Investigations On Palm Fiber Reinforced Hybrid Polymer Composites

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Abstract- *Now-a-days, the natural fibres and fillers from renewable natural resources offer the potential to act as a reinforcing material for polymer composite material alternative to the use of natural fibres and other man-made fibres. Among various natural fibres and fillers like aramid, wheat straw, palmfiberwood powder, jute , hemp etc. are the most widely used natural fibres and fillers due to its advantages like easy availability, low density, low production cost and reasonable physical and mechanical properties. This research work presents the effects of natural fillers, hybrid composite structure is formed. The result of test depicted that hybrid composite has far better properties than single fibre glass reinforced composite under impact and flexural loads. However it is found that the hybrid composite have better strength as compared to single glass fibre composites.*

Scope –

- *Develop high strength and increase in elongation of composite material with mixture of E-glass with Epoxy.*
- *Reduce the density of composite material used in aerospace industry and also to reduce the weight of the material used in interior parts of the aircrafts*

I. INTRODUCTION

The biggest advantage of modern composite materials is that they are light as well as strong. By choosing an appropriate combination of matrix and reinforcement material, a new material can be made that exactly meets the requirements of a particular application. Composites also provide design flexibility because many of them can be moulded into complex shapes. The downside is often the cost. Although the resulting product is more efficient, the raw materials are often expensive.

DEVELOPING THE COMPOSITE MATERIAL PROPERTIES: The scope of the project is to develop high strength and increase in elongation of composite material with mixture of E-glass with Epoxy. To reduce the density of composite material used in aerospace industry and also to reduce the weight of the material used in interior parts of the aircrafts.

II. LITRATURE SURVEY

RECENT PROGRESS ON NATURAL FIBER HYBRID COMPOSITES FOR ADVANCED APPLICATIONS: (MOCHANE, M. J. AND MOKHENA) 2019, VOL. 13 , SAID, A combination of these fibers/fillers, as reinforcement of various polymeric materials, offers new opportunities to produce multifunctional materials and structures for advanced applications.

MECHANICAL AND TRIBOLOGICAL BEHAVIOR OF NANOFILLER REINFORCRD (GUJJALA RAGHAVENDRA) 2015, SAID, Increasing demand for special materials lead to new inventions, one of the most promising inventions is the concept of composites. We always will strive to understand and modify the world around us and the stuff of which it is made. A new era is opened when the thorough understanding of a particular material and combining the valuable properties of the different materials are taken together to optimize the individual properties.

EXPERIMENTAL ANALYSIS ON TRIBOLOGICAL BEHAVIOR OF FIBER REINFORCED COMPOSITES, (S VIGNESHKUMAR AND TRAJASEKARAN 2018 , SAID, The use of fiber reinforced composites are widely used in many application as automobile, aircraft manufacturing because they are cost effective and offers high strength, availability and weight ratio compared to other composites with similar applications.

III. FINDING THE COMPOSITES OBJECTIVES

OBJECTIVE OF THE PROJECT: The main objective of this addition of E-glass to Epoxy reduces density and significantly increases stiffness; for each weight percent of E-glass added to epoxy (up to 4 wt. %), density and elastic modulus is improved by 3% and 4%, respectively. Designers are able to achieve a weight saving of up to 20 % by using E-glass-Epoxy instead of traditional interior materials in aircraft. Studies of the effect of slip morphology on the monotonic and cyclic ductility of E-glass-Epoxy show that ductility is controlled by strain localization which depends on the extent of work softening on the glide plane.

DESIGN CONSIDERATION: When designing a new material in aircraft industry, one has to consider multiple factors and these are;

- Raw materials availability and cost
- Required skills and processing technology
- Finished component rejection rates and waste recycling
- Unknown risks while deciding application area
- Uncertainties in performance
- Damage tolerance maintenance frequency & replacement procedures
- Other factors i.e. improvement in profitability and margins.

USE OF COMPOSITE IN AEROSPACE STRUCTURE :

The composites-in particular, the advanced fibre reinforced composites using carbon or aramid fibres in polymer matrices--offer several of these features as given below

- Light-weight due to high specific strength and stiffness
- Fatigue-resistance and corrosion resistance
- Capability for high-degree of optimization: tailoring the directional strength and stiffness
- Capability to mould large complex shapes in small cycle time reducing part count and assembly times. Good for thin-walled or generously curved construction
- Capability to maintain dimensional and alignment stability in space environment
- Possibility of low dielectric loss in radar transparency
- Possibility of achieving low radar cross section. These composite materials also have some inherent weaknesses
- Laminated structure with weak interfaces: poor resistance to out-of-plane tensile loads

USE OF COMPOSITE IN AUTOMOTIVE INDUSTRY:

The automotive industry has two very distinct parts: the large-volume sector and the specialist area producing modified or complete vehicles in small numbers. The challenges of each are different and this is reflected in the way car manufacturers approach the use of composites.

