



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 9, Issue 10, October 2020

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



9940 572 462



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Investigation of Mechanical Behaviour of Hybrid Fibre Reinforced Polymer Composites

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ABSTRACT:In modern technology, the composites materials play a major role to meet various requirements in all the manufacturing industrials needs. Such as, it increases physical properties, chemical and structural properties. Hybrid fibre can be defined as the two or more fibres mixed together. In our study, the Kapok and Palmyra fibres are mixed together. So these fibres may be called as hybrid fibres. The mixing composition of first matrix is 70%(K) and 30%(P) and mixing composition of second matrix is 30%(K) and 70%(P). In addition as a resin, we use Epoxy (LY556) which is the suitable hardener for this type hybrid fibre. It is proposed to investigate the mechanical properties of fibre such as tensile test, impact test, flexural test and SEM (Scanning Electron Microscope) and its result were compared.

KEYWORDS:Composites, Kapokfibre, Palmyra fibre, Epoxy Resin

I. INTRODUCTION

Composite materials are the combination of two or more distinct materials with intensifies properties. The main objectives of using the composite materials are to gain high strength to weight ratio and to meet the applications with precise properties. Composite materials are made up of fibres, resin and some additives. The visibility of this project is to develop composites with reduced mechanical stresses to avoid failure and creating environmental friendly in atmosphere. Many of the polymer composites have glass fibre such as reinforcement even the polymers in usage process polluted the environment. The glass fibre and fabrics are non-degradable property. Currently the use of natural cellulosic fibres, e.g.: flax, sisal, banana, jute, coir, hemp, is being considered, as an effective alternative to traditional fibres such as glass, carbon and aramid in polymer composite. The increasing interest in this material is due to the inherent environment friendly nature of the natural fibres, leading to carbon dioxide pacification, their low cost and low density. Other advantages include biodegradability, recyclability and significant processing etc. In particular, equipment abrasion, energy consumption, and respiratory irritation are all reduced. Epoxy Resin is widely used in industrial applications, such as adhesive, coatings, and aerospace structure. Due to its excellent mechanical and chemical properties, epoxy is also one of the important materials used as the matrices for FRP. It has low shrinkage upon curing and good resistance. Natural fibres are used in industries like textile, building, plastic and automobile industries. Natural fibres have higher insulation properties. Since natural fibre has low weight and high strength and stiffness. It is used in wide large of application in industries.

II. MATERIALS AND METHODOLOGY

II.1 KapokFibre (Raw Material)

Kapok fibre is obtained from the seed hairs of kapok trees (Ceibapentandra) and belongs to a natural cellulosic fibre. Kapok fibre is consisted of abundant hollow micro tubes with the unique structure of void content as high as 80–90 %. Conventionally, kapok fibre is used as the stuffing for pillows, bedding, and some soft toys. Owing to excellent buoyancy and air-filled lumen, kapok fibre is also utilized as the buoyant material (such as life preservers) and insulation materials against sound and heat. Due to better warm retention property, kapok fibre can blend with other fibres to achieve the required apparel textiles. Kapok fibre contains wax layer on its surface, which affords this fibre to show excellent hydrophobic–oleophilic characteristics, and accordingly, this fibre has received much attention in recent years as the oil-absorbing material. Featured with natural micro tubes structure, kapok fibre can also be used as a desirable template material or supported candidate such as for catalyst carriers. This chapter provides a summary of recent applications of kapok fibre, with special attention to some fields being developed.

II.2 Palmyra Fibre (Raw Material)

Palmyra or Asian Palmyra palm (*Palmyra flabellifer*) is an economically useful and widely cultivated tree, native to South and Southeast Asia. Commonly known as doug palm, palmyra palm, tala palm, toddy palm or wine palm, is native to the Indian subcontinent and Southeast Asia, including Nepal, India, Bangladesh, Sri Lanka, Cambodia, Laos, Burma, Thailand, Vietnam, Malaysia, Indonesia and the Philippines. It is reportedly naturalized in Pakistan, Socotra, and parts of China Palmyra is a long life tree and can live up to 100 years reaching a height of 30 m, with a canopy of leaves and a large trunk resembling that of a coconut tree. The conventional way this fruit is eaten is when the outer casing is still unripe while the seeds are eaten as the fruit. But if the entire fruit is left to ripen, the fibrous outer layer of the palm fruits can also be eaten Raw, boiled, or roasted. When this happens, the fruit takes a purple-blackish hue and tastes similar to a Mango. The skin is also eaten as part of the fruit similar to how mango skins are often consumed along with the fruit. The outer layer of the palm is separated from the ripened palmyra fruit and used as a fibre.

III. METHODOLOGY

III.1 Mould preparation

The fibre and resin were mixed in 1:4 ratios. Then the mixture was poured in the die. The ASTM standard size of the die is 180mm length, 110mm Wide, 5mm Thick.

