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EFFECT ON HYBRIDIZATION OF MECHANICAL PROPERTIES OF NATURAL FIBER COMPOSITES

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Abstract :

The project is on "EFFECT ON HYBRIDIZATION OF MECHANICAL PROPERTIES OF NATURAL FIBER COMPOSITES" deals with polymer matrix reinforced with fibers and material are widely used in automotive, marine, aerospace and construction industries because of their high specific tensile and compressive strength, low coefficient of thermal expansion, good fatigue resistance and suitability for the production of complex shape materials composite material are widely used in aero space industries due to high strength of weight ratio and use in cost wise. So this project aim to create a hybrid natural composite material by using sisal fiber and banana fiber with E-glass fiber and epoxy resin has used. This fabrication of hybrid composite materials has been done. The mechanical testing also carried out (tensile, compression, water absorption, sem test). These testing clearly shows that mechanical properties are higher compare to aluminium material, and also very less weight compare to other aluminium. So this concluded that this hybrid composite material is suitable for aircraft frame application.

Key words – Sisal Fiber ,Banana Fiber ,E-Glass Fiber , Epoxy Resin

I. INTRODUCTION

COMPOSITE MATERIAL

1.1.1 Definition composite material

A structural composite is a material system consisting of two or more phases on a macroscopic scale, whose mechanical performance and properties are designed to be superior to those of the constituent material acting independently. One of the phases is usually continuous and is called reinforcement (fibre), while the less stiff and weaker phase is continuous and is called matrix. Sometimes, due to chemical interactions or other processing effects, and additional phase, exits between the reinforcement and the matrix. The properties of a Composite material depend on the properties of constituents, geometry, and distribution of the phases.

The advent of fibre-reinforced composite materials has constituted a major breakthrough in the construction of lightweight structures. In particular, significant benefits have been realised in the aerospace sector to meet the serve performance requirements with stringent demands of reliability. Almost all aerospace structural components-airframes of fighter aircraft, helicopters. Control surfaces and fins of civil aircraft, various panels in satellites, antennae, rocket motor casings, and some complete airframes of small aircraft are witnessing an increasing use of the advanced composites. An important technological development that has contributed significantly to this growth of composites is the development of strong and stiff fibres such as glass, carbon, and agamid along with concurrent developments in the polymer chemistry, resulting in various polymeric materials to serve as matrix materials. In particular, the versatility of the technology of the carbon fibres having various properties has played a key role in this growth. With complementary developments in computer hardware and software technology, and in computational methods of analysis rendering help to analyse and understand the material behaviour and to provide predictive as well as design tools, the complexity of the polymer-matrix composites has been over come to facilitate the extensive applications.

II.LITERATURE REVIEW

1. Hybridization of Natural Fiber Composites on Mechanical Properties

Sivasubramanian.P1, Shyamraj.R2 (2013) Natural fibers are now considered as a suitable alternative to glass fibers due to their advantages like low cost, high strength-to-weight ratio, recyclables, etc. In this investigation, natural fibers like banana, sisal and hybrid (banana/sisal) were fabricated using moulding method. The tensile, flexural and compression strength of the fabricated composites were tested using Universal Testing Machine and analyzed. In addition to that the wear resistances of the fabricated composites are also tested. All the testing was conducted both in as fabricated and under moisture conditions. The hybridization of composites was found to be enhancing the mechanical properties. Tensile and flexural loading conditions, hybrid and banana reinforced fiber performed well. In compression and impact loading, hybrid and sisal fiber reinforced composites found their suitability. Wear resistance of the hybrid composites are found to be good.

2. Processing of hybrid polymer composites-a review

Mohammad Asim1, Mohammad Jawaid2, Saba3 (2014) In this work study, a range of design scenarios are modelled using analytical equations and finite element method in order to assess the validity of including live pressure in the design. Results indicate that the repair thickness is independent of the live pressure and hence an appropriate modification is proposed to the existing design equation. It was shown that the deviation of the composite laminate strain from the allowable strain varied from 10% to 22%.

