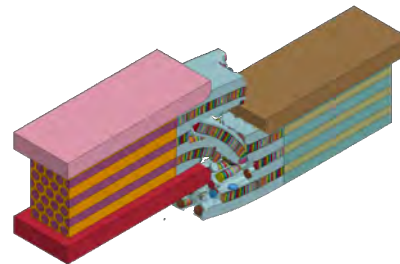
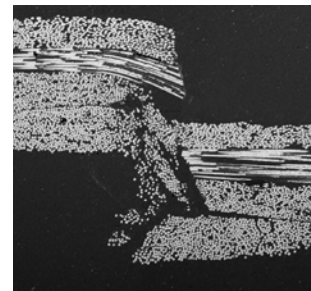
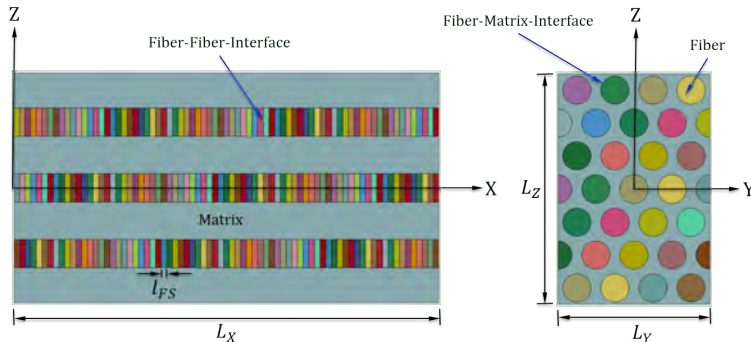


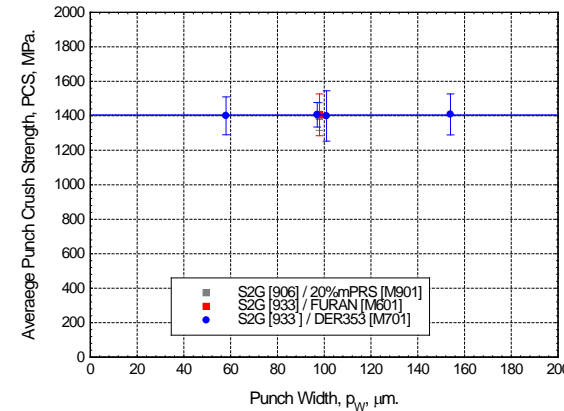
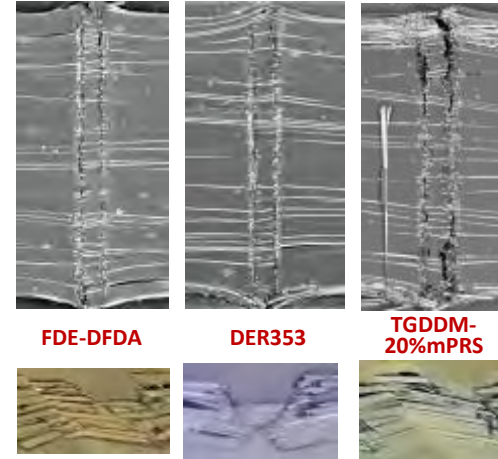
Key Goals and Technical Approach

