Finite Element Method Fatigue

Multi-axially loaded components such as body in white (BIW), suspension components, frames or crankshafts cannot be investigated by simple methods like equivalent uni-axial loading. FEMFAT max has been developed to assess these complex loading situations in an accurate and efficient way.

The methods applied are taken from the appropriate literature, the latest internal developments, cooperation research studies and are verified by countless engineering projects. Typically multi-axial components (wheel axles, body in white) are loaded in different directions. Simultaneously forces from acceleration/braking, curve driving and curb weight affect the structure dynamically at different load histories. The load history can be acquired by various means, such as measurements, finite element analysis or multi body simulation.

In FEMFAT channelmax each load case and the associated load history is called a load channel. Stresses for these load channels can either be computed using a quasi-static approach (e.g. “inertia relief”) or using the modal approach (e.g. Craig Bampton), which is more appropriate if vibrational effects occur.

In case of transient or sequence stress results FEMFAT transmax can be used for fatigue prediction. The advantage of a transient definition is that the non-linear effects taken into consideration in the FEM. FEMFAT max is able to handle fiber reinforced plastics, taking material anisotropy and fiber orientation into account.

Your Benefits

• Reliable and effective multi-axial fatigue assessment of axles, suspension systems, frames, engine components, BIWs, ...
• Interfaces for history data from multibody simulation and measurement data software
• Channel based or transient load definition
• Cutting plane and FE node filters for high analysis performance
• Up-to-date material-sensitive equivalent stress hypotheses
• Analysis of damage/life, endurance safety factors and degree of multiaxiality
• Fatigue life prediction of fiber reinforced plastics including orthotropic material data
• Unlimited number of load channels
• Option for compressing large time histories
• Compatible to FEMFAT weld (arc weldings) and FEMFAT spot (spot joints)
• Continuous fiber-reinforced plastics analyses in combination with FEMFAT laminate in ChannelMAX

FEMFAT Interfaces

• Abaqus • ADAMS • ADEO • ANSYS • COSMOS • CREO
• DASSAULT • DYMOLA • HYPERSHIFT • IDEAS • LS-DYNA
• MARC • MEDINA • MotioFlow • MotionSolve • NASTRAN
• nCode • Optistruct • PATRAN • PERMAS • Pro/MECHANICA
• Radioss • RPC • SIMPACK • TECMAT • TOSCA

FEMFAT Head Office:
Austria
Magna Powertrain Engineering Center Steyr GmbH & Co KG
Berghausstrasse 4000, Steyr
Helmut Dannbauer
Senior Manager Simulation / Testing
FEMFAT Support and Sales
Phone: +43 7435 501 5300
femfat.support.mpt@magna.com

FEMFAT Sales Offices:

• Austria
  Magna Powertrain Engineering Center Steyr GmbH & Co KG
  Berghausstrasse 4000, Steyr
  Helmut Dannbauer
  Senior Manager Simulation / Testing
  FEMFAT Support and Sales
  Phone: +43 7435 501 5300
  femfat.support.mpt@magna.com

• Japan
  Magna International, Tokyo
  Nontoku Muranatsu
  Phone: +81 3 3548 0510
  nontoku.muranatsu@magna.com

FEMFAT Sales Partners:

• Rep. of Korea
  CUBE-Cube, Anyang
  Phone: +(82) 31 34 43 061 2
  tjkim@case-cube.co.kr

• Brazil
  Vitrac CAE, Sao Caetano
  Phone: +55 11 2913 49
  femfat.support.brazil@nationslab.com.br

• Italy
  Engineering, Padova
  Phone: +39 4977 033 11
  femfat.support.italy@enginsoft.it

FEMFAT Customers:

• China
  Magna Powertrain, Shanghai
  Asheng Tang
  Phone: +86 21 6165 1682
  asheng.tang@magna.com

• India
  Finite to Infinity, Pune
  Phone: +91 2024 4434 84
  nitin.gokhale@finitetoinfinity.com

• USA
  CymaSys, Ann Arbor, MI
  Phone: +1 734 783 721 101
  bioacon@csyma.com

• France, Belgium & Luxemburg
  CIMES France, Valenciennes
  Phone: +33 3274 1737 4
  support@maxfrench.com

