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Experimental Study of Sisal and Jute Fiber Based Biocomposite

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Abstract: **The composite manufacturing has been a wide area of research and it is the preferred choice due to its superior properties like low density, stiffness, light weight and possesses better mechanical properties. This has found its wide applications in aerospace, automotive, marine and sporting industries. In this work, eco-friendly natural fiber composites are manufactured using jute and sisal fiber along with epoxy. Different fiber lengths were chosen such as (2.5cm, 2.0cm, 1.5cm, 1.0cm) and are manufactured by hand layup system. Different mechanical properties such as (tensile, Water absorption and impact energy) of the jute and sisal fiber composites are quantified. In this research work sisal fiber based composite exhibits better results in tensile and impact energy test as compared to jute fiber based composites.**

Keywords: **Natural fibers, Biocomposites, Jute Fibers, Sisal Fibers, Epoxy, Hardener.**

1. INTRODUCTION

Composite materials are material systems which consist of one or more discontinuous phases embedded in a continuous phase [1]. Thus, at least two distinct materials that are completely immiscible are combined to form a composite. It consists of fibers of high strength and modulus embedded in or bonded to a matrix with distinct interfaces (boundaries) between them.

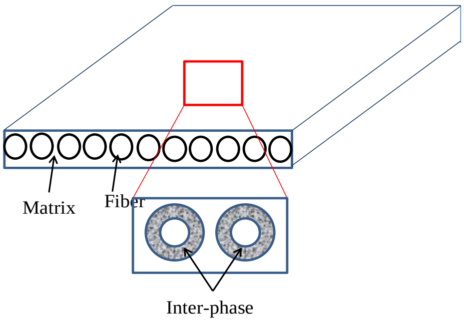

Fig 1: Enlarge View of the composites

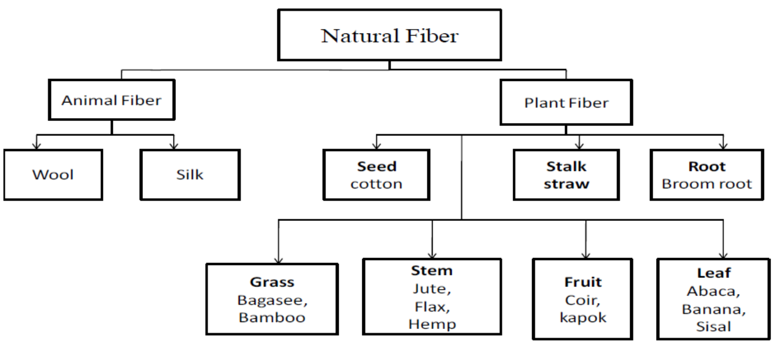

Fig 2: Classification of Natural Fibers [2]

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Figure 2 shows the classification of natural fibers which is classified under the two categories Animal fibers and Plant fibers. Animal Fibers contains wool, silk, avian fiber. It includes sheep's wool, goat hair, horse hair, feathers and feathers fiber. Natural fibers are eco-friendly; lightweight, strong, renewable, cheap and biodegradable. The natural fibers can be used to reinforce both thermosetting and thermoplastic matrices. Thermosetting resins such as epoxy, polyester, polyurethane, phenol are commonly used composites requiring higher performance applications.

1.1 Biocomposite:

Biocomposites are composite materials comprising one or more phase(s) derived from a biological origin. In terms of the reinforcement, this could include plant fibres such as cotton, flax, hemp and the like, or fibres from recycled wood or waste paper, or even by-products from food crops. The ultimate properties of the composite fibres are different from the original materials where one component comes from biological origin such as wood pulp, cotton, flax and hemp. They have specific thickness, strength, stiffness and flexibility. A fiber is defined as a slender and greatly elongated solid substance. A fiber should impart reinforcement when used in composites for structural applications [1].

1.2 Why Biocomposites:

Biocomposites are mainly used because of the environmental concerns. They belong to the family of natural fibres and are ecofriendly in nature [1]. In recent years the prime focus is shifted towards the use of biocomposites in various structural as well as non structural applications. Biocomposites have good recycling capability and they are biodegradable in nature [2].

