REDUCING NOISE POLLUTION BY USING NEW TYPES OF ECOLOGICAL COMPOSITE MATERIALS

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Abstract

Industrial activities cause important environmental changes. It is relevant to observe that the impact of industrial activities on the environment depends on the type of technological process and on the product that is obtained, or on the efficiency of pollution control technologies [1].

A known source for environmental pollution in urban areas or at the workplace is noise. Sound pressure level produces harmful effects on human health. There are several studies that have investigated noise pollution [2] determining the World Health Organization [3] to warn, to raise awareness and to promote actions against noise pollution. This paper aims to introduce innovative systems that absorb and attenuate the noise from industry, urban or extra-urban environment efficient and sustainable based on composite made by recycling solid waste [4].

Research regarding absorptive properties of new types of ecological composite materials, composed of reinforcement materials from various wastes is presented in this paper.

Are presented research on the absorbing properties of new types of ecological composite materials, which are based on use as reinforcement material of various wastes, which can affect the environment. Absorption sound capacity for new composite materials varies depending on the proportion and of the nature of the waste that is used.

Both the absorbtion capacity for each composite materials represented by the absorbtion coefficient and the influention of the reinforcement material are presented in this paper.

Thus the worldwide was taken a series of measures to reduce noise, as in the environment, and jobs.Upon joining the EU, our country is required to align the relevant legal provisions that are regulated by a series of measures to limit noise [5].

Keywords : composite materials, sound absorbing properties, absorption coefficient

Introduction

Over the years there have been some concerns about obtaining some types of materials with superior properties to conventional (composite) that could be used to cover various fields including the reduction of environmental pollution and noise. Pollution, as it is known, represents the contamination of the environment with materials that harm the human health, the quality of life and natural ecosystems functioning.

Although some environmental pollution is the result of the nature actions, the rest of it is mostly caused by human activity. The industrial activity cause important changes on the environment. The impact of industrial activities on the environment depends on the technological process and on the product obtained or on the effectiveness of pollution control technologies [6].

The noise is a sound vibration without well-defined components, an annoying sound, a irregular sound or more different frequencies that overlap. The noise is a source of pollution in the natural environment and in the working environment.

Sound pressure levels in urban areas have produced harmful effects on human health. There have been several studies regarding the reduction of sound pressure level. As a result several measures have been taken in order to reduce noise, both in the natural environmental and at the workplace. Being part of the EU, our country is obliged to respect the legal provisions that regulate a series of measures for the reduction of noise.

Research regarding absorptive properties of new types of ecological composite materials, composed of reinforcement materials from various wastes is presented in this paper.This paper aims to introduce innovative systems to absorb and sound attenuation. Are presented research on the absorbing properties of new types of ecological composite materials, which are based on use as reinforcement material of various wastes, which can affect the environment.

Compared with conventional materials, a composite material incorporates different wastes that may affect the environment. A composite material is achieved when two or more materials in combination, lead to a product with superior properties. There are studies on the absorbing properties of new types of organic composite materials, which are based on use as reinforcement material of various wastes, which may affect the environment.

Experimental part

Tests were made on a sample representing a sound absorption barrier made of composite material containing polyester resin in proportion of 50% representing the polymer matrix reinforced with waste from rubber powder wich represent the other 50%. Rubber powder is obtained through process of recycling used tires and rubber waste resulted in the process of processing of rubbers formed polymers for general use (natural stirenbutadienic, isoprene) [7]. Rubber granules have a particle size between 1-3 mm granular mass without looking black impurities, density at 20 ° C given by the supplier, 1.2 ± 0.3 g/cm3, ignition temperature 300 ° C and are not dangerous for man or nature [8].

The reinforcement material, in this case the rubber powders is dried before dosing and the result is a total moisture W_t = 12.69 %. The humidity and granulometry of reinforcement material was performed according to standards SR ISO 5264/95 and SR ISO 2591-1. The sample is obtained using a process of working through the mix of resin and rubber powder.

The test was performed in an anechoic chamber (deaf) on a sample with the following dimensions (figure 1) : L1 - length of wall = 1.32 m, L2 - length source - wall = 1.62 m; L3 – length wall - receiver = 1m; H1 - height wall = 1.07 m, H2 - height which is the source = 0.75 m, H3 - height which is the receiver = 1 m, H4 - height which is wall = 0.5 m, H5 - H1 + H4 = 1.57 m.

