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Fabrication and testing of Nature fibre Reinforced Hybrid Composites Banana / Bamboo

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ABSTRACT: Hybrid composites possess unique features that can be used to meet different design requirements with respect to strength, stiffness and flexural behaviour. A key parameter in hybrid composite structures arrangement design strongly affects the variety of properties such as tensile and compressive strength based on high performance resin. In this study Natural and synthetic fibres are combined in the same matrix (unsaturated polyester) to make Banana/Bamboo fibre hybrid composites using poly urethane resin. The banana natural fibre is treated with NaOH. The fabrication of hybrid composite is to be done using Hand lay-up method. The fabricated hybrid composite is to be tested and their properties are to be studied. Additionally making banana nano fibre are using chemical treatment like pre-treatment (17.5% NaOH), acid hydrolysis (1M Hcl) and alkali treatment (2% NaOH) followed by hybrid composite was fabricated. The fabricated hybrid composite is to be tested and their properties are to be studied.

KEYWORDS: Hybrid composite, poly urethane, banana fibre, bamboo fibre, Impact strength, Compressive strength, tensile strength.

1 INTRODUCTION

Composites are one of the most advanced and adaptable engineering materials known to men. Progresses in the field of materials science and technology have given birth to these fascinating and wonderful materials. Composites are heterogeneous in nature, created by the assembly of two or more components with fillers or reinforcing fibres and a compactable matrix. The matrix may be metallic, ceramic or polymeric in origin. It gives the composites their shape, surface appearance, environmental tolerance and overall durability while the fibrous reinforcement carries most of the structural loads thus giving macroscopic stiffness and strength .

1.1 OVERVIEW OF COMPOSITE MATERIAL

For the past several years, public attention has gone on natural fibers as a resource due to the fast growth. Now a day, natural fibres are widely used as reinforcements both in partially and totally biodegradable Natural fiber Composites. Natural fibers are an alternative resource to synthetic fibres as reinforcement for polymeric materials for the manufacture of cheap, renewable and environmentally friendly composites. Waste plastic has caused unbearable stress to environment in recent years. Environmental awareness, new rules and legislations are forcing industries to seek new materials which are more environmentally friendly.

Plant fibers from agricultural crops are renewable materials which have potential for creating green products and replacing synthetic materials which are currently being used such as glass fiber, carbon fiber and plastic fibers. The combinations of bio-fiber and bio-polymer could be the products of fully biodegradable composites. Among others, natural fibers (e.g., flax, jute or sisal) reinforced materials have important significance for reduction of density in automobile construction components due to its higher specific stiffness and specific tensile strength.

A composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. One constituent is called reinforcing phase and one in which it is embedded is called the matrix. The reinforcing phase material may be in the form of fibers, particles or flake. The matrix phase materials are generally continuous. Examples of naturally found composites include wood, where the lignin matrix is reinforced with cellulose fibers and bones in which the bone-salt plates made of calcium and phosphate ions reinforce soft collagen. The roles of matrix in composite materials are to give shape to the composite part, protect the reinforcements to the environment, transfer loads to reinforcements and toughness of material, together with reinforcements. The aims of reinforcements in composites are to get strength, stiffness and other mechanical properties, dominate other properties as coefficient of thermal extension, conductivity and thermal transport. As a comparison between composites and metals, the composites materials are some advantages as:

- Light weight High specific stiffness and strength
- Easy moldable to complex forms
- Easy bondable
- Good dumping
- Low electrical conductivity and thermal expansion
- Good fatigue resistance

The high strength to weight ratio and non-corrosive characteristics of these materials like fibre-re- in forced plastics can be utilised to build innovative structures, which are, desirable and economical. The roles of matrix in composite materials are to give shape to the composite part, protect the reinforcements to the environment, transfer loads to reinforcements and toughness of material, together with reinforcements. The aims of reinforcements in composites are to get strength, stiffness and other mechanical properties, dominate other properties as coefficient of thermal extension, conductivity and thermal transport. As a comparison between composites and metals, the composites materials have some advantages as:

1. A higher performance for a given weight leads to fuel savings. Excellent strength-to weight and stiffness-to-weight ratios can be achieved by composite materials. This is usually expressed as strength divided by density and stiffness (modulus) divided by density. These are so-called "specific" strength and "specific" modulus characteristics.
2. Laminate patterns and ply buildup in a part can be tailored to give the required mechanical properties in various directions. Low electrical conductivity and thermal expansion
3. It is easier to achieve smooth aerodynamic profiles for drag reduction. Complex double-curvature parts with a smooth surface finish can be made in one manufacturing operation.
4. Part count is reduced.
5. Production cost is reduced. Composites may be made by a wide range of processes.
6. Composites offer excellent resistance to corrosion, chemical attack, and outdoor weathering; however, some chemical are damaging to composites (e.g., paint stripper), and new types of paint and stripper are being developed to deal with this.

