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THE INFLUENCE OF THE FREQUENCY RANGE, DENSITY AND PANEL THICKNESS, THAT MADE OF RUBBER CRUMB, ON THE VALUE OF THE SOUND INSULATION INDEX

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Annotation. The article considers the problems of sound insulation of light interior walls and partitions, determines the required structure of the material and studies the effect of panels made of recycled car tires on the overall sound insulation of a structure based on the evaluation of the results of the sound insulation experiment.

Keywords: rubber crumb, sound insulation, sound insulation index, wall panel.

Relevance. Issues of the production of new energy-efficient building materials and reducing the ecological footprint, provides for the reuse of materials, are the most relevant. The problem is urgent since increasing the amount of waste is one of the important issues in all countries of the world and the accumulation of such waste is a serious threat from the point of view of protecting the environment and the impact on human health. In recent years, the study of new ways to use products from recycled car tires in all sectors and in construction in the first place has intensified. According to literature, recycled rubber can be used in industrial and residential buildings in such way as it takes an active part in protecting the structure and interior or exterior from various types of insulation, especially in noise protection. During developing new products, it is important to find out how certain properties of the materials used change.

Main text. The experiment was carried out in accordance with the standard HRN EN ISO 717-1: 2013 [3]. Basically, this regulatory document governs the assessment of sound insulation in structural elements of a building, in walls, floors, windows and doors, while taking into account various external and internal noise sources. In addition, the document contains methods that determine the results of measurements and their conversion into the sound insulation value of a building element, expressed in one number. Three variable parameters were used in the studies.

The first variable parameter is the panel thickness; for this study, it was in three sizes: 10, 15, and 20mm.

The second parameter is the density of the panel, which classified the samples as follows: about 600 kg/m^3, about 700 kg/m^3, about 900 kg/m^3.

The third parameter is the particle size distribution of the mixture, which changed as follows: 0.5-2mm; 2-3.5mm; 0.5-2mm * 35% + 2-3.5mm * 65%.

The samples were made at Gumi Impex in Varaždin (Croatia), this company is engaged not only in the manufacture of rubber products, but also in the processing of car tires. The experiment was carried out in the laboratory of building physics and acoustic tests of the Croatian Institute of Construction (IGH).

The study took place in a room separated from the room where the sound source was located. The existing opening in the wall dividing the room, designed to check the soundproofing properties of windows and doors (Fig. 1,2,3). The area of the experimental samples was 0.75m^2, which corresponds to the size of the window opening. During the experiment, samples were embedded in a box similar to a window unit (Fig. 1,2,3).

Fig. 1, 2, 3. Experimental installation of sound insulation panels

The soundproofing value of the partition between the receiver room and the transmitter room is approximately 75dB. According to the regulatory document [3], it is necessary that the sound insulation value due to the experimental sample differ by at least 1dB. Therefore, the laboratory structures were erected without interconnected elements, all joints had air permeability not exceeding regulatory requirements.

The sound source has several positions in which it is placed during the measurement, while the microphone is the sound receiver on a special stand, which has the ability to rotate in several planes and fully accumulate the sound coming from the transmitter (Fig. 4, 5, 6).

Fig. 4, 5, 6. Audio receiver and transmitter during the experiment

In total, 27 samples of various thicknesses, weights and granulometric composition were studied, divided into 3 groups:

- the first group consisted of samples with a specific gravity of 585-600kg/m^3 with a particle size distribution in which the granulation fraction was from 0.5 to 2.0mm. The replaceable coefficient of the panel thickness was - 15 and 20mm;
- the second group consisted of samples with a specific gravity of 700-750kg/m^3 with a particle size distribution in which the granulation fraction was from 0.5 to 2.0mm. Replaceable panel thickness coefficient - 10, 15 and 20mm;
- the third group included samples with a specific gravity of 900-915kg/m^3 and the same particle size distribution in which the granulation fraction ranged from 0.5 to 2.0mm. The shift factor was a panel thickness of 10, 15 and 20mm.

Tables 1-3 show a combination of patterns with fixed and variable factors.

Table 1

Group of samples No. 1

No	Thicknesses (mm)	Weight (kg/m^3)	Granul. composition
10.	15	600	0,5-2,0
19.	20	585	0,5-2,0

Table 2

Group of samples No. 2

No	Thicknesses (mm)	Weight (kg/m^3)	Granul. composition
1.	10	700	0,5-2,0
13.	15	750	0,5-2,0
22.	20	750	0,5-2,0

Table 3

Group of samples No. 3

No	Thicknesses (mm)	Weight (kg/m^3)	Granul. composition
4.	10	900	0,5-2,0
19.	15	915	0,5-2,0
25.	20	915	0,5-2,0

Conclusions and results. The results of experiments to determine the level of sound insulation are presented for each group separately in diagrams (Fig. 7-9). The diagrams below show the relation between the index of sound insulation values for each of the test panels. Graphically and visually, we can track changes associated with the value of the soundproofing index of a particular sample, and compare it with the control curve. Based on observations, conclusions or further research guidelines can be drawn.