3. Natural and synthetic fillers for reaching high performance and sustainable hybrid polymer composites

Daniela de Franc1, Silva Freitas2, Sibele .P3, Cestari and Luis4 (2014) a significant advance was made in the petrochemical industry that led to the development of different polymers and copolymers. They represent a hydrocarbon material class that is similar to other materials in their high molecular weight and low-density (0.90_2.2 g/cm23) but much smaller than conventional materials, such as steel, wood, iron, etc. Whether natural or synthetic, there is a significant diversity in the polymer origin, number of monomers, method of preparation, chemical structure, chain configuration, and tactility of the polymeric chain. There are still differences on fusibility, solubility, and mechanical behavior. From the middle of the 1970s, the polymeric blends were introduced into the market. They tried to combine the qualities of two or more polymers in applications performed previously by homo polymers and copolymers.

4. The Wear Behavior of Composite Materials with Epoxy Matrix Filled With Hard Powde〖Crivelli Visconti〗^1,〖A.Langella 〗^2(2000) The wear behavior of composite materials, sliding under dry conditions against smooth steel counter face, has been investigated. The composite materials consisted of glass woven fabric reinforcing three different systems of matrix: epoxy resin, epoxy resin filled with powders of silica and epoxy resin filled with powders of tungsten carbide. The results put in evidence different wear behaviors of the composite materials observed at different values of sliding speed and pressure. The presence of different wear mechanisms has been appreciated by SEM-micrographic examinations.

5. Bio-based hybrid polymer composites: sustainable high performance material Mohamed Bassyouni1, Umair Javaid2 and Syed W3 (2004) Climate change has induced sustainable and renewable approaches in the development of biodegradable materials, resulting in fewer carbon footprints. Natural fibers (NFs) are making their place as a worthy alternative to the synthetic fibers in reinforced polymer composites. Natural fiber reinforced plastics (NFRPs) are abundantly used in modern composite industry due to their high abundance, low cost, low density, and environment friendly nature; NFs have several inexpensive, technical. i.e., beams, roof panels, boat hulls, tennis rackets, furniture, pipes, and tanks. There are more than 1000 species of bio-fibers which can be used as reinforcements in polymer composites.

6. Synthesis of Conducting Polymer/Carbon Material Composites And Their Application In Electrical Energy Storage Atsushi Gabe1, Mostazo-Lo´pez2, (2008) Conducting polymer-based materials have received much attention because of their variety of applications such as sensors/biosensors, advanced transistors, optical limiting devices photodiodes, electromagnetic absorption, metal corrosion protection, energy storage, etc. This chapter focuses on the preparation of conducting polymer/ carbon material (CP/CM) composites and their application in electrochemical energy storage, as this is one of the most studied fields of application of these materials because of the increasing concern about energy issues.

III. MATERIALS OF PROPERTIES

3.1 E-GLASS FIBRE

Glass fibres are generally produced using melt spinning techniques. These involve melting the glass composition into a platinum crown which has small holes for the molten glass to flow. Continuous fibres can be drawn out through the holes and wound onto spindles, while short fibres may be produced by spinning the crown, which forces molten glass out through the holes centrifugally. Fibres are cut to length using mechanical means or air jets.

3.1.1 Background

E-Glass or electrical grade glass was originally developed for standard off insulators for electrical wiring. It was later found to have excellent fibre forming capabilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fibre glass.

3.1.2 Fibre manufacture

Fibre dimension and to some extent properties can be controlled by the process variables such as melt temperature (hence viscosity) and drawing/spinning rate. The temperature window that can be used to produce a melt of suitable viscosity is quite large, making this composition suitable for fibre forming. As fibre is being produced, they are normally treated with sizing and coupling agents. These reduce the effects of fibre-fibre abrasion which can significantly degrade the mechanical strength of the individual fibres. Other treatments may also be used to promote wetting and adherence of matrix.

