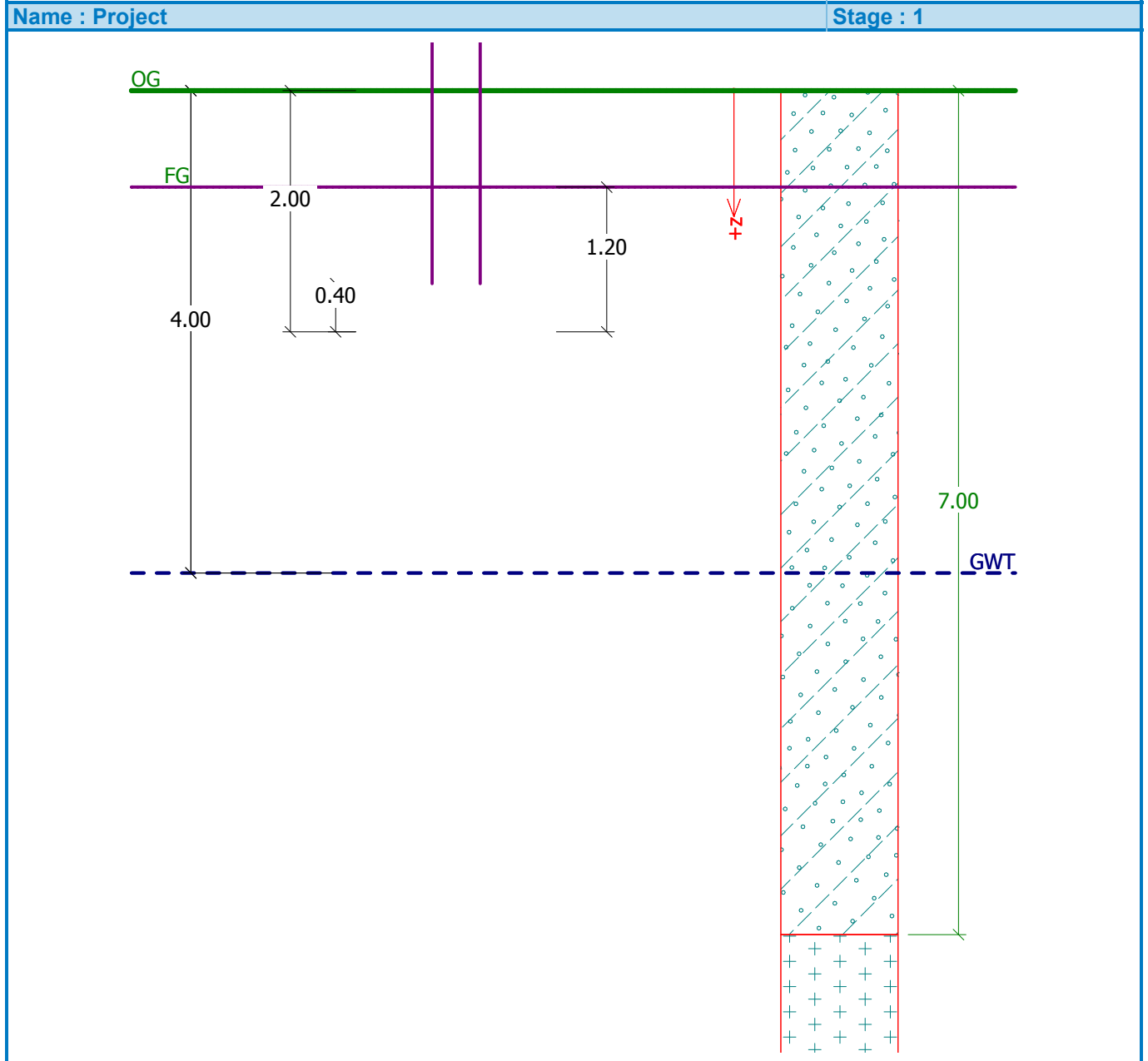


Spread footing verification

Input data

Project



Date : 6/2/2009



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Soil No. 1		31.50	0.00	17.50	7.50	0.00
2	Soil No. 2		45.00	100.00	22.00	12.00	0.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ [°]	ν [-]	OCR [-]	K_r [-]
1	Soil No. 1		cohesive	-	0.30	-	-
2	Soil No. 2		cohesive	-	0.20	-	-

Soil parameters

Soil No. 1

Unit weight :	γ = 17.50 kN/m ³
Angle of internal friction :	ϕ_{ef} = 31.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Deformation modulus :	E_{def} = 21.00 MPa
Poisson's ratio :	ν = 0.30
Coeff. of structural strength :	m = 0.30
Saturated unit weight :	γ_{sat} = 17.50 kN/m ³

