Vibration case study

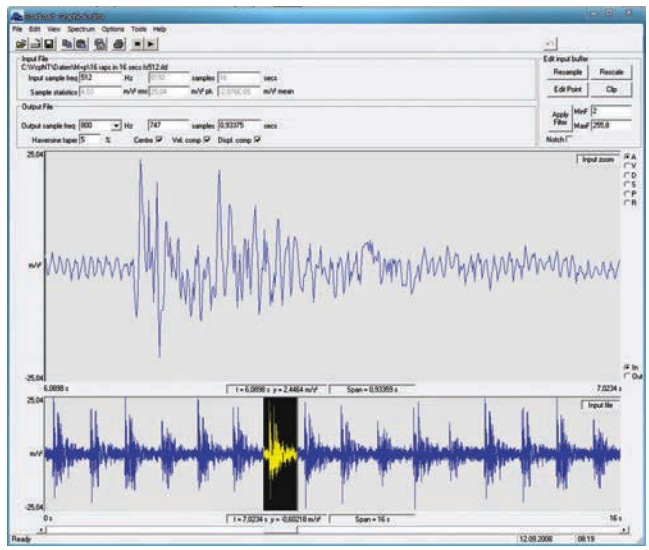
The m+p VibControl software provides unlimited time data replication with real-time, closed-loop control for real-world vibration tests

Vehicles have to cope with a variety of road surfaces during their lifetime: smooth highways, potholed suburban streets, cobbles, sand, gravel and rocky off-road tracks. In addition, the engine and driveline are sources of vibration that generate high levels of potentially damaging vibration. Therefore, vibration testing is essential during design and product development to ensure the reliability and structural integrity, not only of the vehicle, but also its components, to enable them to survive the stresses to which they will be subjected when they encounter these different environments.

For most automotive components, vibration test specifications are traditionally based on sine, swept sine random, or shock vibration profiles, but there are occasions when the test stimulus needs to represent more accurately the actual vibrations likely to be experienced. Road load data, acquired from a vehicle driven around a test track, proving ground or along public roads, can provide a more realistic, real-world control stimulus for a vibration test facility.

Calsonic Kansei is a Tier 1 global automotive component manufacturer that supplies products including exhaust systems, HVAC systems, dashboards, consoles, radiators and cooling components to all the major motor manufacturers. Their European operation has 13 sites spread across the UK, France, Germany, Spain, Romania and Russia. The company is well aware of the responsibility it carries, not only for its own reputation, but also for the reputation of its customers and their marques and as a consequence places a high priority on product quality and reliability.

The European test facility, based in Llanelli, Wales, was recently asked to carry out vibration tests using road load data on an automotive cooling pack assembly. Road load data is derived from real-world measurements, often from a vehicle proving ground or dynamometer. The facility is equipped with four electrodynamic shakers, each controlled by m+p VibControl software and m+p VibPilot

