STUDY OF MECHANICAL PROPERTIES OF HYBRID NATURAL FIBER COMPOSITE

A THESIS SUBMITTED IN PARTIAL FULFILMENT

OF THE REQUIREMENT FOR THE DEGREE OF

Bachelor of Technology
In
Mechanical Engineering

By

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Department of Mechanical Engineering

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CERTIFICATE

This is to certify that the thesis entitled, "**STUDY OF MECHANICAL PROPERTIES OF HYBRID NATURAL FIBER COMPOSITE**" submitted by Sri AVTAR SINGH SAROYA and Sri VISHVENDRA MEENA in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Mechanical Engineering at the NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University / Institute for the award of any Degree or Diploma.

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CONTENTS

ABSTRACT

The present experimental study aims at learning the mechanical behaviour of hybrid natural fiber composites. Samples of several Jute-Bagasse-Epoxy & Jute-Lantana camara-Epoxy hybrids were manufactured using hand layup method where the stacking of plies was alternate and the weight fraction of fibre and matrix was kept at 40%-60%.Specimens were cut from the fabricated laminate according to the ASTM standards for different experiments. For Tensile test & flexural test samples were cut in Dog-bone shape and flat bar shape respectively. After that experiment is performed under Universal testing machine (UTM). ILSS (flexural strength) & Tensile strength were observed and compared to base values of epoxy polymer to perceive the change in strength. SEM analysis was done to ascertain the mode of failure.

CHAPTER 1

INTRODUCTION

1.1 DEFINITION OF COMPOSITE

A composite is combination of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load carrying members. The matrix acts as a load transfer medium between fibers, and in less ideal cases where the loads are complex, the matrix may even have to bear loads transverse to the fiber axis. The matrix is more ductile than the fibers and thus acts as a source of composite toughness. The matrix also serves to protect the fibers from environmental damage before, during and after composite processing. When designed properly, the new combined material exhibits better strength than would each individual material. Composites are used not only for their structural properties, but also for electrical, thermal, tribological, and environmental applications.

Jartiz [1] stated that "Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form".

Kelly [2] very clearly stresses that the composites should not be regarded simple as a combination of two materials. In the broader significance; the combination has its own distinctive properties. In terms of strength to resistance to heat or some other desirable quality, it is better than either of the components alone or radically different from either of them.

Beghezan [3] defines as "The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings", in order to obtain improved materials.

Van Suchetclan [4] explains composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property.

The following are some of the reasons why composites are selected for certain applications:

- High strength to weight ratio (low density high tensile strength)
- High creep resistance
- High tensile strength at elevated temperatures
- High toughness

1.2 CLASSIFICATION OF COMPOSITES

1.2.1 According to the type of reinforcing material composites can be classified as:

(1)Fibrous Composite:

A fiber is characterized by its length being much greater compared to its cross-sectional dimensions. The dimensions of the reinforcement determine its capability of contributing its properties to the composite. Fibers are very effective in improving the fracture resistance of the matrix since a reinforcement having a long dimension discourages the growth of incipient cracks normal to the reinforcement that might otherwise lead to failure, particularly with brittle matrices. Man-made filaments or fibers of non polymeric materials exhibit much higher strength along their length since large flaws, which may be present in the bulk material, are minimized because of the small cross-sectional dimensions of the fiber. In the case of polymeric materials, orientation of the molecular structure is responsible for high strength and stiffness.

(2)Particulate Composites:

In particulate composites the reinforcement is of particle nature. It may be spherical, cubic, tetragonal, a platelet, or of other regular or irregular shape. In general, particles are not very effective in improving fracture resistance but they enhance the stiffness of the composite to a limited extent. Particle fillers are widely used to improve the properties of matrix materials such as to modify the thermal and electrical conductivities, improve performance at elevated temperatures, reduce friction, increase wear and abrasion resistance, improve machinability, increase surface hardness and reduce shrinkage.

1.2.2 According to type of matrix material they are classified as:

- Metal Matrix Composites (MMC)
- Ceramic Matrix Composites (CMC)
- Polymer Matrix Composites (PMC)

(1)Metal Matrix Composites:

Higher strength, fracture toughness and stiffness are offered by metal matrices. Metal matrix can withstand elevated temperature in corrosive environment than polymer composites. titanium, aluminium and magnesium are the popular matrix metals currently in vogue, which are particularly useful for aircraft applications. Because of these attributes metal matrix composites are under consideration for wide range of applications viz. combustion chamber nozzle (in rocket, space shuttle), housings, tubing, cables, heat exchangers, structural members etc.

(2)Ceramic matrix Composites:

One of the main objectives in producing ceramic matrix composites is to increase the toughness. Naturally it is hoped and indeed often found that there is a concomitant improvement in strength and stiffness of ceramic matrix composites.

(3)Polymer Matrix Composites:

Most commonly used matrix materials are polymeric. In general the mechanical properties of polymers are inadequate for many structural purposes. In particular their strength and stiffness are low compared to metals and ceramics. These difficulties are overcome by reinforcing other materials with polymers. Secondly the processing of polymer matrix composites need not involve high pressure and doesn't require high temperature. Also equipments required for manufacturing polymer matrix composites are simpler. For this reason polymer matrix composites developed rapidly and soon became popular for structural applications. Two types of polymer composites are:

(a) Fiber reinforced polymer (FRP)

(b) Particle reinforced polymer (PRP)

(a)Fiber Reinforced Polymer:

Common fiber reinforced composites are composed of fibers and a matrix. Fibers are the reinforcement and the main source of strength while matrix glues all the fibers together in shape and transfers stresses between the reinforcing fibers. Sometimes, filler might be added to smooth the manufacturing process, impact special properties to the composites, and / or reduce the product cost.

