International Journal of Advance Industrial Engineering

E-ISSN 2320 –5539
Available at http://inpressco.com/category/ijaie/

Research Article

Analysis of Noise Isolation Performance of Recycled Rubber and Coco Peat Composite Material

A.B. Lingemali[a] and R. T. Vyavahare[b]

[a]Department of Mechanical Engineering, SKN Sinhgad College of Engineering, Korti, -Pandharpur, Solapur, Maharashtra, India, 413304,
[b]Department of Mechanical Engineering, N B Navale Sinhgad College of Engineering, Kegaon-Solapur, Maharashtra, India, 413255.

Received 15 May 2023, Accepted 20 June 2023, Available online 21 June 2023, **Vol.11, No.2 (June 2023)**

Abstract

This research was conducted to study acoustic noise isolation performance of coco peat and recycled rubber composite material, which has high potential to be used for sound absorbing material. The sample was tested with different composition ratios. The composition ratios varied from 0% to 100 % of coco peat and recycled rubber in the steps of 20%. The samples were manufactured by using mold that was made by using MS sheet with the 5mm thickness. These samples were tested by using DEWE-43 instrument used for finding the sound absorption coefficients. Similarly, simulation was conducted on Ansys software for finding the sound absorption coefficient. For composition 40% of coco peat & 60% of recycled rubber at the various frequencies such as 250,500,750 and 1000 Hz at constant sound pressure source of 100db, the sound absorption coefficient levels achieved were 43.7db, 10.2db, 9.7db and 0.3db respectively for DEWE-43 instruments. These results are better as compared to Baggas panels. These results indicate that manufactured composite panels are promising to be used as sound absorbing material with low cost, light weight, and biodegradable.

Keyword: *Sound Absorption; Composite Material; Recycled Rubber.*

Introduction

The aim of research is to develop a composite material from industrial and agricultural waste. Most of the composite materials are used in noise reduction. Sound is a common part of everyday life. The sounds can also be unpleasant or unwanted, so-called noise. Due to noise pollution in our surroundings, there is a need and demand to find alternative materials that can reduce the noise level at various frequency ranges. Research on composite materials and natural fibers was done on acoustical panels. The common acoustical panels made from synthetic fibers that are hazardous to human health and environment and quite expensive for small portions. Therefore, some researchers showed their great interest in making alternative sound absorbers from recycled materials, such as textile, foam, rubber, or plastic. A composite material is composed of at least two materials, which combine to give properties superior to those of the individual constituents. Some of researchers doing the great work on composite material and its analysis techniques is most important parameter because it shows the sound absorption coefficient, acoustic properties, mechanical properties, water absorption coefficient some of the researchers have uses the different method for analysis of composite materials.

Researchers have used composite material made from coco coir and recycled rubber & two-microphone method is used to analyze sound absorption. It has been found that demonstrates good acoustic performance and highlights the protentional of coconut coir reinforced with recycled rubber as the sound absorption panel [1]. The research was conducted on coco coir fiber used as a composite material and Impedance tube method used for the analyze sound absorption. The results from the experimental tests show that it has good acoustic properties at low and high frequencies and can be used to be an alternative replacement of synthetic based commercial product. By using the porous layer and perforated plate backing to coconut coir fiber, the sound absorber panel shows a good potential to be an environmentally friendly product [2]. The research was conducted on palm coir fiber used as the composite material and Impedance tube (According to international standard & ASTM E1050-98) is used for measuring the sound absorption coefficients. Researcher found that sound absorption coefficients of palm coir fiber were good from 350 Hz to 2000 Hz within the range 0.65 dB – 0.90 dB for Impedance tube [5]. The researcher showed how the sound pressure source level can be expressed, and how the sound analysis can be used for fault detection. He used a sound level meter for sound measurement,

*Corresponding author's ORCID ID: 0000-0000-0000-0000
DOI: https://doi.org/10.14741/ijaie/v.11.2.1

which provides measurements of sound pressure source levels and displays it in units of dB [6]. The researchers used butyl rubber as the composite material for covering cylindrical shell and Acoustic Commercial software (LMS Virtual. Lab) & Experimental element method is used to analyze the failure detection and behavior of composite materials. The results show that, in the case of the same laying rate, the oblique laying has a better noise reduction effect, and the amount of noise reduction increases as the laying thickness increases. Under a constant thickness of the foam-butyl rubber, as the proportion of butyl rubber increases, the noise reduction per unit thickness increases, while the noise reduction per unit mass decreases [7]. The researcher conducted the study on the composite materials and analysis techniques. It has been found that some materials and analysis techniques and this has a bright future scope [8].

