Reinforcement of Sugarcane Baggase with Polyurethane Resin

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Abstract— Natural fiber composites are nowadays being used in various engineering applications to increase the strength and to optimize the weight and the cost of the product. The review of paper is to represent a general study of composite plate. The results are compared for different loading conditions and a suitable composite is selected for the research of sugarcane baggase fiber with polyurethane composite using plate. The study of mechanical properties of the composites was also investigated.

Key words: Sugarcane Baggase, Polyurethane Resin

I. INTRODUCTION

Increased environmental awareness and consciousness throughout the world has developed an increasing interest in natural fibres and its applications in various fields. Natural fibres are now considered as serious alternative to synthetic fibres for use in various fields. The use of natural fibres as reinforcing materials in both thermoplastic and thermoset matrix composites provides positive environmental benefits with respect to ultimate disposability and best utilization of raw materials. Currently, studies on use of lignocelluloses bio fibres in place of synthetic fibres as reinforcing materials are being pursued vigorously. These bio fibres are being extensively used for the production of cost effective eco-friendly bio composites.

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. In contrast to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The two constituents are reinforcement and a matrix. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part.

The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. The reinforcement is usually a fiber or a particulate. Particulate composites have dimensions that are approximately equal in all directions. They may be spherical, platelets, or any other regular or irregular geometry. Particulate composites tend to be much weaker and less stiff than continuous fiber composites, but they are usually much less expensive. Particulate reinforced composites usually contain less reinforcement (up to 40 to 50 volume percent) due to processing difficulties and brittleness. A fiber has a length that is much greater than its diameter. The length-to-diameter (l/d) ratio is known as the aspect ratio and can vary greatly.

Continuous fibers have long aspect ratios, while discontinuous fibers have short aspect ratios. Continuous-fiber composites normally have a preferred orientation, while discontinuous fibers generally have a random orientation. Examples of continuous reinforcements include unidirectional, woven cloth, and helical winding. while examples of discontinuous reinforcements are chopped fibers and random mat. Continuous-fiber composites are often made into laminates by stacking single Sheets of continuous fibers in different orientations to obtain the desired strength and stiffness properties with fiber volumes as high as 60 to 70 percent. Fibers produce high-strength composites because of their small diameter; they contain far fewer defects (normally surface defects) compared to the material produced in bulk.

II. MATERIALS AND METHODS

A. Classification of Fibers

Natural fibers include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin.
- Animal fiber
- Mineral fiber
- Plant fiber
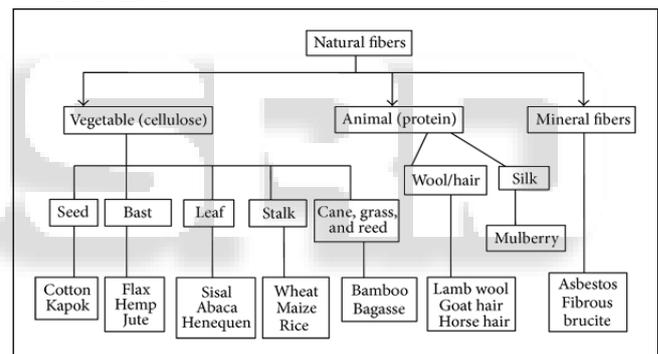
B. Animal hair (wool or hair)

Fiber taken from animals or hairy mammals. E.g. Sheep˝s wool, goat hair (cashmere, mohair), alpaca hair, horse hair, etc.

C. Silk fiber:

Fiber collected from dried saliva of bugs or insects during the preparation of cocoons. Examples include silk from silk worms.

D. Mineral Fiber

Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories:

E. Asbestos

The only naturally occurring mineral fiber. Varietions are serpentine and amphiboles, anthophyllite.

F. Ceramic fibers

Glass fibers (Glass wood and Quartz), aluminum oxide, silicon carbide, and boron carbide.

G. Metal fibers

Aluminum fibers

H. Plant Fiber

Plant fibers are generally comprised mainly of cellulose: examples include cotton, jute, flax, ramie, sisal and hemp. Cellulose fibers servers in the manufacture of paper and cloth. This fiber can be further categorizes into following.

