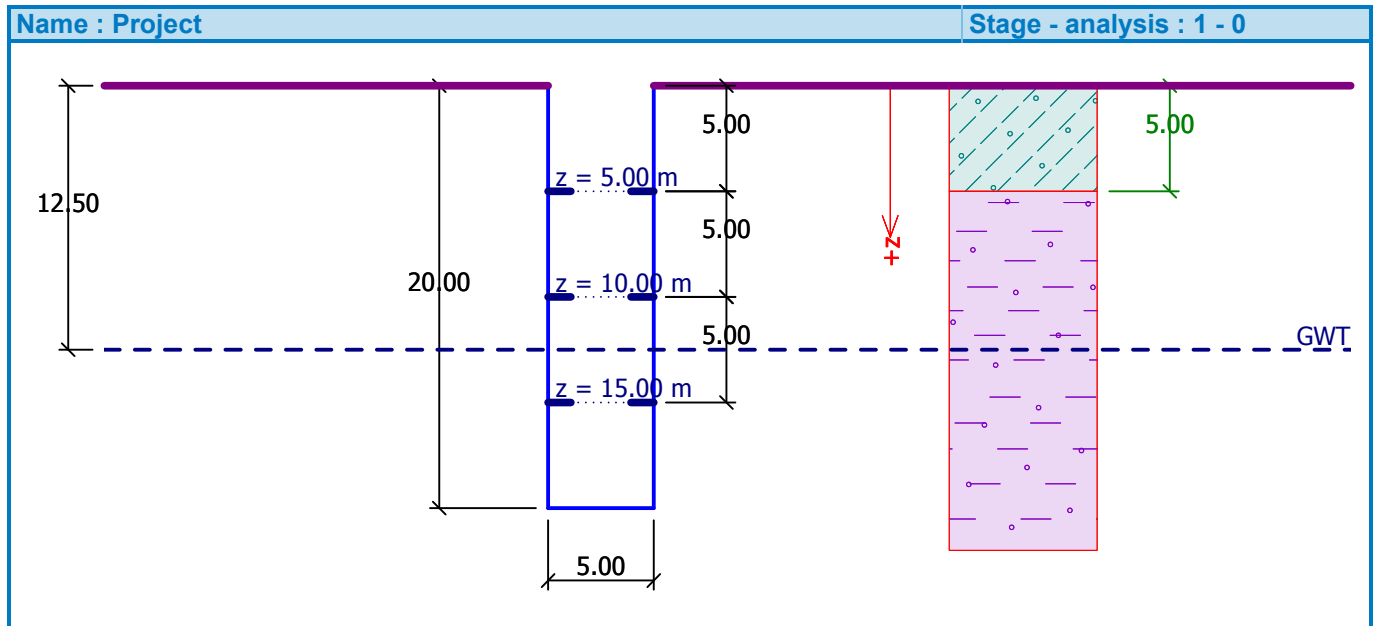


Analysis of vertical shaft

Input data

Project

Date : 22/10/2014



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.

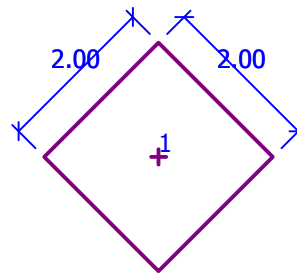
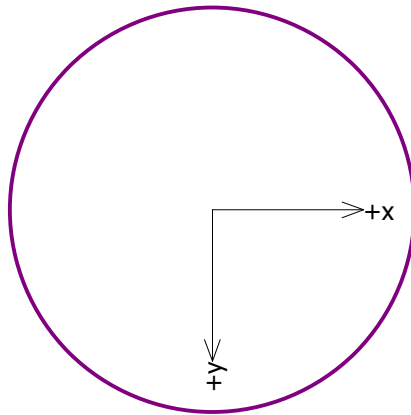
Surface surcharges in the vicinity of footing

No.	Surcharge		Name	x_s	y_s	x	y	q [kPa]	α [°]	h [m]
	new	change		[m]	[m]	[m]	[m]			
1	YES		Surcharge No. 1	5.00	5.00	2.00	2.00	100.00	45.00	0.00

No.	Surcharge		Name	Surcgarage type		Type of action
	new	change				
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°>)

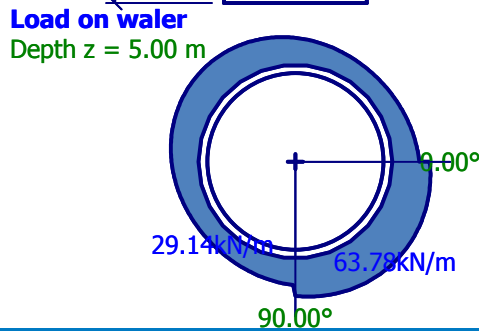
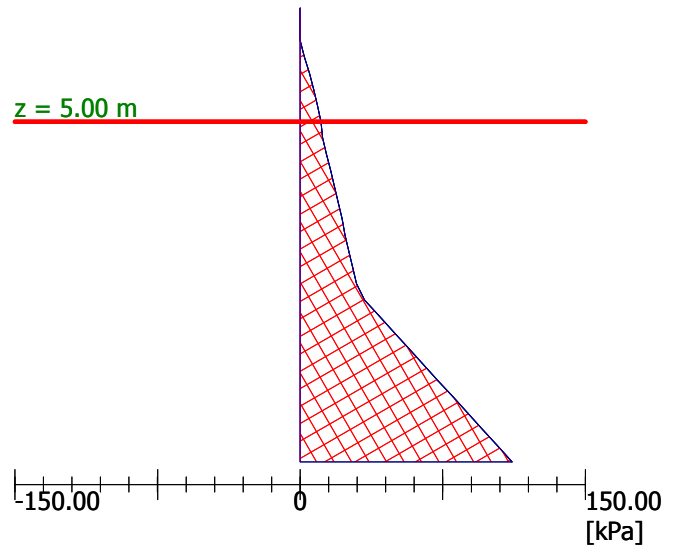
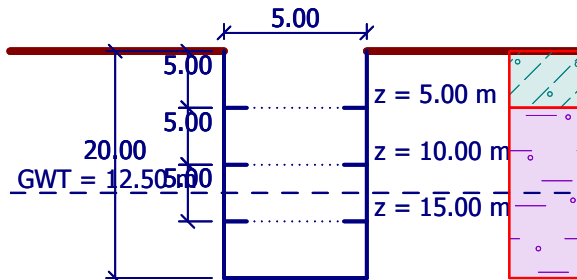
Depth z [m]	Earth pressure [kPa]	Water [kPa]	Cohesion [kPa]	Surcharge No. 1 [kPa]	Overall pressure [kPa]
0.00	0.00	0.00	-11.11	0.00	0.00
0.71	5.01	0.00	-12.87	0.31	0.00
1.43	9.39	0.00	-14.18	1.41	0.00
2.14	13.30	0.00	-15.20	4.05	2.15
2.86	16.86	0.00	-16.02	3.99	4.83
3.57	20.15	0.00	-16.71	3.59	7.03
4.29	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 : Load analysis

Stage - analysis : 1 - 1

Geometry of structure
Length of structure = 20.00 m

Pressure <0.00°, 90.00°>
Maximum pressure = 111.53 kPa



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

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]
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

