FEMtools™ Dynamics

Advanced Finite Element Solutions for Simulating Dynamic Response and Structural Modifications

Components

FEMtools Dynamics contains tools for

- Frequency Response Functions (FRF)
- Harmonic response analysis
- Residual vectors
- Superelement analysis
- Modal-Based Assembly (MBA)
- FRF-Based Assembly (FBA)
- Time domain simulation

Frequency Response Functions

To obtain FRFs, the response function is divided by the excitation force. Because these functions do not contain force information, they only depend on mass, stiffness and damping properties of the structure, just like the modal properties. Therefore they are also suitable as responses for correlation analysis, sensitivity analysis and model updating.

Key Features

- Compute FRFs that are directly comparable to experimentally obtained FRFs
- Modal and direct solvers
- Padé approximant method for faster solution
- Modal FRF synthesis from FEA or test modes
- Dynamic compensation method
- Support for various types of damping (modal, proportional viscous and structural damping viscous damper elements, material damping).
- Support for local coordinate systems

Harmonic Response Analysis

In harmonic response analysis, the excitation is defined in the frequency domain. All of the applied forces are known at each forcing frequency.

Key Features

- Analysis using modal or direct solvers
- Displacement, velocity or acceleration response functions at selected DOFs
- Enforced response analysis

Residual Vectors

Residual vectors (RESVEC) are used to extend the modal base that is used for modal superposition methods. They can compensate the effects of modal truncation and often improve the dynamic response without the need to increase the number of mode shapes or use a direct method. FEMtools supports methods to compute residual vectors that are based on inertia relief, viscous damping and applied loads.

Superelement Analysis

A superelement is defined by grouping a number of elements and solve for this substructure separately. Superelements offer great time-savings in application that require significant re-analysis like time-domain and frequency domain responses analysis, design optimization, probabilistic analysis, robust design and multi-body simulations.

Superelements are also used to overcome situations where a full solution is not even possible because of limited computer resources (internal memory, disk space).

Key Features

- Integrated Craig-Bampton matrix reduction
- Easy definition of superelements using sets of elements or sets of nodes
- Support for assemblies without residual model
- Automatic generation of master DOFs and processing of DOF relations
- Support of slave DOFs in DOF relations as master DOFs of a superelement

Modal-Based Assembly (MBA)

Modal-Based Assembly (MBA) is a modal domain substructuring method to rapidly assess the influence of structural changes on the modal parameters and derived results like FRFs or operational shapes.

The main advantage of the MBA approach is its high computational efficiency. This technique can be used to investigate the effect of different modeling assumptions on the level of correlation with test data. Other applications are in vibration troubleshooting or are design-oriented, for example to find the most efficient structural modification that will shift resonant frequencies away from excitation frequencies.

MBA is an extension of Structural Dynamics Modification (SDM) that supports FEA data, test data or a combination of both (hybrid modeling).

Key Features

- Modification of a finite element model or a test model using individual modification elements (finite elements), using tuned absorbers or modal substructures. An unlimited number of modification elements and types can be combined.

- Point-and-click interactive definition of modifications
- Solution of modified mode shapes and resonance frequencies using modal parameters coming from modal test or finite element analysis
- Correlation analysis between unmodified and modified models
- Variational analysis of all physical properties of the modification elements using the fast modal solver
- A slider control to dynamically change parameter values and immediately see the effect of the change in tables and graphics
- Animated, side-by-side and overlay plots of unmodified and modified models, mode shapes, FRFs and operational shapes

FRF-Based Assembly (FBA)

FRF-based Assembly (FBA) is a frequency domain substructuring method to combine multiple sub-components and predict the response of the assembly from the Frequency Response Functions (FRFs) computed or measured on each component. In case of FBA, the dynamic properties of the subcomponents, as well as the computed behavior of the assembled structure are described with FRFs.

FBA is an alternative to Superelements (using system matrices) and modal-based assembly (using mode shapes only). It is a computationally efficient method that focuses on the coupling between components and is therefore suitable for larger assemblies with many components and for studying the transmission of forces by the connections.

Key Features

- FBA components like boundings and joints to connect FRFs that can be rigid or flexible
- Support for impedances (viscous damper, structural damping) with local coordinate systems
- Support for added masses with local coordinate systems, and tuned absorbers
- Definition of intra-model connectors and multi-point constraints (MPC)
- Definition of FBA forces, enforced displacements and recovery points
- Computation of internal forces in the FBA connection points (Transfer Path Analysis)

Time Domain Simulation

Time Domain Simulation (TDS) provides a set of tools to compute the transient response of structures in a computational efficient way. The FEMtools TDS solver first derives a state-space model from the normal modes of the structure and then uses this model to compute the time series of the responses.

In combination with the modal parameter extractor, TDS can be used in a pretest analysis phase to simulate a vibration test.

Key Features

- Definition and generation of input signals: impulses, sines and random signals
- Computation of displacements, velocities and acceleration response signals
- Export of response signals for pretest analysis

Prerequisites

- FEMtools Framework with Solvers (Included)

Options

- Upgrade to FEMtools Pretest and Correlation
- Upgrade to FEMtools Model Updating
- Upgrade to FEMtools Model Updating and Optimization
- FE interfaces and drivers (Ansys, Abaqus, LS-DYNA, MSC.Nastran, Simcenter Nastran, SAP2000, Universal File)
- Add-ons (Data Acquisition, Modal Parameter Extractor, Rigid Body Properties Extractor)

Services

- Installation, training and customization
- Support by e-mail, phone and support site
- Custom software development
- Project research

Supported Platforms

- Windows 10, 11 (64-bit)
- Linux (64-bit)

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