International Journal of Research Publication and Reviews

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

Mechanical and Acoustic Characterization of Sound Insulating Material Using Agro Waste

Pitchika Naveen[1], Yesu Peketi[2], Undralla Sai[3], Shaik Subhani[4], Vuppala Satya Prasannam[5], Veerarouthu Dileep Kumar[6], Dr. M. Srinivasa Rao[7]

[1,2,3,4,5,6,7]*GMR Institute of Technology Rajam Vijayanagaram 532127*

A B S T R A C T

This work reveals that the characterization of mechanical and the acoustic performance of agricultural waste composites using banana fiber, rice husk, and midribs of coconut leaves in varying ratios for seven different samples. The outcomes demonstrate that the three-material hybrid composite performed admirably in terms of mechanical and acoustic properties. According to ASTM guidelines, the tests were carried out. In this work, we came to the conclusion as to which is superior in many circumstances. The midrib of a coconut leaf is stronger than the other composites (98 N/mm2 along the grains and 10.22 N/mm2 across the grains).Banana fiber has a maximum impact strength (IZOD) value of 0.036 j/mm2, and in combination samples, the hybrid composite has a maximum strength value of 0.0543 j/mm2. Impact strength (Charpy) was obtained for the hybrid material at 0.0643 j/mm2. The ultimate tensile stress for the hybrid materials composite has the highest value of 0.36in N/mm2 compared to the other materials. CLMR also has a higher ultimate tensile stress of 0.3 N/mm2. Rice husk has a high compression property with a value of 72.58 N/mm2. It is very poor at absorbing sound due to its low porosity. At 2500-4000 Hz, hybrid composites have a good sound absorbing coefficient value of 0.9. The obtained results identify the suitable composite for different mechanical and automotive applications.

Keywords: Mechanical properties, Reinforced polymer composites, Natural fibers. Banana Fiber, Rice husk, Coconut leaf mid rib (CLMR).

INTRODUCTION

We all are facing lots of sound pollution at outdoors. When the sound frequency is more it leads to health problems and in some cases, it leads to death also. So that in general sound pollution becomes a serious concern at far and wide. Now a days synthetic accoutrements used for aural immersion are replaced by natural accoutrements in order to improve the environmental health. In particular, the ranch remainders have been considered as valid raw material to manufacture sound gripping panels with low cost. These materials have no dangerous effect to mortal health, and are available in generous as waste product in agriculture farming cycle. Considering the Review of literature of former studies carried out by numerous authors on aural performance of naturally available ranch remainders, this paper reports the auricular performance of some ranch remainders of banana fiber, Coconut splint, rice cocoon. The Sound immersion measure for different samples with varying consistence have been measured. This study reveals that the aural performance of the ranch remainders as immersion panel are perceptible in the mid-range of frequency diapason considered for study

Overview of Argo waste

Agro waste refers to the residues and by-products generated from agricultural activities that are not intended for human consumption. Agro waste can be an environmental and economic challenge, but it can also provide opportunities for recycling, energy production, and value addition. For our study, we consider the Rice husk, Coconut mid leaf rib, Banana fiber.

Rice Husk:

Rice husk is a major by-product of rice milling, accounting for about 20% of the weight of the rice grain. Rice husk is composed of cellulose, hemicellulose, and lignin, and has a high silica content. Rice husk can be used as a fuel for energy production, such as in power plants or for heating, and as a raw material for the production of various products, such as activated carbon, biochar, insulation materials, and animal feed.

Banana fiber:

Banana fiber is a natural fiber extracted from the stem of the banana plant. Banana fiber is composed of cellulose, hemicellulose, and lignin, and is known for its high strength, flexibility, and biodegradability. Banana fiber can be used for the production of textiles, such as clothing, bags, and carpets, as well as for the production of paper, handicrafts, and other product

Coconut leaf mid rib:

Coconut leaf mid rib is the central stem of the coconut leaf. It is composed of cellulose, hemicellulose, and lignin, and is a by-product of coconut farming. Coconut leaf mid rib can be used as a raw material for the production of various products, such as handicrafts, furniture, baskets, and roofing materials.

Overall, agro waste such as rice husk, banana fiber, and coconut leaf mid rib can provide valuable resources for recycling, energy production, and value addition, while also reducing environmental pollution and waste.

LITERATURE SURVEY

Hariprasad. K set al. [1] delved the effect of natural fibers attained for compound medication from banana fiber with polypropylene. They studied that advanced aural immersion frequentness don't profit from an increase in consistence. They concluded that this compound material can used in automotive operations.

Tholkappiyan E et al. [2] has studied on development of banana corroborated paper pulp bio-composites. They noticed that memoir mixes as sound control accoutrements , their consistence has a considerable impact on the NRC(Noise Reduction Measure). It concluded that minimal density are considered for better aural performance.

Chattavirriya P et al. [3] has studied on sound absorber deduced from natural fiber as an alternate way. They observed that the lower rate of banana fiber-gypsum varied with the larger bulk viscosity. Acoustics of a space, structures, and enclosures are exemplifications of natural accoutrements can be used

Marques et al [4] Several by-products, including rice straw, cocoons, and bran, are made from rice products. Almost 20% of the weight of rice product is made up of rice cocoon, which is a major issue in rice-producing regions. Nowadays, rice waste materials are only partially recovered for animal coverlets. The remainder is burned or dumped, which has an adverse effect on the environment. If one takes into account the increased thermal performance and the decreased environmental impact across the life cycle, incorporating rice cocoon has advantages that are implicit. Weight loss results from the studied rice cocoon's apparent bulk viscosity, which ranges from 90 to 110 kg/m3.

Burrati C et al. [5] In general, a high porosity rating for a pervious material indicates good sound immersion. The acoustic test of the fused rice cocoon sample is better at low- mean frequentness(up to 4000 Hz), the maximum value is advanced(0.87) and it's attained at a lower frequency(2600 Hz rather of about 3500 Hz).

Gunasekhar Reddy.M et al. [6] The mechanical test of Natural fibers corroborated epoxy resin mixes showed bettered results when compared with pure epoxy resin. In addition, the compound with alkali treated fibers displayed a slightly advanced tensile and impact strength than the one with undressed fibers. The viscosity of the Hardwicke natural fibers is low compared to the synthetic fibers(Glass fibers, carbon fibers.), so these mixes can be regarded as a useful light weight Engineering. It can be concluded that alkali treatment of the natural fibers is necessary to get mixes with moderate mechanical parcels as well as better adhesion between fibers and matrix.

Pickering k et al. [7] studied the recent developments in natural fiber mixes and their mechanical performance. enhancement has passed due to bettered fiber selection, birth, treatment and interfacial engineering as well as compound processing. This paper has reviewed the exploration that has riveted on perfecting strength, stiffness and impact strength including the effect of humidity and riding on these parcels. Natural fiber corroborated mixes are compared with Glass fiber corroborated mixes in terms of stiffness and cost.