The composites materials have some disadvantages as,

1. Composites are more brittle than wrought metals and thus are more easily damaged. Cast metals also tend to be brittle.
2. If rivets have been used and must be removed, this presents problems of removal without causing further damage.
3. Repair at the original cure temperature requires tooling and pressure.
4. Long development time

All of these have made those composites to change more and more the metals, in specials in aircrafts, automotives, marines, constructions, etc.

1.2 CLASSIFICATION

Composites are classified by geometry of the reinforcement-particulate, flake, fibres, filled, whiskers and directionally solidified eutectics or by the type of matrix-polymer, metal, ceramic and carbon. Polymer matrix material is classified as thermo sets and thermoplastics. Again thermo sets and thermoplastics are divided by epoxy, phenolic polyamide resin, polyester and polyethylene, polystyrene, polyamides, nylons and polypropylene respectively.

1.2.1 PARTICULATE REINFORCED COMPOSITES

A composite whose reinforcement is a particle with all the dimensions roughly equal are called particulate reinforced composites. Particulate fillers are employed to improve high temperature performance, reduce friction, increase wear resistance and to reduce shrinkage. The particles will also share the load with the matrix, but to a lesser extent than a fibre. A particulate reinforcement will therefore improve stiffness but will not generally strengthen.

1.2.2 FIBRE REINFORCED COMPOSITES

Fibre reinforced composites contain reinforcements having lengths higher than cross sectional dimension. Fibrous reinforcement represents physical rather than a chemical means of changing a material to suit various engineering applications

1.2.3 HYBRID COMPOSITES

Composite materials incorporated with two or more different types of fillers especially fibres in a single matrix are commonly known as hybrid composites. Hybridisation is commonly used for improving the properties and for lowering the cost of conventional composites. There are different types of hybrid composites classified according to the way in which the component materials are incorporated. Hybrids are designated as i) sandwich type ii) interply iii) intraply and iv)intimately mixed. In sandwich hybrids, one material is sandwiched between layers of another, whereas in interplay, alternate layers of two or more materials are stacked in regular manner. Rows of two or more constituents are arranged in a regular or random manner in interplay hybrids while in intimately mixed type, these constituents are mixed as much as possible so that no concentration of either type is present in the composite material.

1.2.4 LAMINATES

A laminate is fabricated by stacking a number of laminae in the thickness direction. Generally three layers are arranged alternatively for better bonding between reinforcement and the polymer matrix, for example plywood and paper.

1.2.5 SHORT FIBRE- RUBBER COMPOSITES

The term ‘short fibre’ means that the fibres in the composites have a critical length which is neither too high to allow individual fibres to entangle with each other, nor too low for the fibres to lose their fibrous characteristics. A short fibre composite signifies that the two main constituents, i.e., the short fibres and the rubber matrix remain recognizable in the designed material. When used properly, a degree of reinforcement can be generated from short fibres, which is sufficient for many applications. Short fibre reinforced rubber composites were developed to fill the gap between the long fibre reinforced and particulate filled rubber composites. That is mainly to achieve the high performance of the fibre coupled with easy processability and elasticity of the rubber.

1.3 NATURAL FIBRES COMPOSITES

Natural fibres have become popular reinforcement material for fibre reinforced polymer composite developments. These reinforcement can replace the conventional fibre, such as glass as an alternative material. It is divided into several categories they are as follows,

1.3.1 ANIMAL FIBRE

Animal fibre generally comprise proteins; examples mohair, wool, silk, alpaca, angora. Animal hair (wool or hair) are the fibres taken from animals or hairy mammals. e.g. Sheep’s wool, goat hair (cashmere, mohair), alpaca hair, horse hair, etc. Silk fibres the fibres collected from dried saliva of bugs or insects during the preparation of cocoons. Examples include silk from silk worms. Avian fibres are the fibres from birds, e.g. feathers and feather fibre.

