

EVALUATION OF MECHANICAL PROPERTY ON PALM/COIR BASED POLYMER MATRIX COMPOSITES

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ABSTRACT

Now day's natural fibres as reinforcement have received more attention from the research community all over the world in preparing polymer composites. These natural fibres have lot of advantages over synthetic fibres. In this paper two natural fibers palm and coir reinforced composites were fabricated using compression moulding method which was a new effort and was not done elsewhere. Specimens were cut from the fabricated composite plates according to the ASTM standards. Universal Testing Machine was used for testing tensile and flexural strength of the composites. The impact strength of the composites was analyzed using Impact tester. Further wear and moisture absorption tests were also conducted on the prepared specimen. The results obtained through experimentation of both composites were compared and presented. It can be concluded that the developed palm based composite possess superior property and can be recommended for fabrication of light weight high strength automobile parts.

KEYWORDS

Natural fiber, palm, coir, mechanical properties

1. INTRODUCTION

Composite materials are man made material with origin during Old Stone Age. Use of eco friendly composites gains attraction in the recent years due to its lightweight and moderate strength. Due to increased awareness on the part of end users and pressure from legislators, the composite industry has begun investigating the possibility of increasing the proportion of recycled or biodegradable composite materials. Accordingly, efforts were being deployed to find alternative reinforcement and resin systems that are environmentally friendly while providing the same performance as their synthetic counterparts. Natural fibers offer the potential to act as a reinforcing material for low to medium strength applications such as automotive, sporting goods, marine, electrical, industrial, construction, household appliances, etc. Natural fibers are available in abundance in nature and can be used to reinforce polymers to obtain light and strong materials. Natural fibers from plants are beginning to find their way into commercial applications such as automotive industries, household applications, etc. [1]. Natural fibers have received much attention from the research community over the past decade. Natural fibers are now considered as a serious alternative to glass fibers for use in composite materials as reinforcing agents. The advantages of natural fibers over glass fibers are their low cost, low density, high strength-to-weight ratio, resistance to breakage during processing, low energy content and recyclability [2, 3]. Natural fibres have little resistance towards the environmental influences. This can be recognized in the composites and can be advantageously utilized for the development of biological degradable composites with good mechanical properties. The properties of the natural fiber based composites can be affected or modified by number of reasons like fiber combinations, processing of composites, etc. The process parameters and their influences on the properties are different with different

combinations of fiber and matrix. Palmyra fiber is a natural fiber obtained from the leaf stalk and leaf stalk base of Palmyra tree (*Borassus flabellifer*), which is found in abundance in the southern parts of India. These fibers can be used as reinforcement in polyester matrix. Because of their lignocellulosic and organic origin, Palmyra fibres exhibit a hydrophilic nature. To achieve the full potential of polymer composites, they must have a good environmental stability. Moisture absorption in polymer composites and its effect on mechanical properties such as tensile, flexural and impact strength are reported by few scientists. In the field of technical utilization of plant fibers, banana fiber-reinforced composites represent one of the most important areas. Considering in particular banana, it is a well known fact that it is one of the oldest cultivated plants in the world. The word “banana” comes from Arabic and means “finger”. It belongs to the Musaceae family, and there are approximately 300 species, but only 20 varieties are used for consumption. Approximately 40 million metric tons of bananas are produced every year by the tropical and subtropical regions of the world. In India approximately 1.5 million acres of land is cultivated with banana plantations, which yield about 3×10^5 tons of fibre. It has been noted that banana fibre has been substituted for asbestos in bitumen and can be used for roofing; also banana fibre/polymer composites and cotton fabric/polyester have been used in cars and for bearings, respectively. Banana fibre was the chosen material, due to its abundance and relative cheapness. The objective of this paper is to study the tensile, flexural, impact wear and moisture absorption properties of pseudostem banana fiber and palmyra composites.

