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STUDY ABOUT SOUND ABSORPTION INTO CONCRETED-WOOD MATERIALS

Călin Vasile LUMEI, Mariana ARGHIR

***Abstract*:** *This paper presents sound absorption theory and measurements for a cemented wood-fiber material. An acoustical model is presented in order to determine physical properties of the concreted-wood materials. An inverse acoustical characterization is used by best-fitting the model function to the experimental data with the least squares method. The inversion method contains an optimization process and hence it is verified that the optimal unknown parameters, even though derived from a mathematical optimum for a given experimental configuration (sample's thickness, measured frequency range), are the intrinsic properties of the characterized porous material.*

Keywords: *Acoustical Impedance, Sound Absorption, Mathematical Model*

1. INTRODUCTION

In this work are presented acoustic properties of a composite material of wood shavings unwavering. Material, used when making panels for protection against noise on motorways is composed of wood chips (average area of 1 cm^2) mineralized linked to the cement.

Here have been carried out measurements of the coefficient of absorption soundtrack on a sample which has been cut out from a panel phonoabsorbtion highway, panel from the age of 10 years.

To determine the coefficient of absorption on the way analytical sound is presented a model mathematically was taken from the literature [1]. Mathematical models formulated depending on the physical properties of the environment (porosity, resistance to air passage etc.) are advantageous, because they are the parameters and the practical extent that outputs may be used to interpret experimental results. In this work these parameters will be determined by analysis.

Experimental results are presented (measurement of the coefficient of absorption) which are used to adapt the model in theory.

2. MATHEMATICAL MODEL

The objective of this work consists in learning a model mathematically with the help of which it is unable to determine Sound absorption coefficient of the material being proposed. Sound absorption coefficient can be calculated analytically if any, are known for propagation constant **k** and the characteristic impedance $\mathbf{Z_c}$ under complex shape of the material.

At the level macroscopic, porous material can be replaced with a fluid having a density equivalent dynamic $\boldsymbol{\rho(\omega)}$ and a dynamic volumetric coefficient $\mathbf{K(\omega)}$.

Dynamic density which characterizes viscous effect is associated with the section "narrow" of pore and the module dynamic volumetric that characterizes thermal effects is associated with the section "wide" of pore. Number of waveform and the impedance characteristic can be determined in accordance with relationships (1) and (2).

$$k = -i\omega\sqrt{K(\omega)/\rho(\omega)} \quad (1)$$

$$Z_c = \sqrt{K(\omega)\cdot\rho(\omega)}/\Omega \quad (2)$$

Where: ω, Ω are angular speed respectively porosity material, and $i=\sqrt{-1}$.

Once these are determined number of waveform and characteristic impedance of the material can be calculated coefficient of reflection (R) and the sound absorption (α) in accordance with relationships (3) and (4).

$$R = (Z_c/Z_0 - 1)/(Z_c/Z_0 + 1) \quad (3)$$

$$\alpha = 1 - |R|^2 \quad (4)$$

In relation (3) Z_o is the air impedance.

Due to the fact that the acoustic materials have a complex geometry of pores, the first model has described sound propagation have assumed a cylindrical shape of pore diameters. A model just for these materials with a complex shape the pore is almost impossible to formulate. They call it phenomenological models.

According to this model [1], dynamic the density *ρ(ω)* and the module dynamic volumetric *K(ω)* are given for the relations:

$$\rho(\omega) = \rho_0\alpha_\infty - (i\sigma\Omega/\omega)F(\lambda_\rho) \quad (5)$$

and

$$K(\omega) = \gamma P_0\left(1 + \frac{2(\gamma-1)}{N_{pr}^{0.5}\lambda_k\sqrt{-i}}T(\xi)\right)^{-1} \quad (6)$$

Where ρ_0, α_∞, σ are air density, tortuozity concerned resistance to air passage, and γ, P_0 şi N_{pr} are specific heat (~1.4 $JKg^{-1}K^{-1}$), atmospheric pressure (1 atm) concerned Prandtl number (~0.77).

Variable F(λρ) is given by:

$$F(\lambda_\rho) = -\frac{1}{4}\frac{\lambda_\rho\sqrt{-i}\,T(\zeta)}{\left[1 - 2T(\zeta)/\lambda_\rho\sqrt{-i}\right]} \quad (7)$$

The relations (6) and (7) contain $\xi = N_{pr}^{0.5}\lambda_k\sqrt{-i}$, and $\zeta = \lambda_\rho\sqrt{-i}$, but

$$T(\xi) = J_1(\xi)/J_0(\xi) \quad ; \quad T(\zeta) = J_1(\zeta)/J_0(\zeta) \quad (8)$$

are the ratio of Bassel functions of the order first and zero.

