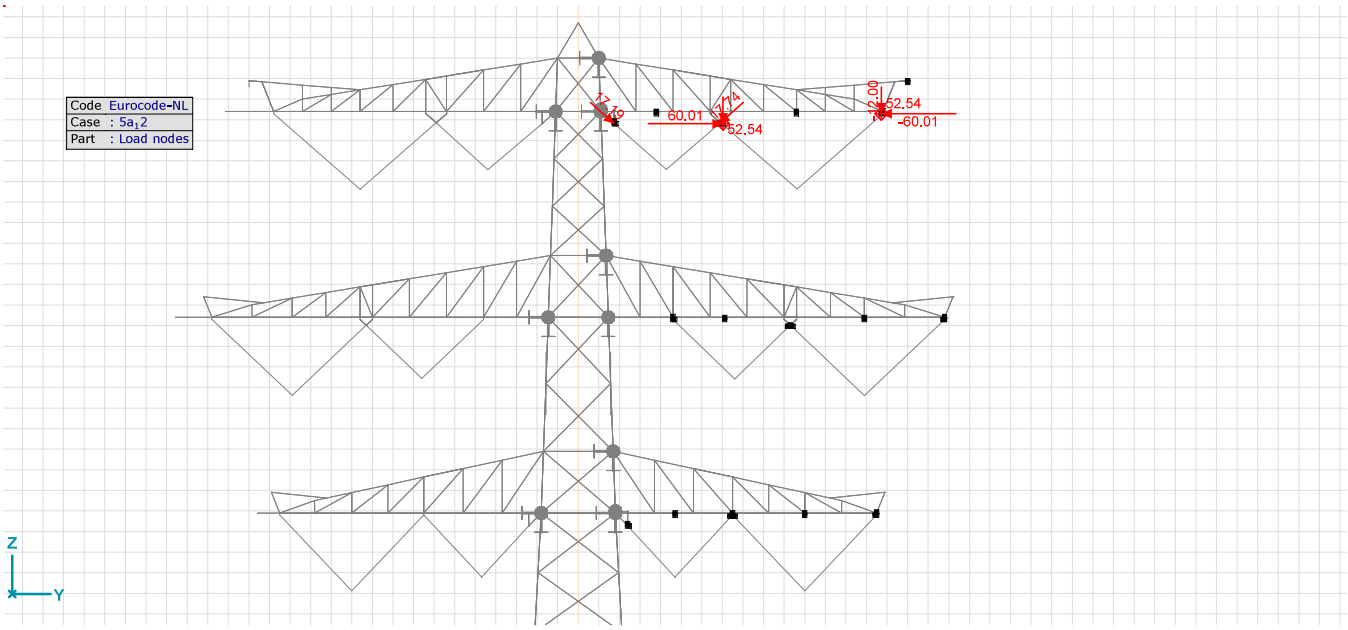


> Load nodes, 5a_11, Side view

5a_12: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
603	Global	52.54	60.01	−12.00	0	0	0
616	Global	52.54	−60.01	−12.00	0	0	0
675	R8	17.74			0		
1	R7	17.19			0		

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

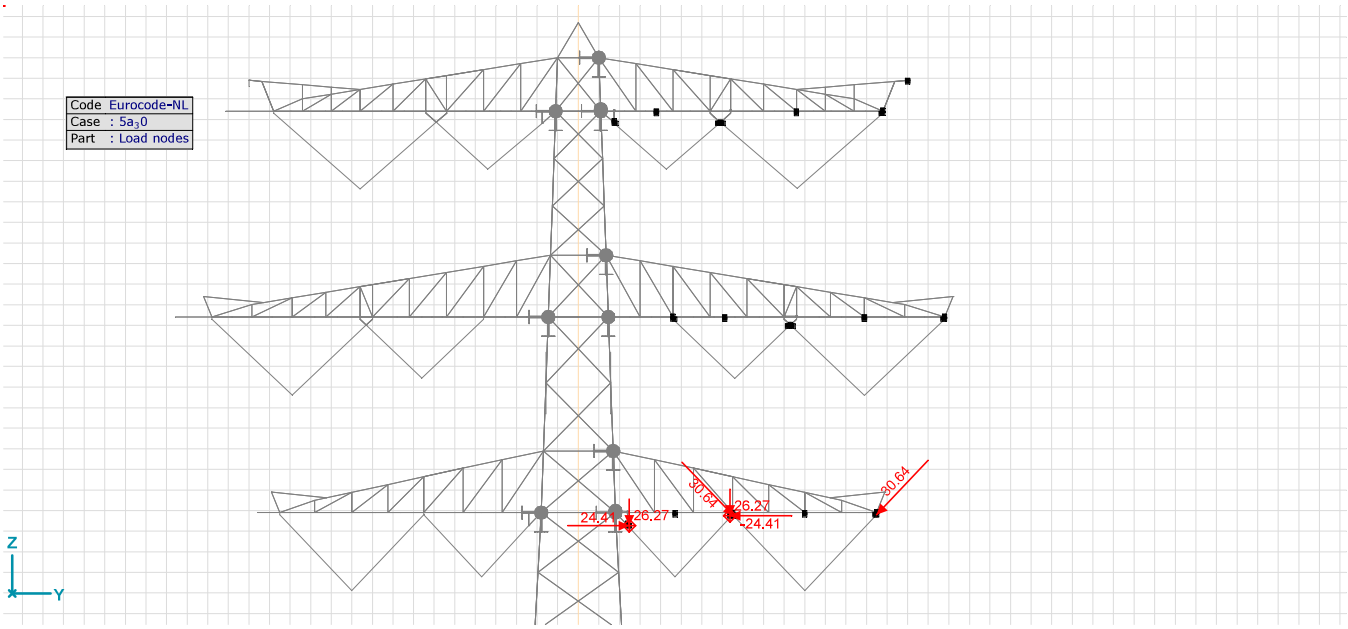


> Load nodes, 5a_12, Side view

5a_30: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
655	Global	26.27	24.41	−6.40	0	0	0
613	Global	26.27	−24.41	−6.40	0	0	0
670	R17	30.64			0		
13	R16	30.64			0		

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

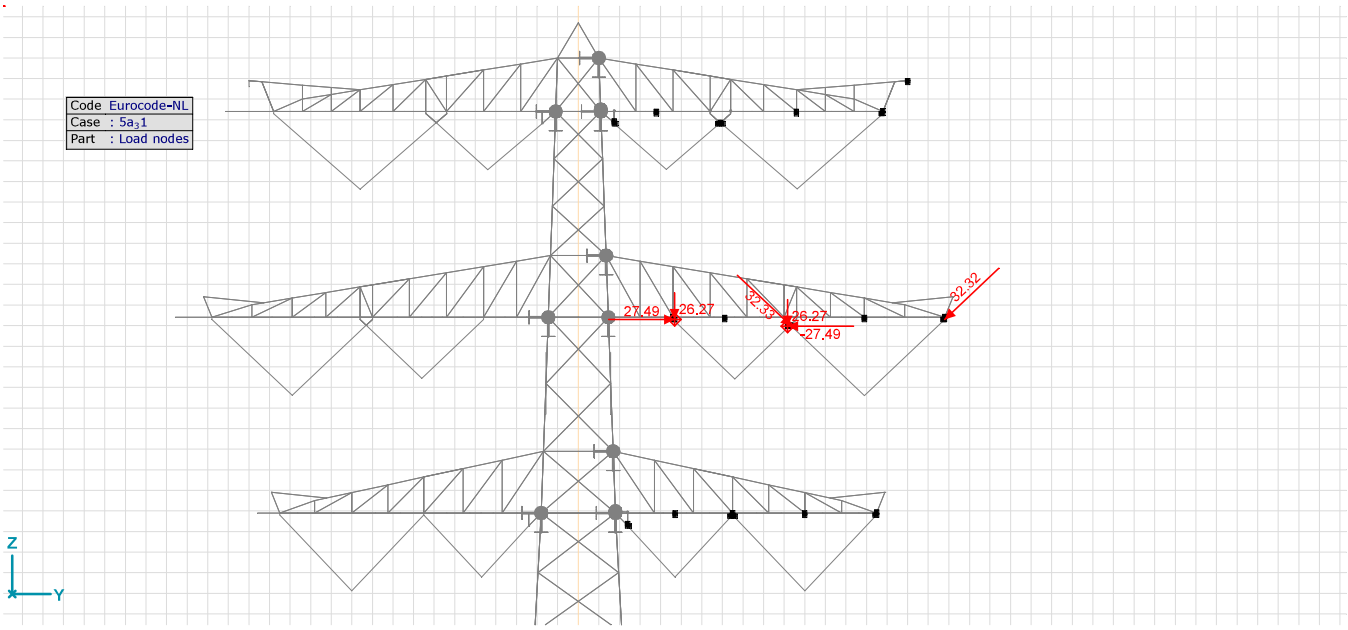


> Load nodes, 5a_30, Side view

5a_31: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
656	Global	26.27	27.49	−6.40	0	0	0
658	Global	26.27	−27.49	−6.40	0	0	0
11	R14	32.32			0		
620	R13	32.33			0		

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

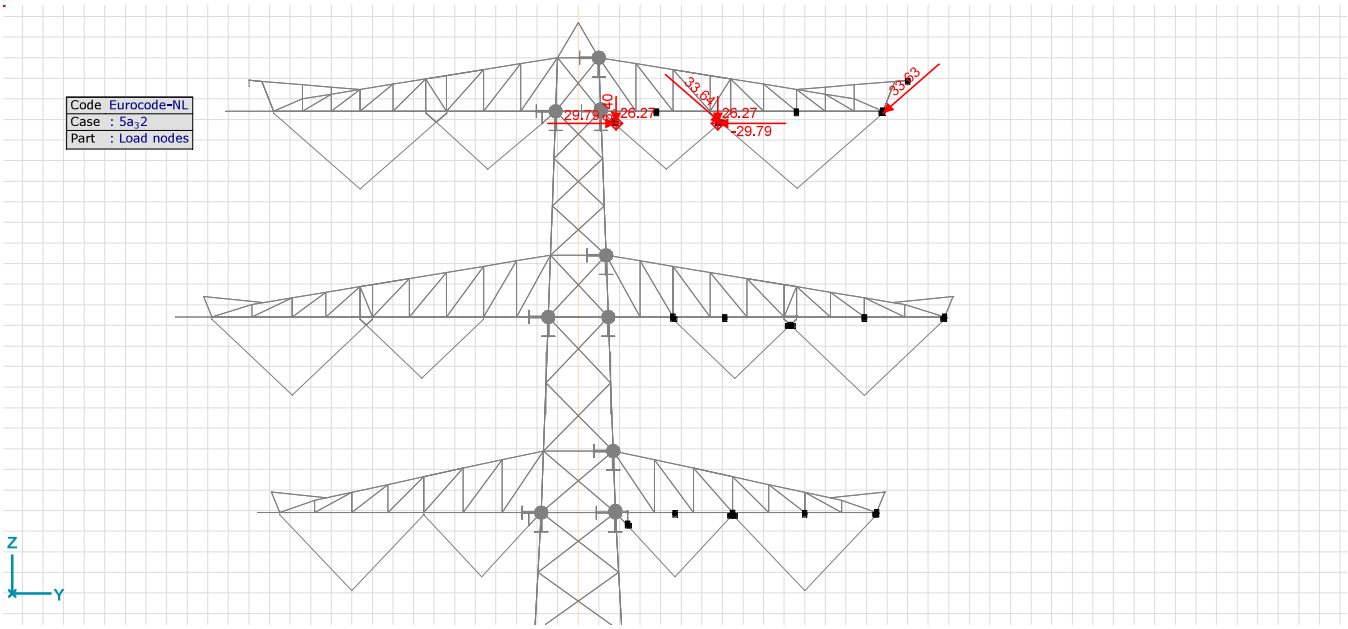


> Load nodes, 5a_31, Side view

5a_32: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
657	Global	26.27	29.79	−6.40	0	0	0
629	Global	26.27	−29.79	−6.40	0	0	0
9	R10	33.63			0		
674	R9	33.64			0		

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

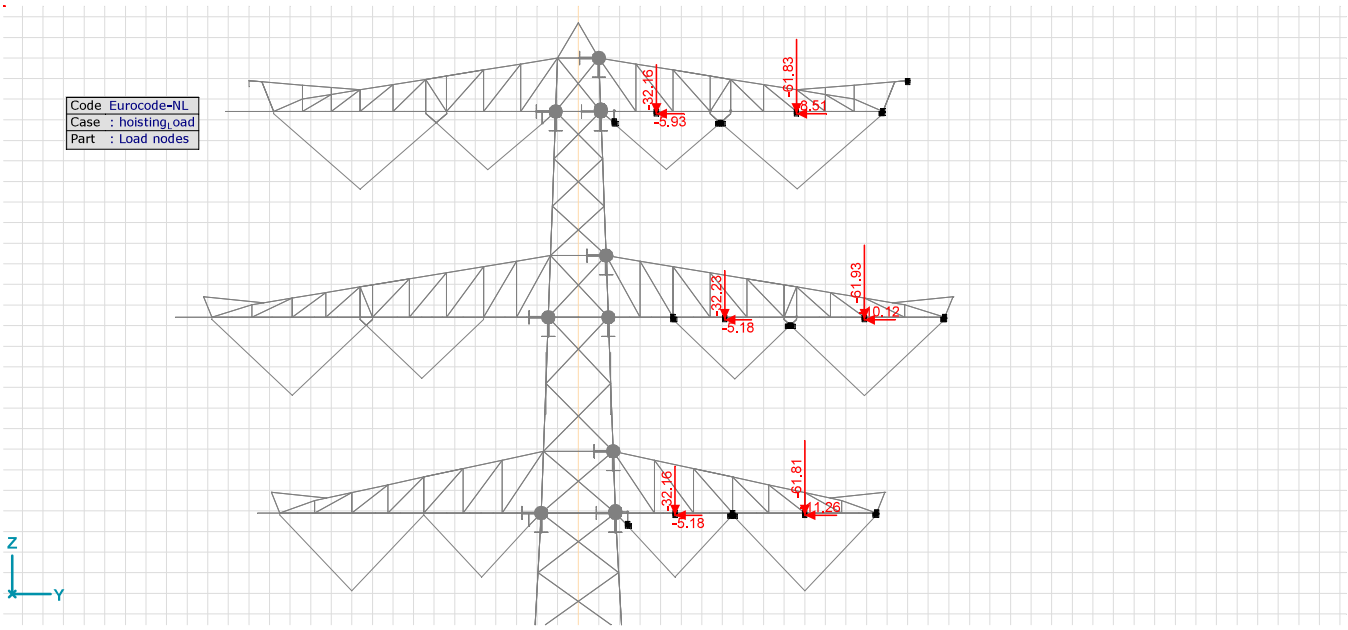


> Load nodes, 5a_32, Side view

hoisting_Load: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
611	Global	0	−10.12	−61.93	0	0	0
610	Global	0	−8.51	−61.83	0	0	0
612	Global	0	−11.26	−61.81	0	0	0
623	Global	0	−5.18	−32.23	0	0	0
654	Global	0	−5.93	−32.16	0	0	0
622	Global	0	−5.18	−32.16	0	0	0

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

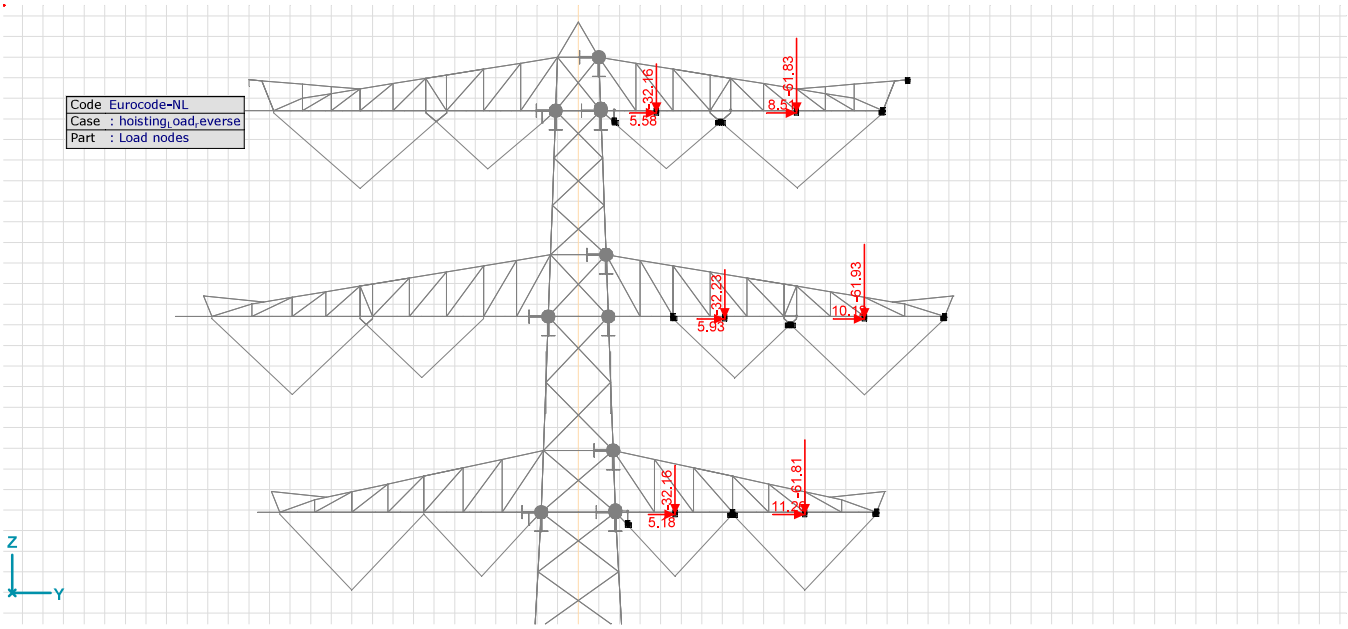


> Load nodes, hoisting_Load, Side view

hoisting_Load_reverse: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
611	Global	0	10.12	−61.93	0	0	0
610	Global	0	8.51	−61.83	0	0	0
612	Global	0	11.26	−61.81	0	0	0
623	Global	0	5.93	−32.23	0	0	0
654	Global	0	5.58	−32.16	0	0	0
622	Global	0	5.18	−32.16	0	0	0

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

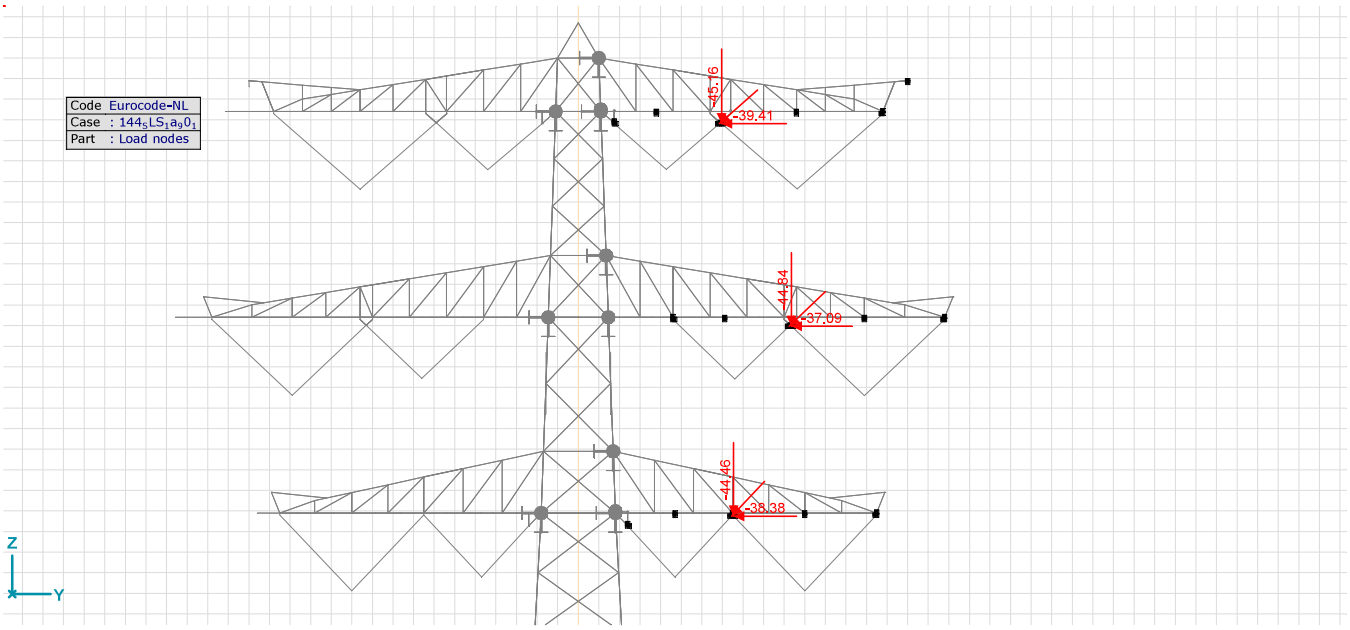


> Load nodes, hoisting_Load_reverse, Side view

144_SLS_1a_90_1: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
674	Global	0	−39.41	−45.16	0	0	0
620	Global	0	−37.09	−44.84	0	0	0
670	Global	0	−38.38	−44.46	0	0	0
671	R16	28.81			0		
621	R12	30.07			0		
675	R8	31.26			0		

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

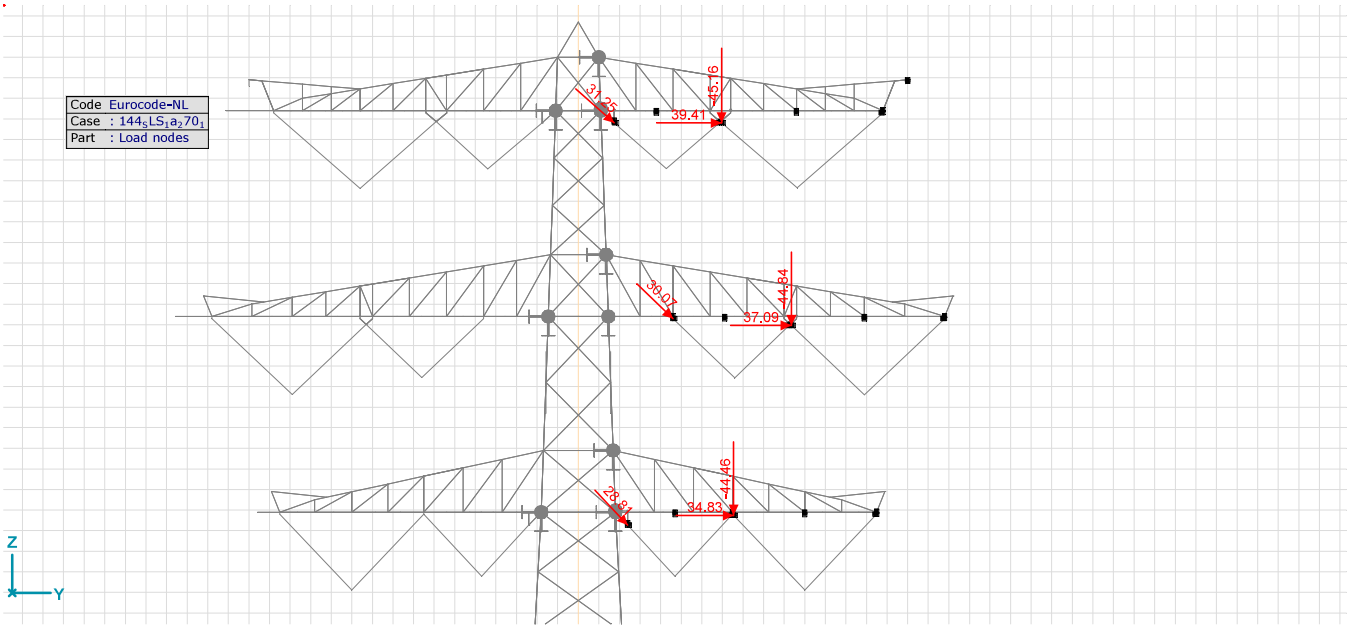


> Load nodes, 144_SLS_1a_90_1, Side view

144_SLS_1a_270_1: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
674	Global	0	39.41	−45.16	0	0	0
620	Global	0	37.09	−44.84	0	0	0
670	Global	0	34.83	−44.46	0	0	0
6	R15	28.81			0		
3	R11	30.07			0		
1	R7	31.25			0		

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

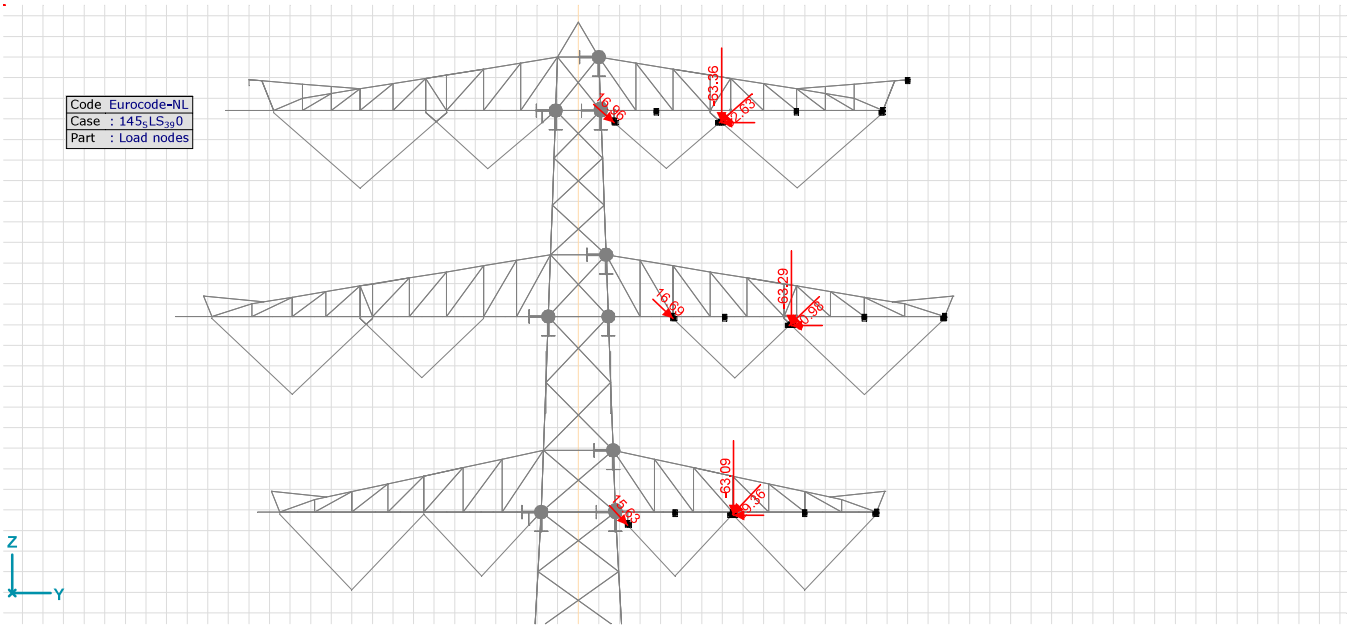


> Load nodes, 144_SLS_1a_270_1, Side view

145_SLS_3_90: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
674	Global	0	−22.27	−63.36	0	0	0
620	Global	0	−20.06	−63.29	0	0	0
670	Global	0	−18.62	−63.09	0	0	0
8	R16	29.36			0		
6	R15	15.63			0		
621	R12	30.98			0		
3	R11	16.69			0		
675	R8	32.63			0		
1	R7	16.96			0		

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

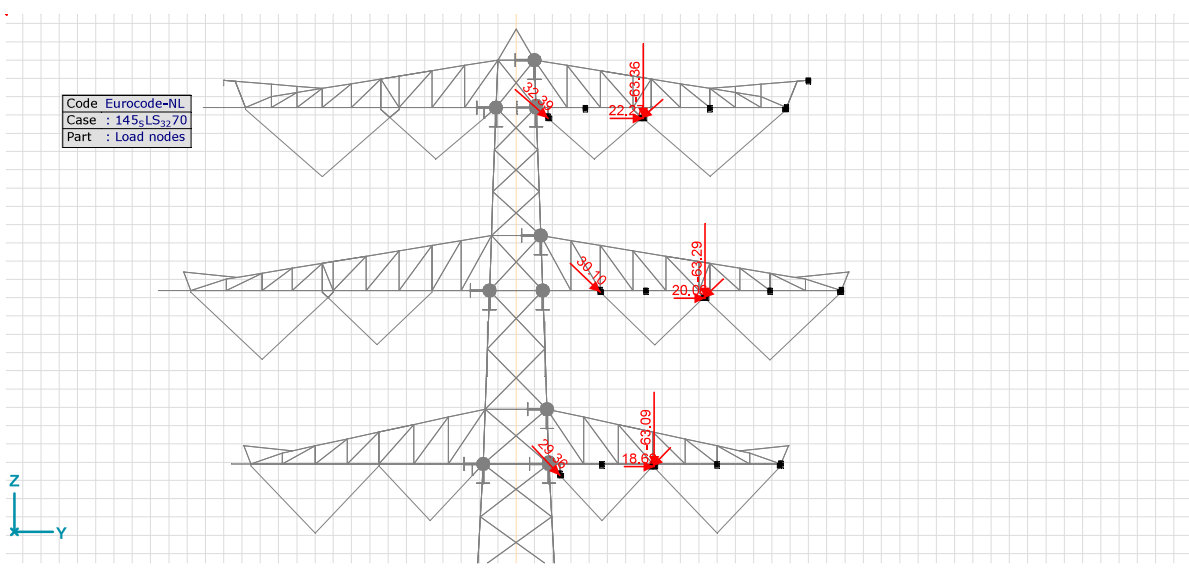


> Load nodes, 145_SLS_3_90, Side view

145_SLS_3_270: Nodal loads [Load nodes]

	Direction	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
674	Global	0	22.27	−63.36	0	0	0
620	Global	0	20.06	−63.29	0	0	0
670	Global	0	18.62	−63.09	0	0	0
671	R16	15.60			0		
6	R15	29.36			0		
621	R12	16.69			0		
3	R11	30.10			0		
675	R8	17.50			0		
1	R7	32.39			0		

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



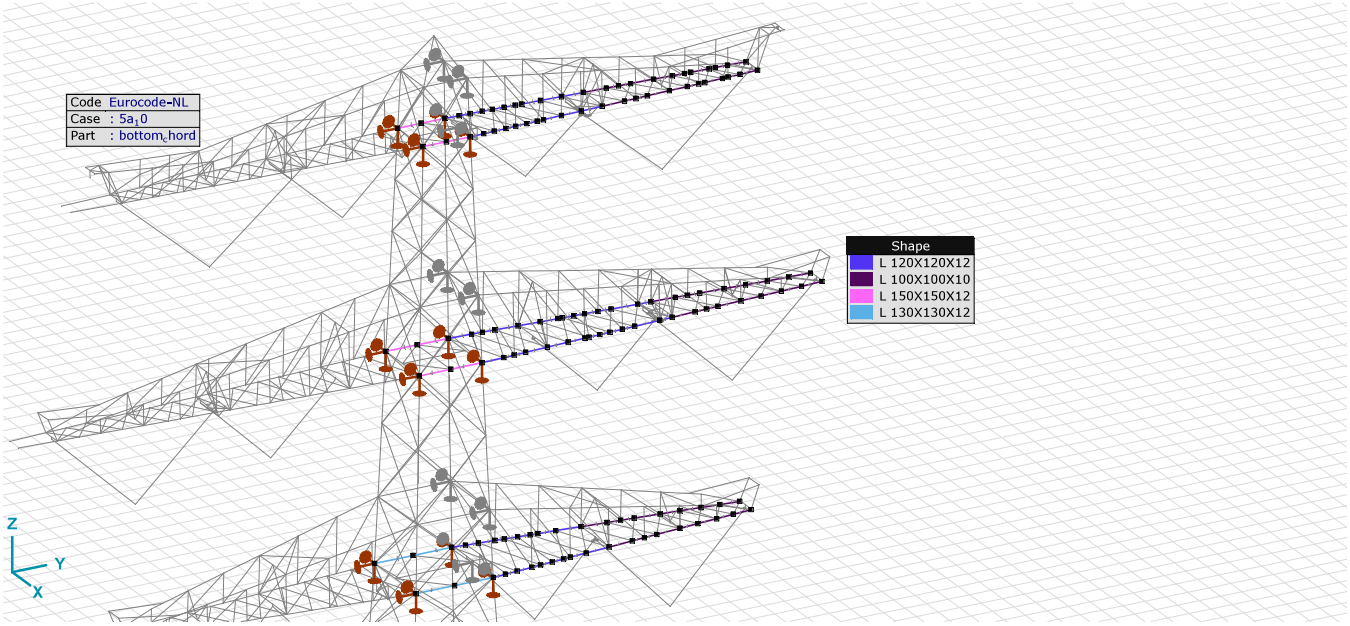
> Load nodes, 145_SLS_3_270, Side view

Custom load combinations by load cases

	Name	*Type*	*144_SLS_1a_90_1*	*144_SLS_1a_270_1*	*145_SLS_3_90*	*145_SLS_3_270*	*1a_90*	*1a_270*	*3_90*	*3_270*	*5a_01*	*5a_10*	*5a_11*	*5a_12*	*5a_30*
1	Co #1	ULS	1.00	0	0	0	0	0	0	0	0	0	0	0	0
2	Co #2	ULS	0	1.00	0	0	0	0	0	0	0	0	0	0	0
3	Co #3	ULS	0	0	1.00	0	0	0	0	0	0	0	0	0	0
4	Co #4	ULS	0	0	0	1.00	0	0	0	0	0	0	0	0	0
5	Co #5	ULS	0	0	0	0	1.00	0	0	0	0	0	0	0	0
6	Co #6	ULS	0	0	0	0	0	1.00	0	0	0	0	0	0	0
7	Co #7	ULS	0	0	0	0	0	0	1.00	0	0	0	0	0	0
8	Co #8	ULS	0	0	0	0	0	0	0	1.00	0	0	0	0	0
9	Co #9	ULS	0	0	0	0	0	0	0	0	1.00	0	0	0	0
10	Co #10	ULS	0	0	0	0	0	0	0	0	0	1.00	0	0	0
11	Co #11	ULS	0	0	0	0	0	0	0	0	0	0	1.00	0	0
12	Co #12	ULS	0	0	0	0	0	0	0	0	0	0	0	1.00	0
13	Co #13	ULS	0	0	0	0	0	0	0	0	0	0	0	0	1.00
14	Co #14	ULS	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Co #15	ULS	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Co #16	ULS	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Co #17	ULS	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Co #18	ULS	0	0	0	0	0	0	0	0	0	0	0	0	0

	5a_31	*5a_32*	*hoisting_Load*	*hoisting_Load_reverse*	*EG*	*Comment*
1	0	0	0	0	1.00	
2	0	0	0	0	1.00	
3	0	0	0	0	1.00	
4	0	0	0	0	1.00	
5	0	0	0	0	1.00	
6	0	0	0	0	1.00	
7	0	0	0	0	1.00	
8	0	0	0	0	1.00	
9	0	0	0	0	1.00	
10	0	0	0	0	1.00	
11	0	0	0	0	1.00	
12	0	0	0	0	1.00	
13	0	0	0	0	1.00	
14	1.00	0	0	0	1.00	
15	0	1.00	0	0	1.00	
16	0	0	1.00	0	1.00	
17	0	0	0	1.00	1.00	
18	0	0	0	0	1.00	

Name: Load combination name; **Type:** Load combination type; **$144_{S}LS_{1}a_{0}0_{1}$, $144_{S}LS_{1}a_{2}70_{1}$, $145_{S}LS_{39}0$, $145_{S}LS_{32}70$, $1a_{9}0$, $1a_{2}70$, $3_{9}0$, $3_{2}70$, $5a_{0}1$, $5a_{1}0$, $5a_{1}1$, $5a_{1}2$, $5a_{3}0$, $5a_{3}1$, $5a_{3}2$, $hoisting_{L}oad$, $hoisting_{L}oad_{e}everse$, EG:** Factor;

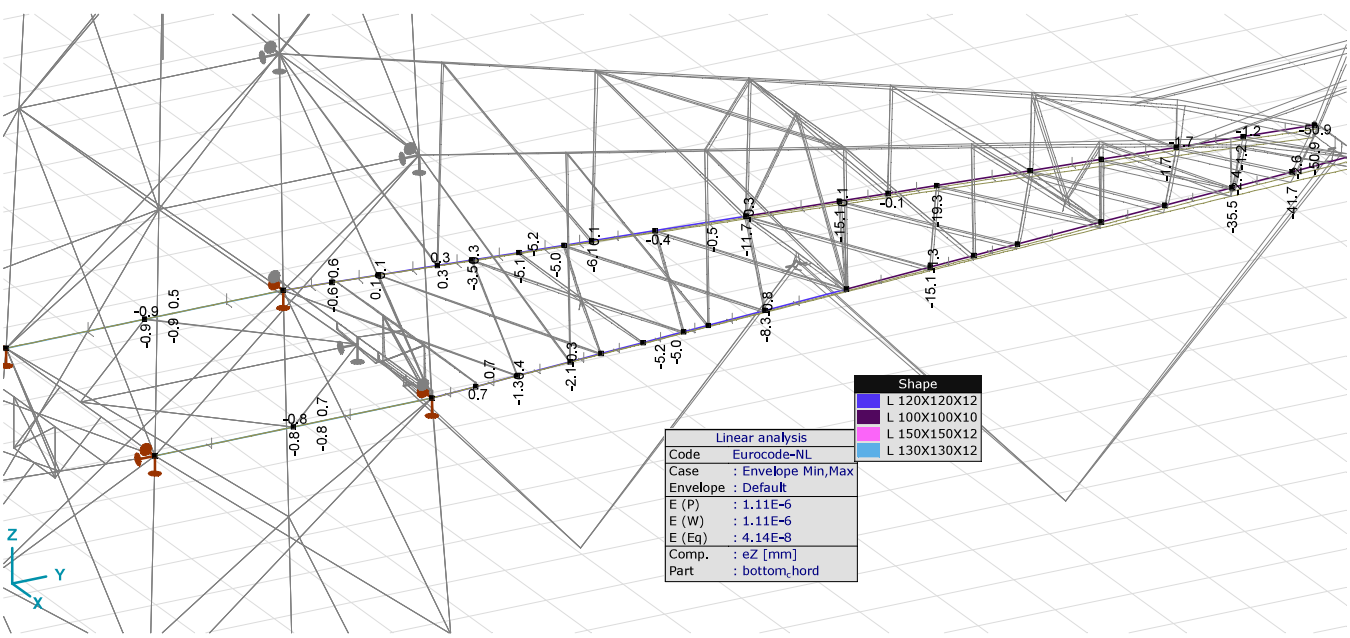


> bottom_chord

Nodal displacements [Linear, Envelope (Default), LCA]

	C	min. max.	Case	eX [mm]	eY [mm]	eZ [mm]	eR [mm]	fX [rad]	fY [rad]	fZ [rad]	fR [rad]
Ext.											
293	eX	min	Co #13	**−1.3**	−0.2	−0.9	1.5	−0.00016	0	0.00023	0.00028
212		max	Co #10	**31.1**	−0.8	−6.0	31.6	0.05066	0.61948	0.00008	0.62155
212	eY	min	Co #7	0.2	**−5.6**	−50.9	51.2	−0.01444	−0.00380	0.00106	0.01497
215		min	Co #7	−0.1	**−5.6**	−50.9	51.2	−0.01444	0.00382	−0.00106	0.01497
188		max	Co #10	6.7	**1.1**	0.2	6.8	0.01395	0.13795	−0.00234	0.13867
531		max	Co #10	5.5	**1.1**	0.3	5.6	0.01164	0.11506	−0.00206	0.11566
212	eZ	min	Co #7	0.2	−5.6	**−50.9**	51.2	−0.01444	−0.00380	0.00106	0.01497
215		min	Co #7	−0.1	−5.6	**−50.9**	51.2	−0.01444	0.00382	−0.00106	0.01497
292		max	Co #10	−1.0	−0.9	**0.7**	1.5	0.00013	0	0.00018	0.00022
71	eR	min	Co #9	0	0	0	**0**	0.00013	0	0.00003	0.00013
212		max	Co #7	0.2	−5.6	−50.9	**51.2**	−0.01444	−0.00380	0.00106	0.01497
215		max	Co #7	−0.1	−5.6	−50.9	**51.2**	−0.01444	0.00382	−0.00106	0.01497

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;

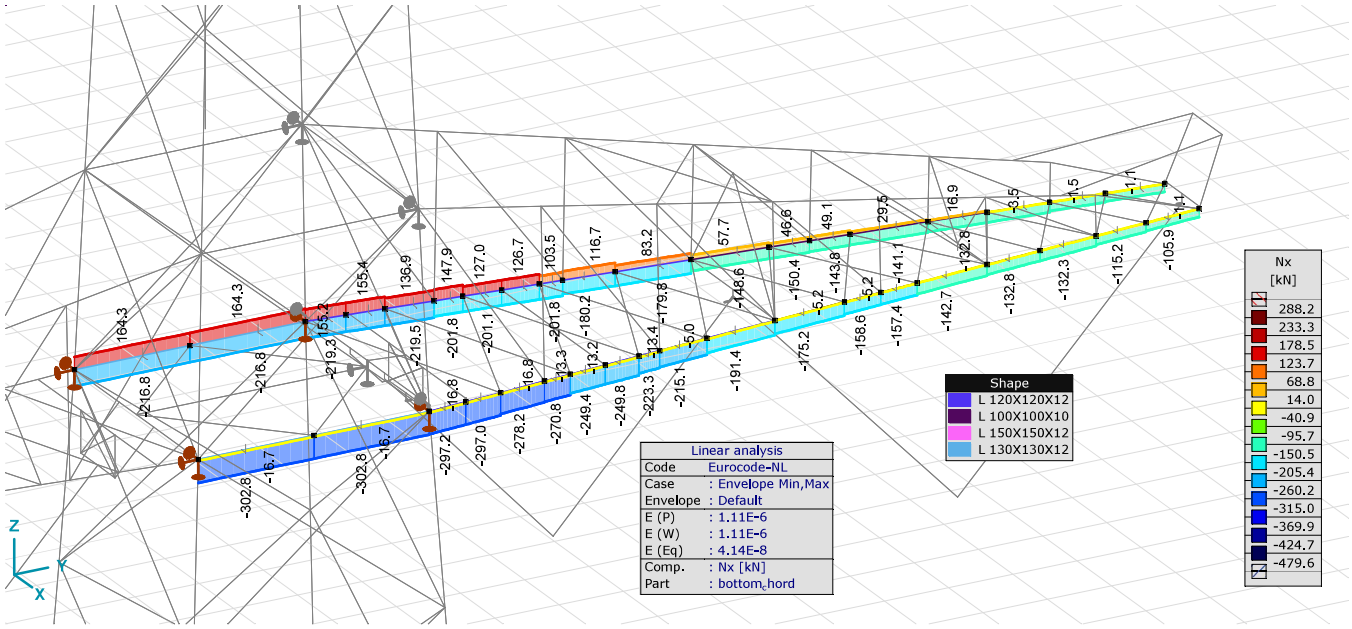


LCA_bottom_chord, Linear, Envelope (Default), eZ [mm], Diagram

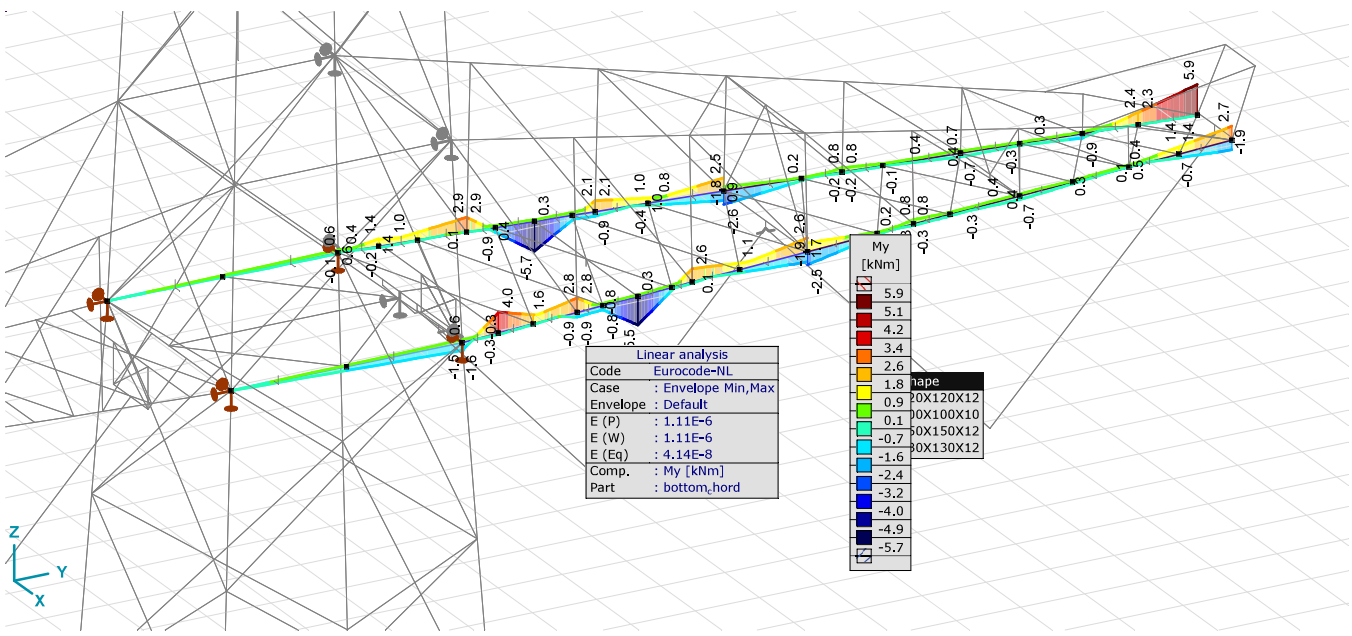
Beam internal forces [Linear, Envelope (Default), LCA]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
497	21	L 130X130X12	Nx	min	Co #10	0	(292)	**−302.8**	0.2	0	0	0.1	−0.3
498	21	L 130X130X12		min	Co #10	0	(71)	**−302.8**	0.2	0	0	0	0
499	21	L 130X130X12		max	Co #10	0	(293)	**164.3**	0.2	−0.1	0	0.3	0.4
500	21	L 130X130X12		max	Co #10	0	(73)	**164.3**	0.2	−0.1	0	0.5	0.9

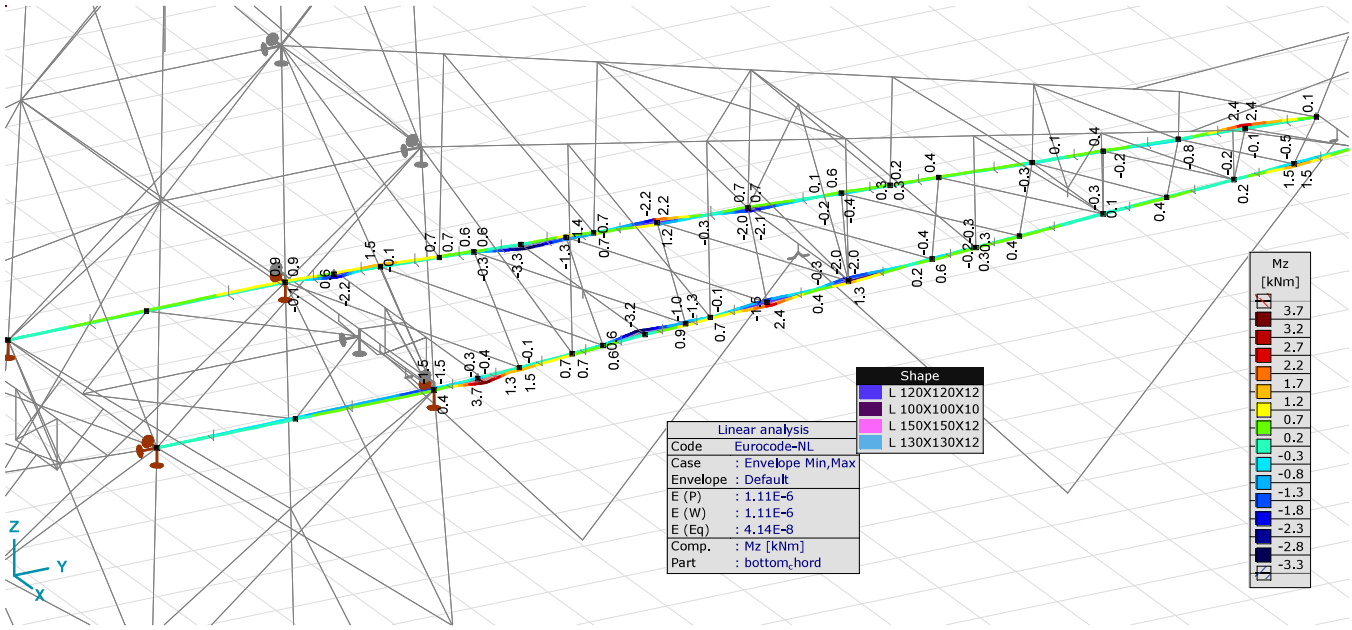
Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:**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



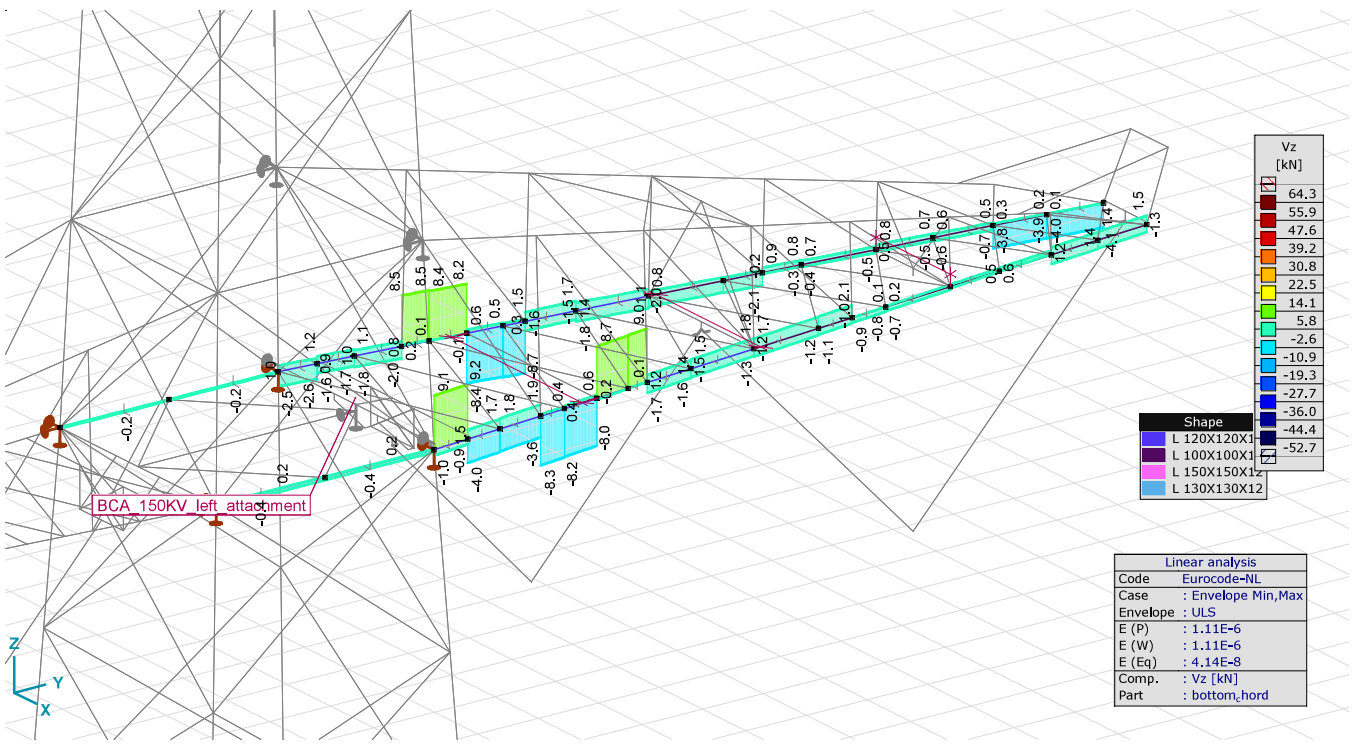
LCA_bottom_chord, Linear, Envelope (Default), Nx [kN], Filled diagram



LCA_bottom_chord, Linear, Envelope (Default), My [kNm], Filled diagram



LCA_bottom_chord, Linear, Envelope (Default), Mz [kNm], Filled diagram

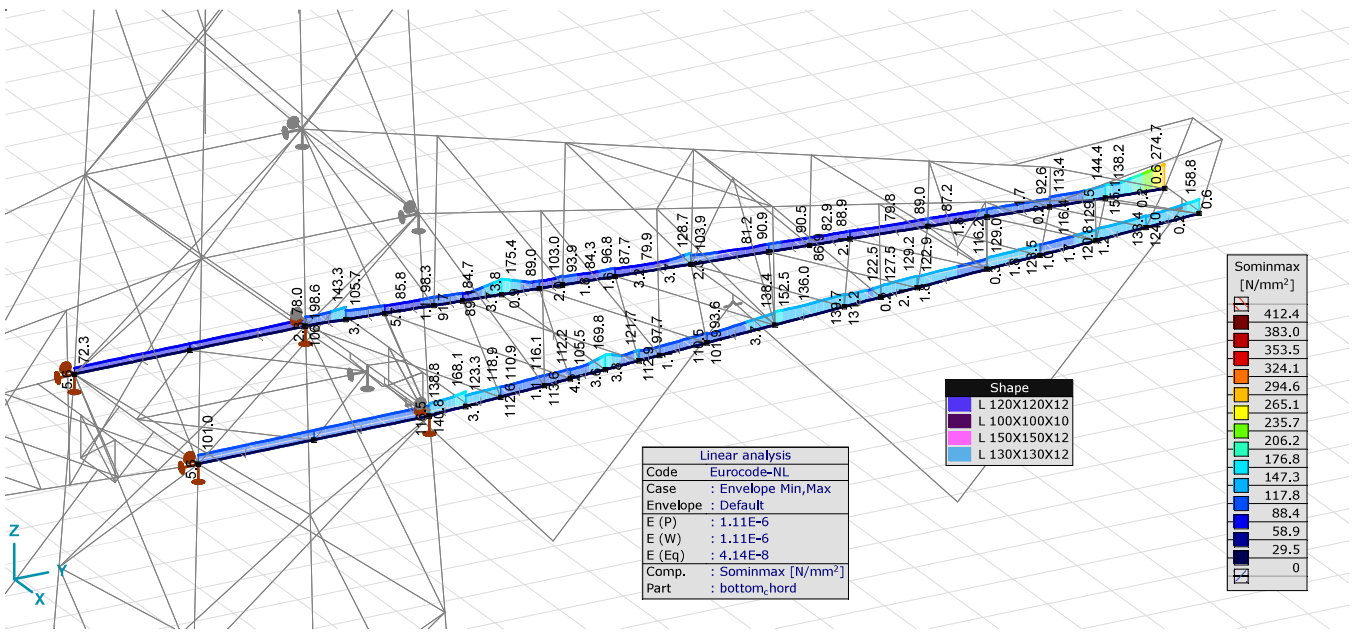


LCA_ bottom_chord, Linear, Envelope (ULS), Vz [kN], Filled diagram

Beam stresses [Linear, Envelope (Default), LCA]

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]
120	8	L 100X100X10	Smin	min	Co #10	0	(212)	**−254.1**	251.7	0	60.3	28.8	274.7	−1.4	−2.2
105	6	L 120X120X12		max	Co #10	0	(178)	**55.6**	57.7	0	39.4	56.4	88.8	−0.4	−0.1
88	6	L 120X120X12	Smax	min	Co #10	0.520		−111.1	**−106.4**	0	25.5	107.8	119.4	0	0.1
120	8	L 100X100X10		max	Co #10	0	(212)	−254.1	**251.7**	0	60.3	28.8	274.7	−1.4	−2.2
87	6	L 120X120X12	Vmin	min	Co #1	0	(70)	−46.9	−30.7	**0**	3.7	31.1	47.1	0.5	−0.3
87	6	L 120X120X12		max	Co #1	0	(70)	−46.9	−30.7	**0**	3.7	31.1	47.1	0.5	−0.3
499	21	L 130X130X12	Vmax	min	Co #17	0	(293)	−41.7	−38.6	0	**0**	38.6	41.7	0	0
500	21	L 130X130X12		min	Co #17	0	(73)	−43.4	−37.1	0	**0**	37.1	43.4	0	0
87	6	L 120X120X12		max	Co #13	0.603	(524)	−124.0	32.5	0	**75.1**	50.3	168.1	−3.1	3.3
89	6	L 120X120X12	Somin	min	Co #9	0.656		−10.6	0	0	0.4	**0.1**	10.6	0	0.2
87	6	L 120X120X12		max	Co #10	0.241		−116.3	−96.3	0	28.5	**107.9**	126.3	−0.4	−0.3
88	6	L 120X120X12		max	Co #10	0	(524)	−115.3	−103.1	0	25.4	**107.8**	123.3	0	0.1
103	8	L 100X100X10	Somax	min	Co #9	0.880	(215)	−1.0	−0.9	0	0.1	1.0	**1.0**	0	0.1
120	8	L 100X100X10		min	Co #9	0	(212)	−1.0	−0.9	0	0.1	1.0	**1.0**	0	−0.1
120	8	L 100X100X10		max	Co #10	0	(212)	−254.1	251.7	0	60.3	28.8	**274.7**	−1.4	−2.2
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	(NL) Seff Min	min		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12		max		0	(70)	0	0	0	0	0	0	0	0
87	6	L 120X120X12	Vymean	min	Co #13	0	(70)	−83.4	−21.2	0	75.1	50.3	140.8	**−3.1**	3.3
105	6	L 120X120X12		max	Co #13	0	(178)	−61.6	−6.1	0	6.4	12.6	61.9	**2.3**	0.4
110	6	L 120X120X12	Vzmean	min	Co #16	0	(134)	−102.6	20.2	0	5.6	6.1	103.0	0.3	**−3.2**
87	6	L 120X120X12		max	Co #13	0.603	(524)	−124.0	32.5	0	75.1	50.3	168.1	−3.1	**3.3**

Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **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;

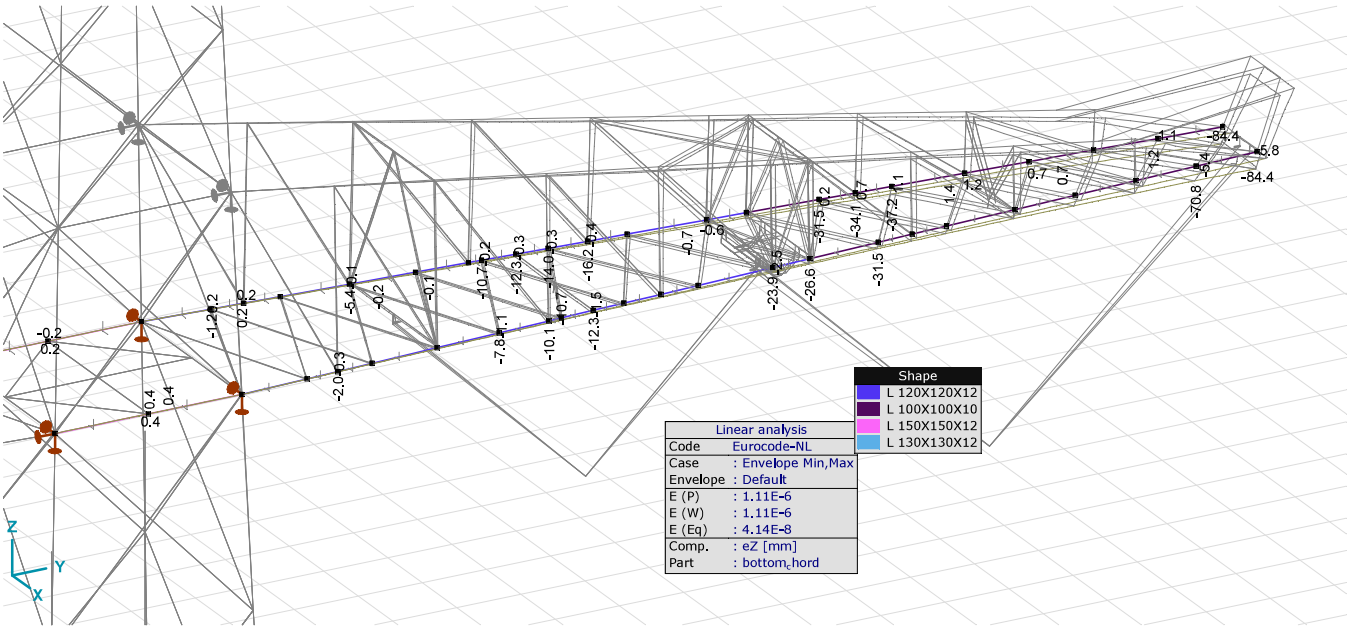


LCA_bottom_chord, Linear, Envelope (Default), Sominmax [N/mm^2], Filled diagram

Nodal displacements [Linear, Envelope (Default), MCA]

Ext.	C	min. max.	Case	eX [mm]	eY [mm]	eZ [mm]	eR [mm]	fX [rad]	fY [rad]	fZ [rad]	fR [rad]
177	eX	min	Co #11	**−0.6**	−1.0	0.4	1.2	0.00009	−0.00063	0.00014	0.00065
337		max	Co #11	**77.1**	0.3	−3.0	77.1	0.02176	0.55199	−0.00425	0.55243
337	eY	min	Co #7	0.1	**−8.0**	−84.4	84.8	−0.01840	−0.00146	0.00164	0.01853
340		min	Co #7	−0.1	**−8.0**	−84.4	84.8	−0.01840	0.00147	−0.00163	0.01853
317		max	Co #11	24.2	**2.4**	−0.6	24.4	0.00084	0.01898	−0.00471	0.01957
337	eZ	min	Co #7	0.1	−8.0	**−84.4**	84.8	−0.01840	−0.00146	0.00164	0.01853
340		min	Co #7	−0.1	−8.0	**−84.4**	84.8	−0.01840	0.00147	−0.00163	0.01853
282		max	Co #11	51.2	1.9	**1.2**	51.3	0.00123	0.03158	−0.00592	0.03215
61	eR	min	Co #9	0	0	0	**0**	0.00003	−0.00155	0.00001	0.00155
340		max	Co #11	76.9	−5.8	−50.6	**92.2**	−0.03824	0.55595	−0.00689	0.55730

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;

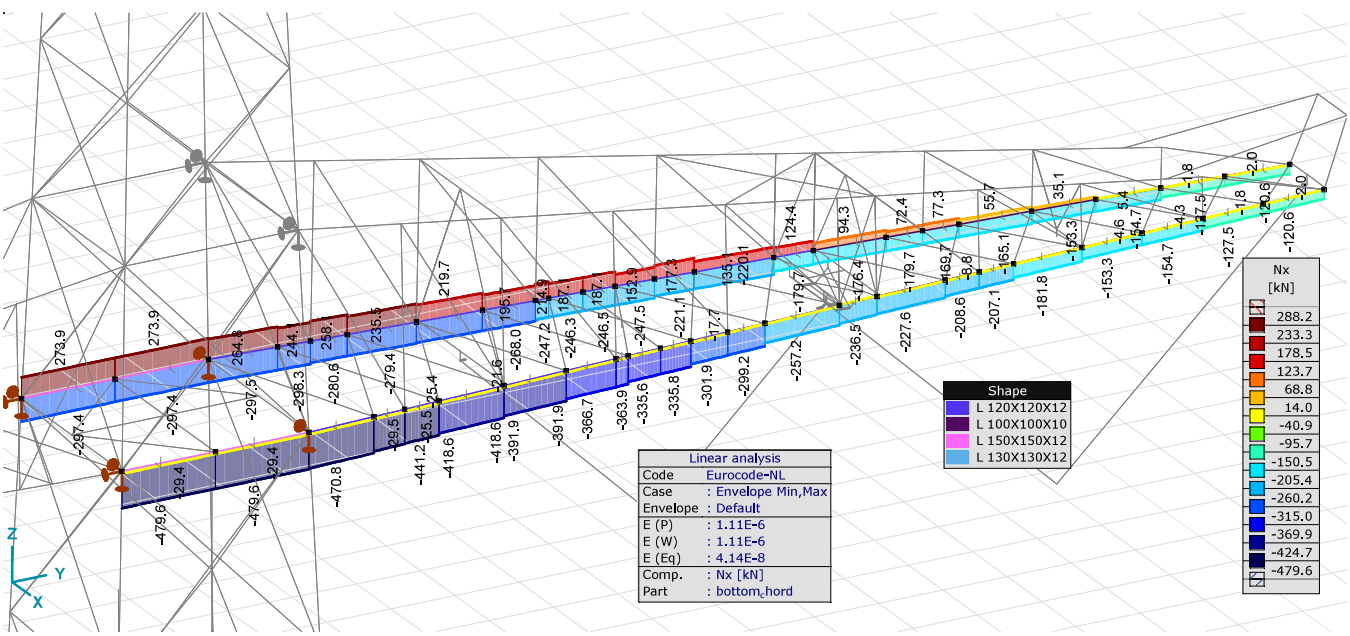


MCA_bottom_chord, Linear, Envelope (Default), eZ [mm], Diagram

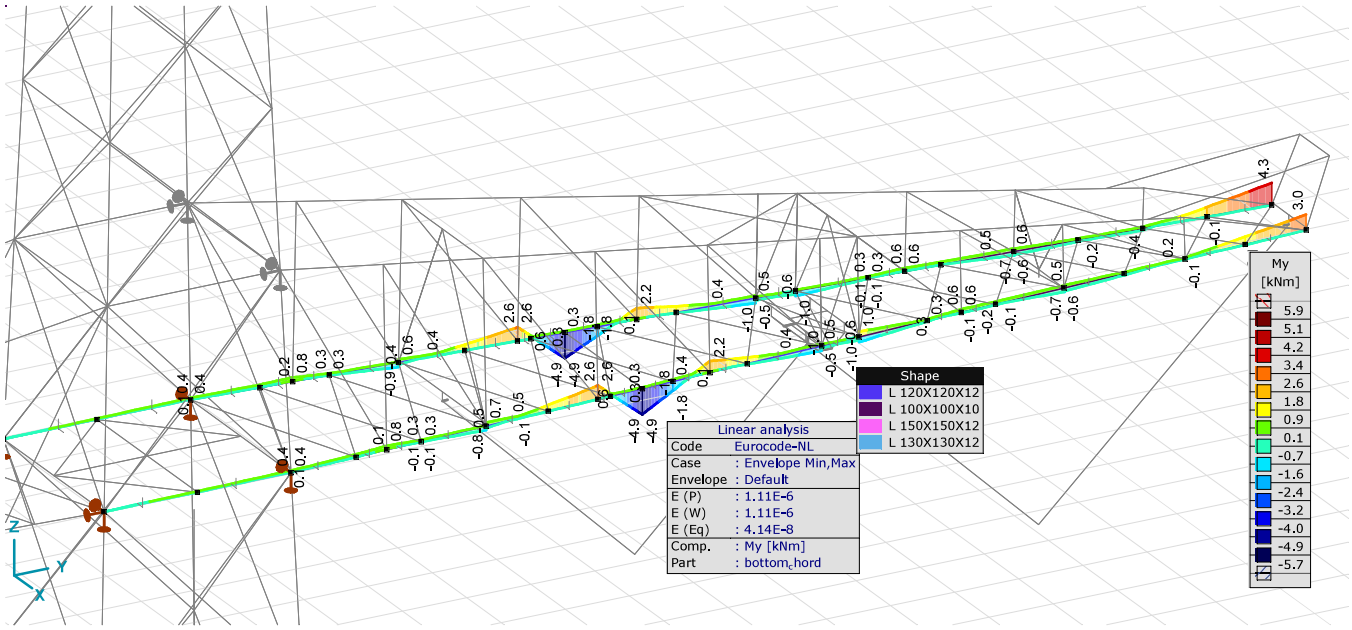
Beam internal forces [Linear, Envelope (Default), MCA]

	Sh.	*Cross-section name*	*C*	*min. max.*	*Case*	*Loc. [m]*	*Node*	*Nx [kN]*	*Vy [kN]*	*Vz [kN]*	*Tx [kNm]*	*My [kNm]*	*Mz [kNm]*
Ext.													
493	20	L 150X150X12	Nx	min	Co #11	0	(177)	**−479.6**	0.4	0	0	0	−0.6
494	20	L 150X150X12		min	Co #11	0	(61)	**−479.6**	0.4	0	0	0	0
495	20	L 150X150X12		max	Co #11	0	(295)	**273.9**	0.4	−0.1	0	0.2	0.6
496	20	L 150X150X12		max	Co #11	0	(63)	**273.9**	0.4	−0.1	0	0.3	1.3
222	6	L 120X120X12	Tx	min	Co #11	0	(266)	124.4	−0.7	−0.4	**−0.1**	−0.1	−0.4
235	8	L 100X100X10		max	Co #11	0	(284)	−90.1	−0.4	0	**0.8**	−0.1	−0.2

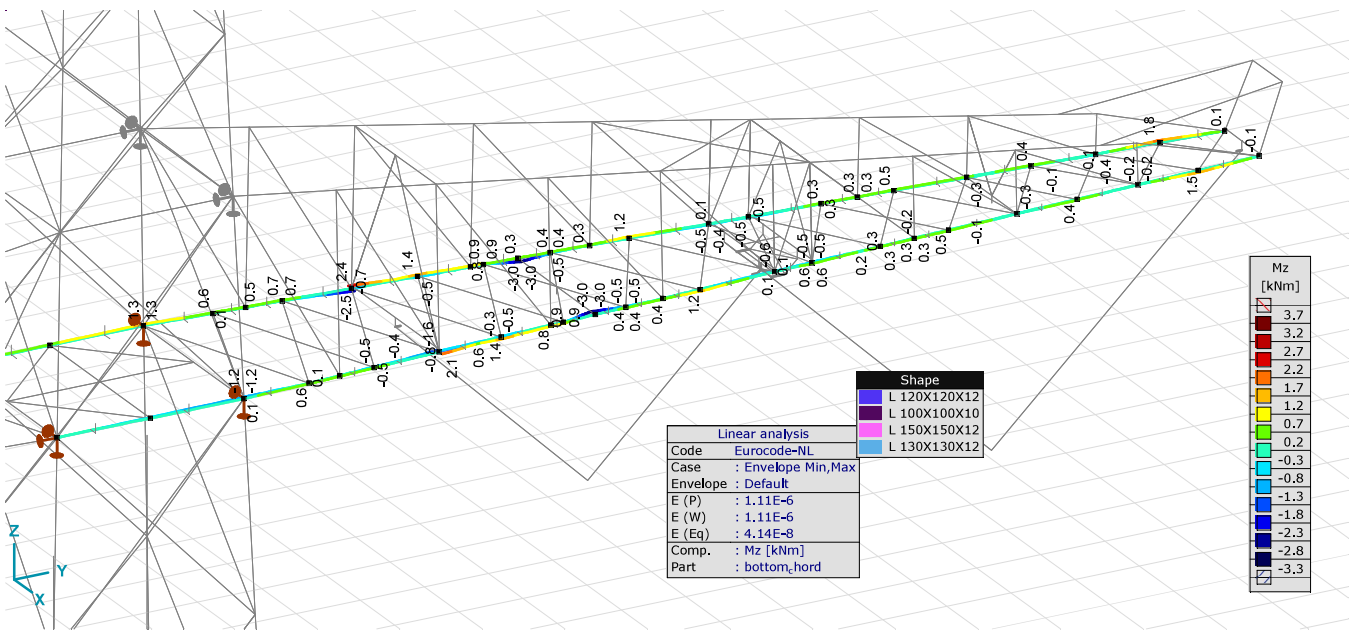
Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:**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



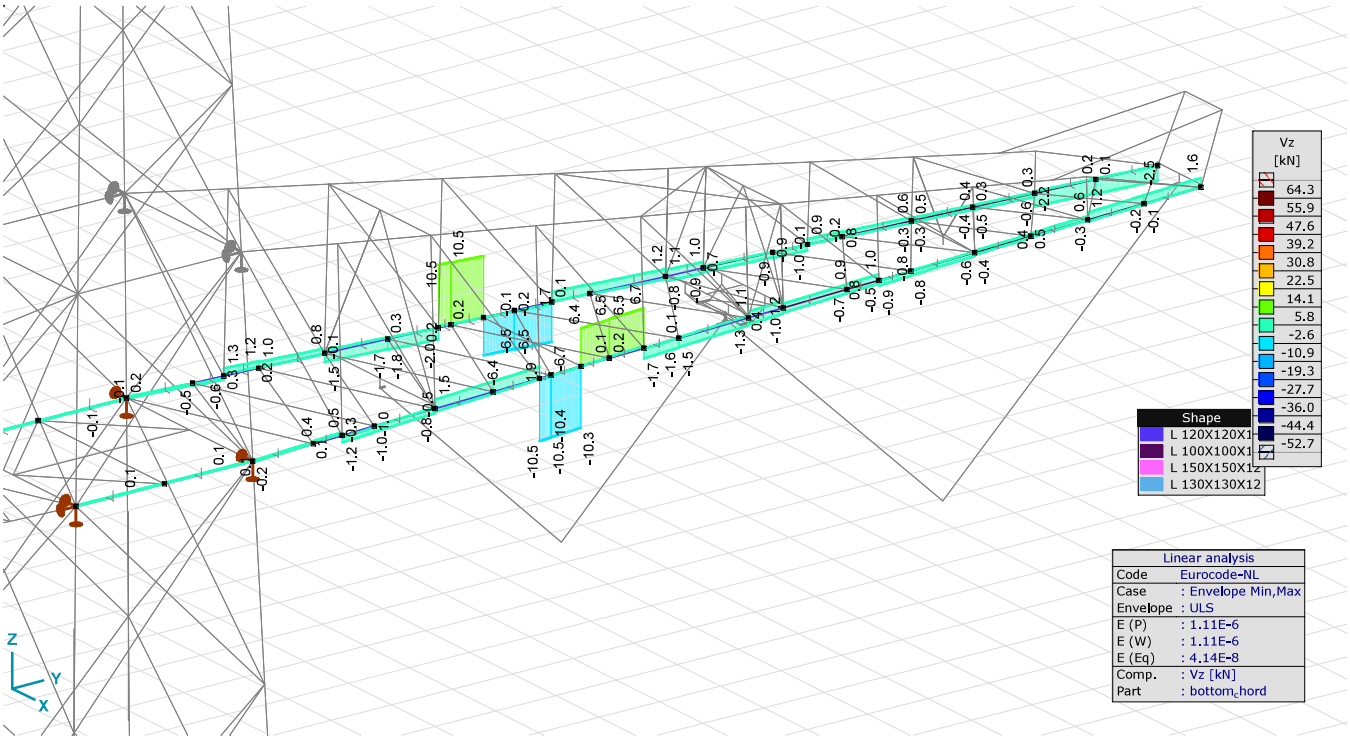
MCA_bottom_chord, Linear, Envelope (Default), Nx [kN], Filled diagram



MCA_ bottom_chord, Linear, Envelope (Default), My [kNm], Filled diagram



MCA_bottom_chord, Linear, Envelope (Default), Mz [kNm], Filled diagram

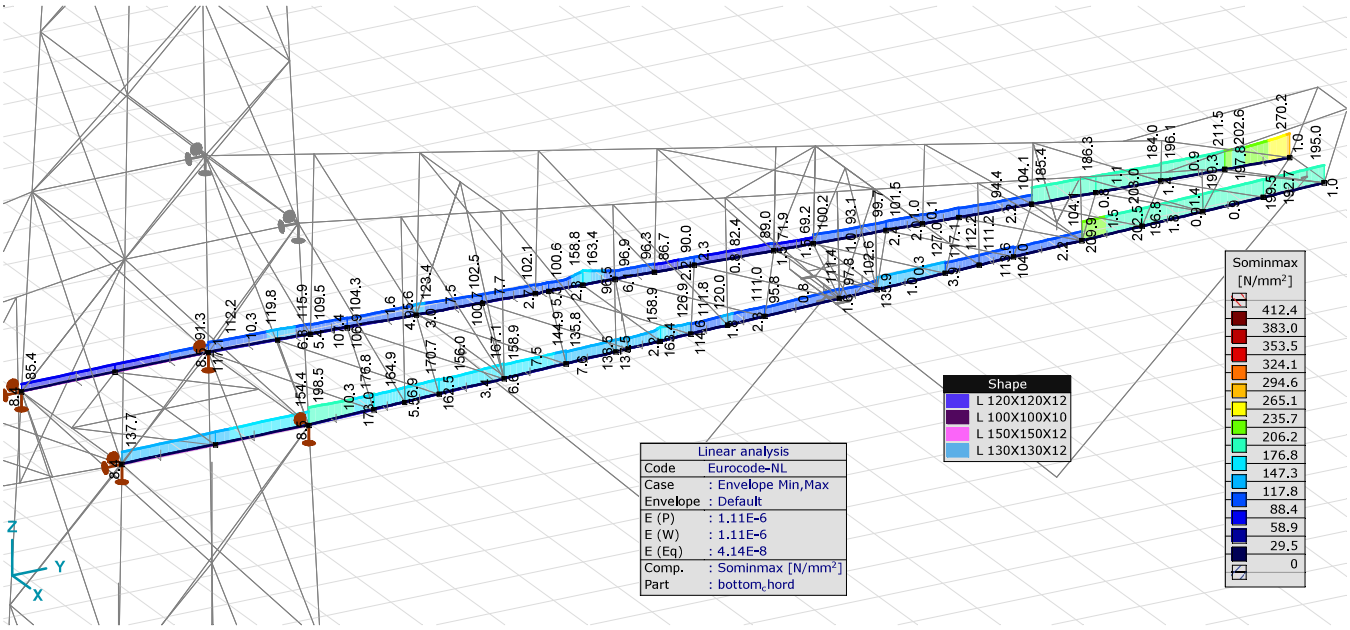


MCA_bottom_chord, Linear, Envelope (ULS), Vz [kN], Filled diagram

Beam stresses [Linear, Envelope (Default), MCA]

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]
197	6	L 120X120X12	Smin	min	Co #11	0	(60)	**−198.5**	−138.4	0	1.0	138.4	198.5	−0.5	0
198	6	L 120X120X12		max	Co #11	0	(296)	**89.7**	104.0	0	2.0	89.7	104.0	−0.3	−0.1
197	6	L 120X120X12	Smax	min	Co #11	0.944		−173.0	**−169.5**	0	1.1	169.5	173.0	−0.5	0
238	8	L 100X100X10		max	Co #11	0	(337)	−191.6	**172.8**	0	110.0	29.6	270.2	−0.9	−1.3
197	6	L 120X120X12	Vmin	min	Co #1	0	(60)	−62.6	−50.7	**0**	1.6	50.8	62.7	0	0
197	6	L 120X120X12		max	Co #1	0	(60)	−62.6	−50.7	**0**	1.6	50.8	62.7	0	0
238	8	L 100X100X10	Vmax	min	Co #14	0.687		−38.3	5.1	0	**0**	5.1	38.3	−0.3	−0.3
236	8	L 100X100X10		max	Co #11	0	(333)	−74.6	55.1	0	**113.1**	9.9	203.8	1.2	−1.2
233	8	L 100X100X10	Somin	min	Co #4	0.785		−3.7	0	0	0.2	**0.1**	3.7	0	0.1
234	8	L 100X100X10		min	Co #4	0.196		−3.7	0	0	0.2	**0.1**	3.7	0	−0.1
197	6	L 120X120X12		max	Co #11	0.944		−173.0	−169.5	0	1.1	**169.5**	173.0	−0.5	0
237	8	L 100X100X10	Somax	min	Co #3	0.982	(340)	−1.1	−1.1	0	0.2	1.1	**1.1**	0	0.1
238	8	L 100X100X10		min	Co #1	0	(337)	−1.1	−1.1	0	0.2	1.1	**1.1**	0	−0.1
238	8	L 100X100X10		max	Co #11	0	(337)	−191.6	172.8	0	110.0	29.6	**270.2**	−0.9	−1.3
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12	(NL) Seff Min	min		0	(60)	0	0	0	0	0	0	0	0
197	6	L 120X120X12		max		0	(60)	0	0	0	0	0	0	0	0
212	6	L 120X120X12	Vymean	min	Co #16	0	(541)	−156.0	0	0	10.0	0.8	156.0	**−2.7**	3.7
211	6	L 120X120X12		max	Co #16	0	(311)	−70.0	−39.2	0	10.0	39.2	70.0	**2.7**	−3.7
207	6	L 120X120X12	Vzmean	min	Co #17	0	(236)	−92.4	23.6	0	8.0	23.8	93.5	0.2	**−3.8**
208	6	L 120X120X12		max	Co #17	0.200	(242)	−92.6	23.7	0	8.0	24.0	93.6	−0.2	**3.8**

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;

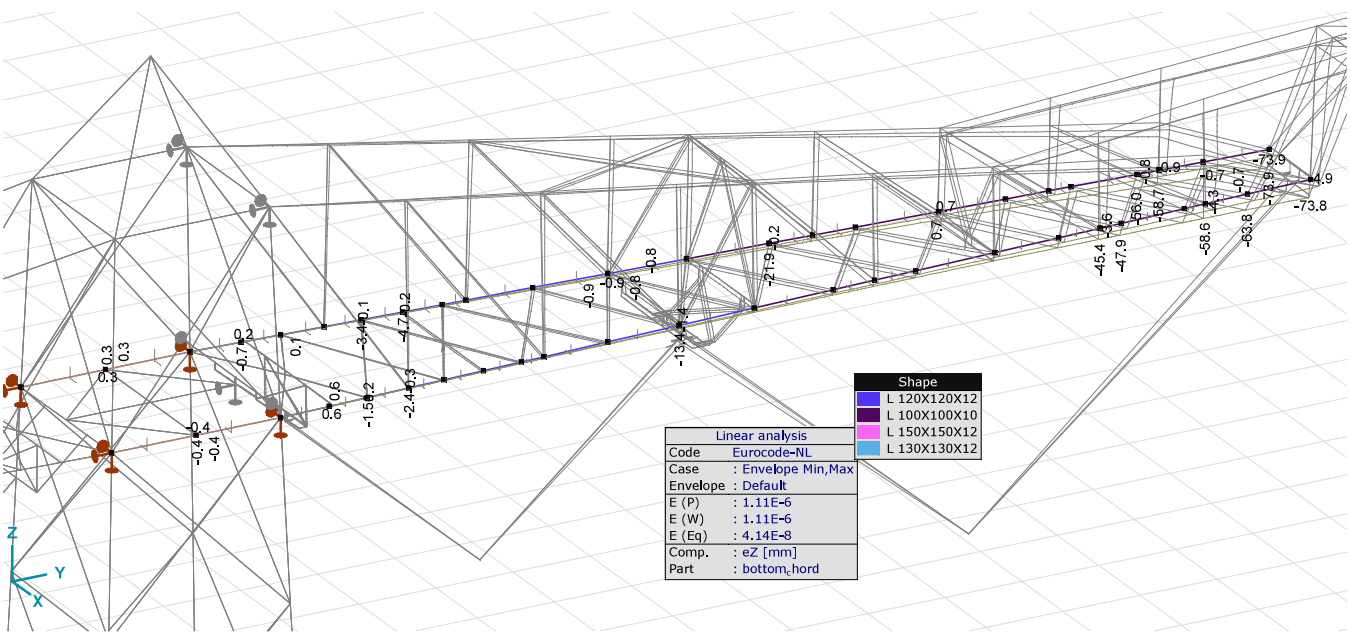


MCA_bottom_chord, Linear, Envelope (Default), Sominmax [N/mm^2], Filled diagram

Nodal displacements [Linear, Envelope (Default), UCA]

	C	*min. max.*	*Case*	*eX [mm]*	*eY [mm]*	*eZ [mm]*	*eR [mm]*	*fX [rad]*	*fY [rad]*	*fZ [rad]*	*fR [rad]*
Ext.											
434	eX	min	Co #15	**−0.4**	−0.1	−0.2	0.5	−0.00005	0	0.00013	0.00014
423		max	Co #12	**64.4**	−5.2	−33.7	72.9	−0.02002	0.30458	−0.00768	0.30533
429		max	Co #12	**64.4**	0.7	−2.5	64.4	0.00710	0.30534	−0.00443	0.30545
429	eY	min	Co #7	−0.2	**−8.2**	−73.9	74.4	−0.01592	−0.00004	0.00206	0.01605
454		max	Co #12	25.6	**2.2**	−0.2	25.7	0.00161	0.02045	−0.00480	0.02107
429	eZ	min	Co #7	−0.2	−8.2	**−73.9**	74.4	−0.01592	−0.00004	0.00206	0.01605
632		max	Co #12	37.4	2.1	**0.7**	37.4	0.00068	0.01920	−0.00580	0.02006
45	eR	min	Co #10	0	0	0	**0**	0.00008	0	0.00002	0.00008
429		max	Co #7	−0.2	−8.2	−73.9	**74.4**	−0.01592	−0.00004	0.00206	0.01605

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;

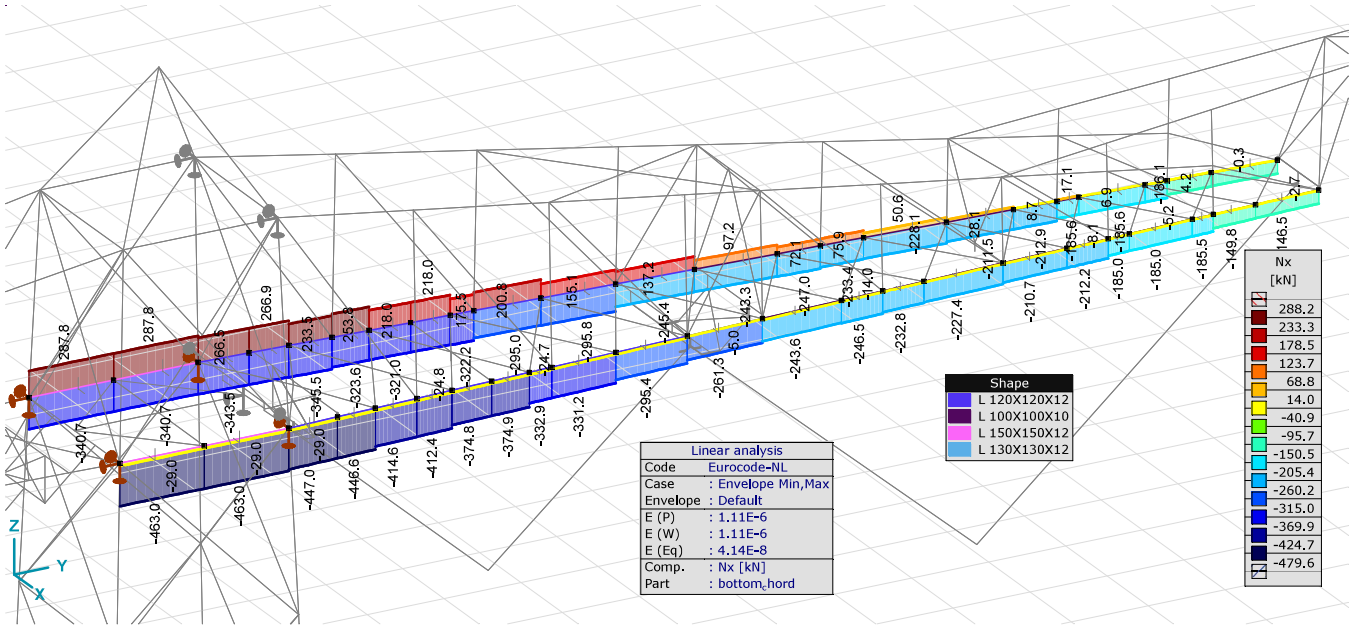


UCA_bottom_chord, Linear, Envelope (Default), eZ [mm], Diagram

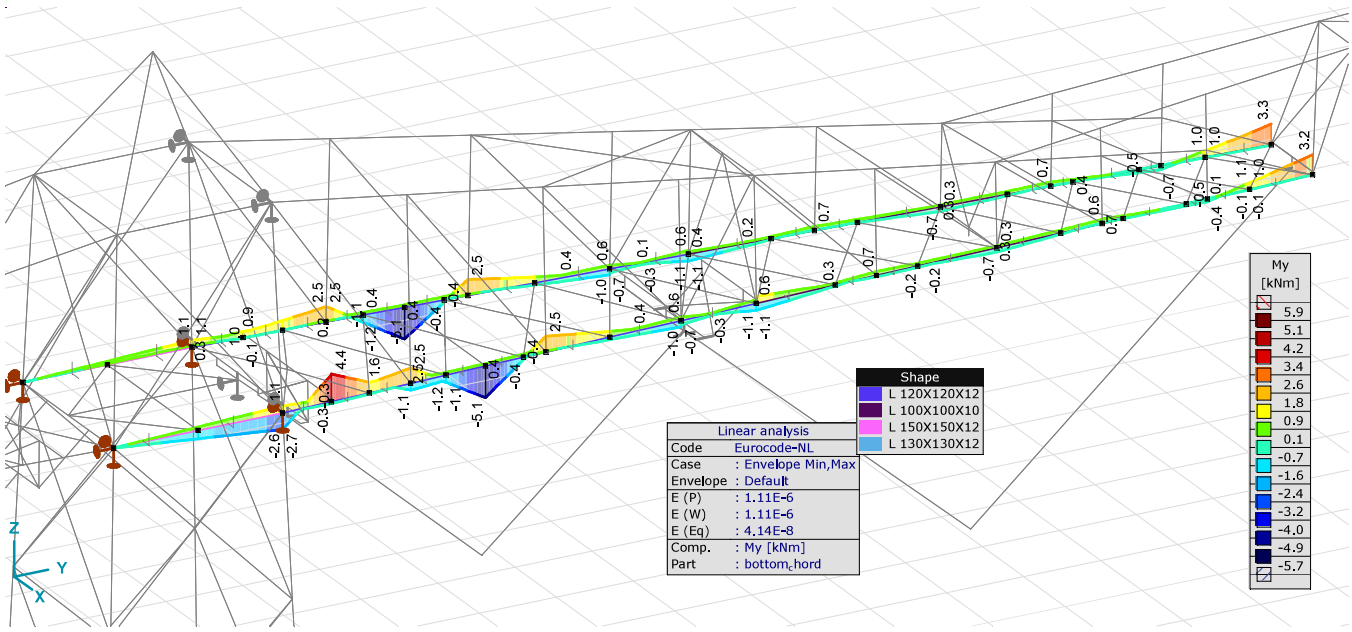
Beam internal forces [Linear, Envelope (Default), UCA]

Ext.	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
501	20	L 150X150X12	Nx	min	Co #12	0	(432)	**−463.0**	0.6	0	0	0	−0.7
502	20	L 150X150X12		min	Co #12	0	(45)	**−463.0**	0.6	0	0	0	0
503	20	L 150X150X12		max	Co #12	0	(434)	**287.8**	0.8	−0.5	0	0.5	0.9
504	20	L 150X150X12		max	Co #12	0	(47)	**287.8**	0.8	−0.5	0	1.1	1.9

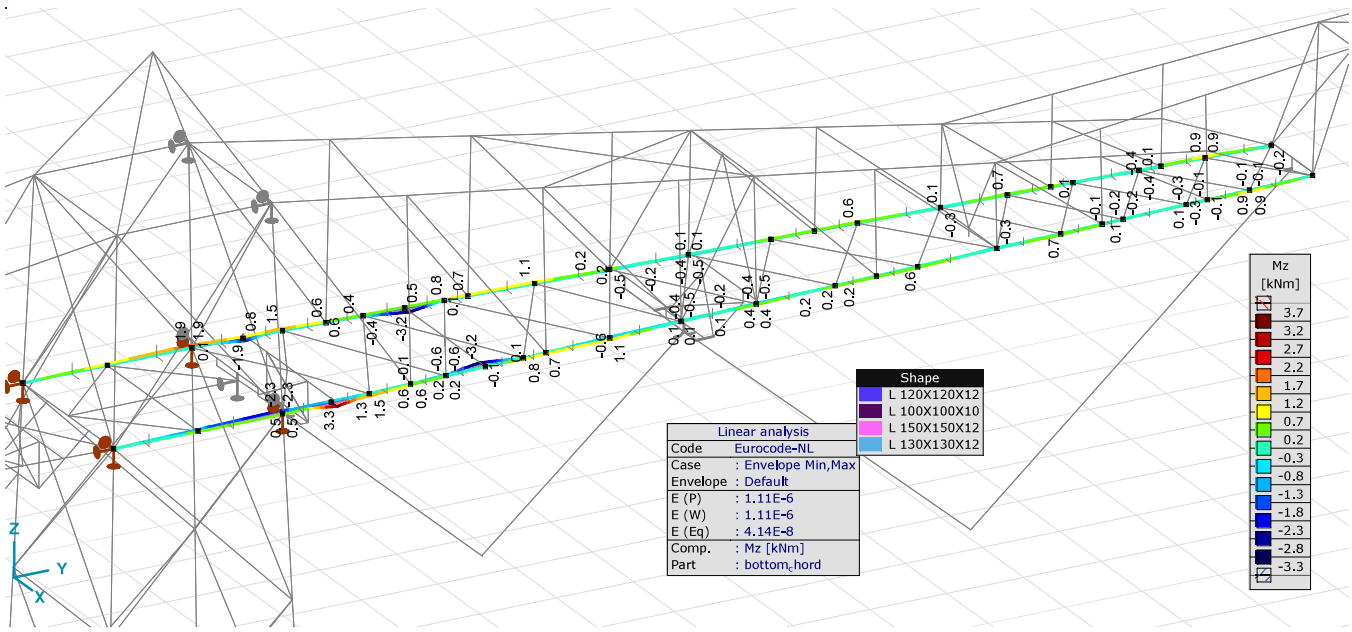
Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:**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



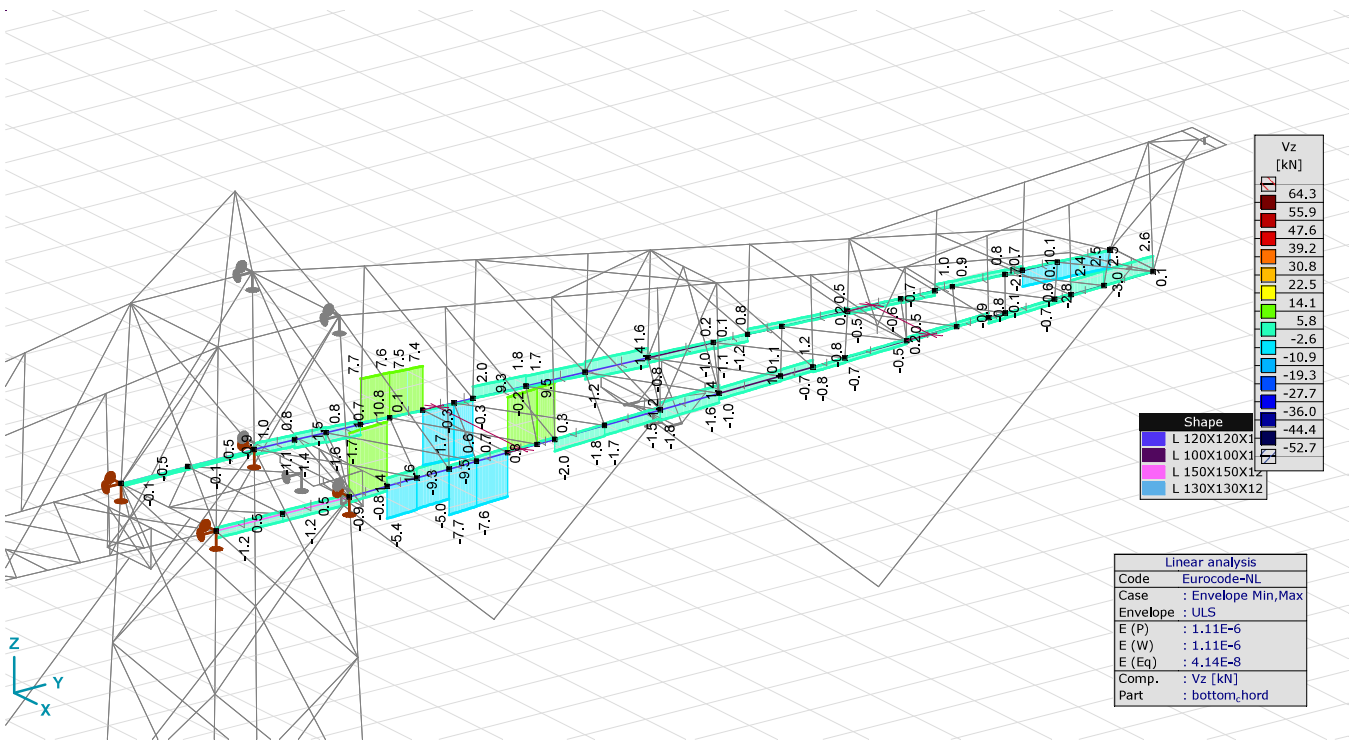
UCA_bottom_chord, Linear, Envelope (Default), Nx [kN], Filled diagram



UCA_bottom_chord, Linear, Envelope (Default), My [kNm], Filled diagram



UCA_bottom_chord, Linear, Envelope (Default), Mz [kNm], Filled diagram

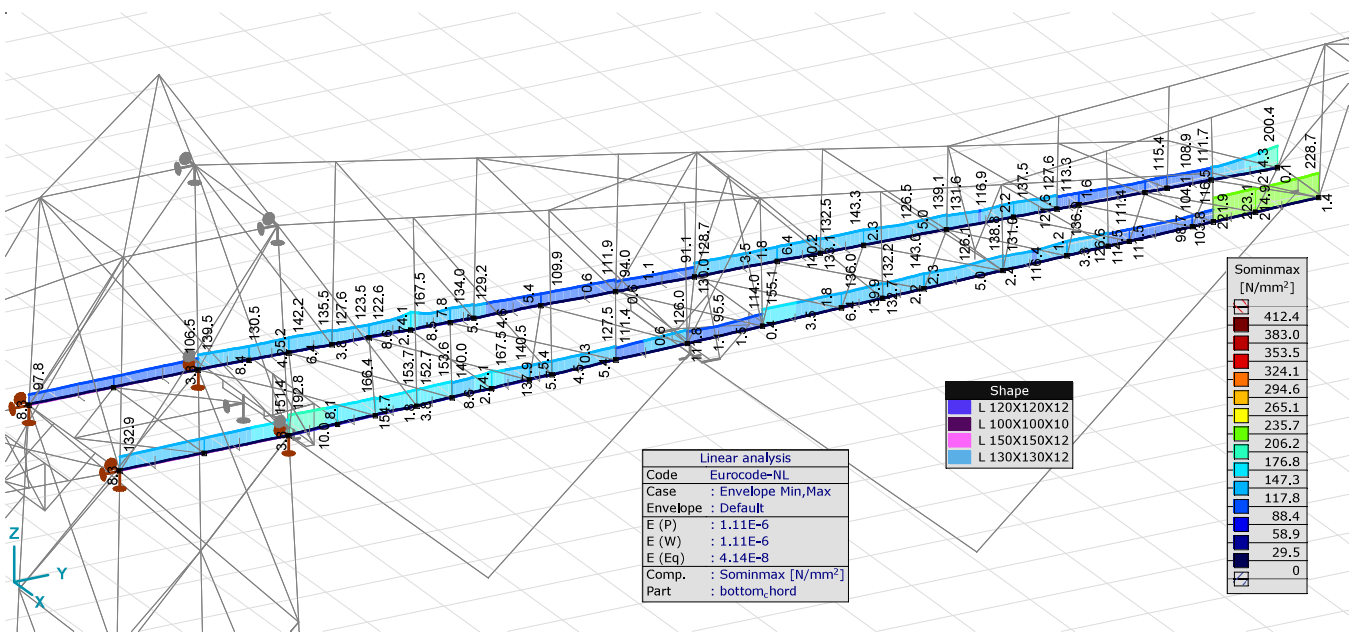


UCA_bottom_chord, Linear, Envelope (ULS), Vz [kN], Filled diagram

Beam stresses [Linear, Envelope (Default), UCA]

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]
380	8	L 100X100X10	Smin	min	Co #7	0.841	(423)	**−200.8**	77.1	0	1.7	38.2	200.8	0.5	1.4
343	6	L 120X120X12		max	Co #12	0	(437)	**86.9**	104.3	0	3.9	87.1	104.5	−0.3	0.1
342	6	L 120X120X12	Smax	min	Co #12	0.504	(440)	−166.2	**−159.8**	0	4.3	159.9	166.4	−0.4	0.1
381	8	L 100X100X10		max	Co #12	0	(429)	−166.0	**129.8**	0	62.2	30.7	197.9	−0.6	−1.6
340	6	L 120X120X12	Vmin	min	Co #1	0	(44)	−61.1	−32.2	**0**	2.9	32.4	61.3	0.1	−0.3
340	6	L 120X120X12		max	Co #1	0	(44)	−61.1	−32.2	**0**	2.9	32.4	61.3	0.1	−0.3
371	8	L 100X100X10	Vmax	min	Co #15	0.165		−39.0	−26.1	0	**0**	26.1	39.0	−0.1	−0.1
378	8	L 100X100X10		max	Co #12	0.561	(477)	−60.7	−19.4	0	**125.8**	41.6	223.1	−0.6	0.6
377	8	L 100X100X10	Somin	min	Co #9	0	(417)	−18.5	18.6	0	5.2	**0**	20.7	0.6	0.1
342	6	L 120X120X12		max	Co #12	0.504	(440)	−166.2	−159.8	0	4.3	**159.9**	166.4	−0.4	0.1
381	8	L 100X100X10	Somax	min	Co #10	0	(429)	−1.4	−1.4	0	0.1	1.4	**1.4**	0	−0.1
380	8	L 100X100X10		max	Co #12	0.841	(423)	−85.0	60.6	0	122.6	20.2	**228.7**	0.3	0.7
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	(NL) Seff Min	min		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12		max		0	(44)	0	0	0	0	0	0	0	0
340	6	L 120X120X12	Vymean	min	Co #15	0	(44)	−121.7	−19.4	0	62.6	64.2	151.4	**−3.1**	3.9
351	6	L 120X120X12		max	Co #17	0	(446)	−70.8	−22.1	0	10.8	29.0	70.8	**2.9**	−3.3
353	6	L 120X120X12	Vzmean	min	Co #16	0	(370)	−95.7	15.2	0	5.5	15.2	96.2	0.1	**−3.5**
340	6	L 120X120X12		max	Co #15	0.649	(560)	−124.1	31.9	0	62.7	64.2	153.4	−3.1	**3.9**

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;



UCA_bottom_chord, Linear, Envelope (Default), Sominmax [N/mm^2], Filled diagram

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
1	23	HE 220 B				L=1.217							
			Nx	min	Co #10	0	(681)	**−38.1**	−9.1	16.6	−3.7	0	0
				max	Co #1	0	(681)	**25.5**	−33.6	−29.1	5.4	0	0
			Tx	min	Co #10	0	(681)	−38.1	−9.1	16.6	**−3.7**	0	0
				max	Co #1	0	(681)	25.5	−33.6	−29.1	**5.4**	0	0
			My	min	Co #1	1.217	(534)	25.5	−32.7	−29.1	5.4	**−35.4**	40.4
				max	Co #6	1.217	(534)	−13.1	−27.4	26.4	−2.9	**32.1**	33.9
			Mz	min	Co #10	0	(681)	−38.1	−9.1	16.6	−3.7	0	**0**
				max	Co #3	1.217	(534)	20.4	−42.2	−19.4	4.3	−23.6	**51.9**
2	23	HE 220 B				L=1.217							
			Nx	min	Co #6	0	(534)	**−13.1**	27.4	−26.4	2.9	32.1	33.9
				max	Co #1	0	(534)	**25.5**	32.7	29.1	−5.4	−35.4	40.4
			Tx	min	Co #1	0	(534)	25.5	32.7	29.1	**−5.4**	−35.4	40.4
				max	Co #6	0	(534)	−13.1	27.4	−26.4	**2.9**	32.1	33.9
			My	min	Co #1	0	(534)	25.5	32.7	29.1	−5.4	**−35.4**	40.4
				max	Co #6	0	(534)	−13.1	27.4	−26.4	2.9	**32.1**	33.9
			Mz	min	Co #1	1.217	(682)	25.5	33.6	29.1	−5.4	0	**0**
				max	Co #3	0	(534)	20.4	42.2	19.4	−4.3	−23.6	**51.9**
3	15	HE 180 B				L=0.500							
			Nx	min	Co #10	0	(646)	**−21.8**	1.1	−20.7	−0.9	0	0
				max	Co #5	0	(646)	**6.7**	−27.9	−26.1	3.7	0	0
			Tx	min	Co #10	0	(646)	−21.8	1.1	−20.7	**−0.9**	0	0
				max	Co #7	0	(646)	6.6	−28.5	−26.6	**3.7**	0	0
			My	min	Co #7	0.500	(536)	6.6	−28.2	−26.6	3.7	**−13.3**	14.2
				max	Co #2	0.500	(536)	−0.3	0	0	0	**0**	0.1
			Mz	min	Co #10	0.500	(536)	−21.8	1.3	−20.7	−0.9	−10.4	**−0.6**
				max	Co #7	0.500	(536)	6.6	−28.2	−26.6	3.7	−13.3	**14.2**
4	15	HE 180 B				L=0.500							
			Nx	min	Co #17	0	(536)	**−0.8**	0	0	0	0	0.1
				max	Co #10	0	(536)	**30.7**	13.4	29.1	−7.0	−14.6	6.8
			Tx	min	Co #10	0	(536)	30.7	13.4	29.1	**−7.0**	−14.6	6.8
				max	Co #6	0	(536)	−0.5	0	0	**0**	0	0.1
			My	min	Co #10	0	(536)	30.7	13.4	29.1	−7.0	**−14.6**	6.8
				max	Co #2	0	(536)	−0.3	0	0	0	**0**	0.1
			Mz	min	Co #4	0.500	(645)	0.1	0.3	0	0	0	**0**
				max	Co #7	0	(536)	6.6	28.2	26.6	−3.7	−13.3	**14.2**
5	15	HE 180 B				L=1.273							
			Nx	min	Co #14	0	(643)	**−11.8**	−2.8	12.0	−1.7	−2.2	−0.5
				max	Co #16	0	(643)	**5.2**	−0.6	0	0	0	0.2
			Tx	min	Co #8	0	(643)	−3.4	−14.9	14.8	**−2.1**	−3.6	−0.7
				max	Co #9	0	(643)	0.2	−0.7	0	**0**	0	0
			My	min	Co #8	0	(643)	−3.4	−14.9	14.8	−2.1	**−3.6**	−0.7
				max	Co #8	1.273	(544)	−3.4	−14.2	14.8	−2.1	**15.2**	17.8
			Mz	min	Co #6	0	(643)	−5.5	−14.5	14.4	−2.0	−3.5	**−0.8**
				max	Co #8	1.273	(544)	−3.4	−14.2	14.8	−2.1	15.2	**17.8**
6	15	HE 180 B				L=0.500							
			Nx	min	Co #11	0	(641)	**−23.0**	1.0	−23.6	1.3	0	0
				max	Co #7	0	(641)	**4.4**	−28.4	−29.7	4.2	0	0
			Tx	min	Co #16	0	(641)	−0.1	−0.3	0	**0**	0	0
				max	Co #7	0	(641)	4.4	−28.4	−29.7	**4.2**	0	0
			My	min	Co #7	0.500	(558)	4.4	−28.1	−29.7	4.2	**−14.9**	14.1
				max	Co #17	0.500	(558)	−0.2	0	0	0	**0**	0.1
			Mz	min	Co #11	0.500	(558)	−23.0	1.3	−23.6	1.3	−11.8	**−0.6**
				max	Co #7	0.500	(558)	4.4	−28.1	−29.7	4.2	−14.9	**14.1**
7	15	HE 180 B				L=0.500							
			Nx	min	Co #17	0	(558)	**−0.2**	0	0	0	0	0.1
				max	Co #11	0	(558)	**29.6**	13.4	32.0	−5.5	−16.0	6.8
			Tx	min	Co #11	0	(558)	29.6	13.4	32.0	**−5.5**	−16.0	6.8
				max	Co #1	0	(558)	0	0	0	**0**	0	0.1
			My	min	Co #11	0	(558)	29.6	13.4	32.0	−5.5	**−16.0**	6.8
				max	Co #6	0	(558)	0	0	0	0	**0**	0.1
			Mz	min	Co #4	0.500	(640)	0	0.3	0	0	0	**0**
				max	Co #7	0	(558)	4.4	28.1	29.7	−4.2	−14.9	**14.1**
8	15	HE 180 B				L=0.500							
			Nx	min	Co #12	0	(630)	**−24.3**	1.1	−25.8	2.8	0	0
				max	Co #7	0	(630)	**3.3**	−28.4	−32.1	4.5	0	0
			Tx	min	Co #10	0	(630)	0	−0.3	0	**0**	0	0
				max	Co #7	0	(630)	3.3	−28.4	−32.1	**4.5**	0	0
			My	min	Co #7	0.500	(572)	3.3	−28.2	−32.1	4.5	**−16.1**	14.2
				max	Co #6	0.500	(572)	0	0	0	0	**0**	0.1
			Mz	min	Co #12	0.500	(572)	−24.3	1.3	−25.8	2.8	−12.9	**−0.6**
				max	Co #7	0.500	(572)	3.3	−28.2	−32.1	4.5	−16.1	**14.2**
9	15	HE 180 B				L=0.500							
			Nx	min	Co #17	0	(572)	**−0.1**	0	0	0	0	0.1
				max	Co #12	0	(572)	**28.2**	13.4	34.2	−4.7	−17.1	6.8
			Tx	min	Co #12	0	(572)	28.2	13.4	34.2	**−4.7**	−17.1	6.8
				max	Co #6	0	(572)	0	0	0	**0**	0	0.1
			My	min	Co #12	0	(572)	28.2	13.4	34.2	−4.7	**−17.1**	6.8
				max	Co #6	0	(572)	0	0	0	0	**0**	0.1
			Mz	min	Co #9	0.500	(631)	1.6	11.4	12.6	−2.1	0	**0**
				max	Co #7	0	(572)	3.3	28.2	32.1	−4.5	−16.1	**14.2**
10	1	HE 160 A				L=1.300							
			Nx	min	Co #8	0	(647)	**0**	−2.9	−1.7	−0.3	0	0
				max	Co #13	0	(647)	**0**	−2.0	−1.0	−0.2	0	0
			Tx	min	Co #8	0	(647)	0	−2.9	−1.7	**−0.3**	0	0
				max	Co #9	0	(647)	0	0	−0.2	**0**	0	0
			My	min	Co #8	1.300	(486)	0	−2.9	−1.3	−0.3	**−2.0**	3.7

