N23 Westfrisiaweg

Kunstwerk 15B
Hulpbrug Binnenwijzend

Project N23 Westfrisiaweg

Document opgesteld door:
Heijmans Integrale Projecten

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1 Inleiding

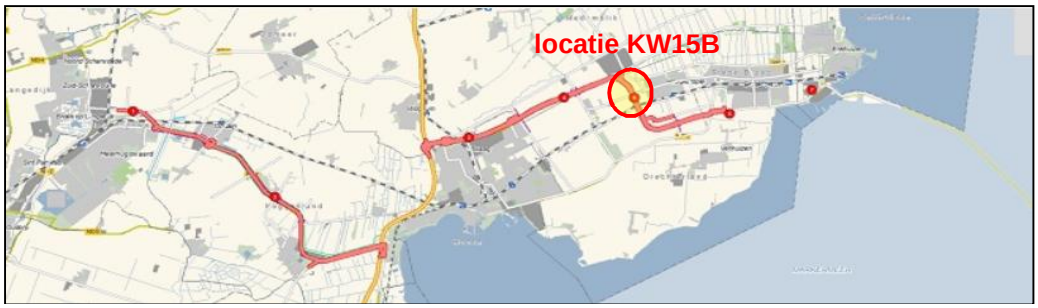
1.1 Omschrijving project en kunstwerk

De route van de N23 Westfrisiaweg beslaat in totaal een weglengte van ongeveer 40 kilometer en loopt door de gemeenten Heerhugowaard, Koggenland, Medemblik, Hoorn, Drechterland, Stede Broec en Enkhuizen. De route bestaat op dit moment uit de provinciale wegen N507 en N243, een stukje van de rijksweg A7 en de provinciale wegen N302 en N506. De route heeft op regionaal niveau een belangrijke ontsluitende functie en vormt een impuls om in de toekomst te komen tot een N23 van Alkmaar naar Zwolle.

Het verkeer op deze route is het afgelopen decennium sterk toegenomen, met als gevolg verminderde verkeersveiligheid, dichtslibbende wegen, vertragingen en overlast door sluipverkeer. Om deze onaantrekkelijke situatie te verbeteren dient de bestaande route te worden opgewaardeerd. Doelstellingen daarbij zijn:

- Het vergroten van de verkeersveiligheid;
- Het verbeteren van de leefbaarheid;
- Het verbeteren van de bereikbaarheid;
- Faciliteren van de groei van het aantal inwoners, de regionale economie en de werkgelegenheid.

Het kunstwerk KW15B is gelegen in het oostelijke tracé, nabij Enkhuizen. In onderstaande afbeelding is de locatie van KW15B aangegeven.



Overzicht N23 Westfrisiaweg (tracé oost en tracé west)

1.2 Doel van het document

In dit document wordt de bovenbouw en onderbouw van de hulpbrug in de Binnenwijzend gecontroleerd. De hulpbrug zit t.p.v. sectie 7 van de bouwkuip.

1.3 Bijbehorende tekeningen

- N23-222-O2302-70-TEK-012: KW15B, Tijdelijke hulpbrug Binnenwijzend

2 Uitgangspunten en randvoorwaarden

2.1 Relevante documenten

[1] N23-222-O2302-92-BER-001 versie 5.0: KW15B, Berekening damwanden bouwkuip;
[2] N23-222-O2302-92-BER-003 versie 1.0: KW15B, Berekening tijdelijke groutankers;
[3] Berekening 5671 versie 0. d.d. 15-10-2015: Statische berekening RLB 27x6m Binnenwijzend
[4] Tekening 5671-P02 versie B, d.d. 04-11-2015: Overzicht RLB hulpbrug KW15B;

2.2 Normen en richtlijnen

Normen welke van toepassing zijn op de berekening:

- NEN-EN 1990 Grondslagen van het constructief ontwerp, 1990+A1+A1/C1:2011 + NB:2011;
- NEN-EN 1991-1-1 Belastingen, Volumieke gewichten, eigen gewicht en opgelegde belastingen voor gebouwen, 1991-1-1+C1:2011 + NB:2011;
- NEN-EN 1991-2 Belastingen, Verkeersbelastingen op bruggen, 1991-2+C1:2011 + NB:2011;
- NEN-EN 1993-1-1 Staalconstructies, Algemene regels en regels voor gebouwen, 1993-1-1+C2:2011 + NB:2011;
- NEN-EN 1993-5 Staalconstructies, Palen en damwanden, 1993-5:2008;
- NEN 9997-1 Geotechnisch ontwerp, Algemene regels, 1997-1+C1:2009 + NB:2011;

Richtlijnen welke van toepassing zijn op de berekening:

- CUR 166 Damwandconstructies, 6^{e} druk;

2.3 Veiligheidsklasse

De tijdelijke verkeersbrug wordt ingedeeld in gevolgklasse CC2 / betrouwbaarheidsklasse RC2 overeenkomstig NEN-EN 1990 +A1+A1/C1; bijlage B.

2.4 Rekenprogrammatuur

De toegepaste rekenprogrammatuur is:

- Technosoft Liggers, versie 6.00;

3 Materialen

3.1 Constructiestaal

De stalen onderdelen worden uitgevoerd in staalkwaliteit S235 respectievelijk S355:

S235 volgens EN 10025-2, t ≤ 40 mm:

Grootheid		**Representatieve waarde in N/mm²**	γ_m	**Rekenwaarde in N/mm²**
Vloeigrens	f_y	235	1,0	235
Afschuiving	τ	136	1,0	136
Treksterkte	f_u	360	1,0	360
Elasticiteitsmodulus	E	210000	1,0	210000

S355 volgens EN 10025-2, t ≤ 40 mm:

Grootheid		**Representatieve waarde in N/mm²**	γ_m	**Rekenwaarde in N/mm²**
Vloeigrens	f_y	355	1,0	355
Afschuiving	τ	205	1,0	205
Treksterkte	f_u	480	1,0	480
Elasticiteitsmodulus	E	210000	1,0	210000

Overig:

- Lassen: S235: $f_{v;w;d} = 360\,N/mm^2$, $f_{t;w;d} = 259\,N/mm^2$, minimaal a=4 mm;
- Bouten: Minimaal kwaliteit 8.8;

4 Belastingen en belastingfactoren

4.1 Belastingen

Voor de verkeersbelasting op de hulpbrug wordt uitgegaan van de verkeersbelasting conform NEN-EN 1991-2. Voor de nadere onderbouwing van de belastingen en belastingfactoren wordt verwezen naar de berekening van de bovenbouw van de hulpbrug (zie **bijlage 1**).

4.2 Belastingfactoren

De belastingfactoren worden aangehouden volgens tabel NB.13-A2.4 van NEN-EN1990:

CC	Blijvende en tijdelijke ontwerp-situaties	Blijvende belastingen		Over-heersende veranderlijke belasting	Veranderlijke belastingen gelijktijdig met de overheersende	
		Ongunstig	Gunstig		Verkeer	Andere
CC2	verg. 6.10a	$1{,}30 \cdot G_{k;j;sup}$	$0{,}90 \cdot G_{k;j;inf}$		$1{,}35 \cdot \psi_{0;1} \cdot Q_{k;1}$	$1{,}50 \cdot \psi_{0;i} \cdot Q_{k;i}$
CC2	verg. 6.10b	$1{,}20 \cdot G_{k;j;sup}$	$0{,}90 \cdot G_{k;j;inf}$	$1{,}35 \cdot Q_{k;1}$		$1{,}50 \cdot \psi_{0;i} \cdot Q_{k;i}$

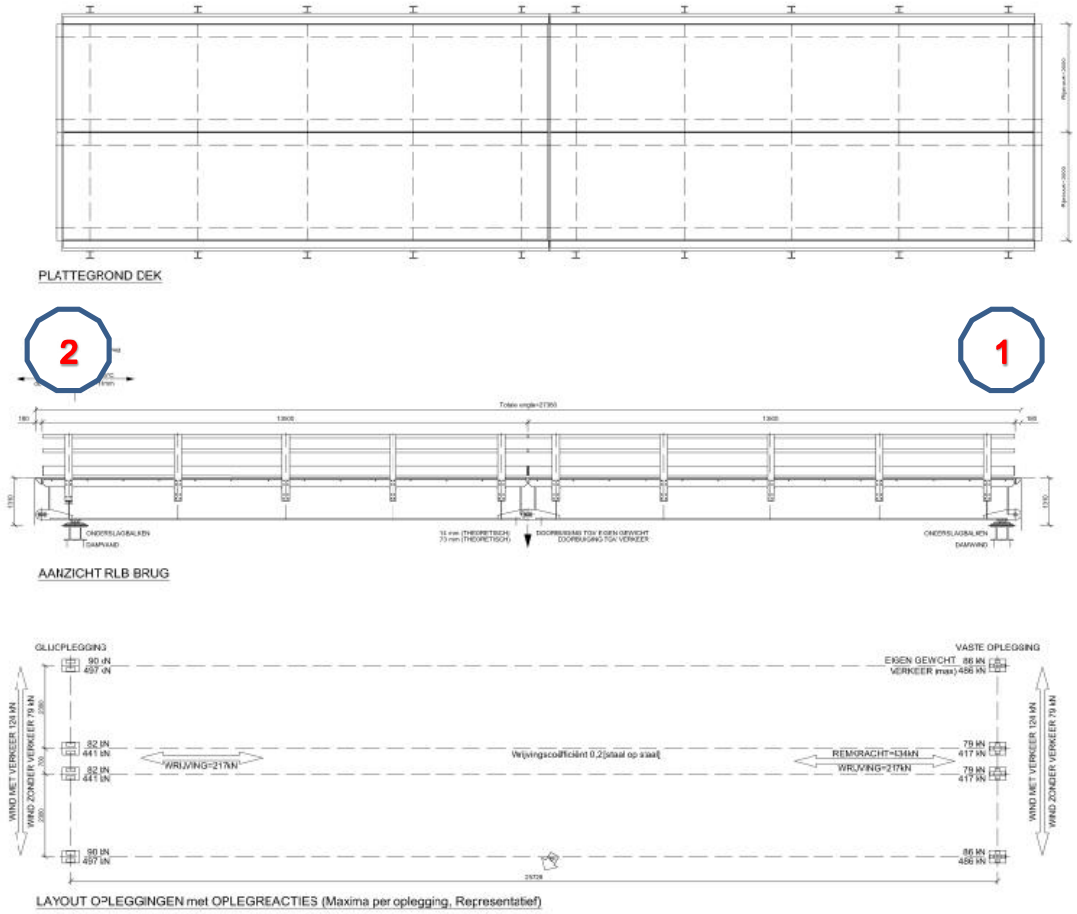
5 Controle bovenbouw

De bovenbouw van de hulpbrug is gecontroleerd door de leverancier van de hulpbrug. Hiervoor wordt verwezen naar **bijlage 1**.

Voor de onderbouw is hierbij van onderstaande schematisering uitgegaan:

Steunpunt	Verticaal	Horizontaal langs	Horizontaal dwars
• Steunpunt 1	Vaste oplegging	Vaste oplegging	Vaste oplegging
• Steunpunt 2	Vaste oplegging	Glijoplegging	Vaste oplegging

Uit de berekening van de bovenbouw volgt een schema met representatieve oplegreacties op de onderbouw. Voor dit schema wordt verwezen naar **bijlage 2**. Deze oplegreacties vormen de input voor de berekening van de onderbouw.

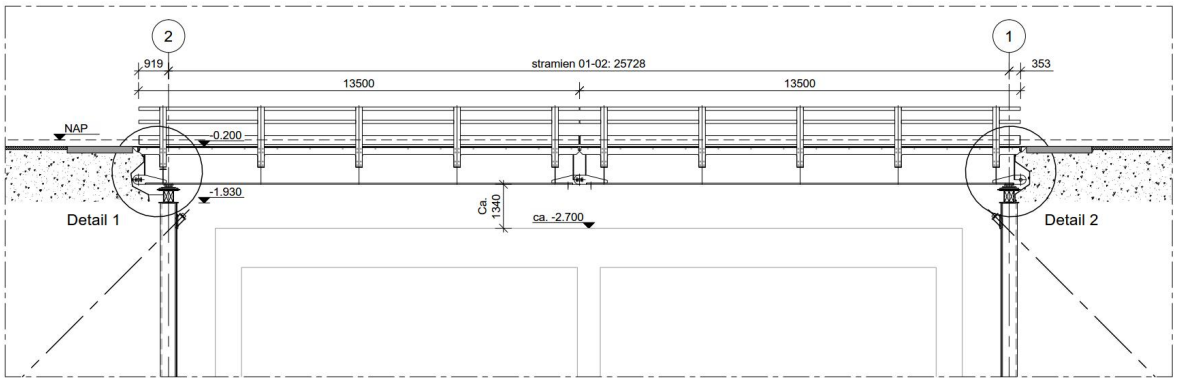


NB.:
De vaste oplegging wordt aan de oostzijde van de bouwkuip toegepast (steunpunt 1), de glijoplegging aan de westzijde (steunpunt 2);

6 Controle onderbouw

6.1 Schematisering

De hulpbrug wordt gefundeerd op:
- Steunpunt 1: Damwanden bouwkuip;
- Steunpunt 2: Damwanden bouwkuip;



Langsrichting hulpbrug:
In langsrichting van de hulpbrug is in horizontale zin uitgegaan van onderstaande schematisering:
- Steunpunt 1: Vaste oplegging → Rem- en wrijvingskrachten
- Steunpunt 2: Glijoplegging → Wrijvingskrachten

Dwarsrichting hulpbrug:
In dwarsrichting wordt de hulpbrug belast door wind. T.p.v. elk steunpunt wordt de bovenbouw van de hulpbrug hiertoe geblokkeerd op de onderbouw.

6.2 Controle onderbouw steunpunt 1 en 2

6.2.1 Belastingen

Uit de berekening van de bovenbouw volgen de belastingen op de onderbouw. De belastingen worden door een moerbalk overgebracht naar de damwanden. Per as worden 4 oplegpunten toegepast. De belastingen op de moerbalk bedragen (as 2 maatgevend):

Verticaal:

Oplegging	**Eigen gewicht** (rep.)	**Verkeer** (rep).
• Oplegging 1	90 kN	497 kN
• Oplegging 2	82 kN	441 kN
• Oplegging 3	82 kN	441 kN
• Oplegging 4	90 kN	497 kN

Horizontaal:
In horizontale zin wordt de damwand belast door een rem- en wrijvingskracht. De rembelasting is maatgevend en voor de wrijvingskracht wordt dus een momentane belasting aangehouden:

- $F_{Hor;rep} = 434 + 0{,}3 \cdot 217 = 499\,kN$

Bovenstaande belasting wordt gelijkmatig verdeeld over de 4 opleggingen.

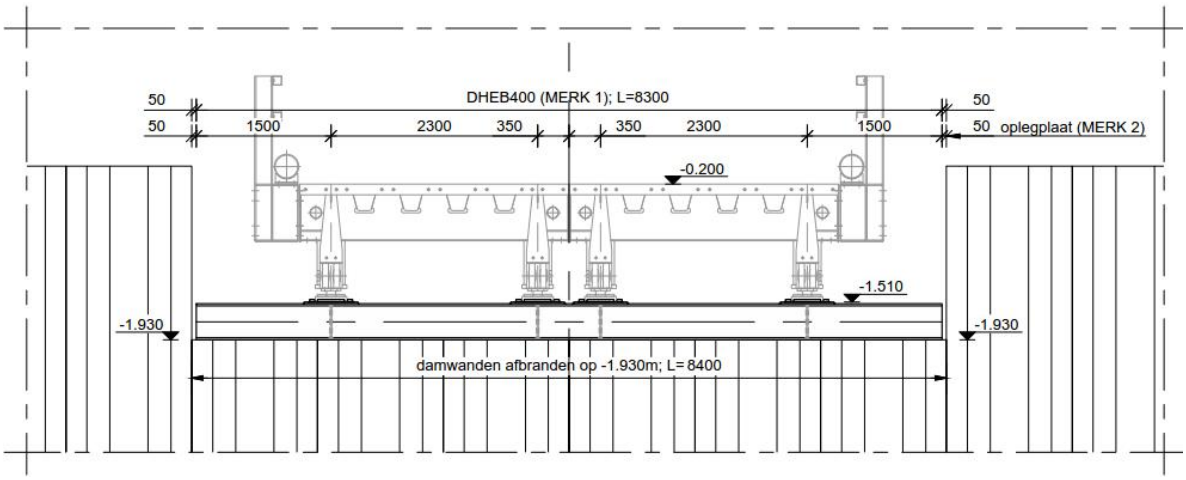
De hulpbrug heeft een hoogte van ca. 1,30 m en zit aan weerszijde opgesloten in een zand- en asfaltpakket. Bij een minimale verplaatsing van de hulpbrug, zal hier passieve gronddruk ontstaan. Uitgaande van een passieve gronddrukcoëfficiënt van 3,0 (ongunstig gezien het zandpakket dat aanwezig is) en een volumieke massa van 18,0 kN/m^2, bedraagt de passieve gronddruk:

- $\sigma'_{Hor;rep} = \frac{1{,}30}{2} \cdot (1{,}30 \cdot 18{,}0) \cdot 3{,}0 = 45{,}6\,kN/m$

NB.:
In de bouwkuip zullen geen voertuigen rijden, er is dus geen kans op aanrijdingsgevaar.

6.2.2 Controle moerbalk

De moerbalken worden uitgevoerd in dubbele HEB400-profielen (S235) met een lengte van 8,30 m. De moerbalk wordt opgelegd op de damwanden van de bouwkuip (damwanden h.o.h. 1,40 m geschematiseerd). Door de rem-en wrijvingskrachten worden de moerbalken ook in hun zwakke as belast.



Op basis van de oplegreacties uit de hulpbrug (zie bijlage 2), is in **bijlage 3** de krachtsverdeling in de moerbalken in hun zwakke as bepaald. Deze krachtsverdeling is ingevoerd bij de controle van de moerbalken in hun sterke as in **bijlage 4**. Aangezien er een dubbele balk wordt toegepast, zijn de belastingfactoren hierbij gehalveerd. Uit de controle m.b.v. TS Liggers volgt:

- $UC = 0{,}69 \leq 1{,}00 \rightarrow$ Voldoet

6.2.3 Controle damwanden

Uit de berekening van de moerbalken volgen de belastingen op de damwanden:

- Verticaal: $Q_{ver;d} = \frac{2 \cdot 329{,}3}{1{,}40} = 470\,\text{kN/m}$ (zie bijlage 4, blz. 4)
- Horizontaal: $Q_{hor;d} = \frac{2 \cdot 51{,}6}{1{,}40} = 74\,\text{kN/m}$ (zie bijlage 3, blz. 4)

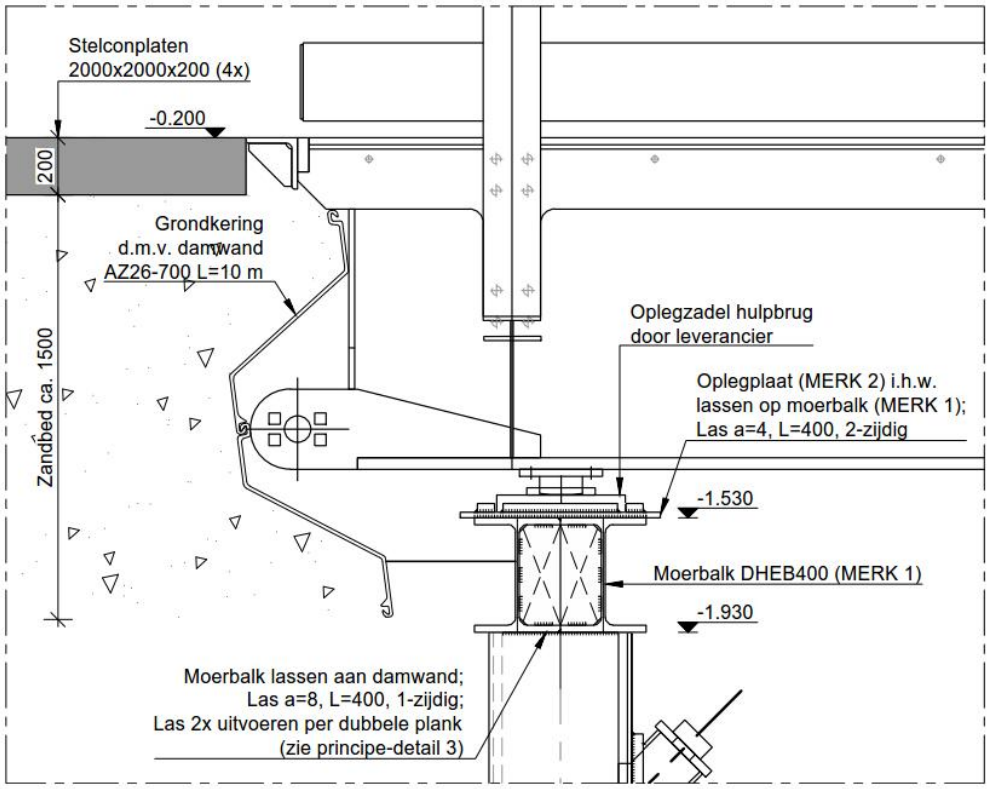
In berekening N23-222-O2302-91-BER-001 [1] zijn de damwanden (sectie 7) gecontroleerd op bovenstaande belastingen.

6.3 Detailcontroles

6.3.1 Fixatie bovenbouw

De hulpbrug wordt opgelegd op oplegzadels (4 stuks), welke standaard onderdeel vormen van de hulpbrug (zie ook tekening 5671-P02 [4]). T.b.v. de overdracht van de horizontale belasting worden deze zadels gelast op de moerbalken. Voor de horizontale belasting per zadel wordt uitgegaan van onderstaande belastingen:

- $F_{Hor;d;langs} = 1{,}35 \cdot \frac{499}{4} = 168\,kN$ (totale horizontale belasting verdeeld over 4 zadels)
- $M_{d;langs} = 0{,}08 \cdot 168 = 13{,}5\,kNm$ (excentriciteit 80 mm)
- $F_{Hor;d;dwars} = 1{,}35 \cdot \frac{124}{4} = 42\,kN$ (totale horizontale belasting verdeeld over 4 zadels)
- $M_{d;dwars} = 0{,}08 \cdot 42 = 3{,}4\,kNm$ (excentriciteit 80 mm)



<u>Controle las a=4, L=400 mm, 2-zijdig:</u>

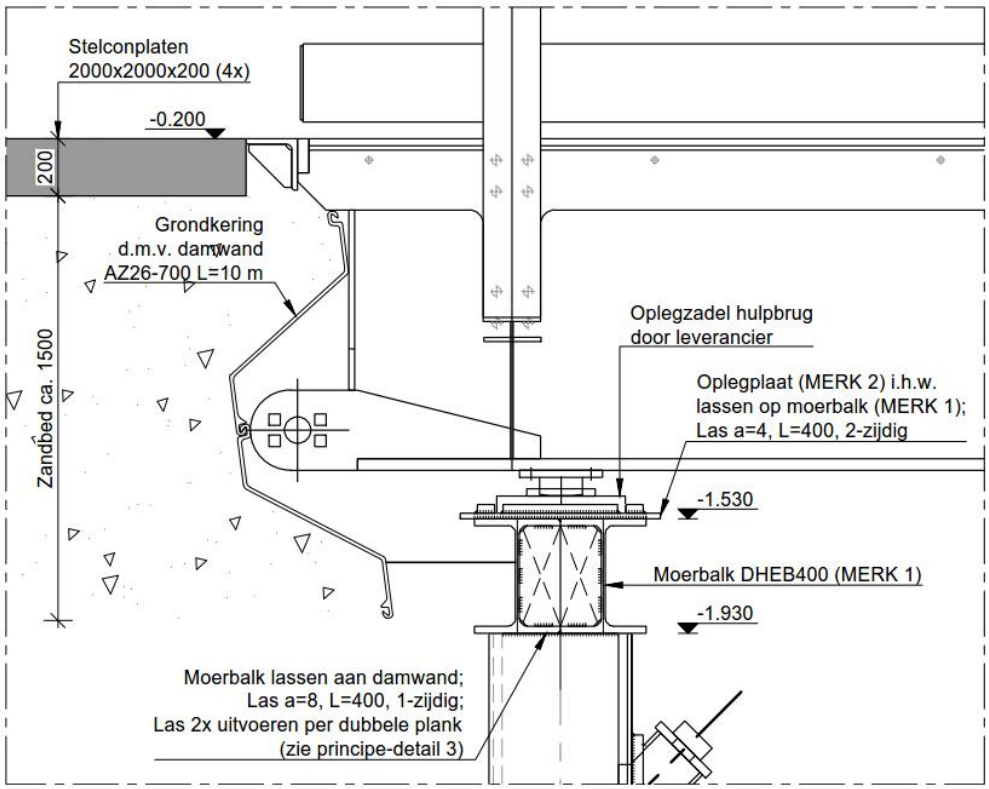
Voor de lascontrole wordt verwezen naar **bijlage 5**. Hieruit volgt:

- $UC_{max} = 0{,}40 \quad \leq 1{,}00 \rightarrow$ Voldoet

6.3.2 Fixatie moerbalk

T.b.v. de afdracht van de horizontale belastingen wordt de moerbalk gelast op de damwanden. De belastingen op de lasverbinding bedragen (per dubbele plank):

- $F_{Ver;d;} = 2 \cdot 329{,}3 = 659\,kN$ (zie bijlage 4, blz. 4)
- $F_{Hor;d;langs} = 2 \cdot 51{,}6 = 103\,kN$ (zie bijlage 3, blz. 4)
- $M_{d;langs} = 0{,}48 \cdot 103 = 49{,}5\,kNm$ (excentriciteit 480 mm)
- $F_{Hor;d;dwars} = 1{,}35 \cdot \frac{124}{4} = 42\,kN$ (belasting per oplegzadel aangenomen)
- $M_{d;dwars} = 0{,}48 \cdot 42 = 20{,}1 kNm$ (excentriciteit 480 mm)



<u>Controle las a=8, L=400 mm, 2-zijdig:</u>

Voor de lascontrole wordt verwezen naar **bijlage 6**. Hieruit volgt:

- $UC_{max} = 0{,}92 \quad \leq 1{,}00 \rightarrow$ Voldoet

6.3.3 Krachtsinleiding

Moerbalk as 1 en 2 – HEB400:

Invoergegevens:

- $R_{E;d}$ = 394 kN Oplegreactie uit hulpbrug per HEB400
- $M_{E;d}$ = 164 kNm Zie bijlage 4
- c = 15 mm
- x = 700 mm Tussenoplegging

Uitvoergegevens (zie **bijlage 7**):

- UC = 0,64
- Krachtsinleiding **voldoet** → **Praktisch toch plooischotten toepassen t.p.v. oplegzadels**

Bijlagen

Bijlage 1 Berekening bovenbouw hulpbrug

Projectnr.: **5671**

Werk: **RLB 27x6m N23 KW15b Binnenwijzen**

Onderdeel: **Statische berekening**

Auteur: **Ir. M.M. Kaczmarek, RC**

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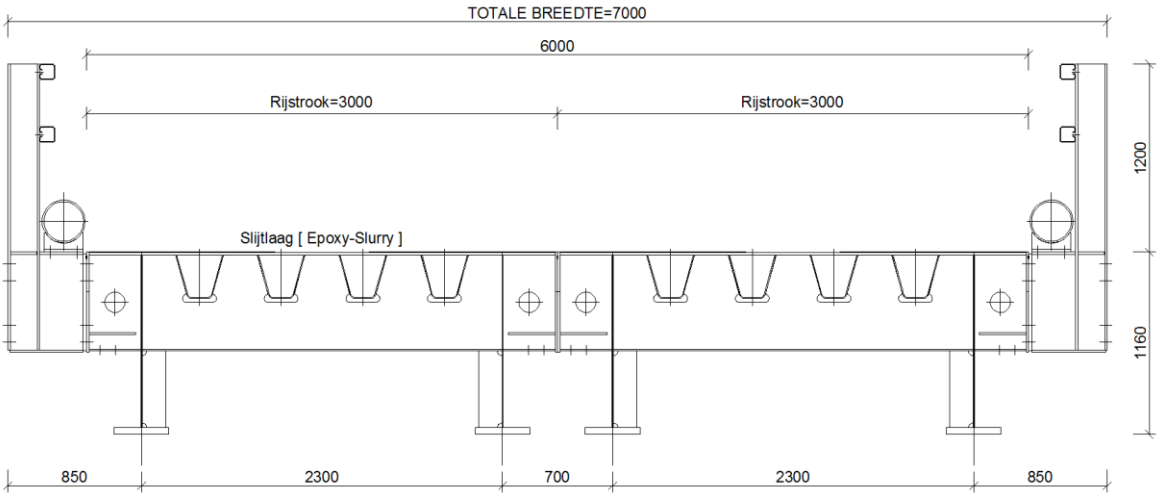
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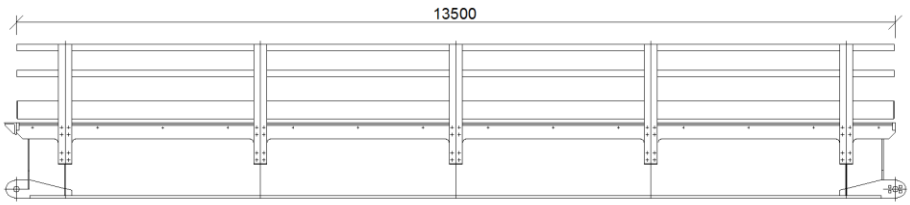
1 Inleiding

In opdracht van Retro Bridge wordt in deze berekening de oplegreacties bepaald en de RLB brug getoetst. De brug wordt aan beide zijden op damwanden opgelegd. De damwanden en de onderslagbalken zijn geen onderdeel van dit rapport.

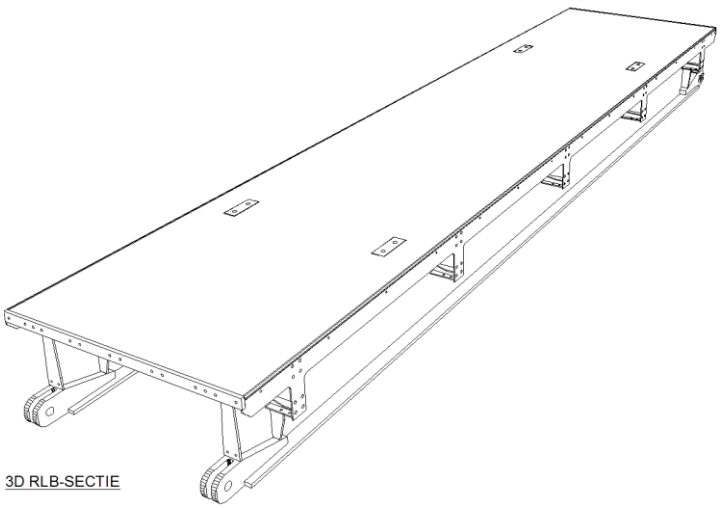
De RLB is opgebouwd uit 4 brugsecties van 3m breed bij 13,5m lang. De secties worden in de breedterichting aan elkaar gebout ter plaatse van de dwarsdragers. In de lengterichting worden de secties ter hoogte van het dek aan elkaar gebouwd. De onderflenzen worden gekoppeld d.m.v. een pen-gaat verbinding.



DOORSNEDE RLB BRUG



AANZICHT RLB-SECTIE



3D RLB-SECTIE

2 Projectgegevens

2.1 Algemeen

Plaats:	Zwaag	
Hulpbrug:	RLB Systeembrug van Retro Bridge BV	
Materiaal:	S355 / S460	
Overspanning:	25,736m^1	
Breedte brug:	2x3,00m =	6,00m^1
	- Rijstrook 1	3,00m^1
	- Rijstrook 2	3,00m^1
		---------- +
		6,00m^1
Verkeer	Belastingmodel 1 en 2 vlgs. NEN-EN 1991-2	

2.2 Toegepaste voorschriften

NEN-EN 1991-2	Belastingen op constructies – Deel 2 Belastingen op bruggen
NEN-EN 1993-1-1	Ontwerp en berekening van staalconstructies – Algemene regels voor gebouwen
NEN-EN 1991-1-4	Belastingen op constructies - Deel 1-4: Algemene belastingen – Windbelasting
NEN-EN 1993-1-8	Ontwerp en berekening van staalconstructies – ontwerp en berekening van verbindingen
NEN-EN 1993-2	Ontwerp van staalconstructies – stalen bruggen

3 Belastingen

3.1 Eigen gewicht

Gewicht per m^1	RLB standaard element	11,0 kN/m^1
	RHB vangrail	1,5 kN/m^1

3.2 Verkeersbelasting

Aantal rijbanen: = 2 rijbanen
Resterend oppervlak: geen

Belastingsmodel 1 (LM1)

Rijstrook 1,	TS:	$Q_{1;k}$	= 300 kN	α_Q = 1,0
	UDL:	$q_{1;k}$	= 9,0 kN/m^2	α_q = 1,0
Rijstrook 2,	TS:	$Q_{2;k}$	= 200 kN	α_Q = 1,0
	UDL:	$q_{2;k}$	= 2,5 kN/m^2	α_q = 1,0

3.3 Horizontale belasting

Remkrachten:

NEN – EN 1991-2, 4.4.1 NEN-EN 1991-2, 4.4.2(4):

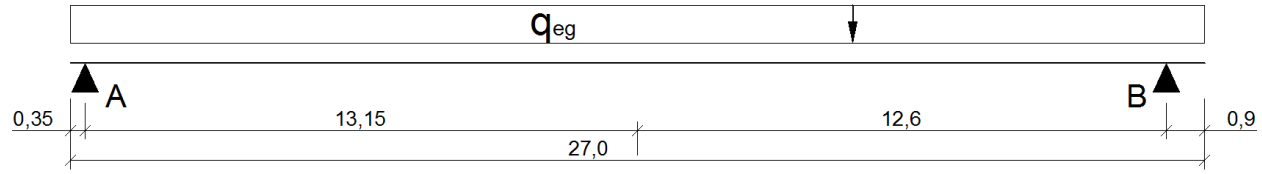
RLB, bruglengte 27,0m:

$F_{l;b;k}$ = 0,6x 1,0x (2x300) + 0,10x 1,0x 9,0x 3,0x 27,0 = 433 kN

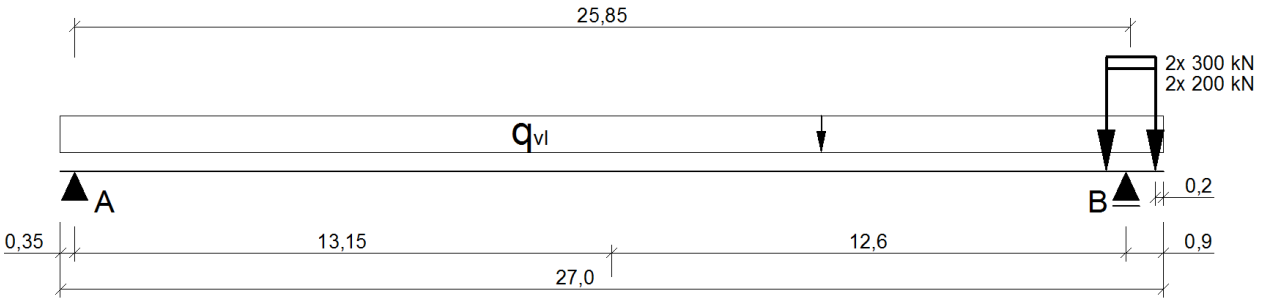
Wrijving:

F_{WR} = μ x (EG + 50%VL)

Wrijvingscoëfficiënt staal op staal : μ = 0,20



Schema over as van de brug



Schema over as van de brug Aslast Q_v =(300+200) x 2 = 1000 kN

$R_{A;EG}$ = (2x11,0 + 2x1,5) x 27,0 x12,6/25,75 = 330 kN
$R_{B;EG}$ = (2x11,0 + 2x1,5) x 27,0 x13,15/25,75 = 345 kN

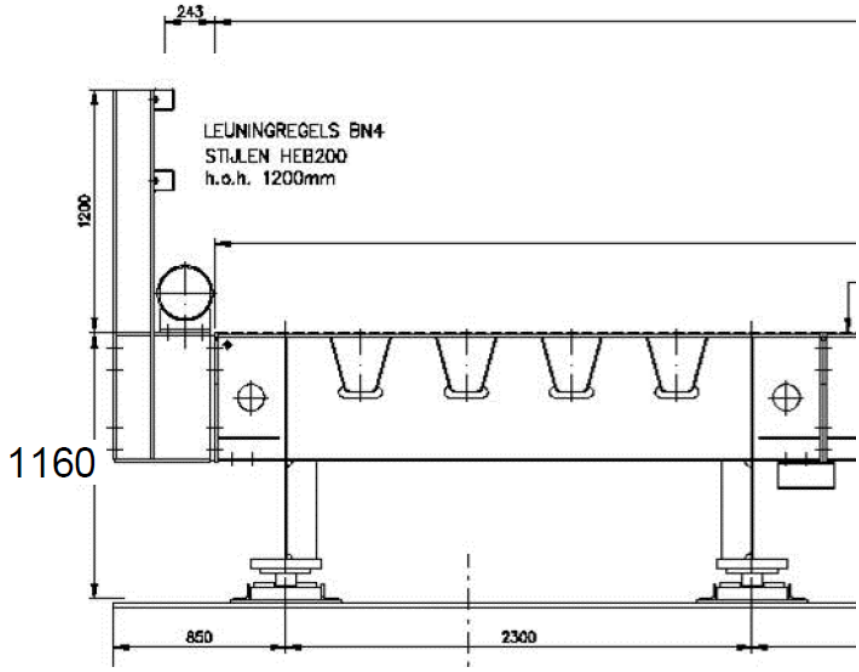
$R_{B;Q;I;k}$ = 1000 x 25,85/25,75 = 1004 kN
$R_{B;Q;I;k}$ = 1000 - 1004 = -4 kN

$R_{A;UDL}$ = (3,0x9 + 3,0x2,5) x 27,0 x12,6/25,75 = 456 kN
$R_{B;UDL}$ = (3,0x9 + 3,0x2,5) x 27,0 x13,15/25,75 = 476 kN

F_{WR} = 0,2 x [345 + 0,5 x (1004 + 456)] = 215 kN

Wind:
Wind belasting volgens NEN-EN 1991-1-4 en NB:

Wind zonder verkeer:



Windoppervlakte wind zonder verkeer RLB

Bepaling van de windbelasting (NEN-EN 1991-1-4/NB)			
Hoogte	z =	7,5 m	*gem. hoogte, veilige aanname*
	c_{dir} =	1	*windrichtingsfactor*
	c_{season} =	1	*seizoensfactor*
	k_I =	1	*aanbevolen turbulentiefactor*
Wind snelheid	$v_b = v_{b,0}$ =	29,5 m/s	*basissnelheid Windgebied I*
	z_0 =	0,2 m	*ruwheidslengte (onbebouwd)*
	k_r =	0,209	*terreinfactor (vergelijking 4.5)*
	c_r =	0,76	*ruwheidsfactor (vergelijking 4.4)*
Vergelijking 4.3	v_m =	22,4 m/s	*gemiddelde windsnelheid*
Luchtdichtheid	ρ =	1,25 kg/m^3	
Vergelijking 4.10	q_b =	0,544 kN/m^2	*basisstuwdruk*
Vergelijking 4.6	σ_v =	6,166	*standaardafwijking*
Vergelijking 4.7	I_v =	0,275	*turbulentie-intensiteit*
Vergelijking 4.8	q_p =	0,917 kN/m^2	*extreme stuwdruk*

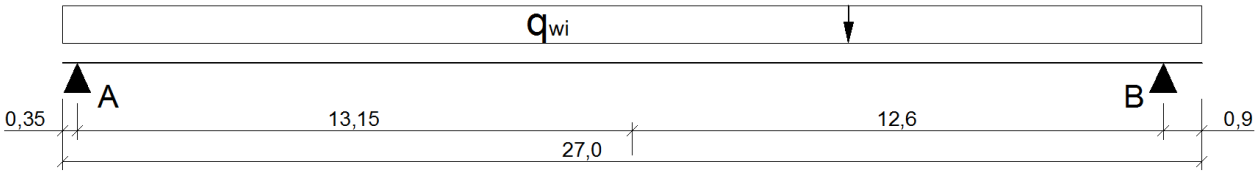
Totale breedte b= 7,2 meter
Totale dikte windband d= 1,16 m + 1,2 m = 2,36 m

b/d = 7,2 / 2,36 = 3,05 → Figuur 8.3 → $c_{fx,0}$ = 1,6
Vergelijking 4.9: $c_e(z)$ = 0,917 / 0,544 = 1,686 → C = 1,6 x 1,686 = 2,7

$p_{w;k}$ = 0,917 x 2,7 = 2,48 kN/m^2

De vangrail wordt als volledig dicht beschouwd :
q_w = 2,36 m x 2,48 = 5,85 kN/m^1

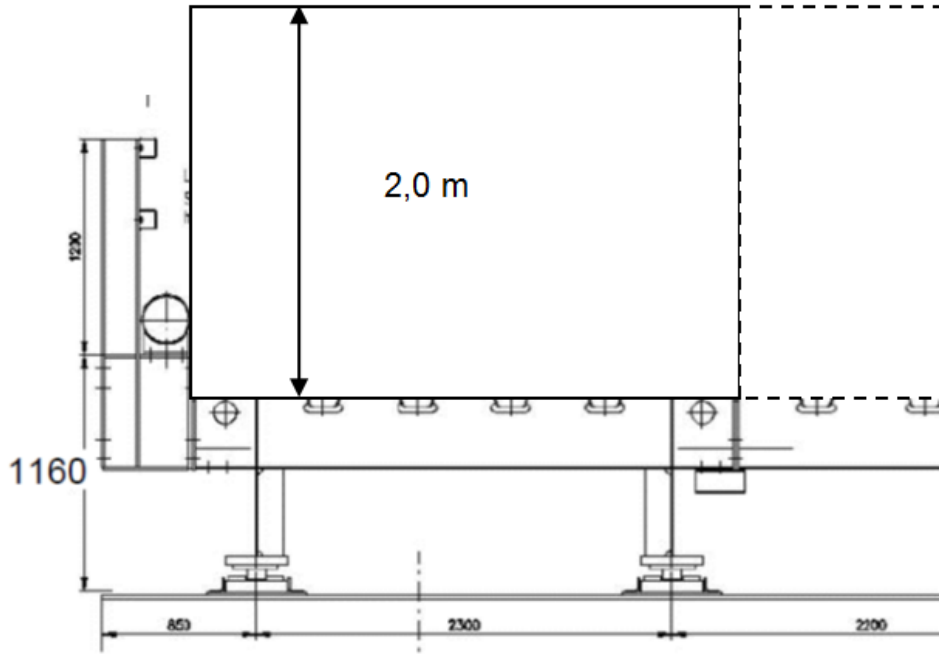
Horizontale oplegreactie uit wind zonder verkeer per as:



Schema over as van de brug

$R_{A;WZV}$ = 5,85 x 27,0 x12,6/25,75 = 77 kN
$R_{B;WZV}$ = 5,85 x 27,0 x13,15/25,75 = 81 kN

Wind met verkeer:



Windoppervlakte wind met verkeersband RLB

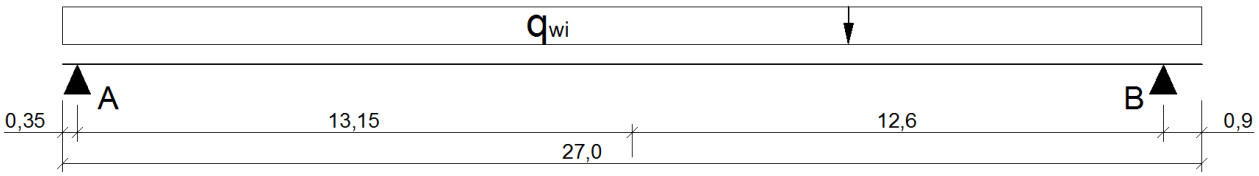
Bepaling van de windbelasting (NEN-EN 1991-1-4/NB)			
Hoogte	z =	8,0 m	*gem. hoogte; veilige aanname*
	c_{dir} =	1	*Windrichtingsfactor*
	c_{season} =	1	*Seizoensfactor*
	k_I =	1	*aanbevolen turbulentiefactor*
Wind snelheid	$v_b = v_{b,0}$ =	29,5 m/s	*basissnelheid Windgebied I*
	z_0 =	0,2 m	*ruwheidslengte (onbebouwd)*
	k_r =	0,209	*terreinfactor (vergelijking 4.5)*
	c_r =	0,77	*ruwheidsfactor (vergelijking 4.4)*
Vergelijking 4.3	v_m =	22,7 m/s	*gemiddelde windsnelheid*
Luchtdichtheid	ρ =	1,25 kg/m^3	
Vergelijking 4.10	q_b =	0,544 kN/m^2	*basisstuwdruk*
Vergelijking 4.6	σ_v =	6,166	*standaardafwijking*
Vergelijking 4.7	I_v =	0,272	*turbulentie-intensiteit*
Vergelijking 4.8	q_p =	0,935 kN/m^2	*extreme stuwdruk*

Totale breedte b= 7,2 meter
Totale dikte windband d= 1,16 m + 2,0 m = 3,16 m

b/d = 7,2 / 2,36 = 2,3 → Figuur 8.3 → $c_{fx,0}$ = 1,8
Vergelijking 4.9: $c_e(z)$ = 0,935 / 0,544 = 1,72 → C = 1,8 x 1,72 = 3,1

$p_{w;k}$ = 0,935 x 3,1 = 2,9 kN/m^2
q_w = 3,16 m x 2,9 = 9,16 kN/m^1

Horizontale oplegreactie uit wind zonder verkeer per as:



Schema over as van de brug

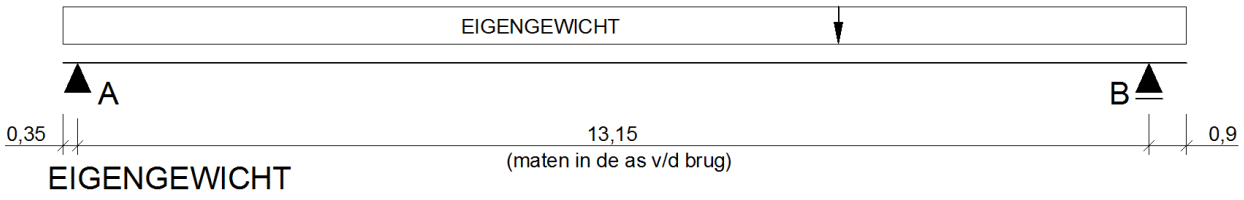
$R_{A;WZV}$ = 9,16 x 27,0 x12,6/25,75 = 121 kN
$R_{B;WZV}$ = 9,16 x 27,0 x13,15/25,75 = 126 kN

