WWW.IJRPR.COM

International Journal of Research Publication and Reviews

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

Fabrication & Analysis of Natural Fiber Composite Material

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A B S T R A C T

Composites are materials which are usually made up of two or more combination of materials which are used to balance the advantages and disadvantages of individual materials. They have been in use from BC's where concrete is used in construction to present day but composites have gain more importance from past few decades mainly in industrial & pharmaceutical sectors, where FRP's and GRP's have come into existence. These Fiber Reinforced Plastics and Glass Reinforced Plastics have wide advantages as there are water resistive, light weight, exhibits high strength and rigidity but the main disadvantage is they are hard to decompose as well as to recycle. Researches are going on to eliminate the disadvantages occurring in composites materials by the use of Natural fibers which are usually Bio-degradable and environmental friendly.

Keywords:Use of natural fibres, AutoCAD design, Hand layup method, Fabrication, Destructive Testing.

1.INTRODUCTION

Composite materials are made up of two or more different elements in order to make material having superior properties from its parental materials. They have played an important role throughout human history.
We have been using Natural fibers (Coconut & Banana Fibers) to fabricate a composite material and to analyze their mechanical strengths.

1.1. Definition

A Composite material may be defined as an artificially prepared or natural multiphase materials that exhibits a significant properties of both the constituent materials such as high strength, stiffness and high coefficient of thermal expansion in which the chemically dissimilar phases are separated by distinct interface.

1.2. Constituents of Composite materials

The constituents of Composites are:

1. Matrix phase: It is the continuous body which encloses the composite and gives its bulk form. Matrix material function is to
    - Hold fibers together.
    - Protects fibers from environment.
    - Distributes load evenly between fibers
    - Helps to avoid propagation of crack growth through the fibers
    - Enhances transverse properties of a laminate.

    Ex: polymer, metal, ceramic material.

2. Dispersed phase: It is the structural constituent which determines internal structure. The role reinforcement is to strengthen and stiffen the composite trough prevention of matrix deformation by mechanical restraint.
   Ex: Fibers, Particulates, Flakes or whisker.

1.3. Types of Composites

1. Naturally Occurring composites: Bones, Wood.
2. Man-made Composites: Reinforced Concrete, Fibrous Composites, Cermet.

1.4. Classification

1. Based on Matrix material.
   - Metal
   - Ceramic
   - Polymer
2. Based on Reinforced material.
   - Fibrous
   - Particulate
   - Laminate

1.5. Methods of Fabrication

1. Hand Lay-up method
2. Open molding method
3. Resin Infusion method
   - Resin Transfer Molding
   - Reaction Injection Molding
   - Vaccum-Assisted Resin Transfer Molding
   - Filament Winding
   - Pultrusion
   - Tube rolling
   - Compression molding
   - Injection Molding

1.6. Applications

1. Automobile parts
2. Storage tanks
3. Flooring
4. Plastic pipes
5. Structural components of air crafts
6. Sport equipment etc.

2.METHODOLOGY

The methodology have the following sequence of steps:

1. Raw material Selection & Purchase.
2. Design Consideration.
3. Fabrication.
4. Destructive Testing.
5. Results.
6. Conclusion.

Here, we have chosen Coconut fiber & Banana Fiber as reinforcement and Epoxy resin as matrix material. We have used AutoCAD to design the composite and shown degree of laying of fibers and order od laying.

RAW MATERIALS:

- Reinforcement:
  - Coconut Fiber : Coconut Fiber exhibits the following properties
    1. Agro-renewability
    2. Biodegradability
    3. Extensibility
    4. Moisture regain
    5. High durability & resistance against Sunlight
  - Banana Fiber : The properties of Banana Fiber are:
    1. Better specific strength properties
    2. Light weight
    3. Fire resistance quality
    4. High strength
    5. Small Elongation
    6. Biodegradable
  - Matrix:
  - Epoxy Resin (Araldite LY 556) along with Hardener (Aradur HY 951)

Properties	Specification	Unit	Araldite LY 556	Aradur HY 951
Viscosity at 25°C	ISO 12058	mPa.s	10,000 – 12,000	10 - 20
Density at 25°C	ISO 1675	gm /cc	1.15 – 1.20	0.97 – 0.99
Flash Point	ISO 2719	°C	>200	>180

- Mixing Ratio:

	Parts by Weight
Araldite LY 556	100
Aradur HY 951	10 - 12

Resin and Hardener should mixed uniformly until they form a Homogenous Mixture.

- Curing Schedule:

Temperature (°C)	25	60*	80*	100*
Duration (hrs.)	24-49	4-8	2-4	1-4
Martens HDT (°C)	35-40	75	75	75

*after gelling at room temperature.

DESIGN CONSIDERATION:

- Dimension : 60 x 60 x 10 (in mm)
- Percentage of constituents : Specimen 1:- 50% Fiber, 50% Epoxy resin
  Specimen 2:- 60% Fiber, 40% Epoxy resin
  Specimen 3:- 40% Fiber, 60% Epoxy resin.

- Standard Specimen Sizes:

TEST	SPECIMEN	STANDARD
Tensile Test	210*50	ASTM E8
Compression Test	140*50	ASTM D3518/M
Rockwell Hardness Test	20*20*6	ASTM D256
Charpy Impact Test	55*10*10	ASTM 370

All Dimensions are in mm

FABRICATION:

We have used Hand Lay-up Method for fabrication of Composite. The sequence of steps are as follows:

- Mold preparation.
- Sheet covering & Greasing.

