ISSN No:-2456-2165

Design and Fabrication of Natural-Glass Fiber Reinforced Polymer Composite

Muthu kumaraswamy[1], V.K.Sandeep[2], B.Derick Nithin[2], R.Manual Livingston[2], J.G.Jigbert Jimsin[2]
[1]Assistant Professor, Department of Mechanical Engineering, Vel tech engineering college, Chennai, India
[2]Student, Department of Mechanical Engineering, Vel tech engineering college ,Chennai ,India

Abstract:- Nowadays, due to environment concern and financial problems of synthetic fibres, bio-fibres are interesting to be used for many structural and construction materials. Natural fibres as reinforcement in polymer composite for making low-cost materials are growing day by day. Researcher's main attention is to apply appropriate technology to utilize these natural fibres as effectively and economically as possible to produce good quality fibre-reinforced polymer composites for various engineering applications .The combination of Aloe Vera and Ramie fibre may have better tensile strength and Flexural strength .The aim of this study is to evaluate mechanical properties such as tensile and flexural properties of these natural fibres. The composite is manufactured by hand-lay process method and it has five layers. Mechanical characteristics are compared with existing materials and used for structural and non-structural application as a product. Glass fibres are used to laminate the composites on the top and bottom because it increases the surface finish and increases the strength.

I. INTRODUCTION

The use of composite materials started centuries ago, and it all done with natural fibre. In ancient Egypt some 3000 years ago, clay was reinforced by the straw to build walls. Composite materials became widely used due to their superior properties, such as low density and cost. Hybrid composite is classified as sandwich type, intra-ply type and inter-ply type. Sandwich-type hybrid composites normally consist of two or more different types of layers to form light weight structures. Typically, this type of structures is used to sustain bending . Over the past two decades, natural plant fibres have been receiving considerable attention as the substitute for synthetic fibre reinforcement such as glass in plastics. The advantages of plant fibres are low cost, low density, acceptable specific strength, good thermal insulation properties, reduced tool wear, reduced dermal and respiratory irritation, renewable resource and recycling . The natural fiber reinforced polymer composites (NFRPC), (simply natural fiber composites (NFC)), became recently highly valuable materials. In this type of materials, natural fibers (such as hemp, sisal, jute, kenaf, flax, etc.) are used as reinforcing material (fillers) for polymer-based matrices. Natural fibres appeal to vehicle manufacturers with their excellent strength to weight ratio, low cost, low carbon footprint and availability. In origin the plant fibers exhibit a high hydrophilic property as they are composed of lingo cellulose, which contains strongly polarized hydroxyl groups . The matrix materials are popularly used in biodegradable composites including thermoplastics such as a polypropylene and a polyethylene. PVC is a member of vinyl polymers. PVC is always used because of its low cost, easy fabrication, long lasting, and its good mechanical and chemical properties. various types of natural fibers, including flax (Linumusitatissimum L.), hemp (Cannabis sativa L.), jute (Corchoruscapsularis L., Corchorusolitorius L.), wood, rice husk, sugarcane (Saccharum spp.), bamboo (Bambusa spp.), kenaf (Hibiscus cannabinus L.), ramie (Boehmerianivea (L.) Gaud.), banana pseudo-stem fiber (Musa sapientum L.), pineapple leaf fiber (Ananascomosus (L.) Merr.) and papyrus (Cyperus papyrus L.) (Taj et al., 2007; Saxena et al., 2011) have been investigated for use in environmental-eco-friendly composites in order to substitute the conventional non-degradable plastics. Aloe vera is compound which has strong antioxidant and anti-inflammatory effects. Ramie, Boehmerianivea, is a perennial plant originating in China, and is also known as China grass . Ramie was recorded in ad 1300 as one of the plant fibers for cloth making in China prior to the introduction of cotton . Ramie is widely cultivated for fibre production in China and several other Asian countries, including the Philippines and India under sub-tropical conditions. Ramie produces one of the strongest and longest bast fibres, with a shiny, almost silky appearance, which could fully satisfy the growing demand for natural textiles and fibre reinforced composite products. Consequently, ramie could profit from this trend better than annual fibre crops, such as cotton and hemp. The few information available on ramie crop cultivation and crop stand duration is not recent and refers to the native Asian countries. Ramie fibers have been used for twines, clothing fabrics, canvas, cordages, fiber reinforced composites, and industrial packaging. Ramie has a higher tensile strength at $850e^{900}$ N/mm2 than that of flax and jute, and the tensile strength of ramie is approximate to that of glass fiber . Glass and glass-ceramic materials containing calcium and phosphorous are the most widely studied materials for bone scaffold fabrication owing to their similarity with natural bone both in terms of chemical composition and achievable mechanical properties.