1.3.2 MINERAL FIBRE

Mineral fibres are naturally occurring fibre or slightly modified fibre procured from minerals. These can be categorized into the following categories: Asbestos is the only naturally occurring mineral fibre. Variations are serpentine and amphiboles, anthophyllite. Ceramic fibres includes glass fibres (Glass wood and Quartz), aluminium oxide, silicon carbide, and boron carbide. Metal fibres include aluminium fibres.

1.3.3 Plant Fibre

Plant fibres are generally comprised mainly of cellulose: examples include cotton, jute, flax, ramie, sisal and hemp. Cellulose fibres serve in the manufacture of paper and cloth. This fibre can be further categorizes into following as Seed fibre are the fibres collected from the seed and seed case e.g. cotton and kapok. Leaf fibre are the fibres collected from the leaves e.g. sisal and agave.

Therefore, these fibres are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, banana, hemp, and soybean. Fruit fibres are the fibres are collected from the fruit of the plant, e.g. bamboo (sugarcane) fibre. Stalk fibre are the fibres are actually the stalks of the plant. E.g. straws of wheat, rice, barley, and other crops including bamboo and grass. Already the ancient Egyptians used clay that was reinforced by straw to build walls. In the beginning of the 20th century wood- or cotton fibre reinforced phenol- or melamine formaldehyde resins were fabricated and used in electrical applications for their non-conductive and heat-resistant properties.

At present day natural fibre composites are mainly found in automotive and building industry and then mostly in applications where load bearing capacity and dimensional stability under moist and high thermal conditions are of second order importance. For example, flax fibre reinforced polyolefin are extensively used today in the automotive industry, but the fibre acts mainly as filler material in non-structural interior panels. Natural fibre composites used for structural purposes do exist, but then usually with synthetic thermoset matrices which of course limit the environmental benefits.

Natural fibres are generally ligno cellulosic in nature, consisting of helically wound cellulose micro fibrils in a matrix of lignin and hemicelluloses.

Natural fibres such as jute, sisal, pineapple, abaca and bamboo have been studied as a reinforcement and filler in composites. Growing attention is nowadays being paid to bamboo fibre due to its availability. The bamboo is available in large quantities as residue from sugarcane production in many areas, which is yielding the coarse bamboo fibre. Bamboo is a lingo-cellulosic natural fibre.

1. Stem fibres (jute, bamboo, banana etc.)
2. Leaf fibres (sisal, pineapple, screw pine etc.)
3. Fruit fibres (cotton, coir, oil palm etc.)

Properties of plant fibres depend mainly on the nature of the plant, locality in which it is grown, age of the plant, and the extraction method used. For example, coir is a hard and tough multicellular fibre with a central portion called “lacuna”. Sisal is an important leaf fibre and is very strong. Pineapple leaf fibre is soft and has high cellulose content. Oil palm fibres are hard and tough, and show similarity to coir fibres in cellular structure. The elementary unit of a cellulose macromolecule is anhydro-d-glucose, which contains three alcohol hydroxyls (-OH) (Bledzki et al., 1996). These hydroxyls form hydrogen bonds inside the macromolecule itself (intramolecular) and between other cellulose macromolecules (intermolecular) as well as with hydroxyl groups from the air. Therefore, all plant fibres are of a hydrophilic nature; their moisture content reaches 8-13%. In addition to cellulose, plant fibres contain different natural substances. The most important of them is lignin. The distinct cells of hard plant fibres are bonded together by lignin, acting as a cementing material. The lignin content of plant fibres influences its structure, properties and morphology. An important characteristic of vegetable fibre is their degree of polymerization.

1.3.4 Advantages of Natural Fibre

- Natural fibres, as reinforcement, have recently attracted the attention of researchers because of their advantages over other established materials. They are environmentally friendly, fully biodegradable, abundantly available, renewable and cheap and have low density.
- The abrasive nature of fibre is much lower which leads to advantages in regard to technical process and recycling process of the composite materials in general. Natural fibre-reinforced plastics, by using biodegradable polymers as matrices, are the most environmental friendly materials, which can be composed at the end of their life cycle.
- Natural fibre composites are used in place of glass mostly in non-structural applications. Although natural fibres and their composites are environmental friendly and renewable (unlike traditional sources of energy, i.e., coal, oil and gas), these have several bottlenecks.

