Utilization of Sawdust and Coconut Coir Fibre as Noise Reducing Wall Surface Materials

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Abstract

With the technological development, industrial noise, which is caused by machines, has become a severe problem for the day-today life of people. They have faced with many problems mentally and healthily. Therefore noise control plays an important role in creating a pleasing environment. This can be achieved when the intensity of sound is brought down to a level that is not harmful to human ears. Noise barriers, noise absorbers, reflectors are used for noise controlling purposes.

This research was conducted to investigate the potential of using sawdust and coconut coir fiber as sound reducers for giving a solution for the existing noise problem. Wall tiles were made by using sawdust and panels by coconut coir fibre. For preparation of tiles using sawdust, sawdust particles were mixed with cement and sand. Latex of rubber was used with coconut coir fiber to produce pannel. For these tiles, sawdust particle sizes and tile thickness were varied. Noise Reduction Co-efficient (NRC), which is a ratio between the reduction levels of noise to the intensity of incident sound, was investigated by using an experimental setup including signal generator, speakers and the noise level meter. It was found that there was a significant effect of increasing the tile thickness, varying particle size, on NRC. NRC values obtained for sawdust and coir fiber tiles ranged from 0.1 to 0.5. It was found that these materials can be effectively used as sound reducing wall surface materials. Utilization of these materials will also reduce environmental pollution and improve sustainability.

1. Introduction[1]

With technological development, rapid industrialization was occurred and industrial noise acts a vital role in causing noise problem. In industry the main sources of causing noise are machines. It has been identified that the machine noises were in the frequency range from 1 kHz to 8 kHz. The tolerance to noise levels of people varies considerably. Mainly the surrounding people face with inconvenience due to huge noises induced by machines. Harmful effects of noise can be listed as hearing impairment, interference with speech communication, disturbance of rest and

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sleep, mental-health and performance effects [1].Therefore noise controlling plays an important role. For noise controlling, glass wool and rock wool are currently used as materials of noise absorbing. However, it is widely argued that these materials have severe effects on human health. Therefore, an investigation of an alternative natural material for noise absorption purpose is urgently required. The capability of a material to absorb noise is measured by Noise Absorption Coefficient (NAC), which has been defined as the ratio of absorbed sound intensity to incident sound intensity in Miao et.al [2].
This research is based on utilization of sawdust and coconut coir fiber to investigate noise reduction coefficients [NRC].

2. Methodology

Methodology includes preparation of sawdust tiles and coconut coir fiber panel and experimental procedure which was prepared to measure Noise Reduction Coefficient of each tile.

2.1 Preparation of Sawdust tiles

Sieve analysis was done to find particle size distribution of saw dust. In casting tiles, sawdust was mixed with cement (Ordinary Portland Cement: OPC), sand in weight basis and sufficient water was added. At first the maximum thickness of a tile was decided as 25mm and the area as 20cm x 20cm. Therefore moulds (Figure.1) having the size of 20cm x 20cm x 2.5 cm, length x width x height were prepared. In order to investigate the effect of partical sizes to noise reduction properties, two particle sizes were selected as large(1.7 - 2.36 mm) and small (less than 0.85mm). Sawdust tiles were cast in two different thickness 15mm and 25 mm to investigate the effect of thickness.

2.2 Preparation of coir fiber panels

Figure 1: Mould

Figure 2: Sawdust Tile

Coir fibers were cut into pieces of 5 - 10 cm length. Latex of rubber was poured into a pan and the same volume of water was added to make a liquid solution. Acetic acid was added (water: acid = 50: 1 in volume basis) into the solution and mixed it well for hardening process. Immediately coir fibers were laid randomly and again mixed well. The mixture was kept in the pan for 2 hours for hardening .Then it was taken out from the pan and put into the roller (the machine used for producing rubber sheets). This process was necessary for removing water. The mixture was kept in an oven at a temperature 40 – 50°C for 3 days. The produced panel (Figure. 4) was 20mm in thickness (thickness was adjusted by the roller).

Figure 4: Coir fiber panel

2.4 Experimental Setup

The experimental setup included a signal generator, Noise level meter, a speaker and a wooden box. Signal generator was used to provide sound signals in the frequency range of 1-8 kHz. The sound at the given frequency was obtained by using a speaker. Sound level meter was placed inside a wooden box having the size of 15cm×15cm×30cm width, height and length so as to measure the noise levels in decibels (dB) before and after placing the tile. The wooden box was used to minimize the effect of background noise on the noise level measurements. The tile was placed between the speaker and the box (50mm from the front face of speaker).

