International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Investigation of Mechanical Properties on Natural Fiber (Caryota Urens) Reinforced Polymer

Anbazhagan.V.N, Edwin Raj.R

Lecturer, Marine Engineering, Massawa College of Marine Science and Technology, Eritrea

Professor, Mechanical Engineering, St.Xavier's Catholic College of Engg., Tamilnadu, India.

Abstract: *The composite material are replacing the traditional material, because of its superior properties such as high tensile strength, low thermal expansion, high strength to weight ratio. The development of new materials are on the anvil and are growing day by day. Natural fiber composites became more attractive due to their high specific strength, lightweight and biodegradability. In this project, natural fiber reinforced polymer composites is developed in two ways that is treated and non-treated and their mechanical properties such as tensile strength, flexural strength, impact strength and hardness test are evaluated. At last we are going to compare the both strength of treated and untreated natural fiber reinforced polymer and evaluate which one is the best and strengthen natural fiber reinforced polymer.*

Keywords: Natural fiber, Caryota Urens, Polyster

1.INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals. The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased volume has resulted in an expected reduction in costs. High performance FRP can now be found in such diverse applications as composite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even papermaking rollers. For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight. Some examples are cascades for engines, curved fairing and fillets, replacements for welded metallic parts, cylinders, tubes, ducts, blade containment bands etc. Further, the need of composite for lighter construction materials and more seismic resistant structures has placed high emphasis on the use of new and advanced materials that not only decreases dead weight but also absorbs the shock & vibration through tailored microstructures. Composites are now extensively being used for rehabilitation/ strengthening of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity. Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects. The design of a structural component using composites involves both material and structural design.

Composite properties (e.g. stiffness, thermal expansion etc.) can be varied continuously over a broad range of values under the control of the designer. Careful selection of reinforcement type enables finished product characteristics to be tailored to almost any specific engineering requirement. Whilst the use of composites will be a clear choice in many instances, material selection in others will depend on factors such as working life time requirements, number of items to be produced (run length), complexity of product shape, possible savings in assembly costs and on the experience &skills the designer in tapping the optimum potential of composites. In some instances, best results may be achieved through the use of composites in conjunction with traditional materials.

1.1 Characteristics of the Composites

A composite material consists of two phases. It consists of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the reinforcement or reinforcing material", whereas the continuous phase is termed as the matrix". The matrix is usually more ductile and less hard. It holds the dispersed phase and shares a load with it. Matrix is composed of any of the three basic material type i.e. polymers, metals or ceramics. The matrix forms the bulk form or the part or product. The secondary phase embedded in the matrix is a discontinuous phase. It is usually harder and stronger than the continuous phase. It servers to strengthen the composites and improves the overall mechanical properties of the matrix. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent. The concentration distribution and orientation of the reinforcement also affect the properties. The shape of the discontinuous phase (which may by spherical, cylindrical, or rectangular cross-sanctioned prisms or platelets), the size and size distribution(which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix. Concentration, usually measured as volume or weight fraction, determines the contribution of a single constituent to the overall properties of the composites. It is not only the single most important parameter influencing the properties of the composites, but also an easily controllable manufacturing variable used to alter its properties.

1.2 Natural Fiber Reinforced Composites

The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lignocellulosic fibers, are more and more often applied as there inforcement of composites. Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. The natural fiber-containing composites are more environmentally friendly, and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling paneling, partition boards), packaging, consumer products, etc.

1.3 Classification of Natural Fibers

Fibers are a class of hair-like material that are continuous filaments or are indiscrete elongated pieces, similar to pieces of thread. They can be spun into filaments, thread, or rope. They can be used as a component of composites materials. They can also be matted into sheets to make products such as paper or felt. Fibers are of two types: natural fiber and manmade or synthetic fiber. Figure 1 shows the classification of natural fibers.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

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

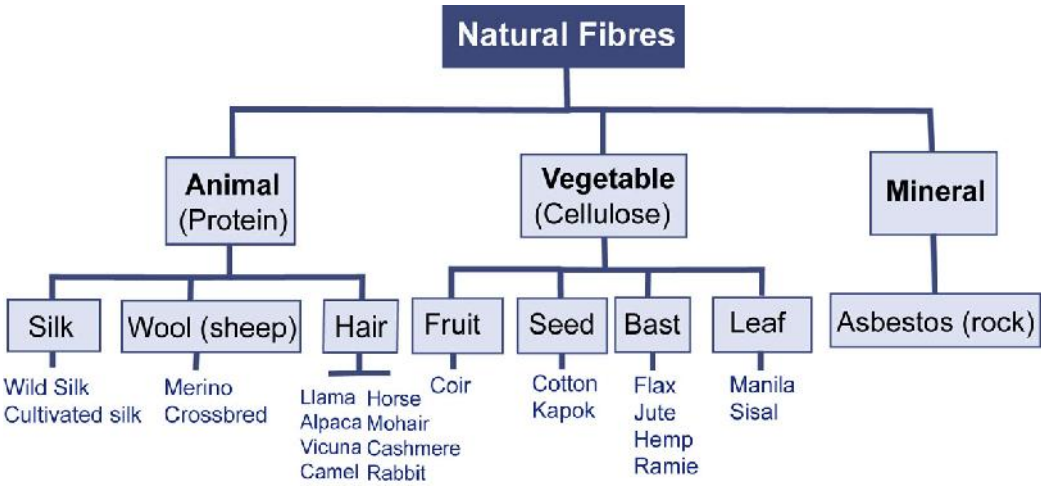

Fig. 1 Classification of natural fibers which can be used as reinforcement of Polymer.

1.4 Merits of Composites

Advantages of composites over their conventional counterparts are the ability to meet diverse design requirements with significant weight savings as well as strength-to-weight ratio. Some advantages of composite materials over conventional ones are as follows:

- Tensile strength of composites is four to six times greater than that of steel or aluminium (depending on the reinforcements).
- Improved torsional stiffness and impact properties.
- Higher fatigue endurance limit (up to 60% of ultimate tensile strength).
- 30% - 40% lighter for example any particular aluminium structures designed to the same functional requirements.
- Lower embedded energy compared to other structural metallic materials like steel, aluminium etc.
- Composites are less noisy while in operation and provide lower vibration transmission than metals.
- Composites are more versatile than metals and can be tailored to meet performance needs and complex design requirements.
- Long life offer excellent fatigue, impact, environmental resistance and reduce maintenance.
- Composites enjoy reduced life cycle cost compared to metals.
- Composites exhibit excellent corrosion resistance and fire retardancy.
- Improved appearance with smooth surfaces and readily incorporable integral decorative melamine are other characteristics of composites.
- Composite parts can eliminate joints / fasteners, providing parts implification and integrated design compared to conventional metallic parts.

Broadly, composite materials can be classified into three groups on the basis of matrix material. They are:

a) Metal Matrix Composites (MMC)

b) Ceramic Matrix Composites (CMC)

c) Polymer Matrix Composites (PMC)

1.5 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.

The reasons for the application of natural fibers in the automotive industry

Include:

- Low density: which may lead to a weight reduction of 10 to 30%?
- Acceptable mechanical properties, good acoustic properties.
- Favorable processing properties, for instance low wear on tools, etc.
- Options for new production technologies and materials.
- Favorable accident performance, high stability, less splintering.
- Favorable eco balance for part production.
- Favorable eco balance during vehicle operation due to weight savings.
- Occupational health benefits compared to glass fibers during production.
- No off-gassing of toxic compounds (in contrast to phenol resin bonded wood and recycled Cotton fiber parts).
- Reduced fogging behavior.
- Price advantages both for the fibers and the applied technologies.

