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An Experimental Study on Thermal And Acoustic Performance of Mixed (Coir, Banana and Jute) Natural Fiber Reinforced Epoxy Composites

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Abstract: This main aim of our research work is to develop a composite material having sound proof and thermal insulating property, by using natural materials. Currently many synthetic materials are used to get sound proof and thermal insulated composite material, but these materials are very harmful for our environment and also costly. So we used natural materials. In this research work we use mixture of coir, banana and jute fibre as a reinforced material and epoxy as a binder. To prepare composite material firstly we crushed the natural fibres, dried for 1 week in presence of sunlight after that required amount and proportion of these natural fibres are mixed with epoxy and 4 samples were prepared. After 24 hours a hard composite material is obtained. After that we go for testing to know whether this material possesses desired properties or not. Unitherm TM Model 2022 testing machine is used for measurement of effective thermal conductivity and for acoustic test the two mouthpiece exchange work technique is used. According to reading on increasing the weight fraction of mixed natural fibre, the thermal conductivity of composite material decreases and the sound absorption capacity increases. So we use this material in houses, industries, cold storage or other places where desired temperature and noise reduction is required.

Keywords: Mixed natural fibre, effective thermal conductivity, sound absorption capacity, weight fraction of mixed natural fibre, epoxy.

I. INTRODUCTION

Natural fibres such as Jute, Coir, Sisal, bamboo, pineapple, banana, bagasse etc. are found abundant, in India. We can use these materials in various field according to our use but most of these fibres are not effectively used and thrown as a waste. We can use these fibres in place of woods in houses and construction sectors. By using these natural fibres in composite materials we increase the profitability and creates an extra source of income to farmers.

A. Requirement of Acoustic Insulation

Sound insulation means the prevention of acoustic energy or noise that are transmitted from one side of the building wall to other side. In today's fast growing modern world, there are large numbers of electrical, electronic and Mechanical devices are used by us. Industries have focused on the problem of noise Pollution produced by them. Due to growth of production, new innovations, large amount of construction, there is a need of latest sound reduction technologies. Usually carbon fibre, glass fibre and polymer fibres are used as soundproofing materials to restrict or absorb sound energy but they are expensive and are made up of synthetic materials which are further harmful for environment. Due to this we go for their natural alternate such as Jute, bagasse, coir, cotton, sisal, paddy, linen and hemp etc. for sound absorbing. They are ecofriendly, recyclable, cheap, biodegradable and easily available. For such significant problems, a natural fibre substitute such as coir, jute, bagasse, paddy, linen, ramie and sisal are most used renewable resources that can be used as sound absorbing materials.

B. Requirement of Thermal Insulation

The main purpose of thermal insulation is to maintain the temperature inside the houses or buildings irrespective to their ambient temperature. It reduces the heat flow rate due to this the temperature inside the house is maintained for a long time. So we tried to improve the thermal insulating property of composite material with the help of natural fibres.

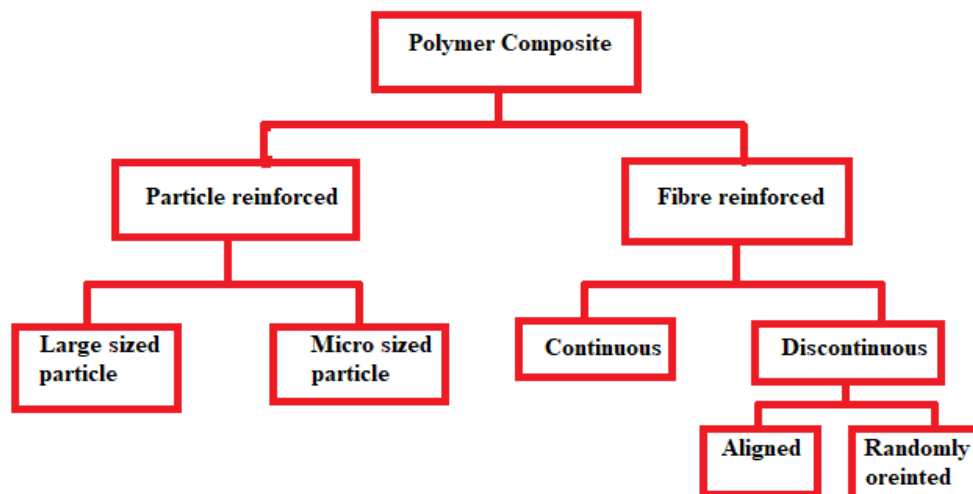


Figure 1. Types of composites on the basis of reinforcement.

