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Finite element model updating of vibrating structures under free–free boundary conditions for modal damping prediction

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ABSTRACT

A method to predict resonance frequencies and modal loss factors of bare and damped samples, using constrained layer damping treatment, under free–free boundary conditions is proposed. In a first phase, measurements of the frequency response functions of these two specimens are performed. In a second phase, a finite element model of the undamped sample is developed. The novelty lies in the consistent modelling of the suspension with spring–damper elements defined with stiffness and damping coefficients with fixed values over the whole considered frequency range. By updating these, the agreement between experiments and simulation is further improved. In a third phase, a finite element model of the damped sample, with constrained layer damping material, is realized. A good agreement with experimental results is obtained thanks to an optimization algorithm used to determine the material parameters of the viscoelastic layer at various frequency. A comparison with experimental results, from a Dynamic Mechanical Analysis, confirms the consistency of the results from the optimization process.
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1. Introduction

The prediction of the vibration damping capabilities of structures is very important for the design of transportation systems. A structure with high damping properties shows a good acoustical comfort as well as an improved resistance to fatigue. A possible approach is to use passive damping methods. It involves the use of viscoelastic materials [1,2]. Constrained with a stiff cover, the dissipation of the mechanical energy is further increased. It is due to the shear deformation occurring in the viscoelastic core. The energy is dissipated into heat because of the relaxation process occurring in the long molecule chains. The main challenge to predict the modal damping of vibrating structures damped with viscoelastic materials is to accurately know their properties. Such materials have a complex behaviour, which depends on frequency and temperature.

1.1. Literature review

Since many years, several model updating methods have been proposed. Imregun and Visser [3] and Mottershead and Friswell [4] detailed them in surveys. The goal of model updating is to reduce the inaccuracies in the finite element model and errors in prediction results coming from inaccurate modelling of the boundary conditions and damping, for example. Many model updating methods [5–9] are based on the frequency response functions (FRFs). The aim is to reduce the errors

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