Opgesteld:	LER	Gecontroleerd:	HAD	Goedgekeurd:	RIW
Datum	17-8-2021	Datum	17-8-2021	Datum	17-8-2021

"For approval"

Expansion storage capacity TP3

Pipe rack 1 and 2

Structural design / weight calculation

Klant	Neste Terminals	Klant projectnr.	2307
Project	Expansion storage capacity TP3	KH projectnr.	68685
Locatie	Vlaardingen		
Installatie	Tank pit 3	Revisie	0
documentnr.	2307-E40-CN-1731-0001	Datum	17-8-2021

Revision	Description	Date
0	Released for approval	17-8-2021

1 Index

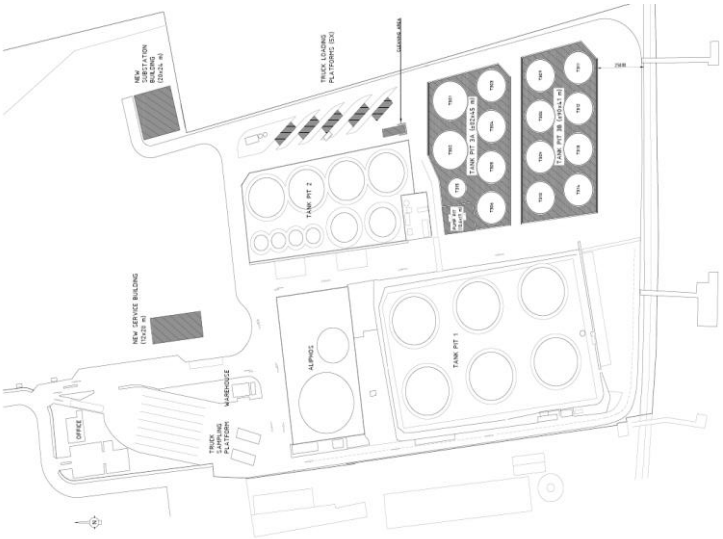
2 Introduction

Neste Terminal in Rotterdam has the intention to expand the storage capacity of their tank terminal in Rotterdam.

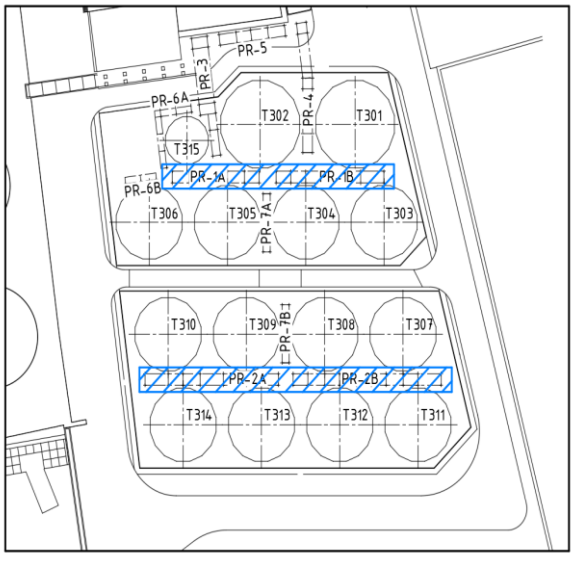
The expansion of the terminal consists of 15 tanks divided over two tank pits. There is a maintenance road between the two tank pits. Both tank pits are connected underground in order to guarantee the buffer capacity of the tank pits. The bund wall shall consist of either a retaining wall or sheet piling wall.

At the north-east side there is a new truck loading area with 5 bays.
The new tank pits are connected to the existing tank pit and new loading area by means of pipe racks.

On the north side of the new tank pits an recently built tank pit (built in 2017-2018) so called phase 1 is present. The tanks in this tank bund are founded on a crushed stone ring on a deep soil improvement.
At the westside also tank pit is present which is built in approximately 40 years ago (1960).



In this calculation the design of pipe rack 1 and 2 is checked and the piling load is determined.



3 General

3.1 Standards

NEN-EN 1990/NB	Eurocode 0: Basis of structural design
NEN-EN 1991	Eurocode 1: Actions on structures
NEN-EN 1991-1-1/NB	General actions - Densities, self-weight, imposed loads for buildings
NEN-EN 1991-1-4/NB	General actions - Wind actions
NEN-EN 1991-1-5/NB	General actions - Thermal actions
NEN-EN 1992	Eurocode 2: Design of concrete structures
NEN-EN 1992-1-1/NB	General rules and rules for buildings
NEN-EN 1993	Eurocode 3: Design of steel structures
NEN-EN 1993-1-1/NB	General rules and rules for buildings
NEN-EN 1993-1-8/NB	Design of joints
2305-000-JSD-1700-04 Rev.4	Gereral rules for steel structure and civil works
2307-000-DC-1708-0004_0	Calculation Note Assumptions

3.2 Reference documents

drawings:

- 2307-E40-DW-0051-0003 TP3 3D view

other:

- FA01-D02-2101015 Geotechnical advice TP03 Neste

3.3 Used programs

SCIA Engineer, version: 20.0.2028
Microsoft Office

3.4 Basis

consequence class	*CC2*				
reliability class	*RC2*				
design working life	*50*	Years			
steel grade structural steel	*S355*	f_y =	*355*	N/mm²	E = *2,1E+05* N/mm²
concrete class	*C30/37*				

materials

deformations limits

Steel structure:

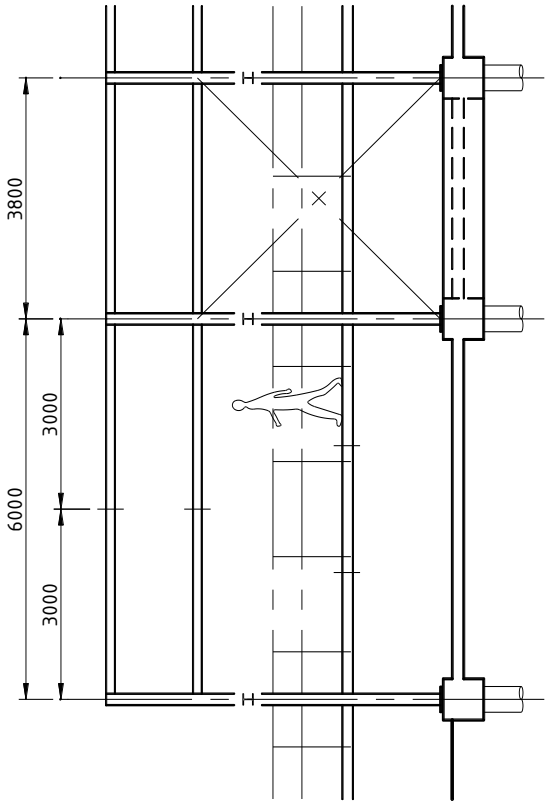
horizontal and vertical deflections	quasi permanent	$\omega_{lim} = l_{rep} / 250$
	frequent	$\omega_3 = l_{rep} / 333$
horizontal displacement pipe bridge	characteristic	$u = H / 250$

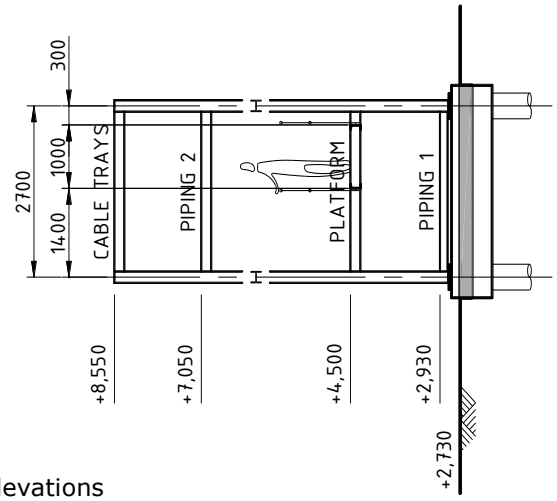
foundations

The springs constants are derived from the geotechnical advise. Because displacement is decisive the characteristic value is applied. For the horizontal spring constant see also chapter 6.8.

k_v = *50* MN/m
k_h = *10* MN/m

4 Structure





elevations

top of concrete						toc =	*2,730* +
top of steel:							
piping 1	layer of 8" pipes + 1x 12"	spacing	=	*0,2*	m	tos =	2,930 +
platform		spacing	=	*1,5*	m	tos =	4,475 +
piping 2	layer of 6" pipes	spacing	=	*2,6*	m	tos =	7,050 +
cable tray		spacing	=	*1,5*	m	tos =	8,550 +

center to centre frames (considered as span of pipe)	=	*6,0* m
width of pipe rack	=	*2,7* m
width of platform	=	*1,0* m
center to centre frames at bracing	=	*3,8* m

5 Loads and load combinations

5.1 Dead load

grating			g_k =	*0,5*	kN/m²
railing			g_k =	*0,3*	kN/m
concrete slab	*0,2* x	*25* =	g_k =	5,0	kN/m²

5.2 Equipment load

piping	6"	8"		12"	
empty	*0,8*	*1,0*	kN/m²	*0,8*	kN/m
operating	*1,8*	*2,2*	kN/m²	*1,6*	kN/m

cable tray	g_k =	*1,67*	kN/m²

5.3 Imposed load

imposed load	- surface load	q_k =	*5,0*	kN/m²
	- point load	Q_k =	*10,0*	kN

5.4 Wind load

The reference height for the wind load on the pipe rack is increased due to the larger adjacent tanks.

top of high structure			h_{high} =	*24,5*	m
largest width of high structure			d_{large} =	*16*	m
radius	$h_{high} \leq 2d_{large}$ ->	h_{high}=	r =	24,5	m
reference height	$x \leq r$ ->	0,5r =	z_n =	12,25	m

terrain category	*II*	area not build on			
basic wind velocity			v_b =	*30*	m/s
roughness length			z_0 =	0,2	m
			$z_{0,II}$ =	*0,05*	m
minimum height			z_{min} =	4	m
terrain factor			k_r =	0,209	
roughness factor			c_r(h) =	0,862	
orography factor			c_0(z) =	*1,00*	
mean wind velocity			$v_{m(h)}$ =	25,85	m/s
turbulence factor			k_I =	*1*	
turbulence intensity			I_v(h) =	0,243	
air density			ρ =	*1,25*	kg/m³
peak velocity pressure			q_p(z) =	1,128	
structural factor			$c_s c_d$ =	*1,0*	

5.4.1 wind load on structural members

force coefficient c_f = *2,0*

h =	*133*	*152*	*160*	*180*
q_k =	0,30	0,34	0,36	0,41

5.4.2 wind load piping layer

force coefficient c_f = *0,8*

width of pipe rack b = *2,7* m

		6"	12"		
diameter	Ø =	*0,22*	*0,4*	m	
wind load	q_k =	0,44	0,65	kN/m	$(Ø+0,1b)q_p(z)c_fc_sc_d$

5.4.3 wind load on a cable tray

force coefficient c_f = *2,0*

height of cable tray h = *0,1* m

wind load q_k = 0,23 kN/m

5.4.4 wind load railing

height of structural beam h = *180* mm

	h	e	h / e	c_f	F_w		a		M_w
toe plate	*150*	*1,0*	150	*2,0*	0,34	x	170	=	0,06
guard rail	*50*	*1,0*	50	*2,0*	0,11	x	705	=	0,08
handrail	*48*	*1,0*	48	*1,2*	0,06	x	1240	=	0,08
baluster	*70*	*1,5*	46,7	*2,0*	0,11	x	665	=	0,07
					0,62				0,29

effective wind height of handrailing 0,62 / (2,0 x 1,13) = h = 0,275 m

5.5 Temperature load

5.5.1 TLt - thermal forces

uniform temperature component Δt_u = *35* °

5.5.2 TLf - pipe stress

longitudinal direction of pipe

vertical bracing F_h = *5* %

top flange of support beam F_h = *10* %

support beam F_h = *10* kN

transverse direction of pipe

beams horizontal F_h = *7,5* kN

vertical F_v = *15* kN

frames F_h = *7,5* kN

5.6 Accidental load

5.6.1 railing

load on top of railing	q =	*1,0*	kN/m
lever arm top of railing to center of beam	a =	*1,24*	m
torsional force at center line structural beam	T =	1,24	kNm/m

5.6.1 tank failure

specific weight of product	γ =	*10*	kN/m³
height of bund wall	h =	*2,1*	m
product load	q_k =	21,0	kN/m²

5.7 Combinations

	ψ_0	ψ_1	ψ_2
industrial - short term	*0,5*	*0,5*	*0,3*
wind	*0,6*	*0,2*	*0,0*
Temperature	*0,6*	*0,5*	*0,0*

$$ULS = \sum_{j\geq 1} \gamma_{G,j} G_{k,j} + \gamma_{Q,1}\psi_{0,1} Q_{k,1} + \sum_{i\geq 1} \gamma_{Q,i}\psi_{0,i} Q_{k,i}$$

$$ULS = \sum_{j\geq 1} \xi\gamma_{G,j} G_{k,j} + \gamma_{Q,1} Q_{k,1} + \sum_{i\geq 1} \gamma_{Q,i}\psi_{0,i} Q_{k,i}$$

ξ = *0,9* γ_G = *1,35* $\gamma_{G,inf}$ = *1,0* γ_Q = *1,5*

$$SLS_{char} = \sum_{j\geq 1} G_{k,j} + Q_{k,1} + \sum_{i>1} \psi_{0,i} Q_{k,i}$$

$$SLS_{freq} = \sum_{j\geq 1} G_{k,j} + \psi_{1,1} Q_{k,1} + \sum_{i>1} \psi_{2,i} Q_{k,i}$$

$$SLS_{quasi} = \sum_{j\geq 1} G_{k,j} + \psi_{2,1} Q_{k,1} + \sum_{i>1} \psi_{2,i} Q_{k,i}$$

6 Calculation

For the check of the cross sections see Scia reports

6.1 typical beam

section HEA140

load

equipment load					2,2	x 6,0	=	g_k =	13,2	kN/m
stress load								Q_k =	10	kN
wind load		*0,1*	x 2,0	x 1,0	x 1,13		=	Q_k =	0,30	kN/m

check top flange

stress load					0,10	x 13,2	=	q_k =	1,32	kN/m
length of beam								l =	2,7	m
characteristic value of bending moment						1/8 $q_k l^2$	=	M_k =	1,20	kNm
design value of bending moment					1,5	x 1,20	=	M_{Ed} =	1,80	kNm
parameters flange	t_f = *8,5*	b = *140*	mm			1/6 $t_f b^2$	=	W =	27767	mm³
design resistance bending moment of flange						Wf_y	=	M_{Rd} =	9,86	kNm
								=	0,18	

0,18 < 1,0 Ok

6.2 piping layer

load - transverse beam

equipment load					1,8	x 6,0	=	g_k =	10,8	kN/m

load - longitudinal beam

equipment load	$G_{k,long}$ - $g_{k,tran}$ =	15	- 0,5	x 2,7	x 10,8		=	G_k =	0,42	kN
stress load								Q_k =	7,5	kN
wind load	beam	*0,2*	x 2,0	x 1,0	x 1,13		=	q_k =	0,34	kN/m
	piping			0,4	x 6,0		=	Q_k =	2,63	kN

normal force

wind load on frame

upper beams	*0,2*	x 2,0	x 1,0	x 1,13		=	q_k =	0,39	kN/m
platform beam	*0,2*	x 2,0	x 1,0	x 1,13		=	q_k =	0,39	kN/m
columns	*0,2*	x 2,0	x 1,0	x 1,13		=	q_k =	0,41	kN/m
upper beams		0,5	x 2,7	x 0,39		=	Q_k =	0,52	kN
platform beam		0,5	x 2,7	x 0,39		=	Q_k =	0,52	kN
columns			5,82	x 0,41		=	Q_k =	2,36	kN
upper beams			*2*	x 0,52		=	Q_k =	1,04	kN
platform beam		0,52	x 1,75	/ 4,32		=	Q_k =	0,21	kN
columns		2,36	x 2,91	/ 4,32		=	Q_k =	1,59	kN
sum of forces									2,84	kN
number of frames								# =	*4*	pcs
compression force in beam				4	x 2,84		=	Q_k =	11,4	kN

stress load

						0,05	x	1,8	=	$q_{k,i}$ =	0,09	kN/m²
			0,5	x	2,7	x	*24*	=	A =	32,4	m²
compression force in beam						0,09	x	32,4	=	Q_k =	2,9	kN

6.3 platform layer

load

dead load	grating				0,5	x	1	x	0,5	g_k =	0,25	kN/m
	railing									g_k =	0,30	kN/m
	total									g_k =	0,55	kN/m
live load					0,5	x	1	x	5	q_k =	2,50	kN/m
										Q_k =	10,00	kN
wind load		(*0,18*	+	*0,3*) x	2,0	x	1,0	x	1,13 =	q_k =	1,03	kN/m
										T_k =	0,29	kNm
accidental load on railing										T_k =	1,24	kNm

6.4 Bracing

number of frames										# =	*10*	pcs
					0,5	x	2,7	x	*51* =	A =	68,85	m²
angle of bracing				TAN (	4,32	/	3,8	)		α =	0,85	R
characteristic value												
- wind	2,84	x	10 =	F_h =	28,4	kN		Fh/COS(α)=		N_k =	43,0	kN
- temp.	2,9 /	32,4	x 68,9 =	F_h =	6,2	kN		Fh/COS(α)=		N_k =	9,4	kN
design value of tension		1,5	x 43,0 +	1,5	x 0,6	x	9,4	=		N_{Ed} =	73,0	kN
design value tension resistance							L70/7, 2x M16 8.8			N_{Rd} =	*121,0*	kN

0,60 < 1,0 Ok

6.5 Frame

load

dead load

piping layer	longitudinal			*30*	x	6	=	182	kg	=	G_k =	1,82	kN
	transverse	*0,5*	x	*25*	x	2,7	=	33,3	kg	=	G_k =	0,33	kN
											G_k =	2,16	kN
platform	longitudinal			*22,0*	x	6	=	132	kg	=	G_k =	1,32	kN
	transverse	*1*	x	*22,0*	x	1	=	22	kg	=	G_k =	0,22	kN
	railing							0,3	x	6 =	G_k =	1,80	kN
	grating			*0,5*	x	1	x	0,5	x	6 =	G_k =	1,50	kN
											G_k =	4,84	kN
equipment													
empty	piping 8"							1	x	6 =	g_k =	6,0	kN/m
	piping 6"							0,8	x	6 =	g_k =	4,8	kN/m
operating	piping 8"							2,2	x	6 =	g_k =	13,2	kN/m
	piping 6"							1,8	x	6 =	g_k =	10,8	kN/m
	cable tray							1,67	x	6 =	g_k =	10,0	kN/m

imposed load	*0,5*	x	1	x	5	x	6	=	Q_k =	15,00	kN
wind load - transverse direction											
piping 6"					0,44	x	6	=	Q_k =	2,63	kN
beams			*2*	x	0,34	x	6	=	Q_k =	4,11	kN
										6,74	kN
piping 12"					0,65	x	6	=	Q_k =	3,87	kN
cable tray									# =	*3*	pcs
			3	x	0,23	x	6	=	Q_k =	4,06	kN
beams			*2*	x	0,34	x	6	=	Q_k =	4,11	kN
										8,17	kN
platform			*2*	x	1,03	x	6	=	Q_k =	12,33	kN
										12,33	kN
wind load - longitudinal direction			28,4	/	3,8	x	4,32	=	F_v =	32,3	kN
stress load - transverse direction									Q_k =	7,5	kN
stress load - longitudinal direction			6,2	/	3,8	x	4,32	=	F_v =	7,0	kN

<u>rotation spring</u>

The rotation stiffness of the connections is estimated using the functions and factors provided in the publication "Momentverbindingen" from the Staalbouwkunding Genootschap.

									t_f =	*14*	mm
	flexibility factor, with endplate								k_f =	*11,5*	
	flexibility factor, with stiffeners in column								k_f =	*8,5*	
	haunch same height as beam										
top	h =	*171*	x	*1,3*	=	z =	222	mm	$S_{j,ini}$ =	12,6	MNm/R
other	h =	*171*	x	*1,5*	=	z =	257	mm	$S_{j,ini}$ =	22,8	MNm/R
baseplate	see appendix D								$S_{j,ini}$ =	*15,0*	MNm/R

<u>analysis type</u>

combination		6.10a												
+ 8,55	*2*	x	1,35	x	2,16	+	1,35	x	10,0	x	2,7		$V_{Ed,1}$ =	42,3 kN
+ 7,05	*2*	x	1,35	x	2,16	+	1,35	x	10,8	x	2,7		$V_{Ed,2}$ =	45,2 kN
+ 4,48	*2*	x(	1,35	x	4,84	+	1,5	x	0,5	x	15,0	)	$V_{Ed,3}$ =	35,6 kN
+ 8,55	1,5	x	0,6	x	8,2								$H_{Ed,1}$ =	7,4 kN
+ 7,05	1,5	x	0,6	x	6,7	+	1,5	x	0,6	x	7,5		$H_{Ed,2}$ =	12,8 kN
+ 4,48	1,5	x	0,6	x	12,3								$H_{Ed,3}$ =	11,1 kN

	H_{Ed}	V_{Ed}	h	δu	α_{cr}
7,05 - 8,55	7,4	42,3	1500	*4,2*	62
4,48 - 7,05	12,8	45,2	2575	*11*	68
2,73 - 4,48	11,1	35,6	1745	*5,8*	94

combination			6.10b												
+ 8,55		2	x	1,2	x	2,16	+	1,2	x	10,0	x	2,7		$V_{Ed,1}$ =	37,6 kN
+ 7,05		2	x	1,2	x	2,16	+	1,2	x	10,8	x	2,7		$V_{Ed,2}$ =	40,2 kN
+ 4,48		2	x(	1,2	x	4,84	+	1,5	x	0,5	x	15,0	)	$V_{Ed,3}$ =	34,1 kN
+ 8,55		1,5	x	8,2										$H_{Ed,1}$ =	12,3 kN
+ 7,05		1,5	x	6,7	+	1,5	x	0,6	x	7,5				$H_{Ed,2}$ =	16,9 kN
+ 4,48		1,5	x	12,3										$H_{Ed,3}$ =	18,5 kN

			H_{Ed}	V_{Ed}	h	δu	α_{cr}
7,05	-	8,55	12,3	37,6	1500	*6,3*	78
4,48	-	7,05	16,9	40,2	2575	*16*	67
2,73	-	4,48	18,5	34,1	1745	*8,8*	107

Because the factor α_{cr} is larger than 10 the structure will be checked using a first order linear-elastic calculation. The buckling length will be the same as the system length.

deflection

	h	ux	δu		δu,lim			
+ 8,55	1,50	*24*	4,2	<	6,0	Ok	l / 357	
+ 7,05	2,58	*19,8*	10,7	<	10,3	Not Ok	l / 241	acceptable
+ 4,48	1,75	*9,1*	6,3	<	7,0	Ok	l / 277	
+ 2,73		*2,8*						
overall	8,55		21,2	<	34,2	Ok	l / 403	

6.6 Reaction forces R_y

6.6.1 *single frame*

stress load										0,5	x	10	=	Q_k =	5 kN
wind load	columns									2,36	-	1,59	=	Q_k =	0,8 kN
	platform									0,52	-	0,21	=	Q_k =	0,3 kN
	beam							0,5	x	2,7	x	0,30	=	Q_k =	0,4 kN
															1,5 kN
design value of shear force		1,5	x	5	+	1,5	x	0,6	x	1,5	=	R_y =	8,8 kN		
design value of bending moment										8,8	x	*0,7*	=	T_x =	6,2 kNm

6.6.2 *with bracing*

wind load				28,4	+	1,5							=	Q_k =	29,9 kN
stress load				6,2	+	0,05	x	13,2	x	0,5	x	2,7	=	Q_k =	7,1 kN
design value of shear force				1,5	x	29,9	+	1,5	x	0,6	x	7,1	=	R_y =	51,3 kN
design value of shear force for single pile										0,5	x	51,3	=	R_y =	25,6 kN

6.7 Foundation

live load	5	x	6	=	g_k	=	30	kN/m	
accidental load	21	x	6	=	q_k	=	126	kN/m	

vertical displacement

l	$u_{z,min}$	$u_{z,max}$	δu	δu,lim			limit	=	*0,003*	l
2,7	*-0,4*	*-4,7*	4,3	8,1	Ok	l /	628			

