MSC Fatigue

Durability and damage analysis

MSC Fatigue

MSC Fatigue is a Finite Element (FE) based durability and damage tolerance solver that ena-bles users to perform comprehensive durability analysis within the Patran environment. High-cycle fatigue, low-cycle fatigue and crack growth problems can all be addressed. Job setup and submittal is done through Patran's easy-to-use graphical interface creating a single environ-ment for durability analysis. Results post-processing gives insight into, and identification of fatigue problem areas allowing for in-depth understanding of model response to changes in fatigue design parameters.

Business value

The Problem: Some estimates put annual costs due to premature fatigue fractures in structural components at well over $100 billion. Issues that drive this statistic include:

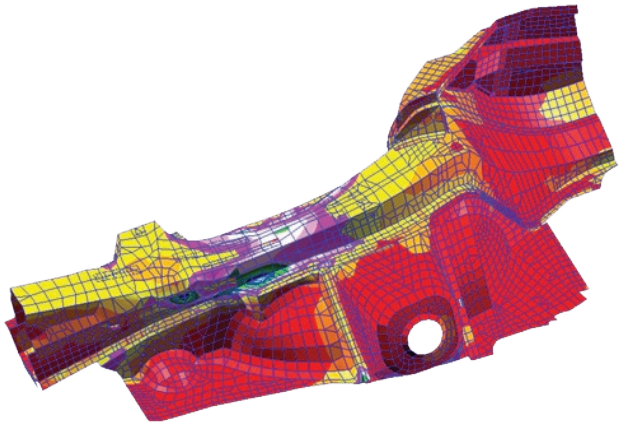
- Expensive Physical Tests: Testing against repeated loading cycles, sometimes millions of times over, is often too expensive and time consuming to be practical
- Limitations of FEA: Finite element analysis can tell you where stress "hot spots" exist, but often cannot tell you whether those hot spots are critical areas for fatigue failure, or when fatigue might become a problem
- Settling for Less: Many manufacturers simply accept long prototype development cycles, overweight components, unpredictable warranty claims and loss of customer confidence

The Solution: MSC Fatigue enables durability engineers to quickly and accurately predict how long products will last under any combination of time-dependent or frequency-dependent loading conditions. Benefits include:

- Reduced prototype testing
- Fewer product recalls
- Lower warranty costs
- Increased confidence designs will pass required test schedules

MSC Fatigue basic package modules

All MSC Fatigue Pre and Post-processing is done within the Patran environment. As such, Patran is a prerequisite for the MSC Fatigue Basic Package. The following modules comprise the MSC Fatigue Basic Package:



Basic stress life and strain life

This module uses stress or strain results from finite element (FE) models, variations in loading, and cyclic material properties to estimate life-to-failure. Both the traditional total life method, also known as the stress-life (S-N) method, and the crack initiation method, also known as the local strain-life (e-N) method, are available.

Strain gauge

This module allows the creation of virtual software strain gauges within an MSC Nastran finite element (FE) model. These gauges can be used to produce analytical response time histories from the FE model under the effect of multiple time varying applied loads. The virtual strain gauges are positioned on the FE model surface, with the gauge aligned in any orientation and the gauge positioned independently of existing finite elements. Stress and strain time histories may be extracted at any point on the FE model surface, based on either standard or user-defined strain gauge definitions. The results obtained from the software strain gauge may be based on static, transient, or quasi-static FE loadings.

MSC Fatigue advanced package modules

All MSC Fatigue Pre and Post-processing is done within the Patran environment. As such, Patran is a prerequisite for the MSC Fatigue Advanced Package. The MSC Fatigue Basic Package is also a prerequisite for the MSC Fatigue Advanced Package. The following modules comprise the MSC Fatigue Advanced Package:

Multiaxial

This module uses stress or strain results from finite element (FE) models, variations in loading, and cyclic material properties to estimate life to failure. A non-proportional, multiaxial stress state is assumed as opposed to the usual uniaxial or proportional loading states. The crack initiation (e-N) and total life (S-N) methods are used in the life prediction and safety factor analyses, respectively. All analysis methods include a