Soil No. 2

Unit weight :	γ = 22.00 kN/m ³
Angle of internal friction :	ϕ_{ef} = 45.00 °
Cohesion of soil :	c_{ef} = 100.00 kPa
Deformation modulus :	E_{def} = 1000.00 MPa
Poisson's ratio :	ν = 0.20
Coeff. of structural strength :	m = 0.30
Saturated unit weight :	γ_{sat} = 22.00 kN/m ³

Foundation

Foundation type: concentric spread footing

Depth from ground surface	h_z = 2.00 m
Depth of footing bottom	d = 1.20 m
Foundation thickness	t = 0.40 m
Incl. of finished grade	s_1 = 0.00 °
Incl. of footing bottom	s_2 = 0.00 °

Unit weight of soil above foundation = 20.00 kN/m³

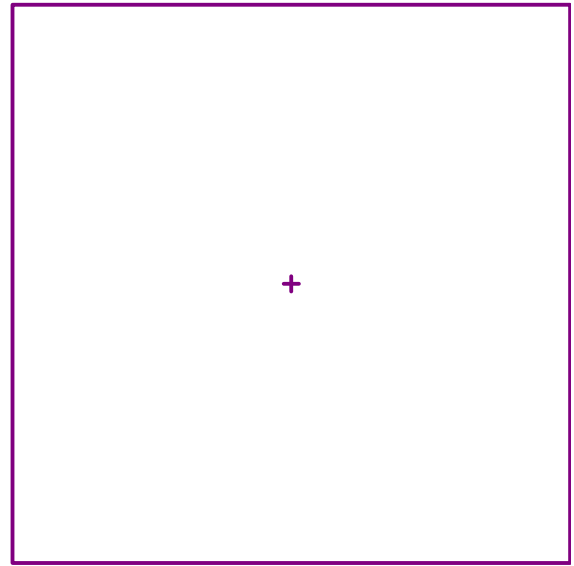
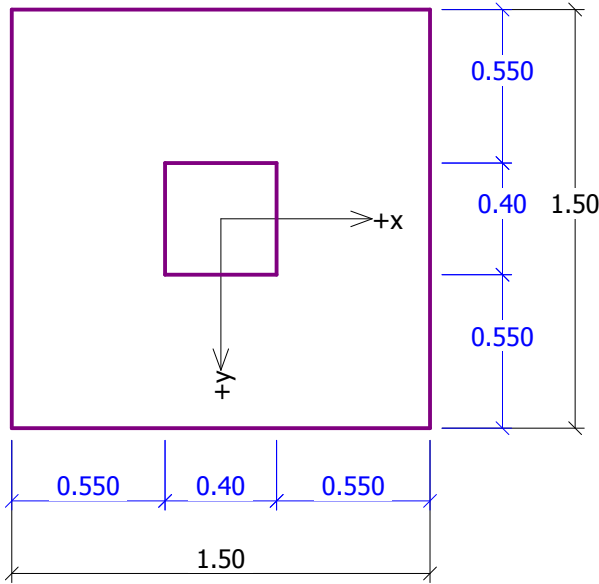
Geometry of structure

Foundation type: concentric spread footing

Spread footing length	x = 1.50 m
Spread footing width	y = 1.50 m
Column width in the direction of x	c_x = 0.40 m
Column width in the direction of y	c_y = 0.40 m
Spread footing volume	= 0.90 m ³

Name : Geometry

Stage : 1



Material of structure

Unit weight $\gamma = 23.00 \text{ kN/m}^3$

Analysis of concrete structures carried out according to the standard EN 1992 1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength $f_{ck} = 20.00 \text{ MPa}$

Tensile strength $f_{ct} = 2.20 \text{ MPa}$

Elasticity modulus $E_{cm} = 29000.00 \text{ MPa}$

Longitudinal steel : B500

Yield strength $f_{yk} = 500.00 \text{ MPa}$



Elasticity modulus $E = 200000.00 \text{ MPa}$

Transverse steel: B500

Yield strength $f_{yk} = 500.00 \text{ MPa}$

Elasticity modulus $E = 200000.00 \text{ MPa}$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	7.00	Soil No. 1	
2	-	Soil No. 2	

