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NON-DESTRUCTIVE TESTING TO DETERMINE ACOUSTIC PROPERTIES OF LIGNOCELLULOSES COMPOSITES REINFORCED WITH WEAVE FABRICS OF FLAX FIBERS

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Abstract: *The aim of this paper is to analyse the acoustic behaviour of lignocelluloses composites reinforced with weave fabrics of flax fibers in order to establish the proper application of them. The non-destructive used method is based on Kundt's tube in accordance with ISO 10534 standards. The experimental results in terms of absorption coefficient, reflection coefficient and impedance ratio are presented. According to variation curves of sound absorption coefficient and reflexive coefficient, the studied materials can be used in automotive components, noise reduction structures, buildings.*
Keywords: *acoustic, lignocelluloses composite, Kundt's tube, noise barriers, reflection, absorption*

1. INTRODUCTION

Designing composite materials obtained from waste or recyclable materials is a current trend in scientific research. Depending on the physical properties, mechanical and elastic that they need to hold, it can be design materials that meet the requirements of the application. This paper presents the study of acoustic properties of lignocelluloses composites reinforced with weave fabrics of flax fibers. Lignocelluloses fibres have a number of advantages compared with traditional glass fibres used to reinforce composite materials [1]. In previous work, the elastic, mechanical and dynamic properties were determined. Regarding the acoustical properties (absorption, reflection, impedance, sound transmission loss), literature review relieved numerous studies on different types of materials such polyester fibre, glass fibre and urethane foam, but about the new designed materials the references are very poor [2, 3]. To characterize the lignocelluloses composites reinforced with weave fabrics of flax fibers, the impedance tube was used in the experimental study.

2. EXPERIMENTAL SET-UP

2.1. Materials

The composite materials made of polyester resin and oak wood particles were studied. Different types of samples in term of thickness, number of layers and type of resin were performed. The plain weave fabric of flax fibres has a density per unit area of 225 g/cm2 and number of yarns per unit length is 14 yarns / cm for both directions of warp and weft yarns. The direction of the warp yarns being aligned with the length of the roll of fabric. The new lignocelluloses material was a laminate having 3 or 5 layers made of epoxy or polyester resin reinforced with plain weave fabric of flax fibres and wood sawdust of oak species. The composition of material can be seen in Figure 1. To manufacture the plate of composite material a lower forming pressure was used by hand lay-up process. The oak density was between 0.71 - 0.75 g/cm^3, but wood substance density (without cellular gaps) of the same wood species varies in the range 1.53 - 1.56 g/cm^3. For each type of composite, four samples were tested. For the experimental tests, the samples were cut into specimens with a diameter of 63.5 mm and the thickness in the range between 3 and 6 mm as can be seen in Figure 2.

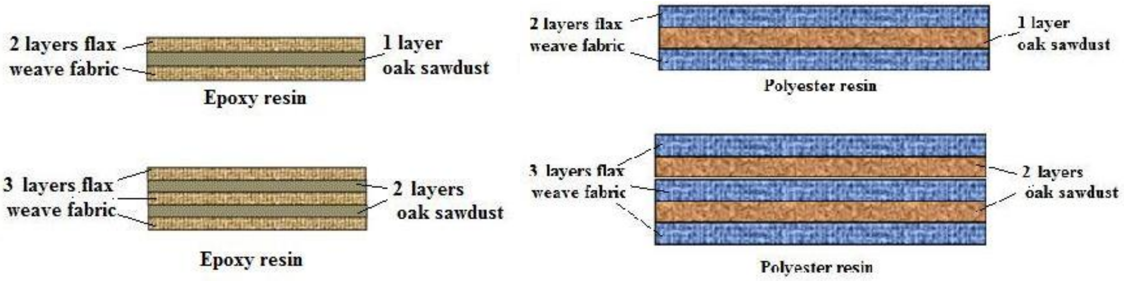

Figure 1: The structure of composite materials

Figure 2: The tested samples

The principle of the impedance tube method is based on the measurement of transfer function between two signals of microphones mounted inside the tube. In accordance with measurement chain, a loudspeaker is placed at the end of the tube as can be seen in Figure 3 [4, 5]. In our experiment we used Kundt's tube [6, 8].

