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CHANGE THE UNIAXIAL COMPRESSIVE STRENGTH OF PASTE BACKFILL DEPENDING ON CHANGE THE PARAMETERS**

Abstract

Traditional methods of ore mining in the underground mine Jama Bor cannot be applied to the ore body Borska reka for several reasons: the position of the ore body to the terrain surface, mining infrastructure and proximity of settlements, physical-mechanical properties of rocks in the ore body, economic viability, ore recovery, etc. In addition to the above, it should be taken into account that this is the ore body with low copper content, so it is necessary to choose a method for mass excavation. Due to these reasons, the mining method of ore was selected with backfilling of excavation area with paste backfill of certain physical-mechanical properties.

This work will be present the test results of uniaxial compressive strength of paste backfill, as one of the most important properties and how this parameter varies depending on the change in balance of components of which a paste backfill is made. Tests were conducted on a number of different recipes for paste backfills and the backfill with 5% cement, 24% water and 71% uncycloned flotation tailings was selected as the best one.

Keywords: *pasta backfill, flotation tailings, uniaxial compressive strength, ore body Borska reka, mass excavation method*

1 INTRODUCTION

Location of deposits and ore bodies for underground mining in Jama Bor, in relation to the terrain surface, old works in Jama and at the Open Pit in Bor in relation to the mining infrastructure limits the selection of methods for excavation. Previous technologies and methods can no longer be applied. Also, above the deposit, on the surface of terrain, there is a settlement (town Bor), roads, urban and industrial infrastructure, railway with the tunnel, collector for a few surface watercourses, as well as the industrial facilities.

Due to the mentioned reasons, it was necessary to select the method of exploitation that would be appropriate from the other aspects: adapted to the physical-mechanical properties of rocks, to achieve large capacity and productivity with minimum decrease of the ore grade, as well as better economy. The method of ore mining ore with backfilling of space with paste backfill of corresponding physical-mechanical and technological characteristics seems to be well selected method, which would meet all requirements listed above.

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For conditions of making a paste backfill, it is given that the basic raw material for making is flotation tailings and as additives to use the other raw materials of RTB (slag, ash, mine waste) in order to improve the characteristics of paste backfill.

The laboratories of the Mining and Metallurgy Institute Bor have carried out the tests of physical-mechanical properties the samples of paste backfill of different recipes, as well as chemical and granulometric properties of flotation tailings, as its basic component.

The main objective of this test was to find an optimal recipe for the paste backfill, which will meet all essential properties, both in terms of physical-mechanical properties, but also in terms of economy.

The following text will show the changes of uniaxial compressive strength (Uniaxial Compressive Strength, hereinafter referred to as **UCS**) as one of the most important characteristics of the paste backfill.

2 PHYSICAL-MECHANICAL CHARACTERISTICS OF PASTE BACKFILL

In order to meet the basic physical and mechanical properties of paste backfill, and here primarily refers to consistency, compressive strength and load capacity, an appropriate recipe must be found, i.e. the ratio of its main components: **flotation tailings - cement - water**. One of the main requirements was that the uniaxial compressive strength after 28 days must be in the range of 1-1.5 [MPa]. For this purpose, as a starting point, the experienced data from the mines in the world (copper mine Čelopek - Bulgaria, Sweden, Canada, Zimbabwe) were used that already have used the paste backfills in their practice.