- These have poor wetability, incompatibility with some polymeric matrices and high moisture absorption. Composite materials made with the use of unmodified plant fibres frequently exhibit unsatisfactory mechanical properties.
- To overcome this, in many cases, a surface treatment or compatibilizing agents need to be used prior to composite fabrication. Mechanical properties of natural fibres are much lower than those of glass fibres but their specific properties, especially stiffness, are comparable to the glass fibres.

1.3.5 Disadvantages of Composites

- High cost of fabrication of composites
- Mechanical characterization of a composite structure is more complex than a metal structure.
- Repair of composites is not a simple process compared to that for metals
- Composites do not have a high combination of strength and
- Fracture toughness compared to metals

2 Objectives

- To develop a new class of natural fibre based composites to explore the potential of bamboo fibre.
- To study the effect of fibre length on mechanical behavior of banana and bamboo fibre reinforced polyurethane based composites.
- To study the properties of the polyurethane resin and compare those properties with the other resins.
- Selection of bamboo and banana fibre with better mechanical characteristics that give better fibre properties.
- Chemical treatment of bamboo fibres to improve its stiffness.
- Evaluation of mechanical properties such as: tensile and compressive strength.
- Identification of different failure types.
- Compare those properties of the composite with the banana and coir composite material

3 Materials And Methods

In this work materials such as banana, bamboo fibres and polyurethane resin with its hardener are utilized directly for hybrid composite preparation whereas bamboo fibre is extracted from bamboo culms

3.1 Banana Fibres

Banana fiber, a ligno-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bast fiber with relatively good mechanical properties. All varieties of banana plants have fibres in abundance. Banana fiber at present is a waste product of banana cultivation and either not properly utilized or partially done so. The extraction of fiber from the pseudostem is not a common practice and much of the stem is not used for production of fibers.

Fig.3.1 Banana Fibre

3.1.1 BANANA FIBRE COLLECTION PROCESS

In banana plantations, after the fruits are harvested, the trunks or stems will be discarded. These wastes provide obtainable sources of fibres, which leads to the reduction of other natural and synthetic fibre production that requires extra energy, fertilizer, and chemical. Figure 4.2 shows the banana stem.

Fig.3.2 Banana stem

The properties of banana fibre are good absorbent, highly breathable, quickly dry with high tensile strength.

3.1.2 BANANA FIBRE EXTRACTION MACHINE

The banana fibre is extracted by means of crushing the banana stem with the help of the fibre extraction machine. This machine gives the continue fibre that produces the good mechanical properties in the fibre. Figure 4.3 shows the banana fibre extraction machine.

Fig.3.3 Banana fibre extraction machine

3.1.3 CHARACTERISTICS OF BANANA FIBRE

Banana fibre is the best natural fibre. It has its own physical and chemical characteristics and many other properties that make it a fine quality fibre.

- Appearance of banana fibre is similar to that of bamboo fibre and ramie fibre, but its fineness and spin ability is better than the two.
- The chemical composition of banana fibre is cellulose, hemicellulose, and lignin.
- It is highly strong fibre.
- It has smaller elongation.
- It has somewhat shiny appearance depending upon the extraction & spinning process.
- It is light weight.
- It has strong moisture absorption quality. It absorbs as well as releases moisture very fast.
- It is bio- degradable and has no negative effect on environment and thus can be categorized as eco-friendly fibre.

3.2 BAMBOO FIBRE

Bamboo is a naturally occurring composite material which grows abundantly in most of the tropical countries. It is considered a composite material because it consists of cellulose fibres imbedded in a lignin matrix. Cellulose fibres are aligned along the length of the bamboo providing maximum tensile flexural strength and rigidity in that direction.

There are several differences between bamboo and wood. In bamboo, there are no rays or knots, which give bamboo a far more evenly distributed stresses throughout its length. Bamboo is a hollow tube, sometimes with thin walls, and consequently it is more difficult to join bamboo than pieces of wood. Bamboo does not contain the same chemical extractives as wood, and can therefore be glued very well.

3.2.1 STRUCTURE AND PROPERTIES OF BAMBOO FIBRE

Bamboos are giant grasses and not trees as commonly believed. They belong to the family of the Bambusoideae. The bamboo column, in general, is a cylindrical shell, which is divided by transversal diaphragms at the nodes.

