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Fabrication and Charactarization of Hybrid Polymer Composite

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ABSTRACT-Glass fibers reinforced polymer composites have been prepared by various manufacturing technology and are widely used for various applications. Initially, ancient Egyptians made containers by glass fibers drawn from heat softened glass. Continues glass fibers were first manufactured in the 1930s for high-temperature electrical application. Nowadays, it has been used in electronics, aviation and automobile application etc. Glass fibers are having excellent properties like high strength, flexibility, stiffness and resistance to chemical harm. It may be in the form of roving's, chopped strand, yarns, fabrics and mats. Each type of glass fibers have unique properties and are used for various applications in the form of polymer composites. The mechanical properties like tensile, compression, bending and impact strength of various glass fiber reinforced polymer composites were reported.

I.INTRODUCTION

Composite materials produce combination properties of two or more materials that cannot be achieved by either fiber or matrix when they are acting alone. Fiber-reinforced composites were successfully used for many decades for all engineering applications. Glass fiber-reinforced polymeric (GFRP) composites were most commonly used in the manufacture of composite materials. The matrix comprised organic, polyester, thermostable, vinylester, phenolic and epoxy resins. Polyester resins are classified into bisphenolic and ortho or isophtalic. The mechanical behavior of a fiber-reinforced composite basically depends on the fiber strength and modulus, the chemical stability, matrix strength and the interface bonding between the fiber/matrix to enable stress transfer. Suitable compositions and orientation of fibers made desired properties and functional characteristics of GFRP composites was equal to steel, had higher stiffness than aluminum and the specific gravity was one-quarter of the steel. The composite materials have been used for many tribological applications such as bearing, gears, wheels and bushes. By adding wood powder to GFRP it can be used for making window panels, wood furniture's because of its high strength and low weight capacity.

II. OBJECTIVES

Keeping in view the above mentioned knowledge gaps, the objectives were chosen for the present research project work.

- Fabrication of E-glass polymer matrix composite with wood powder as a filler material.
- Evaluation of mechanical properties such as tensile strength, bending strength and impact strength.

III.MATERIALS FOR FABRICATION

A. MATRIX-Polyester resins are unsaturated synthetic resins formed by their action of dibasic organic acids and polyhydric alcohols. Maleic Anhydride is a commonly used raw material with diacid functionality. Polyester resins are used in sheet moulding compound, bulk moulding compound and the toner of laser printers. Wall panels fabricated

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Vol. 5, Issue 6 , June 2018

from polyester resins reinforced with fiberglass—so-called fiberglass reinforced plastic (FRP)—are typically used in restaurants, kitchens, rest rooms and other areas that require washable low-maintenance walls. They are also used extensively incured-in-place pipe applications. Departments of Transportation in the USA also specify them for use as overlays on roads and bridges. In this application they are known as PCO Polyester Concrete Overlays. These are usually based on isophthalic acid and Cut with styrene at high levels—usually upto 50%. Polyesters are also used in anchor bolt adhesives though epoxy based materials are also used. Many companies have and continue to introduce styrene free systems mainly due to odor issues.

Figure 1: Polyester Resin

B. REINFORCEMENT-Glass fiber is a material consisting of numerous extremely fine fibers of glass. It has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fiber reinforced polymer(FRP) composite material called glass reinforced plastic (GRP), popularly known as "fiberglass". This material contains little or no air or gas, is more dense, and is a much poorer thermal insulator than is glass wool.

Figure 2: E-Glass Fibers (Chopped strands)

Properties of E-Glass Fiber

Composition	Density (g/cm^3)	Tensile Strength (MPa)	Young's Modulus (GPa)
SiO_2 54wt%,Al_2O_3 14wt%, CaO + MgO 22wt%, B_2O_3 10wt% and Na_2O+K_2O less than 2wt%	2.55	2000	80

C. HARDENER- Hardeners are used to cure polyester resins. Without a hardener, they do not achieve anywhere near the impressive mechanical and chemical properties that they would with the hardener. However, simply adding a hardener to an polyester resin may not cause the mixture to cure quickly enough. If this is the case a different hardener may be required. The correct type of hardener must be selected to ensure the mixture will meet the requirements of the application. Also, hardeners with certain additives can be used. These hardener additives serve as catalysts that speed up the curing process. Common examples of hardeners are anhydride-based, amine-based, polyamide, aliphatic and cycloaliphatic.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 6 , June 2018

