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PREPARATION AND CHARACTERISTICS OF LUFFA AND BANANA FIBER REINFORCED EPOXY POLYMER COMPOSITES

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Abstract

Utilizing the availability of natural resources increasing the needs for different engineering application invite the development of new materials. In the present research new natural fiber luffa and banana was introduced for preparation of luffa fiber reinforced epoxy polymer composites. Already extracted sisal and banana, luffa and groundnut, and to determine the compressive and impact strength of the material. This paper presents the study of the compressive, impact strength. Luffa and banana reinforced epoxy resin matrix composition have been developed by hand lay-up technique with luffa fiber treated and banana fiber treated condition with different composition of 2:1 ratio and 1:1 ratio. Effects of volume fraction on the compressive and impact strength were studied. The optimum mechanical properties were obtained and it can used for roof top applications.

Key words: *Luffa fiber, Banana fiber, Epoxy resin, Properties of fibers*

1.Introduction

Composites

Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in weaker materials (known as matrix). Reinforcement provides strength and rigidity, helping to support structural load. The matrix or binder (organic or inorganic) maintains the position, orientation of the reinforcement and transfers the external load to the reinforcement. Significantly, constituents of the composites retain their individual,physical and chemical properties.Historical examples of composites are abundant in literature. Jute has been used since ancient times in Africa and Asia to provide cordage and weaving fiber from the stem and food from the leaves. In several historical documents (Ain-e-Akbari by AbulFazal, 1590) during the era of the great Mughal Emperor Akbar (1542 –1605) states that the poor villagers of India used to wear clothes made of jute. Chinese papermakers from very ancient times have selected almost all the kinds of plants as hemp, silk, jute, cotton etc. for papermaking. The East India Company which was the first Jute trader in India, was the planet's biggest producer of bananas and Alexander the Great found them growing there in 327 BC, when he conquered India. Infantrymen of Alexander the Great returned to Greece and Persia with bulbs

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from banana plants, 'Musa accuminata ' where they were distributed and planted. Antonius Musa, the private surgeon of Augustus Caesar, imported the first banana trees, 'Musa accuminata, ' to Rome from Africa in 63 BC. Later, slaves from Portugal brought bananas to Europe from Africa in the early 1400's. Although the banana is said to have originated in India, (Eastern East Asia), it was established in Africa and Europe as a basic food product many centuries back and came into North America through Spanish missionaries. The leaves of banana trees are used as wrappers forsteaming other foods within, and the banana flower is also eatable.

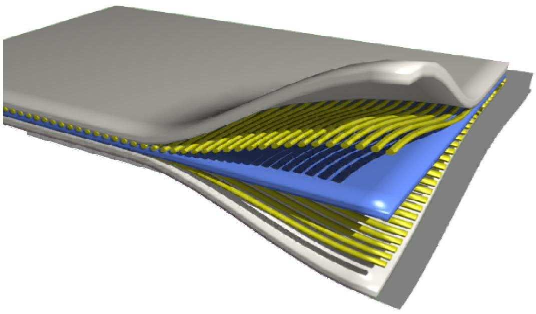

FIG.1.1 COMPOSITES

Types of Composites:

Composites can be grouped into categories based on thenature of the matrix each type possesses.

They are
a) Metal Matrix Composites (MMC)
b) Ceramic Matrix Composites (CMC)
c) Polymer Matrix Composites (PMC)

a) Metal Matrix Composites (MMCs)

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, thermal and electrical conductivities of metals can be reduced by the addition of fibers such as silicon carbide.

b) Ceramic Matrix Composites (CMCs)

Examples of matrices such as alumina, calcium, aluminosilicate 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.

c) Polymer Matrix Composites

Most commonly used matrix materials are polymeric. The reason for this is twofold. 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 equipment required

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for manufacturing polymer matrix composites are simpler. For this reason polymer matrix composites developed rapidly and soon became popular for structural applications. Composites are used because overall properties of the composites are superior to those of the individual components for example polymer/ceramic. Composites have a greater modulus than the polymer component but aren't as brittle as ceramics. Two types of polymer composites are:

- Fiber reinforced polymer (FRP)
- Particle reinforced polymer (PRP)

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. The fibers carry the loads along their longitudinal directions. Sometimes, filler might be added to smooth the manufacturing process, impact special properties to the composites, and / or reduce the product cost. Common fiber reinforcing agents include asbestos, carbon / graphite fibers, beryllium, beryllium carbide, beryllium oxide, molybdenum, aluminum oxide, glass fibers, polyamide, natural fibers etc. Similarly common matrix materials include epoxy, phenolic, polyester, polyurethane, polyetherethylketone (PEEK), vinyl ester etc. Among these resin materials, PEEK is most widely used. Epoxy, which has higher adhesion and less shrinkage than PEEK, stands second for its high cost.

