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Deep material network with cohesive layers: multi-stage training and interfacial failure analysis. (English) Zbl 1436.74015

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Summary: A fundamental issue in multiscale materials modeling and design is the consideration of traction-separation behavior at the interface. By enriching the deep material network (DMN) with cohesive layers, the paper presents a novel data-driven material model which enables accurate and efficient prediction of multiscale responses for heterogeneous materials with interfacial effect. In the newly invoked cohesive building block, the fitting parameters have physical meanings related to the length scale and orientation of the cohesive layer. It is shown that the enriched material network can be effectively optimized via a multi-stage training strategy, with training data generated only from linear elastic direct numerical simulation (DNS). The extrapolation capability of the method to unknown material and loading spaces is demonstrated through the debonding analysis of a unidirectional fiber-reinforced composite, where the interface behavior is governed by an irreversible softening mixed-mode cohesive law. Its predictive accuracy is validated against the nonlinear path-dependent DNS results, and the reduction in computational time is particularly significant.

MSC:

74E30 Composite and mixture properties
74A50 Structured surfaces and interfaces, coexistent phases
74S99 Numerical and other methods in solid mechanics

Keywords:

machine learning; model reduction; path-dependency; composites; debonding analysis

Full Text: DOI

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