

COMPUTER SIMULATION OF GROUND BEHAVIOUR AND ROCK BOLT INTERACTION AT EMERALD MINE

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ABSTRACT

A collaborative project between RAG Emerald Mine, NIOSH, and SCT Operations was conducted to investigate ground behaviour, reinforcement performance, and stress redistribution in a coal mine entry subjected to a severe horizontal stress concentration. Field measurements indicated that the stresses applied to the study site nearly doubled during longwall mining, resulting in roof deformations extending to a height of 4.8 m (16 ft) above the entry.

This paper focuses on the computer simulation that was undertaken to provide more insight into the roof behaviour and rock bolt interaction during mining. The model's input rock properties were derived from extensive laboratory testing, and the model itself simulated a broad range of failure mechanisms. The effects of different bolt patterns on roadway behaviour were evaluated. Comparison between the model results and the field measurements indicated that the model effectively simulated the critical elements of the actual roadway's behaviour. With the confidence gained, the model was used as a baseline for additional simulations that evaluated the expected performance of alternative roof support systems. The study will also provide a benchmark data set for future applications of numerical modelling to U.S. coal underground mining.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) at PRL together with RAG Pennsylvania and SCT Operations of Australia collaborated to conduct an extensive study

of roof bolt strata interaction at Emerald Mine. The goals of the study were to:

- Determine baseline U.S. rock mass and stress properties for input into numerical models;
- Evaluate the performance of U.S. primary supports (roof bolts) in typical U.S. geological conditions;
- Investigate the interaction between supplemental support systems (cable bolts) and primary supports, and;
- Explore the ability of numerical modelling to aid in analyzing complex ground control problems.

The study is part of a broader effort to develop methods to optimize roof bolt designs and prevent roof falls in a range of geologic and stress conditions encountered in U.S. underground coal mines.

The site of the study was the tailgate of the 11 North longwall at the Emerald Mine, located in Greene County, Pennsylvania (Figure 1a). The site was chosen because it was anticipated that the extension of 11 North beyond the start line of 10 North would result in a significant horizontal stress concentration (Mark et al., 1998). From past experience at Emerald Mine, a horizontal stress window like the one created by 11 North could be expected to cause severe loading to be applied to the crosscut and tailgate entry. The location thus provided a unique opportunity to study the roof failure process as the applied horizontal stress increased during the progression from development through longwall mining.

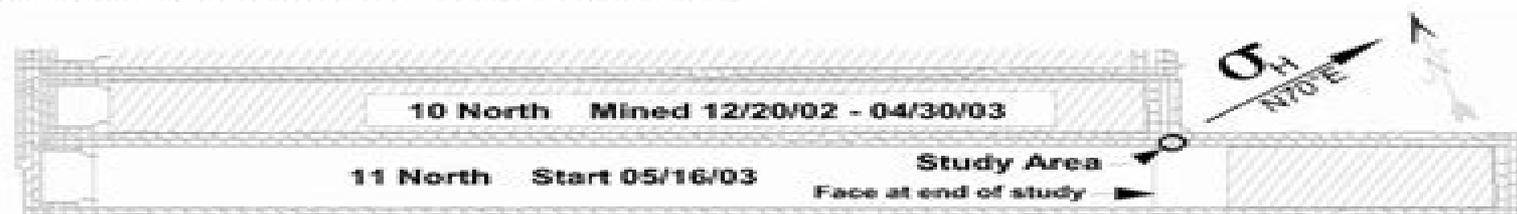


Figure 1a. Emerald Mine and study site.

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Jeffrey Richard Cantwell



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published yet arguably little progress has been made The problem is the social dilemma game models are unrealistic in the sense they contain artificial constructs that deviate from the way humans act This book describes the shortcomings in current social dilemma game modeling techniques and provides guidance on designing more effective models A basic introduction to game theory is provided with an emphasis on the prisoner s dilemma the most widely studied social dilemma game Individual chapters are provided detailing the shortcomings of weak selection spatial games and the Moran process Computer model validation is also discussed at length The recommendations found in this book should help design more realistic social dilemma game models likely to produce a better understanding of human cooperation **Computer**

Simulation of Personality Silvan Solomon Tomkins, Samuel Messick, 1963 **Artificial Behavior** Gene D. Steinhauer, 1986 Computer Simulation of Human Game-playing Behavior Jeffrey Richard Cantwell, 1984 Computer Simulation in the Study of Intelligent Behaviour B. H. Webb, University of Edinburgh. Department of Artificial Intelligence, 1990

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