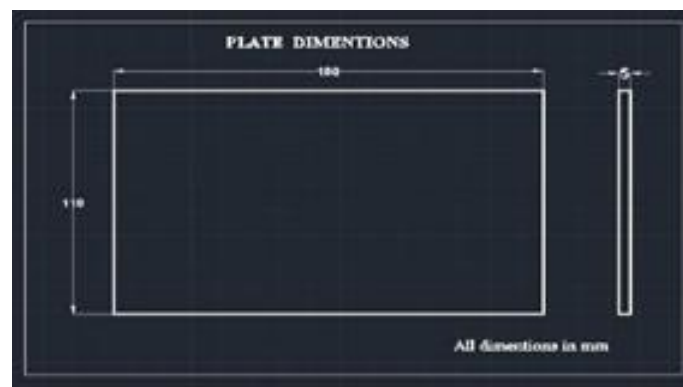


Fig 1 ASTM Standard size of the specimen

III.2 Specimen Preparation

There are two types of preparation used in this study. One is treated specimen preparation and another one is untreated specimen preparation.

III.2.1 Untreated Specimen preparation

The specimens are not treated by any chemical process such as NaOH and HCL. Number of Specimens are carried out by this process is two. First the Kapok and palmyrafibres are taken in desired quantity. The mixing composition is made as follows, (i) Kapok(70%) and Palmyra(30%), (ii) Kapok(30%) and Palmyra(70%). Then these fibres are cutted to 5mm thick. The Epoxy Resin (LY556) is taken into 100g with suitable hardener into 10g. Then the fibres are mixed with resin till to the heat is produced. Then the resin mixed fibres are placed in moulded specimen. This is for both mixing composition such as Kapok (70%) and Palmyra (30%) and then Kapok (30%) and Palmyra(70%). The hand lay-up process as follows. Then the fibres were fully closed with mould. Then the fibres are left undisturbed at room temperature to allow in drying under a weight of 5Kg

III.2.2 Treated Specimen preparation

In this process, fibres are allowed to treat with NaOH and HCL. Sodium hydroxide (NaOH) treatment removes impurities from the fibre surface, Hybrid fibres (Kapok and Palmyra) sample were treated with different concentration of NaOH to soften the fibres and make it suitable for spinning. The concentrations used were 5% and 10% with distilled water. Concentrated HCL is used in this process; the fibres are again treated with 25ml HCL. Because concentrated HCL was used to remove remaining impurities from the fibre's surface.

Table 1 Chemical treatment process with fibre composition

FibreComposition	ChemicalTreatment 1	ChemicalTreatment 2
70% Kapok	5% (5g NaOH) and 25ml HCL	10% (10g NaOH) and 25ml HCL
30% palmyra		
30% Kapok	5% (5g NaOH) and 25ml HCL	10% (10g NaOH) and 25ml HCL
70% palmyra		

IV. MECHANICAL TESTING

IV.A Tensile test

A material is gripped at both ends by an apparatus, which slowly pulls the piece lengthwise until it fractures. The pulling force is called a load, which is plotted against the material length change, or displacement. The load is converted to a stress value and the displacement is converted to a strain value. If a composite material is pulled out until it breaks, a lot of information about the various strengths and mechanical behaviours of that material can be obtained. In this experiment, we will examine the tensile behaviour of different composite fibre materials.



Fig 2 Tensile test specimens

IV.B Impact test

The Impact test is a dynamic test in which a V-notched test piece, gripped vertically, is broken by a single blow of a freely swinging pendulum. The blow is struck on the same face as the notch and at a fixed height above it. The energy absorbed is measured. This absorbed energy is a measure of the impact strength of material. Figure-5.3 shows the ASTM standard of impact test specimen.



Fig 3 Impact test specimens

IV.C Flexural test

In composite materials, specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement. The testing process involves placing the test specimen in the universal testing machine and applying force to it until it fractures and breaks. The specimens used for conducting the flexural test are presented in Figure 4. The flexural test is performed on the Computerized UTM.



Fig 4 Flexural test specimen

V. RESULTS AND DISCUSSION

V. A Tensile Test Result

The various tensile loads applied to various compositions of composites are shown in fig.5. The different composite specimen samples are tested in the universal testing machine (UTM) and the samples are left to break till the ultimate tensile strength occurs. The fig 5 and fig 6 is used to determine the peak load and tensile strength. After considering all the result data, the 5% treated fibre specimen has the highest tensile strength and Young’s modulus.

