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EVALUATION OF MECHANICAL PROPERTIES OF HYBRID INTRALAYER JUTE/SISAL AND FLAX/SISAL EPOXY COMPOSITES

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ABSTRACT

This paper aims to find mechanical properties of intra-ply jute/sisal and flax/sisal epoxy composites. Laminas were fabricated following the hand lay-up technique in intraply woven methods. Results are presented regarding the tensile, flexural behaviour of fabricated laminates. The testing specimens were prepared from the composite laminate for the determination of Tensile strength, Flexural strength according to the ASTM standard guidelines ASTM D638, ASTM D790, and ASTM D-256 respectively. The experimental results reveal that the mechanical properties of intraply jute/sisal and flax/sisal epoxy composite. A greater stress uptake in the intraply jute/sisal and flax/sisal composites was obtained by the interlocking structure between the fiber yarns.

Keywords: Intralayer, Jute, Flax, Sisal, Epoxy, Hybrid Woven, Epoxy.

1.INTRODUTION:

Natural fibers have significant cost advantages when compared with synthetic fibers such as glass, carbon, nylon, etc. Among the different types of natural fibres, bast fibres (flax, hemp, jute and ramie) derived from plants are most commonly used in different applications such as automotive, marine and construction, because of their attractive properties in terms of weight (low density) and performance (high specific strength and modulus). It also has higher strength and modulus upon comparing with plastic and is a good replacement for conventional fibers in many applications. Natural fibers have excellent beneficial properties when used as reinforcement for composites. They are low-density materials, yielding relatively light weight composite with high specific Properties. Composites consists of two or more different reinforcing materials bound in the same matrix called as hybrid composites. For achieve better mechanical properties, hybrid composites are investigated. Past few decades many investigations made on hybrid polymer composites. Also by fillers and nano materials are used N. Venkateshwaran(1) et al this work, alkali (NaOH) of various concentrations (0.5%, 1%, 2%, 5%, 10%, 15% and 20%) was used to treat the fiber surface and the effect of these concentrations on the mechanical and visco-elastic behaviour of the composites were carried out. From the experimental investigation, it is found that 1% NaOH treated fiber reinforced composites behaves superiorly than other treated and untreated fiber composite. Hybrid synthetic and natural fiber composites also found in many investigations. G. Yuvaraj (2) et al proved that composite with equal fibre ratio of glass and sisal (50:50) has improved the mechanical properties than composite with minimum percentage of sisal fiber. M. Thiruchitrambalam (3) et al compared mechanical properties of banana/kenaf hybrid composites with respect to SLS and alkali treatment. In this work they conclude the SLS treatment had provided better mechanical properties that the alkali treated. Verma et al. (4) and Mohan et al. (5) have investigated the mechanical properties of jute/glass hybrid composites in both polyester resin and epoxy resin. Mechanical properties of natural fibers are based on fiber alkali treatments, fiber matrix ratio, fiber loadings. Jochen Gassan (6) et al found fibre treatment and increased fibre content decrease the rate of damage development in the composites.

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M.Ramesh (7) et al found that the incorporation of sisal fiber with GFRP provide superior properties than the jute fiber reinforced GFRP composites in tensile properties and jute fiber reinforced GFRP composites performed better in flexural properties. Winfield (8) analyzed the use of jute-reinforced plastics to low cost housing. In his study jute fabric is directly used as reinforcement. Arifuzzaman Khan et al. [9] developed environmental friendly jute fabric composites and investigated the influence of woven structure on the mechanical properties of the composite. In these composites, it was observed that mechanical strength and modulus in the warp direction are higher when compared to the weft direction. Apart from this, plain-woven jute fabric composites in the warp and weft directions exhibited superior mechanical properties to those of non-woven jute fabric composites. Currently in India, 90 million tons of fly ash is being generated annually, dumped in 65,000 acres of ash ponds. This huge quantity produces challenging problems, like health hazards and environmental issues. Fly ash comprises of fine particles of silica, alumina, calcium and magnesium oxides. Seung Goo Leo (10) et al improved and modified the flax fibers by ethylene plasma treatment and acetylation. Plasma treatment with ethylene results about the higher thermal resistance and larger interfacial strength in flax/PHB biocomposies that the chemical modification by acetic anhydride without the damage to flax fibers. Hybrid composite materials are widely used in the field of engineering applications due to their strength-to-weight ratio, low cost, and ease of manufacturing. Hybrid composites are preferred to achieve a blend of properties such as ductility, stiffness, and strength which cannot be achieved by single fiber reinforced composites. Hybridization allow designers to tailor the composite properties to the exact needs of the structure for various consideration. The purpose of hybridization is also to obtain a new material obtaining the advantages of its constituents, and overcoming some of their disadvantages.