A lot of research has been done on developing and analyzing composite materials from waste. Some of these are mentioned below.

Matrix Material Recycled Rubber

1. Tyre Rubber.
2. Tyre Tube Rubber.
3. Belts.
4. Shoes.

Secondary Materials

1. Coco Peat
2. Coco coir fiber
3. Rice straw
4. Rice husk
5. Bamboo
6. Jute
7. Stalk
8. Baggas

Out of these present study used the tyre recycled rubber as a matrix material, coco peat as a secondary material and polyurethane was used as a binding material.

As compared to this study more alternative materials available in the market out of these Baggas panel is used for the comparison. This is also low cost, light in weight, biodegradable and highly sound absorbing material [3].

Need of the study

Negative effects of noise can be listed as hearing impairment, interference with speech communication, disturbance of rest and sleep, mental-health and performance effects, effects on residential behavior and annoyance, as well as interference with intended activities. Such uncontrolled pollution has always contributed to various levels of discomfort and uneasy feelings for many people Exposure to a very loud noise for a specific duration can lead to hearing impairment; of which sometime to be permanent. Here lies the importance of noise control which tries to reduce the direct contact of noise to humans. Various techniques have been implemented to reduce noise pollution. Therefore, noise control is an urgent need.

Materials and methods

The study used coco peat as the main raw material and recycled rubber as the secondary material. Before being used, both materials underwent several processes. The coco peat underwent several pre-treatment processes. Initially, it was crushed to obtain small grains, soaked in water, washed, and dried before it was ready to be used. The processed coco peat was added with recycled rubber particles and evenly mixed using polyurethane as the binder, prescribed as in Table 1. Here, the percentage of coco peat varied to investigate the influence of resin on the performance of composites panels. The composite boards were prepared with variations in composition of material. The samples as shown in Figure 3 were compacted by a hot press machine to produce composite fiber boards with a pressure of 5 bar and heated with a temperature of 40-degree C [2].

Table 1. Composition of coco peat and recycled rubber

Sample	Coco peat (%)	Recycled rubber (%)
1	0	100
2	10	90
3	20	80
4	30	70
5	40	60

It has been observed that most of the researcher use the same secondary material is a recycled tire rubber because it has good damping, isolation, sound absorption, water absorption properties [Figure 2]. And the primary material like coconut coir fiber, rice straw, rice husk, bamboo, jute, stalk, Baggas these materials are mostly used for developing composite materials [Figure 1].

Figure 1. Raw material Coco Peat

Figure 2. Secondary material recycled rubber.

Figure 3. Picture of Composite material Panels

The coco peat is a secondary material less used, so it has a scope for developing composite material. It has fulfilled the conditions like sound absorption, water absorption, and light in weight, easily available, cost effective.

Here, the sound absorption coefficients of the composite were found experimentally using the DEWE-43 instrument as shown in Figure 4.

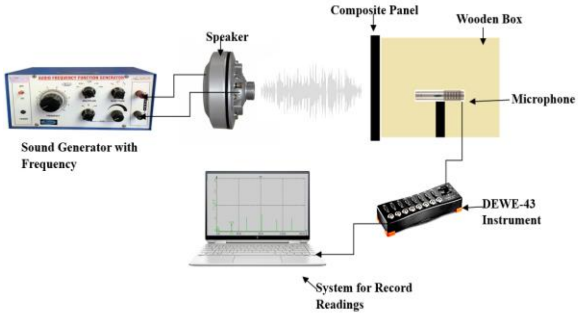

Figure 4. Schematic diagram of experimental setup of acoustic measurement

Similarly, simulation was conducted on Ansys software with the use of Auto Cad for model making and then this model was exported on the Ansys software as shown in Figure 5 for the analysis of sound absorption coefficient. The same properties and composition were given to Ansys of composite material model as prescribed in Table 1. Here, the percentage of coco peat and recycled rubber varied to investigate the influence of resin on the performance of composite panels and find out the results with the frequency and sound pressure source as shown in Figure 6.