4 Overzicht belastinggeneraties STAAD.Pro

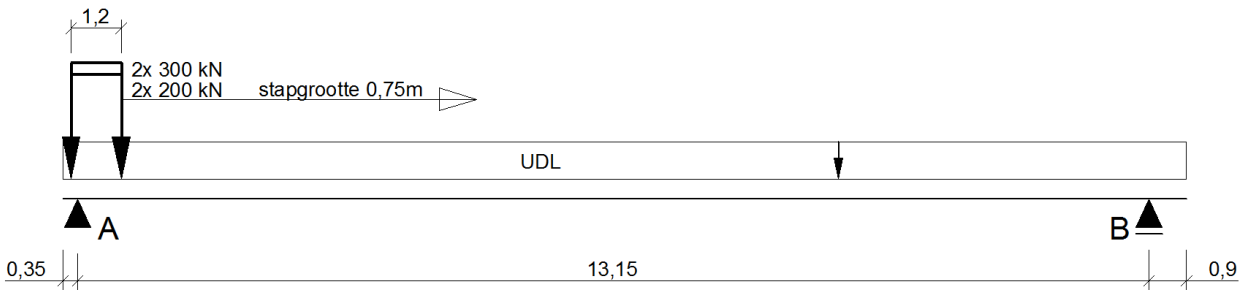
1	Eigen gewicht
100	VL1 Verkeer links : Rijbaan 1 (gelijkmatig verdeelde belasting - UDL)
101 t/m 135	Lopende aslasten van belastinggeval VL1, incl. UDL
200	VL2 Verkeer links : Rijbaan 1 + Rijbaan 2 (gelijkmatig verdeelde belasting - UDL)
201 t/m 235	Lopende aslasten van belastinggeval MB, incl. UDL

- zie de schema's op de volgende bladzijden
- de aslasten zijn als lopende lasten met een stapgrote van 0,75m berekend
- de resultaten van de STAAD.Pro berekening zijn getoetst aan de capaciteiten van de Standaard berekening (Standard calculation)

Schema belastinggevallen StaadPro :



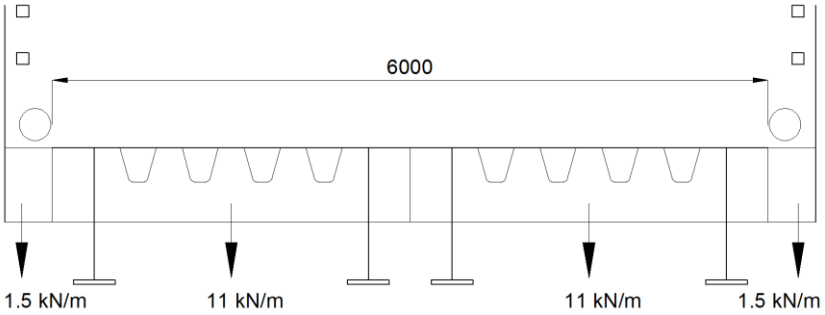
EIGENGEWICHT



VERKEER VLGS NEN-EN 1991-2 (Belastingsmodel 1)

5 Belastinggevallen – schema's

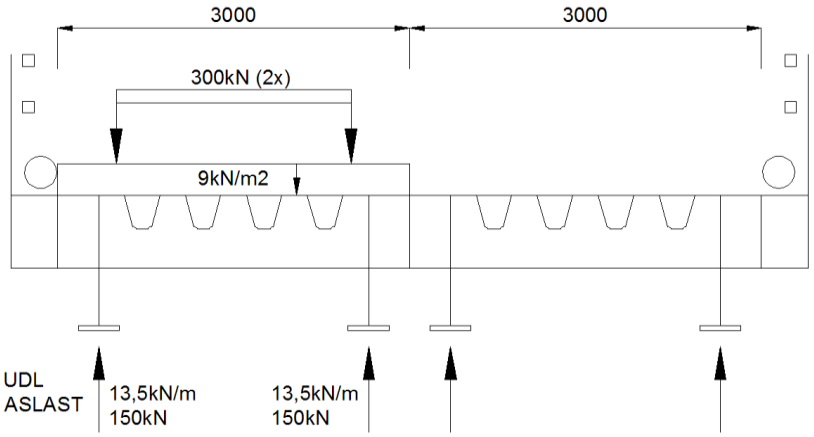
5.1 Eigen gewicht



BG Eigen Gewicht

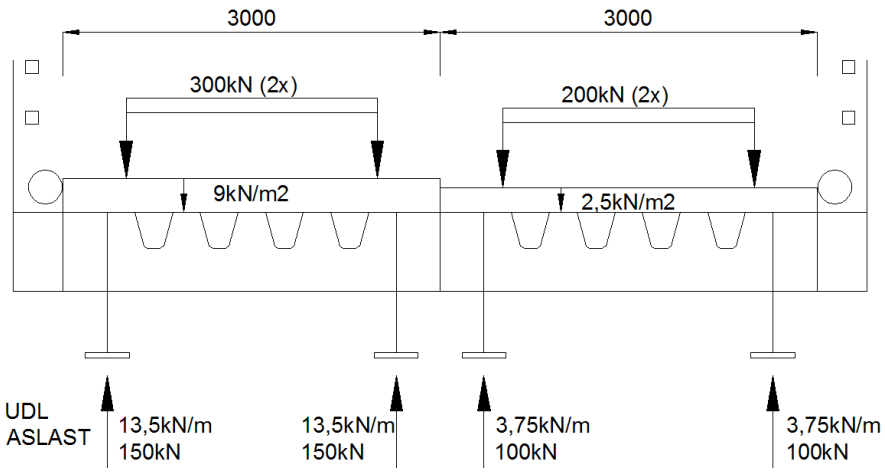
5.2 Verkeer

Verkeer VL1 Links – Rijbaan 1



BG Verkeer VL1 Links – Rijbaan 1

Verkeer VL2 Links – Rijbaan 1 + Rijbaan 2



BG Verkeer VL2 – Rijbaan 1 + Rijbaan 2

6 Veiligheidsfactoren

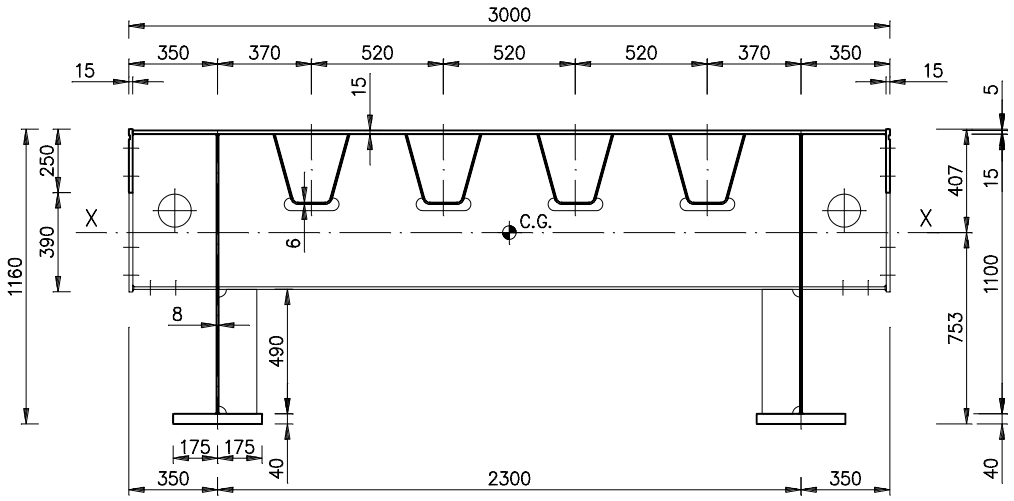
Eigen gewicht	ongunstig	$\gamma_F = 1,2$
	gunstig	$\gamma_F = 0,9$
Verkeersbelastingen		$\gamma_Q = 1,35$
Overige veranderlijke belastingen		$\gamma_Q = 1,5$

7 Belastingcombinaties

Bekeken belastingcombinaties:

Belastingcombinatie 1	Eigen gewicht + verkeer 1,2 x EG + 1,35 x VL
Belastingcombinatie 2	Eigen gewicht (gunstig) + wind 0,9 x EG + 1,5 x WI
Belastingcombinatie 3	Eigen gewicht + verkeer + 0,3 x wind (met verkeer) 1,2 x EG + 1,35 x VL + 0,3 x 1,5 x Wind

8 Statische waarden brugsectie

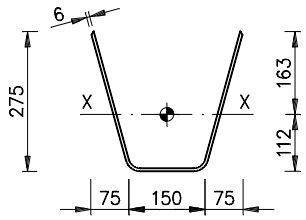


Statische waarden brugsectie:

Dek	A = 445,5 cm2	I = 84 cm4	e = 114,8 cm
Zijplaten	75,0	3906	103,5
Langsverstijvingen	166,0	12740	97,7
Lijf	176,0	177467	59,0
Onderflens	280,0	373	2,0

Totaale doorsnede:

A = 1142 cm2 Ixx = 2583767 cm4 ex = 75,3 cm



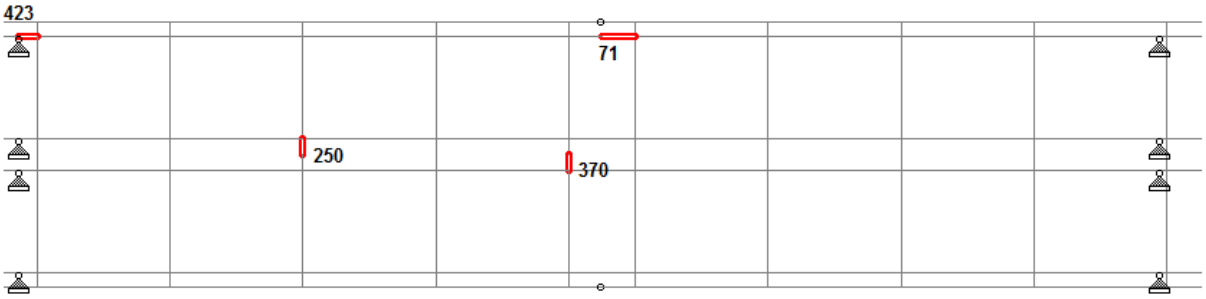
Langsverstijvingen:

A = 41.5 cm2
Ixx = 3185 cm4
ex = 11,2 / 16,3 cm

9 Snedekrachten

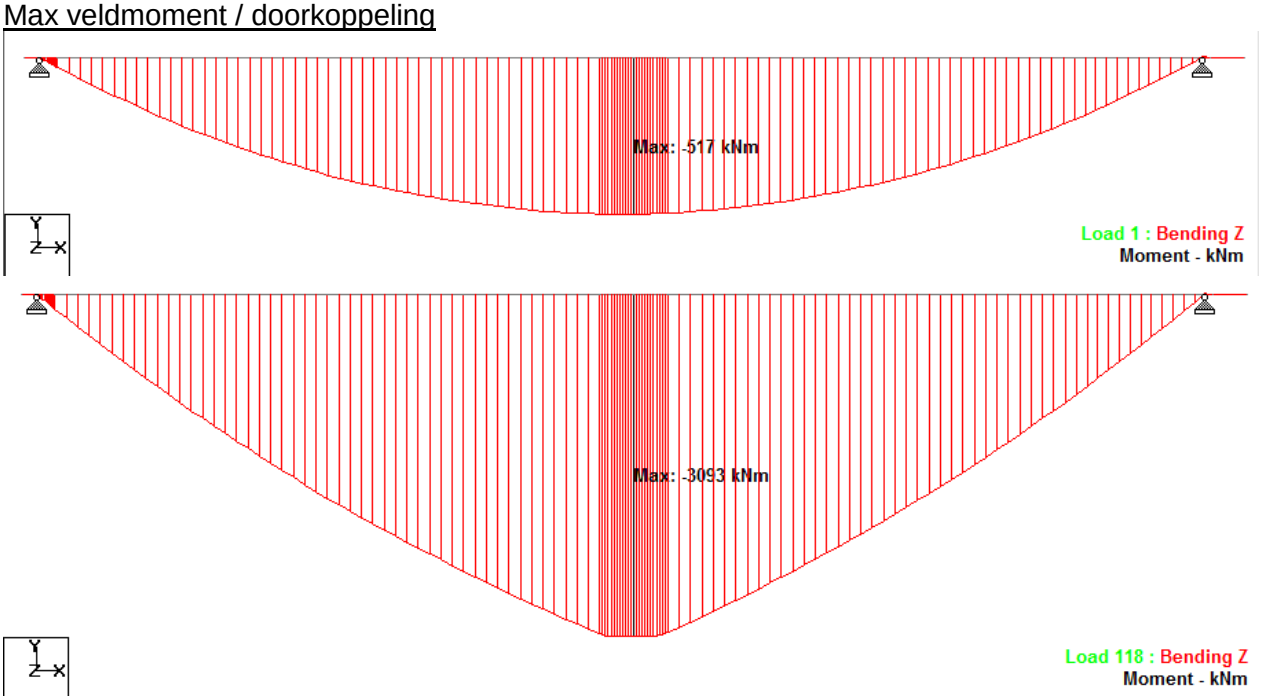
9.1 Overzicht maatgevende staven

(voor de krachten zie de Bijlagen)



9.2 Hoofddrager

Max veldmoment / doorkoppeling

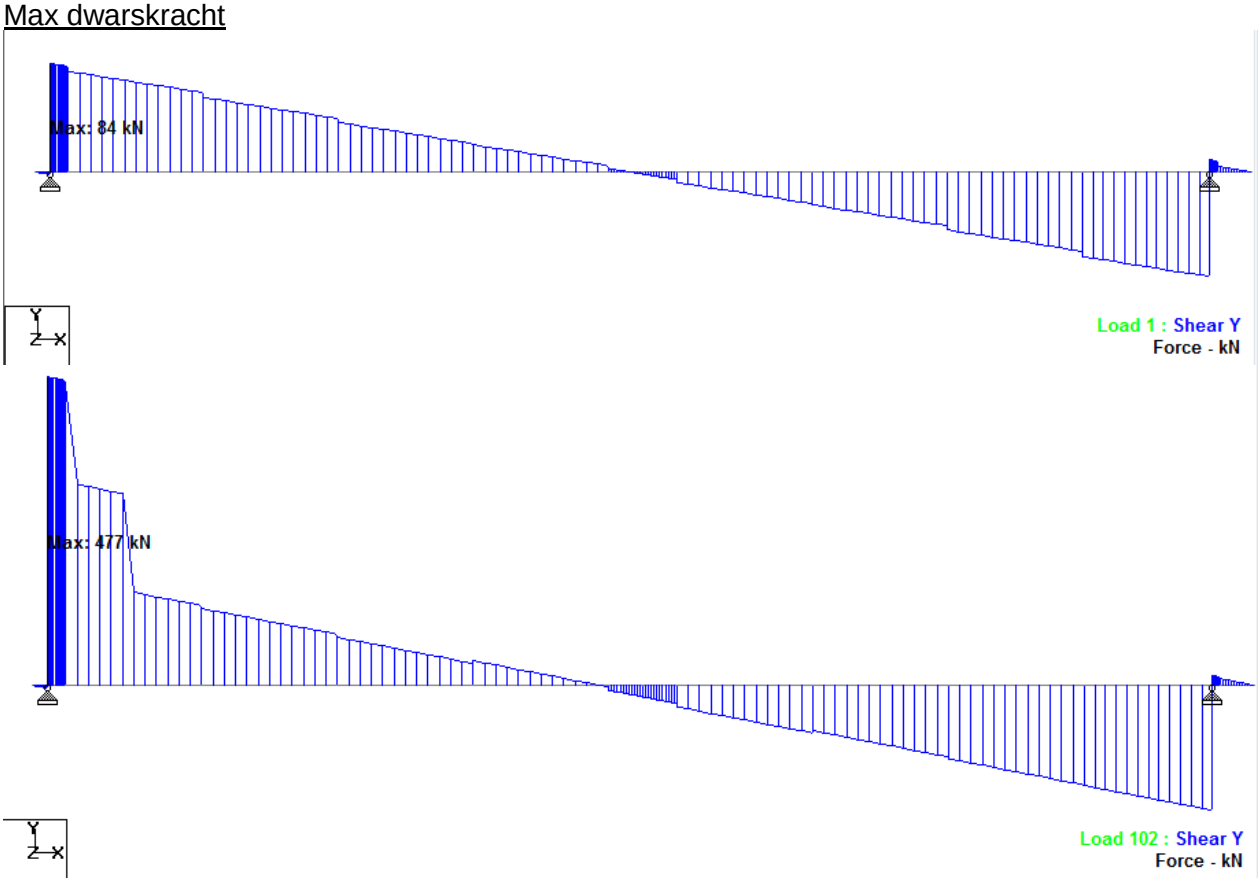


- Beam 71, L/C1, node 12 M = 517 kNm[1]
- Beam 71, L/C118, node 12 M = 3093 kNm[1]

BC1: 1,2 x LC1 + 1,35 x LC118

M_{Ed} = 1,2 x 517 + 1,35 x 3093 = 4796 kNm
V_{Ed} = 0

Max dwarskracht



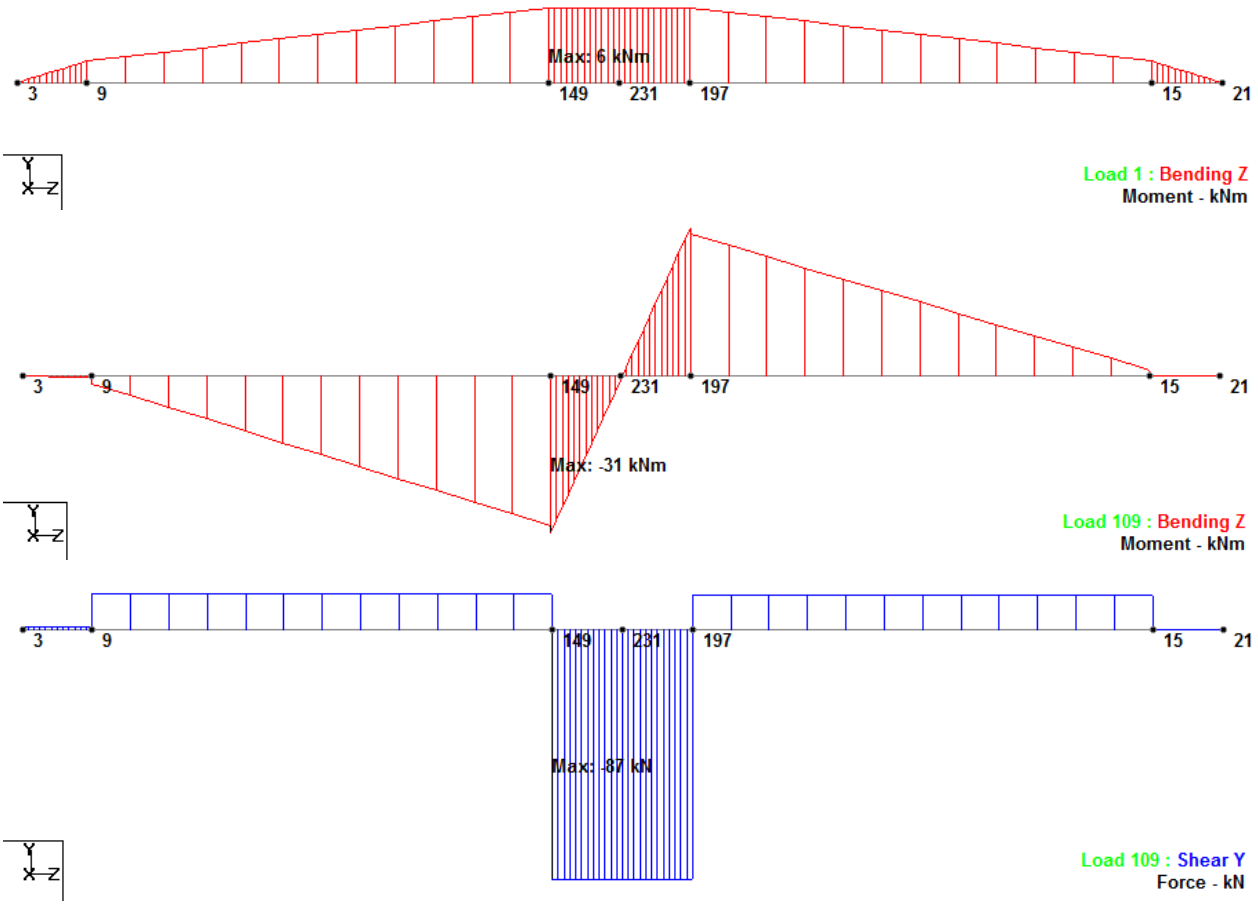
- Beam 423, L/C1, node 259 V = 84 kN
- Beam 423, L/C102, node 259 V = 477 kN

BC1: 1,2 x LC1 + 1,35 x LC102

M_{Ed} = 0
V_{Ed} = 1,2 x 84 + 1,35 x 477 = 745 kN

9.3 Dwarsdrager

Max moment en dwarskracht



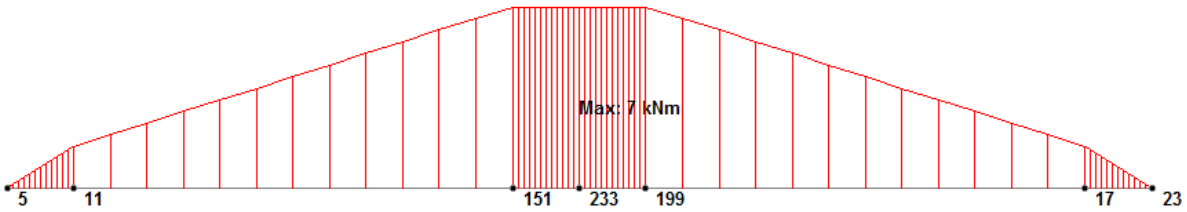
- Beam 250, L/C1, node 149 V = 0 kN M = -6 kNm[1]
- Beam 250, L/C109, node 149 V = 87 kN M = 31 kNm[1]

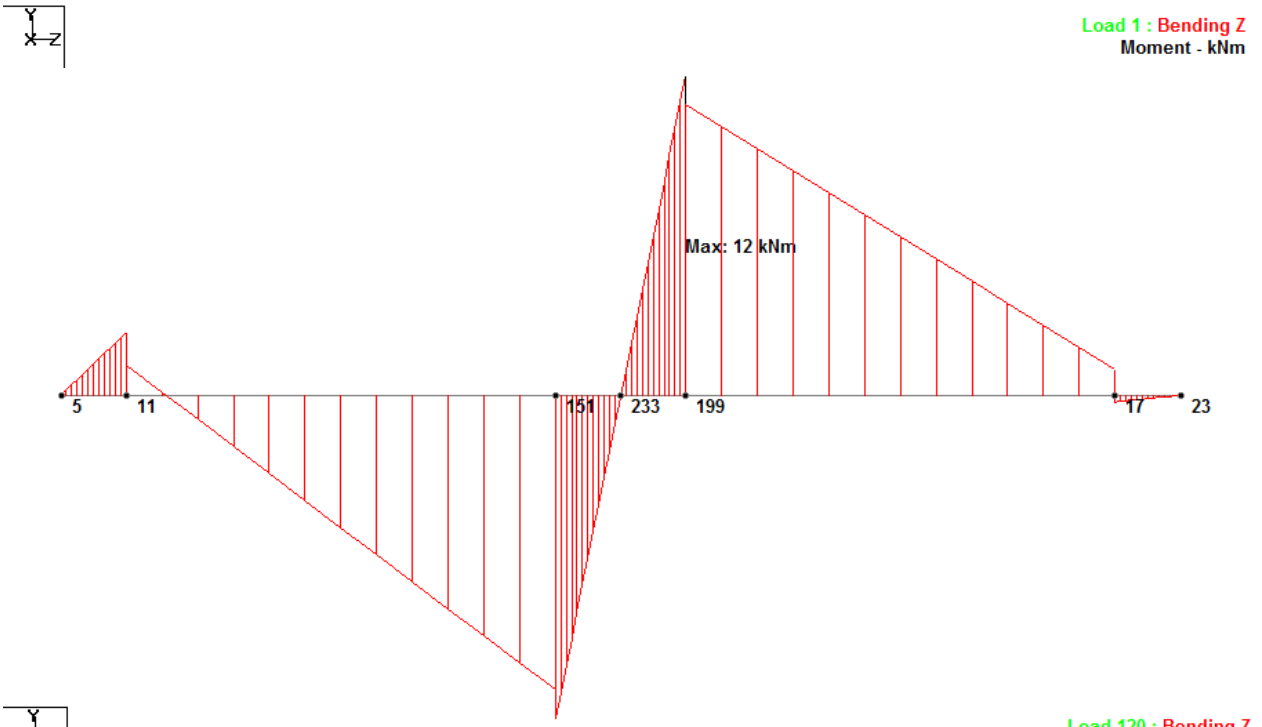
BC2: 0,9 x LC1 + 1,35 x LC109

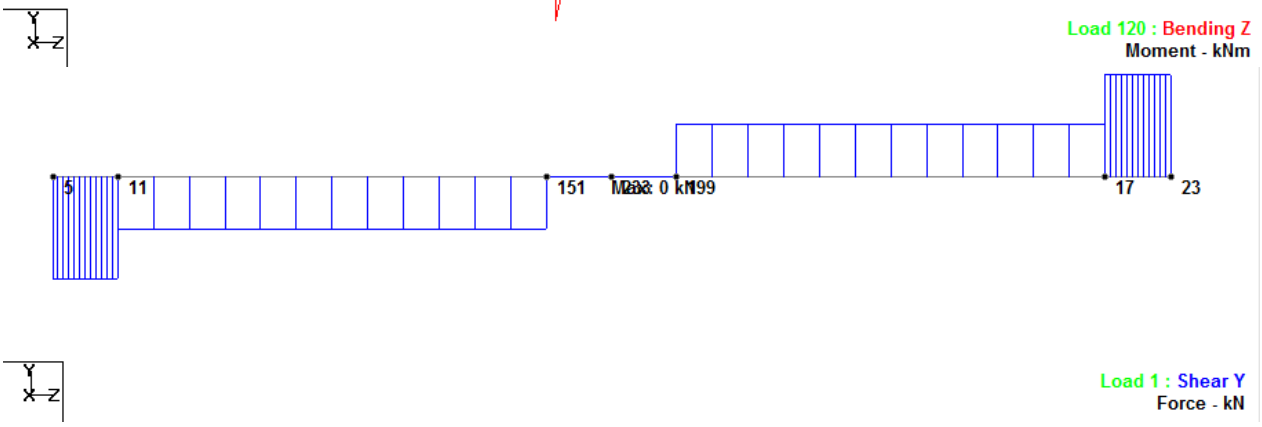
M_{Ed} = - 0,9 x 6 + 1,35 x 31 = 36 kNm
V_{Ed} = 1,35 x 87 = 117 kN

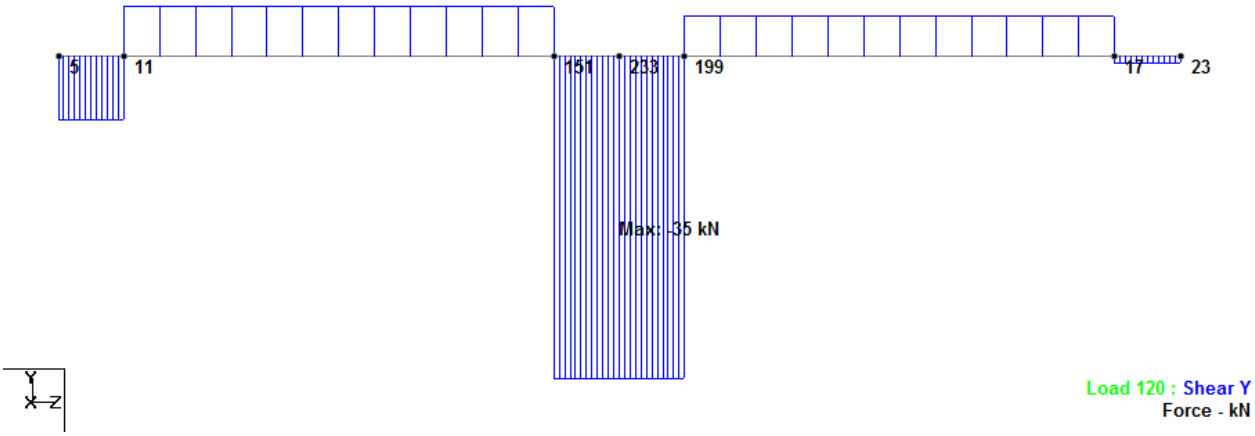
9.4 Koppeling dwarsdragers

Max moment en dwarskracht









- Beam 370, node 199, L/C1 V ≈ 0 kN M = -7 kNm[1]
- Beam 370, node 199, L/C120 V = 35 kN M ≈ 0 kNm[1]

BC1: 1,2 x LC1 + 1,35 x LC120

M_{Ed} = 1,2 x 7 = -8,4 kNm
V_{Ed} = 1,35 x 35 = 47 kN

10 Controles

10.1 Hoofdligger

Hoofdligger

Hoofdligger moment : M_{Ed} = 4796 kNm

Momentcapaciteit van een sectie : $M_{c,Rd}$ = 14349 kNm[1] (voor 2 hoofdliggers)
(zie Standard calculation Page 18)

u.c. = 4796 / 0,5x14349 = 0,67 < 1 OK

Hoofdligger dwarskracht : V_{Ed} = 745 kN

Dwarskrachtcapaciteit van een sectie : $V_{pl,Rd}$ = 4674 kN (voor 2 hoofdliggers)
(zie Standard calculation Page 18)

u.c. = 745 / 0,5x4674 = 0,32 < 1 OK

Standaard RLB oplegging : F_{Ed} = 759 kN (vaste oplegging)
Capaciteit oplegging : F_{Rd} = 2907 kN (zie Standard calculation Page 26)

u.c. = 759 / 2907 = 0,26 < 1 OK

RHB oplegging : F_{Ed} = 779 kN (glijoplegging)

Capaciteit oplegging : F_{Rd} > 865 kN (zie Hoofdstuk 11)

u.c. = 779 / 865 = 0,90 < 1 OK

Hoofdligger doorkoppeling (mv verbinding) – positieve moment

Hoofdligger doorkoppeling (mv verbinding) moment :

M_{Ed} = 4796 kNm[1]

moment capaciteit van een doorkoppeling (mv verbinding) :

M_{Rd} = 6696 kNm[1] (voor 1 hoofdligger)
(zie Standard calculation Page 46)

u.c. = 4796 / 6696 = 0,72 < 1 OK

10.2 Dwarsdrager

Buiging:

Dwarsdrager moment : M_{Ed} = 36 kNm

Moment capaciteit van een dwarsdrager : $M_{c,Rd}$ = 584 kNm (zie Standard calculation Page 31)

u.c. = 36 / 584 = 0,06 < 1 OK

Dwarskracht:

Dwarsdrager schuifkracht : V_{Ed} = 117 kN

Schuifcapaciteit van een dwarsdrager : $V_{c,Rd}$ = 492 kN (zie Standard calculation Page 31)

u.c. = 117 / 492 = 0,24 < 1 OK < 0,5, interactie moment + dwarskracht is niet maatgevend

10.3 Dwarsdragerverbinding

Verbinding:

8 bouten M30 10.9

Buiging:

Dwarsdragerverbinding moment : M_{Ed} = 8,4 kNm (positief)

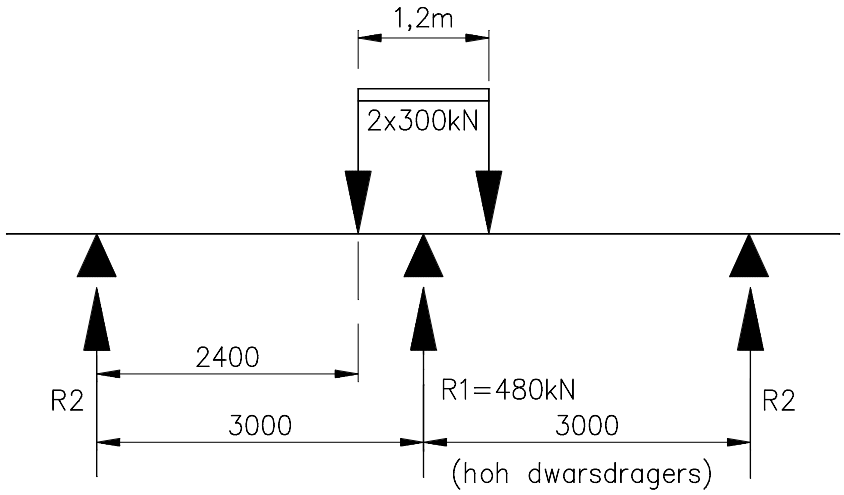
Moment capaciteit : M_{Rd} = 492 kNm (zie Standard calculation Page 38)

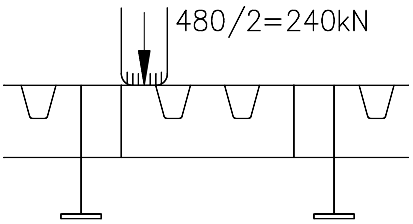
u.c. = 8,4 / 492 = 0,02 < 1 OK (lokale effecten zijn maatgevend, zie Standard Calculation)

Dwarskracht:

Dwarsdragerverbinding dwarskracht : V_{Ed} = 117 kN (globaal, uit StaadPro)

Extra dwarskracht (voertuig boven de dwarsdrager van de tussenelement) :





V_{Ed} ≈ 240 kN (lokaal)

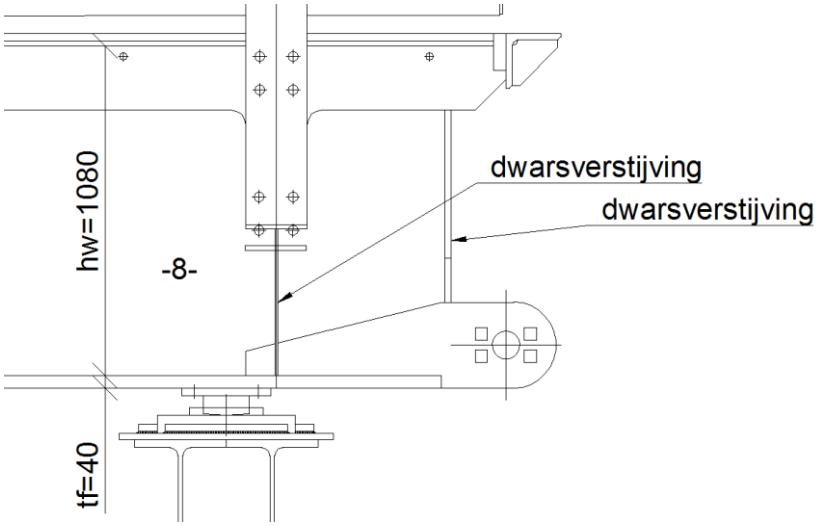
Dwarskrachtcapaciteit capaciteit : $V_{j,Rd}$ = 1008 kN (zie Standard calculation Page 38)

u.c. = (117+240) / 1008 = 0,35 < 1 OK

11 Capaciteit RHB oplegging

11.1 Dwarskrachtcapaciteit

Oplegging wordt beschouwd als oplegging met een niet-stijve vertsijving (enkel de dichtstbijzijnde dwarsverstijving wordt meegenomen, veilige conservatieve aanname).



$\varepsilon = (23.5 / f_{yk})^{0.5} = (23.5 / 46.0)^{0.5} = 0.71$ [-]

$72 / \eta \times \varepsilon = 72 / 1.20 \times 0.71 = 42.6$ [-] (EC3-1-5 5.1)

$h_w / t = 108 / 0.8 = 135 > 42.6$ → lijf dient gecontroleerd worden op dwarskracht

$V_{b,Rd} = V_{bw,Rd} + V_{bf,Rd} \leq \eta \times f_{yw} \times h_w \times t / (\sqrt{3} \times \gamma_{M1})$ (EC3-1-5 5.2)

$V_{bw,Rd} = \chi_w \times f_{yw} \times h_w \times t / \sqrt{3} / \gamma_{M1}$

waarin: $f_{yw} = 46.0$ kN/cm^2

$h_w = 108$ cm

$t = t_w = 0.8$ cm

$\gamma_{M1} = 1.0$

$\overline{\lambda_w} = (h_w / t) / (86.4 \times \varepsilon)$ (EC3-1-5 5.3)

$\overline{\lambda_w} = (108 / 0.8) / (86.4 \times 0.71) = 2.2$ [-]

$\overline{\lambda_w} > 1.08$ → $\chi_w = 0{,}83/\overline{\lambda_w}$ (EC3-1-5 Table 5.1)

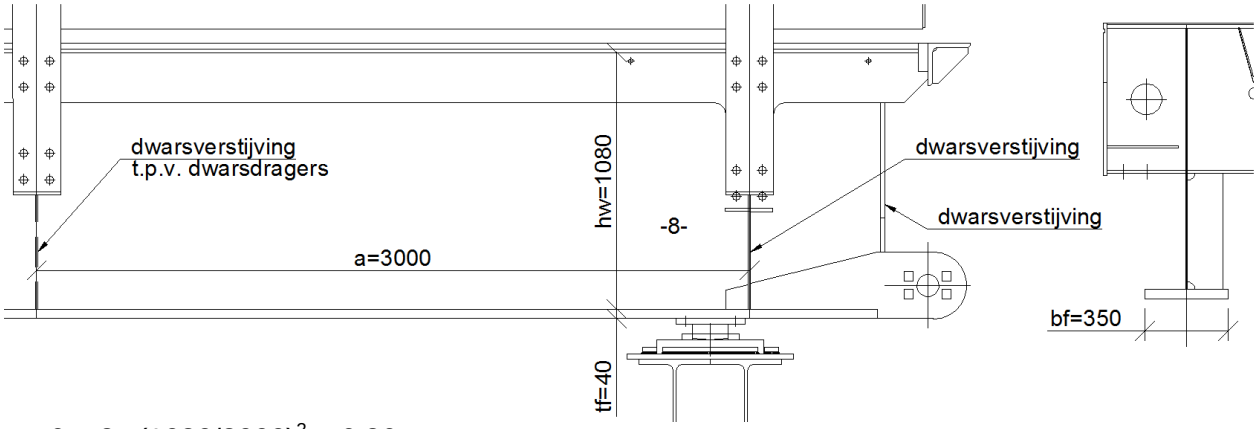
$\chi_w = 0.83/2.2 = 0.377$ [-]

$V_{bw,Rd}$ = 0.377 x 46.0 x 108 x 0.8 / √3 / 1.0 = 865 kN

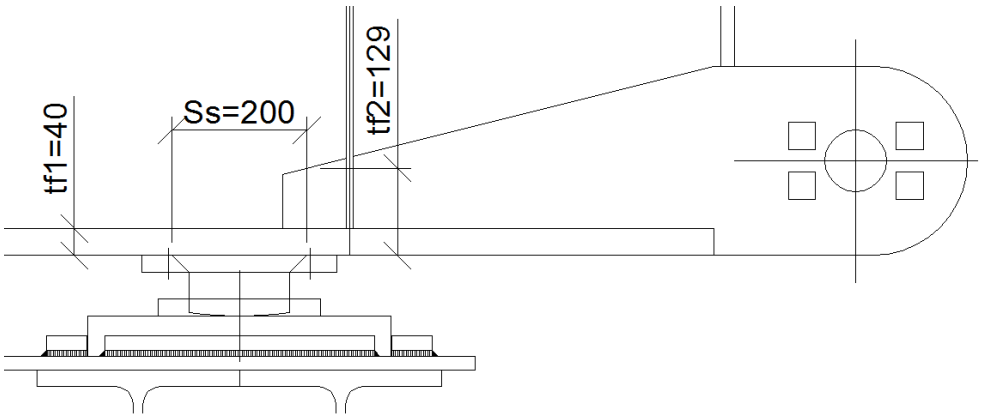
$V_{bf,Rd}$ → wordt nader niet beschouwd

$V_{bw,Rd} + V_{bf,Rd} > 865$ kN

11.2 Knikcapaciteit



$k_F = 6 + 2x\ (1080/3000)^2 = 6,26$



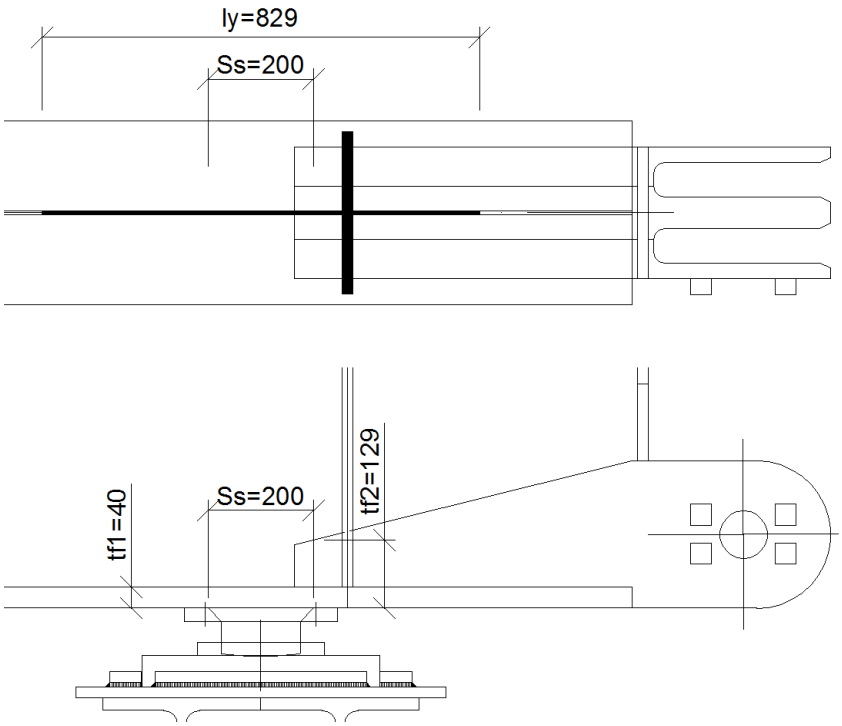
$t_f = (t_{f1} + t_{f2})\ /2 = (40 + 129)\ /2 = 84,5$ mm

$l_y = s_s + 2t_f$ x [1 + √$(m_1 + m_2)$

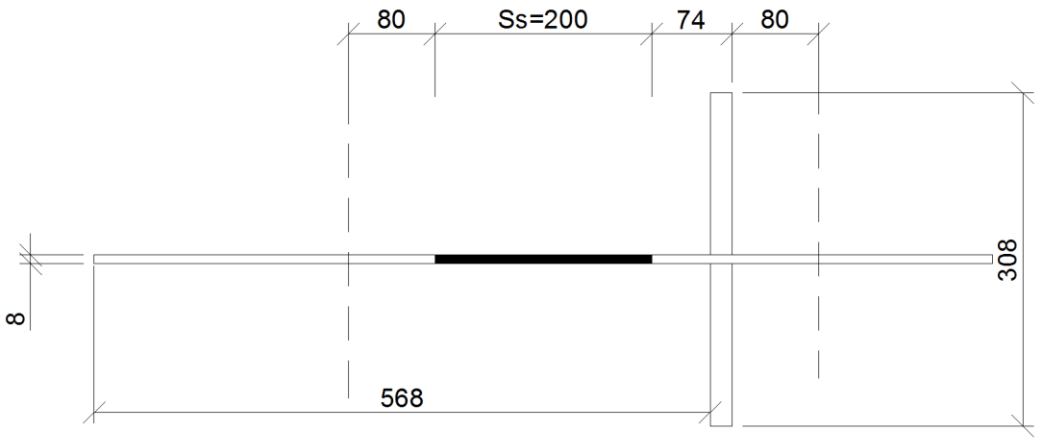
$m_1 = f_{yf}$ x b_f / f_{yw} x t_f = 460/460 x 350/84,5 = 4,142

$m_2 = 0,02$ x $(h_w / t_f)^2 = 0,02x\ (1080/84,5)^2 = 3,267$

$l_y = 220 + 2$ x 84,5 x [1 + √(4,142 + 3,267)] = 220 + 629 = 849 mm < 3000



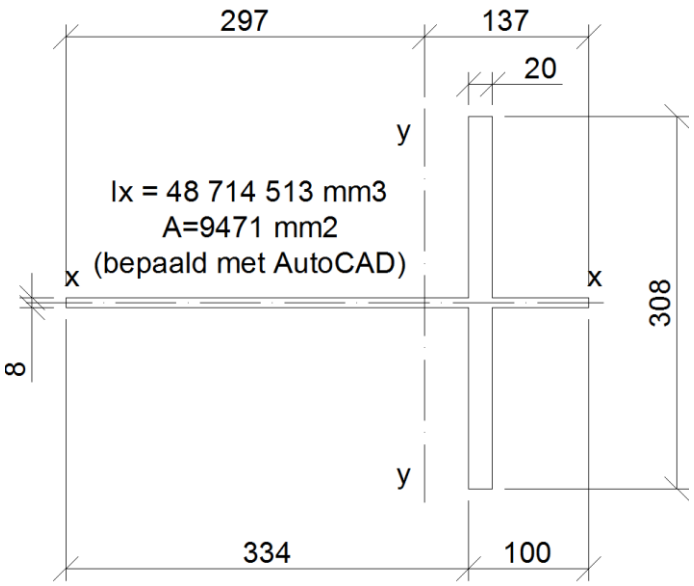
Bepaling meewerkende oppervlakte :



Toelichting : voor het bepalen van de meewerkende lengte van het lijf iser gebruikt gemaakt van tabel 5.2 (blad 2) van NEN-EN 1993-1-1:

Lijf beschouwd als uitkragende flens belast op druk : $c/t \leq 14\varepsilon$ → klasse 3

$c/t \leq 14\varepsilon$ → $c \leq 14 \times 0{,}71 \times 8 = 80$



$\overline{\lambda_w} = \overline{\lambda_x} = L_{cr} / i \times 1 / \lambda_1$

$i_x = \sqrt{} I_x / A = \sqrt{} 48714513 / 9471 = 71{,}7$ mm

$\lambda_1 = 93{,}9\varepsilon = 93{,}9 \times 0{,}71 = 67$

$L_{cr} = h_w = 1080$ mm

$\overline{\lambda_w} = \overline{\lambda_x} = (1080 / 71{,}7) \times (1 / 67) = 0{,}22$

Pas kromme “c” → $\chi_F \approx 1$ → geen reductie op knik → $L_{eff} = \chi_F \times l_y = 829$ mm

$F_{Rd} = f_{yw} \times L_{eff} \times t_w / \gamma_{M1}$ (NEN-EN 1993-1-5; (6.1.))