Kusno A et al. [8] The aural material from the coconut splint midrib can be distributed as a good sound absorber because it has an immersion measure value that's better than the ISO 11654 standard, which is a minimum of0.15. Grounded on the optimum immersion measure at each frequency (0- 1600 Hz) with a frequency interval of 100 Hz at low- frequency intervals (0- 500 Hz) the stylish results come from samples of crossing configurations of 50 mm and 75 mm thick.

Rusil M et al. [9] The frequency, composition, face, consistency, and mounting technique all affect the immersion packets. However, previous accessories are typically set up with a high sound immersion level. Enhanced consistency and viscosity raise the immersion factor. More fibers increase the amount of stored auricular pressure energy in the material. Materials with a 20 mm thickness and 0.1978 gr/cm3 viscosity may absorb sound to a maximum of 90 at frequencies of 3000 Hz, and theoretically even more at higher frequencies.

Peceno.B et al. [10] The compositions' compressive strength at ten times the distortion is designed to be adequate, and as the resin content grows, so does this strength. When a low resin rate is employed, the sound immersion is genuinely high, and this immersion rises as the sample lengths increase.

Silva DE et al. [11] Compared to normal complexion bricks, waste RHA added burnt complexion bricks have a better ability to separate sound. Between 4.5.5 kHz and 8 kHz, there was a sound drop of around 10 dB. After integrating waste RHA, the quantity and size of pores increased, which increased sound immersion. The RHA integrated slipup's high sound immersion or sound sequestration, although having low viscosity, can be attributed to its high porosity, one of the key factors in sound immersion.

Bakri et al. [12] A thicker material typically results in a more advanced sound immersion measure. Based on Zent and Long, a sample's ability to absorb sound depends on how thick it is, or vice versa (a sample's ability to absorb sound depends on how thin it is). Banana fiber's sound immersion value was set to be as high as 0.97 for changes in material consistency and 0.64 for changes in fiber periphery size.

Marques et al. [13] The effectiveness of cement-ground mixes created with rice cocoon intended for use in soundproof walls is assessed in this experiment. A variety of laboratory experiments were conducted to evaluate the mechanical, continuity, and auditory features of the mixtures since the aural walls are exposed to environmental factors and mechanical loads. The life cycle assessment (LCA) was designed to show that rice cocoon-containing materials are appropriate for sheeting aural walls because they provide good mechanical and aural performance.

Buratti et al. [14] In structure operations, recycled waste accoutrements are getting promising aural absorbers and in order to reduce the environmental impact. The end of the exploration is to estimate the aural, and environmental performance of recycled waste panels conforming of rice cocoon(RH) produced by clinging and pressing the raw material. Sound immersion portions were measured by means of the impedance tube.

Antonio et al. [15] The main ideal of the paper is to propose a new compound material incorporating rice cocoon. This paper reports an experimental study on the mechanical, and aural performance of new compound boards made of rice cocoon waste intended for construction operations. In this study, rice cocoon was mixed with expanded cork grains. A sufficient number of small boards were produced to perform small- scale tests and assess parcels similar as compressive strength, enhancement in impact sound sequestration, sound immersion and transmission loss.

Jose et al. [16] This study proposes a compound material that incorporates rice cocoon. This exploration focuses on an experimental analysis of the mechanical and aural performance of compound accoutrements made of rice- cocoon waste. Rice cocoon produces accoutrements with high porosity and permeability, and low sphericity and tortuosity. The rice- cocoon corroborated compound have a better sound immersion measure.

Wang et al. [17] This work evaluates the performance of mixes made with rice cocoon. In this composition, different quantum of RH(2, 5, and 8) was employed into the conformation of PU froth system. the measured results indicated that the sound immersion portions of PU- RH mixes increased at low frequency along with a small drop at high frequency on the addition of RH. And adding further RH will be helpful to ameliorate the low- frequency sound immersion performance of PU froth without adding the consistence.

Taban et al. [18] The purposeful operation of agrarian waste and logical aural models because of their outstanding benefits and an effective approach will encourage the usability of natural accoutrements (eco-friendly, cheap and effective aural products) in inner and out-of-door marketable operations.

Sangmesh et al. [19] The utilization of agricultural wastes has been shown to be an economically viable technological outcome for building construction accessories that might facilitate the use of natural coffers while maintaining energy security. Agro-waste generation also has negative environmental effects. Unavoidably, agro-waste is produced and burned after crop to clean up the tip. Agro-waste from crops including red gramme, sugarcane, and paddy cocoon produces 10 to 15 times more than actual products. In fact, borrowing local and environmentally friendly alternative construction equipment is quite required to meet the need for erecting construction equipment. Agro-waste has demonstrated the potential for applying sustainable essential tools to the construction industry.

Jing et al. [20] Agro-wastes can serve as in this enables-efficient and sustainable pozzolans for unborn concrete diligence. The objectification of these remainders into cementitious accoutrements has proven that the addition of wastes isn't only profitable to the terrain, but also brings about a great performance of concrete parcels. At present, rice cocoon ash is honored as the most applicable indispensable material for stormy ash, while other agrarian wastes are also being studied at a large scale. Generally, they've analogous characteristics to ordinary Portland cement and can be effectively used in construction.

Jayakumari et al. [21]Noise pollution causes damage to the heart, brain, kidneys, and liver and may produce emotional disturbance. Banana fibre is a strong natural fibre that can be easily blended with cotton fibre or other synthetic fibres to create blended fabric and textiles.The observation results ensured good activity with (banana fibre, polyethylene, and polyurethane) when compared with other different composites that were analysed for their sound properties and flame retardancy.

Mamtaz et al. [22] Agro waste are less expensive, more inexpensive, environmentally friendly, and have lower degrees of hardness, moisture resistance, and fire resistance due to their low specific weight. They have a high level of electrical resistance and are commonly accessible. the effects of climate change are made worse (CO2 absorption). posses efficient acoustic and thermal insulation. Less sound is absorbed by fibres with a larger diameter than by synthetic fibres.

Hariprasad et al. [23] Banana fiber is obtained from the pseudostem of banana plant is a lingo-cellulosic fiber which comes under the category of bast fiber which has a relatively good mechanical properties. It has good specific strength comparable to those of conventional material, like glass fiber and has a lower density then glass fibers. These fibers can be explored to develop various technical textiles which are the need of the hour. This study aims in developing technical textiles that can serve multipurpose uses like soundproof, fireproof and antimicrobial at the same time.

Bakri et al. [24] Due to changes in fibre diameter size, the sound absorption coefficient increases with flow resistance. It has been discovered that the sound absorption increases at lower frequencies, between 500 Hz and 2000 Hz, as the flow of resistivity increases and the fibre diameter expands.

