CHARACTERIZATION OF TENSILE PROPERTIES OF TREATED BAMBOO NATURAL FIBRE POLYMER COMPOSITE

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ABSTRACT

This research paper shows the practical observation which includes characterization of tensile properties of potential bamboo fibre. It consist calculation of tensile strength (MPa) of treated bamboo fibre with sodium hydroxide (NaOH). The fabrication of various bamboo fibre samples were made by hand lay-up technique. Result shows the variation in tensile strength in respect with the variation in fibre content (%).

Keywords: Tensile Strength (MPa), Fibre Content (%), Wet Lay-Up Method, Fibre Orientation, Bamboo Fiber.

INTRODUCTION

When two or more materials with different properties are combined together, they form a composite material [1]. Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form [2]. Composite materials are heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property [3].

LITERATURE REVIEW

Tingju Lu, et al., (2013) this paper shows an effect of surface modification of bamboo cellulose fibres on mechanical properties of cellulose/epoxy composites. Bamboo cellulose fibres were treated with NaOH aqueous solution and silane coupling agent, respectively, before they were
applied into epoxy composites [4]. Bhandari Netra L., et al., (2012) this paper shows the analysis of morphological and mechanical behaviours of bamboo flour reinforced polypropylene composites [5]. Prity Aniva Xess, (2012) this research shows the erosion wear behaviour of bamboo fibre based hybrid composites. It involves the study of the physical, mechanical, dynamic mechanical and erosion wear behaviour of the composites [6]. Chattopadhyay Sanjay K., et al., (2011) this research paper shows the mechanical, thermal, and morphological properties of bamboo fibre reinforced polypropylene composites. Short bamboo fibre reinforced polypropylene composites were prepared by incorporation of various loadings of chemically modified bamboo fibres [7]. Ratna Prasad A. V., et al., (2011) this paper shows the mechanical properties of natural Fibre reinforced polyester composites: Jowar, sisal and bamboo. In this paper, the experiments of tensile and flexural tests were carried out on composites made by reinforcing Jowar as a new natural Fibre into polyester resin matrix [8]. Kumar V., et al., (2011) it gives the Impedance-spectroscopy analysis of oriented and mercerized bamboo fibre-reinforced epoxy composite. Bamboo fibre-reinforced epoxy composites were fabricated with untreated and alkali treated bamboo fibres. Dielectric, electric modulus, AC (Alternative Current), and DC (Direct Current) conductivity studies were carried out to rationalize the dielectric behaviour of bamboo/epoxy composites [9]. Pradeep K. Kushwaha, et al., (2010) this paper shows the Effect of Silanes on Mechanical Properties of Bamboo Fibre-epoxy Composites. Bamboo matting-reinforced epoxy composites were fabricated. Untreated and alkali-treated bamboo matting was treated with different silanes. The mechanical properties (tensile strength, elastic modulus, flexural strength and flexural modulus) were determined [10]. Dagang Liu, et al., 2010, this paper presents Starch composites reinforced by bamboo cellulosic crystals. Using a method of combined HNO$_3$–KClO$_3$ treatment and sulphuric acid hydrolysis, bamboo cellulose crystals (BCCs) were prepared and used to reinforce glycerol plasticized starch. Tensile strength and Young’s modulus of the starch/BCC composite films (SBC) were enhanced by the incorporation of the crystals due to reinforcement of BCCs and reduction of water uptake [11]. Samal Sushanta K. et al., (2009) this paper presents the fabrication and analysis of mechanical, morphological, thermal and dynamic mechanical behaviour of polypropylene-bamboo/glass fibre hybrid composites [12]. Long Jiang, et al., (2008) this paper shows the study of Effects of Nucleation Agent and Compatibilizer of Poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV)/Bamboo Pulp Fibre Composites [13]. Hitoshi Takagi, et al., (2007) this paper shows the Thermal conductivity of PLA-bamboo fibre composites. ‘Green’ composites were fabricated from poly lactic acid (PLA) and bamboo fibres by using a conventional hot pressing method [14].

**METHODOLOGY**

Based on the Literature Review with practical research, has been observed that the mechanical properties of a natural fibre-reinforced composite depend on many parameters, such as fibre strength, modulus, fibre length and orientation, in addition to the fibre-matrix interfacial bond strength, strong fibre-matrix interface bond is critical for high mechanical properties of composites.

Unsaturated polyester resin (DERAKANE 411-350 epoxy vinyl ester) is mixed with hardener in 10:1 ratio to prepare the mixture. Bamboo fibres were collected from local sources obtained from manual hammering. A wooden mould is used for composite fabrication. The short bamboo fibres are mixed with epoxy resin by the simple mechanical stirring. The hand lay-up method is used to prepare the sample specimen. Specimens of suitable dimension are cut using a diamond cutter for tensile tests.

