GENOA 5
Tested and Verified.™

GENOA HARMONIC FATIGUE AND POWER SPECTRUM DENSITY

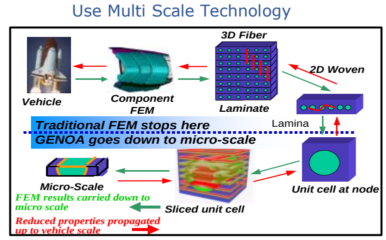
- **Test Validated™ Solutions**
- **Obtain fatigue solutions with NASTRAN, use results in all other solvers: ABAQUS, ANSYS, OPTISTRUCT, MHOST, xDYNA, LS DYNA, RADIOSS**
- **Augments finite element analysis (FEA) with multi-scale composite mechanics.**
- **Damage tracking and fracture to determine all stages of damage evolution under harmonic and power spectral density fatigue.**
- **Predict and simulate all 5 stages of the damage process.**
- **Switch solvers/boundary condition/analysis type before or after simulation 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.**
- **Account for defects (void shapes and sizes), fiber waviness, and residual stresses – Voids/Defects Will Reduce Fatigue Life.**
- **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 HARMONIC FATIGUE AND PSD FATIGUE allows engineers to perform a GENOA Multi Scale Progressive Failure Analysis and characterize the fatigue behavior of composite structures under harmonic, spectrum, or PSD loads. 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).

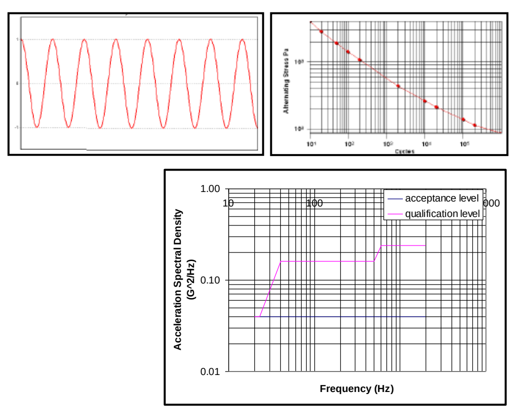
GENOA HARMONIC FATIGUE AND POWER SPECTRUM DENSITY FATIGUE

- ✓ **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 Service Loading**
  - Harmonic Fatigue and PSD Fatigue
  - **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 From Harmonic and PSD Loading



Key Benefits

HARMONIC:

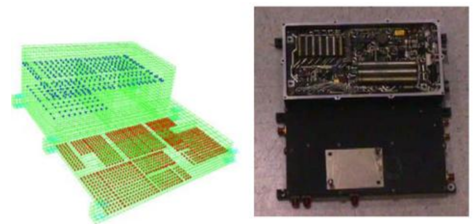
- Evaluates the fatigue life of composite and metal structures subject to dynamic loads of constant amplitude.
- Determines the fatigue failure initiation site in composite and metal structures under the applied cyclic loading.
- For each stress level, the degree of cumulative damage incurred is calculated from the S-N curve, which can be derived from tests or found in the open literature.
- An efficient multi-factor interaction model (MFIM) can be used to account for a broad range of factors that affect the fatigue life of a structure such as temperature and surface finish.
- Can be used with GENOA-PA to account for the probabilistic nature of fatigue.

- The degradation S-N curve for a considered material.

POWER SPECTRUM DENSITY:

- Evaluates various mode shapes for the fatigue life of composite and metal structures subject to dynamic loads of constant amplitude and vibration frequencies above 1/3 natural frequencies.
- Determines the fatigue failure initiation site in composite and metal structures under the applied cyclic loading.
- For each stress level, the degree of cumulative damage incurred is calculated from the S-N curve, which can be derived from tests or found in the open literature.
- An efficient multi-factor interaction model (MFIM) can be used to account for a broad range of factors that affect the fatigue life of a structure such as temperature and surface finish.
- Evaluate material S-N curve degradation with increase in modal frequencies.
- Determines degradation of natural frequencies.
- **Accurately evaluates the service life of composite or metal structures subject to static and dynamic loads of constant amplitude or PSD loading.**
- **Predicts the fatigue failure initiation site and its development in aerospace, automotive and other composite structural components.**
- **Accounts for the probabilistic nature of fatigue.**

GPS L3 Transmitter



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

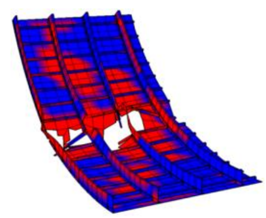
- Windows XP/Vista/7/8 or Linux (64-bit)
- Java 1.7 minimum Runtime Libraries
- Java3D 1.5

Minimum Configuration

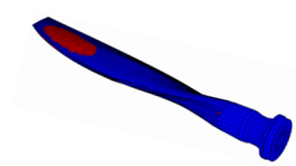
With the minimum configuration, performance and functionality may be less than expected.

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

Stiffened Panel



Wind Blade



Step By Step Instructions

Power Spectrum Density (PSD)

Case Description:	Cantilever beam with harmonic loading applied to its free end.
Example Location:	**Tutorials > Fatigue > Power Spectrum Density**
Model Description:	 Shell Elements: 861 Length = 400 mm Width = 200 mm
Objective of Analysis:	Determine the degradation in natural frequency.
ASTM Number:	N/A
Control Type:	Load Control
Analysis Type:	Dynamic

Harmonic Fatigue

Case Description:	Cantilever beam with harmonic loading applied to its free end.
Example Location:	**Tutorials > Fatigue > Harmonic Fatigue**
Model Description:	 Nodes: 156; Elements: 125 Plate length: 5 inch, Plate width: 1.0 inch and Ply thickness: 0.1 inch
Objective of Analysis:	Determine the number of cycles to failure.

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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