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FABRICATION AND INFLUENCE OF MECHANICAL PROPERITIES OF HYBRID COCONUT FIBRE WITH EPOXY COMPOSITES

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ABSTRACT

Coconut fibers are gaining importance in the manufacturing of hybrid Fiber laminates. Coconut coir fibers should be chemically treated with diluted sodium hydroxide solution before using it to manufacture the composite material. The effect of surface modification on chemically treated fiber for mechanical properties such as tensile strength, flexural strength, impact strength and hardness of the composites were evaluated. Compared with the untreated coir composite and treated epoxy composites it was found that the tensile strength increased by 33% and elongation at break was found to be 20% greater. The flexural strength increased by 35% and impact strength doubled compared to the untreated coir composite material, The Scanning Electron Microscope was used to analyze the fractured surface feature as well as interfacial bonding strength of the composites. The results showed that the chemical modification in the coir fiber led to easier permeating of the coir fiber and epoxy resin and promoted effective interfacial adhesion. It was concluded that the mechanical properties enhanced after chemical treatment and improved the formation of chemical bonds between the coir/nylon epoxy resins with the coupling agent.

Keyword: Hybrid composites, Coconut fiber and Hand layup method.

1.1 Introduction

Composites

Materials of various types are required in our day-to-day life for diverse applications. In the development of any technology, the development of materials with specific properties happens to be a basic requirement. Material science or development of target materials has therefore taken the centre stage in contemporary research. One way of achieving a target material with specific properties is by fabrication of composites. A composite is a material made from two or more constituent materials having significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components.

1.2 Why Composites

Nowadays agriculture resources have been exploded in high technology revolution. The interest in using natural Fibers such as jute Fibers and coconut Fibers as reinforcement in plastic materials has increased dramatically. Now biodegradable and high cost of synthetic Fiber has attracted to use natural Fiber as organic filler. Natural Fibers have many advantages compared to the synthetic Fiber, for example they have low density, recyclable and biodegradable.

Additionally they are renewable material and have relatively high strength and stiffness. Combination of low density and mechanical properties of natural Fibers has produced a composite which suitable for structural applications.

1.3 Natural Composites

Natural composites exist in both animals and plants. For example, wood and bone are actually composites. Wood contains long cellulose fibers held together by lignin, a much weaker substance. The two weak substances, cellulose and lignin, together form a much stronger one. The bone in human body is made from a hard but brittle material called hydroxyapatite (which is mainly calcium phosphate) and a soft and flexible material called collagen.

1.4 Classification of Composites

Composite materials perhaps categorized in distinct ways. Arrangement based on the geometry of a characteristic unit of reinforcement is suitable since it is the geometry of the reinforcement which is liable for the mechanical properties and better presentation of the composites. The two broad classes of composites are:

(i) Fibrous composites

(ii) Particulate composites

Classification of composite materials

The composite materials are classified into the following categories as shown. Fibre-reinforced composites Because of intrinsic high specific strength and stiffness these composites are universally used in numerous industrial applications. These composites are acquiring high potential in tribological applications also as they possess brilliant structural presentation. Fiber reinforced composites materials comprises of fiber of high strength in or bonded to a matrix with discrete interfaces between them . In this form physical and chemical identities are retained by both

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fibres and matrix. Yet they produce an amalgamation of properties which is difficult to achieve with either of the composite constituents individually. In general, the role of fibers is to carry load, whereas the role of matrix is to keeps them in the crave position and alignment .Fibrous composite can be further classified into two groups:

