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"For comments"

Expansion storage capacity TP3

Tank foundations T301-T315

Weight calculation

Klant	Neste Terminals	Klant projectnr.	2305
Project	Expansion storage capacity TP3	KH projectnr.	68685
Locatie	Vlaardingen		
Installatie	Tank pit 3	Revisie	0
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Revision	Description	Date
0	For comments	16-7-2021

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2 Introduction

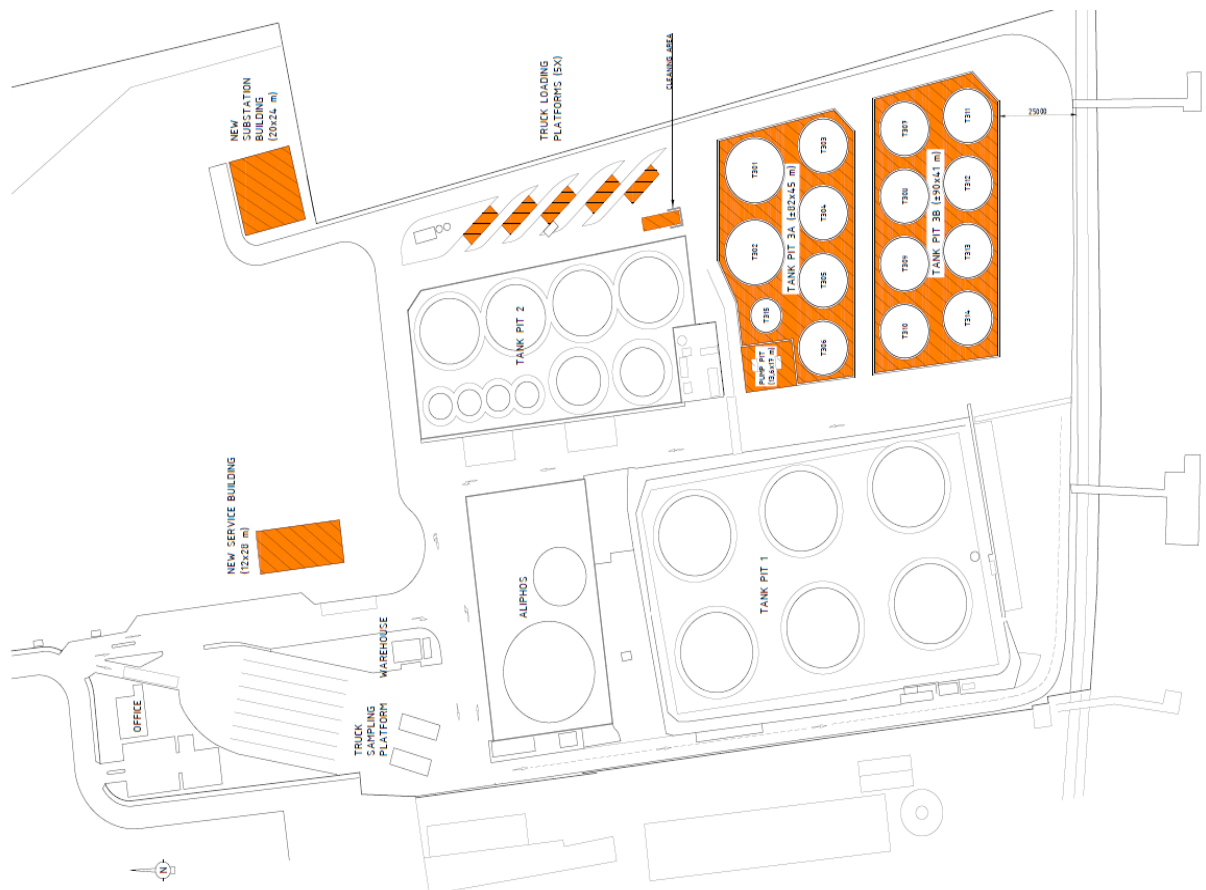
Neste Terminal in Rotterdam has the intention to expand the storage capacity of their tank terminal in Rotterdam.

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 bundwall 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 weight calculation the pile loads are determined for the tank foundations in tank pit 3. In addition deflection and punching of the slab are checked.

3 General

3.1 Standards

NEN-EN 1990+A1+A1/C2/NB:2019	Eurocode 0: Basis of structural design
NEN-EN 1991	Eurocode 1: Actions on structures
NEN-EN 1991-1-1+C1+C11:2019/NB:2019	General actions - Densities, self-weight, etc.
NEN-EN 1991-1-4+A1+C2:2011/NB:2019	General actions - Wind actions
NEN-EN 1991-1-5+C1:2011/NB:2019	General actions - Thermal actions
NEN-EN 1992	Eurocode 2: Design of concrete structures
NEN-EN 1992-1-1+C2:2011/NB+A1:2020	General rules and rules for buildings

3.2 Reference documents

drawings:

• 2307-E40-DW-1432-0001	Piling plan Tank pit 3
• 2307-E40-DW-1743-001	Form drawing Tank Foundation T301-T302
• 2307-E40-DW-1743-002	Form drawing Tank Foundation T303 to T314
• 2307-E40-DW-1743-003	Form drawing Tank Foundation T315

other:

• FA01-D02-2101015	Geotechnical advice TP03 Neste
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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

materials

concrete strength class	C30/37
reinforcing steel grade	B500B

deformations limits

horizontal and vertical deflections	quasi permanent	$\omega_{lim} = l_{rep} / 250$
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piling

The springs constants are derived from the geotechnical advise. Because crack control is decisive the characteristic value is applied. For the horizontal spring constant see also chapter 9.3.

	k_v	k_h
T301 & T302	70	15 MN/m
T303-T314	60	13 MN/m
T315	65	15 MN/m

cracked concrete

In case of thermal forces the structure is checked with the modules of elasticity of the cracked cross section. This reduced stiffness, without tension stiffening, with creep is as follows (ULS only)

Poisson ratio cracked concrete = 0,00

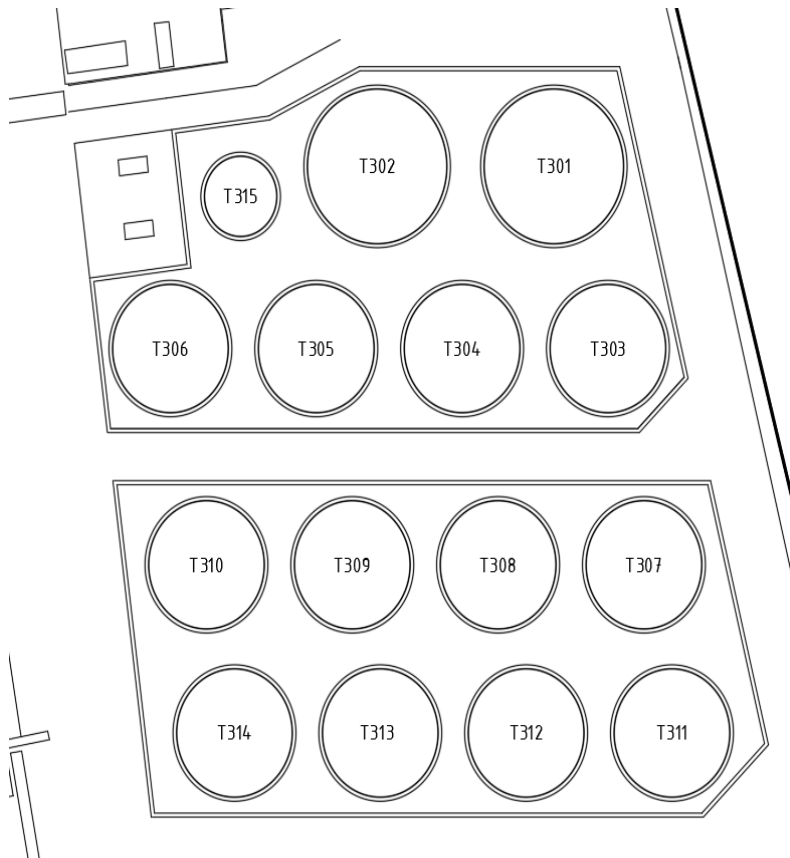
width		$b = 1000$ mm
height		$h = 820$ mm
concrete cover		$c = 50$ mm
cross sectional area of reinforcement	$\emptyset 20 - 100$	$A_s = 3142$ mm ²
effective height	$h - c - 0,5\emptyset =$	$d = 760$ mm
reinforcement ratio	$A_s / A_c =$	$\rho = 0,004$
design value of modules of elasticity reinforcing steel		$E_s = 2E+05$ N/mm ²
secant modules of elasticity		$E_{cm} = 33000$ N/mm ²
tangent modules of elasticity	$1,05E_{cm} =$	$E_c = 34650$ N/mm ²
creep		$\varphi = 1,67$
effective modules of elasticity of concrete	$E_c / (1 + \varphi) =$	$E_{c,eff} = 12994$ N/mm ²
ratio	$E_s / E_{c,eff} =$	$a_e = 15,4$
height of compression area	$-a_e \rho + ((a_e \rho)^2 + 2a_e \rho)^{0,5} d =$	$x = 227$ mm
moment of inertia:	- of uncracked cross section $1/12bh^3 =$	$I_I = 4,6E+10$ mm ⁴
	- of cracked cross section $1/12bx^3 + bx(0,5x)^2 + a_e A_s (d - x)^2 =$	$I_{II} = 1,8E+10$ mm ⁴
ratio	$I_I / I_{II} =$	$\alpha_I = 0,38$
reduced modules of elasticity	$E_{cm} \alpha_I =$	$E_{cr} = 12667$ N/mm ²

4 Structure

The tank foundations consist of concrete slabs on foundation piles. The piling consist of a square grid of piles, positioned such that there is no pile at the centre of the slab. The outer piles are placed in a radial grid, along the periphery of the tank. The top of the slabs have a slope of 1% towards the recess required for draining the tank. This recess is located at the centre of the slab with the exception for tank T315. for tank T315 the recess is located at the edge of the slab.

dimensions of recess

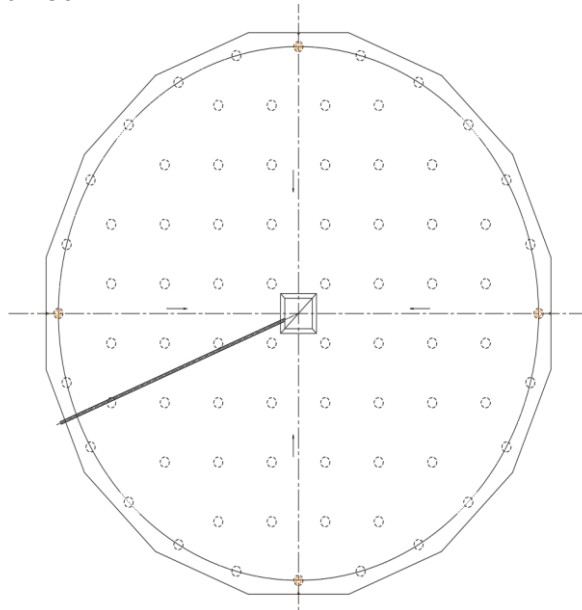
T301-T314	at centre	$b \times h = 1,3 \times 1,27 \text{ m}$	$h = 0,42 \text{ m}$
T315	at edge	$b \times h = 1,0 \times 1,2 \text{ m}$	$h = 0,34 \text{ m}$



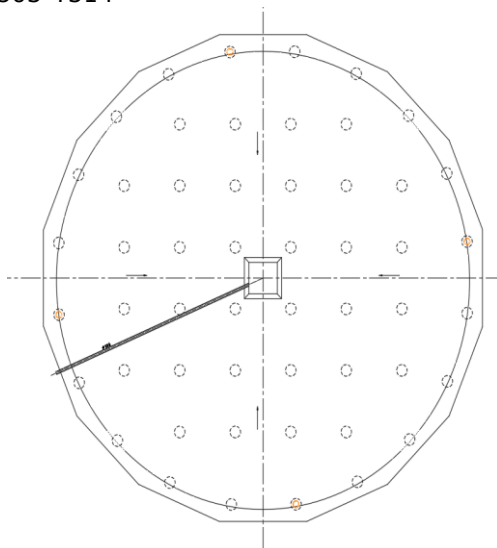
Tanks	pcs.	D [m]	h [m]	t [m]
T301 & T302	2	19,3	16,5	0,9
T303-T314	12	16,0	24,5	0,9
T315	1	10,0	16,5	0,9

D = diameter tank
h = tank height
t = slab thickness

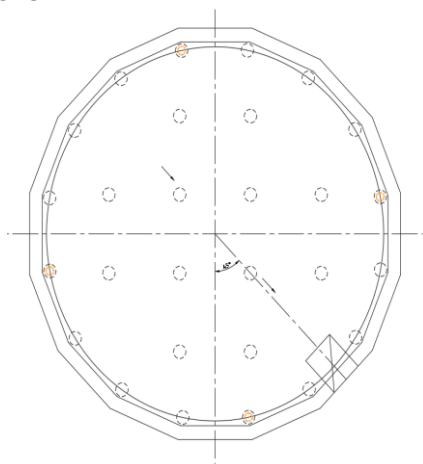
T301 & T302



T303-T314



T315



5 Loads and load combinations

Loads on the tank foundations are taken from the "Foundation loads" from tank supplier, see appendix D

5.1 DL - Dead load

Dead load for compensation slab thickness with slope

T301 & T302	$0,10 \times 25 = g_k = 2,41 \text{ kN/m}^2$
T303-T314	$0,08 \times 25 = g_k = 2,00 \text{ kN/m}^2$

5.2 LL - Imposed load

roof access for inspection and repair $= 1,0 \text{ kN/m}^2$

5.3 EO - Operating load

The resultant of the operating load in Scia is slightly less than expected. This most likely because the surface load is taken into account as a polygon instead of a circle. Therefore this load is increased with the following percentage.

increment of operating load $0,6 \%$

5.4 WL - Wind load

Pressure point based on centre of gravity of half circle with elastic stress distribution

$$\frac{\sum_{i=0}^{\pi} Fa}{\sum_{i=0}^{\pi} F} = \frac{\sum_{i=0}^{\pi} \sin \alpha^2}{\sum_{i=0}^{\pi} \sin \alpha} = \frac{\pi D}{4}$$

5.5 Tlf - Temperature load

temperature of tank volume

$$T_{in} = 95 \text{ }^{\circ}\text{C}$$

temperature of soil

NEN-EN 1991-5 N/A table 5.3 (t_8) $T_{out} = 10 \text{ }^{\circ}\text{C}$

properties of construction layers:

tank bottom	$h_1 = 0,00 \text{ m}$	$\lambda_1 = 52 \text{ W/(mK)}$	$R_{m,1} = 0,00 \text{ m}^2\text{K/W}$
oil sand	$h_2 = 0,05 \text{ m}$	$\lambda_2 = 1,2 \text{ W/(mK)}$	$R_{m,2} = 0,04 \text{ m}^2\text{K/W}$
foam glass	$h_3 = 0,1 \text{ m}$	$\lambda_3 = 0,05 \text{ W/(mK)}$	$R_{m,3} = 2,22 \text{ m}^2\text{K/W}$
concrete slab	$h_4 = 0,9 \text{ m}$	$\lambda_4 = 2 \text{ W/(mK)}$	$R_{m,4} = 0,45 \text{ m}^2\text{K/W}$

thermal resistance of structure

$$\sum R_m = R_c = 2,71 \text{ m}^2\text{K/W}$$

thermal resistance at the inner surface

$$R_{in} = 0,00 \text{ m}^2\text{K/W}$$

thermal resistance at the outer surface

$$R_{out} = 0,00 \text{ m}^2\text{K/W}$$

total thermal resistance

$$R_c + R_{in} + R_{out} = R_t = 2,71 \text{ m}^2\text{K/W}$$

temperature at top of concrete slab $T_{out} - (R_{m,4} + R_{out}) / R_{tot} \times (T_{out} - T_{in}) = T_+ = 24 \text{ }^{\circ}\text{C}$

temperature at bottom of concrete slab $T_{out} - R_{out} / R_{tot} \times (T_{out} - T_{in}) = T_- = 10 \text{ }^{\circ}\text{C}$

reference temperature

$$t_0 = 10 \text{ }^{\circ}\text{C}$$

uniform temperature component

$$\Delta T_u = 7,0 \text{ K}$$

temperature gradient

$$\Delta T_{Mz} = 14,1 \text{ K}$$

5.5 Load combinations

case	type	name	group
DL	Dead Load	Self -weight	LG1
EE	Dead Load	Empty pipe	LG1
EO	Dead Load	Operating load	LG1
LL	Live Load	Imposed load	LG2
WL	Live Load	Wind load	LG3
WL45	Live Load	Wind load 45°	LG3
TLt	Live Load	Thermal forces	LG4

load group		ψ_0	ψ_1	ψ_2
LG1	-	-	-	-
LG2	Category H	0,0	0,0	0,0
LG3	Wind	0,0	0,2	0,0
LG4	Temperature	1,0	0,9	0,8

The partial factors for the temperature load are taken equal to the factors for load category E. This because in this case the temperature load can be considered a permanent load.

STR/GEO (group B)

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

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

$$\xi = 0,89 \quad \gamma_{G,\text{sup}} = 1,35 \quad \gamma_{G,\text{inf}} = 1,0 \quad \gamma_Q = 1,5$$

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

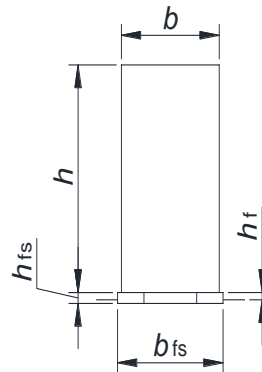
$$SLS_{\text{quasi}} = \sum_{j \geq 1} G_{k,j} + \psi_{2,1} Q_{k,1} + \sum_{i \geq 1} \psi_{2,i} Q_{k,i}$$

6 Tank foundations T301-T302

6.1 Dimensions

6.1.1 Tank

diameter
height



$$b = 19,3 \text{ m}$$

$$h = 16,5 \text{ m}$$

6.1.2 Octagon foundation

slab width
slab thickness

$$b_{fs} = 20,3 \text{ m}$$

$$h_{fs} = 0,9 \text{ m}$$

height from ground level to top of foundation

$$h_f = 0,0 \text{ m}$$

6.2 Loads

6.2.1 DL - Self-weight foundation

specific weight of reinforced concrete
volume of octagon
self weight

$$\gamma_c = 25 \text{ kN/m}^3$$

$$V_{fs} = 295,1 \text{ m}^3$$

$$\gamma_c \times V_{fs} = G_k = 7377 \text{ kN}$$

6.2.2 EE - Self-weight empty tank

self weight
perimeter of tank
line load

$$G_k = 1085 \text{ kN}$$

$$\pi \times b = P = 60,63 \text{ m}$$

$$G_k/P = g_k = 17,9 \text{ kN/m}$$

6.2.3 EO - Operating load

surface of tank roof
specific weight of water
uniformly distributed load
self weight

$$1/4 \times \pi \times b^2 = A_{\text{roof}} = 292,6 \text{ m}^2$$

$$\gamma_l = 10 \text{ kN/m}^3$$

$$h \times \gamma_l = g_k = 165 \text{ kN/m}^2$$

$$g_k \times A_{\text{roof}} = G_k = 48271 \text{ kN}$$

uniformly distributed load with correction

$$c = 0,69 \%$$

$$g_{k,c} = 166,1 \text{ kN/m}^2$$

6.2.4 LL - Imposed load on roof

uniformly distributed load
total load
line load

$$q_k = 1,0 \text{ kN/m}^2$$

$$q_k \times A_{\text{roof}} = Q_k = 293 \text{ kN}$$

$$Q_k/P = q_k = 4,83 \text{ kN/m}$$

6.2.5 WL - Wind load

wind force

$$F_{w,k} = 394,5 \text{ kN}$$

wind moment

$$M_{w,k} = 3430 \text{ kNm}$$

number of anchors

$$= 24 \text{ pcs}$$

starting angle

$$= 0^\circ$$

$$d_a = 19,5 \text{ m}$$

pressure point to edge of tank

$$0,125b(4-\pi) = a = 2,1 \text{ m}$$

anchor forces

#	angle	a_i [m]	a_i^2 [m ²]	F_i [kN]	M_i [kNm]
1	0	0	0	0	0
2	15	0	0	0	0
3	30	0	0	0	0
4	45	0,76	0,58	1,0	0,79
5	60	2,78	7,74	3,8	10,5
6	75	5,13	26,4	6,9	35,7
7	90	7,66	58,6	10,4	79,3
8	105	10,2	104	13,8	140
9	120	12,5	157	17,0	212
10	135	14,6	212	19,7	286
11	150	16,1	259	21,8	351
12	165	17,1	292	23,1	394
13	180	17,4	303	23,5	410
14	195	17,1	292	23,1	394
15	210	16,1	259	21,8	351
16	225	14,6	212	19,7	286
17	240	12,5	157	17,0	212
18	255	10,2	104	13,8	140
19	270	7,66	58,6	10,4	79,3
20	285	5,13	26,4	6,9	35,7
21	300	2,78	7,74	3,8	10,5
22	315	0,76	0,58	1,0	0,79
23	330	0	0	0	0
24	345	0	0	0	0
			<u>2536</u>		<u>3430</u>

$$F_i = M_w a_i / \sum a_i^2$$

maximum tension force on anchor

$$F_{t,k} = 23,5 \text{ kN}$$

shear load on anchor

$$F_{h,k} = 16,4 \text{ kN}$$

compression force

$$\Sigma F_i = F_c = 258 \text{ kN}$$

with of tank at pressure point

$$l = 12,0 \text{ m}$$

compression force as line load

$$F_c/l = q_c = 21,5 \text{ kN/m}$$

6.3 Result

total characteristic load

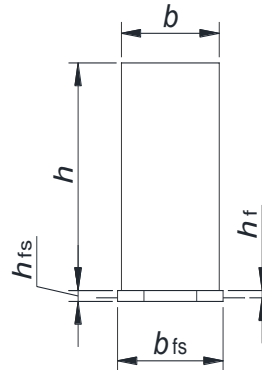
$$F_{Ed} = 57026 \text{ kN}$$

7 Tank foundations T303-T314

7.1 Dimensions

7.1.1 Tank

diameter
height



$$b = 16,0 \text{ m}$$

$$h = 24,5 \text{ m}$$

7.1.2 Octagon foundation

slab width
slab thickness

$$b_{fs} = 17,0 \text{ m}$$

$$h_{fs} = 0,9 \text{ m}$$

height from ground level to top of foundation

$$h_f = 0,0 \text{ m}$$

7.2 Loads

7.2.1 DL - Self-weight foundation

specific weight of reinforced concrete
volume of octagon
self weight

$$\gamma_c = 25 \text{ kN/m}^3$$

$$V_{fs} = 206,9 \text{ m}^3$$

$$\gamma_c \times V_{fs} = G_k = 5174 \text{ kN}$$

7.2.2 EE - Self-weight empty tank

self weight
perimeter of tank
line load

$$G_k = 1055 \text{ kN}$$

$$\pi \times b = P = 50,27 \text{ m}$$

$$G_k/P = g_k = 21,0 \text{ kN/m}$$

7.2.3 EO - Operating load

surface of tank roof
specific weight of water
uniformly distributed load
self weight

$$1/4 \times \pi \times b^2 = A_{\text{roof}} = 201,1 \text{ m}^2$$

$$\gamma_l = 10 \text{ kN/m}^3$$

$$h \times \gamma_l = g_k = 245 \text{ kN/m}^2$$

$$g_k \times A_{\text{roof}} = G_k = 49260 \text{ kN}$$

uniformly distributed load with correction

$$c = 0,69 \%$$

$$g_{k,c} = 246,7 \text{ kN/m}^2$$

7.2.4 LL - Imposed load on roof

uniformly distributed load
total load
line load

$$q_k = 1,0 \text{ kN/m}^2$$

$$q_k \times A_{\text{roof}} = Q_k = 201 \text{ kN}$$

$$Q_k/P = q_k = 4,00 \text{ kN/m}$$

7.2.5 WL - Wind load

wind force

$$F_{w,k} = 472,5 \text{ kN}$$

wind moment

$$M_{w,k} = 5961 \text{ kNm}$$

number of anchors

$$= 20 \text{ pcs}$$

starting angle

$$= 0^\circ$$

$$d_a = 16,2 \text{ m}$$

pressure point to edge of tank

$$0,125b(4-\pi) = a = 1,7 \text{ m}$$

anchor forces

#	angle	a_i [m]	a_i^2 [m ²]	F_i [kN]	M_i [kNm]
1	0	0	0	0	0
2	18	0	0	0	0
3	36	0	0	0	0
4	54	1,6	2,56	6,5	10,5
5	72	3,86	14,9	15,8	60,8
6	90	6,36	40,5	26	165
7	108	8,86	78,6	36,2	321
8	126	11,1	124	45,5	506
9	144	12,9	167	52,8	682
10	162	14,1	198	57,5	808
11	180	14,5	209	59,1	855
12	198	14,1	198	57,5	808
13	216	12,9	167	52,8	682
14	234	11,1	124	45,5	506
15	252	8,86	78,6	36,2	321
16	270	6,36	40,5	26	165
17	288	3,86	14,9	15,8	60,8
18	306	1,6	2,56	6,5	10,5
19	324	0	0	0	0
20	342	0	0	0	0
			<u>1459</u>		<u>5961</u>

