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Geomechanics

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GEOMECHANICAL CHARACTERISTICS OF SMELTING SLAG FROM THE DEPOT IN BOR[**]

Abstract

During the geotechnical research at the RTH flotation tailing dump in Bor, the environment representing the so - called "anthropogenic layers" of smelting slag was singled out in the engineering geological materials of the field. It is a petrified, semi-metallic material, which forms layers in the field or is spread in a loose state. This paper presents the results of geomechanical and chemical tests, as well as the SEM analysis of samples of this material.

Keywords: *smelting slag, geomechanical parameters, rock mass, SEM analysis*

INTRODUCTION

Technogenic copper deposit "Depo sljake 1" - Bor , was created as a "by-product" of one of the phases of the pyro - metallurgical process of copper obtaining. Namely, according to Janković (1960, pp. 331-333), the process of pyrometallurgical processing of sulfide ore and copper concentrate consists of several stages. The first stage is roasting and eventual agglomeration (concentrate). A certain sulfur content is left in the obtained semi-product, which is different, depending on the character of further processing and can vary within wide limits. The second stage is melting, which can be done in a flame or pit (jacket) furnaces. As a result of melting, a copper calcine enriched with copper sulfide is obtained. The content of copper in calcine ranges from 20 to about 80%. Most often, the copper calcine contains 40-50% Cu. Copper calcine has the property of dissolving some precious metals contained in the ore and/or concentrate (gold, silver, platinum group of metals). As the specific mass of copper calcine is significantly higher than the specific mass of slag, their separation during discharge from furnace is facilitated.

SMELTER SLAG

The northwestern edge of the RTH flotation tailing dump in the area of dam 1 rests on the deposited man-made deposits - smelting slag. It is a petrified mass, semi-metallic, of low strength, and occurs in the form of thinner broken layers or in the form of aggregates with fractions the size of coarse gravel.

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Figure 1 *Smelter slag – Core from exploration drill-holes B-5/21 i B-3/21*

In the drill hole B-5/21, a layer of these deposits with a thickness of about 20 m was drilled. It was observed that the core is hollow, pseudo-layered in texture and mostly compact, so this environment can be treated as a rock massif, and the samples taken for geomechanical tests of this environment are treated as the rock material. The following results were obtained:

- bulk weight
  $\gamma = 30.08$ (kN/m^3)
- uniaxial compressive strength
  $\sigma_p = 19.8$ (MPa)
- elasticity module
  $E_{(50)}=19450$ (MPa)
- Poisson coefficient
  $\upsilon = 0.27$.

Smelter slag can also occur in the form of loose coarse-grained material (observed in in drillhole B-3/21 and by mapping the field surface. In this case, the cohesion of this material would be 0, and the angle of natural holding of material, determined by earlier tests, would be $\varphi = 32\text{-}37°$.

The physical and mechanical parameters of this environment, based on the results of sample testing, fund data and direct assessment of the environment state, are:

- bulk weight
  $\gamma = 30$ (kN/m^3)
- angle of internal friction
  $\varphi = 34°$ (for material as rock mass)
  $\varphi = 37°$ (incoherent material)
- cohesion
  $c = 240$ (kN/m^2) (for material as rock mass)
  $c = 0$ (kN/m^2) (incoherent material).

In addition to the physical and mechanical properties of slag, the SEM analysis was also carried out on a sample from depot 1. The results are shown in Figure 2.

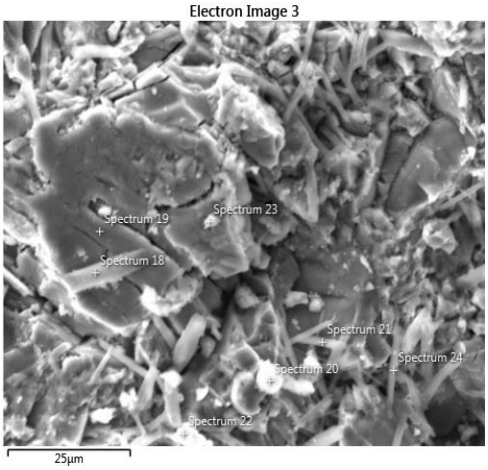

Figure 2 *Analyzed spectra by the SEM-EDS analysis of a slag sample (magnification 1.300×)*

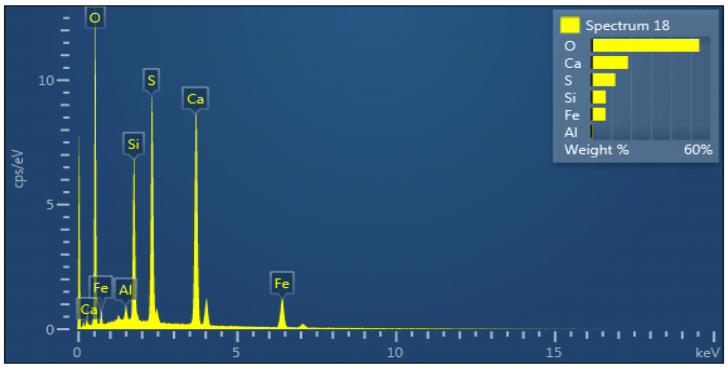

Figure 3 *Results of spectrum analysis for point 18*

Table 3 *Chemical composition of analyzed spectra by the SEM-EDS analysis (sample from Depo 1)*

Spectrum	O	Mg	Al	Si	S	K	Ca	Fe	Cu	Zn	Total %
Spectrum 18	54.48		0.67	7.26	12.03		18.44	7.11			100
Spectrum 19	31.79	0.65	1.59	21.17			17.09	27.71			100
Spectrum 20	39.18			7.39	0.79		2.16	49.32	1.16		100
Spectrum 21	56.90		0.90	9.69	8.03		14.77	9.71			100
Spectrum 22	44.43		2.06	16.28	1.27	0.29	7.71	27.95			100
Spectrum 23	46.63		1.44	14.02	9.24		8.69	14.71		5.27	100
Spectrum 24	49.02		0.42	3.25	16.87		23.26	7.18			100

Test results of the Depo 1 slag sample show the following mineral composition: fayalite, gypsum/anhydrite, pyroxenes, wollastonite, copperite, chalcopyrite, hematite and sphalerite. Fayalite and gypsum/anhydrite are the dominant mineral phases. Pyroxene most likely occurs at the base of sample on which the other mineral phases belong. The results are shown in Figures 2 and 3 and in Table 1.

CONCLUSION

The conducted tests of smelting the slug material yielded the results of geomechanical test of material: bulk density of 30.08 kN/m^3, uniaxial compressive strength of 19.80 MPa, elasticity module 19.45 GPa and Poisson ratio υ = 0.27. Fayalite and gypsum/anhydrite are the dominant mineral phases.

Further laboratory physical-mechanical, chemical and mineralogical tests of this artificial creation will provide more precise parameters needed for its eventual exploitation and possible application in various branches of the economy.

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