Fig3.5 Bamboo fibre

Bamboo shells are orthotropic materials with high strength in the direction parallel to the fibers and low strength perpendicular to the fibers respectively. Bamboo is a composite material, consisting of long and parallel cellulose fibers embedded in a ligneous matrix

Fig. 3.6 An Extracted Bamboo fibre

The bamboo fibre has been extracted by, the bamboo stem is cut into small sticks and then dipped into water by four or five days. Then those sticks are taken out and are hammered. The extracted bamboo fibre is shown in the figure 3.6.

3.3 NATURAL FIBRE PREPARATION

Here banana and bamboo fibre is used for fabricate the natural fibre composites. First the natural fibres are cleaned in the distilled water. The cleaned natural fibres are dried in the sun light. The dried natural fibres are again cleaned by chemical cleaning process. In chemical cleaning process the 80% sodium hydroxide is mixed with 20% distilled water.

Fig3.7 Drying Of Fibre

The dried natural fibres dipped in the diluted sodium hydroxide solution. Its again dried in sun light .The dried natural fibres are cut in the length of 100 mm

3.4 POLYURETHANE RESIN

Polyurethane is a synthetic material that is used in various applications in nearly every field imaginable. It is renowned for its durability and flexibility and can be produced in a number of different forms based on what it will be used for. Everything from airplane wings to tires can be made with polyurethane.

ROH + R'NCO → ROC (O) N (H) R' (R and R' are alkyl or aryl groups)

This combining process, sometimes called condensation, typically requires the presence of a catalyst. More complicated monomers are also used.

3.4.1 POLY URETHANE STRUCTURE

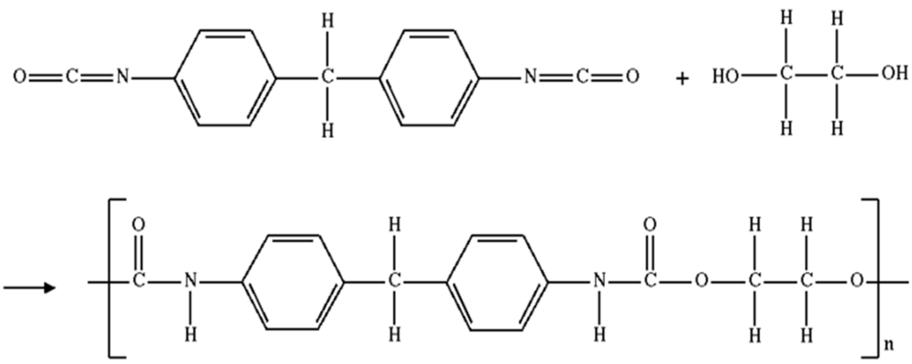

Fig. 4.8 Structure of Polyurethane

3.4.2 IDENTIFICATION

Polyurethane is identified as a polymer, which is basically a string of smaller molecules known as monomers. In this case, it is a string of urethane. An entire polyurethane chain consists of nitrogen, carbon and oxygen atoms double-bonded to a hydroxyl group, which is also known as an alcohol and is a bonded molecule of oxygen and hydrogen. When various other elements are added to this basic chain, the polyurethane changes, sometimes becoming a rubbery solid, liquid or even a foam.

3.4.3 FEATURES

Polyurethane can be manufactured synthetically to have a number of different features, depending on the specific molecules that are added to its basic string of urethane molecules. Some of the more sought-after features of polyurethane are its elasticity and durability. This makes it popular for use with tires and other rubber devices that need to be strong and bendable. Polyurethane can also be made into a squishy, foam-like substance or a substance similar to glue, with the same bonding ability.

3.4.4 FUNCTION

Polyurethane is used in so many different fields and in so many different forms that it is one of the most used synthetic materials. Look around your house, and you will be able to find many things that are made of polyurethane. Much of the firmer rubber used for various reasons is polyurethane, and because as an adhesive it is water and heat resistant, it's used in outdoor and exceptionally hot areas. It is also used in walls as extra padding, and in foam form for soundproofing.

3.4.5 BENEFITS

One of the major benefits of polyurethane is its resistance to heat and flames. Using the substance means that it will offer protection from this, which makes it particularly beneficial in the home and in making important substances and materials. It is often used as a coat for wood, plastic or other substances because of this protective property.

