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Professional paper

ANALYSIS OF SLOPE STABILITY WITH DIFFERENT METHODS IN THE SURFACE MINE IN OSLOMEJ-KICEVO

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Abstract

The reasoning starts from the position that geotechnics represents an interdisciplinary scientific field which consists of a series of narrow and interconnected disciplines that aim to determine the interaction between the geological environment and engineering activity.

The issue of choosing the appropriate methodology for field research is presented as one of the most important issues on which the successful treatment of any geotechnical problem depends.

The irrefutable finding is that the selection of geomechanically parameter values is one of the most complex and sensitive tasks during stability analysis. Therefore, during the research, the methods that we have available for research and examination of the soil, of the location in question and the surroundings should be used in full.

During the compilation of the topic, the candidate will use different methods from the field of geotechnics for stability analysis, in the surface excavation of coal, within REK Oslomej, Kicevo.

Keywords: methods, stability, GGU5, slide, plaxis.

1 Introduction

Based on previous geo-mechanical research and examinations, we can conclude that it is about heterogeneous soil environment with multiple soil layers. From the data of geo-mechanical properties of the treated area, we can divide the soil materials into three groups, as following: *roof sediments*, *productive coal mass* and *underlying sediments*. Analyzing the data and results from previous research, it can be freely stated that the hydro-geological condition has a great impact on geo-mechanical properties of the presented soil materials.

In general, from a geo-mechanical aspect, it can be concluded that in the following period it is necessary to conduct detailed engineering-geological and hydro-geological research and examinations for those areas that lack sufficient data.

2 Methods used to analyze the stability of slopes

Various methods are used to analyze the stability of slopes. They can be roughly divided into two groups:

- Boundary equilibrium methods and
- Numerical methods.

The most used numerical methods for solving geomechanically problems are the finite element method (FEM) and the Boundary equilibrium method (BEM). In the analysis of the geomechanically stability, FEM is used as a method for verifying the results obtained from the limit equilibrium methods, and with it, a complete picture of the state of stresses and deformations in the soil environment is obtained. Namely, numerical methods offer a larger number of output data but also require a correspondingly rich and high-quality fund of input data. Considering that, however, some of them do not directly affect the stability of

the slopes, and complicate and slow down the calculation, the researcher decided to apply boundary balance methods in the analysis for the doctoral thesis.

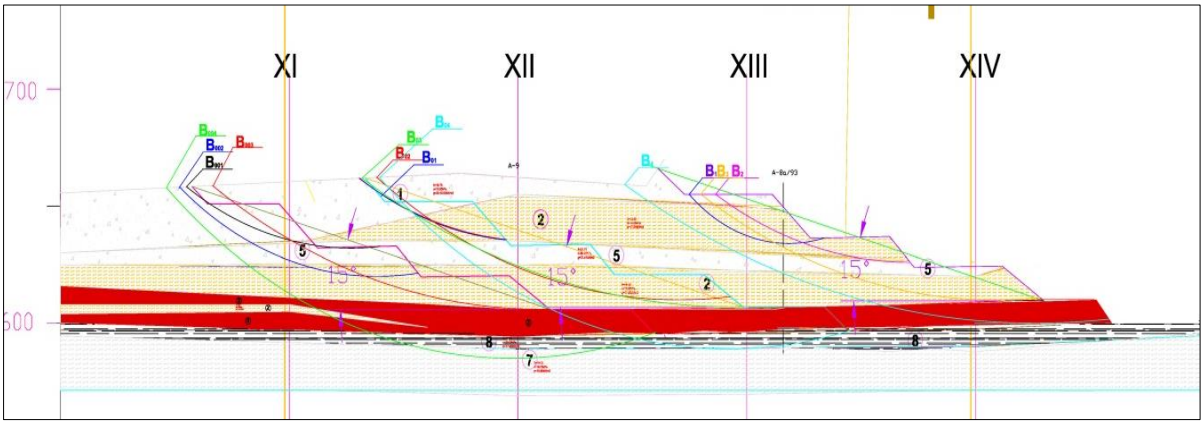

Figure 1. Section showing planned excavations.3-3’

3 Analyzes with GGU Stability software

From the calculations in GGU Stability, the reliability factor (Fs) values obtained from Bishop's method are higher compared to Janbu's method. Specifically, the values according to the Yanbu method are about 5-15% lower than those according to the Bishop method.

