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Fabrication and Mechanical Performance Investigation of Sisal and Sugarcane Fibers

T.E.Narentharan*, M.Sengottian
*Assistant Professor, Department of Mechanical Engineering, Maharaja Engineering College,
Avinashi, Tamil Nadu, India
Assistant Professor, Department of Mechanical Engineering, Nandha Engineering College,
Erode, Tamil Nadu, India

Abstract

Natural fibers, such as sisal, flax and jute, possess good reinforcing capability when properly compounded with polymers. These fibers are relatively inexpensive, originate from renewable resources and possess favorable values of specific strength and specific modulus. Thermoplastic polymers have a shorter cycle time as well as reprocessability despite problems with high viscosities and poor fiber wetting. The renewability of natural fibers and the recyclability of thermoplastic polymers provide an attractive ecofriendly quality to the resulting natural fiber-reinforced thermoplastic composite materials. Common methods for manufacturing natural fiber-reinforced thermoplastic composites, injection moulding and extrusion, tend to degrade the fibers during processing. Development of a simple manufacturing technique for sisal fiber, sugarcane baggage-reinforced polypropylene composites, that minimizes fiber degradation and can be used in developing countries, is the main objective of this study. Combination of sisal and sugarcane baggage fibers possesses good reinforcing capability when properly compounded with polymers.

Keywords: Sisal and Sugarcane fibers, Fabrication, Mechanical performance.

Introduction

The fibre was washed thoroughly with water and dried in an air oven at 80^0C for 6 h, before being chopped into 6 mm length for fibre treatment and the preparation of the composites. Toluene- 2,4-diisocyanate (TDI) and polypropylene glycol (PPG) of molecular weight 1000 were supplied by the Aldrich Chemical Company, USA. Dibutyl tin dilaurate was obtained from Scientific and Industrial Supplies Corporation, Mumbai. Potassium permanganate, sodium hydroxide and maleic anhydride used in the present study were of chemically pure grade [1]. The chopped fibres were taken in a stainless steel vessel. A 10% solution of NaOH was added into the vessel and stirred well. This was kept for 1 h with subsequentstirring. The fibres were then washed thoroughly with water to remove the excess of NaOH sticking to the fibres. Final washings were carried out with distilled water containing a little acid. The fibres were then air dried [2]. Sugar cane biogases, the fibrous solid residue left over after juice extraction from Sugar cane (S. Officinarum) – designated ‘‘B” – was supplied by the Montebello distillery (Petit-Bourg, Guadeloupe). Sugar cane bagasse fibers were obtained by milling using a laboratory blender. Two commercial alkylalkoxysilanes provided by Sigma-Aldrich company, commonly termed silanes S1 and S2 in the text, were used. S1 is in fact an alkyltrialkoxysilane (RSi (OR0)3) while S2 is adialkyldialkoxysilane (R2Si (OR00)2). The commercial ordinary Portland cement (OPC) used was supplied by Cement Antillais (Lafarge Group). CIMABAT NF P 16-102 was composed of 53.6% imported clinker, 42% local pozzolan and 4.4% gypsum [3]. The sugarcane biogases was mixed with 1% (v/v) H2SO4 solution at a ratio of 1 g of biomass to 10.0 ml of acid solution and autoclaved for 1 h. After cooling, the liquid was treated. Twenty grams of sugarcane biogases mixed with 1% (v/v) H2SO4 (200 ml) solution will give around 150 ml of hydrolyaste containing 3.5 dissolved solids (DS) with a conductivity of 7500 lX/cm. The conductivity of the hydrolysate was reduced up to 500 lX/cm with the ion exchange treatment. Monomeric sugar composition in sugarcane bagasse hydrolysates: xylose 56%, glucose 15% and arabinose 24% [4].The use of biodegradable and environment-friendly plantbased ‘lignocellulosic’ fibers has been a natural choice for reinforcing (or filling) polymers (plastics) to make them ‘greener’. The availability of inexpensive plant-based fibers in every part of the world has, in part, fueled their use in the past few years. These fibers offer several other advantages as well. They are nonabrasive to processing equipment, can be incinerated, are CO_2 neutral (when burned), and, because of their hollow and cellular nature, perform well as acoustic and thermal insulators. The hollow tubular structure also reduces their bulk density, making them lightweight [5].The compressive strength and impact strength of unsaturated polyester based sisal/ glass hybrid composite have been studied as a function of fiber content. It is observed that the compressive and impact strength of sisal/glass fiber hybrid component is higher than sisal fiber reinforced composite, but lower than the glass reinforced composite [6]. In the present investigation, the effect of moisture absorption of the sisal-coir composites at room temperature and elevated temperatures has been found. It is found that higher fiber content samples have a greater diffusivity because of higher cellulose content. The moisture uptake at elevated temperatures does not show Fickian behavior as compared to room temperature moisture up take behavior. Reinforced hybrid Epoxy composite were investigated and compared with the results shown that the mechanical properties of fabricated composites had increased by increment of SCFC content, especially for flexural and impact properties. For the physical test, the result showed bad performance on both water absorption and thickness swelling test [7].

