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Effect of Various Matrix Materials on Mechanical Properties Palm Fiber Composites

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Abstract:
In the present scenario, there has been a rapid attention in research and development in the natural fiber composite field due to its better formability, renewable, abundant cost-effective and eco-friendly features. This work presents the extraction of fiber from palm fruits. In this review, to investigate the various mechanical behaviour of palm fruit fiber reinforced resin composites. It helps to provide details about the palm fruit fibers reinforced composite materials, mechanical properties and some of their applications in engineering sectors. The commercially available epoxy, vinyl ester, polyester resins are used as matrix to these composites. For experimentation three different plates were fabricated using these fibers adopting hand lay-up method. Palm fruit fibers available plenty can be used as reinforcements in development of eco-friendly polymer composites. The less utilized palm fruit fibers were researched in this work to have a better reinforcement in preparing composites.

Keywords: Palm fruit fibers, resin, tensile strength, impact test, water absorption.

I. INTRODUCTION

Composite materials are microscopic mixture of two or more different materials, one typically being the continuous phase (matrix), and the other being the discontinuous phase (reinforcement). A clear definition is, Loose terms like “materials composed of two or more distinctly identifiable constituents”. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part. The composite materials derived from natural, renewable sources have received significant interest in recent years due to increased environmental awareness, concern about the depletion of non-renewable resources. The primary advantages of natural fibers over synthetic fibers have been their low cost, light weight, high specific strength, bio degradability, nontoxic and good thermal resistivity. The natural fibers are having of cellulose, hemicellulose, lignin, pectin, waxes and other materials. The main drawback of using natural fiber is their high level of moisture absorption, insufficient adhesion between untreated fibers and the polymer matrix. The surface of natural fiber is usually not suitable for creating a strong bond with a polymeric matrix. Composite materials can be classified based on the types of matrix used as Metal Matrix Composites, Ceramic Matrix Composites and Polymer Matrix Composites. Polymer Matrix Composites is the most commonly used composites. Due to its many advantages such as light weight, high stiffness, low cost, simple manufacturing principle and good corrosion resistance. Polymer Matrix Composites have two types of polymer that have been used as matrix.

These are thermoplastics and thermosetting polymer. Epoxy resin is the most widely used matrix due to its advantages like good adhesion to other materials, high strength, low volatility during cure, low shrink rate, low viscosity etc. The natural fiber composites are used in various applications such as aerospace, automobiles (e.g. door panels, instrument panels, seat shells etc.,), railway coaches, military applications, sports, building and construction area (e.g. walls, ceiling, partition, window and door frames etc.,).

Objectives

The objectives of the project are outlined are

- To extract the palm fruit fiber from the fruit of palm plants.
- To prepare the palm fruit fiber reinforced epoxy, vinyl ester, polyester matrix composites.
- To prepare test specimen according to the ASTM standards.
- To investigate the various mechanical properties like impact, compression, tensile and water absorption of matrix composites.

II. METHODOLOGY PREPARATION OF PALM FIBER

The fibers are cut from palm fruit shown in fig.1. That fiber extracted on hand picking methods is used. The fiber were dried in natural sunlight to remove moisture content and long uniform fiber were obtained. Then the fiber is separate in the equal dimensions (30 mm) for producing a composite material. The palm fibers were available plenty from INDIA fibers.

Figure.1. Palm fruit fiber

PREPARATION OF RESIN

The following three types of polymer matrix used are

- Epoxy resin LY556

- Vinylester resin VBR-4508
- Polyester resin (General purpose G-0051)

The resins are purchased from Covai Seenu & Co, Coimbatore, Tamilnadu, India.

The following hardeners are used with the resins for making reinforced composite material

- Hardener HY951
- Accelerator
- Catalyst
- Promoter

When the resin and hardener are mixed in directly. To remove the clip, remove both end caps, grip each end of the pack and pull apart gently. By using the removed clip, take special care to push unmixed material from the corners of the pack. Mixing normally takes from two to four minutes depending on the skill of the operator and the size of the pack. Both the resin and hardener are evacuated prior to packing so the system is ready for use immediately after mixing. The corner may be cut from the pack so that it may be used as a simple dispenser.

MOULD BOX

In our project the moulding box is manually prepared. The mould box is made in steel plate. This type of mould is prepared for medium size jobs and its smooth surface.

