



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 6, June 2025

Agro Waste based Sound Insulation Technique

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ABSTRACT: Noise pollution is an increasing concern in both urban and rural environments, yet conventional sound insulation materials remain costly and environmentally harmful. This project, titled “Agro-Waste-Based Sound Insulation Technique,” explores the use of agricultural byproducts such as rice husk, coconut coir, and sugarcane bagasse—combined with natural soil—as an eco-friendly and low-cost sound insulating plaster. The experimental phase involved preparing an agrowaste mixture, applying it inside a plastic bucket, and measuring sound levels using a mobile speaker and decibel meter app. A comparative analysis between the insulated bucket and open surroundings was conducted to assess the material’s acoustic performance. The results showed a significant reduction in sound levels, indicating the potential of agro-waste as an effective insulator. A cost analysis was also performed for a 10m × 10m × 10m room, demonstrating that the agrowaste-based plaster is considerably more economical than conventional synthetic insulation materials. The project emphasizes sustainability, affordability, and accessibility, making it especially relevant for resource constrained settings. This study confirms that agro-waste materials, often treated as waste, can be transformed into functional construction resources for acoustic applications. Furthermore, the simplicity of the material preparation process and the accessibility of the raw ingredients make this technique feasible for low-tech, rural, or emergency construction settings. The approach not only promotes sustainable waste management but also contributes to cost effective infrastructure development in areas where conventional soundproofing methods are economically unviable. This project serves as a step toward bridging the gap between environmental responsibility and practical engineering, demonstrating that innovative use of natural resources can yield impactful results in building acoustic.

KEYWORDS: Agro Waste, Sound Insulation and Eco-friendly

I. INTRODUCTION

The growing challenges posed by noise pollution are increasingly recognized worldwide, particularly in urbanized regions where industrialization, transportation systems, and rapid urban expansion have intensified the detrimental effects of excessive noise on public health and well-being. According to a report by the World Health Organization (WHO), exposure to excessive noise is linked to a wide array of health problems, ranging from hearing impairment, sleep disturbances, and stress to more severe conditions like cardiovascular diseases and high blood pressure. As a result, the demand for effective soundproofing materials has risen significantly in both residential and commercial building designs. However, while traditional insulation materials are effective in reducing noise, they come with their own set of challenges, particularly in terms of environmental sustainability, cost, and manufacturing energy consumption.

In today’s increasingly urbanized world, noise pollution has become a significant concern, impacting the comfort, health, and productivity of individuals in residential, commercial, and industrial settings. The rising demand for effective sound insulation solutions has traditionally been met using synthetic materials which, while effective, are often non-biodegradable, expensive, and environmentally harmful. With growing emphasis on sustainability and ecofriendly construction practices, there is a pressing need to explore natural alternatives that are both efficient and environmentally responsible. Agricultural waste materials such as coconut husk, sugarcane bagasse, rice husk, and wheat straw are abundant, renewable, and possess inherent fibrous structures that make them promising candidates for sound insulation applications. These agro-waste materials not only provide a means of acoustic control but also offer a practical solution for managing agricultural byproducts, which would otherwise contribute to environmental degradation. This project aims to study the potential of using agro-waste as an effective material for sound insulation by analyzing its properties, performance, and feasibility as a sustainable substitute to conventional insulation materials.

1.1 OBJECTIVES

The objectives of the study are to investigate the acoustic properties of various agro waste materials and to develop eco-friendly and economically viable sound-insulating panels. It also aims to compare the sound absorption performance of agro-based materials with conventional materials. Furthermore, the study seeks to promote sustainable practices in the construction industry by encouraging the use of renewable resources.

1.2 PROBLEM-STATEMENT:

Despite the growing interest in eco-friendly construction, there is still a significant gap between the rising demand sustainable materials and their actual implementation in the industry. Agro-waste-based acoustic materials are notably underdeveloped when compared to synthetic alternatives. This is largely due to several challenges, such as absence of standardized processing methods tailored to different types of agro waste, variability in raw material properties influenced by region and season, and performance uncertainties in aspects like moisture resistance, fire retardancy, and durability. Additionally, there is a general reluctance within the construction sector to shift from traditional materials to newer, less familiar options. Therefore, detailed research is needed to assess the acoustic potential of various agro-waste materials and to develop clear guidelines for their effective use.

