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Mechanical Characterization of Bagasse and Coconut Coir Reinforced With Vinylester Polymer Composite

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Abstract—This Polymer Matrix Composites (PMC) are gaining more importance compared to the monolithically materials as being more reliable and cheap. Polymer matrix composites are finding application from household to engineering approach. With the advancement of PMC's their properties can be increased by the addition of one more fiber made as hybrid composite which boost the property of PMC where a single fiber composite lags. In our project we have chosen bagasse as the major reinforcement and coconut coir 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 Test specimens are prepared with different weight fractions of bagasse at the optimization point of tensile test a small percentage of coconut coir are added and tests were conducted and the improvement in mechanical properties (tensile strength and flexural strength) of the hybrid composite material is observed.

Keywords— *Bagasse, coconut coir, matrix, reinforcement, vinylester*

1 INTRODUCTION

Natural fibers reinforced with polymer composites have gained more interest because of their biodegradable, less expensive, light weight, easy processing, high specific modulus and also environmentally 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, bagasse is biomass remaining after sugarcane stalks are crushed to extract their juice. A sugar factory produces nearly 30% of bagasse out of total crushing. Many research efforts have attempted to use bagasse as a renewable feedstock for power generation and for the production of bio-based material. However, the consumption of the bagasse is very low, especially in Asian country.

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2 EXPERIMENTAL WORK

A. Preparation of sample

Bagasse and coconut coir were collected from loca mill both material contain impurities like dust, small sand particle. Therefore it need to cleaned in order to get pure bagasse and coconut coir,. After cleaned with 10 % NAOH solution, the bagasse and coconut coir dried in direct sun light for 8 hours. Then it was weighted according to the percentage needed (5%, 10%, 15%, and 20%). After that, the un saturated polymer resin and methyl ethyl ketone peroxide (MEPK) catalyst were mixed in a container ans stirred well for 3 to 5 minutes. the bagasse were than added gradually and stirred to allow proper dispersion of fibre 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 Material Use

Materials	Specifications	Suppliers
Vinyl ester	Density: 1.05 g/cm^3 UTS: 60MPa	Nepatha resin Bangalore
Bagasse	Density: 0.25 g/cm^3 Length : 2-10mm	Local market
Coconut coir	Bulk density :0.28 g/cm^3 length : 3- 6mm	Local market

B. Processing of Bagasse and Coconut Coir, Vinylester Composite

Bagasse Composite is prepared first to know at what percentage of weight fraction the composite gives the Ultimate Tensile Strength from that percentage some percentage of coconut coir is added to enhance its tensile property. First make some sample preparation calculation before preparing the composite as given below and start the fabrication by preparing the temporary mould using beadings arranged on the wooden base representing a rectangular mould of 300x2000x5mm. Pour the calculated amount of resin with thoroughly mixed Promoters, Accelerators & Catalyst of 1%to the mould and wait for ten minutes so that it starts pre hardening then put a Mylar sheet on to it and then apply pressure by placing a concrete block over the setup for 24 hours to complete cure the laminate and once the laminate is completely cured then it" s ready for machining according to ASTM standard for testing, repeat the procedure by adding5, 10, 15, 20% wt of bagasse to the resin. At optimum percentage then add 3, 5, and 7% of coconut coir and repeat the same procedure to get the Hybrid composite and is tested for mechanical properties.

C. Sample preparation

Composite laminate of 300 mm X 200 mm X 5 mm were fabricated according to ASTM standards for mechanical tests.

Density of Vinylester (δ) = 1.05 g/cm^3

Volume of the mold (V) = 300x200 x5mm

= 300000mm^3

= 300cm^3

Mass of resin (m) = Volume of mold x Density of resin

=300cm^3 x 1.05g/cm^3

=315g

Table 2 : Sample preparation calculations for bagasse / Vinylester composite

Samples	% wt of bagasse	% of Resin	Mass of bagasse	Mass of Resin	Total mass
A	0	100	0g	315g	315g
B	5	95	4g	314g	318g
C	10	90	8g	298g	306g
D	15	85	12g	281g	293g
E	20	80	16g	264g	180g

Table 3 : Sample preparation calculations for bagasse & coconut coir / Vinylester composite

Samples	% of Resin	% wt of coconut coir	% wt of Bagasse	Mass of resin	Mass of coconut	Mass of bagasse
F	85	3	12	281	2.64g	9.45g
G	85	5	10	281	4.41g	7.86g
H	85	7	8	281	6.17g	6.3g

3 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 Figure 1 and 2.