Load

No.	Load		Name	Type	c.	N [kN]	M_x [kNm]	M_y [kNm]	H_x [kN]	H_y [kN]
	new	change								
1	YES		Load No. 1	Design	1	910.00	-2.00	70.00	14.00	5.00
2	YES		Load No. 2	Design	1	820.00	0.00	-100.00	0.00	0.00
3	YES		Load No. 3	Service		700.00	0.00	0.00	100.00	0.00
4	YES		Load No. 4	Service		700.00	100.00	0.00	0.00	0.00

Surface surcharges in the vicinity of footing

No.	Surcharge		Name	x_s	y_s	x	y	q	α	h
	new	change		[m]	[m]	[m]	[m]	[kPa]	[°]	[m]
1	YES		Surcharge No. 1	3.00	0.00	2.00	2.00	15.00	0.00	0.00

Ground water table

The ground water table is at a depth of 4.00 m from the original terrain.

Analysis settings

Type of analysis - Analysis for drained conditions
Analysis of vertical bearing capacity - Standard approach
Analysis of settlement - Analysis using oedometric modulus
Bounding of influence zone - based on structural strength
Verification methodology : Analysis according to EN 1997
Input of partial factors : Standard
Design approach : 1 - reduction of actions and materials

Partial factors on actions (F)	Fact.	Combination 1 [-]		Combination 2 [-]	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions	γ_G	1.35	1.00	1.00	1.00

Partial factors for soil parameters (M)		Fact.	Combination 1	Combination 2
			[-]	[-]
Partial factor for internal friction		$\gamma_{m\phi}$	1.00	1.25
Partial factor for effective cohesion		γ_{mc}	1.00	1.25
Partial factor for undrained shear strength		$\gamma_{m_{cu}}$	1.00	1.40

Verification No. 1

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed weight of spread footing $G = 27.95$ kN

Computed weight of overburden $Z = 45.14$ kN

Vertical bearing capacity check

Shape of contact stress : rectangle

Most severe load case No. 1. (Load No. 1)

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.51$ m

Length of slip surface $l_{sp} = 7.77$ m

Design bearing capacity of found.soil $R_d = 872.65$ kPa

Extreme contact pressure $\sigma = 478.74$ kPa

Bearing capacity in the vertical direction is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 1. (Load No. 1)

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 5.01$ kN

Friction angle foundation-footing bottom $\psi = 31.50$ °

Cohesion foundation-footing bottom $a = 0.00$ kPa

Horizontal bearing capacity $R_{dh} = 595.84$ kN

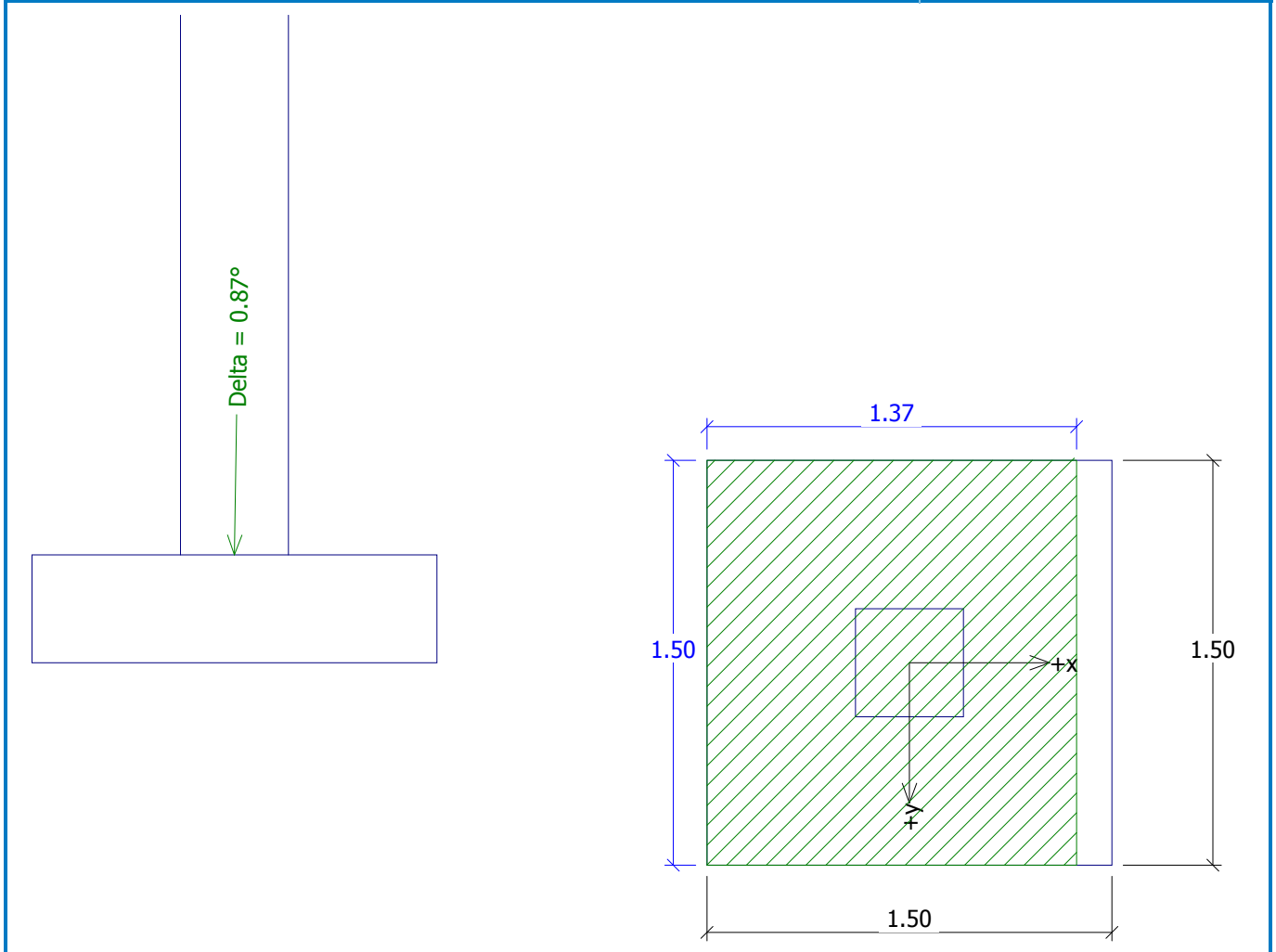
Extreme horizontal force $H = 14.87$ kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap.

