fe-safe™ v5.4

Capabilities Overview

FEA models

- Inputs are usually elastic stresses, so that the results can be scaled and superimposed to produce service stress time histories
- Elastic-plastic stresses can be analysed
- Analysis of solid and shell elements can be mixed in the same model. No limit to the number of elements in the model or the file size. 64-bit file readers allow large files to be analysed
- Temperature data can be accessed for high temperature and creep fatigue analysis
- FEA results from several files can be concatenated
- Surface elements/nodes can be identified automatically
- Stress gradient correction using critical distance methods can be calculated
- Interfaces to ABAQUS (.fil & .odb), as well as other commercial FEA packages
- Selected load cases can be read into fe-safe™- the whole model file need not be input

Component loading

fe-safe™ can analyse very complex load conditions.

- A time history of component loading can be applied to the results of a 'unit load' linear elastic FEA analysis
- Time histories of multiaxial loading can be superimposed to produce a time history of the stress tensor at each location on the model (fe-safe™ supports over 4000 load histories of unlimited length)
- A sequence of FEA stresses can be analysed. For example: the results of a transient analysis; the analysis of several rotations of an engine crankshaft; or models of several discrete loading conditions
- Steady state modal response solutions can be superimposed to calculate fatigue life
- Modal stresses and generalised responses from transient nodal dynamics analyses can be combined and superimposed and fatigue life calculated
- Block loading programs, consisting of blocks of cycles, can be produced and analysed
- Complex test programs and 'proving ground' sequences can be produced easily
- High and low frequency loading can be superimposed with automatic sample rate matching by interpolation. An example is a thermal cycle with superimposed high frequency loading
- Supported file formats include .DAC, single and multi-channel ASCII, Safe Technology .amc file, RPCIII,Servotest, Snap-Master, Nastran PCH and other files. All file formats are read directly, without file converters

These load conditions can be combined and superimposed with great flexibility. PSD's, dynamics, rainflow matrices and other capabilities are included.

Fatigue analysis methods

fe-safe™ can be set to automatically select the most appropriate algorithm for each material.

- Strain-based multiaxial fatigue analysis using maximum shear strain, maximum direct strain, Brown-Miller combined shear and normal strain and other methods, with auto-selected critical plane procedures for non-proportional stresses, including mean stress effects from standard or user-defined mean stress corrections
- Multiaxial fatigue using stress-life (S-N) curves, with auto-selected critical plane analysis for non-proportional stresses, including mean stress effects from standard or user-defined mean stress corrections
- Fatigue analysis using von Mises stress with S-N curves and mean stress corrections
- Dang Van multiaxial fatigue analysis for infinite life design
- Analysis of welded structures using the stress-life data from BS7608, implemented as critical plane analysis
- Analysis of cast irons using non-linear damage accumulation - uniaxial and multiaxial fatigue
- Probability analysis combines material and loading variability
- Mean stress corrections can include Goodman, Gerber, Buch, Morrow, Smith-Watson-Topper and user-defined mean stress corrections
- A multiaxial 'Neuber's Rule' is used to calculate elastic-plastic stresses from elastic FEA
- Uniaxial fatigue using strain-life curves and S-N curves also included
- Fatigue hotspots can be identified automatically using user-defined criteria

Materials data

- A comprehensive database of materials properties is provided - over 450 materials
- AFS cast iron materials database
- The database can be extended and modified by the customer
- Test reports and background data can be accessed
- S-N curves and strain-life data may be included
- Materials data can be plotted and superimposed
- Advanced algorithms are provided to estimate fatigue properties from static test data

Advanced features

- High temperature fatigue included as standard - nodal temperatures can be used to modify materials fatigue properties
- Notch sensitivity and stress gradient effects can be included
- A design life may be specified, and fe-safe™ will calculate the allowable stress factor at each node (FOS). Plasticity is recalculated during the analysis, so the FOS factors can be applied directly to elastic FEA
- Comprehensive management of element and node groups is supported
- The fatigue analysis can be applied to the complete model, or to named element groups
- Different materials data, surface finish effects and residual stresses can be used for each element group (for example, to analyse assemblies, or to allow for machined and as-forged surfaces on the same component)
- An initial residual stress state can be defined as a single value for all or parts of a model
- Results of an elastic-plastic FEA from a modelling process can also be used to define an initial stress state (for example assembly stresses, or the results of press forming sheet metal parts)
- The user can easily change any of the inputs and re-run the analysis
- Standard analyses can be set up and re-run easily
- Powerful batch processing, with parameter modification for sensitivity studies

Output

All contour plots can be generated in a single analysis run.

- Fatigue lives at each node or element (3D contour plot) in user-defined units, e.g. miles, flights, hours
- The stress safety factor (FOS or FRF) at each node or element to achieve the design life (3D contour plot)
- Probability of failure or survival at specified lives (3D contour plot)
- Maximum stress at each node during the fatigue loading, and max stress/yield stress, max stress/tensile strength (all 3D contour plots)
- Mean stress and stress or strain amplitude at each node (contour plots)
- Load sensitivity shows the effect of each load history on the total fatigue damage
- For complex block loading sequences, the fatigue damage from each block can be output
- Stress and strain histories at selected nodes or elements, cycle histograms, biaxiality, critical plane orientation, Haigh and Smith diagrams, fatigue reliability factors etc, for the whole model or selected elements
- Output of virtual strain gauges (single or rosette) at selected points on the model
- Output of influence factors at selected points on the model
- Output of vector plots identifying critical damage plane
- A list of the most damaged elements is saved, and re-analysis can be concentrated on these elements if required
- A text file of user inputs, analysis type and a results summary is produced for QA trace-back
- Additional groups of elements can be defined in fe-safe™ as the hot-spots are identified

Signal processing and analysis

- Digital filters, spike removal and noise shaping
- Interactive multi-channel editing with immediate graphics display
- Single and multi-channel peak/valley time-slicing with cycle omission
- Manipulation and powerful re-scale/combine functions for signals, cycle matrices and load spectra
- Full suite of amplitude and frequency analysis, including rainflow cycle counting, PSD's, transfer functions
- Comprehensive fatigue analysis from strain gauges, including a new multiaxial fatigue analysis suite
- Fully featured graphics display and hard copy
- Print graphics to disk, copy and paste graphics to other MS Windows programs

Additional features

- Comprehensive online help
- Crack propagation. An interface between fe-safe™ and BEASY software allows crack growth calculations with load redistribution as the crack propagates
- Analysis of thermo-mechanical fatigue and creep-fatigue interaction (creep ductility exhaustion and strain range partitioning methods)
- Common user interface across all supported platforms
- Special analysis of cyclically symmetric components (e.g. wheels, bearings) from a single FEA load case

Licensing

- Networked licence manager/controller (including Windows, Linux and UNIX)
- Distributed processing - rapid analysis using multiple licences for distributed processing across a network

This is not a complete list of the features in fe-safe™. To discuss your particular requirements please contact your local distributor or Safe Technology.

Safe Technology Limited
1 The South West Centre, Archer Road, Sheffield S8 0JR UK
Tel: +44 (0) 114 255 5919 Fax: +44 (0) 114 255 5910
E-mail: info@safetechnology.com
Website: www.safetechnology.com

SIMULIA
World Headquarters: 166 Valley Street , Providence, RI, USA 02909
Tel: +1 401 276 4400
E-mail: info.simulia@3ds.com
Website: www.simulia.com