Acoustic tools for seedling, tree and log selection

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1 Introduction

Based on recent research results the link, between the wood-microstructure and quality is rather clear. The low microfiber angle results high velocity in fibber direction, high stiffness, high strength and long tracheids. Among the listed parameters the determination of the velocity is the most easiest and quickest. For this reason, acoustic based tools for selecting seedlings, trees and logs are available for research and industry including nurseries, plantations and saw mills. The applied technology is different because the dimensions and conditions are different as well.

Acoustic technologies for assessing stiffness, such as Fibre-Gen's Director HM200™, FAKOPP's TreeSonic, and the Metriguard 2600™ have become increasingly popular in forest and processing environments (Todoroki, 2010). Their popularity arises from the tools being relatively inexpensive, simple to use, and because they permit testing of wood samples to be done non-destructively. This provides opportunities for better resource quality assessments (Chauhan and Walker, 2006 and Cown, 2005), better log segregation into quality classes (Dickson et al., 2004 and Amishev, 2008), better board segregation into stiffness classes, and early screening for genetic heritability (Kumar et al., 2002), yielding great potential to add value all along the forest-to-products chain. The earlier well-informed decisions are made within the forest-to-products chain, the greater the potential value addition. Thus if it can be shown that strong relationships exist between tree and product, then those relationships can then be used to generate added value.

2 Seedling tester

The seedling tester is an ultrasonic device, has two identical sensors. These sensors are pressed to the seedling by a spring. It provides acoustic coupling between the seedling and sensor. The minimum distance between the starter and receiver sensor is 5 cm, the maximum is 100 cm. The short distance is possible because the time resolution of the ultrasonic timer is 0,1 microsecond. Using the seedling tester an early evaluation of the future wood quality is possible. The recommended seedling age for the acoustic selection is 6 and 9 month. This technique is already patented by the Weyerhaeuser Company, (Huang, 2006)

Recently the interest for seedling segregation by stress wave velocity is rising (Divos 2007). Fakopp Enterprise developed a specialised tool for rapid and precise velocity determination for seedling evaluation. The challenge was the

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high attenuation of the seedling material. The developed ultrasonic timer resolution is 0,1 microseconds and the sensors sensitivity is high, the applied frequency is low: 30kHz. The sensors are coupled to the sensitive seedling by a special clip. Figure 1. shows the battery operated ultrasonic timer together with the special sensors.

Figure 1. The seedling tester device is in a nursery. Manufactured by FAKOPP Bt. Hungary, www.fakopp.com

Figure 2. shows an example test result on *Ligustrum vulgare.* The measured velocity is decreasing by height. Measurement was possible at the tip of the seedling where the diameter was around 1 mm only. The signal amplitude was between 40 and 10 mV, while the threshold level of the timer is 0,2mV, so reliable and quick transit time determination is possible on high moisture content and high damping samples like seedling. The repeatability of the readings are high, the typical standard error of time reading is around 0,4 microseconds. This value depends on the quality of the coupling, evaluation of samples with bark is difficult. In this case different type of sensor is required, like sensor equipped with miniature spike.

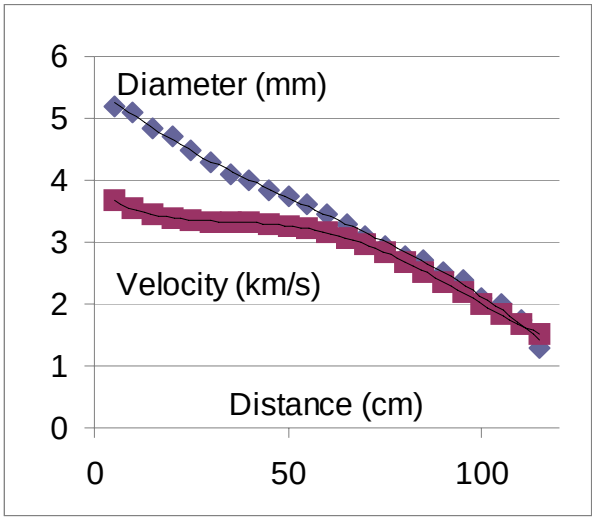

Figure 2. Velocity and diameter versus distance from the ground of Ligustrum vulgare seedling

3 The TreeSonic device

A stress wave timer, specialised for forest conditions is developed for selecting young (10 – 20 years old) trees. The transducers of the timer are equipped with sliding hammer, resulting quick operation, patented by Weyerhaeuser Company (Huang, 2005). One test - including moving to the next tree - takes 40 seconds. The typical distance between transducer is 1 meter. The stress wave is generated by a hammer impact. The high velocity trees producing high strength wood material, so the high velocity trees are preferred for the quality wood production.

