Plane Wave Diffraction by a Semi-infinite Parallel-Plate Waveguide with Fractional Boundary Conditions

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The analysis of electromagnetic scattering by a waveguide is an important subject in electromagnetic theory. Fractional boundary conditions (FBC) show intermediate properties between perfect electric conductor (PEC) and perfect magnetic conductor (PMC). The term 'fractional' means a fractional derivative of the total electric field components in this paper. The surfaces with FBC have scattering characteristics similar to the artificial magnetic conductors (AMC) surfaces since the reflection phase of the surfaces with FBC is controllable by shifting the fractional order.

The diffraction problems related to FBC have been analyzed so far in several papers. Tabatadze *et al*. analyzed the plane wave diffraction problem involving a double half-plane with FBC and clarified the near field behavior [1]. In this paper, we shall consider a semi-infinite parallel-plate waveguide with FBC, and analyze rigorously the E-polarized plane wave diffraction with the aid of the Wiener-Hopf technique [2]. It is worthwhile to mention that the Wiener-Hopf technique has been applied for the first time in this paper for the analysis of diffraction problems involving waveguide structures with FBC.

The geometry of the waveguide with the FBC is shown in Figure 1, where the plate is of zero thickness and ϕ^i denotes the incident field of E polarization. We define the total electric field by $\phi^t = \phi^i + \phi$, where ϕ is the unknown scattered field satisfying the two-dimensional Helmholtz equation. Introducing the Fourier transform of the scattered field and applying the FBC in the transform domain, the problem is reduced to the Wiener-Hopf equations satisfied by unknown spectral functions. The Wiener-Hopf equations are solved via the factorization and decomposition procedure leading to a closed form solution. The scattered field in the real space is derived by taking the inverse Fourier transform of the Wiener-Hopf solution in the Fourier transform domain and using saddle point method of integration.

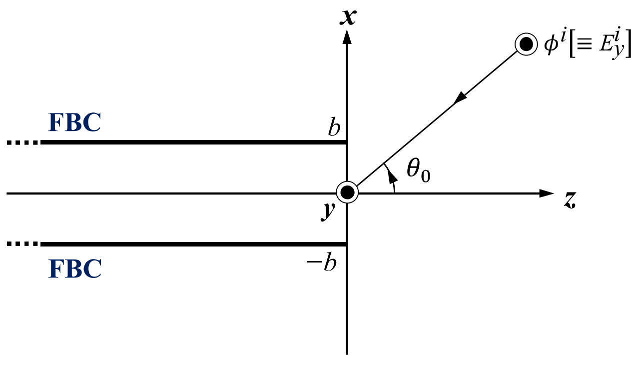

Figure 1. Geometry of the problem.

1. V. Tabatadze, K. Karaçuha, E. Veliev, and E. Karacuha, "Diffraction of the electromagnetic plane waves by double half-plane with fractional boundary conditions," *Progress In Electromagnetics Research M*, **101**, 2021, pp. 207-218.

2. R. Mittra and S.-W. Lee, *Analytical Techniques in the Theory of Guided Waves*, Macmillan, 1971.