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ABSTRACT

SOME GEOMETRIC CONSIDERATIONS IN THE SIMULATION OF TENSILE AND SHEAR FRACTURE GROWTH PROCESSES USING THE DISPLACEMENT DISCONTINUITY METHOD

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The simulation of fracture propagation in brittle materials such as rock or concrete can assist the design of built structures and is useful to aid the forensic analysis of failure mechanisms near mine excavation surfaces. The mechanics of specific applications such as hydraulic fracturing can be analysed as well if suitable models are available to determine likely fracture propagation trajectories. The presentation describes recent progress that has been made in the ongoing development of both two-dimensional and three-dimensional displacement discontinuity fracture growth models to represent tension and shear failure processes. Two growth strategies have been explored. In the first approach, tensile or shear band surfaces are assumed to expand according to prescribed growth rules which govern the advance of the surface edge in a series of explicit growth steps. Each failure surface is represented using discontinuity line segments in two dimensions or is built up using flat triangular or quadrilateral displacement discontinuity elements in three dimensions. It is recognised that this simple strategy may be limited if crack fronts are subjected to mixed-mode loading or are required to represent some of the complexities of shear band structures. A second growth strategy using a special projection plane technique has been developed to allow the representation of mixed mode fracture front stepping in tensile fracture propagation and preliminary extensions to the simulation of shear fracture formation have been evaluated. A initial assessment is made of the limitations of these modelling strategies by considering some typical generic examples of mixed mode fracturing, “petal” fracturing, near-surface fracture propagation and preliminary applications to deep level mine excavation fracturing.

JOHN NAPIER – BIOGRAPHICAL SKETCH

John Napier trained originally as a Chemical Engineer at the University of the Witwatersrand and joined the Chamber of Mines Research Organisation (COMRO) in 1971. He worked extensively on problems of operations research relating to coal mine production planning and then completed a PhD in the field of Gold Mine Planning with emphasis on the development of an econometric model of gold mine capital expenditure and the analysis of optimal grade selection policies. Following these activities, he became involved in rock engineering research and was responsible, with John Ryder, for the design and development of a computer code for the analysis of large scale tabular mining excavations (MINSIM-D) used extensively in the South African gold mining industry. John subsequently assumed responsibility for coordinating research into deep level gold mine rock mass behaviour at COMRO, working mainly to develop models of rock fracture propagation and elastodynamic fault slip behaviour. Following the takeover of COMRO by the CSIR to form the Division of Mining Technology, John was elected as a CSIR Fellow in 1997 and has worked with the Fellow group in introducing initiatives relating to the promotion of scientific excellence within the CSIR. He retired from the CSIR in April 2004 and currently holds an honorary Professorship in the School of Computational and Applied Mathematics at the University of the Witwatersrand, Johannesburg as well as remaining a CSIR Fellow. John is a Fellow of the South African Institute of Mining and Metallurgy and a Fellow of the South African National Institute of Rock Engineering. He was invited to be an MTS Visiting Professor at the University of Minnesota during 1997. He has published a number of papers relating to gold mine planning and rock fracture mechanics.