An Axiometrix Solutions Brand

Measuring resonance frequencies and avoiding operational damage

FRF_Average_F_a_X		
Frequency [Hz]	Peak	Damping
1284.2	13.4	0.089
1295.2	13.4	0.101
1303.7	13.4	0.100
1268.3	13.0	0.094
1311.0	12.8	0.101

FRF_Average_F_a_Y		
Frequency [Hz]	Peak	Damping
1147.5	26.6	0.009
1433.1	12.6	0.013
1284.2	5.1	0.101
1657.7	4.1	0.040
1634.5	4.1	0.040

FRF_Average_F_a_Z		
Frequency [Hz]	Peak	Damping
498.0	20.1	0.007
1147.5	13.0	0.010
766.6	7.0	0.006
412.6	6.6	0.003
710.4	6.3	0.007

Technical structures, such as buildings, machines or plants, can be excited and set into resonant vibration by natural phenomena (wind, waves, earthquakes), traffic or the operation of a motor. These vibrations affect the material or the statics of a structure and can cause damage. To avoid this, the resonance frequency of the structure, machine or plant must be determined. This is where the imc WAVE Structural Analyzer comes into play, with which resonance frequencies can be measured and various spectra calculated.

Why is the measurement of the resonance frequency important?

A permanent load of technical structures by the resonance frequency affects the life span as well as the quality of the products of the machine. To operate machinery or plants outside their natural frequency, it is essential to measure the resonance frequency.

Determination of the resonance frequency

Typically, a defined force signal is introduced into the structure with an impulse hammer. The vibration of the structure is recorded with acceleration sensors. Together with the force signal of the impulse hammer and the acceleration signal a transfer function is calculated, which represents the resonance frequencies in peaks.

Fig. 2: Measurement in the imc WAVE Structural analyzer

The imc NVH Solution

The NVH software imc WAVE can be used for the systematic analysis of the vibration behavior of mechanical structures. The imc WAVE Structural Analyzer takes over the measurement and calculates all signals synchronously and in real-time. Transfer functions, coherence and power spectra are determined. The transfer function describes the ratio of the introduced force of the impulse hammer blow to the resulting vibration (acceleration) in the frequency domain. The coherence describes the dependency between input and output signal in the frequency domain and provides information about the quality of the measurement. The power spectra consist of the quadratic frequency analysis of the input signals.

Fig. 3: Diagram on the upper left: time signal
Diagram on the upper right: averaged spectra of time signals
Diagram on the lower left: transfer function FRF [Y-axis in dB] and coherence
Diagram on the lower right: transfer function FRF [Y-axis linear]

After the measurement, a peak list sorted by amplitude with resonance frequencies, amplitudes and attenuations can be generated and displayed in a table (see Fig. 4).

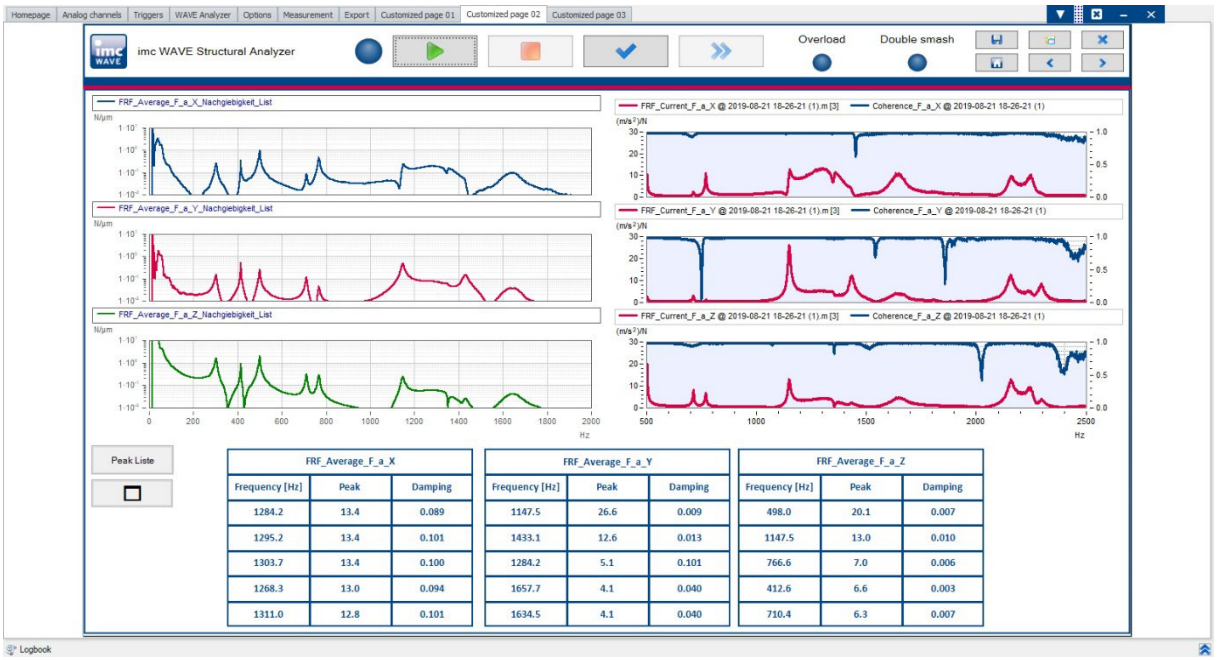

Fig. 4: Diagram on the upper left: Compliance frequency response [Y-axis logarithmic]
Diagram on the upper right: transfer function FRF [Y-axis in dB (logarithmic)]
tables: Peak-Lists X-, Y- and Z- axis sorted by amplitudes with frequency and attenuation

In order to get a more precise picture of the form of vibration, i.e. the detection and localization of vibration nodes and antinodes, the measured FRFs (abbreviated to "Frequence Response Function") can be exported to modal analysis software such as ME' Scope™ at the end of the measurement. The exported files contain not only the time data and spectra, but also all metadata information about the DOF numbers (DOF = Degree of Freedom) as well as the measurement point and direction (+ X, -X, + Y, -Y, + Z, -Z) of the sensors.

Conclusion

The imc WAVE Structure Analyzer is an efficient and specific software for determining the vibration behavior of machines, plants and civil infrastructure. The software covers all parts of the structural analysis, from the setup and execution of the measurement, to the calculation of all signals and the subsequent determination of the resonance frequencies. These resonance frequencies are clearly displayed in a peak list, which is sorted by amplitude. Thus, all relevant resonances can be seen at a glance.

By integrating the analysis software imc FAMOS additional results can be calculated, such as the dynamic stiffness or compliance of the structure.

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imc Test & Measurement GmbH is a manufacturer and solution provider of productive test and measurement systems. Together with its customers from the fields of automotive engineering, mechanical engineering, railway, aerospace and energy, imc implements test and measurement solutions for research, development, service and production. Every day, customers use imc data acquisition (DAQ) systems, software solutions and test stands to validate prototypes, optimize products, monitor processes and gain insights from measurement data. imc consistently pursues its claim of providing services for "productive testing". The company offers its customers top technological performance throughout the entire measurement chain.

The core of the product portfolio consists of imc's modular data acquisition and control systems, which are supplemented by tailor-made sensor and telemetry systems.

As a solution provider, imc offers its customers an attractive range of services. The service includes project consulting, contract measurements, data evaluation, outsourcing of specialists and customer-specific software development through to system integration and test bench automation. Our team of engineers and natural scientists has extensive project experience and a high level of competence in solving test and measurement tasks.

The imc global partner network enables imc customers to find direct contacts in more than 30 countries.