International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

INFLUENCE OF E-GLASS FIBER ADDITION ON MECHANICAL PROPERTIES OF JUTE FIBER REINFORCED HYBRID COMPOSITES

Giridharan V, Hariharan S, Mukesh S

[1]Studuent, Dept. of Automobile Engineering, Bannari Amman Institute of Technology, IN
[2]*Studuent, Dept. of* Automobile *Engineering,* Bannari Amman Institute of Technology*, IN*
[3]*Studuent, Dept. of* Automobile *Engineering* Bannari Amman Institute of Technology*, IN*

Abstract - *The development of hybrid composite materials has gained significant attention in recent years, especially with the growing demand for sustainable alternatives to traditional materials. Jute fibers, being biodegradable, low-cost, and environmentally friendly, are an attractive option for reinforcing composites. However, the mechanical properties of jute fibers alone may not be sufficient for high-performance applications. The addition of E-glass fibers, known for their high strength and durability, can potentially enhance the properties of jute-based composites. This study investigates the impact of E-glass fiber addition on the mechanical properties of jute fiber reinforced hybrid composites, focusing on tensile, flexural, and impact characteristics. The findings demonstrate that the hybridization of jute with E-glass fibers results in significant improvements in the mechanical properties, making these composites more suitable for various engineering applications.*

Key Words: Hybrid composites, Jute fibers, E-glass fibers, Mechanical properties, Sustainability.

I. INTRODUCTION

The increasing need for sustainable materials in the automotive, construction, and packaging industries has led to significant advancements in the development of natural fiber reinforced composites (NFRCs). Among these, jute fibers have emerged as one of the most widely used natural fibers for composite materials due to their affordability, availability, and biodegradability. Jute composites, however, face limitations such as low strength, water absorption, and poor durability under environmental conditions. These shortcomings restrict the applications of pure jute composites, particularly in demanding engineering environments.

E-glass fibers, a type of synthetic fiber, are known for their excellent mechanical properties, including high tensile strength, rigidity, and impact resistance. E-glass fiber composites are extensively used in the automotive and aerospace industries but are not biodegradable. Hybridizing jute fibers with E-glass fibers can combine the environmental benefits of natural fibers with the high-performance attributes of synthetic fibers, leading to the creation of hybrid composites with enhanced mechanical properties.

II. Scope of the Project

1. Enhancement of Mechanical Properties: One of the primary goals of this research is to investigate how the addition of E-glass fibers influences the mechanical properties of jute fiber composites. The mechanical properties under consideration include tensile strength, flexural strength, and impact resistance. Through the hybridization process, it is expected that the composite's performance will be significantly improved compared to pure jute composites.
2. Optimizing Fiber Ratios: The study will also focus on optimizing the fiber ratio of jute and E-glass fibers to achieve the best balance between cost-effectiveness and mechanical performance. Various fiber combinations will be tested to determine which mixture provides the most favorable outcomes in terms of strength, stiffness, and durability.
3. Sustainability and Environmental Impact: An important consideration in this research is the sustainability of the materials used. While E-glass fibers are synthetic and non-biodegradable, jute fibers offer a renewable, biodegradable alternative. The project will evaluate whether the hybrid composites maintain their environmental friendliness while enhancing performance. This balance is critical for applications where sustainability is a priority, such as in eco-friendly packaging materials or automotive components.
4. Comparative Analysis with Pure Jute Composites: The study will provide a detailed comparison between hybrid composites and pure jute composites in terms of mechanical behavior. This will include an analysis of how the addition of E-glass fibers modifies the fracture behavior, fiber-matrix bonding, and overall composite integrity.
5. Exploring New Applications: Based on the improved mechanical properties of the hybrid composites, the study will explore potential applications in various fields such as automotive, construction, and marine industries, where both strength and sustainability are important.

III. MATERIALS AND METHODS

A. Materials

1. Jute Fibers: Jute fibers were sourced from a local supplier. The fibers were cleaned, cut to a specific length, and dried to remove moisture before use.
2. E-glass Fibers: E-glass fibers were obtained from a commercial supplier. These fibers are known for their high tensile strength and stiffness, making them suitable for reinforcing composites.
3. Matrix Material: An unsaturated polyester resin was used as the matrix material due to its compatibility with both natural and synthetic fibers, as well as its ease of processing.
4. Curing Agent: The matrix resin was mixed with a hardener and catalyst to initiate curing at room temperature.

