Sound Performances of Partition Board from Waste Materials

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Abstract. This study is on the sound performances of a selected number of partition boards in Industrialised Building System (IBS) buildings. The proposed bespoke board were made from squandered or waste materials, namely, coconut shells and newspapers. Each board had been tested for six different distances from the speaker in four different levels of sound, changing the level of the sound frequency. Thereon, the results were analysed. The average result of each board with various distances from the sound source, starting from 0 cm to 220 cm, was combined into under one sound level. The percentage of the noise reduction coefficient is designated by the vertical line whereas the levels of the sound is designated by the horizontal line. Point 1 stands for the low frequency and low intensity test. Point 2 stands for low frequency and high intensity test. The board that is being made of 80% coconut shell, 15% cement and 5% newspaper has an average of noise reduction coefficient of 0.21 in low frequency and low intensity, 0.21 in low frequency and high intensity, 0.24 in high frequency, high intensity and 0.12 in high frequency low intensity.

1. Introduction
Industrial building system (IBS) has been adopted by the Malaysian construction industry for the prefabricated process of construction. Most of the structural components in buildings are made onsite or offsite and transported to the construction sites (Azman, at al., 2012). IBS has been theoretically and practically proven to improve the construction delivery apart from reducing the lead of time and cost throughout its supply chain. Under the Malaysian Construction Industry Transformation Programme (CITP) 2016-2020, it is stated that the government is accelerating the adoption of IBS through mechanisation and modern practices (Mohd Zairul, at al., 2021). Building partition wall, as one of the building partition constructions, and as one of the major renovation projects of the decoration and renovation engineering in commercial and official buildings (Qian Wang, at al., 2018). Partition board can be classified as a component of IBS. There are two types of walls structure in use, namely bearing and non-bearing walls. Partition walls, mostly non-bearing are used to separate rooms. Partition walls can be divided into two main types based on their function, viz, bearing and non-bearing partition walls (Menzies, 2011). Partition boards are categorized in non-bearing walls, as they carry minimal load. This differs from the bearing walls that are designed to transfer load from the top structure to the bottom structure. Partition walls are generally soft, thin
and lightweight normally based on their value, quality, level of sturdiness, fire resistance and heat insulation.

The quality of the partition board can be more secure, financially less expensive and lighter in weight. This makes the board special. In addition, it is heat insulation and fire resistance, i.e., imperviousness to fire. This study set to focus on the board in relation to its sound proofing, ecologically friendly and light-weightness.

2. Materials and Methods

Partition walls are the walls which divide a building area into number of rooms to provide privacy to the inhabitants of the building from sound and sight. The partition should be able to contain voices inside the room as to not disturb people outside the room (U.Kassim, at al., 2016). Tam et al. (2007a), Jaillon et al. (2009) and Jaillon & Poon (2010) made it clear that on-site waste generation can be solved by using prefabrication. Jaillon et al. (2009)’s research on the waste reduction potential of using prefabrication in building construction in Hong Kong proof that construction waste reduction was one of the main advantages when using prefabrication compared to traditional construction. By using prefabrication in the construction system, the waste generated can be reduced by a certain percentage. Squandered or waste materials are the main materials used in this study. The waste materials were made of grinded coconut shells, unwanted newspapers and cement are mixed together. The goal was to produce a partition board which is ecological friendly and also has high noise absorptivity. As such, the focus of the experiment is on how noise affects building materials. Therefore, in order to test the amount of the noise reduction that each board has, the noise effect chamber and sound level meter were utilized.

