Investigation of Strength and Durability Properties of Jute Fiber Polymer Composite Materials

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ABSTRACT

Composites are one of the most advanced materials with good adaptability. Composites reinforced with natural fibres have appreciable mechanical performance with an advantage of eco-friendliness. Synthetic fibers are being substituted by natural fibers in various kind of fields. Natural-fibre reinforced composite was made by compression moulding process. The percentage of jute fiber was 10% of the resin weight and size of fiber was varied from 5mm to 20mm. Used with 80% polyester resin (93P) and 2% cobalt accelerator & 8% MEKP catalyst for curing. The Natural-fibre reinforced composite was made with 8Mpa pressure at room temperature. Test specimen was taken from 200mmx200m sheet which was made by compression moulding machine. The investigation of mechanical properties using ASTM standard test for plastic materials. Complete analysis was about the properties with respect to fiber length concludes that mechanical properties increases as the size of fiber increases.

Key Words: Jute Fiber, Polyester Resin, Compression Moulding, Mechanical Properties.

I. INTRODUCTION

Synthetic assembly of multiple components having reinforced and well-matched matrix with explicit characteristics are known as composites. Natural fibers were used in 8000 B.C. too [1]. The Composite, the wonder material with low cost, light weight, high strength and abundantly available. Genus Corchorus has almost 100 types and jute are produced from it. One of the cheapest and most produced fiber is jute. C. capsulris and C. olitorus are the types produced in India [2][15]. Many fibres present in nature including jute have economic advantages compared to synthetic fibres like glass with an extra ecological advantage.

The Shape of the composite depends upon the matrix present and it also decides the finishing in surface including factors like tolerance and durability. The Structural load is carried by the reinforcement hence the stiffness with strength. Properties are controlled by the characteristics and behaviour of composite [3]. It has been estimated that substituting synthetic fibers with bio-fibers in automotive composite parts would reduce the material weight by 30% and their cost by 20%. According to some researchers if some amount of glass fibers is replaced by natural ones the emission of greenhouse gases be minimised by 490 million tons per annum [4].

Poor Wettability with water absorption is a big drawback of fibres that are natural and by the chemical extraction using alkaline treatment it was overcame [5]. This was finished by using polyester resin with jute fiber in a mould for compression moulding process at 80Mpa pressure and at room temperature of 30.2°C and they are left for curing for 15 minutes. Then the panel cut according to the ASTM standards for the testing of mechanical properties of composite. After testing the mechanical properties are analysed according to the fiber size.

II. MATERIALS AND METHOD DETAILS

Jute Fiber

Jute Fiber was purchased from local shops and extraction of fiber for better mechanical properties was purchased from Astha Fiber and Chemicals MI road Jaipur. Then the fiber was chopped in 5mm,10mm,15mm,20mm size the tensile strength of different length raw fibre varied from 331-414 MPa [16] and then they were treated with 10% of NaOH for 1 day then it washed and dry for 3 hours in the sunlight.

Polyester Resin

Resin was also purchased from Aastha Fiber and Chemicals and it was of Polyester 93P grade which can be cured at room temp easily.

Catalyst

MEKP catalyst was used to start the process and in curing the material.

Accelerator:
Cobalt Naphthalene was used as accelerator which accelerated the rate of chemical process and used in curing.

III. FABRICATION OF POLYMER COMPOSITE

Compression Moulding Machine was the best and easiest method for fabrication under the pressure [6][7]. The mild steel mould was used for the specimen of size 200mm X 200mm X 5mm.The Teflon sheet was placed in the mould for better surface finish and for the easily removal of the sheets of composite. The Teflon sheet was used for both side female and male part of the mould and for the surface finish. The Jute fiber after the alkaline treatment was used for fabrication of polymer composite with polyester resin, catalyst and accelerator.

For the betterment of reinforcement 10% fiber to the weight of resin was used and accelerator was 2-3% of the resin weight and catalyst was 5-8% of the resin weight was used.