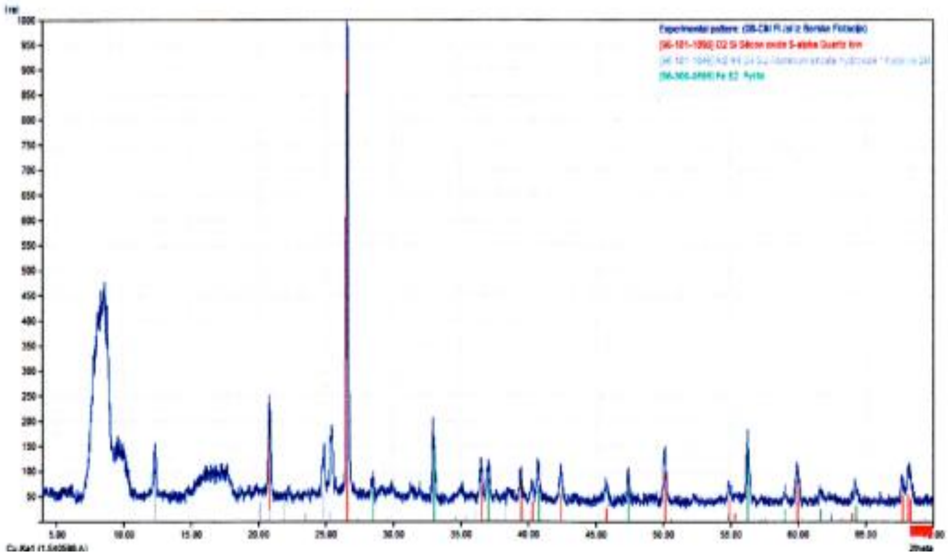
The samples obtained from different recipes were used for carrying out the following physical-mechanical tests:

- Determination the measure of paste consistency by the method of subsidence - Abrams cone,
- Testing the compressive strength of samples after 7, 14, 21, 28 and 90 days,
- Triaxial compression test of samples after 28 (90) days,
- Deformation characteristics of samples after 28 (90) days,
- Determination the cohesion and angle of internal friction of samples after 90 days of shearing test per discontinuity.

The main component of the paste backfill is flotation tailings obtained after ore processing. The original idea was to use the cyclone flotation tailings with the addition of cement and water. After the obtained results of such obtained paste backfill, tests were also carried out with uncycloned flotation tailings.

2.1 Testing the Uniaxial Compressive Strength (UCS) of Paste Backfill with Cycloned Flotation Tailings

The initial idea was to test the properties of paste backfill tailings with ***cycloned*** flotation tailings and cement from the factory "Holcim" - Popovac (cement designation 42,5R). Mineralogical tests and grain size distribution were carried out on it. Report on mineralogical analysis is presented in Figure 1.



Mineral name	Chemical formula	Content (%)
Quartz	SiO_2	46.6
Kaolinite	$Al_2Si_2O_5(OH)_4$	31.2
Pyrite	FeS_2	22.1

Figure 1 *Mineralogical analysis of cycloned flotation tailings*

After these tests, the recipes for obtaining the optimal characteristics of paste backfill were done. Total of 5 recipes were done with different content of cement and cycloned flotation tailings at the ***same water content of 25%,*** Table 1.

Table 1 *Recipes for making the paste backfills at water content of 25%*

Order No.	Amount of cement, %	Amount of cyclone flotation tailings, %
1.	4	71
2.	5	70
3.	6	69
4.	7	68
5.	8	67

USC tests of thus obtained paste backfill showed the following, Figure 2.

