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Laboratory Works on the Examination of the Soil Properties

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***Abstract:** In this work, laboratory engineering - geological examinations of the soil properties were carried out to prepare design documentation for the construction of an apartment building. In order to conduct laboratory research in accordance with the applicable regulatory documents, the following set of engineering and geological works were carried out in the examined area. The indicators obtained as a result of the laboratory research will be one of the important indicators during the design works.*

***Key words:** Laboratory Engineering - Geological Examinations, Design Documentation, Soil Properties, Reconnoitering Examination, Drilling, Soil Sampling, Sounding, Cameral Treatment.*

I. INTRODUCTION

To perform engineering - geological examinations [1] the following work should be carried out:

- collection and examination of the available stock materials [7] on the examined area;
- field work;
- laboratory work;
- cameral treatment of the examined materials [8]

The object of the research is the soil taken for the examining.

The purpose of our work is to conduct laboratory engineering - geological examinations of the soil properties for the preparation of design documentation for the construction of an apartment building at the address: Kirov region, Vyatskopolyansky district, town Krasnaya Polyana, st. Friendship, 1.

The composition and the scope of work will be presented in Table 1.

Table I Composition and scope of work

№	Nameofworks	Unitof measurement	Quantity	Note
Fieldwork				
1	Reconnoiteringexamination	km^2	0,2	Correctedduring work
2	Soilsampling	Sample	20	
Laboratory works				
3	Determination of physical properties of soil	Determ.	20	Correctedduring work
Cameral works				
4	Cameral treatment of the laboratory data	Sample	20	Correctedduring work

II. PROPOSED METHODOLOGY

To accomplish the tasks, a set of semi-laboratory and laboratory tests will be carried out to obtain data recording the state and physical properties of soils, identifying dangerous geological and engineering-geological processes.

Administratively, the site is located in the western part of the urban-type settlement Krasnaya Polyana of the Vyatskopolian district of the Kirov region in a residential building. The city of VyatskiyePolyany, with the same name as the railway station, is located on the Moscow-Yekaterinburg railway. It is a regional center and it is located 18 km from the village Krasnaya Polyana. The distance from the city to the regional center (Kirov) is: 588 kmby railway and 332 km by motorway .Vyatskopoliansky district is located in the southeastern part of the Kirov region and borders: in the northwest with the Malmyzhsky district, north and east with the Republic of Udmurtia; in the south and west with the Republic of Tatarstan.

The location of the area being examined is shown in the diagram of the area of work (Fig. 1).

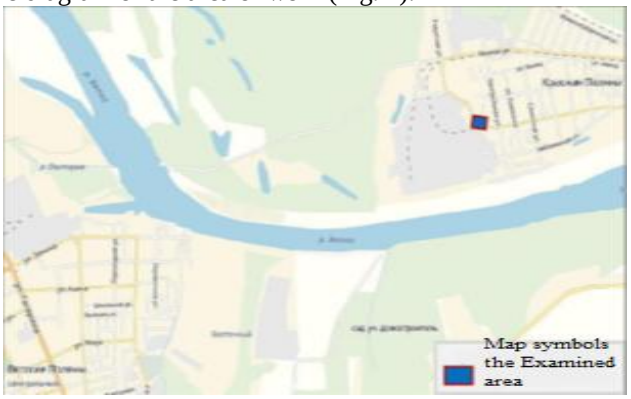

Figure 1 - Location of the area being examined

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The field work was completed in May 2019. The breakdown and planned - high-altitude snapping of wells were done instrumentally.

The catalogue of coordinates and waypoints of engineering and geological workings for the studied object is presented in table 1.

Coordinate system - MSC-43

Baltic altitude system

Table II Catalogue of coordinates and elevations of engineering and geological workings for the object

№ workings	Coordinates		Waypoints м
	X	Y	
Well 1\ тсз.1	320958,45	2286538,29	65,38
Well 2\ тсз.2	320974,30	2286510,86	65,38

The testing of the physical characteristics of soils was performed in the soil laboratory of VyatTISIz LLC in Kirov. In order to conduct laboratory test in accordance with the applicable regulatory documents, the following set of engineering and geological works were carried out in the examined area:

- reconnoitering examination;
- drilling of the wells;
- soil sampling;
- hydrogeologicalexaminations;
- static sounding;
- laboratory works;
- cameral processing.

Reconnoitering examination(engineering-geological) of the area was carried out according to SP 47.13330.2012 [10] and SP 11–105–97 [11] (part I, paragraph 5.4) in order to visually assess the nature of the relief, identify surface manifestations of modern geological and engineering geological processes that can adversely affect the stability of the designed structure, the assessment of possible changes in the geological environment under the influence of the construction and operation of structures.