Materials and Method:

Raw materials used in this experimental work are listed below:

i. Agro waste [Rice husk, Coconut leaves mid rib and Banana fiber]

ii. Epoxy resin[LY556] & Hardener

iii. Mould Release Silicone Spray

Rice husk:

Rice is the third most produced commodity in the world after sugar cane and maize, with more than 740 million tons per year. Rice hulls (or rice husks) are the hard protecting coverings of grains of rice. In addition to protecting rice during the growing season, rice hulls can be put to use as building material, fertilizer, insulation material, or fuel. Rice hulls are part of the chaff of the rice. The hull protects the grain during the growing season from pests. The hull is formed from hard materials, including opaline silica and lignin. The rice husk was collected locally and was sun dried for 5 days. Sun drying was necessary to remove the moisture from the husk. After t85he sun dried the rice husk is grinded into fine powder. The collected powders were sieved in 85, 125, microns were around 40 grams, for the present investigation we have taken this particle size.

Coconut leaf mid rib:

Coconut trees are the available in all over Asia continent, in olden days their leaves are used in house construction. Now technology we are using cement, so there is waste in according to leaves. They can used has for sound insulation.

Banana fiber:

Banana fiber is obtained from the pseudo stem of banana plant is a lingo-cellulosic fiber which comes under the category of bast fiber which has a relatively good mechanical property. The plant's pseudo-stem (trunk), where the banana fibers were found, was harvested. The pseudo-stem banana was divided into pieces and minced using a mincer. The peel and extra mass from the pseudo-stem of the banana plant are removed with the use of a shredding machine. To get rid of filth and dust, the fiber was carefully cleaned with tap water and then twice-distilled water. The banana fibers were afterwards sun-dried to reduce the moisture content by 15%. The banana fiber is next separated into various diameters and sieved to eliminate the dust. The lengths of the fibers collected and employed typically ranged from 1 to 10 mm.

Fig 1 Rice hus

Fig 2 coconut leaf mid rib

Fig 3: Banana Fibers

EPOXY RESIGN:

Thermosetting polymers known as epoxy resins have exceptional mechanical and resistant qualities. As the polymerization technique used to create them results in variable chain length, they are polymeric or semi-polymeric compounds and as such are seldom found as pure substances. Usually, stoichiometric or nearly stoichiometric amounts are used to heal them. Catalytic homo-polymerization of the epoxy resins or cross-linking with a hardener are two methods for achieving the exothermic reaction required for curing. Epoxy thermoset polymers with distinctive adhesion, durability, resistance, and adaptability are the end product of the curing process. Uncured epoxy resins often only have weak mechanical, chemical, and heat resistant qualities. Paints, adhesives, and composite materials with fiber glass and carbon fiber reinforcement are just a few applications for epoxy-based products. Epoxies are generally regarded as having good electrical insulating qualities, excellent adhesion, and chemical and heat resistance. The hardener component, not the epoxy resin itself, is frequently the one that poses the biggest risk when using epoxy. Most liquid epoxy resins are classified as skin and eye irritants when they are uncured. Epoxy resins in solid form are often safer than epoxy resins in liquid form, and many of them are considered non-hazardous compounds. Long-term exposure to epoxy resins causes an allergic response. We utilized Epoxy Ly556, a high-quality and durable epoxy resin, in our job. It has a very low amount of viscosity. Due to its low viscosity, it may enter extremely small fractures.

Hardener:

Hardener is used for curing the epoxy at room temperature. In our project we used Hardener Hy951 which has low viscosity. Epoxy resins with either Hardener HY 951 or Hardener HY 956 produce medium-viscosity adhesives that are ideal for bonding metals, ceramics, glass, rubber and plastics. The solvent-free epoxy adhesives produce chemical-resistant, electrically insulating joints with good mechanical strength. Curing takes place due to heat generated by the exothermic reaction.

MOULD RELEASE SILICON SPRAY:

It is an ultra-dry Silicone Mould Release that is formulated for use as a release Agent for the Injection Moulding & Thermo-Plastic Industries. Its spray pattern is super-atomized to coat the entire mould area, allowing for easy release of all thermoplastic materials from the mould and less wasted parts due to deformity. It improves moulding efficiency in many processes including injection, compression, transfer, vacuum form, pour cast, die cast, and extrusion moulding.

Fig.1 Epoxy Resign

Fig.2 hardener

Fig.3 Silicon spray

METHODOLOGY :

PREPARATION OF MATERAILS:

Rice husk, Coconut leaf mid rib and Banana Fibber are dried for 5 days in the sun light to remove moisture content after they are treated to remove dust particles. The rice husk and coconut leaf mid rib are powdered in to fine particles and banana fiber is combed to make each layer free from each other.

SIEVE ANALSIS:

A Sieve analysis is performed to assess the particle size distribution of a granular material and to decrease the size of the particle into different sizes. A Sieve analysis can be applied to any organic or non-organic granular materials. There are different types of sieves used for sieve analysis like 150 microns sieve and 75 microns sieve. In this work 85-micron sieve has been used. The filler which has been sieved into 85 microns used as filler for the preparation of composite.

Fig. 4 sieve analysis

Fig. 5 preparation of the mould

PREPARATION OF SAMPLES:

Fig 6.1: Mixing of resins

Fig.6.2: Applying silicon spray

Fig 6.3: Making sample

Fig.6.4: Making composite

Fig.6 Preparation of banana fiber composite

PREPARATION OF THE MOULD:

Reinforced epoxy composite was prepared by hand lay-up process. Galvanized iron sheet of thickness 0.3mm has been used. Seven moulds of size (15×15cm) with height of 3cm has been prepared, spot welding has been used for joining the edges of the mould. A G.I sheet mould (dimension 150 X 150 X 30mm) was used for casting the composite sheet. A mould release spray was applied at the inner surface of the mould for quick and easy release of the composite sheet. A calculated amount of epoxy resin and hardener (ratio of 10:1 by weight) was taken and mixed with gentle stirring to minimize air entrapment. Then, the composites according to samples are made.

7.1)

7.2)

7.3)

7.4)

7.5)

7.6)

7.7)

Fig. 7.1) Banana fiber, 7.2) coconut leaf mid rib, 7.3)Rice husk, 7.4) Banana fiber & Rice husk, 7.5)CLMR & Rice husk, 7.6)Banana fiber, CLMR, Rice husk, 7.7) Hybrid

MECHANICAL CHARACTERIZAION:

A) COMPRESSION TEST:

The capacity of a material or structure to support loads on its surface without cracking or deflecting is known as compressive strength. As a material is compressed, its size tends to decrease, and when it is stretched, its size elongates. The load applied at the point of failure to the cross-section area of the face on which load was applied is the formula for compressive strength for any material. taking samples with dimensions of 100mm long by 100mm wide by 10mm thick. The specimen is positioned in the middle of the two compression plates, with the moving head's center vertically above the specimen's center. The moveable head of the universal testing machine is used to apply load on the specimen. Until the specimen breaks, load is applied.

