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Mechanical Properties of Coconut Fiber Reinforced Epoxy Polymer Composites

Satender Kumar[1], Kakali Deka[2], P. Suresh[3]

[1,2]M.Tech Scholar, School of Mechanical Engineering, Galgotias university, Greater Noida, UP-201306
[3]Associate Professor, School of Mechanical Engineering, Galgotias university, Greater Noida, UP-201306

Abstract - *In recent years, composite material replaces conventional material like metal, wood etc due to its light weight, high strength to weight ratio and stiffness properties. Natural fibers like coir, bamboo fiber, banana plant fiber etc has low cost, easily availability and less harmful to human. In this work, coir fiber is used as a reinforced material. Composites were prepared with different weight ratio of coir fibers with epoxy resin. To find the effect of coir fibers on the mechanical properties of composite, tensile test, impact test and hardness test were conducted on the prepared specimens. ASTM D638-V and ASTM D256 standards were used to prepare the specimens for tensile and impact test respectively. Experimental result shows that the addition of coir fibers increases the strength of composite; the composite with 7.5% fiber content shows maximum tensile and impact strength.*

Key Words: Coir fiber, Epoxy resin, Coir Fiber Reinforced Polymer Composite (CFRPC), Mechanical properties

1.INTRODUCTION

The field of composite materials has progressed considerably over the last few decades. Properties like low density, high strength and stiffness, chemical and corrosion resistance, etc. make composite materials an attractive alternative to metals and alloys. The abundant availability of natural fibre gives attention on the development of natural fibre composites primarily to explore value-added application avenues. Reinforcement with natural fiber in composites has recently gained attention due to low cost, easy availability, low density, acceptable specific properties, ease of separation, enhanced energy recovery [1-5].

Natural fibers such as ramie, hemp, jute, sisal, bamboo, banana, oil palm fibers, etc. are used as reinforcements in place of glass fibers. Composite mechanical properties are improved with the increase in fiber weight fraction. But when the fiber weight fraction is too large, the composite fiber bundle strength and ultimate strength gets reduced. Also it depends on the way in which the fibers are aligned with matrix [6-10]. Coir fibers are used as reinforcement in this work, as it is non-toxic, low cost, high lignin content, low density, easy availability and less tool wear. The studies revealed that fiber weight fractions have significant effects on mechanical properties of composite such as strength, stiffness and toughness. Hence the objective of this work is to investigate the mechanical properties of coir fiber reinforced composites with different weight fraction of fiber.

2. EXPERIMENTAL METHODS

2.1 Fibers

Coconut fibers were extracted from exocarp and dried at 45^0C for 48 hrs. After being ground in a mill and sieved to equal size. The coconut fibers were pre-treated with alkaline solution to remove the soluble extractives and to facilitate adhesion between fibers and matrix. Furthermore the fibers were filtered and washed with distilled water. Then, fibers were dried in an oven at 50^0C for 24 h.

2.2 Resin

Epoxy resins are of low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups. Epoxy has a wide range of applications, including metal coatings, use in electronics / electrical components, high tension electrical insulators, fiber-reinforced plastic materials and structural adhesives. Araldite LY 556 Epoxy resin is taken as matrix, coir fiber act as reinforcement. Hardener HY 917 is used as a curing agent, it solidify the mixture of resin and fiber. The properties of epoxy resin and hardener are given in Table 1 and 2 respectively.

2.3 Composite preparation

The specimen prepared was fabricated by resin transfer mould method, with different fiber weight percent i.e 0%, 3%. 5%, 7.5% and 10%. Resin was heated up to 55°C to decrease its viscosity and then cool it to 35°C, after that fiber and hardener was mixed with resin. At last the mixture was transferred to the mould and cured. The releasing agent was used to easy removal of composite from the mould.

2.4 Measurement techniques

ASTM D638-V and ASTM D256 standards were followed for tensile and impact test respectively. Five specimens of CFRP composites with different wt% of fibers were prepared separately for both tensile and impact test. The weight of the specimens was measured by a precision balance weighting machine. Figure 1 and Figure 2 show the various dimension of composite specimen. Four specimen were also prepared for hardness testing having dimension of 60mm×50mm×13mm.

Table - 1: Properties of araldite LY 556 epoxy resin

Aspect (visual)	clear, pale yellow liquid
Colour (Gardner, ISO 4630)	≤2
Epoxy content (ISO 3000)	5.30 - 5.45 [eq/kg]
Viscosity at 25 °C (ISO 9371B)	10000 – 12000 [mPa s]
Density at 25 °C (ISO 1675)	1.15 - 1.20 [g/cm3]
Flash point (ISO 2719)	> 200 [°C]

Table - 2: Properties of hardener HY 917

Aspect (visual)	clear liquid
Colour (Gardner, ISO 4630)	≤2
Viscosity at 25 °C (ISO 9371B)	50 – 100 [m Pa s]
Density at 25 °C (ISO 1675)	1.20 - 1.25 [g/cm3]
Flash point (ISO 2719)	195 [°C]

