Fabrication And Experimental Analysis of Natural Fiber Composites

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Abstract- *Natural fiber Composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load carrying members. The today's research trend in composite is for the development of composite with natural fiber instead of synthetic fiber because of properties like light weight, low cost, biodegradability, low environmental impact and ease to manufacture. The use of natural fibers as reinforcement in polymers has gained importance in recent years due to their eco-friendly nature. Thus, an investigation has been undertaken on coconut-coir and sisal fiber, which is a natural fiber abundantly available in India. Natural fibers are not only strong and lightweight, but also relatively very cheap. Composite plates were prepared with resin, coir, and sisal. The purpose of this work is to establish the tensile, compressive and impact properties of natural fiber composite materials.*

Keywords- fiber, impact, sisal fiber, coconut-coir.

I. INTRODUCTION

Now a days, the natural fibers such as Sisal, Coconut coir have the potential to be used as a replacement for carbon or other traditional reinforcement materials in composites. Other advantages include low density, high toughness, comparable specific strength properties, reduction in tool wear, ease of separation, decreased energy of fabrication.

Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in weaker material (known as matrix). Natural fiber composites are attracting the researcher because of advantages that these fibers make available over conventional reinforcing synthetic fiber. Natural fibers possess properties like light weight, low environmental impact, biodegradability and non-abrasive characteristics. In fact, certain drawbacks like poor moisture resistance, lower stability, hydrophilic nature, lower life cycle and poor fire resistance properties create the resistance in use of natural fiber composite. However nowadays new surface treatments are developed which increases mechanical properties of natural fibers makes them available for certain industrial applications. In the light of mechanical and economical properties, there are different types of natural available from different species and different origin. Mechanical properties of various fibers are compared with synthetic fibers. Since glass fiber has occupied more than 90% of market for reinforcement in composite industry, lower mechanical properties and improper (poor) bonding characteristics of fiber with matrix material limited the use of natural fiber. With the development of improved technology mechanical properties of this natural fiber are started improving.

Polymer composite materials have generated wide interest in various engineering fields, particularly aerospace applications, because these materials exhibit high specific strength and stiffness as compared to monolithic metal alloy. Due to the ease of fabrication and low cost, polymer composite materials find different application such as helicopter rotor blades, pipe line carrying sand slurries in petroleum refining, pump impeller blades, high-speed vehicles and aircraft operating in desert environments, water turbines, and aircraft engine blades.

Natural fiber materials are dime a dozen in nature. Researchers are still working in this field to achieve composite materials with unique properties with low cost and environment friendly. For advanced composite matrix, thermosetting polymer i.e. epoxy resin is widely used for its good stiffness, dimensional stability and chemical resistance characteristic. Natural lingo-cellulosic fillers (bamboo, flax, jute, hemp, etc.) are environmentally friendly in nature as compared to conventional reinforcing fibers (glass, carbon). Luo and Netravali studied the tensile and flexural properties of the green composites with different pineapple fiber content and compared with the virgin resin. Belmares et al. found that sisal, henequen, and palm fiber have very similar physical, chemical, and tensile properties.

Composite Materials

A composite material is composed of at least two materials, which combine to give properties superior to those of the individual constituents. A composite material (also called a composition material or shortened to composite, which is the common name) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials.

Material selection:

The structural materials used in airframe and propulsion systems influence the cost, performance and safety of aircraft, and an understanding of the wide range of materials used and the issues surrounding them is essential for the student of aerospace engineering. Introduction to aerospace materials reviews the main structural and engine materials used in aircraft, helicopters and spacecraft in terms of their production, properties, performance and applications.

Advanced Composite Materials

An advanced composite material is made of a fibrous material embedded in a resin matrix, generally laminated with fibers oriented in alternating directions to give the material strength and stiffness. Fibrous materials are not new; wood is the most common fibrous structural material known to man. A matrix supports the fibers and bonds them together in the composite material.

SISAL FIBER

Sisal is a hard fiber extracted from the leaves of sisal plants which are perennial succulents that grow best in hot and dry areas. Sisal is an environmentally friendly fiber as it is biodegradable and almost no pesticides or fertilizers are used in its cultivation. World production is about 300,000 tones. Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is obtain from sisal plant. These plants produce rosettes of sword-shaped leaves which start out toothed, and gradually lose their teeth with maturity. Each leaf contains a number of long, straight fibers which can be removed in a process known as decortication.

