Pre-conference Workshop (27th Nov) of ACCM-4 (28th – 29th Nov 2019)

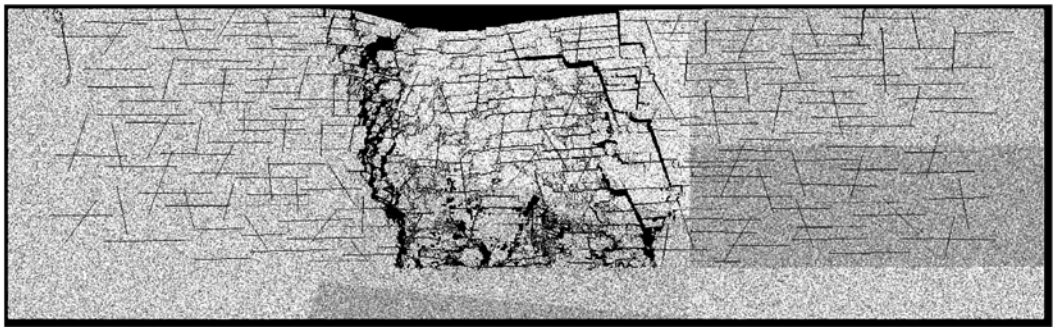
Realistic Failure Process Analysis (RFPA)

Session 1 (9am-12pm) of the Workshop on "Computational Hardrock Mechanics"

Objective:
The objective of the Session 1 of the workshop on "Computational Hardrock Mechanics" in the 4th Australasian Conference on Computational Mechanics to be held at University of Tasmania on 27th – 29th November 2019 is to describe the features of RFPA method, show how it can be used for failure process analysis of materials such as rock or concrete and associated civil engineering structures, and demonstrate its applications. This session includes 2 parts. The first part is a brief introduction of the RFPA principle. The second part demonstrates various potential applications of RFPA in modelling rock failure under laboratory condition, modelling rock failure considering rock reality and modelling rock failure under field circumstances.

Abstract:
Many rock engineering problems involve potential and actual unstable rock failure, such as rockbursts, coal and gas outbursts and crack development in hydraulic fracturing. For this reason, the brittle failure of rock has received considerable attention. Various models and fracture criteria have been invoked in attempts to capture the essential features of the mechanisms which lead to brittle fracture in intact rock and the rock mass. Although much progress has been made and theories and models, such as fracture mechanics and damage mechanics, have provided techniques to solve fracture problems in rock, few approaches are capable of capturing fracture initiation, propagation and coalescence and hence of investigating fracture-induced progressive failure of rock.

A major difficulty in modeling the fracture mechanisms for rock subjected to various loads is the fact that rock is a natural, composite material which is Discontinuous, Inhomogeneous, Anisotropic and Not Elastic (DIANE). It is not possible to analytically examine and evaluate the mechanical behavior of a DIANE rock exhibiting an unstable failure process. The problem becomes more intractable if gas or fluid, as in coal and gas outbursts, hydraulic fracturing, etc., is involved. In most of the cases, analytical models have to be simplified, ignoring important factors influencing the mechanical behavior of rock.



The RFPA modelling result of block caving with undercut depth 1500 m (More RFPA modelling results can be found in www.mechsoft.cn or by sending email to RFPA@mechsoft.cn)

Numerical models that simulate the detailed fracturing sequence are thus useful for understanding rock failure mechanisms on both the small and large scales. A newly developed numerical code, the Realistic Failure Process Analysis (RFPA) model, is firstly introduced. Then, examples are presented in the seminar illustrating how the overall macroscopic response of a brittle rock can be simulated by integration of the interactions between smaller-scale elements. Also, through the modeling of slope/tunnel collapse, strata movement in coal mining, block caving in ore mining, it will demonstrate that RFPA is possible to analyze large-scale practical problems.

