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CONSTRUCTING DEWATERING FACILITIES TO STABILISE THE SLOPE OF AN UNSTABLE OPENCAST MINE

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Abstract

The existence and functioning of the drainage system is a necessary part of the surface mining system, especially in the case of lignite mining. A good drainage system not only generates costs, but also ensures the favorable working conditions for exploitation, but this is only possible with the proper dimensioning and timely investment of funds, i.e., construction of drainage facilities. This paper presents the use of drainage facilities to improve the overall working conditions, all to increase the stability of the open pit.

Keywords: *lignite surface exploitation, slope stability, drainage facilities, water acceptance and evacuation*

1. INTRODUCTION

The impact of surface and underground water on the surface lignite mining is significant. The influx of these types of water into the mine contour complicates the mining process itself, but also affects the change in characteristics of the working environment. When excavating material from the buried massif, there is a problem with the material sticking to the parts of equipment (excavator buckets, truck bodies, conveyor belts). This type of material can cause a problem during disposal and the formation of a waste dump, but also a problem in the massif itself. The ingress of water into the fissure system of the massif, which can be of both natural and artificial origin, and change in the material characteristics can be reflected in the phenomena of instability, both locally and over the entire slope.

This paper presents an example of the Gacko-Central Field opencast mine and remediation of the current instability of opencast mine slope, internal waste dump, and impact of the constructed drainage facilities. The authors of this paper have previously dealt with the issue of lignite mining and other technological operations at the Gacko-Central Field opencast mine. [1] [2] [3] [4] [5]

2. CASE STUDY

In the Central exploitation zone, the instability of southern slope of the open pit and slope of the internal waste dump occurred a year ago (Figure 1). In accordance with the newly created situation, the rehabilitation and stabilization measures are planned to ensure the stabilization of these facilities and smooth operation of the entire Gacko-Central open pit.

Figure 1. *South slope of the Central exploitation zone [6]*

The first step in the slope stabilization process is construction the reinforcement at the toe of the slope using the excavated material from the eastern slope area. The amount of material to be disposed of as part of the reinforcement is approximately 850,000 m^3.

The second step involves the construction of drainage facilities, or more precisely, the facilities that will receive the water that reaches the zone of instability from the surrounding catchment area. The efficient collection and conveyance of this water to the collection and evacuation facilities will provide the following benefits

Preventing the inflow of water into the zone of instability and thus its infiltration into the fracture system.

Elimination the possibility of abrasive action of water on the formed reinforcement.

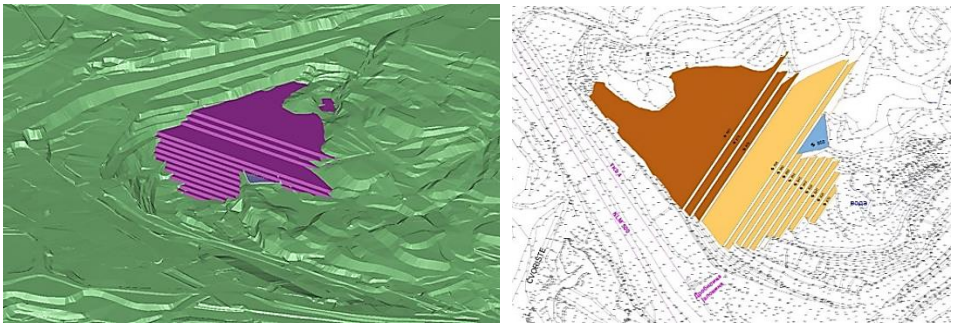


Figure 2. *Layout of solution to stabilize the southern slope of the Central exploitation zone*

There are currently 5 drainage facilities in the zone of instability, namely two 2 reservoirs (WC-C1 and WC-C4) and 3 channels (SC-1, SC-2 and SC-3). In order to optimize them and increase the efficiency of the work, an analysis of the entire area was carried out, with particular reference to the spatial arrangement of the catchment areas (Figure 3). The terrain configuration and position of defended zone have a major impact on the exact location and dimensions of the drainage facilities.

Following the analyzed situation, a special attention was paid to the WC-C4 reservoir and SC-1 channel. The purpose of the WC-C4 water collector is to receive water that reaches the eastern part of the external waste dump and to discharge it via the SC-2 channel towards the Gracanica River. Due to the importance of the function performed by the water collector and possibility of a negative impact on the slope stability, but also on the exploitation system. It is dimensioned by dimensioning the reservoirs and pumping stations within the open pit. [7] The characteristic of this reservoir is that its position is significantly higher than the position of receiver, but the authors have said more about the use of such objects in their works. [1] [8]

Southern channel 2 (SC-2) runs along a part of slope of the western side of external waste dump, but also along the transport road at its foot. Water that reaches this channel, together with water from the WC-C4 reservoir, is discharged into the Gračanica River.

