

A graph-based phase field framework for damage in complex network materials

Marco Paggi¹

¹ IMT School for Advanced Studies Lucca, Italy. marco.paggi@imtlucca.it

Paper ID: 227

[Symposium S10: Coupled problems in material mechanics](#)

[Extended Abstract](#)

Abstract

A theory for simulating nonlocal damage in 2D lattice structures discretized by Euler-Bernoulli beam finite elements is herein proposed. A phase field approach to damage, projected onto the discretized nodes via the graph Laplacian matrix, is formulated to simulate damage evolution by solving a Helmholtz differential equation on the graph. Damage is introduced in the constitutive equations under the assumption of a bilateral damage evolution in tension and in compression, or a monolateral damage only in tension. Both formulations have been enhanced by a threshold driving force to better capture the onset of damage in polymers due to crazing. The staggered coupling scheme alternates between solving mechanical equilibrium and phase field equations, and it has been validated in relation to experiments on unnotched beams made of ABS subject to three-point bending. The approach is then applied to preliminary investigate the response of a complex network material in the nonlinear regime, contributing to understanding how graph-based topologies influence the load-bearing capacity of the material. The method bridges the gap between statistical physics of complex networks and nonlinear mechanics of materials and is expected to have an impact on the design of robust random metamaterials featuring nodes with large connectivities.

Keywords:

Fracture mechanics Phase field approach Complex networks Lattice materials Metamaterials

