Arbitrary bi-dimensional finite strain crack propagation

D. Dias-da-Costa[1*], P. Areias[2], J. Alfaiate[2], E. Júlio[1]

[1]*ISISE, Department of Civil Engineering, University of Coimbra, Rua Luís Reis Santos, Coimbra, 3030-788, Portugal*
[2]*ICIST, Department of Civil Engineering, Instituto Superior Técnico, Av. Rovisco Pais, Lisbon, 1049-001, Portugal*
e-mail: dcosta@dec.uc.pt, pareias@civil.ist.utl.pt, alfaiate@civil.ist.utl.pt, ejulio@dec.uc.pt

Keywords : Discrete fracture, quasi-brittle materials, ALE, complementarity

Abstract

In the past two decades numerous numerical procedures for crack propagation have been developed. Lately, enrichment methods (either local, such as SDA or global, such as XFEM) have been applied with success to simple problems, typically involving some intersections. For arbitrary finite strain propagation, numerous difficulties are encountered: modeling of intersection and coalescence, step size dependence and the presence of distorted finite elements. In order to overcome these difficulties, an approach fully capable of dealing with multiple advancing cracks and self-contact is presented (see Fig.1). This approach makes use of a coupled Arbitrary Lagrangian-Eulerian method (ALE) and local tip remeshing. This is substantially less costly than a full remeshing while retaining its full versatility. Compared to full remeshing, angle measures and crack paths are superior. A consistent continuation-based linear control is used to force the critical tip to be exactly critical, while moving around the candidate set.
The critical crack front is identified and propagated when one of the following criteria reaches a material limiting value: (i) the stress intensity factor; or (ii) the element-ahead tip stress. These are the control equations.
The ability to solve crack intersection and coalescence problems is shown. Additionally, the independence from crack tip and step size and the absence of blade and dagger-shaped finite elements is observed. Classic benchmarks are computed leading to excellent crack path and load-deflection results, where convergence rate is quadratic.

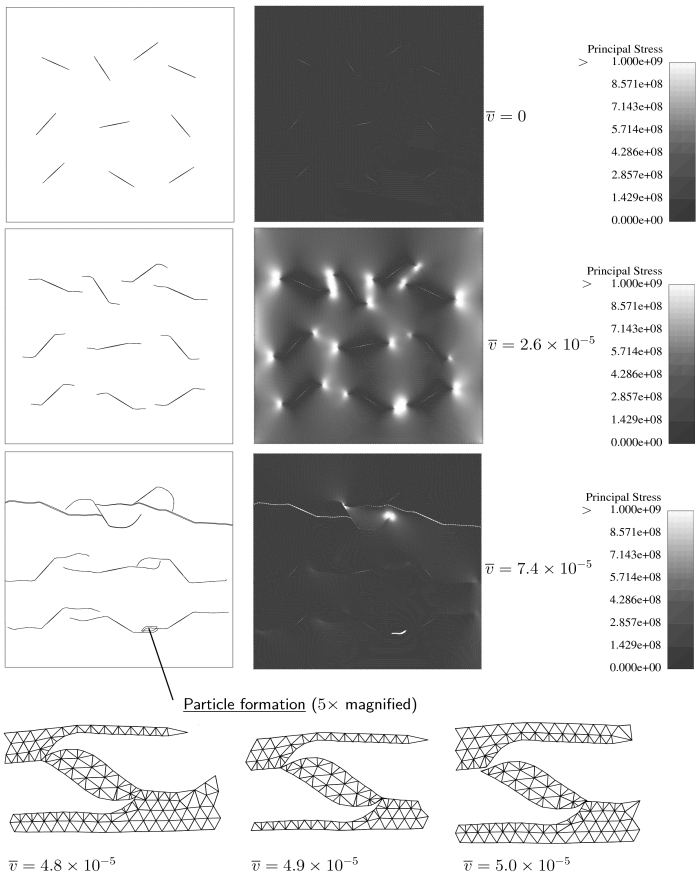

Fig. 1 Multiple crack propagation by remeshing and ALE