Sizes dimensionless λ_ρ and λ_k are given for the relations:

$$\lambda_\rho = S_\rho\left(8\alpha_\infty\rho_0\omega/\sigma\Omega\right)^{0.5} \quad (9)$$

and

$$\lambda_k = S_k\left(8\alpha_\infty\rho_0\omega/\sigma\Omega\right)^{0.5} \quad (10)$$

where S_ρ and S_k are the two factors of structure representing the dependence of viscosity and thermal dependence of porous material.

3. LABORATORY MEASUREMENTS

Coefficient Determination of audible absorption of acoustic materials considered has been carried out using a tube of impedance (Fig. 1) in accordance with a standardized method [2].

This appliance of measurement of the coefficient of absorption soundtrack is composed of a tube, which is at one end a cart on which is mounted task, and at the other end sound source. Two identical microphones for measuring sound pressure are placed in three positions have along the tube (1A, 1B, 2). The frequency range for which the results of the measurements are real (for this tube of impedance) is between 100 - 2000 Hz.

Equipment for signal processing consists of an amplifier and a system of Fourier analysis. The determination of the sounds absorption coefficient was made using the transfer function method (ISO 10534-2:1996) [2]. This method is based on the fact that sound reflection factor R can be determined using the transfer function between the two microphones, after which it is calculated the absorption coefficient soundtrack depending on frequency.

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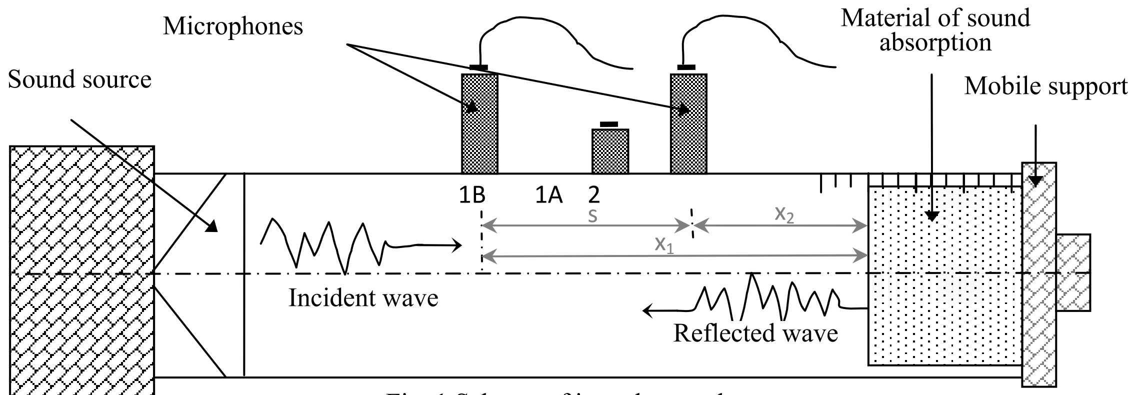

