


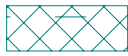
Pile verification

Input data


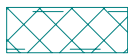
Project

Date : 2.11.2005 16:38:13

Basic soil parametres

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]
1	Silty gravel		32.50	4.00	19.00	9.00
2	Rock R3		29.00	8.00	19.00	9.00

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

No.	Name	Pattern	E_{oed} [MPa]	E_{def} [MPa]	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [-]
1	Silty gravel		94.50	-	19.00	-	-
2	Rock R3		24.00	-	19.00	-	-

Soil parameters

Silty gravel

Unit weight : $\gamma = 19,00 \text{ kN/m}^3$
 Angle of intern. friction : $\varphi_{ef} = 32,50^\circ$
 Cohesion of soil : $c_{ef} = 4,00 \text{ kPa}$
 Poisson's ratio : $\nu = 0,30$
 Oedometric modulus : $E_{oed} = 94,50 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 19,00 \text{ kN/m}^3$

Rock R3

Unit weight : $\gamma = 19,00 \text{ kN/m}^3$
 Angle of intern. friction : $\varphi_{ef} = 29,00^\circ$
 Cohesion of soil : $c_{ef} = 8,00 \text{ kPa}$
 Poisson's ratio : $\nu = 0,35$
 Oedometric modulus : $E_{oed} = 24,00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 19,00 \text{ kN/m}^3$

Geometry of structure

Pile geometry

Pile profile: circular

Dimensions

Diameter $d = 1.30 \text{ m}$
 Length $l = 8.00 \text{ m}$

Location

Off ground height $h = 1.00 \text{ m}$
 Depth of finished grade $h_z = 2.00 \text{ m}$

Technology

Piles with excavation of soil from a bore hole
 Pile type: continuous flight auger pile

Heel resistance reduction = 0.80
Skin resistance reduction = 0.60

Distribution of modulus of subsoil reaction

Depth [m]	Kh [MN/m ³]
0.00	0.00
8.00	10.00



Material of structure

Analysis of concrete structures carried out according to the standard CSN 73 1201 R.

Concrete : B 20
Compressive strength $R_{bd} = 11.50$ MPa
Tensile strength $R_{btd} = 0.90$ MPa
Elastic modulus $E_b = 27000.00$ MPa

Longitudinal steel : 10 216 E
Tensile strength $R_{sd} = 190.00$ MPa
Compressive strength $R_{scd} = 190.00$ MPa
Elastic modulus $E_s = 210000.00$ MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	9.00	Silty gravel	
2	-	Rock R3	

Load

No.	Load		Name	Type	N [kN]	M _x [kNm]	M _y [kNm]	H _x [kN]	H _y [kN]
	new	change							
1	YES		Load No. 1	Design	1200.00	50.00	14.00	0.00	120.00

Ground water table

The ground water table is at a depth of 8.00 m from the original terrain.

Analysis settings

Analysis carried out according to the theory of limit states with reduction of input parameters.

Coeff. of reduction of internal frict.angle $\gamma_{m\phi} = 1.10$
Coeff. of reduction of cohesion $\gamma_{mc} = 1.40$

Verification No. 1

Input data to compute pile horizontal bearing capacity

Analysis carried out with an automatic selection of the most unfavorable load cases.
Horizontal bearing capacity verified in the direction of maximal load effect.

Distributions of internal forces and displacement of pile

Pile displacements and internal forces distributions:

Dist. [m]	Modulus k [MN/m ³]	Displacement [mm]	Rotat. [mRad]	Stress [kPa]	Shear Force [kN]	Moment [kNm]
0.00	0.00	-22.22	3.76	5.55	-120.00	50.00
0.40	0.50	-20.72	3.76	10.36	-117.21	97.44
0.40	0.50	-20.72	3.76	10.36	-117.21	97.44
0.80	1.00	-19.21	3.75	19.21	-109.42	142.74
0.80	1.00	-19.21	3.75	19.21	-109.42	142.74
1.20	1.50	-17.71	3.75	26.57	-97.42	184.08
1.20	1.50	-17.71	3.75	26.57	-97.42	184.08
1.60	2.00	-16.21	3.75	32.42	-81.99	219.92
1.60	2.00	-16.21	3.75	32.42	-81.99	219.92
2.00	2.50	-14.71	3.75	36.78	-63.90	249.03
2.00	2.50	-14.71	3.75	36.78	-63.90	249.03
2.40	3.00	-13.21	3.74	39.64	-43.93	270.53
2.40	3.00	-13.21	3.74	39.64	-43.93	270.53
2.80	3.50	-11.72	3.74	41.02	-22.86	283.80
2.80	3.50	-11.72	3.74	41.02	-22.86	283.80
3.20	4.00	-10.22	3.73	40.90	-1.47	288.57
3.20	4.00	-10.22	3.73	40.90	-1.47	288.57
3.60	4.50	-8.73	3.73	39.29	19.48	284.86
3.60	4.50	-8.73	3.73	39.29	19.48	284.86
4.00	5.00	-7.24	3.73	36.21	39.21	272.99
4.00	5.00	-7.24	3.73	36.21	39.21	272.99
4.40	5.50	-5.75	3.72	31.64	56.94	253.63
4.40	5.50	-5.75	3.72	31.64	56.94	253.63
4.80	6.00	-4.26	3.72	25.58	71.92	227.71
4.80	6.00	-4.26	3.72	25.58	71.92	227.71
5.20	6.50	-2.78	3.71	18.05	83.36	196.49
5.20	6.50	-2.78	3.71	18.05	83.36	196.49
5.60	7.00	-1.29	3.71	9.05	90.50	161.55
5.60	7.00	-1.29	3.71	9.05	90.50	161.55
6.00	7.50	0.19	3.71	-1.44	92.58	124.74
6.00	7.50	0.19	3.71	-1.44	92.58	124.74
6.40	8.00	1.68	3.71	-13.40	88.81	88.27
6.40	8.00	1.68	3.71	-13.40	88.81	88.27
6.80	8.50	3.16	3.71	-26.85	78.44	54.60
6.80	8.50	3.16	3.71	-26.85	78.44	54.60
7.20	9.00	4.64	3.71	-41.77	60.70	26.55
7.20	9.00	4.64	3.71	-41.77	60.70	26.55
7.60	9.50	6.12	3.71	-58.18	34.81	7.21
7.60	9.50	6.12	3.71	-58.18	34.81	7.21
8.00	10.00	7.61	3.71	-74.16	-0.00	0.00

Maximum internal force and deformation :

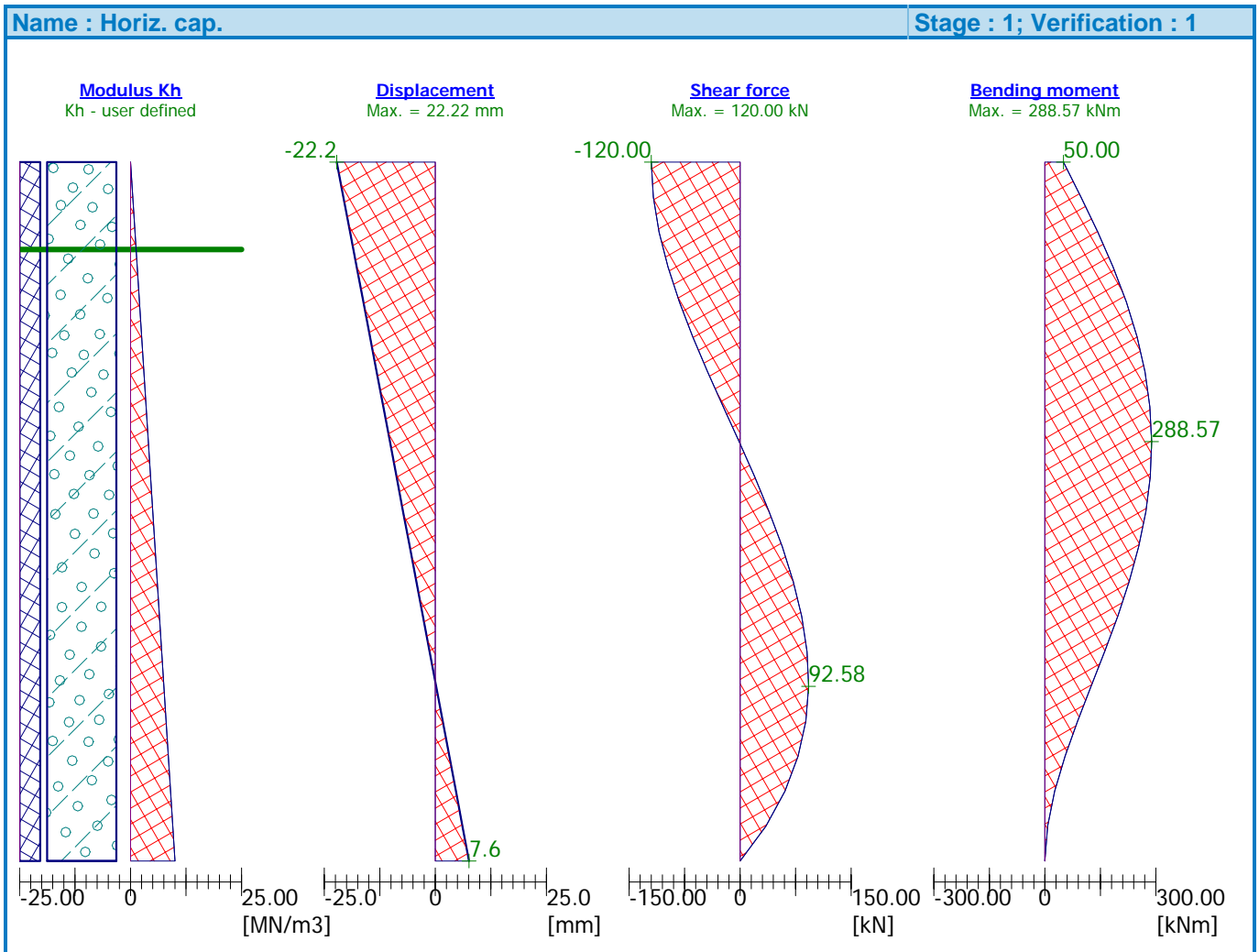
Pile head displacement = -22.2 mm
 Max. pile displacement = 22.2 mm
 Max. shear force = 120.00 kN
 Maximum moment = 288.57 kNm