- In the large-volume sector, a large percentage of the cost is in the capital plant needed for manufacture and so once the required equipment has been procured and commissioned it is very costly to change the design of a component. This naturally makes the industry very conservative, and encourages extensive prototype testing in both real and simulated environments of any new system before the investment is made.
- In small-volume production, however, the manufacturing operations are much less capital intensive and so the resistance to change in material is somewhat less

IV. DETAILED DESIGNATION AND COMPOSITION OF COMPOSITES

MATERIAS REQUIRED :

1. sisalfiber
2. palmfiber
3. epoxy resin LY556
4. hardner HY951

1	C1	Sisalfiber(10%) +palmfiber(10%)+ Epoxy resin(80%)

SISAL FIBER

Sisal with the botanical name ***Agave sisalana***, is a species of *Agave* native to southern Mexico but widely cultivated and naturalized in many other countries.It yields a stiff fibre used in making various products. The term sisal may refer either to the plant's common name or the fibre, depending on the context. It is sometimes referred to as "sisal hemp", because for centuries hemp was a major source for fibre, and other fibre sources were named after it.

Fibre extraction :

Fibre is extracted by a process known as decortication, where leaves are crushed, beaten, and brushed away by a rotating wheel set with blunt knives, so that only fibres remain. The importance of this traditional use is diminishing with competition from polypropylene and the development of other haymaking techniques, while new higher-valued sisal products have been developed.

EPOXY RESIN

Epoxy is either any of the basic components or the cured end products of **epoxy resins**, as well as a colloquial name for the epoxidefunctional group. Epoxy resins, also known as **polyepoxides**, are a class of reactive prepolymers and polymers which contain epoxide groups.

APPLICATIONS :

- The applications for epoxy-based materials are extensive and include coatings, adhesives and composite materials such as those using carbon fiber and fiberglass reinforcements (although polyester, vinyl ester, and other thermosetting resins are also used for glass-reinforced plastic).
- The chemistry of epoxies and the range of commercially available variations allows cure polymers to be produced with a very broad range of properties. In general, epoxies are known for their excellent adhesion, chemical and heat resistance, good-to-excellent mechanical properties and very good electrical insulating properties.
- As with other classes of thermo set polymer materials, blending different grades of epoxy resin, as well as use of additives, plasticizers or fillers is common to achieve the desired processing or final properties, or to reduce cost. Use of blending, additives and fillers is often referred to as **formulating.**

PREPARATION OF MOULD

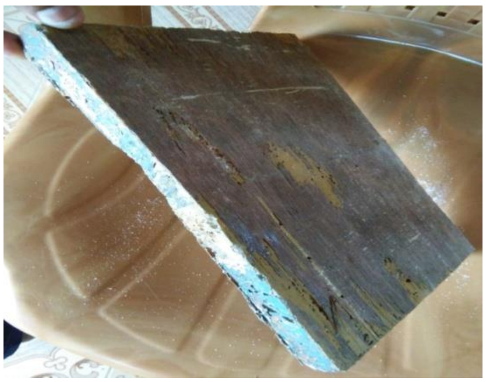
EPOXY, Hardner& Remover

WEIGHTING MACHINE

HAND LAYER MOULDING PREPARATION

COMPRESSION MOULDING PREPARATION

SURFACE FINISHING OF MOULDING



FABRICATED COMPOSITE MATERIAL

V .TEST TO BE PERFORMED

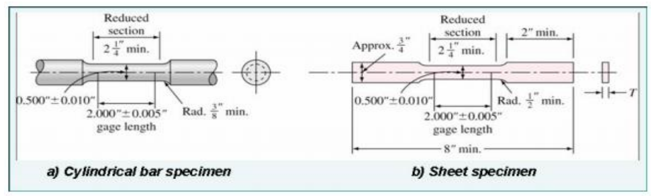
- Tensile test
- Compression test
- Hardness test
- Impact test

