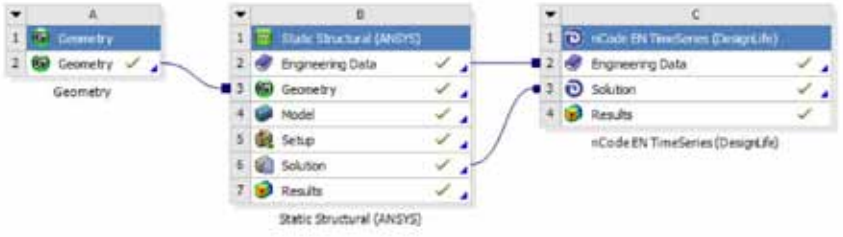
ANSYS nCode DesignLife

Increase Customer Satisfaction and Profits

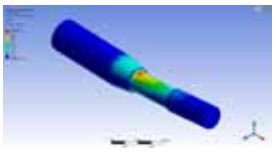
When a product fails in the field, the consequences to manufacturers can be significant. Warranty costs are a direct measurement of in-field failure, but there are many additional unseen costs. Customers can become dissatisfied and consider moving to competitors' offerings, which leads to lost market share over time. In-field failures might also result in overdesign in subsequent offerings, reducing profitability.

Today, single event static-only failure is rarely observed in engineering components or structures during their life cycle. For this reason, in-field failures are predominantly fatigue based. Additionally, fatigue failures are nearly always instantaneous and catastrophic. Fatigue is the progressive and localized structural damage occurring under a repeated or varying load, which never reaches a high-enough level to cause failure in a single application.

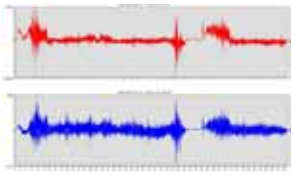
Durability or fatigue analysis must be performed to understand the implications of repeated, fluctuating and rapidly applied loads. Thus, the need to resolve mechanical design problems has become a driver for a growing number of companies to include fatigue analysis as a standard part of their product development processes.



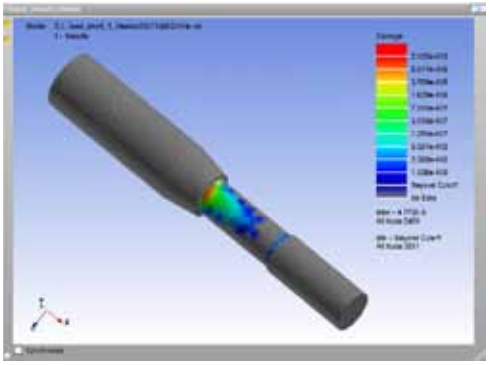
Fatigue life simulation based on static FE results and cyclic loadings



Static Structural Result



Time Series Input Vertical and Torque Loads



Fatigue Life Results

ANSYS nCode DesignLife Solver Features

Stress-Life Solver

- Material models
  - SN mean multi-curve
  - SN R-ratio multi-curve
  - SN Haigh multi-curve
  - SN temperature multi-curve
  - Bastenaire SN
  - Custom SN using Python
- Mean stress corrections
  - FKM guidelines
  - Goodman
  - Gerber
- Stress gradient corrections
  - FKM guidelines
  - User defined
- Back calculations to target life

Strain-Life Solver

- FE results input
  - Stress
  - Linear strain
  - Stress and strain
- Material models
  - Standard EN
  - EN mean multi-curve
  - EN R-ratio multi-curve
  - EN temperature multi-curve
- Mean stress corrections
  - Morrow
  - Smith–Watson–Topper
- Plasticity corrections
  - Neuber
  - Hoffman–Seeger
- Multiaxial assessment
  - Biaxial
  - 3-D multiaxial
  - Auto correction
- Back calculations to target life

ANSYS nCode DesignLife Solver Features (continued)

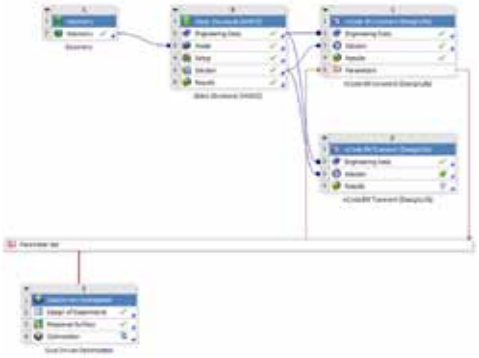
Dang Van Solver

- Multiaxial calculations using Dang Van approach
- Calculate safety factors and danger factors

