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EVALUATING THE EFFICIENCY OF RECYCLING COMPOSITE PANELS MADE FROM ABS TO REDUCE THE TRAFFIC NOISE

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Abstract: *Aim of the study is to determine the capacity of sound insulation composite panels made from recyclable waste from acrylonitrile butadiene styrene (ABS). Sound insulation index was calculated as the difference between the sound pressure level measured at the source and the sound pressure level measured at the point of reception. Tests were conducted in the open, with a fixed omnidirectional sound source, acoustic panels was found that the efficiency depends on a number of geometrical and structural parameters such as: distance between source and noise barrier made of composite material based on ABS (DS1 = 2 m, DS2 = 4 m), noise emitted by the source (LAeq1 = 100 dB (a), LAeq2 = 103 dB (a)) and the distance between the barrier and the receivers are in a position collinear with the source (DR1 = 2m = 4m DR2, DR3 = 6m). It was found both materials of sound barriers and distance between source and receptors influence the efficiency of noise reduction.*
Keywords: *waste, acrylonitrile butadiene styrene, noise reduction*

1. INTRODUCTION

In the current context of the excessive use of plastic materials and the metal - hard degradable, increasing levels of environmental pollution and global warming problems caused by excessive industrialization, there is a tendency to produce new materials, particularly composites with reduced environmental impact that use waste from other manufacturing processes and the end of its life to be easily recyclable and biodegradable. Some application of these materials can be sound absorption panels used both for traffic noise reduction and acoustic insulation of buildings [1, 2]. Acoustic barriers acts as a noise filter media having different acoustic properties, depending on the level of noise produced by sound source, materials of acoustic panels from barrier structure and position of receptors reported of sound barriers. The acoustic barrier structure may contain porous medium materials which absorb high and medium frequency or resonator materials, in which case absorption is producing through a resonance mechanism, being selected only certain frequencies of the sound field. In this paper we propose a new absorbing panels obtained by recycling acrylonitrile butadiene styrene (ABS) resulting from machining edges of furniture [3, 4]. The chips of acrylonitrile butadiene styrene (ABS) were placed in a rectangular mold and pressed at temperature of 100 - 110 ° C for 10 minutes to give plates with dimensions of 300x300xh mm (h = 20 .... 35 mm). The chips bonding were achieved by melting of ABS which creates a physical adhesion between molecules when the melting point temperature was reached. The new material was evaluated from acoustical properties point of view both in laboratory with impedance tube and in free field.

a) b) c) d)

Figura 1: Technological steps of panels performed from acrylonitrile butadiene styrene (ABS) in laboratory conditions: a) ABS edge milling; b) ABS chips – residues; c) pressing mat chips; d) getting panels

2. DETERMINATION OF SOUND ABSORPTION COEFFICIENT

2.1. Method and materials

The impedance tube method or Kundt tube was used to determine the sound absorption coefficient, which test procedure is described in EN ISO 10534-1:2005, [4, 6]. Theoretical principle of the method is based on assessment of stationary plane wave field propagated in a tube. The sound waves decompose in incident and reflected waves at the meeting of sample (Figure 2). Values of sound pressure levels of minimum and maximum are measured for four tested samples. Before the measurement, the device was calibrated. Specimens obtained by pressing ABS chips were cut circular with a diameter of 63.5 mm. Initial sound pressure is measured by the microphone 1 and the reflected sound pressure by sample is measured with microphone 2. The signals are processed with signal analyzer program performed in Pulse platform. The physical characteristics of tested specimens are shown in Table 1..