2. LITERATURE REVIEW

A number of investigations have been conducted on several types of natural fibers such as kenaf, hemp, flax, bamboo and jute to study the effect of these fibers on the mechanical properties of composite materials [4, 5]. It was studied bamboo-mesh reinforced cement composites, this reinforcing material increase significantly its tensile, flexural, and impact strengths. Jute fabric-reinforced polyester composites were compared with wood composite [6] and it was found that the jute fiber composite has better strengths [7]. The flexural properties of *Agave Pinnata* fiber reinforced Epoxy composites was discussed [8]. The tensile properties of bamboo based polymer composites were studied [9]. The addition of sisal fiber content in high impact polystyrene improved stiffness and the tensile strength decreases [10]. Many natural fibers like jute, sisal, hemp, coir and banana have been tried to form a composite [11]. Composites having two or more fillers contained in the same matrix are called as hybrid composites [12]. Sreekala et.al [13] reported hybridization of glass fiber with oil palm fiber reinforced composites improved the mechanical strength. The hybridization of fly ash in glass fiber epoxy on compressive and impact properties studied [14]. The sisal and oil palm hybrid composites reinforced natural rubber composites were studied [15]. Banana/Sisal hybrid composites enhanced the tensile and flexural properties [16]. The Mechanical properties of glass/palmyra fiber waste sandwich composites enhance the mechanical strength due to hybridization [17]. The optimum content of banana fiber is 40% in polyester based composites [18]. Banana and glass hybrid fiber with varying fiber length and fiber content were tested [19]. Efforts have been made by many authors to evaluate the mechanical properties of Palmyra/glass fiber hybrid composites [20], banana empty fruit bunch fibre reinforced polyester composites [21], sisal–jute–glass fiber reinforced polyester composites [22], glass fiber- sisal/jute reinforced epoxy composites [23], jute and banana fiber reinforced epoxy hybrid composites [24] Palmyra Palm Leaf Stalk Fiber/jute fiber reinforced hybrid polyester composites [25]. The analysis of tensile, flexural, and impact properties [26] of these composites revealed that composites with good strength could be successfully developed using banana fiber as the reinforcing agent.

3. EXPERIMENTATION

3.1 Preparation of composites

Polymer composites in form of plates were fabricated on pure polyester resin with alkali treated natural fibers as reinforcements under random orientation. For experimentation two set of plates were prepared, one plate with palm fruit fibers and other with coir fibers as reinforcements. The composite plates were made by conventional compression moulding Technique. After that these composites were cut using a saw cutter to get the required dimension as per ASTM D specimen standard for testing polymer composites.

3.2 Tensile Testing

The tensile test specimens were prepared according to ASTM D 638. For testing the specimen was mounted in the grips of the Instron universal tester with 10 mm gauge length. The stress strain curves were plotted during the test for the determination of ultimate tensile strength and elastic modulus. From the stress-strain curve, a straight line was drawn and from the slope of the line the Young's modulus or elastic modulus was determined. Average of two tests results was taken.

3.3 Flexural Test

The flexural test specimens were prepared according to ASTM D 790. Flexural properties were measured by conducting the three point bend test on computerized UTM using special attachment. The speed of test was set as 2mm/min at room temperature.

3.4 Impact Test

Impact test specimens were prepared according to ASTM D 6110. The specimen was clamped into the pendulum impact test fixture with the notched side facing the striking edge of the pendulum. The energy loss was obtained from reading at scale plate. The fracture values were calculated by dividing the energy absorbed by cross sectional area of the specimen

3.5 Wear Test

Wear test was performed by applying a constant load of 0.5 N on the prepared specimen against a rotating abrasive wheel. The weight losses of the specimen at four constant time intervals of 90 seconds were observed.

3.6 Moisture Absorption Test

Moisture Absorption Test was done by immersing the specimen in distilled water under continuous monitoring. After regular intervals of time the weight of the specimen was measured, thereby the amount of water absorbed was calculated.

4. RESULTS AND DISCUSSION

4.1 Tensile Properties

Figure 1 shows the percentage elongation of palm based composite and the coir based composite and the results reveal that the palm fiber composite elongated more.

