Iranian Journal of Engineering Geology
Summer 2022, Vol.15, No.2

Instability risk assessment of open cut trenches of Sungun copper mine by FAHP

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Abstract

The optimum operation of an open pit mine needs special attention to geotechnical problems including slopes stability. Such investigations should be performed continuously, and the obtained results be used in mine designing and also development studies. There are various types of factors affecting the instability problems of mine slopes and should be identified and investigated during risk assessment process. In this research, an attempt was made to identify the most important factors related to instability of slopes of Sungung copper mine, then rank factors based on their importance. For this purpose Fuzzy Analytical Hierarchy process (FAHP) has been used. At first, using a questionnaire experts were interviewed and on this basis the most important risk factors defined in 3 layers, then the Hierarchal structure of problem was drawn. Then, FAHP was used to calculate the relative weight of factors affecting risk of slope instability and to determine their importance. The results obtained of field studies and also long term plans for slope controlling were compared with FAHP method results. On this basis, delay in mining operations (Layer 1), extended failure (more than a bench) (Layer 2), and discontinuities (Faults & Joints) (Layer 3) were defined as factors with high importance during risk assessment of slopes instability of Sungun copper mine.

Keywords: *Sungun copper mine, Slope instability, Fuzzy Analytical Hierarchy process, Risk assessment*

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Extended Abstract:

1. Introduction

For an open pit mine, the design of the slopes is one of the major challenges at every stage of planning and operation. It requires specialised knowledge of the geology, which is often complex in the vicinity of orebodies where structure and/or alteration may be key factors, and of the material properties, which are frequently highly variable. It also requires an understanding of the practical aspects of design implementation. Therefore, there are various factors including geological, geotechnical, financial, technical and safety may affect the risk related to slopes instability during mining operations.

2. Materials and methods

The extent FAHP method proposed by Chang (1996) used in this study in order to rank factors importance in relation to slope instability of Sungun open pit mine. For this purpose, a questionnaire proposed by Lyu et al. (2020) for risk assessment was used. This includes a table with factors in the first column, and nine scores in the other columns. Then, a group of experienced experts with expertise in engineering geology and mining engineering were selected. On this basis, the result of experts answer was used to identify the major risk types of slope instability during mining operations. These include financial risks (A1), Technical and mine designing risks (A2), Delay in mining activity risks (A3), and safety risks (A4). In order to make a hierarchical structure of the problem, it is necessary to define the different factor layers influencing slopes instability. Based on data obtained from above mentioned process, the hierarchical structure for the assessment of slopes instability risks during mining activities in Sungun Copper mine was established.

3. Results

The questionnaire proposed by Lyu et al. (2020), can remove inconsistency. Therefore, this method was applied in order to assess risks resulted from slope instability of Sungun Copper mine. On this basis, all factors identified by experienced experts to contribute to risk during mining activities were ranked and their relative importance were determined. As indicated in figure 3, the most important factors of each layer influencing upper layers and consequently risk is identified as A3 in layer 1, B3 in layer 2, and C2 in layer 3. In order to control the results of current study and also verifying proposed method for assessing risks resulted from slope instability, a detailed investigation was performed by authors. For this purpose, a detailed field investigations were carried out, and also collected data were analyzed.

These studies showed that the field data have good correlation to results obtained by FAHP method. Considering previous slope failures show that factors such as fault and joints can cause failures with large scales in which influences mining operations.

4. Conclusion

Slope instabilities during mining operation can affect different parameters such as mining costs, workers safety, and technical problems. In order to reduce and control unfavorable effects of this phenomenon, having comprehensive knowledge of related factors is essential. For this purpose, in

this study an attempt was made to collect and analyze data obtained during mining operation. Risk assessment based on new questionnaire for Sungun copper mine showed that it is efficient way for this purpose and can evaluate this process with high validity. Also, it is possible to get the experts judgments with easiness by use of this questionnaire. The application of triangular fuzzy AHP method with new proposed questionnaire to risk assessment showed that delay in mining activities is the most important risk type (A3).

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