Dynamic stiffness of engine mounts

A comparison between three high-frequency test rigs in characterizing engine mounts has shown the influence of different parameters on the accuracy of results

The vibration transmission characteristics of engine mounts, in particular the dynamic stiffness, are of key importance to NVH engineers. There is an increasing demand for higher test frequencies.

m+p international has developed several high-frequency test rigs to characterize elastomer mounts dynamically up to 3,000Hz. They are equipped with either a piezoelectric actuator or an electrodynamic shaker. The purpose of these high-frequency test rigs is to determine dynamic stiffness using a static preload.

One of m+p international's customers, the Fraunhofer Institute for Structural Durability and System Reliability LBF in Darmstadt, Germany, used a VDA (German Automobile Industry) specimen mount to compare measurements using three test rigs: LBF's own high-frequency test rig employing an 8kN electrodynamic shaker; a rig from m+p international, which uses a piezoelectric actuator; and a rig from a well-known manufacturer of passive and active bearings.

The VDA specimen is a cylindrical elastomer made from natural rubber with a diameter of 50mm, a height of 20mm, and Shore hardness of 65. To compare the dynamic stiffness, a number of test parameters have to be considered. In this case, the static preload, dynamic excitation waveform and amplitude, temperature, test adapter design, material and tightening torque, control of the set points, the vibrational influences of the test rig, and preconditioning of the specimen are highly important.

Time constraints meant that many of the listed parameters could not be defined consistently for the comparison between the LBF test rig (with 8kN shaker) and m+p international's (with piezoelectric actuator). However, the main characteristic, namely the continuous rise of dynamic stiffness with frequency, was identical for the two test rigs.

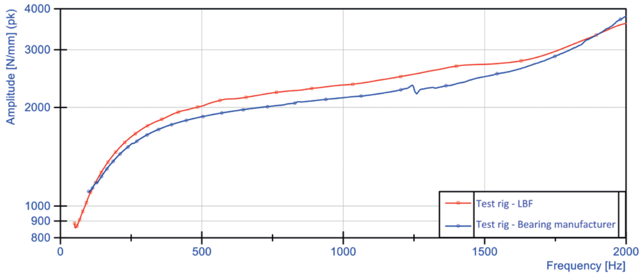
For comparison measurements between its own m+p rig and that of the bearing manufacturer, LBF specified the following parameters:

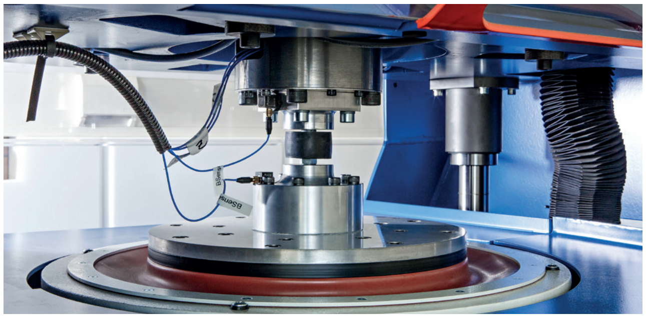
- Static preload: 1,000N
- Dynamic amplitude: +/-10g (sinewave)
- Sweep rate: 1 octave/min
- Preconditioning: 3 x 0-1,500N
- Temperature: room temperature
- Adapter: identical material, design and tightening torque.

The top image shows the dynamic stiffness characteristics measured using the LBF and bearing manufacturer's test rigs. The maximum measurement deviation is around 10% at 1,400Hz and the minimum deviation is about 4% at 150Hz. It should be remembered that these test rigs are very different, particularly the test frame, the measurement chain (sensors and data acquisition), the electrodynamic shaker used and the control system.

During the tests the influence of the parameters listed on the result and the comparison were evaluated. It is evident that the specimen adapter had an enormous influence on the measurement of dynamic stiffness. The preconditioning and the static preload value were the next biggest influence. Temperature variations were negligible, at about ±5°C.

These comparison measurements of dynamic stiffness did not comply fully with all the relevant test parameters, due to the increased effort and cost required to accommodate them across multiple rigs. ❮





LEFT: Dynamic stiffness measurement using LBF's test rig and the bearing manufacturer's system

BELOW LEFT: The specimen mounted on the test unit.
Images: Fraunhofer LBF