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SUITABILITY OF NOISE ABSORBING PANELS BY USING PEANUT SHELL AND COCONUT SHELL

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Abstract - Now-a-days sound pollution is a major issue. Urbanization, industry, transportation, and public gatherings all contribute to noise pollution, which can cause major health problems like stress, hearing loss, and lost productivity. Traditional sound-absorbing materials, such as fiberglass and polyurethane foam, work well but are bad for the environment since they don't biodegrade. Eco-friendly acoustic panels composed of natural waste peanut and coconut shells with a constant 40% binder are the subject of this investigation. Coconut shells improve mid-frequency absorption and provide mechanical strength, whereas peanut shells efficiently absorb high-frequency noises because they are lightweight and porous. Three mix configurations were examined, and each component offered unique acoustic benefits. According to Noise Reduction Coefficient (NRC) analysis, the best balance in acoustic performance was demonstrated by the ideal mixture of 30% peanut shells, 30% coconut shells, and 40% binder. Although their moisture sensitivity necessitates waterproofing measures, these panels are affordable, environmentally friendly, and appropriate for non-load-bearing acoustic applications like wall treatments. The results show that agro-waste has a strong future as a sustainable substitute for synthetic acoustic materials.

Key Words: Acoustics, Natural fibers, Peanut Shells, Coconut Shells, Noise pollution, Sound absorbing panels.

1.INTRODUCTION

An increasing environmental concern is noise pollution, especially in urban and industrialized areas. The increase in automobile traffic, industrial processes, public gatherings, and building projects worldwide has made excessive noise exposure to people a major health and comfort concern. Long-term noise exposure can have negative effects on the body and mind, including stress, hearing loss, sleep disorders, and diminished cognitive function. Effective noise management is becoming more and more necessary, and it is our duty to solve it in an environmentally responsible manner. For acoustic insulation, soundproofing materials like fiberglass, mineral wool, and polyurethane foams have long been used.

Despite being good at reducing sound, these materials are difficult to dispose of, require a lot of energy to produce, and are mostly non-biodegradable. As a result, natural, renewable, and biodegradable substitutes are becoming more and more popular for acoustic applications. Because of their availability, affordability, and minimal environmental impact, agricultural by-products in particular are becoming more and more well-known. Peanut and coconut shells stand out among the several agro-waste materials being investigated because of their distinct physical characteristics, accessibility, and encouraging acoustic behavior. When utilized separately or in combination, these materials have demonstrated significant promise in lowering sound transmission and improving noise absorption over a number of frequency ranges.

2. Objectives

- To Study the properties of Peanut Shells and Coconut shells.
- To Prepare Noise Absorbing Panels.
- To Select Suitable Proportion for Noise Absorption.

3. Literature Review

Avinash M. Badadhe and Vishvesh V. Malgaonkar investigates the potential of raw groundnut shells, an agricultural waste product, as an eco-friendly alternative to conventional sound-absorbing materials. The research focuses on analyzing key acoustic properties such as Air Flow Resistivity (AFR) and Sound Absorption Coefficient (SAC) using sample thicknesses of 10 mm, 20 mm, and 30 mm. The results show that AFR decreases with increasing material thickness, while SAC significantly improves in the medium to high frequency ranges (1000 to 4000 Hz). These findings highlight the effectiveness of groundnut shells in noise control applications and support their potential role in the development of sustainable, biodegradable acoustic materials.

U.A. Malwade and M.G. Jadhav explored the acoustic potential of peanut shells as a sustainable alternative to traditional sound-absorbing materials. The study emphasizes the natural availability, eco-friendliness, and advantageous internal structure of peanut shells, which make them suitable for acoustic applications. Experimental findings revealed that a material-to-binder ratio of 70:30 provided the most effective sound absorption, particularly in the frequency range of 250 Hz to 4500 Hz. These results support the use of peanut shells in the development of environmentally conscious, cost-effective sound insulation products.