$$F_i = M_w a_i / \sum a_i^2$$

maximum tension force on anchor

$$F_{t,k} = 59,1 \text{ kN}$$

shear load on anchor

$$F_{h,k} = 23,6 \text{ kN}$$

compression force

$$\Sigma F_i = F_c = 540 \text{ kN}$$

with of tank at pressure point

$$l = 10,0 \text{ m}$$

compression force as line load

$$F_c/l = q_c = 54,2 \text{ kN/m}$$

7.3 Result

total characteristic load

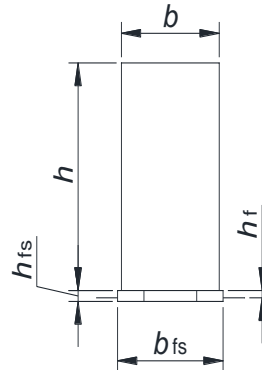
$$F_{Ed} = 55690 \text{ kN}$$

8 Tank foundations T315

8.1 Dimensions

8.1.1 Tank

diameter
height



$$b = 10,0 \text{ m}$$

$$h = 16,5 \text{ m}$$

8.1.2 Octagon foundation

slab width
slab thickness

$$b_{fs} = 11,0 \text{ m}$$

$$h_{fs} = 0,9 \text{ m}$$

height from ground level to top of foundation

$$h_f = 0,0 \text{ m}$$

8.2 Loads

8.2.1 DL - Self-weight foundation

specific weight of reinforced concrete
volume of octagon
self weight

$$\gamma_c = 25 \text{ kN/m}^3$$

$$V_{fs} = 86,65 \text{ m}^3$$

$$\gamma_c \times V_{fs} = G_k = 2166 \text{ kN}$$

8.2.2 EE - Self-weight empty tank

self weight
perimeter of tank
line load

$$\Sigma A \times t \times \gamma_{st} = G_k = 385 \text{ kN}$$

$$\pi \times b = P = 31,42 \text{ m}$$

$$G_k/P = g_k = 12,3 \text{ kN/m}$$

8.2.3 EO - Operating load

surface of tank roof
specific weight of water
uniformly distributed load
self weight

$$1/4 \times \pi \times b^2 = A_{\text{roof}} = 78,54 \text{ m}^2$$

$$\gamma_l = 10 \text{ kN/m}^3$$

$$h \times \gamma_l = g_k = 165 \text{ kN/m}^2$$

$$g_k \times A_{\text{roof}} = G_k = 12959 \text{ kN}$$

uniformly distributed load with correction

$$c = 0,69 \%$$

$$g_{k,c} = 166,1 \text{ kN/m}^2$$

8.2.4 LL - Imposed load on roof

uniformly distributed load
total load
line load

$$q_k = 1 \text{ kN/m}^2$$

$$q_k \times A_{\text{roof}} = Q_k = 79 \text{ kN}$$

$$Q_k/P = q_k = 2,50 \text{ kN/m}$$

8.2.5 WL - Wind load

wind force

$$F_{w,k} = 208,4 \text{ kN}$$

wind moment

$$M_{w,k} = 1765 \text{ kNm}$$

number of anchors

$$= 12 \text{ pcs}$$

starting angle

$$= 15^\circ$$

$$d_a = 10,2 \text{ m}$$

pressure point to edge of tank

$$0,125b(4-\pi) = a = 1,1 \text{ m}$$

anchor forces

#	angle	a_i [m]	a_i^2 [m ²]	F_i [kN]	M_i [kNm]
1	15	0	0	0	0
2	45	0,4	0,16	2,0	0,81
3	75	2,69	7,21	13,7	36,7
4	105	5,33	28,4	27,1	144
5	135	7,61	57,9	38,7	295
6	165	8,93	79,8	45,4	406
7	195	8,93	79,8	45,4	406
8	225	7,61	57,9	38,7	295
9	255	5,33	28,4	27,1	144
10	285	2,69	7,21	13,7	36,7
11	315	0,4	0,16	2,0	0,81
12	345	0	0	0	0
			<u>347</u>		<u>1765</u>

$$F_i = M_w a_i / \sum a_i^2$$

maximum tension force on anchor

$$F_{t,k} = 45,4 \text{ kN}$$

shear load on anchor

$$F_{h,k} = 17,4 \text{ kN}$$

compression force

$$\Sigma F_i = F_c = 254 \text{ kN}$$

width of tank at pressure point

$$l = 6,2 \text{ m}$$

compression force as line load

$$F_c/l = q_c = 40,7 \text{ kN/m}$$

8.3 Result

total characteristic load

$$F_{Ed} = 15589 \text{ kN}$$

9 Calculation

9.1 Deflection control

Characteristic compressive cylinder strength		$f_{ck} = 30$ N/mm ²
required tension reinforcement, see 3.4		$\rho = 0,004$
reference reinforcement		$\rho_0 = 0,005$
span/depth	$l = 2150$ $d = 900$ mm	$l/d = 2,39$
factor to take into account the structural system	table 7.4N	$K = 1,0$
limit span/depth for $\rho \leq \rho_0$	EN 1992-1-1 (7.16a)	$l/d = 22,19$

$2,39 \leq 22,2$ No deflection check is required

9.2 Punching check

9.2.1 face of the piles

design value of pile load		$V_{Ed} = 1800$ kN
pile perimeter	$\emptyset 406$ mm	$u_i = 1275$ mm
coefficient		$\beta = 1,4$
mean effective depth	$0,9 \times 804 =$	$h = 803,5$ mm
punching shear stress		$d = 723,2$ mm
		$V_{Ed} = 2,73$ N/mm ²
Design value of concrete compressive strength		$f_{cd} = 20$ N/mm ²
reduction factor for concrete cracked in shear	EN 1992-1-1 (6.6N)	$v = 0,53$
design value of the maximum punching shear resistance		$V_{Rd,max} = 4,224$ N/mm ²

$2,73 \leq 4,22$ no punching reinforcement is required

9.2.2 basic control perimeter

The spacing between piles in relation to the slab thickness is such that basic control perimeters are overlapping. This means that most of the load is applied within the perimeters and therefore this punching check is not applicable.

9.3 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 E

	rigid	free	mean	
T 101-102	46	88,6 mm	$1 / 67,5 = 14,8$ MN/m	= 15 MN/m
T 103-314	61	97,8 mm	$1 / 79,3 = 12,6$ MN/m	= 12,5 MN/m
T 315	50	90 mm	$1 / 69,8 = 14,3$ MN/m	= 15 MN/m

10 Conclusion

The thickness of the foundation slab is such that no punching reinforcement is required. Also the spacing of foundation piles is such that the deflection of the foundation does not need to be checked. The reaction forces are as follows.

thickness foundation slab 900 mm

reaction forces [kN]	Ø pile	$F_{h,k}$	$F_{c,k}$	$F_{h,Ed}$	$F_{c,Ed}$
T301 & T302	406	20	950	25	1300
T303-T314	406	10	1250	15	1800
T315	406	10	650	15	1000

There are no tension forces on the piles.

check of applied loads in calculation model

resultant reactions [kN]	Excel	Scia	difference
T301 & T302	57026	56999	-27 kN
T303-T314	55690	55677	-13 kN
T315	15589	15555	-34 kN

There is only a small difference between the sum of loads of the Scia and Excel calculation. This is partly because of the recess that is not taken into account in the Excel calculation.

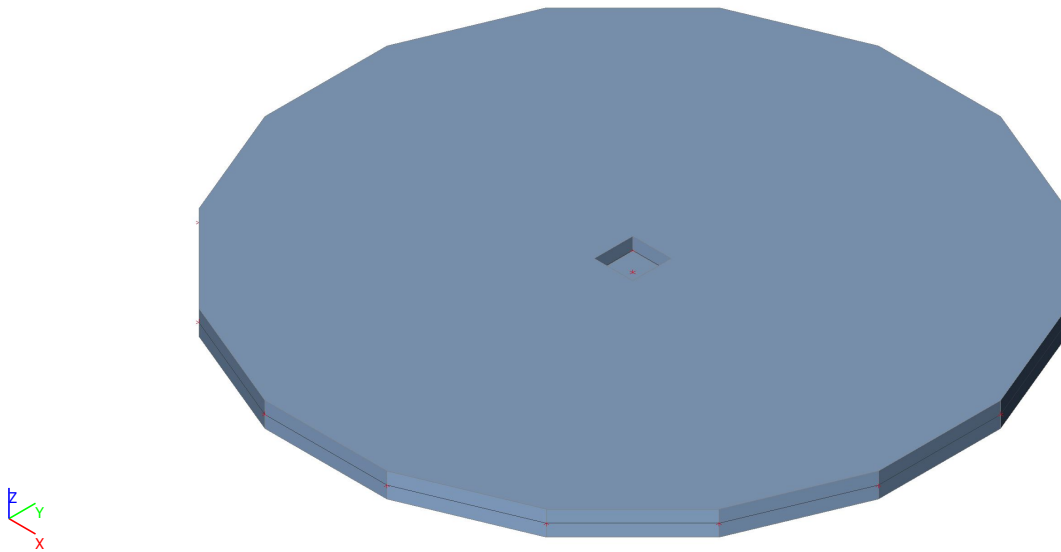
Appendix A

Scia report T301 & T302

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2. General



2.1. Project

Licence name	KH Engineering
Project	Neste - Rotterdam terminal expansion
Part	Tank pit 3 - tank foundations
Description	T301 & T302
Author	LER
Date	07. 2021
Structure	General XYZ
No. of nodes :	97
No. of beams :	0
No. of slabs :	1
No. of solids :	0
No. of used profiles :	0
No. of load cases :	8
No. of used materials :	2
Acceleration of gravity [m/s ²]	10,000
National code	EC - EN

2.2. 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	0.2	0
Temperature	0	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

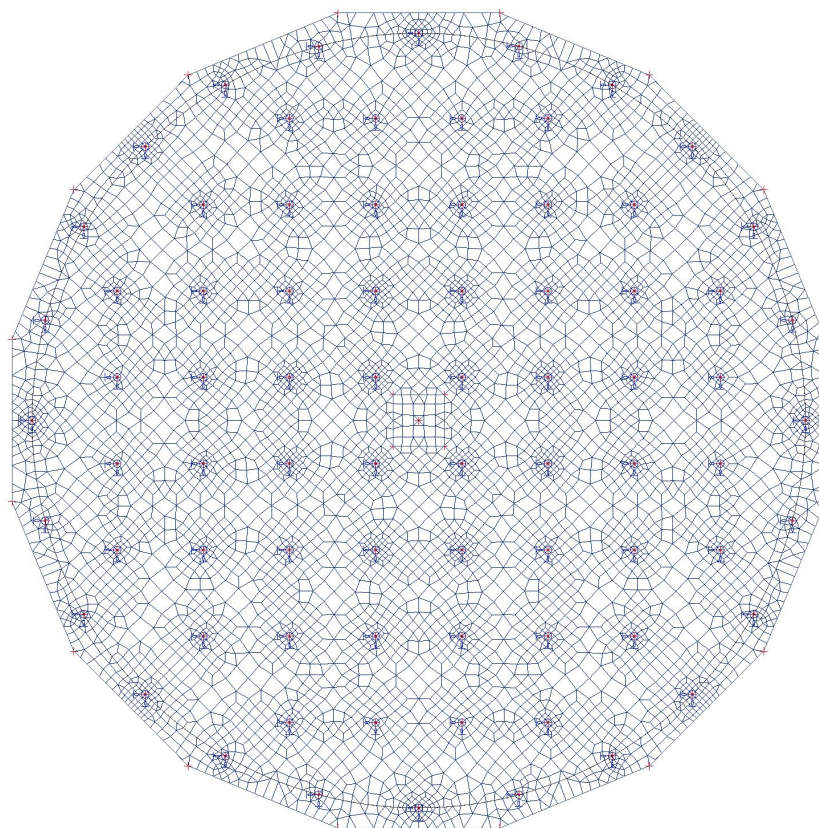
Reliability class	RC2
RC1 [-]	0,90
RC2 [-]	1,00
RC3 [-]	1,10
RC1 [-]	1,00
RC2 [-]	1,00
RC3 [-]	1,00

2.3. Solver setup

Name	SolverSetup1
Neglect shear force deformation (Ay, Az >> A)	x
Initial stress	x
Number of thicknesses of rib plate	20
Maximum soil interaction iterations	10
Maximum iterations	20
Number of increments	1
Number of buckling modes	2
Number of sections on average member	10
Step for soil/water pressure [m]	0,500
C1x [MN/m ³]	1,0000e-01
C1y [MN/m ³]	1,0000e-01
C1z [MN/m ³]	1,0000e+01
C2x [MN/m]	5,0000e+00
C2y [MN/m]	5,0000e+00
Coefficient for reinforcement	1
Warning when maximal translation is greater than [mm]	1000,0
Warning when maximal rotation is greater than [mrad]	100,0
Parallelism tolerance [deg]	10,00
Ratio to half - distance to adjacent beam beff,i/bi [-]	0,20
Ratio to effective span length beff,i/l0 [-]	0,10
Max ratio to effective span length beff,i/l0 [-]	0,20
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever, base ratio to current span [-]	1,00
Cantilever, base ratio to adjacent span [-]	0,15
Cantilever, max ratio to current span [-]	1,50
Max adjacent span length ratio [-]	1,50
Max cantilever length ratio to adjacent span [-]	0,50
Span length ratio Le/beff,i,max (1 side) [-]	8,00
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever [-]	2,00
Method used for non-concrete and non-steel / composite beams	EN 1994-1-1
Solver precision ratio	1
Soil combination	None
Bending theory of plate/shell analysis	Mindlin
Type of solver	Direct
Type of eigen value solver	Lanczos
Method of calculation	Picard

2.4. Mesh setup

Name	MeshSetup1
Generation of eccentric elements on members with variable height	x
Generation of nodes in connections of beam elements	x
Elastic mesh	✓
Use automatic mesh refinement	✓
Connect members/nodes	✓
Division on haunches and arbitrary members	5
Division for 2D-1D upgrade	50
Average number of tiles of 1d element	1
Target error for mesh refinement [%]	10
Average size of 2d element/curved element [m]	0,430
Minimal length of beam element [m]	0,100
Maximal length of beam element [m]	1000,000
Average size of cables, tendons, elements on subsoil, nonlinear soil spring [m]	1,000
Maximal out of plane angle of a quadrilateral [mrad]	30,0
Predefined mesh ratio	1.5
Minimal distance between definition point and line [m]	0.001
Average size of panel element [m]	0,300
Mesh refinement following the beam type	None
Definition of mesh element size for panels	Manual



2.5. Materials

Name	Type	ρ [kg/m ³]	Density in fresh state [kg/m ³]	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	■
C30/37 Cracked	Concrete	2500,0	2600,0	1,2677e+04	0.0001	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.
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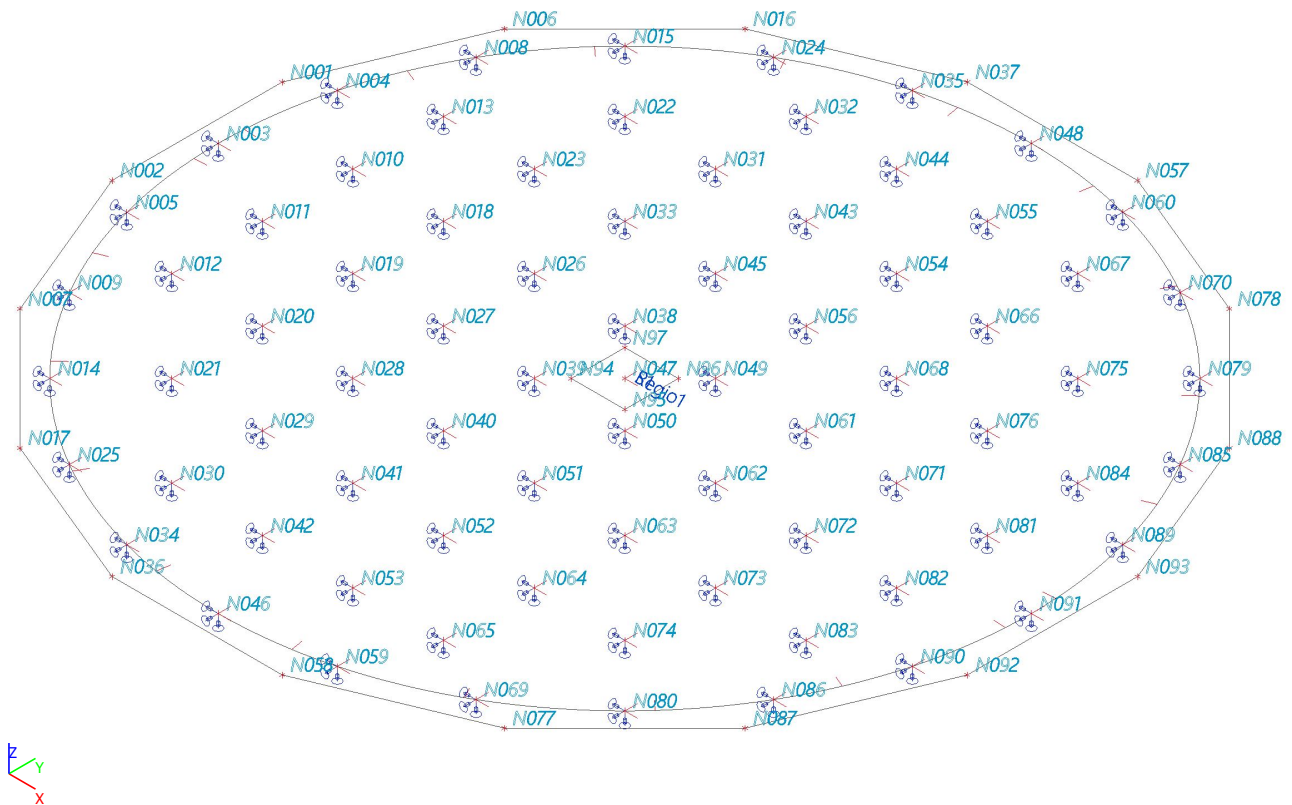
3. Structure

3.1. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N001	-10,150	2,019	0,000
N002	-10,150	-2,019	0,000
N003	-9,650	0,000	0,000
N004	-9,321	2,498	0,000
N005	-9,321	-2,498	0,000
N006	-8,605	5,750	0,000
N007	-8,605	-5,750	0,000
N008	-8,357	4,825	0,000
N009	-8,357	-4,825	0,000
N010	-7,525	1,075	0,000
N011	-7,525	-1,075	0,000
N012	-7,525	-3,225	0,000
N013	-7,525	3,225	0,000
N014	-6,824	-6,824	0,000
N015	-6,824	6,824	0,000
N016	-5,750	8,605	0,000
N017	-5,750	-8,605	0,000
N018	-5,375	1,075	0,000
N019	-5,375	-1,075	0,000
N020	-5,375	-3,225	0,000
N021	-5,375	5,375	0,000
N022	-5,375	5,375	0,000
N023	-5,375	3,225	0,000
N024	-4,825	8,357	0,000
N025	-4,825	-8,357	0,000
N026	-3,225	1,075	0,000
N027	-3,225	-1,075	0,000
N028	-3,225	-3,225	0,000
N029	-3,225	5,375	0,000
N030	-3,225	-7,525	0,000
N031	-3,225	5,375	0,000
N032	-3,225	7,525	0,000
N033	-3,225	3,225	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N034	-2,498	-9,321	0,000
N035	-2,498	9,321	0,000
N036	-2,019	-10,150	0,000
N037	-2,019	10,150	0,000
N038	-1,075	1,075	0,000
N039	-1,075	-1,075	0,000
N040	-1,075	-3,225	0,000
N041	-1,075	-5,375	0,000
N042	-1,075	-7,525	0,000
N043	-1,075	5,375	0,000
N044	-1,075	7,525	0,000
N045	-1,075	3,225	0,000
N046	0,000	-9,650	0,000
N047	0,000	0,000	0,000
N048	0,000	9,650	0,000
N049	1,075	1,075	0,000
N050	1,075	-1,075	0,000
N051	1,075	-3,225	0,000
N052	1,075	-5,375	0,000
N053	1,075	-7,525	0,000
N054	1,075	5,375	0,000
N055	1,075	7,525	0,000
N056	1,075	3,225	0,000
N057	2,019	10,150	0,000
N058	2,019	-10,150	0,000
N059	2,498	-9,321	0,000
N060	2,498	9,321	0,000
N061	3,225	1,075	0,000
N062	3,225	-1,075	0,000
N063	3,225	-3,225	0,000
N064	3,225	-5,375	0,000
N065	3,225	-7,525	0,000
N066	3,225	5,375	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N067	3,225	7,525	0,000
N068	3,225	3,225	0,000
N069	4,825	-8,357	0,000
N070	4,825	8,357	0,000
N071	5,375	1,075	0,000
N072	5,375	-1,075	0,000
N073	5,375	-3,225	0,000
N074	5,375	-5,375	0,000
N075	5,375	5,375	0,000
N076	5,375	3,225	0,000
N077	5,750	-8,605	0,000
N078	5,750	8,605	0,000
N079	6,824	6,824	0,000
N080	6,824	-6,824	0,000
N081	7,525	1,075	0,000
N082	7,525	-1,075	0,000
N083	7,525	-3,225	0,000
N084	7,525	3,225	0,000
N085	8,357	4,825	0,000
N086	8,357	-4,825	0,000
N087	8,605	-5,750	0,000
N088	8,605	5,750	0,000
N089	9,321	2,498	0,000
N090	9,321	-2,498	0,000
N091	9,650	0,000	0,000
N092	10,150	-2,019	0,000
N093	10,150	2,019	0,000
N94	-0,635	-0,635	0,000
N95	0,635	-0,635	0,000
N96	0,635	0,635	0,000
N97	-0,635	0,635	0,000



3.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S1	Layer1	plate (90)	Standard	C30/37	constant	804

3.3. 2D member regions

Name	2D member	Material	Thickness type	MSP at	Ecc. z [mm]	Th. [mm]	Node	Edge
Regio1	S1	C30/37	constant	Centre	-210	384	N94 N95 N96 N97	Line Line Line Line

