Mechanical Behaviour Of Natural Fiber Reinforced Polymer Matrix Composites

B.Brindhavanan,
Department of Mechanical Engineering
Sri Krishna College of Technology
Coimbatore, India

A.Athithanambi, M.E.,
Department of Mechanical Engineering
Sri Krishna College of Technology
Coimbatore, India

***Abstract*— This paper presents the Fiber-reinforced polymer composites have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. The fiber which serves as a reinforcement in reinforced polymer is in the form of natural fibers. In this connection, an investigation has been carried out to make use of coconut fiber which is available abundantly in India. Natural fibers are not only strong and lightweight but also relatively very cheap. The present work describes the development and characterization of a new set of research was carried out by reinforcing the matrix (Epoxy resin) with natural material (Coconut fiber). The newly developed composites are characterized with respect to their mechanical characteristics. The natural fibers were exposure to chemical treatment (NaOH) before manufacturing of laminates. Samples of coconut-Epoxy laminate were manufactured using compression moulding method were the stacking of fibers takes place. Specimens were cut from the fabricated laminate according to the ASTM standards for different experiments. For Tensile test, flexural test and Impact test samples were cut in the desired shape. Tensile Strength, Flexural Strength and Impact Strength were observed and compared to each other. Tensile test showed maximum ultimate tensile strength for untreated 80 mm length fiber compared to others. Flexural test showed maximum ultimate flexural strength for untreated 80 mm length fiber compared to others. Impact test showed higher impact energy for treated 40 mm length fiber compared to others.**

Keywords—CoconutInflorescence;NaOH;Epoxy Resin;Compression moulding;Tensile test;Flexural test;Impact test.

I. INTRODUCTION TO COMPOSITE MATERIAL

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fiber-reinforced composites, owing to their superior properties, are usually applied in different fields like defense, aerospace, engineering applications, sports goods, etc. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties. A lot of work has been done by researchers based on these natural fibers. Natural fibers such as jute, sisal, silk and coir are inexpensive, abundant and renewable, lightweight, with low density, high toughness, and biodegradable. Natural fibres such as jute have the potential to be used as a replacement for traditional reinforcement materials in composites for applications which requires high strength to weight ratio and further weight reduction. Bagasse fiber has lowest density so able to reduce the weight of the composite upto very less. So by using these fibers (jute, bagasse, and lantana camara) the composite developed is cost effective and perfect utilization of waste product. Natural fiber reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibers in fiber reinforced composites. They are high specific strength and modulus materials, low prices, recyclable, easy available in some countries, etc.

II. MATERIALS AND METHODS

1. Raw Materials Used in These Experiments

i. Natural fiber
Coconut inflorescence
ii. Epoxy resin –LY 556
iii. Hardener –HY 951

2. Coconut Inflorescence:

An Inflorescence is a group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches. Morphologically, it is the part of the shoot of seed plants where flowers are formed and which is accordingly modified. The modifications can involve the length and the nature of the Internodes and the phyllotaxis, as well as variations in the proportions, compressions, swellings, adnations, connations and reduction of main and secondary axes. Inflorescence can also be defined as the reproductive portion of a plant that bears a cluster of flowers in a specific pattern. The stem holding the whole inflorescence is called a peduncle and the main stem holding the flowers or more branches within the inflorescence is called the rachis. The stalk of each single flower is called a pedicel. The fruiting stage of an inflorescence is known as an infructescence. A flower that is not part of an inflorescence is called a solitary

flower and its stalk is also referred to as a peduncle. Any flower in an inflorescence may be referred to as a floret, especially when the individual flowers are particularly small and borne in a tight cluster, such as in a pseudanthium.

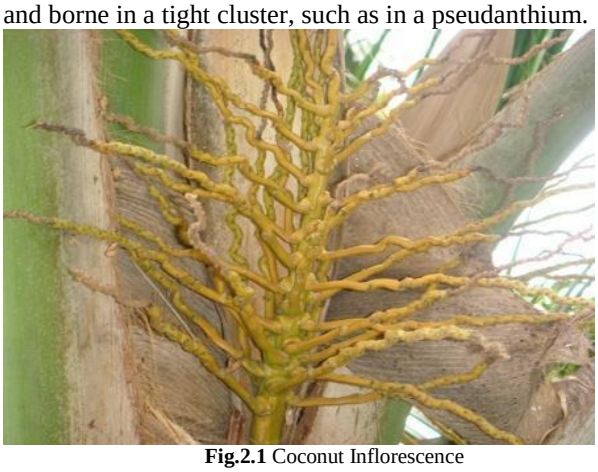

Fig.2.1 Coconut Inflorescence

3.Fiber Preparation:

The various steps in preparation of fiber are fiber extraction, pre-treatment, and chopping according to requirement.

