

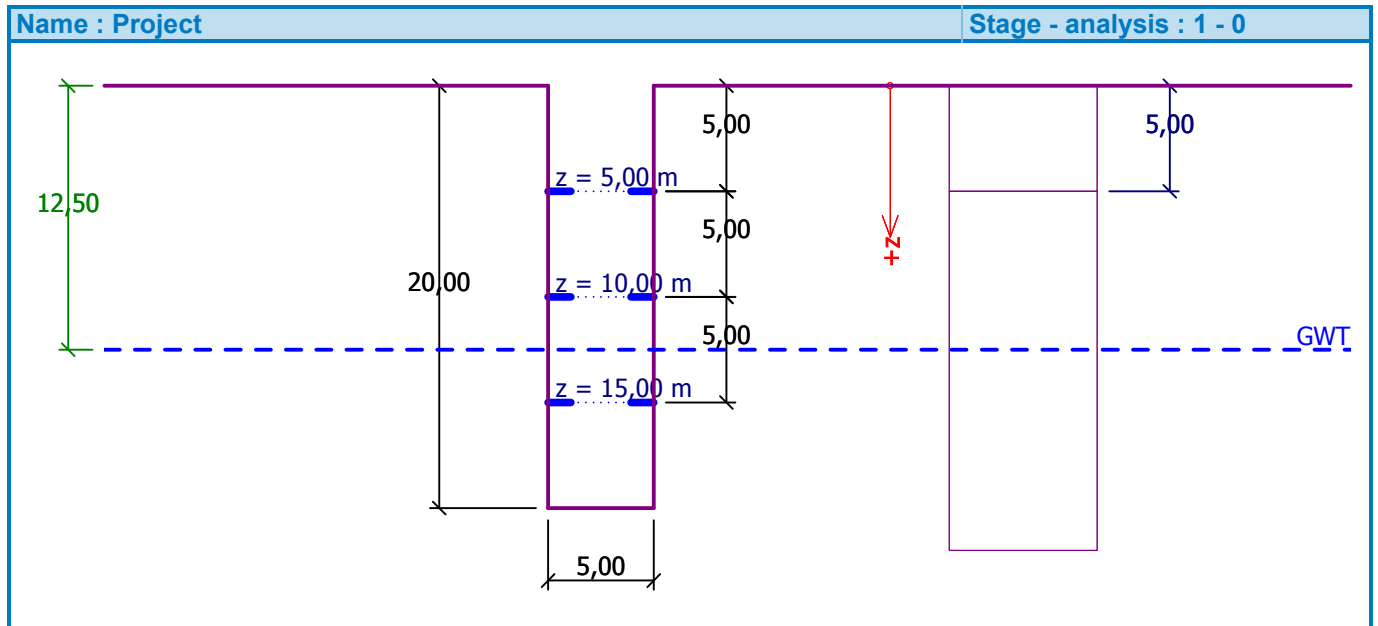


Analysis of vertical shaft

Input data

Project

Date : 28.10.2015



Settings

Standard - limit states

Excavations

Verification methodology : Limit states (LSD)

Reduction coeff. of soil parameters			
Permanent design situation			
Reduction coeff. of internal friction :	$\gamma_{m\phi} =$	1,10	[-]
Reduction coeff. of cohesion :	$\gamma_{mc} =$	1,40	[-]

Geometry

Type of shaft : semirigid

Shaft diameter $d = 5,00$ m

Shaft depth $l = 20,00$ m


Walers

No.	Depth z [m]
1	5,00
2	10,00
3	15,00

Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]
1	Sandy silt (MS), consistency firm		26,50	12,00	18,00	10,00



No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]
2	Sandy clay (CS), consistency firm		24,50	14,00	18,50	10,50

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters



Sandy silt (MS), consistency firm

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 26,50^\circ$
 Cohesion of soil : $c_{ef} = 12,00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20,00 \text{ kN/m}^3$

Sandy clay (CS), consistency firm

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 24,50^\circ$
 Cohesion of soil : $c_{ef} = 14,00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20,50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	5,00	Sandy silt (MS), consistency firm	
2	-	Sandy clay (CS), consistency firm	

Ground water table

The ground water table is at a depth of 12,50 m from the original terrain.