Figure 1: Universal testing machine setup

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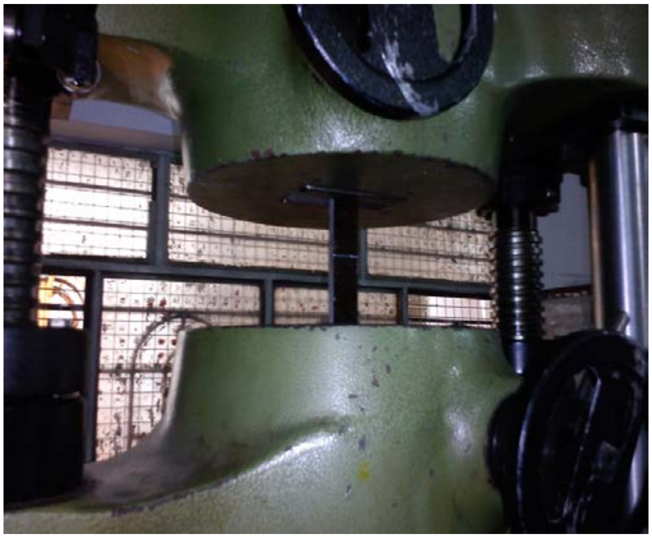

Figure 2: Specimen loaded in tension

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 1b.

Ultimate tensile strength was determined using the equations.

$$\text{Ultimate tensile strength} = \frac{\text{maximum load}}{\text{C/s area in mm}^2} \text{ in Mpa}$$

$$\text{Young's modulus (E)} = \frac{\text{Stress}}{\text{Strain}} \text{ in Gpa}$$

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

$$\text{Strain} = \frac{\text{change in length}}{\text{Original length}}$$

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 4 : Ultimate tensile strength of Bagasse / Vinyl ester composite

Samples	Rice husk (%)	Ultimate Tensile Strength (MPa)			Avg UTS (MPa)
A	0	32.36	30.28	27.42	30.80
B	5	32.00	32.80	32.78	32.52
C	10	33.28	33.98	33.82	33.69
D	15	33.9	35.09	35.58	34.85
E	20	32.08	32.10	32.80	32.32

Table 5 : Ultimate tensile strength of Bagasse and coconut coir / Vinyl ester composite

Samples	Coconut coir (%)	bagasse (%)	Ultimate Tensile Strength (MPa)			Avg UTS (MPa)
F	3	12	35.70	35.63	36.26	35.87
G	5	10	36.50	36.96	37.02	36.81
H	7	8	38.40	38.50	38.46	38.45

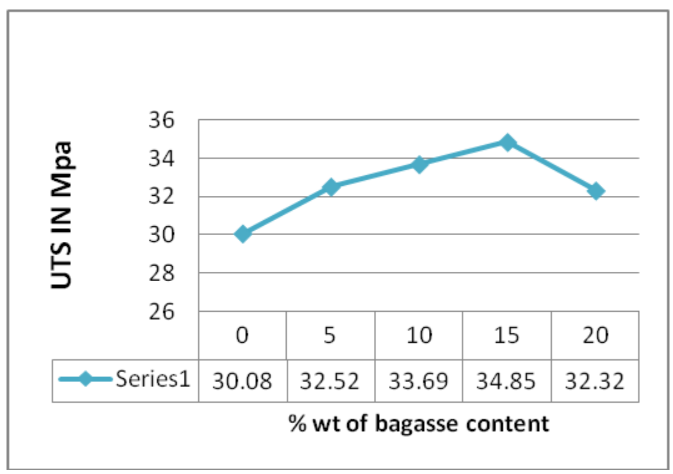

Figure 3: Variation of UTS values with bagasse loading graph

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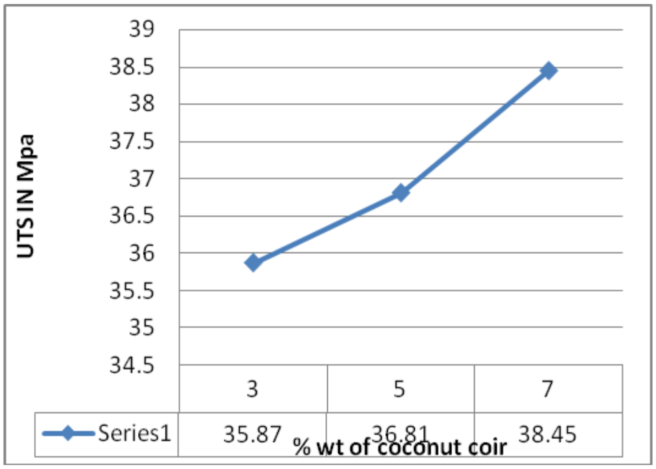

