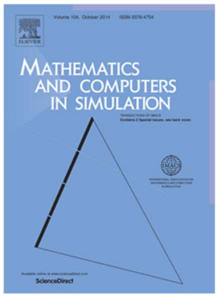

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A multi-cracked particle method for complex fracture problems in 2D

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Abstract

Practical fracture problems are characterised by complex patterns of multiple and branching cracks, somewhat far removed from the fracture problems used for validation of numerical methods, involving single cracks, and the simulation of complex multi-tipped cracks brings many challenges to current numerical methods. The cracking particle method (CPM) incorporates the description of a crack path into the meshless nodes or particles used to discretise a domain. The CPM has recently been improved to make the crack paths continuous and to include adaptivity. In this paper we take this improved CPM further and introduce new crack particles which can model multiple fractures to handle crack branches and crack junctions without the need for any specialised techniques such as enrichment. Some examples with complex crack patterns are tested to show the performance of the proposed methodology and good results are obtained which agree well with previous papers.

Keywords: Cracking particle method, meshless, multiple cracks, adaptivity

1. Introduction

Fracture is a common phenomenon affecting materials such as soil, bone and concrete, however theoretical work to study this problem is difficult to carry out since fracture is a highly non-linear behaviour. In recent decades, several numerical methods have been used for fracture simulation, such as the finite element method (FEM) [33, 46, 52], the extended FEM (XFEM) [6, 18], the element-free Galerkin method (EFGM) [9–11], the numerical manifold method (NMM) [27, 40, 48] and the cracking particle method (CPM) [35, 38, 39], and many good predictions have been obtained for standard test cases [8, 31]. However, there are limitations to the use of some of these numerical methods when applied to more complex examples. Specifically, in the FEM, a crack path is confined to mesh edges perhaps with the use of interface elements [46]. In the XFEM and the EFGM, an explicit description of the crack path is required, which is usually fulfilled using level set functions, and when the number of cracks increases, the expense of updating the level set functions becomes very high [17, 50]. In the NMM, the discontinuities along crack paths are handled by dividing the problem domain into "mathematical covers" and "physical covers", but

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