IJESR/ICETEISM-2019/Special Issue/ Article No-42/202-205 ISSN 2277-2685
International Journal of Engineering & Science Research

Comparative Study on Mechanical Properties of Hybrid Composites using Hemp and E-Glass by Hand Layup and Vacuum Bagging Technique

K.V. Manjunath
Asst. Professor, Department of Mechanical Engineering
K.S. Institute of Technology
Bengaluru, India
manjunathkv@ksit.edu.in

Krishnamurthy. N
Professor & Head, Department of Mechanical Engineering)
Vijaya Vitala Institute of Technology
Bengaluru, India

***Abstract*—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. This paper deals with the hybrid composite material made up of Hemp and E-glass fibers which are fabricated by hand layup and vacuum bagging technique using Lapox L12 epoxy and K6 hardener. The properties of the hybrid composites are determined by tensile test, flexural test, hardness test and are evaluated experimentally according to ASTM standards. The result shows that the hybrid composites prepared by Hemp and E-glass with vacuum bagging technique has better tensile and flexural strength as compared to hand layup technique. The microstructure of the hybrid composite material has been analyzed using SEM.**

Keywords—E-glass, Hemp, Hand layup, Vacuum bagging, Epoxy, Lapox L12.

I. Introduction

A composite material is a combination of two or more than two different materials having different properties [1]. The combination of materials having different properties would give results having superior than the properties of the individual components when used particularly [2]. Composites are made up of reinforcements and to hold reinforcements matrix material is used. Generally, the reinforcement will be in the form of fiber and matrix would be resin for fiber reinforced polymer composites [3-4].

The use of composite materials has increased and has come into light because of their higher strength and also having high stiffness value, having low density compared to the metallic parts. The composite materials allow to reduce the weight of processed part. The reinforcement agents which are fibers provide the strength and makes composite material hard [5-6].

Natural fiber reinforced composite materials are considered as one of the new class of engineering materials. Interest in this area is rapidly growing both in terms of their industrial applications and fundamental research as they are renewable, cheap, completely or partially recyclable, and biodegradable. [7]. Glass Fiber Reinforced Polymers (GFRP) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiber glass is a lightweight, strong, and robust material used.

E-glass is known in the industry as a general-purpose fiber for its strength and electrical resistance. [8-9] It is the most commonly used fiber, in the fiber reinforced polymer composite industry. Composite materials reinforced with natural fibers, such as flax, hemp, kenaf and jute, are gaining increasing importance in automotive, aerospace, packaging and other industrial applications [10].

This work was intended to develop hybrid composite material from different production techniques such as Hand layup technique and Vacuum bagging technique. made of a plastic matrix reinforced by fine fibers of glass. The synthetic fiber E –glass and natural fiber hemp are used to develop the hybrid composite material with epoxy resin. Different mechanical tests like tensile, flexural, hardness test and SEM analysis were conducted and results were analyzed.

II. Experimental Details

A. Hybrid composite material fabrication

1) Hand layup technique

Hand lay-up is the oldest but still widely used fabrication technique employed in the reinforced plastics industry. A large variety of products can be fabricated with this method reaching from smallest parts to large coverings or even sports boats. It is shown in fig. 1.

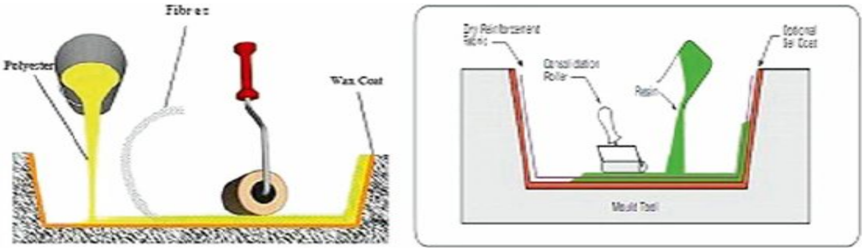


Fig. 1. Shows the hand layup fabrication technique for composite materials.

2) Vacuum bagging technique

Vacuum bag technique 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.

