Manufacturing of Banana Fiber Composites for different Compositions and its Experimental Tensile Testing

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ABSTRACT

The world's attention is now focused on resources that are environmentally friendly and recyclable. Due to growing environmental concerns, a bio composite made of standard fiber and polymeric resin is one of the most recent breakthroughs in the industry and establishes the current scope of experimental activity. In the engineering application, the use of composite materials is gradually growing. The matrix and fiber are the two primary segments of the composite. The availability of high-quality fiber and ease of assembly has prompted inventors all over the world to test regionally accessible low-cost yarn and determine their ability to protect grit and how much they can perform the thankful facts of great reinforced polymer composites intended for structural use. Fiber reinforced polymer compounds have everyday preferences, such as requiring less effort to create, being easier to create, and having a higher quality disparity than perfect polymer. For this reason, fiber reinforced polymer composites are used in a variety of applications as a structural material. Composite materials are mostly developed in response to technological needs. Natural fibers have recently piqued the interest of scientists and technologists due to the advantages they offer over traditional reinforcement materials, and the creation of bio fiber composites has been a hot topic in recent years. The present work spotlight on study of mechanical properties of banana fiber/epoxy resin composite at 30%, 40% and 50% volume fractions of banana fiber and different fiber direction 0^0, 45^0 & 90^0.The mechanical property like tensile strength is experimentally evaluated.

Keywords: Banana fibre, Mechanical Properties, Volume Fraction, fibre orientation.

1 Introduction

The advantage of composite materials over traditional materials seems largely from their superior specific strength, stiffness and fatigue characteristics. By definition, composites are consisting of two or more ingredients in discrete stages. Composites are having strong weight carrying material (known as reinforcement) surrounded in fragile substance (known as matrix). Reinforcement gives strength and stiffness to composite. [1] [2] [3] The matrix upholds the position and direction of the fiber. Significantly, components of the composites keep their individual, physical and chemical properties. [4] [7] [15] [16] [18] The strengthening of composite is due to layers, particles or fibers which improve mechanical properties such as rigidity, strength and durability of material. Long fibers are found suitable for good loading. [5][6][8][12][17] [19]

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2 Manufacturing of banana fiber composite material

2.1 Matrix Material

Epoxy resin 520 and Epoxy hardener-PAM. The epoxy resin and epoxy hardener were combined in the ratio of 10:1 by the mass as suggested. The epoxy resin has the density of 1.22 g/cc. The Epoxy Resin-520 and Epoxy hardener-PAM were blended in the ratio of 10:1 by weight as proposed. Epoxy resin and hardener combination was enthused methodically before fiber mats were initiated in the matrix substance. Each cover was treated beneath constant pressure close to about 24hr in the mould and additional cured at room temperature at least 12 hrs. The Epoxy resin (LY-556) is taken as surrounding substance binder is supplied by Ciba Geigy India Ltd. Generally, epoxy resin has high-quality mechanical and thermal properties.[9][10][11][13][14]

2.2 Hardener

For attaining the properties to be recovered, the resin should experience curing response in which the liner epoxy resin arrangement alters to form three-dimensional cross-linked thermo set construction. This curative reaction takes place by adding up a curing mediator called hardener in a ratio of 10:1 to Epoxy resin. The following retort is an exothermic response of resin takes place. The remedial agent or hardener is triethyltetramine (HY-951) is also completed from Ciba Geigy India Ltd.

2.3 Fiber Material

The banana fiber is acquired from banana plant, which has been gathered from neighbouring resources. The pulled out banana fiber were consequently sun dried for eight hours then dried in oven for 24 hours at 105° C to take away free water present in the fiber

2.4 Fabrication of Process

The alternative of a precise production scheme strongly depends on chemical features of medium, and also the character of ultimate product's profile. So we have selected hand debilitate process for developing of laminates. The comprehensive system is explained below

1) Put the wooden cover (Mould) on the plane surface.

Figure 1: *Wooden plate for mold preparation*

2) Arrange the blend of epoxy and hardener with 10:1 ratio.

Figure 2: *Mixture of Epoxy & Resin*

3) Apply the wax for easy removal

Figure 3: *Wax for removal of composite from mold*

4) Apply the cut sample of banana fiber.

Figure 4: *Banana Fiber*

5) Manufactured plate

Figure 5: *Banana Fiber Composite plates*

2.5 Cutting of Specimen with respect to Orientation

The specimens were cut in different orientations of 0, 45 and 90 in angle. Though three different configurations of the fiber orientations 0, 45and 90 for different volume fraction 30%, 40% and 50%are selected for our study.

