The Fourth Australiasian Ground Control in Mining Conference 2018

Paper Number: 97

New tools for ground control in freeze shaft sinking

S Bock[1], J Franz[2] and N Hentrich[3]

1. Senior Design Manager, Deilmann-Haniel GmbH, 44319 Dortmund, Germany.

2. General Manager of Geo Engineering & Exploration, DMT GmbH & Co. KG, 45307 Essen, Germany. formerly Deilmann-Haniel GmbH, 44319 Dortmund, Germany

3. Senior Design Manager, Deilmann-Haniel GmbH, 44319 Dortmund, Germany.

ABSTRACT

Artificial ground freezing is the unrivalled method for groundwater control during mine shaft sinking. Moreover, ground freezing may also provide temporary ground support. The fast development of fibre-optic temperature monitoring devices, three-dimensional freeze pipe survey methods and numerical modelling software provide grounds for developing new and reliable tools for ground control during freeze shaft sinking.

This paper presents examples of predictive numerical models that are based on back-analysis and calibration of temperature data that covers the complete construction cycle from pre-freezing through to artificial thawing. The back-analyses showed that standard numerical models are not capable of predicting the prevailing thermo-mechanical conditions satisfactorily. This paper describes the development and implementation of new tools for improved consideration of concrete hydration and latent heat, along with the introduction of other algorithms that improve and simplify the efforts of managing complex numerical models. A function is presented that allows for an automated correction of the model's mesh based on results of three-dimensional freeze pipe surveys. This paper demonstrates that the latter consideration is important, because the often employed assumption of idealised freeze circle geometry in numerical models impacts on the accuracy of such model's predictions. Subsequently, the verification of these extended numerical models is demonstrated. Due to its flexibility, the FLAC3D™ code was employed for the numerical modelling. This software provides the possibility of implementing additional functions written in internal FISH or Python language into the models.

It is concluded that state-of-the-art techniques for freeze hole drilling and surveying, on-site monitoring and advanced numerical analysis provide a significant potential for both the design and the operation of large-scale ground freezing measures. The application of the extended numerical models for predictive simulations during construction allows for temporary shaft lining optimisation, for assisting in operational decision making and for compensating temporary loss of monitoring data. Suggestions are made for required future work in order to further improve the developed ground control tools.