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Tensile and Impact Properties of Natural Fiber Hybrid Composite Materials

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Abstract: *This paper is a review on the tensile and impact properties of natural fiber hybrid composites. Natural fibers are having good mechanical properties, high specific strength, low cost, bio-degradable and easily can recyclable through thermal methods. In this paper two different hybrid composites were manufactured by compression molding and properties of tensile and impact results are conducted as per ASTM standards. In this project three different fibers such as sisal, jute and glass with thermosets epoxy resin used with weight ratio of fiber to resin as 15:15:70.Results showed that sisal/glass hybrid composite has more tensile and impact strength while comparing to sisal/jute hybrid composite.*

Keywords: *Tensile, Impact, Sisal, Jute, Glass and Epoxy*

I. INTRODUCTION

Increasing environmental concerns and depletion of petroleum resources calls for new green ecofriendly materials. Among various natural polymers, cellulosic natural fibers are envisioned as the most suitable ways to solve these problems especially environment related issues. The potential of cellulosic fibers as reinforcement in composite materials have been well recognized since many centuries ago. The term 'composite' has been used in material science refers to a material made up of a matrix containing reinforcing agents. The beginning of composite materials may have been the bricks, fashioned by the ancient Egyptians from mud and straw. Nearly 70 years ago, a number of technical products and other commodity materials were derived from natural resources e.g., textile ropes, canvas and paper were made of local natural fibers such as flax and hemp. Emergence of polymers in the beginning of the nineteenth century inculcated the new era of research based on exploring the viability of natural fibers and their applications in more diversified fields. At the same time, interest in synthetic fibers due to its superior dimensional properties, gained attention and slowly replaced the natural fibers in major avenues. With the passage of time, the accumulation of the hazardous synthetic byproducts and waste, started polluting the environment and once again led the scientists towards natural fibers due to their distinct advantages. Thus, the renewed interest in the natural fibers resulted in a large number of modifications in order to bring it equivalent and even superior to synthetic fibers. After tremendous changes in the quality of natural fibers, they emerged as a substitute for the traditional building materials including lumber steel, Portland cement and lime. Considering the high performance standard of composite materials in terms of durability, maintenance and cost effectiveness, applications of natural fiber reinforced composites as construction material, have done wonders and are environment friendly material for the future.

II. REASON OF NATURAL FIBER REINFORCED COMPOSITES

Many shortcomings due to high density and poor recycling properties were seen in glass fiber reinforced plastics. Moreover, glass fiber dust produced during processing triggers allergic skin irritation. The possible substitution of glass fiber by natural fiber in exterior application raised the question about mechanical properties of the material, flammability and effect of weathering. Natural fibers offer several advantages over glass fibers:

- Plant fibers are renewable and their availability is unlimited.
- When natural fiber reinforced plastics are subjected to combustion or landfill at the end of their life cycle, the released amount of carbon dioxide is less with respect to that assimilated during its life cycle.
- Natural fibers are less abrasive and can be easily processed as compared to glass fiber.
- Natural fiber reinforced plastic, consisting of biodegradable polymer matrix are environment friendly and can be composted easily.

III. EXPERIMENTAL METHODOLOGY

1. Selection of Materials

In this project we have used the glass as synthetic fiber and sisal and jute are as natural fiber reinforced plastics. The hybrid composites are used to find out the tensile and impact properties. The sisal/jute and sisal/glass reinforced epoxy are thus used as hybrid composites. The purpose of using E-glass fiber with sisal fiber is to improve the mechanical properties of natural fiber.

2. Chemical Treatment

The sisal and jute fibers are immersed in distilled water for 24 hrs separately and then dried in direct sun light. After that it is immersed in NaOH solution for 24 hrs and then it is dried. After that it was kept in hot air oven for 6 hrs for remove air bubbles. The sodium hydroxide alkali treatment effectively used for improves the adhesive bond between fiber and matrix.

3. Manufacturing Method

There are various methods to fabricate the composites. They are hand lay-up process, pultrusion process, filament winding process, resin transfer molding, sheet molding compound, reaction injection molding. Here we use the compression molding process for the fabrication of hybrid composites.

3.1 Compression Molding Method

- With the dies apart, the prepared polymer 'dough' is placed into the cavity.
- With the die closed, the article is formed and the small amount of flashing on each side will be removed later.
- When the die is closed, heat and pressure are maintained until the condensation polymerization process is completed.
- The hot compression molding process is used to form components from phenolic, urea and melamine thermosetting polymers, as well as alkyl resins.