$F_{Rd} = 460 \times 829 \times 8 / 1{,}00 \times 10^{-3} =$ 3051 kN

11.3 Capaciteit van de oplegging

Maatgevend is de dwarskrachtcapaciteit van de doorsnede :

F_{Rd} > 865 kN

12 Temperatuurvervorming

Temperatuurvervorming brug bij ontwerptemperatuur +10°C :

vervorming bij temperatuur +45°C

ΔT_1 = 35°C

L = 27 m; $\Delta L_1 = 12 \times 10^{-6} \times 35 \times 27000 =$ 11 mm

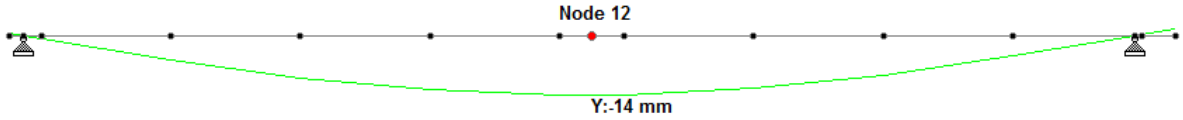
vervorming bij temperatuur -25°C

ΔT_2 = 35°C: $\Delta L_1 =$ -11 mm

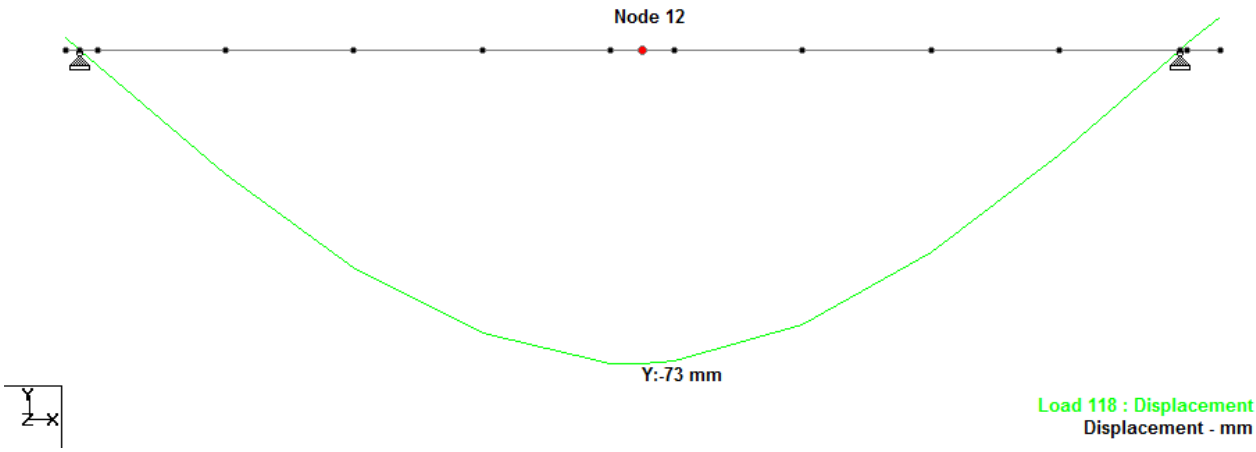
13 Doorbuiging

De doorbuiging is bepaald met een EEM-programma, STAAD.PRO, zie Bijlage A “STAAD.Pro”.

Eigen gewicht



Verkeer

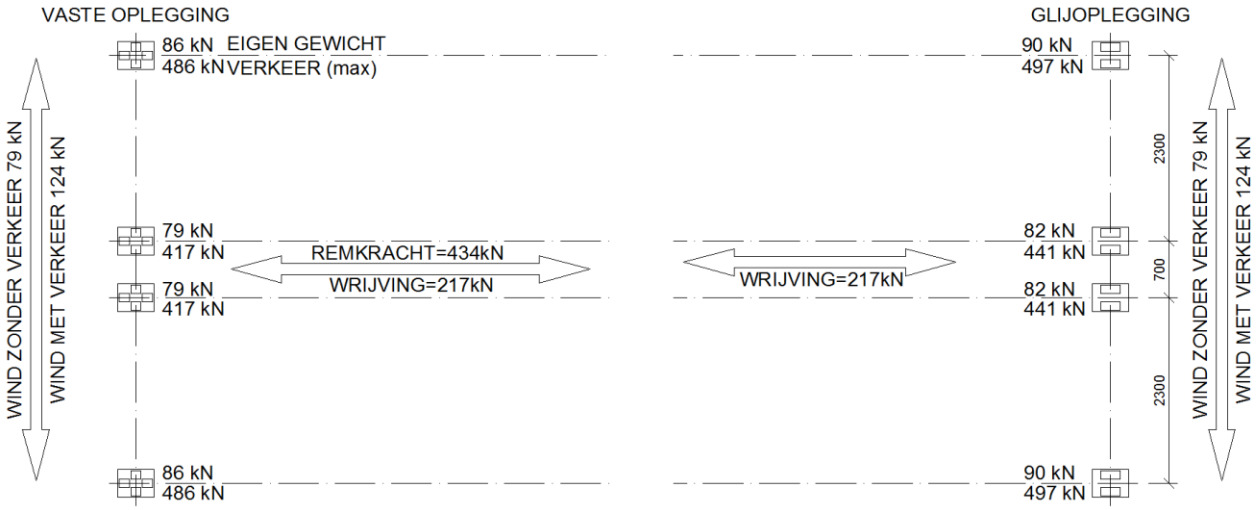


Totale doorbuiging:	δ_{totaal}	= 14 + 73	= 87 mm	→	L / 310
Bijkomende doorbuiging:	δ_{bij}	= 73mm		→	L / 369

Voor de bruggen geldt een toelaatbare doorbuiging van L/250.
Daar voldoet de brug ruim aan.

14 Oplegreacties

De oplegreacties zijn bepaald met een EEM-programma, STAAD.PRO, zie Bijlage A “STAAD.Pro”.



Job Information

	Engineer	Checked	Approved
Name:	MK	AvdM	
Date:	13-10-2015	13-10-2015	

Comments

The sectional properties of all sections in
this model are matching the
actual values of the sections in the bridge

Structure Type	SPACE FRAME

Number of Nodes	96	Highest Node	266
Number of Elements	140	Highest Beam	430

Number of Basic Load Cases	3
Number of Combination Load Cases	0

Included in this printout are data for:

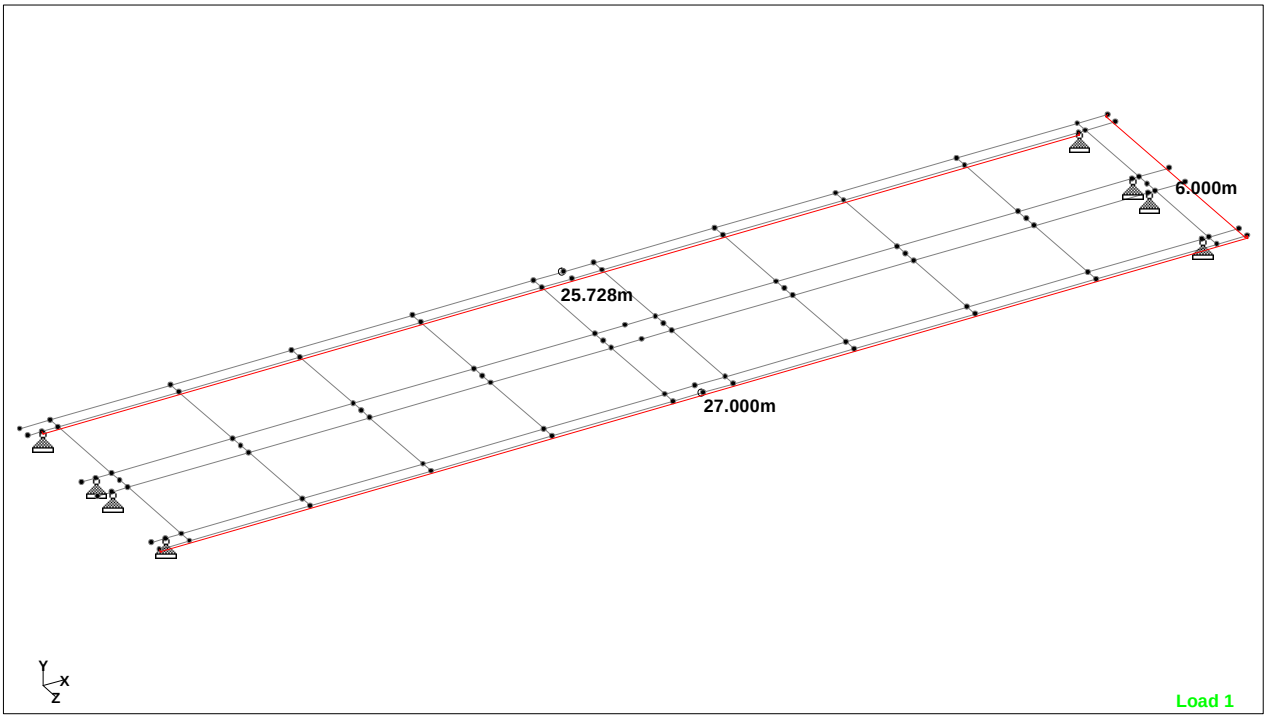
All	The Whole Structure

Included in this printout are results for load cases:

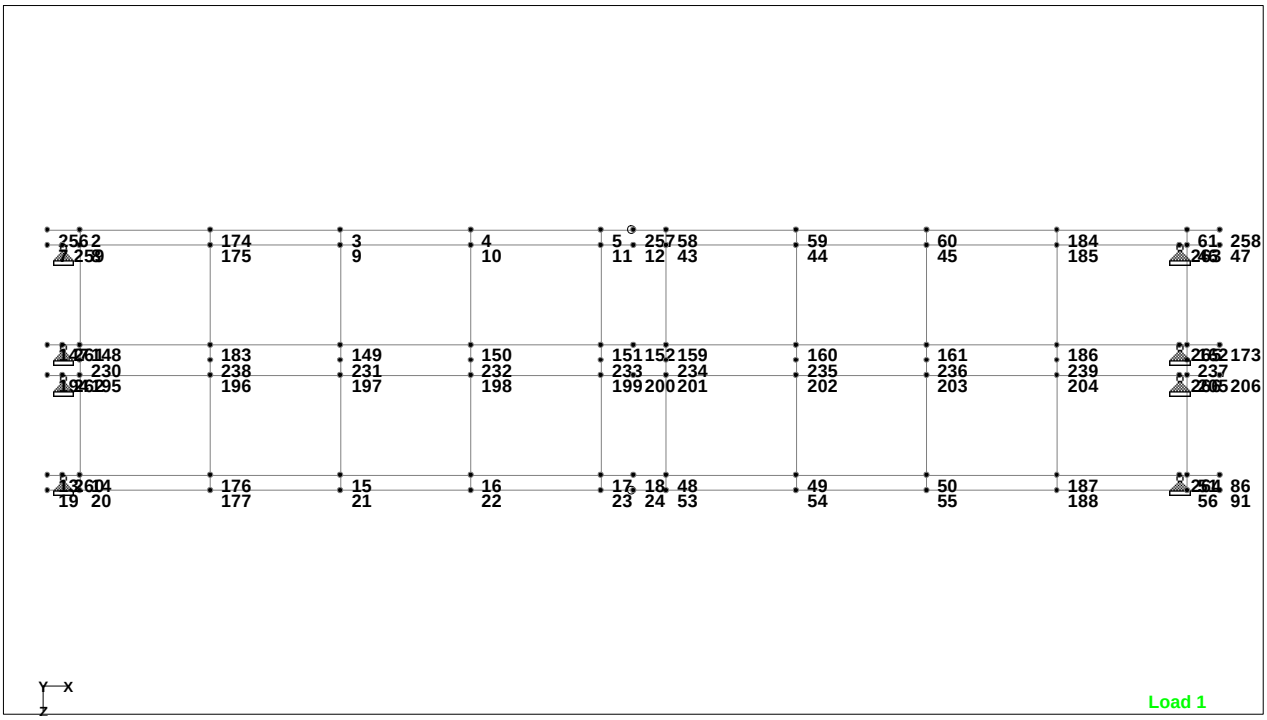
Type	L/C	Name
Primary	1	EG
Primary	100	UDL VL1 RS1 LINKS
Generation	101	LOAD GENERATION, LOAD #101, (1 of 3
Generation	102	LOAD GENERATION, LOAD #102, (2 of 3
Generation	103	LOAD GENERATION, LOAD #103, (3 of 3
Generation	104	LOAD GENERATION, LOAD #104, (4 of 3
Generation	105	LOAD GENERATION, LOAD #105, (5 of 3
Generation	106	LOAD GENERATION, LOAD #106, (6 of 3
Generation	107	LOAD GENERATION, LOAD #107, (7 of 3
Generation	108	LOAD GENERATION, LOAD #108, (8 of 3
Generation	109	LOAD GENERATION, LOAD #109, (9 of 3
Generation	110	LOAD GENERATION, LOAD #110, (10 of
Generation	111	LOAD GENERATION, LOAD #111, (11 of
Generation	112	LOAD GENERATION, LOAD #112, (12 of
Generation	113	LOAD GENERATION, LOAD #113, (13 of
Generation	114	LOAD GENERATION, LOAD #114, (14 of
Generation	115	LOAD GENERATION, LOAD #115, (15 of
Generation	116	LOAD GENERATION, LOAD #116, (16 of
Generation	117	LOAD GENERATION, LOAD #117, (17 of
Generation	118	LOAD GENERATION, LOAD #118, (18 of
Generation	119	LOAD GENERATION, LOAD #119, (19 of
Generation	120	LOAD GENERATION, LOAD #120, (20 of
Generation	121	LOAD GENERATION, LOAD #121, (21 of
Generation	122	LOAD GENERATION, LOAD #122, (22 of
Generation	123	LOAD GENERATION, LOAD #123, (23 of
Generation	124	LOAD GENERATION, LOAD #124, (24 of
Generation	125	LOAD GENERATION, LOAD #125, (25 of

Job Information Cont...

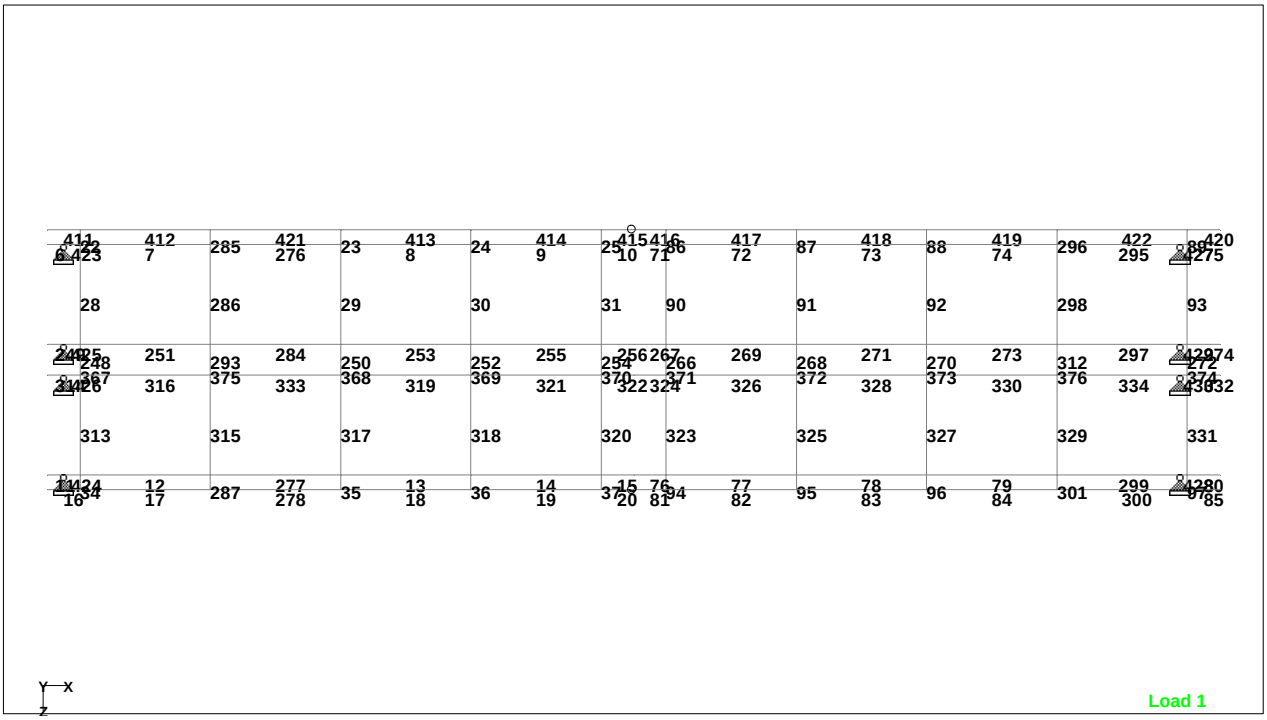
Type	L/C	Name
Generation	126	LOAD GENERATION, LOAD #126, (26 of
Generation	127	LOAD GENERATION, LOAD #127, (27 of
Generation	128	LOAD GENERATION, LOAD #128, (28 of
Generation	129	LOAD GENERATION, LOAD #129, (29 of
Generation	130	LOAD GENERATION, LOAD #130, (30 of
Generation	131	LOAD GENERATION, LOAD #131, (31 of
Generation	132	LOAD GENERATION, LOAD #132, (32 of
Generation	133	LOAD GENERATION, LOAD #133, (33 of
Generation	134	LOAD GENERATION, LOAD #134, (34 of
Generation	135	LOAD GENERATION, LOAD #135, (35 of
Primary	200	UDL VL2 RS1 RS2
Generation	201	LOAD GENERATION, LOAD #201, (1 of 3
Generation	202	LOAD GENERATION, LOAD #202, (2 of 3
Generation	203	LOAD GENERATION, LOAD #203, (3 of 3
Generation	204	LOAD GENERATION, LOAD #204, (4 of 3
Generation	205	LOAD GENERATION, LOAD #205, (5 of 3
Generation	206	LOAD GENERATION, LOAD #206, (6 of 3
Generation	207	LOAD GENERATION, LOAD #207, (7 of 3
Generation	208	LOAD GENERATION, LOAD #208, (8 of 3
Generation	209	LOAD GENERATION, LOAD #209, (9 of 3
Generation	210	LOAD GENERATION, LOAD #210, (10 of
Generation	211	LOAD GENERATION, LOAD #211, (11 of
Generation	212	LOAD GENERATION, LOAD #212, (12 of
Generation	213	LOAD GENERATION, LOAD #213, (13 of
Generation	214	LOAD GENERATION, LOAD #214, (14 of
Generation	215	LOAD GENERATION, LOAD #215, (15 of
Generation	216	LOAD GENERATION, LOAD #216, (16 of
Generation	217	LOAD GENERATION, LOAD #217, (17 of
Generation	218	LOAD GENERATION, LOAD #218, (18 of
Generation	219	LOAD GENERATION, LOAD #219, (19 of
Generation	220	LOAD GENERATION, LOAD #220, (20 of
Generation	221	LOAD GENERATION, LOAD #221, (21 of
Generation	222	LOAD GENERATION, LOAD #222, (22 of
Generation	223	LOAD GENERATION, LOAD #223, (23 of
Generation	224	LOAD GENERATION, LOAD #224, (24 of
Generation	225	LOAD GENERATION, LOAD #225, (25 of
Generation	226	LOAD GENERATION, LOAD #226, (26 of
Generation	227	LOAD GENERATION, LOAD #227, (27 of
Generation	228	LOAD GENERATION, LOAD #228, (28 of
Generation	229	LOAD GENERATION, LOAD #229, (29 of
Generation	230	LOAD GENERATION, LOAD #230, (30 of
Generation	231	LOAD GENERATION, LOAD #231, (31 of
Generation	232	LOAD GENERATION, LOAD #232, (32 of
Generation	233	LOAD GENERATION, LOAD #233, (33 of
Generation	234	LOAD GENERATION, LOAD #234, (34 of
Generation	235	LOAD GENERATION, LOAD #235, (35 of



Hoofdafmetingen



Knoopnummers



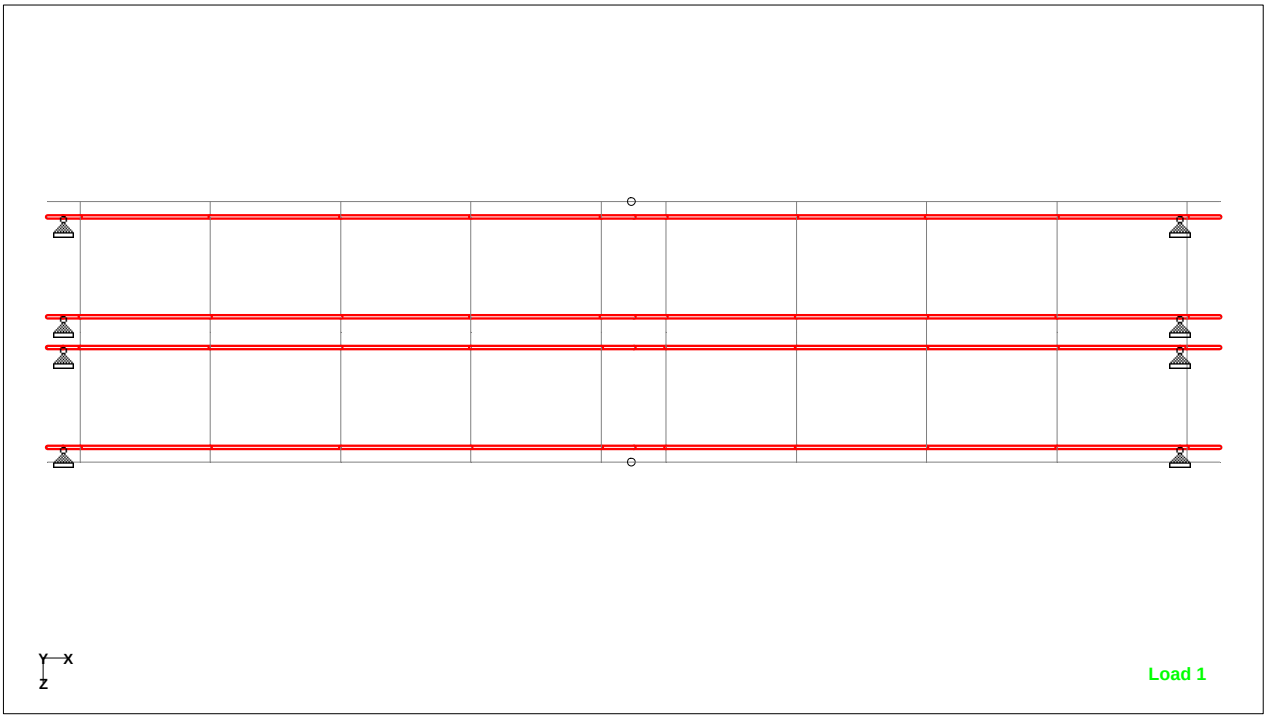
Staafnummers

Section Properties

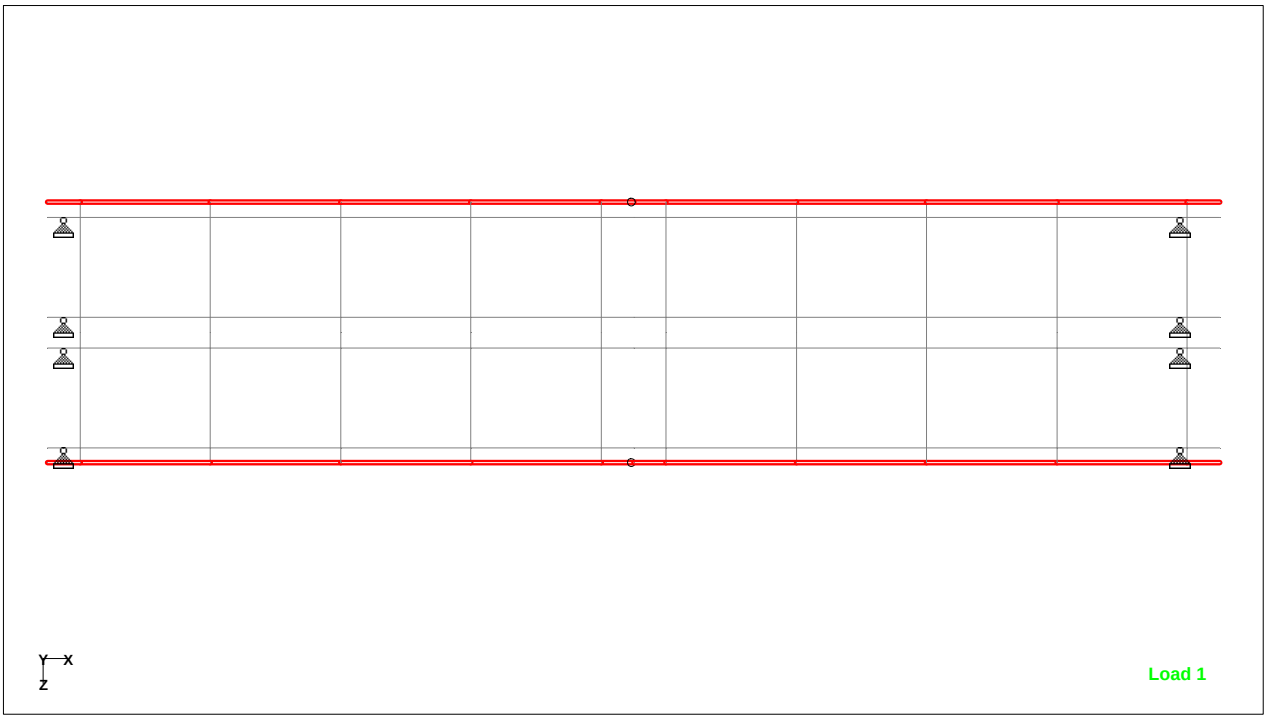
Prop	Section	Area (cm^2)	I_{yy} (cm^4)	I_{zz} (cm^4)	J (cm^4)	Material
1	IPE300	53.800	604.000	8.36E+3	15.702	STEEL
2	HL1100R	635.200	50E+3	1.29E+6	3.09E+3	STEEL
3	IPE550	134.000	2.67E+3	67.1E+3	95.527	STEEL

Materials

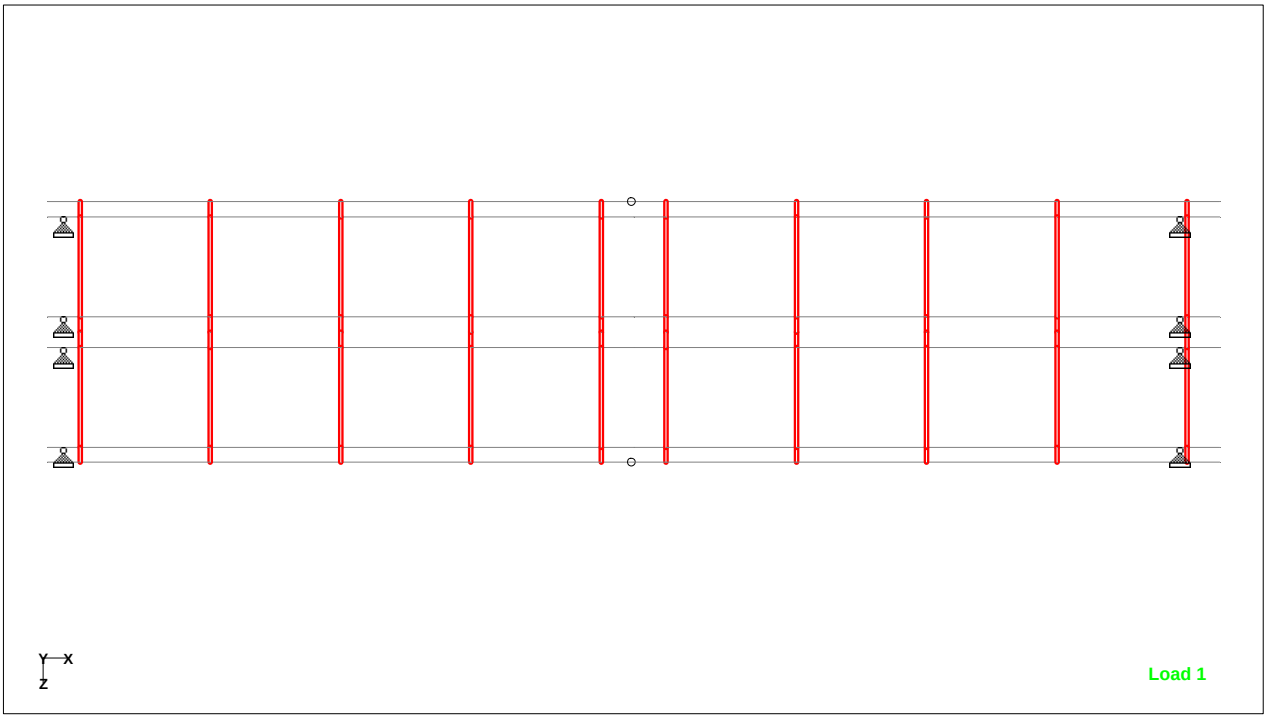
Mat	Name	E (kN/mm^2)	ν	Density (kg/m^3)	α (/℃)
1	STEEL	205.000	0.300	7.83E+3	12E -6
2	STAINLESSSTEEL	197.930	0.300	7.83E+3	18E -6
3	ALUMINUM	68.948	0.330	2.71E+3	23E -6
4	CONCRETE	21.718	0.170	2.4E+3	10E -6



Hoofdliggers



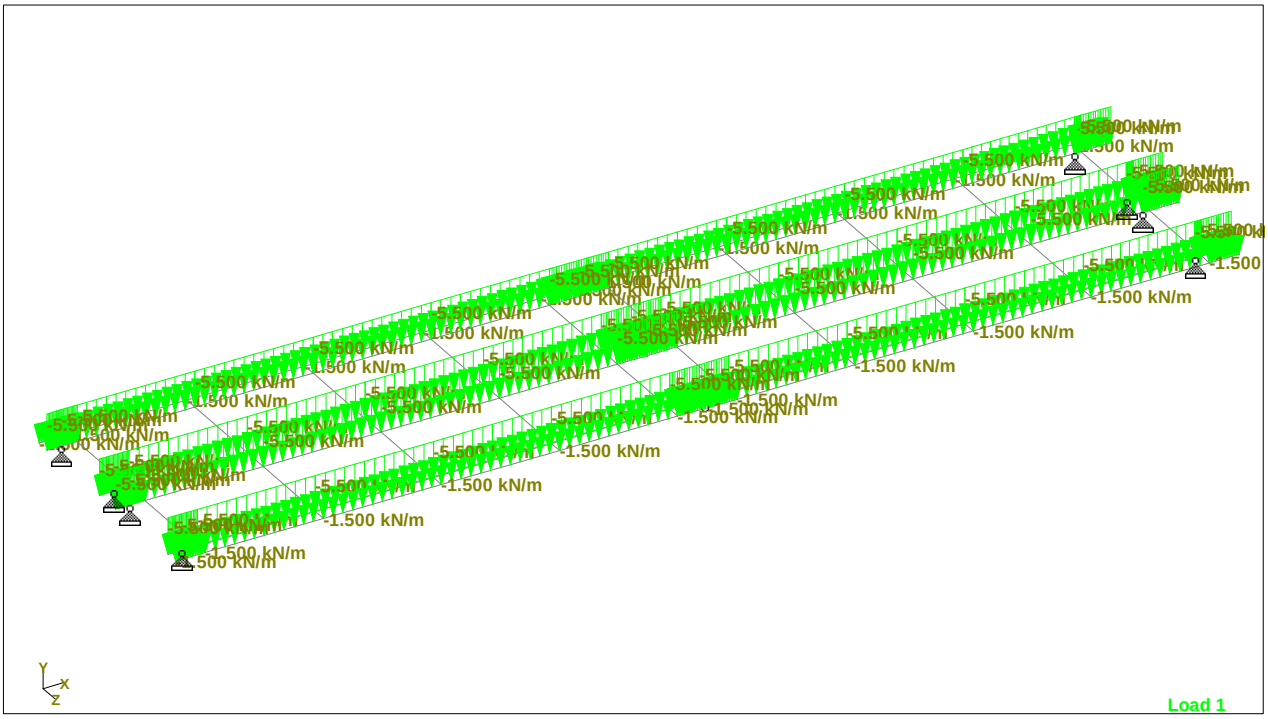
Radkeerders



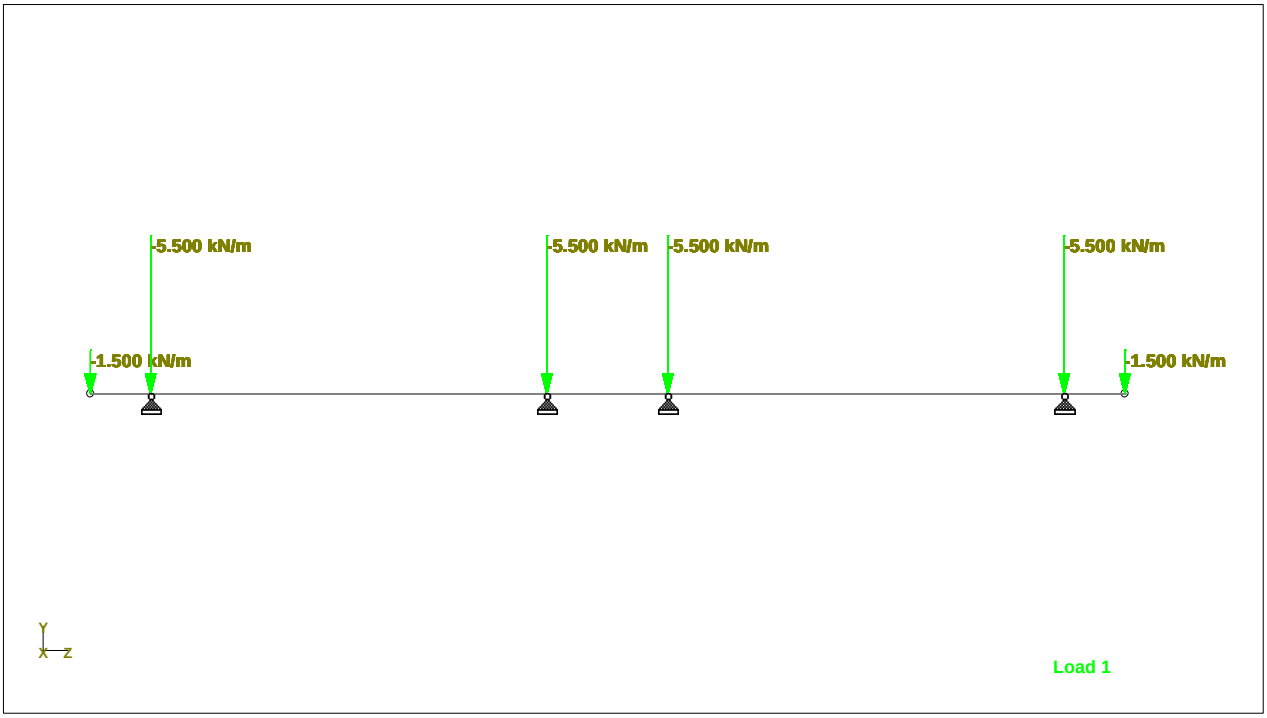
Dwarsdragers

Primary Load Cases

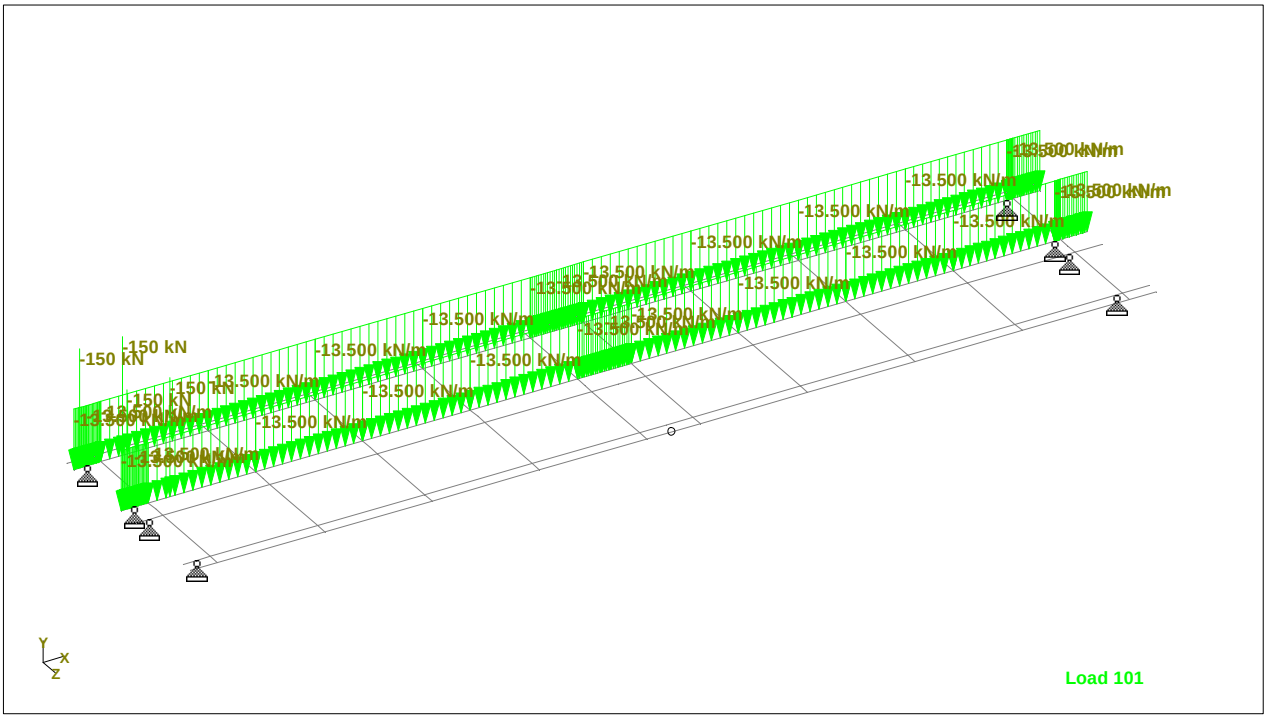
Number	Name	Type
1	EG	None
100	UDL VL1 RS1 LINKS	None
200	UDL VL2 RS1 RS2	None



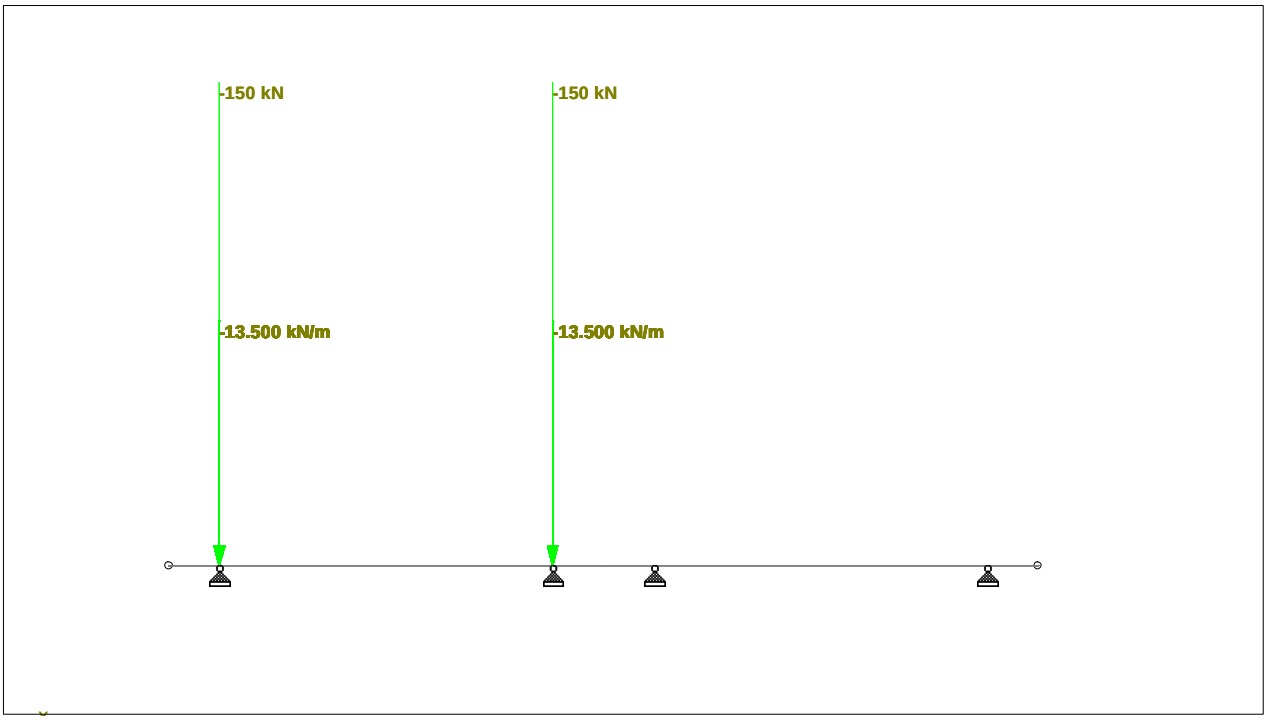
Belastinggeval Eigengewicht (1)



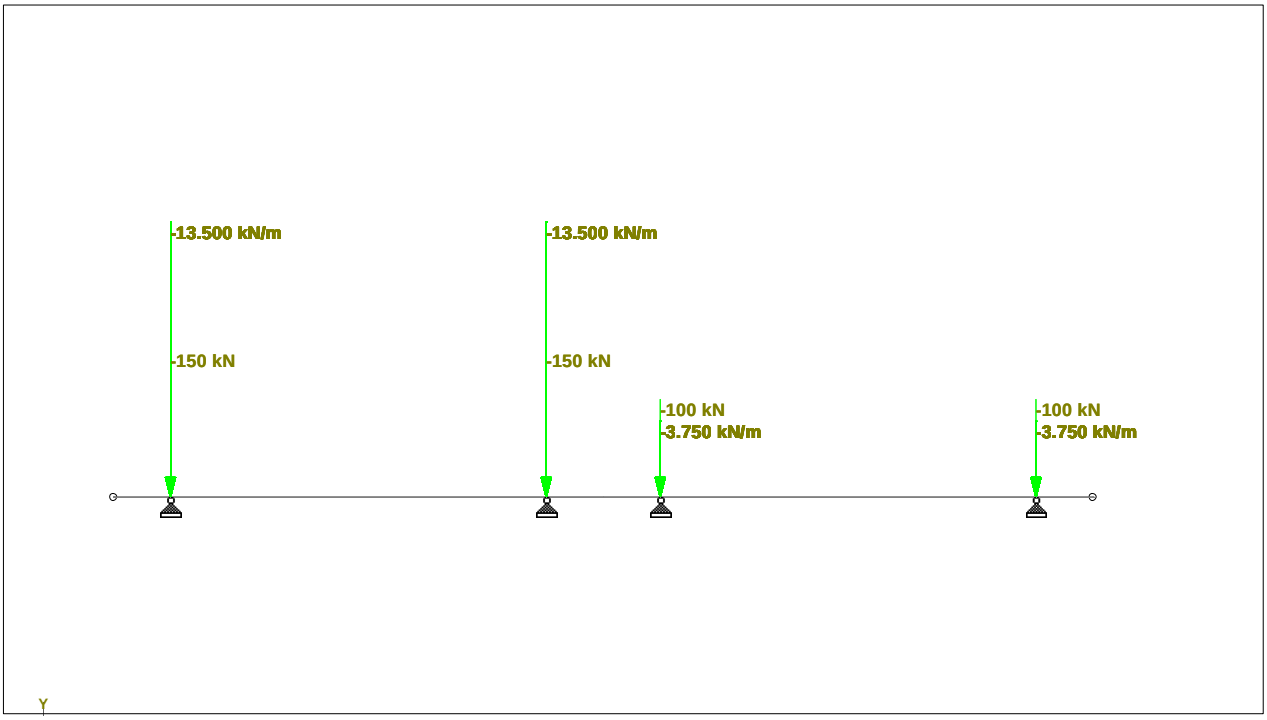
Belastinggeval Eigengewicht (2)



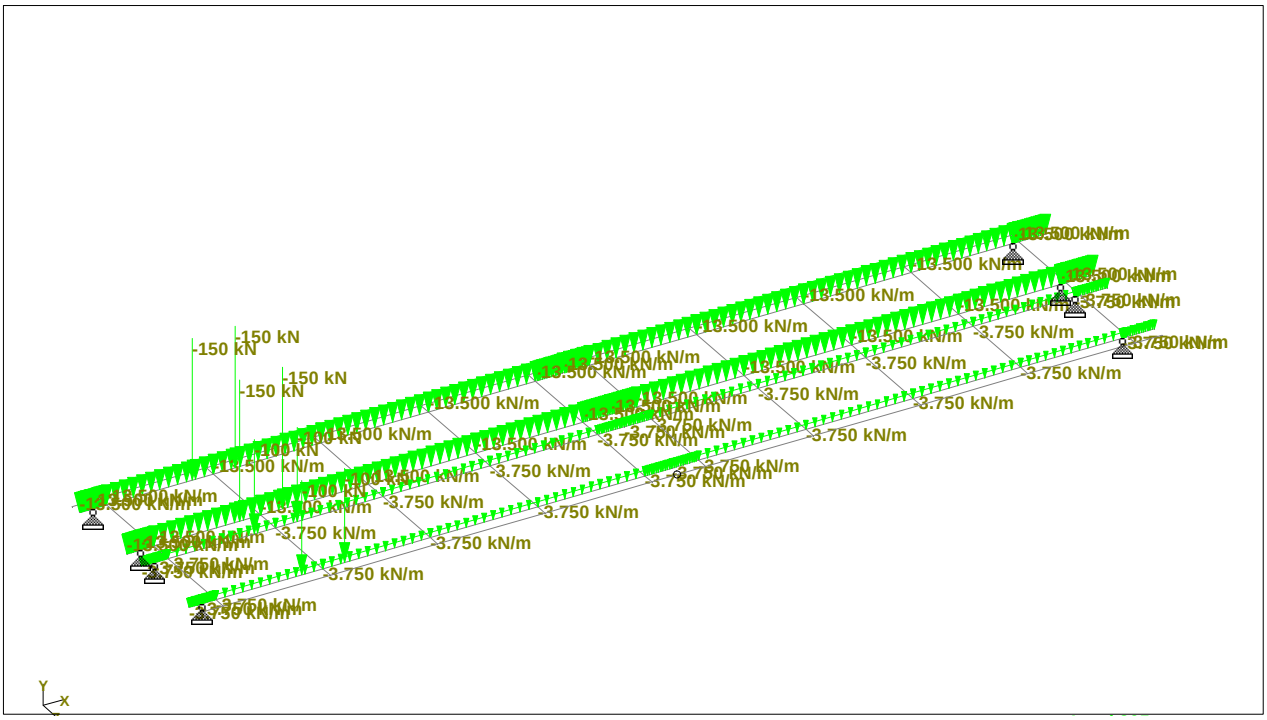
Verkeer incl. lopende lasten LC101 t/m 135 (1)



