Macroscopic model-free analysis of quasi-brittle failure in heterogeneous materials

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ABSTRACT

Innovative materials for aerospace and automotive applications require the improvement of mechanical properties while reducing the structure's weight; accordingly, engineers have been interested in architectured materials. From an industrial point of view, meshing those materials would remarkably slow down computations. Within this context, efforts to understand the interactions between the microstructures of those materials and the crack propagation at a macroscopic scale are widely spread between physicists and engineers.

Within this work, explicit expressions for upscaling the dynamics of crack propagation in architectured materials are presented. Both the Phase Field Modelling [1] and the Eigen Erosion [2] approaches are used for modelling the microscopic crack propagation: The Phase Field Modelling reproduces energetically the crack bifurcation within a framework allowing for robust and fast numerical simulations, while the Eigen Erosion scheme restricts the eigendeformation in a binary sense: elements can be either intact thus elastic, or failed thus eroded. Results from the two algorithms are then coarse-grained, i.e., continuum equations of motion are produced out of the microscopic dynamics using a convolution between the microscopic entities and a specified coarse graining function with a predefined width; a convolution constrained by continuity and equilibrium equations. [3]

Relating the crack anisotropy to both the coarse-grained information and the structure's geometry allows for a deeper understanding of the interactions between crack propagation and microstructures and elaborates constitutive database/models for a macroscopic continuum accounting for these interactions.

REFERENCES

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