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Mechanical properties of banana fiber and coconut coir reinforced composite

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ABSTRACT
In our project we have chosen coconut coir as the major reinforcement. and banana fiber as an additional fiber, to improve the mechanical property of polymer composite with vinyl ester as the base material, prepared by hand layup process according to ASTM standards the test specimens are prepared with different weight fractions of coconut coir and banana fiber. tests were conducted and the improvement in mechanical properties (tensile strength and flexural strength) of the hybrid composite material is observed.

Introduction

Natural fibers reinforced with polymer composites have gained more attention because of their biodegradable, less expensive, light weight, easy processing, high specific modulus and also naturally appeal. The interest in long term sustainability of material resources has make advancements in bio-composites or polymer composites materials which made from natural fibers and resin. Polymeric composites may be understood as the combination of two or more materials, for example, reinforcement elements or filler involved by a polymeric matrix [1]. Natural fibers such as jute, sisal, pineapple, abaca and coir [1-11] have been studied as a reinforcement and filler in composites. Besides, Plant fibres from agricultural crops are renewable materials which have potential for creating green products and replacing synthetic materials which have potential for creating composites panel [12]. According to all the natural fibers listed, Banana fiber, a ligno-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bastfiber with relatively good mechanical properties.

Material and method

Banana fiber and coconut coir were collected from local market both material contain impurities like dust, small sand particle. Therefore it need to cleaned in order to get pure banana fiber and coconut coir,. After cleaned with 10 % NAOH solution, the banana fiber and coconut coir dried in direct sun light for 8 hours. The it were weighted according to the percentage needed after that the epoxy resin and hardener were mixed in a container and stirred well for 3 to 5 minutes. The banana fiber and coconut coir was then added gradually and stirred to allow proper dispersion of fiber with in the gel like mixture. Before the mixture were poured inside the mould, the mould was initially polished with a release agent to prevent the composites from sticking to the mould upon removal finally, after the mixture has been poured in the mould, it was left at room temperature for 24 hours for fully cured and hardened. The materials used in the present are tabulated in table.1

Table 1. Specification of the Materials Used In the Research.

Materials	Specifications	Suppliers
Epoxy resin	Density: 1.15 g/cm^3 UTS: 60MPa Flexural strength:130MPa Heat distortion temperature:125^0	Nepatharesin Bangalore
Banana fiber	Density: 1.12 g/cm^3 Length : 2-10mm	Local market
Coconut coir	Bulk density :0.28 g/cm^3 length : 3- 6mm	Local market

Above materials used in the research work .vinylester is a resin it have low viscosity, higher corrosive resistant, water resistant. Banana fiber and coconut coir are agriculture waste material, lighter in weight, low cost and biodegrable for this reason above materials selected for research work.

Sample preparation

1) Density of Epoxy resin (δ) = 1.15 g/cm3
2) Volume of the mold (V) = 300x200 x5mm
= 300000mm3
= 300cm3
3) Mass of resin (m) =Volume of mold x Density of resin
= 300cm3 x 1.15g/cm3
= 345g

Table 2. Sample preparation calculations for banana fiber / coconut coir/epoxy composite

Samples	% wt of coconut coir	% of Resin	% wt of banana fiber
A	0	100	0g
B	17	80	3g
C	15	80	5g
D	13	80	7g
E	11	80	9g

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Table 2.. Shows sample preparation calculation for banana fiber & coconut coir / epoxy resin.in this case % weight of resin is kept constant and by varying the % weight of banana fiber and coconut coir. The samples are tested according to ASTM standards

Testing

Ultimate tensile strength, often referred to tensile strength is the maximum stress that a material can withstand while being stretched or pulled before fracture. The tensile test for the specimens was conducted according to ASTM D3039. The specimens of size 250 mm x 25 mm x 10 mm were tested with a span length of 250 mm in tensile mode at a cross head speed of 1 mm / min. The fixtures used for the tensile testing is shown in Figure1.

