ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

ULTRASOUNDS AS A NONDESTRUCTIVE METHOD FOR WOODEN BOARD ASSESMENT

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Key words: Ultrasound method, Wood based boards, propagation speed, internal coherence

Abstract: This paper presents a method used to establish, in a nondestructive way, some physical-mechanical features of wooden boards, by using ultrasounds. The investigations consist in the study of a ultrasound energy flow emitted by a source when crossing the board, depending on the features of the wooden material combined with adhesives. Reciprocity relationshios were established between the board crossing speed of ultrasounds and the following features: internal coherence, board thickness, roughness and swelling in thickness. The used frequencies are in the range of 20.000 – 100.000 Hz.

1. INTRODUCTION

In general, methods of non-destructive evaluation of the wooden based boards, are a modality to effectively help their manufacturing process. When manufacturing these boards, the process is qualitatively controlled by maintaining the manufacturing parameters constant and, on the other hand, by testing the specific features of the product. The most important specific features of the boards are:

- modulus of elasticity (traction, bending);
- swelling in thickness;
- limit strengths to the mechanical loads (static or dynamic);
- internal coherence;

On modern process lines, the non-destructive evaluation methods of the board quality fully find their place. Thus, the following features can be measured in the process flow:

- volumic mass;
- thickness;
- defect presence (internal interstices, adhesive stains, local densifications, intrusions such as stones or metals);
- some mechanical features.

Using ultrasounds is a method of non-destructive investigation of the wooden based boards, that can be inserted in the process flow of manufacturing boards [4]. The method is based on the phenomenon of ultrasound propagation through the wooden boards with certain features. The following investigation principles can be used:

♦ crossing the test sample by an ultrasound flow and then study the flow behaviour, as function of the board features;

♦ studying the echo emitted by the ultrasound in order to establish the board uniformity, for instance, for the plywood boards: detecting the defects (separations, insect holes, zreas without adhesive, uneven adhesive thickness between layers, rot areas, anomalies of wood growth, technological defects etc.);

♦ studying the microscopic structure of wood, the features of the cell wall.

Ultrasound investigations are based on the study of the ultrasound energy flow behavior, emitted by a source when crossing the test sample [4].

2. STUDY OF ULTRASOUND FLOW BEHAVIOR AS A FUNCTION OF WOODEN BOARD FEATURES

The frequencies used for the method, ranged between 20.000 – 100.000Hz. The main parameters of the ultrasound energy flow taken into account are:

- ultrasound frequncy spectrum used and the time of flying of the ultrasound flow from the ultrasound emitter to the receiver;
- ultrasound attenuation (decreasing of the ultrasound flow intensity after crossing the test sample);
- changes of the ultrasound wave shape after crossing the test sample;
- changes of the ultrasound flow trajectory[1].

For the wooden based boards, the speed of crossing these boards is firstly measured. Then, the thickness, density, internal coherence and swelling in thickness are determined [5; 6].

2.1. Mode of action

Between an ultrasound source (emitter) and an ultrasound transducer (receiver), wooden boards of different densities and certain features were inserted [5]. The drawing of the measuring device is shown in figure 1:

