Micromechanical Modeling of Punch Shear and Punch Crush of Unidirectional S-2 Glass Composites

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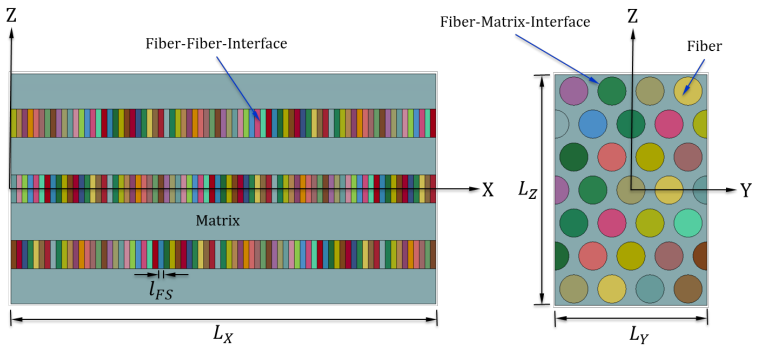
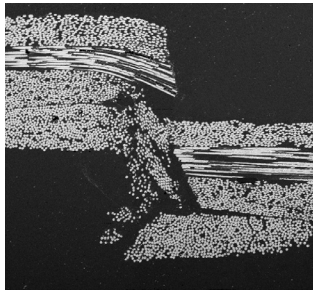
Key Goals and Technical Approach

- Punch crush and punch shear and in-plane tension are the energy dissipating damage mechanisms
- Key goals are stochastic micromechanical modeling of the punch shear and crush considering fiber fracture, fiber-matrix debonding, and non-linear matrix deformation
- Developing model validating punch shear and punch crush experiments at sub-millimeter length scales
- Predict the MAT162 Properties and Parameters from the stochastic micro-mechanical models
- Develop a materials by design Framework

