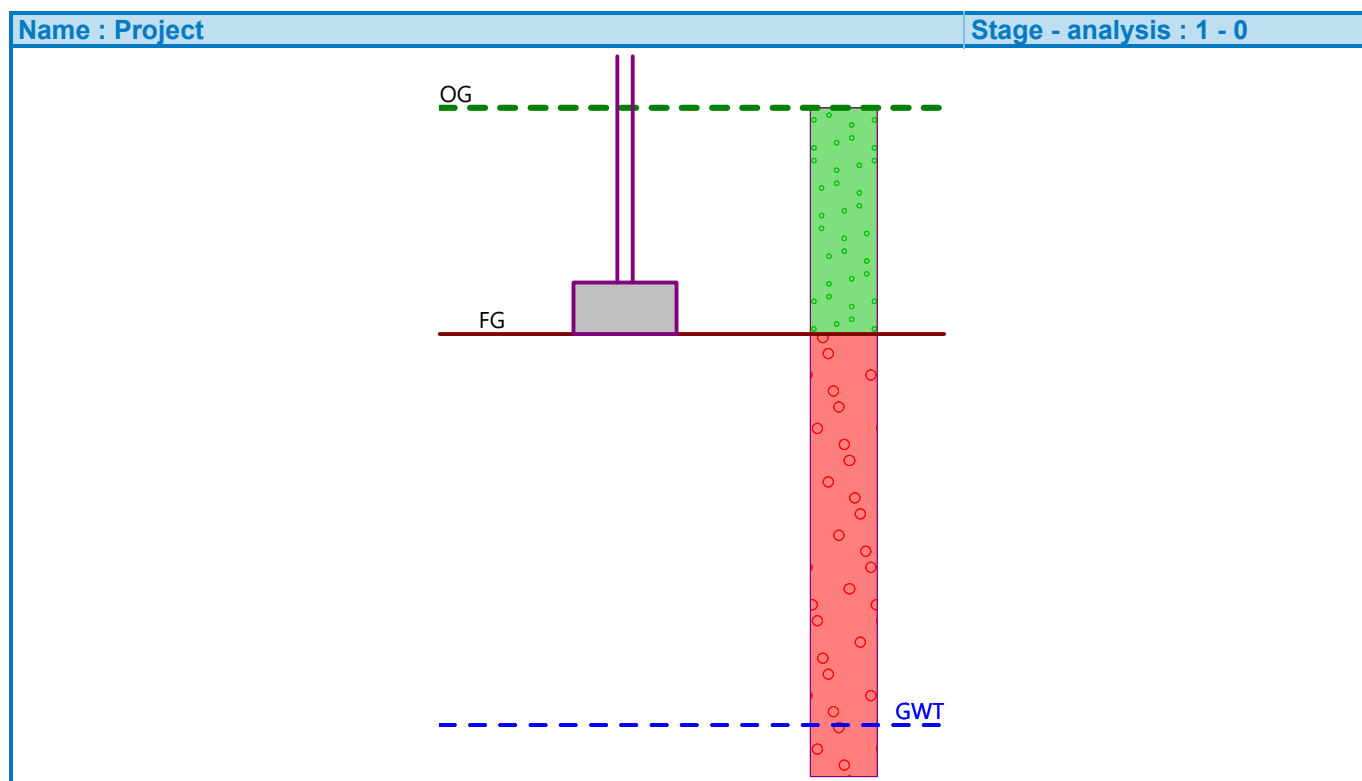


Spread footing verification

Input data

Project

Task : Preliminary design of shallow foundation
Part : Centric spread footing
Customer : CTU
Author : Bc. Yosufi Mohammad Fayez
Date : 20.12.2019



Settings

Standard - safety factors

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma, Or
Coeff. of restriction of influence zone : 10,0 [%]

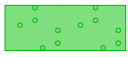

Spread Footing

Analysis for drained conditions : Standard approach
Analysis of uplift : Standard
Allowable eccentricity : 0,333
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF _v =	1,50	[-]

! For non-commercial purposes only !

Safety factors**Permanent design situation**Safety factor for sliding resistance : $SF_h = 1,50$ [-]**Basic soil parameters**

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Poorly graded sand (SP), medium dense		33,50	0,00	18,50	8,50	
2	Well graded gravel (GW), medium dense		38,50	0,00	21,00	11,00	

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

Soil parameters**Poorly graded sand (SP), medium dense**

Unit weight : $\gamma = 18,50$ kN/m³
 Angle of internal friction : $\varphi_{ef} = 33,50^\circ$
 Cohesion of soil : $c_{ef} = 0,00$ kPa
 Oedometric modulus : $E_{oed} = 32,00$ MPa
 Saturated unit weight : $\gamma_{sat} = 18,50$ kN/m³