3.1.3 Composition

E-Glass is a low alkali glass with a typical nominal composition of wt%. Some other materials may also be present at impurity levels.

3.1.4 Properties

Properties that have made E-glass so popular in fibre glass and other glass fibre reinforced composite include:

- Low cost
- High production rates
- High strength
- High stiffness
- Relatively low density
- Non-flammable
- Resistant to heat
- Good chemical resistance
- Relatively insensitive to moisture
- Able to maintain strength properties over a wide range of conditions
- Good electrical insulation

IV, METHODOLOGY

4.1 MATERIALS OF HYBRID

The fabrication of the hybrid composites are prepared by using sisal-banana fiber and glass fiber by hand layup method for investigation of the mechanical properties .The raw banana fiber and sisal fiber are supplied by Anakaputhur weavers association, Chennai India. The glass fiber, epoxy resins (LY556) and hardener (HY951) is purchased from M/s. K. Mohan Company, Chennai, India.

4.2 EXPERIMENTAL PROCEDURE

4.2.1 Preparation method

The methods of preparation of specimen are as follows:

- Mould prepared by using glass plates.
- Banana and Sisal fiber are dried, and chopped into short fiber of 5mm length.
- As per volume fraction of fiber, fibers are weighed.
- Epoxy and hardener are mixed properly in the ratio of 10:1 at room temperature.
- A release agent (remover) is applied on the mould and dries it for few minutes.
- Short fiber and epoxy mixture are mixed properly at room temperature.
- The Fiber and epoxy mixture is poured uniformly on to the mould and excess amount of epoxy mixture was removed and leveling is done by using roller.
- The mould is closed and the composite material was pressed uniformly for 24 hours for curing at room temperature.
- Once the Composites are dried, it is separated from the mould.
- The test specimens are cut according to the ASTM Standard.

The samples were fabricated into three different configurations which are glass fibre, sisal fibre and plantain fibre. The mechanical properties of the samples were determined via tensile and compression testing.

4.3 MATERIAL FABRICATION

Material selection is a very important process as it will narrow down the available options. E-type glass fibre of 200 g/m2 is selected as a benchmark material as it is the closest to C-type glass fibre of 200 g/m2 which is the original material for the helicopter door frame. E-type glass fibre has higher strength compared to the C-type. The other reason for the decision is because of the availability of the material. Thus, this selection process involves determining the natural fibres that will be hybridized with the glass fibres. The samples were fabricated using the hand lay-up process. The matrix used was epoxy cured with hardener. The resin and hardener were prepared with a ratio of 2:1, and were stirred until the solution became no viscous. A rectangular shaped panel with dimensions of 350mm-350mm was fabricated in a specific layer sequence. The glass fibres, bamboo bar and groundnut wastage, respectively.

Finally, in the curing process, the specimen was covered with another metal plate and then compressed with 6kN weights on top of the polymer plate to spread the epoxy and push the air bubbles to the side of the polymer plate. The specimen was allowed to dry for duration of 48 h (2 days). The cured specimens were cut into specific dimensions following the test requirement. For the tensile test, the specimen was cut into 25mm-250mm pieces (ASTM 3039/D 3039Me00/95a). For the compression test, the specimen was cut into 25mm-150mm pieces (ASTM D 3410/D 3410Me03). The cutting process involved using a grinding machine to obtain accurate dimensions and avoid cracking. The thickness for all materials was 4mm (specimen thickness variation-2%).

Figure 4.1Sisal fibre

Figure 4.2 Banana fibre

V.WORK METHODOLOGY OR PROCEDURE

5.2 MATERIALS USED METHOD

5.2.1 Thinner

Thinner is used to clean the beaker and other container before mixing and after mixing of epoxy resin with groundnut wastage.

5.2.2 Brushes

Brushes are used to apply on the glass fibres during hand lay method. Before applying it should be cleaned with the help of thinner so that the resin won't be get strikes with the resin to avoid hardness usage of the brush it is cleaned with the help of thinner for the smooth usage of the process and we can use the brush for the long time.

