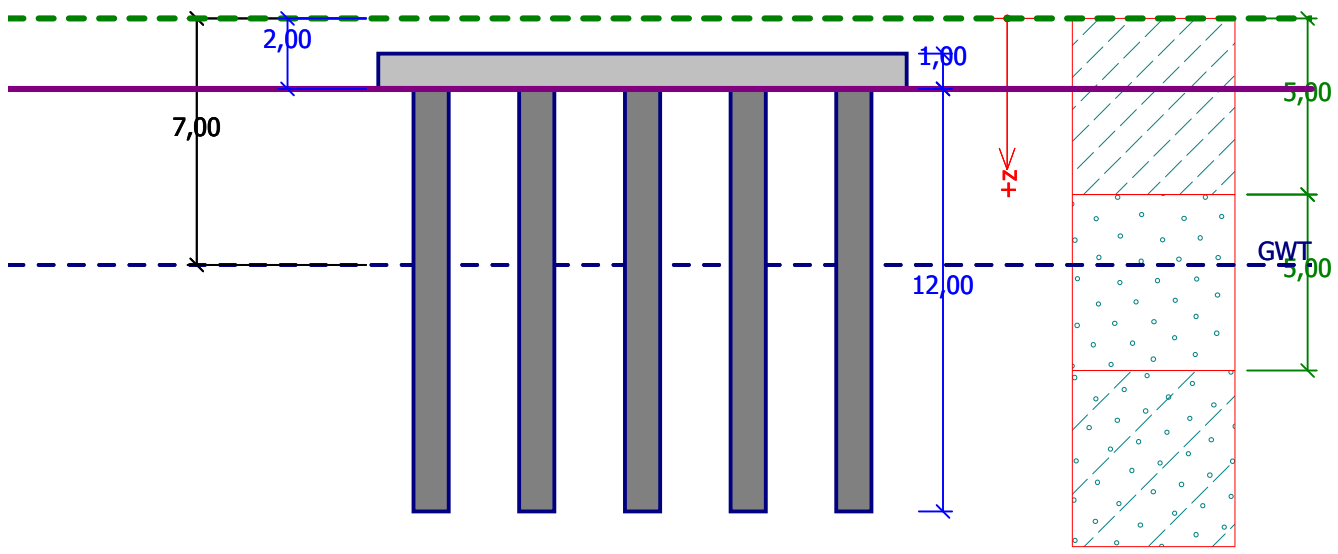
Verification of pile group

Input data

Project

Date : 6.12.2012

Name : Pile Group - Example 3	Stage : 1
Description : Static scheme of Pile Group - Spring method	



Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Partial factors EC2 : standard

Pile group

Reduction coeff. of soil parameters			
Permanent design situation			
Reduction coeff. of internal friction :	$\gamma_{m\varphi}$ =	1,25	[–]
Reduction coeff. of cohesion :	γ_{mc} =	1,40	[–]
Coefficient of unit weight :	$\gamma_{m\gamma}$ =	1,00	[–]

Reduction coeff. of bearing capacity			
Permanent design situation			
Reduction coeff. of shaft resistance :	γ_s =	1,00	[–]
Reduction coeff. of base resistance :	γ_b =	1,00	[–]
Reduction coeff. of total resistance :	γ_t =	1,50	[–]

Soil parameters

Silty sand (SM), medium dense

Unit weight :	γ	=	18,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	29,00 °
Cohesion of soil :	c_{ef}	=	5,00 kPa
Deformation modulus :	E_{def}	=	10,00 MPa
Saturated unit weight :	γ_{sat}	=	20,00 kN/m^3

Sand with trace of fines (S-F), medium dense

Unit weight :	γ	=	17,50 kN/m^3
Angle of internal friction :	φ_{ef}	=	29,50 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Deformation modulus :	E_{def}	=	15,50 MPa
Saturated unit weight :	γ_{sat}	=	19,50 kN/m^3