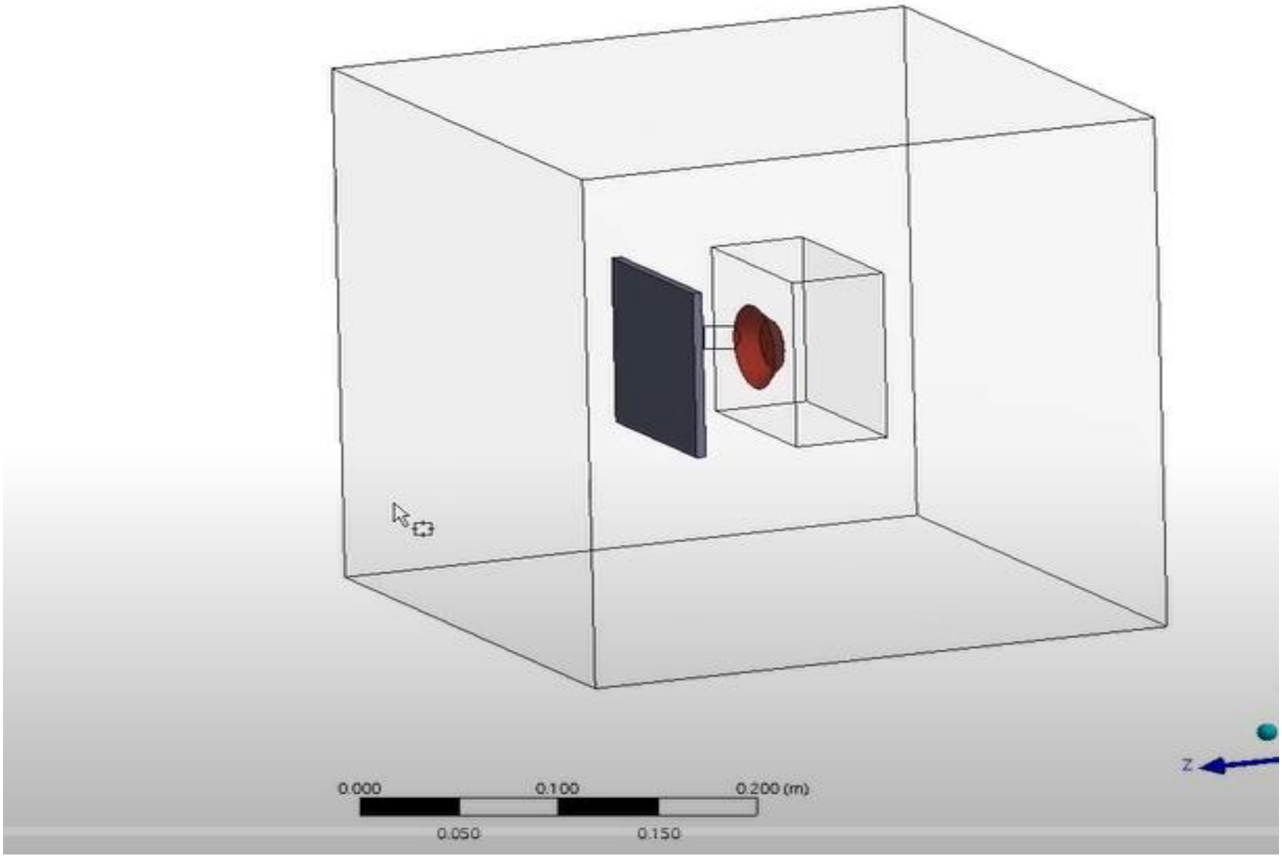

Figure 5. Schematic diagram of model composite material in Ansys Software

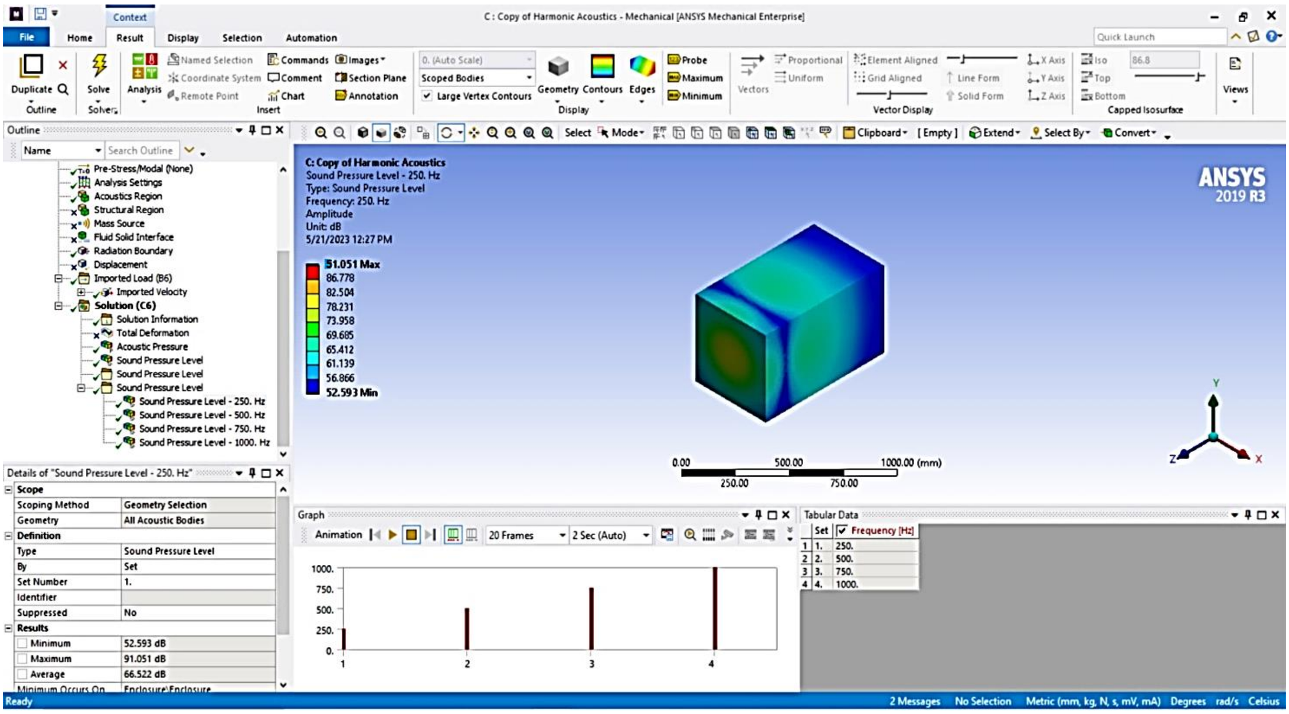

Figure 6. The acoustics measurement in Ansys Software

Results and discussion

Experimental Results

The different experimental readings are obtained by varying the material composition as shown in Table 2[2, 6].

Table 2. Experimental results for various frequency and sound pressure source levels

SR. No	Composition of Material	Baggas Panel	0% Coco Peat &100 % of Recycled Rubber	20% Coco Peat & 80% of Recycled Rubber	40% Coco Peat & 60% of Recycled Rubber	60% Coco Peat & 40% of Recycled Rubber	80% Coco Peat & 20% of Recycled Rubber	90% Coco Peat & 10% of Recycled Rubber
	Frequency and Sound	Sound In DB						
1	250Hz_100dB	61.9	55.5	57.8	56.3	56.1	55.1	52.7
2	500Hz_100dB	86.3	86.5	88.4	89.8	89.8	90	83.1
3	750Hz_100dB	85.7	90.4	90.3	90.3	90.7	90.8	90.1
4	1000Hz_100dB	100	98.1	99.8	99.7	98.6	97.4	100