II. RELATED WORK

Lots of work had been done by the researchers to improve the different properties of cellulose polymer composites.

Vijay Kumar Thakur et al. [1] deep and widespread knowledge regarding polymer composite is obtained. In this we also know about recent researches and applications related to natural cellulose fibers. Cho et al. [2] mechanical behavior of carbon epoxy composite is studied. N. Uddin et al. [3] most recent progress in fiber reinforced polymer and their application in field of engineering were also discussed. New techniques and designs related to fiber reinforced polymer composites were discussed. Nikkeshi S. et al. [4] thermal properties of reinforcing polymer with varying weight percentage were measured. Result shows that on increasing weight percentage of reinforcing material the thermal diffusivity and thermal conductivity increased. Young R.J et al. [5] fortifications of silicate particles with epoxy resin were made and its mechanical properties with different volume of particle were examined. The result shows that on increasing volume percentage of silicate particles the compressive yield stress and young's modulus increases. Lewis T. et al. [6] fortifications of solid glass beads with epoxy resin were made and a numerical simulation of thermal conductivity is analyzed by finite element analysis process. The result shows that on increasing volume fraction of the solid glass beads the thermal conductivity of composite material increases in a parabolic manner. Toshio Kondo et al. [7] best acoustic properties were designed by fortifying two or more materials. Poisson's ratio below 0.1 is obtained whose composite materials are unidirectional. The density and resonance velocity are calculated. Mihai Bratu et al. [8] composite material fortified with wastes and their sound absorbing capacities are measured with varying proportion. The sound absorbing properties of various samples are measured and the result shows that the waste product effects the acoustic property of composite material. Subhankar Biswas et al. [10] natural fibres like bamboo, jute and coir are reinforced with epoxy resin are used for measuring the tensile strength. N. Uddin et al. [11] the applications of fibre fortified polymer composite is discussed. Modern techniques a designs were also discussed. Ropota I. et al. [12] the solid waste materials are reinforced with organic resin because for sustainable development it is necessary to adopt natural material in place of synthetic. Here good compressive strength are obtained by using solid waste as filler material.

III. METHODOLOGY

A sample is prepared from the mixed natural (coir, banana fibre and jute) fibre reinforced epoxy composite moulded in a round shaped mould. Further this sample is used for measuring acoustic absorption capacity and thermal conductivity. Here the sample is prepared in two stages. In first stage we prepare the natural fibre according to our desired quality and in second stage moulding is done. So in first stage mixed natural fibre (coir. Jute & banana) was cut into 3-4 mm length. At this stage we tried to dry these fibres in presence of sun for at least 10 days. Before mixing it is heated at 80 °C for 5 minutes to make it completely dry. At the time of mixing natural fibre with matrix material, four different weight fraction is mixed with matrix material. And the matrix material contains epoxy and hardener having proportion of 1:1. Afterward four samples are manufactured by straightforward hand layup procedure. The natural fibre mixed epoxy which is moulded in barrel shaped glass. At that point, at long last the semi fluid castings are kept at ambient temperature for 30 hours. After that the solidified composite material samples are taken out by broking the glass moulds. Further testing is done to find the thermal conductivity coefficient and sound absorption coefficient.