Particle Reinforced Polymer

Particles used for reinforcing include ceramics and glasses such as small mineral particles, metal particles such as aluminum 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. Particles are also used to reduce the cost of the composites. Reinforcements and matrices can be common, inexpensive materials and are easily processed. Some of the useful properties of ceramics and glasses include high melting temp., low density, high strength, stiffness; wear resistance, and corrosion resistance. Many ceramics are good electrical and thermal insulators. Some have special properties; some are magnetic materials; some are piezoelectric materials; and a few special ceramics are even superconductors at very low temperatures. Ceramics and glasses have one major drawback: they are brittle. An example of particle reinforced composites is an automobile tire, which has carbon black particles in a matrix of poly-isobutylene elastomeric polymer. Polymer composite materials have generated wide interest in various engineering fields, particularly in aerospace applications. Research is underway worldwide to develop newer Composites with varied combinations of fibers and fillers, so as to make them useable under different operational conditions. Against this backdrop, the present work has been taken up to develop a series of PEEK based composites with glass fiber reinforcement and with ceramic fillers and to study their response to solid particle erosion done either after the fruits have just developed or when they have ripened ready for food purposes. Table1 shows the classification of the selected plant fibers. In this it knows that jute fiber is the most abundant followed by banana. These fibers could easily be used in the composite manufacture.

Fibers

Fibers have been classified into three main groups arranged according to their morphological structure namely a) Bast fibers b) leaf fibers c) Seed fibers

Natural fibers or natural fibres are fibres that are produced by plants, animals, and geological processes.They can be used as a component of composite materials, where the orientation of fibers impacts the properties. Natural fibers can also be matted into sheets to make products such as paper, felt or fabric.

The earliest evidence of humans using fibers is the discovery of wool and dyed flax fibers found in a prehistoric cave in the Republic of Georgia that date back to 36,000 BP. Natural fibers can be used for high-tech applications, such as composite parts for automobiles. Compared to composites reinforced with glass fibers, composites with natural fibers have advantages such as lower density, better thermal insulation, and reduced skin irritation. Further, unlike glass fibers, natural fibers can be broken down by bacteria once they are no longer in use.

Fiber name	Botanical name	Plant origin
Banana Luffa	Musa acuminate Cucurbitaceae	Leaf Vegetable ground

TABLE .1.1 FIBERS

Resins

They are viscous liquids that are capable of hardening permanently. The resins that are used in fiber-reinforced composites are sometimes referred to as ′polymers′. Polymers can be classified under two types, according to the effect of heat on their properties.

- Thermoplastic Resins.
- Thermosetting Resins (Polyester and epoxy-High elastic model).

Thermoplastics soften with heating and eventually melt, hardening again with cooling. Typical thermoplastics include nylon, polypropylene, and ABS, and these can be reinforcement, although usually only with short, chopped fibers such as glass.

Thermosetting materials, or ′thermosets′, formed from a chemical reaction, where the resin and hardener or resin and catalyst are mixed and then undergo a non-reversible chemical reaction to form a hard, infusible product.

The determination of whether to use a thermoplastic or thermosetting resin depends largely on the application. Thermosetting resins are preferred because of their increased ability to withstand elevated temperatures. It is expected that the composite spring will be at a working temperature of 100°F to 1000°F and hence thermosetting resins are chosen as thermoplastic works well only for cold and ambient working conditions.

2.Literature survey

Skaith B S (2004) Banana fiber reinforced with epoxy resins treatments were suitable for transportation and automotive industry applications. Environmental tests were conducted and the compressive properties of the composites were evaluated before and after moisture absorption. This increases the strength of material and also the durability of material.

Srinivasan (2014) Natural fibers offer both cost savings and reduction in density when compared to glass fibers. Natural fibers are an alternative resource to synthetic fibers, as reinforcement for polymeric materials for the manufacture is cheap, renewable and environment friendly. This paper discusses in detail about the uses & applications of jute and banana fiber composites.

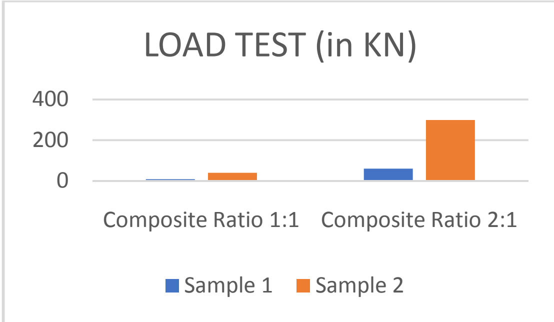
Sathishpujari (2014) This paper presents the study of the tensile, compressive, flexural, impact energy and water absorption characteristics of the luffa fiber and Ground nut reinforced epoxy polymer hybrid composites. Luffa fiber and Ground nut reinforced epoxy resin matrix composites have been developed by hand lay-up technique with luffa fiber treated conditions and Ground nut with different volume fraction of fibers as in 1:1 ratio (10%, 20%, 30%, 40% and 50%). Effects of volume fraction on the Tensile, Compressive, Flexural, Impact strength were studied. SEM analysis on the composite materials was performed. Tensile strength varies from 10.35 MPa to 19.31 MPa, compressive strength varies from 26.66 MPa to 52.22 MPa, flexural strength varies from 35.75 MPa to 58.95 MPa and impact energy varies from 0.6 Joules to 1.3 Joules, as a function of fiber volume fraction. The optimum mechanical properties were obtained at 40% of fiber volume fraction of treated fiber composites. Fractures surface of the composite shows the pull out and de-bonding of fiber is occurred.