Figure 4: Variation of UTS values with coconut coir

C. *Flexural strength*

The flexural strengths of the composites were determined using the formula

$$FS = \frac{3PL}{2BD^2} \text{ in Mpa}$$

Where,

FS – Flexural Strength [N/mm^2]

P – Peak Load [N]

L – Support Length [mm]

B – Breadth of the specimen [mm]

D. *Strength bagasse / vinylester composite*

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 .tables VI and VII list the flexural strenhth of bagasse & coconut coir / vinyl ester composite.

Table 6 : Flexural strength of Bagasse / Vinylester

Sample	Bagasse (%)	Flexural strength (MPa)			Avg FS (MPa)
A	0	74	78.4	76.4	76.27
B	5	79.2	80	84	81.07
C	10	83.2	84	84.8	84
D	15	86.4	87.2	88	87.2
E	20	79.2	82.4	84.8	82.13

Table 7 : Flexural strength of Bagasse and coconut coir / Vinyl ester composite

Sample	Coconut coir (%)	Bagasse (%)	Flexural strength (MPa)			Avg FS (MPa)
F	3	12	91.2	90.4	88	89.87
G	5	10	91.2	94.4	95.2	93.6
H	7	8	95.2	96	96.8	96

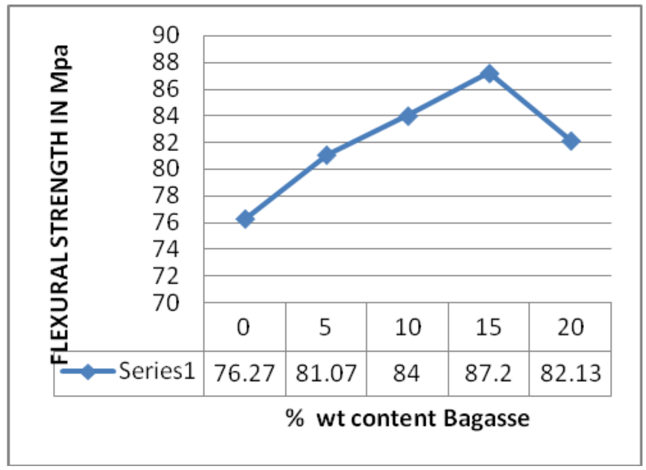

Figure 5: Ultimate flexural Strength of Bagasse composite at different percentage loading

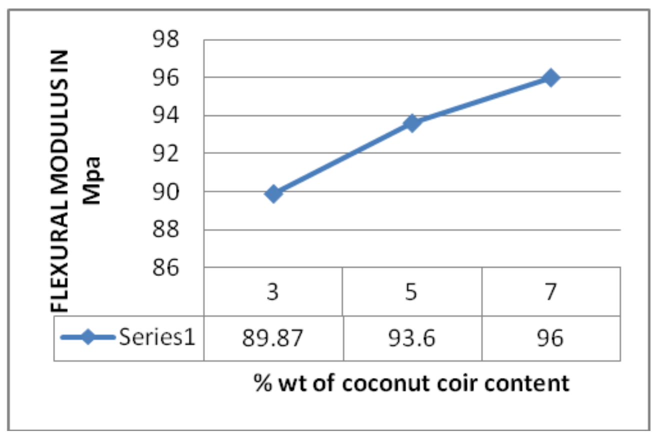

Figure 6: Ultimate Fluxural Strength of bagasse & coconut coir composite at different percentage loading

4 Conclusion

1. Tensile strength increased by 37.66% gradually with more percentage of loading of Bagasse composite and hybrid composite
2. The flexural Strength increased by 20.56%, gradually with the more percentage Bagasse .and hybrid composite

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3. Random oriented bagasse 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.
4. To have better mechanical properties at higher fiber content , The bonding between The bagasse and vinyl ester must improved
5. To increase the mechanical properties of the composite there must be homogonous mixture of the fiber and matrix to have the property of the composite.
6. Hybridization has been successfully found to be better option to have better mechanical property which alone a Bagasse fiber fails.

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