CONCRETE PLATFORM CONSTRUCTION FOR AGRICULTURAL MACHINES BASED ON GEOTECHNICAL STUDY

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Abstract

The geotechnical study resulted from the need to know the foundation soil in order to build a concrete platform. The geotechnical study includes geotechnical exploration works carried out in the area of the site in Bailesti, Dolj, in order to provide data regarding: the stratification of the land on the site, the physical-mechanical characteristics of the identified soils, the admissible pressures at different foundation levels, the framing of the excavations according to the TS standard, the freezing depth, the seismic framing, the hydrogeological data. It is found that the site is flat, with slight unevenness that favors puddles and the surface soil layer (0-6 m) is medium-good for foundations, consisting of clayey to sandy clayey, blackish to yellowish brown (0-1.7 m) and sandy clayey to sandy dusts below 1.7 m depth.

Key words: geotechnical study; field geotechnical works; place; concrete platform

INTRODUCTION

The studied site is located in Bailesti, which tectonically belongs to the Valaha platform, is relatively flat with slight unevenness that favors waterlogging. Quaternary deposits are especially important where the constructions are founded. Two geotechnical drillings were carried out for the field research, from which samples were collected and laboratory analyses were performed.

MATERIALS AND METHODS

The study comprises geotechnical works made within the establishment zone in order to get the data needed for the solving the basis problems that includes: the stratification of the terrain; the physics-mechanical features of the soil; the admissible pressures at different levels; the probable compaction; the classification of the digging operations; the freezing depth; the seismically classification; hydrogeological data.

There have been made two geotechnical drills and there were taken samples and there were made analyses.

The exploration of the soil has been made by: direct observation, geological survey; the performing of two drills (FG1, FG2) with 100 mm diameter and the depth 5.0 m according with the project; the performing of penetrometer trying at different depths within the bulb zone and the foundation pressures using the light penetrometer; the collecting of disturbed and not disturbed samples and their analysis.

The nature and the phisical status of the foundation has required the calculation of the terrain from the drills, for several depths (0.8; 1; 1.5; 2; 2.5; 3) and for several widths of the foundations (1; 2; 3) according to STAS 3300/1-85 and 3300/2-85.

The calculus of the foundation terrain on the basis of the conventional pressures.

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

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=1.0 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: $P_{ef} < P_{pl}$; $P_{ef\ max} < 1.2\ P_{pl}$; $P_{ef\ max} < 1.4\ P_{pl}$

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

- for buildings without basement: P_{pl} = ml (γ xBxNl + qxN2 + cxN3) kPa
- for buildings with basement: P_{pl} = ml (γ xBxNl + (2qe+qi)/3xN2 + cxN3) kPa,

The absolute probable compaction can be calculated with the formula:

$S = 100 \times \beta\ (\Sigma\sigma^{med}_{zi} \times hi)/Ei$ cm,

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

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:

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

In the case of the presence under the foundation of a stratification were the shearing features 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 strata, there will be verified the portent capacity as the foundation would stay directly upon the weak layer.

RESULTS AND DISCUSSIONS

Location and morphological data

The researched site is located in Bailesti, Dolj County. From a tectonic point of view it belongs to the Valaha platform of the Moesic domain, morphologically the site is a relatively flat plateau, with slight unevenness that favors puddles and geologically it belongs to the Romanian Plain.

Two geotechnical drillings were carried out (figure 1), that intercepted formations of Holocene alluvial age from the surface to the Middle Pleistocene and Upper Pleistocene, formations made up of a vegetal layer and clayey dusts to blackish clayey sandy dusts to brownish on the first 1.5-1.9 m to sandy dusts to blackish clayey sandy dusts to yellowish brown at over 1.9 m depth.