TABLE 1. OVERVIEW OF THE RELIABILITY FACTOR VALUES

3-3'

2009	ru=0			ru=0,20			ru=0,30		
	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer
1 (5)	2,108	1,893	2,105	1,798	1,577	1,798	1,614	1,421	1,621
2 (8)	1,553	1,504	1,545	1,273	1,231	1,266	1,133	1,094	1,127
3 (10)	1,386	1,297	1,38	1,161	1,082	1,157	1,047	0,974	1,045
2010	ru=0			ru=0,20			ru=0,30		
	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer
5 (B1)	2,157	2,092	2,161	1,833	1,735	1,836	1,665	1,553	1,666
8 (B2)	1,905	1,748	1,896	1,654	1,519	1,648	1,528	1,404	1,524
10 (B3)	1,694	1,591	1,685	1,479	1,406	1,472	1,372	1,303	1,365
2011	ru=0			ru=0,20			ru=0,30		
	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer
1 (5)	2,304	2,265	2,307	1,942	1,91	1,947	1,761	1,732	1,766
2 (8)	1,979	1,841	1,981	1,725	1,604	1,731	1,598	1,485	1,609
3 (10)	1,524	1,478	1,519	1,305	1,264	1,302	1,194	1,155	1,192

The values of the reliability factor (Fs) for ru=0.00 are higher by approximately 30% than the values of the reliability factor (Fs) for ru=0.30 in applying both methods (Bishop or Janbu). It can be concluded that in profile 3-3', for sliding planes 1, 2, and 3, no noticeable difference in the results according to the three methods can be observed, although the coefficient obtained according to Yanbu's method is a shade lower than that according to Bishop's method and Spenser.

4 Analyzes with SLIDE software

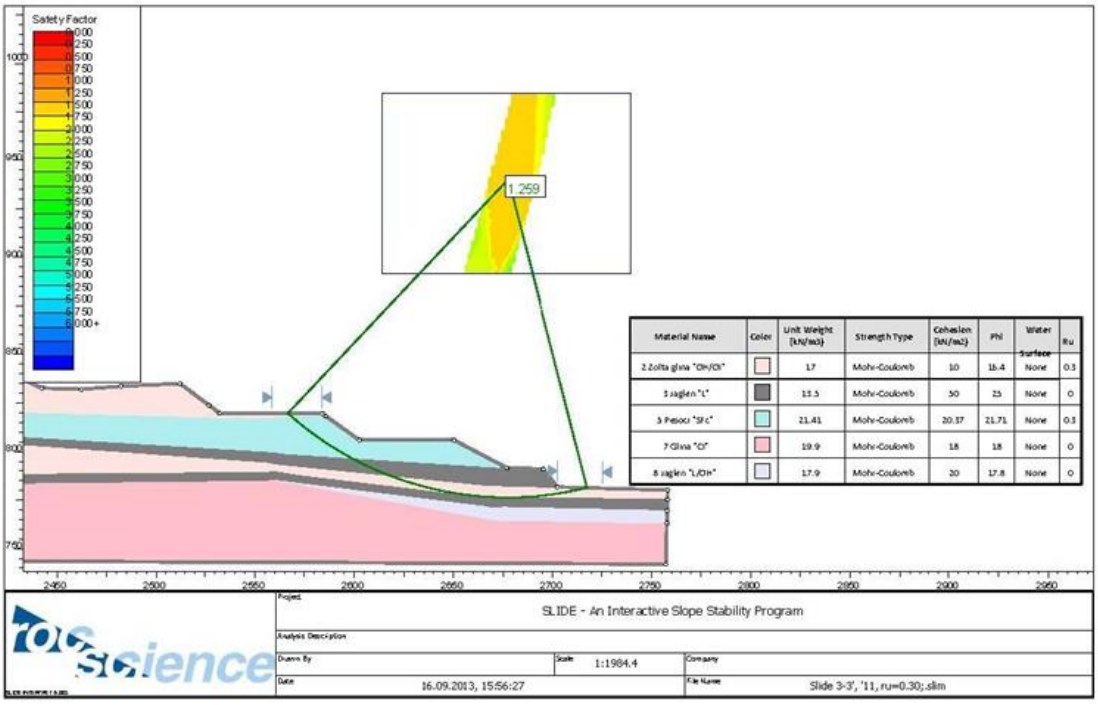

Figure 2. Sliding surface;3.(Bishop) Fs=1.299. ru=0.30 for β=150 Profile;3-3'

