Topic: Tunnel Scale Models for Prediction of Stope Damage using Machine Learning and Numerical Modelling as a Novel Tool for Support System Optimization in Underground Mines.

Abstract

The quest to address the escalating demand for critical minerals essential for various industries including technology and renewable energy has led to inevitable development of deep underground mines due to factors not limited to shrinking ore reserves, diminishing high-grade ore deposits in traditional open pits mines. The shift towards incorporating machine learning (ML) into processing ground instrumentation data relative to numerical modeling as an evolving technology in understanding drift damage of deep underground stopes due to the apparent limitations of traditional techniques, is becoming inevitable. It is very paramount to take cognizance of the behavior of the rock masses when designing, excavating and constructing underground infrastructures to ensure safety and economical sustainability of the project because rock mass behavior changes and becomes more difficult to anticipate as insitu stress increases relative to depth increase, which upsurges operational risks. Understanding the performance of different support systems used while driving the drift in various geotechnical domains encountered would lead to optimization of this support systems at the larger scale for stoping operations. Analysis of historical convergence data or acquired data using ground monitoring instrumentations such as Multi-Point Borehole Extensometers (MPBX) or LIDAR scan measurements in conjunction with the installed support areas and associated lithologies are veritable tools for predictions of support system behavior and expected rock damage under different loading conditions for safety assurance and sustainable production. Hence, this research proposes to evaluate the acquired data from the underground rockmass monitoring instrumentation techniques, using cutting-edge technology for microseismic monitoring of rock surface movement. ML will be employed to conceptualize trained model that can distinguishingly recognize drift deformation and microseismic events by analyzing the baseline convergence data at the developmental stages of the mine. The research will conduct a 3D tunnel (drift) scale baseline calibration model using the latest development and stoping schedule to establish a first iteration volumetric strain estimates for the focused areas of the mine, and utilize "tunnel scale" modelling analyses in combination with field data to adequately calibrate and quantify the behavior of the support performance in multiple geotechnical domains and under various loading conditions to make recommendations on potential optimization in the overall support system design.