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COMPOSITESANALYSIS THE MECHANICAL PROPERTIES OF THE PALM FIBER COMPOSITE MATERIAL

Arumugam P[1], Saravanakumar R[2]
Faculty of Mechanical Engineering Department
Thamirabharani Engineering College
Tirunelveli, Tamilnadu, India

Abstract **-- A composite material is a material made from two or more materials with significantly different physical or chemical properties. In this project, Composite material is made by combined form of palm fiber and resin. This experimental study aims fabrication and characterization of natural fibers in composite materials. The main concept of this project to analysis the mechanical properties of composite material by using the following tests are izod and charpy allowing for a weight reduction in the finished part.**

I. INTRODUCTION

A natural fiber is considered one of the environmentally friendly materials which have good properties compared to synthetic fiber. A late current industry research identified that the worldwide natural fiber reinforced polymer composites industry sector reached U$2.1 billion in 2010. Current pointers are that interest in NFPCs industry will keep on growing quickly around the world. The utilization of NFPCs has expanded considerably in the shopper merchandise as developing industry sectors throughout the last few years. As indicated by evaluations, over 5 years (2011–2016), the NFPCs industries estimated to grow 10% worldwide.

Natural fibers in simple definition are fibers that are not synthetic or manmade. They can be sourced from plants or animals. The use of natural fiber from both resources, renewable and nonrenewable such as oil palm, sisal, flax, and jute to produce composite materials, gained attention in the last decades, so far. The plants, which produce cellulose fibers can be classified into blast fibers (jute, flax, ramie, hemp, and kenaf), seed fibers (cotton, coir, and kapok), leaf fibers (sisal, pineapple, and abaca), grass and reed fibers (rice, corn, and wheat), and core fibers (hemp, kenaf, and jute) as well as all other kinds (wood and roots).

This motivates the researchers and the mechanical designers to find alternative to the synthetic products. Natural fibers could be one of the most useful alternative reinforcements to the synthetic fibers such as glass, carbon, and kevlar. In the light of the above, the combination of environmental friendly characteristics of natural fibers and recycle HDPE polymer in developing a bio recyclable composite will be very attractive research.

In the current study, the HPDE Natural fiber is a type of renewable sources and a new generation of reinforcements and supplements for polymer based materials. The development of natural fiber composite materials or environmentally friendly composites has been a hot topic recently due to the increasing environmental awareness. Natural fibers are one such proficient material which replaces the synthetic materials and its related products for the less weight and energy conservation applications. The application of natural fiber reinforced polymer composites and natural-based resins for replacing existing synthetic polymer or glass fiber reinforced materials in huge. Automotive and aircrafts industries have been actively developing different kinds of natural fibers, mainly on hemp, flax and sisal and bio resins systems for their interior components. High specific properties with lower prices of natural fiber composites are making it attractive for various applications.

II. NATURAL FIBER

Palm fiber is taken from the Leaves of the Palm tree so it's also known as the palm leaf fiber. Palm fiber has the poor spinning characteristics the fiber is naturally hard palm fiber behavior has been classified into two types they are Active behavior and the Passive behavior. It is necessary to characterize plant fiber based on its cellular structure in order to use as reinforcements. The chemical structure of natural fiber or plant fiber comprises of cellulose, hemicellulose, lignin, pectin and extraneous materials. Each cell of fiber comprises of crystalline cellulose regions called micro fiber interconnected by hemicellulose and lignin fragments. Also natural fibers after treating with alkali undergo chemical modification and holds better strength there by replacing glass fibers for reinforcement in polymer matrix. Investigations on the mechanical properties of composite materials reinforced with several natural fibers were studied. Palm trees (Borassus flabellifer) available plenty in the southern parts of India has fibers from root to tip. In this work fibers from various portions of the palm tree were extracted normally by retting and hand picking. The fibers chemical contents (Cellulose, hemicellulose, lignin and moisture) were found through standard tests. The physical properties (fiber density and tensile strength) were also calculated after testing. Composite samples were developed with each fibers and tested for tensile strength. From the test results the composite developed with palm fibers possess appreciable tensile strength and shall replace synthetic fibers for automotive applications.

