学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Pillar Design in Jointed Shallow Room-and-Pillar Hard Rock Mines
(亀裂性硬岩中の浅部柱房式鉱山における鉱柱の設計)

This dissertation addressed three research gaps related to pillar stress estimation, pillar strength determination, and regional support design in shallow hard rock room-and-pillar mines.

The main achievements of the study are as follows:

Firstly, a multi-layer perceptron neural network (MLPNN) was applied to predict the vertical loads of regular pillars more accurately. Hundreds of room-and-pillar mine layouts were modelled using a displacement discontinuity method (DDM), and a database of 2355 sampled pillar cases was compiled. The MLPNN was trained based on this database, and its prediction capabilities were further validated using simulations by a finite difference code (i.e., FLAC3D). The model predictions and the FLAC3D simulations reasonably agreed with a regression coefficient of 0.99. The model was also adapted for mine cases with evenly spaced barrier pillars, and its application to a real case study mine has shown to provide accurate pillar stress estimations; hence, this model is suitable for practical use at mines. Even though the MLPNN model cannot be universally applied to all mine situations, it appears to be a significant improvement over existing analytical techniques in terms of accounting for the influence of abutments on pillar stresses.

Secondly, a framework was proposed to estimate pillar strength based on ongoing pillar mapping, risk management decision making, numerical modelling, and analytical hierarchy process. The framework has the potential to be universally applicable, user-friendly, and customisable for each mine's specific characteristics, allowing for ongoing monitoring.

Lastly, guidelines for barrier pillars are limited and rely mainly on ambiguous rules of thumb. To improve this, the last part of the dissertation presents a new linear model for estimating the spacing of barrier pillars by using large-scale numerical simulations and multivariate regression analysis. The simple linear model, which depends on mining depth and extraction ratio, was confirmed using the case study of a hard rock room-and-pillar mine and an arbitrary hypothetical mine. Its application proved to provide adequate regional mine support and enhanced stiffness of the entire pillar systems. Additionally, the model was compared to the rules of thumb. This method is an improvement over the rules of thumb, which may result in ore sterilisation and unreliable designs in certain circumstances.