II. MATERIALS

A. Mold

A mold is the base part used in layup process to get a desired shape. A Mold setup with a particular shape into which mixture of resin and hardener are poured, so that when the substance becomes hard it takes the shape of the mold. The mold is also called as Tool.

ISSN No:-2456-2165

B. Releasing agent

Releasing agent prevents the resin from sticking on the mold. Release agents are usually applied to the composite moulds or tooling in a separate designed area as they can act as a contaminate if accidentally integrated into the composite layup. The releasing agent used are liquid paraffin

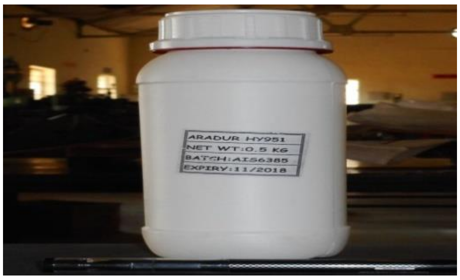
C. Resin

The resin acts as the matrix of the composite to 'bind' the composite materials together and transfer the component stresses that may act on the part to the fibres in the composite. The fibres are designed and selected to handle the designed stresses imposed. In this, a two-part epoxy and hardener resin system will be used .Various speed (set up time) hardeners can be used depending on the requirements of the job. Some resins commonly used in industry are

- Unsaturated polyesters
- Specialty and High-performance Thermosets (vinyl esters).
- Epoxies

D. Hardener

Hardener is used for mixing with epoxy resin in 1:10 ratio. Composites with 15% hardener content show an increase in flexural strength, tensile strength and hardness. The ultimate tensile strength (UTS), flexural strength and hardness for 15% hardener are 411.9 MPa, 51.7 MPa and 85.4 HRR respectively.



E. Fibres Used

- *Glass Fibre*

Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass".

- *Ramie Fiber*

Ramie (pronounced Ray-me) is one of the oldest vegetable fibres and has been used for thousands of years. It was used for Chinese burial shrouds over 2,000 years ago, long before cotton was introduced in the Far East.

III. PREPRATION

A. Work station preparation

An initial preparation of all the materials and tools that are going to be used is a fundamental standard procedure when working with composites. This is mainly because once the resin and the hardener are mixed, the working time (prior to the resin mix gelling) is limited by the speed of the hardener chemically reacting with the epoxy producing an exothermic reaction.So, preparation is done for all materials and supplies available and set up before proceeding.Also, as part of the initial preparation, the woven cloth must be cut according to theshape of the part. In this we need to have two pieces of fiber glass material cut according to the mould shape.

B. Hand Layup Method

The first step is to mix the resin and the hardener. The portions can be either measured by weight for by

ISSN No:-2456-2165

volume but it is important to follow these proportions exactly as this is a complete chemical reaction and all components must react completely for maximum strength of the matrix. It is easiest to measure proportions using the volume method.The mixing is performed in the mixing containers with the mixing stick and should be done slowly so as to not entrain any excess air bubbles in the resin. Be careful to mix completly and deliberately for a full two minutes before applying. It is best to use a “flat” stick- such as tongue depressor, a round stick does not work well as it does not ‘paddle’ the mixture to blend it properly.

C. Cleaning

Once that part is ready to be cured, it must be moved to an adequate location. In this case it can be moved to a curing oven or simply left to cure in place until the next day. Then a cleanup must be done before leaving the class. All the materials used(brushes, rollers, mixing tools, scissor), including the table, must be cleaned using acetone and cloth. Also, the rest of the fiber glass woven reinforcement must be collected from the table and floor. Soap and water can be used on skin if exposed.