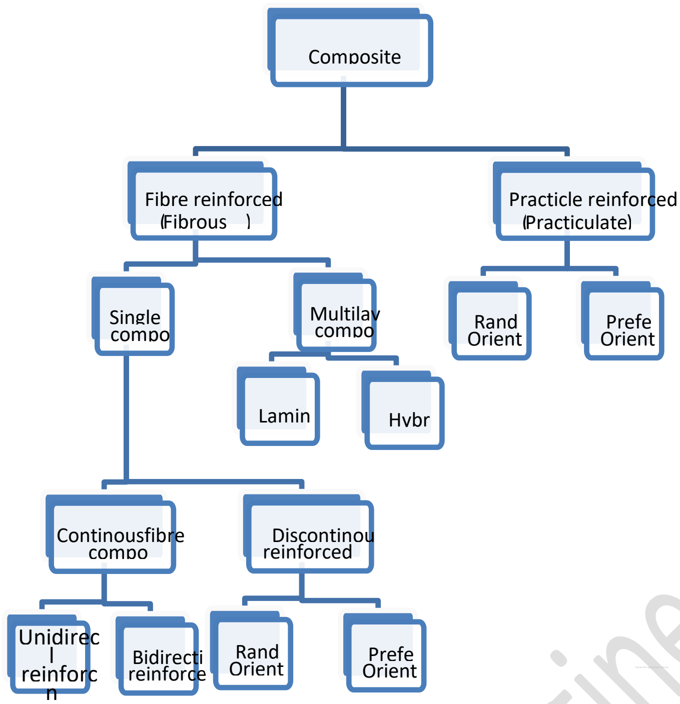

Fig.1.1 Classification of composite material

1.5 Natural fiber reinforced polymer composite (NFRC)

As highlighted above, the issues of health hazard, environmental pollution and high cost associated with synthetic fibers led the scientists and researchers to focus more on the application of natural fibers and plant based resources towards the development of NFRCs. The primary advantages of natural fibers over synthetic fibers have been their low cost, light weight, high specific strength, renewability, and biodegradability.

Therefore, in this thesis the focus is on NFRCs. Depending upon the type of reinforcing fiber, composites are classified as (i) fiber composites, (ii) particle composites and (iii) laminate composites.

In fiber composites, fibers of varying lengths are used for reinforcement. Moreover, fibers are laid in different orientations including random orientation. In particle composites, fibers are powdered and sieved, and then particles of different size are used for reinforcement. In laminate composites, fiber mats are prepared and these mats are laid layer by layer for reinforcement with, of course, the polymer matrix being filled in between the mat layers. Fibers may also be laid layer by layer without making prior mats.

The polymer matrices used in this case are the same as in the case of SFRCs. They are thermoplastics like PS, PE, PP, PVC, PC, PMMA and polylactic acid (PLA) or thermosetts like epoxy, phenol formaldehyde resin (Bakelite), melamine resin and unsaturated polyester

Natural Fiber Composites

Natural Fibers are greatly elongated substances produced by the plants and animals that can spin into filaments, thread or rope. Woven, Knitted, matted or bonded they form fabrics that are essential to the society.

Like agriculture, textiles have a fundamental part in human life since dawn of civilization. Fragments of cotton articles dated from 5000BC have been excavated in Mexico and Pakistan. According to Chinese tradition, the history of silk has been started in the 27th century BC. The oldest textile wool textile, found in Denmark, dates from 1500BC, the oldest wool carpet, from Siberia, from 5000BC. Fibers such as jute and coir have been cultivated since antiquity.

Plant Fibers include seed hairs, such as cotton; stem Fibers, such as flax and hemp; leaf Fibers such as sisal; and husk Fibers, such as coconut. Animal Fibers include wool, hair and secretions, such as silk.

1.6 Advantages

• Low specific weight of Fibers which results in a higher specific strength and stiffness than glass. This is a benefit especially in parts designed for bending stiffness.

• It is a renewable resource, the production requires little energy, and CO2 is used while oxygen is given back to environment.

• Producible with low investment at low cost, which makes the material an interesting product for low-wage countries.

1.7 Disadvantages

• Low impact strength properties.
• Variation in quality
• Moisture absorption, which causes swelling of the Fibers..
• Poor Fiber resistance.

1.8 Chemical Composition of Natural Fibers

The constituents of any natural fibers can vary based on origin, the area of production,variety and maturation of plants .This hydroxyl contains a polymer which distributes throughout the fiber walls.

2. LITERATURE REVIEW

This section stresses on the research work that has already been carried out for testing the mechanical properties of the Natural Fiber Reinforced Hybrid composites. Literature review of such work needs to be done in order to understand the background information available, the work already done and also to show the significance of the current project. This chapter presents a general knowledge of the factors which affect the mechanical properties of hybrid fiber reinforced composites.

Husna P Nur, M Akram Husain, ShahinSultana, M Mamunmollah et al, studied the use of natural fiber as reinforcing material is the latest invention of polymer science in order to get higher strength with lower weight composite materials having several applications. Low density polyethylene (LPDE) – banana fiber reinforced composites were prepared using both untreated and bleached (treated) banana fiber and LDPE with 7.5, 15, 22.5 and 30% weight content of fibers using compression molding technique. Compared to virgin molded LDPE both tensile and flexural strengths and young moduli of these significantly higher. All the variable properties like tensile strength, flexural strength, and water absorption capacity showed a very significant role in these polymer composites. which tool post is moving. Irregularities produced due to deformation of work under the action of cutting forces and the weight of the material are also included in this category.

3.Frp Fabrication Technology:

FRP products can be fabricated can be fabricated in about ten basic process. These are:

1. DOUGH MOULDING COMPOUND (DMC)
2. SHEET MOULDING COMPOUND (SMC)
3. FILAMENT WINDING
4. INJECTION MOULDING
5. HAND LAY-UP
6. SPRAY-UP PROCESSES FOR INTERMEDIATE CURE
7. FRP FOAM SRTUCTURE
8. VACCUM BAG MOULDING
9. PRESSURE BAG MOULDING

However, only the some of the above processes are being employed now.

