Scaling Theory for the Process Zone of Quasibrittle Materials

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we use RG ideas to model the scaling of stress and damage near a disordered crack, or in the crack’s *process zone*

developing a numerical strategy using 2D fuse networks with variable boundary conditions
Introduction
Fracture Mechanisms in Concrete

- mechanism of fracture is size-dependent
- stress relief at crack tip by nonlinear process zone characterized by microcracking
- no consistent geometry-independent characterization of material strength
Introduction
Fracture Mechanisms in Fuse Networks

- fuse network: diamond grid of equally resistive fuses with failure threshold cumulatively distributed as $x^\beta$

$\beta = 3.00$  $\beta = 0.03$
Shekhawat and collaborators found smooth crossover transition between two mechanisms characterized by mean-field avalanches scaling percolation fixed point at infinite disorder unstable, any finite disorder flows to zero-disorder, nucleation-like fixed point however, crossover size is typically extremely large
Studying the Process Zone

The Problem

- stress analysis dominated by finite-size effects
- those effects become far more important with greater disorder
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The Linear Elastic Fixed Point

- After many (500 in blue) iterations, the stress asymptotically approaches the linear elastic result.
- At zero disorder ($\beta = \infty$), linear elastic theory is a fixed point on an infinite lattice.
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Probing the Disordered Region

- the linear elastic theory is unstable to disorder
- rescaling inward for finite disorder should rescale $\beta$ towards $\langle \sigma \rangle \sim$ constant, $\beta = 0$ fixed point
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Open Questions

- how to self-consistently scale $\beta$?
- should $\beta$ scale with the same exponent as it does for finite-size scaling as found by Shekhawat?
- what happens when you consider a realistically rough crack?
Questions?