Comparative Analysis of Hand Layup and Vacuum Bagging Methods for Jute–E-Glass Hybrid Composites

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ABSTRACT

Fiber reinforced polymer composites are being used in almost every type of applications in our daily life and its usage continues to grow at an impressive rate. This paper deals with the hybrid composite material made up of Jute and E-glass fibers which are fabricated by hand layup technique and vacuum bagging technique using Lapox L12 epoxy and K6 hardener. The properties of the hybrid composite are determined by tests like tensile, flexural and hardness tests are evaluated experimentally according to ASTM standards. The results shows that hybrid composites prepared by Jute and E-glass with vacuum bagging technique has better tensile and flexural strength as compared with hand layup technique. The microstructure of the above said hybrid composite material has been analyzed using SEM.

Keyword: E-glass, Jute, Hand layup, Vacuum bagging,epoxy, Lapox L12.

I. INTRODUCTION

Fiber reinforced polymer composites are being used in almost every type of applications in our daily life and its usage continues to grow at an impressive rate. Some of the applications are automobile, air-crafts and space crafts, sporting goods, domestic appliances etc. The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, completely or partially recyclable, bio-degradable, eco-friendly, sustainable, and easily available. Natural fiber material mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. The re-use of waste natural fibers as reinforcement for polymer is a sustainable option to the environment. Natural fibers are available naturally in the form of fiber and these are produced by plants, animals by the geological process. These natural fibers are eco-friendly, available in nature abundantly, even these fibers are renewable and economical. Due to these advantages the natural fiber composite materials have found many applications worldwide. Also, this has led to the opportunities and innovation in the material science and metallurgy. Due to the added advantage of renewable more and more companies are shifting towards natural fiber composite materials. Apart from renewable these fibers are low cost (i,e, one forth of glass fiber), lesser in weight and even these fibers can be recycled. In recent years, there is a growing interest in the use of bio-fibers as reinforcing components for thermoplastics and thermo-sets. It is generally accepted that the mechanical properties of the fiber reinforced polymer composites are controlled by factors such as nature of matrix, fiber-matrix interface, fiber volume or weight fraction, fiber aspect ratio etc.

II. HYBRID COMPOSITE MATERIAL FABRICATION

There are many techniques available in industries for manufacturing of composite material such as hand layup technique, compression technique, vacuum bagging, resin transfer molding etc. The hand lay-up process of manufacturing is one of the simplest and easiest methods for manufacturing composites. A primary advantage of the hand lay-up technique is to fabricate very large, complex parts with reduced manufacturing times. It is shown in fig. 1.

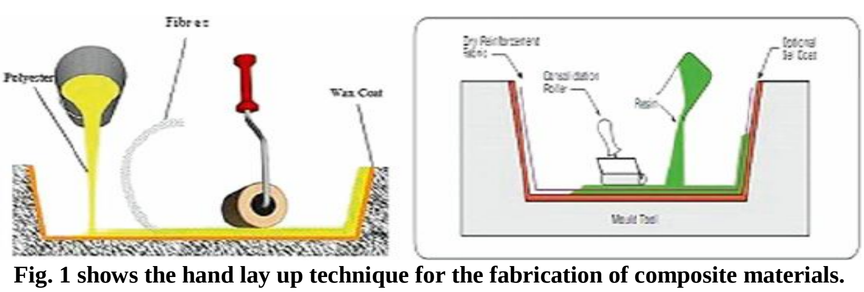

Fig. 1 shows the hand lay up technique for the fabrication of composite materials.

Vacuum bag molding is widely used in aerospace application for high performance components. This method produces high quality molds with complete elimination of voids and air bubbles. Due to this there is a substantial improvement in the inner surface which is not in contact with the mold. The curing process is done in a controlled environment to improve the quality and consistency. Fig.2 shows the vacuum bagging technique

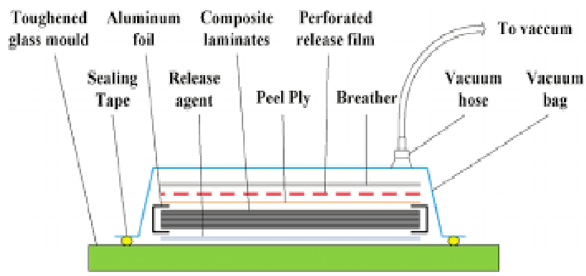

Fig.2 Shows the Vacuum bagging techique.

2.1 Experimental work

All experimental tests are carried out at Composite Technology Park Bangalore. All experimental tests were repeated to generate the data.