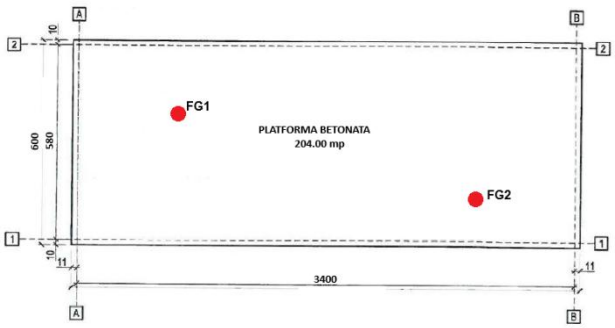

Figure 1. Concrete platform for agricultural machinery

The climate is continental, with very hot summers and poor precipitation in the form of showers, with moderate winters and rare blizzards; the predominant winds are from the east (25.6%) and west (19.8%).

The seismicity falls within zone D with: ag=0.15 g; Tc=1.0 s; seismicity degree 7_1.

Classification in the geotechnical category

Considering the factors related to the ground conditions (weak foundation soils), groundwater (no depletion to normal depletion), the importance of the construction (normal to special) and the vicinity (no risks) and respectively the seismic zone, the result is a classification in geotechnical category 2 with a moderate geotechnical risk (table 1).

Table 1. Establishing the geotechnical category

Factors	Conditions	Score
Ground conditions	Weak foundation soils	4
Groundwater	No to the normal depletion	3
Construction importance	Mormal to special	3
Type of neighboring land	No risks	2
Seismic zone	D	0.15g; 1.0 s; T_1
Geotechnical risk	Moderate	12

Investigation of the foundation ground

The investigation of the foundation ground was carried out through land prospecting works: direct observations (geological mapping), the execution of two geotechnical boreholes with a diameter of 150-200 mm and a depth of 6.0 m; the execution of penetrometric tests at different depths in the area of the foundation pressure bulb using PDU and PDM; shear tests in boreholes; sample collection and analysis

According to the surface geological mapping and the boreholes carried out, it is found that the ground has a uniform stratification; the physical and mechanical characteristics of the soil are centralized in the geotechnical files of the drillings (table 2 and table 3).

Lithological data and physical and mechanical characteristics of the site terrain

The determination of the geotechnical characteristics of the lithological types was carried out on disturbed and undisturbed samples collected from the FG1 and FG2 boreholes. Thus, we have the following particle size (figure 2 and 3), physical and mechanical characteristics of the soils:

