GOING FURTHER WITH THE HYBRID METHOD: INPUT FOR INDUSTRY-STANDARD METHODS

J. Golliard, P.J. van Beek, E. Vedy, L. van Lier
TNO Science and Industry, The Netherlands

1. Introduction

In this second lecture, applications of the method described in the first part are presented. The method presented in first part enables the computation of flow-induced noise in the free-field at reduced distances from — or located on — the studied object. It is possible to extend these results to couple with a Ffowcs-Williams integral to compute the far-field noise, as presented in section 3. In section 2 the prediction of vehicle interior noise is achieved by generating a power input spectrum for a SEA model.

2. Interior noise from separated flow around a vehicle: Coupling with SEA

The excitation of the car exterior by a turbulent – separated – flow yields a semi-stochastic time and position dependent pressure distribution. As argued by Bremmer and Zhu (2003), among others, for any simulation or prediction of this pressure distribution to be accurate as source for interior noise, it is essential that both the correct amplitude and the spatial correlation of this distribution are captured. In literature, most information on the spatial correlation is related to idealized flows, like a fully developed boundary layer (developed in the sense that it is 'self similar') along a semi-infinite flat plate. The crop of this information stems from experimental investigations. Clearly a complex geometry like a car body is much less accessible than 'semi-infinite' plates. To generate the information on the excitation of car bodies the combination CFD-CAA offers an alternative.

In general the most intense pressure fluctuations are related to the convection of turbulent structures in the flow. However, since this part of the pressure distribution convects subsonically, it does not radiate noise into the far field. Therefore this part of the pressure distribution is often referred to as 'pseudo sound'. Furthermore, since the convection velocity of disturbances in the flow is very low, the convection wave number k_c, is much larger than the wave numbers that correspond to the structural vibrations of for example the side window of a passenger car. As a result the pseudo-sound part of the pressure distribution is not an efficient excitation mechanism of vibrations of the car body.

Apart from the 'pseudo-sound' contribution, the pressure distribution contains acoustic contributions as well. In a boundary layer along a semi-infinite flat plate, these acoustic contributions are the result from the deviations of the perfect convection of turbulence. In general these acoustic contributions are much lower (> 30-40 dB) than the pseudo-sound contributions.

Owing to several functional, legal and aesthetic constraints, the degree of aerodynamic optimization is limited and flow around cars exhibits numerous regions of separated flow, even in normal head-on cruising conditions. As a result the flow is much more complex than a 'fully-developed' boundary layer flow and large deviations from ideal convection behaviour