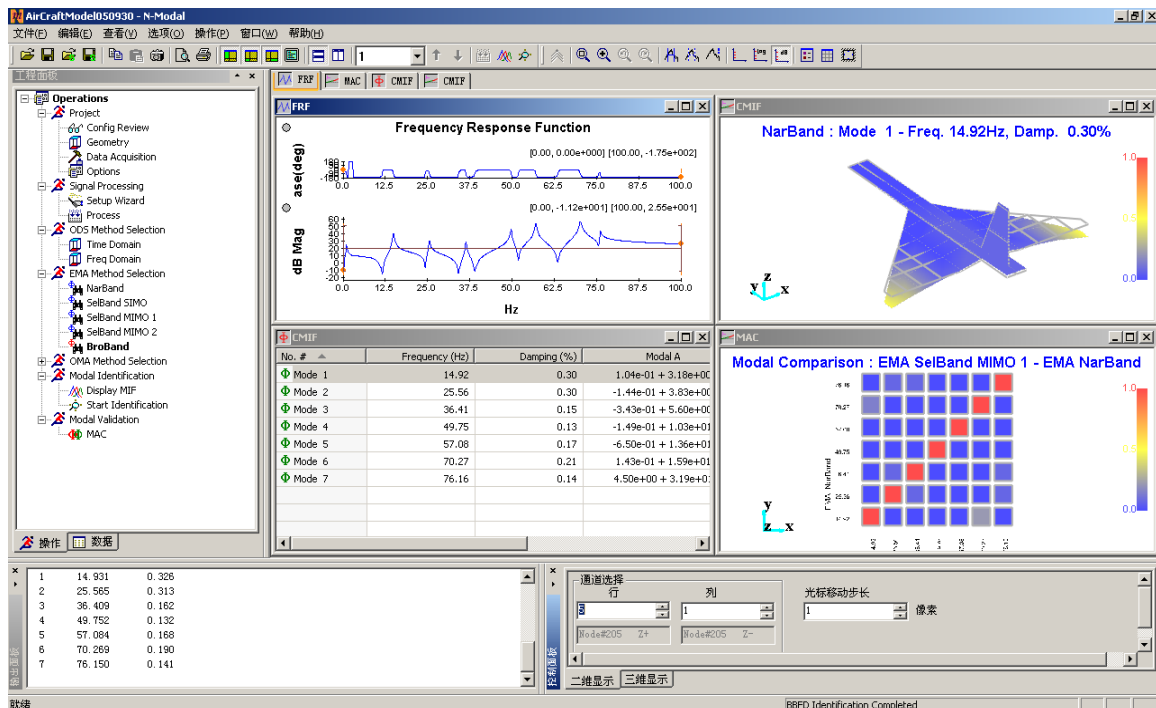


Modal testing and Analysis

- ✎ Modal testing and analysis refers to obtaining excitation (and response) data through a data acquisition system, and determining parameters that reveal the dynamic characteristics of mechanical structures, such as natural frequency, damping ratio, mode shape, and modal participation factor, through dynamic signal analysis and modal parameter identification.
- ✎ After more than 40 years of development, modal testing and analysis have made considerable progress and are widely used in vibration troubleshooting, condition monitoring, fault diagnosis, structural health monitoring, as well as dynamic response prediction, structural dynamic modification, finite element model correction, dynamic analysis and design, vibration control, etc.
- ✎ Modal testing and analysis have become an indispensable means in the development, finalization, use, and maintenance of products such as aerospace, automotive, ships, mechanical equipment, bridges, and buildings.

N-Modal Modal Analysis Software

- ✎ N-Modal is a new-generation modal analysis software jointly developed by OmniSensing (ospmotiongo.com) and the Dynamic Testing and Analysis Center (DyTAC) of the Institute of Vibration Engineering, NUA. It can realize the following three major analysis functions:
 - N-Modal ODS (Operational Deflection Shape), divided into time-domain ODS and frequency-domain ODS. Time-domain ODS is used to observe the vibration response state of mechanical structures at various time points; frequency-domain ODS is used to observe the operating mode shape of mechanical structures at various frequency points, and can also be used to distinguish forced vibration mode shapes in different modal spaces at the same frequency point.
 - N-Modal EMA (Experimental Modal Analysis), suitable for multi-input multi-output (MIMO) vibration modal testing and analysis of large complex structures under the condition that input and output are measurable and artificial excitation (vibrator or hammer) is used. It can perform modal tests with single or multiple vibrators, and also complete hammering modal tests (MRIT) with single or multiple reference points.
 - N-Modal OMA (Operational Modal Analysis), suitable for vibration modal testing and analysis of large complex structures in operating conditions using natural excitation (environmental excitation), with unmeasurable input or only using output data.



The basic characteristics of N-Modal

- ✎ It can run on mainstream operating systems such as Windows 7/10/11, is developed with a 64-bit architecture, and is easy to use.
- ✎ It has Chinese and English bilingual interfaces, and can be quickly customized to develop interfaces in other languages.