I. Seed fiber:

Fibers collected from the seed and seed case e.g. cotton and kapok.

J. Leaf fiber

Fibers collected from the leaves e.g. sisal and agave.

K. Skin fiber

Fibers are collected from the skin or bast surrounding the stem of their respective plant. These fibers have higher tensile strength than other fibers. Therefore, these fibers are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, banana, hemp, and soybean.

L. Applications of Natural fiber composites

The natural fiber composites can be very cost effective material for following applications: Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc. Storage devices: post-boxes, grain storage silos, bio-gas containers, etc. Furniture: chair, table, shower, bath units, etc. Electric devices: electrical appliances, pipes, etc. Everyday applications: lampshades, suitcases, helmets, etc. Transportation: automobile and railway coach interior, boat, etc. Toys

III. SELECTION OF MATERIALS

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

- Sugarcane Bagasse (SCB) fiber
- polyurethane resin

SUGARCANE BAGASSE (SCB) FIBERBagasse is the fibrous residue which remains after sugarcane stalks are crushed to extract their juice. It is mainly used as a burning raw material in the sugar mill furnaces. The low caloric power of bagasse makes this a low efficiency process. Also, the sugarcane mill management encounters problems regarding regulations of clean air from the Environmental Protection Agency, due to the quality of the smoke released in the atmosphere. Presently 85% of bagasse production is burnt. Even so, there is an excess of bagasse. Usually this excess is deposited on empty fields altering the landscape. Approximately 9% of bagasse is used in alcohol (ethanol) production. Ethanol is not just a good replacement for the fossil fuels, but it is also an environmentally friendly fuel. Apart from this, ethanol is a very versatile chemical raw material from which a variety of chemicals can be produced

Fig. 1: Sugarcane Bagasse (SCB) Fiber

Properties of Sugarcane Bagasse (SCB) Fiber

STANDARD	VALUES
Density [g/cm^3]	1.25
Tensile strength	290 MPa
Young's modulus	17 Gpa

IV. POLYURETHANE RESIN

Polyurethane Resins have been commercially available since the early 1950's and are now used in a wide range of industries and applications. Epoxies are classified in the plastics industry as thermosetting resins and they achieve the thermo set state by means of an addition reaction with a suitable curing agent.

Fig. 2: Polyurethane resin

Properties of Polyurethane Resin

PROPERTIES	VALUE
Flexural modulus of elasticity	3,250 MPa
Flexural strength	36 MPa
Tensile strength	22 MPa
Compressive yield strength	57 MPa

The curing agent used will determine whether the polyurethane cures at ambient or elevated temperatures and also influence physical properties such as toughness and flexibility

V. METHODS

A. Die Making

The tooling involved in plastic molding is quite similar to that of stamping dies. The principal difference is that stamping requires force, while molding does not. In plastic molding, two units are required whose design is such that, when brought together, they make up a system of closed cavities linked to a central orifice. Liquid plastic is forced through the

orifice and into the cavities, or molds, and when the plastic solidifies, the molds open and the finished parts are ejected.

B. Making Process

Sugarcane baggase fiber knitted fabric with polyurethane are used in this study. Hardener used is polyamide hardener. The polyurethane resin and hardener are mixed in the ratio of 2:1 and stirred thoroughly. Release agent used was mansion polish. Experimental methods most mentioned method to clean fibers found in literature is distilled water cleaning and then alkaline treatment (NaOH). The concentration of NaOH used is 5%. The fibers are washed with fresh water thoroughly. The fibers are then soaked in NaOH solution for 8 hours. The fibres were then washed several times with fresh water to remove the residual NaOH sticking to the fibre surface and neutralized by Acetic acid finally washed again with water. The fibers were then dried at room temperature for 10 hours.

C. Mixing Process

Two part polyurethane compounds are normally supplied in separate A - B containers, either both full or in a pre-measured kit. Under the Resin lab designation; Part A is the polyurethane resin and the Part B is the polyamine hardener, with some systems the Part B may be an anhydride. Polyurethane resins are normally clear to slightly amber, high viscosity liquids which may be filled with mineral fillers to improve performance and lower cost. These sometimes can settle to the bottom of the container and must be stirred to a homogeneous consistency before adding the hardener. Polyurethane resins can cause mild skin irritation and a form of dermatitis upon repeated contact.

