

Survey of geological materials for the purpose of reclamation

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Abstract

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Geological and soil materials from a depot for the storage of humus and soil materials on the territory of an airport were studied. Geological and soil materials were collected during the construction of construction sites on the territory of the city of Sofia, and those, deposited at the heap for solid waste – the village of Yana.

As a result of the conducted field studies and obtained analytical results, it was established that the studied soil and geological materials are characterized by the absence of toxic contents of heavy metals and radio-nuclides. It has been proven that the materials are suitable for carrying out technical and biological regeneration. It is recommended to improve the water-physical and bio-reductive qualities of the surface layer by applying mineral, organic fertilizers or suitable substrates.

Keywords: geological material; disturbed land; surface mining; biological regeneration; land reclamation

Introduction

Assessing the suitability for reclamation of geological materials diverse in composition and properties is among the current and significant problems in the field of reclamation of disturbed lands. In a general aspect, the assessment shows the options for arranging the geological materials in the implementation of the technical stage of reclamation.

The selective approach in the construction of reclaimed lands is an opportunity to improve their characteristics and properties and to reduce the cost of reclamation. At the same time, the danger of filling materials with toxic, or unfavorable properties in the surface part of the embankments is avoided. Since this approach is still rarely applied in practice, reclaimed lands are characterized by a highly heterogeneous composition, which makes it difficult to develop and carry out measures to increase their productivity.

The study of the various geological materials has the task of establishing the most suitable substrates in terms of physical and chemical properties, with which the reclamation can be carried out.

Materials and Methods

Geological and soil materials from the following sites were studied:

- Depot for storage of humus and soil materials on the territory of the airport, Sofia.
- Geological and soil materials collected during the construction of construction sites on the territory of the city of Sofia.
- Geological and soil materials deposited on the heap for solid waste – Yana village.
- Samples were taken from the described objects, which were analyzed in terms of the following indicators:
 - ✓ distribution of mechanical fractions (Kachinski, 1958);
 - ✓ content of nutrients for plants – nitrogen, phosphorus and potassium (Bremner, 1965; Urumova, 1974; Ivanov, 1984);
 - ✓ organic matter content (humus) (Ponamaryova & Plotnikova, 1975);

- ✓ medium reaction (pH in water and potassium chloride) (Arinushkina, 1970);
- ✓ total amount of carbonates (Vilenski, 1945);
- ✓ heavy metal content – Cu, Zn, Pb, Cd, Co, Ni и Cr (ISO 114 66: 1995).

The obtained analytical results are indicated in Tables 1, 2 and 3.

Averaged samples from the individual sites were tested against a wide range of radiometric parameters.

Results and Discussion

The studied materials cannot be accurately assigned to certain soil taxonomic units, due to the anthropogenic impact on them and the significant violation of their natural mechanical, physical and chemical properties. The area of distribution is in an intensively developed industrial zone, which requires a comprehensive assessment of their characteristics and properties.

The data presented in Table 1 show that the mechanical composition of the individual studied materials is characterized by varying results, which confirms the fact of a strong anthropogenic impact on them. Four groups of materials are established regarding the distribution of mechanical fractions. The first group is represented by the samples from the Sofia Airport heap, which are distinguished by a physical

clay content in the range of 24.9% to 32.7%, which includes them as light to medium sandy-clay.

The geological and soil materials collected during the construction of construction sites on the territory of the city of Sofia, are grouped into two categories – loose sand, in which the fractions of coarse and fine sand predominate, and the content of physical clay is about 3–4% (samples 5 and 6), and materials characterized by relatively evenly distributed sandy and dusty fractions, in which the physical clay content is about 21% (samples 7 and 8).

The samples of the geological and soil materials deposited at the solid waste heap – Yana village have a highly varying content of physical clay – from 25.2% to 55.2%, which is the result of the different origin and time of deposition.