Figure 2. Prepared sample in different weight fraction

IV. RESULT

The equation of Effective thermal conductivity is mentioned above is used for calculation for a variety of weight fractions at 0gm, 1gm, 2gm, and 3 gm of mixed (coir, jute & banana) natural fibers samples. The experimental result of variation in thermal conductivity of mixed natural fiber composite material is mentioned in Table 1 and its graph is plotted in figure 3

Table 1 Variation of thermal conductivity with fibre weight fraction

| Serial No. | Weight Fraction (gm) | Tensile Strength (MPa) |
|------------|----------------------|------------------------|
| 1 | 1gm | 5.56 |
| 2 | 2gm | 6.81 |
| 3 | 3gm | 6.96 |
| 4 | 4gm | 5.87 |

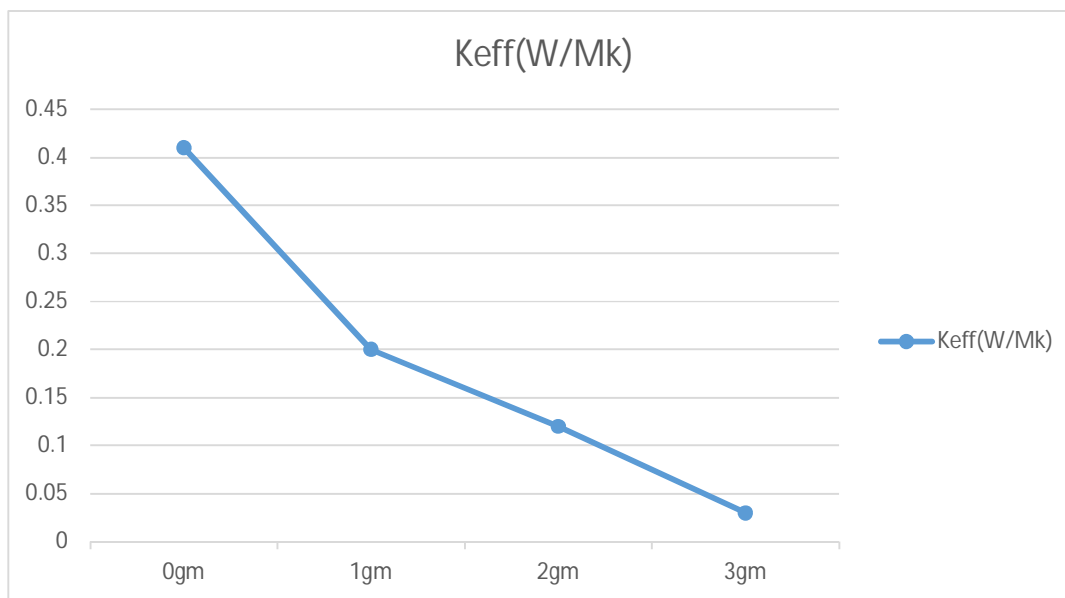


Figure 3. Variation of thermal conductivity with different weight fraction of natural fiber

The experimental data related to sound absorption coefficient of mixed (coir, jute & banana) natural fiber reinforced epoxy composite is mentioned in table 2 and the graph is plotted in Figure 4. Table 2 gives information about the variation sound absorption with the variation of absorption coefficient for 0gm, 1gm, 2gm and 3gm weight fraction of mixed (coir, jute, banana) natural fibre at various frequencies from. 500 Hz to 4000 Hz

Table 2 Variation of absorption coefficient at various frequencies

| Sr.No. | Weight Fration (gm) | Absorption Coefficient (H_z) | | | | | | | |
|--------|---------------------|----------------------------------|--------|--------|--------|--------|--------|--------|--------|
| | | 500Hz | 1000Hz | 1500Hz | 2000Hz | 2500Hz | 3000Hz | 3500Hz | 4000Hz |
| 1 | 0gm | 0.162 | 0.170 | 0.182 | 0.210 | 0.320 | 0.505 | 0.519 | 0.570 |
| 2 | 1gm | 0.220 | 0.260 | 0.299 | 0.370 | 0.450 | 0.597 | 0.637 | 0.689 |
| 3 | 2gm | 0.285 | 0.292 | 0.315 | 0.395 | 0.471 | 0.610 | 0.649 | 0.702 |
| 4 | 3gm | 0.301 | 0.305 | 0.330 | 0.415 | 0.450 | 0.645 | 0.710 | 0.760 |