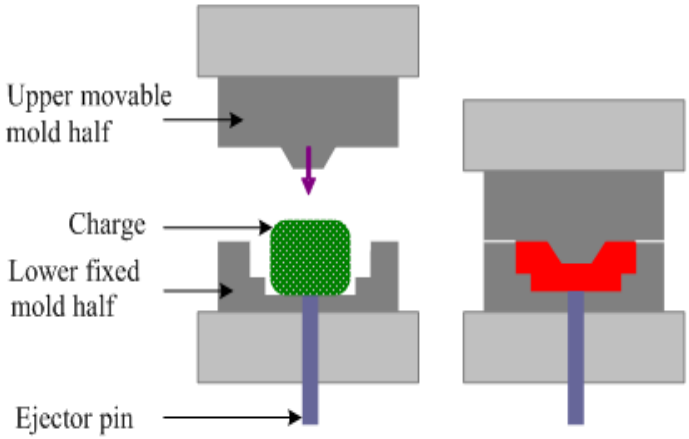

Fig 1. Compression Molding

IV. EXPERIMENTAL TEST

The hybrid composite materials sisal-glass-epoxy and sisal-jute-epoxy are to be tested for their mechanical properties. Tensile test and Impact test are can be done on the samples produced from composites. Here, the samples cut to ASTM standards from the manufactured composites are tested to find out the values of tensile strength and impact strength. The tensile test for two sample pieces are performed by the universal testing machine Instron 1195 and impact test are performed using Izod impact testing machine.

1. Universal Testing Machine

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. During the test a uni-axial load is applied through both the ends of the sample. The dimension of the sample is (250x25x3) mm. The tensile test is performed in the universal testing machine (UTM) Instron 1195 and results are analyzed to calculate the tensile strength of composite samples.

2. Izod Impact Testing Machine

The impact test is for the purpose of knowing the material's ability to resist the impact load and the service life of the material. The impact test designed to give information on how a sample of a known material will respond to a suddenly applied stress, e.g. shock. A method for determining behavior of material subjected to shock loading in bending, tension, or torsion. The Izod test is most commonly used to evaluate the relative toughness or impact toughness of materials and as such is often used in quality control applications where it is a fast and economical test. It is used more as a comparative test rather than a definitive test.

V. RESULTS AND DISCUSSION

The samples of two different combinations tested for their tensile and impact strength showed better result with sisal/glass has lead in both tests.