(b)Particle Reinforced Polymer:

Particles used for reinforcing include ceramics and glasses such as small mineral particles, metal particles such as aluminium and amorphous materials, including polymers and carbon black. Particles are used to increase the modules of the matrix and to decrease the ductility of the matrix

1.3 HYBRID COMPOSITE

Hybrid composites are more advanced composites as compared to conventional FRP composites. Hybrids can have more than one reinforcing phase and a single matrix phase or single reinforcing phase with multiple matrix phases or multiple reinforcing and multiple matrix phases. They have better flexibility as compared to other fiber reinforced composites. Normally it contains a high modulus fiber with low modulus fiber.The high-modulus fiber provides the stiffness and load bearing qualities, whereas the low-modulus fiber makes the composite more damage tolerant and keeps the material cost low. The mechanical properties of a hybrid composite can be varied by changing volume ratio and stacking sequence of different plies.

1.4 NATURAL FIBER REINFORCED COMPOSITES

The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lignocellulosic fibers, are more and more often applied as the reinforcement of composites. Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. The natural fibercontaining composites are more environmentally friendly, and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling paneling, partition boards), packaging, consumer products, etc.

1.5 APPLICATIONS OF NATURAL FIBER COMPOSITES

The natural fiber composites can be very cost effective material for following applications:

- Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc.
- Storage devices: post-boxes, grain storage silos, bio-gas containers, etc.
- Furniture: chair, table, shower, bath units, etc.
- Electric devices: electrical appliances, pipes, etc.
- Everyday applications: lampshades, suitcases, helmets, etc.
- Transportation: automobile and railway coach interior, boat, etc.

CHAPTER 2

LITERATURE REVIEW

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fiber-reinforced composites, owing to their superior properties, are usually applied in different fields like defense, aerospace, engineering applications, sports goods, etc. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties. A lot of work has been done by researchers based on these natural fibers. Natural fibers such as jute, sisal, silk and coir are inexpensive, abundant and renewable, lightweight, with low density, high toughness, and biodegradable. Natural fibres such as jute have the potential to be used as a replacement for traditional reinforcement materials in composites for applications which requires high strength to weight ratio and further weight reduction. Bagasse fiber has lowest density so able to reduce the weight of the composite upto very less. So by using these fibers (jute, bagasse, and lantana camara) the composite developed is cost effective and perfect utilization of waste product.

Natural fiber reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibers in fiber reinforced composites. They are high specific strength and modulus materials, low prices, recyclable, easy available in some countries, etc.

Li *et al*. [5] conducted a research to study the mechanical properties, especially interfacial performances of the composites based on natural fibers due to the poor interfacial bonding between the hydrophilic natural fibers and the hydrophobic polymer matrices. Two types of fiber surface treatment methods, namely chemical bonding and oxidization were used to improve the interfacial bonding properties of natural fiber reinforced polymeric composites. Interfacial properties were evaluated and analyzed by single fiber pull-out test and the theoretical model. The interfacial shear strength (IFSS) was obtained by the statistical parameters. The results were compared with those obtained by traditional ways. Based on this study, an improved method which could more accurately evaluate the interfacial properties between natural fiber and polymeric matrices was proposed.

Joshi *et al.* [6] compared life cycle environmental performance of natural fiber composites with glass fiber reinforced composites and found that natural fiber composites are environmentally superior in the specific applications studied. Natural fiber composites are likely to be environmentally superior to glass fiber composites in most cases for the following reasons: (1) natural fiber production has lower environmental impacts compared to glass fiber production; (2) natural fiber composites have 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 the use phase of the component, especially in auto applications; and (4) end of life incineration of natural fibers results in recovered energy and carbon credits.

Rana *et al*. [7] in their work showed that the use of compatibilizer in jute fibers increases its mechanical properties. At 60% by weight of fiber loading, the use of the compatibilizer improved the flexural strength as high as 100%, tensile strength to 120%, and impact strength by 175%. The following conclusions may be drawn from this paper:

1. The sharp increase in mechanical properties and decrease in water absorption values after addition of the compatibilizer.
2. All these results justify that the role of jute fiber was not as a filler fiber but as a reinforcing fiber in a properly compatibilized system.
3. This system produced a new range of low-energy, low-cost composites having interesting properties and should be given priority over costly and high-energy synthesis reinforcing fiber wherever possible.

Shah and Lakkad [8] tries to compare the mechanical properties of jute-reinforces and glass-reinforced and the results shows that the jute fibers, when introduced into the resin matrix as reinforcement, considerably improve the mechanical properties, but the improvement is much lower than that obtained by introduction of glass and other high performance fibers. Hence, the jute fibers can be used as a reinforcement where modest strength and modulus are required.

Another potential use for the jute fibers is that, it can be used as a 'filler' fiber, replacing the glass as well as the resin in a filament wound component.

The main problem of the present work has been that it is difficult to introduce a large quantity of jute fibers into the JRP laminates because the jute fibers, unlike glass fibers, soak up large amount of resin. This problem is partly overcome when 'hybridsing' with glass fibers is carried out.