Low plasticity silt (ML,MI), consistency firm

Unit weight :	γ	=	20,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	21,00 °
Cohesion of soil :	c_{ef}	=	12,00 kPa
Deformation modulus :	E_{def}	=	4,00 MPa
Saturated unit weight :	γ_{sat}	=	22,00 kN/m^3

Construction

Width of pile cap	b_x	=	15,00	m
	b_y	=	15,00	m
Pile diameter	d	=	1,00	m
Number of piles	n_x	=	5	
	n_y	=	4	
Spacing of piles	s_x	=	3,00	m
	s_y	=	4,00	m

Geometry

Depth from ground surface	h_z	=	2,00	m
Pile head offset	h	=	0,00	m
Thickness of pile cap	t	=	1,00	m
Length of piles	l	=	12,00	m

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength	f_{ck}	=	20,00 MPa
Tensile strength	f_{ct}	=	2,20 MPa

Longitudinal steel : B500

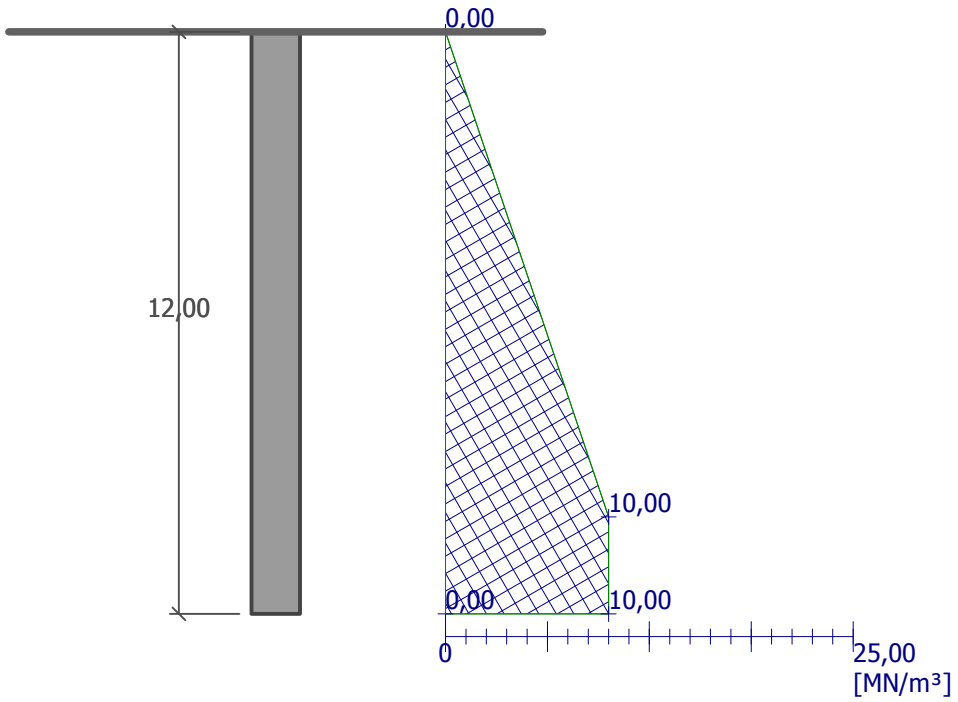
Yield strength	f_{yk}	=	500,00 MPa

Horlizontal modulus of subsoil reaction

Depth [m]	k_h [MN/m^3]
0.00	0.00
10.00	10.00
12.00	10.00

Name : Pile Group - Example 3 | **Stage : 1**

Description : Horizontal modulus - Spring method



Determination of vertical springs

Typical load (for analysis of vertical springs) : 4_Q3:G1+G2+W4 (4)

Geological profile and assigned soils

Number	Layer [m]	Assigned soil	Pattern
1	5,00	Low plasticity silt (ML,MI), consistency firm	
2	5,00	Sand with trace of fines (S-F), medium dense	
3	-	Silty sand (SM), medium dense	

