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Effect of Alkali Treatment on Mechanical Properties of Prosopis Juliflora Hybrid Composites

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Abstract

Prosopis Juliflora hybrid composites were prepared by the rule of mixtures. The mechanical properties of Prosopis Juliflora hybrid composites were studied. The effect of alkali treatment on these mechanical properties (Tensile, Flexural and Impact strength) was also studied. It was observed that the mechanical properties of the hybrid composite improved with increase in glass fiber content. These properties were found to be even better when alkali treated Prosopis Juliflora /glass fibers were used in the hybrid composites. The elimination of amorphous hemi cellulose with alkali treatment led to higher crystalline of the Prosopis Juliflora /glass fibers.

Keywords: Alkali Treatment; Mechanical Properties; Epoxy; Prosopis Juliflora; Hybrid composites

INTRODUCTION

In current years, there is increasing green concerns, greater attention are being paid towards the use of plant fibers taking the advantages of their abundance and availability as renewable resource and their biodegradability in the environment and economical for their cost effectiveness. Accordingly, a number of review papers have been published on plant fiber-polymer composites including biodegradable composites [1-7]. While some fibers have been extensively investigated and used in textile fabrics, composites, and for medical purposes, many other less known fibers find limited applications, for instance, in making ropes, mats, purses and wall hangings. One of the handicaps for finding new uses for these natural fibers is the lack of available scientific data regarding their structure and properties. Natural fibers have little resistance towards environmental influences and show an intrinsic variability of their properties. Hence, the use of natural fibers depends on the environmental conditions which are likely to Influence aging and degradation effects. The use of different kinds of physical or chemical surface treatment such as corona discharge or reaction with alkyl ketone dimmers, alkalis, silane-coupling agents, etc. leads to changes in the fiber surface structure as well as to changes in their surface energy. Due to low density, natural fibers are widely used as reinforcing agent, as it is high biodegradability. Natural fibers are largely divided into two categories depending on their origin: plant based and animal based. Therefore, natural fiber can serve as reinforcements by improving the strength, stiffness and also reduce the weight of resulting biocomposite materials although the properties of natural fibers vary with their source and treatments. The Fiber / Filler reinforced composites improve strength, fatigue, stiffness and strength to weight ratio, by incorporating strong, stiff, brittle Fibers into a softener and more ductile matrix. The matrix material transmits the force to the Fibers and provides ductility and toughness.The largest advantages in using natural fiber composites are the cost of materials, their sustainability and density. Natural fibers can cost as little as \$0.50/kg, and can be grown in just a few months. They are also easy to grow and have the potential to be a cash crop for local farmers. Natural fibres are also significantly lighter than glass, with a density of 1.15-1.50 g/cm³ versus 2.4g/cm³ for E-glass. Two major factors currently limit the large scale production of natural fibres composites. First, the strength of natural fiber composites is very low compared to glass. This is often a result of the incompatibility between the fiber and the resin matrix. The wettability of the fibres is greatly reduced compared to glass and this constitutes a challenge for scale up productions. Though when comparing specific strengths, natural fibres are not much less than glass fiber composites.

In this present work, the authors were synthesized and characterized the epoxy/hybrid composites by randomly dispersion of prosopis juliflora /glass fibres into the matrix. The effect of fibre weights and the treatment of fiber on the mechanical properties, viz. tensile, flexural, and impact properties, have been studied. The main aim of the work is to present partially green-composites with high performance.

MATERIALS AND METHODS

Materials

Commercially available epoxy (LY-5062) and hardener (HY-5062) supplied by Sri Lakshmi composites, Hyderabad. Naturally available Prosopis Juliflora fibers were retrieved from Pesaravai village, Kurnool, Andhra Pradesh, India. In addition, glass fiber was (density: 350g/m2) supplied by sri lakshmi composites, Hyderabad.

Fiber Treatment

Prosopis Juliflora fiber was taken in a glass tray and a 5% NaOH solution was added in to the tray and the fibers were allowed to soak in the solution for 1 hr. The fibers were then washed thoroughly with water to remove the excess of NaOH sticking to the fibers. Final washing was carried out with distilled water and the fibers were then dried in hot air oven at 70°C for 4 hrs.

Composite Manufacturing

A glass mould with required dimensions was used for making sample on par with ASTM standards and it was coated with mould releasing agent enabling to easy removal of the sample. The resin and hardener is taken in the ratio of 10:1 parts by weight respectively. Then pre-calculated amount of hardener is mixed with epoxy resin and stirred for 1hr before pouring in to the mould. Hand lay-up technique was used to impregnate the composite structures. In this technique a glass fiber and Prosopis Juliflora fibers were wetted by a thin layer of epoxy suspension in a mould. Stacking of hybrid fibers was carefully arranged random manner after pouring some amount of resin against the mould to keep the poor impregnation. Left over quantity of mixture is poured over the hybrid fibres. Brush and roller were used to impregnate fiber. The closed mould was kept under pressure for 24 hrs at room temperature. To ensure complete curing the composite samples were post cured at 70ºC for 1 hr and the test specimens of the required size were cut out from the sheet.

Preparation of Samples

Tensile testing samples are prepared like dog-bone shapes and these dimensions are (150mm x 10mm x 3mm) based on the ASTM D 638 standards. Authors used 50KN load cell for flexural testing in addition the sample sizes are cut in accordance with ASTM D 618 (i.e.150mm x 15mm x 3mm). The impact testing specimens (62.5mm x 12.7mm x 3mm) were prepared.

Mechanical Test

The Tensile strength, Flexural strength, and Impact strength of different weight of treated and Prosopis Juliflora /glass epoxy based hybrid composites were carried out on INSTRON Universal Testing Machine (UTM), model 3369.

