Processing and Characterization of Green Composites using Sisal and Palm Fibers
Anilthota. H. G1, Praveen. B. A2
Assistant Professor2
Mechanical Department (machine design)1, Mechanical Department2
Nitte Meenakshi institute of Technology Yelahanka Bangalore India

Abstract:
Fiber reinforced composites are finding applications in automobile industries, civil industries, aerospace industries and chemical industries respectively and also in marine applications in recent years. The term hybrid composite refers to the materials which consist of two constituents which are at nano-level. Basically one of these compounds is organic and inorganic in nature. Hybrid composite materials are different from any other composite materials which are at macroscopic level. Paints are the first most hybrid materials which are prepared from organic and inorganic components. The organic polymers rubber is used as inorganic material. In this project work an attempt has been made to develop a hybrid green composite material using sisal and palm fiber with Epoxy as matrix for different weight percentage is fabricated using the Hand Layup technique. Different mechanical properties such as tensile, bending, dynamic properties were studied by preparing the specimen according to ASTM D- 638 standards. A comparative study of results for two different weight ratios of the fiber is obtained and it was found that ply’s with 40% ply has better mechanical properties than the other. Dynamic analysis carried out for 2 samples shows variation of damping and natural frequencies for both the samples. For the first sample, damping values are increasing, which is not concluded for the second specimen. Also higher natural frequency is observed for the second specimen compared to the first one. Higher natural frequencies are always desirable for better mechanical stability. Even harmonic response of the samples is also observed and graph is shown for 1050Hz. For the first sample, both natural frequencies and damping values are increasing, but for the second configuration, the results shows higher natural frequencies but not in the order. All the relevant pictures are represented for analyzing the problem.

I. INTRODUCTION

Due to their high flexural modulus and strength as well as impact strength and modulus Natural fibers have replaced synthetic fibers as reinforcement. They are cheaper, light in weight, low density, high specific weight, non-corrosive and easier to manufacture. The project work is carried on Hybrid composite – Sisal and Palm as fiber and Epoxy as the matrix. The main objective of this work is to characterize the material properties of hybrid composites using sisal and palm. The development of composite materials and their related design and manufacturing technologies is one of the most important advances in the history of materials. Composites are the material used in various fields having exclusive mechanical and physical properties and are developed for particular application. Composite materials have many advantages over other conventional materials such as tensile strength, impact strength, flexural strengths, stiffness and fatigue characteristics. Due to their numerous advantages they are widely used in the aerospace, automobile, Marine and in health care industry. The biodegradability of natural fibers is well in line with the demands of a healthier environment, while their high performance and affordable cost satisfies the economic benefit of industries. Pineapple leaf, oil palm fiber, hemp, sisal, Jute, kapok, rice husk, palm, and wood are some natural fibers most commonly used as reinforcing materials in polymer composite industry. Of all the plant fibers, palm and sisal is most useful, commercially available, and inexpensive, that can be moulded into different shapes. Here in this project sisal and palm is used as a natural fibers and Epoxy as matrix material.

II. METHODOLOGY

2.8 METHODS FOR PREPARING COMPOSITES

1) 2.8.1 HAND LAY-UP TECHNIQUE

Hand laminating is a primitive but effective method that is still widely used for prototyping and small batch production. The most common materials are E glass fiber and polyester resin, although higher performance materials can also be used. The usual feature of hand laminating is a single sided female mould, which is often itself made of glass fiber reinforced plastics (GRP), by taking a reversal from a male pattern. The GRP shell is often stiffened with local reinforcement, a wooden frame or light steel work to make it sufficiently stiff to withstand handling loads. The mould surface needs to be smooth enough to give an acceptable surface finish and release properties and this is provided by a tooling gel coat that is subsequently coated with a release agent. The latter prevents the matrix resin from bonding to the mould surface and facilitates the de- moulding operation.

