EFFECT OF MOISTURE ABSORPTION AND THEIR IMPACT ON THE MECHANICAL PROPERTIES OF COIR-LUFFA FIBRE REINFORCED POLYMER MATRIX COMPOSITES

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ABSTRACT

The physical properties of fiber reinforced polymeric materials are very important under the various environmental condition. Composite specimens are prepared by hand lay-up method containing luffa mat, small coir fiber with different fiber length and content were developed. Water retention test was conducted by the submersing specimen in distilled water for a variable time period till they achieve their saturation state. The specimen was soaked in normal water for 10 days before testing to decide the impact of water absorption on the mechanical properties. The specimen was tested for reference without water immersion. The tensile strength, flexural strength and impact strength behavior of water immersed specimen were conducted and compared with that of without water immersion specimens as per ASTM standard. A considerable loss in the physical and mechanical properties of coir-luffa fiber composites is observed after water absorption. Moisture absorption leads to the degradation of fiber-matrix interface region creating poor stress transfer efficiencies resulting in the reduction of mechanical and dimensional properties.Fracture surfaces of dry and wet sample of composites were observed by Scanning electron microscope.

KEYWORDS: Luffa Fiber, Coir Fiber, Water Absorption, Mechanical Behaviors & SEM

1. INTRODUCTION

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In fiber reinforcement polymer composites, the reinforcements are either synthetic or natural fibers. Synthetic fibers are made from synthesized polymer or small molecules. *G*rowing need for energy efficient and environment compatible processes andproducts have triggered a fundamental change towards designing of newer the natural fibers have a great attention as they are a substitute to the exhausting petroleum sources. Among all reinforcing fibers, natural fibers have increased substantial importance as reinforcements in polymer matrix composites. Low density, good specific modulus values, considerable toughness, flexibility, easy processing, non-toxicity, non-abrasion during processing, recyclability, low cost, resistance to corrosion are the properties of natural fibre. The natural fibre also has some disadvantages like unsuitability between the hydrophilic and hydrophobic thermoplastic and thermoset matrices. The specific mechanical properties of natural fibers are equivalent to those of

andinnovative materials. Biofibres, derived from renewable plant sources are increasinglybe*ing used as* reinforcing materials in both thermoplastic and thermoset matrixcomposites which provide added advantage of ultimate disposability and raw materialutilization.Nowadays,

synthetic reinforcements. Natural occurring fiber-based composites pay attention for making ecological suitable engineering materials, consequently, it has forced manufacturing industries such as automotive, construction and wrapping to replace new materials that can substitute rather than conventional non-renewable reinforcing materials such as carbon fiber, glass fiber. The current study is based upon the water absorption in luffa fibre with different component ratio and effect of water absorption in luffa fibre in different mechanical properties.[1,2,3]

2. MATERIALS

2.1MaterialRequirements

A. NaturalFibers

Luffacylindrica, coir

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B. Chemicals

Epoxy LY556, Hardener HY951

2.2 Collection of Fiber

A. Luffa Fully ripened and dried fruits of Luffa cylindrica were collected locally from western Odisha region where they are quite abundantly found. After removal of the skin, its outer core was cut and gathered to be used as the fiber source.

B. Coir Coir dust was collected from the outer fiber cover on the hard shell of dried coconut. It was collected so as to be used as a particulate reinforcement.

2.3 Water Absorption

The moisture absorption in composite material is measure by weight difference of sample before immersion and after immersion.[4]

Water absorption (%) = $\frac{W_n - W_d}{W_d}$

Where, Wn = the weight of composite samples after immersion

W_d = the weight of the composite sample before immersion

2.4 Preparation of Mould

Wooden moulds were prepared with inner dimension of (14X12X4) cm3 and were firmly fixed over a board. The mould walls and base were properly covered with silicon paper. Figure 1 represents the mould prepared for fabrication of composites.

3 Evaluation

There is evaluation of behaviour of water absorption on composite materials and their effect on mechanical properties.

