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Mechanical Treatment on The Performance of Grewia Serrulata Fiber Reinforced Compsites

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Abstract: Composite materials are user defined materials. It is possible to get the different properties by means of adding different composition of materials which are not able to obtain by commercial engineering materials. And also it is possible to get different properties in different directions like in X-axis, Y-axis and Z-axis. Alloys of metals with non-metals could only occur if all the component materials were miscible, that is, soluble in each other in the molten state. Composite materials can be made up from materials that are not soluble in each other. Composite materials are not alloys. Due to this strong tailorability, Composite materials can be designed to satisfy the needs of technologies relating to the aerospace, automobile, electronics, and construction, and energy, biomedical and other industries. As a result, composite materials constitute most commercial Engineering materials. In this study natural fiber extract from Grewia serrulata plant.

***Key words: Tailorability, Grewia Serrulata, Retted, Non-Metals, Miscible*.**

1. INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals.

The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased volume has resulted in an expected reduction in costs. High performance FRP cans now to be found in such diverse applications as composite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even paper making rollers. For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight. Some examples are cascades for engines, curved fairing and fillets, replacements for welded metallic parts, cylinders, tubes, ducts, blade containment bands etc. Further, the need of composite for lighter construction materials and more seismic resistant structures has placed high emphasis on the use of new and advanced materials that not only decreases dead weight but also absorbs the shock & vibration through tailored microstructures. Composites are now extensively being used for rehabilitation/ strengthening of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity.

Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects. A composite material consists of two or more physically and/or chemically distinct, suitably arranged or distributed phases, with an interface separating them. It has characteristics that are not depicted by any of the components in isolation. Most commonly, composite materials have a bulk phase, which is continuous, called the matrix, and one dispersed, non-continuous, phase called the reinforcement, which is usually harder and stronger.

2. METHODOLOGY

Step 1: Selection of matrix material
Step 2: Selection of reinforcement and Natural fibers
Step 3: Extraction of fibers
Step 4: Surface treatment of fibers
Step 5: Hand lay-up technique

Step 1: Selection of matrix material

Epoxy LY-556 resin belonging to the Epoxide family was taken as the matrix.HY 951 was used as the hardener.

Step 2: Selection of reinforcement and Natural fibers

Natural fibers such as Sisal, Coconut coir, Arecanut, Ridge gourd and Tamarind were taken to fill as reinforcements in the Polymer composite.

Step 3: Extraction of fibers

Grewia serrulata is commercially available. Grewia serrulata is a natural fiber. Grewia serrulata is fully biodegradable and highly renewable resource. Grewia serrulata fiber is exceptionally durable and a low maintenance with minimal wear and tear.

Figure.1 Grewia serrulata fiber

Step 4: Surface treatment of fibers

Freshly drawn fibers generally include lots of impurities that can adversely affect the fiber matrix bonding. Consequently the composite material made from such fibers may not possess satisfactory mechanical properties. Therefore it is desirable to eliminate the impurity content of the fibers and perhaps enhance the surface topography of the fibers to obtain a stronger fiber-matrix bonding. The fibers were left to treat with 5% NaOH for 3-4 hrs. Later they were drawn and dried under sunlight for 1-2 hours.

Figure.2 Grewia serrulata composite plate

Step 5: Hand lay-up technique

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats are cut as per the mould size and placed at the surface of mould after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mould.

The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mould plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at some specific temperature, mould is opened and the developed composite part is taken out and further processed. The schematic of hand lay-up is shown in figure 1. The time of curing depends on type of polymer used for composite processing. For example, for epoxy based system, normal curing time at room temperature is 24-48 hours. This method is mainly suitable for thermosetting polymer based composites. Capital and infrastructural requirements less as compared to other methods. Production rate is less and high volume fraction of reinforcement is difficult to achieve in the processed composites. Hand lay-up method finds application in many areas like aircraft components, automotive parts, boat hulls, daises board, deck etc.

Figure.3 Hand lay-up process

3. PROPERTIES INVESTIGATION

A Wire Hacksaw blade was used to cut each laminate into smaller pieces, for various experiments. TENSILE TEST- Sample was cut into dog bone shape (150x10x5) mm.WEAR TEST- Sample was cut into flat shape (20x150x5) mm, in accordance with ASTM standards.