Audiences:
This seminar is intended for geoscientists, material scientist, engineers, and students working in the field of rock mechanics, geomechanics, mining engineering, civil engineering and material science. Mechanics experts in university and institutes, engineers and post-graduate students who are involved in rock or brittle material failure process analysis, design and construction activities associated with rock and concrete failure problems in or on fractured materials or structures will benefit from the seminar. A basic understanding of rock or concrete mechanics and computational mechanics is desirable for participants, but the seminar is self-contained; those never exposed to computational mechanics will rapidly pick up the major principles because materials are presented from a mechanical and physical point of view. Even those specialized in numerical methods will find new ideas and methods that will affect how they approach well analysis for complicated rock and concrete failure problems.

Speakers:

The RFPA session will be given by Professor Chun'an Tang and his assistants including Dr Liu. Dr. Tang, as a chair Professor (funded by Cheung Kong Scholar Programme from State Education Ministry), was the Director of the Institute for Deep Underground Engineering and Deep Geothermal Energy and the Director of the Center for Rock Instability and Seismisity Research of Dalian University of Technology, and Chief Scientist of Mechsoft. He was also Vice President of Chinese Society of Rock Mechanics CSRM, and China National Group Chairman of International Society of Rock Mechanics. In 1984, he started his PhD research, in Northeastern University, China, and got his PhD in 1988. In 1991, he continued his post-doctoral work in Imperial College, UK (worked with Prof. J.A.Hudson). Then, as an academic visitor, he had lots of experience working in Canada, Sweden, Singapore, Switzerland and Hong Kong. He leads several major research projects in rock mechanics, especially on rock failure process analysis and monitoring in civil engineering. His work is funded by the "Trans-Century Training Programme Foundation for Outstanding Young Scholars in China" from the State Education Ministry and by the "Special Natural Science Foundation for Outstanding Young Scholars in China" from National Nature Science Foundation. So far, he has published about 300 technical papers on rock failure mechanisms and civil engineering, and is the author of five Chinese books of rock mechanics and the principle author of "Rock Failure Mechanism" published by CRC (Taylor & Francis Group, 2010, UK).

Dr Hong Yuan Liu is a senior lecturer at University of Tasmania and one of the early developers of RFPA. He completed his BEng and MSc at Northeastern University under the supervision of Prof Tang and his PhD at Lulea University of Technology in Sweden. He had worked in University of Sydney and University of Queensland for about three years each before joining in UTAS as a lecturer.

