Application of Acoustical Methods for a Non-Destructive Evaluation of the Elastic Properties of Building Materials

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As is well-known, in contrast to fluid phase materials, in solid phase materials, the propagation of elastic waves proceeds through both longitudinal and traverse waves. Using the speed of longitudinal and shear wave propagation, it is possible to evaluate the elastic properties of the solids under study, determining, for example, the Young's modulus, the Poisson's coefficient, the bulk modulus and the shear modulus. This work aims to propose an accurate method of wave propagation speed measurement in non-homogeneous materials in order to evaluate the mechanical properties of several building materials typologies. First of all, in order to evaluate the performance in terms of accuracy and precision of the proposed methodology, applying the pulse-echo technique, measurements of wave propagation speed have been carried out, at atmospheric conditions, in well-known homogeneous and isotropic materials, such as copper, aluminum, stainless steel and also polymethyl methacrylate (Plexiglas) and optical glass BK7. These data have been compared with literature values, showing like, to the best of the authors knowledge, currently, accurate published speed of sound data are very sparse and not very reliable because of the lack of the uncertainty evaluation and also of the knowledge of the thermodynamic (T, p) state values that should be associated to the speed of sound results. Then, the same experimental apparatus has been used for speed of sound measurements as a function of the temperature (from 274.15 to 313.15 K) for 304 stainless steel, copper oxygen free and optical glass BK7, showing a good accuracy in the results also for conditions of temperature far from ambient. Finally, we have applied the same procedure for non-homogeneous substances, obtaining some preliminary results in typical Mediterranean building materials (i.e. Carrara marble and plaster of Paris). The experimental data obtained have pointed out an attainable accuracy.