IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

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Project title: Investigation of influence of scale effects of strength and failure modes of deep open cut slopes.

Project number: IMURA0112

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Research Academy theme/s

List only the research academy theme/s that is relevant to the project

1. Infrastructure engineering
2. Advanced computational engineering, simulation and manufacture

The research Problem Project Title

Despite significant advances in the study of rock mass behaviour over the past three decades, our knowledge of the *mechanisms for large rock slope failure* and determination of the *rock mass strength* are limited, specially for large and steep slopes in hard, brittle and jointed rock media. There are large amount of work conducted to investigate the strength of slopes and failure modes. These studies are based on results of small scale lab based samples and use of numerical simulations. However, the use of lab based results does not really represent filed scale rock mass/rock slopes.

A great deal of research has aimed at 'upscaling' laboratory scale strength parameters so as they may be applied to much larger scales of design. Empirical studies have concentrated on finding size relations between small size laboratory specimens (e.g. in the range of 30-150 mm diameter cylinders) and also on large scale case studies and back analysis to derive suitable scale relationships. It is generally accepted that there is a significant reduction in strength with increasing sample size, and this general relation quantifying the phenomena is the current benchmark. Hoek (2000) suggests this reduction in strength is due to the increased probability that failure of the rock grains will occur as the sample size is increase. This will reach an asymptotic minimum level at a set sample size that will depend on the type and condition of the rock. Hoek (2000) goes further, hypothesising that when considering large scale rock masses, the strength will reach a constant minimum value if the sizes of the rock blocks are considerably smaller than the scale of the entire rock mass.

Therefore, a comprehensive investigation of influence of scale effects on the slope failure and slope collapse can lead to a better understanding of the failure mode, influence of scale effects, and governing mechanics of failure. In addition to that once the failure mechanics is identified with the geomechanical parameters, the back analysis can be carried out for the determination of strength parameters of those high slopes.

Project aims

The aims of the project are:

(1) To investigate the influence of size effects on the strength of rock mass: Experimental study: various samples sizes and samples with various joint geometries (orientation, joint roughness and joint density) will be tested for samples up to 300mm dia.
(2) To investigate the influence of size effects on the failure mode of a slope and the strength of rock mass: Numerical study: A "Synthetic RockMass" model provided by BHPB will be used to upscale the lab parameters to the field scale problems. These obtained lab parameters first validated with the Synthetic rockmass model output and then will be used in FLAC 3D model to study the influence of scale effects on the failure modes of large deep open cut mines and to determine the strength. The obtained numerical model parameters will also be compared with the conventional methods outputs.
(3) To develop a some guidelines for the use of "Synthetic rock mass" to interpret their results
(4) To quantify the factors contributing to the strength of large scale rock masses.

Expected outcomes

The proposed research project will provide:

(1) Improved understanding of the mechanisms of failure of modes, scale effects on the strength and its influence on the failure mechanism;

(2) Improved understanding on the use of "Synthetic RockMass" model for upscaling rock mass properties for field scale problems

Which of the above Theme does this project address?

This project will address the main research themes on (1) Infrastructure engineering by handling the design and model behaviour of large and deep open-cut mines, monitoring the slopes behaviour and (2) Advanced computational engineering, simulation of mine slopes and back analysis of existing slopes using FLAC3D.

How will the project address the Goals of the above Themes?

Open cut mines comes under the infrastructure engineering. Slope failure can cause extensive delay in mining operation, lost of lives, lost of production cost and some cases closure of mine for a long period of time or indefinitely. The understandings of the mechanisms of slope failure, failure patters, and rate of the slope movement using combined advanced computational simulations with filed works are necessary. Hence the goals of the above themes will be addressed by rigorous analysis of well defined slopes from Australia as well as other countries.