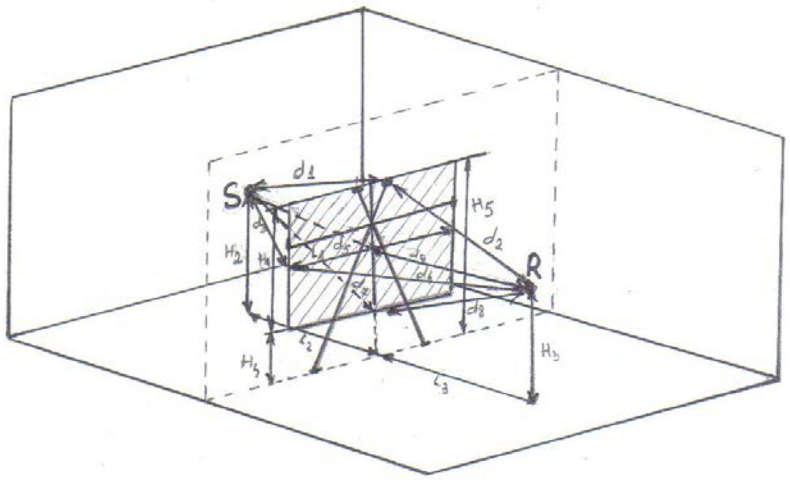


Figure 1 Anechoic chamber with the source diagram - barrier - receiver

Having the experiment from the anechoic chamber (deaf) the mathematical modeling of sound pressure level was made by simulating the use of absorbing noise barriers and drawing a noise map that represents an area for industrial sources. Noise maps are presented in Fig 2 and 3 for an industrial area at the initial moment (Figure 2) without acoustic barrier and in the next moment (Figure 3) after interposing between the source and the receiver the absorptive barrier surrounding the industrial area.

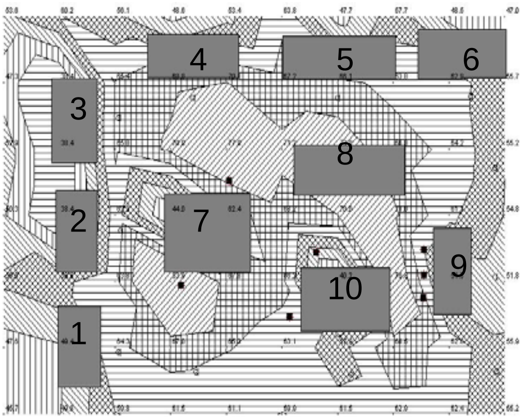


Figure 2 Industrial area without fonoabsorbing barrier

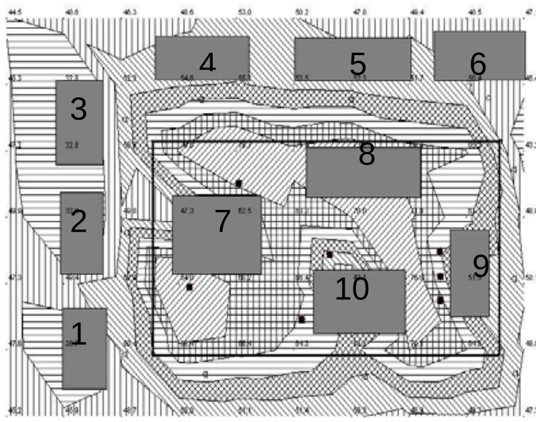
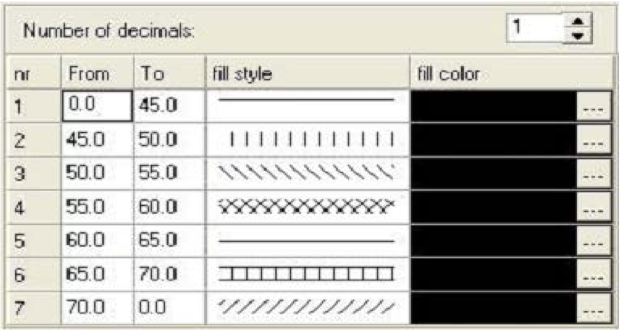


Figure 3 Industrial area with fonoabsorbing fonoabsorbing barrier

The next figure is presented the legend with different fields marked representing the range of sound pressure level in decibels.