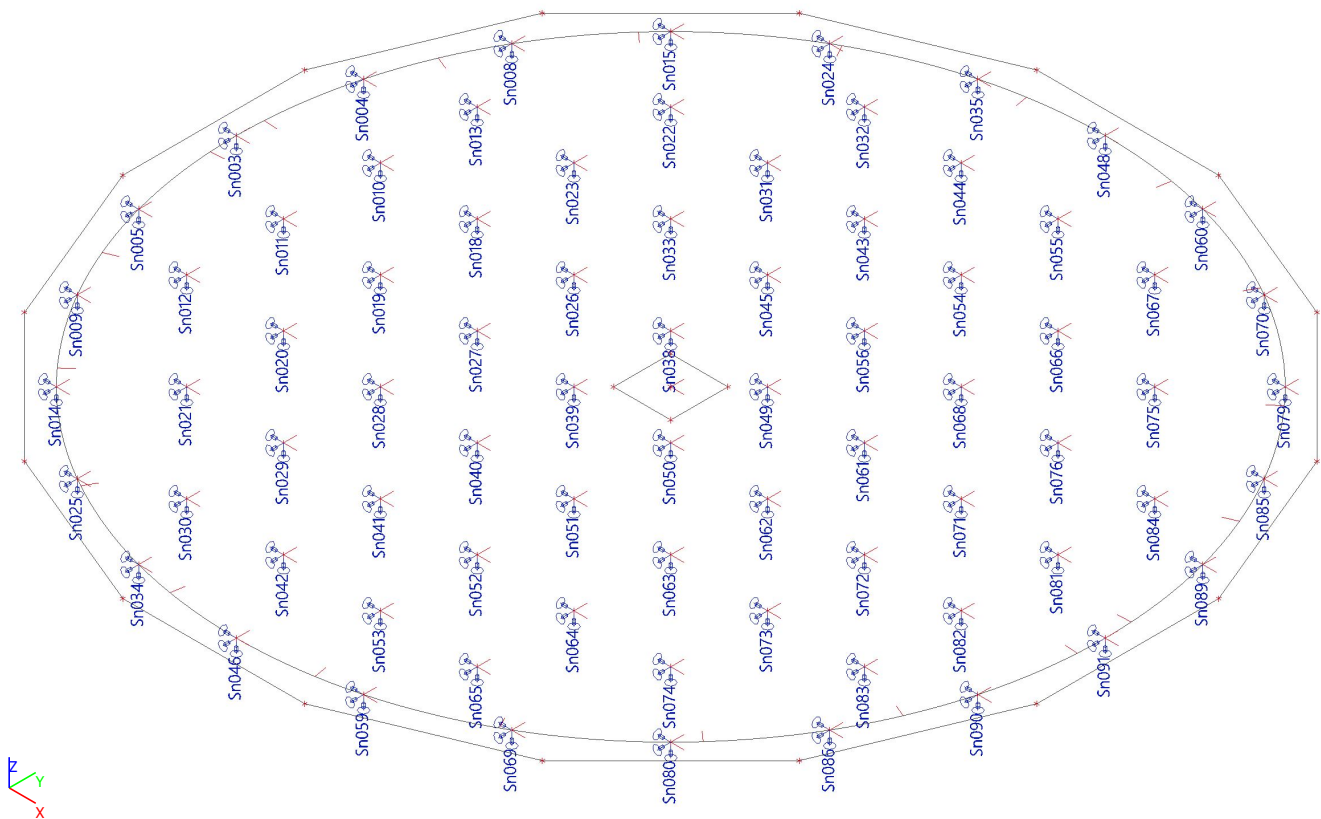
3.4. 2D member internal edges

Name	Member 1	Length [m]	Shape	Node	Edge
ES1	S1	30,316	Arc	N003 N046 N091	Circle arc
ES2	S1	30,316	Arc	N091 N048 N003	Circle arc

3.5. Nodal supports

Name	Node	System	Type	X	Stiffness X [MN/m]	Y	Stiffness Y [MN/m]	Z	Stiffness Z [MN/m]	Rx	Ry	Rz
Sn003	N003	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn004	N004	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn005	N005	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn008	N008	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn009	N009	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn010	N010	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn011	N011	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free
Sn012	N012	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	7,0000e+01	Free	Free	Free

[illegible]

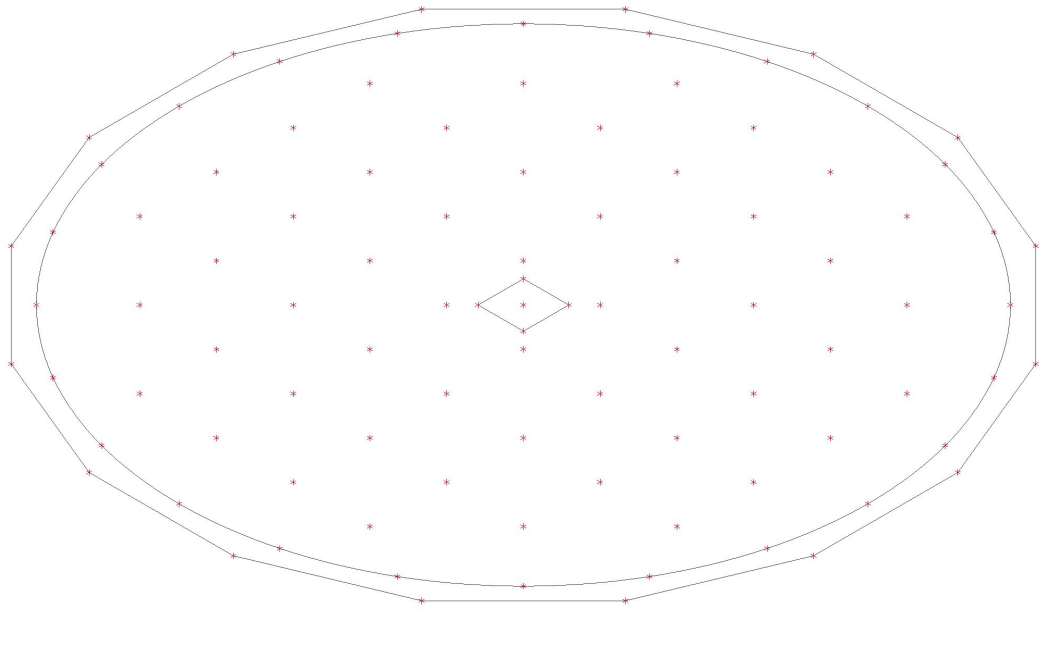


4. loads

4.1. Load cases

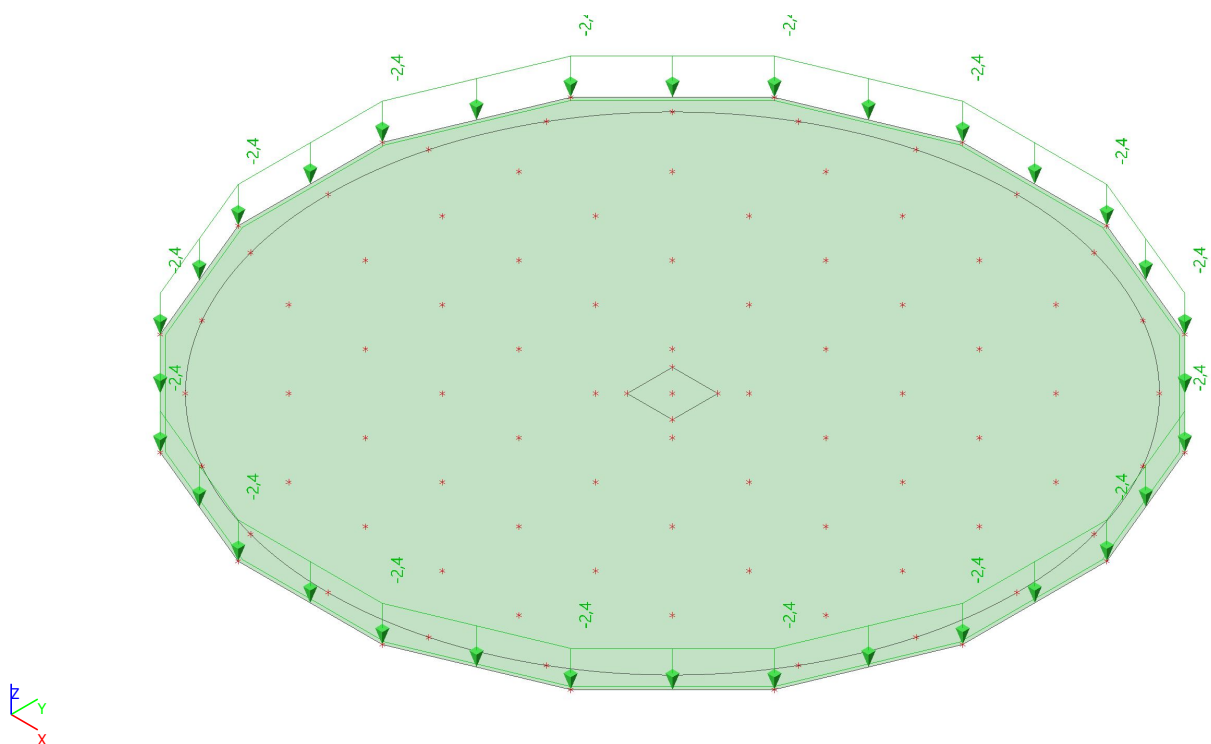
4.1.1. Load cases - DL

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



4.1.2. Load cases - DL1

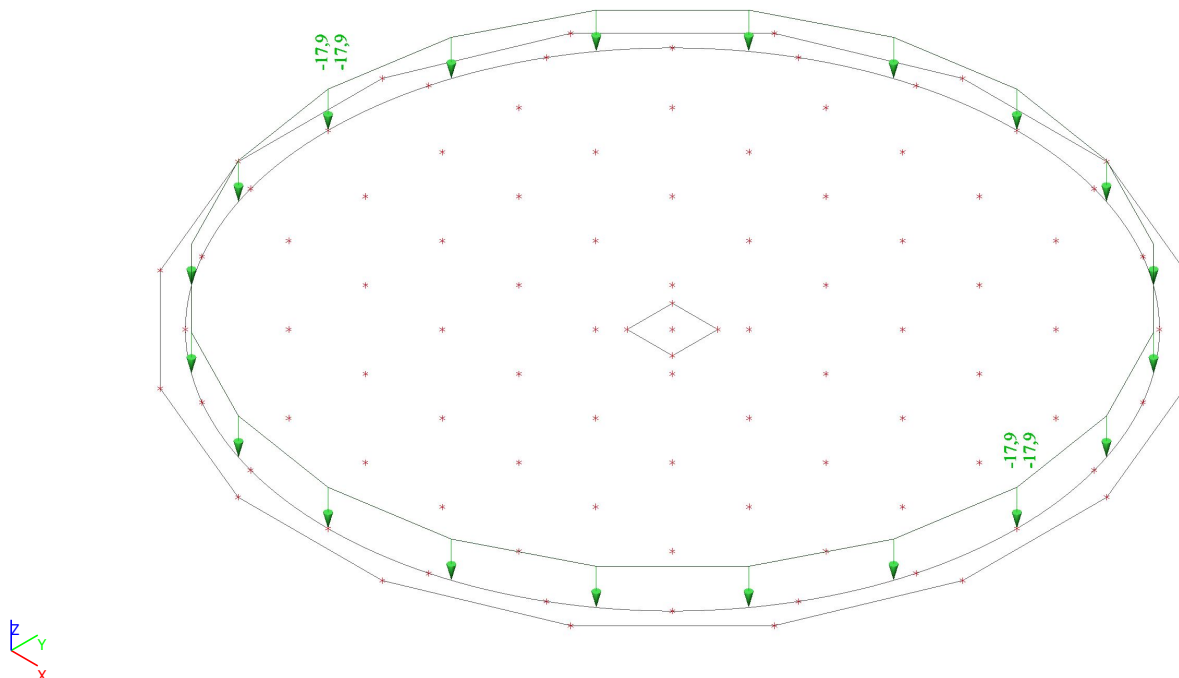
Name	Description	Action type	Load type	Load group
DL1	Dead load - slope	Permanent	Standard	LG1



Name	Dir	Type	Value [kN/m ²]	2D member	Load case	System	Loc
SF1	Z	Force	-2,4	S1	DL1 - Dead load - slope	LCS	Length

4.1.3. Load cases - EE

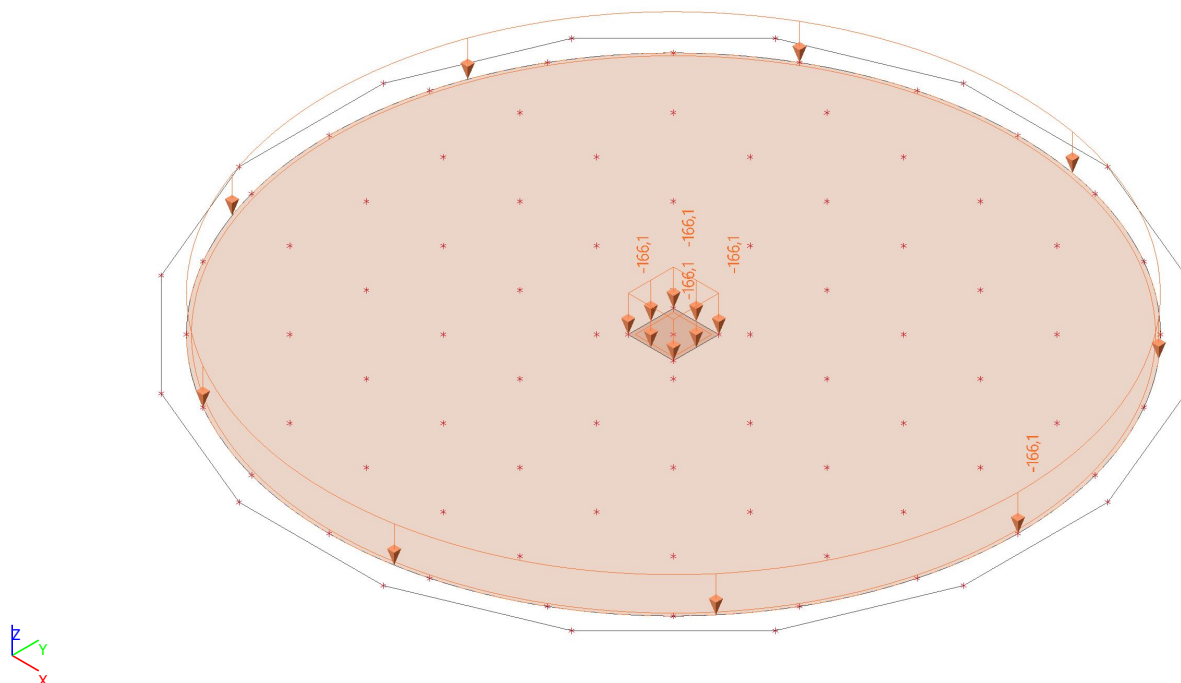
Name	Description	Action type	Load type	Load group
EE	Dead load - Empty equipment	Permanent	Standard	LG1



Name	Internal edge	Type	System	Dir	Distribution	Value - P ₁ [kN/m]	Pos x ₁	Pos x ₂	Loc	Coor	Edge	Orig
LFS5	ES1	Force	LCS	Z	Uniform	-17,9	0.000	1.000	Length	Rela	1	From start
LFS7	ES2	Force	LCS	Z	Uniform	-17,9	0.000	1.000	Length	Rela	1	From start

4.1.4. Load cases - EO

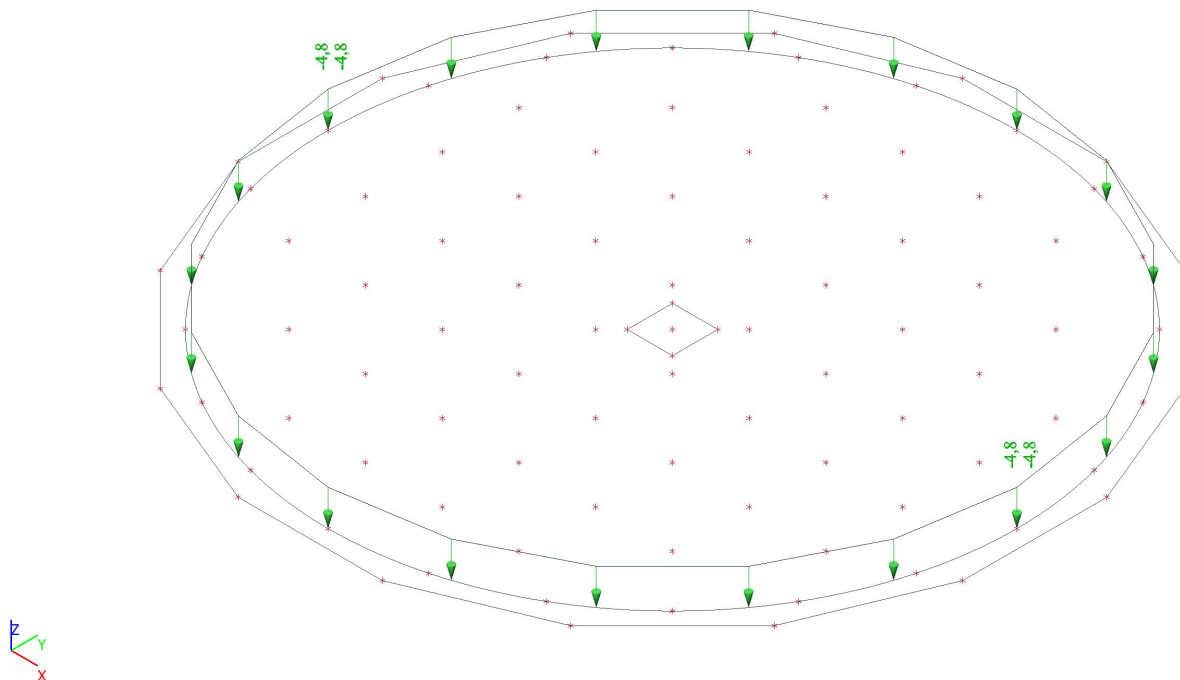
Name	Description	Action type	Load type	Load group
EO	Dead load - Operating load	Permanent	Standard	LG1



Name	Dir	Type	Distribution	q [kN/m ²]	Validity	Select	System	Location
FF1	Z	Force	Uniform	-166,1	All	Auto	GCS	Length

4.1.5. Load cases - LL

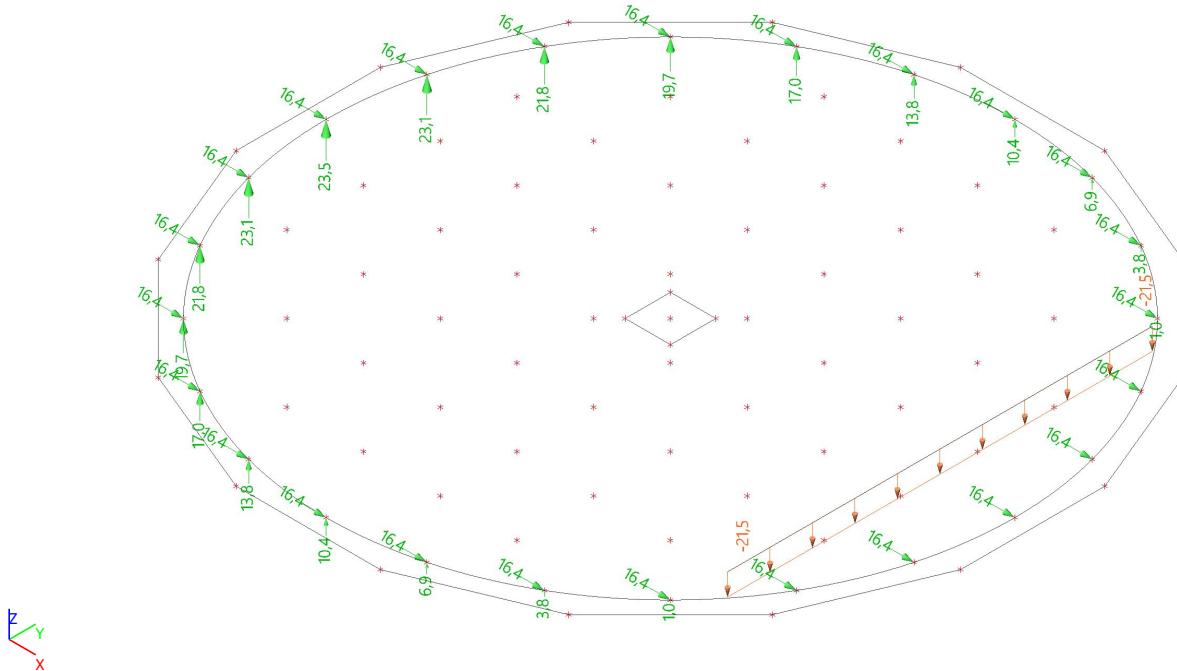
Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL	Live load - Roof	Standard	Variable	Static	LG2	Short	None



Name	Internal edge	Type	System	Dir	Distribution	Value - P ₁ [kN/m]	Pos x ₁	Pos x ₂	Loc	Coor	Edge	Orig
LFS6	ES1	Force	LCS	Z	Uniform	-4,8	0.000	1.000	Length	Rela	1	From start
LFS8	ES2	Force	LCS	Z	Uniform	-4,8	0.000	1.000	Length	Rela	1	From start

4.1.6. Load cases - WL

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



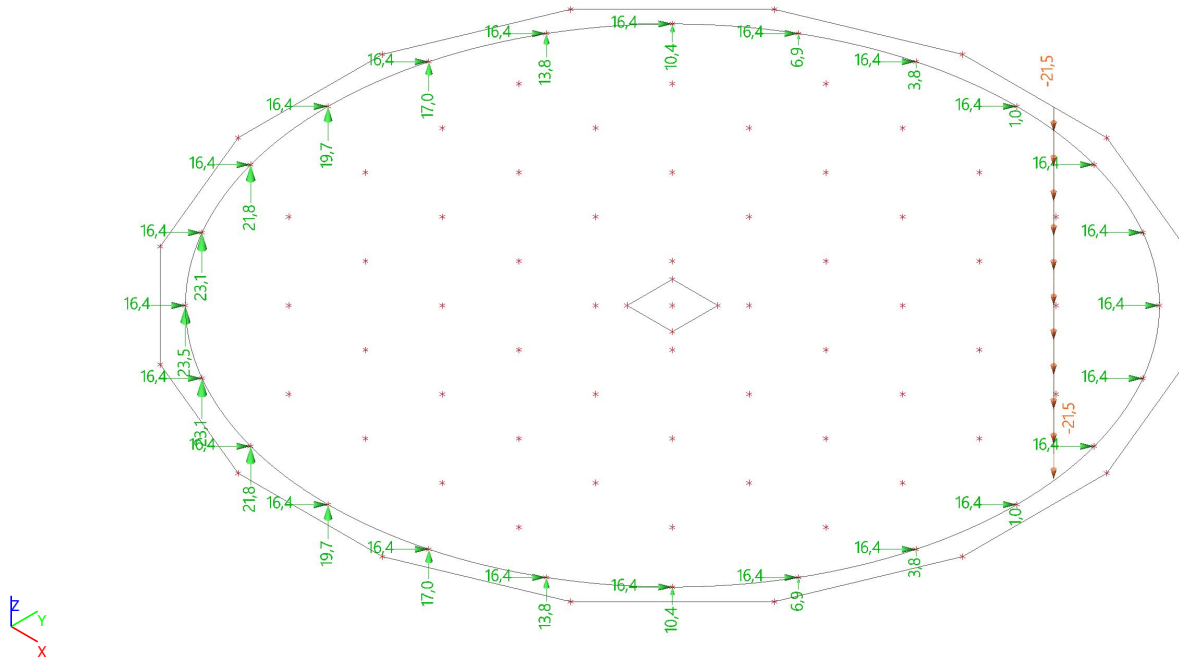
Name	Node	System	Dir	Type	Value [kN]
F110	N070	GCS	Z	Force	3,8
F111	N060	GCS	Z	Force	6,9
F112	N035	GCS	Z	Force	13,8
F113	N024	GCS	Z	Force	17,0
F114	N015	GCS	Z	Force	19,7
F115	N008	GCS	Z	Force	21,8
F116	N004	GCS	Z	Force	23,1
F117	N003	GCS	Z	Force	23,5
F118	N009	GCS	Z	Force	21,8
F119	N005	GCS	Z	Force	23,1
F120	N014	GCS	Z	Force	19,7
F121	N025	GCS	Z	Force	17,0
F122	N034	GCS	Z	Force	13,8
F123	N059	GCS	Z	Force	6,9
F124	N069	GCS	Z	Force	3,8
F126	N048	GCS	Z	Force	10,4
F127	N046	GCS	Z	Force	10,4
F147	N090	GCS	X	Force	16,4
F148	N091	GCS	X	Force	16,4
F149	N089	GCS	X	Force	16,4
F150	N085	GCS	X	Force	16,4
F151	N079	GCS	X	Force	16,4

Name	Node	System	Dir	Type	Value [kN]
F152	N070	GCS	X	Force	16,4
F153	N060	GCS	X	Force	16,4
F154	N048	GCS	X	Force	16,4
F155	N035	GCS	X	Force	16,4
F156	N024	GCS	X	Force	16,4
F157	N015	GCS	X	Force	16,4
F158	N008	GCS	X	Force	16,4
F159	N004	GCS	X	Force	16,4
F160	N003	GCS	X	Force	16,4
F161	N005	GCS	X	Force	16,4
F162	N009	GCS	X	Force	16,4
F163	N014	GCS	X	Force	16,4
F164	N025	GCS	X	Force	16,4
F165	N034	GCS	X	Force	16,4
F166	N046	GCS	X	Force	16,4
F167	N059	GCS	X	Force	16,4
F168	N069	GCS	X	Force	16,4
F169	N080	GCS	X	Force	16,4
F170	N086	GCS	X	Force	16,4
F195	N080	GCS	Z	Force	1,0
F196	N079	GCS	Z	Force	1,0

Name	Dir	Type	Distribution	Value - P ₁ [kN/m]	Validity	Select	System	Location
FL2	Z	Force	Uniform	-21,5	All	Auto	GCS	Length