6.8 piling

The horizontal spring constant is based on the soil elasticity from the geotechnical advise. With this elasticity the displacement of the pile is calculated. For the spring constant the average displacement between a rotation fixed and rotation free is considered. For the displacement calculation see appendix C

	rigid	free			mean				
spring constant	*63*	*120*	mm	1 /	91,4	=	10,9	MN/m	= *10* MN/m

7 Conclusion

The structure is checked with Scia engineer, see appendix A and B. The check is based on a maximum of ten frames for each pipe rack and with a maximum frame spacing of six meters. The results of the calculations are as follows.

member check		unity checks ULS	SLS
frame			
columns	HEB180	*0,3*	*1,04*
beams	HEA180	*0,3*	*0,10*
beams			
typical	HEA140	*0,44*	*0,42*
longitudinal	HEA160	*0,70*	*0,89*
platform	UNP180	*0,86*	*0,44*
bracing	L70.7	0,18	

maximum displacement = 24 mm

reaction forces

tension					$R_{z,min}$ =	*-29*	kN
compression					$R_{z,max}$ =	*318*	kN
shear	Wind load perpendicular	R_x =	*31*	kN	R_y =	7,5	kN
	Wind load longitudinal	R_x =	6,8	kN	R_y =	25,6	kN
bending moment	Wind load longitudinal	R_y =	8,8	kN	T_x =	6,2	kNm

Appendix A

Scia report - beams

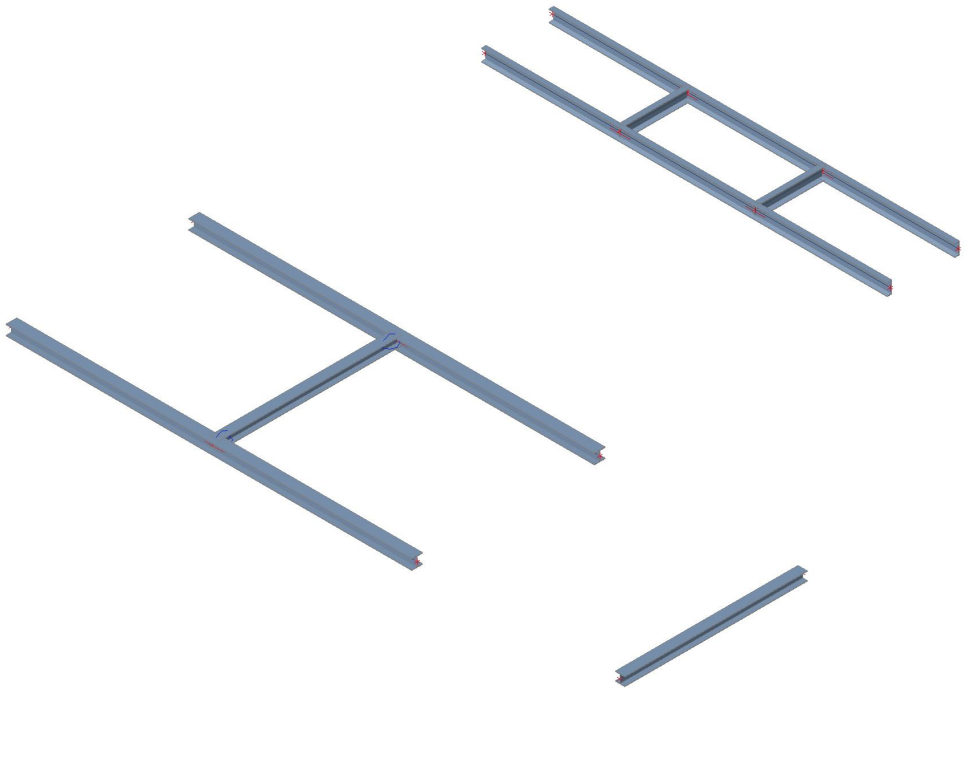
Appendix A

Scia report - beams

1. General

1.1. Project

Licence name	KH Engineering
Project	Neste - Rotterdam terminal expansion
Part	Tank pit 3 - Pipe rack
Description	Beams
Author	LER
Date	06 2021
Structure	General XYZ
No. of nodes :	16
No. of beams :	8
No. of slabs :	0
No. of solids :	0
No. of used profiles :	3
No. of load cases :	9
No. of used materials :	1
Acceleration of gravity [m/s^2]	9,810
National code	EC - EN
National annex	Dutch NEN-EN NA



1.2. Setup manager

Psi factors

Load	Psi0	Psi1	Psi2
CategoryA	0.4	0.5	0.3
CategoryB	0.5	0.5	0.3
CategoryC	0.6	0.7	0.6
CategoryD	0.4	0.7	0.6
CategoryE	1	0.9	0.8
CategoryF	0.7	0.7	0.6
CategoryG	0.7	0.5	0.3
CategoryH	0	0	0
Snow	0	0.2	0
Wind	0.6	0.2	0
Temperature	0.6	0.5	0

Load	Psi0	Psi1	Psi2
Rain water	0	0	0
Construction loads	1	0	0.2

Load combination factors

Permanent action - unfavorable	1,35
Permanent action - favorable [-]	0,90
Leading variable action	1,50
Accompanying variable action	1,50
Reduction factor ksi [-]	0,89
Permanent action - unfavorable	1,00
Permanent action - favorable	1,00
Leading variable action	1,30
Accompanying variable action	1,30

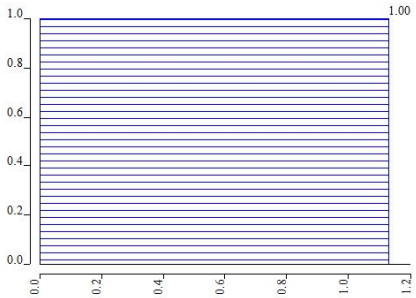
Reliability class

Reliability class	RC2
RC1 [-]	0,90
RC2 [-]	1,00
RC3 [-]	1,10
RC1 [-]	1,00
RC2 [-]	1,00
RC3 [-]	1,00

1.3. Wind pressures

Name	WP1
Input	user
Height / Pressure	0,000[m] / 1,1[kN/m ^{2}]
	1,000[m] / 1,1[kN/m ^{2}]

Drawing



1.4. Materials

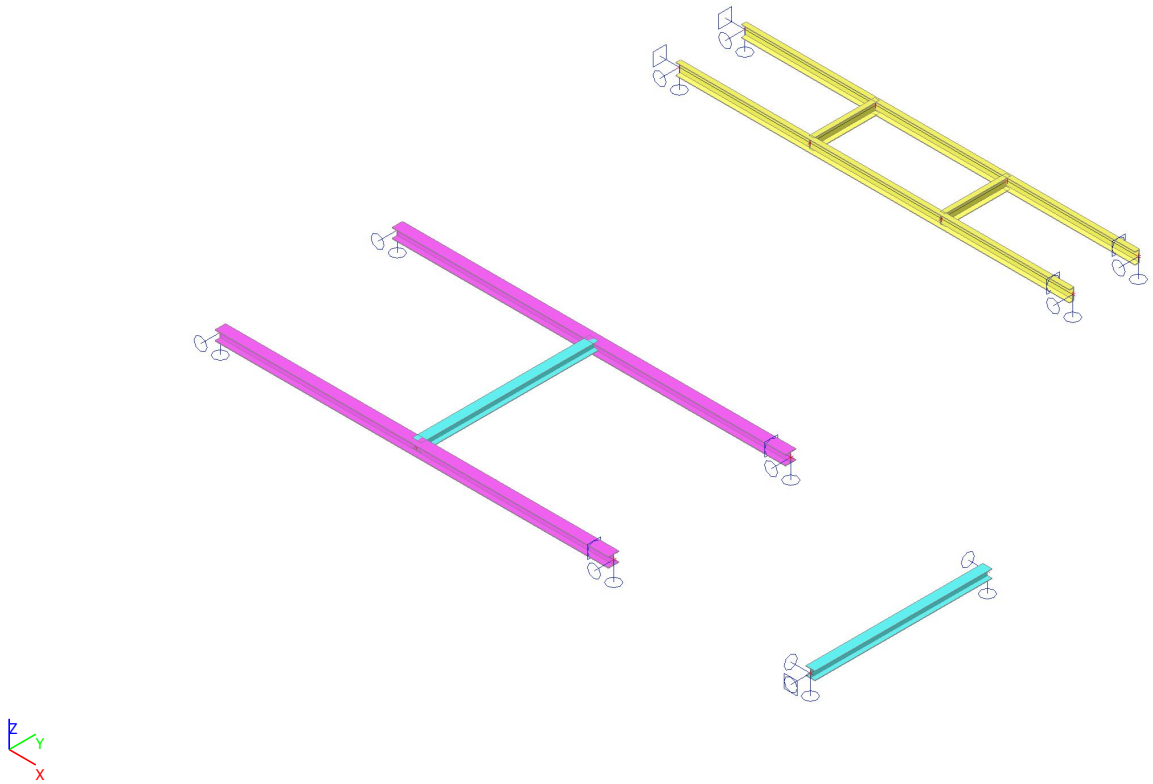
Steel EC3

Name	ρ [kg/m^3]	E_{mod} [MPa] G_{mod} [MPa]	μ α [m/mK]	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
S 355	7850,0	2,1000e+05	0.3	0	40	355,0	490,0	
		8,0769e+04	0,00	40	80	335,0	470,0	

2. Structure

2.1. Cross-sections

Name	Type Detailed	Item material	Fabrication	A [m²]	A_y [m²] A_z [m²]	I_y [m⁴] I_z [m⁴]	$W_{el.y}$ [m³] $W_{el.z}$ [m³]	$W_{pl.y}$ [m³] $W_{pl.z}$ [m³]	Colour
CS1	HEA140	S 355	rolled	3,1400e-03	2,2882e-03 7,8192e-04	1,0300e-05 3,8900e-06	1,5500e-04 5,5600e-05	1,7333e-04 8,5000e-05	
CS2	HEA160	S 355	rolled	3,8800e-03	2,8071e-03 9,8390e-04	1,6700e-05 6,1600e-06	2,2000e-04 7,7000e-05	2,4500e-04 1,1750e-04	
CS3	UNP180	S 355	rolled	2,8000e-03	1,4920e-03 1,4353e-03	1,3500e-05 1,1400e-06	1,5000e-04 2,2400e-05	1,7920e-04 4,2900e-05	



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	6,000	0,000	0,000
N2	0,000	0,000	0,000
N3	6,000	2,700	0,000
N4	0,000	2,700	0,000
N5	3,000	2,700	0,000
N6	3,000	0,000	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N7	9,000	2,700	0,000
N8	9,000	0,000	0,000
N9	2,000	8,000	0,000
N10	6,000	7,000	0,000
N11	0,000	7,000	0,000
N12	6,000	8,000	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N13	0,000	8,000	0,000
N14	2,000	7,000	0,000
N15	4,000	8,000	0,000
N16	4,000	7,000	0,000

2.3. Members

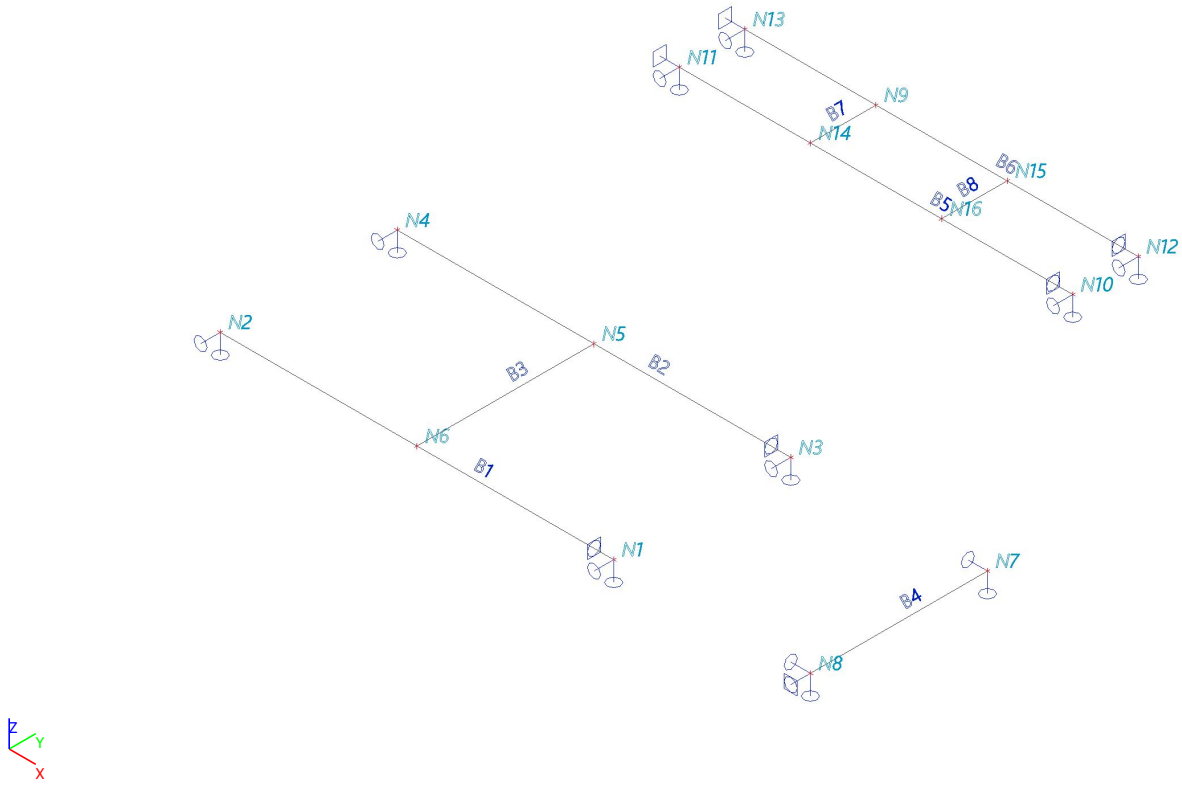
Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - HEA160	S 355	6,000	N1	N2	general (0)
B2	CS2 - HEA160	S 355	6,000	N3	N4	general (0)
B3	CS1 - HEA140	S 355	2,700	N5	N6	general (0)
B4	CS1 - HEA140	S 355	2,700	N7	N8	general (0)
B5	CS3 - UNP180	S 355	6,000	N10	N11	general (0)
B6	CS3 - UNP180	S 355	6,000	N12	N13	general (0)
B7	CS3 - UNP180	S 355	1,000	N9	N14	general (0)
B8	CS3 - UNP180	S 355	1,000	N15	N16	general (0)

2.4. Hinges

Name	Member	Position	ux	uy	uz	fix	fiy	fiz
H1	B3	Both	Rigid	Rigid	Rigid	Rigid	Free	Free

2.5. Nodal supports

Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Free	Free
Sn2	N3	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Free	Free
Sn3	N2	GCS	Standard	Free	Rigid	Rigid	Free	Free	Free
Sn4	N4	GCS	Standard	Free	Rigid	Rigid	Free	Free	Free
Sn5	N7	GCS	Standard	Rigid	Free	Rigid	Free	Free	Free
Sn6	N8	GCS	Standard	Rigid	Rigid	Rigid	Free	Rigid	Free
Sn7	N11	GCS	Standard	Free	Rigid	Rigid	Rigid	Free	Free
Sn8	N13	GCS	Standard	Free	Rigid	Rigid	Rigid	Free	Free
Sn9	N10	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Free	Free
Sn10	N12	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Free	Free

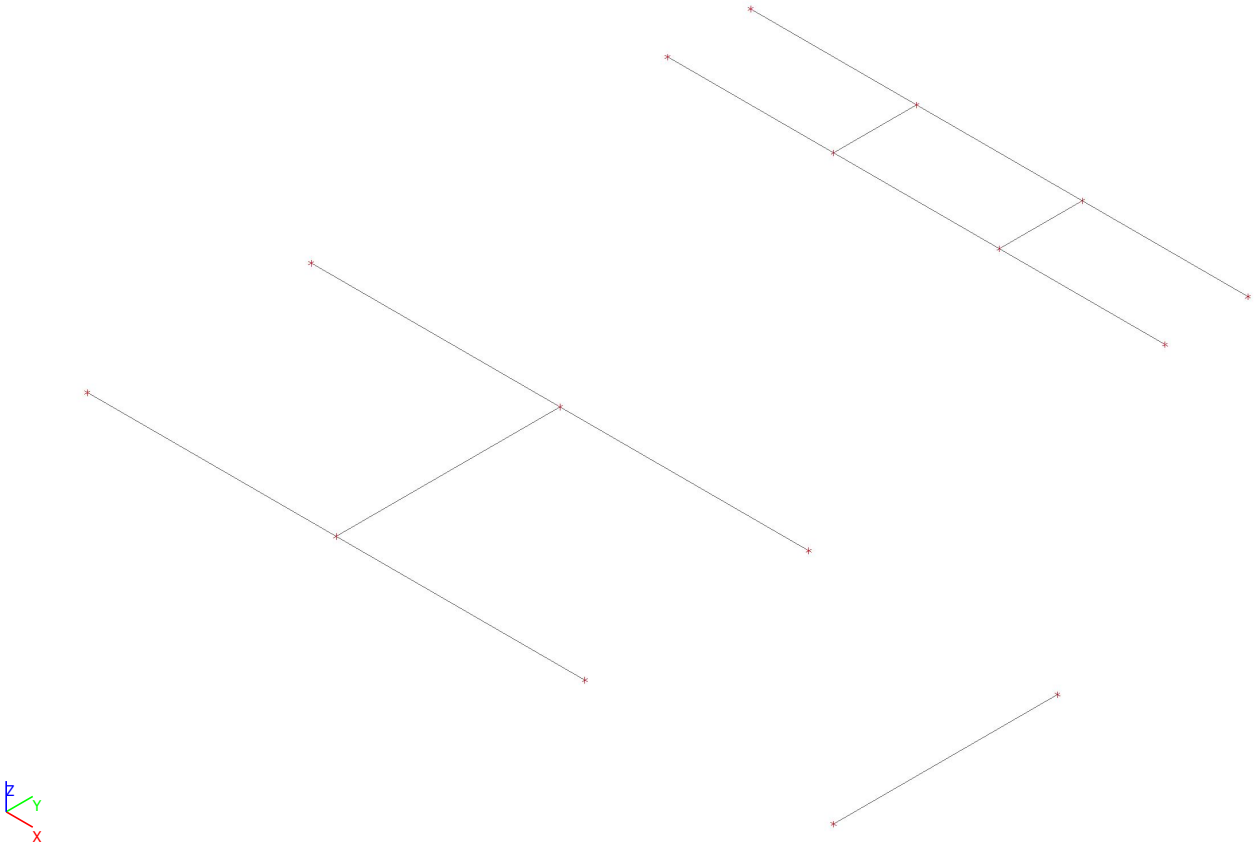


3. Loads

3.1. Load cases

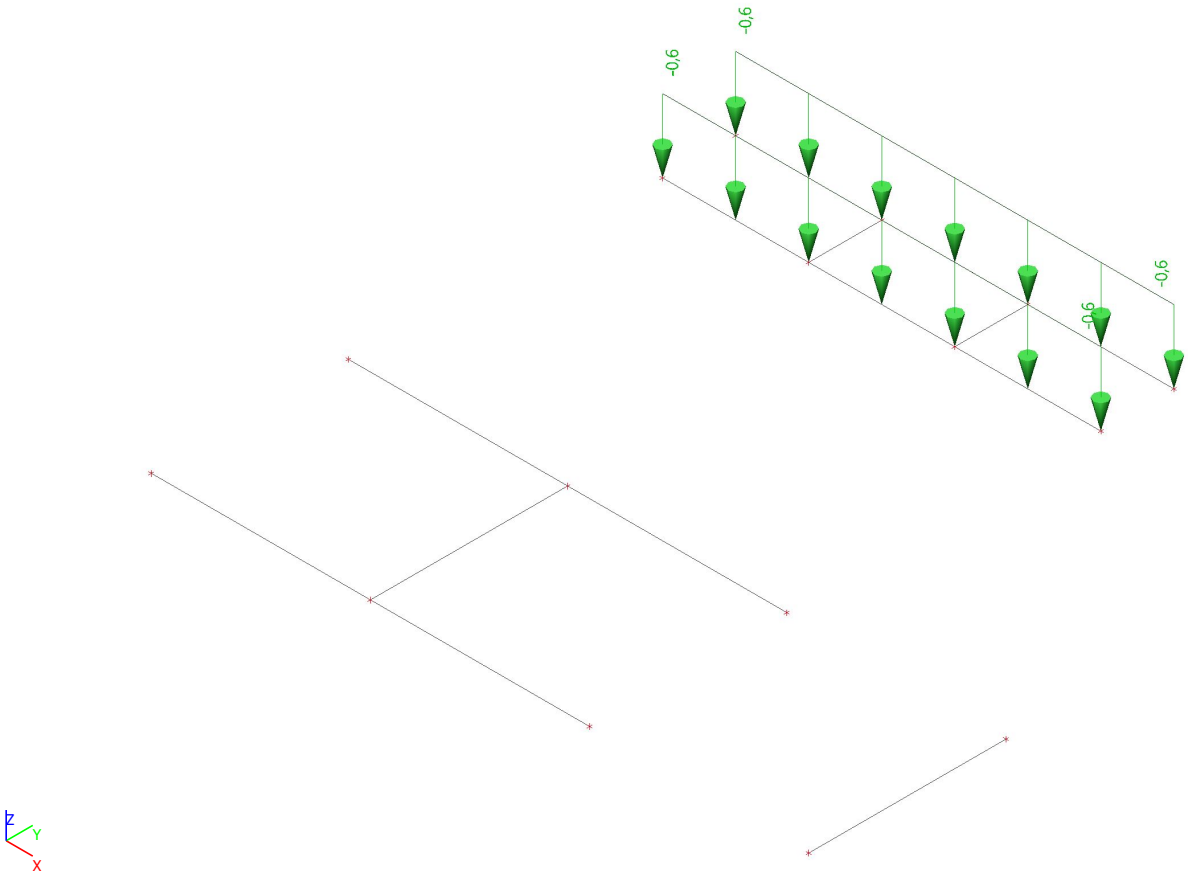
3.1.1. Load cases - DL

Name	Description	Action type	Load type	Load group	Direction
DL	Dead laod - Self weight	Permanent	Self weight	LG1	-Z



3.1.2. Load cases - DLx

Name	Description	Action type	Load type	Load group
DLx	Dead load - platform	Permanent	Standard	LG1

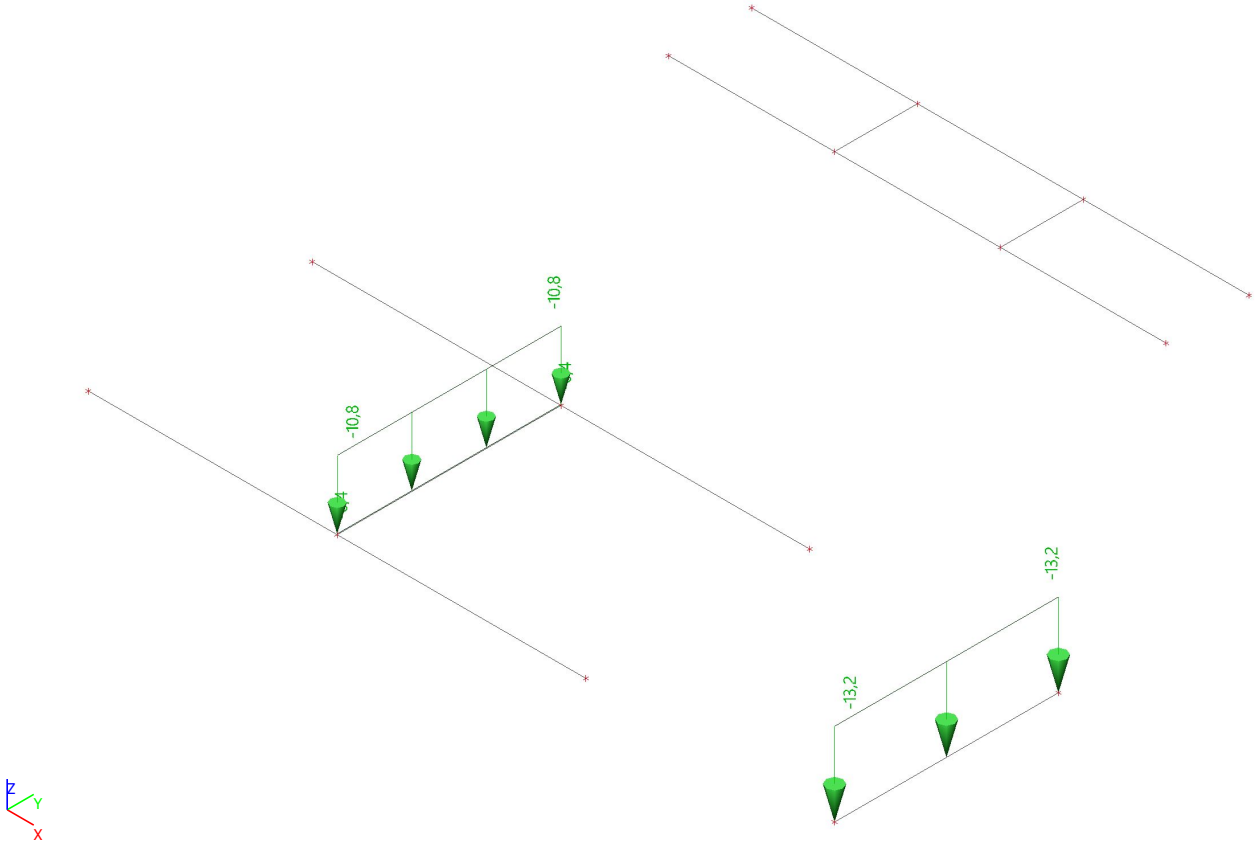


3.1.2.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]	W_1 [m] W_2 [m]
LF12	B5 DLx - Dead load - platform	Force LCS	Z Uniform	-0,6	0.000 1.000	Rela Length	From start	0,000 0,000	
LF13	B6 DLx - Dead load - platform	Force LCS	Z Uniform	-0,6	0.000 1.000	Rela Length	From start	0,000 0,000	