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #6	0	(647)	0	−2.6	−1.7	−0.2	**0**	0
			Mz	min	Co #8	0	(647)	0	−2.9	−1.7	−0.3	0	**0**
				max	Co #8	1.300	(486)	0	−2.9	−1.3	−0.3	−2.0	**3.7**
11	1	HE 160 A				L=1.300							
			Nx	min	Co #8	0	(491)	**0**	2.9	1.3	0.3	−2.0	3.7
				max	Co #13	0	(491)	**0**	3.0	1.6	0.3	−2.4	3.8
			Tx	min	Co #9	0	(491)	0	0	−0.2	**0**	0	0
				max	Co #13	0	(491)	0	3.0	1.6	**0.3**	−2.4	3.8
			My	min	Co #13	0	(491)	0	3.0	1.6	0.3	**−2.4**	3.8
				max	Co #16	1.300	(648)	0	0.3	0.2	0	**0**	0
			Mz	min	Co #13	1.300	(648)	0	3.0	2.0	0.3	0	**0**
				max	Co #13	0	(491)	0	3.0	1.6	0.3	−2.4	**3.8**
12	1	HE 160 A				L=1.000							
			Nx	min	Co #8	0	(486)	**0**	10.9	12.9	1.0	−2.0	3.7
				max	Co #13	0	(486)	**0**	8.4	10.2	0.7	−1.1	2.6
			Tx	min	Co #8	0.500	(652)	0	−10.9	−13.1	**−1.0**	4.5	−1.7
				max	Co #8	0	(486)	0	10.9	12.9	**1.0**	−2.0	3.7
			My	min	Co #13	1.000	(491)	0	−10.9	−12.7	−1.0	**−2.4**	3.8
				max	Co #8	0.500	(652)	0	10.9	13.1	1.0	**4.5**	−1.7
			Mz	min	Co #6	0.500	(652)	0	10.8	12.8	1.0	4.4	**−2.0**
				max	Co #13	1.000	(491)	0	−10.9	−12.7	−1.0	−2.4	**3.8**
13	1	HE 160 A				L=1.239							
			Nx	min	Co #13	0	(649)	**−14.4**	0	13.2	0	0	0
				max	Co #1	0	(649)	**2.6**	0	−0.8	0	0	0
			Tx	min	Co #13	0	(649)	−14.4	0	13.2	**0**	0	0
				max	Co #9	0	(649)	0.2	0	−0.8	**0**	0	0
			My	min	Co #8	1.239	(492)	−0.5	0.3	−0.7	0	**−1.1**	−0.4
				max	Co #13	1.239	(492)	−14.4	0	13.6	0	**16.6**	0
			Mz	min	Co #8	1.239	(492)	−0.5	0.3	−0.7	0	−1.1	**−0.4**
				max	Co #10	0	(649)	−0.8	0.1	−0.9	0	0	**0**
14	1	HE 160 A				L=1.239							
			Nx	min	Co #6	0	(495)	**−0.8**	−0.3	0.7	0	−1.1	−0.4
				max	Co #13	0	(495)	**11.8**	0.2	−4.2	0	5.0	0.2
			Tx	min	Co #13	0	(495)	11.8	0.2	−4.2	**0**	5.0	0.2
				max	Co #8	0	(495)	−0.5	−0.3	0.7	**0**	−1.1	−0.4
			My	min	Co #8	0	(495)	−0.5	−0.3	0.7	0	**−1.1**	−0.4
				max	Co #13	0	(495)	11.8	0.2	−4.2	0	**5.0**	0.2
			Mz	min	Co #8	0	(495)	−0.5	−0.3	0.7	0	−1.1	**−0.4**
				max	Co #13	0	(495)	11.8	0.2	−4.2	0	5.0	**0.2**
15	1	HE 160 A				L=1.000							
			Nx	min	Co #6	0	(492)	**−0.8**	0	−0.1	0	−1.1	−0.4
				max	Co #1	0	(492)	**2.5**	0	−0.1	0	−0.8	0
			Tx	min	Co #13	0	(492)	−0.8	−0.3	−11.7	**0**	16.6	0
				max	Co #6	0	(492)	−0.8	0	−0.1	**0**	−1.1	−0.4
			My	min	Co #8	0.500	(665)	−0.5	0	0	0	**−1.1**	−0.4
				max	Co #13	0	(492)	−0.8	−0.3	−11.7	0	**16.6**	0
			Mz	min	Co #8	1.000	(495)	−0.5	0	0.1	0	−1.1	**−0.4**
				max	Co #13	1.000	(495)	−0.8	−0.3	−11.4	0	5.0	**0.2**
16	16	HE 160 B				L=0.455							
			Nx	min	Co #11	0.455	(546)	**−14.0**	−7.4	−14.8	−0.9	−6.8	3.4
				max	Co #16	0	(636)	**1.3**	0.3	−0.7	0	0	0
			Tx	min	Co #6	0	(636)	−1.1	−13.7	−31.0	**−1.2**	0	0
				max	Co #1	0	(636)	0.1	13.8	3.4	**1.1**	0	0
			My	min	Co #8	0.455	(546)	−0.9	−10.5	−31.0	−0.9	**−14.2**	4.8
				max	Co #1	0.455	(546)	0.1	13.8	3.6	1.1	**1.6**	−6.3
			Mz	min	Co #1	0.455	(546)	0.1	13.8	3.6	1.1	1.6	**−6.3**
				max	Co #6	0.455	(546)	−1.1	−13.7	−30.9	−1.2	−14.1	**6.2**
17	16	HE 160 B				L=0.500							
			Nx	min	Co #11	0	(546)	**−16.5**	2.6	−5.0	0.6	−6.4	3.4
				max	Co #1	0	(546)	**3.0**	−0.2	2.9	−0.9	1.2	−6.3
			Tx	min	Co #1	0	(546)	3.0	−0.2	2.9	**−0.9**	1.2	−6.3
				max	Co #6	0	(546)	−16.3	0.7	−3.4	**1.0**	−11.8	6.2
			My	min	Co #6	0.500	(550)	−16.3	0.7	−3.2	1.0	**−13.5**	5.9
				max	Co #1	0.500	(550)	3.0	−0.2	3.1	−0.9	**2.7**	−6.2
			Mz	min	Co #1	0	(546)	3.0	−0.2	2.9	−0.9	1.2	**−6.3**
				max	Co #6	0	(546)	−16.3	0.7	−3.4	1.0	−11.8	**6.2**
18	16	HE 160 B				L=0.500							
			Nx	min	Co #6	0	(550)	**−16.3**	−0.7	3.2	−1.0	−13.5	5.9
				max	Co #1	0	(550)	**2.6**	0.1	−3.1	0.9	2.7	−6.3
			Tx	min	Co #6	0	(550)	−16.3	−0.7	3.2	**−1.0**	−13.5	5.9
				max	Co #1	0	(550)	2.6	0.1	−3.1	**0.9**	2.7	−6.3
			My	min	Co #6	0	(550)	−16.3	−0.7	3.2	−1.0	**−13.5**	5.9
				max	Co #1	0	(550)	2.6	0.1	−3.1	0.9	**2.7**	−6.3
			Mz	min	Co #1	0.500	(552)	2.6	0.1	−2.9	0.9	1.2	**−6.3**
				max	Co #11	0	(550)	−3.7	1.4	−0.1	−0.8	−8.8	**6.3**
19	16	HE 160 B				L=0.455							
			Nx	min	Co #6	0	(552)	**−1.1**	13.7	30.9	1.2	−14.1	6.2
				max	Co #11	0.455	(638)	**13.9**	12.3	25.2	0.8	0	0
			Tx	min	Co #1	0	(552)	−0.4	−13.9	−3.6	**−1.1**	1.6	−6.3
				max	Co #6	0	(552)	−1.1	13.7	30.9	**1.2**	−14.1	6.2
			My	min	Co #8	0	(552)	−1.0	10.4	31.0	0.9	**−14.2**	4.7
				max	Co #1	0	(552)	−0.4	−13.9	−3.6	−1.1	**1.6**	−6.3
			Mz	min	Co #1	0	(552)	−0.4	−13.9	−3.6	−1.1	1.6	**−6.3**
				max	Co #6	0	(552)	−1.1	13.7	30.9	1.2	−14.1	**6.2**

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
20	16	HE 160 B				L=0.500							
			Nx	min	Co #1	0	(548)	**−18.9**	0.1	−3.5	−1.0	−13.1	−6.5
				max	Co #11	0	(548)	**10.7**	1.3	0.6	0.6	3.0	4.1
			Tx	min	Co #1	0	(548)	−18.9	0.1	−3.5	**−1.0**	−13.1	−6.5
				max	Co #6	0	(548)	1.7	−0.7	2.9	**0.9**	0.7	6.4
			My	min	Co #1	0.500	(554)	−18.9	0.1	−3.3	−1.0	**−14.8**	−6.5
				max	Co #11	0.500	(554)	10.7	1.3	0.8	0.6	**3.3**	3.4
			Mz	min	Co #1	0.500	(554)	−18.9	0.1	−3.3	−1.0	−14.8	**−6.5**
				max	Co #6	0.500	(554)	1.7	−0.7	3.1	0.9	2.2	**6.7**
21	16	HE 160 B				L=0.500							
			Nx	min	Co #1	0	(554)	**−18.4**	−0.2	3.2	1.0	−14.8	−6.7
				max	Co #6	0	(554)	**1.8**	0.7	−3.1	−0.9	2.2	6.7
			Tx	min	Co #6	0	(554)	1.8	0.7	−3.1	**−0.9**	2.2	6.7
				max	Co #1	0	(554)	−18.4	−0.2	3.2	**1.0**	−14.8	−6.7
			My	min	Co #1	0	(554)	−18.4	−0.2	3.2	1.0	**−14.8**	−6.7
				max	Co #11	0	(554)	−2.1	2.5	−3.7	−0.7	**3.3**	6.9
			Mz	min	Co #1	0	(554)	−18.4	−0.2	3.2	1.0	−14.8	**−6.7**
				max	Co #11	0	(554)	−2.1	2.5	−3.7	−0.7	3.3	**6.9**
22	16	HE 160 B				L=0.420							
			Nx	min	Co #3	0.420	(639)	**−0.9**	−11.3	37.7	−1.0	0	0
				max	Co #11	0	(556)	**12.7**	13.3	1.6	0.8	−0.7	5.6
			Tx	min	Co #1	0	(556)	−0.7	−15.6	37.4	**−1.3**	−15.8	−6.6
				max	Co #6	0	(556)	−0.7	15.2	−2.6	**1.2**	1.0	6.4
			My	min	Co #3	0	(556)	−0.9	−11.3	37.6	−1.0	**−15.8**	−4.8
				max	Co #6	0	(556)	−0.7	15.2	−2.6	1.2	**1.0**	6.4
			Mz	min	Co #1	0	(556)	−0.7	−15.6	37.4	−1.3	−15.8	**−6.6**
				max	Co #6	0	(556)	−0.7	15.2	−2.6	1.2	1.0	**6.4**
23	1	HE 160 A				L=0.598							
			Nx	min	Co #7	0	(624)	**0**	−4.0	−1.9	−0.4	0	0
				max	Co #15	0	(624)	**0**	−5.8	−2.9	−0.5	0	0
			Tx	min	Co #8	0	(624)	0	−7.5	−3.9	**−0.7**	0	0
				max	Co #10	0	(624)	0	−0.1	−0.1	**0**	0	0
			My	min	Co #8	0.598	(506)	0	−7.5	−3.8	−0.7	**−2.3**	4.5
				max	Co #2	0	(624)	0	−5.2	−2.9	−0.5	**0**	0
			Mz	min	Co #6	0	(624)	0	−6.9	−3.8	−0.6	0	**0**
				max	Co #8	0.598	(506)	0	−7.5	−3.8	−0.7	−2.3	**4.5**
24	1	HE 160 A				L=0.598							
			Nx	min	Co #7	0	(511)	**0**	4.0	1.7	0.4	−1.1	2.4
				max	Co #15	0	(511)	**0**	7.3	4.0	0.7	−2.5	4.4
			Tx	min	Co #10	0	(511)	0	0.1	0	**0**	0	0
				max	Co #8	0	(511)	0	7.5	3.8	**0.7**	−2.3	4.5
			My	min	Co #15	0	(511)	0	7.3	4.0	0.7	**−2.5**	4.4
				max	Co #3	0.598	(625)	0	3.1	1.6	0.3	**0**	0
			Mz	min	Co #15	0.598	(625)	0	7.3	4.2	0.7	0	**0**
				max	Co #8	0	(511)	0	7.5	3.8	0.7	−2.3	**4.5**
25	1	HE 160 A				L=1.000							
			Nx	min	Co #7	0	(506)	**0**	4.0	5.0	0.4	−1.1	2.4
				max	Co #15	0.500	(651)	**0**	−9.8	−10.6	−0.9	2.8	−0.5
			Tx	min	Co #15	0.500	(651)	0	−9.8	−10.6	**−0.9**	2.8	−0.5
				max	Co #6	0	(506)	0	9.7	10.4	**0.9**	−2.2	4.1
			My	min	Co #15	1.000	(511)	0	−9.8	−10.4	−0.9	**−2.5**	4.4
				max	Co #8	0.500	(651)	0	9.7	10.9	0.9	**3.1**	−0.4
			Mz	min	Co #6	0.500	(651)	0	9.7	10.5	0.9	3.0	**−0.7**
				max	Co #8	0	(506)	0	9.7	10.7	0.9	−2.3	**4.5**
26	1	HE 160 A				L=0.570							
			Nx	min	Co #15	0	(633)	**−14.2**	0.8	16.2	0	0	0
				max	Co #7	0	(633)	**1.2**	0.4	−0.6	0	0	0
			Tx	min	Co #15	0	(633)	−14.2	0.8	16.2	**0**	0	0
				max	Co #10	0	(633)	0.2	0	−0.6	**0**	0	0
			My	min	Co #5	0.570	(512)	1.1	0	−0.5	0	**−0.3**	0
				max	Co #15	0.570	(512)	−14.2	0.8	16.4	0	**9.3**	−0.4
			Mz	min	Co #8	0.570	(512)	0.8	1.0	−0.3	0	−0.2	**−0.5**
				max	Co #12	0	(633)	0.4	0.4	−0.6	0	0	**0**
27	1	HE 160 A				L=0.570							
			Nx	min	Co #10	0	(515)	**0.2**	0	0.5	0	−0.3	0
				max	Co #15	0	(515)	**12.0**	−0.3	−2.2	0	1.2	−0.2
			Tx	min	Co #12	0	(515)	0.4	−0.4	0.4	**0**	−0.3	−0.2
				max	Co #8	0	(515)	0.8	−1.0	0.3	**0**	−0.2	−0.5
			My	min	Co #5	0	(515)	1.1	0	0.5	0	**−0.3**	0
				max	Co #15	0	(515)	12.0	−0.3	−2.2	0	**1.2**	−0.2
			Mz	min	Co #8	0	(515)	0.8	−1.0	0.3	0	−0.2	**−0.5**
				max	Co #8	0.570	(634)	0.8	−1.0	0.5	0	0	**0**
28	1	HE 160 A				L=1.000							
			Nx	min	Co #15	0	(512)	**−0.6**	−0.3	−8.2	0	9.3	−0.4
				max	Co #7	0	(512)	**1.1**	0	−0.1	0	−0.3	−0.3
			Tx	min	Co #15	0	(512)	−0.6	−0.3	−8.2	**0**	9.3	−0.4
				max	Co #8	0	(512)	0.7	0	−0.1	**0**	−0.2	−0.6
			My	min	Co #5	0.500	(664)	1.0	0	0	0	**−0.4**	0
				max	Co #15	0	(512)	−0.6	−0.3	−8.2	0	**9.3**	−0.4
			Mz	min	Co #8	0	(512)	0.7	0	−0.1	0	−0.2	**−0.6**
				max	Co #5	1.000	(515)	1.0	0	0.1	0	−0.3	**0**
29	16	HE 160 B				L=0.363							
			Nx	min	Co #12	0	(659)	**−11.4**	−9.6	8.4	−1.5	−3.1	−3.5
				max	Co #9	0	(659)	**1.6**	−4.4	13.3	−0.7	−4.9	−1.6
			Tx	min	Co #6	0	(659)	−2.3	−15.7	27.9	**−2.3**	−10.2	−5.7

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #1	0	(659)	0.4	13.4	0.8	**2.0**	−0.3	4.9
			My	min	Co #8	0	(659)	−1.9	−12.5	28.8	−1.8	**−10.5**	−4.6
				max	Co #16	0.363	(626)	0.5	0.2	0.7	0	**0**	0
			Mz	min	Co #6	0	(659)	−2.3	−15.7	27.9	−2.3	−10.2	**−5.7**
				max	Co #1	0	(659)	0.4	13.4	0.8	2.0	−0.3	**4.9**
30	16	HE 160 B				L=1.004							
			Nx	min	Co #8	0	(659)	**−9.7**	0	−0.2	0	−9.4	4.6
				max	Co #17	0	(659)	**0.4**	0	−0.2	0	−0.2	0
			Tx	min	Co #12	0	(659)	−5.5	−1.2	−3.8	**−0.2**	−4.0	3.5
				max	Co #9	0	(659)	−4.0	0.8	0.3	**0.1**	−4.0	1.6
			My	min	Co #8	0.502		−9.7	0	0	0	**−9.4**	4.6
				max	Co #1	0	(659)	−1.5	0	−0.2	0	**0**	−4.9
			Mz	min	Co #1	1.004	(660)	−1.5	0	0.2	0	0	**−4.9**
				max	Co #6	1.004	(660)	−9.5	0	0.2	0	−9.1	**5.7**
31	16	HE 160 B				L=0.363							
			Nx	min	Co #9	0	(660)	**−3.0**	2.2	9.9	0.3	−3.6	0.8
				max	Co #12	0	(660)	**9.0**	13.0	26.5	1.9	−9.6	4.7
			Tx	min	Co #1	0	(660)	0.4	−13.4	0.8	**−2.0**	−0.3	−4.9
				max	Co #6	0	(660)	−2.3	15.7	27.9	**2.3**	−10.2	5.7
			My	min	Co #8	0	(660)	−1.9	12.6	28.8	1.8	**−10.5**	4.6
				max	Co #3	0.363	(627)	−0.2	−9.2	9.2	−1.4	**0**	0
			Mz	min	Co #1	0	(660)	0.4	−13.4	0.8	−2.0	−0.3	**−4.9**
				max	Co #6	0	(660)	−2.3	15.7	27.9	2.3	−10.2	**5.7**
32	16	HE 160 B				L=1.002							
			Nx	min	Co #3	0	(661)	**−9.2**	0	−0.2	0	−9.8	−4.6
				max	Co #12	0	(661)	**0.4**	0.7	−2.5	0.1	2.6	4.2
			Tx	min	Co #1	0	(661)	−8.1	0	−0.2	**0**	−9.5	−5.8
				max	Co #9	0	(661)	−1.4	1.1	−0.7	**0.1**	−1.5	1.4
			My	min	Co #3	0.501		−9.2	0	0	0	**−9.8**	−4.5
				max	Co #12	0	(661)	0.4	0.7	−2.5	0.1	**2.6**	4.2
			Mz	min	Co #1	0	(661)	−8.1	0	−0.2	0	−9.5	**−5.8**
				max	Co #6	0	(661)	−2.1	0	−0.2	0	0.1	**4.9**
33	1	HE 160 A				L=0.088							
			Nx	min	Co #5	0	(580)	**0**	0	0	0	0	0
				max	Co #8	0.088	(486)	**14.2**	0	−13.7	0	−1.2	0
			Tx	min	Co #9	0	(580)	0	0	0	**0**	0	0
				max	Co #8	0	(580)	14.2	0	−13.7	**0**	0	0
			My	min	Co #8	0.088	(486)	14.2	0	−13.7	0	**−1.2**	0
				max	Co #1	0	(580)	0	0	0	0	**0**	0
			Mz	min	Co #8	0.088	(486)	14.2	0	−13.7	0	−1.2	**0**
				max	Co #9	0	(580)	0	0	0	0	0	**0**
34	1	HE 160 A				L=0.088							
			Nx	min	Co #1	0	(581)	**0**	0	0	0	0	0
				max	Co #13	0.088	(491)	**14.3**	0	−13.8	0	−1.2	0
			Tx	min	Co #13	0	(581)	14.3	0	−13.8	**0**	0	0
				max	Co #8	0	(581)	14.2	0	−13.7	**0**	0	0
			My	min	Co #13	0.088	(491)	14.3	0	−13.8	0	**−1.2**	0
				max	Co #16	0	(581)	0	0	0	0	**0**	0
			Mz	min	Co #8	0.088	(491)	14.2	0	−13.7	0	−1.2	**0**
				max	Co #13	0	(581)	14.3	0	−13.8	0	0	**0**
35	1	HE 160 A				L=0.140							
			Nx	min	Co #1	0	(3)	**0**	0	0	0	0	0
				max	Co #8	0.140	(544)	**28.5**	0	−29.7	0	−4.2	0
			Tx	min	Co #9	0	(3)	0	0	0	**0**	0	0
				max	Co #14	0	(3)	6.4	−26.3	−27.5	**2.1**	0.5	0
			My	min	Co #8	0.140	(544)	28.5	0	−29.7	0	**−4.2**	0
				max	Co #14	0	(3)	6.4	−26.3	−27.5	2.1	**0.5**	0
			Mz	min	Co #8	0.140	(544)	28.5	0	−29.7	0	−4.2	**0**
				max	Co #14	0.140	(544)	6.4	−26.3	−27.5	2.1	−3.3	**3.7**
36	16	HE 160 B				L=0.148							
			Nx	min	Co #11	0	(496)	**−14.6**	−22.6	−11.0	0	0	0
				max	Co #3	0.148	(548)	**35.0**	17.3	11.3	0	1.7	−2.6
			Tx	min	Co #8	0	(496)	7.0	1.1	−11.3	**0**	0	0
				max	Co #14	0	(496)	4.0	−1.1	0	**0**	0	0
			My	min	Co #6	0.148	(548)	0.3	−2.5	−14.5	0	**−2.1**	0.4
				max	Co #1	0.148	(548)	33.9	17.7	15.4	0	**2.3**	−2.6
			Mz	min	Co #1	0.148	(548)	33.9	17.7	15.4	0	2.3	**−2.6**
				max	Co #11	0.148	(548)	−14.6	−22.6	−11.0	0	−1.6	**3.3**
37	16	HE 160 B				L=0.148							
			Nx	min	Co #1	0	(502)	**−0.7**	−2.9	13.9	0	0	0
				max	Co #8	0.148	(546)	**28.3**	15.0	−11.3	0	−1.7	−2.2
			Tx	min	Co #11	0	(502)	9.7	2.5	−10.1	**0**	0	0
				max	Co #3	0	(502)	7.8	1.7	9.9	**0**	0	0
			My	min	Co #6	0.148	(546)	27.4	15.2	−14.4	0	**−2.1**	−2.3
				max	Co #1	0.148	(546)	−0.7	−2.9	13.9	0	**2.1**	0.4
			Mz	min	Co #6	0.148	(546)	27.4	15.2	−14.4	0	−2.1	**−2.3**
				max	Co #14	0.148	(546)	2.0	−5.1	0	0	0	**0.8**
38	16	HE 160 B				L=0.148							
			Nx	min	Co #1	0	(505)	**−0.8**	3.0	14.0	0	0	0
				max	Co #8	0.148	(552)	**28.3**	−15.0	−11.3	0	−1.7	2.2
			Tx	min	Co #3	0	(505)	7.7	−1.6	9.9	**0**	0	0
				max	Co #9	0	(505)	0.2	−0.3	0	**0**	0	0
			My	min	Co #6	0.148	(552)	27.4	−15.2	−14.3	0	**−2.1**	2.3
				max	Co #1	0.148	(552)	−0.7	3.0	14.0	0	**2.1**	−0.4
			Mz	min	Co #1	0.148	(552)	−0.7	3.0	14.0	0	2.1	**−0.4**

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #11	0.148	(552)	24.8	−17.6	−10.9	0	−1.6	**2.6**
39	16	HE 160 B				L=0.148							
			Nx	min	Co #9	0	(501)	**0.2**	−0.3	0	0	0	0
				max	Co #3	0.148	(556)	**35.0**	−17.4	11.4	0	1.7	2.6
			Tx	min	Co #9	0	(501)	0.2	−0.3	0	**0**	0	0
				max	Co #11	0	(501)	5.0	−14.8	−10.8	**0**	0	0
			My	min	Co #6	0.148	(556)	0.3	2.5	−14.6	0	**−2.1**	−0.4
				max	Co #1	0.148	(556)	34.0	−17.8	15.5	0	**2.3**	2.6
			Mz	min	Co #6	0.148	(556)	0.3	2.5	−14.6	0	−2.1	**−0.4**
				max	Co #1	0.148	(556)	34.0	−17.8	15.5	0	2.3	**2.6**
40	15	HE 180 B				L=0.140							
			Nx	min	Co #1	0	(11)	**0**	0	0	0	0	0
				max	Co #7	0.140	(558)	**56.2**	0	59.5	0	8.3	0
			Tx	min	Co #11	0	(11)	12.0	−52.5	55.6	**−4.2**	−1.0	0
				max	Co #5	0	(11)	54.3	0	57.6	**0**	0	0
			My	min	Co #11	0	(11)	12.0	−52.5	55.6	−4.2	**−1.0**	0
				max	Co #7	0.140	(558)	56.2	0	59.5	0	**8.3**	0
			Mz	min	Co #11	0	(11)	12.0	−52.5	55.6	−4.2	−1.0	**0**
				max	Co #11	0.140	(558)	12.1	−52.5	55.6	−4.2	6.8	**7.3**
41	15	HE 180 B				L=0.140							
			Nx	min	Co #1	0	(9)	**0**	0	0	0	0	0
				max	Co #7	0.140	(572)	**56.3**	0	64.3	0	9.0	0
			Tx	min	Co #12	0	(9)	12.0	−52.5	60.0	**−4.2**	−1.0	0
				max	Co #7	0	(9)	56.3	0	64.3	**0**	0	0
			My	min	Co #12	0	(9)	12.0	−52.5	60.0	−4.2	**−1.0**	0
				max	Co #7	0.140	(572)	56.3	0	64.3	0	**9.0**	0
			Mz	min	Co #12	0	(9)	12.0	−52.5	60.0	−4.2	−1.0	**0**
				max	Co #12	0.140	(572)	12.1	−52.5	60.0	−4.2	7.4	**7.4**
42	1	HE 160 A				L=0.094							
			Nx	min	Co #5	0	(582)	**0**	0	0	0	0	0
				max	Co #8	0.094	(506)	**14.5**	0	−17.1	0	−1.6	0
			Tx	min	Co #8	0	(582)	14.4	0	−17.1	**0**	0	0
				max	Co #15	0	(582)	11.6	0	−13.7	**0**	0	0
			My	min	Co #8	0.094	(506)	14.5	0	−17.1	0	**−1.6**	0
				max	Co #16	0	(582)	0	0	0	0	**0**	0
			Mz	min	Co #8	0.094	(506)	14.5	0	−17.1	0	−1.6	**0**
				max	Co #1	0	(582)	0	0	0	0	0	**0**
43	1	HE 160 A				L=0.094							
			Nx	min	Co #5	0	(583)	**0**	0	0	0	0	0
				max	Co #15	0.094	(511)	**14.5**	0	−17.1	0	−1.6	0
			Tx	min	Co #10	0	(583)	0	0	0	**0**	0	0
				max	Co #15	0	(583)	14.5	0	−17.1	**0**	0	0
			My	min	Co #15	0.094	(511)	14.5	0	−17.1	0	**−1.6**	0
				max	Co #15	0	(583)	14.5	0	−17.1	0	**0**	0
			Mz	min	Co #15	0.094	(511)	14.5	0	−17.1	0	−1.6	**0**
				max	Co #6	0	(583)	14.0	0	−16.6	0	0	**0**
44	3	U 120				L=0.519							
			Nx	min	Co #1	0	(597)	**−11.0**	0.5	9.3	0	−4.8	0.3
				max	Co #6	0.519	(345)	**26.7**	−0.5	10.1	0	0	0
			Tx	min	Co #3	0	(597)	−3.4	0.4	12.6	**0**	−6.6	0.2
				max	Co #9	0	(597)	7.0	−0.8	5.9	**0**	−3.1	−0.4
			My	min	Co #8	0	(597)	24.6	−0.4	12.8	0	**−6.7**	−0.2
				max	Co #12	0.519	(345)	23.6	−1.3	12.6	0	**0**	0
			Mz	min	Co #12	0	(597)	23.6	−1.3	12.6	0	−6.5	**−0.7**
				max	Co #1	0	(597)	−11.0	0.5	9.3	0	−4.8	**0.3**
45	3	U 120				L=0.269							
			Nx	min	Co #11	0	(585)	**−11.7**	−1.3	−2.9	0	0.8	−0.4
				max	Co #1	0.269	(496)	**30.7**	−2.4	13.8	0	0	0
			Tx	min	Co #8	0	(585)	−4.1	1.7	12.9	**0**	−3.5	0.5
				max	Co #14	0	(585)	3.0	0.5	2.8	**0**	−0.8	0.1
			My	min	Co #3	0	(585)	28.4	−1.8	17.4	0	**−4.7**	−0.5
				max	Co #11	0	(585)	−11.7	−1.3	−2.9	0	**0.8**	−0.4
			Mz	min	Co #1	0	(585)	30.7	−2.4	13.8	0	−3.7	**−0.7**
				max	Co #6	0	(585)	−10.4	2.1	10.2	0	−2.8	**0.6**
46	3	U 120				L=0.269							
			Nx	min	Co #1	0.269	(586)	**−10.5**	−2.4	−9.1	0	−2.5	0.6
				max	Co #6	0	(502)	**25.9**	2.2	−9.9	0	0	0
			Tx	min	Co #11	0	(502)	13.0	−1.3	0	**0**	0	0
				max	Co #3	0	(502)	−2.7	−1.7	−12.5	**0**	0	0
			My	min	Co #8	0.269	(586)	24.2	1.8	−12.6	0	**−3.4**	−0.5
				max	Co #11	0.269	(586)	13.0	−1.3	0.1	0	**0**	0.4
			Mz	min	Co #6	0.269	(586)	25.8	2.2	−9.8	0	−2.7	**−0.6**
				max	Co #1	0.269	(586)	−10.5	−2.4	−9.1	0	−2.5	**0.6**
47	3	U 120				L=0.269							
			Nx	min	Co #6	0.269	(588)	**−10.4**	−2.1	−10.2	0	−2.8	0.6
				max	Co #1	0	(501)	**30.8**	2.4	−13.8	0	0	0
			Tx	min	Co #9	0	(501)	0	0	−0.1	**0**	0	0
				max	Co #11	0	(501)	−9.6	−4.6	−11.1	**0**	0	0
			My	min	Co #3	0.269	(588)	28.4	1.8	−17.4	0	**−4.7**	−0.5
				max	Co #5	0	(501)	13.3	1.0	−4.9	0	**0**	0
			Mz	min	Co #1	0.269	(588)	30.7	2.4	−13.8	0	−3.7	**−0.6**
				max	Co #11	0.269	(588)	−9.7	−4.6	−11.0	0	−3.0	**1.3**
48	3	U 120				L=0.269							
			Nx	min	Co #1	0	(589)	**−10.5**	2.3	9.1	0	−2.5	0.6

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #6	0.269	(505)	**25.9**	−2.2	9.9	0	0	0
			Tx	min	Co #3	0	(589)	−2.7	1.7	12.4	**0**	−3.4	0.5
				max	Co #9	0	(589)	0	0	0.1	**0**	0	0
			My	min	Co #8	0	(589)	24.1	−1.8	12.6	0	**−3.4**	−0.5
				max	Co #6	0.269	(505)	25.9	−2.2	9.9	0	**0**	0
			Mz	min	Co #11	0	(589)	21.6	−4.7	10.4	0	−2.8	**−1.3**
				max	Co #1	0	(589)	−10.5	2.3	9.1	0	−2.5	**0.6**
49	5	HE 220 A				L=0.500							
			Nx	min	Co #11	0	(584)	**−32.5**	−4.8	14.4	−2.7	0	0
				max	Co #9	0	(584)	**−0.6**	−0.2	0	0	0	0
			Tx	min	Co #6	0	(584)	−12.5	−27.5	28.9	**−2.8**	0	0
				max	Co #1	0	(584)	−12.5	−33.1	−29.4	**4.9**	0	0
			My	min	Co #1	0.500	(590)	−12.5	−32.8	−29.4	4.9	**−14.7**	16.5
				max	Co #6	0.500	(590)	−12.5	−27.3	28.9	−2.8	**14.5**	13.7
			Mz	min	Co #14	0	(584)	−19.4	−10.7	1.5	0.4	0	**0**
				max	Co #3	0.500	(590)	−16.6	−42.4	−21.2	4.2	−10.6	**21.2**
50	5	HE 220 A				L=0.500							
			Nx	min	Co #3	0	(590)	**−16.6**	42.4	21.2	−4.2	−10.6	21.2
				max	Co #11	0	(590)	**20.0**	19.7	−28.4	2.6	14.2	9.9
			Tx	min	Co #1	0	(590)	−12.5	32.8	29.4	**−4.9**	−14.7	16.5
				max	Co #6	0	(590)	−12.5	27.3	−28.9	**2.8**	14.5	13.7
			My	min	Co #1	0	(590)	−12.5	32.8	29.4	−4.9	**−14.7**	16.5
				max	Co #6	0	(590)	−12.5	27.3	−28.9	2.8	**14.5**	13.7
			Mz	min	Co #3	0.500	(587)	−16.6	42.6	21.2	−4.2	0	**0**
				max	Co #3	0	(590)	−16.6	42.4	21.2	−4.2	−10.6	**21.2**
51	5	HE 220 A				L=0.500							
			Nx	min	Co #12	0	(592)	**−30.4**	−4.5	16.4	−2.9	0	0
				max	Co #10	0	(592)	**−0.3**	−0.2	0	0	0	0
			Tx	min	Co #6	0	(592)	−8.7	−27.4	31.1	**−3.1**	0	0
				max	Co #1	0	(592)	−9.2	−33.2	−31.4	**5.2**	0	0
			My	min	Co #1	0.500	(591)	−9.2	−32.9	−31.4	5.2	**−15.7**	16.5
				max	Co #6	0.500	(591)	−8.7	−27.2	31.1	−3.1	**15.5**	13.7
			Mz	min	Co #8	0	(592)	−10.8	−35.2	24.4	−2.4	0	**0**
				max	Co #3	0.500	(591)	−12.1	−42.5	−23.4	4.5	−11.7	**21.3**
52	5	HE 220 A				L=0.500							
			Nx	min	Co #3	0	(591)	**−12.1**	42.5	23.4	−4.5	−11.7	21.3
				max	Co #12	0	(591)	**22.1**	19.5	−30.3	2.9	15.2	9.8
			Tx	min	Co #1	0	(591)	−9.2	32.9	31.4	**−5.2**	−15.7	16.5
				max	Co #6	0	(591)	−8.7	27.2	−31.1	**3.1**	15.5	13.7
			My	min	Co #1	0	(591)	−9.2	32.9	31.4	−5.2	**−15.7**	16.5
				max	Co #6	0	(591)	−8.7	27.2	−31.1	3.1	**15.5**	13.7
			Mz	min	Co #6	0.500	(595)	−8.7	27.4	−31.1	3.1	0	**0**
				max	Co #3	0	(591)	−12.1	42.5	23.4	−4.5	−11.7	**21.3**
53	3	U 120				L=0.517							
			Nx	min	Co #12	0	(593)	**−13.7**	−0.5	−4.1	0	2.1	−0.3
				max	Co #1	0.517	(346)	**31.7**	−0.5	12.2	0	0	0
			Tx	min	Co #8	0	(593)	−6.1	0.4	13.0	**0**	−6.7	0.2
				max	Co #15	0	(593)	2.7	0.3	1.4	**0**	−0.7	0.1
			My	min	Co #3	0	(593)	29.2	−0.4	15.7	0	**−8.1**	−0.2
				max	Co #12	0	(593)	−13.7	−0.5	−4.1	0	**2.1**	−0.3
			Mz	min	Co #9	0	(593)	−1.1	−0.6	6.5	0	−3.4	**−0.3**
				max	Co #6	0	(593)	−12.5	0.5	10.3	0	−5.3	**0.3**
54	3	U 120				L=0.517							
			Nx	min	Co #6	0.517	(596)	**−12.5**	−0.5	−10.3	0	−5.3	0.3
				max	Co #1	0	(349)	**31.7**	0.5	−12.2	0	0	0
			Tx	min	Co #5	0	(349)	14.0	0.2	−4.8	**0**	0	0
				max	Co #12	0	(349)	−11.0	−1.3	−13.1	**0**	0	0
			My	min	Co #3	0.517	(596)	29.2	0.4	−15.7	0	**−8.1**	−0.2
				max	Co #3	0	(349)	29.3	0.4	−15.8	0	**0**	0
			Mz	min	Co #1	0.517	(596)	31.7	0.5	−12.2	0	−6.3	**−0.3**
				max	Co #12	0.517	(596)	−11.0	−1.3	−13.0	0	−6.7	**0.7**
55	3	U 120				L=0.519							
			Nx	min	Co #1	0.519	(594)	**−11.0**	−0.5	−9.3	0	−4.8	0.3
				max	Co #6	0	(341)	**26.7**	0.5	−10.1	0	0	0
			Tx	min	Co #12	0	(341)	12.1	−0.5	2.2	**0**	0	0
				max	Co #3	0	(341)	−3.3	−0.4	−12.7	**0**	0	0
			My	min	Co #8	0.519	(594)	24.5	0.4	−12.8	0	**−6.7**	−0.2
				max	Co #12	0.519	(594)	12.1	−0.5	2.2	0	**1.2**	0.2
			Mz	min	Co #6	0.519	(594)	26.6	0.5	−10.1	0	−5.2	**−0.3**
				max	Co #9	0.519	(594)	9.7	−0.6	−6.5	0	−3.4	**0.3**
56	4	L 50X 50X 5				L=1.126							
			Nx	min	Co #12	0.563	(677)	**−18.8**	0.1	0.1	0	0	0
				max	Co #3	0	(346)	**9.2**	−0.1	0	0	0	0
			Tx	min	Co #1	0	(346)	8.3	−0.1	0	**0**	0	0
				max	Co #6	0	(346)	2.3	0	0	**0**	0	0
			My	min	Co #6	0.563	(677)	2.4	0	0	0	**0**	0
				max	Co #1	0.563	(677)	7.8	0.1	−0.1	0	**0.1**	0
			Mz	min	Co #12	0.563	(677)	−18.8	0.1	0.1	0	0	**0**
				max	Co #1	0.563	(677)	8.3	−0.1	0	0	0	**0.1**
57	4	L 50X 50X 5				L=1.126							
			Nx	min	Co #10	0	(593)	**0.2**	0	0	0	0	0
				max	Co #12	0.563	(677)	**19.5**	0	−0.1	0	−0.1	0
			Tx	min	Co #6	0.563	(677)	2.3	0	0	**0**	0	0
				max	Co #1	0.563	(677)	8.2	0.1	0	**0**	0	0.1
			My	min	Co #12	0.563	(677)	19.5	0	−0.1	0	**−0.1**	0

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #1	0.563	(677)	7.8	−0.1	0.1	0	**0.1**	0
			Mz	min	Co #6	0.563	(677)	2.3	0	0	0	0	**0**
				max	Co #1	0.563	(677)	8.2	0.1	0	0	0	**0.1**
58	4	L 50X 50X 5				L=1.127							
			Nx	min	Co #15	1.127	(597)	**−6.6**	0	0	0	0	0
				max	Co #8	0	(341)	**8.3**	0	0	0	0	0
			Tx	min	Co #1	0	(341)	2.7	0	0	**0**	0	0
				max	Co #6	0	(341)	7.5	0.1	0	**0**	0	0
			My	min	Co #9	0.563	(678)	7.0	0.1	−0.1	0	**−0.1**	−0.1
				max	Co #12	0.563	(678)	−6.2	0	−0.1	0	**0**	0
			Mz	min	Co #9	0.563	(678)	7.0	0.1	−0.1	0	−0.1	**−0.1**
				max	Co #15	0.563	(678)	−6.6	0	−0.1	0	0	**0**
59	4	L 50X 50X 5				L=1.127							
			Nx	min	Co #9	0	(594)	**0.1**	−0.1	0.1	0	0	0
				max	Co #12	1.127	(345)	**14.9**	−0.1	0.1	0	0	0
			Tx	min	Co #6	0.563	(678)	7.5	−0.1	0	**0**	0	0
				max	Co #1	0.563	(678)	2.7	0	0	**0**	0	0
			My	min	Co #15	0.563	(678)	11.3	0.1	0	0	**0**	0
				max	Co #9	0.563	(678)	0.1	−0.1	0.1	0	**0.1**	0.1
			Mz	min	Co #12	0.563	(678)	14.9	−0.1	0	0	0	**0**
				max	Co #9	0.563	(678)	0.1	−0.1	0.1	0	0.1	**0.1**
60	16	HE 160 B				L=0.500							
			Nx	min	Co #15	0	(599)	**−12.6**	−0.3	12.8	−1.6	0	0
				max	Co #6	0	(599)	**0**	−14.0	15.6	−1.9	0	0
			Tx	min	Co #8	0	(599)	0	−14.4	16.2	**−1.9**	0	0
				max	Co #17	0	(599)	0	−0.2	0	**0**	0	0
			My	min	Co #2	0	(599)	0	−10.5	11.7	−1.4	**0**	0
				max	Co #8	0.500	(598)	0	−14.2	16.2	−1.9	**8.1**	7.2
			Mz	min	Co #1	0	(599)	0	−0.2	0	0	0	**0**
				max	Co #8	0.500	(598)	0	−14.2	16.2	−1.9	8.1	**7.2**
61	16	HE 160 B				L=0.500							
			Nx	min	Co #7	0	(598)	**−0.1**	6.6	−7.5	0.9	3.8	3.4
				max	Co #15	0	(598)	**13.6**	6.3	−17.0	1.5	8.5	3.2
			Tx	min	Co #5	0	(598)	−0.1	0	0	**0**	0	0.1
				max	Co #8	0	(598)	0	14.2	−16.2	**1.9**	8.1	7.2
			My	min	Co #9	0.500	(600)	0	5.9	−6.5	0.8	**0**	0
				max	Co #15	0	(598)	13.6	6.3	−17.0	1.5	**8.5**	3.2
			Mz	min	Co #7	0.500	(600)	−0.1	6.8	−7.5	0.9	0	**0**
				max	Co #8	0	(598)	0	14.2	−16.2	1.9	8.1	**7.2**
62	2	L 60X 60X 6				L=0.722							
			Nx	min	Co #5	0.722	(601)	**0**	0	0	0	0	0
				max	Co #8	0	(582)	**22.4**	0	0	0	0	0
			Tx	min	Co #8	0	(582)	22.4	0	0	**0**	0	0
				max	Co #15	0	(582)	17.9	0	0	**0**	0	0
			My	min	Co #1	0.361		0	0	0	0	**0**	0
				max	Co #8	0	(582)	22.4	0	0	0	**0**	0
			Mz	min	Co #15	0	(582)	17.9	0	0	0	0	**0**
				max	Co #15	0.722	(601)	17.9	0	0	0	0	**0**
63	2	L 60X 60X 6				L=0.722							
			Nx	min	Co #5	0	(602)	**0**	0	0	0	0	0
				max	Co #15	0.722	(583)	**22.4**	0	0	0	0	0
			Tx	min	Co #10	0	(602)	0	0	0	**0**	0	0
				max	Co #15	0	(602)	22.4	0	0	**0**	0	0
			My	min	Co #1	0.361		0	0	0	0	**0**	0
				max	Co #8	0.722	(583)	22.4	0	0	0	**0**	0
			Mz	min	Co #15	0	(602)	22.4	0	0	0	0	**0**
				max	Co #15	0.722	(583)	22.4	0	0	0	0	**0**
64	1	HE 160 A				L=0.100							
			Nx	min	Co #5	0	(601)	**0**	0	0	0	0	0
				max	Co #8	0	(601)	**17.1**	0	−14.4	0	0	0
			Tx	min	Co #8	0	(601)	17.1	0	−14.4	**0**	0	0
				max	Co #15	0	(601)	13.7	0	−11.5	**0**	0	0
			My	min	Co #8	0.100	(599)	17.1	0	−14.4	0	**−1.4**	0
				max	Co #5	0.100	(599)	0	0	0	0	**0**	0
			Mz	min	Co #15	0.100	(599)	13.7	0	−11.5	0	−1.2	**0**
				max	Co #16	0.100	(599)	0	0	0	0	0	**0**
65	1	HE 160 A				L=0.100							
			Nx	min	Co #5	0	(602)	**0**	0	0	0	0	0
				max	Co #15	0	(602)	**17.1**	0	−14.4	0	0	0
			Tx	min	Co #10	0	(602)	0	0	0	**0**	0	0
				max	Co #15	0	(602)	17.1	0	−14.4	**0**	0	0
			My	min	Co #15	0.100	(600)	17.1	0	−14.4	0	**−1.4**	0
				max	Co #5	0.100	(600)	0	0	0	0	**0**	0
			Mz	min	Co #15	0.100	(600)	17.1	0	−14.4	0	−1.4	**0**
				max	Co #15	0	(602)	17.1	0	−14.4	0	0	**0**
66	3	U 120				L=0.513							
			Nx	min	Co #15	0	(600)	**−0.8**	0	0.1	0	−0.1	0
				max	Co #10	0.513	(515)	**0.3**	0	0	0	0	0
			Tx	min	Co #12	0	(600)	0.2	0	0.4	**0**	−0.2	0
				max	Co #15	0	(600)	−0.8	0	0.1	**0**	−0.1	0
			My	min	Co #8	0	(600)	0.1	0	1.0	0	**−0.5**	0
				max	Co #10	0.513	(515)	0.3	0	0	0	**0**	0
			Mz	min	Co #15	0.513	(515)	−0.7	0	0.1	0	0	**0**
				max	Co #15	0	(600)	−0.8	0	0.1	0	−0.1	**0**

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
67	3	U 120				L=0.513							
			Nx	min	Co #15	0.513	(599)	**−17.8**	0	−0.8	0	−0.4	0
				max	Co #10	0	(512)	**0.3**	0	0	0	0	0
			Tx	min	Co #12	0	(512)	0.2	0	−0.4	**0**	0	0
				max	Co #15	0	(512)	−17.7	0	−0.8	**0**	0	0
			My	min	Co #8	0.513	(599)	0.1	0	−1.0	0	**−0.5**	0
				max	Co #10	0	(512)	0.3	0	0	0	**0**	0
			Mz	min	Co #15	0	(512)	−17.7	0	−0.8	0	0	**0**
				max	Co #8	0.513	(599)	0.1	0	−1.0	0	−0.5	**0**
68	1	HE 160 A				L=0.100							
			Nx	min	Co #5	0	(607)	**0**	0	0	0	0	0
				max	Co #8	0	(607)	**13.7**	0	−14.2	0	0	0
			Tx	min	Co #9	0	(607)	0	0	0	**0**	0	0
				max	Co #8	0	(607)	13.7	0	−14.2	**0**	0	0
			My	min	Co #8	0.100	(606)	13.7	0	−14.1	0	**−1.4**	0
				max	Co #5	0.100	(606)	0	0	0	0	**0**	0
			Mz	min	Co #7	0	(607)	6.4	0	−6.6	0	0	**0**
				max	Co #8	0.100	(606)	13.7	0	−14.1	0	−1.4	**0**
69	1	HE 160 A				L=0.100							
			Nx	min	Co #1	0	(609)	**0**	0	0	0	0	0
				max	Co #13	0	(609)	**13.8**	0	−14.3	0	0	0
			Tx	min	Co #13	0	(609)	13.8	0	−14.3	**0**	0	0
				max	Co #8	0	(609)	13.7	0	−14.2	**0**	0	0
			My	min	Co #13	0.100	(608)	13.8	0	−14.2	0	**−1.4**	0
				max	Co #1	0.100	(608)	0	0	0	0	**0**	0
			Mz	min	Co #13	0.100	(608)	13.8	0	−14.2	0	−1.4	**0**
				max	Co #8	0.100	(608)	13.7	0	−14.1	0	−1.4	**0**
70	16	HE 160 B				L=0.500							
			Nx	min	Co #13	0	(606)	**−12.6**	−0.3	10.1	−1.2	0	0
				max	Co #10	0	(606)	**0**	−6.0	5.4	−0.7	0	0
			Tx	min	Co #8	0	(606)	0	−14.7	13.4	**−1.6**	0	0
				max	Co #9	0	(606)	0	−0.2	0	**0**	0	0
			My	min	Co #4	0	(606)	−0.1	−11.0	10.0	−1.2	**0**	0
				max	Co #8	0.500	(605)	0	−14.5	13.4	−1.6	**6.7**	7.3
			Mz	min	Co #5	0	(606)	−0.1	−0.2	0	0	0	**0**
				max	Co #8	0.500	(605)	0	−14.5	13.4	−1.6	6.7	**7.3**
71	16	HE 160 B				L=0.500							
			Nx	min	Co #1	0	(605)	**−0.1**	0	0	0	0	0.1
				max	Co #13	0	(605)	**13.7**	6.4	−14.3	1.2	7.2	3.2
			Tx	min	Co #1	0	(605)	−0.1	0	0	**0**	0	0.1
				max	Co #8	0	(605)	0	14.5	−13.4	**1.6**	6.7	7.3
			My	min	Co #17	0.500	(608)	0	0.2	0	0	**0**	0
				max	Co #13	0	(605)	13.7	6.4	−14.3	1.2	**7.2**	3.2
			Mz	min	Co #3	0.500	(608)	−0.1	6.0	−5.3	0.6	0	**0**
				max	Co #8	0	(605)	0	14.5	−13.4	1.6	6.7	**7.3**
72	2	L 60X 60X 6				L=0.719							
			Nx	min	Co #5	0.719	(607)	**0**	0	0	0	0	0
				max	Co #8	0	(580)	**19.8**	0	0	0	0	0
			Tx	min	Co #9	0	(580)	0	0	0	**0**	0	0
				max	Co #8	0	(580)	19.8	0	0	**0**	0	0
			My	min	Co #1	0.359		0	0	0	0	**0**	0
				max	Co #8	0	(580)	19.8	0	0	0	**0**	0
			Mz	min	Co #13	0	(580)	15.0	0	0	0	0	**0**
				max	Co #8	0.719	(607)	19.7	0	0	0	0	**0**
73	2	L 60X 60X 6				L=0.719							
			Nx	min	Co #1	0	(609)	**0**	0	0	0	0	0
				max	Co #13	0.719	(581)	**19.9**	0	0	0	0	0
			Tx	min	Co #13	0	(609)	19.9	0	0	**0**	0	0
				max	Co #8	0	(609)	19.7	0	0	**0**	0	0
			My	min	Co #1	0.359		0	0	0	0	**0**	0
				max	Co #8	0.719	(581)	19.8	0	0	0	**0**	0
			Mz	min	Co #8	0	(609)	19.7	0	0	0	0	**0**
				max	Co #13	0	(609)	19.9	0	0	0	0	**0**
76	13	HE 140 A				L=0.110							
			Nx	min	Co #1	0	(610)	**0**	0	0	0	0	0
				max	Co #16	0	(610)	**61.8**	0	8.5	0	0	0
			Tx	min	Co #1	0	(610)	0	0	0	**0**	0	0
				max	Co #1	0	(610)	0	0	0	**0**	0	0
			My	min	Co #17	0.110	(351)	61.8	0	−8.5	0	**−0.9**	0
				max	Co #16	0.110	(351)	61.8	0	8.5	0	**0.9**	0
			Mz	min	Co #17	0.110	(351)	61.8	0	−8.5	0	−0.9	**0**
				max	Co #16	0.110	(351)	61.8	0	8.5	0	0.9	**0**
77	13	HE 140 A				L=0.110							
			Nx	min	Co #1	0	(611)	**0**	0	0	0	0	0
				max	Co #16	0	(611)	**61.9**	0	10.1	0	0	0
			Tx	min	Co #1	0	(611)	0	0	0	**0**	0	0
				max	Co #1	0	(611)	0	0	0	**0**	0	0
			My	min	Co #17	0.110	(521)	61.9	0	−10.1	0	**−1.1**	0
				max	Co #16	0.110	(521)	61.9	0	10.1	0	**1.1**	0
			Mz	min	Co #17	0.110	(521)	61.9	0	−10.1	0	−1.1	**0**
				max	Co #16	0.110	(521)	61.9	0	10.1	0	1.1	**0**
78	13	HE 140 A				L=0.110							
			Nx	min	Co #1	0	(612)	**0**	0	0	0	0	0
				max	Co #16	0	(612)	**61.8**	0	11.3	0	0	0
			Tx	min	Co #1	0	(612)	0	0	0	**0**	0	0

Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #1	0	(612)	0	0	0	**0**	0	0
			My	min	Co #17	0.110	(523)	61.8	0	−11.3	0	**−1.2**	0
				max	Co #16	0.110	(523)	61.8	0	11.3	0	**1.2**	0
			Mz	min	Co #17	0.110	(523)	61.8	0	−11.3	0	−1.2	**0**
				max	Co #16	0.110	(523)	61.8	0	11.3	0	1.2	**0**
311	4	L 50X 50X 5				L=1.972							
			Nx	min	Co #11	0	(253)	**−24.3**	0	0	0	0	0
				max	Co #17	0	(253)	**2.0**	0	0	0	0	0
			Tx	min	Co #11	0	(253)	−24.3	0	0	**0**	0	0
				max	Co #5	0	(253)	0.5	0	0	**0**	0	0
			My	min	Co #1	0.986		−0.5	0	0	0	**0**	0
				max	Co #11	0	(253)	−24.3	0	0	0	**0**	0
			Mz	min	Co #11	1.972	(266)	−24.3	0	0	0	0	**0**
				max	Co #11	0	(253)	−24.3	0	0	0	0	**0**
312	4	L 50X 50X 5				L=1.972							
			Nx	min	Co #1	0	(260)	**0**	0	0	0	0	0
				max	Co #11	0	(260)	**26.1**	0	0	0	0	0
			Tx	min	Co #11	0	(260)	26.1	0	0	**0**	0	0
				max	Co #6	0	(260)	1.3	0	0	**0**	0	0
			My	min	Co #1	0.986		0	0	0	0	**0**	0
				max	Co #11	0	(260)	26.1	0	0	0	**0**	0
			Mz	min	Co #11	1.972	(259)	26.1	0	0	0	0	**0**
				max	Co #11	0	(260)	26.1	0	0	0	0	**0**
335	15	HE 180 B				L=0.600							
			Nx	min	Co #8	0	(550)	**−1.7**	0.1	−5.1	0	1.5	0
				max	Co #1	0	(550)	**0.2**	0.4	6.2	0	−1.9	0.1
			Tx	min	Co #17	0	(550)	−0.5	0.2	−0.1	**0**	0	0
				max	Co #11	0	(550)	−1.2	−12.8	−4.8	**0.1**	1.4	−4.3
			My	min	Co #6	0.600	(554)	−1.3	0	−6.1	0	**−1.9**	0
				max	Co #1	0.600	(554)	0.2	0.4	6.5	0	**2.0**	−0.1
			Mz	min	Co #11	0	(550)	−1.2	−12.8	−4.8	0.1	1.4	**−4.3**
				max	Co #11	0.600	(554)	−1.2	−12.8	−4.5	0.1	−1.4	**3.4**
477	3	U 120				L=0.566							
			Nx	min	Co #13	0	(606)	**−17.6**	0	0.3	0	−0.2	0
				max	Co #6	0	(606)	**0.5**	0	0.3	0	−0.2	0
			Tx	min	Co #8	0	(606)	0.5	0	0.3	**0**	−0.2	0
				max	Co #13	0	(606)	−17.6	0	0.3	**0**	−0.2	0
			My	min	Co #8	0	(606)	0.5	0	0.3	0	**−0.2**	0
				max	Co #9	0.566	(492)	0.3	0	0	0	**0**	0
			Mz	min	Co #8	0	(606)	0.5	0	0.3	0	−0.2	**0**
				max	Co #13	0.566	(492)	−17.6	0	0.3	0	0	**0**
478	3	U 120				L=0.566							
			Nx	min	Co #13	0	(608)	**0.1**	0	−0.4	0	0.2	0
				max	Co #6	0	(608)	**0.5**	0	0.3	0	−0.2	0
			Tx	min	Co #9	0	(608)	0.3	0	0	**0**	0	0
				max	Co #13	0	(608)	0.1	0	−0.4	**0**	0.2	0
			My	min	Co #8	0	(608)	0.5	0	0.3	0	**−0.2**	0
				max	Co #13	0	(608)	0.1	0	−0.4	0	**0.2**	0
			Mz	min	Co #13	0.566	(495)	0.1	0	−0.4	0	0	**0**
				max	Co #13	0	(608)	0.1	0	−0.4	0	0.2	**0**
479	16	HE 160 B				L=0.120							
			Nx	min	Co #1	0	(6)	**0**	0	0	0	0	0
				max	Co #8	0.120	(605)	**28.9**	0	−26.8	0	−3.2	0
			Tx	min	Co #10	0	(6)	11.6	0	−10.8	**0**	0	0
				max	Co #13	0	(6)	6.4	−26.3	−24.4	**2.1**	0.5	0
			My	min	Co #8	0.120	(605)	28.9	0	−26.8	0	**−3.2**	0
				max	Co #13	0	(6)	6.4	−26.3	−24.4	2.1	**0.5**	0
			Mz	min	Co #8	0.120	(605)	28.9	0	−26.8	0	−3.2	**0**
				max	Co #13	0.120	(605)	6.5	−26.3	−24.4	2.1	−2.4	**3.2**
492	15	HE 180 B				L=0.140							
			Nx	min	Co #1	0	(13)	**0**	0	0	0	0	0
				max	Co #7	0.140	(536)	**56.4**	0	53.3	0	7.5	0
			Tx	min	Co #10	0	(13)	12.0	−52.5	49.8	**−4.2**	−1.0	0
				max	Co #5	0	(13)	55.2	0	52.3	**0**	0	0
			My	min	Co #10	0	(13)	12.0	−52.5	49.8	−4.2	**−1.0**	0
				max	Co #7	0.140	(536)	56.4	0	53.3	0	**7.5**	0
			Mz	min	Co #10	0	(13)	12.0	−52.5	49.8	−4.2	−1.0	**0**
				max	Co #10	0.140	(536)	12.1	−52.5	49.8	−4.2	6.0	**7.4**
516	16	HE 160 B				L=0.148							
			Nx	min	Co #15	0	(341)	**−0.2**	−5.5	0.9	0	0	0
				max	Co #8	0.148	(659)	**28.7**	7.5	−12.5	0	−1.8	−1.1
			Tx	min	Co #1	0	(341)	0.5	1.9	13.4	**0**	0	0
				max	Co #6	0	(341)	27.7	6.9	−15.7	**0**	0	0
			My	min	Co #6	0.148	(659)	27.8	6.9	−15.7	0	**−2.3**	−1.0
				max	Co #1	0.148	(659)	0.6	1.9	13.4	0	**2.0**	−0.3
			Mz	min	Co #8	0.148	(659)	28.7	7.5	−12.5	0	−1.8	**−1.1**
				max	Co #12	0.148	(659)	4.5	−6.0	−8.4	0	−1.2	**0.9**
517	16	HE 160 B				L=0.148							
			Nx	min	Co #5	0	(345)	**0.1**	−0.9	7.3	0	0	0
				max	Co #12	0.148	(660)	**30.1**	−14.0	−14.2	0	−2.1	2.1
			Tx	min	Co #12	0	(345)	30.0	−14.0	−14.2	**0**	0	0
				max	Co #1	0	(345)	0.5	−1.9	13.4	**0**	0	0
			My	min	Co #6	0.148	(660)	27.8	−6.8	−15.7	0	**−2.3**	1.0
				max	Co #1	0.148	(660)	0.6	−1.9	13.4	0	**2.0**	0.3
			Mz	min	Co #1	0	(345)	0.5	−1.9	13.4	0	0	**0**

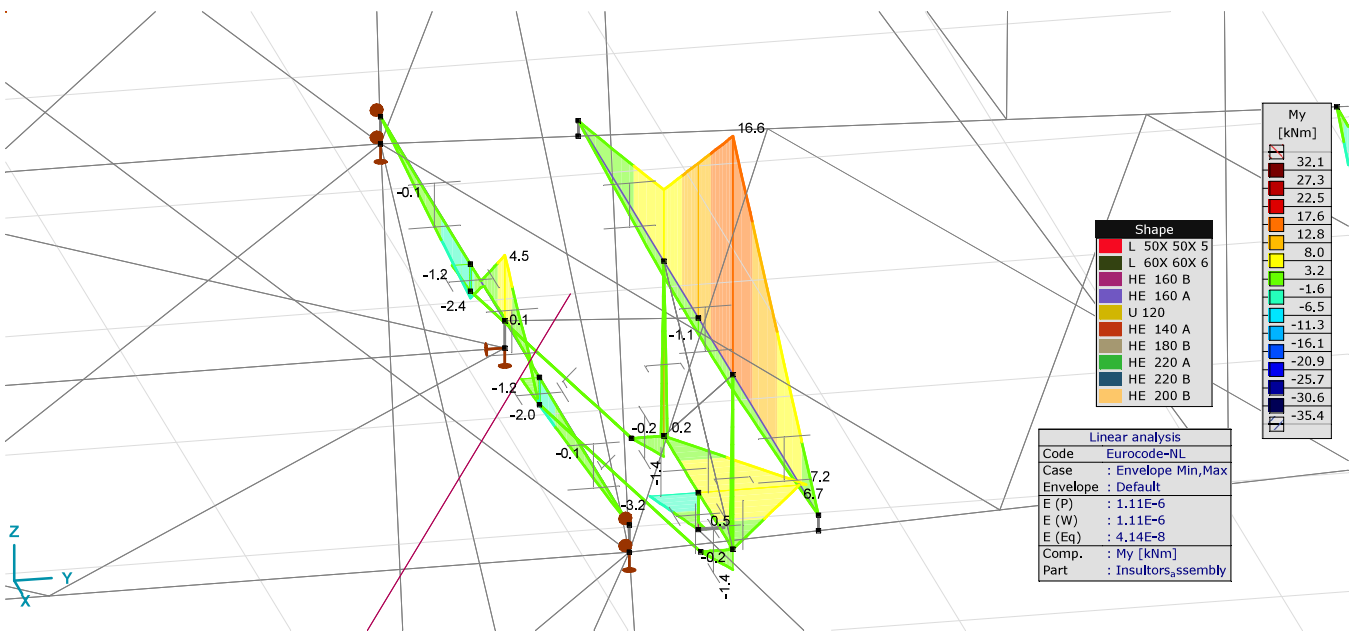
Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #12	0.148	(660)	30.1	−14.0	−14.2	0	−2.1	**2.1**
518	16	HE 160 B				L=0.148							
			Nx	min	Co #12	0	(346)	**−18.1**	−16.1	−13.8	0	0	0
				max	Co #3	0.148	(661)	**34.3**	8.5	14.2	0	2.1	−1.3
			Tx	min	Co #1	0	(346)	32.9	7.7	18.0	**0**	0	0
				max	Co #12	0	(346)	−18.1	−16.1	−13.8	**0**	0	0
			My	min	Co #6	0.148	(661)	0.1	1.6	−15.4	0	**−2.3**	−0.2
				max	Co #1	0.148	(661)	33.0	7.7	18.0	0	**2.7**	−1.2
			Mz	min	Co #3	0.148	(661)	34.3	8.5	14.2	0	2.1	**−1.3**
				max	Co #12	0.148	(661)	−18.0	−16.1	−13.8	0	−2.0	**2.4**
519	16	HE 160 B				L=0.148							
			Nx	min	Co #6	0	(349)	**0**	−1.6	−15.4	0	0	0
				max	Co #3	0.148	(673)	**34.3**	−8.4	14.1	0	2.1	1.2
			Tx	min	Co #6	0	(349)	0	−1.6	−15.4	**0**	0	0
				max	Co #1	0	(349)	32.9	−7.6	18.0	**0**	0	0
			My	min	Co #6	0.148	(673)	0.1	−1.6	−15.4	0	**−2.3**	0.2
				max	Co #1	0.148	(673)	33.0	−7.6	18.0	0	**2.6**	1.1
			Mz	min	Co #6	0	(349)	0	−1.6	−15.4	0	0	**0**
				max	Co #12	0.148	(673)	8.5	−15.9	−10.3	0	−1.5	**2.4**
524	16	HE 160 B				L=0.320							
			Nx	min	Co #12	0	(661)	**−15.8**	−13.1	−15.5	−2.0	4.9	−4.2
				max	Co #7	0	(661)	**2.7**	1.0	14.8	0.1	−4.8	0.3
			Tx	min	Co #6	0	(661)	−0.5	−15.4	0.3	**−2.3**	−0.1	−4.9
				max	Co #1	0	(661)	−0.2	18.0	33.2	**2.7**	−10.6	5.8
			My	min	Co #3	0	(661)	−0.5	14.2	34.4	2.1	**−11.1**	4.5
				max	Co #12	0	(661)	−15.8	−13.1	−15.5	−2.0	**4.9**	−4.2
			Mz	min	Co #6	0	(661)	−0.5	−15.4	0.3	−2.3	−0.1	**−4.9**
				max	Co #1	0	(661)	−0.2	18.0	33.2	2.7	−10.6	**5.8**
525	16	HE 160 B				L=0.320							
			Nx	min	Co #4	0	(673)	**−0.7**	0.9	18.4	0.1	−5.9	0.3
				max	Co #12	0.320	(672)	**16.4**	11.0	6.5	1.6	0	0
			Tx	min	Co #1	0	(673)	−0.2	−18.0	33.2	**−2.7**	−10.6	−5.8
				max	Co #6	0	(673)	−0.5	15.4	0.3	**2.3**	−0.1	4.9
			My	min	Co #3	0	(673)	−0.5	−14.1	34.4	−2.1	**−11.0**	−4.5
				max	Co #10	0.320	(672)	0.1	0	0.6	0	**0**	0
			Mz	min	Co #1	0	(673)	−0.2	−18.0	33.2	−2.7	−10.6	**−5.8**
				max	Co #6	0	(673)	−0.5	15.4	0.3	2.3	−0.1	**4.9**
540	16	HE 160 B				L=0.420							
			Nx	min	Co #11	0.420	(548)	**−11.9**	−9.7	15.1	−1.0	6.3	4.1
				max	Co #5	0	(637)	**1.2**	7.0	−16.0	0.6	0	0
			Tx	min	Co #6	0	(637)	−0.7	−15.2	2.4	**−1.2**	0	0
				max	Co #1	0	(637)	−1.2	15.5	−37.6	**1.3**	0	0
			My	min	Co #3	0.420	(548)	−1.4	11.2	−37.5	1.0	**−15.8**	−4.7
				max	Co #11	0.420	(548)	−11.9	−9.7	15.1	−1.0	**6.3**	4.1
			Mz	min	Co #1	0.420	(548)	−1.2	15.5	−37.4	1.3	−15.7	**−6.5**
				max	Co #6	0.420	(548)	−0.7	−15.2	2.6	−1.2	1.0	**6.4**
541	13	HE 140 A				L=3.006							
			Nx	min	Co #1	0	(528)	**−1.9**	0.1	−0.4	0	0	0
				max	Co #17	0	(528)	**12.5**	−0.3	−16.5	−0.3	0	0
			Tx	min	Co #17	0	(528)	12.5	−0.3	−16.5	**−0.3**	0	0
				max	Co #17	1.503	(186)	11.0	0.3	16.1	**0.3**	−24.5	0.5
			My	min	Co #16	1.503	(186)	11.6	0.3	−16.1	0.3	**−24.5**	−0.5
				max	Co #10	0	(528)	2.6	−0.1	−0.4	0	**0**	0
			Mz	min	Co #16	1.503	(186)	11.6	0.3	−16.1	0.3	−24.5	**−0.5**
				max	Co #17	1.503	(186)	12.5	−0.3	−16.1	−0.3	−24.5	**0.5**
542	13	HE 140 A				L=2.252							
			Nx	min	Co #11	1.126	(312)	**0.2**	0	0	0	−0.2	0
				max	Co #17	0	(538)	**12.2**	−0.7	−16.4	−0.3	0	0
			Tx	min	Co #17	0	(538)	12.2	−0.7	−16.4	**−0.3**	0	0
				max	Co #17	1.126	(312)	12.2	0.7	16.2	**0.3**	−18.3	0.7
			My	min	Co #16	1.126	(312)	12.0	0.2	−16.2	0.3	**−18.3**	−0.2
				max	Co #16	0	(538)	12.0	0.2	−16.4	0.3	**0**	0
			Mz	min	Co #16	1.126	(312)	12.0	0.2	−16.2	0.3	−18.3	**−0.2**
				max	Co #17	1.126	(312)	12.2	−0.7	−16.2	−0.3	−18.3	**0.7**
543	13	HE 140 A				L=1.960							
			Nx	min	Co #12	0.980	(445)	**−0.5**	0	0.1	0	−0.2	0
				max	Co #17	0	(564)	**13.4**	−0.3	−16.4	−0.3	0	0
			Tx	min	Co #16	0.980	(445)	13.3	−0.5	16.1	**−0.3**	−15.9	−0.5
				max	Co #16	0	(564)	13.3	0.5	−16.4	**0.3**	0	0
			My	min	Co #16	0.980	(445)	13.3	0.5	−16.1	0.3	**−15.9**	−0.5
				max	Co #15	0	(564)	1.7	0.1	−0.3	0	**0**	0
			Mz	min	Co #16	0.980	(445)	13.3	0.5	−16.1	0.3	−15.9	**−0.5**
				max	Co #17	0.980	(445)	13.4	−0.3	−16.1	−0.3	−15.9	**0.3**
544	7	HE 200 B				L=0.110							
			Nx	min	Co #9	0	(8)	**0**	0	0	0	0	0
				max	Co #3	0.110	(534)	**84.5**	0	38.8	0	8.6	0
			Tx	min	Co #13	0	(8)	28.5	−26.3	3.2	**−3.4**	0.5	1.4
				max	Co #10	0	(8)	23.5	−52.5	−39.0	**7.0**	−1.1	2.9
			My	min	Co #6	0.110	(534)	54.9	0	−52.7	0	**−5.8**	0
				max	Co #1	0.110	(534)	65.5	0	58.2	0	**10.8**	0
			Mz	min	Co #6	0.110	(534)	54.9	0	−52.7	0	−5.8	**0**
				max	Co #10	0.110	(534)	23.6	−52.5	−39.0	7.0	−5.4	**8.7**
545	15	HE 180 B				L=1.273							
			Nx	min	Co #6	1.253	(642)	**−21.2**	5.9	17.2	0.9	−4.0	−1.1

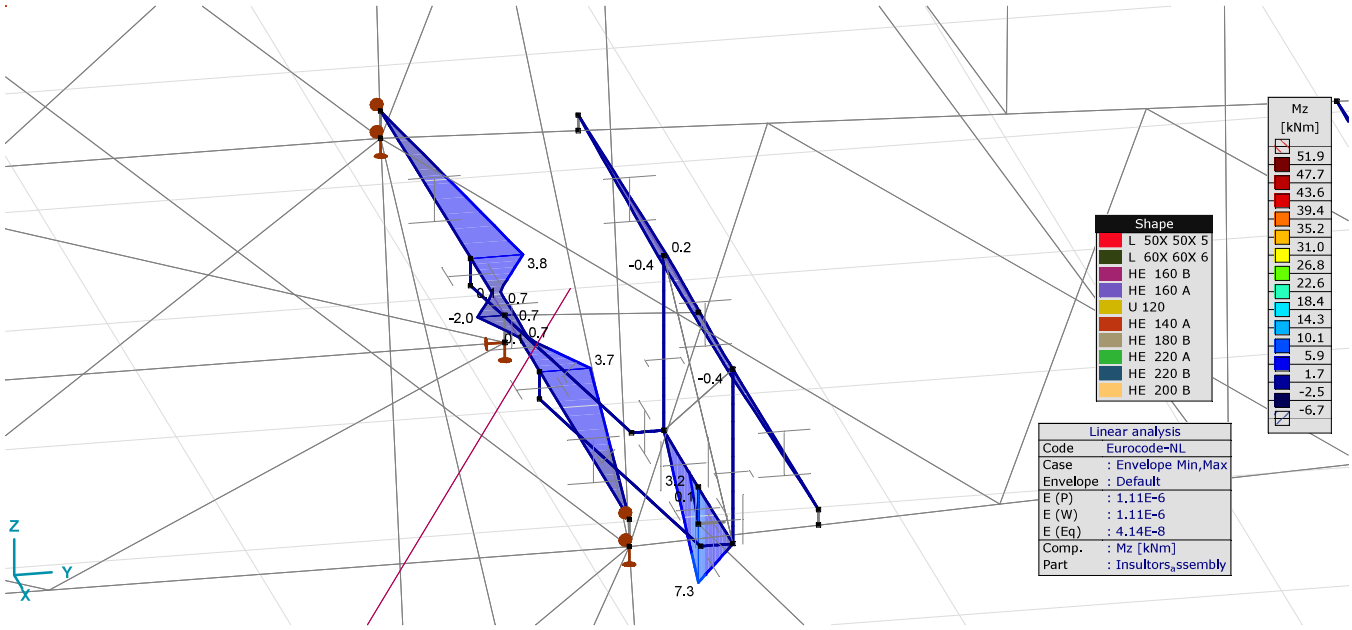
Beam internal forces [Linear, Envelope (Default), Insultors_assembly]

	Sh.	Cross-section name	C	min. max.	Case	Loc. [m]	Node	Nx [kN]	Vy [kN]	Vz [kN]	Tx [kNm]	My [kNm]	Mz [kNm]
				max	Co #14	0	(544)	**14.5**	4.3	−15.5	1.7	15.2	6.3
			Tx	min	Co #1	0	(544)	2.6	0	0	**0**	−0.1	0.6
				max	Co #8	0	(544)	−3.4	14.3	−15.0	**2.1**	15.2	17.8
			My	min	Co #14	1.253	(642)	1.3	−2.3	10.1	0.7	**−4.8**	0
				max	Co #8	0	(544)	−3.4	14.3	−15.0	2.1	**15.2**	17.8
			Mz	min	Co #6	1.273	(644)	−21.2	5.9	17.2	0.9	−3.6	**−1.3**
				max	Co #8	0	(544)	−3.4	14.3	−15.0	2.1	15.2	**17.8**
546	13	HE 140 A				L=1.716							
			Nx	min	Co #6	0.858	(523)	**−2.8**	0	0	0	−0.1	0
				max	Co #1	0.858	(523)	**5.4**	0	0	0	−0.1	0
			Tx	min	Co #17	0	(152)	0.5	−5.6	−31.1	**−0.6**	0	0
				max	Co #17	0.858	(523)	0.5	5.6	30.9	**0.6**	−26.6	4.8
			My	min	Co #17	0.858	(523)	0.5	−5.6	−30.9	−0.6	**−26.6**	4.8
				max	Co #10	0	(152)	−1.9	0	−0.2	−0.3	**0**	0
			Mz	min	Co #16	0.858	(523)	−0.4	5.6	−30.9	0.6	−26.6	**−4.8**
				max	Co #17	0.858	(523)	0.5	5.6	30.9	0.6	−26.6	**4.8**
547	13	HE 140 A				L=1.458							
			Nx	min	Co #6	0.729	(521)	**−0.1**	0	0	0	−0.1	0
				max	Co #7	0	(276)	**6.3**	0	0.1	0	0	0
			Tx	min	Co #17	0	(276)	0.9	−5.1	−31.1	**−0.5**	0	0
				max	Co #17	0.729	(521)	0.9	5.1	31.0	**0.5**	−22.6	3.7
			My	min	Co #17	0.729	(521)	0.9	−5.1	−31.0	−0.5	**−22.6**	3.7
				max	Co #7	0.729	(521)	6.3	0	0.3	0	**0.2**	0
			Mz	min	Co #16	0.729	(521)	0.2	5.1	−30.9	0.5	−22.6	**−3.7**
				max	Co #17	0.729	(521)	0.9	5.1	31.0	0.5	−22.6	**3.7**
548	13	HE 140 A				L=1.366							
			Nx	min	Co #2	0.683	(351)	**0.2**	0	0.1	0	−0.1	0
				max	Co #7	0.683	(351)	**8.1**	0	0.8	0	−0.6	0
			Tx	min	Co #17	0	(396)	1.1	−4.3	−30.9	**−0.5**	0	0
				max	Co #17	0.683	(351)	1.0	4.3	30.7	**0.5**	−21.0	2.9
			My	min	Co #17	0.683	(351)	1.1	−4.3	−30.7	−0.5	**−21.0**	2.9
				max	Co #12	0.683	(351)	0.5	0	0.2	0	**0.1**	0
			Mz	min	Co #16	0.683	(351)	0.7	4.3	−30.7	0.5	−21.0	**−2.9**
				max	Co #17	0.683	(351)	1.0	4.3	30.7	0.5	−21.0	**2.9**

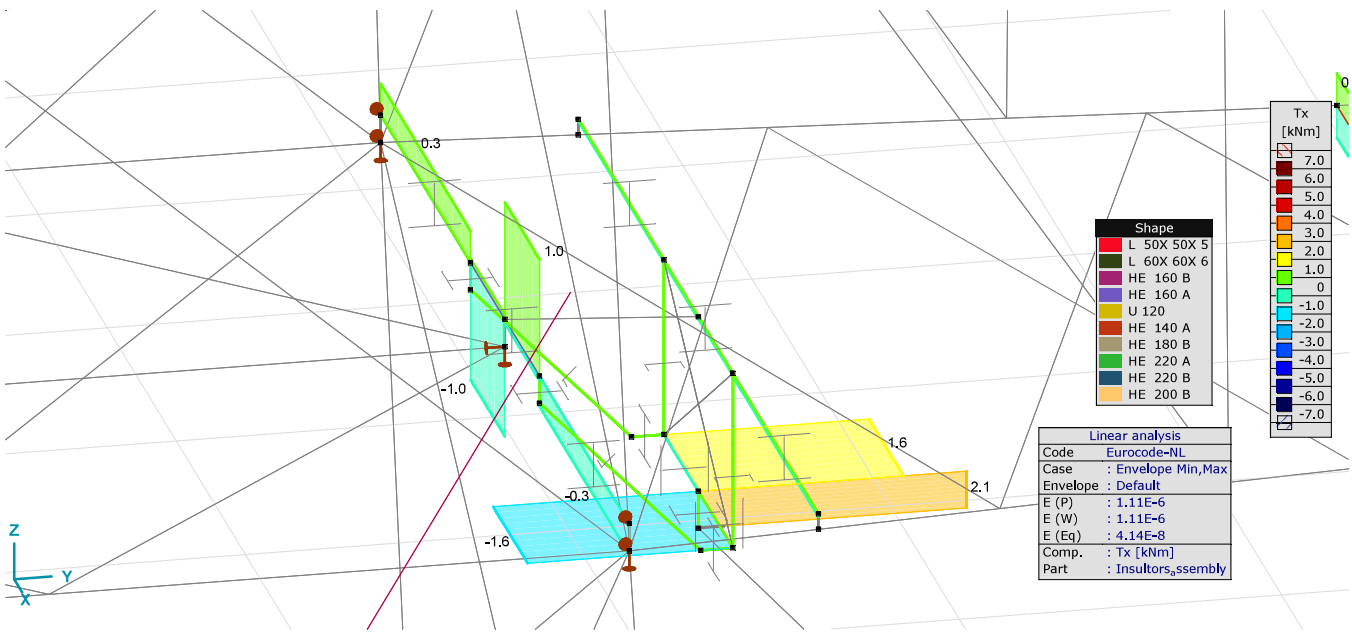
Sh.: Cross-section; **C:** Extremal component; **min. max.:** Extreme type; **Case:** Load case of extreme; **Loc.:** Cross-section local x position on the beam; **Nx:** Axial force; **Vy:** Shear force in local y direction; **Vz:** Shear force in local z direction; **Tx:** Torsional moment; **My:**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



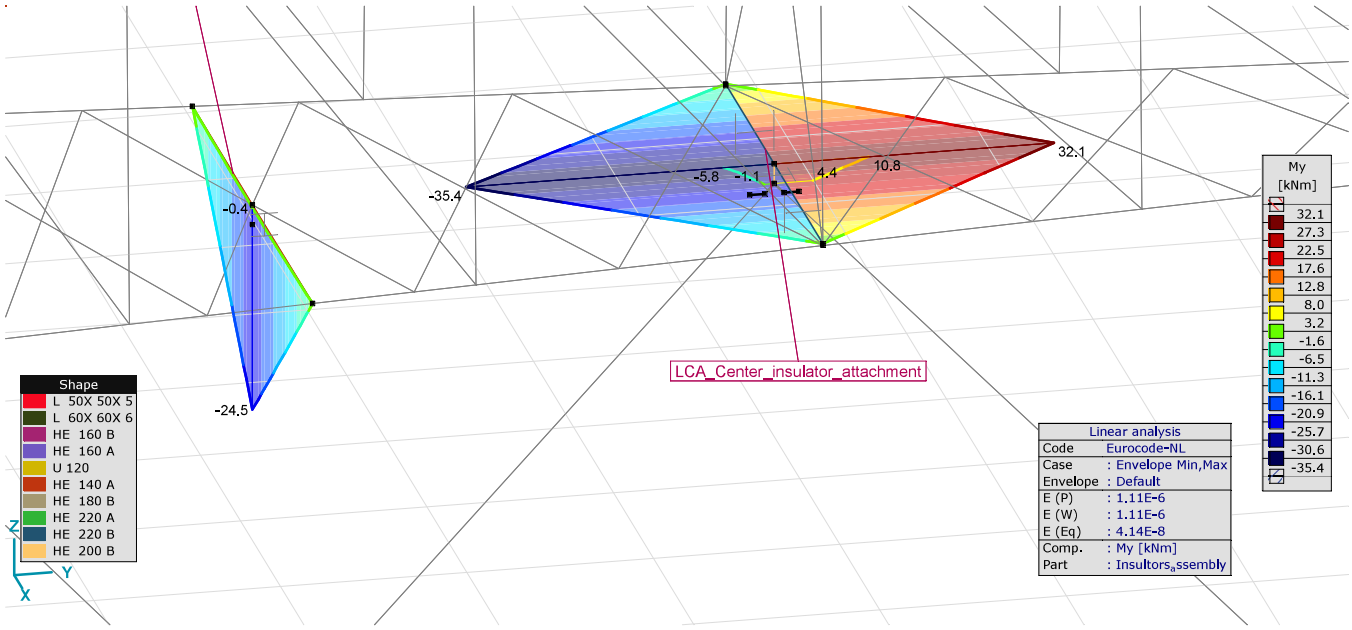
BCA_150KV_left_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



BCA_150KV_left_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram

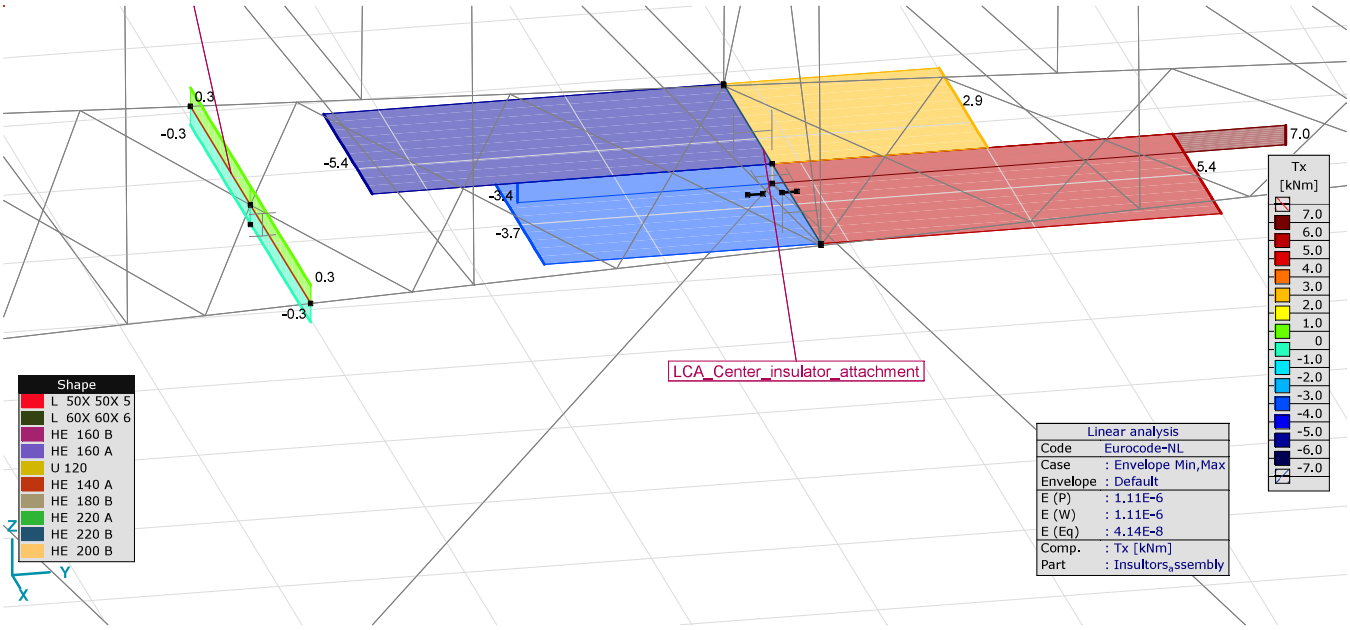


BCA_150KV_left_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram

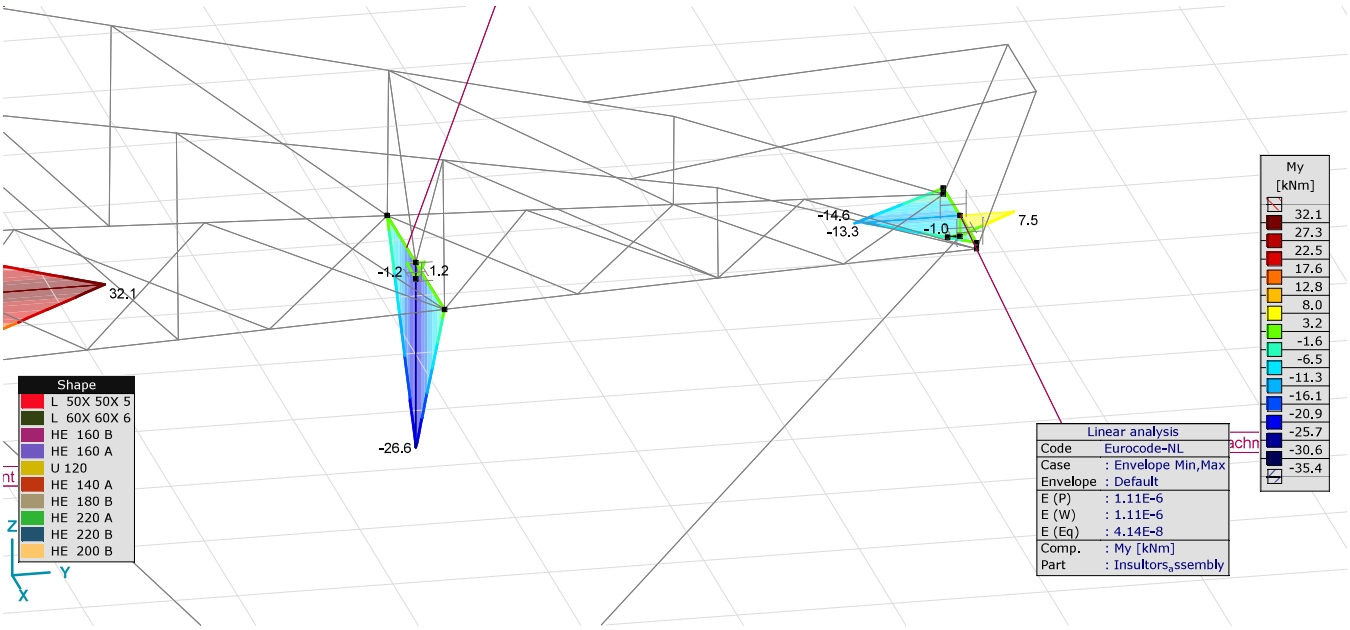


BCA_Center_insulator_attachment_Linear, Envelope (Default), My [kNm], Filled diagram

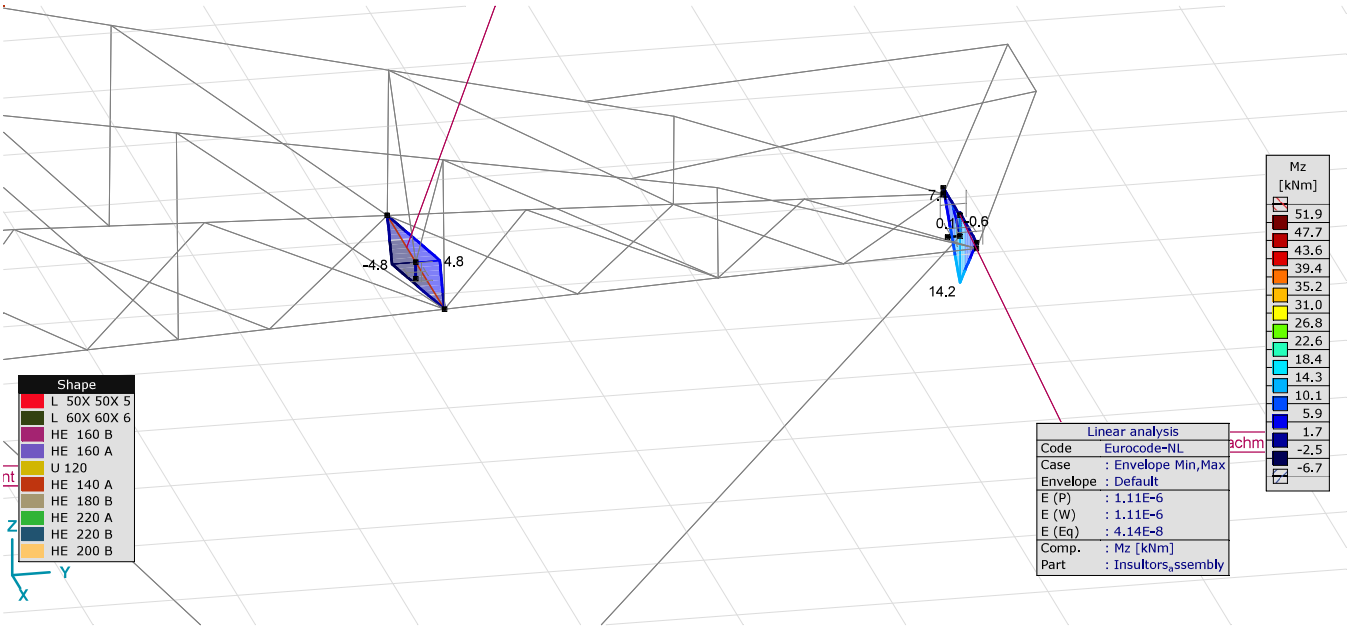
BCA_Center_insulator_attachment_Linear, Envelope (Default), Mz [kNm], Filled diagram



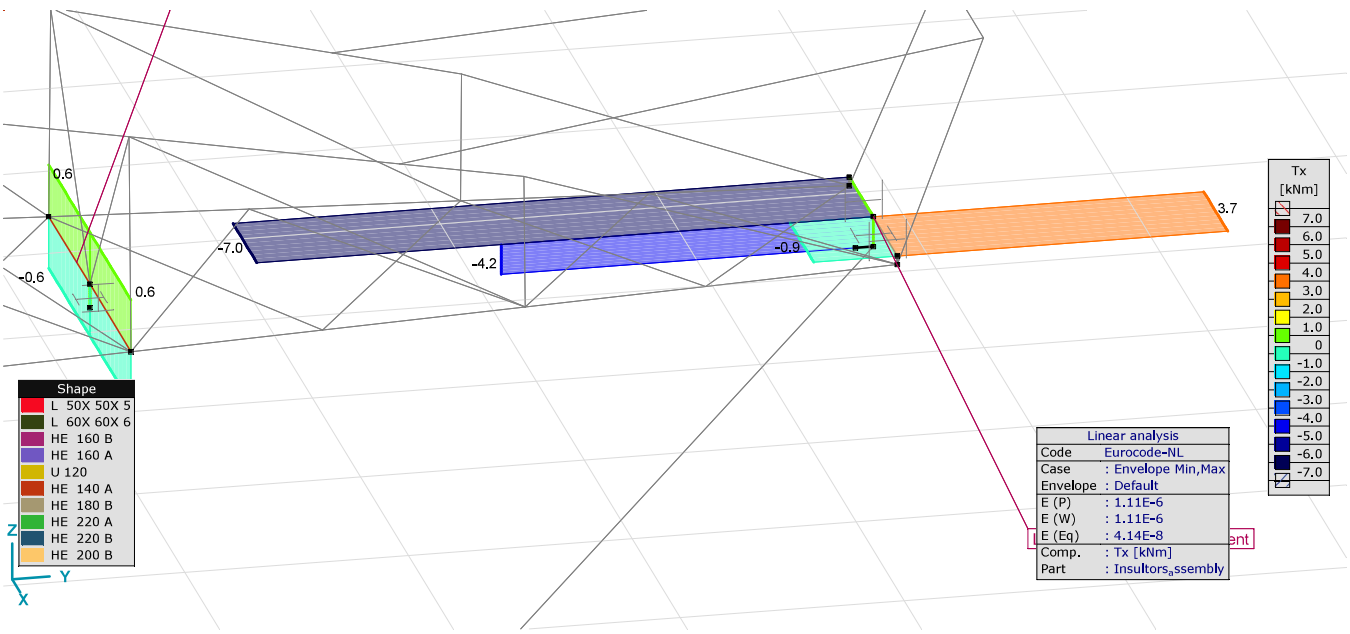
BCA_Center_insulator_attachment_Linear, Envelope (Default), Tx [kNm], Filled diagram



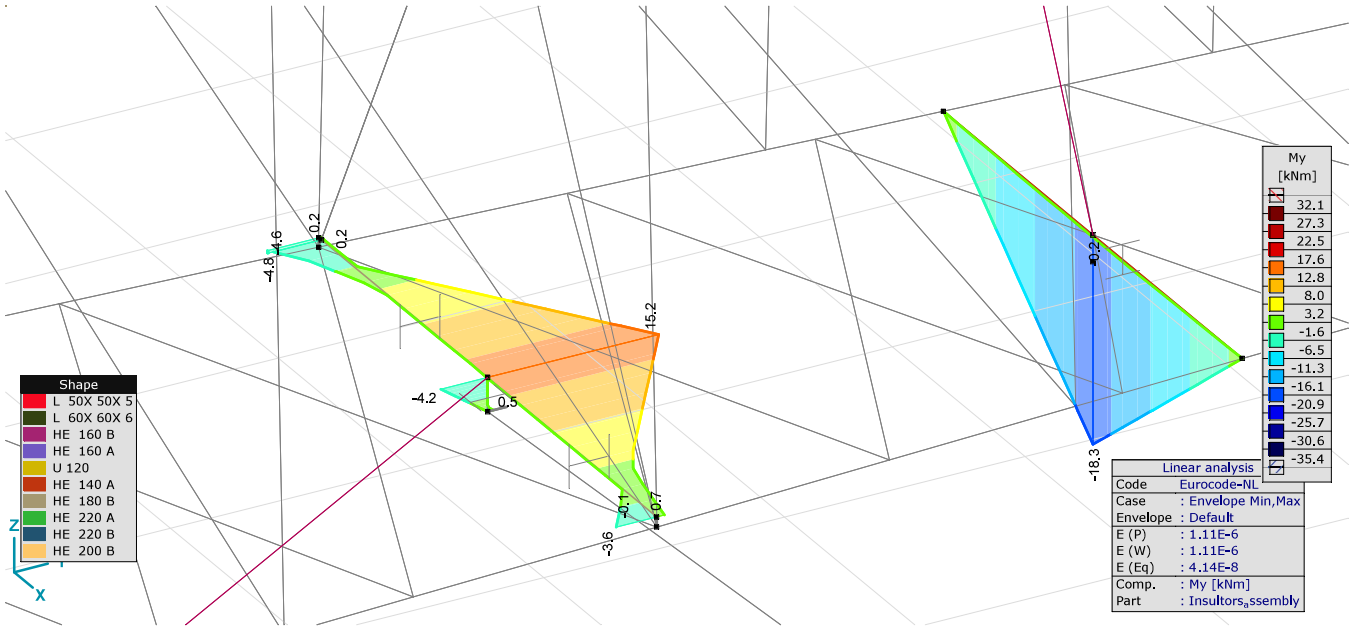
BCA_380KV_right_attachment_Linear, Envelope (Default), My [kNm], Filled diagram



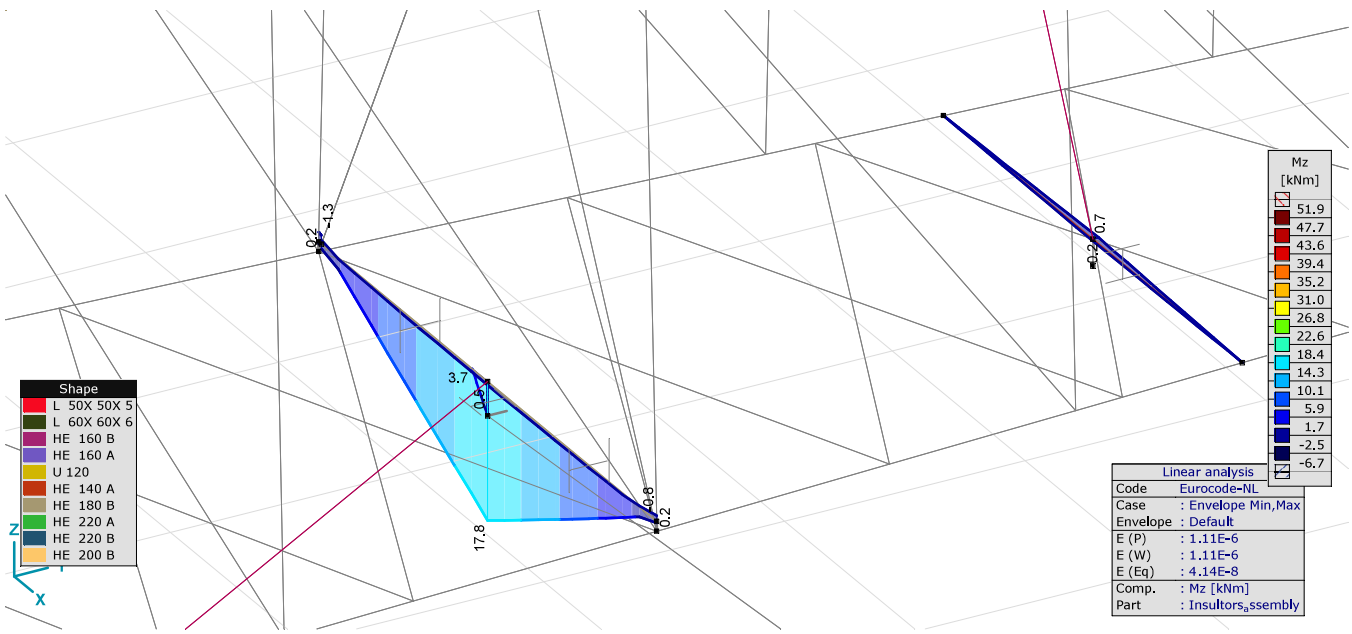
BCA_380KV_right_attachment_Linear, Envelope (Default), Mz [kNm], Filled diagram



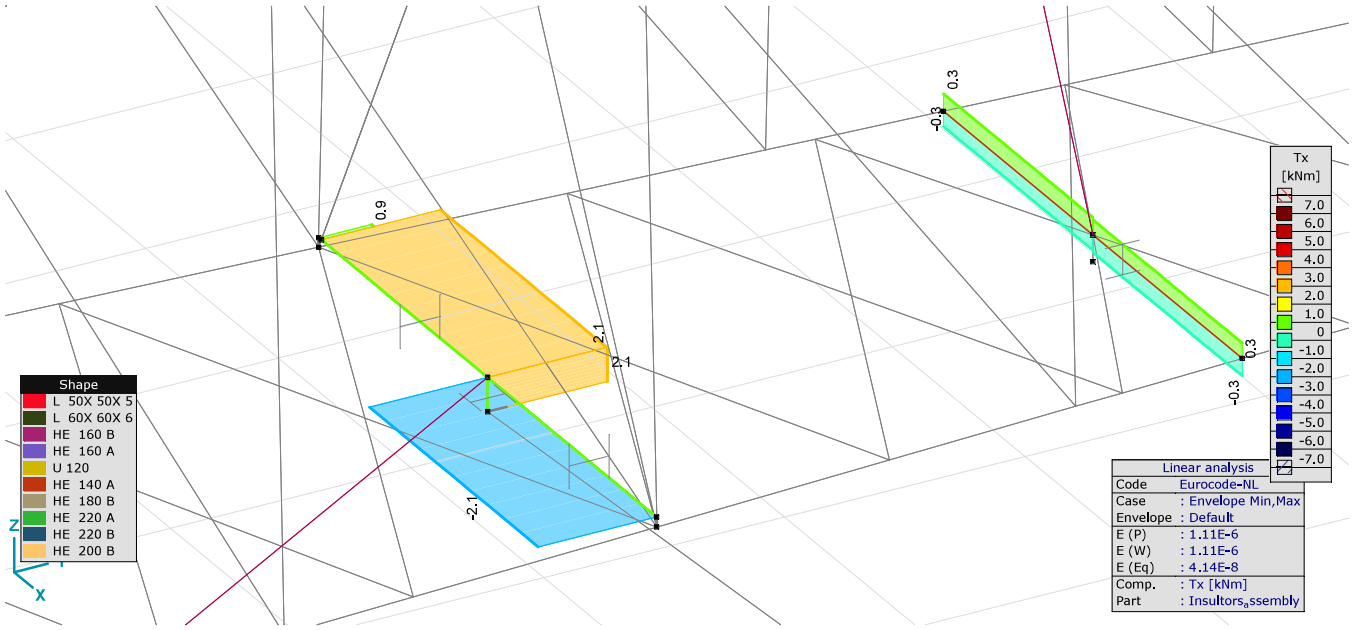
BCA_380KV_right_attachment_LLinear, Envelope (Default), Tx [kNm], Filled diagram



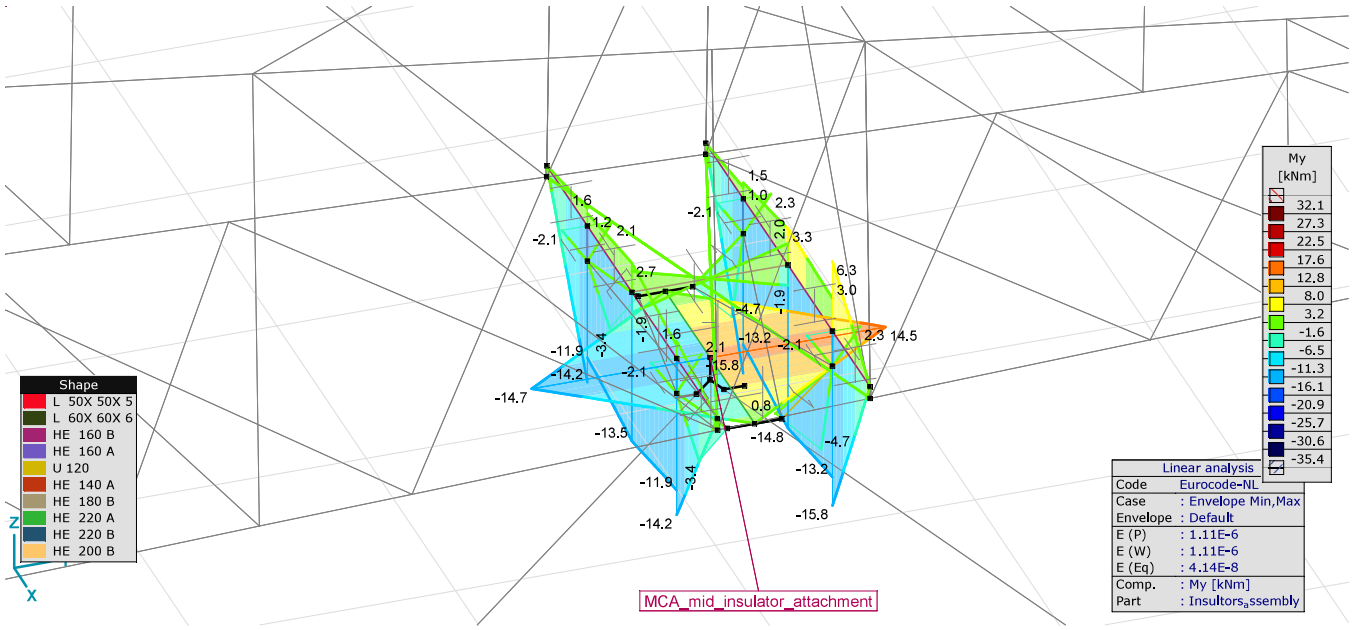
MCA_150_KV_left_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