Well drilling was carried out by a drilling rig PBU 2-312 core drill with a diameter of 198 mm, using a drilling soil carrier. During the field period, 2 wells were drilled with a depth of 8.0 m.

The selection of monoliths and samples, their packaging and transportation were carried out in accordance with GOST 12071-2014. In the process of drilling, a log of geological documentation of wells was kept.

After the completion of work, all workings were eliminated by backfilling them with excavated soil.

Static sounding was carried out in the circuit of the structure near the drilled wells, in order to clarify the geological and lithological section, according to the requirements of GOST 19912-2012 [6] by the mounted attachment of Geotest OJSC (Yekaterinburg) to the PBU-2-312 drilling rig based on the vehicle KAMAZ according to the pressing load method according to GOST 19912-2012. Type of probe was II.

The diameter of the probe base is 35.7 mm, the probe base area is 10 cm², the side surface area is 250 cm². The maximum efforts of the probe indentation as a whole are not less than 10 tons, the probe indentation speed is 1.0 m / min, the type of sounding is without stabilization. Data was recorded through 0.1 m with a TEST-K2M type controller with a maximum scale of 250 divisions.

Table III Statistical processing of the physical characteristics of soils (IGE-2 Super hard (α1 III)

Laboratory number, №	Number of working №	Samplingdepth		Density g / cm3			Naturalmoisturecontent(W)	factorofporosity (e)	watersaturationcoefficient (S_r)	Humidityattheborder		Plasticitynumber (I_p)	liquidityindex(I_L)
		from	till	ofparticles (ρ_s)	Of ground (ρ)	Of dryground(ρ_d)				Fluidity(W_L)	lamination(W_p)		
541	1	1,2	1,4	2,69	1,92	1,66	15,7	0,921	0,68	23,6	17,6	6,0	-0,32
542	1	1,6	1,8	2,69	1,95	1,64	17,8	0,642	0,75	22,6	17,7	4,9	0,02
543	1	2,0	2,2	2,69	1,96	1,64	19,7	0,643	0,82	24,2	19,5	4,7	0,04
544	1	2,4	2,6	2,69	1,92	1,62	18,7	0,663	0,76	24,1	18,6	5,5	0,02
645	1	2,9	3,1	2,69	1,95	1,62	20,1	0,657	0,82	24,6	19,7	4,9	0,08
652	2	0,8	1,0	2,69	1,94	1,67	16,5	0,615	0,72	22,2	16,7	5,5	-0,04
653	2	1,4	1,6	2,69	1,94	1,68	15,6	0,613	0,70	21,1	15,6	5,5	0,00
654	2	2,0	2,2	2,69	1,85	1,59	16,5	0,691	0,63	22,9	16,2	6,7	0,02
655	2	2,6	2,8	2,69	1,88	1,61	17,1	0,676	0,68	23,2	17,4	5,6	-0,05
656	2	3,0	3,2	2,69	1,92	1,60	19,8	0,676	0,79	25,3	20,1	5,2	-0,06
NumberofDefinitions			n	10	10	10	10	10	10	10	10	10	10

Minvalue	x_{min}	2,69	1,85	1,59	1,56	0,603	0,63	21,1	15,6	4,7	-0,32
Max. value	X_{max}	2,69	1,96	1,68	20,1	0,691	0,82	25,3	20,1	6,7	0,08
Normativevalue	X_n	2,66	1,92	1,63	17,7	0,649	0,73	23,4	17,9	5,5	-0,03
Dispersion		0,000	0,001	0,001	3,038	0,001		1,542	2,348		
Meansquaredeviation	S	0,000	0,033	0,029	1,743	0,029		1,242	1,532		
Tovariation	V	0,00	0,02	0,02	0,10	0,05		0,05	0,09		
The value of the coefficient with a confidence probability of α = 0.95	t_α		1,83								
Accuracy indicator of the average value	ρ_o		0,010								
To reliability	Y_g		1,010								
The calculated value of the bearing capacity	X_t		1,90								
The value of the coefficient with a confidence probability of α=0,85	t_α		1,10								
Accuracy indicator of the average value	ρ_o		0,006								
To reliability	Y_g		1,006								
The calculated value of the strain	X_I		1,91								

Laboratory tests were performed to determine the nomenclature and physical characteristics of soils in accordance with:

GOST 5180-2015 "Soils. Laboratory methods for determining physical characteristics"[3];

GOST 30416-2012 "Soils. Laboratory tests. General Provisions"[2];

GOST 25100-2011 "Soils. Classification"[4];

GOST 20522-2012 "Soils. Methods of statistical processing of test results"[5].

