Plane Wave Diffraction by a Semi-infinite plate with Fractional Boundary Conditions

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Recently, the studies of the artificial magnetic conductor (AMC) surfaces have received much attention. Fractional boundary conditions (FBC) describes intermediate case between perfect electric conductor (PEC) and perfect magnetic conductor (PMC). 'Fractional' means fractional derivative of the total electric field components in this paper. The surfaces with FBC have scattering characteristics similar to the AMC surfaces since the reflection phase of the surfaces with FBC is controllable by shifting the fractional order. From the above, the analysis of the electromagnetic wave scattering by materials with FBC becomes a more important subject in electromagnetic theory and antenna design studies.

Many scientists have analyzed so far the electromagnetic scattering problems by using FBC. Veliev *et al.* analyzed the diffraction by a strip with FBC, and obtained the solution for the case where the strip width is relatively small compared with wavelength [1]. The authors also analyzed the diffraction by a strip with FBC using Wiener-Hopf technique, and obtained the solution valid for the case where the strip width is relatively large compared with wavelength [2]. In this paper, we shall consider a semi-infinite plate with FBC, and analyze rigorously the E-polarized plane wave diffraction with the aid of the Wiener-Hopf technique [3]. The Wiener-Hopf technique is originally developed to solved the diffraction by obstacles such as a class of geometries with semi-infinite boundaries and no thick.

The geometry of the semi-infinite plate with FBC is shown in Figure 1, where the semi-infinite 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 unknown scattered field satisfying the 2-D Helmholtz equation. Introducing the Fourier transform of the scattered field and applying FBC in the transform domain, the problem is reduced to the simultaneous Wiener-Hopf equation satisfied by spectral functions. The Wiener-Hopf equation is solved via the factorization and decomposition procedure leading to an exact 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.

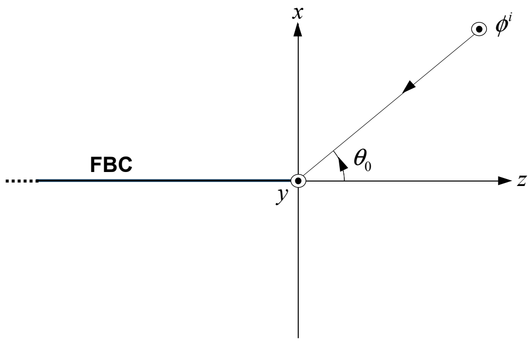

Figure 1. Geometry of the problem.

References

[1] E. Veliev, M. V. Ivakhnychenko, and T. M. Ahmedov, "Fractional boundary conditions in plane wave diffraction on a strip," *PIER,* **79**, 2008, pp. 443-462.

[2] T. Nagasaka and K. Kobayashi, "Wiener-Hopf analysis of the diffraction by a strip with fractional boundary conditions," *Proc. PIERS in Xiamen*, 2019, pp. 66-72.

[3] D. S. Jones, "A simplifying technique in the solution of a class of diffraction problems," *Quart. J. Math. Oxford(2)*, **3**, 1952, pp. 189-196.