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Wiener-Hopf Analysis of the Diffraction by Two Parallel Sinusoidal Strips

T. Eizawa(1) and K. Kobayashi(1)
(1) Chuo University, Tokyo, Japan, e-mail: eizawa@kc.chuo-u.ac.jp; kazuya@tamacc.chuo-u.ac.jp

In microwave and optical engineering, there are many devices with periodic structures such as resonators, filters, reflector antennas, and couplers composed of gratings. Therefore the analysis of the scattering and diffraction by periodic structures is an important subject in electromagnetic theory and optics. Various analytical and numerical methods have been developed thus far and diffraction phenomena have been investigated for a number of periodic structures. It is to be noted that the theoretical analysis in the past is mainly devoted to periodic structures of infinite extent and plane boundaries. Therefore, it is important to investigate scattering problems involving periodic structures without these restrictions.

In the previous papers, we have considered a perfectly conducting strip with sinusoidal corrugation as an example of finite periodic structures with non-plane boundaries, and analyzed the plane wave diffraction for both E and H polarizations using the Wiener-Hopf technique combined with the perturbation method [1, 2]. In this paper, we shall consider two parallel sinusoidal strips as an important generalization of the geometry in our previous papers, and analyze the E-polarized plane wave diffraction via the combined Wiener-Hopf and perturbation approach. Main results of this paper have been published elsewhere [3].

Assuming that the corrugation amplitude of the strips is small compared with the wavelength and expanding the boundary condition on the strip surface into the Taylor series, the problem is reduced to the diffraction by two parallel flat strips with a certain mixed boundary condition. Introducing the Fourier transform for the unknown scattered field and applying the approximate boundary condition together with a perturbation series expansion for the scattered field, the problem is formulated in terms of the zero-order and the first-order Wiener-Hopf equations. The Wiener-Hopf equations are solved via the factorization and decomposition procedure leading to the exact and asymptotic solutions. Taking the inverse Fourier transform and applying the saddle point method, a scattered far field expression is derived explicitly. Scattering characteristics are discussed in detail via numerical examples of the radar cross section (RCS).

References

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