TENSILE TEST :

Tensile Test

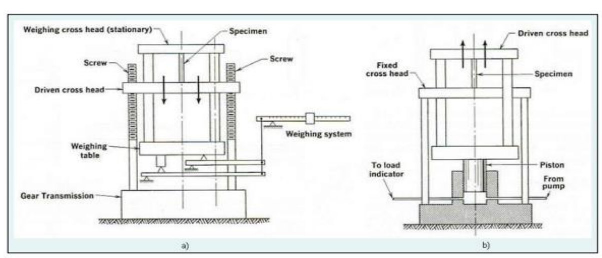
UNIAXIAL TENSILE TESTING:

- Uniaxial tensile test is known as a basic and universal engineering test to achieve material parameters such as ultimate strength, yield strength, % elongation, % area of reduction and Young's modulus.
- These important parameters obtained from the standard tensile testing are useful for the selection of engineering materials for any applications required.
- The tensile testing is carried out by applying longitudinal or axial load at a specific extension rate to a standard tensile specimen with known dimensions (gauge length and cross sectional area perpendicular to the load direction) till failure.
- The applied tensile load and extension are recorded during the test for the calculation of stress and strain.



STANDARD TENSILE SPECIMENS:

The equipment used for tensile testing ranges from simple devices to complicated controlled systems. The so-called universal testing machines are commonly used, which are driven by mechanical screw or hydraulic systems. The below figure illustrates a relatively simple screw-driven machine using large two screws to apply the load whereas next figure shows a hydraulic testing machine using the pressure of oil in a piston for load supply. These types of machines can be used not only for tension, but also for compression, bending and torsion tests. Load cells are used for measuring the load applied while strain gauges are used for strain measurement. A Change in a linear dimension is proportional to the change in electrical voltage of the strain gauge attached on to the specimen.



a) a Lead screw driven machine b) a hydraulic testing machine

COMPRESSION TEST :

Compression Test

Compression tests are used to determine how a product or material reacts when it is compressed, squashed, crushed or flattened by measuring fundamental parameters that determine the specimen behavior under a compressive load. These include the elastic limit, which for "Hookean" materials is approximately equal to the proportional limit, and also known as yield point or yield strength, Young's Modulus (these, although mostly associated with tensile testing, may have compressive analogs) and compressive strength.

HARDNESS TEST :

Hardness Test

Hardness is the property of a material that enables it to resist plastic deformation, usually by penetration. However, the term hardness may also refer to resistance to bending, scratching, abrasion or cutting.

CHARPY IMPACT TEST:

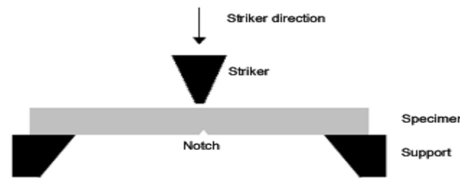
Charpy Impact Test

IMPACT ENERGY:

Impact energy is a measure of the work done to fracture a test specimen.When the striker impacts the specimen, the specimen will absorb energy until it yields. At this point, the specimen will begin to undergo plastic deformation at the notch. The test specimen continues to absorb energy and work hardens at the plastic zone at the notch. When the specimen can absorb no more energy, fracture occurs.

PROCEDURE:

The Charpy test involves striking a suitable test piece with a striker, mounted at the end of a pendulum. The test piece is fixed in place at both ends and the striker impacts the test piece immediately behind a machined notch.



Schematic of the Charpy impact test

DETERMINATION OF CHARPY IMPACT ENERGY:

- At the point of impact, the striker has a known amount of kinetic energy. The impact energy is calculated based on the height to which the striker would have risen, if no test specimen was in place, and this compared to the height to which the striker actually rises.
- Tough materials absorb a lot of energy, whilst brittle materials tend to absorb very little energy prior to fracture.

