International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Mechanical Behaviour of Coconut Coir Fibre Reinforced Unsaturated Polyester Composite

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Abstract*: With low cost, simplicity of manufacturing and the abundant availability of natural fibers have tempted the researchers to try the available fibres and to investigate their possibility of using it for the purpose of reinforcement. Since Coir fiber is renewable, eco-friendly, less weight and has good mechanical performance it is considered as one of the best alternative to Carbon fiber. In this present work the ability of coir fibre in improving the mechanical characteristic has been studied. Four specimens having different weight fractions (5%,10%,15% &20%) of coir fiber with polyester matrix is prepared and their corresponding mechanical properties has been determined. In this work the fiber is treated with Sodium Hydroxide (NaOH) for attaining good fiber separation and hand- lay-up practice have been employed for composite manufacturing. To find the mechanical characteristics of composite the following tests were performed on the prepared specimens like tensile test, Flexure and hardness test. Experimental result reveals that the composite with 15% coir fiber have a maximum tensile strength of 26.5Mpa From the Experimental results it is evident that the increase in coir fiber weight fraction results in improving the mechanical properties of the composite.

Keywords* : Coconut coir fibre, Fibre reinforced composites, Mechanical properties , Natural fibres, Polyester.

I. INTRODUCTION

The usage of natural fibers like plant and wood fibers as a material for reinforcement of plastics during recent times increased dramatically. Considering the environmental effect it would motivate the use of natural fibers as reinforcement material as an alternate to glass fibers in various applications.

Revised Manuscript Received on December 30, 2019.
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With their low cost, superior mechanical properties and their easy availability natural fiber serves as a good renewable and biodegradable option to the common synthetic reinforcement.

The shortcomings of bio composites can be overcome by structural configurations and with the insertion of fibres high strength can be attained The plant fibers which are biodegradable can give a good ecosystem whereas their high performance and less cost fulfil the economical attention of the industries.

In the natural form fibers like coconut and bamboo occur as a numerous waste products such as pulp, shell and wood flour which are used as reinforcing agents of different types of composites.

From the husk of the coconut fruit the Coconut fibre is obtained. The fibre is extracted from the fruit, and the fibres are removed from the husk with beating and washing. These fibres are strong, light and effortlessly survive in heat and salt water.

II. EXPERIMENTAL METHODOLOGY

A. Materials and Methods

In this work Hand lay-up method was employed for making composites by using the Bio- waste material Coir as reinforcement material to an Unsaturated Polyester resin (matrix) as the binding material, accelerator and catalyst are selected as Cobalt octoate and methyl-ethyl-ketone peroxide (MEKP) respectively.

B. Surface alteration of raw coir

The coir fiber obtained is washed thoroughly with distilled water for removing the dirt, sediments and other contaminations. The moisture content in it is removed completely by drying until it attains constant weight. The waxy substances present in the coir will cause poor wetability and bonding. Inorder to eliminate this coir is treated with the organic solvents sodium hydroxide.

The dispersion of the particles will be improved agglomeration is reduced by means of Alkali treatment of coir surface. The natural fibers were soaked in NaOH solution of 10wt%, such that the fiber to liquid weight ratio by 1:7 for 24 hours. The soaked fibre is treated with acetic acid and it is cleaned by means of using distilled water. The fibre is then dehydrated at a temperature of 100˚C until it attains constant weight. Then the fiber is chopped in to pieces of 3mm to 6mm size which is shown in Fig. 1

Fig. 1. Chopped Fiber after Chemical Treatment

C. Specimen Preparation

The specimen is prepared by means of Hand lay-up process for this 1.5gm of MEKP catalyst & 3gm of Cobalt accelerator, as prescribed by the resin maker is mixed with the required proportion of unsaturated polyester resin and chopped coir fiber and blended properly to attain uniform distribution. Then the mixture which is blended is transferred to the mould and it is kept beside a load of 100kg for 24 hours. The specimen taken from the mould undergoes heat treatment in the furnace at 100˚C for 2hours to remove the moisture content. Similarly all the four specimens with different composition was prepared as shown in Table - I.