3.5 MOULDING METHODS

Moulding is the process of manufacturing by shaping liquid or pliable raw material using a rigid frame called a mould or matrix. This itself may have been made using a pattern or model of the final object.

For many moulding methods, it is convenient to refer to one mould piece as a "lower" mould and another mould piece as an "upper" mould. Lower and upper refer to the different faces of the moulded panel, not the mould's configuration in space. In this convention, there is always a lower mould, and sometimes an upper mould. Part construction begins by applying materials to the lower mould. Lower mould and upper mould are more generalized descriptors than more common and specific terms such as male side, female side, a-side, b-side, tool side, bowl, hat, mandrel, etc.

The moulded product is often referred to as a panel. For certain geometries and material combinations, it can be referred to as a casting. For certain continuous processes, it can be referred to as a profile. Applied with a pressure roller, a spray device or manually.

3.5.1 TYPES OF MOULDING

- Blow moulding
- Compaction plus sintering
- Compression moulding
- Expandable bead moulding
- Extrusion moulding
- Foam moulding
- Injection moulding
- Laminating
- Matched mold
- Matrix moulding
- Plastic moulding
- Pressure plug assist moulding
- Rotational moulding (or Rotomoulding)
- Transfer moulding

Here we are using hand-layup method,

3.5.2 HAND LAY-UP PROCESS

Hand lay-up is a simple method for composite production. A mould must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The mould can be as simple as a flat sheet or have infinite curves and edges. For some shapes, moulds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the mould is prepared with a release agent to insure that the part will not adhere to the mold. Reinforcement fibres can be cut and laid in the mould. It is up to the designer to organize the type, amount and direction of the fibres being used.

Fig 3.9 Working process of fibres a) applying of resin in the tray b) mixing of fibres with the resin c) adding layer of resin

Resin must then be catalyzed and added to the fibres. A brush, roller or squeegee can be used to impregnate the fibres with the resin.

3.6 FABRICATION

The manufacturing of natural fibre reinforced composite of banana and bamboo fibre with polyurethane includes the basic steps of fibre collection, alkalizations of fibres and the final processing of composite plate preparation.

3.6.1 MATERIALS

The raw material used in this study was banana and bamboo fibre. These fibres have diameters of approximately 100-300 µm and lengths of 20-30cm.

Fig. 3.10 Bamboo and Banana Fibres

Reagent grade chemicals were used for fibre surface modifications namely, sodium hydroxide, hydrochloric acid.

3.6.2 ALKALIZATION OF NATURAL FIBRES

Alkalization is a common pre-processing technique used on base natural fibre to remove hemicelluloses, fats and waxes that may reduce the interfacial strength when processed into composite form. It is of great interest to understand the effect this has on the base fibre mechanical properties, as whilst it may ultimately increase the resultant composite strength through increasing fibre matrix adhesion, the strength of the fibre itself may reduce. Due to this, to allow fuller understanding of the process effects on mechanical properties it is thought tensile testing of alkalized fibre under the same conditions considered previously is extremely beneficial.

Fig3.11 Bamboofibre

Fig3.12 Banana fibre

Alkalization aims to remove hemicelluloses from natural fibre, which often results in a change in fibre surface energy in a polar or dispersive manner. Hemicelluloses, which is thought to consist principally of xylan, polyuronide and hexosan has been shown to be very sensitive to caustic soda. The caustic soda (sodium hydroxide) is said to exert only minimal influence on the lignin in the fibres and the high strength alpha-cellulose. There are various alkali solutions that can be used including hydrogen peroxide (H_2O_2) and sodium hydroxide (NaOH). Hydrogen peroxide is used much less frequently due to the dangers associated with its use.

3.6.3 INDIVIDUALIZATION PROCESS

The indidualization process of nanofibres is a multi-step process, shown in Figure 4.13 Chemical treatments are applied onto the fibres to individualize nano fibres. The chemical treatments include pre-treatment, acid hydrolysis and alkaline treatment.

