

A Review on Banana Fiber Reinforced Polymer Composite & Its Application

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Table - 1: Physical properties of Banana fiber.

SL No.	Property	Range
1.	Cellulose (%)	60-64
2.	Hemi Cellulose (%)	6-19
3.	Lignin (%)	5-10
4.	Moisture (%)	11
5.	Pectin (%)	3-5
6.	Density (g/cm ³)	1-1.5
7.	Elongation at breaking (%)	4-6.5
8.	Young's Modulus (GPa)	20

Abstract - Natural Fiber Reinforced Polymer Composites has witnessed a rapid growth in the recent years especially in engineering applications. It has several advantages over synthetic fiber composites, such as light weight, low density, bio-degradability, easy availability and low cost with considerable mechanical properties. The physical and mechanical properties of Natural Fiber Reinforced polymer composites have become the point of attraction for both researchers and industry people. Natural fiber composites are extensively used in many industries namely automobile, aerospace, packaging, agriculture etc. This paper will review the different steps followed by different researchers for preparation of the natural fiber composites and its effect on the mechanical properties of the natural fiber composites.

Structure and properties of banana and other fiber is listed below[3]:

Key Words: Banana fiber, Tensile strength, Flexural strength, Impact strength, Hardness, Physical properties, Biodegradability.

Table - 2: Physical properties of different fibers

Fiber	Moisture Content (wt%)	Carbon Content (wt%)	Water Absorption (wt%)	Tensile Strength (Mpa)
Banana	85	50.2	40	142.1
Coconut	26	51.1	168	136.4
Bagasse	52	52.5	233	29.8

1. INTRODUCTION

Banana fiber is a lingo – cellulosic fiber and is obtained from pseudo stem of banana plant. Banana fiber possesses specific strength properties compared to other conventional material that is available in the market such as glass fiber. Leaf stalk bases collectively constitute cylindrical pseudo stem. Qualities like high strength, light weight, fire resistivity, low cost and biodegradability makes banana fiber a great choice for making of composites. Banana fiber is reinforced with polypropylene for manufacturing floor protection panel in luxurious cars. In developing countries like India, Sri Lanka and some of the other African countries, natural fiber is available in abundant but is not utilized properly. In addition to cloth factory, banana and cotton fibers are also used for producing papers. This paper will discuss few experimental procedures that are employed on banana fiber to test its properties.

Table 3: Presence of Metallic ions in cellulosic fibers [3].

Fiber	Ca ⁺	Mg ⁺	Na ⁺	Si ⁺⁴	Al ³⁺
Banana	5.62	1.57	0.27	1.41	0.14
Coconut	2.34	0.75	2.51	2.55	0.02
Bagasse	3.67	1.31	0.96	27.0	3.88

2. PROPERTIES OF BANANA FIBER

Banana is one of the oldest cultivated plants in the world. The word Banana is derived from Arabic language which means finger and belongs to the Musaceae family. The physical properties of banana fiber are listed below [3].

Table 4: Helix angle and number of cells of banana fiber for various diameters [3].

Diameter (Km)	Avg. No. of Xylem cells	Avg. No. of Phloem cells	Avg. No. of sclerenchyma cells	Total No. Of cells	Helix or Microfibrillar angle (h)
100	3	6.25	50	59.25	12
150	3	8	70	81	11
200	4	7.75	91	102.75	11

Table 5: Mechanical property of banana fiber with different diameters [3].

Sample No.	Diameter (km)	Youngs Modulus (GN/m ²)	Breaking strength (MN/m ²)	Strain (%)
1	50	32.703	779	2.75
2	150	29.748	773	3.57
3	250	29.904	766	3.24

Here is the list of few experiments, that are performed on banana fiber to explore its mechanical properties: (I) Tensile, flexural/bending and impact test with varying resin and fiber percentage (ii) properties of banana fiber when it is chemically treated and when it is not chemically treated (iii) influence of fiber parameter on tensile strength, flexural strength, impact strength and hardness.

2.1 Tensile, flexural/bending and impact test with varying resin and fiber percentage.

2.1.1 Tensile Testing

The specimen is prepared according to the ASTM D638 standard. Universal testing machine is used to perform the test. The experiment involves the test sample to be placed on UTM and tension is applied until the specimen reached the fracture stage. Three different types of samples were used according to ASTM standard and the experiment was carried out several times to record the average value. The value is discussed in the table below[2].

Table 6: Experimental tensile strength of the composites sample.

Samples	Trial 1	Trial 2	Trial 3	Average (MPa)
40% banana fiber + 60% Epoxy resin	101	114	109	108
50% banana fiber + 50% Epoxy resin	110	116	114	113.3
60% banana fiber + 40% Epoxy resin	89	104	101	98

2.1.2 Flexural/Bending Testing

The specimen is made using ASTM D790 standards and the experiment is carried out using same UTM. The specimen is placed in the UTM and force is applied until the specimen breaks or fractures [2].

Table 7: Experimental Flexural strength of the composite sample.

