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ASSESSMENT AND ANALYSIS OF THE SLOPE STABILITY LANDFILL MINING WASTE ON THE LOCATION "BRVENICA" – RAŠKA

Abstract

For the purposes of the Project Cadastre of Mining Waste in the Republic of Serbia.", implemented by the association PLEJADES GmbH – Independent Experts and DMT GmbH & Co. KG, Germany, the Mining and Metallurgy Institute Bor has performed the geotechnical exploration and testing in order of the slope stability assessment of the mining waste facilities.

Keywords: *stability analysis, geo mechanical tests, mining waste*

1 INTRODUCTION

For the purposes of the Project "Cadastre of Mining Waste.Republic of Serbia", the research has been performed at the MWS 060 Brvenica, MWF 10212/1, where an observation of the field situation and geomechanical soil sampling were carried out. Subsequently, the geomechanical laboratory tests on samples, as well as the slope stability calculation for selected cross-sections were performed.

2 TYPE AND SCOPE OF THE PERFORMED EXPLORATIONS, TESTS AND CALCULATIONS

Within the framework of exploration, the stability of mining waste facilities according to the set task, the following field exploration works were carried out on August 23rd, 2018 on the MWS 060 Brvenica, MWF 1021/1:

- Field observation and selection of the critical slopes: based on the previously prepared geomechanical sampling plan and assessed state of the slope on the facility in the field.
- Construction of exploratory trenches performed mechanically – depth up to 1.5 m (with trenchers/excavators).

The scope and types of performed laboratory tests were determined on the basis of the types of envisaged tests in the geotechnical works and harmonized with the geomechanical composition of taken samples.

The tests were carried out in the Laboratory for Geomechanics in the MMI Bor, according to the applicable standards. The total of three samples were tested and processed.

3 OVERVIEW OF RESEARCH RESULTS

The results of the laboratory geomechanical testing are shown in Table 1. According to the ordinal numbers in this Table, the samples present the following media:

- No. 1 – sub-soil of the facility
- Nos. 2, 3 – disposed material

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Table 1 *Overview of the geomechanical test results*

No.	Sample label	Grain-size distribution								Water content	Density			Direct shear
		Entrails	Gravel	Sand	Dust	Clay	d_{60}	d_{30}	d_{10}	w	γ	γ_s	φ	C
		%	%	%	%	%	mm	mm	mm	%	[kN/m^3]	[kN/m^3]	°	[kN/m^2]
1.	60 10212-1 MW_G B-1 1.2-1.5 m	-	51.89	43.86	4.25	-	7.95	0.552	0.200	27.44	18.46	20.75	27	17,4
2.	60 10212-1 MW_G B-2 1.0-1.5 m	-	81.22	15.57	3.21	-	48.00	6.400	0.530	32.76	18.76	21.76	26	0
3.	60 10212-1 MW_G B-3 1.0-1.5 m	-	72.94	20.50	6.56	-	17.00	2.700	0.126	30.65	18.85	21.67	25	0

3.1 Stability analysis

The adopted calculation parameters for the stability calculation were defined on the basis of the results of laboratory testing of samples, on-site observations, as well as the analogy with data from the projects with the material of similar characteristics.

The following values of geo-mechanical parameters, shown in Table 2, were used to calculate the safety factors of slopes at the cross-section A-A', as well as to determine the cohesion of materials in the massif.

Table 2 *Calculation parameters for the stability of the site No. 060, facility No. 10212/1*

Geotechnical environment	**Cohesion, kN/m^2**	**Internal friction angle, °**	**Density, kN/m^3**
I – Disposed material	45	25	18.81
II – Sub-soil	17.40	27	18.46

Based on the adopted values of physical and mechanical parameters, a safety factor calculation was performed on the characteristic cross - section A-A' with the maximum slope height. A geomechanical model on the cross-section A-A' is shown in Figure 1.

Stability calculation was performed using the *SLIDE v6.0* program of the company *ROCSCIENCE*. The stability calculation is carried out under the conditions of a limit equilibrium using the SLIDE progRAM. The calculation was done using the Janbu method.

On the seismological map, published in 1987, for the return periods of 50, 100, 200, 500, 1000 and 10000 years, which shows the expected earthquake maximum intensity with an occurrence probability of 63%, the area of Raska Municipality is on the oleate for a return period of 500 years, located in the MCS scale zone 8. The earthquake impact on stability is modeled by the seismic coefficient, which is Ks = 0.15 for the Raska region.

