GENOA 5
Tested and Verified.™

GENOA USER MATERIAL FOR IMPLICIT and EXPLICIT ABAQUS SIMULATIONS (UAB)

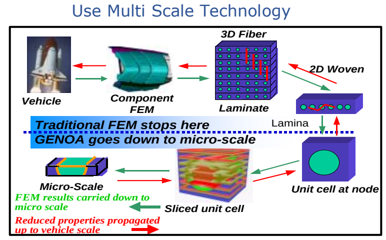
- **Obtain Integrated Implicit and Explicit Dynamics Solutions with ABAQUS using GENOA libraries in ABAQUS subroutines**
- **Augments Implicit and Explicit Dynamics (ED) finite element analysis (FEA) with multi-scale composite mechanics.**
- **Damage tracking and fracture to determine all stages of damage evolution under static, impact, crush, or crash loading condition.**
- **Predict and simulate all 5 stages of the damage process.**
- **Switch solvers/boundary condition/analysis type before or after impact event and keep residual damage and stresses.**
- **Calculates crack density, micro-cracks in the matrix, delamination within the plies, and fiber failure in tension and compression including micro-buckling.**
- **The damage tracking is done by identifying and accumulating damage at the "root cause" of the composite in matrix and fiber using dedicated physics based damage and failure criteria.**

GENOA UAB allows engineers that use Abaqus CAE to stay within their environment and perform a GENOA Multi Scale Progressive Failure Analysis PFA using GENOA libraries inside of Abaqus subroutines. At the end of the simulation a GENOA PFA file is produced that is used to characterize static and impact behavior of composite structures. This analysis determines: laminate and ply damage (types: fiber, matrix, delamination – transverse shear, interlaminar shear, relative rotation , fiber microbuckling, fiber pullout), damage and fracture initiation, energy absorbed, and residual strength. GENOA PFA will accurately predict the behavior of advanced composite laminates (2-D/3-D) considering effects of (1) defects, voids, fiber waviness, (2) micro-crack density (leakage, stiffness reduction), (3) residual stresses (winding, curing).

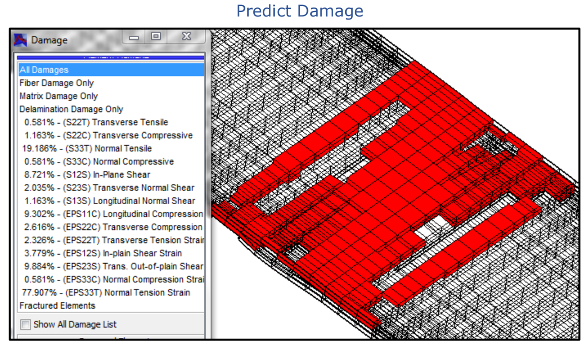
GENOA UAB Highlights

- ✓ **Supports full breadth of 2D/3D composite architectures**
  - Laminated Tape Lay-Up, Polymer, Metals, Ceramics
  - Fiber Architecture (Woven, Triaxial, Harness Satin Weave, Braided,and Stitched)
  - Fiber Coating (InterPhase)
  - Effects of manufacturing defects and residual stresses
- ✓ **Determines composite damage**
  - Laminate and Ply Damage initiation and propagation to final failure
  - Damage types (fiber, matrix, several delamination types)
  - Change ply layups to meet design requirements
  - Residual strength behavior (TAI, CAI, FAI)
- ✓ **Supports Failure Criteria (In-built and User Defined)**
  - Translaminar (Matrix, Fiber, Ply)
  - Interlaminar/Delamination (Tension, Shear, Relative Rotation)
  - Interactive Strength (Tsai-Wu, Tsai-Hill, Puck, MDE, Hoffman, Hashin)
  - Interactive Strain- Strain Invariant Failure Theory (SIFT)
  - Maximum Stress, Maximum Strain, User Defined
- ✓ **Supports Detailed Micromechanical Degradation**
  - **Matrix Defects** – Void shape, size distribution reducing stiffness and strength, matrix creep, fatigue
  - **Residual Stresses** – Curing and other manufacturing effects
  - **Fiber Strength Statistics** – Gradual failure "Rope effect" – Probabilistic Weibull distribution
  - **Interphase Mechanics** – Fiber bridging
- ✓ **Supports Service Loading**
  - Static, Impact, Post Impact
  - **Export Damage/Residual Stresses used in another simulation/solver**
  - Change boundary conditions/solver/ analysis type
  - Static or Impact to static/fatigue/creep (any combination and sequence)
- ✓ **Includes Tutorials/Solutions**

Use Multi Scale Technology

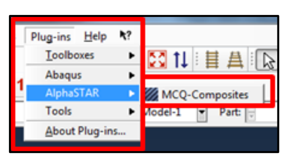


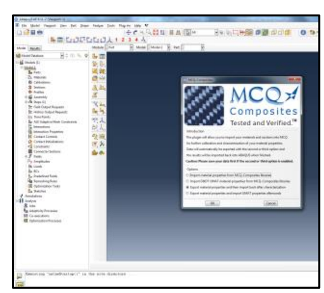
Predict Damage



Plug In with CAE Environment

Import/Export GENOA Materials Inside CAE





Key Benefits

- Rapid assessment/selection of composite static, impact and post impact damage tolerance to meet design requirements
- Reduce physical test by over 65-70% thus saving significant cost
- Ease of use, results verified with test data for class of materials:
  Polymer: chopped, continuous, thermoset, thermoplastic, elastomer
  Ceramic
  Metals: Fracture Toughness, Fatigue Crack Growth
  Nano
  Hybrid Composite (Glare)
- Compression, Tension, Fatigue, and Reliability After Impact
- Identification of damage initiation and propagation to final failure & modes of damage/failure
- Identify damage types and magnitude to asses risk

