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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Development of Acoustic Panel Using Natural Blended Fibres

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Doi: https://doi.org/10.55248/gengpi.5.0424.0938

A B S T R A C T

Acoustic panels are an essential component to sound management in any space.It is designed to absorb sound waves and reduce echoes reverberation, and other unwanted noise. This improves the overall sound quality and clarity of a room,making it more comfortable and functional for its intended purpose. The currentstudy analyzing bast fiber acoustic property and speciality fiber property helps in innovation and development of an material with enhanced acoustic performance.It also promotes the use of sustainable material in various applications,reducing reliance on non-renewable resources. The aim of this project is to analyze how th e distinct physical and chemical properties of speciality fibers in combination with bast fibers influences the acoustic properties. It also aims in the development of nonwoven acoustic panel in combination with suitable speciality fiber and bastfiber thereby enhancing the sound absorption capacity of acoustic panels.The analysis revealed a significant enhancement in acoustic properties when bast fibers were combined with speciality fibers ,showcasing a potential for improved sound absorption on related applications. The combining of bast fiber with speciality fiber enhanced the acoustic properties of the panel thereby providing significantly higher sound absorption capacity with longer durability.

Keywords: Acousticpanel, bastfibers, specialityfibers, nonwoven.

1. INTRODUCTION

Acoustic panels are an essential component of sound management in any space. It is designed to absorb sound waves and reduce echoes, reverberation, and other unwanted noise. This improves the overall sound quality and clarity of a room, making it more comfortable and functional for its intended purpose. Acoustic panels come in a variety of shapes, sizes, and materials, allowing them to be customized to fit the specific needs and aesthetic of a space. They can be made from materials such as foam, fiber hemp, and natural fibers and can be covered in fabric or other decorative finishes to blend seamlessly into the surrounding environment. Incorporating acoustic panels is a crucial step in achieving optimal sound quality and creating a comfortable and functional environment. The goal of this project is to develop a non-woven composite acoustic panel using bast fiber and specialty fiber with needle punching technology which contributes in enhancing the sound absorption.

Nomenclature

Title: Development of Acoustic Panel using natural blended fibres

1.1 Background of the Work

Jute fiber as shown in figure1.1 has good acoustic properties, making it suitable for certain applications. Due to its natural structure and composition, jute fibers have a low density and high stiffness, which can contribute to effective sound absorption and dampening. Low density fibers contribute in higher sound absorption whereas high density fibers are good sound transmitters. Jute fiber helps in reducing noise and vibrations in various products such as automotive interiors, sound proofing materials, and even musical instruments. Jute based composites are gaining popularity in the acoustic industry due to their eco-friendly nature and desirable acoustic characteristics.

FIG 1.2 Jute fibre

Hemp fiber acoustic panels can be used to absorb sound and reduce echo in large spaces like auditoriums and recording studios. Hemp fiber as shown in figure1.2 has high stiffness,but it has high strength, relatively low cost and high chemical.The light weight and ideal for applications that require acoustic insulation without adding significant weight. Hemp fiber is non corrosive, making it suitable for use in environments with high humidity or chemical exposure without degrading its acoustic properties.

Fig 1.3 HEMP FIBER

1.4. Objectives of the Proposed Work

1.Acoustic Performance Improvement: Investigate the potential of jute and hemp fibers in enhancing acoustic absorption and diffusion properties of the panel, aiming for superior soundproofing capabilities compared to traditional materials.

2.Material Characterization: Conduct comprehensive studies to understand the physical, mechanical, and acoustic properties of jute and hemp fibers individually and when blended together. This includes assessing their density, porosity, elasticity, and absorption coefficients.

3.Optimization of Blend Ratio: Determine the most effective ratio of jute to hemp fibers to achieve optimal acoustic performance while maintaining structural integrity and cost-effectiveness of the panel.

4.Enhanced Sustainability: Evaluate the environmental impact and sustainability credentials of the proposed panel by utilizing renewable and biodegradable natural fibers. Compare it with existing acoustic panels made from synthetic materials in terms of eco-friendliness.

5.Manufacturability and Scalability: Develop manufacturing processes that are efficient, cost-effective, and scalable for mass production of the acoustic panels. Explore techniques such as compression molding, hot pressing, or 3D printing to achieve desired shapes and sizes.