2.3.1 Data analysis

Noise Reduction Coefficient (NRC) was determined as the ratio between the noise reductions due to the tile to the incident noise level without placing the tile. The noise reduction was the difference between the noise level measurement without placing the tile (i.e., a in dB) and with placing the tile (i.e., b in dB).

$$\text{Noise Reduction Coefficient} = \frac{\mathrm{a} - \mathrm{b}}{\mathrm{a}}$$

3. Results and Discussion

3.1 Noise Reduction Coefficient of Sawdust Tiles

Figure. 5 shows the NRC for the tiles having thicknesses of 15 and 25mm. The mix proportion was Cement: Sand: Sawdust = 2:1:1. Small size saw dust was used to cast the tiles. It can be clearly seen that noise reduction coefficient of 25mm thick tile has generally gained higher values than the 15 mm thick tile, except at 6 and 7 kHz in a range between 0.25-0.45.

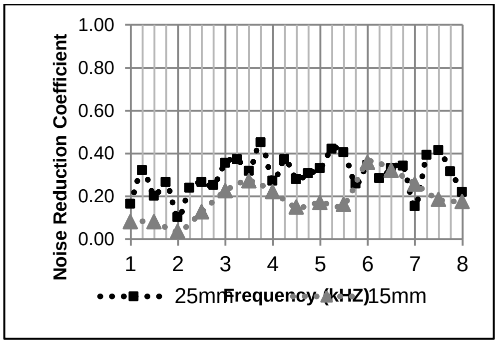

Figure 5: Variation of NRC with tile thickness

The similar trend in the frequency range 1-4 kHz has been observed in a previous study, Rozli et.al [3], in which they have investigated the effect of thickness on Noise Absorption Coefficient (NAC). In the current study, the NRC increases with increasing the thickness from 1- 6 kHz, whereas in the previous study it was observed from 1-4 kHz, although a direct comparison between NAC and NRC would not be appropriate.

When noise waves from outside hit the tile, the particles inside the tile excited and started to vibrate. Consequently, the air at other side of the tile started to vibrate creating a wave travelling through the tile. This is called the transmission. In each transmission step, energy of the sound wave lost. It is the energy absorbed by the tile. With the increasing of the thickness, the transmission length also increases resulting to higher energy loss and that might attribute to increase in NRC.

Figure.6 shows the variation of NRC with the sawdust particle size while other variables are constant. In most of the frequencies, NRC is greater for the tile cast with large particles than that for the tile cast with small particles.

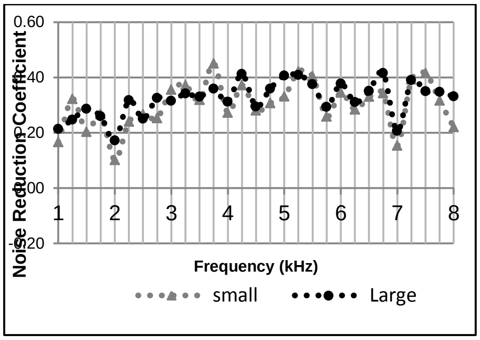

Figure 6: Variation of NRC with particle size

When the particle diameter is large the void ratio (porosity) increases. On the other hand, the smaller diameter particles can pack well reducing the void ratio. If there are more voids means wave can transmit through the medium well and get dampened. It might contribute to increase the absorption component.

3.2 Noise Reduction Coefficient of Coconut Coir Fiber Panel

Noise Reduction Co-efficient for the coir fiber panel (20mm thickness) has the peak of 0.5 at 8 kHz (Figure 7). However it may be effective in all measured frequency range while more effective in the range of 5.5 – 8 kHz.

The NRC values for the coir panel having 20mm thickness reached to 0.5 at 8 kHz. In a previous study Mohd et.al [4] the NAC had investigated using different thickness coir fiber panels and using other experimental methods (i.e., Reverberation room, Impedance tube method). They had obtained their peak values around 0.8- 0.9. However direct comparison of the current results with that may not be appropriate as NRC was measured in the current study while NAC was measured in the previous studies and also the testing method is different.

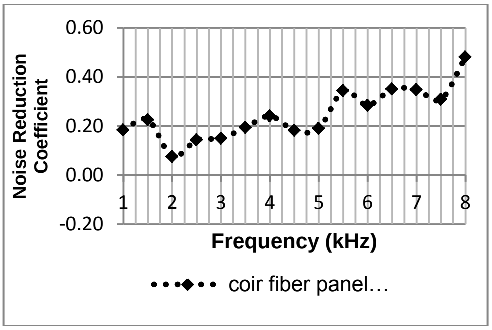

Figure 7: NRC of Coconut coir fiber panel

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