Capabilities

- High-cycle fatigue, low-cycle fatigue and crack growth analysis
- Stress life (S-N) , strain life (e-N) and liner elastic fracture mechanics (LEFM) methods
- No limit on number of nodes or elements analyzed
- Modifiable materials database with comprehensive set of S-N, E-N, Cyclic and Component curves
- Static, transient and quasi-static loading
- Supports simultaneous application of up to 500 load cases
- Modifiable loads database with standard time histories
- Support for RPC, DAC and ASCII load files
- Non-proportional, multiaxial stress states
- Frequency-domain analysis via PSD
- Compliance function library including numerous crack geometries
- Spot and seam weld analysis

Prerequisites

- Patran

MSC Fatigue Basic Package includes:

- Basic Stress Life and Strain Life
- Strain Gauge

multiaxial non-proportional notch correction procedure, incorporating an energy-based notch rule based on Neuber's rule and a Mroz-Garud cyclic plasticity model.

Vibration fatigue

This module predicts the fatigue life of structures subjected to random vibration loads. Durability analysis is performed in the frequency domain rather than the traditional time-based approach. Both the input loads characterization and the damage analysis are performed in the frequency domain. It is important for designers to estimate response at resonance for structures subjected to random input loads and this analysis is best performed in the frequency domain using Power Spectral Densities (PSDs) of input loading and stress response. The uniqueness of the Vibration Fatigue module is that it provides the analyst with the capability to perform fatigue analysis using either direct external response PSDs or computed PSDs from within MSC Fatigue using the input loading PSDs and system transfer functions.

Fracture

This module uses stress results from finite element (FE) models, variations in loading, and cyclic material properties to estimate crack propagation rates and times. Stress results can be nominal or far field stress and can be defined as a single location or averaged from an area on the model. Manual input is also possible with no reliance on an FE model. Traditional linear elastic fracture mechanics (LEFM) are used to determine crack growth. Sophisticated crack growth modeling provides a method for estimating life to grow a crack through a structure. A wide variety of crack growth specific features are included, and a large compliance function library contains numerous crack geometries supported for determining the K-solution.

Spot Weld

This module predicts the fatigue life of spot-welded sheet connections using static or dynamic FE results with the total life (S-N) method. MSC Fatigue Spot Weld supports results from three commonly used modelling methods and uses the Rupp, Storzel and Grubisic algorithm for computing stresses in each spot weld nugget and adjacent sheets. Spot welds can be modeled either as stiff beams, MSC Nastran CWELD elements (allows spot welds between dissimilar meshes of any refinement), or CHEX/MPC ("equivalent" bar forces automatically computed and fatigue results posted on CHEX element faces). Seam welds are modeled with relatively stiff plate elements that are used as load transducers; bending and axial nodal stresses are extracted at the weld line nodes from elements adjacent to the weld.

Wheels

This module allows users to conduct fatigue analyses on wheels for a sequence of loading conditions. The MSC Fatigue Wheels module can be used for any rotating body where the applied loads "travel" around the periphery of the body. The simulation is achieved by applying loads to consecutive segments of the wheel. By using the stress results from these loading conditions, a complete stress-time history and fatigue damage in angular increments about each node is determined. Fatigue results can be displayed as contour plots of fatigue life and fatigue damage for all nodes at the worst (most damaging) surface angle.

Utilities

The Utilities module contains advanced and practical applications to help the MSC Fatigue user who has a need to collect, analyze, and post-process measured data, such as stress or strain time histories, or to process such data to prepare for a subsequent MSC Fatigue analysis. The utility modules are broken into four basic categories: advanced loading manipulation, advanced fatigue analysis and display, file translation, and plotting and printing.

MSC Fatigue Advanced Package includes:

- Multiaxial
- Vibration Fatigue
- Fracture
- Spot Weld
- Wheels
- Utilities

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

MSC Software, part of Hexagon's Manufacturing Intelligence division, is one of the ten original software companies and a global leader in helping product manufacturers to advance their engineering methods with simulation software and services. Learn more at mscsoftware.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.