# Configurational Mechanics-Based Study of Mixed-Mode Fracture in Soft Hydrogels

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**Abstract**

When an initial fracture caused by uniaxial tension is subjected to mixed-mode loading, the crack front deviates from its original planar shape. Under mixed-mode I + III (the superposition of tension and out-of-plane shear), the crack front segments into an array of tilted facets. Unlike traditional approaches based on Linear Elastic Fracture Mechanics, this study explores cracks under mixed-mode I + III loading using configurational mechanics. The Configurational Force Method (1,2), implemented as a post processing algorithm in a Finite Element (FE) simulation, extends beyond the linear elastic assumptions of LEFM and offers a more general approach suited for capturing the complex interactions at the crack tip, particularly under mixed-mode loading and finite strains in soft materials.
We develop an idealized geometrical model of cracks subjected to tensile and out-of-plane shear stress, i.e., Échelon-like cracks, which replicates key features reported in earlier experiments-facet number, tilting angle, and shape-across different combinations of modes I and III. Using FE simulations, we analyze the configurational forces at the crack tip before crack onset, providing new insights into fracture mechanics in soft materials under complex mixed-mode loading, particularly unveiling the intricate interaction among tilted facets.

References:

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