Table- I: Composition of prepared Specimens

Sl.No	Specimen Name	Coir Percentage	Polyester Resin
1	C 5	5%	95%
2	C 10	10%	90%
3	C 15	15%	85%
4	C 20	20%	80%

D. Measurement Techniques

The mechanical property of the prepared specimens is found out by means of conducting experiments such as tension, flexural and hardness test. For performing the test the specimen has to be prepared as per the ASTM standard dimensions. ASTM D638 standard is selected for Tension test, ASTM D-790 for flexural test and Rockwell hardness number is measured. The specimens prepared for conducting the test is shown in Fig. 2 and Fig. 3.

Fig. 2. Tension Test specimen

Fig. 3. Flexure test specimen

III. Result and Discussion

A. Experimental results of Tensile Test

For finding the tensile nature of the prepared coir reinforced polyester composite specimen Universal testing Machine interfaced with the computer is used. Tensile strength, peak load, displacement and strain were calculated for the specimens which is shown in Table- II.

Table- II: Results of Tensile test

Sl. no	Specimen Name	Maximum Load (KN)	Displacement (mm)	Tensile strength (MPa)	Strain %
1	C5	0.58	4.3	12.1	6.9
2	C10	0.53	4.9	15.2	7.8
3	C15	1.02	5.8	26.5	9.1
4	C20	0.83	5.2	22.3	8.2

In this the coir fibre reinforced polyester composites the tension strength improves with respect to the rise in weight percentage of coir fiber. For 15% fiber reinforcement a maximum tensile strength of 26.5MPa is obtained. With the increase in area of bonding at the interfacial region with the matrix results in improved tensile strength. The tensile strength increases upon coir addition upto a certain extent and further addition after that will reduce the tensile strength. Fig. 4 Shows that the tensile strength increases upto 15% weight percentage of coir fiber and further addition of fiber the tensile strength starts to decrease.