-  It has complete functional modules such as geometric modeling, project management, dynamic signal processing, modal parameter identification, time-frequency domain response modal estimation (ODS), and mode shape correlation estimation (MAC).
-  The integrated interactive geometric modeling function is intuitive and convenient to operate, enabling quick establishment of test models for simple structures. It can also import geometric information from universal format files (UFF) or IGES files.
-  Convenient measurement data input interface, which can import time-domain signals (excitation and response time history) or directly import frequency-domain data (frequency response function FRF and coherence function COH). It can import data from UFF 58/58b universal files or N-Modal standard format ASCII files.
-  Complete display and control functions for 2D curves, 3D graphics (geometry, mode shape animation, MAC).
-  Functions such as data copying, screen copying, JPG graphic storage, AVI animation storage, etc., facilitate users to quickly produce test reports and demonstration documents.
-  Flexible interface arrangement and rich mouse and hotkey shortcuts greatly improve work efficiency and usability.
-  Adopting object-oriented programming (OOP) technology, it is easy to maintain and expand.
-  All for the sake of users, it can complete various types of mechanical and structural modal analysis, making modal testing and analysis accurate, fast, convenient, and pleasant.

Fast Geometric Modeling

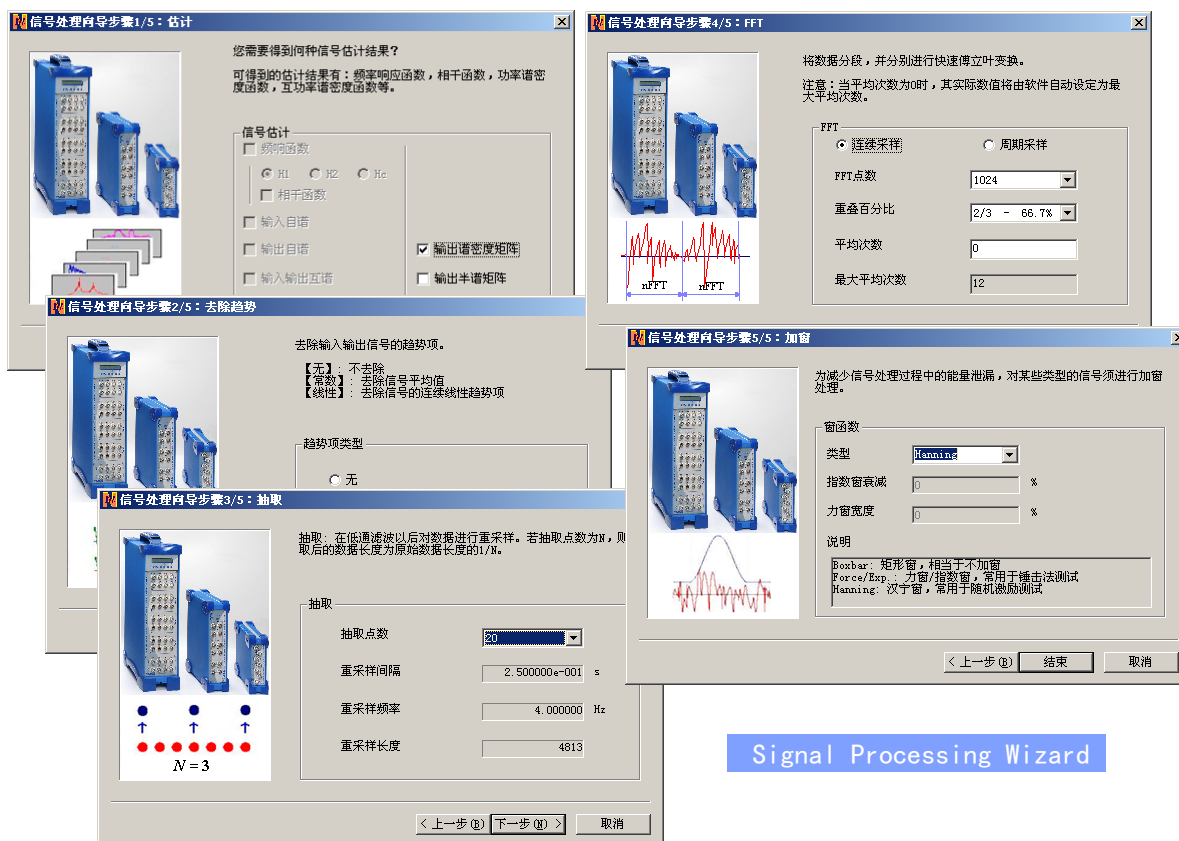
-  Integrated interactive geometric modeling module, realizing interactive selection, movement, rotation, zooming, deletion, modification of nodes, lines, polygons, 3D objects, etc.
-  It can define global coordinates and local coordinates, with three coordinate systems: Cartesian, cylindrical, and spherical, and conversion between various coordinate systems is convenient.
-  It can quickly model regular 3D objects such as line segments, straight lines, rectangles, trapezoids, sectors, ellipses, circular truncated cones, spheres, etc., and also can customize 3D unit libraries.
-  In addition to interactive geometric modeling, model geometric information can also be modified, added, deleted through the configuration information interface.

