1. Introduction

In the light of environmental protection there are increasing requirements for noise reduction which in turn creates needs for new construction materials with excellent vibroacoustic properties. Sound absorbing (porous) materials, e.g. fiberglass, mineral wool and foams, are widely used in the production of structural elements. However, it is very difficult to increase the sound insulation of light-weight panels at low and middle frequencies due to the light weight and less damping [1].

Recycled rubber granulate exhibits very good sound absorptive properties [2]. The use of recycled rubber as alternative to widely used absorptive materials can help combat the existing problems of both waste disposal and noise pollution.

The purpose of this research is to investigate the sound transmission loss characteristics of light-weight panels containing waste rubber chips, especially at low and middle frequencies.

2. Measuring procedure and materials

Analysis of acoustic characteristics for selected materials was performed using the measurements of sound transmission loss (STL). For this purpose the “sound insulation chamber” was built within the reverberation room [3]. The white noise was generated by a loudspeaker that was placed in the sound insulation box. Next, the sound pressure level (SPL) was measured in the reverberation room with a microphone located at 30 different positions. In each position we performed 3 repetitions of SPL measurements. The sound transmission loss was calculated then as difference between SPL measured in the reverberation room with the upper side of the sound insulation box opened and SPL in the reverberation room when the opening was covered with a selected specimen. The accuracy of STL measurements using the proposed measuring techniques is ±1 dB in the frequency range from 250 Hz to 1 kHz, and ±0.5 dB in the frequency range from 1 kHz to 4 kHz.

The specimens were prepared in the form of sandwich panels (0.5 m x 0.5 m) consisting of two outside PVC layers, 2 mm thick each, and absorptive layer of waist rubber chips in between (see fig. 1). Absorptive layer was made of unconsolidated rubber chips produced from truck tires with density 287±10 kg/m^3. Two different thicknesses of absorptive layer were selected, i.e. 30 mm and 90 mm.

![Fig.1: Scheme of the sandwich panel.](image)

As a reference insulation material in this analysis we have used a stone wool plate with the thickness of 30 mm.

3. Experimental Results

The experimental results on sound insulation characteristics of sandwich panels made from granular rubber of two different thicknesses, expressed as STL, are shown in fig. 2. From the diagram one may recognize significant improvement of sound insulation by increasing the thickness of the absorptive rubber layer of the panel from 30 mm to 90 mm, especially within frequency range between 250 Hz and 1 kHz, which is the most critical frequency range in sound insulation applications. Additional improvement of sound insulation is attained by introducing the thin layer of PE film in the middle of 90 mm thick absorptive rubber layer. The thickness of PE film was 0.15 mm. The sound transmission loss of the 90 mm thick sandwich panel with PE film in the middle of absorptive layer is denoted by dashed line in
Fig. 2. By introducing a PE film in the middle of the panel we observed significant increase of sound transmission loss in the frequency range between 1 kHz and 3 kHz.

The effect of the PE film on the sound transmission loss is presented in Fig. 3 where we show the difference between the SPL for thinner panel, i.e. of 30 mm thickness, and SPL for thicker panel, i.e. of 90 mm thickness.

Results in Fig. 3 show the effect of the PE intermediate layer on the STL in the frequency region between the 500 Hz and 3 kHz.

The comparison of STL for 90 mm thick panel with the PE film, with STL for 30 mm thick stone wool panel is shown in Fig. 4. From these results we may observe that the noise reduction properties per unit thickness of the stone wool is three times larger than that of the rubber chips panels. However, we may also observe that introducing the intermediate layer of PE film improves the damping properties of the rubber chip panel for about 5 dB at lower frequencies.

4. Conclusions

From the experimental observations one may conclude that waste rubber chips are prospective soundproofing materials for the variety of applications in civil engineering. Sound insulation of sandwich panels can be significantly improved, especially at low and middle frequencies, by varying the thickness of the absorptive layer and by introducing intermediate layers of thin films.

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6. References