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STABILITY ANALYSIS ACCORDING TO EUROCODE 7 IN THE SLIDE SOFTWARE

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Abstract

Eurocode 7 was primarily developed for construction and geotechnical facilities, so its provisions do not directly refer to mining works within rock masses during surface exploitation, but are applied to the accompanying mining infrastructure: calculation of foundations for heavy mining machinery, crushers, transport systems, as well as for hydrotechnical mining facilities: flotation tailings dams, filter plants and drainage systems.

***Keywords**: Eurocode 7, stability of surface mining facilities, Slide software*

1. INTRODUCTION

Eurocode 7 explicitly states that it does not fully cover the specific requirements of mining operations. The stability of mining facilities is defined by the Rulebook on technical requirements for surface exploitation of mineral deposits, Official gazette of RS no. 96/2010. During the construction of accompanying mining constructions, the requirements of the Law on planning and construction must also be met, Official gazette of RS no. 72/2009, 81/2009 - corrected, 64/2010 - CC decision, 24/2011, 121/2012, 42/2013 - CC decision, 50/2013 - CC decision, 98/2013 - CC decision, 132/2014, 145/2014, 83/2018, 31/2019, 37/2019 - dr. law, 9/2020, 52/2021, 62/2023 and 91/2025.

Modern mining is increasingly adopting the principles of Eurocode 7 in order to harmonize the level of safety and reliability. Eurocode 7 is applied in certain segments of open pit mining projects. When designing mining infrastructure: calculation of foundations for heavy mining machinery, crushers and transport systems. When designing hydrotechnical mining facilities: flotation tailings, filter plants and drainage systems.

2. PRINCIPLES OF STABILITY CALCULATION ACCORDING TO EUROCODE 7

Eurocode 7 consists of two parts. The first part deals with general rules in geotechnical dimensioning, while the second part covers laboratory and field tests.

Eurocode 7 introduces a classification of three geotechnical categories in order to rationalize the scope of investigation works and the complexity of the procedure of proving stability [1]. Geotechnical category 1 refers to the simplest constructions, where

investigative works can include the simplest actions - survey of the terrain, application of experience from neighboring buildings, etc. and evidence of stability can be replaced by comparable experience. The content of the norm refers primarily to geotechnical category 2, which includes routine geotechnical interventions and constitutes the predominant content of most geotechnical projects. For geotechnical category 3, which consists of very complex interventions and interventions of high risk, the norm does not give special instructions, but requires more rigorous criteria and procedures for investigative work, design, observations and supervision. Most mining facilities fall under geotechnical category 3.

The design principle in all Eurocodes is based on the concept of limit states, defined as states beyond which the structure no longer meets the appropriate requirements from the design. Eurocode 7 defines two types of limit states [2]:

- ULS (Ultimate Limit States), i.e. project situations involving the collapse of the structure or some other type of failure, danger to people or great economic damage. For well-designed structures, the probability of occurrence of load-bearing limit states is low. Calculations for this limit state usually involve failure mechanism analysis and the use of soil strength parameters.
- SLS (Serviceability Limit States), i.e. design situations that are associated with the unsatisfactory performance of the designed function (eg excessive deformations, settlements, vibrations and local damage to the structure during normal use). The probability of occurrence of limit states of serviceability is higher than the probability of occurrence of limit states of bearing capacity. Calculations for the serviceability limit state usually involve the analysis of deformations and the use of soil deformability parameters.

Geotechnical design calculations, which are performed according to Eurocode 7, include the following components:

- Loads or movements - action (F);
- Properties of soil and other materials (X) or resistances (R);
- Geometric data (a);
- Partial safety factors (γ);
- Load or displacement effects (E), e.g. load resultants or calculated settlements;
- Limit or permissible values (C) of deformations, crack widths, vibrations, etc.