4.1.7. Load cases - WL45

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
WL45	Wind load	Standard	Variable	Static	LG3	Short	None



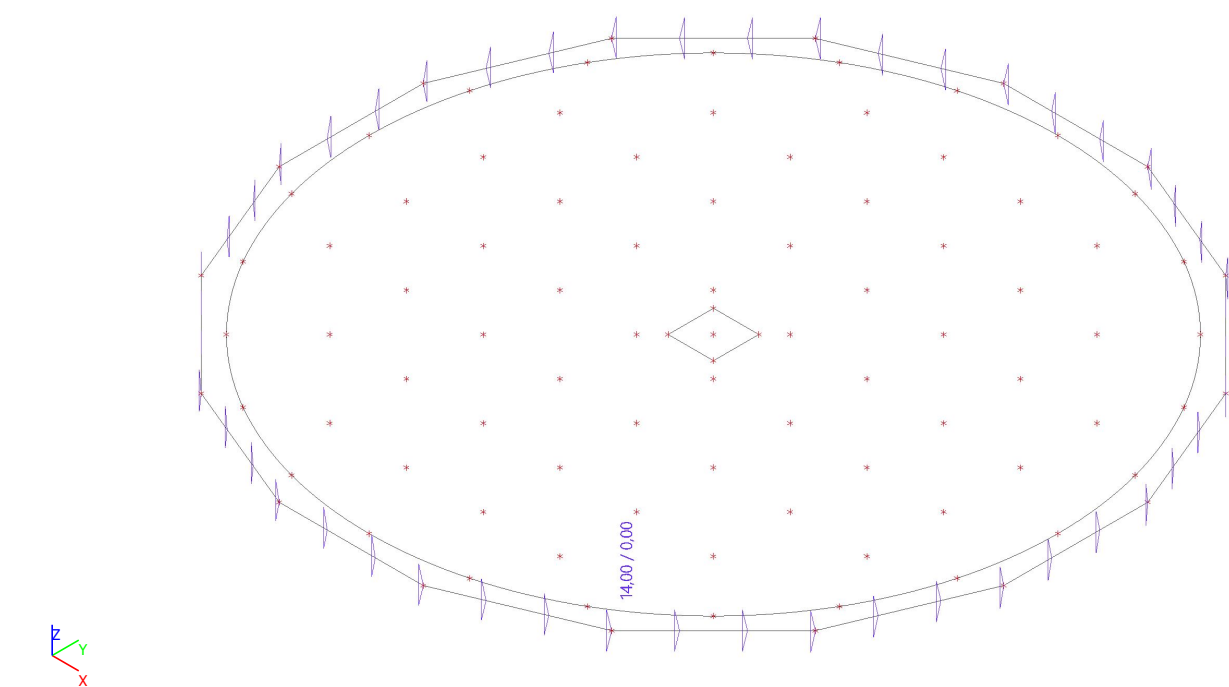
Name	Node	System	Dir	Type	Angle [deg]	Value [kN]
F128	N015	GCS	Z	Force		10,4
F129	N080	GCS	Z	Force		10,4
F130	N086	GCS	Z	Force		6,9
F131	N090	GCS	Z	Force		3,8
F134	N035	GCS	Z	Force		3,8
F135	N024	GCS	Z	Force		6,9
F136	N004	GCS	Z	Force		17,0
F137	N008	GCS	Z	Force		13,8
F138	N003	GCS	Z	Force		19,7
F139	N005	GCS	Z	Force		21,8
F140	N009	GCS	Z	Force		23,1
F141	N014	GCS	Z	Force		23,5
F142	N025	GCS	Z	Force		23,1
F143	N034	GCS	Z	Force		21,8
F144	N046	GCS	Z	Force		19,7
F145	N059	GCS	Z	Force		17,0
F146	N069	GCS	Z	Force		13,8
F171	N086	GCS	X	Force	Rz45,00	16,4
F172	N090	GCS	X	Force	Rz45,00	16,4
F173	N091	GCS	X	Force	Rz45,00	16,4
F174	N089	GCS	X	Force	Rz45,00	16,4
F175	N085	GCS	X	Force	Rz45,00	16,4

Name	Node	System	Dir	Type	Angle [deg]	Value [kN]
F176	N079	GCS	X	Force	Rz45,00	16,4
F177	N070	GCS	X	Force	Rz45,00	16,4
F178	N060	GCS	X	Force	Rz45,00	16,4
F179	N048	GCS	X	Force	Rz45,00	16,4
F180	N035	GCS	X	Force	Rz45,00	16,4
F181	N024	GCS	X	Force	Rz45,00	16,4
F182	N015	GCS	X	Force	Rz45,00	16,4
F183	N008	GCS	X	Force	Rz45,00	16,4
F184	N004	GCS	X	Force	Rz45,00	16,4
F185	N003	GCS	X	Force	Rz45,00	16,4
F186	N005	GCS	X	Force	Rz45,00	16,4
F187	N009	GCS	X	Force	Rz45,00	16,4
F188	N014	GCS	X	Force	Rz45,00	16,4
F189	N025	GCS	X	Force	Rz45,00	16,4
F190	N034	GCS	X	Force	Rz45,00	16,4
F191	N046	GCS	X	Force	Rz45,00	16,4
F192	N059	GCS	X	Force	Rz45,00	16,4
F193	N069	GCS	X	Force	Rz45,00	16,4
F194	N080	GCS	X	Force	Rz45,00	16,4
F197	N091	GCS	Z	Force		1,0
F198	N048	GCS	Z	Force		1,0

Name	Dir	Type	Distribution	Value - P ₁ [kN/m]	Validity	Select	System	Location
FL1	Z	Force	Uniform	-21,5	All	Auto	GCS	Length

4.1.8. Load cases - TLt

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



Name	2D member	Distribution	+z - Top delta [K]	-z - Bottom delta [K]
ST1	S1	Linear	14,00	0,00

4.2. Load groups

Name	Load	Relation	Type
LG1	Permanent		
LG2	Variable	Standard	Cat H : Roofs
LG3	Variable	Exclusive	Wind
LG4	Variable	Standard	Cat E : Storage

4.3. Combinations

Name	Description	Type	Load cases	Coeff. [-]
ULS		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
ULS_NoTemp		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00 1,00
ULS_Empty		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00
SLS_Char		EN-SLS Characteristic	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
SLS_Char_Empty		EN-SLS Characteristic	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00
SLS_Freq		EN-SLS Frequent	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
SLS_Freq_Empty		EN-SLS Frequent	DL - Dead load - Self weight DL1 - Dead load - slope EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00

4.4. Result classes

Name	List
ULS_NoTemp	ULS_NoTemp - EN-ULS (STR/GEO) Set B ULS_Empty - EN-ULS (STR/GEO) Set B
SLS_Char	SLS_Char - EN-SLS Characteristic SLS_Char_Empty - EN-SLS Characteristic

5. Results

5.1. Bill of material

Selection: All

Type of sorting: Material

Summary

Material	Mass [kg]	Surface [m ²]	Volume [m ³]
Concrete	656933,8	327,879	2,6277e+02
Total	656933,8	327,879	2,6277e+02

Note: Value 'Surface' represents for 1D members the total exposed surface area, while for 2D members it corresponds only to the surface area of the centroidal plane.

Concrete (2D)

Material	Density [kg/m ³]	Mass [kg]	Surface [m ²]	Volume [m ³]
C30/37	2500,0	656933,8	327,879	2,6277e+02
Total		656933,8	327,879	2,6277e+02

5.2. Resultant of reactions - Characteristic

Linear calculation

Combination: SLS_Char

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	SLS_Char/1	-278,3	-278,3	56703,2	2383,6	-2383,6	0,0
0,000	0,000	0,000	SLS_Char/2	0,0	0,0	56998,7	0,0	0,0	0,0
0,000	0,000	0,000	SLS_Char/3	-278,3	-278,3	56703,2	2383,6	-2383,6	0,0
0,000	0,000	0,000	SLS_Char/4	-393,6	0,0	56703,2	0,0	-3370,5	0,0

Name	Combination key
SLS_Char/1	DL + EE + EO + WL45 + DL1
SLS_Char/2	DL + EE + EO + LL + TLt + DL1
SLS_Char/3	DL + EE + EO + TLt + WL45 + DL1
SLS_Char/4	DL + EE + EO + WL + DL1

5.3. Resultant of reactions - Load cases

5.3.1. Resultant of reactions - Load cases - DL

Name, Description, Action type, Load type	DL	Dead load - Self weight	Permanent	Self weight
---	----	-------------------------	-----------	-------------

Linear calculation

Load case: DL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	DL	0,0	0,0	6569,3	0,0	0,0	0,0

5.3.2. Resultant of reactions - Load cases - DL1

Name, Description, Action type, Load type	DL1	Dead load - slope	Permanent	Standard
---	-----	-------------------	-----------	----------

Linear calculation

Load case: DL1

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	DL1	0,0	0,0	790,2	0,0	0,0	0,0

5.3.3. Resultant of reactions - Load cases - EE

Name, Description, Action type, Load type	EE	Dead load - Empty equipment	Permanent	Standard
---	----	-----------------------------	-----------	----------

Linear calculation

Load case: EE

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	EE	0,0	0,0	1085,3	0,0	0,0	0,0

5.3.4. Resultant of reactions - Load cases - EO

Name, Description, Action type, Load type	EO	Dead load - Operating load	Permanent	Standard
---	----	----------------------------	-----------	----------

Linear calculation

Load case: EO

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	EO	0,0	0,0	48261,0	0,0	0,0	0,0

5.3.5. Resultant of reactions - Load cases - LL

Name, Description, Action type, Load type	LL	Live load - Roof	Variable	Static
---	----	------------------	----------	--------

Linear calculation

Load case: LL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	LL	0,0	0,0	292,9	0,0	0,0	0,0

5.3.6. Resultant of reactions - Load cases - WL

Name, Description, Action type, Load type	WL	Wind load	Variable	Static
---	----	-----------	----------	--------

Linear calculation

Load case: WL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	WL	-393,6	0,0	-2,6	0,0	-3370,5	0,0

5.3.7. Resultant of reactions - Load cases - WL45

Name, Description, Action type, Load type	WL45	Wind load	Variable	Static
---	------	-----------	----------	--------

Linear calculation

Load case: WL45

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	WL45	-278,3	-278,3	-2,7	2383,6	-2383,6	0,0

5.3.8. Resultant of reactions - Load cases - TLt

Name, Description, Action type, Load type	TLt	Temperature load	Variable	Static
---	-----	------------------	----------	--------

Linear calculation

Load case: TLt

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	TLt	0,0	0,0	0,0	0,0	0,0	0,0

5.4. Reactions

Linear calculation

Class: SLS_Char

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]
Sn091/N091	SLS_Char/1	-15,2	0,0	736,7	0,0	0,0	0,0	0,0	0,0
Sn003/N003	SLS_Char/2	10,1	0,0	724,1	0,0	0,0	0,0	0,0	0,0
Sn048/N048	SLS_Char/3	-3,7	-13,7	726,2	0,0	0,0	0,0	0,0	0,0
Sn046/N046	SLS_Char/2	0,0	10,1	724,1	0,0	0,0	0,0	0,0	0,0
Sn038/N038	SLS_Char_Empty/4	0,0	0,0	101,4	0,0	0,0	0,0	0,0	0,0
Sn049/N049	SLS_Char/5	-3,6	-3,6	919,1	0,0	0,0	0,0	0,0	0,0

Name	Combination key
SLS_Char/1	DL + EE + EO + WL + Tlt + DL1
SLS_Char/2	DL + EE + EO + LL + Tlt + DL1
SLS_Char/3	DL + EE + EO + Tlt + WL45 + DL1
SLS_Char_Empty/4	DL + EE + LL + DL1
SLS_Char/5	DL + EE + EO + WL45 + DL1

Linear calculation

Class: ULS_NoTemp

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]
Sn034/N034	ULS_NoTemp/1	-7,8	0,0	733,1	0,0	0,0	0,0	0,0	0,0
Sn086/N086	ULS_NoTemp/2	-5,5	-5,5	749,1	0,0	0,0	0,0	0,0	0,0
Sn049/N049	ULS_NoTemp/3	0,1	0,1	1235,7	0,0	0,0	0,0	0,0	0,0
Sn003/N003	ULS_Empty/4	-7,8	0,0	83,3	0,0	0,0	0,0	0,0	0,0
Sn039/N039	ULS_NoTemp/3	-0,1	-0,1	1235,7	0,0	0,0	0,0	0,0	0,0

Name	Combination key
ULS_NoTemp/1	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL + 1.20*DL1
ULS_NoTemp/2	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL45 + 1.20*DL1
ULS_NoTemp/3	1.35*DL + 1.35*EE + 1.35*EO + 1.35*DL1
ULS_Empty/4	0.90*DL + 0.90*EE + 1.50*WL + 0.90*DL1

Linear calculation

Combination: 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]
Sn091/N091	ULS/1	-22,8	0,0	610,4	0,0	0,0	0,0	0,0	0,0
Sn003/N003	ULS/2	15,0	0,0	594,3	0,0	0,0	0,0	0,0	0,0
Sn048/N048	ULS/3	-5,6	-20,5	594,6	0,0	0,0	0,0	0,0	0,0
Sn046/N046	ULS/2	0,0	15,0	594,3	0,0	0,0	0,0	0,0	0,0
Sn003/N003	ULS/4	-7,8	0,0	486,0	0,0	0,0	0,0	0,0	0,0
Sn038/N038	ULS/5	0,0	0,0	1279,4	0,0	0,0	0,0	0,0	0,0

Name	Combination key
ULS/1	0.90*DL + 0.90*EE + 0.90*EO + 1.50*WL + 1.50*Tlt + 0.90*DL1
ULS/2	0.90*DL + 0.90*EE + 0.90*EO + 1.50*LL + 1.50*Tlt + 0.90*DL1
ULS/3	0.90*DL + 0.90*EE + 0.90*EO + 1.50*Tlt + 1.50*WL45 + 0.90*DL1
ULS/4	0.90*DL + 0.90*EE + 0.90*EO + 1.50*WL + 0.90*DL1
ULS/5	1.35*DL + 1.35*EE + 1.35*EO + 1.35*DL1

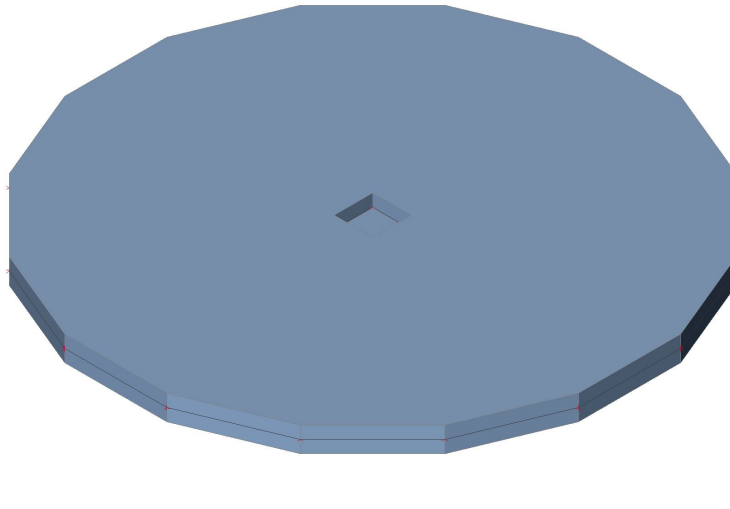
Appendix B

Scia report T303-T314

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2. General



2.1. Project

Licence name	KH Engineering
Project	Neste - Rotterdam terminal expansion
Part	Tank pit 3 - tank foundations
Description	T303-T314
Author	LER
Date	07. 2021
Structure	General XYZ
No. of nodes :	92
No. of beams :	0
No. of slabs :	1
No. of solids :	0
No. of used profiles :	0
No. of load cases :	8
No. of used materials :	2
Acceleration of gravity [m/s ²]	10,000
National code	EC - EN

2.2. 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	0.2	0
Temperature	1	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

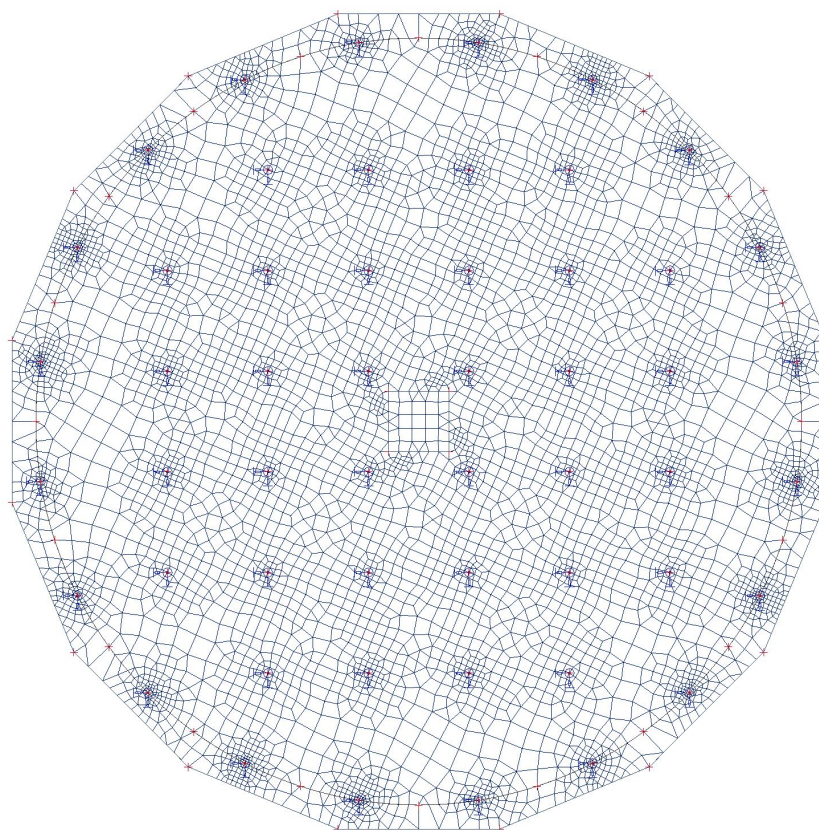
Reliability class	RC2
RC1 [-]	0,90
RC2 [-]	1,00
RC3 [-]	1,10
RC1 [-]	1,00
RC2 [-]	1,00
RC3 [-]	1,00

2.3. Solver setup

Name	SolverSetup1
Neglect shear force deformation (Ay, Az >> A)	x
Initial stress	x
Number of thicknesses of rib plate	20
Maximum soil interaction iterations	10
Number of sections on average member	10
Step for soil/water pressure [m]	0,500
C1x [MN/m ³]	1,0000e-01
C1y [MN/m ³]	1,0000e-01
C1z [MN/m ³]	1,0000e+01
C2x [MN/m]	5,0000e+00
C2y [MN/m]	5,0000e+00
Coefficient for reinforcement	1
Warning when maximal translation is greater than [mm]	1000,0
Warning when maximal rotation is greater than [mrad]	100,0
Parallelism tolerance [deg]	10,00
Ratio to half - distance to adjacent beam beff,i/bi [-]	0,20
Ratio to effective span length beff,i/l0 [-]	0,10
Max ratio to effective span length beff,i/l0 [-]	0,20
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever, base ratio to current span [-]	1,00
Cantilever, base ratio to adjacent span [-]	0,15
Cantilever, max ratio to current span [-]	1,50
Max adjacent span length ratio [-]	1,50
Max cantilever length ratio to adjacent span [-]	0,50
Span length ratio Le/beff,i,max (1 side) [-]	8,00
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever [-]	2,00
Method used for non-concrete and non-steel / composite beams	EN 1994-1-1
Soil combination	None
Bending theory of plate/shell analysis	Mindlin
Type of solver	Direct

2.4. Mesh setup

Name	MeshSetup1
Generation of eccentric elements on members with variable height	x
Generation of nodes in connections of beam elements	x
Elastic mesh	✓
Use automatic mesh refinement	✓
Connect members/nodes	✓
Division on haunches and arbitrary members	5
Division for 2D-1D upgrade	50
Average number of tiles of 1d element	1
Target error for mesh refinement [%]	10
Average size of 2d element/curved element [m]	0,420
Minimal length of beam element [m]	0,100
Maximal length of beam element [m]	1000,000
Average size of cables, tendons, elements on subsoil, nonlinear soil spring [m]	1,000
Maximal out of plane angle of a quadrilateral [mrad]	30,0
Predefined mesh ratio	1.5
Minimal distance between definition point and line [m]	0.001
Average size of panel element [m]	0,400
Mesh refinement following the beam type	None
Definition of mesh element size for panels	Manual
Group of load cases for automatic mesh refinement	EO



2.5. Materials

Name	Type	ρ [kg/m ³]	Density in fresh state [kg/m ³]	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	■
C30/37 Cracked	Concrete	2500,0	2600,0	1,2667e+04	0.0001	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.
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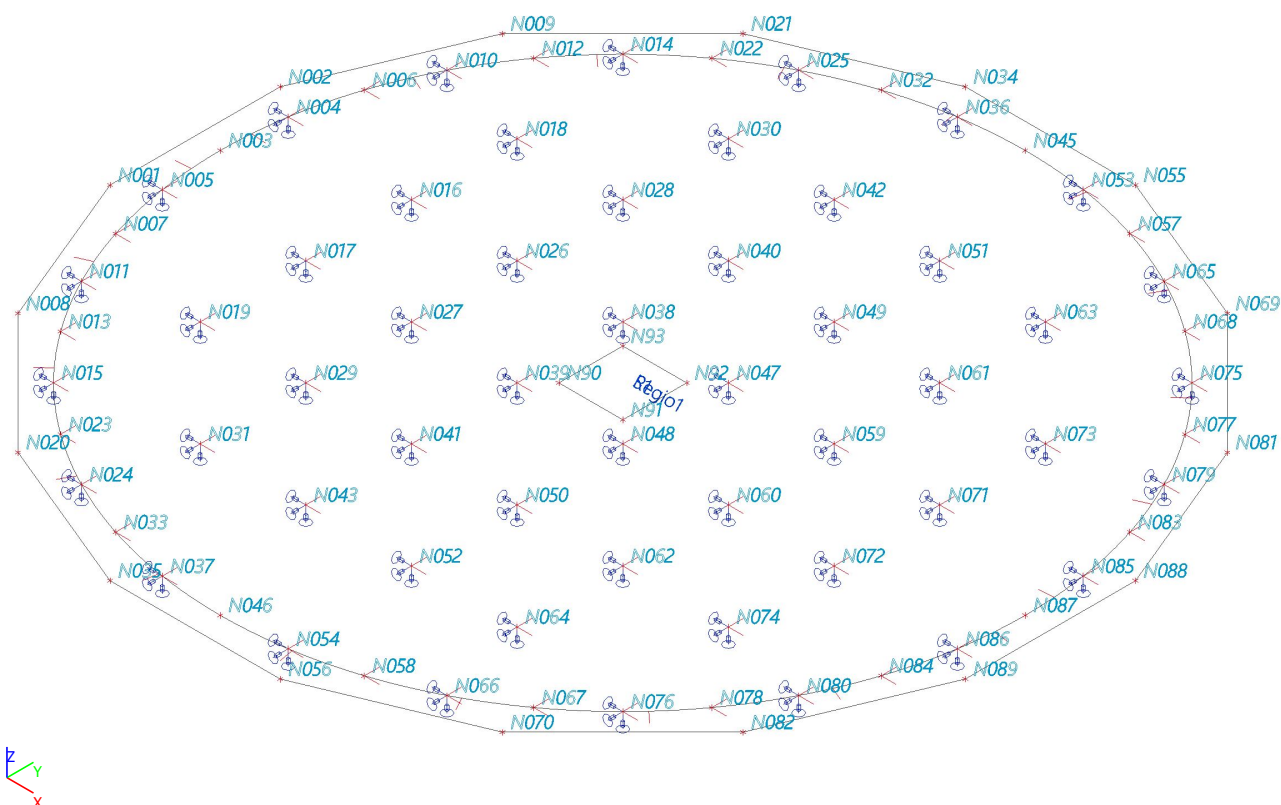
3. Structure