6.Durability and Longevity: Assess the durability and longevity of the panels under various environmental conditions, including exposure to moisture, temperature fluctuations, and mechanical stress. Ensure that the panels maintain their acoustic performance over time.

7.Aesthetic Considerations: Explore options for enhancing the aesthetic appeal of the acoustic panels through surface finishes, colors, and textures, catering to different architectural and interior design preferences.

8.Market Viability and Cost Analysis: Conduct market research to identify potential applications and target markets for the acoustic panels. Perform cost-benefit analysis to determine the economic feasibility of production and competitiveness against existing acoustic solutions.

1.5 Proposed work

MINIATURE CARDING:

At the carding process, fiber is broken up and mixed. Loose fiber beds are fed onto big wired Rollers during the carding process. This wire separates each fiber strand, combines and blends the constituent parts, and directs the fiber in a single direction. The fiber emerges from the carding machine as a web. This webbing has a substance comparable to cotton candy and is like the phony spider webs you see around Halloween. For the first time, the fiber resembles a cloth, but, like cotton candy, this substance has very little strength to it. Using the miniature carding machine jute fiber web and hemp fiber we dare produced. Jute fiber a long with cotton is fed to the feeding roller in the ratio of 70:30. Then jute fiber web is produced. Then hemp fiber along with cotton fiber is fed to the feeding. Miniature carding is a process used in the textile industry to produce a web of fibers. It's a scaled down version of the carding process used in large-scale textile mills. The fibers are selected first. As jute fiber cannot be carded directly due to breakages, jute fiber is mixed with OE short fibers in the ratio of 70:30 and then carded. The same procedure is done for hemp fibers. In this process 5 webs of jute fiber and hemp fiber in combination with OE short fibers are produced. Now these webs are taken to the next process of needle punching

Fig 1.6 Miniature carding

NEEDLE PUNCHING:

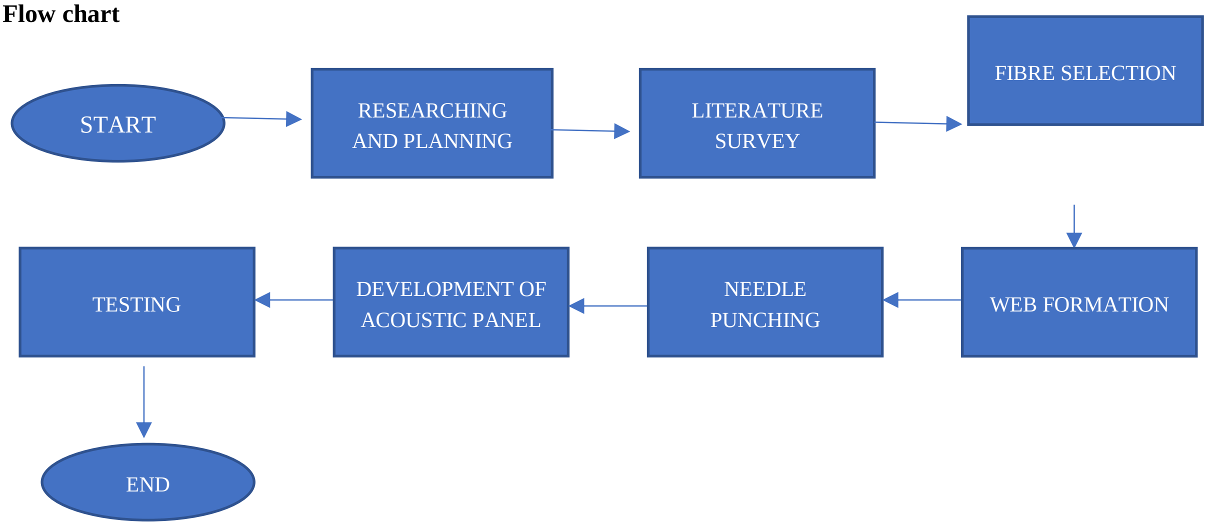
The needle punching process for creating acoustic panels from a combination of jute and hemp fibers is a crucial step in producing effective sound-absorbing materials. To begin, a mixture of jute and hemp fibers is evenly layered onto a frame or support. Then, this layered assembly is subjected to a needle punching machine. The machine's multiple needles rapidly penetrate the layers, catching and interlocking the fibers, which not only binds them together but also creates vital air pockets within the panel. This entangling process significantly enhances the panel's sound-absorption capabilities. After needle punching, an adhesive binder is applied to secure the fibers further and prevent shedding. Subsequently, the panel undergoes a curing and drying phase, allowing it to set and solidify. Once dry, it is trimmed to the desired size and shape, ensuring it fits its intended application. Finally, the finished panel may be covered with various fabrics or finishes to match the room's aesthetics while maintaining its acoustic functionality. The result is an eco-friendly and effective acoustic panel, striking a balance between sustainability and acoustic performance. Needle punching is one of the methods used for making an on woven felt. This involves taking loose fibers and “needling” them together using a needle loom full of barbed needles of force the fiber to push through and entangle itself. The prepared fiber web or matt is fed into the needle punching machine. This web consists of loosely arranged fibers. As the needle punching process continues, the entangled fibers gradually form an on woven material. The thickness, density, and strength of the fabric can be adjusted by controlling the needle density.

