

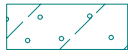

## Spread footing verification

### Input data



#### Project

Date : 2.11.2005

#### Basic soil parametres

No.	Name	Pattern	$\varphi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]	$\gamma_{su}$ [kN/m <sup>3</sup> ]	$\delta$ [°]
1	Silty sand		31.50	0.00	17.50	7.50	0.00
2	Sandstone		45.00	100.00	22.00	12.00	0.00

#### Soil parametres to compute pressure at rest

No.	Name	Pattern	Type calculation	$\varphi$ [°]	$\nu$ [-]	OCR [-]	$K_r$ [-]
1	Silty sand		cohesive	-	0.30	-	-
2	Sandstone		cohesive	-	0.20	-	-

#### Soil parameters

##### Silty sand

Unit weight :  $\gamma = 17,50 \text{ kN/m}^3$   
 Angle of intern. friction :  $\varphi_{ef} = 31,50^\circ$   
 Cohesion of soil :  $c_{ef} = 0,00 \text{ kPa}$   
 Deformation modulus :  $E_{def} = 21,00 \text{ MPa}$   
 Poisson's ratio :  $\nu = 0,30$   
 Coeff. of structural strength :  $m = 0,30$   
 Saturated unit weight :  $\gamma_{sat} = 17,50 \text{ kN/m}^3$

##### Sandstone

Unit weight :  $\gamma = 22,00 \text{ kN/m}^3$   
 Angle of intern. friction :  $\varphi_{ef} = 45,00^\circ$   
 Cohesion of soil :  $c_{ef} = 100,00 \text{ kPa}$   
 Deformation modulus :  $E_{def} = 1000,00 \text{ MPa}$   
 Poisson's ratio :  $\nu = 0,20$   
 Coeff. of structural strength :  $m = 0,30$   
 Saturated unit weight :  $\gamma_{sat} = 22,00 \text{ kN/m}^3$

#### Foundation

##### Foundation type: centric spread footing

Depth from ground surface  $h_z = 2.00 \text{ m}$   
 Depth of footing bottom  $d = 1.20 \text{ m}$   
 Foundation thickness  $t = 0.40 \text{ m}$   
 Incl. of finished grade  $s_1 = 0.00^\circ$   
 Incl. of footing bottom  $s_2 = 0.00^\circ$