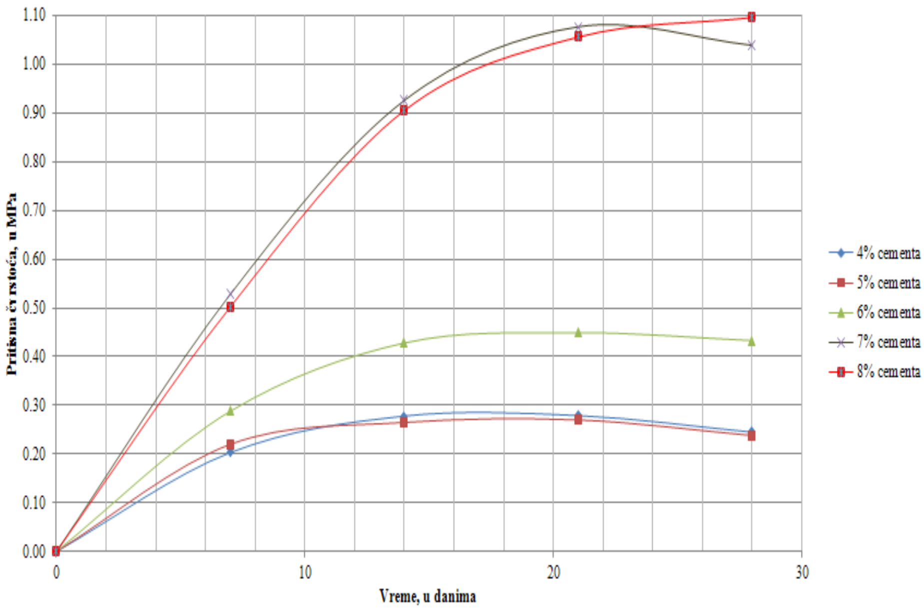


Figure 2 *Cumulative diagram of uniaxial compressive strength of paste backfill for different contents of cement and cycloned tailings and at the same water content of 25%*

Measuring of consistency for the method of subsidence has shown that thus obtained ***material is in the plastic limit.***

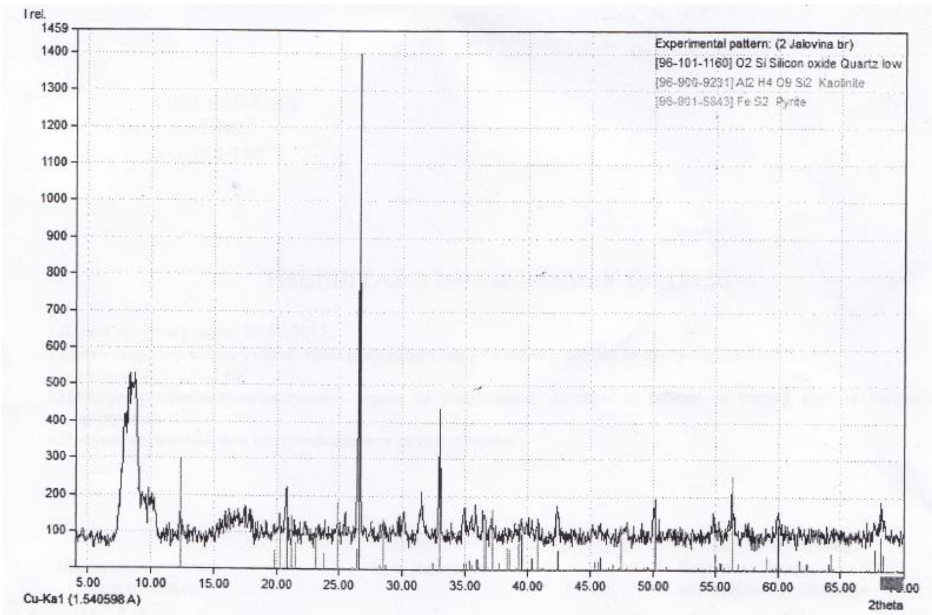
The binding time has shown that thus obtained backfills beginning with the binding after 10 hours.

As you it can be seen from the graph, the basic condition for UCS of 1-1.5 [MPa] is fulfilled by the paste which contain cement of 7 and 8%. However, in terms of economic viability, thus resulting paste backfills do not meet.

For this reason, it is passed on further investigation of paste backfill, which would contain in itself the ***uncycloned flotation tailings*** and small amount of water.

2.2 Testing the Uniaxial Compressive Strength (UCS) of Paste Backfill with Uncycloned Flotation Tailings

After unsatisfactory results obtained using the cycloned flotation tailings, preparing the new recipes was done, which would contain the uncycloned flotation tailings and small amount of water. The quality of cement remained the same as in previous tests. Figure 3 gives a graph mineralogical analysis of uncycloned tailings.



Mineral name	Chemical formula	Content (%)
Quartz	SiO_2	47.1
Kaolinite	$Al_2[Si_4O_{10}](OH)_8$	39.6
Pyrite	FeS_2	13.3

Figure 3 *Mineralogical analysis of uncycloned flotation tailings*

In the first case, 4 recipes were done with different content of cement and flotation tailings, at water content of 20%, Table 2.