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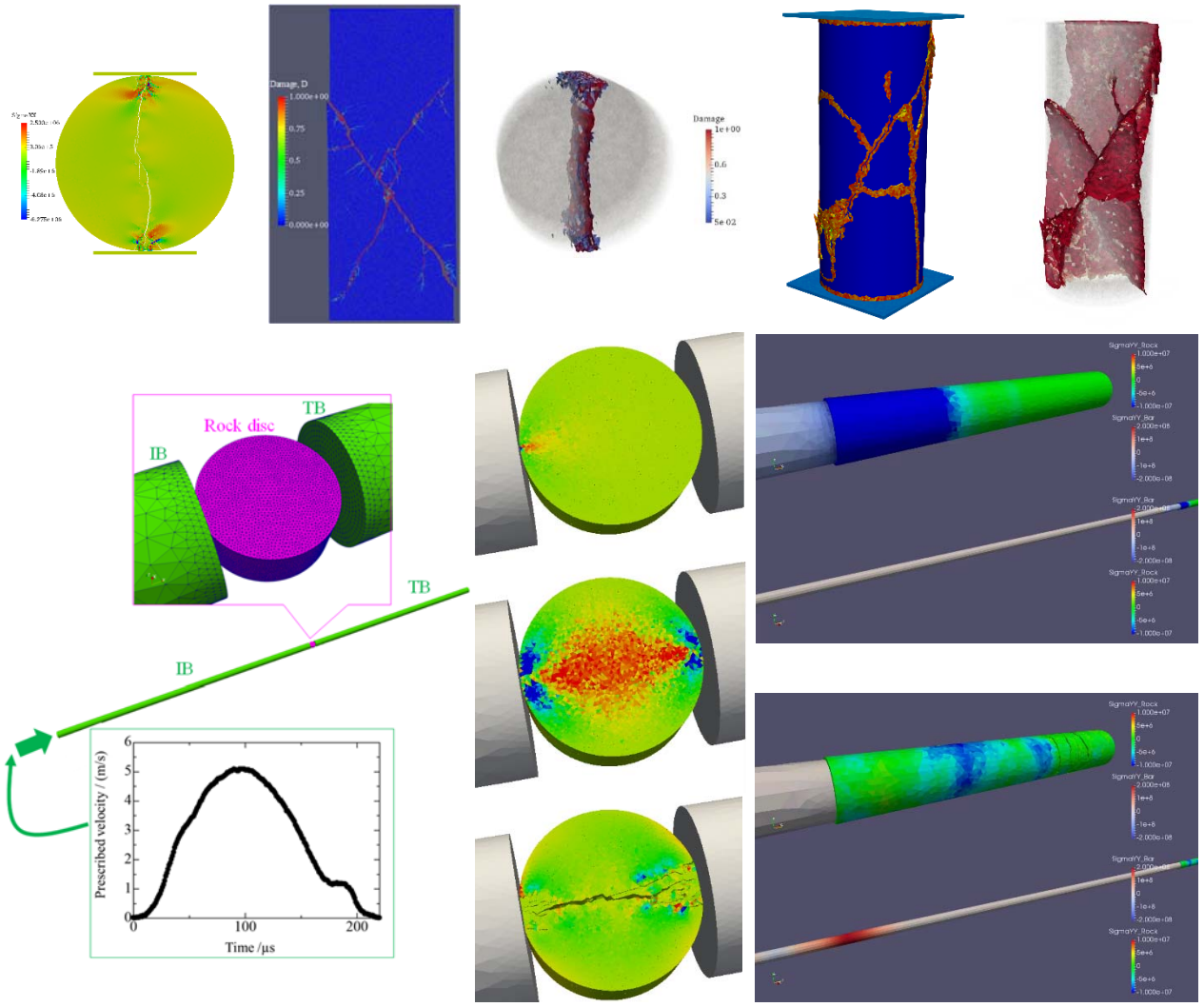
Modelling Rock Fracture and Fragmentation using GPGPU-Parallelized FDEM

Session 2 (1pm-4pm) of the Workshop on "Computational Hardrock Mechanics"

The objective of the Session 2 of the workshop on "Computational Hardrock Mechanics" in the 4th Australasian Conference on Computational Mechanics is to demonstrate the application of Y-HFDEM IDE2D/3D, i.e. a two-dimensional (2D) and three-dimensional (3D) general-purpose graph-processing-unit (GPGPU) parallelized hybrid finite-discrete element method (FDEM) developed at University of Tasmania in collaboration with Hokkaido University on the basis of the sequential Y open-source FDEM library, in modelling rock fracture and fragmentation.

It includes two parts, the first of which is a brief introduction of the FDEM principle, GPGPU parallelization, contact damping, contact friction, local damping, adaptive contact activation and mass scaling. The second part demonstrates various potential application of Y-HFDEM IDE2D/3D in modelling the fracture process of rocks under both static and dynamic laboratory loading conditions and the fragmentation process of rocks in mechanical cutting, rock blasting, and excavation-induced rock strata collapse.



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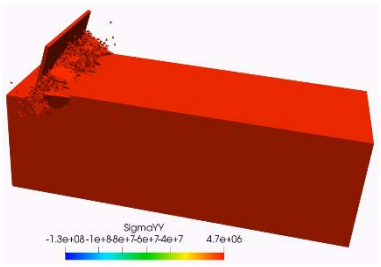
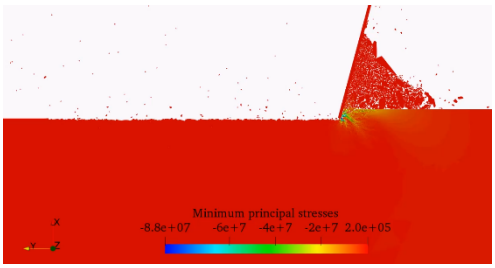
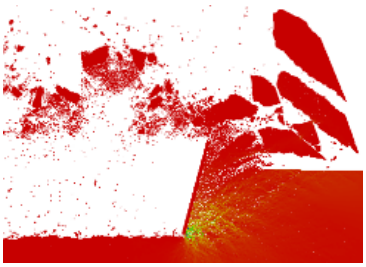
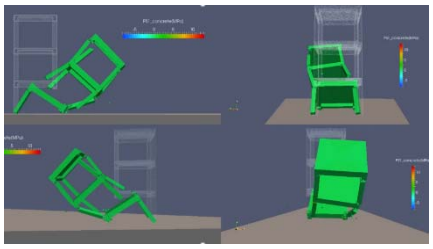