Table 3. Decrease in sound levels by composite panels at various frequency levels for variety of compositions in case of experimental results

SR. No	Composition of Material	Baggas Panel	0% Coco Peat &100 % of Recycled Rubber	20% Coco Peat & 80% of Recycled Rubber	40% Coco Peat & 60% of Recycled Rubber	60% Coco Peat & 40% of Recycled Rubber	80% Coco Peat & 20% of Recycled Rubber	90% Coco Peat & 10% of Recycled Rubber
	Frequency and Sound	Sound Absorption Coefficient						
1	250Hz_100dB	38.1	44.5	42.2	43.7	43.9	44.9	47.3
2	500Hz_100dB	13.7	13.5	11.6	10.2	10.2	10	16.9
3	750Hz_100dB	14.3	9.6	9.7	9.7	9.3	9.2	9.9
4	1000Hz_100dB	0	1.9	0.2	0.3	1.4	2.6	0

It has been observed that the composition of 40% coco peat & 60% recycled rubber is recommended for the domestic application for sound absorption. The results of sound absorption coefficient at composition 40% coco peat & 60% recycled rubber composite at constant sound pressure source of 100dB are 43.7dB, 10.2dB, 9.7dB and 0.3dB [Table 3] respectively at frequency levels of 250Hz, 500Hz, 750Hz and 1000Hz respectively on DEWE-43 instrument (Figure 7).