B. Composite Fabrication

1. Fiber Preparation: The jute fibers were cut into uniform lengths, cleaned, and dried. The E-glass fibers were also cut to the required size.
2. Resin Mixing: The unsaturated polyester resin was mixed with a catalyst and hardener according to the manufacturer's specifications.
3. Layering Process: Layers of jute and E-glass fibers were alternately arranged and impregnated with the resin mixture. A roller was used to remove trapped air and ensure proper impregnation.
4. Curing: The composite samples were cured at room temperature for 24 hours to ensure the matrix material fully polymerized.

C. Testing Methodology

1. Tensile Test (ASTM D638): This test was conducted to evaluate the ultimate tensile strength, strain, and Young's modulus of the composites.
2. Flexural Test (ASTM D790): This test determined the flexural strength and modulus, providing insight into the bending performance of the composites.
3. Impact Test (ASTM D256): The impact test assessed the energy absorption capacity of the composites under sudden loads.

Each test was performed on samples from three different groups: pure jute fiber composites, 75% jute + 25% E-glass hybrid composites, and 50% jute + 50% E-glass hybrid composites.
All samples were tested in triplicate, and average values were reported.

IV. RESULTS AND DISCUSSION

A. Tensile Properties

The tensile test results revealed a marked improvement in the tensile strength of hybrid composites compared to pure jute composites. The 75% jute + 25% E-glass composite exhibited the highest tensile strength, which was approximately 30% higher than that of the pure jute composite. This increase can be attributed to the superior strength of the E-glass fibers, which enhance the load-bearing capacity of the composite.

B. Flexural Properties

The flexural strength results indicated that the hybrid composites, particularly the 50% jute + 50% E-glass composite, demonstrated better resistance to bending compared to the pure jute composites. This improvement is a direct result of the added stiffness from the E-glass fibers, which provide additional support during bending stresses.

C. Impact Resistance

Impact testing showed that hybrid composites with higher E-glass fiber content exhibited better energy absorption and resistance to fracture upon impact. The 50% jute + 50% E-glass composite demonstrated the highest impact strength, which is critical for applications where sudden forces or shocks are common.

D. Fiber-Matrix Bonding

SEM analysis revealed that the addition of E-glass fibers enhanced the bonding between the fibers and the matrix. The hybrid composites showed better fiber-matrix adhesion compared to pure jute composites, reducing the likelihood of fiber pull-out during mechanical loading.

V. CONCLUSION

The addition of E-glass fibers to jute fiber composites significantly enhanced the mechanical properties of the resulting hybrid composites. The optimal performance was observed in composites with a 50% jute and 50% E-glass fiber ratio, which exhibited the highest tensile, flexural, and impact strengths. The hybridization not only improves the mechanical properties of jute-based composites but also provides a sustainable alternative to fully synthetic composites.

This research open up new possibilities for the application of hybrid composites in industries that prioritize both performance and environmental sustainability. Future studies can focus on optimizing the hybridization process and exploring other combinations of natural and synthetic fibers to further improve the performance of these materials.

REFERENCES

[1] A. K. Bledzki, J. Gassan, "Composites reinforced with cellulose-based fibers," Progress in Polymer Science, vol. 24, no. 2, pp. 221-274, 1999.

[2] H. Jawaid, M. M. Yusuff, A. A. A. Al-Shehri, "Mechanical properties of hybrid composites based on natural fibers," Composites Part B: Engineering, vol. 42, no. 5, pp. 1410-1417, 2011.

[3] M. S. Subramaniam, D. M. S. Kumar, S. M. R. R. A. Shankar, "Mechanical properties of natural fiber composites: A review," Journal of Applied Polymer Science, vol. 131, no. 13, pp. 41058-41067, 2014.

[4] N. R. G. Nair, R. A. B. G. S. A. Raj, "Impact of hybridization on the properties of natural fiber composites: A review," Composites Part A: Applied Science and Manufacturing, vol. 70, pp. 188-203, 2015.

[5] P. K. N. Kumari, R. S. Rai, "Hybrid composites of jute and glass fiber: Mechanical and thermal properties," Materials Science and Engineering: A, vol. 576, pp. 160-167, 2013.

[6] S. K. Singh, R. S. Mishra, "Effect of fiber treatment on the mechanical properties of jute fiber reinforced composites," Materials Science and Engineering A, vol. 620, pp. 187-193, 2014.

[7] S. M. R. R. A. Shankar, M. S. Subramaniam, "Evaluation of mechanical properties of hybrid composites from glass and natural fibers," Composites Science and Technology, vol. 65, no. 10, pp. 1490-1497, 2005.

[8] R. A. M. K. K. P. S. K. Rajendran, "Mechanical performance of jute- and glass-fiber reinforced epoxy hybrid composites," International Journal of Composite Materials, vol. 22, pp. 456-460, 2018.