

Synthesis and Analysis of Mechanical Properties of Luffa Cylindrica and Coconut Coir Reinforced Epoxy Composite.

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ABSTRACT: Luffa Cylindrica and coconut are widely available fruits in India. Apart from being edible, these fruits are also a great source of plant fibres. The main objective of this project was to prepare a composite using Luffa cylindrica and Coconut coir together as reinforcement in different ratios with Araldite LY- 556 and Hardener HY 951 as matrix material. The composites were fabricated with help of Hand Layup technique. Experiments were conducted to investigate the water absorption characteristics and mechanical properties such as tensile, flexural and impact strength of the composites with changing ratios of fibres content. After the successful completion of the experiments it was found that the water absorption was lowest in composite with equal ratio of fibres. It was also observed that the tensile and impact strength were increasing with the increase in coconut coir where as the flexural strength was increasing with the increase in luffa fibre in the composites.

KEYWORDS: Luffa Cylindrica, Coconut coir, Araldite LY-556, Hardener HY 951, Hand layup technique, water absorption, tensile, flexural, impact.

I. INTRODUCTION

A composite material is a microscopic or macroscopic combination of two or more distinct materials which are not soluble in each other and having a recognizable interface between them. The combination of two or more materials rectifies weakness of one material by strength of other. Composite material consists of two major component reinforcement and matrix. The main function of reinforcement is to carry load, provide toughness and prohibit crack propagation. On the other hand the function of matrix is to transmit the load to fibres and provide the craved shape by holding the reinforcement.

Fibrous reinforcements are characterised by length greater than the cross sectional area of the fibre. Natural fibre reinforced epoxy composites are receiving great attention due to exacerbating environment problems in recent decades. Plants fibres in the above context are gaining popularity as they are sustainable alternatives of synthetic fibres. Apart from being biodegradable, plants fibres are light in weight and offers appreciable lower cost compared to the synthetic fibres. However, Natural fibre shows lower strength and stiffness which can be improved by systematic arrangement of fibres at critical locations.

This research aimed at exploring the mechanical properties of composites having Luffa Cylindrica and Coconut Coir as reinforcement in different proportions. The Composites were fabricated with luffa and coir reinforcement together in ratios of 3:1, 1:1 and 1:3 respectively. The tensile, flexural, impact strength and water absorption behaviour were investigated according to ASTM Standards. The water absorption capacity of the various fabricated composites were analysed by exposing them to distil water environment for 156 hours. The samples were reweighted and measured after every 12 hours regularly. The tensile, flexural and impact strength tests helps us to trace the maximum load bearing capacity of various composites.

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II. MATERIAL AND METHODS

- 1. Materials:** Luffa Cylindrica is a fruit of Cucurbitaceous family and widely available in India. The young luffa cylindrica is edible and commonly consumed as vegetable curry. When the fruit is fully developed, it becomes fibrous from inside and used as scrubbing and cleaning sponge in kitchens and bathrooms after sun drying. The sun dried Luffa cylindrica fibres were collected from the native farm located in Bikarampur Village of Shridham (Teh.), Narsinghpur District which is 64 kilometres away from Jabalpur city.



Fig.1 Luffa Cylindrica and fibre

Coconut is a fruit of Arecaceae family. India is one of the largest producers of coconuts. Coconut owns versatility in usage ranging from food to cosmetics. The outer shell of the coconut is covered with fibrous husk which is known as coir. Broken coconut shells were collected from Paat Baba Temple located in Gun Carriage Factory Estate, Jabalpur, India for extracting the coir. The fibre and coir were separately washed with water in order to remove all undesirable materials like dust, wax and oil. The fibres were allowed to sundry for one week. The epoxy resin Araldite LY-556 and Hardener HY-951 were supplied by Herenba Instruments and Engineers Chennai Tamil Nadu.



Fig.2. Coconut fruit and its coir.

- 2. Mould Preparation:** A wooden mould of 250 mm x 250 mm was used to prepare the composite. Four small block of 10 mm x 10mm x 6 mm were fixed at corner in order to obtain the composite of thickness of 6 mm.