FACTORS AFFECTING CHARPY IMPACT ENERGY:

- Factors that affect the Charpy impact energy of a specimen will include:
- Yield strength and ductility
- Notches
- Temperature and strain rate
- Fracture mechanism

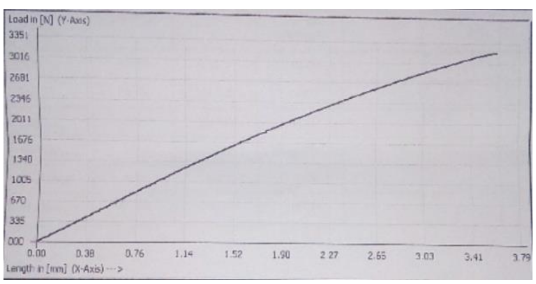
VI. RESULT

1.TENSILE STRENGTH OF COMPOSITES

The composite specimens are tested for tensile properties in universal testing machine and obtained tensile strength are shown in the below figure. The value of tensile strength obtained is

Sample No.	CS Area [mm^2]	Peak Load [N]	% Elongation	UTS[N/ mm^2]
1	75.000	3191.840	2.420	42.556

	CS Area [mm^2]	Peak Load [N]	% Elongation	UTS[N/ mm^2]
Minimum	75.000	3191.840	2.420	42.556
Maximum	75.000	3191.840	2.420	42.556
Average	75.000	3191.840	2.420	42.556
Std Dev	0.000	0.000	0.000	0.000
Variance	0.000	0.000	0.000	0.000
Median	75.000	3191.840	2.420	42.556



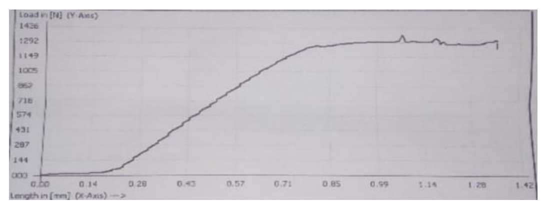
Tensile Test Result

2. COMPRESSION TEST :

The compression strength is one of the important factors in NFRPCs and the following figure shows the variations in the compression strength of composites. The value of compression test obtained is

Sample No.	CS Area [mm^2]	Peak Load [N]	Compressive Strength [N/ mm^2]
1	75.000	1367.337	18.227

	CS Area [mm^2]	Peak Load [N]	Compressive Strength [N/ mm^2]
Minimum	75.00	1367.337	18.227
Maximum	75.00	1367.337	18.227
Average	75.00	1367.337	18.227
Std Dev	0.000	0.000	0.000
Variance	0.000	0.000	0.000
Median	75.00	1367.337	18.227



Compression Test Result

3. HARDNESS TEST :

The hardness of the composite material to deformation absorbed by the Vickers hardness test. The values are furnished in the following figure. The value of hardness test obtained is

S.No	Micro Hardness (Vickers) HV(H)	Average HV (H)
1	21.60	
2	21.90	21.96
3	22.40	

Hardness Test Result

4. IMPACT STRENGTH OF COMPOSITES:

The loss of energy during impact is the energy absorbed by the specimen during impact. The values are furnished in the following figure. The value of impact strength obtained is

Sample No.	Izod Impact Value in J for 3mm thickness
1	0.25

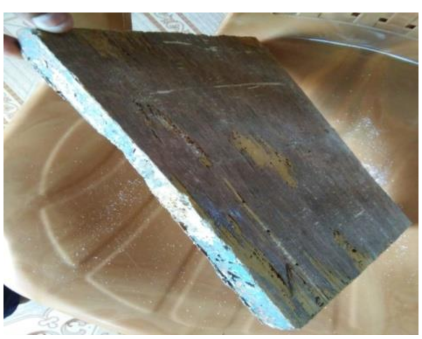
Impact Test Result

VII. CONCULSSION

The experimental study on the hybrid composite with natural fillers on physical, water absorption, wear and mechanical behaviour test leads to the following conclusions

S.No	Test Details	Result Values
1.	Tensile Strength	42.556 N/ mm^2
2.	Compression Strength	18.227 N/ mm^2
3.	Hardness Strength	21.96 H
4.	Impact Strength	0.25 J/m

On the upcoming study the natural fillers are added with the prescribed weight ratio to the E glass polyester composite and its mechanical characteristics are analyzed by the same testing procedure and by comparing the obtained results, the better material composition is finalized.



FINAL COMPOSITE MATERIAL

VIII. APPLICATIONS AND ADVANTAGES

APPLICATION :

- Home applicance like(door)
- Automobile light casing
- Harsbetsheet
- Panel making
- Lathe bet
- Wheel hub etc….

ADVANTAGES :

The possible advantages of such basaltl fiber composites (NFC) could be

- Basaltlfibers are renewable resources.
- Lower pollution level during production.
- Energy necessary for fiber production is lower than that of basalt.
- CO_2 neutral: amount of CO_2 neutralized during fiber plant.

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