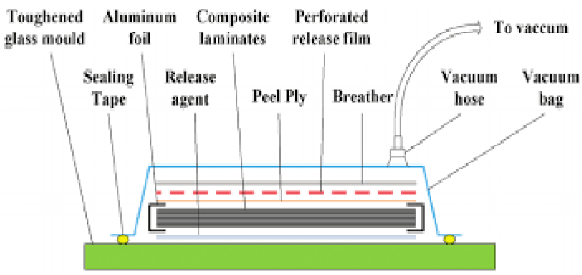


Fig. 2. Shows Vacuum bagging techique.

B. Tensile Test

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

Tensile test is one of the fundamental tests in material science in which the sample is subjected to a controlled tensile failure. The results obtained from this test are used in material selection process for various applications and to predict how the specimen behaves under application of different loads. Many mechanical properties are also measured such as Young's modulus, ultimate tensile strength, elongation property and Poisson's ratio etc., Usually UTM (Universal testing machine) is used for obtaining mechanical properties for an isotropic structured material. The tensile test is performed according to the ASTM standard D-638. Commonly, these tests are carried out on UTM. Fig.3 shows the UTM with tensile specimen.

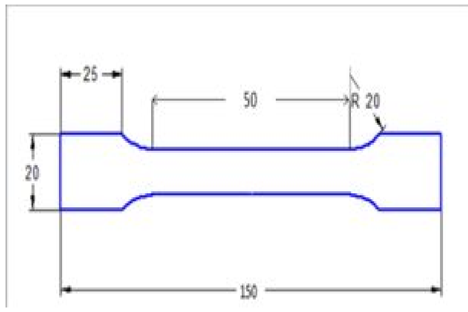


Fig. 3. Shows UTM with tensile specimen

C. 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 specimens are prepared according to the ASTM standards to carry the flexural test in order to determine the flexural strength of the material. Fig.4. shows the UTM with flexural specimen.

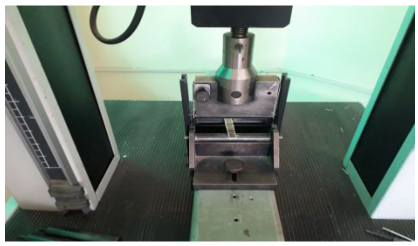


Fig. 4. Shows UTM with flexural specimen

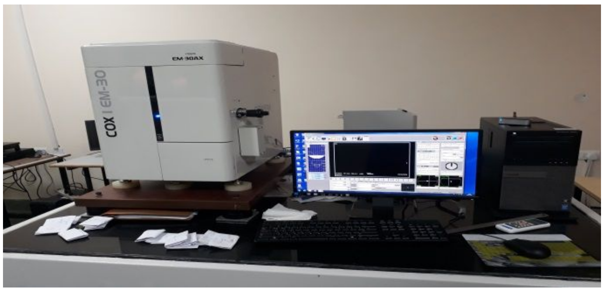
D. Rockwell hardness test

In Rockwell hardness test, the indenter is allowed to penetrate into the specimen surface. The indenter used may be a 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 Rockwell hardness tester

E. SEM analysis

The main purpose of studying the SEM micrographs is to know the failures at the laboratory level and to investigate the service of the component. The fundamental approach is to study the fractured surface of the specimens under different failure modes. One of the major issues of laminate composites is delamination. SEM can achieve resolution better than 1 nanometer. Fig.6 shows the SEM analysis equipment.



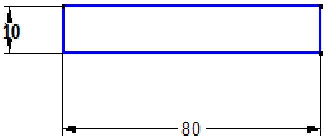


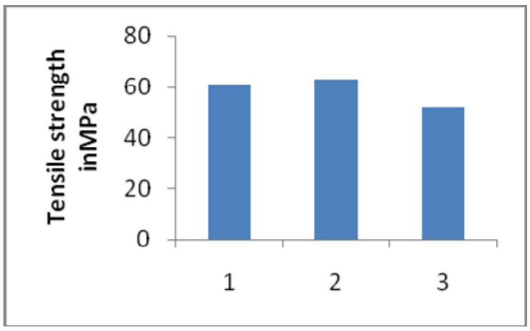
Fig. 6. Shows SEM analysis equipment

III. RESULTS AND DISCUSSIONS

Experiments were conducted to determine the tensile strength, flexural 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.

A. Tensile test results for hand layup technique

The hybrid composites using Hemp and E-glass were prepared by hand layup technique. The mechanical behaviors of natural and synthetic fibers were 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 58.54MPa and the corresponding average Young's modulus was 4625.67MPa. The variations in the strength is due to uneven distribution of epoxy and fiber in the material.