Well graded gravel (GW), medium dense

Unit weight : $\gamma = 21,00$ kN/m³
 Angle of internal friction : $\varphi_{ef} = 38,50^\circ$
 Cohesion of soil : $c_{ef} = 0,00$ kPa
 Oedometric modulus : $E_{oed} = 355,50$ MPa
 Saturated unit weight : $\gamma_{sat} = 21,00$ kN/m³

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 4,40$ m
 Depth of footing bottom $d = 0,00$ m
 Foundation thickness $t = 1,00$ m
 Incl. of finished grade $s_1 = 0,00^\circ$
 Incl. of footing bottom $s_2 = 0,00^\circ$

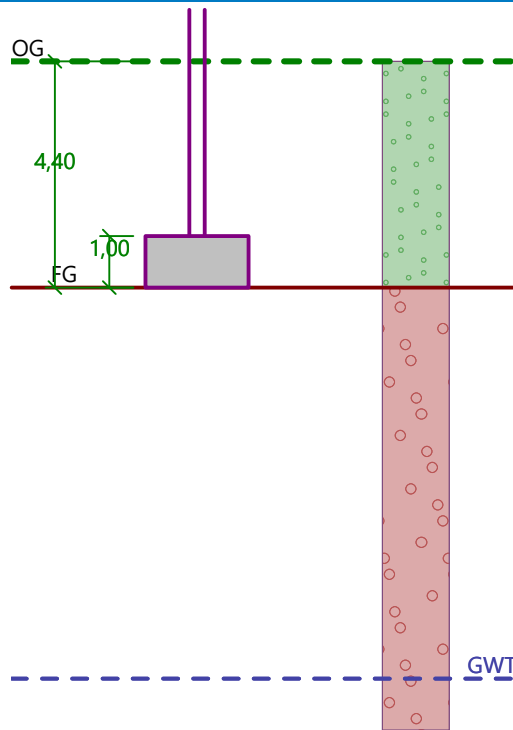
Unit weight of soil above foundation = 20,00 kN/m³