Figure 5: *Banana Fiber Composite plates with different orientations*

2.6 Tensile Testing of Banana Fibber composite Material

The tensile investigation is carried out by applying longitudinal or axial load at an exact extension rate to a benchmark tensile specimen with identified dimensions (gauge span and cross sectional area perpendicular to the load route) till failure. The applied tensile weight and extension are documented during the examination for the computation of stress and strain.

Table 1: *Tensile test Specimens before test*

Sr. No.	Composition			Tensile Testing	Quantity
	Banana fiber %	Epoxy %	Fiber orientation (˚)	Size (L×B×H) mm	
1	30	70	0	200×20×3	2
2	40	60	45	200×20×3	2
3	50	50	90	200×20×3	2
4	30	70	0	200×20×3	2
5	40	60	45	200×20×3	2
6	50	50	90	200×20×3	2
7	30	70	0	200×20×3	2
8	40	60	45	200×20×3	2
9	50	50	90	200×20×3	2

Table shows the dimensions and composition of tensile test specimens according to the various compositions of banana fiber and epoxy resin along with the change in fiber orientation. The different specimens are also imaged below.

Figure 6: *Specimen with 30/70 composition before tensile test*

Figure 7: *Specimen with 40/60 composition before tensile test*

Figure 8: *Specimen with 50/50 composition before tensile test*

2.7 Tensile Testing-

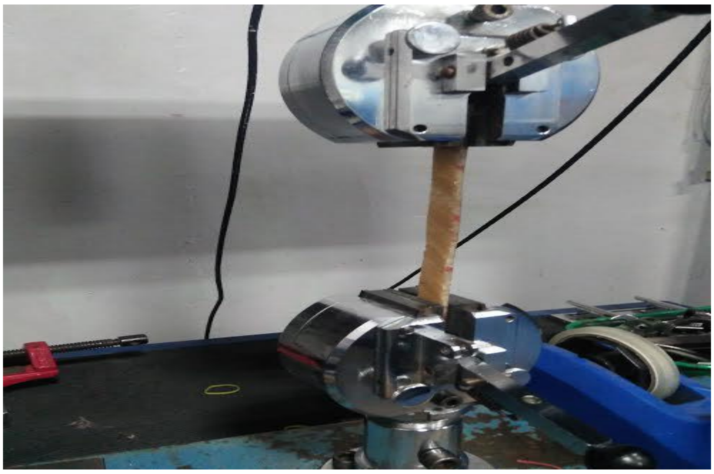

Figure 9: *Tensile testing setup on UTM*

1.5 Tensile test Specimens after test:

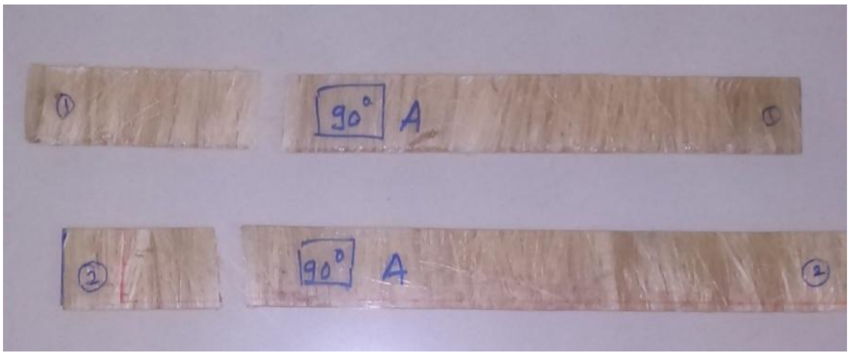

Figure 10: *Specimens after tensile testing*

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Table 2: *Observations recorded during tensile testing*

Sr. no	Compo-sition	Fiber orientation (˚)		Specimen width (mm)	Specimen thickness (mm)	Area (mm2)	Maximum load(N)	Ultimate tensile strength (N/mm2)
1	A (30/70)	0	T1	20.930	3.960	82.8828	1271.06	15.336
			T2	21.00	3.800	79.80	1204.42	15.093
		45	T1	20.880	3.360	70.1568	491.96	7.012
			T2	21.050	3.700	77.885	537.04	6.895
		90	T1	20.830	4.240	88.3192	521.36	5.903
			T2	20.860	5.00	104.30	450.80	4.322
2	B (40/60)	0	T1	18.400	3.860	71.024	2817.50	39.650
			T2	20.320	3.320	67.4624	2308.88	34.225
		45	T1	19.140	2.150	41.151	404.74	9.835
			T2	18.280	2.770	50.6356	283.22	5.593
		90	T1	19.600	3.540	69.384	385.14	5.551
			T2	21.320	5.550	118.326	635.04	5.367
3	C (50/50)	0	T1	20.130	4.040	81.3252	1465.10	18.015
			T2	20.470	3.500	71.645	997.64	13.925
		45	T1	19.980	3.300	65.934	796.74	12.084
			T2	20.950	3.200	67.04	682.08	10.174
		90	T1	20.950	3.200	67.04	552.32	8.537
			T2	20.680	3.887	80.0316	246.96	3.086

2.8 Result of Tensile Testing

Following table shows tensile test results of various specimens with 30%, 40% and 50% volume fraction and 0˚, 45˚ and 90˚ fiber orientation by experimental method. Two specimens are made with same volume fraction and same orientation. They are tested as trial 1 and trial 2 and average strength of trial 1 and trial 2 is considered as average U.T.S.

