GEOTECHNICAL DOCUMENTATION FOR THE CONSTRUCTION OF A GREENHOUSE IN THE LIMITROPHE AREA OF CRAIOVA

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ABSTRACT

The geotechnical documentation constitutes the quality verification at the requirement of resistance and stability of the foundation lands and earth masses and includes technical information about the land location and morphological data, classification in the geotechnical category, investigation of the foundation land, lithology and physical-mechanical characteristics of the land and the foundation conditions, obtained by performing a geotechnical drilling and dynamic penetration tests and the analysis of stratification, granulometry and physical-mechanical characteristics. The ground is flat and good foundation on 0.0-6.0 m depth, the conventional pressure is 170 kPa for Df = 0.8 m and B = 0.6 m and respectively 264 kPa for Df = 4.0 m and B = 2.0 m being recommended insulated foundations or insulated foundations with balancing beams, the terrain presents a low geotechnical risk and a degree of seismicity 8_2.

INTRODUCTION

The present study has resulted from the necessity to know the foundation terrain in order to properly locate for the construction of a greenhouse. The site under investigation is located in the east part of the periurban area of Craiova, Dolj County and it falls within the geological unit “Campia Romana”.

Morphologically, the location is relatively plain, good for the foundation, with good stability; tectonically features, this place belongs to the Valaha Platform, the Moesic Domain and this zone incorporates neogenical and quaternary formations.

MATERIALS AND METHODS

The geotechnical study shall be used to determine the strength and stability of foundation fields and earth stocks, on the basis of geotechnical exploration work carried out in the site area, specifying aspects relating to: the stratification of the terrain; the physical and mechanical soil characteristics; the admissible pressures at different levels; the classification of the digging operations; the freezing depth; the seismically classification; hydrogeological data.

There have been made one geotechnical drill and there were taken samples and there were made analyses, with a diameter of 150-200 mm and a depth of 6.0 m from which samples have been taken and laboratory tests carried out.

Soil research on site has been made by: direct observation (geological mapping of the studied area); the performing of one drills (FG1) with a diameter of 150-200 mm and a depth of 6,0 m according with the project; performing penetrometric tests at different depths in the area of the foundation pressure bulb, with light and medium dynamic penetrometer (PDU and PDM); shear drilling attempts; collecting disturbed and undisturbed samples and analyzing them.

The calculation of the dynamic penetration resistance on the cone has been performed with the relationship:

$R_d = 1/A[(G_1^2\ h \cdot N)/10(G_1+G_2)]$

Where: A=cross-section of cone, cm^2; G_1=weight of ram, daN; G_2=weight of rods,

anvil and cone, daN; h=weight drop height, cm; N=number of strokes required for a cone penetration of 10 cm.

The allowable pressure for plastic deformation has been established with the relationship: $P_a=R_d/20$

Standard dynamic penetration (SPT) was performed by determining the number of blows applied from a height of 760 mm, with a weight of 63.5 kg for the core tube to penetrate 300 mm.

The determination of the physical and mechanical characteristics of the soil was made by geotechnical indices and indices of resistance and deformability (γ_a, γ_s, W, W_c, W_p, Ip, Ic, n, e, Sr, Id, α, K, Ca, Ul, φ, C, M_{2-3}, av_{2-3}, ep_2)

The nature and the phisical status of the foundation has required the calculation of the terrain from the drill, for several depths (0,8-4,0 m) and for several widths of the foundations (0,6;1,0; 2,0) according to STAS 3300/1-85 and 3300/2-85.

With the preliminary or definitive calculus of the foundation terrain on the basis of the conventional pressures there have to be complied the following conditions;

- with centrically loadings:
  - $P_{ef} < P_{conv}$ şi $P'_{ef} < 1.2\ P_{conv}$
- with excentrical loadings on one direction:
  - $P_{ef\,max} < 1,2\ P_{conv}$ in the fundamental grouping
  - $P'_{ef\,max} < 1,4\ P_{conv}$ in the special grouping
- with loadings with excentricities on both directions:
  - $P_{efmax} < 1,4\ P_{conv}$ in the fundamental grouping;
  - $P'_{ef\,max} < 1,6\ P_{conv}$ in the special grouping

where: P_{ef}, P'_{ef} = the average vertical pressure on the base plate derived from the calculation charges in the fundamental grouping, respectively; P_{conv} = conventional calculation pressure; $P_{ef\,max}$; $P'_{ef\,max}$ = the maximum effective pressure on the base plate resulting from the calculation loads in the fundamental grouping and the special grouping.

