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ESTIMATING ROCK MASS LONG-TERM STRENGTH USING IN-SITU MEASUREMENT AND TESTING RESULTS

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Abstract

A method for estimating rock mass long-term strength (σ_{LT}) using the results of *in situ* measurement and test has been developed. It consists of estimation of rock mass strength (σ_{cm}) using Hoek-Brown criterion, determination of rock mass modulus of deformation (E_m) through Goodman's jack test, and construction of rock mass rheological model based on displacement monitoring data, taking into account the stress changes due to stoping activities underneath the test and monitoring locations. The rheological model is used to determine the rock mass long-term modulus of deformation (E_{LT}). It is proposed that the long-term strength of rock mass can be estimated by using the rock mass strength and deformation modulus, rock mass long term modulus, and a coefficient that depends on the rock mass characteristics.

Keywords: Rock mass; Hoek-Brown criterion; Long-term strength; Rheological model.

1. Introduction

Reliable estimate of rock mass strength is required for almost any form of analysis used for the design of underground excavations. Hoek and Brown [1] proposed a method for obtaining estimates of the strength of jointed rock masses, based upon an assessment of the interlocking of rock blocks and the condition of the surfaces between these blocks. This method was modified over the years in order to meet the needs of users who applied it to problems that were not considered when the original criterion was developed. A review of the development of the criterion and of the equations proposed at various stages in this development is given in [2].

Although it is very useful for estimating the rock mass strength, the Hoek-Brown criterion can not be used in estimation of rock mass long-term strength, for which there is no method currently applicable [3, 4, 5]. This work suggests an alternative method for estimating the long-term strength of the rock mass, in particular that in Pongkor underground gold mine, Indonesia. It combined laboratory test, *in situ* test and monitoring, and numerical and rheological modelling.

2. Rock and Rock Mass Strengths

2.1. *Intact Rock Strength*

Among others, uniaxial and triaxial compression tests seem to be the most frequent tests conducted for design purposes. However, researches have revealed that the uniaxial compressive strength is not an intrinsic material property, as it depends on the specimen geometry (size and shape) and loading rates.

Researches on the geometrical effects have concluded that there is a reduction in strength with increasing sample size. Medhurst and Brown [6] have reported that for coal from Moura mine in Australia, the 'critical' sample size is about one metre, above which the strength remains constant. This argument was further extended by Hoek and Brown [2] who suggested that when dealing with large scale rock masses, the strength will reach a constant value when the size of individual rock pieces is sufficiently small in relation to the overall size of the structure being considered.

A number of studies also reported that the strength decreases as the sample slenderness increases. In addition, it has been observed over