Fabrication and Characterisation of Epoxy Resin Bagasse and Jute Fiber Reinforced Composite

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Abstract— Natural fibers characterized by sustainability have gained a considerable attention in recent years due to their advantages of environmental acceptability and commercial viability.as we know the fibers are strong and stiff relative to the matrix. In recent time natural fibers have been employed to use with plastics. the availability of natural fibers in India such as coir, jute, sisal, bagasse, bamboo, hemp, banana etc. gives more attention to the development of natural fiber composites to explore new application avenues .natural fibers are well suited for making automobile parts and they can be used as wood substitutes in construction sector. Natural fiber reinforced composites are taking attention due to low density, ease of separation, low cost and bio degradability. This present thesis aims at studying the mechanical behaviour of natural fiber composites of jute and bagasse with matrix as epoxy resin separately is compared with hybrid composite of jute and bagasse with epoxy resin as matrix were manufactured using hand layup method by weight fractions of fiber and matrix was kept at 30%-70%. Specimens were cut according to the ASTM standards for different experiments such as tension, bending, impact and hardness are prepared and tests were performed.

Keywords: Metal Matrix Composites(MMCs), Ceramic Matrix Composites (CMCs), Jute Tensile Specimen

I. INTRODUCTION

A. *Overview of Composites*

Over the last thirty years composite materials, plastics and ceramic have been the dominant merging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion other engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals.

1) *Matrix Phase:*

The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it.

2) *Dispersed (reinforcing) Phase:*

The second phase (or phases) is embedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase. Many of common materials (metal alloys, doped Ceramics and Polymers mixed with additives) also have a small amount of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their base constituents(physical properties of steel are similar to those of pure iron). There are two classification systems of composite materials. One of them is based on the matrix material (metal, ceramic, polymer) and the second is based on the material structure.

B. *Types of Composites*

For the sake of simplicity, however, composites can be grouped into categories based on the nature of the matrix each type possesses. Methods of fabrication also vary according to physical and chemical properties of the matrices and reinforcing fibers.

1) *Metal Matrix Composites(MMCs)*

Metal matrix composites, as the name implies, have a metal matrix. Examples of matrices in such composites include aluminum, magnesium and titanium. The typical fiber includes carbon and silicon carbide. Metals are mainly reinforced to suit the needs of design. For example, the elastic stiffness and strength of metals can be increased, while large co- efficient of thermal expansion, and thermal and electrical conductivities of metals can be reduced by the addition of fibers such as silicon carbide

2) *Ceramic Matrix Composites (CMCs)*

Ceramic matrix composites have ceramic matrix such as alumina, calcium, alumina silicate reinforced by silicon carbide. The advantages of CMC include high strength, hardness, high service temperature limits for ceramics, chemical inertness and low density. Naturally resistant to high temperature, ceramic materials have a tendency to become brittle and to fracture. Composites successfully made with ceramic matrices are reinforced with silicon carbide fibers. These composites offer the same high temperature tolerance of super alloys but without such a high density. The brittle nature of ceramics makes composite fabrication difficult. Usually most CMC production procedures involve starting materials in powder form. There are four classes of ceramics matrices: glass(easy to fabricate because of low softening temperatures, include borosilicate and alumino silicates),conventional ceramics(silicon carbide, silicon nitride, aluminum oxide and zirconium oxide are fully crystalline), cement and concreted carbon components

3) *Polymer Matrix Composites (PMC)*

Most commonly used matrix materials are polymeric. There as on for this are two-fold. In general the mechanical

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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 does not require high temperature. Also equipment required for manufacturing polymer matrix composites are simpler. For this reason polymer composites developed rapidly and soon became popular for structural applications. Polymer composites are used because overall properties of the composites are superior to those of the individual polymers. They have a greater elastic modulus than the neat polymer but are not as brittle as ceramics. Polymeric matrix composites are composed of a matrix from thermoset (unsaturated polyester, epoxy or thermoplastic polycarbonate, polyvinyl chloride, nylon, polystyrene and embedded glass, carbon, steel or Kevlar fibers (dispersed phase).