Loading Inputs

- Linear superposition, time step, constant amplitude, duty cycle, aero spectrum input, random (PSD) and swept-sine loading inputs
- Hybrid load provider allows superposition of time series, transient and constant amplitude loads
- Loading inputs in all nCode supported formats
- Read a .laf (load association) file
- Read GlyphWorks® schedule files
- Use duty cycles for all analysis types
  - Use different channels in different events
  - Mix different types of events within a duty cycle
  - Nesting of duty cycles
  - Loading sequence
- Duty cycle processing options:
  - Calculate event damage independently
  - Logically concatenate schedule
  - Fast approach including consideration of residuals
- Filter loading inputs for efficient processing
- Functions for import, display and manipulation of loading inputs
- Stress gradient sensitivity taken into account

ANSYS now offers an advanced set of fatigue capabilities built on nCode's DesignLife™ by HBM — increasing an already unparalleled breadth of mechanical simulation tools. The ANSYS® nCode DesignLife product is integrated with the ANSYS® Workbench™ platform so a user can perform advanced and extensive fatigue analysis as a simple add on to an existing simulation.



Design optimization in ANSYS Workbench using DesignLife

Using ANSYS nCode DesignLife software, businesses benefit by reducing warranty costs and validating the fitness of purpose of the design throughout its entire lifecycle — thereby reducing overdesign and making cost-effective, profitable products. The cost of in-service failures is huge; these failure modes can be efficiently predicted and prevented by using ANSYS nCode DesignLife technology across a wide analysis spectrum.

Because ANSYS nCode DesignLife is integrated within the ANSYS Workbench environment, it provides results and materials data from simulations within the framework directly to DesignLife. Leveraging the ANSYS Workbench integration, DesignLife durability results such as fatigue life or damage can be parameterized and included in "what-if" or design optimization studies. This results in an unparalleled combination of ease of use and powerful fatigue analysis for those who use software from ANSYS.

In addition to offering general stress-life and strain-life approaches, DesignLife provides established methods for both spot- and seam-weld analysis. Vibration shaker tests can be directly simulated in the frequency domain. ANSYS nCode DesignLife software efficiently analyzes large finite element models and complete usage schedules. It is highly configurable for the expert user including support for Python® scripting to enable new or proprietary fatigue methods.

ANSYS nCode DesignLife also includes tools to help combine and correlate test data with simulated results. A wide range of data processing functions enable manipulation, editing and display of measured data. Virtual strain gauges can be positioned on the finite element model and stress or strain time series extracted for direct correlation to help validate models. This time series data can also be used for Crack Growth analysis, employing linear elastic fracture mechanics to predict how a crack will grow after initiation.

A Powerful Solution to Predict Fatigue Life from Virtual Simulations

ANSYS nCode DesignLife software makes it possible to:

- Perform virtual durability assessment up front to reduce reliance on physical testing and avoid costly design and tooling changes
- Perform smarter and quicker physical tests by simulating first
- Design durability into products and, thereby, reduce warranty claims

ANSYS®

- Assess more design options, consider more realistic loading conditions and more confidently reduce cost and weight
- Standardize analysis processes to improve consistency and quality
- Seamlessly access results and an expanded material library from simulations within ANSYS Workbench

ANSYS nCode DesignLife Standard Package

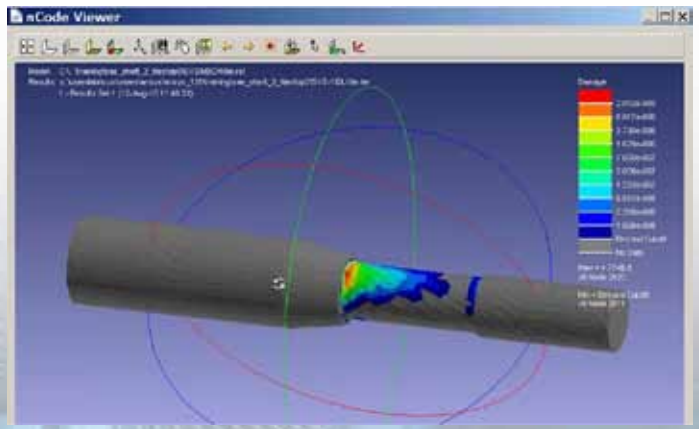
Stress-Life Solver enables fatigue life calculations using the stress-life approach. The software includes the ability to interpolate between material curves depending on the temperature. Python scripting can be used to add new or proprietary stress life (SN) methods. The primary application for the stress-life solver is high-cycle fatigue (long lives) in which nominal stress controls the fatigue life.

Strain-Life Solver enables fatigue life predictions using the local strain approach. The solver includes the ability to interpolate between material curves depending on the temperature at each location. It can be applied to a wide range of problems, including low-cycle fatigue in which the local elastic–plastic strain controls the fatigue life.

Dang Van Solver performs Dang Van safety factor calculations. This criterion is a method of predicting the endurance limit under complex loading situations. The output from the analysis is always expressed as a safety factor, not a fatigue life. Specific material parameters are calculated from tensile and torsion tests. The method is primarily used in engine and powertrain-type applications in which there are very large numbers of loading cycles.