Figure 1. Hand lay-up Technique
2.8.2 SPRAY UP TECHNIQUE
This technique is applied to many other composite construction projects using fiberglass or carbon fiber. In this method spray gun is used for uniform distribution of mixture of hardener and epoxy.

Figure 2. Spray Up Technique

B. 4.1 SPECIMEN PREPARATION
By HAND LAY-UP TECHNIQUE

Step 1:
For preparing specimen we need sisal, palm fiber, Epoxy Lapox L-12, Hardener K6, Glass slab, Plastic sheet, Weighing machine, Brush, Hand Roller.

Step 2:
Cut the fiber mat to required size. Then mix the epoxy resin and Hardener in the ratio of 10:1 by weight.

Step 3:
Cover the work table with plastic sheet so that the table cannot be affected by epoxy and hardener mixture, and place the glass slab on the table and again we placed the plastic sheet above it so that it can be used further and always we can get maximum smoothness of the material.

Step 4:
Sandwich the sisal and palm with Epoxy hardener mixture in consecutive layers to get a minimum thickness of 5mm (For that we have to apply 6 layers of jute and 7 layers of E-glass).

Step 5:
For drying purpose keep the above specimen for 12-24 hours under regular observation.

Figure 3. Finished Material using sisal and palm fiber

Step 6:
Once the specimen becomes harder mark the specimen according to ASTM standard and cut the specimen. These specimens are then ready for conducting tests (Bending, Tensile, dynamic specimen)

ASTM D638 Standard

Figure 4. Tensile specimen

Figure 5. Bending specimen

Figure 6. Bending test specimen

III. 5. RESULTS AND DISCUSSIONS

5.1. Tensile strength for 30% fiber
Tensile specimen has been prepared according to ASTM D 638 and test was conducted at SJCIT Chikaballapur

Figure 7. Graph of Stress vs Deformation for first specimen – Tensile Test
The above figure shows the relation between the stress and deformation for first tensile test specimen for the specimen with sisal and palm respectively. It was found that specimen failed at an ultimate stress of 16.8Mpa. The young’s modulus for first specimen was found to be 2905.6Mpa.

5.6.2 MODAL AND HARMONIC RESULTS FOR MODEL 2

The figure shows testing procedure applied to find the vibration behavior of the system. A hammer is taken and pointed at modal points of the grid structure to find vibration behavior.

The table shows obtained natural frequencies for the second model and mode shape corresponding to the first natural frequency. The natural frequencies in the tabular form area as follows.

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Natural Frequency(Hz)</th>
<th>Damping Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30.3</td>
<td>1.25</td>
</tr>
<tr>
<td>2</td>
<td>68.203</td>
<td>2.513</td>
</tr>
<tr>
<td>3</td>
<td>121.699</td>
<td>2.917</td>
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<tr>
<td>4</td>
<td>173.84</td>
<td>1.776</td>
</tr>
<tr>
<td>5</td>
<td>196.209</td>
<td>1.883</td>
</tr>
</tbody>
</table>

Table 9 Natural Frequencies and Damping Ratio’s for Model 2

The table shows obtained natural frequencies for the system. The natural frequencies are sufficiently high to prevent resonant conditions for normal working conditions.

5.6.3 HARMONIC RESPONSE GRAPH

IV. CONCLUSION

Firstly, by analyzing the graphs obtained by conducting tensile, and bending tests for three specimens prepared each percentage of the fibers it was found as the percentage of fiber increased there was an improvement in the tensile and bending strength.
From the dynamic analysis, it is observed that natural frequency will vary for the sample based on the composition of the structure. But the result shows sufficiently high first natural frequency for the considered configuration. Also it is observed that damping is not following any particular pattern (either increasing or decreasing), but is mainly depending on the natural frequency values. The harmonic response analyses are plotted in the graph up to 1050Hz. Also dynamic analysis results shows, compared to the first specimen, the second specimen has better fundamental natural frequency. Higher fundamental natural frequencies are desirable for better dynamic stability. If low natural frequencies exist for the material, there is every possibility of resonance.

V. REFERENCES


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