Numerical modeling of crack front segmentation under mode I+III loading

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ABSTRACT

Crack growth under combined mode I+III loading has been widely studied over the past decades since the pioneering works of Sommer [1] and Knauss [2]. Such a loading leads to a crack rotation around the direction of propagation in order to reduce mode III and reach a pure mode I situation, which is achieved by a fragmentation of the initial crack into multiple daughter cracks usually called facets. Once initiated, some of these facets grow and coalesce to form a stepped fracture surface becoming coarser as the crack grows. Several models such as *e.g.*, [3], are able to capture the crack rotation from a macroscopic point of view . However, modeling the crack front segmentation into multiple daughter crack is still challenging and looks like a crack initiation problem rather than a problem of crack growth. In the present work, a numerical study of the crack front segmentation into facets under mode I+III is proposed. Facets initiation ahead of a parent crack is predicted through a three dimensional application of the coupled criterion [4]. Crack initiation shape, orientation and spacing are determined for any mode mixity ratio by coupling a stress and an energy criterion using matched asymptotic expansions. 3D finite element modeling of a periodic network of facets ahead of the parent crack allows computing the stress and the energy conditions. The initiation shape, loading and spacing of facets depend on the blunted parent crack tip radius. A good estimate of facet orientations is obtained based on the direction of maximum tensile stress. The facet shapes, determined based on the stress isocontours, are qualitatatively similar to those observed experimentally. The order of magnitude of numerical predictions of facet spacing is very close to experimental measurements [5].

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