Ray *et al.* [9] in their work, Jute fibres were subjected to alkali treatment with 5% NaOH solution for 0, 2, 4, 6 and 8 h at 30^0C. It was found that improvement in properties both for fibres and reinforced composites. The fibres after treatment were finer, having less hemicellulose content, increased crystallinity, reduced amount of defects resulting in superior bonding with the vinylester resin. As fibres, the improvements in properties were predominant around 6–8 h treatment whereas as composites, it was maximum when reinforced with 4 h-treated fibres at 35% fibre loadings.

The modulus of the jute fibres improved by 12, 68 and 79% after 4, 6 and 8 h of treatment, respectively. The tenacity of the fibres improved by 46% after 6 and 8 h treatment and the% breaking strain was reduced by 23% after 8 h treatment. For 35% composites with 4 h-treated fibres, the flexural strength improved from 199.1 to 238.9 MPa by 20%, modulus improved from 11.89 to 14.69 GPa by 23% and laminar shear strength increased from 0.238 to 0.283 MPa by 19%. On plotting different values of slopes obtained from the rates of improvement of flexural strength and modulus, against NaOH treatment time, two different failure modes were apparent before and after 4 h of NaOH treatment.

Saha *et al.* [10] in their paper, jute fibers were treated with alkali(NAOH) solution and physic-chemical properties of jute fibers was investigated. The treatments were applied under ambient and elevated temperatures and high pressure steaming conditions. The results indicated that the uniaxial tensile strength increased by up to 65% for alkali-steam treatment. The treatments without steaming were not as effective. Physico-chemical characterization of fibers showed that the increase in tensile strength was due to the removal of non-cellulosic matters like lignin, pectin and hemicellulose.

Gassan and Bledzki [11] used the coupling methods to improve the properties of composites. Composites have high level of moisture absorption, poor wettability, and insufficient adhesion between untreated fibers and the polymer matrix leads to debonding with age. To improve the properties of the composites, the natural reinforcing fibers can be modified coupling methods. The coupling agents have chemical groups which can react with fiber or polymer and thus improve the interfacial adhesion.

This paper concerns with the use of MAH-PP copolymers as coupling agents in jute-propylene composites. It is found that the flexural strength was increased by 40% and flexural modulus by 90%. SEM investigation showed the improved fiber-matrix adhesion which was due to the chemical bonds between fiber and matrix provided by the coupling agent.

Monteiro SN. Rodriquez *et al*. [12] tries to use the sugar cane bagasse waste as reinforcement to polymeric resins for fabrication of low cost composites. They reported that composites with homogeneous microstructures could be fabricated and mechanical properties similar to wooden agglomerates can be achieved.

Hassan *et al.* [13,14] have converted the bagasse into a thermo formable material through esterification of the fiber matrix. The dimensional stability and mechanical properties of the composites prepared from the esterified fibers were reported in this work.

BC Ray [15] used 3-point flexural test to qualitatively assess such effects for 55, 60 and 65 weight percentages of E-glass fibers reinforced epoxy composites during cryogenic and after thawing conditions. The specimens were tested at a range of 0.5 mm/min to 500 mm/min crosshead speed to evaluate the sensitivity of mechanical response during loading at ambient and sub-ambient (- 80°C temperature). These shear strength values are compared with the testing data of as-cured samples.

After reviewing the existing literature available on natural fiber composites, particularly natural fibers (jute, bagasse and lantana camara) composites put efforts to understand the basic needs of the growing composite industry. The conclusions drawn from this is that, the success of combining vegetable natural fibers with polymer matrices results in the improvement of mechanical properties of the composites compared with the matrix materials. These composite fibers are cheap and nontoxic, can be obtained from renewable sources, and are easily recyclable. Moreover, despite their low strength, they can lead to composites with high specific strengths because of their low density.

CHAPTER 3

MATERILAS AND METHODS

The following section will elaborate in detail the experimental procedure carried out during the course of our project work. The steps involved are:

1. Specimen Fabrication (Fabrication of FRP).
   - By Hand Lay-Up method.
   - Cutting of Laminates into samples of desired dimensions.
2. Tensile test
3. Flexural test (3-Point Bend test)
4. SEM of fractured surface.

3.1 RAW MATERIALS

Raw materials used in this experimental work are:

(i) Natural fiber
- Jute
- Bagasse
- Lantana camara

(ii) Epoxy resin

(iii)Hardener

3.1.1 JUTE FIBRE:

Jute is a long, soft, shiny plant fiber that can be spun into coarse, strong threads. It is produced from plants in the genus Corchorus. Jute is one of the cheapest natural fibres, and is second only to cotton in amount produced and variety of uses. Jute fibres are composed primarily of the plant materials cellulose and lignin. Jute is a rainy season crop, growing best in warm, humid climates.

The stalks are cut off close to the ground. The stalks are tied into bundles and retted (soaked) in water for about 20 days. This process softens the tissues and permits the fibres to be separated. The fibres are then stripped from the stalks in long strands and washed in clear, running water. Then they are hung up or spread on thatched roofs to dry. After 2-3 days of drying, the fibres are tied into bundles. Jute is graded (rated) according to its colour, strength, and fibre length. The fibres are off-white to brown, and 1-4 m long.It is 100% bio-degradable & recyclable and thus environment friendly.

