FE modelling of quasi-brittle cracks in 2D and 3D with enhanced strain accuracy

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ABSTRACT

Modelling of cracking in quasi-brittle materials has been the object of intensive study in computational solid mechanics over the last five decades. In most of the studies carried out with standard irreducible elements, the attempts to predict the crack path fail because the obtained solution suffers from spurious bias mesh dependency. The problem is addressed via a mixed strain/displacement finite element formulation [1-4].

In this presentation, a mixed strain/displacement finite element formulation is applied to the solution of nonlinear solid mechanics problems. For this, an enhanced version of the finite element program COMET [5] has been developed. The proposed mixed formulation is fully general and is applied in 2D and 3D. Also, it is independent of the specific finite element discretization considered; it can be equally used with triangles/tetrahedra, quadrilaterals/hexahedra and prisms.

The feasibility and accuracy of the method is assessed through extensive comparison with experimental evidence. The correlation with the experimental tests shows the capacity of the mixed formulation to reproduce the experimental crack path, failure mechanism and the force-displacement curves with remarkable accuracy. Both 2D and 3D examples produce results consistent with the documented data. Spurious mesh dependency suffered by both continuous and discontinuous irreducible formulations is avoided by the mixed FE, without the need of auxiliary tracking techniques or other computational schemes that alter the continuum mechanical problem.

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