6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

A FINITE-DISCRETE ELEMENT METHOD FOR DYNAMIC CRACK PROPAGATION IN HETEROGENEOUS MATERIALS

Andreas Kampitsis[1], Ado Farsi[2], Jiansheng Xiang[3], John-Paul Latham[4]

Applied Modelling & Computation Group, Department of Earth Science and Engineering,
Faculty of Engineering, Imperial College London, SW7 2BP, UK.
a.kampitsis@imperial.ac.uk[1], ado.farsi@imperial.ac.uk[2]
j.xiang@imperial.ac.uk[3], j.p.latham@imperial.ac.uk[4]

Key Words: *Crack Propagation, Material Microstructure, Heterogeneous Materials, Finite-Discrete Element Method.*

Numerical simulations based on the Coupled Finite-Discrete Element Method (FEMDEM) have been around for almost twenty years. The Y-code [1] was released by Munjiza in 2004, and after various code developments [2] has been released by the Applied Modelling and Computation Group (AMCG) at Imperial College London [3]. While the first Y-code employed finite strain elasticity coupled with a smeared crack model to capture deformation, rotation, contact interaction and fragmentation, the AMCG has greatly improved the code, implementing a range of constitutive models in 3D [4] and parallelisation and a faster contact detection algorithm [5]. Computational simulation of such processes is a challenging task, as the underlying mechanics span various temporal and length scales.

In this work, the problem of dynamic crack initiation and propagation in heterogeneous materials, is presented using FEMDEM. The solid domain is discretised with a triangular mesh, where each triangle is both a discrete element and a linear finite element. Dynamic cracking is treated by 4-noded joint-elements inserted between each couple of adjacent edges of the triangular finite-discrete element mesh. For the fracture model both the tensile (Mode I) and the shear (Mode II) stresses in joint elements are taken into account. The combined FEMDEM uses an explicit solver and thereby transient dynamics can also be taken into account. Validation as well as assessment of the proposed numerical scheme is performed though a set of illustrative benchmark problems. The computational model is then used to simulate a Brazilian Test experimental set up, illustrating its accuracy and capabilities.

REFERENCES

[1] A. Munjiza, *The Combined Finite-Discrete Element Method*. Wiley, 2004.

[2] E. Rougier, E. Knight, S. Broome, A. Sussman, and A. Munjiza, ‘Validation of a three-dimensional Finite-Discrete Element Method using experimental results of the Split Hopkinson Pressure Bar test’, *Int. J. Rock Mech. Min. Sci.*, 70, 101–108, Sep. 2014.

[3] J. Xiang, A. Munjiza, and J. Latham, ‘Finite strain, finite rotation quadratic tetrahedral element for the combined finite-discrete element method’, *Int. J. Numer. Methods Eng.*, 79, 8, 946–978, Aug. 2009.

[4] N. Karantzoulis, J. Xiang, B. Izzuddin, and J. P. Latham, ‘Numerical implementation of plasticity material models in the combined finite-discrete element method and verification tests’, 319–323, 2013.

[5] J. Xiang, J. Latham, and A. Farsi, ‘Algorithms and Capabilities of Solidity to Simulate Interactions and Packing of Complex Shapes’, in *7th Inter Conf on DEM*, Springer Singapore, 139–149, 2017.