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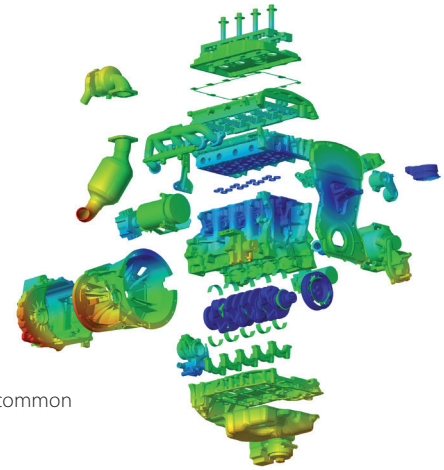
FEARCE

Ricardo Software

Powertrain CAE Solutions

www.**software.ricardo**.com



What is FEARCE?

FEARCE is a finite element (FE) pre- and post-processing environment written specifically to support engine and vehicle analysis. FEARCE acts as an interface to integrate each stage of an FE analysis, from assembling of component models into larger systems, through the application of loads and boundary conditions, to the solution and post-processing of results. FEARCE adds automation to these key tasks so that complex analyses can be performed quickly and accurately whilst ensuring common processes are identical between iterations.

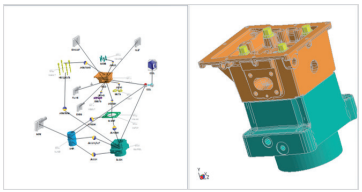
Key product features

- Integrated graphical user interface (GUI) providing a single environment for all key stages in the process
- Unique network approach allows a user to construct complex FE assemblies from component models
- Automated joining of interfaces between components
  - All types of connectivity can be applied, including advanced non-linear interfaces such as contact joins and structural or thermal gaps
  - Dissimilar meshes can be joined using multi-point constraints
  - All connectivity is automatically checked, with conflicts, fixes and warnings flagged and documented
- Easy application of force, pressure or displacement loads to the system
- Automatic mapping of boundary conditions from external sources
- Internal linear solver and translators to automatically set up solution decks for all major third party FE packages
- Full suite of post-processing tools, including
  - Plots and animations
  - Loadcase combination and factoring
  - Bore, bearing and valve distortion studies
  - Durability analyses
  - NVH studies

Model assembly

FEARCE provides a number of powerful tools that automate the creation of systems built from one or more individual model components. The pre-processing GUI allows a user to build-up a 2D network of models and connection, whilst at the same time displaying the fully 3D view of the resulting assembly.

Connectivity between contact surfaces is defined identifying surface geometry rather than relying on the individual node IDs of the models. This allows components to be easily replaced within assemblies whilst retaining the same physical joins. Mating surfaces can be defined using the FEARCE GUI – or with third-party modelling packages, if preferred.

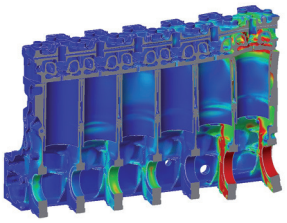


FEARCE provides tools for the automatic generation of bolts. This can be done using a simplified beam model, where the user defines the head and thread contact regions along with the bolt shaft diameter and material.

Capabilities

- Importing component models from different sources
- Scaling, translation and transformation of models for assembly
- Enabled copying of repeated components (e.g. valve seats) to reduce modelling overhead
- Joins are based on mating surfaces rather than node numbers – allowing for changes to be made easily
- Various types of connections (e.g. slide, contact, weld, thermal and structural gaps) can be generated automatically
- Automatic joining of dissimilar meshes using multi-point constraints
- Automatic checking of assemblies, with conflicts, fixes and warnings flagged

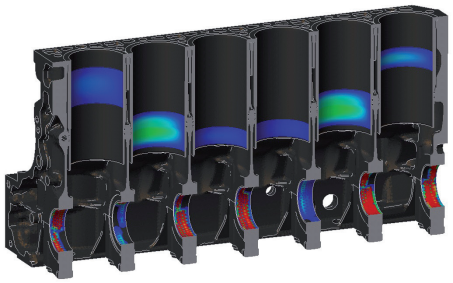
Application of loads



FEARCE incorporates a range of features to aid the engineer in applying loads to FE structures and assemblies. A user only has to select a named area, choose what type of load is required and FEARCE will automatically distribute pressure across a surface, ensuring that individual nodes are supplied with the correct force components.

