MID FREQUENCY STRUCTURE-BORNE NOISE MODELING IN A TRIMMED AUTOMOTIVE VEHICLE

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Abstract

Finite Element Method (FEM) and the Statistical Energy Analysis (SEA) are standard methods in the automotive industry for the prediction of vibrational and acoustical response of vehicles. The FE method, based on a deterministic description of the dynamics is typically used for structure-borne and air-borne problems and is usually limited to below 250 Hz. The method becomes prohibitively expensive in terms of computational costs with increasing frequency as more Degrees-of-Freedom (DOF) are required to correctly represent the dynamic response of the structure. Additionally, the dynamic response becomes sensitive to small perturbations in the model, thus defeating the purpose of a deterministic modeling method. SEA is a statistical method widely applied in automotive industry for air-borne problems at frequencies higher than 300 Hz. The method is highly efficient for the design and optimization of sound packages facing airborne sources, but it lacks accuracy when dealing with structure-borne sources in the mid frequency range. However, both methods are not capable of handling the so called "mid frequency problem", where both short and long wavelength components are present in the same system. A Hybrid method has been recently proposed that rigorously couples SEA and FEM. In this work, the HybridFE-SEA method has been used to create fast/efficient model of structure-borne noise in a fully trimmed vehicle from 200Hz to 1 kHz. This paper first describes simple guidelines used to partition the vehicle into stiff components described with FE and modally dense components described with SEA. It is also demonstrated how detailed local FE models can be used to improve SEA descriptions of car panels and couplings. After review of the Hybrid FE-SEA models of a full vehicle that were built, sample experimental validation results of interior Sound Pressure Levels and panel vibration are shown for both bare and fully trimmed vehicle configurations.

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