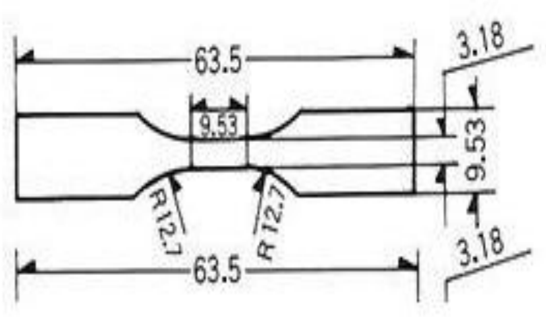

Fig - 1: Tensile specimen

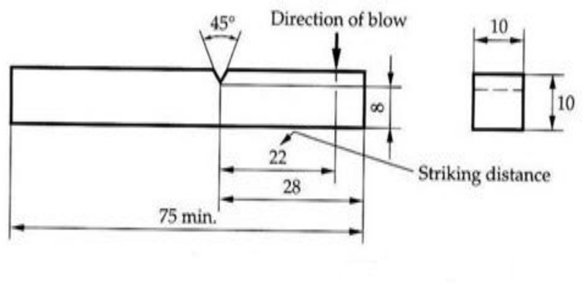

Fig - 2: Impact specimen (Izod)

3. RESULTS AND DISCUSSIONS

3.1 Tensile testing

For finding the tensile properties of CFRP composite specimen an electronic tensometer (model PC-2000, Bench model horizontal tensile testing machine, capacity: 20 KN) was used. Five different specimens with varying wt% were tested using tensometer with 2mm/min test speed. Figure 3 shows electronic tensometer in which tensile tests were conducted.

Fig - 3: PC-2000 Electronic tensometer

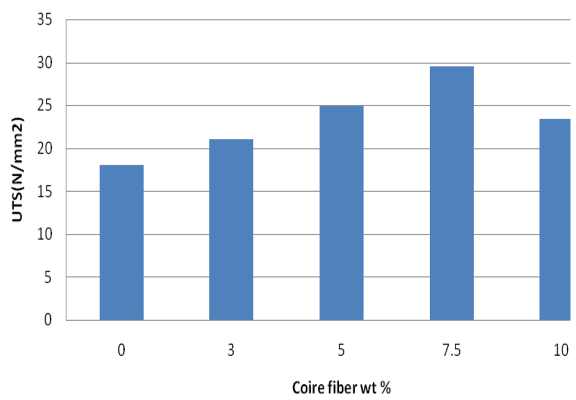

Fig - 4: Variation of tensile strength at different wt % of coir fibers

From figure 4, it is concluded that the increase in wt % of coir fiber in epoxy resin leads to increase in tensile strength. This is because fibers constitute an important factor in determining the strength of fiber reinforced composites. But after 7.5 wt % its strength goes on decreasing because as fiber wt % increases, the binding force and interface between fibers to resin starts decreasing.

3.2 Impact testing

TMI impact testing machine was used to measure the impact resistance of polymer and composite materials in compliance with ASTM D256. A precision notch was made on the specimens using notching machine.

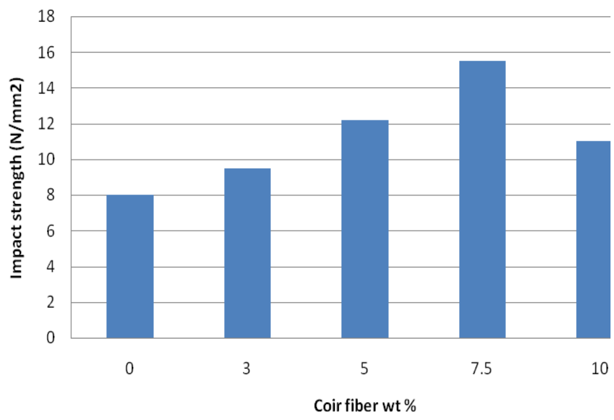

Fig - 5: Variation of impact strength at different wt % of coir fibers

Figure 5 shows that increase in coir wt%, leads to increase in impact strength of composites because fibers provide strength to the composite. But at wt 10%, the impact strength decreased due to the poor interface bonding between fiber and resin. As the fiber wt % increases more than 7.5 %, interface bonding between matrix and fiber goes on decreasing.

3.3 Hardness testing

Rockwell hardness testing was performed on the specimens of 0 wt%, 3 wt%, 5 wt%, 7.5 wt% and 10 wt% of coir fibers. Specimen size is 50mm×60mm×13mm.

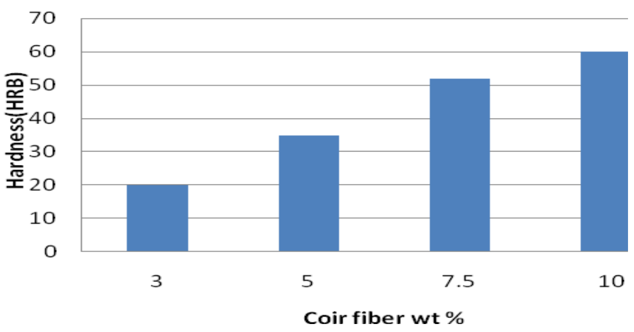

Fig - 6: Hardness values Vs wt % of coir fibers

Figure 6 shows the variation of hardness values with different weight % of coir fibers. As coir wt % increases, the hardness of specimen starts increasing because fiber basically increases the strength of composites.

4. CONCLUSIONS

In this work, CFRP composite specimens are prepared from coir fiber and epoxy polymer. Experimental investigation are done on the CFRP composites with different wt % coir fibers, the mechanical properties of epoxy thermoset plastic composites are improved. Effects of wt % coir fibers on tensile properties, impact strength and hardness property of specimens are investigated. The following conclusions are drawn from this study.

1. Compared with pure plastic specimen, adding coir fiber into plastic materials could increase tensile strength, impact strength and hardness because fibers provide strength to reinforced composite.
2. After a point, strength of composite starts decreasing because interface bonding between fiber and resin goes on decreasing as fiber wt % increases in composite.
3. Hardness of the specimen also determined for composites, as fiber wt % increases hardness of specimen increases.
4.

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