A. *Fabrication of Composite Fiber*

The fiber piles were cut to size from the Palm fiber cloth. The appropriate numbers of fiber plies were taken: two for each. Then the fibers were weighed and accordingly the resin and hardeners were weighed. Epoxy and hardener were mixed by using glass rod in a bowl. Care was taken to avoid formation of bubbles. Because the air bubbles were trapped in matrix may result failure in the material. The subsequent fabrication process consisted of first putting a releasing film on the mould surface. Next a polymer coating was applied on the sheets. Then fiber ply of one kind was put and proper rolling was done. Then resin was again applied, next to it fiber ply of another kind was put and rolled. Rolling was done using cylindrical mild steel rod. This procedure was repeated until eight alternating fibers have been laid. On the top of the last ply a polymer coating is done which serves to ensure a god surface finish.

B. *Fiber extraction*

The palm fibers were available plenty from Kanyakumari District, Tamil Nadu, INDIA fibers from various parts of the palm tree were extracted by either by retting in water and/or by mechanical processing or hand picking. The fibers were cleaned with water after soaking for two weeks. The fibers were further dried in natural sunlight to remove moisture content and long uniform fibers were obtained.

Sisal plants were prepared. Some portions of cleaned fibres were soaked in 10 wt % $NaHCO_3$ solution for 24 h, 120 h and 240 h at room temperature, then washed with distilled water and dried in an oven at 40C for 24 h. Tensile test was conducted in UTM. It is possible to observe that the values of both Young's modulus and tensile strength increase with increasing the treatment time up to 120 h. After 120 h of treatment, Young's modulus keeps increasing whereas tensile strength of the treated fibres begun to decrease. This may be due to degradation phenomena which occur if the treatment time is too long.

Palm leaf stalk fiber

Palm fruit fiber

C. *Composite preparation*

- Bottom layer of the Die is covered with the Aluminum foil sheet.
- The Wax is applied on the Aluminum foil sheet it is used for easy removing of composites from foil sheet.
- Then the mixture of epoxy resin and hardener is placed on the sheet and palm leaf fibers mate is dipped.
- After that Male die is compressed for some times
- This process is repeated for others also

D. *Advantages of palm fibre*

- Palm is bio-degradable and replenishes earth nutrients.
- Palm possesses no threat to the environment because it neither emits toxic gases nor harmful chemicals.
- Palm will not cause the problems like the synthetic material in waste management cycles through emitting hazardous gases during incineration of landfill sites.
- Palm makes durable and strong composite, handling of which is easier.

III. MANUFACTURING PROCESS

A. *DIE SET PROCESS*

The word die is a generic term used to describe the tooling used to produce stamped parts. A die set assembly consisting of a male and female component is the actual tool that produces the shaped stamping. The male and female components work in opposition to both form and punch holes in the stock. The upper half of the die set, which may be either the male or female, is mounted on the press ram and delivers the stroke action. The lower half is attached to an intermediate bolster plate which in turn is secured to the press bed. Guide pins are used to insure alignment between the upper and lower halves of the die set.

B. *SHEET METAL STAMPING*

InStamping presses and stamping dies are tools used to produce high volume sheet metal parts. The press provides the force to close the stamping dies where they shape and cut the sheet metal into finished parts.

Hole punching and other cutting operations require specific and carefully maintained clearances between the punch and the die. The setting of the required clearances is determined by both the stock thickness and temper. In general, die clearances increase as the stock thickness increases. The depth of punch penetration into the sheet metal stock will also increase as softer stock is used. The main forming operations accomplished with press mounted dies are drawing involves forcing a blank deeply into a die cavity and shaping, it into the shape and contour of the punch face and sides. Without sufficient formability qualities, drawn blanks are subject to wrinkling, thinning, and fracturing. Draw forming requires an addition to the die set called a blank holder. The function of the blank holder, usually a ring through which the punch and ram pass, is to control the metal flow as it is forced into the die cavity. In practice, the blank holder must exert less pressure against the blank than the punch, so metal can flow into the die.

Bending is a relatively simple forming operation which provides rigidity and shape to sheet metal parts. Similar to bending is flanging. However a flange is significantly smaller in dimension than the rest of the part.

C. EPOXY RESIN

Epoxy resin was discovered in 1938 by Pierre Castan, a chemist in Switzerland. As of 1989, 137,000 tons of epoxy resin had been produced in Japan and epoxy resin has been used in a wide range of fields, such as paint, electricity, civil engineering and bonds. This is because epoxy resin has excellent bonding property, and also after curing, it has excellent properties on mechanical strength, chemical resistance and electrical insulation. In addition, epoxy resin is able to have various different properties as it is combined and cured together with various curing agents. This issue describes the types of curing agents for epoxy resin and their characteristics comparing to Three Bond products.