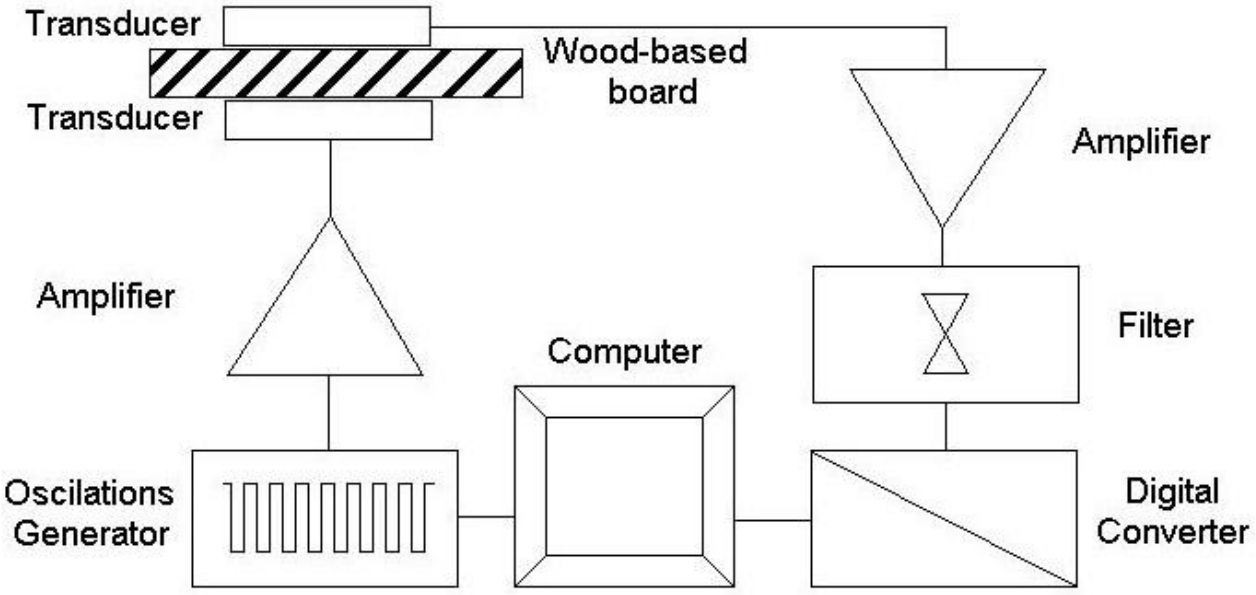


Fig.1. Measuring device with ultrasounds by method "no contact"

The parameters of the ultrasound energy flow were measured before and after inserting the boards between the emitter and the receiver. Reciprocity relationships were established between the ultrasound speed of crossing the board and the internal coherence, modulus of elasticity and swelling in thickness.

Two methods of placing the receiving transducer:

- on the board surface, called "with contact" method;
- outside the board, called "no contact" method.

2.2. Results

The results of the investigations are shown in the diagrams below [5]:

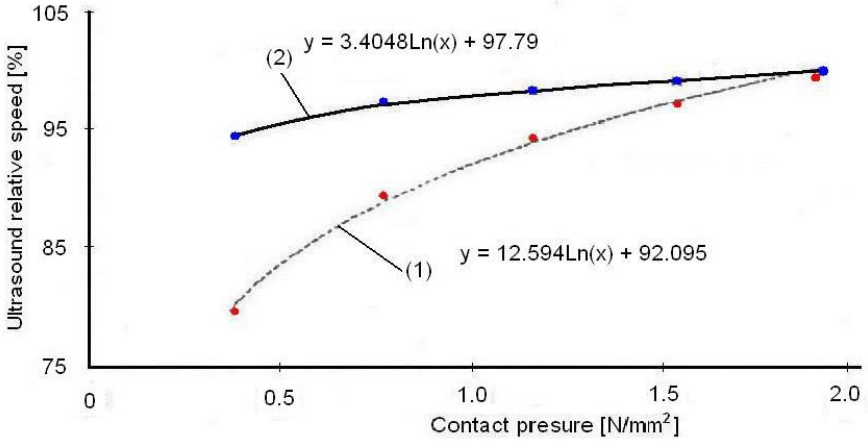
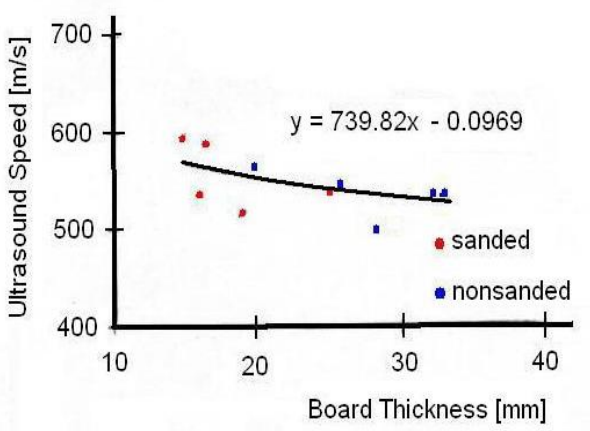


Fig. 2. The influence of the contact pressure of the receiver transducer on the propagation speed of the ultrasounds through wooden boards

