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EXPERIMENTAL INVESTIGATION AND BEHAVIOUR OF EPOXY RESIN REINFORCED WITH WOVEN GLASS FIBRE AND JUTE COMPOSITE

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Abstract - *The aim of this paper is to replace the traditional fibre composites with the natural fibre composite in perception of tribiological and mechanical aspects. A systematic stud has been carried out to investigate jute fibre with bidirectional glass fibre properties when incorporated into epoxy matrix. In this study, an attempt has been made to fabricate jute-glass fibre with a weight ratio of 1:5 and 45 degree angle orientation based polymer composite and investigate its performances. Hand lay- up technique is the methodology used in fabrication of the composite. This jute based polymer composite is used as replacement to plastic material. In this study experimental investigation of tensile strength, flexural strength, impact strength and hardness have been carried out according to the ASTM standards.*

Key Words: Tensile strength, glass fibre, jute fibre, impact test, flexural test.

1. INTRODUCTION

Now-a-days a big portion of material science has been conquered by composite materials. Composites are one of the most widely used materials because of their adaptability to different situations and the relative ease of combination with other materials. They can serve specific purposes and exhibit desirable properties. This is a very important issue in many engineering works. Recently there has been a greater inclination towards natural fiber reinforced plastic composites because these are environmental friendly and cost effective to synthetic fiber reinforced composites. Additionally, Natural fibers have lot of advantages over traditional fibers in terms of low cost, low density, biodegradable and easily processed. The conventional material such as glass, carbon and boron fibers are quite expensive and the use of fiber like carbon or boron is justified only in aerospace application.

2. COMPOSITE MATERIAL

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. In contrast to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The two constituents are a reinforcement and a matrix. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part. The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix.

3. LITERATURE REVIEW

A fibre is characterized by its length being much greater compared to its cross sectional dimensions. The dimensions of the reinforcement determine its capability of contributing its properties to the composite. Fibres are very effective in improving the fracture resistance of the matrix since a reinforcement having a long dimension discourages the growth of incipient cracks normal to the reinforcement that might otherwise lead to failure, particularly with brittle matrices.

In the case of polymeric materials, orientation of the molecular structure is responsible for high strength and stiffness. Fibres because of their small cross-sectional dimensions are not directly usable in engineering applications. They are therefore embedded in matrix materials to form fibrous composites.

The matrix serves to bind the fibres together transfer loads to the fibres and protect them against environmental attack and damage due to handling. In discontinuous fibre reinforced composites the load transfer function of the matrix is more critical than in continuous fibre composites.

The most common type of fibre material used to reinforce FRPs is glass. The other regularly used fibre materials are aramid carbon and in small quantities. Banana fibre is the most common fibre available in our country. It is extracted from the pseudo stem of the banana tree. Flax fibre is reported to be able to withstand the same tensile force as ramie and can out- perform glass fibre on a weight-for-weight basis. However to counter the other drawbacks of natural reinforcements various forms of resin matrix are being studied. Polyurethane, processing at low temperatures, is promising. Jute is one of the most

important natural fibres. It is reduced in India, Bangladesh, Thailand, Vietnam and other countries. It contains 6- 64 wt% cellulose. 29-25% hemi celluloses, 11-14% lignin, and a small proportion of fats, pectin, ash and waxes

4. RAW MATERIALS

4.1 JUTE FIBRE:

Cellulose - 65%

Hemi-cellulose – 22.5%

Lignin – 11%

Fat and wax – 0.3%

Water soluble materials – 1.2%

4.2 EPOXY RESIN:

Type - LY556

Colour - Transparent, liquid

Specific gravity - 1.14-1.19

Viscosity - 9500-13500 cps

Epoxy value - 5-5.5

4.3 HARDENER:

Type - HY951

Colour - Transparent liquid

Specific gravity - 0.95-1.05

Viscosity – 10-30 cps

5. OBJECTIVE

Fabrication of Polymer composite . It is observed Hand lay-up methods used widely in fabrication of Polymer composite. Also, some researcher used Centrifugal molding, Pultrusion molding, etc. Inorganic filler used as reinforcing particles in development of natural filler reinforced epoxy based composite. Cost and quality control of natural filler reinforced composite is the major stone to use as alternative material by product designer and manufacturers. Application of natural filler reinforced composite is very wide like as aerospace, automobile, construction, decking, etc.

6. MATERIAL PROPERTIES

Epoxy Resin (LL 556):

The system is easy to process, has good fiber impregnation properties and exhibits excellent mechanical, dynamic and thermal properties. It has an excellent chemical resistance especially to acids at temperatures up to 80°C. This epoxy system fulfills MIL specifications R 9300.