Epoxy resin is defined as a molecule containing more than one epoxide groups. The epoxide group also termed as oxidant or ethoxyline group are also known as poly epoxides. Epoxy resins are also known as poly epoxides, are a class of reactive polymers which contain epoxide groups. It is a polymer formed a reaction of epoxide resin with curing agent. They have the following characteristics good thermal and electric property, excellent mechanical property & cohesiveness to variety of substrates, chemical and corrosion resistance, good Process ability & electrical conductivity, high mechanical properties and large cohesive force.

D. CURING OF EPOXY RESINS

Epoxy resins are cured by means of a curing agent, often referred as catalysts, hardeners or activators. Often amines are used as curing agents. In amine curing agents, each hydrogen on amine nitrogen is reactive and can open one epoxide ring to form a covalent bond.

Two part epoxy coatings were developed for high quality service on metal substrates use less energy than heat-cured powder coatings. These systems make use of a 4:1 by volume mixing ratio, dry quickly providing a hardcore, protective coating with excellent hardness. Their low volatility and water clean-up makes them helpful for factory cast iron, cast steel, cast aluminium’s applications reduces exposure and flammability issues associated with solvent-borne coatings. They are usually utilized in industrial automotive applications being that they are more heat resistant than latex-based alkyd based paints. Epoxy paints often deteriorate called as a result of UV exposure. Polyester epoxies are employed as powder coatings for washers, driers and other white goods.

E. DIE LUBRICATION

The resistance of the sheet metal stock to the forces exerted by the moving dies creates friction. For this reason, lubrication is vital for successful sheet metal forming. Lubrication’s function is to minimize contact between the tooling and the work piece. This results in reduced tonnage requirements, longer tooling life, and improved product quality. Lubricants range from light mineral oils to high viscosity drawing compounds. They may be oil base, water soluble, synthetic materials. These lubricants may be applied in a variety of ways including are manually by roller or brush, drip, machine roller, spraying and flooding.

F. Composites

Epoxies may also be used in producing fibre-reinforced or composite parts. They are more costly than polyester resins and vinyl ester resins, but usually produce stronger more temperature-resistant composite parts. Epoxy resins are suitable as a fibre reinforcing material since they exhibit excellent adhesion to reinforcement, cure with low shrinkage and provide good mechanical, electrical and thermal, chemical, fatigue and moisture-resistant properties.

The processes for making composites encompass the whole range of epoxy resin technology. i.e. laminating, filament winding, pultrusion, casting and moulding. For their excellent adhesion, good mechanical properties, resistance to humidity chemicals, epoxy resins are employed in combination with glass, graphite, boron kevlar fibres. The orientation of the fibres is important in establishing the properties of the laminate. In the manufacture of tools, epoxy casting resins are utilized as prototype and master models for product design, drilling, and welding jigs, checking fixtures, vacuum forming and injection moulding.

IV. IZOD IMPACT TEST

A. IMPACT TESTING

The purpose of impact testing is to measure a material ability to resist high rate reading impact often is one the determining factor in the service life of the material. Impact testing commonly consists of Charpy and Izod specimen configuration.

B. IMPACT ENERGY

Impact energy is a measure of the work done to fracture a test specimen. When the striker impacts the specimen, the specimen will absorb energy until it yields. At this unit, the specimen will begin to undergo plastic deformation at the notch. The test specimen continues to absorb energy and work hardness at the plastic zone at the notice. When the specimen can absorb no more energy and fracture occurs.

C. IZOD IMPACT TEST MACHINE

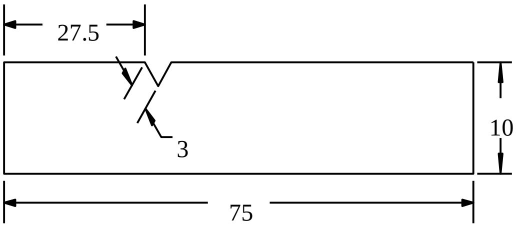
Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation that they can endure. The impact value of a material can also change with temperature. Generally, at lower temperatures, the impact energy of a material is decreased. The size of the specimen may also affect the value of the Izod impact test because it may allow a different number of imperfections in the material, which can act as stress risers and lower the impact energy.

D. Izod impact test machine

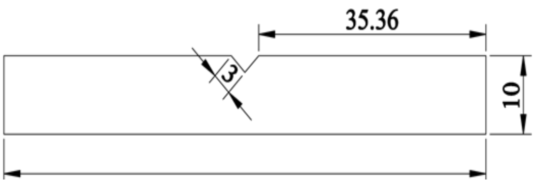
The apparatus consists of a pendulum hammer swinging at a notched sample of material. The energy transferred to the material can be inferred by comparing the difference to the height of the hammer before and after a big fracture. The notch in the sample affects the results of the impact test. Thus it is necessary the notch to be of a regular dimension determine the material is in plane stain, difference can greatly affect conclusions made.