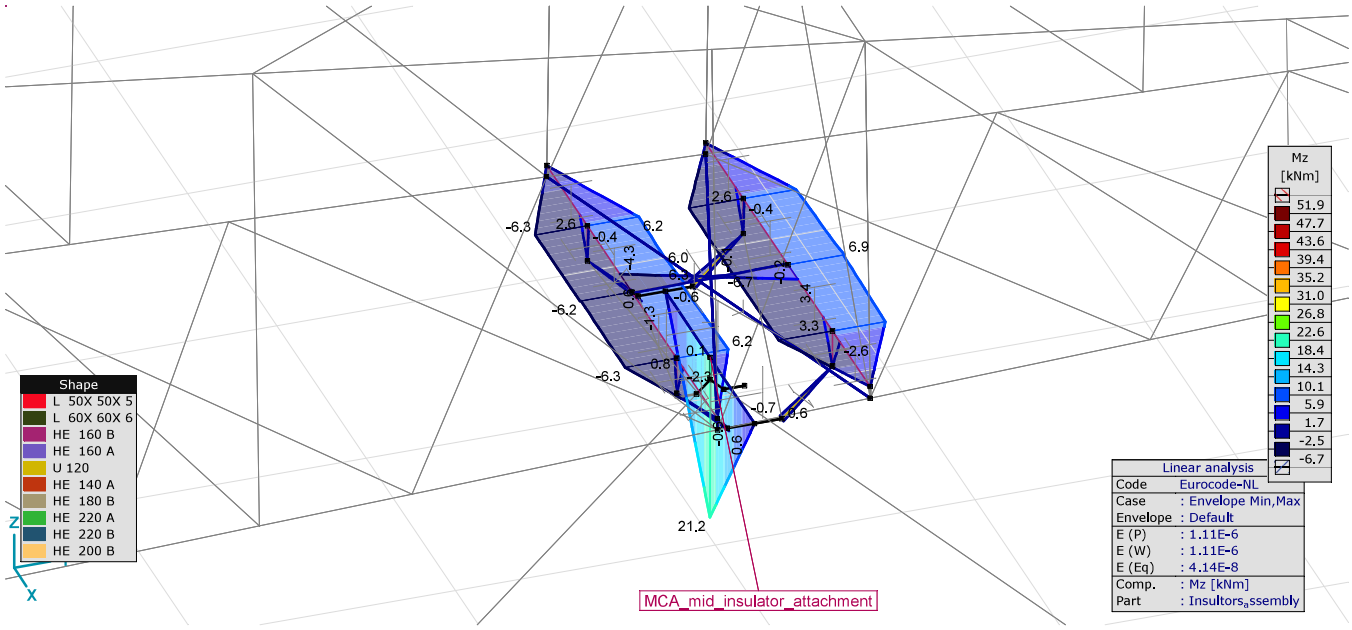
MCA_150_KV_left_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram



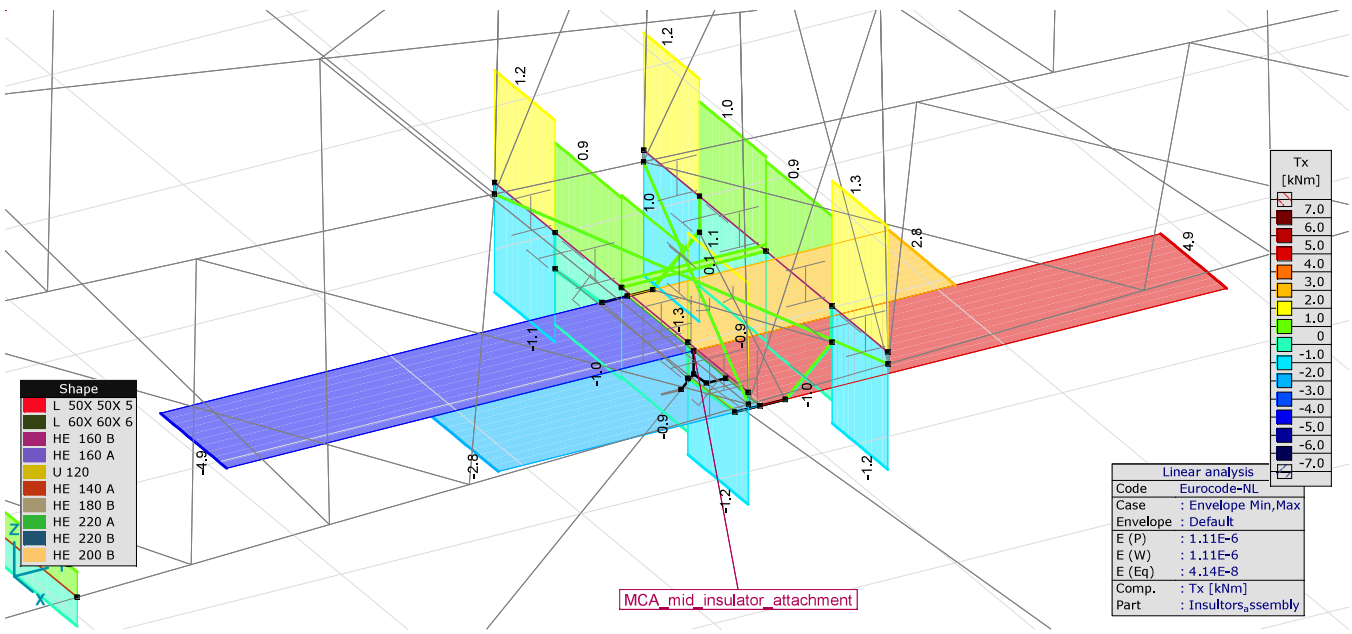
MCA_150_KV_left_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram



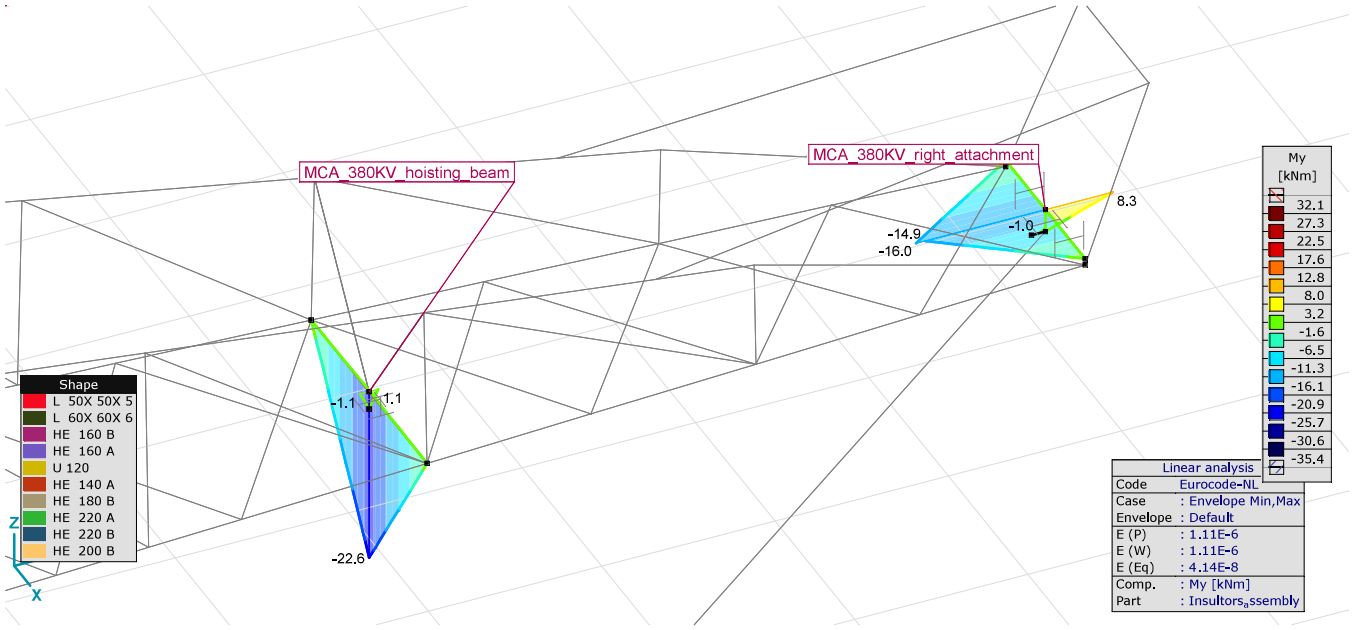
MCA_mid_insulator_attachment_ Linear, Envelope (Default), My [kNm], Filled diagram



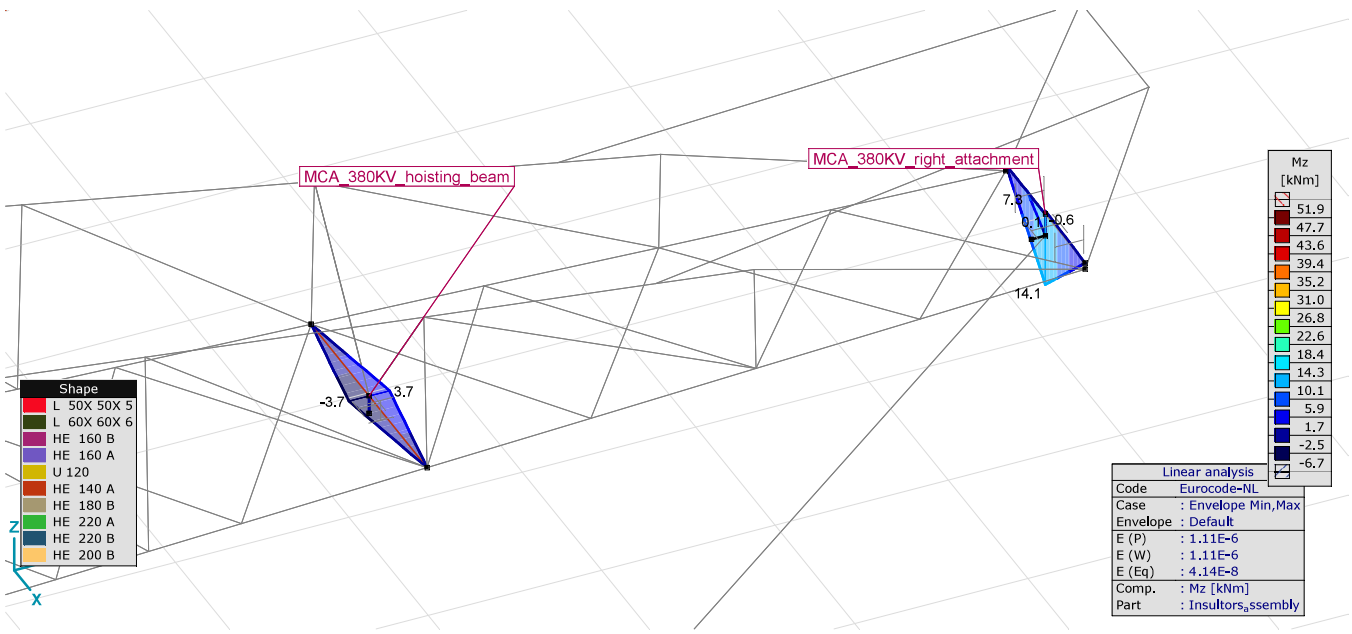
MCA_mid_insulator_attachment_Linear, Envelope (Default), Mz [kNm], Filled diagram



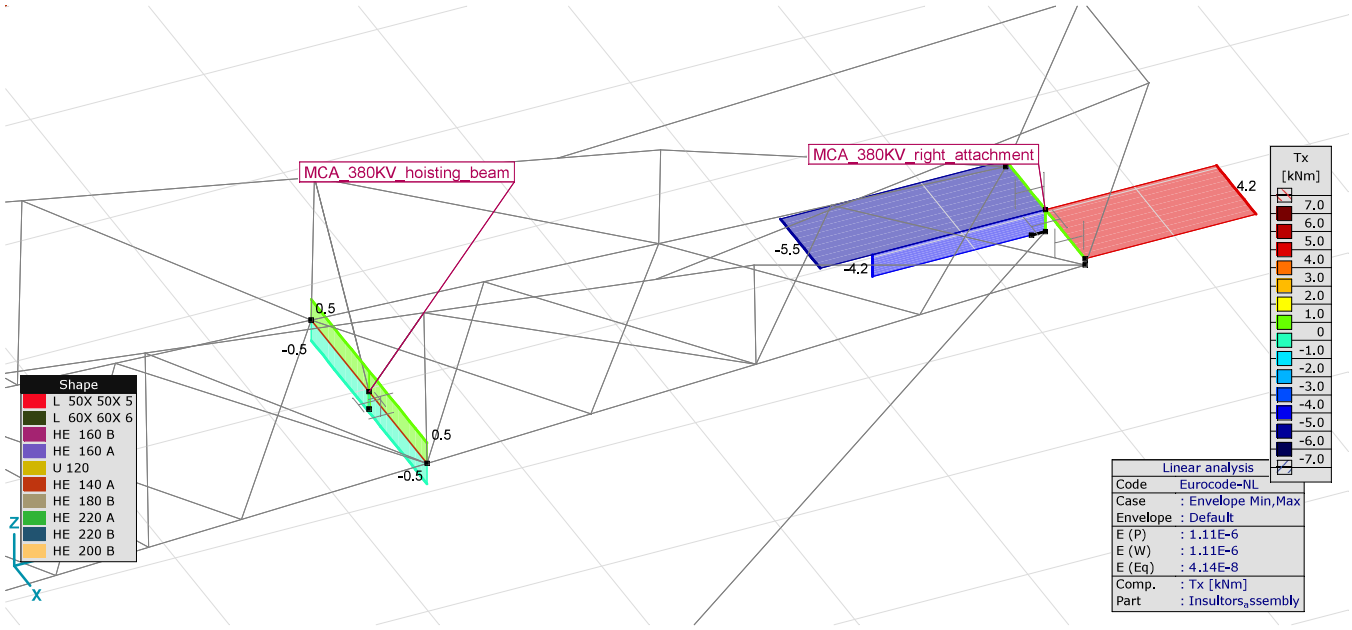
MCA_mid_insulator_attachment_Linear, Envelope (Default), Tx [kNm], Filled diagram



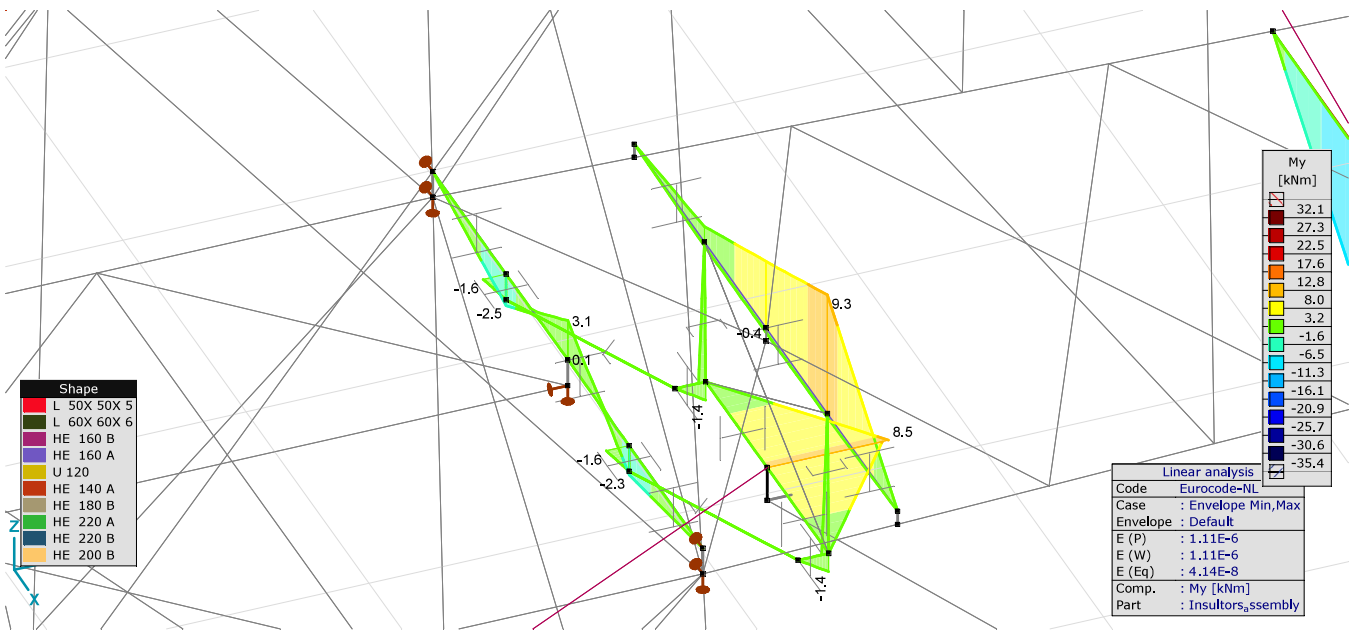
MCA_380KV_right_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



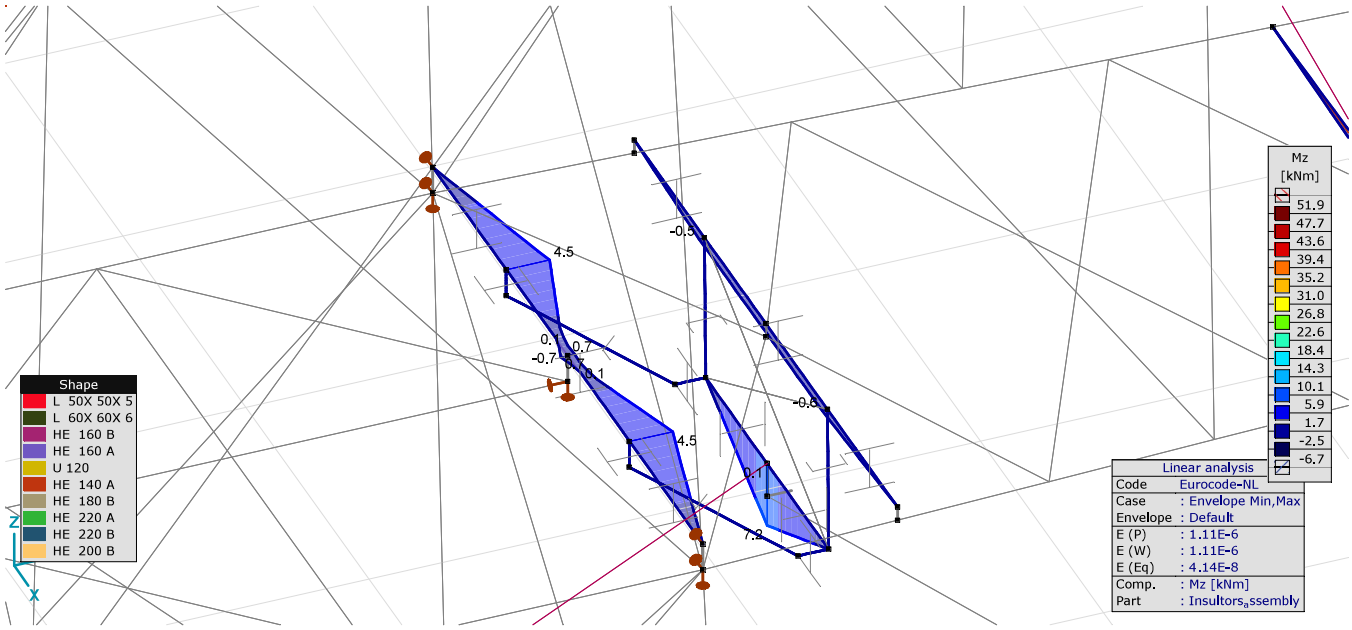
MCA_380KV_right_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram



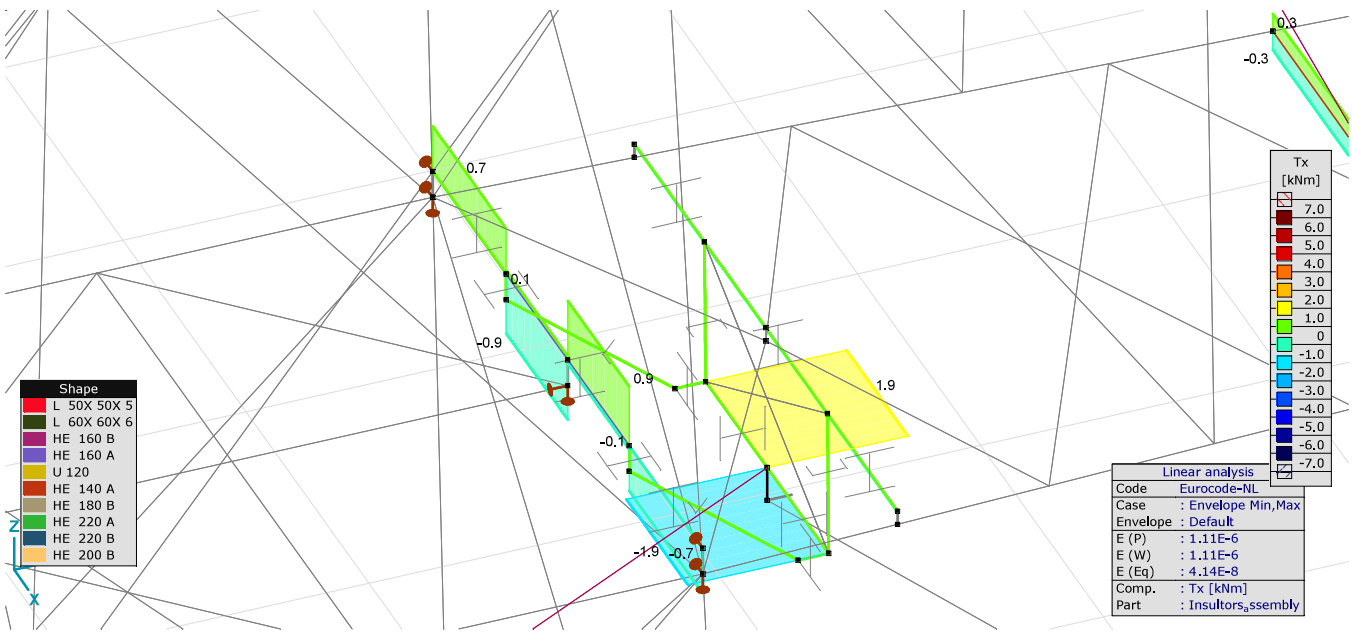
MCA_380KV_right_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram



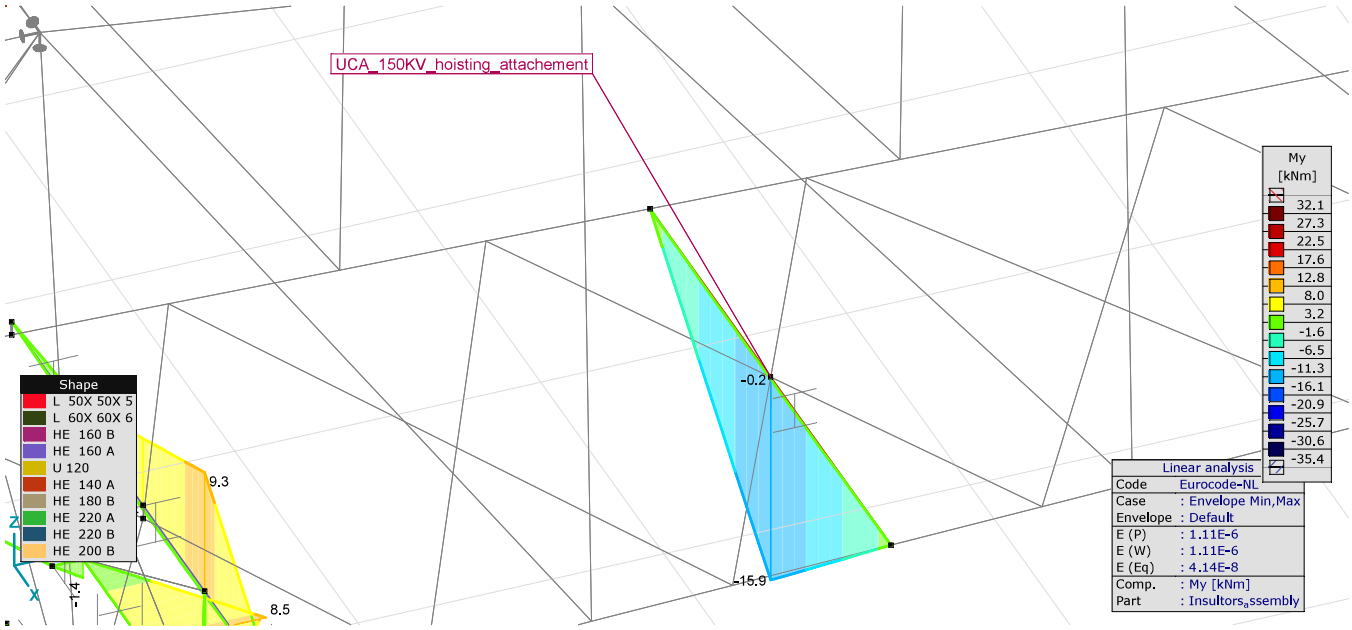
UCA_150KV_left_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



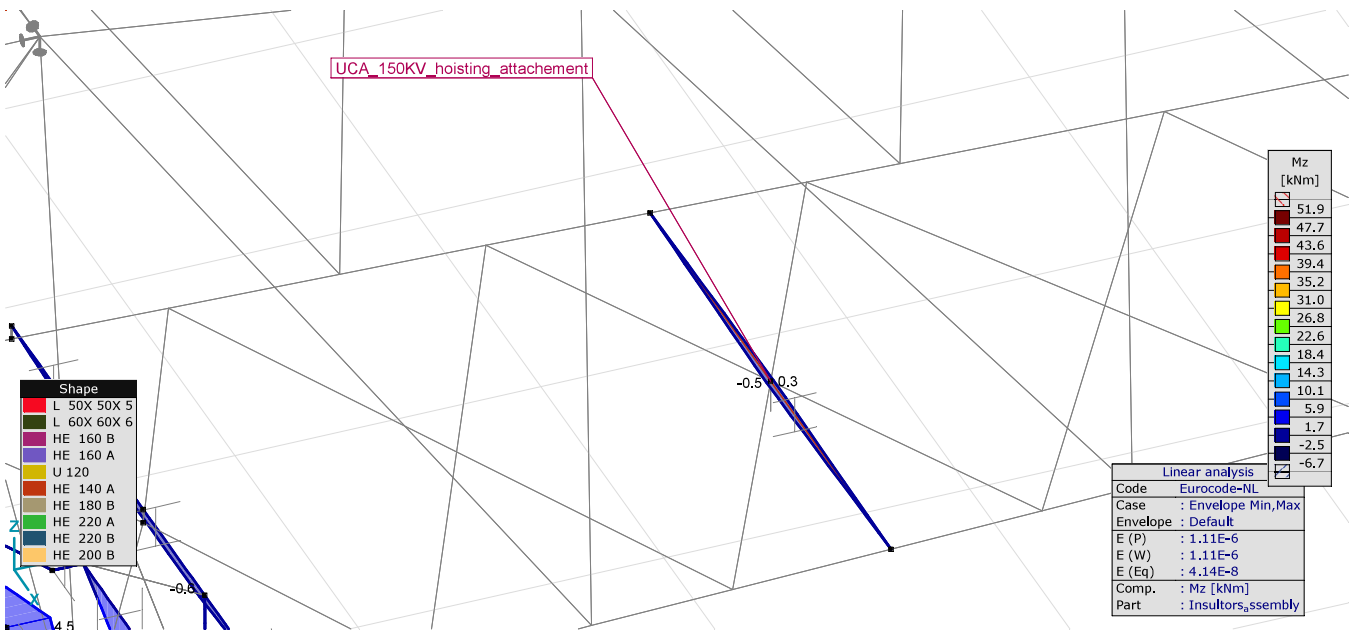
UCA_150KV_left_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram



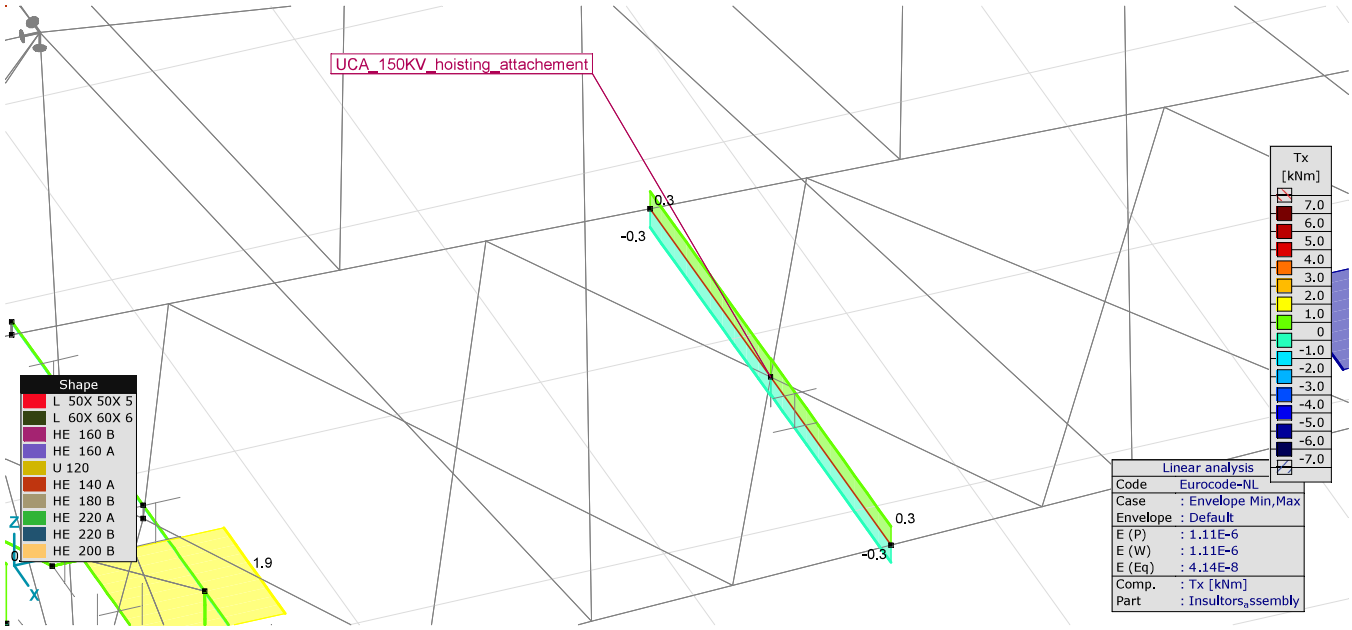
UCA_150KV_left_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram



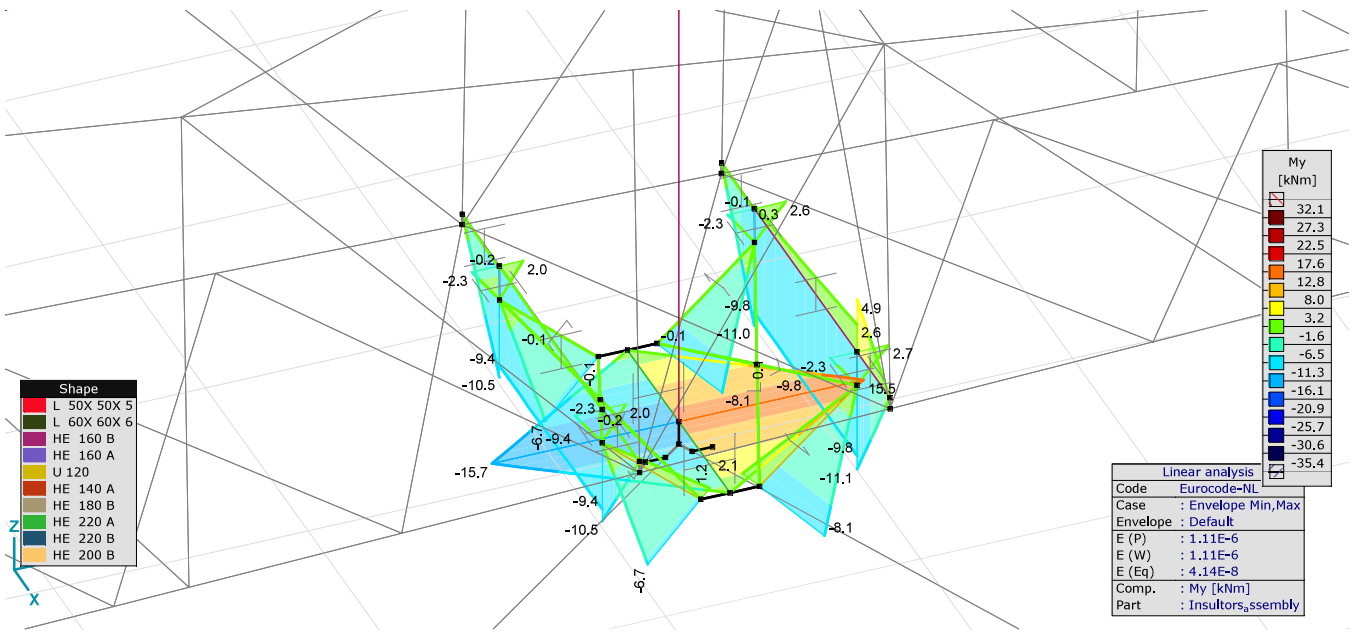
UCA_150KV_hoisting_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



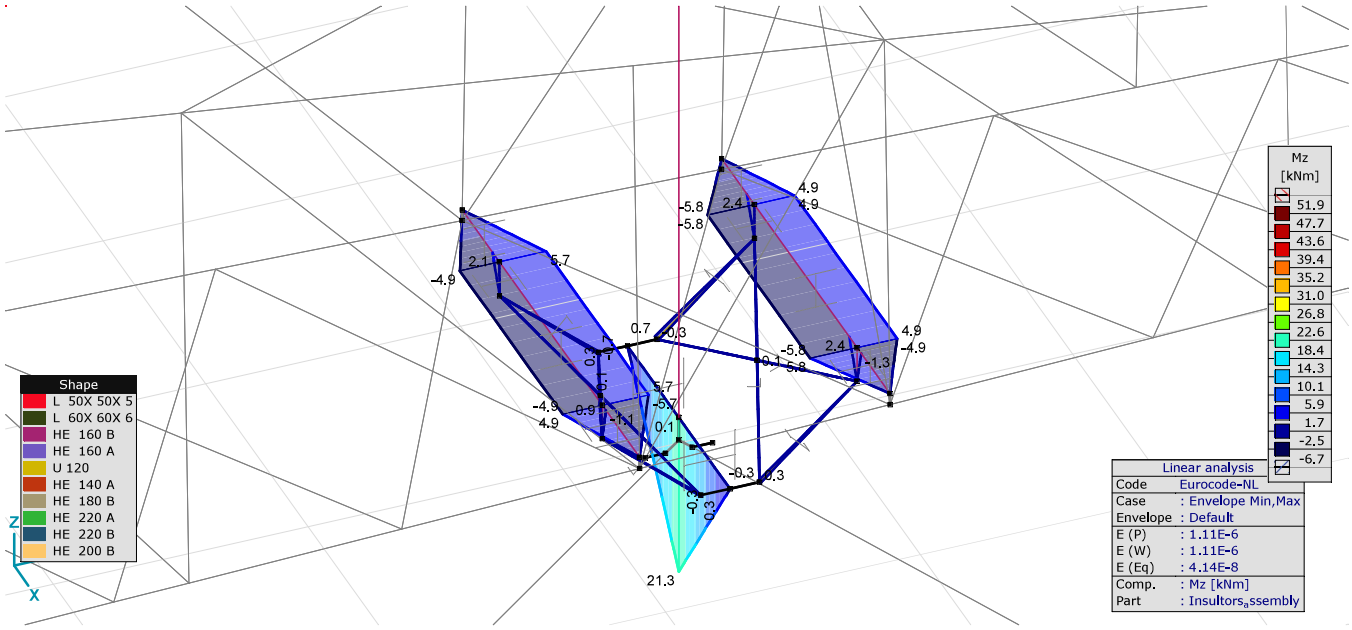
UCA_150KV_hoisting_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram



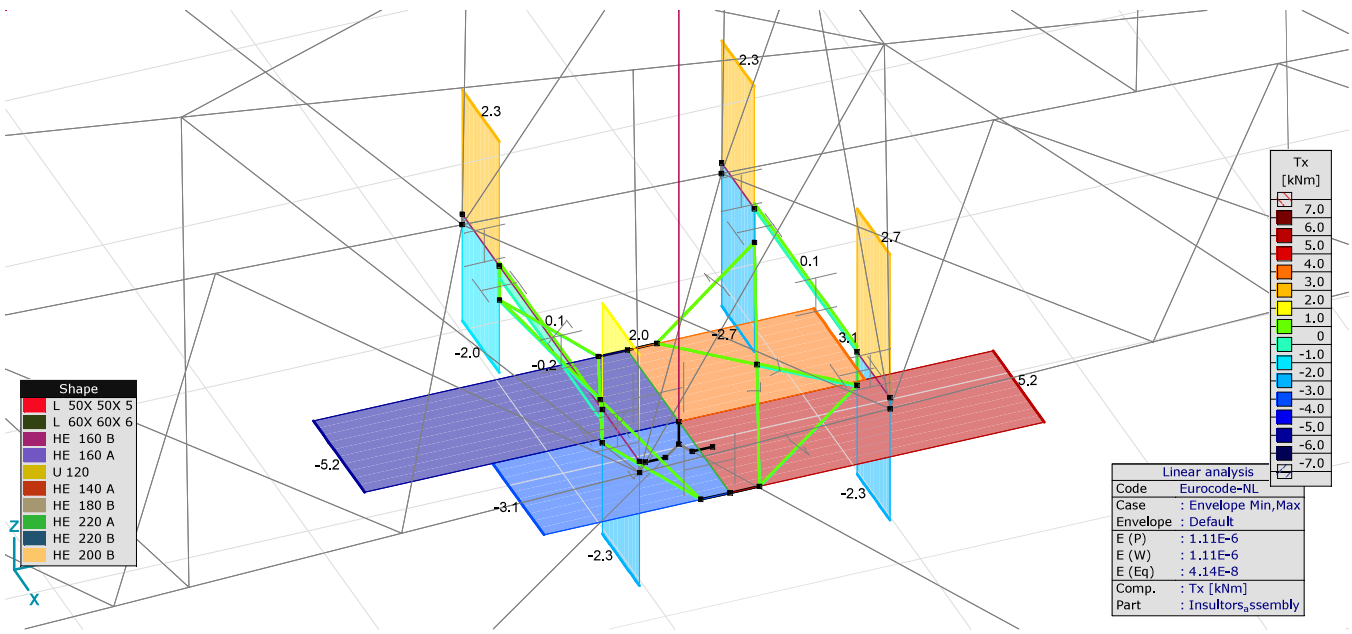
UCA_150KV_hoisting_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram



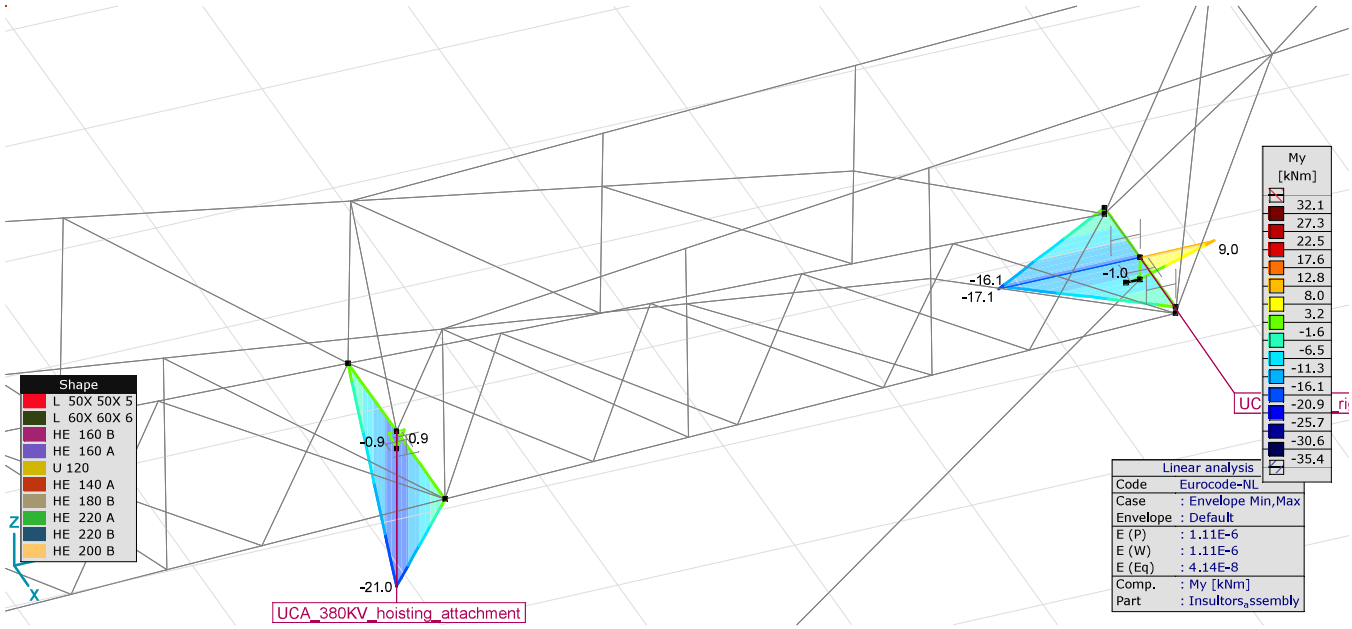
UCA_mid_insulator_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



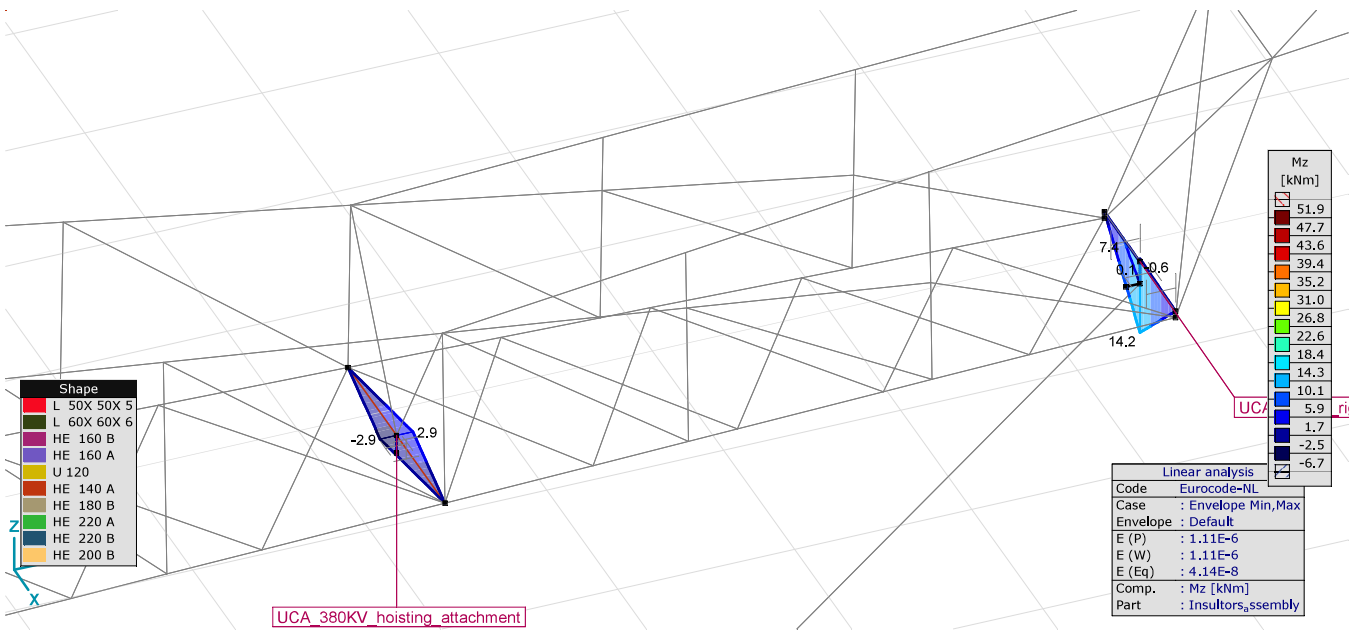
UCA_mid_insulator_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram



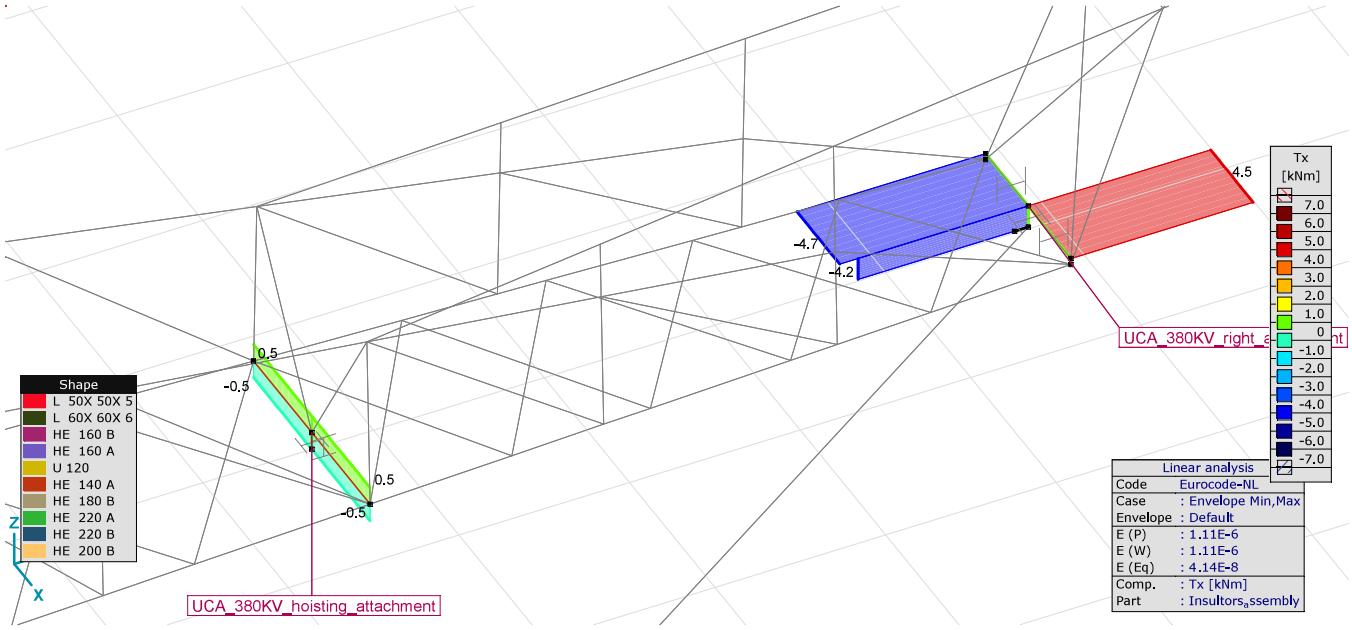
UCA_mid_insulator_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram



UCA_380KV_right_attachement_Linear, Envelope (Default), My [kNm], Filled diagram



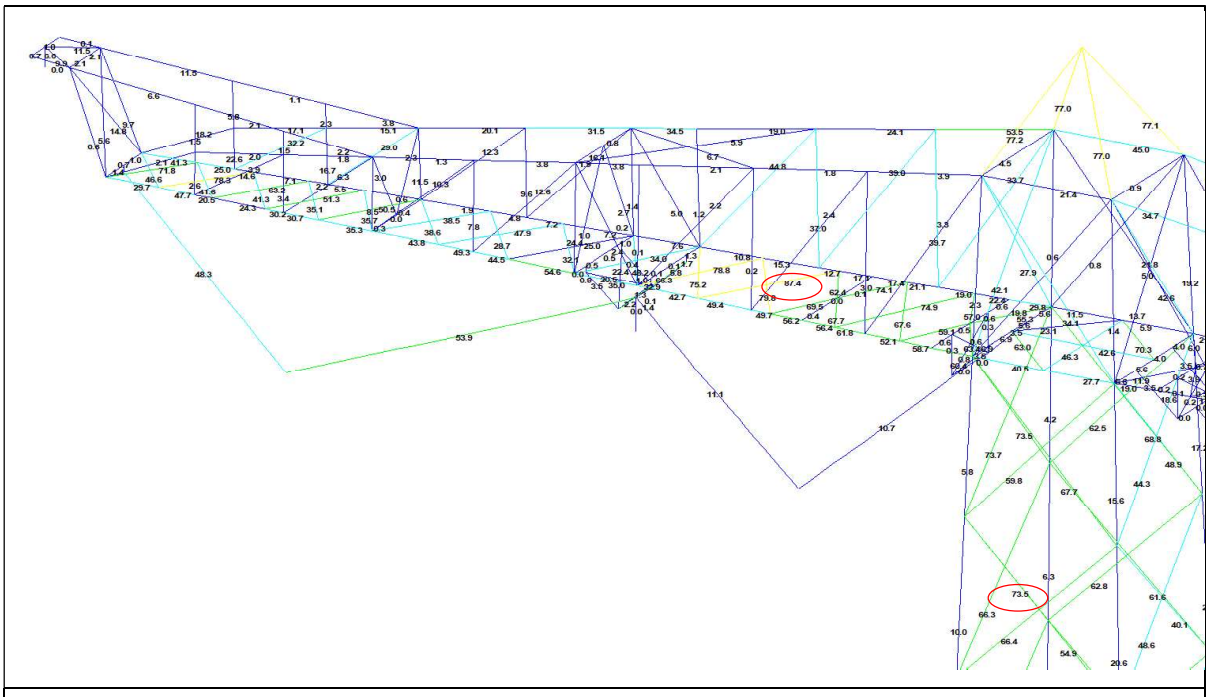
UCA_380KV_right_attachement_Linear, Envelope (Default), Mz [kNm], Filled diagram



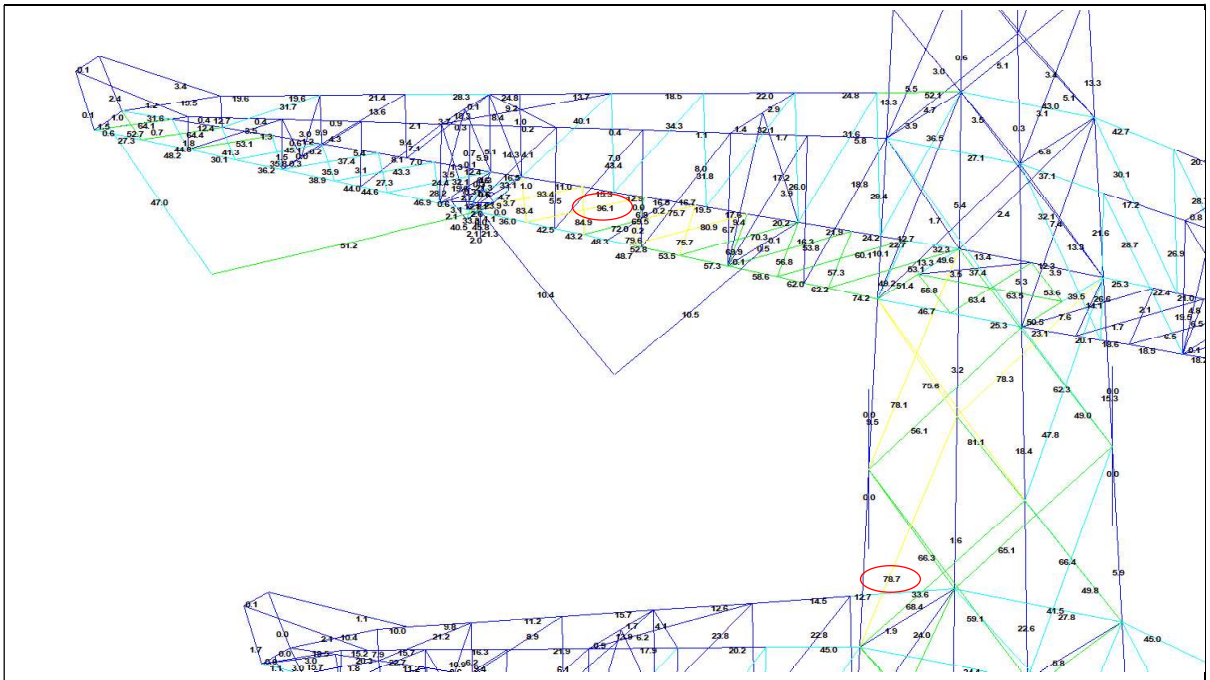
UCA_380KV_right_attachement_Linear, Envelope (Default), Tx [kNm], Filled diagram

APPENDIX F
Sterkte-coördinatie

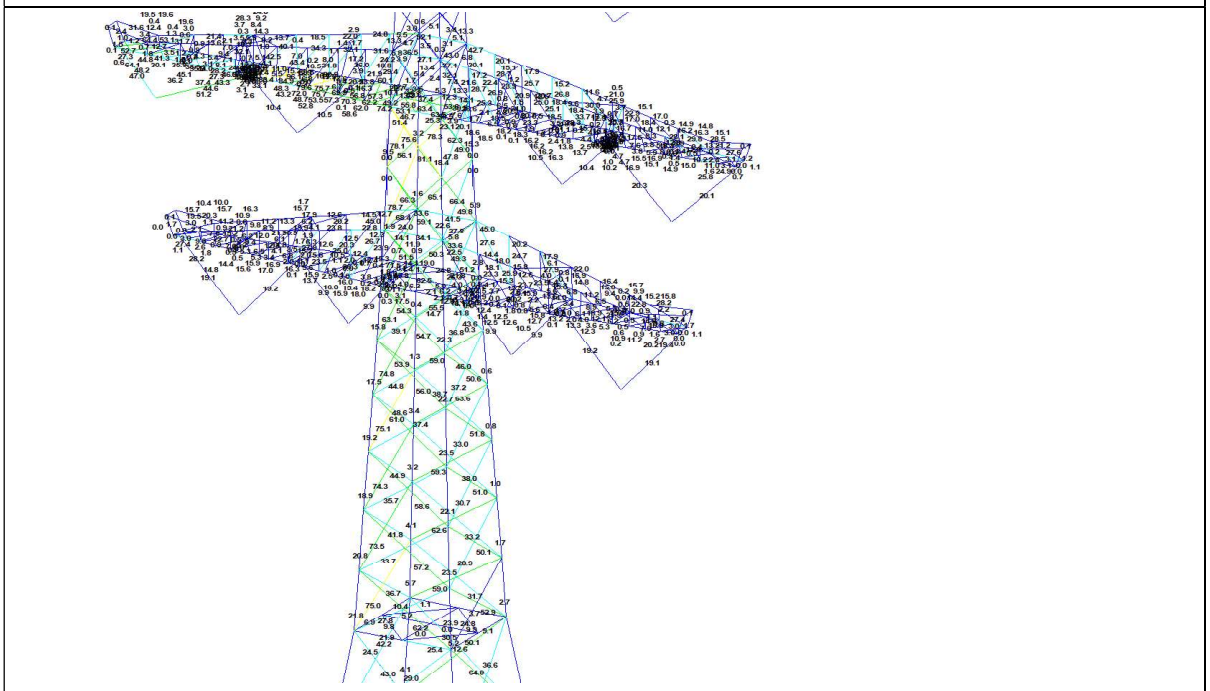
In 5.5.1 van het uitgangspuntenrapport is beschreven dat aan sterkte-coördinatie wordt voldaan als de U.C. van de staven in de traverse 10 procentpunt groter is dan de U.C. van de staven in het mastlichaam. Uitgangspunt is belastingcombinatie 5a, geleiderbreuk. In deze Appendix wordt getoetst of de U.C. van de staven in het mastlichaam voldoende laag is ten opzichte van de U.C. van de staven in de traverse.



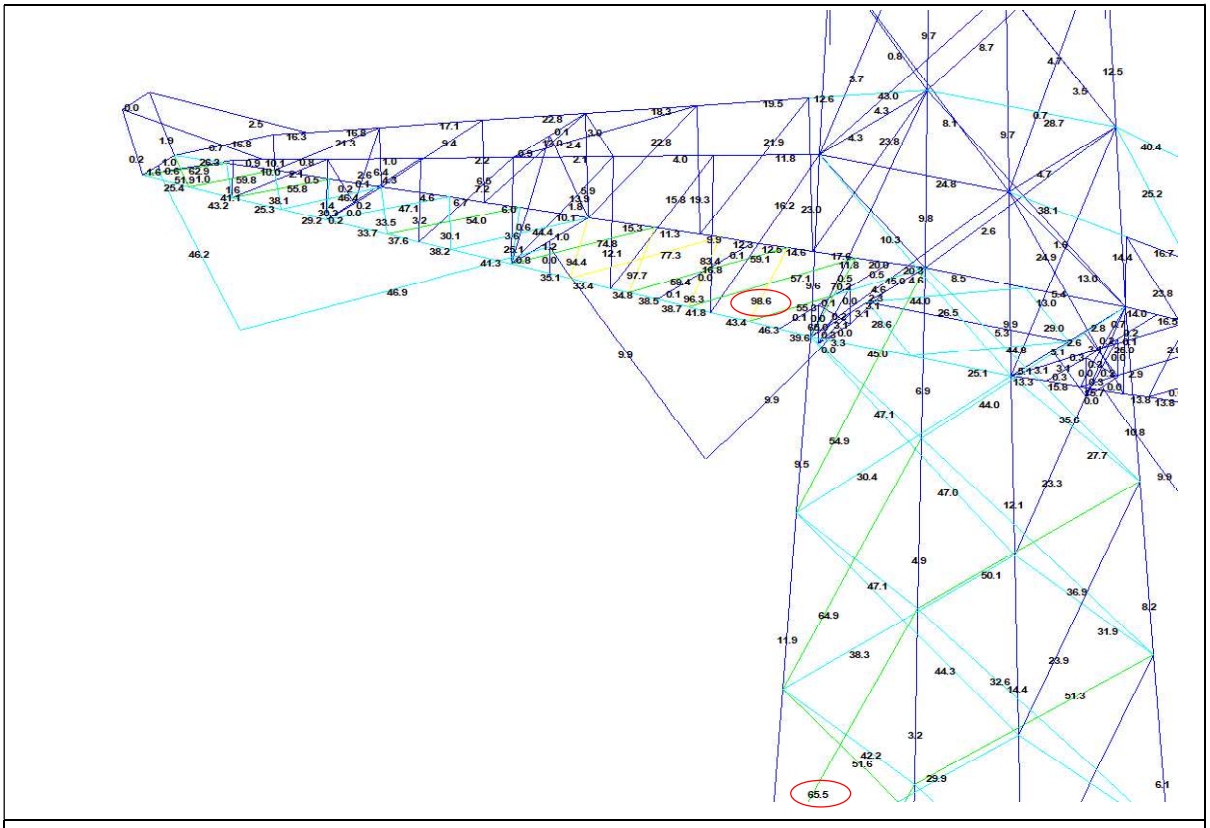
Boventraverse – diagonalen bovenstuk 2: 87,4 / 73,5 = 1,18 ≥ 1,10 OK.



Middentraverse – diagonalen bovenstuk 1: 96,1 / 78,7 = 1,22 ≥ 1,10 OK.



Middentraverse – diagonalen onderstuk: 96,1 / 75,0 = 1,28 ≥ 1,10 OK.



Ondertraverse: 98,6 / 65,5 = 1,22 ≥ 1,10 OK

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.

B.4 Mastrapportage hoekmasten

ZUID-WEST 380 KV OOST VERBINDINGEN

Mastrapport combi-hoekmast HC+0/c

TenneT TSO B.V.

Meridian doc.nr.: 002.678.00.0928553
Rapport nr.: 21-0817, Rev. 1
Datum: 2021-07-19

DATUM:	01-11-2021
STATUS TENNET:	DEFINITIEF
REVISIE TENNET:	1.0

Projectnaam:	Zuid-West 380 kV Oost Verbindingen	Energy Systems
Rapport titel:	Mastrapport combi-hoekmast HC+0/c	DNV Netherlands B.V.
Klant:	TenneT TSO B.V.,	Utrechtseweg 310-B50
Contactpersoon klant:	[redacted]	6812 AR Arnhem
Datum uitgave:	2021-07-19	
Project nr.:	10124719	
Organisatie unit:	TDT	Tel: 026 356 9111
Meridian doc.nr..:	002.678.00.0928553	Handelsregister Arnhem 09006404
Rapport nr.:	21-0817, Rev. 1	

[redacted]

Copyright © DNV 2021. All rights reserved. Unless otherwise agreed in writing: (i) This publication or parts thereof may not be copied, reproduced or transmitted in any form, or by any means, whether digitally or otherwise; (ii) The content of this publication shall be kept confidential by the customer; (iii) No third party may rely on its contents; and (iv) DNV undertakes no duty of care toward any third party. Reference to part of this publication which may lead to misinterpretation is prohibited.

DNV Distributie:

☒ Open

☐ Intern

☐ Commercieel vertrouwelijk

☐ Vertrouwelijk

☐ Geheim

*Specificatie distributie: --

Trefwoorden:

Rev.	Datum	Reden van uitgave	Auteur	Beoordelaar	Goedkeuder
0	2021-06-02	Eerste uitgave	[redacted]		
1	2021-07-19	Eerste uitgave			

Inhoudsopgave

1 INLEIDING 1

2 UITGANGSPUNTEN EN RANDVOORWAARDEN 2
2.1 Normen 2
2.2 TenneT-specificaties 2
2.3 Eisenverificatie 2
2.4 Ontwerprapporten 2
2.5 Materialen 2
2.6 Software 3

3 MASTONTWERP 4
3.1 Mastbeeld 4
3.2 Uitgangspunten berekening 5
3.3 Mastenlijst 5
3.4 Geleiderbelastingen 5
3.5 Reacties op de fundering 5
3.6 Modellering 6
3.7 Overige controles 6
3.8 Mastgewicht 6

4 TOETSING 7
4.1 Resultaat PLS-TOWER 7
4.2 Toetsing overige onderdelen 8

Appendix A Geleiderbelastingen
Appendix B Resultaten PLS
Appendix C Knikverkorters
Appendix D Blokdeuvels
Appendix E Liggers
Appendix F Sterkte-coördinatie
Appendix G Galloping

1 INLEIDING

In het basisontwerp van de vakwerkmasten voor de verbinding RLL-TLB380 in het project Zuid-West 380 kV-Oost zijn voor het vaststellen van de haalbaarheid constructieve berekeningen uitgevoerd aan de masten en fundaties. In de Definitief Ontwerpfase, moeten berekeningen verder worden uitgewerkt om te kunnen dienen voor de benodigde vergunningsdocumentatie, voor de aanbesteding en als voorbereiding voor de uitvoeringsfase. Het DO omvat het ontwerp van de mastconstructies, de fundaties en de opstijgpunten in de verbinding.

Deze rapportage bevat de resultaten van de toetsing van de combi-hoekmast HC+/c, een masttype geschikt voor twee circuits 380 kV. De toetsing bestaat uit controle van:

- de profielen en boutverbindingen onderdeel van de hoofddraagconstructie
- de knikverkorters
- de liggers voor de isolatorkettingen
- de verbinding met de fundatie via blokdeuvels
- aanvullende controle op sterkte-coördinatie
- galloping

Buiten de scope van dit DO-rapport valt de controle van de schetsplaten en overige verbindingsdetails in de constructie. Dit moet in de UO-fase worden uitgewerkt. Ook de voorzieningen voor de high-step rail en bordessen vallen onder uitwerking in UO-fase.

In hoofdstuk 2 zijn de uitgangspunten en randvoorwaarden vanuit de van toepassing zijnde normen en TenneT-specificaties opgenomen. Hoofdstuk 3 beschrijft de gevolgde aanpak van de berekening. In hoofdstuk 4 is de toetsing opgenomen.

2 UITGANGSPUNTEN EN RANDVOORWAARDEN

2.1 Normen

Er is gebruik gemaakt van de normen volgens Tabel 1.

Tabel 1 Gebruikgemaakte normen, voorschriften en richtlijnen

Norm	Titel
NEN-EN 50341-1:2013	“Overhead electrical lines exceeding AC 1 kV - Part 1: General requirements – Common”
NEN-EN 50341-2-15:2019	“Overhead electrical lines exceeding AC 1 kV Part 2 National Normative Aspects (NNA) for THE NETHERLANDS”
NEN-EN 1990+A1+A1/C2:2019/NB:2019nl	“Grondslagen van het ontwerp”
NEN-EN 1991-1-4+A1+C2:2011/NB:2019+C1:2020	“Deel 1-4: Windbelasting op constructies”
NEN-EN 1992-1-1+C2:2011/NB:2016+A1:2020	“Eurocode 2: Ontwerp en berekening van betonconstructies, deel 1-1: algemene regels en regels voor gebouwen”
NEN-EN 1993-1-1+C2+A1:2016 nl	“Eurocode 3: Ontwerp en berekening van staalconstructies, deel 1-1: algemene regels en regels voor gebouwen”
NEN-EN 1993-3-1:2007/NB:2011 nl	“Deel 3-1: Torens, masten en schoorstenen - Torens en masten”
NEN-EN 1993-1-8+C2:2011/NB:2011 nl	“Ontwerp en berekening van staalconstructies, deel 1-8: ontwerp en berekening van verbindingen”

2.2 TenneT-specificaties

In Tabel 2 zijn de documenten opgenomen die relevant zijn voor de berekeningen en toetsingen die binnen dit project in de mastrapportage uitgevoerd zullen worden.

Tabel 2 Relevante documenten t.b.v. mechanische rapportages

Nummer	Onderwerp
PVE.05.000 v3.2	PvE Lijnen
sPVE.05.001	sPvE Lijnen
SPE.05.346 v1.3	Algemene specificatie stalen masten

2.3 Eisenverificatie

Voor de eisenverificatie wordt verwezen naar het rapport “Verificatierapport eisen DO Moldau”, DNV GL rapport 21-0451, Meridiannummer 002.678.00 0910757.

2.4 Ontwerprapporten

Voor de achtergrond van het ontwerp wordt verwezen naar het uitgangspuntenrapport “Uitgangspunten definitief ontwerp Moldaumast”, DNV GL rapport 21-0036, Meridiannummer 002.678.00 0876917.

2.5 Materialen

Voor het ontwerp van de mastconstructies en fundaties wordt uitgegaan van de eigenschappen volgens Tabel 3.

Tabel 3 Materialen aangepaste constructie

Staalsoort	S355J0 (t≤16 mm) S355J2 (16<t≤40 mm)
Boutkwaliteit	8.8 gerolde draad
Betonkwaliteit	C30/37
Wapeningsstaal	B500

Voor de constructie geldt conform TenneT-specificatie:

- Toe te passen bouten: M16/M20/M24;
- Voor hoekstaal is de minimale afmeting L50x5 mm;
- Minimale plaatdikte 6 mm.

Mocht het noodzakelijk zijn M30 toe te passen, bij grote plaatdiktes is dit als afwijking door TenneT toegestaan.

2.6 Software

De gebruikte software wordt benoemd in Tabel 4.

Tabel 4 Toegepaste software

Software		Versie
Mastontwerp	PLS-CADD	16.65
Mastberekeningen	PLS-TOWER	16.65
Constructieve analyse	AxisVM	X5 R4h

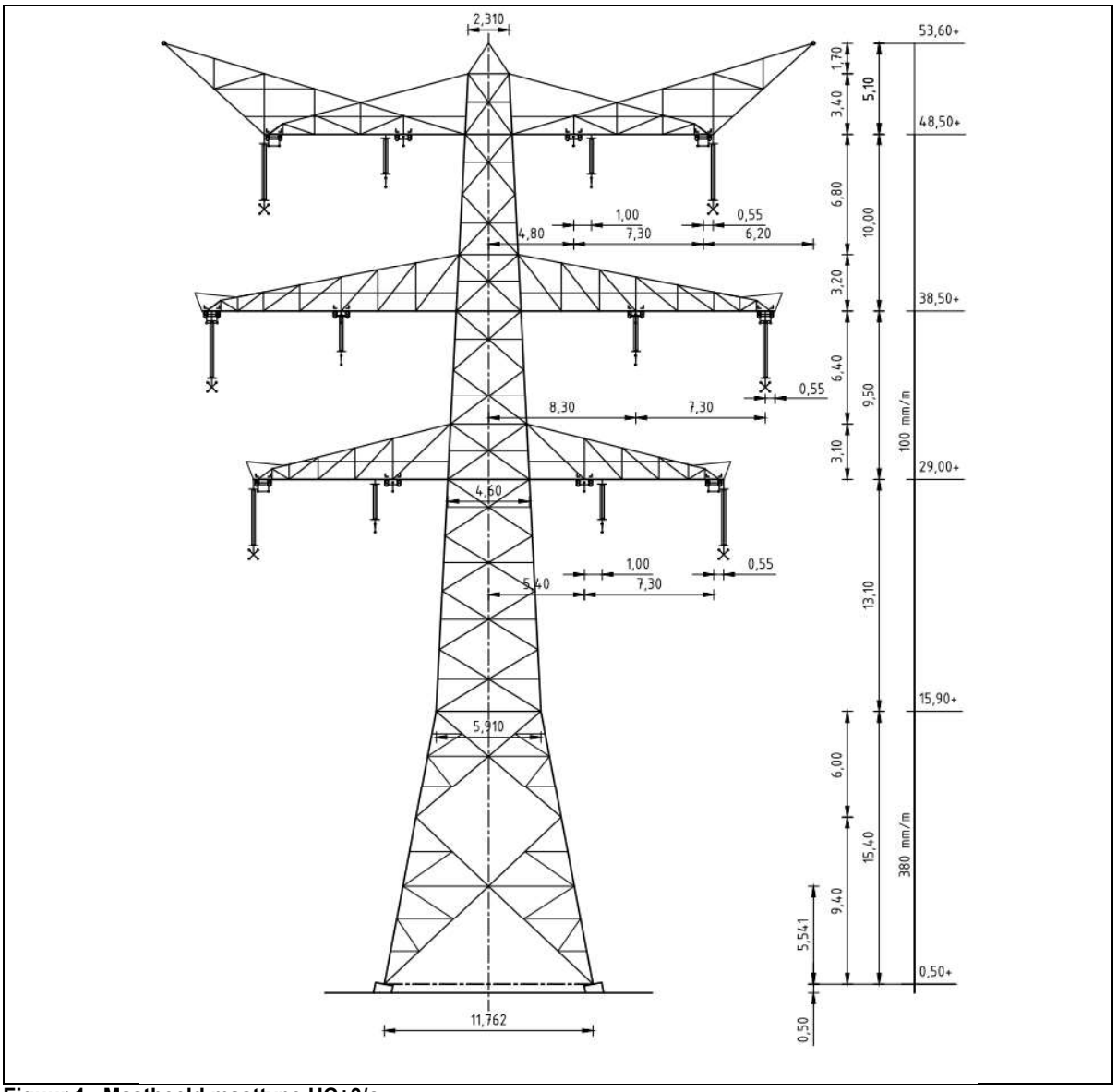
3 MASTONTWERP

3.1 Mastbeeld

In dit hoofdstuk wordt het mastbeeld weergegeven met de belangrijkste maatvoering, voor de tekening van het masttype met volledige maatvoering en aanzichten wordt verwezen naar onderstaande tekeningen:

- Mastbeeldentekening, Meridiannummer 002.678.00 0890099
- Overzichtstekening HC+0/c, Meridiannummer 002.678.00 0927484

Masttype HC+0/c is een combi-hoekmast voor twee circuits 380 kV en twee circuits 150kV. De belastingen grijpen als trekkrachten aan via de afspankettingen. Onder de traverse bevinden zich verticale post-isolatoren die de bretellebogen fixeren.



Figuur 1 Mastbeeld masttype HC+0/c

3.2 Uitgangspunten berekening

De uitgangspunten volgens Tabel 5 zijn van toepassing.

Tabel 5 Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

3.3 Mastenlijst

De mastenlijst is gebaseerd op de “staking table” van het DO-uitgangspuntenrapport en benaamd als “VKA 1.1 Concept 20201112 1037-1044_1086-1094_1099-1105_1192-1204.xlsx”. De mastenlijst is vanwege lopende traceringsvraagstukken aan verandering onderhevig en is derhalve indicatief.

In Tabel 6 zijn alle masten in het tracé van het type HC+0/c opgenomen. De mast met grootste wind span is vetgedrukt aangegeven. Het masttype zal niet met deze wind en weight span worden berekend maar met generieke wind en weight span, zie uitgangspuntenrapport.

Tabel 6 Mastenlijst HC+0/c

Mast-nummer	Masttype	Lijnhoek (°)	Wind span (m)	Weight span (m)	Hoogteverschil ba+ah (m)	Hoogte-verschil back (m)	Hoogte-verschil ahead (m)
1131	HC+0_c	134.1	265.3	260.4	-0.8	-0.7	-0.1
1133	HC+0_c	129.3	309.8	310.1	0.0	0.1	-0.1
1159	HC+0_c	139.3	380.5	363.7	-3.7	-0.3	-3.4
1187	HC+0_c	129.2	384.3	369.4	-3.2	-2.5	-0.6

3.4 Geleiderbelastingen

De berekening is uitgevoerd met het geleiderbelastingprogramma van DNV GL. De belastingen op de mastconstructie zijn bepaald op basis van de modellering in PLS-TOWER (staafoppervlaktes). Voor de toeslagen op eigen gewicht en windoppervlakte wordt verwezen naar het uitgangspuntenrapport. In Appendix A zijn de resultaten van de geleiderbelastingen samengevat. Masttype HC+0 wordt berekend met minimale en maximale lijnhoek 120° en 140° voor dit type.

3.5 Reacties op de fundering

De oplegreacties op de fundering worden ontleend aan de uitvoer van het geleiderbelastingenprogramma. Zie Appendix A.

3.6 Modellering

Op basis van de ontwerptekeningen is de mast in PLS-TOWER ingevoerd. De toetsing wordt per staafgroep uitgevoerd. De hoofdelementen zijn gemodelleerd, niet-dragende profielen als knikverkorters zijn weggelaten, deze worden separaat getoetst. De profielen zijn in PLS-TOWER inclusief de boutverbindingen ingevoerd en getoetst, de controle van de schetsplaten en andere detailverbindingen valt buiten de scope.

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

De gewichts- en windbelasting op de mastconstructie wordt door PLS-TOWER automatisch bepaald. Via toeslagfactoren wordt de invloed van niet gemodelleerde elementen als knikverkorters, bordesconstructies en klimvoorzieningen meegenomen. Voor schetsplaten, zinklaag en bouten is een aanvullende toeslag op het gewicht van 20% toeslag gerekend.

Diagonalen in voor- en achtervlak respectievelijk de twee zijvlakken zijn samengenomen in een groep.

3.7 Overige controles

In PLS-TOWER zijn niet alle elementen getoetst. Knikverkorterprofielen en overige profielen voor beloopbaarheid worden separaat getoetst. In Appendix C is dit opgenomen. De verbinding met de fundatie bestaat uit ingestorte profielen voorzien van blokdeuvels. Dit is in Appendix D opgenomen. De liggers van isolatorkettingen vereisen een aanvullende controle op buiging. De toetsing is uitgevoerd met de software AxisVM en is beschreven in Appendix E. Appendix F omvat de toetsing op sterkte-coördinatie. Voor hoekmasten moet een toetsing op vermoeiing worden uitgevoerd voor galloping. Dit is in Appendix G opgenomen.

De mastranden uitgevoerd als XEA-profielen worden separaat op torsieknik gecontroleerd. Dit is in Appendix B opgenomen. De berekende capaciteit die lager is dan de capaciteit voor buigingsknik is in PLS-TOWER via aangepaste buckling-ratio ingevoerd.

3.8 Mastgewicht

Het totale mastgewicht per masttype is met de uitgangspunten van paragraaf 3.6 bepaald op:

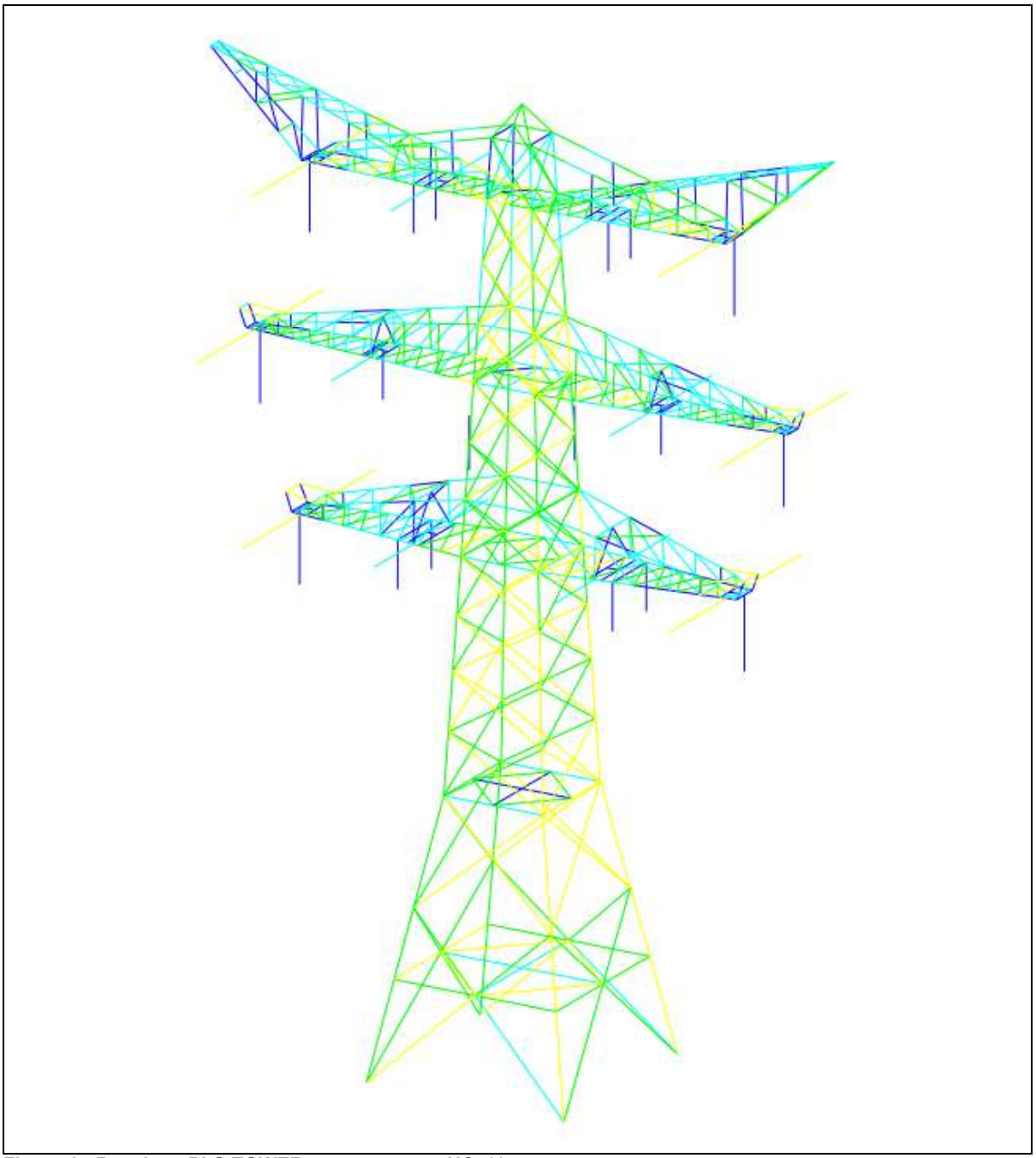
- Masttype HC+0/c 104,1 t

4 TOETSING

4.1 Resultaat PLS-TOWER

Het resultaat van de toetsing met PLS-TOWER is weergegeven in Figuur 2. De belastingen zijn bepaald voor het masttype HC+0/c, inclusief bouwfase en afspannen.

De uitnutting van de constructie loopt op van blauw (0-25%) tot geel (75-100%). Uit de figuur wordt geconcludeerd dat alle profielen en boutverbindingen voldoen.



Figuur 2 Resultaat PLS-TOWER voor masttype HC+0/c

4.2 Toetsing overige onderdelen

In Tabel 7 zijn de resultaten van de uitgevoerde toetsingen weergegeven.

Tabel 7 Samenvatting uitgevoerde controles

Controle van	Beoordeling	Referentie
Profielen	Voldoen	Figuur 2 Appendix B
Knikverkorters	Voldoen	Appendix C
Blokdeuvels randstijl	Voldoen	Appendix D
Liggers	Voldoen	Appendix E
Sterkte-coördinatie	Voldoet	Appendix F
Galloping	Voldoet	Appendix G

APPENDIX A
Geleiderbelastingen

Geleiderbelastingen opgenomen:

- Masttype HC+0/c – 120gr
- Masttype HC+0/c – 140gr
- Masttype HC+0/c – bouwfase
- Masttype HC+0/c – Afspannen

Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Hoekmast
Masthoogte	53,1 m
Max. veldlengte	400 m
Lijnhoek	120°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	481 m
Min. Weight span	129 m
Max. Weight span	549 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-07-16			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype HC+0_c - 120gr

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

Document name:

RLL-TLB380_HC+0_c - 120gr_1187_Report.pdf

Project number:

Project client number:

0.0											

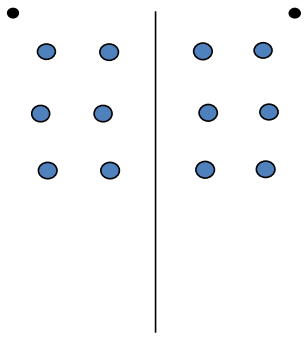
Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

Geleiderbelastingen

Auteur: TBR
Versie: v12.0

Algemeen

Benaming	HC+0_c - 120gr
Masttype	Hoekmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	Afspanketting	3,00	6,50	1,10
Circuit 2	Afspanketting	3,00	6,50	1,10
Circuit 3	Afspanketting	2,00	4,50	0,80
Circuit 4	Afspanketting	2,00	4,50	0,80
Bliksemdraad 1	Afspanketting	0,10	0,20	0,10
Bliksemdraad 2	Afspanketting	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	48,0 m	48,0 m	-12,1 m
Circuit 1	11	380ct1f2	38,0 m	38,0 m	-15,6 m
Circuit 1	12	380ct1f3	28,5 m	28,5 m	-12,7 m
Circuit 2	40	380ct2f1	48,0 m	48,0 m	12,1 m
Circuit 2	41	380ct2f2	38,0 m	38,0 m	15,6 m
Circuit 2	42	380ct2f3	28,5 m	28,5 m	12,7 m
Circuit 3	20	150ct3f1	48,0 m	48,0 m	-4,8 m
Circuit 3	21	150ct3f2	38,0 m	38,0 m	-8,3 m
Circuit 3	22	150ct3f3	28,5 m	28,5 m	-5,4 m
Circuit 4	30	150ct4f1	48,0 m	48,0 m	4,8 m
Circuit 4	31	150ct4f2	38,0 m	38,0 m	8,3 m
Circuit 4	32	150ct4f3	28,5 m	28,5 m	5,4 m
Bliksemdraad 1	1	bl1	53,1 m	53,1 m	-18,3 m
Bliksemdraad 2	3	bl2	53,1 m	53,1 m	18,3 m

Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	18,0 m	6,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-9,0 m	-9,0 m	(negatief: omlaag, grotere weight span)

Verlaging: Niet in 0,9EG-combinaties

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

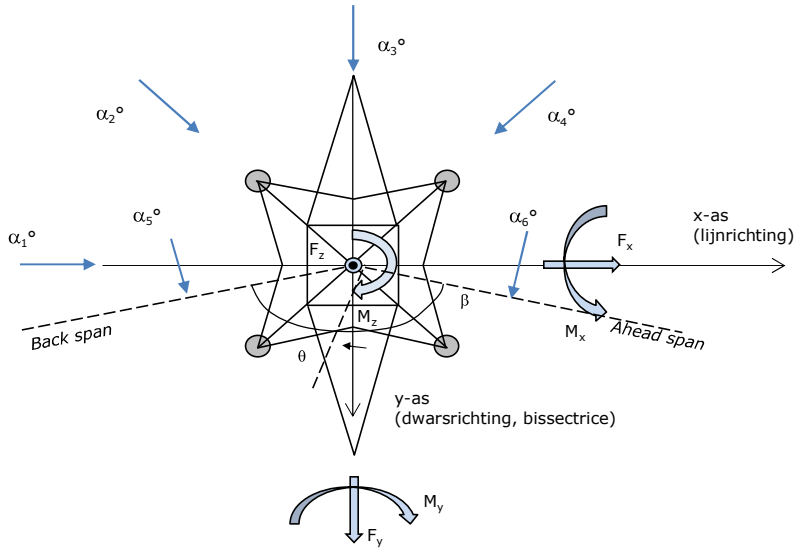
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	40	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	41	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	42	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	20	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	21	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	22	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	30	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	31	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	32	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	120 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		400	400 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	60 °	
	α_6	120 °	

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

Windrichtingen en positieve richtingen belastingen



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

Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

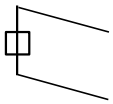
Geleiderafval

		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	150ct3f1	1	0	1	0	1	0
Circuit 3	150ct3f2	1	0	1	0	1	0
Circuit 3	150ct3f3	1	0	1	0	1	0
Circuit 4	150ct4f1	0	1	1	0	1	0
Circuit 4	150ct4f2	0	1	1	0	1	0
Circuit 4	150ct4f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

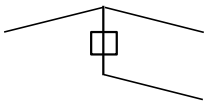
Belastingsituaties SPLS

Beschouwde situaties SPLS: 1 t/m 6, alle mogelijke situaties.

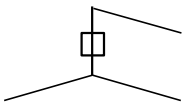
Principe belastingssituaties:



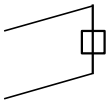
1. Ba All cts



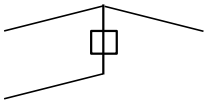
2. Ba ct1



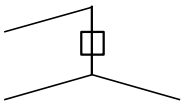
3. Ba ct2



4. Ah All cts



5. Ah ct1

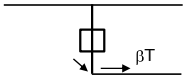


6. Ah ct2

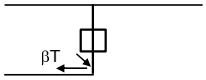
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

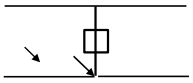
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht.
Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

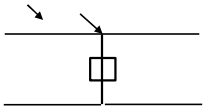
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

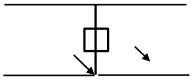
Principe belastingssituaties:



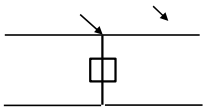
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

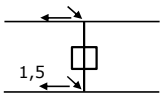
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

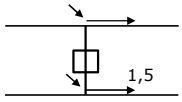
Beschouwde situaties lijndansen 8: 1 en 2, alle mogelijke situaties.

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: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

Mastconstructie

Eigenschappen

Masttype	Hoekmast	
Mastbenaming	HC+0_c - 120gr	
Voetplaat t.o.v. maaiveld	0,5	m
Masthoogte t.o.v. voetplaat	53,1	m
Gewicht mast	1021,2	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	11,76	11,76	m
Helling van de randstijl	0,190	0,190	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	15,40	11,76	5,91	15,40	0,190	136,07	31,88	0,23	2,79
Eerste tussenstuk	22,20	5,91	5,23	6,80	0,050	37,88	13,58	0,36	2,34
Tweede tussenstuk	28,50	5,23	4,60	6,30	0,050	30,96	10,07	0,33	2,45
Bovenstuk 1	38,00	4,60	3,65	9,50	0,050	39,19	12,64	0,32	2,46
Bovenstuk 2	51,40	3,65	2,31	13,40	0,050	39,93	13,53	0,34	2,40
Topstuk	53,10	2,31		1,70		1,96	0,33	0,17	3,08
Ondertraverse	28,50	10,70		3,10		16,59	5,05	0,30	2,52
Middentraverse	38,00	14,08		3,20		22,52	6,95	0,31	2,50
Boventraverse	48,00	16,98		5,10		43,29	8,13	0,19	2,98

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	15,40	11,76	5,91	15,40	0,190	136,07	31,88	0,23	2,79
Eerste tussenstuk	22,20	5,91	5,23	6,80	0,050	37,88	13,58	0,36	2,34
Tweede tussenstuk	28,50	5,23	4,60	6,30	0,050	30,96	10,07	0,33	2,45
Bovenstuk 1	38,00	4,60	3,65	9,50	0,050	39,19	12,64	0,32	2,46
Bovenstuk 2	51,40	3,65	2,31	13,40	0,050	39,93	13,53	0,34	2,40
Topstuk	53,10	2,31		1,70		1,96	0,33	0,17	3,08
Ondertraverse	28,50	10,70		3,10		16,59	5,05	0,30	2,52
Middentraverse	38,00	14,08		3,20		22,52	6,95	0,31	2,50
Boventraverse	48,00	16,98		5,10		43,29	8,13	0,19	2,98

NB: oppervlakte traverse dwarsrichting van de tabel wordt in berekening gereduceerd.
NB: oppervlakte traverse per zijde, dus helft van totaal van twee traverses.

Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	15,4	1,5
Eerste tussenstuk	0,14	0,71	6,8	0,7
Tweede tussenstuk	0,14	0,71	6,3	0,6
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	34,7	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	62,3	52,8	0,0	-52,8	7,7	479,4	406,8	0,0	-406,8
Eerste tussenstuk	0,86	27,4	23,2	0,0	-23,2	18,8	514,6	436,6	0,0	-436,6
Tweede tussenstuk	0,94	23,2	19,7	0,0	-19,7	25,4	588,3	499,2	0,0	-499,2
Bovenstuk 1	1,02	31,7	26,9	0,0	-26,9	33,3	1054,8	895,0	0,0	-895,0
Bovenstuk 2	1,10	35,8	30,4	0,0	-30,4	44,7	1601,8	1359,2	0,0	-1359,2
Topstuk	1,15	1,2	1,0	0,0	-1,0	52,3	60,7	51,5	0,0	-51,5
Ondertraverse	0,98	25,0	14,9	0,0	-14,9	29,5	739,2	439,1	0,0	-439,1
Middentraverse	1,06	37,0	22,0	0,0	-22,0	39,1	1446,1	859,0	0,0	-859,0
Boventraverse	1,13	55,0	32,7	0,0	-32,7	49,7	2734,8	1624,4	0,0	-1624,4
Totaal		298,6	223,6	0,0	-223,6		9219,8	6570,8	0,0	-6570,8

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	52,8	62,3	52,8	7,7	0,0	406,8	479,4	406,8
Eerste tussenstuk	0,86	0,0	23,2	27,4	23,2	18,8	0,0	436,6	514,6	436,6
Tweede tussenstuk	0,94	0,0	19,7	23,2	19,7	25,4	0,0	499,2	588,3	499,2
Bovenstuk 1	1,02	0,0	26,9	31,7	26,9	33,3	0,0	895,0	1054,8	895,0
Bovenstuk 2	1,10	0,0	30,4	35,8	30,4	44,7	0,0	1359,2	1601,8	1359,2
Topstuk	1,15	0,0	1,0	1,2	1,0	52,3	0,0	51,5	60,7	51,5
Ondertraverse	0,98	0,0	14,9	10,0	14,9	29,5	0,0	439,1	295,7	439,1
Middentraverse	1,06	0,0	22,0	14,8	22,0	39,1	0,0	859,0	578,5	859,0
Boventraverse	1,13	0,0	32,7	22,0	32,7	49,7	0,0	1624,4	1093,9	1624,4
Totaal		0,0	223,6	228,4	223,6		0,0	6570,8	6267,7	6570,8

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	1021	0	0	0
Windrichting 0°	306	0	0	0	9472	0
Windrichting 45°	229	229	0	6749	6749	0
Windrichting 90°	0	236	0	6520	0	0
Windrichting 135°	-229	229	0	6749	-6749	0

Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	3,00	1	3	6,5	1,1	48,50	1,13	1,2	1,49
380ct1f2	3,00	1	3	6,5	1,1	38,50	1,06	1,2	1,40
380ct1f3	3,00	1	3	6,5	1,1	29,00	0,98	1,2	1,29
380ct2f1	3,00	1	3	6,5	1,1	48,50	1,13	1,2	1,49
380ct2f2	3,00	1	3	6,5	1,1	38,50	1,06	1,2	1,40
380ct2f3	3,00	1	3	6,5	1,1	29,00	0,98	1,2	1,29
150ct3f1	2,00	1	2	4,5	0,8	48,50	1,13	1,2	1,08
150ct3f2	2,00	1	2	4,5	0,8	38,50	1,06	1,2	1,02
150ct3f3	2,00	1	2	4,5	0,8	29,00	0,98	1,2	0,94
150ct4f1	2,00	1	2	4,5	0,8	48,50	1,13	1,2	1,08
150ct4f2	2,00	1	2	4,5	0,8	38,50	1,06	1,2	1,02
150ct4f3	2,00	1	2	4,5	0,8	29,00	0,98	1,2	0,94
bl1	0,10	1	0,1	0,2	0,1	53,60	1,16	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	53,60	1,16	1,2	0,14

Project: RLL-TLB380
Tower: HC+0_c - 120gr
Number: 1187

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	50,1	1,14	0,62	0,68	0,96	33,37	89,8	98,8	51,8	174,5	191,9
380ct1f2	40,1	1,07	0,60	0,66	0,98	33,37	84,0	92,4	51,8	159,9	175,9
380ct1f3	30,6	0,99	0,58	0,64	1,00	33,37	77,1	84,9	51,8	143,2	157,6
380ct2f1	50,1	1,14	0,62	0,68	0,96	33,37	89,8	98,8	51,8	174,5	191,9
380ct2f2	40,1	1,07	0,60	0,66	0,98	33,37	84,0	92,4	51,8	159,9	175,9
380ct2f3	30,6	0,99	0,58	0,64	1,00	33,37	77,1	84,9	51,8	143,2	157,6
150ct3f1	50,1	1,14	0,62	0,68	0,96	33,37	44,9	49,4	51,8	87,3	95,9
150ct3f2	40,1	1,07	0,60	0,66	0,98	33,37	42,0	46,2	51,8	79,9	88,0
150ct3f3	30,6	0,99	0,58	0,64	1,00	33,37	38,6	42,4	51,8	71,6	78,8
150ct4f1	50,1	1,14	0,62	0,68	0,96	33,37	44,9	49,4	51,8	87,3	95,9
150ct4f2	40,1	1,07	0,60	0,66	0,98	33,37	42,0	46,2	51,8	79,9	88,0
150ct4f3	30,6	0,99	0,58	0,64	1,00	33,37	38,6	42,4	51,8	71,6	78,8
bl1	55,2	1,17	0,62	0,69	1,18	22,24	19,1	21,0	63,1	55,2	60,6
bl2	55,2	1,17	0,62	0,69	1,18	22,13	19,0	20,9	63,0	55,1	60,5

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	44,1	1,10	0,61	0,67	0,97	33,37	86,5	95,1	51,8	166,0	182,6
380ct1f2	34,1	1,02	0,59	0,65	0,99	33,37	79,9	87,9	51,8	149,7	164,8
380ct1f3	24,6	0,93	0,56	0,62	1,02	33,37	71,7	78,9	51,8	130,4	143,6
380ct2f1	44,1	1,10	0,61	0,67	0,97	33,37	86,5	95,1	51,8	166,0	182,6
380ct2f2	34,1	1,02	0,59	0,65	0,99	33,37	79,9	87,9	51,8	149,7	164,8
380ct2f3	24,6	0,93	0,56	0,62	1,02	33,37	71,7	78,9	51,8	130,4	143,6
150ct3f1	44,1	1,10	0,61	0,67	0,97	33,37	43,2	47,6	51,8	83,0	91,3
150ct3f2	34,1	1,02	0,59	0,65	0,99	33,37	39,9	43,9	51,8	74,9	82,4
150ct3f3	24,6	0,93	0,56	0,62	1,02	33,37	35,8	39,5	51,8	65,2	71,8
150ct4f1	44,1	1,10	0,61	0,67	0,97	33,37	43,2	47,6	51,8	83,0	91,3
150ct4f2	34,1	1,02	0,59	0,65	0,99	33,37	39,9	43,9	51,8	74,9	82,4
150ct4f3	24,6	0,93	0,56	0,62	1,02	33,37	35,8	39,5	51,8	65,2	71,8
bl1	49,2	1,13	0,62	0,68	1,19	22,24	18,4	20,2	63,1	52,8	58,0
bl2	49,2	1,13	0,62	0,68	1,19	22,13	18,3	20,1	63,0	52,7	57,9

NB: belastingen w_v gelden voor bundel

Project: RLL-TLB380
Masttype: HC+0_c - 120gr
Mast: 1187

Geleiderbelastingen

Auteur: TBR
Versie: v12.0

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	6
Aantal belastingcombinaties ULS	100
Aantal belastingcombinaties SPLS	246
Aantal belastingcombinaties SLS	15
Aantal knooplasten	12274

Project: RLL-TLB380
Masttype: HC+0_c - 120gr
Mast: 1187

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 (Ba+Ah) in het globale assenstelsel 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

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	-56,0	55,7	38,1	37,7	11,1	11,0
380ct1f1	-227,0	225,3	154,2	150,7	39,8	39,7
380ct1f2	-224,2	222,3	148,1	144,7	39,7	39,6
380ct1f3	-221,2	219,2	143,4	140,9	39,6	39,5
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	0,0	0,0	0,0	0,0	0,0	
380ct2f1	-227,0	225,3	154,2	150,7	39,8	39,7
380ct2f2	-224,2	222,3	148,1	144,7	39,7	39,6
380ct2f3	-221,2	219,2	143,4	140,9	39,6	39,5
150ct3f1	-113,4	112,6	77,6	75,8	21,3	21,3
150ct3f2	-112,0	111,1	74,5	72,5	21,3	21,3
150ct3f3	-110,5	109,5	71,8	70,6	21,3	21,3
150ct4f1	-113,4	112,6	77,6	75,8	21,3	21,3
150ct4f2	-112,0	111,1	74,5	72,5	21,3	21,3
150ct4f3	-110,5	109,5	71,8	70,6	21,3	21,3
bl2	-55,2	54,9	37,7	37,2	11,0	10,9
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	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	489,9	495,8	481,0
380ct1f1	484,5	495,6	481,0
380ct1f2	484,1	495,4	481,0
380ct1f3	483,5	495,2	481,0
Post-isolator 1			
Post-isolator 2			
Post-isolator 3			
380ct2f1	484,5	495,6	481,0
380ct2f2	484,1	495,4	481,0
380ct2f3	483,5	495,2	481,0
150ct3f1	484,5	495,6	481,0
150ct3f2	484,1	495,4	481,0
150ct3f3	483,5	495,2	481,0
150ct4f1	484,5	495,6	481,0
150ct4f2	484,1	495,4	481,0
150ct4f3	483,5	495,2	481,0
bl2	490,3	496,0	481,0
Post-isolator 4			
Post-isolator 5			
Post-isolator 6			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	548,6	461,8
380ct1f1	513,1	477,6
380ct1f2	509,4	476,9
380ct1f3	505,0	476,1
Post-isolator 1		
Post-isolator 2		
Post-isolator 3		
380ct2f1	513,1	477,6
380ct2f2	509,4	476,9
380ct2f3	505,0	476,1
150ct3f1	513,1	477,6
150ct3f2	509,4	476,9
150ct3f3	505,0	476,1
150ct4f1	513,1	477,6
150ct4f2	509,4	476,9
150ct4f3	505,0	476,1
bl2	550,6	461,4
Post-isolator 4		
Post-isolator 5		
Post-isolator 6		

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	548,6 m	1,371 -
Min. weight span	128,9 m	0,322 -

Project: RLL-TLB380
Masttype: HC+0_c - 120gr
Mast: 1187

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	33,6	71,1	11,1	-67,6	67,1
380ct1f1	178,5	280,4	39,8	-271,5	269,2
380ct1f2	175,2	276,1	39,7	-267,5	264,9
380ct1f3	171,7	271,3	39,6	-263,3	260,2
Post-isolato	4,2	4,2	6,8	0,0	
Post-isolato	3,2	3,2	4,7	0,0	
Post-isolato	4,9	4,9	6,8	0,0	
380ct2f1	178,5	280,4	39,8	-271,5	269,2
380ct2f2	175,2	276,1	39,7	-267,5	264,9
380ct2f3	171,7	271,3	39,6	-263,3	260,2
150ct3f1	94,3	140,4	21,3	-135,8	134,6
150ct3f2	94,3	138,2	21,3	-133,8	132,4
150ct3f3	94,2	135,8	21,3	-131,6	130,1
150ct4f1	94,3	140,4	21,3	-135,8	134,6
150ct4f2	94,3	138,2	21,3	-133,8	132,4
150ct4f3	94,2	135,8	21,3	-131,6	130,1
bl2	33,1	70,1	11,0	-66,7	66,1
Post-isolato	4,2	4,2	6,8	0,0	
Post-isolato	3,2	3,2	4,7	0,0	
Post-isolato	4,9	4,9	6,8	0,0	

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	14,9	8,6	2,4	-17,2	17,2
380ct1f1	113,7	65,7	20,5	-131,3	131,3
380ct1f2	113,7	65,7	20,5	-131,3	131,3
380ct1f3	113,7	65,7	20,5	-131,3	131,3
Post-isolato	0,0	0,0	5,0	0,0	
Post-isolato	0,0	0,0	3,5	0,0	
Post-isolato	0,0	0,0	5,0	0,0	
380ct2f1	113,7	65,7	20,5	-131,3	131,3
380ct2f2	113,7	65,7	20,5	-131,3	131,3
380ct2f3	113,7	65,7	20,5	-131,3	131,3
150ct3f1	56,9	32,8	10,8	-65,7	65,7
150ct3f2	56,9	32,8	10,8	-65,7	65,7
150ct3f3	56,9	32,8	10,8	-65,7	65,7
150ct4f1	56,9	32,8	10,8	-65,7	65,7
150ct4f2	56,9	32,8	10,8	-65,7	65,7
150ct4f3	56,9	32,8	10,8	-65,7	65,7
bl2	14,5	8,4	2,3	-16,8	16,8
Post-isolato	0,0	0,0	5,0	0,0	
Post-isolato	0,0	0,0	3,5	0,0	
Post-isolato	0,0	0,0	5,0	0,0	

Controle 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
	Post-isolato	0,0	
	Post-isolato	0,0	
	Post-isolato	0,0	
	380ct2f1	0,0	0,0
	380ct2f2	0,0	0,0
	380ct2f3	0,0	0,0
	150ct3f1	0,0	0,0
	150ct3f2	0,0	0,0
	150ct3f3	0,0	0,0
	150ct4f1	0,0	0,0
	150ct4f2	0,0	0,0
	150ct4f3	0,0	0,0
	bl2	0,0	0,0
	Post-isolato	0,0	
	Post-isolato	0,0	
	Post-isolato	0,0	

Project: RLL-TLB380
Masttype: HC+0_c - 120gr
Mast: 1187

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		-35	2342	519	91364	-1318	0
ULS 1a_0,9_0		81	1496	331	57853	3189	0
ULS 1a_0,9_0,9_90		-41	2190	211	85607	-1526	0
ULS 3_0		41	2337	789	91014	1635	0
SLS 7		0	1216	412	46916	0	0

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

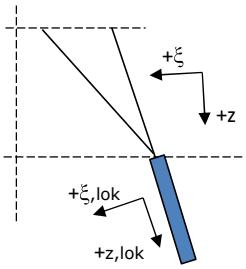
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-35	2696	1744	101143	-1318	0
ULS 1a_0,9_0,9_90	-41	2544	1130	95387	-1526	0
SLS 7	0	1216	1434	46916	0	0

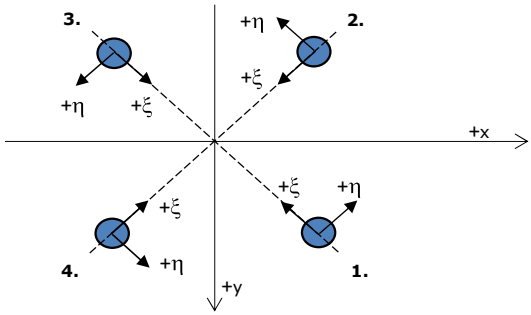
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 3_0,9_90	-10	2739	1448	**105796**	-368	0
SPLS 3_60 Ah All Cts	-1587	1117	1562	42559	**-62279**	8
SPLS 3_60 Ba Ct1	702	1473	1673	57470	26401	**-9307**
ULS 1a_0,9_60	-394	2584	1213	**96738**	**-18023**	1

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_120	1023	870	**5169**	108	-1338	50	5352
2	SPLS 1a_0 Ba All Cts	220	-408	**1646**	133	-444	-2	1704
3	ULS 8 Ba	-161	-392	**1472**	-163	-391	4	1525
4	ULS 1a_60	-1049	897	**5314**	-107	-1376	52	5502

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 8 Ba	-3	-235	**-718**	164	168	-25	-743
2	ULS 1a_0,9_60	-895	743	**-4575**	107	1158	-72	-4737
3	ULS 1a_0,9_120	868	714	**-4424**	-108	1118	-70	-4581
4	SPLS 1a_0,9_0 Ba All Cts	80	-268	**-976**	-133	246	-16	-1010

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	SPLS 3_90 Ah Ct1	605	10	1647	**421**	-435	7	1706
2	SPLS 3_0,9_60 Ba Ct2	-452	-128	-935	**410**	229	-22	-968
3	SPLS 3_60 Ba Ct2	378	713	-3035	**237**	771	-44	-3143
4	SPLS 3_0,9_120 Ah Ct1	-551	864	3860	**221**	-1001	36	3997

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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_60 Ba Ct1	546	865	3841	**-225**	-998	34	3978
2	SPLS 3_120 Ah Ct2	-382	713	-3045	**-234**	774	-44	-3153
3	SPLS 3_0,9_90 Ah Ct2	436	-140	-836	**-407**	209	-15	-866
4	SPLS 3_60 Ba Ct1	-620	23	1739	**-422**	-455	12	1801

Project: RLL-TLB380
Masttype: HC+0_c - 120gr
Mast: 1187

Combinatie Ftrek+Fhor

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 8 Ba	-3	-235	**-718**	**164**	168	-25	-743
2	ULS 1a_0,9_60	-895	743	**-4575**	**107**	1158	-72	-4737
3	ULS 1a_0,9_120	868	714	**-4424**	**-108**	1118	-70	-4581
4	SPLS 3_0,9_0 Ba All Cts	50	-270	**-916**	**-156**	226	-20	-949

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	492	379	2353	80	-616	17	2436
2	SLS 7	-342	229	-1636	80	404	-36	-1694
3	SLS 7	342	229	-1636	-80	404	-36	-1694
4	SLS 7	-492	379	2353	-80	-616	17	2436

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_60	-1049	897	**5314**	-107	-1376	52	5502
Max. trek	ULS 1a_0,9_60	-895	743	**-4575**	107	1158	-72	-4737
Max. pos. torsie	SPLS 3_90 Ah Ct1	605	10	1647	**421**	-435	7	1706
Max. neg. torsie	SPLS 3_60 Ba Ct1	-620	23	1739	**-422**	-455	12	1801
Comb. trek+torsie	ULS 1a_0,9_60	-895	743	**-4575**	**107**	1158	-72	-4737

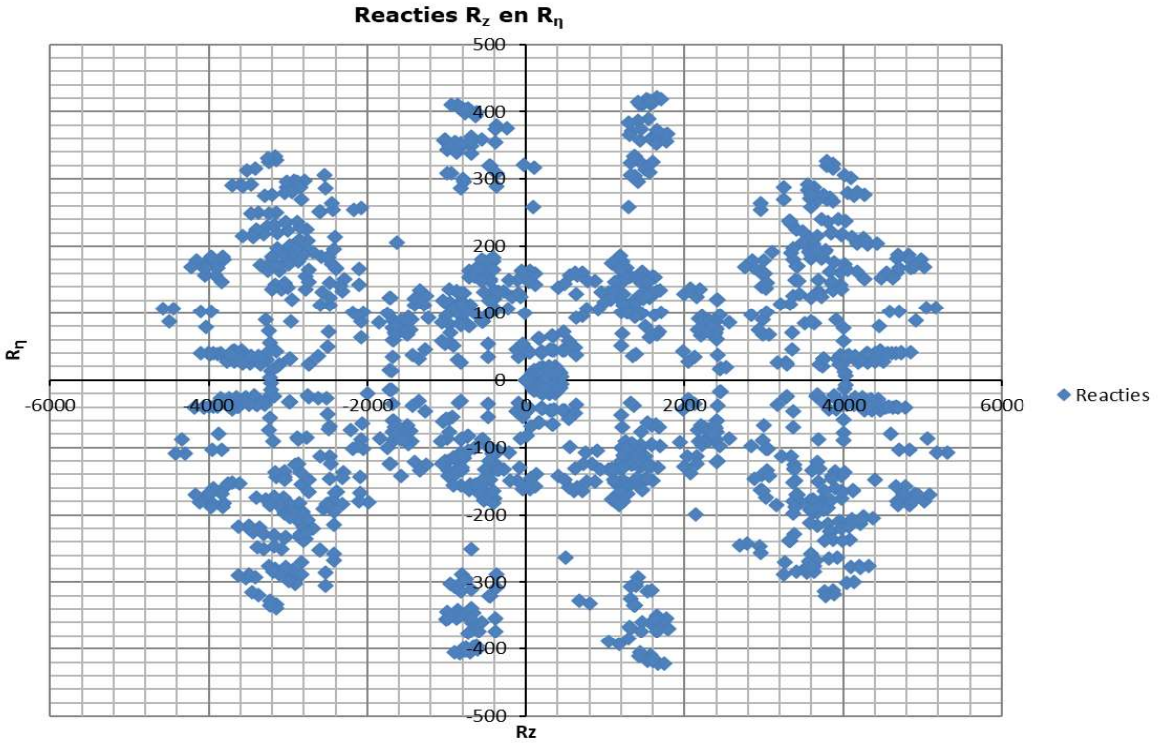
Maximale trekbelasting SLS

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	492	379	**2353**	80	-616	17	2436
2	SLS 1a_60	-647	521	**-3287**	89	826	-57	-3403
3	SLS 1a_120	630	502	**-3189**	-90	800	-56	-3302
4	SLS 1a_0	-419	288	**1945**	-93	-500	22	2014

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 3_120	826	633	**3986**	136	-1032	39	4127
2	SLS 1a_0	-269	138	**-1227**	93	288	-41	-1270
3	SLS 7	342	229	**-1636**	-80	404	-36	-1694
4	SLS 3_60	-832	640	**4023**	-136	-1041	40	4166

Project: RLL-TLB380
Masttype: HC+0_c - 120gr
Mast: 1187



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	50 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24,5 m/s
Terreincategorie	II
Reductie factor Cdir	1,00
IJsgebied	B
Masttype	Hoekmast
Masthoogte	53,1 m
Max. veldlengte	400 m
Lijnhoek	140°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	481 m
Min. Weight span	110 m
Max. Weight span	565 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-07-16			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype HC+0_c - 140gr

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

Document name:

RLL-TLB380_HC+0_c - 140gr_1187_Report.pdf

Project number:

Project client number:

0.0											

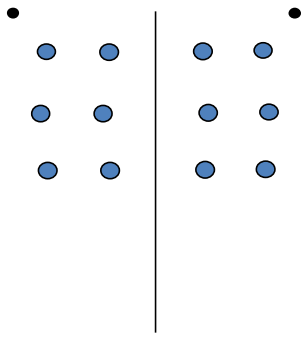
Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

Geleiderbelastingen

Auteur: TBR
Versie: v12.0

Algemeen

Benaming	HC+0_c - 140gr
Masttype	Hoekmast
Aantal circuits	4
Configuratie	4-circuit-dubbel verticaal
Aantal bliksemgeleiders	2



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	50 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	50 jaar
Windgebied	III
Windsnelheid (m/s)	24,5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1,00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 3	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Circuit 4	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800
Bliksemdraad 2		OPGW AFL-226/38	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	Afspanketting	3,00	6,50	1,10
Circuit 2	Afspanketting	3,00	6,50	1,10
Circuit 3	Afspanketting	2,00	4,50	0,80
Circuit 4	Afspanketting	2,00	4,50	0,80
Bliksemdraad 1	Afspanketting	0,10	0,20	0,10
Bliksemdraad 2	Afspanketting	0,10	0,20	0,10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	48,0 m	48,0 m	-12,1 m
Circuit 1	11	380ct1f2	38,0 m	38,0 m	-15,6 m
Circuit 1	12	380ct1f3	28,5 m	28,5 m	-12,7 m
Circuit 2	40	380ct2f1	48,0 m	48,0 m	12,1 m
Circuit 2	41	380ct2f2	38,0 m	38,0 m	15,6 m
Circuit 2	42	380ct2f3	28,5 m	28,5 m	12,7 m
Circuit 3	20	150ct3f1	48,0 m	48,0 m	-4,8 m
Circuit 3	21	150ct3f2	38,0 m	38,0 m	-8,3 m
Circuit 3	22	150ct3f3	28,5 m	28,5 m	-5,4 m
Circuit 4	30	150ct4f1	48,0 m	48,0 m	4,8 m
Circuit 4	31	150ct4f2	38,0 m	38,0 m	8,3 m
Circuit 4	32	150ct4f3	28,5 m	28,5 m	5,4 m
Bliksemdraad 1	1	bl1	53,1 m	53,1 m	-18,3 m
Bliksemdraad 2	3	bl2	53,1 m	53,1 m	18,3 m

Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	18,0 m	6,0 m	(positief: omhoog)
Verlaging voor verticale belasting	-9,0 m	-9,0 m	(negatief: omlaag, grotere weight span)
Verlaging: Niet in 0,9EG-combinaties			

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

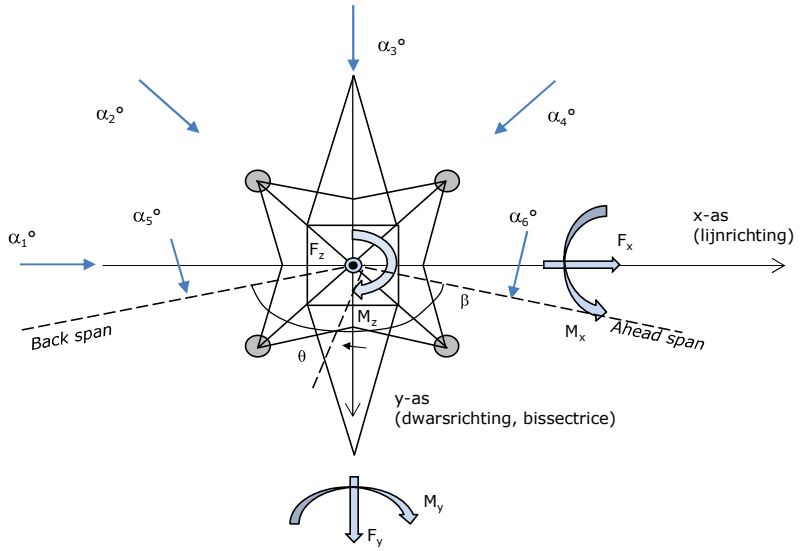
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0,0	0,0 m	0,0	0,0 m
Circuit 1	11	380ct1f2	0,0	0,0 m	0,0	0,0 m
Circuit 1	12	380ct1f3	0,0	0,0 m	0,0	0,0 m
Circuit 2	40	380ct2f1	0,0	0,0 m	0,0	0,0 m
Circuit 2	41	380ct2f2	0,0	0,0 m	0,0	0,0 m
Circuit 2	42	380ct2f3	0,0	0,0 m	0,0	0,0 m
Circuit 3	20	150ct3f1	0,0	0,0 m	0,0	0,0 m
Circuit 3	21	150ct3f2	0,0	0,0 m	0,0	0,0 m
Circuit 3	22	150ct3f3	0,0	0,0 m	0,0	0,0 m
Circuit 4	30	150ct4f1	0,0	0,0 m	0,0	0,0 m
Circuit 4	31	150ct4f2	0,0	0,0 m	0,0	0,0 m
Circuit 4	32	150ct4f3	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 1	1	bl1	0,0	0,0 m	0,0	0,0 m
Bliksemdraad 2	3	bl2	0,0	0,0 m	0,0	0,0 m

Lijn- en mastgegevens

		Back	Ahead
		400,0	400,0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400,0	400,0 m
Lijnhoek	β	140 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		400	400 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	70 °	
	α_6	110 °	

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

Windrichtingen en positieve richtingen belastingen



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

Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

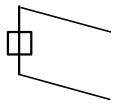
Geleiderafval

		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	150ct3f1	1	0	1	0	1	0
Circuit 3	150ct3f2	1	0	1	0	1	0
Circuit 3	150ct3f3	1	0	1	0	1	0
Circuit 4	150ct4f1	0	1	1	0	1	0
Circuit 4	150ct4f2	0	1	1	0	1	0
Circuit 4	150ct4f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0
Bliksemdraad 2	bl2	0	1	1	0	1	0

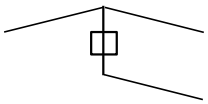
Belastingsituaties SPLS

Beschouwde situaties SPLS: 1 t/m 6, alle mogelijke situaties.

