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FABRICATION AND MECHANICAL CHARACTERISATION OF ISOPHTHALIC POLYESTER BASED PINEAPPLE LEAF FIBER REINFORCED COMPOSITES

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ABSTRACT

A composite material is a macroscopic combination of two or more distinct materials, having a recognizable interface between them. Composites are used not only for their structural properties, but also for electrical, mechanical, and environmental applications. Present review deals with the recent development of lingo-cellulosic/lingo-cellulosic and lingo-cellulosic/synthetic fibers based reinforced hybrid composites. Fibers are taken from leaves of Pineapple leaf by retting process. This fiber along with glass fiber can be a new source of raw material and can be a potential replacement of the expensive and non renewable synthetic fiber. Isophthalic polyester is used as the binding agent. This work intended to present an outline of main results presented on hybrid composites focusing the attention in terms of processing, mechanical and heat resistant properties. Hybrid composites are one of the emerging fields in polymer science that triumph attention for application in various sectors ranging from automobile to the building industry.

KEYWORDS: Composite, Glass Fiber, Isophthalic Polyester, Pineapple Fiber, Synthetic Fiber

INTRODUCTION

There has been growing interest in using eco-friendly materials in engineering due to the ever rising environmental awareness. Natural fiber reinforced composites is an emerging area in polymer science. Unlike the traditional engineering fibers, e.g. glass and carbon fibers, and mineral fillers, these lingo-cellulosic fibers are able to impart the composite certain benefits such as low density, low cost, bio degradability, high flexibility, renewable and environmental friendly. They have acceptable specific properties and compared to synthetic fibers such as glass or carbon fibers, they reduce dermal and respiratory irritation, lower green house gas emission, CO_2 sequestration and have less wear during processing. The natural fiber composites offer specific properties comparable to those of conventional fiber composites The most important advantages of using polymers are the ease of processing, productivity, and cost reduction. In most of these applications, the properties of polymers are modified using fillers and fibers to suit the high strength/high modulus requirements. Fiber-reinforced polymers offer advantages over other conventional materials when specific properties are compared. These composites are finding applications in diverse fields from appliances to spacecrafts.

Pineapple leaf fiber is obtained from the pineapple plant's leaves. Major compounds of pineapple leaf fibre are cellulose (70–80%), lignin (5–12%), and ash. Pineapple leaf fibers can be profitably used in the manufacture of short fiber polymer reinforced composites because they posses attractive physical and mechanical properties. This is true because these fibers, unlike glass fibers, will bend rather than fracture during processing. Whole natural fibers undergo some breakage while being intensively mixed with the polymeric matrix, but this is not as notorious as with brittle or mineral fibers. Pineapple leaf fiber composites are likely to be environmentally superior to glass fiber composites in most cases for the following reasons: (1)lower environmental impacts compared to glass fiber production; (2) higher fiber content for equivalent performance, reducing more polluting base polymer content; (3) the light weight natural fiber composites improve fuel efficiency and reduce emissions in auto applications; (4) high strength and flexibility;

In all the collection, pineapple leaf fibre is more compatible natural fibre resource and constitutes a good chemical composition. Pineapple leaf fibre has better mechanical strength than the jute when it is used in making of fine yarn. Pineapple leaf fibre is a vital natural fibre, which have high specific strength, tensile strength, impact and flexural strength and less water absorption as much as jute fibres.

FABRICATION OF COMPOSITES

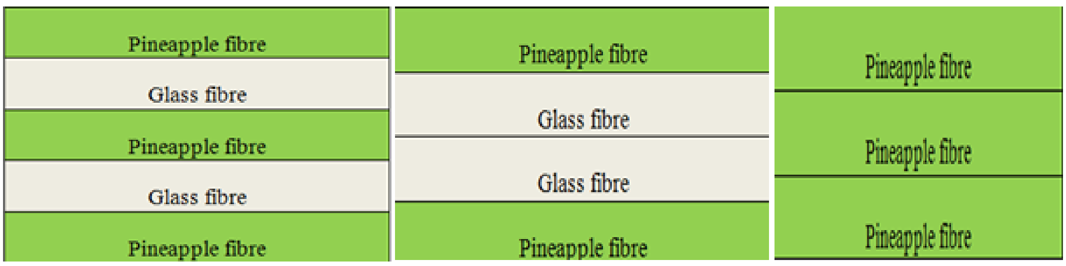
Collection and Extraction

Pineapple leaves are collected from different places. Fiber is extracted from the leaf by water retting process. Water retting is performed by submerging the pineapple leaves in a tank of water for a period of 7-15 days depending upon water temperature and mineral content. And thus water is penetrating into the leaves and swells the cells and bursting the layer and then increases the moisture and decay producing bacteria. After retting, the straws are dried in open air and are stores for a short period to allow curing to occur. Final separation of fiber is obtained by a breaking process by hand in order to remove the waste portions.

