STOCHASTIC ASPECTS OF HIGH FIDELITY DISCRETE CRACKING SIMULATIONS

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Focus Material: Composites

Focus of the Presentation:
(i) Physics-based multi-scale model development

Abstract

To be regarded as being faithful to reality, simulations of discrete cracking events in composites must be able to relate the stochastic variability of the material to scatter in its engineering properties, e.g., strength and fatigue life. Material variability arises in the positioning of fibers within tows or plies, as well as in the positions and shapes of tows or plies considered as homogenized entities. In recent years, new, rich sources of 3D data on material variability have inspired the generation of stochastic virtual specimens, which are calibrated by measured statistics. Calibrated virtual specimens are being generated at the fiber scale, e.g., bundles of 10^3 fibers; the tow scale, e.g., $10 – 10^2$ tows in a textile unit cell; and the sub-component scale, e.g., $10^4 – 10^6$ tow segments in an integrally woven structure [1]. Simultaneously, new formulations of fracture simulations are being sought that can deal with stochastic, multiple interacting crack systems within stochastic virtual specimens. Challenges include assuring that the physics of crack initiation, bifurcation, and coalescence is correctly represented [2] while dealing with large ensembles of virtual specimens, e.g., $10^3 – 10^4$ instantiations, that are each very large, e.g., containing by $10^8 – 10^9$ degrees of freedom.

References

[1] Cox, B.N., H.A. Bale, M. Begley, M. Blacklock, B.-C. Do, T. Fast, M. Naderi, M. Novak, V.P. Rajan, and R.G. Rinaldi, 2014, "Stochastic virtual tests for high-temperature ceramic matrix composites", Annual Review of Materials Research, **44**: pp. 479-529.

[2] Yang, Q., D. Schesser, M. Niess, P. Wright, M. Mavrogordato, I. Sinclair, S. Spearing, and B. Cox, 2015, "On crack initiation in notched, cross-plied polymer matrix composites", Journal of the Mechanics and Physics of Solids, **78**: pp. 314-332.