The composite CS/SF/BF hybrid composite was prepared successfully and it was confirmed by FTIR, X ray, DSC and SEM analysis. From the above results it is obvious that sorption efficiency was dependent on operating conditions such as pH, contact time, adsorbent dose. The optimum pH for the maximum removal of Cu (II) ion from an aqueous solution is found to be 5.0 [8]. Increase of adsorbent dose prominently increased the adsorption due to an increase in the surface area. The equilibrium data were analyzed by the kinetic model indicates the adsorption of copper (II) ion from solution by CS/SF/BF hybrid composite corresponds to the pseudo second order reaction [9]. In the present investigation, the effect of moisture absorption of the sisal-coir composites at room temperature and elevated temperatures has been found. It is found that higher fiber content samples have a greater diffusivity because of higher cellulose content. The moisture uptake at elevated temperatures does not show Fickian behavior as compared to room temperature moisture up take behavior.

At elevated temperature there is 33% higher moisture absorption for 40% sisal-coir fiber reinforced composites. The moisture absorption results in this investigation show Fickian behavior at room temperature and non-Fickian at boiling temperature [10].

Composites

Composites are formed by combining materials together to form an overall structure that is better than the individual components. Composite materials are materials made from two or more constituent materialswith significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials.

Green composite elements

Compositing is the combining of visual elements from separate sources into single image often to create the insulation that all those elements are parts of same scene. The parts are,

- Natural fiber
- Resins
- Filler materials

Natural fiber

Vegetable fibers are generally based on arrangements of cellulose, often with lignin, examples include cotton, hemp, jute, flax, ramie, sisal and bagasse.

- Sisal fiber
- Sugarcane fiber

Sisal fiber

Sisal fiber made from the large spear shaped tropical leaves of the Agave Sisal and plant. Fine fiber available as plaid, herringbone and twill.

Sugarcane fiber

Bagasse is one of the most eco-friendly resources suitable for various applications; bagasse fiber is extracted from sugar cane.

Resin

Resin in the most specific use of the term is a hydrocarbon secretion ofmanyplants,particularly coniferous trees.

Epoxy

Epoxy is both the basic component and the cured end product of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as poly epoxides are a class of reactive pre polymers and polymers which contain epoxide groups. The mixing ratio is based on the composite weight percentage. Thoroughly mixed peroxide treated sisal and sugarcane fiber as shown in figure.

Filler materials

Fillers are particles added to material (plastics, composite material, and concrete) to lower the consumption of more expensive binder material or to better some properties of the mixture material.

Rice husk

Rice hulls (or rice husks) are the hard protecting coverings of grains of rice. In addition to protecting rice during the growing season, rice hulls can be put to use as building material, fertilizer, insulation material, or fuel. Rice hulls are the coatings of seeds, or grains, of rice.

Pre- treatment

Particularly focused on the modification of filler surface in order to improve the interfacial adhesion between filler particles (hydrophilic) and polymer macromolecules (generally hydrophobic) and their dispersion in the matrix. The overall comment which can be drawn is that the green composites can achieve greater stiffness.

Various Pre- treatment techniques

- Untreatment
- NaOH treatment
- Benzylation
- Acrylation
- Peroxide
- Permanganate

Fabrication process

Mould preparation

The Mould for the Hand Lay-up method was made with the help of steel and mica sheet is as shown below.

Mixing Ratio

The manufacturing of the specimen is based on the Hand Lay-up process. In this process the sisal fiber and sugarcane fiber, rice huskers, epoxy resin and hardener are mixed in the beaker and is then moulded by hand using some pressure. The pretreated fibers are cuted into small size of 3-5mm. Then both sisal and sugarcane fibers are mixed together along with rice husk.