D. Hardeners

Part B, the hardener, is typically a polyamine or mixture of polyamines and has can have strong ammonia-like smell. Most are considered DOT Corrosive materials and should be respected as such. They are typically light colored to dark amber liquids. The hardener, like the resin, can be filled with metal or mineral fillers to improve performance or lower costs. And just like the resin, these fillers may settle over time and must be stirred to a homogeneous consistency before mixing with the resin. Some polyurethane hardeners are based on anhydrides rather than amines. These hardeners are more likely used in electrical potting and encapsulation applications and are likely to be heat cured in nature. Both polyamines and anhydrides are somewhat sensitive to moisture. Keep containers tightly sealed and when used in meter-mix-dispense equipment it is best to use a dry nitrogen purge or a dessicating air drier on the vent. Static Mixing Guidelines Resin lab Technical Data Sheets include this general guide for ranking the ability of a product to function acceptable in a range of applications. In general best case is a 1/1 ratio with even viscosity, worst case is a 10/1 ratio with a wide viscosity difference. The type of cartridge can also have a dramatic effect on dispense quality, especially when used in a pulsing mode. Larger and thin walled cartridges can induce a lead / lag effect where A and B show an extreme ratio change in a very short period do to the expansion and relaxation of the cartridge barrel. The thicker walled cartridges show much less tendency to produce this lead lag

effect which is a primary cause on intermittent tacky areas on small pottings or castings

This rating scale is a general guideline to give the user an expected level of success in a typical bench-top dispensing scenario. Important process variables to consider are: Cartridge type and size, wall thickness; manual or pneumatic gun type; static mixer design and dimensions; product viscosity spread and ratio; shot size, shot frequency, flow rate; temperature range during use. This scale also address's product stability in a cartridge. Factors such as filler content and settling rate, storage temperature and cartridge orientation are important factors which affect this. It is important for the user to define the optimum static mix for each dispensing process; a change in any of the above variables can affect the mix quality. Dispensing the product on a flat surface using the dispensing pattern can help show the quality of mixing in terms of thoroughness and lead/lag consistency.

E. Surface Preparation

If the surfaces that you intend to adhere together are not prepared properly, the best adhesive in the world will not hold them together. The major problems in adhesive delamination are dirt and oil. Whenever possible, the surfaces to be adhered should be abraded with sand paper or by sand or shot blasting before the adhesive is applied. Oil on the surface of steel or even oil from fingerprints can ruin a bond. If the surface to be bonded is painted, the bond of the paint to the substrate will be a limiting factor in the overall bond quality. Plastic surfaces should be abraded and when possible flame treated or corona treated to remove any plasticizer from the surface and provide an oxygen rich surface environment for the adhesive. Mixing: When hand mixing the polyurethane resins and the hardeners, it is best to pour the resin, the Part A, into the mixing vessel first. The product should be weighed to the nearest gram or to the nearest 0.5%, whichever is more precise. Next, the Part B is added using the same weighing procedure. Mix the two components using a stir stick or a paint mixer in a drill or drill press. Mix the product for at least 3 minutes by the clock. Scraping the sides and bottom of the mix vessel frequently. [Remember, it's just like baking a cake!] After the products have been thoroughly mixed, the mixture should be poured into the mold or used in the adhesive step. Often, the end product must be totally free of voids and bubbles. If this is the case, the mix must be vacuumed before being poured into the mold. This is done by putting the mix vessel into a vacuum chamber and pulling a vacuum of at least 28" Hg. This will usually degas the product within 5 minutes. The reaction mixture will bubble and froth. You should have a mix container at least 4 times the volume of the liquid in the container for vacuum degassing. Therefore, 1 quart of the liquid product will require a 1 gallon bucket to degas the mixture. If you intend to vacuum degas a product, make sure that you tell Star Technology about your wishes. We will need to formulate to product with a delayed gel time and extra air release additives to allow sufficient time to accomplish the process.