Figure 3: Hardener and Catalyst

IV. METHOD OF FABRICATION

HAND LAY-UP TECHNIQUE-It is the simplest method for producing the composites. The moulds are prepared according to ASTM standards for fabrications of composites are made up of aluminum. The inner cavity dimensions of the moulds are 195mm x 50mm x 10mm (bending), 400mm x 50mm x 10mm (tensile). The fiber and resin are weighed based on the volume fraction; hardener and filler material (wood flour) is added to the resin and mixed properly. The resin is poured in the mould and the e-glass fibers are spreaded on it and compressed uniformly, this is repeated for several times and the mould is kept for 48 hrs for curing. Now the prepared composites are cut for testing to the dimensions of the specimen required.

Figure 4: Hand Lay Up Technique

V. RESULTS AND DISCUSSION

A.TENSILE TEST-The Ability To Resist Breaking Under Tensile Stress Is One Of The Most Important And Widely Measured Properties Of Material Used In Structural Applications. The Force Per Unit Area (Mpa Or Psi) Required To Break A Material In Such A Manner Is The Ultimate Tensile Strength Or Tensile A Strength At Break. Tensile Properties Indicate How The Material Will React To Forces Being Applied In Loaded In A Very Controlled Manner While Measuring The Applied Load And The Elongation Of The Specimen Over Some Distance. Tensile Tests Are Used To Determine The Modulus Of Elasticity, Elastic Limit, Elongation, Proportional Limit And Reduction In Area, Tensile Strength, Yield Point, Yield Strength And Other Tensile Properties.

ISSN: 2350-0328
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Vol. 5, Issue 6 , June 2018

a) With Filler Material **b) Without Filler Material**

Figure 5: Specimens for Tensile Test

Tensile Strength for Composite With Filler (Wood) Material

SL NO	LENGTH in mm	WIDTH in mm	THICKNESS in mm	ULTIMATE STRENGTH in N/mm^2
1	400	50	10	26.16
2	400	50	10	32.36
3	400	50	10	28.72

Tensile Strength for Composite without Filler Material

SL NO	LENGTH in mm	WIDTH in mm	THICKNESS in mm	ULTIMATE STRENGTH in N/mm^2
1	400	50	10	25.2
2	400	50	10	26.5
3	400	50	10	25.7

CONCLUSION-By referring the above table we conclude that the composite with filler (wood) material is having more tensile strength as well as the displacement compared to teak wood and composite without filler material.

B. FLEXURAL STRENGTH-Flexural strength, also known as modulus of rupture, bend strength, or fracture strength a mechanical parameter for brittle material, is defined as a material stability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol. When an object formed of single material, like a wooden beam or a steel rod, is bending, it experiences a range of stresses across its depth. At the edge of the object on the inside of the bend (concave face) the stress will beat maximum compressive stress valve. At the outside of the bend(convex face)the stress will be at its maximum tensile value. These inner and outer edges of the beam or rod are known as the ‘extreme fibers’. Most materials fail under tensile stress before they fail under compressive stress, so the maximum tensile stress value that can be sustained before the beam or rod fails is its flexural strength.

ISSN: 2350-0328
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Vol. 5, Issue 6 , June 2018

Figure 6: Specimen for bending test

Flexure strength for composite with filler (wood) material

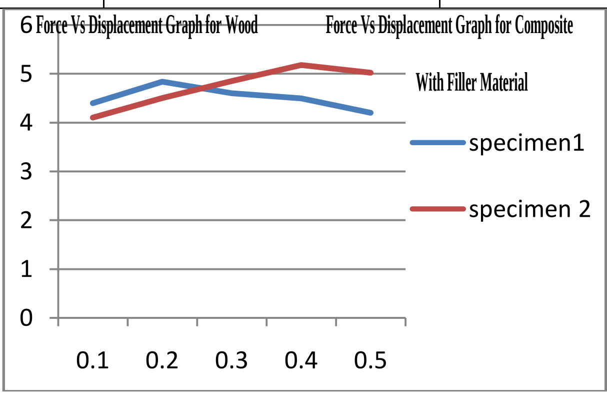
SL NO	LENGTH in mm	WIDTH in mm	THICKNESS in mm	BENDING STRENGTH in N/mm^2
1	195	50	10	4.22
2	195	50	10	4.56