. 3.1 Water Absorption Behaviour

The effect of fiber loading and length of fiber on the water absorption behavior of coir epoxy composites added with luffa mate with an increase in immersion time is shown in figure 1

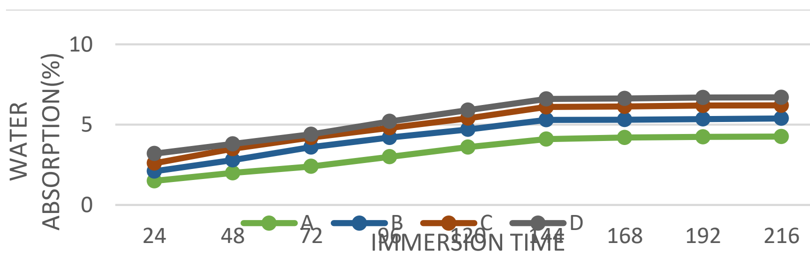

Figure 1: Water Aging Behavior of Hybrid Composites

IIt has been observed from the experimental investigation over the water aging behavior of hybrid composites that the rate of water absorption of the composites increases with increase in immersion time.It is further observed that after a certain value of water absorption, a saturation point will be reached and consequently no more water absorption takes place at that point of saturation.

3.2 Influence of water absorption on tensile strength

In this section, the studies are done for the effect of tensile strength of coir-luffa polymer composites. Fabrication of composites plays a vital role on the strength. The experiment has been done to study the tensile strength and results were obtained for both dry and water aged samples. The obtained graph are linear up to the point of failure which is shown in Figure.2

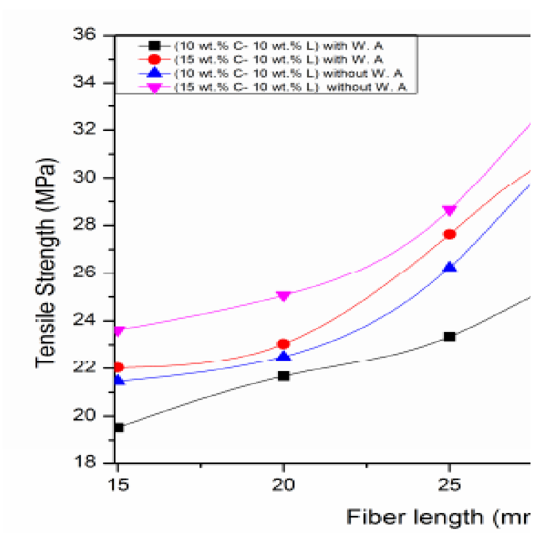

Figure 2: Variation in Tensile Properties with the Effect of Fibre Content and Fibre Length

It is observed that the tensile strength gradually increases with the increase in fiber length and reaches to a maximum value of 34.54 MPa at 30 mm fiber length in dry condition. It concludes a lower value at a greater length of fiber i.e. 35 mm.It is observed by experimental result that in case of small fiber length, tensile strength is less. The reason may be that length may not be sufficient for proper distribution of load.

3.3 Influence of water absorption on flexural strength

In this section, the studies are done for the effect of fiber length and content on the flexural strength of normal coir-luffa polymer composites. The results obtained is presented in figure. 3. It is observed that flexural strength increases as fiber content increased at 25 wt. % and 35 mm fiber length in the normal condition. The consequence is drawn from the figure 3 that the flexural strength of luffa-coir polymer increased from 31.64 Mpa to 60.13 Mpa. The reason for the increase of flexural strength may be because of the increased fiber length and content of coir-luffa polymer composites and also due to the ability of the natural fiber[4]

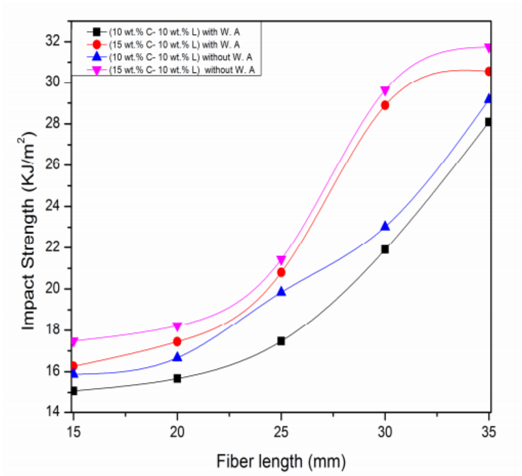

Figure 3: Variation in Flexural Properties with the Effect of Fiber Content and Fiber Length

