Dynamic Behaviour of Rubber Engine Mounts

C.A.J. Beijers, A. de Boer

University of Twente, Twente Institute of Mechanics
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone +31-(0)53-4894368/2460, email c.a.j.beijers@utwente.nl

Introduction

An important source for interior sound problems in vehicles is structure-borne sound caused by the vibrations of the engine. A research project in cooperation with TNO deals with a combination of active and passive isolation of engines. This poster focusses on the modelling of passive isolation of the engine with rubber mounts. The mounts prevent transmission of high frequency engine vibrations which cause the interior noise in the vehicle. To judge the isolating properties of rubber mounts, a realistic model must be composed to analyse the dynamic behaviour over a broad frequency range which is characteristic for interior noise.

Method and Results

Rubber has typical properties: it can undergo large elastic deformations; the load-extension relation is nonlinear; it is nearly incompressible and viscoelastic. The analysis is performed with the finite element package Abaqus and is split in two parts. First a nonlinear static calculation is made to determine the relatively large pre-deformation of the mount due to the weight of the engine, see Figure 1.

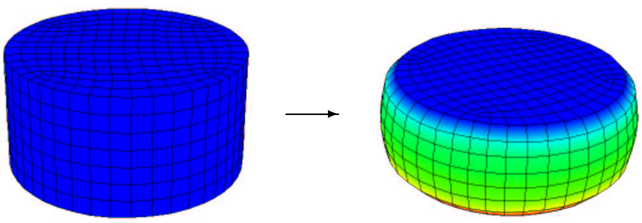

Figure 1 : Static pre-deformation u_z in axial direction.

Secondly, a linear harmonic dynamic analysis is performed and superimposed on the pre-deformed mount. It is hereby assumed that the vibration amplitudes of the engine are sufficiently small to consider the kinematic and material response as linear perturbations about the pre-deformed state.

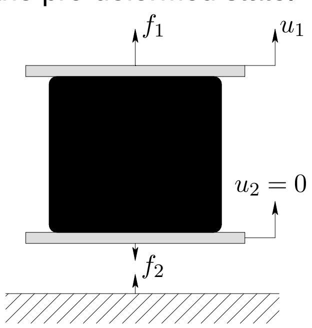

Figure 2 : Definition of blocked dynamic stiffness.

The dynamic behaviour of the mount is characterised by a blocked dynamic transfer stiffness matrix with three translational and three rotational directions. In the axial direction for example the dynamic stiffness is defined as $k_{12} = f_2/u_1$ (see figure 2). The magnitude and the phase of the axial dynamic transfer stiffness are plotted in Figure 3 and 4 for different pre-deformations.

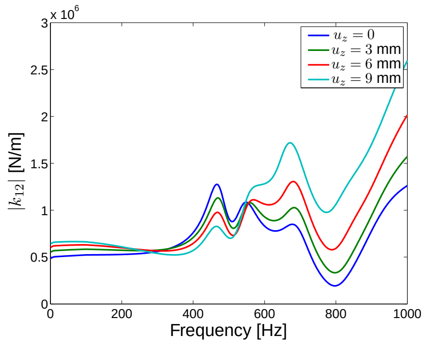

Figure 3 : Magnitude of dynamic transfer stiffness in axial direction.

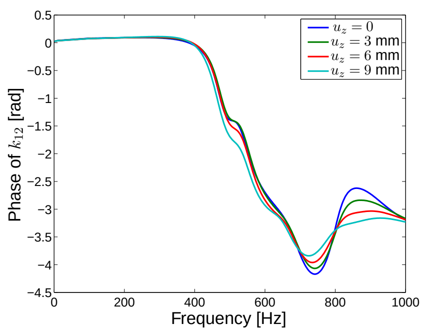

Figure 4 : Phase of dynamic transfer stiffness in axial direction.

Conclusions

The static preload and dynamic behaviour of the mount significantly influences the dynamic stiffness and consequently the isolating properties and transmission of structure-borne sound. At some frequencies the dynamic stiffness strongly increases, resulting in decreasing isolation in axial direction.

References

1. Kari, L., (1998) Structure-Borne Sound Properties of Vibration Isolators, PHD-thesis, Stockholm