3.1.2 BAGASSE FIBRE:

The sugar cane bagasse is a residue widely generated in high proportions in the agro-industry. It is a fibrous residue of cane stalks left over after the crushing and extraction of juice from the sugar cane. Bagasse is generally gray-yellow to pale green in color. It is bulky and quite non uniform in particle size. The sugar cane residue bagasse is an under utilized, renewable agricultural material that consist of two distinct cellular constituents. The main chemical constituents of bagasse are cellulose, hemicellulose and lignin. Hemicellulose and cellulose are present in the form of hollow cellulose in bagasse which contributes to about 70 % of the total chemical constituents present in bagasse. Another important chemical constituent present in bagasse is lignin. Lignin acts as a binder for the cellulose fibers and also behaves as an energy storage system.

3.1.3 LANTANA CAMARA:

These weeds are dangerous for surrounding greenery and abundantly available everywhere. After removing its outer shell we have to cut it between two nodes.

Lantana camara is used for the manufacture of cheap furniture, utility articles, and mosquito repellent and in the extraction of medicine for various cures, particularly for skin-related diseases. On the other hand, the plant is an invasive weed and is almost treated like bamboo in some parts of India

3.1.4 POLYMER: EPOXY RESIN:

Epoxy resin (Araldite LY 556) made by CIBA GUGYE Limited, having the following outstanding properties has been used.

i. Excellent adhesion to different materials

ii. Great strength, toughness resistance

iii. Excellent resistance to chemical attack and to moisture

iv. Excellent mechanical and electrical properties.

v. Odorless, tasteless and completely nontoxic.

vi. Negligible shrinkage.

3.1.5 HARDENER:

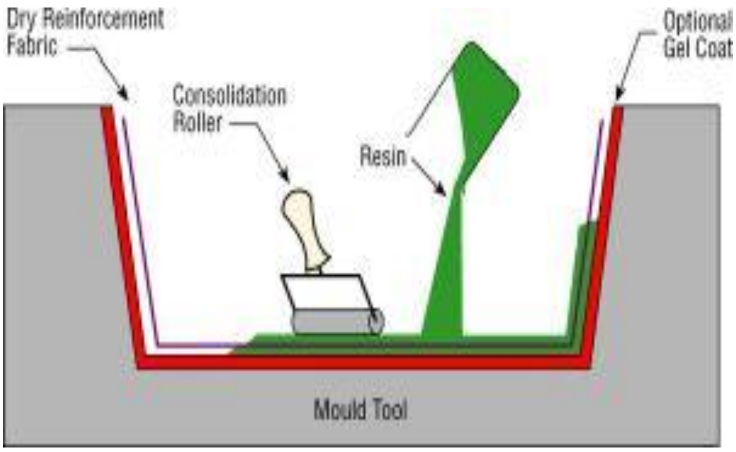
In the present work Hardener (araldite) HY 951 is used. This has a viscosity of 10-20 poise at 25^0C.

3.2 FABRICATION OF COMPOSITE FIBER

The composite fibre is prepared by hand lay-up technique:

3.2.1 HAND LAY-UP TECHNIQUE:

The fiber piles were cut to size from the jute fiber cloth. The appropriate numbers of fiber plies were taken: two for each. Then the fibers were weighed and accordingly the resin and hardeners were weighed. Epoxy and hardener were mixed by using glass rod in a bowl. Care was taken to avoid formation of bubbles. Because the air bubbles were trapped in matrix may result failure in the material. The subsequent fabrication process consisted of first putting a releasing film on the mould surface. Next a polymer coating was applied on the sheets. Then fiber ply of one kind was put and proper rolling was done. Then resin was again applied, next to it fiber ply of another kind was put and rolled. Rolling was done using cylindrical mild steel rod. This procedure was repeated until eight alternating fibers have been laid. On the top of the last ply a polymer coating is done which serves to ensure a god surface finish. Finally a releasing sheet was put on the top; a light rolling was carried out. Then a 20 kgf weight was applied on the composite. It was left for 72 hrs to allow sufficient time for curing and subsequent hardening.



Fig(1). Hand Lay-up technique

3.2.2 General overview:

The composites sheets were fabricated from jute fiber, with (bagasse/lantana camera) and resin matrix. The resin used was epoxy resin. The weight fraction of composites was maintained at 40% fiber and 60% resin. Number of plies for each fiber taken was two i.e. total number of plies used in hybrid composite are four. Two natural hybrid composites are made i.e. J-B-J (jute bagasse jute) & J-LC-J (jute lantana camera jute). After the hybrid composites fabrication cutting of the specimen is done in the desired shape to test the mechanical properties of the natural hybrid composite fiber. The tensile and flexural testing of the samples were done by UTM (universal testing machine). This apart, SEM analysis of the fractured surfaces.

3.2.3 CALCULATION:

For the preparation of the composite we calculate the percentage of fibers, polymer and hardener required from the table we come to know about the amounts accurately.

S No	Jute (%)	Lantana Camara (%)	Bagasse (%)	Epoxy (%)
1	20	-----	20	60
2	20	20	-----	60

3.2.4 MOULD PREPARATION:

First of all the mould for the composite is prepared. We have to prepare moulds of size 150 x 60 x 5 mm for the preparation of required composite. A clean smoothed surfaced wooden board is taken and washed thoroughly. We give a cover to the wooden board with a non-reactive thin plastic sheet. Then the glass of equal size (thickness 3mm) that of the mould is taken. We place the glass on the wooden board. Square bits of 8mm are cut in desired dimension and are nailed surrounding the glass. These bits should be nailed in such a way that no polymer leaks out while casting. The bits are carefully nailed so that the glass does not move aside, so that the dimension of the mould is not distorted. After nailing the bits, the glass is smoothly taken out leaving behind the mould.

