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Loic Brancheriau

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## Ultrasonic analysis of moisture content effect on the mechanical characterization of wood properties

Rebecca Dijoux<sup>1</sup>, Andres Arciniegas<sup>1</sup>, Nicolas Wilkie-Chancellor<sup>1</sup>, Marguerite Jossic<sup>2,3</sup>,  
Loïc Brancheriau<sup>4</sup>

<sup>1</sup>Laboratoire SATIE UMR CNRS 8029, CY Cergy Paris Université, 5 Mail Gay Lussac,  
95000, Neuville, France

<sup>2</sup>Equipe Conservation Recherche, Musée de la Musique, Cité de la  
Musique/Philharmonie de Paris, 221 Avenue Jean Jaurès, 75019, Paris, France

<sup>3</sup>Centre de Recherche sur la Conservation, Muséum National d'Histoire  
Naturelle/Ministère de la Culture, 36 rue Geoffroy Saint-Hilaire, 75005, Paris, France

<sup>4</sup>CIRAD, UPR BioWooEB, Université de Montpellier, Montpellier, France

[andres.arciniegas-mosquera@cyu.fr](mailto:andres.arciniegas-mosquera@cyu.fr)

Construction, furnishings, musical instruments, daily life, energy - the raw material needs are diverse, as are the materials available to us. Unlike other raw materials, wood and wood-based products are a renewable resource, thanks to the ability of trees to capture carbon from the atmosphere and regenerate and to the determination of human beings to preserve and renew them. The use of wood-based products and construction systems enables buildings to reduce greenhouse gas emissions over their entire lifecycle, and to store carbon over the long term. Despite its use over the centuries, the great variability of this material places it at the heart of perpetual questioning. Indeed, being hygroscopic, anisotropic and heterogeneous, wood mechanical properties will vary according to numerous parameters such as the species considered, the orientation of the sample and climatic conditions. Characterizing the properties of wood and wood-based products is therefore an essential step in their development and use.

Among non-destructive testing methods, acoustic and/or ultrasonic techniques are widely used, due to their relative ease of use and low cost. To analyze the mechanical properties associated with wave propagation in an hygroscopic material, several vibration measurement techniques employ acoustic/ultrasonic actuators and sensors, including force hammers, vibrating pots, accelerometers, microphones, laser vibrometers and ultrasonic transducers. The advantage of these methods lies in their non-destructive nature and their ability to deliver results within a reasonable testing time (approximately one minute per sample).

Given the current state of knowledge, it seems necessary to take into account fluid/structure interactions to better understand mechanical wave propagation phenomena and to better characterize and monitor wood properties. The first challenge of this study is to set up a reproducible experimental protocol for monitoring the evolution of wood's mechanical properties at different moisture contents using ultrasonic transmission measurements. Signal analysis and processing are then carried out in order to extract the propagation parameters (propagation time, wave velocity, wave number,...) and damping (amplitude, wave attenuation) during sample drying. The second challenge involves comparing the results with pre-existing equations and models mentioned in the scientific literature.

In the course of this study, ultrasonic analyses were carried out on samples from different wood species to deepen our understanding of mechanical properties and wave propagation phenomena in wood at different moisture contents. Very little is known about these phenomena beyond the fiber saturation point since scientific consensus differ according to the frequency range of the acoustic technique. Consequently, the aim is to characterize the material's properties over a wide range of moisture contents, from saturated to dry. First results show that ultrasonic testing combined by viscoelastic modeling provides a better understanding of wood mechanical characterization at mesoscopic and macroscopic scales. In order to assist the analysis and interpretations, the results are compared to literature. This last supports the potential of ultrasonic methodologies for the mechanical testing and evaluation of wood, taking into account fluid/structure interactions.