The study for improvement of NV performance by contribution analysis of interior noise and optimization of acoustic package for next-generation BEV

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With the transition of the main vehicle powerplant from an internal combustion engine to an electric motor, it is expected that dominant contribution to interior noise changes from those of conventional vehicles. However, detailed and quantitative investigations remain limited, and the optimal placement and specifications of acoustic materials have not been clearly established. As an effective solution against these issues, contribution analysis of internal noise has been conducted applying Hybrid Statistical Energy Analysis (HSEA). Furthermore, based on the result, an optimized vehicle package was designed to enhance NV performance without increasing mass. The validity of this optimization was verified by testing actual vehicle.

The HSEA model is a hybrid analysis methodology that integrates experimentally obtained data into an SEA model constructed based on conventional Statistical Energy Analysis theory. An HSEA model for the next generation BEV was constructed by applying a morphing process to an existing model. Morphing is a technique that updates analytical SEA parameters—such as acoustic material specifications—within an existing model and transforms it into a calibrated model using a limited set of experimental data. This approach enables rapid construction of new models. The morphing process in this study involves converting an ICEV-based model into a BEV model. These two vehicle types differ fundamentally in several aspects, including the powertrain and the installation of a large-capacity battery in the lower vehicle structure. Accordingly, supplementary experiments were conducted to obtain the necessary information on these differences, and the morphing process was carried out using the acquired data.

Using the HSEA model obtained through the morphing process, a contribution analysis was performed for the vehicle interior noise at 50 km/h during wide-open-throttle acceleration. The contribution analysis results of both the ICEV model and the target BEV model are presented in Fig. 1.

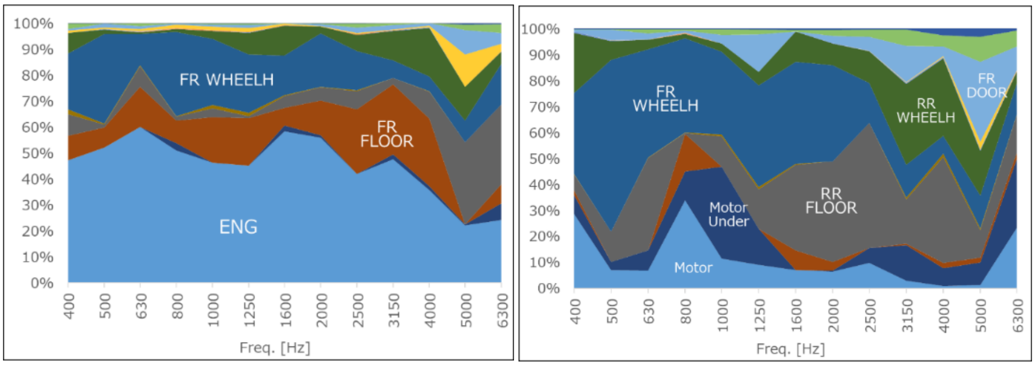

Fig.1 Input contribution at the front-seat position at 50 km/h during WOT. (L) ICEV (R) BEV

This analysis indicates that, compared with the ICEV, the BEV exhibits a substantial reduction in input noise originating from the front section of the vehicle, while the contribution from the FR WHEELH is relatively higher. In addition, due to having the battery, the contribution from the FR FLOOR becomes smaller, whereas under body area such as RR FLOOR show increased contribution levels.

Based on the results of the contribution analysis, an optimization of the acoustic materials installed in the target BEV was conducted. The objective of the optimization was to improve NV performance under both wide-open-throttle acceleration and constant-speed driving conditions, without increasing mass. For the optimization of the acoustic materials, a Pareto chart analysis was conducted utilizing HOWA's proprietary analysis program. By computing and plotting all possible combinations of acoustic material specifications for each component, the material combination which can meet the optimization target were evaluated.

The optimized acoustic materials derived from the analysis were installed in the vehicle, and their effectiveness was evaluated by testing actual vehicle. The results demonstrated an improvement of up to 1.7 dB in NV performance, which showed good agreement with the predictions obtained from the HSEA analysis.