5.2.3 Gloves and Mask

Its use for the safety in this work the mat and resin are use so it will easily set in the hand and body so for applying the resin and to do in hand layup process its will be use.

5.2.4 Resin

Epoxy resin is the matrix material and it is in the form of liquid wax. Its use to transfer the lode.

Figure 5.1 Resin

5.2.5 Hardener

Hardener is the hardening and curing agent which is used to solidify the epoxy material along with reinforcement. Because of the resin which is very less viscosity we are using hardener to solidify the resin. Here we are using the methyl EY 556 as a hardener for epoxy resin.

Figure 5.2 Hardener

5.2.6 E-Glass fibre

The E-Glass fibre material which is used as the reinforcement. The density of the E-glass fibre is 500 gm/mm^2. Because of its density is low it is used as a one of the reinforcement material which has high stiffness with the help of specific properties as per the requirement of the product to be made.

5.3 PREPARING OF E-GLASS FIBRE AND RESIN AND SISAL AND BANANA FIBRE

In the preparation of e-glass fibre are taken and as per our dimension the e-glass fibre will cut, that's at 30cm and it will be cut for the preparation that will be taken as 4 layers. And as per the weight the resin will be taken that's as per the need the hardeners will be measure and taken, this all will work done by using varying machine Sisal and Banana where taken by calculation.

5.4 CLEANING THE MANDREL WITH THINNER

The prepared will be clean by using thinner and cloth and emery sheet the surface will get smooth and good surface. And the dust particles wild cleaning.

5.5 APPLYING SISAL AND BANANA PREPARING THE RESIN AND E-GLASS FIBRE

Polyvinyl alcohol was use to for easy remove of product from the mandrel it's applied before 1hr for curing. And as per the percentage the resin and Fibres where mixed and layer will be taken to the working now the resin will be apply by using brush evenly to the mandrel.

Sample - I

Sample- II

Sample – III

Sample - IV

Figure -5.6 Testing samples

VI. Result and Dissection

6.1 TESTING METHOD FOR TENSILE AND COMPRESSION TEST

Tensile and compression tests were performed using a floor model universal testing machine. The testing was carried out using an Instron 3382 with a capacity of 100 kN, maximum speed of 500 mm/min and a vertical test speed of 1323mm.The ASTM Standard to processing the test.

6.1.2 Tensile test analysis

The specimen where maintained under the same experimental conditions to prevent data variation. When each specimen reached its maximum elongation and break, the data was recorded, e.g., extension, load, tensile stress, and tensile strain. The average of the maximum load, tensile strength, tensile strain, tensile extension.

Table 6.1: Tabulation for tensile test

Identification	Thick mm	Width mm	CSA mm^2	TL KN	TS N/mm^2	IGL mm	FGL mm	%E
S1	8.00	10.00	80.00	1.24	15.50	3.45	43.13	50.0
S2	8.50	15.00	127.50	2.89	17.23	6.34	49.73	50.00
S3	17.00	14.00	246.50	4.52	18.34	10.24	41.54	50.00
S4	15.40	14.50	223.40	5.10	22.84	12.38	55.44	50.00