2.2. Tensile Test

Tensile is test is one of the fundamental test in material science in which the sample is subjected to a controlled tensile failure. The results are used to predict how the material will react under tensile loading. Some of the mechanical properties that are directly measured by tensile test are tensile strength, Young's modulus, yield strength. This test is commonly used for obtaining mechanical properties of isotropic materials. Fig.3 shows the UTM with tensile specimen.

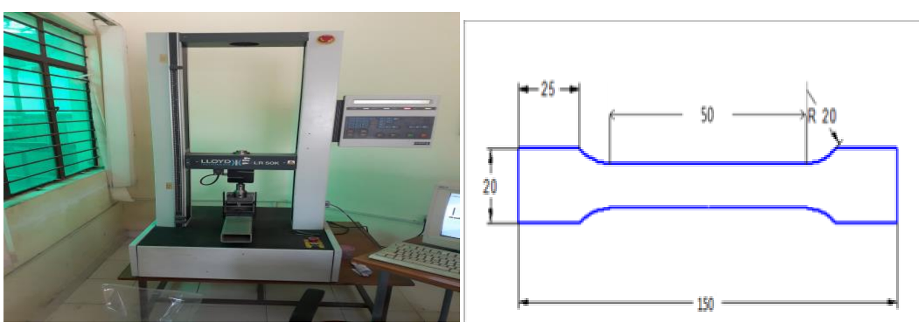

Fig. 3. Shows the UTM with tensile specimen

2.3 Flexural test

The three-point bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress–strain response of the material. The main advantage of a three-point flexural test is the ease of the specimen preparation and testing. However, this method has also some disadvantages: the results of the testing method are sensitive to specimen and loading geometry and strain rate. Fig.4. Shows the UTM with flexural specimen.

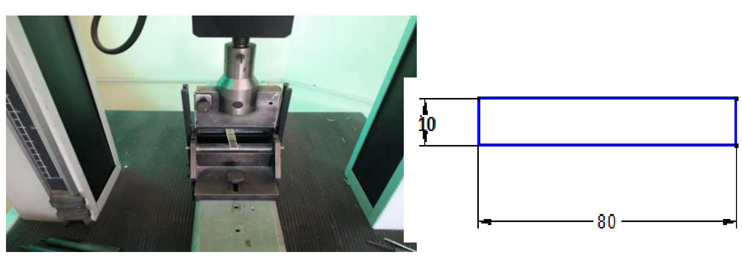

Fig.4. Shows the UTM with flexural specimen

2.4 Rockwell hardness test

In Rockwell hardness test the indenter is allowed to penetrate into the specimen surface, the indenter used may be steel ball or spherical diamond cone. The loading is done with applying minor load up to (3Kgf)and indicator is set to zero, after that major load up to 150Kgf is applied.Fig.5. Shows the Rockwell hardness tester.

Fig.5. Shows the Rockwell hardness tester

2.5 SEM analysis

A scanning electron microscope is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. SEM can achieve resolution better than 1 nanometer. SEM samples are prepared to withstand the vacuum conditions and the high energy beam of electrons, and have to be small enough to fit on the specimen stage. Samples are generally mounted rigidly to a specimen holder or stub using a conductive adhesive.Fig.6. Shows the SEM analysis equipment.

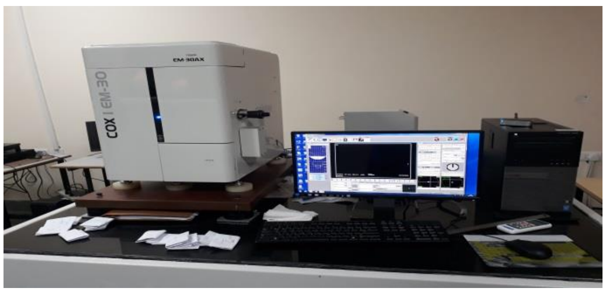

Fig.6. Shows the SEM analysis equipment

III. RESULTS AND DISCUSSIONS

Experiments were conducted to determine the tensile strength, fleural strength, hardness of the above said material. All experimental tests were repeated three times to generate the data. The SEM analysis has been carried out to understand the internal structure of the hybrid composite material.