2. LITERATURE REVIEW

A lot of work has been carried out regarding to the field of composites many of the authors discussed about the use of composites and how they behave when they are subjected to different conditions. Now a day's composites have very wide areas of applications. According to Pandian et.al [3] the sandwich laminate that has 8 vol% of jute and 8 vol% of linen (J2-L3) presents superior tensile property and great impact strength, an asset for engineering applications.Wambua et.al[4]discussed about the mechanical properties of sisal, hemp, coir, kenaf and jute reinforced polypropylene composites have been investigated. The mechanical properties of the natural fiber composites tested were found to compare favorably with the corresponding properties of glass mat polypropylene composites.Gopinath et.al [5] discussed about the use of jute-epoxy and jute-polyester composite specimens prepared as per ASTM standards subjected to mechanical characterization results were analyzed and compared. The tensile strength for jute-epoxy and jute-polyester composites was found to be 12.46 N/mm2 and 9.23N/mm2.Jawaid et.al [6] discussed about the tensile properties which were increased with the increase in ratio of jute fiber in the hybrid composites. As the weight fraction of jute fiber increases in the hybrid composites, jute fibres are able to withstand a higher load while redistributing a lesser load to the EFB fibres resulting in better tensile strength and modulus of the hybrid composites with the addition of jute fibres. Ramesh et.al [7] discussed about the sisal/GFRP and jute/GFRP hybrid composite specimens which are prepared and subjected to tensile and flexural loading. The sisal/GFRP composite samples possess good tensile strength and can withstand the strength up to 68.55 MPa. The jute/GFRP composite specimen is holding the maximum flexural load of 1.03KN slightly higher than the sisal/GFRP composite sample. The failure morphology of the tested samples is examined by using Scanning Electron Microscope. Alam et.al [8] discussed about the natural fiber composites plates which could be fabricated using maximum of 45% of fiber content. The maximum tensile strength of natural fiber composite plate was 137Mpa and the maximum modulus of elasticity was 14.91Gpa.According to Oksman et.al [9] the main objective of his study was to investigate if PLA can be used as matrix in composite systems where natural fibres are used as reinforcements. In Franco et.al [10] the mechanical behavior of continuous natural fiber reinforced HDPE was studied. The fiber-matrix interaction were changed by modifying the surface properties of the fiber, first to increase the area of contact and to further expose the cellulose micro fibrils, and then to improve fiber wetting and impregnation. As per Lu.et.al [12] Starch is renewable from carbon dioxide, water and sunshine. It is biodegradable, cheap and to be physical or chemical modified easily.

3. EXPERIMENTAL

3.1 Materials and methods:

Jute fibers, sisal fibers, epoxy resin (LY556) and hardener (HY951) are used to formulate the Natural composites. A thin plastic sheet is used which is placed at the internal periphery of the mould after applying release gel. Fibers are cut into different lengths as per the analysis. The epoxy resin mixed with hardener in the ratio 10:1 is poured onto the surface of natural fibers and mixed properly. A Tamping rod is then used in order to fill the composites into the mould and tempted properly in order to achieve dense packing.

Fig 3: Jute Plant and Jute Fibers [1]

Fig 4: Sisal fibers

Fig 5: Specimens of Jute Fiber Composites for Water absorption and Impact Energy Test

Fig 6: Specimens of Sisal Fiber Composites for Tensile and Impact Energy Test

3.2 Methods:

The process of creating a composite material and structure from its constituent fiber and matrix. For the manufacturing of Biocomposites different methods were available such as:-Hand Lay-up and Autoclave processing ,Manual Lay-up ,Liquid Composite Molding, Filament Winding, Tape Placement, Fiber Placement, Pultrusion, Compression Molding

In this research work we have used the Hand Layup process for the manufacturing of the biocomposites after than the different parameters were calculated and analyzed. A release gel is spread over the outer periphery of the mould then after the fibers are properly lay down and mixed properly with the matrix. A cylindrical specimen of 1.5cm in diameter is taken for Tensile Test and release gel is sprayed over the inside periphery of the composites after than different lengths of the fibers are taken and properly mixed with the epoxy and kept for 24 Hours. In order to carry out the water absorption test samples are kept dipped inside the water for 24 hours and both dry weight as well wet weight were calculated. For impact energy test square specimens are casted.

