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Vibration Reduction Technology using Modal Energy Propagation Analysis Method for Rigid-Flexible Coupled Systems

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A modal energy propagation analysis method is proposed to evaluate the mode contribution in frequency bands where the mode density is high and the individual mode contributions are dispersed.This analytical method evaluates the relationship between the vibration power flow between subsystems and the modes (Fig. 1).In this report, we apply the method to a vehicle structure model to verify the effectiveness of the analysis method, and verify the vibration reduction effect of the proposed structural modification based on the result obtained from the analysis method.

The analysis method was applied to a FEM model of a top ceiling (referred to as "T/C") vibration in the 125-Hz band. The analysis results show that the contribution of the 10th-order mode of T/C, which causes second-order bending at the tip of the T/C, is high and dominant at 122 Hz (Fig. 2). In addition, in order to clarify the cause of the increase in transmitted power, the modal displacement and the enforced deformation component via the connecting points were analyzed. The results show that the mode shapes of the modal displacement and enforced displacement are similar at 122 Hz, which may have caused the increase in transmitted power (Fig. 3). Based on these results, the attaching of a concentrated mass was investigated to suppress the modal displacement (Fig. 4). As a result, the secondary bending mode at the tip of T/C was suppressed and the peak at 125 Hz in the ERP was reduced (Fig. 5).

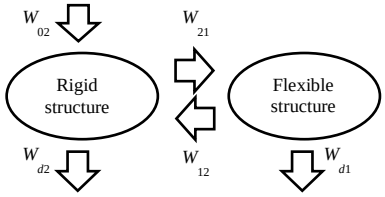

Fig. 1 Schematic vibration Power Flow

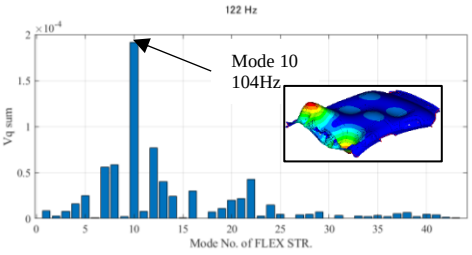

Fig. 2 Contribution of eigen mode of topceiling for transmieetd power

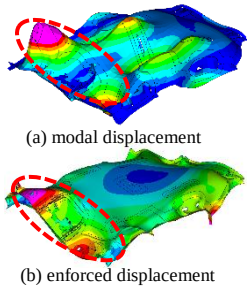

Fig. 3 Calculated modal/enforced displacement at 122 Hz

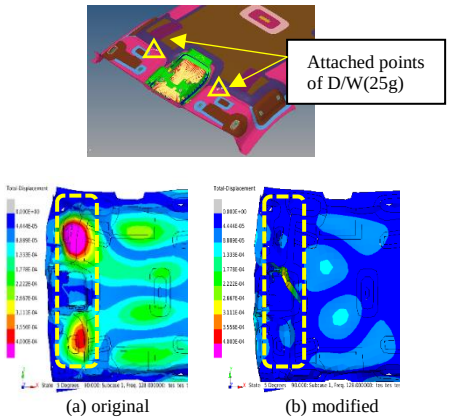

Fig. 4 Comparison of modal displacement between original and modified

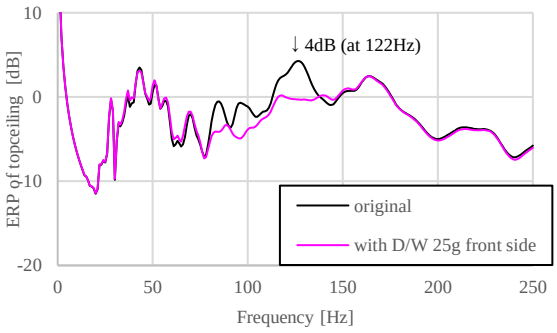

Fig. 5 Comparison of ERP between original and D/W attached