Dimension of Moulding Box:

Length : 290 mm
Breath : 290 mm
Height : 3mm

WORKING

The mounding box is manually prepared by using sheet metal. And the wax is coated bottom side. The resin is mixed with the hardener due to the increasing the hardness properties of resin. The palm is fiber is collected manually and it is cut required size. The wax is used for easily removing the composite material from the mould box. In epoxy content has 10:1 ratio of resin and hardener mixture. Vinyl ester content has 10:0.15:0.15 ratio of resin, accelerator, and catalyst and promoter mixture. Polyester has 10:0.15 ratios of resin, accelerator and catalyst. Inside the mould box the resin and fiber are pasted alter natively like a layer. The wax is pasted before the first layer and also after the last layer. It takes 100^{o}C in 30 minutes and it can mould method is compression moulding in 1500 PSI. After completion of work the job is includes in the mechanical test.

TESTING METHODS

IMPACT TEST

An impact test is a technique for determining the behaviour of material subjected to shock loading. The test designed to determine how a specimen of a known material will respond to a suddenly applied stress. The test ascertains whether the material is too tough or brittle. Impact test is also known as ASTM D256. The impact test is a method form evaluating the toughness, impact strength, and notch sensitivity of engineering materials. They are basically two types of impact test, pendulum and drop weight. (Table no. 1 and chart no.1)

Table .1. Impact test result

Material name	Izod impact value in J for 3mm thickness
Epoxy	0.250.85
Vinyl ester	0.40
Polyester	0.250

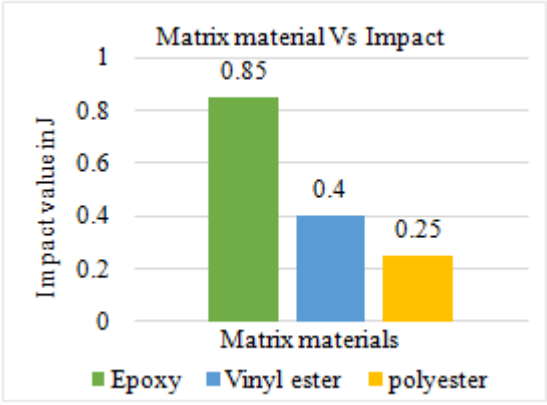

Chart no. 1. Impact strength

TENSILE TESTING

The tensile test specimens were prepared according to ASTM D3039. For testing the specimen was mounted in the grips of the universal tester with 10 mm gauge length. The stress strain plotted during the test for the determination of ultimate tensile strength and percentage of elongation. The tensile strength of three palm fruit fibres reinforced composite are shown in table-2 and chart-2. The tensile behaviour of the palm fibers increases with increase in gauge lengths from 10 mm to 20 mm. As the gauge length increases the deviation from the mean value for various samples increases, which was expected for any natural fibre characterization. Tensile strength, also known as Ultimate Tensile Strength (UTS). (Table no.2 and chart no.2)

Test Mode : Tensile Test Type : Normal
Elongation device: Crosshead Test Parameter: Peak Load
Test speed (mm/min): 2.00

Table no.2. Tensile test result

Material name	CS Area (mm^2)	Peak load (N)	% Elongation	UTS (N/mm^2)
Epoxy	75.000	920.33	1.060	12.272
Vinyl ester	75.000	513.69	1.130	6.847
polyester	75.000	738.06	1.070	9.839

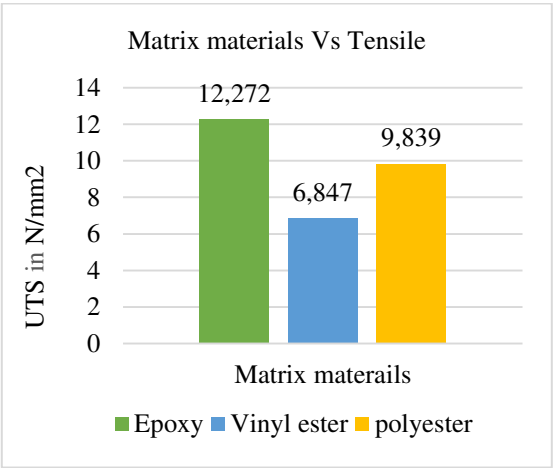

Chart no.2 Tensile strength

COMPRESSION TESTING

Most of the structural members include the compression members. Such members can be loaded directly in compression or under a combination of flexural and compression loading. The axial stiffness of such members depends upon the cross-sectional area. Thus, it is proportional

to the weight of the structure. One can alter the stiffness by changing the geometry of the cross section within limits. However, some of the composites have low compressive strength and this fact limits the full potential application of these composites. The compression testing of the composites is very challenging due to various reasons. The application of compressive load on the cross section can be done in three ways. Directly apply the compressive load on the ends of a specimen, loading the edges in shear and mixed shear and direct loading. These three ways of imposing the loads for compression testing. During compression loading the buckling of the specimen should be avoided. This demands a special requirement on the holding of the specimen for loading purpose. Further, it demands for special geometry of the specimen. These specimens are smaller in size as compared to the tensile testing specimens.

