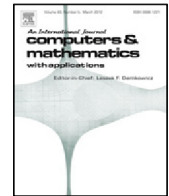




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On an equivalent representation of the Green's function for the Helmholtz problem in a non-absorbing impedance half-plane

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ABSTRACT

The Green's function associated with the Helmholtz problem in a non-absorbing impedance half-plane can be expressed as an integral form. In the non-absorbing case, the presence of surface waves presents a challenge in order to obtain accurate approximations. In this work, we present an equivalent representation for this Green's function, expressed as a sum of analytical terms and bounded integrals. The resulting representation is numerically stable and it can be estimated by any well known robust integration rule for bounded intervals. We provide a detailed description of the equivalent representation and we validate it with numerical experimentation.

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1. Introduction

Several problems in engineering can be modeled as the scattering of an incident acoustic field due to a local perturbation of a half-plane. One such problem is, for instance, the determination of electromagnetic modes of two-dimensional photonic crystals, where the photonic crystal is assumed to be covered by a substrate which is modeled as a half-plane [1,2]. Another situation where this problem appears is in the computation of harbor resonances in marine hydraulics, where the sea is assumed to fill a locally perturbed half-plane and the perturbation is given by the harbor geometry [3–5]. Another example is the propagation of elastic wave modes above the ground due to blasting and drilling operations in a mine. Here, the mine can be considered to be the local perturbation of a half-plane [6].

When considering a time-harmonic decomposition for acoustic waves, i.e., an explicit time dependency of the form $e^{-i\omega t}$, with ω denoting the angular frequency, the problem of acoustic sound propagation above ground can be reduced to the estimation of a spatial total field $u_T(\mathbf{x})$ (decomposed into a known incident field plus an unknown scattered field), satisfying the following impedance (or Robin) boundary condition (over the boundary of the locally perturbed half-plane):

$$\partial_n u_T(\mathbf{x}) = i\beta\kappa u_T(\mathbf{x}), \quad (1)$$

where ∂_n denotes the partial derivative in the normal direction (that is assumed to be outwardly directed), $\beta \in \mathbb{C}$ denotes the acoustic admittance of the boundary and $\kappa = \omega/c > 0$ is the wave number (with c being the sound speed). When the

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