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Mechanical Behavior of Coconut Shell Powder Filled with Sisal Fiber, Reinforced Epoxy Hybrid Composites

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Abstract - *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. 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 The aim of the research paper is to study the mechanical behavior of compression molded coconut shell powder/sisal fiber reinforced epoxy matrix for various weight percentages. The specimens are prepared for testing as per ASTM standards to estimate the mechanical properties. The fiber taken as sisal-35%, epoxy taken as 65% and coconut shell powder taken as (0%, 5%, 10%, 15%).Mechanical characterization was done and a comparison was made between different samples. Then conduct various useful mechanical tests with this composite specimen.*

Key Words: Coconut shell powder, Sisal fiber, Epoxy resin, Hardener and Renewable.

1. INTRODUCTION

Composites are made by combining two or more natural or artificial materials to maximize their useful properties and minimize their weaknesses. One of the oldest and best-known composites, glass-fibers reinforced plastic (GRP), combines glass fibers (which are strong but brittle) with plastic (which is flexible) to make a composite material that is tough but not brittle. Composites are typically used in place of metals because they are equally strong but much lighter. Most composites consist of fibers of one material tightly bound into another material called a matrix. The fibers are typically glass, carbon, silicon carbide, or asbestos, while the matrix is usually plastic, metal, or a ceramic material (though materials such as concrete may also be used)

1.1 HYBRID COMPOSITE

Hybrid composites are more advanced composites as compared to conventional FRP composites. Hybrids can have more than one reinforcing phase and a single matrix phase or single reinforcing phase with multiple matrix phases or multiple reinforcing and multiple matrix phases. They have better flexibility as compared to other fiber reinforced composites. Normally it contains a high modulus fiber with low modulus fiber.

2. MATERIAL USED

Materials used in this experimental work are: Epoxy resin, Hardener, Coconut shell powder and Sisal fibers

2.1 EPOXY RESINS

Epoxy resin Araldite LY 556 an unmodified epoxy resin based on Biphenyl l-A supplied by (CIBA GUGYE limited) having the following outstanding properties has been used as the matrix material. Excellent adhesion to different materials, High resistance to chemical and atmospheric attack. High dimensional stability. Free from internal stresses. Excellent mechanical and electrical properties. Odorless, tasteless and completely nontoxic. Negligible shrinkage.

2.2 HARDENER

Hardener HY951, aliphatic Primary amines which has a viscosity of 10-20 MPa at 250 c is used along with the matrix material.

2.3 COCONUT SHELL POWDER

Coconut shell powder made from the most versatile part of the coconut shell which is organic in nature. Since it is good durability characteristics, high toughness and abrasion resistant properties, it is suitable for long standing use. The shell

similar to hard woods in chemical composition although lignin content is higher and cellulose content is lower. The cleaned coconut shells were cut into small pieces by using hammer. These small pieces were then grounded into powder form by a using a jaw crusher and ball milling. The collected powder was then sieved to different mesh sizes. The particle size chosen for the experiments was -90 to +45 microns collected from mesh sizes of between 40 to 70 due to its highest weight percentage among all size.

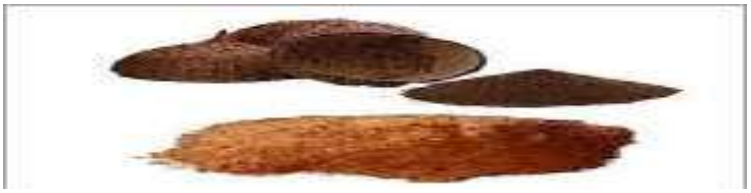

Fig -1: Coconut Shell Powder

2.4 SISAL FIBERS

Sisal is a natural fiber (Scientific name is Agave sisalana) of Agavaceae (Agave) family yields a stiff fiber traditionally used in making twine and rope. Sisal is fully biodegradable and highly renewable resource of energy. Sisal fiber is exceptionally durable and a low maintenance with minimal wear.

Fig -2: Sisal Fiber

2.5 COMPRESSION MOULDING TECHNIQUES

In this thesis we are trying to build a metal part in composite for the formula SAE team which would reduce weight and benefit the team. A process should be selected which is capable of reducing the lead time and capable of producing intricate parts with strength properties matching the existing grade aluminum. Refer Appendix B for detailed process review available for thermoset composites. Compression molding process is a suitable process for the defined requirements. Compression molding primarily utilizes short fibers. Continuous fiber also can be molded but a perform is made prior to the process in order to avoid fiber damage. Compression molding process lead to quicker cycle times and intricate shapes can be processed along with ribs and bosses.

