EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF SISAL, JUTE AND BANANA FIBER HYBRID COMPOSITE

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ABSTRACT. Now a day's characteristic fiber polymer composite have been utilized as a part of place of engineered fiber strengthened composite in view of biodegradability, light weight, non-peril, insecurity, decreased condition tainting, negligible exertion and effortlessness to recyclability. This research work presents an experimental study on the development of natural polymer hybrid composite. Sisal, jute and banana fibers are used as reinforcement with epoxy resin to from hybrid composite specimen. Natural fibers surface was treated with 1 % of sodium hydroxide for three hours. The fiber compositions in each specimen are 1:1 while the resin and hardener composition respectively. The created composites were tried according to ASTM norms to assess the mechanical properties as rigidity, flexural quality. The mechanical properties additionally anticipated by utilizing the rules of hybrid mixture and compare with experimental results. The anticipated outcomes were contrasted and exploratory outcome and found that test result is nearer to anticipated consequences of rules of hybrid mixture (RoHM). The flexural quality and modulus is higher incentive than elasticity and modulus of composite. It was discovered that the quality and modulus increments with increment in volume portion up to half of fiber content.

Keywords: Polymer hybrid composite, Rigidity, Flexural quality, Rules of hybrid mixture (RoHM)

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INTRODUCTION

Natural fiber composites combine natural fibers which are extracted from plants with polymer matrix. Natural fiber composites are also known as bio-composite. Now a days natural fiber polymer composite has been used in place of synthetic fiber reinforced composite because of biodegradability, light weight, non-danger, instability, diminished condition, contamination, minimal effort and simplicity to recyclability [Sreekala et al.]. In the previous days some regular fiber like coconut fiber and characteristic elastic latex were utilized by the car business. Yet, now day's normal filaments have step by step substituted by recently created man-improved fiber on account of its execution [Geethamma et al.].

The natural fiber polymer compositehas many applications in the electrical field, for example, wire and link sheathing and protecting against electromagnetic interface required the polymer to the mode directing with a specific end goal to scatter electrostatic charges [Haseena et al.]. Characteristic fiber, for example, jute, banana, sisal and coir, pineapple leaves, cotton have pulled in consideration of researchers and technologist for a few applications like purchaser products, minimal effort lodging and common structures and normal polymer composite have better electrical obstruction warm and higher protection from facture[Oksman et al.]. On the other way natural fiber composites have some disadvantage. Many investigations have been done on the potential of natural fiber composite in many times it shows that the natural fiber polymerpossesses great solidness however the composite don't achieve an indistinguishable level from glass fiber composite [Oksman et al.]. Points of interest and inconveniences of common fiber composite have been given underneath [Cao and Qiang, Lee et al., Li et al., Meheta et al.]

Natural fiber as a substitution to man-made fiber in fiber reinforced composite have expanded and opened up modern potential outcomes and used different chemical modification on natural fiber which was used in natural fiber reinforced composite. The chemical treatments were done for the improvement of the grip between the fiber and matrix. Water retention of composites was diminished and their mechanical properties are moved forward [Li et al.]. In hybrid natural fiber composite there are two or more different types of natural fiber used in the same matrix. The properties of hybrid composite rely on the fiber content, fiber introduction and length of every fiber and fiber framework holding. The mechanical properties of hybrid composite can be assessed utilizing the run of cross breed blend condition which is generally used to foresee the quality and modulus and crossover composite [Fu et al., Mirbagheri et al.].

The objective of this research work is to study the mechanical properties of sisal, jute and banana fiber by incorporating them into epoxy resin for preparation of hybrid composite of various volume fractions. The composites were tested to evaluate the tensile and flexural properties.