3.1.3. Load cases - EO

Name	Description	Action type	Load type	Load group
EO	Equipment - Operating	Permanent	Standard	LG1



3.1.3.1. Point force in node

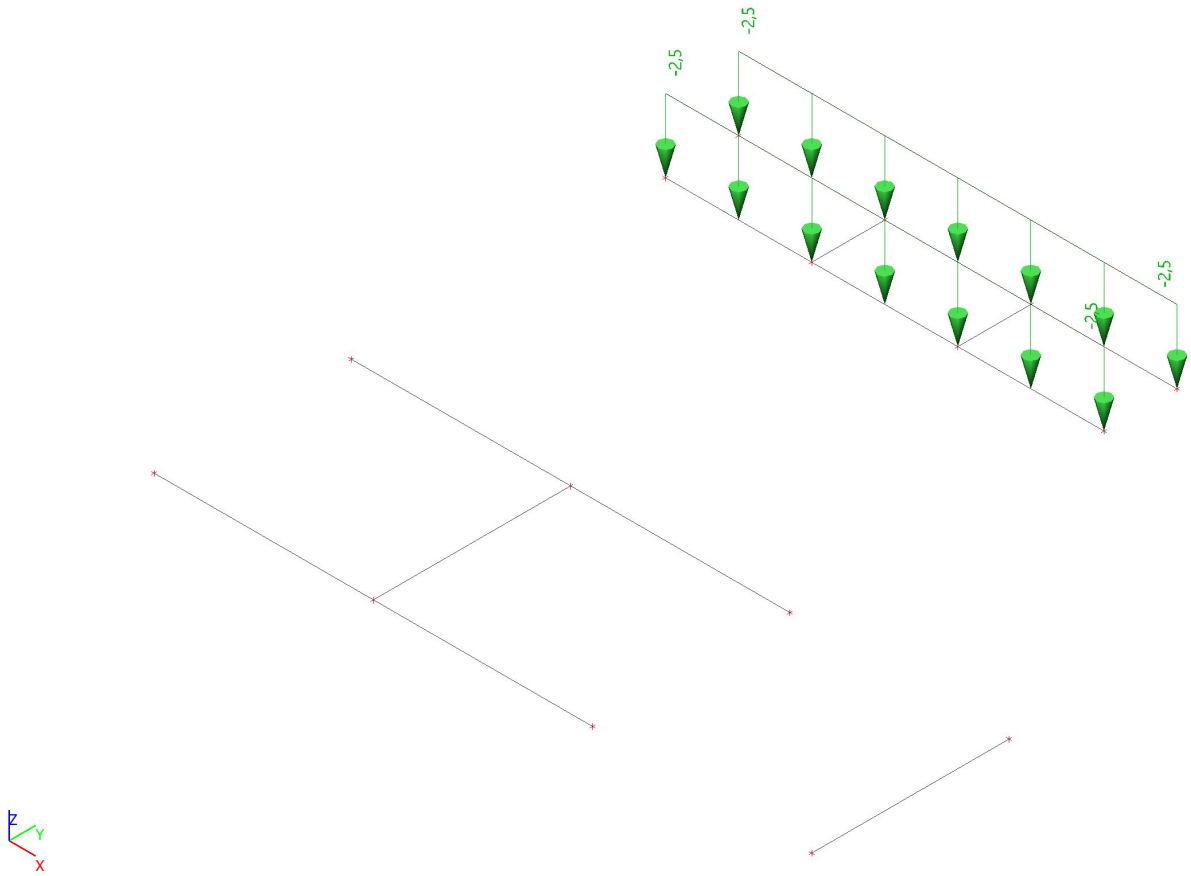
Name	Node	Load case	System	Dir	Type	Value - F [kN]
F2	N6	EO - Equipment - Operating	GCS	Z	Force	-0,4
F3	N5	EO - Equipment - Operating	GCS	Z	Force	-0,4

3.1.3.2. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]	W_1 [m] W_2 [m]
LF1	B3 EO - Equipment - Operating	Force LCS	Z Uniform	-10,8	0.000 1.000	Rela Length	From start	0,000 0,000	
LF2	B4 EO - Equipment - Operating	Force LCS	Z Uniform	-13,2	0.000 1.000	Rela Length	From start	0,000 0,000	

3.1.4. Load cases - LL_q

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL_q	Live load - imposed load	Standard	Variable	Static	LG2	Short	None

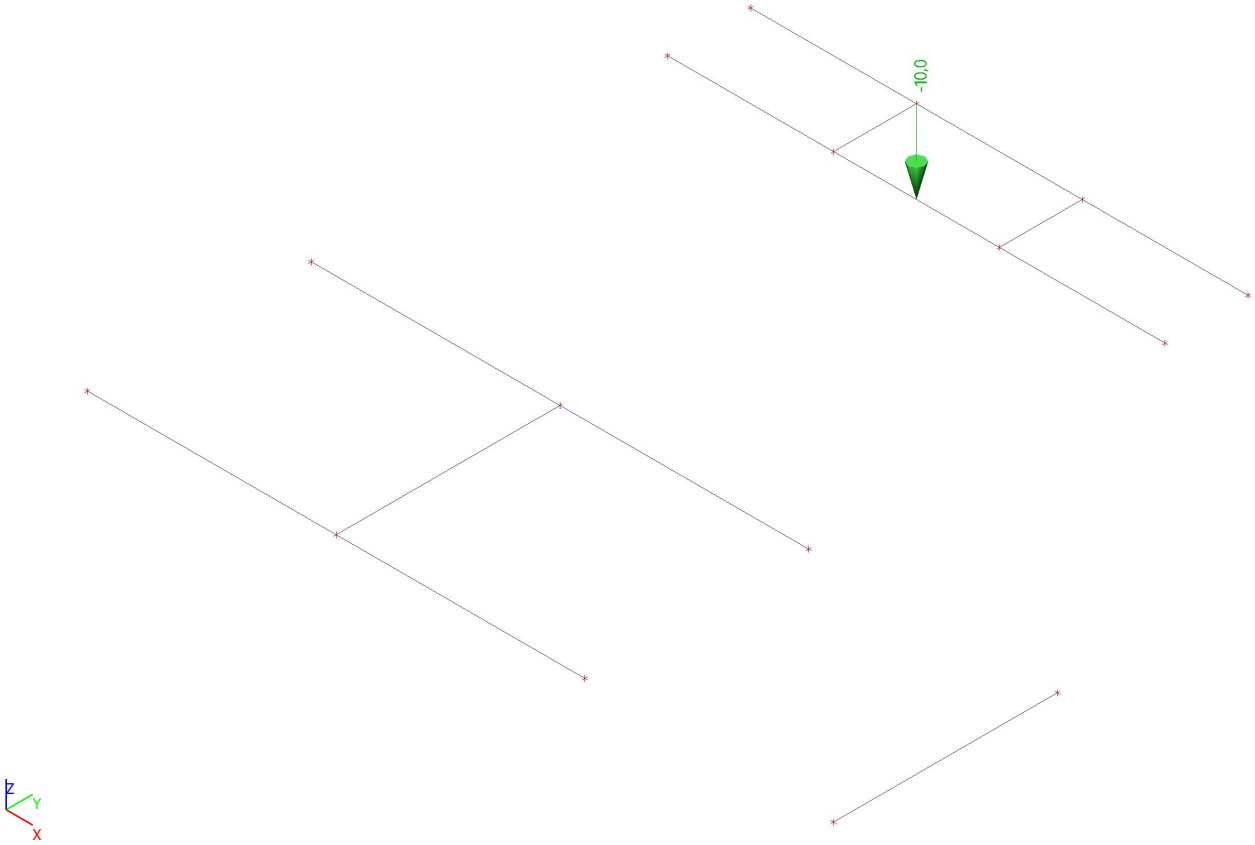


3.1.4.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]	W_1 [m] W_2 [m]
LF10	B6 LL_q - Live load - imposed load	Force LCS	Z Uniform	-2,5	0.000 1.000	Rela Length	From start	0,000 0,000	
LF11	B5 LL_q - Live load - imposed load	Force LCS	Z Uniform	-2,5	0.000 1.000	Rela Length	From start	0,000 0,000	

3.1.5. Load cases - LL_Q

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL_Q	Live load - imposed load	Standard	Variable	Static	LG2	Short	None

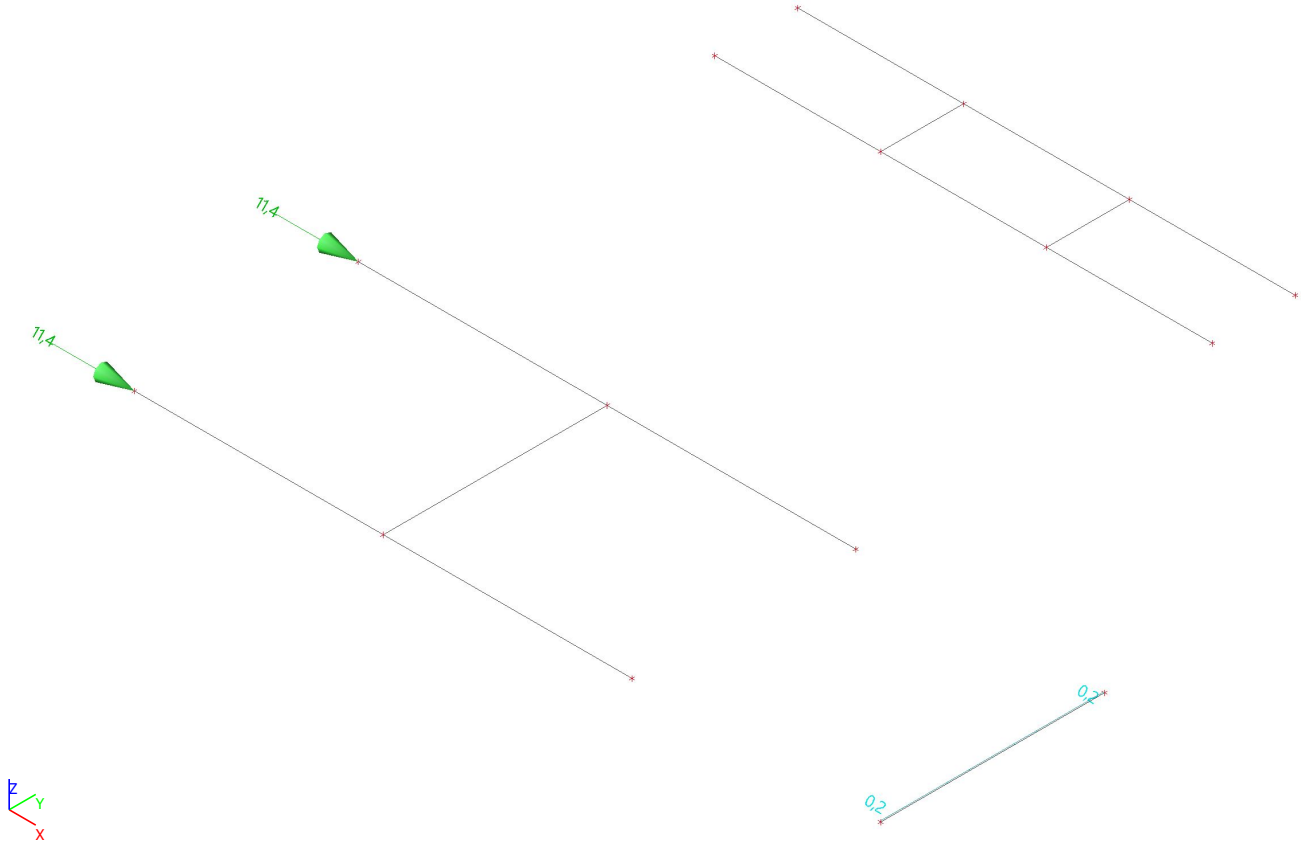


3.1.5.1. Point force on beam

Name	Member Load case	System Dir	Value - F [kN] Type	Pos x	Coor Orig	Rep (n) Regularly
Fb3	B5 LL_Q - Live load - imposed load	GCS Z	-10,0 Force	0.500	Rela From start	1

3.1.6. Load cases - Wx

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
Wx	Wind load	Standard	Variable	Static	LG3	Short	None



3.1.6.1. Point force in node

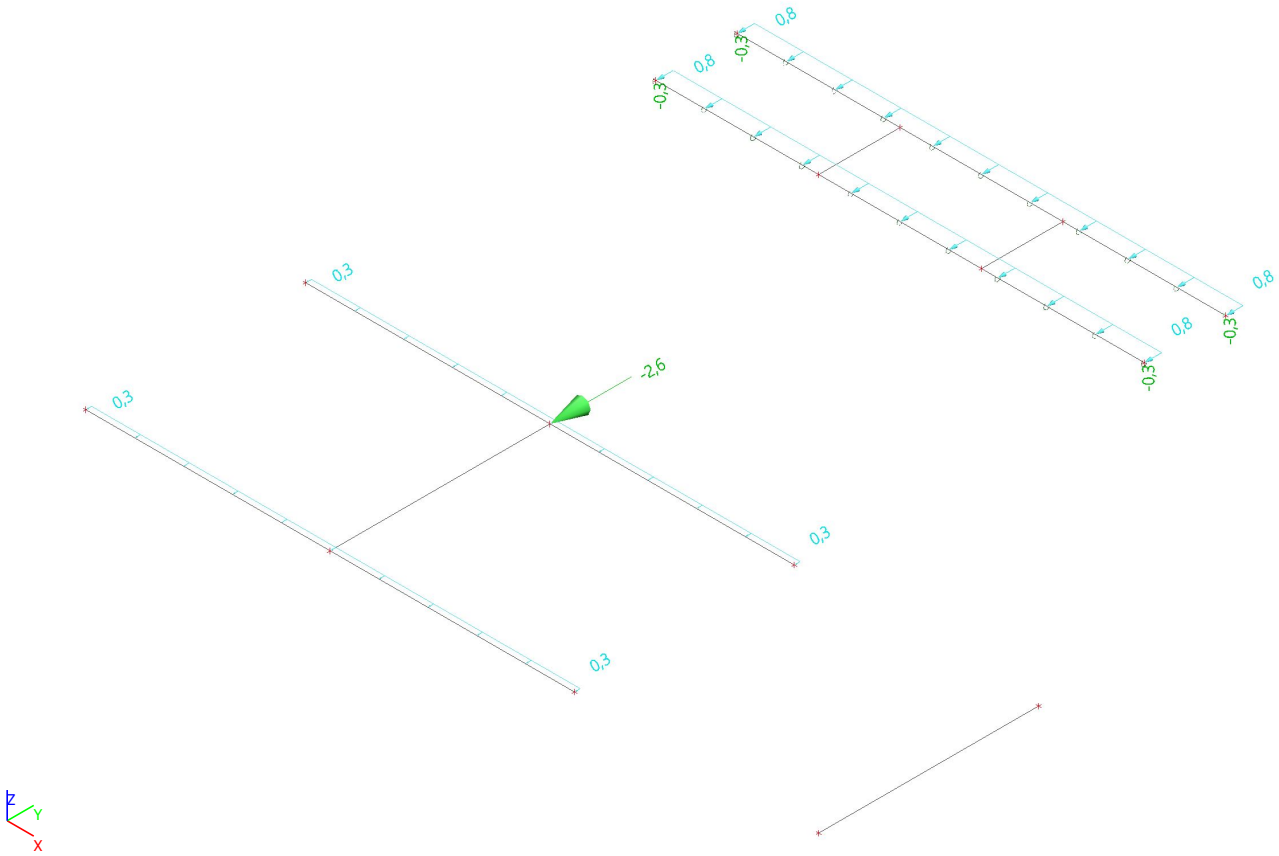
Name	Node	Load case	System	Dir	Type	Value - F [kN]
F6	N2	Wx - Wind load	GCS	X	Force	11,4
F7	N4	Wx - Wind load	GCS	X	Force	11,4

3.1.6.2. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]	W_1 [m] W_2 [m]
LF14	B4 Wx - Wind load	Wind LCS	Y Uniform	0,2 0,2	0.000 1.000	Rela Length	From start	0,000 0,000	0,133

3.1.7. Load cases - Wy

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
Wy	Wind load	Standard	Variable	Static	LG3	Short	None



3.1.7.1. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F8	N5	Wy - Wind load	GCS	Y	Force	-2,6

3.1.7.2. Line force

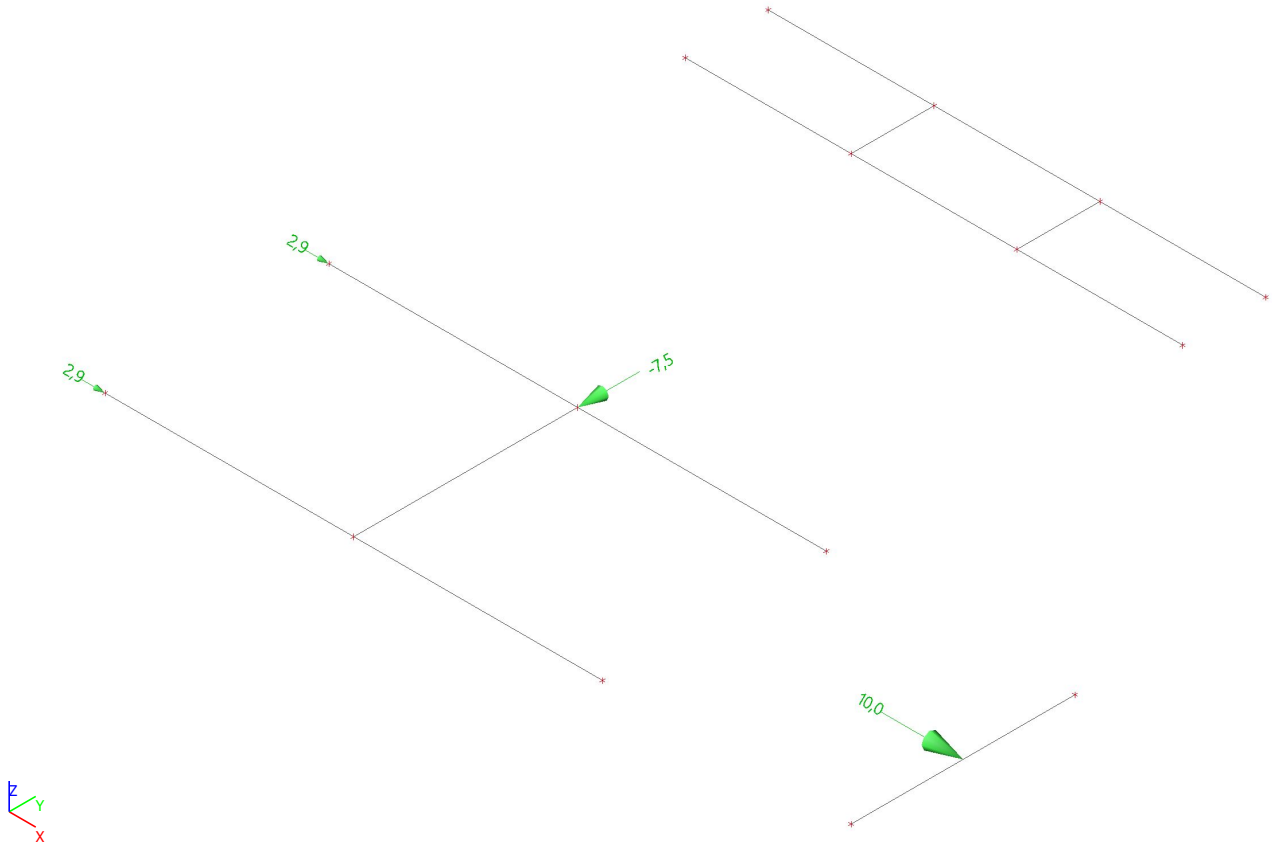
Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]	W_1 [m] W_2 [m]
LF4	B2 Wy - Wind load	Wind LCS	Y Uniform	0,3 0,3	0.000 1.000	Rela Length	From start	0,000 0,000	0,152
LF5	B1 Wy - Wind load	Wind LCS	Y Uniform	0,3 0,3	0.000 1.000	Rela Length	From start	0,000 0,000	0,152
LF7	B5 Wy - Wind load	Wind LCS	Y Uniform	0,8 0,8	0.000 1.000	Rela Length	From start	0,000 0,000	0,455
LF8	B6 Wy - Wind load	Wind LCS	Y Uniform	0,8 0,8	0.000 1.000	Rela Length	From start	0,000 0,000	0,455

3.1.7.3. Line moment

Name	Type System	Dir Distribution	Value - M_1 [kNm/m] Value - M_2 [kNm/m]	Pos x_1 Pos x_2	Coor Loc	Orig
LM1	Moment LCS	Mx Uniform	-0,3	0.000 1.000	Rela Length	From start
LM2	Moment LCS	Mx Uniform	-0,3	0.000 1.000	Rela Length	From start

3.1.8. Load cases - TLs

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
TLs	Temperature load - Stress	Standard	Variable	Static	LG4	Short	None



3.1.8.1. Point force in node

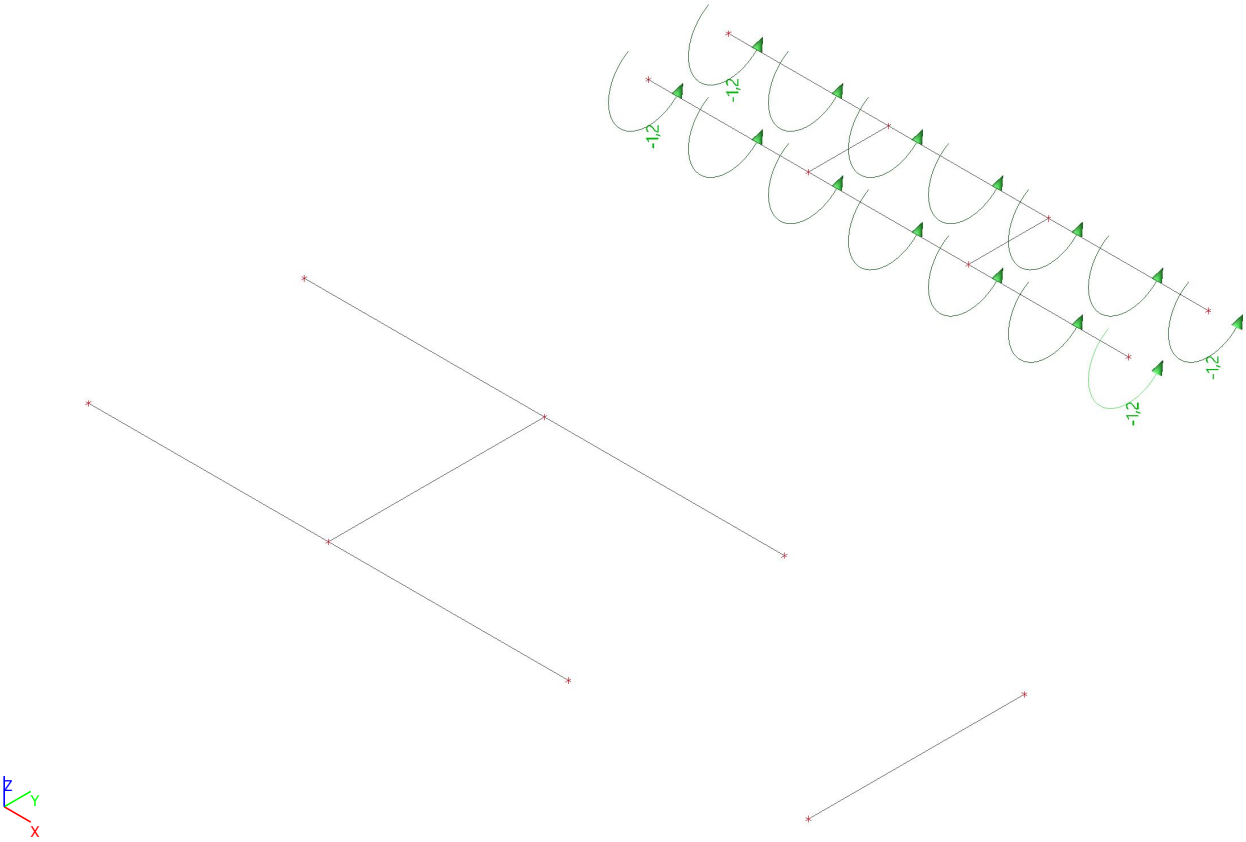
Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N5	TLs - Temperature load - Stress	GCS	Y	Force	-7,5
F4	N2	TLs - Temperature load - Stress	GCS	X	Force	2,9
F5	N4	TLs - Temperature load - Stress	GCS	X	Force	2,9