2.6 PROCESS DESCRIPTION

Compression molding is a closed mold process. It consists of matched die molds. Two molds (Male and Female) are provided with heating and cooling sources. Ejector pins are placed in the bottom mold to facilitate the component removal. Sheet molding compound also called as charge is the raw material for this process. Charge is cut in predetermined shapes and placed in the mold. Compression molding employs a heated mold for curing the sheet molding compound in the mold. Charge which is in semi cured stage is placed in the mold and the mold is closed by bringing down the male mold and female mold together. The charge is squeezed and allowed to flow inside the cavity. Due to the heat source in the mold the charge gets heated and the viscosity drops thereby starts flowing inside the cavity. The molding process requires high pressures so the molds are mounted in big presses. The presses enable rapid curing cycles and high production volume. Because of this advantage this is highly used in automotive industry where there is a need for high volume process. Part repeatability is better than the other composite processes.

2.7 POLYMER-HARDNER MIXTURE PREPARATION

For the making of good composite the measurement of the samples should be accurate and the mixture should be very uniform. We take accurate amount of polymer which we have calculated earlier and 10% of its hardener. Then this mixture is stirred thoroughly till it becomes a bit warm. Bit extra amount of hardener is taken for the wastage in the process. Hardener should taken very minutely because little extra amount of hardener can spoil the composite.

Table -1: MATERIAL USE FOR CURRENT STUDY

SL.NO	MATRIX	FIBER	FILLER
1	Epoxy resin (65wt %)	Sisal fiber (35wt %)	Coconut shell powder (0wt %)
2	Epoxy resin	Sisal fiber	Coconut shell powder

	(60wt %)	(35wt %)	(5wt %)
3	Epoxy resin (55wt %)	Sisal fiber (35wt %)	Coconut shell powder (10wt %)
4	Epoxy resin (50wt %)	Sisal fiber (35wt %)	Coconut shell powder (15wt %)

3. MECHANICAL TESTING PROCEDURE

Tensile testing, Impact testing and Bending testing.

3.1 TENSILE TEST (ASTM 790)

A material is gripped at both ends by an apparatus, which slowly pulls lengthwise on the piece until it fractures. The pulling force is called a load, which is plotted against the material length change, or displacement. The load is converted to a stress value and the displacement is converted to a strain value.

Fig – 3: Tensile Testing Machine

3.2 IZOD IMPACT TESTING

Izod impact testing is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height (constant potential energy) and then released. The arm swings down hitting a notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity.

Fig -4: Izod Testing Machine

3.3 BENDING TESTING

In a 3-point bend test, the convex side of the sheet or plate is placed in tension, and the outer fibers are subjected to maximum stress and strain. Failure will occur when the strain or elongation exceeds the material's limits. Fracture toughness can be determined using a three-point flexural test.

Fig -5: Three point Bending Test

3.4 TENSILE TEST

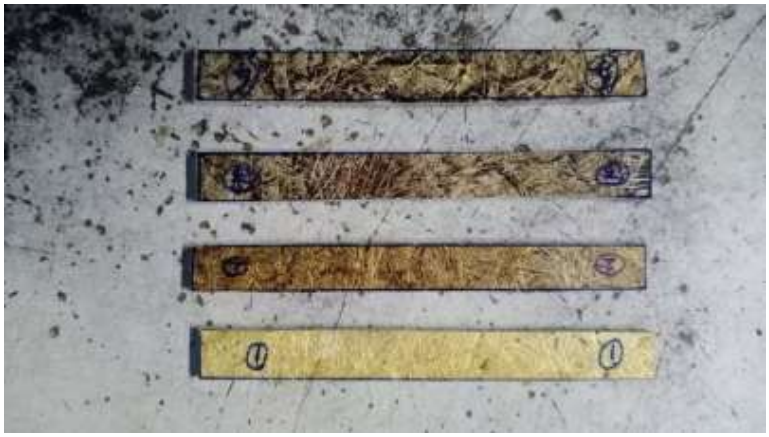

Fig -6: Before Break

Fig -7: After Break

3.5 RESULT

By the result of tensile test peak load and brake load are plotted. And also by impact test the result of peak load are plotted.