Connect the Data Collection Device

-  N-Modal can connect data acquisition equipment from mainstream domestic and foreign manufacturers through USB, Ethernet, Thunderbolt and other interfaces to achieve seamless communication and control, forming an advanced modal analysis system.
-  Through the universal file format (UFF) interface or N-Modal standard format ASCII file interface, it can be matched with excellent data acquisition front-ends and dynamic signal analyzers from all existing domestic and foreign manufacturers.
-  Cooperating with the data acquisition front-end, it supports charge/IEPE/voltage sensors such as voltage, displacement, velocity, acceleration, force (including strain type), temperature, sound pressure, supports 1/4 bridge, half bridge, full bridge (including/excluding Poisson's ratio) strain measurement, and supports TEDS sensors.
-  Adopting virtual measurement channels (AI and AO) to separate the test design and implementation process, and quickly switch between different acquisition equipment.
-  Based on the geometric model and test plan, the test process control has automatic operation and test set automatic switching functions, helping to guide and quickly complete modal tests.
-  It has acquisition mode/zero adjustment mode/signal source mode, supporting free running/channel trigger/manual trigger/signal source trigger/recorder mode.
-  It can complete single/multi-reference point hammering modal tests, supporting overload prompt/double hit prompt/overload rejection/double hit rejection/channel health status display.
-  It can complete single/multi-input vibrator modal tests, supporting the generation of sine/sine sweep/stepped sine/random/burst random and other excitation signals.
-  Supports re-testing of a single test set, realizing quick re-testing of single or partial measuring points simply and efficiently, improving the overall test effect.
-  Time-domain data or frequency-domain data can be saved in text or binary UFF format and quickly sent to modal software for processing and analysis.
-  Supports online re-sampling to realize low-frequency testing.
-  Supports estimation and display of time waveform/windowed waveform/autopower spectrum/crosspower spectrum/frequency response function, etc., supports linear average/exponential average/peak average, and supports force window/exponential window/Hanning window/Hamming window/flat top window.

Fast and User-friendly Analysis Function

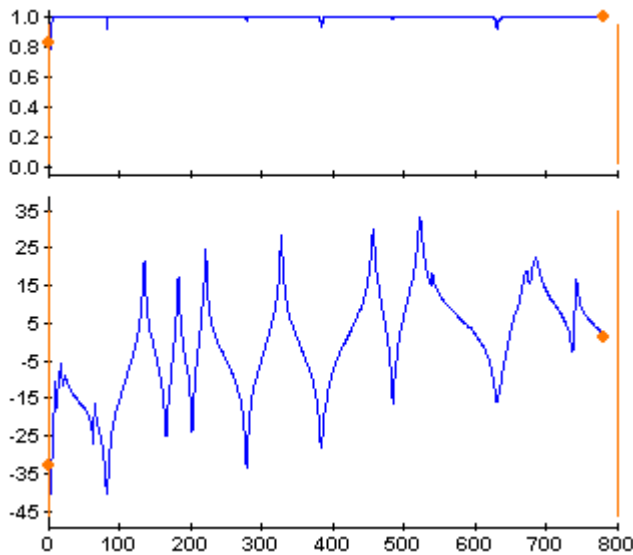
- ☞ Wizard-style signal processing parameter setting to realize trend removal, time-domain extraction, fast Fourier transform (FFT), windowing and other functions.
- ☞ FFT length: base 2 integer, freely selectable according to measured data; overlap: 0%~83%, selectable from the drop-down list; number of averages: user-defined; window function: rectangular window, Hanning window, Hamming window, flat top window, exponential window, force window, exponential window, etc.; analysis frequency range: 1/2 or 1/2.56 of the sampling frequency.
- ☞ Power spectrum estimation: autospectrum, cross-spectrum, power spectrum matrix, half-power spectrum matrix.
- ☞ Single input multiple output (SIMO) frequency response function (FRF) estimation: H1, H2 and Hc estimation.
- ☞ Multi-input multi-output (MIMO) frequency response function estimation and coherence function estimation.
- ☞ Multi-threaded signal processing process, which can be repeated with different setting parameters.



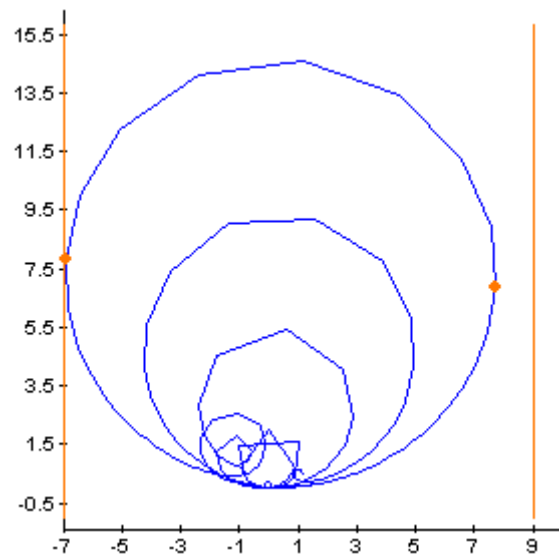
Flexible Two-dimensional and Three-dimensional Graphic Display, Control and Output

- ☞ Provide dedicated 2D curve and 3D graphics control panels, as well as various control methods such as mouse, shortcut keys, and menus.
- ☞ Multiple curve expression methods, such as amplitude (linear, logarithmic, dB coordinates), phase, unwrapped phase, real part, imaginary part, Nyquist diagram of frequency response function, etc.
- ☞ Convenient and flexible 2D curve display and control, grid, legend and other elements can be displayed or hidden, and can provide complete measurement information of the corresponding curve (measurement node, direction, whether it is origin measurement, etc.).
- ☞ Practical functions such as zooming (with memory capacity for different zoom states), segment selection, peak and valley finding, etc.
- ☞ Convenient and flexible 3D graphics display and control, node numbers, input/output markers, coordinate axes and other elements can be displayed or hidden, and can be easily translated, scaled, rotated, etc.
- ☞ Provide 3D graphics views such as pitch, left-right, front-back, and can realize frame line display or colored surface rendering of the structure.