Load

Number	Load new	Load change	Name	Type	N [kN]	M_x [kNm]	M_y [kNm]	H_x [kN]	H_y [kN]	M_z [kNm]
1	YES		1_G1+G2 (1)	Design	17355,00	0,00	1879,25	-0,05	0,08	0,00
2	YES		2_W4:G1+G2 (2)	Design	18600,00	-162,00	1879,25	728,95	0,08	0,00
3	YES		3_Q3:G1+G2 (3)	Design	19250,00	0,00	3499,25	1079,95	0,08	0,00
4	YES		4_Q3:G1+G2+ (4)	Design	22500,00	-97,20	3499,25	1517,35	0,08	0,00
5	YES		5_W4:G1+G2+ (5)	Design	23700,00	-162,00	3013,25	1484,95	0,08	0,00
6	YES		1_G1+G2 (6)	Service	15165,00	0,00	1392,04	-0,04	0,06	0,00

Number	Load new	Load change	Name	Type	N [kN]	M_x [kNm]	M_y [kNm]	H_x [kN]	H_y [kN]	M_z [kNm]
7	YES		2_W4:G1+G2 (7)	Service	16430,00	-108,00	1392,04	485,96	0,06	0,00
8	YES		3_Q3:G1+G2 (8)	Service	17865,00	0,00	2472,04	719,96	0,06	0,00
9	YES		4_Q3:G1+G2+ (9)	Service	21125,00	-64,80	2472,04	1011,56	0,06	0,00
10	YES		5_W4:G1+G2+ (10)	Service	22075,00	-108,00	2148,04	989,96	0,06	0,00

Ground water table

The ground water table is at a depth of 7,00 m from the original terrain.

Global settings

Analysis type : spring method
Type of pile : floating piles - compute the stiiffness of springs from soil parameters
Connection piles / pile cap : fixed
Modulus of subsoil reaction : input by distribution

Settings of the stage of construction

Design situation : permanent

Analysis results

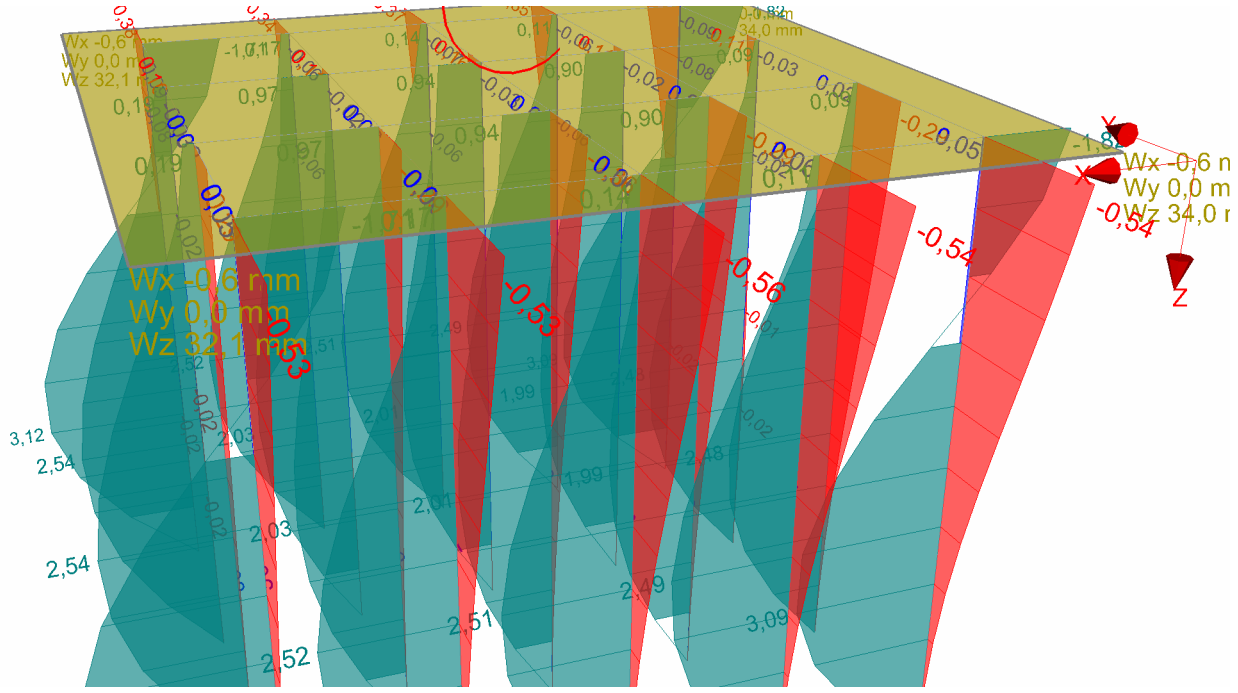
Maximum internal forces (all load casesí)

