ICCES, 2023, vol.27, no.1
DOI: 10.32604/icces.2023.09605

PROCEEDINGS

Design Sensitivity Analysis of Thin-Body Acoustic Problems Above an Infinite Impedance Plane by Using a Fast Multipole Indirect BEM

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ABSTRACT

This paper presents an accurate and efficient indirect boundary element method (IBEM) accelerated by the fast multipole algorithm (FMA) for the design sensitivity analysis of large-scale thin-body acoustic problems above an infinite impedance plane. The non-uniqueness issue of the IBEM in solving exterior acoustic problems is avoided by applying a hybrid combination of single- and double-layer potentials. The half-space impedance Green's function which involves an image complex line source and is valid for both mass-like and spring-like impedance plane is employed to involve the sound-absorbing effect of the ground surface. Explicit evaluation formulations of the singular boundary integrals are derived and an integrator with adaptive interval subdivision is introduced to ensure the easy and stable application of the FMA. The efficiency and accuracy of the proposed method are verified through numerical examples, and its potential in the acoustic optimal design of thin-body structures is also shown in the numerical simulation.

KEYWORDS

Design sensitivity analysis; thin-body acoustic problems; infinite impedance plane; indirect boundary element method; fast multipole algorithm

Funding Statement: The author(s) received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.