Samples	Trial 1	Trial 2	Trial 3	Average (MPa)
40% banana fiber + 60% Epoxy resin	73.01	67.93	73.05	71.33
50% banana fiber +	64.43	56.51	70.26	63.7

50% Epoxy resin				
60% banana fiber + 40% Epoxy resin	81.29	79.22	72.31	77.60

2.1.3 Impact Testing

The specimen for the impact test is made using ASTM A370 standards. In this process, the specimen is loaded in the testing machine and the pendulum is allowed to break or fracture it. Energy required to break the material can be easily determined using impact testing. This method can also be used to measure the toughness and yield strength of the material too [2].

Table 8: Experimental impact strength of the composite samples.

Samples	Trial 1	Trial 2	Trial 3	Average (MPa)
40% banana fiber + 60% Epoxy resin	10.43	8.15	7.28	8.62
50% banana fiber + 50% Epoxy resin	12.82	6.77	8.85	9.48
60% banana fiber + 40% Epoxy resin	9.08	13.11	11.47	11.22

2.2 Properties of banana fiber when it is chemically treated and when it is not chemically treated.

Banana fiber is Hydro phobic in nature and thus absorbs water if not chemically treated. A table is given below which shows mechanical property of banana fiber when treated chemically and when left untreated.

Table 9: Properties if banana fiber

Fiber	Diameter (mm)	Young's Modulus	Ultimate Stress	Strain %
Untreated	0.07-0.20	6.6 – 25	199-782	1.7-3.2
Treated	0.07-0.171	9.72-21.4	148-536	1.3-2.3

2.3 Influence of fiber parameter on tensile strength, flexural strength, impact strength and hardness.

The specimen for tensile test is prepared according to ASTM D638 standard. In this process five samples with different fiber length and weight ratio were tested and the average value at the breaking point is recorded. Flexural strength was found out using UTM, according to ASTM D790 procedure. Average flexural strength of five samples was recorded. Impact strength of the specimen was determined using an IZOD impact test machine according to ASTM D256 procedure. Below is the figure showing the test results of tensile, flexural and impact test using graph [1].

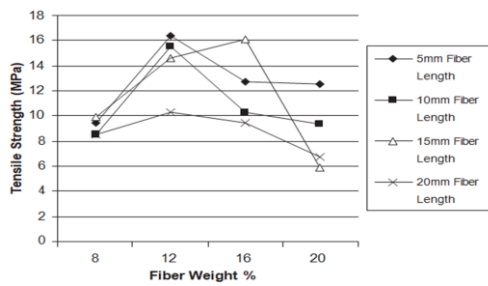


Fig-1: Effect of fiber length and weight percentage on tensile strength.

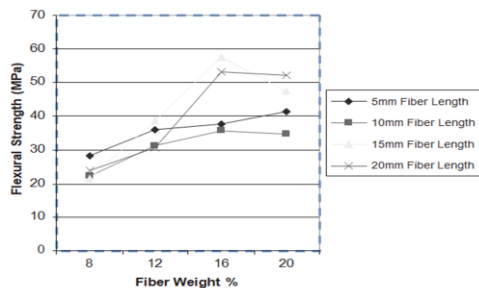


Fig-2: Effect of fiber length and weight percentage on flexural strength.

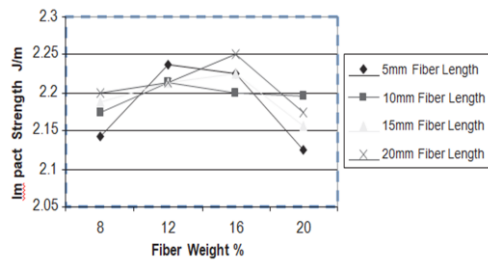


Fig-3: Effect of fiber length and weight percentage on impact strength.

The optimum fiber length and weight ratio are 15mm and 16% respectively for banana fiber epoxy composite. The maximum tensile strength is 113.3 MPa which contains the combination of 50% banana fiber and 50% epoxy resin. The maximum flexural strength is 77.6 MPa which holds 60% banana fiber and 40% Epoxy resin. The experiment suggests that 50% banana fiber and 50% epoxy resin composite materials can sustain greater loads when compared to other combinations. We thus conclude that better and persistent research in the field of banana fiber will increase its application in different fields.

REFERENCES

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3. APPLICATION

Banana fiber is used for making currencies, bond papers and specialty paper which can last for upto 100 years. It reduces the use of wood for making papers and thus reducing environmental impact of deforestation. In many places, it is used as a replacement of fiber glass. It is used for making pillows, mattresses and cushions in the furniture industry. It is also used in manufacturing for textiles. It is used in handicrafts too, such as bags, purse, mobile phone cover, mats etc.

4. CONCLUSION

The status, structure, physical and mechanical properties of banana fiber as a reinforcing agent in polymer based composite is reviewed in this paper. Low density, high tensile strength and low elongation at break makes banana fiber, a fine alternative to be used in the field of construction, automotive, transportation, machinery etc.