It has been observed that at the composition of 90% coco peat & 10% recycled rubber is recommended for the commercial application for sound absorption. The results of sound absorption coefficient at composition 90% coco peat & 10% recycled rubber composite at constant sound pressure source of 100dB are 47.3dB, 16.9dB and 9.9dB [Table 3] respectively at frequency levels of 250Hz, 500Hz and 750Hz respectively on DEWE-43 instrument (Figure 7).

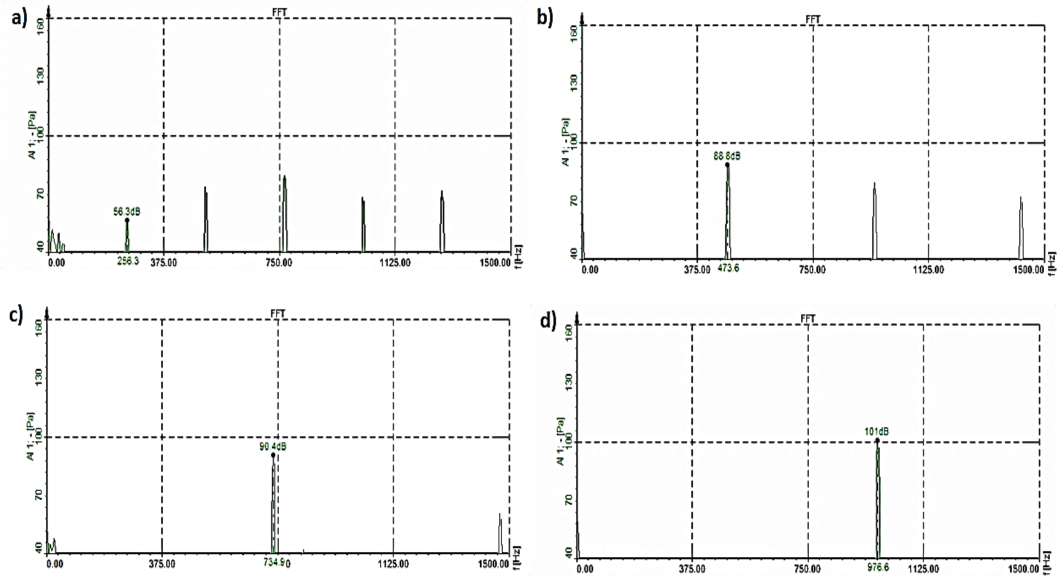

Figure 7. FFT for frequency levels [a] 250Hz, [b] 500Hz, [c] 750Hz, [d] 1000Hz and constant sound pressure source100 dB with composition 40% Coco Peat and 60% of Recycled Rubber

Simulation Results

Similarly, simulation was conducted on Ansys software with the use of Auto Cad for model making and then this model was exported on the Ansys software as shown in Figure 5 for the analysis of sound absorption coefficient. The same properties and composition were given to Ansys of composite material model as prescribed in Table 2. Here, these percentages of coco peat and recycled rubber varied to investigate the influence of resin on the performance of composite panels and find out the results with the frequency and sound pressure source as shown in Figure 8.

It has been observed that at the composition of 40% coco peat & 60% recycled rubber is recommended for the domestic application for sound absorption. The results of sound absorption coefficient at composition 40% coco peat & 60% recycled rubber composite at constant sound pressure source of 100dB are 43.82dB, 12.77dB and 9.15dB respectively at frequency levels of 250Hz, 500Hz and 750Hz respectively on Ansys Software.

