

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.

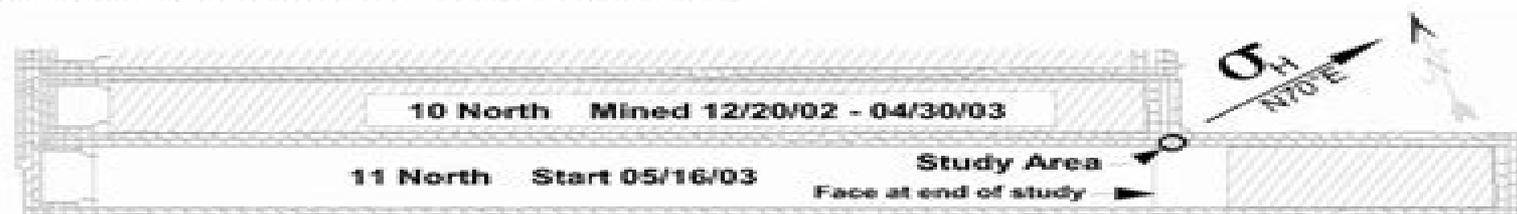


Figure 1a. Emerald Mine and study site.

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Table of Contents The Computer Simulation Of Behaviour Harper Colophons Cn234

1. Understanding the eBook The Computer Simulation Of Behaviour Harper Colophons Cn234
 - The Rise of Digital Reading The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Advantages of eBooks Over Traditional Books
2. Identifying The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an The Computer Simulation Of Behaviour Harper Colophons Cn234
 - User-Friendly Interface
4. Exploring eBook Recommendations from The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Personalized Recommendations
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 User Reviews and Ratings
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 and Bestseller Lists
5. Accessing The Computer Simulation Of Behaviour Harper Colophons Cn234 Free and Paid eBooks
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 Public Domain eBooks
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 eBook Subscription Services
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 Budget-Friendly Options
6. Navigating The Computer Simulation Of Behaviour Harper Colophons Cn234 eBook Formats
 - ePub, PDF, MOBI, and More
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 Compatibility with Devices
 - The Computer Simulation Of Behaviour Harper Colophons Cn234 Enhanced eBook Features
7. Enhancing Your Reading Experience

- Adjustable Fonts and Text Sizes of The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Highlighting and Note-Taking The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Interactive Elements The Computer Simulation Of Behaviour Harper Colophons Cn234
8. Staying Engaged with The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers The Computer Simulation Of Behaviour Harper Colophons Cn234
 9. Balancing eBooks and Physical Books The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection The Computer Simulation Of Behaviour Harper Colophons Cn234
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Setting Reading Goals The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Fact-Checking eBook Content of The Computer Simulation Of Behaviour Harper Colophons Cn234
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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