2. LITERATURE SURVEY

2.1. General

Now a days, Natural fibers are widely used as a composite material as a replacement for conventional & traditional fiber reinforced composite material such as carbon fibers, glass fibers, etc have excellent mechanical properties. But there are disadvantages in using these fibers such as non-eco friendly, toxic, etc. While comparing with natural fiber, the advantages of natural fiber are environmental friendly, fully biodegradable, cheap, light in weight, non toxic, no abrasion to machine & have low density. As like traditional fiber & conventional fiber the natural fiber also have good specific strength, high toughness, good thermal insulation & less respiratory irriation. The pollution is the major problem in our environment. While the end of the life cycle the fibers should be destructed. While destructing the conventional & traditional fiber will release large amount of CO_2 which will affect the environment than natural fibers. Due to this good environmental friendly feature of natural fiber material, it is very popular in engineering sides for making Automotive interiors.

Amar Singh Singha& Vijay Kumar Thakur (2012) found that the natural fiber (grewiaoptiva) treated with silane has improving their properties such as swelling behavior, moisture absorbance, chemical resistance etc.

M.Thiruchitrambalam et.al (2010) compared the mechanical properties at banana / kenaf hybrid composite (natural fiber) subjected to alkali and sodium lauryl sulfate treatment and concluded that the SLS treatment has improved the mechanical properties than alkali treatment.

Maya Jacob et.al (2004) compared the sisal/oil palam hybrid fiber reinforced natural rubber composites in the function of loading, ratio & treatment. And concluded that the mechanical properties of the composites treated with alkali in longitudinal direction are superior to those in the transverse direction.

X.Y.Liu & G.C.Dai (2007) implemented a new treating method using sodium hydroxide (NaOH) & Maleic anhydride grafted polypropylene to treat jute fiber to enhance the performance by film stacking method. And found it is very effective in improving the fiber matrix adhesion in jute fiber.

D.Chandramohan & Dr.K.Marimuthu (2010) fabricated the natural fibers such as sisal, banana, roselle, sisal & banana, roselle& banana, &roselle& sisal by using bio epoxy resin by moulding method and tested it's hardness by brinell hardness testing machine & scanned the micro structure of the specimen by scanning electron microscope. They determined that the material properties of sisal &roselle (hybrid) is good compared to others.

J.T.WinowlinJappes et.al. (2012) prepared a new type reinforcement, naturally woven coconut sheath composite laminates in compression moulding press. And tested it's tensile, flexural & impact strengths. Then results are compared with glass fiber results. Then concluded that this composite exhibits better performance in flexural & impact tests.It's tensile performance is reduced due to the presence of waxy layer.

M.Thiruchitrambalam et.al. (2010) fabricated the roselle fiber polyester composite and treated with alkali have good potential as reinforcements in polymer composites & can be used as source of raw materials in various industries.

V.Manikandan et.al. (2010) developed an unsaturated polyester composites by basalt fiber using hand layup technique at room temperature both with & without acid & alkali treatments (NaOH& H_2SO_4). Then its mechanical properties & fracture are tested by using computer-assisted universal testing machine, Izod Impact testing machine & SEM. They concluded that the basalt fibre reinforced composites treated with the acid is superior to the glass fiber in mechanical properties.

Irullappasamysive et.al. (2012) investigated the mechanical &tribological behavior of naturally woven coconut sheat reinforced polymer composite compared with glass fiber composite using pin-on-disc sliding wear tester. The both composite are treated with silane coupling agent. They concluded that the coconut sheath has mechanical &tribological properties than glass fiber.

Paul Wambua et.al.(2003) fabricated the natural fibers such as kenaf, hemp, juste, coir & sisal by compression moulding using film stacking method. Then the mechanical properties is compared with the glass mat reinforced polypropylene composites. They suggested that the natural fiber composite have a potential to replace glass in many applications that do not require very high load bearing capabilities.

A.S.Singha & vijaykumarthakur (2009) fabricated the hibiscus sabdariffa fiber and tested its mechanical properties. The Urea-fermaldehyde resin is used for fabrication. They suggest that the hibiscus sabdariffa fiber is more effective as compared to short fiber reinforcement and has immense scope in the industrial applications.

3. MATERIALS AND PROCESS

3.1 Introduction

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

1. caryota urens Fiber
2. polyester resin

3.1.1 CARYOTA URENS

Caryotaurens is a species of flowering plant in the palm family from Sri Lanka, Singapore, Myanmar, and India where they grow in fields and rain-forest clearings.

Caryotaurens is species is solitary-trunked to 12 metres (39 ft) in height and trunk 30 centimetres (0.98 ft) wide. Widely-spaced leaf-scar rings cover the gray trunks which culminate in a 6 metres (20 ft) wide, 6 metres (20 ft) tall leaf crown. The bipinnate leaves are triangular in shape, bright to deep green, 3.5 metres (11 ft) long, and held on 60 cm long petioles. The obdeltoid pinnae are 30 cm long with a pointed edge and a jagged edge.

The 3 metres (9.8 ft) long inflorescences emerge at each leaf node, from top to bottom, producing pendent clusters of white, unisexual flowers. The fruit matures to a round, 1 cm drupe, red in color with one seed. Like all *Caryotas*, the fruit contains oxalic acid, a skin and membrane irritant. As these plants are monocarpic, the completion of the flower and fruiting process results in the death of the tree.

Fig.2 CARYOTA URENS

3.1.2 POLYESTER RESIN

Fig.3 POLYESTER RESIN

Polyester resins are the most commonly used matrix in the marine and composite industry. These resins are styrene-based, flammable and catalyzed when combined with Methyl Ethyl Ketone Peroxide(MEKP). When working with these resins in large projects it is advised to use gloves and a chemical respirator to protect yourself from the fumes. These resins can be used with any type of fiber glass, carbon fiber or kevlar, as well as used over urethane foam and other sandwich core materials. These resins tend to be fairly rigid when cured and also more brittle than epoxy resins.

3.1.2.1 CHARACTERISTICS OF POLYESTER RESIN

The material has the potential to be 100 percent solid. This depends on how fast the reaction takes place. The styrene is volatile prior to the reaction. Heat is not typically added to the system except when cure time is expected to be long, such as on cool spring or fall days. The catalyst is added to drive the reaction. Usually, the catalyst is methyl ethyl ketone (MEK) or benzoyl peroxide. The polyester resin and the styrene solvent react together to crosslink, or polymerize, to form a film. The polyester resin system will not cure properly if the appropriate quantity of catalyst is not added.

3.1.2.2 CURING OF RESINS

Thermoset resin like polyester is cured by adding a catalyst, which causes a chemical reaction without changing its own composition. The catalyst initiates the chemical reaction of the unsaturated polyester and monomer ingredient from liquid to a solid state. When used as a curing agent, catalysts are referred to as catalytic hardeners. Proper care is required to be taken while handling the catalysts as they can cause skin burning and permanent eye damage.

Epoxy resin is cured by adding hardener. Unlike the catalytic hardeners used for curing polyester resin, epoxy resin hardener contains monomers, which contribute to the curing reaction. Proper care is required to be taken while handling the epoxy resin liquids and hardeners as they give off potentially harmful vapour causing skin rashes.

After curing, low shrinkage is desirable in order to minimise in-built stressing and distortion of the fibres and matrix. Desirable qualities for a matrix are that it should be tough, durable and thermally stable over a wide range of temperatures and t hat it should resist cracking, chemical attack, ultra violet light and moisture.

3.1.2.3 Ingredients and Additives used in Manufacturing of Resins

Manufacturers of all types of resins use various ingredients and additives, in different proportions, to give their resins differing properties and characteristics suited to particular applications. Some general classes of additives used are as follows:

3.1.2.3.1 Catalysts, Promoters, Inhibitors

In polyesters, the most important additive is catalyst or initiator. Typically, organic peroxide such 3SMEKP (Methyl Ethyl Ketone Peroxide) is used for room temperature cured processes, or benzoyl peroxide is added to the resin for heat cured molding. When triggered by heat, or used in conjunction with a promoter (such as cobalt napthenate), peroxides convert to a reactive state (exhibiting free radicals), causing the unsaturated resin to react (cross-link) and become solid. Some additives such as TBC (Tertiary Butyl Catechol) are used to slow the rate of reaction and are called inhibitors. They are used in polyester resins to extend their shelf life. Accelerators such as DMA (Dimethyl Aniline) speed up curing process.

