EXPERIMENTAL INVESTIGATION OF FLEXURAL STRENGTH OF BANANA FIBER REINFORCED COMPOSITES

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Abstract: The present generation widely makes use of an number of composites in the field of materials technology, with a very high performance and costs appropriate for the applications such as structural and automotives etc. Fiber reinforced composites are those composites that are called as the oldest and frequently used composite materials, in which Banana fibers are the most common ones. Nowadays consciousness and environmental awareness about using natural fibers as a serious alternative has been keep on increasing globally. And also in these present days natural fiber reinforced polymer composites are being widely used in various engineering applications. Natural fibers such as jute, sisal, palm, coir and banana are the most commonly used reinforcements. In vinyl ester resin matrix banana fibers have been used as reinforcement. This work deals with the study of effect of sodium hydroxide (NaOH) on fibers in addition with alumina (Al₂O₃) particulate. It is seen that the flexural strength value of UT, UT+ Al₂O₃, T+ Al₂O₃ has increased with increase in the fiber content.

Keywords: Composite Fabrication, Vinyl ester, Mechanical properties, Scanning electron microscopy, UT - Untreated, T - Treated

1. Introduction

In this Paleolithic age all humans are well aware and well known about composites. Clay mixed with finely chopped straw was used in constructing the 300 ft high ziggurat or temple tower in the city center of Babylon [1, 2]. In recent years, many applications such as automotives, sporting goods, marine, electrical, industrial, construction, household appliances, etc makes use of polymeric based composite materials. These types of composites have very high stiffness and strength, light in weight, and high corrosion resistance. An extensive research work has been carried out in the past decades on the natural fiber reinforced composite materials. It was found that natural fibers which are available in abundant can be used to reinforce the polymers in order to obtain light and strong materials from them. The researchers have given results as natural fibers from plants are in the beginning stage to find their way into commercial applications such as automotive industries, household applications, etc.

Lot of investigations has been made on several types of natural fibers to study the effect of these fibers on the mechanical properties of composite materials [4–7]. Mansur and Aziz [6] has studied about bamboo-mesh reinforced cement composites and found that this reinforcing material could enhance the ductility and toughness of the cement matrix, and increase its tensile, flexural, and impact strengths significantly. On the other hand, in order to evaluate the mechanical properties and compare it with wood composites, the jute fabric-reinforced polyester composites were tested [7], and the test came up with good results that the jute fiber composite has better strengths than wood composites. Also there was an investigation made with pulp fiber reinforced thermoplastic composite and it was found to have an increase in stiffness by a factor of 5.2 and increase in strength by a factor of 2.3 relative to the virgin polymer [8]. Information on the usage of banana fibers in reinforcing polymers is limited in the literature.
In dynamic mechanical analysis, Laly et al. [9] has made an investigation on banana fiber reinforced polyester composites and found that the optimum content of banana fiber is 40%. Mechanical properties of banana–fiber–cement composites were investigated physically and mechanically by Corbiere-Nicollier et al. [10]. It was reported that Kraft pulped banana fiber composite has good flexural strength. In addition, short banana fiber reinforced polyester composite was studied by Pothan et al. [11]; the study concentrated on the effect of fiber length and fiber content. The maximum tensile strength was observed at 30 mm fiber length while maximum impact strength was observed at 40 mm fiber length. Incorporation of 40% untreated fibers Provides a 20% increase in the tensile strength and a 34% increase in impact strength tested with banana fiber and glass fiber with varying fiber length and fiber content as well.

2. Experimental Details

This research work aims in developing the flexural strength of Banana Fiber/Particulate Reinforced Epoxy Hybrid Composites. It was found that only few researches were made using this material and hence to explore the mechanical properties such as flexural strength of the material this work is proposed which may be a platform for the future development.

