HIGH PERFORMANCE COMPUTATION CODES FOR VIBROACOUSTIC SIMULATION IN THE AUTOMOTIVE FIELD

G. Miccoli*, C. Bertolini, K. Vansant*****

***Imamoter Institute – National Research Council (C.N.R.), Italy**
****Autoneum Management Ag, Winterthur, Switzerland**
*****Lms International N.V., Leuven, Belgium**

ABSTRACT

As the legislation for pass-by noise (PBN) has become more stringent, it is clear that car manufacturers face again a challenging task to reach the new SPL objective (70dB (A)). Following the well-known scheme of source-transmission-receiver, we can see how a good design of the engine bay is required to sufficiently attenuate the noise coming from sources as the engine and the intake. This involves proper design of the engine bay's panels including apertures, and a good selection of the type and location of acoustic treatments. Such optimization or redesign can be inspired by a new target SPL, but can also be initiated by a change in source: the radiated noise from an electric motor differs from that of a conventional IC engine.

For a given engine bay design, the PBN SPL results can be obtained with a PBN test or by an equivalent simulation. The conditions for a good PBN test setup are well described but not always easy to obtain. Using simulation models however it is possible to create the perfect test environment virtually and moreover to obtain acoustic results for a large number of designs upfront of any actual testing or prototype. The challenge for simulation models is however that, as the results should typically be available from 20 Hz up to 4 or 5 kHz and overall SPL results should be retrieved from a narrow band response over this large frequency range, the CAE models required can become very large and many frequencies need to be computed resulting in long solving times. To explore more design variants, acceptable solving times are of key importance.

This paper will give an update and comparison of deterministic modelling and solver technologies that can be used to predict powertrain exterior Acoustic Transfer Functions (ATFs) for a mockup model of an engine bay. The influence of apertures and acoustic treatments is illustrated and a comparison with test results is provided to judge on the model's accuracy. Special focus is given to a comparative performance study for the different simulation approaches.

A Fast Multipole BEM approach, using an iterative solver, will be compared with direct or iterative solving approaches for FEM models. In this paper, the

Automatically Matched Layer (AML) technology is used for the acoustic FEM models in order to ensure an anechoic condition at the FEM model's boundary. AML allows for relatively small meshes to be used and therefore facilitates faster computation times. Another important technology addressed in this article is the patent pending FEM AO (Finite Element Method Adaptive Order) methodology, which can be combined with AML and has been made available in commercial software (LMS Virtual Lab) recently. In this approach the order of each element is automatically adapted for each frequency. This allows starting with a relatively coarse model to compute faster in lower frequencies and only gradually adding DOFs for the higher frequencies. The performance study in this paper points out that FEM AO outperforms the other deterministic methods for the engine mockup model.

Key words: BEM, Fast Multipole BEM, FEM, FEM AML, FEMAO, sound absorption and insulation, Pass-by noise, exterior noise simulation, engine bay mockup