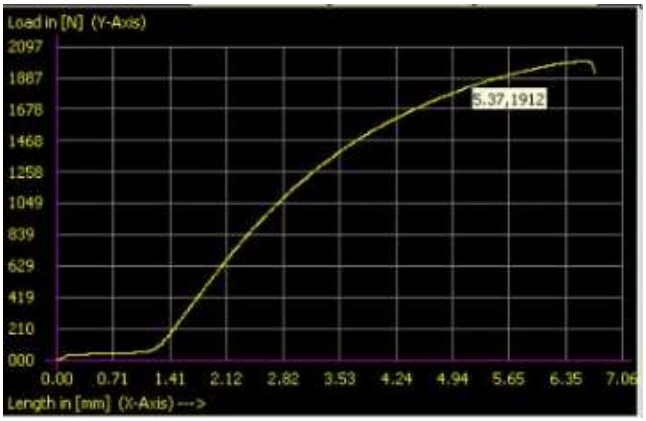

Fig -8: Tensile properties of sisal (35%) / coconut shell powder (0%) / epoxy (65%)

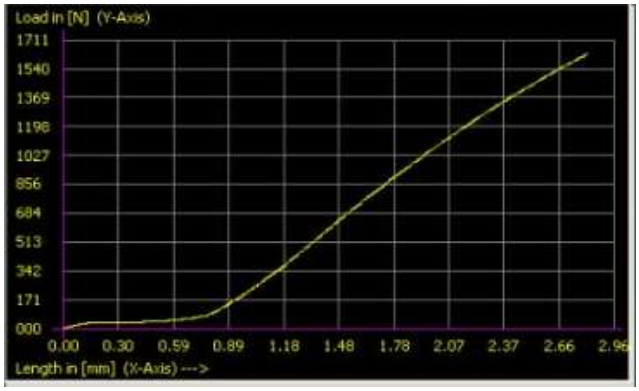

Fig -9: Tensile properties of sisal (35%) / coconut shell powder (5%)/ epoxy (65%)

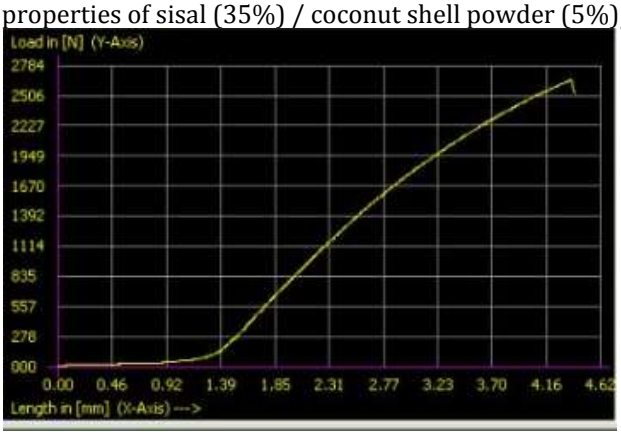

Fig -10: Tensile properties of sisal (35%) / coconut shell powder (10%)/ epoxy (55%)

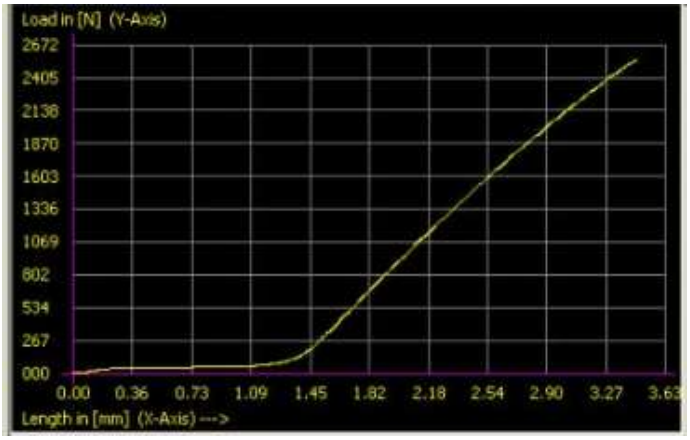

Fig -11: Tensile properties of sisal (35%) / coconut shell powder (15%)/epoxy (50%)

