COMPARISON OF COMPRESSION BEHAVIOUR OF DIFFERENT HYBRID FIBER REINFORCED COMPOSITES

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Abstract

In the present day scenario, the composite materials are used to get better products and overcome the problem of shortage of conventional materials and also most of these materials are biodegradable. Composite materials are strong and durable in spite of their low density and weight. These composites give us the freedom to design into any shape possible. Commonly fibers are used as the reinforcement for a composite material. In this experiment, hybrid fiber composite laminates are prepared by hand layup method using natural fibers like Flax, Sisal, Kenaf and Aloe Vera fibers along with glass fibers in epoxy resin. Four types of composite materials are prepared and compared for the compression strength. Laminates are cut with D695 ASTM standards which state that material should be having 50x50mm for composite materials and the test is done using Universal Testing Machine (UTM). When the results are compared, Glass Flax Glass composite is having high compression resistance when compared with the other three.

Keywords: Hybrid fiber reinforced composites, ASTM D695, Compression Strength.

1. INTRODUCTION

Composite materials are generally a combination of two or more different materials; irrespective of the type of material (metals/non-metals) which are combined to get a better material than the parent materials. These are biodegradable in most cases.
The concept of composite materials can be the solution for creating renewable materials that can compete with the performance of manmade petroleum-based polymers [1]. There is a lot of interest growing for the development of natural fiber composites because they can be able to replace synthetic fiber reinforced plastics with improved durability, less cost and less weight [2, 10]. Natural fibers exhibit good mechanical properties such as flexibility, stiffness and modulus compared to glass fibers [3]. Though the natural fibers are not as strong as glass fibers, some of their properties are considerable. Natural fibers such as Kenaf, Flax and Sisal have the potential to form a good bond between thermoplastic binder polymers [4]. Brazil is the great producer of sisal and exporter for the entire world with a yearly 111,900 tons, in 2005. It is also responsible for 56% of the worldwide production [5]. These natural composites are recently been used in exterior composite components and also be used in both interior and exteriors of automobiles [4]. Because of increased environmental awareness and regulations, there is an increasing need for unconventional materials. Due to this, there is a good development of eco-friendly materials. The best advantages of these eco-friendly composites are biodegradability and recyclability [6, 11]. Some of the other benefits associated with natural fiber reinforced polymers are their nonabrasive nature and natural fibers can eliminate CO₂ from the atmosphere, hence can provide an advantageous contribution to global carbon budget [7]. Cellulose-based natural fibers are favourable ones for using as a reinforcement in any polymer matrix composite, these can be used as a replacement for E-glass fibers which are used widely. These eco-friendly fibers may have a wide range of applications such as Automobile industries, furniture industries [8]. Natural fibers have been the replacement of conventional fibers because they are also having the same toughness, but when we use natural fibers with glass fibers they can give different results which are considerable. Natural fibers have been the replacement of conventional fibers because they are also having the same toughness, but when we use natural fibers with glass fibers they can give different results which are considerable.

The present paper describes the series of test conducted on the compression behavior of Aloe Vera, Sisal, Flax, and Kenaf when combined with Glass fiber reinforcement. Composites can be made with desired properties by orienting the fibers based upon the application. The manufacturing of the composites is cheaper and there are various manufacturing processes available for composites [9]. Composites used in these processes are made using hand layup method. Compression test was conducted using a Universal Testing Machine. The compressive strength of a composite material was determined according to ASTM D695 [12].

2. MATERIALS USED [13]

In this work, four types of natural fibers are used, they are Aloe Vera fiber, Flax fiber, Sisal fiber, and Kenaf fiber. These natural fibers are combined with glass fiber (10% natural fiber and 20% glass fiber) with 70% resin based on weight fraction. Four different laminates are prepared from that combination they are:
• Glass-Aloe Vera-Glass
• Glass-Flax-Glass
• Glass-Sisal-Glass
• Glass-Kenaf-Glass

All these composite laminates are cut according to ASTM D-695 Standards that is 50x50mm. We took 3 samples of each laminate for testing.

3. COMPRESSION TEST

In a compression test the material experiences opposing forces that push inward upon the specimen from opposite sides or in otherwise compressed or flattened. The test sample is generally placed in between two plates that distribute the applied load across the entire surface area of two opposite faces of the test sample and then the plates are pushed together by a universal testing machine causing the sample to squash. All composite laminates are cut into shapes according to the ASTM D-695 standards to test on a Universal Testing Machine fig-1 (UTM) with a minimum of 1KN and maximum of 600 KN capacity at room temperature. These tests are done for all the 3 samples of each composite until each sample gets fractured. The machine used is shown in Figure: 1

![Universal Testing Machine](image)

4. RESULTS AND DISCUSSION

Figure:2 (A) shows the GSG sample before testing, (B) shows GSG sample after testing (C) shows the GFG sample before testing and (D) shows the GFG sample after testing. From the Figure:2 we can clearly see that D is completely deformed and B is slightly deformed. So it has more compression resistance than GSG. Table: 1 gives the compression strength for different composites. From that we can state that GFG has high compression resistance and GAG has lowest compression resistance among the four composites.
Table 1: The compression strength for different composites

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Sample-1</th>
<th>Sample-2</th>
<th>Sample-3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass-Aloe Vera Glass</td>
<td>286.24</td>
<td>258.34</td>
<td>290.33</td>
<td>278.30</td>
</tr>
<tr>
<td>Glass-Kenaf-Glass</td>
<td>358.67</td>
<td>296.34</td>
<td>324.48</td>
<td>326.49</td>
</tr>
<tr>
<td>Glass-Flax-Glass</td>
<td>324.38</td>
<td>358.11</td>
<td>330.86</td>
<td>337.78</td>
</tr>
<tr>
<td>Glass-Sisal-Glass</td>
<td>327.76</td>
<td>318.61</td>
<td>289.69</td>
<td>312.02</td>
</tr>
</tbody>
</table>

For the compression test of Kenaf, Aloe Vera, Flax, and Sisal the results for the first sample from below graph Figure: 3, we can state that Kenaf has maximum compression value followed by Sisal, Flax and Aloe Vera. From the Figure: 3 for sample 2 we can state that GFG has the highest compression strength followed by GSG, GKG, and GAG. From the sample-3, we can state that GFG has the highest compression strength followed by GKG, GAG, and GSG.
The Figure: 4 represents the average of three test samples of each composite material. From the Figure:4, we can state on whole that GFG has the highest compression strength with 337.38 N/mm$^2$ followed by GKG at 326.49 N/mm$^2$, GSG at 312.02 N/mm$^2$ and GAG at 278.30 N/mm$^2$.

5. CONCLUSION

The composite materials which we used were made by using hand layup method, with epoxy as its adhesive material and glass fiber as its reinforcement. In the experiment, the compression strengths for different types of composites have been found and from the results, we can state that GFG has the highest compression resistance among the other four materials.

6. REFERENCES