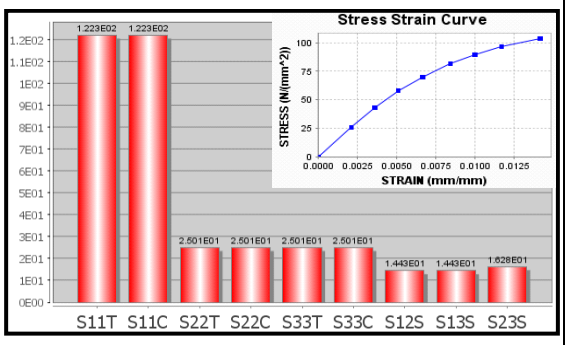
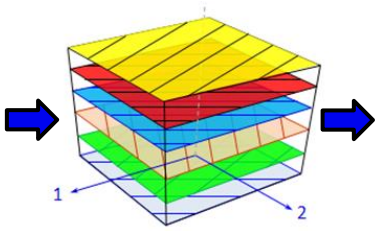
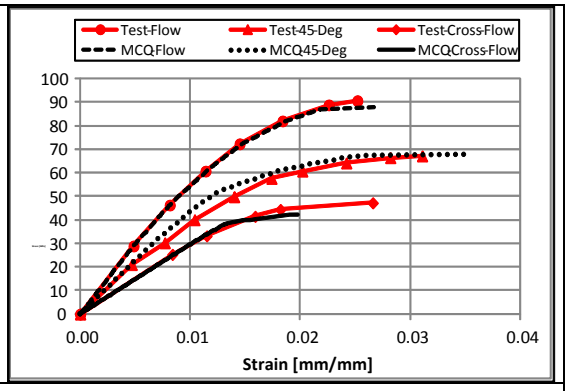
MCQ CHOPPED



Non-linear material properties: strength also predicts stiffness



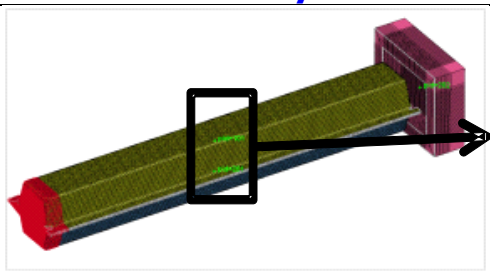
Through thickness orientation

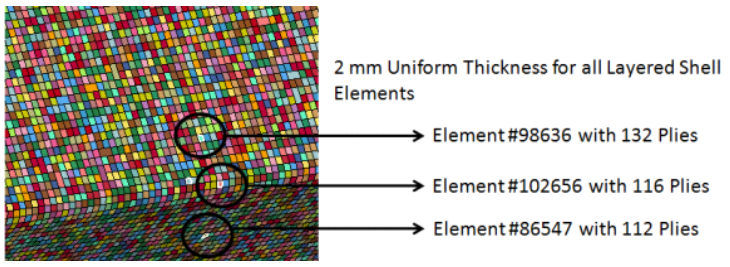


Test validated material model

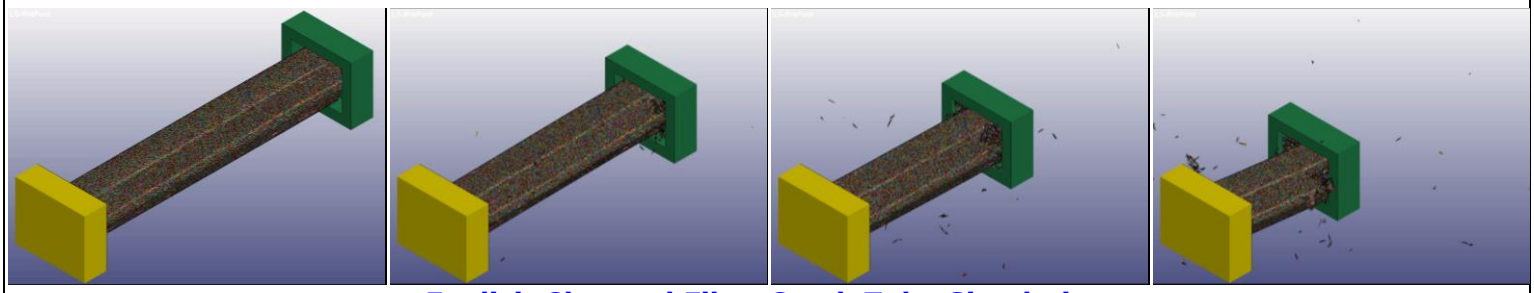
MCQ Chopped is a software toolset designed to assist in predicting chopped properties based on effective particles and matrix material properties. The software allows engineers to characterize chopped fiber reinforced composite material properties as a function of several manufacturing, geometric, and material variables. Using a de-homogenized, multi-scale material modeling approach, MCQ Chopped is ideal for the end-user that wants to accurately predict strength, stiffness in response to manufacturing anomalies, effect of defects, and environmental conditions.

