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Abstract: A systematic sensitivity analysis using three-dimensional Discrete Element Models with Discrete Fracture Networks (DEM-DFN) was conducted to evaluate underground excavation support in jointed rock masses at the CLAB2 site in southeastern Sweden. The site features a joint network comprising six distinct joint sets, each with unique geometrical properties. The study examined 10 DFNs and 19 rock bolt patterns, both conventional and unconventional. It covered 200 scenarios, including 10 unsupported and 190 supported cases. Technical and economic criteria for stability were assessed for each support system. Results indicated that increasing rock bolt length enhances stability up to a certain point. However, multi-length rock bolt patterns with similar consumption can yield significantly different stability outcomes. Notably, the arrangement and properties of rock bolts are crucial for stability, particularly in blocks between bolting sections. These blocks remain interlocked in unsupported areas due to the induced pressure from supported sections. Although equal-length rock bolt patterns are commonly used, the analysis revealed that triple-length rock bolts (3, 6, and 9 meters) provided the most effective support across all ten DFN scenarios.

Keywords: support pattern, rock bolt, tunnel, numerical modeling, DEM-DFN

1. Introduction

Challenges related to support system design and the stability of a tunnel wall and tunnel roof are vital for underground construction. Usually, jointed rockmasses are encountered during underground excavation. There are severe consequences of failure occurring on tunnel walls and roof blocks. These include safety issues, delays in progress, and damage to surface structures. Such failures are particularly concerning when the space is excavated at shallow depths [1,2].

The Distinct Element Method (DEM) is promptly becoming popular in analyzing the behavior of underground spaces constructed in jointed rock masses [3-6]. However, this method is rarely used as a design procedure and