3.4 Influence of water absorption on impact strength

In this section, the studies are done for the impact strength of coir-luffa polymer composites and the results has been shown in figure 4. It can be observed from figure 4 that impact strength rapidly increases up to fiber content 25 wt. %at 35 mm length in the dry sample because the presence of luffa mat increases the ability of these composites to absorb impact energy. The addition of luffa fiber and coir fiber from 10 wt. % to 15 wt. % increases the impact strength from 15.87 kJ/m2 to 31.75 kJ/m2 respectively in dry condition.[5,6,7]

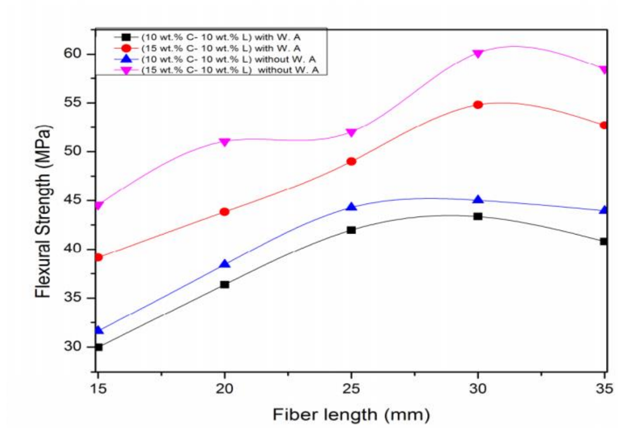

Figure 4: Variation in Impact Properties with the Effect of Fibre Content and Fibre Length

5 Conclusion

The following conclusions can be drawn from the experimental results of the coir-luffa composites which is summarized as below:

- The water aging behavior of hybrid composites that the rate of water absorption of the composites increases with increase in immersion time. After a certain value of water absorption, a saturation point will be reached and consequently no more water absorption takes place at that point of saturation. E2 composites (i.e. with 25 wt. % fiber loading and 35 mm fiber length) have maximum water absorption.
- Hardness decreases in all coir-luffa fiber reinforced sample in wet condition. The

hardness of the coir fiber reinforced composites decreases as the water absorption increases. The deformation depth increases for waterimmersed specimen compared to dry one.

• The tensile strength gradually increases with the increase in fiber length. Flexural strength increases as fiber content increased at 25 wt. % and 35 mm fiber length in the normal condition. The flexural strength of composite decreases after water absorption. The flexural strength characteristics decreases in wet composites as compared to dry composite sample.

• Impact strength rapidly increases up to fiber content 25 wt. % at 35 mm length in the dry sample. The addition of luffa fiber and coir fiber from 10 wt. % to 15 wt. % increases the impact strength from 15.87 kJ/m2 to 31.75 kJ/m2 respectively in dry condition. After water absorption, SEM image of the composites confirms that coir has a great tendency of swelling and absorb more moisture.

6. Reference

1.Bledzki AK, Gassan J. (1999) Composite reinforced with cellulose-based fiber. ProgrPolym Sci. 24(2), 221-247.

2. Mallick PK (1993) fiber reinforced composites- materials, manufacturing and design, 2nd edition. Marcel Dekker, Inc., New York, p 74

3. Satyanarayana KG, Sukumaran K, Kulkarni AG, Pillai SGK, Rohatgi PK (1986) Fabrication and properties of natural fiber reinforced polyester composite 17:329.

4. Monteiro SN, Terrones LAH, D'Almeaida JRM (2008) Mechanical performance of coir fiber/polyester composites. Polym test 27: 591-595.

5. Rashdi, A. A. A., Salit, m. S., abdan, K., &megat, M. M. H. (2010). Water absorption behavior of kenaf reinforced unsaturated polyester composites and its influence on their mechanical properties. Pertanika J. Sci. &Technol, 18(2), 433-44

6.C. Parida, S. K. Dash, and P. Chaterjee, "Mechanical Properties of Injection Molded Poly(lactic) Acid—<i>Luffa</i> Fiber Composites," *Soft Nanosci. Lett.*, vol. 05, no. 04, pp. 65–72, 2015, doi: 10.4236/snl.2015.54008.

7.A. Khan, S. Joshi, M. A. Ahmad, and V. Lyashenko, "Some Effect of Chemical Treatment by Ferric Nitrate Salts on the Structure and Morphology of Coir Fibre

Composites," *Adv. Mater. Phys. Chem.*, vol. 05, no. 01, pp. 39–45, 2015, doi: 10.4236/ampc.2015.51006.