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- Chemical Modification:** Natural fibres are hydrophilic in nature. They tend to absorb moisture due to the presence of hydrogen bonding in network structure of fibres. The natural fibres are made hydrophobic in nature by Alkaline Treatment. The treatment ensures the eviction of hydrogen bonding from the fibre structure. Fibres were immersed in 2% Sodium Hydroxide (NaOH) solution for 3 hours at room temperature. They were washed thoroughly to remove the excess NaOH sticking to them. The final wash was done with distill water and then, fibers were sundried for 1 week to eradicate the moisture completely. The reaction involved in the treatment is shown below.

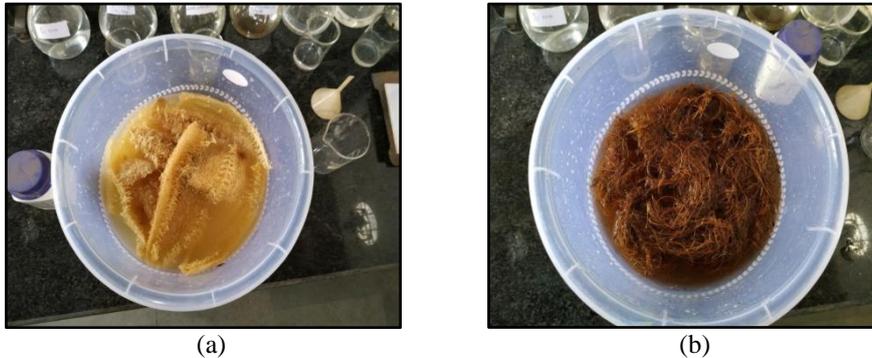
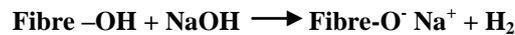


Fig.3 Alkali treatment of (a) Luffa fibres and (b) Coconut coir.

- Composite Fabrication:** The composite were fabricated by using Hand Lay technique. A mould film was placed at the bottom of the mould for the easy removal of the composite. The Araldite LY 556 was preheated up to 50°C to simplify the mixing process with Hardener HY 951. A homogenous mixture of resin and hardener was prepared in ratio 10:1 by weight respectively. A thin layer of the mixture was poured followed by placing of fibre mat onto the mixture. The resin-hardener mixture was applied over the fibre mats with help of spatula. A roller was rolled after placement of mats to remove air bubbles from the layers of composite. The procedure was repeated to get desired Luffa-Coir ratio. All fibres were placed unidirectional in the mould. The mould was closed and clamped under pressure in C Clamps for 24 hours.

III. EXPERIMENTAL DETAILS

- Water Absorption Test:** The samples from various composites were prepared according to ASTM D 570 standards for water absorption test. The specimens of composites were subjected to distil water environment for 156 hours. The weights of specimen were taken before they were immersed in water. The changes in the final weights of specimen were noted after an interval of 12 hours consecutively. The moisture sticking to the specimens were removed by a clean dry cloth before recording the weights.
- Tensile Strength:** The tensile strength of the composites was tested as per specifications laid in the ASTM D 3039 standard. The test specimen were of dog bone shape having dimensions 140 mm x 15 mm x 6 mm with span length of 42 mm and width of 10 mm. The test was performed on Amsler universal testing machine 10 tonnes capacity. A uniform strain rate of 2 mm/min was employed.

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Fig. 4 specimen for tensile test

- Flexural Strength:** The flexural strength of the composites was tested using 3 point bending method. The specification is laid in the ASTM D 790-03 standards. The test specimens were prepared in dimension of 140 mm x 15mm x 10 mm. The test was performed on Amsler universal testing machine of 10 tonne capacity. The crosshead speed of 2mm/ min was maintained.



Fig. 5 Specimen for Flexural test.

- Impact Strength:** The impact strength of the composite was tested using Charpy Test. The specimens were prepared in dimension of 55 mm x 10 mm x 10 mm according to ASTM E 23. The depth of U notch was 2 mm with 45° angle. The samples were fractured in Charpy impact testing machine and the energy absorbed (in Joules) were recorded.

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Fig 6. Specimen for Charpy Impact test.

IV. EXPERIMENTAL RESULTS

1. **Water Absorption Test:** Table 1 shows the composition of various composite and their initial weight before the commencement of experiment. The final weights of composites were noted and percentage gains in weight were calculated after exposure of specimens to distil water environment for 156 hours.

Table.1. Percentage change in weight of various composites.