Cameral processing. Based on the results of cameral processing of field and laboratory studies, the physic and mechanical properties of soils are determined with their display in text and tabular form.

Statistical processing of test results is performed in accordance with GOST 20522-2012 "Soils. Methods of statistical processing of test results "(table 2,3). To obtain the calculated values for the deformation and bearing capacity, we used the values of the coefficient tα with a one-sided confidence probability α equal to 0.85 and 0.95 with the number of degrees of freedom indicated in Table E.2 GOST 20522-2012 "Methods of statistical processing of test results".

Table IV Statistical processing of the physical characteristics of soils (IGE-3 Soft sandy loam (α2 III).

Laboratory number, №	Number of working №	Samplingdepth from	Samplingdepth till	Density g / cm3 ofparticles (ρ_s)	Density g / cm3 Of ground (ρ)	Density g / cm3 Of dryground(ρ_d)	Naturalmoisturecontent(W)	factorofporosity (e)	watersaturationcoefficient (S_r)	Humidityattheborder Fluidity(W_L)	Humidityattheborder lamination(W_p)	Plasticitynumber (I_p)	liquidityindex(I_L)
646	1	4,0	4,2	2,69	1,99	1,63	21,9	0,648	0,91	24,2	17,9	6,3	0,64
647	1	4,9	5,1	2,69	1,85	1,59	22,4	0,688	0,88	25,3	18,6	6,7	0,57
648	1	6,1	6,6	2,69	1,95	1,59	22,7	0,693	0,88	25,6	20,1	5,5	0,47
649	1	7,6	7,8	2,69	1,97	1,62	22,0	0,666	0,89	25,1	18,3	6,8	0,54
650	1	7,8	8,0	2,69	1,97	1,67	17,9	0,610	0,79	21,7	16,2	5,5	0,31
657	2	4,0	4,2	2,69	1,96	1,61	21,5	0,668	0,87	24,6	24,6	6,5	0,52
658	2	5,2	5,4	2,69	2,01	1,68	19,4	0,601	0,87	22,2	22,2	5,9	0,53
659	2	6,2	6,4	2,69	1,94	1,66	17,2	0,625	0,74	20,8	20,8	5,5	0,35
660	2	7,9	7,5	2,69	2,06	1,74	18,0	0,546	0,89	21,8	21,8	6,7	0,49
661	2	7,8	8,0	2,69	1,95	1,65	18,5	0,635	0,78	22,5	22,5	6,5	0,39
NumberofDefinitions			n	10	10	10	10	10	10	10	10	10	10
Minvalue			x_{min}	2,69	1,94	1,59	17,2	0,546	0,74	20,8	15,1	5,5	0,31
Max. value			X_{max}	2,69	2,06	1,74	22,7	0,693	0,91	25,6	20,1	6,8	0,64
Normativevalue			X_n	2,66	1,98	1,64	20,2	0,638	0,85	23,4	17,2	6,2	0,47
Dispersion				0,000	0,001	0,002	4,616	0,002		3,097	2,683		
Meansquaredeviation			S	0,000	0,037	0,046	2,149	0,045		1,760	1,638		
Tovariation			V	0,00	0,02	0,03	0,11	0,07		0,06	0,10		

The value of the coefficient with a confidence probability of α = 0.95	t_α		1,83								
Accuracy indicator of the average value	ρ_o		0,011								
Toreliability	Y_g		1,011								
The calculated value of the bearing capacity	X_t		1,95								
The value of the coefficient with a confidence probability of α=0,85	t_α		1,10								
Accuracy indicator of the average value	ρ_o		0,006								
Toreliability	Y_g		1,006								
The calculated value of the strain	X_I		1,96								

The standard values of the indicators of mechanical properties according to IGE-2, 3 are taken according to table. B.2.3 adj. B SP 22.13330.2011 [9], the calculations are performed according to the clause 5.3.18, taking into account table 5.11 SP 22.13330.2011.

III. RESULTS

The values of the indicators of physical and mechanical properties of soils are given in table 4 "Summary table of indicators of physical and mechanical properties of soils."