Number of decimals: 1

nr	From	To	fill style	fill color
1	0.0	45.0		
2	45.0	50.0		
3	50.0	55.0		
4	55.0	60.0		
5	60.0	65.0		
6	65.0	70.0		
7	70.0	0.0		

Figure 4. Legend with fields marked different

Results and discussion

Measurements of noise level having frequencies between 250 - 8000 Hz at the initial moment without barrier have been taken, then the sample consisting from the sound absorption barrier was interposed between source and receiver.

In figure 5 are presented the values of the sound pressure level depending on each frequency measured at the initial moment without acoustic barrier.

Frequency (Hz)	Sound pressure level (dB)
250	82
500	88,5
1000	82
2000	86,5
4000	97
8000	86,5

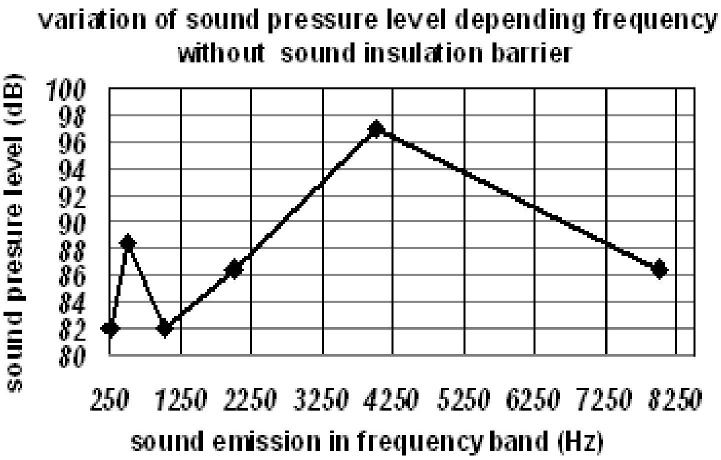


Figure 5 Variation of sound pressure level without barrier

After obtaining the above values interposition barrier between source and receiver was realized. Figure 6 presents the values of sound pressure level based on frequency at the next moment, when the acoustic barrier was interposed between the source and receiver.

Frequency (Hz)	Sound pressure level (dB)
250	85
500	84
1000	71
2000	69
4000	72
8000	68

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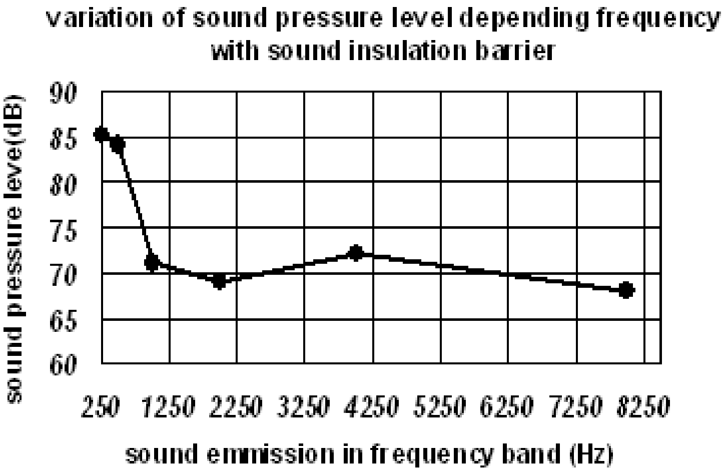

Figure 6. Variation of sound pressure level with sound insulation barrier

In order to calculate the diffraction coefficient were taken into account the equation of Moreland and Musa [9] where N is the number of Fresnel:

$$(1) \quad p_{b2}^2 = p_{d2}^2 \sum_{i=1}^{n} \frac{1}{3+10N_i} \qquad (2) \quad N_i \equiv \frac{2\delta_i}{\lambda}$$

Distances from d_1 to d_8 (shown in figure 1) were calculated. These distances represent the length between the sources, the edges of the barrier and the receiver; the values that are obtained are shown in Table 1 in meters. The Fresnel number was calculated using values from Table 1. For the determination of δ_i was used the difference between the direct and the diffracted part between the source and receiver.

