

Branching Instability of Brittle Fracture

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A new method for determining the elastodynamic stress fields associated with the propagation of antiplane branched cracks is presented. The exact dependence of the stress intensity factor just after branching is given as a function of the stress intensity factor just before branching, the branching angle and the instantaneous velocity of the crack tip. The jump in the dynamic energy release rate due to the branching process is also computed. Applying a growth criterion for a branched crack, it is shown that the minimum speed of the initial single crack which allows branching is equal to $0.39c$, where c is the shear wave speed. At the branching threshold, the corresponding bifurcated cracks start their propagation at a vanishing speed with a branching angle of approximately 40 degrees. Using these exact results, the branching of a single propagating crack under mode I loading is also considered and the critical velocity for branching is computed.

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