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Evaluation of Mechanical Properties in Banana Fibre Reinforced Polymer Composites

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Abstract* — Uses of natural fibre-reinforced thermoplastic composites are gaining popularity in automotive, cosmetic, and plastic lumber applications. Natural fibres such as cellulose, jute, coir, banana, sisal, palm etc. are used as an alternative to synthetic fibres e.g. glass, carbon, etc. These fibres are advantageous to the synthetic fibres because of having renewable character, acceptable specific strength properties, low cost, enhanced energy recovery and biodegradability. Natural fibre-reinforced polymer composites combine good mechanical properties with low specific mass and these composites are having increasing interest for producing structural materials for housing, railways, aerospace etc. Along with other natural fibres, banana fibre is also used widely as reinforcing agent in thermoplastics. Biological fibre-reinforced composite has the potential to improve the physical or mechanical properties for a wide range of potential application. The properties of some natural fibres have been investigated and the reported results showed promising utilization of some of them as an alternative to glass fibre in many application. In this present work treated (with NAOH) banana (of 3cm length) and jute fibres are used as the reinforcing material. Epoxy-banana & jute fibre reinforced composites were prepared for different weight content of fibres by using hand layup moulding technique. Mechanical properties of different types of prepared composites were characterized.

***Indexed Terms* — Composites, Hand lay-up, Epoxy, Banana fibre.**

I. INTRODUCTION

Much work is done in the application of natural fibre as reinforcement in polymer composites. In India, banana is abundantly cultivated. Banana fibre can be obtained easily from the plants which are rendered as waste after the fruits have ripened. So banana fibre can be explored as a potential reinforcement. Thermo set resin commonly used in engineering applications is epoxy. Epoxy has better mechanical properties but it is costly. The thermoplastics offer recycling possibilities whereas the thermosets achieve improved mechanical properties [6]. Polyester resins are low cost materials, but have inferior mechanical properties. Vinyl ester resins make a compromise between the above two limits. They have properties comparable with epoxy, but are available at low cost. Plant fibre polymer composites are used in interior parts of automobiles. Researchers have reported that the mechanical properties can be improved by appropriate surface treatments. With the increase in surface area, the cellulose micro fibrils get exposed, which in turn improves the wettability and impregnation. In the present work, the fibres were treated with NaOH to increase the wettability. Banana fibres are used as reinforcement in epoxy resin and the effect of fibre volume fraction in the composite is studied.

II. CHEMICAL TREATMENT OF FIBRES

Figure 1. Banana fibre

Banana fibres as shown in figure1 were procured from Akshaya fibres – India. The fibres were then treated with 10% NaOH solution for 6 hours. The fibres are then washed thoroughly with distilled water. Fibres are then put in an oven for 24 hours at 80 ^{o}C to remove any traces of moisture

III. MATRIX

Epoxy resin is obtained from Yukey India pvt ltd under the trade name of Ecmalon 9911. It appears as a clear yellow color liquid with viscosity of 400 cps and specific gravity of 1.05. The cast resin has a tensile strength of 70 MPa and tensile modulus of 3200 MPa

IV. PREPARATION OF THE COMPOSITE

The composites are made by hand lay-up technique. As shown in figure 2 (a) & (b) (mould design). The mould used for the composite is made of mild steel.. The inner cavity dimension of the mould is 200 mm x 200 mm x 10 mm. The upper plate is bolted to the mould and the setup is left to cure for 24 hours at room temperature. The composite plate so formed is then oven cured for 24 hours at 80oC. Specimens are cut for testing as per ASTM standards.

Figure 2(a). Mould design

Figure 2(b). Mould design

V. RESULTS AND DISCUSSION

There is a decrease in the density of the composite with the increase in the fibre volume fraction. This can be attributed to the fact that the density of fibre is lower than the resin. Figure 3 shows the variation of mean tensile strength with the increase in percentage of fibre volume fraction. There is a dip in the mean tensile strength during the initial stages of fibre loading. This shows that the load is not properly transmitted to the fibres. The sole purpose of reinforcement is not properly served at lower volume fractions. But as the fibre volume percentage increases from 10%, the mean tensile strength also increases. At 35 % of fibre volume, the tensile strength is increased by 38.6%. This should be because of the increased bonding between the fibre and the matrix. The load sharing is easily transmitted to the fibres. Figure shows the tensile strength of the composites. The graph shows an increase in the tensile strength for fibre volume fraction 35%.

