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Research article

Investigating Rockbolt Support Pattern on Stability of Underground Structures in Jointed Rock Mass Using Three-Dimensional DFN-DEM Methods, case study: Clab2 cavern

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English Extended Abstract

Summary

A novel procedure for selecting the optimal length of the rock bolts is developed, as the main supporting component in supporting underground structures. The data of the study is obtained from a Clab2 cavern in Sweden which includes six joint sets with different irregular geometric characteristics. A three-dimensional distinct element method along with discrete fracture network approach is utilized for the analyses. To support this blocky structure, rock bolts with lengths of 3, 6 and 9 meters were implemented. Technical and economic criteria have been used and the recommended pattern was 6-meter rock bolts with 2 meter spacing.

Introduction

The collapse of blocks is one of the most important issues in the stability and design of underground. However, most of the studies have been performed to stabilize the underground spaces by rock bolts in continuous environments with regular joint networks and in two dimensions. This study presents a procedure to investigate the stability of underground spaces in three dimensions in rock mass with irregular discontinuities by stochastic discrete fracture network (DFN) method evaluating the effect of bolt length and spacing on the stability of underground structures.

Methodology and Approaches

The purpose of this study is to provide a process to optimize the bolting pattern in the support system. For this, the geomechanical data of Clab2 cavern located in the Sympivarp region, Sweden was utilized. This cavern has a depth, length. Width and height of 30, 115, 21, and 27 meters with a horseshoe section. The joint studies in the area identified six joint sets around the cavern. Ten DFN realizations were generated along with different patterns of bolting systems with various lengths and spacing. The rock bolts used in this research have lengths of 3, 6 and 9 meters with a longitudinal and transverse distance of 2 meters.

Results and Conclusions

The effect of a particular supporting system on various discontinuity networks is different, which can be significantly effective or ineffective in some discontinuity networks. This shows the need to apply and examine support systems on different discontinuity networks to achieve the optimal pattern. In this study, a new trend is presented to achieve the optimal pattern based on the total volume of unstable blocks and the volume of which 80% of unstable blocks are smaller, along with the total length of the used bolts. The results show that the stability of the cavern in using the bolt support system does not necessarily increase using longer rock bolts. Initially, increasing the length of the bolts increases the stability, however after a certain length, increasing the length of the bolts no longer significantly improves the stability of the structure. Therefore, considering the economic criteria, the 6-meter model is the best model for stabilizing the desired cave.

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