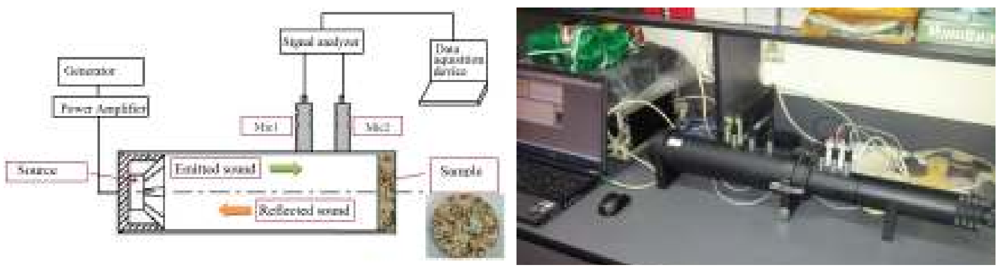

Figure 2: Experimental set-up

Table 1: Table caption

Column 1	Thickness h [mm]	Mass m [g]	Density ρ [g/cm^3]
Sample 1	14	13,11	0,296
Sample 2	15	14,31	0,301
Sample 3	13	15,92	0,387
Sample 4	14	14,24	0,321

2.2. Results and discussion

Sound absorption coefficient indicates the ability of the material to absorb sound waves with different frequencies. The coefficient of absorption of a material varies depending on the frequency and angle from which a sound or sound wave reaches the material. In Figure 3 it is noted the variation of sound absorption coefficient for composite based on ABS waste. The values of absorption coefficient of these materials ranks among those with good soundproofing properties (class B), making them comparable to other types of composites made from industrial waste.

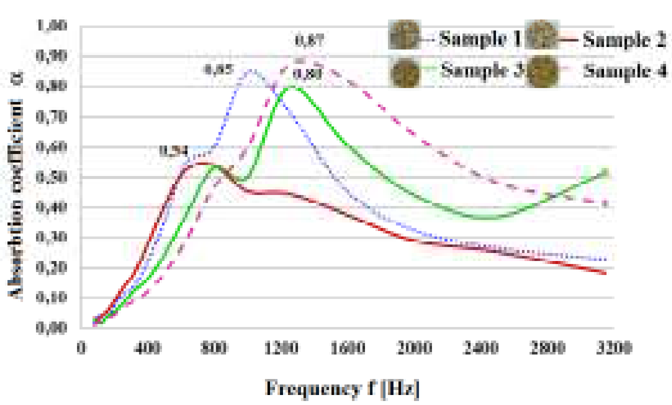

Figure 4: The variation coefficient of absorption of the waste ABS composites

3. PERFORMANCE ASSESSMENT OF NOISE REDUCTION BY COMPOSITE PANEL MADE FROM ABS RESIDUES

3.1. Experimental set-up

In order to test the new composite structure was made the experimental stand consisting of a mobile metal frame and with the option of turning the panel to the vertical plane in both directions, an OSB panel to a support plate for absorbing panels, composite plates with absorption role [5]. Noise from sound level meter B&K 2260 Investigator is amplified by the power amplifier and transmitted by omnipower source. Source emits noise at a predetermined noise level (N1 = 100 dB (A) and then N2 = 103 dB (A)). Between source and receiver represented by the sound level meter B&K2250 Light acoustic barrier is located (Figure 5). Acquired data were processed and visualized with the program B&K 7815 Noise Explorer. The experiment was performed in open field, with a fixed source. Sound insulation index was calculated as the difference between the sound pressure level measured at the source and the sound pressure level measured at the point of receivers, according to the diagrams shown in the Figure 6.