RESULTS AND DISCUSSION

The Tensile Strength and Flexural Strength of the specimens were measured by using an INSTRON model 3369 UTM instrument and Impact Strength of the specimens were measured by using IZOD impact tester. The mechanical tests results of randomly oriented Prosopis Juliflora/glass epoxy based with and without alkali treated hybrid composites are presented in Table 1.

Table 1. Mechanical Tests results of the hybrid composite specimens

Prosopis Juliflora weight (g)	Glass weight (g)	Tensile Strength (MPa) for Treated fibers	Tensile Strength (MPa) for Untreated fibers	Flexural Strength (MPa) for Treated fibers	Flexural Strength (MPa) for Untreated fibers	Impact Strength (KJ/m2) for Untreated fibers	Impact Strength (KJ/m2) for Treated fibers
10	20	83.71	72.14	241.79	230.16	44.29	41.05
15	15	64.31	50.62	240.03	225.66	59.05	48.92
20	10	36.41	19.72	199.11	186.82	39.37	31.37

As the glass fiber content is increasing the Tensile Strength of the hybrid composites are also improved as shown in the figure 1.

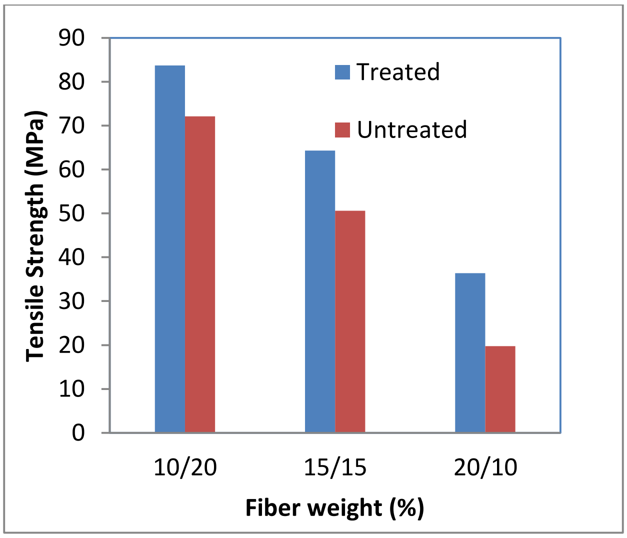

Figure 1. Variation of maximum Tensile strength with ratio of Prosopis Juliflora/glass reinforced Epoxy Composites for treated and untreated composites

As the glass fiber content is increasing the Flexural Strength of the hybrid composites are also improved as shown in the figure 2.

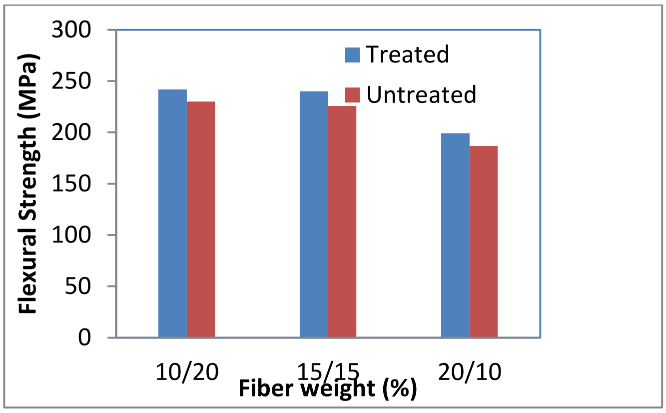

Figure 2. Variation of maximum Flexural Strength with ratio of Prosopis Juliflora/glass reinforced Epoxy Composites for treated and untreated composites

As the glass fiber content is increasing the Impact Strength of the hybrid composites are also improved as shown in the figure 3.

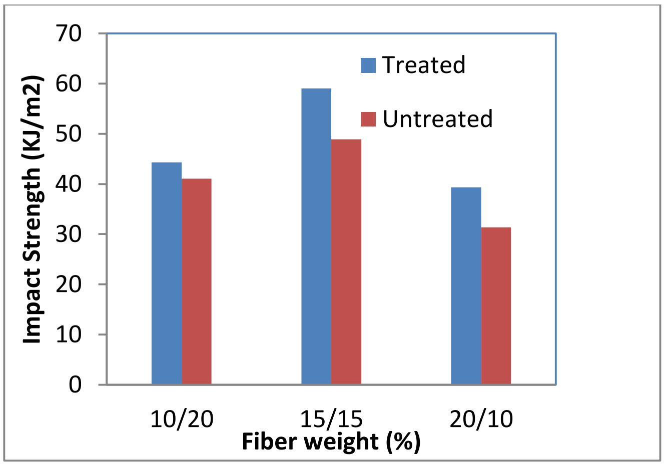

Figure 3. Variation of maximum Impact Strength with ratio of Prosopis Juliflora/glass reinforced Epoxy Composites for treated and untreated composites

CONCLUSION

The hybrid composites of Prosopis Juliflora/glass reinforced Epoxy were prepared and their Mechanical properties were studied. The effect of glass fiber percentage on these properties was studied. These hybrid composites were found to exhibit good mechanical properties as the weight of the glass fiber content increases. It was also found that the treated fibers have good mechanical properties than the untreated fibers. The hybrid composites with more glass fiber content were found to possess higher mechanical properties. The results obtained, it can be inferred that Natural Fiber Reinforced Hybrid Epoxy Matrix composites (Green composites) can be made as a replacement for the synthetic fiber reinforced polymeric plastic materials.

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