- Have a designated clean up area so that part of the lab incorporated clean upof the tools and equipment. Have acetone cleanup stations and materials laid out ready for students to use so that tools do not get hardened resin on them.

Note: scissors, rollers etc., are particularly susceptible to damage if not cleaned immediately after use with resin. Usually, all paintbrushes and squeegees are thrown away, be sure to leave them in a non-flammable area until the resin is cured so they can then be properly disposed of.

- The lay up will harden after about an hour, but leave the lay up overnight and evaluate them sometime after that curing period.

IV. CUTTING AND TESTING

A. Cutting Process

Cutting process is done by Abrasive Water-jet Cutting Machine .Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM) are two non-traditional or non-conventional machining processes. They belong to mechanical group of non-conventional processes like Ultrasonic Machining (USM) and Abrasive Jet Machining (AJM). In these processes (WJM and AJWM), the mechanical energy of water and abrasive phases are used to achieve material removal or machining. However in all variants of the processes, the basic methodology remains the same. Water is pumped at a sufficiently high pressure, 200-400 MPa (2000- 4000 bar) using intensifier technology. An intensifier works on the simple principle of pressure amplification using hydraulic cylinders of different cross sections as used in “Jute Bell Presses”. When water at such pressure is issued through a suitable orifice (generally of 0.2- 0.4 mm dia), the potential energy of water is converted into kinetic energy, yielding a high velocity jet (1000 m/s). Such high velocity water jet can machine thin sheets/foils of aluminium, leather, textile, frozen food etc. In pure WJM, commercially pure water (tap water) is used for machining purpose. However as the high velocity water jet is discharged from the orifice, the jet tends to entrain atmospheric air and flares out decreasing its cutting ability. Hence, quite often stabilisers (long chain polymers) that hinder the fragmentation of water jet are added to the water. In AWJM, abrasive particles like sand (SiO_2), glass beads are added to the water jet to enhance its cutting ability by many folds. AWJ are mainly of two types – entrained and suspended type as mentioned earlier. In entrained type AWJM, the abrasive particles are allowed to entrain in water jet to form abrasive water jet with significant velocity of 800 m/s. Such high velocity abrasive jet can machine almost any material. The photographic view of a commercial CNC water jet machining system along with close-up view of the cutting head.

B. Testing

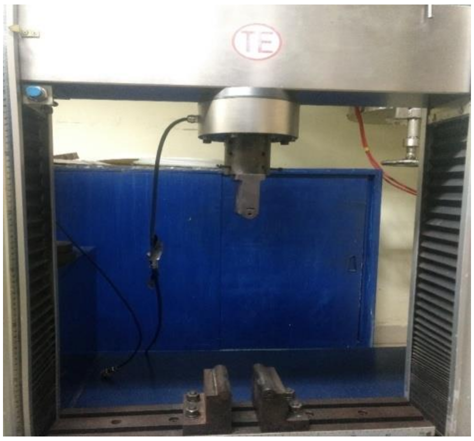
- Tensile Test
- Flexural Test

➢ *Tensile Test*

Tensile testing, is also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.Uniaxial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials.

➢ *Fractural Test*

Fracture toughness tests measure a material’s ability to resist the growth or propagation of a pre-existing flaw. The flaw or defect may be in the form of a fatigue crack, void, or any other inconsistency in the test material. Fracture toughness tests are performed by machining a test sample with a pre-existing crack and then cyclically applying a load to each side of the crack so that it experiences forces that cause it to grow. The cyclic load is applied until the sample's crack grows. The number of cycles to fracture is recorded and used to determine the material's fracture growth characteristics. The two most common types of flexure test are three point and four point flexure bending tests. A three point bend test consists of the sample placed horizontally upon two points and the force applied to the top of the sample through a single point so that the sample is bent in the shape of a "V". A four point bend test is roughly the same except that instead of the force applied through a single point on top it is applied through two points so that the sample experiences contact at four different points and is bent more in the shape of a "U".