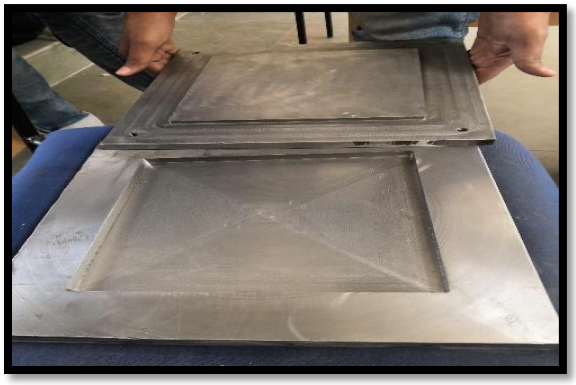

Figure 1. Mild Steel Mould

The accelerator was added in resin after the catalyst and addition of the fiber into the mixture and stirred the mixture properly then poured the mixture into the mould and pressure was applied through hydraulic bottle jack and pressure was measured using the pressure gauge which was attached with the hydraulic jack and for the measurement of temperature there was one thermocouple fixed on the frame as shown in figure 2. Then the sheet was removed from the mould and it was cured about 30 minutes then it was severed according to the ASTM standards. Simultaneously same process was followed for other size fiber for the fabrication of the sheets.

Preparation of Specimen for various Mechanical testing as per ASTM Standards
From the sheets as per the mould size of 200mmX200mmX5mm the specimen were severed for tensile, flexural, impact testing.

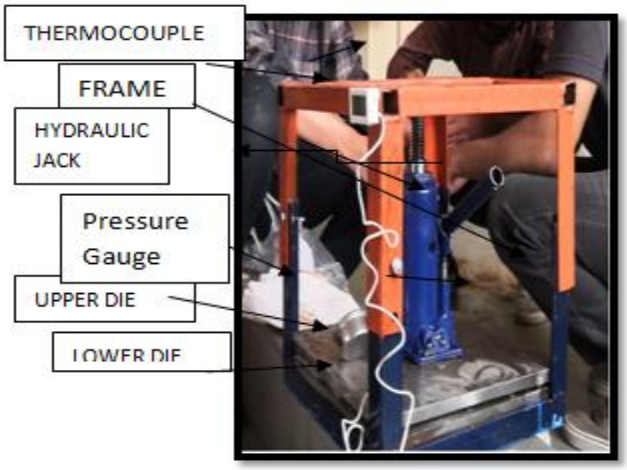

Figure2. Compression Moulding Setup

Mechanical Tests

The main objective was to determine the three important properties of composite materials which are following test at room temperature.

Tensile Test: - The tensile strength was determined using ASTM D638 Standard testing machine and the specimen was severed out from the sheet of 150mmX 20mmX5mm and gauge length was 50mm. The test was conducted using computerised tensile testing machine and tensile strength was reported in MPa [8].

Flexural Test: - This test was also conducted at room temp using ASTM D790 Standard through three-point computerised testing machine and the size of specimen severed from the sheet was 115mm X 15mm X 5mm. The Flexural Strength was carried out and reported in MPa [9].

Impact Test: - Izod Impact test was conducted using ASTM D256 Standard by swinging pendulum was similar in the case of metal using sudden application of load to the specimen and the size of the specimen was 55mmX10mmX5mm.The Impact Strength was carried out and reported in J/m [10].

Figure 3. Specimen for Testing

These three tests were carried out and the results were noted for the analysis.

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS:

Tensile Test: - The maximum stretching force a material can withstand is known as tensile strength. Measured in fpa. Tensile strength can use determine using the below equation

$$\sigma t = \frac{Fc}{Af} \quad (1)$$

$$Af = \frac{m}{\rho L} \quad (2)$$

Here σt is tensile strength of fiber, Fc was the force at the failure point, m was the mass of the fiber and ρ was the density of the fiber, **Af** was the cross-section area of the specimen, Length of the fiber and weight of fiber was 10% of the resin weight. The jute polymer composite fiber result were found 10% higher than those found by [11] and similar to those found by [12].