Compressive strength = maximum load / area across & along the specimen (j/mm^2)

Table-1 compression strength

S. No	Specimen	Load (KN)	Area along the grains (mm^2)	Area across the grains (mm^2)	Compressive strength along the grains (N/mm^2)	Compressive strength across the grains (N/ mm^2)
1	Rice husk	78	1073.58	10109.28	72.69	7.71
2	Coconut leaf Mid rib	103	1039.17	10078.17	98	10.22
3	Banana fiber	47	1053.19	10089.196	44.62	4.65
4	Banana fiber & Rice husk	45	1044.917	10043.04	43.06	4.48
5	Banana fiber& coconut leaf Mid rib	90	1045.43	10093.18	86.08	8.91
6	Rice husk & Coconut leaf Mid rib	43	1047.44	10075.13	41.05	4.26
7	HYBRID COMPOSITE	55	1038.34	10094.21	52.96	5.44

B) IMPACT TEST:

Impact testing is a type of mechanical test which is performed on the sampled material to measure the amount of absorbed energy during fracture. This test is applied widely in various industries such as oil and gas, petrochemical, automotive, and also the equipment, which used in the powerplants, steel structures, pharmaceutical, food industries, and so on. They are mainly two types: 1)Charpy Test 2)Izod Test

Since this method of testing is cheap and quick, it is performed on the used material for fabrication under the presence of the third-party inspection agency representative in the laboratory. A pivoting arm is raised to a specific height and then released. The arm swings down hitting a notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity. The test procedure for Izod & Charpy is similar, the only difference in between them is the arrangement of the specimen. The specimen measurement of the Izod is taken as 10×10×75 mm and for Charpy is taken as 10×10×55mm, and readings are taken in the joules and then find out the impact strength.

IMPACT STRENGTH = ENERGY ABSORBED / AREA OF SPECIMEN (j/mm^2)

Table-2 Impact (IZOD) Test

S.NO	MATERIAL TAKEN	LENGTH OF THE SPECIMEN (in mm)	DEPTH OF THE SPECIMEN (in mm)	WIDTH OF THE SPECIMEN (In mm)	CROSS SECTIONAL AREA OF SPECIMEN (in mm2)	ENERGY ABSORBED BY SPECIMEN (joules)	IMPACT STRENGTH (j/mm^2)
1	Rice husk	75	10.55	10.52	110.986	2	0.018
2	Coconut leaf mid rib (CLMR)	75	10.34	10.58	109.39	2	0.0182
3	Banana fiber	75	10.36	10.4	107.74	4	0.037
4	Rice husk + Banana Fibber	75	10.22	10.54	107.71	4	0.037
5	Rice husk + CLMR	75	10.49	10.22	107.2	2	0.018
6	Banana Fibber + CLMR	75	10.13	10.57	107.07	4	0.03712
7	Hybrid Material	75	10.31	10.5	108.32	6	0.055

Table-3 Impact (CHARPY) Tes

S.NO	MATERIAL TAKEN	LENGTH OF THE SPECIMEN (in mm)	DEPTH OF THE SPECIMEN (in mm)	WIDTH OF THE SPECIMEN (In mm)	CROSS SECTIONAL AREA OF SPECIMEN (in mm2)	ENERGY ABSORBED BY SPECIMEN (joules)	IMPACT STRENGTH (j/mm2)
1	Rice husk	75	10.27	10.72	104.97	2	0.019
2	Coconut leaf mid rib (CLMR)	75	10.43	10.5	110.46	2	0.0181
3	Banana fiber	75	10.31	10.4	108.92	4	0.036
4	Rice husk + Banana Fibber	75	10.59	10.46	119.35.	4	0.0335
5	Rice husk + CLMR	75	10.46	10.44	119.35	2	0.016
6	Banana Fibber + CLMR	75	10.59	10.46	115.8	4	0.0345
7	Hybrid Material	75	10.50	10.35	110.354	6	0.0543

C) TENSILE TEST

Tensile strength, maximum load that a material can support without fracture when being stretched, divided by the original cross-sectional area of the material. Tensile testing is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.

Table-4 Tensile Test

S.NO	MATERIATAKEN	LENGTH OF THE SPECIMEN (in mm)	DEPTH OF THE SPECIMEN (in mm)	WIDTH OF THE SPECIMEN (In mm)	CROSS SECTIONAL AREA OF SPECIMEN (in mm2)	ENERGY ABSORBED BY SPECIMEN (joules)	IMPACT STRENGTH (j/mm2)
1	Rice husk	75	10.27	10.72	104.97	2	0.019
2	Coconut leaf mid rib (CLMR)	75	10.43	10.5	110.46	2	0.0181
3	Banana fiber	75	10.31	10.4	108.92	4	0.036
4	Rice husk + Banana Fibber	75	10.59	10.46	119.35.	4	0.0335
5	Rice husk + CLMR	75	10.46	10.44	119.35	2	0.016
6	Banana Fibber + CLMR	75	10.59	10.46	115.8	4	0.0345
7	Hybrid Material	75	10.50	10.35	110.354	6	0.0543

D) HARDNESS TEST:

The Rockwell hardness test is a method consisting of indenting the test material with a diamond cone or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load 60kgf. The indenter used in this test is ¼ ball and the scale is L scale. When equilibrium has been reached, an indenter device, which follows the movements of the indenter and so responds to the change in depth of penetration of the indenter is set to a datum position. While preliminary minor load is applied in the resulting increase in penetration. When equilibrium has again been reaching, the additional major load is removed but the preliminary minor load is still maintained. Removal of additional major load allows a partial recovery, so reducing the depth of penetration. The permanent increase in depth of penetration, resulting from the application and removal of additional major load is used to calculate the Rockwell hardness.

Table -5 Hardness Test

S NO	MATERIAL TAKEN	SCALE READING	INDENTOR	LOAD (Kg.)	ROCKWELL HARDNESS			ROCKWELL HARDNESS NUMBER (RHN) Avg=$\frac{T1+T2+T3}{3}$
					Trail 1	Trail 2	Trail 3	
1	Rice husk	C scale	Cone indenter (diamond cone)	45kgf	1.25	1.23	1.08	1.186
2	Coconut leaf Mid rib	C scale	Cone indenter (diamond cone)	45kgf	0.38	0.29	0.51	0.393
3	Banana fiber	C scale	Cone indenter (diamond cone)	45kgf	0.39	0.42	0.62	0.47
4	Banana fiber& Rice husk	C scale	Cone indenter (diamond cone)	45kgf	0.35	0.51	0.37	0.41
5	Banana fiber& coconut Mid rib	C scale	Cone indenter (diamond cone)	45kgf	1.47	1.18	1.29	1.31
6	Rice husk & Coconut Mid rib	C scale	Cone indenter (diamond cone)	45kgf	0.36	0.39	0.48	0.41
7	Hybrid composite	C scale	Cone indenter (diamond cone)	45kgf	1.44	1.10	1.23	1.256