The results of the agrochemical and chemical analyzes of the samples (Table 2) show that they can be divided into three main groups with the following characteristics:

The soil reaction of the samples from the Sofia Airport depot is weakly alkaline. The content of organic matter (humus) defines the studied materials as poorly stocked. The quantity of the main biogenic elements is unbalanced, as for phosphorus and nitrogen it is in the low level of reserves, and for potassium – in the very good level.

The geological and soil materials collected during the construction of construction sites on the territory of the city of Sofia are distinguished by a pronounced alkaline reaction

Table 1. Distribution of mechanical fractions in % to air dry state in the studied geological and soil materials

№	Sample	Hydroscopic moisture, %	Particle size, mm							
			Sum > 1	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	Sum <0.01
1.	Depot of Sofia Airport	4.02	12.6	20.0	21.4	13.6	12.2	7.5	13.0	32.7
2.	Depot of Sofia Airport	3.08	10.4	17.1	19.6	27.9	5.1	4.7	15.2	25.0
3.	Depot of Sofia Airport	3.53	9.3	18.4	19.2	27.6	5.6	4.9	14.9	25.4
4.	Depot of Sofia Airport	3.98	9.5	18.9	18.9	26.8	6.3	5.1	13.5	24.9
5.	Geological materials – Sofia	1.41	0.5	57.4	34.8	3.9	1.0	1.5	0.9	3.4
6.	Geological materials – Sofia	1.39	0.7	55.3	36.7	3.8	1.2	1.4	1.4	4.0
7.	Geological materials – Sofia	4.43	2.4	20.4	39.2	16.6	12.4	5.0	4.0	21.4
8.	Geological materials – Sofia	3.23	2.0	19.9	40.1	16.1	12.0	5.4	4.3	21.7
9.	Deposited on the heap geological materials	3.12	9.4	18.1	19.6	27.9	5.2	4.9	15.1	25.2
10.	Deposited on the heap geological materials	4.10	22.6	31.0	0.4	13.6	12.5	7.2	12.7	32.4
11.	Deposited on the heap geological materials	3.43	12.5	24.2	0.6	9.5	13.3	9.4	30.5	53.2
12.	Deposited on the heap geological materials	2.51	18.1	39.7	3.3	7.3	11.1	4.3	16.2	31.6
13.	Deposited on the heap geological materials	3.03	8.1	26.5	7.9	12.4	12.9	8.4	23.8	45.1
14.	Deposited on the heap geological materials	3.84	5.8	20.7	5.7	12.6	16.3	7.0	31.9	55.2

and poor organic content. Phosphorus and nitrogen are almost absent, and the potassium content is at the lower limit of the average stock.

The samples of the materials deposited at the solid waste heap – Yana village also have an alkaline reaction. The content of organic matter places them in the category of weak humus. Nitrogen is in a low degree of storage, phosphorus and potassium in good and very good.

The analytical results for the content of heavy metals (Table 3) in the studied soils and geological materials, were evaluated according to the requirements of Ordinance No. 3 on norms for permissible content of harmful substances

in the soil and its supplement. Taking into account that the soil reaction in aqueous suspension of the samples is > 7.00 , the amount of heavy metals is below the accepted limits for maximum permissible concentrations (MPC).

The tests conducted for the content of radionuclides show the absence of toxic amounts of uranium-235, uranium-238, cesium-137, potassium-40, actinium-228, bismuth-214 and lead-214 (Basic Norms for Radiation Protection, 2001).

The conclusions drawn show that the soil and geological materials from all three sites can be used for the purposes of technical reclamation.