3.2.5 FIBER PREPARATION:

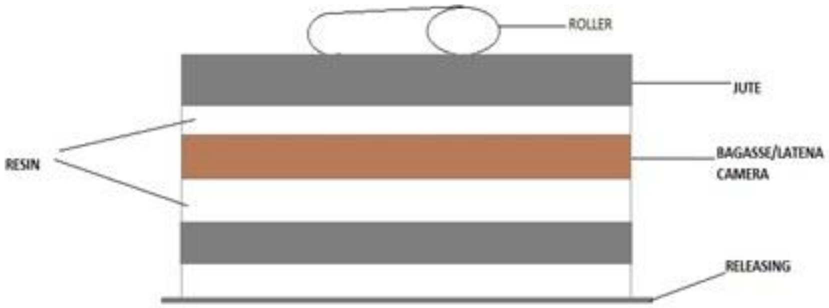
Raw Bagasse and lantana camara which are brought and cleaned with water and dried. Then the aggregations are gently dispersed with hand sitting patiently. Then its outer shell is removed by the knife and it is cut into required dimension. After that it is measured for proper weight and kept.

3.2.6 POLYMER-HARDNER MIXTURE PREPARATION:

For the making of good composite the measurement of the samples should be accurate and the mixture should be very uniform. We take accurate amount of polymer which we have calculated earlier and 10% of its hardener. Then this mixture is stirred thoroughly till it becomes a bit warm. Bit extra amount of hardener is taken for the wastage in the process. Hardener should taken very minutely because little extra amount of hardener can spoil the composite.

3.2.7 CASTING:

First of all mould release spray was spread overall after that we pour some mixture after that we place one jute mate. Above that we pour mixture of fiber polymer mixture. Again we place another jute mate then above that pour some polymer mixture. This sample is then left for 72 hours. The composite gets dried up in 72 hours in which the silk fiber and the polymers adheres itself tightly in the presence of hardener. After a day we put out the weights. Then carefully the nailed bits are removed from the wooden board. Now we have the composite attached with the glass. The hardener has so strong effect that it attachés the glass with the composite. This attachment is slowly and gently hammered on the boundary of its attachment when the glass and the composite separate out. Then we see whether any undesired voids are left behind. We fill the voids with polymer and the sample is prepared.



FIG(2). Hybrid natural fiber composite

3.3 EXPERIMENT PROCEDURE

3.3.1 CUTTING OF LAMINATES INTO SAMPLES OF DESIRED DIMENSIONS:

A WIRE HACKSAW blade was used to cut each laminate into smaller pieces, for various experiments:

- TENSILE TEST- Sample was cut into dog bone shape(150x10x5)mm.
- FLEXURAL TEST- Sample was cut into flat shape(20x150x5)mm, in accordance with ASTM standards.

FIG(3.1) Dog-bone shape FIG(3.2) Flat bar shape

3.3.2 TESNSILE TEST:

The tensile strength of a material is the maximum amount of tensile stress that it can take before faliure. The commonly used specimen for tensile test is the dog-bone type. During the test a uniaxial load is applied through both the ends of the specimen. The dimension of specimen is (150x10x5)mm. Typical points of interest when testing a material include: ultimate tensile strength (UTS) or peak stress; offset yield strength (OYS) which represents a point just beyond the onset of permanent deformation; and the rupture (R) or fracture point where the specimen separates into pieces. 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.

FIG(4.1) UTM machine Sample unloaded condition for tensile testing.

FIG(4.2) UTM machine Sample loaded condition for tensile testing.

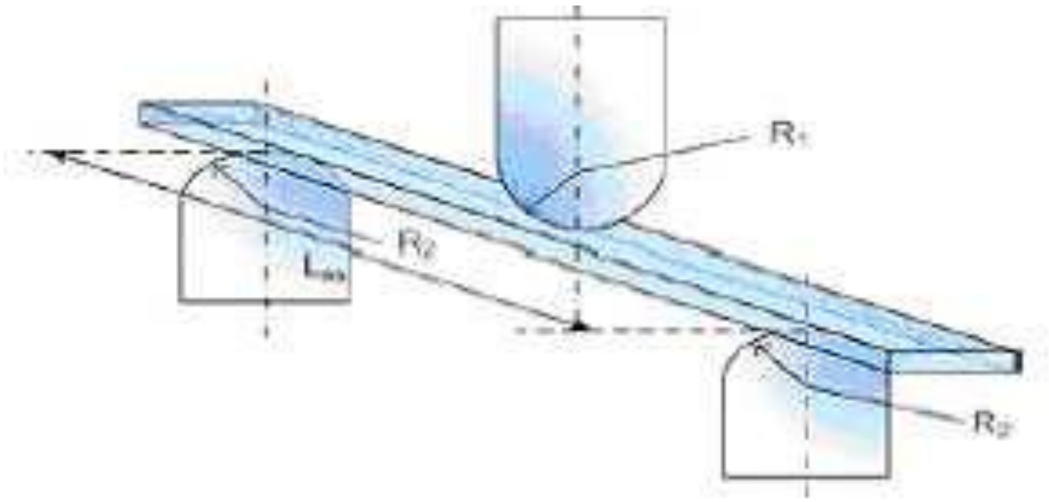
3.3.3 FLEXURAL TEST:

Flexural strength is defined as a materials's ability to resist deformation under load. The short beam shear (SBS) tests are performed on the composites samples to evaluate the value of inter-laminar shear strength (ILSS). It is a 3-point bend test, which generally promotes failure by inter-laminar shear. This test is conductedas per ASTM standard using UTM. The loading arrangement is shown in figure . The dimension of the specimen is (20x150x5)mm. It is measured by loading desired shape specimen(6x6-inch) with a span length at least three times the depth. The flexural strength is epressed as modulus of rupture(MR) in psi (MPa) .