Stage : 1; Analysis : 1



Verification No. 2

Analysis carried out for the load case No. 1. (Load No. 1)
Computed weight of spread footing $G = 27.95$ kN
Computed weight of overburden $Z = 45.14$ kN

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.51$ m

Length of slip surface $l_{sp} = 7.77$ m

Design bearing capacity of found.soil $R_d = 872.65$ kPa

Extreme contact pressure $\sigma = 478.74$ kPa

Bearing capacity in the vertical direction is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 5.01$ kN

Friction angle foundation-footing bottom $\psi = 31.50$ °

Cohesion foundation-footing bottom $a = 0.00$ kPa

Horizontal bearing capacity $R_{dh} = 595.84$ kN

Extreme horizontal force $H = 14.87$ kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 20.70$ kN
Computed weight of overburden $Z = 33.44$ kN

Settlement of mid point of edge x - 1 = 7.2 mm
Settlement of mid point of edge x - 2 = 3.8 mm
Settlement of mid point of edge y - 1 = 5.6 mm
Settlement of mid point of edge y - 2 = 5.5 mm
Settlement of foundation centre point = 9.7 mm
Settlement of characteristic point = 6.5 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:

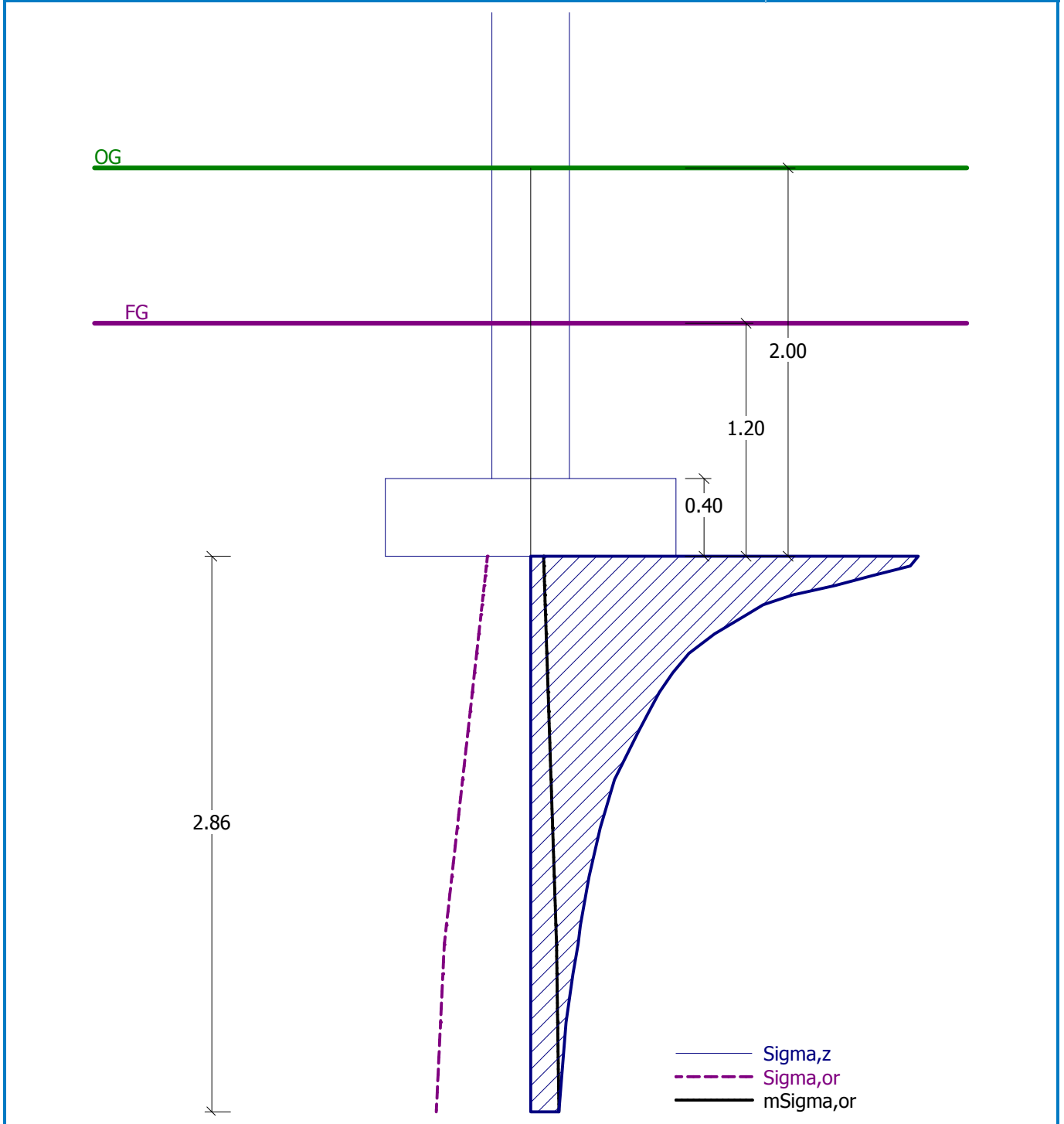
Computed weighted average modulus of deformation $E_{def} = 21.00$ MPa
Foundation in the longitudinal direction is rigid ($k=26.19$)
Foundation in the direction of width is rigid ($k=26.19$)

Overall settlement and rotation of foundation:

Foundation settlement = 6.5 mm
Depth of influence zone = 2.86 m