Table.1 Mechanical Properties of Jute, Sisal and Flax Fiber:

QUANTITY	**JUTE**	**SIAL**	**FLAX**
Materials	 **Fig.1**	 **Fig.2**	 **Fig.3**
Young's modulus (GPa)	26.5	22	22
Tensile Strength (MPa)	393	458	458
Elongation (%)	1.5-1.8	1.5-1.8	1.5-1.8
Density (Kg/m^3)	1470	1450	1450

R Yahaya et al (11) evaluated that the hybridization affects in intermediate mechanical properties of composites compared to the highest Kevlar/epoxy properties and the lowest properties of kenaf/epoxy composite. Alessandro Pegoretti et al (12) studied the impact data clearly show that hybrid intraply composites reached higher ductility index value when compared to those of interply hybrids. Another method for improving the mechanical properties is to add fillers or nano particles while fabricating natural fiber polymer composites. Mohan et al (13) determined, increasing the Wt. % of MWCNT and also varying the stacking sequence of the

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fiber layers can enhance the mechanical properties of the natural fiber hybrid composites. V. Jute(Fig.1) stem has very high volume of cellulose that can be procured within 4-6 months, and hence it also can save the forest and meet cellulose and wood requirement of the world. Sisal Fiber (Fig.2) is one of the most widely used natural fiber and is very easily cultivated. It is obtain from sisal plant. The plant, known formally as Agave sisal Ana.

Figure.4 Weaving of Jute/Flax Fiber.

Flax fiber is extracted from the bast beneath the surface of the stem of the flax plant. Flax fiber (Fig.3) is soft, lustrous, and flexible; bundles of fiber have the appearance of blonde hair, hence the description "flaxen" hair. From the results the following three major conclusions were drawn. The tensile strength of the composite has decreased by 10.4 %, This is because of the air entrapment caused by the nano particles. A.B. Maslinda (15) et al found tensile and flexural strength of the intralayer kenaf/jute and kenaf/hemp laminates were superior to those of the individual kenaf, hemp, jute woven composites due to the different load distributed to the warp and weft fiber directions. Finally in this paper, the intra woven jute/flax and intra woven sisal/flax natural fiber mechanical properties are investigated based on the research gap purpose.

2. Experimental Work:

2.1 Alkaline Treatment:

The Natural fibers are derived from lignocelluloses, they are hydrophilic in nature and hence they become weak at the interface between matrix and fiber. The main disadvantage encountered is including sisal fiber and jute into a polymer matrix is the lack of good interfacial adhesion between the two components, which results in poor properties in the final product. Due to poor adhesion mechanical properties of the natural fiber composite are low and hence it becomes important to improve the adhesion either by physical or chemical methods. Fiber matrix interfacial adhesion can be improved with many chemical modification of the fiber. One of the familiar and effective chemical modification applied to sisal fibre is an alkaline treatment based on sodium hydroxide.

Fig.5. Fiber mat soaked in NaOH Solution

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2.2 Matrix:

The resin used in this work epoxy which is obtained from Bharath Resins, Thirumullaivoyal. Epoxy-Br 111 and Hardner-Hy951. The curing reaction for epoxy resin will start immediately upon addition of suitable catalyst and accelerator. The epoxy resin used in this work is normally preaccelerated. Once die catalyst is added, the curing reaction starts immediately at the room temperature.

2.3 Manufacturing of Laminates:

First weight of four layers of respective (sisal,flax & Jute) fiber cut to dimension 300 x 300 mm. According to the volume fraction (VF), the required volume of matrix is calculated. The ratio of epoxy resin (BR 111) and the hardener (HY 951) are assigned as 10:1 respectively. Then this resin and hardener are mixed in a beaker continuously for 5 minutes to make homogenous mixture. The pot life of the mixture is 20 and 30 minutes. Dam of size 300 x 300 mm is placed over a polythene sheet. Releasing agent (Silicone spray) is applied all over the sheet and on the edges of the dam. Matrix is applied over the sheet using paint brush. Then the first jute fiber layer is placed neatly without any slack over. Then the jute fiber is rolled by a hand roller to ensure the uniform flow of the resin throughout the layer.

Fig.6 Applying Epoxy on the fiber

Fig.7 Jute/Sisal Laminate

Fig.8 Flax/Sisal Laminate

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3. RESULTS & DISCUSSION:

3.1 TENSILE TEST:

The woven and intraply hybrid composites were subjected to a tensile test, under untreated and treated conditions, to determine their tensile strength.

Furthermore, the two fibers with difference properties created a complex load-sharing property, between the longitudinal and transverse directions, when they were weaved together. This resulted in a greater stress uptake by the intraply hybrid composites, which were observed to break at higher failure strains, in comparison with the individually woven composites. The proper stress transfer from them matrix to the fibers contributed to a lower crack propagation rate, which resulted in the higher ductility of the intraply hybrid composites. The tensile strength of intraply jute/sisal(J/S) and intraply flax/sisal(F/S).

Fig.9 Tensile test & Flexural Test-Jute/Sial.

Fig.10 Tensile test & Flexural Test-Flax/Sisal.

Table.2 Tensile Strength Properties of Jute/Sisal and Flax/Sisal Inter woven type Hybrid Natural fiber:

Property	Condition	J/S	F/S
Tensile strength (Mpa)	Untreated	48* 10#	55* 14#
	Treated	71* 15#	76* 18#

*Sisal-warp direction, #Jute & Flax Weft Direction.