The ULS design calculation assumes that the effects of the actions (E) do not exceed the resistances (R). The index d indicates the design value:

$$Ed \leq Rd \quad (1)$$

The SLS calculation includes the assumption that the designed effects of actions (Ed) (e.g. settlement) are less than the allowable value of structural deformation (Cd):

$$Ed \leq Cd \quad (2)$$

The design value of the soil parameter (Xd) is determined according to the expression:

$$Xd = Xk / \gamma m \quad (3)$$

where are:

- Xk – characteristic value of soil parameter X
- γm – partial safety factor

3. STABILITY ANALYSIS ACCORDING TO EUROCODE 7 IN THE SLIDE SOFTWARE

The stability analysis with the Rocscience software package, i.e. its Slide tool, is based on boundary equilibrium conditions [3-6]. Calculations can be made for arbitrary sliding surfaces by all methods used in practice: Bishop, Janbu, Morgenstern–Price, Spencer, etc. The program enables the automatic search of the critical sliding plane with a minimum safety factor, Figure 1.

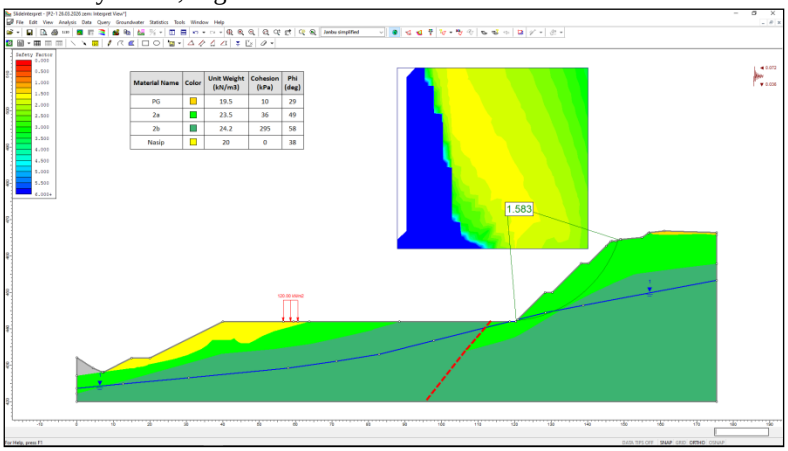


Figure 1. *Slide software output interface*

According to the SRPS EN 1997-1 standard adopted in Serbia, special national calculation approaches are applied, most often approach 3 or DA3 for short, which define coefficients for loads and strength of the rock mass. The calculation of the safety factor is based on the method of partial coefficients.

In the Slide program, there is a possibility to select option DA3. When selecting this option, the program automatically downloads the partial safety factors defined by this approach, Figure 2.

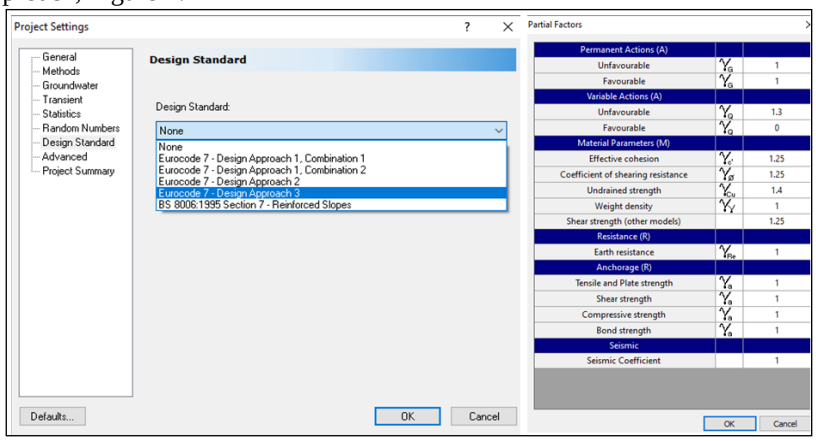


Figure 2. *Partial safety factors in the Slide software, option DA3*

The correction factors for option DA3 have the following values:
1. Variable actions - unfavourable: 1.30;
2. Material parameters:
   2.1. Effective cohesion: 1.25:
   2.2. Coefficient of shearing resistance: 1.25;
   2.3. Undrained strength: 1.40;
   2.4. Shear strength: 1.25.

The further calculation procedure in the Slide program is standard [3-6].

4. CONCLUSION

The biggest challenge when analyzing the stability of mining facilities is improving the accuracy of the estimation of initial parameters and solving spatial variability in complex geotechnical conditions.

Eurocode 7 sets unique European standards for geotechnical design. His main conclusion is that safety and stability are achieved by harmonizing methods and using methods of partial coefficients, thus adapting geotechnical calculations to modern design requirements.

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