For non-commercial purposes only



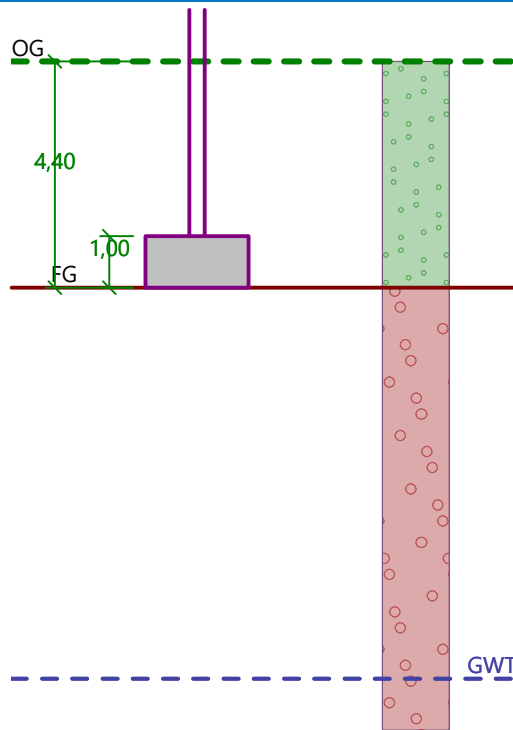
Name : Foundation

Stage - analysis : 1 - 0



Name : Foundation

Stage - analysis : 1 - 0



Geometry of structure

Foundation type: centric spread footing

Spread footing length $x = 2,00$ m

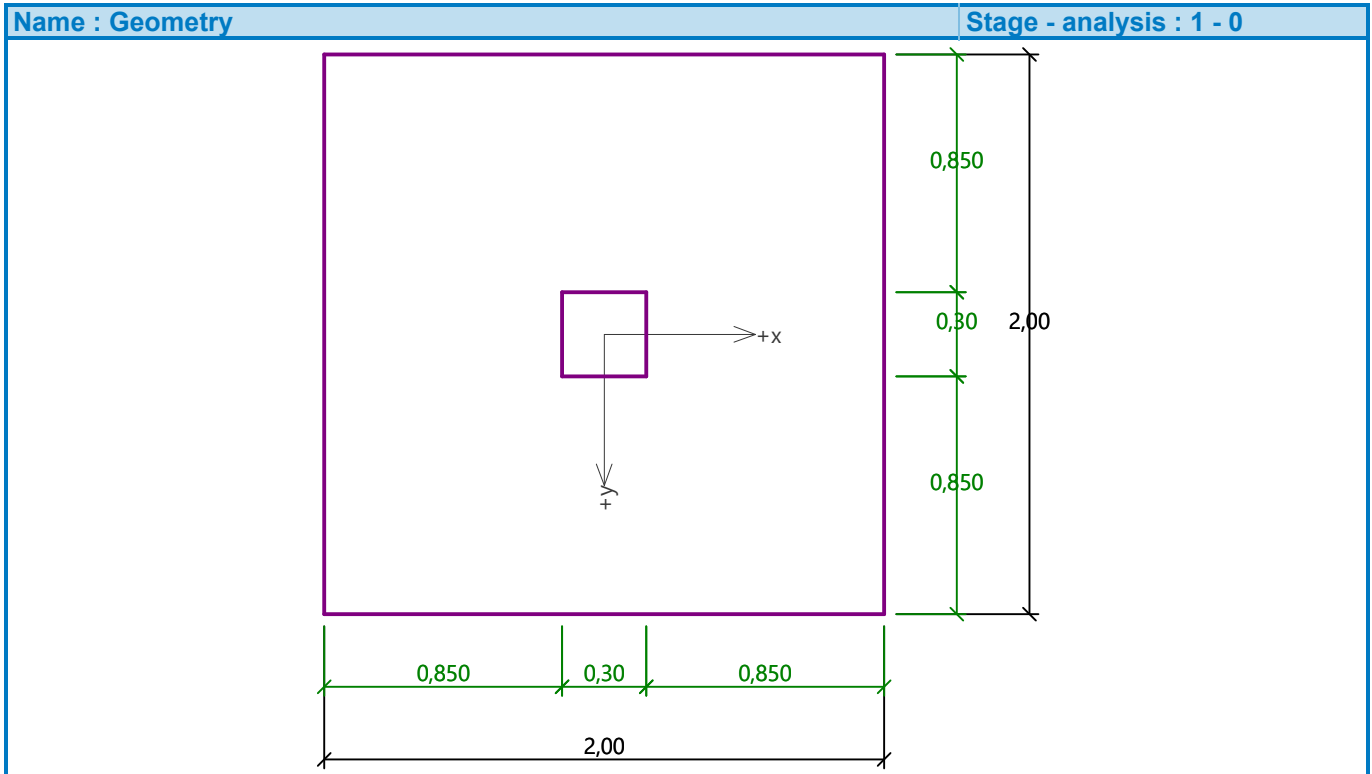
Spread footing width $y = 2,00$ m



For non-commercial purposes only



Column width in the direction of x $c_x = 0,30$ m
 Column width in the direction of y $c_y = 0,30$ m
 Spread footing volume = $4,00$ m³



Material of structure

Unit weight $\gamma = 23,00$ kN/m³

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

Concrete : C 30/37

Cylinder compressive strength $f_{ck} = 30,00$ MPa
 Tensile strength $f_{ctm} = 2,90$ MPa
 Elasticity modulus $E_{cm} = 33000,00$ MPa

Longitudinal steel : B500

Yield strength $f_{yk} = 500,00$ MPa

Transverse steel: B500

Yield strength $f_{yk} = 500,00$ MPa

Geological profile and assigned soils

Position information

Terrain elevation = 4,40 m

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Altitude [m]	Assigned soil	Pattern
1	4,40	0,00 .. 4,40	4,40 .. 0,00	Poorly graded sand (SP), medium dense	
2	-	4,40 .. ∞	0,00 .. -	Well graded gravel (GW), medium dense	