3.1.8.2. Point force on beam

Name	Member Load case	System Dir	Value - F [kN] Type	Pos x	Coor Orig	Rep (n) Regularly
Fb1	B4 TLs - Temperature load - Stress	GCS X	10,0 Force	0.500	Rela From start	1

3.1.9. Load cases - A

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
A	Dead load - platform	Standard	Variable	Static	LG5	Short	None



3.1.9.1. Line moment

Name	Type System	Dir Distribution	Value - M_1 [kNm/m] Value - M_2 [kNm/m]	Pos x_1 Pos x_2	Coor Loc	Orig
LM3	Moment LCS	Mx Uniform	-1,2	0.000 1.000	Rela Length	From start
LM4	Moment LCS	Mx Uniform	-1,2	0.000 1.000	Rela Length	From start

3.2. Load groups

Name	Load	Relation	Type
LG1	Permanent		
LG2	Variable	Exclusive	Cat B : Offices
LG3	Variable	Exclusive	Wind
LG4	Variable	Exclusive	Temperature
LG5	Accidental	Exclusive	

3.3. Combinations

Name	Description	Type	Load cases	Coeff. [-]
ULS		EN-ULS (STR/GEO) Set B	DL - Dead laod - Self weight DLx - Dead load - platform EO - Equipment - Operating LL_q - Live load - imposed load LL_Q - Live load - imposed load Wx - Wind load Wy - Wind load TLs - Temperature load - Stress	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
Accidental		EN-Accidental 1	DL - Dead laod - Self weight DLx - Dead load - platform EO - Equipment - Operating LL_q - Live load - imposed load LL_Q - Live load - imposed load Wx - Wind load Wy - Wind load TLs - Temperature load - Stress A - Dead load - platform	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
Frequent		EN-SLS Frequent	DL - Dead laod - Self weight DLx - Dead load - platform EO - Equipment - Operating LL_q - Live load - imposed load LL_Q - Live load - imposed load Wx - Wind load Wy - Wind load TLs - Temperature load - Stress	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
Quasi permanent		EN-SLS Quasi-permanent	DL - Dead laod - Self weight DLx - Dead load - platform EO - Equipment - Operating LL_q - Live load - imposed load LL_Q - Live load - imposed load Wx - Wind load Wy - Wind load TLs - Temperature load - Stress	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00

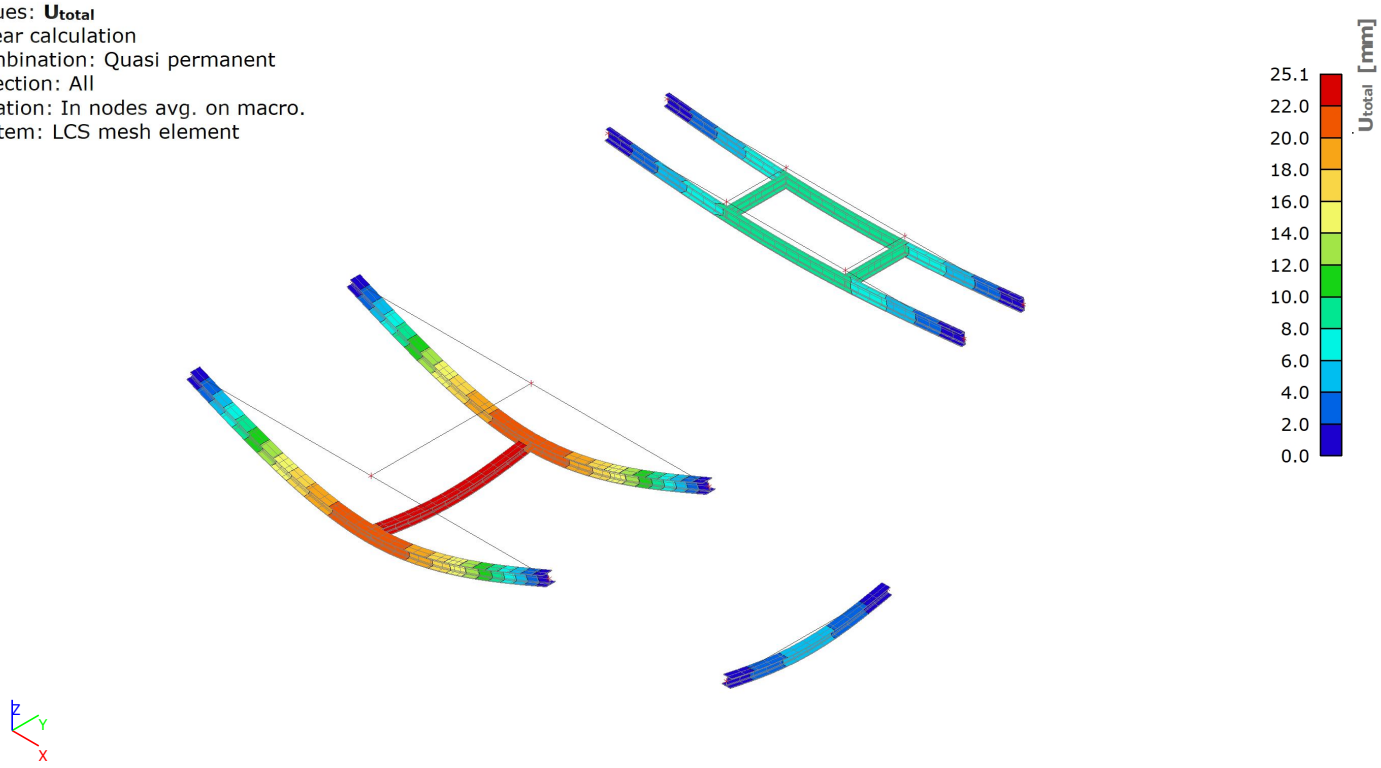
3.4. Result classes

Name	List
All ULS	ULS - EN-ULS (STR/GEO) Set B Accidental - EN-Accidental 1

4. Results

4.1. 3D displacement; U_total

Values: **U_{total}**
Linear calculation
Combination: Quasi permanent
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.2. 1D internal forces

Linear calculation
Load case: DL
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B1	6,000	DL	CS2 - HEA160	0,0	0,0	**-1,1**	0,0	**0,0**	0,0
B1	3,000-	DL	CS2 - HEA160	**0,0**	**0,0**	0,2	**0,0**	**1,8**	**0,0**
B1	0,000	DL	CS2 - HEA160	0,0	0,0	**1,1**	0,0	0,0	**0,0**
B3	2,700	DL	CS1 - HEA140	0,0	0,0	**-0,3**	0,0	**0,0**	0,0
B4	1,350-	DL	CS1 - HEA140	**0,0**	**0,0**	0,0	**0,0**	**0,2**	**0,0**
B3	0,000	DL	CS1 - HEA140	0,0	0,0	**0,3**	0,0	0,0	**0,0**
B5	6,000	DL	CS3 - UNP180	0,0	0,0	**-0,8**	**0,0**	0,0	0,0
B7	0,000	DL	CS3 - UNP180	0,0	0,0	0,1	0,0	**0,0**	0,0
B5	3,000-	DL	CS3 - UNP180	**0,0**	**0,0**	0,0	0,0	**1,2**	**0,0**
B5	0,000	DL	CS3 - UNP180	0,0	0,0	**0,8**	**0,0**	0,0	**0,0**

Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All
Selected sections: Ends

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B2	6,000	ULS/1	CS2 - HEA160	-4,3	**4,2**	-10,3	0,0	**0,0**	**0,0**
B1	6,000	ULS/2	CS2 - HEA160	0,0	0,0	**-11,6**	0,0	0,0	0,0
B1	0,000	ULS/2	CS2 - HEA160	**0,0**	0,0	**11,6**	0,0	0,0	0,0
B2	0,000	ULS/1	CS2 - HEA160	-4,3	**-4,2**	10,3	**-0,1**	0,0	0,0
B1	0,000	ULS/1	CS2 - HEA160	-4,3	-4,1	10,3	**0,1**	0,0	0,0
B1	0,000	ULS/3	CS2 - HEA160	**-19,7**	-1,7	10,3	0,0	0,0	**0,0**
B4	0,000	ULS/4	CS1 - HEA140	0,0	**-7,8**	21,8	0,0	0,0	0,0
B4	2,700	ULS/4	CS1 - HEA140	**0,0**	**7,8**	-21,8	**0,0**	**0,0**	**0,0**
B4	2,700	ULS/2	CS1 - HEA140	0,0	0,0	**-24,5**	0,0	0,0	0,0
B4	0,000	ULS/2	CS1 - HEA140	0,0	0,0	**24,5**	0,0	0,0	0,0
B3	0,000	ULS/1	CS1 - HEA140	**-6,8**	0,0	17,9	0,0	0,0	**0,0**
B5	0,000	ULS/5	CS3 - UNP180	**-0,1**	-3,8	4,6	0,5	0,0	0,0
B6	0,000	ULS/5	CS3 - UNP180	**0,1**	-3,8	1,2	0,5	0,0	0,0
B7	0,000	ULS/5	CS3 - UNP180	0,0	**-9,3**	-1,5	0,0	0,8	4,7
B5	6,000	ULS/6	CS3 - UNP180	0,0	2,3	**-15,1**	-0,3	0,0	0,0
B5	0,000	ULS/6	CS3 - UNP180	0,0	-2,3	**15,1**	0,3	0,0	0,0
B6	6,000	Accidental/7	CS3 - UNP180	0,0	0,5	2,6	**-1,4**	0,0	0,0
B6	0,000	Accidental/7	CS3 - UNP180	0,0	-0,5	-2,6	**1,4**	0,0	0,0
B7	1,000	Accidental/8	CS3 - UNP180	0,0	-1,2	-5,1	0,1	**-2,5**	-0,6
B7	0,000	Accidental/8	CS3 - UNP180	0,0	-1,2	-4,9	0,1	**2,5**	0,6
B8	0,000	ULS/5	CS3 - UNP180	0,0	9,4	-1,5	0,0	0,8	**-4,7**
B8	1,000	ULS/5	CS3 - UNP180	0,0	**9,4**	-1,8	0,0	-0,8	**4,7**

Name	Combination key
ULS/1	1.20*DL + 1.20*EO + 0.90*Wy + 1.50*TLs + 1.20*DLx
ULS/2	1.35*DL + 1.35*EO + 1.35*DLx
ULS/3	1.20*DL + 1.20*EO + 0.90*TLs + 1.20*DLx + 1.50*Wx
ULS/4	1.20*DL + 1.20*EO + 1.50*TLs + 1.20*DLx + 0.90*Wx
ULS/5	1.20*DL + 1.20*EO + 1.50*Wy + 1.20*DLx
ULS/6	1.20*DL + 1.20*EO + 0.90*Wy + 1.50*LL_q + 1.20*DLx
Accidental/7	DL + EO + 0.20*Wy + DLx + A + 0.30*LL_Q
Accidental/8	DL + EO + 0.20*Wy + DLx + A

4.3. Reactions

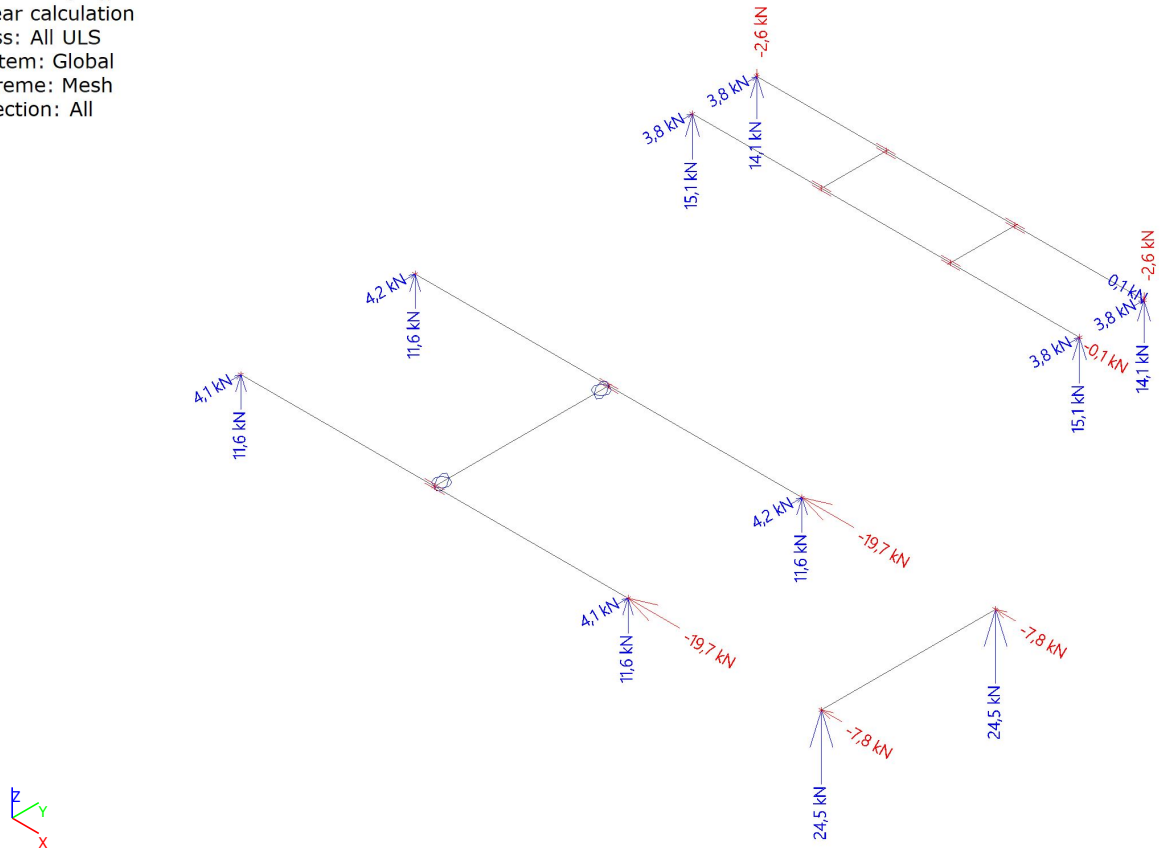
Linear calculation
Class: All ULS
System: Global
Extreme: Global
Selection: All

Nodal reactions

Name	Case	R_x [kN]	R_y [kN]	R_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]	e_x [mm]	e_y [mm]
Sn10/N12	ULS/1	**0,1**	3,8	1,2	-0,5	**0,0**	**0,0**	-384,7	0,0
Sn8/N13	Accidental/2	0,0	0,5	**-2,6**	-1,4	0,0	0,0	533,7	0,0
Sn5/N7	ULS/3	0,0	**0,0**	**24,5**	0,0	0,0	0,0	0,0	0,0
Sn8/N13	Accidental/4	0,0	0,5	-2,6	**-1,4**	0,0	0,0	545,8	0,0
Sn2/N3	ULS/5	-4,3	**4,2**	10,3	**0,1**	0,0	0,0	6,2	0,0
Sn1/N1	ULS/6	**-19,7**	1,7	10,3	0,0	0,0	**0,0**	-3,1	0,0

Name	Combination key
ULS/1	1.20*DL + 1.20*EO + 1.50*Wy + 1.20*DLx
Accidental/2	DL + EO + 0.20*Wy + DLx + A
ULS/3	1.35*DL + 1.35*EO + 1.35*DLx
Accidental/4	DL + EO + 0.20*Wy + DLx + A + 0.30*LL_Q
ULS/5	1.20*DL + 1.20*EO + 0.90*Wy + 1.50*TLs + 1.20*DLx
ULS/6	1.20*DL + 1.20*EO + 0.90*TLs + 1.20*DLx + 1.50*Wx

Values: R_x, R_y, R_z
Linear calculation
Class: All ULS
System: Global
Extreme: Mesh
Selection: All



5. Check

5.1. Steel slenderness

Linear calculation

Member	CS Name	Part	Sway y	Sway z	Ly [m]	Lz [m]	ky [-]	kz [-]	ly [m]	lz [m]	Lam y [-]	Lam z [-]	lyz [m]	l LTB [m]
B1	CS2	1	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	91,46	150,58	6,000	6,000
B1	CS2	2	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	91,46	150,58	6,000	6,000
B2	CS2	1	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	91,46	150,58	6,000	6,000
B2	CS2	2	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	91,46	150,58	6,000	6,000
B3	CS1	1	Yes	No	2,700	2,700	1,00	1,00	2,700	2,700	47,14	76,71	2,700	2,700
B4	CS1	1	Yes	No	2,700	2,700	1,00	1,00	2,700	2,700	47,14	76,71	2,700	2,700
B5	CS3	1	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	86,41	297,36	6,000	2,000
B5	CS3	2	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	86,41	297,36	6,000	2,000
B5	CS3	3	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	86,41	297,36	6,000	2,000
B6	CS3	1	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	86,41	297,36	6,000	2,000
B6	CS3	2	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	86,41	297,36	6,000	2,000
B6	CS3	3	Yes	No	6,000	6,000	1,00	1,00	6,000	6,000	86,41	297,36	6,000	2,000
B7	CS3	1	Yes	No	1,000	1,000	1,00	1,00	1,000	1,000	14,40	49,56	1,000	1,000
B8	CS3	1	Yes	No	1,000	1,000	1,00	1,00	1,000	1,000	14,40	49,56	1,000	1,000

5.2. EC-EN 1993 Steel check ULS

Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All
There are 1 warnings on selected members. 1 of them are shown.
Overall Unity Check

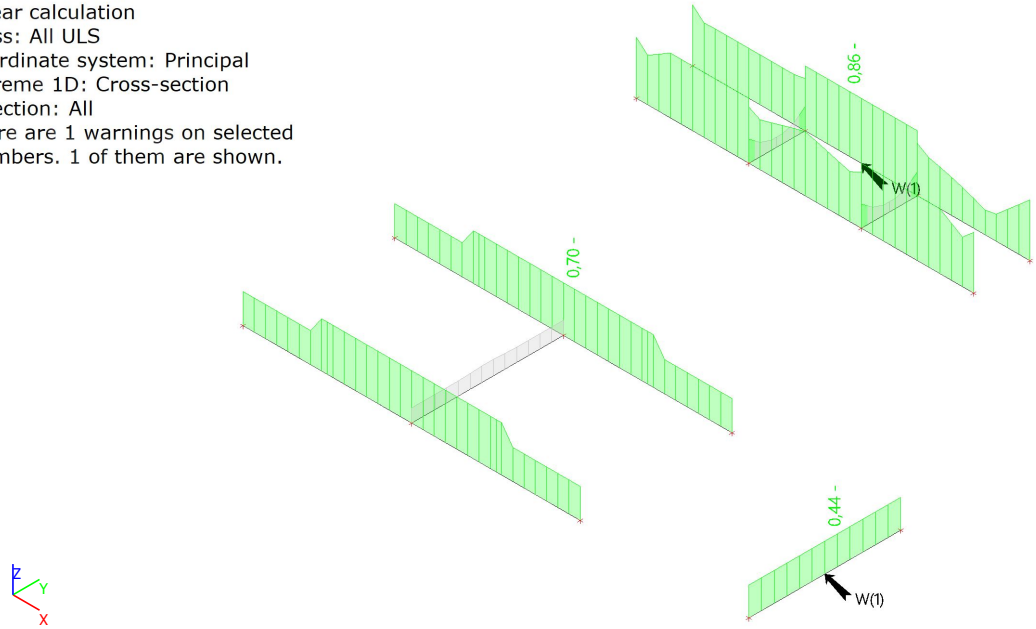
Name	dx [m]	Case	Cross-section	Material	$UC_{Overall}$ [-]	UC_{Sec} [-]	UC_{Stab} [-]	Errors, warnings, notes
B2	3,000-	ULS/1	CS2 - HEA160	S 355	**0,70**	0,39	0,70	
B4	1,350-	ULS/2	CS1 - HEA140	S 355	**0,44**	0,40	0,44	W30
B6	3,000+	ULS/3	CS3 - UNP180	S 355	**0,86**	0,35	0,86	W30

Name	Combination key
ULS/1	1.20*DL + 1.20*EO + 0.90*Wy + 1.50*TLs + 1.20*DLx
ULS/2	1.20*DL + 1.20*EO + 1.50*TLs + 1.20*DLx + 0.90*Wx
ULS/3	1.20*DL + 1.20*EO + 0.90*Wy + 1.50*LL_q + 1.20*DLx

E/W/N	Present on members
W30	B3, B4, B5, B6, B7, B8

E/W/N	Description
W30	Not all conditions of the Dutch NEN-EN NA (Art. NB.NB.1) are fulfilled, therefore the standard EC-EN approach is used.

Values: **$UC_{Overall}$**
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All
There are 1 warnings on selected members. 1 of them are shown.