3.Mechanical Testing

Compressive Test

Compressive test is performed on the universal testing machine (UTM) and compression testing machine (CTM). COMPRESSIVE TESTS are performed for several reasons. The results of compressive tests are used in selecting materials for engineering applications. compressive properties frequently are included in material specifications to ensure quality Compressive properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, compressive properties often are used to predict the behavior of a material under forms of loading other than compression.

TABLE .2.1 LOAD TEST



Impact Test

Impact testing is of enormous importance. A collision between two objects can often result in damage to one or both of them. The damage might be a scratch, crack, fracture or break. Scientists need to know about how materials and products behave under impact and the magnitude of forces they can resist. When two objects collide, damage is often done to one or other of them. How well something resists damage is called its impact resistance. An impact test measures how much energy is absorbed when an object fractures or breaks under a high speed collision. It's an important property. The safety of many consumer products depends on their resistance to breaking. But impact resistance is difficult to quantify. An impact testing machine with charpy arrangement is employed to perform the test. It is done as per the ASTM: D256 standards.

s.no	Composite specimen	Composite ratio	Machine	Load KN
1	Sample 1	1:1	UTM	7.950
2	Sample 2	2:1	UTM	39.45
3	Sample 1	1:1	CTM	60
4	Sample 2	2:1	CTM	300

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S.no	Composite specimen	Composite ratio	Machines	Impact
1	Sample 1	1:1	Izod impact machine	3 J/m^2
2	Sample 2	2:1		5 J/m^2

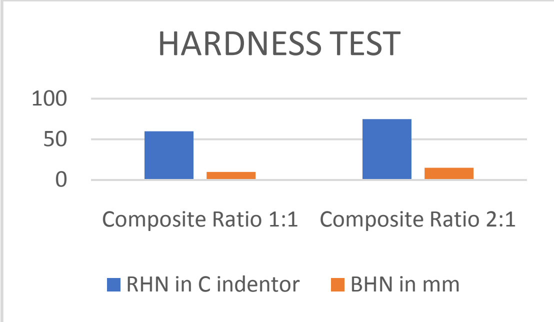
TABLE .2.2IMPACT TEST

Hardness Test

The Rockwell test is generally easier to perform, and more accurate than other types of hardness testing methods. The Rockwell test method is used on all metals, except in condition where the test metal structure or surface conditions would be too large for the application, or where the sample size or sample shape prohibits its use.The Rockwell method measures the permanent depth of indentation produced by a force/load on an indenter. First, a preliminary test force (commonly referred to as preload or minor load) is applied to a sample using a diamond or ball indenter. This preload breaks through the surface to reduce the effects of surface finish. After holding the preliminary test force for a specified dwell time, the baseline depth of indentation is measured.

INDENTOR: DIAMOND				
s.no	Composite Specimen	Composite Ratio	Machine	Hardness Number
1	sample 1	1:1	RHN	C60
2	sample 2	2:1	BHN	Dia-10mm

TABLE .2.3 HARDNESS TEST



Weight Test

S.No	Dimension Of The Component	Weight
1	25 X 25 cm	0.510 g
2	10 X 10 cm	0.100 g

TABLE .2.4 HARDNESS TEST

4.Conclusion

The present review explores the potentiality of luffa and banana fiber composites, emphasizes both mechanical and physical properties and their chemical composition. The utilization and application of cheaper goods in higher performance appliance is possible with the help of composite materials technology. Combining the useful properties of two different materials, cheaper manufacturing cost, versatility etc, makes them useful in various fields of engineering, high performance applications such as roof top and flooring purpose etc., hence with this background it is concluded that, the composites stand the most wanted technology in the fast growing current trend.

4.1.Application

- Used for roof top application.
- Roof top which consists of asbestos sheet which transfer heat to the space

area and this natural composite fiber is used to reduce the heat absorption inside the space area.

- Water resistant application.
- Used for flooring purposes.
- It can also be used for flooring purpose which is three times stronger than concrete which reinforced with fibers to enhance the strength of the component.
- Used in automotive and transportation applications.
- Car doors panels are made of fibers reinforcement.

4.2.Advantages

- Used for the automotive and transportation applications which carries heavy weight and used for different applications.
- Three times stronger than concrete material which carries more load than concrete ceiling.
- It is also used for wide applications in the field of engineering.
- It can also used in high end cars to reduce the weight of the automotive.
- In a review of chemical treatments of natural fibers which loose hydroxyl groups due to different chemical treatments thereby reducing the weight of the component and enhances the mechanical strength of the component.
- Impact strength of the component was also increased which is used for railway applications.
- RHN and BHN was also noted and it also had a good results in testing.
- Manufacturing cost is low.

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