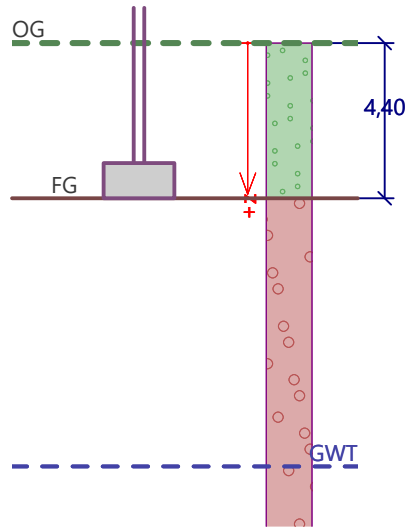


For non-commercial purposes only



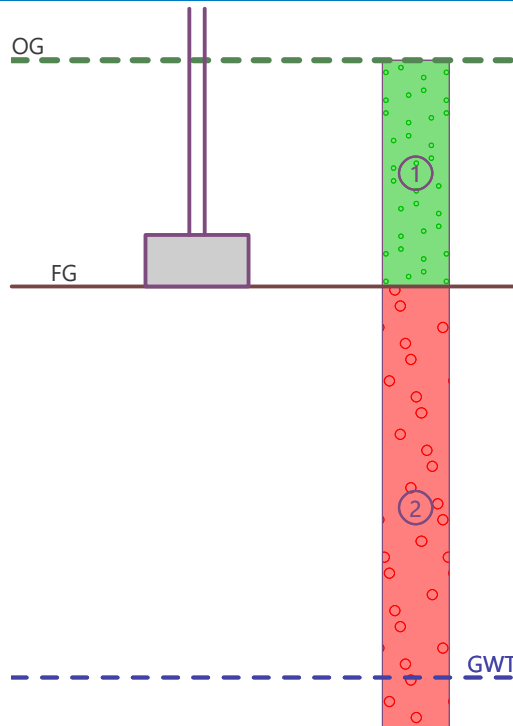
Name : Profile and assignment

Stage - analysis : 1 - 0



Name : Profile and assignment

Stage - analysis : 1 - 0

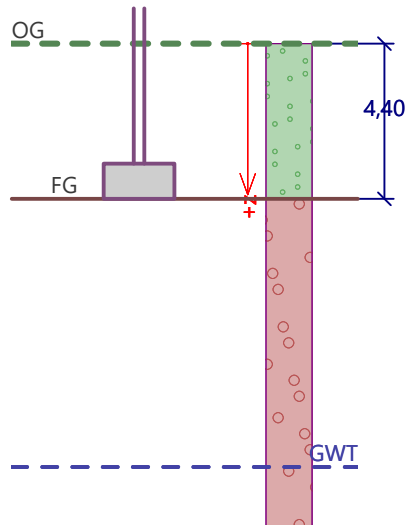


For non-commercial purposes only



Name : Profile and assignment

Stage - analysis : 1 - 0

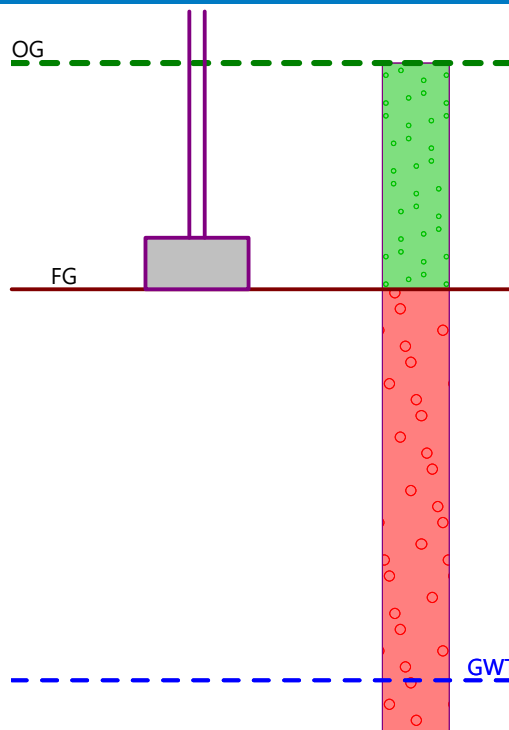


Load

No.	Load change		Name	Type	N [kN]	M _x [kNm]	M _y [kNm]	H _x [kN]	H _y [kN]
	new	change							
1	Yes		Load No. 1	Design	2004,74	10,00	10,00	5,00	3,00
2	Yes		Load No. 1 - service	Service	1431,96	7,14	7,14	3,57	2,14

Name : Load - LC

Stage - analysis : 1 - 0



Ground water table

The ground water table is at a depth of 12,00 m from the original terrain.

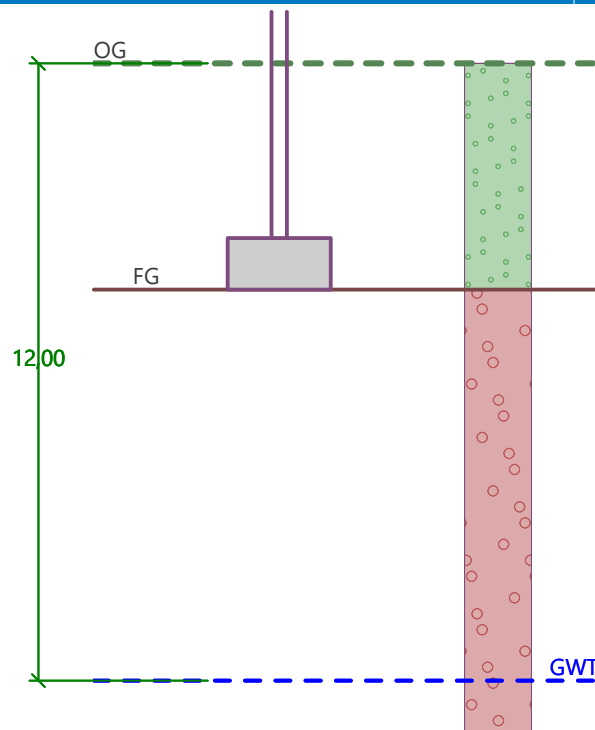


For non-commercial purposes only



Name : GWT + subsoil

Stage - analysis : 1 - 0

**Global settings**

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1**Load case verification**

Name	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfactory
Load No. 1	0,00	-0,01	528,72	890,81	89,03	Yes

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

Computed weight of spread footing $G = 92,00$ kNComputed weight of overburden $Z = 0,00$ kN**Vertical bearing capacity check**

