STUDIES ON MECHANICAL BEHAVIOUR OF BASALT FIBER COMPOSITE

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Abstract

Natural fiber reinforced composites is an emerging area in polymer science. These natural fibers are low cost fibers with low density and high specific properties. In this paper, hybrid composite is fabricated with basalt fibre as a major constituents and glass fibre reinforced polymer as are in forcing agent. The method used for manufacturing the composite is handlay method in which all the operations are done manually at room temperature. The objective of this investigation was to study the effect of surface modifications and also the mechanical properties, including shear and impact strengths of composite fibre. Variations in mechanical properties such as the impact strength of various specimens were calculated using a computer-assisted universal testing machine and an Izod Impact testing machine.

Keywords: Hybrid composites, Hand layup method, Mechanical properties.

1. Introduction

Since composite materials are replacing conventional materials, study and analysis of composites are necessary. Moreover, composites are Bio- degradable and also have high strength to weight ratio. Schloesser and Knothe (1997) reviewed a report work on natural fiber reinforced composites with special reference to the type of fibers, matrix polymers, treatment of fibers and fiber-matrix interface. They concluded that in most of these applications, the properties of polymers are modified using filler sand fibers to suit the high strength/high modulus requirements. Vijaya Ramnath et al (2016) investigated the shear and hardness of Abaca based Hybrid composite fabricated by hand layup process. They evaluated properties like double shear and hardness were evaluated and found that the double shear properties and hardness of the hybrid composites [GFRP +Abaca+Raffia] is better than other two combinations. Puneet Kumar Shrivastav and Kshitij Tare (2015) investigated certain drawbacks and incompatibility with the hydrophobic polymer matrix and its tendency to form aggregates during processing. Also it showed poor resistance to moisture which greatly reduces the potential of natural fibers to be used as reinforcement in polymers. Vijaya Ramnath et al (2014) studied the mechanical properties of hybrid natural fibre composite (banana jute glass fibre) and compared it seperately with single fibre natural composites made up of jute and banana by Hand layup method. They performed mechanical test and found that hybrid composite has better mechanical properties when compared to mono composites. Sandeep Bhardwaj et al (2014) studied the fibers used for durable yarn, fabric, packaging, and paper. Such as fibers from flax, jute, kenaf, industrial hemp, ramie, rattan, and vine fibers.
Above fibers are collected from the fruit of the plant, e.g. coconut (coir) fiber. Schneider et al (1995) observed that natural fiber composites offer specific properties comparable to those of conventional fiber composites. They found that the incompatibility of the fibers and poor resistance to moisture often reduce the potential of natural fibers. Schneider et al studied fiber-reinforced polymers are advantages over conventional materials when specific properties are compared. They concluded that natural fibers have recently attracted the attention of scientists and technologists because of the advantages that these fibers provide over conventional reinforcement materials, and the development of natural fiber composites has been a subject of interest for the past few years. Sim et al studied the advantages of synthetic fibre composites, including low environmental impact and low cost and support their potential across a wide range of applications. They concluded that much effort has gone into increasing their mechanical performance to extend the capabilities and applications of this group of materials.

Vijaya ramnath et al (2014) evaluated the mechanical properties of abaca–jute–glass fibre reinforced epoxy composite by testing the composite lamina for tensile, flexural, shear, and impact strength. They found that jute fibre is present at the center flanked by abaca fibre on both sides and also glass fibre is used to laminate the composite on top and bottom, which improves the surface finish and adds strength. They also found that the abaca–jute hybrid composite has better properties than the abaca fibre in tensile and shear. Srinivasan et al (2014) evaluated the mechanical and thermal properties of banana–flax based natural fibre composite. They used volume fraction of 40% with Epoxy resin and HY951 hardener. Glass fibre reinforcement polymer (GFRP) is used for lamination on both sides. The properties of this hybrid composite are determined and they concluded that hybrid composites of flax and banana with GFRP have better thermal stability and flame resistance over flax, banana with GFRP single fibre hybrid composites. Vijaya Rammath et al (2014) determined the mechanical properties of intra-layer abaca–jute–glass fiber reinforced composite made up of five layers with three layers of jute and abaca enclosed by two layers of glass fibers. The composites are manufactured with three different fiber orientations and the compositions are varied in three different proportions. They concluded that composites with 45° orientation have better mechanical behaviour than others. Sathish et al (2015) investigated the mechanical and thermal properties of banana-kenaf glass fiber reinforced epoxy composite fabricated by a hand layup process with different fiber orientations and different volume fractions. They concluded that the hybrid composites in which fibers arranged at 45 degrees inclination hybrid composites has better properties compared to others. Vijaya Rammath et al (2015) investigated the effect of twisting and the fibre orientation on the mechanical properties of bio degradable green composites. They fabricated the laminate with compression moulding technique by using two fibers namely twisted neem and twisted kenaf. They found that there is a significant improvement in mechanical properties of composites due to the presence of twisted fibers. Yuvaraj et al (2016) investigated mechanical behaviour of sisal
epoxy hybrid composites fabricated by hand layout process. Due to their properties such as bio-degradability, low strength to weight ratio, these composites possess better mechanical properties. They observed that breaking load of double shear test, hardness and delamination is increased. They also proved that composites with equal fiber ratio of glass and sisal have improved the mechanical properties.