Table 4. Simulation results for various frequency levels at constant sound pressure source of 100 dB

SR. No	Composition of Material	0% Coco Peat &100 % of Recycled Rubber	20% Coco Peat & 80% of Recycled Rubber	40% Coco Peat & 60% of Recycled Rubber	60% Coco Peat & 40% of Recycled Rubber	80% Coco Peat & 20% of Recycled Rubber	90% Coco Peat & 10% of Recycled Rubber
	Frequency and Sound	Sound In DB					
1	250Hz_100dB	56.1	52.7	51.18	50.9	57.8	52.7
2	500Hz_100dB	88.56	83.1	87.23	84.9	88.4	83.1
3	750Hz_100dB	90.7	90.1	90.85	91.18	90.3	90.1
4	1000Hz_100dB	98.6	100	100	99.1	99.8	100

Table 5. Decrease in sound levels by composite panels at various frequency levels for variety of compositions in case of simulation results

SR. No	Composition of Material	0% Coco Peat &100 % of Recycled Rubber	20% Coco Peat & 80% of Recycled Rubber	40% Coco Peat & 60% of Recycled Rubber	60% Coco Peat & 40% of Recycled Rubber	80% Coco Peat & 20% of Recycled Rubber	90% Coco Peat & 10% of Recycled Rubber
	Frequency and Sound	Sound Absorption Coefficient					
1	250Hz_100dB	43.9	47.3	48.82	49.1	42.2	47.3
2	500Hz_100dB	11.44	16.9	12.77	15.1	11.6	16.9
3	750Hz_100dB	9.3	9.9	9.15	8.82	9.7	9.9
4	1000Hz_100dB	1.4	0	0	0.9	0.2	0

It has been observed that at the composition of 90% coco peat & 10% recycled rubber is recommended for the commercial application for sound absorption. The results of sound absorption coefficient at composition 90% coco peat & 10% recycled rubber composite at constant sound pressure source of 100dB are 47.3dB, 16.9dB and 9.9dB respectively at frequency levels of 250Hz, 500Hz and 750Hz respectively on Ansys Software.

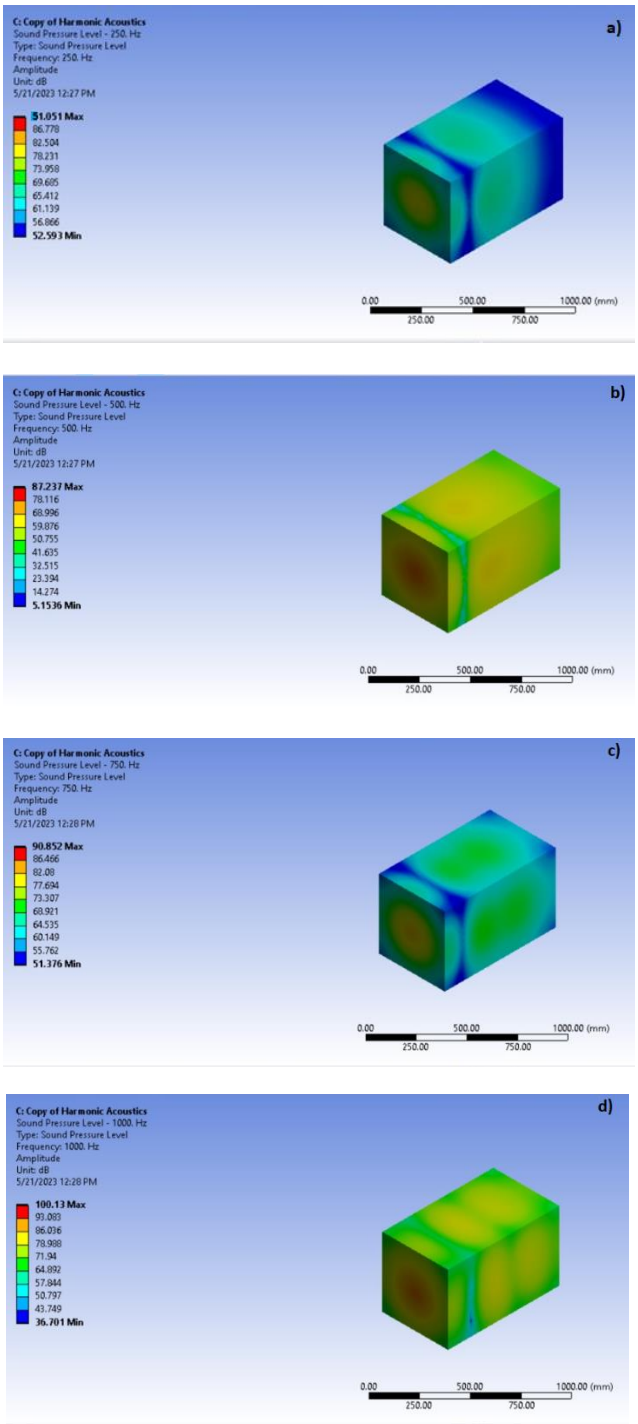

Figure 8. FFT Analysis on Ansys for Frequency [a] 250Hz, [b] 500Hz, [c] 750Hz, [d] 1000Hz at constant sound pressure source 100dB with composition 40% Coco Peat and 60% of Recycled Rubber