4) Open mould process

1) Hand lay-up process
2) Spray upprocess
3) Vacuum-bag auto clave process

II. Literature Review

A. Introduction

Yashawanth M K.,studied the mechanical properties of coir reinforced epoxy resin composite and sisal reinforced epoxy resin composite. The experimental study by using short coconut coir fibers and sisal fibers reinforced with epoxy LY556 resin composite is reported in earlier studies. Experiment conducted as per ASTM standards and results of tensile flexural strengths are reported. It is also reported that the fibre length is having significant effect on the properties of composites. The test conducted on 2mm, 4mm, 6mm thick specimens varying the percentages of coir fibre and sisal fibre from 7.5%, 10%, 15%, 20% and 30% of volume fractions. From our study usage of coir composite panels at 20% fibre volume fraction depicts the maximum tensile strength fibre volume fraction at 15% depicts the maximum flexural strength. But in case of sisal reinforced composite tensile strength increases gradually up to 15% fibre volume fraction and decreases thereafter but flexural strength increases gradually as fibre volume fraction increases.

K. Murali Mohan Rao., at all aims at introducing new natural fibers used as fillers in a polymetric matrix enabling production of economical and lightweight composites for load carrying structure.An of the extraction procedures of vakka (Reystonearegia),date and bamboo fibers has been undertaken. The cross-sectional shape, the density and tensile properties of these fibers, along with established fibers like sisal, banana, coconut, and palm are determined experimentally under similar conditions and compared. The fibers introduced in the present study could be used as an effective reinforcement for making composites, which have an added advantage of being lightweight.

D.ChandraMohan, Over the last thirty year composite materials, plastic sand ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering

New markets relentlessly.Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven wort as weight-saving materials, the current challenge is to make them cost effective. This review paper discuss about world wide review report on natural fibers and its applications. Also, this paper concentrates on in the field of orthopaedics.An effort to utilize the advantages offered by renewable resources for the development of bio-composite materials based on bio epoxy resin and tampons, incontinence products, panty shields, wipes, etc., are mostly single natural fibers such as Agave sisalana; Musa sepientum; Hibiscus sabdariffa and its application in bone grafting substitutes.

D. Chandramohan stated that, the natural fibers are renewable, cheap, easily recyclable, bio degradable and they can be used as reinforcing fibers in the composites.

Anna KicinskaJakubowska stated that, the natural fibers are considered as the most important part of the human environment, they are used as textile and non-textile production. The new applications are being discovered day by day.

M.Sakthive mentioned that, the natural fibers have additional advantages when compared to the synthetic conventional fibers; they are renewable raw materials and have relatively high strength,low density,and low specific mass. The natural fibers can be grown easily in tropical countries.

G.Bogoeva-Gaceva explained the problems of pollution, one of the most important problems, which is to be addressed immediately is that,the pollution from plastic waste.The tremendous use of the plastic in every stage of life increased the huge plastic waste. Now lot many researchers have focused on eco-friendly composites that can be degrad easily.

N. Cordeiroa explained the importance of natural fibers, the biodegradability of natural fibers contributes to healthier ecosystem, the renew-ability, low cost and their reasonable engineering properties are attracting to use the natural fibers in automotive industry.

Scott W. Beckwith explained the advantages of natural fibers. The natural fibers have many advantages over synthetic fibers, the natural fibers have 30-50 % lower density as compare to the glass fibers. The stiffness can also be higher than or equal to the E-glass fibers. Natural composite composites.

III. Materials and Methods

This chapter describes the details of processing of the composites and the experimental procedures followed for their mechanical characterization. The raw materials used in this work are

A. Materials Used

1) Epoxy resin
2) Hardener
3) Natural Fibers (jute, bagasse fiber)

1) Hardener

Hardener is a curing agent for epoxy or fiberglass. Epoxy resin requires a hardener to initiate curing; it is also called as

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catalyst, the substance that hardens the adhesive when mixed with resin. It is the specific selection and combination of the epoxy and hardener components that determines the final characteristics and suitability of the epoxy coating for given environment.

