

Mechanical Characterization on Woven Bidirectional Natural Fiber Reinforced Polymer Composites

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Abstract: Natural fibers play a vital role in material technology as a renewable source. The natural fibers were found to possess better properties when compared to other materials. Mostly unidirectional fibers were used in the recent past. These unidirectional fibers were replaced by bidirectional natural fibers. These bidirectional fibers tend to possess better mechanical properties when compared to unidirectional fibers. This literature paper explores the history of different natural fibers woven in bidirectional with applications. This paper focuses the anatomical segmentation of various properties of bidirectional natural fibers (jute, hemp, bamboo and sisal) and its applications to substitute glass fiber.

Key words: bidirectional, natural fiber, mechanical properties, comparative study.

I. INTRODUCTION

Natural fibers are a type of renewable sources, which have been recycled by nature and human ingenuity for long thousands of years ago. They are also neutral in carbon; they can absorb equal amount of carbon dioxide they produce. These fibers are wholly recyclable, ecofriendly, good specific strength, abrasive less, less cost, and rapid bio-degradability [1]. As these materials possess all the above properties it proves to be a better replacement for glass fibers. Recently, natural fibers such as sisal and bamboo composite materials are replacing the glass and carbon fibers due to their easy availability and cost. Composite material is manufactured by the joining of two or more dissimilar materials in such a manner that the output material results with better property when compared individually. Fibre reinforced Composite (FRP) composites, due to their improved properties, are mostly used in different areas such as defense, aerospace, engineering applications, marine, automotive sectors etc. Hence natural FRP composites have attained vast interest due to their eco-friendly nature [2].

FRP composites are highly durable and even much impregnated shapes can be made with the help of this. These natural composites can be easily processed even at room temperature with simple methods such as hand lay-up. The woven jute FRP composite which was mechanically subjected

to heat has shown the highest flexural strength of 208.705 N/mm² and flexural modulus of 4500 N/mm², which is the highest flexural strength value, obtained from all the pretreatment procedures used for pre treating the woven jute, and is also higher as compared to controlled samples of woven jute FRP, where no treatment was carried out [3]. Now days 100% highly crystalline cellulose fiber industry made are available. These are obtained by mechanical process which possess almost half the weight of glass fiber, on-par in density with aramid fiber and much less abrasive than glass fiber, translucent and odorless.

II. EXPERIMENTAL DETAILS

Fabrication of the composite processes is done using Polyester resin Hand lay-up which is the cheapest and oldest molding method. Large components, such as Boat hulls suited especially for a low volume, labor intensive method. Hence, this method is preferred for the manufacturing of composite plates. For matrix material Polyester resin is chosen and bi-directional bamboo fiber in woven form as reinforcing material. In the case of hybrid material, both woven bamboo and glass fiber are used as reinforcing material.

Tensile test is done to measure the force required to break the fabricated specimen according to ASTM standards

and the extent to which the specimen stretches or elongates to that breaking point using UTM machine.

Tensile tests records a stress – displacement diagram & load-displacement diagram, which is employed to determine tensile modules. Observed readings are used to find a material, to design parts to withstand application force and as a measure of quality check control of materials [4-7]. High aspect ratio and young's modulus with Tensile strength, in combination with an electrical and thermal Conductivity make them super materials in polymers (smart materials) and open up new ideas for innovative materials.

Fabricated ASTM D 638 specimens are placed in the grippers of a computerized UTM at a specified grip separation and pulled of the until failed at test speed of 60 mm/min to measure elongation and strength.

TABLE 1

Specimen	Combinations	%	Weight(gm)
A	PR	85	1275
	FR	15	225
B	PR	80	1200
	FR	20	300
C	PR	75	1125
	FR	25	375
D	PR	70	1050
	FR	30	450

Table 1 indicates the variety combinations of Polyester resin, and natural woven bidirectional bamboo fiber in wt% Specimens. Specimens A, B, C, and D were manufactured in the mixing of PR and FR. ASTM D 638 standards are used to prepare the mould specimens were as per and tested in computerized universal testing machine in 60 mm/min at room temperature.

III. RESULTS AND DISCUSSION

Table.2 Tensile properties of specimens with respect to orientation

S.No	Specimens	UTS In MPa	Yield Strength in MPa	Young's modulus in MPa	Elongation (%)
1	A	16.34	10.06	302.71	0.82
2	B	17.36	12.24	311.55	1.20
3	C	19.90	12.26	347.70	1.50
4	D	21.6	12.492	357.33	1.56

3.1 Specimen Vs UTS

Figure 1 reveals the Ultimate tensile strength (UTS) in MPa versus specimens of various combinations plot. It is noticed that the specimen A yielded 16.34 for 15% of FR, B yielded UTS in 17.36 in increment of 5 wt % of FR, almost it is increased 1.02 MPa of UTS for the increase of 5% of fiber due to better bonding strength between FR and PR. Specimen C gives 19.90 MPa for the increment of 5% FR. UTS increased in 2.54 MPa. D yielded 21.6 MPa for the increment of 5% FR.

