FABRICATION OF THE FIBER REINFORCED COMPOSITE MATERIAL FROM BAMBOO, SUGAR CANE AND GLASS FIBER

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***Abstract*—** Waste natural fibers, bit coir fiber residue of traditional coir industries, and sugarcane bagasse fibers were subjected to chemical modifications via alkaline steam explosion treatments toward the extraction of reinforcing fibers with better compatibility and reinforcing characteristics in the polymer matrix. The treated fibers were utilized in the fabrication of composites with polypropylene (PP) as the base polymer with the aid of maleic anhydride–grafted PP as the compatibilizer. Percent composition of fiber in the composites was decided to facilitate maximum replacement of the matrix and further applicability in large-scale continuous polymeric production processes. Mechanical, thermal, and morphological characterization of the composites reveals the best composition to be of 30% composition, in the added view of maximum replacement of polymer matrix with the reinforcing filler, retention of requisite properties, reduced cost of manufacture and inventory, and reduction in the carbon footprint per unit dimensions in comparison with the wholly polymer component. The thermal properties of coir fiber-reinforced composites showed good improvement up to 134.5°C increase in onset degradation temperature while retaining matrix properties for sugarcane bagasse-reinforced composites.

I. INTRODUCTION

Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite unique properties, but within the composite you can easily tell the different materials apart – they do not dissolve or blend into each other.

Nowadays many composites are made for functions other than simply improved strength or other mechanical properties. Many composites are tailored to be good conductors or insulators of heat or to have certain magnetic properties; properties that are very specific and specialised but also very important and useful. These composites are used in a huge range of electrical devices, including transistors, solar cells, sensors, detectors, diodes

and lasers as well as to make anti-corrosive and anti-static surface coatings.

Composites exist in nature. A piece of wood is a composite, with long fibres of cellulose (a very complex form of starch) held together by a much weaker substance called lignin. Cellulose is also found in cotton and linen, but it is the binding power of the lignin that makes a piece of timber much stronger than a bundle of cotton fibres.

A	+	B	=	C
(Matrix)		(Reinforcement)		(Composite)

Most composites are made up of just two materials. One material (the matrix or binder) surrounds and binds together a cluster of fibres or fragments of a much stronger material (the reinforcement).

a) Bamboo Fiber

- Reinforcement- Bamboo
- Botanical Name- Bambusa vulgaris
- Local Name- Phyllostachys edulis

Figure: Bamboo Fiber

Family- Grasses

Over 115 genera and 1,400 species of bamboo are included in the family Poaceae's Bambusoideae, a subfamily of tall tree-like grasses.The most species of bamboo can be found in East and Southeast Asia, as well as on islands in the Indian and Pacific oceans. Bamboos can be found in tropical, subtropical, and mild temperate climates.The southern United States is home to a few native species of the genus Arundinaria, which form dense canebrakes along riverbanks and in marshy areas.

b) Sugar Cane Wastage (Bagasse) Fiber

- Reinforcement- Sugar Cane
- Botanical Name- Saccharum officinarum
- Local Name- Aakh, Ikkhu, Gendari, Hussel, Kajuli, Kusa, Kushiar
- Family- Poaceae

The sugarcane botanical name was also given. Saccharum officinarum is the botanical name for sugarcane. Sugarcane is a grass plant that is in the saccharum genus and the poaceae family. It has been believed to have come from new guinea and been planted in both the subtropical and tropical parts of the country. The plant is also grown for biofuel production, particularly in brazil, because the canes can be directly used to produce ethyl alcohol (ethanol). S.officinarum produces about 70 percent of the world's sugar.

Figure: Sugar Cane Wastage (Bagasse) Fiber

c) Glass wastage Fiber

In this undertaking glass filaments are utilized for creating the composite example. The glass strands were gotten from Dharmapuri Area, Tamil Nadu, and India.

Figure: Glass Wastage

Polyester sap and the impetus Methyl Ethyl Ketone Peroxide (MEKP) were bought from M/s. Sakthi fiber glass Ltd., Chennai, India. 10% of impetus is added with the sap for the amount taken. The are various sorts of filaments the glass strands utilized for the composite creation are introduced in Figure the gum, gas pedal, impetus, and more slender utilized for handling of composites are given in Figure.

II. RELATED WORK

Amit bindal, satnam Singh, N. K. Batra, and Rajesh khannaet al, studied the composites play significant role as engineering material and their use has been increasing day by day due to their specific properties such as high strength to weight ratios, high modulus to weight ratio, corrosion resistance, and wear resistance. The effect of jute fiber on mechanical properties of glass fiber reinforced polyester composite was studied and it showed that by incorporating the optimum amount of natural fibers, the overall strength of synthetic fiber reinforced polyester composite can be increased and cost saving of more than 20 % can be achieved.

