S&V OBSERVER

Polytec Weight Optimization Can Improve Mileage

Figure 1. Polytec RoboVib Structural Test Station in use.

With increased use of lightweight plastic and metal matrix composite materials, three-dimensional, finite-element modeling of composite materials has become more critical. This modeling ensures that lighter weight materials will retain their strength while reducing costs.

As these new materials emerge on the manufacturing floor, quality control is being asked to determine how to identify measurements that will quickly and accurately sort parts. As manufacturers integrate unitary construction techniques and implement newer, lighter designs, or use lighter materials to produce parts, they need to change the way they test. Lighter materials shift the resonance and modal frequencies of the heavier part they replaced.

Meanwhile, new forming techniques are creating much more complex shapes than they have in the past. These all lead to a different resonant response at higher frequencies that can easily move into the audible range. To combat this shift, a much higher point density of the measurements must be used in the test setup to avoid spatial aliasing. The concept of aliasing is well understood in the NVH community; few engineers would consider using an FFT without settings that circumvent aliasing. For some reason, in the spatial domain the dangers of aliasing are forgotten.

Classically it has been difficult and time consuming to perform appropriate measurements. The result has been that a million-point (or more), finite element model will be verified with 200, 100 or even fewer measured data points. The measured data are not even a good stick-figure approximation of reality. In fact, if the bending shape is somewhat close to the model shape, the model has been accepted as validated. Such approximations are not good enough for today's standards.

As components become lighter, this gap in the modeling process will grow unless a different technique is adopted. Polytec offers a solution to fill this gap with its RoboVib Structural Test Station – an automated 3D laser system shown in Figure 1. RoboVib is capable of measuring at node locations on an FE model for verification and updating, making point density limitations history.

Correcting models early in the process is highly important today, with manufacturers reducing cost through sharing components over multiple models or on multiple vehicles on the same platform,

Weight reduction is a particularly important topic due to the 2025 CAFE standard of 54.5 mpg. One of the areas where weight can be saved is a combination of designing panels so that they need less vibration damping, and optimizing the type of damping material used and where it is placed. In tests performed by Polytec, as much as 40% of the damping material weight could be removed.

Typically, accelerometers have been used to optimize placement – for example, placing 22 accelerometers on the floor area of an SUV to measure vibration, and using that data to optimize placement of vibration damping material. This would yield the measured bending response shown in Figure 2.

To save time, many test labs would not even bother applying 22 sensors. This leads to an incomplete picture. The value comes when you are able to increase this density. By increasing the number of data points to 100, one can see that the results already show much greater detail for where damping material needs to be applied (Figure 3).

Measuring with this point density using accelerometers is not only time consuming, but also alters the physical response and damping due to the mass of the sensors. Compensating for the mass and allowing time for this measurement is usually not possible in a standard engineering process. This is especially true when everyone is clamoring for the prototype. The extra time required for high-quality measurements is a smart trade-off. In the past, an SUV floor was a relatively flat section with a lot of mass and relatively lax NVH targets. This was fine, but if the goal is to meet tomorrow's high standards, higher-resolution data are essential. When using sufficient spatial density, the image becomes clearer and more vivid. The data in Figure 4 was captured using a Polytec Structural Test Station.

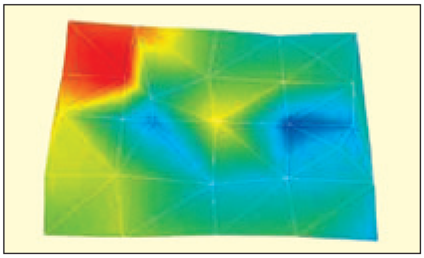

Figure 2. Dynamic analysis of SUV floor panel measured with 22 accelerometers.

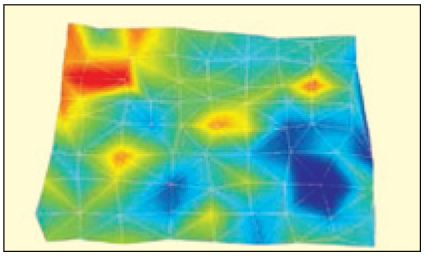

Figure 3. Dynamic analysis of SUV floor panel based on 100 measurement points.

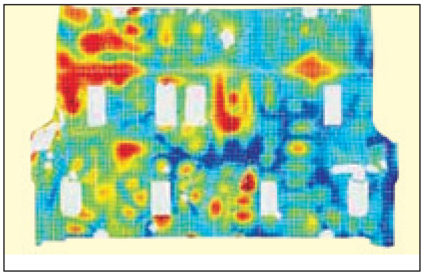

Figure 4. Dynamic analysis of SUV floor panel using the Polytec Structural Test Station.

Using data like that shown in Figure 4 makes it is easy to identify the areas in need of damping and the frequency of interest. The optimum damping material type can now be selected and placed in the correct areas. The data also show where additional improvements can be accomplished with minor structural changes. The small embossed areas add stiffness, but they also have their own localized modes (shown as hot spots).

The downfalls of spatial aliasing can be seen by comparing Figures 2 and 4. With appropriate testing, overall NVH can be improved while reducing weight by pinpointing and identifying local modes. The scanning vibrometer simultaneously highlights local modes and measures structural parameters without mass loading.

For more information on the Polytec RoboVib Structural Test Station and other Polytec products, please visit: www.polytec.com.