3.1 Tensile test results for hand layup technique.

The hybrid composites were prepared by hand layup technique. The mechanical behavior of natural and synthetic fibers was investigated. Fig. 7 shows the tensile strength and Young's modulus of the hybrid composites prepared by hand layup technique. It was found that the average tensile strength was found to be 60.40MPa and the corresponding average Young's modulus will be 4306.6 MPa

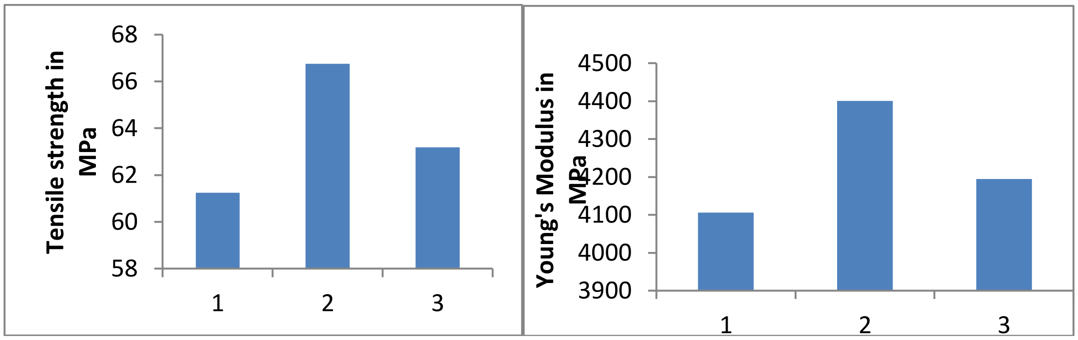

Fig. 7 shows the tensile strength and Young's Modulus of the composite matreial

3.2 Flexural and hardness test results for hand layup technique

Fig. 8 shows the flexural strength and Rockwell hardness of the hybrid composites prepared by hand layup technique. It was found that the average flexural strength was found to be 159.47MPa and the corresponding average Hardness number is 92.

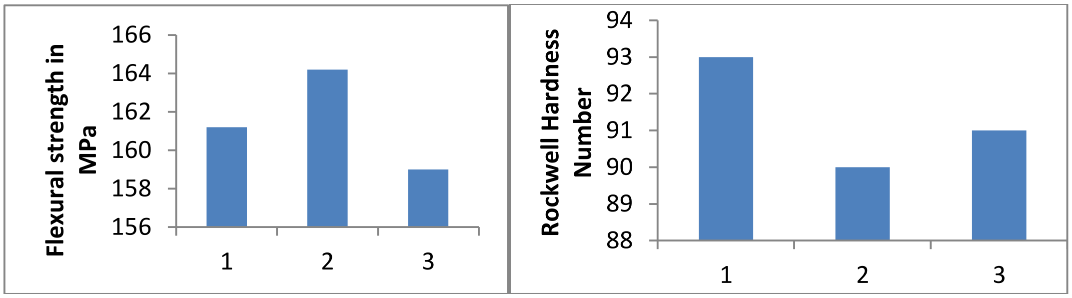

Fig. 8 shows the Flexural strength and Hardness of the composite material

3.3. Tensile test results for Vacuum bagging technique

Fig. 9 shows the tensile strength and Young's modulus of the hybrid composites prepared by vacuum bagging technique. It was found that the average tensile strength was found to be 116.04 MPa and the corresponding average Young's modulus is 8721.67 MPa.

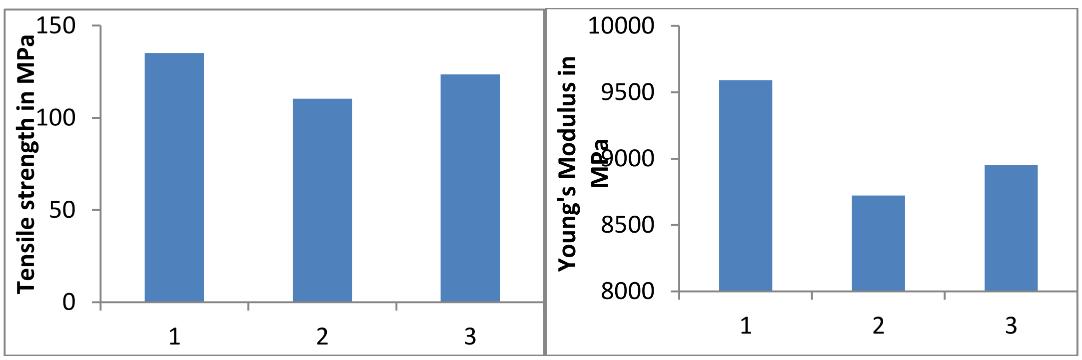

Fig. 9 shows the tensile strength and Young's Modulus of the composite material

2.5 Flexural and hardness test results for Vacuum bagging technique

Fig.10 shows the flexural strength and Rockwell hardness of the hybrid composites prepared by vacuum bagging technique. It was found that the average flexural strength was found to be 450.50 MPa and the corresponding average Hardness number is 96.