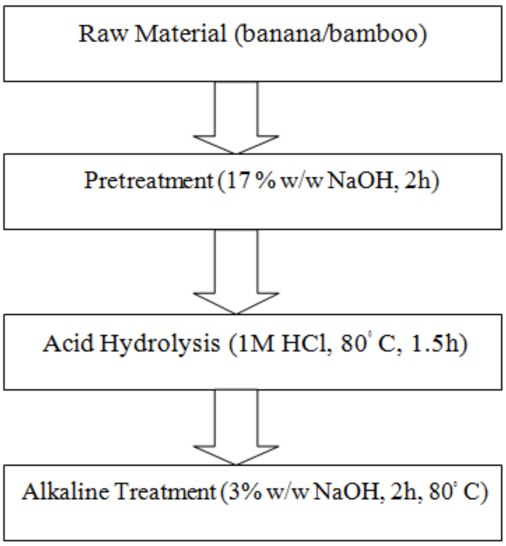

Fig 3.13 Process of chemical treatment

3.6.4 CHEMICAL TREATMENTS

The main objective of the chemical treatments is to remove the starch, hemi-cellulose and lignin/pectins surrounding cellulose. Generally, the first step for all of the fibre surface treatments is mercerization (pre-treatment process), which changes the crystal structure of cellulose (Gassan and Bledki 1997). The essence of mercerizing fibre is that in the swelling of Cellulose fibres due to exposure to alkalis.

The natural crystalline structure of the cellulose relaxes under an appropriate tension and the dimensions can be set by the conditions (Shimbun 1985).

Fig3.14 NaOH

Fig3.14 Reaction of fibre with NaOH

Cellulose fibres were soaked in a sodium hydroxide solution of 17.5 % w/w at room temperature for 2 h, enabling chemical molecules to penetrate through the crystalline region of the cellulose.

Fig3.15 Colouring Agent

For giving attraction for the product the colouring agent is used, it gives the good colour to the product.

Acid hydrolysis with 1 M hydrochloric acid followed by alkaline treatment with 2 % w/w sodium hydroxide was applied to remove the undesired components.

Fibre Composition

Banana and bamboo fibre thickness ratio : 1:1

Weight of banana fibre : 13g

Weight of bamboo fibre : 13g

Weight of poly urethane : 85g

Table 3.2 shows the size of banana and bamboo fibre composite

Table 3.2

LENGTH	**200mm**
WIDTH	**60.70mm**
THINKNESS	**4.16mm**

The main objective is to determine the material properties (Flexural modulus, flexural rigidity, Hardness number, % gain of water, density, Impact Strength) of natural FIBRE reinforced composite material by conducting the following respective tests.

1. Tensile test
2. Compressive test

Fig 3.15, 3.16 shows the final composites of banana and bamboo fibre with the thickness ratio of 1:1

Fig 3.15 Final composite for tensile testing

Fig 3.16 Final composite for compressive testing

The fabricated natural fibre composite is shown in the figure, For tensile testing the size of the composite is 200x60x3 and for the compressive test the size of the composite is 40x40x3

4 EXPERIMENTAL TEST

4.1 INTRODUCTION

The experiment was conducted at constant strain rate values in static condition for tensile and compressive under constant room temperature. The testing laboratory is held at Chennai. In that laboratory they followed the ASTM Standard.

4.1.1 ASTM STANDARD

For the tensile testing of natural fibre, the closest applicable standard used was ASTM D 3822-01 the 'Standard for Tensile Properties of Single Fibres'. This ASTM standard is typically used to quantify the mechanical properties of textile fibres and threads, which are often from a natural source, such as flax or cotton. This provides a good guideline as it is on the correct testing scale with the fibres being fine in cross-section.

The testing was done in the kidao laboratories, Chennai.

4.1.2 TESTING EQUIPMENT

As well as using the ASTM standard for the testing procedures for the fibres themselves, the ASTM standard for the specification of testing equipment also has to be met. This was found to be ASTM D 76-99 the 'Standard Specification for Testing Machines for fibres'. The Lloyd LRX testing machine shown in Figure5.1 meets these requirements.

Fig4.1 Experimental tensile and compressive test

4.1.3 EXPERIMENTAL EVOLUTION

In this chapter, the banana/bamboo with poly urethane resin is fully characterized experimentally and the results are presented. The results of static experiments for measuring the strength under tension and compression. The experimental determination of the mechanical properties of banana/ bamboo fibre under static loading conditions has always been a key issue in the research on composite materials. With the rise of huge variety of composites, the need for an efficient and reliable way of measuring these properties has become more important. The experiments, if conducted properly, generally reveal both strengths and stiffness characteristics of the material.