Capabilities

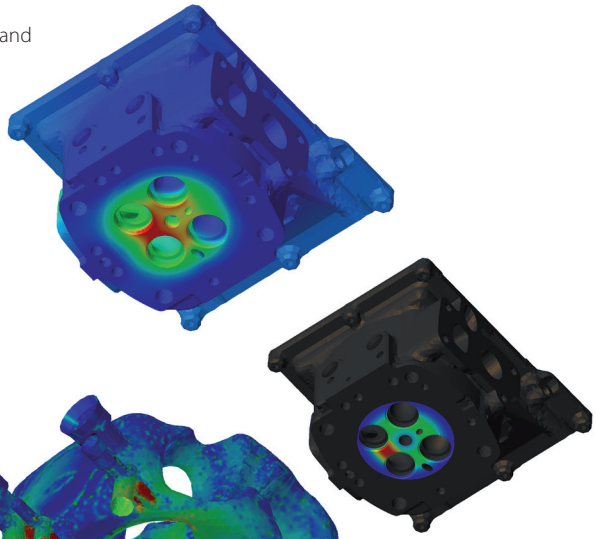
- Pre-processing time reduced through automation of load application
- Increased accuracy as loads are defined explicitly and any conversions (for example pressure into force) are carried out by FEARCE
- Load regions are defined as named areas rather than relying on individual node IDs – allowing component models to be easily replaced
- Bearing models allow accurate profiles to be added automatically regardless of mesh distribution
- Mapping of loads between models



Thermal boundary conditions

FEARCE has unique capabilities for the prediction of temperatures in combustion systems. In powertrain analysis, the accurate determination of the temperature distribution at key operating conditions is critical to component design. FEARCE has been developed specifically to address these needs and so provides a number of tools for the application of thermal boundary conditions to an FE analysis.

For coolant side boundary conditions, FEARCE can quickly and efficiently map fluid temperature and heat transfer coefficients (HTCs) from CFD analysis onto the appropriate coolant surfaces of the FE models. This can be done by either linking directly into Ricardo's VECTIS CFD code, or by mapping from ASCII tables of co-ordinate temperature and HTC values output from any major CFD solver. In addition to linking directly to VECTIS to extract results, the FEARCE GUI can also display the VECTIS models, allowing an engineer to visualize the CFD results alongside the loaded FE models.



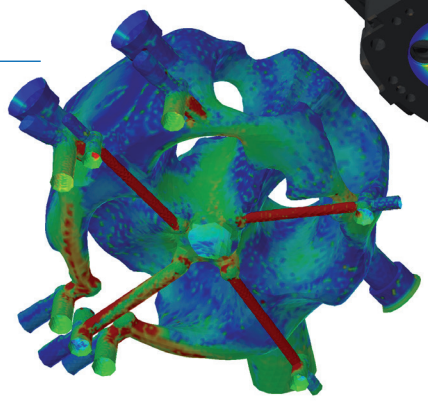
Capabilities

- Flux, temperature, HTC and pressure interpolated CFD results
- Links directly with VECTIS for results extraction and visualization
- Time averaging of transient results for steady state analyses

NVH

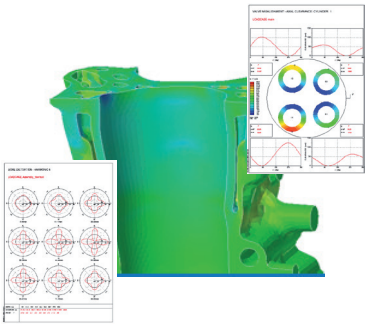
FEARCE includes an advanced NVH module for vibration and sound prediction.