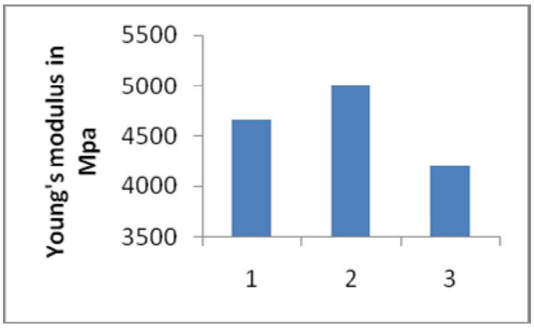
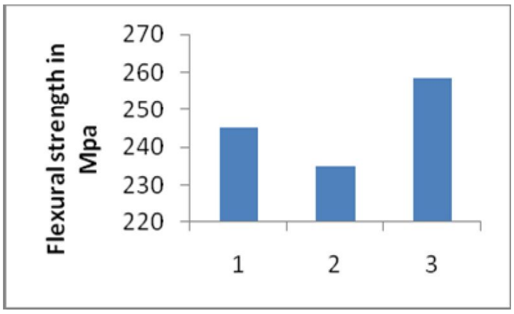


Fig. 7. Shows the tensile strength and Young's Modulus of the composite matreial

B. 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 246.17 MPa and the corresponding average Hardness number was 89.



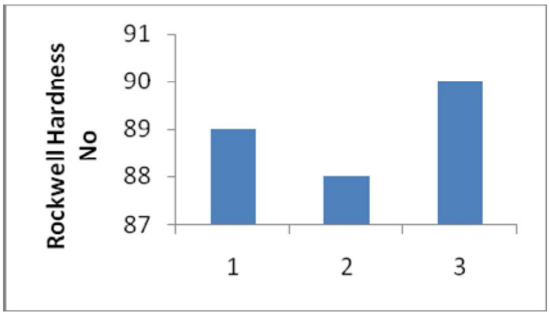


Fig. 8. Shows the Flexural strength and Hardness of the composite matreial

C. 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 129.63MPa and the corresponding average Young's modulus was 6839.33MPa. In vacuum bagging technique, there is substantial increase in the strength of hybrid composite since the distribution of fiber and epoxy is uniform and even the fibers are properly oriented as compared with hand layup technique.

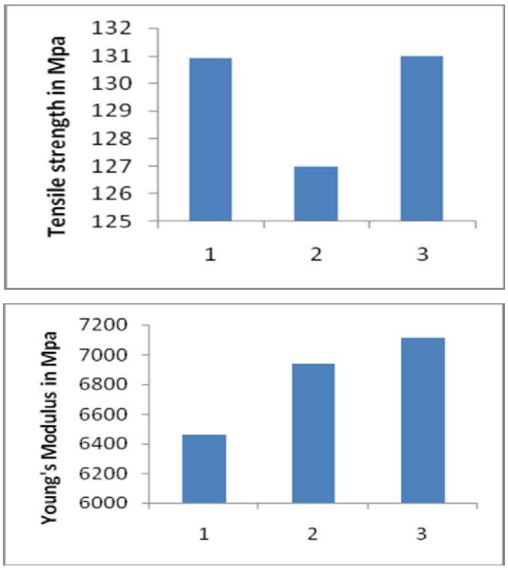


Fig. 9. Shows the tensile strength and Young's Modulus of the composite matreial.

D. 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 443.80 MPa and the corresponding average Hardness number was 95.