After the extraction of pineapple leaf fiber, these fibers are spinned and weaved. Wovened pineapple mat is used as the matrix phase of the composite material.

Stacking Sequence and Specimen Preparation

Mainly three stacking sequences are chose. They were chose in order to compare the mechanical properties of composite as natural composite, and the combination of natural and synthetic composites.



sp-01: PGPGP sp-02: PGGP sp-03: PPP

Figure 1: Stacking Sequences of Composites

Then these sequences are prepared by Hand Lay-Up technique. A release gel is sprayed and thin plastic sheets are spreaded the mold plate to get good surface finish. Reinforcement in the form of woven pineapple leaf fiber mats are cut as per the mold size and placed at the surface of mold after plastic sheet. Then polyester resin is poured onto the surface of mat. Glass fiber is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure is applied.

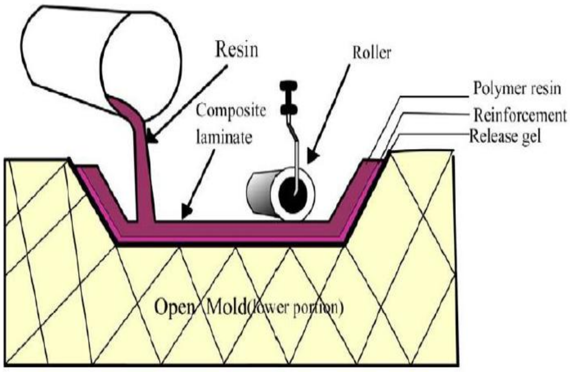


Figure 2: Hand Lay-Up

EXPERIMENTAL ANALYSIS

All tests are performed according to ASTM standards

Tensile Test

Tensile test measures the resistance of the composite specimen for slowly applied force.

- Maximum tensile strength of 69.84 MPa was obtained for stacking sequence sp-01
- 64.08 MPa was obtained for sequence sp-02 and less strength was for sequence sp-03

(a) **(b)** **(c)**

Figure 3: Tensile Testing Using Computerized UTM (a) Specimen is Cut According to ASTM D3039, (b) Tensile Testing of the Specimen Using Computerized UTM, (c) Specimen After Tensile Test

Table 1: Tensile Test Values

Specimen	Max Load(N)	Ultimate stress (MPa)
1	8730	69.84
2	8010	64.08
3	2580	20.64

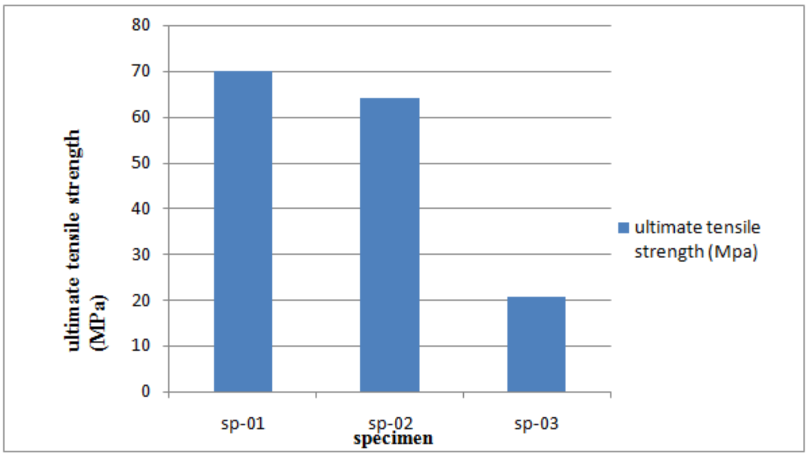


Figure 4: Ultimate Tensile Strength for Each Specimen

Flexural Strength Test

Table 2: Flexural Strength Values

Specimens	Maximum Load (N)	Bending Moment (Nm)	Flexural Strength (GPa)
sp-01	5250	111.125	2.1
sp-02	4800	101.6	1.92
sp-03	2500	52.916	1

