WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Composite Material Using Natural Fibre (Water Hyacinth & Banana Stem)

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ABSTRACT:

This project explores the development and testing of composite materials made using natural fibres such as water hyacinth and banana stems. These fibres, treated with caustic soda, were used as reinforcement in an epoxy resin matrix to produce sustainable composite materials using the hand lay-up method. The mechanical and physical properties of the composites were evaluated through tensile strength testing, impact resistance testing, and water absorption tests. The study aims to contribute to eco-friendly material innovation by utilizing agricultural and aquatic waste to create viable alternatives to synthetic composites.

Keywords: Natural Fibre, Water Hyacinth, Banana Stem, Epoxy Resin, Composite Material, Hand Lay-Up, Mechanical Testing

Introduction:

In recent years, increasing environmental concerns and the push for sustainable development have driven interest in natural fibre-reinforced composites. Natural fibres offer the advantages of biodegradability, low cost, low density, and availability from renewable resources. This study focuses on utilizing fibres derived from water hyacinth and banana stems — agricultural and aquatic biomass often considered waste — in developing composite materials. The objective is to fabricate composite samples using the hand lay-up method, with epoxy resin as the binding matrix and caustic soda-treated fibres as reinforcement. By conducting mechanical tests such as tensile, impact, and water absorption tests, the study evaluates the feasibility of using these natural fibres for engineering applications.

Methodology:

The composite specimens were fabricated using the hand lay-up method, a simple and cost-effective technique for preparing fibre-reinforced composites. The following materials were used:

- Natural fibres: Water hyacinth stems and banana stems
- Resin: Epoxy resin as the matrix material
- Chemical treatment: Caustic soda (NaOH) used to treat the fibres

Steps followed in fabrication:

1. Fibre Preparation: Extracted, cleaned, chopped, treated with 5% NaOH, washed, and dried.
2. Resin Mixing: Epoxy resin mixed with hardener in 10:1 ratio.
3. Lay-up Process: Layers of fibres placed in mould and impregnated with epoxy mixture.
4. Curing: Cured at room temperature for 24–48 hours.
5. Specimen Cutting: Cut into standard sizes for testing per ASTM standards.

Testing Performed:

- Tensile Test
- Impact Test
- Water Absorption Test

Results

- Tensile Strength*: The composite material demonstrated tensile strength ranging from 32 MPa to 36 MPa, outperforming existing natural fibre composites, which typically range between 28 MPa to 34 MPa.
- Impact Resistance*: Charpy impact testing showed the composite absorbed energy in the range of 2.5 J to 4 J, indicating moderate toughness suitable for light structural applications.
- Water Absorption*: Absorption studies revealed a weight gain between 2% to 5%, with the sample weight increasing from 190 grams to 198.5 grams, compared to a typical 4% increase in standard natural fibre composites.

These findings validate the mechanical and environmental performance of banana stem and water hyacinth fibre-reinforced epoxy composites.

Conclusion

The study concludes that composite materials made from water hyacinth and banana fibres show promising properties for lightweight and low-cost applications. The hand lay-up method proved effective for fabrication. Fibre treatment with caustic soda significantly improved bonding and mechanical properties. The results demonstrate potential for using agricultural and aquatic waste as raw material for eco-friendly composite alternatives, reducing environmental impact, and enhancing sustainability in material science.

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