Sisal Fiber	- 35%
Sugarcane fiber	- 20%
Rice Husk	- 5%
Resin	- 35%
Hardener	- 5%

Hand lay-up process

In the hand lay-up process, fiber reinforcement is manually inserted into a single-sided mold. Following steps are used in Hand lay-up process. The mould is cleaned and polished for easy de-moulding.Epoxy resin is mixed with its hardener with required ratio. The layer of resin is poured into the mould and spread it all over the mould surface. Then layer of mixed sisal and sugarcane chopped fiber are applied. Another layer of epoxy resin is added. Resin is forced through the thickness of the fiber mats using hand rollers, and then excess resin is removed using squeegees. The part is allowed to cure and then disassembled from the mould. The part is de-moulded and sent for finishing work. The size of finished material,

Length : 300 mm
Breath : 300 mm
Thickness : 5 mm

Material testing

The mechanical testing of composite structures to obtain parameters such as strength and stiff less is a time consuming and often difficult process. It is, however, an essential process, and can be somewhat simplified by the testing of simple structures, such as flat coupons. The data obtained from these tests can then be directly related with varying degrees of simplicity and accuracy to any structural shape. The test methods outlined in this section merely represent a small selection available to the composites scientist. Some, such as the tensile coupon test, are widely recognized as standards.

4.1 Tensile test

Tensile testing utilizes the classical coupon test geometry as shown below and consists of two regions, a central region called the gauge length, within which failure is expected to occur, and the two end regions which are clamped into a grip mechanism connected to a test machine.

4.2 Impact test

Before looking at impact testing let us first define what is meant by 'toughness' since the impact test is only one method by which this material property is measured.

Table 1 Impact test values

Sl. No.	Impact Value for 5 mm thick specimen in J	Treatment
1	0.45	NaOH (I_1)
2	0.50	Benzoylation (I_2)
3	0.25	Acrylation (I_3)
4	0.25	Un-treatment (I_4)
5	0.20	Peroxide (I_5)
6	0.10	Permanganate (I_6)

