講演番号	140

文献番号	20225140

Auralization of Road Noise CAE Simulation Results for Interactive Sound Quality Evaluations

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KEY WORDS: vibration, noise, and ridecomfort, road noise/pattern noise, sound quality evaluation/ridecomfort evaluation (B3)

Automotive customers are constantly expecting better NVH (noise, vibration and harshness) performance for new vehicles. This trend is even accelerating with electric vehicles. Electric powertrains are quieter than internal combustion engines, drivers and passengers are then getting used to a quieter driving experience and this in turns, pushes the expectations for road and wind noise further down. Road noise is the dominant contribution to a vehicle interior noise when cruising below highway speed. Road noise includes a structure-borne and an airborne contribution.

In this paper, we present the process we created to simulate and auralize the road noise of automotive vehicles. We focus on the structure-borne road noise, a process for airborne road noise has already been proposed. The objective is to apply this process as early as possible when developing new vehicles to assess the road noise performance, identify any risk of not meeting the customer expectations and define design countermeasures if necessary. The process uses as input the results from CAE simulations to calculate the body interface forces and the transfer functions between the attachment points and the driver's ear sound pressure level. These inputs are then combined to create sounds that are evaluated in a driving simulator for NVH (Fig. 1). We used a passenger truck (Fig. 2) as application case to illustrate the process.

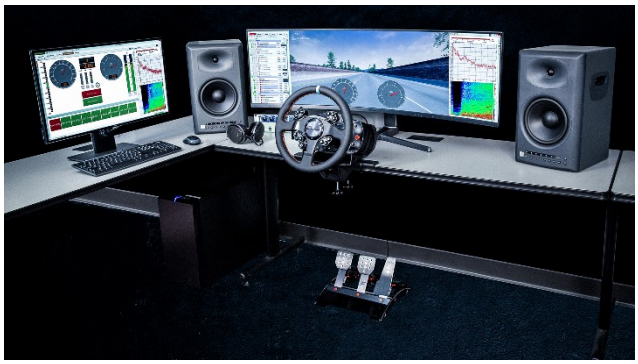

Fig. 1: driving simulator for NVH

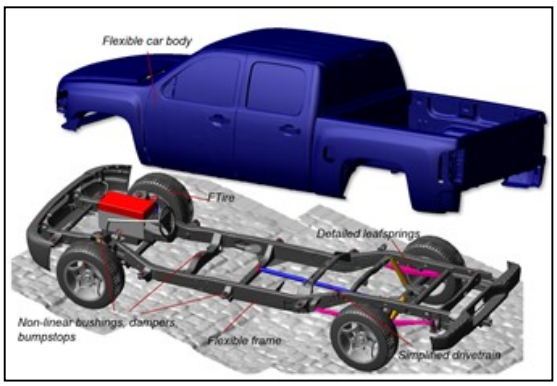

Fig. 2: truck CAE simulation model

Our results show that with this process, we can now compare the interior sound results against target curves and perform subjective evaluations. To get to that point, we did not need to have access to a physical prototype and this is where lies the value of the proposed process. These results can be generated from the very early stages of a vehicle development program when design decisions are still being made. This helps identify the risks of NVH issues and support the definition and evaluation of design countermeasures if necessary. Being able to listen and experience makes the decision process even easier. Our experience shows that it is easier to justify the need for design countermeasures when stakeholders and decision makers can experience how the interior sound will be affected. Being able to translate a quantitative difference in the sound pressure results into a change in perceptions always prove to be very valuable.