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ATTENUATION OF NOISE POLLUTION IN AN INDUSTRIAL HALL, THROUGH THE SOUND-ABSORBING PANELS MADE FROM TREE BARK

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Abstract: *The paper presents numerical simulation of sound attenuation average pollution in an industrial Hall by using MATLAB Simulink package programme. The pollutant is mounted a sound-absorbing panel consisting of tree bark from different species in the mix, which has a wall thickness of 10 cm and 50 cm. The study shall be carried out at frequencies of 125Hz, 250Hz, 500Hz, 4000Hz, and 1000 Hz within, for as these are frequent cleaner producing auditory organ diseases of human operator.*

Key words: *attenuation of noise pollution, industrial hall, sound-absorption panel, tree bark.*

1. INTRODUCTION

Sound pollution in industrial halls produces imbalances throughout the body in human with temporary or permanent effects [3]. It produces sleep disturbance, anxiety, depression, heart rhythm disorders, neurosis, glandular poison, muscle hypertonia, hyperactivity and especially sensorineural hearing loss or perception.

Worldwide, it is estimated that 500 million people suffer from some form of hearing loss. Financial cost of noise to society is estimated as being between 0.2-2% of GDP [1].

2. THEORETICAL CONSIDERATIONS

Studies on the possibilities of noise absorption, deep vegetable regn was presented in the [1] that the fact of the plants, they can be used as a sound attenuator, through absorption, reflection, refraction, diffraction through both closed environments (inside industrial buildings, the case of approach towards), and outside, if the plants are arranged under form of the curtains before major sources of noise in an industrial enterprise.

The paper shows the realization of simulation in MATLAB Simulink of sound absorption by a curtain from the bark of the tree, which represents a phonoabsorbant barrier in the path of an industrial machine that produces a strong sound pollution.

The purpose of the simulation of sound absorption by the sound-absorbing panel must know: the coefficient of absorption, transmission coefficient and reflexive coefficient. The sum of the three coefficients is unitary for the same type of material.

For tree bark absorption coefficient is estimated experimentally and it is centralized in table 1 for various frequencies.

Table 1.
Absorption coefficient for tree bark

	Absorbtion Coefficientul					
Frequency [Hz]	125	250	500	1000	2000	4000
Tree bark	0,05	0,16	0,26	0,46	0,73	0,88

The transmission coefficient is estimated approximately from [4], with the relation:

$$A_{gr} = 4{,}8\, f - \left(\frac{2h_m}{d}\right)\left[17 + \left(\frac{300}{d}\right)\right] \geq 0\ [dB] \quad (1)$$

In this relationship the notations significance is: A_{gr} – the absorption coefficient is centralized in table 1; h_m – transmission coefficient; d – the distance from the source; f – source frequency.

For tree bark is determined the transmission coefficient using the relationship (1) and with the use of the coefficient of absorption centralized in table 1. The result is given in the table 2.

Table 2.
Transmission coefficient for tree bark

	Transmission Coefficientul					
Frequency [Hz]	125	250	500	1000	2000	4000
Tree bark	0,23	0,21	0,20	0,15	0,05	0,06

2.1. Absorption of Sound Waves

Studies on the absorption of sound waves moving through the different mediums, and is exponentially diminution depends on sound-absorbing material of the panel.

Sound waves are hitting the barrier/veil from plant material. Here they suffer some transformations:

- some of these are reflected and return to the environment from which they came, where form stationary waves, with the incident waves;
- part of them are absorbed by the deep noise barrier. In table 1 is the coefficient of absorption;
- another part crosses barrier and transmission coefficient depends on the frequency of the source;
- part of them diffract, or refract to the surface barrier/veil. What is here, but they form together the coefficient of reflection.

Between the absorption coefficient - labeled "a"; - the transmission - labeled "t" - and the coefficient of reflection - labeled "r" - there are a linear relationship. Their sum is constant and equal with "1".

$$1 = a + t + r \qquad (2)$$

The sound wave propagates after law:

$$p(x,t) = \begin{cases} \left(A \cdot e^{-a_1 \cdot x} \cdot \cos\left(\omega t - \frac{\omega}{c} \cdot x\right)\right) & \text{if } x \le x_0 \\ \left[(1-r) A \cdot e^{-a_1 \cdot x_0} \cdot e^{-a_2 (x - x_0)} \cdot \cos\left(\omega t - \frac{\omega}{c} \cdot x\right)\right] & \text{if } (x > x_0 \wedge x < x_1) \\ \left[(1-r) \cdot \tau \cdot A \cdot e^{-a_1 \cdot x_0} \cdot e^{-a_2 (x_1 - x_0)} \cdot e^{-a_3 (x - x_1)} \cdot \cos\left(\omega t - \frac{\omega}{c} \cdot x\right)\right] & \text{otherwise} \end{cases} \qquad (3)$$