Figure: 4 Dag bone shape

Figure: 5 Flat bar shape

3.1Tensile Test

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. The commonly used specimen for tensile test is the dog-bone type. During the test a uniaxial load is applied through both the ends of the specimen. The dimension of specimen is (150x10x5) mm.

Typical points of interest when testing a material include: ultimate tensile strength (UTS) or peak stress; offset yield strength (OYS) which represents a point just beyond the onset of permanent deformation; and the rupture (R) or fracture point where the specimen separates into pieces[3]. The tensile test is performed in the universal testing machine (UTM) Introns 1195 and results are analysed to calculate the tensile strength of composite samples

Figure: 6 Material testing

3.2Impact Test

The advantages of composite materials are numerous and well documented. Composite materials are often used in environments in which they will suffer from impact damage. For example, damage can occur from a hammer being dropped on a composite pipe or from a bullet striking composite armor. Since impact damage resistance is such an important property for composite materials, this chapter will be devoted to the theory behind impact testing, and the procedures used to perform impact testing. The chapter will describe in detail the best way to perform impact tests. Different ways to evaluate impact data will be examined, as well as ways to characterize the impact induced damage.

Once the composite specimen has finished curing, the composite specimen is removed from the vacuum bag setup. (For more information on composite lay-up preparation, refer to the work by Adams, Carlson, and Pipes [5].) The resultant plate can then be cut into small rectangles which will be used as Charpy impact specimens. The final step is to cut the notch into the specimen.

Impact testing fits into two main categories: (a.) low velocity impact, and (b.) high velocity impact [1]. These two main categories lead to three main types of impact testing. Charpy impact testing and drop weight impact testing fall into the category of low velocity impact testing (here it should be noted that an impact test machine can be used for high velocity impact also; for reference see ASTM D 3763 [2]). Ballistics impact testing falls into the category of high velocity impact testing. Technology has increased to the point that there are now sophisticated measuring devices for instrumented impact testing. For all low velocity instrumented impact test devices there are three major components: the dynamic load cell (or tub), the data display system, and the signal conditioning unit [3]. The tup is placed on the impactor used to strike the specimen. Within the tup is a strain gage that measures the change in strain vs. time as the impactor strikes the specimen.

Conditioning unit removes the noise associated with the signal, and the data display system plots the measured data. An in-depth exploration on the benefits and methods of each type of impact test will be explored more in the following sections [3]. For example, damage can occur from a hammer being dropped on a composite pipe or from a bullet striking composite armor. Since impact damage resistance is such an important property for composite materials, this chapter will be devoted to the theory behind impact testing, and the procedures used to perform impact testing. The chapter will describe in detail the best way to perform impact tests. Different ways to evaluate impact data will be examined, as well as ways to characterize the impact induced damage.

4. RESULT AND DISCUSSION

Single filament test for Grewia serrulata fiber:

4.1 Physical test

S. No	F_{max} (N)	ΔL at F_{max} (%)
1	33.6	1.8
2	23.6	1.1
3	19.7	1.3
4	20.3	1.9
5	22.8	1.6
6	25.5	1.4
7	16.5	1.7
8	21.4	2.6
9	15.2	1.9
10	25.8	1.8
11	38.9	2.1
12	13.8	1.4
13	16.6	1.4
14	9.6	1.5
15	10.1	1.6
16	31.7	1.8
17	30.3	1.8
18	29.8	2.3
19	25.9	2.3
20	15.4	1.7

4.2 Statistics Test

Series N=20	F_{max} (N)	ΔL at F_{max} (%)
X	23.8	1.8
S	9.74	0.3
V[%]	40.85	16.6

4.3 Chemical Test:

Density At Room Temperature	Sample Particulate-Grewia Serrulata- Fiber
Density at 27ºC	1.31(g/cc)

5. CONCLUSION

The natural fibers have been successfully reinforced with the epoxy resin by simple wet hand lay-up technique. The aim of this project is to find the tensile, Bending, Wear test of natural fiber reinforced bio-composites. The fiber like Grewia serrulata fibers was successfully used to fabricate bio-composites with varying the fiber percentage. The new hybrid composite produced with natural fibers as reinforcements gives good mechanical properties as compared with pure matrix material. These hybrid bio-composite can be used in Aerospace and automobile applications. In the present work, bio-composite with multiple natural fibers such as Grewia serrulata fibers have been successfully reinforced with the epoxy resin by simple and inexpensive hand lay-up technique.

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