FEMtools™ Rigid Body Properties Extractor

Extract the Rigid Body Properties of a Structure from Measured FRFs

The FEMtools Rigid Body Properties Extractor (RBPE) is a FEMtools add-on module to obtain the rigid body properties of a structure from a set of measured Frequency Response Functions (FRFs).

The following properties are obtained from the low-frequency portion of measured accelerances:

- Mass (M)
- Center of gravity locations (CoG)
- Mass moments of inertia (MoI)

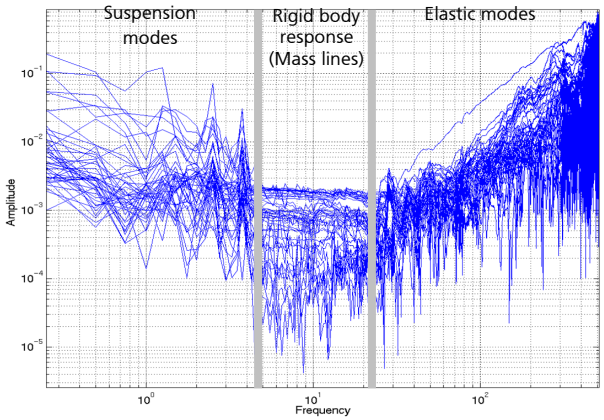
The rigid body properties can be used to validate a finite element model, for substructuring or motion analysis.

Overview

The Rigid Body Property Extractor module is a tool for identifying the rigid body mass properties (mass, center of gravity and inertia) of a structure using accelerance (acceleration/force) frequency response functions (FRF) obtained from measurement.

The determination of rigid body properties is performed in 2 steps. In a first step, the RBPE uses a robust curve-fitting method to extract the rigid body response of the structure characterized as horizontal *mass lines* located between the low-frequency suspension modes and the elastic modes of the structure.

From these rigid body responses, in a second step, the



Accelerance FRFs and mass lines.

structure's mass properties are obtained by solving a set of rigid body equations of motion.

Experimental data (FRFs) are obtained with FEMtools DAQ or imported from a Universal File (UF) or other. A translator for UF is standard included in the FEMtools Framework. If the FRFs are provided in another format, a custom translator can be written in FEMtools Script language.

The rigid body properties that can be extracted depend on the amount of experimental data that is available. In order to extract all possible rigid body properties, the experimental data must satisfy the following requirements:

- FRFs must be acceleration/force and obtained from a free/free test
- Minimum 3 excitation points (one per axis) and 6 accelerometers, resulting in 18 FRFs (3 x 6)
- The excitation and accelerometer positions (x, y, z coordinates) must be known precisely

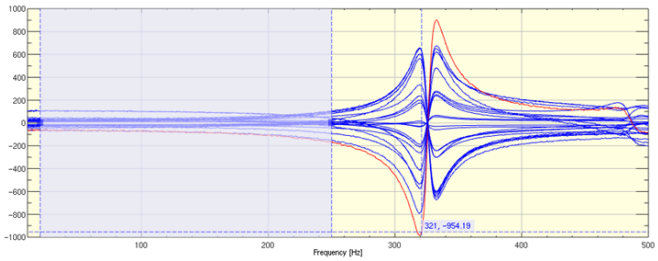
An optional wireframe mesh may also be provided for visualization purposes.

Uncertainty on the obtained results is function of uncertainty in pickup positions, uncertainty in the excitation direction (especially with an impact hammer), calibration and acquisition chain errors, influence of suspension and/or elastic modes.

A graphical tool is provided to allow the user to display the FRFs, define a frequency interval between the suspension modes and elastic modes, and extract the mass line values.

The rigid body properties are reported in tabular form or exported to file.

Applications



Selection of frequency range.

The rigid body properties are obtained by dedicated experimental testing (FRFs) and can be used as reference values for verification of finite element models. Other applications include:

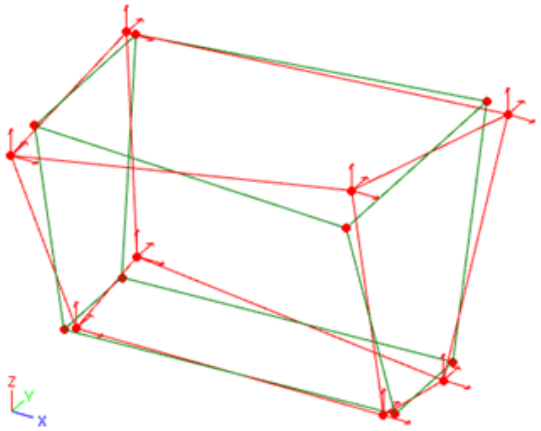
- Automated model updating using rigid body properties as reference target
- Reduce components to lumped masses for model substructuring in structural dynamics simulations or motion analysis
- Generation of rigid body modes for modal-based synthesis

FEMtools
simulate > validate > update > optimize

Benefits

- **Easy to Use** – A single control window is used for all settings, data visualization and table with results.
- **Cost Effective** - Using the same equipment for experimental modal analysis, FRFs are inexpensive to obtain compared to traditional experimental methods that use dedicate machinery to identify CoG and MoI.
- **Robust Solutions** - Rigid body properties are obtained from a (redundant) set of FRFs using curve fitting and straightforward equation solving. Assess the uncertainty of the results using error estimators.

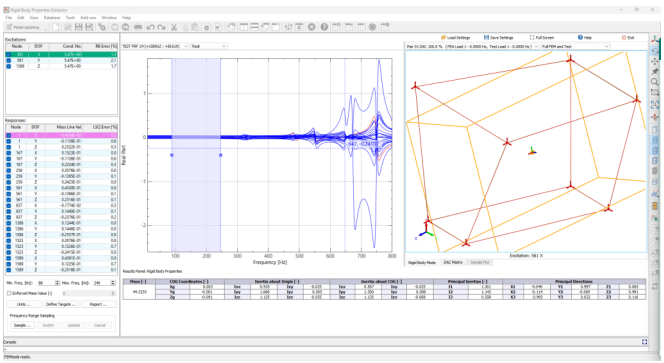
Key Features



Error estimation using rigid body mode comparison of the equivalent homogeneous brick.

The RBP extractor offers the following key features integrated in a simple-to-use and fully interactive graphical environment:

- Automatic computation of rigid body mass properties (mass, COG and inertias)
- Option to compute COG and inertias using an imposed mass value
- Full control for including/excluding excitation and response DOF
- Point-and-click interactive selection
- Definition of excitation and response DOF in local coordinate systems if necessary
- Interactive definition/modification of frequency interval used for mass line identification
- Automatic selection of interpolation scheme for identification of mass line values
- Error estimation parameters for rigid body responses and mass line values
- Methods to improve FRFs (remove first elastic modes; including lower residuals,…)
- Automatic sampling of frequency range to evaluate impact on mass properties and optimal selection
- Animation of rigid body responses (measured and least-squares)
- Visualization of COG and inertias using equivalent homogeneous brick
- Export of identified rigid body mass properties to a formatted text file
- Automatic definition of the identified rigid body mass properties as targets for model updating
- Complete digital documentation
- Unlimited customization using FEMtools Script



The RBPE user interface provides access to settings, graphics and tables in a single window.

Prerequisites and Licensing

The RBP Extractor requires a separate license that is used together with a license for any FEMtools standard configuration.

Test FRFs can be obtained with the FEMtools DAQ add -on or imported from 3rd party sources.

Services

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

Supported Platforms

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

For more information, contact us at

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