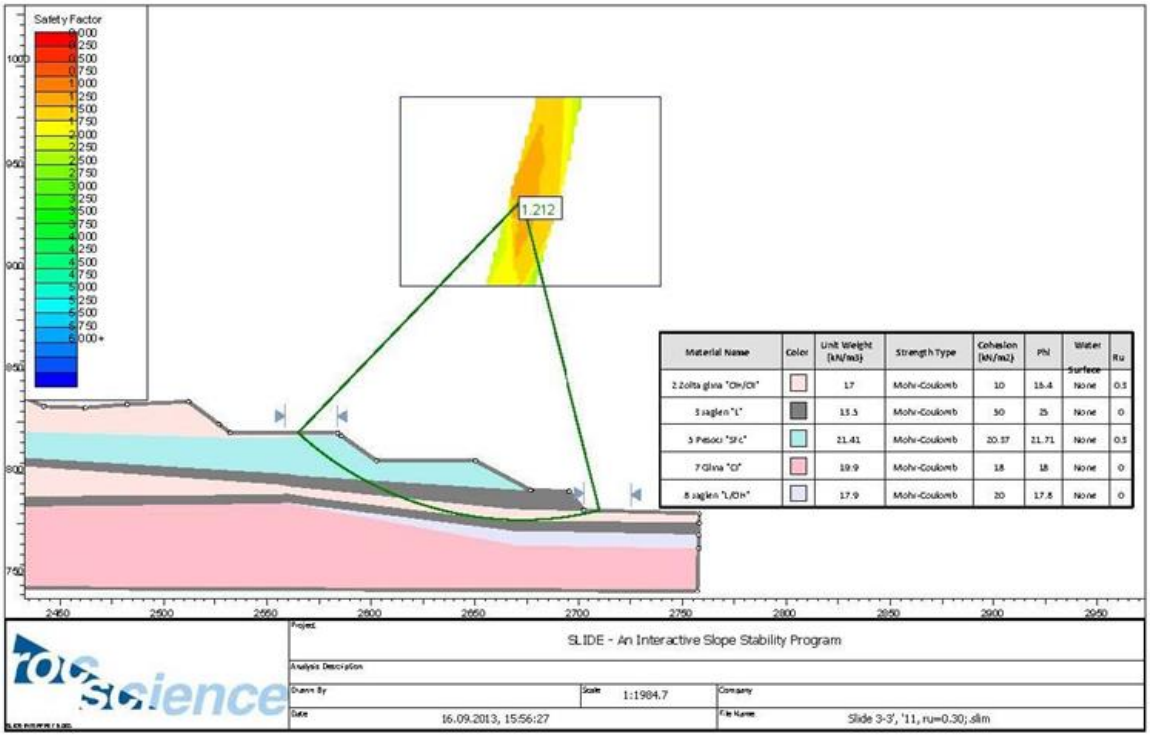

Figure 3. Slip surface;3.(Janbu) Fs=1.212. ru=0.30 for β=150 Profile;3-3'

