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Waste Storage Feasibility of Concentrating Mill in Overburden Dumps

Henry Alexandrovich Kholodjakov and Kaerbek Rafkatovich Argimbaev

National Mineral Resource University "University of mines", Russia,
199106, St. Petersburg, 21 Line V.O., 2,

Abstract: Nowadays the majority of the world's mining companies suffer from challenge of industrial waste disposal, which is the main ecological and economical issue needed to be solved. The main solution of industrial waste disposal is constructing of tailings which are enlarged to project boundaries and destined for industrial waste disposal. This problem can be solved by construction of containers for industrial waste disposal sites in overburden dumps that allow a more rational and integrated use of the occupied lands. The results of studies were conducted in the laboratories of the National University of Mineral Resources, they help to know how to use the overburden dumps which contains industrial waste of concentrators represented by iron tailings.

Key words: Physical and mechanical properties · Ore tailings · Overburden · Compression properties · Experience · Experiment

INTRODUCTION

Operation of mining-and-processing plant has put forward complex problems of industrial waste disposal of overburden and ore tailings. The problem appears due to the lack of tailings capacities, which leads to additional financial investments to take additional measures for enlarging their capacity. When tailings is enlarging specific capital investments in the construction of one cubic meter will be increased up to $ 20 and the prime storage cost of one cubic meter storage will be up to $ 35.

At the same time mining-and-processing plants have significant costs for transportation to overburden dumps and quarries. According to carried out calculations the average extract cost of 1 m^3 overburden at the mining-and-processing plants dump in 2012 amounted to $ 27. and in 2013 was $ 29.

The possibility of concentrator waste disposal in overburden dumps allows mining companies to use their land allotment and to reduce operating and capital costs of overburden dump constructions and disposal of waste. In turn, the overburden dumps should meet the requirements for hydraulic engineering constructions.

MATERIALS AND METHODS

To solve this problem laboratory method of investigation as well as short-term and long-term experiments, analytical calculations, recording results of investigation of the mechanical fracture processes and the interaction of rocks at the low temperature, the study of compression properties tailings in order to detect changes in the porosity and compressibility under pressure were used.

All laboratory tests were performed on modern certified equipments in accordance with established unified European construction standards EUROCODE (EN), the American Society of Testing Materials (ASTM), Russian State Standards and Indian Standard Code.

The Main Body: Investigations have been carried out on the base of the mining-and-processing integrated works, which is one of international supplier of iron concentrate and which is developing the deposit the ferruginous quartzite.

Corresponding Author: Henry Alexandrovich Kholodjakov, National mineral resource university "University of mines", Russia, 199106, St. Petersburg, 21 Line V.O., 2.

Overburden Properties: Overburden rock quarry is composed with rocks and loose rocks (sediments).

Loose rocks are represented by loam, clay, sandy clay, sand and marl limestones. These existing pits have almost been worked out and cannot be used as a building material for the tailings dumps construction of overburden.

Study of physical and mechanical properties of rock overburden was carried out in the laboratories of the National Mineral Resources University (University of Mines).

Rock mass, selected in the quarry, is represented with crystal biotite-chlorite- amphibolic shale with interlayer of carbonaceous quartzite and carbonaceous and amphibole-carbonate with crystalline shale. In the rock mass there is no clay lumps impurities, loam, topsoil and plant residues.

Specification of physical and mechanical properties of the rock mass pits was conducted according to the requirements for building materials of hydraulic constructions [1, 2]. Stability of the structure of the rock mass against decay was determined according to (ASTM) [3, 4]. Plasticity number of grounding products was determined according to the procedures [5, 6]. Frost resistance determination was conducted by accelerated method in sodium sulphite by turn of freezing and thawing in the freezer [7]. Investigation of water-soluble sulfur and sulfuric acid compounds was carried out according to the procedure [4].

