Analysis of the "Crack characteristic signal" using a generalized scattering matrix representation

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Electromagnetic properties of a system formed by an open-ended rectangular waveguide and a surface crack/slot in a metallic specimen are described in this paper. Scanning a crack on a metal surface changes the reflection coefficient of the incident dominant mode. A model as a function of relative crack location within the waveguide aperture (i.e., crack moving with respect to the waveguide aperture) is desired to describe and optimize practical crack detection applications. Hence, the change in the reflection coefficient for a generalized system encompassing empty, filled, and finite cracks located at an arbitrary position inside the waveguide aperture, is evaluated. A moment solution approach is employed, and a magnetic current density M is introduced over the common aperture formed by the waveguide and the crack. Subsequently, the junction formed by the waveguide and the cracked metallic surface is separated into two systems. A numerical solution employing the method of moments is obtained, and the reflection coefficient at the waveguide aperture is expressed in terms of the generalized scattering matrix. The convergence behavior is studied to determine an optimized set of basis functions and the optimal number of higher order modes for a fast and accurate solution. Numerical results presented in this paper include the evaluation of the field distribution over the waveguide aperture. Finally, the theoretical and measured crack characteristic signals are compared.

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