Glass Fiber:

Bidirectional glass fibers have been the standard within the aerospace industry for many years, the fiber is typically impregnated with thermosetting resins. Tape products have high strength in the fiber direction and virtually no strength across the fibers.

Jute:

Jute is soft material basically used to make ropes. It do not emit any harmful substances during combustion and hence eco friendly to use. It is decomposable.

7. STAGES OF FABRICATION

1. First the plate is coated with wax for the smooth surface

2. After getting the polished surface the first layer is kept over the plate and the resin mixture is applied equally all over the layer till the layer is wetted fully.

3. Once the first layer is finished then one by one remaining layers are kept and resin mixture applied to it.

4. Then after completion the weight press plate is placed over it and the entire experimental setup is kept for curing time at room temperature.

5. After curing time the weight press plate is removed and the require laminate is obtained.

FLEXURAL TEST:

In this test, the bend behavior of glass fiber inforced jute composites in different weight percentages of glass is presented. The bending test was carried out on computerized universal testing machine. The flexural specimens are prepared as per the ASTM D790.The two specimens are subjected to flexural test and their values are reported. The 3-point flexure test is the most common flexural test for composite materials. Specimen deflection is measured by the crosshead position the testing process involves placing the test specimen in the universal testing

machine and applying force to it until it fractures and breaks.

COMPRESSION TEST:

The testing specimen is prepared as per the **ASTM D695**specification and the compression test is carried out in the testing machine.It is compared that whether the change in orientation angle has influenced in the withstanding capability of load at compression for with of the matrix and fibre component Specimen size (50*50*8mm)

TENSILE TEST:

Various m/c and structure components are subjected to tensile loading in numerous applications.

For safe design of these components, there ultimate tensile strength and ductility one to be determine before actual use. Tensile test can be conducted on UTM-40. These resistances come due to atomic bonding between atoms of the material.

The resisting force for unit normal cross-section area is known as stress. The value of stress in material goes on increasing with an increase in applied tensile load, but it has a certain maximum (finite) limit too.. The end of elastic limit is indicated by the yield point (load). Thiscan be seen during experiment as explained later in procedure with increase in loading beyond elastic limit original cross-section area (Ao) goes on decreasing and finally reduces to its minimum value when the specimen breaks by **ASTM D638** standard size for the specimen is (80mmx12mmx5mm).

IMPACT TEST:

The impact test specimens are prepared according to the required dimension following the **ASTM D256** (IZOD method) standard size for the specimen is (65x13x10mm).

During the testing process, the specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks.

Using the impact test, the energy needed to break the material can be measured easily and can be used to measure the toughness of the material and the yield strength.

SHEAR TEST:

This test method measures the shear stress/strain, the ultimate strength and the ultimate strain, as well as the shear chord modulus of elasticity using **ASTM D2344.**

The test utilizes a standard universaltesting machine and a specially-designed fixture with wedge grip interfaces that clamp one half of the test specimen across its width and support it on its back face as described in the specification.

The lower fixture should be mounted on a base plate that supports a linear bearing shaft. The upper fixture should contain a linear bearing which mounts over the shaft on the base.

SHORE HARDNESS TEST:

This test method measures the shear stress/strain, the ultimate strength and the ultimate strain, as well as the shear chord modulus of elasticity using **ASTM D2344.**

The test utilizes a standard universaltesting machine and a specially-designed fixture with wedge grip interfaces that clamp one half of the test specimen across its width and support it on its back face as described in the specification.

The lower fixture should be mounted on a base plate that supports a linear bearing shaft. The upper fixture should contain a linear bearing which mounts over the shaft on the base.

8. RESULTS

8.1 RESULT OF SHORE HARDNESS TEST

S. NO.	TYPE OF TEST	RESULT
1	Shore hardness test	52,55,54

8.2 RESULT OF MECHANICAL TESTS

S. NO.	TYPE OF TEST	LOAD
1	Tensile test	140.33 MPa
2	Flexural test	5.11 KN
3	Compression test	54.43 KN
4	Impact test	30 Joule
5	Shear test	8.46 KN

9. CONCLUSION

Composite consisting of jute,glass fiber with epoxy resin as matrix component is fabricated using simple hand lay-up technique. It has been observed that there is a significant effect of fibre loading and orientation on the performance of jute/glass fibre reinforced epoxy based hybrid composites. The developed hybrid composites undergo different kinds of tests. The result shows hybrid composites having good strength and stiffness compared to natural hybrid composites.

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