Oscillation amplitude variation has the expression:

$$A_{dl}(x) := \begin{cases} A \cdot e^{-a_1 \cdot x} & \text{if } x < x_0 \\ (1-r) \cdot A \cdot e^{-a_1 \cdot x_0} \cdot e^{-a_2 \cdot (x - x_0)} & \text{if } [(x \ge x_0) \wedge (x < x_1)] \\ (1-r) A \cdot e^{-a_1 \cdot x_0} \cdot e^{-a_2 \cdot (x_1 - x_0)} \cdot e^{-a_3 \cdot (x - x_1)} & \text{otherwise} \end{cases} \qquad (4)$$

3. SIMULATION OF NOISE POLLUTION ABSORPTION THROUGH THE VEGETABLE PANEL

It will analyze the plant panel of sound-absorbing made by tree bark, with wall thicknesses: 10cm, 50cm, at the frequency source equal with: 125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz, and 4000Hz. The graphical representations are given in the following figures.

3.1. The Barrier from the Bark of the Tree with the Thickness of 10 cm

Each representation of only one frequency is shown in a figure in the following sequence. In the figure 1 is given for 125Hz, in the figure 2 is given for 250Hz, in the figure 3 for 500Hz, in the figure 4 for 1000Hz, in the figure 2000Hz, and in the figure 6 for 4000Hz.

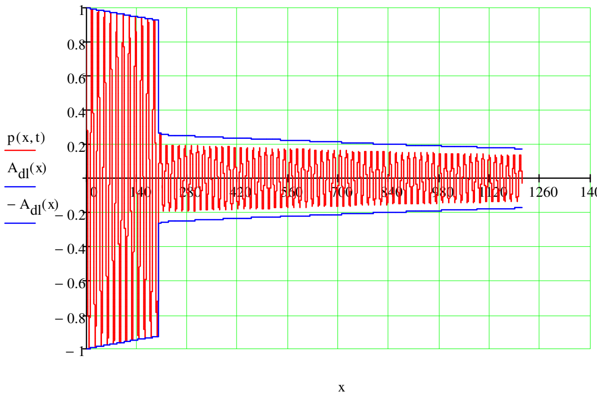

Fig. 1. Attenuation due to the barrier of 10 cm from the bark of the tree, at the 125Hz frequency

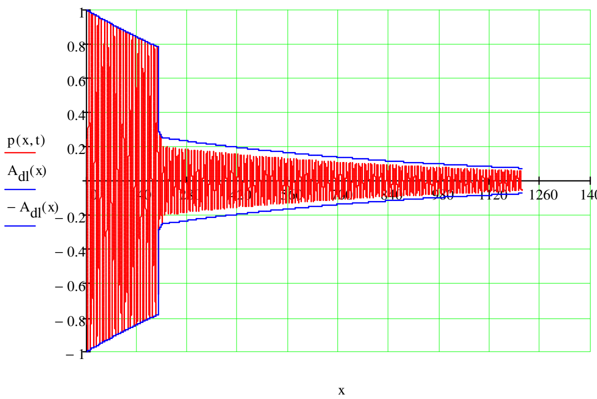

Fig. 2. Attenuation due to the barrier of 10 cm from the bark of the tree, at the 250Hz frequency

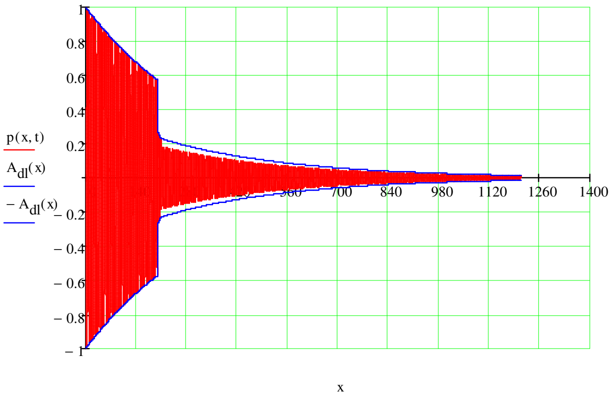

Fig. 3. Attenuation due to the barrier of 10 cm from the bark of the tree, at the 500Hz frequency