Table V Summary table of indicators of physical and mechanical properties of soils

Nameofindicator		soilunit2	soilunit 3
		sandyclay(α_1 III)	soft sandy loam (α_2 III).
Soildensity	$\rho_н$	1,92	1,98
	ρ_I	1,90	1,95
	ρ_{II}	1,91	1,96
Porosityfactor	e	0,649	0,638
Plasticityindex, %	I_p	5,5	6,2
Liquidityindex	I_L	-0,03	0,47
Specificcohesion(c), кkPa	$C_н$	15	13
	C_I	10	9
	C_{II}	15	13
Angle of internal friction, degrees	$\varphi_н$	27	24
	φ_I	23	21
	φ_{II}	27	24
Moduleofdeformation, MPa	E	16	17
Designresistance, kPa	R_0	263	219
K-ratio	k	1,1	1,1

ρIis the calculated indicator for calculations of bearing capacity (with confidence probability α = 0.95);

ρII is the calculated indicator for calculations by deformation (at a confidence level of α = 0.85);

K - The coefficient adopted when calculating the resistance of the soil of the base, determined by the formula (5.7) SR 22.13330.2011.

IV. CONCLUSION

Thus, we conclude on the basis of laboratory tests.The work site is located in the western part of the urban-type village of Krasnaya Polyana, Vyatskopolian district, Kirov region. Residential and public buildings are located in the immediate vicinity of the examination site. At the time of the examination, the proposed construction site is free from development and is a wasteland. In geomorphological terms, the site of work is confined to the second floodplain terrace of the river Vyatka. The territory of the examionation site has a general decrease in relief in a southerly direction towards r. Vyatka with a slope of 0 ° 30´, the surface of the site is planned (previously a residential building was located on the site). The absolute elevations of the workings on the site vary from 65.38 to 65.53 m.

The upper quaternary alluvial deposits of the first floodplain terrace (a1III) and technogenic formations (t IV) are involved in the geological structure. In the section are highlighted (top to bottom):

Man-made soil (t IV):

Soil Unit-1is a mechanical mixture of loam, sand, in the roof layer with small building debris.

Alluvial deposits (a2III):

Soil Unit-2 is sandy brown, hard sand, plastic interlayers;

Soil Unit-3 is brown, plastic sandy loam.

The groups of soils according to the difficulty of developing a single-bucket excavator according to GESN-81-02-01-2017 [12] (Appendix 1.1) are shown in Table 5.

Table 5

Difficulty groups of soils

IGE Soil name Category Item number

1 Technogenic soil 2 35v

2 Sandy loam, solid 1 36b

3 Soft sandy loam 1 36b

REFERENCES

1. "Urban Planning Code of the Russian Federation" dated December 29, 2004 N 190-FL (as amended on August 2, 2019) (as amended and supplemented, entered into force on August 13, 2019) // "RossiyskayaGazeta", No. 290 12/30/2004
2. GOST 30416-96 Soils. Laboratory tests. General Provisions // Tekhekspert

3. GOST 5180-84 Soils. Methods of laboratory determination of physical characteristics // "Tekhekspert"
4. GOST 25100-2011 “Soils. Classification "// ATP" Tekhekspert "
5. GOST 20522-2012 "Soils. Methods of statistical processing of test results "// "Tekhekspert"
6. "GOST 19912-2012. Interstate standard. Soils. Methods of field tests by static and dynamic sounding ”(entered into force by the Order of Rosstandart dated December 27, 2012 N 2005-ст) (as amended on April 18, 2019) //“Tekhekspert ”
7. "SR 47.13330.2016. Set of rules. Engineering examinations for construction. The main provisions. Updated edition of SNiP 11-02-96 ”(approved and put into effect by the Order of the Ministry of Construction of Russia dated 12.30.2016 N 1033 / pr) // “ Tekhekspert ”
8. "SR 317.1325800.2017. Set of rules. Geodetic engineering examinations for construction. General rules for the production of works ”(approved and put into effect by Order of the Ministry of Construction of Russia dated December 22, 2017 N 1702 / pr) // “Tekhekspert ”
9. “SR 22.13330.2011. Set of rules. Foundations of buildings and structures. Updated version of SNiP 2.02.01-83 * "(approved by Order of the Ministry of Regional Development of the Russian Federation of December 28, 2010 N 823) // " Tekhekspert "
10. “SR 47.13330.2012. Set of rules. Engineering examinations for construction. The main provisions. The updated edition of SNiP 11-02-96 ”(approved by the Order of the Gosstroy of Russia dated 10.12.2012 N 83 / GS) // Tekhekspert
11. "SR 11-105-97. Engineering and geological examinations for construction. Part I. General rules for the performance of work ”(approved by the Letter of the Gosstroy of Russia of 10/14/1997 N 9-4 / 116) // “Tekhekspert ”
12. State itemized cost estimate standards81-02-01-2017. State estimated standards. State estimated norms. State elemental estimated norms for construction and special construction works. Collection 1. Earthwork ”(approved and introduced by Order of the Ministry of Construction of Russia dated 12.30.2016 N 1038 / pr) // “ Tekhekspert ”