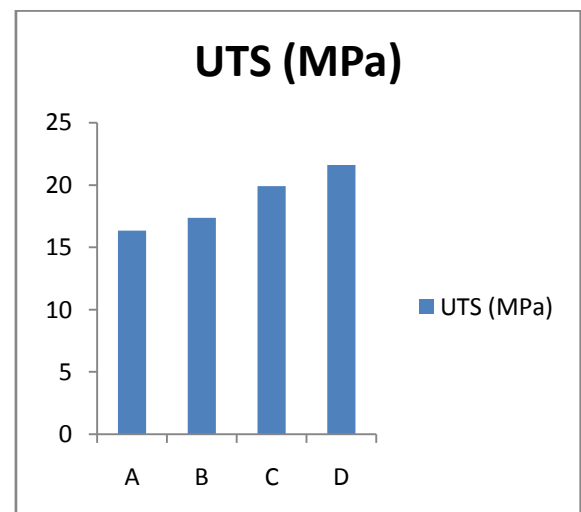


Figure 1

3.2 Specimen Vs Yield Strength:

Figure 2 points the plots of yield strength verses different specimen. For 15 wt% Increase of FR specimen A yields 10.06 MPa and for increment of 5wt% of FR B yields 12.24 MPa. For the increment of 5 wt % FR results in yield of 12.26 MPa for the specimen C. Specimen D yields 12.492 MPa for 5wt% increment of FR. When FR go on increasing there is increase in yield strength when 30 wt% FR is added.

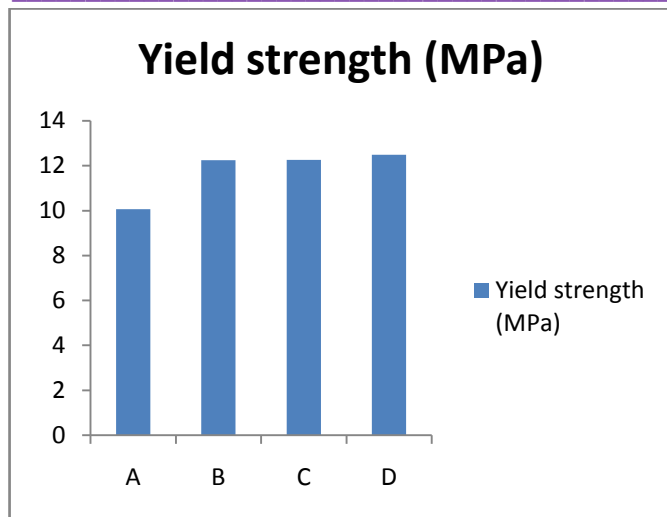


Figure 2

3.3 Specimen Vs Young's Modulus

Figure 3 depicts the values of Young's modulus in MPa versus different specimens. For 15wt% of FR, Specimen A gives 302.71MPa B yielded 311.55. For the addition of 5wt% of FR yielded 347.70 for C. Specimen D yielded 357.33 MPa, for the increment of 5wt% of FR.

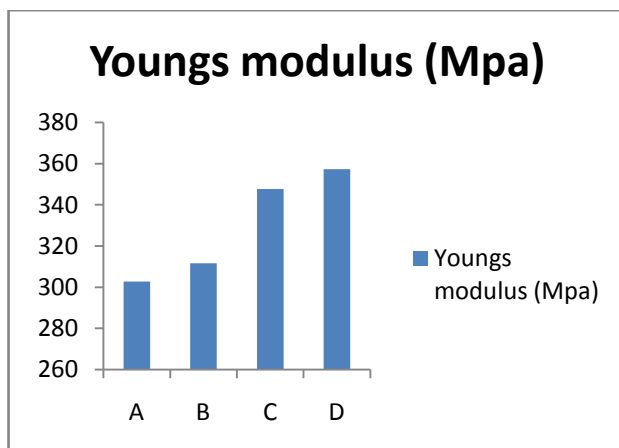


Figure 3

3.4 Specimen Vs Elongation

Figure 4 illustrates the diagrams of elongation with various specimens. Specimen A has 0.82% elongation for the addition of 15Wt. % of fiber. Increment of 5wt% FR in specimen B increase the linear elongation from 0.82% to 1.20%. Addition of 5wt% of FR, C elongation slightly increased to 1.50 %. Further increment of 5wt% of FR specimen D can increase the elongation in to 1.56%.

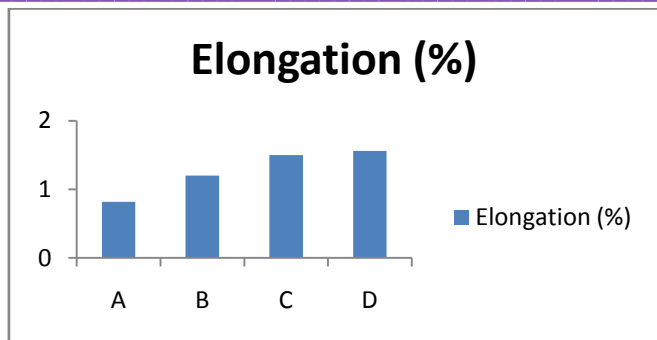


Figure 4

IV. CONCLUSIONS

Under this methodology, the Mechanical property of a produced woven bamboo bidirectional FRP composites with various mingling of PR and FR was investigated at room temperature. The results are presented as follows.

FRP has significant ultimate tensile strength when FR is incremented by 5%. Yield strength increases into 12.492Mpa on addition of 30 wt% of FR.

Young's modulus increases into 357.33MPa in D with an addition of 30 wt% of FR.

Increase in % elongation for specimen D with an addition of 30wt% of FR.

The above six parameters of this work which can predict the influences of FR in FRP are greatly increasing UTS, yield strength and young's modulus and elongation in specimens.

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