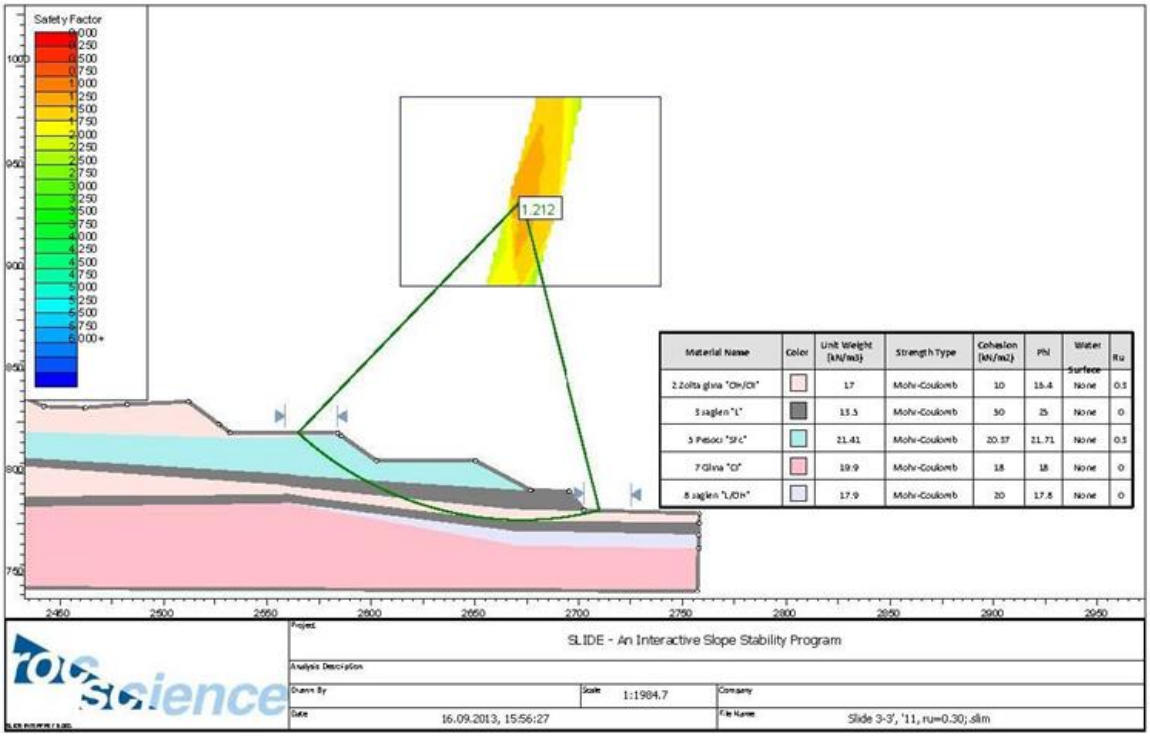

Figure 4. Sliding surface;3. (Spencer) Fs=1,260. ru=0.30 for β=150 Profile;3-3'

TABLE 2. OVERVIEW OF THE RELIABILITY FACTOR VALUES

3-3'

2009	ru=0			ru=0,20			ru=0,30		
	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer
1 (5)	1,791	1,714	1,797	1,561	1,471	1,569	1,437	1,34	1,441
2 (8)	1,939	1,789	1,933	1,65	1,52	1,648	1,505	1,386	1,505
3 (10)	1,757	1,682	1,749	1,489	1,425	1,484	1,356	1,295	1,351
2010	ru=0			ru=0,20			ru=0,30		
	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer
5 (B1)	1,289	1,181	1,298	1,144	1,03	1,156	1,065	0,95	1,081
8 (B2)	2,193	1,939	2,187	1,691	1,662	1,691	1,516	1,489	1,516
10 (B3)	1,499	1,396	1,488	1,306	1,208	1,299	1,209	1,114	1,2
2011	ru=0			ru=0,20			ru=0,30		
	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer	Bishop	Janbu	Spencer
1 (5)	0,843	0,787	0,838	0,702	0,644	0,697	0,631	0,572	0,628
2 (8)	1,62	1,558	1,618	1,38	1,327	1,379	1,259	1,212	1,26

From the calculations in SLIDE, the values according to Yanbu's method are about 5-20% lower than those according to Bishop and Spencer's method, which difference is most pronounced for medium-deep sliding surfaces and at high pore pressure coefficient. What is advantageous from a stable and practical point of view is that the achieved coefficients are higher than the minimum ones. With analysis of the stability of the working slopes, it was found that Fs obtained with FEM in several cases have similarities with Fs obtained with the method of Bishop and Spencer, and in turn have a permissible difference with Fs obtained with Janbu, which argues the application of FEM in the stability analysis about the geotechnical conditions in the pits. Just like the method of Janbu, Spencer, and the finite element method, the Bishop method can be applied to the stability analysis for the potential compound non-circular sliding surface mechanism, but for many analyzed cases higher values of (Fs) compared to the aforementioned methods.

Graphical interpretations of reliability factors (Fs) depending on φ, c, ru and β represent the clarification of the optimality of the heights and steepness of the slopes in yellow and gray clay, as well as coal.

For stability analyzes with limit equilibrium methods (BEM), 2D geotechnical software: SLIDE, GGU were used, while PLAXIS software was used with the finite element method (FEM).

