Study of a Loudspeaker in a Vehicle Door

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Abstract

COMSOL Multiphysics® was used to evaluate the performance of a woofer coupled to an automotive door. Two uses cases were considered: rigid and non-rigid door structures. Using the Structural Mechanics Module, the speaker membrane displacement was computed for both cases from 20Hz to 500 Hz. For the rigid door, all door components are assumed as fully rigid and there is no mechanical interaction between the transducer and the door structure. It means that only the influence of the air volume behind the speaker membrane is considered. For the non-rigid door case, the interaction between the speaker displacement and the inner-outer door structure panels is added.

The Pressure Acoustic solver was implemented to predict the sound pressure inside the vehicle cabin. For the rigid and non-rigid models, only the sound pressure radiated by the speaker is considered. The comparison between the in situ measurement and the simulation data shows that the non-rigid boundary condition allows to reach a superior simulation accuracy below 100 Hz. A deviation between the simulation and the measurement at around 60-70 Hz can be explained by boundary conditions in the non-rigid door model. For further investigations, a more complex COMSOL Multiphysics® model could be developed and intermediate comparisons between simulated and measured data could be performed, for example using accelerometers or a laser to acquire structural response data. An anechoic measurement of a door subsystem could be also performed to verify the simulation tool chain.

Figures used in the abstract

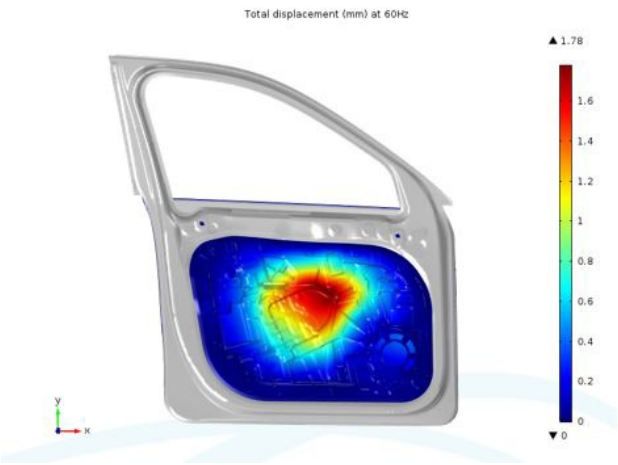

Figure 1: Use of the Structural Mechanics solver for an automotive door analysis.