IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project title: Investigation of fundamental mechanism on rock fracture by nanomechanics based modeling techniques.

Project number: IMURA0125

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Research Academy theme/s

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

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

The research problem

Fracture behaviours of rock structures have become a topic of practical importance, as applied in the design of the rock structures generated by mining, drilling, reservoir production, or civil construction activity, e.g. tunnels, mining shafts, underground excavations, open pit mines, oil and gas wells, road cuts, waste repositories, and other structures built in or of rock. It also includes the design of reinforcement systems such as rock bolting patterns. It is important to have an understanding of the fundamental mechanism of rock fracture under different displacement rates and moisture contents. This is because rock structures are subjected to drying and wetting process and various loading condition including in situ stresses, induced stresses and earthquakes.

Project aims

The main aim of the project is to establish a novel nanomechanics based theoretical scheme by using atomistic modeling techniques to analysis the fracture behaviors of rock structures including the crack closure, crack initiation, secondary cracking, crack damage and peak failure of dry, partially wet and fully wet concrete specimens at displacement rates corresponding to different loading rates. The proposed nanomechanics based scheme will be verified experimentally in the lab of department of civil engineering, Monash University.

Expected outcomes

The expected outcomes and benefits include:-

(1) Develop nanomechanics based analytical models for rock structures failure under various loading conditions with the aid from atomistic modeling techniques;
(2) Establish the understanding on the effect of fluid on rock structures fracture;
(3) Provide basis for developing design standards for strengthening rock structures;
(4) Strengthen international cooperation on research into the application of nanotechnology in civil engineering.

Which of the above Theme does this project address?
This project will address the main research themes on (1) Infrastructure engineering - the modelling of fracture behaviour of rock structures including tunnels, mining shafts, underground excavations, open pit mines, oil and gas wells, road cuts, waste repositories, and other structures built in or of rock, and (2) Nanotechnology – atomistic modelling techniques will be conduced in the project.

How will the project address the Goals of the above Themes?
This proposal is directed mainly towards the following categories: Underground. It comes under the infrastructure engineering and nanotechnology. The prediction of fracture behaviours of rock structures from the view of nanomechanics may promote the understanding on fundamental mechanism of rock fracture and it is of highest importance in underground excavation works including mining, civil and petroleum engineering. Advanced computational techniques - nanomechanics based methods will be adopted in the project.