Experimental Investigation of Mechanical Characteristics of Natural Reinforced Ground Nut/ Rice Husk/Coir Fiber Composites

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***Abstract* -** In technology innovation and development are mainly concerned in composite material. It has high strength to weight ratio compared to conventional materials. The present research is an attempt to develop an investigation of two different types of fiber that has combination of groundnut shell and rice husk (natural fiber) next one is ground nut and coir (natural fiber) the resin is epoxy (synthetic resin). Two number of plates in different mixing ratio (fiber: resin) using reinforced epoxy resin/ groundnut fiber, rice husk, coir with the help of hand lay-up and compression molding method. Mechanical properties like tensile strength, flexural strength, impact strength for epoxy resin/groundnut fiber, rice husk and coir composite have been investigated and compared.

Keywords*: Reinforced Epoxy Resins; Hand Layup; Compression Molding; Resin Mixing Ratio*

1. INTRODUCTION

Composites are combinations of two or more than two materials in which one of the materials, is reinforcing phase (fibers, sheets or particles) and the other is matrix phase (polymer, metal or ceramic).

Composite materials are usually classified by type of reinforcement such as polymer composites, cement and metal- matrix composites. Polymer matrix composites are mostly commercially produced composites in which resin is used as matrix with different reinforcing materials. Polymer (resin) is classified in two types thermoplastics (polyethylene (PE), polypropylene (PP), polyether ether ketone (PEEK), polyvinyl chloride (PVC), polystyrene (PS), polyolefin etc.) and thermosets (epoxy, polyester, and phenol– formaldehyde resin, etc.) which reinforces different type of fiber like natural (plant, animal, mineral) and man-made fiber for different application

Due to increase in population, natural resources are being exploited substantially as an alternative to synthetic materials. Due to this, the utilization of natural fibers for the reinforcement of the composites has received increasing attention. Natural fibers have many remarkable advantages over synthetic fibers. Natural fibers are largely divided into three categories depending on their origin: Mineral based, Plant based, and Animal based

Composites are fast taking over as superior alternative to other traditional materials even in high pressure and aggressive environmental situations. Applications of composite are increasing tremendously along with the concurrent need for knowledge generation in the area. With technology innovations and developments in processes and products, composites have become attractive candidates for applications in oil gas, piping system, topside applications, down-hole tubing in sub-sea, and others.

Composites meet diverse design requirements with significant weight savings and exhibit high strength-to-weight ratio compared to conventional materials. Composites have proved to be

worthy alternative to other traditional materials even in the high-pressure and aggressive environmental situations. Besides superior corrosion resistance, composite materials exhibit excellent fatigue performance, good resistance to temperature extremes and wear, especially in industrial sectors

Epoxy is a term used to denote both the basic components and the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as poly-epoxides, are a class of reactive pre-polymers and polymers which contain epoxide groups. Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerization, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols

Groundnut botanically known as Arachis hypogeal belongs to Leguminosae family. India is the second largest producer of groundnut after China. In India, groundnut is the largest oilseed in terms of production and accounted for about 7.5 million tons during 2009-10. A complete seed of Groundnut is called as pod and outer layer of Groundnut is called shell. Brian George et.al. [2] Investigated the groundnut shell fiber characterization. Average length of the groundnut

shell fibers was found to be 38mm and 0.25mm diameter. Average tenacity of groundnut shell fiber is of 1.06 g/den. Also, average strain of the fibers was 7.45 % and average modulus 25.3 g/den.

Coir (also known as "Kokos" or "Coco") is a natural seed-hair fiber obtained from the outer shell (endocarp), or husk, of the coconut, the fruit of Cocos nucifera, a tropical plant of the Arecaceae (Palmae) family, extensively grown in tropical countries. Coir yarn has been produced in the coastal belt of Kerala from time immemorial, but the first coir factory for the manufacture of coir products was established at Alleppy, in Kerala during 1858.

Fabrication process for making composites are Hand Lay-Up, Bag Molding, Pultrusion, Filament Winding, Preformed Molding Compounds, Resin Transfer Molding, Injection Molding, Reaction Injection Molding (RIM)Reinforced Reaction Injection Molding, Spray-Up.

2. EXPERIMENTAL PROCEDURE

2.1 Materials

In this, the ground nut and coir fiber have been used with epoxy with matrix material.

2.2 Matrix Material Preparation

The epoxy was sourced from the local markets.

First, to prepare epoxy resin. It is initially added to the 10:1 ratio with hardener to make epoxy a little solid.