Results and discussions

Impact test results

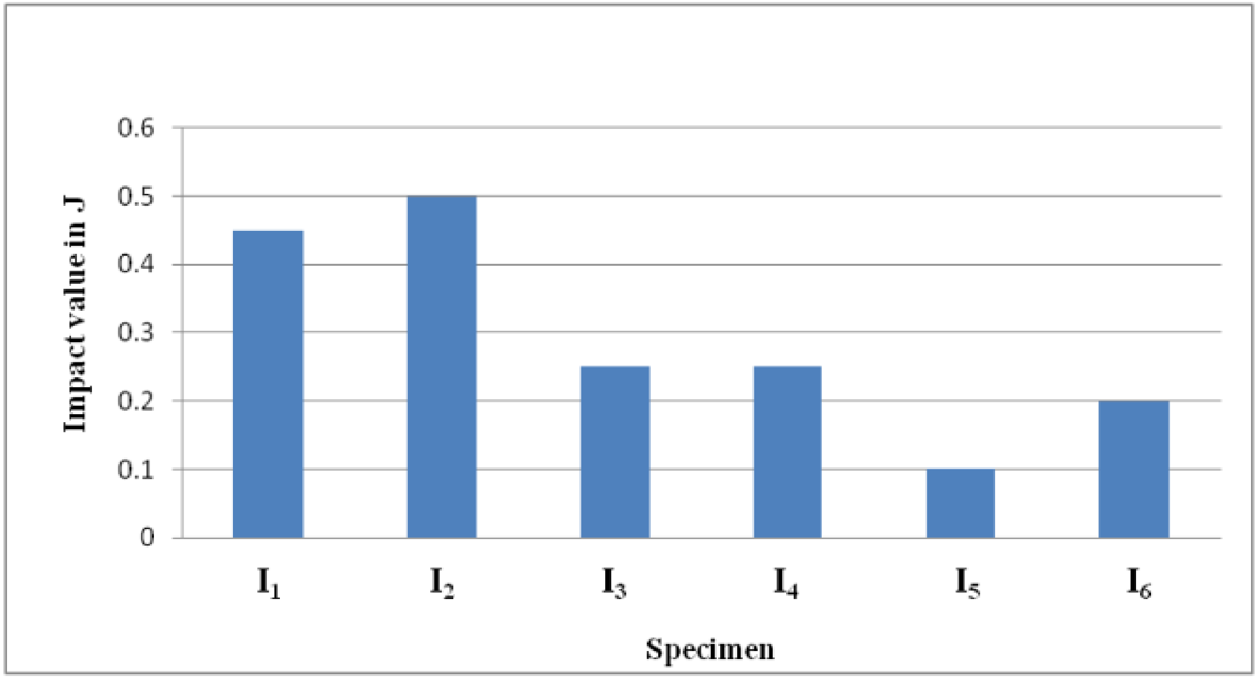

Figure 1 Impact test values for different specimen

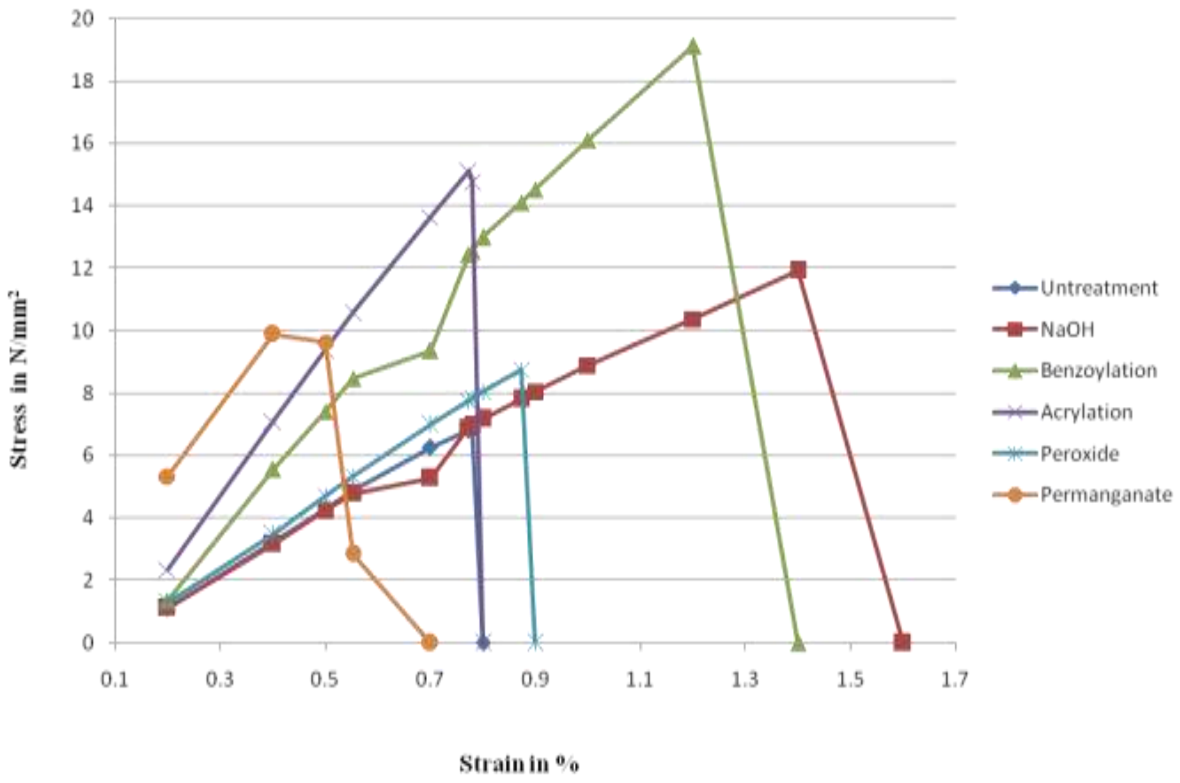

Figure 2 Comparison of stress Vs strain of specimens

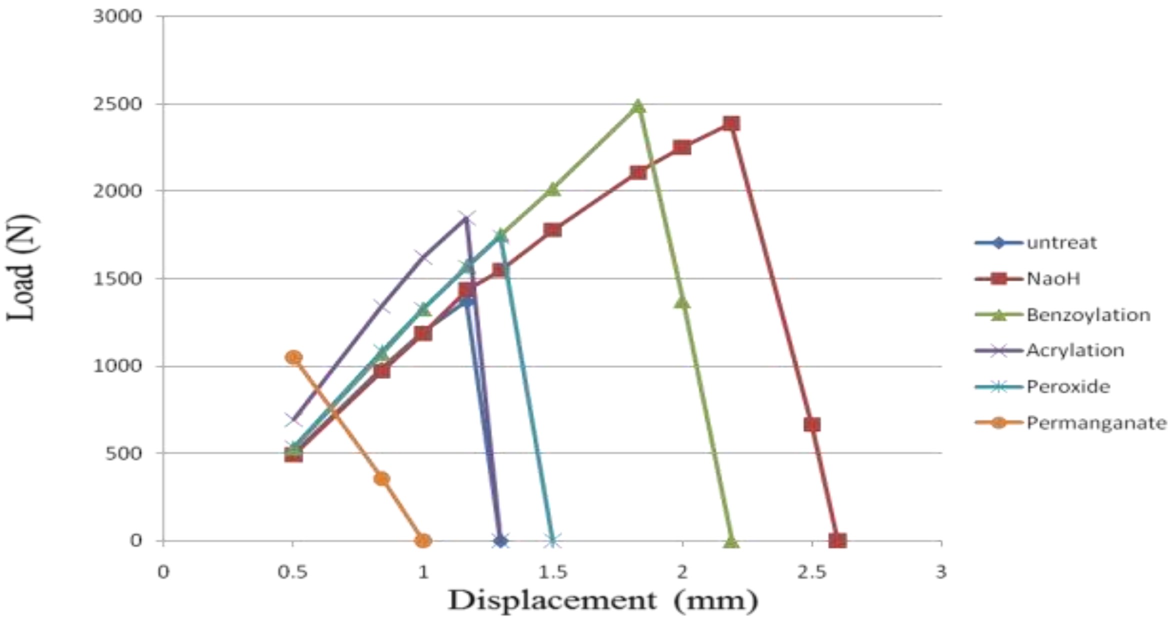

Figure 3 Comparison of displacement Vs load of specimens

Table 2 Comparison Statement of Mechanical Properties

Treatments	Impact reading (J)	Max. Load (N)	Max. Elongation (mm)	Max. Strain %	Max. Stress (N/mm^2)
I_4	0.25	1369.67	1.17	0.78	6.848
I_1	0.45	2388.245	2.19	1.46	11.941
I_2	0.5	2490.605	2.83	1.22	19.122
I_3	0.25	1896.242	1.17	0.773	15.128
I_5	0.2	1748.633	1.32	0.873	8.743
I_6	0.1	369.248	0.84	0.527	2.984

Conclusion

From the above comparison of results of impact and tensile properties and SEM analysis report, Benzoylation treated composite material have the higher impact value, higher load carrying capacity which was obtained from the impact and tensile test and also have low voids and impurities that are obtained from the SEM Analysis and eventually it is evident that the material obtained from the compression moulding with banana and sisal fiber as a matrix element is the most suitable replacement in most of the modern equipment.

References

1. Anil N. Netravali and Shitij Chabba 'Composites get greener' April 2013:page.no.[22].F.P. La Mantia, M.Morreale; 'Green Composites: A brief review'; Part A 42(2011) page. no.[578-588].
2. Folkes, M.J. 'Short Fiber Reinforced Thermoplastics'Wiely, NewYork, 1982, Ch.6. [564.