Shape of contact stress : rectangle

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

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 3,80$ mLength of slip surface $l_{sp} = 12,52$ mDesign bearing capacity of found.soil $R_d = 890,81$ kPaExtreme contact stress $\sigma = 528,72$ kPaFactor of safety = $1,68 > 1,50$ 

For non-commercial purposes only



Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0,001 < 0,333$

Max. eccentricity in direction of base width $e_y = 0,003 < 0,333$

Max. overall eccentricity $e_t = 0,003 < 0,333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

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

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 0,00$ kN

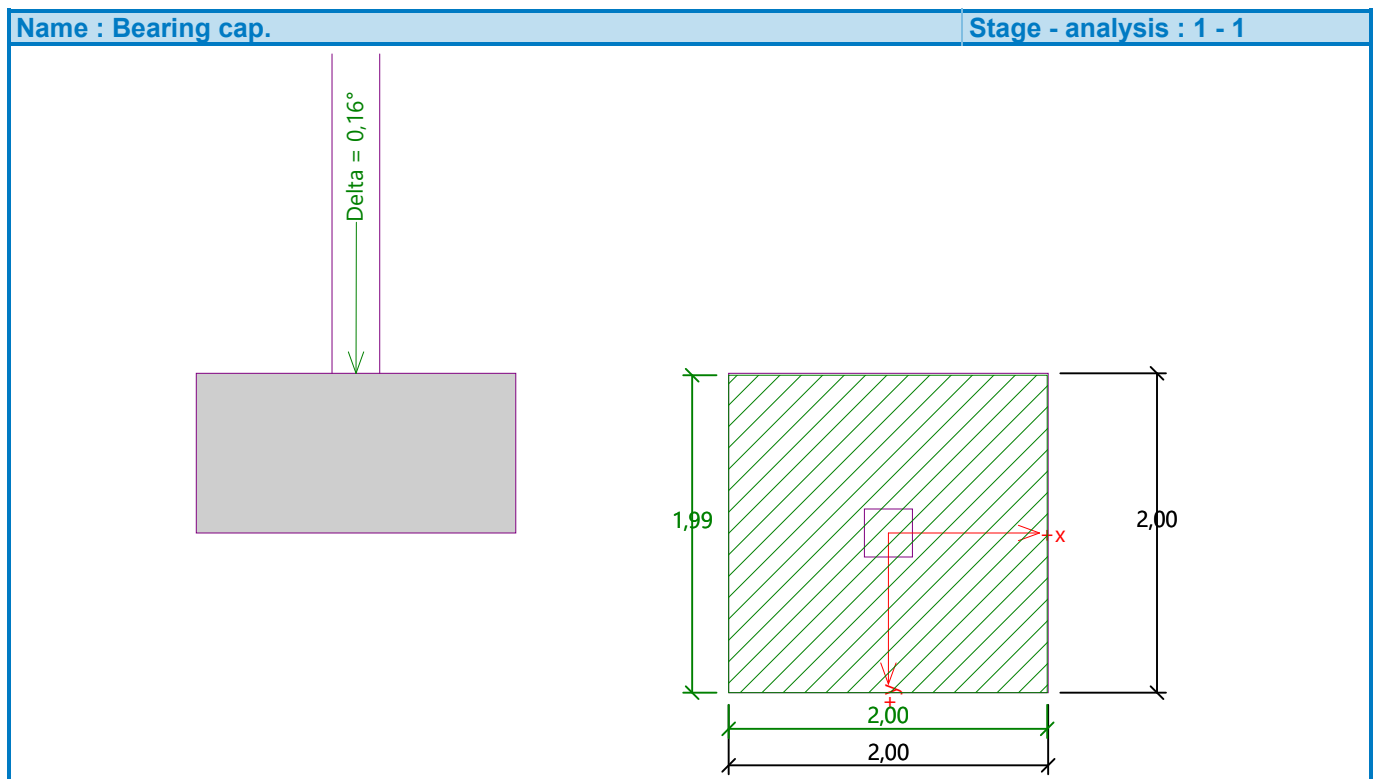
Horizontal bearing capacity $R_{dh} = 1667,82$ kN

