THEORETICAL ANALYSES OF CONFIGURATIONAL INSTABILITY OF CRACK PROPAGATION IN MIXED-MODE I+III OR I+II+III: A REVIEW

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The instability of coplanar propagation of cracks loaded in mixed-mode I+III conditions is well documented experimentally. Under such conditions the crack front is generally observed to split into small disconnected tilted facets. This phenomenon occurs in a wide variety of brittle materials, suggesting that it is independent of details of fracture processes and analyzable using the standard tools of LEFM.

This talk reviews some recent analyses of this instability, based on a combination of two elements:

- theoretical formulae of Gao and Rice (1986) and Movchan et al. (1998), providing general expressions of the stress intensity factors along the front of a semi-infinite crack slightly perturbed both within and out of its initial plane;
- a "double" propagation criterion, applied at all times all along the front, combining Griffith (1920)'s energetic condition and Goldstein and Salganik (1974)'s principle of local symmetry.

A first analysis (Leblond et al., 2011) evidenced an instability of coplanar propagation for values of the unperturbed mode mixity ratio K_{III}^0/K_I^0 larger than some threshold depending on Poisson's ratio. But the predicted thresholds were much larger than those generally observed.

Leblond et al. (2019) then proposed an extended analysis incorporating a heuristic dependence of the fracture energy upon the local mixity ratio. Values of the theoretical threshold much more compatible with experiments were then obtained.

Vasudevan (2019) finally further extended the analysis by including a small mode II global loading component. This extra component was found to generate a gradual drift of instability modes along the front during propagation.