J. Sahari and S. M. Sapaun, et al, examined currently, numerous research groups have explored the production and properties of biocomposite where the polymer matrices are derived from renewable resources such as poly lactide (PLA), thermoplastic starch (TPS), cellulose and polyhydroxyalkanoates (PHAs). Natural fiber reinforced biodegradable polymer composites appear to have very bright future for wide range of applications. These bio composite materials with various interesting properties may soon be competitive with the existing fossil plastic materials.

III. METHODOLOGY

a) Hand Lay-Up Method

The least complex assembling procedure took on is setting down unidirectional glass meandering over a cleaned form surface recently treated with a delivering specialist: after this, a fluid thermosetting tar is worked into the support by hand with a brush or roller. The cycle is rehashed various times equivalent to the quantity of layers expected for the last composite. Epoxy pitches are generally normally utilized with glass strands as a result of their great strength properties. Sap and restoring specialists are pre-blended and typically intended to cross-connect and solidify at room temperature. The significant benefit of this assembling system is its incredible adaptability, since it suits most normal form sizes and complex shapes. In spite of the fact that tooling is ordinarily costly, it tends to be re-utilized for a few runs and the genuine expense of the unrefined components make this cycle monetarily practical.

b) Vacuum Bagging Method

Otherwise called vacuum forming, it requires a siphon that will utilize air strain to unite the material while restoring by applying vacuum to the shape hole. Normally the filaments are put on a solitary shape surface and covered by an adaptable film, fixed around the edges of the form. The space between the form and the film is then cleared with a siphon and the vacuum held until the tar has relieved. Figure shows an illustration of vacuum packing as given by Kornmann et al (3005) where a few layers of glass texture were set intercalated with epoxy pitch.

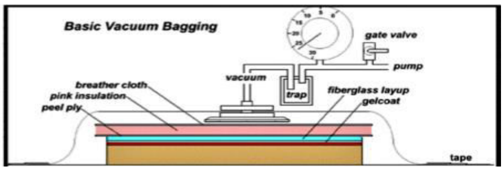

Fig: Vacuum Bagging Technique

c) Composite Specimen Preparation

The hand rest up is one of the most seasoned, least difficult and most normally involved strategies for composite parts' development. The example is created in layer stacking, and each layer is arranged to accomplish the greatest usage of its properties. Layers of various materials can be joined to additional improve the general presentation of the overlaid composite examples. Saps are impregnated by hand into strands, which are as woven, weaved, sewed or fortified textures. This is generally achieved by rollers or brushes, with a rising utilization of nip-roller type impregnators for compelling the pitch into the textures, through turning rollers. Then the composite covers are permitted to fix under ordinary air conditions and dried under the blistering sun for more than 34 hours.

The composite examples utilized for the current examination comprise of five layers, and manufactured by the hand layup strategy. In the five layers, the glass fiber layers are mounted on the top, center and lower part of the example. Add 10% impetus by weight with sap for speedy setting, prompt blending, and decrease the intensity created because of exothermic response. Prior to creating the composite example the glass strands are dried in the hot air stove at 80ºC for 8 hours to totally eliminate the dampness. At first, the delivering specialist is covered over the plain even table for simple expulsion of the example, and the primary layer of the example, i.e., the glass fiber mat is put over the covered surface after the delivering specialist gets dried.

Then, at that point, the gum is applied over the glass fiber mat and the pitch is uniformly conveyed on the whole surface by utilizing a roller. The gum is permitted 10-30 minutes for getting totally blended; from that point onward, the second layer of the example. The air holes framed between the layers during handling are tenderly pressed out. Then, at that point, these examples are taken to the water driven press to eliminate the air hole between the layers, and any overabundance air present in the gum, by applying a power of around 70 to 100N for 48 hours, to get wonderful examples. After the examples get solidified totally, they are taken out from the water powered press, and the unpleasant edges are conveniently cut according to the necessary aspects.

d) 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.

e) Glass Mould To Prepare Composite Material Nomenclature

The following nomenclature has been followed by us to prepare the specimen

Table: Compositions with respect to Fiber percentage

NAME	COMPOSITION
C1	184gms Epoxy + 116gm Hardener
C2	184gms Epoxy + 116gm Hardener + 3.33gms bamboo, 3.33gms sugar cane and 3.33gms glass fibre
C3	184gms Epoxy + 116gm Hardener + 6.66gms bamboo, 6.66gms sugar cane and 6.66gms glass fibre
C4	184gms Epoxy + 116gm Hardener + 10gms bamboo, 10gms sugar cane and 10gms glass fibre

IV. MATERIALS

In this undertaking glass filaments are utilized for creating the composite example. The glass strands were gotten from Dharmapuri Area, Tamil Nadu, and India.

Polyester sap and the impetus Methyl Ethyl Ketone Peroxide (MEKP) were bought from M/s. Sakthi fiber glass Ltd., Chennai, India. 10% of impetus is added with the sap for the amount taken. The are various sorts of filaments the glass strands utilized for the composite creation are introduced in Figure.