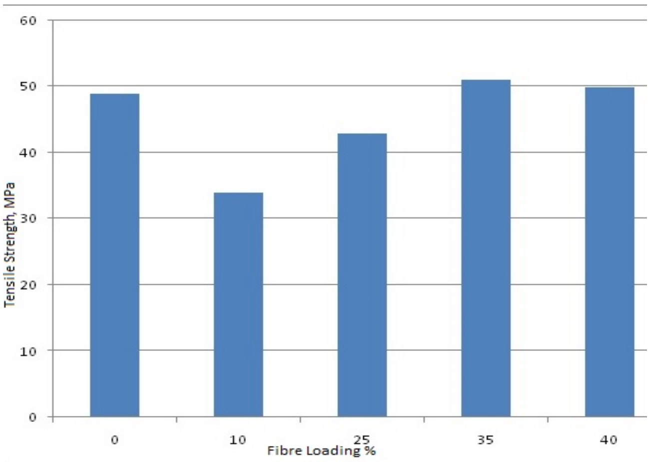

Figure 3. Tensile strength v/s Fibre Loading %

A. Flexural properties

On alkali treatment, flexural properties of the composite were found to be improved and it is depicted in figure 4. At a fibre loading of 40 vol. %, the flexural strength of the composite improved by 8.5%.

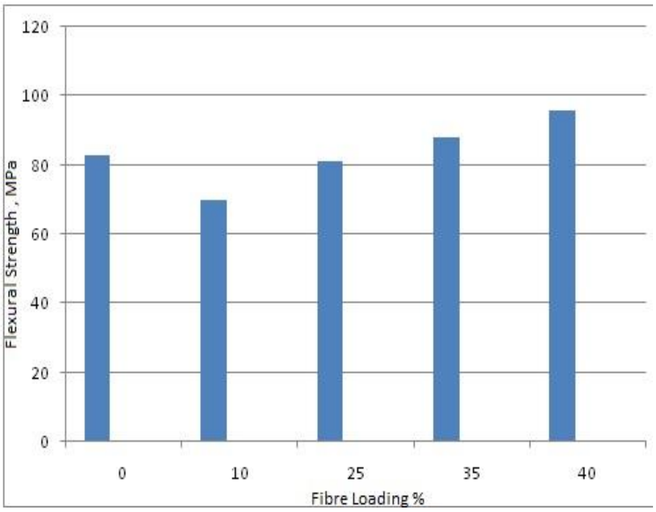

Figure 4. Flexural strength v/s Fibre Loading %

The increase in flexural strength and flexural modulus on alkali treatment of fibre can be attributed to the formation of rough fibre surface leading to the improved wetting of fibres with the matrix.

B. Impact strength

The effect of alkali treatment on the impact strength of randomly Banana-epoxy composite containing 40 vol % fibre is depicted in the figure 5.

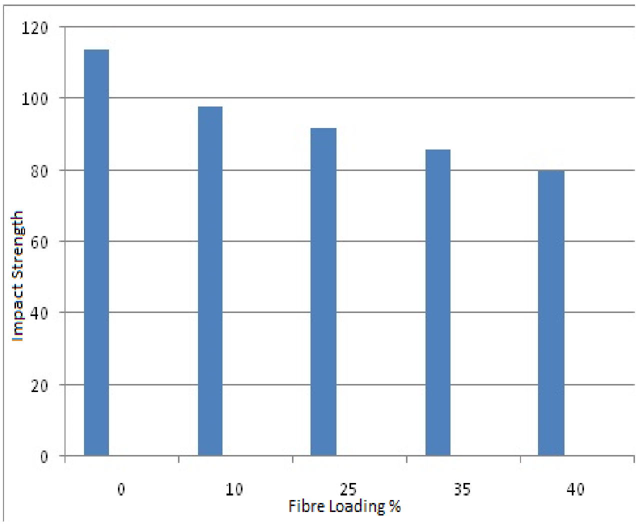

Figure 5. Impact strength v/s Fibre Loading %

This lowering of impact strength of the alkali treated fibre composite may be attributed to the stronger interfacial bonding between the fibre and the resin. A weak interface will not facilitate efficient stress transfer resulting in a weak but tough composite. But the composites having strong interface will have low toughness value compared to the one having weaker interface. The low impact strength of the alkali treated fibre composite is assumed to be due to the strong interface as evidenced from the mechanical properties of the composite

VI. CONCLUSION

There is an improvement in the tensile properties of the randomly oriented banana fibre – epoxy resin composites. At 35% of fibre volume fraction, the tensile strength is increased. At lower volume fractions of banana fibre, the strength of the composite specimen is reduced when compared with the virgin resin. The impact strength decreases when fibre volume gets increased. Banana fibre having high specific strength and flexural strength makes a lightweight composite material and can be used to make light weight automobile interior parts.

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