Unit weight of soil above foundation =  $20.00 \text{ kN/m}^3$

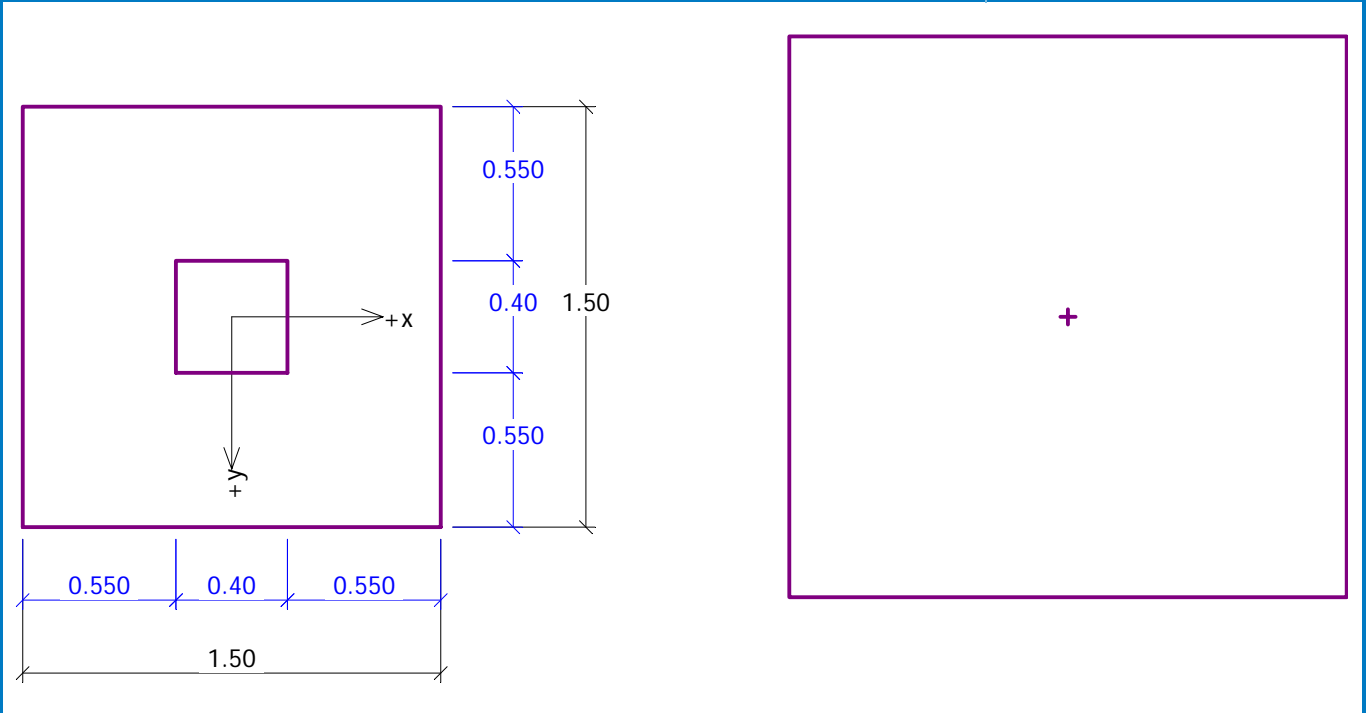
#### Geometry of structure

##### Foundation type: centric 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<sup>3</sup>

**Name : Geometry**

**Stage : 1**



**Material of structure**

Unit weight  $\gamma = 23.00$  kN/m<sup>3</sup>

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

Concrete : 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 : Reinf.bars 10 216 E

Tensile strength  $R_{sd} = 190.00$  MPa  
 Compressive strength  $R_{scd} = 190.00$  MPa  
 Elastic modulus  $E_s = 210000.00$  MPa

Transverse steel: Reinf.bars 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	7.00	Silty sand	
2	-	Sandstone	

### Load

No.	Load		Name	Type	N [kN]	M <sub>x</sub> [kNm]	M <sub>y</sub> [kNm]	H <sub>x</sub> [kN]	H <sub>y</sub> [kN]
	new	change							
1	YES		Zatížení číslo: 1	Design	910.00	-2.00	70.00	14.00	5.00
2	YES		Zatížení číslo: 2	Design	820.00	0.00	-100.00	0.00	0.00
3	YES		Zatížení číslo: 3	Service	700.00	0.00	0.00	100.00	0.00
4	YES		Zatížení číslo: 4	Service	700.00	100.00	0.00	0.00	0.00

### Surface surcharges in the vicinity of footing

No.	Surcharge		Name	x <sub>s</sub> [m]	y <sub>s</sub> [m]	x [m]	y [m]	q [kPa]	α [°]	h [m]
	new	change								
1	YES		Surcharge No. 1	3.00	0.00	2.00	2.00	0.00	15.00	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 - CSN 73 1001

Analysis of settlement - Analysis using oedometric modulus (CSN 73 1001)

Bounding of influence zone - based on structural strength

Soil parameters are reduced according to CSN 73 1001.