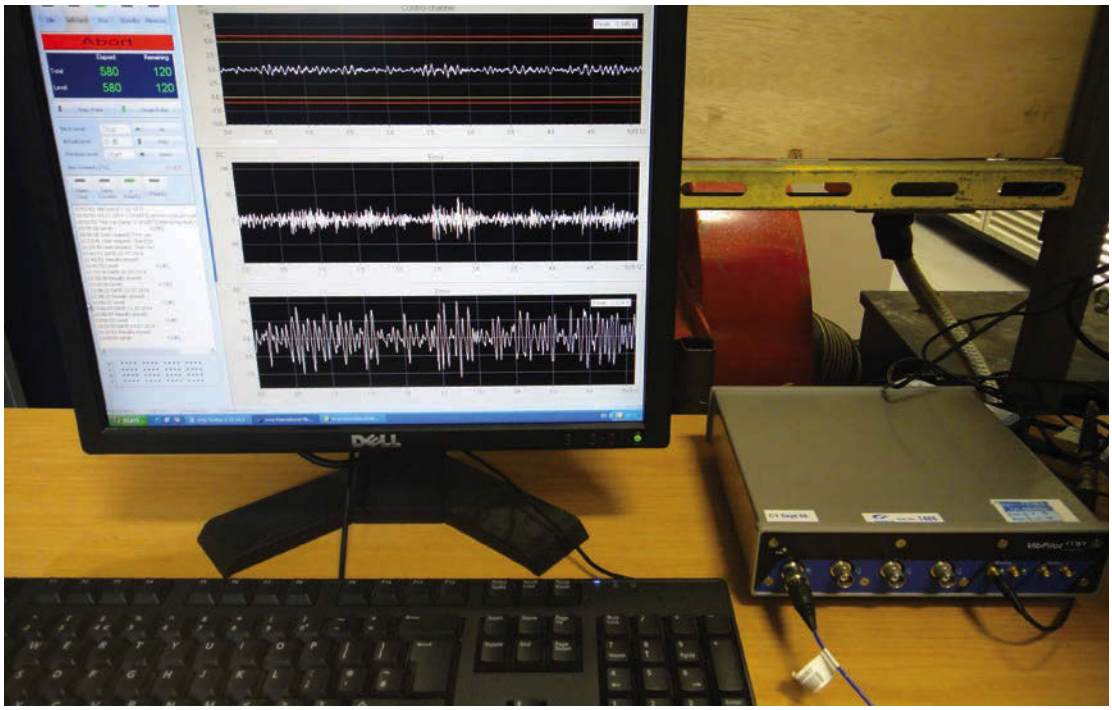


ABOVE: Road load simulation editor
BELOW: Road load vibration test rig at Calsonic Kansei, Llanelli

front-ends. Vibration tests normally use sinusoidal (fixed or swept) and random stimuli, but Calsonic was able to meet this request by installing the road load option for m+p VibControl.

Road load simulation enables raw data in almost any format to be imported, viewed, and edited to create a suitable drive file for the vibration test system. Using m+p's road load software, engineers at Calsonic Kansei were able to create a 15-minute profile from the data supplied by their customer. The full test consisted of 700 repetitions of the profile, using a single control point at the top of the cooling pack assembly (shown left).

The m+p VibControl software provides unlimited time data replication with



LEFT: m+p VibControl dashboard showing road load test signal

real time, closed-loop control. The road load simulation option for m+p VibControl works equally well with electrodynamic and hydraulic shakers. It is fully compatible with other vibration modes, includes sine, random and shock, and is particularly suited for durability testing on automotive components such as radios, entertainment systems, light assemblies, and ECUs, as well as heating and cooling components.

Road load uses data acquired from sensors fitted to the bodywork, axles or critical components as the vehicle is driven across the relevant road surfaces. Data can be measured using, for example, a laptop connected to the vibration sensors via an m+p VibPilot front end. The road load software is able to handle very large sample files recorded at any sample frequency and in virtually any format, including RPC3, WAV and ASCII files. Data can be viewed as acceleration, velocity or displacement, time histories, spectra or PSD.

Key to the flexibility of road load is its extensive data editing facilities. Raw data can rarely be used to control a vibration system without some form of editing to meet the needs or limitations of the test system. Data can be edited as single points, and signal clipping and bandpass filtering can be applied quickly and easily to sections of the data or to the whole data file. Areas of low vibration – and therefore of little interest – can be removed to avoid wasting valuable test time. Data from a variety of road surfaces, taken at different times, can be combined to provide a more comprehensive test. A section of the data from one or more files can be cut, pasted or appended as required to create the final file.

Filtering to remove the DC content from an accelerometer signal is essential as the constant of (double) integration can result in the shaker displacement exceeding its travel limits.

The random nature of road load testing makes significant demands on the shaker control system. The m+p VibControl/VibPilot system, used at Calsonic Kansei, uses advanced, real-time, continuous loop control to ensure that the vibration applied to the unit under test conforms closely to the required test profile. The coherence averaging technique used responds in real time to the dynamic response of the shaker to give stable, long-term control and accuracy.

This eliminates the need for the traditional time-consuming iteration process at lower levels of vibration. It also ensures that changes in structural dynamics due to product deterioration are automatically accounted for.

Once started, tests run autonomously, enabling the operator to perform other tasks. At the conclusion of the test run – or if the test is aborted for any reason – an email or SMS text message can be sent to alert the operator; this is particularly useful for long tests, such as that at Calsonic Kansei, where the test lasted over seven days, including overnight and weekend operation.

When testing has been completed, m+p VibControl also provides flexible and comprehensive reporting tools. Test result data can be presented in a wide variety of pre-determined or customized formats, and include company logos where required; the data can also be forwarded to recipients using the ActiveX output.

Road load data does not replace conventional sine or random testing, but can provide another useful tool for vibration test engineers, ensuring that automotive components and assemblies will work reliably in the environments for which they are designed. The ease with which this type of testing can be implemented into an m+p VibControl system, demonstrated by Calsonic Kansei's recent experience, makes it a worthwhile option to consider. ❮