3.1 Emergence Of Major Frp Systems

The hand lay-up technique of fabricating fiber-reinforced plastic refers to room temperature cure in open moulds of liquid thermostat resin after saturating it with suitable fiber reinforcement. This technique becomes popular as follows. Engineering Under graduate in USA with flair for water based activities performed as a thesis. The construction of model boat hulls using available fabric and liquid urea resins. When the prime FRP materials become available i.e., fiber glass cloth and polyester resin, he performed a natural shift.

His action helped to create the FRP industry and paved the way for the improvement in materials and methods. Hence the hand lay-up is till now the most applicable process it's forth lead to the development of spray-up technique bringing down the labor requirement and molding time.Single thickness FRP laminates were too low flexural strength and elastic module. To overcome this difficulty two or more FRP skins were laminated employing a foam material. This method is called bag molding.

Recent improvement comprises recombining resins and reinforcement to form SMC, a moldable composites in sheet form. This eliminates the need of handling liquid resin at the press.

3.2 Fabrication Process

3.2.1.Dough Moulding Compound (Dmc)

A dough-molding compound is also known as a premix. Premix is a fiber reinforced, ready to use molding material. It is a pre-blended combination of polyester resin, chopped reinforcement in organic fillers.It is commercially available in the form of a rope. Premix does not require preheating to advance cure or drive off volatiles, as is the case with other thermo set compounds. The premix can be molded either by compression molding or transfer molding or injection molding technique of fabricating the premix.

The following are the advantages realized by using premix to fabricate FRP products.

1.The cure rate is very rapid at temperature for below those for other thermo set compounds.

2.Premix has a very low shrinkage, which ranges from 0.004 inch to minimum of 0.001 inch. Due to this dimensional stability that can be achieved as a remarkable.Low molding pressure requirement is a big advantage with premix the higher pressure required is at the lower end of the pressure range needed for other thermo set compounds. Simple shapes can be molded at pressures as low as 100 psi. Thicker sections require higher pressures ranging up to 1500 psi.

micrometer shown in Fig-4.6. The chip reduction co-efficient can be given by formula below. Unreformed chip thickness = f sinKr where f is the feed and kr is the principal cutting edge.

4.EXPERIMENTAL WORK

4.1 Materials

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

(i) Polyester resin
(ii) Coconut Fiber
(iii) Accelerator
(iv) Catalyst

4.2 Polyester Resin

The unsaturated types come out as the more popular of the two. They are versatile in nature formed through the reaction of aromatic acids with a mixture of glycols and malefic anhydride. They have unparalleled strength compared to the saturated resins with great resistance to chemicals and heat. When induced on glass Fiber they form excellent Fiber Reinforced Plastic or FRP the common abbreviation.

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The unique and advantaged properties of the unsaturated polyester resin give them an upper hand in household, industrial and automobile applications. For starters, they are used in water proof fans, wall panels and ceiling panels. For an exquisite home décor, unsaturated polyester resin is the trick used in decorated panels for the walls.

4.3 Structure Of Polyester

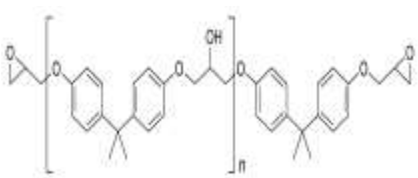

Figure 4.1 Structure of polyster

The heat resistance abilities of unsaturated polyester resins get a go ahead from automobile engineers in the production of air spoilers and engine covers. They also form part of the ceiling covers for cars and window frame covers.

Away from automobile arena, unsaturated polyester resin has approval in producing circuit breakers for electrical appliances. Moreover they are also the components used in telephone boxes, dish antennas and light covers. Lastly, unsaturated polyester resin is credited with the manufacture of DVD trays and honeycomb bases. Not forgetting LCD projectors and optical units.

The saturated type doesn't have much consideration in our day to day application. Formed from the polycondensation reaction of multifunctional organic acids and multihydroxy alcohols, they can only be used as powered coatings. But the powered coating is gaining popularity and becoming widely used throughout the world.

4.4 Preparation Of Mould

- Glass plates of dimension 200*200*3 mm are selected as a base for the mould.
- One set of piece has a dimension of 200*20*3 mm and other set has 150*20*3 mm
- Glass pieces are attached to base plate with the help of araldite.
- Care should be taken that no gap should be present at corners of the attachment.
- This glass moulds are kept one day to open air to get firm attachment.

Table 4.1: Compositions with respect to Fiber %

NAME	COMPOSITION
C1	POLYESTER + 12gm coconut FIBER
C2	POLYESTER + 25gm coconut fiber
C3	POLYESTER + 35gm coconut fiber

4.2 Pictures representing the formation of the composite

4.5. Mechanical Testing Of Specimens

- After fabrication the test specimen were subjected to various mechanical tests as per the ASME Standards. The Tensile test and three flexural tested were carried out Model METM 2000 ER-1 apparatus.