3.1.2.3.2 Additives and Modifiers

A wide variety of additives are used in composites to modify materials properties and tailor the laminates performance. Although these materials are generally used in relatively low quantity by weight compared to resins, reinforcements and fillers, they perform critical functions. Additive used in thermoset and thermoplastic composites exhibits the following properties:

• ***Low shrink/low profile*** - When parts with smooth surfaces are required, a special thermoplastic resin, which moderates resin shrinkage, can be added to thermoset resins.

• ***Fire resistance*** –Combustion resistance is improved by proper choice of resin, use of fillers or flame retardant additives. Included in this category are materials containing antimony trioxide, bromine, chlorine, borate and phosphorus.

• ***Air release-*** Most laminating resins, gel coats and other polyester resins might entrap air during processing and application. This can cause air voids and improper fibre wet-out. Air release additives are used to reduce such air entrapment and to enhance fibre wet-out.

• ***Emission control*** - In open mold applications, styrene emission suppressants are used to lower emissions for air quality compliance.

• ***Viscosity control-***In many composite types, it is critical to have a low, workable viscosity during production. Lower viscosity in such filled systems is usually achieved by use of wetting and dispersing additives. These additives facilitate the wet-out and dispersion of fillers resulting in lower viscosity.

• ***Electrical conductivity-*** Most composites do not conduct electricity. It is possible to obtain a degree of electrical conductivity by the addition of metal, carbon particles or conductive fibres. Electromagnetic interference shielding can be achieved by incorporating conductive materials.

• ***Toughness-*** Toughness can be enhanced by the addition of reinforcements. It can also be improved by special additives such as certain rubber or other **elastomeric** materials.

• ***Antioxidants*** - Plastics are sometimes modified with antioxidants, which retard or inhibit polymer oxidation and the resulting degradation of the polymer.

• ***Antistatic agents*** – Antistatic agents are added to polymers to reduce their tendency to attract electrical charge. Control of static electricity is essential in processing and handling operation of certain plastics, as well as in finished products. Static charges on plastics can produce shocks, present fire hazard and attract dust. The effect of static charge in computer/data processing applications, for example, is particularly detrimental.

• ***Foaming agents-*** Foaming agents are added to polymers during processing to form minute cells throughout the resin. Foamed plastics exhibit lower density, decrease material costs, improves electrical and thermal insulation, increase strength to weight ratio and reduce shrinkage and part warping.

• ***Plasticisers-*** Plasticisers are added to compounds to improve processing characteristics and offer a wide range of physical and mechanical properties. Slip and blocking agents **-** They provide surface lubrication. This results in reduced coefficient of friction on part surfaces and enhances release of parts from the mold.

• ***Heat stabilisers-*** They are used in thermoplastic resins to inhibit polymer degradation that results from exposure to heat.

• ***Ultraviolet Stabilisers-*** Both thermoset and thermoplastic composites use special materials which are added to prevent loss of gloss, crazing, chalking, discoloration, changes in electrical characteristics, embrittlement and disintegration due to ultraviolet (UV) radiation. Additives, which protect composites by absorbing the UV, are called ultraviolet absorbers. Materials, which protect the polymer in some other manner, are known as ultraviolet stabilizers.

• ***Colorants*** -Colorants are often used in composites to provide colour throughout the part. Additives can be mixed in as part of the resin or applied as part of the molding process (as a gel coat). Also, a wide range of coatings can be applied after molding.

• ***Release Agents***

Release agents facilitate removal of parts from molds. These products can be added to the resin, applied to molds, or both. Correct selection of release agents can optimise not only cycle time, but also consistency of surface finish, minimising post mold operation prior to painting or bonding. Zinc stearate is a popular mold release agent that is mixed into resin for compression molding. Waxes, silicones and other release agents may be applied directly to the surface of molds.

Release agents must be used at the lowest possible concentration. Use of excessive amounts can reduce mechanical strength and affect adhesion characteristics.

3.1.3 ADVANTAGES

- Essentially two components in one container
- Long lasting and durable
- Does not discolor badly
- Relatively inexpensive
- Works well on concrete

3.2. PROCESS

3.2.1 EXTRACTION OF FIBER

The extraction of fiber from carvota urens is as shown in the figure 4.

Fig.4 Beating process was carried out for extracting the fiber from caryota urens.

3.2.2 FABRICATION OF DIE

The fabrication of die is as shown in the figure 5.

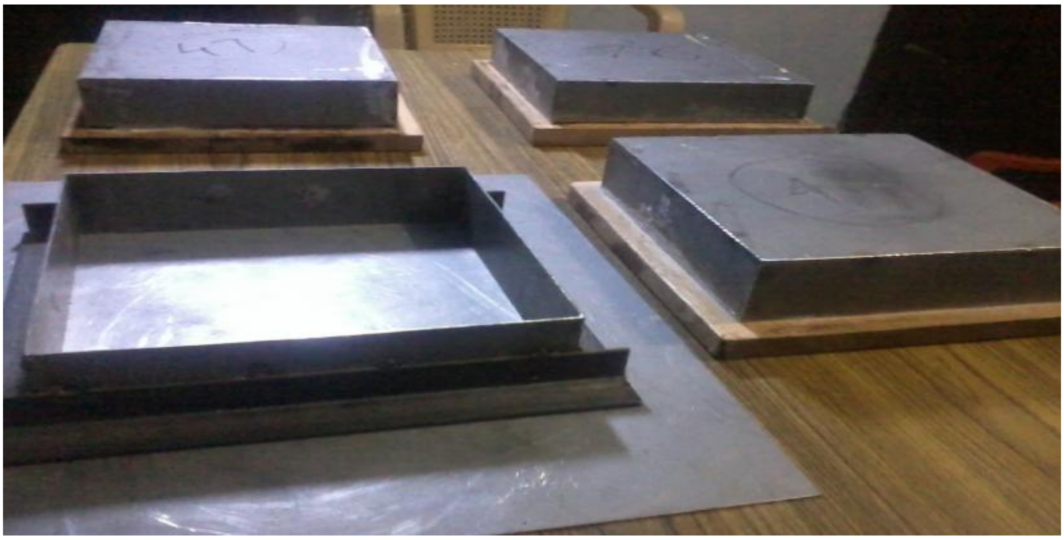

Fig.5 Fabrication of Die

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

DIMENSIONS OF DIE

Male die :-

1. **200×200×48mm**
2. **200×200×47mm**
3. **200×200×46mm**

Female die :-

1. **200×200×50mm**

3.2.3 CHEMICAL TREATMENT

Alkaline Treatment or NaOH Treatment

Alkaline treatment or mercerization is one of the most used chemical treatment of natural fibers when used toreinforce thermoplastics and thermosets. The importantmodification done by alkaline treatment is thedisruption of hydrogen bonding in the network structure,thereby increasing surface roughness. This treatmentremoves a certain amount of lignin, wax and oilscovering the external surface of the fiber cell wall,depolymerizes cellulose and exposes the short lengthcrystallites . Addition of aqueous sodium hydroxide(NaOH) to natural fiber promotes the ionization ofthe hydroxyl group to the alkoxide :

Fiber - OH +NaOH → Fiber - O - Na + H2O

Thus, alkaline processing directly influences thecellulosic fibril, the degree of polymerization and theextraction of lignin and hemicellulosic compounds.In alkaline treatment, fibers are immersed in NaOHsolution for a given period of time. It is reported that alkaline treatment has two effectson the fiber: (1) it increases surface roughness resultingin better mechanical interlocking; and (2) it increasesthe amount of cellulose exposed on the fiber surface,thus increasing the number of possible reaction sites. Consequently, alkaline treatment has a lastingeffect on the mechanical behavior of fibers,especially on fiber strength and stiffness. Alkaline treatmentgave up to a 30% increase in tensile properties (bothstrength and modulus) for flax fiber–epoxy compositesand coincided with the removal of pectin. Alkalinetreatment also significantly improved the mechanical,impact fatigue and dynamic mechanical behaviors offiber-reinforced composites .This is because at higher alkali concentration,excess delignification of natural fiber occursresulting in a weaker or damaged fiber. The tensilestrength of the composite decreased drastically aftercertain optimum NaOH concentration.