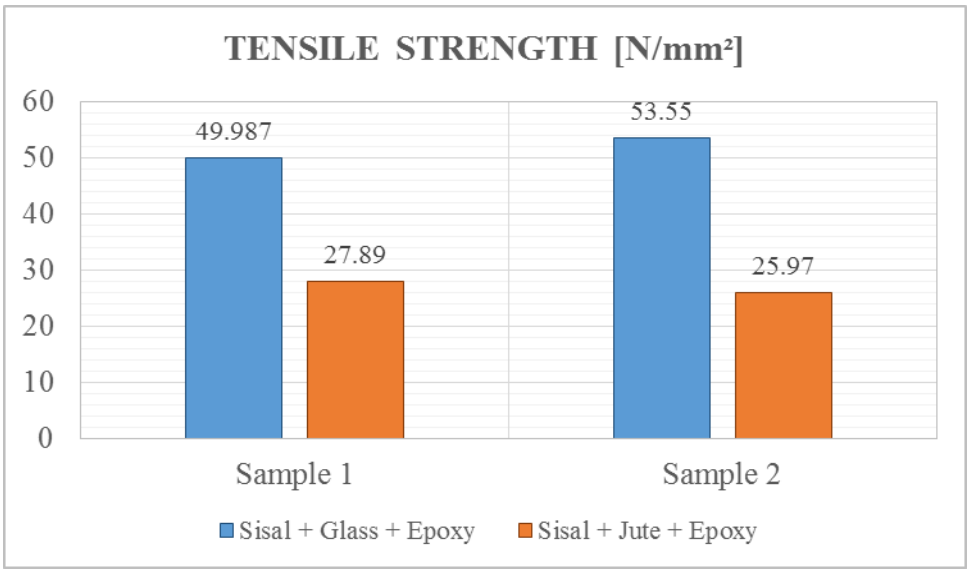

Fig 2. Result of Tensile Strength

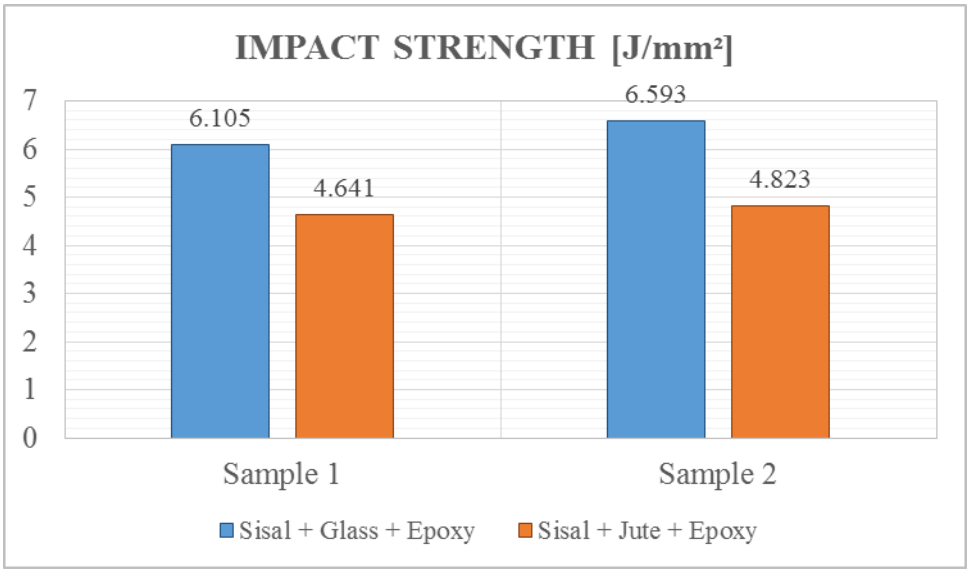

Fig 3. Result of Impact Strength

- For sisal/jute combination tensile strength of two samples are 27.89 N/mm2 and 25.97 N/mm2.
- For sisal/glass combination tensile strength of two samples are 49.98 N/mm2 and 53.55 N/mm2.
- For sisal/jute combination impact strength of two samples are 4.641 J/mm2 and 4.823 J/mm2.
- For sisal/glass combination impact strength of two samples are 6.105 J/mm2 and 6.593 J/mm2.

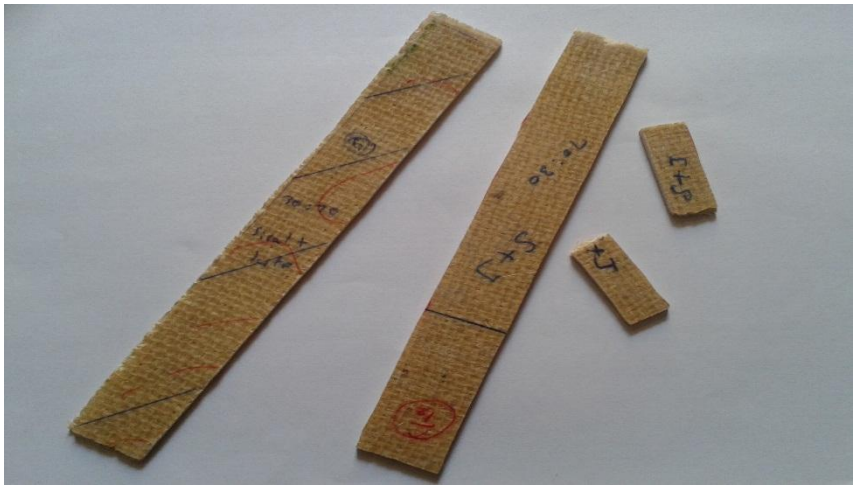

Fig 4. Sample after Tensile and Impact Test

VI. CONCLUSION

- Treatment of sisal and jute with NaOH resulted in increase an adhesive strength and tensile strength.
- Tensile and impact properties were studied for two different hybrid composites such as sisal/glass and sisal/jute.
- Sisal/glass shows great tensile and impact strength with comparing to sisal/jute hybrid composite.
- Because naturally glass fiber has good specific strength and high elongation but it cannot recycle throughout.
- Sisal/jute hybrid composite can be easily recyclable and biodegradable. So it can be apply for similar applications.

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