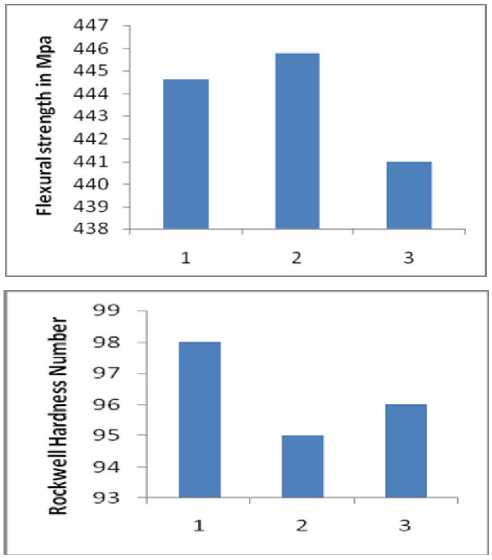


Fig. 10. Shows the Flexural strength and Hardness of the composite matreial

E. SEM Analysis of hybrid composite materials

The internal structure of the developed hybrid composite material using Hemp and E-glass by hand layup and vacuum bagging technique were observed in detail by SEM. Fig 11 shows the internal structure of the material by hand layup technique. It was observed that the presence of uneven distribution of epoxy and fiber. Also, it was observed the presence of voids and clustering of resin.

Fig. 11. Shows tensile fracture of hybrid composites using hand lay up techique

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

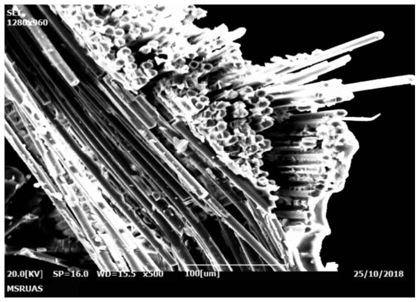


Fig. 12. Shows tensile fracture of hybrid composite using vaccum bagging techique

IV. CONCLUSIONS

- Fabrication of reinforced hybrid composite using Hemp and E-glass with Epoxy resin was prepared using hand layup and vacuum bagging technique.
- The mechanical and physical properties of the reinforced composite material are greatly affected by orientation, types of fiber, and the fabrication process.
- There is a considerable increase in the strength of hybrid composite material developed by vacuum bagging technique as compared to hand layup technique.
- The SEM analysis of the fractured surface shows the presence of voids and debris in case of hand layup technique.

REFERENCES

[1] V. K. Thakur and M. K. Thakur, "Processing and characterization of natural cellulose fibers/thermoset polymer composites," Carbohydrate Polymers, vol. 109, pp. 102–117, 2014.

[2] H. Ku, H.Wang, N.Pattarachaiyakoop, M.Trada, "Review on the tensile properties of natural fiber reinforced polymer composites," Elsevier, Composites by part B, vol. 42, no. 4, pp. 254-262, June 2011.

[3] F. M. Al-Oqla and S. M. Sapuan, "Natural fiber reinforced polymer composites in industrial applications: feasibility of date palm fibers

for sustainable automotive industry," Journal of Cleaner Production, vol. 66, pp. 347–354, 2014.

[4] A. Thygesen, "Characterization of hemp fibers," Thesis submitted in partial fulfillment of the requirements for the Ph.D. degree at The Royal Agricultural and Veterinary University of Denmark.

[5] S.B. Chopade, K.M. Narkar, P.K Satav, "Design and analysis of E-'glass/ epoxy composite mono-leaf spring for light vehicle," International Journal of Innovative Research in Science Engineering and Technology, vol 8, no. 12, 2012.

[6] M.S. Sreekala, J. George, M.G. Kumaran, S. Thomas, "The Mechanical Performance of Hybrid Phenol Formaldehyde-Based Composites Reinforced with Glass and Oil Palm Fibers," Composites Science and Technology, vol. 6, pp. 339-353, 2012.

[7] S. Mishra, A.K. Mohanty, L.T. Drzal, S.K. Nayak, S.S Tripathy, "Studies on Mechanical Performance of Bio-fiber/Glass Reinforced Polyester Hybrid Composites," Composites Science and Technology, vol.63, pp.1377-1385, 2014.

[8] Y.L. Zhang, Y. Li, H. Ma, and T. Yu, "Tensile and Interfacial Properties of Unidirectional Flax/Glass Fiber Reinforced Hybrid Composites," Composites Science and Technology, vol. 8, pp. 172-177, 2013.

[9] T.M. Gowda, A.C.B Naidu, R. Chhaya, "Mechanical Properties of Untreated Jute Fabric-Reinforced Polyester Composites," Composites: Part A30, pp.277-284, 1999.

[10] R.D. Anandjiwala, S. Blouw, "Composites from Bast Fibers-Prospects and Potential in the Changing Market Environment," Journal of Natural Fibers, vol. 4, pp. 344-367, 2007.