4. Fiber Extraction:

The coconut inflorescence contains fiber which is surrounded by thick flesh material. In order to obtain the fiber the inflorescence is placed in water for about 10 days. Then the coconut inflorescence is hammered such that fiber comes out of the flesh. Then the fiber which is obtained is placed in a room without contact with sunlight such that the fiber gets separated individually. Then the fiber can be prepared for chemical treatment.

5. Fiber Treatment:

The extracted fibers are to be chemically treated with NaOH for making the surface of the fiber rougher such that bonding will be better during composite fabrication. In this work the fibers were treated with 5% of NaOH. The chemical treatment erodes the material from the fiber. The chemical treatment erodes the cellulose, lignin and wax contents.

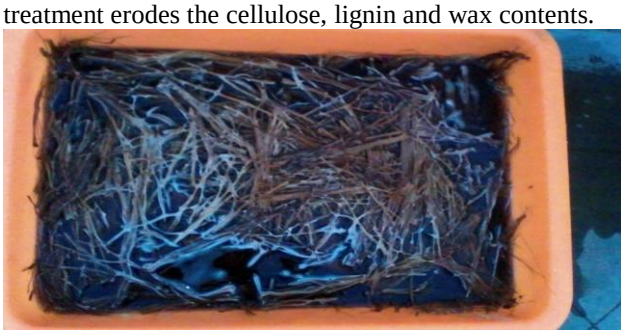

Fig.5.1 Chemical Treatment of Coconut Inflorescence

6. Fiber Chopping:

Treated fibers were chopped uniformly for different length of 40mm & 80mm.

7. Fabrication Of Composite:

The composite specimen is fabricated by compression moulding technique.

8. Sizing of Fiber:

The fiber treated with 5% of NaOH solution, and non treated fiber, both the materials are cutted into a specific standard size that are 40mm & 80 mm. Comparing process of coconut fiber consist of four type of fiber material that are.

1. Treating 40mm size fiber with NaOH
2. Treating 80mm size fiber with NaOH
3. Non treated 40mm fiber
4. Non treated 80mm fiber

9. Fabrication Of Fiber Plates:

Fiber plates are made by using compression moulding process. Required dimension of fiber plates are 270mm square and thickness of 3mm.

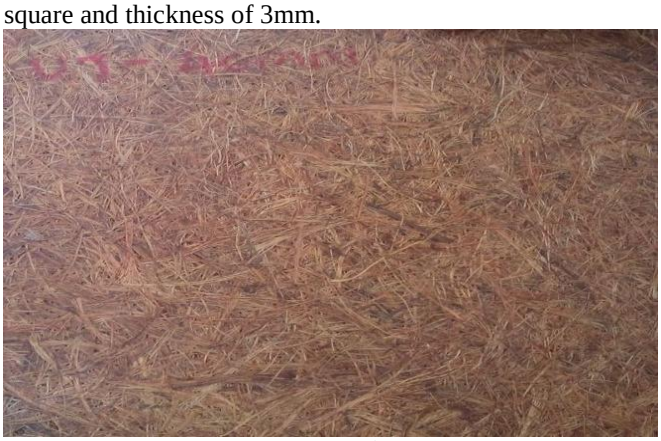

Fig 9.1: Fabrication of Fiber Plates.

Dies are selected with accurate dimensions of required plate size, addition of clearance 20mm because of compression force elongate the fiber and it may increase the size. Poly vinyl alcohol is pouring on the surface of female die as well as the male die to remove the fiber plate safely. Fiber plate should contain Epoxy Resin of 30% to increasing the strength. Compression pressures play a leading role in fiber plate fabrications. Applied Pressure to the male die is **1500 psi** and the temperature maintained at **70-80 C**. Dies are keep in the position and hold it for 2 hours.

The four type of fiber plates are fabricated by using compression moulding process.