Maximum compressive force	=	-2600,51	kN
Minimum compressive force	=	-528,93	kN
Max. bending moment	=	485,47	kNm
Max. shear force	=	119,58	kN

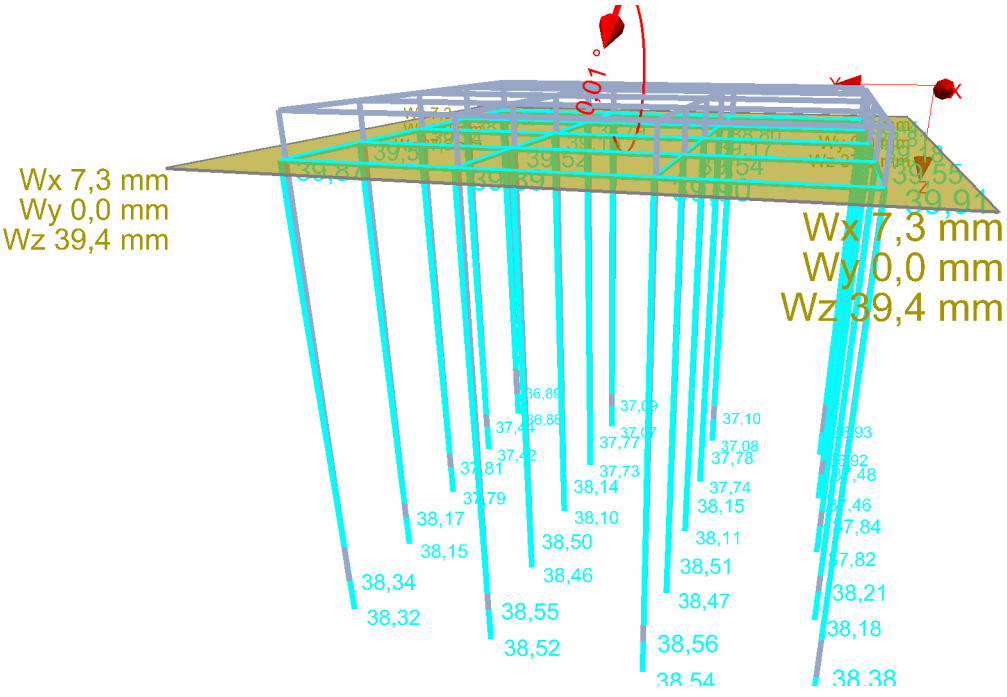
Maximum displacements (only service load casesí)

Max. settlement	=	38,6	mm
Maximum vertical displacement of pile cap	=	4,8	mm
Max. rotation of pile cap	=	6,0E-03	°

Name : Analysis | **Stage : 1**



Name : Analysis | **Stage : 1**



Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Dimensioning of reinforcement:

Reinforcement - 20 pc bars 26,0 mm; covering 60,0 mm
Type of structure (reinforcement ratio) : pile

Reinforcement ratio ρ = 1,352 % > 0,357 % = ρ_{min}

Load : N_{Ed} = -2600,51 kN (compression) ; M_{Ed} = 485,47 kNm
Bearing capacity : N_{Rd} = -8471,81 kN; M_{Rd} = 1581,55 kNm

Designed pile reinforcement is SATISFACTORY

Name : Dimensioning	Stage : 1; Verification : 1