### Verification No. 1

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

Computed weight of spread footing  $G = 22.77$  kN

Computed weight of overburden  $Z = 43.47$  kN

### Vertical bearing capacity check

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  $R_d = 520.10$  kPa

Extreme contact pressure  $\sigma = 475.73$  kPa

**Bearing capacity in the vertical direction is SATISFACTORY**

### Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance  $S_{pd} = 3.86$  kN

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

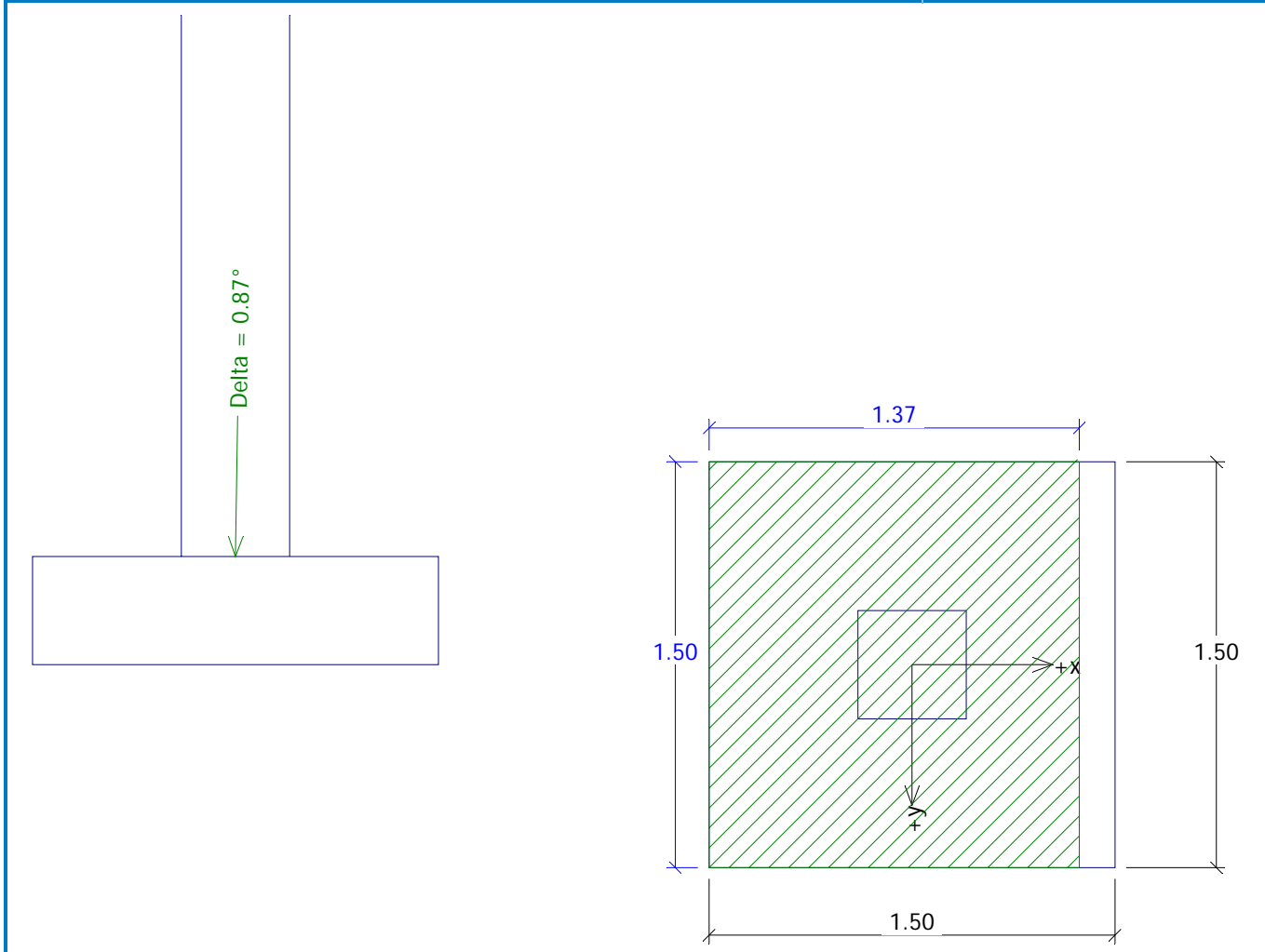
Cohesion foundation-footing bottom  $a = 0.00$  kPa