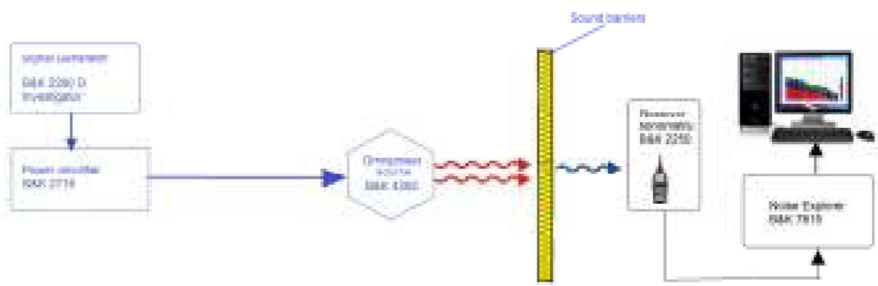

Figure 5: Experimental set-up of acoustic test in open field

Acoustic performance of tested panels was evidenced by identifying the influence of the distance between source and noise barrier made of composite material based on ABS (DS1 = 2 m, DS2 = 4 m), the influence of noise emitted by the source (LAeq1 = 100 dB (a) LAeq2 = 103 dB (a)) receptors, the influence of distance between the barrier and receivers placed on different distance (2; 4; 6 m) (Figure 6).

Figure 6: Position of source and receiver to the sound barrier

3.2. Results and discussion

It was found that the sound pressure level in the three measuring points is about 20 ... 22 *dB* less than the amount emitted by the source, then the panel sound absorption index falls in this range (Figure 7). Doubling the distance between the source and the sound barrier, it was found that the largest difference (3.4 *dB*) of sound absorption panel capacity are registered at the measuring point R1 located at 2 *m* (case 1) and 4 *m* (case 2) away from the sound barrier, or 4 m (case 1) and 6m (case 2) to the source. Reduce noise in point R1 is explained by acoustic shadow effect produced by it. The noise reduction depends on the length and height of the sound barrier. Another case study was to analyze the index to reduce noise when increasing the noise source at 100 dB (A) to 103 dB (A), the distance between source and barrier (ds = 2 m) and receivers remains the same. It was found that shielding no lead to significant reduction of noise. It is noted that the greatest reduction is recorded in the vicinity of the screen (at a distance of 2 m). At a distance of 4 m, the values are approximately identical to increase the distance between source and receiver. At high levels of noise (eg 103 dB (A)), increasing the distance between source and receptor does not contribute to noise reduction, the measuring point out the acoustic shadow screen (Figure 8).

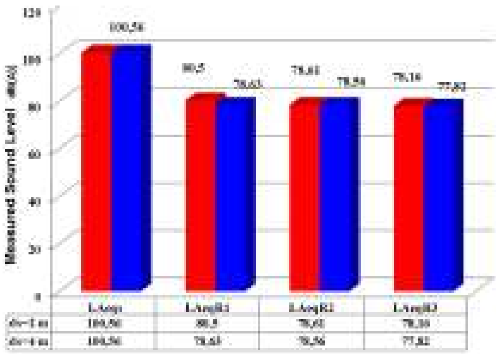

Figure 7: Variation of sound pressure level according to the distance between source and noise barrier

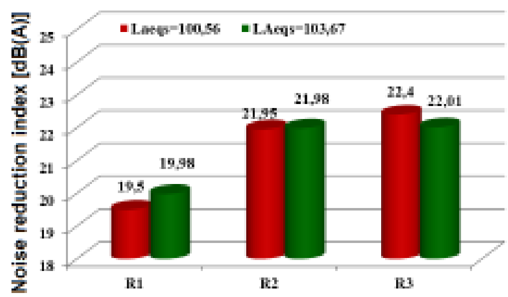

Figure 8: Variation of noise level with increasing the noise level emitted by source

3. CONCLUSION

Experiments showed that there are numerous factors that influence the performance of acoustic barriers to reduce traffic noise: distance between source and receptor, receptor position to source/barrier, sound barrier arrangement angle from the vertical, the environment measurements are made (open field / area construction, enclosures, etc.), environmental factors such as air temperature, humidity, wind speed, etc. Thus the air temperature should be between 0 - 40 °C, no precipitation, and wind speed does not exceed 5 m / s. Position of source - receiver assembly has to be fixed and to follow the plane of rotation of the measurements, in order to avoid parasitic reflections. The accuracy of noise map largely depends on the input data and therefore, as in the case of the traffic volume, it means that in every city in the number of people and the budget to be deployed monitoring stations noise.

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