5th International Symposium

MINING AND ENVIRONMENTAL PROTECTION

10 - 13 June 2015., Vrdnik, Serbia

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PROCEEDINGS

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REGULATION OF SASKA RIVER WITH AIM FOR ENVIRONMETAL PROTECTION AT N°.4 FLOTATION TAILING DAM CONSTRUCTION IN THE SASA MINE

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Abstract: *In the paper will be presented the regulation of the Saska river flow by construction of diversion tunnel on the N°.4 Flotation tailing dam and its location in the surrounding rocks. Considering the negative experiences in the regulation of the river flow with gallery tunnel which was made beneath the former flotation tailing dams, management team of the Sasa mine decided to secure technical solution in terms of environmental protection.*

Keywords: *Saska River, Diversion Tunnel, Flotation Tailing Dam.*

1. INTRODUCTION

1.1 Geographical location of the "Sasa" mine

Mine "Sasa" for production of lead and zinc concentrates is located in the north-eastern part of R.Macedonia, in the central part of the Osogovo mountain range (Fig.1). Permission for exploitation of mineral deposit was given to mining company Sasa LLC - Makedonska Kamenica.

Mine "Sasa" territorially belongs to the Municipality Makedonska Kamenica, close to the village Sasa, and to the north-east "Sasa" mine extends near to the Macedonian-Bulgarian border. Administrative building of "Sasa" mine is located at the mine, where also are located the plant for processing the minerals and other working plants.

The main road of "Sasa" mine - M. Kamenica is with length of about 12 km, which connects the mine to the regional road Delchevo – Kochani. In the Municipality of Kochani which is away of "Sasa" mine for 38 km is situated the nearest railway station.

Figure 1 *Location of the "Sasa" mine in Republic of Macedonia*

Ore field "Sasa" consists of three ore deposits: "Svinja River, "Kozja River" and "Golema River" with height from 750 to 1,700 meters, width from 2,000 m, and length to approximately 10.000 m. Currently the active exploitation is in the ore deposit of "Svinja River".

1.2 Environmental description in the wider area of the "Sasa" mine

The relief of the wider area of the "Sasa" mine is mostly mountainous, and because of that, this area is sparsely populated. Surrounding of the mine is rich in forests, especially with beech forest.

Municipality of Makedonska Kamenica covers an area of 190.37 km^2. Within this Municipality there are 9 settlements, city of Makedonska Kamenica and the villages: Dulica, Kosevica, Kostin Dol, Lukovica, Moshtica, Sasa, Todorovci and Cera. According to the statistical data of the R.Macedonia for 2005, this Municipality has 8,110 people. In the village of Sasa, which is located near the mine live 876 inhabitants.
The area of the mine and the immediate surroundings are very rich with water. The river Saska and the other rivers: Svinja river, Kozja river and Crvena river that originate from the site of ore deposit and flow into Saska river, which further flows into Kamenichka river, throughout the whole year are rich with water.

South of town Makedonska Kamenica, the Kamenichka River flows into the river Bregalnica which flows in the artificial lake for irrigation "Kalimanci" with a capacity of 127 million m^3 stored water.

1.3 Description of "Sasa" mine as an industrial facility

The development path of "Sasa" mine started from 1954 when it was first made elaborate for calculation of geological ore reserves in the region of Osogovo mountain range. Active mine production began in 1964. The maximum production of ore for the period when the mine was in public ownership accounted for 625,000 t / year.

In the year 2006 the "Sasa" mine was bought by a Russian company, which restarted the production of lead and zinc ore. The new ownership made a long term plan for production of ore for the period 2013-2024, in which the maximum output is limited to 750,000 t/y. The exploitation of the ore deposit in "Sasa" mine is done by sublevel caving method.

The system for processing the raw minerals, designed for processing 900 000 tonnes of dry ore uses method of flotation concentration. The end products of this technological process is lead and zinc concentrate and flotation waste slag.

The waste flotation slag goes in the tailing dam (Fig.2, Fig.3), which is located near the mine in the riverbed of Saska river.

