

## Experimental Analysis of Acoustic Anisotropy of Green Wood by using Guided Waves

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### Abstract

In this investigation we present an experimental analysis of the acoustic anisotropy of wood, in particular the dependence between the propagation velocities of stress waves and the natural anisotropy axis in the cross section. Wave velocities are measured on Douglas discs samples and on bars obtained from slicing discs. The experimentations are carried under cantilever conditions. Elasticity modulus and densities are determined in free vibrations. The results show a significant difference in propagation velocity between waves propagating in whole volume and waves guided on bars. Under cantilevering conditions the modulus of elasticity increases with the applied stress. The acoustic anisotropy of wood is discussed and the simulation of stress wave form was presented.

### 1. INTRODUCTION

Wood quality is related to growing conditions, environment and silvicultural practices. Wood may contain natural defects which can be divided in two categories, the first one includes all malformations in the tree trunk like knots, splits and hole, and the second category concerns those defects caused by external agents like rots and fungal which alter wood performances principally the strength of the material. The evaluation of wood quality is an important step for the optimisation of manufacturing process. Recently, many researches were interested on the development of non-destructive evaluation techniques of wood and wood products. Various technologies were used to assess standing trees wood quality in forest industry [1-3]. Acoustics techniques have received considerable attention as an alternatives tool for the evaluation of wood quality at different scales. The use of acoustics vibrations for detection decay in wood is developed for application to logs, utility poles or construction timber [4,5]. Others studies were interested on decay detection and to assess the mechanical properties of wood in standing timber; the characteristics of induced stress waves is correlated to wood mechanical properties resulting from the tree [6,7]. Others approaches were based on analyse of the wave form by conducting multiple measurements in different orientations at the cross section. Tomographic inversion of the obtained stress wave data from multiple measurements help to obtain an image of stress wave velocity distribution in the cross section and to define the extent of internal defects [8-11]. It's well known that wood is an anisotropic material, stress waves propagation depend on the orientation of the grain and the excitation direction. The structure of wood imposes some privilege propagation directions, the grain can be considered as wave guide, refractions and diffraction phenomena occur in the cross section. Under certain assumptions this acoustic anisotropy is associated to the mechanical anisotropy [12].

The aim of this work is to study the relation between wood structure and stress wave propagation phenomena, and to establish data base for the dependency of stress wave velocity between propagation direction and principal growth directions in the cross section. The experimentation is realised with a systematic sapling.

### 2. MATERIAL AND METHODS

A series of experimentations were conducted on Douglas (*Pseudotsuga Menziesii*) wood samples (see Figs. 1 and 2). The trees were filled in CIRAD Park and coated as logs (50-60 cm of length) stored in water at ambient temperature in order to keep them green. Logs were sawn as discs samples with a thickness between 60 and 70 mm and were classed as samples without defect and with heart rot. The experimentations were realized in conditions that supporting compressions stress waves than the others wave shape. A cantilevering system is formed by two MDF panels and the disc sample is placed

