PROPAGATION OF EXTENDED FRACTURES BY LOCAL NUCLEATION AND RAPID TRANSVERSE EXPANSION OF CRACK-FRONT DISTORTION

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Fractures are ubiquitous and can lead to the catastrophic material failure of materials. Although fracturing in a two-dimensional plane is well understood, all fractures are extended in and propagate through three-dimensional space. Moreover, their behaviour is complex. Here we show that the forward propagation of a fracture front occurs through an initial rupture, nucleated at some localized position, followed by a very rapid transverse expansion at velocities as high as the Rayleigh-wave speed. We study fracturing in a circular geometry that achieves an uninterrupted extended fracture front and use a fluid to control the loading conditions that determine the amplitude of the forward jump. We find that this amplitude correlates with the transverse velocity. Dynamic rupture simulations capture the observations for only a high transverse velocity. These results highlight the importance of transverse dynamics in the forward propagation of an extended fracture.