Experimental Analysis of Mechanical and Thermal Properties of the Natural Fibre Reinforced Polymer Composites

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Abstract - *This study deals with the preparation of natural fibre reinforced composite and to study the various mechanical and thermal aspect of different samples. The samples were made by varying the concentration of banana fibre in 10%, 15% & 20% by weight while polyester was kept constant whereas catalyst & accelerator were taken in 2% by weight of polyester. Banana fibres were subjected to alkali treatment with a view to improving the wettability of banana fibres by a commercially available resin such as polyester. Hand lay-up moulding method was used to fabricate the composite materials. Mechanical test such as hardness and tensile tests were performed at room temperature while impact test of thermally treated samples were taken at 30ºC, 60ºC and 100ºC. Hardness increases with the addition of banana fibre loading, but the rate of increase is maximum at 10%-15% fibre loading as compared to 15%-20% fibre loading. Tensile strength were increases as increase with the addition of coir fibre loading, but the rate of increase is maximum at 10%-15% fibre loading as compared to 15%-20% fibre loading. The impact strength increases with the addition of banana fibre loading. At 30ºC the impact strength maximum at 20% fibre loading, but the rate of increase is higher at 10%-15% fibre loading as compared to 15%-20% fibre loading. At 50ºC the impact strength maximum at 20% fibre loading, but the rate of increase is higher at 10%15% fibre loading as compared to 15%-20% fibre loading. Similarly at 100ºC the impact strength maximum at 20% fibre loading, but the rate of increase is higher at 10%-15% fibre loading as compared to 15%-20% fibre loading.*

***Key Words*: Polymer Composite, Polyester, Banana fibre, Chemical treatment, Mechanical properties.**

1. INTRODUCTION

Composite materials are being widely used in recent period for day to day applications and at the same time they possess a vital role in manufacturing of highly sophisticated machines and equipment also. Composite materials has many advantages over the conventional materials such as light weight, simple and cheap manufacturing process and also have comparable properties of their constituent materials So the main task for researchers are to improve the properties of composite materials according to the application and make them more durable, weightless and cost effective. Composites consists of two phases one is called discrete phase called reinforcing material, which may be fibre, particulate or flakes and the other is a continuous phase which termed as matrix material which possess the major share of composite material. In a composite material components like matrix and fibres are bounded together but its main difference from an alloy is that its constituents will retain their own identity and properties If we define composite materials, it is a unique combination of fibre and matrix where function of the fibre is to withstand load and make the composite stiffer meanwhile matrix is a binder which holds the fibre in place. Composite shows advantages like low weight, low density, low cost and good specific properties like tensile, flexural and impact strengths. Fibre composites are having lot of advantages and applications which are bio degradable, economical and non-toxic. Hence, they are replacing conventional materials in aerospace, automotive, agriculture and construction industries. Natural fibres such as Abaca, sisal, jute, acacia, ramie, hemp, flax, bamboo and banana are preferred in general in industries for making composites using epoxy and polystyrene resin. Normally, hand layup method is preferred for making composites because of its simple procedure and low cost. Sometimes, when requirement is high, compression moulding and other machine moulding processes are employed. This paper mainly reviews the banana fibre based composites which have wide application in industries. The abundant availability of banana fibres is an added advantage.

2. Material Description

1. The banana fiber is obtained from banana plant, which has been collected from local sources. The extracted banana fiber were subsequently sun dried for eight hours then dried in oven for 24 hours at 105° C to remove free water present in the fiber. The dried fiber were subsequently cut into lengths of 10, 15, 20 mm. The banana fiber based polyester composite is fabricated using hand lay-up process. The molds have been prepared with dimensions of 180×180×40mm.

2. Polyester is defined as the long-chain of polymers which are chemically composed of 80% by weight of a dihydric alcohol and a terephthalic acid and ester. Polyester resin is durable, comparatively inexpensive, has superior corrosion resistance, has good range of mechanical properties, it is a general purpose polyester resin is used as matrix material. One of earliest use of polyester was to make polyester suits– all the rage in the 70s. PET bottles are today one of the most popular uses of polyester. Polyester resin is purchased from Aishna fibres aliganj, lucknow.

3. Curing or cross-linking of polyester is achieved by adding a catalyst (initiator) at room temperature. The function of catalyst is to speed up a chemical reaction by providing an alternate reaction pathway with lower activation energy. In this work, Methyl Ethyl Ketone Peroxide (MEKP) catalyst is used.

4. Curing or cross-linking of polyester is achieved by adding an accelerator (promoter) at room temperature. The function of accelerator is to alter chemical bonds and speed up the chemical process. In this work, cobalt accelerator is used.

(a)banana fiber, (b) Catalyst, (c) Accelerator (d) Polyester resin.