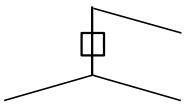
Principe belastingssituaties:



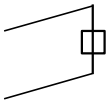
1. Ba All cts



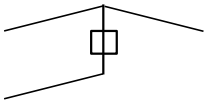
2. Ba ct1



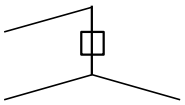
3. Ba ct2



4. Ah All cts



5. Ah ct1

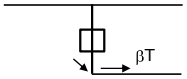


6. Ah ct2

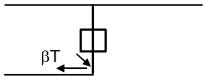
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

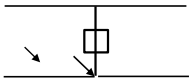
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht.
Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4,0 kN	2,0 kN
Puntlast op traverse	1,0 kN	1,0 kN

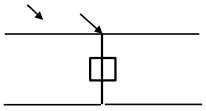
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

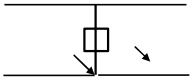
Principe belastingssituaties:



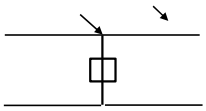
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

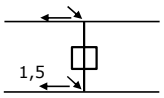
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

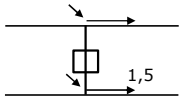
Beschouwde situaties lijndansen 8: 1 en 2, alle mogelijke situaties.

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: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

Mastconstructie

Eigenschappen

Masttype	Hoekmast	
Mastbenaming	HC+0_c - 140gr	
Voetplaat t.o.v. maaiveld	0,5	m
Masthoogte t.o.v. voetplaat	53,1	m
Gewicht mast	1021,2	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	11,76	11,76	m
Helling van de randstijl	0,190	0,190	-
Factor spatkracht	1,1	1,1	-

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 langsrichting (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	15,40	11,76	5,91	15,40	0,190	136,07	31,88	0,23	2,79
Eerste tussenstuk	22,20	5,91	5,23	6,80	0,050	37,88	13,58	0,36	2,34
Tweede tussenstuk	28,50	5,23	4,60	6,30	0,050	30,96	10,07	0,33	2,45
Bovenstuk 1	38,00	4,60	3,65	9,50	0,050	39,19	12,64	0,32	2,46
Bovenstuk 2	51,40	3,65	2,31	13,40	0,050	39,93	13,53	0,34	2,40
Topstuk	53,10	2,31		1,70		1,96	0,33	0,17	3,08
Ondertraverse	28,50	10,70		3,10		16,59	5,05	0,30	2,52
Middentraverse	38,00	14,08		3,20		22,52	6,95	0,31	2,50
Boventraverse	48,00	16,98		5,10		43,29	8,13	0,19	2,98

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	15,40	11,76	5,91	15,40	0,190	136,07	31,88	0,23	2,79
Eerste tussenstuk	22,20	5,91	5,23	6,80	0,050	37,88	13,58	0,36	2,34
Tweede tussenstuk	28,50	5,23	4,60	6,30	0,050	30,96	10,07	0,33	2,45
Bovenstuk 1	38,00	4,60	3,65	9,50	0,050	39,19	12,64	0,32	2,46
Bovenstuk 2	51,40	3,65	2,31	13,40	0,050	39,93	13,53	0,34	2,40
Topstuk	53,10	2,31		1,70		1,96	0,33	0,17	3,08
Ondertraverse	28,50	10,70		3,10		16,59	5,05	0,30	2,52
Middentraverse	38,00	14,08		3,20		22,52	6,95	0,31	2,50
Boventraverse	48,00	16,98		5,10		43,29	8,13	0,19	2,98

NB: oppervlakte traverse dwarsrichting van de tabel wordt in berekening gereduceerd.
NB: oppervlakte traverse per zijde, dus helft van totaal van twee traverses.

Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0,14	0,71	15,4	1,5
Eerste tussenstuk	0,14	0,71	6,8	0,7
Tweede tussenstuk	0,14	0,71	6,3	0,6
Bovenstuk 1	0,14	0,71	9,5	0,9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4,7	34,7	1,5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	62,3	52,8	0,0	-52,8	7,7	479,4	406,8	0,0	-406,8
Eerste tussenstuk	0,86	27,4	23,2	0,0	-23,2	18,8	514,6	436,6	0,0	-436,6
Tweede tussenstuk	0,94	23,2	19,7	0,0	-19,7	25,4	588,3	499,2	0,0	-499,2
Bovenstuk 1	1,02	31,7	26,9	0,0	-26,9	33,3	1054,8	895,0	0,0	-895,0
Bovenstuk 2	1,10	35,8	30,4	0,0	-30,4	44,7	1601,8	1359,2	0,0	-1359,2
Topstuk	1,15	1,2	1,0	0,0	-1,0	52,3	60,7	51,5	0,0	-51,5
Ondertraverse	0,98	25,0	14,9	0,0	-14,9	29,5	739,2	439,1	0,0	-439,1
Middentraverse	1,06	37,0	22,0	0,0	-22,0	39,1	1446,1	859,0	0,0	-859,0
Boventraverse	1,13	55,0	32,7	0,0	-32,7	49,7	2734,8	1624,4	0,0	-1624,4
Totaal		298,6	223,6	0,0	-223,6		9219,8	6570,8	0,0	-6570,8

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	52,8	62,3	52,8	7,7	0,0	406,8	479,4	406,8
Eerste tussenstuk	0,86	0,0	23,2	27,4	23,2	18,8	0,0	436,6	514,6	436,6
Tweede tussenstuk	0,94	0,0	19,7	23,2	19,7	25,4	0,0	499,2	588,3	499,2
Bovenstuk 1	1,02	0,0	26,9	31,7	26,9	33,3	0,0	895,0	1054,8	895,0
Bovenstuk 2	1,10	0,0	30,4	35,8	30,4	44,7	0,0	1359,2	1601,8	1359,2
Topstuk	1,15	0,0	1,0	1,2	1,0	52,3	0,0	51,5	60,7	51,5
Ondertraverse	0,98	0,0	14,9	10,0	14,9	29,5	0,0	439,1	295,7	439,1
Middentraverse	1,06	0,0	22,0	14,8	22,0	39,1	0,0	859,0	578,5	859,0
Boventraverse	1,13	0,0	32,7	22,0	32,7	49,7	0,0	1624,4	1093,9	1624,4
Totaal		0,0	223,6	228,4	223,6		0,0	6570,8	6267,7	6570,8

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	1021	0	0	0
Windrichting 0°	306	0	0	0	9472	0
Windrichting 45°	229	229	0	6749	6749	0
Windrichting 90°	0	236	0	6520	0	0
Windrichting 135°	-229	229	0	6749	-6749	0

Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 2	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 3	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Circuit 4	AAAC-AL7 620	32,4	621,0	17,71	56000	2,30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21,8	281,0	9,38	70165	1,97E-05
Bliksemdraad 2	OPGW AFL-226/38	21,7	264,0	9,13	72000	1,98E-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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 2	4	3	73,0	B	4+0,2d	10,5	41,9
Circuit 3	2	3	36,5	B	4+0,2d	10,5	21,0
Circuit 4	2	3	36,5	B	4+0,2d	10,5	21,0
Bliksemdraad 1	1	2	9,6	A	15+0,4d	23,7	23,7
Bliksemdraad 2	1	2	9,3	A	15+0,4d	23,7	23,7

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	3,00	1	3	6,5	1,1	48,50	1,13	1,2	1,49
380ct1f2	3,00	1	3	6,5	1,1	38,50	1,06	1,2	1,40
380ct1f3	3,00	1	3	6,5	1,1	29,00	0,98	1,2	1,29
380ct2f1	3,00	1	3	6,5	1,1	48,50	1,13	1,2	1,49
380ct2f2	3,00	1	3	6,5	1,1	38,50	1,06	1,2	1,40
380ct2f3	3,00	1	3	6,5	1,1	29,00	0,98	1,2	1,29
150ct3f1	2,00	1	2	4,5	0,8	48,50	1,13	1,2	1,08
150ct3f2	2,00	1	2	4,5	0,8	38,50	1,06	1,2	1,02
150ct3f3	2,00	1	2	4,5	0,8	29,00	0,98	1,2	0,94
150ct4f1	2,00	1	2	4,5	0,8	48,50	1,13	1,2	1,08
150ct4f2	2,00	1	2	4,5	0,8	38,50	1,06	1,2	1,02
150ct4f3	2,00	1	2	4,5	0,8	29,00	0,98	1,2	0,94
bl1	0,10	1	0,1	0,2	0,1	53,60	1,16	1,2	0,14
bl2	0,10	1	0,1	0,2	0,1	53,60	1,16	1,2	0,14

Project: RLL-TLB380
Tower: HC+0_c - 140gr
Number: 1187

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	50,1	1,14	0,62	0,68	0,96	33,37	89,8	98,8	51,8	174,5	191,9
380ct1f2	40,1	1,07	0,60	0,66	0,98	33,37	84,0	92,4	51,8	159,9	175,9
380ct1f3	30,6	0,99	0,58	0,64	1,00	33,37	77,1	84,9	51,8	143,2	157,6
380ct2f1	50,1	1,14	0,62	0,68	0,96	33,37	89,8	98,8	51,8	174,5	191,9
380ct2f2	40,1	1,07	0,60	0,66	0,98	33,37	84,0	92,4	51,8	159,9	175,9
380ct2f3	30,6	0,99	0,58	0,64	1,00	33,37	77,1	84,9	51,8	143,2	157,6
150ct3f1	50,1	1,14	0,62	0,68	0,96	33,37	44,9	49,4	51,8	87,3	95,9
150ct3f2	40,1	1,07	0,60	0,66	0,98	33,37	42,0	46,2	51,8	79,9	88,0
150ct3f3	30,6	0,99	0,58	0,64	1,00	33,37	38,6	42,4	51,8	71,6	78,8
150ct4f1	50,1	1,14	0,62	0,68	0,96	33,37	44,9	49,4	51,8	87,3	95,9
150ct4f2	40,1	1,07	0,60	0,66	0,98	33,37	42,0	46,2	51,8	79,9	88,0
150ct4f3	30,6	0,99	0,58	0,64	1,00	33,37	38,6	42,4	51,8	71,6	78,8
bl1	55,2	1,17	0,62	0,69	1,18	22,24	19,1	21,0	63,1	55,2	60,6
bl2	55,2	1,17	0,62	0,69	1,18	22,13	19,0	20,9	63,0	55,1	60,5

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	44,1	1,10	0,61	0,67	0,97	33,37	86,5	95,1	51,8	166,0	182,6
380ct1f2	34,1	1,02	0,59	0,65	0,99	33,37	79,9	87,9	51,8	149,7	164,8
380ct1f3	24,6	0,93	0,56	0,62	1,02	33,37	71,7	78,9	51,8	130,4	143,6
380ct2f1	44,1	1,10	0,61	0,67	0,97	33,37	86,5	95,1	51,8	166,0	182,6
380ct2f2	34,1	1,02	0,59	0,65	0,99	33,37	79,9	87,9	51,8	149,7	164,8
380ct2f3	24,6	0,93	0,56	0,62	1,02	33,37	71,7	78,9	51,8	130,4	143,6
150ct3f1	44,1	1,10	0,61	0,67	0,97	33,37	43,2	47,6	51,8	83,0	91,3
150ct3f2	34,1	1,02	0,59	0,65	0,99	33,37	39,9	43,9	51,8	74,9	82,4
150ct3f3	24,6	0,93	0,56	0,62	1,02	33,37	35,8	39,5	51,8	65,2	71,8
150ct4f1	44,1	1,10	0,61	0,67	0,97	33,37	43,2	47,6	51,8	83,0	91,3
150ct4f2	34,1	1,02	0,59	0,65	0,99	33,37	39,9	43,9	51,8	74,9	82,4
150ct4f3	24,6	0,93	0,56	0,62	1,02	33,37	35,8	39,5	51,8	65,2	71,8
bl1	49,2	1,13	0,62	0,68	1,19	22,24	18,4	20,2	63,1	52,8	58,0
bl2	49,2	1,13	0,62	0,68	1,19	22,13	18,3	20,1	63,0	52,7	57,9

NB: belastingen w_v gelden voor bundel

Project: RLL-TLB380
Masttype: HC+0_c - 140gr
Mast: 1187

Geleiderbelastingen

Auteur: TBR
Versie: v12.0

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw 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°	1,20	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0,90	1,20	0,00	1,50	0,00	0,0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0,90	0,90	0,00	1,50	0,00	0,0
ULS 3	Wind+ijs	-5°	1,20	1,20	0,00	0,45	1,50	0,0
ULS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,00	0,45	1,50	0,0
ULS 4	Koude+wind	-20°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,00	0,30	0,00	0,0
ULS 5a	Torsiebelastingen	10°	1,00	1,00	1,00	0,00	0,00	1,0
ULS 5b	Longitudinale belastingen	10°	1,00	1,00	0,00	0,00	0,00	1,0
ULS 6	Bouw en onderhoud	5°	1,20	1,20	1,50	0,30	0,00	0,0
ULS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	0,00	0,30	0,00	0,0
ULS 7	Permanent	10°	1,35	1,35	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°	1,20	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9	Wind 0,9	10°	0,90	1,20	0,0	0,78	0,00	0,0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0,90	0,90	0,0	0,78	0,00	0,0
SPLS 3	Wind+ijs	-5°	1,20	1,20	0,0	0,36	0,34	0,0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0,90	1,20	0,0	0,36	0,34	0,0
SPLS 4	Koude+wind	-20°	1,20	1,20	0,0	0,24	0,00	0,0
SPLS 4_0,9	Koude+wind 0,9	-20°	0,90	1,20	0,0	0,24	0,00	0,0
SPLS 6	Bouw en onderhoud	5°	1,20	1,20	1,2	0,24	0,0	0,0
SPLS 6_0,9	Bouw en onderhoud	5°	1,20	1,20	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	Bouw en onderhoud	5°	1,00	1,00	0,0	0,20	0,0	0,0
SLS 7	PB (EDS, geen wind)	10°	1,00	1,00	0,0	0,00	0,0	0,0

Aantal windrichtingen	6
Aantal belastingcombinaties ULS	100
Aantal belastingcombinaties SPLS	246
Aantal belastingcombinaties SLS	15
Aantal knooplasten	12274

Project: RLL-TLB380
Masttype: HC+0_c - 140gr
Mast: 1187

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 (Ba+Ah) in het globale assenstelsel 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

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	-61,8	61,4	27,8	27,5	11,1	11,0
380ct1f1	-249,6	247,6	115,6	112,9	39,8	39,7
380ct1f2	-246,2	244,1	110,8	107,4	39,7	39,6
380ct1f3	-242,7	240,3	105,1	100,7	39,6	39,5
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	0,0	0,0	0,0	0,0	0,0	
380ct2f1	-249,6	247,6	115,6	112,9	39,8	39,7
380ct2f2	-246,2	244,1	110,8	107,4	39,7	39,6
380ct2f3	-242,7	240,3	105,1	100,7	39,6	39,5
150ct3f1	-124,7	123,8	58,3	56,9	21,3	21,3
150ct3f2	-123,1	122,0	55,9	54,2	21,3	21,3
150ct3f3	-121,3	120,1	53,0	50,8	21,3	21,3
150ct4f1	-124,7	123,8	58,3	56,9	21,3	21,3
150ct4f2	-123,1	122,0	55,9	54,2	21,3	21,3
150ct4f3	-121,3	120,1	53,0	50,8	21,3	21,3
bl2	-60,9	60,5	27,5	27,1	11,0	10,9
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	0,0	0,0	0,0	0,0	0,0	
Post-isolato	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	483,1	497,1	481,0
380ct1f1	481,8	496,1	481,0
380ct1f2	481,7	495,8	481,0
380ct1f3	481,6	495,5	481,0
Post-isolator 1			
Post-isolator 2			
Post-isolator 3			
380ct2f1	481,8	496,1	481,0
380ct2f2	481,7	495,8	481,0
380ct2f3	481,6	495,5	481,0
150ct3f1	481,8	496,1	481,0
150ct3f2	481,7	495,8	481,0
150ct3f3	481,6	495,5	481,0
150ct4f1	481,8	496,1	481,0
150ct4f2	481,7	495,8	481,0
150ct4f3	481,6	495,5	481,0
bl2	483,2	497,3	481,0
Post-isolator 4			
Post-isolator 5			
Post-isolator 6			

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	564,6	463,1
380ct1f1	522,6	479,3
380ct1f2	518,2	478,3
380ct1f3	512,8	477,2
Post-isolator 1		
Post-isolator 2		
Post-isolator 3		
380ct2f1	522,6	479,3
380ct2f2	518,2	478,3
380ct2f3	512,8	477,2
150ct3f1	522,6	479,3
150ct3f2	518,2	478,3
150ct3f3	512,8	477,2
150ct4f1	522,6	479,3
150ct4f2	518,2	478,3
150ct4f3	512,8	477,2
bl2	567,0	462,7
Post-isolator 4		
Post-isolator 5		
Post-isolator 6		

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	564,6 m	1,412 -
Min. weight span	110,0 m	0,275 -

Project: RLL-TLB380
Masttype: HC+0_c - 140gr
Mast: 1187

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	36,7	53,3	11,1	-67,6	67,1
380ct1f1	195,1	210,8	39,8	-271,5	269,2
380ct1f2	191,4	203,2	39,7	-267,5	264,9
380ct1f3	187,5	198,1	39,6	-263,3	260,2
Post-isolato	4,2	4,2	6,8	0,0	
Post-isolato	3,2	3,2	4,7	0,0	
Post-isolato	4,9	4,9	6,8	0,0	
380ct2f1	195,1	210,8	39,8	-271,5	269,2
380ct2f2	191,4	203,2	39,7	-267,5	264,9
380ct2f3	187,5	198,1	39,6	-263,3	260,2
150ct3f1	102,8	106,2	21,3	-135,8	134,6
150ct3f2	102,7	101,9	21,3	-133,8	132,4
150ct3f3	102,7	99,3	21,3	-131,6	130,1
150ct4f1	102,8	106,2	21,3	-135,8	134,6
150ct4f2	102,7	101,9	21,3	-133,8	132,4
150ct4f3	102,7	99,3	21,3	-131,6	130,1
bl2	36,2	52,7	11,0	-66,7	66,1
Post-isolato	4,2	4,2	6,8	0,0	
Post-isolato	3,2	3,2	4,7	0,0	
Post-isolato	4,9	4,9	6,8	0,0	

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	16,2	5,9	2,4	-17,2	17,2
380ct1f1	123,4	44,9	20,5	-131,3	131,3
380ct1f2	123,4	44,9	20,5	-131,3	131,3
380ct1f3	123,4	44,9	20,5	-131,3	131,3
Post-isolato	0,0	0,0	5,0	0,0	
Post-isolato	0,0	0,0	3,5	0,0	
Post-isolato	0,0	0,0	5,0	0,0	
380ct2f1	123,4	44,9	20,5	-131,3	131,3
380ct2f2	123,4	44,9	20,5	-131,3	131,3
380ct2f3	123,4	44,9	20,5	-131,3	131,3
150ct3f1	61,7	22,5	10,8	-65,7	65,7
150ct3f2	61,7	22,5	10,8	-65,7	65,7
150ct3f3	61,7	22,5	10,8	-65,7	65,7
150ct4f1	61,7	22,5	10,8	-65,7	65,7
150ct4f2	61,7	22,5	10,8	-65,7	65,7
150ct4f3	61,7	22,5	10,8	-65,7	65,7
bl2	15,7	5,7	2,3	-16,8	16,8
Post-isolato	0,0	0,0	5,0	0,0	
Post-isolato	0,0	0,0	3,5	0,0	
Post-isolato	0,0	0,0	5,0	0,0	

Controle 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
	Post-isolato	0,0	
	Post-isolato	0,0	
	Post-isolato	0,0	
	380ct2f1	0,0	0,0
	380ct2f2	0,0	0,0
	380ct2f3	0,0	0,0
	150ct3f1	0,0	0,0
	150ct3f2	0,0	0,0
	150ct3f3	0,0	0,0
	150ct4f1	0,0	0,0
	150ct4f2	0,0	0,0
	150ct4f3	0,0	0,0
	bl2	0,0	0,0
	Post-isolato	0,0	
	Post-isolato	0,0	
	Post-isolato	0,0	

Project: RLL-TLB380
Masttype: HC+0_c - 140gr
Mast: 1187

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		-49	1916	526	74870	-1824	0
ULS 1a_0,9_0		43	978	335	37764	1684	0
ULS 1a_0,9_0,9_90		-55	1826	200	71459	-2043	0
ULS 3_0		18	1591	789	61941	722	0
SLS 7		0	832	412	32092	0	0

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

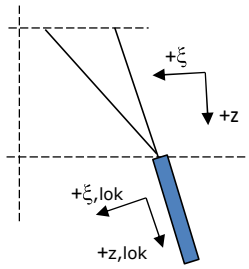
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-49	2270	1751	84650	-1824	0
ULS 1a_0,9_0,9_90	-55	2180	1119	81238	-2043	0
SLS 7	0	832	1434	32092	0	0

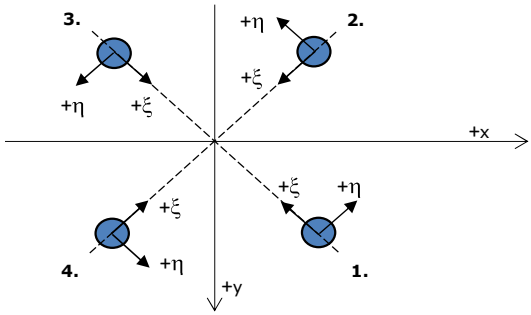
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0,9_90	-49	2270	1210	**84651**	-1824	0
SPLS 3_70 Ah All Cts	-1760	818	1562	30867	**-68826**	9
SPLS 3_70 Ba Ct1	789	1096	1675	42893	30078	**-10169**
SPLS 3_0,9_70 Ah All Cts	-1760	818	1118	**30868**	**-68826**	9

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	SPLS 3_110 Ba All Cts	786	887	**4571**	-71	-1183	45	4733
2	SPLS 3_0 Ba All Cts	312	-517	**2218**	144	-586	10	2296
3	ULS 8 Ba	-294	-510	**2165**	-153	-568	13	2242
4	SPLS 3_70 Ah All Cts	-796	898	**4629**	72	-1198	46	4793

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 8 Ba	-136	-353	**-1411**	154	346	-34	-1461
2	SPLS 3_0,9_70 Ah All Cts	-656	757	**-3959**	-72	999	-64	-4099
3	SPLS 3_0,9_110 Ba All Cts	643	743	**-3886**	71	980	-64	-4024
4	SPLS 3_0,9_0 Ba All Cts	169	-374	**-1534**	-145	384	-28	-1588

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	SPLS 3_90 Ah Ct1	469	-143	843	**433**	-230	-4	873
2	SPLS 3_0,9_90 Ba Ct2	-308	-288	-78	**422**	14	-7	-81
3	SPLS 3_70 Ba Ct2	252	669	-2571	**295**	651	-40	-2663
4	SPLS 3_0,9_110 Ah Ct1	-429	824	3419	**279**	-887	32	3541

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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_70 Ba Ct1	420	821	3378	**-284**	-878	30	3498
2	SPLS 3_110 Ah Ct2	-260	674	-2605	**-293**	660	-40	-2697
3	SPLS 3_0,9_90 Ah Ct2	299	-293	-32	**-419**	4	-4	-33
4	SPLS 3_90 Ba Ct1	-477	-137	883	**-434**	-240	-3	914

Project: RLL-TLB380
Masttype: HC+0_c - 140gr
Mast: 1187

Combinatie Ftrek+Fhor

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 8 Ba	-136	-353	**-1411**	**154**	346	-34	-1461
2	SPLS 3_0,9_70 Ah All Cts	-656	757	**-3959**	**-72**	999	-64	-4099
3	SPLS 3_0,9_110 Ba All Cts	643	743	**-3886**	**71**	980	-64	-4024
4	SPLS 3_0,9_0 Ba All Cts	169	-374	**-1534**	**-145**	384	-28	-1588

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	360	283	1723	55	-455	8	1784
2	SLS 7	-210	133	-1006	55	243	-28	-1041
3	SLS 7	210	133	-1006	-55	243	-28	-1041
4	SLS 7	-360	283	1723	-55	-455	8	1784

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	SPLS 3_70 Ah All Cts	-796	898	**4629**	72	-1198	46	4793
Max. trek	SPLS 3_0,9_70 Ah All Cts	-656	757	**-3959**	-72	999	-64	-4099
Max. pos. torsie	SPLS 3_90 Ah Ct1	469	-143	843	**433**	-230	-4	873
Max. neg. torsie	SPLS 3_90 Ba Ct1	-477	-137	883	**-434**	-240	-3	914
Comb. trek+torsie	SPLS 3_0,9_70 Ah All Cts	-656	757	**-3959**	**-72**	999	-64	-4099

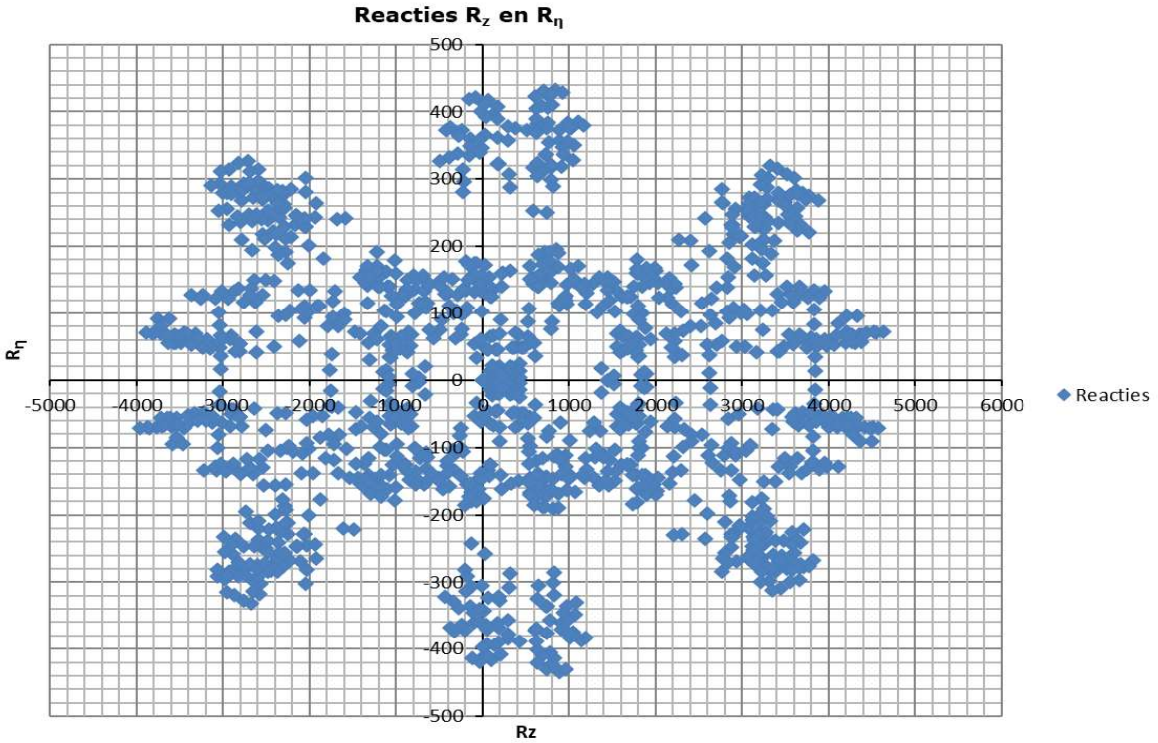
Maximale trekbelasting SLS

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	SPLS 3_0,9_70 Ah All Cts	-107	-349	**-1334**	171	323	-36	-1382
2	SPLS 3_0,9_70 Ah All Cts	-656	757	**-3959**	-72	999	-64	-4099
3	SPLS 3_0,9_110 Ba All Cts	643	743	**-3886**	71	980	-64	-4024
4	SPLS 3_0,9_110 Ba All Cts	102	-341	**-1300**	-169	313	-36	-1346

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	SPLS 3_110 Ba All Cts	786	887	**4571**	-71	-1183	45	4733
2	SPLS 3_110 Ba All Cts	246	-483	**1984**	168	-516	18	2055
3	SPLS 3_70 Ah All Cts	-248	-489	**2004**	-170	-521	18	2075
4	SPLS 3_70 Ah All Cts	-796	898	**4629**	72	-1198	46	4793

Project: RLL-TLB380
Masttype: HC+0_c - 140gr
Mast: 1187



Inhoud

- Uitgangspunten p. 2
- Mastconstructie p. 6
- Tussenresultaten p. 8
- Belastingen initiëel p. 10
- Belastingen na aanpassing p. 15

Gegevens

Norm	NEN-EN50341-2-15:2019
Initieel	
Gevolgklasse	CC2
Betrouwbaarheidsniveau	Nieuwbouw
Referentieperiode	15 jaar
Na aanpassing	
Gevolgklasse	n.v.t.
Betrouwbaarheidsniveau	n.v.t.
Referentieperiode	n.v.t.
Windgebied	III
Windsnelheid	24.5 m/s
Terreincategorie	II
Reductie factor Cdir	1.00
IJsgebied	B
Masttype	Hoekmast
Masthoogte	53.1 m
Max. veldlengte	400 m
Lijnhoek	140°
Trekparameter	1800 m
Wind span	400 m
EDS Weight span	481 m
Min. Weight span	143 m
Max. Weight span	547 m

ISSUE	DATE	REVISION	CHK'D	APP'D
0.0	2021-07-16			

Client: TenneT Taking power further

DNV

Title:

Berekening masttype HC+0_c - bouwfase

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

Document name:

RLL-TLB380_HC+0_c - bouwfase_1187_Report.pdf

Project number:

Project client number:

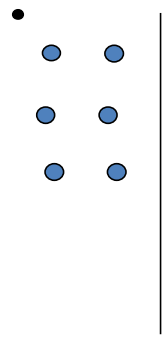
0.0											

Geleiderbelastingen

Auteur: TBR
Versie: v12.0

Algemeen

Benaming	HC+0_c - bouwfase
Masttype	Hoekmast
Aantal circuits	2
Configuratie	2-circuit-verticaal
Aantal bliksemgeleiders	1



Configuratie geleiders

Uitgangspunten

Norm	NEN-EN50341-2-15:2019
Gevolgklasse initieel	CC2
Betrouwbaarheidsniveau initieel	Nieuwbouw
Referentieperiode initieel	15 jaar
	CC2
Betrouwbaarheidsniveau na aanpassing	n.v.t.
	15 jaar
Windgebied	III
Windsnelheid (m/s)	24.5 m/s
Terreincategorie	II
Reductiefactor c_{dir}	1.00
IJsgebied fasegeleider	B
IJsgebied bliksemgeleider	A

Geleiders Back

Omschrijving	Spanning	Geleider Back	Bundel Ba	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{back}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800

Geleiders Ahead

Omschrijving	Spanning	Geleider Ahead	Bundel Ah	IJsgebied	Toeslag gewicht	Toeslag diameter	Intrekwaarden P_{ahead}
Circuit 1	380 kV	AAAC-AL7 620	4	B	3 %	3 %	1800
Circuit 2	150 kV	AAAC-AL7 620	2	B	3 %	3 %	1800
Bliksemdraad 1		AACSR 241-AL3-39-A20SA	1	A	2 %	2 %	1800

Isolatoren *(1)*

Omschrijving	Ophanging	Gewicht [kN]	Lengte [m]	Windopp. [m^2]
Circuit 1	Afspanketting	3.00	6.50	1.10
Circuit 2	Afspanketting	3.00	6.50	1.10
Bliksemdraad 1	Afspanketting	0.10	0.20	0.10

1. Eigenschappen gelden voor geheel van de isolatorset

Ophanghoogte en positie in mast

Circuits	Aanduiding	Nummer	Ophanghoogte	Aangrijppunt	Positie in mast Horizontale afstand
Circuit 1	10	380ct1f1	48.0 m	48.0 m	-12.1 m
Circuit 1	11	380ct1f2	38.0 m	38.0 m	-15.6 m
Circuit 1	12	380ct1f3	28.5 m	28.5 m	-12.7 m
Circuit 2	40	150ct2f1	48.0 m	48.0 m	-4.8 m
Circuit 2	41	150ct2f2	38.0 m	38.0 m	-8.3 m
Circuit 2	42	150ct2f3	28.5 m	28.5 m	-5.4 m
Bliksemdraad 1	1	bl1	53.1 m	53.1 m	-18.3 m

Project: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

Hoogteaanpassing naastgelegen masten (aanpassing wind- en weight span)

	Back	Ahead	
Verhoging voor windbelasting	18.0 m	6.0 m	(positief: omhoog)
Verlaging voor verticale belasting	-9.0 m	-9.0 m	(negatief: omlaag, grotere weight span)
Verlaging: Niet in 0,9EG-combinaties			

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

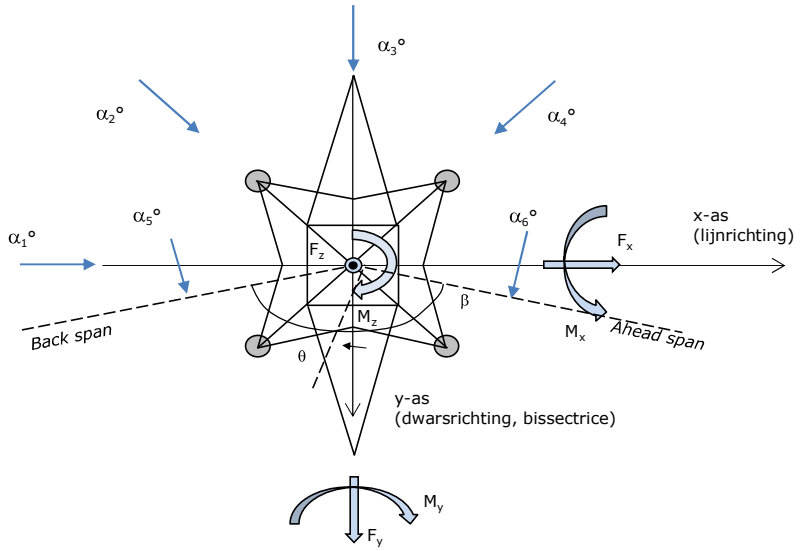
			Hoogteverschil		Richtingsverandering	
Circuits	Aanduiding	Nummer	Δh_back	Δh_ahead	Δy_back	Δy_ahead
Circuit 1	10	380ct1f1	0.0	0.0 m	0.0	0.0 m
Circuit 1	11	380ct1f2	0.0	0.0 m	0.0	0.0 m
Circuit 1	12	380ct1f3	0.0	0.0 m	0.0	0.0 m
Circuit 2	40	150ct2f1	0.0	0.0 m	0.0	0.0 m
Circuit 2	41	150ct2f2	0.0	0.0 m	0.0	0.0 m
Circuit 2	42	150ct2f3	0.0	0.0 m	0.0	0.0 m
Bliksemdraad 1	1	bl1	0.0	0.0 m	0.0	0.0 m

Lijn- en mastgegevens

		Back	Ahead
		400.0	400.0 m
Ruling span $\sqrt{(\Sigma L^3/\Sigma L)}$		400.0	400.0 m
Lijnhoek	β	140 °	
Rotatie mast t.o.v. bissectrice	θ	0 °	
Vaklengte		400	400 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	70 °	
	α_6	110 °	

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

Windrichtingen en positieve richtingen belastingen



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

Project: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

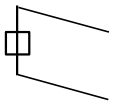
Geleiderafval

		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	150ct2f1	0	1	1	0	1	0
Circuit 2	150ct2f2	0	1	1	0	1	0
Circuit 2	150ct2f3	0	1	1	0	1	0
Bliksemdraad 1	bl1	1	0	1	0	1	0

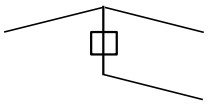
Belastingsituaties SPLS

Beschouwde situaties SPLS: 1 t/m 6, alle mogelijke situaties.

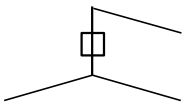
Principe belastingssituaties:



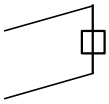
1. Ba All cts



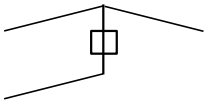
2. Ba ct1



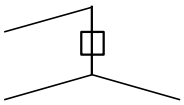
3. Ba ct2



4. Ah All cts



5. Ah ct1

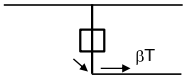


6. Ah ct2

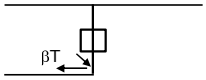
Belastingsituaties 5a. Geleiderbreuk

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

Principe belastingssituaties:



1. Ba



2. Ah

Project: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

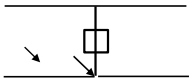
Belastingsituaties 6. Bouw- en onderhoud
Onder 6a wordt de belasting door aanwezigheid lijnwagen of lijnfiets in combinatie met puntlast op traverse in rekening gebracht.
Combinatie 6b bevat geen belastingen in geleider of op traverse. Deze combinatie is toegevoegd om te kunnen combineren met separate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

	Fase	Bliksem
Lijnwagen	4.0 kN	2.0 kN
Puntlast op traverse	1.0 kN	1.0 kN

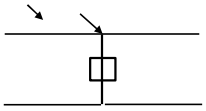
Beschouwde situaties bouw- en onderhoud 6a: 1 t/m 4, alle mogelijke situaties.

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

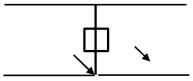
Principe belastingssituaties:



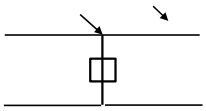
1. Ba Ct1



2. Ba Ct2



3. Ah Ct1



4. Ah Ct2

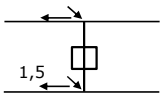
Belastingsituaties 8. Lijndansen als statische belasting

Geleider		
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

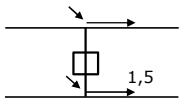
Beschouwde situaties lijndansen 8: 1 en 2, alle mogelijke situaties.

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: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

Mastconstructie

Eigenschappen

Masttype	Hoekmast	
Mastbenaming	HC+0_c - bouwfase	
Voetplaat t.o.v. maaiveld	0.5	m
Masthoogte t.o.v. voetplaat	53.1	m
Gewicht mast	1021.2	kN

Breedte en helling mast bij fundatie	x-ri.	y-ri.	
Pootsprei	11.76	11.76	m
Helling van de randstijl	0.190	0.190	-
Factor spatkracht	1.1	1.1	-

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 langsrichting (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	15.40	11.76	5.91	15.40	0.190	136.07	31.88	0.23	2.79
Eerste tussenstuk	22.20	5.91	5.23	6.80	0.050	37.88	13.58	0.36	2.34
Tweede tussenstuk	28.50	5.23	4.60	6.30	0.050	30.96	10.07	0.33	2.45
Bovenstuk 1	38.00	4.60	3.65	9.50	0.050	39.19	12.64	0.32	2.46
Bovenstuk 2	51.40	3.65	2.31	13.40	0.050	39.93	13.53	0.34	2.40
Topstuk	53.10	2.31		1.70		1.96	0.33	0.17	3.08
Ondertraverse	28.50	10.70		3.10		16.59	5.05	0.30	2.52
Middentraverse	38.00	14.08		3.20		22.52	6.95	0.31	2.50
Boventraverse	48.00	16.98		5.10		43.29	8.13	0.19	2.98

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	15.40	11.76	5.91	15.40	0.190	136.07	31.88	0.23	2.79
Eerste tussenstuk	22.20	5.91	5.23	6.80	0.050	37.88	13.58	0.36	2.34
Tweede tussenstuk	28.50	5.23	4.60	6.30	0.050	30.96	10.07	0.33	2.45
Bovenstuk 1	38.00	4.60	3.65	9.50	0.050	39.19	12.64	0.32	2.46
Bovenstuk 2	51.40	3.65	2.31	13.40	0.050	39.93	13.53	0.34	2.40
Topstuk	53.10	2.31		1.70		1.96	0.33	0.17	3.08
Ondertraverse	28.50	10.70		3.10		16.59	5.05	0.30	2.52
Middentraverse	38.00	14.08		3.20		22.52	6.95	0.31	2.50
Boventraverse	48.00	16.98		5.10		43.29	8.13	0.19	2.98

NB: oppervlakte traverse dwarsrichting van de tabel wordt in berekening gereduceerd.
NB: oppervlakte traverse per zijde, dus helft van totaal van twee traverses.

Project: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

Windoppervlak feeders telecominstallaties

Onderdeel	A (m^2/m)	Factor	Δh	A_1
Broekstuk	0.14	0.71	15.4	1.5
Eerste tussenstuk	0.14	0.71	6.8	0.7
Tweede tussenstuk	0.14	0.71	6.3	0.6
Bovenstuk 1	0.14	0.71	9.5	0.9
Bovenstuk 2				

Invoer antennes

Omschrijving	A (m^2)	h (m)	C_f (m)
Antenne top			
Antenne o.t.	4.7	34.7	1.5

Belastingen mastsectie langsrichting (x-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	62.3	52.8	0.0	-52.8	7.7	479.4	406.8	0.0	-406.8
Eerste tussenstuk	0.86	27.4	23.2	0.0	-23.2	18.8	514.6	436.6	0.0	-436.6
Tweede tussenstuk	0.94	23.2	19.7	0.0	-19.7	25.4	588.3	499.2	0.0	-499.2
Bovenstuk 1	1.02	31.7	26.9	0.0	-26.9	33.3	1054.8	895.0	0.0	-895.0
Bovenstuk 2	1.10	35.8	30.4	0.0	-30.4	44.7	1601.8	1359.2	0.0	-1359.2
Topstuk	1.15	1.2	1.0	0.0	-1.0	52.3	60.7	51.5	0.0	-51.5
Ondertraverse	0.98	25.0	14.9	0.0	-14.9	29.5	739.2	439.1	0.0	-439.1
Middentraverse	1.06	37.0	22.0	0.0	-22.0	39.1	1446.1	859.0	0.0	-859.0
Boventraverse	1.13	55.0	32.7	0.0	-32.7	49.7	2734.8	1624.4	0.0	-1624.4
Totaal		298.6	223.6	0.0	-223.6		9219.8	6570.8	0.0	-6570.8

Belastingen mastsectie dwarsrichting (y-richting) per windrichting

Omschrijving	p_w [kN/m^2]	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	52.8	62.3	52.8	7.7	0.0	406.8	479.4	406.8
Eerste tussenstuk	0.86	0.0	23.2	27.4	23.2	18.8	0.0	436.6	514.6	436.6
Tweede tussenstuk	0.94	0.0	19.7	23.2	19.7	25.4	0.0	499.2	588.3	499.2
Bovenstuk 1	1.02	0.0	26.9	31.7	26.9	33.3	0.0	895.0	1054.8	895.0
Bovenstuk 2	1.10	0.0	30.4	35.8	30.4	44.7	0.0	1359.2	1601.8	1359.2
Topstuk	1.15	0.0	1.0	1.2	1.0	52.3	0.0	51.5	60.7	51.5
Ondertraverse	0.98	0.0	14.9	10.0	14.9	29.5	0.0	439.1	295.7	439.1
Middentraverse	1.06	0.0	22.0	14.8	22.0	39.1	0.0	859.0	578.5	859.0
Boventraverse	1.13	0.0	32.7	22.0	32.7	49.7	0.0	1624.4	1093.9	1624.4
Totaal		0.0	223.6	228.4	223.6		0.0	6570.8	6267.7	6570.8

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	1021	0	0	0
Windrichting 0°	306	0	0	0	9472	0
Windrichting 45°	229	229	0	6749	6749	0
Windrichting 90°	0	236	0	6520	0	0
Windrichting 135°	-229	229	0	6749	-6749	0

Project: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

Tussenresultaten geleiderbelastingen

Geleiders back

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32.4	621.0	17.71	56000	2.30E-05
Circuit 2	AAAC-AL7 620	32.4	621.0	17.71	56000	2.30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21.8	281.0	9.38	70165	1.97E-05

Geleiders ahead

Circuit	Geleider	Diameter [mm]	A [mm^2]	G [N/m]	E [N/mm^2]	αT [-]
Circuit 1	AAAC-AL7 620	32.4	621.0	17.71	56000	2.30E-05
Circuit 2	AAAC-AL7 620	32.4	621.0	17.71	56000	2.30E-05
Bliksemdraad 1	AACSR 241-AL3-39-A20SA	21.8	281.0	9.38	70165	1.97E-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	4	3	73.0	B	4+0,2d	10.5	41.9
Circuit 2	2	3	36.5	B	4+0,2d	10.5	21.0
Bliksemdraad 1	1	2	9.6	A	15+0,4d	23.7	23.7

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	4	3	73.0	B	4+0,2d	10.5	41.9
Circuit 2	2	3	36.5	B	4+0,2d	10.5	21.0
Bliksemdraad 1	1	2	9.6	A	15+0,4d	23.7	23.7

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	3.00	1	3	6.5	1.1	48.50	1.13	1.2	1.49
380ct1f2	3.00	1	3	6.5	1.1	38.50	1.06	1.2	1.40
380ct1f3	3.00	1	3	6.5	1.1	29.00	0.98	1.2	1.29
150ct2f1	3.00	1	3	6.5	1.1	48.50	1.13	1.2	1.49
150ct2f2	3.00	1	3	6.5	1.1	38.50	1.06	1.2	1.40
150ct2f3	3.00	1	3	6.5	1.1	29.00	0.98	1.2	1.29
bl1	0.10	1	0.1	0.2	0.1	53.60	1.16	1.2	0.14

Project: RLL-TLB380
Tower: HC+0_c - bouwfase
Number: 1187

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	50.1	1.14	0.62	0.68	0.96	33.37	89.8	98.8	51.8	174.5	191.9
380ct1f2	40.1	1.07	0.60	0.66	0.98	33.37	84.0	92.4	51.8	159.9	175.9
380ct1f3	30.6	0.99	0.58	0.64	1.00	33.37	77.1	84.9	51.8	143.2	157.6
150ct2f1	50.1	1.14	0.62	0.68	0.96	33.37	44.9	49.4	51.8	87.3	95.9
150ct2f2	40.1	1.07	0.60	0.66	0.98	33.37	42.0	46.2	51.8	79.9	88.0
150ct2f3	30.6	0.99	0.58	0.64	1.00	33.37	38.6	42.4	51.8	71.6	78.8
bl1	55.2	1.17	0.62	0.69	1.18	22.24	19.1	21.0	63.1	55.2	60.6

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	44.1	1.10	0.61	0.67	0.97	33.37	86.5	95.1	51.8	166.0	182.6
380ct1f2	34.1	1.02	0.59	0.65	0.99	33.37	79.9	87.9	51.8	149.7	164.8
380ct1f3	24.6	0.93	0.56	0.62	1.02	33.37	71.7	78.9	51.8	130.4	143.6
150ct2f1	44.1	1.10	0.61	0.67	0.97	33.37	43.2	47.6	51.8	83.0	91.3
150ct2f2	34.1	1.02	0.59	0.65	0.99	33.37	39.9	43.9	51.8	74.9	82.4
150ct2f3	24.6	0.93	0.56	0.62	1.02	33.37	35.8	39.5	51.8	65.2	71.8
bl1	49.2	1.13	0.62	0.68	1.19	22.24	18.4	20.2	63.1	52.8	58.0

NB: belastingen w_v gelden voor bundel

Project: RLL-TLB380
Masttype: HC+0_c - bouwfase
Mast: 1187

Geleiderbelastingen

Auteur: TBR
Versie: v12.0

Uitgangspunten

Betrouwbaarheidsniveau	Nieuwbouw CC2
Referentieperiode	15 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°	1.20	1.20	0.00	1.25	0.00	0.0
ULS 1a_0,9	Wind 0,9Gk alleen mast	10°	0.90	1.20	0.00	1.25	0.00	0.0
ULS 1a_0,9_0,9	Wind 0,9Gk ook geleider	10°	0.90	0.90	0.00	1.25	0.00	0.0
ULS 3	Wind+ijs	-5°	1.20	1.20	0.00	0.38	1.07	0.0
ULS 3_0,9	Wind+ijs 0,9	-5°	0.90	1.20	0.00	0.38	1.07	0.0
ULS 4	Koude+wind	-20°	1.20	1.20	0.00	0.25	0.00	0.0
ULS 4_0,9	Koude+wind 0,9	-20°	0.90	1.20	0.00	0.25	0.00	0.0
ULS 5a	Torsiebelastingen	10°	1.00	1.00	1.00	0.00	0.00	1.0
ULS 5b	Longitudinale belastingen	10°	1.00	1.00	0.00	0.00	0.00	1.0
ULS 6	Bouw en onderhoud	5°	1.20	1.20	1.50	0.25	0.00	0.0
ULS 6_0,9	Bouw en onderhoud	5°	1.20	1.20	0.00	0.25	0.00	0.0
ULS 7	Permanent	10°	1.35	1.35	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°	1.20	1.20	0.0	0.78	0.00	0.0
SPLS 1a_0,9	Wind 0,9	10°	0.90	1.20	0.0	0.78	0.00	0.0
SPLS 1a_0,9_0,9	Wind 0,9	10°	0.90	0.90	0.0	0.78	0.00	0.0
SPLS 3	Wind+ijs	-5°	1.20	1.20	0.0	0.36	0.34	0.0
SPLS 3_0,9	Wind+ijs 0,9	-5°	0.90	1.20	0.0	0.36	0.34	0.0
SPLS 4	Koude+wind	-20°	1.20	1.20	0.0	0.24	0.00	0.0
SPLS 4_0,9	Koude+wind 0,9	-20°	0.90	1.20	0.0	0.24	0.00	0.0
SPLS 6	Bouw en onderhoud	5°	1.20	1.20	1.2	0.24	0.0	0.0
SPLS 6_0,9	Bouw en onderhoud	5°	1.20	1.20	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	0.87	0.0	0.0
SLS 3	Wind+ijs	-5°	1.00	1.00	0.0	0.26	0.71	0.0
SLS 4	Wind	-20°	1.00	1.00	0.0	0.17	0.0	0.0
SLS 6	Bouw en onderhoud	5°	1.00	1.00	0.0	0.17	0.0	0.0
SLS 7	PB (EDS, geen wind)	10°	1.00	1.00	0.0	0.00	0.0	0.0

Aantal windrichtingen	6
Aantal belastingcombinaties ULS	68
Aantal belastingcombinaties SPLS	222
Aantal belastingcombinaties SLS	15
Aantal knooplasten	5185

Project: RLL-TLB380
Masttype: HC+0_c - bouwfase
Mast: 1187

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 (Ba+Ah) in het globale assenstelsel 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

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	-50.6	50.1	22.9	22.5	8.2	8.2
380ct1f1	-225.4	223.8	103.0	100.7	35.6	35.6
380ct1f2	-222.7	220.8	99.0	96.1	35.5	35.5
380ct1f3	-219.7	217.7	94.3	90.6	35.4	35.4
Post-isolato	0.0	0.0	0.0	0.0	0.0	
Post-isolato	0.0	0.0	0.0	0.0	0.0	
Post-isolato	0.0	0.0	0.0	0.0	0.0	
150ct2f1	-112.6	111.8	52.4	51.2	22.5	22.5
150ct2f2	-111.2	110.3	50.4	48.9	22.5	22.5
150ct2f3	-109.8	109.4	48.0	46.2	22.5	22.5

Min. Weight span (m)

Weight spar	Combinatie1		
Geleider	SLS 1a	SLS 4	SLS 7
bl1	482.6	495.9	481.0
380ct1f1	481.6	495.6	481.0
380ct1f2	481.5	495.4	481.0
380ct1f3	481.4	495.2	481.0
Post-isolator 1			
Post-isolator 2			
Post-isolator 3			
150ct2f1	481.6	495.6	481.0
150ct2f2	481.5	495.4	481.0
150ct2f3	481.4	495.2	481.0

Max. Weight span (m)

Weight spar	Combinatie1	
Geleider	ULS 1a	ULS 3
bl1	547.1	470.4
380ct1f1	512.2	481.3
380ct1f2	508.6	480.4
380ct1f3	504.3	479.4
Post-isolator 1		
Post-isolator 2		
Post-isolator 3		
150ct2f1	512.2	481.3
150ct2f2	508.6	480.4
150ct2f3	504.3	479.4

Omhullende weight span over alle combinaties (incl. 0,9 combinaties)		
Voor alle geleiders		Wind / Weight span verhouding
Max. weight span	547.1 m	1.368 -
Min. weight span	143.4 m	0.358 -

Project: RLL-TLB380
Masttype: HC+0_c - bouwfase
Mast: 1187

Maximale waarden back+ahead span **Maximale waarden trekkracht geleider**

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	36.7	43.6	8.2	-55.3	54.8
380ct1f1	195.1	189.1	35.6	-244.9	242.9
380ct1f2	191.4	182.1	35.5	-241.5	239.3
380ct1f3	187.5	177.8	35.4	-237.9	235.4
Post-isolato	3.5	3.5	6.8	0.0	
Post-isolato	2.7	2.7	4.7	0.0	
Post-isolato	4.1	4.1	6.8	0.0	
150ct2f1	102.8	96.1	22.5	-122.4	121.5
150ct2f2	102.7	92.4	22.5	-120.8	119.7
150ct2f3	102.6	89.4	22.5	-119.0	117.7

EDS-belastingen geleiders

Geleider	Fx [kN]	Fy [kN]	Fz [kN]	Ft_ba [kN]	Ft_ah [kN]
bl1	16.2	5.9	2.4	-17.2	17.2
380ct1f1	123.4	44.9	20.5	-131.3	131.3
380ct1f2	123.4	44.9	20.5	-131.3	131.3
380ct1f3	123.4	44.9	20.5	-131.3	131.3
Post-isolato	0.0	0.0	5.0	0.0	
Post-isolato	0.0	0.0	3.5	0.0	
Post-isolato	0.0	0.0	5.0	0.0	
150ct2f1	61.7	22.5	11.8	-65.7	65.7
150ct2f2	61.7	22.5	11.8	-65.7	65.7
150ct2f3	61.7	22.5	11.8	-65.7	65.7

Controle 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
	Post-isolato	0.0	
	Post-isolato	0.0	
	Post-isolato	0.0	
	150ct2f1	0.0	0.0
	150ct2f2	0.0	0.0
	150ct2f3	0.0	0.0

Project: RLL-TLB380
Masttype: HC+0_c - bouwfase
Mast: 1187

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

Combinatie	Combination	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90		-20	864	266	31193	-733	222
ULS 1a_0.9_0		18	487	175	17205	713	52
ULS 1a_0.9_0.9_90		-23	811	111	30825	-847	257
ULS 3_0		8	719	359	24304	303	-10
SLS 7		0	416	212	14057	0	0

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

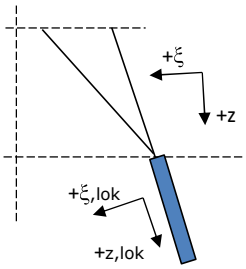
Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_90	-20	1159	1492	39362	-733	222
ULS 1a_0.9_0.9_90	-23	1107	1031	38995	-847	257
SLS 7	0	416	1233	14057	0	0

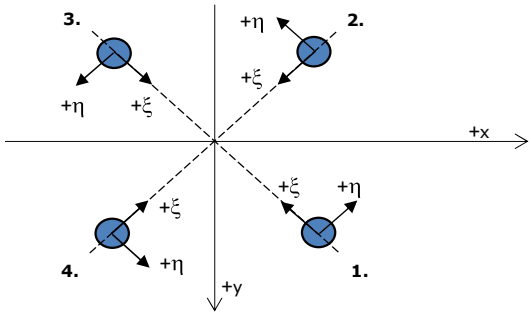
Fundatiebelastingen, selectie belastingcombinaties op basis grootste waarde

Combinatie	F_x [kN]	F_y [kN]	F_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
ULS 1a_0.9_90	-20	1159	1077	**40481**	-733	222
SPLS 3_0 Ba All Cts	909	286	1398	9579	**34281**	-8920
SPLS 3_70 Ah All Cts	-864	454	1401	15204	-33964	**10182**
SPLS 3_0.9_70 Ah All Cts	-864	454	1026	**15888**	**-33964**	10182

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	SPLS 3_110 Ba All Cts	206	697	**2412**	-347	-638	10	2497
2	SPLS 1a_0 Ba All Cts	389	-152	**1434**	-167	-383	3	1485
3	ULS 8 Ba	-403	-77	**1327**	230	-339	17	1374
4	SPLS 3_70 Ah All Cts	-208	705	**2440**	351	-645	10	2527

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 8 Ba	139	-355	**-695**	349	152	-34	-719
2	SPLS 3_0.9_70 Ah All Cts	-520	145	**-1863**	265	470	-30	-1929
3	SPLS 3_0.9_110 Ba All Cts	508	141	**-1813**	-259	459	-28	-1877
4	SPLS 1a_0.9_0 Ba All Cts	-55	-341	**-817**	-280	202	-18	-846

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	SPLS 3_0.9_70 Ah All Cts	195	-351	-512	**386**	110	-27	-530
2	SPLS 3_0.9_70 Ah All Cts	-520	145	-1863	**265**	470	-30	-1929
3	SPLS 3_70 Ah All Cts	-371	-45	1148	**230**	-294	15	1188
4	SPLS 3_70 Ah All Cts	-208	705	2440	**351**	-645	10	2527

Maximale torsiebelasting (negatief)

Stijl Index	Combinatie 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_110 Ba All Cts	206	697	2412	**-347**	-638	10	2497
2	ULS 8 Ah	403	-77	1327	**-230**	-339	17	1374
3	SPLS 3_0.9_110 Ba All Cts	508	141	-1813	**-259**	459	-28	-1877
4	SPLS 3_0.9_110 Ba All Cts	-192	-344	-509	**-379**	108	-29	-527

Project: RLL-TLB380
Masttype: HC+0_c - bouwfase
Mast: 1187

Combinatie Ftrek+Fhor

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 8 Ba	139	-355	**-695**	**349**	152	-34	-719
2	SPLS 3_0.9_70 Ah All Cts	-520	145	**-1863**	**265**	470	-30	-1929
3	SPLS 3_0.9_110 Ba All Cts	508	141	**-1813**	**-259**	459	-28	-1877
4	SPLS 3_0.9_0 Ba All Cts	-105	-367	**-773**	**-334**	185	-22	-801

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	189	168	906	15	-253	-10	938
2	SLS 7	-60	40	-289	15	71	-7	-299
3	SLS 7	60	40	-289	-15	71	-7	-299
4	SLS 7	-189	168	906	-15	-253	-10	938

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	SPLS 3_70 Ah All Cts	-208	705	**2440**	351	-645	10	2527
Max. trek	SPLS 3_0.9_70 Ah All Cts	-520	145	**-1863**	265	470	-30	-1929
Max. pos. torsie	SPLS 3_0.9_70 Ah All Cts	195	-351	-512	**386**	110	-27	-530
Max. neg. torsie	SPLS 3_0.9_110 Ba All Cts	-192	-344	-509	**-379**	108	-29	-527
Comb. trek+torsie	SPLS 3_0.9_70 Ah All Cts	-520	145	**-1863**	**265**	470	-30	-1929

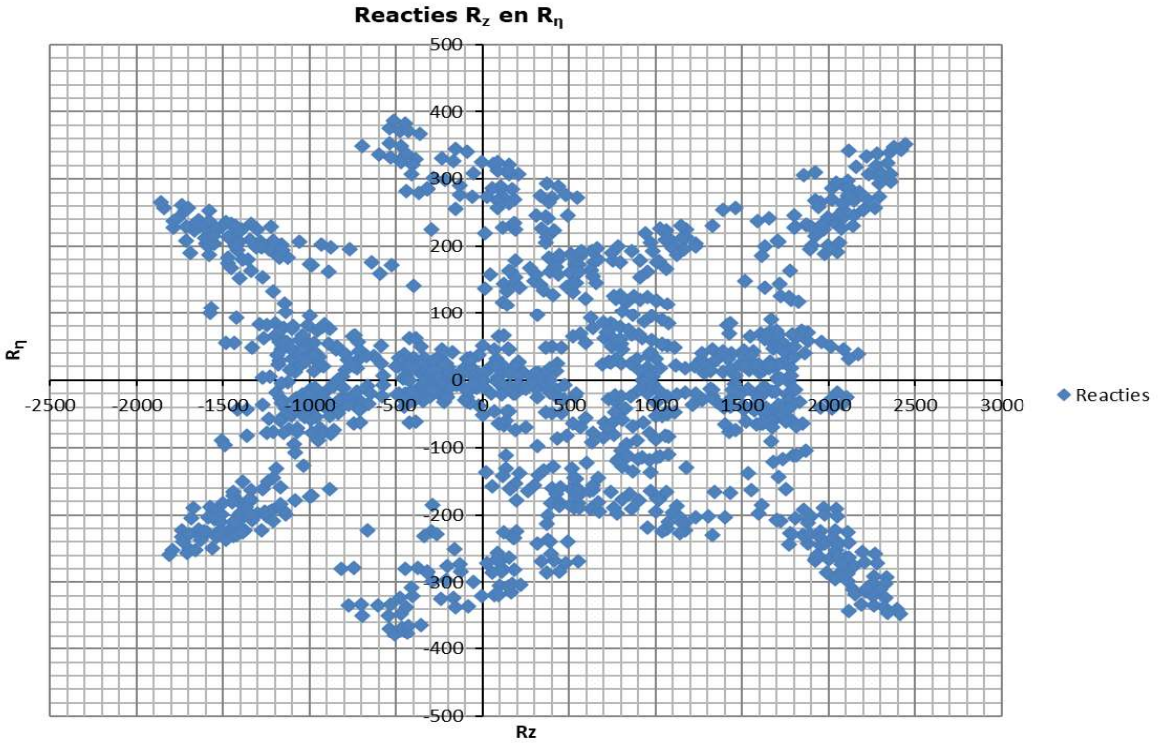
Maximale trekbelasting SLS

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	SPLS 3_0.9_110 Ah All Cts	164	-335	**-541**	353	121	-24	-560
2	SPLS 3_0.9_70 Ah All Cts	-520	145	**-1863**	265	470	-30	-1929
3	SPLS 3_0.9_110 Ba All Cts	508	141	**-1813**	-259	459	-28	-1877
4	SPLS 1a_0.9_0 Ba All Cts	-55	-341	**-817**	-280	202	-18	-846

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	SPLS 3_110 Ba All Cts	206	697	**2412**	-347	-638	10	2497
2	SPLS 1a_0.9_0 Ba All Cts	369	-135	**1339**	-165	-356	4	1387
3	SPLS 3_110 Ah All Cts	-366	-64	**1175**	213	-304	11	1216
4	SPLS 3_70 Ah All Cts	-208	705	**2440**	351	-645	10	2527

Project: RLL-TLB380
Masttype: HC+0_c - bouwfase
Mast: 1187



Belastinggeval - afspannen

Date: 2021-05-31
Author: TBR
Version: 1.1

RLL-TLB
HB+0/c (afspannen)

Invoergegevens

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

			Hoogteverschil			Richtingsverandering		
Circuits	Aanduiding	Nummer	Dh_back	Dh_ahead		Dy_back	Dy_ahead	
Circuit 1	10	380ct1f1	0,0	-9,0	m	0,0	0,0	m
Circuit 1	11	380ct1f2	0,0	-9,0	m	0,0	0,0	m
Circuit 1	12	380ct1f3	0,0	-9,0	m	0,0	0,0	m
Circuit 2	40	380ct2f1	-48,0	0,0	m	0,0	0,0	m
Circuit 2	41	380ct2f2	-38,0	0,0	m	0,0	0,0	m
Circuit 2	42	380ct2f3	-28,5	0,0	m	0,0	0,0	m
Circuit 3	20	150ct3f1	0,0	-9,0	m	0,0	0,0	m
Circuit 3	21	150ct3f2	0,0	-9,0	m	0,0	0,0	m
Circuit 3	22	150ct3f3	0,0	-9,0	m	0,0	0,0	m
Circuit 4	30	150ct4f1	-48,0	0,0	m	0,0	0,0	m
Circuit 4	31	150ct4f2	-38,0	0,0	m	0,0	0,0	m
Circuit 4	32	150ct4f3	-28,5	0,0	m	0,0	0,0	m
Bliksemdraad 1	1	bl1	0,0	-9,0	m	0,0	0,0	m
Bliksemdraad 2	3	bl2	-53,1	0,0	m	0,0	0,0	m

Lijn- en mastgegevens

		Back		Ahead	
		72,8		400,0	m
Ruling span √(SL3/SL)		72,8		400,0	m
Lijnhoek	β	180	°		
Rotatie mast t.o.v. bissectrice	θ	-30	°		
Vaklengte		73		400	m
Hoogte onderkant mast t.o.v. maaiveld		0,5	m		
Beschouwde windrichtingen	a1	0	°		
Windrichtingen volgens:	a2	45	°		
Geleiderbelastingen	a3	90	°		
	a4	135	°		
	a5	120	°		
	a6	120	°		

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

In onderstaande tabel zijn de optredende belastingen weergegeven, voor deze situatie geldt:
- belasting op geleider1, 10 t/m 12 en 20 t/m 22 zijn permanent aanwezig
- van de belasting op de overige geleiders is er telkens één aanwezig per belastingcombinatie

Uitvoer geleiderbelastingen

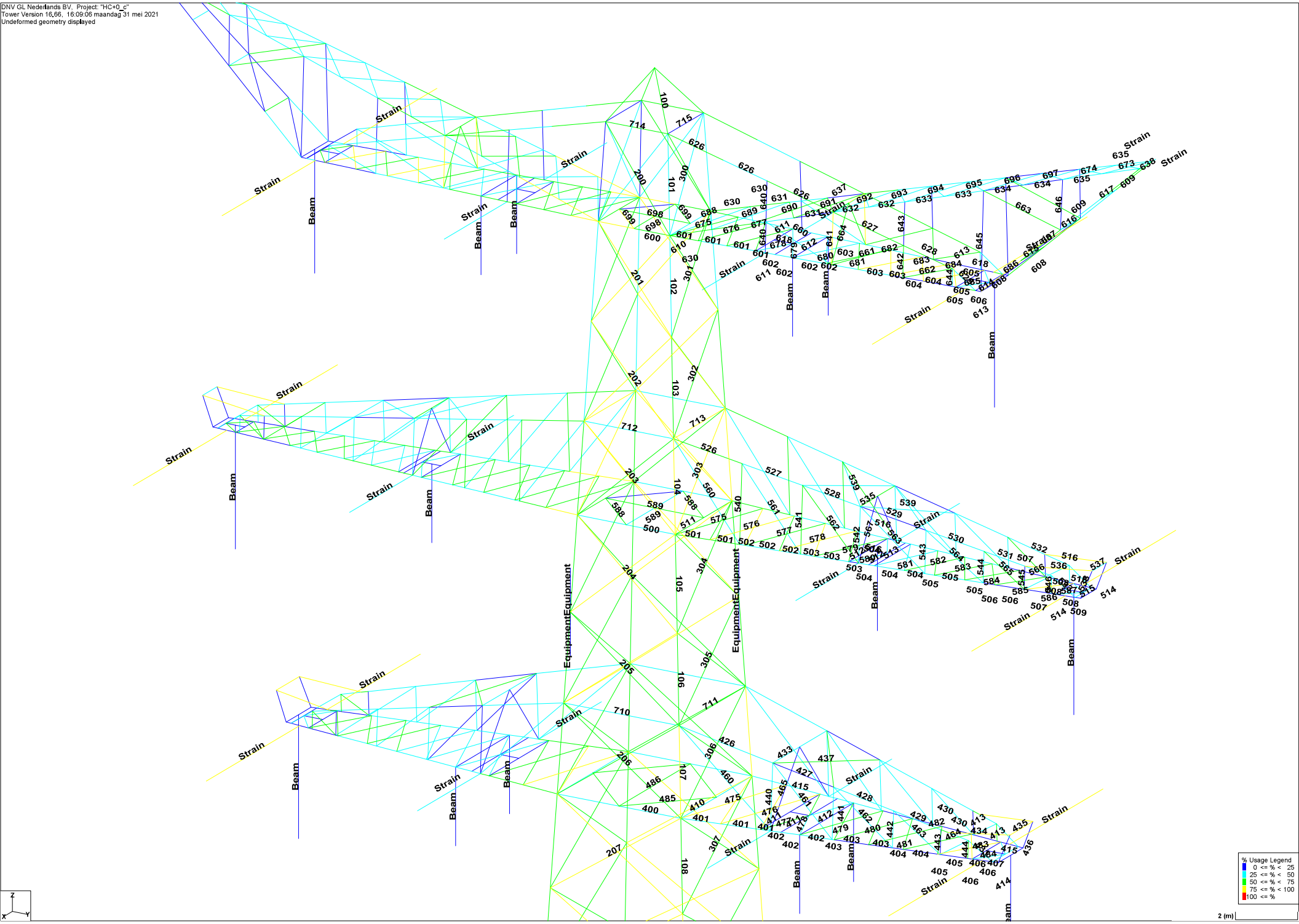
Belastingcombi	nummer	Fxtotaal	Fytotaal	Fztotaal	Ftrekahead	Ftrekback
ULS 6b_90	1	**17,9**	**11,2**	**2,9**	21,1	0,0
	10	**134,8**	**81,9**	**24,7**	157,7	0,0
	11	**134,6**	**81,4**	**24,7**	157,3	0,0
	12	**134,4**	**80,8**	**24,6**	156,8	0,0
	20	**67,4**	**41,0**	**12,9**	78,8	0,0
	21	**67,3**	**40,8**	**12,9**	78,6	0,0
	22	**67,1**	**40,5**	**12,9**	78,4	0,0
	40	**-129,4**	**-73,8**	**105,0**	0,0	-149,0
	41	**-129,3**	**-73,8**	**84,5**	0,0	-148,9
	42	**-129,3**	**-73,8**	**65,1**	0,0	-148,8
	30	**-64,7**	**-36,8**	**53,1**	0,0	-74,5
	31	**-64,7**	**-36,8**	**42,9**	0,0	-74,5
	32	**-64,7**	**-36,8**	**33,1**	0,0	-74,4
	3	**-16,9**	**-9,6**	**14,8**	0,0	-19,5

APPENDIX B
Resultaten PLS-TOWER

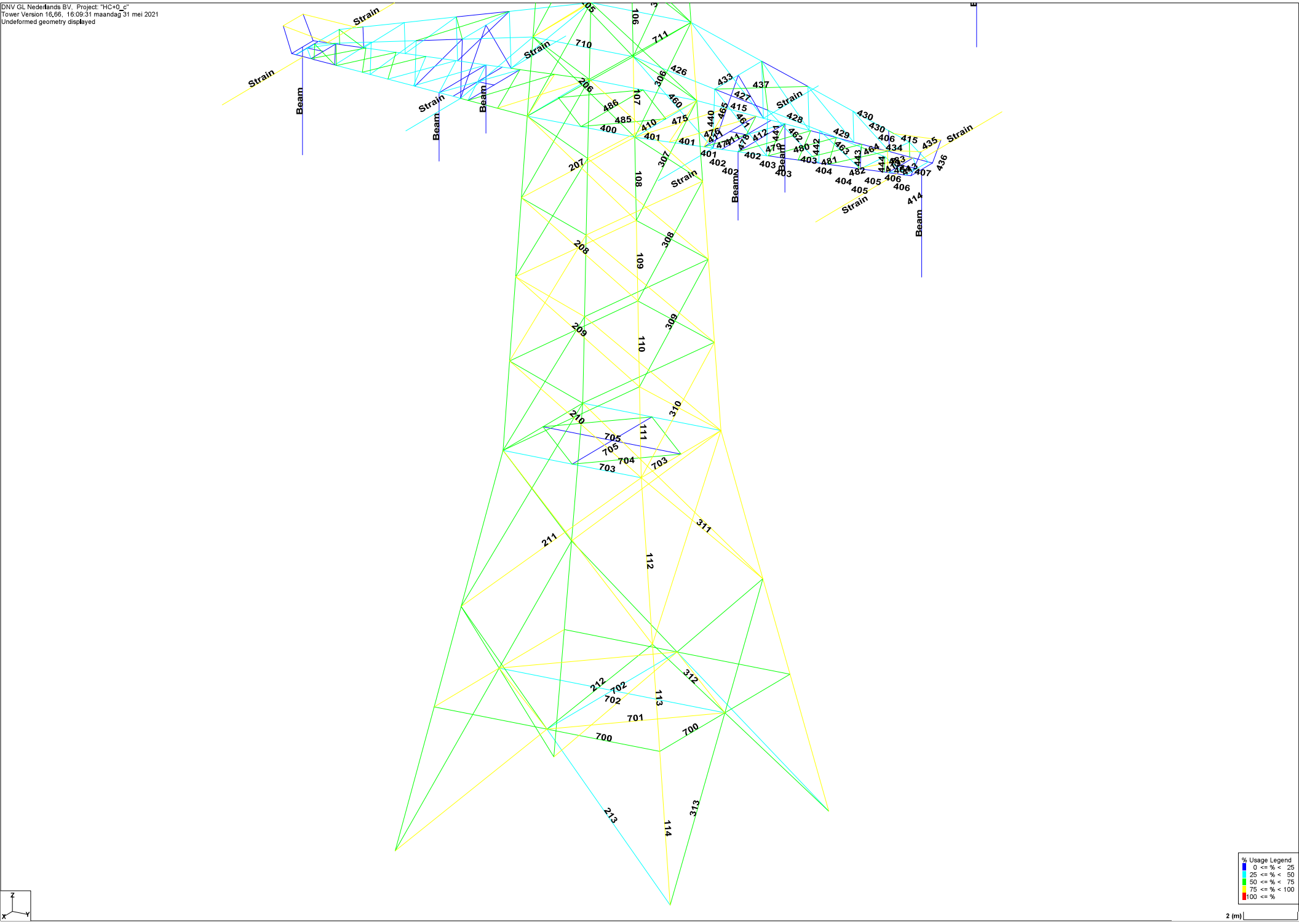
Deze Appendix bevat de resultaten uit PLS-TOWER voor onderstaande masttype:

- Masttype HC+0/c

DNV GL Nederlands BV, Project: "HC+0_c"
Tower Version 16,66, 16:09:06 maandag 31 mei 2021
Undeformed geometry displayed



DNV GL Nederlands BV, Project: "HC+0_c"
Tower Version 16,66, 16:09:31 maandag 31 mei 2021
Undeformed geometry displayed



Assessment of angle groups

Date 16-7-2021
Author MRE
Version 1.0

RLL-TBG
HC+0/c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.pl	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compress	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	eedance (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	ring (Tens)	U.C. (Tens)	ance (Tens)
100	Main leg	EA	80x80x8	S355	2M20-8,8t	1	45	35	70	1,00	1,00	1,00	151	-61,4	SPLS 3_0,9_70 Ah All Cl	93,9	188,2	235,2	0,65		61,3	SPLS 3_0,9_70 Ah All C	199,1	188,2	213,8	0,33	
101	Main leg	EA	130x130x12	S355	4M24-8,8t	1	55	40	80	0,54	0,54	0,54	72	-208,4	ULS 6b_90_afspannen_	741,1	542,2	846,7	0,38		110,6	ULS 8 Ah_bouw	948,3	542,2	796,1	0,20	
102	Main leg	EA	180x180x16	S355	8M24-8,8t	1	55	40	80	0,54	0,54	0,54	52	-519,8	ULS 3_60_120gr	1637,8	1084,4	2257,9	0,48		402,0	SPLS 3_60 Ah Ct1_120	1807,7	1084,4	2122,8	0,37	
103	Main leg	EA	180x180x16	S355	8M24-8,8t	2	55	40	80	0,53	0,53	0,53	51	-1060,4	ULS 3_60_120gr	1643,5	2168,8	2257,9	0,65		849,6	ULS 1a_0,9_60_120gr	1807,7	2168,8	2122,8	0,47	
104	Main leg	EA	180x180x16	S355	10M24-8,8t	2	55	40	80	0,53	0,53	0,53	48	-1334,1	ULS 3_60_120gr	1682,9	2711,0	2822,4	0,79		1055,6	ULS 1a_0,9_60_120gr	1807,7	2711,0	2653,5	0,58	
105	Main leg	EA	250x250x24	S355	10M24-8,8t	2	55	40	80	0,53	0,53	0,53	35	-2005,4	ULS 3_60_120gr	3752,3	2711,0	4233,6	0,74		1748,6	ULS 1a_0,9_60_120gr	3834,2	2711,0	3980,3	0,65	
106	Main leg	EA	250x250x24	S355						0,52	0,52	0,52	33	-2737,2	ULS 1a_60_120gr	3799,2	0,0	0,0	0,72		2376,4	ULS 1a_0,9_60_120gr	4079,7	0,0	0,0	0,58	
107	Main leg	EA	250x250x24	S355	16M24-8,8t	2	55	40	80	0,52	0,52	0,52	33	-3110,2	ULS 1a_60_120gr	3799,2	4120,8	6773,8	0,82		2697,9	ULS 1a_0,9_60_120gr	3834,2	4120,8	6368,5	0,70	
108	Main leg	XEA	200x200x24	S355	32M24-8,8t	2	55	50	70	0,52	0,52	1,18	50	-3891,6	ULS 1a_60_120gr	5222,6	8345,5	13547,5	0,75		3422,3	ULS 1a_0,9_60_120gr	5511,3	8345,5	11694,9	0,62	
109	Main leg	XEA	200x200x24	S355	20M24-8,8t	2	55	50	70	0,52	0,52	1,22	50	-4577,2	ULS 1a_60_120gr	5219,1	5422,1	8467,2	0,88		4061,1	ULS 1a_0,9_60_120gr	5511,3	5422,1	7309,3	0,75	
110	Main leg	XEA	250x250x24	S355	24M24-8,8t	2	55	50	70	0,52	0,52	1,63	56	-5243,8	ULS 1a_60_120gr	6248,4	6448,9	10160,6	0,84		4693,3	ULS 1a_0,9_60_120gr	7210,5	6448,9	8771,2	0,73	
111	Main leg	XEA	250x250x24	S355	32M24-8,8t	2	55	50	70	0,52	0,52	1,54	56	-5680,2	ULS 1a_60_120gr	6230,7	8345,5	13547,5	0,91		5125,5	ULS 1a_0,9_60_120gr	7210,5	8345,5	11694,9	0,71	
112	Main leg	XEA	250x250x24	S355	32M24-8,8t	2	55	50	70	0,29	0,29	0,88	56	-5940,7	ULS 1a_60_120gr	6209,5	8345,5	13547,5	0,96		5295,6	ULS 1a_0,9_60_120gr	7210,5	8345,5	11694,9	0,73	
113	Main leg	XEA	250x250x24	S355						0,50	0,50	1,36	56	-5532,6	ULS 1a_60_120gr	6210,7	0,0	0,0	0,89		4853,3	ULS 1a_0,9_60_120gr	8141,5	0,0	0,0	0,60	
114	Main leg	XEA	250x250x24	S355	24M24-8,8t	2	55	50	70	0,33	0,33	0,95	56	-5537,9	ULS 1a_60_120gr	6200,2	6448,9	10160,6	0,89		4822,4	ULS 1a_0,9_60_120gr	7210,5	6448,9	8771,2	0,75	
200	Diag front face	EA	100x100x10	S355	2M24-8,8t	1	55	40	80	0,54	0,54	0,54	116	-208,1	ULS 6b_90_afspannen_	257,7	271,1	352,8	0,81		204,4	ULS 6b_90_afspannen_	305,3	271,1	329,6	0,75	
201	Diag front face	EA	150x150x14	S355	6M24-8,8t	1	55	40	80	0,54	0,54	0,54	80	-684,0	SPLS 3_60 Ba Ct1_120g	773,8	806,5	1481,8	0,88		609,4	SPLS 3_0,9_60 Ba Ct1_	781,4	806,5	1379,7	0,78	
202	Diag front face	EA	150x150x14	S355	5M24-8,8t	1	55	40	80	0,53	0,53	0,53	84	-515,8	SPLS 3_0,9_60 Ba Ct1_	748,2	677,8	1234,8	0,76		572,1	SPLS 3_60 Ba Ct1_120	781,4	677,8	1150,1	0,84	
203	Diag front face	EA	150x150x14	S355	5M24-8,8t	1	55	40	80	0,53	0,53	0,53	85	-573,6	SPLS 3_90 Ah Ct1_140g	741,6	677,8	1234,8	0,85		500,5	SPLS 3_0,9_90 Ba Ct2_	781,4	677,8	1150,1	0,74	
204	Diag front face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,53	0,53	0,53	73	-951,5	SPLS 3_60 Ba Ct1_120g	1086,4	1084,4	1693,4	0,88		837,2	SPLS 3_0,9_60 Ba Ct2_	1346,9	1084,4	1578,1	0,77	
205	Diag front face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	74	-731,3	SPLS 3_0,9_60 Ba Ct2_	1074,7	1084,4	1693,4	0,68		828,4	SPLS 3_60 Ba Ct1_120	1346,9	1084,4	1578,1	0,76	
206	Diag front face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	77	-775,2	SPLS 3_90 Ah Ct1_140g	1036,2	1084,4	1693,4	0,75		713,5	SPLS 3_0,9_90 Ba Ct2_	1346,9	1084,4	1578,1	0,66	
207	Diag front face	DEA	130x130x12#(15,0,	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	75	-968,4	SPLS 3_60 Ba Ct1_120g	1166,9	1084,4	1693,4	0,89		893,6	SPLS 3_0,9_60 Ba Ct2_	1511,6	1084,4	1578,1	0,82	
208	Diag front face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	85	-835,8	SPLS 3_0,9_60 Ba Ct1_	958,8	1084,4	1693,4	0,87		863,7	SPLS 3_60 Ba Ct1_120	1346,9	1084,4	1578,1	0,80	
209	Diag front face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	90	-800,3	SPLS 3_60 Ba Ct2_120g	906,7	1084,4	1693,4	0,88		810,6	SPLS 3_0,9_60 Ba Ct1_	1346,9	1084,4	1578,1	0,75	
210	Diag front face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	96	-785,5	SPLS 3_0,9_60 Ba Ct1_	855,3	1084,4	1693,4	0,92		751,3	SPLS 3_60 Ba Ct2_120	1346,9	1084,4	1578,1	0,69	
211	Diag front face	DEA	150x150x12(12,0,3	S355	3M24-8,8t	2	55	40	80	0,29	0,58	0,29	102	-648,7	SPLS 3_60 Ba Ct1_120g	1013,3	813,3	1270,1	0,80		673,9	SPLS 3_60 Ba Ct1_120	1782,0	813,3	1184,6	0,83	
212	Diag front face	DEA	130x130x12#(15,0,	S355	3M24-8,8t	2	55	40	80	0,50	1,00	0,50	122	-510,7	SPLS 3_60 Ba Ct1_120g	721,7	813,3	1270,1	0,71		511,1	SPLS 3_60 Ba Ct1_120	1511,6	813,3	1184,6	0,63	
213	Diag front face	DEA	150x150x12(12,0,3	S355	5M24-8,8t	2	55	40	80	0,33	1,00	0,33	154	-491,9	SPLS 3_60 Ba Ct1_120g	617,0	1355,5	2116,8	0,80		467,3	SPLS 3_60 Ba Ct1_120	1782,0	1355,5	1971,6	0,34	
300	Diag side face	EA	80x80x8	S355	2M24-8,8t	1	55	40	80	0,54	0,54	0,54	144	-70,6	ULS 8 Ah_bouw	124,7	271,1	282,2	0,57		54,8	ULS 8 Ba_bouw	188,0	271,1	263,7	0,29	
301	Diag side face	EA	150x150x14	S355	6M24-8,8t	1	55	40	80	0,54	0,54	0,54	80	-619,2	SPLS 3_0,9_70 Ah All Cl	773,8	806,5	1481,8	0,80		609,3	SPLS 3_0,9_70 Ah All C	781,4	806,5	1379,7	0,78	
302	Diag side face	EA	150x150x14	S355	5M24-8,8t	1	55	40	80	0,53	0,53	0,53	84	-513,6	SPLS 3_0,9_70 Ah All Cl	748,2	677,8	1234,8	0,76		518,7	SPLS 3_0,9_70 Ah All C	781,4	677,8	1150,1	0,77	
303	Diag side face	EA	150x150x14	S355	4M24-8,8t	1	55	40	80	0,53	0,53	0,53	85	-502,1	SPLS 3_0,9_90 Ba Ct2_	741,6	542,2	987,8	0,93		501,6	SPLS 3_0,9_90 Ah Ct1_	781,4	542,2	920,6	0,93	
304	Diag side face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,53	0,53	0,53	73	-783,8	SPLS 3_0,9_70 Ah All Cl	1086,4	1084,4	1693,4	0,72		795,6	SPLS 3_0,9_70 Ah All C	1346,9	1084,4	1578,1	0,73	
305	Diag side face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	74	-696,7	SPLS 3_0,9_70 Ah All Cl	1074,7	1084,4	1693,4	0,65		686,2	SPLS 3_0,9_70 Ah All C	1346,9	1084,4	1578,1	0,63	
306	Diag side face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	77	-679,0	SPLS 3_0,9_70 Ba Ct2_	1036,2	1084,4	1693,4	0,66		685,2	SPLS 3_0,9_90 Ah Ct1_	1346,9	1084,4	1578,1	0,63	
307	Diag side face	DEA	130x130x12#(15,0,	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	75	-854,8	SPLS 3_0,9_70 Ah All Cl	1166,9	1084,4	1693,4	0,79		858,8	SPLS 3_70 Ah All Cts_b	1511,6	1084,4	1578,1	0,79	
308	Diag side face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	85	-780,7	SPLS 3_70 Ah All Cts_bc	958,8	1084,4	1693,4	0,81		783,5	SPLS 3_0,9_70 Ah All C	1346,9	1084,4	1578,1	0,72	
309	Diag side face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	90	-746,5	SPLS 3_0,9_70 Ah All Cl	906,7	1084,4	1693,4	0,82		729,1	SPLS 3_70 Ah All Cts_b	1346,9	1084,4	1578,1	0,67	
310	Diag side face	DEA	120x120x12(12,0,3	S355	4M24-8,8t	2	55	40	80	0,52	0,52	0,52	96	-712,8	SPLS 3_70 Ba Ct2_140g	855,3	1084,4	1693,4	0,83		720,4	SPLS 3_0,9_90 Ah Ct1_	1346,9	1084,4	1578,1	0,66	
311	Diag side face	DEA	150x150x12(12,0,3	S355	3M24-8,8t	2	55	40	80	0,29	0,58	0,29	102	-662,8	SPLS 3_90 Ba Ct1_140g	1013,3	813,3	1270,1	0,82		631,1	SPLS 3_70 Ah All Cts_b	1782,0	813,3	1184,6	0,78	
312	Diag side face	DEA	130x130x12#(15,0,	S355	3M24-8,8t	2	55	40	80	0,50	1,00	0,50	122	-499,6	SPLS 3_70 Ah All Cts_bc	721,7	813,3	1270,1	0,69		485,0	SPLS 3_0,9_70 Ah All C	1511,6	813,3	1184,6	0,60	
313	Diag side face	DEA	150x150x12(12,0,3	S355	5M24-8,8t	2	55	40	80	0,33	1,00	0,33	154	-491,3	SPLS 3_70 Ah All Cts_bc	617,0	1355,5	2116,8	0,80		454,3	SPLS 3_0,9_70 Ah All C	1782,0	1355,5	1971,6	0,34	
400	Horizontal lower ca.	EA	180x180x16	S355	10M24-8,8t	1	55	40	80	2,00	1,00	1,00	83	-325,8	SPLS 3_70 Ah Ct2_140g	1182,3	1355,5	2822,4	0,28		142,3	SPLS 3_0,9_70 Ah All C	1807,7	1355,5	2653,5	0,11	
401	Lower chord lower ca.	EA	150x150x14	S355	10M24-8,8t	1	55	40	80	1,00	2,25	1,00	68	-711,9	SPLS 3_70 Ah All Cts_bc	1029,6	1355,5	2469,6	0,69		418,7	SPLS 3_0,9_70 Ah Ct2_	1287,7	1355,5	2321,8	0,33	
402	Lower chord lower ca.	EA	150x150x14	S355						1,00	3,25	1,00	47	-536,8	SPLS 3_70 Ah All Cts_bc	1228,5	0,0	0,0	0,44		323,0	SPLS 3_0,9_70 Ah Ct2_	1425,0	0,0	0,0	0,23	
403	Lower chord lower ca.	EA	150x150x14	S355						30,00	17,29	1,00	43	-489,1	SPLS 3_70 Ah All Cts_bc	1255,8	0,0	0,0	0,39		289,8	SPLS 3_0,9_70 Ah Ct2_	1425,0	0,0	0,0	0,20	
404	Lower chord lower ca.	EA	150x150x14	S355						3,24	4,49	1,00	37	-383,5	SPLS 3_60 Ah Ct1_120g	1301,5	0,0	0,0	0,29		204,5	SPLS 3_0,9_70 Ah Ct2_	1425,0	0,0	0,0	0,14	
405	Lower chord lower ca.	EA	150x150x14	S355						13,33	18,44	1,00	36	-278,1	ULS 3_60_120gr	1302,7	0,0	0,0	0,21		117,0	ULS 1a_0,9_60_120gr	1425,0	0,0	0,0	0,08	
406	Lower chord lower ca.	EA	150x150x14	S355						5,67	8,00	1,00	26	-199,6	ULS 1a_60_120gr	1368,3	0,0	0,0	0,15		145,8	ULS 1a_0,9_60_120gr	1425,0	0,0	0,0	0,10	
407	Lower chord lower ca.	EA	150x150x14	S355						2,50	1,00	1,00	11	-5,3	ULS 1a_70_140gr	1425,0	0,0	0,0	0,00		2,3	ULS 1a_90_120gr	1425,0	0,0	0,0	0,00	
410	Horizontal lower ca.	EA	130x130x12	S355	3M24-8,8t	1	55	40	80	2,00	1,00	1,00	116	-156,2	SPLS 3_0,9_90 Ah Ct1_	380,0	406,7	635,0	0,41		200,8	SPLS 3_90 Ba Ct1_120	575,5	406,7	592,3	0,49	
411	Horizontal lower ca.	DEA	150x150x14 (not co	S355	2M24-8,8t	2	55	40	80	2,00	1,00	1,00	84	-2,0	ULS 8 Ah 42_120gr	1410,7	542,2	493,9	0,00		71,8	ULS 3_0,9_70_140gr	1409,7	542,2	461,5	0,16	
412	Horizontal lower ca.	HEA	HEA140	S355						1,00	1,00	1,00	99	-6,6	ULS 3_0,9_90_120gr	444,4	0,0	0,0	0,01		4,7	ULS 3_90_120gr	1114,7	0,0	0,0	0,00	
413	Horizontal lower ca.	DEA	150x150x18 (not co	S355	2M24-8,8t	2	55	40	80	2,00	1,00	1,00	36	-2,5	SPLS 1a_45 Ah All Cts_l	2768,8	542,2	635,0	0,00		150,5	ULS 3_0,9_70_140gr	1790,1	542,2	593,3	0,28	
414	Beam lower ca.	HEB	HEB220	S355						2,00	1,00	1,00	17	-22,3	ULS 3_0,9_0_140gr	2728,2	0,0	0,0	0,01		0,8	SPLS 3_70 Ah All Cts_b	3231,9	0,0	0,0	0,00	
415	Horizontal lower ca.	UNP	UNP220	S355		2	55	40	80	1,00	1,00	1,00	30	-50,2	ULS 3_90_140gr	765,6	0,0	0,0	0,07		0,0	ULS 8 Ah 40_120gr	413,1	542,2	296,7	0,00	
426	Upper chord lower ca.	EA	120x120x12	S355	4M24-8,8t	1	45	35	80	1,00	1,00	1,00	144	-35,6	ULS 8 Ba_bouw	280,7	542,2	846,7	0,13		251,9	ULS 6b_90_afspannen_	522,0	542,2	539,1	0,48	
427	Upper chord lower ca.	EA	120x120x12	S355						1,00	1,00	1,00	94	-33,0	ULS 8 Ba_bouw	461,7	0,0	0,0	0,07		227,6	ULS 6b_90_afspannen_	976,3	0,0	0,0	0,23	
428	Upper chord lower ca.	EA	120x120x12	S355						2,73	1,00	1,00	161	-33,3	ULS 8 Ba_bouw	229,1	0,0	0,0	0,15		187,9	ULS 6b_90_afspannen_	976,3	0,0	0,0	0,19	
429	Upper chord lower ca.	EA	120x120x12	S355						3,43	1,00	1,00	161	-35,7	ULS 8 Ba_bouw	229,3	0,0	0,0	0,16		128,3	ULS 6b_90_afspannen_	976,3	0,0	0,0	0,13	
430	Upper chord lower ca.	EA	120x120x12	S355	2M20-8,8t	1	45	35	70	23,52	1,00	1,00	163	-35,8	ULS 8 Ba_bouw	225,8	188,2	352,8	0,19		128,3	ULS 6b_90_afspannen_	469,5	188,2	320,7	0,68	
431	Upper chord lower ca.	EA	120x120x12	S355	2M20-8,8t	1	45	35	70	5,65	1,00	1,00	162	-43,1	ULS 8 Ba_bouw	228,1	188,2	352,8	0,23		91,5	SPLS 3_90 Ah All Cts_1	469,5	188,2	320,7	0,49	
433	Stability bracing lower ca.	EA	70x70x6	S355	1M16-8,8t	1	35	25	55	1,00	1,00	1,00	127	-2,0	SPLS 3_135 Ba Ct2_140	87,0	60,3	70,6	0,03		2,0	SPLS 3_70 Ah All Cts_b	75,3	60,3	53,4	0,04	
434	Hand rail	EA	60x60x6	S355	1M16-8,8t	1	35	25		1,00	1,00	1,00	187	-0,3	ULS 8 Ba_140gr	48,7	60,3	70,6	0,01		0,7	SPLS 1a_90 Ah All Cts_	75,3	60,3	53,4	0,01	
435	Hand rail	UA	100x50x6	S355	2M16-8,8t	1	35	25	55	1,00	1,00	1,00	138	0,0	ULS 1a_90_140gr	91,9	120,6	141,1	0,00		0,0	ULS 1a_0,9_0,9_70_bo	84,5	120,6	106,8	0,00	
436	Hand rail	EA	60x60x6	S355	1M16-8,8t	1	35	25		1,00	1,00	1,00	92	-1,1	SPLS 1a_70 Ah All Cts_	117,8	60,3	70,6	0,02		0,2	ULS 8 Ba_140gr	75,3	60,3	53,4	0,00	
437	Stability bracing lower ca.	EA	70x70x6	S355	1M16-8,8t	1	35	25		0,55	0,55	0,55	155	-4,5	SPLS 3_70 Ah All Cts_14	67,0	60,3	70,6	0,07		4,4	SPLS 3_70 Ah All Cts_1	75,3	60,3	53,4	0,08	
440	Vertical side face lower ca.	EA	70x70x6	S355	1M16-8,8t	1	35	25		0,57	1,00	0,57	108	-21,2	ULS 6b_90_afspannen_	73,3	60,3	70,6	0,35		0,5	ULS 8 Ah 12_120gr	75,3	60,3	53,4	0,01	
441	Vertical side face lower ca.	EA	70x70x6	S355	1M16-8,8t	1	35	25		0,58	1,00	0,58	83	-24,3	ULS 6b_90_afspannen_	94,0	60,3	70,6	0,40		0,7	ULS 8 Ba 12_120gr	75,3	60,3	53,4	0,01	
442	Vertical side face lower ca.	EA	60x60x6	S355	1M16-8,8t	1	35	25		0,81	1,00	0,81	86	-30,3	ULS 6b_90_afspannen_	92,8	60,3	70,6	0,50		1,3	ULS 8 Ba_bouw	75,3	60,3	53,4	0,02	
443	Vertical side face lower ca.	EA	60x60x6	S355	1M16-8,8t	1	35	25	55	1,00	1,00	1,00	72	-1,4	SPLS 3_0 Ba Ct1_120gr	145,3	60,3	70,6	0,02		2,0	SPLS 3_70 Ah All Cts_1	75,3	60,3	53,4	0,04	
444	Vertical side face lower ca.	EA	60x60x6	S355	1M16-8,8t	1	35	25	55	1,00	1,00	1,00	51	-25,9	SPLS 3_70 Ah All Cts_14	131,8	60,3	70,6	0,43		34,1	SPLS 3_0 Ah All Cts_14	75,3	60,3	53,4	0,64	
460	Diag side face lower ca.	EA	90x90x8	S355	2M16-8,8t	1	35	25	55	0,68	1,00	0,68	174	-3,3	ULS 8 Ba_bouw	108,7	120,6	188,2	0,03		61,4	ULS 6b_90_afspannen_	227,9	120,6	142,4	0,51	
461	Diag side face lower ca.	EA	60x60x6	S355	2M16-8,8t	1	35	25	55	0,58	1,00	0,58	172	-0,4	ULS 8 Ba 12_120gr	52,5	120,6	141,1	0,01		35,4	ULS 6b_90_afspannen_	106,5	120,6	106,8	0,33	
462	Diag side face lower ca.	EA	60x60x6	S355	2M16-8,8t	1	35	25	55	0,58	1,00	0,58	150	-2,1	ULS 8 Ba_bouw	63,3	120,6	141,1	0,03		51,2	ULS 6b_90_afspannen_	106,5	120,6	106,8	0,48	
463	Diag side face lower ca.	EA	60x60x6	S355	2M16-8,8t	1	35	25	55	0,80	1,00	0,80	142	-2,9	ULS 8 Ba_bouw	71,7	120,6	141,1	0,04		72,3	ULS 6b_90_afspannen_	106,5	120,6	106,8	0,68	
464	Diag side face lower ca.	EA	60x60x6	S355	2M16-8,8t	1	35	25	55	1,00	1,00	1,00	97	-77,3	ULS 6b_90_afspannen_	112,0	120,6	141,1	0,69		3,6	ULS 8 Ah 12_140gr	106,5	120,6	106,8	0,03	
465	Stability bracing lower ca.	EA	90x90x9	S355	1M16-8,8t	1	35	25		1,00	1,00	1,00	168	-3,5	SPLS 1a_0 Ah Ct2_140g	101,1	60,3	105,8	0,06		2,5	SPLS 3_0,9_135 Ba Ct2	112,9	60,3	80,1	0,04	
475	Diag lower plane lower ca.	EA	80x80x6	S355	2M20-8,8t	1	35	35	55	0,53	0,53	0,53	153	-76,8	ULS 8 Ah_140gr	88,5	188,2	176,4	0,87		84,3	SPLS 3_70 Ah All Cts_1	126,7	188,2	124,7	0,68	
476	Diag lower plane lower ca.	EA	80x80x6	S355	2M20-8,8t	1	35	35	55	0,53	0,53	0,53	141	-96,5	SPLS 3_70 Ah Ct2_140g	98,7	188,2	176,4	0,98		89,7	SPLS 3_0,9_70 Ah Ct2_	126,7	188,2	124,7	0,72	
477	Diag lower plane lower ca.	EA	80x80x6	S355	2M20-8,8t	1	35	35	55	1,00	1,00	1,00	129	-60,9	SPLS 3_70 Ah Ct2_140g	110,7	188,2	176,4	0,55		62,7	SPLS 3_0,9_70 Ah Ct2_	126,7	188,2	124,7	0,50	
478	Diag lower plane lower ca.	EA	80x80x6	S355	2M20-8,8t	1	35	35	55	1,00	1,00	1,00	117	-47,0	SPLS 3_70 Ah All Cts_14	99,7	188,2	176,4	0,47		45,5	SPLS 3_0,9_70 Ah Ct2_	126,7	188,2	124,7	0,37	
479	Diag lower plane lower ca.	EA	70x70x6	S355	2M20-8,8t	1	35	35	55	0,53	0,53	0,53	136	-54,5	SPLS 3_0,9_70 Ah Ct2_	88,7	188,2	176,4	0,61		54,0	SPLS 3_0,9_70 Ah Ct2_	106,3	188,2	124,7	0,51	
480	Diag lower plane lower ca.	EA	70x70x6	S355	2M20-8,8t	1	35	35	55	0,53	0,53	0,53	124	-61,6	SPLS 3_0,9_70 Ah Ct2_	99,5	188,2	176,4	0,62		61,4	SPLS 3_0,9_70 Ah Ct2_	106,3	188,2	124,7	0,58	
481	Diag lower plane lower ca.	EA	70x70x6	S355	2M20-8,8t	1	35	35	55	0,54	0,54	0,54	114	-69,5	SPLS 3_0,9_70 Ah Ct2_	110,6	188,2	176,4	0,63		70,7	SPLS 3_0,9_70 Ah Ct2_	106,3	188,2	124,7	0,67	
482	Diag lower plane lower ca.	EA	70x70x6	S355	2M20-8,8t	1	35	35	55	0,54	0,54	0,54	102	-84,1	SPLS 3_0,9_70 Ah Ct2_	124,5	188,2	176,4	0,68		81,6	SPLS 3_0,9_70 Ah Ct2_	106,3	188,2	124,7	0,77	
483	Diag lower plane lower ca.	EA	70x70x6	S355	2M20-8,8t	1	35	35	55	0,54	0,54	0,54	92	-95,1	SPLS 3_0,9_70 Ah Ct2_	138,5	188,2	176,4	0,69		96,0	SPLS 3_0,9_70 Ah Ct2_	106,3	188,2	124,7	0,90	
484	Diag lower plane lower ca.	EA	70x70x6	S355	2M16-8,8t	1	35	25	55	1,00	1,00	1,00	85	-44,2	SPLS 3_70 Ah Ct1_140g	149,6	120,6	141,1	0,37		47,2	SPLS 3_70 Ah All Cts_1	128,4	120,6	106,8	0,44	
485	Plan bracing lower ca.	EA	120x120x10	S355	3M24-8,8t	1	55	40	80	1,00	1,00	1,00	138	-147,0	SPLS 3_70 Ah All Cts_bc	250,3	406,7	529,2	0,59		147,6	SPLS 3_70 Ah All Cts_b	441,0	406,7	493,6	0,36	
486	Plan bracing lower ca.	EA	70x70x6	S355	1M16-8,8t	1	35	25		0,50	0,50	0,50	168	-0,1	ULS 8 Ah 11_140gr	53,4	60,3	70,6	0,00		1,2	ULS 3_0_140gr	75,3	60,3	53,4	0,02	
500	Horizontal mid ca.	EA	200x200x18	S355	10M24-8,8t	1	55	40	80	2,00	1,00	1,00	60	-668,7	SPLS 3_70 Ah All Cts_14	1920,6	1355,5	3175,2	0,49		445,4	SPLS 3_0,9_70 Ah All C	2272,7	1355,5	2985,2	0,33	