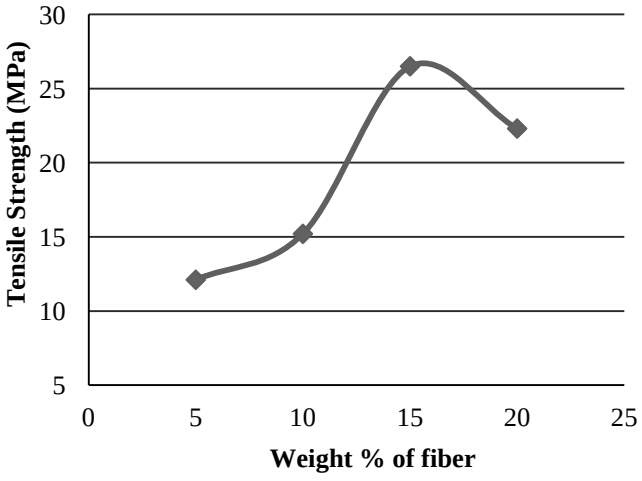

Fig. 4. Tensile strength of CFRP composite

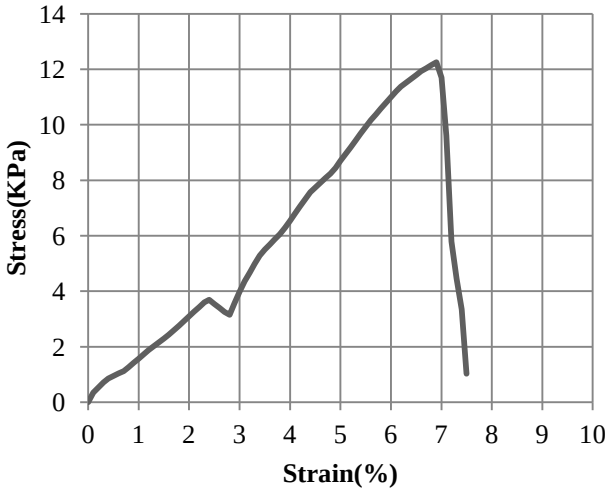

Fig. 5. Stress Strain curve for C5 specimen

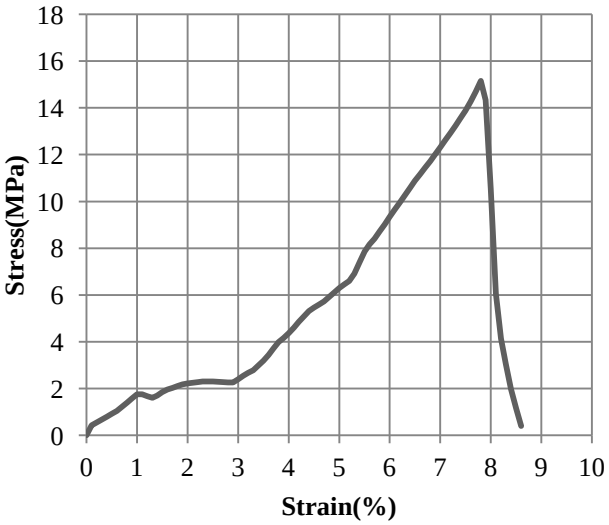

Fig. 6. Stress Strain curve for C10 specimen

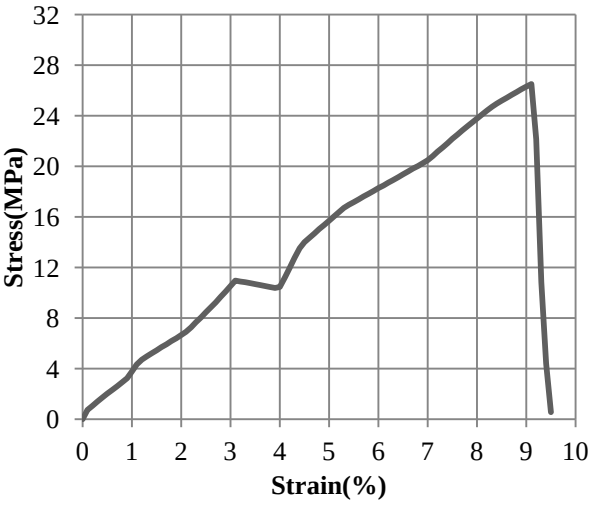

Fig. 7. Stress Strain curve for C15 specimen

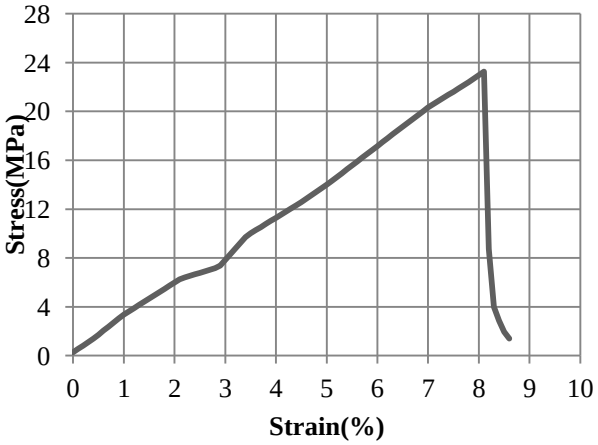

Fig. 8. Stress Strain curve for C20 specimen

B. Experimental Results of Flexural Test

For conducting the flexure test the specimen is made with ASTM D-790 standard of 250mmx25mmx2.5mm. The ultimate bending load, ultimate bending stress is calculated by conducting the experiment for all the test specimens and the results attained is shown in Table-III

Table- III: Results of Flexural test

Sl.no	Specimen Name	Ultimate bending Load (N)	Ultimate bending stress (N/mm^2)
1	C5	120.23	1.92
2	C10	125.82	2.01
3	C15	129.34	2.07
4	C20	133.58	2.17

It is observed from Fig. 9 that the presence of fiber content will influence the flexural properties of the composite. It is improved with the addition of weight percentage of coir fiber. The peak flexural strength of 2.17 MPa is obtained for 20% of reinforced fiber. The flexural property is increased due to the improved bonding area at the boundary region of the polyester and the coir reinforcement.