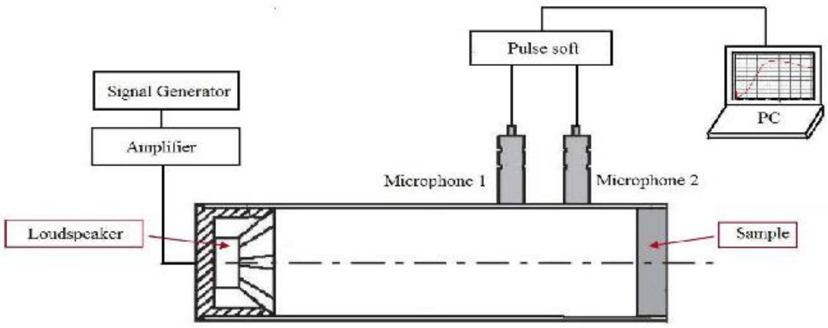

Figure 3: Schematic view of the experimental set-up

When the tube is fed by 1/3 octave frequency bands, a stationary plane wave is created and pressure measured with microphones can be decomposed into its incident and reflected components. First, the equipment without samples was prepared, in order to configure the microphones and to calibrate them using the calibration function from Pulse soft. [7] This operation is necessary because of phase and amplitude of the two microphones is not perfectly identical. In this sense the frequency response function is measured with the two microphones interchanged position. After calibration, each sample is properly inserted into the tube and the measurements started. The generated noise is connected to the amplifier and the tube filter emits the set signals. The emitted signal and reflected signal is captured by microphones and transmitted to Pulse hardware and displayed with the Pulse soft. The input data from the project set-up are established automatically by soft in the calibration stage.

Figure 4: Capture image during the measurements

2.2. Results and discussion

The sound absorption coefficient indicates what amount of sound is absorbed in the actual material and depends of the frequency type. In Figure 5, the variation of average values of sound absorption coefficient against the frequency is presented, for different materials. Generally, all tested composite recorded low values of absorption coefficient. For high frequencies, it can be noticed that the absorption varied in accordance with type of resin and number of layers. So, the lignocelluloses composites with epoxy resin tend to absorb the high sound compare with the other one with polyester resin which tends to have a constant behavior.

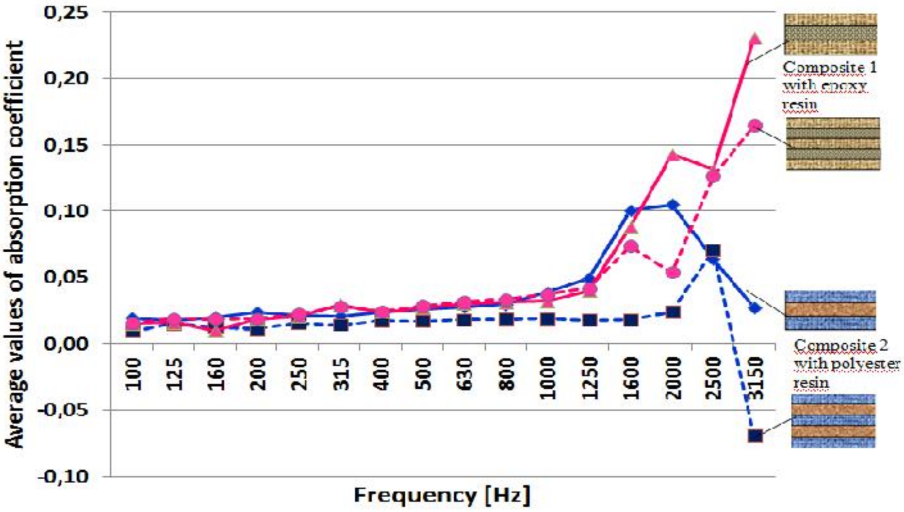

Figure 5: The average values of sound absorption coefficient of different types of materials

In Figures 6, 7, 8 and 9 the comparisons of reflection coefficients are presented. The acoustic reflection capacity characterized these lignocelluloses materials in terms of high values for frequency range between 100 and 3150 Hz. At high frequencies, it can be noticed the differences between composite with three and five layers (Figure 6).

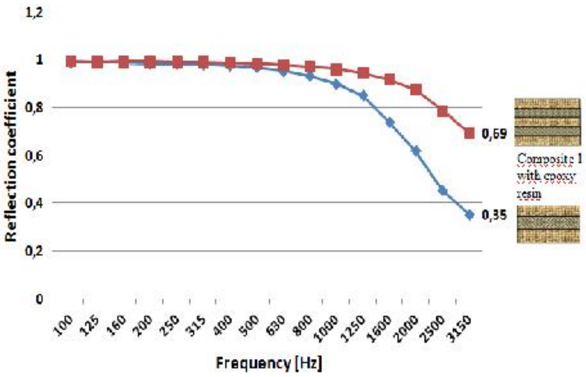

Figure 6: Comparison between the average values of sound reflection coefficient of composite with 3 and 5 layers with epoxy matrix

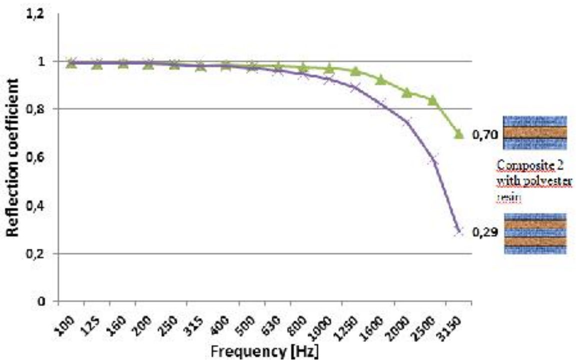

Figure 7: Comparison between the average values of sound reflection coefficient of composite with 3 and 5 layers with polyester matrix

The decreasing of reflection coefficient is more obviously for composite with five layers which express that at higher frequencies, the number of layers influences the acoustic behaviour. In Figure 8 is presented the comparison between different lignocelluloses composites in terms of type of used resin. If for the low and medium frequencies, the reflection behaviours is similarly for both types of materials, at high frequencies, the reflection of composite with epoxy resin is two time lower compared with the other one which contains polyester resin. Unlike the behavior of composites with three layers, the composites with five layers recorded the value of reflection coefficient almost twice higher for epoxy resin, as can be seen in Figure 9.