ACOUSTIC CHARACTERIZATION

Noise is undesirable sound that can be loud or disturbing to hearing, not just for humans but also for animals. Because of the change and periodic vibration in a medium, noise is a result of discordant sound in terms of mechanics and physics. Yet, how noise is really described depends on the listener. An emotional influence on the hearer might result from the place and fluctuation of the sound. For instance, anger, distraction, frustration, or stress can cause changes in the body's systems, including the brain. In order to manage the noise, we need what are known as "sound gripping accessories." The basic property of a medium is that when a sound wave strikes it, sound-absorbing accessories will absorb the majority of the sound energy and will reflect very little of it. These qualities make them useful in creating sound-absorbing panels for a space or a quadrangle. Many pervious, membrane, and resonance sound-absorbing accessories are available upon request. The mounting technique, frequency, composition, face, and consistency all have a significant impact on the immersion packets. Nevertheless, previous accessories are often set up with a high sound immersion level. Based on their minute configurations, previous absorbent accessories can then be divided into cellular, stringy, or grainy categories. In actuality, stringy pervious accessories like gemstone hair, glass hair, polyurethane, and polyester are frequently used. Moreover, mineral and polymer applications for noise reduction have skyrocketed. Polymers and materials grounded in minerals have a detrimental influence on the environment and create serious health problems since they are produced using high-temperature extrusion and artificial processes based on synthetic chemicals. So, it is necessary to locate essential sound absorbers with the aid of recycling, much like compound absorbers made of recycled rubber flyspeck, cellulose from recycled paper, granulates from tires, and the usage of cigarette sludge. Based on their minute configurations, previous absorbent accessories can then be divided into cellular, stringy, or grainy categories. In actuality, stringy pervious accessories like gemstone hair, glass hair, polyurethane, and polyester are frequently used. Moreover, mineral and polymer applications for noise reduction have skyrocketed. Polymers and materials grounded in minerals have a detrimental influence on the environment and create serious health problems since they are produced using high-temperature extrusion and artificial processes based on synthetic chemicals. So, it is necessary to locate essential sound absorbers with the aid of recycling, much like compound absorbers made of recycled rubber flyspeck, cellulose from recycled paper, granulates from tires, and the usage of cigarette sludge. The potential for developing recycled accessories as a sound-absorbing material is favorable. Another option is to use agricultural waste, which is completely biodegradable and whose processing may be made more efficient and ecologically friendly by new specialized advances. Rice cocoon, coconut coir, banana fiber from pseudo-stem, coconut splint medial caricature, sugarcane, lamb hair, pineapple-splint fibers, and other agricultural waste accessories have the potential to be transformed into strong gripping materials. Some of the agricultural waste that is readily available in Asia's mainland includes coconut coir fiber, banana fiber from pseudo-stems, rice fiber obtained after discarding rice grains, and pineapple splint fiber. The research of these waste's potential use as an interior sound absorber material is essential to maximizing their usefulness and marketability. The sound immersion properties of agricultural waste, such as banana fiber, coconut splint medial caricature, and rice cocoon, will be examined in this research. The color consistency and material viscosity are used to estimate the sound immersion measurement. The dimension uses a simple impedance tube with two microphones. The transfer function of both microphones is used to determine the samples' sound immersion measurement. TWO IMPEDENCE TUBE

EQUIPMENT SET UP

Measurement of sound absorption (ASTM E 1050). The measurement of sound absorption of the nonwovens was based on the method of ASTM E 1050: Standard Test Method for Impedance and Absorption of Acoustical Properties Using a Tube, Two Microphones and a Digital Frequency Analysis System. This method was developed to determine the ability of materials for absorbing normal incidence sound waves. A TWO IMPEDENCE TUBE measuring instrument was used for testing within the frequency range 0–4.5 kHz. This instrument includes Type 4206 Impedance Tube, PULSE Analyzer Type 3560. The testing principle of this system is illustrated in Fig:8. A sound source is mounted at one end of the impedance tube and the material sample is placed at the other end. The loudspeaker generates broadband, stationary random sound waves. These incident sound signals propagate as plane waves in the tube and hit the sample surface. The reflected wave signals are picked up and compared to the incident sound wave. We take a sample of dial (100 mm diameter) is set up for measuring the low frequency range from 0Hz to 1500 Hz, the high frequency range of 1500–2500 Hz and the high frequency range of 2500-4500 Hz. Four specimens were tested for the experimental acoustic composites.

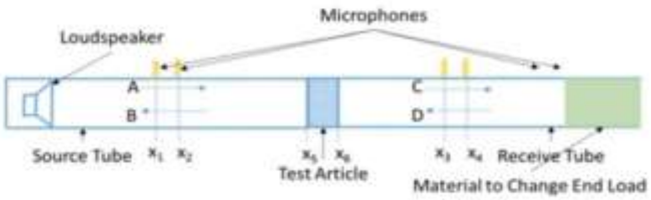


Fig:8 Schematic diagram of Two Impendence Tube

Fig:9.1 Fig:9.2 Fig:9.3 Fig:9.4

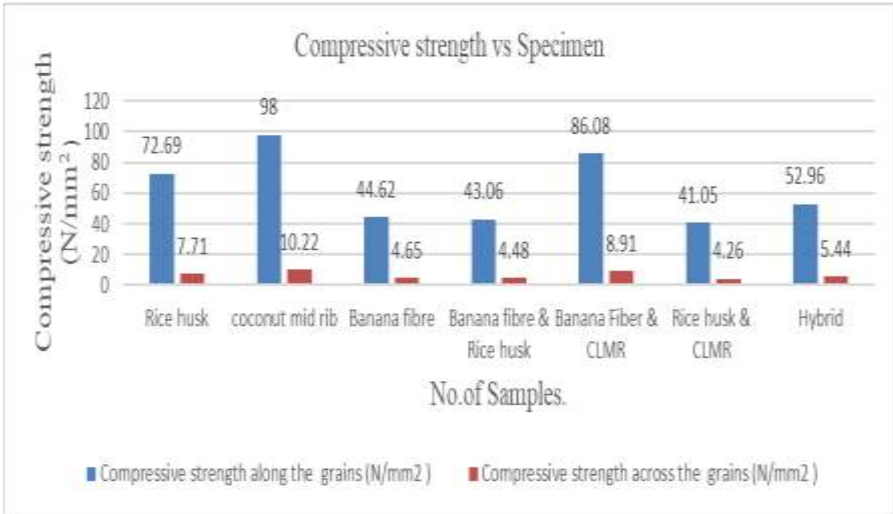
Fig:9.1 Banana fiber, 9.2:Rice husk, 9.3: Coconut leaf mid rib, 9.4: Hybrid

Table-6 Two impendence tube test

S.no	Material taken	Diameter (In mm)	Thickness (In mm)	Input Frequency Range (Hz)	Sound Absorption Coefficient
1	RICE HUSK	75	16	0-1500	0.35
				1500-2500	0.36
				2500-4500	0.6
2	Coconut leaf mid rib (CLMR)	75	15	0-1500	0.75
				1500-2500	0.93
				2500-4500	0.95
3	Banana Fiber	75	15	0-1500	0.69
				1500-2500	0.746
				2500-4500	0.7
4	Hybrid	75	15	0-1500	0.7
				1500-2500	0.88
				2500-4500	0.9