1.3 LITURATURE REVIEW SUMMARY

Recent studies show that agro-waste Fibers like coconut coir, rice husk, jute, and sugarcane bagasse are effective, eco- friendly sound insulators. Panels made from these materials offer good absorption, especially at mid to high frequencies, while hybrids and thicker boards improve low-frequency performance. Natural adhesives are widely used, but challenges like moisture sensitivity, fire resistance, and mechanical strength remain. Overall, agro-waste panels are lightweight, biodegradable, cost-effective, and present a sustainable alternative for green building applications.

II. METHODOLOGY

The methodology adopted for this project is designed to assess the sound insulating capabilities of selected agro-waste materials in a systematic and reproducible manner. This study follows a structured experimental plan starting from the identification and selection of raw materials to the preparation of sound insulation samples and finally their acoustic testing. The primary objective is to compare the effectiveness of agro-waste materials—namely rice husk, sugarcane bagasse, and coconut coir—in reducing sound transmission.



2.1 Coconut Coir



2.2 Sugarcane Bagasse

The methodology involves several key stages. First, raw agro-waste materials are collected, cleaned, and dried to remove impurities and moisture. These materials are then shredded into smaller particles to improve uniformity and mixing. A suitable natural binder is added to the shredded material to aid in molding and compaction. The mixture is then placed into a plastic container (or mold) and allowed to set and cure, forming a compact panel or block..

Once the samples are prepared, they are tested using a simple setup involving a sound source (such as a speaker) and a decibel meter (typically an app-based sound level meter on a mobile device). The setup is designed to measure the

difference in sound levels with and without the agro-waste material, providing insight into its sound absorption performance. The procedure is kept simple and reproducible within academic constraints, with a focus on comparing results between the control sample and the agro-waste-based sample.

This methodology ensures a consistent approach throughout the project and provides a foundation for the experimental investigation detailed in the subsequent chapter...

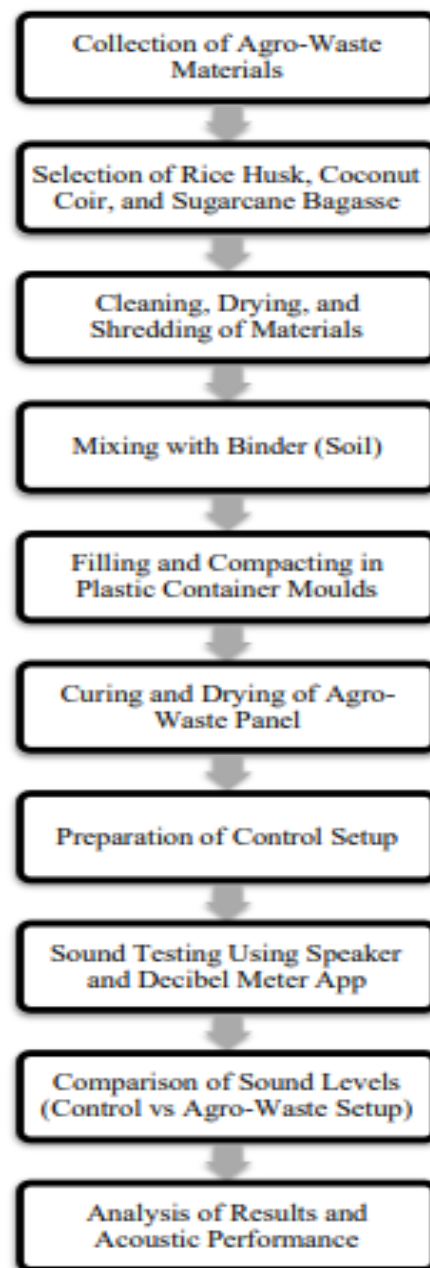


Figure 2.3 Methodology for Fabrication and Testing of Agro-Waste-Based Sound Insulation Material

III. EXPERIMENTAL SETUP

The experimental setup was designed to evaluate the sound insulation performance of the agro-waste-based material when applied inside a closed container. A plastic bucket served as the test chamber, chosen for its ease of handling, uniform shape, and ability to simulate a compact enclosed space. The objective of the setup was to measure how much sound was absorbed or blocked by the plastered layer of agro-waste material in comparison to the natural ambient environment. A mobile phone speaker was used as the sound source, playing a consistent audio output at a fixed volume. To assess the sound insulation effect, a decibel meter application installed on a second mobile device was used to record sound levels at different positions relative to the bucket. The key positions for measurement included:

- Outside the insulated bucket (to capture how much sound passes through the agro-waste layer),
- Open surroundings (without any bucket or material, to serve as a control/reference level).

