The 55th International October Conference on Mining and Metallurgy
15 - 17 October 2024, Kladovo, Serbia
https://ioc.irmbor.co.rs

DOI: 10.5937/IOC24401M Original Scientific Paper-Environmental Protection

REHABILITATION AND REINFORCEMENT THE OUTER SLOPE OF THE DAM 6

Sandra Milutinović[1a], Ljubiša Obradović[1b], Goran Angelov[1c], Srđana Magdalinović[1d], Sanja Petrović[1e]

[1]Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia

[1a] sandra.milutinovic@irmbor.co.rs, https://orcid.org/0000-0003-0146-8636;
[1b] obradovicljubisa@gmail.com, https://orcid.org/0000-0002-6715-4173;
[1d] srdjana.magdalinovic@irmbor.co.rs, https://orcid.org/0000-0002-2916-2850;
[1e] sanja.bugarinovic@irmbor.co.rs, https://orcid.org/0000-0001-5197-1614

Abstract

As a result of a wide front of filtered water through the outer slope of embankment at the tailing dump Valja Fundata, the dam became unstable in the Sector 6. The embankment no. 6 is almost along its entire length of about 1300 m, built with hydrocyclone sand to a designed level height of K+541 m with a design crown level width of 10 m, even more than that. In addition to the seepage of water, the sand suffusion from the embankment body appears in several places, where smaller or larger ravines are created due to the suffusion. This paper provides a solution to this problem.

Keywords: *tailing dump, stability, rehabilitation, reinforcement, geogrid*

1. INTRODUCTION

The "Valja Fundata" tailing dump has been in a continuous exploitation since 1961 and presents the main tailing dump in Majdanpek.

This tailing dump was formed in the valley of the "Valja Fundata" stream, which starts right in front of the Coppe r Flotation Plant in Majdanpek and extends in the south direction for about 1300 m, where two new branches flow into it. At a distance of about 1800 m, this valley changes its direction to the west, where it joins another larger branch. Then, at about 2400 m from the Flotation Plant, this valley widens considerably and joins a new branch, which eventually ends with a rocky limestone barrier.[1]

One of the infrastructural facilities on the Valja Fundata tailing dump, next to the Kaluđerica pumping station, is the Dam 6, which is in a very bad condition (Figure1). In order to enable the further elevation of the flotation tailing dump and its exploitation in safe and stable conditions up to the designed elevation of K+545 m above sea level, since the stability coefficients in the part of the tailing dump next to the pump station Kaluđerica are below the minimum due to the wide seepage front through the outer slope of the embankment, its rapid rehabilitation is necessary.

Figure 1. *Discharge of material from the dam body in the seepage front zone on the outer slope of embankment in the Sector no. 6, Valja Fundata flotation tailing dump*

2. REHABILITATION OF THE DAM 6

The terrain on which this flotation tailing dump is located was the subject of geotechnical and hydrogeological research, when the goal of research was to provide the new geotechnical and hydrogeological foundations for the entire area, covered by the tailing dump and its surroundings. [2]. Comparing the obtained values of the safety coefficients of the flotation tailing dam with the permitted minimum values, prescribed by the technical conditions for the design of embanked dams and hydrotechnical embankments - SRPS U.C5.020, which for the embanked dams over 15 m in height is a minimum of Fs = 1.50 in the case of constant static loading , i.e., Fs = 1.00 in the case of occasional dynamic load for the earthquake occurrence, it can be concluded that, according to the analytical profile 6 - 6', the values of safety coefficients for the static and dynamic loads are below the minimum prescribed value. Also, the results of performed geotechnical and hydrogeological research showed that the future expansion of the flotation tailing dump in the Sector no. 6 will engage terrain with the complex structures and unfavorable geotechnical and hydrogeological properties.[1]

As the entire outer slope of the Dam 6 is very waterlogged with a layer of deposited tailings about twenty meters thick, the movement of people on such terrain is not possible due to the deterioration meaning that the movement of construction machinery and trucks weighing 40 tons or more is not possible.