Properties of Sisal Fiber:

Sisal Fiber is exceptionally durable with a low maintenance with minimal wear and tear.

1. It is Recyclable.
2. Sisal fibers are obtained from the outer leaf skin, removing the inner pulp.
3. It is available as plaid, herringbone and twill.
4. Sisal fibers are Anti-static, does not attract or trap dust particles and do not absorb moisture or water easily.
5. The fine texture takes dyes easily and offers the largest range of dyed colors of all natural fibers.
6. It exhibits good sound and impact absorbing properties.

COCONUT COIR FIBER

Coconut fiber is a natural fiber extracted from the husk of coconut and used in products such as floor mats, doormats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets.

Physical Properties of Coconut / Coir Fiber:

- Length in inches…………6-8
- Density (g/cc)…………………..1.40
- Tenacity (g/Tex)…………….…10.0
- Breaking elongation%..............30%
- Diameter in mm………….0.1 to 1.5
- Rigidity of Modulus……….1.8924 dyne/cm2
- Swelling in water (diameter)…………5%
- Moisture at 65% RH…………10.50%

II. EXPERIMENTAL WORK

FABRICATION METHOD

There are numerous methods for fabricating composite components. Some methods have been borrowed (injection molding, for example), but many were developed to meet specific design or manufacturing challenges. The most basic fabrication method for thermoset composites is hand layup, which typically consists of laying dry fabric layers, or “plies,” or prepreg plies, by hand onto a tool to form a laminate stack. Resin is applied to the dry plies after layup is complete (e.g., by means of resin infusion). In a variation known as wet layup, each ply is coated with resin and “debulked” or compacted after it is placed.

HAND LAYUP TECHNIQUE

Hand lay-up is an open molding method suitable for making a wide variety of composites products from very small to very large. Production volume per mold is low; however, it is feasible to produce substantial production quantities using multiple molds. Hand lay-up is the simplest composites molding method, offering low cost tooling, simple processing, and a wide range of part sizes. Design changes are readily made. There is a minimum investment in equipment. With skilled operators, good production rates and consistent quality are obtainable.

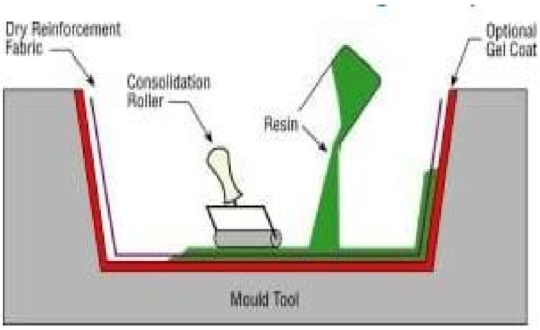

Fig.2.1 Hand Layup technique

III. RESULTS AND DISCUSSION

Tensile and compressive test

The tension test is generally performed on flat specimens. The most commonly used specimen geometries are the dog-bone specimen and straight-sided specimen with end tabs. The standard test method as per ASTM D 3039-76 has been used; length of the test specimen used is 125 mm. The tensile test is performed in universal testing machine.

Impact test

Izod and charpy test is used to measure the impact strength of the composite materials and tests are conducted.

Fig.3.1. Test Specimens for Tensile and Compressive Test

Fig.3.2 Test specimens for Impact Test

Dimensions of the Test Specimens:

Sl No	Tests	Length(mm)	Thickness(mm)	Breadth(mm)
1	**Tensile**	250	10	25
2	**Compression**	250	10	25
3	**Izod**	65	8	12
4	**Charpy**	65	8	12

Results of the Test Specimens:

Sl No	Specimen	Tensile Strength(MPa)	Compression Strength (MPa)	(Izod) Impact Load(KN)	(Charpy) Impact Load(KN)
1	Sisal-glass fiber	36	38	2.1	1.5
2	Coconut coir-glass fiber	37	37	1.3	1.4
3	Banana-glass fiber	38	37	2.2	1.8

IV. CONCLUSION

The Sisal-glass fiber, Coconut coir-glass fiber and Banana-glass fiber reinforced hybrid composites are fabricated and the mechanical properties such as tensile strength and impact strength of these composites are estimated. The following conclusions have been derived from the experimental investigations.

The banana-glass fiber composite have more tensile strength than other composites can withstand the tensile strength of 38 MPa followed by the sisal banana-glass reinforced composites which holds the value of 36 MPa. From the above results obtained from the experiment, it is concluded that composite material of banana fiber is more efficient than other fibre.

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