5 The PLAXIS software analysis

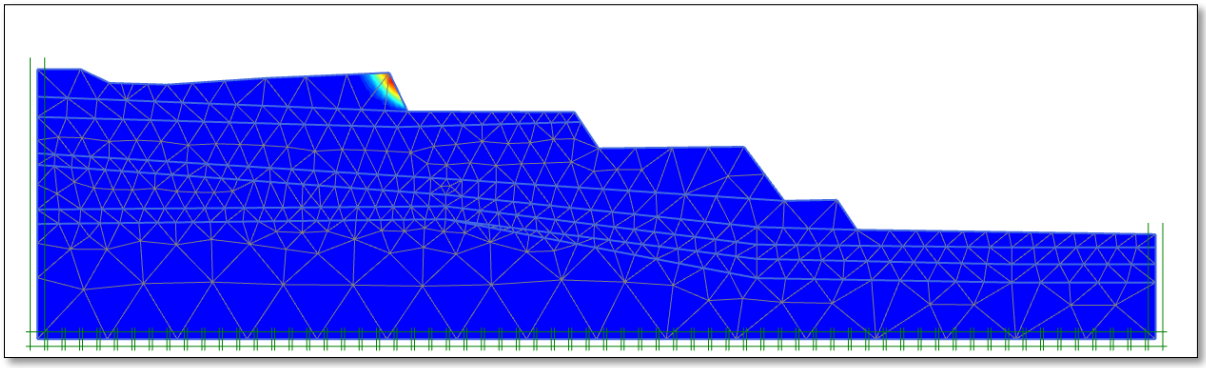

Figure 5. Output of stability analyzes in Plaxis software package

It can also be stated that the stability analysis with FEM (PLAXIS) yields values for the reliability factor that are close to those achieved with BEM (SLIDE and GGU), although there are also certain differences in the procedures, which further partially affect the amount of Fs:

- With MGR, the shapes, position and research zone of the potential sliding surfaces should be assumed beforehand (especially if it is a question of polygonal sliding surfaces), then the position of the interlamellar forces, etc., while with FEM there is no need to make such assumptions, due to which one gets an insight into the zone of sliding and breaking of the material, ie. exceeding its shear strength.
- With FEM, more input parameters are required, and sometimes assumptions that, for their part, can significantly affect the achieved results, but also shift the emphasis from stability and strength to deformations, which, on the other hand, is not the case with BEM

6 Conclusions and recommendations

The analyzes in this paper provide opportunities for numerous analyzes and scientific researches in the future, where as fields for further research, the following aspects should be devoted:

It is a complex task to select the right physical models and parameters that are most significant in the process of interaction of the environment with engineering intervention. The choice of the right parameters can only be made through the optimal placement of investigative methods and procedures, in relation to a given design phase. The economic and environmental effects during the performance of any building largely depend on that choice.

References

[1]. Ameti, F. (1986): “Mekanika e dherave”, Prishtinë, Kosova
[2]. Bathe, K. J. (1986):“Finite Element method” Springer V. V., Berlin H.S
[3]. Bishop, A. (1976): “The measurement of soil properties in the triaxial test” London, United Kingdom.
[4]. Craig, F. (1978):”Soil mechanics”, London, United Kingdom.
[5]. D.Ilievski, Lj,Dimitrievski, D.Dimitrievski, (2009) “Case study for dislocation of river Temnica over height embankment on a deposit material”, XVII International Conference on Soil Mechanics and Geotechnical Engineering, Alexandria, Egypt.
[6]. Đukić , D. (1984): “Geomehanika u površinskoj eksploataciji”, Tuzla. Bosna.
[7]. Eurocode 7: Geotehnical design, Part 1, General rules.

[8]. Förster, V. (1998):”Bodenmechanik”, Technische Universität Berg Akademie Freiberg, Stuttgart-Leipzig, Deutschland
[9]. Gojković, N., Obradović, R., Čabašek (2008): “Stabilnost kosina odlagališta površinskih kopova”, Beograd, Srbija.
[10]. Комаров, И. С. (1972): “Накопление и обработка информации при инженерско-геологическим иследованиах”, Недра, Москва.
[11]. Kamalzare M., Zimmie T.F. (2013): “Computer simulation of Levee’s Erosion and Overtopping”, Geo-Congress, San Diego, California, United States
[12]. Lokin, P., Janic, M. (1972):”Inzenerskogeološka istraživanja kao deo geotehnickih istrazivanja kod projektovanja povrsinskih kopova u cvrstim stenckim masama”, III JSMSPR, Tuzla, Bosna