Time-harmonic acoustic scattering from a non-locally perturbed trapezoidal surface

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This paper is concerned with acoustic scattering from a sound-soft trapezoidal surface in two dimensions.The trapezoidal surface is supposed to consist of two horizontal half-lines pointing oppositely, and a single finite verticalline segment connecting their endpoints, which can be regarded as a non-local perturbation of a straight line. For incident plane waves, we enforce that the scattered wave, post-subtracting reflected plane waves by the two half lines of the scattering surface in certain two regions respectively, satisfies an integral form of Sommerfeld radiation condition at infinity. With this new radiation condition, we prove uniqueness and existence of weak solutions by a coupling scheme between finite element and integral equation methods. This consequently indicates that our new radiation condition is sharper than the Angular Spectrum Representation, and has generalized the radiation condition for scattering problems in a locally perturbed half-plane. Furthermore, we develop a numerical mode matching method based on this new radiation condition. A perfectly matched layer is setup to absorb outgoing waves at infinity. Since the medium composes of two horizontally uniform regions, we expand, in either uniform region, the scattered wave in terms of eigenmodes and match the mode expansions on the common interface between the two uniform regions, which in turn gives rise to numerical solutions to our problem. Numerical experiments are carried out to validate the new radiation condition and to show the performance of our numerical method.

Preferred mode of presentation: Oral