3.6 TENSILE TEST – Conclusion:

The plot shows that, the maximum tensile strength is obtained for the composite prepared with **(35%) / coconut shell powder (10%)/ epoxy (55%).**

4.0 IZOD TEST

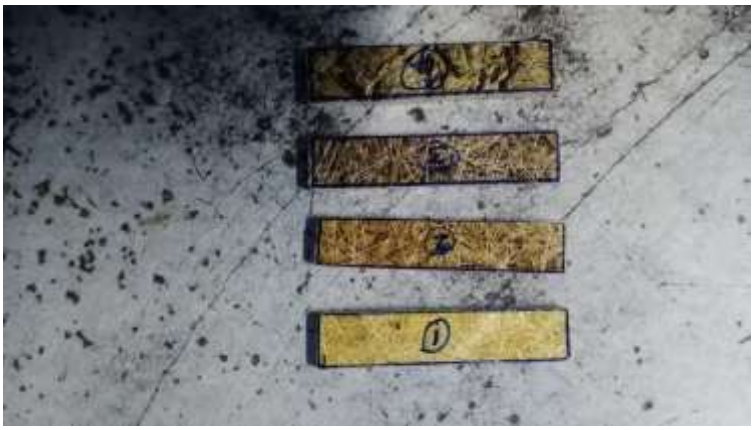

Fig- 12: Before Break

Fig-13: After Break

4.1 RESULTS

Table-2: Izod Impact Result

Sample	Izod Impact Value in J for 3mm Thickness
1	1.40
2	0.35
3	0.65
4	0.80

5. BENDING TEST

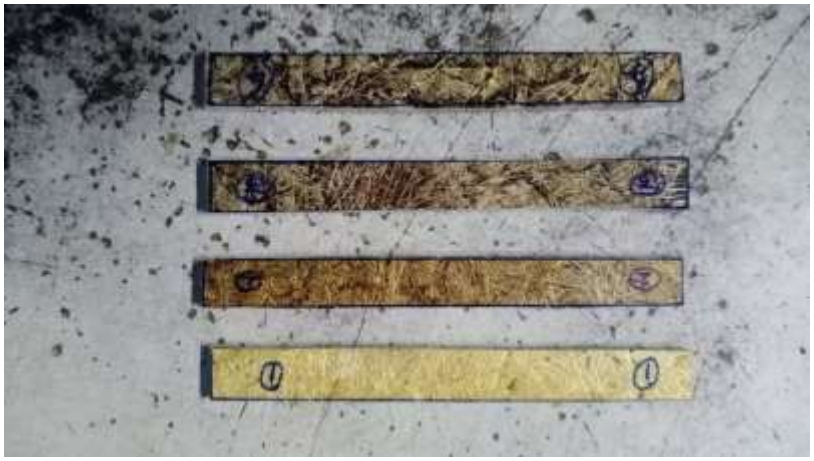

Fig-14 Before Break

Fig-15 After Break

5.1 RESULT

By the result of flexural load is plotted.

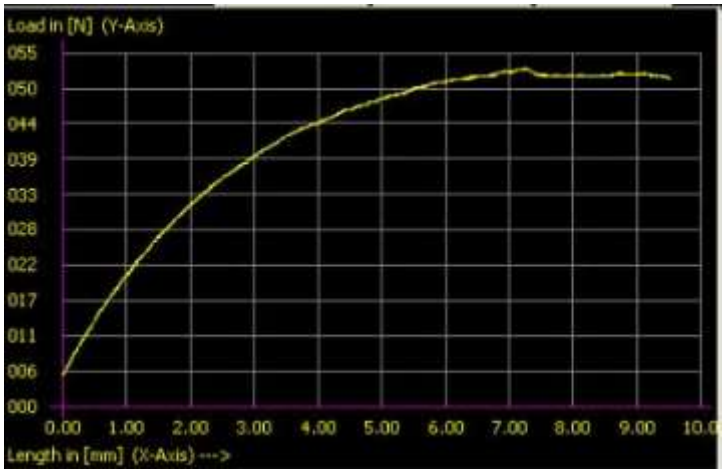

Fig-16 Flexural properties of sisal (35%) / coconut shell powder (0%) / epoxy (65%)