DNV·GL

Assessment of angle groups

Date 16-7-2021
Author MRE
Version 1.0

RLL-TBG
HC+0/c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.pl	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression Load Case (Compress	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	eedance (Comp)	Tension Load Case (Tension)	Net Section	ear (Tens)	tring (Tens)	U.C. (Tens)	ance (Tens)
501	Lower chord mid ca.	EA	180x180x18	S355	10M24-8.8t	1	55	40	80	1.00	1.83	1.00	41	**-1105.3** SPLS 3_70 Ah All Cts_bo	1959.4	1355.5	3175.2	0.82		**749.4** SPLS 3_0_9_70 Ah Ct2_	2018.7	1355.5	2985.2	0.55	
502	Lower chord mid ca.	EA	180x180x18	S355						6.82	12.13	1.00	39	**-1041.6** SPLS 3_70 Ah All Cts_bo	1983.2	0.0	0.0	0.53		**715.5** SPLS 3_0_9_70 Ah Ct2_	2197.5	0.0	0.0	0.33	
503	Lower chord mid ca.	EA	180x180x18	S355						1.00	1.89	1.00	42	**-833.0** SPLS 3_70 Ah All Cts_bo	1944.1	0.0	0.0	0.43		**604.4** SPLS 3_0_9_70 Ah Ct2_	2197.5	0.0	0.0	0.28	
504	Lower chord mid ca.	EA	180x180x18	S355	8M24-8.8t	1	55	40	80	1.00	11.75	1.00	43	**-692.8** SPLS 3_70 Ah Ct1_bouw	1936.7	1084.4	2540.2	0.64		**463.2** SPLS 3_0_9_70 Ah Ct2_	2018.7	1084.4	2388.2	0.43	
505	Lower chord mid ca.	EA	160x160x15	S355	8M24-8.8t	1	55	40	80	3.08	5.91	1.00	42	**-598.3** SPLS 3_70 Ah Ct1_bouw	1474.0	1084.4	2116.8	0.55		**392.4** SPLS 3_0_9_70 Ah Ct2_	1510.3	1084.4	1990.2	0.36	
506	Lower chord mid ca.	EA	160x160x15	S355						2.55	3.47	1.00	30	**-445.3** SPLS 3_70 Ah Ct1_bouw	1569.0	0.0	0.0	0.28		**271.5** SPLS 3_0_9_70 Ah Ct2_	1658.2	0.0	0.0	0.16	
507	Lower chord mid ca.	EA	160x160x15	S355						35.67	31.66	1.00	24	**-295.3** SPLS 3_60 Ah Ct1_120g	1607.8	0.0	0.0	0.18		**205.4** SPLS 3_0_9_70 Ah Ct2_	1658.2	0.0	0.0	0.12	
508	Lower chord mid ca.	EA	160x160x15	S355						7.13	5.66	1.00	22	**-196.3** ULS 1a_60_120gr	1624.2	0.0	0.0	0.12		**161.0** ULS 1a_0_9_60_120gr	1658.2	0.0	0.0	0.10	
509	Lower chord mid ca.	EA	160x160x15	S355	2M20-8.8t	1	45	35	70	2.50	1.00	1.00	10	**-2.9** ULS 3_70_140gr	1658.2	188.2	441.0	0.02		**0.1** ULS 8 Ah_bouw	819.9	188.2	400.9	0.00	
511	Horizontal mid ca.	EA	150x150x12	S355	3M24-8.8t	1	55	40	80	2.00	1.00	1.00	79	**-237.4** SPLS 3_60 Ba Ct1_120g	641.6	406.7	635.0	0.58		**261.0** SPLS 3_90 Ah Ct1_120	678.2	406.7	592.3	0.64	
512	Beam mid ca.	DEA	150x150x14 (not co	S355	2M24-8.8t	2	55	40	80	2.00	1.00	1.00	52	**-36.7** SPLS 3_70 Ah Ct1_140g	1925.3	542.2	493.9	0.07		**91.5** SPLS 3_0_9_70 Ah Ct1_	1409.7	542.2	461.5	0.20	
513	Horizontal mid ca.	HEA	HEA140	S355						1.00	1.00	1.00	67	**-2.5** ULS 1a_0_9_0_9_90_14	587.5	0.0	0.0	0.00		**3.6** ULS 6b_90_afspannen_	1114.7	0.0	0.0	0.00	
514	Beam mid ca.	DEA	150x150x18 (not co	S355	2M24-8.8t	2	55	40	80	2.00	1.00	1.00	23	**-3.9** SPLS 3_0_9_70 Ah All Ct	3014.8	542.2	635.0	0.01		**160.0** ULS 3_0_9_90_140gr	1790.1	542.2	593.3	0.30	
515	Horizontal mid ca.	HEB	HEB220	S355						1.00	1.00	1.00	18	**-29.3** ULS 3_0_9_90_140gr	2715.4	0.0	0.0	0.01		**1.5** SPLS 3_70 Ah All Cts_b	3231.9	0.0	0.0	0.00	
516	Beam mid ca.	UNP	UNP220	S355		2	55	40	80	1.00	1.00	1.00	15	**-77.6** ULS 3_90_140gr	818.9	0.0	0.0	0.09		**0.0** ULS 8 Ba 20_120gr	413.1	542.2	296.7	0.00	
526	Upper chord mid ca.	EA	120x120x12	S355	4M24-8.8t	1	55	40	80	1.88	1.00	1.00	128	**-60.5** ULS 8 Ah_bouw	308.2	542.2	846.7	0.20		**378.7** ULS 6b_90_afspannen_	522.0	542.2	789.1	0.73	
527	Upper chord mid ca.	EA	120x120x12	S355						2.13	1.00	1.00	128	**-60.0** ULS 8 Ah_bouw	308.7	0.0	0.0	0.19		**352.7** ULS 6b_90_afspannen_	976.3	0.0	0.0	0.36	
528	Upper chord mid ca.	EA	120x120x12	S355	6M24-8.8t	1	55	40	80	1.00	1.00	1.00	89	**-54.2** ULS 8 Ah_bouw	484.8	813.3	1270.1	0.11		**322.1** ULS 6b_90_afspannen_	860.1	813.3	1194.1	0.40	
529	Upper chord mid ca.	EA	120x120x12	S355	6M24-8.8t	1	55	40	80	1.00	1.00	1.00	102	**-47.1** ULS 8 Ah_bouw	425.1	813.3	1270.1	0.11		**280.0** ULS 6b_90_afspannen_	860.1	813.3	1194.1	0.34	
530	Upper chord mid ca.	EA	120x120x12	S355						2.66	1.00	1.00	153	**-50.9** SPLS 3_0_9_70 Ah All Ct	244.8	0.0	0.0	0.21		**218.1** ULS 6b_90_afspannen_	976.3	0.0	0.0	0.22	
531	Upper chord mid ca.	EA	120x120x12	S355						3.78	1.00	1.00	153	**-60.7** SPLS 3_0_9_70 Ah All Ct	244.7	0.0	0.0	0.25		**139.4** ULS 6b_90_afspannen_	976.3	0.0	0.0	0.14	
532	Upper chord mid ca.	EA	120x120x12	S355	4M24-8.8t	1	55	40	80	5.76	1.00	1.00	153	**-61.6** SPLS 3_0_9_70 Ah All Ct	245.2	542.2	846.7	0.25		**139.2** ULS 6b_90_afspannen_	750.1	542.2	796.1	0.26	
533	Upper chord mid ca.	EA	120x120x12	S355	2M24-8.8t	1	55	40	80	5.38	1.00	1.00	153	**-79.9** SPLS 3_0_9_70 Ah All Ct	244.6	271.1	423.4	0.33		**132.5** SPLS 3_70 Ah All Cts_1	448.4	271.1	395.5	0.49	
535	Stability bracing mid ca.	EA	70x70x6	S355	1M16-8.8t	1	35	25	55	1.00	2.00	1.00	105	**-3.8** SPLS 3_70 Ah Ct1_140g	102.7	60.3	70.6	0.06		**1.4** SPLS 1a_0_9_0 Ah All (	75.3	60.3	53.4	0.03	
536	Hand rail	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	207	**-0.2** ULS 8 Ba_140gr	41.8	60.3	70.6	0.01		**0.5** SPLS 1a_110 Ah All Cts	75.3	60.3	53.4	0.01	
537	Hand rail	UA	100x50x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	86	**-0.1** ULS 1a_90_140gr	153.5	120.6	141.1	0.00		**0.0** ULS 1a_0_9_0_9_90_12	84.5	120.6	106.8	0.00	
538	Hand rail	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	92	**-0.9** ULS 7_bouw	117.9	60.3	70.6	0.01		**0.1** ULS 8 Ba_140gr	75.3	60.3	53.4	0.00	
539	Stability bracing mid ca.	EA	70x70x6	S355	1M16-8.8t	1	35	25		0.55	0.55	0.55	125	**-6.0** SPLS 3_70 Ah All Cts_1	88.9	60.3	70.6	0.10		**7.8** SPLS 3_70 Ah All Cts_1	75.3	60.3	53.4	0.15	
540	Vertical side face mid ca.	EA	80x80x6	S355	1M16-8.8t	1	35	25		0.64	1.00	0.64	111	**-38.5** ULS 6b_90_afspannen_	82.7	60.3	70.6	0.64		**1.1** ULS 8 Ba 11_140gr	75.3	60.3	53.4	0.02	
541	Vertical side face mid ca.	EA	80x80x6	S355	1M16-8.8t	1	35	25		0.57	1.00	0.57	94	**-41.3** ULS 6b_90_afspannen_	97.6	60.3	70.6	0.68		**2.8** ULS 8 Ba_bouw	75.3	60.3	53.4	0.05	
542	Vertical side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.53	1.00	0.53	105	**-28.6** ULS 6b_90_afspannen_	63.9	60.3	70.6	0.47		**1.5** ULS 8 Ah_bouw	75.3	60.3	53.4	0.03	
543	Vertical side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.68	1.00	0.68	85	**-33.7** ULS 6b_90_afspannen_	82.0	60.3	70.6	0.56		**1.3** ULS 8 Ah_bouw	75.3	60.3	53.4	0.02	
544	Vertical side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	91	**-42.6** ULS 6b_90_afspannen_	95.3	60.3	70.6	0.71		**1.8** ULS 8 Ah_bouw	75.3	60.3	53.4	0.03	
545	Vertical side face mid ca.	EA	60x60x6	S355	1M16-8.8t	1	35	25	55	1.00	1.00	1.00	67	**-1.0** SPLS 3_0_9_90 Ba Ct1_	120.1	60.3	70.6	0.02		**4.8** SPLS 3_70 Ah All Cts_1	75.3	60.3	53.4	0.09	
546	Vertical side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	51	**-38.7** SPLS 3_70 Ah All Cts_1	131.8	120.6	141.1	0.32		**39.7** SPLS 3_0 Ah All Cts_14	106.5	120.6	106.8	0.37	
560	Diag side face mid ca.	EA	80x80x6	S355	2M16-8.8t	1	35	25	55	0.69	1.00	0.69	175	**-4.2** ULS 8 Ba_bouw	73.2	120.6	141.1	0.06		**50.1** ULS 6b_90_afspannen_	152.2	120.6	106.8	0.47	
561	Diag side face mid ca.	EA	70x70x6	S355	2M16-8.8t	1	35	25	55	0.63	1.00	0.63	163	**-1.6** ULS 8 Ba 11_140gr	66.3	120.6	141.1	0.02		**57.3** ULS 6b_90_afspannen_	128.4	120.6	106.8	0.54	
562	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.58	1.00	0.58	170	**-4.9** ULS 8 Ah_bouw	53.4	120.6	141.1	0.09		**64.8** ULS 6b_90_afspannen_	106.5	120.6	106.8	0.61	
563	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.53	1.00	0.53	166	**-3.7** ULS 8 Ah_bouw	37.5	120.6	141.1	0.10		**56.5** ULS 6b_90_afspannen_	106.5	120.6	106.8	0.53	
564	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.68	1.00	0.68	146	**-2.8** ULS 8 Ah_bouw	69.0	120.6	141.1	0.04		**77.1** ULS 6b_90_afspannen_	106.5	120.6	106.8	0.72	
565	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	154	**-4.1** ULS 8 Ah_bouw	64.2	120.6	141.1	0.06		**95.8** ULS 6b_90_afspannen_	106.5	120.6	106.8	0.90	
566	Diag side face mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	97	**-97.2** ULS 6b_90_afspannen_	112.6	120.6	141.1	0.80		**6.1** ULS 8 Ah_bouw	106.5	120.6	106.8	0.06	
567	Stability bracing mid ca.	EA	70x70x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	166	**-4.8** SPLS 1a_0 Ah Ct2_140g	54.2	60.3	70.6	0.09		**3.9** SPLS 1a_0 Ah Ct2_140	75.3	60.3	53.4	0.07	
575	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.52	0.52	0.52	141	**-62.3** SPLS 3_0_9_70 Ah Ct1_	84.5	188.2	176.4	0.74		**67.0** SPLS 3_70 Ah All Cts_1	128.1	188.2	160.4	0.52	
576	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.52	0.52	0.52	134	**-78.2** SPLS 3_0_9_70 Ah Ct2_	90.7	188.2	176.4	0.86		**74.3** SPLS 3_0_9_70 Ah Ct2_	128.1	188.2	160.4	0.58	
577	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.52	0.52	0.52	126	**-78.1** SPLS 3_0_9_70 Ah Ct2_	98.0	188.2	176.4	0.80		**78.9** SPLS 3_0_9_70 Ah Ct2_	128.1	188.2	160.4	0.62	
578	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.52	0.52	0.52	118	**-87.9** SPLS 3_0_9_70 Ah Ct2_	106.1	188.2	176.4	0.83		**86.5** SPLS 3_0_9_70 Ah Ct2_	128.1	188.2	160.4	0.68	
579	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.53	0.53	0.53	111	**-90.9** SPLS 3_0_9_70 Ah Ct2_	113.6	188.2	176.4	0.80		**90.2** SPLS 3_0_9_70 Ah Ct2_	128.1	188.2	160.4	0.70	
580	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	1.00	1.00	1.00	105	**-65.7** SPLS 3_70 Ah Ct1_140g	121.0	188.2	176.4	0.54		**67.1** SPLS 3_0_9_70 Ah Ct2_	128.1	188.2	160.4	0.52	
581	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.53	0.53	0.53	95	**-54.6** SPLS 3_0_9_70 Ah All Ct	133.7	188.2	176.4	0.41		**52.8** SPLS 3_0_9_70 Ah Ct2_	128.1	188.2	160.4	0.41	
582	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	35	35	55	0.53	0.53	0.53	89	**-58.7** SPLS 3_0_9_70 Ah All Ct	143.4	188.2	176.4	0.41		**58.2** SPLS 3_0_9_70 Ah All (	106.3	188.2	124.7	0.55	
583	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	35	35	55	0.53	0.53	0.53	83	**-66.7** SPLS 3_0_9_70 Ah Ct2_	152.3	188.2	176.4	0.44		**66.5** SPLS 3_0_9_70 Ah Ct2_	106.3	188.2	124.7	0.63	
584	Diag lower plane mid ca.	EA	70x70x6	S355	2M20-8.8t	1	35	35	55	0.53	0.53	0.53	76	**-75.2** SPLS 3_0_9_70 Ah All Ct	162.8	188.2	176.4	0.46		**76.6** SPLS 3_0_9_70 Ah Ct2_	106.3	188.2	124.7	0.72	
585	Diag lower plane mid ca.	EA	80x80x6	S355	2M20-8.8t	1	35	35	55	0.54	0.54	0.54	61	**-94.7** SPLS 3_0_9_70 Ah All Ct	218.9	188.2	176.4	0.54		**91.4** SPLS 3_0_9_70 Ah All (	126.7	188.2	124.7	0.73	
586	Diag lower plane mid ca.	EA	80x80x6	S355	2M20-8.8t	1	35	35	55	0.54	0.54	0.54	56	**-104.5** SPLS 3_70 Ah Ct1_140g	228.1	188.2	176.4	0.59		**103.5** SPLS 3_0_9_70 Ah Ct2_	126.7	188.2	124.7	0.83	
587	Diag lower plane mid ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	78	**-63.6** SPLS 3_60 Ah Ct1_120g	136.5	120.6	141.1	0.53		**63.1** SPLS 3_60 Ah Ct1_120	106.5	120.6	106.8	0.59	
588	Plan bracing mid ca.	EA	140x140x13	S355	5M24-8.8t	1	55	40	80	1.00	1.00	1.00	94	**-474.7** SPLS 3_0_9_70 Ah All Ct	591.0	677.8	1146.6	0.80		**466.3** SPLS 3_0_9_110 Ba All	681.4	677.8	1068.0	0.69	
589	Plan bracing mid ca.	EA	150x150x12	S355	4M24-8.8t	1	55	40	80	1.00	0.50	0.50	79	**-299.4** SPLS 3_0_9_110 Ba All (	648.1	542.2	846.7	0.55		**304.5** SPLS 3_0_9_70 Ah All (	678.2	542.2	789.1	0.56	
600	Horizontal top ca.	EA	200x200x18	S355	10M24-8.8t	1	55	40	80	2.00	1.00	1.00	43	**-1138.3** SPLS 3_70 Ah All Cts_1	2159.0	1355.5	3175.2	0.84		**924.1** SPLS 3_0_9_70 Ah All (	2272.7	1355.5	2985.2	0.68	
601	Lower chord top ca.	EA	180x180x18	S355	8M24-8.8t	1	55	40	80	1.00	3.34	1.00	63	**-852.7** SPLS 3_70 Ah All Cts_bo	1662.3	1084.4	2540.2	0.79		**622.1** 1_0_9_70 Ah Ct2_140gr	2018.7	1084.4	2388.2	0.57	
602	Lower chord top ca.	EA	180x180x18	S355	8M24-8.8t	1	55	40	80	1.00	3.72	1.00	44	**-634.4** SPLS 3_70 Ah Ct1_bouw	1924.1	1084.4	2540.2	0.59		**445.6** 3_0_9_70 Ah Ct1_bouw	1853.6	1084.4	2388.2	0.41	
603	Lower chord top ca.	EA	150x150x14	S355	8M24-8.8t	1	55	40	80	1.00	2.66	1.00	56	**-531.1** SPLS 3_70 Ah All Cts_bo	1150.2	1084.4	1975.7	0.49		**332.7** 3_0_70 Ah All Cts_140gr	1159.3	1084.4	1857.5	0.31	
604	Lower chord top ca.	EA	150x150x14	S355						1.67	2.25	1.67	43	**-297.4** SPLS 3_60 Ah Ct1_120g	1258.6	0.0	0.0	0.24		**155.2** 3_70 Ah All Cts_140gr	1425.0	0.0	0.0	0.11	
605	Lower chord top ca.	EA	150x150x14	S355						7.65	5.14	1.00	24	**-213.8** ULS 1a_60_120gr	1380.9	0.0	0.0	0.15		**120.5** 1a_0_9_0_9_60_120gr	1425.0	0.0	0.0	0.08	
606	Lower chord top ca.	EA	150x150x14	S355	2M20-8.8t	1	45	35	70	2.50	1.00	1.00	11	**-41.3** ULS 6b_90_afspannen_	1425.0	188.2	411.6	0.22		**11.9** ULS 8 Ba 10_140gr	700.0	188.2	374.2	0.06	
608	Earth peak lower chord	EA	80x80x8	S355	2M20-8.8t	1	45	35	70	2.00	1.00	1.00	157	**-54.3** ULS 3_120_120gr	72.0	188.2	235.2	0.75		**15.3** ULS 8 Ba 10_140gr	199.1	188.2	213.8	0.08	
609	Earth peak lower chord	EA	80x80x8	S355	2M20-8.8t	1	45	35	70	2.00	1.00	1.00	157	**-50.3** ULS 3_60_120gr	95.6	188.2	235.2	0.53		**14.6** 1a_0_9_0_9_60_120gr	199.1	188.2	213.8	0.08	
610	Horizontal top ca.	EA	130x130x12	S355	3M24-8.8t	1	55	40	80	2.00	1.00	1.00	67	**-244.0** SPLS 3_70 Ba Ct1_140g	628.1	406.7	635.0	0.60		**272.9** 3_70 Ah All Cts_bouw	575.5	406.7	592.3	0.67	
611	Horizontal top ca.	DEA	150x150x14 (not co	S355	2M24-8.8t	2	55	40	80	2.00	1.00	1.00	51	**-2.4** ULS 6b_90_afspannen_	1940.2	542.2	493.9	0.00		**68.9** ULS 3_0_9_70_140gr	1409.7	542.2	461.5	0.15	
612	Horizontal top ca.	HEA	HEA140	S355						1.00	1.00	1.00	65	**-5.4** ULS 1a_0_9_0_9_90_14	594.8	0.0	0.0	0.01		**7.0** S 6b_90_afspannen_10	1114.7	0.0	0.0	0.01	
613	Horizontal top ca.	DEA	150x150x18 (not co	S355	2M24-8.8t	2	55	40	80	2.00	1.00	1.00	39	**-2.8** ULS 1a_0_bouw	2719.9	542.2	635.0	0.01		**146.8** ULS 3_0_9_70_140gr	1790.1	542.2	593.3	0.27	
614	Beam top ca.	HEB	HEB220	S355						2.00	1.00	1.00	19	**-21.1** ULS 3_0_9_0_120gr	2705.9	0.0	0.0	0.01		**1.8** ULS 1a_0_bouw	3231.9	0.0	0.0	0.00	
615	Earth peak horizontal	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	129	**-2.4** ULS 6b_90_afspannen_	64.6	60.3	70.6	0.04		**2.4** PLS 1a_0 Ah Ct1_bouw	75.3	60.3	53.4	0.04	
616	Earth peak horizontal	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	109	**-2.5** ULS 6b_90_afspannen_	79.1	60.3	70.6	0.04		**1.8** PLS 1a_0 Ah Ct1_bouw	75.3	60.3	53.4	0.03	
617	Earth peak horizontal	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	89	**0.0** SPLS 6a_90 Ba All Cts A	97.7	60.3	70.6	0.00		**0.0** ULS 8 Ba 10_140gr	75.3	60.3	53.4	0.00	
618	Beam top ca.	UNP	UNP220	S355		2	55	40	80	1.00	1.00	1.00	30	**-47.9** ULS 3_90_140gr	765.7	0.0	0.0	0.06		**0.1** ULS 8 Ah 40_140gr	413.1	542.2	296.7	0.00	
626	Upper chord top ca.	EA	120x120x12	S355		1	55	40	80	2.25	3.74	2.25	172	**-67.7** SPLS 3_0_9_70 Ah All Ct	208.8	0.0	0.0	0.32		**373.6** S 6b_90_afspannen_10	522.0	542.2	789.1	0.72	
627	Upper chord top ca.	EA	100x100x10	S355	3M24-8.8t	1	55	40	80	1.00	1.00	1.00	137	**-12.3** ULS 8 Ba 1_120gr	208.0	406.7	529.2	0.06		**321.2** S 6b_90_afspannen_10	355.4	406.7	493.0	0.90	
628	Upper chord top ca.	EA	100x100x10	S355	6M24-8.8t	1	55	40	80	1.00	1.00	1.00	95	**-9.5** ULS 8 Ah 1_120gr	318.0	813.3	1058.4	0.03		**243.4** S 6b_90_afspannen_10	493.9	813.3	995.1	0.49	
629	Upper chord top ca.	EA	100x100x10	S355	3M24-8.8t	1	55	40	80	1.00	1.00	1.00	53	**-21.3** ULS 8 Ba 10_140gr	477.8	406.7	529.2	0.05		**132.8** ULS 3_0_120gr	355.4	406.7	493.6	0.37	
630	Earth peak upper chord	EA	130x130x12	S355						3.00	1.00	1.00	119	**-347.8** SPLS 3_70 Ah All Cts_bo	367.0	0.0	0.0	0.95		**283.9** 9_70 Ah All Cts_140gr	948.3	542.2	796.1	0.52	
631	Earth peak upper chord	EA	130x130x12	S355	4M24-8.8t					2.00	1.00	1.00	75	**-200.5** SPLS 3_70 Ah Ct1_bouw	579.4	542.2	846.7	0.37		**109.1** 3_0_9_70 Ah Ct1_bouw	948.3	542.2	796.1	0.20	
632	Earth peak upper chord	EA	120x120x10	S355	4M24-8.8t	1	55	40	80	3.00	1.00	1.00	110	**-225.2** SPLS 3_0_9_70 Ah All Ct	310.9	542.2	705.6	0.72		**221.9** 3_70 Ah All Cts_140gr	726.8	542.2	663.4	0.41	
633	Earth peak upper chord	EA	120x120x10	S355						2.00	1.00	1.00	81	**-199.7** SPLS 3_0_9_70 Ah All Ct	420.5	0.0	0.0	0.47		**195.6** 3_70 Ah All Cts_140gr	823.6	0.0	0.0	0.24	
634	Earth peak upper chord	EA	120x120x10	S355						2.00	1.00	1.00	81	**-161.3** SPLS 3_0_9_70 Ah All Ct	418.8	0.0	0.0	0.39		**151.3** 3_70 Ah All Cts_140gr	823.6	0.0	0.0	0.18	
635	Earth peak upper chord	EA	120x120x10	S355	2M20-8.8t	1	45	35	70	2.00	1.00	1.00	81	**-98.7** SPLS 3_0_9_60 Ah All Ct	422.2	188.2	294.0	0.52		**84.7** 3_70 Ah All Cts_140gr	396.6	188.2	267.3	0.45	
637	Stability bracing top ca.	EA	70x70x7	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	74	**-48.9** SPLS 3_70 Ah All Cts_1	174.4	60.3	82.3	0.81		**48.8** 3_70 Ah All Cts_140gr	87.8	60.3	62.3	0.81	
638	Earth peak horizontal	HEB	HEB160	S355	2M20-8.8t	1	45	35	70	2.00	1.00	1.00	12	**-0.4** ULS 1a_0_bouw	1583.9	188.2	235.2	0.00		**59.9** ULS 3_0_9_90_140gr	992.3	188.2	213.8	0.32	
640	Vertical side face top ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	89	**-5.3** ULS 8 Ba 40_140gr	97.1	120.6	141.1	0.05		**40.7** S 6b_90_afspannen_20	106.5	120.6	106.8	0.38	
641	Vertical side face top ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.56	1.00	0.56	98	**-56.1** SPLS 3_0_9_70 Ah All Ct	105.4	120.6	141.1	0.53		**92.6** 3_70 Ah All Cts_140gr	106.5	120.6	106.8	0.87	
642	Vertical side face top ca.	EA	80x80x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	68	**-1.7** ULS 8 Ah 1_140gr	162.7

DNV·GL

Assessment of angle groups

Date 16-7-2021
Author MRE
Version 1.0

RLL-TBG
HC+0/c

Group Label	Description	Type	Profile	Steel Quali	Bolts	#sh.pl	e1	e2	p1	RLX	RLY	RLZ	Slenderness	Compression	Load Case (Compress	Buckling	Shear (Comp)	aring (Comp)	U.C. (Comp)	eedance (Comp)	Tension	Load Case (Tension)	Net Section	ear (Tens)	ring (Tens)	U.C. (Tens)	ance (Tens)
645	Vertical side face top ca.	EA	80x80x8	S355	1M16-8.8t	1	35	25		0.44	1.00	1.00	218	**-3.7**	SPLS 3_70 Ah All Cts_1	54.7	60.3	94.1	0.07		**0.4**	ULS 8 Ba_bouw	100.4	60.3	71.2	0.01	
646	Earth peak vertical side face	EA	60x60x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	146	**-2.4**	ULS 3_135_120gr	55.0	60.3	70.6	0.04		**0.4**	ULS 8 Ah 10_140gr	75.3	60.3	53.4	0.01	
660	Diag side face top ca.	EA	80x80x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	166	**-58.0**	ULS 6b_90_afspannen_	78.8	120.6	141.1	0.74		**10.3**	ULS 8 Ba 40_140gr	152.2	120.6	106.8	0.10	
661	Diag side face top ca.	EA	80x80x8	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	180	**-81.7**	ULS 6b_90_afspannen_	91.4	120.6	188.2	0.89		**3.0**	ULS 8 Ah 1_140gr	198.7	120.6	142.4	0.02	
662	Diag side face top ca.	EA	80x80x8	S355	2M20-8.8t	1	45	35	70	1.00	1.00	1.00	121	**-144.7**	ULS 6b_90_afspannen_	156.0	188.2	235.2	0.93		**4.7**	ULS 8 Ah 1_140gr	199.1	188.2	213.8	0.02	
663	Earth peak diag side face	EA	80x80x6	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	186	**-0.4**	ULS 8 Ah 10_140gr	53.4	60.3	70.6	0.01		**3.5**	ULS 3_135_120gr	75.3	60.3	53.4	0.07	
664	Stability bracing top ca.	EA	80x80x8	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	133	**-93.3**	SPLS 3_70 Ah All Cts_1	138.4	120.6	188.2	0.77		**93.0**	3_70 Ah All Cts_140gr	198.7	120.6	142.4	0.77	
673	Earth peak diag upper side	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.55	0.55	0.55	79	**-32.3**	SPLS 3_70 Ah Ct1_140g	122.0	120.6	141.1	0.27		**32.8**	3_70 Ah All Cts_140gr	106.5	120.6	106.8	0.31	
674	Earth peak diag upper side	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.54	0.54	0.54	83	**-27.2**	SPLS 3_70 Ah All Cts_1	116.6	120.6	141.1	0.23		**26.0**	PLS 3_70 Ah Ct1_bouw	106.5	120.6	106.8	0.24	
675	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.51	0.51	0.51	105	**-73.6**	ULS 8 Ah_140gr	121.6	188.2	176.4	0.61		**73.9**	_9_70 Ah All Cts_140gr	128.1	188.2	160.4	0.58	
676	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.51	0.51	0.51	102	**-91.9**	SPLS 3_0_9_70 Ah Ct2_	125.3	188.2	176.4	0.73		**91.2**	1_0_9_70 Ah Ct2_140gr	128.1	188.2	160.4	0.71	
677	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.51	0.51	0.51	99	**-84.1**	ULS 8 Ah_bouw	129.0	188.2	176.4	0.65		**83.7**	1_0_9_70 Ah Ct2_140gr	128.1	188.2	160.4	0.65	
678	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	1.00	1.00	1.00	101	**-60.7**	ULS 8 Ba_bouw	125.6	188.2	176.4	0.48		**59.4**	1_0_9_70 Ah Ct2_140gr	128.1	188.2	160.4	0.46	
679	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	1.00	1.00	1.00	96	**-45.0**	SPLS 3_0_9_90 Ah Ct1_	106.1	188.2	176.4	0.42		**40.3**	3_0_9_90 Ah Ct1_bouw	128.1	188.2	160.4	0.31	
680	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	45	35	70	0.51	0.51	0.51	95	**-49.5**	SPLS 3_0_9_90 Ah Ct1_	134.2	188.2	176.4	0.37		**47.9**	3_0_9_90 Ah Ct1_bouw	128.1	188.2	160.4	0.37	
681	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	35	35	55	0.51	0.51	0.51	92	**-84.5**	SPLS 3_0_9_70 Ah All Ct	138.5	188.2	176.4	0.61		**84.0**	_9_70 Ah All Cts_140gr	106.3	188.2	124.7	0.79	
682	Diag lower plane top ca.	EA	70x70x6	S355	2M20-8.8t	1	35	35	55	0.51	0.51	0.51	89	**-98.8**	SPLS 3_0_9_70 Ah All Ct	143.0	188.2	176.4	0.69		**99.9**	_9_70 Ah All Cts_140gr	106.3	188.2	124.7	0.94	
683	Diag lower plane top ca.	EA	80x80x6	S355	2M20-8.8t	1	35	35	55	0.51	0.51	0.51	74	**-106.0**	SPLS 3_0_9_70 Ah All Ct	193.2	188.2	176.4	0.60		**104.2**	_9_70 Ah All Cts_140gr	126.7	188.2	124.7	0.84	
684	Diag lower plane top ca.	EA	80x80x6	S355	2M20-8.8t	1	35	35	55	0.51	0.51	0.51	71	**-108.9**	SPLS 3_70 Ah Ct1_140g	198.2	188.2	176.4	0.62		**107.6**	_9_70 Ah All Cts_140gr	126.7	188.2	124.7	0.86	
685	Diag lower plane top ca.	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	1.00	1.00	1.00	98	**-47.9**	SPLS 3_70 Ah Ct1_140g	88.5	120.6	141.1	0.54		**49.3**	1_0_9_70 Ah Ct1_140gr	106.5	120.6	106.8	0.46	
686	Earth peak diag lower plane	EA	70x70x7	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	184	**-3.5**	ULS 1a_0_120gr	54.0	60.3	82.3	0.07		**3.0**	1a_0_9_0_9_135_120gr	87.8	60.3	62.3	0.05	
687	Earth peak diag lower plane	EA	70x70x7	S355	1M16-8.8t	1	35	25		1.00	1.00	1.00	174	**-6.0**	SPLS 1a_0 Ah Ct1_bouw	59.0	60.3	82.3	0.10		**7.1**	S 6b_90_afspannen_20	87.8	60.3	62.3	0.12	
688	Earth peak diag upper plane	EA	70x70x6	S355	2M16-8.8t	1	35	25	55	0.52	0.52	0.52	114	**-52.4**	SPLS 3_70 Ah All Cts_1	110.0	120.6	141.1	0.48		**51.5**	3_70 Ah All Cts_140gr	128.4	120.6	106.8	0.48	
689	Earth peak diag upper plane	EA	70x70x6	S355	2M16-8.8t	1	35	25	55	0.52	0.52	0.52	109	**-56.9**	SPLS 3_70 Ah All Cts_1	116.1	120.6	141.1	0.49		**56.6**	3_70 Ah All Cts_140gr	128.4	120.6	106.8	0.53	
690	Earth peak diag upper plane	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.52	0.52	0.52	120	**-61.2**	SPLS 3_70 Ah All Cts_1	88.2	120.6	141.1	0.69		**61.6**	3_70 Ah All Cts_140gr	106.5	120.6	106.8	0.58	
691	Earth peak diag upper plane	EA	60x60x6	S355	2M16-8.8t	1	35	25	55	0.52	0.52	0.52	114	**-67.4**	SPLS 3_70 Ah All Cts_1	94.4	120.6	141.1	0.71		**66.6**	3_70 Ah All Cts_140gr	106.5	120.6	106.8	0.63	
692	Earth peak diag upper plane	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.52	0.52	0.52	105	**-10.7**	SPLS 3_70 Ah All Cts_1	93.0	60.3	70.6	0.18		**10.9**	3_70 Ah All Cts_140gr	75.3	60.3	53.4	0.20	
693	Earth peak diag upper plane	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.53	0.53	0.53	101	**-10.5**	SPLS 3_70 Ah All Cts_1	97.0	60.3	70.6	0.17		**9.8**	PLS 3_70 Ah Ct1_bouw	75.3	60.3	53.4	0.18	
694	Earth peak diag upper plane	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.53	0.53	0.53	100	**-12.4**	SPLS 3_70 Ah All Cts_1	98.3	60.3	70.6	0.21		**12.5**	3_70 Ah All Cts_140gr	75.3	60.3	53.4	0.23	
695	Earth peak diag upper plane	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.53	0.53	0.53	95	**-14.4**	SPLS 3_70 Ah All Cts_1	102.6	60.3	70.6	0.24		**14.2**	3_70 Ah All Cts_140gr	75.3	60.3	53.4	0.27	
696	Earth peak diag upper plane	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.54	0.54	0.54	92	**-17.2**	SPLS 3_70 Ah All Cts_1	106.7	60.3	70.6	0.29		**16.8**	3_70 Ah All Cts_140gr	75.3	60.3	53.4	0.32	
697	Earth peak diag upper plane	EA	60x60x6	S355	1M16-8.8t	1	35	25		0.54	0.54	0.54	87	**-20.5**	SPLS 3_70 Ah Ct1_bouw	111.9	60.3	70.6	0.34		**20.8**	3_70 Ah All Cts_140gr	75.3	60.3	53.4	0.39	
698	Plan bracing top ca.	EA	150x150x12	S355	4M24-8.8t	1	55	40	80	1.00	0.50	0.50	58	**-351.8**	SPLS 3_110 Ba All Cts_I	808.8	542.2	846.7	0.65		**357.3**	1_9_70 Ah All Cts_bouw	678.2	542.2	789.1	0.66	
699	Plan bracing top ca.	EA	140x140x13	S355	5M24-8.8t	1	55	40	80	1.00	1.00	1.00	68	**-586.5**	SPLS 3_70 Ah All Cts_bo	766.7	677.8	1146.6	0.87		**576.8**	3_110 Ba All Cts_bouw	681.4	677.8	1068.0	0.85	
700	Hor. Plan bracing hip structure	EA	100x100x8	S355	2M20-8.8t	1	45	35	70	1.00	1.00	1.00	246	**-55.5**	ULS 3_0_9_90_120gr	71.1	188.2	235.2	0.78		**43.0**	ULS 3_90_120gr	259.5	188.2	213.8	0.23	
701	Hor. Plan bracing hip structure	EA	100x100x8	S355	2M20-8.8t	1	45	35	70	0.50	1.00	0.50	223	**-8.9**	ULS 1a_0_9_0_9_45_12(	80.1	188.2	235.2	0.11		**5.8**	1_0_9_45 Ba Ct1_120gr	259.5	188.2	213.8	0.03	
702	Hor. Plan bracing hip structure	DEA	100x100x8 (not cou	S355	2M20-8.8t	1	45	35	70	0.50	0.50	0.50	246	**-2.5**	ULS 3_90_120gr	142.3	188.2	235.2	0.02		**0.0**	ULS 8 Ba_140gr	552.3	188.2	213.8	0.00	
703	2nd plan bacing	DEA	130x130x12#(15,0,	S355	3M24-8.8t	2	55	40	80	1.00	2.00	1.00	127	**-552.9**	ULS 3_90_120gr	687.1	813.3	635.0	0.87		**444.7**	ULS 3_0_9_90_120gr	1511.6	813.3	597.0	0.74	
704	2nd plan bacing	EA	90x90x8	S355	2M20-8.8t	1	45	35	70	1.00	1.00	1.00	237	**-8.9**	SPLS 3_60 Ah Ct2_120g	67.7	188.2	235.2	0.13		**8.4**	PLS 3_60 Ah Ct2_120gr	229.3	188.2	213.8	0.04	
705	2nd plan bacing	DEA	90x90x8 (not coupl	S355	2M20-8.8t	1	45	35	70	0.50	0.50	0.50	168	**-0.3**	ULS 3_90_120gr	228.9	188.2	235.2	0.00		**0.0**	ULS 8 Ba 11_140gr	458.6	188.2	213.8	0.00	
710	Horizontal top of lower ca.	EA	120x120x12	S355	4M24-8.8t	1	55	40	80	1.00	1.00	1.00	183	**-66.2**	SPLS 3_0_9_70 Ah All Ct	200.5	542.2	846.7	0.33		**229.7**	3_70 Ah All Cts_140gr	522.0	542.2	789.1	0.44	
711	Horizontal top of lower ca.	EA	130x130x12	S355	2M24-8.8t	1	55	40	80	1.00	1.00	1.00	169	**-187.7**	ULS 3_90_120gr	244.9	271.1	423.4	0.27		**188.6**	ULS 3_90_120gr	494.4	271.1	395.5	0.70	
712	Horizontal top of mid ca.	EA	120x120x12	S355	4M24-8.8t	1	55	40	80	1.00	1.00	1.00	142	**-20.0**	ULS 8 Ba 10_140gr	286.0	542.2	846.7	0.07		**256.1**	ULS 3_70_140gr	522.0	542.2	789.1	0.49	
713	Horizontal top of mid ca.	EA	120x120x10	S355	2M24-8.8t	1	55	40	80	1.00	1.00	1.00	141	**-193.4**	ULS 3_0_9_90_120gr	242.7	271.1	352.8	0.80		**211.0**	ULS 3_90_120gr	378.9	271.1	329.6	0.78	
714	Horizontal top of top ca.	EA	120x120x12	S355	4M24-8.8t	1	55	40	80	1.00	1.00	1.00	98	**-22.4**	SPLS 3_0_9_70 Ah All Ct	440.7	542.2	846.7	0.05		**281.7**	ULS 3_70_140gr	522.0	542.2	789.1	0.54	
715	Horizontal top of top ca.	EA	100x100x10	S355	2M24-8.8t	1	55	40	80	1.00	1.00	1.00	118	**-17.5**	ULS 6b_90_afspannen_	250.3	271.1	352.8	0.07		**16.5**	S 6b_90_afspannen_10	305.3	271.1	329.6	0.06	

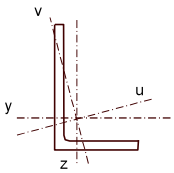
Project: ZW-Oost
Mast: H_c

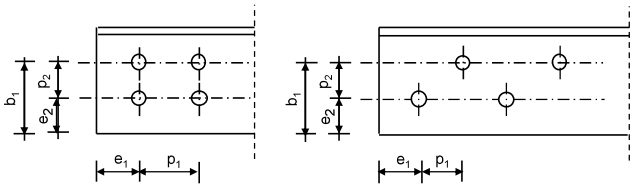
Angle check

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

Datum: 2021-06-02
Auteur: TBR
Versie: 3.0

Member name	**Group 108-109**	***Conclusion***		
Section	**XEA 200x200x24**	U.C.	(compression)	**0.88** **< 1,0 OK**
		U.C.	(tension)	**0.59** **< 1,0 OK**





Steel grade		**S355**	

Member loads

Compressive force	N_{Ed} =	**4581**	kN
Tensile force		**-4064**	kN

Crossing diagonal loads

Applicable:	**No**	
Min. tensile force diagonal 2	**1**	kN
Max. comp. force diagonal 1	**1**	kN
Position crossing diagonal y-axis	1.00	m

Construction loads

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

Geometry

System length y-axis	$L_{y,buc}$ =	1.66	m
System length z-axis	$L_{z,buc}$ =	1.66	m
System length v-axis	$L_{v,buc}$ =	1.66	m
System length x-asis	$L_{tk,buc}$ =	1.66	m
Member type		**Leg**	
Type bracing		Non staggered	

End conditions

Begin	Continuous
End	Continuous
Restraint code TOWER	C4

Bolted connection

Bolt type		M24		
Bolt class		8.8		
Number of bolts per leg		6		(24 total)
Shearplane through		Thread		
Boltpattern		Zigzag		
Boltpattern (leg-member only)		Staggered		
End distance	e_1 =	55	mm	Ok
Separation distance //	p_1 =	70	mm	Ok
Separation distance |	p_2 =	100	mm	Ok
End distance ⌟	e_2 =	50	mm	Ok
Double strap or single strap		Double		
Tie plate	b_p =	230	mm	OK
	t_p =	15	mm	OK
	e_2 =	40	mm	OK
A		18118	mm^2	
G		144.9	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	$F_{v;b;Rd}$ =	135.6	kN	

Slenderness $\lambda_{max} = L / i$: 22 -
Allowed: 120 **OK**

Bending due to vertical construction load

$M_{y,Ed} = 1/4\ F_{Ed}\ L_{pr}$ = 0.62 kNm
U.C. = **0.00** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.66	m	0.26	1,00 l	0.26	0.98	1	6299	0.73
$L_{z,buc}$ =	1.66	m	0.26	1,00 l	0.26	0.98	1	6299	0.73
$L_{v,buc}$ =	1.66	m	0.28	0,10+0,80 l	0.28	0.97	1	6237	0.73
$L_{tk,buc}$ =	1.66	m	0.55			0.81	1	5229	0.88

Bolted connection

Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	6432	0.71		*Net section angle*	$F_{u;Rd}$ =	6987	0.58	
Cross section tie plate	$F_{u;Rd}$ =	8094	0.57		*Net section tie plate*	$F_{u;Rd}$ =	6943	0.59	
Shear strength	$F_{v;Rd}$ =	8675	0.53		*Block shear*	$F_{u;Rd}$ =	10634	0.38	
Bearing strength	$F_{b;Rd}$ =	11695	0.39		*Shear strength*	$F_{v;Rd}$ =	8675	0.47	
Combined effect	$F_{v;Rd}$ =	8675	0.53	elastisch	*Bearing strength*	$F_{b;Rd}$ =	11825	0.34	
					Combined effect	$F_{v;Rd}$ =	8675	0.47	elastisch

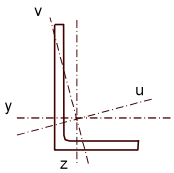
Project: ZW-Oost
Mast: H_c

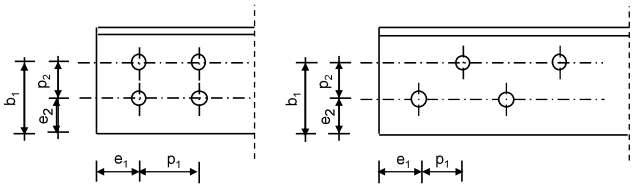
Angle check

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

Datum: 2021-06-02
Auteur: TBR
Versie: 3.0

Member name	**Group 110-111**	***Conclusion***		
Section	**XEA 250x250x24**	U.C.	(compression)	**0.91** **< 1,0 OK**
		U.C.	(tension)	**0.74** **< 1,0 OK**





Steel grade		**S355**	

Member loads

Compressive force	N_{Ed} =	**5685**	kN
Tensile force		**-5129**	kN

Crossing diagonal loads

Applicable:	**No**	
Min. tensile force diagonal 2	**1**	kN
Max. comp. force diagonal 1	**1**	kN
Position crossing diagonal y-axis	1.00	m

Construction loads

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

Geometry

System length y-axis	$L_{y,buc}$ =	1.81	m
System length z-axis	$L_{z,buc}$ =	1.81	m
System length v-axis	$L_{v,buc}$ =	1.81	m
System length x-asis	$L_{tk,buc}$ =	1.81	m
Member type		**Leg**	
Type bracing		Non staggered	

End conditions

Begin	Continuous
End	Continuous
Restraint code TOWER	C4

Bolted connection

Bolt type		M24		
Bolt class		8.8		
Number of bolts per leg		6		(24 total)
Shearplane through		Thread		
Boltpattern		Zigzag		
Boltpattern (leg-member only)		Staggered		
End distance	e_1 =	55	mm	Ok
Separation distance //	p_1 =	70	mm	Ok
Separation distance |	p_2 =	100	mm	Ok
End distance ⌟	e_2 =	50	mm	Ok
Double strap or single strap		Double		
Tie plate	b_p =	230	mm	OK
	t_p =	15	mm	OK
	e_2 =	40	mm	OK
A		23036	mm^2	
G		184.3	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	$F_{v;b;Rd}$ =	135.6	kN	

Slenderness $\lambda_{max} = L / i$: 19 -
Allowed: 120 **OK**

Bending due to vertical construction load

$M_{y,Ed} = 1/4\ F_{Ed}\ L_{pr}$ = 0.68 kNm
U.C. = **0.00** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.81	m	0.23	1,00 l	0.23	0.99	1	8098	0.70
$L_{z,buc}$ =	1.81	m	0.23	1,00 l	0.23	0.99	1	8098	0.70
$L_{v,buc}$ =	1.81	m	0.25	0,10+0,80 l	0.25	0.98	1	8045	0.71
$L_{tk,buc}$ =	1.81	m	0.64			0.76	1	6250	0.91

Bolted connection

Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	8178	0.70		*Net section angle*	$F_{u;Rd}$ =	6987	0.73	
Cross section tie plate	$F_{u;Rd}$ =	8094	0.70		*Net section tie plate*	$F_{u;Rd}$ =	6943	0.74	
Shear strength	$F_{v;Rd}$ =	8675	0.66		*Block shear*	$F_{u;Rd}$ =	10634	0.48	
Bearing strength	$F_{b;Rd}$ =	11695	0.49		*Shear strength*	$F_{v;Rd}$ =	8675	0.59	
Combined effect	$F_{v;Rd}$ =	8675	0.66	elastisch	*Bearing strength*	$F_{b;Rd}$ =	11825	0.43	
					Combined effect	$F_{v;Rd}$ =	8675	0.59	elastisch

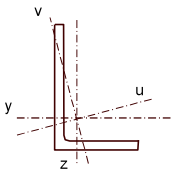
Project: ZW-Oost
Mast: H_c

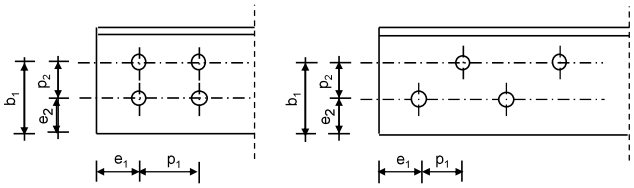
Angle check

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

Datum: 2021-06-02
Auteur: TBR
Versie: 3.0

Member name	**Group 112-113-114**	***Conclusion***		
Section	**XEA 250x250x24**	U.C.	(compression)	**0.96** **< 1,0 OK**
		U.C.	(tension)	**0.76** **< 1,0 OK**





Steel grade **S355**

Member loads

Compressive force	N_{Ed} =	**5945**	kN
Tensile force		**-5299**	kN

Crossing diagonal loads

Applicable:	**No**	
Min. tensile force diagonal 2	**1**	kN
Max. comp. force diagonal 1	**1**	kN
Position crossing diagonal y-axis	1.00	m

Construction loads

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

Geometry

System length y-axis	$L_{y,buc}$ =	1.96	m
System length z-axis	$L_{z,buc}$ =	1.96	m
System length v-axis	$L_{v,buc}$ =	1.96	m
System length x-asis	$L_{tk,buc}$ =	1.96	m
Member type		**Leg**	
Type bracing		Non staggered	

End conditions

Begin	Continuous
End	Continuous
Restraint code TOWER	C4

Bolted connection

Bolt type		M24		
Bolt class		8.8		
Number of bolts per leg		6		(24 total)
Shearplane through		Thread		
Boltpattern		Zigzag		
Boltpattern (leg-member only)		Staggered		
End distance	e_1 =	55	mm	Ok
Separation distance //	p_1 =	70	mm	Ok
Separation distance |	p_2 =	100	mm	Ok
End distance ⌟	e_2 =	50	mm	Ok
Double strap or single strap		Double		
Tie plate	b_p =	230	mm	OK
	t_p =	15	mm	OK
	e_2 =	40	mm	OK
A		23036	mm^2	
G		184.3	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	$F_{v;b;Rd}$ =	135.6	kN	

Slenderness $\lambda_{max} = L / i$: 20 -
Allowed: 120 **OK**

Bending due to vertical construction load

$M_{y,Ed} = 1/4\ F_{Ed}\ L_{pr}$ = 0.74 kNm
U.C. = **0.00** **< 1,00 OK**

Results stability

			$\lambda_{eff,rel}$	λ_{eff}	$\lambda_{eff,mod}$	χ_{buc}	η	$N_{b,Rd} = \eta\chi A f_y / \gamma_{M1}$	
$L_{y,buc}$ =	1.96	m	0.25	1,00 l	0.25	0.98	1	8043	0.74
$L_{z,buc}$ =	1.96	m	0.25	1,00 l	0.25	0.98	1	8043	0.74
$L_{v,buc}$ =	1.96	m	0.27	0,10+0,80 l	0.27	0.98	1	7985	0.74
$L_{tk,buc}$ =	1.96	m	0.64			0.76	1	6216	0.96

Bolted connection

Compression		F_{Rd} (kN)	U.C.		Tension		F_{Rd} (kN)	U.C.	
Cross section angle	$F_{u;Rd}$ =	8178	0.73		*Net section angle*	$F_{u;Rd}$ =	6987	0.76	
Cross section tie plate	$F_{u;Rd}$ =	8094	0.73		*Net section tie plate*	$F_{u;Rd}$ =	6943	0.76	
Shear strength	$F_{v;Rd}$ =	8675	0.69		*Block shear*	$F_{u;Rd}$ =	10634	0.50	
Bearing strength	$F_{b;Rd}$ =	11695	0.51		*Shear strength*	$F_{v;Rd}$ =	8675	0.61	
Combined effect	$F_{v;Rd}$ =	8675	0.69	elastisch	*Bearing strength*	$F_{b;Rd}$ =	11825	0.45	
					Combined effect	$F_{v;Rd}$ =	8675	0.61	elastisch

APPENDIX C
Knikverkorters

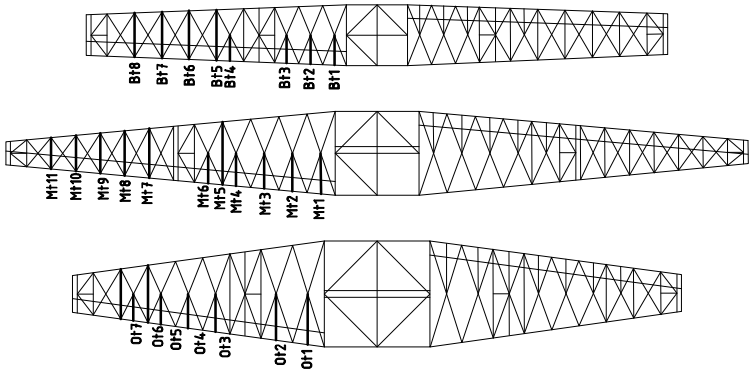
Niet in PLS-TOWER gemodelleerde elementen in de constructie worden aanvullend getoetst. Hieronder vallen de knikverkorters van de randstijl en profielen onderdeel van stabiliteitsverbanden. De staven worden getoetst op:

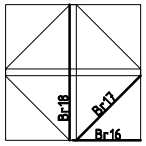
- voldoende trek- of druksterkte als steungevend profiel voor randstijl, 1% van de knikcapaciteit van de randstijl;
- slankheid;
- klimbelasting

Voor de beloopbaarheid zijn staven in de traverse aanwezig. Deze zijn niet constructief (voorzien van slobgaten) en worden enkel getoetst op de klimbelasting van 1,0 kN. Zie hoofdstuk 4.2.5 en 5.7.2 van het uitgangspuntenrapport.

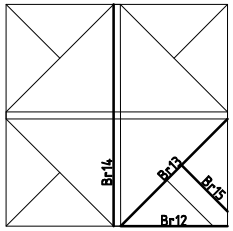
Profielen uit horizontaalverbanden van het onderstuk zijn in PLS-TOWER aanwezig maar worden in deze Appendix aanvullend getoetst op buiging. Profielafmeting en boutverbinding uit PLS-TOWER is leidend.

Overzicht knikverkorters - HC+0/c

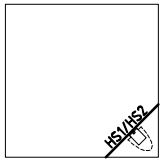




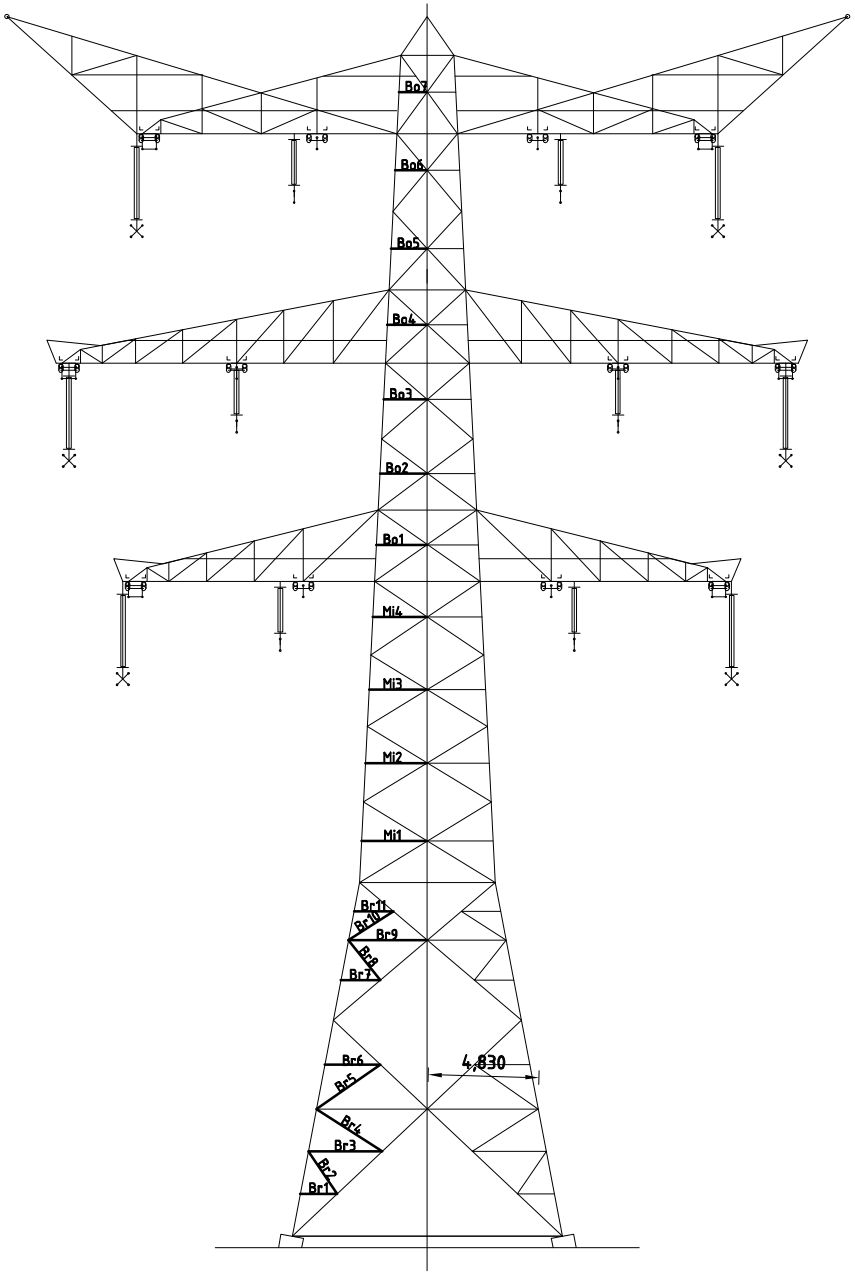
Tussenschot +15,9m



Tussenschot +6,04m



Standaard frame



Redundant members

Date: 2021-07-09
Author: MRE
Version: 1.9

RLL-TLB
HC+0/c

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.	Max. usage	Notes
Br1	Broekstuk	Enkele staaf	L70x6	S355J0	M20	8.8	1.62	0	118	**62.0**	**0.61**	85.4	94.1	71.3	112.9	1.99	0.87	Bearing	
Br2	Broekstuk	Enkele staaf	L80x6	S355J0	M20	8.8	2.24	55	142	**62.0**	**0.00**	77.3	94.1	71.3	136.4	2.68	0.87	Bearing	
Br3	Broekstuk	Enkele staaf	L90x8	S355J0	M20	8.8	3.23	0	183	**62.0**	**1.21**	80.6	94.1	95.0	213.2	4.34	0.77	Buckling	
Br4	Broekstuk	Enkele staaf	L90x8	S355J0	M20	8.8	3.41	33	194	**62.0**	**0.00**	74.2	94.1	95.0	213.2	4.34	0.84	Buckling	
Br5	Broekstuk	Enkele staaf	L90x8	S355J0	M20	8.8	3.40	33	193	**62.0**	**0.00**	74.5	94.1	95.0	213.2	4.34	0.83	Buckling	
Br6	Broekstuk	Enkele staaf	L80x6	S355J0	M20	8.8	2.50	0	159	**62.0**	**0.94**	66.6	94.1	71.3	136.4	2.68	0.93	Buckling	
Br7	Broekstuk	Enkele staaf	L70x6	S355J0	M20	8.8	1.72	0	125	**62.0**	**0.64**	79.3	94.1	71.3	112.9	1.99	0.87	Bearing	
Br8	Broekstuk	Enkele staaf	L80x6	S355J0	M20	8.8	2.23	51	141	**62.0**	**0.00**	78.0	94.1	71.3	136.4	2.68	0.87	Bearing	
Br9	Broekstuk	Enkele staaf	L90x8	S355J0	M20	8.8	3.43	0	195	**62.0**	**1.29**	73.5	94.1	95.0	213.2	4.34	0.84	Buckling	
Br10	Broekstuk	Enkele staaf	L80x6	S355J0	M20	8.8	2.32	33	148	**62.0**	**0.00**	73.6	94.1	71.3	136.4	2.68	0.87	Bearing	
Br11	Broekstuk	Enkele staaf	L70x6	S355J0	M20	8.8	1.17	0	86	**62.0**	**0.44**	119.0	94.1	71.3	112.9	1.99	0.87	Bearing	
Br12	Tussenschot +6,04m	Enkele staaf	L100x8	S355J0	M16	8.8	4.83	0	245	**0.0**	**1.81**	57.4	60.3	69.7	257.2	5.49	0.34	Bending	
Br13	Tussenschot +6,04m	Kniksteun op 0,5L	L100x8	S355J0	M16	8.8	6.83	0	222	**0.0**	**2.56**	56.8	60.3	69.7	257.2	7.19	0.36	Bending	
Br14	Tussenschot +6,04m	Kruisende staaf halverwege	L100x8	S355J0	M16	8.8	9.65	0	245	**0.0**	**1.81**	57.4	60.3	69.7	257.2	7.19	0.25	Bending	
Br15	Tussenschot +6,04m	Enkele staaf	L70x6	S355J0	M16	8.8	3.41	0	249	**0.7**	**1.28**	29.4	60.3	52.3	122.3	1.99	0.67	Bending	
Br16	Tussenschot +15,9m	Kniksteun op 0,5L	L130x12	S355J0	M16	8.8	2.94	0	74	**0.0**	**1.10**	380.6	60.3	104.5	620.9	17.91	0.06	Bending	
Br17	Tussenschot +15,9m	Enkele staaf	L90x8	S355J0	M16	8.8	4.17	0	237	**0.0**	**1.56**	54.4	60.3	69.7	225.8	4.34	0.37	Bending	
Br18	Tussenschot +15,9m	Kruisende staaf halverwege	L90x8	S355J0	M16	8.8	5.91	0	168	**0.0**	**1.11**	91.6	60.3	69.7	225.8	5.70	0.19	Bending	
Mi1	Middenstuk1	Enkele staaf	L80x8	S355J0	M20	8.8	2.87	0	184	**62.3**	**1.07**	71.0	94.1	95.0	181.9	3.33	0.88	Buckling	
Mi2	Middenstuk1	Enkele staaf	L80x8	S355J0	M20	8.8	2.70	0	173	**62.3**	**1.01**	77.6	94.1	95.0	181.9	3.33	0.80	Buckling	
Mi3	Middenstuk2	Enkele staaf	L80x6	S355J0	M20	8.8	2.53	0	161	**52.2**	**0.95**	65.3	94.1	71.3	136.4	2.68	0.80	Buckling	
Mi4	Middenstuk2	Enkele staaf	L80x6	S355J0	M20	8.8	2.38	0	151	**52.2**	**0.89**	71.4	94.1	71.3	136.4	2.68	0.73	Bearing	
Bo1	Bovenstuk1	Enkele staaf	L70x6	S355J0	M16	8.8	2.22	0	162	**38.0**	**0.83**	56.3	60.3	52.3	122.3	1.99	0.73	Bearing	
Bo2	Bovenstuk1	Enkele staaf	L70x6	S355J0	M16	8.8	2.07	0	151	**38.0**	**0.78**	62.0	60.3	52.3	122.3	1.99	0.73	Bearing	
Bo3	Bovenstuk1	Enkele staaf	L60x6	S355J0	M16	8.8	1.90	0	163	**38.0**	**0.71**	47.5	60.3	52.3	98.8	1.4	0.80	Buckling	
Bo4	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1.74	0	179	**13.6**	**0.65**	28.8	60.3	41.3	43.1	0.8	0.83	Bending	
Bo5	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1.58	0	162	**13.6**	**0.59**	33.3	60.3	41.3	43.1	0.8	0.75	Bending	
Bo6	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1.41	0	144	**13.6**	**0.53**	39.0	60.3	41.3	43.1	0.8	0.67	Bending	
Bo7	Bovenstuk2	Enkele staaf	L50x5	S355J0	M16	8.8	1.24	0	127	**7.4**	**0.46**	46.0	60.3	41.3	43.1	0.8	0.59	Bending	
Ot1	Ondertraverse	Enkele staaf	L60x6	S355J0	M16	8.8	2.20	0	188	**0.0**	**0.83**	38.5	60.3	52.3	98.8	1.4	0.61	Bending	
Ot2	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	2.01	0	207	**0.0**	**0.75**	23.2	60.3	41.3	43.1	0.8	0.96	Bending	
Ot3	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.65	0	170	**0.0**	**0.62**	31.2	60.3	41.3	43.1	0.8	0.79	Bending	
Ot4	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.49	0	153	**0.0**	**0.56**	36.0	60.3	41.3	43.1	0.8	0.71	Bending	
Ot5	Ondertraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.33	0	137	**0.0**	**0.50**	41.9	60.3	41.3	43.1	0.8	0.64	Bending	
Ot6	Ondertraverse	Enkele staaf	L60x6	S355J0	M16	8.8	2.50	0	214	**0.0**	**0.94**	31.7	60.3	52.3	98.8	1.4	0.69	Bending	
Ot7	Ondertraverse	Kruisende staaf halverwege	L50x5	S355J0	M16	8.8	1.16	0	119	**0.0**	**0.44**	49.7	60.3	41.3	43.1	0.8	0.55	Bending	
Ot8	Ondertraverse	Kruisende staaf halverwege	L60x6	S355J0	M16	8.8	2.18	0	187	**0.0**	**0.82**	39.0	60.3	52.3	98.8	1.4	0.60	Bending	
Mt1	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.77	0	182	**0.0**	**0.66**	28.2	60.3	41.3	43.1	0.8	0.85	Bending	
Mt2	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.65	0	170	**0.0**	**0.62**	31.2	60.3	41.3	43.1	0.8	0.79	Bending	
Mt3	Middentraverse	Kruisende staaf halverwege	L50x5	S355J0	M16	8.8	1.54	0	158	**0.0**	**0.58**	34.4	60.3	41.3	43.1	0.8	0.74	Bending	
Mt4	Middentraverse	Kruisende staaf halverwege	L50x5	S355J0	M16	8.8	1.43	0	147	**0.0**	**0.54**	38.1	60.3	41.3	43.1	0.8	0.68	Bending	
Mt5	Middentraverse	Kruisende staaf halverwege	L60x6	S355J0	M16	8.8	2.74	0	234	**0.0**	**1.03**	27.5	60.3	52.3	98.8	1.4	0.76	Bending	
Mt6	Middentraverse	Kruisende staaf halverwege	L50x5	S355J0	M16	8.8	1.31	0	135	**0.0**	**0.49**	42.7	60.3	41.3	43.1	0.8	0.63	Bending	
Mt7	Middentraverse	Kruisende staaf halverwege	L60x6	S355J0	M16	8.8	2.15	0	184	**0.0**	**0.81**	39.8	60.3	52.3	98.8	1.4	0.59	Bending	
Mt8	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.96	0	201	**0.0**	**0.74**	24.2	60.3	41.3	43.1	0.8	0.94	Bending	
Mt9	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.76	0	181	**0.0**	**0.66**	28.4	60.3	41.3	43.1	0.8	0.84	Bending	
Mt10	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.56	0	160	**0.0**	**0.59**	33.8	60.3	41.3	43.1	0.8	0.75	Bending	

Redundant members

Date: 2021-07-09
Author: MRE
Version: 1.9

RLL-TLB
HC+0/c

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.	Max. usage	Notes
Mt11	Middentraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.36	0	140	**0.0**	**0.51**	40.7	60.3	41.3	43.1	0.8	0.65	Bending	
Bt1	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.30	0	134	**0.0**	**0.49**	43.1	60.3	41.3	43.1	0.8	0.62	Bending	
Bt2	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.26	0	129	**0.0**	**0.47**	44.9	60.3	41.3	43.1	0.8	0.60	Bending	
Bt3	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.22	0	125	**0.0**	**0.46**	46.7	60.3	41.3	43.1	0.8	0.58	Bending	
Bt4	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	1.13	0	116	**0.0**	**0.42**	51.3	60.3	41.3	43.1	0.8	0.54	Bending	
Bt5	Boventraverse	Enkele staaf	L60x6	S355J0	M16	8.8	2.21	0	189	**0.0**	**0.83**	38.3	60.3	52.3	98.8	1.4	0.61	Bending	
Bt6	Boventraverse	Enkele staaf	L60x6	S355J0	M16	8.8	2.11	0	181	**0.0**	**0.79**	41.0	60.3	52.3	98.8	1.4	0.58	Bending	
Bt7	Boventraverse	Enkele staaf	L50x5	S355J0	M16	8.8	2.02	0	208	**0.0**	**0.76**	23.1	60.3	41.3	43.1	0.8	0.97	Bending	
Bt8	Boventraverse	Kruisende staaf halverwege	L50x5	S355J0	M16	8.8	1.93	0	198	**0.0**	**0.72**	24.7	60.3	41.3	43.1	0.8	0.92	Bending	
HS1	High Step	Kruisende staaf halverwege	L80x6	S355J0	M16	8.8	3.25	0	207	**0.0**	**2.44**	45.2	60.3	52.3	145.8	2.7	0.95	Bending	
HS2	High Step	Kruisende staaf halverwege	L70x7	S355J0	M16	8.8	2.80	0	205	**0.0**	**2.10**	46.0	60.3	61.0	142.7	2.2	0.97	Bending	

APPENDIX D
Blokdeuvels

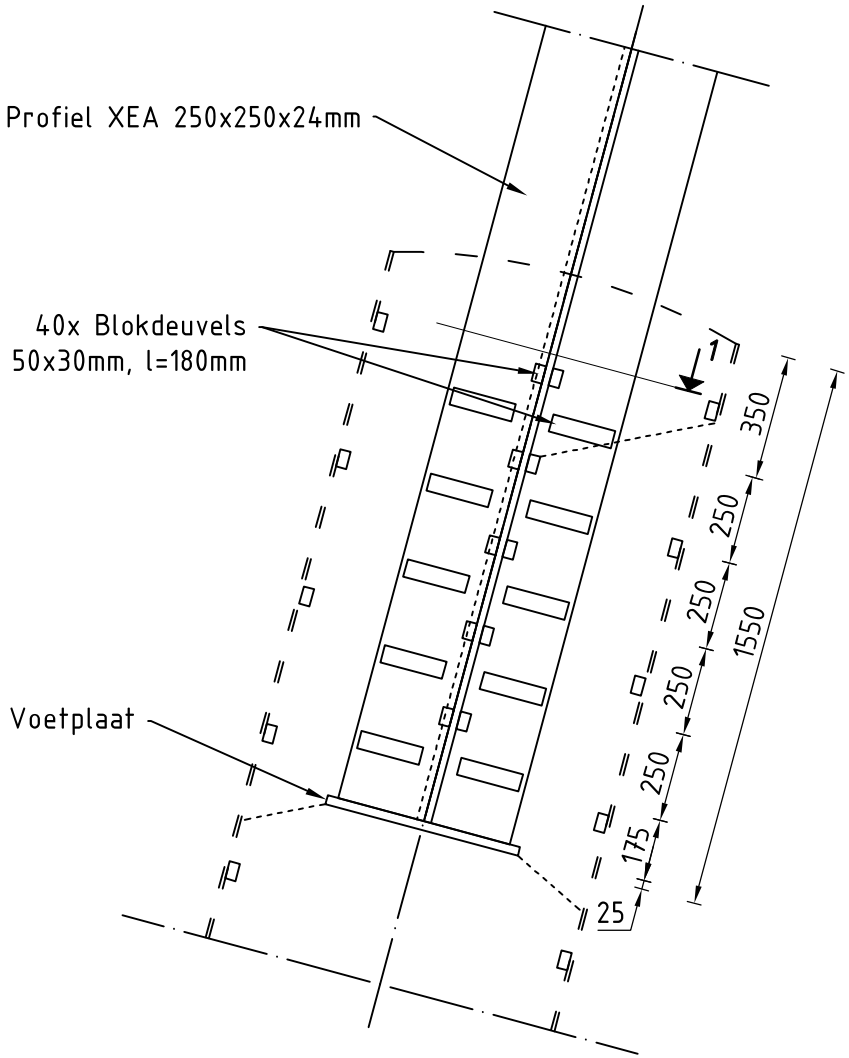
Het uitgangspunt voor de berekening van de ingestorte rand met blokdeuvels zijn de belastingen op de fundatie uit de uitvoer van het geleiderbelastingprogramma van DNV. De belastingen in de richting van de randstijl zijn van toepassing. In de tabellen is dit opgenomen in de laatste kolom $R_{z,lok}$. De controles zijn uitgevoerd met een spreadsheet. Vanwege de helling van de drukdiagonaal wordt per krachtsrichting bepaald hoeveel deuvels effectief zijn, hierdoor is het aantal ingevoerde deuvels in de berekening kleiner dan het aantal deuvels op de principetekening.

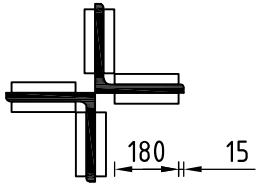
Er wordt voor gekozen om de blokdeuvels universeel uit te werken op basis van het profiel van de randstijl, dit betreft een XEA250x250x24-profiel en heeft betrekking op de volgende masttypen:

- Masttype HA+0/c, HA+0/ci, HA+3/c, HA+3/ca en HA+6/c;
- Masttype HB+0/c en HB+6/c;
- Masttype HC+0/c;
- Masttype WA+0/c en WA+6/c;
- Masttype WB+0/c;
- Masttype EA-3/co.

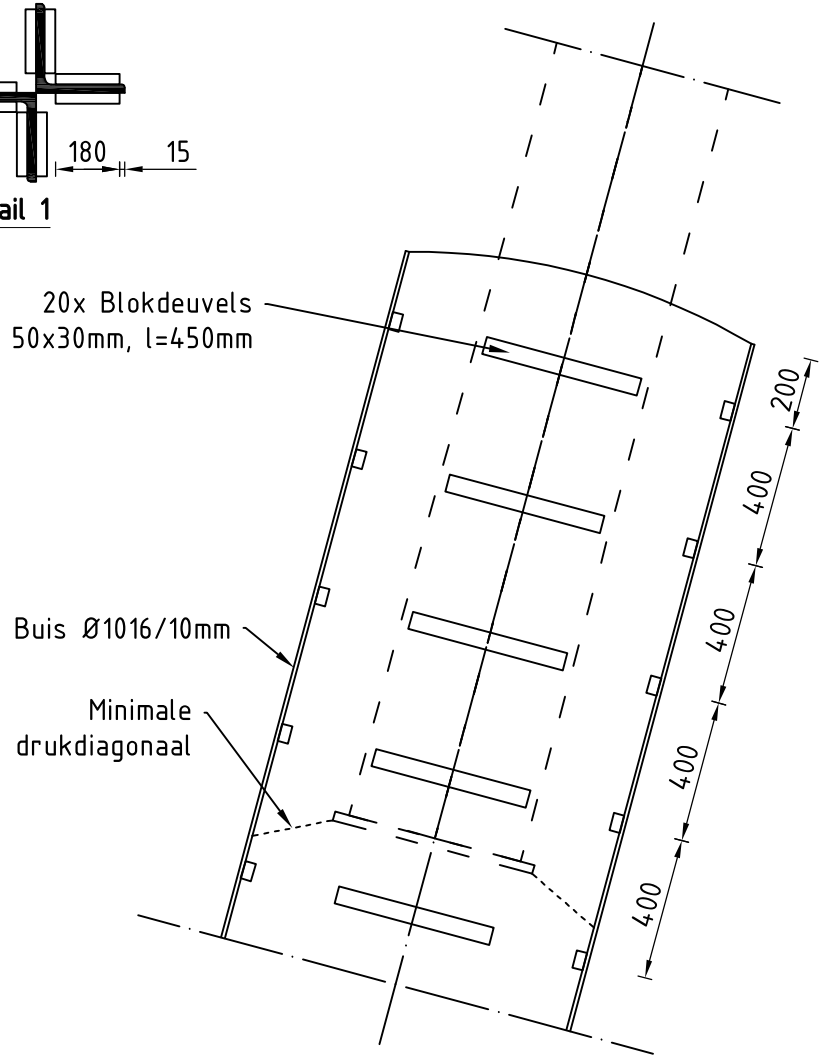
De blokdeuvels worden getoetst op de maatgevende belasting van bovenstaande masttypen. De belasting is opgenomen in Appendix A van het betreffende masttype, masttype HC+0/c is maatgevend. De optredende belastingen van masttype HC+0/c zijn 5503kN (druk) en -4739kN (trek), deze worden ruim naar boven afgerond op **5600kN** (druk) en **-4800kN** (trek). Met deze belastingen worden alle masttypen geborgd en hebben eventuele kleine aanpassingen geen invloed op deze uitwerking.

Principe blokdeuvels - combi-hoek-, combi-wissel en combi-eindmasten





Detail 1



Algemene opmerkingen

- Aarding niet aangegeven
- Spiraalwapening niet aangegeven

Project: RLL-TBG
Mast: HA-B-C/c & WA-B/c & EA-co

Shear blocks

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

Datum: 2021-07-09
Auteur: TBR
Versie: 1.5

Load				***Results***			
Compression	$F_{Ed,c}$	**5600**	kN	Compression	U.C.	0.87	< 1,00 OK
Tension	$F_{Ed,t}$	**4800**	kN	Tension	U.C.	0.78	< 1,00 OK

Main leg

Profile		**XEA 250x250x24**	
Type		Double (XEA)	
Steel material		S355	
Cross section		22934	mm^2
Axial capacity	N_{pl}	8142	kN
Width	b	500	mm
Thickness	t	24	mm
Length in concrete		1550	mm

Capacity shear blocks main leg

$A_{f1} = A_{f1,out} + A_{f1,in}$ =	10800	mm^2
$A_{f2} = A_{f2,out} + A_{f2,in}$ =	31807.5	mm^2
Slope	1: 5	
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.72	
$f_{jd} = C_A \times f_{cd}$ =	25.8	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd}$ =	4459	kN
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd}$ =	4459	kN

Shear blocks main leg

Sides		2	
Width	b	50	mm
Thickness	h	30	mm
Length - outside	L_{out}	180	mm
Length - inside	L_{in}	180	mm
Eccentricity	e	15	mm
Welds	a	5	mm
c.t.c. separation	s	250	mm
Number for compr.	n_c	16	-
Number for tension	n_t	16	-

Capacity foot plate

k_d =	1.73	-
$f_{jd} = C_A \times f_{cd}$ =	26.0	N/mm^2
$c = t\sqrt{(f_{yd} / 3f_{jd})}$ =	53	mm
m* = min(c,m) =	30	mm
Type foot plate	Extending	
Effective for	Compr. and tension	
$A_{p,c}$ =	86534	mm^2
$F_{Rd,c} = A_{p,druk} \times f_{jd}$ =	2254	kN
$A_{p,t}$ =	63600	mm^2
$F_{Rd,t} = A_{p,t} \times f_{jd}$ =	1657	kN

Foot plate

Thickness	t	25	mm
Ext. length	m	30	mm
Welds	a	5	mm

Capacities

$F_{rd,c,plate}$ =	2254	kN
$F_{rd,blocks,c}$ =	4459	kN
$F_{rd,c} = F_{rd,blck} + F_{rd,footplate}$ =	**6713**	kN
U.C. compression	0.83	< 1,00 OK
Welds foot plate (see next page)	2454	kN
$F_{rd,t}$ = min. (welds / foot plate) =	1657	kN
$F_{rd,blocks,t}$ =	4459	kN
$F_{rd,t} = F_{rd,blck} + F_{rd,footplate}$ =	**6116**	kN
U.C. tension	0.78	< 1,00 OK
U.C. welds	0.47	< 1,00 OK

Pile

Name	Buispaal	
Diameter	1016	mm
Thickness	10	mm
Cross section	31604	mm^2
Steel material	S355	
Capacity	11220	kN
Concrete strength	C30/37	

Shear blocks pile

Width	b	50	mm
Thickness	h	30	mm
Length	L	450	mm
Welds	a	5	mm
c.t.c. separation	s	400	mm
Number for compr.	n_c	16	-
Number for tension	n_t	16	-
Blocks per row	n_{bl}	4	-
Effectivity of total	c_{red}	100%	-

Capacity shear blocks pile

A_{f1} =	13500	mm^2
A_{f2} =	53076	mm^2
$C_A = \sqrt{(A_{f2}/A_{f1})}$ =	1.98	-
$f_{jd} = k_d \times f_{cd}$ =	29.8	N/mm^2
$F_{Rd,c} = n_c \times A_{f1} \times f_{jd} \times c_{red}$ =	**6440**	kN
U.C. compression	0.87	< 1,00 OK
$F_{Rd,t} = n_t \times A_{f1} \times f_{jd} \times c_{red}$ =	**6440**	kN
U.C. tension	0.75	< 1,00 OK
U.C. welds	0.45	< 1,00 OK

Design value concrete strength

Material factor	γ_c	1.5	
Add. mat. factor	γ_m	1.33	-
f_{cd} =		15.0	N/mm^2

Steel tower stub

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

"Splitting" of pile

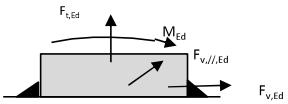
Spread of forces		45	°
Length force flow		1052	mm
Splitting force		2281	kN/m
Yield strength wall	f_{yd} =	355	N/mm^2
Capacity tubular pile		7100	kN/m
U.C.		0.32	< 1,00 OK

Project: RLL-TBG
Mast: HA-B-C/c & WA-B/c & EA-co

Welds of shear blocks of main leg

Out-of-plane loading

Plate			***Welds***		
t =	50	mm	a =	5	mm
Grade	S355		l =	360	mm
f_{yd} =	355	N/mm^2	β_w =	0.9	-
f_u =	490	N/mm^2	γ_{M2} =	1.25	-



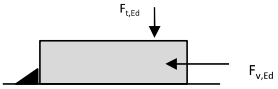
Member forces			***Stress components***		
Factor	1.2		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 4al$ =	0	N/mm^2
$F_{t,Ed}$ =	**0**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 4al$ =	66	N/mm^2
$F_{v,Ed} = F_{rd,c} / n$ =	**334**	kN		66	N/mm^2
$F_{v//,Ed}$ =	**0**	kN	$b^* = b + 2/3a\sqrt{2}$	54.7	mm
$M_{Ed} = 1/2\ b / h \times F_{v,Ed}$ =	**5.02**	kNm	$\sigma_1 = \tau_1 = 0{,}706M_{Ed} / al\ b^*$ =	36	N/mm^2
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	203	N/mm^2

Check								
$\sigma_{vw,Ed}$ =	203	N/mm^2	≤	$f_u / \beta_w\gamma_{M2}$ =	436	N/mm^2	U.C. =	**0.47** OK
σ_1 =	102	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0.29** OK

Welds of shear blocks of pile

Out-of-plane loading

Plate			***Welds***		
t =	50	mm	a =	5	mm
Grade	S355		l =	450	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		$\sigma_1 = \tau_1 = F_{t,Ed}\sqrt{2} / 2al$ =	23	N/mm^2
$F_{t,Ed} = 1/2\ b / h \times F_{v,Ed}$ =	**145**	kN	$\sigma_1 = \tau_1 = F_{v,Ed}\sqrt{2} / 2al$ =	76	N/mm^2
$F_{v,Ed}$ =	**483**	kN		99	N/mm^2
$F_{v//,Ed}$ =	**0**	kN			
M_{Ed} =	**0.00**	kNm			
			$\tau_{//} = F_{v//,Ed} / 2al$ =	0	N/mm^2
			$\sigma_{vw,Ed} = \sqrt{(\sigma_1^2 + 3\tau_1^2 + 3\tau_{//}^2)}$ =	197	N/mm^2

Check								
$\sigma_{vw,Ed}$ =	197	N/mm^2	≤	$f_u / \beta_w\gamma_{M2}$ =	436	N/mm^2	U.C. =	**0.45** OK
σ_1 =	99	N/mm^2	≤	$0{,}9f_u / \gamma_{M2}$ =	353	N/mm^2	U.C. =	**0.28** 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 =	1952	mm
Capacity	$F_{Rd} = a \times l \times f_{w,d} / \sqrt{3}$ =	**2454**	kN

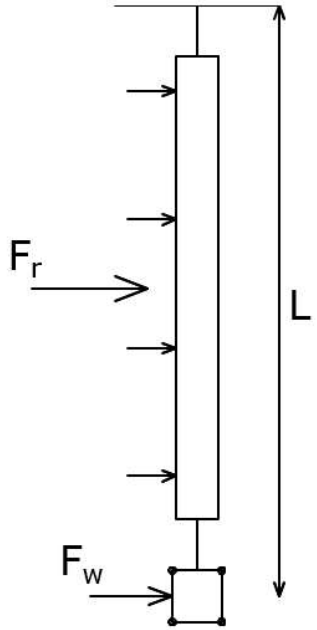
APPENDIX E
Liggers

1 BEREKENING OPHANGING POSTISOLATOREN

De volgende onderdelen worden berekend:

- De belastingen op de ophanging van de postisolatoren door wind en eigen gewicht;
- De dimensionering van de ophangconstructies.

Onderstaand zijn de optredende belastingen geschematiseerd:



Figuur 1 Belastingschema

1.1 Uitgangspunten & afmetingen postislatoren

Voor het berekenen van de liggers voor de ophanging van de postisolatoren in de mastkoppen van de HA-masten wordt één berekening gemaakt met de volgende uitgangspunten:

- Windgebied II;
  - Windhoogte 54,5m (conservatief hoogte masttype HB+6/c aangehouden);
  - Onbebouwd;
- Referentieperiode 50 jaar;
- Belastingfactor 1,5.

De volgende factoren worden gehanteerd:

- Krachtcoëfficiënt 1,2 voor isolatoren
- Constructiefactor geleider 1,0;
- Krachtcoëfficiënt geleider 1,0;
- Constructiefactor geleider 1,0.

Conform het uitgangspuntendocument zijn de afmetingen als volgt:

Tabel 1 Gegevens postisolatoren

Omschrijving	Ophanging	Gewicht	Lengte	Windopp.
		[kN]	*[m]*	*[m]*
Fasegeleider 380 kV	Bretelfixatie	2,0	4,5	1,0
Fasegeleider 150 kV	Bretelfixatie	1,5	2,7	0,7

De diameter van de geleiders is 32mm.

1.2 Belastingen

De extreme stuwdruk $q_{p(z)}$ in windgebied II op een hoogte van 54,5m is 1,41 kN/m^2.

Er komen drie varianten voor:

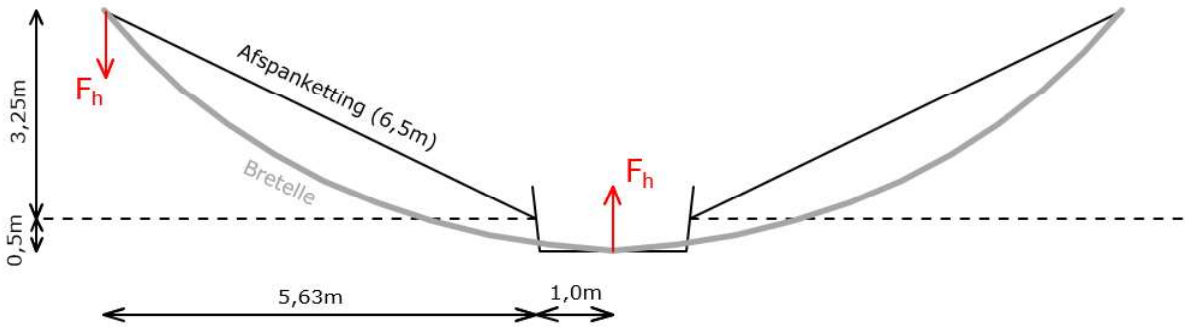
1. 380 kV geleider met één postisolator;
    - Lengte geleider aan postisolator ca. 9 m;
2. 150 kV geleider met één postisolator;
    - Lengte geleider aan postisolator ca. 7 m;
3. 150 kV geleider met twee postisolatoren;
    - Lengte geleider aan postisolator ca. 3,5 m.

In het horizontale vlak bestaat er een afstand tussen het uiteinde van de afspanketting en de postisolator (zie figuur 2). Dit veroorzaakt een extra horizontale kracht vanuit de bretelle op de onderzijde van de postisolator (zie figuur 3). Het gewicht van de bretelle (380kV) is gelijk aan (4x 17,7N/m =) 70,8N/m. De horizontale kracht evenwijdig aan de brettelle is gelijk aan:

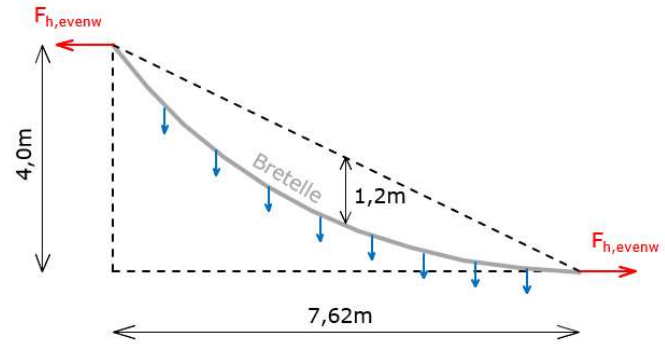
- $F_{h,evenw}$ = $1/8 \cdot q \cdot L^2 / u = 1/8 \cdot 0{,}0708\text{kN/m} \cdot (7{,}62\text{m})^2 / 1{,}2\text{m} = 0{,}4$ kN.

De horizontale kracht loodrecht op de postisolator is gelijk aan:

- $F_{h,gel}$ = $2 \cdot 0{,}4\text{kN} \cdot 3{,}75\text{m} / 7{,}62\text{m} = 0{,}4$ kN.



Figuur 2 Bovenaanzicht bretelle



Figuur 3 Zij-aanzicht bretelle

Voor het 180kV-circuit wordt dezelfde berekening gemaakt. De afspanketting heeft een lengte van 4,0m en de tussen afstand is 2 x 2m (i.p.v. 2 x 1m). De postisolator hangt 1,0m naar buiten en de horizontale afstand (ten gevolge van de hoek) is gelijk aan (sin(30º) · 4m =) 2m. De lengte is dan gelijk aan ($\sqrt{((\cos(30º)\cdot 4m+2m)^2 + (2m+1m)^2}$=) 6,23m. De krachten zijn dan gelijk aan:

- $F_{h,evenw}$ = 1/8 · q · L^2 / u = 1/8 · 0,0354kN/m · $(6,23m)^2$ / 0,8m = 0,2 kN;
- $F_{h,gel}$ = 2 · 0,4kN · 3,0m / 6,23m = 0,2 kN.

<u>Belasting bij wind loodrecht op de geleider</u>

Voor elke variant zijn in onderstaande tabellen de optredende reactiekrachten (F_h, $F_{v,tot}$ en M_{tot}) op het ophangpunt van de postisolator berekend.

Tabel 2 Optredende belastingen per variant – wind loodrecht

Var.	$q_{p(z)}$ [kN/m²]	G_{post} [kN]	L_{post} [m]	Opp [m²]	n_{gel} [n]	$Ø_{gel}$ [m]	G_{gel} [kN/m]	L_{gel} [m]	$F_{h,gel}$ [kN]
1	1,41	2	4,5	1	4	0,032	0,0177	9	0,4
2	1,41	1,5	2,7	0,7	2	0,032	0,0177	7	0,2
3	1,41	1,5	2,7	0,7	2	0,032	0,0177	3,5	0,1

Var.	$C_{f,r}$ [-]	S_r [-]	$F_{r;k}$ [kN]	$M_{r;k}$ [kNm]	$C_{f,w}$ [-]	S_w [-]	$F_{w;k}$ [kN]	$M_{w;k}$ [kNm]
1	1,2	1	1,69	3,81	1	1	1,62	7,31
2	1,2	1	1,18	1,60	1	1	0,63	1,71
3	1,2	1	1,18	1,60	1	1	0,32	0,85

Var.	γ [-]	$F_{v,Ed}$ [kN]	$F_{h,tot,Ed}$ [kN]	$M_{tot,Ed}$ [kNm]
1	1,5	4,0	5,6	19,4
2	1,5	2,6	3,0	5,8
3	1,5	2,4	2,4	4,1

Belasting bij wind evenwijdig aan de geleider

Waar relevant wordt er ook getoetst aan wind evenwijdig aan de geleider. In onderstaande tabel zijn de optredende krachten weergegeven.

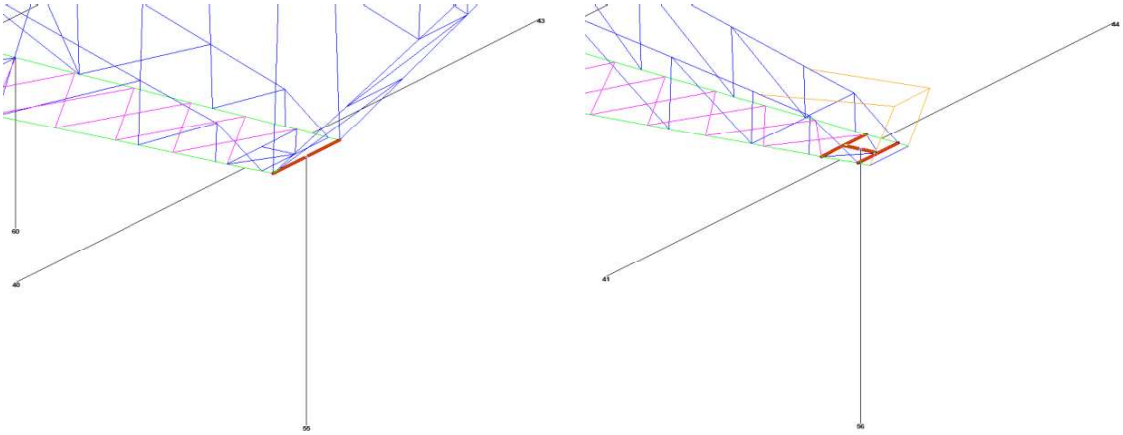
Tabel 3 Optredende belastingen per variant – wind evenwijdig

Var.	L_{post} [m]	$F_{h,gel}$ [kN]	$M_{r,\perp,k}$ [kNm]	$F_{r;k}$ [kN]	$M_{r;//,k}$ [kNm]	$F_{v,Ed}$ [kN]	$F_{h,\perp,Ed}$ [kN]	$M_{r;\perp,Ed}$ [kNm]	$F_{h,//,Ed}$ [kN]	$M_{r;//,Ed}$ [kNm]
1	4,5	0,4	1,8	1,69	3,81	4,0	0,6	2,7	2,5	5,7
2	2,7	0,2	0,54	1,18	1,60	2,6	0,3	0,8	1,8	2,4
3	2,7	0,1	0,27	1,18	1,60	2,4	0,2	0,4	1,8	2,4

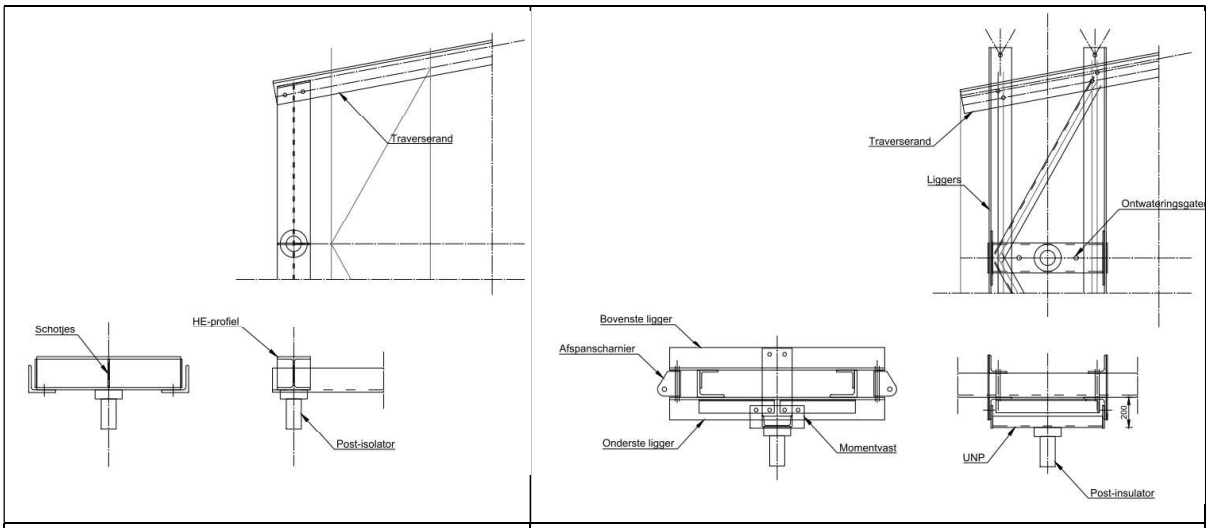
2 VARIANT 1 – 380 KV – 1 POSTISOLATOR

De ophanging van de postisolator bij variant 1 kent twee varianten:

A. Ophanging aan enkele ligger (onderstaand links);
B. Ophanging aan frame (onderstaand rechts).



Figuur 4 Principe ophanging variant 1A (links) en 1B (rechts)



Variant 1A: post-isolator rechtstreeks op ligger	*Variant 1B: post-isolator via een UNP-profiel tussen de onderste afspanliggers*

Figuur 5 Principedetails voor bevestiging post-isolator variant 1A en 1B

2.1 Variant A

De postisolator wordt opgehangen aan een enkele stalen ligger. Deze ligger wordt daardoor in twee richtingen en op torsie belast. De optredende belastingen zijn:

- Verticaal F_v 4,0 kN;
- Horizontaal $F_{h,tot}$ 5,6 kN;
- Torsiemoment M_{tot} 19,4 kNm.

De maximale lengte van de ligger is 1,82m (boventraverse). Het profiel van de ligger is HEB220 (S355). De ligger wordt getoetst aan de hand van een excel-sheet. Uit berekening blijkt dat de ligger voldoet met een maximale UC van 0,78. Voor berekening, zie na pagina 6.

2.2 Variant B

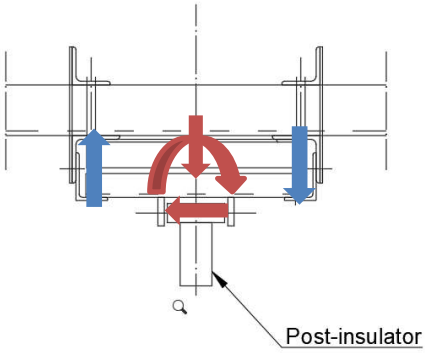
Onderstaand is de situatie schematisch weergegeven. De hoeklijnen hebben een (minimale) doorsnede van 150x150x14mm. De afstand tussen de hoeklijnen is minimaal 600 mm. De bovenste en onderste hoeklijnen worden halverwege de overspanning gekoppeld.

De optredende maximale reactiekracht is gelijk aan (4,0kN/2 + 19,4kNm/0,6m =) 34,3kN. Per ligger is de kracht gelijk aan (34,3kN / 2 =) 17,2kN.

De maximale overspanning is 2,5m (middentraverse → 150kV heeft langste ligger, deze als maatgevend aangehouden). Het totale moment in het hoekstaal wordt dan (0,25 · (17,2kN + 5,3kN/2) · 2,5m =) 12,4kNm.

Het weerstandsmoment is gelijk aan 83500mm^3. De spanning is gelijk aan (12,4·10^6 Nmm/78300mm^3 =) 158MPa. De ligger voldoet met een UC van (158MPa / 355MPa =) 0,45.

De ligger die hoeklijnen koppelt heeft een doorsnede van UNP220 en wordt om de zwakke as belast. Het optredende moment is gelijk aan (1/4 · 4,0kN · 0,6m + 1/2 · 19,4kNm =) 10,3kNm. De spanning is gelijk aan (10,3·10^6 Nmm / 33500mm^3 =) 307MPa. De ligger voldoet met een UC van (307MPa / 355MPa =) 0,86.



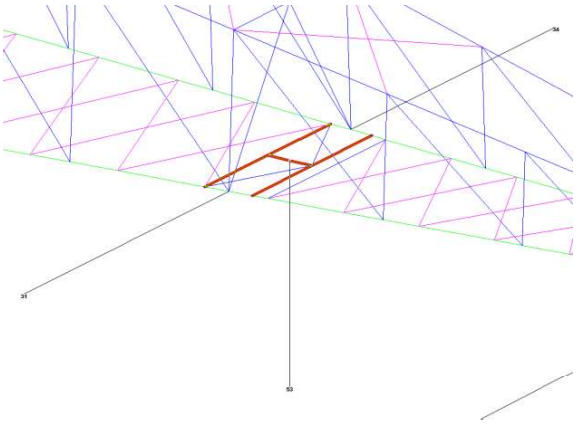
Figuur 6 Schematische weergave ophanging variant 1B

3 VARIANT 2 – 150 KV – 1 POSTISOLATOR

Bij deze variant wordt de postisolator opgehangen aan een frame, dit komt overeen met variant 1B. De optredende belastingen zijn:

- Verticaal F_v 2,6 kN;
- Horizontaal $F_{h,tot}$ 3,0 kN;
- Torsiemoment M_{tot} 5,8 kNm.

De belastingen zijn lager en de liggers maximaal even lang als bij variant 1B. Voor variant 2 voldoen profielen 150x150x14mm dus ook, voor uitwerking zie variant 1B.

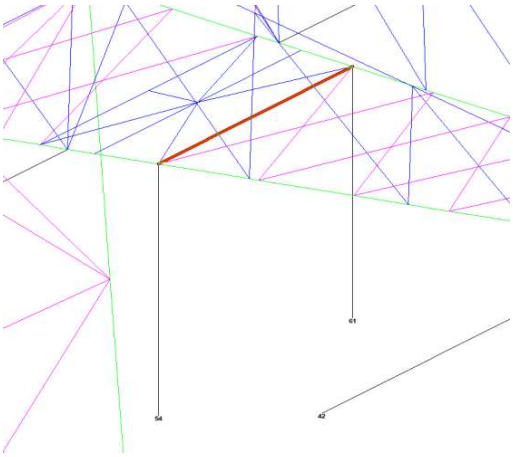


Figuur 7 Principe ophanging variant 2

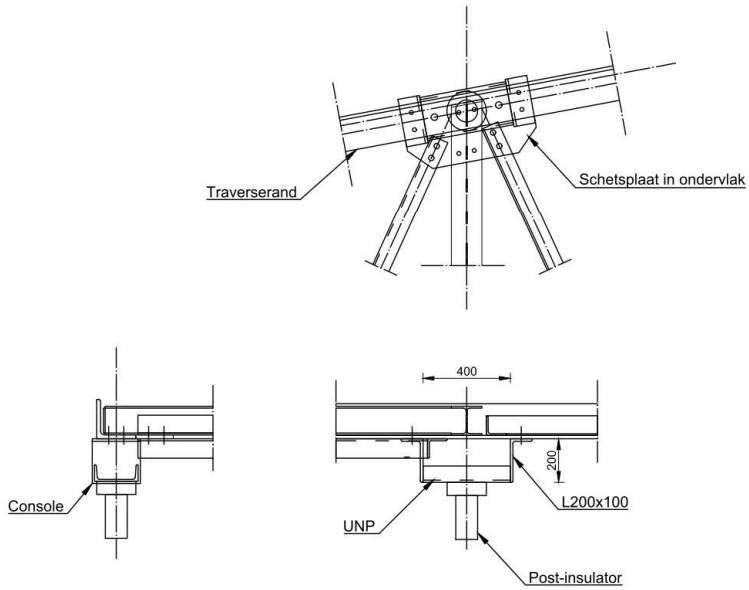
4 VARIANT 3 – 150 KV – 2 POST-ISOLATOR

De postisolator wordt via een verlaagde console ingeklemd in twee richtingen opgehangen aan de onderrand van de traverse. De torsie op de onderrand wordt opgenomen door een ligger uit HE-profiel (diagonalen worden verwaarloosd), in de richting van de onderrand neemt de rand de momenten op. De optredende belastingen zijn:

- Verticaal F_v 2,4 kN;
- Horizontaal $F_{h,tot}$ 2,4 kN;
- Torsiemoment M_{tot} 4,1 kNm.