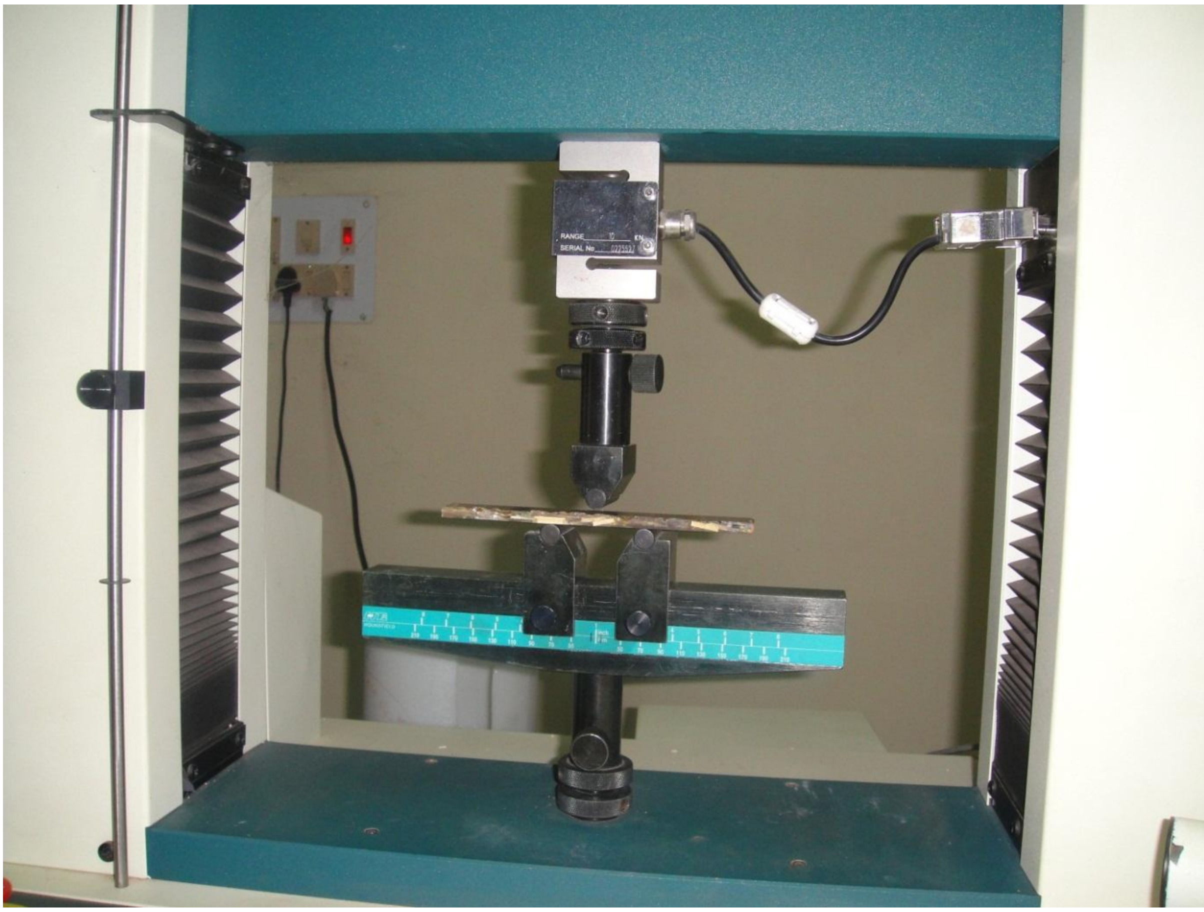
Flexural MR is about 10 to 20 precent of compressive strength depending on the type, size and volume of coarse aggregate used. However the best correlation for specific materials is obtained by laboratory tests for given materials and mix design. The MR determined by third-point loading is lower than the MR determined by centre-point loading, sometimes by as much as 15%. The ILSS values are calculated as follows, Where, P is maximum load, b the width of specimen and t the thickness of specimen.

The data recorded during the 3-point bend test is used to evaluate the flexural strength also. The flexural strength (F.S) of any composite material is determined using the following equation.

Where, L is the span length of the sample.



FIG(5.1) 3-Point Bending Test Setup



FIG(5.2) UTM machine Sample loaded condition for Flexural testing.

3.4 SEM FRACTROGRAPHY

The surfaces of the specimens are examined directly by scanning electron microscope JEOL JSM-6480LV as shown in Figure 3.4. The composite samples are mounted on stubs with silver paste. To enhance the conductivity of the samples, a thin film of platinum is vacuum-evaporated onto them before the photomicrographs are taken.