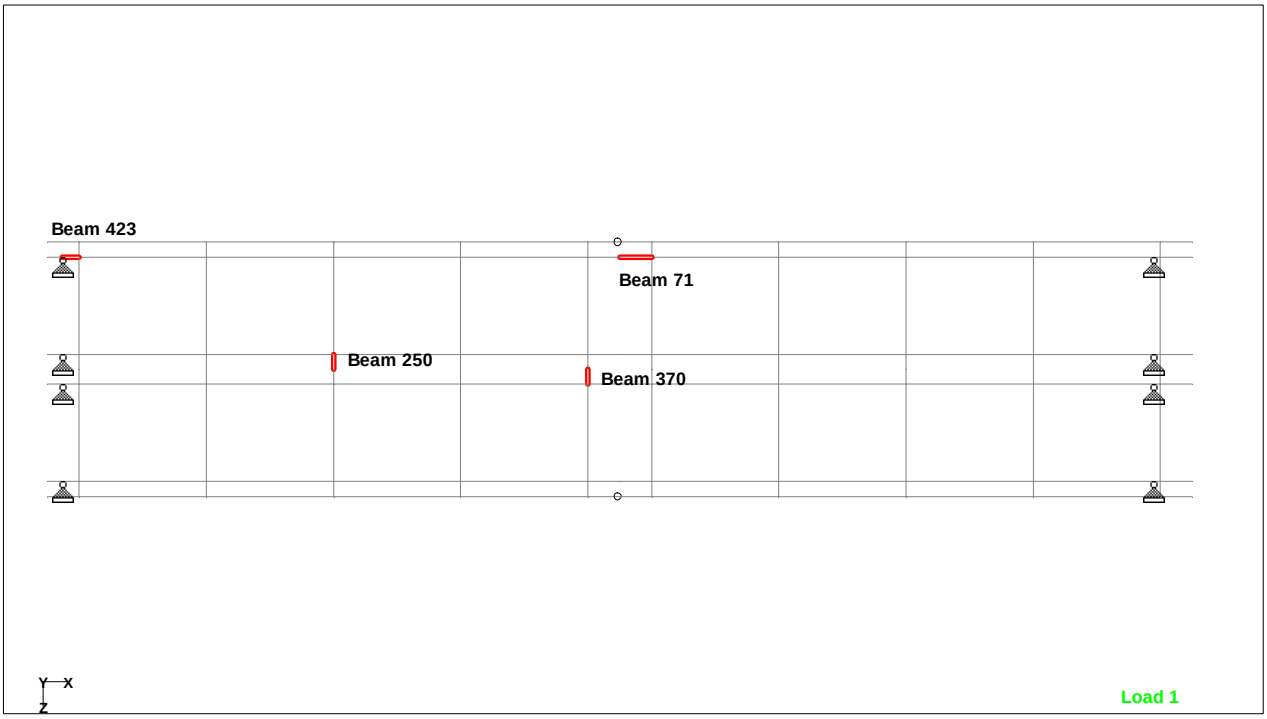
Verkeer incl. lopende lasten LC101 t/m 135 (2)



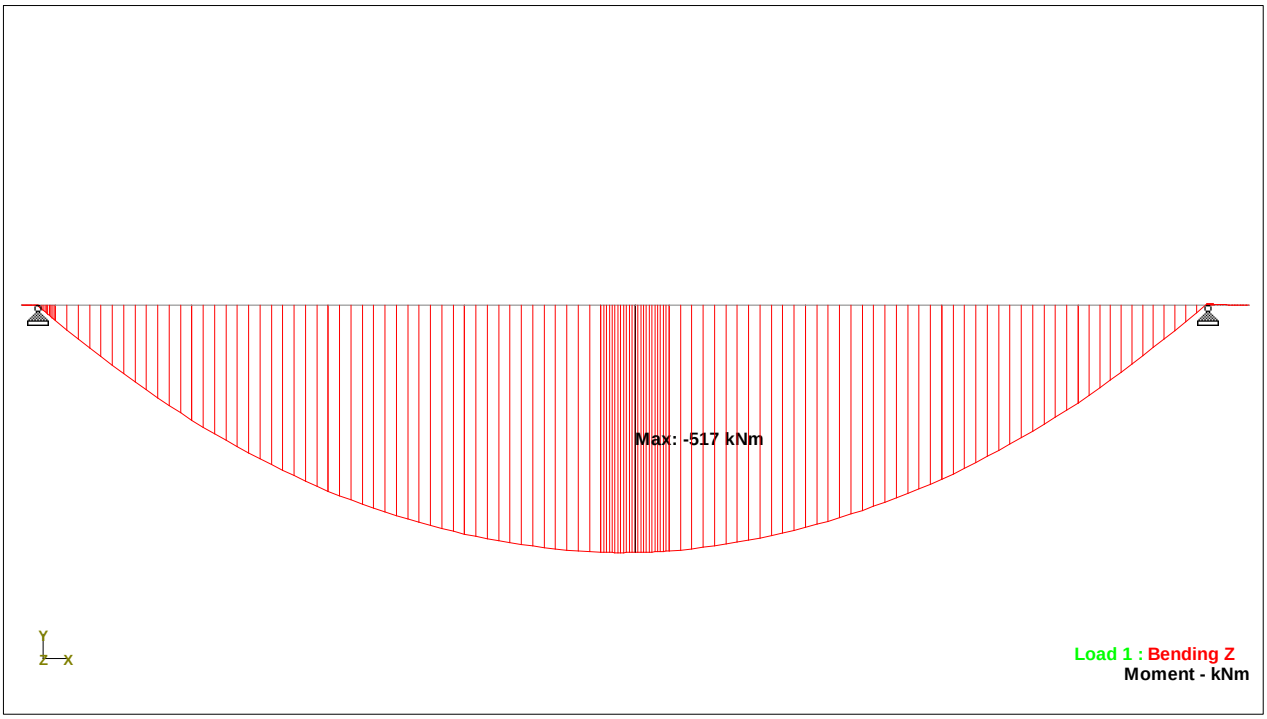
Verkeer incl. lopende lasten LC201 t/m 235 (2)



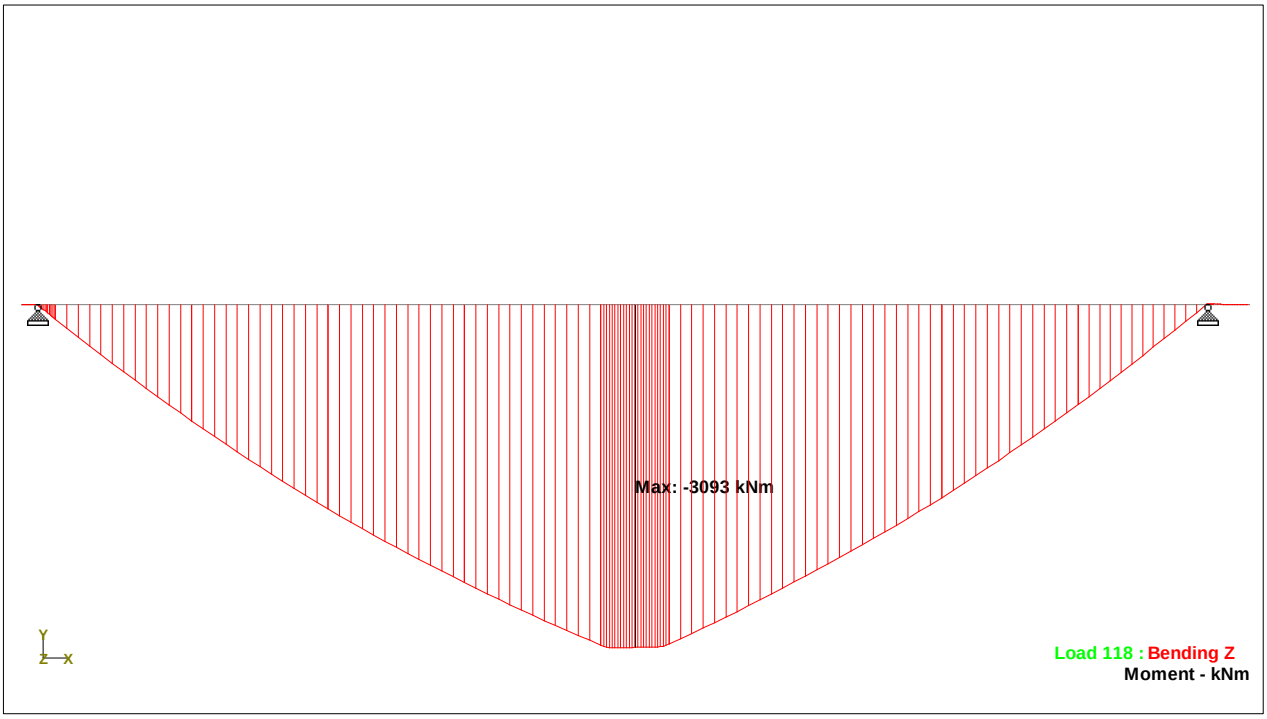
Verkeer incl. lopende lasten LC201 t/m 235 (1)



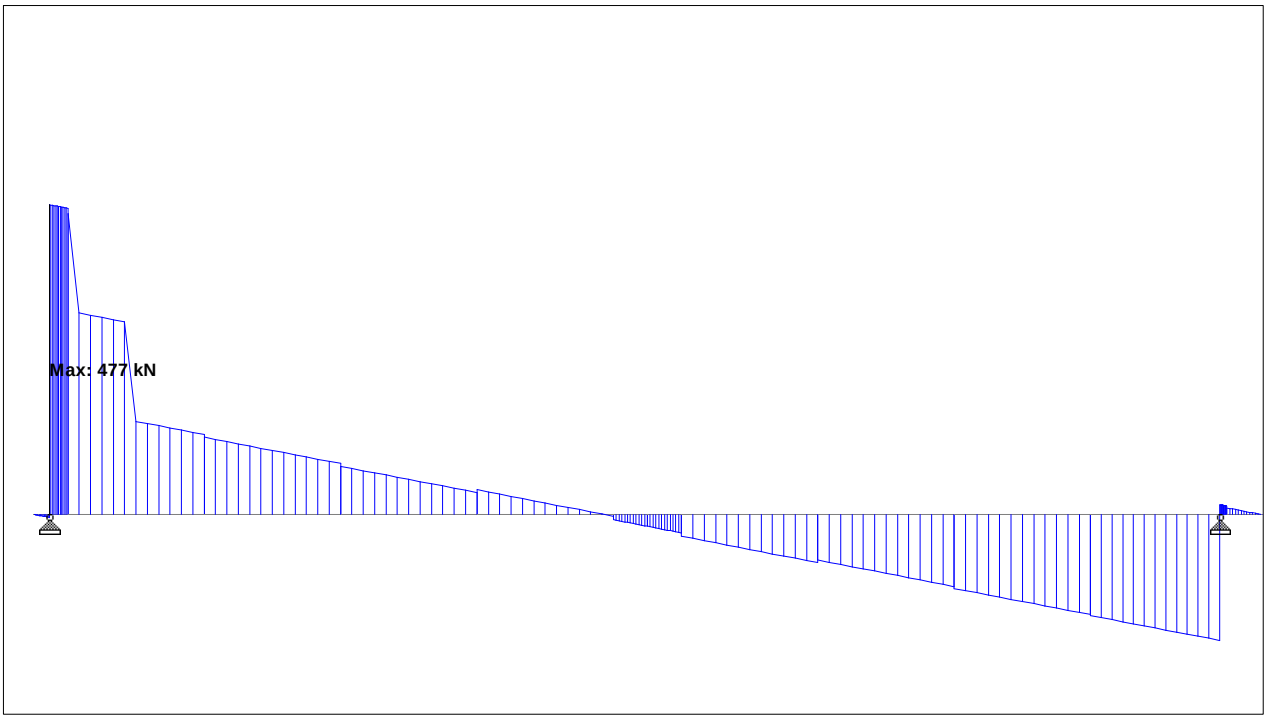
Maatgevende staven



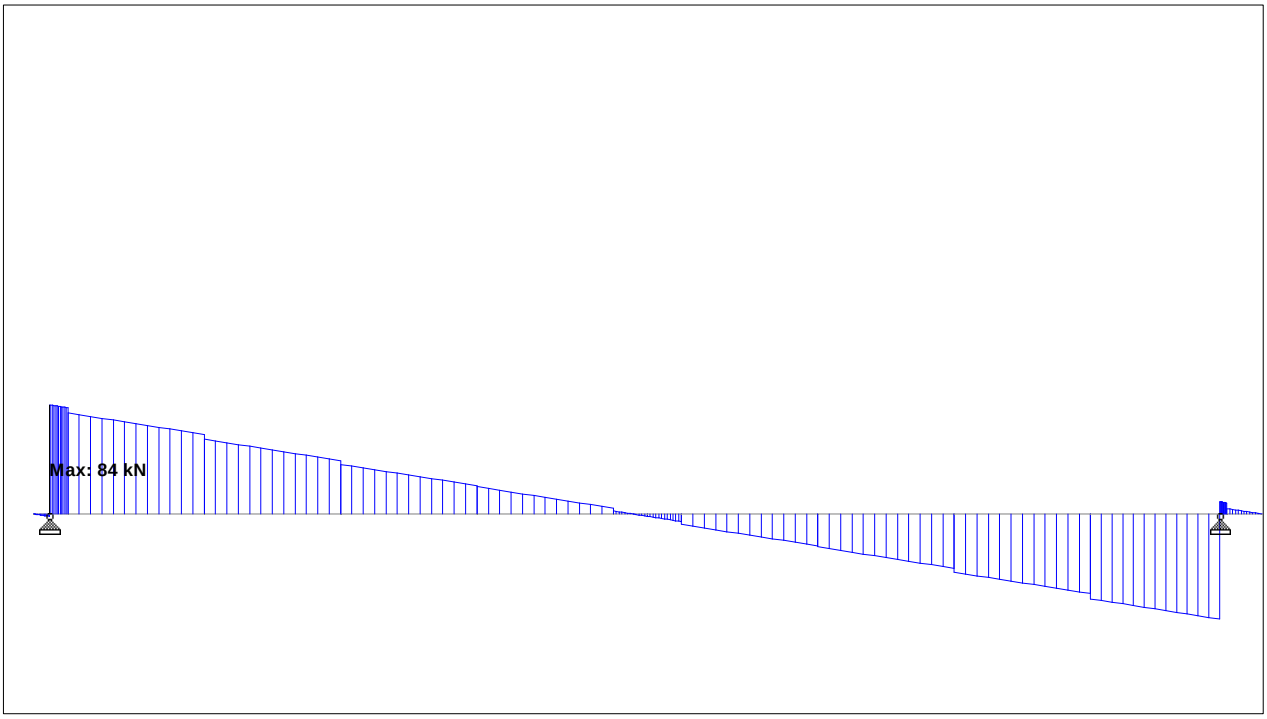
Hoofddrager Meg



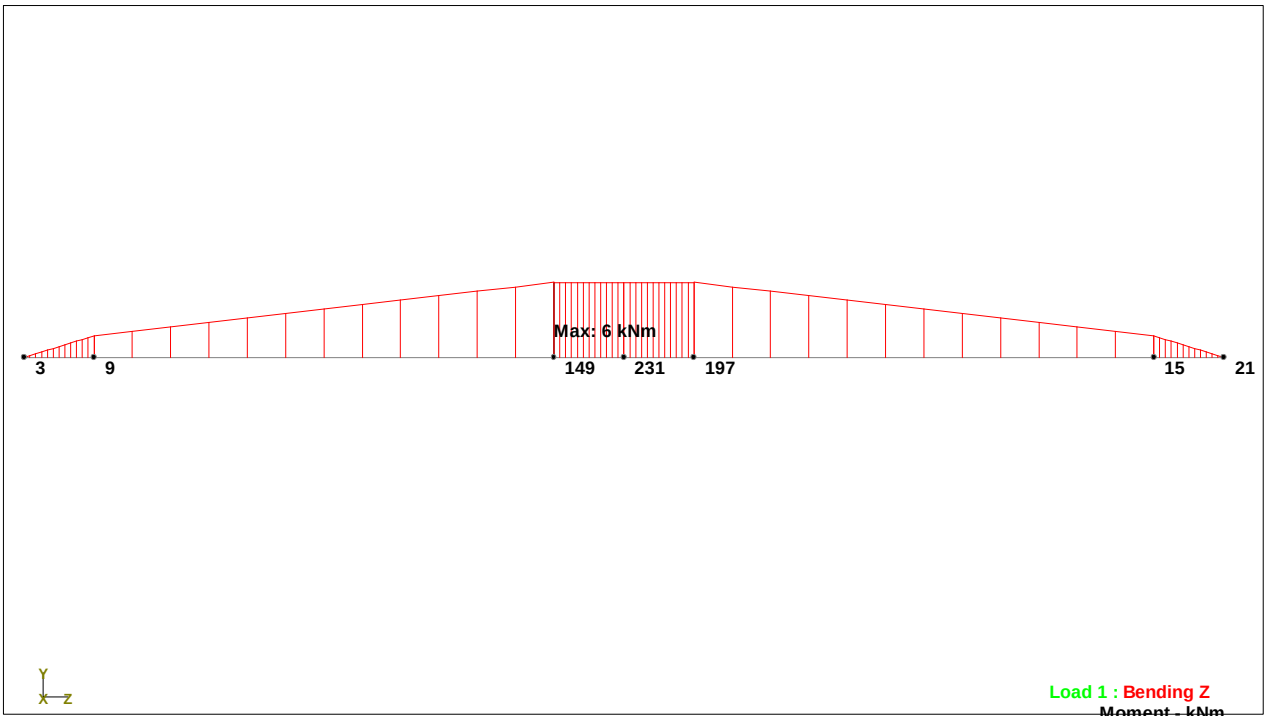
Hoofddrager Mvl



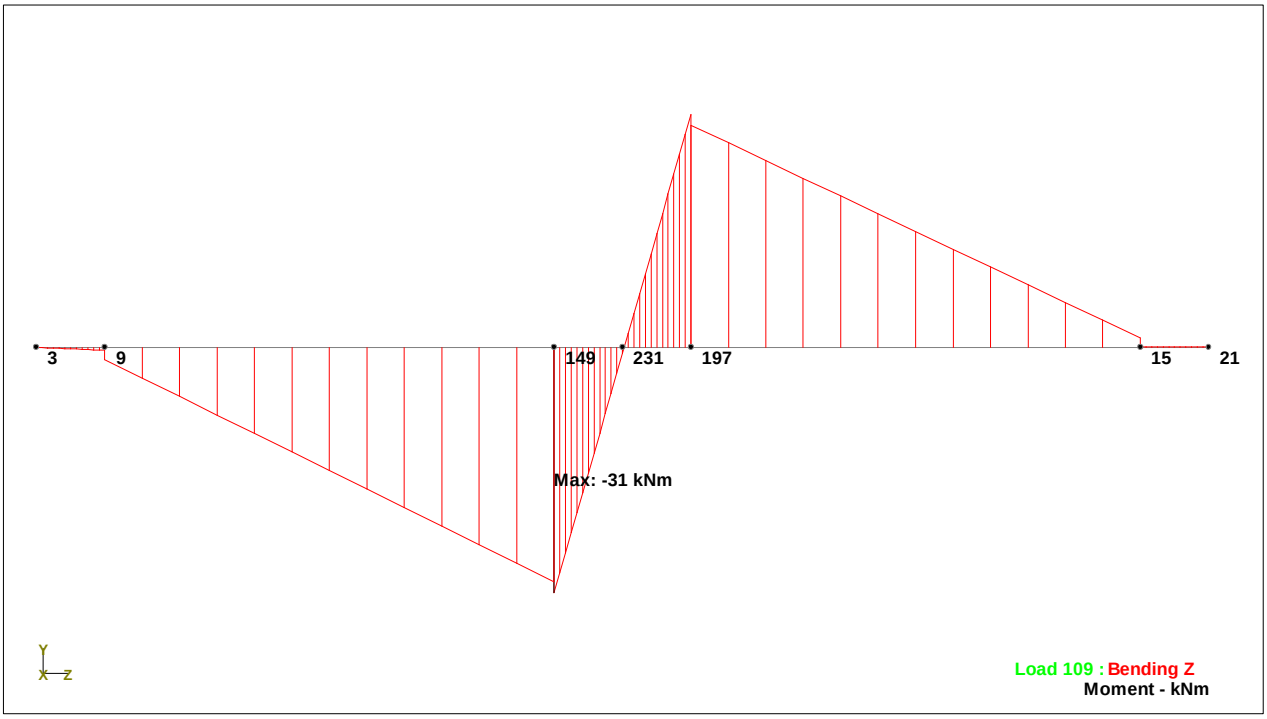
Hoofdliggers - maximale dwarskracht tgv Verkeer



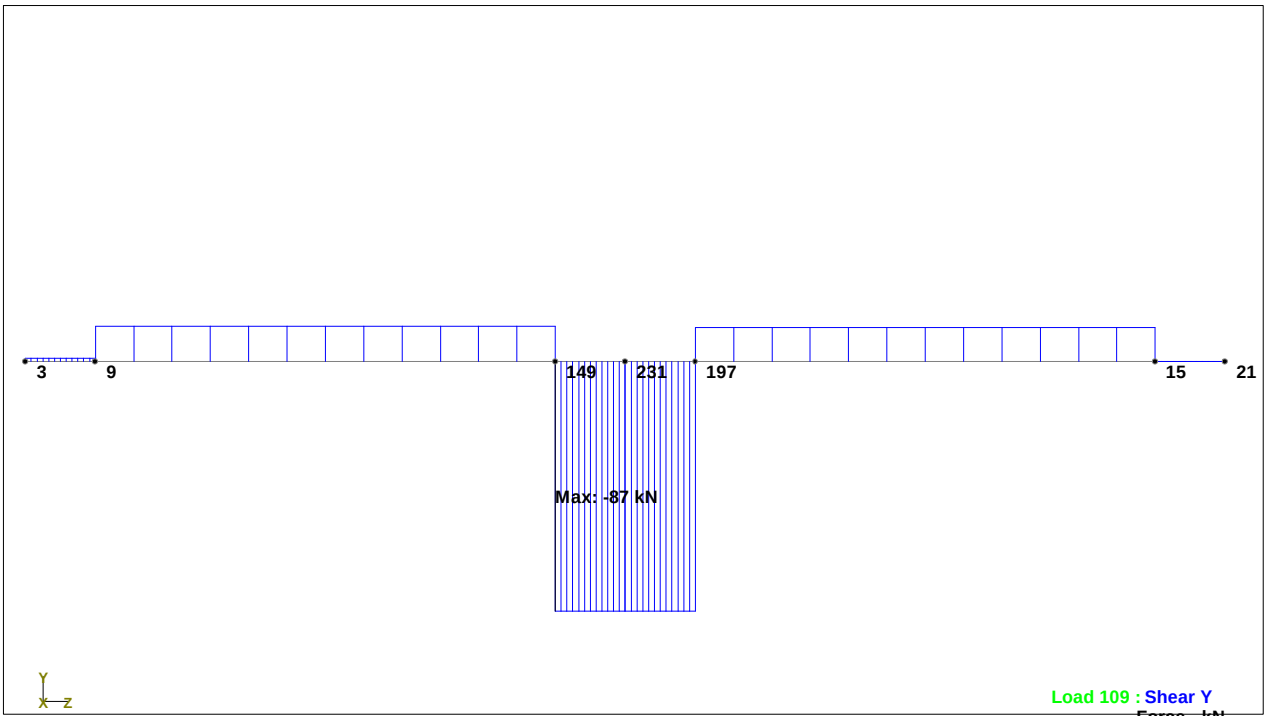
Hoofdliggers - dwarskracht tgv Eigengewicht



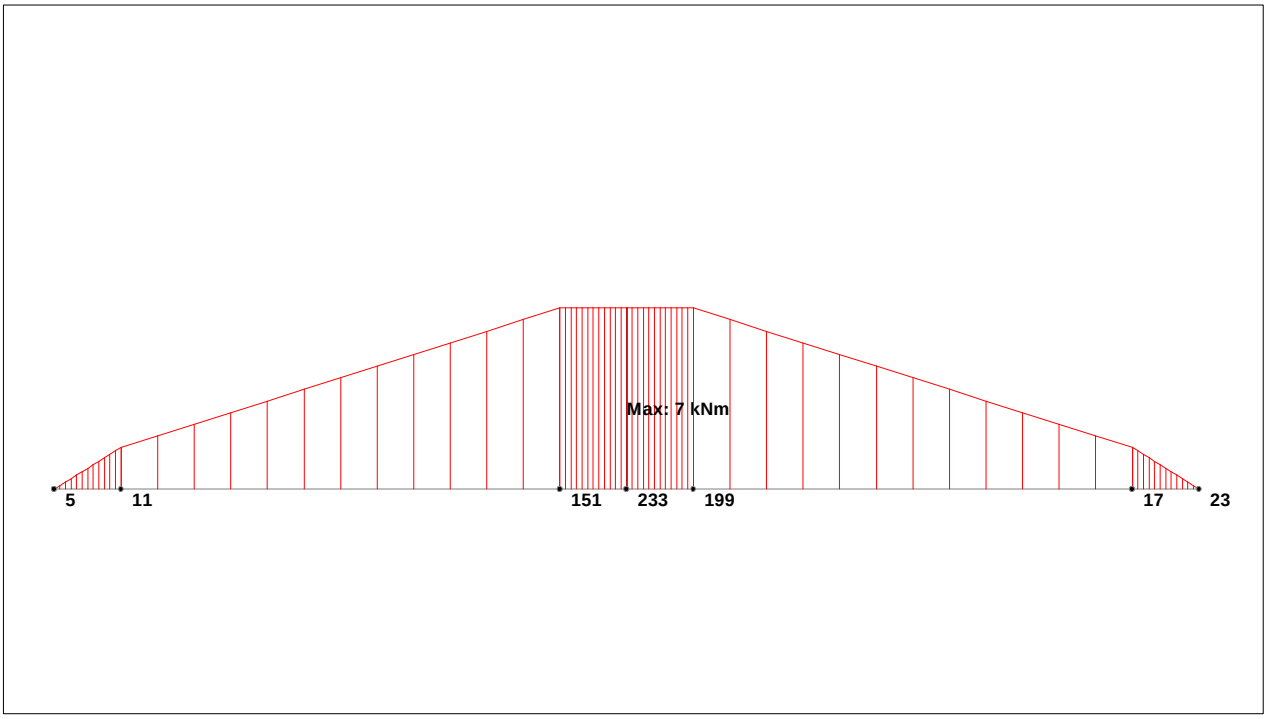
Dwarsdragers - dwarskracht tgv Eigengewicht



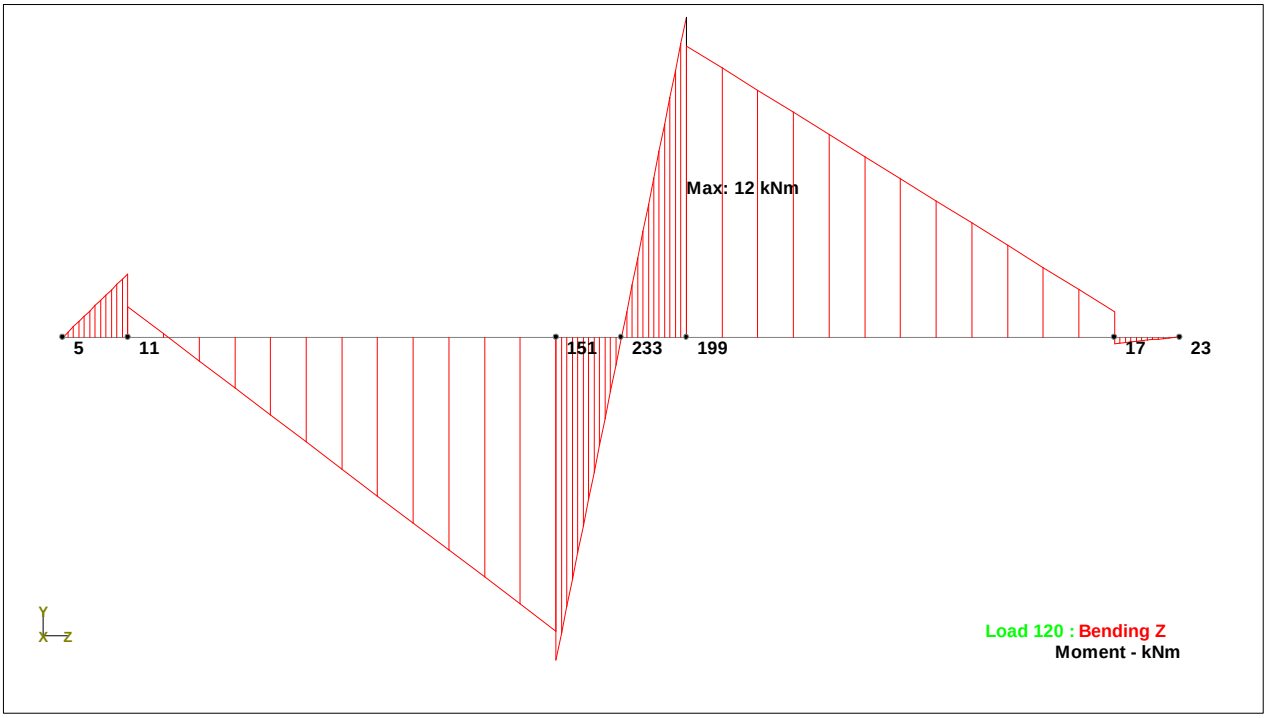
Dwarsdragers - maximale moment ten gevolge verkeer



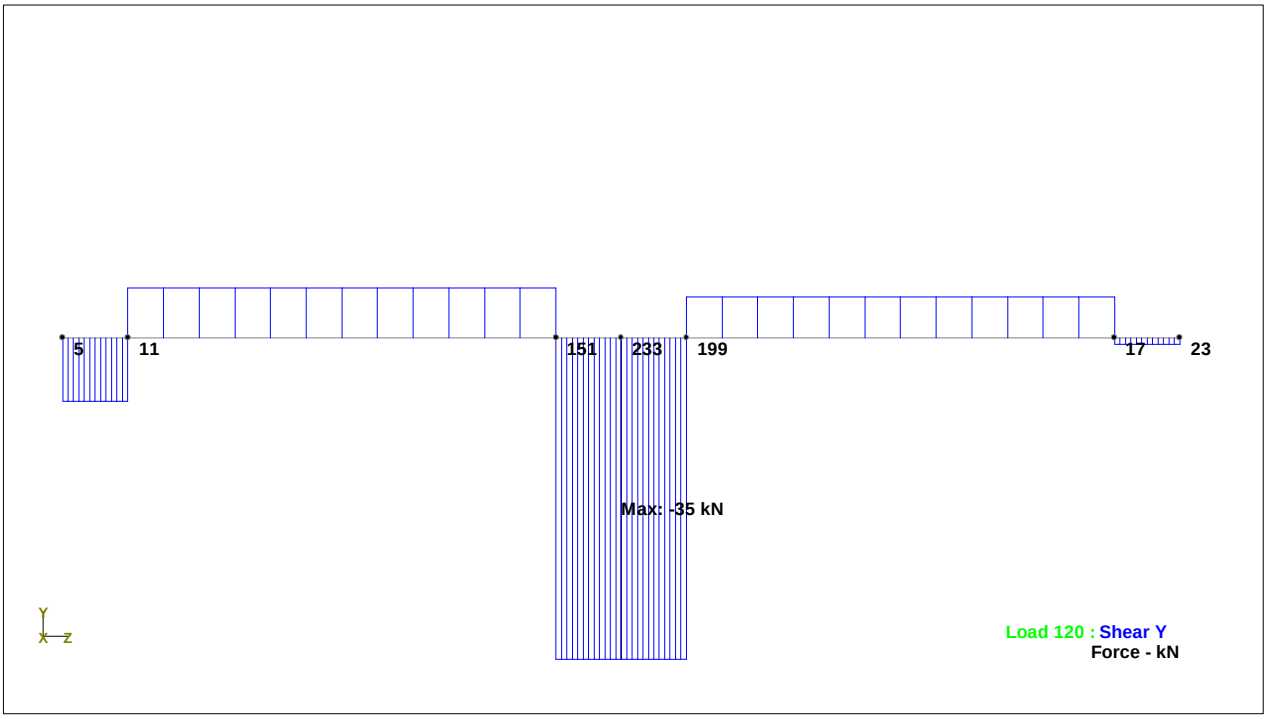
Dwarsdragers - dwarskracht tgv verkeer bij Mmax



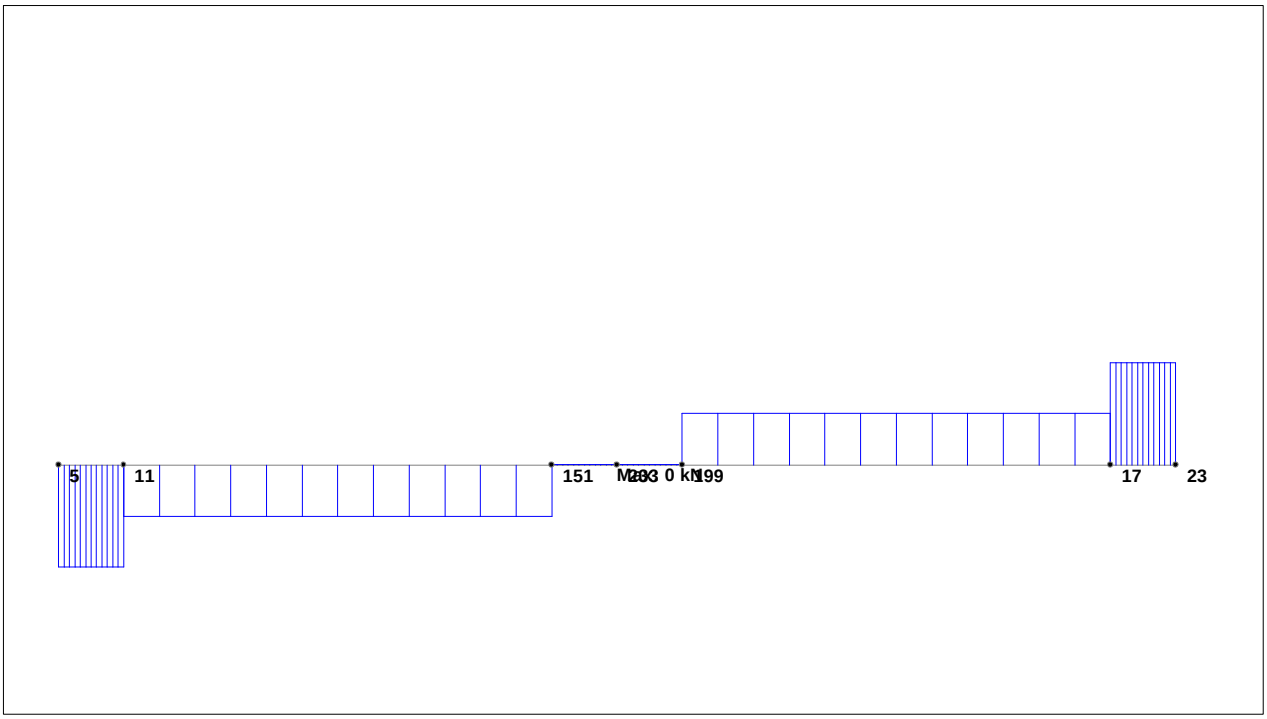
Koppeling dwarsdragers - maximale moment tgv Meg



Koppeling dwarsdragers - moment tgv Verkeer bij Mmax



Koppeling dwarsdragers - maximale dwarskracht tgv Verkeer bij Mmax



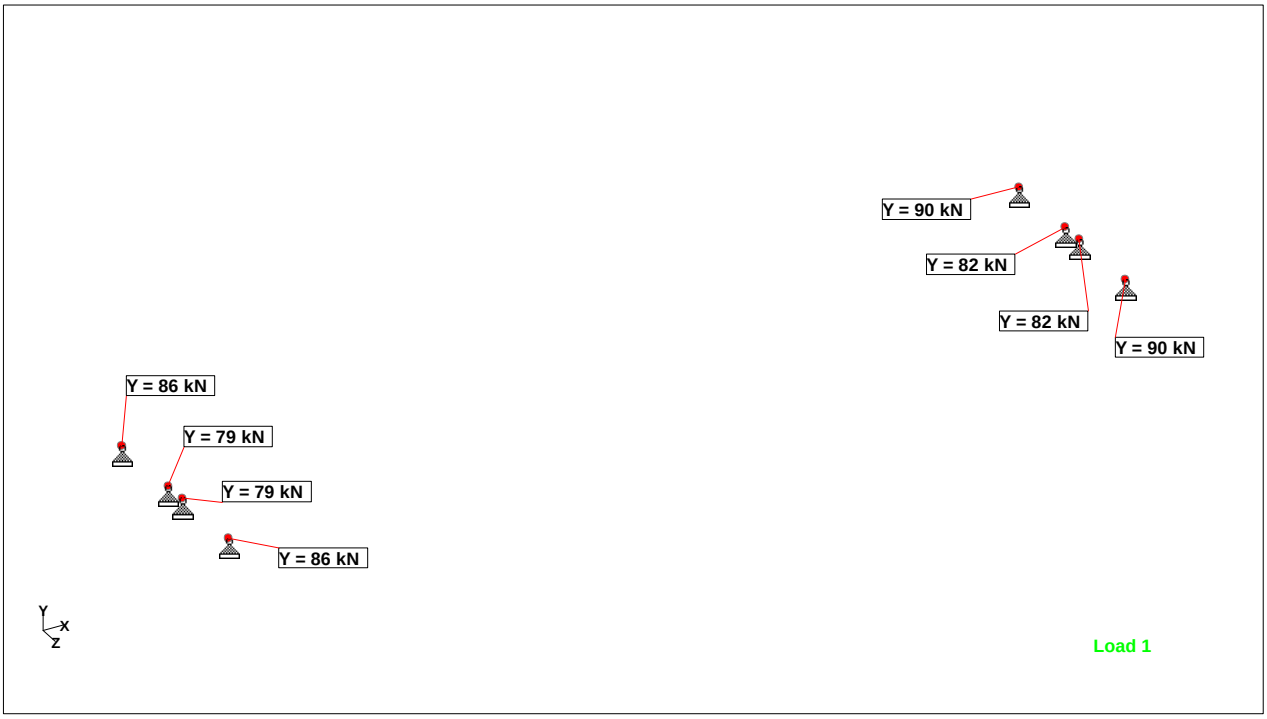
Koppeling dwarsdragers - dwarsdragers tgv Eigengewicht bij Mmax

Beam Maximum Forces by Section Property

Section		Axial	Shear		Torsion	Bending	
		Max Fx (kN)	Max Fy (kN)	Max Fz (kN)	Max Mx (kNm)	Max My (kNm)	Max Mz (kNm)
IPE300	Max +ve	0	8	0	0	0	3
	Max -ve	0	-8	0	-0	0	-25
HL1100R	Max +ve	0	477	0	4	0	134
	Max -ve	0	-469	0	-4	0	-3094
IPE550	Max +ve	0	12	0	0	0	30
	Max -ve	0	-87	0	-0	0	-31