V. GRAPHS

- *Ramie Fibre*

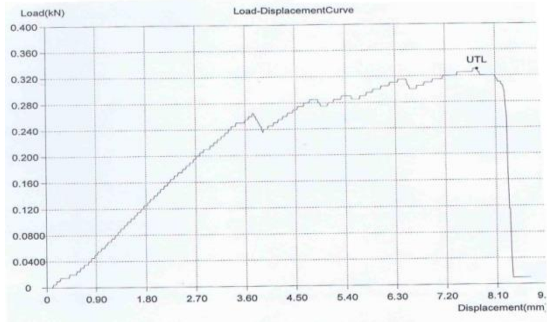
A. Tensile Test

The dimension of the first sample of the tensile test is 12.87*2.91mm and area is 37.45mm2 and this specimen withstands 98Mpa of Ultimate Tensile Stress and the Ultimate Tensile Load is 3.685KN.

The dimension of the second sample of the tensile test is 12.87*3.51mm and the area is 45.17mm2 and this specimen can withstand up to 85Mpa of Ultimate Tensile Stress and the Ultimate Tensile Load is 3.825 KN.

The dimension of the third sample of the tensile test is 12.94*2.70mm and the area is 34.94mm2 and this specimen can withstand up to 106Mpa of Ultimate Tensile Stress and the Ultimate Tensile Load is 3.705KN.

Thus we can conclude that 3.738KN of Ultimate Tensile Load and 96.33Mpa of Ultimate Tensile stress is Calculated in Average.



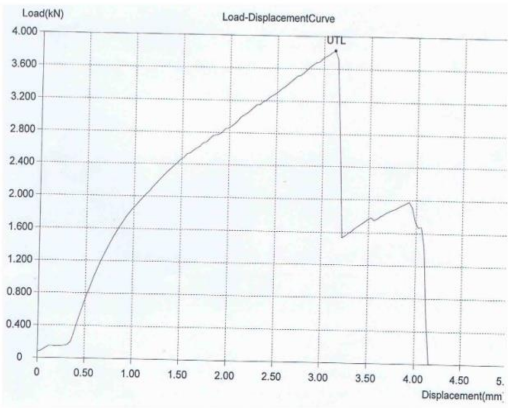
B. Flexural Test

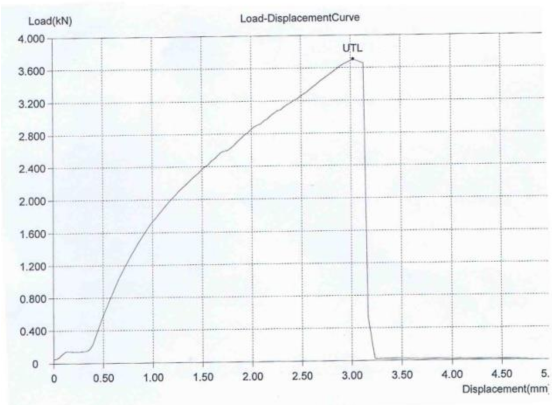
The dimension of the first sample of the Flexural test is 12.74*3.32mm and area is 42.30mm^{2}and this specimen withstands 8 Mpa of Ultimate Tensile Stress and the Ultimate Tensile Load is 0.355 KN.

The dimension of the second sample of the Flexural test is 12.69*3.15mm and the area is 39.97mm^2 and this specimen can withstand up to 9Mpa of Ultimate Tensile Stress and the Ultimate Tensile Load is 0.355 KN.

.The dimension of the third sample of the Flexural test is 12.69*3.43 and the area is 43.53.mm^2 and this specimen can withstand up to 8 Mpa of Ultimate Tensile Stress and the Ultimate Tensile Load is 0.330 KN.

Thus we can conclude that the material can with stand upto 226.723/mm^2 inaverage.





