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Analysis of Sugarcane Waste with Leaf Fibre Combinations for Automotive Products

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ABSTRACT:

In recent years, it has become increasingly crucial for a variety of businesses, including the manufacturing of automobiles, to use environmentally friendly and sustainable materials. This initiative, which follows this trend, focuses on making automotive items from sugarcane waste and Pandanus veitchii (screw pine) leaf fiber. A hybrid plant called Pandanus veitchii is mostly used for ornamental purposes. However, it has excellent promise as a reinforcing material because of its high fiber content and long staple length. The organization of air affects the Sound Absorption Coefficient (SAC), which has an effect on the SAC. When developing or optimizing an acoustic structure, air gaps should be carefully considered because the right placement and design can significantly increase the structure's capacity to absorb sound. The main purpose of this project is to produce a sustainable acoustic material with better result of sound absorption and to analyze the structural changes in various chemical treatments. Combination of both the waste such as sugar cane bagasse and the pandanus veitchii naturally with the help of drumstick tree resin to enhance the property of sound absorption. The natural resin provide additional advantage to this composite material which enhance the sound absorption by reducing the brittleness of the material.

Keywords: Sustainable Acoustic Material, Sound Absorption, Pandanus Veitchii, Drumstick Tree Resin, Composite Material

Introduction:

This research intends to create an innovative composite material that excels at sound absorption while integrating ecologically friendly components in the search for sustainable acoustic material solutions. The main components of this composite are pandanus veitchii and sugar cane bagasse, both of which are regarded as waste products. Drumstick tree resin is added to their combination to strategically improve it. This innovative mixture aims to improve sound absorption by repurposing agricultural waste materials as well as natural resin's favorable characteristics. Utilizing pandanus veitchii and sugar cane bagasse not only tackles the problem of waste management but also promotes sustainable methods of material development. The project aims to take advantage of the drumstick tree resin by adding it to the composite. The goal of the initiative is to take advantage of the resin's natural qualities, particularly its capacity to lessen brittleness. It is believed that this addition will strengthen the composite material's overall structural integrity, making it more robust and subsequently enhancing its sound-absorbing capabilities.

In summary, this idea is an innovative attempt to create an eco-friendly acoustic material that not only utilizes agricultural waste but also takes advantage of the special qualities of natural resin. These components work well together to create a sustainable acoustic solution with exceptional sound absorption properties, opening the door for environmentally aware material science developments.

What is the Acoustic material?

Acoustic materials are used to manage and control sound in both the interior and external environments of vehicles. In addition to improving the overall acoustics inside the car cabin, these materials also reduce noise from the engine, the road, the wind, and other external influences. The following are some typical acoustic material types seen in automobile applications: Materials for Acoustic Insulation:

Foam Insulation: Due to their ability to absorb sound, closed-cell foam materials are frequently employed. They aid in reducing airborne noise and dampening vibrations.Materials used as barriers to stop the transmission of sound and vibrations are frequently composed of dense rubber or vinyl composites.

Materials for Sound Absorption

Fibrous Materials: Fibrous materials are utilized to absorb sound energy and lessen reverberation inside the vehicle. Examples include felt and fiberglass. Acoustic panels are frequently incorporated into interior design and placed in key locations to absorb and diffuse sound.

Materials for Vibration Dampening

Constrained Layer Damping: To reduce resonance and dampen vibrations in metal panels, multilayered materials, frequently with a viscoelastic core, are utilized.

Damping pads made of butyl rubber: These pads stick to metal surfaces and transform vibrational energy into low level heat.

These materials are combined with care to produce a vehicle interior with a balanced and comfortable acoustic environment. While adhering to safety and legal requirements, automakers prioritize creating quiet and enjoyable vehicles. Automobile acoustics breakthroughs are also being driven by developments in materials science and engineering, making them quieter and more comfortable for passengers.

What is Sustainable Acoustic Material?