Figure 2 *Disposal of slag flotation - Tailing dam No.3/2*

For the disposal of the slag flotation, in the next ten years is planned building new Tailing dam No.4. The amount of waste flotation slag which is predicted to be placed in Tailing dam No.4 between years 2018 to 2024 is 3.471.300 t or 1.950.168 m^3 of flotation slag.

The location of tailing dams in the "Sasa" mine and Saska river is shown in Fig.3.

Figure 3 *Location of tailing dams and Saska River*

2. HARMFUL IMPACTS ON THE ENVIRONMENT AS A RESPONSE TO INADEQUATE TECHNICAL SOLUTIONS IN REGULATING SASKA RIVER

Construction of tailing dams 1; 2; 3/1 and 3/2 in the riverbed of Saska river get regulation of the water flow solved with a technical solution for the construction of hydro-technical tunnel located mostly beneath drainage sand (tailing dams 1 and 2) and in sediment lake section that passes through tailing dams No. 3/1 and 3/2. In those sections the hydro-technical tunnel is made according the gallery method, where first there is cementing of the section and then it is covered with waste slag flotation, Fig.4.

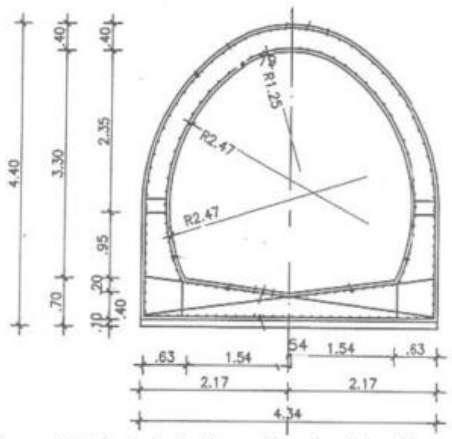

Figure 4 *Hydro-technical tunnel made with gallery method*

In 2003 on August 30th, in heavy rain, there was a blockage at the entrance of the collector 6, which should accept stormwater from the right side of the tailing dam and bring them in the diversion tunnel of Saska river.

The tailing dam was built on higher elevation than previously planned, which filled with water and flooded with additional water layer with a height of about 1 meter. This additional weigh exceeded the load capacity of the cover plate wich collapses and caused waste slag flotation of 150,000 m^3 to leak through the tunnel. Waste slag flotation flowed in to the Saska river, reaching artificial lake accumulation Kalimanci. After this in the tailing dam was formed gap in shape like crater with diameter greater than 100 m, Fig.5, [3].

The amount of waste slag flotation which flowed by this diversion tunnel, caused enormous environmental pollution along the Saska river while polluting the surface waters, soil and underground waters. To fix this disaster, the Government of R.Macedonia has taken range of activities including:

- Fixing the diversion tunnel of Saska river
- Returning of the waste slag flotation in the tailing dam
- Making a protective dam to protect from possible breaking of the tailing dam

Figure 5 *Gap in shape like crater in tailing dam No.3/1, formed as a result of leakage of waste slag flotation through diversion tunnel*

3. TECHNICAL SOLUTION FOR REGULATING SASKA RIVER WITH BUILDING DIVERSION TUNNE IN SURROUNDING ROCK MASSES

Taking into account the negative experience with previous disaster, management of "Sasa" mine in building the next tailing dam No.4, decided the regulating of Saska river to be perform in such a way so the diversion tunnel be located in the surrounding rock masses (Fig.6).