RULES OF HYBRID MIXTURE

By seeing a hybrid composite framework comprises of three single composite arrangements and accepting that there is no cooperation between the three single frameworks. As there is no communication between three strands, it can apply the iso- strain condition to the three system i.e.$\epsilon_{hc}=\epsilon_{jf}= \epsilon_{bf} = \epsilon_{sf}$ (1)

Where, ϵ_{hc} is the strain of hybrid composite, ϵ_{jf} is the strain in jute fiber, ϵ_{bf} is the strain in the banana fiber andϵ_{sf} is the strain in the sisal fiber.At that point the modulus of half breed composite can be assessed utilizing RoHM condition by ignoring the association between three frameworks as takes after

$$E_{hc}= E_{c1}V_{c1} + E_{c2}V_{c2} + E_{c3}V_{c3} \quad (2)$$

WhereE_{hc},E_{c1}, E_{c2}, E_{c3} are elastic modulus of hybrid composite. V_{c1},V_{c2}, and V_{c3} are relative hybrid volume fraction of the first, second and third system respectively. It should be considered that the expressions listed below are valid for the assumed system.

$$V_{c1} + V_{c2} + V_{c3} = 1 \quad (3)$$

$$V_{c1}= V_{f1}/V_t \quad (4)$$

$$V_{c2} = V_{f2}/V_t \quad (5)$$

$$V_{c3} = V_{f3}/V_t \quad (6)$$

$$V_t= V_{f1} + V_{f2} + V_{f3} \quad (7)$$

Where V_t is the total reinforcement volume fraction in additional (V_{f1} + V_{f2} +V_{f3}) should be used as a reinforcement volume fraction for calculation of the elastic modulus [Lee et al.].

EXPERIMENTAL PROGRAMME

Materials

Table 1 Properties of Natural Fiber

PROPERTIES	JUTE FIBER	BANANA FIBER	SISAL FIBER
Cellulose (%)	60-70	65	66
Hemi cellulose (%)	12-21	18	13
Ligini (%)	11.5-13.5	6	8.9
Moisture content (%)	13	10	11
Density (kg/m^3)	1300-1500	1345	1460
Flexural modulus (Mpa)	10-15	3-6	13-18
Tensile strength (Mpa)	100-350	56	70
Young's modulus(Mpa)	11-30	3.5	3.8

Natural fibers used for making sample are sisal, jute and banana fiber supplied from kovai green fibers, Chennai and materials are used. The properties of fibers are given in Table 1. Here Aralidite Aw106 epoxy and hardener used for making of composite. It is taken from local dealers of Rourkela. Epoxy and hardener mixed 1:10 proportion for making composite.

Fabrication of Sample

Alkaline treatment is the one most common chemical treatments of natural fiber, in this research, all the fibers were treated with sodium hydroxide with 1% by weight of water concentration and soaked in the solution for 3 hours. After three hours fibers were washed out in running water and kept for open drying. In this research hand lay-up process was used to fabricate polymer composite reinforced with jute, sisal and banana fiber composite. The composites were manufactured by varying the weight division of fiber ranging 10 wt%, 30 wt% and 50 wt% and the fibers were considered 1:1 by ratio at each volume fraction. The epoxy resin and hardener weighted in the required proportion.

After that process first a releasing sheet was put down and spry heavy duty silicon on the sheet for release the composite from the releasing sheet. After that epoxy and hardener mix applied to releasing sheet, then one layer of one fiber placed on epoxy mix. Then the fibers were compressed with a hand roller. Then the rolling process, then the epoxy mix was placed on the fibers and placed and rolling process repeat. After that epoxy mix applied on the top of fiber then another releasing sheet applied top of the fiber stacking then some load put on the top of the composite and keep it for 48hours for curing. After the 48hours releasing sheets are separated and specimens were cut by jaw saw machine for required size.

Testing of Composite Specimen

Tensile test

The tensile behavior of hybrid composite specimens was prepared ASTM standard D3039. The tensile specimens with 150mm long, 25mm wide and 6mmthickness were prepared. The tensile specimen is held in testing machine by wedge action grip. Then specimens were tested at a strain rate of 1mm/min using UTM machine. In each of volume fraction three numbers of specimens were tested and average value obtained as shown in Figure 2.

Flexural strength test

Three point bending tests were performed according to ASTM standard D790 to measure flexural properties. The specimens were 150 mm long, 25 mm wide and 6 mm thickness. Then the specimens were tested at a strain rate of 1mm/min using UTM machine. In each of volume fraction three numbers of specimens were tested and average value obtained. Flexural test results of specimens are shown in Figure 3.