2) Natural fibers such as jute/bagasse fiber

Fiber-reinforced polymer composites have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. The manufacture, use and removal of traditional fiber–reinforced plastic, usually made of glass, carbon or aramid fibers–reinforced thermoplastic and thermo set resins are considered critically because of environmental problems. By natural fiber composites we mean a composite material that is reinforced with fibers, particles or platelets from natural or renewable resources, in contrast to for example carbon or aramid fibers that have to be synthesized.

B. Methodology

1) Step 1: Selection of matrix material

Epoxy resin belonging to the Epoxide family was taken as the matrix. was used as the hardener.

2) Step 2: Selection of reinforcement and Natural fibers

Natural fibers such as jute,, bagasse, Sisal, Coconut coir, Ridge gourd and Tamarind were taken to fill as reinforcements in the Polymer composite.

3) Step 3: Extraction of fibers

4) Step 4: Surface(chemical) treatment of fibers

Freshly drawn fibers generally include lots of impurities that can adversely affect the fiber matrix bonding. Consequently the composite material made from such fibers may not possess satisfactory mechanical properties. Therefore it is desirable to eliminate the impurity content of the fibers and perhaps enhance the surface topography of the fibers to obtain a stronger fiber- matrix bonding. In this fibers are treated with 5%0f NAOH i,e 5ml of NAOH in 100 ml of distilled water. Fiber was soaked in this solution for an hour and dried in sunlight for a day. Then we observe removal of dirt and impurities on the fiber.it will helpful in giving better mechanical properties.

5) Step 5: Wet Hand lay-up technique

SAMPLE PREPARATION BY WET HANDLAY UP PROESS PROCESS OF MATERIAL MAKING

IV. SAMPLES OF COMPOSITION

A. Jute Fiber Reinforcement Composition:

Jute(30%) + (epoxy resin+hardener=70%)

FIBERS	WEIGHTES(gm)
JUTE FIBER	120
EPOXY RESIN	250
HARDNER	25

Table 4.1: composition

B. Reinforcement of Bagasse Fiber Composite

(Bagasse fiber(30%) + epoxy resin + hardener (70%)

Fig COMPOSITE MATERIAL OF BAGASSE

C. Reinforced Composite of Bagasse and Jute

MATERIAL	Weight (in gm)
jute fiber	60
Bagasse fiber	60
epoxy resin	250
Hardner	25

V. TESTING AND RESULTS

A. Tensile Test:

Cross-section is gripped in the jaws of machine at the both ends and a pull is exerted Tensile test is conducted as per ASTM D638 standards specimen cut in to 33× 6 × 5.

Tensile test is widely used to find the behavior material when subjected to a slowly applied tensile load. It is conducted on computerized universal testing machine (UTM).

B. Impact Test:

ASTM D 256: Standard test method for impact properties of polymer matrix composites. Izod impact strength of composite samples is evaluated as per ASTM D256, using Impact Testing Machine supplied by International Equipments, Mumbai, India

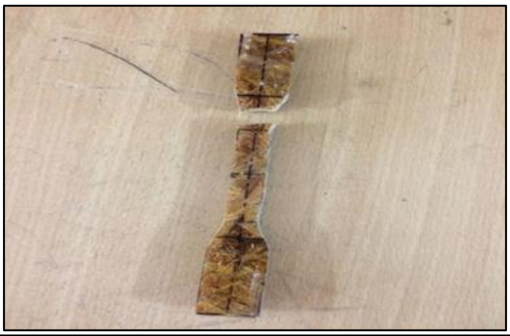
The test specimen geometry as specified in the above standard for balance symmetric any composites are 56mm long × 12.7 mm wide × 3mm thick. The charpy test specimens are placed as a simply supported beam and notch of the specimen is placed opposite side of the striking position of hammer.