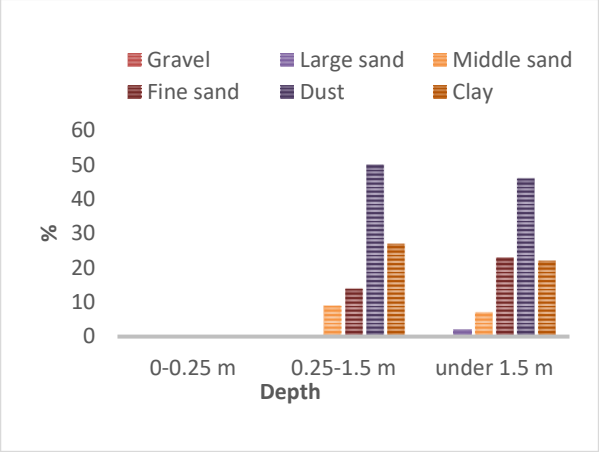

Figure 2. FG1 Drilling geotechnical sheet

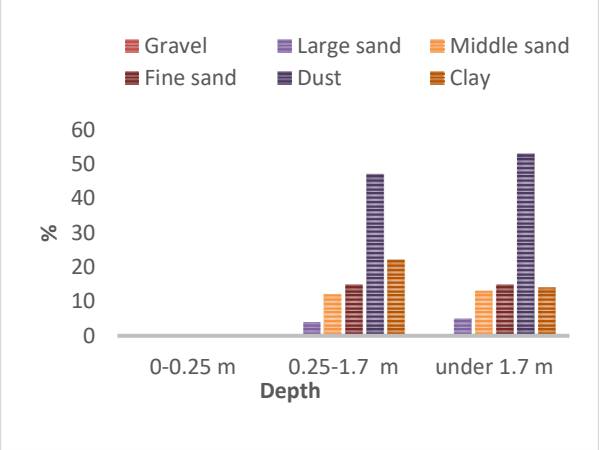

Figure 3. FG2 Drilling geotechnical sheet

- clayey to sandy clayey, blackish to yellowish brown, soft to consistent plastic, with high compressibility, moist on the first 1.5-1.7 m: w=22.0-21.5 %; e=0.62-0.63; γ=18.8-19.0 kN/m^3; M_{2-3}=91-98 daN/cm^2; Ø=11-13^0; c=23-24 kPa

- sandy clayey to sandy, soft to consistent plastic, with high compressibility to medium, very moist from 1.5-1.7 m down: w=21.7-23.0%; e=0.60-0.61; γ=19.2-19.4 kN/m^3; M2-3=98-110 daN/cm^2; Ø=13-16^0; c=20-22 kPa

The aquifer horizon was identified at depths of 2.5 m and 3.1 m, respectively. During heavy rainfall, puddles appear that cause infiltrations in conditions of improper execution of waterproofing and depletion.

Foundation conditions

Considering the nature and physical condition of the foundation soil and the type of construction to be executed, calculations of the foundation soil, established through geotechnical drilling, were carried out for different foundation depths and different foundation widths, based on conventional pressures and at the bearing capacity limit state.

The results of the calculus are written in the table 4 (P_{conv}) and 5 (P_{pl} and P_{cr}).

Conventional pressures vary between P_{conv} = 161 kPa, for the foundation depth Df = 0.8 m and the foundation width B = 0.6 m and P_{conv} = 267 kPa pentru Df = 4.0 m şi B = 2.0 m (figure 4 and table 4).

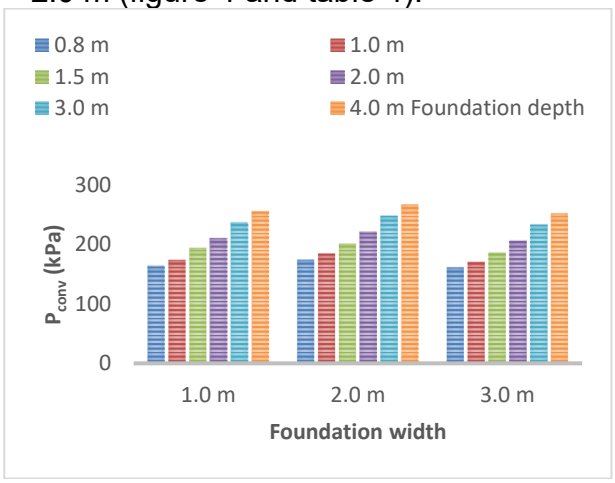

Figure 4. The conventional pressures of calculus (P_{conv})

The admissible pressures at the limit deformation status (fundamental loading) vary between Ppl = 171 kPa for Df = 0.8 m and B = 0.6 m and Ppl = 284 kPa, for the foundation depth Df = 4.0 m and the width of the foundation B = 2.0 m (figure 5 and table 5).

The admissible pressures at the limit status of portent capacity vary from (special loads) vary from Pcr = 225 kPa for the foundation depth Df = 0.8 m and the foundation width B = 0.6 m and Pcr = 407 kPa for Df = 4.0 m and B = 2.0 m (figure 6 and table 5).