Fig: Epoxy resin

Fig: MEKP catalyst

Fig: Mould preparation

V. RESULTS

The subsequent covers is permitted to fix in the shape minus any additional treatment. In pack forming process, overlaid filaments are laid inside a shape, covered with an adaptable sack and afterward relieved with intensity and tension. After the determined restoring time, the composites turns into a coordinated part framed into an ideal shapes. It is partitioned into three, to be specific: pressure pack, vacuum sack and autoclave. Pultrusion is a robotized interaction utilized for assembling ceaseless cross segment profiles. In this items are pulled out of the bite the dust as opposed to being constrained by pressure. Lines, tubes and underlying lines are fabricated from this method utilizing a suitable mould.Filament winding is utilized for delivering revolted surfaces e.g pipes, tubes, chambers, huge and pipe work. Preformed forming process is partitioned into three, to be specific pregreg, sheet and batter moldings.

It can done wet or dry. Tar move forming includes use of gum to preform put in a pre-arranged shape. Gum is brought into the form at high tension from the absolute bottom and fills the shape in the vertical bearing to diminish entangled air. Cinching is important to forestall sap misfortune through the snare. When the form vent is topped off with gum, tar stream is halted and the relieving starts right away. This is partitioned into tar move implantation (RTI), vacuum air sap move form (vacuum helped gum move shape). Infusion forming includes warming the polymer matrix and filler in a barrel and the liquid mix is taken care of at high tension into a pit of a pre-arranged shape. This technique is utilized for the creation of thermoplastic and thermoset based composites.

Mechanical properties of composites were assessed by tractable and hardness estimations. The examples were ready from the created composites and edges of the example are done by utilizing record and emery paper for tractable testing. Tractable tests were inspected by ASTM D638.

Figure: 184gms Epoxy + 116gm Hardener + 3.33gms bamboo, 3.33gms sugar cane and 3.33gms glass fibre

Figure: 184gms Epoxy + 116gm Hardener + 3.33gms bamboo, 3.33gms sugar cane and 3.33gms glass fibre

Figure: 184gms Epoxy + 116gm Hardener + 10gms bamboo, 10gms sugar cane and 10gms glass fibre

Tensile Strength

After the strands built up composite was dried, it was sliced utilizing a saw shaper to get the element of example for mechanical testing. The elastic test example was ready as per ASTM D3039; the most well-known example for ASTM D3039 has a consistent rectangular cross segment, 25 mm (1 in) wide and 250 mm (10 in) long.

Compression Test

After the strands built up composite was dried, it was sliced utilizing a saw shaper to get the element of example for mechanical testing. The pressure test example was ready as per ASTM D3039; the most well-known example for ASTM D3039 has a steady rectangular cross segment, 1.90 mm wide and 7.14 mm long.

Impact Test

Influence is a solitary guide test that actions a materials opposition toward influence from a swinging pendulum. Influence is characterized as the need might have arisen to start crack and proceed with the break until the example is broken. This test can be utilized as a speedy and simple quality control check to decide whether a material meets explicit effect properties or to look at materials for general sturdiness. The standard example for ASTM is 64 x 12.7 x 3 mm .The most well-known example thickness is 3 mm, since it isn't as liable to curve or pulverize.

VI. CONCLUSION

Various concentrations of bamboo fiber have been used to create epoxy-reinforced bamboo fiber composites.The experimental analysis revealed that the epoxy matrix's inclusion of bamboo fiber reinforcement enhanced the composite structure's mechanical properties.The hand-lay-up method, which is one of the easiest ways to make composites in normal conditions, was used to make the composites.The fiber and resin are properly bonded in the fabricated composites, which are of high quality.However, in composite fabrication, particularly when using hand-layup, voids are inevitable.A number of mechanical properties and even the composites' performance are significantly impacted by the structure's pores and voids.Typically, higher void contents indicate decreased fatigue resistance and increased water penetration susceptibility.The composites' tensile and flexural strength have both decreased as a result of the increase in fiber loading, but the hardness has increased as a result of studying the fiber variations.The fiber's inability to support the stress transferred from the polymer matrix is the cause of this decrease.A weak structure is also caused by partial gaps between the fiber and matrix material caused by poor interfacial bonding.Composites' impact strength also increased up to a fiber loading of 20 wt percent and then decreased to 30 wt percent.Micro-spaces between the fiber and matrix polymer caused a reduction in impact strength at a fiber loading of 30%. When a composite is struck, this results in a large number of micro-cracks, which facilitate crack propagation and reduce the composite's impact strength.Tests have been conducted on composites' water absorption.As the fiber content of the bamboo epoxy composite increased, so did the percentage of chemicals that were absorbed. Composites' water absorption increased with fiber loading. Water 161 absorption is caused by bamboo fibers' hydrophilic nature.

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