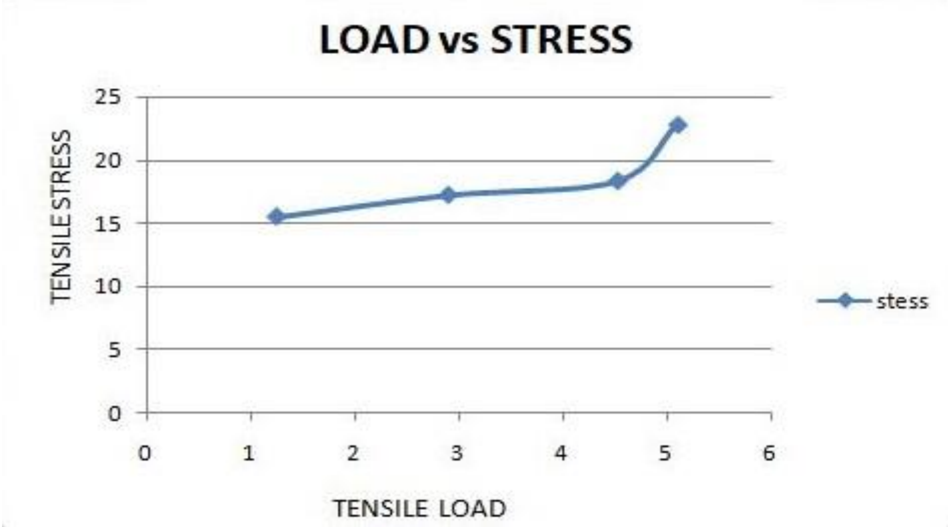


Figure 6.1 Tensile Load Vs Tensile Stress

6.1.2 Compression test analysis

Compression testing is conducted to determine the specimen's properties under compressive loading (e.g., compressing squashing, crushing or planar). These embody the elastic limit, which for a "Hookean" material is approximately the same as the proportional limit, and is additionally referred to as the yield point or yield strength, the compressive modulus and the compressive strength.

Table 6.2: Tabulation for compression test

Identification	Thick mm	Width mm	CSA mm^2	CL KN	CS N/mm^2
S1	8.00	10.00	80.00	124.56	432.76
S2	8.50	15.00	127.50	127.67	443.64
S3	17.00	14.00	246.50	130.43	451.67
S4	15.40	14.50	223.40	134.56	469.29

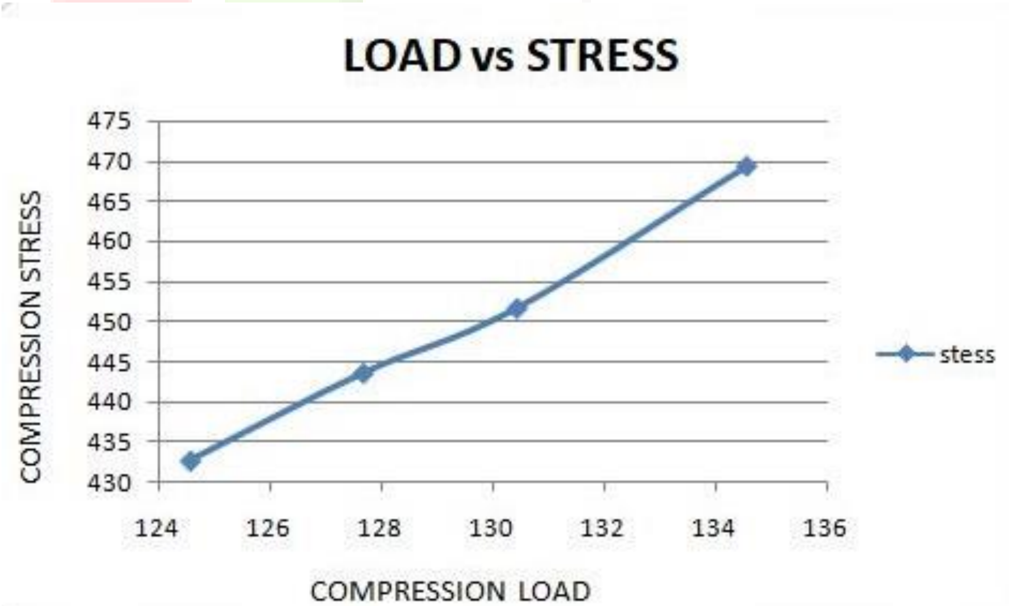


Figure 6.2 compression load vs compression stress

6.1.3 WATER ABSORPTION FOR GAP SAMPLE PIECE

The specific gravity test of aggregates is done to measure the strength or quality of the material while water absorption test determines the water holding Capacity of the coarse and fine aggregates.