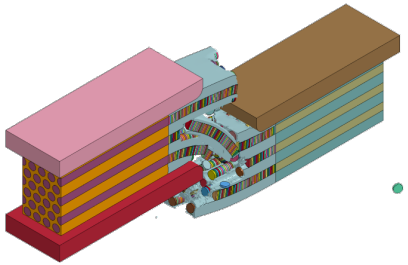


Depth of Penetration Crush of Composites

Perforation Punch-Shear & Tension



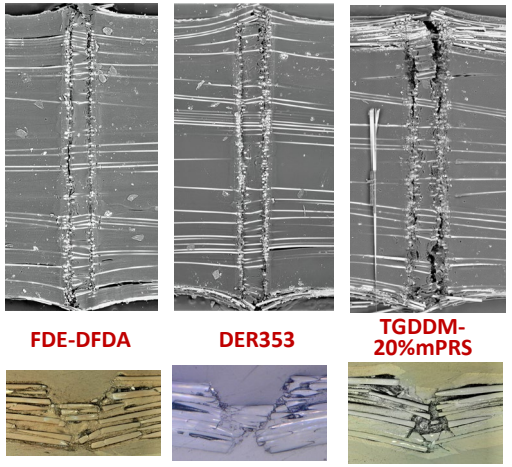
Punch-Shear Fracture

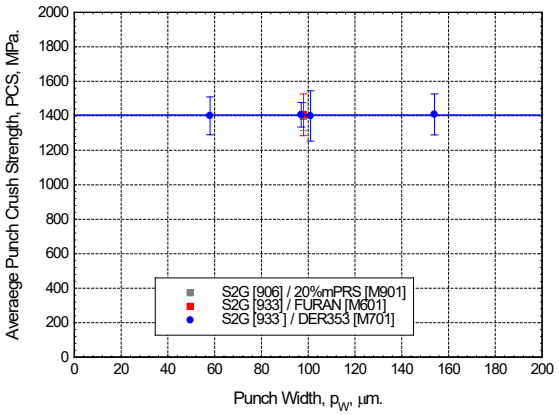


Micromechanical modeling of Punch Shear

Major Results, Key Accomplishments

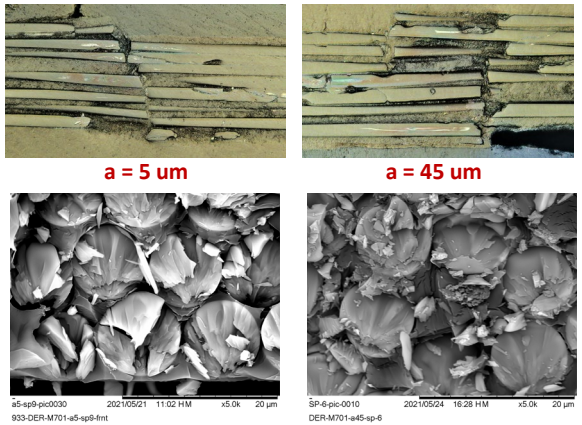
Punch Crush Experiments



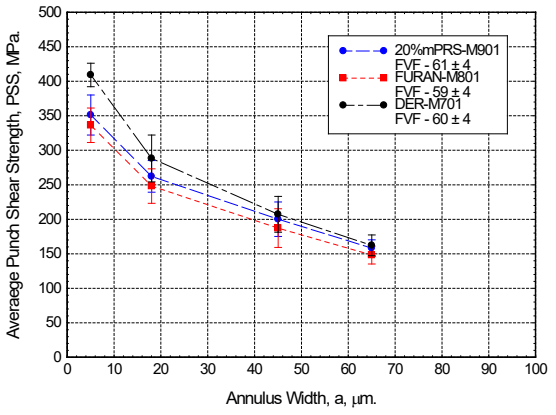


Punch Crush Strength = 1400 MPa

Punch Shear Experiments



Punch Shear Fracture Surface



Punch Shear Strength vs Annulus Width

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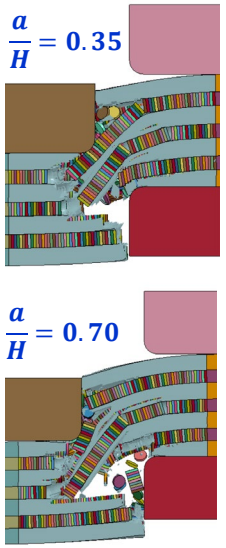
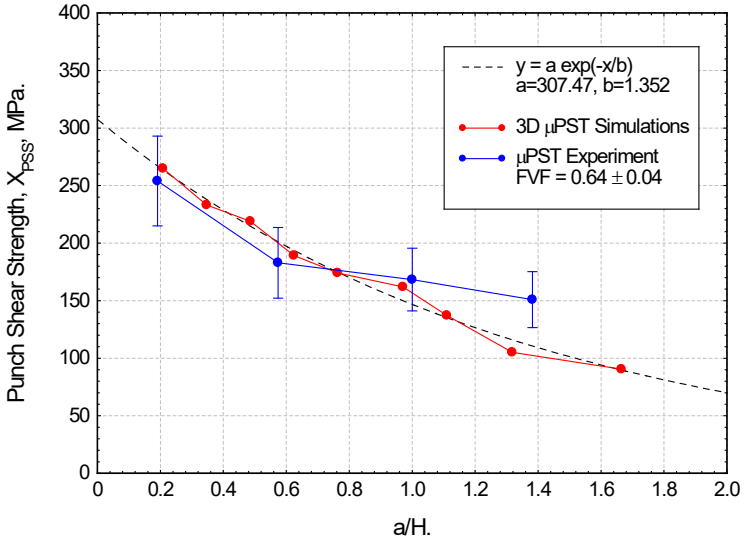
Stochastic Micromechanical Prediction od Punch Shear Strength as a Function of Annulus Width