3.1. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N001	-8,500	-1,691	0,000
N002	-8,500	1,691	0,000
N003	-8,000	0,000	0,000
N004	-7,902	1,251	0,000
N005	-7,902	-1,251	0,000
N006	-7,608	2,472	0,000
N007	-7,608	-2,472	0,000
N008	-7,206	-4,815	0,000
N009	-7,206	4,815	0,000
N010	-7,128	3,632	0,000
N011	-7,128	-3,632	0,000
N012	-6,472	4,702	0,000
N013	-6,472	-4,702	0,000
N014	-5,657	5,657	0,000
N015	-5,657	-5,657	0,000
N016	-5,250	1,050	0,000
N017	-5,250	-1,050	0,000
N018	-5,250	3,150	0,000
N019	-5,250	-3,150	0,000
N020	-4,815	-7,206	0,000
N021	-4,815	7,206	0,000
N022	-4,702	6,472	0,000
N023	-4,702	-6,472	0,000
N024	-3,632	-7,128	0,000
N025	-3,632	7,128	0,000
N026	-3,150	1,050	0,000
N027	-3,150	-1,050	0,000
N028	-3,150	3,150	0,000
N029	-3,150	-3,150	0,000
N030	-3,150	5,250	0,000
N031	-3,150	-5,250	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N032	-2,472	7,608	0,000
N033	-2,472	-7,608	0,000
N034	-1,691	8,500	0,000
N035	-1,691	-8,500	0,000
N036	-1,251	7,902	0,000
N037	-1,251	-7,902	0,000
N038	-1,050	1,050	0,000
N039	-1,050	-1,050	0,000
N040	-1,050	3,150	0,000
N041	-1,050	-3,150	0,000
N042	-1,050	5,250	0,000
N043	-1,050	-5,250	0,000
N045	0,000	8,000	0,000
N046	0,000	-8,000	0,000
N047	1,050	1,050	0,000
N048	1,050	-1,050	0,000
N049	1,050	3,150	0,000
N050	1,050	-3,150	0,000
N051	1,050	5,250	0,000
N052	1,050	-5,250	0,000
N053	1,251	7,902	0,000
N054	1,251	-7,902	0,000
N055	1,691	8,500	0,000
N056	1,691	-8,500	0,000
N057	2,472	7,608	0,000
N058	2,472	-7,608	0,000
N059	3,150	1,050	0,000
N060	3,150	-1,050	0,000
N061	3,150	3,150	0,000
N062	3,150	-3,150	0,000
N063	3,150	5,250	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N064	3,150	-5,250	0,000
N065	3,632	7,128	0,000
N066	3,632	-7,128	0,000
N067	4,702	-6,472	0,000
N068	4,702	6,472	0,000
N069	4,815	7,206	0,000
N070	4,815	-7,206	0,000
N071	5,250	1,050	0,000
N072	5,250	-1,050	0,000
N073	5,250	3,150	0,000
N074	5,250	-3,150	0,000
N075	5,657	5,657	0,000
N076	5,657	-5,657	0,000
N077	6,472	4,702	0,000
N078	6,472	-4,702	0,000
N079	7,128	3,632	0,000
N080	7,128	-3,632	0,000
N081	7,206	4,815	0,000
N082	7,206	-4,815	0,000
N083	7,608	2,472	0,000
N084	7,608	-2,472	0,000
N085	7,902	1,251	0,000
N086	7,902	-1,251	0,000
N087	8,000	0,000	0,000
N088	8,500	1,691	0,000
N089	8,500	-1,691	0,000
N90	-0,635	-0,635	0,000
N91	0,635	-0,635	0,000
N92	0,635	0,635	0,000
N93	-0,635	0,635	0,000



3.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S1	Layer1	plate (90)	Standard	C30/37	constant	820

3.3. 2D member regions

Name	2D member	Material	Thickness type	MSP at	Ecc. z [mm]	Th. [mm]	Node	Edge
Regio1	S1	C30/37	constant	Centre	-210	400	N90 N91 N92 N93	Line Line Line Line

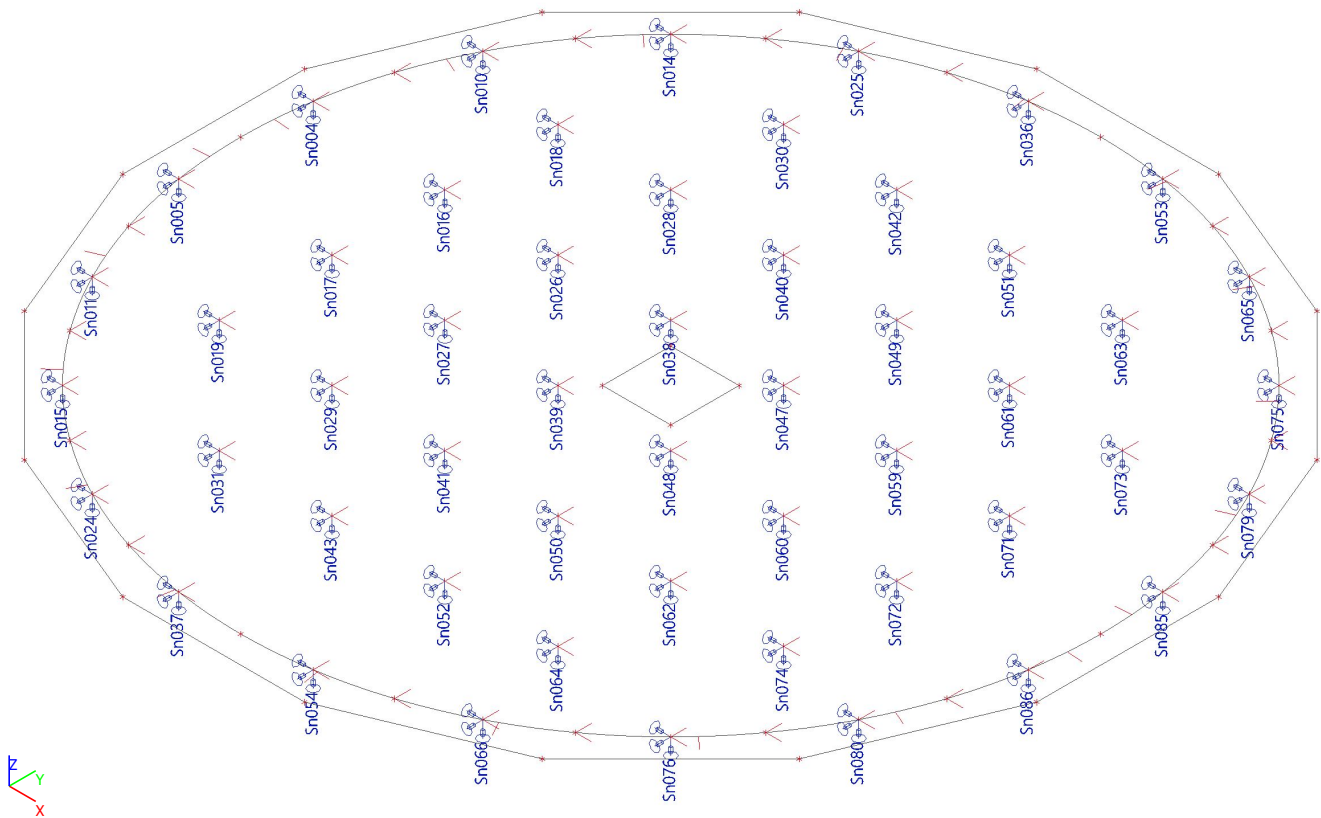
3.4. 2D member internal edges

Name	Member 1	Length [m]	Shape	Node	Edge
ES1	S1	25,133	Arc	N087 N045 N003	Circle arc
ES2	S1	25,133	Arc	N087 N046 N003	Circle arc

3.5. Nodal supports

Name	Node	System	Type	X	Stiffness X [MN/m]	Y	Stiffness Y [MN/m]	Z	Stiffness Z [MN/m]	Rx	Ry	Rz
Sn004	N004	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn005	N005	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn010	N010	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn011	N011	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn014	N014	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn015	N015	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn016	N016	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn017	N017	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn018	N018	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn019	N019	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn024	N024	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn025	N025	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn026	N026	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn027	N027	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn028	N028	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn029	N029	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn030	N030	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn031	N031	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn036	N036	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn037	N037	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn038	N038	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn039	N039	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn040	N040	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn041	N041	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn042	N042	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn043	N043	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn047	N047	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn048	N048	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn049	N049	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn050	N050	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn051	N051	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn052	N052	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn053	N053	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn054	N054	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn059	N059	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn060	N060	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn061	N061	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn062	N062	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn063	N063	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn064	N064	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn065	N065	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn066	N066	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn071	N071	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn072	N072	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn073	N073	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn074	N074	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn075	N075	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn076	N076	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free

Name	Node	System	Type	X	Stiffness X [MN/m]	Y	Stiffness Y [MN/m]	Z	Stiffness Z [MN/m]	Rx	Ry	Rz
Sn079	N079	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn080	N080	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn085	N085	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free
Sn086	N086	GCS	Standard	Flexible	1,2500e+01	Flexible	1,2500e+01	Flexible	6,0000e+01	Free	Free	Free

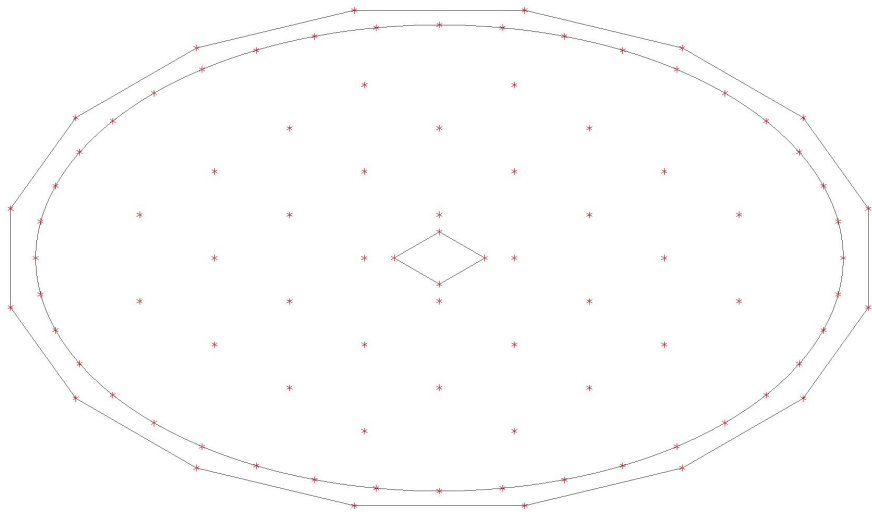


4. loads

4.1. Load cases

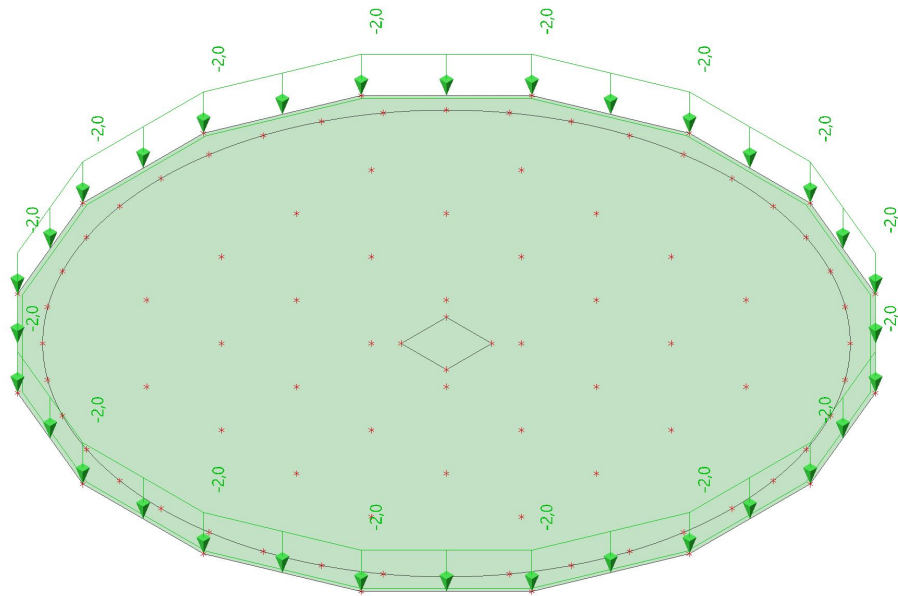
4.1.1. Load cases - DL

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



4.1.2. Load cases - DL1

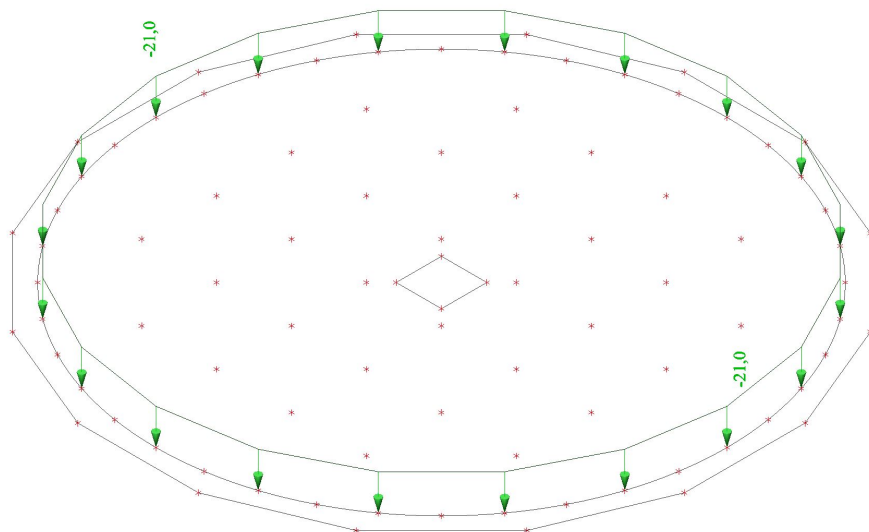
Name	Description	Action type	Load type	Load group
DL1	Dead load - Slope	Permanent	Standard	LG1



Name	Dir	Type	Value [kN/m ²]	2D member	Load case	System	Loc
SF1	Z	Force	-2,0	S1	DL1 - Dead load - Slope	LCS	Length

4.1.3. Load cases - EE

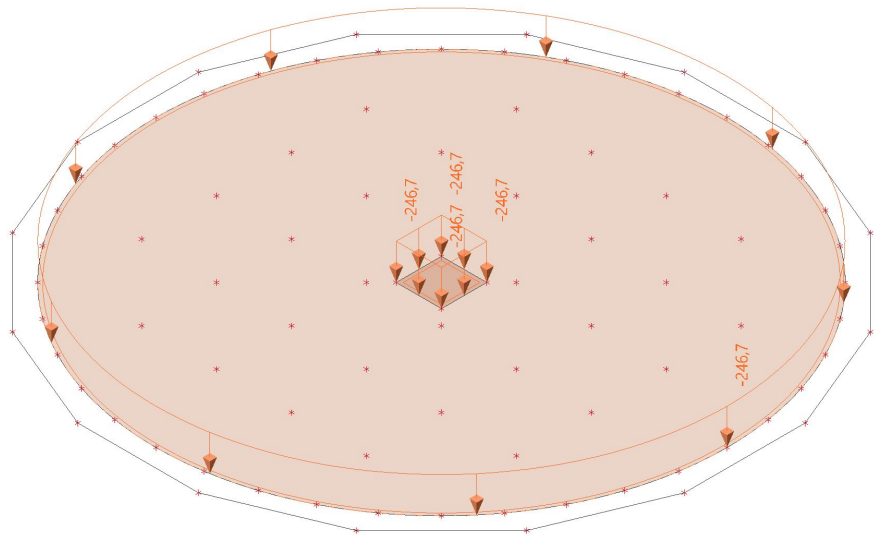
Name	Description	Action type	Load type	Load group
EE	Dead load - Empty equipment	Permanent	Standard	LG1



Name	Internal edge	Type	System	Dir	Distribution	Value - P ₁ [kN/m]	Pos x ₁	Pos x ₂	Loc	Coor	Edge	Orig
LFS7	ES1	Force	LCS	Z	Uniform	-21,0	0.000	1.000	Length	Rela	1	From start
LFS9	ES2	Force	LCS	Z	Uniform	-21,0	0.000	1.000	Length	Rela	1	From start

4.1.4. Load cases - EO

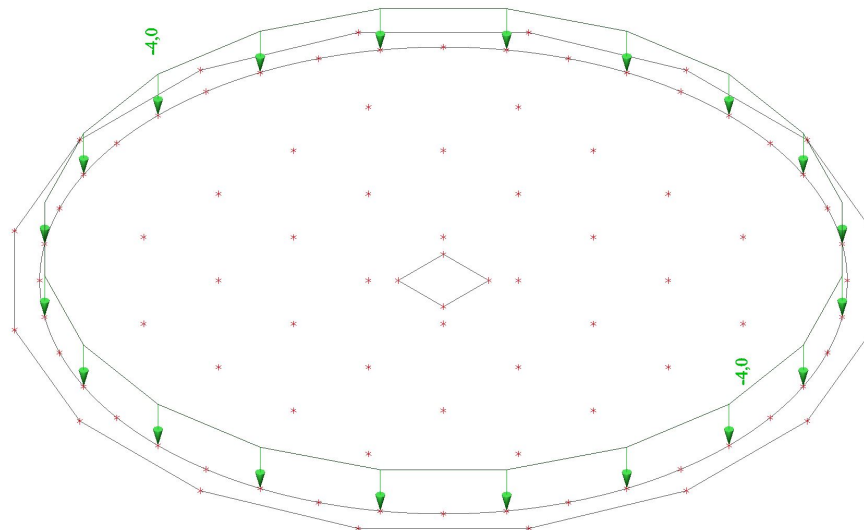
Name	Description	Action type	Load type	Load group
EO	Dead load - Operating load	Permanent	Standard	LG1



Name	Dir	Type	Distribution	q [kN/m ²]	Validity	Select	System	Location
FF1	Z	Force	Uniform	-246,7	All	Auto	GCS	Length

4.1.5. Load cases - LL

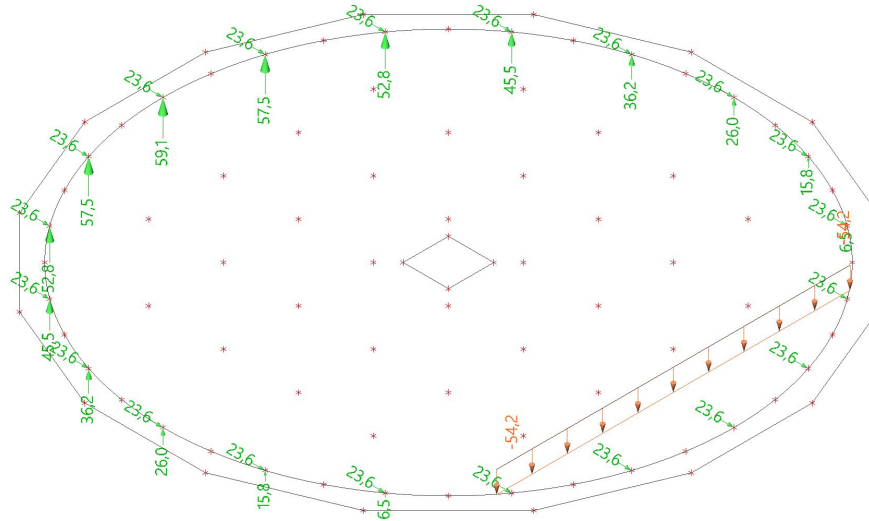
Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL	Live load - Roof	Standard	Variable	Static	LG2	Short	None



Name	Internal edge	Type	System	Dir	Distribution	Value - P ₁ [kN/m]	Pos x ₁	Pos x ₂	Loc	Coor	Edge	Orig
LFS8	ES1	Force	LCS	Z	Uniform	-4,0	0.000	1.000	Length	Rela	1	From start
LFS10	ES2	Force	LCS	Z	Uniform	-4,0	0.000	1.000	Length	Rela	1	From start

4.1.6. Load cases - WL

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



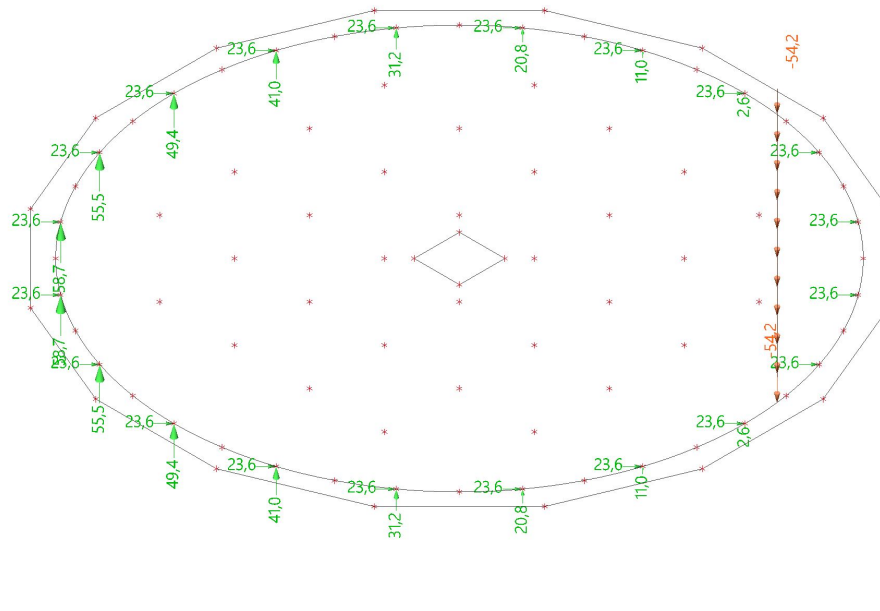
Name	Node	System	Dir	Type	Value [kN]
F96	N067	GCS	Z	Force	6,5
F98	N046	GCS	Z	Force	26,0
F99	N033	GCS	Z	Force	36,2
F100	N023	GCS	Z	Force	45,5
F101	N013	GCS	Z	Force	52,8
F102	N007	GCS	Z	Force	57,5
F103	N003	GCS	Z	Force	59,1
F104	N006	GCS	Z	Force	57,5
F105	N012	GCS	Z	Force	52,8
F106	N022	GCS	Z	Force	45,5
F107	N032	GCS	Z	Force	36,2
F108	N045	GCS	Z	Force	26,0
F109	N057	GCS	Z	Force	15,8
F110	N068	GCS	Z	Force	6,5
F111	N058	GCS	Z	Force	15,8
F126	N084	GCS	X	Force	23,6
F127	N087	GCS	X	Force	23,6
F128	N083	GCS	X	Force	23,6

Name	Node	System	Dir	Type	Value [kN]
F129	N077	GCS	X	Force	23,6
F130	N068	GCS	X	Force	23,6
F131	N057	GCS	X	Force	23,6
F132	N045	GCS	X	Force	23,6
F133	N032	GCS	X	Force	23,6
F134	N022	GCS	X	Force	23,6
F135	N012	GCS	X	Force	23,6
F136	N006	GCS	X	Force	23,6
F137	N003	GCS	X	Force	23,6
F138	N007	GCS	X	Force	23,6
F139	N013	GCS	X	Force	23,6
F140	N023	GCS	X	Force	23,6
F141	N033	GCS	X	Force	23,6
F142	N046	GCS	X	Force	23,6
F143	N058	GCS	X	Force	23,6
F144	N067	GCS	X	Force	23,6
F145	N078	GCS	X	Force	23,6

Name	Dir	Type	Distribution	Value - P ₁ [kN/m]	Validity	Select	System	Location
FL1	Z	Force	Uniform	-54,2	All	Auto	GCS	Length

4.1.7. Load cases - WL45

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
WL45	Wind load	Standard	Variable	Static	LG3	Short	None