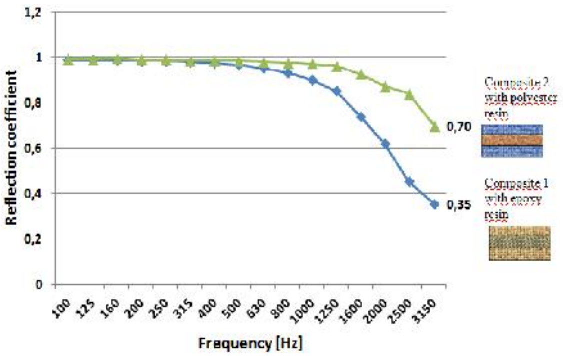

Figure 8: Comparison between the average values of sound reflection coefficient of composite with 3 layers with different matrix

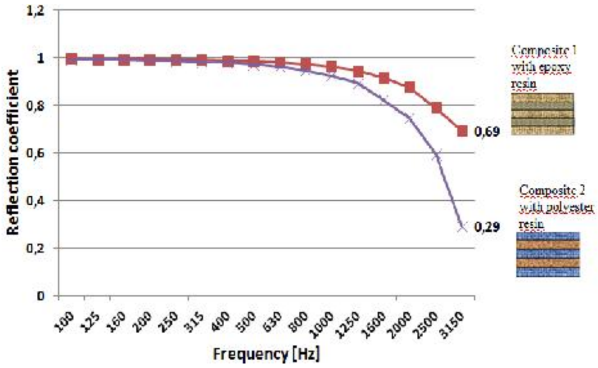

Figure 9: Comparison between the average values of sound reflection coefficient of composite with 5 layers with different matrix

3. CONCLUSION

The surface of separation between two different medium, reflection is always accompanied by a phenomenon of energy absorption. The tested composites recorded low the sound absorption at low and middle frequencies (100 - 1600 Hz). Being characterized by a good absorption coefficient for very high frequencies (ultrasonic), they are recommended for noise protection produced by industrial equipment and machine tools which emit high frequency. In this sense, it can be used in cabin structures, industrial wall and helmet or in combination with other soundproofing materials in construction of noise barriers or other structures with improved acoustic behavior.

4. ACKNOWLEDGMENTS

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REFERENCES

[1] Terciu O. M, Curtu I., New Hybrid Lignocellulosic Composite made of Epoxi Resin Reinforced with Flax Fibres and Wood Sawdust, in Rev. Materiale Plastice, Vol 49 (2) (81-132), nr. 2, iunie 2012, ISSN 0025-5289, Bucuresti, Romania, pp. 114 –117.
[2] Bratu M, Ropota I, Vasile O, Dumitrescu O, Muntean M., Research On The Absorbing Properties Of Somenew Types Of Composite Materials, In Romanian Journal Of Materials, Vol. 41, Nr. 2, 2011, P. 147-154
[3] Bratu P., Tracing Curves For The Sound Absorbing Characteristics In Case Of Composites Consisting Of Textile Materials, In Romanian Journal Of Acoustics And Vibrations, Vol 4, Nr. 1, 2007, P. 23-26
[4] Jung S.S., Kim Y.T, Lee Y. B, Measurement Of Sound Transmission Loss By Using Impedance Tubes, In Journal Of The Korean Physical Society, Vol. 53, Nr. 2, 2008, P. 596-600.
[5] Curtu I., Stanciu M. D., Cosereanu C., Vasile O., Assessment Of Acoustic Properties Of Biodegradable Composite Materials With Textile Inserts, In Rev. Materiale Plastice, Vol 49, Nr. 1, Ianuarie 2012, Issn 0025-5289, Bucuresti, Romania, Pp. 68 – 72.
[6] Youneung Lee, Changwhan Joo, Sound Absorption Properties Of Recycled Polyester Fibrous Assembly Absorbers, Autex Research Journal, Vol. 3, No2, June 2003
[7] Stanciu, M.D., Curtu I., Cosereanu C., Lica D., Nastac, S.: Research regarding acoustical properties of recycled composites, in Proceedings of the 8th International Conference of DAAAM Baltic Industrial Engineering, 19 – 21 April, 2012, Tallinn, Estonia, ISBN 978-9949-23-265-9, p. 741 - 746
[8] ***SR EN ISO 10534-1 Determination Of Sound Absorption Coefficient And Acoustic Impedance With The Interferometer, Part 1: Stationary Wave Ratio Method, 2002