複雑な形状をもつ物体の レーダ断面積解析法に関する研究

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Study on the Analysis Methods for the Radar Cross Section of Complicated Structures

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The analysis of electromagnetic scattering by open-ended metallic waveguide cavities has received much attention recently in connection with the prediction and reduction of the radar cross section (RCS) of a target. Various diffraction problems involving two-dimensional (2-D) and three-dimensional (3-D) cavities have been analyzed thus far based on high-frequency techniques and numerical methods. However, the solutions obtained by these methods are not uniformly valid for arbitrary cavity dimensions.

In this research, we consider a 2-D finite parallel-plate waveguide with four-layer material loading as shown in Fig. 1, being illuminated by a plane wave of E or H polarization. The waveguide plates are perfectly conducting and of zero thickness, and the material layers I, II, III, and IV are loaded inside the waveguide. The method of solution is based on the Wiener-Hopf technique, which is known as a powerful tool for analyzing electromagnetic wave problems. Introducing the Fourier transform for the unknown scattered field and applying boundary conditions in the transform domain, the problem is formulated in terms of the simultaneous Wiener-Hopf equations. The Wiener-Hopf equations are solved via the factorization and decomposition procedure together with the use of the edge condition, leading to the exact solution. However, the solution is formal in the sense that it contains an infinite number of unknowns as well as several branch-cut integrals with unknown integrands. We have developed an efficient approximation procedure based on a rigorous asymptotics and derived an approximate solution, which is shown to be valid for broad frequency range. Taking the inverse Fourier transform of the solution in the transform domain, the scattered field in the real space is evaluated. The field inside the waveguide is expressed in terms of the TE or TM modes depending on the polarization of incident waves, whereas the filed outside the waveguide is evaluated asymptotically using the saddle point method.

Based on the results, we have carried out numerical computation of the RCS for various physical parameters, and investigated the backscattering characteristics of the waveguide in detail. The results obtained on this research serve as a reference solution and can be used for validating more general approximate methods.

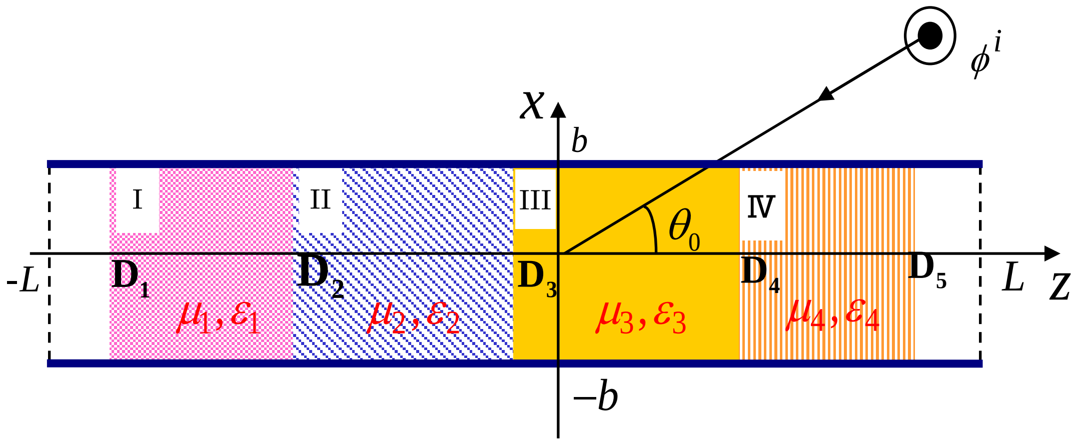

Fig. 1. Geometry of the waveguide.