IMPEDANCE TUBE :

The impedance tube method is a commonly used technique to measure the sound absorption properties of materials, especially in the context of acoustics. This method involves using a tube with a known cross-sectional area, usually with a loudspeaker at one end and the material sample at the other .The loudspeaker emits sound waves that travel through the tube and hit the sample. A microphone is placed in the tube to measure the sound intensity at different frequencies before and after the sound waves interact with the material sample. By comparing the sound intensity levels, we can calculate the amount of sound absorbed by the material. However, due to sample preparation, sample mounting, and impedance tube size (limits), the sound absorption coefficients determined using the impedance tube approach may vary slightly.Results from the impedance tube method provide insights into how well a material attenuates or absorbs sound at different frequencies. This information is crucial for designing **acoustic** materials used in various applications, such as soundproofing in buildings, automotive interiors, or industrial equipment.

Fig 1.7 Impedance Test

1.6 Flow chart



1.7 Results and discussion

S. No	***Frequency in (Hz)***	***Sound absorption Coefficient***
1.	125.00	0.20
2.	250.00	0.09
3.	500.00	0.18
4.	1000.00	0.44
5.	2000.00	0.72

6.	2500.00	0.75
7.	3150.00	0.79
8.	4000.00	0.83
9.	5000.00	0.89
10.	6300.00	0.84

It is concluded that the acoustic panel made using jute fiber and hemp fiber have good sound absorption coefficient at higher frequency sound wave. As the frequency of sound wave is about 5000 hertz, 89% of the sound produced is absorbed by the acoustic panel.The creation of an acoustic panel through the fusion of jute and hemp fibers promises a composite material that could harness the diverse properties of both constituents. The combination could potentially yield a balanced absorption profile across various frequency ranges, offering an opportunity to optimize sound absorption characteristics. However, achieving this balance demands careful consideration of factors such as the density, arrangement, and compatibility of the fibers within the panel's structure. This hybrid approach, blending natural (jute) and synthetic (hemp) fibers, aims to strike a balance between acoustic performance and environmental sustainability. Nevertheless, realizing the full potential of this composite panel involves overcoming challenges in material optimization, cost-effectiveness, production consistency, and validating its acoustic performance through rigorous testing methodologies like impedance tube measurements. Ultimately, the successful fusion of jute and hemp fibers into an acoustic panel requires meticulous experimentation and testing to validate its acoustic efficacy and ensure a harmonious blend of performance and practicality.Frequency dependency emerged as a critical factor. Panels with a higher content of hemp fibers exhibited improved sound absorption at higher frequencies, demonstrating their effectiveness in attenuating high-pitched sounds. Conversely, compositions skewed towards jute fibers displayed superior performance in mid-range frequencies, whereas our application is at generator rooms which provide mid range frequences.

1.8 Output product

Acknowledgements

I would like to express my sincere gratitude to all those who have contributed to the success of this project on "Development of Acoustic panel using Natural blended fibres." Their support and insights have been invaluable in shaping this research.

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