Opleggingen - knoopnummers



Oplegreacties tgv Eigengewicht

Oplegreacties tgv Verkeer

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
263	135	0	497	0	0	0	0
263	235	0	495	0	0	0	0
263	134	0	491	0	0	0	0
263	234	0	487	0	0	0	0
259	101	0	486	0	0	0	0
263	133	0	485	0	0	0	0
259	102	0	482	0	0	0	0
259	201	0	481	0	0	0	0
263	132	0	480	0	0	0	0
263	233	0	479	0	0	0	0
259	103	0	476	0	0	0	0
259	202	0	474	0	0	0	0
263	131	0	474	0	0	0	0
263	232	0	472	0	0	0	0
259	104	0	469	0	0	0	0
259	203	0	467	0	0	0	0
263	130	0	466	0	0	0	0
263	231	0	464	0	0	0	0
259	105	0	462	0	0	0	0
259	204	0	459	0	0	0	0
263	129	0	458	0	0	0	0
263	230	0	456	0	0	0	0
259	106	0	454	0	0	0	0
259	205	0	450	0	0	0	0
263	128	0	450	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
263	229	0	447	0	0	0	0
259	107	0	445	0	0	0	0
259	206	0	442	0	0	0	0
265	235	0	441	0	0	0	0
263	127	0	441	0	0	0	0
263	228	0	439	0	0	0	0
259	108	0	436	0	0	0	0
259	207	0	433	0	0	0	0
263	126	0	432	0	0	0	0
263	227	0	430	0	0	0	0
259	109	0	427	0	0	0	0
265	234	0	427	0	0	0	0
259	208	0	424	0	0	0	0
263	125	0	423	0	0	0	0
265	135	0	423	0	0	0	0
263	226	0	421	0	0	0	0
259	110	0	417	0	0	0	0
261	201	0	417	0	0	0	0
259	209	0	416	0	0	0	0
263	124	0	413	0	0	0	0
263	225	0	412	0	0	0	0
265	233	0	410	0	0	0	0
259	111	0	408	0	0	0	0
259	210	0	407	0	0	0	0
263	123	0	404	0	0	0	0
263	224	0	403	0	0	0	0
259	112	0	399	0	0	0	0
259	211	0	398	0	0	0	0
261	202	0	397	0	0	0	0
265	134	0	397	0	0	0	0
263	122	0	395	0	0	0	0
263	223	0	394	0	0	0	0
265	232	0	393	0	0	0	0
259	113	0	389	0	0	0	0
259	212	0	389	0	0	0	0
263	222	0	385	0	0	0	0
263	121	0	385	0	0	0	0
261	101	0	383	0	0	0	0
261	203	0	381	0	0	0	0
259	114	0	380	0	0	0	0
259	213	0	380	0	0	0	0
265	231	0	378	0	0	0	0
263	221	0	376	0	0	0	0
263	120	0	376	0	0	0	0
259	214	0	371	0	0	0	0
259	115	0	370	0	0	0	0
263	220	0	367	0	0	0	0
263	119	0	367	0	0	0	0
261	204	0	367	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
265	230	0	365	0	0	0	0
265	133	0	364	0	0	0	0
259	215	0	362	0	0	0	0
259	116	0	361	0	0	0	0
263	219	0	359	0	0	0	0
263	118	0	357	0	0	0	0
265	229	0	355	0	0	0	0
261	205	0	354	0	0	0	0
259	216	0	353	0	0	0	0
259	117	0	352	0	0	0	0
263	218	0	350	0	0	0	0
263	117	0	348	0	0	0	0
265	228	0	345	0	0	0	0
259	217	0	344	0	0	0	0
261	206	0	344	0	0	0	0
259	118	0	343	0	0	0	0
263	217	0	341	0	0	0	0
261	102	0	340	0	0	0	0
263	116	0	339	0	0	0	0
265	227	0	337	0	0	0	0
261	207	0	335	0	0	0	0
259	218	0	335	0	0	0	0
259	119	0	333	0	0	0	0
263	216	0	332	0	0	0	0
265	132	0	331	0	0	0	0
263	115	0	330	0	0	0	0
265	226	0	329	0	0	0	0
261	208	0	327	0	0	0	0
259	219	0	326	0	0	0	0
259	120	0	324	0	0	0	0
263	215	0	323	0	0	0	0
265	225	0	321	0	0	0	0
263	114	0	320	0	0	0	0
261	209	0	320	0	0	0	0
259	220	0	317	0	0	0	0
259	121	0	315	0	0	0	0
265	224	0	314	0	0	0	0
263	214	0	314	0	0	0	0
261	210	0	312	0	0	0	0
263	113	0	311	0	0	0	0
261	103	0	310	0	0	0	0
262	203	0	309	0	0	0	0
262	204	0	308	0	0	0	0
259	221	0	308	0	0	0	0
262	202	0	308	0	0	0	0
265	223	0	307	0	0	0	0
262	205	0	306	0	0	0	0
259	122	0	306	0	0	0	0
261	211	0	305	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
263	213	0	305	0	0	0	0
266	231	0	304	0	0	0	0
266	232	0	304	0	0	0	0
265	131	0	303	0	0	0	0
262	201	0	302	0	0	0	0
263	112	0	302	0	0	0	0
266	230	0	302	0	0	0	0
266	233	0	301	0	0	0	0
262	206	0	301	0	0	0	0
265	222	0	300	0	0	0	0
266	235	0	300	0	0	0	0
266	234	0	299	0	0	0	0
259	222	0	299	0	0	0	0
261	212	0	298	0	0	0	0
266	229	0	298	0	0	0	0
259	123	0	296	0	0	0	0
263	212	0	296	0	0	0	0
262	207	0	295	0	0	0	0
263	111	0	293	0	0	0	0
265	221	0	292	0	0	0	0
266	228	0	292	0	0	0	0
261	213	0	291	0	0	0	0
259	223	0	290	0	0	0	0
262	208	0	289	0	0	0	0
259	124	0	287	0	0	0	0
263	211	0	287	0	0	0	0
266	227	0	286	0	0	0	0
261	104	0	285	0	0	0	0
265	220	0	285	0	0	0	0
261	214	0	284	0	0	0	0
263	110	0	283	0	0	0	0
265	130	0	283	0	0	0	0
262	209	0	281	0	0	0	0
259	224	0	281	0	0	0	0
266	226	0	279	0	0	0	0
263	210	0	278	0	0	0	0
265	219	0	278	0	0	0	0
259	125	0	278	0	0	0	0
261	215	0	277	0	0	0	0
262	210	0	274	0	0	0	0
263	109	0	274	0	0	0	0
259	225	0	272	0	0	0	0
266	225	0	272	0	0	0	0
265	218	0	271	0	0	0	0
265	129	0	269	0	0	0	0
261	216	0	269	0	0	0	0
263	209	0	269	0	0	0	0
259	126	0	268	0	0	0	0
262	211	0	267	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
261	105	0	266	0	0	0	0
266	224	0	265	0	0	0	0
263	108	0	265	0	0	0	0
259	226	0	263	0	0	0	0
265	217	0	263	0	0	0	0
261	217	0	262	0	0	0	0
263	208	0	260	0	0	0	0
262	212	0	259	0	0	0	0
259	127	0	259	0	0	0	0
265	128	0	259	0	0	0	0
266	223	0	258	0	0	0	0
265	216	0	256	0	0	0	0
263	107	0	256	0	0	0	0
261	218	0	254	0	0	0	0
259	227	0	254	0	0	0	0
261	106	0	253	0	0	0	0
262	213	0	252	0	0	0	0
263	207	0	251	0	0	0	0
265	127	0	251	0	0	0	0
266	222	0	250	0	0	0	0
259	128	0	250	0	0	0	0
265	215	0	248	0	0	0	0
264	235	0	247	0	0	0	0
261	219	0	247	0	0	0	0
263	106	0	246	0	0	0	0
259	228	0	245	0	0	0	0
265	126	0	245	0	0	0	0
262	214	0	245	0	0	0	0
261	107	0	244	0	0	0	0
266	221	0	243	0	0	0	0
263	206	0	242	0	0	0	0
265	214	0	241	0	0	0	0
259	129	0	241	0	0	0	0
264	234	0	241	0	0	0	0
265	125	0	240	0	0	0	0
261	220	0	240	0	0	0	0
260	201	0	239	0	0	0	0
261	108	0	238	0	0	0	0
262	215	0	237	0	0	0	0
263	105	0	237	0	0	0	0
259	229	0	237	0	0	0	0
266	220	0	236	0	0	0	0
265	124	0	235	0	0	0	0
264	233	0	234	0	0	0	0
263	205	0	233	0	0	0	0
265	213	0	233	0	0	0	0
261	109	0	233	0	0	0	0
260	202	0	232	0	0	0	0
261	221	0	232	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
259	130	0	231	0	0	0	0
265	123	0	231	0	0	0	0
262	216	0	230	0	0	0	0
261	110	0	229	0	0	0	0
266	219	0	229	0	0	0	0
263	104	0	228	0	0	0	0
259	230	0	228	0	0	0	0
264	232	0	227	0	0	0	0
265	122	0	227	0	0	0	0
265	212	0	226	0	0	0	0
260	203	0	226	0	0	0	0
261	111	0	225	0	0	0	0
261	222	0	225	0	0	0	0
263	204	0	224	0	0	0	0
262	217	0	223	0	0	0	0
265	121	0	223	0	0	0	0
259	131	0	222	0	0	0	0
266	218	0	221	0	0	0	0
261	112	0	221	0	0	0	0
264	231	0	221	0	0	0	0
260	204	0	219	0	0	0	0
259	231	0	219	0	0	0	0
263	103	0	219	0	0	0	0
265	120	0	218	0	0	0	0
265	211	0	218	0	0	0	0
261	223	0	217	0	0	0	0
261	113	0	217	0	0	0	0
262	218	0	216	0	0	0	0
263	203	0	215	0	0	0	0
264	230	0	214	0	0	0	0
266	217	0	214	0	0	0	0
265	119	0	214	0	0	0	0
259	132	0	213	0	0	0	0
260	205	0	213	0	0	0	0
261	114	0	213	0	0	0	0
265	210	0	211	0	0	0	0
259	232	0	210	0	0	0	0
261	224	0	210	0	0	0	0
265	118	0	209	0	0	0	0
263	102	0	209	0	0	0	0
262	219	0	209	0	0	0	0
261	115	0	208	0	0	0	0
264	229	0	208	0	0	0	0
266	216	0	207	0	0	0	0
260	206	0	207	0	0	0	0
263	202	0	207	0	0	0	0
265	117	0	205	0	0	0	0
261	116	0	204	0	0	0	0
259	133	0	204	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
265	209	0	203	0	0	0	0
264	228	0	203	0	0	0	0
261	225	0	202	0	0	0	0
262	220	0	202	0	0	0	0
260	207	0	201	0	0	0	0
259	233	0	201	0	0	0	0
266	215	0	200	0	0	0	0
263	101	0	200	0	0	0	0
265	116	0	200	0	0	0	0
261	117	0	199	0	0	0	0
263	201	0	198	0	0	0	0
264	227	0	197	0	0	0	0
265	208	0	196	0	0	0	0
260	208	0	196	0	0	0	0
263	100	0	195	0	0	0	0
262	221	0	195	0	0	0	0
261	226	0	195	0	0	0	0
265	115	0	195	0	0	0	0
259	134	0	194	0	0	0	0
261	118	0	194	0	0	0	0
266	214	0	193	0	0	0	0
263	200	0	193	0	0	0	0
259	234	0	192	0	0	0	0
264	226	0	191	0	0	0	0
260	209	0	190	0	0	0	0
265	114	0	190	0	0	0	0
261	119	0	189	0	0	0	0
265	207	0	188	0	0	0	0
262	222	0	188	0	0	0	0
259	100	0	187	0	0	0	0
261	227	0	187	0	0	0	0
266	213	0	186	0	0	0	0
264	225	0	185	0	0	0	0
259	135	0	185	0	0	0	0
259	200	0	185	0	0	0	0
265	113	0	185	0	0	0	0
261	120	0	184	0	0	0	0
260	210	0	184	0	0	0	0
259	235	0	183	0	0	0	0
265	206	0	181	0	0	0	0
262	223	0	181	0	0	0	0
264	224	0	180	0	0	0	0
261	228	0	180	0	0	0	0
265	112	0	180	0	0	0	0
261	121	0	179	0	0	0	0
266	212	0	179	0	0	0	0
260	211	0	179	0	0	0	0
262	107	0	176	0	0	0	0
262	106	0	176	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
265	111	0	175	0	0	0	0
261	122	0	174	0	0	0	0
264	223	0	174	0	0	0	0
262	224	0	174	0	0	0	0
265	205	0	173	0	0	0	0
260	212	0	173	0	0	0	0
262	108	0	173	0	0	0	0
261	229	0	172	0	0	0	0
266	211	0	172	0	0	0	0
262	105	0	171	0	0	0	0
265	110	0	170	0	0	0	0
261	123	0	169	0	0	0	0
262	109	0	169	0	0	0	0
264	222	0	168	0	0	0	0
260	213	0	167	0	0	0	0
262	225	0	167	0	0	0	0
266	128	0	167	0	0	0	0
265	204	0	166	0	0	0	0
266	127	0	166	0	0	0	0
266	129	0	165	0	0	0	0
266	210	0	165	0	0	0	0
261	230	0	165	0	0	0	0
262	110	0	165	0	0	0	0
265	109	0	165	0	0	0	0
261	124	0	164	0	0	0	0
266	126	0	164	0	0	0	0
264	221	0	163	0	0	0	0
260	214	0	162	0	0	0	0
262	104	0	161	0	0	0	0
266	130	0	160	0	0	0	0
262	111	0	160	0	0	0	0
266	125	0	160	0	0	0	0
262	226	0	160	0	0	0	0
265	108	0	160	0	0	0	0
261	125	0	159	0	0	0	0
265	203	0	159	0	0	0	0
266	209	0	158	0	0	0	0
261	231	0	157	0	0	0	0
264	220	0	157	0	0	0	0
260	215	0	156	0	0	0	0
266	124	0	155	0	0	0	0
262	112	0	155	0	0	0	0
265	107	0	155	0	0	0	0
261	126	0	154	0	0	0	0
262	227	0	153	0	0	0	0
264	219	0	151	0	0	0	0
265	202	0	151	0	0	0	0
266	208	0	151	0	0	0	0
266	123	0	151	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
260	216	0	150	0	0	0	0
262	113	0	150	0	0	0	0
261	232	0	150	0	0	0	0
265	106	0	150	0	0	0	0
261	127	0	149	0	0	0	0
266	131	0	149	0	0	0	0
266	122	0	146	0	0	0	0
264	218	0	146	0	0	0	0
262	114	0	146	0	0	0	0
262	228	0	146	0	0	0	0
262	103	0	145	0	0	0	0
260	217	0	145	0	0	0	0
265	105	0	145	0	0	0	0
261	128	0	144	0	0	0	0
266	207	0	144	0	0	0	0
265	201	0	144	0	0	0	0
261	233	0	142	0	0	0	0
266	121	0	142	0	0	0	0
262	115	0	141	0	0	0	0
264	217	0	140	0	0	0	0
265	200	0	140	0	0	0	0
265	104	0	139	0	0	0	0
261	129	0	139	0	0	0	0
260	218	0	139	0	0	0	0
262	229	0	138	0	0	0	0
266	120	0	137	0	0	0	0
262	116	0	137	0	0	0	0
266	206	0	137	0	0	0	0
261	234	0	135	0	0	0	0
265	103	0	134	0	0	0	0
264	216	0	134	0	0	0	0
261	130	0	134	0	0	0	0
260	219	0	133	0	0	0	0
266	119	0	133	0	0	0	0
262	117	0	133	0	0	0	0
262	230	0	131	0	0	0	0
266	132	0	131	0	0	0	0
266	205	0	130	0	0	0	0
265	102	0	129	0	0	0	0
261	131	0	129	0	0	0	0
262	118	0	129	0	0	0	0
266	118	0	129	0	0	0	0
261	200	0	129	0	0	0	0
264	215	0	129	0	0	0	0
260	220	0	128	0	0	0	0
261	235	0	127	0	0	0	0
262	119	0	126	0	0	0	0
266	117	0	125	0	0	0	0
265	101	0	124	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
262	231	0	124	0	0	0	0
261	132	0	124	0	0	0	0
262	102	0	124	0	0	0	0
264	214	0	123	0	0	0	0
266	204	0	123	0	0	0	0
260	221	0	122	0	0	0	0
265	100	0	122	0	0	0	0
262	120	0	122	0	0	0	0
266	116	0	121	0	0	0	0
261	133	0	119	0	0	0	0
262	121	0	118	0	0	0	0
266	115	0	118	0	0	0	0
262	232	0	117	0	0	0	0
264	213	0	117	0	0	0	0
260	222	0	116	0	0	0	0
266	203	0	116	0	0	0	0
262	122	0	114	0	0	0	0
261	134	0	114	0	0	0	0
266	114	0	114	0	0	0	0
264	212	0	112	0	0	0	0
262	123	0	111	0	0	0	0
260	223	0	111	0	0	0	0
261	100	0	110	0	0	0	0
262	233	0	110	0	0	0	0
266	113	0	110	0	0	0	0
261	135	0	109	0	0	0	0
266	202	0	109	0	0	0	0
262	124	0	107	0	0	0	0
266	112	0	107	0	0	0	0
266	133	0	106	0	0	0	0
264	211	0	106	0	0	0	0
260	224	0	105	0	0	0	0
262	125	0	103	0	0	0	0
262	234	0	103	0	0	0	0
266	111	0	103	0	0	0	0
266	201	0	102	0	0	0	0
264	210	0	100	0	0	0	0
262	126	0	100	0	0	0	0
266	110	0	99	0	0	0	0
260	225	0	99	0	0	0	0
262	200	0	98	0	0	0	0
266	200	0	98	0	0	0	0
262	235	0	96	0	0	0	0
262	127	0	96	0	0	0	0
266	109	0	96	0	0	0	0
264	209	0	95	0	0	0	0
260	226	0	93	0	0	0	0
262	128	0	92	0	0	0	0
266	108	0	92	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
262	101	0	90	0	0	0	0
264	208	0	89	0	0	0	0
262	129	0	89	0	0	0	0
266	107	0	88	0	0	0	0
260	227	0	88	0	0	0	0
262	130	0	85	0	0	0	0
266	106	0	84	0	0	0	0
264	207	0	83	0	0	0	0
266	134	0	82	0	0	0	0
260	228	0	82	0	0	0	0
262	131	0	81	0	0	0	0
266	105	0	81	0	0	0	0
264	206	0	77	0	0	0	0
262	132	0	77	0	0	0	0
266	104	0	77	0	0	0	0
260	229	0	76	0	0	0	0
262	133	0	74	0	0	0	0
266	103	0	73	0	0	0	0
264	205	0	72	0	0	0	0
260	230	0	71	0	0	0	0
262	134	0	70	0	0	0	0
266	102	0	70	0	0	0	0
262	100	0	67	0	0	0	0
262	135	0	66	0	0	0	0
264	204	0	66	0	0	0	0
266	101	0	66	0	0	0	0
266	135	0	65	0	0	0	0
260	231	0	65	0	0	0	0
266	100	0	64	0	0	0	0
264	203	0	60	0	0	0	0
260	232	0	59	0	0	0	0
264	202	0	55	0	0	0	0
260	233	0	54	0	0	0	0
264	201	0	49	0	0	0	0
260	234	0	48	0	0	0	0
264	200	0	46	0	0	0	0
260	200	0	43	0	0	0	0
260	235	0	42	0	0	0	0
264	100	0	-8	0	0	0	0
264	135	0	-8	0	0	0	0
260	135	0	-8	0	0	0	0
264	101	0	-9	0	0	0	0
260	100	0	-9	0	0	0	0
260	134	0	-9	0	0	0	0
264	102	0	-9	0	0	0	0
260	133	0	-9	0	0	0	0
264	103	0	-9	0	0	0	0
260	132	0	-10	0	0	0	0
264	104	0	-10	0	0	0	0

Oplegreacties tgv Verkeer Cont...

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
260	131	0	-10	0	0	0	0
264	105	0	-10	0	0	0	0
264	134	0	-11	0	0	0	0
260	130	0	-11	0	0	0	0
264	106	0	-11	0	0	0	0
260	129	0	-11	0	0	0	0
264	107	0	-11	0	0	0	0
260	101	0	-12	0	0	0	0
260	128	0	-12	0	0	0	0
264	108	0	-12	0	0	0	0
260	127	0	-12	0	0	0	0
264	109	0	-12	0	0	0	0
260	126	0	-13	0	0	0	0
264	110	0	-13	0	0	0	0
260	125	0	-13	0	0	0	0
264	111	0	-13	0	0	0	0
260	124	0	-14	0	0	0	0
264	112	0	-14	0	0	0	0
264	133	0	-14	0	0	0	0
260	123	0	-14	0	0	0	0
264	113	0	-14	0	0	0	0
260	122	0	-15	0	0	0	0
264	114	0	-15	0	0	0	0
260	121	0	-15	0	0	0	0
264	115	0	-15	0	0	0	0
260	120	0	-16	0	0	0	0
264	116	0	-16	0	0	0	0
260	102	0	-16	0	0	0	0
260	119	0	-16	0	0	0	0
264	117	0	-16	0	0	0	0
260	118	0	-16	0	0	0	0
264	118	0	-17	0	0	0	0
264	132	0	-17	0	0	0	0
260	117	0	-17	0	0	0	0
264	119	0	-17	0	0	0	0
260	116	0	-17	0	0	0	0
264	120	0	-18	0	0	0	0
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264	121	0	-18	0	0	0	0
260	114	0	-19	0	0	0	0
260	103	0	-19	0	0	0	0
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260	113	0	-19	0	0	0	0
264	131	0	-19	0	0	0	0
264	123	0	-19	0	0	0	0
260	112	0	-20	0	0	0	0
264	124	0	-20	0	0	0	0
260	111	0	-20	0	0	0	0
264	125	0	-21	0	0	0	0

Oplegreacties tgv Verkeer Cont...

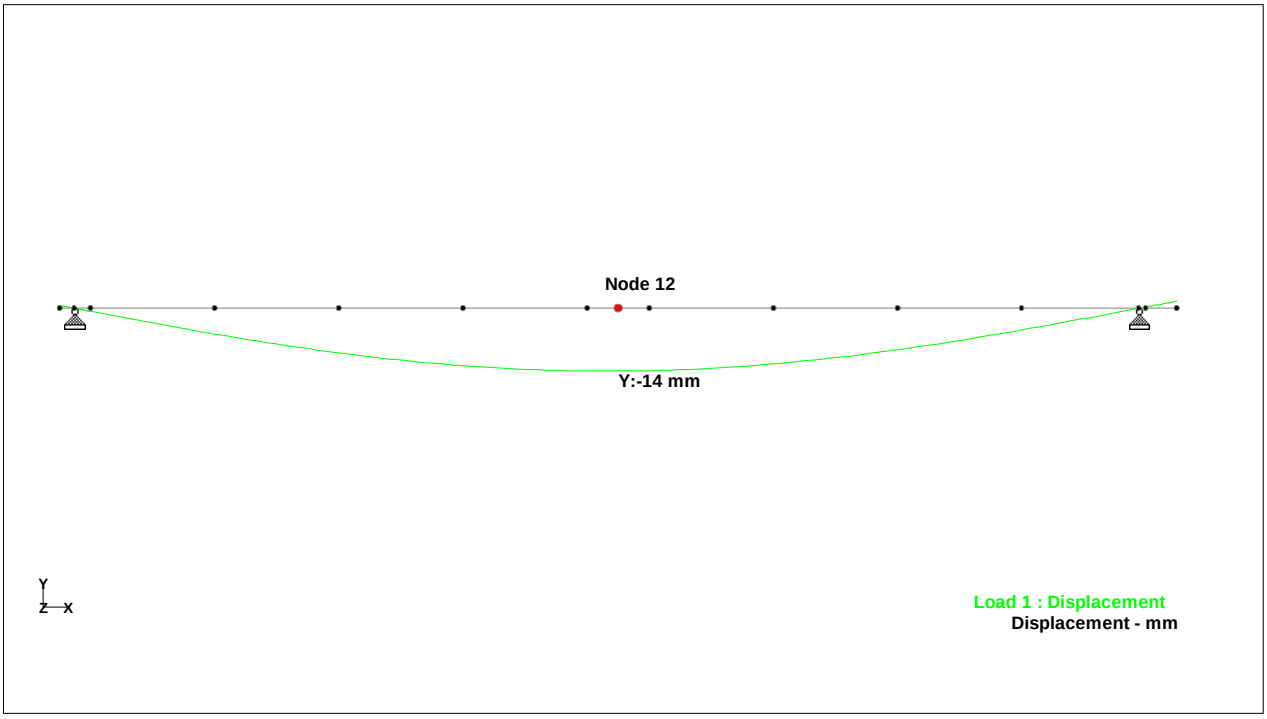
Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
260	104	0	-21	0	0	0	0
264	130	0	-21	0	0	0	0
260	110	0	-21	0	0	0	0
264	126	0	-21	0	0	0	0
264	129	0	-21	0	0	0	0
264	127	0	-21	0	0	0	0
264	128	0	-22	0	0	0	0
260	109	0	-22	0	0	0	0
260	105	0	-22	0	0	0	0
260	108	0	-22	0	0	0	0
260	107	0	-23	0	0	0	0
260	106	0	-23	0	0	0	0

Reaction Envelope

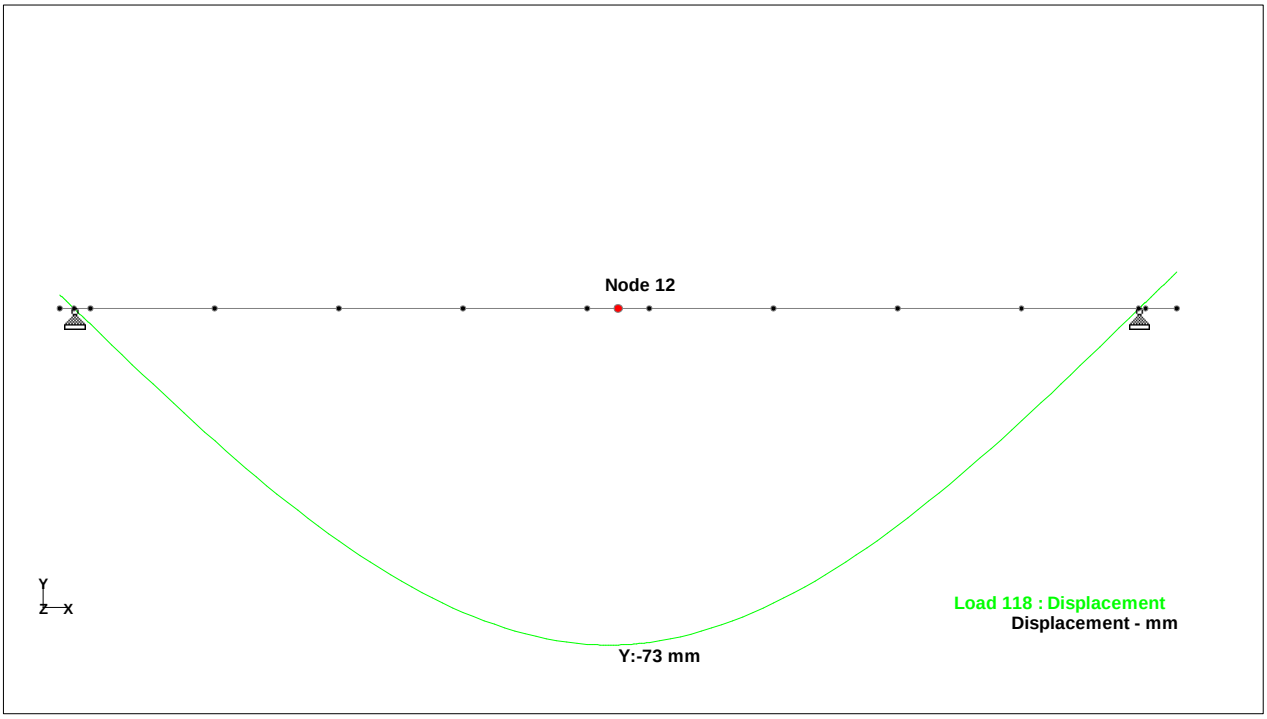
Results are not available - This Printing is possible only from Post Processing

Reaction Envelope Cont...

Results are not available - This Printing is possible only from Post Processing



Doorbuiging tgv Eigengewicht



Maximale doorbuiging tgv Verkeer

Project no.: 5286

Project: Standard Calculation - RLB Bridge

Subject: Static Calculation acc. Eurocode

Rev.B: December 2011

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Ir. M.M. Kaczmarek

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1. Foreword

The calculation contains a structural analysis of the Retro Bridge plate-girder bridge with an orthotropic steel deck. The analysis is made in agreement with :

- Eurocode 1: Basis of design and actions on structures.
  Part 3: Traffic loads on bridges (EC1-3)

- Eurocode 3: Design of steel structures
  Part 1-1: General rules and rules for buildings (EC3-1-1)
  Part 1-5: Supplementary rules for planar plated structures without transverse loading (EC3-1-8)
  Part 1-8: Design of joints (EC3-1-8)

- Eurocode 3: Design of steel structures
  Part 2: Steel bridges. (EC3-2)

Material properties steel:

$E = 210000\ N/mm^2$ $G = 81000\ N/mm^2$ $\nu = 0.3$

$\alpha = 12 \times 10^{-6}$ pro °C $\rho = 7850\ kg/m^3$

Steel quality:

-	Main girder bottom flange and web	S460N	-	(EN10025)
-	Deck, transom and other	S355J2	-	(EN10025)
-	Rigid joint pin Ø90 high-quality steel	34CrNiMo6	-	(EN10250 - 3:2000)
-	Bolts	HSFG 10.9	-	(EN14399 - 4:2000)

2. Loads on the bridge

2.1. Loads

Load model 1 (EC1-3 4.3.2)

This load model consist of a double-axle concentrated loads and an uniformly distributed load.

a. Double-axle concentrated loads (tandem system TS)

Each axle has a weight α_Q x Q_K [kN].

The basic values for the lane 1 are:

α_{Q1} = 1.0 [-]

α_Q x Q_K = 300 kN

the distance between two axles is 1.2 m.

Each axle of the tandem consists of two identical wheels at a distance of 2.0 m.

The load per wheel is 0.5 α_Q x Q_K = 150 kN

The wheel print is a square 0.40 x 0.40 m^2

Only one TS is to be applied per lane.

b. Uniformly Distributed Loads (UDL)

The weight density per m^2 is α_q x q_k [kN/m]

The basic values for the lane 1 are:

α_q = 1 [-]

q_k = 9 kN/m^2

Load model 2 (EC1-3 4.3.3)

a. Single axle load.

Single axle weight β_Q x Q_{ak} [kN]

The basic values for the lane 1 are:

β_Q = 1.0 [-]

β_Q x Q_{ak} = 400 kN

The axle has two identical wheels with a distance 2.00 m. On the wheel print of 0.35 x 0.60 m^2 acts a load 200 kN.

Dead Load

Dead Load of one RLB bridge section consists of :

- Deck plate

Deck finish 0.005 [m] x 25 [kN/m^3]		= 0.125 kN/m^2
Deck plate 0.015 [m] x 78.5 [kN/m^3]		= 1.1775 kN/m^2
		---------- +
	$q_{G.k}$	= 1.30 kN/m^2

- Hollow rib

Deck finish 0.52 [m] x 0.005 [m] x 25 [kN/m^3]		= 0.065 kN/m^1
Deck plate + Hollow rib 0.012 [m^2] x 78.5 [kN/m^3]		= 0.942 kN/m^1
		---------- +
	$q_{G.k}$	= 1.01 kN/m^1

- Transom

Deck finish 3.0 [m] x 0.005 [m] x 25 [kN/m^3]		= 0.375 kN/m^1
Deck plate 3.0 [m] x 0.015 [m] x 78.5 [kN/m^3]		= 3.5325 kN/m^1
Hollow ribs 4[-] x 3.0 [m] x 0.00415 [m^2] x 78.5 [kN/m^3] / 3.0 [m]		= 1.303 kN/m^1
Web plate 0.60 [m] x 0.008 [m] x 78.5 [kN/m^3]		= 0.3768 kN/m^1
Bottom flange 0.15[m] x 0.010 [m] x 78.5 [kN/m^3]		= 0.1178 kN/m^1
		---------- +
	$q_{G.k}$	= 5.71 kN/m^1

- Bridge section (two main girds)

Transom 5.71 [kN/m^1] x 3.0 [m] / 3 [m]		= 5.71 kN/m^1
Web plate 2 [-] x 1.1 [m] x 0.008 [m] x 78.5 [kN/m^3]		= 1.382 kN/m^1
Bottom flange 2 [-] x 0.35[m] x 0.040[m] x 78.5 [kN/m^3]		= 2.20 kN/m^1
Side flanges 2 [-] x 0.25[m] x 0.015[m] x 78.5 [kN/m^3]		= 0.589 kN/m^1
Rest (stiffeners, welds, bolts, etc)		= 1.10 kN/m^1
		---------- +
	$q_{G.k}$	= 11.0 kN/m^1

2.2. Load cases – safety factors

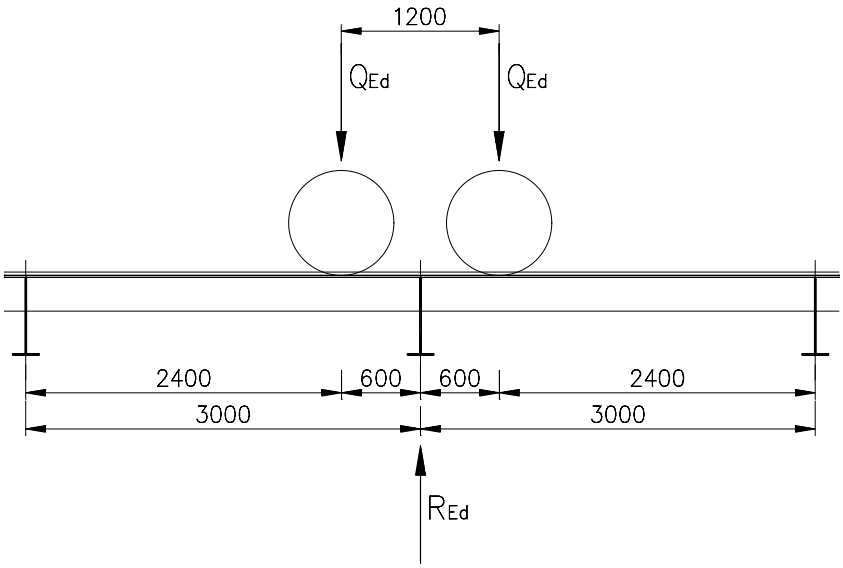
$\gamma_{G.sup}$ = 1.35 [-] (EC1-3 C2.3)

γ_Q = 1.35 [-] (for traffic actions)

γ_Q = 1.50 [-] (for other variable actions)

2.3. Maximum bending in transom

Load model 1 is decisive.



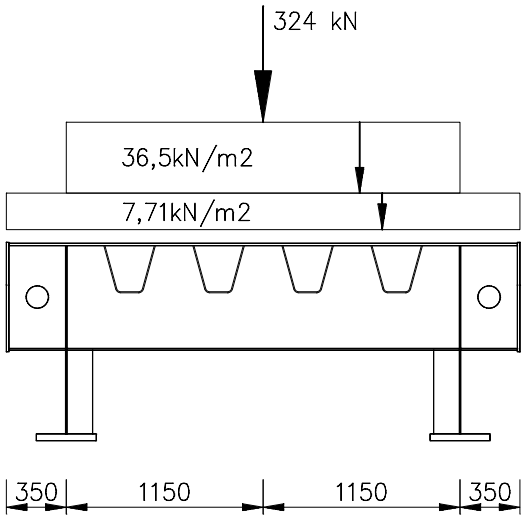
α_Q x Q_k = 300 kN per axle

$Q_{Ed} = \gamma_Q$ x (α_Q x Q_K)

Q_{Ed} = 1.35 x 300 = 405 kN

R_{Ed} = 2 x 405 x 2.4 / 3.0 = 648 kN

- Maximum bending between supports



$F_{Ed} = R_{Ed} / 2 = 648 / 2 = 324$ kN

$q_{EG.Ed} = \gamma_{G.sup} \times q_{G.k} = 1.35 \times 5.71 = 7.71$ kN/m^1

$q_{vl.Ed} = \gamma_Q \times q_{udl.k} = 1.35 \times 9.0 \times 3.0 = 36.5$ kN/m^1

Support reactions:

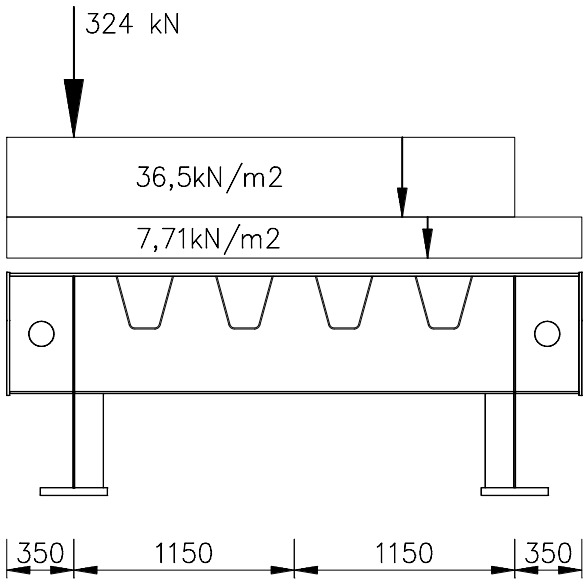
$R_{Ed} = ½ \times (7.71 \times 3.00 + 36.5 \times 2.30 + 324) = 216$ kN

$M_{Ed} = - ½ \times 1.75^2 \times 7.71 - ½ \times 1.15^2 \times 36.5 + 1.15 \times 216 = 212$ kNm

Shear force at the midspan is 324/2 = 162 kN < $0.5V_{Rd}$ therefore interaction bending with shear is not necessary

$M_{Ed} / M_{Rd} = 212 / 584 = 0.36 < 1$ OK

- Maximum shear in transom over support



$F_{Ed} = 324$ kN

$q_{EG.Ed} = 7.71$ kN/m^1

$q_{vl.Ed} = 36.5$ kN/m^1

$R_{Ed} = 2.65 \times 1.325/2.3 \times 36.5 + 3.0/2 \times 7.71 + 324 = 391$ kN

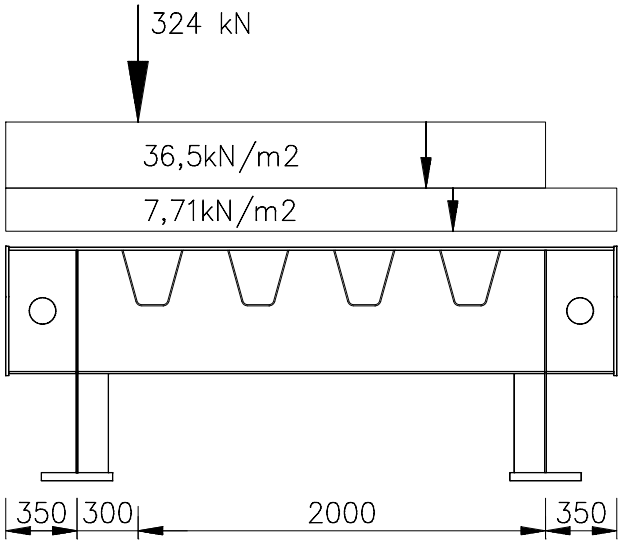
$R_{Ed} / V_{Rd} = 391 / 984 = 0.40 < 0.5\ V_{Rd}$ therefore interaction bending with shear is not necessary

- Maximum shear in transom at the hollow rib

F_{Ed} = 324 kN

$q_{EG.Ed}$ = 7.71 kN/m^1

$q_{Vl.Ed}$ = 36.5 kN/m^1



R_{Ed} = 0.5 x 3.0 x 7.71 + 2.65 x 1.325/2.3 x 36.5 + 324 x 2.0/2.3 = 349 kN

V_{Ed} = 349 - (0.35 + 0.3) x (7.71 + 36.50) = 320 kN

M_{Ed} = 349 x 0.3 – 0.5 x 0.65^2 x (7.71 + 36.50) = 95 kNm

V_{Ed} / V_{Rd} = 320 / 492 = 0.65 > 0.5 V_{Rd} so interaction bending with shear is necessary

$\rho = (2V_{Ed} / V_{pl,Rd} - 1)^2$ (EC3-1-1 6.2.8)

$\rho = (2 \times 320 / 492 - 1)^2 = 0.09$

→ calculate with reduced yield stress $(1- \rho) \times f_y = 0.91\ f_y$

$M_{y,V,,Rd} = 0.91 \times M_{c,Rd} = 0.91 \times 584 = 531$ kNm

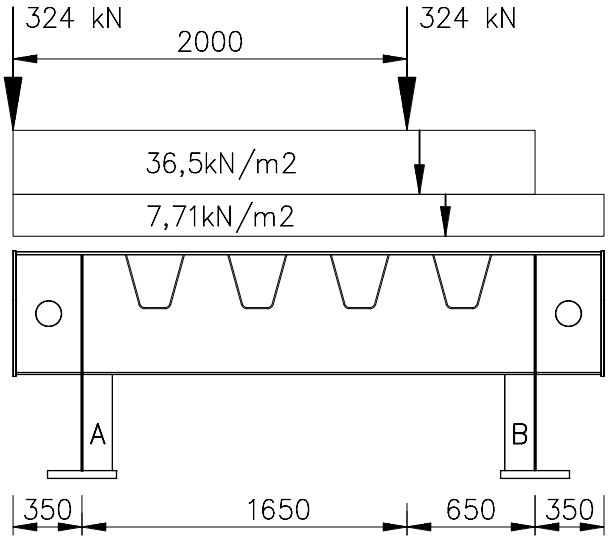
M_{Ed} / M_{Rd} = 95 / 531 = 0.18 < 1 OK

- Maximum bending in transom over support

F_{Ed} = 324 kN

$q_{EG.Ed}$ = 7.71 kN/m^1

$q_{vl.Ed}$ = 36.5 kN/m^1



R_A = (2.65 + 0.65)/2.3 x 324 + 0.5 x 3.0 x 7.71 + 2.65 x 1.325/2.3 x 36.5 = 532 kN

On the support A:

V_{Ed} = 324 + 0.35 x (7.71+ 36.5) = 339 kN < 0.5 V_{Rd} = 0.5 x 984 = 492 kN

M_{Ed} = 324 x 0.35 + 0.5 x 0.35^2 x (7.71 + 36.5) = 116 kNm

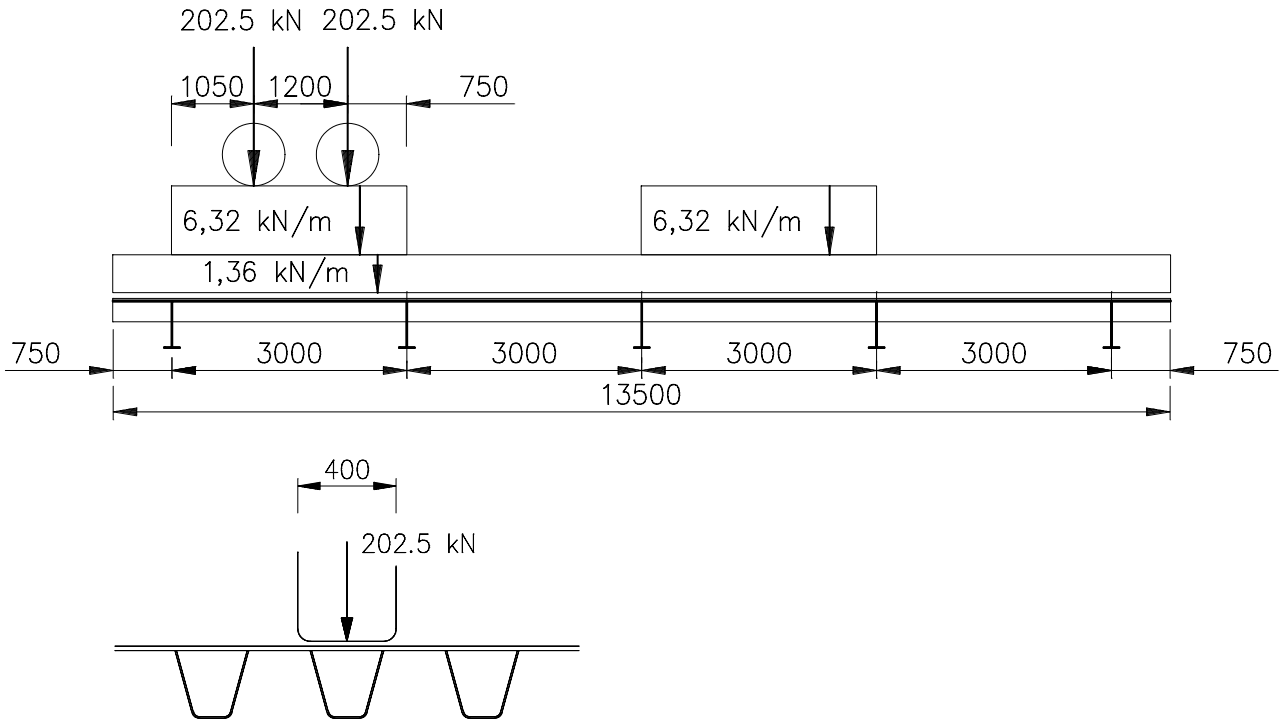
M_{Ed} / M_{Rd} = 116 / 543.5 = 0.21 < 1 OK

2.4. Maximum forces on the hollow rib

All forces are calculated using a statics computer software.

- Maximum bending at the midspan

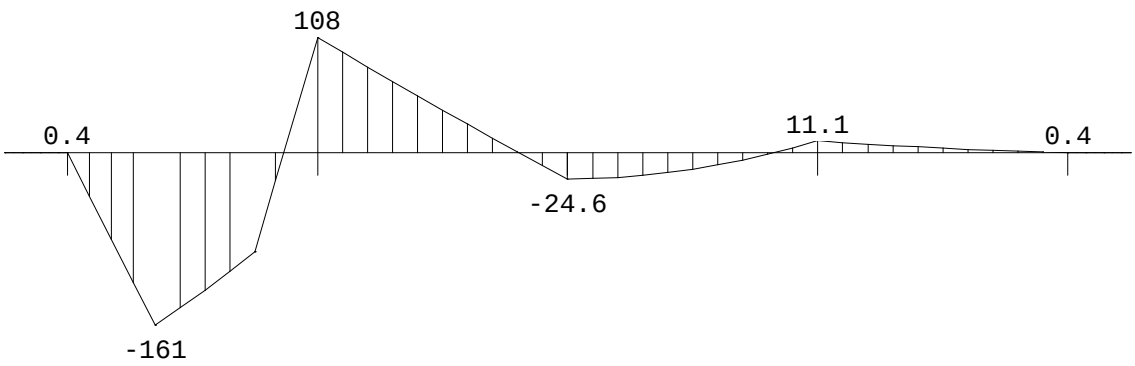
Load model 1 is decisive



F_{Ed} = 1.35 x 300/2 = 202.5 kN (one wheel load)

$q_{vl.Ed}$ = 1.35 x 9 x 0.52 = 6.32 kN/m^1

$q_{eg.Ed}$ = 1.35 x 1.01 = 1.36 kN/m^1

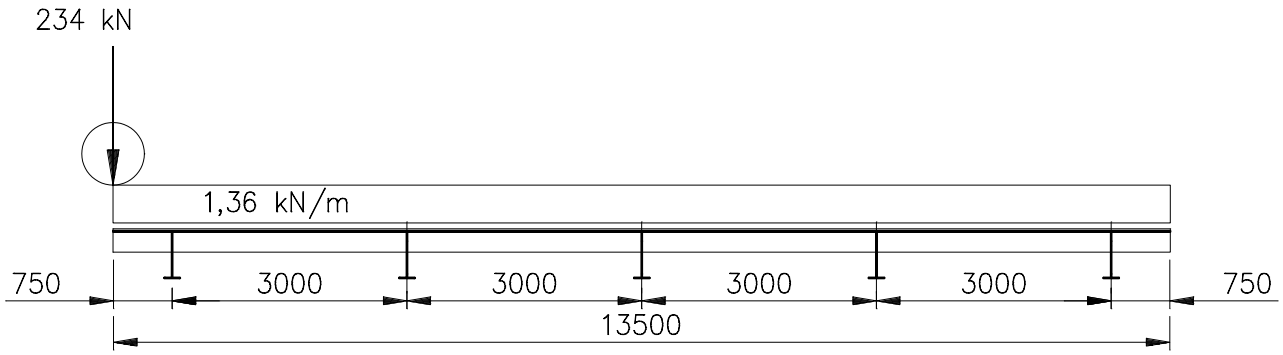


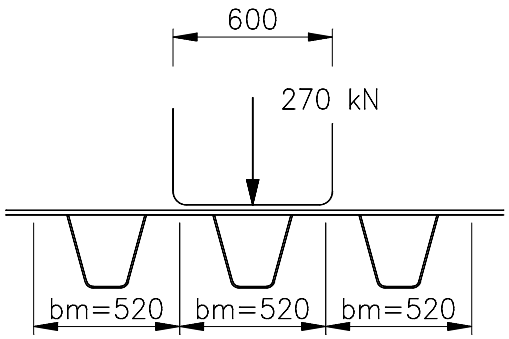
Bending [kNm]

M_{Ed} / M_{Rd} = 161 / 259 = 0.62 < 1 OK

- Maximum bending at the support

Load model 2 is decisive.

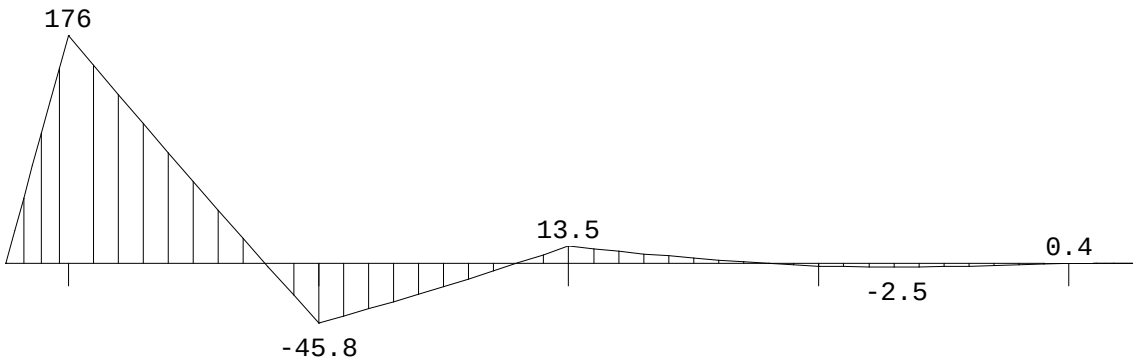




$F_{Ed,wheel}$ = 1.35 x 400/2 = 270 kN (one wheel load)

F_{Ed} = 520/600 x 270 = 234kN (load on one hollow rib)

$q_{eg.Ed}$ = 1.35 x 1.01 = 1.36 kN/m[1]

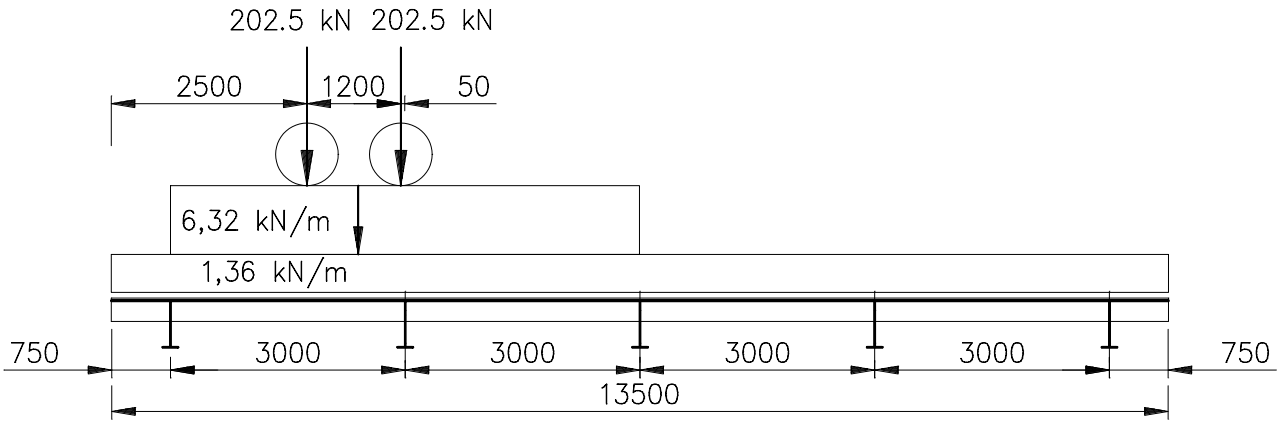


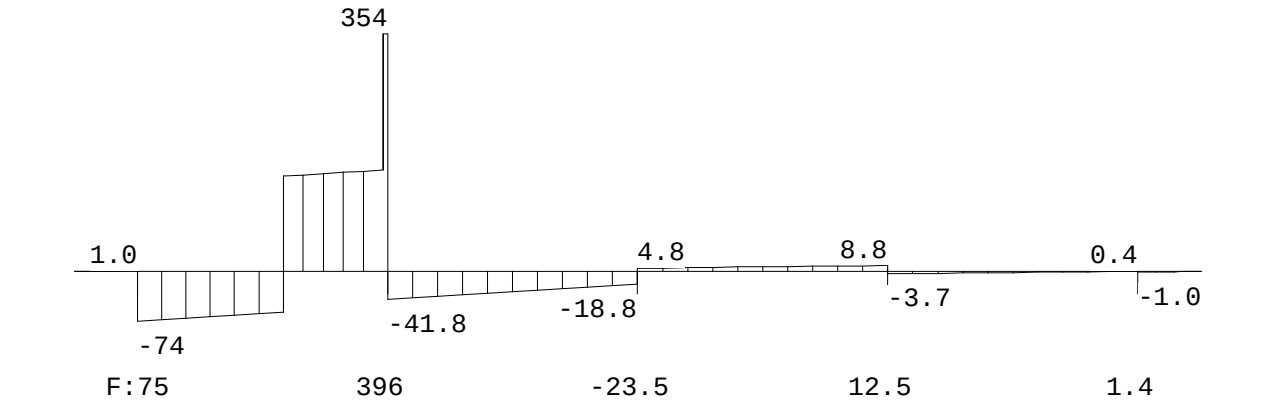
Bending [kNm]

M_{Ed} / M_{Rd} = 176 / 259 = 0.68 < 1 OK

- Maximum shear

Load model 1 is decisive



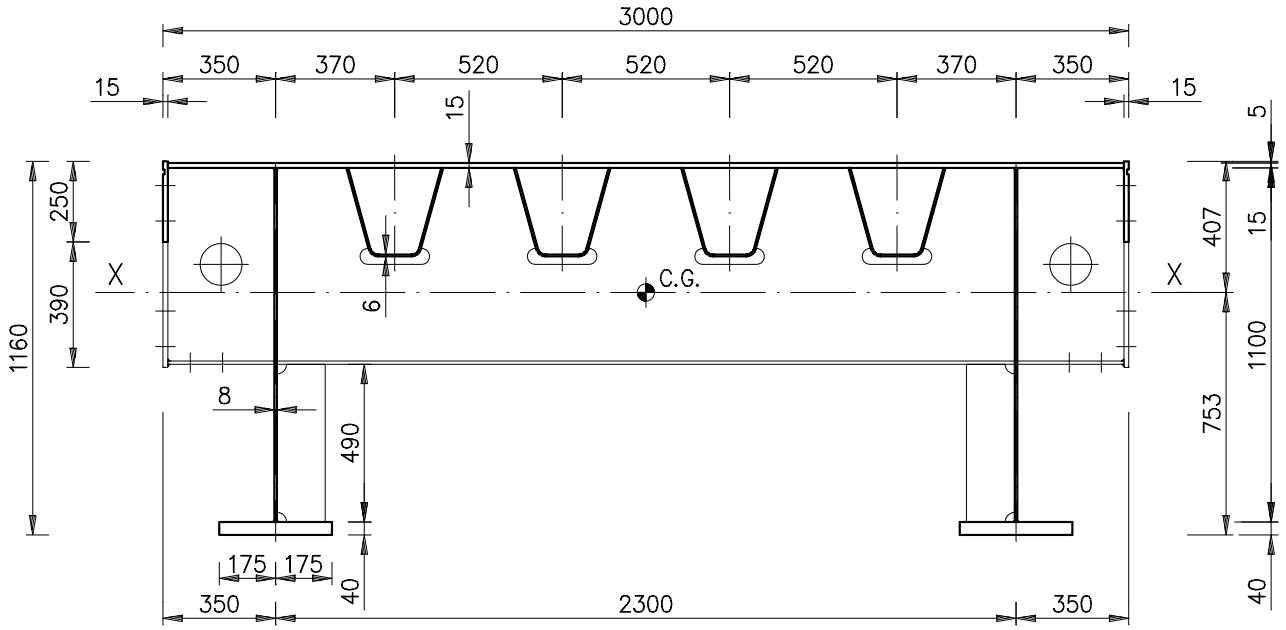


Shear [kN]

