GENOA
Tested and Verified.™

GENOA VIRTUAL CRACK CLOSURE TECHNIQUE (VCCT)

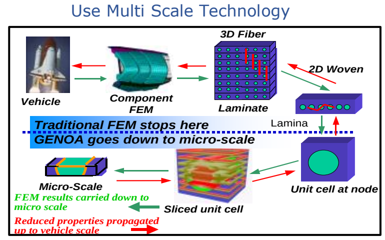
- **Fracture mechanics based approach for the progressive crack growth analysis integrated into GENOA-PFA**
- **Based on the linear spring elements**
- **Insensitive to FEM mesh size. Avoids the use of "singular" crack elements. As a result, extensive mesh preparation is eliminated**
- **Is computationally efficient due to the use of the node-based displacements and forces, which does not affect the problem size**
- **Requires a fracture path to be predetermined based on either: 1) experimental testing; 2) a preliminary GENOA/PFA analysis; or 3) the user experience. The predetermined path can be effectively prescribed using the GENOA GUI**
- **Can be used for computing strain energy release rate in linear elastic materials**
- **Requires fracture toughness data as input. The fracture toughness test data can be obtained from testing, material handbooks, or from GENOA-FTD.**
- **Obtain solutions with NASTRAN, ABAQUS, ANSYS, OPTISTRUCT, MHOST, xDYNA, LS DYNA, RADIOSS**
- **Augments finite element analysis (FEA) with multi-scale composite mechanics.**

GENOA VIRTUAL CRACK CLOSURE TECHNIQUE allows engineers to perform a fracture mechanics based approach to characterize the durability of composite structures. This analysis determines crack propagation mechanisms in composites, and predicts facesheet-core delamination in sandwich materials. The simulation can be coupled with GENOA PFA to determine 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).

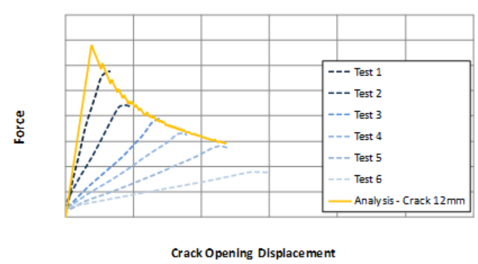
GENOA VIRTUAL CRACK CLOSURE TECHNIQUE

- ✓ **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 crack propagation mechanisms in composites**
  - Apply to 2D line crack and 3D surface cracks
- ✓ **Couple with GENOA PFA to**
  - Determine composite damage
  - Improve accuracy
  - Support All GENOA_PFA Failure Criteria (In-built and User Defined)
  - Support Detailed Micromechanical Degradation
  - Support All Types of Service Loading
  - Laminate and Ply Damage initiation and propagation to final failure
  - Damage types (fiber, matrix, several delamination types)
  - Offers load displacement shedding (after peak load)
  - Change ply layups to meet design requirements
  - Residual strength behavior (TAI, CAI, FAI)
  - Export Damage/Residual Stresses use in another simulation/solver
- ✓ **Supports Service Loading**
  - Quasi Static Fatigue and Random Fatigue (low, high, random, PSD, two stage)
  - **Export Damage/Residual Stresses use 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



Load vs. crack opening displacement



Key Benefits

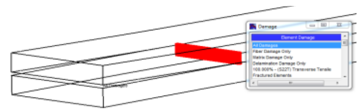
- Efficiently solves crack propagation problems for aerospace, automotive and other structural applications.
- Predicts crack propagation mechanisms in composites.
- Predicts facesheet-core delamination in sandwich materials.
- Provides accurate failure analysis of adhesively bonded joints.
- Crack growth uncertainty in direction predicted
- Detects critical crack propagation and arrest in pipelines.
- Can be applied to interface failure analysis in MEMS (Micro Electro Mechanical Systems).
- Reduce physical tests by over 65-70% thus saving significant costs
  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.

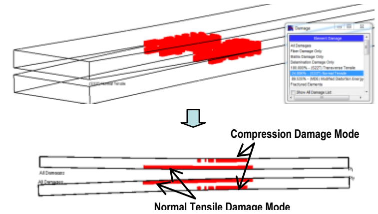
  Nano

  Hybrid Composite (Glare)

Initiation



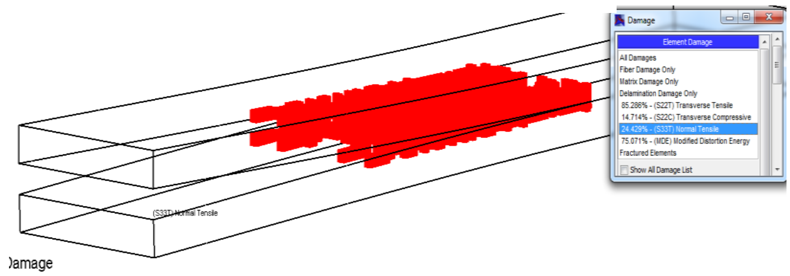
Propagation



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.**

Final Failure



System Requirements

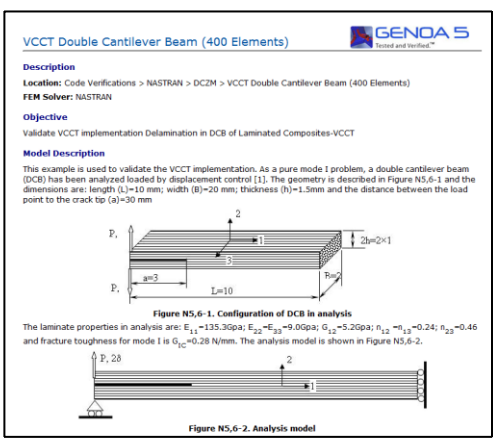
- Windows XP/Vista/7/8/10 (64-bit) or Linux (64-bit)
- Java 1.7 minimum Runtime Libraries
- Java3D 1.5

Minimum Configuration

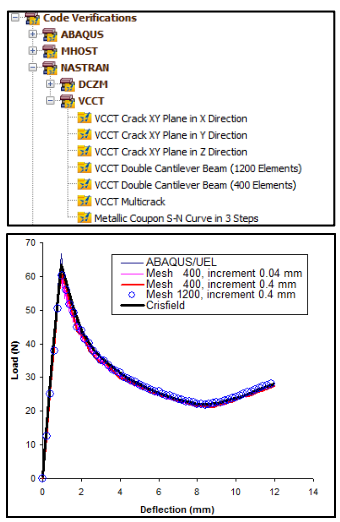
With the minimum configuration, performance and functionality may be less than expected.

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

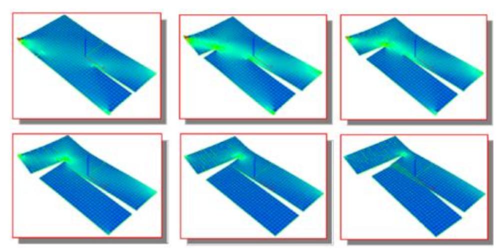
Step By Step Instructions



Tutorials with Solutions and Code Verifications



Predict Multi Crack Direction



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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