3.3 COMPOSITE FABRICATION : HAND LAY UP / WET LAY UP

3.3.1.HANDLAY-UP

In this process resins are impregnated by hand into fibres which are in the form of woven, knitted, stitched or bonded fabrics. Hand layup process usually accomplished by rollers or brushes. An increasing use of nip-roller type impregnators for forcing resin into the fabrics by means of rotating rollers and a bath of resin. Laminates then, are left to cure under standard atmospheric conditions.The figure 3.5 shows the Hand layup / Wet layup process.

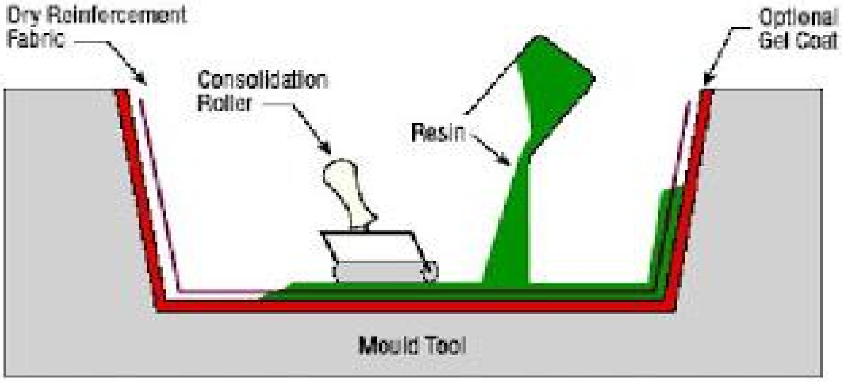

Fig.6 Hand layup / Wet layup process

Materials Options:

Resins: Any, e.g. epoxy, polyester, vinylester, phenolic.
Fibres: Any, (although heavy aramid fabrics can be hard to wet-out by hand)
Cores: Any

3.3.2 HAND LAY UP / WET LAY UP PROCEDURE

›››Hand lay-up is the simplest process in the low end composite products, require low investment, higher operating skill, and versatile shapes of product that need single high quality surface finish.
›››Hand lay-up is the process that starts with the application of gel coating onto a completely polished and waxed mould. (gel coating is an optional step. We will discuss about gel coating next time)
›››A coat of laminating resin (resin that being mixed with catalyst / hardener, or else your part will not cure) is then being applied by brush or roller. Follow by the first layer of chopped strand mat (preferably 300 gs/m2 or less), or if desire a surface tissue.
›››The laminating resin is then applied to the reinforcement (the fiber) so that all trap air can be force out using roller.
››› Continue doing this for your next layer of fiber, until desired thickness is achieved.
›››Once finished, allow the resin to cure. You can feel the reaction taken place when your product is producing heat.
›››Finally, remove your product from the mould (demould) and next step is trimming the fiber product.

3.3.3 ADVANTAGES OF HAND LAY-UP PROCESS:

- Widely used for many years.
- Simple principles to teach.
-Low cost tooling, if room-temperature cure resins are used.
- Wide choice of suppliers and material types.
-Higher fibre contents, and longer fibres than with spray lay-up

3.3.4 DISADVANTAGES OF HAND LAY-UP PROCESS:

-Quality (mixing, fibre contents, laminate quality)
- very dependent on skills (Low resin/high fibre content cannot usually be achieved)
-Health & safety considerations; lower molecular weights resins – have potential to be more harmful than higher molecular weight products and also have an increased tendency to penetrate clothing etc.
-Limiting airborne styrene concentrations; becoming increasingly hard without expensive extraction systems.
-Resins need to be low in viscosity to be workable by hand – generally compromises mechanical/thermal properties (high diluent/styrene levels).

3.4 FABRICATED COMPOSITE MATERIAL

The figure 7 and figure 8 shows the chemical treated and untreated composite material.

Fig.7 Chemical treated composite material

Fig.8 Untreated Composite Material

3.5 MECHANICAL PROPERTIES

3.5.1 IMPACT STRENGTH

The static properties of materials and their attendant mechanical behavior are very much functions of factors such as the heat treatment the material may have received as well as design factors such as stress concentrations.

The behavior of a material is also dependent on the rate at which the load is applied. Polymeric materials and metals which show delayed yielding are most sensitive to load application rate. Low-carbon steel, for example, shows a considerable increase in yield strength with increasing rate of strain. In addition, increased work hardening occursat high-strain rates. This results in reduced local necking, hence, a greater overall material ductility occurs. A practical application of these effects is apparent in the fabrication of parts by high-strain rate methods such as explosive forming. This method results in larger amounts of plastic deformation than conventional forming methods and, at the same time, imparts increased strength and dimensional stability to the part.

In design applications, impact situations are frequently encountered, such as cylinder head bolts, in which it is necessary for the part to absorb a certain amount of energy without failure. In the static test, this energy absorption ability is called "toughness" and is indicated by the modulus of rupture. A similar "toughness" measurement is required for dynamic loadings; this measurement is made with astandard ASTM impact test known as the Izod or Charpy test. When using one of these impact tests, a small notched specimen is broken in flexure by a single blow from as winging pendulum. With the Charpy test, the specimen is supported as a simple beam, while in the Izod it is held as a cantilever.

3.5.1.1 IZOD TEST:

The Izod test consists of a pendulum with a determined weight at the end of its arm swinging down and striking the specimen while it is held securely in a vertical position. The impact strength is determined by the loss of energy of the pendulum as determined by precisely measuring the loss of height in the pendulum's swing.

3.5.1.2 CHARPY TEST:

While most commonly used on metals, it is also used on polymers, ceramics and composites. The Charpy test is most commonly used to evaluate the relative toughness or impact toughness of materials and as such is often used in quality control applications where it is a fast and economical test. It is used more as a comparative test rather than a definitive test.The impact test is used to find out the energy required to break

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

the specimen. The un-notched Charpy impact test is conducted to study the impact energy according to the ASTM D256. The un-notched specimens are kept in cantilever position and the pendulum swings around to break the specimen. The impact energy (J) is calculated from the dial gauge, which is fitted on the machine. Five samples are taken for each test and the results are averaged. The impact test specimen and impact testing is as shown in figure 9 and figure 10.