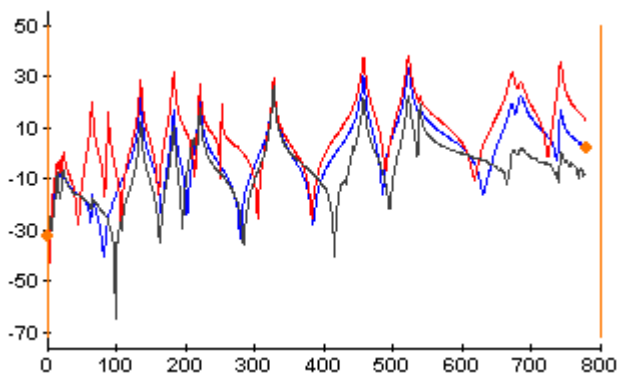
- ☞ The colors of various elements of 2D curves and 3D graphics can be customized.
- ☞ OpenGL-based 3D graphics animation control, realizing functions such as play, pause, frame play, amplitude control, speed control, etc.
- ☞ Various 2D curves and 3D graphics can be copied to the operating system clipboard, or stored as PNG, BMP, JPG, GIF and other format graphic files with one click.
- ☞ Mode shape animation and ODS animation can be directly output as MP4 video files or GIF animation files.



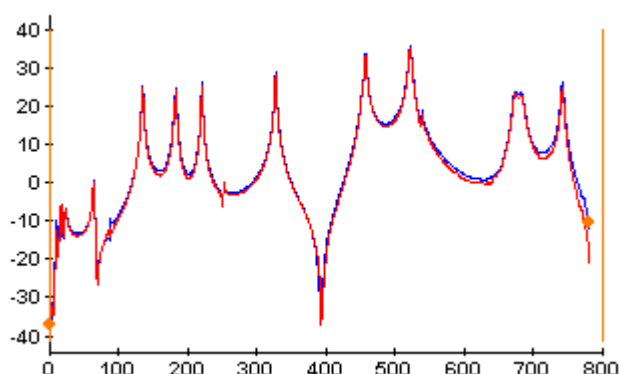
Origin FRF amplitude and its coherence function test



The Nyquist plot of the frequency response



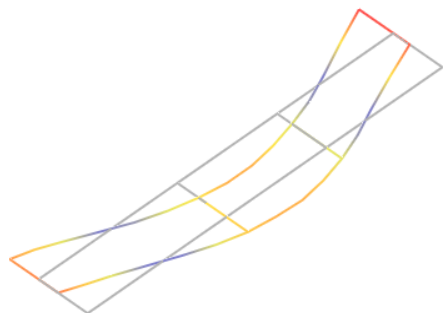
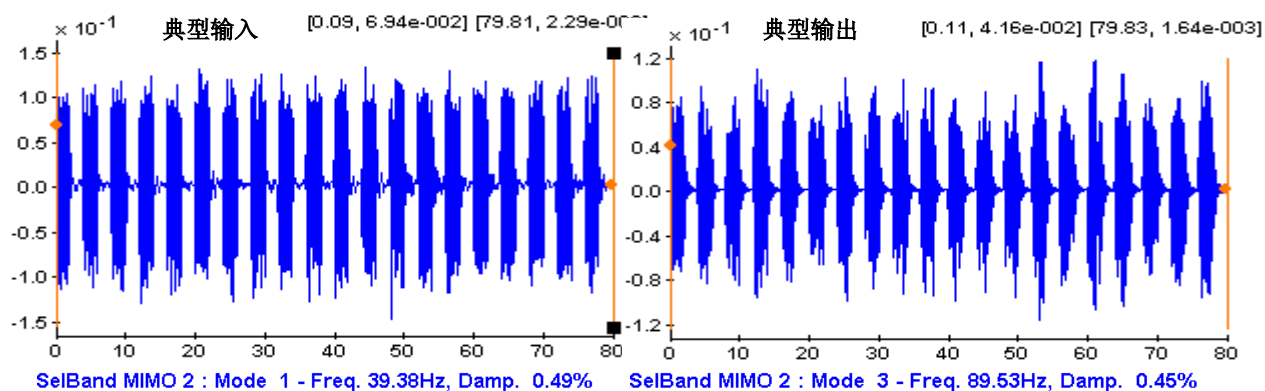
Overlay display of the frequency response



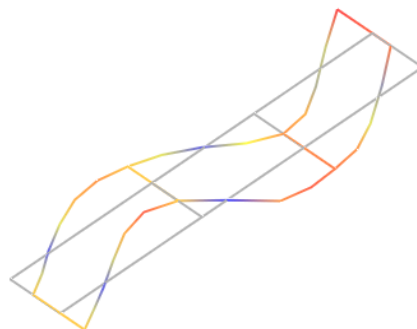
Verification of FR and Non-identity at Crosspoints

