# Analysis of complex structural-acoustic systems using a coupled smoothed finite element formulation

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## Abstract

Coupled structural-acoustic problems are very common in practical engineering, especially in designing automobiles, airplanes, trains, steamers, and so on. As the structure of these sophisticated products are rather complex, numerical methods have been widely used to investigate the acoustic performance of such enclosed cavities. Researchers have paid great attention to developing advanced numerical methods for such problems; however, it is hard to find a balance between the accuracy and efficiency. Thus, a coupled formulation of edge-based smoothed finite element method (ES-FEM) and a stable node-based finite element method (SNS-FEM) is present for coupled structural-acoustic problems. The ES-FEM is employed to simulate the structural part using the simplest linear elements and the SNS-FEM is introduced to calculate the response of the acoustic domain. The coupling relation between the structural domain and the acoustic domain is constructed based on the appropriate compatibility and equilibrium conditions on the interface boundaries. Besides, the well-known Dirichlet-to-Neumann (DtN) boundary condition has also been taken into account in case the acoustic domain is infinite. Thus, the present formulation is both available for the interior acoustic-structure coupled problems and exterior acoustic-structure coupled problems. A series of numerical examples has been employed to investigate the performance of the proposed coupled formulation and the results demonstrate that the coupled ES/SNS-FEM can generally obtain very accurate results with rather coarse meshes with higher efficiency.

**Keywords:** Acoustic; Shell structure; Acoustic-structure interaction; Numerical methods; The edge-based smoothed finite element method (ES-FEM); The stable node-based smoothed finite element method (SNS-FEM)