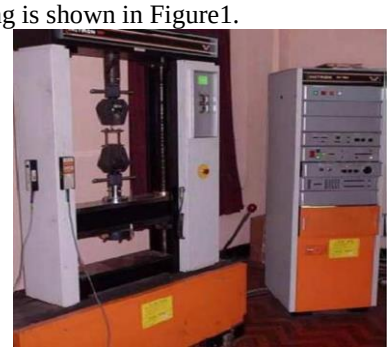

Figure 1. Universal testing machine.

A Universal Testing Machine (UTM) is an instrument used for the measurement of loads and the associated test specimen deflections such as those encountered in tensile, compression or flexural modes. It is used to test the tensile, compression, flexural and Inter Laminar Shear Strength (ILSS) properties of materials

A.Ultimate tensile strength

Ultimate tensile strength, often referred to tensile strength is the maximum stress that a material can withstand while being stretched or pulled before fracture. The tensile test for the specimens was conducted according to ASTM D3039. The specimens of size 250 mm x 25 mm x 5 mm were tested with a span length of 250 mm in tensile mode at a cross head speed of 1 mm / min. The fixtures used for the tensile testing is shown in Figure 1.

Ultimate tensile strength was determined using the equation (1)

1) Ultimate tensile strength = $\frac{\text{Maximum load}}{\text{C/s area in mm}^2}$ ----- (1)

2) Young's modulus (E) = $\frac{\text{Stress in GPa}}{\text{Sstrain}}$ ----- (2)

3) Stress = $\frac{\text{Load}}{\text{Area (bXd)}}$ ------ (3)

4) Strain = $\frac{\text{change in length}}{\text{Original length}}$ ----- (4)

Where,

P = maximum load in N

b = width of the specimen in mm

d = thickness of the specimen in mm

B.Tensile test report

Table 3. Ultimate tensile strength of coconut coir/Banana fiber / Epoxy resin composite.

Samples	Coconut coir (%)	banana fiber(%)	Avg UTS in MPa
A	0	0	29.35
B	17	3	32.86
C	15	5	34.69
D	13	7	35.19
E	11	9	31.99

The above table 3. shows that tensile strength of banana fiber / Epoxy resin composite. The tensile strength increases from 29.35MPa to maximum 35.19 MPa and then decreases to 31.99MPa.

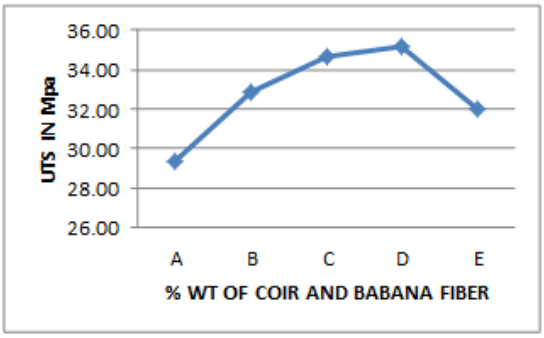

Figure 2. UTS of coconut coir / banana fiber composite at different percentage loadings.

C.Flexural strength

The use of flexural test to determine the mechanical properties of polymeric composite is widely prevalent because of the relative simplicity of the test method, instrumentation and testing equipment required. The flexural strength of the specimens were determined for specimen using the three-point bending test as per ASTM –D790.The specimen of dimensions 200mm x15mmx5mm. The specimens of dimensions 200 mm x 15 mm x 5 mm tested with a span length 50 mm. Figure 5.6 shows the flexural test setup used in the experiment.is shown in figure III.