4.5.1 Specifications

- The tensile properties of the samples of sizes 100 mm long, 10 mm wide and 3 mm thick were measured in accordance with ASTM: D638-10.
- The samples were tested at a cross head speed of 2 mm/min, using an electronic tensometer (Model METM 2000 ER – 1), supplied by M/s Mikrotech, Pune. India.

4.6 Tensile Test

The Tensile test is performed on specimens according to ASTM test standard D638-03 on aUniversal Testing Machine METM 2000 ER-1. The cross head speed was maintained at 2 mm/min, at a temperature 22˚ c and humidity 50%. In each case three samples are taken and average values are recorded.

4.6.1 Definition

The tensile test determines the overall strength of the given object. In a tensile test, the object fitted between two grippers at either end then slowly pulled apart until it breaks.

A tensile provides vital information related to a products durability including yield point, tensile strength and proof stress.

4.7 Flexural Test

Flexural test were performed using 3- point bending according to ASTM D90-03 procedure. The specimens were tested at a cross head speed of 2mm/min, at a temperature 22˚C and humidity 50%. In each case three samples are taken and average values are recorded.

4.7.1 Definition

The flexural test method measures behavior of materials subjected to simple beam loading. It is also called as transverse beam test. Flexural strength is defined as maximum in the outer most Fiber this is calculated at the surface of the specimen on convex side.

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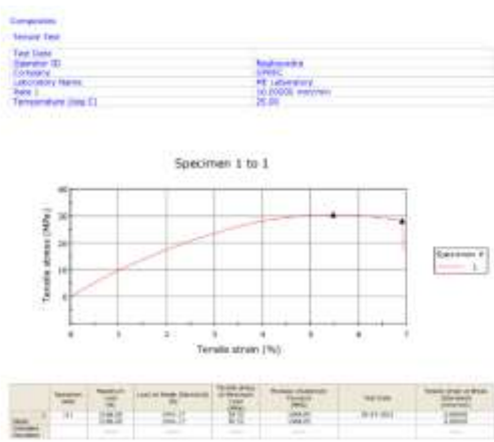
4.8 Impact Test

Impact strength of notched specimens was tested in accordance with ASTM: D256-10 using plastic impact testing machine, supplied by M/s International equipments, Mumbai, India. The specimens were 63.5 mm long, 12.7 mm deep and 3 mm wide. Maximum load capacity is 26.17 J.

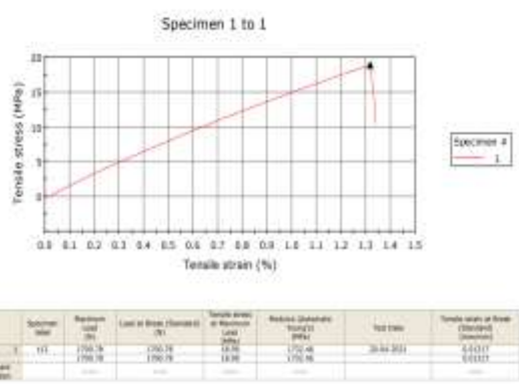
4.8.1 Definition

A test definition to give information on how a specimen of known material will respond to a suddenly applied stress, eg.shock, the ascertains whether the material is tough or brittle. A notched test piece is normally employed and the two methods in generally use or either the Izod or the charpy test. The result is usually reported as the energy in KJ, required to fracture the test piece.

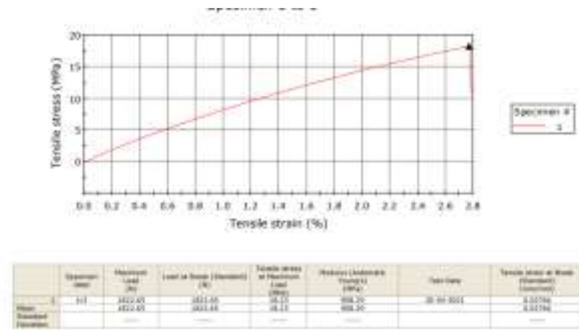
5.TESTING AND RESULTS OF COMPOSITES



5.1 Tensile Testing on specimen t11(Epoxy resin)



5.2 Tensile Testing on specimen t12 (Epoxy resin with 18 gm coconut coir powder)



5.3 Tensile Testing on specimen t13 (Epoxy resinwith 25 gm coconut coir powder)

6. CONCLUSION

The hybrid coconuts coir fiber with epoxy composite materials were prepared using hand layup technique successfully and it is a natural hybrid fiber and it very eco friendly and it is biodegradable and have high mechanical properties.

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