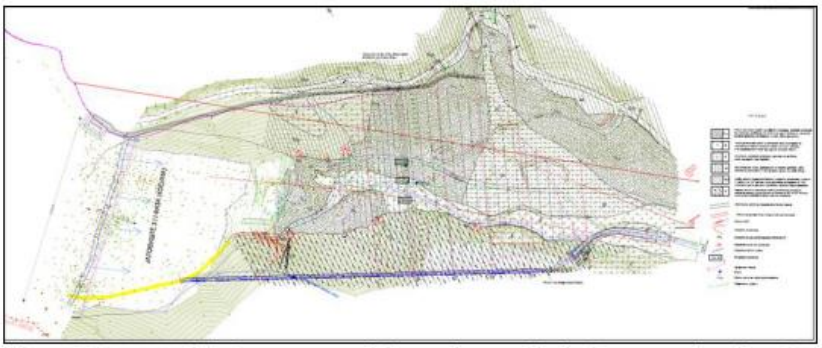

Figure 6 *Location of the diversion tunnel for regulation of Saska River in tailing dam No.4*

It is planned the diversion tunnel in the right block of the valley to be connected to the existing tunnel, and the location of its output construction is planned in the area downstream of the tailing dam No.4 [2]. The tunnel has a total length of 540 m, and its length is not exposed to the same loads because of various geotechnical conditions in the surrounding rock masses. Therefore, for several specific sections is performed structural analysis in PLAXIS software based on method for finite elements, which provides a simple display of loads and deformed conditions of the surrounding rock masses.

The route of the tunnel is mostly located in the gneisses, which according the geomechanical classification of Bienavski is located in category III of the working environment.

The hydro-technical tunnel has horseshoe shaped cross section with surface of P_{is}=18 m^2, (Fig.7). The primary constraction layer of the tunnel will be consist of sprayed concrete, anchor bolts and steel mesh, while secondary constraction layer is reinforced concrete, (Fig.8).

For building the diversion tunnel will be used drilling and blasting technology using electro-hydraulically drilling mechanisation [1]. For the transport of the excavated material will be used diesel-powered machine with a shovel capacity of 2,7 m^3. The total amount for one blasting will be 100 kg of explosives, and the advance is around 2,4 m/day.

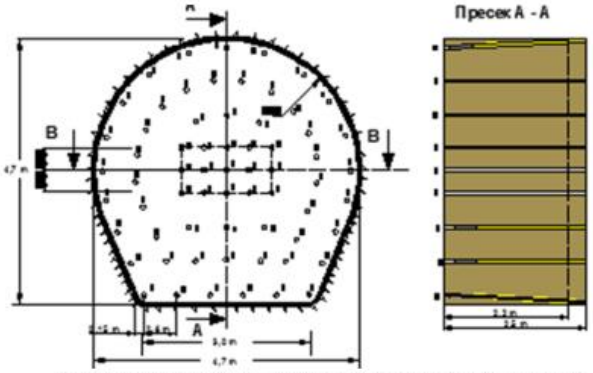

Figure 7 *Blasthole pattern in making the diversion tunnel*

The final concrete lining is planned to be performed with pumped concrete MB-30, which satisfies the criteria according to PBAB standard.

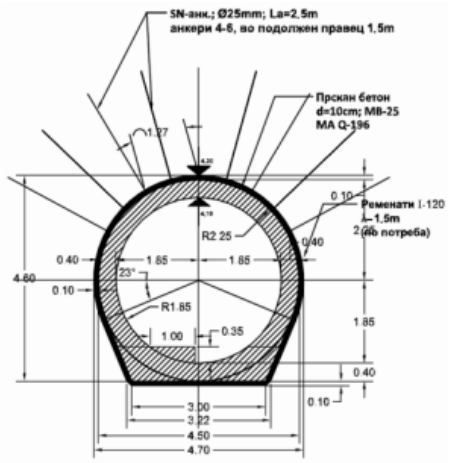

Figure 8 *Final concrete lining of diversion tunnel*

The total time to complete the preparation of the diversion tunnel is estimated to be 700 days (1.9 years), working in 3 shifts. Construction work will be done by special unit of "Sasa" mine. The total investment for the construction of the diversion tunnel of Saska river are estimated to be 2.423.720 €, with cost of 4.661 €/ m '.

4. CONCLUSION

Based on the text above can be concluded that the construction of hydro-technical diversion tunnel, surrounded with rock masses to regulate the flow of Saska river as one of the stages for the construction of new tailing dam No.4 is good technical solution. Although this technical solution requires certain capital investments but protecting the environment is invaluable and it should always be at first plan.

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