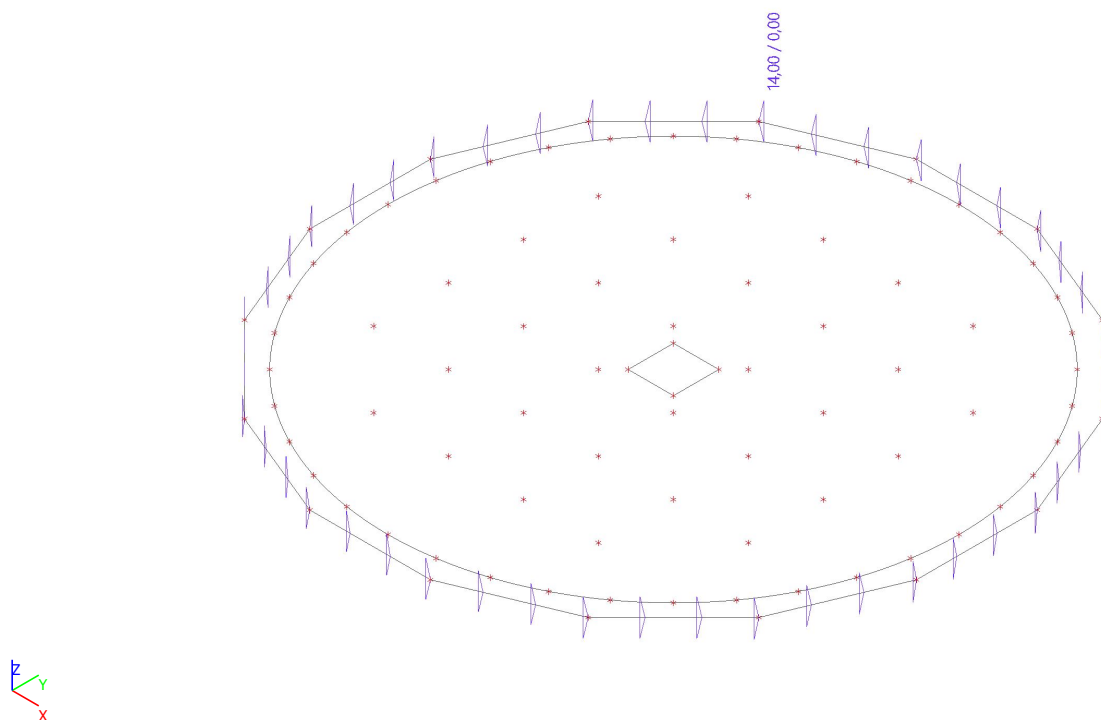
Name	Node	System	Dir	Type	Angle [deg]	Value [kN]
F112	N022	GCS	Z	Force		20,8
F113	N012	GCS	Z	Force		31,2
F114	N006	GCS	Z	Force		41,0
F115	N003	GCS	Z	Force		49,4
F116	N007	GCS	Z	Force		55,5
F117	N013	GCS	Z	Force		58,7
F118	N023	GCS	Z	Force		58,7
F119	N033	GCS	Z	Force		55,5
F120	N046	GCS	Z	Force		49,4
F121	N058	GCS	Z	Force		41,0
F122	N067	GCS	Z	Force		31,2
F123	N078	GCS	Z	Force		20,8
F124	N084	GCS	Z	Force		11,0
F125	N032	GCS	Z	Force		11,0
F146	N084	GCS	X	Force	Rz45,00	23,6
F147	N087	GCS	X	Force	Rz45,00	23,6
F148	N083	GCS	X	Force	Rz45,00	23,6
F149	N077	GCS	X	Force	Rz45,00	23,6

Name	Node	System	Dir	Type	Angle [deg]	Value [kN]
F150	N068	GCS	X	Force	Rz45,00	23,6
F151	N057	GCS	X	Force	Rz45,00	23,6
F152	N045	GCS	X	Force	Rz45,00	23,6
F153	N032	GCS	X	Force	Rz45,00	23,6
F154	N022	GCS	X	Force	Rz45,00	23,6
F155	N012	GCS	X	Force	Rz45,00	23,6
F156	N006	GCS	X	Force	Rz45,00	23,6
F157	N003	GCS	X	Force	Rz45,00	23,6
F158	N007	GCS	X	Force	Rz45,00	23,6
F159	N013	GCS	X	Force	Rz45,00	23,6
F160	N023	GCS	X	Force	Rz45,00	23,6
F161	N033	GCS	X	Force	Rz45,00	23,6
F162	N046	GCS	X	Force	Rz45,00	23,6
F163	N058	GCS	X	Force	Rz45,00	23,6
F164	N067	GCS	X	Force	Rz45,00	23,6
F165	N078	GCS	X	Force	Rz45,00	23,6
F166	N087	GCS	Z	Force		2,6
F167	N045	GCS	Z	Force		2,6

Name	Dir	Type	Distribution	Value - P ₁ [kN/m]	Validity	Select	System	Location
FL2	Z	Force	Uniform	-54,2	All	Auto	GCS	Length

4.1.8. Load cases - TLt

Name	Description	Spec	Action type	Load type	Load group	Master load case
TLt	Temperature load	Temperature	Variable	Static	LG3	None



Name	2D member	Distribution	+z - Top delta [K]	-z - Bottom delta [K]
ST1	S1	Linear	14,00	0,00

4.2. Load groups

Name	Load	Relation	Type
LG1	Permanent		
LG2	Variable	Standard	Cat H : Roofs
LG3	Variable	Exclusive	Wind
LG4	Variable	Standard	Cat E : Storage

4.3. Combinations

Name	Description	Type	Load cases	Coeff. [-]
ULS		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
ULS_NoTemp		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00 1,00
ULS_Empty		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00
SLS_Char		EN-SLS Characteristic	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
SLS_Char_Empty		EN-SLS Characteristic	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00
SLS_Freq		EN-SLS Frequent	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
SLS_Freq_Empty		EN-SLS Frequent	DL - Dead load - Self weight DL1 - Dead load - Slope EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00

4.4. Result classes

Name	List
ULS_NoTemp	ULS_NoTemp - EN-ULS (STR/GEO) Set B ULS_Empty - EN-ULS (STR/GEO) Set B
SLS_Char	SLS_Char - EN-SLS Characteristic SLS_Char_Empty - EN-SLS Characteristic

5. Results

5.1. Bill of material

Selection: All

Type of sorting: Material

Summary

Material	Mass [kg]	Surface [m ²]	Volume [m ³]
Concrete	469689,0	229,943	1,8788e+02
Total	469689,0	229,943	1,8788e+02

Note: Value 'Surface' represents for 1D members the total exposed surface area, while for 2D members it corresponds only to the surface area of the centroidal plane.

Concrete (2D)

Material	Density [kg/m ³]	Mass [kg]	Surface [m ²]	Volume [m ³]
C30/37	2500,0	469689,0	229,943	1,8788e+02
Total		469689,0	229,943	1,8788e+02

5.2. Resultant of reactions - Characteristic

Linear calculation

Combination: SLS_Char

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	SLS_Char/1	0,0	0,0	55676,4	0,0	0,0	0,0
0,000	0,000	0,000	SLS_Char/2	0,0	0,0	55475,4	0,0	0,0	0,0
0,000	0,000	0,000	SLS_Char/3	-472,0	0,0	55472,3	0,0	-5879,3	0,0
0,000	0,000	0,000	SLS_Char/4	0,0	0,0	55475,4	0,0	0,0	0,0
0,000	0,000	0,000	SLS_Char/5	-333,8	-333,8	55471,6	4150,1	-4150,1	0,0

Name	Combination key
SLS_Char/1	DL + EE + EO + LL + DL1
SLS_Char/2	DL + EE + EO + TLt + DL1
SLS_Char/3	DL + EE + EO + WL + DL1
SLS_Char/4	DL + EE + EO + DL1
SLS_Char/5	DL + EE + EO + WL45 + DL1

5.3. Resultant of reactions - Load cases

5.3.1. Resultant of reactions - Load cases - DL

Name, Description, Action type, Load type	DL	Dead load - Self weight	Permanent	Self weight
---	----	-------------------------	-----------	-------------

Linear calculation

Load case: DL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	DL	0,0	0,0	4696,9	0,0	0,0	0,0

5.3.2. Resultant of reactions - Load cases - DL1

Name, Description, Action type, Load type	DL1	Dead load - Slope	Permanent	Standard
---	-----	-------------------	-----------	----------

Linear calculation

Load case: DL1

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	DL1	0,0	0,0	459,9	0,0	0,0	0,0

5.3.3. Resultant of reactions - Load cases - EE

Name, Description, Action type, Load type	EE	Dead load - Empty equipment	Permanent	Standard
---	----	-----------------------------	-----------	----------

Linear calculation

Load case: EE

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	EE	0,0	0,0	1055,6	0,0	0,0	0,0

5.3.4. Resultant of reactions - Load cases - EO

Name, Description, Action type, Load type	EO	Dead load - Operating load	Permanent	Standard
---	----	----------------------------	-----------	----------

Linear calculation

Load case: EO

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	EO	0,0	0,0	49263,1	0,0	0,0	0,0

5.3.5. Resultant of reactions - Load cases - LL

Name, Description, Action type, Load type	LL	Live load - Roof	Variable	Static
---	----	------------------	----------	--------

Linear calculation

Load case: LL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	LL	0,0	0,0	201,1	0,0	0,0	0,0

5.3.6. Resultant of reactions - Load cases - WL

Name, Description, Action type, Load type	WL	Wind load	Variable	Static
---	----	-----------	----------	--------

Linear calculation

Load case: WL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	WL	-472,0	0,0	-3,1	0,0	-5879,3	0,0

5.3.7. Resultant of reactions - Load cases - WL45

Name, Description, Action type, Load type	WL45	Wind load	Variable	Static
---	------	-----------	----------	--------

Linear calculation

Load case: WL45

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	WL45	-333,8	-333,8	-3,8	4150,1	-4150,1	0,0

5.3.8. Resultant of reactions - Load cases - TLt

Name, Description, Action type, Load type	TLt	Temperature load	Variable	Static
---	-----	------------------	----------	--------

Linear calculation

Load case: TLt

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	TLt	0,0	0,0	0,0	0,0	0,0	0,0

5.4. Reactions

Linear calculation

Class: SLS_Char

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]
Sn005/N005	SLS_Char/1	6,9	1,1	1051,9	0,0	0,0	0,0	0,0	0,0
Sn036/N036	SLS_Char/1	1,1	-6,9	1051,9	0,0	0,0	0,0	0,0	0,0
Sn054/N054	SLS_Char/1	-1,1	6,9	1051,9	0,0	0,0	0,0	0,0	0,0
Sn015/N015	SLS_Char_Empty/2	-6,4	-6,4	85,5	0,0	0,0	0,0	0,0	0,0
Sn047/N047	SLS_Char/3	-6,3	-6,3	1223,4	0,0	0,0	0,0	0,0	0,0
Sn038/N038	SLS_Char/4	-9,1	0,1	1209,9	0,0	0,0	0,0	0,0	0,0

Name	Combination key
SLS_Char/1	DL + EE + EO + Tlt + DL1
SLS_Char_Empty/2	DL + EE + WL45 + DL1
SLS_Char/3	DL + EE + EO + WL45 + DL1
SLS_Char/4	DL + EE + EO + WL + DL1

Linear calculation

Class: ULS_NoTemp

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]
Sn048/N048	ULS_NoTemp/1	0,1	-0,1	1635,6	0,0	0,0	0,0	0,0	0,0
Sn048/N048	ULS_NoTemp/2	-9,5	-9,7	1460,3	0,0	0,0	0,0	0,0	0,0
Sn047/N047	ULS_NoTemp/1	0,1	0,1	1635,6	0,0	0,0	0,0	0,0	0,0
Sn015/N015	ULS_Empty/3	-9,6	-9,6	52,4	0,0	0,0	0,0	0,0	0,0
Sn039/N039	ULS_NoTemp/1	-0,1	-0,1	1635,6	0,0	0,0	0,0	0,0	0,0
Sn038/N038	ULS_NoTemp/4	-13,7	0,1	1453,2	0,0	0,0	0,0	0,0	0,0

Name	Combination key
ULS_NoTemp/1	1.35*DL + 1.35*EE + 1.35*EO + 1.35*DL1
ULS_NoTemp/2	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL45 + 1.20*DL1
ULS_Empty/3	0.90*DL + 0.90*EE + 1.50*WL45 + 0.90*DL1
ULS_NoTemp/4	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL + 1.20*DL1

Linear calculation

Combination: 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]
Sn036/N036	ULS/1	-13,7	0,0	1048,1	0,0	0,0	0,0	0,0	0,0
Sn005/N005	ULS/2	10,3	1,6	883,3	0,0	0,0	0,0	0,0	0,0
Sn036/N036	ULS/2	1,6	-10,3	883,2	0,0	0,0	0,0	0,0	0,0
Sn054/N054	ULS/2	-1,6	10,3	883,3	0,0	0,0	0,0	0,0	0,0
Sn015/N015	ULS/3	-9,6	-9,6	724,4	0,0	0,0	0,0	0,0	0,0
Sn039/N039	ULS/4	-0,1	-0,1	1742,2	0,0	0,0	0,0	0,0	0,0

Name	Combination key
ULS/1	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL + 1.20*DL1
ULS/2	0.90*DL + 0.90*EE + 0.90*EO + 1.50*Tlt + 0.90*DL1
ULS/3	0.90*DL + 0.90*EE + 0.90*EO + 1.50*WL45 + 0.90*DL1
ULS/4	1.35*DL + 1.35*EE + 1.35*EO + 1.35*DL1

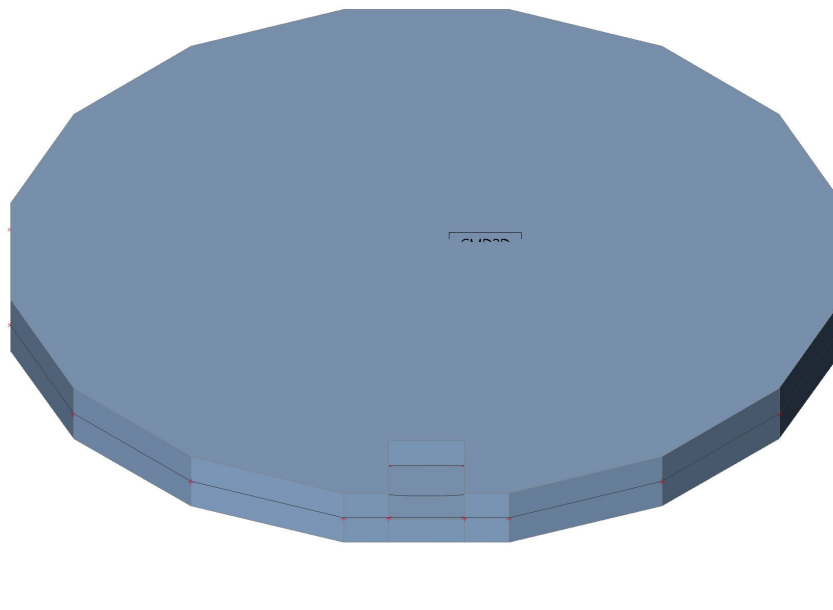
Appendix C

Scia report T315

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2. General



2.1. Project

Licence name	KH Engineering		
Project	Neste - Rotterdam terminal expansion		
Part	Tank pit 3 - tank foundations		
Description	T315		
Author	LER		
Date	07. 2021		
Structure	General XYZ		
No. of nodes :		60	
No. of beams :		0	
No. of slabs :		1	
No. of solids :		0	
No. of used profiles :		0	
No. of load cases :		8	
No. of used materials :		2	
Acceleration of gravity [m/s ²]		10,000	
National code	EC - EN		

2.2. 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	0.2	0
Temperature	0	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

2.3. Solver setup

Name	SolverSetup1
Neglect shear force deformation ($A_y, A_z \gg A$)	x
Initial stress	x
Number of thicknesses of rib plate	20
Maximum soil interaction iterations	10
Maximum iterations	20
Number of increments	1
Number of buckling modes	2
Number of sections on average member	10
Step for soil/water pressure [m]	0,500
C1x [MN/m ³]	1,0000e-01
C1y [MN/m ³]	1,0000e-01
C1z [MN/m ³]	1,0000e+01
C2x [MN/m]	5,0000e+00
C2y [MN/m]	5,0000e+00
Coefficient for reinforcement	1
Warning when maximal translation is greater than [mm]	1000,0
Warning when maximal rotation is greater than [mrad]	100,0
Parallelism tolerance [deg]	10,00
Ratio to half - distance to adjacent beam beff,i/bi [-]	0,20
Ratio to effective span length beff,i/l0 [-]	0,10
Max ratio to effective span length beff,i/l0 [-]	0,20
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever, base ratio to current span [-]	1,00
Cantilever, base ratio to adjacent span [-]	0,15
Cantilever, max ratio to current span [-]	1,50
Max adjacent span length ratio [-]	1,50
Max cantilever length ratio to adjacent span [-]	0,50
Span length ratio Le/beff,i,max (1 side) [-]	8,00
Simply supported beam [-]	1,00
Inner span [-]	0,70
End span [-]	0,85
Cantilever [-]	2,00
Method used for non-concrete and non-steel / composite beams	EN 1994-1-1
Solver precision ratio	1
Soil combination	None
Bending theory of plate/shell analysis	Mindlin
Type of solver	Direct
Type of eigen value solver	Lanczos
Method of calculation	Picard

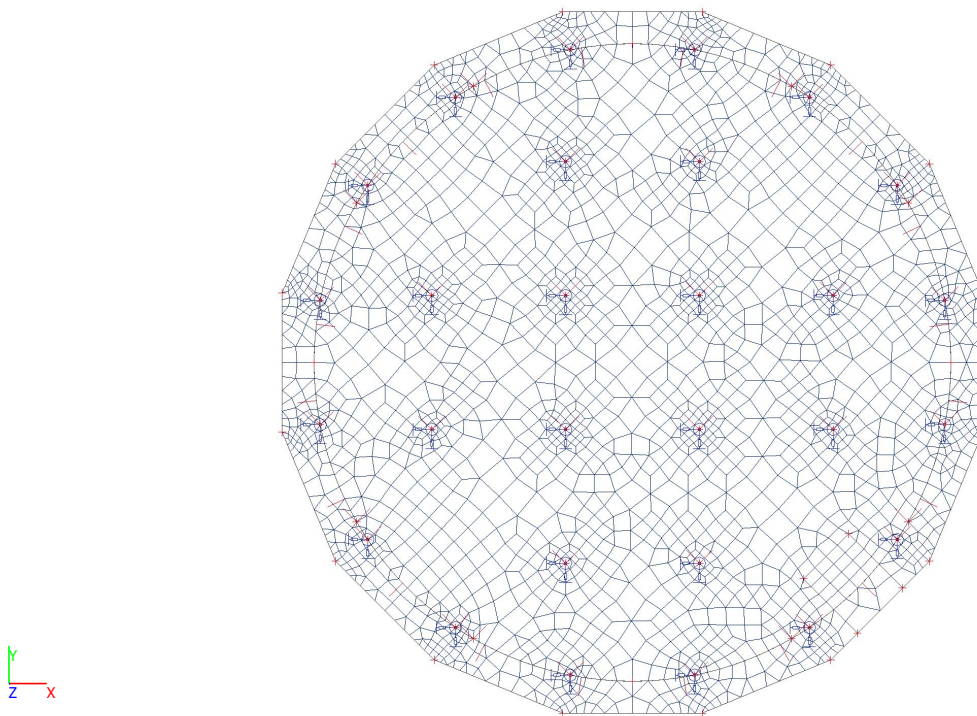
2.4. Mesh setup

Name	MeshSetup1
Generation of eccentric elements on members with variable height	x
Generation of nodes in connections of beam elements	x
Elastic mesh	✓
Use automatic mesh refinement	✓
Connect members/nodes	✓
Division on haunches and arbitrary members	5
Division for 2D-1D upgrade	50
Average number of tiles of 1d element	1
Target error for mesh refinement [%]	10
Average size of 2d element/curved element [m]	0,420
Minimal length of beam element [m]	0,100
Maximal length of beam element [m]	1000,000
Average size of cables, tendons, elements on subsoil, nonlinear soil spring [m]	1,000
Maximal out of plane angle of a quadrilateral [mrad]	30,0
Predefined mesh ratio	1.5

Minimal distance between definition point and line [m]	0.001
Average size of panel element [m]	0,300
Mesh refinement following the beam type	None
Definition of mesh element size for panels	Manual
Group of load cases for automatic mesh refinement	EO

2.5. Mesh setup

Name	MeshSetup1
Generation of eccentric elements on members with variable height	x
Generation of nodes in connections of beam elements	x
Elastic mesh	✓
Use automatic mesh refinement	✓
Connect members/nodes	✓
Division on haunches and arbitrary members	5
Division for 2D-1D upgrade	50
Average number of tiles of 1d element	1
Target error for mesh refinement [%]	10
Average size of 2d element/curved element [m]	0,420
Minimal length of beam element [m]	0,100
Maximal length of beam element [m]	1000,000
Average size of cables, tendons, elements on subsoil, nonlinear soil spring [m]	1,000
Maximal out of plane angle of a quadrilateral [mrad]	30,0
Predefined mesh ratio	1.5
Minimal distance between definition point and line [m]	0.001
Average size of panel element [m]	0,300
Mesh refinement following the beam type	None
Definition of mesh element size for panels	Manual
Group of load cases for automatic mesh refinement	EO



2.6. Materials

Name	Type	ρ [kg/m ³]	Density in fresh state [kg/m ³]	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	■
C30/37 Cracked	Concrete	2500,0	2600,0	1,2667e+04	0.0001	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.
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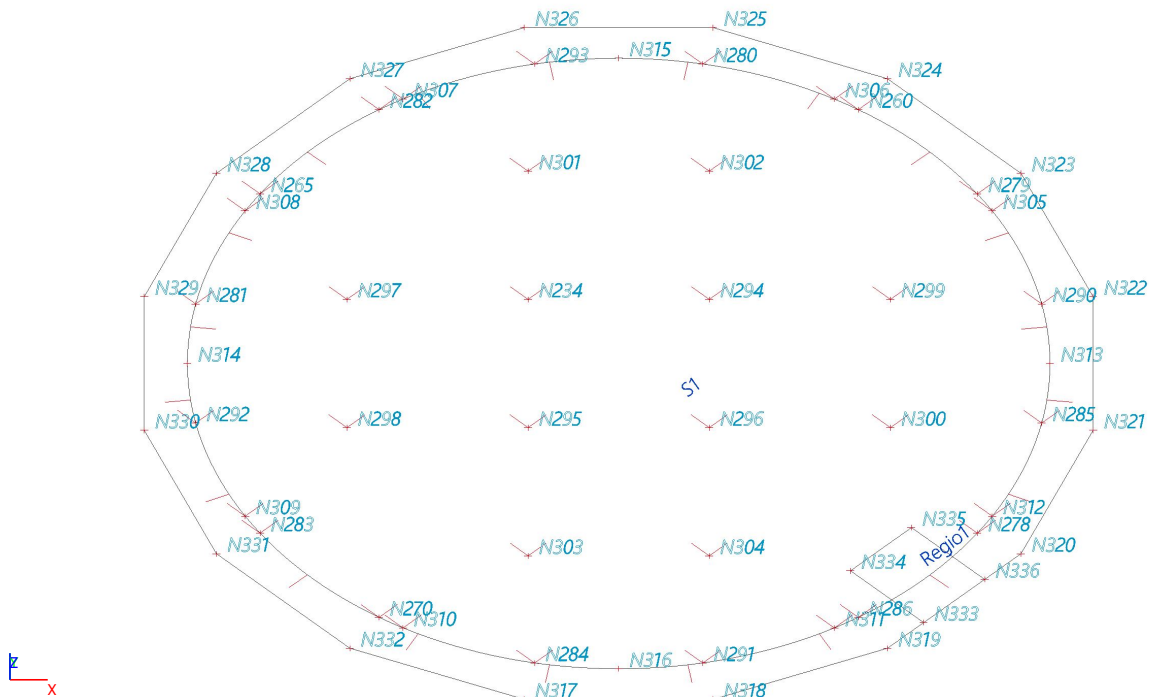
3. Structure

3.1. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N234	-1,050	1,050	0,000
N260	2,778	4,157	0,000
N265	-4,157	2,778	0,000
N270	-2,778	-4,157	0,000
N278	4,157	-2,778	0,000
N279	4,157	2,778	0,000
N280	0,975	4,904	0,000
N281	-4,904	0,975	0,000
N282	-2,778	4,157	0,000
N283	-4,157	-2,778	0,000
N284	-0,975	-4,904	0,000
N285	4,904	-0,975	0,000
N286	2,778	-4,157	0,000
N290	4,904	0,975	0,000
N291	0,975	-4,904	0,000
N292	-4,904	-0,975	0,000
N293	-0,975	4,904	0,000
N294	1,050	1,050	0,000
N295	-1,050	-1,050	0,000
N296	1,050	-1,050	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N297	-3,150	1,050	0,000
N298	-3,150	-1,050	0,000
N299	3,150	1,050	0,000
N300	3,150	-1,050	0,000
N301	-1,050	3,150	0,000
N302	1,050	3,150	0,000
N303	-1,050	-3,150	0,000
N304	1,050	-3,150	0,000
N305	4,330	2,500	0,000
N306	2,500	4,330	0,000
N307	-2,500	4,330	0,000
N308	-4,330	2,500	0,000
N309	-4,330	-2,500	0,000
N310	-2,500	-4,330	0,000
N311	2,500	-4,330	0,000
N312	4,330	-2,500	0,000
N313	5,000	0,000	0,000
N314	-5,000	0,000	0,000
N315	0,000	5,000	0,000
N316	0,000	-5,000	0,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N317	-1,094	-5,500	0,000
N318	1,094	-5,500	0,000
N319	3,115	-4,663	0,000
N320	4,663	-3,115	0,000
N321	5,500	-1,094	0,000
N322	5,500	1,094	0,000
N323	4,663	3,115	0,000
N324	3,115	4,663	0,000
N325	1,094	5,500	0,000
N326	-1,094	5,500	0,000
N327	-3,115	4,663	0,000
N328	-4,663	3,115	0,000
N329	-5,500	1,094	0,000
N330	-5,500	-1,094	0,000
N331	-4,663	-3,115	0,000
N332	-3,115	-4,663	0,000
N333	3,536	-4,243	0,000
N334	2,687	-3,394	0,000
N335	3,394	-2,687	0,000
N336	4,243	-3,536	0,000