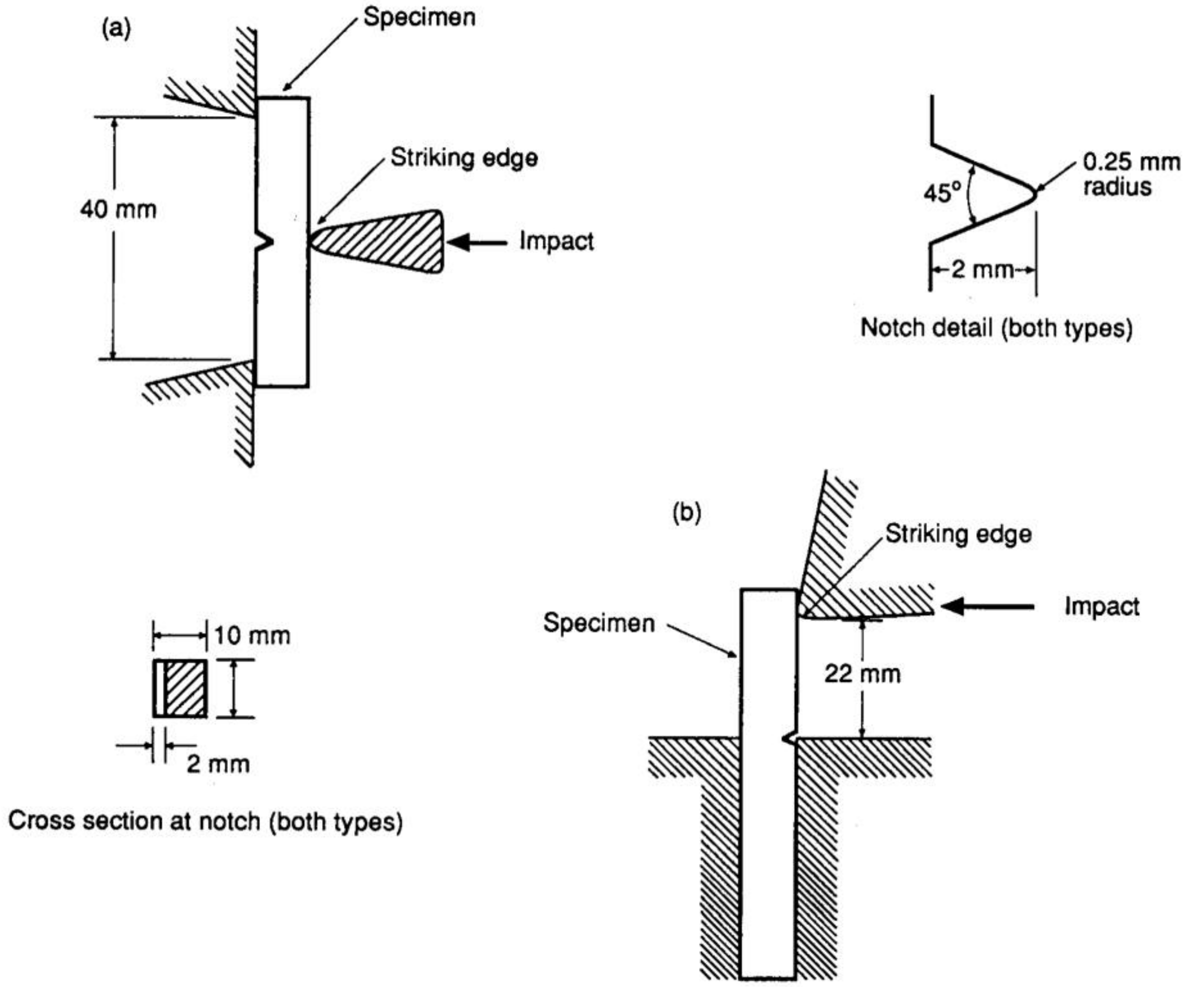

Fig.9 Impact Test Specimen

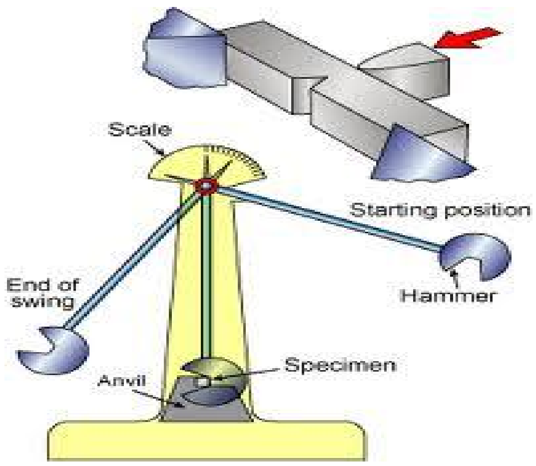

Fig.10 Impact Testing

3.5.2 TENSION TEST

One of the most common mechanical stress–strain tests is performed in *tension.* As will be seen, the tension test can be used to ascertain several mechanical properties of materials that are important in design. A specimen is deformed, usually to fracture, with a gradually increasing tensile load that is applied uniaxially along the long axis of a specimen. A standard tensile specimen is shown in Figure. Normally, the cross section is circular, but rectangular specimens are also used. During testing, deformation is confined to the narrow center region, which has a uniform cross section along its length. The standard diameter is approximately 12.8 mm (0.5 in.),where as the reduced section length should be at least four times this diameter; 60mm (2in.) is common. Gauge length is used in ductility computations, the standard value is 50 mm (2.0 in.). The specimen is mounted by its ends into the holding grips of the testing apparatus shown in Figure . The tensile testing machine is designed to elongate the specimen at a constant rate, and to continuously and simultaneously measure the instantaneous applied load (with aload cell) and the resulting elongations (using an extensometer). A stress–straintest typically takes several minutes to perform and is destructive; that is, the test specimen is permanently deformed and usually fractured.

The output of such a tensile test is recorded on a strip chart (or by a computer)as load or force versus elongation. These load–deformation characteristics are dependent on the specimen size. For example, it will require twice the load to produce the same elongation if the cross-sectional area of the specimen is doubled. To minimize these geometrical factors, load and elongation are normalized to there spective parameters of **engineering stress** and **engineering strain.** The typical tensile composite test specimen and computerized Universal testing machine is shown in figure 11 and figure 12.

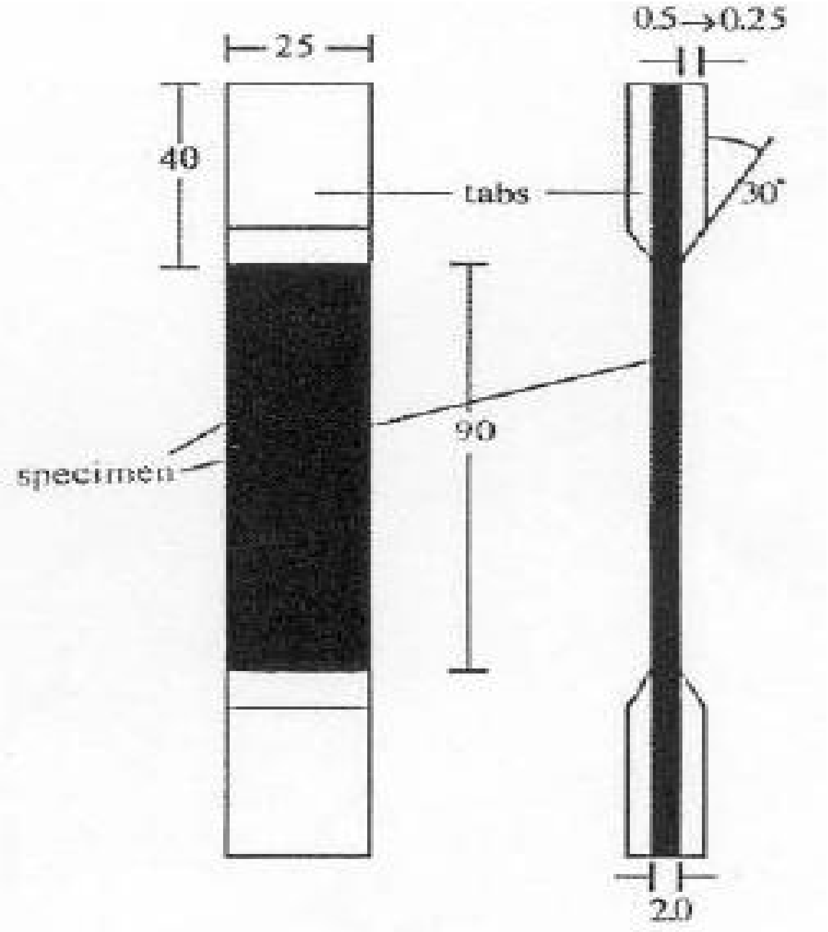

Fig. 11 Typical tensile composite test specimen (all dimensions in mm)

Fig.12 computerized universal testing machine

3.5.3 FLEXURAL STRENGTH

Flexural strength, also known as **modulus of rupture**, **bend strength**, or **fracture strength**. A mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress.

When an object formed of a single material, like a wooden beam or a steel rod, is bent, it experiences a range of stresses across its depth. At the edge of the object on the inside of the bend (concave face) the stress will be at its maximum compressive stress value. At the outside of the bend (convex face) the stress will be at its maximum tensile value. These inner and outer edges of the beam or rod are known as the 'extreme fibers'. Most materials fail under tensile stress before they fail under compressive stress, so the maximum tensile stress value that can be sustained before the beam or rod fails is its flexural strength. The flexural test with three point load is as shown in figure 13.