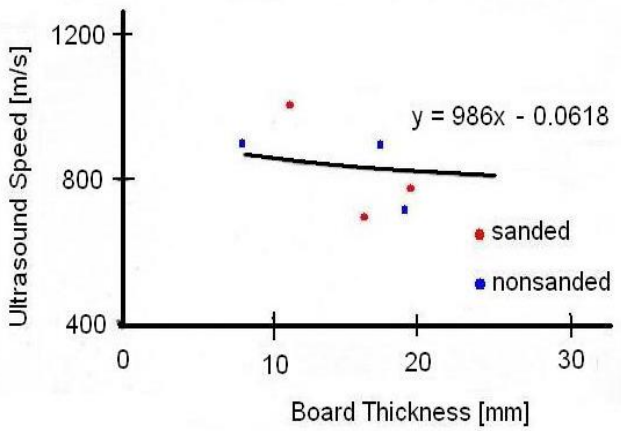
Thus, it was determined:

♦ the influence of the contact pressure of the receiver transducer on the propagation speed of the ultrasounds through wooden boards, in the case of using the "with contact" method (fig. 2). The curve marked by (1) is characteristic for the wooden chips glued with carbamidic type adhesives with density ranging between 620-680 kg/m^3 and thickness between 15,0-33,0 mm, while the curve marked with (2) belongs to the average density boards (670-900 kg/m^3) and thickness between 8,0-25,1 mm. From the diagram results that, for higher densities of the boards, for the same values of the contact pressure, the ultrasound propagation speed increases [6];

♦ the influence of the thickness and roughness of the panel surface on the ultrasound propagation speed (fig. 3a) and the influence of the internal coherence of the boards on the ultrasound propagation speed (fig. 3b). From the diagrams results that the ultrasound speed decreases with the board thickness increasing. The values depend as well on the grinding degree of the finished surface.