Bagas Panel Results

In the same way the composite material panels compared with Baggas panels experimentally validated with the frequency 250 Hz to 1000 Hz at constant sound pressure source 100dB and it was observed that the sound absorption coefficient shown 38.1dB, 13.7dB, 14.3dB and 0dB [Table 3] at frequency 250Hz, 500Hz, 750Hz and 1000Hz respectively. So, it has been confirmed that as compared to Baggas panels, composite material panels are more efficient[3] as shown in Table 6.

Table 6. Experimental Results for various frequency and Sound pressure source Levels

Composite Panel	Baggas Panel
Composite panels are made from coco peat and recycled rubber	Baggas Panels made from sugarcane waste
High Strength	Low Strength
High Water Absorption Capacity	Low Water absorption Capacity
High Density, Bulk Modulus, Youngs Modulus and Poisson's ratios	Low Density, Bulk Modulus, Youngs Modulus and Poisson's ratios
High Sound absorption capacity	Low Sound absorption capacity
Low cost as compared to Baggas panels	High cost as compared to composite material
Light in weight as compared to Baggas panels	Heavy as compared to composite material
Biodegradable	Biodegradable
Used as the sound absorption material in domestic and commercial	Used as the sound absorption material only in domestic area

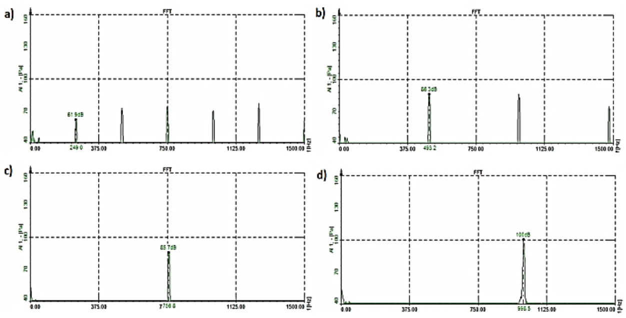

Figure 9. FFT Graph for Frequency [a] 250Hz, [b] 500Hz, [c] 750Hz, [d] 1000Hz and constant sound pressure source 100 dB of Baggas Panel

Conclusion

- As per the Indian norms loud noise above 120 dB will damage ears instantly. So, sound above 80 dB is harmful to the human ear. The allowable noise level in India has been set by the CPCB for various areas. The acceptable sound maximum in industrial areas is 75dB during the daytime and 70dB at night and in educational institutions and hospitals in daytime is 40dB and 45dB at night. For minimizing this sound, we made the composite panels. The potential of composite boards made of coco peat and recycled rubber for sound absorbent panel has been manufactured successfully. By considering the performance of acoustics and physical properties, the composition of composite boards as shown in Table 2.

- The composition 90 % coco peat and 10% recycled rubber is recommended for sound absorption applications in industry and Aeroplan higher sound absorption coefficients such as 47.3dB, 16.9dB and 9.9dB are observed at frequency levels 250Hz, 500Hz and 750Hz respectively at constant sound pressure source at 100dB.
- The composition 40 % coco peat and 60% recycled rubber is recommended for sound absorption applications in educational institutions and hospitals, higher sound absorption coefficients such as 43.7dB, 10.2dB, 9.7dB and 0.3dBare observed at frequency levels 250Hz, 500Hz and 750Hz respectively at constant sound pressure source at 100dB.
- As per the international standards suggest the highest of 50 dB in the day and 40 dB during nighttime in a residential area. So manufactured composite material panels are recommended especially for the residential area.
- These results can be identified by using experimental methods and in Ansys software. The superior performance, that is high absorption coefficient and wider frequency range enables this composite board to be employed in various sound absorption applications.
- Additionally, the utilization of recycled rubber will boost recycling of waste rubber and use of coco peat will promote use of natural ecofriendly materials.

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