F. Reaction Rates

Now is probably a good time to talk about the reaction rate of the mixture and what effects it. Reaction rates are usually

stated at a certain temperature and at a certain mass of material. If you are working with a larger mass, the reaction time will be shorter. Lower masses and thin films will be much longer. If the reaction starting temperature is higher, the reaction rate will be faster. A rule of thumb is that for every 10 degrees C that you increase the temperature of the reactants, the reaction rate will double the gel time will be cut in half. That is why larger masses will react more quickly than small masses. As the reaction proceeds, it generates its own heat. The heat builds up inside the mixing vessel and the reaction goes faster, which makes more heat, which makes the reaction go even faster
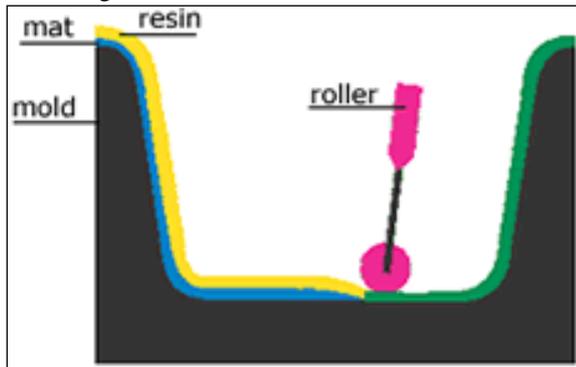

Fig. 3: Hand Layup Method

G. *PROCESSGel coat*

PROCESSGel coat is first applied to the mold using a spray gun for a high quality surface. When the gel coat has cured sufficiently, roll stock fiber glass reinforcement is manually placed on the mold. The laminating resin is applied by pouring, brushing, spraying, or using a paint roller. FRP rollers, paint rollers, or squeegees are used to consolidate the laminate, thoroughly wetting the reinforcement and removing entrapped air. Subsequent layers of fiber glass reinforcement are added to build laminate thickness. Low density core materials such as end-grain balsa, foam, and honeycomb, are commonly used to stiffen the laminate. This is known as sandwich construction.

MATERIALS PREPARATIONS The sugarcane baggase fiber with polyurethane which is taken as reinforcement in this study is collected from local sources. The polyurethane resin and the hardener are supplied. Wooden mould having been first manufactured for composite fabrication. The fiber material is mixed polyurethane resin by simple mechanical stirring and the mixture was poured into various moulds, keeping in view the requirement of various testing conditions and characterization standard. The composite sample of different composition is prepared. The composite of mixing ratio of sugarcane baggase fiber 45% with polyurethane resin 55%. The different type of fiber is used, while keeping the length of the glass fiber constant. The detailed composition and designation of composite materials. A releasing agent is used on the mould release sheets to facilitate easy removal of the composite from the mould after curing. The entrapped air bubbles are removed carefully with a sliding roller and the mould is closed for curing at a temperature Of 30 degree C for 24 hours at a constant load of 50kg .after curing the specimen of suitable dimension is cut using a diamond cutter for mechanical test as per the ASTM standards.

VI. MECHANICAL PROPERTY TESTS

A. *Tensile Test*

Tensile tests are performed for several reasons. The results of tensile tests are used in selecting materials for engineering applications. Tensile properties frequently are included in material specifications to ensure quality. Tensile properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, tensile properties often are used to predict the behavior of a material under forms of loading other than uniaxial tension.

The strength of a material often is the primary concern. The strength of interest may be measured in terms of either the stress necessary to cause appreciable plastic deformation or the maximum stress that the material can withstand. These measures of strength are used, with appropriate caution (in the form of safety factors), in engineering design. Also of interest is the material's ductility, which is a measure of how much it can be deformed before it fractures. Rarely is ductility incorporated directly in design rather, it is included in material specifications to ensure quality and toughness.

Low ductility in a tensile test often is accompanied by low resistance to fracture under other forms of loading. Elastic properties also may be of interest, but special techniques must be used to measure these properties during tensile testing, and more accurate measurements can be made by ultrasonic techniques. This chapter provides a brief overview of some of the more important topics associated with tensile testing. These include

– Tensile specimens and test machines
– Stress-strain curves, including discussions of elastic versus plastic deformation, yield points, and ductility
– True stress and strain
– Test methodology and data analysis

It should be noted that subsequent chapters contain more detailed information on these topics.