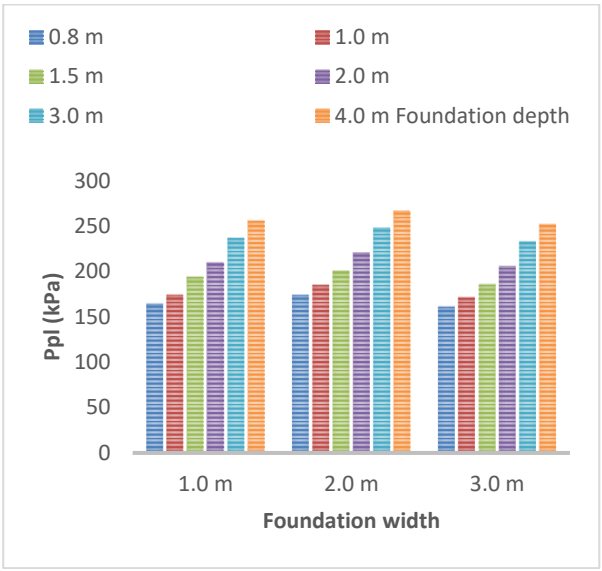

Figure 5. The pressures at the limit deformation status (P_{pl})

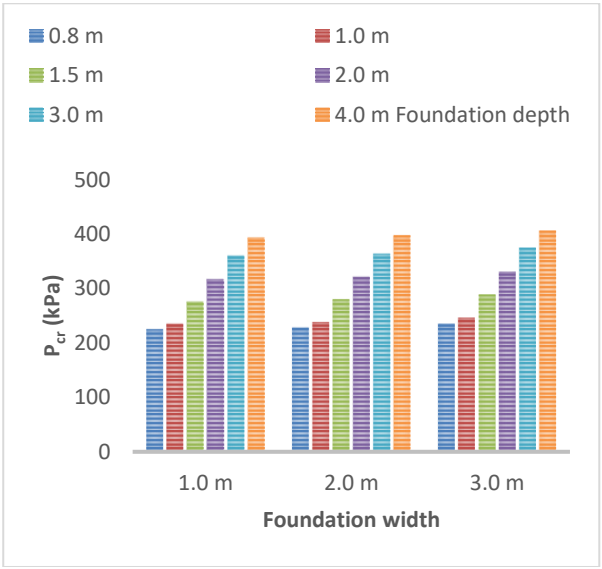

Figure 6. The admissible pressures at the limit status of portent capacity (Pcr)

Construction of the concrete platform

The platform for storing agricultural machinery will be made of lightly reinforced concrete C12/15. Perimeter foundation excavations will be carried out, the reinforcement will be made with STNB mesh with a diameter of 6 at 100x100. A 20 cm thick concrete platform reinforced with two rows of STNB mesh with a diameter of 6 at 100x100 will be poured (figure 7).

Table 2. FG1 drilling geotechnical sheet

Depth	Particle size						Lithological interpretation
	Gravel	Large sand	Middle sand	Fine sand	Dust	Clay	
m	%						
0.25	-	-	-	-	-	-	Vegetal cover
0.25-1.5	0	0	9	14	50	27	Blackish brown clayey dust, strong plastic with high compressibility, moist.
>1.5 (NA= 2.5 m	0	2	7	23	46	22	Brownish to blackish sandy clayey dust, soft plastic with high compressibility, very moist.

Lithological interpretation	Physical characteristics									
	γ_a	γ_s	Wc	Wf	Ip	Ic	W	Sr	n	e
	kN/m^3	kN/m^3	%	%	%	-	%	-	%	-
Vegetal cover	-	-	-	-	-	-	-	-	-	-
Blackish brown clayey dust, strong plastic with high compressibility, moist.	18.8	26.2	40.5	14.4	26.1	0.71	22.0	0.83	38.5	0.63
Brownish to blackish sandy clayey dust, soft plastic with high compressibility, very moist.	19.2	26.2	36.4	13.6	22.8	0.59	23.0	0.89	37.8	0.61

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	-	-	-	-	-	-	-
Blackish brown clayey dust, strong plastic with high compressibility, moist.	11	23	91	0.02	3.09	13	38
Brownish to blackish sandy clayey dust, soft plastic with high compressibility, very moist.	13	22	103	0.02	2.97	14	43

