Diffraction by a Strip with Fractional Boundary Conditions

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The analysis of the diffraction by strips with fractional boundary conditions (FBC) is an important subject in radar cross section (RCS) studies and antenna design studies. The surface with FBC describes the intermediate case between well-known perfect electric conductor (PEC) surface and perfect magnetic conductor (PMC) surface. 'Fractional' means fractional derivative of the total electric field in this paper. A number of scientists have analyzed so far the diffraction problems with FBC by using various analytical and numerical methods. Veliev *et al*. [1, 2] analyzed the diffraction by a strip with FBC, and obtained the solution for the case where the strip width is relatively small case compared with wavelength. In [1, 2], Veliev *et al*. noted that the strip with FBC has scattering characteristics similar to the well-known impedance strip. In this paper, we shall consider a strip with FBC, and analyze rigorously the E-polarized plane wave diffraction with the aid of the Wiener-Hopf technique. The problem belongs to a class that can be rigorously treated by formal application of the Wiener-Hopf technique [3], and then there are few papers treating the diffraction by materials with FBC together with Wiener-Hopf technique.

The geometry of the strip with FBC is shown in Figure 1, where ϕ^i denotes the incident field of E polarization. Let us define the total electric field by $\phi^t = \phi^i + \phi$ where ϕ is unknown scattered field satisfying the Helmholtz equation. Introducing the Fourier transform of the scattered field and applying FBC in the transform domain, the problem is formulated in terms of the Wiener-Hopf equation. Applying the factorization and decomposition procedure, the Wiener-Hopf equation is solved exactly. However, the solution is formal since branch-cut integrals with unknown integrands are involved. Employing a rigorous asymptotic method, we derive a high-frequency asymptotic solution to the Wiener-Hopf equation. Our final solution is valid for the case where the strip width is large in comparison to the wavelength. The scattered field in the real space is evaluated asymptotically by taking the inverse Fourier transform and applying the saddle point method of integration. Numerical examples are presented for various physical parameters and scattering characteristics of the strip are discussed.

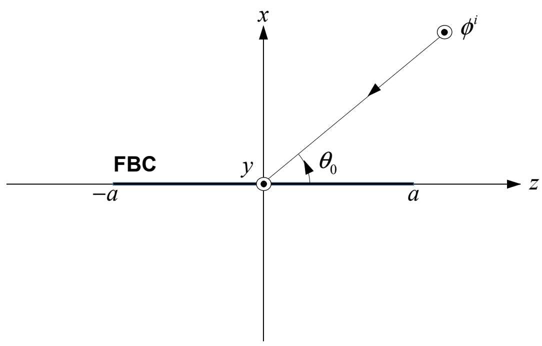

Figure 1. Geometry of the problem.

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] M. V. Ivakhnychenko, E. Veliev, and T. M. Ahmedov, "Scattering properties of the strip with fractional boundary conditions and comparison with the impedance strip," *PIER C*, **2**, 2008, pp. 189-205.

[3] K. Kobayashi, "Solutions of wave scattering problems for a class of the modified Wiener-Hopf geometries," *IEEJ Transactions on Fundamentals and Materials*, **133**, 2013, pp.233-241.