A novel hybrid deterministic-statistical approach for the mid-frequency vibro-acoustic problems

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Abstract

It is difficult to predict precisely the frequency response of a complex vibro-acoustic system in mid-frequency region. To overcome this deficiency, a novel hybrid stable node-based smoothed finite element method/statistical energy analysis (SNS/SEA) is proposed in this work. The whole vibro-acoustic system is divided into a combination of a structural subsystem with statistical characteristic and an acoustic subsystem with deterministic feature. The recently developed SNS-FEM is employed here to simulate the deterministic subsystem, and the well-known SEA is utilized to deal with the statistical subsystem. Based on the so-called diffuse field reciprocity relationship, these two subsystems can be easily connected and coupled. Due to the introducing of gradient smoothing technique (GST), the SNS-FEM can significantly reduce the dispersion error compared with the traditional FEM. Thus, it can be expected that the present coupling model can provide ultra-accurate results. Numerical examples, including both benchmark cases and practical engineering problems, have been conducted to demonstrate the effectiveness and accuracy of the hybrid SNS/SEA for mid-frequency vibro-acoustic analysis.

Keywords: vibro-acoustic problems; mid-frequency; stable node-based smoothed finite element method; statistical energy analysis; gradient smoothing technique.