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DETERMINATION OF THE CHARACTERISTICS VALUES FOR GEOTECHNICAL PARAMETERS

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Abstract

The main purpose of the geotechnical studies is to determine the physical and mechanical properties of the foundation soil. For the geotechnical studies it is necessary to be taken into account the calculation characteristics which are determined based on characteristic values. This article aims to determine the characteristic values of the geotechnical parameters resulted from the laboratory studies. The calculation of the characteristic values was done according to the Normative of Design NP 122:2010, and the laboratory studies were done according to the national standards in force.

Key words: *geotechnical study, geotechnical parameters, characteristic values.*

INTRODUCTION

The laboratory tests have been conducted regarding the elaboration of a geotechnical study in order to design a rainwater tank from a wastewater treatment plant. In order to realize the geotechnical study it is desired to identify the characteristic values of the geotechnical parameters from the site. The emplacement is located in the Romanian Plain in an area of flat land.

In order to determinate the characteristic values of the geotechnical parameters, the Romanian normative NP 122:2010 was used, according to this normative have been covered the following steps:

Step I: The identification of the soil type in the ternary diagram.

Step II: The verification of the soil type identified in the ternary diagram.

Step III: The verification of the physical properties of the soils in order to verify if they correspond with the same geological layer.

Step IV: The calculation of the characteristic values for every geological layer.

MATERIALS AND METHODS

The laboratory tests were done based on samples collected from two boreholes, named F1 and F2; these boreholes were made up to 10 meters. All the geotechnical parameters were determined according to the Romanian standards in force.

The determination of granulometry has been made according to STAS 1913/5-85 and SR EN ISO 14688-1:2004 and it represents the distribution of the weight procentual content, on fractions of the solid particles which can be found in its composition.

The moisture content (w) represents the quantity of water which is stored in the earth's pores reported to the dry mass samples, the moisture content has been determined according to STAS 1913/1-82.

Liquid limit (w_L) represents the moisture content where a soil emerges from a liquid state to a plastic one; the plastic limit (w_P) represents the humidity where a smooth soil becomes too dry to be in plastic state, these limits has been determined according to STAS 1913/4-86.

Based on the values of the plasticity limits, the plasticity index (IP) and the consistency index

(IC) can be determined with the following formulas:

$$I_P = w_L - w_P, (\%)$$

$$I_C = \frac{w_L - w}{w_L - w_P}$$

The density (ρ) of a soil is the ratio between the mass of solid particles and the total volume of the sample, according to STAS 1913/3-76.

The dry density can be determined with the following relation:

$$\rho_d = \frac{m_d}{V}, (g/cm^3)$$

where:

md – the soil mass in dry state, g;

V – the volume occupied by the soil.

The soil porosity (n) it is defined as the ratio of the volume occupied by pores (Vp) and the total volume of the soil (V).

Pores index (e) represent the ratio between the pores volume (Vp) and the solid phase volume (Vs).

The level of saturation (Sr) is defined as the ratio between the volume of the pores filled with water and the total volume of the pores.

The in situ and laboratory tests provide measured values of the geotechnical parameters. These values cannot be directly used in the geotechnical design, but must be statistically processed in order to determine the characteristic and design values of the geotechnical parameters (Olinic, 2014).

The statistical coefficient kn depends on the number of test results and on the knowledge about the coefficient of variation (case Vx known or Vx unknown). When only the values determined directly by testing are taken into account, the coefficient of variation for the soil in question is not known in advance and kn values are taken from column Vx unknown. Because in many practical cases, for a geological stratum few values are selected, leading to high values for Vx and kn, can be used the "existing knowledge" method, which takes the value of the coefficient of variation Vx from relevant documentations. In these situations, the statistical coefficient values kn are taken from column Vx known (Olinic, 2014).

Below is presented the order in which the characteristic and design values of the geotechnical parameters are determined (NP 122:2010):

- Measured values $X_1, X_2, X_3 ... X_i ... X_n$
- Mean value $X_m = \frac{\sum X_i}{n}$
- Standard deviation of the selected measured values $s_x = \sqrt{\frac{1}{n-1}\sum (X_i - X_m)^2}$
- Coefficient of variation $V_x = \frac{s_x}{X_m}$
- Statistical coefficient $k_n = f(n, V_{x\,known}\ or\ V_{x\,unknown})$
- Characteristic values $X_{k\,\sup} = X_m (1 + k_n \cdot V_x)$ $X_{k\,\inf} = X_m (1 - k_n \cdot V_x)$
- Local characteristic values $X_{k\,\mathrm{loc}} = X_m (1 \pm 2V_x)$

RESULTS AND DISCUSSIONS

From laboratory studies result the geotechnical characteristics presented in Table 1.