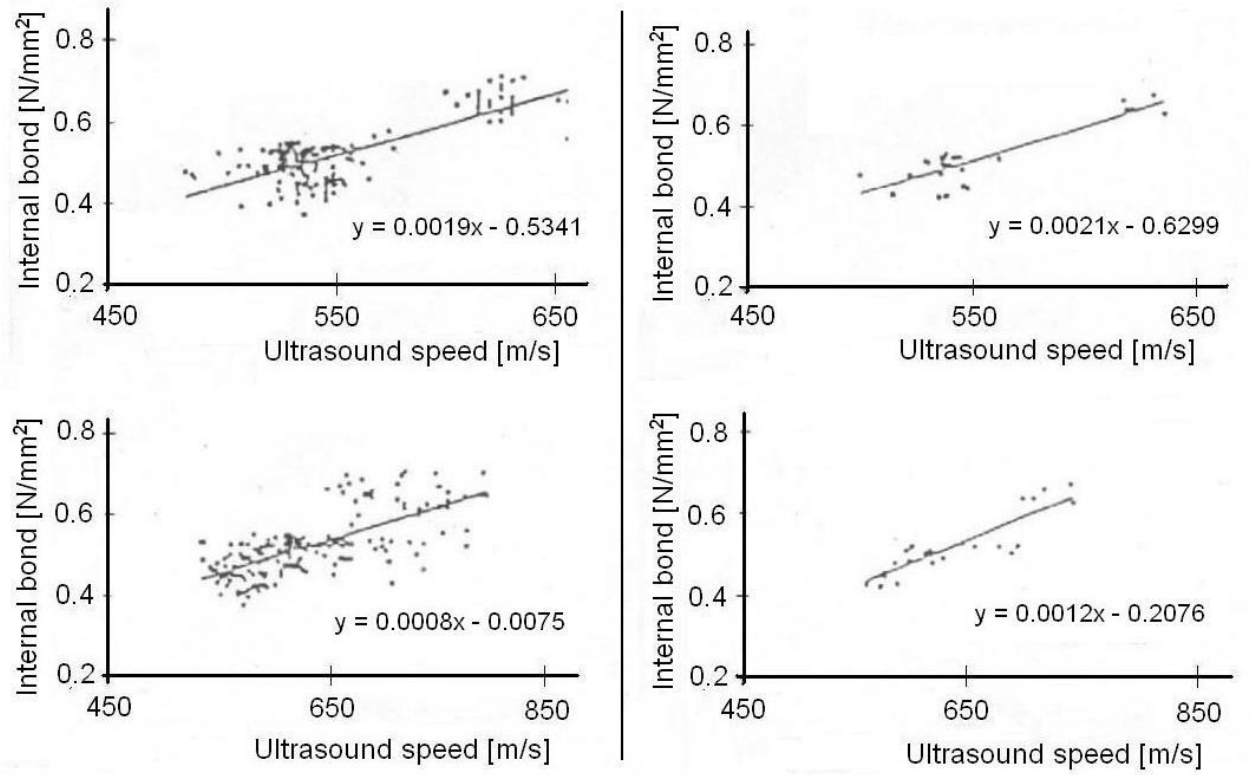


"with contact" method



"no contact" method

Fig. 3a



point values for speed ***average values for speed***

Fig. 3b. The influence of the thickness, roughness and internal bond of the boards, on the ultrasound propagation speed

♦ the influence of the swelling in thickness (24 hours) of the panels on the ultrasound propagation speed, fig. 4;

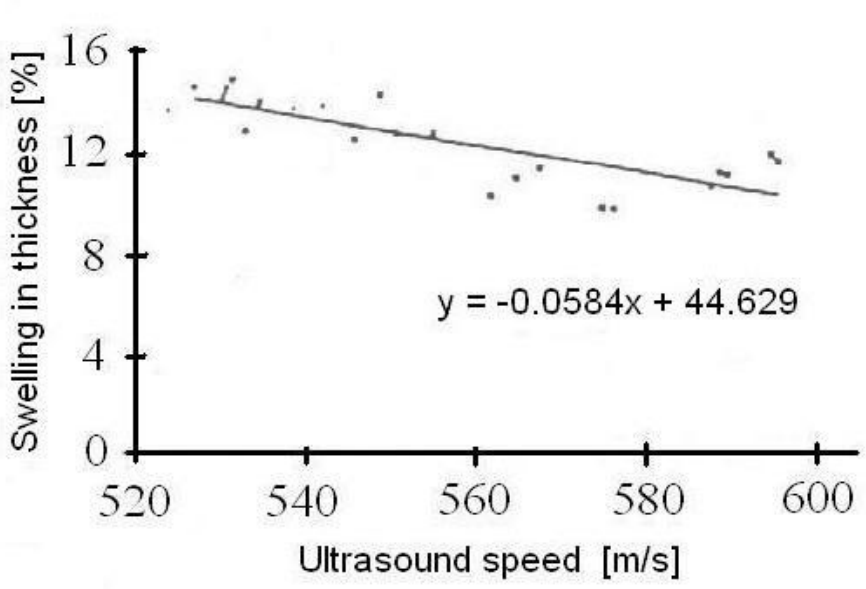


Fig. 4. The influence of the board swelling in thickness after 24 hours, on the ultrasound propagation speed

♦ the relationship between the ultrasound propagation speed in the case of "with contact" method and the ultrasound propagation speed in the case of "no contact" method, for a frequency spectrum ranging between 20 kHz and 100 kHz (fig. 5).