3. John Z. Lu, Quiglin Wu; 'The Influences of fiber Feature and Polymer Melt Index on Mechanical Properties of Sugarcane Fiber/Polymer Composites'; 16.04.2006.page.no.[5608]
4. K. Bilba, M.-A.Arsene 'Silane treatment of bagasse fiber for reinforcement of cementitious composites' Composites: Part a 39 (2008) page. no.[1489]
5. Kestur G. Satyanarayana, Gregorion G.C. Arizaga, Fernando Wypych; 'Biodegradable Composites based on Lignocellulosic Fibers-An Overview'; Progress in polymer science 34(2009). Page.no.[982-1021]
6. Kuruvilla Joseph and Sabu Thomast 'Effect of chemical treatment on the tensile properties of short sisal fiber-reinforced polyethylene composites' Polymer Vol. 37, pp. 5139-5149, 1996.page.No.[23]
7. P.V. Josepha, K. Joseph, 'The thermal and crystallization studies of short sisal fiber reinforced polypropylene composites'. 10.9.2001:page no.[254].
8. R.Sreenivas Rao, Ch. Pavana Jyothi, 'Xylitol production from corn fiber and sugarcane bagasse hydrolysates by Candida tropicalis' Bioresource Technology 97 (2006) page.no.[1975].
9. A.Varada Rajulu, G. Babu Rao, L. Ganga Devi, D. Sidda Ramaiah, K. Shubhaprada, K. Shrikant Bhat, R. Shylashree, Mechanical properties of short, natural fiber hildegardia populifolia-reinforced styrenated polyester composites, J. Rein. Plast. Comp. 24(4) (2005) 423–428.(13).
10. H. P. S. Abdul Khalil, S. Hanida, C. W. Kang, N.A. Nikfuaad, Agrohybrid composite: the effects on mechanical and physical properties of oil palm fiber.(11) International Journal of Fiber and Textile Research 2011; 1(1): 11-14