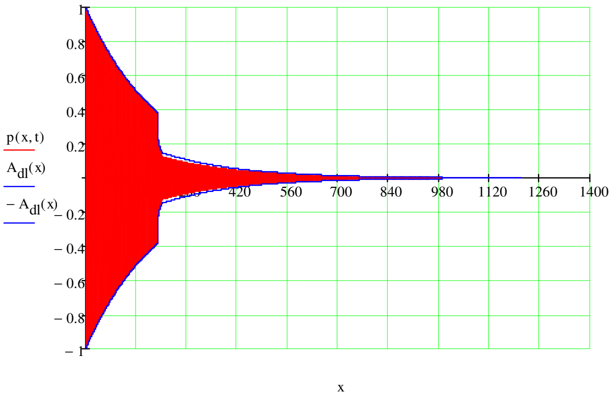

Fig. 4. Attenuation due to the barrier of 10 cm from the bark of the tree, at the 1000Hz frequency

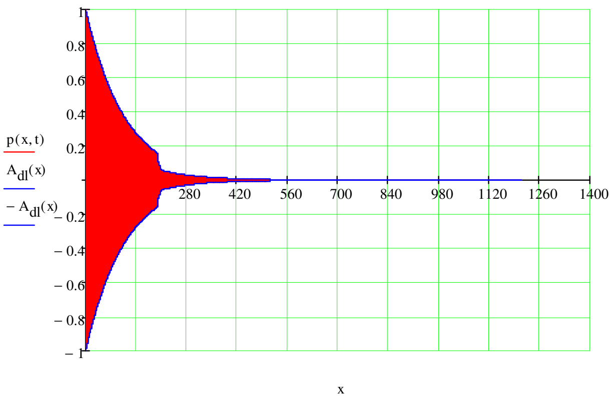

Fig. 5. Attenuation due to the barrier of 10 cm from the bark of the tree, at the 2000Hz frequency

3.2. The Barrier from the Bark of the Tree with the Thickness of 50 cm

Each representation of only one frequency is shown in a figure in the following sequence, between 7 and 12.

4. CONCLUSIONS

From sound-absorbing panels for representations made from tree bark they can:

1. The bark of the tree is a powerful noise attenuator, function of the frequency;
2. Attenuation is stronger for higher frequencies and more diminished for lower frequencies;
3. There were some anomalies in the situation: the frequency of 125 Hz and the thickness of the barrier of 50 cm, is less compared to previous statements, which means that the sound waves and not to bypass the barrier.

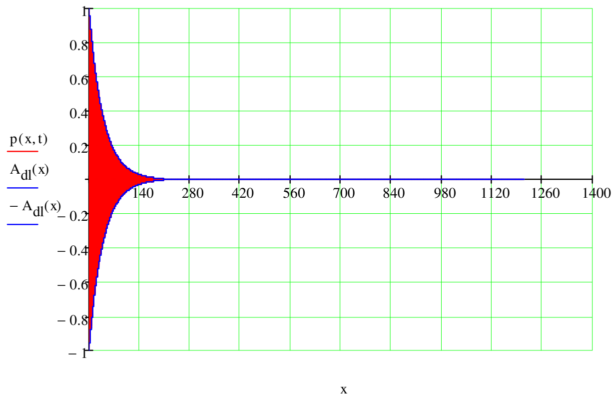

Fig. 6. Attenuation due to the barrier of 10 cm from the bark of the tree, at the 4000Hz frequency

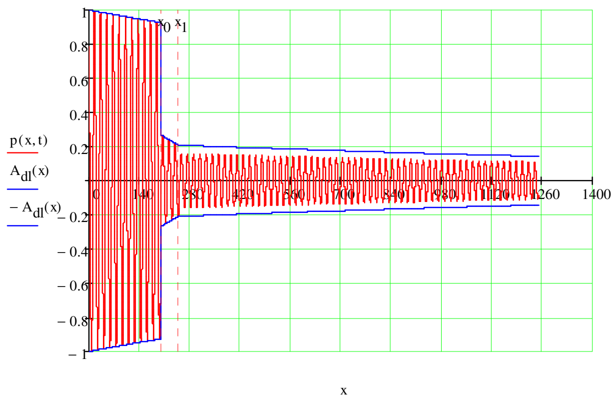

Fig. 7. Attenuation due to the barrier of 50 cm from the bark of the tree, at the 125Hz frequency

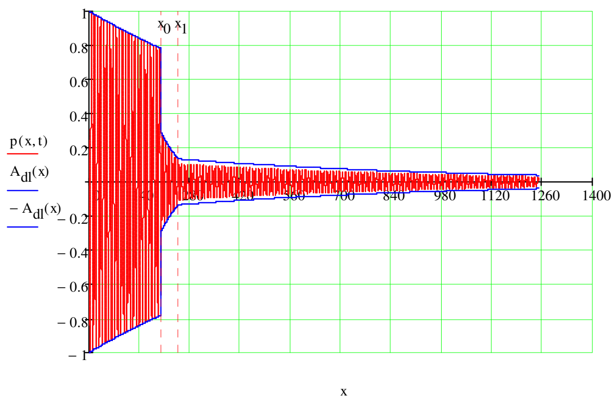

Fig. 8. Attenuation due to the barrier of 50 cm from the bark of the tree, at the 250Hz frequency