2. Experimental Details

2.1 Materials

Basalt is a igneous rock formed as a result of Lava cooling at the surface of the planet. It is drawn into continuous fiber by rock melt drawing at about 1500°C. It is similar to fiberglass, having better mechanical properties than fiberglass. GFRP is very commonly and widely used polymer made from extremely fine fibers of glass which makes them lightweight, strong and robust. Epoxy resin when used along with the hardener give very high bonding properties between the fibre layers to form a composite. The best bonding properties were obtained by using the combination of Epoxy LY556 resin and HY951 hardener at the room temperature.

2.2 Hand lay-up process

Basalt fiber and GFRP of 300 mm length were used to prepare the specimen. The size of the fabricated laminate is restricted to 200×200×5 mm. The composite consists of 1, 3 and 5 layers of basalt fibers named as composite 1, 2 and 3. The mats were impregnated with epoxy resin. Initially, the basalt fibers are dried under the hot sun to remove the moisture for more than 24 hours. The fiber layers are washed in the acetone thinner before they are fabricated. This removes the impurities on them and makes them ready for binding with the resin. Then they are spreaded on the base plate which is placed on the table, and then it is completely filled with the epoxy resin. The resin gets mixed with the fiber and may tend to dried up in the open atmosphere under hot sun for 48 hours.

3 Testing of composites

The following tests were performed in order to study the mechanical behaviour of fabricated composite.

3.1 Flexural test:

The flexural test is performed by using the universal testing machine. Three point flexural testing is carried out. The load is applied continuously until ASTM: D790 standard specimen breaks. Figure 1 represents the flexural test specimen.

Figure 1 : Flexural test specimen
3.2 Impact test:
The charpy test is conducted on the ASTM: D256 standard specimen. To find the maximum energy absorbed by the specimen, a pendulum is dropped at the notch which is prepared and the load is noted. Figure 2 shows impact test specimen.

![Impact test specimen](image)

Figure 2 Impact test specimen

4. RESULTS AND DISCUSSION

4.1 Flexural properties

Composite specimens 1, 2 and 3 were tested for flexural properties such as flexural break load, maximum displacement and ultimate flexural strength. It can also be noted that specimen 3 has a higher flexural breaking load and higher displacement than specimens 1 and 2 by at least 0.125 kN. Specimen 3 could withstand 75.51% higher load over specimen 2 and 65.30% higher load over specimen 1. Table 1 shows the tabulated result of flexural test and figure 3 shows result of flexural test.

**Table 1 Result of flexural test**

| COMPOSITES | MAXIMUM FLEXURAL BREAKING LOAD (kN) | MAXIMUM DISPLACEMENT (mm) |
|------------|-------------------------------------|---------------------------|
| COMPOSITE 1 | 0.32                                | 7.2                       |
| COMPOSITE 2 | 0.37                                | 8.1                       |
| COMPOSITE 3 | 0.49                                | 8.9                       |
4.2 Result of impact test

The impact test was performed on three specimens 1.2 and 3. It was observed that maximum impact strength is found to be 12, 8, and 7 J respectively on specimen 3, 2 and 1. Table 2 shows the tabulated result of impact test and figure 4 shows the result of impact test.

| COMPOSITES | TRAIL 1 | TRAIL 2 | AVERAGE IMPACT STRENGTH (J) |
|------------|---------|---------|-----------------------------|
| COMPOSITES 3 | 13      | 11      | 12                          |
| COMPOSITES 2 | 7       | 9       | 8                           |
| COMPOSITES 1 | 8       | 6       | 7                           |

Conclusion

Thus the mechanical behaviour of basalt fiber composite have been studied and the results of flexural and impact testing shows the following

- The specimen 3 could withstand 75.51% higher load over specimen 2 and 65.30% higher load over specimen 1.
The maximum impact strength is found to be 12, 8, and 7 J respectively on specimen 3, 2 and 1.

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