Composite Damage Under Dynamic Impact

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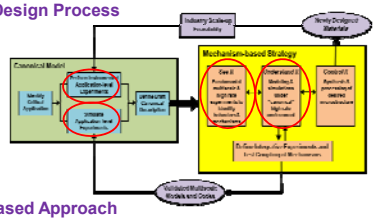
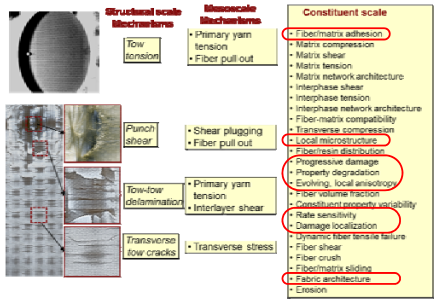
Enterprise for Multi-scale Research of Materials

How We Fit

Materials-by-Design Process

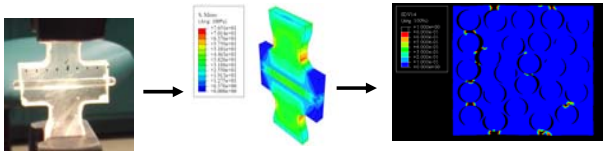


Mechanism-based Approach



Goals and Motivation

- Impact response of composite materials is complex and dependent on details of damage evolution at meso-, micro-, and nanoscales.
- Simulating and optimizing composite structure performance requires efficient micro-level computational tools that can be validated by experiment.



Cruciform Experiment

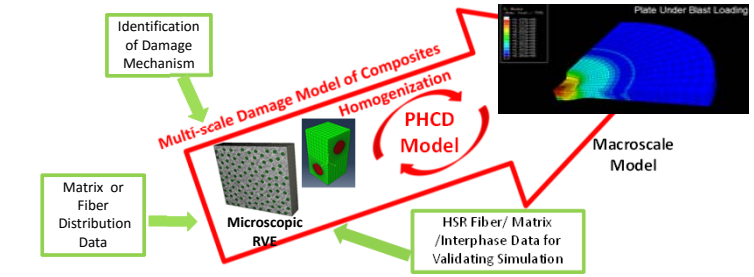
Von Mises Stress Configuration from FEM Calibration Result

Contour of Damage Variable D in CDM

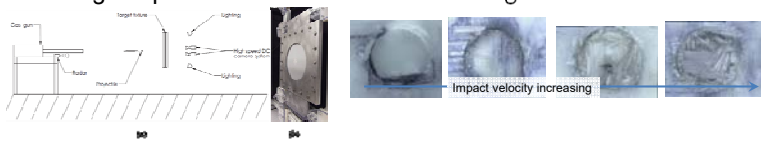
- Identify key damage mechanisms in composite impact
- Optimize high strain rate performance through multiscale structure design.

Technical Approach

- Develop a computationally efficient multi-scale damage model to be used for modeling macro-scale composite structures

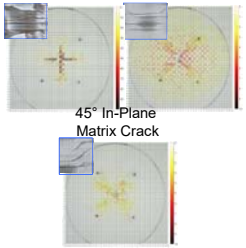


- Design experiments to elicit relevant damage modes

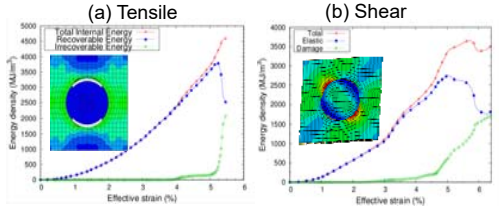


Major Results

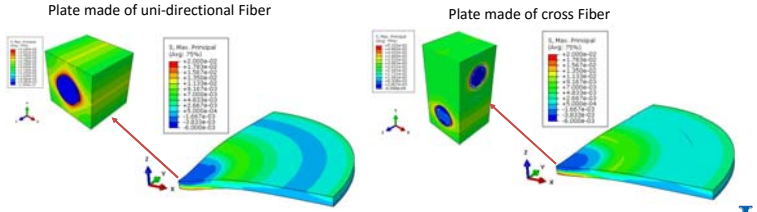
Key damage mechanisms



Micromechanical model of RVE energy absorption



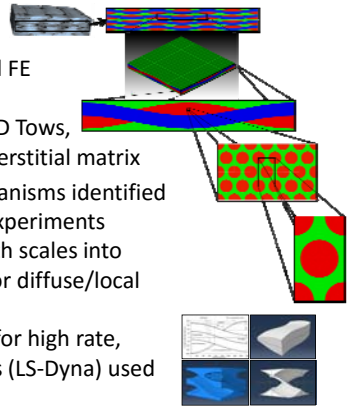
Application: Plate subjected to pressure wave



Key Accomplishments

- Developed framework for predicting high-rate, continuum-scale material parameters, connecting microscale to continuum to enable materials by design of composite materials
- Enabled simulation of high-rate response of large scale composite structures, accounting for critical subscale behavior

Future Directions



- Develop meso-mechanical FE models of plain-weave composites considering UD Tows, tow-tow debonding, & interstitial matrix
- Predict Key damage mechanisms identified in canonical perforation experiments
- Incorporate evolving length scales into PHCD Model to account for diffuse/local damage
- Predict input parameters for high rate, progressive damage codes (LS-Dyna) used in structural design
- Integrate with cross-cutting hierarchical multiscale simulations

Impact

- Framework for materials-by-design for composite materials under high rate loading
- Models and simulations will increase understanding of how particular *local* damage mechanisms affect *global* response.
- The tools developed here will lead to improved protection materials and structures while decreasing the cost and time for development.

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