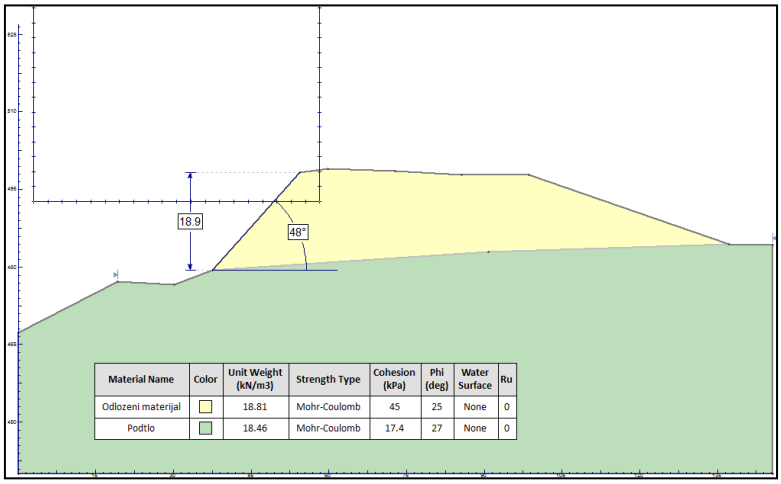

Figure 1 *Geomechanical model on the cross-section A-A'*

The results of calculation the safety factors on the cross-section A-A' are provided as the output forms of the program: Figure 2 for the static loading conditions, and Figure 3 for the dynamic loading conditions. These Figures show the slide levels with minimal stability coefficient. In all other slopes, the stability coefficients are higher than the shown ones. Summary overview of the results is shown in Table 3.

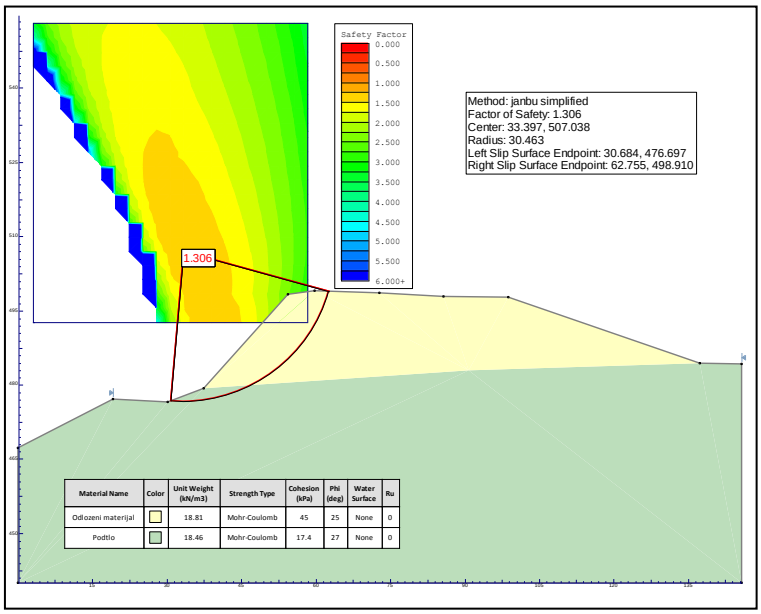

Figure 2 *Minimum safety factor on the cross-section A-A' under the static loading conditions*

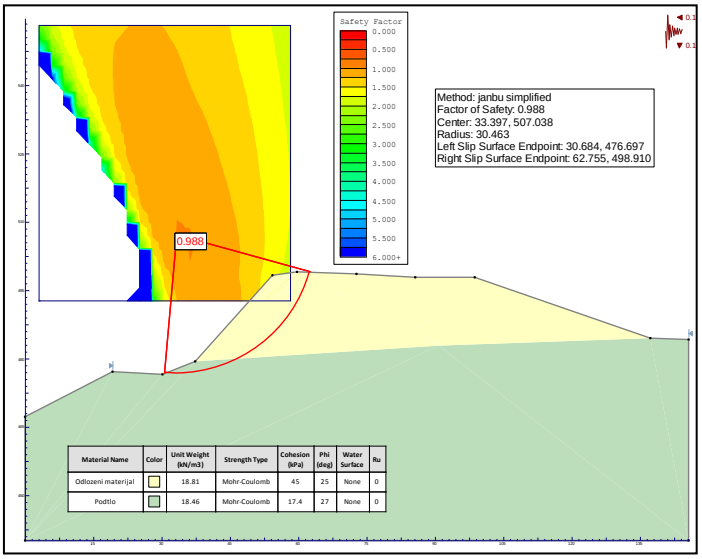

Figure 3 *Minimum safety factor on the cross-section A-A' under the dynamic loading conditions*

Table 3 *Summary overview of the stability coefficient by A - A' profile*

A – A' Profile	F_s static	F_s dynamic
Values	1.306	0.988

The permitted values of the safety coefficient are defined by the Rulebook on Technical Requirements for Surface Mineral Exploitation (Official Gazette of RS, No. 96/2010). For the stability calculation of individual slopes, the slope system and final slopes for soft rocks on the facility - if the open pit is out of operation, the minimum permissible Ks = 1.30.

The minimum safety coefficient of the final slopes for periodical dynamic loads in the event of earthquake is not defined by this Rulebook.

CONCLUSION

Based on the value of calculated slope safety factor, it can be concluded that the stability coefficients, according to the analyzed profile for the mining waste facility No.1021/1 on the site 60 Brvenica, are higher than the minimum prescribed value for the static loading conditions.

Regarding to the safety of slopes of the waste facility in the conditions of dynamic loading, based on the calculated safety factor, it can be concluded that in the event of earthquake of the maximum expected intensity, there will be the instability of the mining waste facility, since the calculated safety factor is less than 1.

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