As the investigation approved this rock mass of mining-and-processing integrated works contains 0,04-0,16% water-soluble sulfur and sulfur acid compounds. Biotite- chlorite shale with interlayer of barren quartzite contains 0,37% water-soluble compounds. The basic components shale compounds are approximated to the system SiO_2-Fe_2O_3-Al_2O_3. These components amount to 83-86%. It can be found in small quantities of shale CaO (1,1-3,95%), MgO (3,4-5,91%) and calcinations loss is (0,72-7,31%). In all samples sulfur and sulfurous compounds only very small amount of them was found.

The peculiarities of the rock mass compared with granite are the true increased density (2.91-3.22 tons per cubic meter) at its average value (2,88-3,09 tons per cubic meter) and iron content (Få$_2$0$_3$) is 19-46%.

Shale crushed rock porosity is 0,3-3%, water absorption is 0,46 -0,65%, the grain content of platy and needle forms is 4-23%, soft rock is 2,1-5%. There are sort of rocks: strength is 1200, depreciation (attrition) in the Stone Drum is 1, on the impact resistance at shock testing machine is 75, for waterproofing is 1, ductility is 1, frost resistance is 300.

Compression Properties of Tailings: Thickness of tailings, when placed in overburden dumps, for the final period of operation at the lower places reaches 70-80m, which may influence the choice of screening material, as well as lead to the internal structure destruction of the tailings and non developing it in the future. Therefore, the purpose of the compression properties study is to determine compressibility and porosity properties.

Laboratory experiments were carried out at the compressive load of 1 MPa. Totally, compression tests were performed on eight samples tails selected with undamaged structure in standard ring. Test results are presented in Table 1, which shows the data that in two samples the average diameter tails (d$_{CÂ}$) was less than 0.04 and the initial porosity index of the tails ε_0 of the size ranges from 0,848 to 0.970. In tails with more d$_{CÂ}$ is more 0.04mm ε_0 varied from 0,845 to 0,980.

Table 1: Changes in contractibility and porosity factors of tails according to compression tests

	Trial Number							
Item No.	001	002	003	004	005	006	007	008
dcp	0,028	0,037	0,044	0,067	0,116	0,126	0,186	0,22
Compressibility shift								
1	0,028	0,037	0,044	0,067	0,116	0,126	0,190	0,220
2	2,86	2,92	2,89	2,90	3,09	2,94	3,30	2,90
3	1,54	1,69	1,70	1,64	1,80	1,78	1,96	1,61
4	0,857	0,728	0,700	0,768	0,716	0,651	0,683	0,801
5	0,05	0,017	0,18	0,019	0,28	0,20	0,074	5,0
The relative values of the porosity coefficient (ε^*_p)								
6	0,97	0,96	0,98	0,966	0,978	0,968	0,980	0,960
7	0,947	0,948	0,974	0,949	0,965	0,951	0,969	0,945
8	0,911	0,918	0,960	0,911	0,938	0,912	0,943	0,911
9	0,889	0,900	0,947	0,891	0,920	0,889	0,913	0,890
10	0,848	0,863	0,917	0,852	0,887	0,845	0,896	0,849

As a figure characterizing the density tails under load, we find the ratio

$$\varepsilon_p^* = \frac{\varepsilon_p}{\varepsilon_0} \qquad (1)$$

where ε^*_p is the index for tails porosity under load, ε_p- the coefficient of porosity after appropriate load.

The data in the Table 1presents that at constant values ε^*_p remains practically unchanged P. Thus, for the entire investigations of the size tailing and their relative compressibility factor are equal.

Along with the study of the contractibility properties it was determined the angle of repose on the basis of the developed bench, by which the angle of repose for dry iron tailings is equal to 23 degree and for watered it is 7 degrees.

CONCLUSION

The mining rock that is placed in overburden dumps and is resistant to decay the loss of it is 0,1-0,8% by weight, which meets the requirements of hydraulic engineering constructions [2].

Tailings of various sizes have almost the same contractibility; angle of repose is 23 degrees, which creates favorable conditions to place overburden dumps.

Findings: Taken into account the results of the investigations it can be concluded that the rock overburden of this quarry in hydraulic engineering, particularly for the formation of overburden dumps can be used as the capacity for waste disposal in tailings with the perspective view to develop it in the future.

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