3.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S1	Layer1	plate (90)	Standard	C30/37	variable	900 790

3.3. 2D member regions

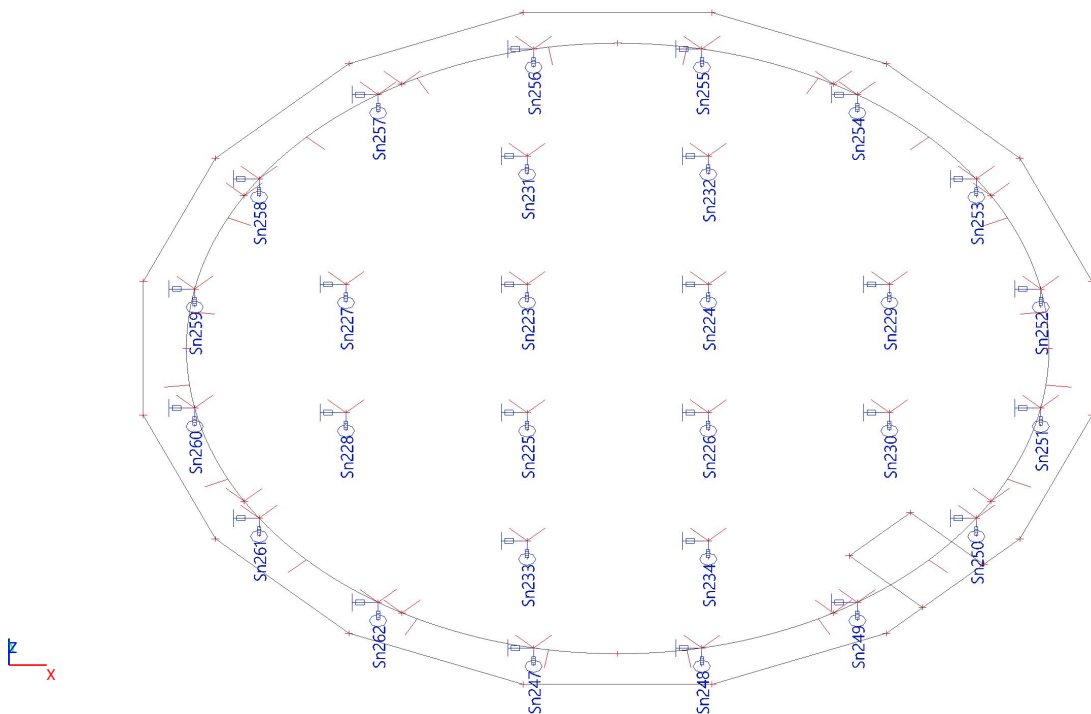
Regio1			
2D member, Material, Thickness type	S1	C30/37	constant
MSP at, Ecc. z [mm]	Centre	-208	
Th. [mm]	375		
Node, Edge, Weight	N333	Line	
	N334	Line	
	N335	Line	
	N336	Line	

3.4. 2D member internal edges

Name	Member 1	Length [m]	Shape	Node	Edge
ES4	S1	15,708	Arc	N313 N315 N314	Circle arc
ES5	S1	15,708	Arc	N313 N316 N314	Circle arc

3.5. Nodal supports

Name	Node	System	Type	X	Stiffness X [MN/m]	Y	Stiffness Y [MN/m]	Z	Stiffness Z [MN/m]	Rx	Ry	Rz
Sn223	N234	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn224	N294	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn225	N295	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn226	N296	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn227	N297	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn228	N298	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn229	N299	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn230	N300	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn231	N301	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn232	N302	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn233	N303	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn234	N304	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn247	N284	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn248	N291	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn249	N286	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn250	N278	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn251	N285	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn252	N290	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn253	N279	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn254	N260	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn255	N280	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn256	N293	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn257	N282	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn258	N265	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn259	N281	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn260	N292	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn261	N283	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free
Sn262	N270	GCS	Standard	Flexible	1,5000e+01	Flexible	1,5000e+01	Flexible	6,5000e+01	Free	Free	Free

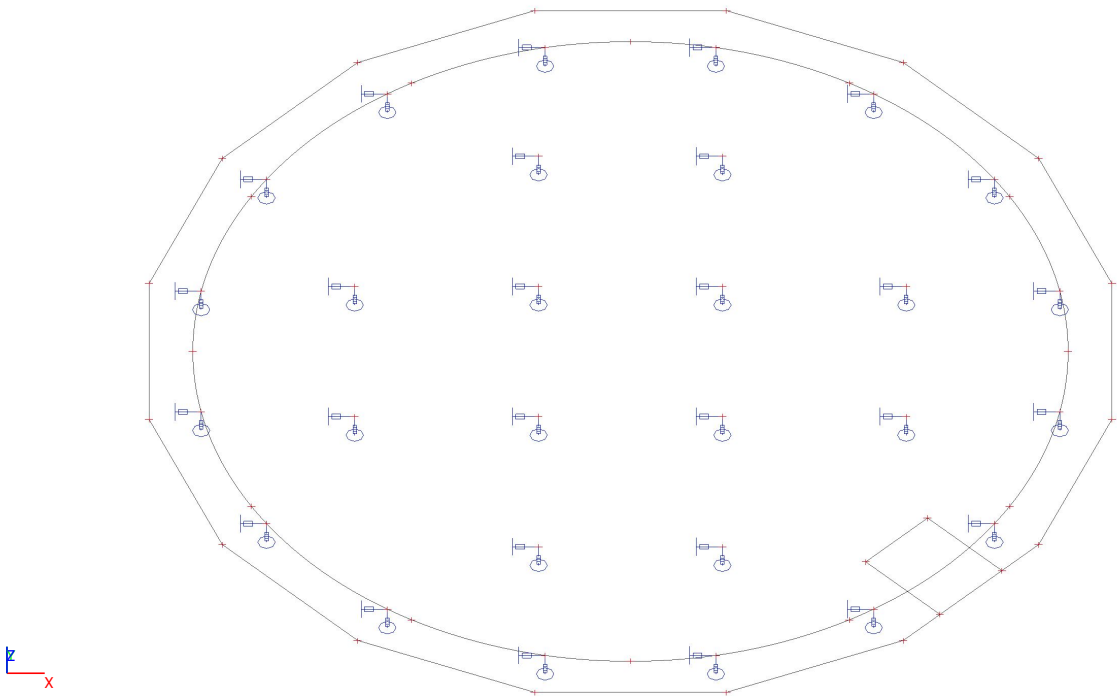


4. loads

4.1. Load cases

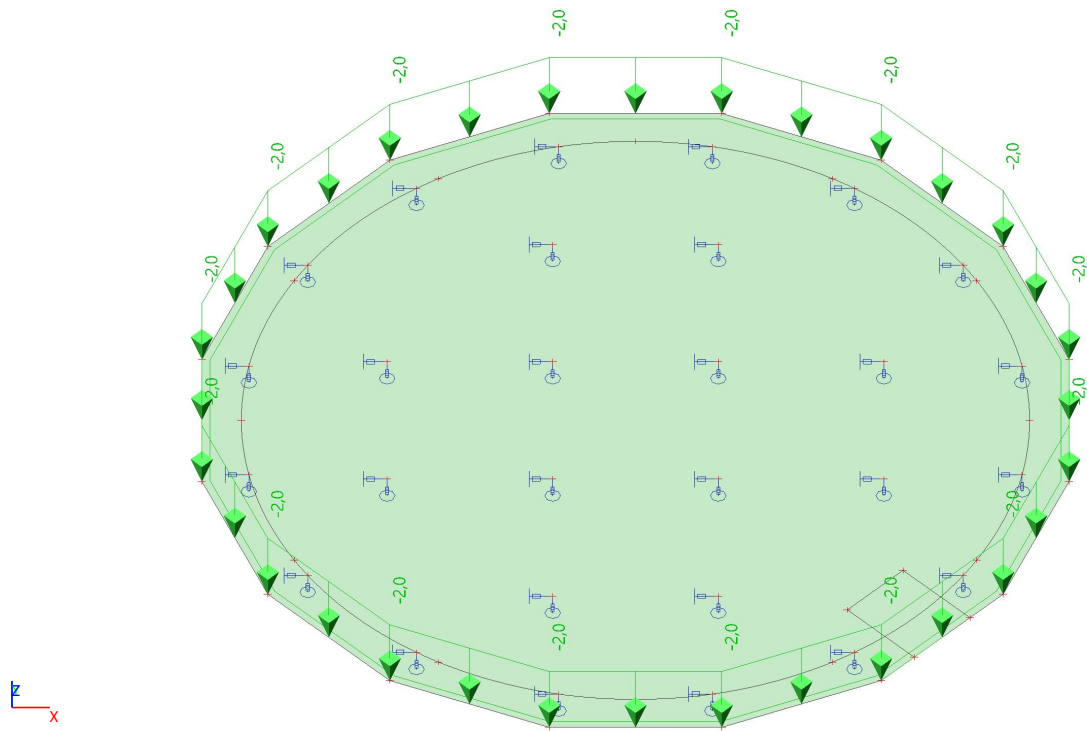
4.1.1. Load cases - DL

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



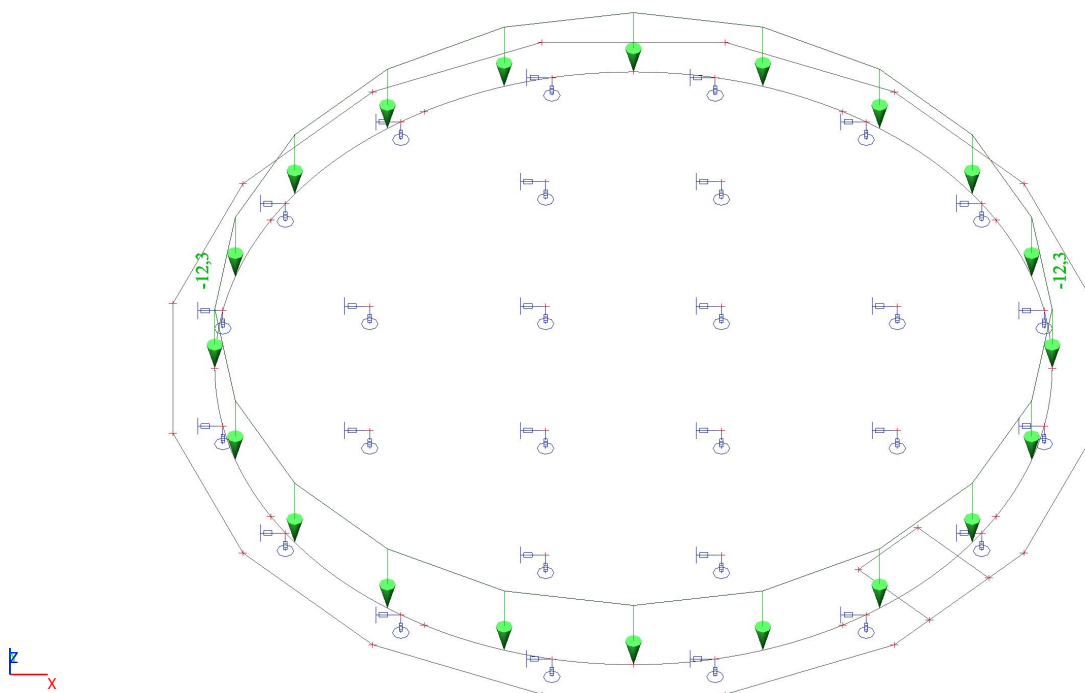
4.1.2. Load cases - DL1

Name	Description	Action type	Load type	Load group
DL1	Wind load	Permanent	Standard	LG1



4.1.3. Load cases - EE

Name	Description	Action type	Load type	Load group
EE	Dead load - Empty equipment	Permanent	Standard	LG1

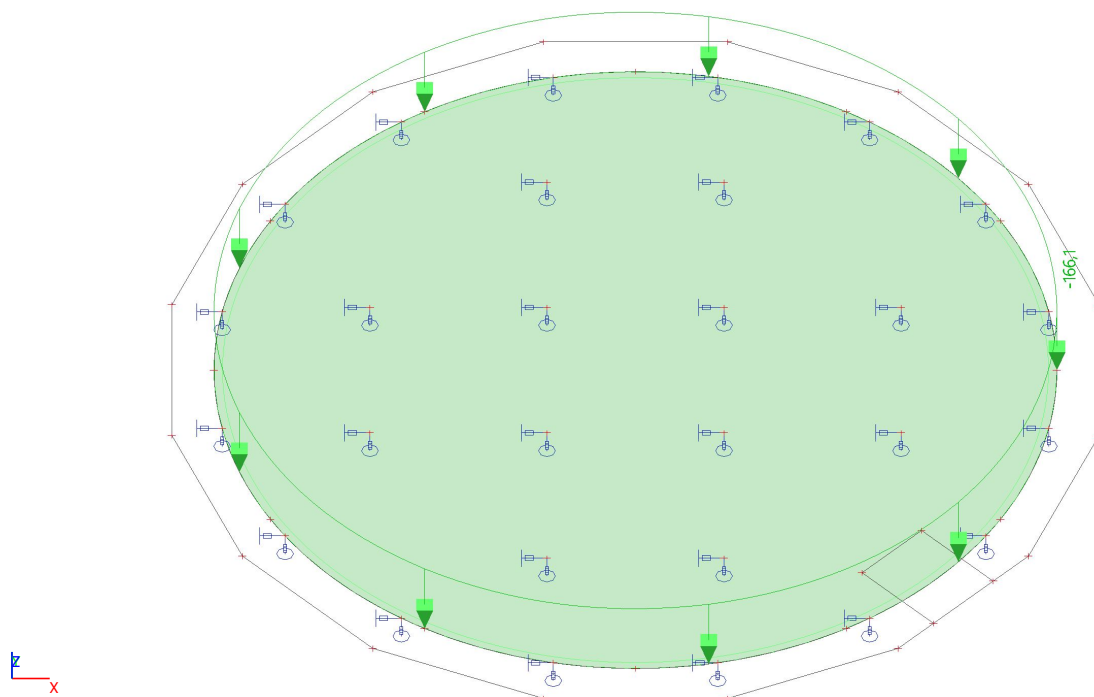


4.1.3.1. Line force on 2D member edge

Name	Internal edge	Type	System	Dir	Distribution	Value - P ₁ [kN/m]	Pos x ₁	Pos x ₂	Loc	Coor	Edge	Orig
LFS7	ES4	Force	LCS	Z	Uniform	-12,3	0.000	1.000	Length	Rela	1	From start
LFS9	ES5	Force	LCS	Z	Uniform	-12,3	0.000	1.000	Length	Rela	1	From start

4.1.4. Load cases - EO

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

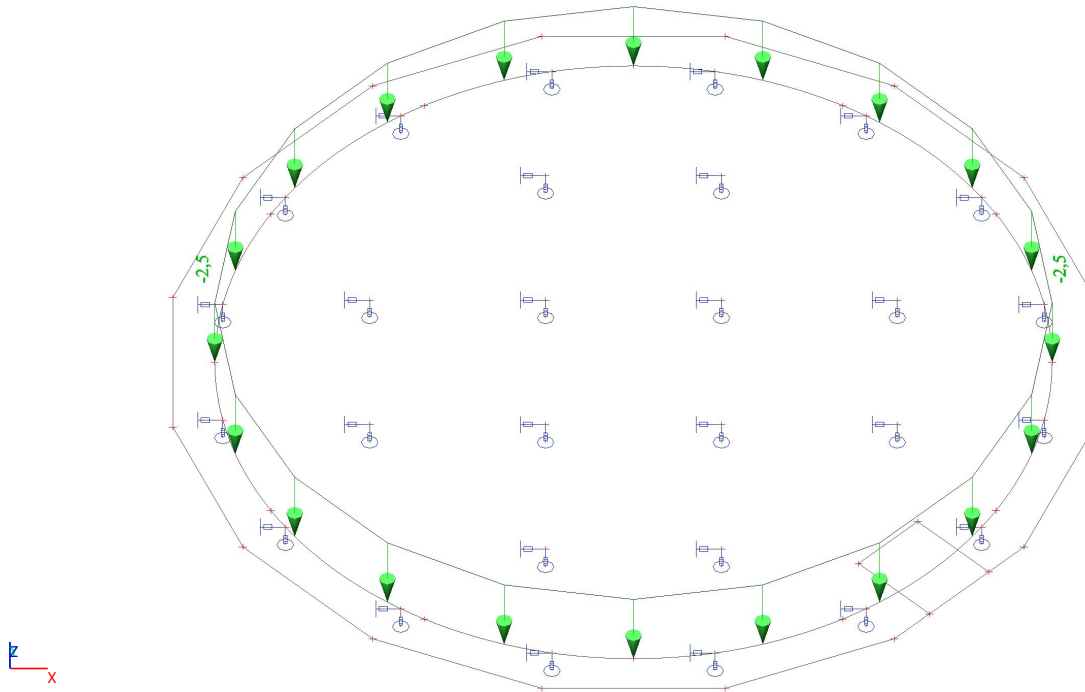


4.1.4.1. Free surface load

Name	Dir	Type	Distribution	q [kN/m ²]	Validity	Select	System	Location
FF1	Z	Force	Uniform	-166,1	All	Auto	GCS	Length

4.1.5. Load cases - LL

Name	Description	Spec	Action type	Load type	Load group	Duration	Master load case
LL	Live load - Roof	Standard	Variable	Static	LG4	Short	None

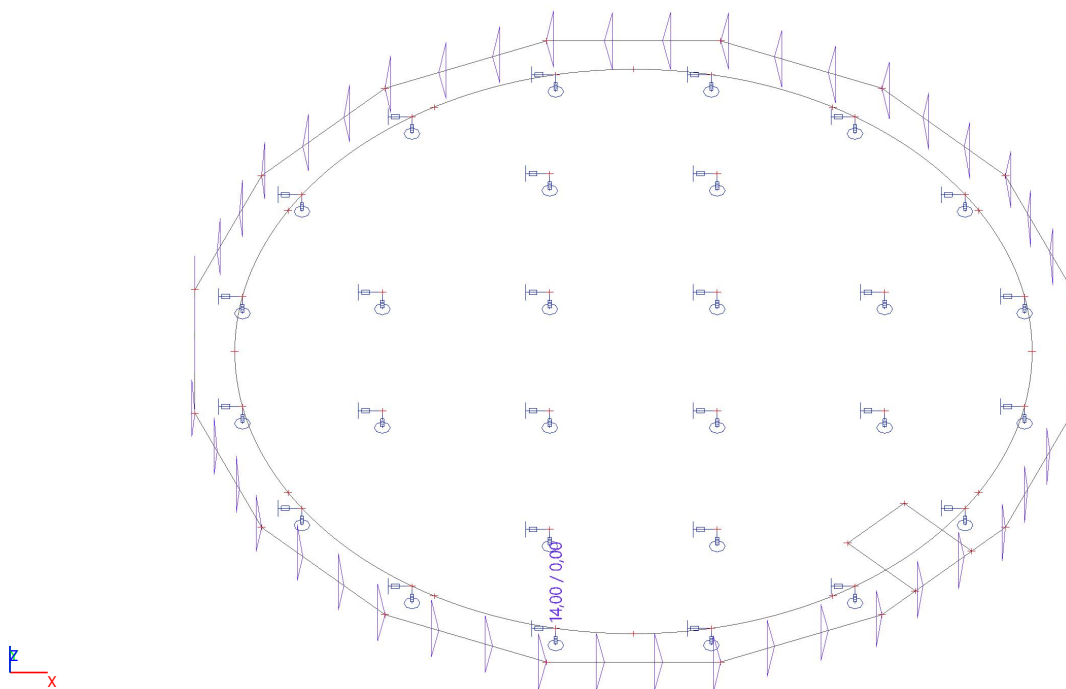


4.1.5.1. Line force on 2D member edge

Name	Internal edge	Type	System	Dir	Distribution	Value - P ₁ [kN/m]	Pos x ₁	Pos x ₂	Loc	Coor	Edge	Orig
LFS8	ES4	Force	LCS	Z	Uniform	-2,5	0.000	1.000	Length	Rela	1	From start
LFS10	ES5	Force	LCS	Z	Uniform	-2,5	0.000	1.000	Length	Rela	1	From start

4.1.8. Load cases - TLt

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



4.1.8.1. Thermal load on 2D member

Name	2D member	Distribution	+z - Top delta [K]	-z - Bottom delta [K]
ST1	S1	Linear	14,00	0,00

4.2. Load groups

Name	Load	Relation	Type
LG1	Permanent		
LG2	Variable	Standard	Cat H : Roofs
LG3	Variable	Exclusive	Wind
LG4	Variable	Standard	Temperature

4.3. Combinations

Name	Description	Type	Load cases	Coeff. [-]
ULS		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
ULS_NoTemp		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00 1,00
ULS_Empty		EN-ULS (STR/GEO) Set B	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00
SLS_Char		EN-SLS Characteristic	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
SLS_Char_Empty		EN-SLS Characteristic	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00
SLS_Freq		EN-SLS Frequent	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment EO - Dead load - Operating load LL - Live load - Roof WL - Wind load WL45 - Wind load TLt - Temperature load	1,00 1,00 1,00 1,00 1,00 1,00 1,00 1,00
SLS_Freq_Empty		EN-SLS Frequent	DL - Dead load - Self weight DL1 - Wind load EE - Dead load - Empty equipment LL - Live load - Roof WL - Wind load WL45 - Wind load	1,00 1,00 1,00 1,00 1,00 1,00

4.4. Result classes

Name	List
ULS_NoTemp	ULS_NoTemp - EN-ULS (STR/GEO) Set B ULS_Empty - EN-ULS (STR/GEO) Set B
SLS_Char	SLS_Char - EN-SLS Characteristic SLS_Char_Empty - EN-SLS Characteristic

5. Results

5.1. Bill of material

Selection: All

Type of sorting: Material

Summary

Material	Mass [kg]	Surface [m ²]	Volume [m ³]
Concrete	202115,0	96,274	8,0846e+01
Total	202115,0	96,274	8,0846e+01

Note: Value 'Surface' represents for 1D members the total exposed surface area, while for 2D members it corresponds only to the surface area of the centroidal plane.