The FEARCE NVH module carries out vibration analyses on models by performing a forced response after a modal analysis has been run. A sinusoidal forcing function is applied to the mode shapes as a Fourier loading on individual nodes in the frequency domain. This loading is then solved to calculate the resulting contribution of each mode. Finally, the modal contributions are combined to give complex vibration levels for each forcing frequency. Output can be in either the time or frequency domain. Calculated values are nodal displacement, velocity and acceleration spectra.



Capabilities

- Direct and indirect vibration solutions
- Rayleigh and BEM solution methods
- Automatic creation of BEM meshes



Solution and post processing

FEARCE is not just a pre-processing tool. In addition to being able to set up appropriate solution decks for all major FE packages, FEARCE also contains it's own linear solver. Ideal for thermal analysis – the solver has been benchmarked and proven to be as accurate and faster than the major 3rd party alternatives – the solver can also be used for a range of other solutions, including; displacement prediction, stress prediction, modal contribution and forced response analysis, eigenvalue calculation and model reduction.

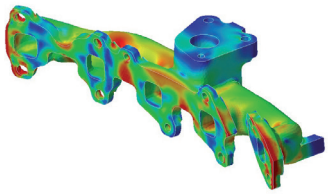
Beyond the initial solution, FEARCE includes a large number of post-processing tools, many of which have been developed for the specific needs of powertrain and vehicle analysis. For linear analyses, results loadcases can be combined and factored to create more complex conditions. This can also include calculations to account for the amelioration of bolt loads in an assembly. In non-linear solutions, nodal stress and strain histories can be identified and plotted.

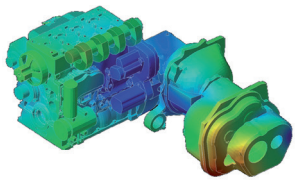
For powertrain analysis, FEARCE can perform bore, bearing and valve distortion calculations and produce suitable plots of deformations, harmonics, alignment and ring conformability.

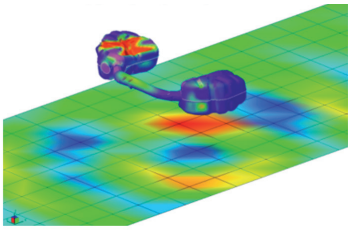
For vehicle analysis FEARCE can carry out design sensitivity analyses, perform quick checks for modal assurance, and provide transient difference plots between models undergoing crash analyses.

Capabilities

- Built-in linear solver
- Solution set-up for any major 3rd party FE package
- Large range of post-processing tools
- Loadcase combination and factoring
- Stress and strain history plotting
- Thermocouple and strain gauge predictions
- Bore, bearing and valve distortion plots
- Design sensitivity analysis
- Durability calculations







Durability analysis

FEARCE incorporates a fatigue module that includes a large array of linear and non-linear durability algorithms.

Linear algorithms include the Goodman and Gerber methods. Multiaxial algorithms include Dang Van, McDiarmid and Multi-axial Goodman methods. For non-linear analyses the SWT, Brown-Miller and Fatemi-Socie methods can be employed.

FEARCE also provides alternative approaches to calculating a stress tensor from the principal stresses; these include the Von Mises (signed and unsigned), the maximum principal stress approach, the P1 principal stress approach and the ASME approach.

FEARCE will calculate fatigue safety factors for defined regions based upon either infinite or defined life. All results can be displayed on the actual FE model as numeric values or colour contours.

FEARCE can also perform reliability calculations by defining the standard deviation on all material properties and loads. This enables the calculation of the number of failures within a given life span.

Capabilities

- Large array of linear and non-linear fatigue algorithms
- Flexibility in equivalent uniaxial stress calculation
- Automatic generation of Haigh diagrams
- Results displayed directly onto models
- Prediction of Number of Failures

For further information about Ricardo Software products and services contact us:

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