VI. RESULTS AND DISCUSSIONS

A. Tensile Test Results:

1) Jute Composite

Fig. 6.1: Jute Tensile Specimen (After test)



SPECIMEN	TENSILE STRENGTH (MPa)
S-1	45.80

Tensile strength of jute specimen - 45.80mpa
Load at break - 2.210 kN
BAGASSE COMPOSITE SPECIMEN:
Fig After test bagasse tensile specimen
Tensile load of specimen : 29.525 mpa
Breaking load of specimen: 2.185 kN
JUTE +BAGASSE COMPOSITE SPECIMEN:

Fig After test

S.NO	TENSILE STRENGTH(MPa)
1	51.60

Tensile strength of the specimen : 51.602 MPa
Breaking load : 2.905 kN

2) Graphical Representation of Tensile Strength of Fibers

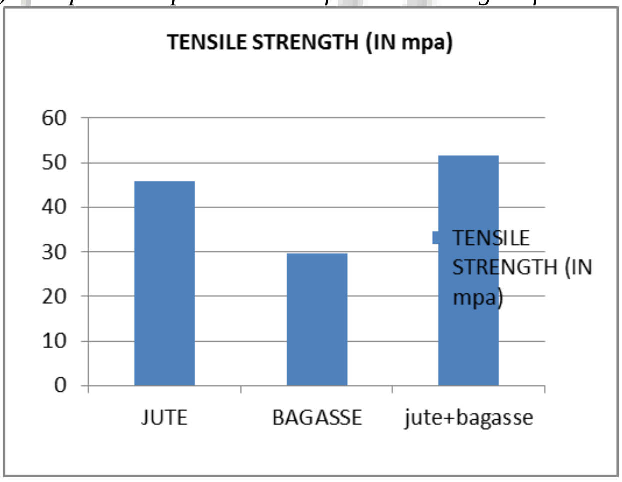


Fig. 6.16: graphical representation of tensile strength of fibers

B. *Impact Test Results:*

The Charpy impact test, also known as the Charpy V-notch test, is a standardized high strain rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent ductile-brittle transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply.

1) Calculations:

Initial angle (α) : 141.4∘
Pendulum radius : 0.815 mm
Effective weight of hammer : 21.04 kg
Observed angle (β) :
Rupture energy (υ) : w.n.(cosβ –cosα)
Modulus of rupture : υ/V
Notch impact strength : υ/A

2) Jute Composite Specimen:

Fig. 6.35: Jute fiber charpy test specimen

Rupture energy of jute composite specimen: 2.451 J
Notch impact strength of specimen : 0.45 J/mm^2
Modulus of rupture : 0.8225 J/mm^3
rupture energy of bagasse composite specimen : 2.220J
modulus of rupture : 0.007304 J/mm^3
notch impact strength : 0.401 J/mm^2
Rupture (impact) energy : 2.550 J
Modulus of rupture : 0.008416 J/mm^3
Notch impact strength : 0.4628 J/mm^2

3) Graphical Representation of Impact Test Results:

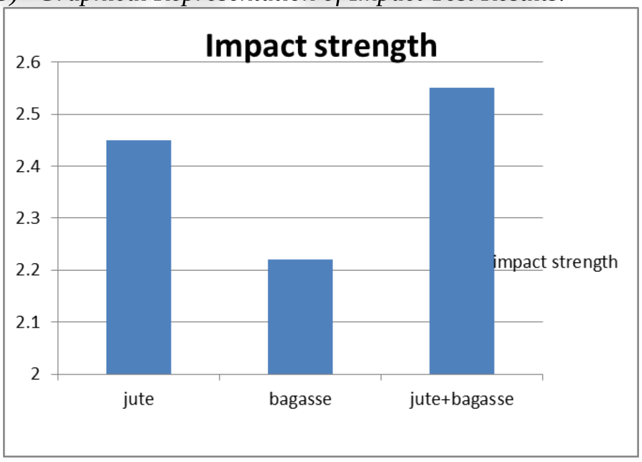


Fig. 6.38: graphical representation of impact strength

VII. CONCLUSIONS

From tested results we are concluded that the hybrid composite of jute and bagasse is giving better mechanical properties such as tensile strength and impact energy.

- in case of jute composite exhibit more tensile strength due to strong bonding between jute fiber and epoxy resin
- in case of bagasse composite, we observed less tensile strength as compared to jute due to weak bonding between epoxy and bagasse.

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- However coming to hybrid composite i,e jute and bagasse composite will give better results as compared to jute and bagasse fiber separately.
- Finally hybrid composite i,e combination jute,bagasse and epoxy exhibit more Strength .we will suggest to light weight applications and decorative parts.

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