For lands that are very compresible, the preliminary set up of the foundation dimensions can be made on the basis of the $P_{conv.\,min.}$ for the respective class but it is compulsory the subsequent verification at the limit deformation status (P_{pl}) and of portent capacity (P_{cr}).

Within the very compresibile, lands are the loosened sands and the cohesive lands (clays) with Ic< 0.5 or e>0.90.

The conventional pressures are determined taking account of the basis values P_{conv} from the tables. The basis values from tables correspond to the conventional pressures, with the width of the sole B=2 m. and the depth of foundation Df=2.0 m.

The calculus of the foundation terrain with the limit status of deformation (P_{pl})

In order to accomplish the calculus there must be fulfilled the following conditions:

- for centrical loaded foundations: $P_{ef} < P_{pl}$
- for excentrical loaded foundations: $P_{ef} < P_{pl}$; $P_{ef\,max} < 1.2\ P_{pl}$; $P_{ef\,max} < 1.4\ P_{pl}$

in which: P_{ef} = vertical pressure on the base plate, derived from the calculation charges in the fundamental grouping; $P_{ef\,max}$ = maximum vertical pressure on the base plate derived from the calculation charges in the fundamental grouping in case of excentricity in a single direction; $P_{ef\,max}$ = maximum vertical pressure on the base plate derived from the calculation charges in the fundamental grouping, in case of excentricity in both directions; P_{pl} = pressure corresponding to a limited extension of the plastics area in the field of foundation

For rectangular foundations in P_{pl} plan it is calculated as follows:

- for buildings without basement: $P_{pl} = ml\ (\gamma \cdot B \cdot N1 + q \cdot N2 + c \cdot N3)$,kPa
- for buildings with basement: $P_{pl} = ml\ (\gamma \cdot B \cdot N1 + (2qe+qi)/3 \cdot N2 + c \cdot N3)$,kPa

where: *ml* = coefficient of working conditions; *γ* = weighted average of the volumetric calculation weight of the underfloor layers contained within a depth of B/4 measured from the foundation base (kN/m^3); B = small edge of the foundation (m); q = calculation overload at the base plate, lateral foundation (kPa); qe,qi = calculation overload at the base plate on the outside and inside of the basement, respectively (kPa); c = calculation value of the cohesion of the underfloor layer, (kPa); N1,N2,N3 = dimensionless coefficients in relation to the value of calculating the inner friction angle of the land under foundation base

The calculus of the terrain at the limit status of portent capacity must ensure the following condition: $Q < m \cdot R$

where: Q = calculation load on the foundation ground derived from the actions in the special groups; this may be of the nature of effective pressure, slip force, tipping moment, etc.; R = the load capacity for calculating the ground floor, may be critical pressure, shear resistant, moment of stability, etc.; m = coefficient of working conditions.

When the resultant of the loading calculus has a declination over the vertical less than 5^0 in the conditions of horizontal stratification, the critical pressure, can be calculated with the following relation:

$$P_{cr} = \gamma^* \cdot B' \cdot N_\gamma \cdot \lambda_\gamma + q \cdot N_q \cdot \lambda_q + c^* \cdot Nc \cdot \lambda_c \quad , kPa$$

where: γ^* = the volumetric weight of the ground layers under the base plate (kPa); B = reduced width of the base plate (m); *Nγ, Nq , Ne* = load capacity coefficients depending on the calculation value of the internal friction angle, ∅* of the layers under the base plate; q = calculation overload acting at the base of the foundation, (kPa); c = calculation value of the cohesion of the earth layers under the base of the foundation,(kPa); λ_γ, λ_q, λ_c = coefficients of the shape of the foundation.