(3) $\delta_1 = [(d_1 + d_2) - (d_5 + d_6)]$ $\delta_2 = [(d_3 + d_4) - (d_5 + d_6)]$ $\delta_3 = [(d_7 + d_8) - (d_5 + d_6)]$ (m)

The next values resulted: δ_1 = 0.35 m; δ_2 = 0.33 m; δ_3 = 0.14 m;

Wavelength λ represent the speed of sound waves propagated in air c = 343 m / s reported at frequency f. In Table 2 are presented values of wavelength for each frequency. (4) $\lambda = \frac{c}{f}$ (m)

Table 1. Distaces d_1- d_8 source –barrier edges -receptor

d_1	1.82
d_2	1.15
d_3	1.75
d_4	1.2
d_5	1.62
d_6	1
d_7	1.64
d_8	1.12

Table 2. Calculated values for wavelenght determination frequency

Frecventa (Hz)	λ = 343/f (m)
250	1.372
500	0.686
1000	0.343
2000	0.1715
4000	0.0857
8000	0.0428

The Fresnel number N, was calculated taking into account the wavelength value at each frequency: for 250 Hz : N1 = 0.51, N2 = 0.48, N3 = 0.2 ; for 500 Hz : N1 = 1,02, N2 = 0.96, N3 = 0.4 Hz ; for 1000 Hz : N1 = 2, N2 = 1.92, N3 = 0.81; for 2000 Hz : N1 = 4.08, N2 = 3.84 , N3 = 1.63, for 4000 Hz : N1 = 8.16, N2 = 7.7, N3 = 3.26; for 8000 Hz : N1 = 16.35, N2 = 15.42, N3 = 6.54 .

With Fresnel number N calculated according to Moreland and Musa equation we can then calculate the diffraction coefficient, a physical phenomenon defined by sound waves encountering an obstacle, diffraction coefficient is calculated using the following equation: (5) $D = \sum_{i=1}^{n} \frac{1}{3+10N_i}$

In the next figure is presented the diffraction coefficient of variation depending on working frequency.

Frequency (Hz)	Diffraction coefficient
250	0.45
500	0.3
1000	0.2
2000	0.1
4000	0.05
8000	0.03

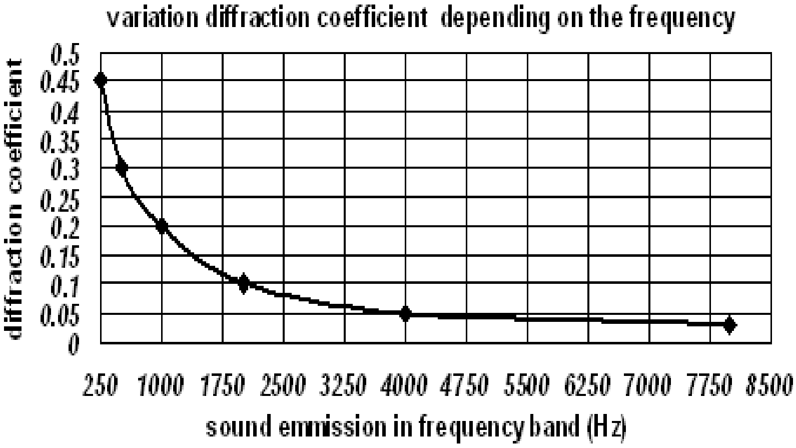

Figure 7. The diffraction coefficient of variation depending on working frequency.

Using an absorptive barrier like this one in an industrial area has lead to the mathematical modeling of sound pressure level, realized by simulation on a computer program designed to draw noise maps (from Brüel & Kjǽr, Predictor Type 7810).Geometric shapes with numbers from 1 to 6 shown in Figure 5-6 represent the houses that surround the industrial area, respectively the receptors from 7 to 10 are numbered the buildings belonging to the black points represent noise sources, the values of noise level at each frequency are determined using a sound level meter with filter 1 / 1 octave.

Initially (without sound absorption barrier - Figure 5.) sound pressure level values at the receptor was from 60 to 66 dB. Because the limit value indicated by the STAS 10009/88 is 55 dB at home, placing an absorptive barrier between the source and the receptors was the next step (Figure 6.). A significant reduction in noise level up to between 50 to 54.5 dB can be observed.

Conclusions

- in this paper are presented the results from the sound absorption test performed in a silent chamber on a composite material sample.
- It was obtained a new type of material composed of polyester resin in proportion of 50% representing the polymer matrix, reinforced with rubber waste in proportion of 50%.
- It is used as reinforcement material rubber powder having between 1-3 mm. This powder is a non-biodegradable waste that can affect the natural environment.
- the diffraction coefficient decreases proportionally with the increasing of the operating frequency.
- a reduction of sound pressure level due to absorptive properties of the new type of composite material was observed.
- the simulation program confirms the utility of these materials created for manufacture of sound-absorbing barriers in order to reduce the noise level in the industrial areas and also to respect the actual legislation.

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