4. Methodology

4.1 Materials

4.1.1 Peanut Shells as Natural Sound Absorbers

Peanut shells, which are frequently thrown away as agricultural waste, are fibrous, lightweight, and porous materials with exceptional potential for acoustic absorption and sound wave dispersion. According to experimental research, they function especially well in high-frequency

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bands above 2000 Hz, where sound absorption coefficients can reach 0.9. They attain a Noise Reduction Coefficient (NRC) of roughly 0.54 when employed in loose-packed forms at a 90 mm thickness in impedance tube testing, which is comparable to traditional acoustic materials like bamboo fibers or recycled wool. These characteristics make peanut shells appropriate for settings like workplaces, auditoriums, and public transportation where speech clarity and high-frequency noise suppression are crucial. Their long-term mechanical performance is impacted by their inherent limitations, such as their susceptibility to moisture and deterioration.

4.1.2 Coconut Shells and Fibers in Acoustic Panels

Widely accessible agro-waste materials like coconut shells and coir fibers have a lot of potential for use in acoustic applications because of their naturally fibrous and porous structure, which allows for effective sound energy dissipation over mid-to-high frequency ranges (1000–3000 Hz). According to studies, coconut fiber panels can attain peak sound absorption coefficients of 0.94 to 0.97, particularly when paired with porous backings or perforated plates. Coconut shell-based materials are perfect for use in wall panels, ceiling boards, and partitions in both residential and commercial contexts since they offer structural strength, biodegradability, and thermal insulation in addition to their acoustic performance. Coconut shells are more mechanically strong than peanut shells, which makes them suitable for use in load-bearing or self-supporting acoustic constructions. To improve longevity and preserve environmentally beneficial qualities, they must be treated with natural or synthetic coatings, waxes, or biopolymer impregnation because they are also vulnerable to biological deterioration and moisture absorption.

4.1.3 Yellow Dextrin Powder (Binding Material)

A water-soluble, carbohydrate-based binding agent, yellow dextrin powder is made by partially hydrolysing starch, usually by heating it under controlled conditions with acids. Because of its superior adhesive and binding qualities, it is utilized extensively in a variety of industrial applications and appears as a fine, yellow to light brown powder. When used in the production of acoustic panels, yellow dextrin serves as a biodegradable and environmentally friendly binder that strengthens the mechanical integrity of the composite by holding fibrous or particle materials—like peanut and coconut shells—together. It is appropriate for environmentally friendly and non-toxic product formulations because it offers good workability, dries rapidly, and creates a solid, cohesive bond without the use of hazardous chemicals. It is often used in the creation of green building materials because of its affordability and compatibility with natural resources.

Sr No.	Peanut shells	Coconut shells	Binding material
1	60	-	40
2	-	60	40
3	30	30	40

Table – 1: Proportion for different moulds

4.2 Test Specimen Preparation

Three distinct mix combinations were made utilizing peanut shells, coconut shells, and a binding agent (40 percent by weight) in order to assess the panels' acoustic qualities. To guarantee consistent particle size, the raw materials were first dried, crushed, and sieved. After properly mixing each mixture with the binder to create a uniform paste, the mixture was poured into moulds with conventional measurements (usually 6 inches in diameter and 2.5 inches in height). Before undergoing mechanical and acoustic testing, the specimens were left to air dry for a full day and then cured for seven days at room temperature

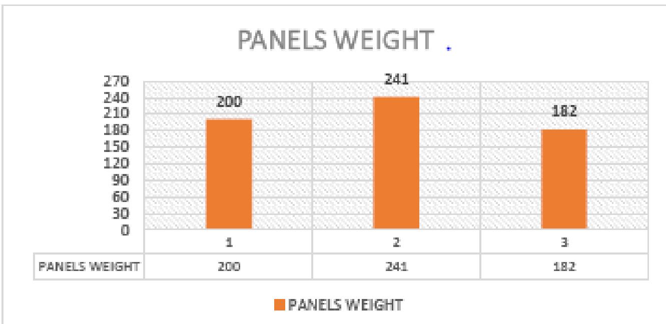
Fig -1: Preparation of Panels

5. Tests on Materials

5.1 Properties of Materials

Sr No	Properties	Peanut Shells	Coconut Shells
1	Porosity	High	Moderately
2	Density	Low	High
3	Acoustic Property	Absorption coefficient upto – 0.54 when loose-packed.	Absorption coefficient upto – 0.97 when loose-packed.
4	Thermal Insulation	Moderate	Excellent
5	Biodegradability	Fully Biodegradable	Naturally Biodegradable
6	Mechanical Strength	Low	High
7	Moisture Resistance	Low	Moderate
8	Availility & Cost	Abundantly available and affordable	Widely available and higher cost