Surface surcharges in the vicinity of footing

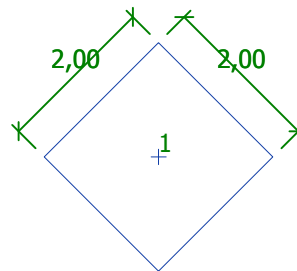
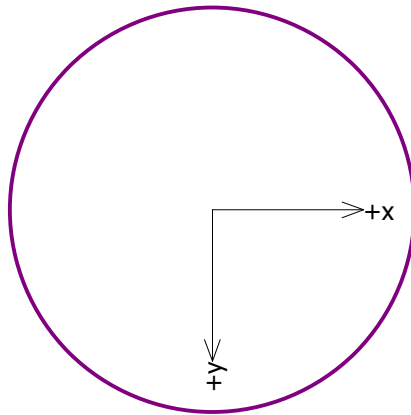
No.	Surcharge new change	Name	x_s [m]	y_s [m]	x [m]	y [m]	q [kPa]	α [°]	h [m]
1	Yes	Surcharge No. 1	5,00	5,00	2,00	2,00	100,00	45,00	0,00

No.	Surcharge new change	Name	Surcharge type	Type of action
1	Yes	Surcharge No. 1	local	permanent



Name : Surchage

Stage - analysis : 1 - 0



Settings of the stage of construction

Design situation : permanent

Analysis No. 1

Partial factors

No.	Description	Value k [-]
1	Earth pressure	1,00
2	Water	1,00
3	Cohesion	1,00
4		1,00

Lateral pressures (Section number: 1, <0,00°;90,00°>)

Depth z [m]	Earth pressure [kPa]	Water [kPa]	Cohesion [kPa]	Surchage No. 1 [kPa]	Overall pressure [kPa]
0,00	0,00	0,00	-11,11	0,00	0,00
0,71	5,01	0,00	-12,87	0,31	0,00
1,43	9,39	0,00	-14,18	1,41	0,00
2,14	13,30	0,00	-15,20	4,05	2,15
2,86	16,86	0,00	-16,02	3,99	4,83
3,57	20,15	0,00	-16,71	3,59	7,03
4,29	23,20	0,00	-17,28	3,11	9,03
5,00	26,07	0,00	-17,78	2,64	10,93
5,71	31,80	0,00	-22,41	2,33	11,72
6,43	34,80	0,00	-22,90	1,94	13,83
7,14	37,67	0,00	-23,34	1,59	15,92
7,86	40,42	0,00	-23,73	1,29	17,98
8,57	43,07	0,00	-24,08	1,02	20,00



Depth z [m]	Earth pressure [kPa]	Water [kPa]	Cohesion [kPa]	Surcharge No. 1 [kPa]	Overall pressure [kPa]
9,29	45,63	0,00	-24,41	0,77	21,98
10,00	48,10	0,00	-24,70	0,14	23,53
10,71	50,50	0,00	-24,98	0,10	25,62
11,43	52,83	0,00	-25,23	0,07	27,67
12,14	55,09	0,00	-25,46	0,05	29,68
12,86	55,91	3,57	-25,68	0,04	33,84
13,57	56,72	10,71	-25,89	0,03	41,58
14,29	57,53	17,86	-26,08	0,02	49,33
15,00	58,33	25,00	-26,26	0,01	57,09
15,71	59,13	32,14	-26,43	0,00	64,85
16,43	59,92	39,29	-26,59	0,00	72,62
17,14	60,71	46,43	-26,74	0,00	80,40
17,86	61,49	53,57	-26,88	0,00	88,18
18,57	62,27	60,71	-27,02	0,00	95,96
19,29	63,04	67,86	-27,15	0,00	103,75
20,00	63,80	75,00	-27,27	0,00	111,53

Lateral pressures (Section number: 2, <90,00°;0,00°>)