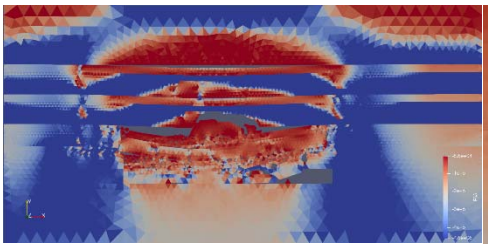




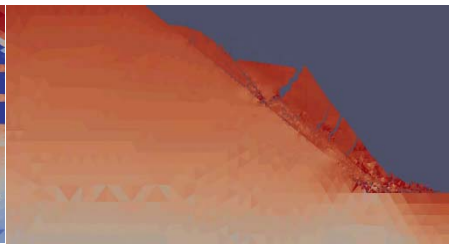
Rock cutting



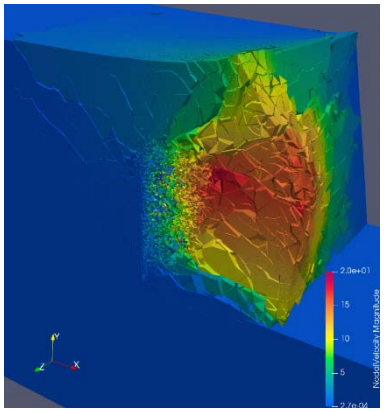
Structure Demolition

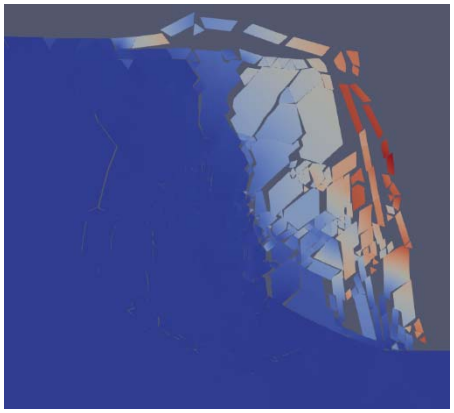


Excavation-induced strata movement

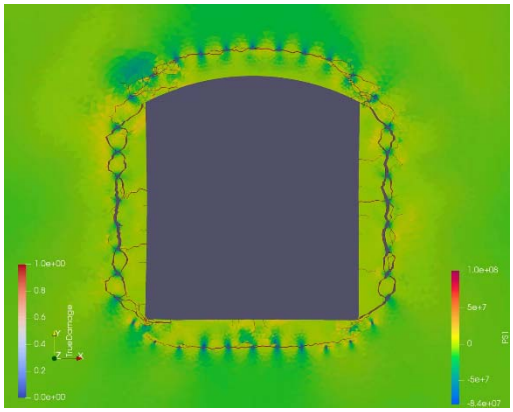


Excavation-induced slope instability





Bench Blasting



Contour Blasting

Speakers:

Prof Andrew Chan
Head of School of Engineering
University of Tasmania (UTAS)
Workshop Opening Ceremony

Dr Hong Yuan Liu
Senior Lecturer in Geomechanics in UTAS
Development of GPGPU-parallelized HFDEM IDE and application in rock cutting and blasting

Moji Mohammadnejad
PhD Candidate in UTAS
How to model rock failure process using GPGPU-parallelized HFDEM IDE

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