Flexural Properties of Bamboo Fiber Reinforced Hybrid Composite

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Abstract- **With advancements in the methods of research, the branch of Material Science has seen its extremes but there are some areas upon which much attention should be kept. One such area is the natural composite. Taking the ecological problems created by synthetic material into account, there is a need to search for the alternatives for which nature gives the answer which furnishes us with a wide variety of plant material with extraordinary properties leaving us to explore its engineering applications. This work focuses on the extraction of fibres from jute, coir and bamboo belong to this category. Fillers are used along with various commodities as well as engineering polymers to improve the properties of polymers. In this project bamboo fiber hybrid composites have been developed from polypropylene filled with fly ash of constant 10%wt Concentration. Concentration of fiber was varied up to 25 % by weight and the test specimens were prepared by Injection Moulding. Bending properties were tested by using tensometer and the Bending Strength, Bending Moment were increased with the increment of fiber weight % in the composition.**

Index Terms- **Natural composite, Bamboo fiber, Polypropylene, Fly ash, Injection Moulding, Bending properties.**

I. INTRODUCTION

In the fast developing society there is a requirement of materials with unusual combination of properties, which cannot be met by conventional metal alloys, ceramics, and polymeric materials. Many of our modern technologies demand not only the strength, but also high performance, specific service materials. In order to fulfil the above requirements lot of research work has been done in the area of material science. At last, Composite materials are chosen as one of the best engineering materials.

The flexibility that can be achieved with composite materials is immense. Merely by changing the composition, variety of properties can be obtained thus making the composites versatile and reliable substitutes for the conventional structural materials.

Composite materials have a long history of usage. Their beginnings are unknown, but all recorded history contains references to some form of composite material. More recently, fiber reinforced resin composites that have high strength - to - weight and stiffness - to - weight ratios have become important in weight sensitive applications such as aircraft and space vehicles.

The increasing population needs more and more construction materials. Wood and metals are the construction materials, which have been extensively consumed in building construction, vehicle body, furniture, etc. The growth rate of material resources is not in pace with that of population. To meet the deficiency, man has to find suitable substitutes. The materials from natural resources under-explored and unused so far, if put to effective. Utility will solve the problem arising out of the inadequacy of conventional materials.

Over the last four decades, composites of synthetic fibers have been developed adopting the knowledge of naturally available vegetative organs of Bamboo, Palm trees, Sisal, etc. It is concerned with the reduction of weight of space vehicles and aircraft for optimum pay load. The constituents of these exotic composites are of high-cost. They are cost effective only in high-tech fields. They do not meet the needs of common man.

II. EXPERIMENTAL WORK

A. Injection capacity: The proper injection capacity is found from the relationship of the molding machine capacity for the weight of 1 shot as shown in Figure 1・1-2. It is necessary to select the molding machine that satisfies the capacity of the shaded area. This figure is the summary of the actual molding results in the past, but basically, it is based on the following idea.At the side where the capacity is small, plasticizing time and injection time become long, and it is used at the narrow capacity of the molding machine. That is, the filling shortage is caused due to the extension of molding cycle and slow filling rate.

B. Barrel: Generally, using the material (for example, nitride steel etc.) for the molding of Iupilon / NOVAREX is good. However, concerning the molding of glass fiber reinforced grade (Iupilon GS etc.) and optical grade (Iupilon H-400 etc.), it is good to consider the following for the barrel material.

C. Nozzle: A nozzle with the structure without PC stagnation is desirable as possible. Therefore, it is necessary to avoid using the needle shut off nozzle and torpedo nozzle due to resin stagnation. The open nozzle is the best for use. The open nozzle is easy to cause drooling, stringiness, and it is difficult to prevent them but using a long-extended nozzle and adjusting independently the temperature at two separate places of the tip and the bottom, are effective.

D. Heater: Since PC is molded at high temperature, the heater with heat capacity can be heated to about 370^0 c is used, and a band heater is usually used.

When disassembling to clean the nozzle and cylinder head and when the heater is stuck with drooling resin, the heater is disconnected. It is necessary to note that it is easy to cause the burn when continuing molding without being aware of heater disconnection.

III. COMPOSITIONS USED IN INJECTION MOULDING

Fig.1 Composition Mixture

These compositions were mixed and added according to their weight percentages are injected into the injection moulding machine without inserting the die and the exerted irregular materials were collected according to their composition because irregular composition occurs in the final composite, in order to deplete that problem die was not inserted.

Fig.2 Complex shape specimens

Fig.3 Grinding Machine

These complex shaped composition were grinded in GRINDING MACHINE and they were made into fine pieces except plain polypropylene which can be directly prepared without making of any irregular shapes.