Figure 3. TreeSonic device is in use, *photo by Keith Jayawickrama.*

4 Resonance Log Grader

Longitudinal vibration technique is applied in log selection. The user of the tool hit the end of the log by hammer. The sound of the log is detected by a microphone, located close to the same end of the log. The velocity is calculated from the longitudinal vibration frequency and the length of the log. The first vibration mode is used in the calculation. The utilization of the log is depends on the measured velocity. High velocity log will produce high strength lumber. Resonance Log Grader (RLG) tool is a standard PDA with an RLG software. Figure 4. shows the testing procedure and the PDA screen. The length of the log is set by the operator. Grade number is depends on the measured velocity. The bottom part of the screen is the FFT spectra of the sound captured from the

log. A frequency window (see figure 4.) is calculated, based on the length of the sample. A tall peak in the frequency window - represents the resonant frequency of the longitudinal vibration, mode number 1. This frequency is used in the velocity calculation.

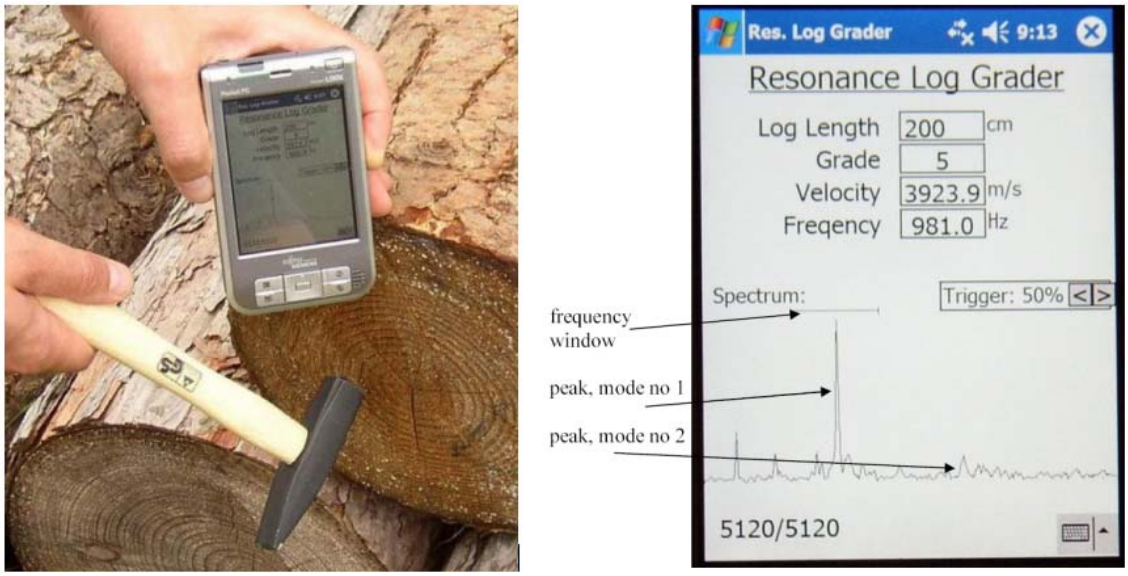

Figure 4. The log grader in a log yard. And the PDA screenshot.

5 Conclusion

Different acoustic tools, available for seedling, standing tree and log selections are presented. This paper concentrated to the tools manufactured by the authors company. The importance of acoustic selection and grading is indicated by tool manufacturers activity. Table 1. shows – probably not a complete – list of the acoustic tool manufacturers. Hopefully a reliable comparison between similar tools will be available soon.

Table 1. Acoustic tool manufacturers and their websites

Tool	Application(s)	Manufacturer	Website
Ultrasonic Timer	Seedling	Fakopp Enterprises, Hungary	www.fakopp.com
ST-300	Standing tree	Fibre-gen, New Zealand	www.fibre-gen.com
Sylvatest Duo	Standing tree	CBS–CBT, France	www.sylvatest.com
TreeTap	Standing tree	Univ. of Canterbury, New Zealand	www.research.canterbury.ac.nz
TreeSonic	Standing tree	Fakopp Enterprises, Hungary	www.fakopp.com
IML Hammer	Standing tree	IML GmbH, Germany	www.iml.de
LG-640	Felled logs/sawn timber	Fibre-gen, New Zealand	www.fibre-gen.com
RLG	Felled logs/sawn timber	Fakopp Enterprises, Hungary	www.fakopp.com
HM-200	Felled logs/sawn timber	Fibre-gen, New Zealand	www.fibre-gen.com
Dynagrade	Sawn timber	Dynalyse AB, Sweden	www.dynagrade.com
ViSCAN	Sawn timber	Microtec, Italy	www.microtec.eu
MTG	Sawn timber	AB Brookhuis, Netherlands	www.brookhuis.com
PLG	Sawn timber	Fakopp Enterprises, Hungary	www.fakopp.com
PUNDIT	Laboratory	CNS Farnell, UK	www.cnsfarnell.com
Grindosonic	Laboratory	J W Lemmens, Belgium	www.grindosonic.com

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