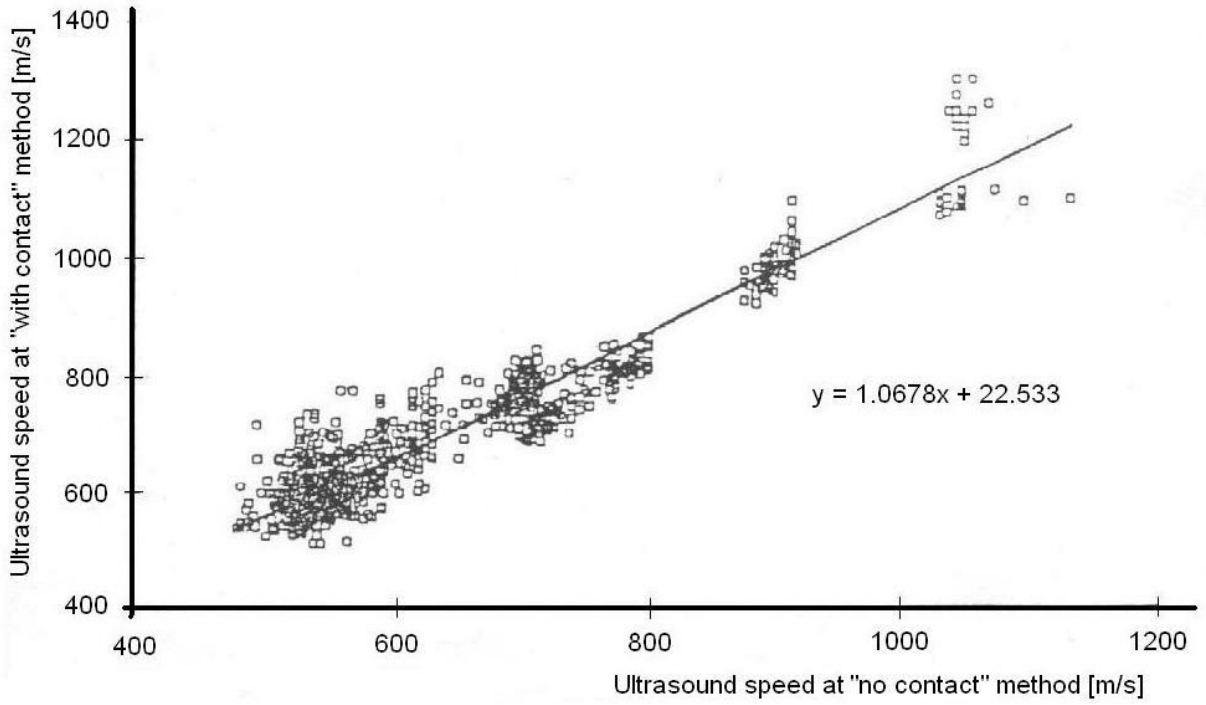


Fig. 5. The relationships between the ultrasounds speed at "with contact" method and the ultrasounds speed "no contact" method

3.CONCLUSIONS

♦ Correlations of the speeds (for the two methods) were determined within a range of speed between 500m/s and 1220m/s, in fig. 5, resulting that the relationship between the two speeds is linear and doesn't depend on the used adhesive. This fact encourages the using of "no contact" method, with a certain spectrum of frequencies.
♦ It was established that the speed of crossing the board by the ultrasounds by using the "with contact" method is influenced by the pressure of pressing the receiver transducer on the board. This fact leads to the misinterpretations of the determinations. In order to avoid this, the "no contact" method is used, so that, between the emitter and the wooden board there is an air layer. Thus, the errors given by the uneven contact pressure between the receiver transducer and the board surface are avoided.
♦ The physical-mechanical features of the boards used to correlate the ultrasound speed and board features, were established by using standardized destructive methods (according to EN). More determinations were made. A "cloud" of values were graphically obtained. The reciprocity relationship between the features (speed – property) was mathematically established, being an average value, as first degree function [8].
♦ Ultrasound frequencies are used to investigate the test samples in a wide range of shape and dimension, following the establishment of certain physical-mechanical features, and other type of characteristics, such as: defect presence, inclusions etc.

REFERENCES

[1]. Bodig, J., 2000: *Introduction at the 11th Symposium of Nondestructiv Testing of* wood, Sopron, Hungary.
[2]. Harris, C., Crede,C, E.,1966: *Şocuri şi vibraţii*, vol.I, Editura Tehnică, Bucureşti.
[3]. Harris, C., Crede,C, E.,1966: *Şocuri şi vibraţii,* vol.II, Editura Tehnică, Bucureşti.
[4]. Harris, C., Crede,C, E.,1966: *Şocuri şi vibraţii*, vol.III, Editura Tehnică, Bucureşti
[5]. Krusse, K, Broker, F, W.,Fruhwald, A., 1996 : *Non contact method to determine ultrasonic velocity of wood based panels*, Holz als Roh und Werkstoff, nr. 5/1996
[6]. Krusse, K, et ad.1996: *Interrelation between International Bond, Density Distribution and Ultrasonic Velocity of particleboards*, Holz als Roh und Werkstoff, nr. 5/1996.
[7]. Sava, R. The Phd-thesis "*Study of physical, mechanical and technological characteristics for indigenous species of thin wood (1÷3mm) based boards"* TRANSILVANIA" University of Brasov 2004;
[8]. Schulte, M şi colectiv., 1996: *Nondestructive testing of panel products by vibration tehnique*, 10th International Symposium of Nondestructive Testing of Wood, Laussane, Switzerland.