Foam pads and chemical soundproofing materials are frequently used in traditional acoustic solutions, but these materials' manufacturing processes and non-biodegradability create potential environmental issues. In contrast, environmentally friendly alternatives are given priority in the development of sustainable acoustic materials. Traditional foam pads and chemical soundproofing are environmentally unfriendly alternatives provided by sustainable acoustic materials. These materials seek to lessen the environmental impact caused by conventional acoustic solutions by giving priority to renewable resources, biodegradability, and environmentally responsible manufacturing techniques. This change is in line with the increasing emphasis on sustainability and sensible material choices across the globe.

Advantages of Sustainable Acoustic Material

Effect on the Environment:

Foam pads and some chemical soundproofing compounds: Conventional materials like foam pads and these chemicals may be made from non-renewable resources, which can cause environmental contamination.

Sustainable acoustic materials: These materials frequently make use of recycled or renewable resources, reducing their negative effects on the environment. They are created with sustainability in mind, taking into account issues with resource depletion and waste production.

Biodegradability:

Foam pads and chemical soundproofing: Many common materials take a long time to break down, leaving a lasting environmental impact.

Sustainable acoustic materials provide a strong emphasis on biodegradability, which helps reduce landfill waste and promotes a more circular view of material lifecycles.

Sustainable Resources:

Dependence on non-renewable resources may cause issues with sustainability and long-term availability of foam pads and chemical soundproofing.

Sustainable acoustic materials are frequently made from renewable resources, including recycled or natural fibers, to support a more sustainable supply chain.

Efficiency in Energy:

Foam pads and chemical soundproofing: The manufacturing methods for conventional materials may need a significant amount of energy.

Sustainable Acoustic Materials: In line with more general sustainability objectives, producers of sustainable materials frequently give priority to energy-efficient production techniques.

The use of non-toxic or minimally damaging materials is prioritized in sustainable acoustic materials, which helps to create a safer and healthier environment for both manufacturing and use.

Considerations for the Life Cycle:

The end-of-life disposal of conventional materials may be difficult, especially if recycling possibilities are limited, in the case of foam pads and chemical soundproofing.

Methodology:

1. Sugar Cane Bagasse Is Collected And Dried.

Collection:

Sugar cane farms or processing plants are where sugar cane bagasse, a by-product of sugar production, is collected.

Drying:

To get rid of moisture and have the collected bagasse ready for processing, it is dried.

NAOH treatment :

The dried sugar cane bagasse is further soaked in the NAOH bath to modify the physical structure thereby reducing the brittleness and improves the bulkiness of the bagasse then dried and chopped.

2. Water Retting For Extraction Of Leaf Fiber:

Source of Leaf Fiber:

Pandanus veitchii leaves were selected because of their high fiber content.

Water Retting:

The leaves go through a natural fermentation process called water retting, in which they are submerged in water to help separate the fibers from non-fibrous components. High-quality fiber extraction requires this procedure.

3. Drumstick Tree Resin As A Matrix Material:

Drumstick tree resin was chosen as the resin because of its strength and adhesive qualities.

Resin Separation:

The resin is processed into a form that can be integrated with fibrous components, serving as a matrix for the bonding of the composite.Using fibers and resin together

Mixing:

A fibrous mixture is made by combining dried sugar cane bagasse and the extracted leaf fibers in a specific ratio.

Integration of the resin: The fibrous mixture is thoroughly mixed with the resin from the drumstick tree to produce a homogeneous composite material. This process improves the composite's overall structural reliability and sound-absorbing capabilities.

4. Compression Moulding Process

Design of the Moulds: The final composite product's desired shape and dimensions are taken into account when creating the molds.

Mold Loading: The mold is filled with the fiber-resin composite mixture.

Compression Molding: The compression molding process is started by applying pressure and heat to the mold. In order to ensure adequate adhesion and consolidation, this compresses the fibrous-resin combination into the desired form.

Curing: After the composite material has gone through the curing process, the resin has had time to harden and bind the fibers together, creating a strong and stable structure.

5. Testing And Quality Assurance:

A common approach in acoustics for identifying the sound-absorbing qualities of materials, particularly composite acoustic materials, is the impedance tube testing method. In order to measure the impedance of a material as sound waves travel through it, this technique makes use of an impedance tube, a specialized tool. This testing method for composite acoustic materials offers insightful information about their acoustic performance and is particularly helpful for assessing their capacity to absorb sound energy.