Table 3. FG2 drilling geotechnical sheet

Depth	Particle size						Lithological interpretation
	Gravel	Large sand	Middle sand	Fine sand	Dust	Clay	
m	%						
0.25	-	-	-	-	-	-	Vegetal cover
0.25-1.7	0	4	12	15	47	22	Blackish brown clayey sandy dust, consistent plastic, highly compressible, saturated
>1.7 (NA= 3.1 m	0	5	13	15	53	14	Yellowish brown sandy dust, consistent plastic, highly compressible, very moist

Lithological interpretation	Physical characteristics									
	γ_a	γ_s	Wc	Wf	Ip	Ic	W	Sr	n	e
	kN/m^3	kN/m^3	%	%	%	-	%	-	%	-
Vegetal cover	-	-	-	-	-	-	-	-	-	-

Lithological interpretation	Physical characteristics									
	γ_a	γ_s	Wc	Wf	Ip	Ic	W	Sr	n	e
	kN/m^3	kN/m^3	%	%	%	-	%	-	%	-
Blackish brown clayey sandy dust, consistent plastic, highly compressible, saturated	19	26.2	36.6	13.7	22.9	0.66	21.5	0.82	38.1	0.62
Yellowish brown sandy dust, consistent plastic, highly compressible, very moist	19.4	26.2	31.7	13.5	18.2	0.55	21.7	0.85	37.5	0.60

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	-	-	-	-	-	-	-
Blackish brown clayey sandy dust, consistent plastic, highly compressible, saturated	13	24	98	0.02	3.02	14	41
Yellowish brown sandy dust, consistent plastic, highly compressible, very moist	16	20	110	0.01	2.90	15	46

Table 4. The conventional pressures of calculus (P_{conv}) for different foundation depths and widths (kPa)

Nr. foraj	Foundation depth	The conventional pressures of calculus for different widths of B (m)			The land nature
	(m)	1	2	3	
FG1	0,8	164	174	161	clayey dust to blackish to yellowish brown clayey sandy dust, consistent plastic, highly compressible, moist
	1	174	185	171	clayey dust to blackish to yellowish brown clayey sandy dust, consistent plastic, highly compressible, moist
FG2	1.5	194	201	186	clayey dust to blackish to yellowish brown clayey sandy dust, consistent plastic, highly compressible, moist
	2	210	221	206	sandy dust to blackish to brownish and yellowish clayey sandy dust, soft to firm plastic, with high to medium compressibility, very moist
	3	237	248	233	sandy dust to blackish to brownish and yellowish clayey sandy dust, soft to firm plastic, with high to medium compressibility, very moist
	4	256	267	252	sandy dust to blackish to brownish and yellowish clayey sandy dust, soft to firm plastic, with high to medium compressibility, very moist

Table 5. The pressures at the limit deformation status (P_{pl}) and at the limit of the portant capacity for different widths (B=1; 2; 3 m) of the foundations and to different depths of foundation (0.8-3 m), drills FG1 and FG2

The calculus depth (m)	γ kN/mc	ϕ gr	c kPa	ml	Ppl (kPa)			Pcr (kPa)		
					$P_{pl} = ml\ (\gamma\ xBxNl+(2qe+qi)/3xN2+cxN3)$ $P_{cr} = \gamma\ x\ BxN_\gamma\ x\ \lambda_\gamma + qxN_q\ x\lambda_q + cxNcx\lambda_c$					
					1	2	3	1	2	3
0.8	18.8	12	19	1.5	171	172	175	225	228	235
1	18.6	12	19	1.5	182	183	186	235	238	246
1.5	17.5	13	19	1.4	198	199	202	276	280	289