In the case of the presence under the foundation of a stratification were the shearing strength characteristics (ϕ^*, c^*, λ^*) do not vary more than 50% over the average values, there can be adopted for the calculus of the portent capacity the weighted average.

When, within the active zone there appears a weak layer, with a shearing resistance less than 50% the value of the shearing resistance of the superior strate, there will be verified the portent capacity as the foundation would stay directly upon the weak layer.

RESULTS

The site under investigation is located in the east part of the periurban area of Craiova, Dolj County and it falls within the geological unit “Campia Romana”.

Morphologically, the location is relatively plain, good for the foundation, with good stability; tectonically features, this place belongs to the Valaha Platform, the Moesic Domain and this zone incorporates neogenical and quaternary formations.

The characteristic lithological profile of the site consists of: vegetal cover soil (0.0-0.25 m); brownish brown dusty sands, consistent plastic, with medium compressibility, wet (0.25-1.60 m); brown clayey sands, consistent plastic, with medium compressibility, wet to very wet in depth (>1.6).

From a meteorological point of view, the area falls within the continental climate sector (climate type “1”, with humidity index Im=-20-0), characterized by very hot summers with poor rainfall that fall in the form of averse and by moderate winters with rare blizzards.

The average annual temperature is about 51.4^0F; July averages are 72.9^0F and January has an average of -36.5^0F.

The wind action in the studied area has a basic dynamic pressure of 0.5 kN/m^2.

The actions due to the snow have a load on the ground of 2.0 kN/m^2 with a recurrence period of 50 years.

The freezing depth of the natural terrain in the area is 0.85 m.

The seismicity area is D with values of ag=0.20 g and a corner period Tc=1.0 s (degree 8_2 seismicity).

The establishment of the geotechnical category and of the geotechnical risk was performed based on the correlation of the factors and the conditions related to them, resulting in the classification in the first geotechnical category and a reduced geotechnical risk.

The aquifer horizon was not intercepted with geotechnical drilling, but puddles and infiltrations may occur during precipitation.

The exploration of the soil has been made by: direct observation, geological survey; the performing of one drill (FG1) with a diameter of 150-200 mm and a depth of 6,0 m according with the project (figure 1).

Figure 1 - Location of geotechnical drilling

Disturbed and undisturbed samples were taken to determine the geotechnical characteristics of the lithological types on the construction site and analyzed for the physical and mechanical characteristics of the earth.

Laboratory determinations on samples taken consisted of particle size determinations, lithological interpretation and determination of physical and mechanical characteristics (table 1).

Table 1

FG1 drilling geotechnical sheet

Depth	Particle size						Lithological interpretation
	Gravel	Large sand	Middle sand	Fine sand	Dust	Clay	
m	%						
0.25	-	-	-	-	-	-	Vegetal cover
0.25-1.6	-	4	18	25	38	15	Brownish brown dusty sands, consistent plastic, with medium compressibility, wet
>1.6	-	6	8	30	34	22	Brown clayey sands, consistent plastic, with medium compressibility, wet to very wet in depth

Lithological interpretation	Physical characteristics									
	γ_a	γ_s	Wc	Wf	Ip	Ic	W	Sr	n	e
	kN/m^3	kN/m^3	%	%	%	-	%	-	%	-
Vegetal cover	-	-	-	-	-	-	-	-	-	-
Brownish brown dusty sands, consistent plastic, with medium compressibility, wet	18.8	26.4	27.0	10	16.6	0.48	19.8	0.67	38.4	0.62
Brown clayey sands, consistent plastic, with medium compressibility, wet to very wet in depth	19.0	26.3	31.3	11	20.6	0.46	21.6	0.74	38.1	0.62

Lithological interpretation	Mechanical characteristics						
	Ø	c	M_{2-3}	av_{2-3}	ep_2	Penetration	Dynamic penetration
	^{0}	kPa	daN/cm^2	daN/cm^2	cm/m	strikes	daN/cm^2
Vegetal cover	-	-	-	-	-	-	-
Brownish brown dusty sands, consistent plastic, with medium compressibility, wet	14	12	117	0.01	2.83	17	39
Brown clayey sands, consistent plastic, with medium compressibility, wet to very wet in depth	14	15	123	0.01	2.77	18	41

Taking into account the nature and physical condition of the foundation ground and the type of construction, calculations were made based on drilling performed at different foundation depths (0,8-4,0 m) and different foundation widths (0,6;1,0; 2,0).