2.3 Fiber Preparation

Ground nut fibers and coir fibers obtained from the rural areas of Tamilnadu, India.

The fibers plate configuration was prepared by arranging and cutting for [28×25] centimeters for cloth based.

2.4 Fabrication Method

The below combination of Resin Samples were made up with Hand Lay-Up method. The combinations were allowed to cure at room temperature. No load is applied to any of the samples. Fiber Resin Ratio is 30: 70. For all the combinations only coir fiber, groundnut shell and rice husk combination is employed as reinforcement. It is found that Epoxy is preferred for the carryover of this project as they provide rich appearance and good bonding.

The disadvantages with Hand Lay-Up method say like waviness of the surface, significant long curing time of this particular resin combination, equal dispersion of resin throughout etc., is been recovered using Compression Molding.

Description of plates

Plate – 1

Fig: 70 % epoxy resin + 30 % (groundnut shell and rice husk)

Fiber Resin mixing ratio	30:70	**Fiber**	**Resin**
		300 Grams	700 Grams
Resin Mixing Ratio	10:1	**Epoxy**	**Hardener**
		700 Grams	70 Grams
Fiber Mixing Ratio	1:1	**Groundnut cell**	**Rise husk**
		150 Grams	150 Grams
Load applied	1500 psi		
Time Taken for Load Application	1 Hour		
Heat Applied	80°c		

Plate - 2

Fig: 70%epoxy+30%groundnut and coir

Fiber Resin mixing ratio	30:70	**Fiber**	**Resin**
		300 Grams	700 Grams
Resin Mixing Ratio	10:1	**Epoxy**	**Hardener**
		700 Grams	70 Grams
Fiber Mixing Ratio	1:1	**Groundnut cell**	**Coir**
		150 Grams	150 Grams
Load applied	1500 psi		
Time Taken for Load Application	1 Hour		
Heat Applied	80°c		

2.5. Mechanical characterization

2.5.1. Tensile test

The tensile test was performed in accordance with the MME4 Tensile (FRB)-ASTM D638 standards. The test specimen size was 165mm×19mm×6mm. The test was performed in universal testing machine (U.T.M) of 10 ton capacity. The flat specimen of required dimension made by vernier caliper. Then the specimen were fixed between the grips of each head of the testing machine in such a way that the direction of force applied on the specimen longitudinal axis.

Fig: After Tensile Test specimen

S.No	Sample	Tensile Strength
1.	Epoxy 70% + Fiber 30% (groundnut +rice husk)	9.17 Mpa
2.	Epoxy 70% + Fiber 30% (groundnut +coir)	13.59 Mpa

2.5.2. Flexural Test

The flexural test was performed a per the MME5 Flexural (FRB) ASTM D790 standards the test specimen was 150mm×12.7mm×10mm. The material is laid horizontally over two point of contact and then force is applied at the top of the material through either one or two point of contact until sample fails. Then maximum flexural strength of the material is recorded.

Fig: After Flexural Test specimen

S.No	Sample	Flexural Strength
1.	Epoxy 70% + Fiber 30% (groundnut +rice husk)	0.135 kN
2.	Epoxy 70% + Fiber 30% (groundnut +coir)	0.085 kN

2.5.3. Impact strength

Charpy impact test of the specimens conducted as per the MME8 (FRB) – ASTM D256 ASTM standards. The test specimen of 127mmx10mmx12.7mm was prepared and V notch was provided with the triangular shape 45° from the center axis. The specimen was fixed in the vice. When the pendulum was released the energy transferred to the material can be observed and calculated by comparing the difference in the height of the hammer before and after the fracture.

Fig: After Impact Test specimen

S.No	Sample	Impact Strength
1.	Epoxy 70% + Fiber 30% (groundnut +rice husk)	0.4 J
2.	Epoxy 70% + Fiber 30% (groundnut +coir)	0.2 J

2.5.4. Result and Discussion

The two types of (Fiber: Resin) mixing ratio fabricated into various composite plates using natural fiber (Coir, Rice husk, Ground nut) and reinforced with epoxy resin. Various characterization tests were conducted and their results are observed and calculated.

2.5.5. Tensile Strength

It was observed that the tensile strength of composites Groundnut and Coir showed better result as compared to the plate Groundnut and Rice husk composites. In general tensile strength of epoxy was 30-35N/mm^2, the tensile strength of plate Groundnut and Coir composites with 70% resin shows the significant increase in the tensile strength with the maximum value of 13.59 MPa. It directly indicates the positive effect of reinforcement in the material.

