



FLYING ASH TRANSPORTATION FROM PP KOSOVO „B“ OBILIC TO THE HYDRAULIC STOWING STATION BELO BRDO AND PULP PREPARATION

TRANSPORT LEBDEĆEG PEPELA IZ TE KOSOVO „B“ OBILIĆ DO HIDRO - ZASIPNE STANICE BELO BRDO I PRIPREMA PULPE

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Abstract: In this paper, a truck transportation of so called flying ash to the loading station (Thermo electric power plant "Kosovo" Obilić) to the unloading location (Hydraulic stowing station "Belo Brdo") is selected and described. This basic stowing material transportation will be made by trucks- of 20m³ volume, i.e. 25t bearing weight. The pulp preparation process on the hydro-stowing station is described in details and also pulp distribution from hydro-stowing station to the shaft stowing openings.

Key words: Flying ash transportation and stowing pulp preparation

Apstrakt: U radu izabran je i opisan kamionski transport tzv. „Lebdećeg“ pepela od utovarne stanice (TC „Kosovo“ – Obilić) do mesta istovara (Hidro – zasipna stanica „Belo Brdo“). Transport ovog osnovnog zasipnog materijala vršiće se kamionima – cisternama zapremine 20 m³ tj. nosivosti 25 tona. Detaljno je opisan proces pripreme pulpe na hidro – zasipnoj stanici i distribucija pulpe od hidro – zasipne stanice do jamskih zasipnih otkopa.

Ključne reči: Transport lebdećeg pepela i priprema pulpe za zasipanje otkopa

1 INTRODUCTION

The exploitation of lead-zinc ores into the mine Gomile for ore bodies G₁ and G₂ of Belo Brdo mine has started in 1981. The selected exploitation method was horizontal opening upward with filling the opened surfaces with dry stowing.

Considering the fact that this method with dry stowing didn't pass the criteria for technical reasons, the method of downhill mining by solidified stowing was applied. As for the filling process there were used aggregates: cement-armatures-limestone-water, because of the high prices of aggregates, the actual method was not profitable for these stowing conditions. For the

1 UVOD

Eksplotacija olovo–cinkane rude u reviru Gomile za rudna tela G₁ i G₂ rudnika Belo Brdo počela je 1981. godine. Za eksplotaciju je primenjena metoda horizontalnog otkopavanja odozdo na gore sa zapunjavanjem otkopanih prostora suvim zasipom.

Obzirom da ova metoda zasipavanja sa suvim zasipom, iz tehničkih razloga, nije zadovoljila kriterijume zapunjavanja, prešlo se na metodu otkopavanja odozgo na dole primenom očvrslog zasipa. Kako su se za zapunjavanje otkopanih prostora primenjivali agregati: cement – armatura – krečnjak – voda, zbog visokih cena navedenih agregata, postojeća metoda se pokazala kao

achieving of good quality stowing material and transportation means for flying ash to the hydro-stowing station and pulp distribution to the openings we have suggested the following transportation systems:

1. Flying ash transportation from Power plant Kosovo "B" Obilic to the hydro-stowing station Belo Brdo.
2. Milling flotation tailing waste transportation from Leposavic flotation to the hydro stowing station Belo Brdo.
3. Pulp distribution to the opening in "Gomile" ore deposit.

neekonomična za današnje uslove poslovanja. Za dobijanje kvalitetnog zasipnog materijala i način transporta „lebdećeg“ pepela do hidro – zasipne stanice i distribucija pulpe do otkopnih prostora, predložen je sledeći sistem transporta:

1. Transport lebdećeg pepela iz TE Kosovo „B“ Obilić do hidro-zasipne stanice Belo Brdo.
2. Transport mlinške flotacije jalovine od flotacije Leposavić do hidro-zasipne stanice Belo Brdo kao distribucija pulpe do jamskih otkopa u reviru „Gomile“.
3. Transport lebdećeg pepela iz TE Kosovo „B“ do hidro-zasipne stanice Belo Brdo.

2 FLYING ASH TRANSPORTATION FROM PP KOSOVO "B" TO THE HYDRO- STOWING STATION BELO BRDO

Transportation mass balance

Flying ash supply of hydro-stowing station Belo Brdo which will be used for hydro-stowing will be made from Thermo-electric power plant Kosovo "B"

For the annual capacity of 100.000 t of mining ore there are calculated annual, monthly and daily quantities of flying ash for hydro stowing made only by flying ash.