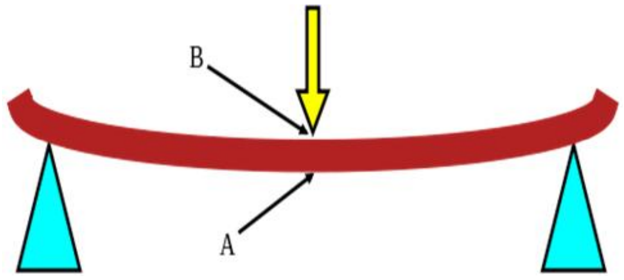

Fig.13 Flexural test with three point load

4. RESULTS AND DISCUSSION

This chapter presents the physical and mechanical characterization of the class of polymer matrix composites developed for the present investigation. They are bidirectional caryota urens fiber reinforced polyester resin composites. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The results of various characterization tests are reported here. They include evaluation of tensile strength, flexural strength and impact strength has been studied and discussed.

Table:1 FLEXURAL TEST REPORT FOR TREATED CARYOTA URENS COMPOSITE

1	Test Sr No:	**687**			
2	Party Name	**ETH S-1**			
3	Party Code:	**ETH S-1**			
4	Test Date:	**19/04 /2012**	Test Time:	**9:36:49 AM**
5	Speed of Testing:	**5**	Tested By :	**CCM**

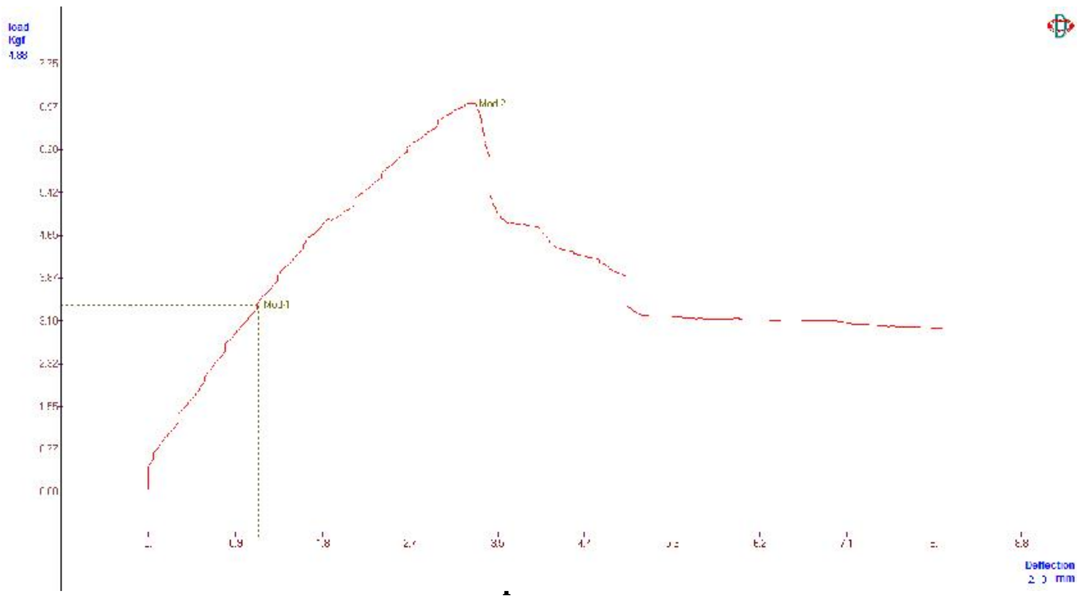

Fig.14 Flexural Test for treated Caryota Urens :Deflection vs Load

Table:2 Sample Details

	Span	
1	Length(mm)	50
2	Thickness (mm)	4
3	Width (mm)	13
4	Ref.Standard	**ASTMD790**

Table:3 Test Results

1	MOD 1 FORCE	3.39	Kg
2	MODE 1 DEFLECTION	1.11	mm
3	MOD 2 FORCE	7.02	Kg
4	MOD2 DEFLECTION	3.29	mm
5	Stress 1	1.22	
6	Stress 2	2.53	
7	FLEXURAL MODULES	-1266.50	N/mm^2

Table:4 FLEXURAL TEST REPORT FOR UNTREATED CARYOTA URENS COMPOSITE

1	Test Sr No:	**688**		
2	Party Name	**ETH S-2**		
3	Party Code:	**ETH S-2**		
4	Test Date:	**19/04 /2012**	Test Time:	**9:41:08 AM**
5	Speed of Testing:	**5**	Tested By :	**CCM**

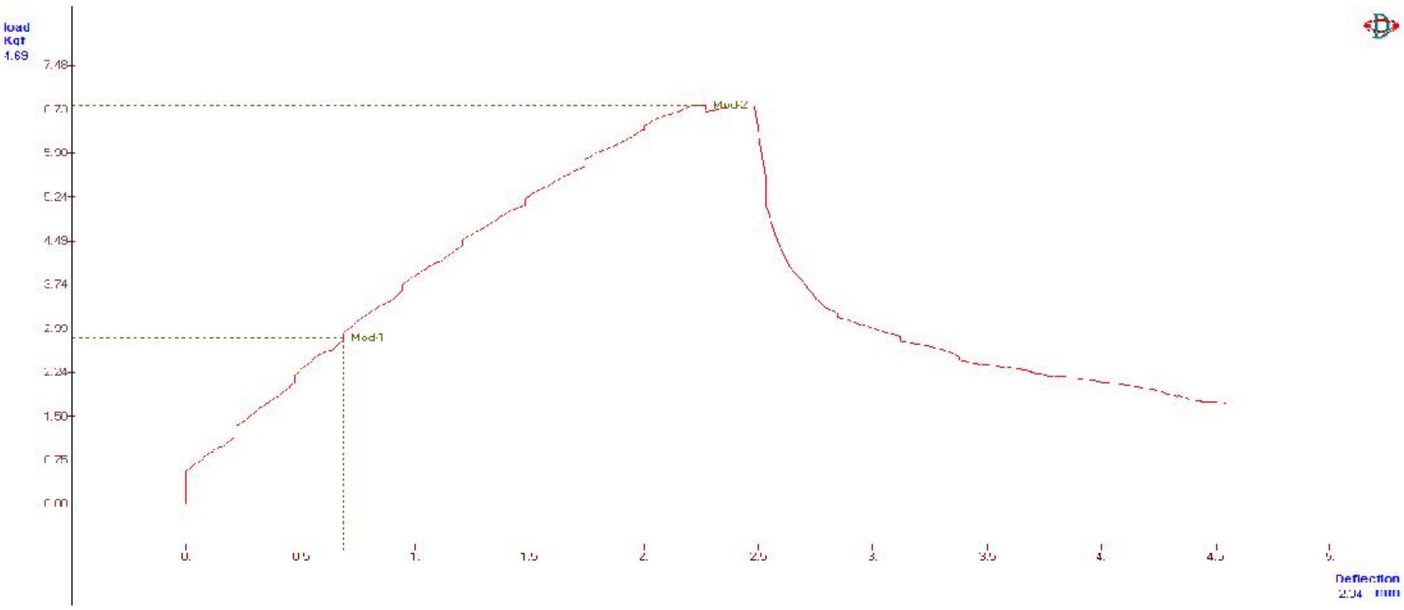

Fig.15 Flexural Test for untreated Caryota Urens :Deflection vs Load

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Table:5 Sample details

	Span	
1	Length(mm)	50
2	Thickness (mm)	4
3	Width (mm)	13
4	Ref.Standard	**ASTMD790**

Table:6 Test Results

1	MOD 1 FORCE	**2.83**	Kg
2	MODE 1 DEFLECTION	**0.68**	mm
3	MOD 2 FORCE	**6.80**	Kg
4	MOD2 DEFLECTION	**2.25**	mm
5	Stress 1	**1.02**	
6	Stress 2	**2.45**	
7	FLEXURAL MODULES	**-1225.71**	N/mm^2

