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A Revised Complex Refractive Index Model for Inferring the Permittivity of Heterogeneous Concrete Models

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The estimation of the bulk permittivity of heterogeneous mixtures is of great interest for many Ground Penetrating Radar (GPR) and electromagnetic sensing applications [1], [2]. The most used method for estimating the bulk permittivity is the Complex Refractive Index Model (CRIM). The simplicity of this method is one its advantages however, the accuracy of the permittivity estimation has not been tested. Here, the CRIM model's shape factor is examined and optimised in order to achieve a more accurate concrete bulk permittivity estimation. The concrete components are aggregate particles, cement particles, air-voids and moisture content; and they are randomly distributed with different volume percentages to produce various combinations. These combinations are modelled using the Finite-Difference Time-Domain (FDTD) method as it is an accurate and computationally efficient method [3]. The numerical modelling is then used to predict the bulk permittivity allowing to fine-tune CRIM model's shape factor. The models are modelled in 3D and a GSSI-like antenna structure is used as the transmitting source [4]. The permittivity estimation uses an accurate time-zero method, which increases the accuracy of the estimated bulk permittivity hence, the shape factor [5], [6]. The results have shown that the optimised CRIM model over-performs the original CRIM model shape factor therefore, a better and more accurate bulk permittivity estimation is achieved for concrete mixtures.

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