FIG(6) Scanning Electron Microscope(SEM)

CHAPTER 4

RESULT AND DISCUSSION

RESULT AND DISCUSSION

4.1 FLEXURAL TEST

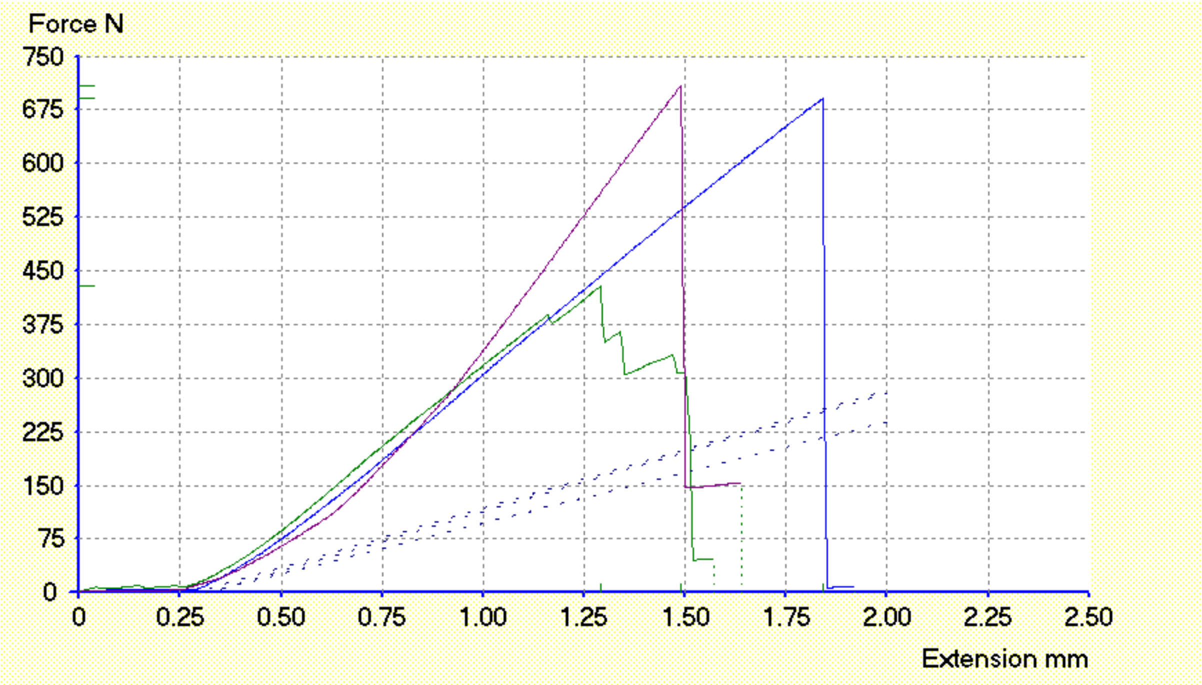
Three point bend test was carried out in an UTM machine in accordance with ASTM standard to measure the flexural strength of the composites. All the specimens (composites) were of rectangular shape having dimension of (150x20x5) mm . The span length was 75mm. The experiment was conducted on both samples of jute-bagasse and jute-lantana camara combinations. The results are tabulated in the table 1.

SAMPLE NAME	LENGTH mm	BREADTH mm	THICKNESS mm	EXTENSION mm	MAXIMUM LOAD(N)
J-B-J	150	20	5	1.45	701
J-LC-J	150	20	5	1.86	691.1

TABLE(1) 3-point bend test data

By calculating the flexural strength using the relation,

It is found that the flexural strength for jute-bagasse was 155.5MPa and for jute-lantana camara was 310.9MPa.



FIG(7) Variation of force with extension in 3-point bend test

4.2 TENSILE TEST

Tensile test was also carried out on UTM machine in accordance with ASTM standard. All the specimens were of dog bone shape of dimension (150x10x5)mm. The results are tabulated in the table 2.

SAMPLE NAME	LENGTH mm	BREADTH mm	THICKNESS mm	EXTENSION mm	MAXIMUM LOAD(N)
J-B-J	150	(20-10)	5	2.803	859.3
J-LC-J	150	(20-10)	5	3.168	1651.7

4.3 SEM ANALYSIS

Fig 8.1 and Fig 8.2 shows the SEM micrographs of flexural fracture surface of Jute-Bagasse and Jute-Lantana Camara reinforced epoxy composite.

The micrographs fig 8.1 clearly shows the damage caused to the fibers. Extensive damage cause to the jute fiber also clearly visible. The damages is so severe that fiber braking and removal is clearly visible. Debonding of fiber and matrix is also visible.

Fig 8.2 shows the micrographs of Jute-Lantana Camara fiber. Wetting of fibers is seems to be very high. Fiber pullout and fiber breaking are not visible. Though the fibers are embedded nicely with matrix, still some cavities are formed in the composite. Therfore the strength of the jute lantana camra fiber strength is found to be much higher then Jute-Bagasse fiber composite.