The results of the calculations are listed in the table 2 for conventional calculation pressures and table 3 for deformations limit conditions (P_{pl}) and load capacity limit conditions (P_{cr}).

Table 2

The conventional calculation pressures (Pconv), kPa

Nr. foraj	Adâncime fundare	Conventional pressures calculation for different widths B (m)			Soil description
	(m)	0.6	1	2	
FG1	0,8	170	174	180	Brownish brown dusty/powdery sands, consistent plastic, with medium compressibility, wet
	1	180	185	194	
	1.5	196	200	209	
	2	201	205	215	
	3	223	228	238	
	4	250	254	264	

Table 3

Deformations values of the limit conditions (P_{pl}) and load capacity limit conditions (P_{cr})

Depth (m)	γ kN/m^3	ϕ gr	c kPa	ml	Ppl (kPa)			Pcr (kPa)			Soil description
					0.6	1	2	0.6	1	2	
0.8	18.9	15	14	1.7	176	180	185	221	227	241	Brownish brown dusty/powdery sands, consistent plastic, with medium compressibility, wet
1	18.3	15	14	1.7	189	192	197	233	239	252	
1.5	16.4	15	13	1.7	205	208	212	246	251	263	
2	14.8	14	13	1.7	214	216	220	246	249	258	
3	13.6	14	13	1.6	240	242	245	285	289	297	
4	12.4	14	12	1.6	263	265	268	306	309	317	

CONCLUSIONS

After the researches, can be formulated the following conclusions:

- Morphologically speaking the site is relatively flat.

- The prospective earth layer of the surface (0-6 m), is good for foundation and consists of: vegetal cover (0.0 to 0.25 m); Brownish brown dusty sands, consistent plastic, with medium compressibility, wet (0.25 to 1.60 m) and Brown clayey sands, consistent plastic, with medium compressibility, wet to very wet in depth (± 1.6 m).

- Geotechnical forages did not intercept the aquifer horizon.

- Conventional pressures vary between P_{conv} = 170 kPa, for the foundation depth Df = 0.8 m and the foundation width B = 0.6 m and P_{conv} = 264 kPa pentru Df = 4.0 m şi B = 2.0 m (tabelul 2).

- The admissible pressures at the limit deformation status (fundamental loading) vary between Ppl = 176 kPa for Df = 0.8 m and B = 0.6 m and Ppl = 265 kPa, for the foundation depth Df = 4.0 m and the width of the foundation B = 2.0 m (table 3).

- The admissible pressures at the limit status of portent capacity vary from (special loads) vary from Pcr = 221 kPa for the foundation depth Df = 0.8 m and the foundation width B = 0.6 m and Pcr = 317 kPa for Df = 4.0 m and B = 2.0 m (table 3).

- It is recommended to make insulated foundationa or insulated foundations with balancing beams for hall-type constructions.

- The minimum foundation depth is 1.0 m from the natural terrain level.

- The last 10 cm of the digging will be made manually during the day when the concrete will be put.

- For a B=1.0 m is recommended Ks = 2.2-2.4 daN/cm^3.

- Regarding the seismicity, the researched surface is located in the D zone with the coefficient ag = 0.20 g, the corner period Tc=1.0 s, the 8_2 degree (8_2 degree with a

period of return of 100 years).

- The wind actions classify the location in the zone B (0.50 kN/m^2) și v_{2m} = 26.0 m/s
- The snow actions classify the location in the zone C (2.0 kN/m^2)
- The site under study is part of first geotechnical category and has a low level geotechnical risk.

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