Advanced, Accurate and Reliable Modal Analysis Technology

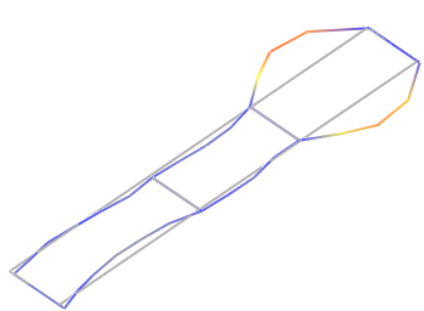
- It includes three types of algorithms: narrowband (NarBand), selected band (SelBand), and broadband (BroBand). The narrowband method identifies modes one by one, which is convenient and easy to use; the selected band method identifies several modes at one time within the selected frequency band, with good accuracy; the broadband modal identification method based on the latest p-LSCF algorithm identifies all modes in a wide frequency band or even the full frequency band, which is efficient and used for complex structures with large damping.
- Experimental Modal Analysis (EMA) technology based on input (excitation force) and output (response) measurement.
- Single input/multiple output (SIMO) global modal identification technology, which can identify global modal parameters.
- Multi-input/multi-output (MIMO) modal identification technology with multi-point excitation, which has the ability to identify high-density or repeated frequency modes, and is an ideal method for experimental modal analysis of large and complex structures.



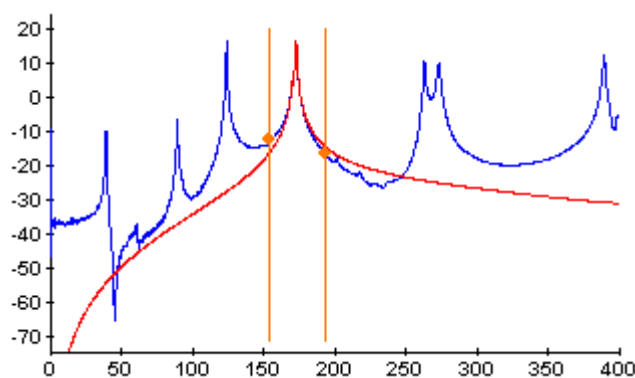
SelBand MIMO 2 : Mode 5 - Freq. 170.15Hz, Damp. 0.18%



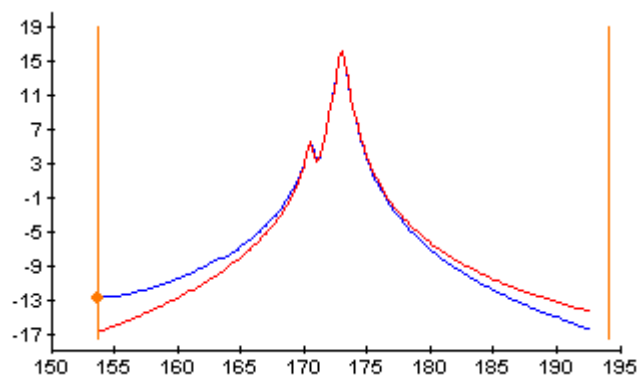
SelBand MIMO 2 : Mode 7 - Freq. 263.20Hz, Damp. 0.23%



The EMA test modal analysis of a bus frame using two excitation devices for vibration excitation



Band selection identification of FR and results of dense mode fitting

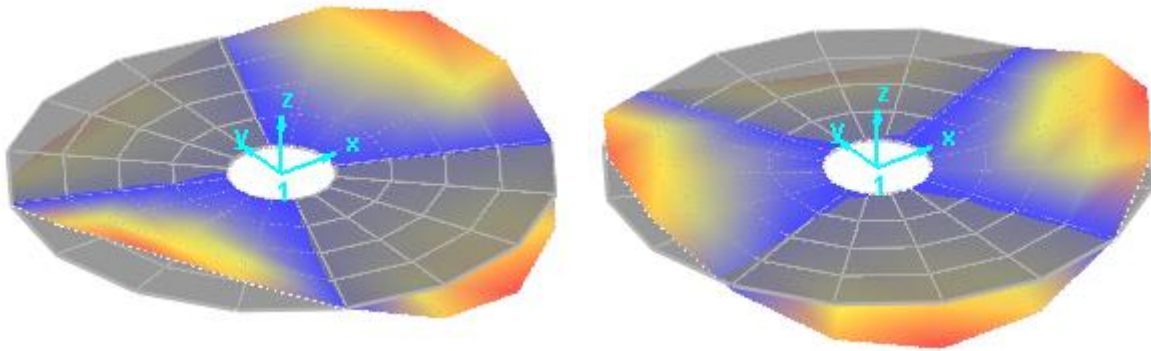


Local magnification of the fitted curve

- Single reference point and multi-reference point hammering method (MRIT) modal identification technology

