Rigorous RCS Analysis of the Plane Wave Diffraction by a Perfectly Conducting Rectangular Cylinder

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The diffraction by a perfectly conducting rectangular cylinder is a critical area of study in Radar Cross Section (RCS) research, with wide-ranging applications in electromagnetics. While previous studies have extensively analyzed the scattering phenomenon from such cylinders using high-frequency and numerical techniques, the solutions derived from these approaches are often not uniformly valid for arbitrary dimensions of the cylindrical objects. This paper conducts a rigorous RCS analysis into the diffraction of an H-polarized plane by a perfectly conducting rectangular cylinder employing the Wiener-Hopf technique [1]. The geometry of the problem is illustrated in Figure 1.

The Fourier transform of the scattering field, incorporating boundary conditions, formulates the problem into a system of Wiener-Hopf equations. The exact solution requires factorization and decomposition procedures but remains formal due to the presence of infinite series with unknown coefficients and branch-cut integrals with indeterminate integrands. To simplify the problem, an asymptotic solution is derived through expansion, while an approximate solution, involving two sets of infinite unknown constants satisfying matrix equations, is obtained using simultaneous equations. By applying the Fourier inverse transform and the saddle point method, an asymptotic representation of the scattered far field is determined.

Figure 2 shows the normalized RCS σ λ/ in decibels [dB] versus the observation angle, incidence angle $\theta_0 = 30^\circ$, *a/b*=1. Three values of the normalized cylinder thickness *kb* and the normalized cylinder width *ka* are considered. From Fig 2, when *ka* and *kb* is equal to 4, we can see that the RCS curve has no significant peak. The Oscillation of the RCS is very weak. As the frequency (*ka* and *kb*) increases, the RCS values in the reflected and shadow areas become higher, and the oscillations of the RCS become stronger. The results presented here serve as a reference solution for validating more general analysis methods. Main results of this paper are published in our paper [2].

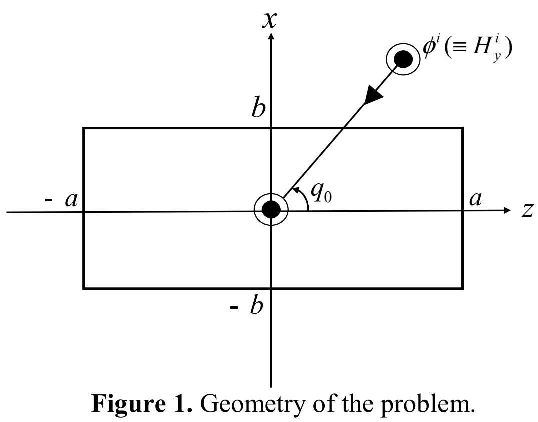

Figure 1. Geometry of the problem.

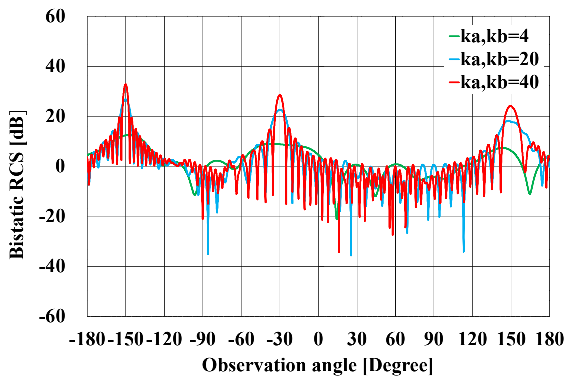

Figure 2. Bistatic RCS [dB] versus observation angle, for incidence angle $\theta_0 = 30^\circ$, *a/b*=1.

References

[1] V. G. Danile and R. S. Zich, *The Wiener-Hopf Method in Electromagnetic,* Scitech Publishing, 2014.
[2] K. W. He, K. Kobayashi, "Wiener-Hopf Analysis of the Plane Wave Diffraction by a Perfectly Conducting Rectangular Cylinder: The Case of H Polarization", *IEICE Trans. Electron.,* vol. E108-C, No.5, May 2025. doi:10.1587/transele.2024ECP5036. *(in press)*