Spread footing verification

Input data

Project

Date : 30.10.2017

Settings

Standard - EN 1997 - DA2

Materials and standards

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

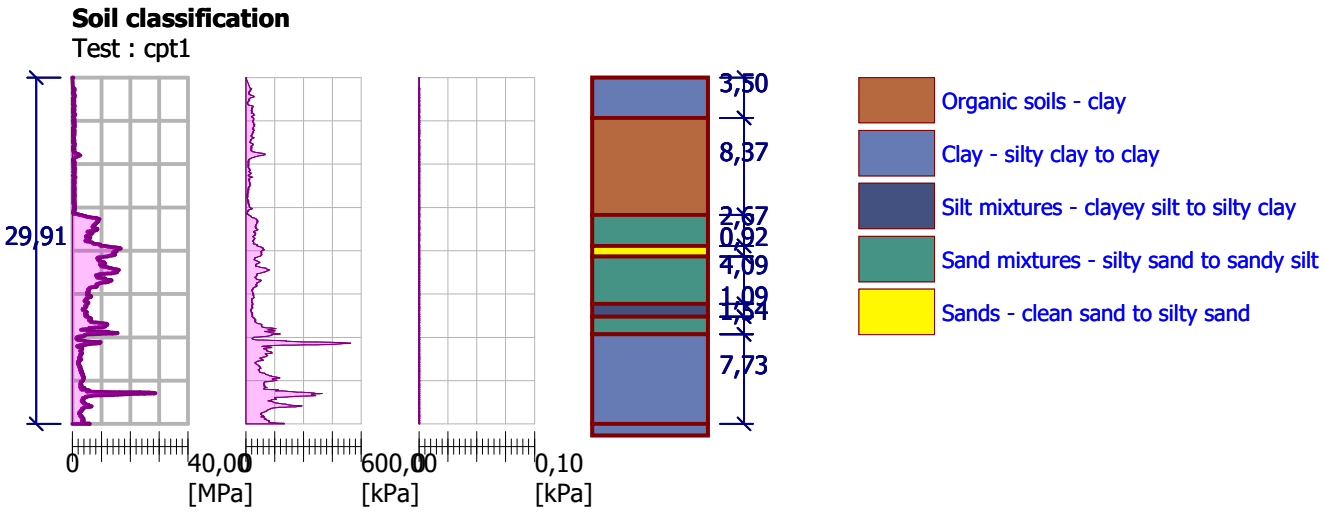
Classification

Sourced CPT : cpt1
Classification type : Robertson 2010
Penetrometer net area ratio : 0,75

Classified soils

No.	Soil name
1	Organic soils - clay
2	Clay - silty clay to clay
3	Silt mixtures - clayey silt to silty clay
4	Sand mixtures - silty sand to sandy silt
5	Sands - clean sand to silty sand

Name : Soil classification | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	Organic soils - clay		15,00		16,55	6,55	

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m3]	γ_{su} [kN/m3]	δ [°]
2	Clay - silty clay to clay		20,00		18,47	8,47	
3	Silt mixtures - clayey silt to silty clay		23,00		17,62	7,62	
4	Sand mixtures - silty sand to sandy silt		22,00		18,42	8,42	
5	Sands - clean sand to silty sand		30,00		19,11	9,11	

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

Soil parameters

Organic soils - clay
Unit weight : $\gamma = 16,55$ kN/m3
Saturated unit weight : $\gamma_{sat} = 16,55$ kN/m3

Clay - silty clay to clay
Unit weight : $\gamma = 18,47$ kN/m3
Saturated unit weight : $\gamma_{sat} = 18,47$ kN/m3

Silt mixtures - clayey silt to silty clay
Unit weight : $\gamma = 17,62$ kN/m3
Saturated unit weight : $\gamma_{sat} = 17,62$ kN/m3

Sand mixtures - silty sand to sandy silt
Unit weight : $\gamma = 18,42$ kN/m3
Saturated unit weight : $\gamma_{sat} = 18,42$ kN/m3

Sands - clean sand to silty sand
Unit weight : $\gamma = 19,11$ kN/m3
Saturated unit weight : $\gamma_{sat} = 19,11$ kN/m3

Foundation

Foundation type: eccentric spread footing
Depth from original ground surface $h_z = 4,00$ m
Depth of footing bottom $d = 1,20$ m
Foundation thickness $t = 0,60$ 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: eccentric spread footing
Spread footing length $x = 2,80$ m
Spread footing width $y = 2,80$ m
Column width in the direction of x $c_x = 0,50$ m
Column width in the direction of y $c_y = 0,50$ m
Spread footing volume $= 4,70$ m3

Dist. of column axis from spr.footing edge in direct. of x = 1,20 m
Dist. of column axis from spr.footing edge in direct. of y = 1,70 m

Material of structure

Unit weight γ = 23,00 kN/m^3

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,50	Clay - silty clay to clay	
2	8,37	Organic soils - clay	
3	2,67	Sand mixtures - silty sand to sandy silt	
4	0,92	Sands - clean sand to silty sand	
5	4,09	Sand mixtures - silty sand to sandy silt	
6	1,09	Silt mixtures - clayey silt to silty clay	
7	1,54	Sand mixtures - silty sand to sandy silt	
8	7,73	Clay - silty clay to clay	
9	-	Clay - silty clay to clay	

Load

No.	Load		Name	N [kN]	M_x [kNm]	M_y [kNm]	H_x [kN]	H_y [kN]
	new	change						
1	Yes		zatížení 1	500,00	150,00	-100,00	0,00	0,00

Analysis No. 1

Analysis of bearing capacity - CPT (Skempton)