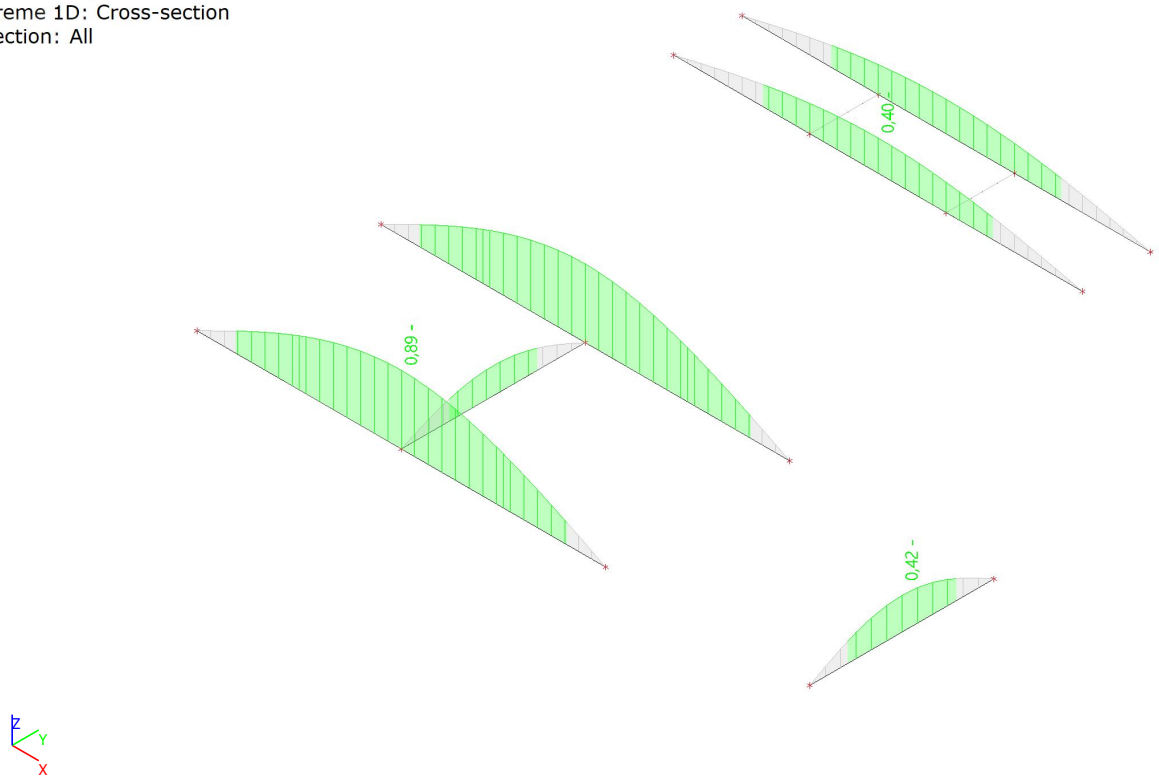
5.3. EC-EN 1993 Steel Check SLS - wtot

Linear calculation
Combination: Quasi permanent
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All
Deformation u_z

Name	dx [m]	Case	Cross-section	$u_{z,max}$ [mm]	$u_{z,var}$ [mm]	Lim. $u_{z,max}$ [mm]	Lim. $u_{z,var}$ [mm]	Check $u_{z,max}$ [-]	Check $u_{z,var}$ [-]	Camber dx u_z [mm]	Camber [mm]	Check u_z [-]
B1	3,000-	Quasi permanent/1	CS2 - HEA160	-21,4	-	24,0	18,0	**0,89**	-	-	-	**0,89**
B4	1,350-	Quasi permanent/1	CS1 - HEA140	-4,5	-	10,8	8,1	**0,42**	-	-	-	**0,42**
B5	3,000-	Quasi permanent/2	CS3 - UNP180	-9,6	-4,7	24,0	18,0	**0,40**	0,26	-	-	**0,40**

Name	Combination key
Quasi permanent/1	DL + EO + DLx
Quasi permanent/2	DL + EO + DLx + 0.30*LL_Q

Values: **Check $u_{z,max}$**
Linear calculation
Combination: Quasi permanent
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All



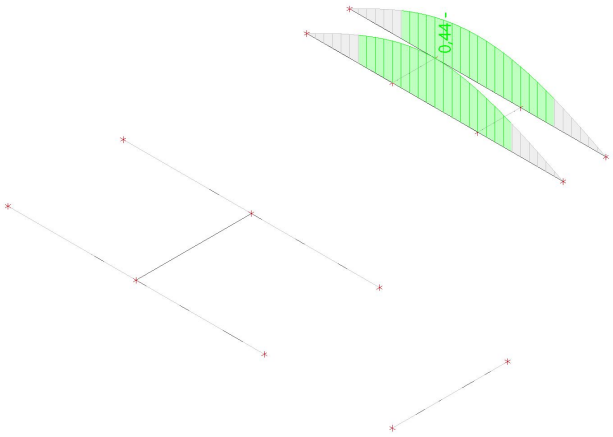
5.4. EC-EN 1993 Steel Check SLS - w3

Linear calculation
Combination: Frequent
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All
Overall Unity Check

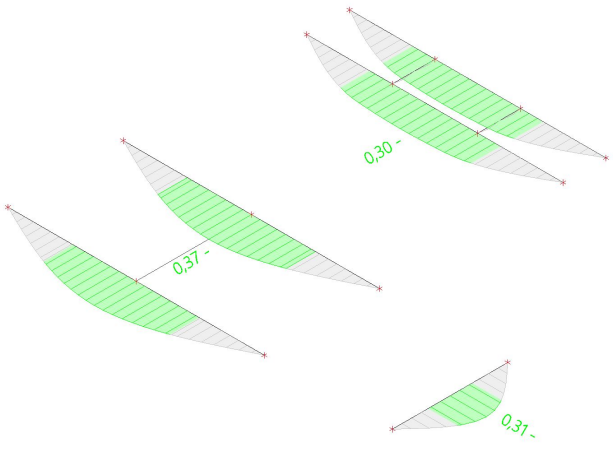
Name	dx [m]	Case	Cross-section	$u_{y,max}$ [mm] $u_{z,max}$ [mm]	$u_{y,var}$ [mm] $u_{z,var}$ [mm]	Lim. $u_{y,max}$ [mm] Lim. $u_{z,max}$ [mm]	Lim. $u_{y,var}$ [mm] Lim. $u_{z,var}$ [mm]	Check $u_{y,max}$ [-] Check $u_{z,max}$ [-]	Check $u_{y,var}$ [-] Check $u_{z,var}$ [-]	Camber dx u_z [mm] Camber [mm]	Check Overall [-]
B2	3,000-	Frequent/1	CS2 - HEA160	6,6 -21,4	6,6 0,0	24,0 24,0	18,0 18,0	0,27 0,89	**0,37** **0,00**	- -	**0,89**
B4	1,350-	Frequent/1	CS1 - HEA140	2,5 -4,5	2,5 0,0	10,8 10,8	8,1 8,1	0,23 0,42	**0,31** **0,00**	- -	**0,42**
B5	3,000-	Frequent/2	CS3 - UNP180	5,4 -5,5	5,4 -0,6	24,0 24,0	18,0 18,0	0,22 0,23	**0,30** 0,03	- -	0,30
B5	3,000-	Frequent/3	CS3 - UNP180	0,0 -12,7	0,0 -7,8	24,0 24,0	18,0 18,0	0,00 0,53	0,00 **0,44**	- -	**0,53**

Name	Combination key
Frequent/1	DL + EO + 0.50*TLs + DLx
Frequent/2	DL + EO + 0.20*Wy + DLx
Frequent/3	DL + EO + DLx + 0.50*LL_Q

Values: **Check $u_{z,var}$**
Linear calculation
Combination: Frequent
Coordinate system: Principal
Extreme 1D: Global
Selection: All



Values: **Check $u_{y,var}$**
Linear calculation
Combination: Frequent
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All



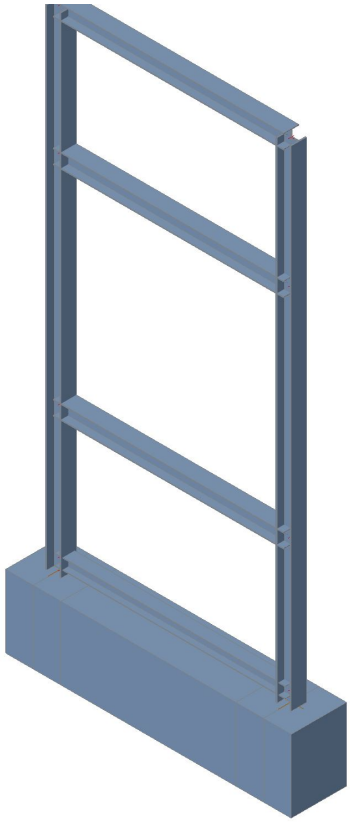
Appendix B

Scia report - frames

1. General

1.1. Project

Licence name	KH Engineering
Project	Neste - Rotterdam terminal expansion
Part	Tank pit 3 - pipe rack
Description	Frame
Author	LER
Date	06 - 2021
Structure	Frame XZ
No. of nodes :	14
No. of beams :	9
No. of slabs :	0
No. of solids :	0
No. of used profiles :	5
No. of load cases :	15
No. of used materials :	2
Acceleration of gravity [m/s^2]	9,810
National code	EC - EN
National annex	Dutch NEN-EN NA



1.2. Setup manager

Psi factors

Load	Psi0	Psi1	Psi2
CategoryA	0.4	0.5	0.3
CategoryB	0.5	0.5	0.3
CategoryC	0.6	0.7	0.6
CategoryD	0.4	0.7	0.6
CategoryE	1	0.9	0.8
CategoryF	0.7	0.7	0.6
CategoryG	0.7	0.5	0.3
CategoryH	0	0	0
Snow	0	0.2	0
Wind	0.6	0.2	0
Temperature	0.6	0.5	0
Rain water	0	0	0
Construction loads	1	0	0.2

Load combination factors

Permanent action - unfavorable	1,35
Permanent action - favorable [-]	0,90
Leading variable action	1,50
Accompanying variable action	1,50
Reduction factor ksi [-]	0,89
Permanent action - unfavorable	1,00
Permanent action - favorable	1,00
Leading variable action	1,30
Accompanying variable action	1,30

Reliability class

Reliability class	RC2
RC1 [-]	0,90
RC2 [-]	1,00
RC3 [-]	1,10
RC1 [-]	1,00
RC2 [-]	1,00
RC3 [-]	1,00

1.3. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa] G_{mod} [MPa]	μ α [m/mK]	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
S 355	7850,0	2,1000e+05 8,0769e+04	0.3 0,00	0 40	40 80	355,0 335,0	490,0 470,0	

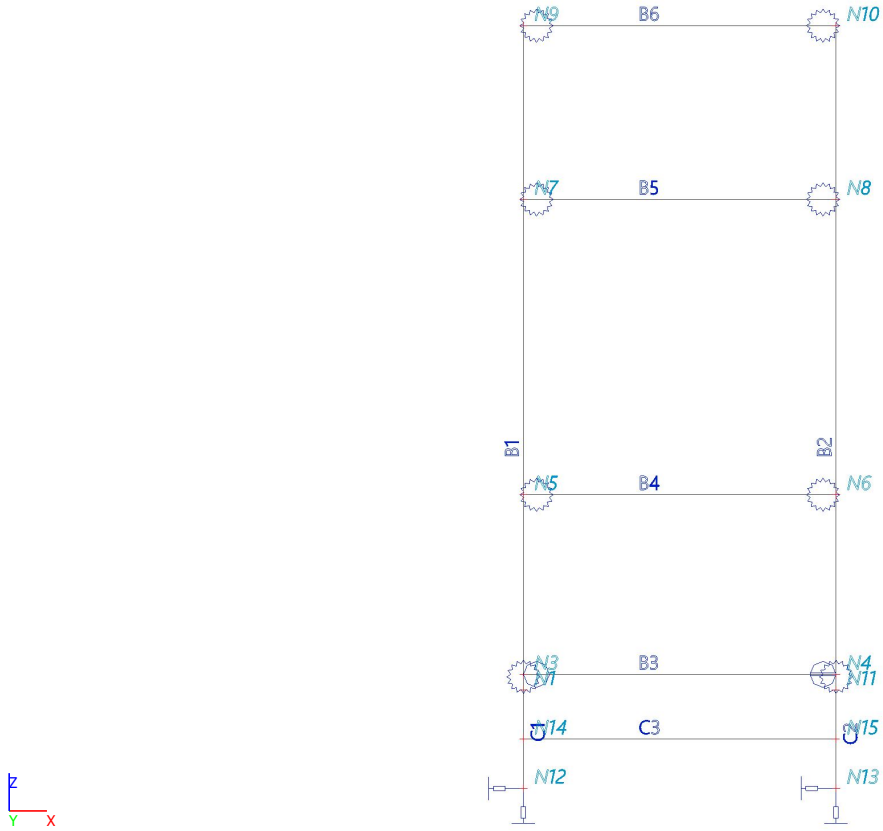
Name	Type	ρ [kg/m³]	Density in fresh state [kg/m³]	E_{mod} [MPa]	μ	α [m/mK]	$f_{c.k.28}$ [MPa]	Colour
C30/37	Concrete	2500,0	2600,0	3,2800e+04	0.2	0,00	30,00	

Explanations of symbols	
Density in fresh state	The value in the density in fresh state property is used only in case a composite deck is input and its self-weight load is taken into account.

2. Structure

2.1. Cross-sections

Name	Type Detailed	Item material	Fabrication	A [m²]	A_y [m²] A_z [m²]	I_y [m⁴] I_z [m⁴]	$W_{el.y}$ [m³] $W_{el.z}$ [m³]	$W_{pl.y}$ [m³] $W_{pl.z}$ [m³]	Colour
CS1	HEB180	S 355	rolled	6,5250e-03	4,8159e-03 1,6236e-03	3,8310e-05 1,3630e-05	4,2570e-04 1,5140e-04	4,8140e-04 2,3100e-04	
CS2	HEA140	S 355	rolled	3,1400e-03	2,2882e-03 7,8192e-04	1,0300e-05 3,8900e-06	1,5500e-04 5,5600e-05	1,7333e-04 8,5000e-05	
CS4	HEA180	S 355	rolled	4,5300e-03	3,2772e-03 1,0992e-03	2,5100e-05 9,2500e-06	2,9400e-04 1,0300e-04	3,2500e-04 1,5667e-04	
CS5	Rectangle 650; 650	C30/37	concrete	4,2250e-01	3,5245e-01 3,5245e-01	1,4876e-02 1,4876e-02	4,5771e-02 4,5771e-02	0,0000e+00 0,0000e+00	
CS6	Rectangle 850; 650	C30/37	concrete	5,5250e-01	4,6104e-01 4,6077e-01	3,3265e-02 1,9453e-02	7,8271e-02 5,9854e-02	0,0000e+00 0,0000e+00	



2.2. Nodes

Name	Coord X [m]	Coord Z [m]
N1	0,000	0,000
N3	0,000	0,134
N4	2,700	0,134
N5	0,000	1,685

Name	Coord X [m]	Coord Z [m]
N6	2,700	1,685
N7	0,000	4,234
N8	2,700	4,234
N9	0,000	5,734

Name	Coord X [m]	Coord Z [m]
N10	2,700	5,734
N11	2,700	0,000
N12	0,000	-0,850
N13	2,700	-0,850

Name	Coord X [m]	Coord Z [m]
N14	0,000	-0,425
N15	2,700	-0,425

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - HEB180	S 355	5,734	N1	N9	general (0)
B2	CS1 - HEB180	S 355	5,734	N11	N10	general (0)
B3	CS2 - HEA140	S 355	2,700	N3	N4	general (0)
B4	CS4 - HEA180	S 355	2,700	N5	N6	general (0)
B5	CS4 - HEA180	S 355	2,700	N7	N8	general (0)
B6	CS4 - HEA180	S 355	2,700	N9	N10	general (0)

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
C1	CS5 - Rectangle (650; 650)	C30/37	0,850	N1	N12	general (0)
C2	CS5 - Rectangle (650; 650)	C30/37	0,850	N11	N13	general (0)
C3	CS6 - Rectangle (850; 650)	C30/37	2,700	N14	N15	general (0)

2.4. Hinges

Member	Name	Position	ux	uy	uz	fix	fiy	Stiff - fiy [MNm/rad]	fiz
B1	H7	Begin	Rigid		Rigid		Flexible	1,5000e+01	
B2	H8	Begin	Rigid		Rigid		Flexible	1,5000e+01	
B3	H2	Begin	Rigid		Rigid		Free		
B3	H3	End	Free		Rigid		Free		
B4	H5	Both	Rigid		Rigid		Flexible	2,2500e+01	
B5	H6	Both	Rigid		Rigid		Flexible	2,2500e+01	
B6	H4	Both	Rigid		Rigid		Flexible	1,2500e+01	

2.5. Nodal supports

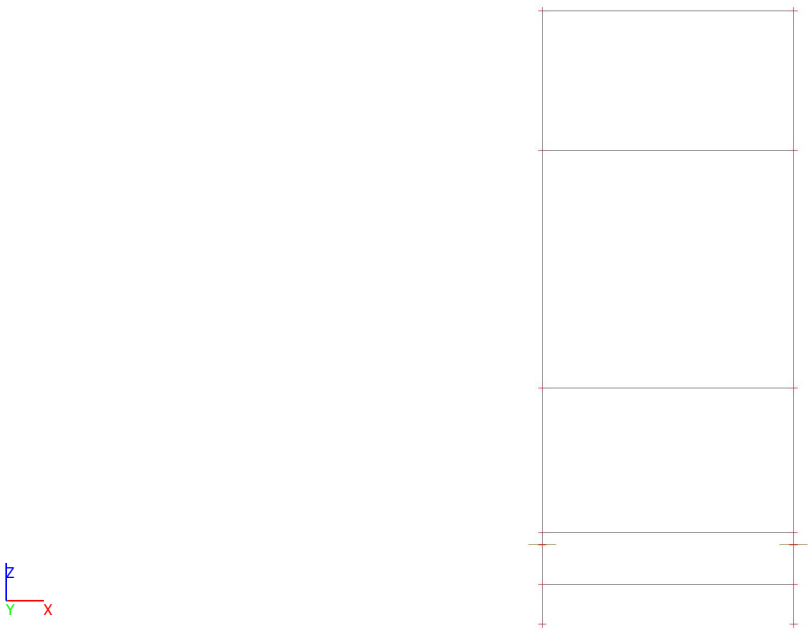
Name	Node	System	Type	X	Z	Stiffness Z [MN/m]	Ry
Sn1	N12	GCS	Standard	Flexible	Flexible	5,0000e+01	Free
Sn2	N13	GCS	Standard	Flexible	Flexible	5,0000e+01	Free

3. Loads

3.1. Load cases

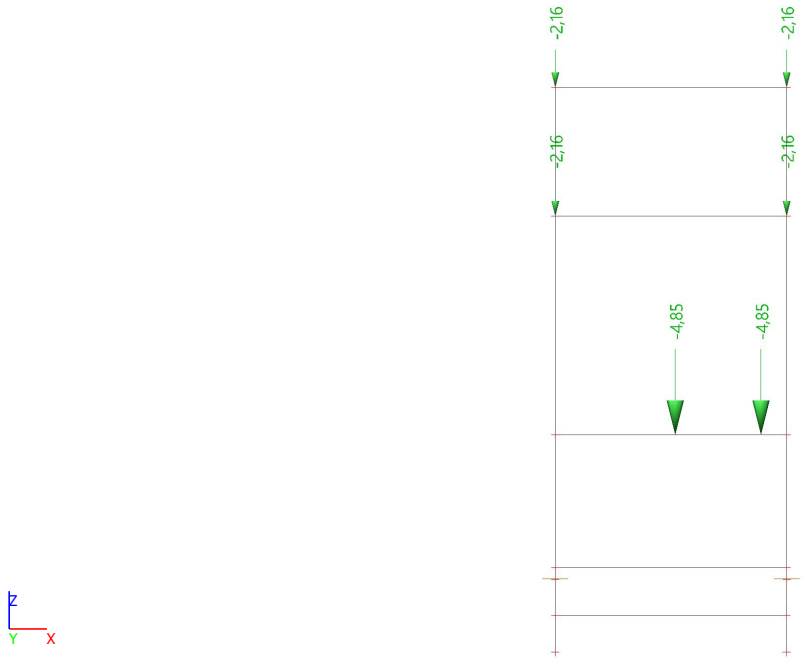
3.1.1. Load cases - DL

Name	Description	Action type	Load type	Load group	Direction
DL	Dead load - self-weight	Permanent	Self weight	LG1	-Z



3.1.2. Load cases - DL1

Name	Description	Action type	Load type	Load group
DL1	Dead load - other	Permanent	Standard	LG1



3.1.2.1. Point force on beam

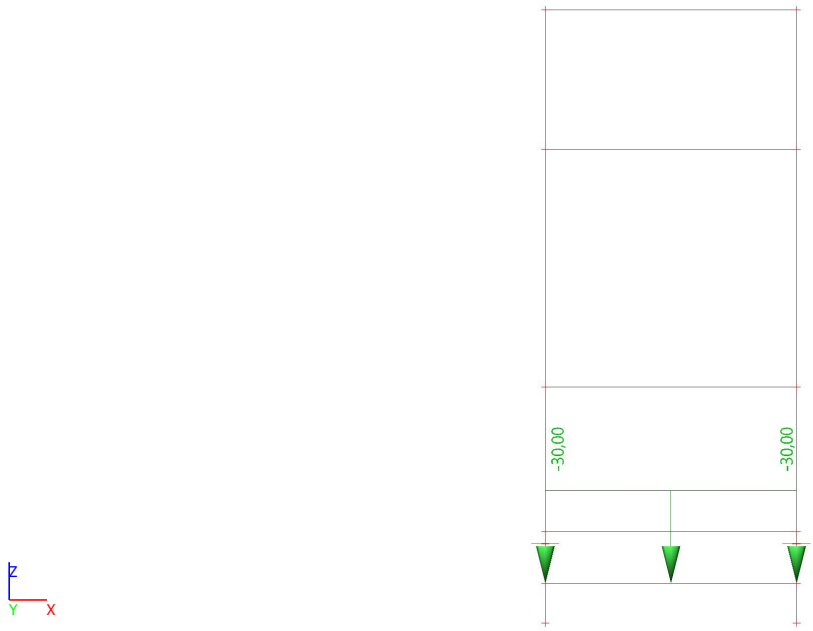
Name	Member Load case	System Dir	Value - F [kN] Type	Pos x [m]	Coor Orig	Rep (n) Regularly
Fb3	B4 DL1 - Dead load - other	GCS Z	-4,85 Force	0,300	Abso From end	2

3.1.2.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F4	N9	DL1 - Dead load - other	GCS	Z	Force	-2,16
F5	N7	DL1 - Dead load - other	GCS	Z	Force	-2,16
F6	N10	DL1 - Dead load - other	GCS	Z	Force	-2,16
F7	N8	DL1 - Dead load - other	GCS	Z	Force	-2,16

3.1.3. Load cases - DL2

Name	Description	Action type	Load type	Load group
DL2	Dead load - concrete slab	Permanent	Standard	LG1

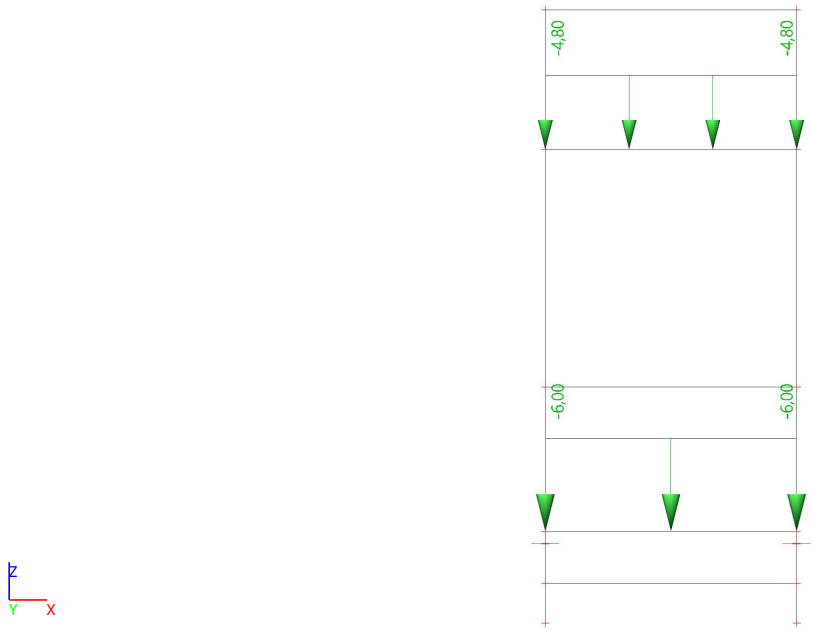


3.1.3.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF11	C3 DL2 - Dead load - concrete slab	Force LCS	Z Uniform	-30,00	0.000 1.000	Rela Length	From start	 0,000

3.1.4. Load cases - EE

Name	Description	Action type	Load type	Load group
EE	Equipment load - empty	Permanent	Standard	LG1

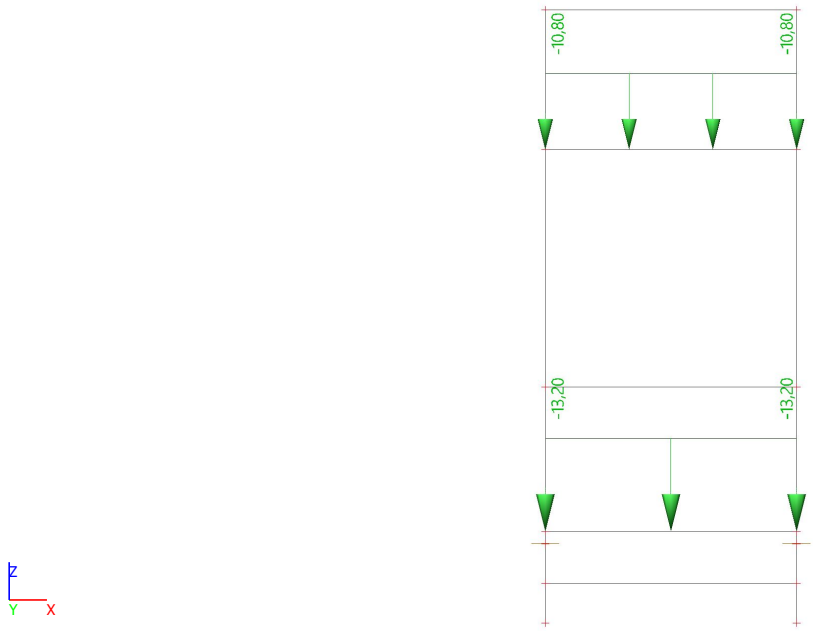


3.1.4.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF2	B5 EE - Equipment load - empty	Force LCS	Z Uniform	-4,80	0.000 1.000	Rela Length	From start	 0,000
LF8	B3 EE - Equipment load - empty	Force LCS	Z Uniform	-6,00	0.000 1.000	Rela Length	From start	 0,000