4 th: 166.13 Hz, 0.96%

5th: 166.56 Hz, 0.95%

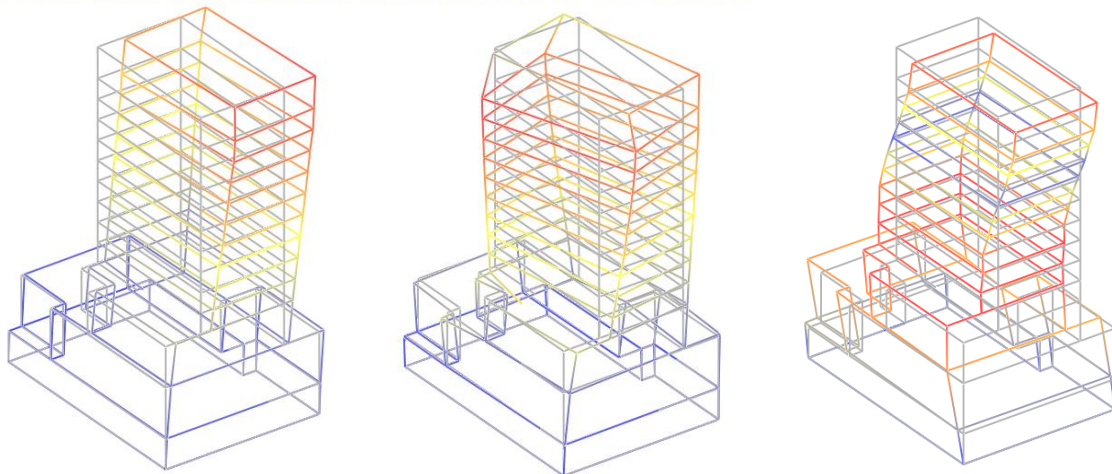


A pair of heavy root modes identified for an engine toothed disk

Operational Modal Analysis (OMA) technology with only measurable output (response) under environmental excitation, which can test and analyze the vibration modes of mechanical structures such as bridges, buildings, automobiles, aircraft, rotating machinery, etc. in operating conditions without artificial excitation, only measuring response.

- It is not only simple and feasible, but also can obtain the dynamic characteristics of the structure in the real operating state, and naturally has multi-reference point characteristics, with the ability to decouple dense modes.
- The narrowband modal parameter identification method (Frequency Domain Spatial Decomposition, FSDD) based on the full power spectral density matrix is convenient to use and has accurate results.
- The narrowband modal parameter identification method based on the half-power spectral density matrix is easy to operate and realizes the unification of EMA and OMA analysis.

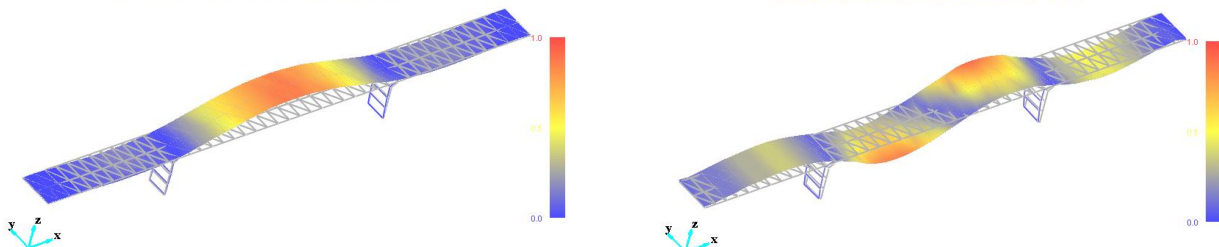
NarBand Full : Mode 1 - Freq. 0.76Hz, Damp. 0.75% NarBand Full : Mode 3 - Freq. 1.11Hz, Damp. 0.90% NarBand Full : Mode 5 - Freq. 2.47Hz, Damp. 1.32%



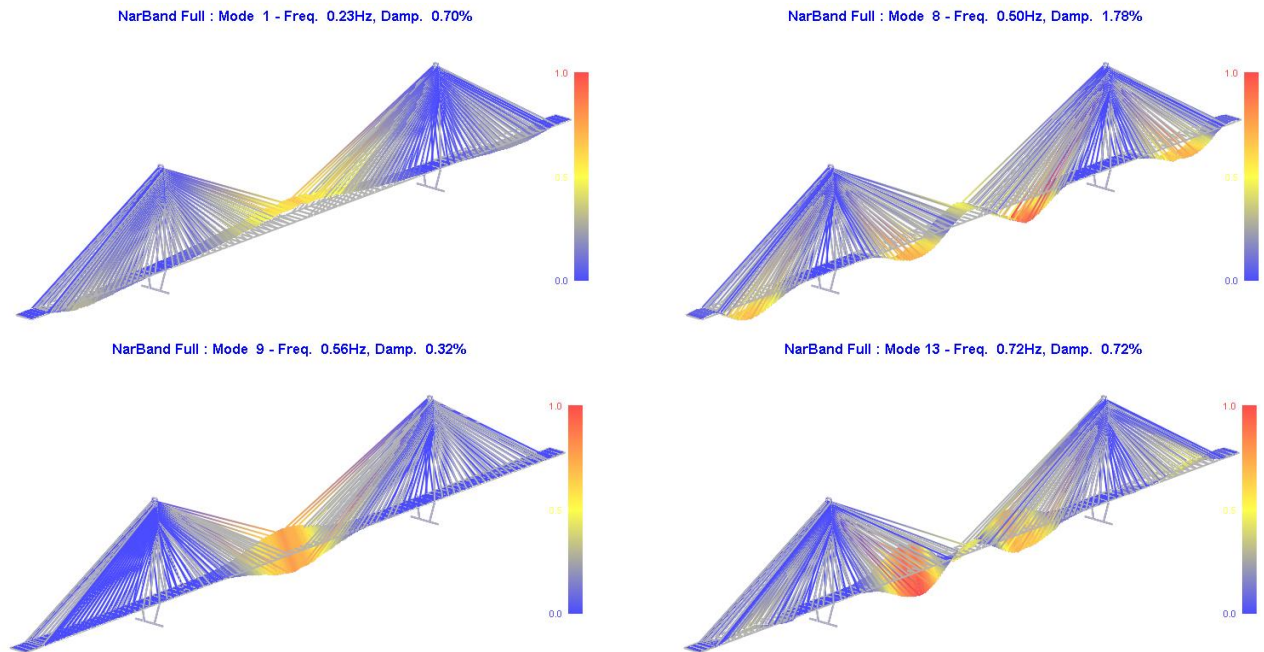
Modalities identified by the OMA for the building structure