Results and Discussion:

A) Compression Test

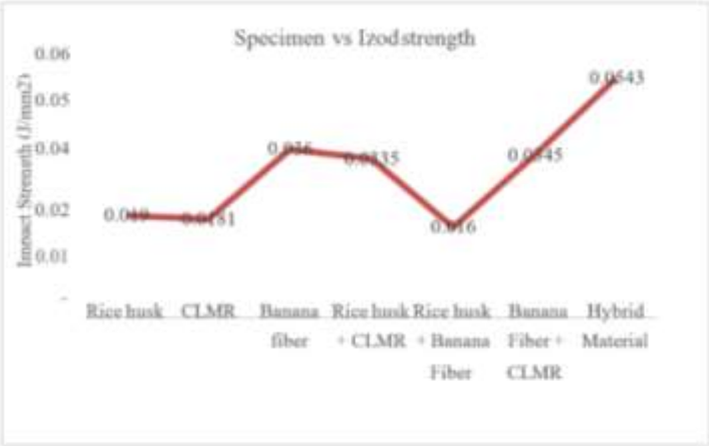


Graph 1: Compression Test

Analysis from graph:

- Graph 1 represents comparison between the compression strength in along & across the grains**,** of different materials.
- The statistics shows that the highest & lowest values of compressive strength in both along and across the grains.
- Coconut leaf mid rib has more strength of value (98N/mm^2 in along the grains & 10.22N/mm^2 in across the grains) compared to remaining composites.
- The combination of banana fiber with the CLMR have the more strength of 86.08N/mm^2 in combinations.
- Banana fiber has the medium value of the 44.62N/mm^2 in along the grains.
- Rice husk has the lowest strength 72.69N/mm^2 in along the grains of single composites.
- In across the grains, CLMR has more strength of 10.22N/mm^2 & banana fiber has lowest strength of 4.65N/mm^2 in single composites.
- In combinations Banana fiber & CLMR have the more strength of 8.91 N/mm^2, Rice husk & CLMR have the lowest strength of 4.26 N/mm^2
- Hybrid has the average value of 5.44 N/mm^2.

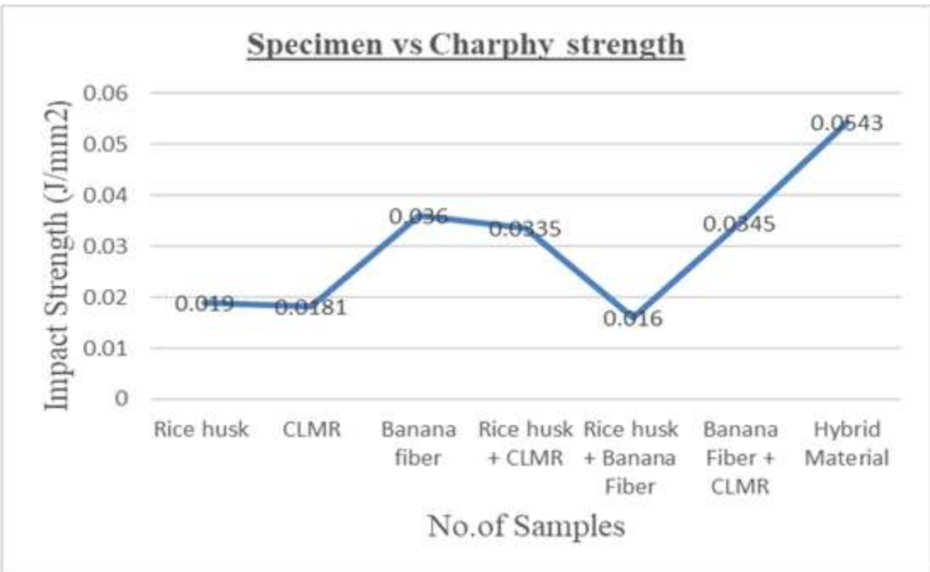
B) Impact Tests:



Graph-2 Izod test

Analysis from graph 2:

- This graph shows the comparison between the Impact strength (Izod) and different specimens
- In single composites, the Banana fiber has the maximum impact strength (IZOD) value of 0.036 j/mm2.
- The rice husk & CLMR have the minimum impact strength of 0.019 j/mm2 & 0.0181 j/mm2 respectively.
- In combination samples, the hybrid composite has the maximum strength value of 0.0543j/mm2 compared to all 7 samples.
- Rice husk & banana fiber has the poor impact strength value of 0.016j/mm2 compared to all 7 samples.4.

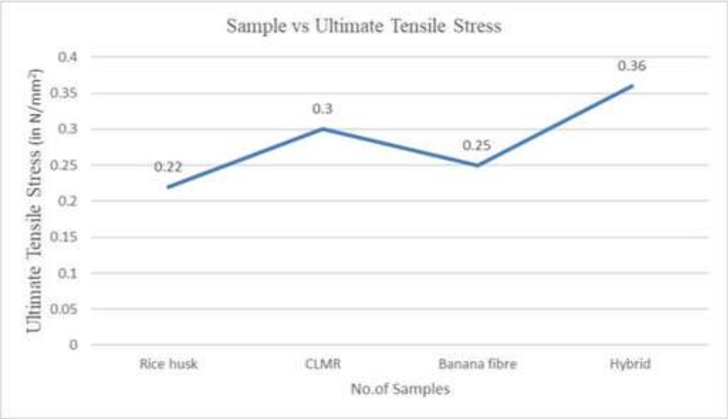


Graph-3 Charpy test

Analysis from graph 3:

- The above graph makes comparison between the impact strength (Charpy) between 7 samples.
- From the Charpy test better impact strength was obtained to the hybrid material with 0.0643j/mm2.
- Banana fiber has maximum strength value of 0.036 j/mm^2 in single composites.
- Rice husk and CLMR shows the least value of 0.019 j/mm^2, 0.018 j/mm2 of impact strength respectively.
- For Rice husk and banana fiber combination gives the minimum impact (Charpy) strength value of 0.016j/mm^2

C) Tensile test:

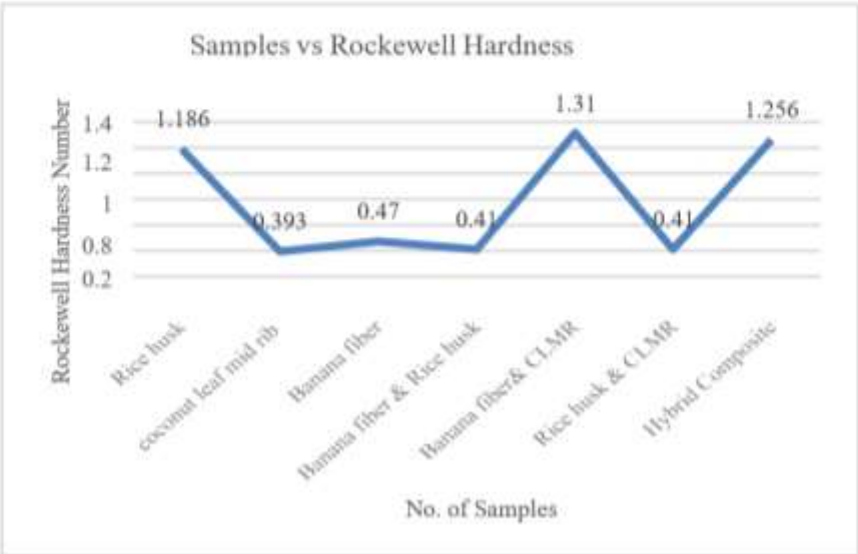


Graph-4 Tensile Stress

Analysis from graph 4:

- The Graph gives the comparison between Ultimate tensile stress vs Samples.
- The ultimate Tensile stress for the Hybrid materials composite has a highest value of 0.36in N/mm^2 compared to the other materials.
- The CLMR has also have the better ultimate tensile stress of 0.3 N/mm^2.
- The hybrid material can perform at higher loads and have a great property and long life while it can undergoes working conditions.
- The rice husk has the low value of tensile stress having 0.22N/mm^2.

D) Hardness Test:

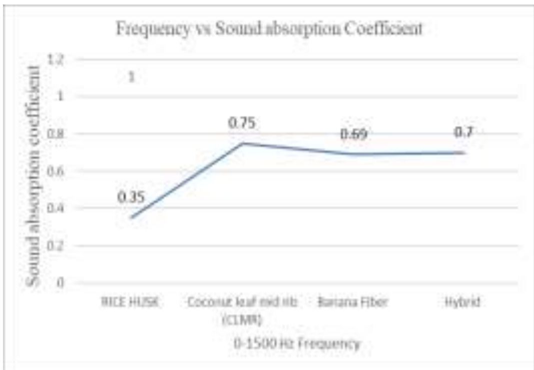


Graph-5 Hardness Number

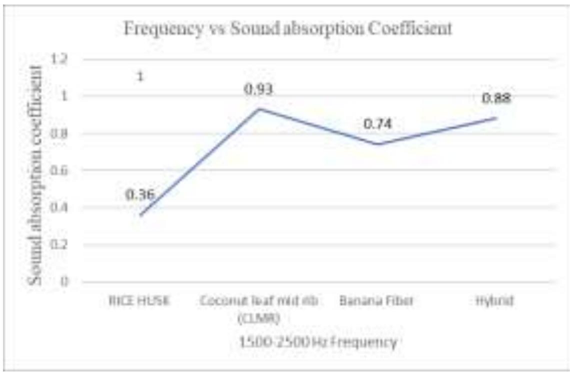
Analysis from graph 5:

- From the graph, the comparison between samples & Hardness number can be analysed.
- Rice husk gives the high hardness value of 1.186 in single composites.
- CLMR & banana fibre have the minimum value of 0.39 & 0.47 respectively.
- In combinations, Banana fibre & CLMR have the maximum hardness value of 1.31
- Rice husk & CLMR have minimum hardness value of 0.41.
- The hybrid material also performs well as it has highest hardness number of 1.256

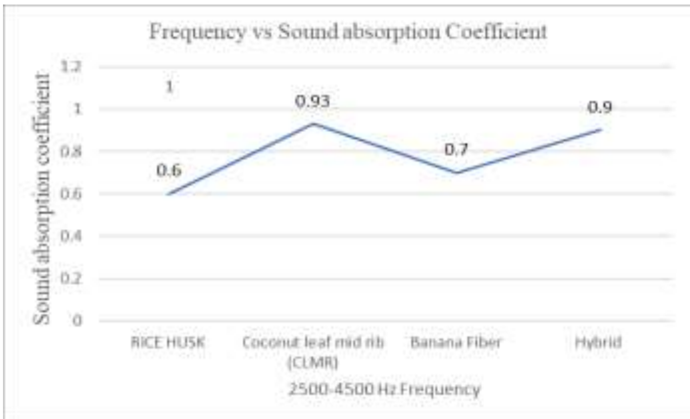
E) Sound absorbing Co-efficient:



a)



b)



c)

Graph-6 Sound absorbing Coefficient at a) 0-1500Hz, b)1500-2500Hz, c)2500-4500Hz.

Analysis from graph 6:

- The above graphs show the comparison between Sound absorbing Coefficient & Samples at different frequency of a)0-1500Hz, b)1500-2500Hz, c)2500- 4500Hz.
- Rice husk have low absorption coefficient at low frequency value & medium frequency range of 0.35 & 0.36 compared to other samples.
- But rice husk has above average absorption coefficient at high frequency range of 0.6.
- Coconut leaf mid rib has the better sound absorbing property at all frequency range.
- It has sound absorbing coefficient value of 0.93,0.95,0.93 at low frequency value & medium frequency range respectively.
- Banana fiber have the medium range absorption value 0.69, 0.74, 0.7 at the frequency of 0-1500Hz, 1500-2500 Hz, 2500-4000Hz respectively.
- Hybrid composite also have a good sound absorbing coefficient value of 0.7, 0.88, 0.9 at the frequency of 0-1500Hz, 1500-2500 Hz, 2500-4000Hz.

Conclusion:

- Coconut leaf mid rib has more strength of value (98N/mm^2 in along the grains & 10.22N/mm^2 in across the grains) compared to remaining composites.
- In single composites, the Banana fiber has the maximum impact strength (IZOD) value of 0.036 j/mm2. and in combination samples, the hybrid composite has the maximum strength value of 0.0543j/mm2 compared to all 7 samples.
- in single composites banana fiber has maximum impact (charpy) strength value of 0.036 j/mm2.
- Impact strength (Charpy) was obtained to the hybrid material with 0.0643j/mm2.
- The ultimate Tensile stress for the Hybrid materials composite has a highest value of 0.36in N/mm^2 compared to the other materials.

- The CLMR has also have the better ultimate tensile stress of 0.3 N/mm^2.
- Rice husk has the good compression property of having value of 72.58 N/mm2. It is very poor in absorbing of sound due to less porosity.
- Rice husk has average value of 0.35,0.36 and 0.6 at the frequency range of 0-1500 Hz, 1500-2500 Hz, 2500-4500 Hz respectively.
- Coconut leaf mid rib has the better sound absorbing property at all frequency range. It has sound absorbing coefficient value of 0.93,0.95,0.93 at 0-1500 Hz, 1500-2500 Hz, 2500-4500 Hz respectively.
- Banana fiber have the medium range absorption value 0.69, 0.74, 0.7 at the frequency of 0-1500Hz, 1500-2500 Hz, 2500-4000Hz respectively.
- Hybrid composite also have a good sound absorbing coefficient value of 0.9 at the frequency of 2500-4000 Hz.
- From the overall tests it is clearly stated that the Hybrid composite which is made up of the three material performed very well in all conditions like in both Mechanical and also in Acoustic conditions.
- Thus, the combination of banana fiber, rice husk and coconut mid leaf rib can used in construction sites like bulidings, movie theaters, and in automotive applications as sound absorbing materials.