Coconut shells and used newspapers were the waste materials, used in this experiment. These materials were gathered from certain shops and persons. After that, the materials, underwent the preparation process. The coconut shells were seared or bunt utilizing an oven in the laboratory. They were then undergone crushing or grinding process, together with the newspaper that are being grinded earlier. The powder produced is blended with cement to make four boards varying differently by changing the extent of the materials and adding more ground coconut shells in the greater part of the boards. The first board was made by utilizing 40% of coconut shell powder, 40% cement and 20% grinded newspaper. The second board is produced using half, 50% of coconut shell powder, 35% cement and 15% newspaper. While for the third and final boards were of 80% of coconut shell powder, 15% cement, 5% newspaper and 80% cement, 20% newspaper respectively. The noise effect chamber was being utilized to test the noise reduction of each board. This board was a rectangular box of 220 cm long, separated into two sections with a long wood in the middle also included a speaker for sound as well. Inside the box has little wood cut fitted inside it. A sound measuring meter is put outside the box to record the different sound level to produce outputs. During the test, each board was tested for 6 distances from the speaker, which are 0 cm, 50 cm, 100 cm, 120 cm, 170 cm and 220 cm. Each board was tested at various levels, which are 1: low frequency, low intensity, 2: low frequency, high intensity, 3: high frequency, high intensity and 4: high frequency, low intensity. The percentage of noise reduction was calculated by using the following equation;

\[
NCR = \frac{\text{sound level without panel} - \text{sound level with the panel}}{\text{sound level without panel}}
\]

\[
NCR = \frac{a-b}{c}
\]

\[
A = \text{sound level outside the partition}
\]

\[
B = \text{sound level inside the partition}
\]
Figure 1: Grinder Machine for grinding Process

Figure 2: Grinded Newspapers

Figure 3: Grinded Coconut Shells

Figure 4: Materials mixed with water
Figure 5: Newly Casted Partition Boards

Figure 6: Noise Effect System Chamber

Figure 7: Noise Effect System Chamber; Inside Configuration (No Partition)

3.0 Results
The graph shown below is the result of the percentage of noise reduction resulting from the proposed partition boards. The results were recorded after being tested from 6 various locations away from the speaker also with sound level differences. For each board the noise reduction coefficient also was being calculated and after that, the average of NRC board too was found.
Figure 8: Low Frequency; Low Intensity

Figure 9: Low Frequency; High Intensity

Figure 10: High Frequency; High Intensity
Figure 11: High Frequency; Low Intensity

Figure 12: Tested Boards Average Result

4.0 Discussion
In this study, the experiment was carried out on the noise effects on partition boards, namely, the four boards and an existing gypsum board. Each board has been tested for six different distances from the speaker in four different levels of sound and at various levels of sound frequency and intensity. The main aim was to test the noise effects of the newly proposed partition boards. These partition boards were made from squandered or waste materials, that is the coconut shells and newspapers. Each board is tested for six various distances at four different levels of sound. The variant levels of sound frequency and intensity and their result were recorded. After that, the average results collected were analysed. In Figure 12, the average result of each board with various distances from the sound source, starting from 0 cm to 220 cm were recorded. They were then combined into under one sound level. The percentage of the noise reduction coefficient is designated by the vertical line whereas the levels of the sound is designated by the horizontal line. Thus, Point 1 stands for the low frequency and low intensity test and Point 2 stands for low frequency and high intensity test and so on and so forth.

After calculating and compiling, the average result was as shown; maximum score of the noise reduction coefficient is at the top line. As shown in the graph, Board C, has the maximum NRC. The board that is being made of 80% coconut shell, 15% cement and 5 % newspaper has an average of noise reduction coefficient of 0.21 in low frequency and low intensity, 0.21 in low frequency and high intensity, 0.24 in high frequency, high intensity and 0.12 in high frequency low intensity.
5.0 Conclusion
The results gained proved that this research has met its main objective which was to develop partition boards made from squandered or waste materials to reduce sound or noise externally and reducing the noises from diffusing and passing into the board. Besides, the use of squandered or waste materials too is sustainable as it can help to reduce the amount of wastes produced. Construction waste reduction was one of the main advantages when using prefabrication compared to traditional construction. By using prefabrication in the construction system, the waste generated can be reduced by a certain percentage. The use of recycled materials of waste construction materials can overcome the problem of waste pollution, especially at construction sites. In addition, recycled products are cheaper and can provide various benefits and profits if applied in the construction industry.

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