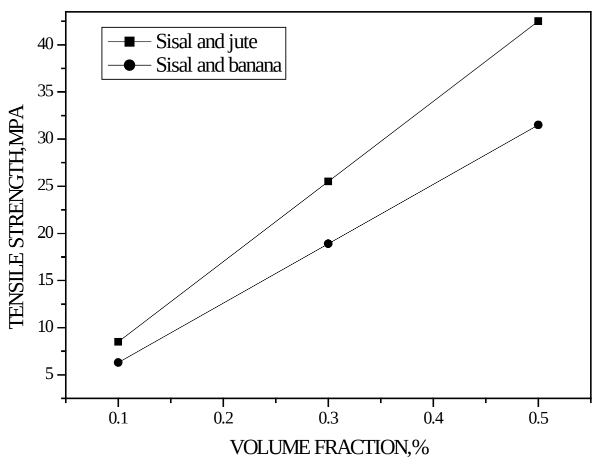

Figure 1 RoHM tensile strength results comparison between sisal-jute and sisal-banana composite

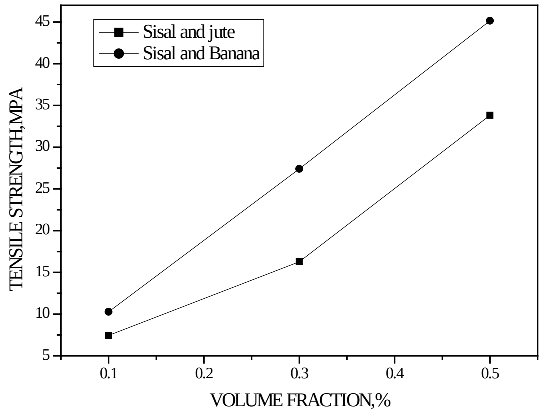

Figure 2 Tensile strength results comparison between sisal-jute and sisal-banana composite

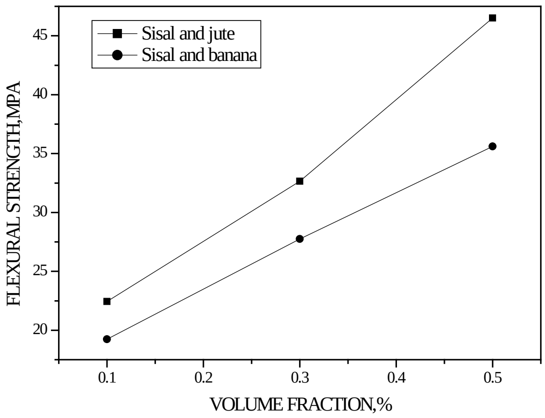

Figure 3 Flexural strength results comparison between sisal-jute and sisal-banana composite

RESULTS AND DISCUSSION

The predicted tensile strength and experimental tensile strength of hybrid composites were shown in Figure 1 and Figure 2. Figure1 and Figure 2 shows that the tensile strength of two hybrid composite increases to the 50% of volume fraction. Figure 1 show that predicted tensile strength of sisal-jute hybrid composite is more than the sisal-banana hybrid composite. Figure 2 shows that the experimental tensile strength of sisal-jute and sisal-banana hybrid composite. The tensile strength of sisal-banana composites is more than the sisal-jute hybrid composite. In the Figure 1 and Figure 2 the experimental tensile strength is increases more than the predicted tensile strength and the sisal-banana hybrid composite gives better performance than the sisal-jute hybrid composite. Figure 3 indicates that the flexural strength of hybrid composites. It shows that the flexural strength test results of sisal-jute is more than the sisal-banana because banana fiber is poor in cellulose content so it weak fiber reduces the stiffness of fiber. Due to this phenomenon is not improving the flexural properties. It was also observed that the tensile strength and modulus of jute and banana fiber composite is lower than other composite and similar results also obtain in case of flexural strength.

CONCLUSIONS

In this study, the details and symmetric experimental investigation were carried out on mechanical properties of natural hybrid composite. The influence of different volume fraction natural fiber on hybrid composite also investigated. The tensile strength of hybrid composite was studied using RoHM equations. It is also observed that the experimental result is slight higher than the predicted result. Chemical treatment improves the mechanical properties of fiber. In the test results of chemical treatment of natural fibers, the interfacial adhesion between the polymer and natural fiber increased. It leads to a reduction in voids which in terms caused a reduction in moisture uptake. Flexural strength was increased with increased in fiber content and it is light weight hence it can be used in automobile industries, building construction, aerospace engineering etc.

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