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Vibration damping properties of porous materials

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Porous materials are traditionally used in industry for their sound absorption and insulation properties. Over the past decade, more attention has been given to their elastic and damping properties. There is a particular interest in the automotive industry to replace heavy layers (consisting of constrained viscoelastic rubber layers) with felts or foams evidencing high damping capabilities. In this work, the viscoelastic behaviour of porous materials and their resulting vibration damping properties are under study.

The first goal of this work is to present the characterisation procedure used to measure the complex shear modulus of several foams. This procedure is based on the measurement of complex shear modulus by means of a torsional rheometer [1] on a reduced frequency range and at different temperatures, and the application of the time-temperature superposition principle [2]. This methodology was successfully applied to obtain the master curves of two porous materials (one open cell foam and one closed cell foam). A fractional derivative model is identified from experimental master curves to describe the frequency dependency of the material's properties.

In order to assess the vibration damping properties of each material tested, simulations are carried out on a finite element model of a plate with a constrained layer of porous material, and compared with those obtained by a constrained layer of elastomeric material from a tier supplier. The goal of this study if twofold. The first one is to quantify the reduction in the amplitude of the frequency response of the multi-layered structure compared to classical passive damping treatments. The second goal is to determine whether the damping resulting from porous materials is broadband.

An extension of this work concerns the influence of pre-strain and strain rates on the damping properties of porous materials. This will be investigated through compression tests and the identification of a hyper(-visco)elastic model.

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