Table 2. Agrochemical and chemical indicators of the studied geological and soil materials

№	Sample	pH		N-NH ₄	N-NO ₃	P ₂ O ₅	K ₂ O	Carbonates,%	Humus,%
		H ₂ O	KCL	mg/kg soil		mg/100 g soil			
1.	Depot of Sofia Airport	7.5	6.9	6.99	4.33	4.8	20.6	0.0	1.32
2.	Depot of Sofia Airport	7.4	6.7	5.72	4.21	5.1	21.6	0.0	1.40
3.	Depot of Sofia Airport	7.5	6.8	6.54	5.30	5.5	19.6	0.0	1.27
4.	Depot of Sofia Airport	7.5	6.8	6.20	4.65	5.1	20.6	0.0	1.30
5.	Geological materials – Sofia	8.5	7.5	3.34	1.99	2.4	16.7	0.0	1.17
6.	Geological materials – Sofia	8.4	7.5	3.21	2.25	2.1	15.6	0.0	1.20
7.	Geological materials – Sofia	8.4	7.0	4.33	2.33	1.6	13.3	0.0	0.21
8.	Geological materials – Sofia	8.5	7.3	3.53	2.36	1.1	12.6	0.0	0.19
9.	Geological materials deposited on the heap	7.8	5.9	4.23	3.56	8.5	20.6	0.0	1.58
10.	Geological materials deposited on the heap	8.7	7.3	5.99	4.99	25.3	23.1	0.0	2.16
11.	Geological materials deposited on the heap	8.4	7.0	5.87	2.39	20.3	27.0	0.0	1.72
12.	Geological materials deposited on the heap	7.9	6.1	4.33	3.56	8.5	20.6	0.0	1.54
13.	Geological materials deposited on the heap	8.6	7.2	5.90	4.89	9.2	21.1	0.0	2.16
14.	Geological materials deposited on the heap	7.6	7.0	4.33	1.66	18.9	23.8	0.0	1.32

Table 3. Content of heavy metals in the studied geological and soil materials

№	Sample	Cu, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg	Co, mg/kg	Ni, mg/kg	Cr, mg/kg
1.	Depot of Sofia Airport	19.8	38.0	13.8	<0.50	9.00	14.3	17.8
2.	Depot of Sofia Airport	17.6	36.0	11.3	<0.50	9.20	15.1	16.3
3.	Depot of Sofia Airport	18.9	37.5	12.6	<0.50	8.90	15.3	18.2
4.	Depot of Sofia Airport	19.2	38.1	14.2	<0.50	9.20	16.5	17.6
5.	Geological materials in Sofia	3.50	14.3	<2.00	<0.50	<2.50	4.50	5.50
6.	Geological materials in Sofia	2.60	13.3	<2.00	<0.50	<2.50	3.60	6.10
7.	Geological materials in Sofia	4.30	17.2	<2.00	<0.50	<2.50	4.30	6.20
8.	Geological materials in Sofia	3.40	15.1	<2.00	<0.50	<2.50	4.20	5.60
9.	Deposited on the heap geological materials	43.3	123	61.5	<0.50	19.8	42.0	35.0
10.	Deposited on the heap geological materials	25.5	46.0	7.75	<0.50	8.50	10.0	15.8
11.	Deposited on the heap geological materials	28.9	98.0	8.95	<0.50	9.50	7.50	16.5
12.	Deposited on the heap geological materials	33.1	83.5	7.65	<0.50	8.50	7.50	14.7
13.	Deposited on the heap geological materials	38.7	111	9.15	<0.50	8.00	10.0	15.5
14.	Deposited on the heap geological materials	41.5	105	8.25	<0.50	8.50	9.50	14.5

Conclusion

As a result of the conducted research, the following conclusions can be drawn:

The analyzed soil and geological materials from the depot on the territory of the airport, the city of Sofia, collected during the construction of construction sites on the territory of the city of Sofia and deposited at the solid waste heap – the village of Yana are characterized by the absence of toxic contents of heavy metals and radio-nuclides.

The studied materials are suitable for carrying out technical and biological reclamation of the heap for solid waste – village of Yana subject to compliance with the other requirements specified in the project.

We recommend improving the water-physical and bio-productive qualities of the surface layer by applying mineral, organic fertilizers or suitable substrates.

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