A compression test specimen according to ASTM D3410 (modified) standard. (Table no.3 and chart no.3)

Test name: Compression test Test type: Normal
Elongation device: crosshead Test parameter: peak load
Test speed (mm/min): 2.00

Table no.3 Compression test result

Material name	CS Area (mm^2)	Peak load (N)	Compressive strength (N/mm^2)
Epoxy	75.000	1575.869	21.013
Vinyl ester	75.000	1230.409	16.402
polyester	75.000	2208.015	29.440

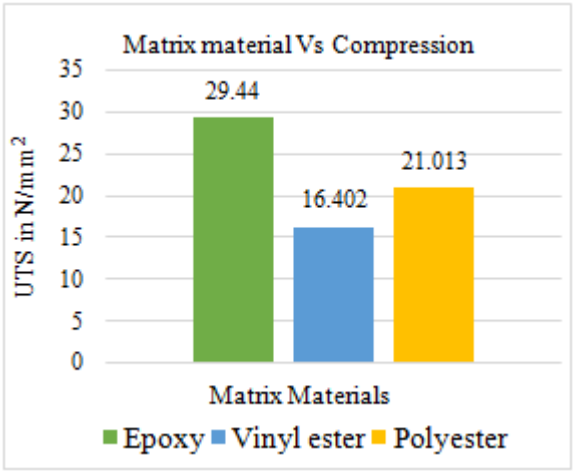

Chart no.3 Compression strength

WATER ABSORPTION

The water absorption tests were carried out following the recommendations specified in ASTM D5229. Each composite sample was dried in an air blast oven to remove surface moisture and adhering lubricant before weighing. The weight of the oven dried samples was reported as the initial weight of the composites. The samples were then placed in distilled water maintained at room temperature (25°C); and at time intervals of 48 hours, the composite samples were removed from the water, cleaned using a dry cloth and weighed. The percentage of water absorption has been tabulated in table no.4.

Table no.4 Water absorption result

Material name	Weight before test in gms	Weight after test in gms (48 hrs)	% of water absorption
Epoxy	1.68	1.73	3.0
Vinyl ester	1.18	1.25	5.9
polyester	1.7	1.78	4.7

The variation of three reinforced composites and its percentage of water absorption in blown chart no.4

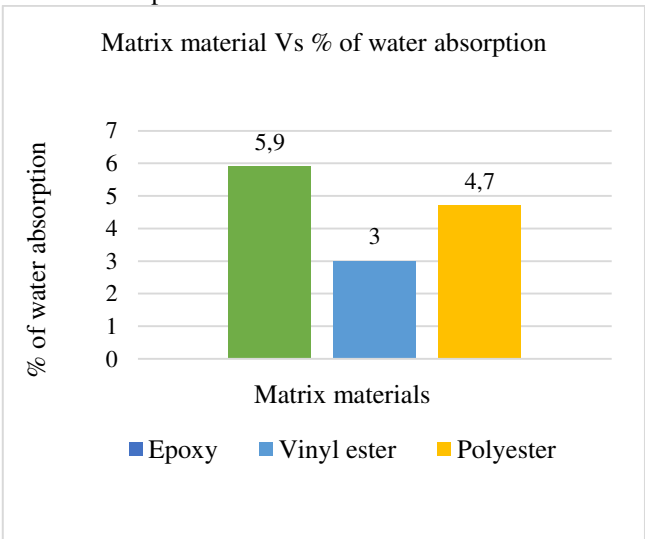

Chart no.4 Water absorption

COMPARISION

Totally done the four types of mechanical properties tested as follows are impact, tensile, compressions, water absorption. Combination of palm fiber-epoxy, palm fiber-vinylester, palm fiber-polyester is tested for above properties. For palm fiber-epoxy resin is very best and it gives good result. So I have selected plam fiber-epoxy resin combination.

III. CONCLUSION

The mechanical properties (impact, tensile, compression and water absorption) of palm fruit fiber's reinforced composites matrix (Epoxy, Vinyl ester, polyester)are discussed in this paper. Among the three composite matrix samples the palm fruit fiber reinforced epoxy composite holds appreciable tensile strength and low water absorption.

Hence it can be concluded that the palm fruit fibers shall be used as reinforcements in to the polymer matrix for use in various application automotive industry, buildings, home appliances, wall ceiling and etc.

IV. REFERENCE

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