Table:7 TENSILE AND ELONGATION TEST REPORT FOR TREATED CARYOTA URENS COMPOSITE

Test Sr.No.	**709**	Test Date	**21/04 /2012**
		Test Time	**9:40:39 AM**
Customer Name	**JTW (1)**		
Customer Code	**JTW (1)**		
Operator Name	**CCM**		

Table:8 Sample details (*All dimension in mm)

Specimen code	**JTW (1)**		
Ref. Standard	**ASTMD638**		
Grip Length	**100**	Guage Length	**100**
Sample Width	**13**	Sample Thickness	**4**
Speed of testing (mm/min)	**5**		

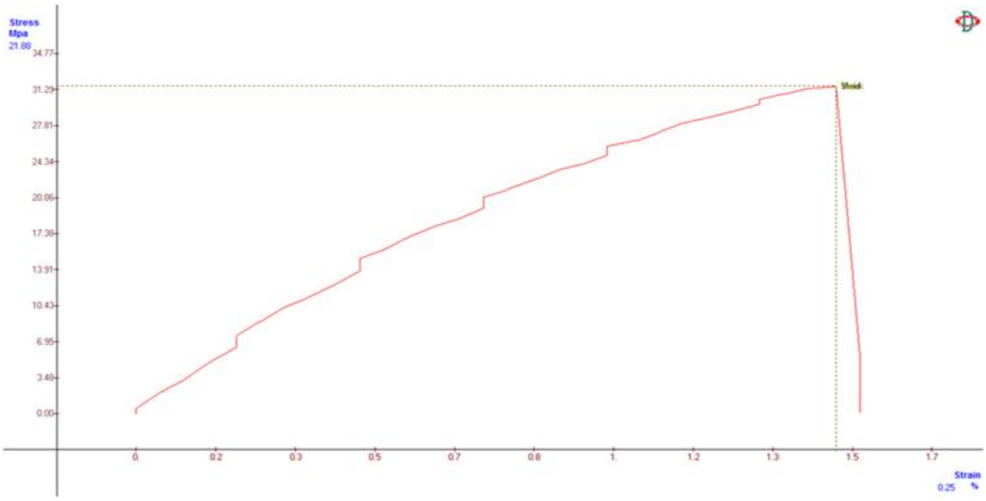

Fig.16 Tensile Test for treated Caryota Urens : Strain vs Stress

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Table:9 Test results

Sr. No.	Results	Value	
1	Area	**0.52**	**cm²**
2	Yield Force	**31.65**	**Kg**
3	Yield Elongation	**1.47**	**mm**
4	Break Force	**31.6**	**Kg**
5	Break Elongation	**1.47**	**mm**
6	Tensile Strength at Yield	**60.86**	**Kg/cm²**
7	Tensile Strength at Break	**60.86**	**Kg/cm²**
8	% Elongation	**1.47**	**%**

Table:10 TENSILE AND ELONGATION TEST REPORT FOR UNTREATED CARYOTA URENS COMPOSITE

Test Sr.No.	**710**	Test Date	**21/04 /2012**
		Test Time	**9:43:29 AM**
Customer Name	**JTW (2)**		
Customer Code	**JTW (2)**		
Operator Name	**CCM**		

Table:11 Sample details (*All dimension in mm)

Specimen code	**JTW (2)**		
Ref. Standard	**ASTMD638**		
Grip Length	**100**	Guage Length	**100**
Sample Width	**13**	Sample Thickness	**4**
Speed of testing (mm/min)	**5**		

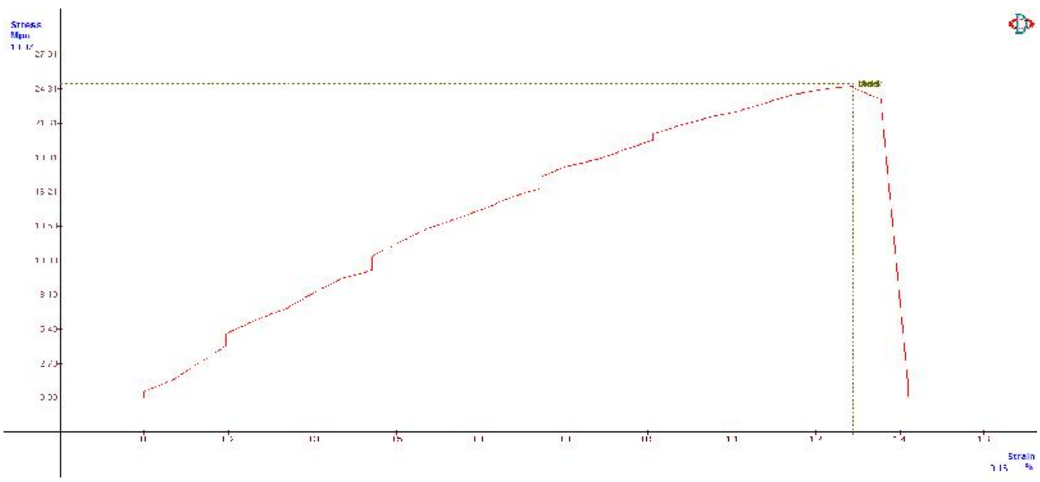

Fig.17 Tensile Test for untreated Caryota Urens : Strain vs Stress

Table:12 Test results

Sr. No.	Results	Value	
1	Area	**0.52**	**cm²**
2	Yield Force	**24.72**	**Kg**
3	Yield Elongation	**1.31**	**mm**
4	Break Force	**24.7**	**Kg**
5	Break Elongation	**1.31**	**mm**
6	Tensile Strength at Yield	**47.55**	**Kg/cm²**
7	Tensile Strength at Break	**47.55**	**Kg/cm²**
8	% Elongation	**1.31**	**%**

IMPACT VALUES:

Impact value of treated and untreated caryota urens composite is given below.

S.NO	SPECIMEN NO	JOULES
1	TREATED	22.492
2	UNTREATED	22.352

4. CONCLUSION

From this investigation, alkaline treated natural fiber reinforced polymer composites shows better performance than the untreated natural fiber reinforced polymer composites. Among two fibers, alkaline treated caryota urens fiber reinforced polymer composites shows good performance than the untreated caryota urens fiber reinforced composites.

REFERENCES

1. Wang Wei, Huang Gu, "Characterisation and utilization of natural coconut fibres composites", Materials and Design 30 (2009) 2741–2744.
2. R. Velmurugan, T.P. Mohan, "Epoxy-Clay Nanocomposites and Hybrids: Synthesis and Characterization", Journal of Reinforced Plastics and Composites, Vol. 28, No. 1, 17-37 (2009).
3. S. Harish, D. Peter Michael, A. Bensely,, D. Mohan Lal, A. Rajaduraic, "Mechanical property evaluation of natural fiber coir composite", materials Characterization 60 (2009) 44 – 49.
4. Wulin Q, Farao Z, Endo T, Hirotsu T. (2005), Isocyanate as a compatibilizing agent on the properties of highly crystalline cellulose/polypropylene composites. J Mater Sci 2005; 40:3607–14.
5. J.T.WinowlinJappes and I.Siva (2012), Fractography Analysis of Naturally Woven Coconut Sheath Reinforced Polyester Composite: A Novel Reinforcement, Polymer-Plastics Technology and Engineering, 51: 419–424.
6. V. Manikandan, J.T. WinowlinJappes, S.M. Suresh Kumar, P. Amuthakkannan (2011), Investigation of the effect of surface modifications on the mechanical properties of basalt fibre reinforced polymer composites, 43 (2012) 812–818.
7. J.T.WinowlinJappes, and I.Siva, (2011) Studies on the Influence of Silane Treatment on Mechanical Properties of Coconut Sheath Reinforced Polyester Composite, Polymer-Plastics Technology and Engineering, 50(15): 1600-1605.

