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Vibro-acoustic analysis in vehicles: A general framework for low-frequency problems

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Before the manufacturing of the physical prototype, NVH characteristics of vehicles are validated and examined using the CAE tools in the virtual prototyping stage. Unforeseen noise problems are often occurred depending on many reasons, such as aleatory uncertainty, epistemic uncertainty, manufacturing variability and the lack of structural damping information. To diagnose the NVH problems of a vehicle, many samples should be subjected to tests. The number of samples is determined according to the sound pressure level (SPL) results. The results are expected to converge in an acceptable interval. The chosen sample vehicles are used to acquire data for the advanced tests, such as transfer path analysis (TPA) and experimental modal analysis (EMA). TPA is used to identify the dynamic forces acting on the structure and to rank the noise contributions of predetermined virtual paths. EMA is used to identify the structural modes and the damping characteristics of the structure. All these experimental findings complement the CAE tools in achieving a robust vibro-acoustic analysis. Due to the masking effect of sound and the human perception, the low-frequency problems have prior importance in the assessment of NVH characteristics of vehicles. In this study, a general framework for low- frequency problems are discussed. To exemplify the framework discussion, a case study is given. In the case study, low-frequency problems of a vehicle are examined. The conducted experimental and numerical studies are explained in detail. Finally, the modifications offered to improve the NVH characteristics of the vehicle used in the case study are stated.

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