According to the operation methodology described by NP 122:2010 it has been followed the next steps:

Step I: The identification of the soil type in the ternary diagram

In this stage has been concluded that the foundation soil has been divided on two geological layers and it has resulted: one layer of silty clay and another one of clayey silt, according to ternary diagram from STAS 1913/5-85 (Figure 1.a).

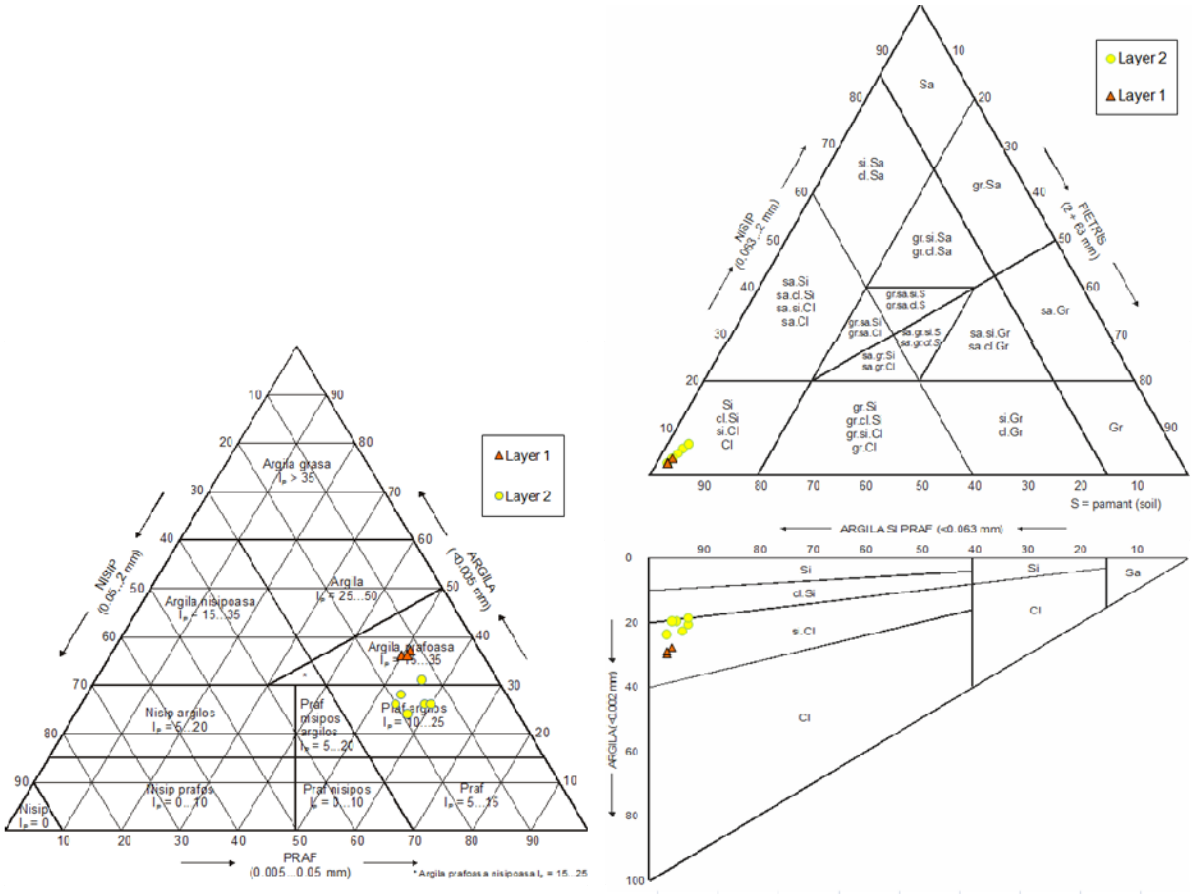
According to the ternary diagram from SR EN ISO 14688-1:2004, all the soils take part into the category of silty clays (Figure 1.b).