Table 2 *Recipes for making the paste backfills at water content of 20%*

Order No.	Amount of cement, %	Amount of uncycloned flotation tailings, %
1.	3	77
2.	5	75
3.	7	73
4.	9	71

USC tests of thus obtained paste back fill showed the following, Figure 4.

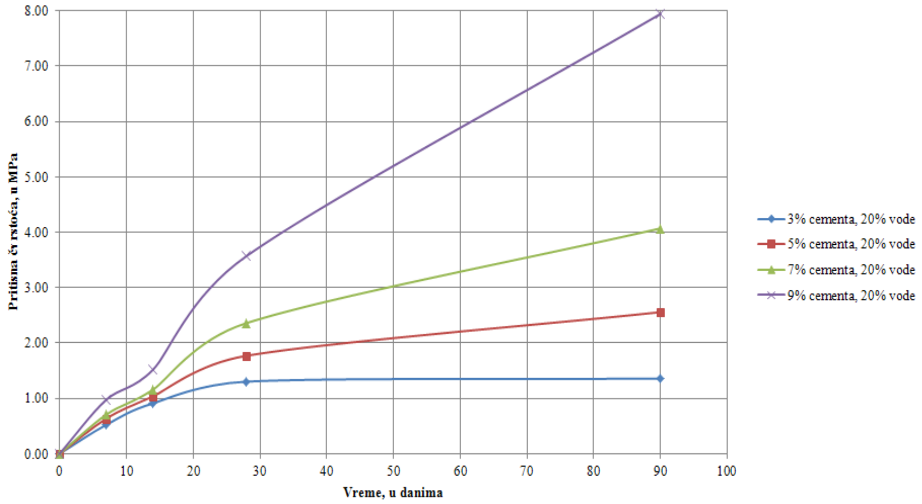


Figure 4 *Cumulative diagram of uniaxial compressive strength of paste backfill for different contents of cement and uncycloned tailings and at the same water content of 20%*

In terms of consistency, thus obtained backfills are quite thick, i.e. they belong to a group of ***poor plastic materials***.

The binding time was also only after 10 hours.

It can be seen from the cumulative graph that the basic condition for UCS of 1-1.5 [MPa] is fulfilled after 28 days even for the paste recipe which contain 3 % of cement.

Although of excellent compressive strengths, thus obtained paste backfills would require far more complex kind of material transportation to the place of installation, which raises the process of backfilling process.

Since it is necessary to achieve fluidity in these backfills, testing the paste backfills has started with the uncycloned tailings, but with a higher percentage of humidity (24%). Content of cement in paste is not changed (3, 5, 7, and 9% of the same quality cement), except the amount of water and uncycloned flotation tailings, Table 3.

Table 3 *Recipes for making the paste backfills at water content of 24%*

Order No.	Amount of cement, %	Amount of uncycloned flotation tailings, %
1.	3	73
2.	5	71
3.	7	69
4.	9	67

USC tests of thus obtained paste back fill showed the following, Figure 5.