4.1.4 TEST PROCEDURES

Tests are performed using Tensile and compressive Testing Machine. A personal computer is connected to the testing machine for data acquisition. Displacement and load are monitored for static experiments. The strain is measured by using strain gages.

4.1.5 DETERMINATION OF THE TENSILE AND COMPRESSIVE PROPERTIES OF BANANA/BAMBOO FIBRE HYBRID COMPOSITE

The tensile specimen is placed in the testing machine, taking care to align the longitudinal axis of the specimen and pulled at a cross-head speed of 0.5 mm/min. The specimens are loaded step by step up to failure under uni-axial tensile loading. A continuous record of load and deflection is obtained by a digital data acquisition system. Axial and transverse strains are obtained by means of a pair of two-stain gauge rosettes bonded in the gage section of the specimen.

The compressive specimen is placed in the testing machine, taking care to align the longitudinal axis of the specimen and pushed at a cross-head speed of 0.5 mm/min. The specimens are loaded step by step up to failure under uni-axial loading. A continuous record of load and deflection is obtained by a digital data acquisition system. Axial and transverse strains are obtained by means of a pair of two-stain gauge rosettes bonded in the gauge section of the specimen.

5 RESULTS AND DISCUSSIONS

In the following subsections, the experimental results of loaded composite materials are presented. The general behaviour of the all composite mentioned above was obtained from the load/displacement record from the testing machine.

Because the appropriate value of banana/bamboo fibre strength depends upon the failure load. The failure loads in deterministic sense were measured and were presented below.

Formula For Tensile And Compressive Strength

Tensile strength: Tensile load /Area

Compressive strength: Compressive load / Area

Breaking load of Tensile and Compressive

Table 6.1 shows the breaking load of tensile and compressive properties of banana and bamboo fibre composites.

Table 5.1

MATERIAL	BREAKING LOAD	
	TESILE LOAD N/mm²	**COMPRESSIVE LOAD KN**
BANANA/BAMBOO FIBRE	3840	250
ISOLATION OF BANANA/BAMBOO FIBRE	4320	380

Tensile and Compressive strength

Tensile strength =17.11N/mm²

Compressive strength =1504.8N

Area =60.70*4.16 mm²

=252.51mm²

5.1 COMPARISION OF MECHANICAL PROPERTIES OF BANANA/BAMBOO AND BANANA/COIR COMPOSITES

5.1.1 BEFORE ALKALI TREATMENT

Table 5.2

BANANA/ BAMBOO		BANANA /COIR	
TensileLoad (N)	Compressive Load(KN)	TensileLoad(N)	Compressive Load(KN)
3840	250	3600	220

The test result of banana/bamboo and banana/coir before alkali treatment has been analyzed, and the values are tabulated in table 5.2 the bamboo/banana combination provides the higher results.

5.1.2 AFTER ALKALI TREATMENT

Table 5.3

BANANA/ BAMBOO		BANANA /COIR	
Tensile Load (N)	Compressive Load(KN)	Tensile Load (N)	Compressive Load(KN)
4320	380	3720	380

The test result of banana/bamboo and banana/coir after alkali treatment has been analyzed, and the values are tabulated in table 6.3 the bamboo/banana combination provides the higher results.

6 CONCLUSION

6.1 CONCLUSION OF THE PROJECT

In this project, polyurethane banana/bamboo fibre hybrid composite was fabricated by hand lay-up method. And the composite material was machined according to the dimension and tested. The experimentally results are obtained for the polyurethane banana/bamboo fibre hybrid composite. The test result has been compared with the banana and coir composite material. The combination of banana and bamboo composite has the highest value of tensile and compressive properties.

6.2 FUTURE SCOPE OF THIS PROJECT

Thus a considerable amount of work has been done on natural fibres for use in composites. There is scope for further research to completely characterise the banana and bamboo fibres and facilitate proper applications in natural fibre reinforced composites. In terms of practical interest, the bamboo fibre composites can be regarded as valid alternatives to replace some conventional fibres such as coir fibre. In future the combination of banana and bamboo fibre composites with and without alkalization should be developed and characterized so as to arrive at a series of composites which may find use in several areas such as marine, structural, consumer articles and industrials applications.

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