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Time Domain Diffraction by Composite Structures

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Time domain (TD) diffraction problems are receiving great attention because of the widespread use of ultra wide band (UWB) communication and radar systems. It is commonly accepted that, due to the large bandwidth of the UWB signals, the analysis of the wave propagation mechanisms in the TD framework is preferable to the frequency domain (FD) data processing. Furthermore, the analysis of transient scattering phenomena is also of importance for predicting the effects of electromagnetic pulses on civil structures.
Diffraction in the TD framework represents a challenging problem and numerical discretization techniques can be used to support research and industry activities. Unfortunately, these methods become rapidly intractable when considering excitation pulses with high frequency content.
This contribution deals with the TD diffraction phenomenon related to composite structures containing a dielectric wedge with arbitrary apex angle when illuminated by a plane wave. The approach is the same used in [1]-[3]. The transient diffracted field originated by an arbitrary function plane wave is evaluated via a convolution integral involving the TD diffraction coefficients, which are determined in closed form starting from the knowledge of the corresponding FD counterparts. In particular, the inverse Laplace transform is applied to the FD Uniform Asymptotic Physical Optics (FD-UAPO) diffraction coefficients available for the internal region of the structure and the surrounding space. For each observation domain, the FD-UAPO expressions are obtained by considering electric and magnetic equivalent PO surface currents located on the interfaces. The surface radiation integrals using these sources is assumed as starting point and manipulated for obtaining integrals able to be solved by means of the Steepest Descent Method and the Multiplicative Method.

[1] G. Gennarelli and G. Riccio, “Time domain diffraction by a right-angled penetrable wedge,” IEEE Trans. Antennas Propag., Vol. 60, 2829–2833, 2012.
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[3] M. Frongillo, G. Gennarelli and G. Riccio, “TD-UAPO diffracted field evaluation for penetrable wedges with acute apex angle,” J. Opt. Soc. Am. A, Vol. 32, 1271–1275, 2015.