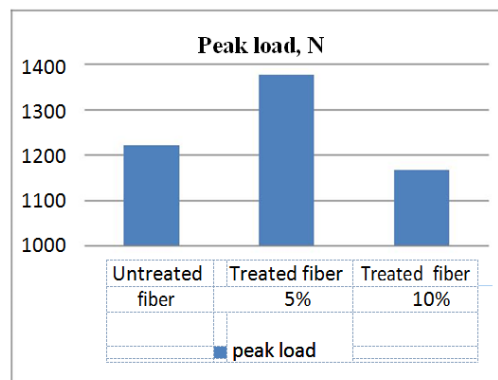


Fig 5 Tensile load test

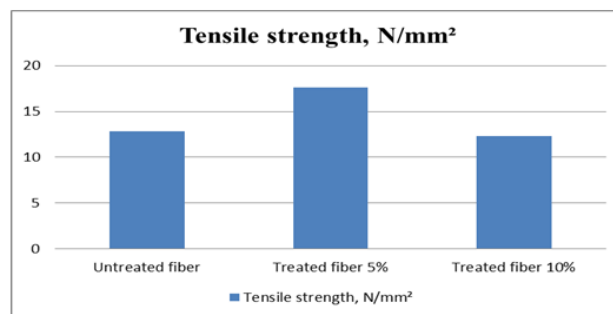


Fig 6 Tensile strength test

V.B Flexural test

The various Flexural loads applied to various compositions of composites are shown in fig 7. The different composite specimen samples are tested in the universal testing machine (UTM) and the samples are left to bend till the flexural strength occurs. The fig 7 and fig 8 is used to determine the peak load and flexural strength. After considering all the result data, the 5% treated fibre specimen had the highest flexural strength.



Formula to calculate flexural strength,

$$\text{Flexural Strength} = (3PL) / (2wt^2)$$

Where, P = Peak Load in KN, L = Gauge Length in mm, w = Width of the Specimen in mm and t = Thickness of the Specimen in mm

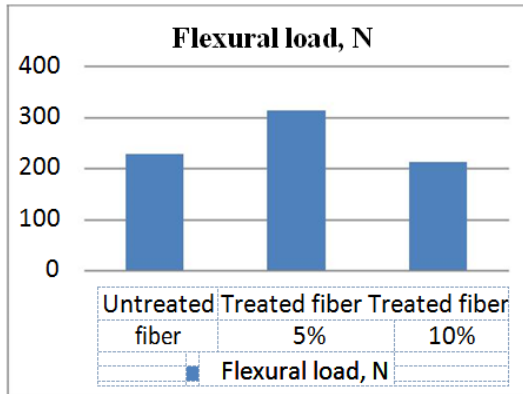


Fig 7 Flexural load test

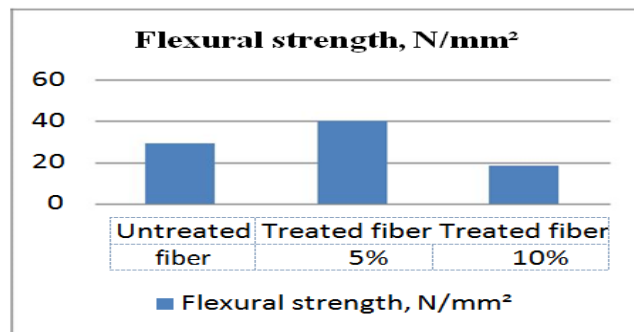


Fig 8 Flexural Strength test

V.C Impact test

Izod Impact Test was carried out to determine the impact properties of the material. In this test, 5% had the highest Impact energy, and Non-treated fibre had the lowest Impact energy. The Impact energy level variations are shown in Figure 9.

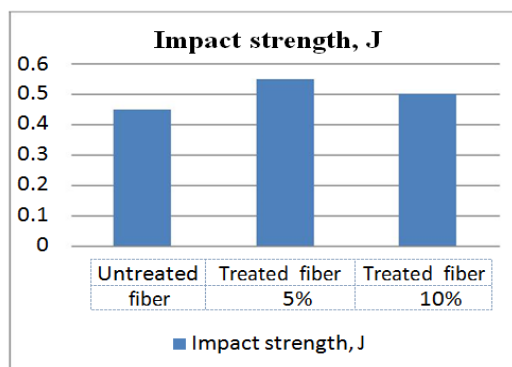


Fig 9 Impact strength test

VI. CONCLUSION

This experimental investigation and analysis of mechanical behaviour of natural fibre reinforced polyester hybrid composites leads to the following conclusions:

- This work shows that successful fabrication of Kapok and Palmyra reinforced polyester hybrid composites with different weight proportion of the fibres is possible by using simple hand lay-up technique.
- It has been noticed that the mechanical properties of the composites such as Tensile strength, Flexural strength and Impact strength etc. are greatly influenced by the fibres percentages.
- The result reveals that high tensile strength is 17.629N/mm² obtained for treated specimen because the Kapok fibre percentage is more than Palmyra fibre has high tensile properties and also because these fibres are treated with 5% NaOH with 25ml HCL.
- For high Flexural Strength is 40.041MPa obtained for treated specimen, because the Palmyra fibre percentage is more than Kapok fibre has good flexural properties and also because these fibres are treated with 5% NaOH with 25ml HCL.
- For high impact strength is 0.50J obtained for treated specimen, because the Kapok fibre percentage is more than Palmyra fibre has a good impact properties also because these fibres are treated with 5% NaOH with 25ml HCL.
- From the present work it is concluded that the tensile strength and impact strength of composites depends on Kapok fibre and flexural strength of composites depends on Palmyra fibre and also treated fibres are have more tensile, impact and flexural strength than the untreated fibres.

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