Depth z [m]	Earth pressure [kPa]	Water [kPa]	Cohesion [kPa]	Surcharge No. 1 [kPa]	Overall pressure [kPa]
0,00	0,00	0,00	-11,11	0,00	0,00
0,71	5,01	0,00	-12,87	0,00	0,00
1,43	9,39	0,00	-14,18	0,00	0,00
2,14	13,30	0,00	-15,20	0,00	0,00
2,86	16,86	0,00	-16,02	0,00	0,84
3,57	20,15	0,00	-16,71	0,00	3,44
4,29	23,20	0,00	-17,28	0,00	5,92
5,00	26,07	0,00	-17,78	0,00	8,29
5,71	31,80	0,00	-22,41	0,00	9,39
6,43	34,80	0,00	-22,90	0,00	11,90
7,14	37,67	0,00	-23,34	0,00	14,33
7,86	40,42	0,00	-23,73	0,00	16,69
8,57	43,07	0,00	-24,08	0,00	18,98
9,29	45,63	0,00	-24,41	0,00	21,22
10,00	48,10	0,00	-24,70	0,00	23,40
10,71	50,50	0,00	-24,98	0,00	25,52
11,43	52,83	0,00	-25,23	0,00	27,60
12,14	55,09	0,00	-25,46	0,00	29,63
12,86	55,91	3,57	-25,68	0,00	33,80
13,57	56,72	10,71	-25,89	0,00	41,55
14,29	57,53	17,86	-26,08	0,00	49,31
15,00	58,33	25,00	-26,26	0,00	57,08
15,71	59,13	32,14	-26,43	0,00	64,85
16,43	59,92	39,29	-26,59	0,00	72,62
17,14	60,71	46,43	-26,74	0,00	80,40
17,86	61,49	53,57	-26,88	0,00	88,18
18,57	62,27	60,71	-27,02	0,00	95,96
19,29	63,04	67,86	-27,15	0,00	103,75



Depth z [m]	Earth pressure [kPa]	Water [kPa]	Cohesion [kPa]	Surcharge No. 1 [kPa]	Overall pressure [kPa]
20,00	63,80	75,00	-27,27	0,00	111,53

