



SURFACE VEHICLE RECOMMENDED PRACTICE

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Brake Insulator Damping Measurement Procedure

RATIONALE

This technical report is stabilized because it covers technology, products, or processes that are mature and not likely to change in the foreseeable future.

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1. SCOPE

This procedure is applicable to modes from 500 and 13,000 Hz. The parameters measured with this procedure are defined as the damping factor, ξ for first nine vibration modes of the beam. The measurement will be done in free-free conditions and with temperature.

1.1 Purpose

This SAE Recommended Practice is intended to establish a standardized and repeatable method for performing damping measurements on a brake insulator. The insulator is bonded to a standardized steel plate and the procedure measures the Frequency Response Function (FRF) of the specimen with insulator and the damping is calculated at the resonance frequencies. The measurements are performed at different temperatures and the damping of the insulator is hence established as a function of temperature and frequency.

2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

D. J. Ewins, Modal Testing - Theory, Practice and Application, Second Edition, 2000, Research Studies Press LTD, England

B&K Technical Review n°1, 1994: "Digital Filter Techniques vs. FFT Techniques for Damping Measurements", Svend Gade & Henrik Herlufsen

3. GLOSSARY AND TERMINOLOGY

3.1 RESONANCE (NATURAL) FREQUENCY (EIGENFREQUENCY)

One of the frequencies at which the beam naturally vibrates at when excited in a free-free condition.

3.2 LOSS FACTOR

The energy loss factor, η , which is the percent critical damping divided by 50.

3.3 DAMPING

It is generally expressed as a percentage of critical damping. The damping ratio in % is given by: $\xi = 50 \times \eta$.

4. ORGANIZATION OF THIS DOCUMENT

The first step is to define the basic measurement configuration and the measurement requirements. We will then describe the test procedure, the damping calculation and proposed data format.

5. MEASUREMENT CONFIGURATION

Excitation: 2 options:

- An electro-magnetic exciter can be used. The exciter must be located at a suitable distance to the specimen and the signal amplifier must be adjusted to properly excite the specimen in the frequency range of interest.
- An impact hammer with force transducer can also be used. The hammer must be equipped with a tip sufficiently hard to excite frequencies in the range of interest. An automated hammer is preferred to ensure repeatable impacts.

Response:

- An accelerometer will be used to measure the beam response. A single point laser can also be used.
- The recommended accelerometer will be lightweight, screw able, with a top cable connector. The cable should be as thin as possible to ensure that its influence on damping is negligible. The accelerometer should be screwed with a given torque to ensure repeatable results.
- The weight of the accelerometer should be less than 2 g. It should have a ± 3 dB frequency response function from 500 to 13000 Hz. Examples of recommended accelerometers are PCB353B18, PCB320C18, Bruel&Kjaer 4518.
- A dual-channel FFT analyzer capable of calculating a frequency response function (FRF) and simple coherence is required.

Temperature Conditioning:

- The specimen must be brought to the required temperature, using an environmental chamber or equivalent to heat up and cool down the sample. The minimum required range is -10°C to $+120^{\circ}\text{C}$, with a delta of 10°C . A sufficient soaking time is recommended. If the FRF measurements are done while the specimen is on a transient temperature slope, the actual specimen temperature must be measured with, preferably, a non-contact equipment. If a contact temperature sensor is used, it must be validated to show that it has no influence on the damping measurements.