The calculus depth (m)	γ kN/mc	ϕ gr	c kPa	ml	Ppl (kPa)			Pcr (kPa)		
					$P_{pl} = ml\ (\gamma\ xBxNl+(2qe+qi)/3xN2+cxN3)$ $P_{cr} = \gamma\ x\ BxN_{\gamma}\ x\ \lambda_{\gamma} +qxN_q\ x\lambda_q+cxNcx\lambda_c$					
					1	2	3	1	2	3
2	16.0	14	19	1.4	224	225	228	317	321	330
2.5	14.8	15	19	1.4	250	251	255	360	364	375
4	12.2	15	18	1.4	280	282	284	394	398	407

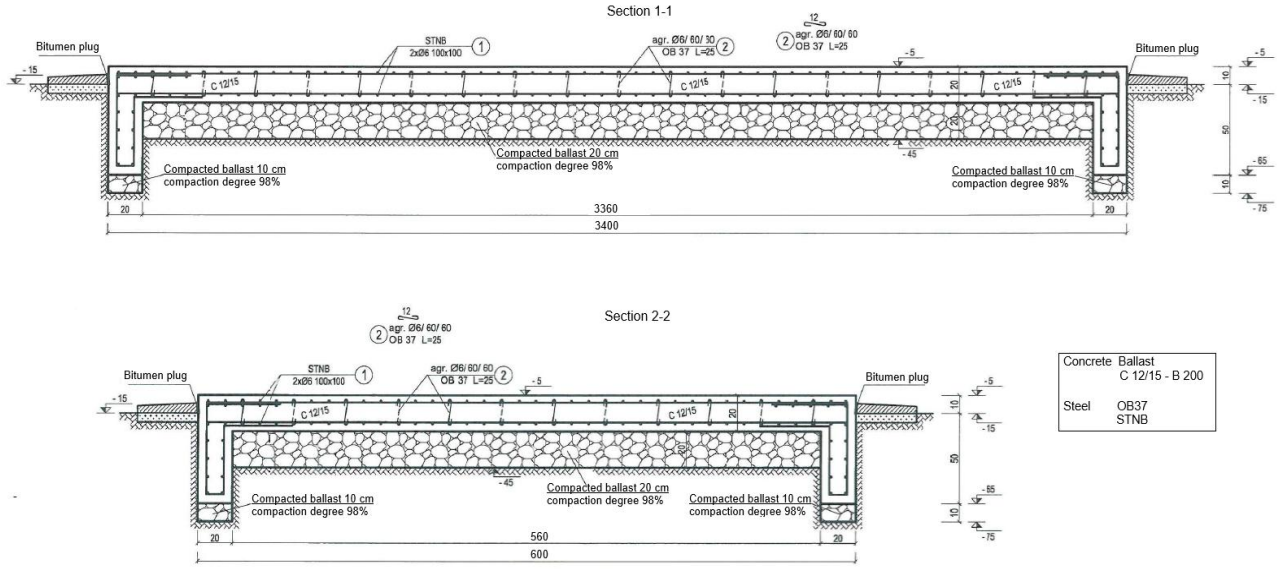

Figure 7. Concrete platform sections

CONCLUSIONS

From a morphological perspective, the site is flat, with slight unevenness that favors water stagnation.

The analyzed soil layer is average to good for foundations and consists of:

- clayey to sandy clayey, blackish to yellowish brown, soft to consistent plastic, with high compressibility, moist on the first 1.5-1.7 m: w=22.0-21.5 %; e=0.62-0.63; γ=18.8-19.0 kN/m^3; M_{2-3}=91-98 daN/cm^2; Ø=11-13^0; c=23-24 kPa
- sandy clayey to sandy, soft to consistent plastic, with high compressibility to medium, very moist from 1.5-1.7 m down: w=21.7-23.0%; e=0.60-0.61; γ=19.2-19.4 kN/m^3; M2-3=98-110 daN/cm^2; Ø=13-16^0; c=20-22 kPa

The aquifer horizon was identified at depths of 2.5 m and 3.1 m, respectively. During heavy rainfall, puddles appear that cause infiltrations in conditions of improper execution of waterproofing and depletion.