Lateral pressures (Section number: 1, <0,00°;90,00°>)

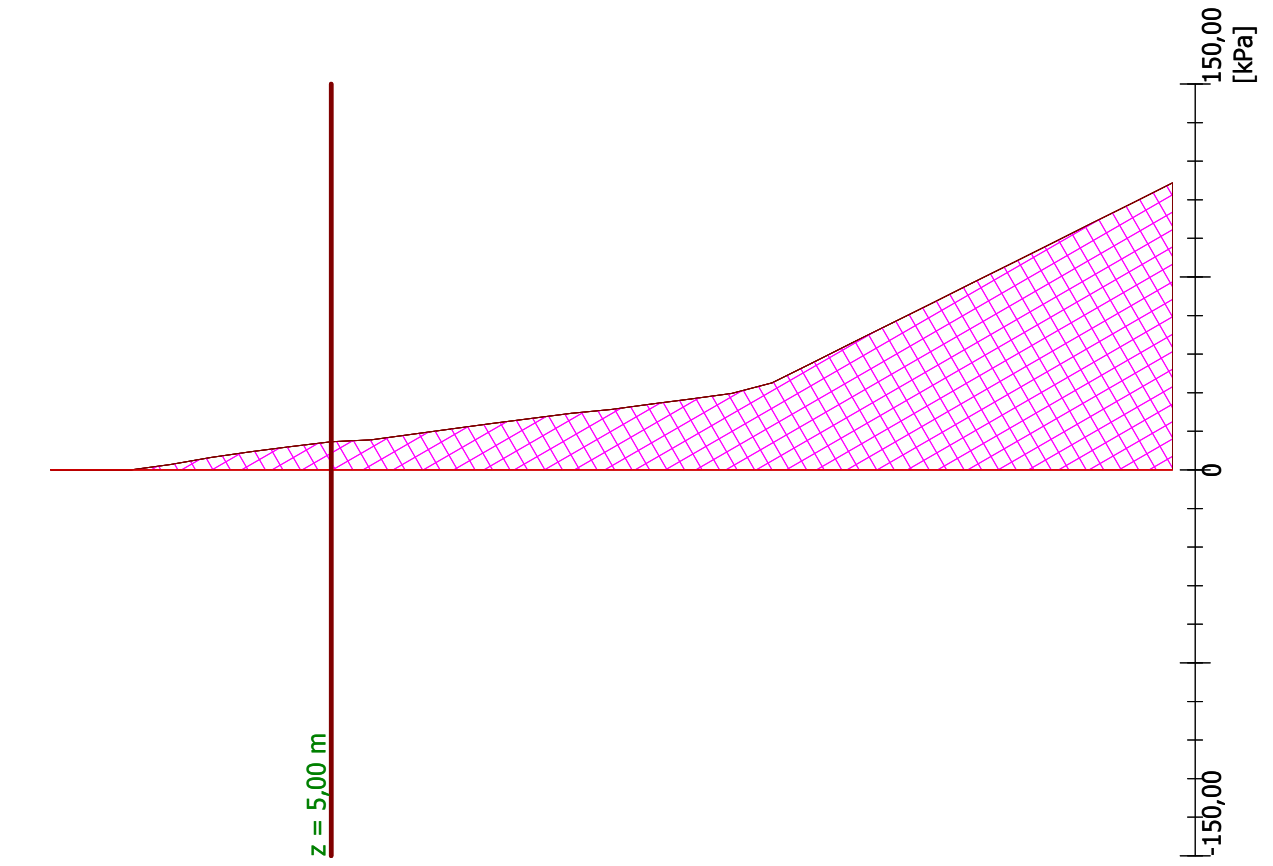
Depth z [m]	Earth pressure [kPa]	Water [kPa]	Cohesion [kPa]	Surcharge No. 1 [kPa]	Overall pressure [kPa]
0,00	0,00	0,00	-11,11	0,00	0,00
0,71	5,01	0,00	-12,87	0,31	0,00
1,43	9,39	0,00	-14,18	1,41	0,00
2,14	13,30	0,00	-15,20	4,05	2,15
2,86	16,86	0,00	-16,02	3,99	4,83
3,57	20,15	0,00	-16,71	3,59	7,03
4,29	23,20	0,00	-17,28	3,11	9,03
5,00	26,07	0,00	-17,78	2,64	10,93
5,71	31,80	0,00	-22,41	2,33	11,72
6,43	34,80	0,00	-22,90	1,94	13,83
7,14	37,67	0,00	-23,34	1,59	15,92
7,86	40,42	0,00	-23,73	1,29	17,98
8,57	43,07	0,00	-24,08	1,02	20,00
9,29	45,63	0,00	-24,41	0,77	21,98
10,00	48,10	0,00	-24,70	0,14	23,53
10,71	50,50	0,00	-24,98	0,10	25,62
11,43	52,83	0,00	-25,23	0,07	27,67
12,14	55,09	0,00	-25,46	0,05	29,68
12,86	55,91	3,57	-25,68	0,04	33,84
13,57	56,72	10,71	-25,89	0,03	41,58
14,29	57,53	17,86	-26,08	0,02	49,33
15,00	58,33	25,00	-26,26	0,01	57,09
15,71	59,13	32,14	-26,43	0,00	64,85
16,43	59,92	39,29	-26,59	0,00	72,62
17,14	60,71	46,43	-26,74	0,00	80,40
17,86	61,49	53,57	-26,88	0,00	88,18
18,57	62,27	60,71	-27,02	0,00	95,96
19,29	63,04	67,86	-27,15	0,00	103,75
20,00	63,80	75,00	-27,27	0,00	111,53



