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2D Numerical Modeling of Ultrasonic Measurements in Concrete: Wave Propagation in a Multiple-Scattering Medium

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Abstract : Linear Ultrasonic Techniques play a major role in Non-Destructive Evaluation (NDE) for civil engineering structures in concrete since they can meet operational requirements. Interpretation of ultrasonic measurements could be improved by a better understanding of ultrasonic wave propagation in a multiple scattering medium. This work aims to develop a 2D numerical model of ultrasonic wave propagation in a heterogeneous medium, like concrete, integrating the multiple scattering phenomena in SPECFEM software. The coherent field of multiple scattering is obtained by averaging numerical wave fields, and it is used to determine the effective phase velocity and attenuation corresponding to an equivalent homogeneous medium. First, this model is applied to one scattering element (a cylinder) in a homogenous medium in a linear-elastic system, and its validation is completed thanks to the comparison with analytical solution. Then, some cases of multiple scattering by a set of randomly located cylinders or polygons are simulated to perform parametric studies on the influence of frequency and scatterer size, concentration, and shape. Also, the effective properties are compared with the predictions of Waterman-Truell model to verify its validity. Finally, the mortar viscoelastic behavior is introduced in the simulation in order to considerer the dispersion and the attenuation due to porosity included in the cement paste. In the future, different steps will be developed: The comparisons with experimental results, the interpretation of NDE measurements, and the optimization of NDE parameters before an auscultation.

Keywords : attenuation, multiple-scattering medium, numerical modeling, phase velocity, ultrasonic measurements
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