3.1.5. Load cases - EO1

Name	Description	Action type	Load type	Load group
EO1	Equipment load - operating	Permanent	Standard	LG1

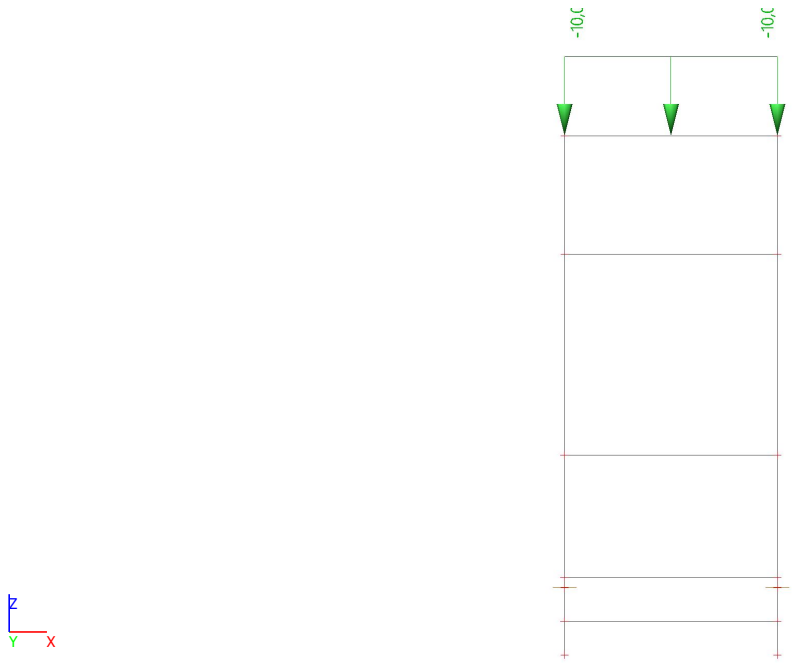


3.1.5.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF3	B5 EO1 - Equipment load - operating	Force LCS	Z Uniform	-10,80	0.000 1.000	Rela Length	From start	 0,000
LF9	B3 EO1 - Equipment load - operating	Force LCS	Z Uniform	-13,20	0.000 1.000	Rela Length	From start	 0,000

3.1.6. Load cases - EO2

Name	Description	Action type	Load type	Load group
EO2	Equipment load - operating	Permanent	Standard	LG1

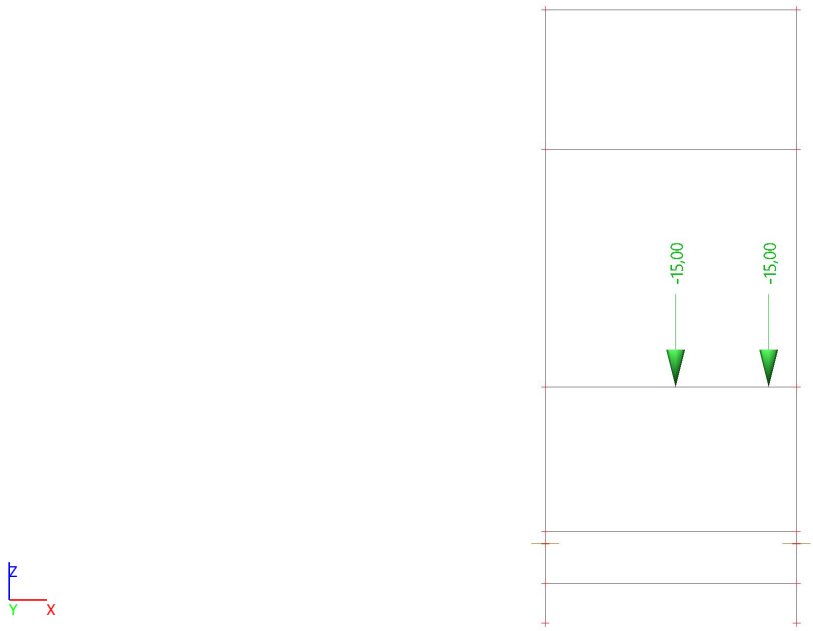


3.1.6.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF4	B6 EO2 - Equipment load - operating	Force LCS	Z Uniform	-10,00	0.000 1.000	Rela Length	From start	 0,000

3.1.7. Load cases - LL_1

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL_1	Live load - imposed load	Standard	Variable	Static	LG2	Short	None

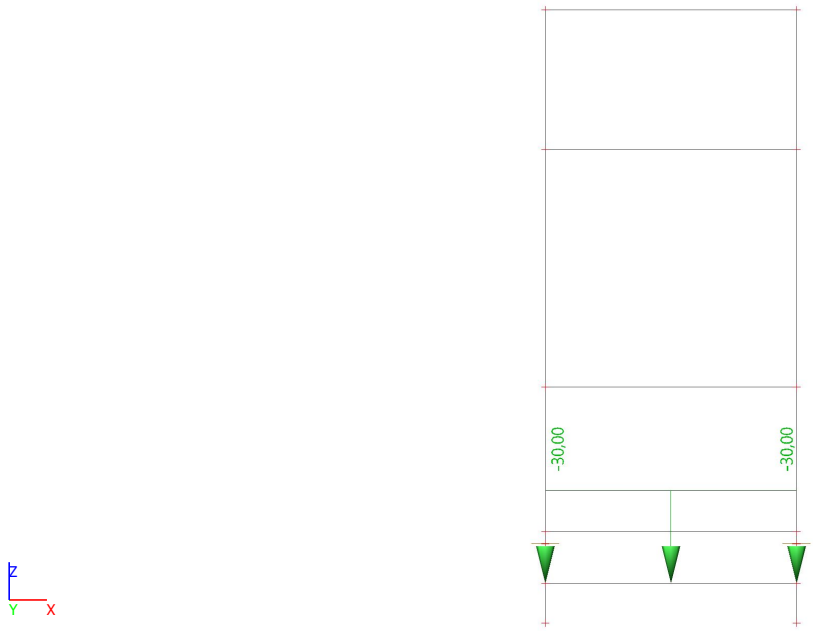


3.1.7.1. Point force on beam

Name	Member Load case	System Dir	Value - F [kN] Type	Pos x [m]	Coor Orig	Rep (n) Regularly
Fb2	B4 LL_1 - Live load - imposed load	GCS Z	-15,00 Force	0,300	Abso From end	2

3.1.8. Load cases - LL_2

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL_2	Live load - imposed load	Standard	Variable	Static	LG2	Short	None

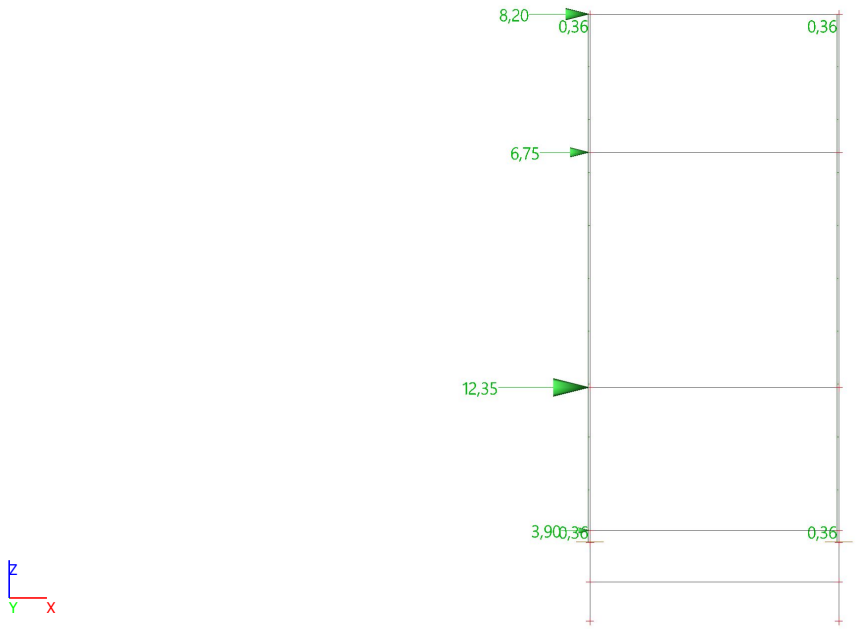


3.1.8.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF12	C3 LL_2 - Live load - imposed load	Force LCS	Z Uniform	-30,00	0.000 1.000	Rela Length	From start	 0,000

3.1.9. Load cases - WLx

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
WLx	Wind load	Standard	Variable	Static	LG3	Short	None



3.1.9.1. Point force in node

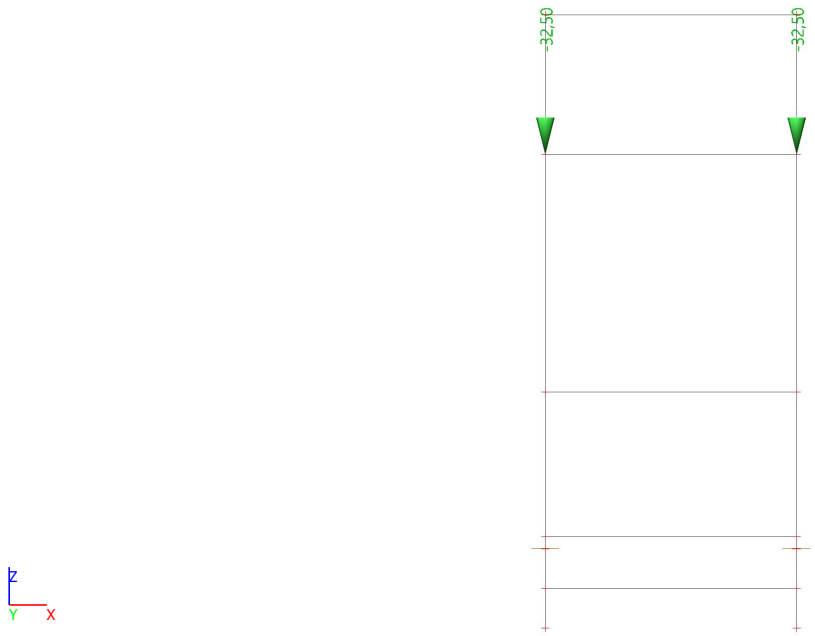
Name	Node	Load case	System	Dir	Type	Value - F [kN]
F19	N9	WLx - Wind load	GCS	X	Force	8,20
F20	N7	WLx - Wind load	GCS	X	Force	6,75
F21	N5	WLx - Wind load	GCS	X	Force	12,35
F22	N3	WLx - Wind load	GCS	X	Force	3,90

3.1.9.2. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF5	B2 WLx - Wind load	Force GCS	X Uniform	0,36	0.000 1.000	Rela Length	From start	 0,000
LF6	B1 WLx - Wind load	Force GCS	X Uniform	0,36	0.000 1.000	Rela Length	From start	 0,000

3.1.10. Load cases - WLy_1

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
WLy_1	Wind load	Standard	Variable	Static	LG3	Short	None

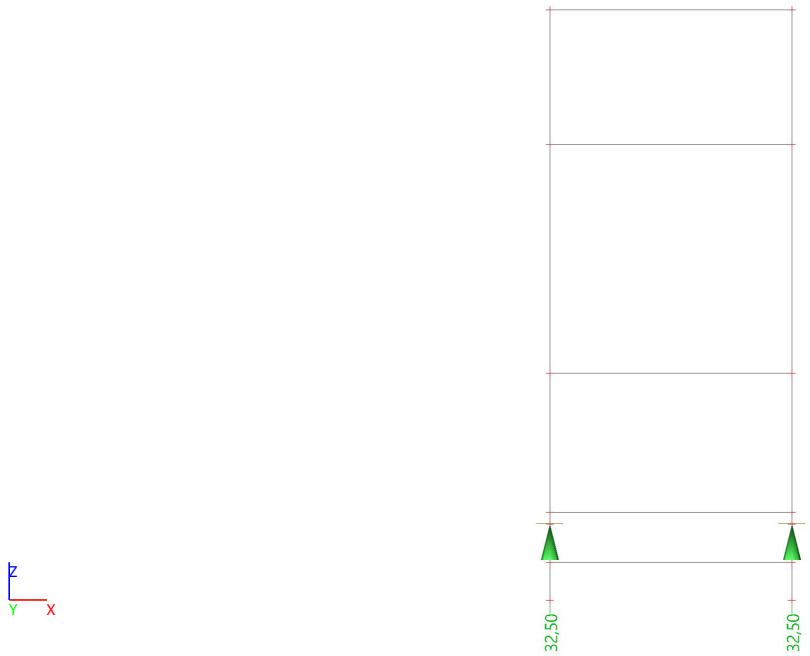


3.1.10.1. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F25	N8	WLy_1 - Wind load	GCS	Z	Force	-32,50
F26	N7	WLy_1 - Wind load	GCS	Z	Force	-32,50

3.1.11. Load cases - WLy_2

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
WLy_2	Wind load	Standard	Variable	Static	LG3	Short	None



3.1.11.1. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F35	N1	WLy_2 - Wind load	GCS	Z	Force	32,50
F36	N11	WLy_2 - Wind load	GCS	Z	Force	32,50

3.1.12. Load cases - TLf

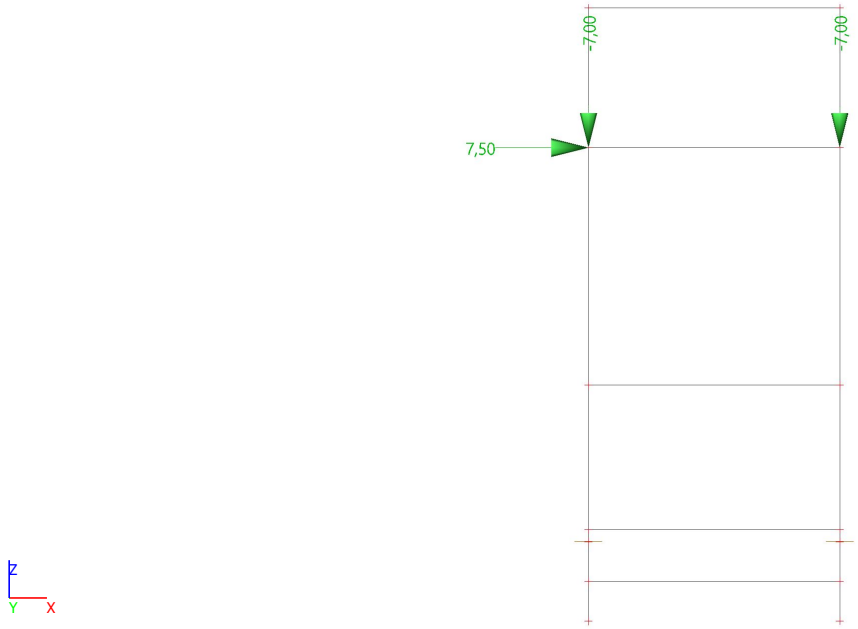
Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
TLf	Temperature load - friction	Standard	Variable	Static	LG4	Short	None

3.1.12.1. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F39	N7	TLf - Temperature load - friction	GCS	X	Force	7,50

3.1.13. Load cases - TLf_1

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
TLf_1	Temperature load - friction	Standard	Variable	Static	LG4	Short	None

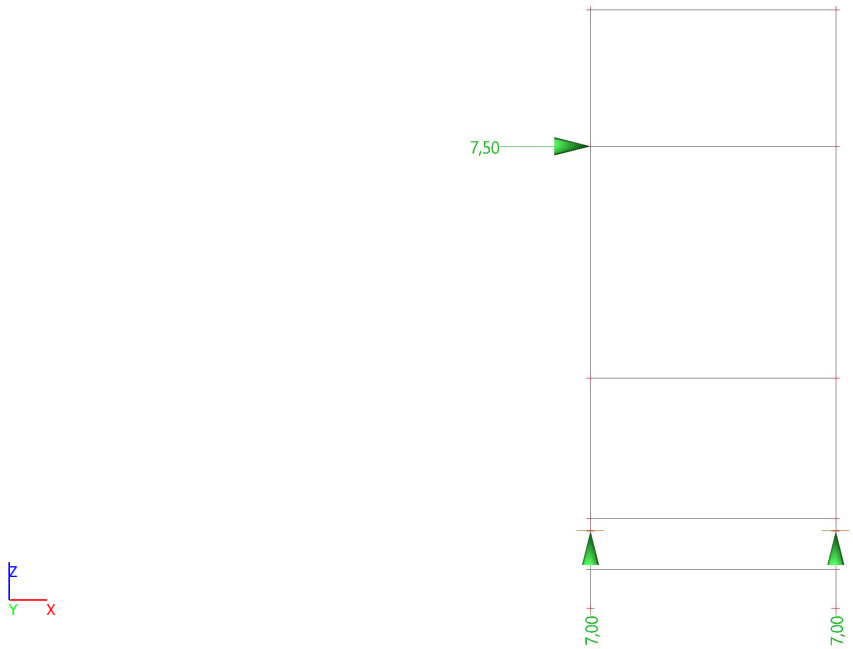


3.1.13.1. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N7	TLf_1 - Temperature load - friction	GCS	X	Force	7,50
F27	N7	TLf_1 - Temperature load - friction	GCS	Z	Force	-7,00
F28	N8	TLf_1 - Temperature load - friction	GCS	Z	Force	-7,00

3.1.14. Load cases - TLf_2

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
TLf_2	Temperature load - friction	Standard	Variable	Static	LG4	Short	None

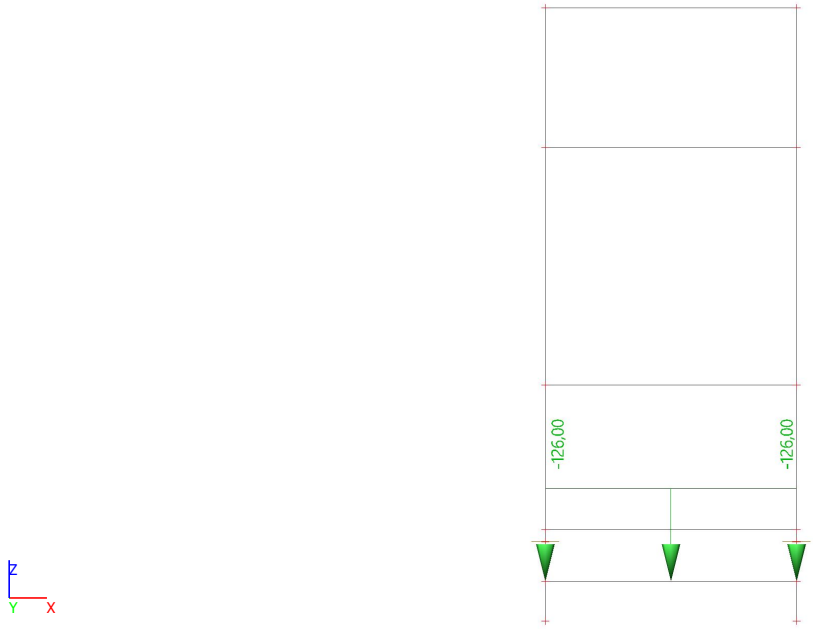


3.1.14.1. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F31	N7	TLf_2 - Temperature load - friction	GCS	X	Force	7,50
F37	N11	TLf_2 - Temperature load - friction	GCS	Z	Force	7,00
F38	N1	TLf_2 - Temperature load - friction	GCS	Z	Force	7,00

3.1.15. Load cases - A

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
A	Accidental load	Standard	Variable	Static	LG5	Short	None

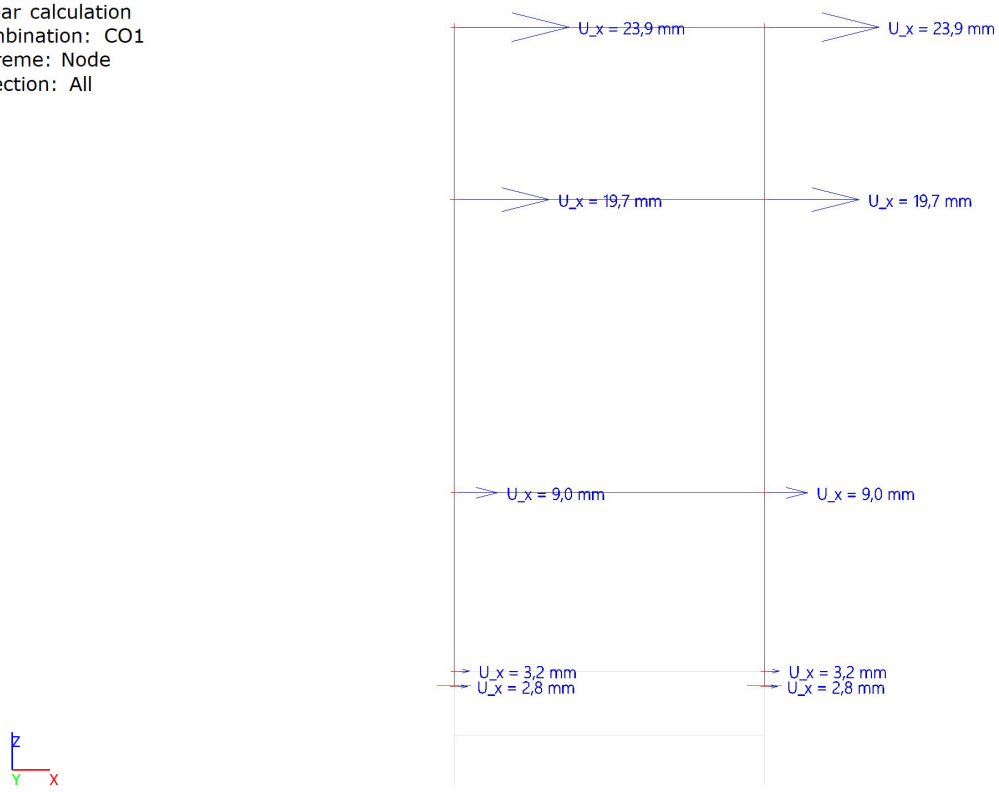


3.1.15.1. Line force

Name	Member Load case	Type System	Dir Distribution	Value - P_1 [kN/m] Value - P_2 [kN/m]	Pos x_1 Pos x_2	Coor Loc	Orig	Ecc ey [m] Ecc ez [m]
LF10	C3 A - Accidental load	Force LCS	Z Uniform	-126,00	0.000 1.000	Rela Length	From start	0,000

4. analysis

Values: $\mathbf{U_x}$
Linear calculation
Combination: CO1
Extreme: Node
Selection: All

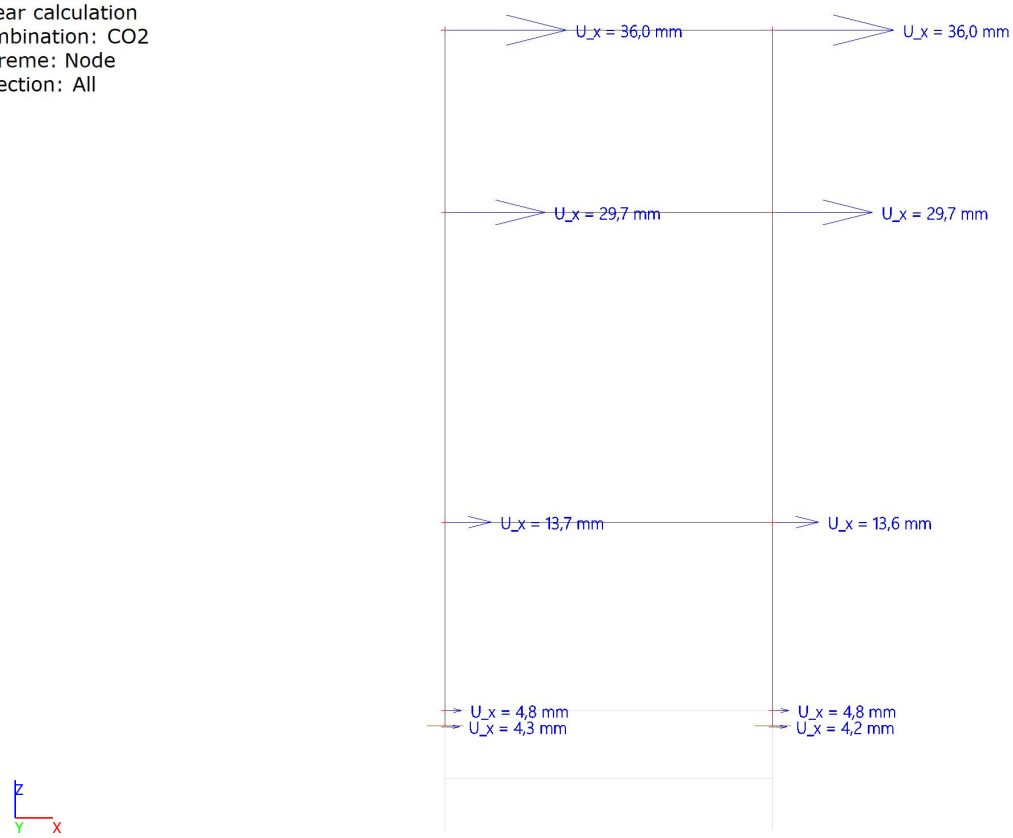


Linear calculation
Combination: CO1
Extreme: Global
Selection: Named selection - analysis