$V_{Ed} / V_{Rd} = 354 / 676 = 0.52 < 1$ OK

3. Sectional properties and capacity of the main girder

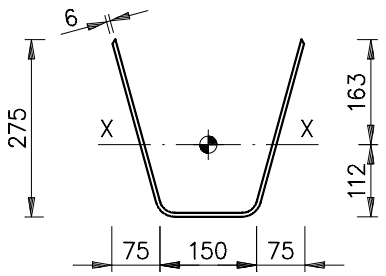
3.1. Properties of the bridge section



Sectional properties of the bridge section

Deck plate	A =	445,5	cm2	I = 84	cm4	e = 114,8 cm
Side flanges		75,0		3906		103,5
Hollow ribs		166,0		12740		97,7
Web plates		176,0		177467		59,0
Bottom flanges		280,0		373		2,0

Total section: A = 1142 cm2 Ixx = 2583767 cm4 ex = 75,3 cm



Hollow rib:

A = 41.5 cm2
Ixx = 3185 cm4
ex = 11,2 / 16,3 cm

3.2. Classification of cross-sections

(EC3-1-1 5.5.2)

		In bending		(Table 5.2)
Deck plate	Main girder	**1**		
	Transom	**1**	**(*)**	
	Hollow rib	**1**		
Web	Main girder	**4**		
	Transom	**3**		
	Hollow rib	**1**		
Bottom flange	Main girder	**1**		
	Transom	**1**		
	Hollow rib	**1**		

(*) is stiffened due to hollow rib

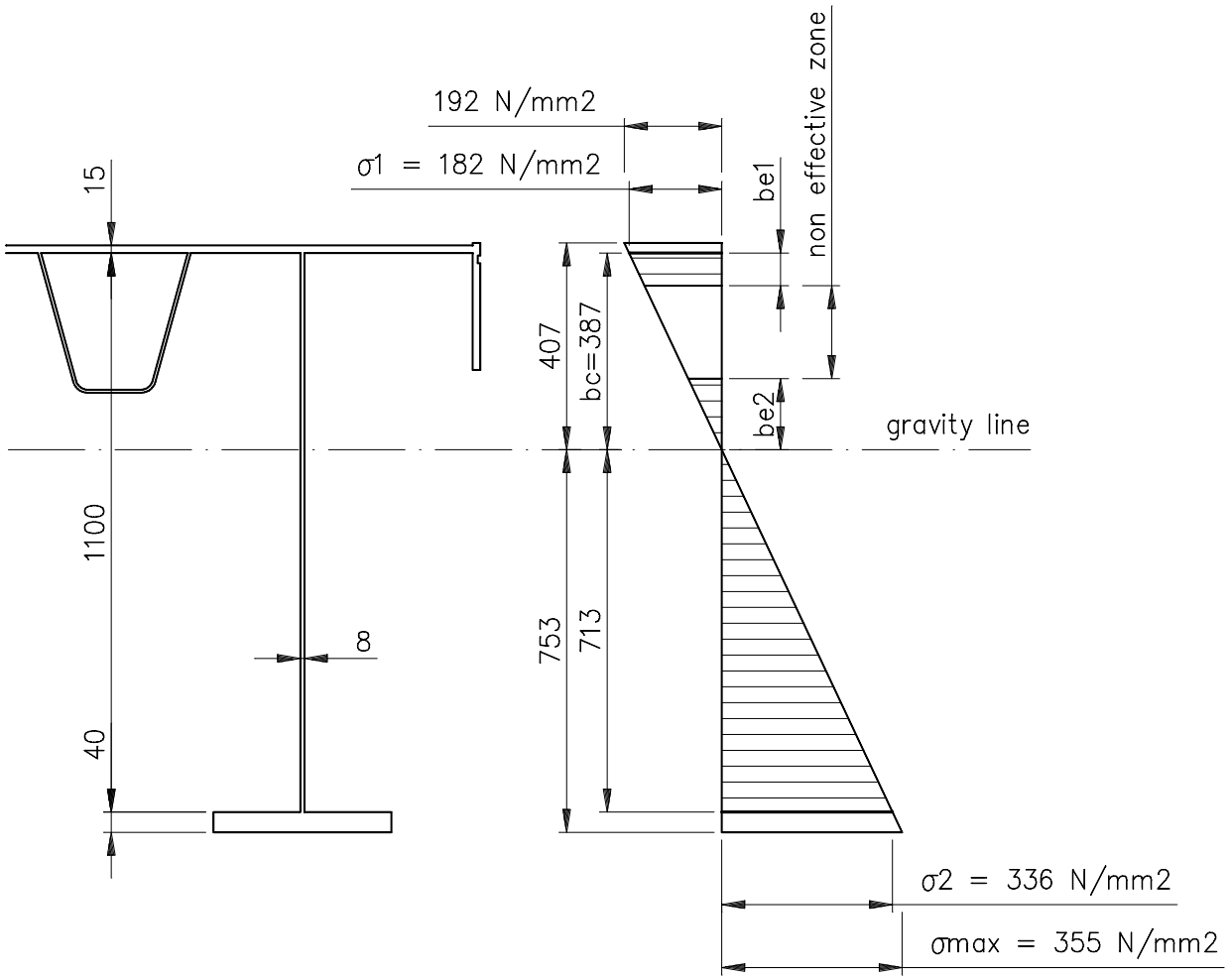
3.3. Bending- and shear capacity of the bridge section

Classification of the main girder

Web →	Class 4	I			
		>	Main girder → Class 4		(EC3-1-1 5.5.2)
Flange →	Class 1	I			

Effective web - Class 4

Stresses by maximum allowable bending of the bridge :



$\psi = \sigma_2 / \sigma_1$ (EC3-1-5 Table 4.1)

ψ = - 336 / 182 = -1.85 (compression is positive)

$-1 > \psi < -3$ → $k_\sigma = 5.98 (1- \psi)^2 = 5.98 (1 + 1.85)^2 = 48.6$

$$\rho = \frac{\overline{\lambda_p} - 0.055(3+\psi)}{\overline{\lambda_p}^2} \leq 1.0$$ (EC3-1-5 4.4)

$$\overline{\lambda_p} = \frac{\bar{b}/t}{28.4\varepsilon\sqrt{k_\sigma}}$$

wherein:

$\bar{b}$ = b_w = 110 cm (web height)

t = 0.8 cm (web thickness)

ε = $(23.5 / f_{yk})^{0.5}$ = $(23.5 / 46.0)^{0.5}$ = 0.71 [-] (web steel S460)

$\overline{\lambda_p}$ = 110 / 0.8 / (28.4 x 0.71 x √48.6) = 0.98

ρ = (0.98 – 0.055 x (3 – 1.85)) / 0.98^2 = 0.95

b_{eff} = ρ x $\bar{b}$ / (1 – ψ) = 0.95 x 1100 / (1 + 1.85) = 366 mm (EC3-1-5 Table 4.1)

b_c = 387 mm

387 – 366 = 21 mm = 2.1 cm → (*) the contribution of the 2.1 cm web will be ignored (its influence on the bending capacity is very low)

Maximum positive bending :

$M_{c,Rd}$ = W_{eff} x f_y / γ_{M1} (EC3-1-1 6.2.5)

wherein :

W_{eff} = W_{el} → see the remark (*)

W_{el} = I_{xx} / e_x = 2,583,767 / 75.3 = 34,313 cm^3 (for the section properties see Chapter 3.1)

f_y = 46 kN/cm^2

γ_{M1} = 1.10 [-]

$M_{c,Rd}$ = 34,313 x 46 / 1.1 = 1,434,907 kNcm = 14,349 kNm (per 2 main girders)

Maximum shear capacity :

$V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0}$ (EC3-1-1 6.2.6)

wherein:

$f_y = 46.0$ kN/cm^2

$\gamma_{M0} = 1.00$ [-] (EC3-1-1 6.1)

$A_v = 2x\ 110x\ 0.8 = 176$ cm^2

$V_{pl,Rd}$ = 4674 kN (per 2 main girder)

Combination bending- and shear capacity :

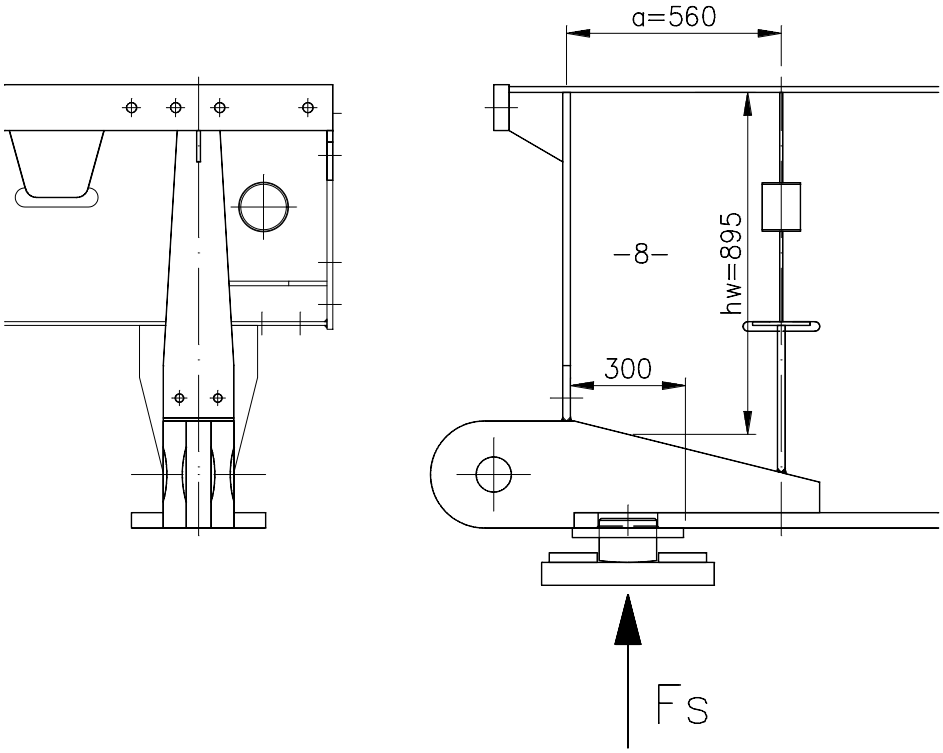
Bending and shear combination is not examined. For forces greater than

$0.5\ V_{pl,Rd} = 2337$ kN

De bending moment capacity should be reduced acc the formula :

$M_{v,Rd} = (W_{pl} - \rho \times A_v^2 / 4 \times t_w)\ fy / \gamma_{M0}$ (EC3-1-1 6.2.8)

3.4. Support capacity – resistance to shear



$\varepsilon = (23.5 / f_{yk})^{0.5} = (23.5 / 46.0)^{0.5} = 0.71$ [-]

$72 / \eta \times \varepsilon = 72 / 1.20 \times 0.71 = 42.6$ [-] (EC3-1-5 5.1)

$h_w / t = 89.5 / 0.8 = 112 > 42.6$ → therefore the web should be checked for resistance to shear buckling

$V_{b,Rd} = V_{bw,Rd} + V_{bf,Rd} \leq \eta \times f_{yw} \times h_w \times t / (\sqrt{3} \times \gamma_{M1})$ (EC3-1-5 5.2)

$V_{bw,Rd} = \chi_w \times f_{yw} \times h_w \times t / \sqrt{3} / \gamma_{M1}$

wherein: $f_{yw} = 46.0$ kN/cm^2

$h_w = 89.5$ cm

$t = t_w = 0.8$ cm

$\gamma_{M1} = 1.0$

$\overline{\lambda_w} = (h_w / t) / (86.4 \times \varepsilon)$ (EC3-1-5 5.3)

$\overline{\lambda_w} = (89.5 / 0.8) / (86.4 \times 0.71) = 1.82$ [-]

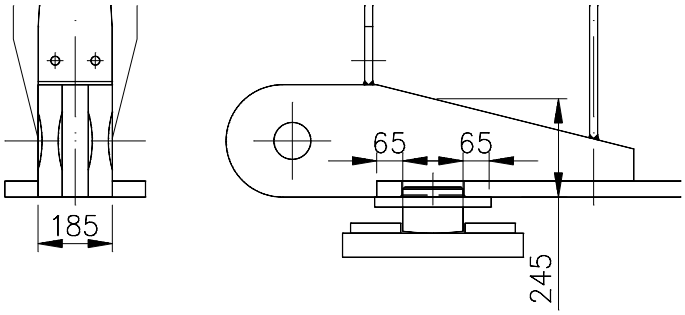
$\overline{\lambda_w} > 1.08$ → $\chi_w = 1,37/(0.7+\overline{\lambda_w})$ (EC3-1-5 Table 5.1)

$\chi_w = 1.37/2.52 = 0.54$ [-]

$V_{bw,Rd}$ = 0.54 x 46.0 x 89.5 x 0.8 / √3 / 1.0 = 1027 kN

$V_{bf,Rd} = b_f \times t_f^2 \times f_{yf} / (c \times \gamma_{M1}) \times [\, 1 - (M_{Ed} / M_{f,Rd})^2 \,]$ (EC3-1-5 5.4)

wherein: b_f = 18.5 cm
h_w = 89.5 cm
t_f = 24.5 cm
f_{yf} = 46.0 kN/cm^2
γ_{M1} = 1.00



$c = a \times [0.25 + 1.6 \times b_f \times t_f^2 \times f_{yf} / (t \times h_w^2 \times f_{yw})]$

$c = 56 \times [0.25 + 1.6 \times 18.5 \times 24.5^2 \times 46.0 / (0.8 \times 89.5^2 \times 46.0) = 169$ cm

M_{Ed} = 0 (there is no bending at the support) → $M_{Ed} / M_{f,Rd} = 0$

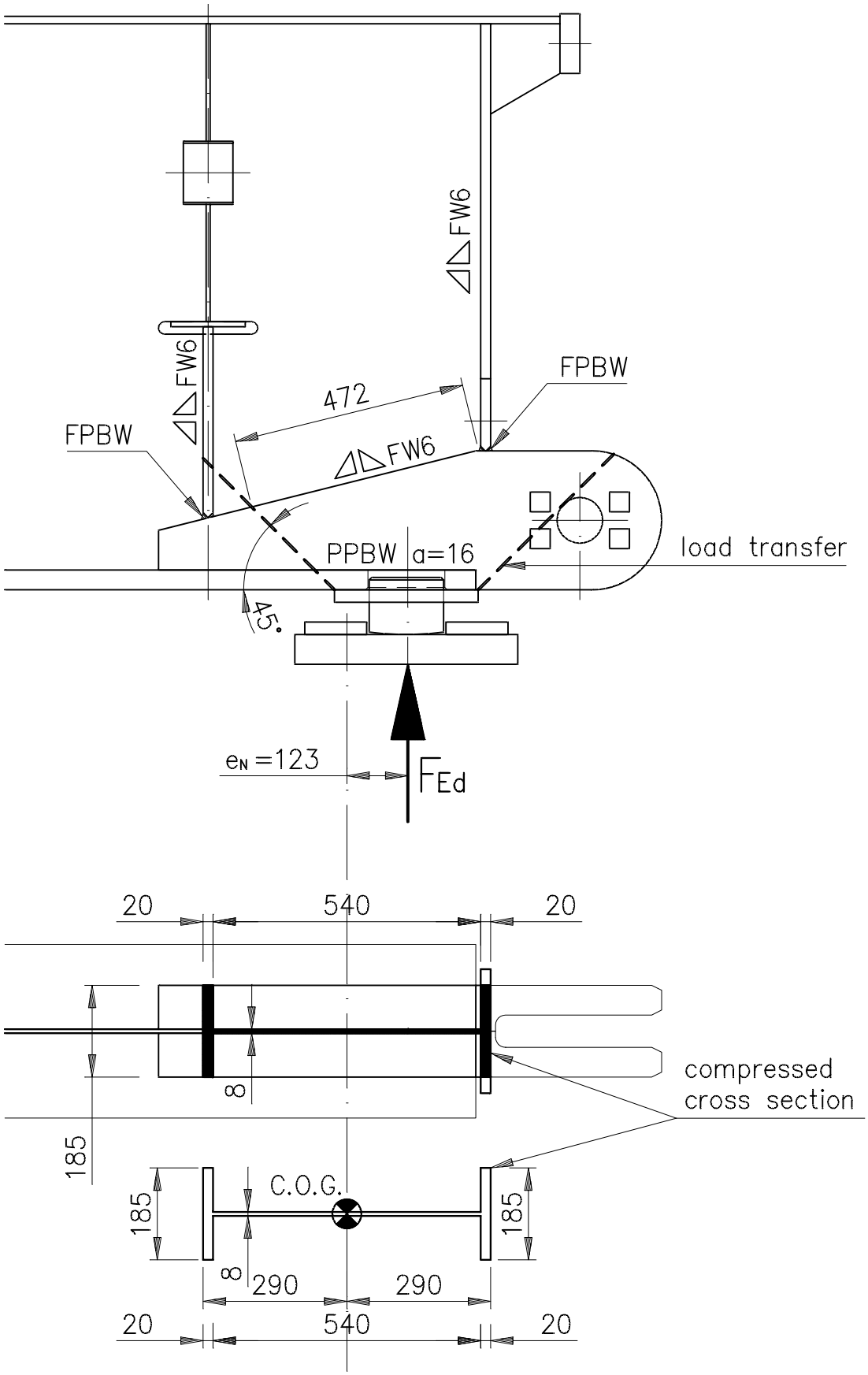
$V_{bf,Rd} = 18.5 \times 24.5^2 \times 46.0 / (169 \times 1.0) = 3023$ kN

$V_{b,Rd} \leq \eta \times f_{yw} \times h_w \times t / (\sqrt{3} \times \gamma_{M1})$ (EC3-1-5 5.2)

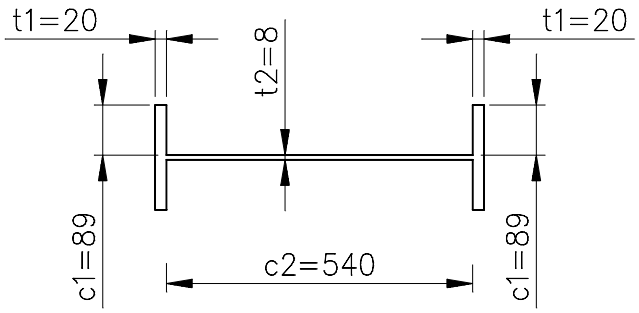
$V_{b,Rd} \leq 1.2 \times 46.0 \times (89.5 + 24.5) \times 0.8 / (\sqrt{3} \times 1.0) = 2907$ kN

$V_{bw,Rd} + V_{bf,Rd} = 1027 + 3023 = 4050$ kN > 2907 kN → therefore $V_{b,Rd}$ = 2907 kN

3.5. Support capacity – plate buckling effect



- Cross-section classification : (EC3-1-1 5.6)



Flange : (EC3-1-1 Table 5.2-2)

c1 / t1 = 89 / 20 = 4.45 < 9ε cross-section class 1

wherein:

ε = 0.71 (S460)

Web : (EC3-1-1 Table 5.2-1)

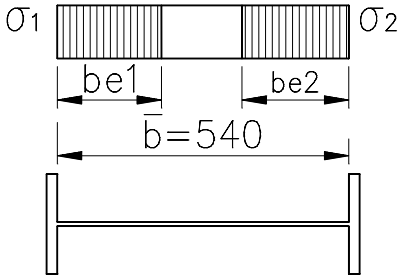
c2 / t3 = 540 / 8 = 67.5 < 42ε cross-section class 4

Conclusion:

The web area has to be reduced.

- Effective cross section (reduced web area) : (EC3-1-5 4.3)

Compression : (EC3-1-5 Table 4.1)



$b_{e1} = b_{e2} = 0.5 b_{eff}$

wherein :

$b_{eff} = \rho \times \bar{b}$

$\bar{b}$ = 540 mm

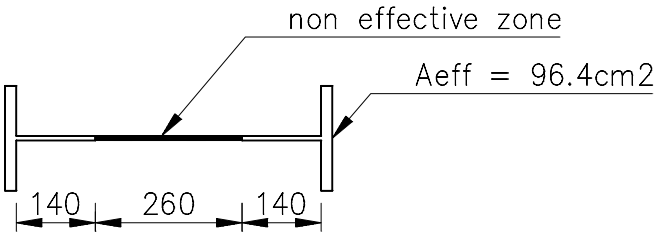
$\rho = \frac{\overline{\lambda_p} - 0.055 \cdot (3+\psi)}{\overline{\lambda_p^2}}$ = (1.674 – 0.055 x 4) / 1.674^2 = 0.519

$\overline{\lambda_p} = \frac{\bar{b}/t}{28.4\varepsilon\sqrt{k_\sigma}}$ =(540 / 8) / (28.4x0.71x√4) = 1.674 > 0.673 (EC3-1-5 4.4)

(ψ = 1 → k_σ = 4.0)

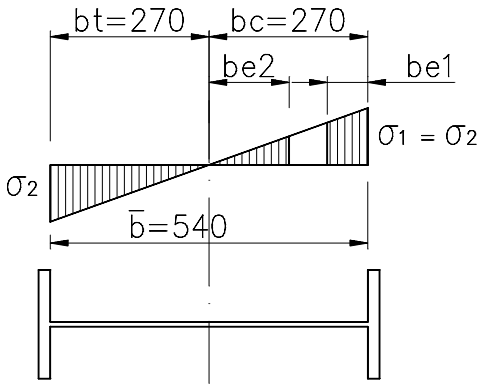
b_{eff} = 0.519 x 540 = 280.3 mm

$b_{e1} = b_{e2}$ = 0.5 x 280.3 = 140 mm



A_{eff} = 96.4 cm^2

Bending : (EC3-1-5 Table 4.1)



$b_{e1} = 0.4 b_{eff}$ $b_{e2} = 0.6 b_{eff}$

wherein :

$b_{eff} = \rho \times b_c$

$b_c = 270$ mm

$\rho = \dfrac{\overline{\lambda_p} - 0.055 \cdot (3+\psi)}{\overline{\lambda_p^2}}$ = (0.685 – 0.055 x 2) / 0.685^2 = 1.225 > 1

$\rho = 1$

$\overline{\lambda_p} = \dfrac{\bar{b}/t}{28.4\varepsilon\sqrt{k_\sigma}}$ (540 / 8) / (28.4x0.71x√23.9) = 0.685 > 0.673 (EC3-1-5 4.4)

$\psi = \sigma_2 / \sigma_1 = -1$ → $k_\sigma = 23.9$

$b_{eff} = 1.0 \times 270 = 270$ mm $= b_c$ there is no web reduction required

$I_{eff} = 685382667$ mm^4

$W_{eff} = 685382667 / 270 = 2538454$ mm^3 = 2538 cm^3

- Plate buckling resistance :

$$\eta_1 = \frac{N_{Ed}}{\frac{f_y A_{eff}}{\gamma_{M0}}} + \frac{M_{Ed} + N_{Ed} \times e_N}{\frac{f_y W_{eff}}{\gamma_{M0}}} \leq 1 \qquad \text{(EC3-1-5 4.6)}$$

wherein :

W_{eff} = 2538 cm^3

A_{eff} = 96.4 cm^2

M_{Ed} = 0

e_N = 12.3 cm

f_y = 46.0 kN/cm^2

γ_{M0} = 1.00

$\eta_1 = N_{Ed} / 4434 + N_{Ed} / 9492 \leq 1$

N_{Ed} = 3022 kN → η_1 = 1

$N_{Ed} = F_{Ed}$ = 3022 kN is the buckling capacity of the support

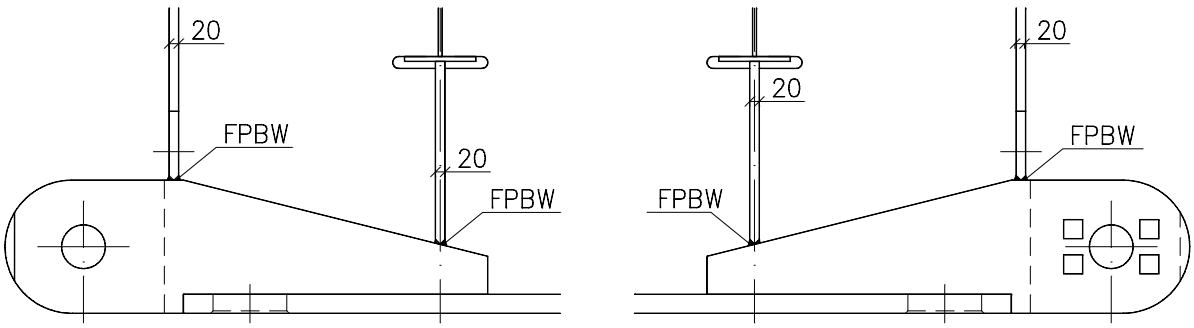
- Welds :

Flange – web welded joint :

fillet weld a = 5 → t = 2x 5 = 10mm > t_w = 8mm therefore the welds are not decisive

Flange – stiffeners (t=20) welded joint :

FPBW - full partial penetration butt welds are used, therefore the welds are not decisive :



FPBW – FULL PENETRATION BUTT WELD

3.6. Support capacity – total capacity

Decisive is shear buckling criterion : **F_{Rd} = 2907 kN**

4. Sectional properties and capacity of the transom

4.1. Effective width at midspan

Deck plate:

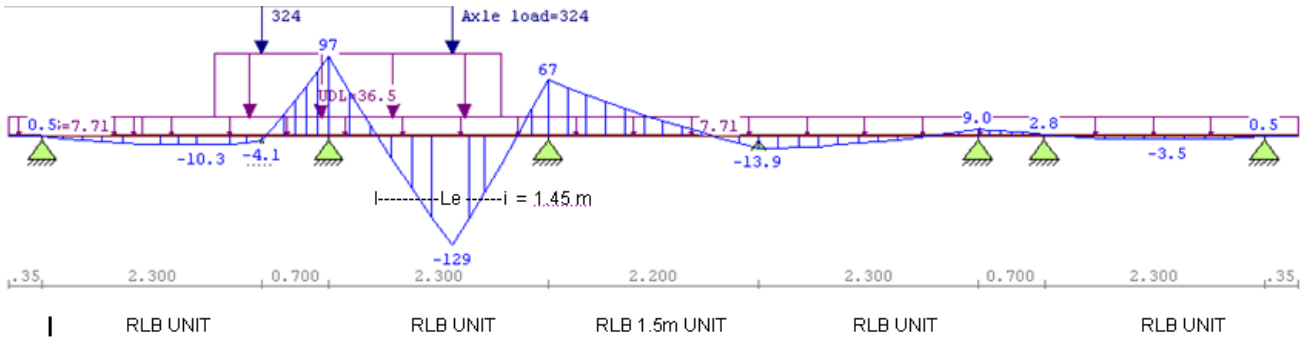
- $b_{eff;} = ß \times b_0$ (EC3-1-5 3.2)

$b_0 = 150cm$

$\kappa = \alpha_0 \times b_0 / L_e$

L_e → distance between two adjacent points of zero bending moments:

- for the loads see Chapter 1



Loads + Bending [kNm]

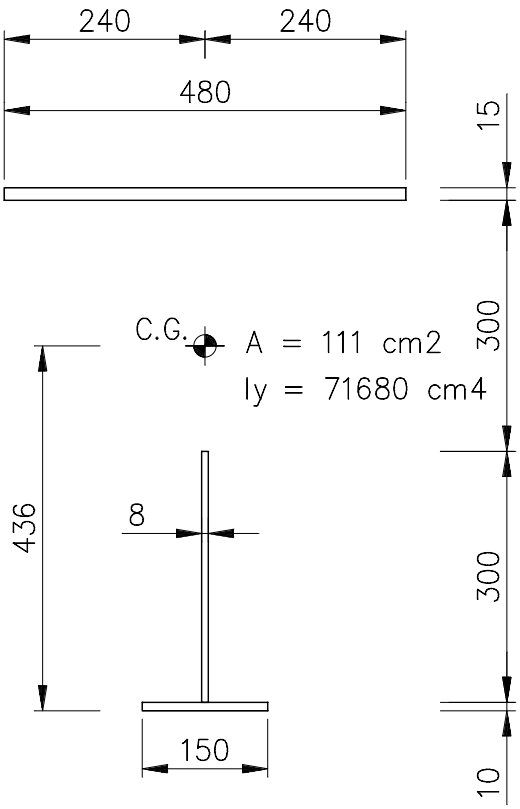
L_e = 1.45 m

$\alpha_0 = \sqrt{1+\frac{A_{sl}}{b_0 \times t}}$ A_{sl} = 0 → α_0 = 1.0 [-]

κ = 1.0 x 150 / 145 = 1.03 [-]

ß = $ß_1$ = 1/5.9 κ = 0.16 (EC3-1-5 Table 3.1)

b_{eff} = 0.16 x 150 = 24 cm



4.2. Effective width at the support

Deck plate:

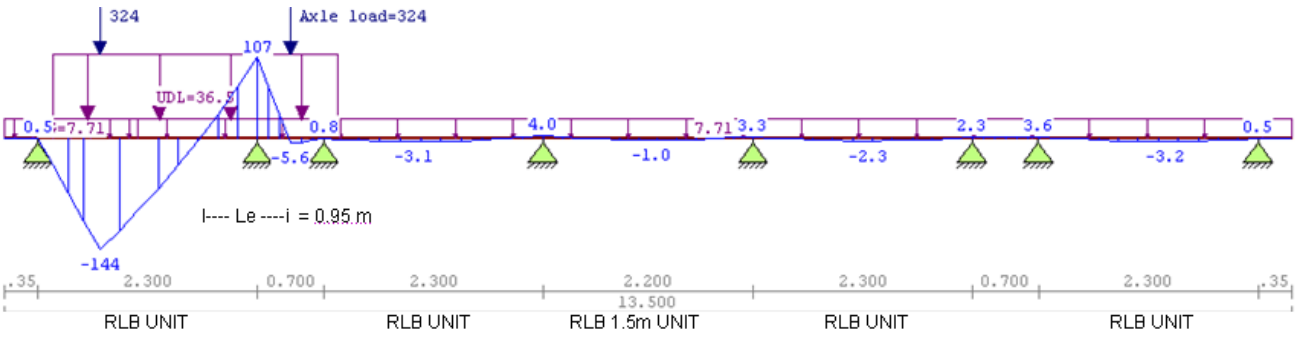
- $b_{eff;1} = ß \times b_0$ (EC3-1-5 3.2)

b_0 = 150cm

$\kappa = \alpha_0 \times b_0 / L_e$

L_e → distance between two adjacent points of zero bending moments:

- for the loads see Chapter 1



Loads + Bending [kNm]

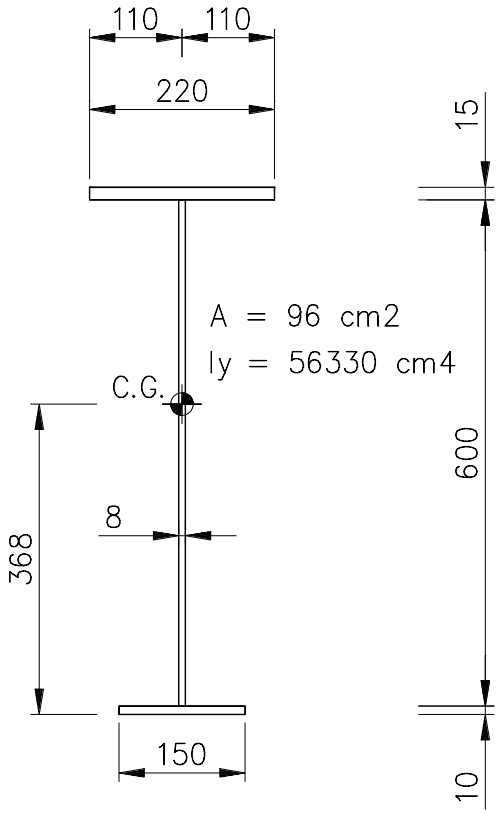
L_e = 0.95 m

$\alpha_0 = \sqrt{1+\frac{A_{sl}}{b_0 \times t}}$ A_{sl} = 0 → α_0 = 1.0 [-]

κ = 1.0 x 150 / 95 = 1.58 [-]

ß = $ß_1$ = 1/8.6 κ = 0.0736 (EC3-1-5 Table 3.1)

b_{eff} = 0.0736 x 150 = 11 cm



4.3. Capacity of the transom

- Midspan: Class 3

Bending capacity :

$M_{c.Rd} = f_y \times W_{el} / \gamma_{M0}$ (EC3-1-1 6.2.5)

wherein:

$f_y = 35.5$ kN/cm^2

$W_{el} = I / e_x = 71680 / 43.6 = 1644$ cm^3

$\gamma_{M0} = 1.0$ [-] (EC3-1-1 6.1)

$M_{c.Rd} = 35.5 \times 1644 = 58362$ kNcm = 584 kNm

Shear capacity: (EC3-1-1 5.4.6)

$\varepsilon = (23.5 / f_{yk})^{0.5} = (23.5 / 35.5)^{0.5} = 0.81$ [-]

$72 \times \varepsilon = 58.3$

$d / t_w = (30 - 0.5\sqrt{2}) / 0.8 = 36.6 < 72 \times \varepsilon$ so no check for shear buckling resistance necessary:

The capacity for the reduced section (under a hollow rib) is ::

$V_{pl.Rd} = d \times t_w \times f_y / (\sqrt{3} \times \gamma_{M0}) = 30.0 \times 0.8 \times 35.5 / (\sqrt{3} \times 1.0) = 492$ kN (EC3-1-1 6.2.6)

$V_{pl.Rd} = 492$ kN

- at support: Class 3

Bending capacity, $M_{c.Rd}$: (EC3-1-1 6.2.5)

$M_{c.Rd} = f_y \times W_{el} / \gamma_{M0}$

wherein:

$W_{el} = I / e_x = 56330 / 36.8 = 1531$ cm^3

$M_{c.Rd} = 35.5 \times 1531 = 54351$ kNcm = 543.5 kNm

Shear capacity, $V_{pl.Rd}$:

$V_{pl.Rd} = d \times t_w \times (f_{yw} / \sqrt{3}) / \gamma_{M0} = 60.0 \times 0.8 \times (35.5 / \sqrt{3}) / 1.0 = 984$ kN

$V_{pl.Rd} = 984$ kN

- capacity of the welded connection transom – main girder

(EC3-1-8 4.5.3.3)

The weld type is a fillet weld.

$F_{w.Rd} = f_{vw.d} \times a$

wherein:

$f_{vw.d} = f_u / (\sqrt{3} \times \beta_w \times \gamma_{Mw})$

$f_u = 51.0$ kN/cm^2

$\beta_w = 0.9$ [-]

$\gamma_{M2} = 1.25$ [-] (EC3-1-8 Table 2.1)

$f_{vw.d} = 51.0 / (\sqrt{3} \times 0.9 \times 1.25) = 26.2$ kN/cm^2

$a = 2 \times 0.5 = 1.0$ cm

$F_{w.Rd} = 26.2 \times 1.0 = 26.2$ kN/cm

$F_{Rd} = l \times F_{w.Rd} = 60.0 \times 26.2 = 1572$ kN > 984, therefore the welds are sufficiently strong

4.4. Capacity of the bolted connection between transoms

- Bolts M30 - 10.9 double shear

- the contact surfaces are class B, inorganic zinksilicat

- the bolted connection is of category C, slip resistant at the ultimate limit state

The criteria for the category C : $F_{v,Ed} \leq F_{s,Rd}$ (EC3-1-8 Table 3.2)

$F_{v,Ed} \leq F_{b,Rd}$

To connect two or more bridge sections in the transverse (perpendicular to the traffic) direction, the end of a transom is connected by means of a 4- or 8-bolt splice-connection. The capacity needed for this connection differs from the bridge geometry (span, width) and the specific loading.

Negative bending :

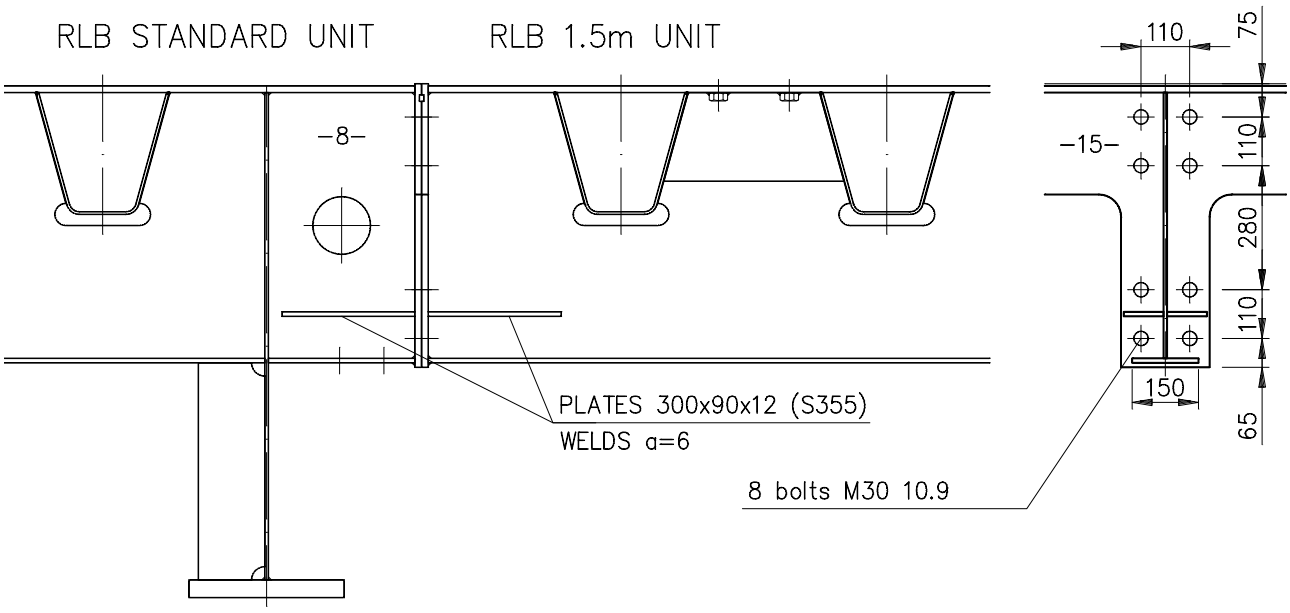
The calculations of the bending capacity of both a 4-bolt connection and a 8-bolt connection are calculated using the CoP program and added in the Annex (Chapter 8).

The negative bending capacities calculated using CoP are :

4 Bolts : $M_{j,Rd}$ = 240 kNm (*)
8 Bolts : $M_{j,Rd}$ = 240 kNm (*)

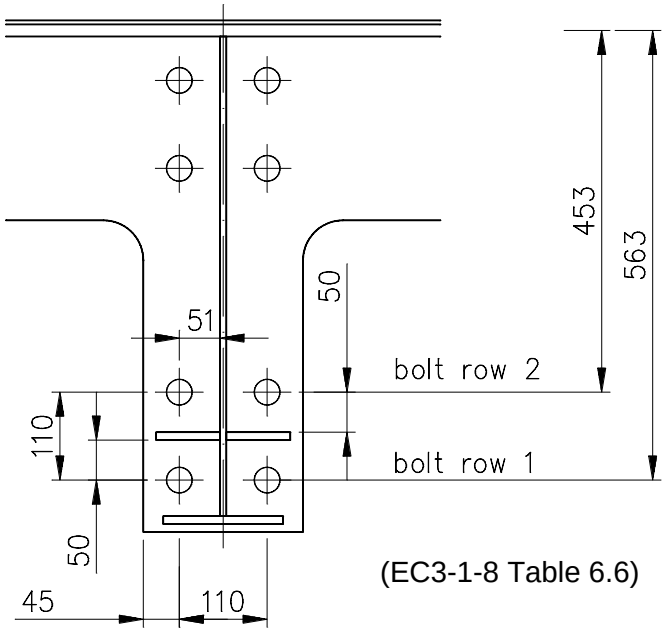
(*) welds are decisive

Positive bending :



Positive bending capacity:

(EC3-1-8)



→ Bolt row 1 :

(EC 1993-1-8 6.2.6.5)

m = 51 – 0,8x5√2 = 44,345,3 mm

e = 45 mm

n = e = 45 mm

$L_{eff,cp} = 2 \times \pi \times m$ (EC3-1-8 Table 6.6)

$L_{eff,cp} = 2 \times \pi \times 4.53 = 28.5$ cm

(EC3-1-8 Table 6.2)

$F_{T,1,Rd} = 4\ M_{pl,Rd} / m$

wherein :

$M_{pl,Rd} = 0.25 \times L_{eff} \times t_f^2 \times f_y / \gamma_{M0} = 0.25 \times 28.5 \times 1.5^2 \times 35.5 / 1.00 = 569$ kNcm

$\underline{F_{T,1,Rd} = 4 \times 569 / 4.53 = 503 \text{ kN}}$ (decisive)

$F_{T,2,Rd} = (2\ M_{pl,Rd} + n\Sigma F_{t,Rd}) / (m + n)$

wherein :

$M_{pl} = 569$ kNcm

$F_{t,Rd} = k_2 \times f_{ub} \times A_s / \gamma_{M2} = 0.9 \times 100 \times 5.61 / 1.25 = 403.9$ kN (Table 3.4)

$F_{T,2,Rd} = (2 \times 569 + 4.5 \times 2 \times 403.9) / (4.53 + 4.5) = 529$ kN

$F_{T,3,Rd} = \Sigma F_{t,Rd} = 2 \times 403.9 = 808$ kN

→ Bolt row 2 :

(EC 1993-1-8 6.2.6.5)

$m_2 = 50 - 0{,}8x5\sqrt{2} = 44{,}3$ mm

$m = 51 - 0{,}8x5\sqrt{2} = 45{,}3$ mm

$e = 45$ mm

$n = e = 45$ mm

$\lambda_1 = m / (m + e) = 45.3 / (45.3 + 45) = 0.50$

$\lambda_2 = m_2 / (m + e) = 44.3 / (45.3 + 45) = 0.49$

$\alpha = 5.8$

$L_{eff,cp} = \alpha \times m$ (EC3-1-8 Table 6.6)

$L_{eff,cp} = 5.8 \times 4.53 = 26.3$ cm

(EC3-1-8 Table 6.2)

$F_{T,1,Rd} = 4\ M_{pl,Rd} / m$

wherein :

$M_{pl,Rd} = 0.25 \times L_{eff} \times t_f^2 \times f_y / \gamma_{M0} = 0.25 \times 26.3 \times 1.5^2 \times 35.5 / 1.00 = 525$ kNcm

$\underline{F_{T,1,Rd} = 4 \times 525 / 4.53 = 464 \text{ kN}}$ (decisive)

$F_{T,2,Rd} = (2\ M_{pl,Rd} + n\Sigma F_{t,Rd}) / (m + n)$

wherein :

$M_{pl} = 525$ kNcm

$F_{t,Rd} = 403.9$ kN

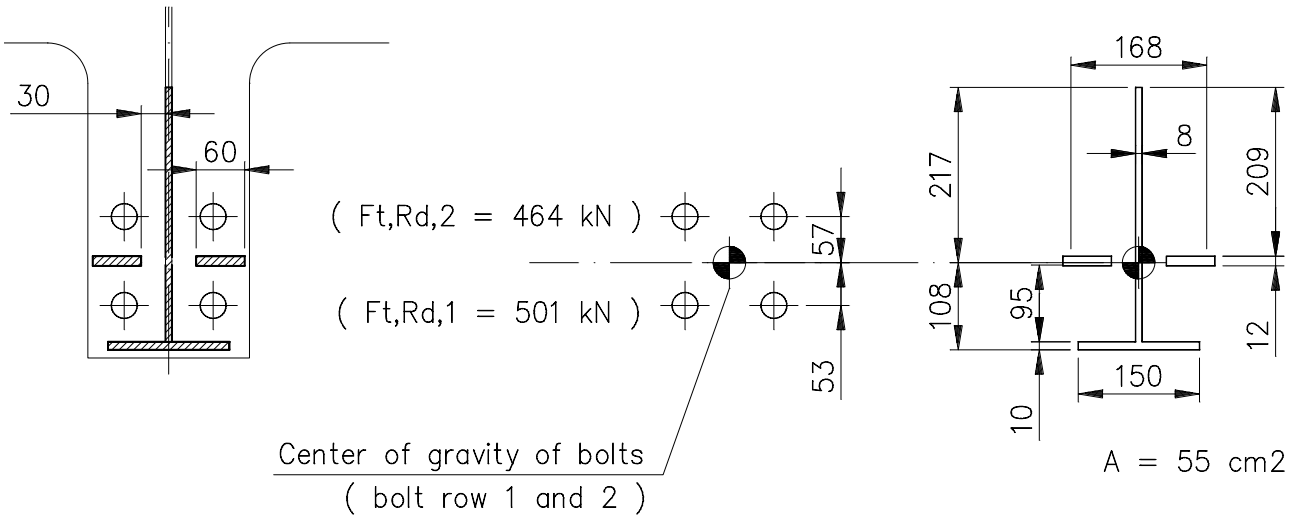
$F_{T,2,Rd} = (2 \times 525 + 4.5 \times 2 \times 403.9) / (4.53 + 4.5) = 519$ kN

$F_{T,3,Rd} = \Sigma F_{t,Rd} = 2 \times 403.9 = 808$ kN

→ bending capacity 8-Bolts connection :

$M_{Rd} = 503 \times 0.563 + 464 \times 0.453 = 493$ kNm

→ Stresses in the profile due to maximum moment (capacity) :



σ_{Ed} = (501+ 464) / 55 = 17.5 kN/cm^2 < 35.5 kN/cm^2 OK

→ capacity of the welded connection stiffeners - web :

$A_{stiffener}$ = 1.2 x 6 = 7.2 cm^2

F_{Ed} = 7.2 / 55 x (501 + 464) = 126 kN (force per 1 stiffener)

welds L = 300 mm / a = 6

$F_{w,Rd} = f_{vw,d}$ x a (per 1 cm length) / (EC3-1-8 4.5.3.3)

wherein :

$f_{vw,d} = f_u / (\sqrt{3} \times \beta_w \times \gamma_{M2}) = 51 / (\sqrt{3} \times 0.9 \times 1.25) = 26.2$ kN/cm^2

a = 2 x 6 = 12 mm (weld thickness)

$F_{w,Rd}$ = 26.2 x 1.2 = 31.4 kN/cm

therefore for L = 300 mm → $F_{w,Rd}$'' = 31.4 x 30 = 942 kN > 126 kN OK

→ bending capacity 4-Bolts connection :

M_{Rd} = 501 x 0.563 = 282 kNm

Shear capacity:

The design slip resistance at the ultimate limit state :

- $F_{s.Rd} = k_s * n * \mu * F_{p.Cd} / \gamma_{Ms}$ (EC3-1-8 6.3.9.1)

wherein: $k_s = 1.0$ [-]

$n = 1$ [-]

$\mu = 0.40$ [-]

$F_{p.Cd} = 0.70 * f_{ub} * A_s = 0.70 * 100.0 * 5.61 = 393$ kN

$F_{s.Rd} = 1.0 * 1 * 0.40 * 393 / 1.25 = 126$ kN

The design bearing resistance :

- $F_{b.Rd} = k_1 * \alpha * f_u * d * t / \gamma_{M2}$ (EC3-1-8 Table 3.4)

wherein : k_1 is the smallest of $2.8 * e_2/d_o - 1.7$; $1.4 * p_2/d_o - 1.7$ or 2.5

α is the smallest of : $e_1 / 3d_o$; $p_1 / 3d_o - 0.25$; f_{ub} / f_u

$e_1 = 6.5$ cm

$d_o = 3.2$ cm

$p_{1;\,(4\ Bolts)} = 50.0$ cm

$p_{1;\,(8\ Bolts)} = 11.0$ cm

$f_{ub} = 100.0$ kN/cm^2

$f_u = 51.0$ kN/cm^2

$\alpha = e_1 / 3d_0 = 0.68$ [-]

$d = 3.0$ cm

$t = 1.5$ cm

$\gamma_{M2} = 1.25$ [-]

$F_{b.Rd} = 2.5 * 0.68 * 51.0 * 3.0 * 1.5 / 1.25 = 312$ kN

Conclusion:

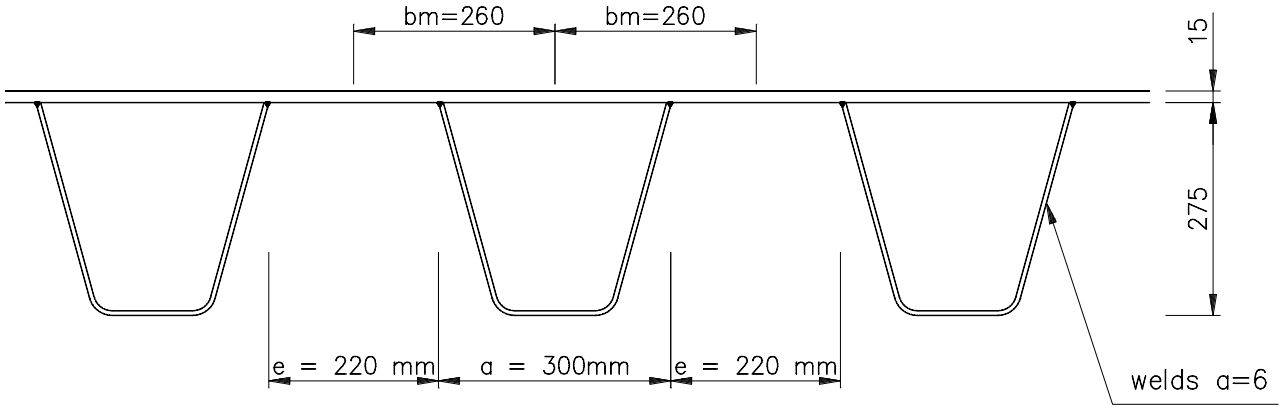
Decisive is the slip at the ultimate limit state criterion : $F_{s.Rd}$ = 126 kN

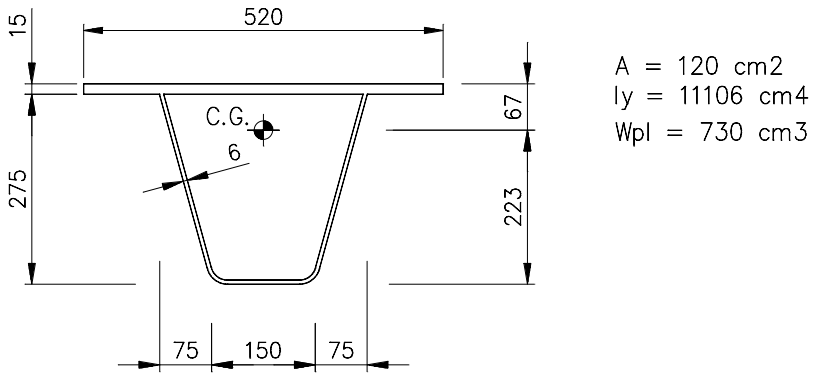
The design capacity of the joint is : F_{Rd} = number bolts * 126 kN

4 bolts :	**$M_{j,Rd,N}$ = 240**	**kNm**	**(<u>negative</u> bending moment)**
	$M_{j,Rd,P}$ = 282	**kNm**	**(<u>positive</u> bending moment)**
	$V_{j,Rd}$ = 504	**kN**	
8 bolts :	**$M_{j,Rd,N}$ = 240**	**kNm**	**(<u>negative</u> bending moment)**
	$M_{j,Rd,P}$ = 492	**kNm**	**(<u>positive</u> bending moment)**
	$V_{j,Rd}$ = 1008	**kN**	

5. Capacity of the hollow rib section

- Effective width :





A = 120 cm2
Iy = 11106 cm4
Wpl = 730 cm3

- Bending capacity $M_{c.Rd}$

$M_{c.Rd} = f_y \times W_{pl} / \gamma_{M0}$ (EC3-1-1 6.2.5)

wherein: $f_y = 35.5$ kN/cm^2

$W_{pl} = 730$ cm^3

$M_{c.Rd} = 35.5 \times 730 / 1.0 = 25{,}915$ kNcm

$M_{c.Rd}$ = 259 kNm

- Shear capacity, $V_{pl.Rd}$ (EC3-1-1 6.18)

$V_{pl.Rd} = 2 \times h \times t \times f_y / (\sqrt{3} \times \gamma_{M0}) = 2 \times 27.5 \times 0.6 \times 35.5 / (\sqrt{3} \times 1.0) = 676$ kN

$V_{pl.Rd}$ = 676 kN

- Welded connection deck plate - hollow rib

The weld is a partial penetration butt weld.