NarBand Full : Mode 1 - Freq. 3.85Hz, Damp. 0.77%

NarBand Full : Mode 3 - Freq. 9.72Hz, Damp. 1.24%

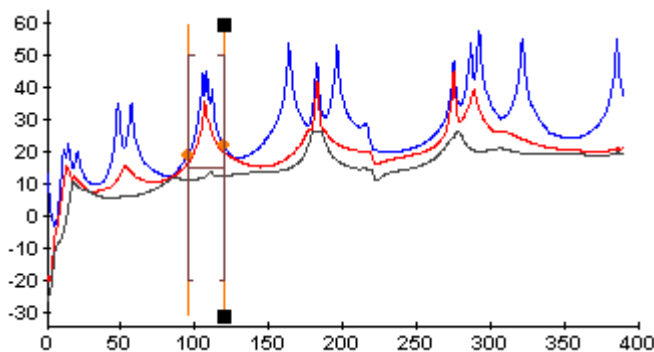


the OMA result beam-type highway bridge

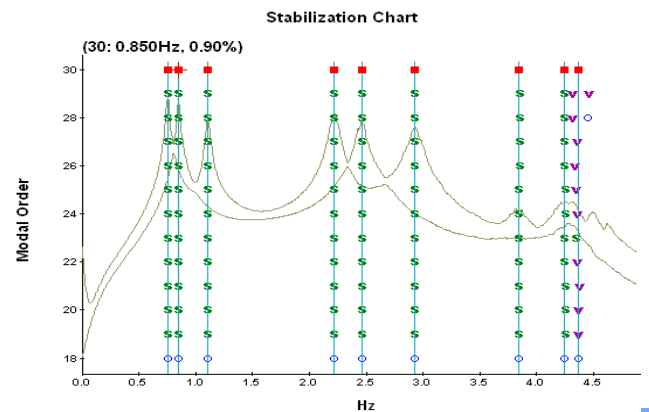


The OMA results of a large-span cable-stayed bridge

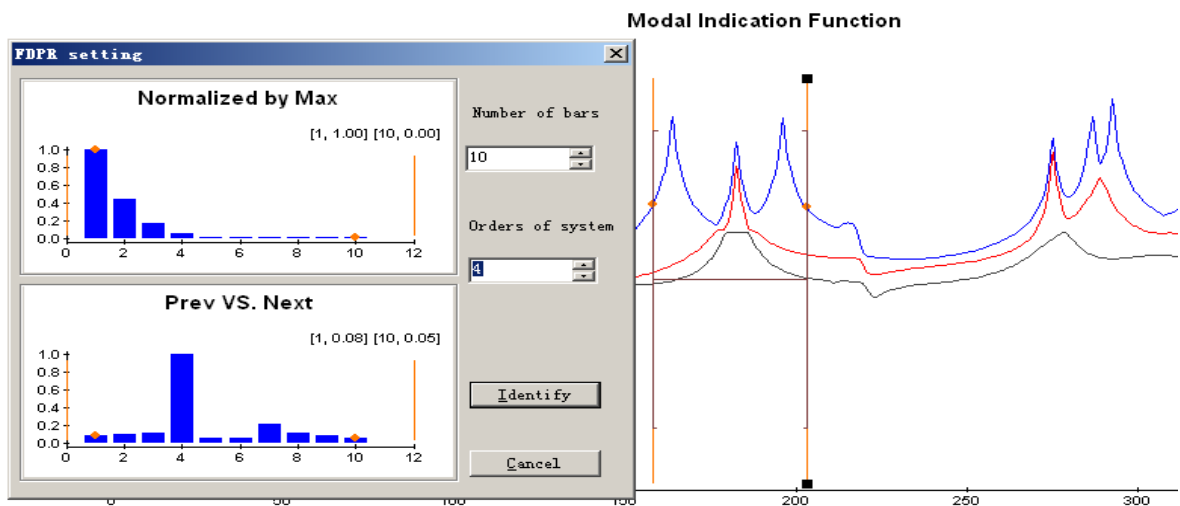
- Modal Indication Function (MIF) is used as the basis for judging the modal order, which can reliably determine the structural modes and avoid missing modes.
- Frequency stabilization chart is used to distinguish structural modes from computational modes.