In order to stabilize the terrain surface and enable the movement of construction machinery, it is proposed to stabilize the terrain surface with the geocomposite networks, which are widely used in Serbia, mainly for the swampy terrain stabilization during the construction of highways, railways, increasing the terrain bearing capacity for construction the various construction facilities, etc.

2.1 Surface Stabilization on the Outer Slope of the Dam 6

For rehabilitation the embankment in the Sector no. 6 for stabilization the watery part of the embankment outer slope and formation the stone ballast, a geogrid network was procured, in order to determine on the ground on the test section its usability for rehabilitation the watery areas. The geogrid network was installed by the workers on the tailing dump, according to the instructions of the network manufacturer, in a small part of the Sector 6, in order to stabilize the field surface, where due to the needs of rehabilitation of this sector, it is necessary to introduce the construction machinery (Figure 2).

Figure 2. *Laying of the geogrid membrane*

Figure 3 presents the examples of use a securgrid (geogrid with double-sided geotextile) on highways throughout Serbia [3].

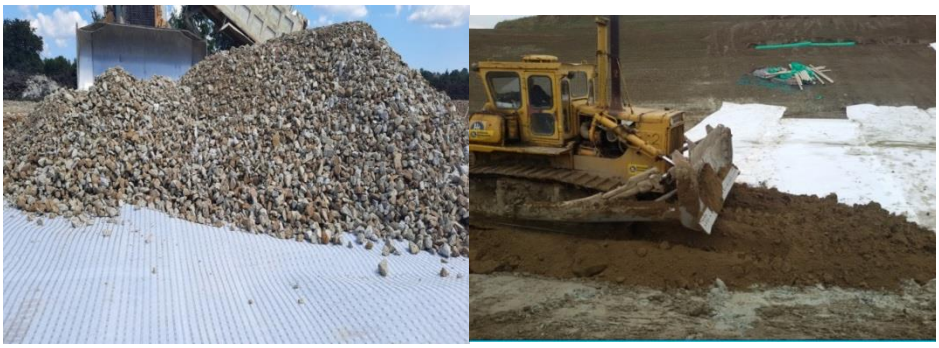

Figure 3. *Laying of granulate over a securgrid, the Miloš Veliki Highway and Kolubara River bed [3]*

2.2 Embankment Rehabilitation in the Sector 6

The solution for embankment rehabilitation in the Sector no. 6 is shown in Figure 4, where a cross-section of the rehabilitated slope of embankment with individual layers of embedded material can be seen.

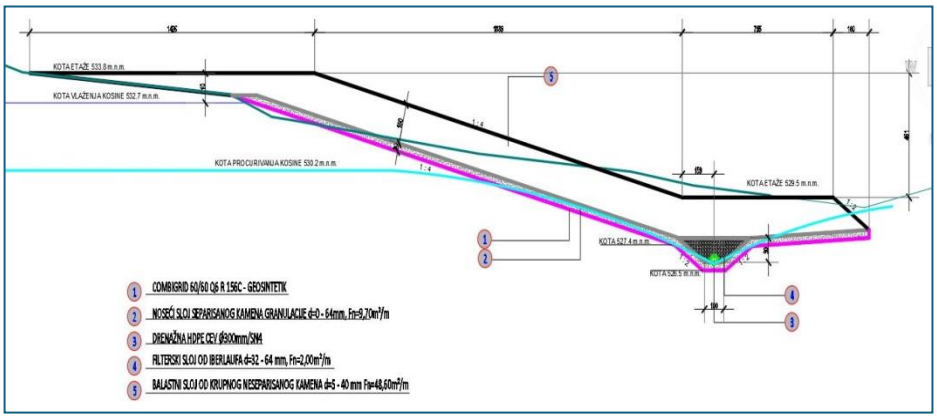

Figure 4. *Cross-section of the rehabilitated embankment slope with individual layers of embedded material*

The solution for embankment rehabilitation in the Sector no. 6 consists of:

- Placement of the first layer for stabilization the terrain surface consisting of a securgrid geosynthetic network, with openings measuring 60x60, covered with geotextile on both sides. This geosynthetic network should also be resistant to the acidic seepage that occurs on the tailing dump on embankments that are ten or more years old.
- The second layer is a bearing layer of separated stone with granulation of 0-64 mm, which is placed over the geosynthetic network in a layer of 30-50 cm thickness. The layer thickness will be determined exactly on a test section of 50 m length on the endangered part of embankment no. 6 and will also depend on the used construction machinery as well as trucks for transporting the crushed stone and stone for making ballast, which will be in use on the field.
- A thicker layer of several meters is placed over the bearing layer. This layer is marked with the number 5 in a drawing, and it represents a ballast layer of coarse stone with a diameter of 5cm - 40cm.
- Points 3 and 4 in a drawing show a drainage channel in which a geosynthetic network is placed on the bottom, over which a drainage HDPE pipe with a diameter of 300 mm/SN4 is placed on the bottom, which is covered with a filter layer of iberlauf, granulation 32-64 mm.
- Due to a large length of drainage channel, a drop of canal of 0.5% (minimum 0.3%) with two sections, upstream and downstream, is foreseen. The upstream section starts almost from the junction of the Dam 1 and embankment no. 6, with the point of pouring the collected drainage water near the road via a concrete channel. The downstream section of drainage canal starts from the road over the

canal and ends not far from the sinkholes, with the place where the drainage water flows into the canal 20-30 m upstream from the sinkholes.

3. CONCLUSION

The stability check after the designed rehabilitation works was performed for the same profile 6-6' for identical water level in the piezometers on this profile, as well as the same geotechnical parameters. Figure 5 shows the obtained static and dynamic stability coefficients. Both obtained stability coefficients are above the legally prescribed values. Based on this, it can be concluded that this rehabilitation solution brings the downstream slope of the dam to a stable state and gives the possibility to think about overhanging the Valja Fundata 8 tailing dump.

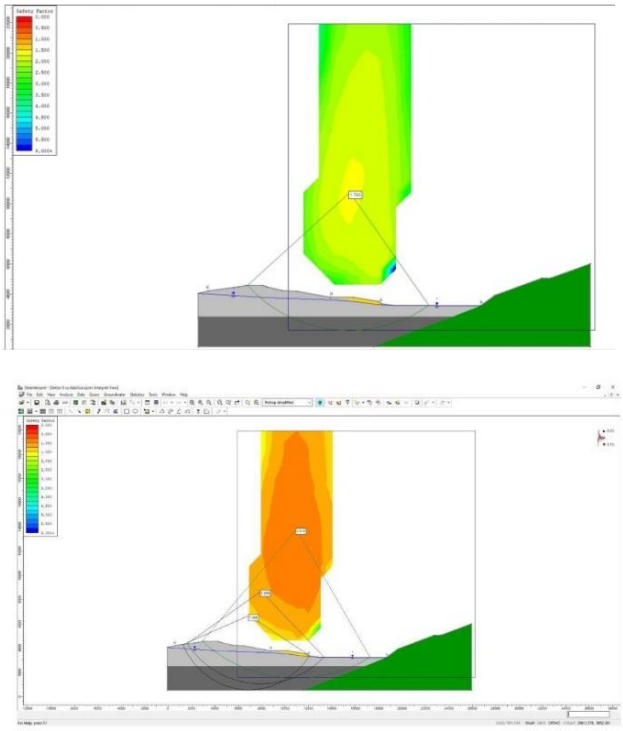

Figure 5. *Static and dynamic coefficients of stability after rehabilitation in the Sector 6*

ACKNOWLEDGEMENTS

This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Contract No. 451-03-47/2023-01/ 200052.

REFERENCES

[1] S. Milutinović, Lj. Obradović, D. Tašić, R. Rajković, Possibility of Rehabilitation and Overhang the Dam 6 at the "Valja Fundata" Tailing Dump in Majdanpek, Mining and Metallurgy Engineering Bor (2023) pp.17-22
[2] Elaborate on Additional Geotechnical Investigations for the Needs of Overhang the Flotation Tailing Dump "Valja Fundata" in the Copper Mine Majdanpek, MMI Bor, (2019) (In Serbian)
[3] Naue Image brochure, Naue GmbH & Co. (2023)