The bucket was sealed from the top as much as practically possible to prevent direct sound leakage from the opening and focus the analysis on sound escaping through the bucket walls. The same sound was played for both test cases to maintain consistency. All measurements were taken from a fixed distance outside the bucket to ensure uniformity. This simple and cost-effective setup enabled the practical evaluation of the sound-absorbing properties of the agro-waste insulation material using easily available tools and techniques.

IV. RESULTS AND DISCUSSION:

The results obtained from the acoustic testing indicate a noticeable reduction in sound levels when the agro-waste-based insulation material was applied. As shown in the observation table, the sound level measured in open surroundings (control) was approximately 84.5 dB, whereas the sound level measured outside the insulated bucket was 73.2 dB, resulting in a sound reduction of 11.3 db. This reduction demonstrates that the mixture of rice husk, coconut coir, and sugarcane bagasse, when used with a natural soil binder, possesses effective sound-absorbing characteristics. The fibrous structure of the agro-waste materials, combined with the density of the compacted plaster, likely contributed to the dissipation and absorption of sound waves within the bucket. While the test was performed using basic tools in a non-laboratory setting, the reduction of over 10 dB is significant and suggests that agro-waste can play a role in cost-effective and sustainable sound insulation solutions. The consistent difference between control and insulated conditions supports the hypothesis that these materials can reduce sound transmission when applied to structural surfaces.

The results obtained from the experimental investigation highlight the practical potential of using agro-waste as a sustainable material for sound insulation. The measured sound reduction confirms that naturally available waste materials like rice husk, coconut coir, and sugarcane bagasse—when combined with a soil-based binder—can effectively dampen sound transmission. This finding is significant in several ways. Firstly, it provides a low-cost alternative to synthetic soundproofing materials, which are often expensive and non-biodegradable. Secondly, the use of agricultural byproducts contributes to waste management by utilizing resources that would otherwise be discarded or burned, thus supporting environmental sustainability.

Furthermore, the simplicity of the fabrication method and the accessibility of raw materials make this approach particularly relevant for rural construction, low-income housing, and eco-conscious building projects. The encouraging performance shown in this small-scale setup suggests that the concept could be further developed and tested for use in larger applications, such as wall panels, ceilings, or portable noise barriers. Overall, the results validate the core aim of the project: to demonstrate that ecofriendly, agro-waste-based composites can serve as effective and sustainable sound insulation materials.

V. CONCLUSION

This study aimed to explore the potential of agro-waste materials for sound insulation in the context of sustainable building practices. Based on the objectives of the research, the following conclusions have been drawn:

- To prepare a sound-insulating material using a mixture of agro-waste (rice husk, coconut coir, and sugarcane bagasse): This objective was successfully achieved by formulating a composite plaster using the specified agro-waste materials. The fibrous nature of these components, coupled with the binding strength of soil, resulted in a stable, compact insulating mixture suitable for application.
- To experimentally evaluate the sound reduction capability of the prepared material using a controlled container setup and mobile-based decibel measurement: The experimental setup yielded a sound reduction of 11.3 dB, demonstrating the material's effectiveness. The insulated container measured 73.2 dB compared to 84.5 dB in open surroundings. This significant decrease validates the acoustic absorption potential of the agro-waste mix even under basic, non-laboratory conditions.
- To assess the potential of agro-waste plaster as a low-cost, eco-friendly alternative for basic sound insulation applications: Based on the observed results and the simplicity of the preparation process, the study confirms the viability of agro-waste plaster as a cost-effective and sustainable alternative for basic soundproofing needs. The use of abundant, natural, and biodegradable materials aligns with environmentally responsible construction practices.

In conclusion, the findings underscore the potential of agro-waste materials for sustainable soundproofing solutions. While further experimental validation is needed to confirm the theoretical results, these materials offer significant promise for green building practices. Future research should focus on real-world testing, material optimization, and long-term durability to fully realize the benefits of agro-waste materials in acoustic applications.

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