Dimensioning of reinforcement:

Reinforcement - 6 pc bars 9.5 mm; covering 40.0 mm

Reinforcement ratio $\mu_{st} = 0.016 \% < 0.158 \% = \mu_{st,min}$

Cross-section is NOT ACCEPTABLE; necessary to increase reinforcement ratio.



Verification No. 1

Input data

Maximum displacement 25.0 mm

Coeff. of increase of limit skin friction due to technology 1

Depth of influenc zone is post-computed.

Load transfer curve

No.	Load [kN]	Settlement [mm]
1	0.00	0.0
2	199.10	1.1
3	398.20	2.2
4	597.30	3.3
5	796.40	4.5
6	995.50	5.9
7	1194.60	8.0

No.	Load [kN]	Settlement [mm]
8	1393.70	9.8
9	1592.81	13.2
10	1791.91	17.1
11	1929.75	25.0

Loading Q = 1200.00 kN yields pile settlement 8.0 mm

Shear - deformation dependence at a depth of 4.00m

No.	Displacemer [mm]	Shear [kPa]
1	0.0	0.00
2	1.0	16.01
3	2.1	32.75
4	3.2	50.15
5	4.4	69.11
6	5.8	90.35
7	7.9	106.35
8	9.7	108.73
9	13.0	106.71
10	16.9	113.40
11	25.0	112.57

Analysis for load F = 199.10 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	199.10	1.00	0.00	0.00
1.00	199.10	1.00	0.00	0.00
1.70	182.93	0.92	16.17	0.08
2.40	166.82	0.84	32.28	0.16
3.10	150.76	0.76	48.34	0.24
3.80	134.74	0.68	64.36	0.32
4.50	118.77	0.60	80.34	0.40
5.20	102.83	0.52	96.28	0.48
5.90	86.92	0.44	112.18	0.56
6.60	71.03	0.36	128.07	0.64
7.30	55.17	0.28	143.93	0.72
8.00	41.68	0.21	157.42	0.79

Analysis for load F = 398.20 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	398.20	1.00	0.00	0.00
1.00	398.20	1.00	0.00	0.00
1.70	374.12	0.94	24.08	0.06
2.40	341.15	0.86	57.05	0.14
3.10	308.29	0.77	89.91	0.23
3.80	275.52	0.69	122.68	0.31
4.50	242.83	0.61	155.37	0.39
5.20	210.21	0.53	187.99	0.47

Company Name	Project Name
Project Author	Project Part

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
5.90	177.66	0.45	220.54	0.55
6.60	145.17	0.36	253.04	0.64
7.30	112.71	0.28	285.49	0.72
8.00	85.11	0.21	313.10	0.79

Analysis for load F = 597.30 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	597.30	1.00	0.00	0.00
1.00	597.30	1.00	0.00	0.00
1.70	572.73	0.96	24.58	0.04
2.40	522.24	0.87	75.06	0.13
3.10	471.91	0.79	125.39	0.21
3.80	421.73	0.71	175.57	0.29
4.50	371.67	0.62	225.63	0.38
5.20	321.73	0.54	275.58	0.46
5.90	271.88	0.46	325.42	0.54
6.60	222.12	0.37	375.19	0.63
7.30	172.42	0.29	424.88	0.71
8.00	130.15	0.22	467.15	0.78