Durability and Damage Tolerance (Structural Analysis)





Orientation Tensor Mapping and Through Thickness Orientation



Explicit Chopped Fiber Crush Tube Simulation

Highlights

- ✓ Predicts aligned, in-plane random and 3D random material properties;
- ✓ Reverse engineers effective constituent material properties
- ✓ Determines Orientation Tensor and Predict effective orientation distribution of plies through-thickness
- ✓ Identify variation in aligned properties with variation in constituent material properties and manufacturing variables
- ✓ Predict aligned layer, 2D random, 3D random and user defined layup stress-strain curve
- ✓ Reverse engineer aligned layer stress-strain curve from flow or cross-flow test
- ✓ Predict damage evolution, growth and final failure for chosen orientation
- ✓ Predict damage initiation and final failure of coupons subjected to biaxial loading
- ✓ Predict average material properties directions considering material uncertainty, orientation, and thickness effect

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MCQ CHOPPED

Key Benefits

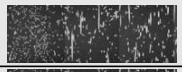
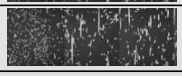
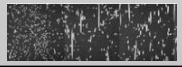
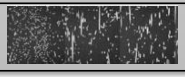
- ✓ Generates de-homogenized material model including ply orientation through thickness and the effect of defect Effective and efficient calibration of material properties of constituents using ASTM Tests
- ✓ Accurately predict strength in addition to stiffness
- ✓ Material database for several validated classes of Thermoplastic, Elastomer and Thermoset

Modules

• **GUI**	Base GUI for project management, setup and post-processing results
• **Aligned Layer Non-Linearity**	Reverse engineer aligned layer stress-strain curve from flow or cross-flow direction test stress strain curve
• **Chopped Characterization**	Graphically verify the variation in aligned layer properties with variation in constituent material properties and manufacturing variables
• **Chopped Mechanics**	Predict aligned, in-plane random and 3D random material properties and reverse engineer effective constituent material properties
• **Design Failure Envelope**	Predict damage initiation and final failure of coupons subjected to biaxial loading
• **Material Non-Linearity**	Predict aligned layer, 2D random, 3D random and user defined layup stress-strain curve using matrix stress-strain curve as input
• **Material Uncertainty**	Predict average material properties (flow, cross-flow, user defined) directions considering material uncertainty, orientation, and thickness effect
• **Orientation Distribution Determination**	Predict effective % orientation distribution of the fillers through-thickness
• **Progressive Failure**	Predict damage evolution, damage growth and final failure for chosen orientation (e.g., user defined, flow or cross-flow direction un-notched coupons)
• **Orientation Tensor Distribution**	Predict effective layup and properties from 5 component orientation tensors

Validated Material Database

Thermoset/Thermoplastic/Elastomers Chopped Fiber Composites

Material	Fiber/Polymer	Specimen View	Manufacturing
1. CR-GF15	Fiberglass + Neoprene (Elastomer)	 Short Fiber Distribution	Two Roll Mill
2. PP-GF40/PP-LGF30/PP-SGF40	Fiberglass + Polypropylene (Thermoplastic)	 Long/Short Fiber Distribution	Injection Molding
3. PBT-GF20/PBT-SGF30	Fiberglass + PolyButylene Terephthelate (Thermoplastic)	 Short Fiber Distribution	Injection Molding
4. Urethane 420 IMR-T300	Carbon + Urethane (Thermoset)	 Discontinuous Long Fiber	Prepreg
5. AS4-8852-HexMC	Carbon + Epoxy (Thermoset)	 Discontinuous Long Fiber	Prepreg (SMC)
6. TR-50S-Nylon-6	Carbon + Polycaprolactam (Thermoplastic)	 Discontinuous Long Fiber	Compression Molding
7. MuCell (PA-6)	None + Poly Amide-6 (Thermoplastic)	 Discontinuous Long Fiber	Injection Molding
8. ABS-CF13	Carbon + ABS (Thermoplastic)	 Short Fiber Distribution	FDM BAAM
9. GNP-Inclusion	Graphene + Epoxy (Thermoset)		
10. Filled ULTEM 1010	Carbon + ULTEM 1010 Resin (Thermoplastic)	 Short Fiber Distribution	FDM