

## Mechanical Properties Estimation by Non-destructive Testing of Irish Hardwood Round Timber from Thinnings for Construction Purposes

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### ABSTRACT

Thinning involves the removal of competitors of high quality trees, and trees for extraction racks, all to favour the growth of the selected trees. Many felled trees are small-diameter and in Ireland hardwood thinnings are mainly used for energy production (DORAN 2012; MOCKLER 2013) or for wood-based panels or in the pulp industry (CAMPION AND SHORT 2016). Since the 1990's the Irish Government has been encouraging private owners to combine agricultural and forest commercial activities. Grant aid was initially provided each year for the first 20 years (nowadays 15) in order to compensate the loss of agricultural land use. Furthermore, the first and second hardwood thinning is also grant aided. There is commercial value in seeking to use hardwood thinnings in higher value-added end uses as structural components within the construction industry and to develop its volume use in local rural industry (WOLFE AND MOSELEY 2000; CUMBO ET AL. 2004; GORMAN ET AL. 2016). The Exploitation And Realisation of Thinnings from Hardwoods (EARTH) project aims to investigate potential added-value uses of hardwood thinnings and develop a grading system for sorting into different classes, estimating mechanical properties using non-destructive testing (NDT).

### Materials and methods

38 first and second thinning trees and round timber obtained from four Irish hardwood species (common alder, European ash, European birch and sycamore) were used. Time-of-flight (ToF) of acoustic waves over a 1 m length using Treasonic (Fakopp, Sopron, Hungary) device was measured on standing trees before felling. One log from the bottom part of the tree with a length 25 times its diameter was selected from each tree. According to some authors there are differences in static (MOE) and dynamic (Edyn) modulus of elasticity between bottom and top logs from the same tree (KRAJNC ET AL. 2016). The minimum diameter of selected logs was 8 cm. MTG (Brookhuis, Enschede, The Netherlands) was used to determine fundamental frequency in longitudinal direction on felled selected logs just after harvesting. After conditioning the roundwood at 65% relative humidity and 20°C, testing in four-point bending over a span of 18 times its diameter.

### Results and discussion

Mechanical properties (bending strength, MOE and density) were determined in logs in order to characterize small round timber from thinnings for construction purposes. Regression models were developed to investigate the correlation between velocities obtained in standing trees and green selected logs from NDT (ToF and natural frequency) and mechanical properties obtained in conditioned logs by mechanical testing. In the regression models between acoustic velocity obtained by ToF on standing trees and mechanical properties, good correlation was found with MOE as other authors found in black poplar (CASADO ET AL. 2013). As result ToF

measurements could be considered a good method to segregate standing trees before felling them. Better correlation was found between acoustic velocity obtained in green selected logs by the resonance method and MOE as other authors showed in previous research (SANTA CLARA AND MERLO 2011).

### Conclusions

Non-destructive testing measurements on standing trees and green logs are suitable methods to estimate the mechanical properties of the final product, in this study round hardwood timber. Good correlation between acoustic velocity obtained in standing trees from ToF using stress waves and mechanical properties was found. Better correlation between velocity obtained from natural frequency in green logs using a resonance device and mechanical properties was found. It is possible to develop a grading system based on NDT measurements for sorting hardwood thinnings into different end-use classes.

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*Peter Rademacher, Miklós Bak*





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As part of the interaction between this Action and Hardwood Conference, the following presenters have been provided with assistance for their involvement at this conference:

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