Table I. Tensile test result for the polyester reinforced with 5-20mm length Jute fiber

S.No	Fiber Length (mm)	Tensile Strength (MPa)
1	5	10.57
2	10	15.83
3	15	21.65
4	20	26.23

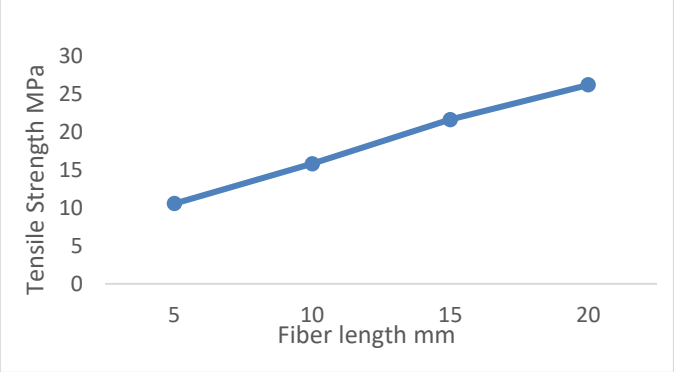

Figure 4. Graph between tensile strength and fiber

Flexural Test: Between the two supports the specimen was acting like simply supported beam and load was applied at the center of the specimen producing bending at a rate which was specified. Including the support span with maximum deflection there was one more parameter the speed of loading for test [13].

Table II. Flexural test result for the polyester composites reinforced with 5-20mm length Jute fiber.

S.No	Fiber Length (mm)	Flexural Strength (MPa)
1.	5	26.8
2.	10	30.9
3.	15	34.7
4.	20	41.1

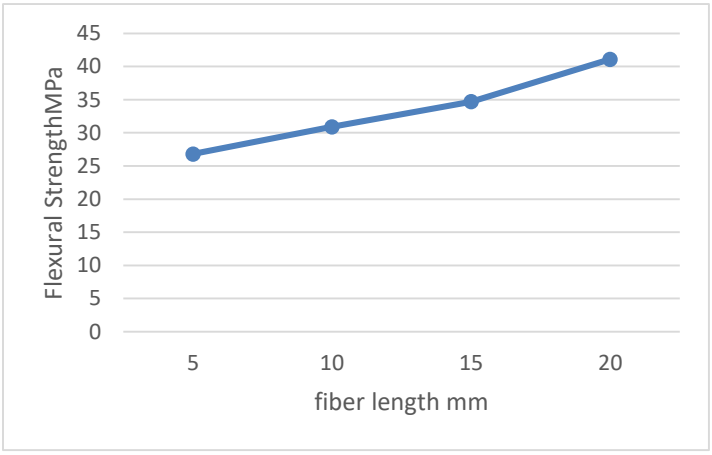

Figure 5. Graph between flexural strength and fiber length

Izod Impact Test: -Impact resistance of material is derived. From a specific height specimen is released a certain load is applied with pendulum. The swings of pendulum are applied impact or sudden load on the specimen and the impact strength is reported in the Joule [14]

Table III. Impact test result for the polyester composites reinforced with 5-20mm length Jute fiber.

S.No	Fiber Length (mm)	Impact Strength (J/m)
`1.	5	1.7
2.	10	3.0

3.	15	4.8
4.	20	6.4

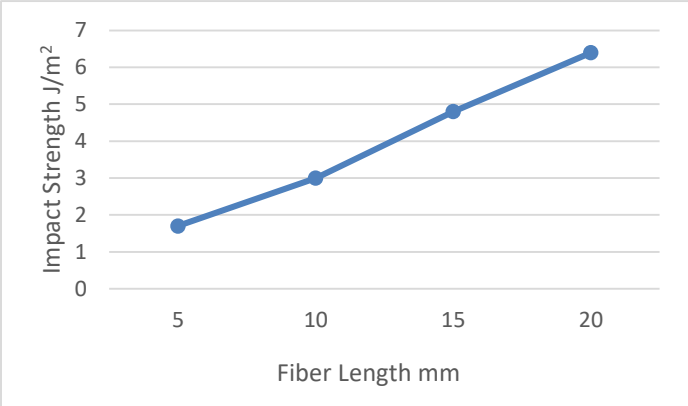

Figure 6. Graph between Impact strength and fiber length

V. CONCLUSION

Tensile strength with flexural strength and one other parameter impact strengths. These are checked for the mechanical properties

1. In the tensile strength case, the increase of length of fiber from 5mm to 20mm the tensile strength also increases.
2. In case of the flexural strength it is directly proportional to fiber length it also increased with the increment in the fiber length.
3. In case of the Impact test impact strength of composite it also increased as the increment in fiber length from 5mm to 20mm

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