Concrete (2D)

Material	Density [kg/m ³]	Mass [kg]	Surface [m ²]	Volume [m ³]
C30/37	2500,0	202115,0	96,274	8,0846e+01
Total		202115,0	96,274	8,0846e+01

5.2. Resultant of reactions

Linear calculation

Combination: SLS_Char

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	SLS_Char/1	0,0	0,0	15635,0	174,1	174,1	0,0
0,000	0,000	0,000	SLS_Char/2	0,0	0,0	15556,4	174,1	174,1	0,0
0,000	0,000	0,000	SLS_Char/3	-208,8	0,0	15554,7	174,1	-1541,7	0,0
0,000	0,000	0,000	SLS_Char/4	0,0	0,0	15635,0	174,1	174,1	0,0
0,000	0,000	0,000	SLS_Char/5	-147,6	-147,6	15555,0	1386,1	-1038,0	0,0

Name	Combination key
SLS_Char/1	DL + EE + EO + LL + TLt + DL1
SLS_Char/2	DL + EE + EO + TLt + DL1
SLS_Char/3	DL + EE + EO + WL + DL1
SLS_Char/4	DL + EE + EO + LL + DL1
SLS_Char/5	DL + EE + EO + WL45 + DL1

Name, Description, Action type, Load type	DL	Dead load - Self weight	Permanent	Self weight
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Linear calculation

Load case: DL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	DL	0,0	0,0	2021,1	174,0	174,0	0,0

Name, Description, Action type, Load type	DL1	Wind load	Permanent	Standard
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Linear calculation

Load case: DL1

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	DL1	0,0	0,0	192,5	0,0	0,0	0,0

Name, Description, Action type, Load type	EE	Dead load - Empty equipment	Permanent	Standard
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Linear calculation

Load case: EE

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	EE	0,0	0,0	386,4	0,0	0,0	0,0

Name, Description, Action type, Load type	EO	Dead load - Operating load	Permanent	Standard
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Linear calculation

Load case: EO

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	EO	0,0	0,0	12956,3	0,0	0,0	0,0

Name, Description, Action type, Load type	LL	Live load - Roof	Variable	Static
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Linear calculation

Load case: LL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	LL	0,0	0,0	78,5	0,0	0,0	0,0

Name, Description, Action type, Load type	WL	Wind load	Variable	Static
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Linear calculation

Load case: WL

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	WL	-208,8	0,0	-1,8	0,0	-1715,8	0,0

Name, Description, Action type, Load type	WL45	Wind load	Variable	Static
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Linear calculation

Load case: WL45

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	WL45	-147,6	-147,6	-1,5	1212,0	-1212,0	0,0

Name, Description, Action type, Load type	TLt	Temperature load	Variable	Static
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Linear calculation

Load case: TLt

Extreme: Global

Selection: All

System: Global

x [m]	y [m]	z [m]	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]
0,000	0,000	0,000	TLt	0,0	0,0	0,0	0,0	0,0	0,0

5.3. Reactions

Linear calculation

Class: SLS_Char

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]
Sn249/N286	SLS_Char/1	-7,6	-0,3	542,7	0,0	0,0	0,0	0,0	0,0
Sn259/N281	SLS_Char/2	5,1	-1,0	567,6	0,0	0,0	0,0	0,0	0,0
Sn249/N286	SLS_Char/3	-5,4	-5,6	515,5	0,0	0,0	0,0	0,0	0,0
Sn247/N284	SLS_Char/4	1,0	5,1	561,7	0,0	0,0	0,0	0,0	0,0
Sn262/N270	SLS_Char_Empty/5	-5,3	-5,3	60,1	0,0	0,0	0,0	0,0	0,0
Sn224/N294	SLS_Char/3	-5,3	-5,3	627,5	0,0	0,0	0,0	0,0	0,0

Name	Combination key
SLS_Char/1	DL + EE + EO + WL + DL1
SLS_Char/2	DL + EE + EO + Tlt + DL1
SLS_Char/3	DL + EE + EO + WL45 + DL1
SLS_Char/4	DL + EE + EO + LL + Tlt + DL1
SLS_Char_Empty/5	DL + EE + WL45 + DL1

Linear calculation

Class: ULS_NoTemp

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]
Sn249/N286	ULS_NoTemp/1	-11,4	-0,4	656,9	0,0	0,0	0,0	0,0	0,0
Sn249/N286	ULS_NoTemp/2	-8,1	-8,2	616,1	0,0	0,0	0,0	0,0	0,0
Sn250/N278	ULS_NoTemp/3	0,4	0,2	710,4	0,0	0,0	0,0	0,0	0,0
Sn262/N270	ULS_Empty/4	-7,9	-7,9	35,4	0,0	0,0	0,0	0,0	0,0
Sn226/N296	ULS_NoTemp/3	0,1	-0,1	831,8	0,0	0,0	0,0	0,0	0,0

Name	Combination key
ULS_NoTemp/1	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL + 1.20*DL1
ULS_NoTemp/2	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL45 + 1.20*DL1
ULS_NoTemp/3	1.35*DL + 1.35*EE + 1.35*EO + 1.35*DL1
ULS_Empty/4	0.90*DL + 0.90*EE + 1.50*WL45 + 0.90*DL1

Linear calculation

Combination: 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]
Sn249/N286	ULS/1	-11,6	-0,9	609,7	0,0	0,0	0,0	0,0	0,0
Sn259/N281	ULS/2	7,7	-1,5	636,2	0,0	0,0	0,0	0,0	0,0
Sn249/N286	ULS/3	-8,3	-8,7	568,2	0,0	0,0	0,0	0,0	0,0
Sn247/N284	ULS/4	1,4	7,7	481,6	0,0	0,0	0,0	0,0	0,0
Sn247/N284	ULS/5	-8,1	-7,9	394,5	0,0	0,0	0,0	0,0	0,0
Sn226/N296	ULS/6	0,1	-0,1	949,5	0,0	0,0	0,0	0,0	0,0

Name	Combination key
ULS/1	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL + 1.20*DL1
ULS/2	1.20*DL + 1.20*EE + 1.20*EO + 1.50*Tlt + 1.20*DL1
ULS/3	1.20*DL + 1.20*EE + 1.20*EO + 1.50*WL45 + 1.20*DL1
ULS/4	0.90*DL + 0.90*EE + 0.90*EO + 1.50*LL + 1.50*Tlt + 0.90*DL1
ULS/5	0.90*DL + 0.90*EE + 0.90*EO + 1.50*WL45 + 0.90*DL1
ULS/6	1.35*DL + 1.35*EE + 1.35*EO + 1.35*DL1

Appendix D

Foundation loads

Foundation loads

Settling Tanks: T301 - 302



I. General data

Client	Neste Oil
Contact person	...
Project number	34510
Project description	New Terminal Rotterdam
Number of tank	Settling Tanks: T301 - 302
Date	21/06/2021
By	MMI
Revised	0

II. Design data

Diameter of tank	D =	19300	mm
Cylindrical height	Hf =	16500	mm
Design pressure : Overpressure	p	10,0	mbar
Underpressure	pv	5	mbar
Testpressure	pt	0	mbar
Roofload		1	kN/m ²
Windspeed acc	EN 1991-1-4:	45	m/s
	horizontal windload :	394,5	kN
	windmoment :	3430,3	kNm
Own weight :			
	shell :	632,3	kN
	roof :	259,0	kN
	Bottom :	193,1	kN

III. Foundation loads

A. Under the bottomplates (pression)
(combination of own weight, hydrostatic pression and overpressure)

normal case :	163,5	kN/m²
test case :	162,5	kN/m²

B. Under the shellplates (pression)
(combination of own weight, roofload and windload)

normal case :	21,94	kN/m
extreme wind :	28,84	kN/m

C. At anchorage (tension)
(combination of own weight, overpressure and windload)

anchorage :	24 X M30	Da =	19500	mm
	normal case :	0,0	kN	
	test case :	0,0	kN	
	extreme wind :	23,2	kN	

Foundation loads

Strategic Tanks: T303 - 309
+ Final Tanks: T310 - 314



I. General data

Client	Neste Oil
Contact person	...
Project number	34510
Project description	New Terminal Rotterdam
Number of tank	Strategic Tanks: T303 - 309 + Final Tanks: T310 - 314
Date	21/06/2021
By	MMI
Revised	0

II. Design data

Diameter of tank	D =	16000	mm
Cylindrical height	Hf =	24500	mm
Design pressure : Overpressure	p	10,0	mbar
Underpressure	pv	5	mbar
Testpressure	pt	0	mbar
Roofload		1	kN/m ²
Windspeed acc	EN 1991-1-4:	45	m/s
	horizontal windload :	472,5	kN
	windmoment :	5961,4	kNm
Own weight :			
	shell :	752,4	kN
	roof :	170,0	kN
	Bottom :	132,7	kN

III. Foundation loads

A. Under the bottomplates (pression)
(combination of own weight, hydrostatic pression and overpressure)

normal case :	241,9	kN/m²
test case :	240,9	kN/m²

B. Under the shellplates (pression)
(combination of own weight, roofload and windload)

normal case :	24,35	kN/m
extreme wind :	50,00	kN/m

C. At anchorage (tension)
(combination of own weight, overpressure and windload)

anchorage :	20 X M30	Da =	16200	mm
normal case :	0,0	kN		
test case :	0,0	kN		
extreme wind :	57,8	kN		

Foundation loads

Slop Tank: T315



I. General data

Client	Neste Oil
Contact person	...
Project number	34510
Project description	New Terminal Rotterdam
Number of tank	Slop Tank: T315
Date	21/06/2021
By	MMI
Revised	0

II. Design data

Diameter of tank	D =	10000	mm
Cylindrical height	Hf =	16500	mm
Design pressure : Overpressure	p	10,0	mbar
Underpressure	pv	5	mbar
Testpressure	pt	0	mbar
Roofload		1	kN/m ²
Windspeed acc	EN 1991-1-4:	45	m/s
	horizontal windload :	208,4	kN
	windmoment :	1764,7	kNm
Own weight :			
	shell :	273,7	kN
	roof :	59,1	kN
	Bottom :	51,8	kN

III. Foundation loads

A. Under the bottomplates (pression)
(combination of own weight, hydrostatic pression and overpressure)

normal case :	163,5	kN/m²
test case :	162,5	kN/m²

B. Under the shellplates (pression)
(combination of own weight, roofload and windload)

normal case :	14,34	kN/m
extreme wind :	34,31	kN/m

C. At anchorage (tension)
(combination of own weight, overpressure and windload)

anchorage :	12 X M30	Da =	10200	mm
	normal case :	0,0	kN	
	test case :	0,0	kN	
	extreme wind :	49,5	kN	

Appendix E

Horizontal spring constant

1. Nodes

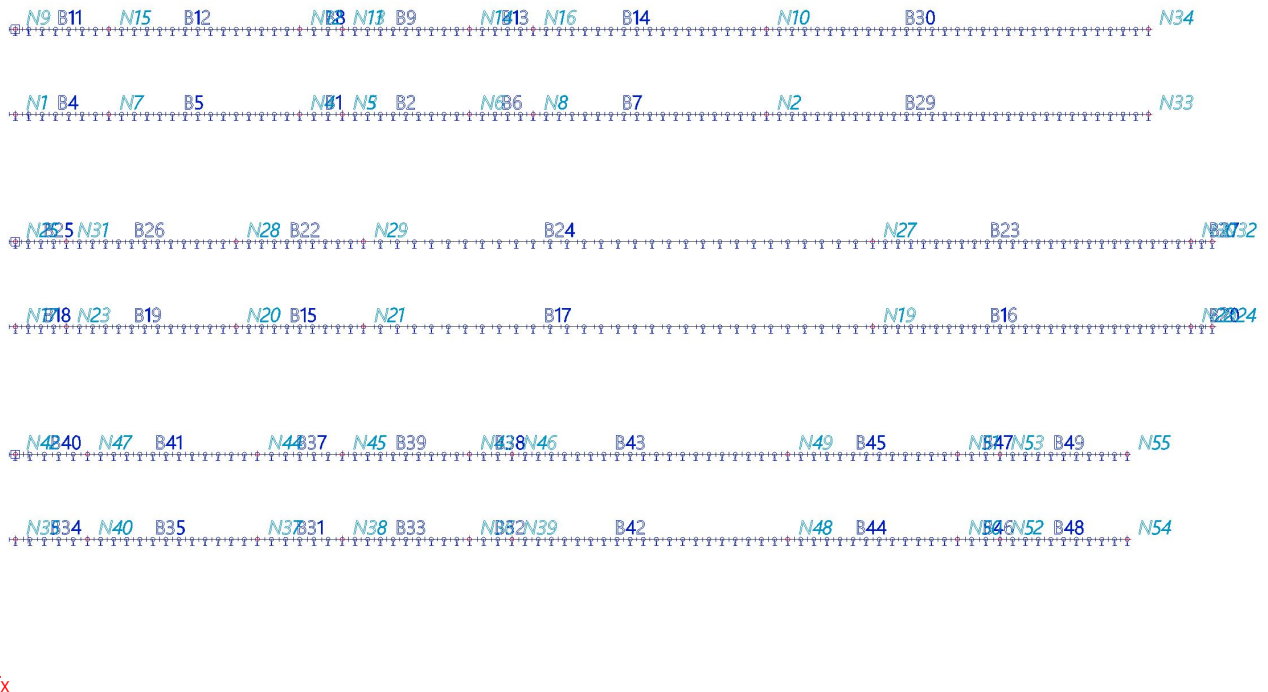
Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	-3,200	0,000	0,000
N2	14,500	0,000	0,000
N3	4,500	0,000	0,000
N4	3,500	0,000	0,000
N5	4,500	0,000	0,000
N6	7,500	0,000	0,000
N7	-1,000	0,000	0,000
N8	9,000	0,000	0,000
N9	-3,200	0,000	2,000
N10	14,500	0,000	2,000
N11	4,500	0,000	2,000
N12	3,500	0,000	2,000
N13	4,500	0,000	2,000
N14	7,500	0,000	2,000
N15	-1,000	0,000	2,000
N16	9,000	0,000	2,000
N17	-3,200	0,000	-5,000
N19	17,000	0,000	-5,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N20	2,000	0,000	-5,000
N21	5,000	0,000	-5,000
N22	24,500	0,000	-5,000
N23	-2,000	0,000	-5,000
N24	25,000	0,000	-5,000
N25	-3,200	0,000	-3,000
N27	17,000	0,000	-3,000
N28	2,000	0,000	-3,000
N29	5,000	0,000	-3,000
N30	24,500	0,000	-3,000
N31	-2,000	0,000	-3,000
N32	25,000	0,000	-3,000
N33	23,500	0,000	0,000
N34	23,500	0,000	2,000
N35	-3,200	0,000	-10,000
N36	7,500	0,000	-10,000
N37	2,500	0,000	-10,000
N38	4,500	0,000	-10,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N39	8,500	0,000	-10,000
N40	-1,500	0,000	-10,000
N42	-3,200	0,000	-8,000
N43	7,500	0,000	-8,000
N44	2,500	0,000	-8,000
N45	4,500	0,000	-8,000
N46	8,500	0,000	-8,000
N47	-1,500	0,000	-8,000
N48	15,000	0,000	-10,000
N49	15,000	0,000	-8,000
N50	19,000	0,000	-10,000
N51	19,000	0,000	-8,000
N52	20,000	0,000	-10,000
N53	20,000	0,000	-8,000
N54	23,000	0,000	-10,000
N55	23,000	0,000	-8,000

2. Members

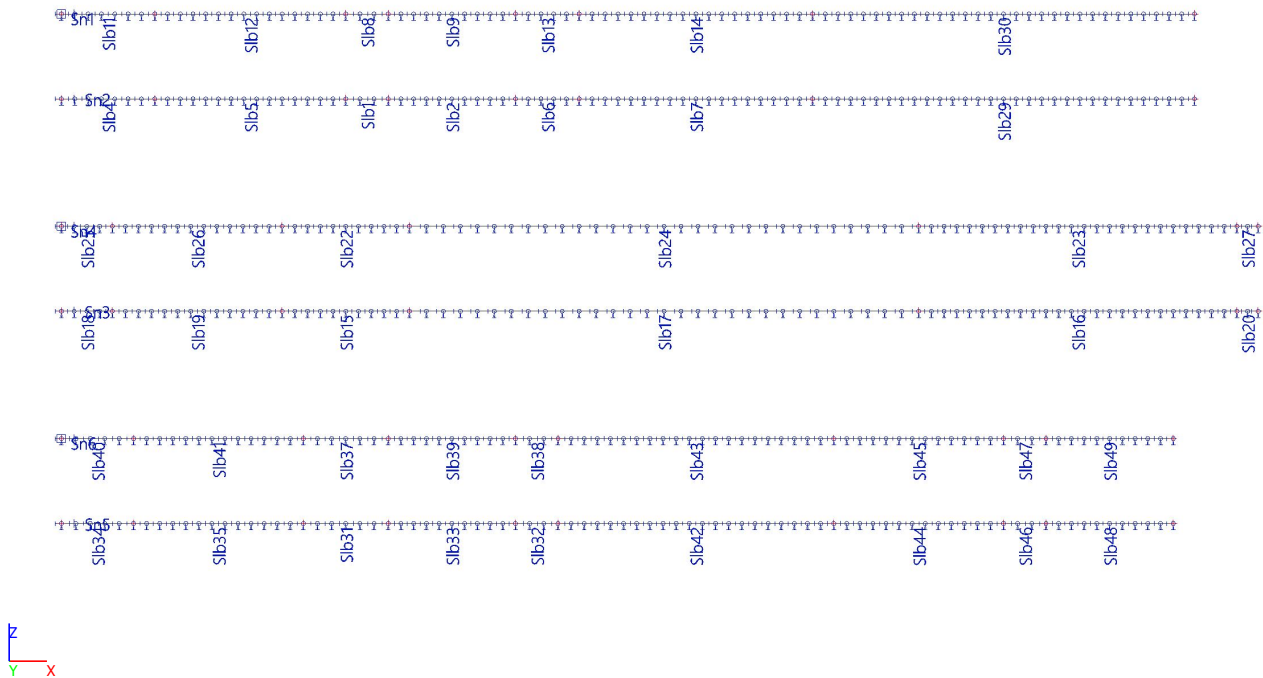
Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Circle (406)	C30/37	1,000	N4	N5	general (0)
B2	CS2 - Circle (406)	C30/37	3,000	N3	N6	general (0)
B4	CS2 - Circle (406)	C30/37	2,200	N1	N7	general (0)
B5	CS2 - Circle (406)	C30/37	4,500	N7	N4	general (0)
B6	CS2 - Circle (406)	C30/37	1,500	N6	N8	general (0)
B7	CS2 - Circle (406)	C30/37	5,500	N8	N2	general (0)
B8	CS2 - Circle (406)	C30/37	1,000	N12	N13	general (0)
B9	CS2 - Circle (406)	C30/37	3,000	N11	N14	general (0)
B11	CS2 - Circle (406)	C30/37	2,200	N9	N15	general (0)
B12	CS2 - Circle (406)	C30/37	4,500	N15	N12	general (0)
B13	CS2 - Circle (406)	C30/37	1,500	N14	N16	general (0)
B14	CS2 - Circle (406)	C30/37	5,500	N16	N10	general (0)
B15	CS2 - Circle (406)	C30/37	3,000	N20	N21	general (0)
B16	CS2 - Circle (406)	C30/37	7,500	N19	N22	general (0)
B17	CS2 - Circle (406)	C30/37	12,000	N21	N19	general (0)
B18	CS2 - Circle (406)	C30/37	1,200	N17	N23	general (0)
B19	CS2 - Circle (406)	C30/37	4,000	N23	N20	general (0)
B20	CS2 - Circle (406)	C30/37	0,500	N22	N24	general (0)
B22	CS2 - Circle (406)	C30/37	3,000	N28	N29	general (0)
B23	CS2 - Circle (406)	C30/37	7,500	N27	N30	general (0)
B24	CS2 - Circle (406)	C30/37	12,000	N29	N27	general (0)
B25	CS2 - Circle (406)	C30/37	1,200	N25	N31	general (0)
B26	CS2 - Circle (406)	C30/37	4,000	N31	N28	general (0)
B27	CS2 - Circle (406)	C30/37	0,500	N30	N32	general (0)
B29	CS2 - Circle (406)	C30/37	9,000	N2	N33	general (0)
B30	CS2 - Circle (406)	C30/37	9,000	N10	N34	general (0)
B31	CS2 - Circle (406)	C30/37	2,000	N37	N38	general (0)
B32	CS2 - Circle (406)	C30/37	1,000	N36	N39	general (0)
B33	CS2 - Circle (406)	C30/37	3,000	N38	N36	general (0)
B34	CS2 - Circle (406)	C30/37	1,700	N35	N40	general (0)
B35	CS2 - Circle (406)	C30/37	4,000	N40	N37	general (0)
B37	CS2 - Circle (406)	C30/37	2,000	N44	N45	general (0)
B38	CS2 - Circle (406)	C30/37	1,000	N43	N46	general (0)
B39	CS2 - Circle (406)	C30/37	3,000	N45	N43	general (0)
B40	CS2 - Circle (406)	C30/37	1,700	N42	N47	general (0)
B41	CS2 - Circle (406)	C30/37	4,000	N47	N44	general (0)
B42	CS2 - Circle (406)	C30/37	6,500	N39	N48	general (0)
B43	CS2 - Circle (406)	C30/37	6,500	N46	N49	general (0)
B44	CS2 - Circle (406)	C30/37	4,000	N48	N50	general (0)
B45	CS2 - Circle (406)	C30/37	4,000	N49	N51	general (0)
B46	CS2 - Circle (406)	C30/37	1,000	N50	N52	general (0)
B47	CS2 - Circle (406)	C30/37	1,000	N51	N53	general (0)
B48	CS2 - Circle (406)	C30/37	3,000	N52	N54	general (0)
B49	CS2 - Circle (406)	C30/37	3,000	N53	N55	general (0)



3. Line supports on member

Name	Type	Member	System	Pos x ₁	Pos x ₂	Coord	Orig	X	Y	Z	Rx	Ry	Rz	Stiffness Z [MN/m ²]
Slb1	Line	B1	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,9300e+01
Slb2	Line	B2	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	7,5000e+00
Slb4	Line	B4	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb5	Line	B5	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb6	Line	B6	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	4,0000e+00
Slb7	Line	B7	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb8	Line	B8	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,9300e+01
Slb9	Line	B9	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	7,5000e+00
Slb11	Line	B11	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb12	Line	B12	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb13	Line	B13	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	4,0000e+00
Slb14	Line	B14	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb15	Line	B15	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1200e+01
Slb16	Line	B16	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,0900e+01
Slb17	Line	B17	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	6,0000e+00
Slb18	Line	B18	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb19	Line	B19	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,9000e+00
Slb20	Line	B20	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,9000e+00
Slb22	Line	B22	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1200e+01
Slb23	Line	B23	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,0900e+01
Slb24	Line	B24	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	6,0000e+00
Slb25	Line	B25	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb26	Line	B26	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,9000e+00
Slb27	Line	B27	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,9000e+00
Slb29	Line	B29	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,4700e+01
Slb30	Line	B30	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,4700e+01
Slb31	Line	B31	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb32	Line	B32	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	4,0000e+00
Slb33	Line	B33	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	5,6000e+00
Slb34	Line	B34	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb35	Line	B35	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb37	Line	B37	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb38	Line	B38	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	4,0000e+00

Name	Type	Member	System	Pos x ₁	Pos x ₂	Coor	Orig	X	Y	Z	Rx	Ry	Rz	Stiffness Z [MN/m ²]
Slb39	Line	B39	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	5,6000e+00
Slb40	Line	B40	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	1,1600e+01
Slb41	Line	B41	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb42	Line	B42	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb43	Line	B43	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,7000e+00
Slb44	Line	B44	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,8600e+01
Slb45	Line	B45	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	3,8600e+01
Slb46	Line	B46	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	5,6000e+00
Slb47	Line	B47	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	5,6000e+00
Slb48	Line	B48	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	2,8900e+01
Slb49	Line	B49	GCS	0.000	1.000	Rela	From start	Free	Rigid	Flexible	Rigid	Free	Free	2,8900e+01



4. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N1	LC2 - Self weight	GCS	Z	Force	-1000,00
F2	N9	LC2 - Self weight	GCS	Z	Force	-1000,00
F3	N17	LC2 - Self weight	GCS	Z	Force	-1000,00
F4	N25	LC2 - Self weight	GCS	Z	Force	-1000,00
F5	N35	LC2 - Self weight	GCS	Z	Force	-1000,00
F6	N42	LC2 - Self weight	GCS	Z	Force	-1000,00



5. 1D deformations

Linear calculation

Load case: LC2

Coordinate system: Global

Extreme 1D: Member

Selection: Named selection - Selection

Deformations

Name	dx [m]	Case	u _x [mm]	u _y [mm]	u _z [mm]	φ _x [mrad]	φ _y [mrad]	φ _z [mrad]	U _{total} [mm]
B4	2,200	LC2	0,0	0,0	-11,6	0,0	-20,6	0,0	11,6
B4	0,000	LC2	0,0	0,0	-88,6	0,0	-45,0	0,0	88,6
B11	2,200	LC2	0,0	0,0	-23,0	0,0	-12,0	0,0	23,0
B11	1,540	LC2	0,0	0,0	-31,5	0,0	-13,1	0,0	31,5
B11	0,000	LC2	0,0	0,0	-46,4	0,0	0,0	0,0	46,4
B18	1,200	LC2	0,0	0,0	-50,6	0,0	-33,0	0,0	50,6
B18	0,000	LC2	0,0	0,0	-97,8	0,0	-42,9	0,0	97,8
B25	1,200	LC2	0,0	0,0	-51,4	0,0	-11,8	0,0	51,4
B25	0,000	LC2	0,0	0,0	-60,8	0,0	0,0	0,0	60,8
B34	1,700	LC2	0,0	0,0	-26,2	0,0	-26,8	0,0	26,2
B34	0,000	LC2	0,0	0,0	-90,0	0,0	-44,2	0,0	90,0
B40	1,700	LC2	0,0	0,0	-32,9	0,0	-12,9	0,0	32,9
B40	0,000	LC2	0,0	0,0	-49,5	0,0	0,0	0,0	49,5

Values: u_z

Linear calculation

Load case: LC2

Coordinate system: Global

Extreme 1D: Member

Selection: All