Analysis for load F = 796.40 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	796.40	1.00	0.00	0.00
1.00	796.40	1.00	0.00	0.00
1.70	771.01	0.97	25.39	0.03
2.40	719.49	0.90	76.91	0.10
3.10	650.13	0.82	146.27	0.18
3.80	580.97	0.73	215.44	0.27
4.50	511.98	0.64	284.42	0.36
5.20	443.15	0.56	353.25	0.44
5.90	374.45	0.47	421.95	0.53
6.60	305.87	0.38	490.53	0.62
7.30	237.38	0.30	559.02	0.70
8.00	179.14	0.22	617.26	0.78

Analysis for load F = 995.50 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	995.50	1.00	0.00	0.00
1.00	995.50	1.00	0.00	0.00
1.70	971.58	0.98	23.92	0.02
2.40	923.04	0.93	72.46	0.07
3.10	849.89	0.85	145.61	0.15
3.80	759.47	0.76	236.03	0.24
4.50	669.28	0.67	326.22	0.33
5.20	579.29	0.58	416.21	0.42

Company Name	Project Name
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x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
5.90	489.48	0.49	506.02	0.51
6.60	399.82	0.40	595.68	0.60
7.30	310.28	0.31	685.22	0.69
8.00	234.09	0.24	761.41	0.76

Analysis for load F = 1194.60 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	1194.60	1.00	0.00	0.00
1.00	1194.60	1.00	0.00	0.00
1.70	1170.15	0.98	24.45	0.02
2.40	1120.53	0.94	74.07	0.06
3.10	1045.75	0.88	148.85	0.12
3.80	945.80	0.79	248.80	0.21
4.50	823.47	0.69	371.14	0.31
5.20	701.38	0.59	493.22	0.41
5.90	579.52	0.49	615.09	0.51
6.60	457.82	0.38	736.78	0.62
7.30	336.27	0.28	858.33	0.72
8.00	232.85	0.19	961.75	0.81

Analysis for load F = 1393.70 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	1393.70	1.00	0.00	0.00
1.00	1393.70	1.00	0.00	0.00
1.70	1368.89	0.98	24.82	0.02
2.40	1318.54	0.95	75.17	0.05
3.10	1242.65	0.89	151.06	0.11
3.80	1141.21	0.82	252.49	0.18
4.50	1014.23	0.73	379.47	0.27
5.20	863.85	0.62	529.85	0.38
5.90	713.73	0.51	679.97	0.49
6.60	563.83	0.40	829.88	0.60
7.30	414.10	0.30	979.61	0.70
8.00	286.65	0.21	1107.06	0.79

Analysis for load F = 1592.81 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	1592.81	1.00	0.00	0.00
1.00	1592.81	1.00	0.00	0.00
1.70	1568.45	0.98	24.36	0.02
2.40	1519.03	0.95	73.77	0.05
3.10	1444.55	0.91	148.25	0.09
3.80	1345.01	0.84	247.79	0.16
4.50	1220.40	0.77	372.41	0.23
5.20	1070.72	0.67	522.08	0.33

Company Name	Project Name
Project Author	Project Part

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
5.90	893.33	0.56	699.48	0.44
6.60	691.17	0.43	901.63	0.57
7.30	489.23	0.31	1103.58	0.69
8.00	317.39	0.20	1275.41	0.80

Analysis for load F = 1791.91 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	1791.91	1.00	0.00	0.00
1.00	1791.91	1.00	0.00	0.00
1.70	1766.03	0.99	25.87	0.01
2.40	1713.53	0.96	78.37	0.04
3.10	1634.40	0.91	157.51	0.09
3.80	1528.62	0.85	263.29	0.15
4.50	1396.19	0.78	395.72	0.22
5.20	1237.09	0.69	554.81	0.31
5.90	1051.34	0.59	740.56	0.41
6.60	838.93	0.47	952.98	0.53
7.30	602.67	0.34	1189.24	0.66
8.00	380.02	0.21	1411.88	0.79

Analysis for load F = 1991.01 kN

x [m]	Norm. force [kN]	Rel. norm. [-]	Shear [kN]	Rel. shear [-]
0.00	1991.01	1.00	0.00	0.00
1.00	1991.01	1.00	0.00	0.00
1.70	1965.39	0.99	25.61	0.01
2.40	1913.42	0.96	77.59	0.04
3.10	1835.09	0.92	155.92	0.08
3.80	1730.38	0.87	260.62	0.13
4.50	1599.31	0.80	391.70	0.20
5.20	1441.86	0.72	549.15	0.28
5.90	1258.03	0.63	732.97	0.37
6.60	1047.83	0.53	943.18	0.47
7.30	814.02	0.41	1176.99	0.59
8.00	567.43	0.28	1423.58	0.72

Name : Vert. cap. FEM

Stage : 1; Verification : 1

Ultimate load transfer curve