Figure 7 shows a comparison of samples from group No. 1 with a thickness of 15 mm (600kg/m^3) and 20mm (585kg/m^3). In this case, the sound insulation panels are very homogeneous and both have approximately the same results. It is observed that the change in the frequency range has a greater effect on the sound insulation of the panel.

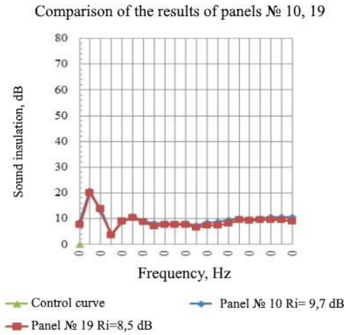

Fig. 7. Group of samples No. 1

So, in the low-frequency range for a panel thickness of 15mm, the sound insulation value is higher by 0.3-0.9dB. In the average frequency range for a panel with a thickness of 15mm, the value of sound insulation is higher by 0.6-1.3dB. In the high-frequency range for a panel with a thickness of 15mm, the sound insulation value is higher by 0.6-1.6dB

In group No. 2, samples were compared with a thickness of 10 mm (700kg/m^3), 15mm (750kg/m^3) and 20mm (750kg/m^3). In this case, the sound insulation of the samples showed significant differences. The soundproofing value of a 10mm thick panel is 14dB, the soundproofing of a

15mm thick panel is 18.2dB, and the soundproofing of a 20mm thick panel is 18.8dB.

The diagram (Fig. 8) shows a significantly lower sound insulation value of a panel 10mm of thick compared to panels 15 and 20mm of thick. This fact can be explained by a lower specific gravity of the sample. Therefore, it is advisable to consider the influence of frequency ranges on the sound insulation of these panels.

In the low range for a panel with a thickness of 20mm, the sound insulation value is variable. The diagram shows that at frequencies of 80, 100 and 160Hz, the minimum sound insulation is observed even up to 1.4dB, while for the remaining low-frequency range the sound insulation is 0.1-0.9dB more.

In the middle frequency band for a panel thickness of 20mm, the sound insulation value is more by 0.0-0.9dB. In the high-frequency band for a panel thickness of 20mm, the sound insulation value is 0.3-3.8dB more.

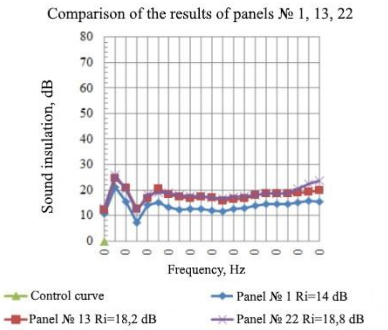

Fig. 8. Group of samples No.2

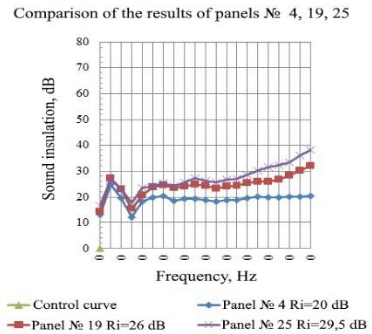

Fig. 9. Group of samples No. 3

In group No. 3, samples were compared with a thickness of 10mm (900kg/m^3), 15mm (916kg/m^3) and 20mm (915kg/m^3). The value of soundproofing panels show significant differences. It can be seen from the diagram (Fig. 9) that the sound insulation value of a panel 10 mm thick is 20dB. Sound insulation with a panel thickness of 15mm is 26dB, and sound insulation of a panel with a thickness of 20mm is 29.5dB.

In the low-frequency band, for a panel thickness of 20mm, the sound insulation value is variable. This means that at a frequency of 63Hz the sound insulation is less than 0.4dB, while for the remaining low-frequency band the sound insulation is higher for 0.1-2.8dB. In the middle frequency range for a panel thickness of 20 mm, the sound insulation value is 2.4-5.4dB higher. In the high-frequency band for a panel thickness of 20mm, the sound insulation value is higher by 5.2-6dB.

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