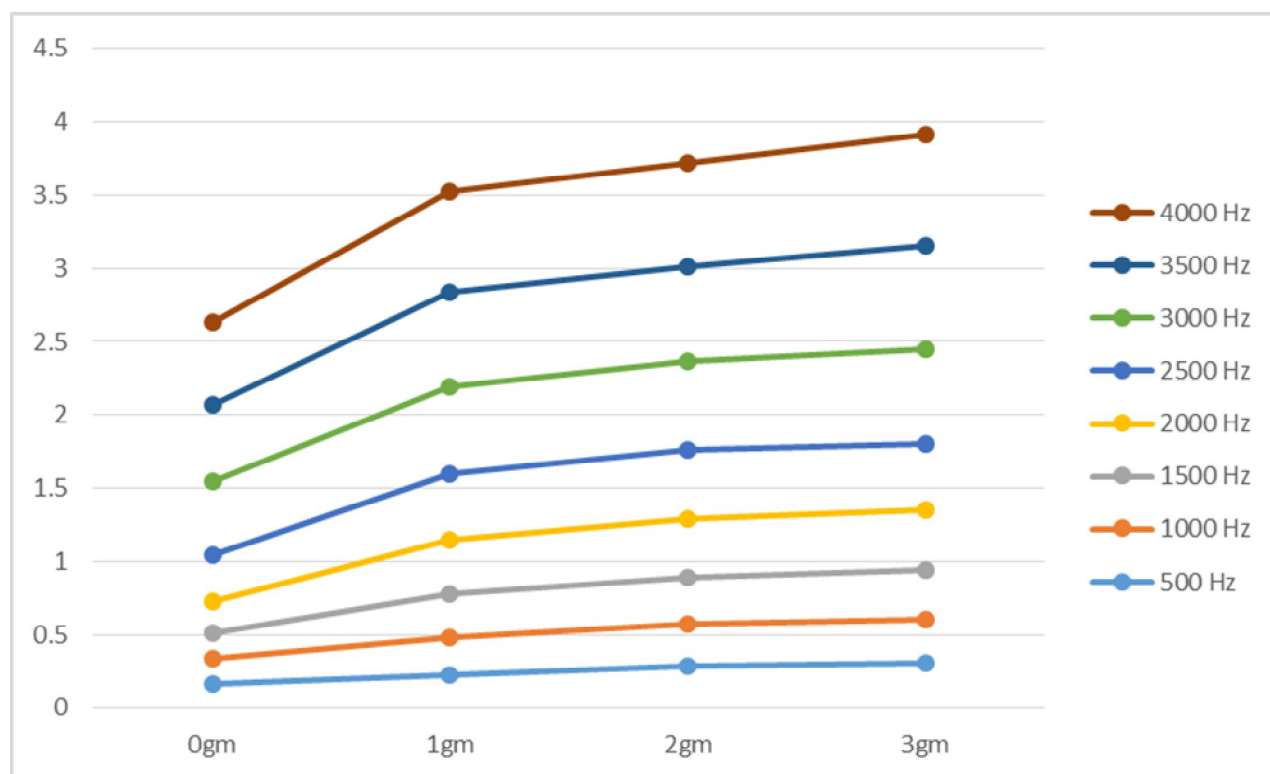


Figure 4. Variation of absorption coefficient at various frequencies

V. CONCLUSIONS

- The By simple hand layup technique successful fabrication of mixed (coir, banana & jute fibre) natural fibre reinforced epoxy composites is done
- On adding mixed natural fibre, thermal conductivity of material is remarkably decreases.
- On adding mixed natural fibre, acoustic absorption coefficient is remarkably improved.
- On adding 0gm, 1gm, 2gm and 3gm of mixed natural fibre the thermal conductivity decreased to 51.2%, 70.2%, and 92.7% respectively.
- On adding 0gm, 1gm, 2gm and 3gm of mixed natural fibre, Between 2.5 KHz – 4 KHz a good sound absorption is found with average absorption coefficient of 0.64 and the result is really appreciable compared to traditional synthetic absorber.



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