VI. RESULT

From the results of testing the ramie fibre material we found that the Tensile Load of 3.738KN and the Ultimate Tensile strength is 96.33 N/mm^2 ,with Flexural Strength of 226.723N/mm^2

From the above Results we can conclude that strength of the combinations we used have more strength than compared with the other combination of Natural Fibre ,RAMIE

Below Fig shows the Resultant values of the test made above.

MICROLAB
AN IS/ISO/IEC 17025 METALLURGICAL SERVICES
SP 101, 2nd Main Road, Ambattur Industrial Estate, Chennai – 600 058.
Phone: 044 2624 2525, Fax: 044 2624 4872.
Email: cre@microlabchennai.com, web: www.microlabchennai.com

Page 1 of 1

TEST REPORT

Customer: Mr. V.K. Sandeep (Vel Tech College) No. 39, 2nd Street, Pallavan Nagar Avadi, Chennai 600 071.	Report No / Date	ML/34850A/2/Dt: 22.03.2017
	Your ref./ Date	Letter / Dt: 20.03.2017
	Our ref./ Date	TOCR: 34850A/Dt: 20.03.2017
	Nature of test	Tensile Test, Flexural Test, Charpy Impact Test.
	Test reference	Customer Specification
	Date of Testing	21.03.2017 & 22.03.2017
	Sample Drawn By	Customer
	Sample Description	Ramie Fiber Composite Qty: 9Nos.

1. Tensile Test:

Test Parameters	Observed Values		
	ID-1	ID-2	ID-3
Gauge Thickness (mm)	2.91	3.51	2.70
Gauge Width (mm)	12.87	12.87	12.94
Original Cross Sectional Area (mm^2)	37.45	45.17	34.94
Ultimate Tensile Load (kN)	3.69	3.83	3.71
Ultimate Tensile Strength (N/mm^2 or Mpa)	98.00	85.00	106.00

2. Flexural Test:

Test Parameters	Observed Values		
	ID-1	ID-2	ID-3
Flexural Strength (N/mm^2 or Mpa)	227.52	253.74	198.93

3. Charpy Impact Test:

Test Temperature	Notch Type	Specimen Size (mm)	Absorbed Energy – Joules		
			ID-1	ID-2	ID-3
24°C	Un Notched	3 x 13 x 65	06	06	06

Verified by:

CONCLUDED

For MICROLAB

P. Selvakumar – Head Mechanical
Authorized Signatory

[illegible] Format No: ML/S.10/AD/TR/01

XXXVII

VII. CONCLUSION

The composite materials are suitable for the application where medium load is experienced it can be effectively interchanged to the conventional materials due to their advantages such as Less weight, Good load bearing capacity, thus it can act as a replacement for many materials. In future Composite materials will find the broad applications in many fields the characteristics like high load capacity to the weight ratio, easy production methods, cheap availability of raw materials will make it suitable for various applications.

REFERENCE

[1]. Hasim Pihtili An experimental investigation of wear of glass fibre–epoxy resin and glassfibre–polyester resin composite materials ,Department of Mechanical Engineering, Engineering Faculty, Firat University, 23119 Elazıg, Turkey.
[2]. Ben Amor*, M. Arous, A. Kallel, Effect of maleic anhydride on dielectric properties of natural fiber Composite
[3]. Mei-po Ho, Kin-tak Lau, Design of an impact resistant glass fibre/epoxy composites using short silk fibres
[4]. Cheng Zhoua,b, Yanfen Xuea,b, Yanhe Ma , Characterization and overproduction of a thermo-alkaline pectatelyase from alkaliphilic Bacillus licheniformis with potential in ramiedegumming

ISSN No:-2456-2165

[5]. Y. DU , N. YAN , and M. T. KORTSCHOT , The use of ramie fi bers as reinforcementsin composites University of Toronto , Canada

[6]. Géraldine Oliveux , Jean-Luc Bailleul , Eric Le Gal La Salle , Chemical recycling of glass fibre reinforced composites using subcritical wate

[7]. Nannan Li , Hongqiang Yan , Lei Xia , Lebo Mao , Zhengping Fang , Yihu Song ,Hao Wang , Flame retarding and reinforcing modification of ramie/polybenzoxazine composites by surface treatment of ramie fabric