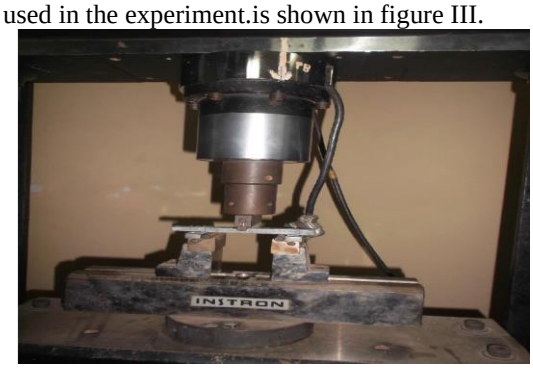

Figure 3.Flexural test setup.

The flexural strengths of the composites were determined using the formula using equation 4.

$$FS = \frac{3PL}{2BD^2} \text{ in MPa} \quad \text{----------} \quad (5)$$

Where,

FS – Flexural Strength [N/mm^2]

P – Peak Load [N]

L – Support Length [mm

B – Breadth of the specimen [mm]

Flexural Strength of coconut coir / Banana fiber / Epoxy

The use of flexural tests to determine the mechanical properties of polymeric composites is widely prevalent because of the relative simplicity of the test method, instrumentation and testing equipment required.

Table 4.Lists the flexural strength of coconut coir / Banana fiber / Epoxy.

Samples	coconut coir (%)	banana fiber (%)	Avg FL (Mpa)
A	0	0	75.6
B	17	3	82
C	15	5	85.13
D	13	7	88.13
E	11	9	82.27

The above table4.Shows that flexural strength of banana fiber and coconut coir / Epoxy resin composite. The flexural strength increases from 75.6MPa to maximum 88.13 MPa.

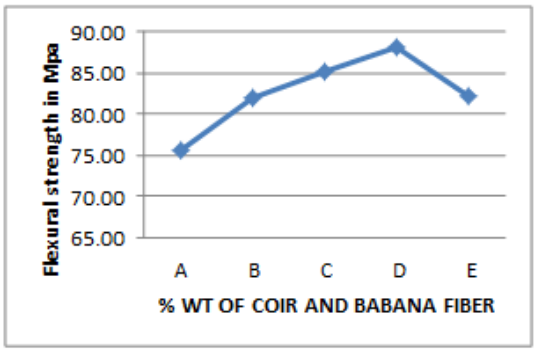

Figure 4. UTS of coconut coir / banana fiber composite at different percentage loadings.

Result

Mechanical properties of coconut coir and banana fibe / epoxy resin

Experimental Study on : Coconut coir& Banana fiber /. Epoxy composite

Mechanical test : Tensile Test

Table 5. Results of UTS of composite material.

Samples	Avg.UTS	Results
A	29.35	
B	32.86	Tensile strength increases by 10.68%
C	34.69	Tensile strength increases by 5.27%
D	35.19	Tensile strength increases by 1.42%
E	31.99	Tensile strength decreases by 9.09%

Experimental Study on : Coconut coir & Banana fiber / Epoxy composite.

Mechanical tests : Three Point Bending Test (Flexural test)

Table 6. Results of flexural strength of composite material.

Samples	Avg.FS	Results
A	75.6	
B	82	Flexural strength increased by7.80%
C	85.13	Flexural strength increased by3.6%
D	82.27	Flexural strength increased by3.4%
E	82.27	Tensile strength decreases by 9.09%

Conclusions

The conclusion of the study of banana fiber & coconut coir reinforced epoxy resin composite is that there is significant increase in the tensile and flexural strength of the composite.

Tensile strength increased by16.59% gradually with more percentage of loading of coconut fiber and Banana fiber composite and hybrid composite. the flexural Strength increased by14.22 gradually with the more percentage coconut coir Banana fiber hybrid composite. Random oriented coconut coir and banana fiber fiber –polyester composites are low-strength materials, but can be designed to have a set of flexural strengths that enable their use as non-structural building elements. to have better mechanical properties at higher fiber content , The bonding between The coconut coir/ banana fiber and epoxy resin must improved .to increase the mechanical properties of the composite there must be homogenous mixture. of the fiber and matrix .

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