Name	Case	U_x [mm]	U_z [mm]	Φ_y [mrad]	U_{total} [mm]
N11	CO1/1	**0,0**	-2,4	0,0	2,4
N9	CO1/2	**23,9**	-1,4	2,6	24,0
N10	CO1/2	23,9	**-4,2**	2,0	**24,3**
N1	CO1/3	2,7	**-1,1**	1,0	3,0
N10	CO1/1	0,2	-2,6	**-0,2**	2,6
N5	CO1/2	9,0	-1,3	**3,9**	9,1

Name	Combination key
CO1/1	1.35*DL + 1.35*DL1 + 1.35*EO1 + 1.35*EO2
CO1/2	1.35*DL + 1.35*DL1 + 0.75*LL_1 + 1.35*EO1 + 1.35*EO2 + 0.90*WLx + 0.90*TLf
CO1/3	1.35*DL + 1.35*DL1 + 1.35*EO1 + 1.35*EO2 + 0.90*WLx + 0.90*TLf

Values: U_x
Linear calculation
Combination: CO2
Extreme: Node
Selection: All



Linear calculation
Combination: CO2
Extreme: Global
Selection: Named selection - analysis

Name	Case	U_x [mm]	U_z [mm]	Φ_y [mrad]	U_{total} [mm]
N11	CO2/1	**0,0**	-2,1	0,0	2,1
N9	CO2/2	**36,0**	-0,4	3,7	36,0
N10	CO2/2	36,0	**-4,6**	3,2	**36,3**
N1	CO2/3	4,2	**-0,2**	1,4	4,2
N10	CO2/1	0,1	-2,3	**-0,2**	2,3
N5	CO2/2	13,7	-0,4	**5,8**	13,7

Name	Combination key
CO2/1	1.20*DL + 1.20*DL1 + 1.20*EO1 + 1.20*EO2
CO2/2	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 1.20*EO2 + 1.50*WLx + 0.90*TLf
CO2/3	1.20*DL + 1.20*DL1 + 1.20*EO1 + 1.20*EO2 + 1.50*WLx + 0.90*TLf

5. Results

5.1. Reactions

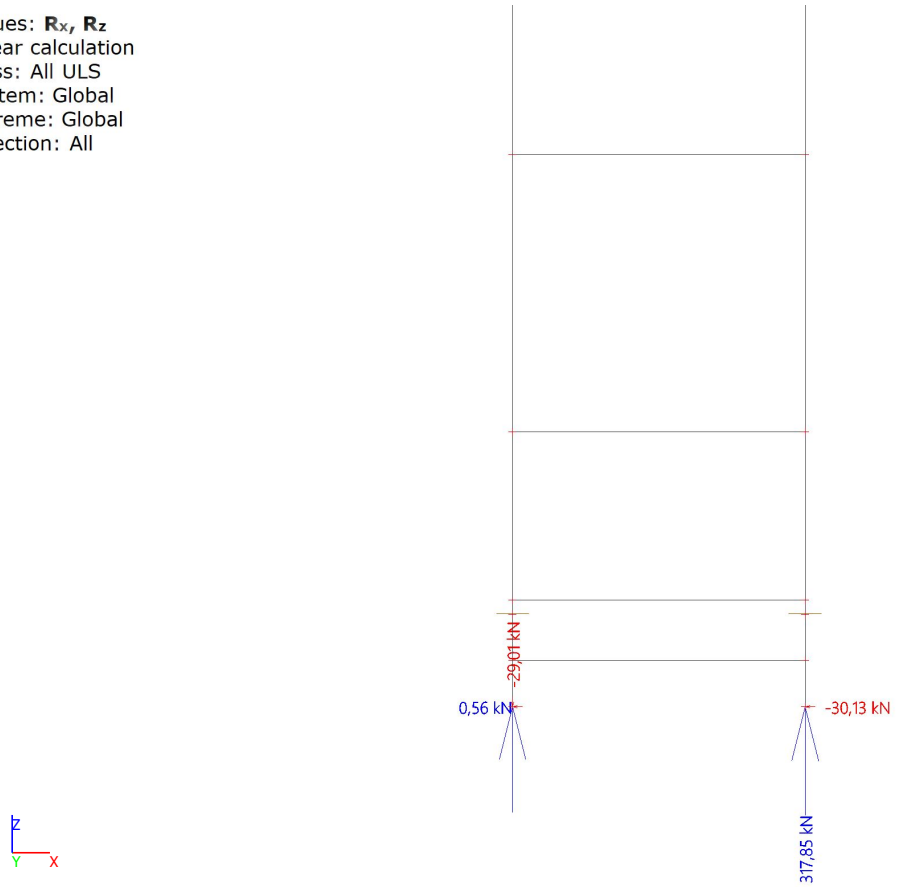
Linear calculation
Class: All ULS
System: Global
Extreme: Global
Selection: All

Nodal reactions

Name	Case	R_x [kN]	R_z [kN]	M_y [kNm]	e_y [mm]
Sn2/N13	ULS_Operating_Slab/1	**-30,13**	281,86	0,00	0,0
Sn1/N12	ULS_Operating_Accidental/2	**0,56**	307,56	**0,00**	0,0
Sn1/N12	ULS_Empty/3	-26,47	**-29,01**	0,00	0,0
Sn2/N13	ULS_Operating_Accidental/4	-0,56	**317,85**	0,00	0,0

Name	Combination key
ULS_Operating_Slab/1	1.20*DL + 1.20*DL1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx + 1.20*DL2 + 0.75*LL_2
ULS_Operating_Accidental/2	DL + DL1 + EO1 + EO2 + DL2 + A + 0.30*LL_2
ULS_Empty/3	0.90*DL + 0.90*DL1 + 0.90*EE + 1.50*WLx
ULS_Operating_Accidental/4	DL + DL1 + 0.30*LL_1 + EO1 + EO2 + DL2 + A + 0.30*LL_2

Values: R_x, R_z
Linear calculation
Class: All ULS
System: Global
Extreme: Global
Selection: All



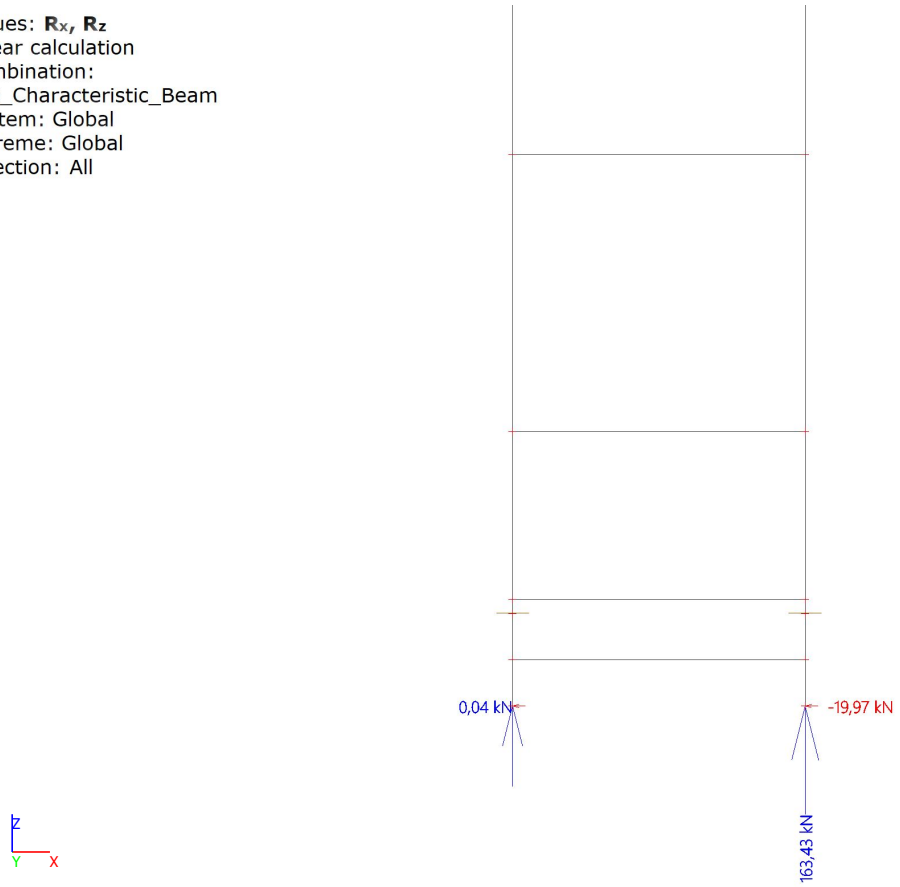
Linear calculation
Combination: SLS_Characteristic_Beam
System: Global
Extreme: Global
Selection: All

Nodal reactions

Name	Case	R_x [kN]	R_z [kN]	M_y [kNm]	e_y [mm]
Sn2/N13	SLS_Characteristic_Beam/1	**-19,97**	152,88	0,00	0,0
Sn1/N12	SLS_Characteristic_Beam/2	**0,04**	84,81	**0,00**	0,0
Sn1/N12	SLS_Characteristic_Beam/3	-19,88	**20,70**	0,00	0,0
Sn2/N13	SLS_Characteristic_Beam/4	-19,97	**163,43**	0,00	0,0

Name	Combination key
SLS_Characteristic_Beam/1	DL + DL1 + EO1 + 0.60*TLf_1 + EO2 + WLx
SLS_Characteristic_Beam/2	DL + DL1 + EO1 + EO2
SLS_Characteristic_Beam/3	DL + DL1 + EO1 + EO2 + WLx + 0.60*TLf_2
SLS_Characteristic_Beam/4	DL + DL1 + 0.50*LL_1 + EO1 + 0.60*TLf_1 + EO2 + WLx

Values: R_x, R_z
Linear calculation
Combination:
SLS_Characteristic_Beam
System: Global
Extreme: Global
Selection: All



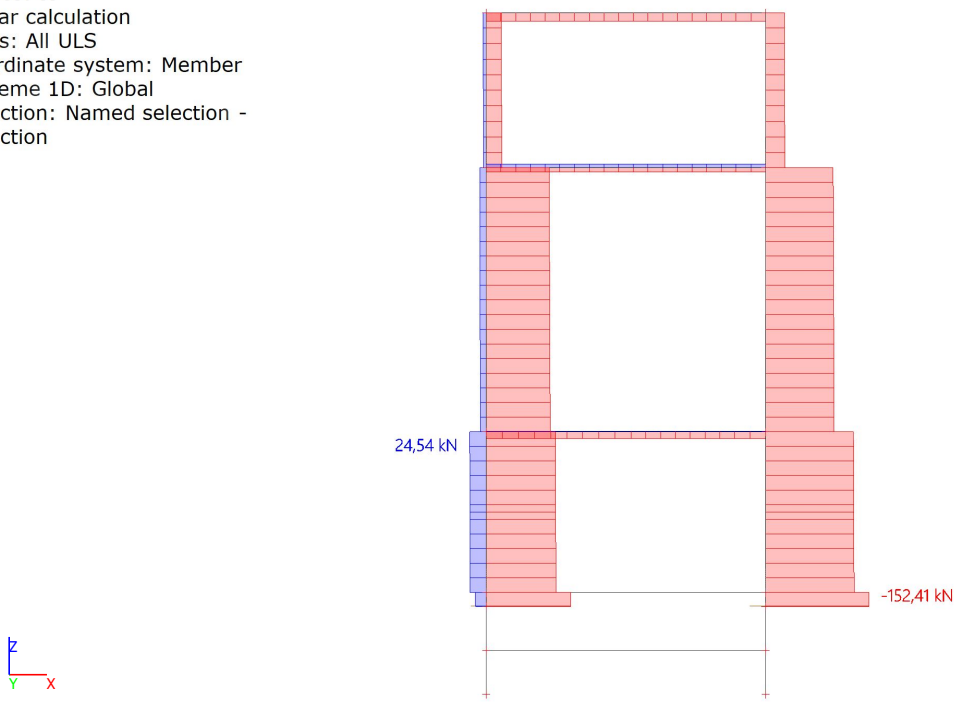
5.2. 1D internal forces

Linear calculation
Class: All ULS
Coordinate system: Member
Extreme 1D: Cross-section
Selection: Named selection - Selection

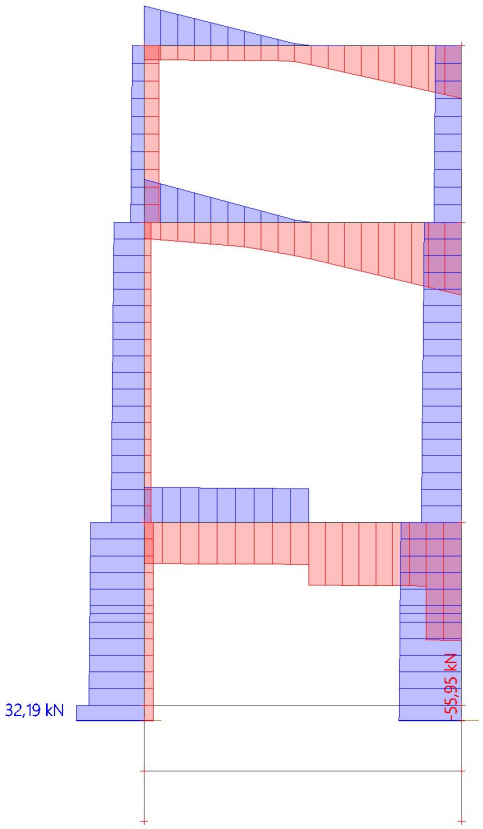
Name	dx [m]	Case	Cross-section	N [kN]	V_z [kN]	M_y [kNm]
B2	0,000	ULS_Operating_Beam/1	CS1 - HEB180	**-152,41**	5,72	-5,02
B1	1,685-	ULS_Empty/2	CS1 - HEB180	**24,54**	21,96	10,88
B1	4,234+	ULS_Operating_Slab/3	CS1 - HEB180	-21,81	**-6,97**	6,11
B1	0,000	ULS_Operating_Beam/4	CS1 - HEB180	-11,10	**32,19**	-32,26
B2	0,000	ULS_Operating_Slab/5	CS1 - HEB180	-143,55	29,74	**-33,00**
B2	4,234-	ULS_Operating_Beam/6	CS1 - HEB180	-71,82	17,71	**26,01**
B6	0,000	ULS_Operating_Slab/7	CS4 - HEA180	**-12,34**	8,62	5,97
B5	0,000	ULS_Operating_Slab/8	CS4 - HEA180	**5,37**	20,37	-7,24
B4	2,700	ULS_Operating_Beam/9	CS4 - HEA180	-6,44	**-55,95**	-31,30
B5	0,000	ULS_Operating_Beam/10	CS4 - HEA180	4,14	**20,44**	-7,45
B4	2,700	ULS_Operating_Slab/5	CS4 - HEA180	-9,79	-47,36	**-37,13**
B4	0,000	ULS_Operating_Beam/4	CS4 - HEA180	-8,80	-19,45	**28,54**

Name	Combination key
ULS_Operating_Beam/1	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLy_1
ULS_Empty/2	0.90*DL + 0.90*DL1 + 0.90*EE + 1.50*WLx
ULS_Operating_Slab/3	1.35*DL + 1.35*DL1 + 1.35*EO1 + 0.90*TLf_1 + 1.35*EO2 + 1.35*DL2 + 0.75*LL_2
ULS_Operating_Beam/4	0.90*DL + 0.90*DL1 + 0.90*EO1 + 0.90*TLf_1 + 0.90*EO2 + 1.50*WLx
ULS_Operating_Slab/5	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx + 1.20*DL2 + 0.75*LL_2
ULS_Operating_Beam/6	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx
ULS_Operating_Slab/7	1.20*DL + 1.20*DL1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx + 1.20*DL2 + 0.75*LL_2
ULS_Operating_Slab/8	1.35*DL + 1.35*DL1 + 1.35*EO1 + 1.35*EO2 + 1.35*DL2 + 0.75*LL_2
ULS_Operating_Beam/9	1.20*DL + 1.20*DL1 + 1.50*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 0.90*WLx
ULS_Operating_Beam/10	1.35*DL + 1.35*DL1 + 0.75*LL_1 + 1.35*EO1 + 1.35*EO2

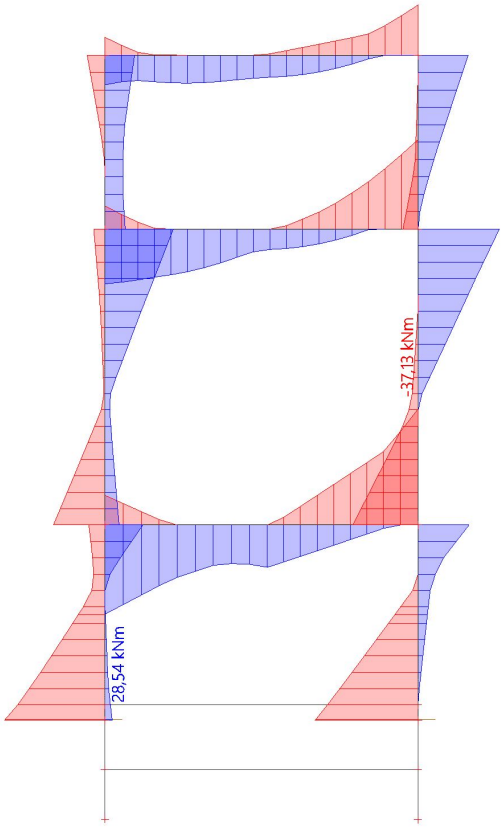
Values: **N**
Linear calculation
Class: All ULS
Coordinate system: Member
Extreme 1D: Global
Selection: Named selection - Selection



Values: V_z
Linear calculation
Class: All ULS
Coordinate system: Member
Extreme 1D: Global
Selection: Named selection - Selection



Values: M_y
Linear calculation
Class: All ULS
Coordinate system: Member
Extreme 1D: Global
Selection: Named selection - Selection



5.3. 1D internal forces - ends

Linear calculation
Class: All ULS
Coordinate system: Member
Extreme 1D: Cross-section
Selection: Named selection - Selection
Selected sections: Ends

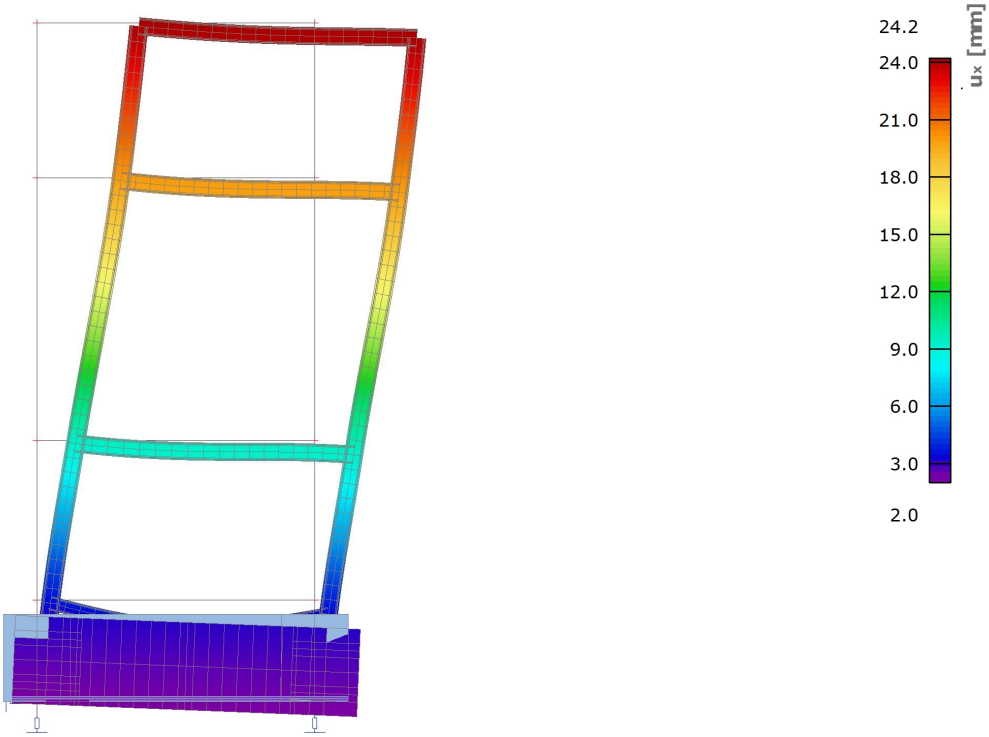
Name	dx [m]	Case	Cross-section	N [kN]	V_z [kN]	M_y [kNm]
B2	0,000	ULS_Operating_Beam/1	CS1 - HEB180	**-152,41**	5,72	-5,02
B1	0,000	ULS_Empty/2	CS1 - HEB180	**16,19**	28,72	-27,66
B1	5,734	ULS_Operating_Slab/3	CS1 - HEB180	-20,80	**-6,97**	-4,35
B1	0,000	ULS_Operating_Beam/4	CS1 - HEB180	-11,10	**32,19**	-32,26
B2	0,000	ULS_Operating_Slab/5	CS1 - HEB180	-143,55	29,74	**-33,00**
B2	5,734	ULS_Operating_Slab/6	CS1 - HEB180	-27,55	12,34	**16,07**
B6	0,000	ULS_Operating_Slab/6	CS4 - HEA180	**-12,34**	8,62	5,97
B5	0,000	ULS_Operating_Slab/7	CS4 - HEA180	**5,37**	20,37	-7,24
B4	2,700	ULS_Operating_Beam/8	CS4 - HEA180	-6,44	**-55,95**	-31,30
B5	0,000	ULS_Operating_Beam/9	CS4 - HEA180	4,14	**20,44**	-7,45
B4	2,700	ULS_Operating_Slab/5	CS4 - HEA180	-9,79	-47,36	**-37,13**
B4	0,000	ULS_Operating_Beam/4	CS4 - HEA180	-8,80	-19,45	**28,54**

Name	Combination key
ULS_Operating_Beam/1	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLy_1
ULS_Empty/2	0.90*DL + 0.90*DL1 + 0.90*EE + 1.50*WLx
ULS_Operating_Slab/3	1.35*DL + 1.35*DL1 + 1.35*EO1 + 0.90*TLf_1 + 1.35*EO2 + 1.35*DL2 + 0.75*LL_2
ULS_Operating_Beam/4	0.90*DL + 0.90*DL1 + 0.90*EO1 + 0.90*TLf_1 + 0.90*EO2 + 1.50*WLx
ULS_Operating_Slab/5	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx + 1.20*DL2 + 0.75*LL_2
ULS_Operating_Slab/6	1.20*DL + 1.20*DL1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx + 1.20*DL2 + 0.75*LL_2
ULS_Operating_Slab/7	1.35*DL + 1.35*DL1 + 1.35*EO1 + 1.35*EO2 + 1.35*DL2 + 0.75*LL_2
ULS_Operating_Beam/8	1.20*DL + 1.20*DL1 + 1.50*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 0.90*WLx
ULS_Operating_Beam/9	1.35*DL + 1.35*DL1 + 0.75*LL_1 + 1.35*EO1 + 1.35*EO2

