

Phase Field Approaches for Modeling Fracture in Steel and Rubber-like Materials

Christian Linder, Stanford University

Abstract

This presentation explores the essential role of fracture study in materials to optimize performance and ensure engineering safety. Due to their extensive applications and complex behavior, we focus on steel and rubber-like materials. We present micromechanically motivated continuum approaches for modeling their fracture behavior, employing a finite deformation framework and the phase field method for failure propagation. For steel, the model accounts for elastic and plastic strain energies and crack surface energy, incorporating a stress-weighted ductile fracture model to propose an evolution of fracture toughness. In rubber-like materials, we use a multiscale continuum model, bridging deformations through the non-affine microsphere model. Polymer chains are modeled with elastic segments, and entropic free energy and bond stretch internal energy are considered. Nonlocal damage effects and damage evolution due to molecular bond breaking are incorporated at the macroscale. We validate our numerical implementations using the finite element method by comparing simulation results with experimental data.

Biosketch

Professor Christian Linder is the principal investigator of the *Computational Mechanics of Materials Lab* at Stanford University. He received his Ph.D. in Civil and Environmental Engineering from UC Berkeley, an M.A. in Mathematics from UC Berkeley, an M.Sc. in Computational Mechanics from the University of Stuttgart, and a Dipl.-Ing. degree in Civil Engineering from TU Graz. Before joining Stanford in 2013, he was a Junior-Professor of Micromechanics of Materials at the Applied Mechanics Institute of Stuttgart University, where he also obtained his Habilitation in Mechanics. Notable honors include a Fulbright scholarship, the 2013 Richard-von-Mises Prize, the 2016 ICCM International Computational Method Young Investigator Award, the 2016 NSF CAREER Award, and the 2019 Presidential Early Career Award for Scientists and Engineers (PECASE).