Per year:	16.210 m ³
Per month:	1.351 m ³
Per day:	65 m ³

Transportation conditions analysis

Transportation route description

Flying ash transportation would be made by road transportation by trucks. Transportation route is: PP Kosovo "B"- Leposavic - hydro-stowing station Belo Brdo.

Transportation route length will be 101 km. Transportation will be driven on the asphalt road of 97 km, and 4 km of macadam covered road (Belo Brdo-hydro-stowing station Belo Brdo).

The climate characteristics of the area will have a great impact to the truck transportation dynamics. Flying ash unloading place is on the mountain (Kopaonik mountain) on the altitude

2 TRANSPORT LEBDEĆEG PEPELA IZ TE KOSOVO „B“ DO HIDRO – ZASIPNE STANICE BELO BRDO

Bilans masa koje se transportuje

Snabdevanje hidro – zasipne stanice Belo Brdo tzv. lebdećim pepelom koji će se koristiti za spravljanje hidro-zasipa vršiće se iz TE Kosovo „B“.

Za planirani godišnji kapacitet od 100.000 tona rovne rude proračunate su godišnje, mesečne i dnevne količine lebdećeg pepela za hidro – zasip spravljen samo od istog.

Godišnja potreba	16.210 m ³
Mesečna potreba	.351 m ³
Dnevna potreba	65 m ³

Analiza uslova transportovanja

Opis transportnog puta

Transport lebdećeg pepela vršio bi se drumskim transportom sa kamionima – cisternama. Trasa transportnog puta je: TE Kosovo „B“-Leposavić – hidro-zasipna stanica Belo Brdo.

Dužina transportnog puta je 101 km u jednom pravcu. Transport bi se vršio putem sa asfaltnom podlogom na dužini od 97 km i putem sa makadamskom podlogom u dužini od 4 km (Belo Brdo – hidro-zasipna stanica Belo Brdo).

Na dinamiku kamionskog transporta veliki uticaj će imati klimatske prilike ovog područja. Mesto istovara lebdećeg pepela je na planinskom području (Kopaonik) na nadmorskoj visini

k+1332m with extremely cold and snowy winters (December to April). This is the reason why the number and storage capacity of the silos must be as large as possible.

Type, and capacity of the transportation means selection

Considering the type and transported materials properties, the transportation capacity requested and the transportation route, the kind, type and volume of the transportation means were selected. As the optimal flying ash transportation device there were selected trucks with volume 20 m³ or bearing capacity of 25 t.

Transportation calculation

a) Transportation capacity

Based on daily needs for the hydro-stowing daily needs (65 t) for flying ash needed to be delivered to the hydro-stowing station were determined.

Daily needs of flying ash for hydro-stowing station Belo Brdo can be delivered by three transportation truck tours.

b) Transportation trucks calculation

Based on daily, monthly and annual request for flying ash supply, the number of transportation truck is determined. Daily needs for flying ash supply for the planned daily stowing can be supplied by three truck transportation tours. There will be more than one hour for uploading one truck or 25 tons of flying ash.

When in the Belo Brdo mine hydro-stowing made by mixture of flotation milling tailing waste and flying ash is used, than the daily ash supply (40 m³, ie. 48 t) can be delivered by two truck tours.

3 FLOTATION MILLING TAILING WASTE TRANSPORTATION FROM LEPOSAVIC FLOTATION PLANT TO THE HYDRO-STOWING STATION BELO BRDO

Transportation mass balance

Flotation milling tailing waste for the hydro stowing made by using the mixture of flotation

k+1332 m sa izrazito hladnim i snežnim zimskim godišnjim periodom (XII – IV mesec). Iz ovog razloga, broj i skladišni kapacitet silosa mora biti što veći.

Izbor vrste, tipa i veličine transportnog sredstava

S obzirom na vrstu i osobine materijala koji se transportuje, potreban transportni kapacitet kao i trasu transporta, izabrana je vrsta, tip i veličina transportnog sredstva. Kao optimalno transportno sredstvo za transport lebdećeg pepela izabran je kamion–cisterna 20 m³, nosovosti oko 25 t.

Proračun transporta

a) Kapacitet transporta

Na osnovu dnevnih količinskih potreba za hidro-zasipom određene su dnevne potrebe (65 t) za lebdećim pepelom koje je potrebno kamionski dopremiti na hidro – zasipnu stanicu.