Table 6.3 Water absorption for gap sample piece

S.NO	NORMAL SAMPLE VALUE (mm)	WATER OBSERVED SAMPLE VALUE (mm)
1	4.3	4.5
2	4.4	4.6
3	4.3	4.5
4	4.4	4.6

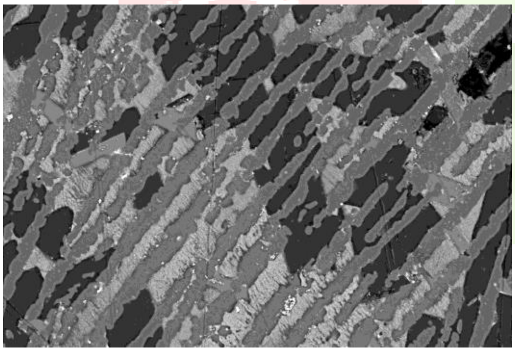
6.1.4 WATER ABSORITION FOR WITHOUT GAP SAMPLE PIECE

Table 6.4 Water absorption for without gap sample piece

S.NO	NORMAL SAMPLE VALUE (mm)	WATER OBSERVED SAMPLE VALUE (mm)
1	4.5	5.0
2	5.1	5.2
3	5.1	5.3
4	5.1	5.2

6.1.5 SEM Test

Scanning Electron Microscopy (SEM) is a test process that scans a sample with an electron beam to produce a magnified image for analysis. The method is also known as SEM analysis and SEM microscopy, and is used very effectively in microanalysis and failure analysis of solid inorganic materials. Electron microscopy is performed at high magnifications, generates high-resolution images and precisely measures very small features and objects.



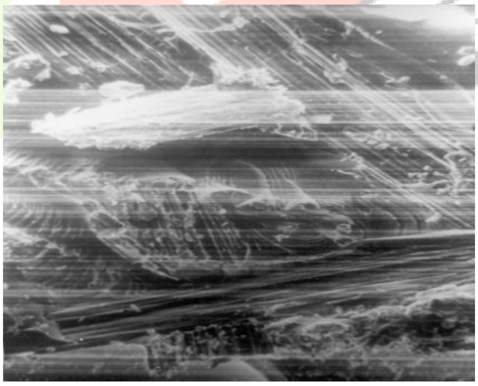


Figure 6.3 SEM test for the hybrid fiber composite material

The effect of fibers on the percentage elongation is compression, the percentage elongation in dry condition is found to be more or less equal in all the cases. But after water absorption, more elongation is observed in the case of banana fiber composites. As explained earlier the reason could be the presence of water which acts as a plasticizer, lead more strain. The presence of sisal fiber plays a vital role in the reduction of elongation in the hybrid composites. The SEM photographs taken for the samples of banana, sisal and hybrid composites are shown in figures of samples to 200µ-500µ respectively. The increase in the impact strength could be observed for hybrid and sisal fiber composites. This could be attributed to fiber bridging through fiber pull out. The greater level of fiber pull out which is observed in the specimen fabricated by sisal and hybrid reinforcement attributes superior impact strength. Banana fiber composite exhibits increased compression and tensile stress. The reason could be the reduced fiber bridging effect resulting lower fiber pull out. The complete breaking of the fiber rather than pull out is observed through SEM analysis.

VII.CONCLUSION

At present, hybrid composite (Banana: sisal) fiber of different weight fraction fabricated and tested for tensile strength and compression test. The addition of reinforced natural fiber with glass fiber it has achieves the high level of compression stress with compression load and tensile stress with tensile load.

At w% without adding the natural fiber with glass fiber with 10 layers the material has prepared with epoxy. The second spice the material has prepared with 4 layers of sisal fiber and 6 layers of glass fiber. The third spice material has prepared has 4 layers banana fiber and 6 layers of glass fiber on material has prepared. The fourth spice with the addition of 4 layers of glass fiber, 3 layers of sisal fiber, 3 layers of banana fiber the material has prepared from the comparative strength of the four pieces the fourth work piece has achieve the great result of strength and elasticity.

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