Master thesis

Phase-field modeling of fracture in architected structural materials

Description: Architected structural materials - such as truss lattices and bioinspired composites - can achieve properties not found in conventional structural materials, such as excellent stiffness-to-weight ratios, superior strength and fracture toughness. They derive these properties not only from their constituent materials but also from their carefully designed geometry and topology at a microstructural scale. This project will specifically explore the predictive modeling of fracture in those materials, which remains a major scientific challenge. To this end, the student will develop and apply phase-field fracture models to simulate crack initiation and propagation in these solids. The goal is to understand how microstructural features — such as periodicity, hierarchical organization, or intentional defects — influence the resulting fracture toughness, fracture modes, and overall energy dissipation. They will also have the opportunity to explore modern machine-learning based surrogate modeling techniques for phase-field evolution as alternatives to classical solvers to reduce computational cost, while collaborating with ongoing experimental efforts. The outcomes of the project is to establish new computational tools for predicting fracture in architected materials, and to provide insights that can guide the design of more resilient structures.

Prerequisites:

- Background in computational mechanics and/or numerical modeling
- Coding skills (Python)

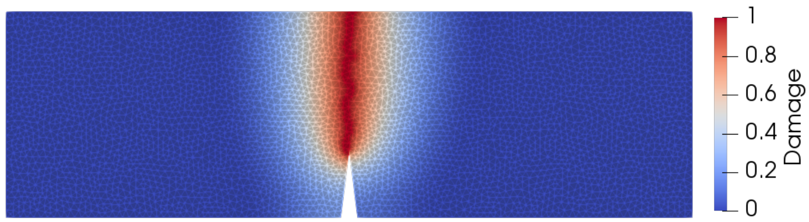

Figure 1: Phase-field modeling of fracture in a structural beam undergoing three point bending.

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