B. *Tensile*

Specimens and Testing Machines consider the typical tensile specimen. It has enlarged ends or shoulders for gripping. The important part of the specimen is the gage section. The cross-sectional area of the gage section is reduced relative to that of the remainder of the specimen so that deformation and failure will be localized in this region. The gage length is the region over which measurements are made and is centered within the reduced section. The distances between the ends of the gage section and the shoulders should be great enough so that the larger ends do not constrain deformation within the gage section, and the gage length should be great relative to its diameter. Otherwise, the stress state will be more complex than simple tension. Detailed descriptions of standard specimen shapes are given in Chapter 3 and in sub-sequent chapters on tensile testing of specific materials.

1) *Tensile Strength:*

The tensile test of the composites was performed as per the ASTM D3039 standards. The test was done using a universal testing machine (Tinius Olsen H10KS).The specimen of required dimension was cut from the composite cast. The test

was conducted at a constant strain rate of 2 mm/min. The tensile test arrangement is shown in figure

Fig. 4: UTM Machine

Tensile test is used to determine the tensile strength of the specimen, % elongation of length and % reduction of area. Tensile test is usually carried out in universal testing machine. A universal testing machine is used to test tensile strength of materials. It is named after the fact that it can perform many standard tensile and compression tests on materials, components, and structures. The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips. Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen.

C. Hardness Test

This gives the metals ability to show resistance to indentation which show it's resistance to wear and abrasion. Hardness testing of welds and their Heat Affected Zones (HAZs) usually requires testing on a microscopic scale using a diamond indenter. The Vickers Hardness test is the predominant test method with Knop testing being applied to HAZ testing in some instances. Hardness values referred to in this document will be reported in terms of Vickers Number, HV.

D. Toughness Test

The principal measurement from the impact test is the energy absorbed in fracturing the specimen. Energy expended during fracture is sometimes known as notch toughness. The energy expended will be high for complete ductile fracture, while it is less for brittle fracture. However, it is important to note that measurement of energy expended is only a relative energy, and cannot be used directly as design consideration. Another common result from the Charpy test is by examining the fracture surface. It is useful in determining whether the fracture is fibrous (shear fracture), granular (cleavage fracture), or a mixture of both.
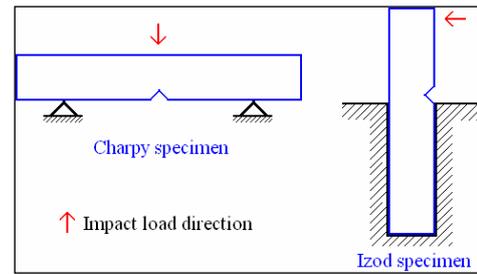

Fig. 4: Impact test

E. Fracture toughness test

The fracture toughness of the composite specimens was measured using Fracture Tester (MTS 810 material test system). The specimens were cut according to dimensions as specified by the ASTM E1820; this test method is for the opening mode (Mode I) of loading. The objective of this test method is to load a fatigue pre cracked test specimen as shown in Figure 8 to induce either or both of the following responses

- Unstable crack extension, including significant pop-in, referred to as "fracture instability" in this test method;
- Stable crack extension, referred to as "stable tearing" in this test method.

Toughness determined at the point of instability. Stable tearing results in continuous fracture toughness versus crack extension relationship (R-curve) from which significant point-values may be determined. Stable tearing interrupted by fracture instability results in an R-curve up to the point of instability. This investigation split into two major computation scopes to estimate the fracture toughness and energy release rate: it include the experiment data for fiber reinforcement polyurethane composites specimens. Meanwhile, the compact tension (CT) specimen was instructed according to the ASTM E 1820 standard for the fracture toughness measurement. The thickness was 10mm for all the specimens, while the initial notch length to specimen was between 10mm and the notch tip was sharpened with a razor blade to simulate a sharp crack.

VII. CONCLUSION

The fiber composite mechanical behavior was performed.
- Then the study in weight reduction of composite for sugarcane bagasse fiber composite materials has been done.
- On the basis of that study, the analysis of fiber composite materials are analyzed in the automobile application of which is used in corrosion resisting areas
- From the analysis we got the tensile, hardness and impact values for fiber composite materials weight and cost is less. So from these analysis mechanical behavior results.

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