Figuur 8 Principe ophanging variant 3



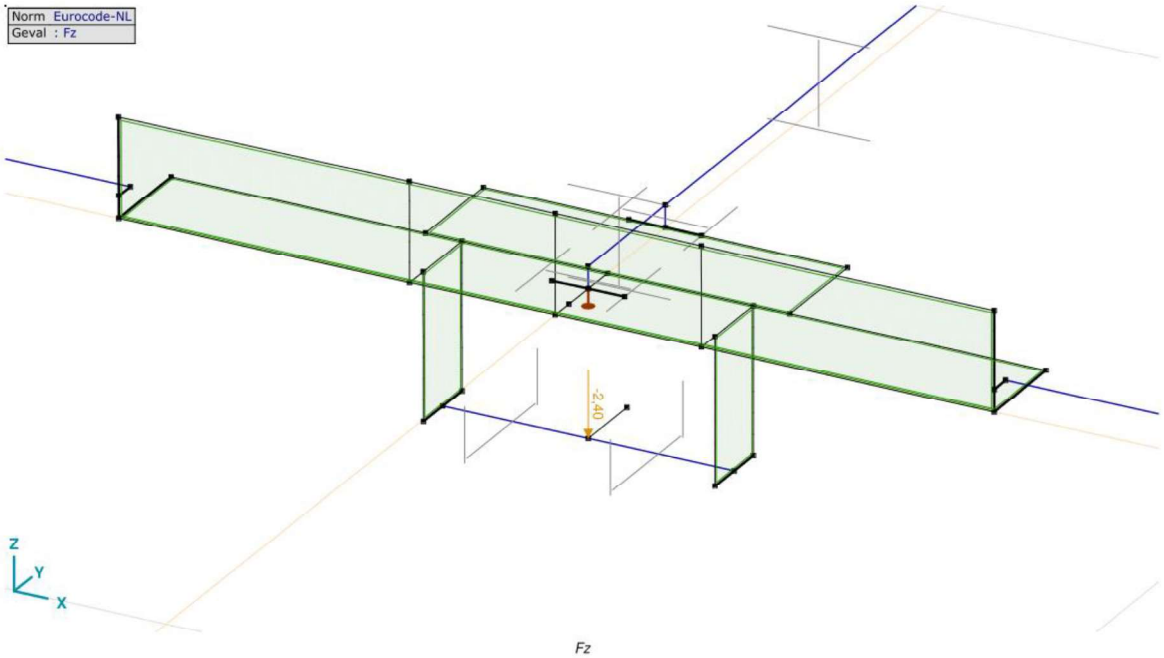
Figuur 9 Principedetail bevestiging post-isolator aan rand

De ligger wordt belast door een kopmoment. Dit moment is volgens Tabel 3 gelijk aan 2,4 kNm. Ligger met praktisch gekozen profiel HE140A volstaat.

Kritisch aspect in de verbinding is de krachtsoverdracht van het buigend moment uit het vlak van de console naar de ligger. De onderrand wordt lokaal (tussen de console en HE-ligger) op torsie belast en de flens van het hoekprofiel

wordt ook op buiging belast. Om de krachtsinleiding mogelijk te maken wordt de onderrand verstijfd met een schetsplaat waarmee de HE-ligger en diagonalen worden verbonden.

De controle is uitgevoerd met het programma AxisVM. Zowel buiging in het vlak als buiging uit het vlak is gecontroleerd. Als minimaal profiel van de onderrand is uitgegaan van L150x150x14. De maximale drukkracht in de rand is in combinatie met de buiging meegenomen.



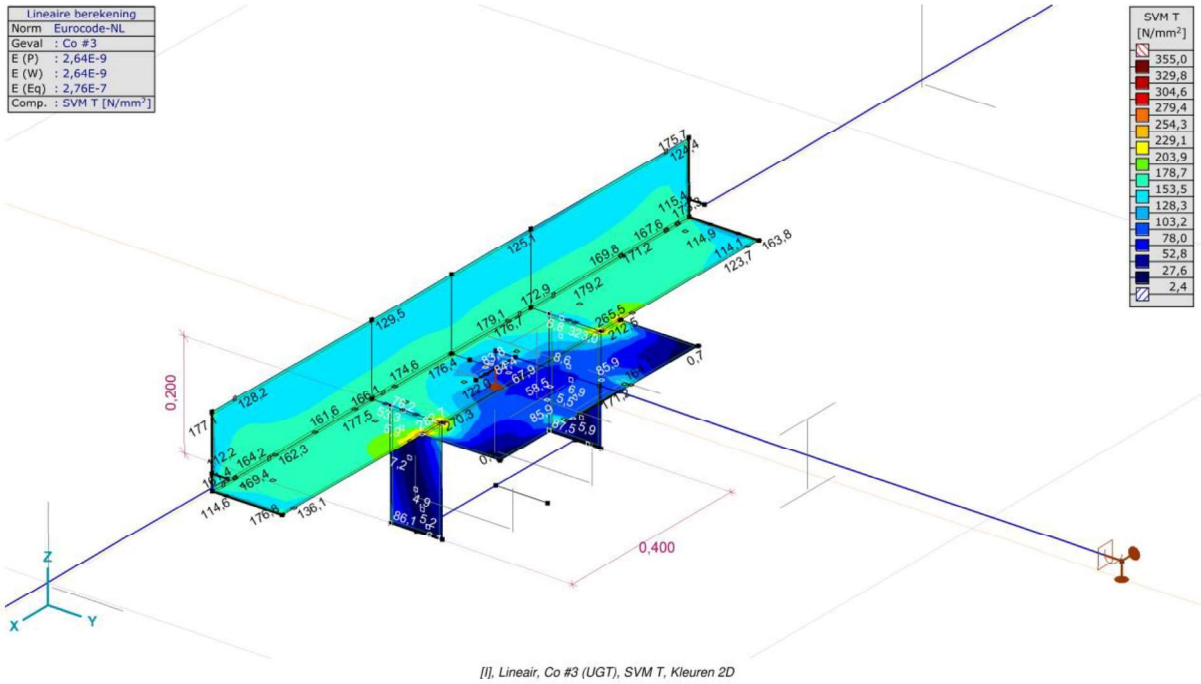
Figuur 10 Rekenmodel krachtsinleiding post-isolator aan onderrand

De belastingen zijn ontleend aan Tabel 2 en Tabel 3 voor de 150 kV post-isolator. De belastingen zijn in AxisVM gecombineerd met het verticale gewicht, en met twee richtingen van Mx en My, waarbij belastinggevallen zijn verminderd tot een factor 0,71.

Tabel 4 Belastingen op console

Var.	$F_{z,Ed}$	$F_{x,Ed}$	$F_{v,Ed}$	$M_{x,Ed}$	$M_{y,Ed}$
	[kN]	*[kN]*	*[kN]*	*[kNm]*	*[kNm]*
Mx			1,8	2,4	
My		3,0			5,8
Fz	2,4				
N	600				

Uit de berekening blijkt dat de combinatie van spanningen door torsie en buiging toelaatbaar is.



Figuur 11 Spanningen in de maatgevende belastingcombinatie

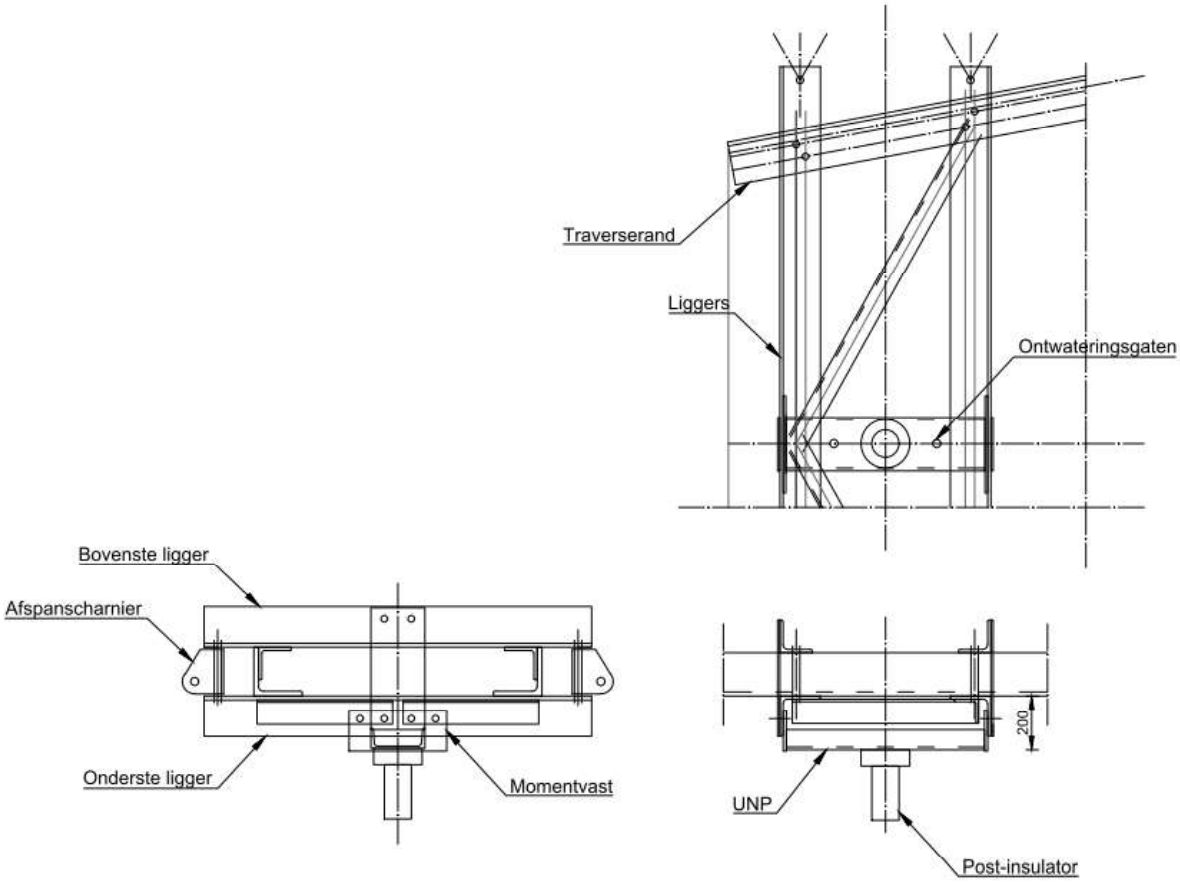
In het model treden elastisch berekend bij hoeken spanningsconcentraties op. Zie Figuur 11. In de uitvoer opgenomen in de bijlage blijkt dat de hoogste spanning 323 N/mm^2 bedraagt. De toetsing is:

U.C. = 323 N/mm^2 / 355 N/mm^2 = 0,91 ≤ 1,00 OK.

De staalprofielen voldoen.

5 CONTROLE AFSPANLIGGERS

De afspankettingen van de hoekmast worden bevestigd tussen twee paren van hoekprofielen. De liggers worden belast op buiging in het geval van een lijnhoek. Als gevolg van de belasting van het afspanscharnier wordt het hoekprofiel ook op lokale buiging belast.



Figuur 12 Principe van de afspanliggers. De uitkragende ligger wordt in het geval van een lijnhoek op buiging belast door de kracht uit de afspanketting

De profielen worden gecontroleerd op buiging met het programma AxisVM, de profielen worden geschematiseerd met plaatelementen.

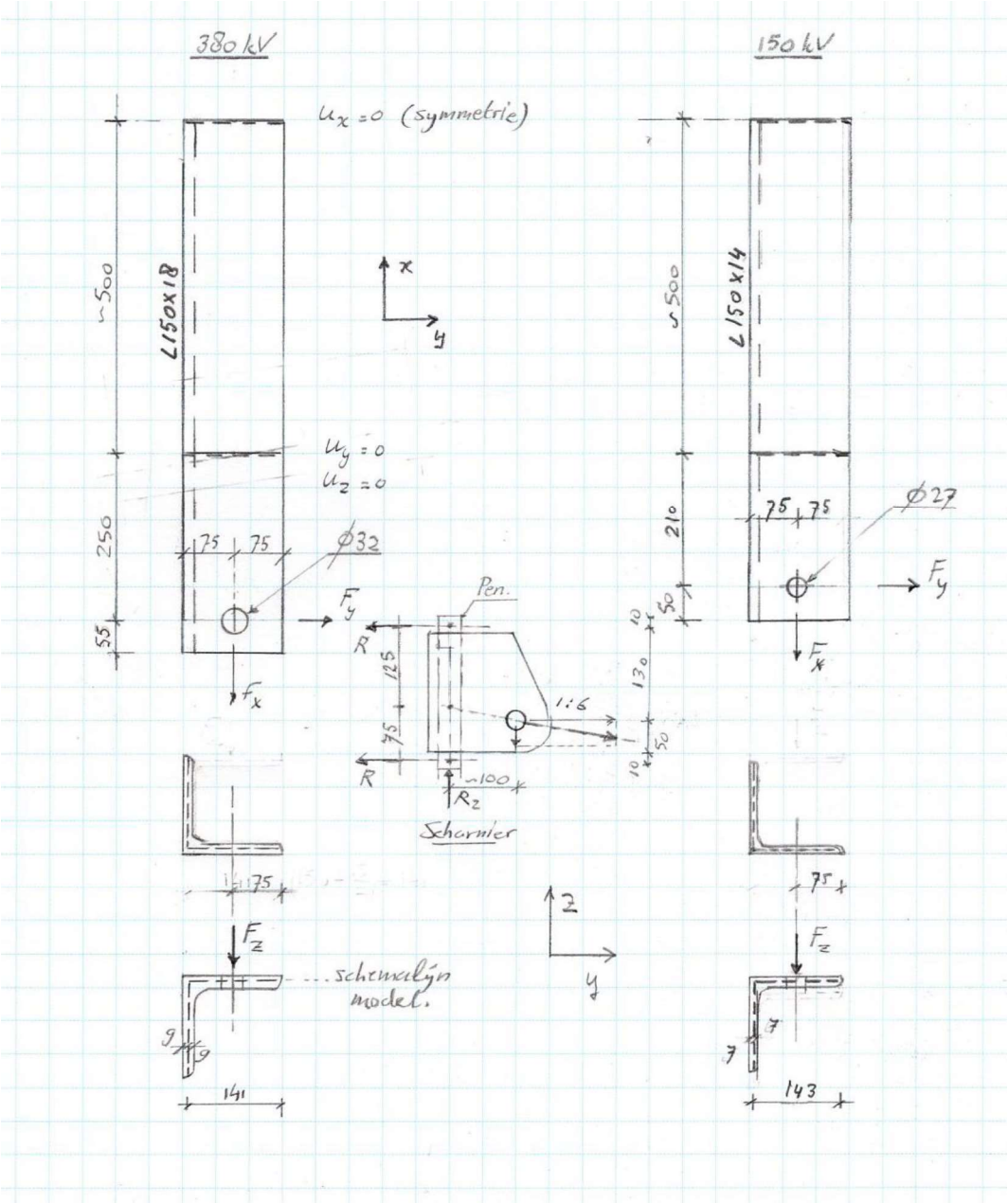
Vanwege uniformiteit over de masttypes in afspanscharnieren wordt de controle uitgevoerd op basis van het masttype met de grootste lijnhoek en de grootste uitkraging. Dit is de HC+0-mast van het solo-type, omdat de ondertraverse de grootste breedteverandering heeft, met bijbehorend grootste uitkraging.

In het DO zal de verbinding verder in detail worden gecontroleerd. Omdat de plaatbuiging bepalend is voor het profiel dat wordt toegepast, wordt nu de controle van de liggers op buiging uitgevoerd.

Twee profielen worden gecontroleerd: het profiel voor de 150 kV-afspankettingen (L150x150x14) en het profiel voor de 380 kV-afspankettingen (L150x150x18).

Voorlopig worden bovenste en onderste ligger gelijk genomen, in UO-fase kan de bovenste ligger nog geoptimaliseerd worden omdat deze niet door de verticale belasting belast wordt.

Schema



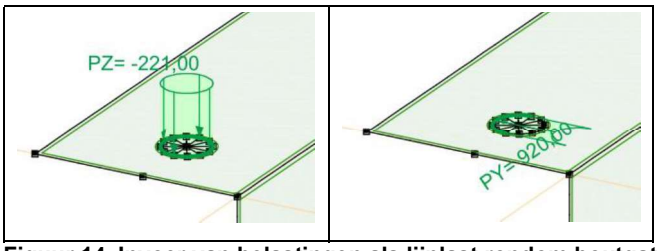
Figuur 13 Schematisering liggers

De helft van de ligger wordt berekend met symmetrie randvoorwaarden. De zwaartelijn van de plaatdikte is het uitgangspunt voor de geometrie. De verbinding met de traverserand wordt vereenvoudigd tot een lijnoplegging aan de bovenflens met fixatie van y- en z-richting. De berekening is lineair-elastisch.

Tabel 5 Geleiderbelastingen

Belastingcombinatie	Spanning	Fxtotaal	Fytotaal	Fztotaal	Ftrekahead
ULS 3_120	380 kV	220,0	142,3	44,4	261,6
	150 kV	109,9	71,0	22,2	130,7

De belastingen worden omgezet naar een lijnlast rondom het gat voor de pen. De x- en y-belasting op de helft van de omtrek, de verticale belasting (z-richting) rondom de gehele omtrek.



Figuur 14 Invoer van belastingen als lijnlast rondom boutgat

De belasting van Tabel 5 wordt verdeeld over twee kettingen. Vanwege de geometrie van het afspanscharnier wordt circa 65% van de belasting verdeeld naar de onderste ligger.

Tabel 6 Schematisering belasting

	d (mm)	Omtrek bij Fx (mm)	Omtrek bij Fy (mm)	Omtrek bij Fz (mm)
380 kV	32	50,3	50,3	100,5
150 kV	27	42,4	42,4	84,8
Verhouding afdracht		0,65	0,65	1

De lijnbelasting wordt berekend met:

$q = 1/2 \cdot k \cdot F / O$

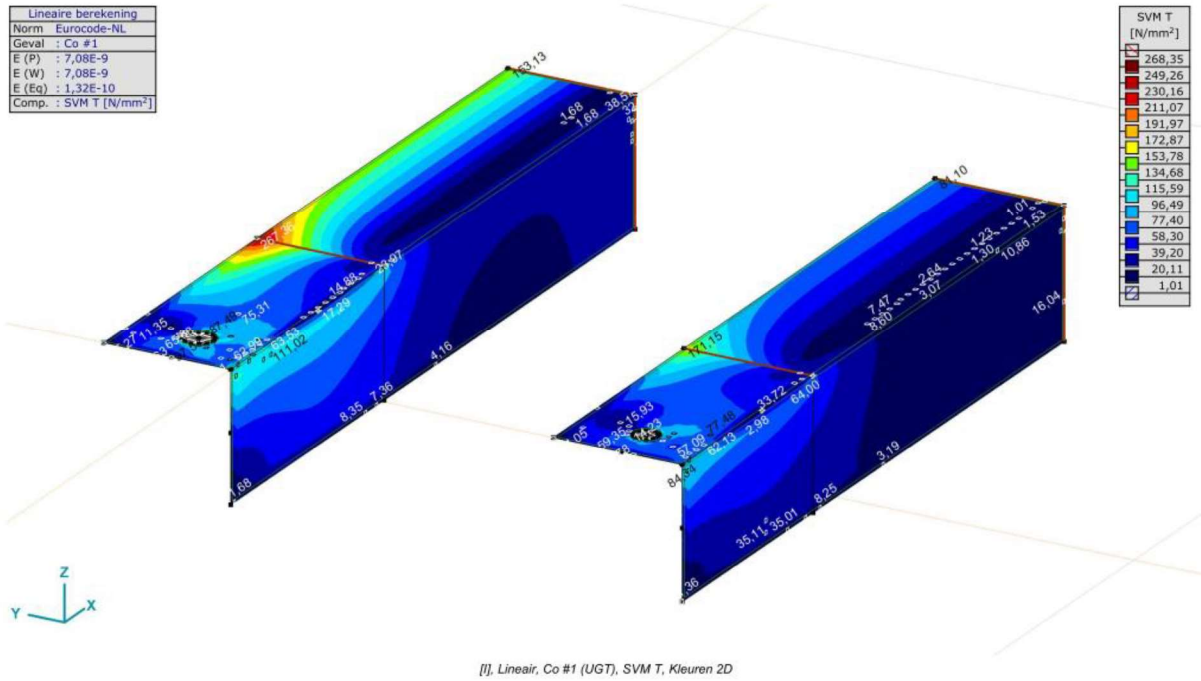
In Tabel 7 zijn de lijnlasten berekend met bovenstaande formule. Deze zijn in AxisVM ingevoerd.

Tabel 7 lijnlast rond gat

	qx (kN/m)	qy (kN/m)	qz (kN/m)
380 kV	1422	920	221
150 kV	842	544	131

Toetsing

Zie de uitvoer van AxisVM. De combinatie van buiging en lokale buiging op het bovenvlak van het hoekprofiel ter plaatse van de lijnoplegging is maatgevend.



Figuur 15 Maximale spanning in hoekprofiel voor 380 kV en 150 kV

Toetsing:

L150x18: U.C. : 267 / 355 = 0,75 ≤ 1,00 OK

L150x14: U.C. : 171 / 355 = 0,48 ≤ 1,00 OK

De profielen voldoen.

Project:

Constructeur: DNV GL - Energy

AxisVM X5 R4h · Geregistreerd aan DNV GL - Energy

Post aan onderrand HA_s.axs

Rapport

Rapport, Inhoudsopgave

Onderdeel	*Pagina*
Materialen	3
Knopen en staven	4
Dikte	5
Profielen	6
Domeinen	7
Knoopopleggingen	7
Mx: Knoopbelastingen	8
Mx	9
My: Knoopbelastingen	10
My	11
Fz: Knoopbelastingen	12
Fz	13
N: Knoopbelastingen	14
N	15
Gebruiker gedefinieerde belastingcombinaties uit belastinggevallen	16
[I], Lineair, Omhullende (Alle UGT), Nx, Lijnen (gevuld)	17
[I], Lineair, Omhullende (Alle UGT), My, Lijnen (gevuld)	18
[I], Lineair, Omhullende (Alle UGT), Mz, Lijnen (gevuld)	19
[I], Lineair, Omhullende (Alle UGT), Vz, Lijnen (gevuld)	20
[I], Lineair, Omhullende (Alle UGT), Vy, Lijnen (gevuld)	21

Onderdeel	*Pagina*
[I], Lineair, Omhullende (Alle UGT), Tx, Lijnen (gevuld)	22
[I], Lineair, Co #1 (UGT), eR, Lijnen	23
[I], Lineair, Co #2 (UGT), eR, Lijnen	24
[I], Lineair, Co #3 (UGT), eR, Lijnen	25
[I], Lineair, Co #4 (UGT), eR, Lijnen	26
[I], Lineair, Co #5 (UGT), eR, Lijnen	27
[I], Lineair, Co #6 (UGT), eR, Lijnen	28
[I], Lineair, Co #1 (UGT), SVM T, Kleuren 2D	29
[I], Lineair, Co #2 (UGT), SVM T, Kleuren 2D	30
[I], Lineair, Co #3 (UGT), SVM T, Kleuren 2D	31
[I], Lineair, Co #4 (UGT), SVM T, Kleuren 2D	32
[I], Lineair, Co #5 (UGT), SVM T, Kleuren 2D	33
[I], Lineair, Co #6 (UGT), SVM T, Kleuren 2D	34
[I], Lineair, Omhullende (Alle UGT), SVM B, Iso vlakken 3D	35
[I], Lineair, Omhullende (Alle UGT), SVM C, Iso vlakken 3D	36
[I], Lineair, Omhullende (Alle UGT), SVM T, Iso vlakken 3D	37
Vlakspanningen [Lineair, Omhullende (Alle UGT)]	38
[I], Lineair, Omhullende (Alle UGT), S;x;minmax, Lijnen (gevuld)	39
Staafspanningen [Lineair, Omhullende (Alle UGT)]	40
Interne krachten knoopoplegging [Lineair, Omhullende (Alle UGT)]	41

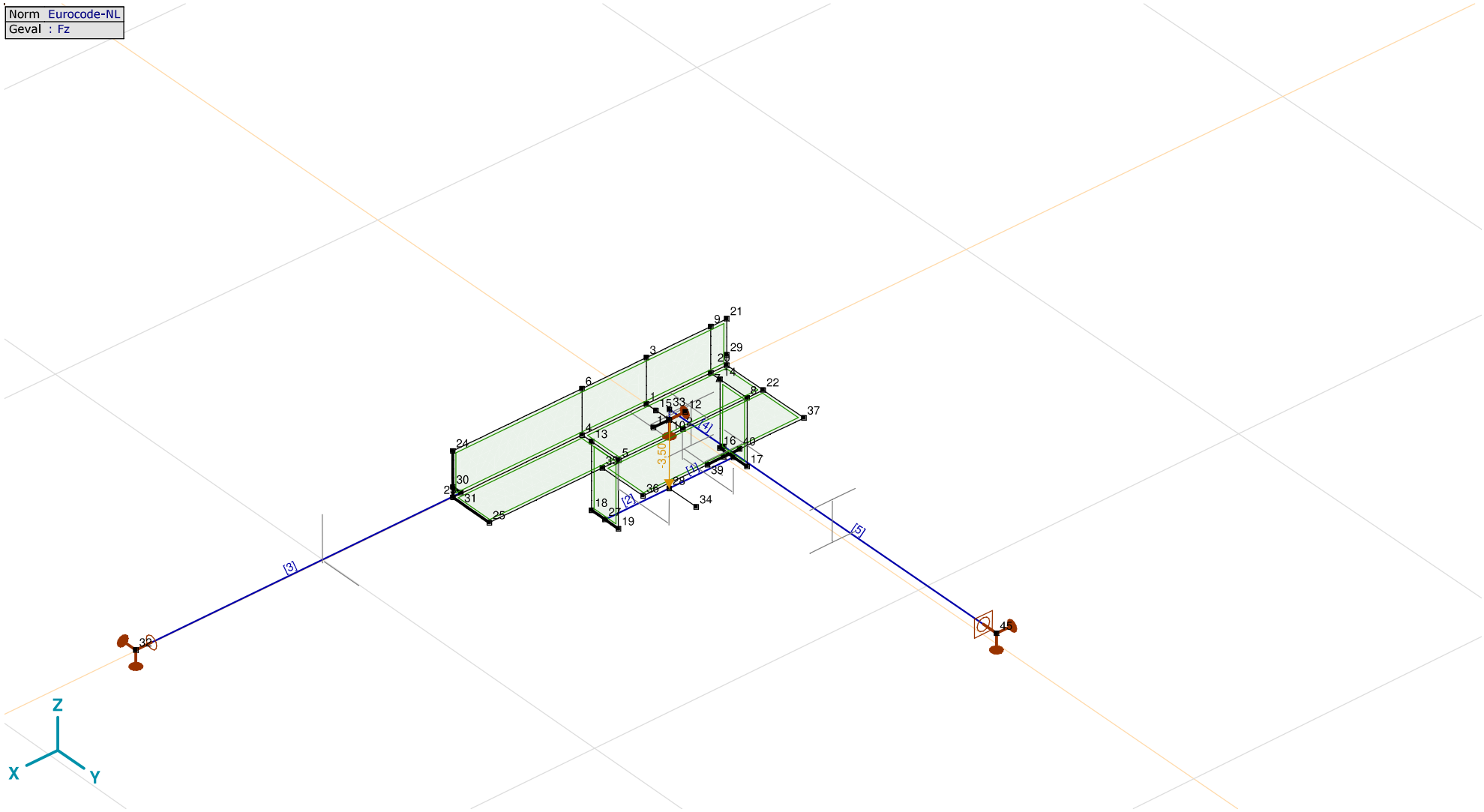
Materialen

	Naam	*Type*	*Nationale norm*	*Materiaalnorm*	*Model*	*E_x [N/mm^2]*	*E_y [N/mm^2]*	*v*	*α_T [1/°C]*	*ρ [kg/m^3]*	*Materiaal kleur*	*Contour kleur*	*Structuur*	*P_1*
1	S 355	Staal	Eurocode-NL	10025-2	Lineair	210000	210000	0,30	1,2E-5	7850			Steel	f_y[N/mm^2] = 355,00

	Naam	*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 355	f_u[N/mm^2] = 510,00	f_y^*[N/mm^2] = 335,00	f_u^*[N/mm^2] = 470,00										

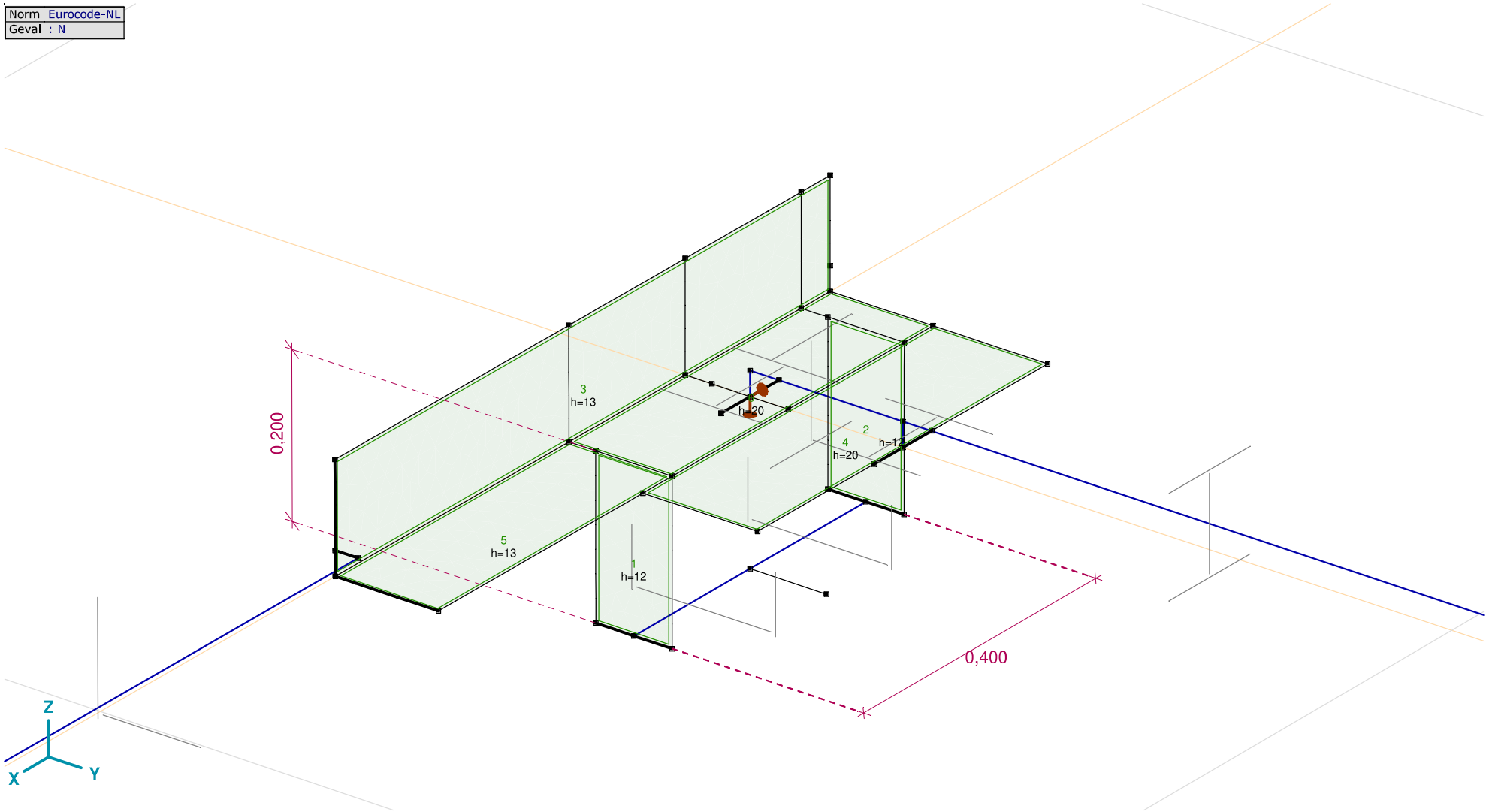
Naam: Materiaalnaam; **Type:** Type materiaal; **Model:** Materiaal model; **E_x:** Elasticiteitsmodulus in lokale x richting; **E_y:** Elasticiteitsmodulus in lokale y richting; **v:** Poisson's verhouding; **α_T:** Warmteuitzettingscoëfficiënt; **ρ:** Dichtheid; **Materiaal kleur:** Materiaalkleur; **Contour kleur:** Contourkleur; **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}:** Ontwerpparameter;

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



Knopen en staven

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



Dikte

Profielen

	Naam	Tekening	Productie	Vorm	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	U 200		Gewalst	U	200,0	75,0	8,5	11,5	11,5	6,0	0	3218,52	931,26	1555,63	121078,6	1,9E+07	1477534,0
2	L 150X150X14		Gewalst	L	150,0	150,0	14,0	14,0	16,0	8,0	0	4031,60	1760,18	1776,16	278959,0	8453331,0	8453331,0
3	HE 140 A		Gewalst	I	133,0	140,0	5,5	8,5	12,0	0	0	3142,19	2147,66	704,86	81932,8	1E+07	3893251,0
4	L 140X140X13		Gewalst	L	140,0	140,0	13,0	13,0	15,0	7,5	0	3495,25	1525,43	1539,45	208736,7	6384907,0	6384907,0

	Naam	Iyz [mm^4]	I_1 [mm^4]	I_2 [mm^4]	α [°]	$I\omega$ [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	U 200	0	1,9E+07	1477534,0	0	8,9E+09	191091,8	191091,8	26935,4	73344,2	227755,3	51850,6	77,1	21,4	75,0	200,0
2	L 150X150X14	–4971153,0	1,3E+07	3482178,0	45,00	4,2E+08	126567,2	126567,2	65498,4	58536,3	200109,5	102485,0	45,8	45,8	150,0	150,0
3	HE 140 A	0	1E+07	3893251,0	0	1,5E+10	155382,8	155382,8	55617,9	55617,9	173525,9	84852,6	57,3	35,2	140,0	133,0
4	L 140X140X13	–3754641,0	1E+07	2630265,0	45,00	2,7E+08	102424,9	102424,9	53024,7	47412,5	161917,9	82940,4	42,7	42,7	140,0	140,0

	Naam	y_G [mm]	z_G [mm]	y_s [mm]	z_s [mm]	S.p.
1	U 200	20,1	100,0	–38,7	0	8
2	L 150X150X14	42,1	42,1	–33,9	–33,9	4
3	HE 140 A	70,0	66,5	0	0	9
4	L 140X140X13	39,2	39,2	–31,7	–31,7	4

Naam: Doorsnede naam; **Productie:** Productieproces; **Vorm:** Profiel; **h:** Doorsnede hoogte; **b:** Doorsnede breedte; **tw:** Lijfdikte; **tf:** Flensdikte; **r_1, r_2, r_3:** Afrondingswaarde; **Ax:** Doorsnede-oppervlak; **Ay, Az:** Afschuivingsoppervlak; **Ix:** Torsietraagheidsmoment; **Iy, Iz:** Buigtraagheidsmoment; **Iyz:** Centrifugaal traagheidsmoment; **I_1, I_2:** Hoofdbuigtraagheidsmoment; **α:** Hoofdrichtingen; **Iω:** Krommingsconstante; **$W_{1,el,t}$, $W_{1,el,b}$, $W_{2,el,t}$, $W_{2,el,b}$:** Elasticiteit modulus; **$W_{1,pl}$, $W_{2,pl}$:** Plasticiteit modulus; **i_y, i_z:** Traagheidsstraal; **Hy:** Afmeting in lokale Y-richting; **Hz:** Afmeting in lokale Z-richting; **y_G:** Y-coördinaat van het zwaartepunt; **z_G:** Z-coördinaat van het zwaartepunt; **y_s:** Y-coördinaat van het afschuivingsmiddelpunt (torsie); **z_s:** Z-coördinaat van het afschuivingsmiddelpunt (torsie); **S.p.:** Spanningspunten;

Domeinen

	Element type	*Materiaal*	*Ref_x*	*Ref_z*	*Dikte [mm]*	*k,buiging []*	*k,torsie []*	*k,afschuiving []*	*Oppervlakte [m^2]*	*Gat*	*Mesh*
1	Schaal	S 355	Auto	Auto	12				0,020	–	✓
2	Schaal	S 355	Auto	Auto	12				0,020	–	✓
3	Schaal	S 355	Auto	Auto	13				0,115	–	✓
4	Schaal	S 355	Auto	Auto	20				0,075	–	✓
5	Schaal	S 355	Auto	Auto	13				0,054	–	✓
6	Schaal	S 355	Auto	Auto	20				0,061	–	✓

Element type: Plaatelement type; **Ref_x:** Referentie voor lokale X-richting; **Ref_z:** Referentie voor lokale Z-richting; **k,buiging:** Buigsterkte coefficient; **k,torsie:** Torsiesterkte coefficient; **k,afschuiving:** Dwarskrachtsterkte coefficient; **Oppervlakte:** Domein oppervlak; **Gat:** Aantal gaten in domein; **Mesh:** Gegenereerde mesh;

Knoopopleggingen

	Knoop	*X [m]*	*Y [m]*	*Z [m]*
1	32	1,600	0,030	0,030
2	45	0	1,285	0,030
3	10	0	0,085	0

	Knoop	*Type*	*$Naam_x$*	*K_x [kN/m]*	*K_{xV} [kN/m]*	*$Naam_y$*	*K_y [kN/m]*	*K_{yV} [kN/m]*	*$Naam_z$*	*K_z [kN/m]*	*K_{zV} [kN/m]*	*$Naam_{xx}$*	*K_{xx} [kNm/rad]*	*K_{xxV} [kNm/rad]*	*$Naam_{yy}$*
1	32	Glob.	—	–	–	Vast - translatie	1E+10	1E+10	Vast - translatie	1E+10	1E+10	Vast - rotatie	1E+10	1E+10	—
2	45	Glob.	Vast - translatie	1E+10	1E+10	Vast - translatie	1E+10	1E+10	Vast - translatie	1E+10	1E+10	—	–	–	Vast - rotatie
3	10	Glob.	Vast - translatie	1E+10	1E+10	—	–	–	Vast - translatie	1E+10	1E+10	—	–	–	—

	Knoop	*K_{yy} [kNm/rad]*	*K_{yyV} [kNm/rad]*	*$Naam_{zz}$*	*K_{zz} [kNm/rad]*	*K_{zzV} [kNm/rad]*
1	32	–	–	—	–	–
2	45	1E+10	1E+10	—	–	–
3	10	–	–	—	–	–

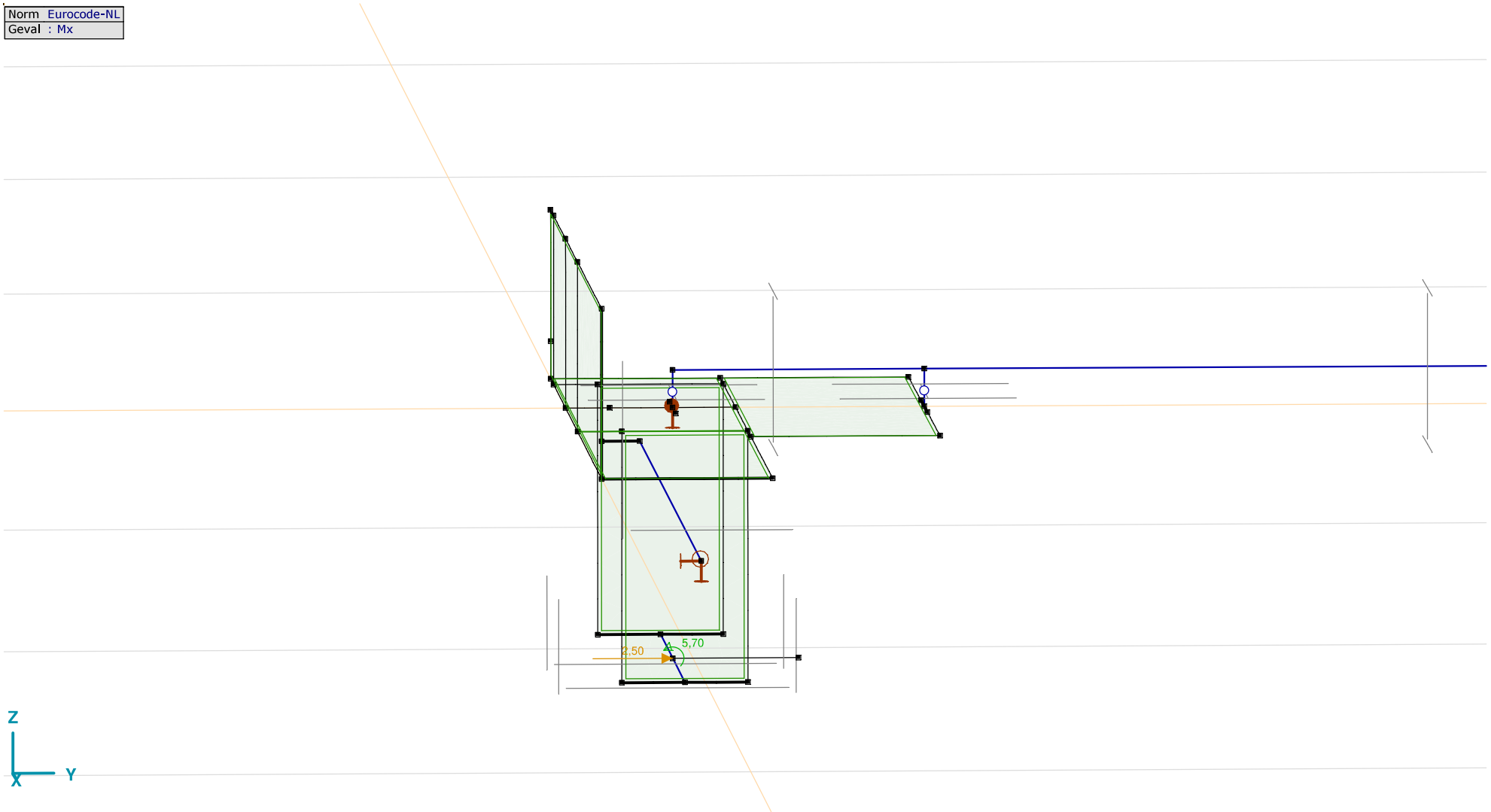
Knoop: Ondersteunde knoop; **Type:** Opleggingstype; **$Naam_x$:** Naam van de veereigenschappen; **K_x:** Initiële stijfheid; **K_{xV}:** Trillingsstijfheid; **$Naam_y$:** Naam van de veereigenschappen; **K_y:** Initiële stijfheid; **K_{yV}:** Trillingsstijfheid; **$Naam_z$:** Naam van de veereigenschappen; **K_z:** Initiële stijfheid; **K_{zV}:** Trillingsstijfheid; **$Naam_{xx}$:** Naam van de veereigenschappen; **K_{xx}:** Initiële stijfheid; **K_{xxV}:** Trillingsstijfheid; **$Naam_{yy}$:** Naam van de veereigenschappen; **K_{yy}:** Initiële stijfheid; **K_{yyV}:** Trillingsstijfheid; **$Naam_{zz}$:** Naam van de veereigenschappen; **K_{zz}:** Initiële stijfheid; **K_{zzV}:** Trillingsstijfheid;

Mx: Knoopbelastingen

	Richting	*Fx [kN]*	*Fy [kN]*	*Fz [kN]*	*Mx [kNm]*	*My [kNm]*	*Mz [kNm]*
28	Globaal	0	2,50	0	5,70	0	0

Fx, Fy, Fz: Belastingkracht component; **Mx, My, Mz:** Belastingsmoment component;

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



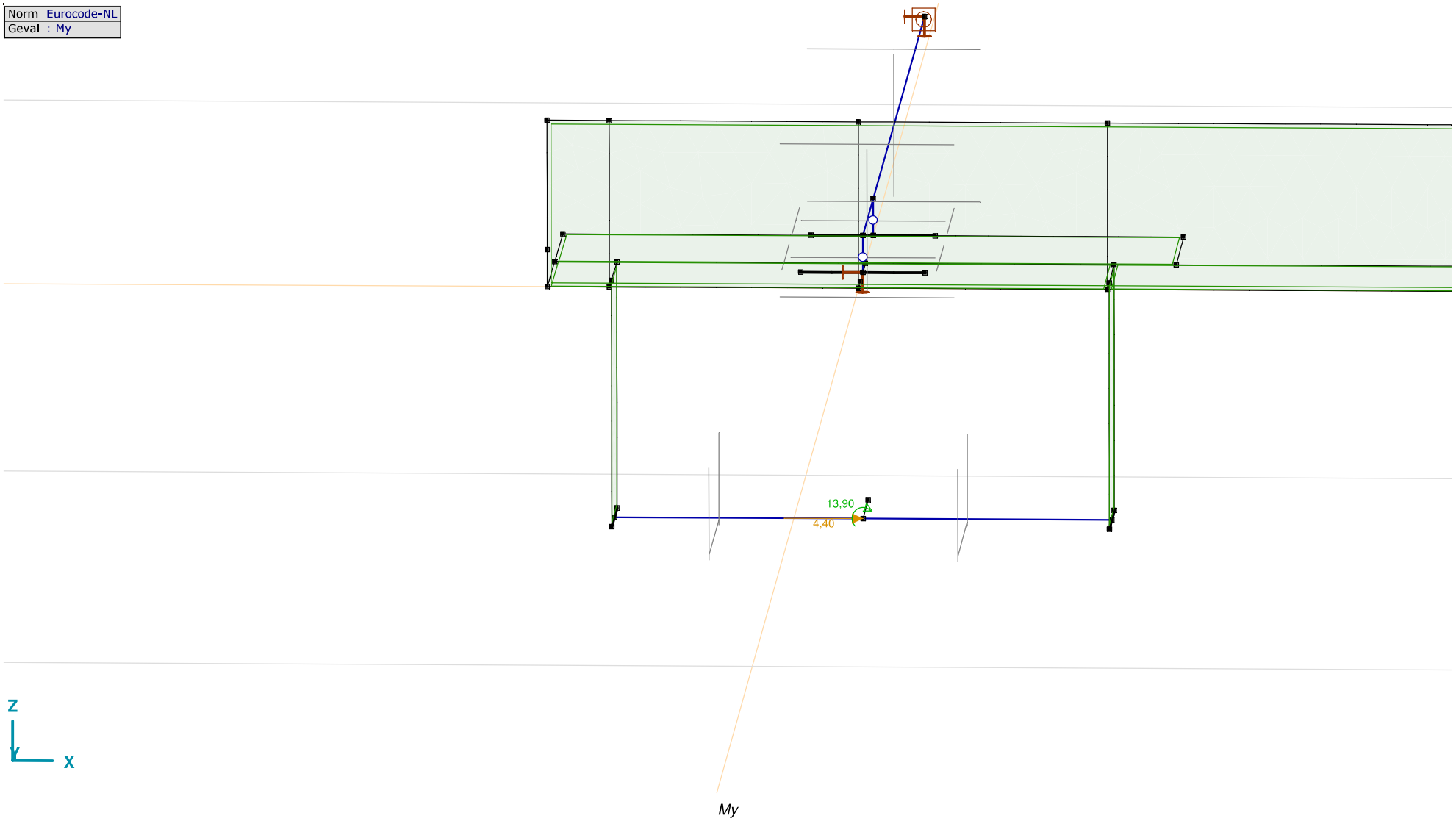
Mx

My: Knoopbelastingen

	Richting	*Fx [kN]*	*Fy [kN]*	*Fz [kN]*	*Mx [kNm]*	*My [kNm]*	*Mz [kNm]*
28	Globaal	4,40	0	0	0	13,90	0

Fx, Fy, Fz: Belastingkracht component; **Mx, My, Mz:** Belastingsmoment component;

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

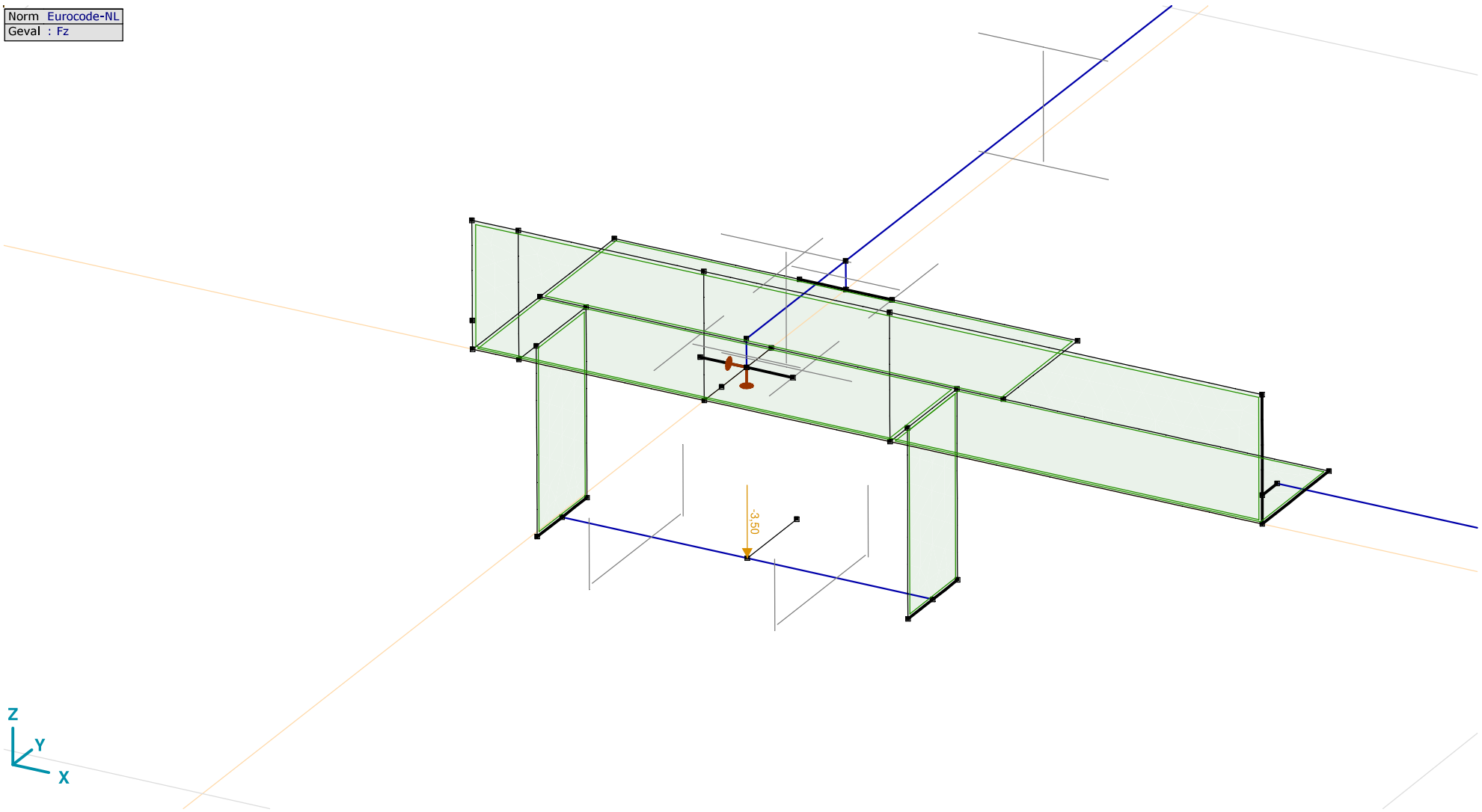


Fz: Knoopbelastingen

	Richting	*Fx [kN]*	*Fy [kN]*	*Fz [kN]*	*Mx [kNm]*	*My [kNm]*	*Mz [kNm]*
28	Globaal	0	0	–3,50	0	0	0

Fx, Fy, Fz: Belastingkracht component; **Mx, My, Mz:** Belastingsmoment component;

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



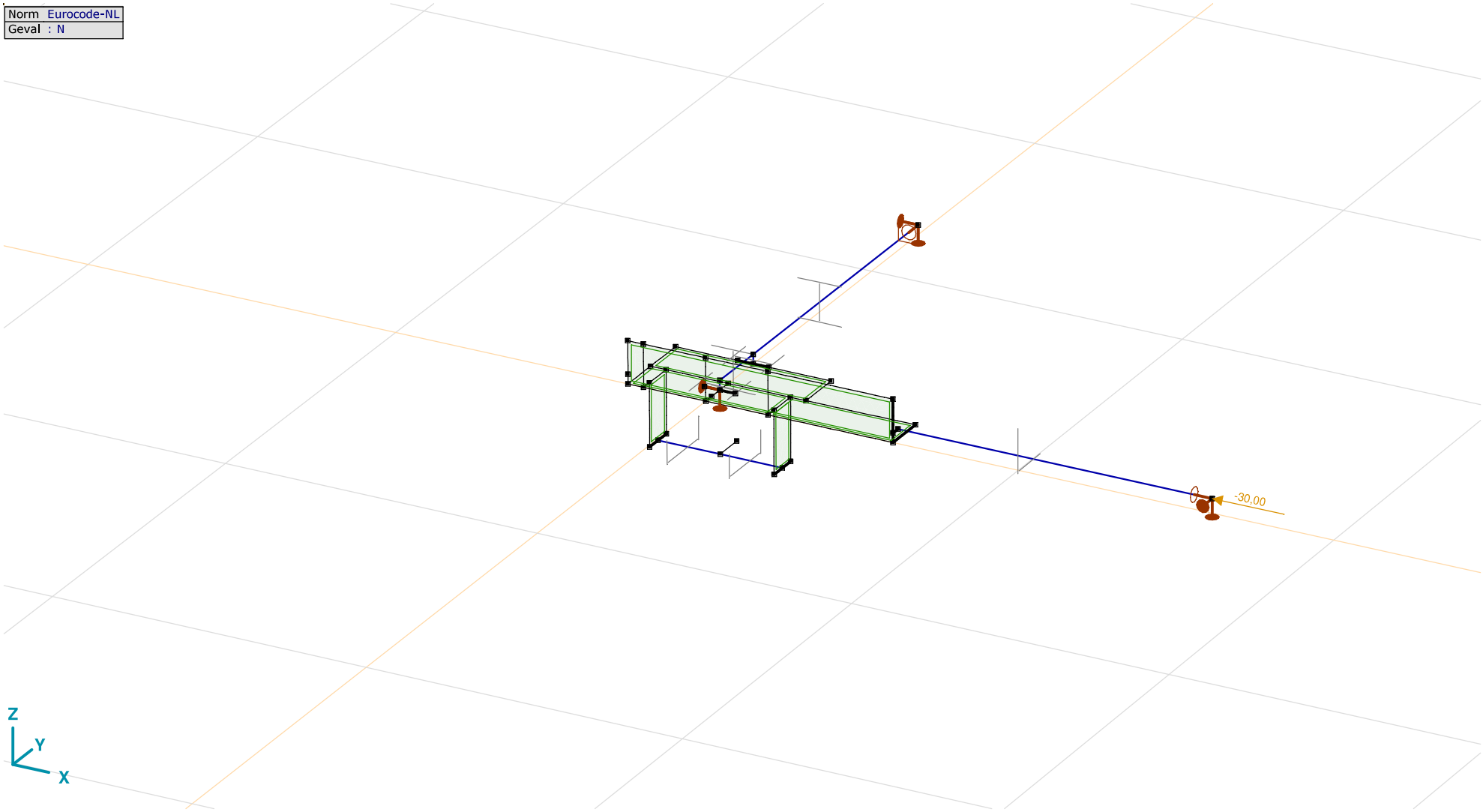
Fz

N: Knoopbelastingen

	Richting	*Fx [kN]*	*Fy [kN]*	*Fz [kN]*	*Mx [kNm]*	*My [kNm]*	*Mz [kNm]*
32	Globaal	−30,00	0	0	0	0	0

Fx, Fy, Fz: Belastingkracht component; **Mx, My, Mz:** Belastingsmoment component;

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



N

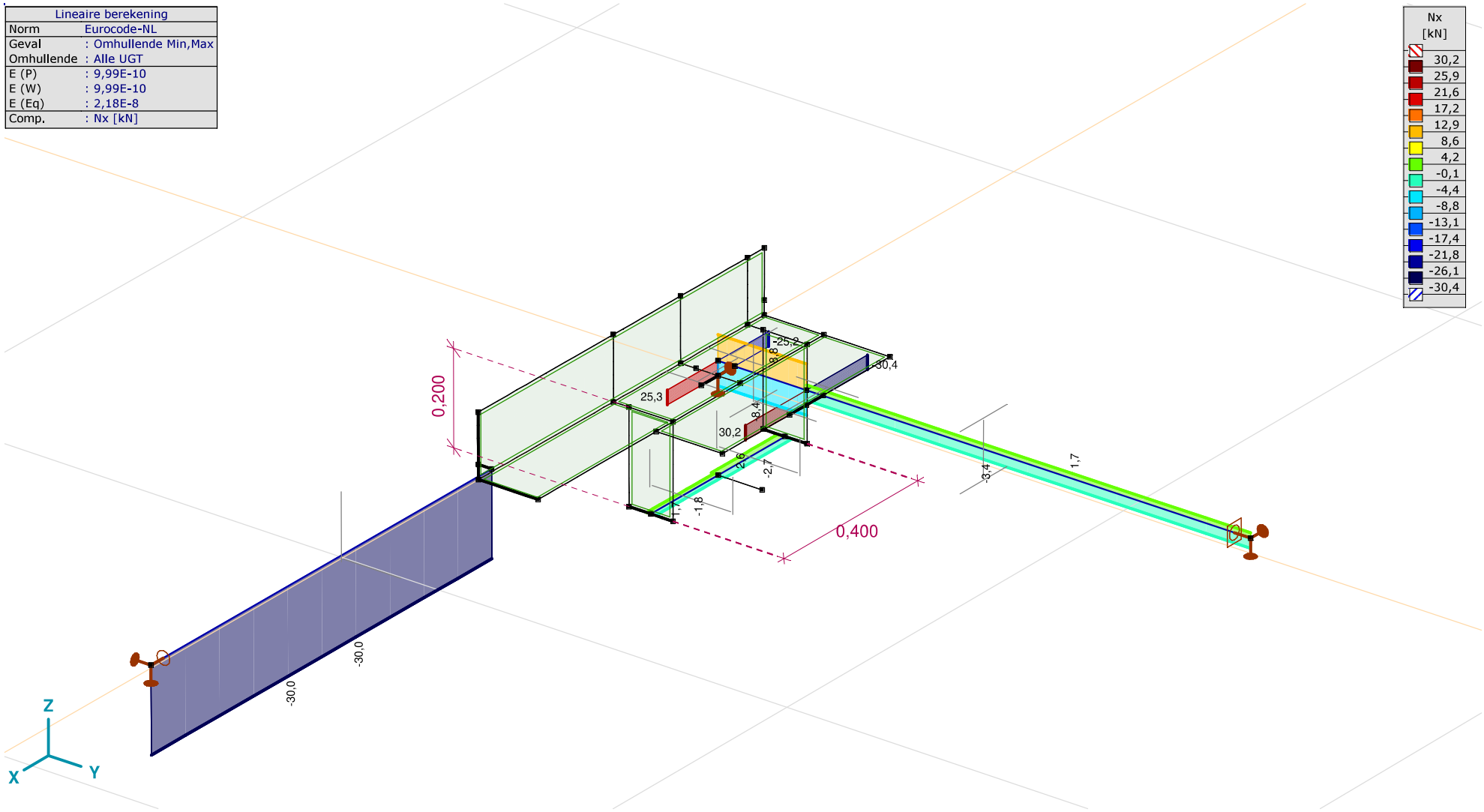
Gebruiker gedefinieerde belastingcombinaties uit belastinggevallen

	Naam	*Type*	*Mx*	*My*	*Fz*	*N*	*Commentaar*
1	Co #1	UGT	1,00	0	1,00	1,00	
2	Co #2	UGT	0	1,00	1,00	1,00	
3	Co #3	UGT	−1,00	0	1,00	1,00	
4	Co #4	UGT	0	−1,00	1,00	1,00	
5	Co #5	UGT	0,71	0,71	1,00	1,00	
6	Co #6	UGT	−0,71	−0,71	1,00	1,00	

Naam: Naam belastingcombinatie; **Type:** Type belastingcombinatie; **Mx, My, Fz, N:** Factor;

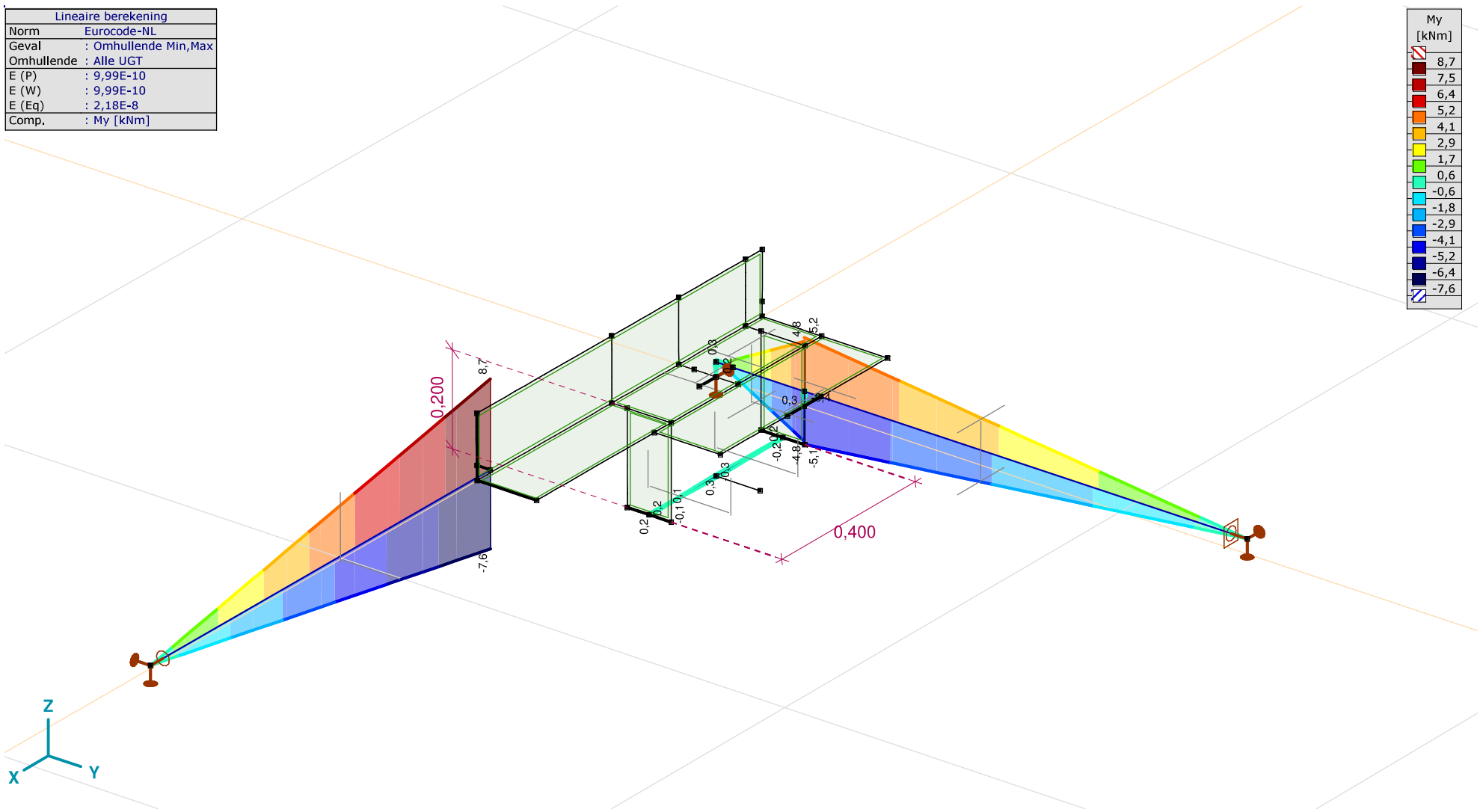
Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: Nx [kN]



[I], Lineair, Omhullende (Alle UGT), Nx, Lijnen (gevuld)

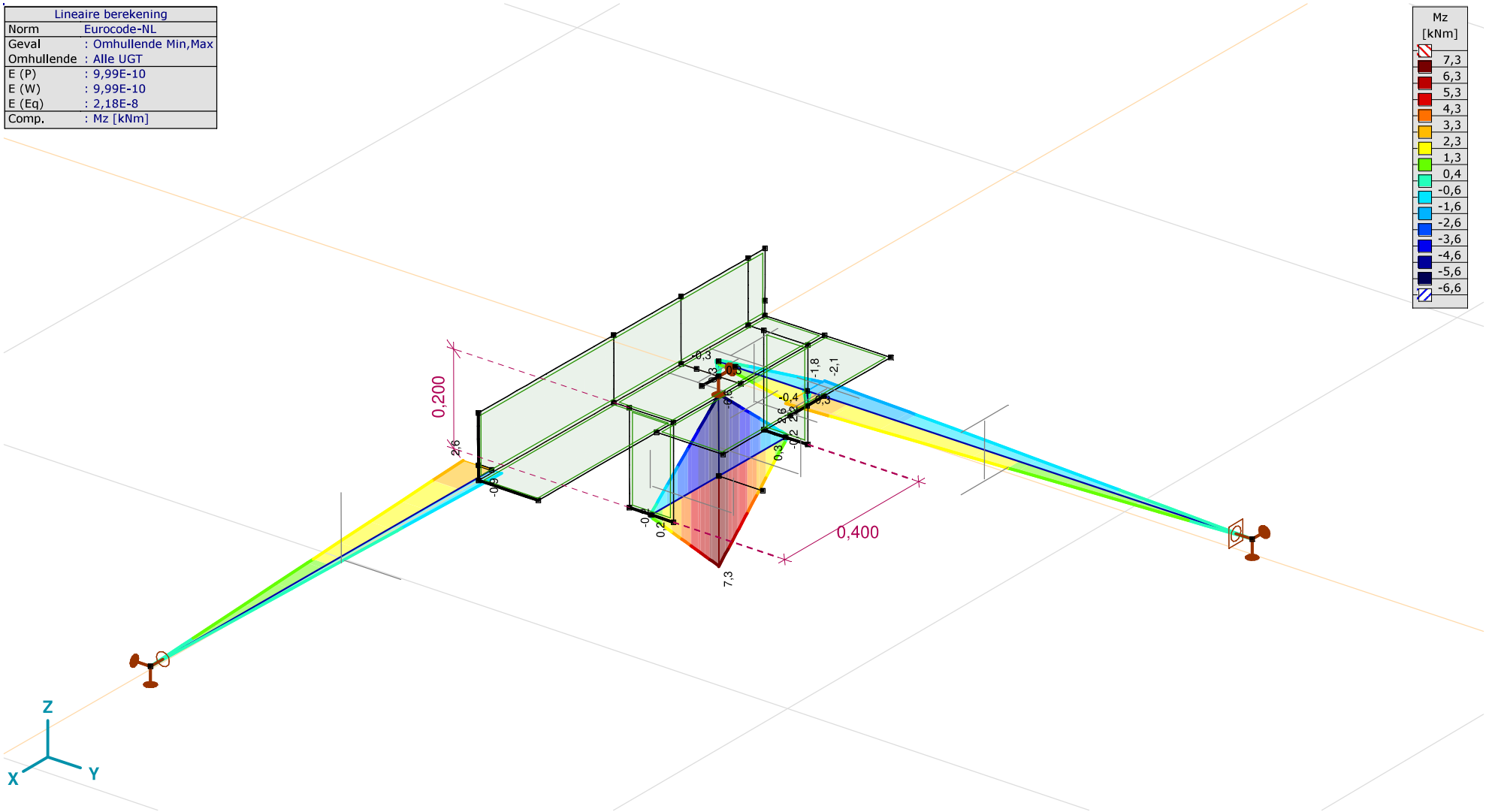
Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



[I], Lineair, Omhullende (Alle UGT), My, Lijnen (gevuld)

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

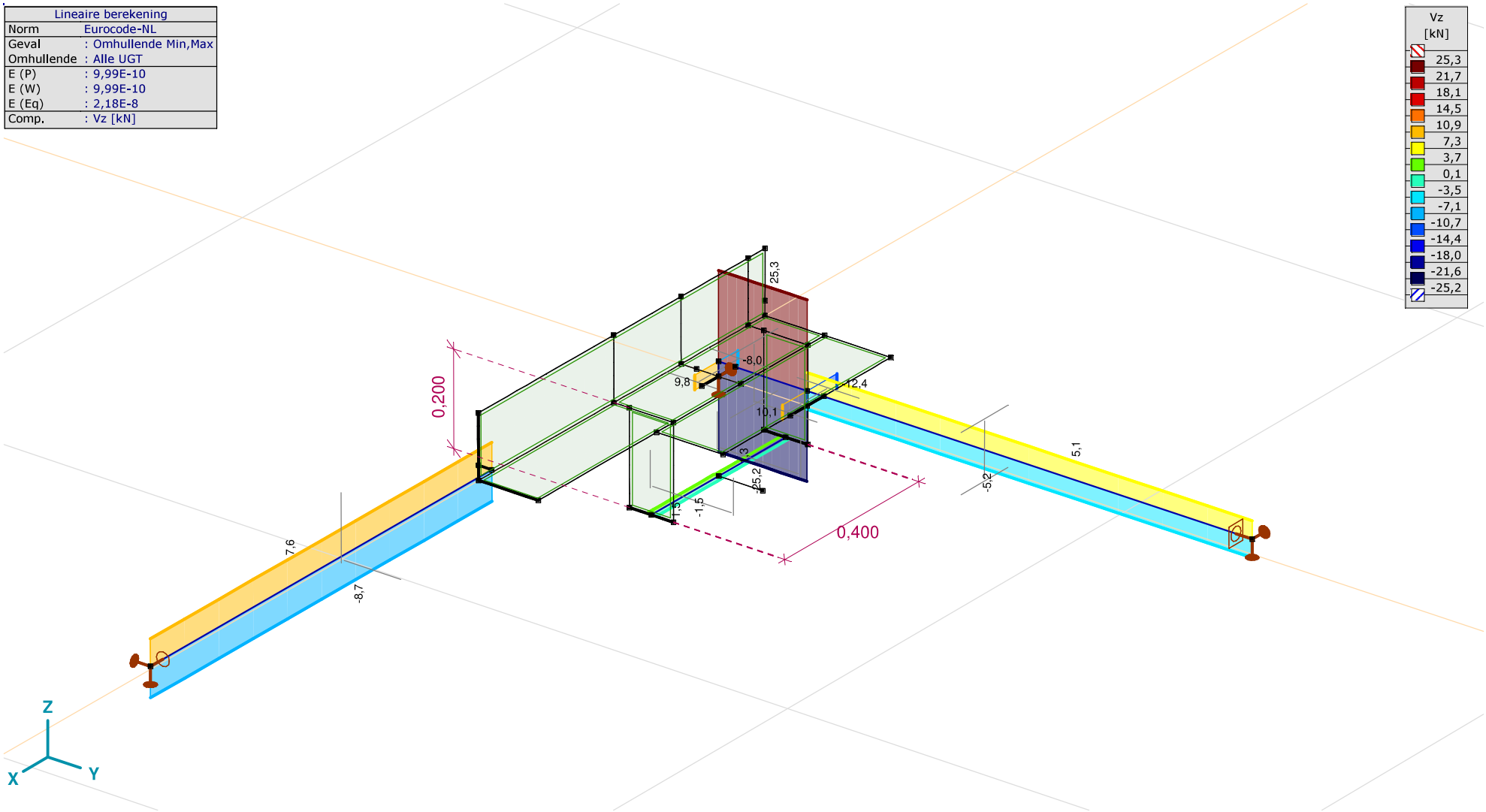
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: Mz [kNm]



[I], Lineair, Omhullende (Alle UGT), Mz, Lijnen (gevuld)

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

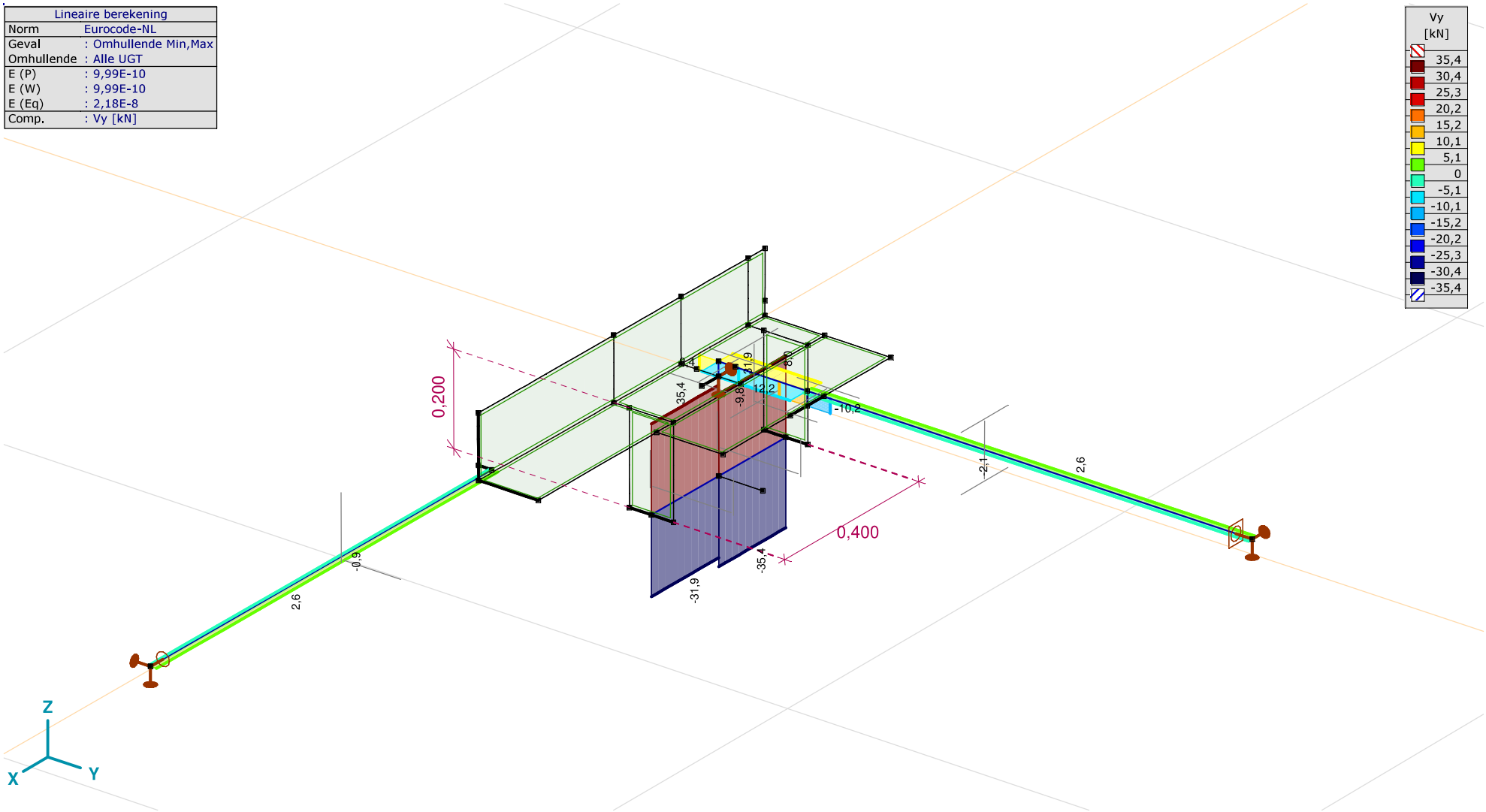
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: Vz [kN]



[I], Lineair, Omhullende (Alle UGT), Vz, Lijnen (gevuld)

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

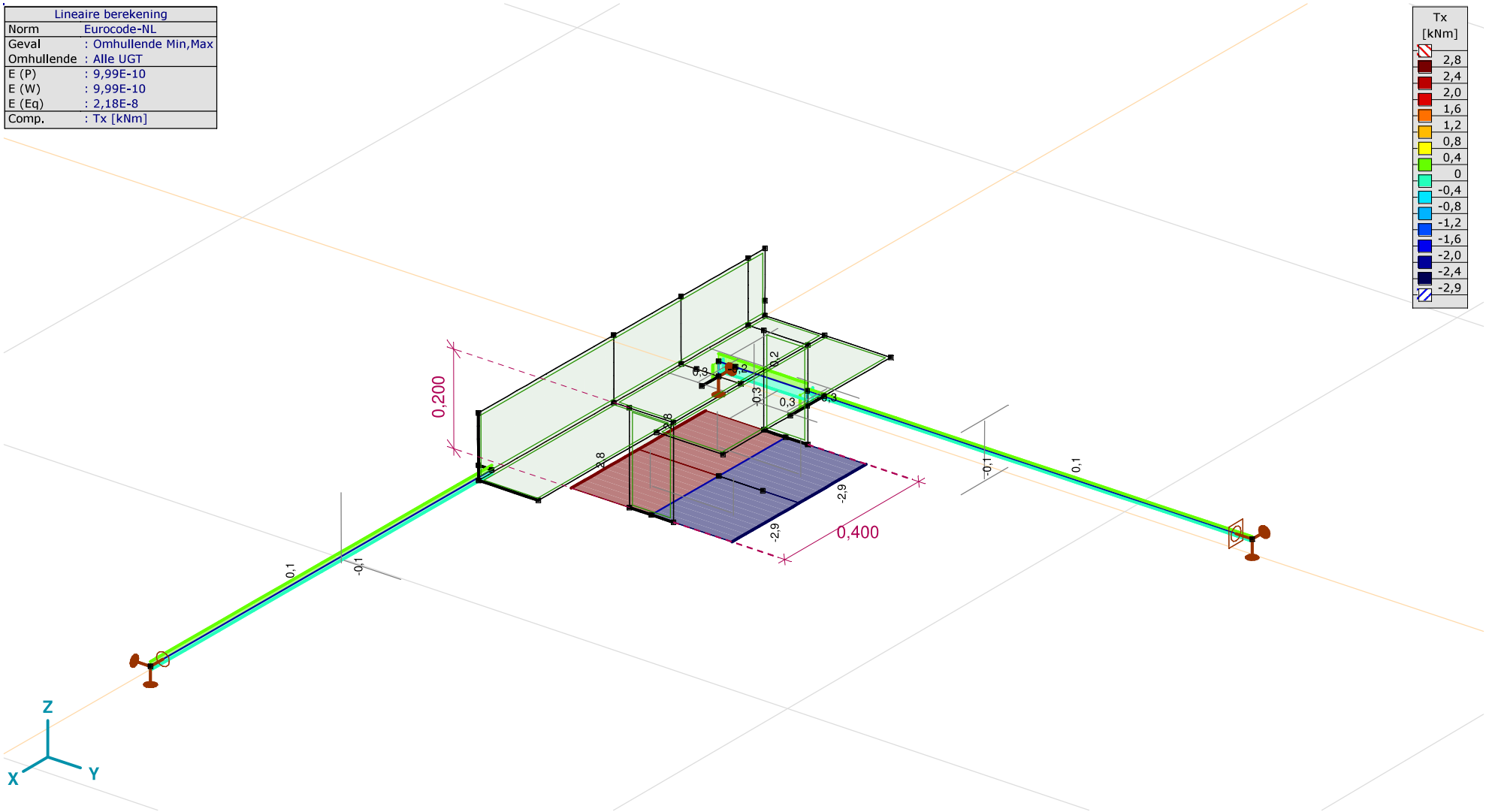
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: Vy [kN]



[I], Lineair, Omhullende (Alle UGT), Vy, Lijnen (gevuld)

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

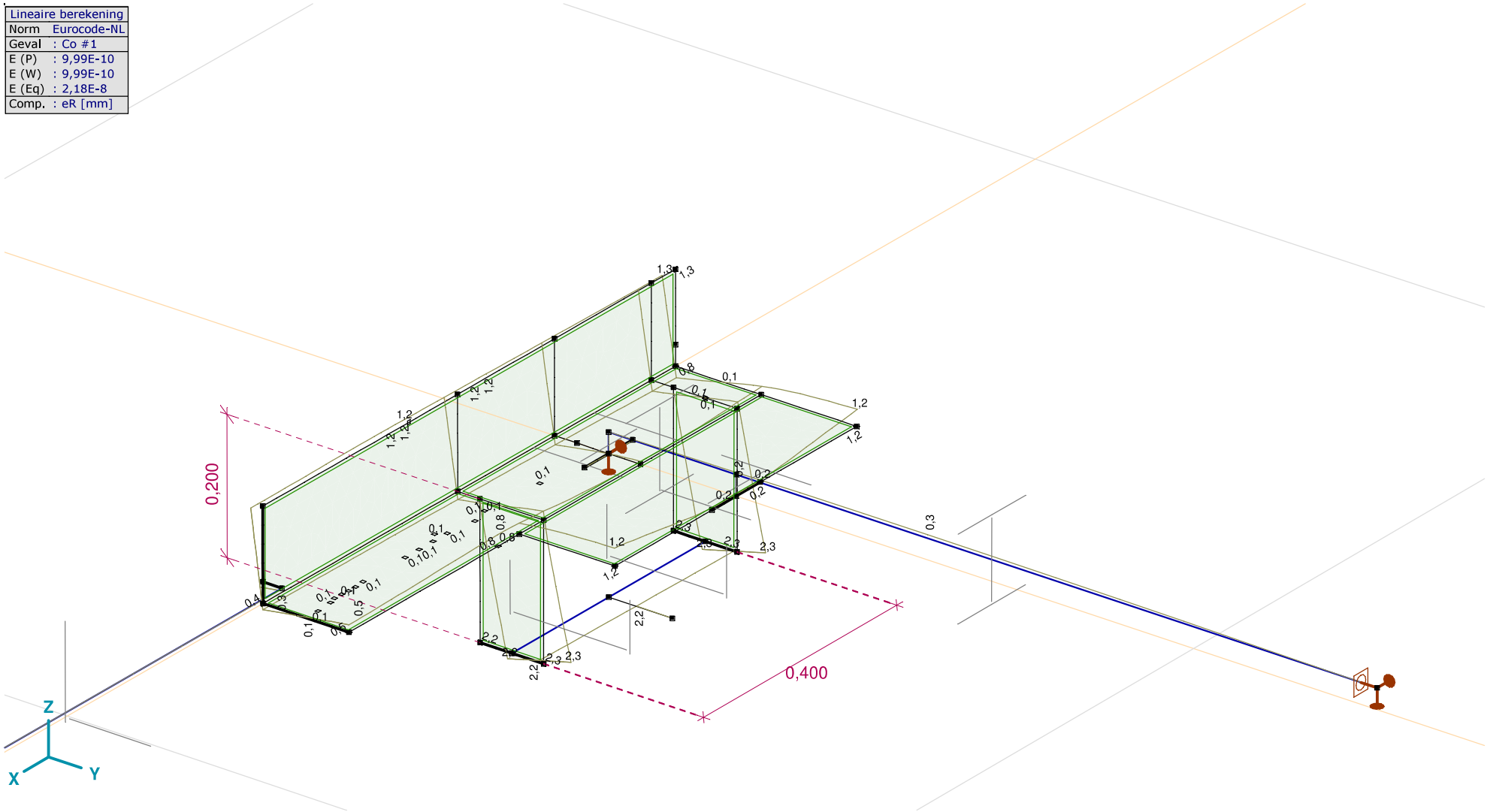
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: Tx [kNm]



[I], Lineair, Omhullende (Alle UGT), Tx, Lijnen (gevuld)

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

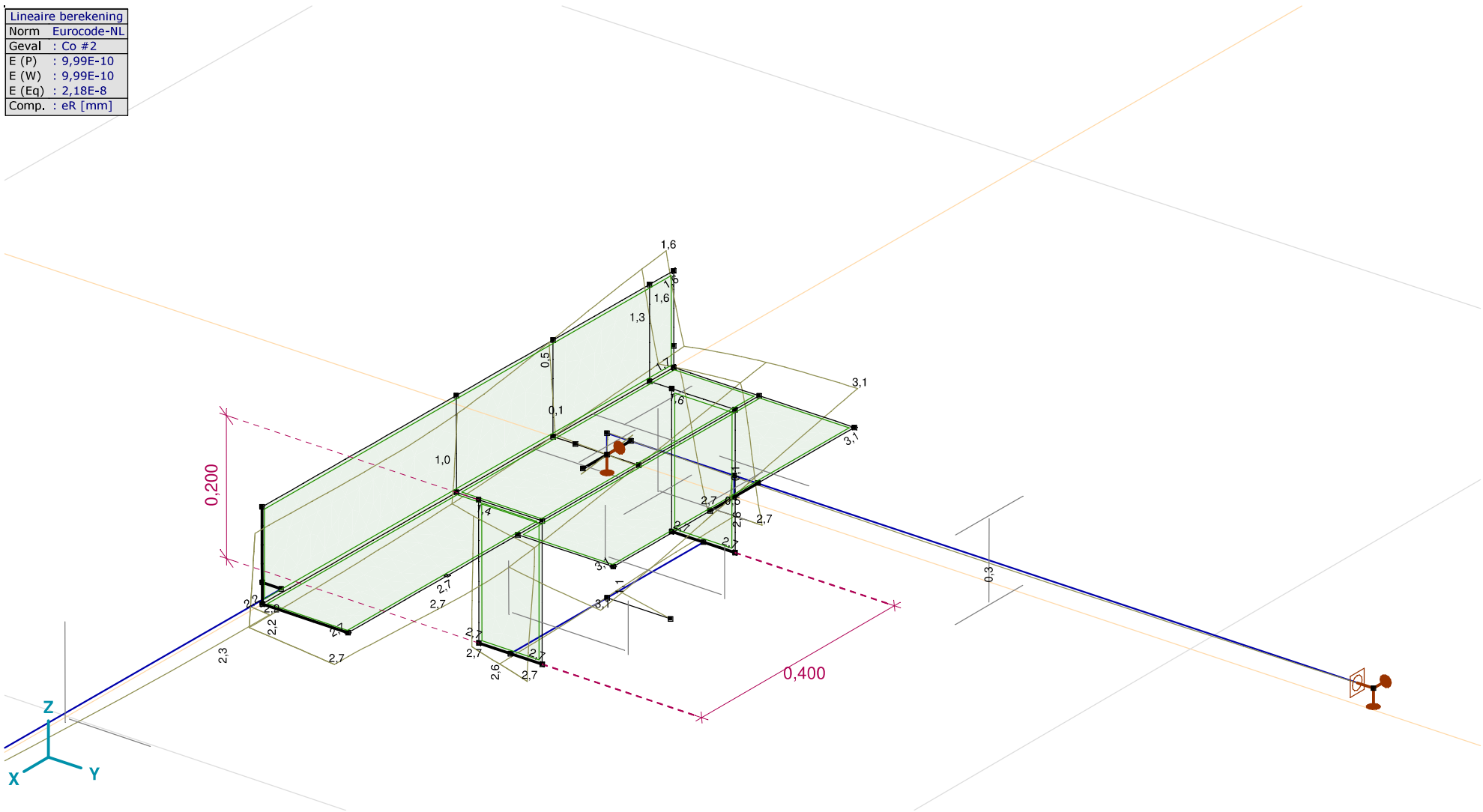
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #1
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: eR [mm]



[I], Lineair, Co #1 (UGT), eR, Lijnen

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

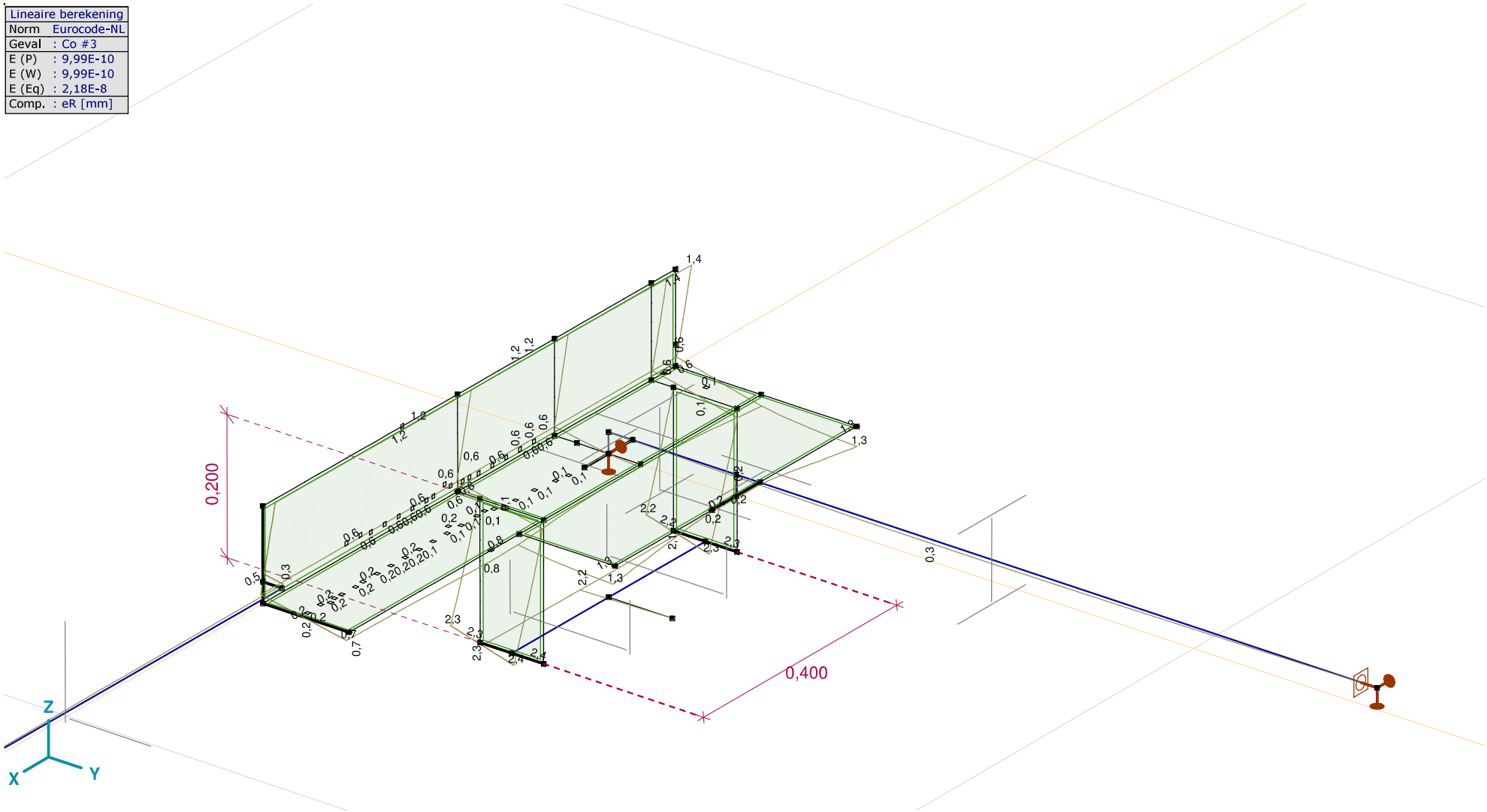
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #2
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: eR [mm]



[I], Lineair, Co #2 (UGT), eR, Lijnen

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs** 18-5-2021 Pag. 25

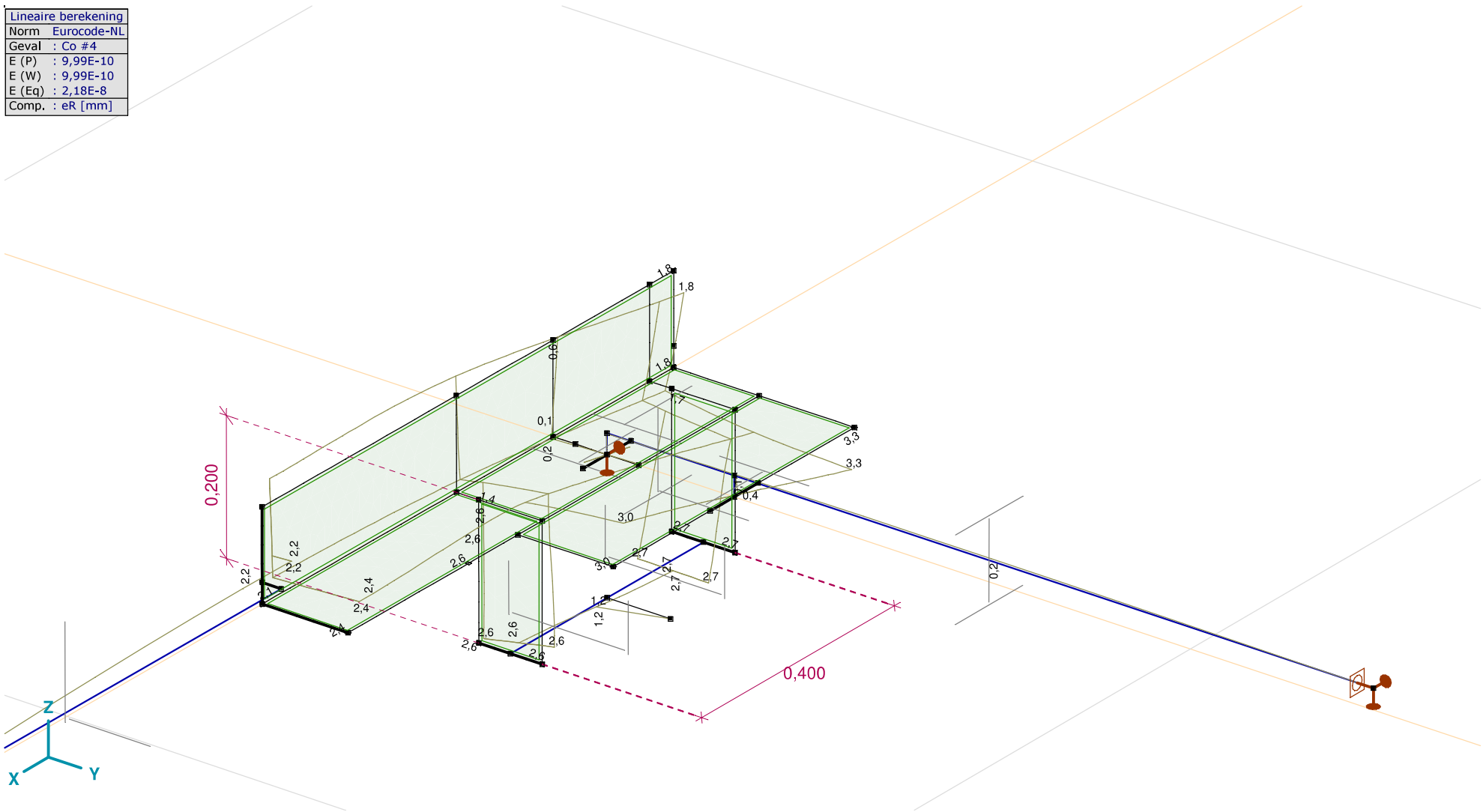
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #3
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: eR [mm]



[I], Lineair, Co #3 (UGT), eR, Lijnen

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs** 18-5-2021 Pag. 26

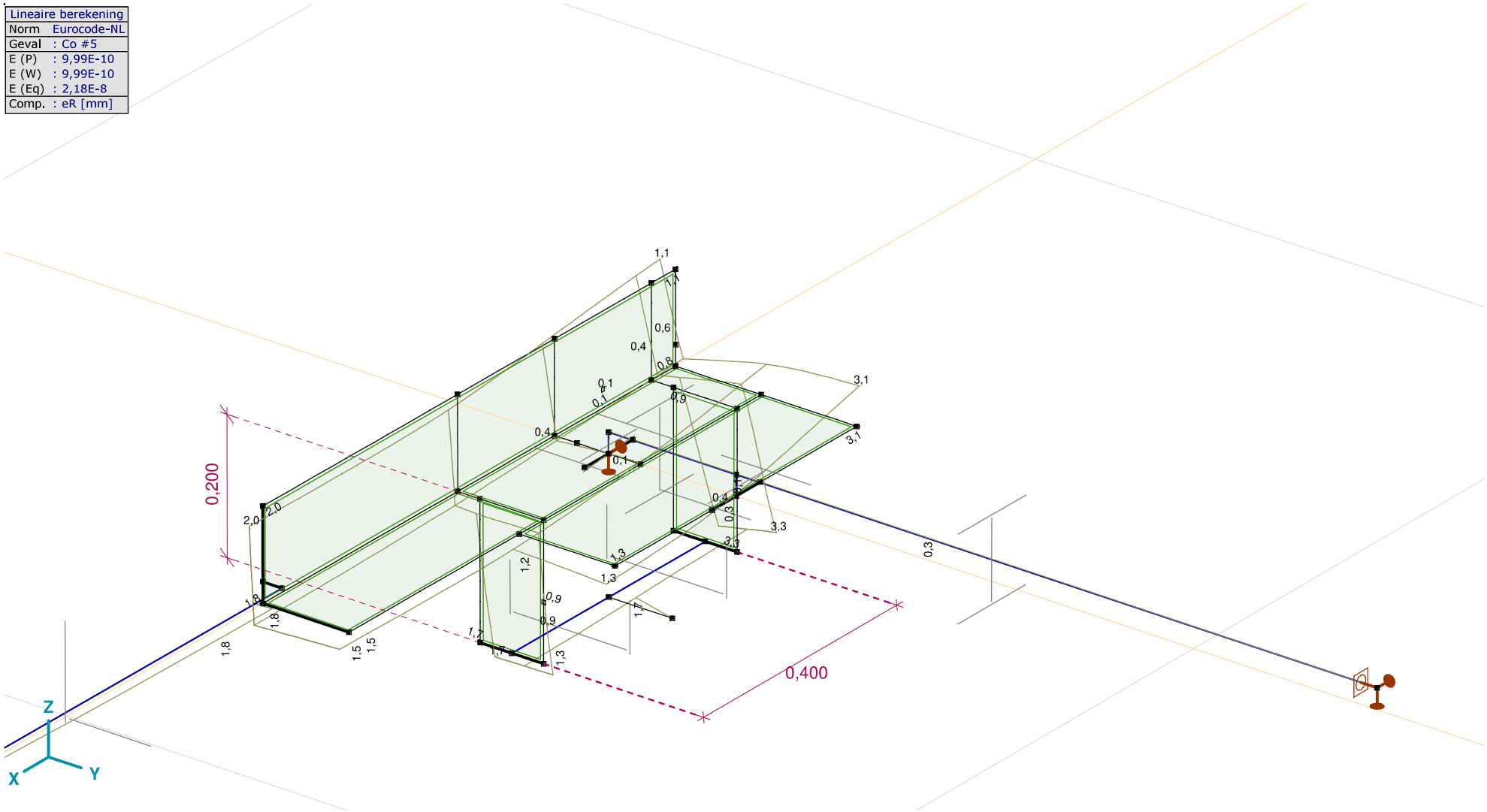
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #4
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: eR [mm]



[I], Lineair, Co #4 (UGT), eR, Lijnen

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

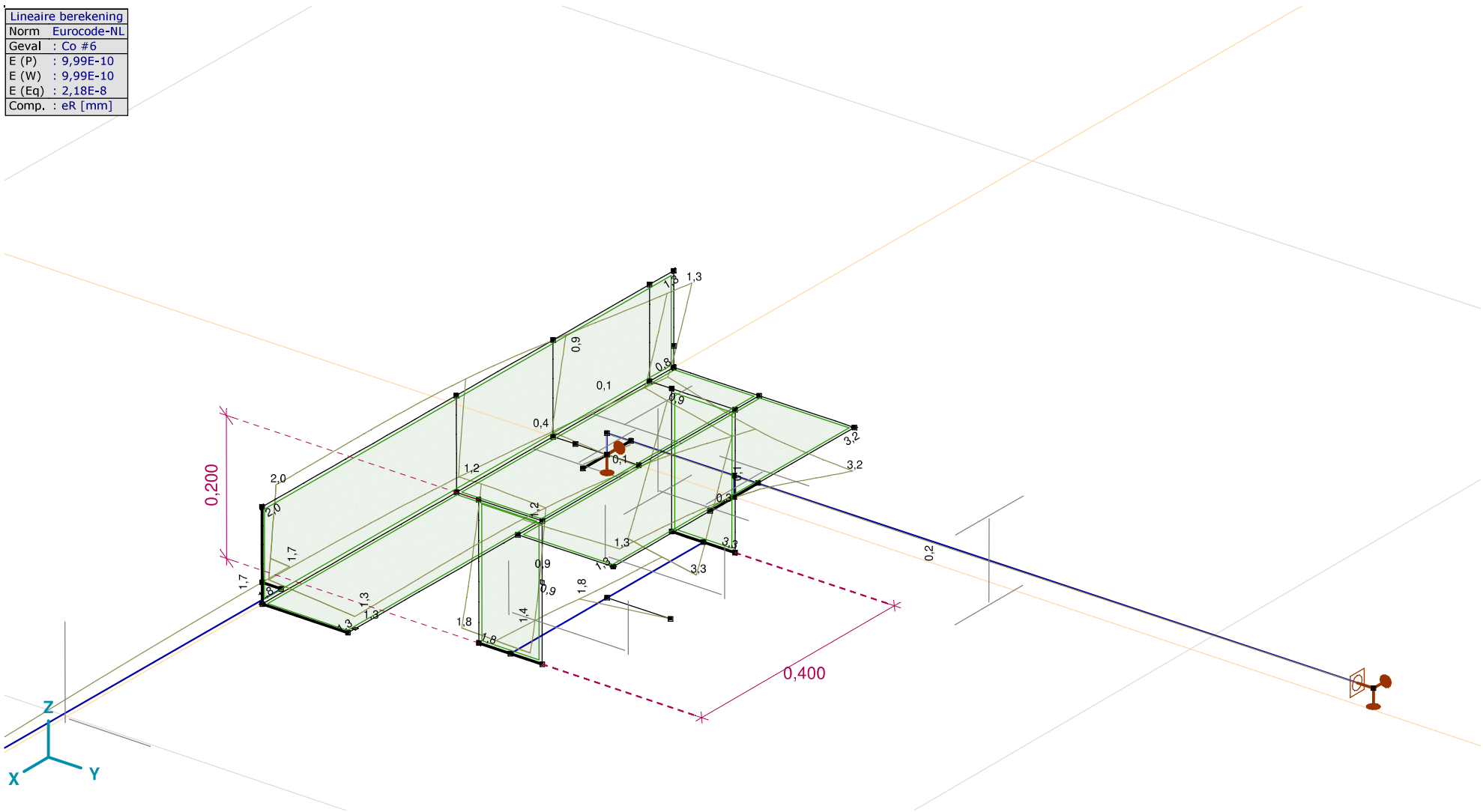
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #5
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: eR [mm]



[I], Lineair, Co #5 (UGT), eR, Lijnen

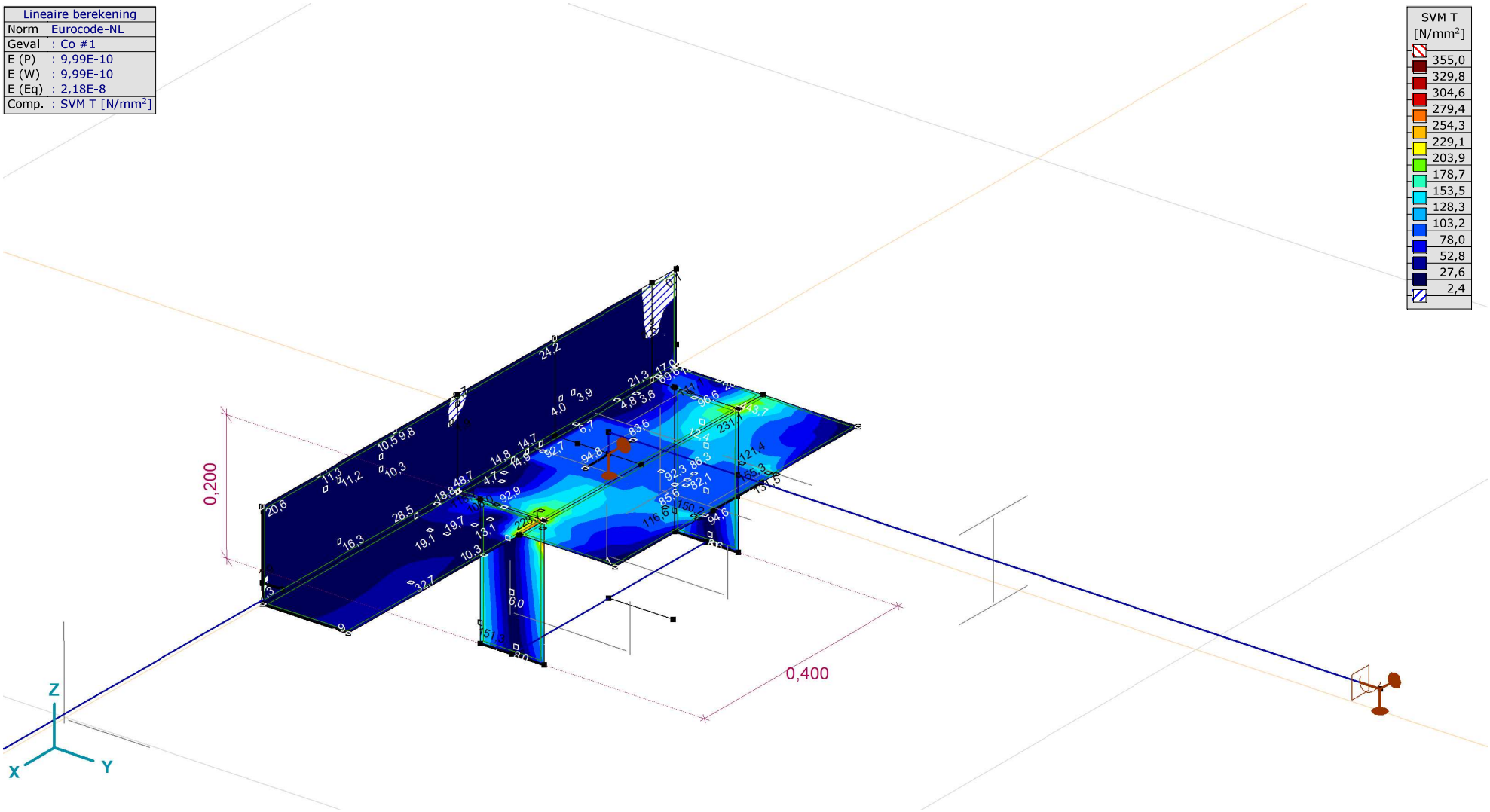
Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs** 18-5-2021 Pag. 28

Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #6
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: eR [mm]