Step II: The verification of the soil type identified in the ternary diagram

It has been made a verification of the results from stage I. This verification has been made with the help of the data received from the site.

Table 1. The geotechnical parameters

BOREHOLE	GEOLOGICAL LAYER	NR. SAMPLE	DEPTH	PHYSICAL PARAMETERS													
				Clay	Silt	Sand	w	w_P	w_L	I_P	I_C	r	r_d	n	e	S_r
			m				%	%	%	%		t / m^3	t / m^3	%	-	-
F1	Brownish silty clay with traces of degraded chalk and rare chalky concretions, with high plasticity, hard	N2	2	36	50	14	15.8	17.6	41.5	24.0	1.08	1.74	1.50	44.0	0.79	0.56
F1	Brownish silty clay with high plasticity, vigorous plastic	N4	4	37	51	12	20.8	18.8	40.8	22.0	0.91	1.88	1.53	42.8	0.75	0.83
F2	Brownish silty clay with traces of degraded chalk, with high plasticity, vigorous plastic	N2	2	36	50	14	19.5	19.2	42.2	23.1	0.99	1.93	1.62	39.1	0.64	0.78
F2	Brownish silty clay with high plastiity, vigorous plastic	N4	4	36	51	13	21.1	18.9	39.9	21.0	0.90	1.91	1.59	40.3	0.68	0.79
F1	Light brownish clayey silt-yellowish, with rare traces of degraded chalk and chalky concretions, with medium plasticity, plastic consistency	N6	6	28	54	18	26.4	17.5	36.2	18.7	0.52	1.99	1.58	40.7	0.69	1.0
F1	Light brownish clayey silt- yellowish, with medium plasticity, solf plasticity	N8	8	31	56	13	30.2	19.2	38.6	19.4	0.44	1.95	1.52	43.0	0.75	1.0
F1	Light brownish clayey silt, with medium plasticity, solf plastic	T10	10	26	54	20	26.0	15.5	33.5	18.1	0.42					
F2	Light brownish clayey silt- yellowish, with high plasticity, solf plastic	N6	6	24	57	19	27.2	20.3	33.4	13.1	0.47	1.98	1.56	41.5	0.71	1.0
F2	Light brownish clayey silt- yellowish, with high plasticity, solf plastic	T8	8	26	59	15	28.7	17.0	34.6	17.6	0.33					
F2	Light brownish clayey silt- yellowish with chalky concretions, with medium plasticity, solf plastic	T10	10	26	60	14	29.2	17.4	34.7	17.2	0.32					



a. b.