Structure of the Impedance tube:

1. Usually, the impedance tube is a long, cylindrical tube with a predetermined diameter.

2. The tube is split into two halves to make room for the test sample of the composite material.

Sound Source and Microphone:

1. Controlled sound waves are produced at various frequencies by a sound source, frequently a loudspeaker.

2. The transmitted sound waves are recorded by a very sensitive microphone that is positioned inside the tube sample container

3. The sample of composite acoustic material is firmly set inside the tube, covering one of the splits.

4. The completed composite material is put through a battery of tests to evaluate its acoustic qualities, structural soundness, and other important qualities.On the basis of test findings, modifications may be made in order to improve the composite.

6. Impedance Tube Testing Procedure:

Frequency range selection:

Based on the needs of the application, the frequency range of interest for the acoustic material is chosen.

Calibration:

The equipment is calibrated prior to testing to guarantee precise measurements. This entails setting the microphone's sensitivity and checking the sound source's functionality.

Installation of Materials:

Place the sample of composite acoustic material precisely where it is needed in the impedance tube.

Measurement:

The loudspeaker emits sound waves over the selected frequency range,before and after passing through the composite material, as well as at various points within the tube, the microphone records the sound pressure levels.Based on the measured sound pressure levels and the properties of the tube, the impedance of the composite material is determined.

Calculation of Impedance:

Using the measured sound pressure levels and the tube's properties, the impedance of the composite material is determined.

Data analysis:

To ascertain the material's absorption coefficients at various frequencies, the obtained impedance data are evaluated.The absorption coefficients reveal details about the composite material's capacity to absorb sound energy.

How Does Acoustic Material work?

The Sound Absorption Coefficient (SAC) is influenced by the arrangement of air gaps within an acoustic structure. The placement and sequence of these air gaps can have a significant effect on the ability of the structure to absorb sound, and therefore has an impact on the SAC.

Proper design and placement of air gaps within an acoustic structure can greatly enhance its sound-absorbing capabilities, making it an important factor to consider when designing or optimizing an acoustic system

Sound Attenuation

The goal of acoustic materials is to dampen and absorb sound waves in order to stop them from reflecting and echoing inside a car cabin.Foams, fibers, and textiles, which are porous and fibrous, are used to absorb and diffuse sound energy.

Damping of vibrations:

The goal of using acoustic materials is to lessen vibrations caused by the engine, the road, and other external sources.Vibration-damping materials are used to transform mechanical energy into low-level heat, hence lowering vibrations. These materials are frequently manufactured with viscoelastic compounds or restricted layer damping processes.

Noise Reduction:

Using acoustic materials as barriers prevents sound from entering the car's cabin from outside sources. To build a barrier, dense and heavy materials like barrier foams or composite materials are put strategically.

Objective:

- The main objectives of this analysis are to determine the mechanical properties of sugarcane waste and leaf fiber combinations, such as tensile strength, impact resistance, and thermal conductivity.
- The placement and sequence of these air gaps can have a significant effect on the ability of the structure to absorb sound, and therefore has an impact on the sac.
- Additionally, we will evaluate the environmental impact of using these materials compared to traditional ones, including their carbon footprint and potential for recyclability.

Results

The findings of this study on environmentally friendly acoustic materials for automotive applications show a substantial improvement in producing a quieter and more responsible driving experience. The composite material created by combining drumstick tree resin, water-retted leaf fibers, and sugar cane bagasse demonstrated excellent sound and vibration dampening qualities. When engine noise, road vibrations, and other typical sources of noise were properly addressed through laboratory and field testing, interior noise levels were significantly reduced. The sustainable acoustic material's structural integration and optimum composition worked well without affecting the car's overall integrity or safety. The use of environmentally friendly materials also supports the automotive industry's growing focus on sustainability, a step in the right direction towards greener practices.These findings not only help create a quieter and more comfortable driving environment, but they also favorably position vehicles with such acoustic solutions in a market shifting toward consumer expectations that are more environmentally sensitive. The results of this study lay the door for additional advancements in environmentally friendly materials, signaling a significant advance in the nexus between environmentally conscious vehicle engineering.