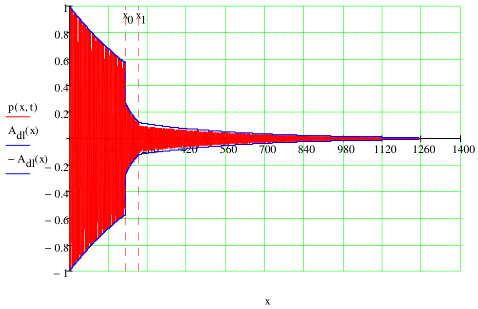

Fig. 9. Attenuation due to the barrier of 50 cm from the bark of the tree, at the 500Hz frequency

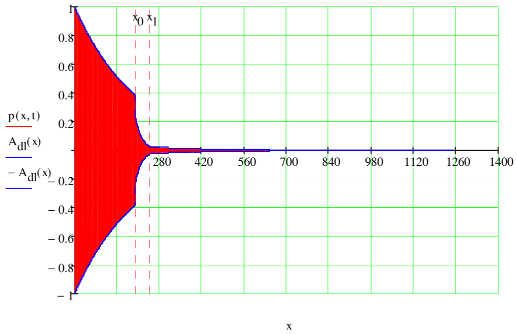

Fig. 10. Attenuation due to the barrier of 50 cm from the bark of the tree, at the 1000Hz frequency

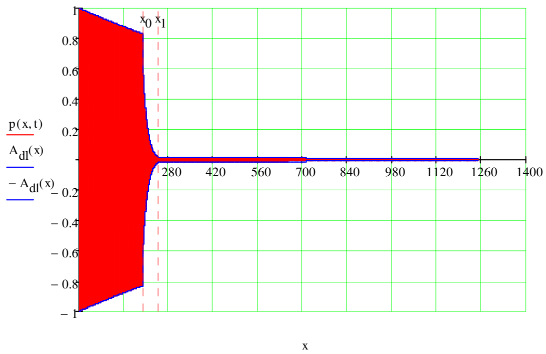

Fig. 11. Attenuation due to the barrier of 50 cm from the bark of the tree, at the 2000Hz frequency

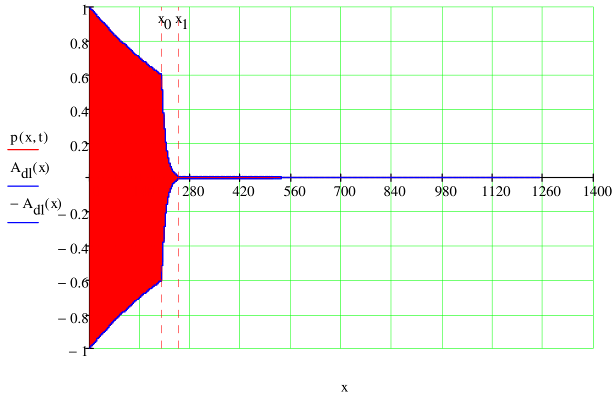

Fig. 12. Attenuation due to the barrier of 50 cm from the bark of the tree, at the 4000Hz frequency

5. REFERENCES

[1]http://www.ecophon.com/en/resources/acoustic-knowledge-bank/Basic-Acoustics/Sound-absorption;

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[3] Arabela LUNGU, Mariana ARGHIR, Studii şi cercetări privind poluarea sonoră în halele industriale, *„Conferinţa Internaţională Multidisciplinară „Profesorul Dorin Pavel – fondatorul hidroenergeticii româneşti*”, Sebeş, 6 – 7 iunie 2014, Ştiinţă şi Inginerie, ISSN 2067-7138, An XIV, Vol. 26 / 2014, pag. 191-198, Ed. AGIR;

[4] ISO 9613-2, Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation, 1996.

Atenuarea poluarii sonore intr-o hala industriala, prin montarea unor panouri fonoabsorbante realizate din scoarta de copac

Rezumat: Lucrarea prezintă simularea numerica aproximativa a atenuarii poluarii sonore intr-o hala industriala prin utilizarea pachetului de programme MatLab Simulink. In zona poluantului se prevede montarea unui panou fonoabsorbant format din scoarta de copac de diferite specii in amestec, care are grosimea peretelui de 10cm si de 50 cm. Studiul se efectueaza la frecventele de 125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz si 4000Hz, pentru ca acestea sunt frecventele poluante si care produc afectiuni asupra organului auditiv al operatorului uman

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