Add-on ANSYS nCode DesignLife Products

ANSYS nCode DesignLife Welds enables spot-weld and seam-weld fatigue life calculations. Several model methods are supported for each weld type. The spot-weld method is based on the LBF method (SAE 950711). Spot welds are modeled by stiff beam elements. Cross-sectional forces and moments are used to calculate structural stress around the edge of the weld spot. Life calculations are made around spot welds using linear damage summation and reporting worst case. The seam-weld method is based on the Volvo approach (SAE 982311) and validated through years of use in industry. ANSYS nCode DesignLife Welds software offers support for fillet, overlap and laser welds with weld toe, root and throat failure analysis.



Light weight result viewer in ANSYS Workbench project page

ANSYS nCode DesignLife Solver Features (continued)

Managing Materials

- Import bill of materials; define complete material mapping for each group
- Import part numbers and other information for improved post-processing
- Database of commonly used material properties with examples to support all analysis types
- Materials database manager – create, edit or import material data
- Tabulate and graphically display material curves
- Estimate fatigue properties from monotonic data
- Estimate effects of surface condition on fatigue performance
  - FKM guideline method used for roughness and treatment
  - Use descriptive or quantitative roughness value
  - User input correction factor
  - Method applicable to all SN and EN calculations

Virtual Strain Gauge

- Powerful way to correlate test with finite element results
- Graphically position single or rosette gauges on FE node or element
- Import and export gauge definitions via XML file

Crack Growth

- Predict crack growth using linear elastic fracture mechanics
- Library of stress intensity functions for standard geometries
- Growth laws include Paris, Forman and NASGRO

ANSYS nCode DesignLife Solver Features (continued)

Spot-Weld Analyzer
- Spot-weld fatigue analysis using Rupp/LBF approach
- Beam elements
- Optionally predicts torsional failure mode

Seam-Weld Analyzer
- Seam-weld analysis using Volvo method
- Applicable to fillet, overlap and laser welds
- Thickness and mean stress correction
- Bending correction by interpolation
- Weld toe, root and throat failures may be predicted
- User-defined bending ratio threshold

Vibration Fatigue
- Vibration shaker tests simulation
- Random loadings, e.g. wind, waves
- Uses harmonic response analysis
- Power spectral density (PSD) or swept-sine loading definitions

Accelerated Testing
- Create a representative vibration test from multiple time or frequency domain data sets
- Shorten test times
- PSD or swept-sine

Parallel Processing
- Use multiple cores
- Linear speed improvement

Platform Support
- Windows® (64-bit): Windows XP Vista® 64, Windows 7
- Windows (32-bit): Windows XP, Vista, Windows 7

ANSYS nCode DesignLife Vibration enables stress-life fatigue calculations based on finite element (FE)-based frequency response functions and power spectral density (PSD) or swept-sine loading definitions, including a static offset load case. This provides an efficient way of analyzing fatigue problems in the frequency domain with particular applications in simulating vibration shaker tests or loadings typically described in the frequency domain, such as wind or wave states.

ANSYS nCode DesignLife Parallel is for parallel processing on machines with multiple processors (SMP only). Each parallel license allows another core to be utilized.

ANSYS nCode DesignLife Accelerated Testing provides the ability to create a representative PSD or swept-sine shaker vibration test based on measured data. The software enables the combination of multiple-time or frequency domain data sets into representative spectra that accelerate the test without exceeding realistic levels. This option creates the spectra that are used together with the vibration fatigue solver option to simulate vibration tests.

One Environment

The ANSYS Workbench environment provides a single setting for simulation from start to finish, enabling users to perform more product development tasks faster. ANSYS Workbench delivers the basis for a full engineering simulation solution from ANSYS, providing access to a wide variety of simulation technologies. All settings are persistent and connected to the parametric computer-aided design (CAD) model, from analysis-specific modifications made to the geometry through the application of physics, solver control parameters, graphic objects created during post-processing, and quantitative expressions evaluating performance.

The ANSYS Advantage

With the unequalled depth and unparalleled breadth of engineering simulation solutions, companies are transforming their leading-edge design concepts into innovative products from ANSYS and processes that work. Today, almost all of the top 100 industrial companies on the "FORTUNE Global 500" invest in engineering simulation as a key strategy to win in a globally competitive environment. They choose ANSYS as their simulation partner, deploying the world's most comprehensive multiphysics solutions to solve their complex engineering challenges. The engineered scalability of solutions from ANSYS delivers the flexibility customers need, within an architecture that is adaptable to the processes and design systems of their choice. No wonder the world's most successful companies turn to ANSYS — with a track record of 40 years as the industry leader — for the best in engineering simulation.

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