FEMFAT Interfaces

• Abaqus • ADAMS • ADFO • ANSYS • COSMOS • CREO
• DASSAULT • DYMOLA • HYPERSHIFT • IDEAS • LS-DYNA
• MARC • MEDINA • MotioFlow • MotionSolve • NASTRAN
• nCode • Optistruct • PATRAN • PERMAS • Pro/MECHANICA
• Radioss • RPC • SIMPACK • TECMAT • TOSCA

FEMFAT Customer Partners:

• Rep. of Korea
  CUBE-Cube, Anyang
  Phone: +(82) 31 34 43 061 2
  tjkim@case-cube.co.kr

• Brazil
  Vitrac CAE, Sao Caetano
  Phone: +55 11 2913 49
  femfat.support.brazil@nationslab.com.br

• Italy
  Engineering, Padova
  Phone: +39 4977 033 11
  femfat.support.italy@enginsoft.it

FEMFAT Sales Offices:

• Japan
  Magna International, Tokyo
  Nontoku Muranatsu
  Phone: +81 3 3548 0510
  nontoku.muranatsu@magna.com

FEMFAT Sales Partners:

• China
  Magna Powertrain, Shanghai
  Asheng Tang
  Phone: +86 21 6165 1682
  asheng.tang@magna.com

• India
  Finite to Infinity, Pune
  Phone: +91 2024 4434 84
  nitin.gokhale@finitetoinfinity.com

• USA
  CymaSys, Ann Arbor, MI
  Phone: +1 734 783 721 101
  bioacon@csyma.com

• France, Belgium & Luxemburg
  CIMES France, Valenciennes
  Phone: +33 3274 1737 4
  support@maxfrench.com

FEMFAT Multiaxial Fatigue Analysis

• Complex load conditions
• Transient and channel based
• Critical cutting plane method

Multiaxial Fatigue Analysis

Finite Element Method Fatigue

Multiaxially loaded components such as body in white (BIW), suspension components, frames or crankshafts cannot be investigated by simple methods like equivalent uni-axial loading. FEMFAT max has been developed to assess these complex loading situations in an accurate and efficient way.

The methods applied are taken from the appropriate literature, the latest internal developments, cooperation research studies and are verified by countless engineering projects. Typically multi-axial components (wheel axles, body in white) are loaded in different directions. Simultaneously forces from acceleration/braking, curve driving and curb weight affect the structure dynamically at different load histories. The load history can be acquired by various means, such as measurements, finite element analysis or multi body simulation.

In FEMFAT channelmax each load case and the associated load history is called a load channel. Stresses for these load channels can either be computed using a quasi-static approach (e.g. “inertia relief”) or using the modal approach (e.g. Craig Bampton), which is more appropriate if vibrational effects occur.

In case of transient or sequence stress results FEMFAT transmax can be used for fatigue prediction. The advantage of a transient definition is that the non-linear effects taken into consideration in the FEM. FEMFAT max is able to handle fiber reinforced plastics, taking material anisotropy and fiber orientation into account.
Method

All load history information is summarized by means of standard (e.g., principal stress) or the critical cutting plane hypothesis, specially developed for multiaxial fatigue analysis.

Data processing in FEMFAT max

Channel based modeling requires the definition of unit loadcases for each loading direction.

- Endurance safety factors
- Static safety factor
- Damage values
- Life time
- Degree of multiaxiality

Multi body system

In order to analyze the interaction of all loads, all stress information is superimposed, transformed to an equivalent stress and rainflow counted. Next the fatigue analysis begins with the help of local S/N curves including relevant influences such as notches, mean stress, isothermal temperature… The results are damage values, endurance or static safety factors.

Postprocessing

A multitude of graphical and tabular outputs are available to present and deeply understand the results:

- A critical load case representative of the most damaging load
- Cutting planes and critical plane in a Haigh diagram
- Unit stress and maximum stress of channels
- Rainflow and damage matrix (3D-plot)
- Partial and total damage results
- Equivalent stress history

Tools

We provide two stand-alone tools for creating special types of loadings. Both tools can be used with Windows and Linux workstations. Those tools are free for customers with valid FEMFAT maintenance contracts.

HARMONIC

uses various methods to generate load-time profiles from modal response calculations for multi-axial fatigue analysis of harmonic vibrations.

ELASTOLOADS

Generation of ABAQUS input files and Channel-MAX load histories for the multiaxial fatigue analysis of nonlinear systems (elastomers, contact) with long transient time histories.