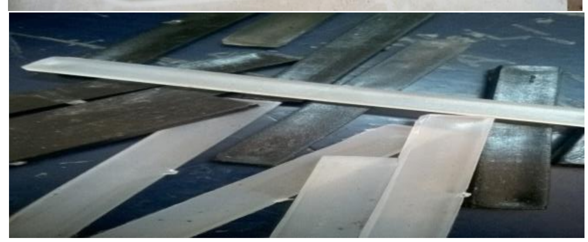


Fig.4 Fine Particles formed by grinding Fig.5 Final specimens of some compositions

These were again injected in INJECTION MOULDING MACHINE and introducing mould in its place and the process continues. For measurement of flexural strength and flexural modulus The flexural properties of the composites were measured as per the standard test method ASTM D638–89. The test specimens with 98 mm long, 10 mm wide and 4 mm thick were prepared. Five identical specimens were tested for each weight percentage of fiber. The specimens were tested at a crosshead speed of 2 mm/min, using an electronic tensometer (ModelMETM 2000 ER-1). Flexural test specimens were prepared in accordance with ASTM.

IV. RESULTS AND DISCUSSION

Measurement of flexural strength and flexural moment: Flexural strength and flexural modulus of the composites as a function of weight fraction was measured using tensometer. In accordance with ASTM D638-89 the test sample of 98 mm long, 10 mm deep and 4 mm wide were prepared.

Calculation of flexural strength:

$\sigma = \frac{3FL}{2bd^2}$

- F is the load (force) at the fracture point (N)
- L is the length of the support span
- b is width
- d is thickness

Table.1 Plain Polypropylene

LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
40	13.2	26.25	699.95
50	14.1	32.82	874.95
60	14.4	39.38	1049.93
AVG-50N	AVG-13.9mm	AVG-32.81MPa	AVG-874.94 N/mm

Table.2 90% Polypropylene+10%FlyAsh

LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
40	9.2	26.25	699.96
50	12.6	32.81	874.95
70	13.2	45.94	1225
Avg-53.33 N	Avg-11.67mm	Avg-32.81 MPa	Avg-933.3 N/mm

Table.310%FlyAsh+5%Fibre+85%Polypropylene

LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
50	11.4	32.81	874.95
60	14.7	39.37	1049.93
70	15.9	45.94	1225
Avg-58N	Avg-13.56mm	Avg-38.06 MPa	Avg-991.60 N/mm

Table.410%FlyAsh+10%Fibre+80%Polypropylene

LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
40	10	26.25	699.96
50	12.3	32.81	874.95
70	11.9	45.94	1225
Avg-60N	Avg-12.08mm	Avg-39.38 MPa	Avg-1049.98 N/mm

Table.510%FlyAsh+15%Fibre+75%Polypropylene

LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
60	11.0	39.37	1049.93
70	13.5	45.94	1225
80	14.7	52.04	1399.91
Avg-64N	Avg-12.92mm	Avg-44.53 MPa	Avg-1189.96 N/mm

Table.610%FlyAsh+20%Fibre+70%Polypropylene

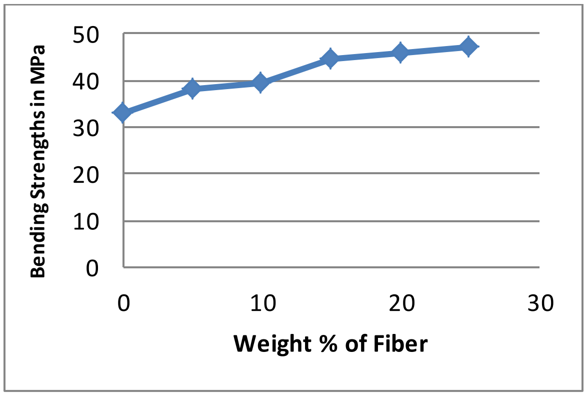
LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
50	12.3	32.81	874.95
70	15.1	45.94	1225
80	15.9	52.04	1399.91
100	18.3	65.62	1749.89
Avg-70N	Avg-15.18mm	AVG-45.94 MPa	AVG-1224.94 N/mm

Table.710%FlyAsh+25%Fibre+65%Polypropylene

LOAD (N)	ELONGATION (mm)	BENDING STRESS (MPa)	BENDING MOMENT (N/mm)
50	10.7	32.81	874.95
60	14.6	39.37	1049.93
90	15.6	59.06	1574.90
100	18.9	65.63	1749.89
Avg-	Avg-14.5mm	AVG-	AVG-