8. I.Siva and J.T.WinowlinJappes, (2011) Investigation on Coir Sheath/Polyester Composites: Effect of Moisture on Wear Properties International Journal of Advanced Manufacturing Systems, 2(1): 73-82.
9. A. Athijayamani, M. Thiruchitrambalam, J. T. WinowlinJappes, S. Saravanan and A. Alavudeen (2011), Efect of Fiber Content on Mechanical Properties of Short Roselle and Sisal Fiber Hybrid Polyester Composite, International Journal of Computer Aided Engineering and Technology (IJCAET), 3(5/6):538-546.
10. A. Alavudeen , M. Thiruchitrambalam, J. T. WinowlinJappes, and A. Athijayamani (2011), Analysis of Mechanical Properties of Banana Fiber Polymer Composite. International Journal of Computer Aided Engineering and Technology (IJCAET), 3(5/6): 434-442.
11. Ibraheem, S.A.; Aidy, A.; Khalina, A. Development of green insulation boards from kenaffibres and polyurethane, Polym.-Plast. Technol. Eng. 2011, 50 (6), 613–621.
12. Mahmoud, A.H.; Taya, G.S.; Rozman, H.D. A preliminary study on ultraviolet radiation-cured unsaturated polyester resin based on palm oil. Polym.-Plast. Technol. Eng. 2011, 50(6), 573–580.
13. K. Honjo1, I. Furukawa2 & M.H. Sahri3 RADIAL VARIATION OF FIBER LENGTH INCREMENT IN ACACIA MANGIUM IAWA Journal, Vol. 26 (3), 2005: 339–352.
14. H. Ben Salema ,*, A. Nefzaouia, Lamia Ben Salemb, J.L. Tisserandc Deactivation of condensed tannins in Acacia cyanophyllaLindl. foliage by polyethylene glycol in feed blocks Effect on feed intake, diet digestibility, nitrogen balance, microbial synthesis and growth by sheep Livestock Production Science 64 (2000) 51–60.
15. H.K. Mokoboki, L.R. Ndlovu[#], J.W. Ng´ambi, M.M. Malatje and R.V. Nikolova Nutritive value of Acacia tree foliages growing in the Limpopo Province of South Africa South African Journal of Animal Science 2005, 35 (4).
16. Steve R.A. Adewusia,*, Olumuyiwa S. Faladea, Chris Harwoodb Chemical composition of caciacolei and Acacia tumida seeds—potential food sources in the semi-arid tropics Food Chemistry 80 (2003) 187–195.
17. V. Manikandan, J.T. WinowlinJappes⇑, S.M. Suresh Kumar, P. Amuthakkannan Investigation of the effect of surface modifications on the mechanical properties of basalt fibre reinforced polymer composites Composites: Part B 43 (2012) 812–818.
18. Ahmed M. El-Waziry Nutritive Value Assessment of Ensiling or Mixing Acacia and Atriplex Using *In Vitro* Gas Production Technique Research Journal of Agriculture and Biological Sciences, 3(6): 605-614, 2007.
19. Mohd. HamamiSabri, FaridahRanum Ibrahim and Nor Aini Ab. Shukor ANATOMY OF ACACIA MANGIUM GROWN IN MALAYSIA IAWA Journal, Vol. 14 (3), 1993: 245 -251.
20. MohdYuhazri, Y., Phongsakorn, P.T., and HaeryipSihombing A COMPARISON PROCESS BETWEEN VACUUM INFUSION AND HAND LAY-UP METHOD TOWARD KENAF/POLYESTER COMPOSITES International Journal of Basic & Applied Sciences IJBAS-IJENS Vol: 10 No: 03.
21. A. S. Singhaa & Vijay Kumar Thakur a Chemical Resistance, Mechanical and Physical Properties of Biofibers-Based Polymer Composites Available online: 04 Jun 2009.
22. M. Thiruchitrambalama , A. Athijayamani b , S. Sathiyamurthy c & A. Syed Abu Thaheer d A Review on the Natural Fiber- Reinforced Polymer Composites for the Development of Roselle Fiber-Reinforced Polyester Composite http://www.tandfonline.com/loi/wjnf20 09 Dec 2010.
23. Amar Singh Singha a & Vijay Kumar Thakur a Synthesis and Characterizations of Silane Treated Grewiaoptiva Fibers This article was downloaded by: [117.239.105.146] On: 23 May 2012, At: 02:17.
24. *M. Kaci*, H. Djidjelli, A. Boukerrou, L. Zaidi*Effect of wood filler treatment and EBAGMA compatibilizer on morphology and mechanical properties of low density polyethylene/olive husk flour composites *eXPRESS Polymer Letters Vol.1, No.7 (2007) 467–473.*
25. Marianne Le Troëdec*, Claire S. Peyratout*, Thierry Chotard*, Jean-Pierre Bonnet*, Agnès Smith*, René Guinebretière** Physico-chemical modifications of the interactions between hemp fibres and a lime mineral matrix: impacts on mechanical properties of mortars J.G.Heinrich and C. Aneziris, Proc. 10th ECerS Conf., GöllerVerlag, Baden-Baden, 2007, 451-456, ISBN: 3-87264-022-4451.
26. Luisa Medina, Ralf Schledjewski *, Alois K. Schlarb Process related mechanical properties of press molded natural fiber reinforced polymers Composites Science and Technology 69 (2009) 1404–1411.
27. Xun Lu1,2,3, Ming Qiu Zhang2*, Min Zhi Rong1, Da Lei Yue1 and Gui Cheng Yang2 The Preparation of Self-Reinforced Sisal Fiber Composites Received: 2nd June 2003; Accepted: 10th November 2003.
28. *X. Y. Liu*, G. C. Dai* Surface modification and micromechanical properties of jute fiber mat reinforced polypropylene composites *eXPRESS Polymer Letters Vol.1, No.5 (2007) 299–307.*
29. D. CHANDRAMOHAN* Dr.K.MARIMUTHU, *Tensile and Hardness Tests on Natural Fiber Reinforced Polymer Composite Material*Vol No. 6, Issue No. 1, 097 – 104.

30. M. Brahmakumar, C. Pavithran *, R.M. Pillai Coconut fibre reinforced polyethylene composites: effect of natural waxy surface layer of the fibre on fibre/matrix interfacial bonding and strength of composites Composites Science and Technology 65 (2005) 563–569.
31. W. Wang, M. Sain *, P.A. Cooper Study of moisture absorption in natural fiber plastic composites Composites Science and Technology 66 (2006) 379–386.
32. Flavio de Andrade Silva a, NikhileshChawla b,*, Romildo Dias de Toledo Filho a Tensile behavior of high performance natural (sisal) fibers Composites Science and Technology 68 (2008) 3438–3443.
33. G. Ramakrishna *, T. Sundararajan Impact strength of a few natural fibre reinforced cement mortar slabs: a comparative study Cement & Concrete Composites 27 (2005) 547–553.
34. Maya Jacoba, SabuThomasa,*, K.T. Varugheseb Mechanical properties of sisal/oil palm hybrid fiber reinforced natural rubber composites Composites Science and Technology 64 (2004) 955–965.
35. J. T. WinowlinJappesa , I. Siva a & N. Rajini a Fractography Analysis of Naturally Woven Coconut Sheath Reinforced Polyester Composite: A Novel Reinforcement This article was downloaded by: [Mr Siva Irullappasamy] On: 05 March 2012, At: 22:28.
36. J. T. WinowlinJappes a & I. Siva a Studies on the Influence of Silane Treatment on Mechanical Properties of Coconut Sheath-Reinforced Polyester Composite This article was downloaded by: [Mr Siva Irullappasamy] On: 06 March 2012, At: 02:04.
37. J. T. WinowlinJappesa , I. Siva a & N. Rajini a Fractography Analysis of Naturally Woven Coconut Sheath Reinforced Polyester Composite: A Novel Reinforcement This article was downloaded by: [Mr Siva Irullappasamy] On: 05 March 2012, At: 22:28.