PROCEEDINGS OF THE 1995 ELECTRONICS SOCIETY CONFERENCE OF IEICE

EiC 電子情報通信學会

1995年 エレクトロニクスソサイエティ大会

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1995年 9 月 5 日～ 8 日　中央大学理工学部（東京都文京区）

September 5～8, 1995, CHUO UNIVERSITY, TOKYO

ELECTRONICS SOCIETY

THE INSTITUTE OF ELECTRONICS, INFORMATION AND COMMUNICATION ENGINEERS

社団法人 電子情報通信學会

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Analytical-Numerical Approach for the Solution of the Diffraction by a Resistive Strip — Part I: The Case of *H* Polarization

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The analysis of scattering by a resistive strip is an important subject in diffraction theory. This geometry can be regarded as a suitable model of thin dielectric slabs and coating of finite length which are often used for radar cross section (RCS) reduction. There have been several investigations on the scattering by resistive/impedance strips based on high-frequency and numerical methods [1, 2]. In this two-part paper, we shall analyze the plane wave diffraction by a resistive strip using the analytical-numerical approach [3] which is entirely different from the previous methods employed to solve the impedance-related problems. In this first part, the case of *H* polarization is considered. The time factor is assumed to be $e^{-i\omega t}$ and suppressed in the following.

The geometry of the resistive strip is shown in Fig. 1, where $H_z^i\,[=e^{-ik(x\cos\theta+y\sin\theta)}]$ is the incident field of *H* polarization with k being the free-space wavenumber. The total field satisfies the impedance-type boundary condition, as given by [4]

$$E_x(x,+0)=E_x(x,-0)=\frac{\zeta Z}{2}[H_z(x,+0)-H_z(x,-0)] \quad (1)$$

for $|x|<a$, where ζ is the resistivity and Z is the intrinsic impedance of free space. Using Green's formula, we can express the scattered field $H_z^s\,(\equiv H_z-H_z^i)$ as

$$H_z^s(x,y)=\frac{1}{4i}\int_{-a}^{a}J_H(x')\frac{\partial H_0^{(1)}(k\sqrt{(x-x')^2+y^2})}{\partial y}dx', \quad (2)$$

where $H_0^{(1)}(\cdot)$ denotes the Hankel function of the first kind and $J_H(\cdot)$ is the unknown current density function. Taking into account the edge condition for a resistive half-plane [4], the current density function can be expanded using the Gegenbauer polynomial $C_n^1(\cdot)$ as

$$J_H(\eta)=(1-\eta^2)^{1/2}\sum_{n=0}^{\infty}J_n^H C_n^1(\eta), \quad |\eta|<1, \quad (3)$$

where $\eta=x/a$, and J_n^H for $n=0,1,2,\cdots$ are the unknown coefficients to be determined. It is shown that these coefficients satisfy the infinite system of linear algebraic equations (SLAE)

$$\gamma_m^H-\sum_{n=0}^{\infty}(A_{mn}^H+\zeta B_{mn}^H)J_n^H=0, \quad m=0,1,2,\cdots, \quad (4)$$

where γ_m^H, A_{mn}^H, and B_{mn}^H are known. After solving (4) numerically via truncation and using (3) in (2), the scattered far field is derived by the saddle point method.

Figure 2 illustrates the normalized total scattering cross section (SCS) $\sigma/4a$ as a function of normalized frequency ka for $\theta=90°$, $\zeta=0.1+i0.27$. The results of a perfectly conducting strip ($\zeta=0$) have been added for comparison. It is seen that the resistive strip gives lower SCS level than the perfectly conducting case for $ka \geqq 1$. A similar analysis for the *E* polarization is carried out in the companion paper [5].

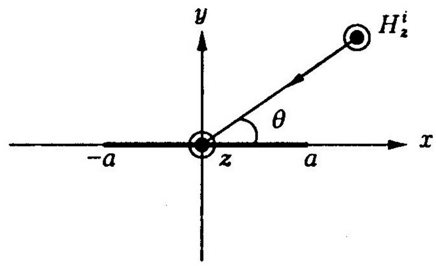

Fig. 1. Geometry of the problem.

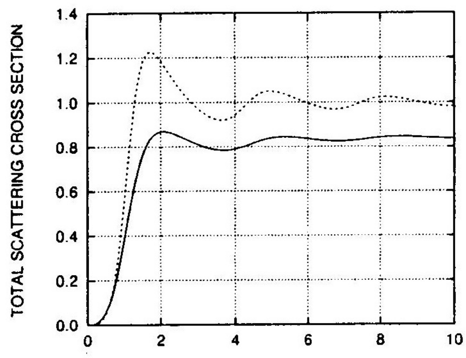

Fig. 2. Frequency dependences of the total scattering cross section $\sigma/4a$ for $\theta=90°$. ——— : $\zeta=0.1+i0.27$; ·········· : $\zeta=0$.

Acknowledgment

This work was supported in part by the Institute of Science and Engineering, Chuo University.

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