E. DIMENSIONS OF SPECIMENS

Dimensions of izod specimen



Dimensions of charpy specimen



Izod & charpy test specimens normally measure 75× 10 ×10mm and 55× 10×10 have a notch machined across one of the larger faces. The notch dimensions are v-shaped notch 3mm deep, with 45º angle and 0.25mm radius along the base.

V. FACTORS AFFECTING IZOD IMPACT TEST

Factors that affect the Izod impact energy of a specimen include.

- Yield strength and ductility
- Notches
- Temperature and stain rate
- Fracture mechanism

A. QUANTITATIVE RESULTS

The quantitative results of the impact test can be used to determine the ductility of material. If the material breaks on a flat plane, the fracture was brittle and if the material breaks with jagged edges or shear lips. Then the fracture was ductile. Usually a material does not break in just one way or the other and thus comparing the jagged to flat surface areas of the facture will give an estimate of the percentage of ductile and brittle fracture.

B. TOUGHNESS PROPERTIES OF COMPOSITES

Due to the layered structure of composites and their intrinsic ability to deflect cracks it is very difficult in many GRP (Glass Reinforced Plastic) to propagate a crack perpendicular to the plane of lamination instead crack growth have concentrated on the inter laminar delaminating fracture toughness values are invariably higher for continues unidirectional GRP materials then for ERP. The higher strain energy release rates for GRP can be attributed to poor fibre/matrix interfacial bonding that occurs with these materials giving an increased crack surface energy and fibre bridging for mode GRP specimens which contributes significantly to crack growth resistance.

VI. CALCULATION

A. SPECIFICATIONS OF IZOD IMPACT TEST

Pendulum weight	= 21.350 kg
Angle of pendulum for izod	= 90º
Angle of pendulum for charpy	= 140º
Breadth of the specimen	= 10 mm
Thickness of the specimen	= 10 mm
Length of the specimen	= 75 mm
Initial izod scale reading	= 164 J
Initial charpy scale reading	= 300 J
Depth of 'v' notch	= 3 mm

B. FORMULA USED

Energy observed= Initial reading-final reading
Impact strength= Energy observed/ cross sectional area
Cross sectional area=width X breadth

C. CALCULATION

Cross sectional area=10 X 10=100mm^2

D. Resin & hardner Mixing Ratio 2:1

CHARPY TEST

Energy absorbed= initial charpy scale reading – final charpy scale reading
=300-20= 280 J
Impact strength = 280/100=2.80 J/mm2

IZOD TEST

Energy absorbed = initial izod scale reading – final izod scale reading
= 164-28= 136J
Impact strength = 136/100=1.36 J/mm2

RESIN HARDNER MIXING RATIO 3:1

CHARPY TEST

Energy absorbed = initial charpy scale reading – final charpy scale reading

=300-26= 274 J
Impact strength = 274/100=2.70 J/mm2

IZOD TEST

Energy absorbed = initial izod scale reading – final izod scale reading
= 164-24= 140J
Impact strength = 140/100=1.40 J/mm2

E. COMPARISION AND COST ESTIMATION

DESCRIPTION	RESIN & HARDNER MIXING RATIO	
	2:1	**3:1**
CHARPY TEST	2.80 J/mm^2	2.70 J/mm^2
IZOD	1.36 J/mm^2	1.40 J/mm^2

F. COST ESTIMATION

MATERIALS USED	QUANTITY	COST (RS)
Palm fiber	1kg	350
Epoxy resin	1000ml	500
Epoxy hardener	100ml	200
Sheet metal	150 × 70mm	50
Brush	2 Numbers	100
Total cost		**1200**

VII. CONCLUSION

With this project we came to an understanding of the behaviour of our composite material. Many composite materials are produced and each of them serves unique purpose with their respective properties. So with our work we conclude that the composite material (palm fibre) we made in a successful one and it has the strength properties as mentioned in the comparison table. This can serve in material selection that is, whoever need the strength or properties of the composite material. We made can choose our material for the manufacturing process.

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[4] S Gopi1, Shaik Ismail Basha2, VVN Bhaskar3 Characterization Of Natural Fibers In Composite Materials 1,2Assistant Professor, Aditya College of Engineering, Madanapalle, Chittoor District, A.P 3Associate Professor, Aditya College of Engineering, Madanapalle, Chittoor District, A.P

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