Dnevne količinske potrebe lebdećeg pepela za hidro–zasipnu stanicu Belo Brdo mogu se obezbediti sa tri kamionske transportne ture.

b) Proračun potrebnog broja transportnih kamiona

Na osnovu dnevnih, mesečnih i godišnjih potrebnih količina lebdećeg pepela određen je broj i transportni kapacitet kamiona. Dnevne potrebe lebdećeg pepela za planirane dnevne zasipe, mogu se obezbediti sa tri kamionske transportne ture. Biće potrebno više od jednog sata za utovar jednog kamiona tj. 25 tona lebdećeg pepela.

Kada se u rudniku Belo Brdo bude koristio hidro – zasip spravljen od mešavine mlinske flotacijske jalovine i lebdećeg pepela, dnevna potreba pepela (40 m³ tj. 48 t) se može obezbediti sa dve ture kamiona – cisterne.

3 TRANSPORT MLINSKE FLOTACIJE JALOVINE OD FLOTACIJE LEPOSAVIĆ DO HIDRO – ZASIPNE STANICE BELO BRDO

Bilans mase koje se transportuje

Mlinska flotaciona jalovina za spravljanje hidro – zasipa od mešavine mlinske flotacione jalovine,

milling tailing waste, flying ash, cement and industrial water on hydro-stowing station "Belo Brdo" will be delivered by truck transportation from Leposavic flotation plant. For the planned annual capacity of "Belo Brdo" mine of 100.000t of ore the annual, monthly and daily needs for the flotation tailing waste are calculated:

Per year	11,876 m ³
Per month	990 m ³
Per day	48 m ³

Pulp preparation

The proposal for the second stage of implementation of hydro-stowing by using flying ash in the underground mining on Kosovo and Metohija is made.

The results of flying ash testing are presented from the reports and the activities for the filling of shafts by hydro-stowing are determined. The following activities were conducted:

- Flying ash samples from Kosovo "B" were tested and analyzed
- The parameters of the main system for hydraulic stowing by using flying ash, cement and industrial water were determined
- Hydraulic system of stowing was developed
- The method of hydro-stowing was analyzed in mine
- The next steps in usage of flying ash, cement and industrial water were presented.

Hydraulic stowing unit will be flexible, i.e. made for mixing, distribution and filling of two types of stowing in openings:

1. Hydro-stowing made by mixture of flying ash, cement and industrial water.
2. Hydro-stowing made by mixture of flying ash, flotation milling tailing waste, cement and industrial water.

Hydro-stowing material mixture

For the estimation of the best ratio of technical water and solid material for the technology of hydro-stowing there were made and analyzed the following mixtures with water/solid material ratio:

1 (W_t %); 0,945 (W_t %); 0,7 (W_t %); 0,6 (W_t %); and 0,5 (W_t %).

lebdećeg pepela, cementa i tehničke vode na hidro – zasipnoj stanici „Belo Brdo“ dopremaće se kamionskim transportom iz flotacije Leposavić. Za planirani godišnji kapacitet rudnika Belo Brdo od 100.000 tona rovne rude proračunate su godišnje, mesečne i dnevne potrebe flotacione jalovine za hidro – zasip:

Godišnja potreba	11.876 m ³
Mesečna potreba	990 m ³
Dnevna potreba	48 m ³

Priprema pulpe

Napravljen je predlog za II fazu implementacije hidrozasipavanja uz upotrebu lebdećeg pepela u jamama rudnika na Kosovu i Metohiji.

U izveštaju su predstavljeni rezultati testiranja lebdećeg pepela i date preporuke za aktivnosti zasipavanja jamskih otkopa sa hidrozasipom. Obavljene su sledeće aktivnosti

- Uzorci lebdećeg pepela iz TE Kosovo „B“ su testirani i analizirani
- Određeni su parametri glavnog sistema za hidrauličko zasipavanje sa upotrebom lebdećeg pepela, cementa i tehničke vode
- Razvijen je hidraulički sistem zasipavanja
- Analizirana je metoda hidro-zasipavanja u rudniku
- Preporučeni su sledeći koraci za upotrebu lebdećeg pepela, cementa i tehničke vode

Hidro – zasipno postrojenje biće fleksibilno tj. izgrađeno za spravljanje, distribuciju i ugradnju dve vrste zasipa u jamske otkope:

1. Hidro-zasip spravljen od mešavine lebdećeg pepela, cementa i tehničke vode.
2. Hidro-zasipa spravljen od mešavine lebdećeg pepela mlinske flotacione jalovine, cementa i tehničke vode.