Extreme horizontal force $H = 5,83$ kN

Factor of safety = 286,03 > 1,50

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

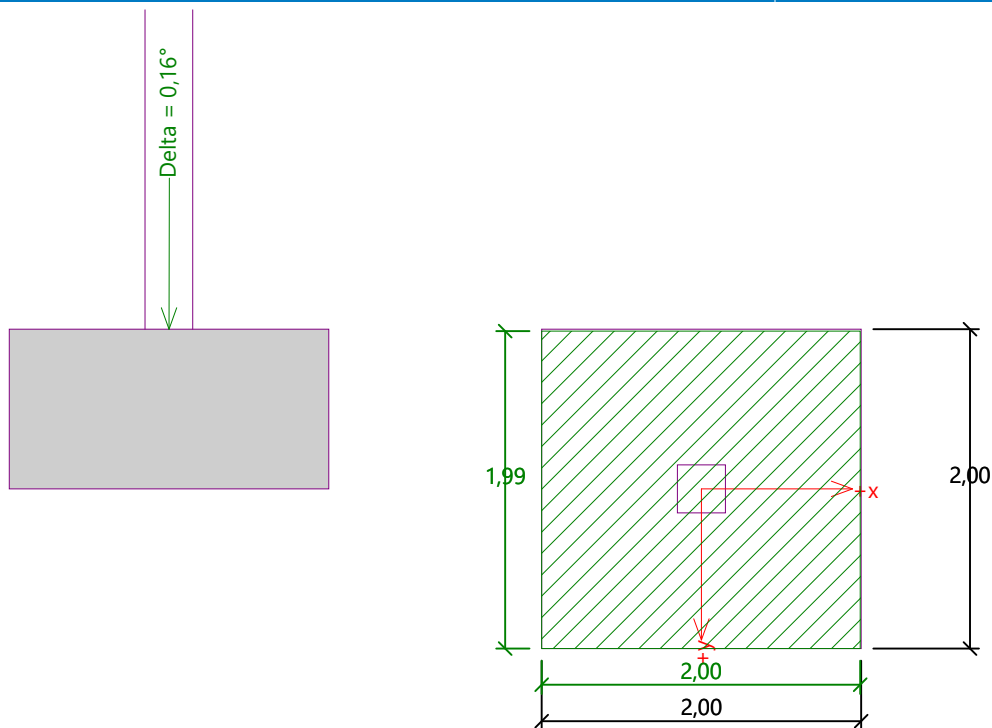


For non-commercial purposes only



Name : Bearing cap.

Stage - analysis : 1 - 1



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 $G = 92,00$ kN

Computed weight of overburden $Z = 0,00$ kN

Settlement of mid point of edge x - 1 = 1,3 mm

Settlement of mid point of edge x - 2 = 1,3 mm

Settlement of mid point of edge y - 1 = 1,3 mm

Settlement of mid point of edge y - 2 = 1,3 mm

Settlement of foundation center point = 2,1 mm

Settlement of characteristic point = 1,5 mm

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

Settlement and rotation of foundation - results

Foundation stiffness:

Computed weighted average modulus of deformation $E_{def} = 319,95$ MPa

Foundation in the longitudinal direction is rigid ($k=12,89$)

Foundation in the direction of width is rigid ($k=12,89$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0,001 < 0,333$

Max. eccentricity in direction of base width $e_y = 0,003 < 0,333$

Max. overall eccentricity $e_t = 0,003 < 0,333$

Eccentricity of load is SATISFACTORY



For non-commercial purposes only



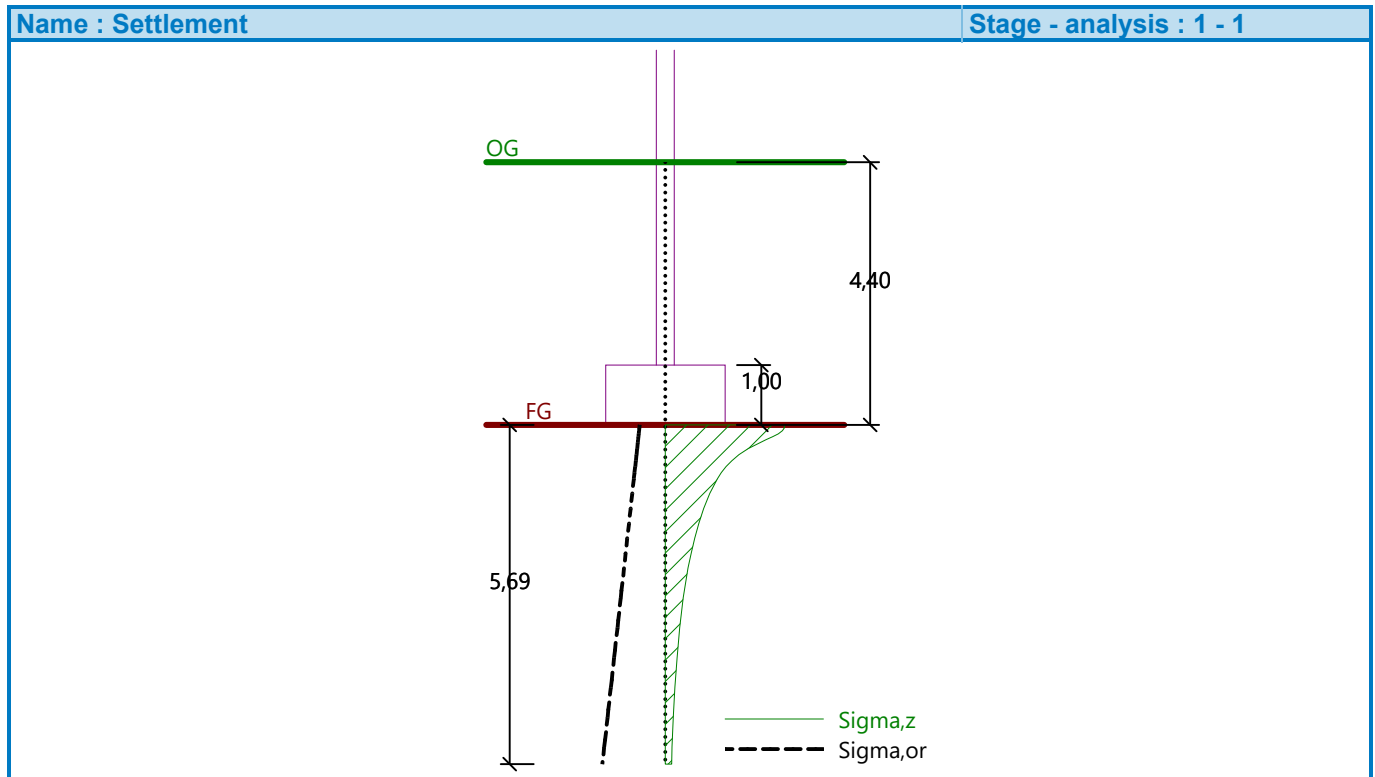
Overall settlement and rotation of foundation:

Foundation settlement = 1,5 mm

Depth of influence zone = 5,69 m

Rotation in direction of x = 0,004 (tan*1000); (2,3E-04 °)

Rotation in direction of y = 0,010 (tan*1000); (5,9E-04 °)

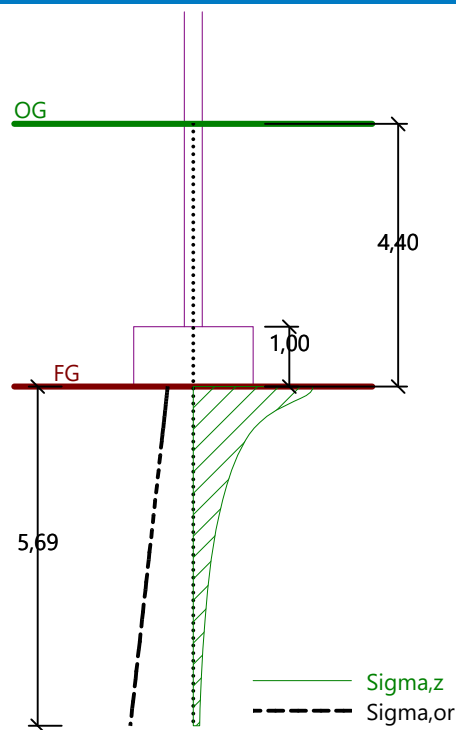


For non-commercial purposes only



Name : Settlement

Stage - analysis : 1 - 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

6 prof. 25,0 mm, cover 50,0 mm

Cross-section width = 2,00 m

Cross-section depth = 1,00 m

Reinforcement ratio $\rho = 0,16 \% > 0,15 \% = \rho_{min}$

Position of neutral axis $x = 0,04 \text{ m} < 0,58 \text{ m} = x_{max}$

Ultimate moment $M_{Rd} = 1180,01 \text{ kNm} > 363,96 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.

Verification of longitudinal reinforcement of foundation in the direction of y

6 prof. 25,0 mm, cover 50,0 mm

Cross-section width = 2,00 m

Cross-section depth = 1,00 m

Reinforcement ratio $\rho = 0,16 \% > 0,15 \% = \rho_{min}$

Position of neutral axis $x = 0,04 \text{ m} < 0,58 \text{ m} = x_{max}$

Ultimate moment $M_{Rd} = 1180,01 \text{ kNm} > 366,93 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.