Conventional pressures vary between P_{conv} = 161 kPa, for the foundation depth Df = 0.8 m and the foundation width B = 0.6 m and P_{conv} = 267 kPa pentru Df = 4.0 m şi B = 2.0 m (figure 4 and table 4).

The admissible pressures at the limit deformation status (fundamental loading) vary between Ppl = 171 kPa for Df = 0.8 m and B = 0.6 m and Ppl = 284 kPa, for the foundation depth Df = 4.0 m and the width of the foundation B = 2.0 m (figure 5 and table 5).

The admissible pressures at the limit status of portent capacity vary from (special loads) vary from Pcr = 225 kPa for the foundation depth Df = 0.8 m and the foundation width B = 0.6 m and Pcr = 407 kPa for Df = 4.0 m and B = 2.0 m (figure 6 and table 5).

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 = 0.15 g, the corner period Tc=1.0 s, the 7_1 degree (7_1 degree with a period of return of 50 years).
The wind actions classify the location in the zone B (0.40 kN/m^2) și v_{2m} = 24.0 m/s
The snow actions classify the location in the zone C (2.0 kN/m^2)
The site under study is part of second geotechnical category and has a moderate geotechnical risk.
The platform for storing agricultural machinery will be made of lightly reinforced concrete C12/15. Perimeter foundation excavations will be carried out, the reinforcement will be made with STNB mesh with a diameter of 6 at 100x100. A 20 cm thick concrete platform reinforced with two rows of STNB mesh with a diameter of 6 at 100x100 will be poured (figure 7).

ACKNOWLEDGEMENTS

This research work was conducted without external support or funding.

REFERENCES

Brumar D., *2010, Construcţii civile-industriale-agricole. Editura Sitech. Craiova.*

Brumar, D., & Croitoru, A., 2022, *Geotechnical study and calculation of thefoundation land for the location of raising chickens farm*. " Annals of the University of Craiova-Agriculture Montanology Cadastre Series", 52(2), 190-193. https://doi.org/10.52846/aamc.v52i2.1383

Miluț, M., Călina, J., Călina, A., & Bădescu, G.. 2019, *Utilization of total stations in the work of detachment a property*. Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, 48(2), 328-331.

Mihai D., *2000, Construcţii agricole şi amenajări rurale. USAMVB Timişoara.*

Mirel Delia., *2004, Construcţii. Subansambluri constructive. Editura Matrix-Rom. Bucureşti.*

MDRAP, 2014, *NP 074:2014 Normativ privind documentaţiile geotehnice pentru construcţii,* Ministerul Dezvoltării Regionale și Administrației Publice, București, România.

MLPTL, 2002, *GT 035/2002 Ghid privind modul de întocmire și verificare a documentaţiilor geotehnice pentru construcţii*, Ministerul Lucrărilor Publice, Transporturilor și Locuinței, București.

Pham, T. A., 2025, *Climate change impacts on geotechnical infrastructure: role of unsaturated soil mechanics for adaptation*. Frontiers in Built Environment, vol.11, https://doi.org/10.3389/fbuil.2025.1666334

Plătică D., *2004, Elemente generale privind proiectarea fundaţiilor. Editura Matrix-Rom. Bucureşti.*

Popa H., *200, Indrumător de proiectare pentru fundaţii. Editura Matrix-Rom. Bucureşti.*

Şmuleac, A., Mărgelu, C., Paşcalău, R., Mărgelu, N., & Şmuleac, L. I, 2022, *Specific cadastral regulations to obtain construction permit*. Research Journal of Agricultural Science, 54(1). https://www.rjas.ro/paper_detail/3618

Tassinari, P., & Torreggiani, D., 2006, *Location planning: a methodological approach for agro-industrial buildings in rural territory*. Transactions of the ASABE, 49(2), 505-516. DOI: 10.13031/2013.20405