

### **Reliability of Void Detection in Brickwork Masonry Using Radar, Ultrasonic and Complex Resistivity Tomography**

---The influence of moisture on the reliability of detection of larger voids in brick masonry was investigated using three non-destructive techniques: radar, ultrasonic and complex resistivity (CR). To obtain a spatial reconstruction of the internal structure, tomographic measurements were performed over a specific cross section containing a larger void at a known position. The travel times of electromagnetic and acoustic waves as well as complex resistivity were measured respectively to determine the moisture influence on wave velocity and the complex resistivity magnitude of bricks. According to velocity images, moisture remarkably increases the dielectric constant of the masonry while having little effect on the elastic properties. In addition, the ultrasonic data were found to be more scattered and sensitive to moisture than radar data. We propose a numerical estimator to quantitatively determine the void detection efficiency from the obtained images while subjecting masonry to various moisture levels. It has been proven that radar is by far the most reliable technique for void detection in dry masonry. Nonetheless, a tremendous increase in efficiency value in wet versus dry masonry proved that CR is a powerful method in detecting larger air voids even at relatively low humidity levels.

### **A Rough Deal: Efficient Simulation of Ultrasound Scattering in 3D**

---Simulating scalar wave interactions with a rough surface is a complex problem. Current models either rely heavily on approximations limiting their applications or suffer from high computational loads. A semi-analytical model is presented which can simulate scattering of scalar waves in three dimensions while accounting for the effects of shadowing and multiple scattering at the surface. The mathematical framework is based on the Distributed Point Source Method (DPSM) which is shown to improve upon the accuracy of the Kirchoff approximation and the speed of the Finite Element Method (FEM). Comparison of 2D and 3D results from Gaussian distributed rough surfaces indicates that spatial averaging causes scattered energy content within a reflected pulse to decrease. A potential method of correcting results from 2D simulations to more closely approximate 3D results in order to take advantage of the much lower computational load is subsequently presented and limitations are discussed.