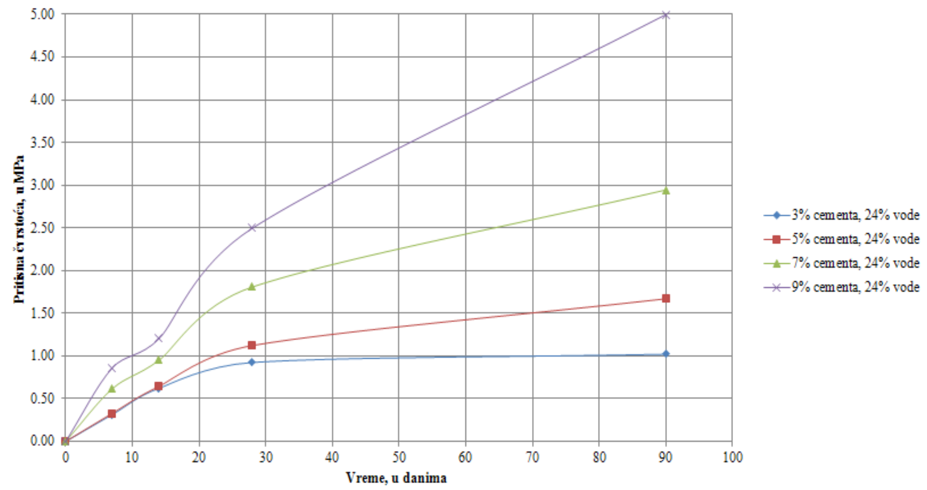


Figure 5 *Cumulative diagram of uniaxial compressive strength of paste backfill for different contents of cement and uncycloned tailings and at the same water content of 24%*

In terms of consistency, thus obtained backfills belong to a group of ***materials with liquid consistency.***

The binding time was also only after 12 hours.

It can be seen from the cumulative graph that the basic condition for UCS of 1-1.5 [MPa], after 28 days, is fulfilled for the paste recipes which contain 3 % of cement. Thus obtained paste backfills, besides the physical - mechanical, also meet the economic parameters.

Comparing the results obtained with cycloned tailings and 25% water and uncycloned tailings and 24% water, a significant difference can be seen considering UCS, Figure 6.

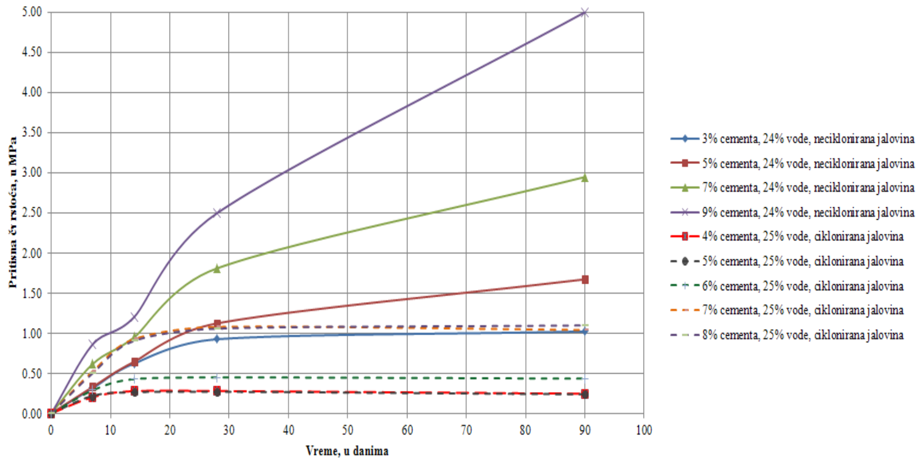


Figure 6 *Comparative analysis of paste backfills obtained from cyclone and uncycloned tailings*

CONCLUSION

Due to numerous difficulties that would occur in the traditional excavation of the ore body Borska reka, it is necessary to select the method of exploitation that would be suitable, both in terms of physical-mechanical properties as well as economically. For this reason, the selected method is the chamber pole method with back filling of excavation area.

Selected method also required a good selection of paste backfills, which must meet the demanding physical-mechanical characteristics of the structural elements in the stopes.

The laboratories of the Mining and Metallurgy Institute Bor have carried out the tests flotation tailings as the basic material for backfilling, but also the paste backfills obtained from different recipes of three basic elements: **flotation tailings – cement – water**.

Based on present tests of compressive strength of paste backfills with cyclone and uncycloned flotation tailings, as well as the other tested physical-mechanical properties, it can be concluded that the paste backfill, made with uncyloned tailings, has far better characteristics than the pate backfill with cyclone tailings. Since at first the opposite would be expected as the grain size distribution of uncycloned tailings is the most unfavorable due to the finest fractions, the test results showed that the thus obtained paste backfills satisfy the expected characteristics.

Due to such obtained good results, should further research should be continued as well as the application possibilities of the thus obtained paste backfill, but also to ttest the properties of paste backfill with additives to improve the quality of concrete.

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