Rotation in direction of x = 0.969 (\tan^*1000)
Rotation in direction of y = 2.306 (\tan^*1000)

Name : Settlement

Stage : 1; Analysis : 1



Dimensioning No. 1

Analysis carried out with automatic selection of the most unfavourable load cases.

Verification of longitudinal reinforcement of foundation in the direction of x

Bar diameter = 22.0 mm
Number of bars = 10
Reinforcement cover = 35.0 mm
Cross-section width = 1.50 m
Cross-section depth = 0.40 m

Reinforcement ratio $\rho = 0.72\% > 0.13\% = \rho_{min}$
 Ultimate moment $M_{Rd} = 516.78 \text{ kNm} > 144.59 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.

Verification of longitudinal reinforcement of foundation in the direction of y

Bar diameter = 22.0 mm
 Number of bars = 8
 Reinforcement cover = 35.0 mm
 Cross-section width = 1.50 m
 Cross-section depth = 0.40 m

Reinforcement ratio $\rho = 0.57\% > 0.13\% = \rho_{min}$
 Ultimate moment $M_{Rd} = 424.35 \text{ kNm} > 129.70 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.

Spread footing for punching shear failure check

Column normal force = 820.00 kN
 Force transmitted into found.soil = 524.80 kN
 Force transmitted by shear strength of SRC = 295.20 kN

Maximum shear force $V_{Ed} = 136.37 \text{ kN/m}$
 Outline of critical cross-section $u_{cr} = 3.20 \text{ m}$
 Shear force transmitted by concrete $V_{Rd,c} = 167.23 \text{ kN/m}$

$V_{Ed} < V_{Rd,c} \Rightarrow$ Reinforcement is not required

Spread footing for punching shear is SATISFACTORY