Mešavina hidrozasipnog materijala

Za procenu najboljeg odnosa tehničke vode i čvrstog materijala za tehnološku operaciju hidrozasipavanja, spravljene su i analizirane sledeće mešavine sa odnosom voda/čvrst materijal:

1 (W_t %); 0,954 (W_t %); 0,7 (W_t %); 0,6 (W_t %) i 0,5 (W_t %).

The analyze showed that, for the achieving of appropriate pump capacities the most adequate Water/Solid material is 1 and 0,8 (50W_t % - 55W_t % of solid materials). The mixture with WS ratio of 0,8 shows that there is no water drainage and the best quality of hydro-stowing is achieved.

For the estimation of the compressive direction of hydro-stowing material and bending resistance test after 28 days and 56 days, solidification was accomplished by the W/S ratio of 1,0; 0,9 and 0,8.

The obtained results are presented in Figures 1, 2, and 3.

Analiza je pokazala da je zbog postizanja povoljnog pumpnog kapaciteta najpovoljniji odnos voda/čvrst materijal 1 i 0,8 (50W_t % - 55W_t % čvrstog materijala). Mešanje sa WS odnosom od 0,8 pokazuje da nema drenaže vode i da se postiže najbolji kvalitet hidro-zasipa.

Za procenu kvaliteta kompresivnog pravca hidro-zasipnog materijala i testa na otpornost savijanja posle 28 dana i 56 dana očvršćavanje će biti postignuto sa odnosom vode/čvrst materijal od 1,0; 0,9 i 0,8.

Dobijeni rezultati su prikazani kao dijagrami na slikama 1, 2 i 3.

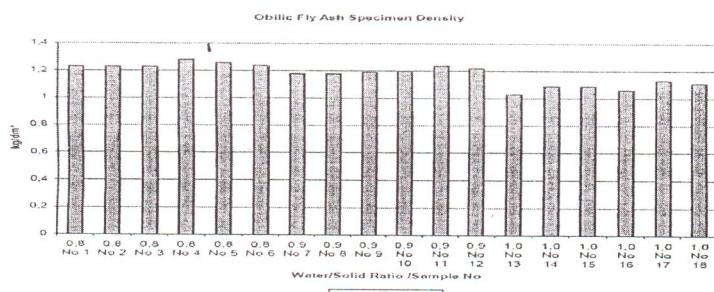


Figure 1 Density after 28 days of solidification
slika 1 Gustina posle 28 dana očvršćavanja

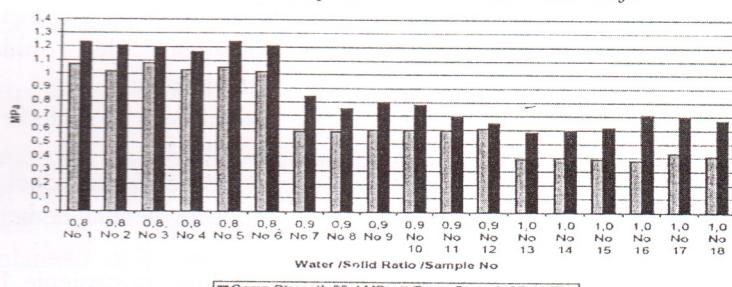


Figure 2 Compressive strength after 28 and 56 days of solidification
Kompresivna otpornost posle 28 i 56 dana ošvršćavanja

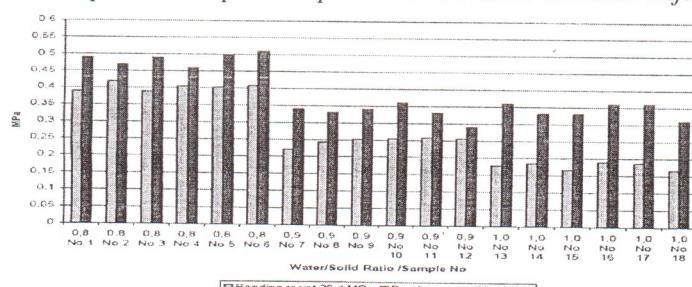


Figure 3. Bending resistance after 28 and 56 days of solidification
Otpornost na savijanje posle 28 i 56 dana ošvršćavanja

The best single axe compressive resistance is about 1MPa after 28 days and about 1,2 MPa after 56 days for the samples with W/S ratio of 0,8.