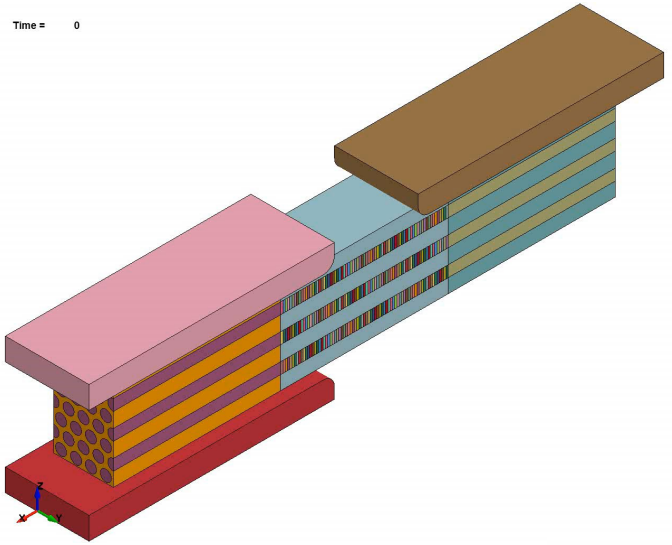


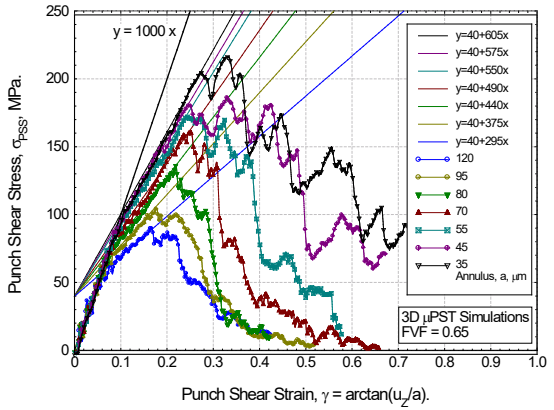
Transitions (materials, codes/tools, legacy publications)

- Micromechanical Models of Unidirectional Composites for Different Fiber Volume Fractions
- Stochastic Framework for Micromechanical Predictions of MAT162 Properties and Parameters

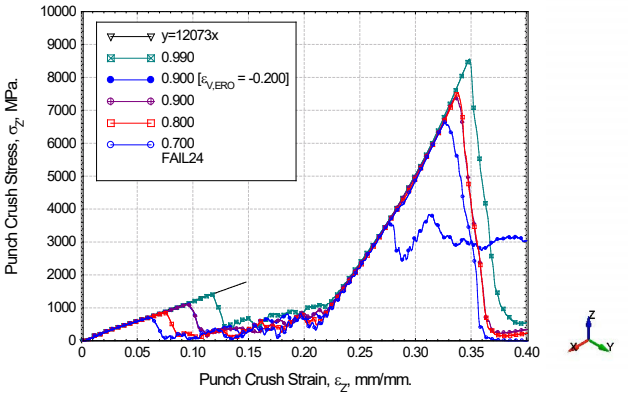
1. Bazle Z. (Gama) Haque and John W. Gillespie Jr. "Depth of Penetration of Dyneema® HB26 Hard Ballistic Laminates," Journal of Thermoplastic Composites, May 26, 2021.
2. Bazle Z. (Gama) Haque, Tam Nguyen, Isabel Catugas, Daniel O'Brien, and John W. Gillespie Jr. Micromechanical Finite Element Modeling of Unidirectional Composites in Three Dimensions: Prediction of Transverse Tensile & Compressive, Transverse Shear & In-Plane Shear Progressive Damage Behavior. ASC 36th ASC Technical VIRTUAL Conference. September 19-22, 2019. Texas A&M University, TX, USA.
3. Bazle Z. (Gama) Haque, Molla A. Ali, Raja H. Ganesh, Sandeep Tamrakar, Chian F. Yen, Daniel O'Brien, and John W. Gillespie Jr. Stochastic micromechanical modeling of transverse punch shear damage behavior of unidirectional composites. Journal of Composite Materials, 2019, Volume 53(9).

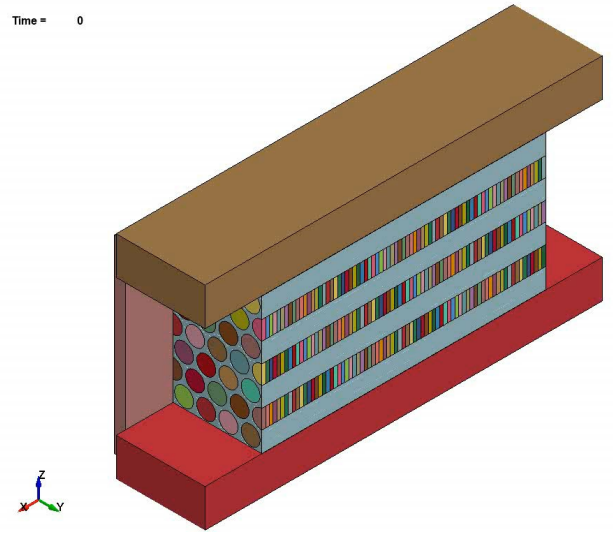
Micromechanical Modeling of Punch Shear & Punch Crush





Prediction of Punch Shear Stress-Strain for MAT162 Application





Prediction of Punch Crush Strength = 1400 MPa

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