Three-dimensional Analytical Solution and Numerical Solution in a Penetrable Wedge-shaped Waveguide

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Introduction

An analysis of the three-dimensional sound field in a penetrable wedge is presented. This is a two-and-one-half-dimensional (2.5-D) problem in which the waveguide is two-dimensional but the source is three-dimensional. Analytical solutions are available for such acoustic propagation problems in penetrable wedges. This paper presents a complete analytical solution which not only applies to the acoustic field in water but also the acoustic field in the bottom. In addition, A numerical method based on the wavenumber integration technique is also presented for solving the acoustic propagation problem in the penetrable wedge.

Theory

1. The three-dimensional direct-global-matrix coupled-mode method based on the wavenumber integration technique

2. Three-dimensional analytical solution in a penetrable wedge-shaped waveguide

A. The 3D analytical solution in water

B. The 3D analytical solution in the bottom

Numerical and Analytical Results

- A complete analytical solution for three-dimensional pressure field generated by a point source in a wedge-shaped waveguide is presented.
- A numerical method is also presented for computing the 3D pressure field by the wave-number integration technique. The basic technique entails synthesizing the three-dimensional solution by using Fourier transform methods based on a sequence of two-dimensional problems.
- The 3D numerical model and the 3D analytical solutions are applied to sound propagation excited by a point source in a benchmark wedge waveguide. The numerical solutions by the three-dimensional model agree well with the analytical solutions in the benchmark wedge waveguide.

Conclusions