Sample	Ratio of Luffa : Coir	Composition (Grams)		Initial Weight (Grams)	Final Weight (Grams)	Weight gain (Grams)	Percentage of Weight Gain
		Luffa	Coir				
A 1	3:1	30	10	13.70	15.79	2.09	15.25
B 1	1:1	20	20	14.36	15.81	1.45	10.09
C 1	1:3	10	30	14.42	17.37	2.95	20.45

Table.1 shows the nature of weight gain of the composites due to water absorption in distil water environment. The figure shows increase in rate of water absorption with increase in the immersion time. The composites showed saturation after 120 hours after which very slight increase in weight was observed with passage of time. The sample C4 showed maximum water absorption. There was an increase of 2.95 grams after passage of 156 hours. The sample B5 showed minimum water absorption with an increase of 1.45 grams from the initial weight after the completion of the experiment.

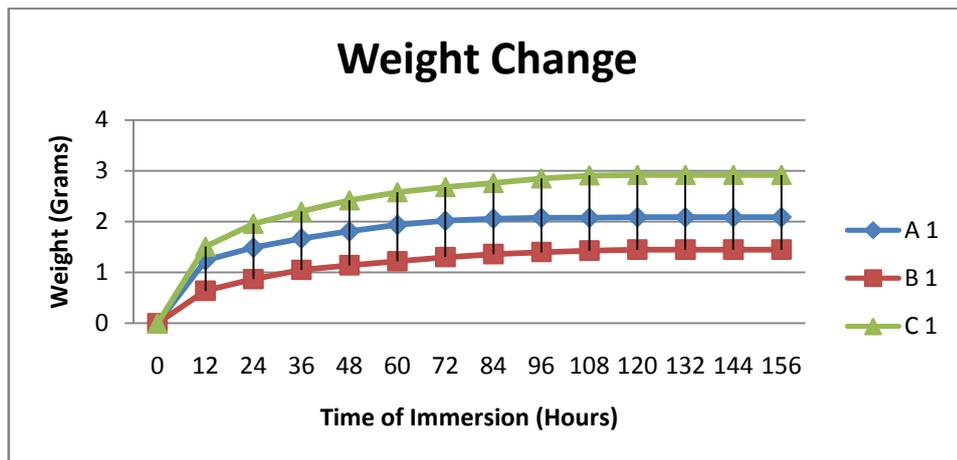


Fig.7 Change in weight of composites in grams

2. **Tensile Strength:** Fig 8 shows the variation in tensile strength of composites with varying ratios of luffa fibre and coconut coir. It has been observed that the tensile strength is found to maximum in the sample C2 having luffa to Coir ratio as 1:3. The tensile strength of C2 was found to be 50.41 MPa. The experiment showed increase in tensile strength with increase in the coconut coir fibre.

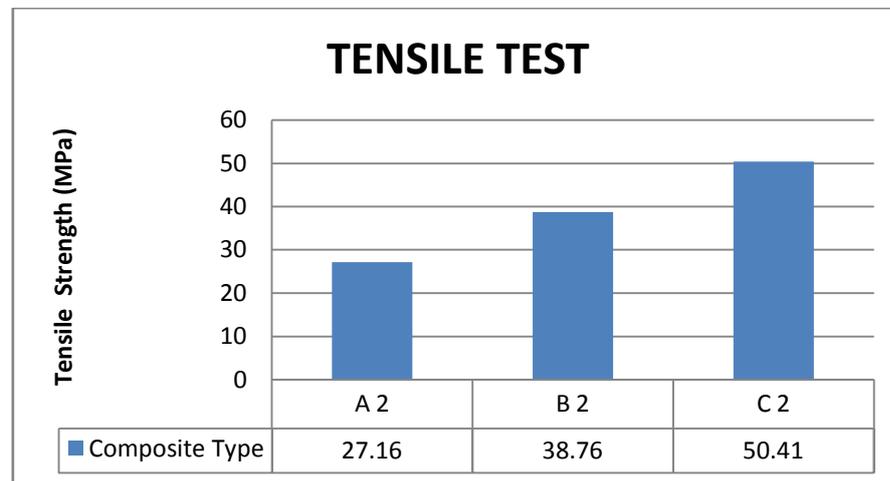


Fig.8. Tensile Strength of various composites.