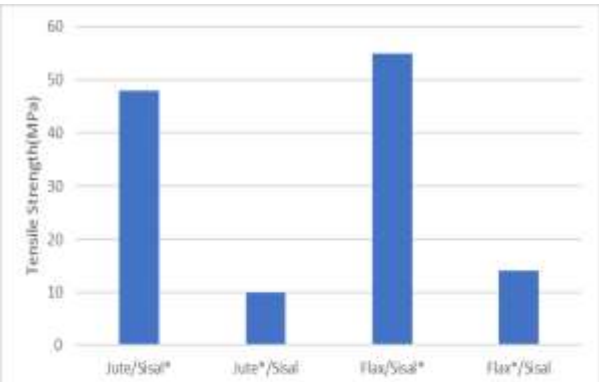

Fig 11 Untreated Intra Woven Fiber

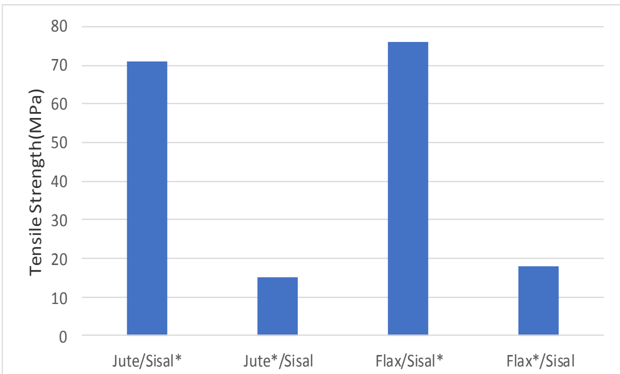

Fig 12 Treated Inter woven Fiber

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3.2 FLEXURAL TEST:

The flexural strength describe the ability of composites to withstand a bending load and deformation before reaching their breaking point.

Table summarizes the results obtained from the flexural test. As a result of hybridization, excellent flexural properties were achieved. A flexural performance was recorded for the intraply hybrid composites, at the untreated and treated conditions.

The increments of the flexural strength show that the intraply hybrid composites were stronger and more rigid, in comparison with the individually woven composites.

Table.3 Flexural Strength Properties of Jute/Sisal and Flax/Sisal Inter woven type Hybrid Natural fiber:

Property	Condition	J/S	F/S
Flexural strength (Mpa)	Untreated	134* 23#	96* 118#
	Treated	139* 36#	126* 54#

*Sisal – warp direction, #Jute & Flax Weft Direction.

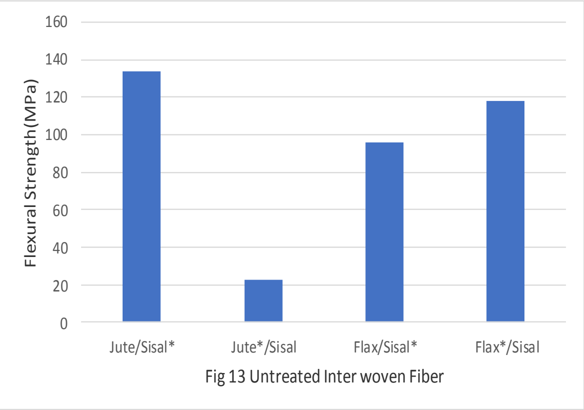

Fig 13 Untreated Inter woven Fiber

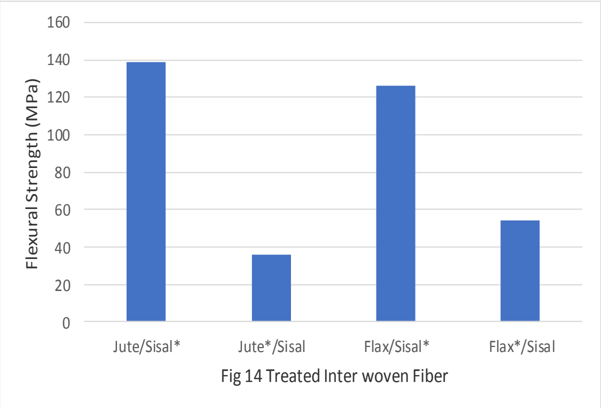

Fig 14 Treated Inter woven Fiber

4. CONCLUSIONS:

The tensile, Flexural and impact mechanical properties of intraply hybrid composites, based on Epoxy, have been investigated. The intraply jute/sisal and flax/sisal composites, and its effect on their mechanical properties, were investigated following. The conclusions from the experiment as follow:
1. The tensile strength of the intraply jute/sisal and flax/sisal hybrid composites were superior to those of the remaining intraply composites due to the different load sharing properties.
2. A greater stress uptake in the intraply jute/sisal and flax/sisal hybrid composites was obtained by the interlocking structure between the fiber yarns; therefore, a larger load was required to break the structure. From this combinations, Maximum flexural strength was achieved in the jute/sisal treated intraply hybrid composites.

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