Fig. 1 Scheme of impedance tube

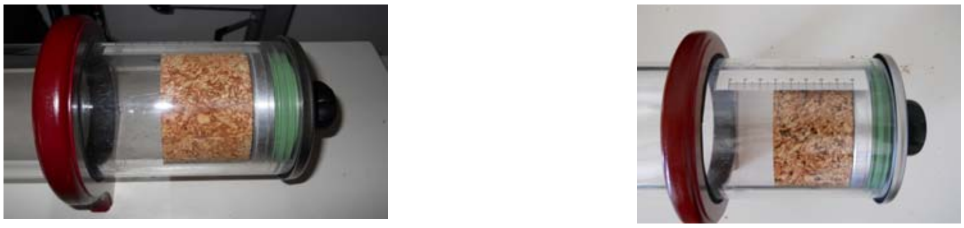

Fig. 2 Samples taken from wood chips concreted

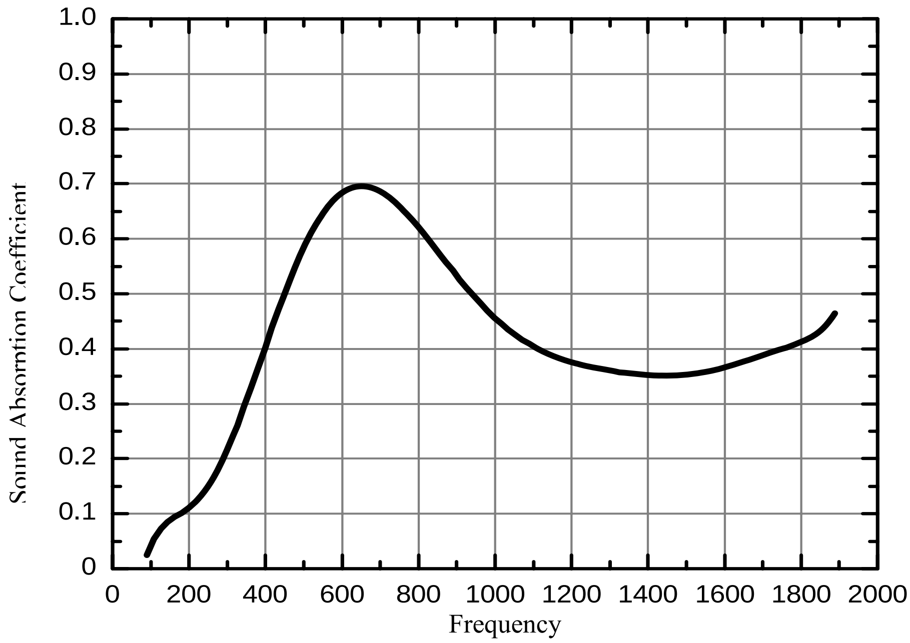

Fig. 3 Curve of sound absorption

microphones, after which it is calculated the absorption coefficient soundtrack depending on frequency.

Measurements have been carried out in two samples of wood chips unwavering (Fig. 2) Having a thickness of 50 mm, after which it has been, calculated average of the absorption coefficient soundtrack. In figure 3 is displayed in the graphic media Sound absorption coefficient of the material in wood chips concreted. In the figure 4 there are presented the two possibility of the absorption coefficient evaluation: first is measurement result and the second contains the computed result. The results are in the same scale of values for the theory and the measurement.

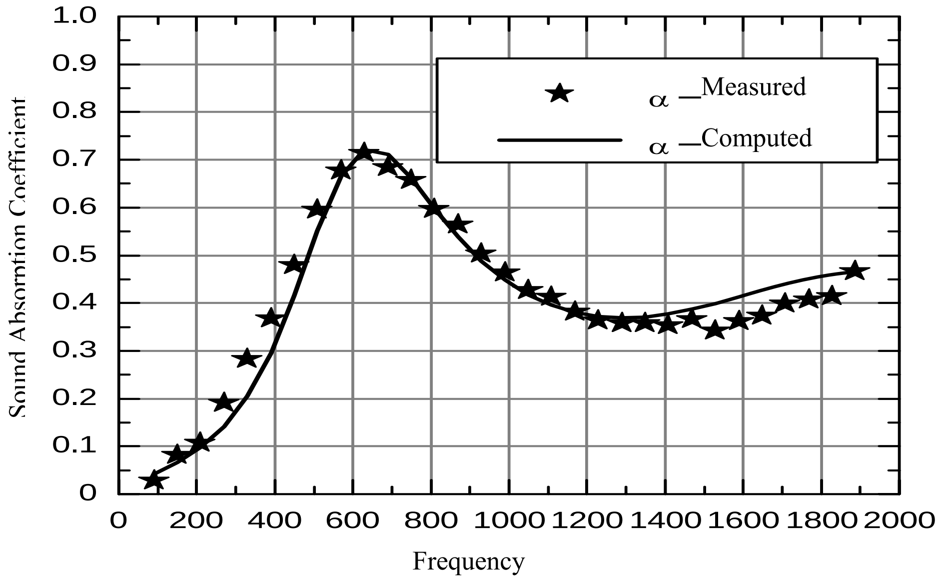

Fig. 4 Curve of sound absorption (α^c and α^m)

4. CONCLUSIONS

In this paper has been carried out the measurements of sound absorption coefficient for a material phonoabsorbant made from wood chips concreted.

It is presented a mathematical model for the determination of the absorption coefficient soundtrack.

Using the method of least squares was carried out an adjustment in the mathematical model to experimental results to determine unknown parameters you have mathematical model.

Are the results real values of the parameters adjust it? Materials manufactured from wood chips concreted in general have a porosity of between 0.3 - 0.4; Porosity resulting is 0.34 which corresponds to fields are being cataloged.

5. BIBLIOGRAPHY

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STUDIUL COEFICIENTULUI DE ABSORBȚIE ÎNTR-UN MATERIAL DE FIBRE DE LEMN CEMENTATE

Rezumat : Lucrarea prezinta două metode de determinare a coeficientului de absorbție într-un material din fibre de lemn cementate. Cele două metode constau din: o metodă teoretică bazată pe teoria celor mai mici pătrate, iar cea de a doua este o metodă experimentală de determinare (măsurare) al coeficientului sonor de absorbție într-un tub de impedanță acustică. Cele două metode dau rezultate identice, deci se validează una cu alta.

Călin Vasile LUMEI, PhD. Stud., Eng., Department of Mechanics and Computer Programming, Faculty of Machines Building, Technical University of Cluj-Napoca, Tel: (+)40.264.401.759;

Mariana ARGHIR, Prof. Dr., Mech. Eng., Department of Mechanics and Computer Programming, Faculty of Machines Building, Technical University of Cluj-Napoca, Tel: (+)40.264.401.657.