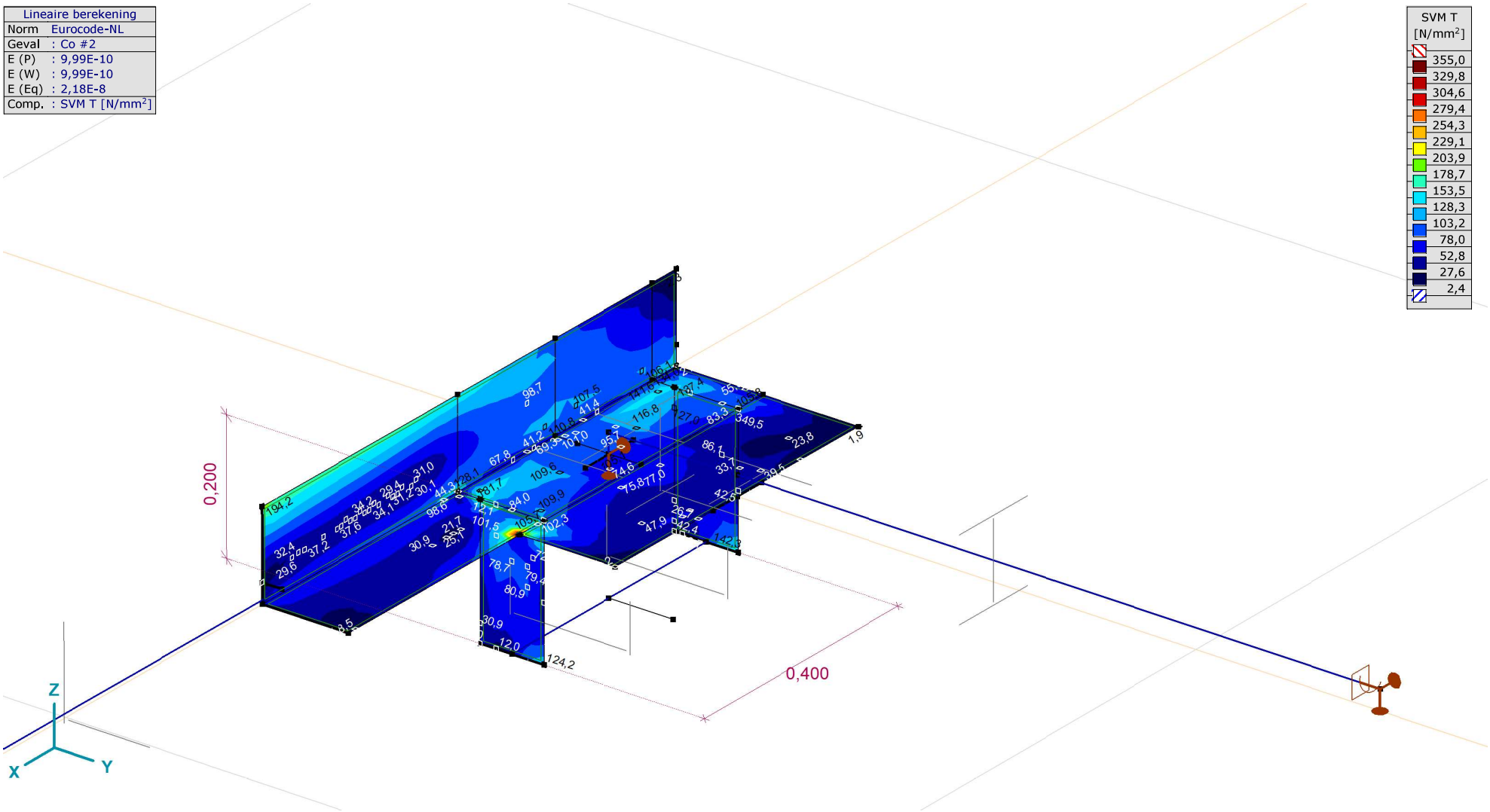
[I], Lineair, Co #6 (UGT), eR, Lijnen

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



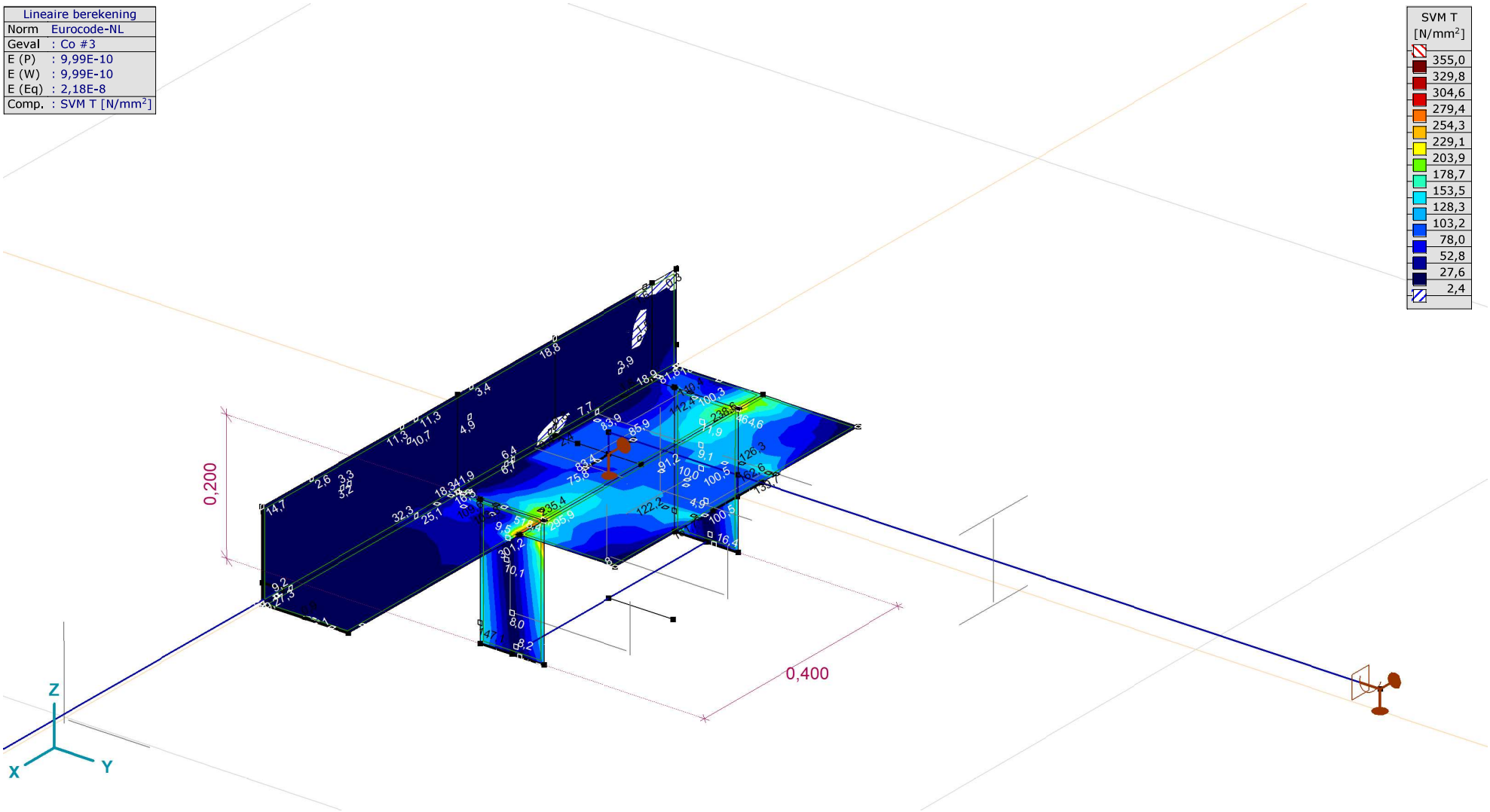
[I], Lineair, Co #1 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



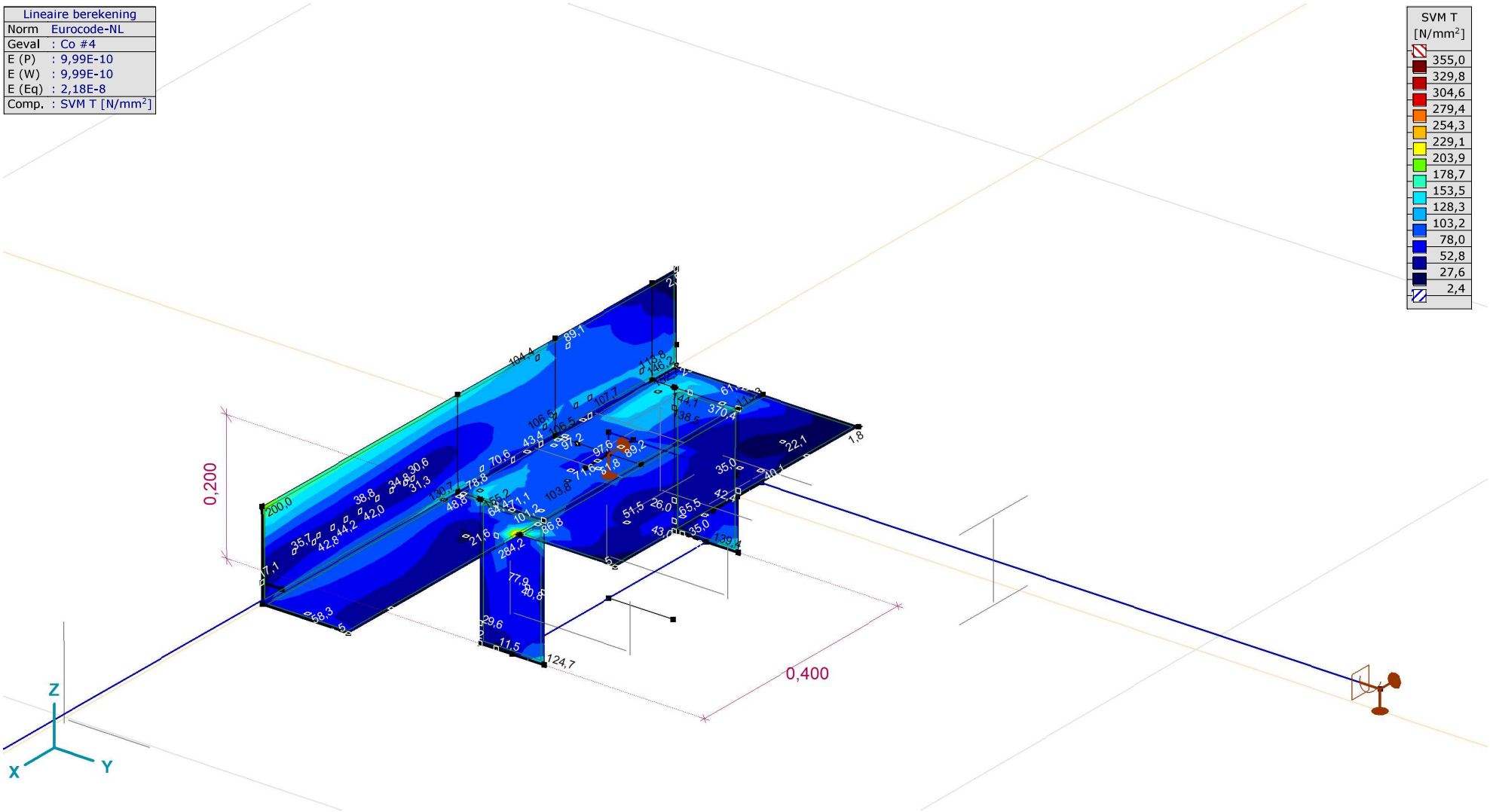
[I], Lineair, Co #2 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



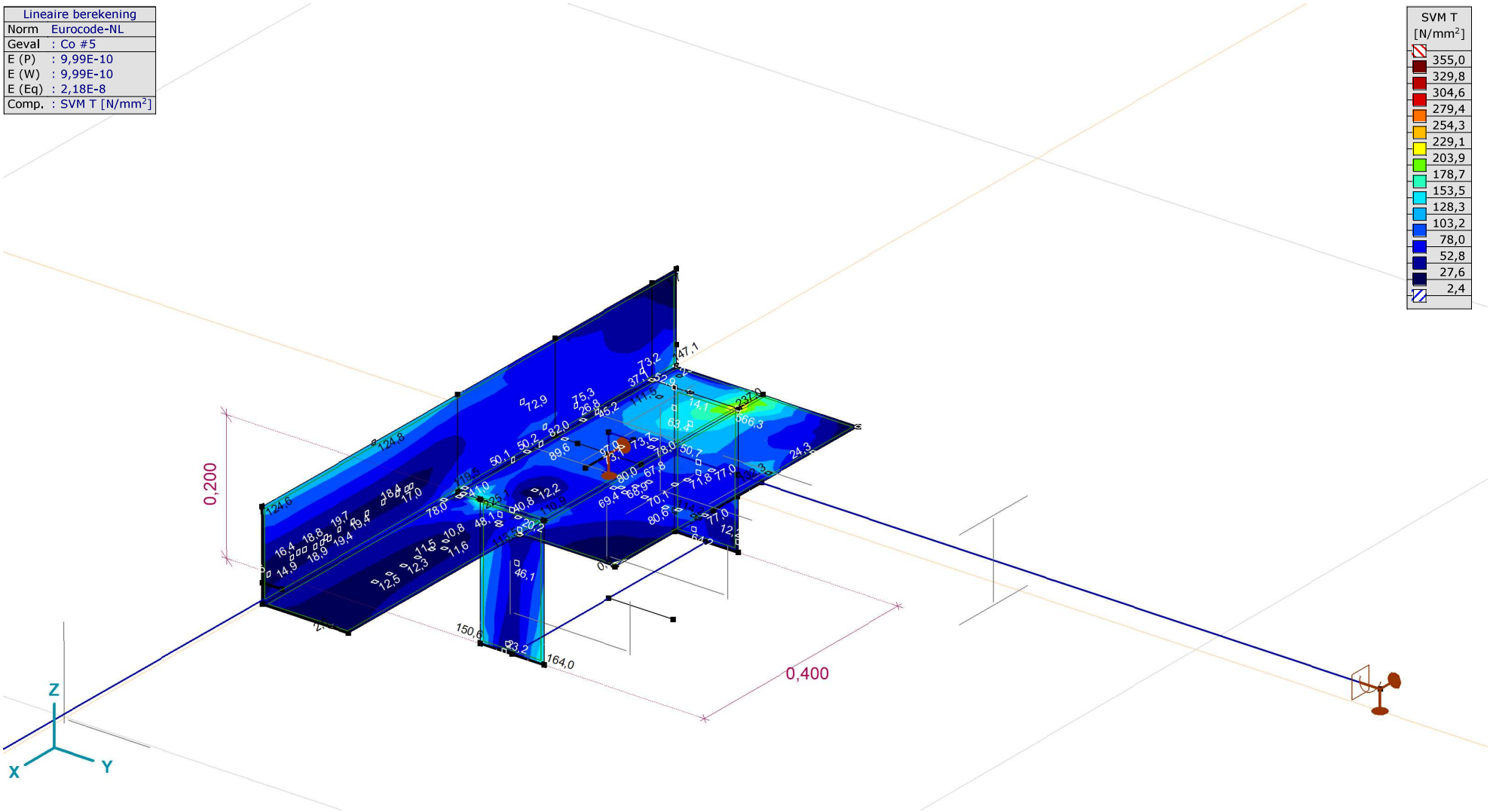
[I], Lineair, Co #3 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



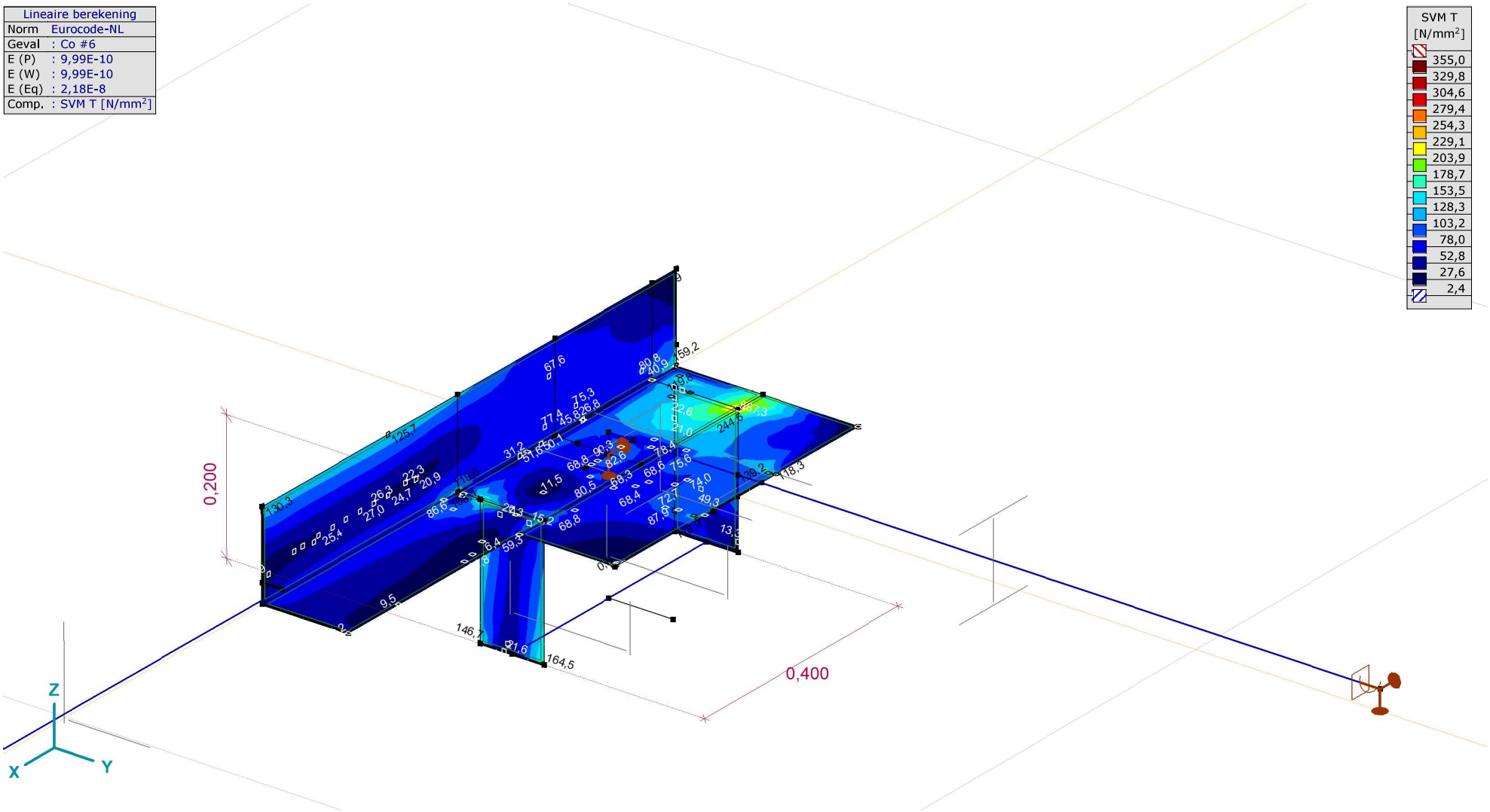
[I], Lineair, Co #4 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



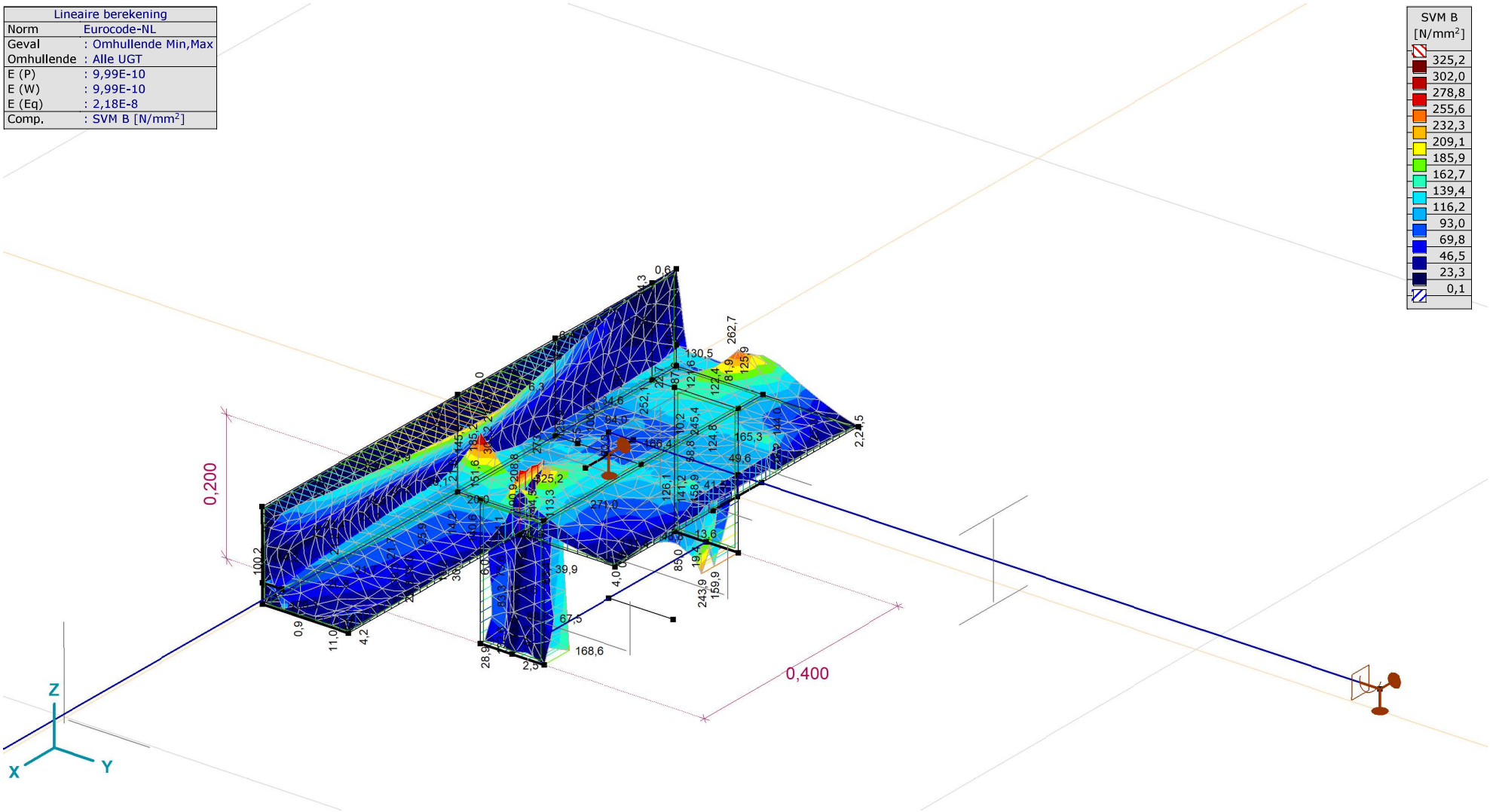
[I], Lineair, Co #5 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



[I], Lineair, Co #6 (UGT), SVM T, Kleuren 2D

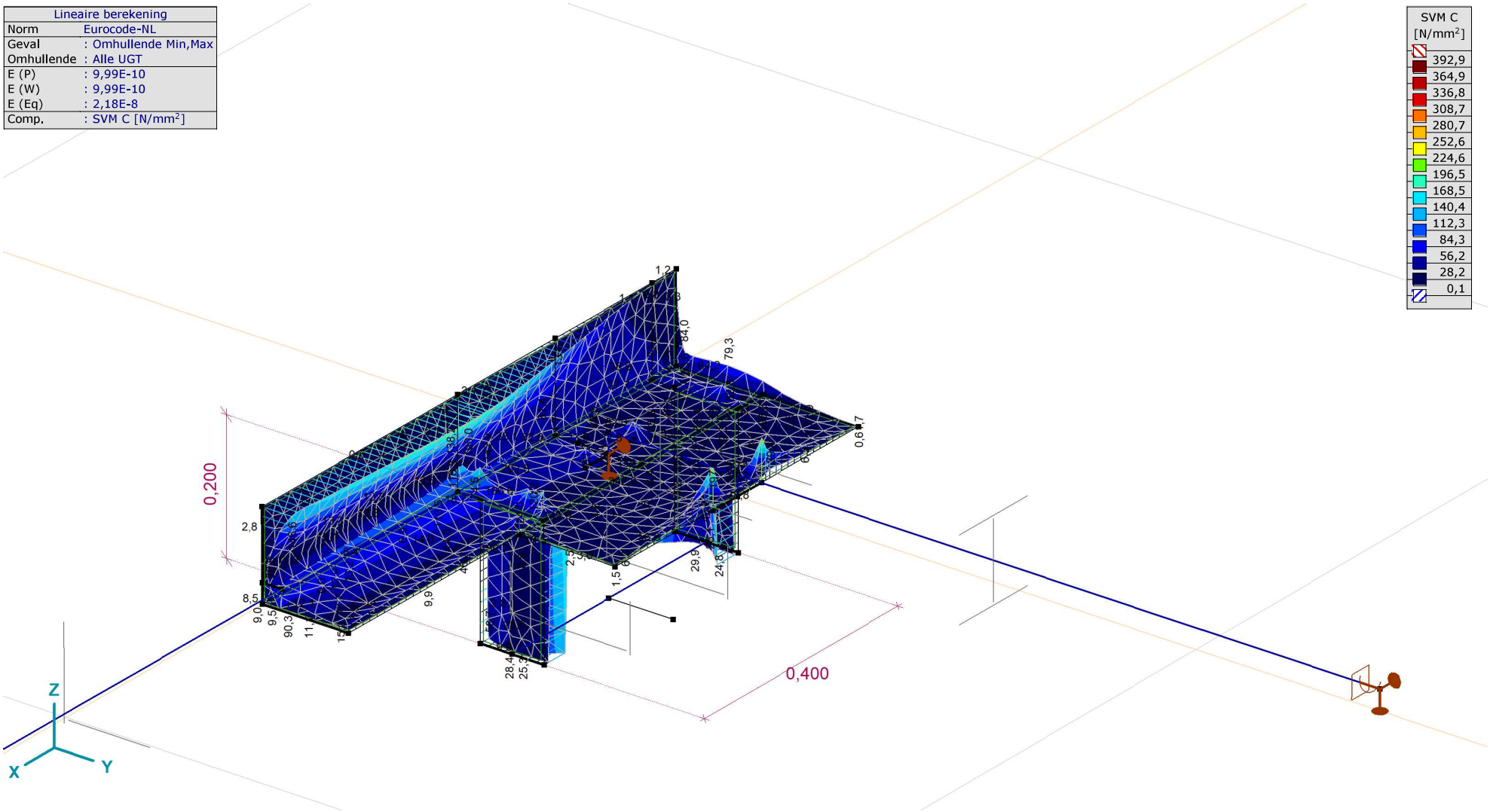
Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



[I], Lineair, Omhullende (Alle UGT), SVM B, Iso vlakken 3D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

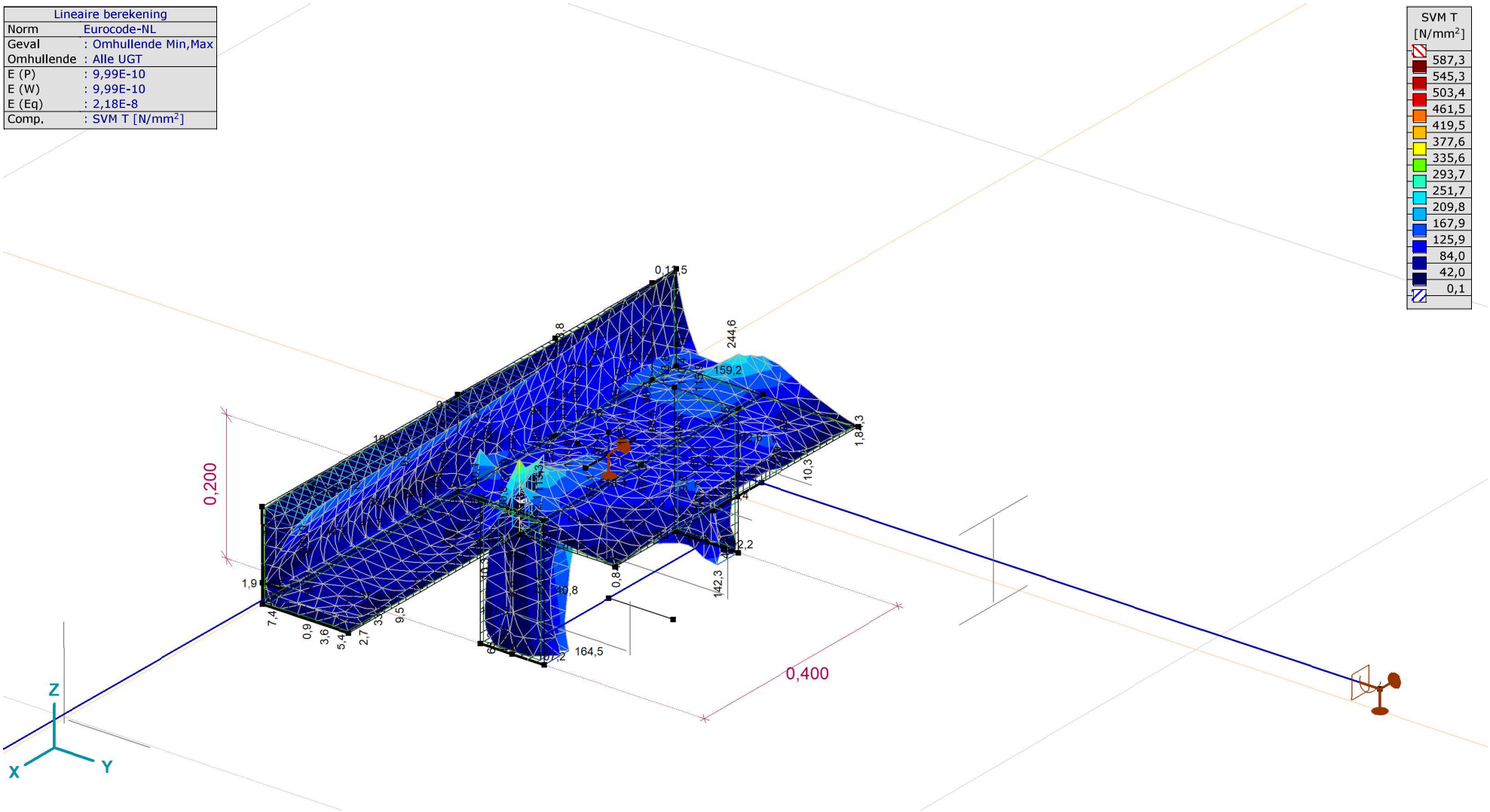
Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: SVM C [N/mm²]



[I], Lineair, Omhullende (Alle UGT), SVM C, Iso vlakken 3D

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**

Lineaire berekening	
Norm	Eurocode-NL
Geval	: Omhullende Min,Max
Omhullende	: Alle UGT
E (P)	: 9,99E-10
E (W)	: 9,99E-10
E (Eq)	: 2,18E-8
Comp.	: SVM T [N/mm²]



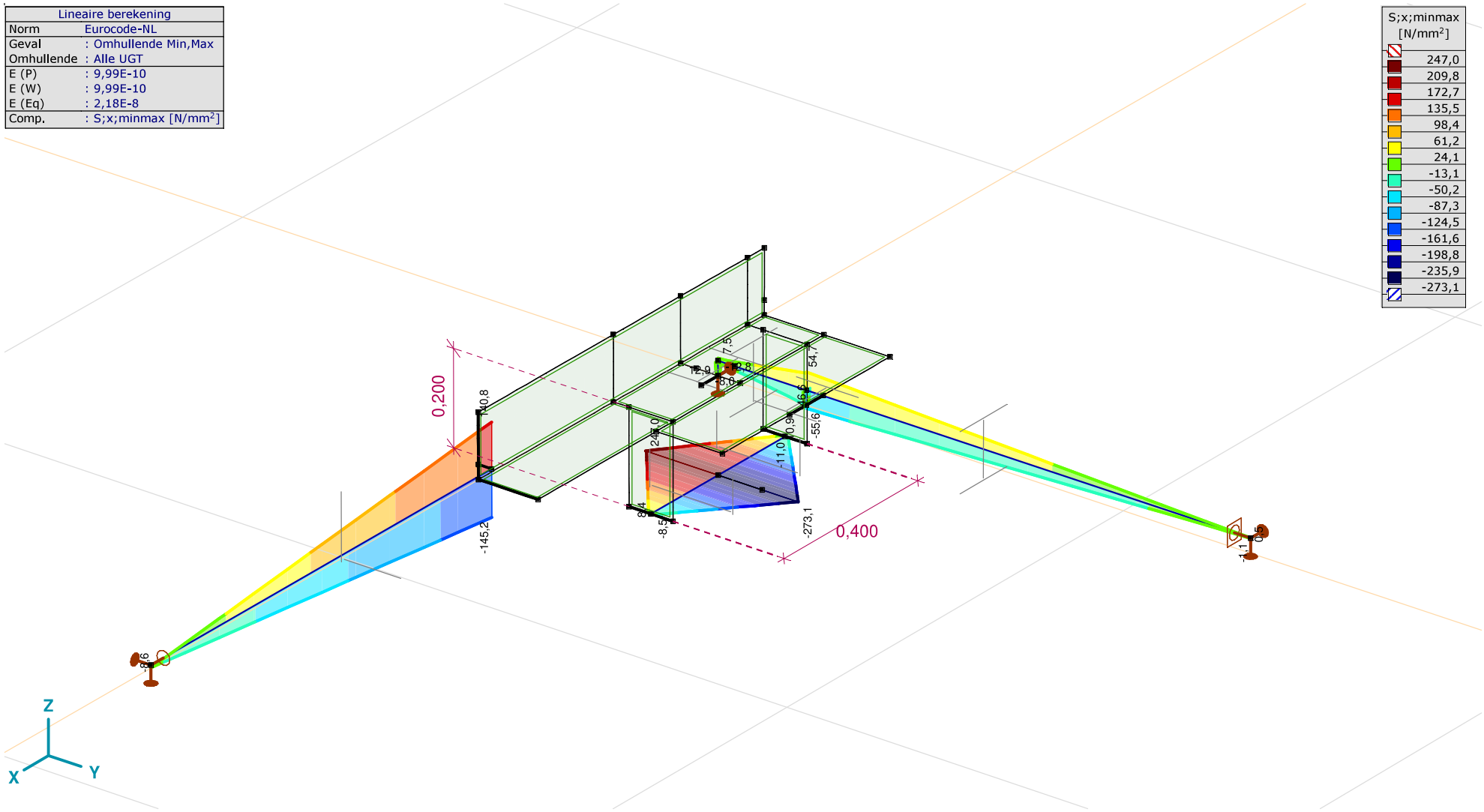
[I], Lineair, Omhullende (Alle UGT), SVM T, Iso vlakken 3D

Vlakspanningen [Lineair, Omhullende (Alle UGT)]

Knoop	*C*	*min. max.*	*Geval*	*Oppervlak*	*Pos.*	*Sxx [N/mm²]*	*Syy [N/mm²]*	*Szz [N/mm²]*	*Sxy [N/mm²]*	*Sxz [N/mm²]*	*Syz [N/mm²]*	*SVM [N/mm²]*	*S1 [N/mm²]*	*S2 [N/mm²]*	*aS [°]*
Ext.															
13	Sxx	min	Co #6	Sch 165	B	**−339,3**	−198,1	0	37,2	0	0	302,2	−188,9	−348,5	76,10
13		max	Co #5	Sch 165	B	**330,1**	210,5	0	−47,7	0	0	301,0	346,8	193,8	−19,30
8	Syy	min	Co #5	Sch 65	T	−59,0	**−551,7**	0	−123,0	0	0	566,3	−30,0	−580,8	−13,27
8		max	Co #6	Sch 65	T	60,8	**572,1**	0	127,3	0	0	587,3	602,1	30,8	76,76
1	Szz	min	Co #1	Sch 280	T	−7,8	−0,7	**0**	1,3	0	0	7,8	−0,5	−8,0	80,09
1		max	Co #1	Sch 280	T	−7,8	−0,7	**0**	1,3	0	0	7,8	−0,5	−8,0	80,09
5	Sxy	min	Co #3	Sch 1	T	53,8	488,3	0	**−133,9**	0	0	518,4	526,2	15,9	−74,18
35		max	Co #2	Sch 159	T	−263,4	−202,3	0	**136,7**	0	0	336,3	−92,8	−373,0	51,30
40	Sxz	min	Co #1	Sch 554	C	−0,3	−4,0	0	0	**−70,4**	−86,0	192,6	−0,3	−4,0	0,59
40		max	Co #3	Sch 554	C	−0,1	3,3	0	0	**71,7**	89,6	198,8	3,3	−0,1	−89,37
39	Syz	min	Co #1	Sch 550	C	−0,3	−4,0	0	0	68,3	**−86,6**	191,0	−0,3	−4,0	0,59
39		max	Co #3	Sch 550	C	−0,1	3,3	0	0	−69,9	**90,1**	197,6	3,3	−0,1	−89,37
21	SVM	min	Co #1	Sch 803	B	0	−0,1	0	0	0	0	**0,1**	0	−0,1	11,54
8		max	Co #6	Sch 65	T	60,8	572,1	0	127,3	0	0	**587,3**	602,1	30,8	76,76
1	S1	min	Co #3	Sch 280	T	−2,1	−2,4	0	0,5	0	0	2,4	**−1,7**	−2,8	37,00
1		max	Co #3	Sch 280	T	−2,1	−2,4	0	0,5	0	0	2,4	**−1,7**	−2,8	37,00
1	S2	min	Co #4	Sch 280	T	−26,8	−1,4	0	−25,4	0	0	51,3	14,4	**−42,6**	−58,30
1		max	Co #4	Sch 280	T	−26,8	−1,4	0	−25,4	0	0	51,3	14,4	**−42,6**	−58,30
1	aS	min	Co #4	Sch 280	T	−26,8	−1,4	0	−25,4	0	0	51,3	14,4	−42,6	**−58,30**
1		max	Co #4	Sch 280	T	−26,8	−1,4	0	−25,4	0	0	51,3	14,4	−42,6	**−58,30**

Knoop: Index; **C:** Extreme component; **min. max.:** Extreme type; **Geval:** Belastinggeval van de extreme; **Oppervlak:** Vlak behorend bij knoop; **Pos.:** Punt voor spanningsberekening; **Sxx:** Normaalspanning in lokale x-richting; **Syy:** Normaalspanning in lokale y-richting; **Szz:** Normaalspanning in lokale z-richting; **Sxy:** Torsie-/Schuifspanning; **Sxz, Syz:** Draai/afschuivingsspanning; **SVM:** Von Mises spanning; **S1:** Primaire spanning 1; **S2:** Primaire spanning 2; **aS:** Richting primaire spanning;

Project:
Constructeur: DNV GL - Energy
Model: **Post aan onderrand HA_s.axs**



[l], Lineair, Omhullende (Alle UGT), S;x;minmax, Lijnen (gevuld)

Staafspanningen [Lineair, Omhullende (Alle UGT)]

	Prof.	*Doorsnede naam*	*C*	*min. max.*	*Geval*	*Pos. [m]*	*Knoop*	*S;x;min [N/mm²]*	*S;x;max [N/mm²]*	*Vmin [N/mm²]*	*Vmax [N/mm²]*	*Somin [N/mm²]*	*Somax [N/mm²]*	*V;y;gem [N/mm²]*	*V;z;gem [N/mm²]*
Ext.															
1	1	U 200	S;x;min	min	Co #4	0,200	(28)	**–273,1**	99,1	0	54,7	0,8	276,5	–11,0	–0,3
7	3	HE 140 A		max	Co #3	0	(38)	**9,6**	9,6	4,7	11,7	12,6	22,4	–3,2	–0,5
7	3	HE 140 A	S;x;max	min	Co #1	0	(38)	–9,7	**–9,7**	2,1	9,9	10,4	19,7	3,9	–0,2
1	1	U 200		max	Co #2	0,200	(28)	–89,6	**247,0**	0	52,2	0,8	250,9	9,9	0,3
1	1	U 200	Vmin	min	Co #1	0	(26)	–0,5	2,0	**0**	272,2	0,2	471,5	–0,5	–0,4
7	3	HE 140 A		max	Co #2	0	(38)	0,5	0,5	**34,9**	41,0	60,5	71,1	0,4	–3,9
3	4	L 140X140X13	Vmax	min	Co #5	0	(31)	–103,9	64,1	0	**5,0**	8,6	104,0	–0,1	1,5
1	1	U 200		max	Co #3	0	(26)	–2,2	0,5	0	**272,6**	0,3	472,2	–0,5	0,4
2	1	U 200		max	Co #1	0	(28)	–12,4	5,8	0	**272,8**	0,2	472,5	0,5	0,4
2	1	U 200	Somin	min	Co #6	0,200	(27)	–1,7	4,3	0	228,8	**0,2**	396,3	–6,9	–0,5
7	3	HE 140 A		max	Co #2	0,030	(44)	–2,5	3,5	34,9	41,0	**60,5**	71,1	0,4	–3,9
3	4	L 140X140X13	Somax	min	Co #5	1,000	(32)	–8,6	–8,6	0	5,0	8,6	**12,2**	–0,1	1,5
1	1	U 200		max	Co #3	0,200	(28)	–16,5	6,6	0	272,6	0,3	**472,2**	–0,5	0,4
2	1	U 200		max	Co #1	0	(28)	–12,4	5,8	0	272,8	0,2	**472,5**	0,5	0,4
1	1	U 200	V;y;gem	min	Co #4	0	(26)	–11,0	3,5	0	54,7	0,8	94,8	**–11,0**	–0,3
2	1	U 200		max	Co #2	0	(28)	–270,5	98,6	0	55,1	0,6	274,1	**11,0**	0,3
4	3	HE 140 A	V;z;gem	min	Co #3	0	(33)	–5,0	–0,4	4,0	40,0	6,9	69,3	–0,4	**–8,0**
4	3	HE 140 A		max	Co #1	0	(33)	0,8	4,8	1,7	38,7	3,0	67,0	–0,2	**8,0**

Prof.: Profiel; **C:** Extreme component; **min. max.:** Extreme type; **Geval:** Belastinggeval van de extreme; **Pos.:** Lokale X-positie van de doorsnede op de staaf; **S;x;min:** Doorsnede minimum normaalspanning; **S;x;max:** Doorsnede maximum normaalspanning;
Vmin: Doorsnede minimum afschuifspanning; **Vmax:** Doorsnede maximum afschuifspanning; **Somin:** Doorsnede minimum Von Mises spanning; **Somax:** Doorsnede maximum Von Mises spanning; **V;y;gem:** Afschuifspanning in lokale Y-richting; **V;z;gem:** Afschuifspanning in lokale Z-richting;

Interne krachten knoopoplegging [Lineair, Omhullende (Alle UGT)]

	Knoop	*X [m]*	*Y [m]*	*Z [m]*	*Type*	*C*	*min. max.*	*Geval*	*Rx [kN]*	*Ry [kN]*	*Rz [kN]*	*Rr [kN]*	*Rxx [kNm]*	*Ryy [kNm]*	*Rrr [kNm]*	*αR*
1	32	1,600	0,030	0,030	Glob.	Ry	min	Co #4		**−2,6**	8,7	9,1	0		0	0,299
							max	Co #2		**0,9**	−7,6	7,6	−0,1		0,1	−0,119
						Rz	min	Co #2		0,9	**−7,6**	7,6	−0,1		0,1	−0,119
							max	Co #4		−2,6	**8,7**	9,1	0		0	0,299
2	45	0	1,285	0,030	Glob.	Rx	min	Co #4	**−2,1**	2,6	0,4	3,4		0,1	0,1	9,132
							max	Co #2	**2,6**	−0,9	−0,3	2,8		−0,1	0,1	−9,372
						Ry	min	Co #3	0,3	**−1,7**	−5,1	5,4		0	0	−0,346
							max	Co #1	0,1	**3,4**	5,2	6,2		0	0	0,664
						Rz	min	Co #3	0,3	−1,7	**−5,1**	5,4		0	0	−0,346
							max	Co #1	0,1	3,4	**5,2**	6,2		0	0	0,664
3	10	0	0,085	0	Glob.	Rx	min	Co #4	**−32,3**		−12,6	34,7				−2,571
							max	Co #2	**−28,2**		4,4	28,5				6,453
						Rz	min	Co #4	−32,3		**−12,6**	34,7				−2,571
							max	Co #2	−28,2		**4,4**	28,5				6,453
Ext.																
3	10	0	0,085	0	Glob.	Rx	min	Co #4	**−32,3**		−12,6	34,7				−2,571
2	45	0	1,285	0,030	Glob.		max	Co #2	**2,6**	−0,9	−0,3	2,8		−0,1	0,1	−9,372
1	32	1,600	0,030	0,030	Glob.	Ry	min	Co #4		**−2,6**	8,7	9,1	0		0	0,299
2	45	0	1,285	0,030	Glob.		max	Co #1	0,1	**3,4**	5,2	6,2		0	0	0,664
3	10	0	0,085	0	Glob.	Rz	min	Co #4	−32,3		**−12,6**	34,7				−2,571
1	32	1,600	0,030	0,030	Glob.		max	Co #4		−2,6	**8,7**	9,1	0		0	0,299

Knoop: Ondersteunde knoop; **Type:** Opleggingstype; **C:** Extreme component; **min. max.:** Extreme type; **Geval:** Belastinggeval van de extreme; **Rx:** X-component opleggingsreactiekracht; **Ry:** Y-component opleggingsreactiekracht; **Rz:** Z-component opleggingsreactiekracht; **Rr:** Resulterende opleggingsreactiekracht; **Rxx:** X-component opleggingsreactiemoment; **Ryy:** Y-component opleggingsreactiemoment; **Rrr:** Resulterend opleggingsreactiemoment; **αR:** Verhouding verticale oplegkracht / horizontale oplegkracht;

Project:

Constructeur: DNV GL - Energy

AxisVM X5 R4h · Geregistreerd aan DNV GL - Energy

Model 1.axs

Rapport

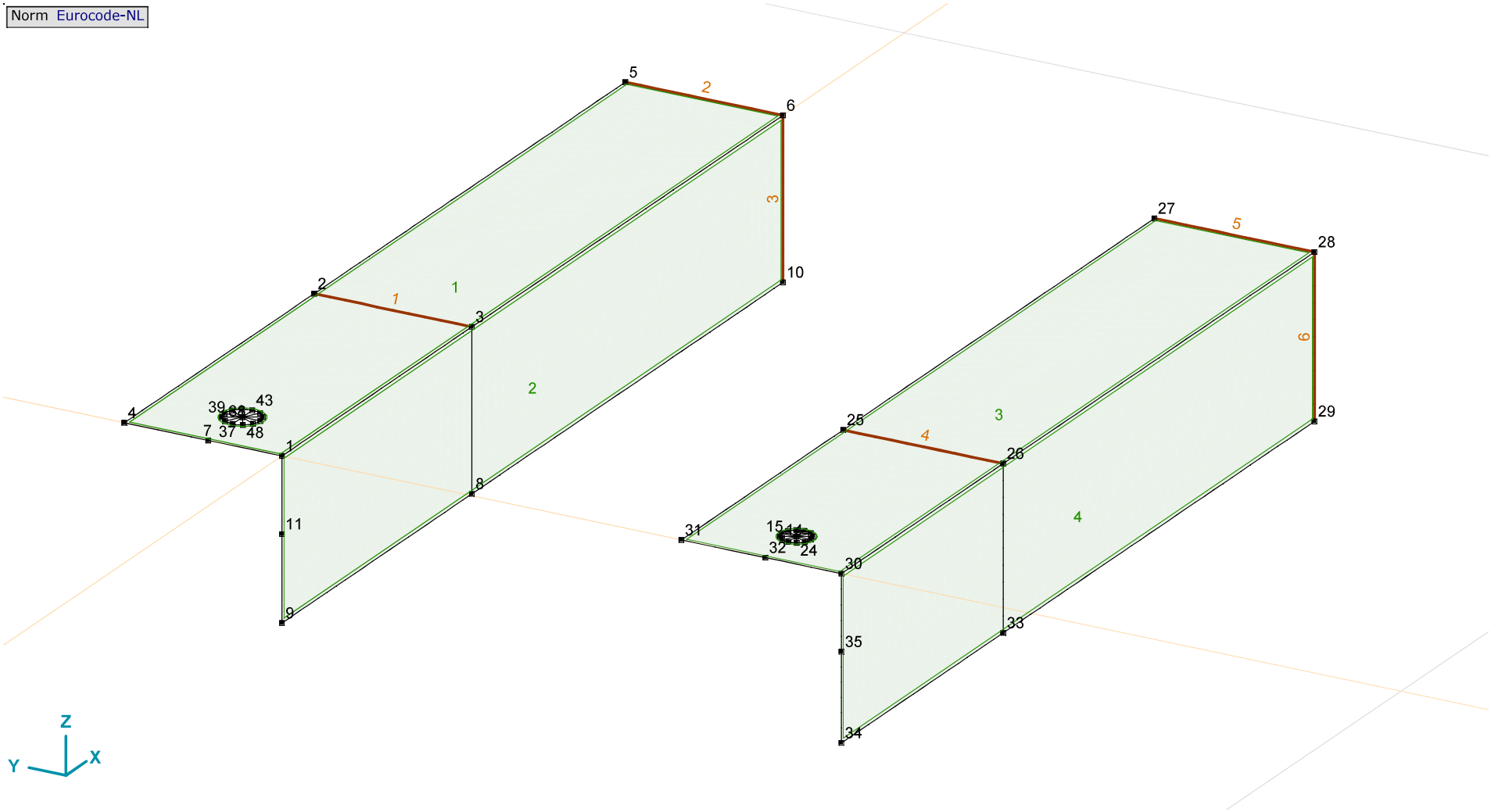
Rapport, Inhoudsopgave

Onderdeel	*Pagina*
Tekening	3
Tekening2	4
Materialen	5
Domeinen	5
Lijnopleggingen	6
Fx	7
Fx: Oppervlak lijnlast	8
Fy1	9
Fy1: Oppervlak lijnlast	10
Fy2	11
Fy2: Oppervlak lijnlast	12
Fz	13
Fz: Oppervlak lijnlast	14

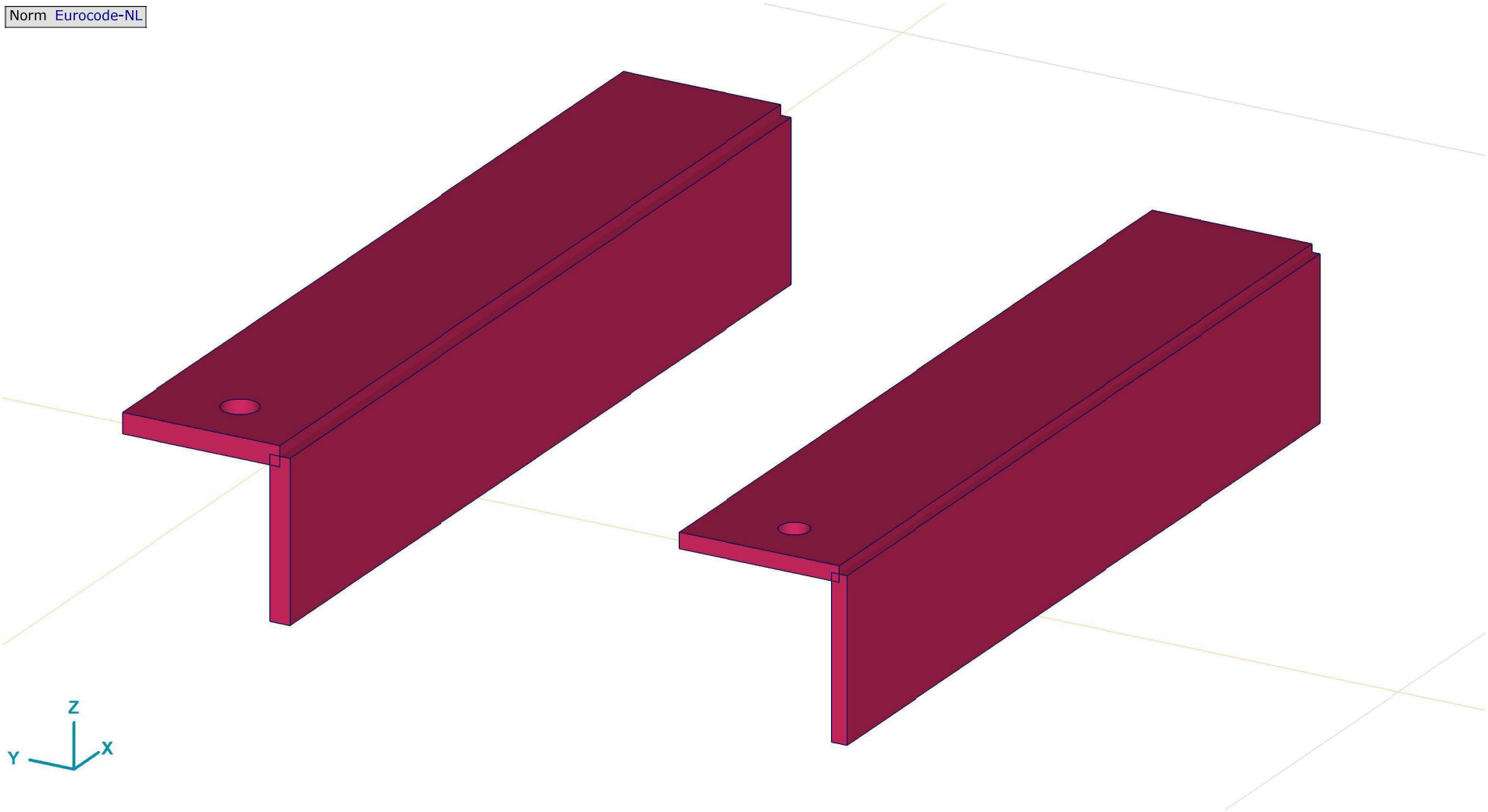
Onderdeel	*Pagina*
Gebruiker gedefinieerde belastingcombinaties uit belastinggevallen	14
[I], Lineair, Co #1 (UGT), SVM T, Kleuren 2D	15
[I], Lineair, Co #2 (UGT), SVM T, Kleuren 2D	16
[I], Lineair, Co #1 (UGT), SVM C, Kleuren 2D	17
[I], Lineair, Co #2 (UGT), SVM C, Kleuren 2D	18
[I], Lineair, Co #1 (UGT), eY, Lijnen	19
[I], Lineair, Co #2 (UGT), eY, Lijnen	20
[I], Lineair, Co #1 (UGT), eZ, Lijnen	21
[I], Lineair, Co #2 (UGT), eZ, Lijnen	22
[I], Lineair, Co #1 (UGT), Ry (lijnopp.), Doorsnedelijn	23
[I], Lineair, Co #2 (UGT), Ry (lijnopp.), Doorsnedelijn	24
[I], Lineair, Co #1 (UGT), Rz (lijnopp.), Doorsnedelijn	25
[I], Lineair, Co #2 (UGT), Rz (lijnopp.), Doorsnedelijn	26

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**

Norm Eurocode-NL



Tekening



Tekening2

Materialen

	Naam	*Type*	*Nationale norm*	*Materiaalnorm*	*Model*	*E_x [N/mm²]*	*E_y [N/mm²]*	*ν*	*α_T [1/°C]*	*ρ [kg/m³]*	*Materiaal kleur*	*Contour kleur*	*Structuur*
1	S 355	Staal	Eurocode-NL	10025-2	Lineair	210000	210000	0,30	1,2E-5	7850			Steel

	Naam	*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 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										

Naam: Materiaalnaam; **Type:** Type materiaal; **Model:** Materiaal model; **E_x:** Elasticiteitsmodulus in lokale x richting; **E_y:** Elasticiteitsmodulus in lokale y richting; **ν:** Poisson's verhouding; **α_T:** Warmteuitzettingscoëfficiënt; **ρ:** Dichtheid; **Materiaal kleur:** Materiaalkleur; **Contour kleur:** Contourkleur; **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}:** Ontwerpparameter;

Domeinen

	Element type	*Materiaal*	*Ref_x*	*Ref_z*	*Dikte [mm]*	*k,buiging []*	*k,torsie []*	*k,afschuiving []*	*Oppervlakte [m²]*	*Gat*	*Mesh*
1	Schaal	S 355	Auto	Auto	18				0,113	1	✓
2	Schaal	S 355	Auto	Auto	18				0,114	–	✓
3	Schaal	S 355	Auto	Auto	14				0,108	1	✓
4	Schaal	S 355	Auto	Auto	14				0,109	–	✓

Element type: Plaatelement type; **Ref_x:** Referentie voor lokale X-richting; **Ref_z:** Referentie voor lokale Z-richting; **k,buiging:** Buigsterkte coefficient; **k,torsie:** Torsiesterkte coefficient; **k,afschuiving:** Dwarskrachtsterkte coefficient; **Oppervlakte:** Domein oppervlak; **Gat:** Aantal gaten in domein; **Mesh:** Gegenereerde mesh;

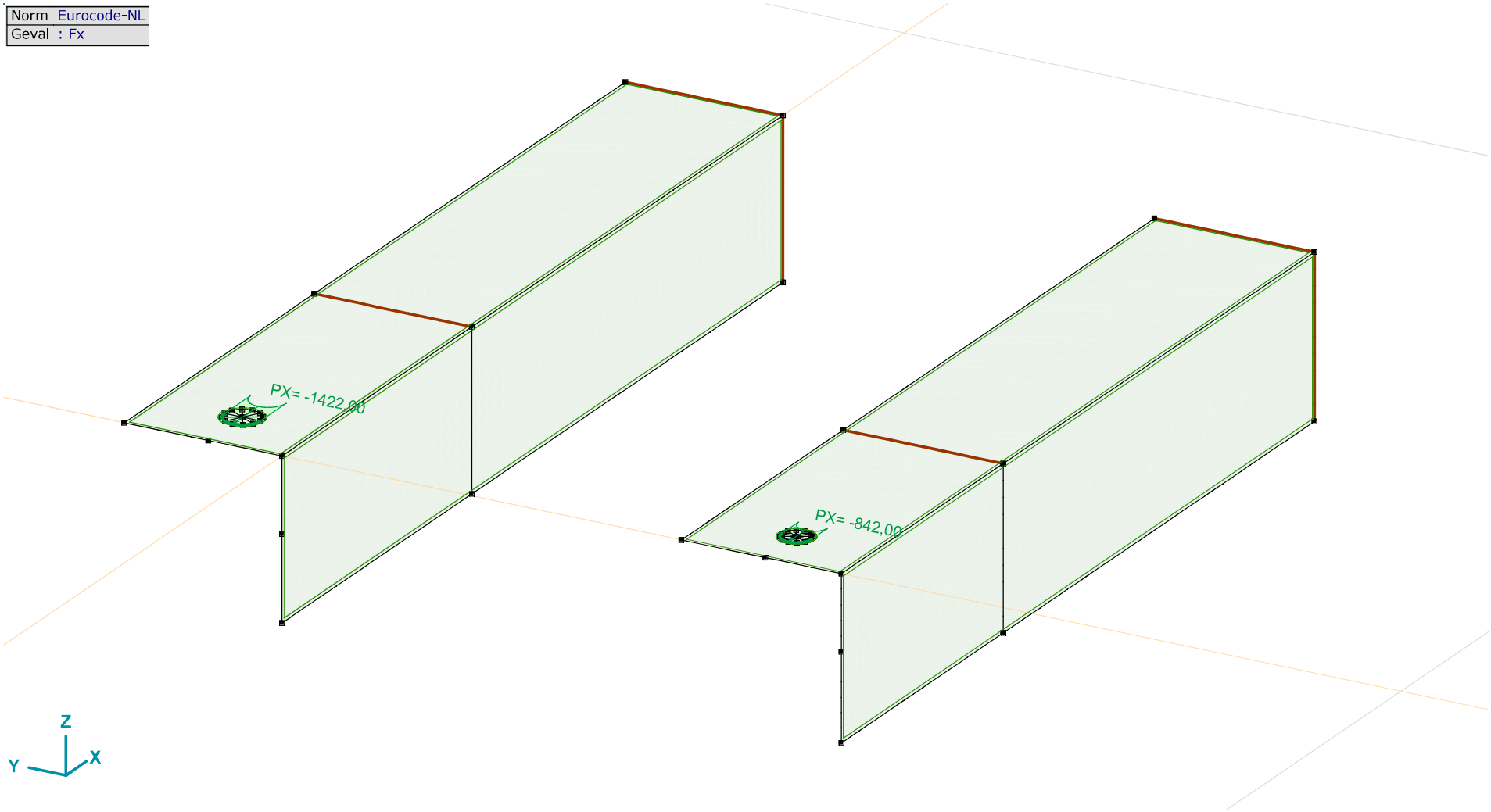
Lijnopleggingen

	Lijn	*Type*	*Ref. elem.*	*Rx [kN/m/m]*	*Ry [kN/m/m]*	*Rz [kN/m/m]*	*Rxx [kNm/rad/m]*	*Ryy [kNm/rad/m]*	*Rzz [kNm/rad/m]*	*NL(x)*	*NL(y)*	*NL(z)*
1	Rand (2034)	Glob.	Domein 1	0	1E+7	1E+7	0	0	0		Symmetrisch	Symmetrisch
2	Rand (1959)	Glob.	Domein 1	1E+10	0	0	0	0	0	Symmetrisch		
3	Rand (104)	Glob.	Domein 2	1E+10	0	0	0	0	0	Symmetrisch		
4	Rand (3938)	Glob.	Domein 3	0	1E+7	1E+7	0	0	0		Symmetrisch	Symmetrisch
5	Rand (3866)	Glob.	Domein 3	1E+10	0	0	0	0	0	Symmetrisch		
6	Rand (5718)	Glob.	Domein 4	1E+10	0	0	0	0	0	Symmetrisch		

	Lijn	*NL(xx)*	*NL(yy)*	*NL(zz)*	*F(x) [kN/m]*	*F(y) [kN/m]*	*F(z) [kN/m]*	*M(x) [kNm/m]*	*M(y) [kNm/m]*	*M(z) [kNm/m]*
1	Rand (2034)									
2	Rand (1959)									
3	Rand (104)									
4	Rand (3938)									
5	Rand (3866)									
6	Rand (5718)									

Lijn: Ondersteund lijnelement; **Type:** Opleggingstype; **Ref. elem.:** Referentie-element; **Rx, Ry, Rz:** Verplaatsingsstijfheid; **Rxx, Ryy, Rzz:** Rotatiestijfheid; **NL(x), NL(y), NL(z), NL(xx), NL(yy), NL(zz):** Niet-lineaire parameters; **F(x):** Weerstand in X-richting; **F(y):** Weerstand in Y-richting; **F(z):** Weerstand in Z-richting; **M(x):** Weerstandsmoment in X-richting; **M(y):** Weerstandsmoment in Y-richting; **M(z):** Weerstandsmoment in Z-richting;

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



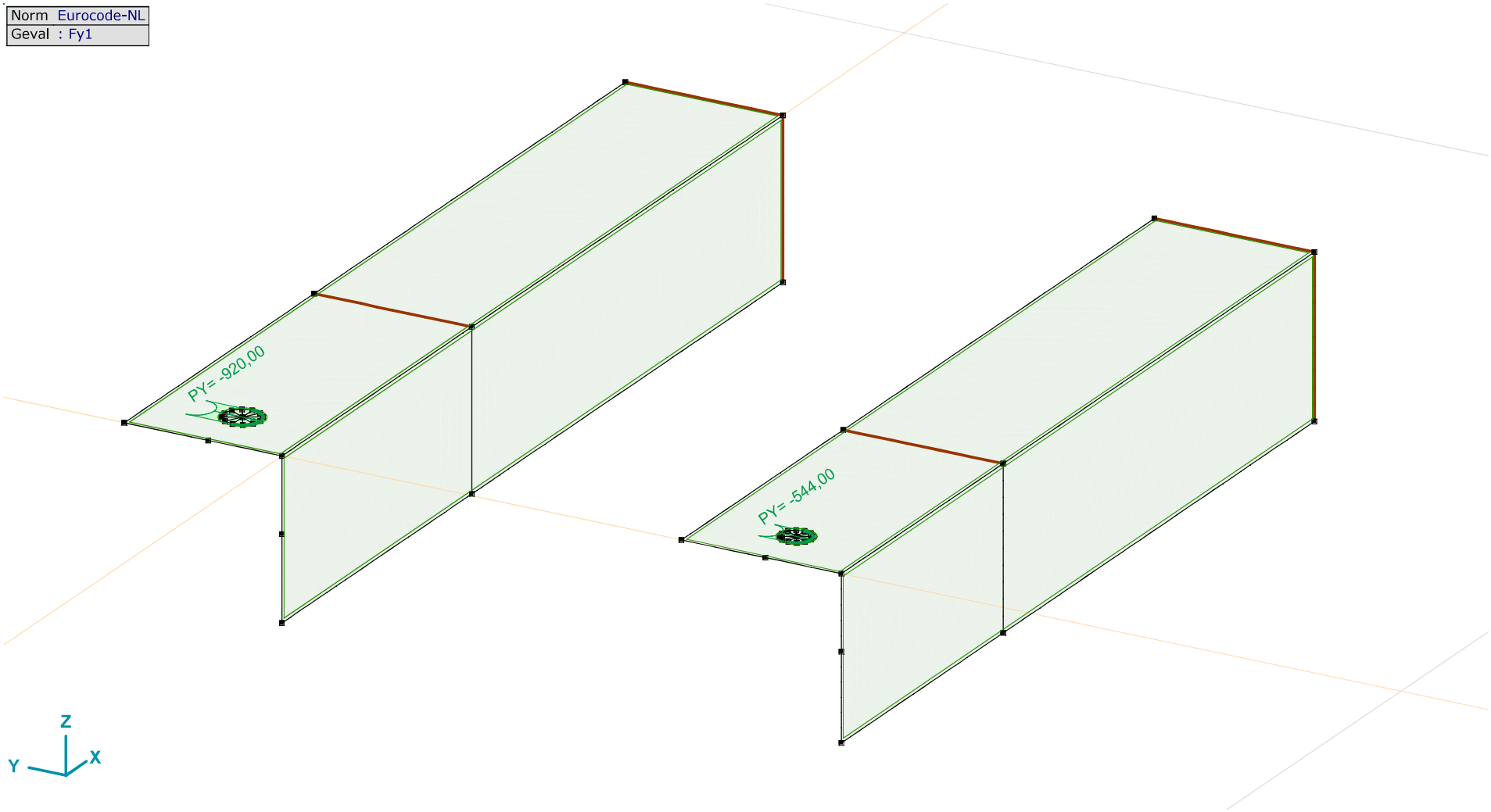
Fx

Fx: Oppervlak lijnlast

	Richting	*px [kN/m]*	*py [kN/m]*	*pz [kN/m]*	*pm [kNm/m]*	*X [m]*	*Y [m]*	*Z [m]*	*Richting*	*dL [m]*
1	Globaal	−1422,00	0	0	0	0,055	0,082	0	(0,055; 0,066; 0,000)	0
		−1422,00	0	0	0	0,055	0,050	0	-	0,050
4	Globaal	−842,00	0	0	0	0,050	−0,419	0	(0,050; -0,432; 0,000)	0
		−842,00	0	0	0	0,050	−0,445	0	-	0,041

px, py, pz: Belastingkracht component; **pm:** Belastingsmoment component; **X:** Belasting in X-richting; **Y:** Belasting in Y-richting; **Z:** Belasting in Z-richting;

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



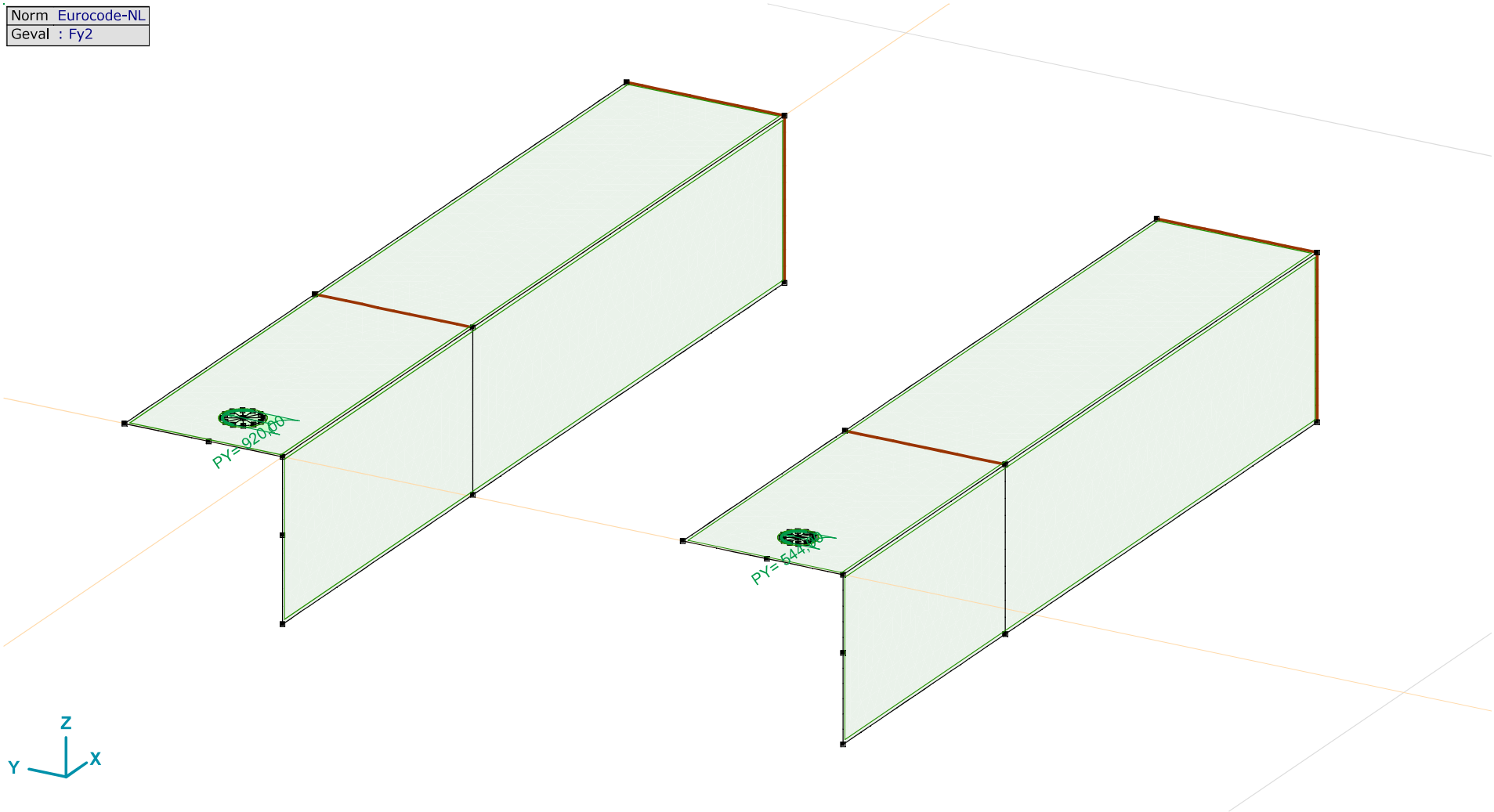
Fy1

Fy1: Oppervlak lijnlast

	Richting	*px [kN/m]*	*py [kN/m]*	*pz [kN/m]*	*pm [kNm/m]*	*X [m]*	*Y [m]*	*Z [m]*	*Richting*	*dL [m]*
5	Globaal	0	−920,00	0	0	0,071	0,066	0	(0,055; 0,066; 0,000)	0
		0	−920,00	0	0	0,039	0,066	0	-	0,050
7	Globaal	0	−544,00	0	0	0,037	−0,432	0	(0,050; -0,432; 0,000)	0
		0	−544,00	0	0	0,063	−0,432	0	-	0,041

px, py, pz: Belastingkracht component; **pm:** Belastingsmoment component; **X:** Belasting in X-richting; **Y:** Belasting in Y-richting; **Z:** Belasting in Z-richting;

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



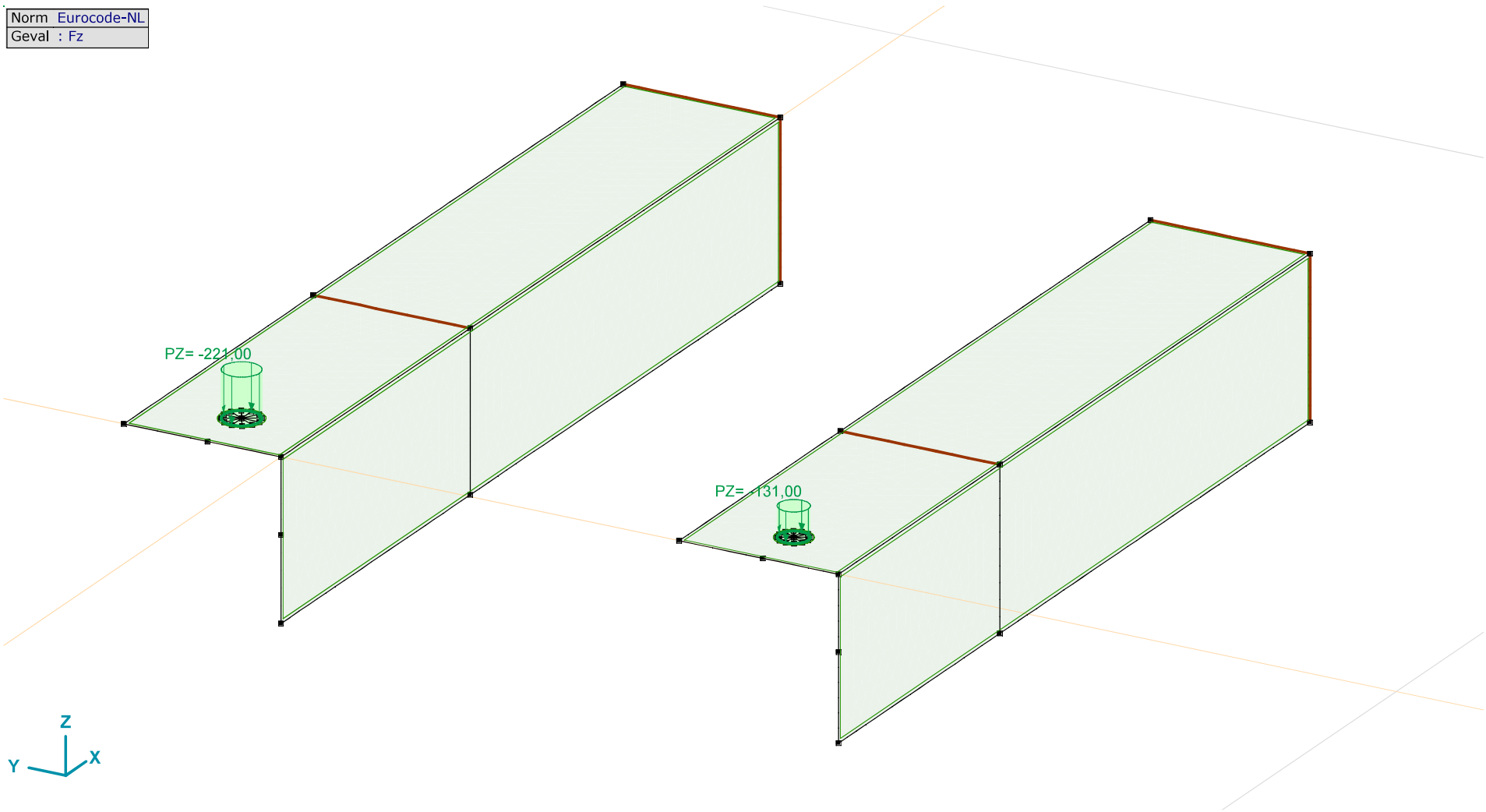
Fy2

Fy2: Oppervlak lijnlast

	Richting	*px [kN/m]*	*py [kN/m]*	*pz [kN/m]*	*pm [kNm/m]*	*X [m]*	*Y [m]*	*Z [m]*	*Richting*	*dL [m]*
6	Globaal	0	920,00	0	0	0,071	0,066	0	(0,055; 0,066; 0,000)	0
		0	920,00	0	0	0,039	0,066	0	-	0,050
8	Globaal	0	544,00	0	0	0,063	−0,432	0	(0,050; -0,432; 0,000)	0
		0	544,00	0	0	0,037	−0,432	0	-	0,041

px, py, pz: Belastingkracht component; **pm:** Belastingsmoment component; **X:** Belasting in X-richting; **Y:** Belasting in Y-richting; **Z:** Belasting in Z-richting;

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



Fz

Fz: Oppervlak lijnlast

	Richting	*px [kN/m]*	*py [kN/m]*	*pz [kN/m]*	*pm [kNm/m]*	*X [m]*	*Y [m]*	*Z [m]*	*Richting*	*dL [m]*
2	Globaal	0	0	−221,00	0	0,071	0,066	0	(0,055; 0,066; 0,000)	0
		0	0	−221,00	0	0,071	0,066	0	-	0,101
3	Globaal	0	0	−131,00	0	0,063	−0,432	0	(0,050; -0,432; 0,000)	0
		0	0	−131,00	0	0,063	−0,432	0	-	0,082

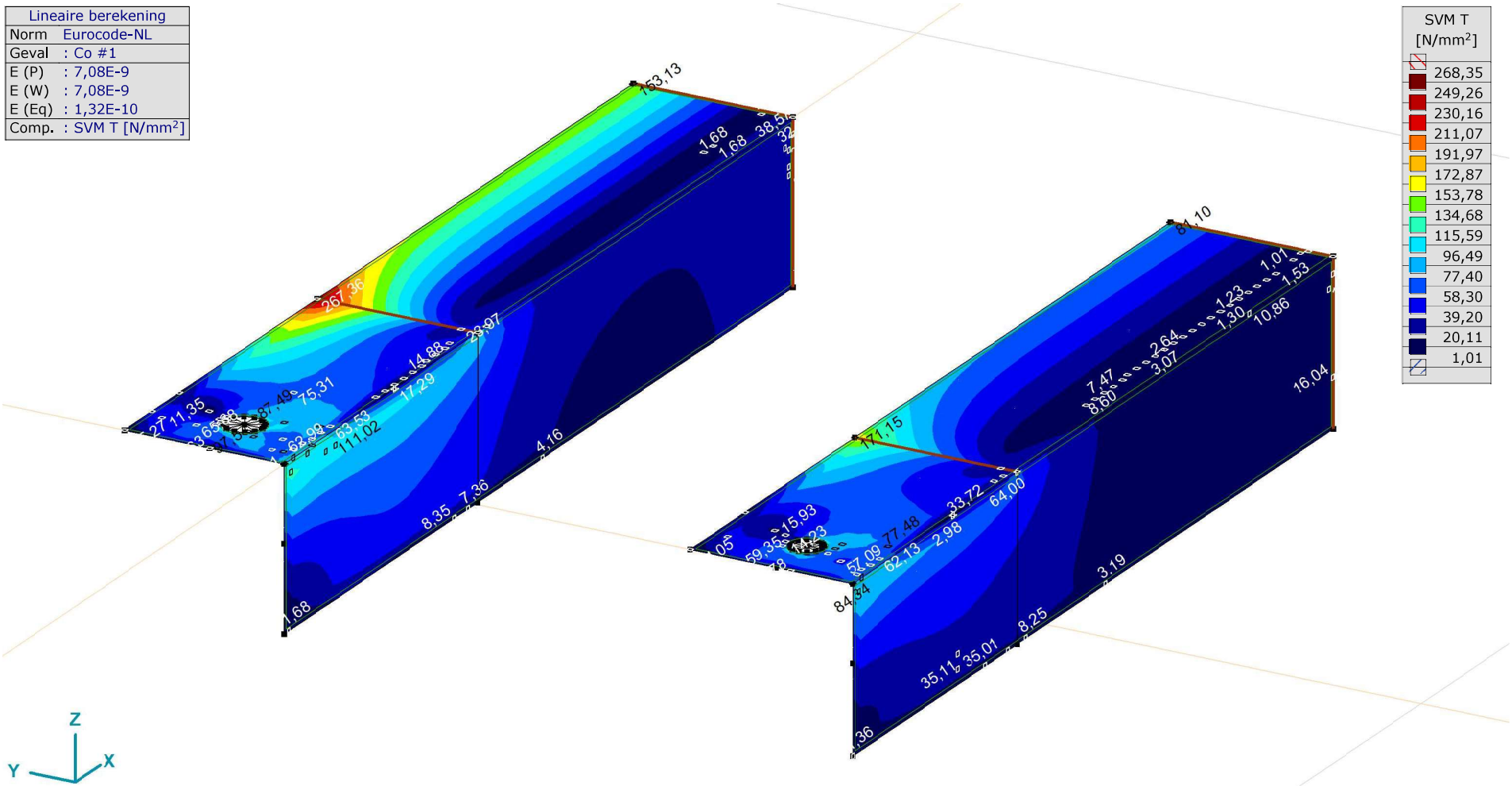
px, py, pz: Belastingkracht component; **pm:** Belastingsmoment component; **X:** Belasting in X-richting; **Y:** Belasting in Y-richting; **Z:** Belasting in Z-richting;

Gebruiker gedefinieerde belastingcombinaties uit belastinggevallen

	Naam	*Type*	*Fx*	*Fy1*	*Fy2*	*Fz*	*Commentaar*
1	Co #1	UGT	1,00	1,00	0	1,00	
2	Co #2	UGT	1,00	0	1,00	1,00	

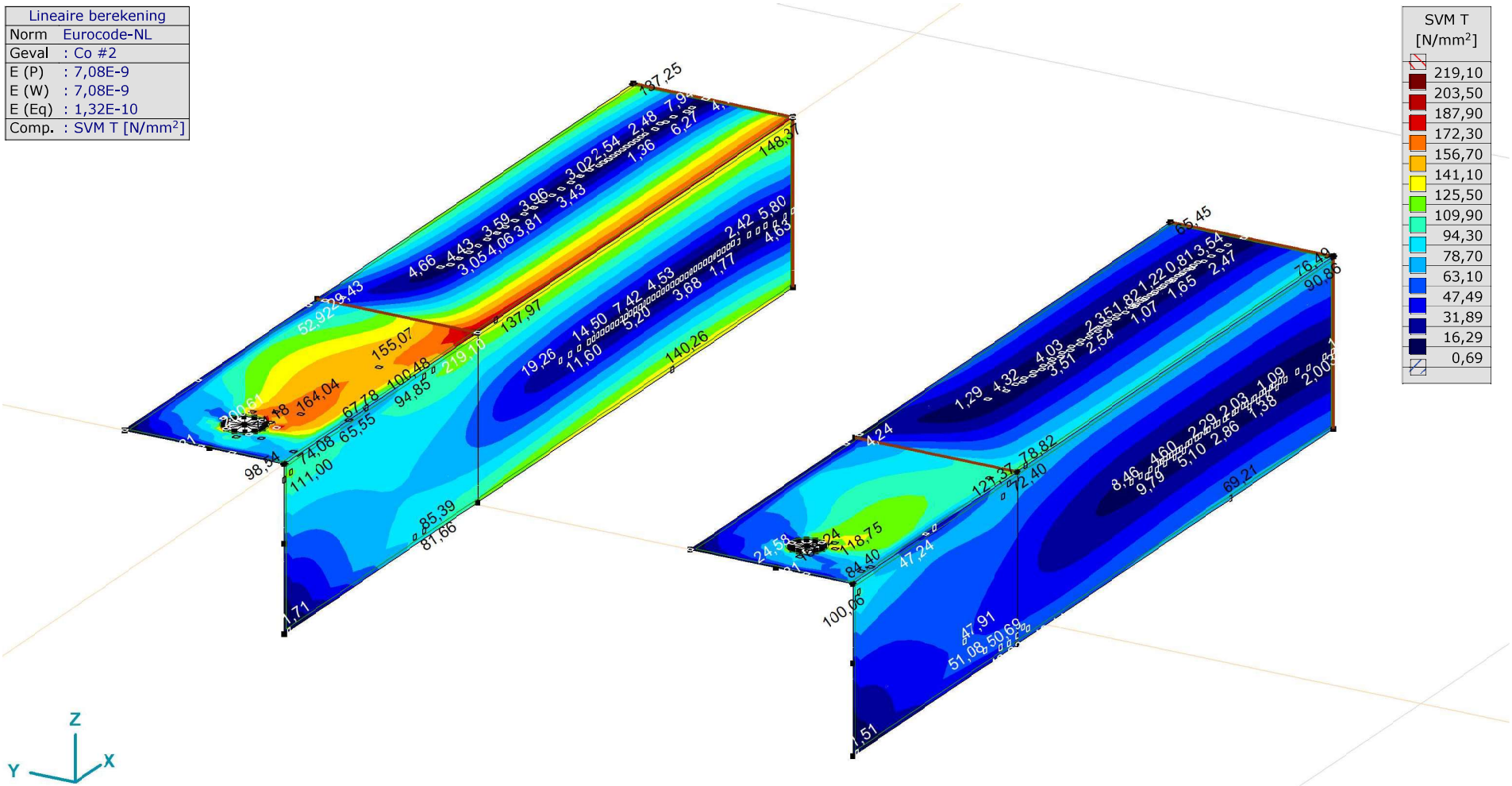
Naam: Naam belastingcombinatie; **Type:** Type belastingcombinatie; **Fx, Fy1, Fy2, Fz:** Factor;

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



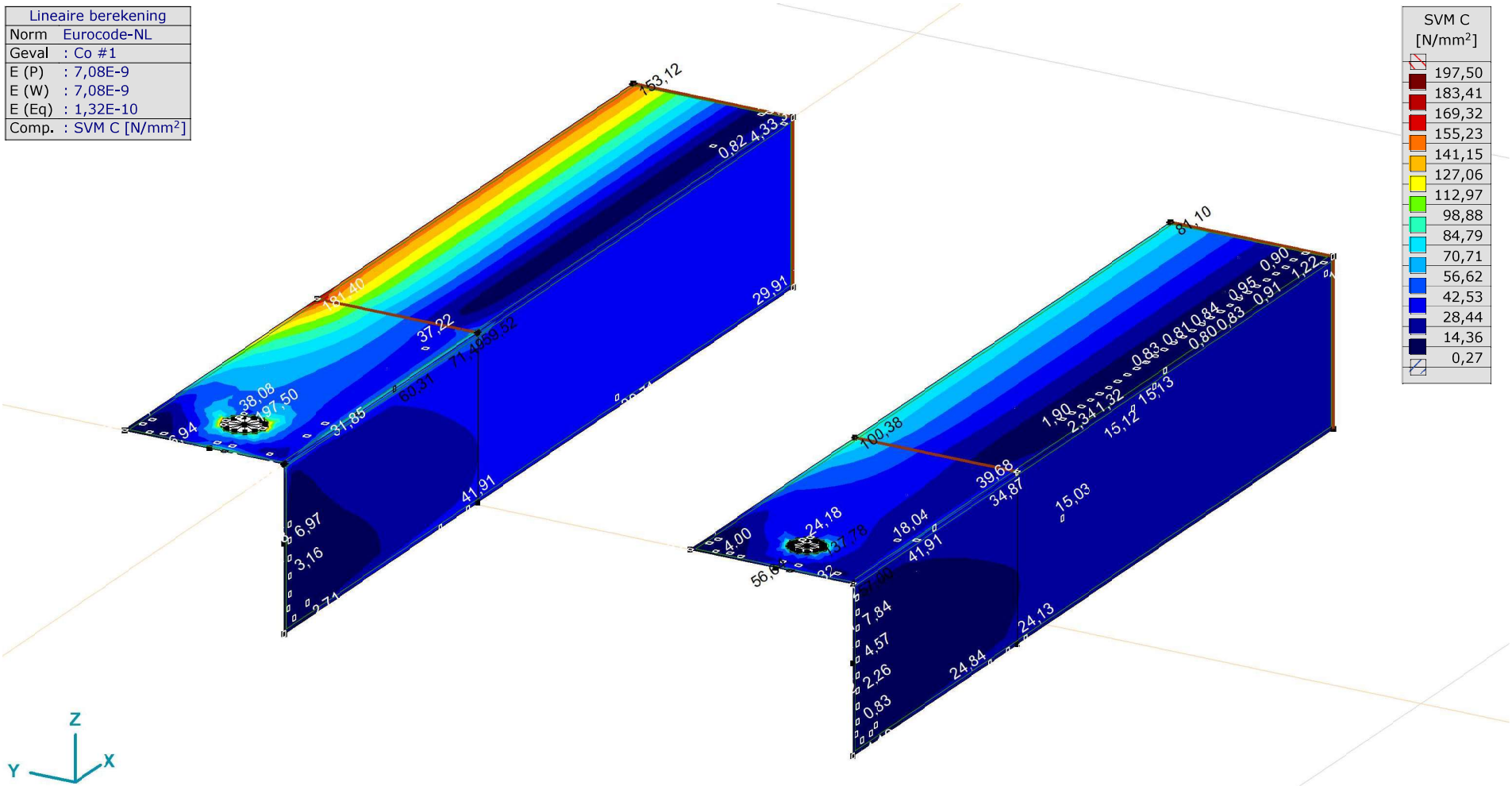
[I], Lineair, Co #1 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



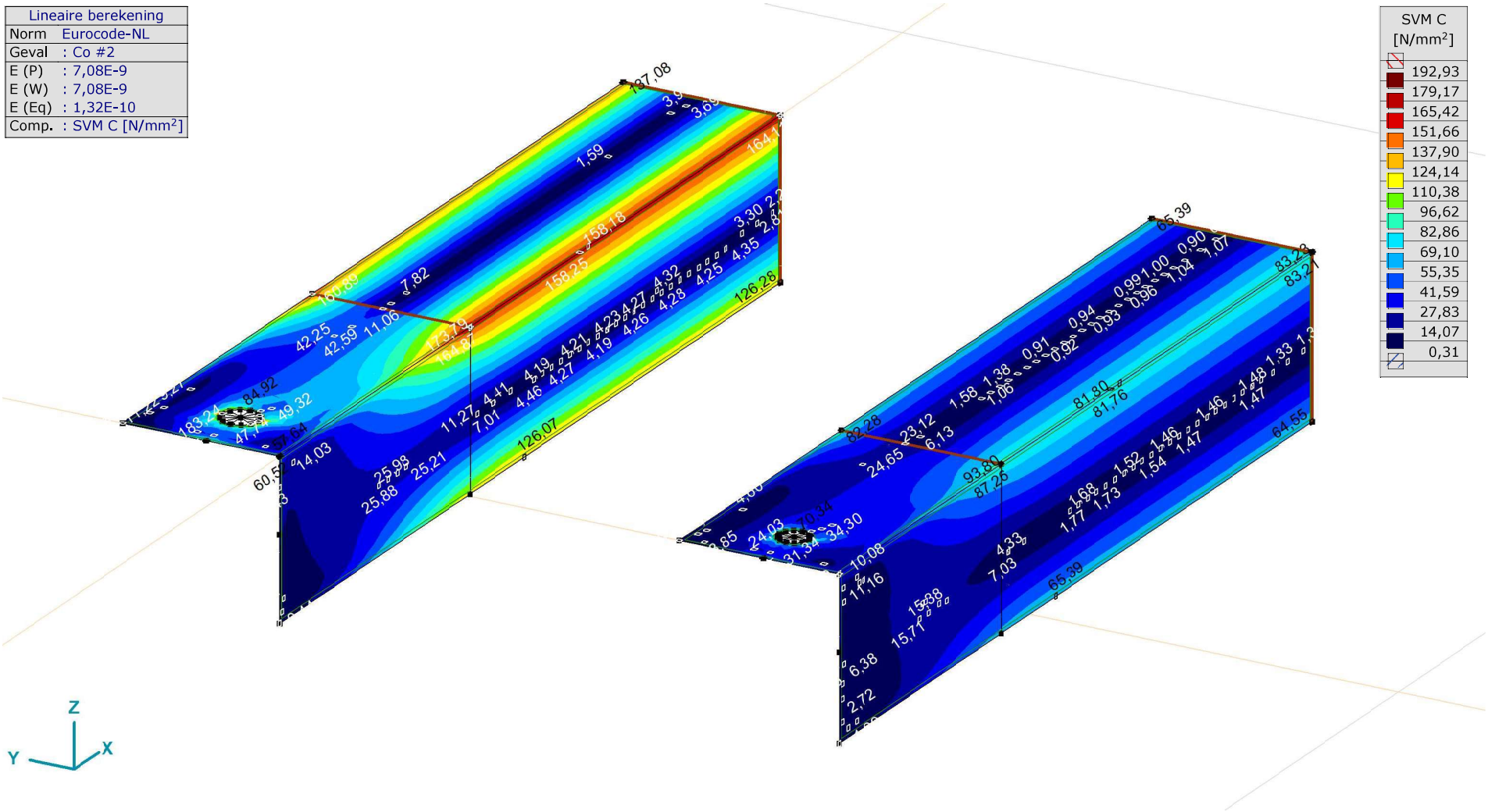
[I], Lineair, Co #2 (UGT), SVM T, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



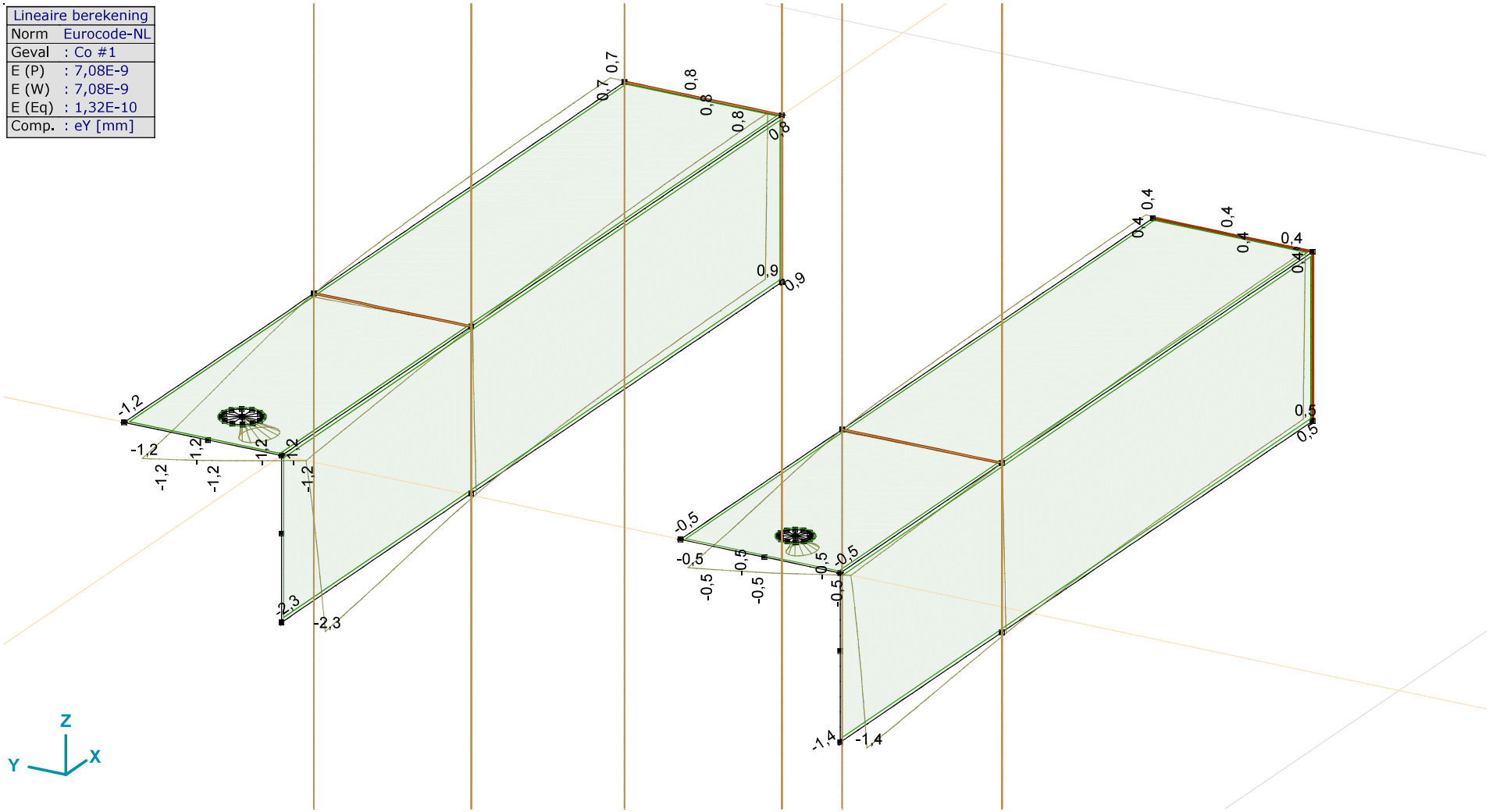
[I], Lineair, Co #1 (UGT), SVM C, Kleuren 2D

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



[I], Lineair, Co #2 (UGT), SVM C, Kleuren 2D

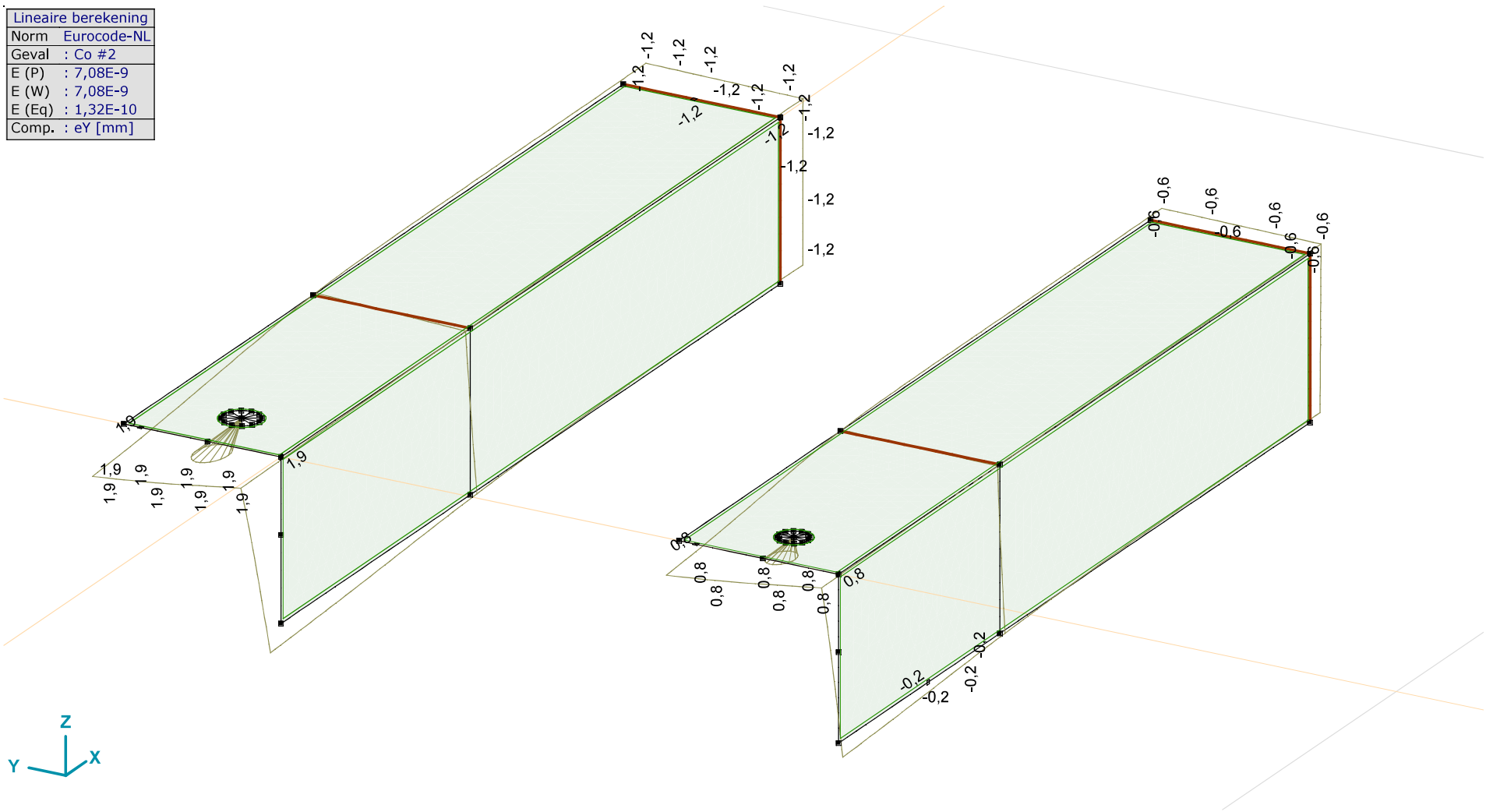
Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



[I], Lineair, Co #1 (UGT), eY, Lijnen

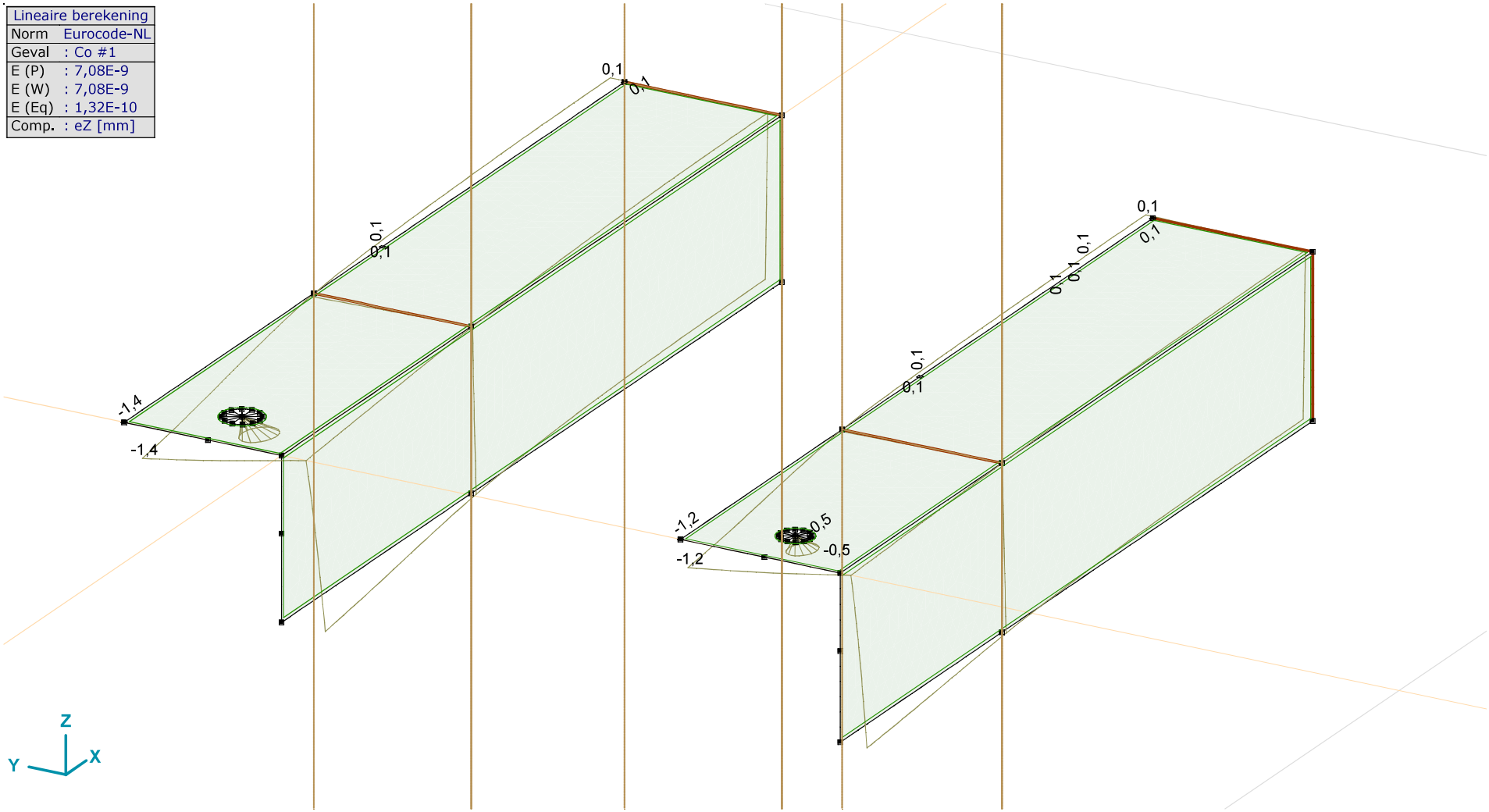
Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**

Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #2
E (P)	: 7,08E-9
E (W)	: 7,08E-9
E (Eq)	: 1,32E-10
Comp.	: eY [mm]



[I], Lineair, Co #2 (UGT), eY, Lijnen

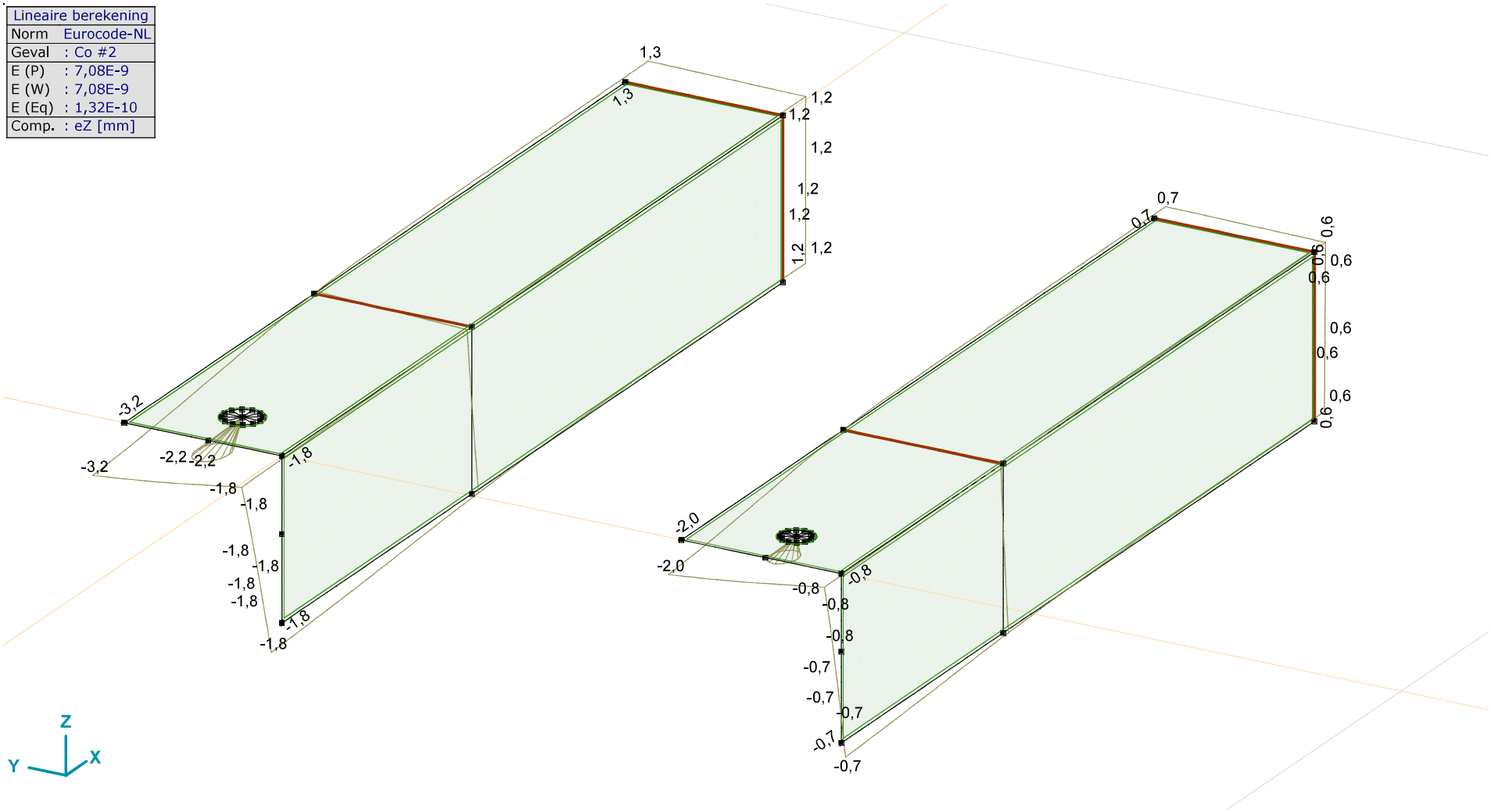
Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