Figure 1. The identification of the soil type in the ternary diagram

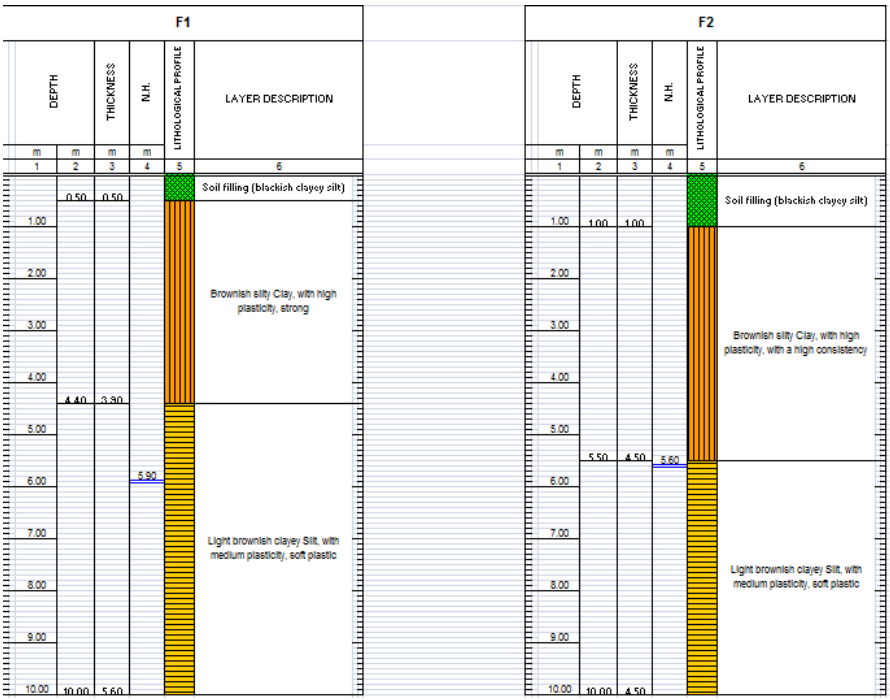


Figure 2. The borehole sheet

Table 2. The characteristic values

CARACTERISTICS	GRAIN SIZE			PHYSICAL PARAMETERS									
	Clay	Silt	Sand	w	w_P	w_L	I_P	I_C	r	r_d	n	e	S_r
				%	%	%	%		t / m^3	t / m^3	%	-	-
The calculation of characteristic values - Clayey Silt													
Minimum values Xmin	24	54	13	26.0	15.5	33.4	13.1	0.3	2.0	1.5	40.7	0.7	1.0
Maximum values Xmax	31	60	20	30.2	20.3	38.6	19.4	0.5	2.0	1.6	43.0	0.8	1.0
Average values Xmed	27	57	17	28.0	17.8	35.2	17.3	0.4	2.0	1.6	41.7	0.7	1.0
Nr. values xi, n				6.0	6.0	6.0	6.0	6.0	3.0	3.0	3.0	3.0	3.0
Standard deviation, sx				1.7	1.7	2.0	2.2	0.1	0.0	0.0	1.2	0.0	0.0
Coefficient of variation Vx				0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.1	0.0
Kn for Vx unknown				0.8	0.8	0.8	0.8	0.8	1.7	1.7	1.7	1.7	1.7
Xk superior				29.3	19.2	36.8	19.2	0.5	2.0	1.6	43.8	0.8	1.0
Xk inferior				26.6	16.4	33.6	15.5	0.4	1.9	1.5	39.7	0.7	1.0
Xk local superior				31.3	21.2	39.1	21.8	0.6	2.0	1.6	44.1	0.8	1.0
Xk local inferior				24.6	14.4	31.2	12.9	0.3	1.9	1.5	39.3	0.6	1.0
The calculation of characteristic values													
Minimum values Xmin	36	50	12	15.8	17.6	39.9	21.0	0.9	1.7	1.5	39.1	0.6	0.6
Maximum values Xmax	37	51	14	21.1	19.2	42.2	24.0	1.1	1.9	1.6	44.0	0.8	0.8
Average values Xmed	36	51	13	19.3	18.6	41.1	22.5	1.0	1.9	1.6	41.6	0.7	0.7
Nr. values Xi, n				4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Standard deviation, sx				2.5	0.7	1.0	1.3	0.1	0.1	0.1	2.2	0.1	0.1
Coefficient of variation Vx				0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.2
Kn for Vx unknown				1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Xk superior				22.2	19.4	42.3	24.0	1.1	2.0	1.6	44.2	0.8	0.9
Xk inferior				16.4	17.8	39.9	21.0	0.9	1.8	1.5	38.9	0.6	0.6
Xk local superior				24.2	20.0	43.1	25.1	1.1	2.0	1.7	46.0	0.8	1.0
Xk local inferior				14.4	17.2	39.1	20.0	0.8	1.7	1.4	37.1	0.6	0.5

Step III: The verification of the physical properties of the soils in order to verify if they correspond with the same geological layer

Were analyzed the geotechnical properties resulted from laboratory test, such as: moisture content, plasticity limits, plasticity index, consistency index, density, porosity and the saturation degree. These characteristics confirmed the soil classification into those two layers resulted in the ternary diagram from STAS 1913/5-85. According to these results has been made the borehole sheet (Figure 2).

Step IV: The calculation of the characteristic values for every geological layer

This calculation was done according to NP 122:2010. It has been calculate all the characteristic values presented in the previous chapter. The characteristic values were determinate for each geological layer (Table 2).

CONCLUSIONS

The physical characteristics of soils give us some indications about the mechanical behavior of the soils and help us to schedule in a fairy mode all the laboratory tests that follow. Geotechnical design is based on design values of geotechnical parameters derived from the characteristic values, respectively measured values.

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