3. **Flexural Strength:** Fig.9 shows the variation in flexural strength of composite with varying ratios of luffa fibre and coconut coir. An increase in flexural strength was found with increase of luffa fibre in the composites. The sample A3 showed maximum flexural strength of 44.5 MPa.

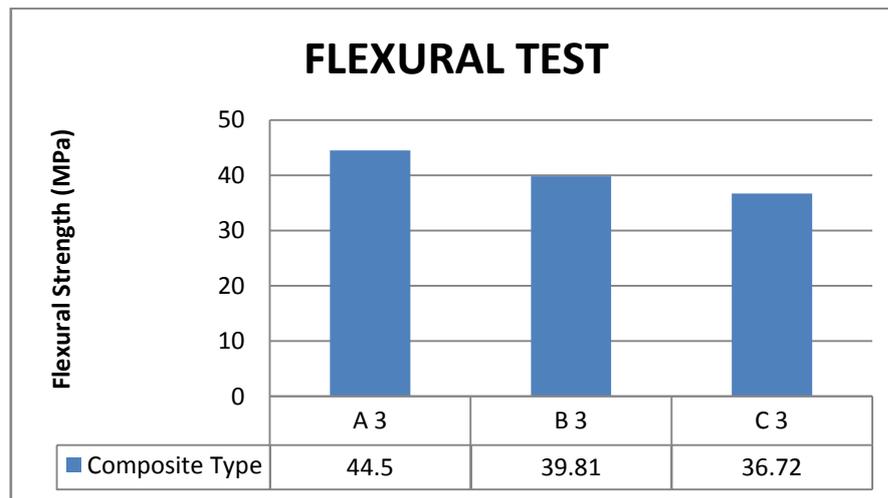


Fig.9. Flexural Strength of various composites.

4. **Impact Strength:** Fig.10 shows the variation in Impact strength of composite with varying ratios of luffa fibre and coconut coir. The maximum energy was absorbed by sample C4 having luffa to coir ratio as 1:3. It was observed that absorption of impact energy was increased with increment of the coir fibre in the composite.

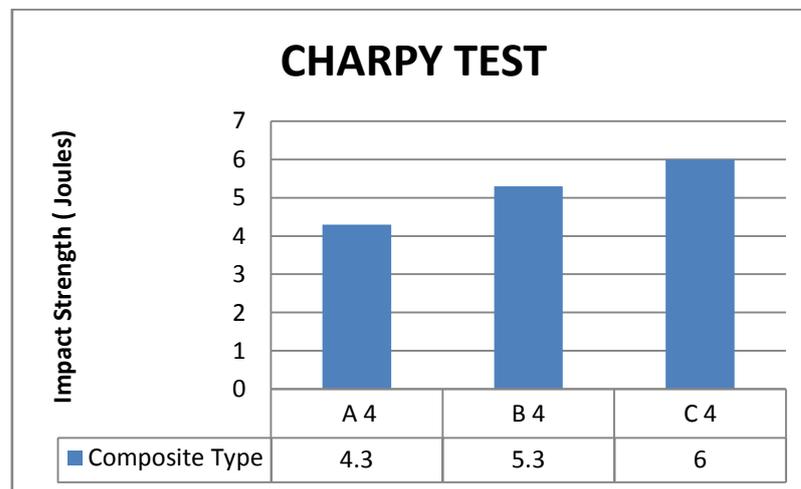


Fig.10. Impact strength of various composites.

V. CONCLUSION

In the present research endeavour, different tests were conducted over composites having different ratios of fibres for the analysis of their characteristics. Based on experimental results, this study has led to the following conclusions:

1. A new natural fibre composite can successfully be fabricated using Luffa cylindrical fibre and coconut coir together as reinforcement.
2. The rate of weight gain increases with increase in immersion time.
3. The point of saturation in moisture absorption appears after 120 hours.

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- The rate of moisture absorption was fast at beginning which slowed down while reaching towards the saturation point.
- The sample with luffa and coconut coir ratio as 1:1 showed minimum water absorption.
- The tensile strength and impact strength were found to be increasing with increase in coconut coir content in composite.
- The flexural strength was found to be increasing with the increase of luffa fibre in composites.
- The composite having luffa to coir ratio 1:1 has shown intermediate values for tensile, flexural and impact strength.

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