- Fiber Lay-up.
- Resin preparation and applying.
- Curing time.

TESTING:

Our main motto is to fabricate Natural fiber Composite material and to determine its mechanical properties.
So we have conducted the following Destructive Tests:

- Tensile Test
- Compression Test
- Rockwell Hardness Test
- Charpy Impact Test

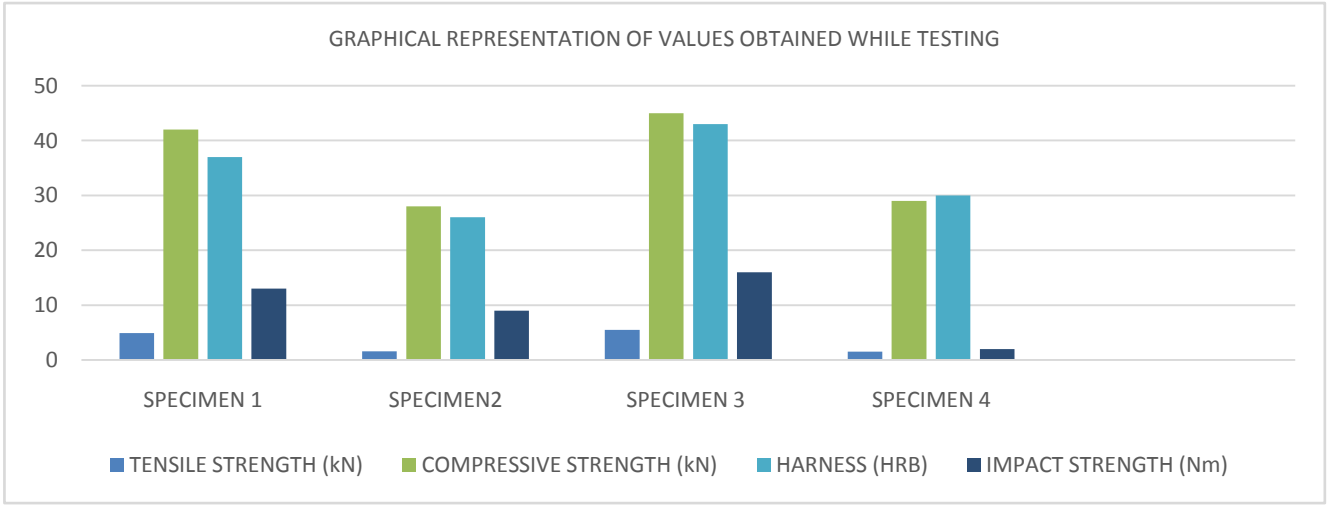
3. EQUATIONS& RESULT

Tensile Stress = Tensile Load / cross-section Area; Tensile Strain = Change in length / original length;Young's modulus =Tensile stress/Tensile Strain.

Compressive Stress = Compression Load/Cross-section Area; Compressive Strain= Change in length /original length; Young's modulus= Compressive stress /Compressive strain.

Rockwell Hardness Test: For scale using Diamond indenter: - 100-h/0.002
For scale using ball indenter: - 130-h/0.002 where, h= height (in mm)

SPECIMEN RESULTS				
	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3	WOODEN SPECIMEN
TENSILE TEST (in kN)	4.9	1.6	5.5	1.5
COMPRESSION TEST (in kN)	42	28	45	29
ROCKWELL HARDNESS TEST(in HRB)	37	26	43	30
CHARPY IMPACT TEST(in Nm)	13	09	16	02



Other tabular form of tensile & compression tests are below respectively:

S.No	TENSILE LOAD (kN)	TENSILE STRESS (kN/m2)	TENSILE STRAIN	YOUNG'S MODULUS (MN/m2)
Composite 1	4.9	1633.33	0.01	163.333
Composite 2	1.6	533.33	0.0066	80.808
Composite 3	5.5	1833.33	0.0133	137.844
Wooden Specimen	1.5	500.00	0.0066	75.757

S.No	COMPRESSIVE LOAD (kN)	COMPRESSIVE STRESS (kN/m2)	COMPRESSIVE STRAIN	YOUNG'S MODULUS(MN/m2)
Composite 1	42	76.363	0.0545	1.401
Composite 2	28	50.909	0.0363	1.402
Composite 3	45	81.818	0.0545	1.501
Wooden Specimen	29	52.727	0.0363	1.452

4. CONCLUSION

Our project focuses on utilization of domestic waste as reinforcement and comparative study shows our Coconut and Banana fiber Composite has much good properties than wood.

It has better Mechanical Strength properties and it had wide scope for research has we have ended up with mechanical properties still it has scope for finding physical properties like density, Moisture Absorption, Void Content, Fiber Volume Percentage etc... As well as methods of recycling or decomposing as in case of Glass & Carbon Fiber Composites were Pyrolysis Method is used and Solvolysis is a chemically dissolving for resin composite.

Natural Fiber Composite Materials are rapidly growing importance both in Industrial application & Fundamental Research as they are Renewable, completely or partially recyclable, biodegradable so in order to produce cost effective and to safe guard Ecosystem.

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- kb.appinc.co was first indexed by Google in January 2018

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