For tensile testing the specimens are cut in dog bone shape as per the dimensions, detailed dimensions for this are shown in figure 1 and Table 1. The testing is done in standard laboratory atmosphere of $23°C ± 2°C$ and $38 ± 5\%$ relative humidity. Universal Testing Machine (Instron 3382,
1.0KN UTM) is used for testing at cross-head speed of 06 mm/minute. The specimens are positioned vertically in the grips of the testing machine. The grips will then tighten evenly and firmly to prevent any slippage with gauge length kept at 50mm. The precise three tested result will be chosen for each fibre composition of Bamboo reinforced Unsaturated Polyester matrix.

As the tensile test starts, the specimen elongates; the resistance of the specimen increases and is detected by a load cell. This load value (F) is recorded until a rupture of the specimen occurred. Instrument software provided along with the equipment will calculate the tensile properties for yield strength and elongation at break. Below are the basic relationships to determine these properties:

\[
\text{Tensile strength at yield} = \frac{\text{Maximum load recorded}}{\text{Cross section area}} \quad \text{----- (1)}
\]

Following table 2 shows composition of various samples prepared for tensile tests.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Composition</th>
<th>No. of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Pure Epoxy</td>
<td>5+5+5 = 15</td>
</tr>
<tr>
<td>B1</td>
<td>Epoxy (95%) + Bamboo Fibre (5%)</td>
<td>5+5+5 = 15</td>
</tr>
<tr>
<td>B2</td>
<td>Epoxy (90%) + Bamboo Fibre (10%)</td>
<td>5+5+5 = 15</td>
</tr>
<tr>
<td>B3</td>
<td>Epoxy (80%) + Bamboo Fibre (20%)</td>
<td>5+5+5 = 15</td>
</tr>
<tr>
<td>B4</td>
<td>Epoxy (75%) + Bamboo Fibre (25%)</td>
<td>5+5+5 = 15</td>
</tr>
<tr>
<td>B5</td>
<td>Epoxy (70%) + Bamboo Fibre (30%)</td>
<td>5+5+5 = 15</td>
</tr>
</tbody>
</table>
Following figure 2 shows specimens prepared for tensile testing.

Tensile tests are carried out on Instron 3382, 1.0kN Universal Testing Machine at a temperature of 23±2°C, and with relative humidity of 38±5%. Testing procedures is carried out in ASTM D638 for tensile tests. Summary of the entire test performed are shown in the Table 3.

<table>
<thead>
<tr>
<th>Testing</th>
<th>Machine Used</th>
<th>Working Variables</th>
<th>No of Specimen Tested</th>
<th>Standard Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile</td>
<td>Instron 3382, 1.0kN UTM</td>
<td>Load cell = 500KN Rate = 6mm/min</td>
<td>5×6 = 30</td>
<td>ASTM D638</td>
</tr>
</tbody>
</table>

Result: The tensile strength of bamboo fibre reinforced epoxy composites with different fibre loading under this investigation are presented in table 4. Tensile testing of bamboo-epoxy composite is done at Central Institute of Plastic Engineering and Technology, Lucknow.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Fibre Content (%)</th>
<th>Orientation (degree)</th>
<th>Tensile Strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>0%</td>
<td>-</td>
<td>18.16</td>
</tr>
<tr>
<td>B1</td>
<td>5%</td>
<td>Random</td>
<td>26.22</td>
</tr>
<tr>
<td>B2</td>
<td>10%</td>
<td>Random</td>
<td>37.98</td>
</tr>
<tr>
<td>B3</td>
<td>20%</td>
<td>Random</td>
<td>45.28</td>
</tr>
<tr>
<td>B4</td>
<td>25%</td>
<td>Random</td>
<td>53.61</td>
</tr>
<tr>
<td>B5</td>
<td>30%</td>
<td>Random</td>
<td>46.91</td>
</tr>
</tbody>
</table>
The effect of weight fraction of fibre in the composite on the tensile strength is shown in figure 4.1. As the weight fraction of bamboo fibre increases in the composite the tensile strength of composite is also increases. It is evident from the figure 4.1.1 tensile strength of composite increases from 18.16 MPa at 0wt% to the maximum value of 53.61 MPa at 25wt%. Furthermore increase in fibre loading tensile strength of the composite is reduced to 46.91 MPa at 30wt% from 53.61 MPa at 25wt%.

![Tensile strength vs fiber content graph](image)

Figure 3: Effect of fibre loading on tensile strength of composite

CONCLUSION

The present study shows that the tensile strength of bamboo-epoxy composite increases to the certain level of fibre loading and then starts decreasing on further fibre loading. The maximum value of tensile strength is obtained at 25wt% of fibre loading.

REFERENCES