Spread footing for punching shear failure check

Shear reinforcement of critical cross section

2 prof. 10,0 mm

Angle of slope = 45,00 °

Column normal force = 2004,74 kN



For non-commercial purposes only



Maximum resistance at the column perimeter

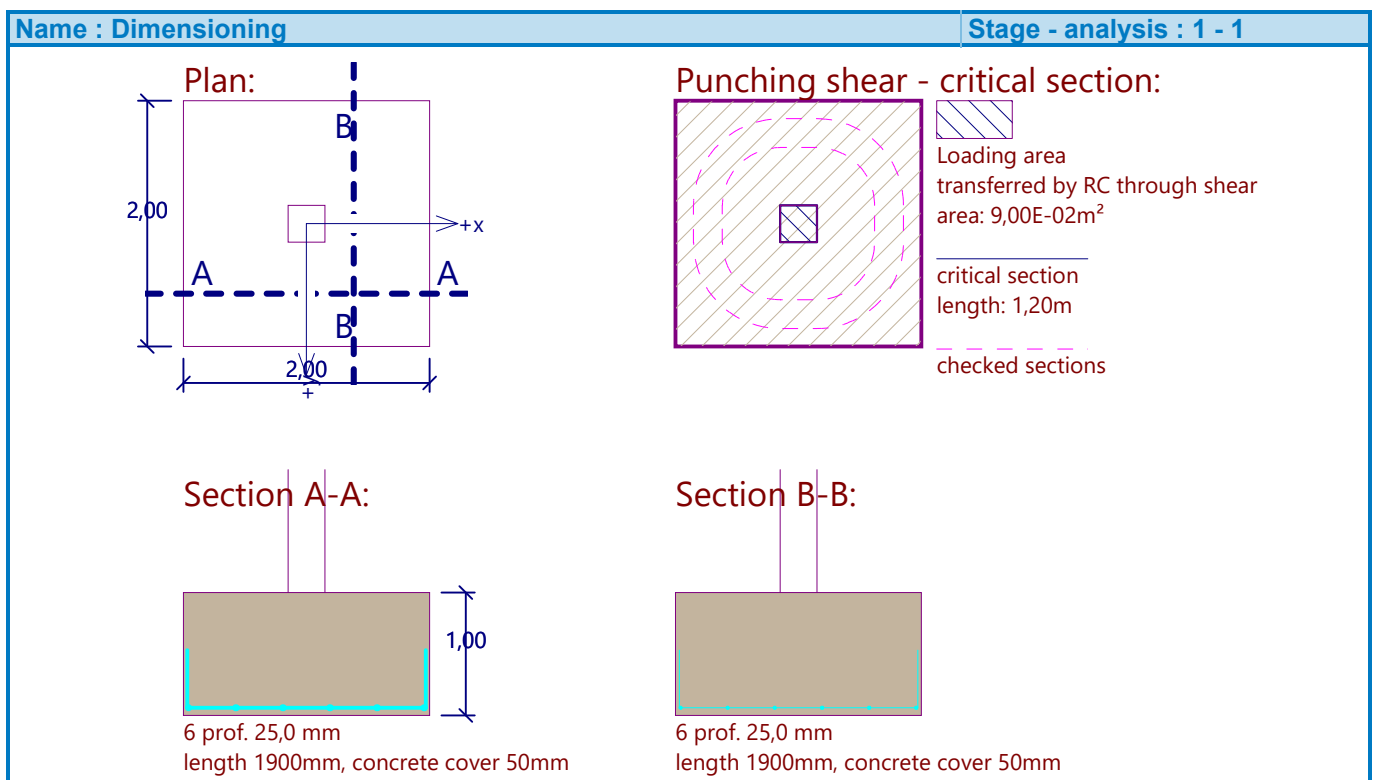
Force transferred into found. soil	=	45,11 kN
Force transferred by shear strength of foundation	=	1959,63 kN
Considered column perimeter	u_0	= 1,20 m
Shear resistance at the column perimeter	$V_{Ed,max}$	= 1,81 MPa
Resistance at the column perimeter	$V_{Rd,max}$	= 4,22 MPa

Critical section with shear reinforcement

Force transferred into found. soil	=	672,83 kN
Force transferred by shear strength of foundation	=	1331,91 kN
Distance of section from the column	=	0,47 m
Section perimeter	u	= 4,14 m
Shear stress at section	V_{Ed}	= 0,35 MPa
Reinforced section shear resistance	$V_{Rd,cs}$	= 1,36 MPa

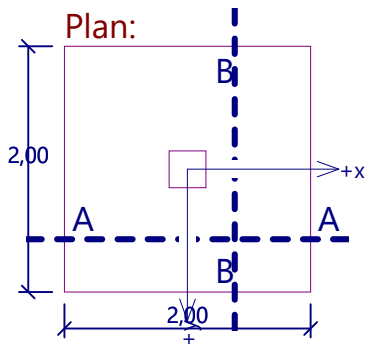
$V_{Ed} < V_{Rd,cs} \Rightarrow$ SECTION IS SATISFACTORY

Spread footing for punching shear is SATISFACTORY

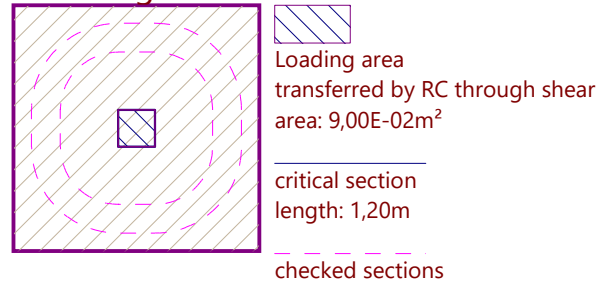


For non-commercial purposes only





Punching shear - critical section:



Section A-A:



6 prof. 25,0 mm
length 1900mm, concrete cover 50mm

Section B-B:



6 prof. 25,0 mm
length 1900mm, concrete cover 50mm



For non-commercial purposes only