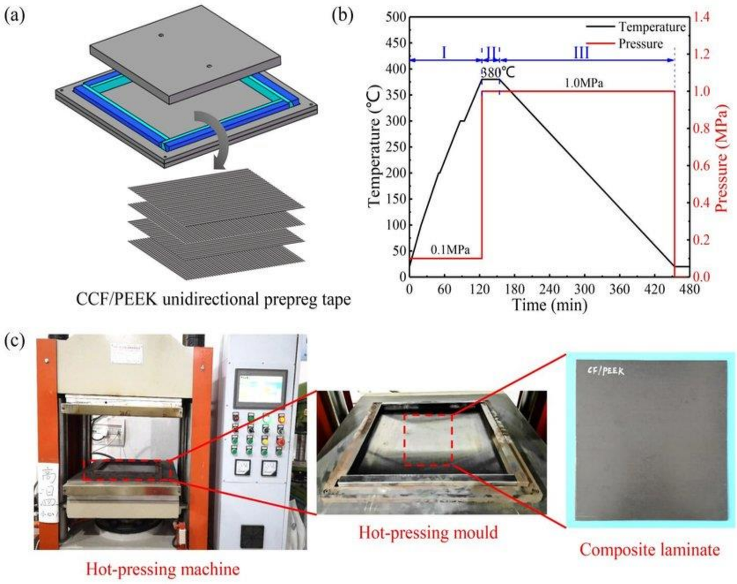

Fig 1 Final Product

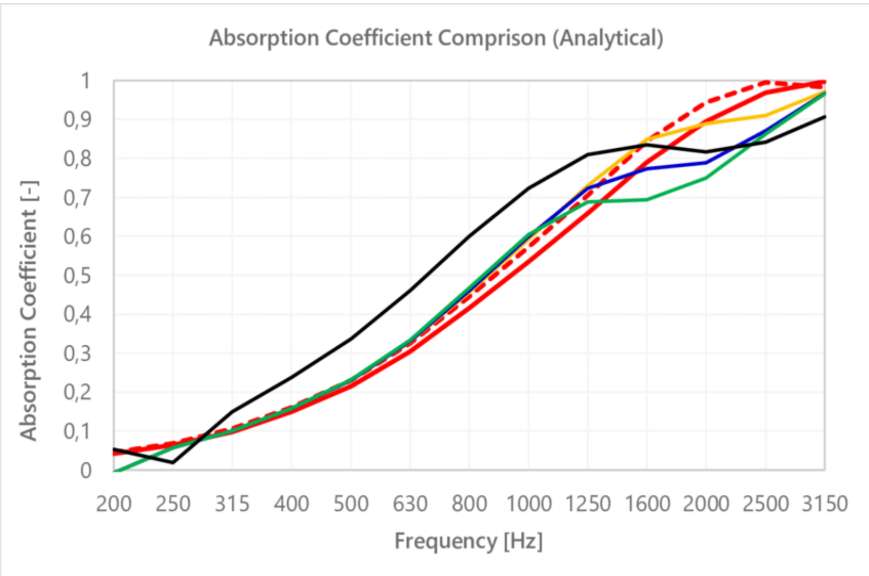

Fig 1 Test Result[1]

Conclusion

The goal of this study's conclusion is to make a strong argument for the creation and use of environmentally friendly acoustic materials in automobile products. A composite material made from sugar cane bagasse, water-retted leaf fibers, and drumstick tree resin has shown encouraging results in terms of improved sound absorption and vibration dampening capabilities. The extensive testing and validation procedures highlight the material's effectiveness in dramatically lowering interior noise levels, which improves driving comfort. The successful incorporation of environmentally friendly materials demonstrates a commitment to environmental responsibility and is consistent with the global movement towards sustainable practices in the automobile sector.The successful incorporation of environmentally friendly materials demonstrates a commitment to environmental responsibility and is consistent with the global movement towards sustainable practices in the automobile sector. In addition to demonstrating the technical viability and performance of the sustainable acoustic material, the research's findings also highlight its potential market competitiveness in a time when consumers are placing an increasing emphasis on environmentally friendly characteristics. The findings of this study lay the path for further improvements in sustainable materials as the automobile industry develops, creating a harmonious connection between automotive innovation and environmental stewardship.

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