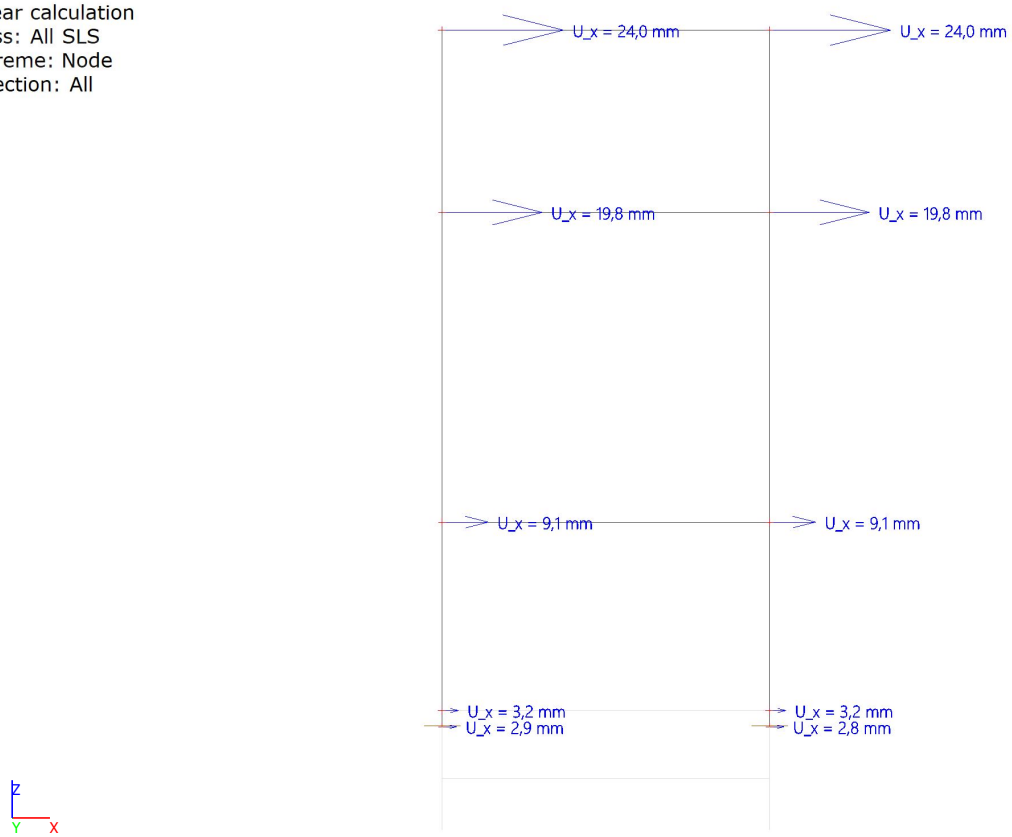
6. Stiffness

6.1. 3D displacement; U_x

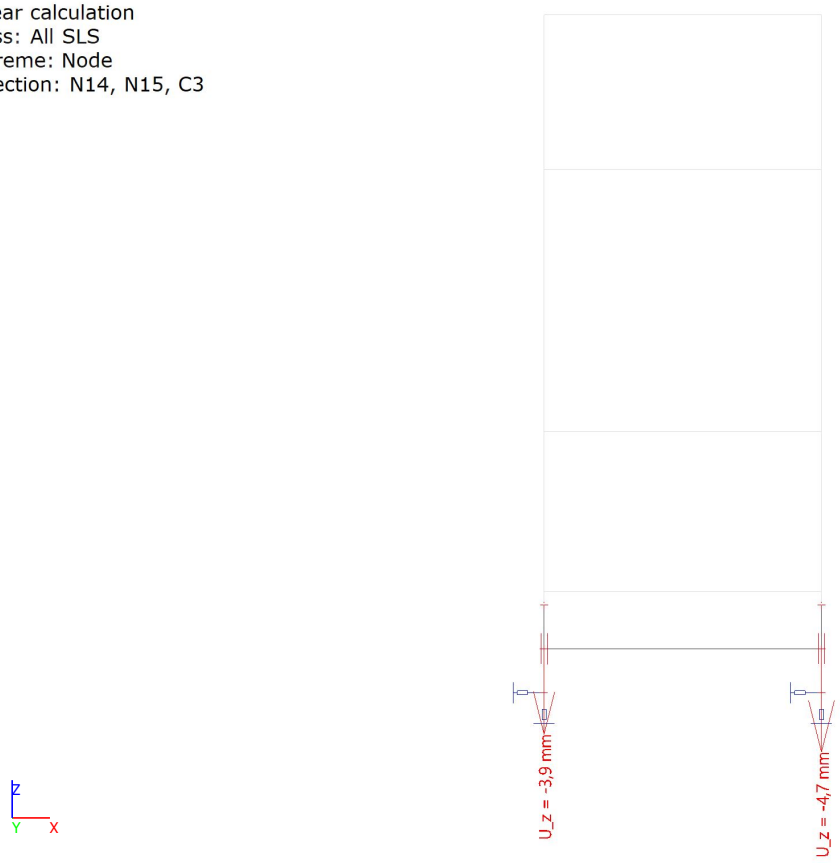
Values: u_x
Linear calculation
Class: All SLS
Selection: All
Location: In nodes avg.. System: Global



Values: U_x
Linear calculation
Class: All SLS
Extreme: Node
Selection: All



Values: U_z
Linear calculation
Class: All SLS
Extreme: Node
Selection: N14, N15, C3



Linear calculation
Class: All SLS
Extreme: Global
Selection: N14, N15

Name	Case	U_x [mm]	U_z [mm]	Φ_y [mrad]	U_{total} [mm]
N15	SLS_Characteristic_Slab/1	1,6	**-4,7**	0,7	5,0
N14	SLS_Characteristic_Beam/2	2,4	**-0,4**	0,9	2,4
N15	SLS_Characteristic_Slab/3	**0,0**	-3,4	**0,0**	3,4
N14	SLS_Characteristic_Slab/4	**2,4**	-1,9	**1,0**	3,1
N15	SLS_Characteristic_Slab/4	2,4	-4,5	0,9	**5,1**

Name	Combination key
SLS_Characteristic_Slab/1	DL + DL1 + LL_1 + EO1 + 0.60*TLf_1 + EO2 + 0.60*WLx + DL2 + LL_2
SLS_Characteristic_Beam/2	DL + DL1 + EO1 + EO2 + WLx + 0.60*TLf_2
SLS_Characteristic_Slab/3	DL + DL1 + EO1 + EO2 + DL2 + LL_2
SLS_Characteristic_Slab/4	DL + DL1 + 0.50*LL_1 + EO1 + 0.60*TLf_1 + EO2 + WLx + DL2 + 0.50*LL_2

6.2. EC-EN 1993 Steel Check SLS

Linear calculation
Class: All SLS
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS1 - HEB180
Limit setting

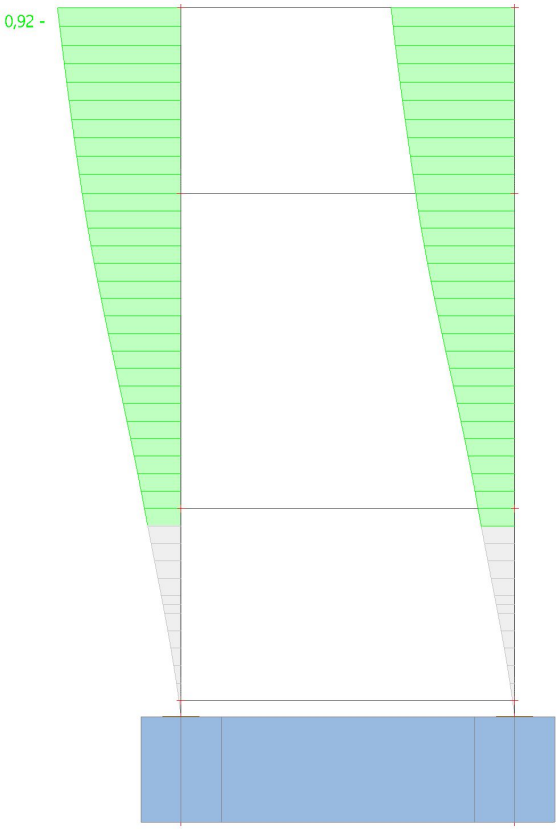
Name	dx [m]	Cross-section	$L_{def,y}$ [m] $L_{def,z}$ [m]	Total load y [1/xx] Total load z [1/xx]	Variable load y [1/xx] Variable load z [1/xx]	Lim. $u_{y,max}$ [mm] Lim. $u_{z,max}$ [mm]	Lim. $u_{y,var}$ [mm] Lim. $u_{z,var}$ [mm]
B1	0,000	CS1 - HEB180	**5,734** 5,734	1/250 1/500	1/250 1/500	22,9 22,9	22,9 22,9

Linear calculation
Combination: SLS_Characteristic_Beam
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS1 - HEB180
Overall Unity Check

Name	dx [m]	Case	Cross-section	$u_{y,max}$ [mm] $u_{z,max}$ [mm]	$u_{y,var}$ [mm] $u_{z,var}$ [mm]	Lim. $u_{y,max}$ [mm] Lim. $u_{z,max}$ [mm]	Lim. $u_{y,var}$ [mm] Lim. $u_{z,var}$ [mm]	Check $u_{y,max}$ [-] Check $u_{z,max}$ [-]	Check $u_{y,var}$ [-] Check $u_{z,var}$ [-]	Camber dx u_z [mm] Camber [mm]	Check Overall [-]
B1	5,734	SLS_Characteristic_Beam/1	CS1 - HEB180	0,0 -21,2	0,0 -21,1	22,9 22,9	22,9 22,9	0,00 0,92	0,00 0,92	- -	**0,92**

Name	Combination key
SLS_Characteristic_Beam/1	DL + DL1 + 0.50*LL_1 + EO1 + 0.60*TLf_1 + EO2 + WLx

Values: **Check Overall**
Linear calculation
Class: All SLS
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS1 - HEB180



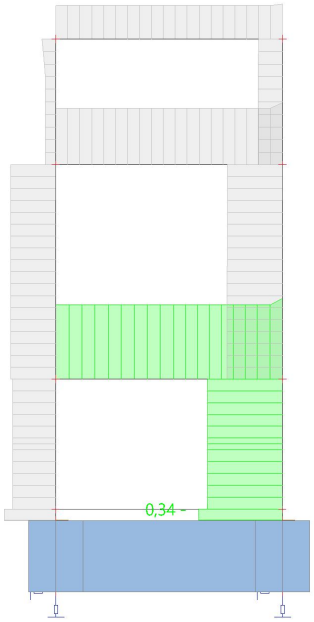
7. strength

7.1. Steel slenderness

Linear calculation

Member	CS Name	Part	Sway y	Sway z	Ly [m]	Lz [m]	ky [-]	kz [-]	Iy [m]	Iz [m]	Lam y [-]	Lam z [-]	Iyz [m]	l LTB [m]
B6	CS4	1	Yes	No	2,700	2,700	1,00	1,00	2,700	2,700	36,27	59,75	2,700	2,700
B4	CS4	1	Yes	No	2,700	2,700	1,00	1,00	2,700	2,700	36,27	59,75	2,700	2,700
B5	CS4	1	Yes	No	2,700	2,700	1,00	1,00	2,700	2,700	36,27	59,75	2,700	2,700
B1	CS1	1	Yes	No	4,234	5,734	1,00	1,00	4,234	5,734	55,26	125,47	5,734	5,734
B1	CS1	2	Yes	No	4,234	5,734	1,00	1,00	4,234	5,734	55,26	125,47	5,734	5,734
B1	CS1	3	Yes	No	4,234	5,734	1,00	1,00	4,234	5,734	55,26	125,47	5,734	5,734
B1	CS1	4	Yes	No	1,500	5,734	1,00	1,00	1,500	5,734	19,58	125,47	5,734	5,734
B2	CS1	1	Yes	No	4,234	5,734	1,00	1,00	4,234	5,734	55,26	125,47	5,734	5,734
B2	CS1	2	Yes	No	4,234	5,734	1,00	1,00	4,234	5,734	55,26	125,47	5,734	5,734
B2	CS1	3	Yes	No	4,234	5,734	1,00	1,00	4,234	5,734	55,26	125,47	5,734	5,734
B2	CS1	4	Yes	No	1,500	5,734	1,00	1,00	1,500	5,734	19,58	125,47	5,734	5,734

Values: **$UC_{Overall}$**
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Global
Selection: Named selection - Selection
There are 1 warnings on selected members. 0 of them are shown.



7.2. EC-EN 1993 Steel check ULS

Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: Named selection - Selection
There are 1 warnings on selected members. 1 of them are shown.
Overall Unity Check

Name	dx [m]	Case	Cross-section	Material	$UC_{Overall}$ [-]	UC_{Sec} [-]	UC_{Stab} [-]	Errors, warnings, notes
B2	0,000	ULS_Operating_Slab/1	CS1 - HEB180	S 355	**0,34**	0,19	0,34	
B4	2,700	ULS_Operating_Slab/1	CS4 - HEA180	S 355	**0,32**	0,32	0,30	W30

Name	Combination key
ULS_Operating_Slab/1	1.20*DL + 1.20*DL1 + 0.75*LL_1 + 1.20*EO1 + 0.90*TLf_1 + 1.20*EO2 + 1.50*WLx + 1.20*DL2 + 0.75*LL_2

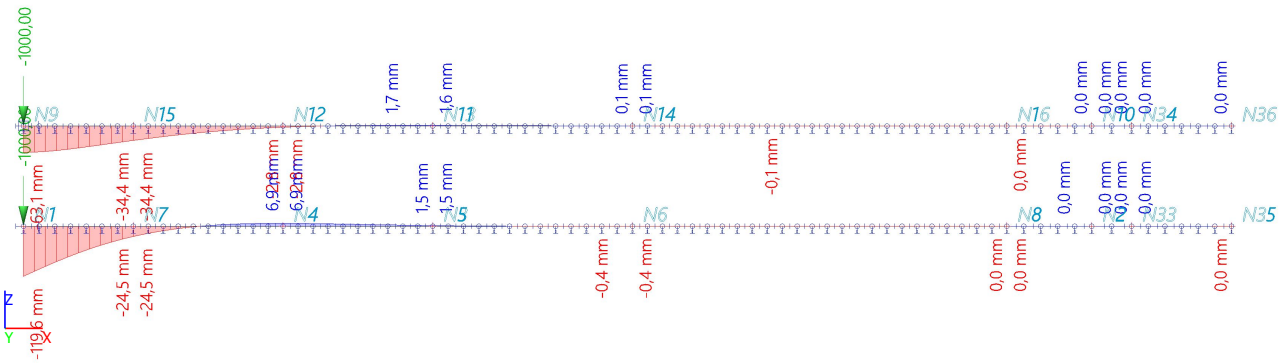
E/W/N	Present on members
W30	B4, B5, B6

E/W/N	Description
W30	Not all conditions of the Dutch NEN-EN NA (Art. NB.NB.1) are fulfilled, therefore the standard EC-EN approach is used.

Appendix C

Displacement foundation piles

1. 1D deformations; u_z



2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	-3,200	0,000	0,000
N2	18,200	0,000	0,000
N3	5,000	0,000	0,000
N4	2,000	0,000	0,000
N5	5,000	0,000	0,000
N6	9,000	0,000	0,000
N7	-1,000	0,000	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N8	16,500	0,000	0,000
N9	-3,200	0,000	2,000
N10	18,200	0,000	2,000
N11	5,000	0,000	2,000
N12	2,000	0,000	2,000
N13	5,000	0,000	2,000
N14	9,000	0,000	2,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N15	-1,000	0,000	2,000
N16	16,500	0,000	2,000
N33	19,000	0,000	0,000
N34	19,000	0,000	2,000
N35	21,000	0,000	0,000
N36	21,000	0,000	2,000

3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Circle (406)	C30/37	3,000	N4	N5	general (0)
B2	CS2 - Circle (406)	C30/37	4,000	N3	N6	general (0)
B4	CS2 - Circle (406)	C30/37	2,200	N1	N7	general (0)
B5	CS2 - Circle (406)	C30/37	3,000	N7	N4	general (0)
B6	CS2 - Circle (406)	C30/37	7,500	N6	N8	general (0)
B7	CS2 - Circle (406)	C30/37	1,700	N8	N2	general (0)
B8	CS2 - Circle (406)	C30/37	3,000	N12	N13	general (0)
B9	CS2 - Circle (406)	C30/37	4,000	N11	N14	general (0)
B11	CS2 - Circle (406)	C30/37	2,200	N9	N15	general (0)
B12	CS2 - Circle (406)	C30/37	3,000	N15	N12	general (0)
B13	CS2 - Circle (406)	C30/37	7,500	N14	N16	general (0)
B14	CS2 - Circle (406)	C30/37	1,700	N16	N10	general (0)
B29	CS2 - Circle (406)	C30/37	0,800	N2	N33	general (0)
B30	CS2 - Circle (406)	C30/37	0,800	N10	N34	general (0)
B31	CS2 - Circle (406)	C30/37	2,000	N33	N35	general (0)
B32	CS2 - Circle (406)	C30/37	2,000	N34	N36	general (0)

4. Nodal supports

Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz	Angle [deg]
Sn1	N9	GCS	Standard	Rigid	Free	Free	Free	Rigid	Free	Ry180.00
Sn2	N1	GCS	Standard	Rigid	Free	Free	Free	Free	Free	Ry180.00

5. Line supports on member

Name	Type	Member	System	Pos x_1	Pos x_2	Coor	Orig	X	Y	Z	Stiffness Z [MN/m²]	Rx	Ry	Rz
Slb1	Line	B1	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	1,1600e+01	Rigid	Free	Free
Slb2	Line	B2	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	7,5000e+00	Rigid	Free	Free
Slb4	Line	B4	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	7,7000e+00	Rigid	Free	Free
Slb5	Line	B5	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	3,7000e+00	Rigid	Free	Free
Slb6	Line	B6	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	2,3000e+00	Rigid	Free	Free
Slb7	Line	B7	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	3,0900e+01	Rigid	Free	Free
Slb8	Line	B8	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	1,1600e+01	Rigid	Free	Free
Slb9	Line	B9	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	7,5000e+00	Rigid	Free	Free
Slb11	Line	B11	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	7,7000e+00	Rigid	Free	Free
Slb12	Line	B12	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	3,7000e+00	Rigid	Free	Free
Slb13	Line	B13	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	2,3000e+00	Rigid	Free	Free
Slb14	Line	B14	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	3,0900e+01	Rigid	Free	Free
Slb29	Line	B29	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	5,6000e+00	Rigid	Free	Free
Slb30	Line	B30	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	5,6000e+00	Rigid	Free	Free
Slb31	Line	B31	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	3,0900e+01	Rigid	Free	Free
Slb32	Line	B32	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	3,0900e+01	Rigid	Free	Free

Appendix D

Baseplate

column baseplate

Materials

steel grade - baseplate	S 355			$f_{yd,p}$ =	355	N/mm²
steel grade - column	S 355			$f_{yd,c}$ =	355	N/mm²
concrete strength class	C 30/37			f_{cd} =	20	N/mm²
anchor quality	4.6			f_{ub} =	400	N/mm²
secant modules of elasticity of concrete				E_{cm} =	32837	N/mm²
tangent modules of elasticity of concrete				E_c =	16418	N/mm²
modules of elasticity of steel				E_s =	210000	N/mm²

Dimensions

dimensions of baseplate		w_p = 340	mm	d_p =	340	mm
thickness of baseplate				t_p =	20	mm
thickenss of grouting layer				t_{gr} =	30	mm
dimensions of column section	HEB 180	w_c = 180	mm	h_c =	180	mm
thickness of column flange and web		t_{cf} = 14	mm	t_{cw} =	9	mm
system length of column				L_c =	2800	mm
throut thickness of weld				a_w =	5	mm
anchors		M 24		A_s =	353	mm²
center to center of anchors		w_a = 240	mm	d_a =	240	mm
edge of baseplate to edge of concrete		w_e = 155		d_e =	155	mm
thickness of concrete slab				h_s =	700	mm
thickness of washer				t_w =	4	mm
thickeness of nut				t_n =	20,2	mm
lever arm of column				Z_I =	166	mm
lever arm of anchor				Z_t =	120	mm
lever arm of compression area				z_c =	83	mm
type of stress distribution				type =	II	
lever arm				z =	203,0	mm
dimension		f_{jd} = 40,2		c =	34,3	
effective width				b_{eff} =	83	mm
effective length				l_{eff} =	249	mm
anchor bolt elongation length				l_b =	256	mm

Internal forces

design value of applied normal force (tension ≥ 0)				N_{Ed} =	0	kN
design value of applied bending moment (clockwise ≥ 0)				M_{Ed} =	25	kNm
design value of applied shear force				V_{Ed} =	0	kN
compression force				F_c =	123	kN
tension force				T =	123	kN

Parameters

foundation joint material coefficient				β_j =	0,67	
loaded area	w_0 = 249 mm	d_0 = 83	mm	A_{c0} =	20544	mm
	w_1 = 559 mm	d_1 = 248	mm	A_{c1} =	138475	mm
factor				k_d =	3,00	
design bearing strength				f_{jd} =	40,2	N/mm²
eccentricity of normal force				e =	#####	mm
factor				$T/V_{pl,Rd}$ =	0,13	
reduction factor for interaction bending moment and schear force in baseplate				ρ =	1,00	

Stifness coefficients

coefficient			k_{13} =	8,79
coefficient			k_{15} =	58,60
coefficient			k_{16} =	2,75
tension stiffness coefficient			k_t =	2,63
compression stiffnes coefficient			k_c =	8,79

Design resistance

distance from centre of anchor to effective edge of column web					m	=	110,1 mm
distance from centre of anchor to effective edge of column flange					$m_2;m_x$	=	24,3 mm
end distance from centre of anchor to edge of base plate (width)					e	=	50 mm
end distance from centre of anchor to edge of base plate (depth)					e_1	=	50 mm
spacing between centers of anchors (depth)					p	=	240 mm
effective width of column web	$l_{eff,cp}$ =	446	$l_{eff,nc}$ =	301	$b_{eff,t,wc}$	=	301 mm
shear area of cthe column					A_v	=	2024 mm²
transformation factor					β	=	*1,0*
factor for interaction with shear	ω_1 =	0,99	ω_2 =	0,95	ω	=	0,99
coëfficiënt					n	=	50,0 mm
coëfficiënt	λ_1 =	0,69	λ_2 =	0,15	a	=	*6,3*
bending in baseplate conform:	*Eurocode 1993-1-8*						
effective length	$l_{eff,cp}$ =	153	$l_{eff,nc}$ =	130	$l_{eff,1}$	=	130
design shear resistance of baseplate					$V_{pl,Rd}$	=	984 kN
design moment resistance of baseplate					$M_{pl,1,Rd}$	=	4,6 kNm
design tension resistance of T-stub flange - mode 1 and 2					$F_{t,1,2,Rd}$	=	379 kN
design tension resistance of T-stub flange - mode 3					$F_{t,3,Rd}$	=	203 kN
design moment resistance of the beam cross-section					$M_{c,Rd}$	=	171 kNm
design tension resistance of anchor					$F_{t,a,Rd}$	=	102 kN
design resistance of column web in tension					$F_{t,wc,Rd}$	=	897 kN
design resistance of base plate in bending					$F_{t,pl,Rd}$	=	203 kN
design tension resistance					$F_{t,Rd}$	=	203 kN
design resisitance of concrete in compression					$F_{c,pl,Rd}$	=	826 kN
column flange and web in compression					$F_{c,fc,Rd}$	=	1030 kN
design compression resistance					$F_{c,Rd}$	=	826 kN
design moment resistance					M_{Rd}	=	41 kNm

Rotation spring constant

eccentricity					e_k	=	36 mm
stifness ratio					μ	=	1,0
rotation spring constant					S_j	=	17,5 MNm/rad
			simplified method		S_j	=	17,5 MNm/rad

Classification

rotation spring constant					$S_{j,ini}$	=	17,5 MNm/rad
moment of inertia of column					I_y	=	4E+07 mm⁴
radius of gyration					i_y	=	77 mm
slenderness value					λ_1	=	76,399
relative slenderness					λ_0	=	0,48
structure in which the bracing system reduces the horizontal displacement at least 80%							*No*
lower limit rigid classification					Zone 1	≥	86,2 MNm/rad
upper limit nominally pinned classification					Zone 3	≤	1,4 MNm/rad
The connection is classified in zone:	2 Semi-Rigid			17,5 MNm/rad			

Unity Checks

bending of baseplate	u.c. =	123	/ 379	=	0,32	
tension of anchors	u.c. =	62	/ 102	=	0,61	
concete under compression	u.c. =	123	/ 826	=	0,15	

Note: This calculation does not include the check of reinforcing steel, shear force and anchor pull out.