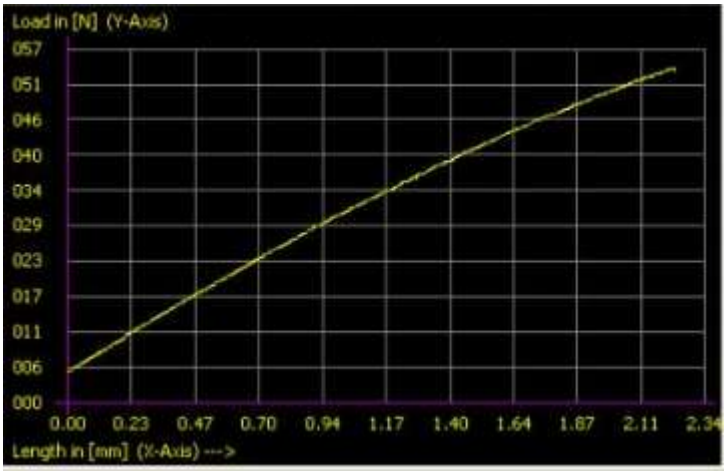

Fig -17 Flexural properties of sisal (35%) / coconut shell powder (5%)/ epoxy (65%)

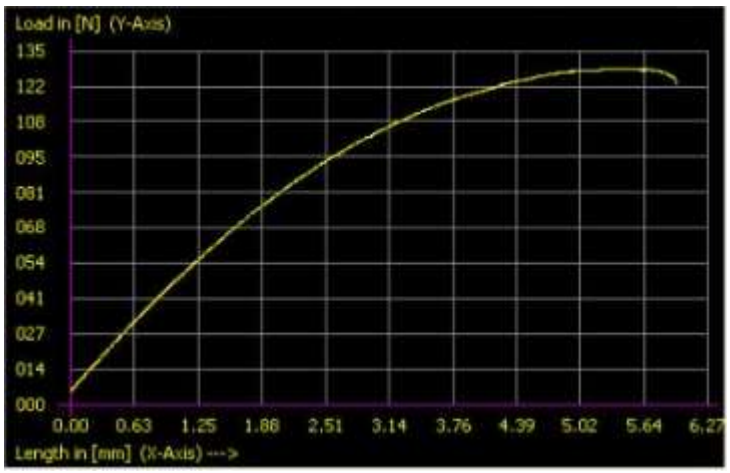

Fig -18 Flexural properties of sisal (35%) / coconut shell powder (10%)/ epoxy (55%)

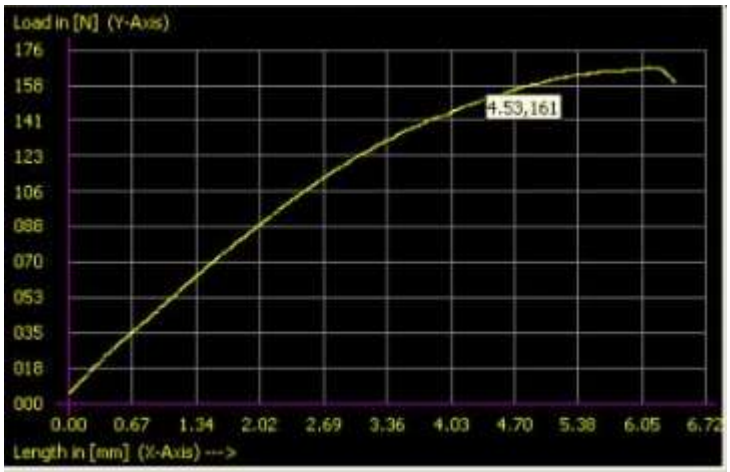

Fig -19 Flexural properties of sisal (35%) / coconut shell powder (15%)/epoxy (50%)

6.1 FLEXURAL TEST – CONCLUSION:

The plot shows that, the maximum flexural strength is obtained for the composite prepared with **sisal (35%) / coconut shell powder (10%)/ epoxy (55%)**

7. CONCLUSION

By doing literature survey idea about types, structure, advantages and application of composite material has been obtained. This has been needed for developing composite material using coconut shell powder and sisal fiber along with epoxy matrix material. By using this information bilateral composite specimen of size 27cm27cm has been manufactured. Experiments were conducted on coconut shell powder / sisal fiber laminate composite specimens with varying fiber weight percentage to evaluate the tensile properties.

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