Sound transmission analysis of plate structures using the finite element method and elementary radiator approach with radiator error index

In this paper, an accurate and efficient numerical method for sound transmission analysis is presented. As an alternative to conventional numerical methods, such as the Finite Element Method (FEM), Boundary Element Method (BEM) and Statistical Energy Analysis (SEA), the FE-ERA method, which combines the FEM and Elementary Radiator Approach (ERA) is proposed. The FE-ERA method analyzes the vibrational response of the plate structure excited by incident sound using FEM and then computes the transmitted acoustic pressure from the vibrating plate using ERA. In order to improve the accuracy and efficiency of the FE-ERA method, a novel criterion for the optimal number of elementary radiators is proposed. The criterion is based on the radiator error index that is derived to estimate the accuracy of the computation with used number of radiators. Using the proposed criterion a radiator selection method is presented for determining the optimum number of radiators. The presented radiator selection method and the FE-ERA method are combined to improve the computational accuracy and efficiency. Several numerical examples that have been rarely addressed in previous studies, are presented with the proposed method. The accuracy and efficiency of the proposed method are validated by comparison with the results of the three dimensional (3D) FEM structure-acoustic interaction models.