Table 2: *Tensile testing results for different compositions*

Sr. No.	Composition	Fiber Orientation (˚)	U.T.S. (N/mm2)		Average U.T.S. (N/mm2)
			Trial 1	Trial 2	
1	A (30/70)	0	15.336	15.093	15.21
		45	7.012	6.895	6.95
		90	5.903	4.322	5.11
2	B (40/60)	0	39.670	34.225	36.94
		45	9.835	5.593	7.71
		90	5.551	5.367	5.46
3	C (50/50)	0	18.015	13.925	15.97
		45	12.084	10.174	11.113
		90	8.537	3.086	5.81

Following fig. point towards result of fiber direction and volume fraction of fiber on tensile strength by experimental method. Tensile investigation examples were organized according to ASTM D-3039. The thorough dimensions, gauge span and cross head speed can be found in ASTM D-3039. Each sample was loaded to breakdown. The force - extension curve was plotted automatically by the equipment soft- ware. The eventual tensile strength and elastic modulus of the trials were thereafter determined from the plot. The test results graph.6.1 was taken from the regular of trial I and trial II. From the graph, the ultimate tensile strength of banana fiber natural compound has been found to be 36.94 MPa 0 degree orientation and 40% fiber volume fraction

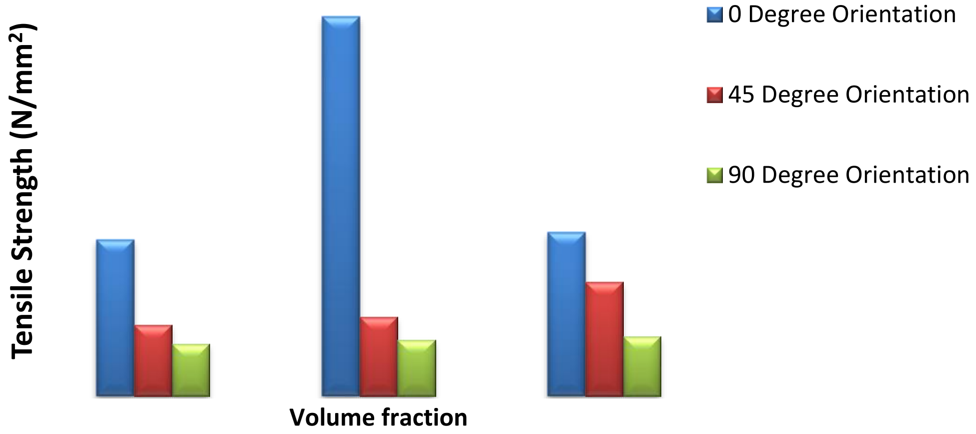

Figure 11: *Comparison of testing results for various compositions*

The ultimate tensile strength of banana fiber natural composite at different volume fraction and different orientation is described below:

A) 30/70volume fraction- In 30/70 volume fraction 30% banana fiber and 70% epoxy resin are used. With this volume fraction have made 3 different specimens with different orientation like 00,450and 900. Out of 3 orientations 00gives maximum tensile strength as compare to 450& 900 because in 00 orientations applied load parallel to the fiber direction.

B) 40/60volume fraction-In 40/60 volume fractions consist of 40% banana fiber and 60% epoxy resin. At this volume fraction got highest tensile strength (36.94N/mm2) at 00 orientation because in this volume fraction fiber % is increased by 10% as compare to condition A. It means that fiber % is increased, tensile strength also increased because fiber is stronger material than epoxy resin.

C) 50/50 volume fraction- In 50/50 volume fraction 50% banana fiber& 50% epoxy resin are used. At this volume fraction it is analyzed that tensile strength is increased at 450& 900 as compare to condition A & condition B.

3 Conclusions

A detailed study has been conducted on the mechanical behavior of banana fiber/epoxy composite on the basis of different volume fraction and fiber orientation. The study led to the conclusions mentioned below.

1. Epoxy resin reinforced with fiber has been fabricated by hand lay-up method.

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2. In tensile testing, tensile strength is gradually decreasing within creasing fiber orientation degree. It is also found that, the maximum tensiles trength (36.94 N/mm2) is obtained in case of 40% volume fraction and 0 degree fiber direction.

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