GSTC applied to a Coaxial Transmission Line

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Perforated wave guiding structures can arise in applications where the shield may be purposely perforated or simply be an approximation to an imperfect condition. Classic guided waves as well as surface waves may result. Potential examples include a coaxial cable having a braided outer shield or a perforated PCB ground plane.

In this paper a form of boundary condition known as the Generalized Sheet Transition Condition (GSTC) will be applied to gain modal information quickly but accurately. This technique uses the concept of porosities to model the transparencies of periodic perforations. Whereas the GSTC has generally been applied to planar structures in the past, here a circular cylindrical geometry is analyzed.

In this presentation a GSTC condition is applied to analyze a coaxial cable having a perforated shield. This boundary condition is applied to solutions of Maxwell's equations to obtain expressions for fields of the modes. These fields are expressed in terms of Bessel functions. Two limiting cases, the perfectly closed shield (TM / TEM modes) as well as no shield at all (Goubau line), are shown to agree analytically. The resultant transcendental equations for the mode propagation constants are derived and solved numerically.

The TM fields are also plotted based on the GSTC numerical solutions. Both quasi-TEM modes and TM surface waves are predicted. Various perforation sizes are explored and their model field patterns are presented for the TEM, surface wave and higher order TM modes. Comparison with finite-element simulation is made and plots illustrating good agreement. This approach computes modes in approximately 30 seconds over a range of frequencies on a standard PC, which is important when solution speed is an issue. The finite-element approach requires several hours for a complete frequency sweep.

The approximate method presented here using the GSTC boundary condition to model the modes of a cylindrical structure reveals it's guided wave characteristics both quickly and accurately.