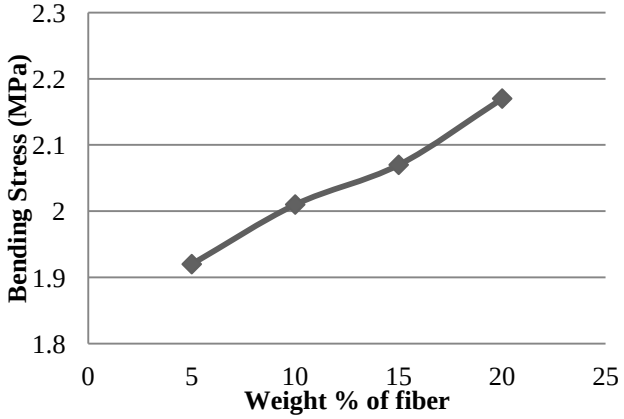

Fig. 9. Flexural strength of CFRP composite

C. Experimental Results of Hardness Test

Rockwell Hardness testing machine is used to measure the hardness of the composite. Three samples of each specimen were experimented and their mean value is presented. ASTM D 785 standard is used in preparing the specimen. The ball indenter having a ball diameter of 0.25 inches is selected and a load of 60kgf is applied over the specimen. The experiments were conducted for all the samples and their hardness values are tabulated as shown in Table- IV.

Table- IV: Results of Rockwell hardness Test

Specimen Name	Rockwell Hardness Number(RHN)			
	Sample-1	Sample-2	Sample-3	Average RHN
C5	128	131	127	129
C10	126	127	125	126
C15	126	123	122	124
C20	123	120	124	122

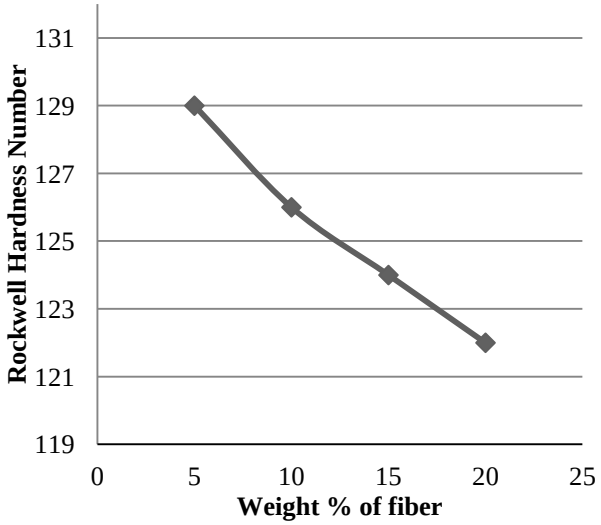

Fig. 10. Rockwell Hardness number of CFRP composite

The Hardness number of the composite decreases as the weight of fiber increases. The maximum hardness of 129 RHN is obtained for 5% coir fiber reinforcement. The hardness number decreases by 5.4% with the increase in weight percentage of coir fiber from 5% to 20% weight fiber.

IV. CONCLUSION

Simple hand lay-up method has been employed for the manufacture of composites from the coconut coir which is a Bio- waste materials is used as the reinforcement material along with Unsaturated Polyester resin as the binding material. It is observed from the result that the increase in Weight fraction of Coir fiber the tensile properties of the material will improve upto a certain extent and reduces by further addition. From this work maximum tensile strength of 26.5MPa is attained for 15% weight of fiber. The flexure strength is maximum at 20% of weight coir fiber where the maximum bending stress attained is 2.17Mpa.The tensile strength of the specimen is improved two times with the addition of coir fiber from 5% to 15% weight of the fiber and further addition the strength starts to decrease. Flexural strength of composite is improved with the increase in weight of coir fiber. Adding excessive coir fiber will increase the flexure strength and their by reducing the tensile strength and hardness number.

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