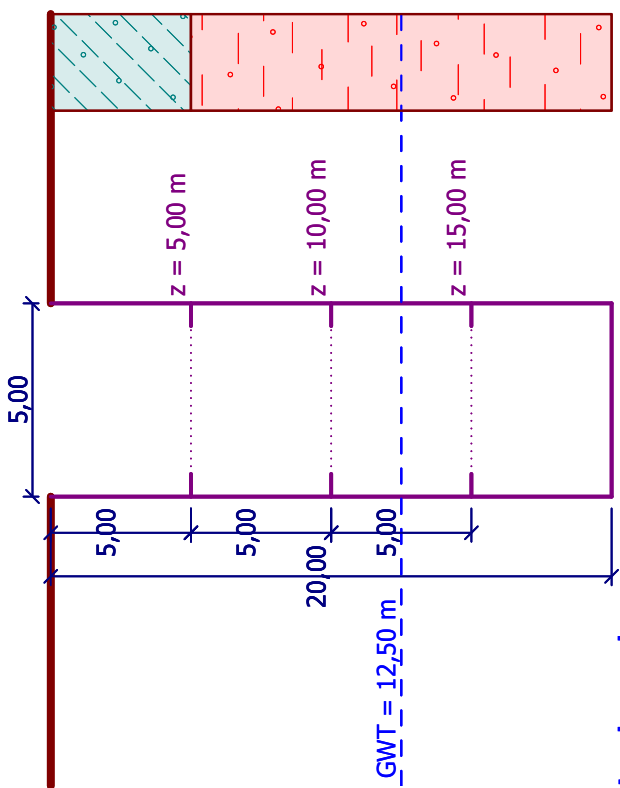
Name : Calculation

Stage - analysis : 1 - 1

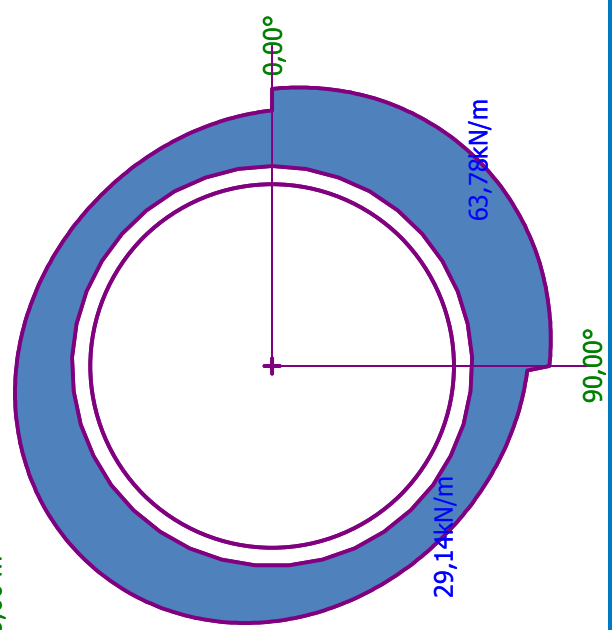
Pressure <math><0,00^\circ, 90,00^\circ></math>
Maximum pressure = 111,53 kPa



Geometry of structure
Length of structure = 20,00 m



Load on water
Depth z = 5,00 m





Dimensioning No. 1

Maximum forces

Bending moment Max M = 37,98 kNm Min M = -36,69 kNm

Normal force Max N = -103,61 kN Min N = -133,18 kN

Shear force Max Q = 38,52 kN

Envelope of internal forces

Angle [°]	Bending moment		Normal force		Shear force	
	Max M [kNm]	Min M [kNm]	Max N [kN]	Min N [kN]	Max Q [kN]	Min Q [kN]
0°	-3,06	-3,06	-118,40	-118,40	-27,14	-27,14
15°	-21,54	-21,54	-111,26	-111,26	-16,22	-16,22
30°	-33,79	-33,79	-105,06	-105,06	-9,99	-9,99
45°	-36,46	-36,46	-103,61	-103,61	8,04	8,04
60°	-30,36	-30,36	-105,42	-105,42	21,25	21,25
75°	-16,68	-16,68	-110,13	-110,13	32,86	32,86
90°	3,68	3,68	-118,28	-118,28	38,52	38,52
105°	23,22	23,22	-125,49	-125,49	33,42	33,42
120°	34,38	34,38	-131,85	-131,85	13,75	13,75
135°	37,23	37,23	-133,18	-133,18	2,39	2,39
150°	29,39	29,39	-130,72	-130,72	-12,04	-12,04
165°	13,44	13,44	-124,88	-124,88	-19,83	-19,83
180°	-4,06	-4,06	-117,77	-117,77	-22,32	-22,32
195°	-20,21	-20,21	-111,59	-111,59	-13,83	-13,83
210°	-31,48	-31,48	-105,94	-105,94	-9,16	-9,16
225°	-33,99	-33,99	-104,57	-104,57	7,79	7,79
240°	-28,45	-28,45	-106,22	-106,22	19,86	19,86
255°	-16,25	-16,25	-110,45	-110,45	29,73	29,73
270°	1,26	1,26	-117,54	-117,54	32,74	32,74
285°	19,06	19,06	-123,81	-123,81	33,57	33,57
300°	31,76	31,76	-130,71	-130,71	17,80	17,80
315°	37,98	37,98	-133,17	-133,17	8,11	8,11
330°	33,03	33,03	-132,05	-132,05	-9,47	-9,47
345°	17,32	17,32	-126,58	-126,58	-21,76	-21,76



Name : Dimensioning

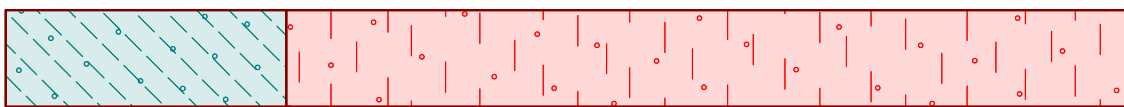
Stage - analysis : 1 - 1

Maximum internal forces, depth z = 5,00 m

Max M = 37,98 kNm, Min M = -36,69 kNm

Max N = -103,61 kN, Min N = -133,18 kN

Max Q = 38,52 kN



Geometry of structure

Length of structure = 20,00 m