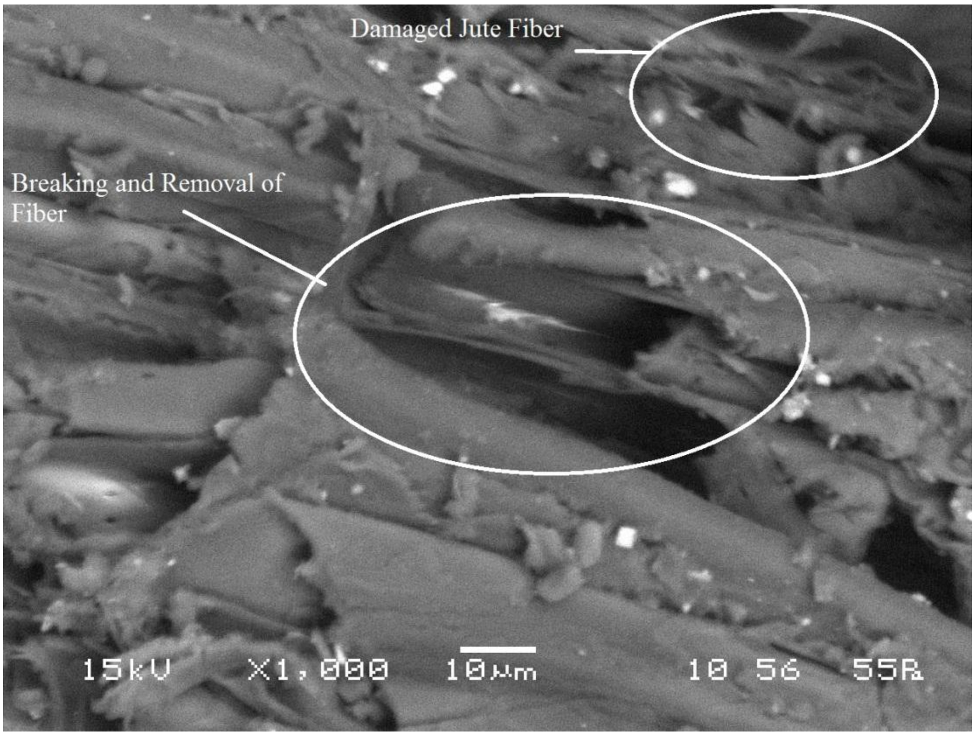


Fig 8.1 SEM micrograph of Jute Bagasse flexural

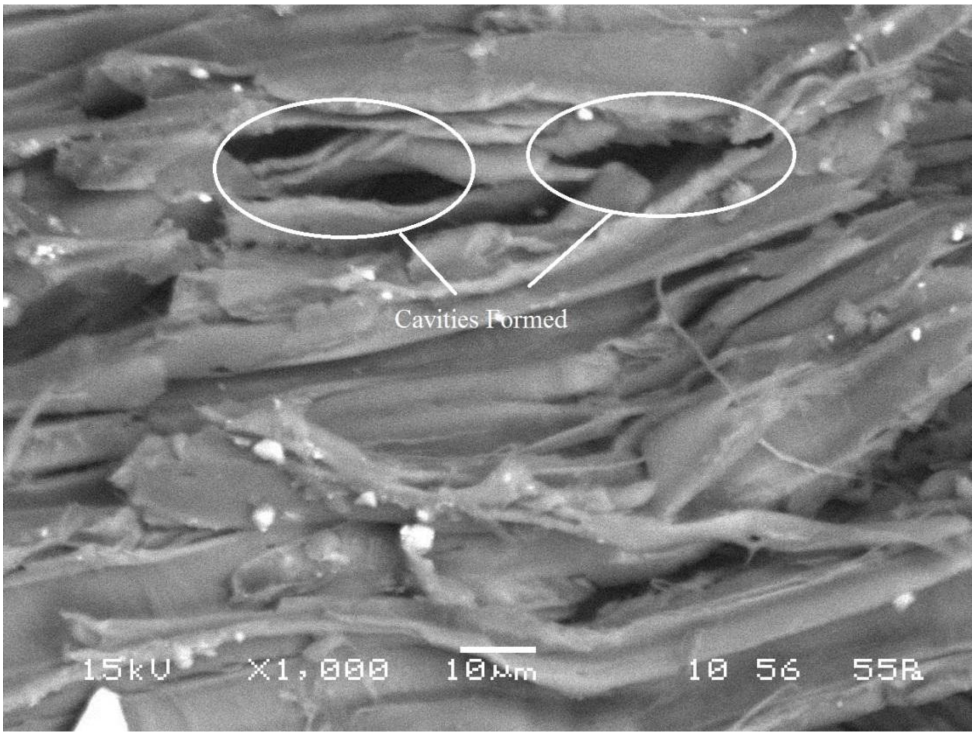


Fig 8.2 SEM micrograph of Jute Lantana Camara Flexural

CHAPTER 5

CONCLUSION

CONCLUSION

1. The jute, bagasse and lantana camara fibers was successfully used to fabricate hybrid natural composites with 40% fiber and 60 % resin, these fibers are bio-degradable and highly crystalline with well aligned structure. So it has been known that they also have higher tensile strength than glass, good elasticity, excellent resilience and in turn it would not induce a serious environmental problem like in glass fibres.

2. The flexural strength of pure epoxy resin is 130-136 MPa with (7-9.5)% elongation. With increase of fiber loading capacity by 20%, the flexural strength value increases to 155.5MPa for Jute-bagasse and 310.9MPa for jute-lantana camara.
The tensile strength of epoxy is 62-72 MPa wit 3-4 % elongation and with increase of fiber loading capacity by 20 % the tensile strength increase.
So, it is clearly indicates that inclusion of natural fibers improves the load bearing capacity (tensile strength) and the ability to withstand bending (flexural strength) of the composites.

3. In flexural test, Jute-lantana camara combination sustains more elongation than jute-bagasse combination, but there is no large difference in maximum load of both samples. Due to more elongation in jute-lantana combination it has more flexural strength than jute-bagasse sample.

4. In tensile test also jute-lantana has more elongation than jute-bagasse combination, and hence the tensile strength of jute-lantana camara is more than jute-bagasse sample.

5. By comparing the flexural strength and tensile strength of the composites with varying, the best mechanical property results are obtained with jute-lantana camara combination.

6. From SEM micrograph fig. 8.2 it is clearly visible that fiber is nicely embaded with matrix but still there are some cavaties.

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