Acknowledgements

We would like to thank our project guide who is helping us to accomplish or project work as soon as possible.

References:

1. Ricciardi, P., 2018. Rice husk panels for building applications: Thermal, acoustic and environmental characterization and comparison with other innovative recycled waste materials. *Construction and Building Materials*, *171*, pp.338-349.
2. A study on the potential of sugarcane fibers/polyester composite for tribological Applications, El-Tayeb N.S.M, volume 2(2008),13 pages wear 265 (2008) 223–235.
3. Banana fiber- reinforced biodegradable soy protein composites, Rakesh Kumar, Veena Choudhary, Saroj Mishra, Varma IK , volume 5(2008), 8 pages, DOI 10.1007/s11458-008-0069-1. Kusno, A., Ishak, M.T., Rahim, R., Hamzah, B., Mulyadi, R., Jamala, N. and Anggraeni, R., 2020, June. Coconut Leaf Midribs as an Acoustical Panel–Feasibility Study through Impedance Tube
4. Hariprasad, K., Ravichandran, K., Jayaseelan, V. and Muthuramalingam, T., 2020. Acoustic and mechanical characterisation of polypropylene composites reinforced by natural fibres for automotive applications. *Journal of Materials Research and Technology*, *9*(6), pp.14029-14035.
5. Tholkappiyan, E., Saravanan, D., Jagasthitha, R., Angeswari, T. and Surya, V.T., 2016. Prediction of acoustic performance of banana fiber-reinforced recycled paper pulp composites. *Journal of Industrial textiles*, *45*(6), pp.1350-1363.
6. Chattaviriya, P., Supawantanakul, D., Sangsirimongkolying, R. and Sua-iam, G., 2022. Thai Cultivated Banana Fibers as The Sustainable Sound and Heat Insulation Materials. *The Journal of Industrial Technology*, *18*(1), pp.63-74.
7. Marques, B., Tadeu, A., Antonio, J., Almeida, J. and de Brito, J., 2020. Mechanical, thermal and acoustic behaviour of polymer-based composite materials produced with rice husk and expanded cork by-products. *Construction and Building Materials*, *239*, p.117851.
8. Buratti, C., Belloni, E., Lascaro, E., Merli, F. and Method. In *IOP Conference Series: Materials Science and Engineering* (Vol. 875, No. 1, p. 012007). IOP Publishing.
9. Rusli, M., Irsyad, M., Dahlan, H. and Bur, M., 2019, August. Sound absorption characteristics of the natural fibrous material from coconut coir, oil palm fruit bunches, and pineapple leaf. In *IOP Conference Series: Materials Science and Engineering* (Vol. 602, No. 1, p. 012067). IOP Publishing.
10. Peceño, B., Perez-Soriano, E.M., Ríos, J.D., Luna-Galiano, Y., Cifuentes, H. and Leiva Fernández, C., 2022. Morphological analysis of porosity and sound absorption in sustainable materials from rice husk. *Building Acoustics*, *29*(3), pp.387-399.
11. De Silva GHMJS, P.B., 2018. Effect of waste rice husk ash (RHA) on structural, thermal and acoustic properties of fired clay bricks. J Build Eng 18: 252–259.
12. Bin Bakri, M.K., Jayamani, E., Soon, K.H., Hamdan, S. and Kakar, A., 2017. An experimental and simulation studies on sound absorption coefficients of banana fibers and their reinforced composites. In *Nano hybrids and composites* (Vol. 12, pp. 9-20). Trans Tech Publications Ltd.
13. Marques, B., Almeida, J., Tadeu, A., António, J., Santos, M.I., de Brito, J. and Oliveira, M., 2021. Rice husk cement-based composites for acoustic barriers and thermal insulating layers. *Journal of Building Engineering*, *39*, p.102297.

14. Buratti, C., Belloni, E., Lascaro, E., Merli, F. and Ricciardi, P., 2018. Rice husk panels for building applications: Thermal, acoustic and environmental characterization and comparison with other innovative recycled waste materials. *Construction and Building Materials*, *171*, pp.338-349.

15. Peceño, B., Perez-Soriano, E.M., Ríos, J.D., Luna-Galiano, Y., Cifuentes, H. and Leiva Fernández, C., 2022. Morphological analysis of porosity and sound absorption in sustainable materials from rice husk. *Building Acoustics*, *29*(3), pp.387-399.

16. António, J., Tadeu, A., Marques, B., Almeida, J.A. and Pinto, V., 2018. Application of rice husk in the development of new composite boards. *Construction and Building Materials*, *176*, pp.432-439.

17. Wang, Y., Wu, H., Zhang, C., Ren, L., Yu, H., Galland, M.A. and Ichchou, M., 2019. Acoustic characteristics parameters of polyurethane/rice husk composites. *Polymer Composites*, *40*(7), pp.2653-2661.

18. Taban, E., Amininasab, S., Mehrzad, S., Fattahi, M., Tajik, L. and Samaei, S.E., 2022. Comparison of Experimental and Empirical Approaches for Determination of Sound Absorption Properties of Bagasse and Cornhusk Fibers. *Journal of Natural Fibers*, *19*(14), pp.9024-9038.

19. Sangmesh, B., Patil, N., Jaiswal, K.K., Gowrishankar, T.P., Selvakumar, K.K., Jyothi, M.S., Jyothilakshmi, R. and Kumar, S., 2023. Development of sustainable alternative materials for the construction of green buildings using agricultural residues: A review. *Construction and Building Materials*, *368*, p.130457.

20. He, J., Kawasaki, S. and Achal, V., 2020. The utilization of agricultural waste as agro-cement in concrete: A review. *Sustainability*, *12*(17), p.6971.

21. Jayakumari, M., Manonmani, G. and Divya, R., 2017. Development of sound proof material with flame retardant property using natural and synthetic composites.

22. Mamtaz, H., Fouladi, M.H., Al-Atabi, M. and Narayana Namasivayam, S., 2016. Acoustic absorption of natural fiber composites. *Journal of Engineering*, *2016*.

23. Hariprasad, K., Ravichandran, K., Jayaseelan, V. and Muthuramalingam, T., 2020. Acoustic and mechanical characterisation of polypropylene composites reinforced by natural fibres for automotive applications. *Journal of Materials Research and Technology*, *9*(6), pp.14029-14035.

24. Bin Bakri, M.K., Jayamani, E., Soon, K.H., Hamdan, S. and Kakar, A., 2017. An experimental and simulation studies on sound absorption coefficients of banana fibers and their reinforced composites. In *Nano hybrids and composites* (Vol. 12, pp. 9-20). Trans Tech Publications Ltd