MIF of disc EMA analysis

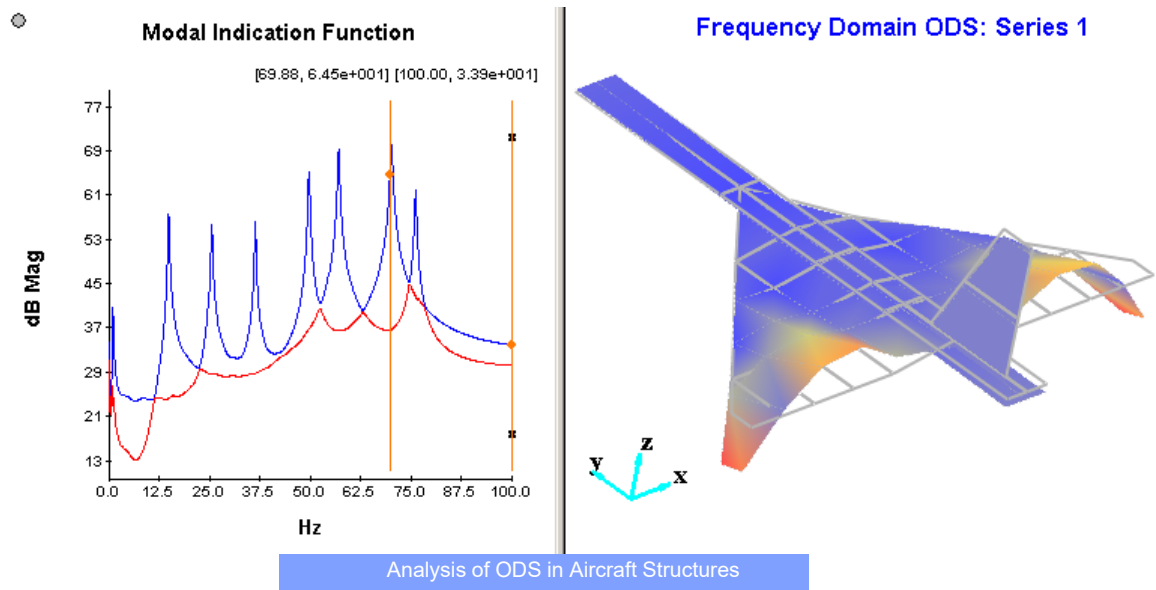


Modal indicator functions and stability of the OMA analysis



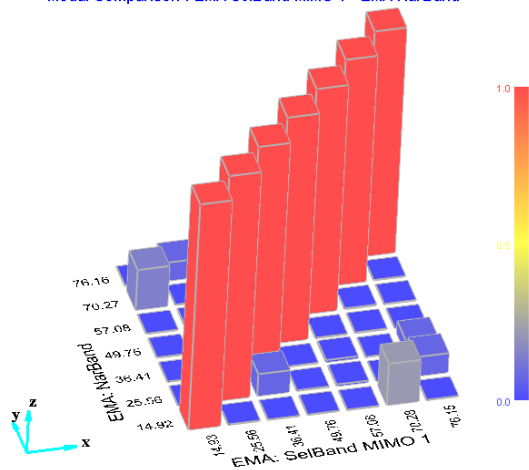
Perform EMA analysis on the disc using the FDPR

- Time and frequency domain response modal analysis (ODS) and visualization, allowing users to understand the structural vibration mode at a certain time or frequency point in real time.



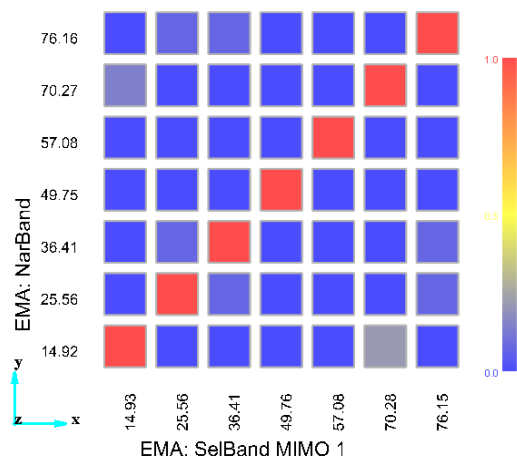
- Mode shape correlation matrix (MAC) estimation and visualization for checking mode shape accuracy, including 3D Bar graph and numerical table.

Modal Comparison : EMA SelBand MIMO 1 - EMA NarBand



3D bar chart of the MAC matrix

Modal Comparison : EMA SelBand MIMO 1 - EMA NarBand



3D bar chart (top view) of the MAC

MAC Table: EMA: SelBand MIMO 1 (V) vs. EMA: NarBand (H), Unit: (%)

No.	1-14.92	2-25.56	3-36.41	4-49.75	5-57.08	6-70.27	7-76.16
1-14.93	99.9	0.2	0.0	0.1	0.0	17.7	0.0
2-25.56	0.1	99.7	8.9	0.1	0.4	0.0	8.0
3-36.41	0.0	9.6	99.8	0.0	0.9	0.0	5.0
4-49.76	0.1	0.2	0.0	100.0	0.1	0.3	0.1
5-57.08	0.0	0.7	0.8	0.0	99.8	0.1	0.2
6-70.28	18.2	0.2	0.0	0.2	0.3	100.0	0.0
7-76.15	0.0	8.4	5.1	0.1	0.1	0.0	99.7

拷贝 确定

Numeric table of the MAC matrix

If you have any questions, please call us or send an email to sales@osphotronics.com.



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