

Fracture roughness of concrete sample with hard inclusions

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ABSTRACT

Fracture mechanics has attracted much attention from physicists in many decades. Recently, several remarkably universal features in the fracture process have been discovered, including the anisotropy of fracture surface roughness in directions parallel and perpendicular to the crack propagation, as well as the self-affinity of the crack surface. It has been shown that the crack surface can be described by a roughness parameter called the Hurst exponent, H , whose value is largely debated in the literature [1].

However, the physical role played by the heterogeneities in concrete (i.e., the hard inclusions) in relation to crack roughness is not well understood. The fundamental challenge is here to understand how the development of instabilities for a dynamic propagating crack front within a disordered media.

The aim of this presentation is to investigate via the lattice beam method the scaling properties of fracture in concrete samples without and with hard inclusions. Our lattice is a mesoscale representation of concrete and we focus on mode I cracks. This type of study has essentially been realized by discrete lattice method in two-dimensions or in three-dimensions with quasistatic fuse model [2]. To capture and explain the interplay between disorder and dynamical effects at a mesoscopic scale, we simulate the fracture process from a random three-dimensional lattice beam network developed by G. Lilliu et al. [3], where the aggregate particles are included as spherical grains. Moreover, to satisfy the large computational demand of the discrete-element method, the lattice model based on Bernoulli beams theory is implemented in an open source parallel code.

Our results demonstrate the capacity of the 3D beam lattice model to capture the anisotropy of the fracture surface roughness and to estimate the Hurst exponent. We also exhibit the influence of the hard inclusions on the self-affine properties of the crack surface.

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