Hand Layup/Manual Layup Method:

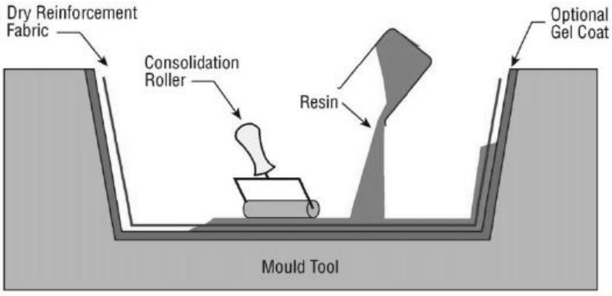

Fig 7: Manual Layup Method

4. RESULTS AND DISCUSSIONS

4.1. Jute fibers:

4.1.1 Tensile Test:

Figure shows the tensile strength variation for the jute fiber based composites .The tensile test results showed a variation in the tensile strength when different fiber lengths of the jute fibers were taken [6]. Fibers of 1.0cm in lengths when used to form composites exhibits good results when compared to different fiber lengths based composites. Tensile test was carried out in UTM (Universal Testing Machine) to estimate the tensile strength of jute-epoxy composite as per ASTM D3039 standards.

Table 1: Ultimate Tensile Strength of Jute Fiber based composites

S.NO.	FIBER LENGTH IN (Cm)	LOAD APPLIED IN (Kn)	ULTIMATE TENSILE STRENGTH IN (Mpa)
1	1.0cm	3.76	22.19391
2	1.5cm	3.92	21.28804
3	2.0cm	3.68	20.8351
4	2.5cm	2.163	12.2293

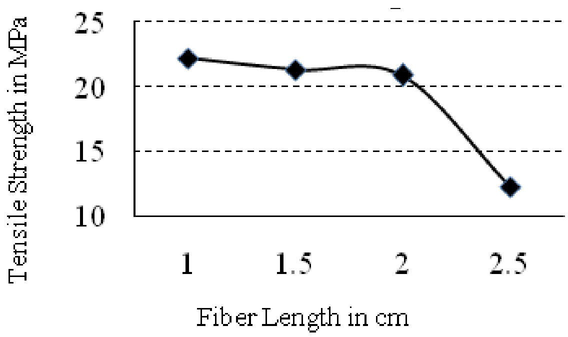

Fig 8: Tensile strength Vs Fiber length of jute fiber Composite in MPa

4.1.2 Water Absorption Test:

Table 2: Water Absorption of Jute Fiber based composites

S.NO.	FIBER LENGTH IN (Cm)	DRY WEIGTH (Gm)	WET WEIGTH (Gm)	WATER ABSORPTION
1.	2.5	14.08	14.5	2.98
2	2.0	14.04	14.28	1.71
3.	1.5	14.01	14.22	1.50
4.	1.0	13.68	13.89	1.54

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4.1.3 Impact Energy Test:

Izod Test

The Izod test specimens were made according to the dimensions of ASTM A370 in which the dimension is 75 x 10 x 10 mm.The results of jute fiber based composites are shown below

Table 3: Represents the impact energy values

S.NO.	FIBER LENGTH IN (Cm)	IMPACT ENERGY IN (KJ)
1.	2.5	11.6
2.	2.0	11.2
3.	1.5	9.6
4.	1.0	8.7

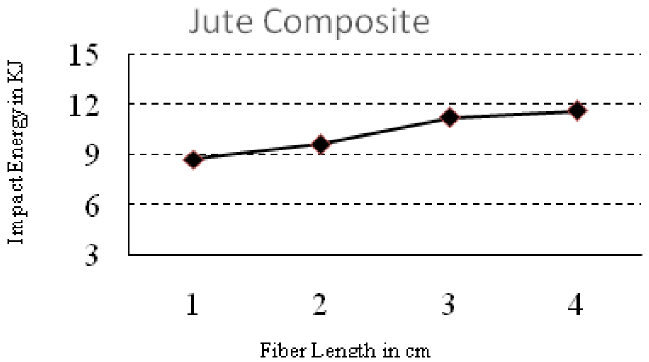

Fig 9: Impact energy of Jute fiber based composite

4.2. Sisal Fibers:

4.2.1Tensile Test:

Table 4: Ultimate Tensile Strength of sisal Fibers based composites

S.NO.	FIBER LENGTH IN (Cm)	LOAD APPLIED IN (Kn)	ULTIMATE TENSILE STRENGTH IN(Mpa)
1	2.5cm	3.6	17.26
2	2.0cm	4	19.18
3	1.5cm	4.8	23.01
4	1.0cm	5.4	25.89

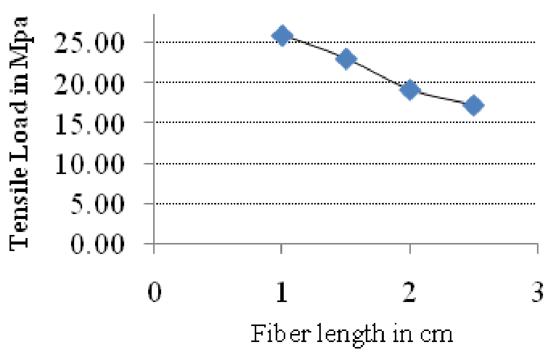

Fig 10: Tensile strength Vs Fiber length of sisal fiber Composite in MPa

4.2.2 Water Absorption Test:

Table 5: Water Absorption Values of different Fiber Length

S.no.	Fiber Length in (cm)	Dry Weight (Gm)	Wet Weight (Gm)	Water Absorption
1.	2.5cm	15.25	15.98	4.78
2.	2.0cm	15.10	15.65	3.64
3.	1.5cm	14.98	15.32	2.26
4.	1.0cm	15.01	15.27	1.73

4.2.3 Impact Energy Test:

Izod Test

The Izod test specimens were made according to the dimensions of ASTM A370 in which the dimension is 75 x 10 x 10 mm. One of the main reasons of concern for composites generally is the low values of impact energy. They show relatively low values of impact energy compared to metals [1]. The ways to increase the impact energy of the composites are being made the major area of research. The impact test was carried out by Izod test and the results were recorded

Table 6: Represents the Impact Energy values of sisal fiber composites

S.NO.	FIBER LENGTH IN (Cm)	IMPACT ENERGY IN (Kj)
1	2.5	13.5
2	2.0	12.89
3	1.5	11.59
4	1.0	10.5

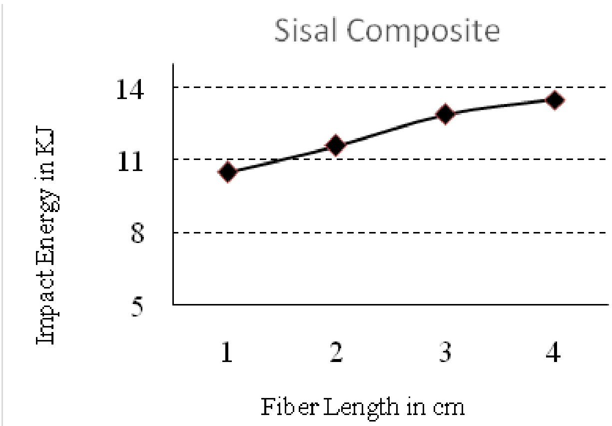

Fig 11: Impact energy Vs Fiber length of sisal fiber Composite in Kj

5. CONCLUSION

The jute and sisal fiber based biocomposites specimens prepared as per ASTM standards subjected to mechanical characterization results were analyzed and compared. The maximum tensile strength for jute and sisal fiber based composites for 2.5cm fiber length was found to be 22.19391Mpa and 25.89Mpa whereas in case of Izod test sisal fiber based composite exhibits good results.

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