Horizontal bearing capacity  $R_{dh} = 512.06$  kN

Extreme horizontal force  $H = 14.87$  kN

**Horizontal bearing capacity is SATISFACTORY**

**Foundation bearing capacity is SATISFACTORY**



## Verification No. 2

Analysis carried out for the load case No. 1. (Zatížení číslo: 1)

Computed weight of spread footing  $G = 22.77$  kN

Computed weight of overburden  $Z = 43.47$  kN

### Vertical bearing capacity check

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  $R_d = 520.10$  kPa

Extreme contact pressure  $\sigma = 475.73$  kPa

**Bearing capacity in the vertical direction is SATISFACTORY**

### Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance  $S_{pd} = 3.86$  kN

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

Cohesion foundation-footing bottom  $a = 0.00$  kPa

Horizontal bearing capacity  $R_{dh} = 512.06$  kN  
Extreme horizontal force  $H = 14.87$  kN

**Horizontal bearing capacity is SATISFACTORY**

**Foundation bearing capacity is SATISFACTORY**

## Verification No. 1

### Settlement and rotation of foundation - input data

Analysis carried out with an automatic selection of the most unfavorable load cases.  
Analysis carried out with accounting for coefficient  $\kappa_1$  (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 = 5.5 mm  
Settlement of mid point of edge x - 2 = 5.5 mm  
Settlement of mid point of edge y - 1 = 6.2 mm  
Settlement of mid point of edge y - 2 = 4.8 mm  
Settlement of foundation center point = 9.6 mm  
Settlement of characteristic point = 6.5 mm

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

### Settlement and rotation of foundation - results

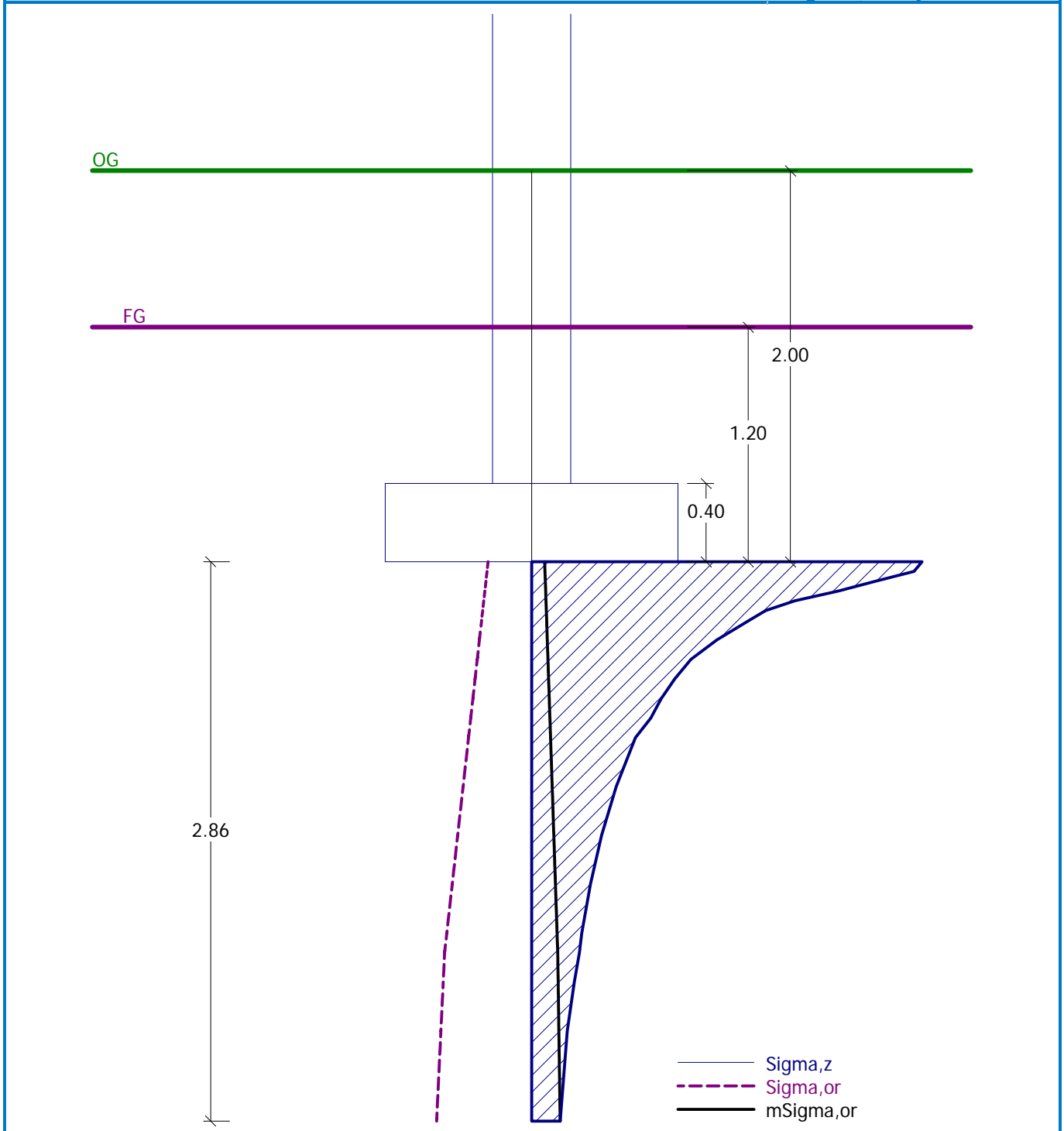
#### Foundation stiffness:

Computed weighted average modulus of deformation  $E_{def} = 21.00$  MPa  
Foundation in the longitudinal direction is rigid ( $k=24.38$ )  
Foundation in the direction of width is rigid ( $k=24.38$ )

#### Overall settlement and rotation of foundation:

Foundation settlement = 6.5 mm  
Depth of influence zone = 2.86 m

Rotation in direction of x = 0.961 (tan\*1000)  
Rotation in direction of y = 2.285 (tan\*1000)



### Dimensioning No. 1

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

#### Verification of longitudinal reinforcement of foundation in the direction of x

Bar diameter = 22.0 mm  
Number of bars = 10.00  
Reinforcement cover = 35.0 mm  
Cross-section width = 1.50 m

Cross-section depth = 0.40 m

Reinforcement ratio  $\mu_{st} = 0.63 \% > 0.16 \% = \mu_{st,min}$

Position of neutral axis  $x_u = 0.04 \text{ m} < 0.19 \text{ m} = x_{u,lim}$

Ultimate moment  $M_u = 229.87 \text{ kNm} > 132.76 \text{ kNm} = M_d$

**Cross-section is SATISFACTORY.**

#### Verification of longitudinal reinforcement of foundation in the direction of y

Bar diameter = 22.0 mm

Number of bars = 8.00

Reinforcement cover = 35.0 mm

Cross-section width = 1.50 m

Cross-section depth = 0.40 m

Reinforcement ratio  $\mu_{st} = 0.51 \% > 0.16 \% = \mu_{st,min}$

Position of neutral axis  $x_u = 0.03 \text{ m} < 0.19 \text{ m} = x_{u,lim}$

Ultimate moment  $M_u = 186.20 \text{ kNm} > 121.09 \text{ kNm} = M_d$

**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  $Q_d = 136.37 \text{ kN/m}$

Outline of critical cross-section = 3.20 m

Shear force transmitted by concrete  $Q_{bu} = 194.25 \text{ kN/m}$

$Q_d < Q_{bu} \Rightarrow$  Reinforcement is not required

**Spread footing for punching shear is SATISFACTORY**