- ❖ 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



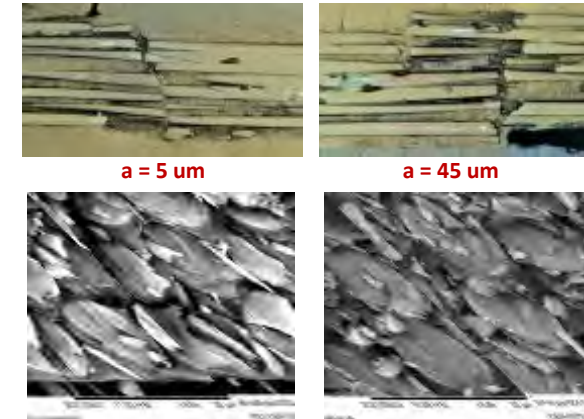
Major Results, Key Accomplishments

Punch Crush Experiments

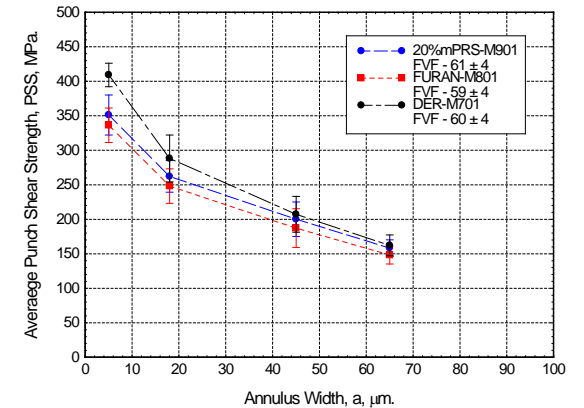


Punch Crush Strength = 1400 MPa

Punch Shear Experiments

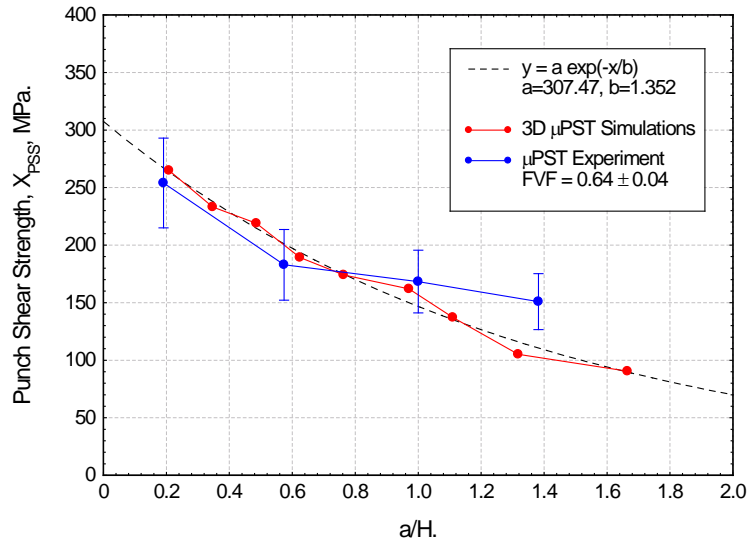
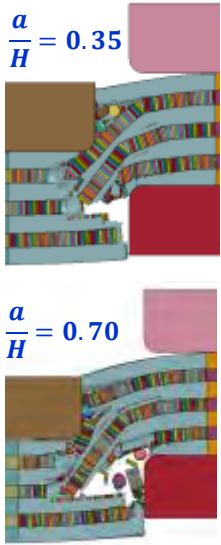


Punch Shear Fracture Surface



Punch Shear Strength vs Annulus Width

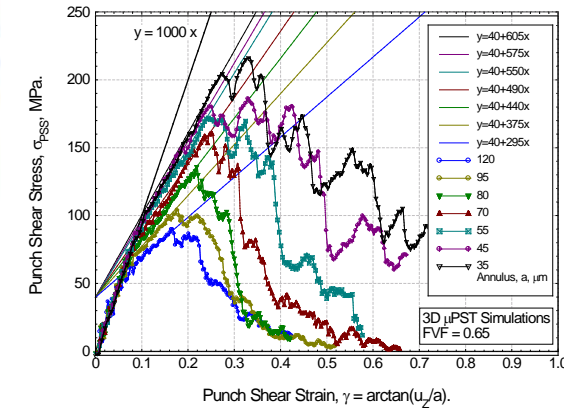
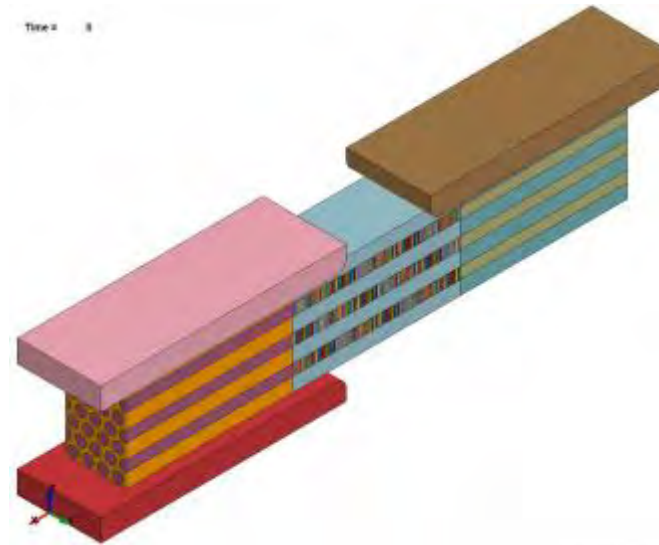
Stochastic Micromechanical Prediction of Punch Shear Strength as a Function of Annulus Width



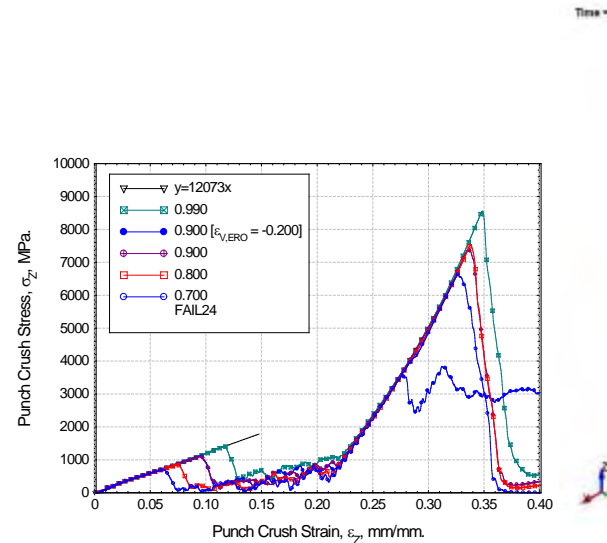
Transitions (materials, codes/tools, legacy publications)

- ❖ 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