$F_{w.Rd} = f_{vw.d} \times a$ (EC3-1-8 4.5.3.3)

wherein: $f_{vw.d} = f_u / (\sqrt{3} \times \beta_w \times \gamma_{Mw})$

$f_u = 51.0$ kN/cm^2

$\beta_w = 0.9$ [-]

$\gamma_{Mw} = 1.25$ [-]

$f_{uw.d} = 51.0 / (\sqrt{3} \times 0.9 \times 1.25) = 26.2$ kN/cm^2

$a = (2 \times 0.6) = 1.2$ cm

$F_{w.Rd} = 26.2 \times 1.2 = 31.4$ kN/cm

$F_{Rd} = V_{pl.Rd} \times S / I$

wherein: $V_{pl.Rd} = 676$ kN

$S = (6.0 - 0.75) \times (52 \times 1.5) = 410$ cm^3 (section statical moment)

$I = 11106$ cm^4

$F_{Rd} = 676 \times 410 / 11106 = 25.0$ kN/cm

$F_{rd} / F_{w.Rd} = 25.0 / 31.4 = 0.8 < 1$, therefore the welds are sufficiently strong

- Welded connection hollow rib - transom

The weld is a partial penetration butt weld.

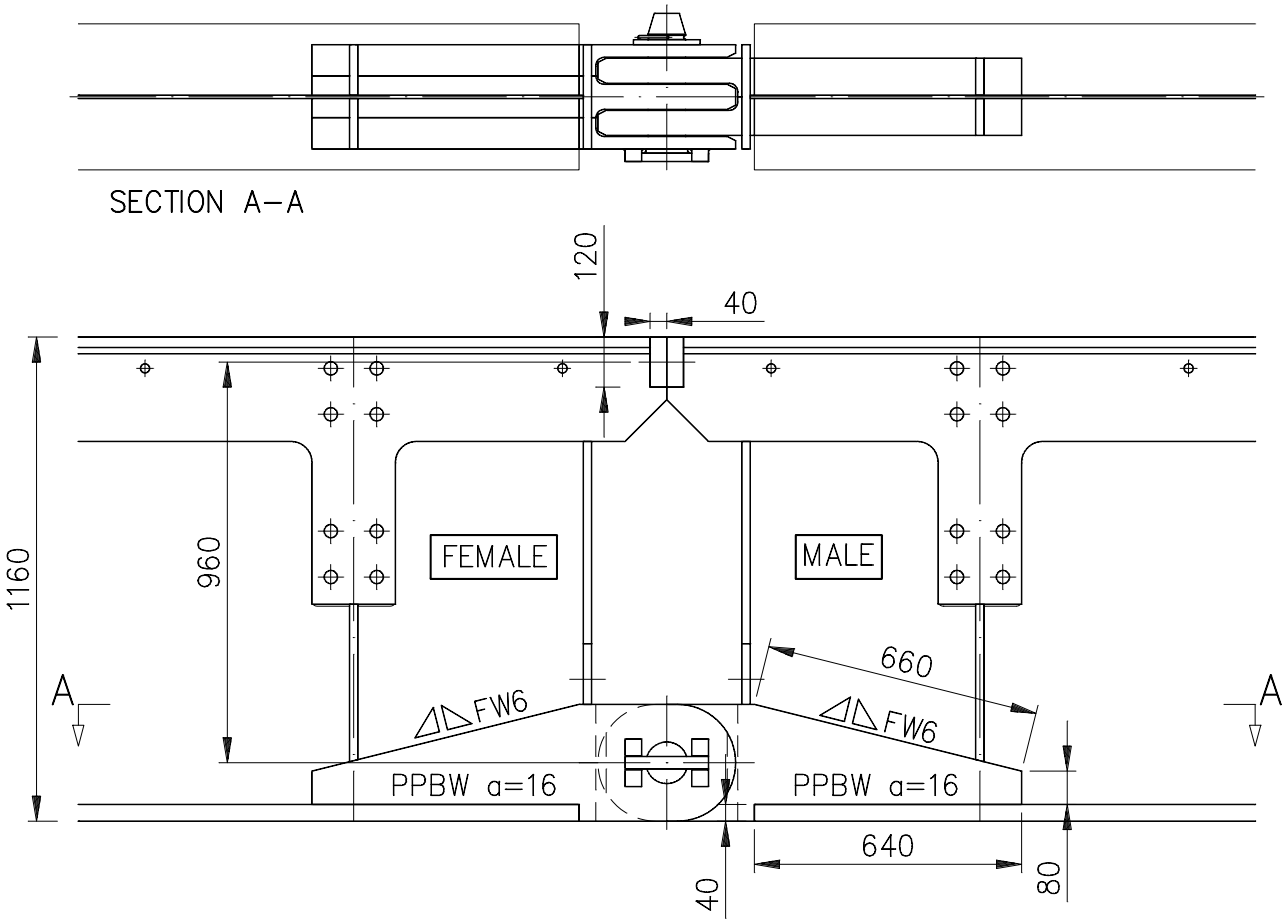
$F_{w.Rd} = 31.4$ kN/cm

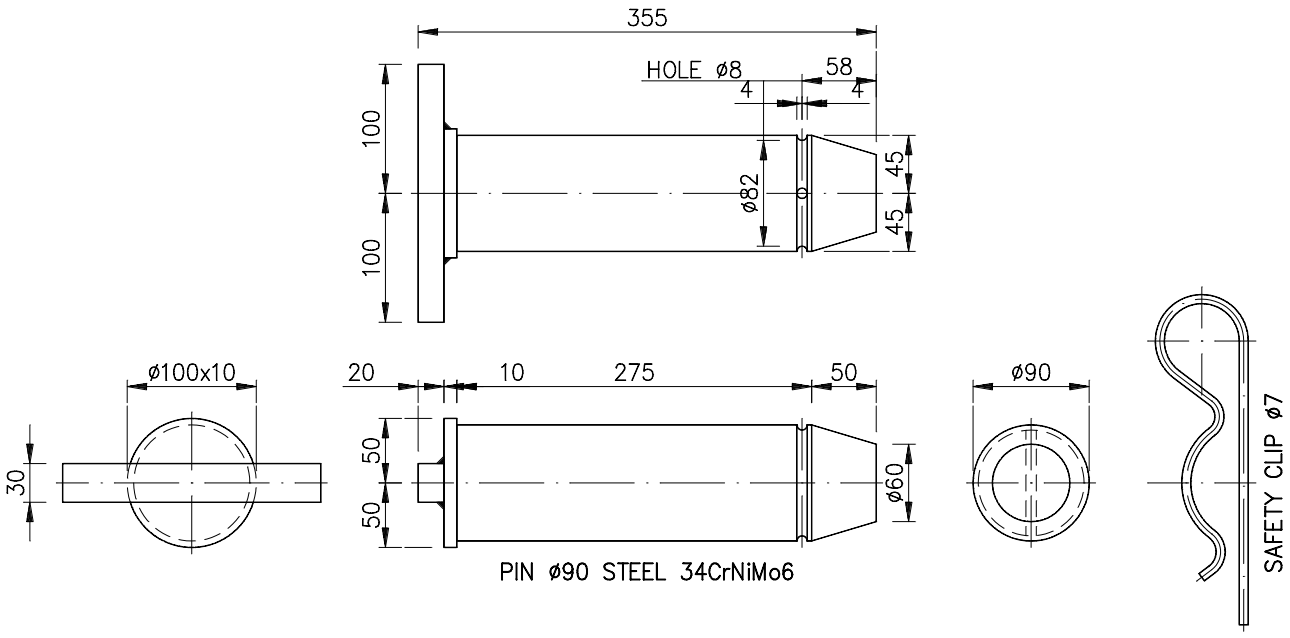
$F_{Rd} = V_{pl.Rd} / (2 \times h) = 676 / 55 = 12.3$ kN/cm

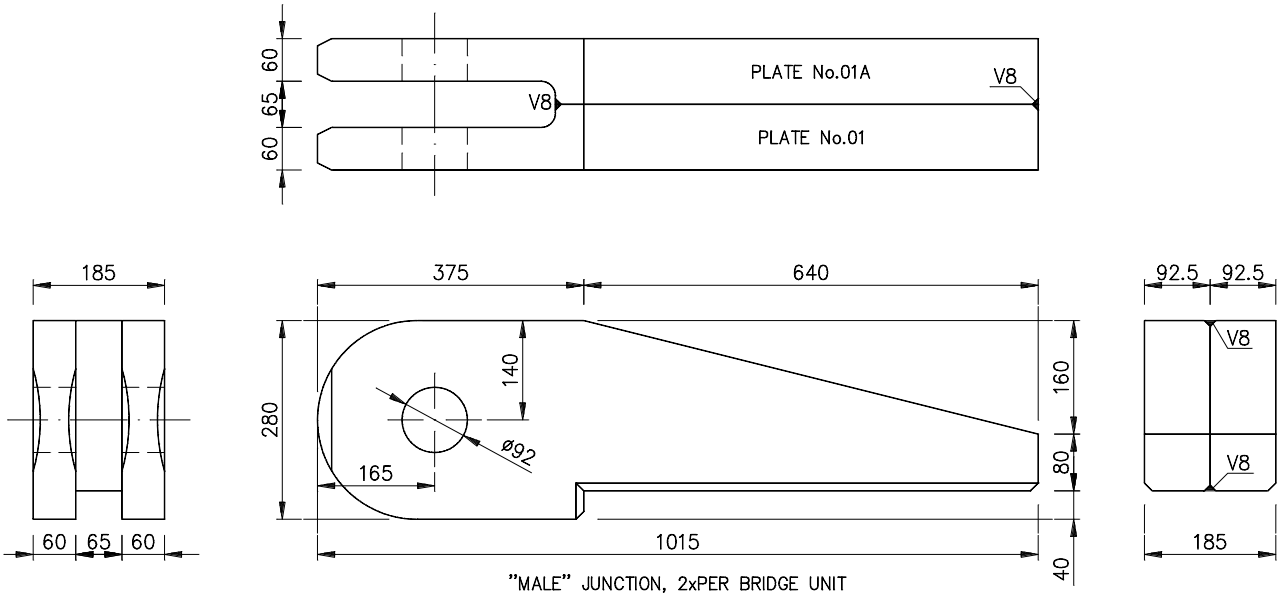
$F_{Rd} / F_{w.Rd} = 12.3 / 31.4 = 0.39 < 1$ OK

6. Capacity of the rigid joint

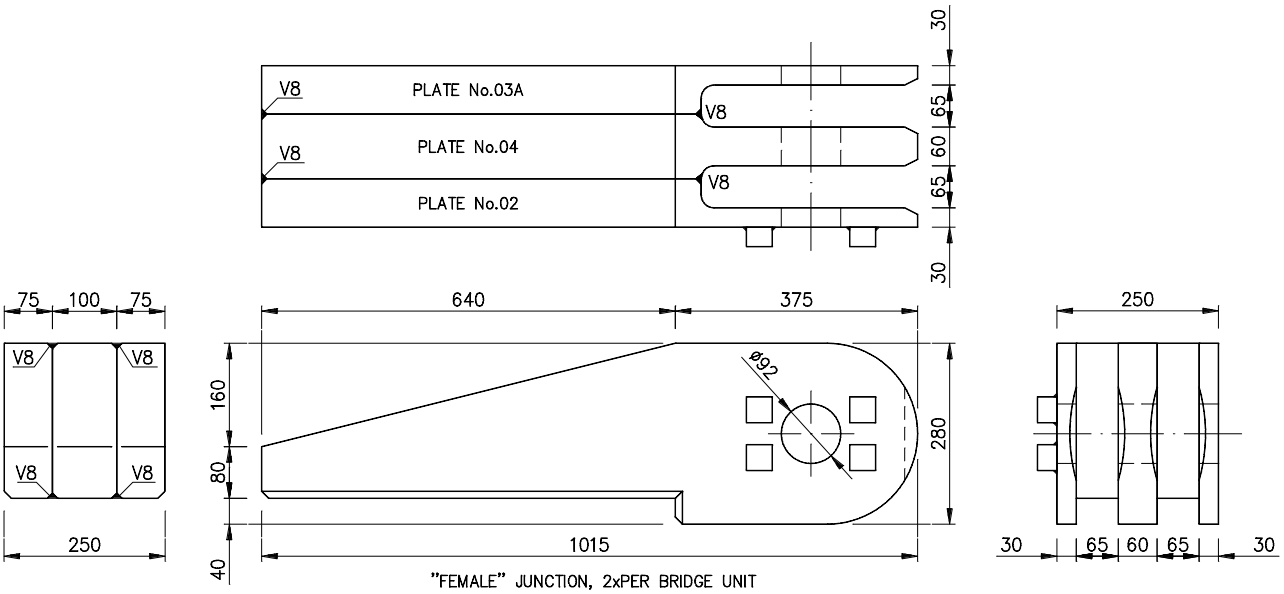
6.1. Overview parts of the joint







"MALE" JUNCTION, 2xPER BRIDGE UNIT
PLATES AROUND WELDED V8, THEN SURFACE GRINDING
THEN WELD THE JUNCTION ON THE MAIN GIRDRER PPBW a=12



"FEMALE" JUNCTION, 2xPER BRIDGE UNIT
PLATES AROUND WELDED V8, THEN FLACHSCHLEIFEN
THEN WELD THE JUNCTION ON THE MAIN GIRDRER PPBW a=12

6.1. Capacity of the pin connection

Since the pin is insured against rotation, may be measured as a bolted connection

(EC3-1-8 3.13.1 (2))

- $F_{b.Rd} = k_1 \times \alpha_b \times f_u \times d \times t / \gamma_{M2}$ (EC3-1-8 Table 3.4)

  wherein: $F_{b.Rd}$ = design resistance of the pin against bearing [kN]

  $k_1 = 2.5$

  $\alpha_b = e_1 / 3d_0 = 140 / 3x92 = 0.507$ (vertical force – due to shear)

  α_b“ $= e_1 / 3d_0 = 165 / 3x92 = 0.598$ (horizontal – due to bending)

  $f_u = 54$ kN/cm^2

  d = 90 mm

  t = 120 mm (sum thickness of the plates)

  $\gamma_{M2} = 1.25$ [-]

  Vertical (due to shear bridge) :

  $F_{b.Rd} = 2.5 \times 0.507 \times 54 \times 9 \times 12 / 1.25 = 5914$ kN

  $F_{b.Rd}$ = 5914 kN

  Horizontal (due to bending bridge) :

  $F_{b.Rd} = 2.5 \times 0.598 \times 54 \times 9 \times 12 / 1.25 = 6975$ kN

  $F_{b.Rd}$ = 6975 kN

6.2. Capacity welded connection plates - bridge

- Welded connection plates **–** web of the main girder

  → welds a = 6 / l = 660 + 80 + 185 = 925 mm

  $F_{w.Rd} = f_{vw.d}$ x a (EC3-1-8 4.5.3.3)

  wherein: $f_{vw.d} = f_u / (\sqrt{3} \times \beta_w \times \gamma_{Mw})$

  $f_u = 54.0$ kN/cm^2

  $\beta_w = 1.0$ [-]

  $\gamma_{M2} = 1.25$ [-]

  $f_{uw.d} = 54.0 / (\sqrt{3} \times 1.0 \times 1.25) = 24.94$ kN/cm^2

  a = (2 x 0.6) = 1.2 cm

  $F_{w.Rd}$ = 24.94 x 1.2 = 29.93 kN/cm

  F_{Rd} = 29.93 x 92.5 = 2768 kN

- Welded connection plates **–** flange the bridge section

  → welds a = 16 / l = 640 + 40 = 680 mm

  $f_u = 54.0$ kN/cm^2

  $\beta_w = 1.0$ [-]

  $\gamma_{M2} = 1.25$ [-]

  $f_{uw.d} = 24.94$ kN/cm^2

  a = (2 x 1.6) = 3.2 cm

  $F_{w.Rd}$ = 24.94 x 3.2 = 79.81 kN/cm

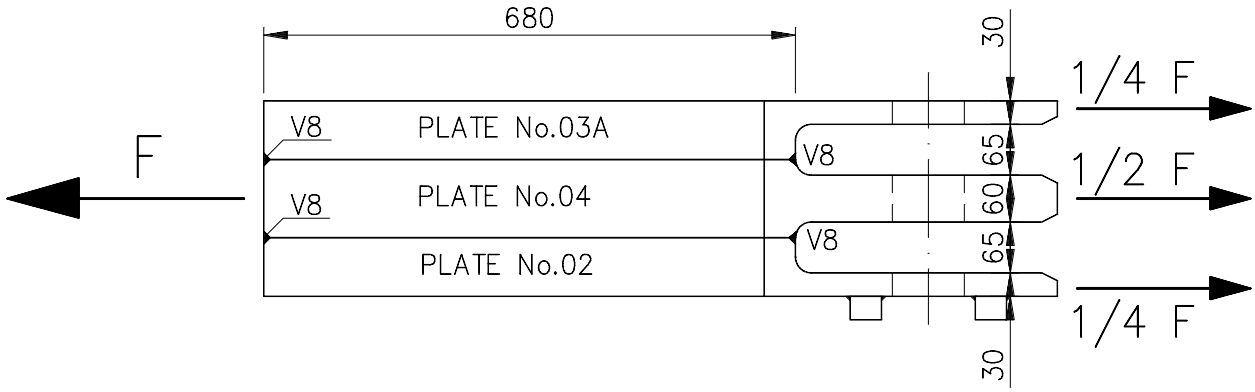
  F_{Rd} = 79,81 x 68 = 5427 kN

Conclusion:

the capacity the welded connection is :

F_{Rd} = 2768 + 5427 = 8195 kN > 6975 therefore the welds are not decisive for the connection

6.3. Capacity welded connection plates



F_{Ed} = 6975 kN (see page above)

- Welded connection plates

→ welds a = 8 / l ≈ 2x 680 = 1360 mm (only horizontal welds calculated)

1/4 F_{Ed} = 6975 / 4 = 1744 kN (these force should be transmitted from the plate No.03A / No.02 in the plate No.04 and then in the web/flange of the main girder)

$F_{w.Rd} = f_{vw.d}$ x a (EC3-1-8 4.5.3.3)

wherein: $f_{vw.d} = f_u / (\sqrt{3} \times \beta_w \times \gamma_{Mw})$

f_u = 54.0 kN/cm^2

β_w = 1.0 [-]

γ_{M2} = 1.25 [-]

$f_{uw.d}$ = 24.94 kN/cm^2

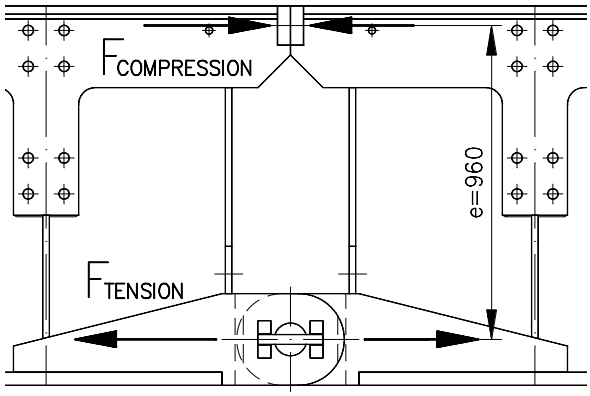
a = 0.8 cm

$F_{w.Rd}$ = 24.94 x 0.8 = 19.95 kN/cm

F_{Rd} = 19,95 x 136 = 2713 kN > 1744 therefore the connection is sufficiently strong

6.4. Total capacity of the rigid connection

The maximal capacity of the connection :



$M_{Rd} = F_{Rd} \times e$

wherein:

e = 0.96m (lever arm – see the Chapter 6.1)

F_{Rd} = 6975 kN (capacity of the weakest part)

$M_{Rd,max}$ = 0,96 x 6975 = 6696 kNm (per one main girder, by V = 0)

$V_{Rd,max}$ = 5914 kN (per one main girder, by M = 0)

Combination bending + shear :

Example :

The bolted connection is decisive for the horizontal load on the bolts (by bending of the main girder) and for vertical force (shear in the main girder).

For the vertical (shear)force V_{Ed} = 1000 kN will be 1000 / 5914 x 100% = 16.9% of the capacity of the pin used.

So we have still 100 - 16.9 = 83.1 % of the capacity of the pin :

M_{Rd} = 0.831 x 6696 = 5564 kNm (bending capacity the rigid joint of the main girder by V_{Ed} = 1000 kN)



7. Guardrail

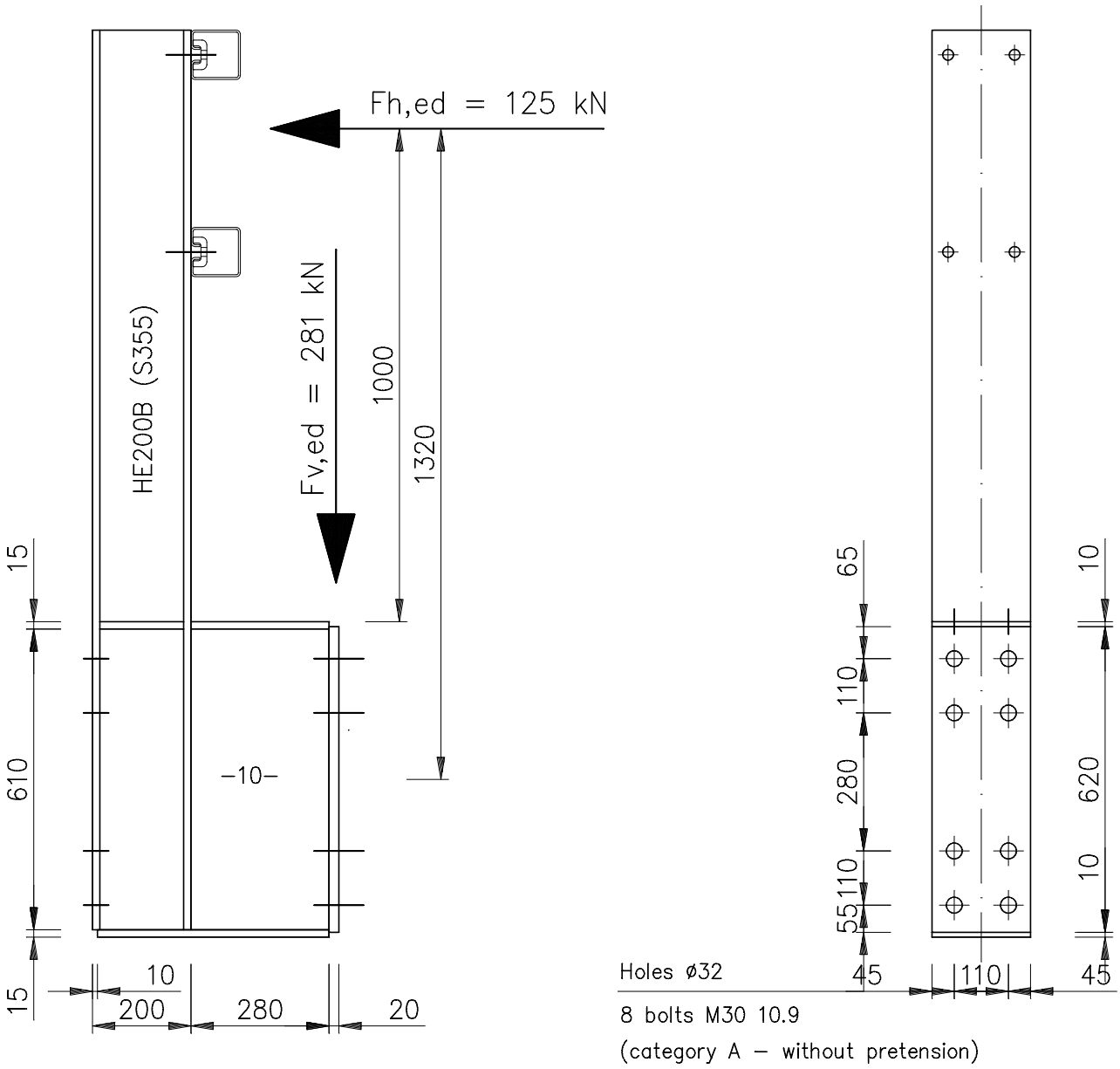
7.1. Connection guardrail post – transom

The value of the accidental load on the guardrail post is 100 kN acting 1.0 meter above the level of the carriageway. (EC1-3 4.7.3.3)

The safety factor is 1.25 [-]
therefore: $F_{h.Ed}$ = 1.25 x 100 = 125 kN

The vertical force on the kerb is: 0.75 x α_{Q1} x Q_{1k} = 0.75 x 300 = 225 kN

$F_{v.Ed}$ = 1.25 x 225 = 281 kN



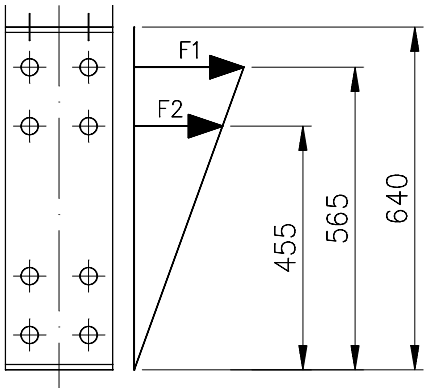
Calculation of the bolted connection (shear-/bearing joint - Category A) :

$F_{v,Ed}$ = 281 kN < 833.5 OK (see transom joint calculation – Chapter 8.2)

M_{Ed} = 1.32 x 125 = 165 kNm < 234.9 OK

Combination shear and tension

$F_1 = F_{t,Ed} = M_{Ed} / (0.565 + 0.455^2)$
$= 165 / 0.93$
$= 177$ kN



$F_{v,Ed} / F_{v,Rd} + F_{t,Ed} / 1.4F_{t,Rd} \leq 1.0$ (EC3-1-8 Table 3.4)

281 / 833.5 + 177 / 1.4 x 403.9 = 0.65 < 1 OK

Control HE200B section:

- Shear capacity, $V_{pl.Rd}$: (EC3-1-1 6.2.6)

$V_{pl.Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{MO}$

wherein: $A_v = A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f$

$A_v = 78.08 - 2 \times 20 \times 1.5 + (0.9 + 2 \times 1.8) \times 1.5 = 24.8$ cm^2

$V_{pl.Rd} = 24.8 \times 35.5 / \sqrt{3} / 1.0 = 508$ kN

V_{Ed} = 125 kN < 0.5 x 508 = 254 combination with bending moment is not necessary

- Bending capacity $M_{c.Rd}$

$M_{c.Rd} = f_y \times W_{pl} / \gamma_{M0}$ (EC3-1-1 6.2.5)

wherein: $f_y = 35.5$ kN/cm^2

$W_{pl} = 642.5$ cm^3

$\gamma_{M0} = 1.0$ [-]

$M_{c.Rd} = 35.5 \times 642.5 / 1.0 = 22809$ kNcm = 228 kNm

M_{Ed} = 1.0 x 125 = 125 kNm < 228 OK

7.2. Kerb

(EC1-3 4.7.3.2)

The action from vehicle collision with kerb is a lateral force equal 100 kN in distance of 0.05m from the top of the kerb.
Simultaneously a vertical load is acting : $0.75 \times \alpha_{Q1} \times Q_{1K}$

The safety factor is 1.25 [-]

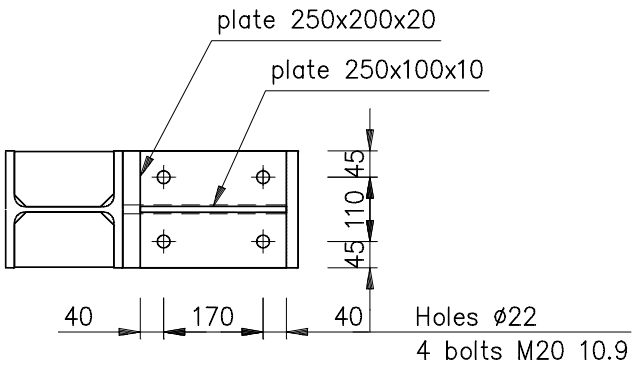
$F_{v.Ed} = 1.25 \times 0.75 \times \alpha_{Q1} \times Q_{1K}$

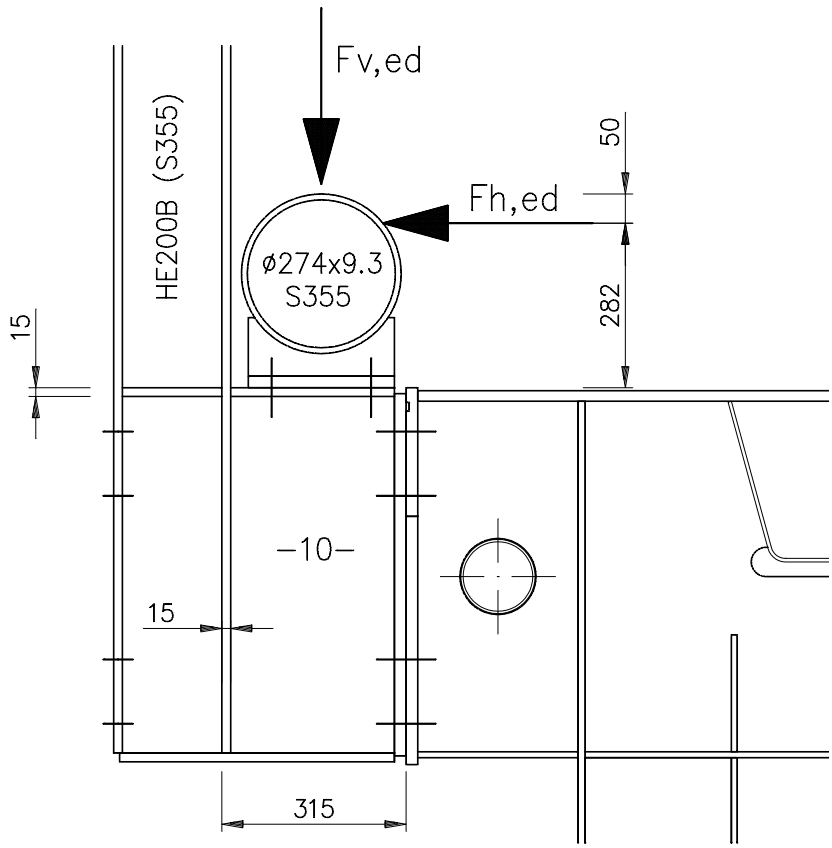
$F_{v.Ed} = 1.25 \times 0.75 \times 1.0 \times 300$

$F_{v.Ed} = 281$ kN

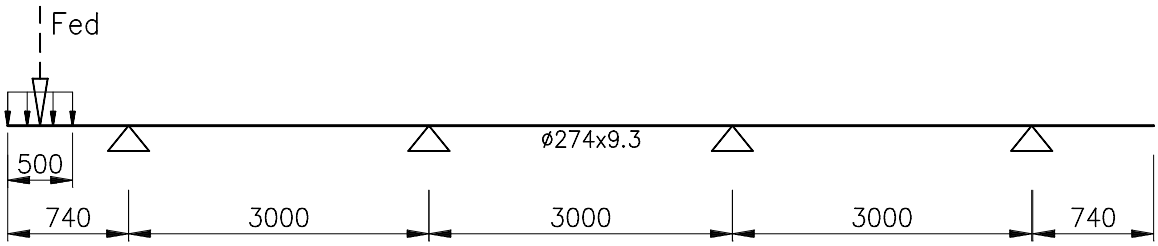
$F_{h.Ed} = 1.25 \times 100 = 125$ kN

$F_{Ed} = \sqrt{281^2+125^2} = 308$ kN
(a resulting force)





Control circular hollow section (kerb)



$V_{Ed} = F_{Ed} = 308$ kN

$M_{Ed} = (74 - 0.5 \times 50) \times 308 = 15092$ kNcm

- Shear capacity, $V_{pl.Rd}$: (EC3-1-1 6.2.6)

$V_{pl.Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{MO}$

wherein: $A_v = 2A / \pi = 2 \times 77.3 / \pi = 49.2$ cm^2

$V_{pl.Rd} = 49.2 \times 35.5 / \sqrt{3} / 1.0 = 1008$ kN

$V_{Ed} = 308$ kN < $0.5 \times 1008 = 504$ combination with bending moment is not necessary

- Bending capacity $M_{c.Rd}$

$M_{c.Rd} = f_y \times W_{pl} / \gamma_{M0}$ (EC3-1-1 6.2.5)

wherein: $f_y = 35.5$ kN/cm^2

$W_{pl} = 650$ cm^3

$\gamma_{M0} = 1.0$ [-]

$M_{c.Rd} = 35.5 \times 650 / 1.0 = 23075$ kNcm > 15092 OK

Kerb bolted connection

$F_{v.Ed} = 0$

$F_{h.Ed} = 125$ kN

$M_{Ed} = e_x \times F_{h,Ed} = 28.2 \times 125 = 3525$ kNcm = 35.25 kNm

$F_{t.Ed} = 3525 / 17 / 2 = 104$ kN (tension force per one bolt)

$F_{t.Rd} = 176$ kN (tension capacity of M20 10.9)

104/176 = 0.59 < 1 OK

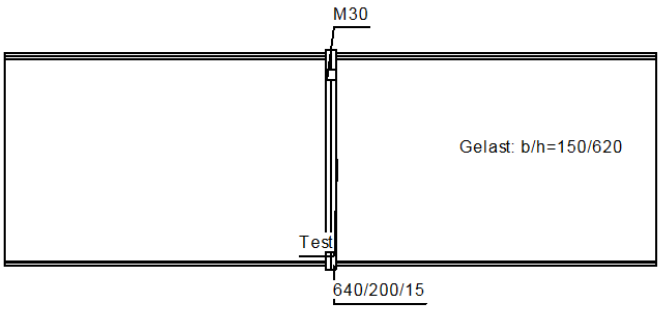
8. Annex

8.1 Calculation of the 4-bolts joint between the transoms

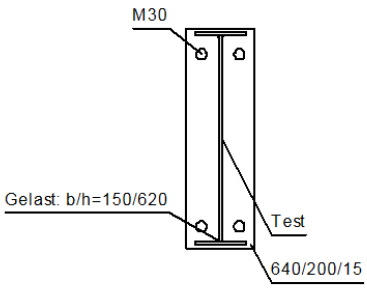
General data

Bracing .....: Unbraced
Corrosive environment .....: Yes
Joint configuration .....: Beam splice
Beam .....: <user def.> , S 355, a = 0°, L_b = 3000 mm
Type of connection .....: Flush end plate connection
Design code .....: Eurocode 3
Design procedure .....: EP - Elastic frame analysis / plastic joint design

Elevation



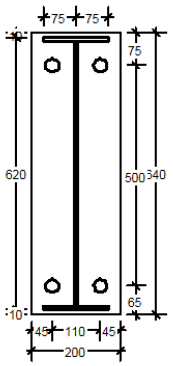
Section



Components

End plate .....: b/h/t=640/200/15 mm, S 355
Bolts .....: 4 M30 10.9
Welds
  Beam .....: a_f = 5 mm, a_w = 5 mm

Detail



Results

Positive moment
Resistance
$M_{j,Rd}$ = 239.5 kNm
$V_{j,Rd}$ = 256.5 kN
Stiffness
$S_{j,ini}$ = 205361 kNm/rad
Classification
Strength: partial strength
Stiffness: semi-rigid
Failure
Welds at beam end

© RWTH/PSP Aachen, M&S Liège, ICCS Hoofddorp

Design of joints in building frames according to Eurocode 3 - revised Annex J

1. INPUT DATA

1.1 PROJECT DATA

```
project ......................:  5262 RLB Standard Calculation
structure ....................:  RLB Bridge
joint ........................:  Transom Connection 4 Bolts M30
joint id .....................:  Transom Connection 2
engineer .....................:  MK
date .........................:  08-12-2009

design procedure .............:  elastic analysis / plastic joint design

environment ..................:  corrosive
framing ......................:  not braced
```

1.2 main joint data

```
beam :                    ( built-up profile )
flush end plate :         640 X 200 X 15,  S 355
```

2. JOINT PROPERTIES FOR POSITIVE MOMENTS

2.1 ASSEMBLY OF THE COMPONENTS

```
resistance of bolt row nb  1 .......................: FRd(1) =      408.83 kN
resistance of bolt row nb  2 .......................: FRd(2) =      313.26 kN

moment resistance (weld failure disregarded) .......: MRdj   =      240.52 kNm
moment resistance of the welds .....................: MRdw   =      239.48 kNm
                                                                   ---------
moment resistance ..................... ( J.3.6 ) :                 239.48 kNm

elastic moment resistance ............. ( J.2.1.2 ) : Me     =      160.34 kNm

initial stiffness ................... ( Form. J.34 ) : Sji    =   205361.46 kNm/rad

idealized stiffness . ( J.2.1.2 - J.2.1.4 - T.J.3 ) : Sjn    =    68453.82 kNm/rad


design shear resistance of the joint ...............: VRd    =      256.46 kN
```

2.1.1 collapse mode

```
collapse mode : welds at beam end
```

2.2 DESIGN PROPERTIES OF THE JOINT FOR ELASTIC ANALYSIS / PLASTIC JOINT DESIGN

```
design moment resistance ...........................: MRd    =      239.48 kNm

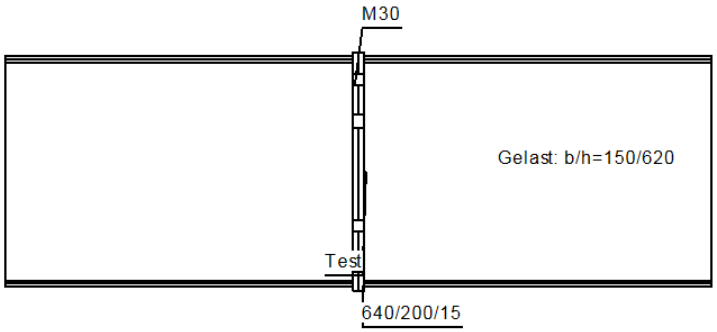
relevant stiffness .................................: Sjn    =    68453.82 kNm/rad
```

8.2 Calculation of the 8-bolts joint between the transoms

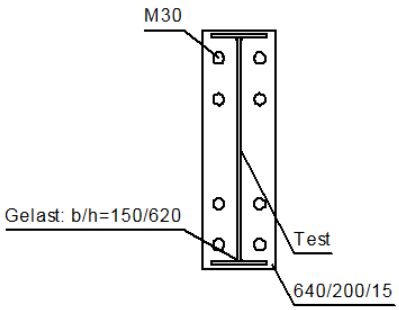
General data

Bracing .....: Unbraced
Corrosive environment .....: Yes
Joint configuration .....: Beam splice
Beam .....: <user def.> , S 355, a = 0°, L_b = 3000 mm
Type of connection .....: Flush end plate connection
Design code .....: Eurocode 3
Design procedure .....: EP - Elastic frame analysis / plastic joint design

Elevation



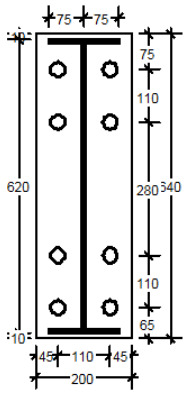
Section



Components

End plate .....: b/h/t=640/200/15 mm, S 355
Bolts .....: 8 M30 10.9
Welds
Beam .....: a_f = 5 mm, a_w = 5 mm

Detail



Results

Positive moment

Resistance

$M_{j,Rd}$ = 239.5 kNm
$V_{j,Rd}$ = 833.5 kN

Stiffness

$S_{j,ini}$ = 268193 kNm/rad

Classification

Strength: partial strength
Stiffness: semi-rigid

Failure

Welds at beam end

© RWTH/PSP Aachen, M&S Liège, ICCS Hoofddorp

Design of joints in building frames according to Eurocode 3 - revised Annex J

1. INPUT DATA

1.1 PROJECT DATA

```
project ....................:  5262 RLB Standard Calculation
structure ..................:  RLB Bridge
joint ......................:  Transom Connection 8 Bolts M30
joint id ...................:  Transom Connection 1
engineer ...................:  MK
date .......................:  08-12-2009

design procedure ...........:  elastic analysis / plastic joint design

environment ................:  corrosive
framing ....................:  not braced
```

1.2 main joint data

```
beam :                    ( built-up profile )
flush end plate :         640 X 200 X 15,  S 355
```

2. JOINT PROPERTIES FOR POSITIVE MOMENTS

2.1 ASSEMBLY OF THE COMPONENTS

```
resistance of bolt row nb  1 .....................: FRd(1) =      408.83 kN
resistance of bolt row nb  2 .....................: FRd(2) =      176.16 kN
resistance of bolt row nb  3 .....................: FRd(3) =      137.10 kN
resistance of bolt row nb  4 .....................: FRd(4) =        0.00 kN

moment resistance (weld failure disregarded) .....: MRdj   =      324.30 kNm
moment resistance of the welds ...................: MRdw   =      239.48 kNm
                                                                 ---------
moment resistance ..................... ( J.3.6 ) :               239.48 kNm

elastic moment resistance ............. ( J.2.1.2 ) : Me     =      216.20 kNm

initial stiffness .................. ( Form. J.34 ) : Sji    =   268193.90 kNm/rad

idealized stiffness . ( J.2.1.2 - J.2.1.4 - T.J.3 ) : Sjn    =    89397.97 kNm/rad


design shear resistance of the joint ..............: VRd    =      833.49 kN
```