Table – 2: Properties of Material



Graph 1 – Panel Weight Graph

5.2 Sound Absorption Tests

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Measurement of Sound Absorption Using Sound Level Meter

Using a sound level meter to evaluate sound absorption entails comparing the sound pressure levels before and after a test panel is placed in a controlled acoustic environment. Setting up a reverberation chamber or a peaceful space with low levels of background noise is the first step in the process. Broadband noise or a steady sound at particular frequencies is produced by a calibrated sound source, usually a loudspeaker.

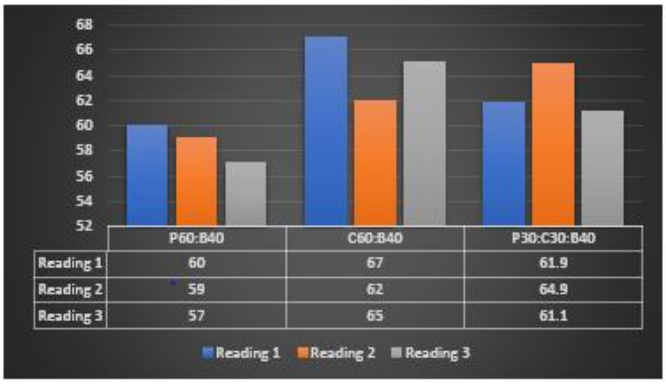
The initial sound pressure level (L_1) without the panel is recorded by the sound level meter, which is positioned at a certain distance from the source. A second reading (L_2) is then obtained once the noise-absorbing panel has been positioned between the source and the meter. The panel's ability to absorb sound is indicated by the decrease in sound level ($\Delta L = L_1 - L_2$). To evaluate performance thoroughly, this procedure is performed at various frequencies. The material's absorption efficiency or Noise Reduction Coefficient (NRC) can be ascertained with the use of the decibel difference.

6. Result And Discussion

The experimental results indicate that the C60:B40 mix (60% coconut shells and 40% binder) demonstrated the highest overall sound absorption values across all three readings (67, 62, and 65), suggesting superior acoustic performance likely due to the denser, more rigid structure of coconut shells. The P30:C30:B40 mix (30% peanut shells, 30% coconut shells, and 40% binder) also showed consistently high readings (61.9, 64.9, and 61.1), highlighting a well-balanced performance in terms of both sound absorption and material composition. In contrast, the P60:B40 mix (60% peanut shells and 40% binder) recorded the lowest values (60, 59, and 57), indicating that while peanut shells contribute to sound absorption due to their porosity, a higher proportion may compromise structural compactness and reduce overall effectiveness. Thus, the inclusion of coconut shells improves acoustic performance and supports optimal mix design.

Sr no.	Peanut Shells	Coconut Shells	Binding Materials	Density	Sound Absorption Coefficient	Observations
1	60	-	40	500	0.62	Lightweight, moderate sound absorption
2	-	60	40	520	0.65	Slightly denser, better acoustic performance
3	30	30	40	540	0.68	Balanced mix, highest sound absorption

Table – 2: Result Analysis and Observation



Graph 2 – Sound absorption by Panels

3. CONCLUSIONS

The study aimed to develop eco-friendly noise-absorbing panels using different mix proportions of peanut shells, coconut shells, and a suitable binding material. Through physical property analysis and experimental testing, peanut shells were found to be lightweight with excellent porosity, offering strong sound absorption, while coconut shells provided superior structural strength and dimensional stability. Panels were effectively manufactured using these agro-industrial wastes, resulting in a sustainable and cost-efficient process. Among various combinations, the mix with 30% peanut shells, 30% coconut shells, and 40% binder demonstrated the best balance of acoustic performance and physical strength, making it the most effective and practical formulation.

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