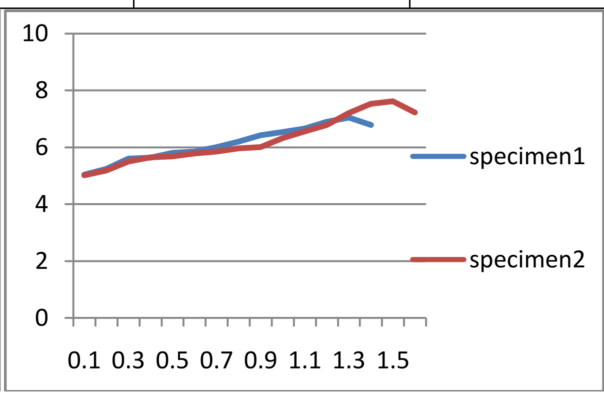
Flexure strength for composite without filler (wood) material

SL NO	LENGTH in mm	WIDTH in mm	THICKNESS in mm	BENDING STRENGTH in N/mm^2
1	195	50	10	2.94
2	195	50	10	3.29

Flexure Strength for Teak Wood

SL NO	LENGTH in mm	WIDTH in mm	THICKNESS in mm	BENDING STRENGTH in N/mm^2
1	195	50	10	2.8
2	195	50	10	3.1





Force Vs Displacement Graph for Wood

Force Vs Displacement Graph for Composite With Filler Material

ISSN: 2350-0328
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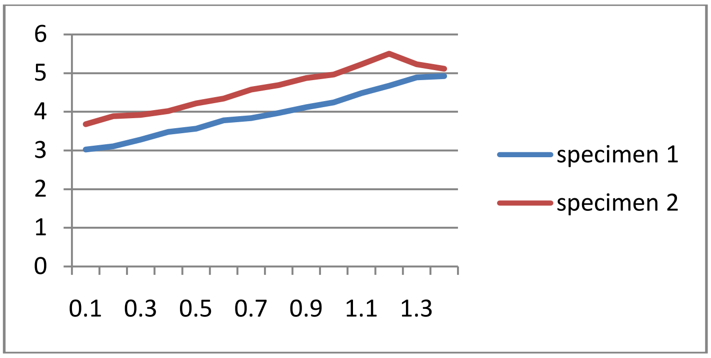
Vol. 5, Issue 6 , June 2018



Force Vs Displacement Graph for Composite without Filler Material

CONCLUSION- By referring the above table we conclude that the composite with filler (wood) material is having more bending strength as well as the displacement compared to teak wood and composite without filler material.

C. IMPACT TEST- Impact test is a standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height and then released. The arm swings down hitting the notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity.
The test is similar to charpy impact test but uses a different arrangement of the specimen under test. The izod impact test differs from the charpy impact test in that the sample is held in cantilevered beam configuration as oppose to a three point bending configuration.

a)Without filler

b) with filler

Figure 7: Specimen for Izod Test

Izod Test For Composite With Filler (Wood) Material

SL NO	LENGTH in mm	WIDTH in mm	HEIGHT in mm	ENERGY In joules
1	75	10	10	134
2	75	10	10	136
3	75	10	10	136

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 6 , June 2018

Izod Test For Composite Without Filler (Wood) Material

SL NO	LENGTH in mm	WIDTH in mm	HEIGHT in mm	ENERGY In joules
1	75	10	10	134
2	75	10	10	134
3	75	10	10	134

Izod Test for Teak Wood

SL NO	LENGTH in mm	WIDTH in mm	HEIGHT in mm	ENERGY In joules
1	75	10	10	132
2	75	10	10	132
3	75	10	10	130

CONCLUSION- By referring the above table we conclude that the composite with filler (wood) material is having more impact strength compared to teak wood and composite without filler material.

VI. CONCLUSION

In this work, Mechanical properties of glass fiber composite with filler material is compared with glass fiber composite without filler material and teakwood and investigated with results. It has been observed from the above stated results and worked compared. The tensile, flexural and impact properties of the composites as the function of fiber content were analyzed.

The filler material as improved the mechanical properties like tensile, flexural and impact strength with polyester resin. Therefore it is conclusive from the above result that filler material has provided better mechanical properties. In future various other natural reinforcing material could be used with glass fiber and filler material to form better hybrid composite which has better mechanical properties as well as cost effective.

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Vol. 5, Issue 6 , June 2018

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