2.1.1 collapse mode

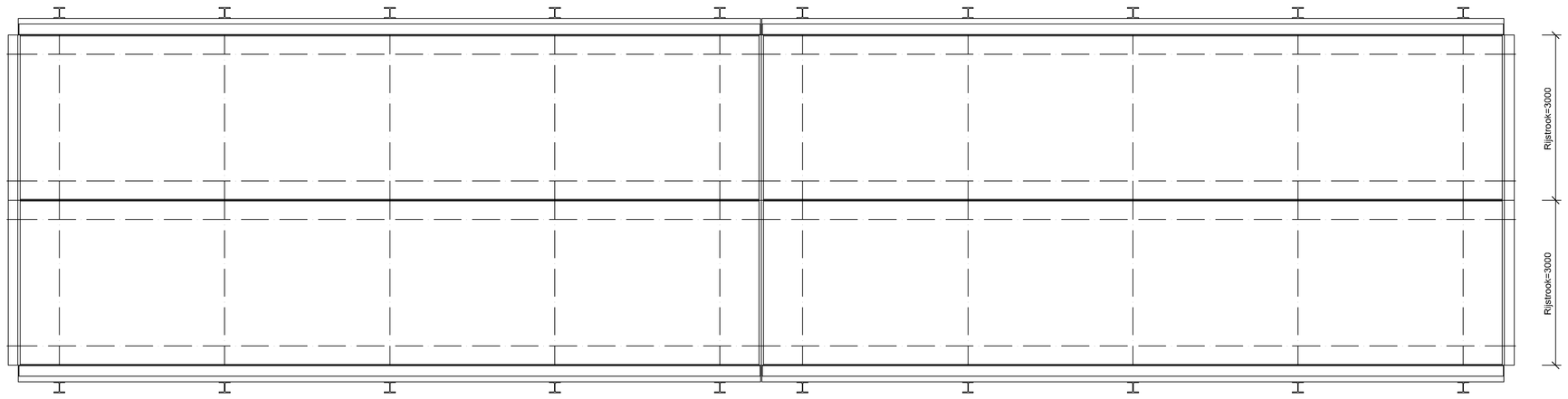
```
collapse mode : welds at beam end
```

2.2 DESIGN PROPERTIES OF THE JOINT FOR ELASTIC ANALYSIS / PLASTIC JOINT DESIGN

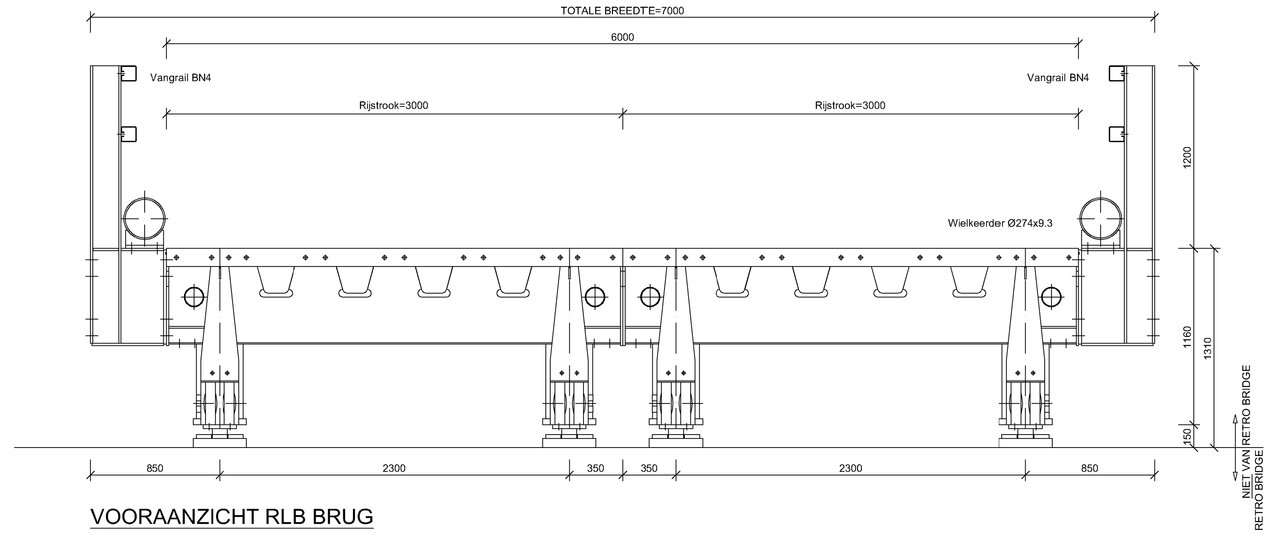
```
design moment resistance ...........................: MRd    =      239.48 kNm

relevant stiffness .................................: Sjn    =    89397.97 kNm/rad
```

Bijlage 2 Overzicht hulpbrug incl. oplegreacties

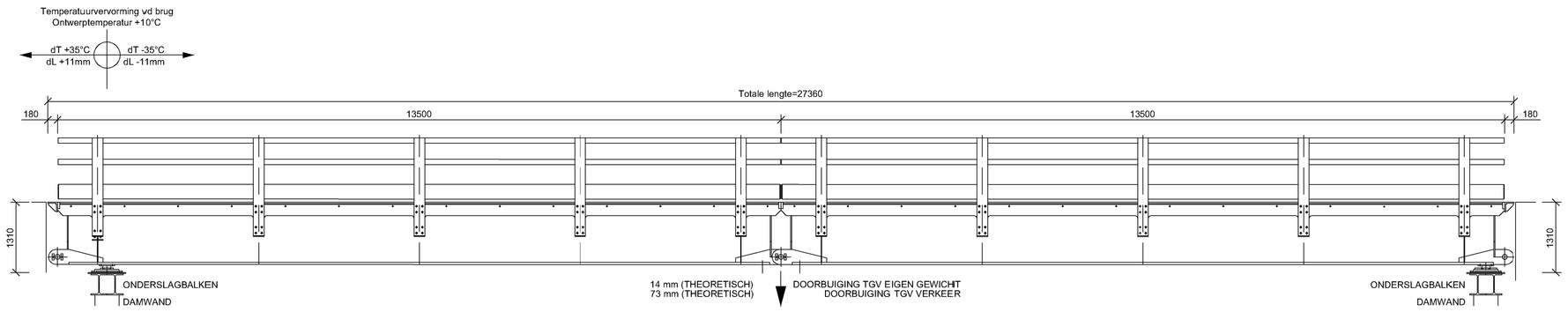


PLATTEGROND DEK

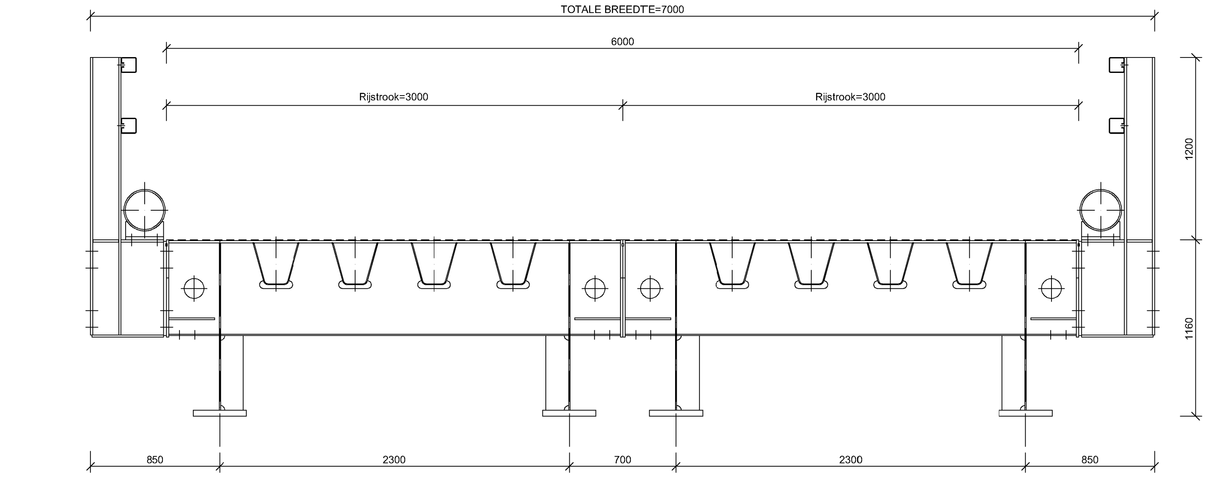


VOORAANZICHT RLB BRUG

1:20

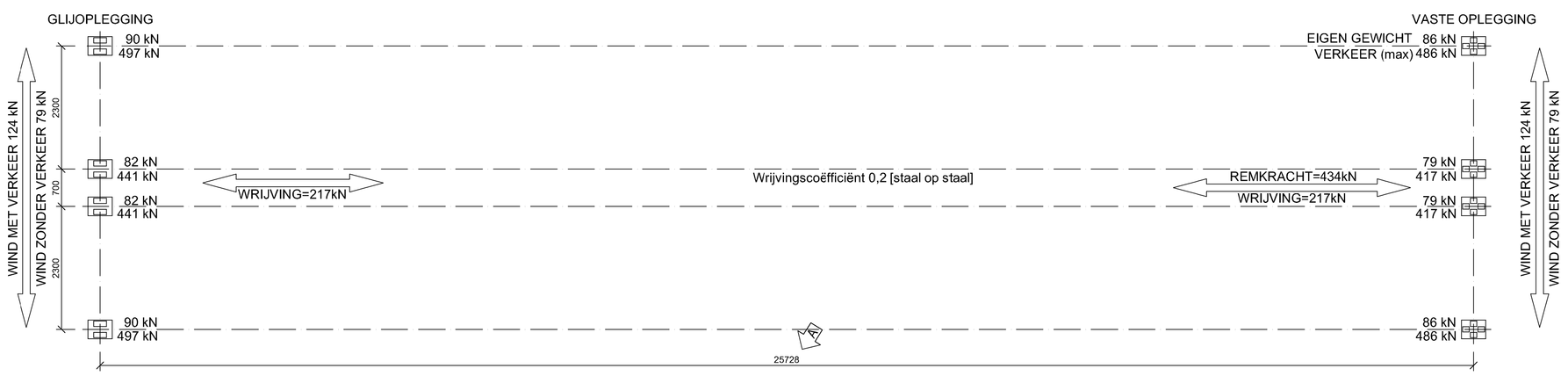


AANZICHT RLB BRUG

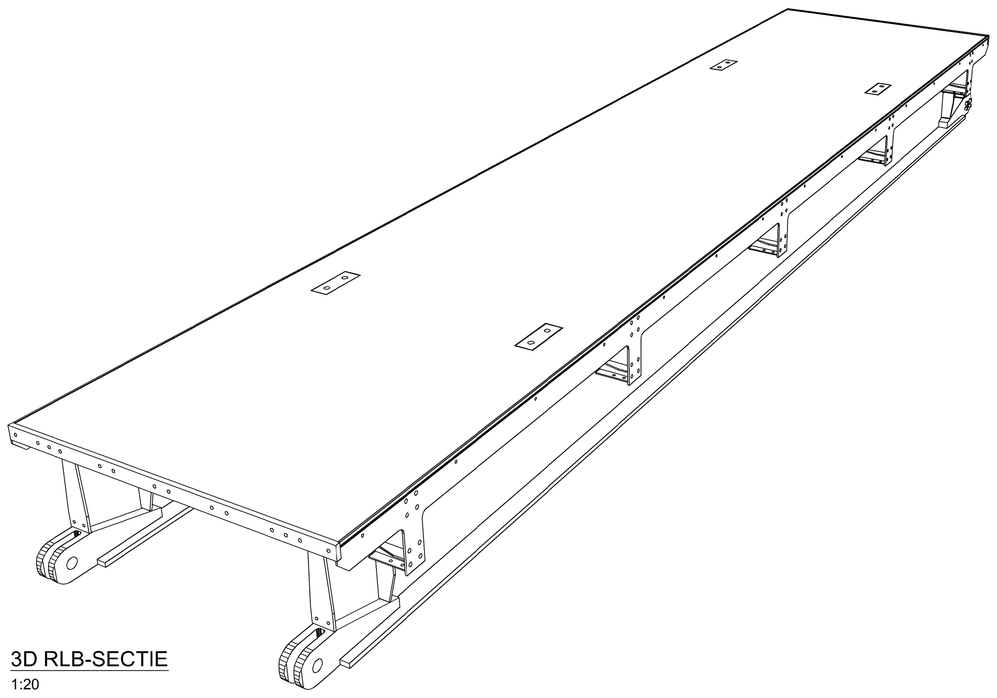


DOORSNEDE RLB BRUG

1:20



LAYOUT OPLEGGINGEN met OPLEGREACTIES (Maxima per oplegging, Representatief)



3D RLB-SECTIE

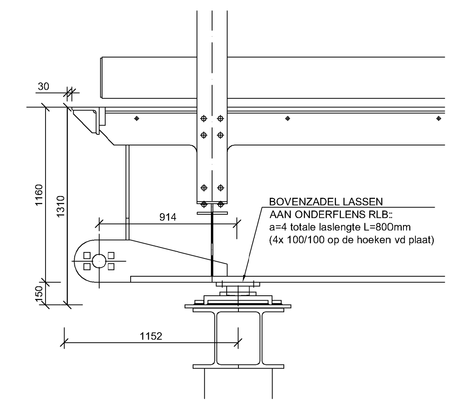
1:20

OPMERKINGEN: ALGEMEEN

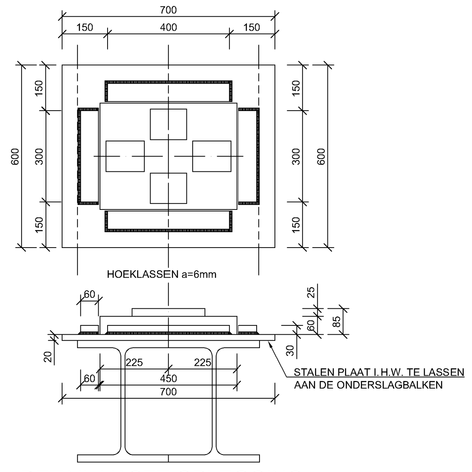
- ALLE MATEN IN MILLIMETERS
- MATEN IN HET WERK TE CONTROLEREN
- LEVERING ONDERSLAGBALKEN/DAMWANDEN NIET DOOR RETRO BRIDGE
- STRIPPEN T.B.V. MONTAGE / BEVESTIGING VD OPLEGGINGEN NIET DOOR RETI BRIDGE

OPMERKINGEN: RLB BRUG

STAALKWALITEIT S355J2 EN S460N ZIE TEKENING 5161-S01
[TENZIJ ANDERS AANGEGEVEN]
BOUTEN 10.9

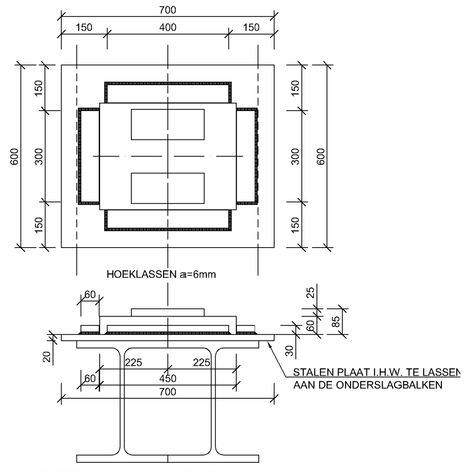


DETAIL GLIJOPLEGGING



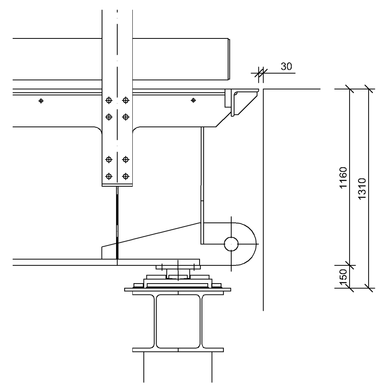
DETAIL VASTE OPLEGGING

1:10



DETAIL GLIJOPLEGGING

1:10



DETAIL VASTE OPLEGGING

1:20

Rev.	Datum	Omschrijving/Status	Gecontr	Gezien	Opmerkingen
B	04-11-2015	OPLEGGINGEN GESPEIGELD	MK	AvdM	
0	25-09-2015	TER GOEDKEURING	MK	AvdM	

RETRO BRIDGE
Retro Bridge BV
Bruistensingel 152
5232 AC 's-Hertogenbos.ch NL
Tel. +31 (0)73 6408770
Fax. +31 (0)73 6442369
Mob.+31 (0)610 522571
E-mail sales@retrobridge.com
Website www.retrobridge.com

project
RLB-HULPBRUG 27x6mtr.
N23 KW15B Binnenwijzen

Onderdeel
OVERZICHT RLB HULPBRUG 27x6mtr.

de Heer
Aannemer voor stage- en betonconstructies
Westhavenkade 87a
3133 AV Vlaardingen
Tel.010-8503940
Fax.010-4358183
E-mail:info@bdeheer.nl

Getek.	MK	Schaal	1:50 / 20/ 10
Datum	04-11-2015	Formaat	A0
Projectnr.		Tekeningnr.	Rev.
	5671	P02	B

I:\7.projecten cp\p32.219 n23 westfrisiaweg\38. realisatie\06 ber.tijd.const\rkw150/hulpbrug/retro\5671_p02-b-overzicht rlb 27x6m.dwgA0_841x1189

Bijlage 3 Krachtsverdeling moerbalk as 1-2, zwakke richting

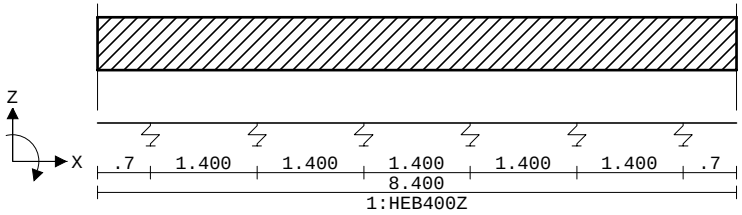
TS/Liggers Rel: 6.01 22 okt 2015
Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten
Constructeur.: dilu
Opdrachtgever:
Dimensies....: kN/m/rad
Datum.....: 16/10/2015
Bestand.....: l:\7.projecten cp\p32.219 n23 westfrisiaweg\38. realisatie\06 ber.tijd.constr\kw15b\hulpbrug\ts liggers\moerbalk op damwanden zwak.dlw

Toegepaste normen volgens Eurocode met Nederlandse NB

Belastingen	NEN-EN 1990:2002	C2:2010	NB:2011(nl)
	NEN-EN 1991-1-1:2002	C1:2009	NB:2011(nl)
Staal	NEN-EN 1993-1-1:2006	C2:2009	NB:2011(nl)

GEOMETRIE

Ligger:1



VELDLENGTEN

Ligger:1

Veld	Vanaf	Tot	Lengte	Veld	Vanaf	Tot	Lengte
1	0.000	0.700	0.700	6	6.300	7.700	1.400
2	0.700	2.100	1.400	7	7.700	8.400	0.700
3	2.100	3.500	1.400				
4	3.500	4.900	1.400				
5	4.900	6.300	1.400				

MATERIALEN

Mt	Omschrijving	E-mechanica[N/mm2]	Cement	Kruipcoef.	S.M.	S.M.verh.	Pois.
1	S235	210000			78.5		0.30

PROFIELEN [mm]

Prof.	Omschrijving	Materiaal	Oppervlak	Traagheid
1	HEB400Z	1:S235	1.9780e+004	1.0820e+008

PROFIELEN vervolg [mm]

Prof.	Vormf.	Breedte	Hoogte	ey	Type	b1	h1	b2	h2
1	0.00	300	400	150.0					

TS/Liggers Rel: 6.01 22 okt 2015

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

PROFIELVORMEN [mm]

1 HEB400Z



VEREN

Ligger:1

Veer	Steunpunt	Richting	Veerwaarde	Type	Ondergrens	Bovengrens
1	1	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
2	2	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
3	3	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
4	4	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
5	5	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
6	6	2:Z-transl.	5.000e+004	Normaal	0.000	0.000

BELASTINGGEVALLEN

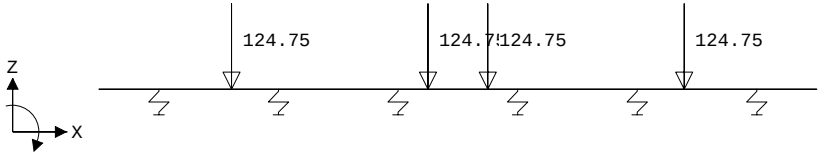
B.G.	Omschrijving	Belast/onbelast	Ψ_0	Ψ_1	Ψ_2	e.g.
1	Rem- en wrijvingskra	0:Alles tegelijk	1.00	1.00	1.00	0.00
2	Passieve gronddruk	0:Alles tegelijk	1.00	1.00	1.00	0.00

BELASTINGGEVALLEN

B.G.	Omschrijving	Type
1	Rem- en wrijvingskracht	0 Onbekend
2	Passieve gronddruk	0 Onbekend

VELDBELASTINGEN

Ligger:1 B.G:1 Rem- en wrijvingskracht



VELDBELASTINGEN

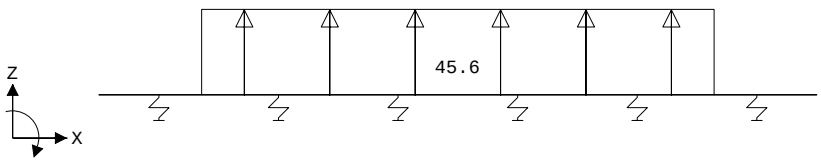
Ligger:1 B.G:1 Rem- en wrijvingskracht

Last	Ref.	Type	Omschrijving	q1/p/m	q2	psi	Afstand	Lengte
1		8:Puntlast		-124.750			1.550	
2		8:Puntlast		-124.750			3.850	
3		8:Puntlast		-124.750			4.550	
4		8:Puntlast		-124.750			6.850	

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

VELDBELASTINGEN

Ligger:1 B.G:2 Passieve gronddruk



VELDBELASTINGEN

Ligger:1 B.G:2 Passieve gronddruk

Last Ref.	Type	Omschrijving	q1/p/m	q2	psi	Afstand	Lengte
1	1:q-last		45.600	45.600		1.200	6.000

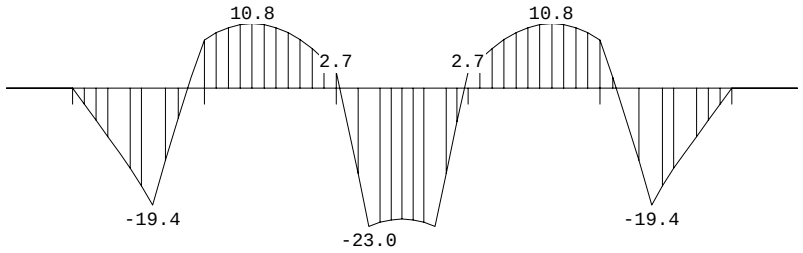
BELASTINGCOMBINATIES

BC	Type	BG	Gen.	Factor	BG	Gen.	Factor	BG	Gen.	Factor	BG	Gen.	Factor
1	Fund.	1	Extr	0.68	2	Extr	0.45						
2	Kar.	1	Extr	0.50	2	Extr	0.50						

OMHULLENDE VAN DE FUNDAMENTELE COMBINATIES

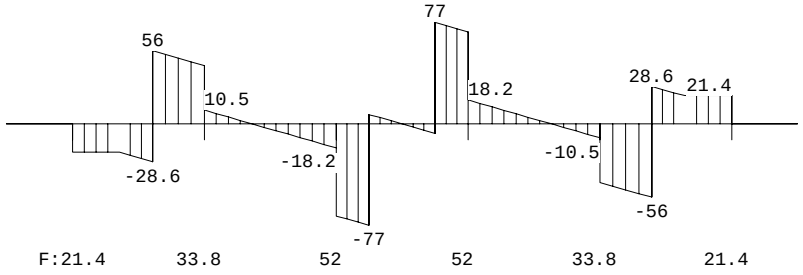
MOMENTEN

Ligger:1 Fundamentele combinatie



DWARSKRACHTEN

Ligger:1 Fundamentele combinatie



Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

REACTIES

Ligger:1 Fundamentele combinatie

Stp	F	M
1	21.39	0.00
2	33.83	0.00
3	51.63	0.00
4	51.63	0.00
5	33.83	0.00
6	21.39	0.00

OMHULLENDE VAN DE KARAKTERISTIEKE COMBINATIES

REACTIES

Ligger:1 Karakteristieke combinatie

Stp	F	M
1	13.53	0.00
2	15.96	0.00
3	26.86	0.00
4	26.86	0.00
5	15.96	0.00
6	13.53	0.00

STAALPROFIELEN - ALGEMENE GEGEVENS

Ligger:1

Stabiliteit: Classificatie gehele constructie: Geschoord

MATERIAAL

Mat nr.	Profielnaam	Vloeisp. [N/mm^2]	Productie methode	Min. drsn. klasse
1	HEB400Z	235	Gewalst	3

Partiële veiligheidsfactoren:
Gamma M;0 : 1.00 Gamma M;1 : 1.00

KIPSTABILITEIT

Ligger:1

Staaf	Plts. aangr.		l gaffel [m]	Kipsteunafstanden [m]
1	1.0*h	boven:	1.40	0.700
		onder:	1.40	0.700
2	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
3	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
4	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
5	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
6	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
7	1.0*h	boven:	1.40	0.700
		onder:	1.40	0.700

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

TOETSING SPANNINGEN

Ligger:1

Staaf	Mat nr.	BC	Sit	Kl	Plaats	Norm Artikel	Formule	Hoogste toetsing U.C.	[N/mm^2]	Opm.
1	1					Staaf is onbelast				57
2	1	1	1	3	Mz-max	EN3-1-1 6.2.8	(6.29)	0.115	27	
3	1	1	1	3	Mz-max	EN3-1-1 6.2.5	(6.12z)	0.063	15	
4	1	1	1	3	Mz-max	EN3-1-1 6.2.8	(6.29)	0.136	32	
5	1	1	1	3	Mz-max	EN3-1-1 6.2.5	(6.12z)	0.063	15	
6	1	1	1	3	Mz-max	EN3-1-1 6.2.8	(6.29)	0.115	27	
7	1					Staaf is onbelast				57

Opmerkingen:
[57] Staaf is (nagenoeg) onbelast.

Bijlage 4 Controle moerbalk as 1-2

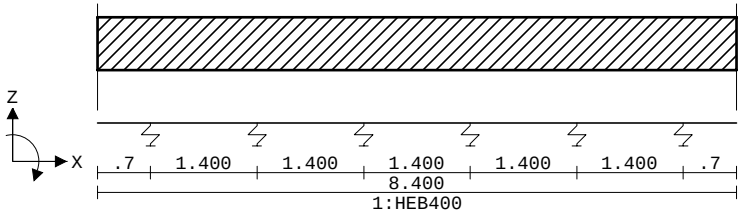
TS/Liggers Rel: 6.01 4 nov 2015
Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten
Constructeur.: dilu
Opdrachtgever:
Dimensies....: kN/m/rad
Datum.....: 16/10/2015
Bestand.....: l:\7.projecten cp\p32.219 n23 westfrisiaweg\38. realisatie\06 ber.tijd.constr\kw15b\hulpbrug\ts liggers\moerbalk op damwanden sterk.dlw

Toegepaste normen volgens Eurocode met Nederlandse NB

Belastingen	NEN-EN 1990:2002	C2:2010	NB:2011(nl)
	NEN-EN 1991-1-1:2002	C1:2009	NB:2011(nl)
Staal	NEN-EN 1993-1-1:2006	C2:2009	NB:2011(nl)

GEOMETRIE

Ligger:1



VELDLENGTEN

Ligger:1

Veld	Vanaf	Tot	Lengte	Veld	Vanaf	Tot	Lengte
1	0.000	0.700	0.700	6	6.300	7.700	1.400
2	0.700	2.100	1.400	7	7.700	8.400	0.700
3	2.100	3.500	1.400				
4	3.500	4.900	1.400				
5	4.900	6.300	1.400				

MATERIALEN

Mt	Omschrijving	E-mechanica[N/mm2]	Cement	Kruipcoef.	S.M.	S.M.verh.	Pois.
1	S235	210000			78.5		0.30

PROFIELEN [mm]

Prof.	Omschrijving	Materiaal	Oppervlak	Traagheid
1	HEB400	1:S235	1.9780e+004	5.7680e+008

PROFIELEN vervolg [mm]

Prof.	Vormf.	Breedte	Hoogte	ey	Type	b1	h1	b2	h2
1	0.00	300	400	200.0					

TS/Liggers Rel: 6.01 4 nov 2015

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

PROFIELVORMEN [mm]

1 HEB400



VEREN

Ligger:1

Veer	Steunpunt	Richting	Veerwaarde	Type	Ondergrens	Bovengrens
1	1	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
2	2	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
3	3	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
4	4	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
5	5	2:Z-transl.	5.000e+004	Normaal	0.000	0.000
6	6	2:Z-transl.	5.000e+004	Normaal	0.000	0.000

BELASTINGGEVALLEN

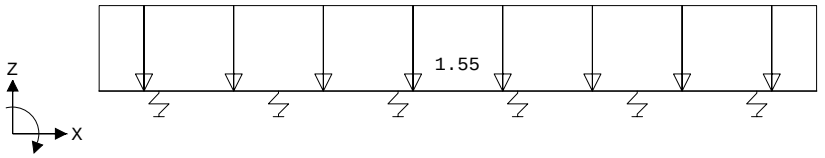
B.G.	Omschrijving	Belast/onbelast	ψ_0	ψ_1	ψ_2	e.g.
1	EG Moerbalk	0:Alles tegelijk	1.00	1.00	1.00	0.00
2	EG hulpbrug	0:Alles tegelijk	1.00	1.00	1.00	0.00
3	Veranderlijk hulpbru	0:Alles tegelijk	1.00	1.00	1.00	0.00

BELASTINGGEVALLEN

B.G.	Omschrijving	Type
1	EG Moerbalk	0 Onbekend
2	EG hulpbrug	0 Onbekend
3	Veranderlijk hulpbrug	0 Onbekend

VELDBELASTINGEN

Ligger:1 B.G:1 EG Moerbalk



VELDBELASTINGEN

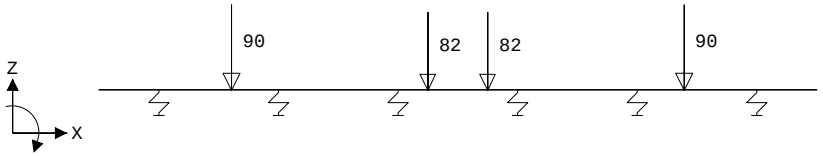
Ligger:1 B.G:1 EG Moerbalk

Last	Ref.	Type	Omschrijving	q1/p/m	q2	psi	Afstand	Lengte
1		1:q-last		-1.550	-1.550		0.000	8.400

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

VELDBELASTINGEN

Ligger:1 B.G:2 EG hulpbrug



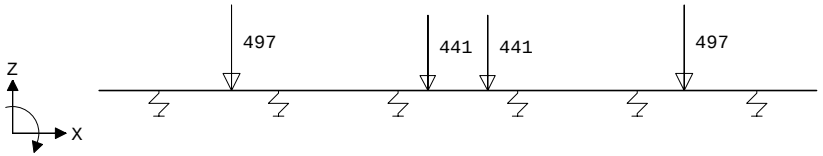
VELDBELASTINGEN

Ligger:1 B.G:2 EG hulpbrug

Last Ref.	Type	Omschrijving	q1/p/m	q2	psi	Afstand	Lengte
1	8:Puntlast		-90.000			1.550	
2	8:Puntlast		-82.000			3.850	
3	8:Puntlast		-82.000			4.550	
4	8:Puntlast		-90.000			6.850	

VELDBELASTINGEN

Ligger:1 B.G:3 Veranderlijk hulpbrug



VELDBELASTINGEN

Ligger:1 B.G:3 Veranderlijk hulpbrug

Last Ref.	Type	Omschrijving	q1/p/m	q2	psi	Afstand	Lengte
1	8:Puntlast		-497.000			1.550	
2	8:Puntlast		-441.000			3.850	
3	8:Puntlast		-441.000			4.550	
4	8:Puntlast		-497.000			6.850	

BELASTINGCOMBINATIES

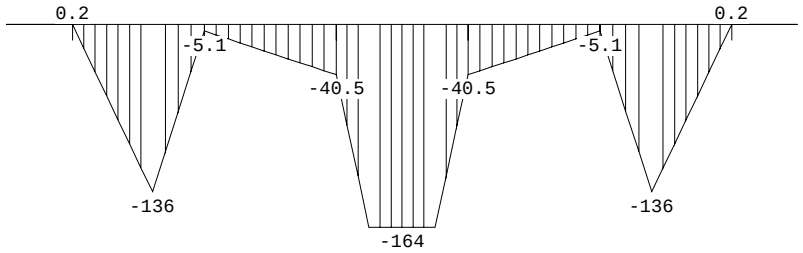
BC	Type	BG	Gen.	Factor	BG	Gen.	Factor	BG	Gen.	Factor	BG	Gen.	Factor
1	Fund.	1	Extr	0.65	2	Extr	0.65	3	Extr	0.68			
2	Kar.	1	Extr	0.50	2	Extr	0.50	3	Extr	0.50			

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

OMHULLENDE VAN DE FUNDAMENTELE COMBINATIES

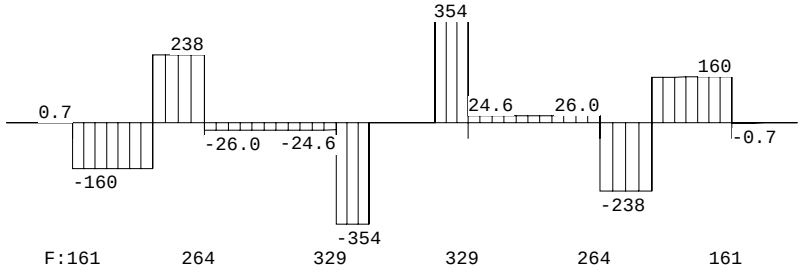
MOMENTEN

Ligger:1 Fundamentele combinatie



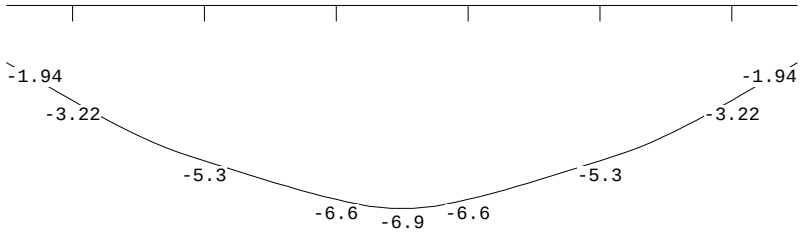
DWARSKRACHTEN

Ligger:1 Fundamentele combinatie



VERPLAATSINGEN [mm]

Ligger:1 Fundamentele combinatie



REACTIES

Ligger:1 Fundamentele combinatie

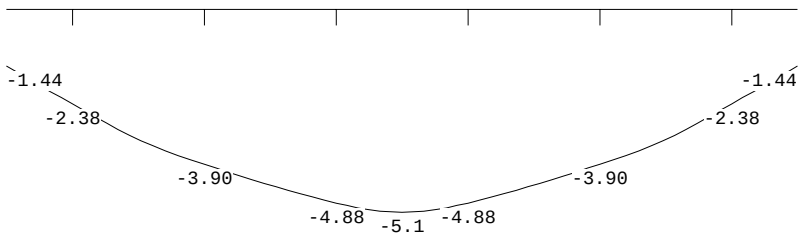
Stp	F	M
1	160.97	0.00
2	263.62	0.00
3	329.27	0.00
4	329.27	0.00
5	263.62	0.00
6	160.97	0.00

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

OMHULLENDE VAN DE KARAKTERISTIEKE COMBINATIES

VERPLAATSINGEN [mm]

Ligger:1 Karakteristieke combinatie



REACTIES

Ligger:1 Karakteristieke combinatie

Stp	F	M
1	119.21	0.00
2	195.22	0.00
3	243.83	0.00
4	243.83	0.00
5	195.22	0.00
6	119.21	0.00

STAALPROFIELEN - ALGEMENE GEGEVENS

Ligger:1

Stabiliteit: Classificatie gehele constructie: Geschoord

MATERIAAL

Mat nr.	Profielnaam	Vloeisp. [N/mm^2]	Productie methode	Min. drsn. klasse
1	HEB400	235	Gewalst	3

Partiële veiligheidsfactoren:
Gamma M;0 : 1.00 Gamma M;1 : 1.00

KIPSTABILITEIT

Ligger:1

Staaf	Plts. aangr.		l gaffel [m]	Kipsteunafstanden [m]
1	1.0*h	boven:	1.40	0.700
		onder:	1.40	0.700
2	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
3	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
4	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
5	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
6	1.0*h	boven:	1.40	1.400
		onder:	1.40	1.400
7	1.0*h	boven:	1.40	0.700
		onder:	1.40	0.700

Project.....: N23 - KW15B: Hulpbrug Binnenwijzend
Onderdeel....: Moerbalk steunpunten

KRACHTEN UIT HET VLAK

Ligger:1

Staaf	Mbegin [kNm]	Mmidden [kNm]	Meinde [kNm]	Vbegin [kN]	Vtpv [kN]	Mmax [kNm]	Veinde [kN]	Lx [kNm]
1	0.0	0.0	0.0	0.0	0.0	0.0	10.3	
2	0.0	-19.4	10.8	-21.4	56.0	56.0	10.3	
3	10.8	10.8	2.7	10.5	0.0	-18.2	10.3	
4	2.7	-23.0	2.7	-77.0	0.0	77.0	10.3	
5	2.7	10.8	10.8	18.2	0.0	-10.5	10.3	
6	10.8	-19.4	0.0	-56.0	-56.0	21.4	10.3	
7	0.0	0.0	0.0	0.0	0.0	0.0	10.3	

TOETSING SPANNINGEN

Ligger:1

Staaf	Mat nr.	BC	Sit	Kl	Plaats	Norm Artikel	Formule	Hoogste toetsing U.C.	[N/mm^2]	Opm.
1	1	1	1	3	Einde	EN3-1-1 6.2.7	(6.23)	0.256	35	3,8,4
2	1	1	1	3	Einde	EN3-1-1 6.2.6	(6.17)	0.435	59	46,3,88
3	1	1	1	3	Begin	EN3-1-1 6.2.7	(6.23)	0.158	21	3,88
4	1	1	1	3	1.050	EN3-1-1 6.2.1	(6.1)	0.686	161	46,3,88
5	1	1	1	3	Begin	EN3-1-1 6.2.7	(6.23)	0.158	21	3,88
6	1	1	1	3	Begin	EN3-1-1 6.2.6	(6.17)	0.435	59	46,3,88
7	1	1	1	3	Begin	EN3-1-1 6.2.7	(6.23)	0.256	35	3,8,4

Opmerkingen:
[3] Als ongest. lengte voor wringing is de syst.lengte-Y aangehouden.
[4] Controle gedrukte T-rand houdt geen rekening met 2e-orde-wringing.
[8] Controle van de gedrukte rand is toegepast (zonder buiging!).
[46] T.b.v. kip is een equivalente Q-last berekend.
[88] Controle van de gedrukte rand is toegepast (met buiging zwakke as).

Bijlage 5 Controle las fixatie oplegzadels

HEIJMANS CIVIEL BV
Technisch Bedrijfsbureau

heijmans

Project: N23: KW15B - Hulpbrug Binnenwijzend
Projectnummer:
Onderdeel: Las oplegzadel - moerbalk
Datum:
Opsteller:

Controle hoeklasverbindingen volgens EN 1993-1-8

INVOERGEGEVENS HOEKLASVERBINDING

Lasdikte	4	mm	$\gamma_{M;2}$	1,25	-
Laslengte	400	mm	β_w	0,80	-
Lassoort	2	-	$f_{u;d}$	360	N/mm^2
Staalsoort	S235	-	$f_{v;w;d}$	360	N/mm^2
Dikte plaat t	600	mm	$f_{t;w;d}$	259	N/mm^2

CONTROLE HOEKLASVERBINDING

Basisgeval 1		
$F_{E;d}$	168,0	kN
$\sigma_\perp = \tau_\perp$	0,0	N/mm^2
$\tau_\parallel$	52,5	N/mm^2

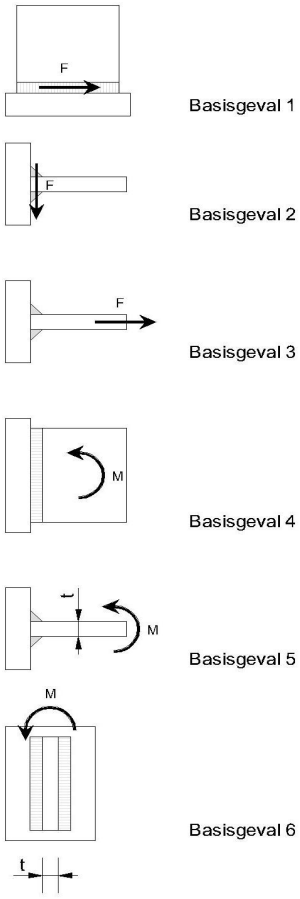
Basisgeval 2		
$F_{E;d}$	42,0	kN
$\sigma_\perp = \tau_\perp$	9,3	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 3		
$F_{E;d}$	0,0	kN
$\sigma_\perp = \tau_\perp$	0,0	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 4		
$M_{E;d}$	13,5	kNm
$\sigma_\perp = \tau_\perp$	44,7	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 5		
$M_{E;d}$	3,4	kNm
$\sigma_\perp = \tau_\perp$	2,5	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 6		
$M_{E;d}$	0,0	kNm
$\sigma_\perp = \tau_\perp$	0,0	N/mm^2
$\tau_\parallel$	0,0	N/mm^2



Voorwaarde 1

$\sigma_{w;E;d}$	145	N/mm^2
$f_{v;w;d}$	360	N/mm^2
UC	0,40	-

Voorwaarde 2

$\sigma_{1;tot}$	57	N/mm^2
$f_{t;w;d}$	259	N/mm^2
UC	0,22	-

CONCLUSIE

Hoeklasverbinding voldoet

UC_{max}	**0,40**	-

Bijlage 6 Controle las moerbalk as 1-2

HEIJMANS CIVIEL BV
Technisch Bedrijfsbureau

heijmans

Project: N23: KW15B - Hulpbrug Binnenwijzend
Projectnummer:
Onderdeel: Las oplegzadel - moerbalk
Datum:
Opsteller:

Controle hoeklasverbindingen volgens EN 1993-1-8

INVOERGEGEVENS HOEKLASVERBINDING

Lasdikte	8	mm	$\gamma_{M;2}$	1,25	-
Laslengte	400	mm	β_w	0,80	-
Lassoort	2	-	$f_{u;d}$	360	N/mm^2
Staalsoort	S235	-	$f_{v;w;d}$	360	N/mm^2
Dikte plaat t	685	mm	$f_{t;w;d}$	259	N/mm^2

CONTROLE HOEKLASVERBINDING

Basisgeval 1		
$F_{E;d}$	103,0	kN
$\sigma_\perp = \tau_\perp$	0,0	N/mm^2
$\tau_\parallel$	16,1	N/mm^2

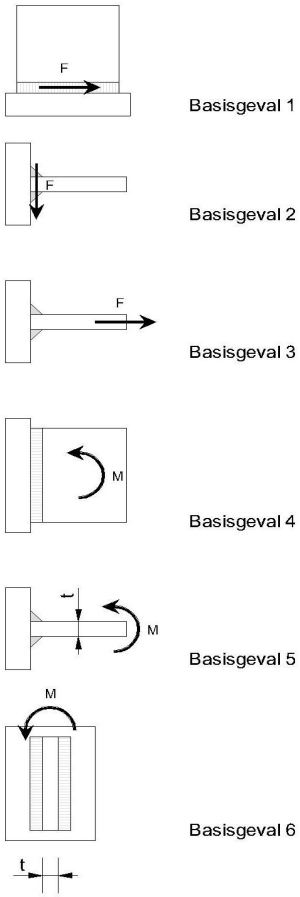
Basisgeval 2		
$F_{E;d}$	42,0	kN
$\sigma_\perp = \tau_\perp$	4,6	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 3		
$F_{E;d}$	659,0	kN
$\sigma_\perp = \tau_\perp$	72,8	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 4		
$M_{E;d}$	49,5	kNm
$\sigma_\perp = \tau_\perp$	82,0	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 5		
$M_{E;d}$	20,1	kNm
$\sigma_\perp = \tau_\perp$	6,4	N/mm^2
$\tau_\parallel$	0,0	N/mm^2

Basisgeval 6		
$M_{E;d}$	0,0	kNm
$\sigma_\perp = \tau_\perp$	0,0	N/mm^2
$\tau_\parallel$	0,0	N/mm^2



Voorwaarde 1

$\sigma_{w;E;d}$	333	N/mm^2
$f_{v;w;d}$	360	N/mm^2
UC	0,92	-

Voorwaarde 2

$\sigma_{1;tot}$	166	N/mm^2
$f_{t;w;d}$	259	N/mm^2
UC	0,64	-

CONCLUSIE

Hoeklasverbinding voldoet
UC_{max} **0,92** -

Bijlage 7 Controle krachtsinleiding

HEIJMANS CIVIEL BV
Technisch Bedrijfsbureau

heijmans

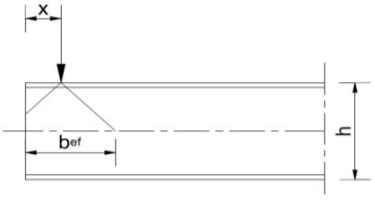
Project: N23: KW15B - Hulpbrug Binnenwijzend
Projectnummer:
Onderdeel: Krachtsinleiding moerbalk
Datum:
Opsteller:

Controle krachtsinleiding conform NEN-EN 1993-1-1 art. NB 6.5.3

INVOERGEGEVENS

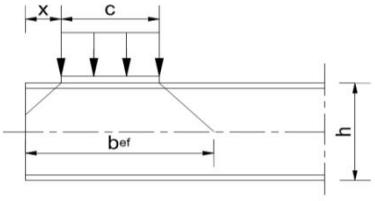
Profielgegevens

Kwaliteit	S235		Rekenmodel	elastisch	
Profiel	HEB400		t_f	24,0	mm
h	400	mm	r	27,0	mm
b	300	mm	W_y	2884000	mm^3
t_w	13,5	mm			



Belastingen

F_k	394	kN	γ_{M0}	1,00
$M_{y;k}$	164	kNm	γ_{M1}	1,00
			γ_q	1,00



Geometrie

c	15	mm	(volgens figuur NB.10)
x	700	mm	(volgens figuur NB.10)
Oplegging	Tussen		

UITVOERGEGEVENS

Vloeien van het lijf

d_1	220	mm	b_f	300	mm
$F_{1;Rd}$	**744**	**kN**			

Lokaal plooien

$F_{2;Rd}$	**900**	**kN**

Globaal plooien

i_z	3,9	mm	λ_1	93,9
b_{ef}	400	mm	$\bar{\lambda}$	1,09
$\alpha_{knikromme\ c}$	0,49	-	Φ	1,32
			χ	0,49
$F_{3;Rd}$	**620**	**kN**		

Interactieformules

Formule NB.79	UC 0,64	Globaal plooien is maatgevend
Formule NB.80	UC 0,45	

CONCLUSIE

Profiel voldoet	**UC_{max}**	**0,64**	-