User Friendliness

- Graphic User Interface (GUI) is easy to learn with navigation tutorials and videos. Manages multiple projects, input and output for material characterization
- Quick import/export of material properties and laminate layups with commonly used third-party FE Solvers and UMATS: NASTRAN (.bdf), ABAQUS (.inp), ANSYS (.cdb), RADIOSS (.rad), LSDYNA (.k) and Optistruct (.fem)
- **Easy creation and editing of composite laminates. Quickly study multiple designs.**

System Requirements

- Windows XP/Vista/7/8 or Linux (64-bit)
- Java 1.7 minimum Runtime Libraries
- Java3D 1.5

Minimum Configuration

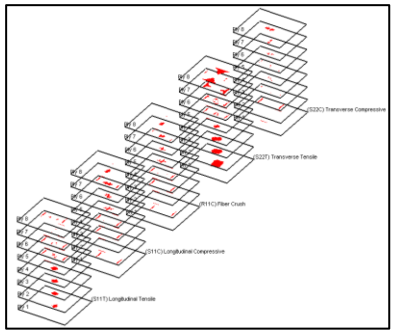
With the minimum configuration, performance and functionality may be less than expected.

- 1 GHz or higher CPU, 4GB RAM, 10GB disk space

Easily Identify Damage Types and Location

All Damages
Fiber Damage Only
Matrix Damage Only
Delamination Damage Only
22.630% - (S11T) Longitudinal Tensile
23.135% - (S11C) Longitudinal Compressive
20.354% - (R11C) Fiber Crush
99.747% - (S22T) Transverse Tensile
21.618% - (S22C) Transverse Compressive
38.306% - (S12S) In-Plane Shear
8.344% - (S23S) Transverse Normal Shear
5.183% - (S13S) Longitudinal Normal Shear
95.702% - (MDE) Modified Distortion Energy

Peel the Onion to Determine Ply Damages, Type, and Location



Quickly Check On/Off Damage Types and Run Multiple Simulations (Stress, Strain, Interactive, User)

Maximum Stress Based Failure Criteria	true
Fiber Failure Criteria	
(S11T) Longitudinal Tensile	true
(S11C) Longitudinal Compressive	true
(F11C) Fiber Micro-Buckling	true
(R11C) Fiber Crush	true
(D11C) Delaminations	false
Matrix Failure Criteria	
(S22T) Transverse Tensile	true
(S22C) Transverse Compressive	true
(S33C) Normal Compressive	true
(S12S) In-Plane Shear	true
Delamination Failure Criteria	
(S33T) Normal Tensile	true
(S23S) Transverse Normal Shear	true
(S13S) Longitudinal Normal Shear	true
(RROT) Relative Rotation	true
Maximum Strain Based Failure Criteria	true
Fiber Failure Criteria	
(EPS11T) Longitudinal Tension Strain	true
(EPS11C) Longitudinal Compression Strain	true
Matrix Failure Criteria	
(EPS22T) Transverse Tension Strain	true
(EPS22C) Transverse Compression Strain	true
Delamination Failure Criteria	
(EPS33T) Normal Tension Strain	false
(EPS33C) Normal Compression Strain	true
(EPS12S) In-plain Shear Strain	true
(EPS13S) Long. Out-of-plain Shear Strain	true
(EPS23S) Trans. Out-of-plain Shear Strain	false
Interactive Failure Criteria	
(MDE) Modified Distortion Energy	true
(TSAI) Tsai Wu	false
(HILL) Tsai Hill	false
(HOFF) Hoffman	false
(HASH) Hashin	false
(PUCK) PUCK	false
(SIFT) Strain Invariant Failure Theory	false
Honeycomb Failure Criteria	false
(WRNK) Wrinkling for Honeycomb	false
(CRMP) Crimping for Honeycomb	false
(DIMP) Dimpling for Honeycomb	false
Miscellaneous	
(UDFC) User Defined Failure	false

Tutorials with Solutions

UMAT
ABAQUS UMAT

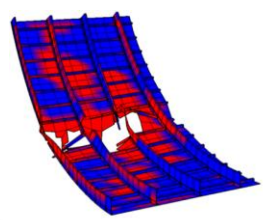
Step By Step Instructions

Setting Load Sequence in PFAUsing ABAQUS UMAT with PFA

Case Description:	Composite plate.
Example Location:	**Tutorials > Advanced > Load Sequence**
Model Description:	 Plate length: 10 , Plate width: 1.5 and Plate thickness: 0.044
Material Description:	Carbon/Epoxy Fiber/Matrix properties are used with 57% and 2% Fiber and Void Volume Ratio, lay-up of [0/90/-60/60]s and 0.0055 ply thickness
Objective of Analysis:	To set the load sequence card for GENOA-PFA analysis
ASTM Number:	NA
Control Type:	Displacement, force and thermal loads
Analysis Type:	Static

Fully Supports Complex Models

Stiffened Panel



Wind Blade

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http://www.alphastarcorp.com/
More of Alpha STAR's Test Validated products:
MCQ: Composites, Ceramics, Metals, Nano, Chopped
GENOA: PFA, PFDA, UAB, URD, ABS, PCP, PA, Quasi Static Fatigue & Random Fatigue, Harmonic & PSD Fatigue, Fatigue with Fracture Mechanics, PFA_AGING, VCCT, DCZM, Filament Winding, Jobspooler, GENOA_CLOUD