Average cone penetration resistance	q_c	= 0,42	MPa
Undrained shear strength	S_u	= 31,90	kPa
Load inclination factor	K_c	= 1,00	
Skempton bearing capacity factor	N_c	= 6,92	

Analysis of bearing capacity - partial results - CPT (Skempton)

Terrain inclination factor	g_q	= 1,00	
Footing bottom inclination factor	b_q	= 1,00	
Effective length	l_{ef}	= 2,80	m
Effective width	b_{ef}	= 2,80	m
Average cone penetration resistance	q_{c1}	= 0,45	MPa
	q_{c2}	= 0,39	MPa
Average vertical stress	σ_{v0}	= 102,32	kPa
Penetration cone factor	N_k	= 10,00	

Settlement analysis - CPT (Schmertmann)

Geostatic stress : considered from the original grade

Geostatic stress in footing bottom	σ_{or}	= 72,92	kPa
Stress in footing bottom	σ_{ol}	= 16,27	kPa

Correction factor for footing depth	c_1	=	0,50
Correction factor for creep settlement	c_2	=	1,54
Shape factor	χ	=	2,50

Overall verification

Max. eccentricity in direction of base length	e_x	=	0,000<0,333
Max. eccentricity in direction of base width	e_y	=	0,000<0,333
Max. overall eccentricity	e_t	=	0,000<0,333

Eccentricity of load is SATISFACTORY
Analysis carried out for the load case No. 1. (zatížení 1)
Analysis for : test with highest utilization (cpt2)

Contact stress	σ	=	89,19	kPa
Bearing capacity of foundation soil	R_d	=	293,69	kPa
Foundation settlement	s_s	=	19,43	mm

Safety factor = 3,29 > 3,00
Spread footing is SATISFACTORY

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

12 prof. 16,0 mm, cover 40,0 mm
Cross-section width = 2,80 m
Cross-section depth = 0,60 m

Reinforcement ratio	ρ	=	0,16	%	>	0,13	%	= ρ_{min}
Position of neutral axis	x	=	0,04	m	<	0,34	m	= x_{max}
Ultimate moment	M_{Rd}	=	564,32	kNm	>	192,36	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Verification of longitudinal reinforcement of foundation in the direction of y

12 prof. 16,0 mm, cover 40,0 mm
Cross-section width = 2,80 m
Cross-section depth = 0,60 m

Reinforcement ratio	ρ	=	0,16	%	>	0,13	%	= ρ_{min}
Position of neutral axis	x	=	0,04	m	<	0,34	m	= x_{max}
Ultimate moment	M_{Rd}	=	564,32	kNm	>	221,92	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Spread footing for punching shear failure check

Column normal force = 500,00 kN

Maximum resistance at the column perimeter

Force transferred into found. soil		=	15,94	kN
Force transferred by shear strength of foundation		=	484,06	kN
Considered column perimeter	u_0	=	2,00	m
Shear resistance at the column perimeter	$v_{Ed,max}$	=	0,99	MPa
Resistance at the column perimeter	$v_{Rd,max}$	=	2,94	MPa

Critical section without shear reinforcement

Force transferred into found. soil		=	344,07	kN
Force transferred by shear strength of foundation		=	155,93	kN
Distance of section from the column		=	0,97	m
Section perimeter	u	=	4,32	m

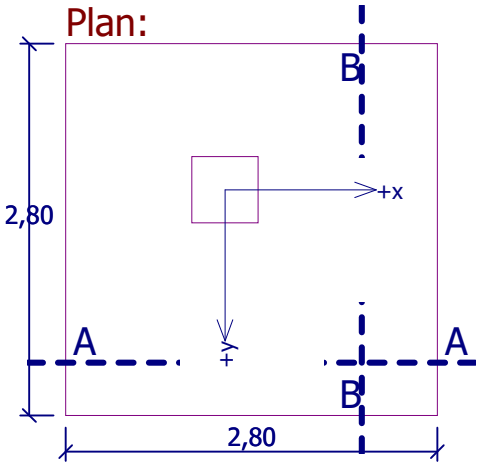
Shear stress at section v_{Ed} = 0,14 MPa
Shear resistance of section without shear reinforcement $v_{Rd,c}$ = 0,36 MPa

$v_{Ed} < v_{Rd,c}$ => Reinforcement is not required

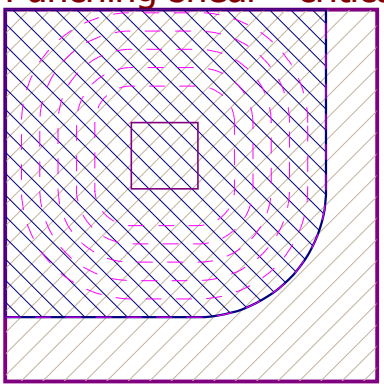
Spread footing for punching shear is SATISFACTORY

Name : Dimenzování | **Stage - analysis : 1 - 1**

Plan:



Punching shear - critical section:

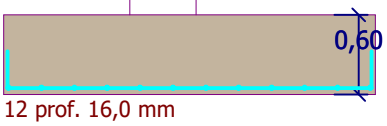


Loading area
tranfered by RC through shear
area: 5,39E+00m²

critical section
length: 4,32m

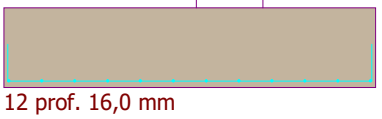
checked sections

Section A-A:



12 prof. 16,0 mm
length 2720mm, concrete cover 40mm

Section B-B:



12 prof. 16,0 mm
length 2720mm, concrete cover 40mm