Najbolja jednoosna kompresivna otpornost je oko 1MPa po sle 28 dana i oko 1,2 MPa posle 56 dana. Za uzorke sa WS – odnosom od 0,8.

Hydro-stowing material mixtures

The mixture with W/S ratio of 0,8 i.e. with 55% of solid material in a pulp has a low water permeability and good pumping abilities and the best strength results at density of 1,2 t/m³.

The experiences related to the usage of flying ash as a hydro-stowing material could be applied for the flying ash from Thermo electric power plant Kosovo "B", although its application is limited. So called flying ash from Thermoelectric power plant Kosovo "B" can be used as a principle in hydro-stowing. Without cement added, it is not recommended for usage as a bonding material.

This characteristic can be improved by adding small quantities of cement, compensating a low content of CaO. Based on the experience with flying ash usage, the addition of 3-5% of cement would improve its properties. The quantity of cement in the pulp is calculated after the tests and analyze with the different percentages.

4 PULP DISTRIBUTION TO THE SHAFT OPENINGS IN THE REVEIRE "GOMILE"

Both types distribution on the transportation route hydro-stowing station- shift horizon will be made through plastic hose with inner diameter of 2,5 inches, situated through drilling hole with diameter of 114mm. The hydro-stowing distribution from the horizon H-1155 to the shifts stowing on the horizon H-1155; H-1105 and H-1055 will be done through the plastic hoses , with working pressure of 4-16 bar.

5 CONCLUSION

The annual, monthly and daily needs for flying ash from Thermo electric power plant Kosovo "B" are calculated and estimated for the planned capacity of ores of 100.000 t per year, and the analyze of the transportation to the hydro-stowing station were made. For the same production capacities the annual, monthly and daily transportation of the flotation milling tailing waste from the Leposavic flotation plant to the hydro-stowing station were calculated and the analysis of pulp preparation was made. The best Industrial water/ solid material (W/S) ratio was determined for the technology process of hydro-stowing.

Mešavine hidro – zasipnog materijala

Mešavina sa odnosom 0,8 WS tj. sa 55% čvrstog materijala u pulpi, ima nisku prospustljivost vode, i ima dobre pumpne sposobnosti kao i najbolje rezultate u smislu postizanja čvrstoće kod gustine 1,2 t/m³.

Iskustva koja se odnose na upotrebu lebdećeg pepela kao hidrozasipnog materijala mogu biti primljena i za lebdeći pepeo iz TE Kosovo "B", mada je njegova upotreba kao hidrozasipnog materijala ograničena. Lebdeći pepeo iz TE Kosovo "B" može se koristiti kao princip u hidrozasipnom zasipavanju. Bez dodataka cementa, nije preporučljivo da se koristi kao vezivni materijal.

Ova osobina se može poboljšati i dodavanjem malih količina cementa koji bi se u lebdećem pepelu nadoknadio slab sadržaj CaO. Na osnovu iskustva sa lebdećim pepelom samo 3–5% cementa bi pomoglo da se poboljša čvrstoća. Potrebna količina cementa u pulpi bi se odredila nakon testova i analiza sa različitim procentualnim učešćem istog.

4 DISTRIBUCIJA PULPE DO JAMSKIH OTKOPOVA U REVIRU „GOMILE“

Distribucija obe vrste na transportnoj relaciji hidro – zasipna stanica – jamski horizont obavlja će se kroz plastično crevo unutrašnjeg prečnika od 2,5 cm koje je postavljeno kroz bušotinu čiji je prečnik 114 mm. Distribucija hidro – zasipa od horizonta N-1155 do jamskih zasipnih otkopa na horizontima N-1155; H-1105 i N-1055 vršiće se kroz plastična creva čiji je radni pritisak 4–16 bara.

5 ZAKLJUČAK

Na planiran godišnji kapacitet od 100.000 tona rovne rude proračunate su godišnje, mesečne i dnevne potrebe lebdećeg pepela iz TE Kosovo "B", i izvršena je analiza transporta do hidro – zasipne stanice. Za istu proizvodnju izračunate su godišnje, mesečne i dnevne potrebe transporta mlnske flotacione jalovine sa flotacije Leposavić do hidro – zasipne stanice i ujedno data je analiza pripreme pulpe. Dat je najbolji odnos tehničke vode i čvrstog materijala (WS odnos) za tehnološku operaciju hidro – zasipavanja.

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