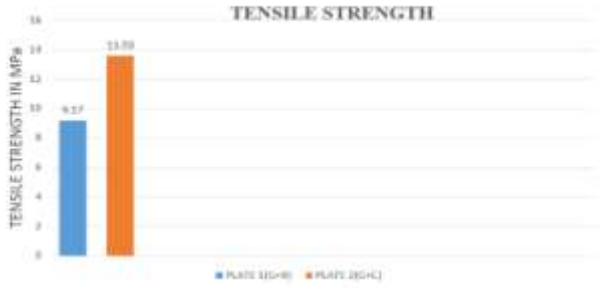

Figure shows the comparison of tensile strength of natural reinforced fiber composites.

2.5.6. Flexural strength

The flexural bending test was conducted on UTM and observed that the flexural strength of Groundnut and Coir natural resin reinforced based composite shows better flexural strength as compared to Groundnut and Rice Husk composites plate. The flexural strength of the Groundnut and Coir, Groundnut and Rice Husk are 0.135 kN and 0.085 kN.

Fig shows the comparison of flexural strength of natural reinforced composites fiber composites.

2.5.7. Impact strength

Charpy test was conducted on Impact testing machine and observed that the impact strength Groundnut and Coir and Groundnut and Rice Husk reinforced epoxy composite plates. The impact strength as compared between two composite plates Groundnut Coir shows the better impact strength. The Impact strength of the Groundnut+Coir, Groundnut+Rice Husk are 0.4 J, 0.2 J.

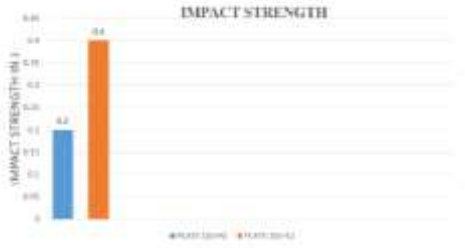

Fig shows the comparison in impact strength of composites plates.

3. Conclusion

Recent improvement in fiber extraction, treatments and resin systems are successful application in automotive industry have created a positive future in utilization of natural fibers. Here a natural fiber with biodegradable epoxy resin with different composition were initially fabricated with hand layup method on trial and error basis to study the bonding ability of resin with fiber and curing nature. In order to reduce drawback in hand layup method, compression mold is used. The combination of two plates were tested according to ASTMstandards. From the test results, it is found that combination of ground nut+ coir plates were better than the combination of ground nut + rise husk plates. Groundnut and coir combination possess the high strength in tensile, flexural, impact tests.

REFERENCES

Journals

1. AKINDAPO Jacob Olaitan, AGOV Emmanuel Terhemen **"Comparative Assessment of Mechanical Properties of Groundnut Shell and Rice Husk Reinforced Epoxy Composites"** American Journal of Mechanical Engineering, 2017, Vol. 5, No. 3, 76-86.

2. Paul Wambua, Jan Ivens, Ignaas Verpoest **"Natural fibers: can they replace glass in fiber reinforced plastics?"** Composites Science and Technology 63 (2003) 1259–1264.

3. Tushar Sonar, Shirish Patil **"Natural Fiber Reinforced Polymer Composite Material-A Review"** IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 22781684, p-ISSN: 2320–334X.

4. K. P. Ashik, Ramesh S. Sharma **"A Review on Mechanical Properties of Natural Fiber Reinforced Hybrid Polymer"** Composites Journal of Minerals and Materials Characterization and Engineering, 2015, 3, 420-426.

5. M. R. Sanjay, G. R. Arpitha, **"Applications of Natural Fibers and Its Composites: An Overview"** Natural Resources, 2016, 7, 108-114.

6. Salim Yamini, Robert J. Young **"The Mechanical Properties of Epoxy Resins"** Journal of Materials Science 15 (1980) 1823-1831 Vol. 0022-2461/80/071823-095

7. D.Vermal, P.C.Gope, **"Coir Fiber Reinforcement and Application in Polymer Composites: A Review "** J. Mater. Environ. Sci. 4 (2) (2013) 263-276 ISSN: 2

Books

8. **"Engineering Composite Material"** by Bryan Harris. Institute of Materials, London (1999).

9. **"Non Wood Forest Products, Gums, Resins, Latexes of Plant Origin"** by J.J.W Coppen. Food and Agricultural Organization of the United Nations Rome (1995)