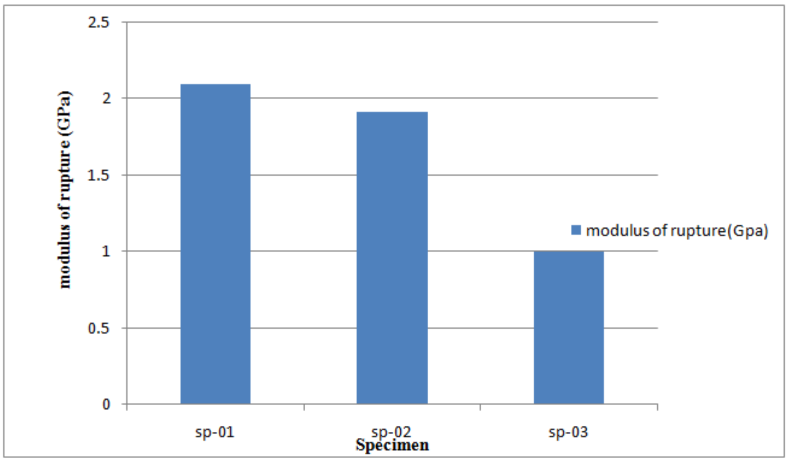


Figure 4: Flexural Strength for Each Specimen

- Influence of flexural strength for different stacking sequence was determined by conducting flexural test
- Specimen was cut according to ASTM D790(127x12.7x5mm)
- Flexural strength for sp-01 was obtained as 2.1 GPa; for sp-02 it is 1.92 GPa and for sp-03 its 1 GPa
- Maximum flexural strength was obtained for stacking sequence sp-01(PGPGP)

IMPACT TEST

(a) (b) (c)

Figure 4: Charpy Impact Tested Specimen (a) Sequence sp-01; (b) Sequence sp-02; (c) Sequence sp-03

Table 3: Impact Test Values

Sequence	Impact Energy (J)	Impact Strength (kJ/mm²)
sp-01	265.79	4252.64
sp-02	18.683	298.928
sp-03	97.715	1563.44

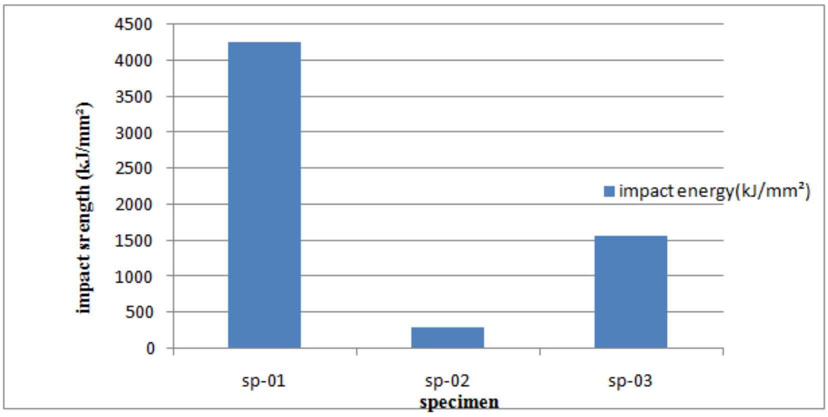


Figure 4: Impact Strength for Each Specimen

- Impact strength for various stacking sequence was determined by Charpy Impact test
- Specimen of size 63x12.5x5 mm (ASTM D256) was cut and tested
- Maximum impact energy of 265.79J was obtained for stacking sequence sp-01

Water Absorption Test

Table 4: Water Test Results

Sequence	Dry Weight, W_1(kg)	Wet Weight, W_2(kg)	Percentage of Water Absorbed $(W_2-W_1)/W_1$ x100
sp-01	0.030	0.038	25.68
sp-02	0.025	0.030	20
sp-03	0.025	0.030	20

- 76.2x25.4x5.5 mm sized specimen was cut and was immersed in water for 3 days
- Wet weight was checked after 24 hours, 48 hours and 72 hours respectively and note down

- 20% of water was absorbed by stacking sequence sp-02 and sp-03 and sp-01 absorbs 25.68%

CONCLUSIONS AND SCOPE OF FUTURE WORK

Conclusion

The effect of stacking sequence and hybridization of pineapple leaf fiber with glass fiber for mechanical and water absorption was studied. The laminates were manufactured by hand lay-up technique and tested according to ASTM standards.

- Tensile strength of different sequence was obtained and maximum tensile strength of 69.84 MPa was obtained for sequence sp-01.
- Better impact energy of 265.79 J was obtained for sequence sp-01
- Maximum flexural strength of 2.1 GPa gained by sp-01
- 20% of water was absorbed by sequence sp-02 and sp-03 and 25.68% water absorbed by sequence sp-01

Future Work

- From the observation the hybrid composite laminates are showing good results and is suitable for load applications, automobile load panels etc.
- It has been found that the mechanical properties of the composites such as tensile strength, flexural strength and impact strength are greatly influenced by fabrication sequence.
- The developed pineapple leaf fiber reinforced composites can be used in different engineering applications and construction works.

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