자동차 유동기인 실내소음 예측을 위한 CFD/FEM/BEM/SEA 의 조합 및 검증 - 현대자동차 BMT4

Combining CFD/FEM/BEM/SEA to Predict Interior Vehicle Wind Noise – Validation Case Hyundai BMT4

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ABSTRACT

Recent developments in the prediction of the contribution of windnoise to the interior SPL have opened a realm of new possibilities in terms of i) how the convective and acoustic sources terms can be identified, ii) how the interaction between the source terms and the side glass can be described and finally iii) how the transfer path from the sources to the interior of the vehicle can be modelled. This work discusses several simulation methods that can be used to represent the physical phenomena involved such as CFD, FEM, BEM, FE/SEA Coupled and SEA. This work focuses on the validation of the wind noise source characterization method and the vibro-acoustic models on which the wind noise sources are applied in the framework of a benchmark proposed by Hyundai Motors Corporation.

1. Introduction

In order to model wind noise it is necessary to understand the source, the paths which typically involve direct vibro-acoustic transmission through certain regions of the structure, transmission through nearby leaks/seals and isolation and absorption provided by the interior sound package and the receiver and in particular, the frequency range(s) in which wind noise provides an audible contribution to the interior noise in the occupant's ears. While many regions of a vehicle can contribute to wind noise, the fluctuating surface pressures on the front side glass due to vortices and separated flow generated by the A-pillar and side mirror are often important contributors.

This paper presents an overview of different approaches that can be used to efficiently predict wind noise contribution to overall SPL at the driver's ear. First, a review of major wind noise source characterization will be presented. Following is a description of vibro-acoustics methods used to predict interior SPL for a given wind noise source model. Finally, validation cases for both vibro-acoustics (VA) and Aero-Vibro-Acoustics (AVA) are presented.

The current BMT involves the study of a vehicle-like structure with includes a windshield

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and two side glasses. The structure base configuration is similar to the Hyundai BMT3 except that it has been raised 75mm from the ground to allow the flow to run under the structure. The case 1 is similar to the base case except for the A-Pillar which has a different shape. The case 2 is similar to the base case except that it has a side mirror on both sides of the structure. Material and physical properties have been published in the framework of BMT3 and will not be repeated here.

To properly represent the transfer of vibro-acoustic energy from the exterior of the structure to the interior, an accurate vibro-acoustic model needs to be created and validated against test. Two vibro-acoustic models are created. Both models use FEM to represent the whole structure including the sides, floor, roof, windshield and side glasses. In model 1, FEM is used to represent the fluid inside the structure.

In model 2, SEA is used to represent the interior fluid. These vibro-acoustic models are compared with measurements performed by Hyundai Motors Corporation.

To represent the turbulent flow around the structure, OpenFOAM is used. The predicted turbulent flow is then coupled to the vibro-acoustic model to validate if the combined simulation models (AVA) can predict the measured SPL inside the structure. The results are shown for the base case and case1 and 2.

References

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