3. Experimental Procedure

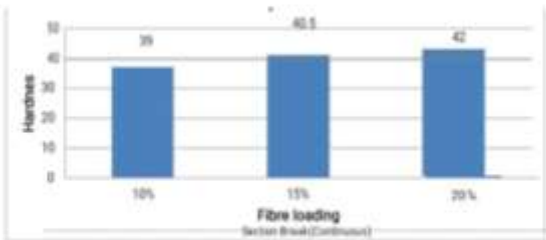
Fabrication of composite is done by conventional method called hand lay-up method. A mold of dimension 210 × 210 × 40 mm3 is used. Mold releasing silicon spray is applied to mold releasing sheet because the purpose of releasing agent is to facilitate easy removal of the composite from the mold after curing. Take the required mass of polyester resin in a measuring jar, add required amount of catalyst to the resin and stir it fast and then add required amount of accelerator to the mix and stir it fast which is shown in fig Extreme caution should be taken in ensuring that the catalyst and accelerator does not get into direct contact with each other, else they both react chemically extremely rapidly. Immediately apply this paste on bottom of the fibers and then on the top of the fibers which are filled in the mold, otherwise it would solidify rapidly in the measuring jar itself. To ensure that no air bubbles are trapped inside, take a transparency sheet and cover it over the mold immediately by using rolling operation. This mixture is allowed to set inside the mould under the weight of 20 kg for 24 hrs until the composite cures. The final composites sheet after curing and cutting of composite sheet into desired specimen for mechanical and thermal test.

(a) Material (b) weighting of polymer (c) weighting of natural fiber (d)composite sheet under the pressure (e) Prepared composite sheet, (f) Cutting of composite sheet into desired specimen

4. Result and discussion

4.1 Effect of different fiber loading on hardness test:

The hardness values of composites are show in Figure. It can be understood from the figure that the hardness value increases with increase in fiber length and it is maximum at 10 mm fiber length. However, with increase of fiber loading hardness value increases up to fiber loading 15 wt. % then the hardness value decreases.

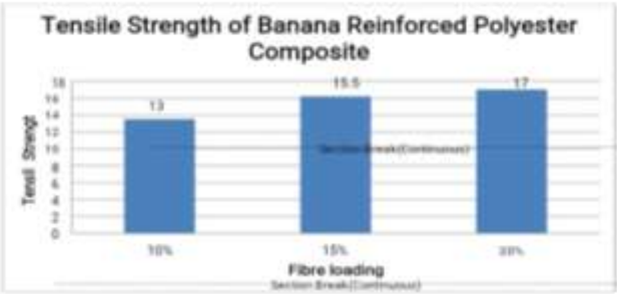


Bar Chart for Hardness strength at different fibre loading

Hardness test sample

4.2 Effect of different banana fiber loading on tensile test:

The mechanical behavior of the banana fiber based polyester composites depends on fiber parameters. The influence of fiber length and loading on tensile properties of composites is shown in Figures. It has been observed that the tensile strength of composites increases with increase in fiber length and loading.

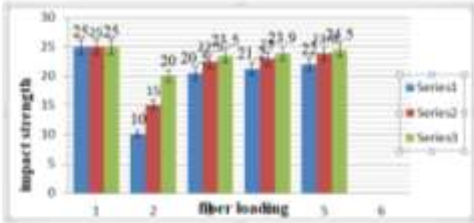


Bar Chart for Tensile strength at different fibre loading

Tensile test sample

4.3 Thermal effect of different banana fibre loading on impact test:

The effect of different banana fibre loading on impact test in banana polyester reinforced composite is shown in fig. Izod impact testing machine is used for measuring the impact strength of the composite samples. The specification of the specimen is 75mm×10mm×10mm with notch depth of 2 mm and a notch of angle of 45° were prepared. The impact behavior of banana fibre reinforced composite was studied based on impact strength. This specimen of 75mm×10mm×10mm was kept in oven for 30 minutes at 50ºC and 100ºC.three different samples of 10%,15% and 20% of coir concentration at three different temperatures 30ºC,50ºC and 100ºC were subjecting to impact testing. It was observed that at room temperature the impact strength values was higher at 10%-15% banana fibre loading as compared to 15%-20% banana fibre loading, similarly for 50ºC and 100ºC these values were continuously increased. Many researchers reported thermal impact of different temperatures on impact strength. Similarly Zafer Ozdemir and Osman Selim Turkbas studied the impact strength at various conditions.



Bar Chart for impact strength at different fibre loading at different temperature (30°c, 50oc, 100°c)

Impact Test Sample

5. Conclusions

The present review explore the potentiality of banana fiber composites, emphasizes both mechanical and physical properties and their chemical composition. Properties of banana fibers are superior as compare to other natural fibers. The utilization and application of the cheaper goods in high performance appliance is possible with the help of this composite technology. Combining the useful properties of two different materials, cheaper manufacturing cost, versatility etc., makes them useful in various fields of engineering, high performance applications such as leisure and sporting goods, shipping industries, Aerospace etc. If we talk about the future of banana fibers, are very bright because they are cheaper, lighter and environmentally superior to glass fiber or other synthetic fibers composites in general. Hence, with this back ground, it is concluded that, the composites stand the most wanted technology in the fast growing current trend.

After the three test conducted it was observed that there was a good improvement in the tensile strength after the reinforcing with banana fibre. There was an increase of about 30 to 40% in the tensile strength. With increase in the fibre loading there was good improvement in all three cases but the increase from 15% to 20% loading was not very significant. The impact strength improved to about 20-30% with increase in fibre loading. It was observed that there was a good improvement upto 15% loading but after that the strength started decreasing. The hardness test was conducted showed great improvement at 10% loading. The hardness improved at 15% loading but after loading with 20% the improvement was minor.

1.The fabrication of banana fiber based polymer composites with different loading of fibers and the different length of fiber is possible by hand lay-up process.
2. From the current experiments results, it has been observed that fiber loading and length has major effect on the mechanical properties of the composites like as hardness, tensile strength, and impact strength.
3. It has been observed that the better mechanical properties

found for composites reinforced with 10 mm fiber length with 15% fiber loading.

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