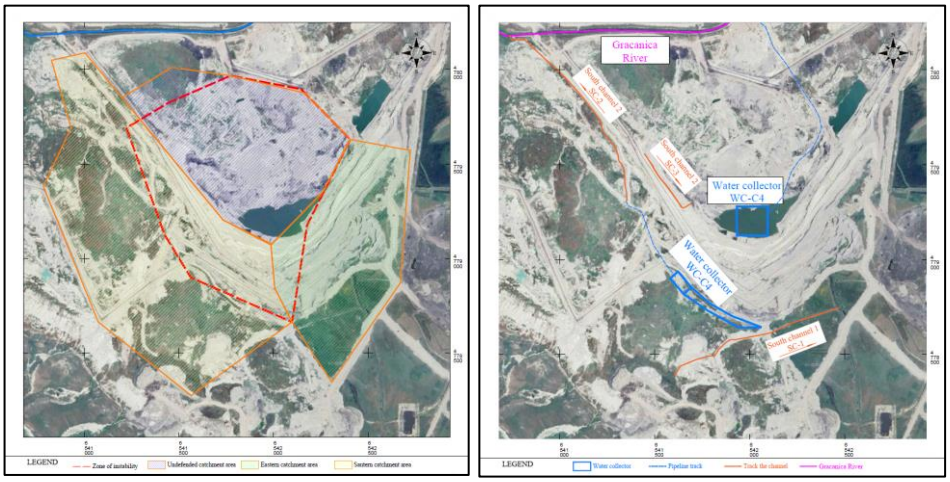


Figure 3. *Layout of catchment areas and drainage facilities in the southern slope zone [9]*

The third facility in the southern slope protection system is the SC-3, which is built along the conveyor of a combined transport system and collects all the water that cannot be accommodated by the WC-C4 water reservoir and SC -2 channel. Its original position in the newly created situation does not provide full protection, i.e. if the existing position of the channel was maintained, there would be a possibility that the water directed towards the contour of the open pit would flow over the reinforcement and wash it away. Therefore, it was proposed to extend the channel as shown in Figure 4. In addition to the new (extended) position of the SC-3 channel, Figure 4 shows the area where the water reaches and is not accepted by any drainage facility.

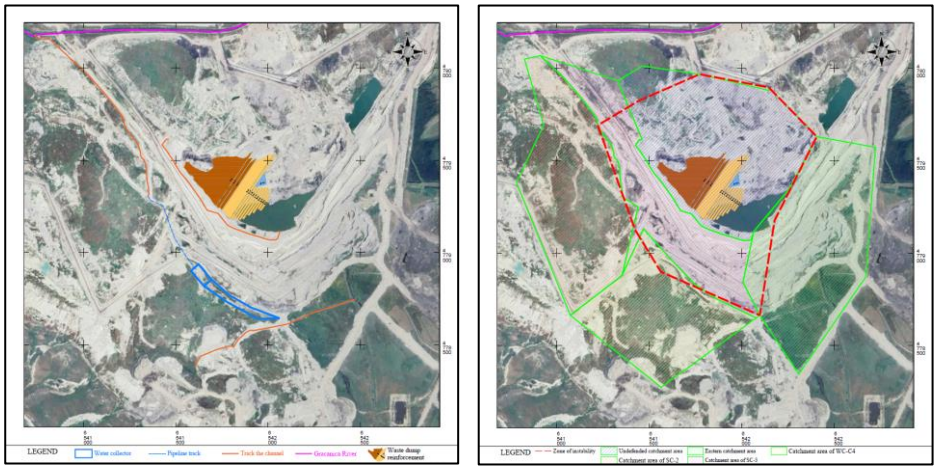
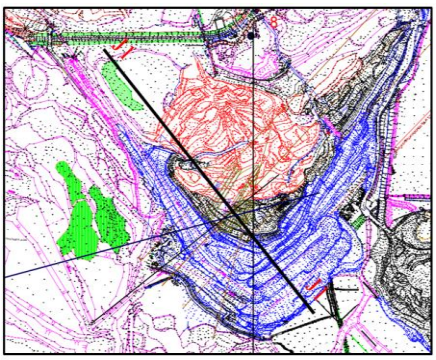


Figure 4. *Layout of the new catchment areas and drainage facilities in the southern slope zone [9]*

Following the reduction of expected water inflow, the value of stability coefficient was determined on one of the characteristic profiles with the value of r_u coefficient of 0.1, 0.2, 0.3 and 0.4. After the construction of an internal waste dump, the safety factors are higher than the minimum allowed for all tested values of r_u (0.1 to 0.4) in the case when the presence of water in the slope of waste dump can be characterized by a value of pore pressure $r_u \leq 0.2$. The safety factor values of the existing slope condition and slope condition after the construction of stabilizing embankment are shown in Figure 5. The safety factor values of the stabilized slope that are higher than the minimum required value are shown in bold red.



		Before stabilization		After stabilization	
Cross section	r_u	Bishop	Janbu	Bishop	Janbu
J1	0.1	0.745 (1.255)	0.702 (1.227)	**1.331**	**1.229**
	0.2	0.678 (1.125)	0.638 (1.098)	**1.206**	**1.177**
	0.3	0.613 (1.019)	0.575 (0.996)	1.081	1.055
	0.4	0.547 (0.902)	0.510 (0,881)	0.956	0.932

Figure 5. *Position of the cross-section for geomechanical check of the slope stability of internal waste dump and safety coefficients*

3. CONCLUSION

The analysis of the slope safety, presented in Figure 5, as well as the reduced space in which the water arrives without the possibility of a controlled direction towards the recipient or evacuation system, confirms the importance of providing the drainage facilities. The water collection before it reaches a contour of the open pit should be an imperative and obligation for all open pit, even if it is implemented as in the shown example. Otherwise, all water that reaches the interior of open pit must be received in a controlled manner and directed to the recipient or evacuation system.

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