This paper presents a finite element based numerical framework for the predictive modelling of three dimensional crack propagation in brittle solids. The presentation briefly sets out the theoretical basis for determining the initiation and direction of propagating cracks, based on the concept of configurational forces. Attention is focussed on resolution of cracks by the finite element mesh. Cracks are restricted to the element faces and the mesh is adapted in order to align element faces with the predicted crack path. A local mesh improvement procedure is developed to maximise mesh quality in order to improve accuracy and solution robustness and to reduce the influence of the initial mesh on the direction of propagating cracks. The performance of this modelling approach is demonstrated on three numerical examples that qualitatively illustrate its ability to predict complex crack paths. All problems are three-dimensional, including a torsion problem that results in the accurate prediction of a doubly-curved crack. In order to trace the dissipative load-displacement path, fully consistent with the assumption of quasi-static crack propagation, an arc-length scheme is adopted with a control function taken as an increment in change in crack surface area. Finally, the influence of hp-adaptivity is studied and the smoothing influence on the load-displacement response is demonstrated.

The approach taken in this paper is principally based on the principle of global maximum energy dissipation for elastic solids, with configurational forces determining the direction of crack propagation. This has been successfully adopted by a number of other authors, but here we mainly follow the work of Gürses and Miehe [1]. Such an approach for predicting the crack path can be coupled with local r-adaptivity to mitigate the influence of the mesh. In this paper problem tailored mesh improvement technique base on a volume-length quality measure is adopted. The fracture criterion is based on the Griffith force work conjugate to crack area increase. The governing equations are solved monolithically for material and spatial displacements.

**Examples**

Three numerical examples are presented for crack propagation in three-dimensions that demonstrate the ability of the formulation to accurately predict crack paths, as well as demonstrate mesh independence and the influence of both mesh adaptivity and controlling mesh quality on the solution obtained.

**Acknowledgements**

This work was supported by EDF Energy Nuclear Generation Ltd.

**References**