10. Sample Dimensions Analyze:

Three types of tests are involved in this process to measure the strength of a specimen. Before testing we made cut samples. Various tests need a various dimensions that are given below,

Tensile test needs dimensions with the ASTM D638 standard: 19 mm width, 165 mm length and 3 mm thickness and 10 mm min-1 crosshead speed. Flexural tests, a load were applied on the specimen at 2.8 mm min-1 crosshead motion rate. It needs dimensions with the ASTM D 790 standard: 25 mm width,76 mm length and 3mm thickness. Impact tests needs dimensions with the ASTM D 6110 standard: 12 mm with, 63.5 mm length and 3mm thickness. It was evaluate impact strength.

11. Mechanical Testings:

Experimental investigation on the mechanical properties of natural fiber.

1. Tensile strength
2. Flexural strength
3. Impact strength

III. RESULT AND DISCUSSION

1.Results of Tensile Test

As determined the UTS vs Length of fiber reinforcement is shown in fig .The strength of 80mm untreated fiber reinforcement reach the maximum content, compare to other. That is 18.179 N/mm2.

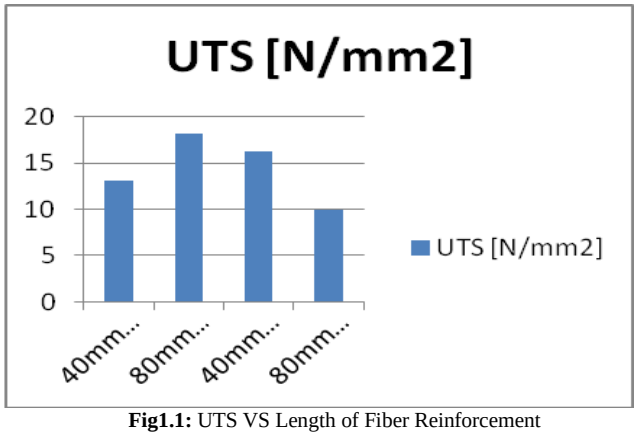

Fig1.1: UTS VS Length of Fiber Reinforcement

2. Results of Flexural Test

The flexural properties of the fibers/PR composites with different proportions were tested. The volume fraction of fibers and resin was used is 70:30.And 80mm untreated fiber reinforcement reach the maximum content, coMpare to other. That is 52.049Mpa.

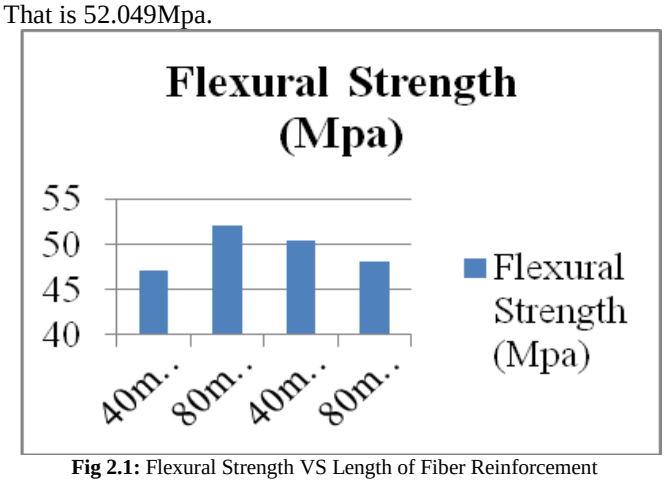

Fig 2.1: Flexural Strength VS Length of Fiber Reinforcement

3. Results of Impact Test

Izod impact tests were conducted based on ASTM D256 standard. Four samples for each reinforcement were tested and among them 40 mm treated fiber reinforcement has high impact strength of about 0.616 joules.

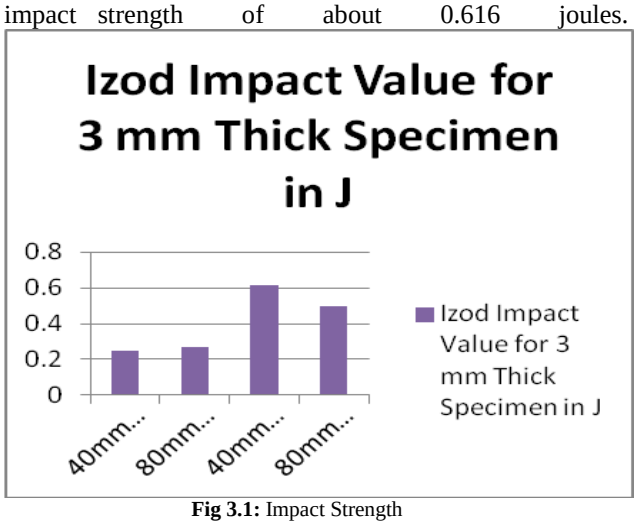

Fig 3.1: Impact Strength

IV. CONCLUSION

The experimental investigation on the mechanical properties of coconut fiber rei nforced polymer matrix composites leads to the following conclusions:

- ✓ Mercerization of coconut inflorescence fiber leads to thinner fiber with higher elongation.
- ✓ It is possible to make use of coconut inflorescence fiber as an alternate for synthetic fibers in the reinforcement of polymer matrix composites.
- ✓ Composites have been fabricated according to different length of fiber.
- ✓ According to the ASTM standards, the mechanical properties that have been founded are tensile, flexural, &impact test.
- ✓ Tensile test showed maximum ultimate tensile strength of 18.179 N/mm^2 for untreated 80 mm length fiber compared to others.
- ✓ Flexural test showed maximum ultimate flexural strength of 52.049 N/mm^2 for untreated 80 mm length fiber compared to others.
- ✓ Impact test showed higher impact energy of about 0.616 joules for treated 40 mm length fiber compared to others.

V. REFERENCES

1. Sudhir.A, Madhukiran.J, Dr.S.Srinivasa Rao, Dr.S.Madhusudan (2014): "Tensile and Flexural Properties of Sisal/Jute Hybrid Natural Fiber Composites",ISSN:2249-6645.
2. D.Chandramohan, Dr.K.Marimuthu (2011):"Tensile and Hardness Tests on Natural Fiber Reinforced Polymer Composite Material", ISSN:2230-7818.
3. Girisha.C, Sanjeevamurthy,Gunti Ranga srinivas (2012):"Sisal/Coconut Coir Natural Fibers-Epoxy Composites: Water Absorption and Mechanical Properties", ISSN:2277-3754.
4. Subramanian Raman, Chattopadhyay Subhanjan Salil Kumar , Sharan Chandran M (2014):"Fabrication, Testing and Analysis of Braided and Short fibre reinforced Jute Epoxy Bio-composite", pp 1721-1724.
5. Alok Singh, Savita Singh, Aditya Kumar (2013) : "Study of mechanical properties and absorption behaviour of coconut shell powder-epoxy composites", pp 157-161.
6. P. Hari Sankar , H.Raghavendra Rao (2011): "Chemical Resistance and Tensile Properties of Bamboo and Glass Fibers Reinforced Epoxy Hybrid Composites". ISSN 2277-7164.

7. Abdul Hakim Abdullah,Siti Khadijiah Alias,Norhisyam Jenal, Khalina Abdan,Aidy Ali (2012):"Fatigue behavior of kenaf fibre reinforced epoxy composites", ISSN 0125-8281.
8. Kishore Debnath, Vikas Dhawan, Inderdeep Singh, Akshay Dvivedi (2014)**: "**Adhesive Wear and Frictional Behavior of Rice Husk Filled Glass/Epoxy Composites", pp247-667.
9. Dr. Shajan Kuriakose, Dr. Deviprasad Varma, Vaisakh V.G (2012): "Mechanical Behaviour of Coir reinforced Polyster Composites–An Experimental Investigation", ISSN 2250-2459.
10. Dheeraj Kumar (2014): "Mechanical Characterization of Treated Bamboo Natural Fiber Composite", pp. 551-556.
11. E. F. Cerqueira, C. A. R. P. Baptista, D. R. Mulinari (2011): "Mechanical behaviour of polypropylene reinforced sugarcane bagasse fibers composites", pp 2046–2051.
12. Goulart.S.A.S, Oliveira.T.A, Teixeira.A, Mileo.P.C, Mulinari.D.R. (2011): "Mechanical Behaviour of Polypropylene Reinforced Palm Fibers Composites", pp 2034–2039.
13. P. S. Souza, E. F. Rodrigues, J. M. C Preta, S. A. S. Goulart, D. R. Mulinari (2011): "Mechanical properties of HDPE/textile fibers composites" , pp 2040–2045.