72N		47.25 MPa	1259.92 N/mm

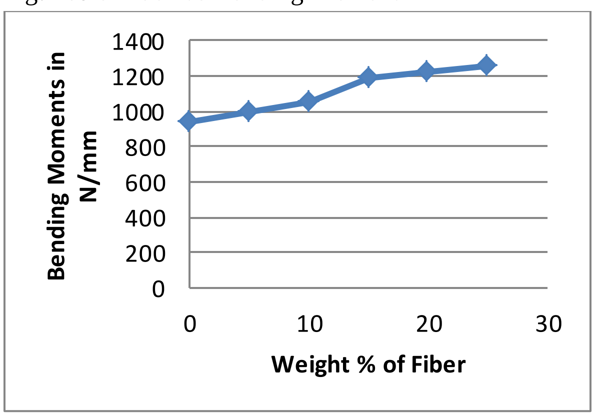
Fig.6 % of Fiber vs Bending Strengths



Discussion

With the increase in percentage of fiber the Bending Strengths also increases

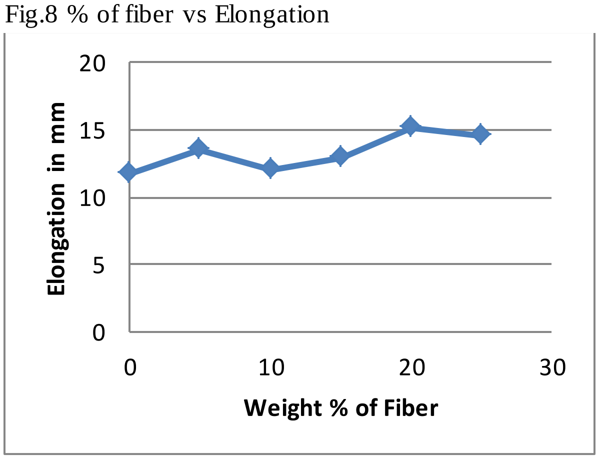
Fig.7 % of fiber vs Bending Moment



Discussion:

With the increase in weight percentage of fiber the Bending Moment also increases.

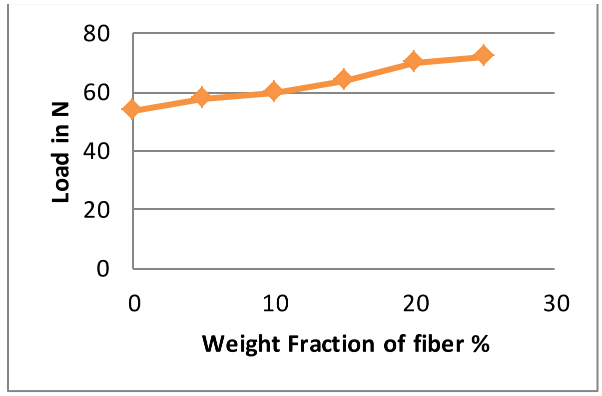
Fig.8 % of fiber vs Elongation



Discussion:

With the increase in weight percentage of fiber the elongation fluctuates with a gradual increment and decrement.

Fig.9 % of Fiber vs Load



Discussion:

With the addition of Fiber Weight % in the composition there is an increase in Load.

V. CONCLUSIONS

From the previous study it was known that polypropylene with fly ash composition, the maximum values are attained with10% Fly ash + Polypropylene. So in our Hybrid Composite we fixed the 10wt% of Fly ash as constant and differed the weight composition of Fiber and Polypropylene.

Bamboo fiber reinforced hybrid composites (Polypropylene + Fly Ash + Bamboo Fiber) mechanical properties are studied and the following conclusions are derived.

- The flexural strength increases with the increment of weight percentage of fiber according to the compositions mentioned above and it shows maximum at 25% of fiber in the composition.
- Flexural Moment also increases with the increment of weight percentage of fiber according to the compositions mentioned above and it shows maximum at 25% of fiber in the composition.
- Load also increases with the increment of weight percentage of fiber according to the compositions mentioned above and it shows maximum at 25% of fiber in the composition.
- But elongation Fluctuates by showing an increment and decrement with the addition of fiber weight percentage.

It was found that the fibre percentage cannot be increased more than 25 % because of reduction of quantity of polypropylene in the composition; the moulds cannot be formed in Injection Moulding Machine. The Flexural Properties show a gradual increment in Bending Strength and Bending Moment because of its high strength to weight ratio of Bamboo Fiber and due to lower specific gravity and higher shear strength of Fly ash.

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