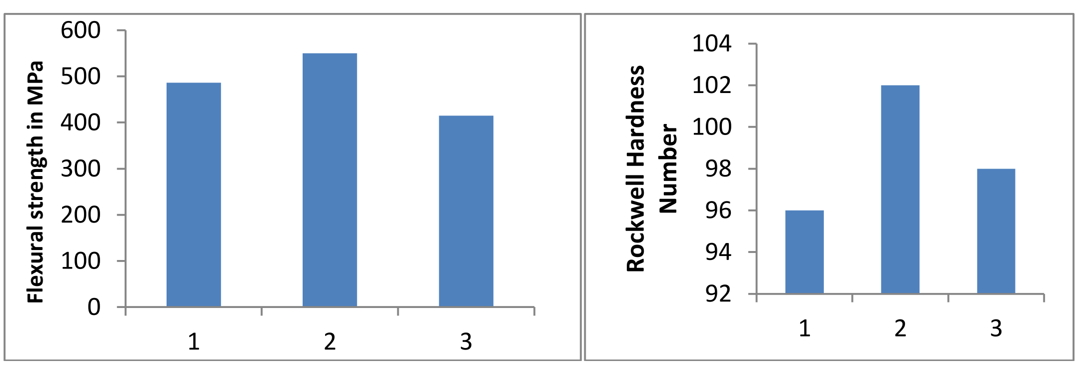

Fig. 10 shows the Flexural strength and Hardness of the composite material

3.5 SEM Analysis of hybrid composite materials

The internal structures of the fiber reinforced composites were examined in detail by SEM analysis as shown in Fig 11. In case of hand layup technique, it was observed the presence of voids and clustering of fiber and resin.

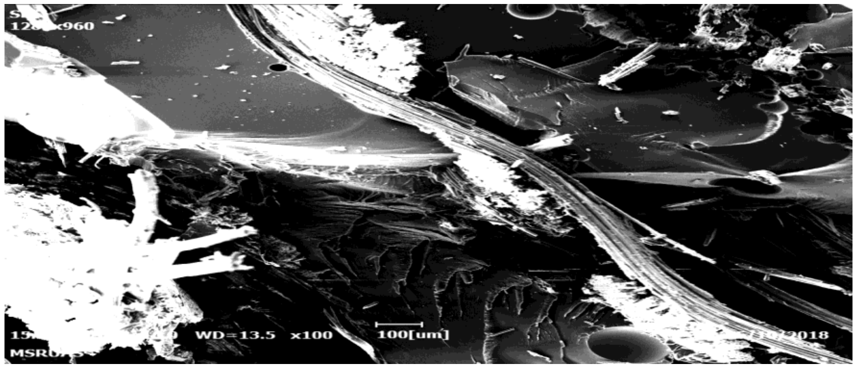

Fig. 11 shows tensile fracture of hybrid composites using hand layup techique

Fig. 12 shows the tensile fractured hybrid composites using vacuum bagging technique. It was observed that there were no voids were formed in both micro and macro structure since resin was absorbed into the fiber structure using vacuum bagging technique.

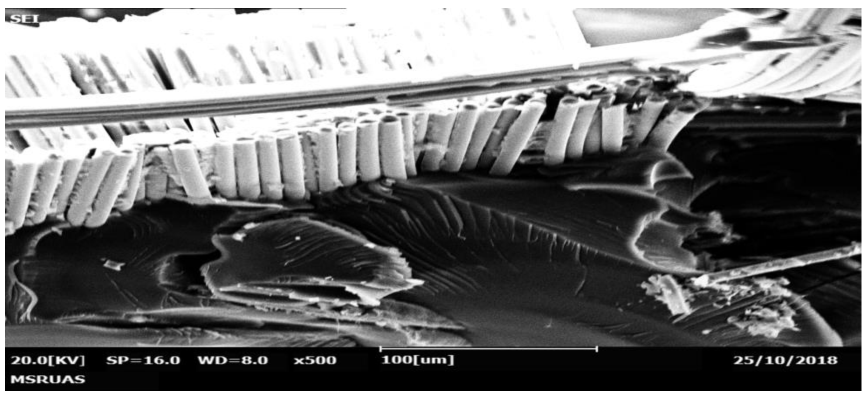

Fig. 12 shows tensile fracture of hybrid composites using vaccum bagging techique

IV. CONCLUSIONS

- Production of multi layered reinforced hybrid composites using E-glass and jute with epoxy is successfully carried out by hand layup and vacuum bagging technique.
- It can be concluded from the experiments that mechanical and physical properties are greatly affected by fiber type and orientation.
- Vacuum bagging technique was found to be more suitable as compared to hand layup technique since vacuum bagging has yielded considerable better results.
- Micro structure of the above said composite is observed using SEM. The fractured surface has shown the presence of voids and debris in case of hand layup technique.

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