[I], Lineair, Co #1 (UGT), eZ, Lijnen

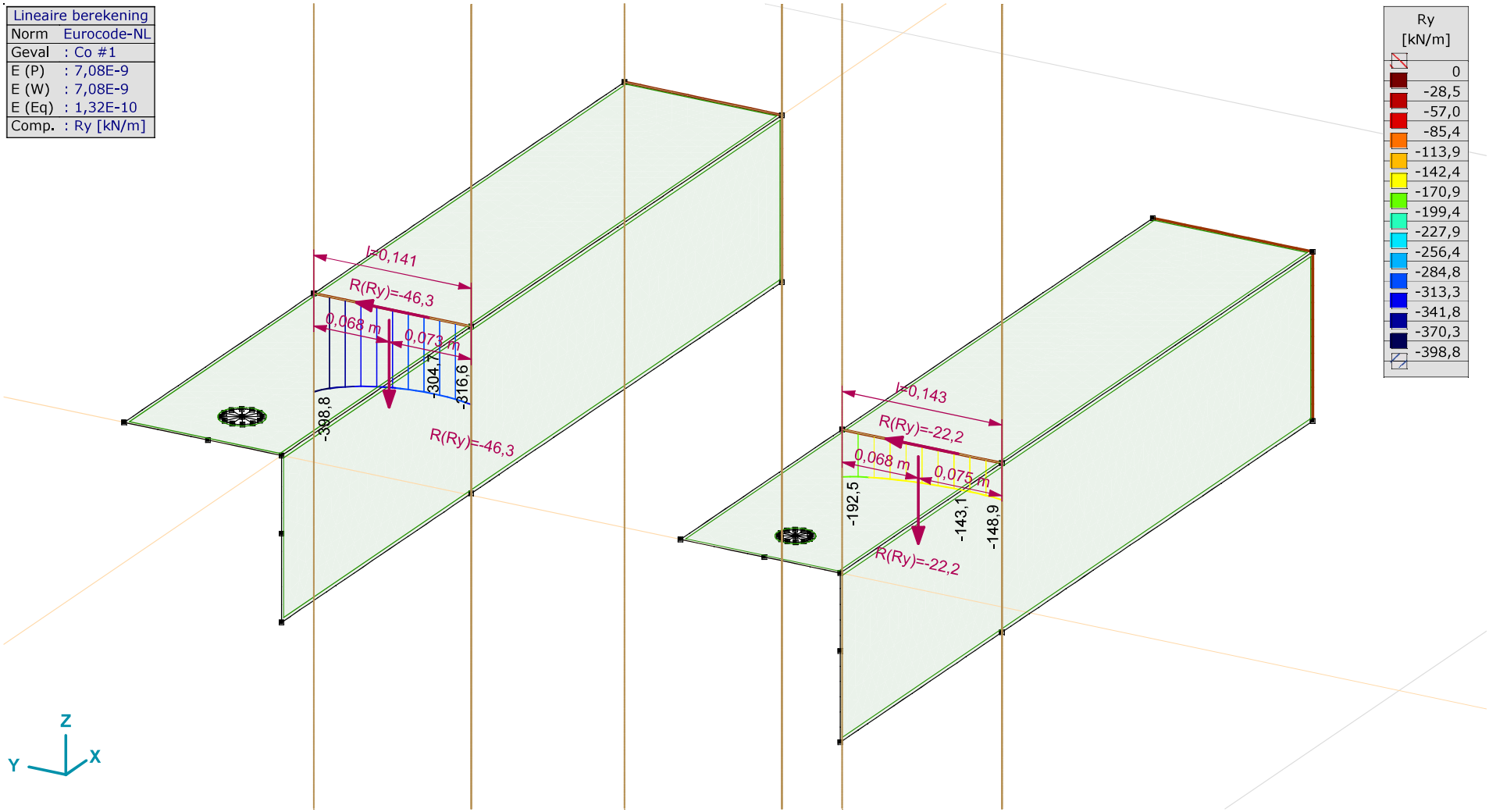
Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**

Lineaire berekening	
Norm	Eurocode-NL
Geval	: Co #2
E (P)	: 7,08E-9
E (W)	: 7,08E-9
E (Eq)	: 1,32E-10
Comp.	: eZ [mm]



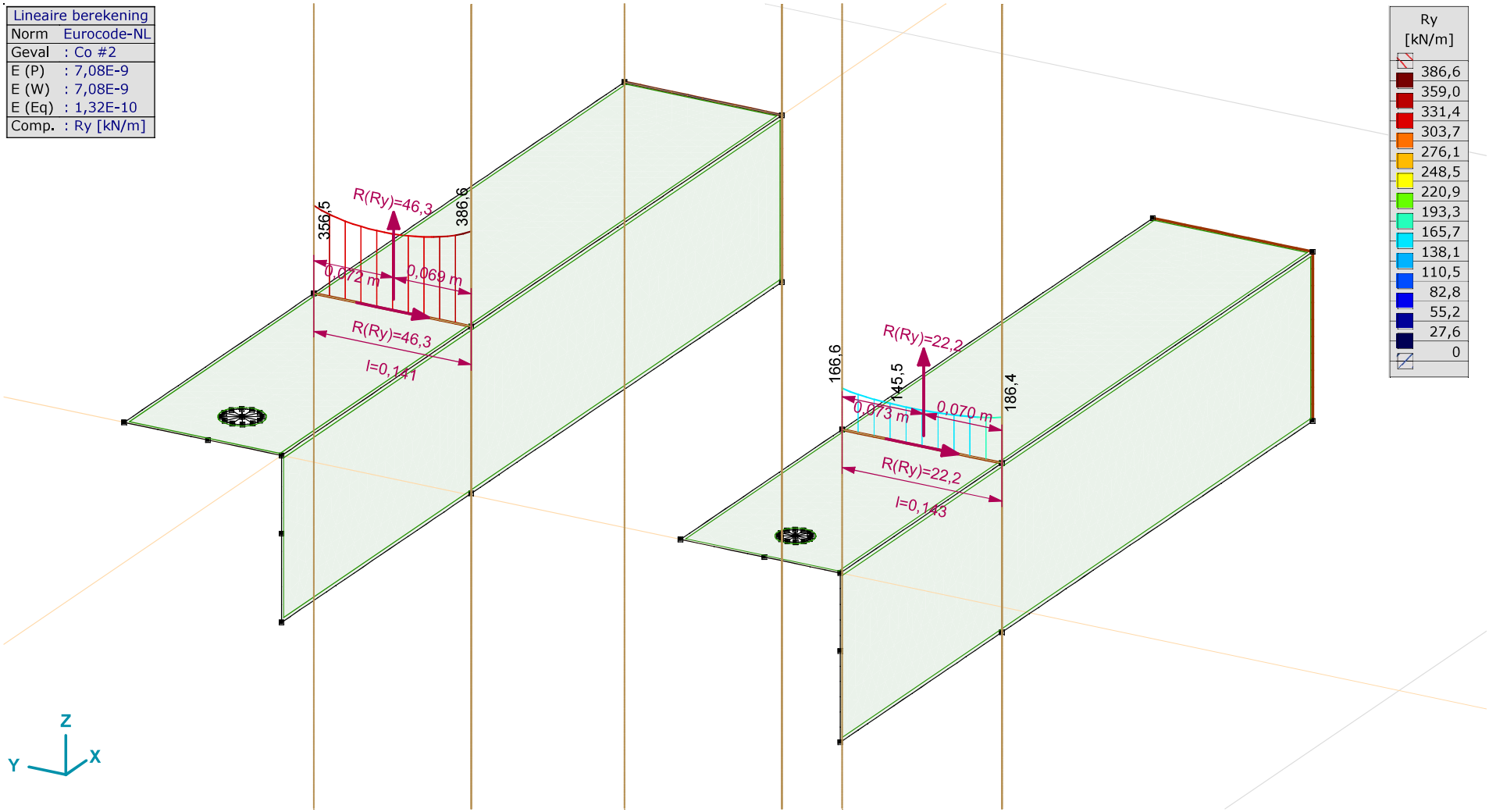
[I], Lineair, Co #2 (UGT), eZ, Lijnen

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



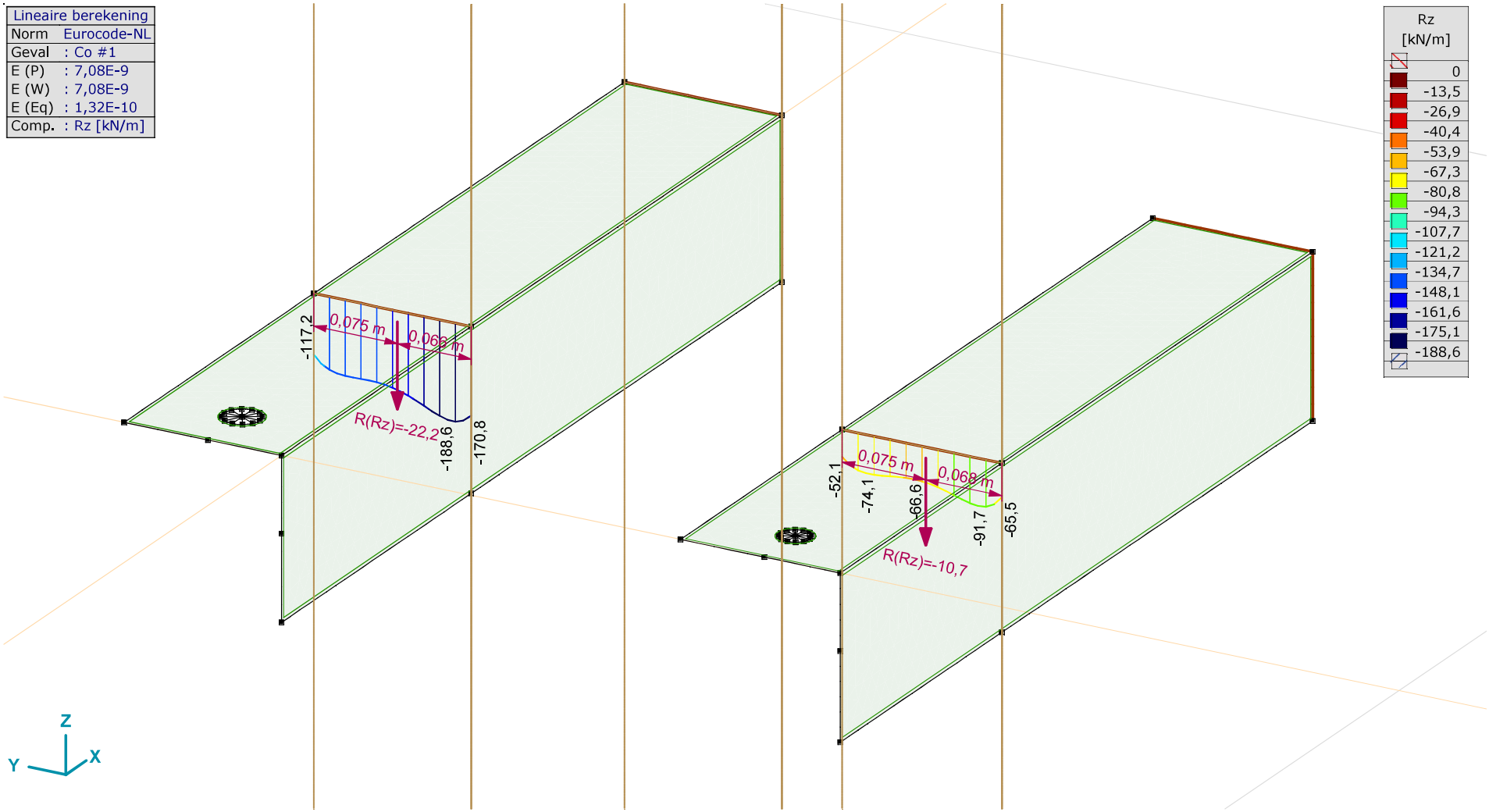
[l], Lineair, Co #1 (UGT), Ry (lijnopp.), Doorsnedelijn

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



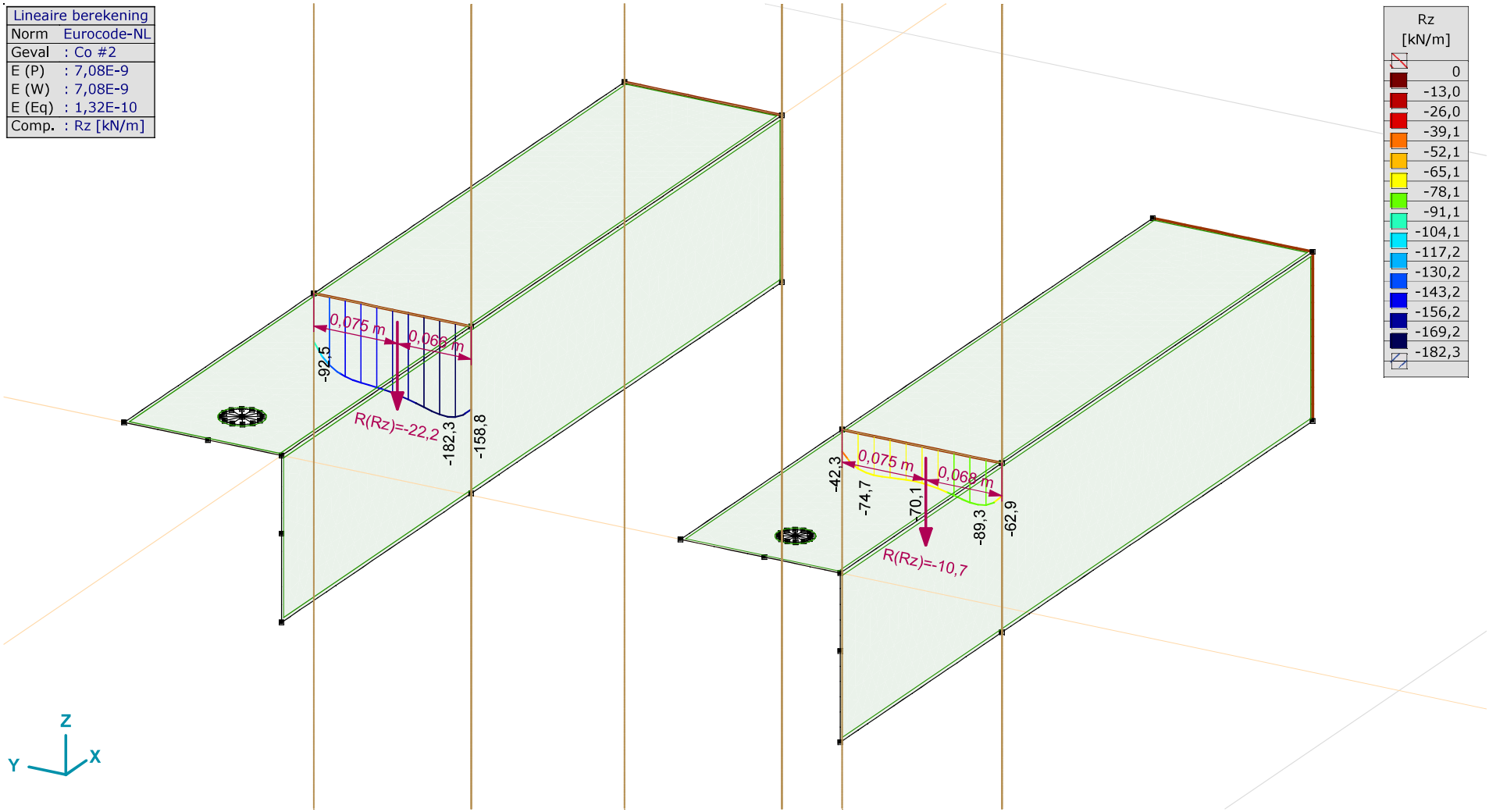
[l], Lineair, Co #2 (UGT), Ry (lijnopp.), Doorsnedelijn

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



[I], Lineair, Co #1 (UGT), Rz (lijnopp.), Doorsnedelijn

Project:
Constructeur: DNV GL - Energy
Model: **Model 1.axs**



[I], Lineair, Co #2 (UGT), Rz (lijnopp.), Doorsnedelijn

Project: RLL-TBG
Mast: HA+0_c

Steel beams in torsion

Calculation of unrestrained beams with eccentric load

Datum: 2021-02-22
Auteur: MRE
Versie: 1.1

Load		***Beam 1***	***Beam 2***	***Beam 3***	***Beam 4***		
Force on insulator		6.88					*kN*
Angle of insulator (to vertical)		54					*°*
Horizontal force in direction of		z-as					
Horizontal force	F_h	5.6					*kN*
Vertical force	F_v	4.0					*kN*
Eccentricity of force (below beam)	e	3375					*mm*
Torsional moment	T	19.4					*kNm*
Beams							
Beam length	L	1820					*mm*
Yield stress	f_y	355					*Mpa*
Elastic modulus	E	210000					*Mpa*
Shear modulus	G	81000					*Mpa*
Profile		HEB 220					
		HEB220					
Height	h	220					*mm*
Width	b	220					*mm*
Web thickness	t_w	9.5					*mm*
Flange thickness	t_f	16.0					*mm*
Torsional constant	I_t	77				$\cdot 10^4$	mm^4
Warping constant	I_{wa}	295418				$\cdot 10^6$	mm^6
Moment of inertia	I_y	8091				$\cdot 10^4$	mm^4
	I_z	2843				$\cdot 10^4$	mm^4
Flange stiffness	$I_f = I_z / 2 =$	1422					mm^3
Moment of resistance	$W_{y,el}$	736				$\cdot 10^3$	mm^3
	$W_{z,el}$	258				$\cdot 10^3$	mm^3
Torsional bending constant	d	997					*mm*
	L/d	1.8					
	α	0.5					

Calculation of second derivative of angular deflection ϕ'':

$A = T / (G \cdot I_t \cdot d) =$	3.12E-07	
$B = \sinh(\alpha \cdot L / d) =$	1.04E+00	
$C = \tanh(L/d) =$	9.49E-01	
$D = \cosh(\alpha \cdot L / d) =$	1.45E+00	
$F = \sinh(0.5 \cdot L / d) =$	1.04E+00	
$H = (B / C - D) \cdot F =$	-3.61E-01	
$X = A \cdot H =$	-1.13E-07	
$Y = X \cdot G \cdot I_t \cdot d / T =$	-3.61E-01	
$\phi'' = Y \cdot T / (G \cdot I_t \cdot d) =$	-1.13E-07	rad/mm^2

Project: RLL-TBG
Mast: HA+0_c

Steel beams in torsion
Calculation of unrestrained beams with eccentric load

Datum: 2021-02-22
Auteur: MRE
Versie: 1.1

Acting moments:

$M_{w,Ed} = E \cdot I_f \cdot (h - t_f) \cdot \phi'' / 2 =$	34.3	*kNm*
$M_{y,Ed} = 1/4 \cdot F \cdot L =$	1.8	*kNm*
$M_{z,Ed} = 1/4 \cdot F \cdot L =$	2.5	*kNm*

Capacities of beams:

$M_{w,Rd} = W_{z,el} \cdot f_y / 2 =$	45.9	*kNm*
$M_{y,Rd} = W_{y,el} \cdot f_y =$	261.1	*kNm*
$M_{z,Rd} = W_{z,el} \cdot f_y =$	91.8	*kNm*

Combined check of beam:

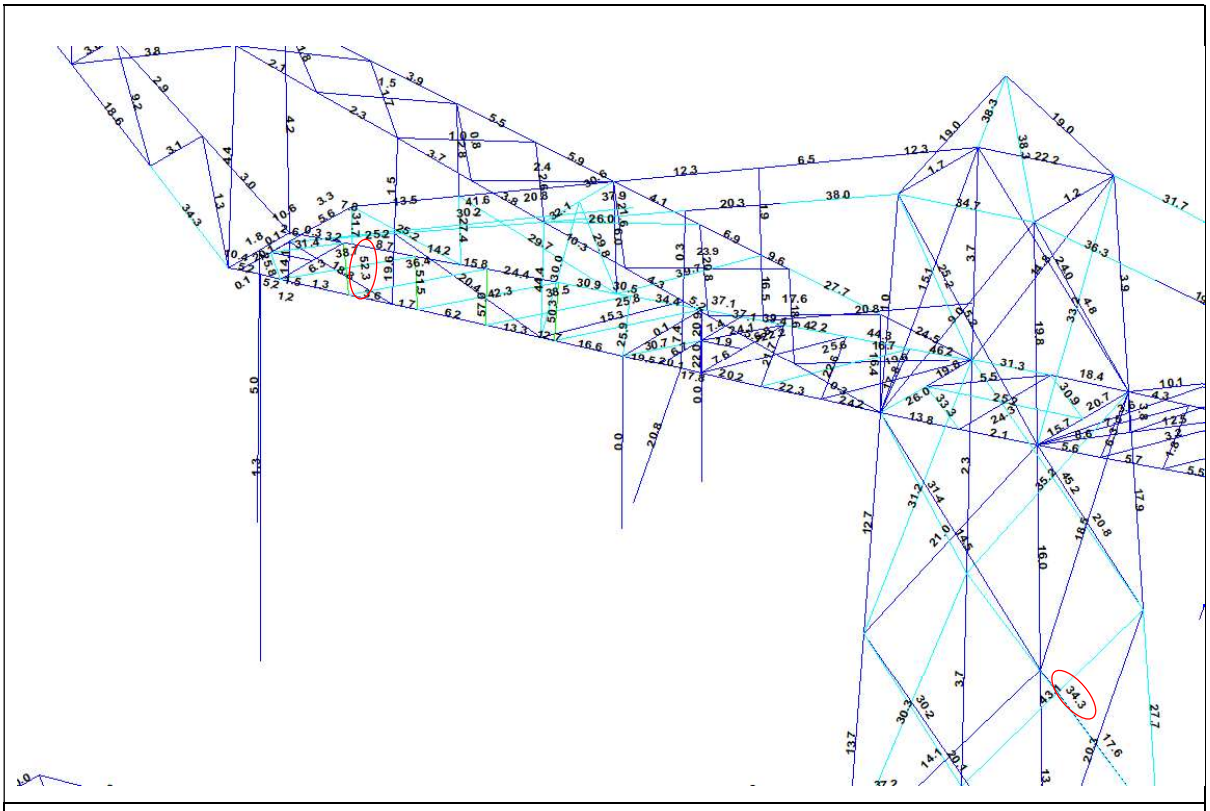
UC	0.78	

Displacements:

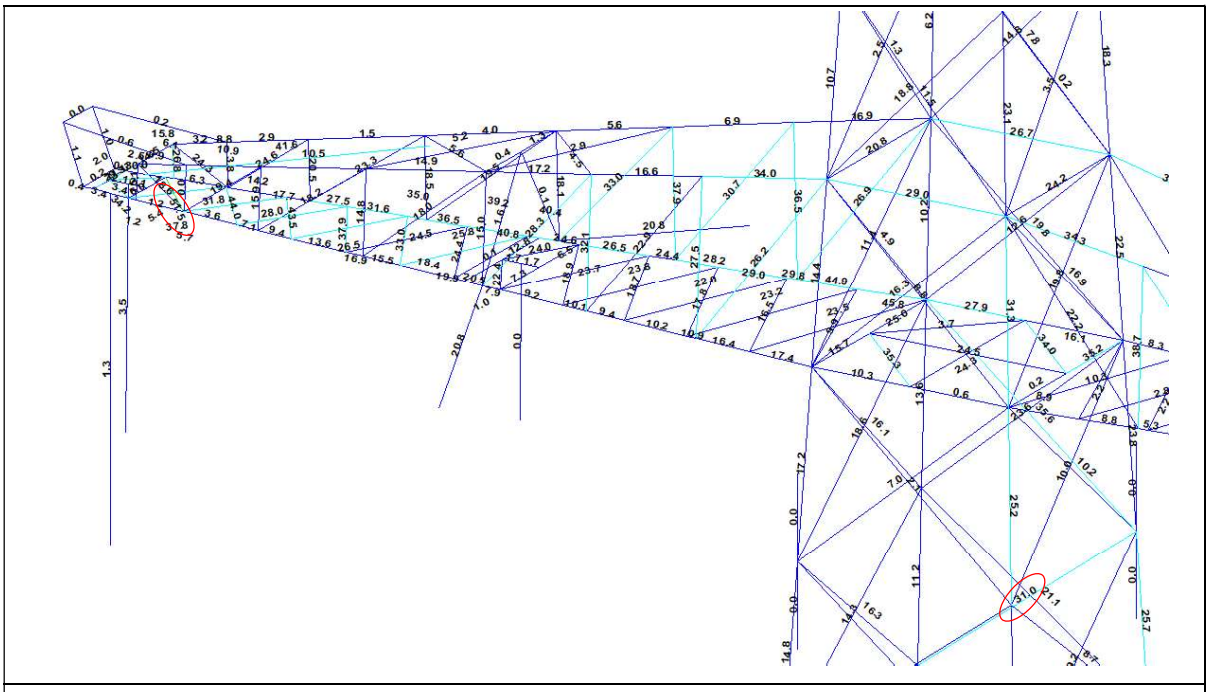
Factor F_{ed} / F_k		1.2	
Displacement y-direction	u_y	0.02	*mm*
Relative displacement	rel.	73062	-
Displacement z-direction	u_z	0.10	*mm*
Relative displacement	rel.	18654	-

APPENDIX F
Sterkte-coördinatie

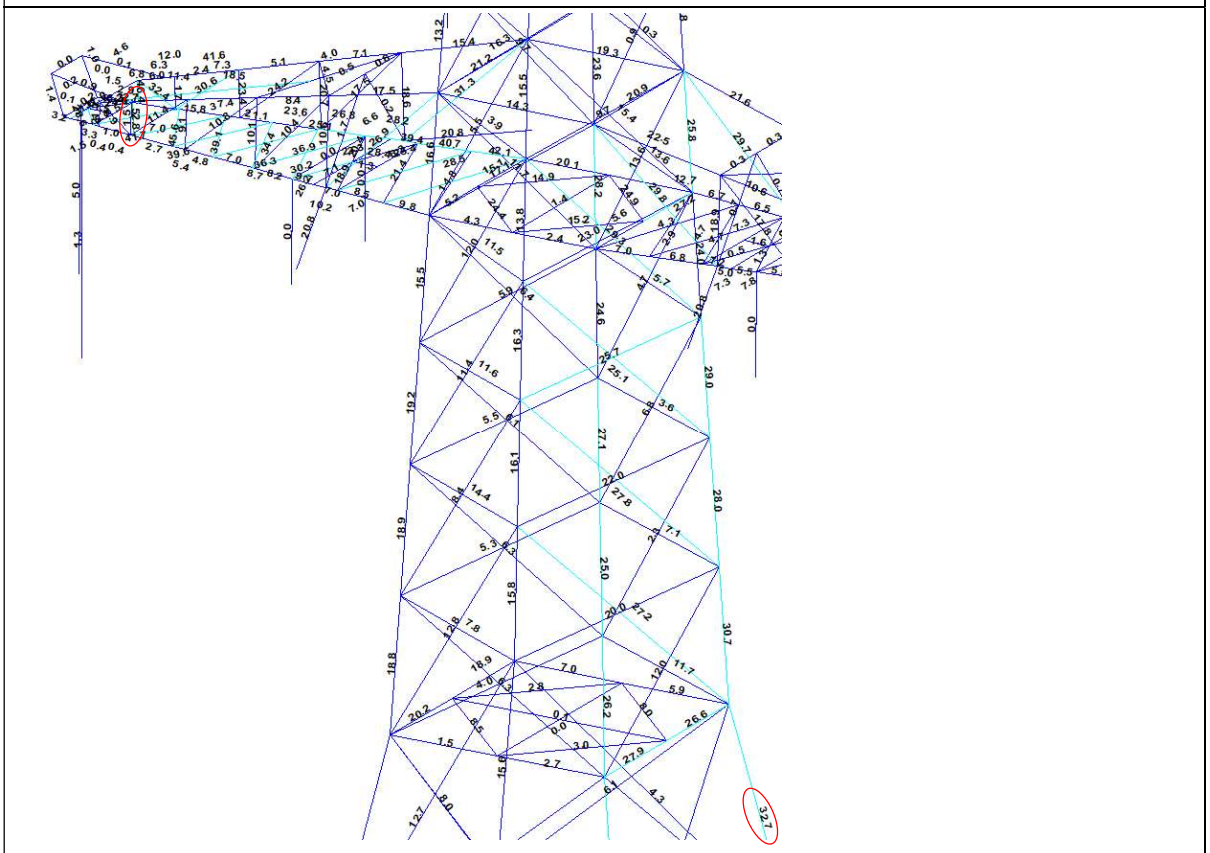
In 5.5.1 van het uitgangspuntenrapport is beschreven dat aan sterkte-coördinatie wordt voldaan als de U.C. van de staven in de traverse 10 procentpunt groter is dan de U.C. van de staven in het mastlichaam. Uitgangspunt is belastingcombinatie 5a, geleiderbreuk. In deze Appendix wordt getoetst of de U.C. van de staven in het mastlichaam voldoende laag is ten opzichte van de U.C. van de staven in de traverse.



Boventraverse – diagonalen bovenstuk 2: 52,3 / 34,3 = 1,52 ≥ 1,10 OK.



Middentraverse – tussenschot: 51,5 / 31,0 = 1,66 ≥ 1,10 OK.



Ondertraverse: 52,8 / 32,7 = 1,61 ≥ 1,10 OK

APPENDIX G
Galloping

Uitgangspunten

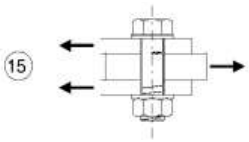
In het uitgangspuntendocument is beschreven dat wordt uitgegaan van een materiaalfactor voor vermoeiing γ_{mf} = 1,15. Dit komt overeen met de “Safe-life methode” met “Low consequence” van tabel 3.1 van NEN-EN 1993-1-9 of met “Damage tolerant” en “High consequence”.

Assessment method	Consequence of failure	
	Low consequence	High consequence
Damage tolerant	1,00	1,15
Safe life	1,15	1,35

Voor staven met gatverzwakking met bouten in ruime gaten geldt volgens fig. 8.1 van NEN-EN 1993-1-9 categorie 50, met m=3

50		13) One sided or double covered symmetrical connection with non-preloaded bolts in normal clearance holes. No load reversals.	13) ... net cross-section.

Voor niet voorgespannen bouten belast op afschuiving geldt volgens fig. 8.1 van NEN-EN 1993-1-9 categorie 100, met m=5.

100 m=5		Bolts in single or double shear Thread not in the shear plane 15) - Fitted bolts - normal bolts without load reversal (bolts of grade 5.6, 8.8 or 10.9)	15) $\Delta\tau$ calculated on the shank area of the bolt.

Het belastingsspectrum is in de NNA (NEN-EN 50341-2-15) als volgt gedefinieerd.

Table 4.11/NL.1 Load spectra line galloping for tension supports

Load spectra line galloping for tension supports		Number of load cycles in 50 years	
Number	Peak-to-peak load	Ice region A	Ice region B
1	2·EDS	7.000	3.000
2	1,5·EDS	36.000	17.000
3	1,0·EDS	125.000	65.000
4	0,5·EDS	482.000	265.000

Aanpak

De vier belastingen van 0,5 tot 2,0EDS hebben een vaste onderlinge verhouding. Aangezien het aantal wisselingen zich in het m=3 gebied van de vermoeiingskromme bevindt vanwege n < 2 x 10^6, kan een relatie worden afgeleid tussen de grootte van de spanningswissel met bijvoorbeeld 1,0EDS en de spanningswisseling die bij 2 x 10^6 wisselingen op basis van het spectrum nog net toelaatbaar is. Dit staat bekend als de equivalente spanningen methode. Via de factor lambda kan de spanningswisseling worden berekend.

$$\lambda = \left[\frac{\sum \Delta\sigma_i^m \cdot n_i}{2 \cdot 10^6}\right]^{\frac{1}{m}}$$

Toepassen van de formule voor een spanning van 1 N/mm^2 bij 1,0EDS levert:

Helling	m=3		m=5	
IJsgebied	A	B	A	B
Wisseling	σ_i^m x n_i	σ_i^m x n_i	σ_i^m x n_i	σ_i^m x n_i
2,0EDS	5,60E+04	2,40E+04	2,24E+05	9,60E+04
1,5EDS	1,22E+05	5,74E+04	2,73E+05	1,29E+05
1,0EDS	1,25E+05	6,50E+04	1,25E+05	6,50E+04
0,5EDS	6,03E+04	3,31E+04	1,51E+04	8,28E+03
$\Sigma\sigma_i^m$ x n_i	3,63E+05	1,80E+05	6,37E+05	2,98E+05
$\lambda = (\Sigma\sigma x n_i/2x10^6)^{1/m}$	0,57	0,45	0,80	0,68

Voor ijsgebied A is de toelaatbare spanningswisseling bij 1,0 EDS en 125.000 wisselingen dus 1/0,57 (175%) van de toelaatbare spanningswisseling bij een aantal wisselingen van 2,0 x 10^6. Er kan ook worden gesteld dat als de spanningswisselingen van 1,0 EDS 363.000 maal voorkomen, dezelfde schade wordt behaald als de vier niveaus afzonderlijk. Deze aanpak is gehanteerd.

- In de berekening van de mast wordt telkens één afspanpunt van de geleiders belast met een trekkracht in lijnrichting van 1,0 EDS.
- Het aantal wisselingen dat deze trekkracht voorkomt wordt vergroot om het hele spectrum te vervangen, dit is afhankelijk van ijsgebied en m-factor.
- Voor iedere staaf in de constructie wordt de schade berekend als gevolg van de trekkracht voor elke geleider.
- De schade wordt gesommeerd over alle geleiders.
- De toetsing is uitgedrukt als de verhouding tussen de optredende spanningswisseling bij n = 2 x 10^6 wisselingen en de toelaatbare spanningswisseling (43 MPa voor het staalprofiel en 87 MPa voor de bout).

Resultaten

In de tabellen zijn de resultaten van mast HC+0/c gegeven. Vanwege de exponentiële invloed van het spanningsniveau heeft de verdeling van de U.C.'s een grote variatie. Het meest zwaar belast zijn de diagonalen in het ondervlak van de traverse in de nabijheid van de afspanpunten en de randen van de traverse. De conclusie is dat de staven en bouten voldoen.

Check galloping- 120gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
100	**Main leg**	80x80x8	**2**	M20	15.2	1230	1054	14.4	50	43	0.33	23.1	314	36.8	100	87	0.42
101	**Main leg**	130x130x12	**4**	M24	25.2	3000	2688	9.4	50	43	0.22	38.0	452	21.0	100	87	0.24
102	**Main leg**	180x180x16	**8**	M24	33.1	5540	5124	6.5	50	43	0.15	48.4	452	13.4	100	87	0.15
103	**Main leg**	180x180x16	**8**	M24	63.3	5540	5124	12.4	50	43	0.28	89.5	452	24.8	100	87	0.28
104	**Main leg**	180x180x16	**10**	M24	87.8	5540	5124	17.1	50	43	0.39	125.1	452	27.7	100	87	0.32
105	**Main leg**	250x250x24	**10**	M24	123.2	11492	10868	11.3	50	43	0.26	179.9	452	39.8	100	87	0.46
106	**Main leg**	250x250x24	**0**		149.9	11492	11492	13.0	50	43	0.30	217.7	0	0.0	100	87	0.00
107	**Main leg**	250x250x24	**16**	M24	162.5	11492	10868	15.0	50	43	0.34	231.0	452	31.9	100	87	0.37
108	**Main leg**	200x200x24	**32**	M24	191.3	9060	8436	22.7	50	43	0.52	267.6	452	18.5	100	87	0.21
109	**Main leg**	200x200x24	**20**	M24	209.4	9060	8436	24.8	50	43	0.57	290.8	452	32.2	100	87	0.37
110	**Main leg**	250x250x24	**24**	M24	229.1	11492	10868	21.1	50	43	0.48	315.4	452	29.1	100	87	0.33
111	**Main leg**	250x250x24	**32**	M24	241.4	11492	10868	22.2	50	43	0.51	328.5	452	22.7	100	87	0.26
112	**Main leg**	250x250x24	**32**	M24	244.0	11492	10868	22.5	50	43	0.52	327.6	452	22.6	100	87	0.26
113	**Main leg**	250x250x24	**0**		220.2	11492	11492	19.2	50	43	0.44	291.5	0	0.0	100	87	0.00
114	**Main leg**	250x250x24	**24**	M24	219.6	11492	10868	20.2	50	43	0.46	290.6	452	26.8	100	87	0.31
200	**Diag front face**	100x100x10	**2**	M24	19.6	1920	1660	11.8	50	43	0.27	29.8	452	33.0	100	87	0.38
201	**Diag front face**	150x150x14	**6**	M24	111.6	4014	3650	30.6	50	43	0.70	168.5	452	62.1	100	87	0.71
202	**Diag front face**	150x150x14	**5**	M24	93.5	4014	3650	25.6	50	43	0.59	141.1	452	62.4	100	87	0.72
203	**Diag front face**	150x150x14	**5**	M24	76.8	4014	3650	21.0	50	43	0.48	115.7	452	51.2	100	87	0.59
204	**Diag front face**	120x120x12(12,0.33)	**4**	M24	107.1	5500	5188	20.7	50	43	0.47	152.4	452	84.3	100	87	0.97
205	**Diag front face**	120x120x12(12,0.33)	**4**	M24	93.1	5500	5188	17.9	50	43	0.41	132.5	452	73.3	100	87	0.84
206	**Diag front face**	120x120x12(12,0.33)	**4**	M24	81.6	5500	5188	15.7	50	43	0.36	113.8	452	62.9	100	87	0.72
207	**Diag front face**	130x130x12#(15,0.33	**4**	M24	82.0	6040	5728	14.3	50	43	0.33	108.6	452	60.1	100	87	0.69
208	**Diag front face**	120x120x12(12,0.33)	**4**	M24	72.9	5500	5188	14.0	50	43	0.32	96.4	452	53.3	100	87	0.61
209	**Diag front face**	120x120x12(12,0.33)	**4**	M24	67.0	5500	5188	12.9	50	43	0.30	88.1	452	48.7	100	87	0.56
210	**Diag front face**	120x120x12(12,0.33)	**4**	M24	65.3	5500	5188	12.6	50	43	0.29	85.7	452	47.4	100	87	0.54
211	**Diag front face**	150x150x12(12,0.33)	**3**	M24	54.4	6970	6658	8.2	50	43	0.19	72.3	452	53.3	100	87	0.61
212	**Diag front face**	130x130x12#(15,0.33	**3**	M24	39.7	6040	5728	6.9	50	43	0.16	52.6	452	38.8	100	87	0.45
213	**Diag front face**	150x150x12(12,0.33)	**5**	M24	38.7	6970	6658	5.8	50	43	0.13	51.2	452	22.7	100	87	0.26
300	**Diag side face**	80x80x8	**2**	M24	14.8	1230	1022	14.5	50	43	0.33	22.6	452	25.0	100	87	0.29
301	**Diag side face**	150x150x14	**6**	M24	105.7	4014	3650	29.0	50	43	0.67	159.7	452	58.9	100	87	0.68
302	**Diag side face**	150x150x14	**5**	M24	88.9	4014	3650	24.4	50	43	0.56	134.3	452	59.4	100	87	0.68
303	**Diag side face**	150x150x14	**4**	M24	74.5	4014	3650	20.4	50	43	0.47	112.5	452	62.2	100	87	0.72
304	**Diag side face**	120x120x12(12,0.33)	**4**	M24	93.5	5500	5188	18.0	50	43	0.41	129.5	452	71.6	100	87	0.82
305	**Diag side face**	120x120x12(12,0.33)	**4**	M24	82.0	5500	5188	15.8	50	43	0.36	113.5	452	62.8	100	87	0.72

Check galloping- 120qr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
306	**Diag side face**	120x120x12(12,0.33)	**4**	M24	75.7	5500	5188	14.6	50	43	0.34	104.3	452	57.7	100	87	0.66
307	**Diag side face**	130x130x12#(15,0.33	**4**	M24	82.8	6040	5728	14.5	50	43	0.33	109.5	452	60.6	100	87	0.70
308	**Diag side face**	120x120x12(12,0.33)	**4**	M24	75.7	5500	5188	14.6	50	43	0.34	100.2	452	55.4	100	87	0.64
309	**Diag side face**	120x120x12(12,0.33)	**4**	M24	72.1	5500	5188	13.9	50	43	0.32	95.4	452	52.8	100	87	0.61
310	**Diag side face**	120x120x12(12,0.33)	**4**	M24	68.1	5500	5188	13.1	50	43	0.30	90.1	452	49.8	100	87	0.57
311	**Diag side face**	150x150x12(12,0.33)	**3**	M24	63.3	6970	6658	9.5	50	43	0.22	84.4	452	62.3	100	87	0.72
312	**Diag side face**	130x130x12#(15,0.33	**3**	M24	47.8	6040	5728	8.3	50	43	0.19	63.6	452	46.9	100	87	0.54
313	**Diag side face**	150x150x12(12,0.33)	**5**	M24	45.6	6970	6658	6.8	50	43	0.16	60.7	452	26.9	100	87	0.31
400	**Horizontal lower ca.**	180x180x16	**10**	M24	74.6	5540	5124	14.6	50	43	0.33	113.6	452	25.1	100	87	0.29
401	**Lower chord lower ca.**	150x150x14	**10**	M24	147.2	4014	3650	40.3	50	43	0.93	224.0	452	49.6	100	87	0.57
402	**Lower chord lower ca.**	150x150x14	**0**		131.4	4014	4014	32.7	50	43	0.75	200.6	0	0.0	100	87	0.00
403	**Lower chord lower ca.**	150x150x14	**0**		120.4	4014	4014	30.0	50	43	0.69	183.8	0	0.0	100	87	0.00
404	**Lower chord lower ca.**	150x150x14	**0**		93.9	4014	4014	23.4	50	43	0.54	143.4	0	0.0	100	87	0.00
405	**Lower chord lower ca.**	150x150x14	**0**		57.3	4014	4014	14.3	50	43	0.33	87.5	0	0.0	100	87	0.00
406	**Lower chord lower ca.**	150x150x14	**0**		41.9	4014	4014	10.4	50	43	0.24	63.9	0	0.0	100	87	0.00
407	**Lower chord lower ca.**	150x150x14	**0**		0.3	4014	4014	0.1	50	43	0.00	0.5	0	0.0	100	87	0.00
410	**Horizontal lower ca.**	130x130x12	**3**	M24	21.5	3000	2688	8.0	50	43	0.18	32.5	452	24.0	100	87	0.28
411	**Horizontal lower ca.**	150x150x14 (not coup	**2**	M24	11.6	8028	7664	1.5	50	43	0.03	17.7	452	19.6	100	87	0.23
412	**Horizontal lower ca.**	HEA140	**0**		0.9	3140	3140	0.3	50	43	0.01	1.3	0	0.0	100	87	0.00
413	**Horizontal lower ca.**	150x150x18 (not coup	**2**	M24	23.4	10200	9732	2.4	50	43	0.06	35.8	452	39.6	100	87	0.46
414	**Beam lower ca.**	HEB220	**0**		1.8	9104	9104	0.2	50	43	0.00	2.8	0	0.0	100	87	0.00
415	**Horizontal lower ca.**	UNP220	**0**		4.6	3740	3740	1.2	50	43	0.03	7.1	0	0.0	100	87	0.00
426	**Upper chord lower ca.**	120x120x12	**4**	M24	14.7	2750	2438	6.0	50	43	0.14	22.2	452	12.3	100	87	0.14
427	**Upper chord lower ca.**	120x120x12	**0**		14.1	2750	2750	5.1	50	43	0.12	21.3	0	0.0	100	87	0.00
428	**Upper chord lower ca.**	120x120x12	**0**		14.2	2750	2750	5.2	50	43	0.12	21.6	0	0.0	100	87	0.00
429	**Upper chord lower ca.**	120x120x12	**0**		15.1	2750	2750	5.5	50	43	0.13	22.9	0	0.0	100	87	0.00
430	**Upper chord lower ca.**	120x120x12	**2**	M20	15.2	2750	2486	6.1	50	43	0.14	23.0	314	36.6	100	87	0.42
431	**Upper chord lower ca.**	120x120x12	**2**	M20	18.7	2750	2486	7.5	50	43	0.17	28.3	314	45.1	100	87	0.52
433	**Stabiltity bracing lower ca.**	70x70x6	**1**	M16	0.3	810	702	0.4	50	43	0.01	0.4	201	1.9	100	87	0.02
434	**Hand rail**	60x60x6	**1**	M16	0.1	690	582	0.2	50	43	0.00	0.2	201	0.8	100	87	0.01
435	**Hand rail**	100x50x6	**2**	M16	0.0	870	762	0.0	50	43	0.00	0.0	201	0.0	100	87	0.00
436	**Hand rail**	60x60x6	**1**	M16	0.0	690	582	0.1	50	43	0.00	0.1	201	0.4	100	87	0.00
437	**Stabiltity bracing lower ca.**	70x70x6	**1**	M16	1.0	810	702	1.4	50	43	0.03	1.5	201	7.5	100	87	0.09
440	**Vertical side face lower ca.**	70x70x6	**1**	M16	2.0	810	702	2.9	50	43	0.07	3.1	201	15.2	100	87	0.17
441	**Vertical side face lower ca.**	70x70x6	**1**	M16	2.6	810	702	3.7	50	43	0.09	4.0	201	19.8	100	87	0.23

Check galloping- 120gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
442	**Vertical side face lower ca.**	60x60x6	**1**	M16	3.5	690	582	5.9	50	43	0.14	5.3	201	26.2	100	87	0.30
443	**Vertical side face lower ca.**	60x60x6	**1**	M16	0.5	690	582	0.9	50	43	0.02	0.8	201	3.9	100	87	0.05
444	**Vertical side face lower ca.**	60x60x6	**1**	M16	10.0	690	582	17.2	50	43	0.40	15.3	201	76.0	100	87	0.87
460	**Diag side face lower ca.**	90x90x8	**2**	M16	5.5	1390	1246	4.4	50	43	0.10	8.1	201	20.2	100	87	0.23
461	**Diag side face lower ca.**	60x60x6	**2**	M16	3.3	690	582	5.7	50	43	0.13	5.1	201	12.7	100	87	0.15
462	**Diag side face lower ca.**	60x60x6	**2**	M16	5.8	690	582	9.9	50	43	0.23	8.8	201	22.0	100	87	0.25
463	**Diag side face lower ca.**	60x60x6	**2**	M16	8.3	690	582	14.2	50	43	0.33	12.6	201	31.4	100	87	0.36
464	**Diag side face lower ca.**	60x60x6	**2**	M16	10.6	690	582	18.1	50	43	0.42	16.1	201	40.1	100	87	0.46
465	**Stabiltity bracing lower ca.**	90x90x9	**1**	M16	0.4	1539	1377	0.3	50	43	0.01	0.6	201	2.8	100	87	0.03
475	**Diag lower plane lower ca.**	80x80x6	**2**	M20	11.7	940	808	14.5	50	43	0.33	16.3	314	26.0	100	87	0.30
476	**Diag lower plane lower ca.**	80x80x6	**2**	M20	13.8	940	808	17.1	50	43	0.39	19.3	314	30.7	100	87	0.35
477	**Diag lower plane lower ca.**	80x80x6	**2**	M20	10.7	940	808	13.3	50	43	0.31	16.0	314	25.5	100	87	0.29
478	**Diag lower plane lower ca.**	80x80x6	**2**	M20	11.7	940	808	14.5	50	43	0.33	17.9	314	28.5	100	87	0.33
479	**Diag lower plane lower ca.**	70x70x6	**2**	M20	13.0	810	678	19.1	50	43	0.44	19.8	314	31.5	100	87	0.36
480	**Diag lower plane lower ca.**	70x70x6	**2**	M20	14.5	810	678	21.4	50	43	0.49	22.2	314	35.3	100	87	0.41
481	**Diag lower plane lower ca.**	70x70x6	**2**	M20	16.6	810	678	24.6	50	43	0.56	25.4	314	40.5	100	87	0.47
482	**Diag lower plane lower ca.**	70x70x6	**2**	M20	19.7	810	678	29.0	50	43	0.67	30.0	314	47.8	100	87	0.55
483	**Diag lower plane lower ca.**	70x70x6	**2**	M20	23.0	810	678	33.9	50	43	0.78	35.1	314	55.9	100	87	0.64
484	**Diag lower plane lower ca.**	70x70x6	**2**	M16	11.2	810	702	16.0	50	43	0.37	17.1	157	54.6	100	87	0.63
485	**Plan bracing lower ca.**	120x120x10	**3**	M24	26.8	2320	2060	13.0	50	43	0.30	40.3	452	29.7	100	87	0.34
486	**Plan bracing lower ca.**	70x70x6	**1**	M16	0.1	810	702	0.1	50	43	0.00	0.1	201	0.4	100	87	0.00
500	**Horizontal mid ca.**	200x200x18	**10**	M24	123.0	6910	6442	19.1	50	43	0.44	186.6	452	41.3	100	87	0.47
501	**Lower chord mid ca.**	180x180x18	**10**	M24	212.8	6190	5722	37.2	50	43	0.86	322.6	452	71.4	100	87	0.82
502	**Lower chord mid ca.**	180x180x18	**0**		206.3	6190	6190	33.3	50	43	0.77	313.4	0	0.0	100	87	0.00
503	**Lower chord mid ca.**	180x180x18	**0**		190.0	6190	6190	30.7	50	43	0.71	289.6	0	0.0	100	87	0.00
504	**Lower chord mid ca.**	180x180x18	**8**	M24	168.4	6190	5722	29.4	50	43	0.68	257.1	452	71.1	100	87	0.82
505	**Lower chord mid ca.**	160x160x15	**8**	M24	146.9	4671	4281	34.3	50	43	0.79	224.2	452	62.0	100	87	0.71
506	**Lower chord mid ca.**	160x160x15	**0**		109.9	4671	4671	23.5	50	43	0.54	167.8	0	0.0	100	87	0.00
507	**Lower chord mid ca.**	160x160x15	**0**		76.2	4671	4671	16.3	50	43	0.38	116.4	0	0.0	100	87	0.00
508	**Lower chord mid ca.**	160x160x15	**0**		46.0	4671	4671	9.9	50	43	0.23	70.3	0	0.0	100	87	0.00
509	**Lower chord mid ca.**	160x160x15	**2**	M20	0.2	4671	4341	0.1	50	43	0.00	0.4	314	0.6	100	87	0.01
511	**Horizontal mid ca.**	150x150x12	**3**	M24	37.3	3480	3168	11.8	50	43	0.27	56.7	452	41.8	100	87	0.48
512	**Beam mid ca.**	150x150x14 (not coup	**2**	M24	13.9	8028	7664	1.8	50	43	0.04	19.4	452	21.5	100	87	0.25
513	**Horizontal mid ca.**	HEA140	**0**		0.5	3140	3140	0.1	50	43	0.00	0.7	0	0.0	100	87	0.00
514	**Beam mid ca.**	150x150x18 (not coup	**2**	M24	22.6	10200	9732	2.3	50	43	0.05	34.5	452	38.2	100	87	0.44

Check galloping- 120gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
515	**Horizontal mid ca.**	HEB220	**0**		2.3	9104	9104	0.2	50	43	0.01	3.5	0	0.0	100	87	0.00
516	**Beam mid ca.**	UNP220	**0**		7.2	3740	3740	1.9	50	43	0.04	11.0	0	0.0	100	87	0.00
526	**Upper chord mid ca.**	120x120x12	**4**	M24	34.7	2750	2438	14.2	50	43	0.33	52.6	452	29.1	100	87	0.33
527	**Upper chord mid ca.**	120x120x12	**0**		35.2	2750	2750	12.8	50	43	0.29	53.3	0	0.0	100	87	0.00
528	**Upper chord mid ca.**	120x120x12	**6**	M24	34.3	2750	2438	14.1	50	43	0.32	52.1	452	19.2	100	87	0.22
529	**Upper chord mid ca.**	120x120x12	**6**	M24	31.5	2750	2438	12.9	50	43	0.30	48.0	452	17.7	100	87	0.20
530	**Upper chord mid ca.**	120x120x12	**0**		29.0	2750	2750	10.5	50	43	0.24	44.1	0	0.0	100	87	0.00
531	**Upper chord mid ca.**	120x120x12	**0**		26.9	2750	2750	9.8	50	43	0.23	40.9	0	0.0	100	87	0.00
532	**Upper chord mid ca.**	120x120x12	**4**	M24	26.9	2750	2438	11.0	50	43	0.25	41.0	452	22.6	100	87	0.26
533	**Upper chord mid ca.**	120x120x12	**2**	M24	28.9	2750	2438	11.9	50	43	0.27	44.0	452	48.7	100	87	0.56
535	**Stabiltity bracing mid ca.**	70x70x6	**1**	M16	0.3	810	702	0.4	50	43	0.01	0.4	201	1.9	100	87	0.02
536	**Hand rail**	60x60x6	**1**	M16	0.1	690	582	0.1	50	43	0.00	0.1	201	0.5	100	87	0.01
537	**Hand rail**	100x50x6	**2**	M16	0.0	870	762	0.0	50	43	0.00	0.0	201	0.0	100	87	0.00
538	**Hand rail**	60x60x6	**1**	M16	0.0	690	582	0.1	50	43	0.00	0.0	201	0.2	100	87	0.00
539	**Stabiltity bracing mid ca.**	70x70x6	**1**	M16	1.3	810	702	1.8	50	43	0.04	1.9	201	9.7	100	87	0.11
540	**Vertical side face mid ca.**	80x80x6	**1**	M16	3.1	940	832	3.7	50	43	0.09	4.3	201	21.6	100	87	0.25
541	**Vertical side face mid ca.**	80x80x6	**1**	M16	3.0	940	832	3.6	50	43	0.08	4.3	201	21.6	100	87	0.25
542	**Vertical side face mid ca.**	60x60x6	**1**	M16	1.6	690	582	2.8	50	43	0.06	2.5	201	12.4	100	87	0.14
543	**Vertical side face mid ca.**	60x60x6	**1**	M16	2.1	690	582	3.5	50	43	0.08	3.2	201	15.7	100	87	0.18
544	**Vertical side face mid ca.**	60x60x6	**1**	M16	2.6	690	582	4.4	50	43	0.10	3.9	201	19.6	100	87	0.23
545	**Vertical side face mid ca.**	60x60x6	**1**	M16	0.7	690	582	1.2	50	43	0.03	1.1	201	5.3	100	87	0.06
546	**Vertical side face mid ca.**	60x60x6	**2**	M16	11.4	690	582	19.6	50	43	0.45	17.4	201	43.2	100	87	0.50
560	**Diag side face mid ca.**	80x80x6	**2**	M16	2.9	940	832	3.5	50	43	0.08	4.4	201	10.9	100	87	0.13
561	**Diag side face mid ca.**	70x70x6	**2**	M16	4.7	810	702	6.7	50	43	0.15	6.6	201	16.4	100	87	0.19
562	**Diag side face mid ca.**	60x60x6	**2**	M16	4.7	690	582	8.1	50	43	0.19	6.8	201	17.0	100	87	0.19
563	**Diag side face mid ca.**	60x60x6	**2**	M16	2.9	690	582	5.0	50	43	0.11	4.4	201	11.0	100	87	0.13
564	**Diag side face mid ca.**	60x60x6	**2**	M16	4.9	690	582	8.5	50	43	0.19	7.5	201	18.7	100	87	0.22
565	**Diag side face mid ca.**	60x60x6	**2**	M16	5.6	690	582	9.7	50	43	0.22	8.6	201	21.4	100	87	0.25
566	**Diag side face mid ca.**	60x60x6	**2**	M16	6.6	690	582	11.4	50	43	0.26	10.1	201	25.1	100	87	0.29
567	**Stabiltity bracing mid ca.**	70x70x6	**1**	M16	0.5	810	702	0.6	50	43	0.01	0.6	201	3.2	100	87	0.04
575	**Diag lower plane mid ca.**	70x70x6	**2**	M20	9.5	810	678	14.0	50	43	0.32	13.2	314	21.0	100	87	0.24
576	**Diag lower plane mid ca.**	70x70x6	**2**	M20	11.5	810	678	17.0	50	43	0.39	16.1	314	25.6	100	87	0.29
577	**Diag lower plane mid ca.**	70x70x6	**2**	M20	12.1	810	678	17.9	50	43	0.41	16.9	314	26.9	100	87	0.31
578	**Diag lower plane mid ca.**	70x70x6	**2**	M20	13.3	810	678	19.7	50	43	0.45	18.6	314	29.7	100	87	0.34
579	**Diag lower plane mid ca.**	70x70x6	**2**	M20	14.0	810	678	20.7	50	43	0.48	19.6	314	31.2	100	87	0.36

Check galloping- 120gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
580	**Diag lower plane mid ca.**	70x70x6	**2**	M20	12.0	810	678	17.6	50	43	0.41	17.9	314	28.5	100	87	0.33
581	**Diag lower plane mid ca.**	70x70x6	**2**	M20	13.4	810	678	19.8	50	43	0.46	20.5	314	32.6	100	87	0.38
582	**Diag lower plane mid ca.**	70x70x6	**2**	M20	14.3	810	678	21.1	50	43	0.49	21.8	314	34.8	100	87	0.40
583	**Diag lower plane mid ca.**	70x70x6	**2**	M20	16.4	810	678	24.2	50	43	0.56	25.0	314	39.9	100	87	0.46
584	**Diag lower plane mid ca.**	70x70x6	**2**	M20	18.7	810	678	27.5	50	43	0.63	28.5	314	45.4	100	87	0.52
585	**Diag lower plane mid ca.**	80x80x6	**2**	M20	22.7	940	808	28.0	50	43	0.64	34.6	314	55.1	100	87	0.63
586	**Diag lower plane mid ca.**	80x80x6	**2**	M20	26.3	940	808	32.6	50	43	0.75	40.2	314	64.0	100	87	0.74
587	**Diag lower plane mid ca.**	60x60x6	**2**	M16	11.1	690	582	19.1	50	43	0.44	17.0	201	42.2	100	87	0.49
588	**Plan bracing mid ca.**	140x140x13	**5**	M24	87.8	3521	3183	27.6	50	43	0.63	133.6	452	59.1	100	87	0.68
589	**Plan bracing mid ca.**	150x150x12	**4**	M24	56.3	3480	3168	17.8	50	43	0.41	85.5	452	47.3	100	87	0.54
600	**Horizontal top ca.**	200x200x18	**10**	M24	141.7	6910	6442	22.0	50	43	0.51	214.3	452	47.4	100	87	0.55
601	**Lower chord top ca.**	180x180x18	**8**	M24	186.7	6190	5722	32.6	50	43	0.75	284.7	452	78.7	100	87	0.91
602	**Lower chord top ca.**	180x180x18	**8**	M24	157.0	6190	5722	27.4	50	43	0.63	239.6	452	66.3	100	87	0.76
603	**Lower chord top ca.**	150x150x14	**8**	M24	125.7	4014	3650	34.5	50	43	0.79	192.0	452	53.1	100	87	0.61
604	**Lower chord top ca.**	150x150x14	**0**		69.0	4014	4014	17.2	50	43	0.40	105.3	0	0.0	100	87	0.00
605	**Lower chord top ca.**	150x150x14	**0**		40.6	4014	4014	10.1	50	43	0.23	61.9	0	0.0	100	87	0.00
606	**Lower chord top ca.**	150x150x14	**2**	M20	5.9	4014	3706	1.6	50	43	0.04	8.2	314	13.1	100	87	0.15
608	**Earth peak lower chord**	80x80x8	**2**	M20	7.8	1230	1054	7.4	50	43	0.17	10.9	314	17.4	100	87	0.20
609	**Earth peak lower chord**	80x80x8	**2**	M20	7.3	1230	1054	7.0	50	43	0.16	10.3	314	16.4	100	87	0.19
610	**Horizontal top ca.**	130x130x12	**3**	M24	40.8	3000	2688	15.2	50	43	0.35	61.4	452	45.3	100	87	0.52
611	**Horizontal top ca.**	150x150x14 (not coup	**2**	M24	12.0	8028	7664	1.6	50	43	0.04	18.3	452	20.3	100	87	0.23
612	**Horizontal top ca.**	HEA140	**0**		1.0	3140	3140	0.3	50	43	0.01	1.5	0	0.0	100	87	0.00
613	**Horizontal top ca.**	150x150x18 (not coup	**2**	M24	23.9	10200	9732	2.5	50	43	0.06	36.6	452	40.4	100	87	0.46
614	**Beam top ca.**	HEB220	**0**		2.1	9104	9104	0.2	50	43	0.01	3.2	0	0.0	100	87	0.00
615	**Earth peak horizontal**	60x60x6	**1**	M16	0.8	690	582	1.4	50	43	0.03	1.2	201	6.1	100	87	0.07
616	**Earth peak horizontal**	60x60x6	**1**	M16	0.8	690	582	1.5	50	43	0.03	1.3	201	6.3	100	87	0.07
617	**Earth peak horizontal**	60x60x6	**1**	M16	0.0	690	582	0.0	50	43	0.00	0.0	201	0.1	100	87	0.00
618	**Beam top ca.**	UNP220	**0**		4.6	3740	3740	1.2	50	43	0.03	7.1	0	0.0	100	87	0.00
626	**Upper chord top ca.**	120x120x12	**0**		40.7	2750	2750	14.8	50	43	0.34	62.1	0	0.0	100	87	0.00
627	**Upper chord top ca.**	100x100x10	**3**	M24	18.3	1920	1660	11.0	50	43	0.25	27.5	452	20.3	100	87	0.23
628	**Upper chord top ca.**	100x100x10	**6**	M24	17.3	1920	1660	10.4	50	43	0.24	26.2	452	9.7	100	87	0.11
629	**Upper chord top ca.**	100x100x10	**3**	M24	16.9	1920	1660	10.2	50	43	0.23	25.7	452	18.9	100	87	0.22
630	**Earth peak upper chord**	130x130x12	**0**		56.1	3000	3000	18.7	50	43	0.43	76.1	0	0.0	100	87	0.00
631	**Earth peak upper chord**	130x130x12	**4**	M24	48.5	3000	2688	18.1	50	43	0.42	68.2	452	37.7	100	87	0.43
632	**Earth peak upper chord**	120x120x10	**4**	M24	46.9	2320	2060	22.8	50	43	0.52	65.8	452	36.4	100	87	0.42

Check galloping- 120gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
633	**Earth peak upper chord**	120x120x10	**0**		41.6	2320	2320	17.9	50	43	0.41	58.3	0	0.0	100	87	0.00
634	**Earth peak upper chord**	120x120x10	**0**		33.0	2320	2320	14.2	50	43	0.33	46.3	0	0.0	100	87	0.00
635	**Earth peak upper chord**	120x120x10	**2**	M20	19.6	2320	2100	9.3	50	43	0.21	27.4	314	43.7	100	87	0.50
637	**Stabiltity bracing top ca.**	70x70x7	**1**	M16	8.1	940	814	9.9	50	43	0.23	12.2	201	60.8	100	87	0.70
638	**Earth peak horizontal**	HEB160	**2**	M20	4.2	5430	5254	0.8	50	43	0.02	5.9	314	9.4	100	87	0.11
640	**Vertical side face top ca.**	60x60x6	**2**	M16	3.7	690	582	6.4	50	43	0.15	5.4	201	13.5	100	87	0.16
641	**Vertical side face top ca.**	60x60x6	**2**	M16	12.3	690	582	21.2	50	43	0.49	18.6	201	46.2	100	87	0.53
642	**Vertical side face top ca.**	80x80x6	**1**	M16	2.9	940	832	3.5	50	43	0.08	4.4	201	21.8	100	87	0.25
643	**Vertical side face top ca.**	80x80x6	**1**	M16	0.2	940	832	0.3	50	43	0.01	0.3	201	1.7	100	87	0.02
644	**Vertical side face top ca.**	80x80x6	**1**	M16	7.4	940	832	8.9	50	43	0.21	11.4	201	56.5	100	87	0.65
645	**Vertical side face top ca.**	80x80x8	**1**	M16	0.1	1230	1086	0.1	50	43	0.00	0.2	201	0.8	100	87	0.01
646	**Earth peak vertical side face**	60x60x6	**1**	M16	0.3	690	582	0.5	50	43	0.01	0.4	201	1.8	100	87	0.02
660	**Diag side face top ca.**	80x80x6	**2**	M16	5.8	940	832	6.9	50	43	0.16	8.0	201	20.0	100	87	0.23
661	**Diag side face top ca.**	80x80x8	**2**	M16	5.0	1230	1086	4.6	50	43	0.11	7.6	201	19.0	100	87	0.22
662	**Diag side face top ca.**	80x80x8	**2**	M20	8.1	1230	1054	7.7	50	43	0.18	12.3	314	19.6	100	87	0.23
663	**Earth peak diag side face**	80x80x6	**1**	M16	0.3	940	832	0.3	50	43	0.01	0.4	201	1.8	100	87	0.02
664	**Stabiltity bracing top ca.**	80x80x8	**2**	M16	15.4	1230	1086	14.1	50	43	0.33	23.2	201	57.7	100	87	0.66
673	**Earth peak diag upper side**	60x60x6	**2**	M16	7.2	690	582	12.3	50	43	0.28	10.1	201	25.0	100	87	0.29
674	**Earth peak diag upper side**	60x60x6	**2**	M16	5.7	690	582	9.8	50	43	0.23	8.0	201	20.0	100	87	0.23
675	**Diag lower plane top ca.**	70x70x6	**2**	M20	11.9	810	678	17.5	50	43	0.40	16.5	314	26.3	100	87	0.30
676	**Diag lower plane top ca.**	70x70x6	**2**	M20	14.8	810	678	21.9	50	43	0.50	20.8	314	33.1	100	87	0.38
677	**Diag lower plane top ca.**	70x70x6	**2**	M20	14.0	810	678	20.6	50	43	0.47	19.5	314	31.0	100	87	0.36
678	**Diag lower plane top ca.**	70x70x6	**2**	M20	12.5	810	678	18.5	50	43	0.43	19.0	314	30.3	100	87	0.35
679	**Diag lower plane top ca.**	70x70x6	**2**	M20	12.7	810	678	18.8	50	43	0.43	19.4	314	30.9	100	87	0.36
680	**Diag lower plane top ca.**	70x70x6	**2**	M20	13.8	810	678	20.4	50	43	0.47	21.1	314	33.5	100	87	0.39
681	**Diag lower plane top ca.**	70x70x6	**2**	M20	21.8	810	678	32.2	50	43	0.74	33.3	314	53.0	100	87	0.61
682	**Diag lower plane top ca.**	70x70x6	**2**	M20	24.9	810	678	36.7	50	43	0.84	38.0	314	60.4	100	87	0.69
683	**Diag lower plane top ca.**	80x80x6	**2**	M20	26.4	940	808	32.6	50	43	0.75	40.2	314	64.1	100	87	0.74
684	**Diag lower plane top ca.**	80x80x6	**2**	M20	27.6	940	808	34.2	50	43	0.79	42.2	314	67.2	100	87	0.77
685	**Diag lower plane top ca.**	60x60x6	**2**	M16	10.9	690	582	18.7	50	43	0.43	16.6	201	41.4	100	87	0.48
686	**Earth peak diag lower plane**	70x70x7	**1**	M16	0.4	940	814	0.5	50	43	0.01	0.6	201	3.0	100	87	0.04
687	**Earth peak diag lower plane**	70x70x7	**1**	M16	2.5	940	814	3.1	50	43	0.07	3.7	201	18.5	100	87	0.21
688	**Earth peak diag upper plane**	70x70x6	**2**	M16	7.8	810	702	11.2	50	43	0.26	11.7	201	29.1	100	87	0.33
689	**Earth peak diag upper plane**	70x70x6	**2**	M16	8.6	810	702	12.3	50	43	0.28	12.8	201	32.0	100	87	0.37
690	**Earth peak diag upper plane**	60x60x6	**2**	M16	9.3	690	582	15.9	50	43	0.37	13.8	201	34.3	100	87	0.39

Check galloping- 120gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
691	**Earth peak diag upper plane**	60x60x6	**2**	M16	10.2	690	582	17.5	50	43	0.40	15.2	201	37.8	100	87	0.43
692	**Earth peak diag upper plane**	60x60x6	**1**	M16	2.1	690	582	3.7	50	43	0.08	3.0	201	14.9	100	87	0.17
693	**Earth peak diag upper plane**	60x60x6	**1**	M16	2.3	690	582	3.9	50	43	0.09	3.2	201	16.1	100	87	0.18
694	**Earth peak diag upper plane**	60x60x6	**1**	M16	2.7	690	582	4.6	50	43	0.11	3.7	201	18.6	100	87	0.21
695	**Earth peak diag upper plane**	60x60x6	**1**	M16	3.1	690	582	5.3	50	43	0.12	4.3	201	21.4	100	87	0.25
696	**Earth peak diag upper plane**	60x60x6	**1**	M16	3.6	690	582	6.3	50	43	0.14	5.1	201	25.5	100	87	0.29
697	**Earth peak diag upper plane**	60x60x6	**1**	M16	4.5	690	582	7.6	50	43	0.18	6.3	201	31.1	100	87	0.36
698	**Plan bracing top ca.**	150x150x12	**4**	M24	59.3	3480	3168	18.7	50	43	0.43	89.2	452	49.3	100	87	0.57
699	**Plan bracing top ca.**	140x140x13	**5**	M24	97.6	3521	3183	30.7	50	43	0.71	146.7	452	64.9	100	87	0.75
700	**Hor. Plan bracing hip structu**	100x100x8	**2**	M20	2.4	1550	1374	1.8	50	43	0.04	3.2	314	5.2	100	87	0.06
701	**Hor. Plan bracing hip structu**	100x100x8	**2**	M20	0.4	1550	1374	0.3	50	43	0.01	0.6	314	0.9	100	87	0.01
702	**Hor. Plan bracing hip structu**	100x100x8 (not coupl	**2**	M20	0.0	3100	2924	0.0	50	43	0.00	0.0	314	0.0	100	87	0.00
703	**2nd plan bacing**	130x130x12#(15,0.33	**3**	M24	15.3	6040	5728	2.7	50	43	0.06	20.6	452	15.2	100	87	0.17
704	**2nd plan bacing**	90x90x8	**2**	M20	2.6	1390	1214	2.1	50	43	0.05	3.8	314	6.0	100	87	0.07
705	**2nd plan bacing**	90x90x8 (not coupled)	**2**	M20	0.0	2780	2604	0.0	50	43	0.00	0.0	314	0.0	100	87	0.00
710	**Horizontal top of lower ca.**	120x120x12	**4**	M24	12.1	2750	2438	5.0	50	43	0.11	17.4	452	9.6	100	87	0.11
711	**Horizontal top of lower ca.**	130x130x12	**2**	M24	3.4	3000	2688	1.3	50	43	0.03	4.9	452	5.4	100	87	0.06
712	**Horizontal top of mid ca.**	120x120x12	**4**	M24	11.5	2750	2438	4.7	50	43	0.11	15.7	452	8.7	100	87	0.10
713	**Horizontal top of mid ca.**	120x120x10	**2**	M24	4.5	2320	2060	2.2	50	43	0.05	6.3	452	7.0	100	87	0.08
714	**Horizontal top of top ca.**	120x120x12	**4**	M24	19.7	2750	2438	8.1	50	43	0.19	30.0	452	16.6	100	87	0.19
715	**Horizontal top of top ca.**	100x100x10	**2**	M24	1.0	1920	1660	0.6	50	43	0.01	1.4	452	1.6	100	87	0.02

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
100	**Main leg**	80x80x8	**2**	M20	16.2	1230	1054	15.4	50	43	0.35	24.7	314	39.3	100	87	0.45
101	**Main leg**	130x130x12	**4**	M24	26.3	3000	2688	9.8	50	43	0.23	39.7	452	22.0	100	87	0.25
102	**Main leg**	180x180x16	**8**	M24	38.1	5540	5124	7.4	50	43	0.17	55.5	452	15.4	100	87	0.18
103	**Main leg**	180x180x16	**8**	M24	59.9	5540	5124	11.7	50	43	0.27	84.3	452	23.3	100	87	0.27
104	**Main leg**	180x180x16	**10**	M24	83.5	5540	5124	16.3	50	43	0.37	118.0	452	26.1	100	87	0.30
105	**Main leg**	250x250x24	**10**	M24	115.7	11492	10868	10.6	50	43	0.24	168.8	452	37.3	100	87	0.43
106	**Main leg**	250x250x24	**0**		140.8	11492	11492	12.2	50	43	0.28	204.4	0	0.0	100	87	0.00
107	**Main leg**	250x250x24	**16**	M24	152.6	11492	10868	14.0	50	43	0.32	216.5	452	29.9	100	87	0.34
108	**Main leg**	200x200x24	**32**	M24	179.7	9060	8436	21.3	50	43	0.49	250.8	452	17.3	100	87	0.20
109	**Main leg**	200x200x24	**20**	M24	196.6	9060	8436	23.3	50	43	0.54	272.7	452	30.2	100	87	0.35
110	**Main leg**	250x250x24	**24**	M24	214.9	11492	10868	19.8	50	43	0.45	295.7	452	27.3	100	87	0.31
111	**Main leg**	250x250x24	**32**	M24	226.4	11492	10868	20.8	50	43	0.48	307.9	452	21.3	100	87	0.24
112	**Main leg**	250x250x24	**32**	M24	228.9	11492	10868	21.1	50	43	0.48	307.1	452	21.2	100	87	0.24
113	**Main leg**	250x250x24	**0**		206.6	11492	11492	18.0	50	43	0.41	273.3	0	0.0	100	87	0.00
114	**Main leg**	250x250x24	**24**	M24	205.9	11492	10868	18.9	50	43	0.44	272.5	452	25.1	100	87	0.29
200	**Diag front face**	100x100x10	**2**	M24	20.4	1920	1660	12.3	50	43	0.28	31.1	452	34.4	100	87	0.40
201	**Diag front face**	150x150x14	**6**	M24	114.6	4014	3650	31.4	50	43	0.72	173.0	452	63.8	100	87	0.73
202	**Diag front face**	150x150x14	**5**	M24	96.0	4014	3650	26.3	50	43	0.60	144.8	452	64.1	100	87	0.74
203	**Diag front face**	150x150x14	**5**	M24	79.1	4014	3650	21.7	50	43	0.50	119.2	452	52.8	100	87	0.61
204	**Diag front face**	120x120x12(12,0.33)	**4**	M24	110.5	5500	5188	21.3	50	43	0.49	157.4	452	87.1	100	87	1.00
205	**Diag front face**	120x120x12(12,0.33)	**4**	M24	96.0	5500	5188	18.5	50	43	0.43	136.8	452	75.7	100	87	0.87
206	**Diag front face**	120x120x12(12,0.33)	**4**	M24	84.2	5500	5188	16.2	50	43	0.37	117.5	452	65.0	100	87	0.75
207	**Diag front face**	130x130x12#(15,0.33	**4**	M24	83.4	6040	5728	14.6	50	43	0.33	110.5	452	61.1	100	87	0.70
208	**Diag front face**	120x120x12(12,0.33)	**4**	M24	74.1	5500	5188	14.3	50	43	0.33	98.1	452	54.3	100	87	0.62
209	**Diag front face**	120x120x12(12,0.33)	**4**	M24	68.5	5500	5188	13.2	50	43	0.30	90.1	452	49.8	100	87	0.57
210	**Diag front face**	120x120x12(12,0.33)	**4**	M24	66.9	5500	5188	12.9	50	43	0.30	87.9	452	48.6	100	87	0.56
211	**Diag front face**	150x150x12(12,0.33)	**3**	M24	56.0	6970	6658	8.4	50	43	0.19	74.1	452	54.6	100	87	0.63
212	**Diag front face**	130x130x12#(15,0.33	**3**	M24	40.7	6040	5728	7.1	50	43	0.16	53.8	452	39.6	100	87	0.46
213	**Diag front face**	150x150x12(12,0.33)	**5**	M24	39.9	6970	6658	6.0	50	43	0.14	52.7	452	23.3	100	87	0.27
300	**Diag side face**	80x80x8	**2**	M24	15.7	1230	1022	15.4	50	43	0.35	24.0	452	26.6	100	87	0.31
301	**Diag side face**	150x150x14	**6**	M24	112.8	4014	3650	30.9	50	43	0.71	170.4	452	62.8	100	87	0.72
302	**Diag side face**	150x150x14	**5**	M24	94.8	4014	3650	26.0	50	43	0.60	143.3	452	63.4	100	87	0.73
303	**Diag side face**	150x150x14	**4**	M24	77.5	4014	3650	21.2	50	43	0.49	117.1	452	64.7	100	87	0.74
304	**Diag side face**	120x120x12(12,0.33)	**4**	M24	100.6	5500	5188	19.4	50	43	0.45	139.5	452	77.1	100	87	0.89
305	**Diag side face**	120x120x12(12,0.33)	**4**	M24	88.2	5500	5188	17.0	50	43	0.39	122.2	452	67.6	100	87	0.78

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
306	**Diag side face**	120x120x12(12,0.33)	**4**	M24	79.8	5500	5188	15.4	50	43	0.35	110.3	452	61.0	100	87	0.70
307	**Diag side face**	130x130x12#(15,0.33	**4**	M24	89.0	6040	5728	15.5	50	43	0.36	117.8	452	65.2	100	87	0.75
308	**Diag side face**	120x120x12(12,0.33)	**4**	M24	81.3	5500	5188	15.7	50	43	0.36	107.7	452	59.5	100	87	0.68
309	**Diag side face**	120x120x12(12,0.33)	**4**	M24	77.1	5500	5188	14.9	50	43	0.34	102.1	452	56.5	100	87	0.65
310	**Diag side face**	120x120x12(12,0.33)	**4**	M24	72.4	5500	5188	13.9	50	43	0.32	95.8	452	53.0	100	87	0.61
311	**Diag side face**	150x150x12(12,0.33)	**3**	M24	67.4	6970	6658	10.1	50	43	0.23	90.0	452	66.4	100	87	0.76
312	**Diag side face**	130x130x12#(15,0.33	**3**	M24	51.2	6040	5728	8.9	50	43	0.21	68.3	452	50.4	100	87	0.58
313	**Diag side face**	150x150x12(12,0.33)	**5**	M24	48.8	6970	6658	7.3	50	43	0.17	65.1	452	28.8	100	87	0.33
400	**Horizontal lower ca.**	180x180x16	**10**	M24	76.7	5540	5124	15.0	50	43	0.34	116.8	452	25.8	100	87	0.30
401	**Lower chord lower ca.**	150x150x14	**10**	M24	149.5	4014	3650	40.9	50	43	0.94	227.7	452	50.4	100	87	0.58
402	**Lower chord lower ca.**	150x150x14	**0**		132.3	4014	4014	33.0	50	43	0.76	202.0	0	0.0	100	87	0.00
403	**Lower chord lower ca.**	150x150x14	**0**		120.1	4014	4014	29.9	50	43	0.69	183.4	0	0.0	100	87	0.00
404	**Lower chord lower ca.**	150x150x14	**0**		91.0	4014	4014	22.7	50	43	0.52	139.0	0	0.0	100	87	0.00
405	**Lower chord lower ca.**	150x150x14	**0**		50.1	4014	4014	12.5	50	43	0.29	76.5	0	0.0	100	87	0.00
406	**Lower chord lower ca.**	150x150x14	**0**		34.8	4014	4014	8.7	50	43	0.20	53.1	0	0.0	100	87	0.00
407	**Lower chord lower ca.**	150x150x14	**0**		0.4	4014	4014	0.1	50	43	0.00	0.6	0	0.0	100	87	0.00
410	**Horizontal lower ca.**	130x130x12	**3**	M24	22.2	3000	2688	8.3	50	43	0.19	33.6	452	24.8	100	87	0.28
411	**Horizontal lower ca.**	150x150x14 (not coup	**2**	M24	13.0	8028	7664	1.7	50	43	0.04	19.8	452	21.9	100	87	0.25
412	**Horizontal lower ca.**	HEA140	**0**		0.8	3140	3140	0.3	50	43	0.01	1.2	0	0.0	100	87	0.00
413	**Horizontal lower ca.**	150x150x18 (not coup	**2**	M24	26.3	10200	9732	2.7	50	43	0.06	40.1	452	44.4	100	87	0.51
414	**Beam lower ca.**	HEB220	**0**		2.1	9104	9104	0.2	50	43	0.01	3.2	0	0.0	100	87	0.00
415	**Horizontal lower ca.**	UNP220	**0**		5.1	3740	3740	1.4	50	43	0.03	7.8	0	0.0	100	87	0.00
426	**Upper chord lower ca.**	120x120x12	**4**	M24	15.3	2750	2438	6.3	50	43	0.14	23.1	452	12.8	100	87	0.15
427	**Upper chord lower ca.**	120x120x12	**0**		14.6	2750	2750	5.3	50	43	0.12	22.1	0	0.0	100	87	0.00
428	**Upper chord lower ca.**	120x120x12	**0**		14.7	2750	2750	5.4	50	43	0.12	22.3	0	0.0	100	87	0.00
429	**Upper chord lower ca.**	120x120x12	**0**		15.6	2750	2750	5.7	50	43	0.13	23.5	0	0.0	100	87	0.00
430	**Upper chord lower ca.**	120x120x12	**2**	M20	15.6	2750	2486	6.3	50	43	0.14	23.6	314	37.6	100	87	0.43
431	**Upper chord lower ca.**	120x120x12	**2**	M20	19.2	2750	2486	7.7	50	43	0.18	29.1	314	46.4	100	87	0.53
433	**Stabiltity bracing lower ca.**	70x70x6	**1**	M16	0.3	810	702	0.4	50	43	0.01	0.4	201	2.1	100	87	0.02
434	**Hand rail**	60x60x6	**1**	M16	0.1	690	582	0.2	50	43	0.00	0.2	201	0.8	100	87	0.01
435	**Hand rail**	100x50x6	**2**	M16	0.0	870	762	0.0	50	43	0.00	0.0	201	0.0	100	87	0.00
436	**Hand rail**	60x60x6	**1**	M16	0.1	690	582	0.1	50	43	0.00	0.1	201	0.4	100	87	0.00
437	**Stabiltity bracing lower ca.**	70x70x6	**1**	M16	1.1	810	702	1.5	50	43	0.04	1.6	201	7.9	100	87	0.09
440	**Vertical side face lower ca.**	70x70x6	**1**	M16	2.0	810	702	2.9	50	43	0.07	3.1	201	15.2	100	87	0.18
441	**Vertical side face lower ca.**	70x70x6	**1**	M16	2.6	810	702	3.7	50	43	0.09	4.0	201	19.8	100	87	0.23

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
442	**Vertical side face lower ca.**	60x60x6	**1**	M16	3.5	690	582	5.9	50	43	0.14	5.3	201	26.2	100	87	0.30
443	**Vertical side face lower ca.**	60x60x6	**1**	M16	0.5	690	582	0.9	50	43	0.02	0.8	201	3.8	100	87	0.04
444	**Vertical side face lower ca.**	60x60x6	**1**	M16	10.0	690	582	17.2	50	43	0.40	15.3	201	76.0	100	87	0.87
460	**Diag side face lower ca.**	90x90x8	**2**	M16	5.5	1390	1246	4.4	50	43	0.10	8.1	201	20.2	100	87	0.23
461	**Diag side face lower ca.**	60x60x6	**2**	M16	3.3	690	582	5.7	50	43	0.13	5.1	201	12.7	100	87	0.15
462	**Diag side face lower ca.**	60x60x6	**2**	M16	5.8	690	582	9.9	50	43	0.23	8.8	201	21.9	100	87	0.25
463	**Diag side face lower ca.**	60x60x6	**2**	M16	8.3	690	582	14.2	50	43	0.33	12.6	201	31.4	100	87	0.36
464	**Diag side face lower ca.**	60x60x6	**2**	M16	10.4	690	582	17.8	50	43	0.41	15.8	201	39.3	100	87	0.45
465	**Stabiltity bracing lower ca.**	90x90x9	**1**	M16	0.4	1539	1377	0.3	50	43	0.01	0.6	201	3.0	100	87	0.03
475	**Diag lower plane lower ca.**	80x80x6	**2**	M20	13.1	940	808	16.3	50	43	0.37	18.4	314	29.3	100	87	0.34
476	**Diag lower plane lower ca.**	80x80x6	**2**	M20	15.5	940	808	19.1	50	43	0.44	21.5	314	34.3	100	87	0.39
477	**Diag lower plane lower ca.**	80x80x6	**2**	M20	11.8	940	808	14.6	50	43	0.34	17.6	314	28.1	100	87	0.32
478	**Diag lower plane lower ca.**	80x80x6	**2**	M20	13.0	940	808	16.1	50	43	0.37	19.8	314	31.6	100	87	0.36
479	**Diag lower plane lower ca.**	70x70x6	**2**	M20	14.5	810	678	21.4	50	43	0.49	22.2	314	35.3	100	87	0.41
480	**Diag lower plane lower ca.**	70x70x6	**2**	M20	16.3	810	678	24.0	50	43	0.55	24.9	314	39.6	100	87	0.46
481	**Diag lower plane lower ca.**	70x70x6	**2**	M20	18.7	810	678	27.6	50	43	0.63	28.5	314	45.4	100	87	0.52
482	**Diag lower plane lower ca.**	70x70x6	**2**	M20	22.1	810	678	32.6	50	43	0.75	33.7	314	53.7	100	87	0.62
483	**Diag lower plane lower ca.**	70x70x6	**2**	M20	25.6	810	678	37.8	50	43	0.87	39.1	314	62.3	100	87	0.72
484	**Diag lower plane lower ca.**	70x70x6	**2**	M16	12.6	810	702	18.0	50	43	0.41	19.3	157	61.4	100	87	0.71
485	**Plan bracing lower ca.**	120x120x10	**3**	M24	28.4	2320	2060	13.8	50	43	0.32	42.8	452	31.5	100	87	0.36
486	**Plan bracing lower ca.**	70x70x6	**1**	M16	0.0	810	702	0.1	50	43	0.00	0.1	201	0.3	100	87	0.00
500	**Horizontal mid ca.**	200x200x18	**10**	M24	128.8	6910	6442	20.0	50	43	0.46	195.5	452	43.2	100	87	0.50
501	**Lower chord mid ca.**	180x180x18	**10**	M24	220.9	6190	5722	38.6	50	43	0.89	335.3	452	74.2	100	87	0.85
502	**Lower chord mid ca.**	180x180x18	**0**		213.9	6190	6190	34.6	50	43	0.79	325.3	0	0.0	100	87	0.00
503	**Lower chord mid ca.**	180x180x18	**0**		196.2	6190	6190	31.7	50	43	0.73	299.1	0	0.0	100	87	0.00
504	**Lower chord mid ca.**	180x180x18	**8**	M24	172.7	6190	5722	30.2	50	43	0.69	263.6	452	72.9	100	87	0.84
505	**Lower chord mid ca.**	160x160x15	**8**	M24	149.0	4671	4281	34.8	50	43	0.80	227.5	452	62.9	100	87	0.72
506	**Lower chord mid ca.**	160x160x15	**0**		108.6	4671	4671	23.3	50	43	0.53	165.8	0	0.0	100	87	0.00
507	**Lower chord mid ca.**	160x160x15	**0**		72.8	4671	4671	15.6	50	43	0.36	111.1	0	0.0	100	87	0.00
508	**Lower chord mid ca.**	160x160x15	**0**		39.5	4671	4671	8.5	50	43	0.19	60.3	0	0.0	100	87	0.00
509	**Lower chord mid ca.**	160x160x15	**2**	M20	0.3	4671	4341	0.1	50	43	0.00	0.4	314	0.7	100	87	0.01
511	**Horizontal mid ca.**	150x150x12	**3**	M24	39.4	3480	3168	12.4	50	43	0.29	59.9	452	44.2	100	87	0.51
512	**Beam mid ca.**	150x150x14 (not coup	**2**	M24	15.5	8028	7664	2.0	50	43	0.05	21.5	452	23.8	100	87	0.27
513	**Horizontal mid ca.**	HEA140	**0**		0.4	3140	3140	0.1	50	43	0.00	0.6	0	0.0	100	87	0.00
514	**Beam mid ca.**	150x150x18 (not coup	**2**	M24	25.1	10200	9732	2.6	50	43	0.06	38.4	452	42.4	100	87	0.49

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
515	**Horizontal mid ca.**	HEB220	**0**		2.7	9104	9104	0.3	50	43	0.01	4.1	0	0.0	100	87	0.00
516	**Beam mid ca.**	UNP220	**0**		7.8	3740	3740	2.1	50	43	0.05	11.9	0	0.0	100	87	0.00
526	**Upper chord mid ca.**	120x120x12	**4**	M24	36.4	2750	2438	14.9	50	43	0.34	55.2	452	30.5	100	87	0.35
527	**Upper chord mid ca.**	120x120x12	**0**		36.8	2750	2750	13.4	50	43	0.31	55.9	0	0.0	100	87	0.00
528	**Upper chord mid ca.**	120x120x12	**6**	M24	35.9	2750	2438	14.7	50	43	0.34	54.5	452	20.1	100	87	0.23
529	**Upper chord mid ca.**	120x120x12	**6**	M24	33.0	2750	2438	13.5	50	43	0.31	50.1	452	18.5	100	87	0.21
530	**Upper chord mid ca.**	120x120x12	**0**		30.3	2750	2750	11.0	50	43	0.25	46.0	0	0.0	100	87	0.00
531	**Upper chord mid ca.**	120x120x12	**0**		28.0	2750	2750	10.2	50	43	0.23	42.6	0	0.0	100	87	0.00
532	**Upper chord mid ca.**	120x120x12	**4**	M24	28.0	2750	2438	11.5	50	43	0.26	42.6	452	23.6	100	87	0.27
533	**Upper chord mid ca.**	120x120x12	**2**	M24	30.1	2750	2438	12.3	50	43	0.28	45.8	452	50.7	100	87	0.58
535	**Stabiltity bracing mid ca.**	70x70x6	**1**	M16	0.3	810	702	0.4	50	43	0.01	0.4	201	2.0	100	87	0.02
536	**Hand rail**	60x60x6	**1**	M16	0.1	690	582	0.1	50	43	0.00	0.1	201	0.5	100	87	0.01
537	**Hand rail**	100x50x6	**2**	M16	0.0	870	762	0.0	50	43	0.00	0.0	201	0.0	100	87	0.00
538	**Hand rail**	60x60x6	**1**	M16	0.0	690	582	0.1	50	43	0.00	0.0	201	0.2	100	87	0.00
539	**Stabiltity bracing mid ca.**	70x70x6	**1**	M16	1.4	810	702	1.9	50	43	0.04	2.1	201	10.3	100	87	0.12
540	**Vertical side face mid ca.**	80x80x6	**1**	M16	3.1	940	832	3.7	50	43	0.09	4.3	201	21.6	100	87	0.25
541	**Vertical side face mid ca.**	80x80x6	**1**	M16	3.0	940	832	3.6	50	43	0.08	4.3	201	21.5	100	87	0.25
542	**Vertical side face mid ca.**	60x60x6	**1**	M16	1.6	690	582	2.7	50	43	0.06	2.4	201	12.1	100	87	0.14
543	**Vertical side face mid ca.**	60x60x6	**1**	M16	2.0	690	582	3.5	50	43	0.08	3.1	201	15.3	100	87	0.18
544	**Vertical side face mid ca.**	60x60x6	**1**	M16	2.5	690	582	4.3	50	43	0.10	3.8	201	19.0	100	87	0.22
545	**Vertical side face mid ca.**	60x60x6	**1**	M16	0.7	690	582	1.2	50	43	0.03	1.1	201	5.5	100	87	0.06
546	**Vertical side face mid ca.**	60x60x6	**2**	M16	11.5	690	582	19.7	50	43	0.45	17.5	201	43.5	100	87	0.50
560	**Diag side face mid ca.**	80x80x6	**2**	M16	2.9	940	832	3.5	50	43	0.08	4.4	201	10.8	100	87	0.12
561	**Diag side face mid ca.**	70x70x6	**2**	M16	4.7	810	702	6.7	50	43	0.15	6.6	201	16.4	100	87	0.19
562	**Diag side face mid ca.**	60x60x6	**2**	M16	4.7	690	582	8.1	50	43	0.19	6.8	201	16.9	100	87	0.19
563	**Diag side face mid ca.**	60x60x6	**2**	M16	2.8	690	582	4.8	50	43	0.11	4.3	201	10.6	100	87	0.12
564	**Diag side face mid ca.**	60x60x6	**2**	M16	4.8	690	582	8.3	50	43	0.19	7.3	201	18.3	100	87	0.21
565	**Diag side face mid ca.**	60x60x6	**2**	M16	5.5	690	582	9.4	50	43	0.22	8.3	201	20.7	100	87	0.24
566	**Diag side face mid ca.**	60x60x6	**2**	M16	6.2	690	582	10.7	50	43	0.25	9.5	201	23.7	100	87	0.27
567	**Stabiltity bracing mid ca.**	70x70x6	**1**	M16	0.5	810	702	0.7	50	43	0.02	0.7	201	3.4	100	87	0.04
575	**Diag lower plane mid ca.**	70x70x6	**2**	M20	10.5	810	678	15.5	50	43	0.36	14.6	314	23.3	100	87	0.27
576	**Diag lower plane mid ca.**	70x70x6	**2**	M20	12.8	810	678	18.8	50	43	0.43	17.8	314	28.4	100	87	0.33
577	**Diag lower plane mid ca.**	70x70x6	**2**	M20	13.4	810	678	19.8	50	43	0.46	18.7	314	29.8	100	87	0.34
578	**Diag lower plane mid ca.**	70x70x6	**2**	M20	14.8	810	678	21.8	50	43	0.50	20.7	314	33.0	100	87	0.38
579	**Diag lower plane mid ca.**	70x70x6	**2**	M20	15.5	810	678	22.9	50	43	0.53	21.6	314	34.5	100	87	0.40

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
580	**Diag lower plane mid ca.**	70x70x6	**2**	M20	13.1	810	678	19.4	50	43	0.45	19.6	314	31.2	100	87	0.36
581	**Diag lower plane mid ca.**	70x70x6	**2**	M20	14.8	810	678	21.9	50	43	0.50	22.6	314	36.0	100	87	0.41
582	**Diag lower plane mid ca.**	70x70x6	**2**	M20	15.8	810	678	23.3	50	43	0.54	24.2	314	38.5	100	87	0.44
583	**Diag lower plane mid ca.**	70x70x6	**2**	M20	18.2	810	678	26.8	50	43	0.62	27.7	314	44.1	100	87	0.51
584	**Diag lower plane mid ca.**	70x70x6	**2**	M20	20.7	810	678	30.5	50	43	0.70	31.6	314	50.3	100	87	0.58
585	**Diag lower plane mid ca.**	80x80x6	**2**	M20	25.2	940	808	31.1	50	43	0.72	38.4	314	61.2	100	87	0.70
586	**Diag lower plane mid ca.**	80x80x6	**2**	M20	29.0	940	808	35.8	50	43	0.82	44.2	314	70.4	100	87	0.81
587	**Diag lower plane mid ca.**	60x60x6	**2**	M16	12.3	690	582	21.2	50	43	0.49	18.8	201	46.9	100	87	0.54
588	**Plan bracing mid ca.**	140x140x13	**5**	M24	94.3	3521	3183	29.6	50	43	0.68	143.4	452	63.5	100	87	0.73
589	**Plan bracing mid ca.**	150x150x12	**4**	M24	60.4	3480	3168	19.1	50	43	0.44	91.8	452	50.8	100	87	0.58
600	**Horizontal top ca.**	200x200x18	**10**	M24	147.7	6910	6442	22.9	50	43	0.53	223.3	452	49.4	100	87	0.57
601	**Lower chord top ca.**	180x180x18	**8**	M24	192.5	6190	5722	33.6	50	43	0.77	293.6	452	81.2	100	87	0.93
602	**Lower chord top ca.**	180x180x18	**8**	M24	159.8	6190	5722	27.9	50	43	0.64	244.0	452	67.5	100	87	0.78
603	**Lower chord top ca.**	150x150x14	**8**	M24	125.5	4014	3650	34.4	50	43	0.79	191.6	452	53.0	100	87	0.61
604	**Lower chord top ca.**	150x150x14	**0**		64.4	4014	4014	16.0	50	43	0.37	98.2	0	0.0	100	87	0.00
605	**Lower chord top ca.**	150x150x14	**0**		33.4	4014	4014	8.3	50	43	0.19	50.8	0	0.0	100	87	0.00
606	**Lower chord top ca.**	150x150x14	**2**	M20	5.8	4014	3706	1.6	50	43	0.04	8.5	314	13.5	100	87	0.16
608	**Earth peak lower chord**	80x80x8	**2**	M20	7.3	1230	1054	6.9	50	43	0.16	10.6	314	16.9	100	87	0.19
609	**Earth peak lower chord**	80x80x8	**2**	M20	6.8	1230	1054	6.4	50	43	0.15	9.5	314	15.2	100	87	0.17
610	**Horizontal top ca.**	130x130x12	**3**	M24	42.9	3000	2688	16.0	50	43	0.37	64.3	452	47.4	100	87	0.55
611	**Horizontal top ca.**	150x150x14 (not coup	**2**	M24	13.1	8028	7664	1.7	50	43	0.04	20.1	452	22.2	100	87	0.26
612	**Horizontal top ca.**	HEA140	**0**		0.9	3140	3140	0.3	50	43	0.01	1.3	0	0.0	100	87	0.00
613	**Horizontal top ca.**	150x150x18 (not coup	**2**	M24	26.2	10200	9732	2.7	50	43	0.06	40.0	452	44.3	100	87	0.51
614	**Beam top ca.**	HEB220	**0**		2.3	9104	9104	0.3	50	43	0.01	3.6	0	0.0	100	87	0.00
615	**Earth peak horizontal**	60x60x6	**1**	M16	0.9	690	582	1.5	50	43	0.03	1.3	201	6.3	100	87	0.07
616	**Earth peak horizontal**	60x60x6	**1**	M16	0.9	690	582	1.5	50	43	0.03	1.3	201	6.4	100	87	0.07
617	**Earth peak horizontal**	60x60x6	**1**	M16	0.0	690	582	0.0	50	43	0.00	0.0	201	0.2	100	87	0.00
618	**Beam top ca.**	UNP220	**0**		5.0	3740	3740	1.3	50	43	0.03	7.7	0	0.0	100	87	0.00
626	**Upper chord top ca.**	120x120x12	**0**		42.8	2750	2750	15.6	50	43	0.36	65.3	0	0.0	100	87	0.00
627	**Upper chord top ca.**	100x100x10	**3**	M24	18.7	1920	1660	11.3	50	43	0.26	28.1	452	20.8	100	87	0.24
628	**Upper chord top ca.**	100x100x10	**6**	M24	17.7	1920	1660	10.7	50	43	0.25	26.9	452	9.9	100	87	0.11
629	**Upper chord top ca.**	100x100x10	**3**	M24	17.2	1920	1660	10.4	50	43	0.24	26.2	452	19.3	100	87	0.22
630	**Earth peak upper chord**	130x130x12	**0**		59.1	3000	3000	19.7	50	43	0.45	80.4	0	0.0	100	87	0.00
631	**Earth peak upper chord**	130x130x12	**4**	M24	50.9	3000	2688	18.9	50	43	0.44	71.4	452	39.5	100	87	0.45
632	**Earth peak upper chord**	120x120x10	**4**	M24	48.8	2320	2060	23.7	50	43	0.55	68.5	452	37.9	100	87	0.44

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
633	**Earth peak upper chord**	120x120x10	**0**		43.0	2320	2320	18.5	50	43	0.43	60.3	0	0.0	100	87	0.00
634	**Earth peak upper chord**	120x120x10	**0**		33.6	2320	2320	14.5	50	43	0.33	47.1	0	0.0	100	87	0.00
635	**Earth peak upper chord**	120x120x10	**2**	M20	18.8	2320	2100	8.9	50	43	0.21	26.2	314	41.8	100	87	0.48
637	**Stabiltity bracing top ca.**	70x70x7	**1**	M16	8.7	940	814	10.7	50	43	0.25	13.1	201	65.3	100	87	0.75
638	**Earth peak horizontal**	HEB160	**2**	M20	4.5	5430	5254	0.9	50	43	0.02	6.4	314	10.1	100	87	0.12
640	**Vertical side face top ca.**	60x60x6	**2**	M16	3.7	690	582	6.4	50	43	0.15	5.4	201	13.5	100	87	0.15
641	**Vertical side face top ca.**	60x60x6	**2**	M16	13.2	690	582	22.7	50	43	0.52	19.9	201	49.4	100	87	0.57
642	**Vertical side face top ca.**	80x80x6	**1**	M16	2.9	940	832	3.5	50	43	0.08	4.3	201	21.5	100	87	0.25
643	**Vertical side face top ca.**	80x80x6	**1**	M16	0.2	940	832	0.3	50	43	0.01	0.3	201	1.7	100	87	0.02
644	**Vertical side face top ca.**	80x80x6	**1**	M16	7.4	940	832	8.9	50	43	0.20	11.3	201	56.0	100	87	0.64
645	**Vertical side face top ca.**	80x80x8	**1**	M16	0.1	1230	1086	0.1	50	43	0.00	0.2	201	0.8	100	87	0.01
646	**Earth peak vertical side face**	60x60x6	**1**	M16	0.3	690	582	0.5	50	43	0.01	0.4	201	1.8	100	87	0.02
660	**Diag side face top ca.**	80x80x6	**2**	M16	5.8	940	832	7.0	50	43	0.16	8.1	201	20.0	100	87	0.23
661	**Diag side face top ca.**	80x80x8	**2**	M16	5.0	1230	1086	4.6	50	43	0.11	7.6	201	18.8	100	87	0.22
662	**Diag side face top ca.**	80x80x8	**2**	M20	8.0	1230	1054	7.6	50	43	0.17	12.0	314	19.0	100	87	0.22
663	**Earth peak diag side face**	80x80x6	**1**	M16	0.3	940	832	0.3	50	43	0.01	0.4	201	1.8	100	87	0.02
664	**Stabiltity bracing top ca.**	80x80x8	**2**	M16	16.5	1230	1086	15.2	50	43	0.35	24.9	201	62.0	100	87	0.71
673	**Earth peak diag upper side**	60x60x6	**2**	M16	7.6	690	582	13.0	50	43	0.30	10.6	201	26.4	100	87	0.30
674	**Earth peak diag upper side**	60x60x6	**2**	M16	6.1	690	582	10.4	50	43	0.24	8.5	201	21.2	100	87	0.24
675	**Diag lower plane top ca.**	70x70x6	**2**	M20	13.1	810	678	19.3	50	43	0.44	18.3	314	29.1	100	87	0.33
676	**Diag lower plane top ca.**	70x70x6	**2**	M20	16.4	810	678	24.1	50	43	0.55	22.9	314	36.5	100	87	0.42
677	**Diag lower plane top ca.**	70x70x6	**2**	M20	15.4	810	678	22.7	50	43	0.52	21.5	314	34.2	100	87	0.39
678	**Diag lower plane top ca.**	70x70x6	**2**	M20	13.7	810	678	20.1	50	43	0.46	20.7	314	33.0	100	87	0.38
679	**Diag lower plane top ca.**	70x70x6	**2**	M20	13.9	810	678	20.5	50	43	0.47	21.2	314	33.8	100	87	0.39
680	**Diag lower plane top ca.**	70x70x6	**2**	M20	15.3	810	678	22.5	50	43	0.52	23.3	314	37.1	100	87	0.43
681	**Diag lower plane top ca.**	70x70x6	**2**	M20	23.9	810	678	35.3	50	43	0.81	36.5	314	58.2	100	87	0.67
682	**Diag lower plane top ca.**	70x70x6	**2**	M20	27.2	810	678	40.1	50	43	0.92	41.6	314	66.2	100	87	0.76
683	**Diag lower plane top ca.**	80x80x6	**2**	M20	28.9	940	808	35.8	50	43	0.82	44.1	314	70.3	100	87	0.81
684	**Diag lower plane top ca.**	80x80x6	**2**	M20	30.1	940	808	37.3	50	43	0.86	46.0	314	73.2	100	87	0.84
685	**Diag lower plane top ca.**	60x60x6	**2**	M16	11.9	690	582	20.5	50	43	0.47	18.2	201	45.3	100	87	0.52
686	**Earth peak diag lower plane**	70x70x7	**1**	M16	0.4	940	814	0.5	50	43	0.01	0.6	201	3.1	100	87	0.04
687	**Earth peak diag lower plane**	70x70x7	**1**	M16	2.6	940	814	3.2	50	43	0.07	3.8	201	19.0	100	87	0.22
688	**Earth peak diag upper plane**	70x70x6	**2**	M16	8.4	810	702	12.0	50	43	0.28	12.5	201	31.1	100	87	0.36
689	**Earth peak diag upper plane**	70x70x6	**2**	M16	9.3	810	702	13.2	50	43	0.30	13.8	201	34.3	100	87	0.39
690	**Earth peak diag upper plane**	60x60x6	**2**	M16	9.9	690	582	17.1	50	43	0.39	14.8	201	36.8	100	87	0.42

Check galloping- 140gr

Datum: 16-7-2021
Auteur: TBR
Versie: 1.0

RLL-TBG
HC+0/c

					Controle netto oppervlak profiel							Controle boutdoorsnede					
Group	**Omschrijving**	**Profiel**	**Aantal bouten**	**Bout**	**ΔF;o [kN]**	**Brutto [mm2]**	**Netto [mm2]**	**Δσi;o [Mpa]**	**DC;o [Mpa]**	**Δσ;c;o [Mpa]**	**UC opp.**	**ΔF;b [kN]**	**Opp. Bout [mm2]**	**Δσ;i;b [Mpa]**	**DC;b [Mpa]**	**Δσ;c;b [Mpa]**	**UC bout**
691	**Earth peak diag upper plane**	60x60x6	**2**	M16	10.9	690	582	18.8	50	43	0.43	16.3	201	40.5	100	87	0.47
692	**Earth peak diag upper plane**	60x60x6	**1**	M16	2.3	690	582	3.9	50	43	0.09	3.2	201	15.7	100	87	0.18
693	**Earth peak diag upper plane**	60x60x6	**1**	M16	2.4	690	582	4.2	50	43	0.10	3.4	201	17.1	100	87	0.20
694	**Earth peak diag upper plane**	60x60x6	**1**	M16	2.8	690	582	4.9	50	43	0.11	4.0	201	19.9	100	87	0.23
695	**Earth peak diag upper plane**	60x60x6	**1**	M16	3.3	690	582	5.6	50	43	0.13	4.6	201	22.9	100	87	0.26
696	**Earth peak diag upper plane**	60x60x6	**1**	M16	3.9	690	582	6.7	50	43	0.15	5.5	201	27.2	100	87	0.31
697	**Earth peak diag upper plane**	60x60x6	**1**	M16	4.7	690	582	8.2	50	43	0.19	6.7	201	33.2	100	87	0.38
698	**Plan bracing top ca.**	150x150x12	**4**	M24	63.0	3480	3168	19.9	50	43	0.46	94.7	452	52.4	100	87	0.60
699	**Plan bracing top ca.**	140x140x13	**5**	M24	103.7	3521	3183	32.6	50	43	0.75	155.7	452	68.9	100	87	0.79
700	**Hor. Plan bracing hip structu**	100x100x8	**2**	M20	2.4	1550	1374	1.8	50	43	0.04	3.2	314	5.1	100	87	0.06
701	**Hor. Plan bracing hip structu**	100x100x8	**2**	M20	0.4	1550	1374	0.3	50	43	0.01	0.6	314	1.0	100	87	0.01
702	**Hor. Plan bracing hip structu**	100x100x8 (not coupl	**2**	M20	0.0	3100	2924	0.0	50	43	0.00	0.0	314	0.0	100	87	0.00
703	**2nd plan bacing**	130x130x12#(15,0.33	**3**	M24	16.5	6040	5728	2.9	50	43	0.07	22.3	452	16.5	100	87	0.19
704	**2nd plan bacing**	90x90x8	**2**	M20	2.7	1390	1214	2.2	50	43	0.05	4.0	314	6.4	100	87	0.07
705	**2nd plan bacing**	90x90x8 (not coupled)	**2**	M20	0.0	2780	2604	0.0	50	43	0.00	0.0	314	0.0	100	87	0.00
710	**Horizontal top of lower ca.**	120x120x12	**4**	M24	12.2	2750	2438	5.0	50	43	0.12	17.4	452	9.6	100	87	0.11
711	**Horizontal top of lower ca.**	130x130x12	**2**	M24	2.2	3000	2688	0.8	50	43	0.02	3.1	452	3.4	100	87	0.04
712	**Horizontal top of mid ca.**	120x120x12	**4**	M24	12.0	2750	2438	4.9	50	43	0.11	16.4	452	9.0	100	87	0.10
713	**Horizontal top of mid ca.**	120x120x10	**2**	M24	2.7	2320	2060	1.3	50	43	0.03	3.7	452	4.1	100	87	0.05
714	**Horizontal top of top ca.**	120x120x12	**4**	M24	20.7	2750	2438	8.5	50	43	0.20	31.5	452	17.4	100	87	0.20
715	**Horizontal top of top ca.**	100x100x10	**2**	M24	1.0	1920	1660	0.6	50	43	0.01	1.5	452	1.6	100	87	0.02

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.