2.1. Specimen Preparation

The mould should be well cleaned and dried using releasing agent (wax) before laying the vinyl ester resins on the mould. The first layer of the mould is uniformly laid with vinyl ester mixture using a special brush. The first layer of non-woven fiber mat is placed into the mould. Another layer of Vinyl ester will be applied uniformly on the first layer of non-woven fiber mat. The second layer of non-woven fiber mat is then placed. In order to get the required laminates all these procedures are continuously followed. The mould is then closed and the composite laminates are pressed uniformly for 24 hours to obtain required thickness and curing. Once the composite is completely dried out then it is separated from the mould. The composite laminates are cut in to specimen size as per ASTM standard for testing.

3. Testing of Flexural Property

A measure of the force that is required to bend a beam under three point loading conditions is known as flexural strength. These datas are often used to select materials for parts that will support loads without flexing. An indication of a material’s stiffness when it is flexed is called as flexural modulus. Since the physical properties of many materials (especially thermoplastics) can vary depending on ambient temperature, it is sometimes appropriate to test materials at temperatures that simulate the intended end user environment.

3.1 Flexural Test Procedure:

- Most commonly the specimen will be lying on a support span.
- The load is applied at the center by the loading nose, producing three points which in turn starts bending at a specified rate.
- We have to consider certain parameters such as support span, speed of loading, and the maximum deflection.
- These parameters are based on the test specimen thickness and these are well defined differently by ASTM and ISO. For ASTM D 790, the test is completed when the specimen reaches 5% deflection or the specimen breaks before 5%.
- For ISO 178, the test is completed when the specimen breaks.
If the specimen does not break, then the test has to be continued as far as it is possible.

Table 1. Various composite samples and its Flexural strength.

| Samples   | Flexural Strength in Mpa |
|-----------|--------------------------|
| Sample 1  |                          |
| UT        | 4                        |
| UT+Al₂O₃  | 3                        |
| T         | 3                        |
| T+Al₂O₃   | 5                        |
| Sample 2  |                          |
| UT        | 4                        |
| UT+Al₂O₃  | 5                        |
| T         | 4                        |
| T+Al₂O₃   | 4                        |
| Sample 3  |                          |
| UT        | 4                        |
| UT+Al₂O₃  | 4                        |
| T         | 3                        |
| T+Al₂O₃   | 4                        |

Figure 1. Shows the loading of the specimen in UTM for Flexural Test.
4. Result and Discussion

4.1 Flexural strength

The bending properties of composites were tested by applying 3-point bending method. Sample 1 - The flexural strength of T+Al2O3 has been increased by 25% when compared with UT. Sample 2 - The flexural strength of composite faring UT+ Al2O3 of 5 Mpa, has been increased by 25% when compared with T+ Al2O3. Sample 3 – The flexural strength of UT, UT+ Al2O3 and T+ Al2O3 are same as show in figures 4 (a) & (b), 5 (a) & (b) and 6 (a) & (b).
**Figure 4 (b).** Flexural Test Result of Sample 1

**Figure 5 (a).** Flexural Test Result of Sample 2

**Figure 5 (b).** Flexural Test Result of Sample 2
The variations in the flexural strength of samples 1, 2 & 3 in single layer composite laminate, and Samples 1, 2 & 3 in double layer composite laminate are shown in figures 4 (a) & (b), 5 (a) & (b) and 6 (a) & (b) respectively.

5. Conclusion

In this research work, by adding Al₂O₃ and modifying the surface some of the mechanical properties are experimentally evaluated and the following conclusions have been drawn:

- Flexural strength has been increased invariably.
- In addition of Al₂O₃ when it is treated with NaOH it has provided better results in the increase/improvement of flexural strength and other mechanical properties.
- The flexural strength can be even increased more when these hybrid composites undergoes with surface treatment.
- Composite materials that are light in weight are made using banana fiber with high specific strength which in turn can be used in making automotive interiors.
- Hybridized synthetic and natural fiber polymer composites, can be utilized in various fields like structure, marine, consumer articles and in industries also.
Thus it has been concluded that when a systematic and persistent research is carried out it will bring lot of scope and a better future is developed for synthetic and natural fibre – polymer hybrid composites in the upcoming years.

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