Figure 2 shows the ultimate tensile strength (UTS) of palm based composite and the coir based composite. The ultimate tensile stress of palm based composite is greater than coir based composite.

It was evident from the results of tensile test that the palm reinforced polyester composite possesses appreciable tensile values.

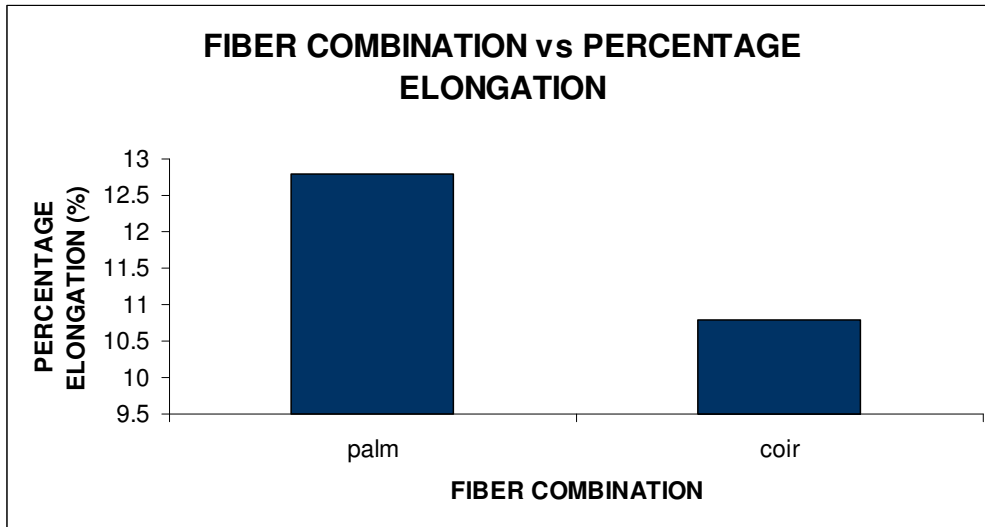


Figure 1 Comparison of effect of fiber combination on percentage elongation

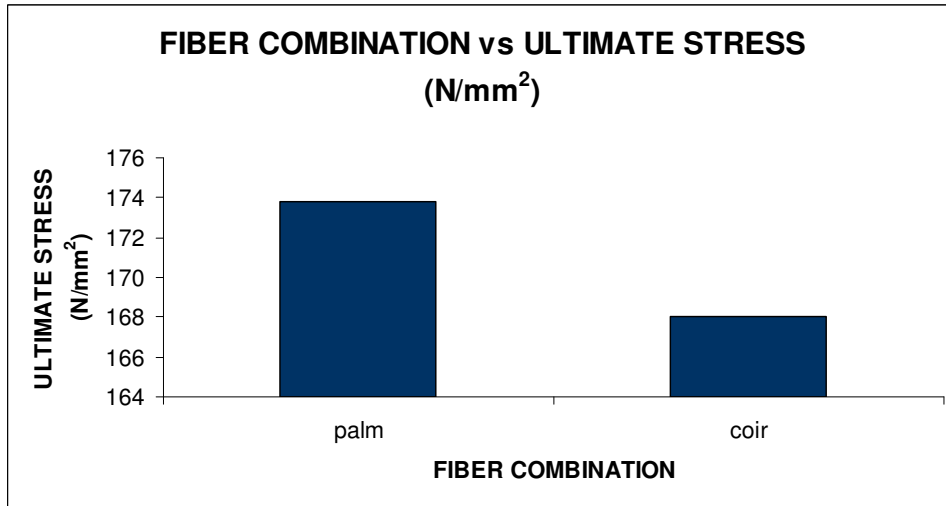


Figure 2 Comparison of effect of fiber combination on ultimate stress.

4.2 Flexural Properties

Figure 3 shows the flexural strength of palm based composite and the coir based composite. From the results of flexural test, the palm matrix composite shows better flexural property than coir matrix composite.

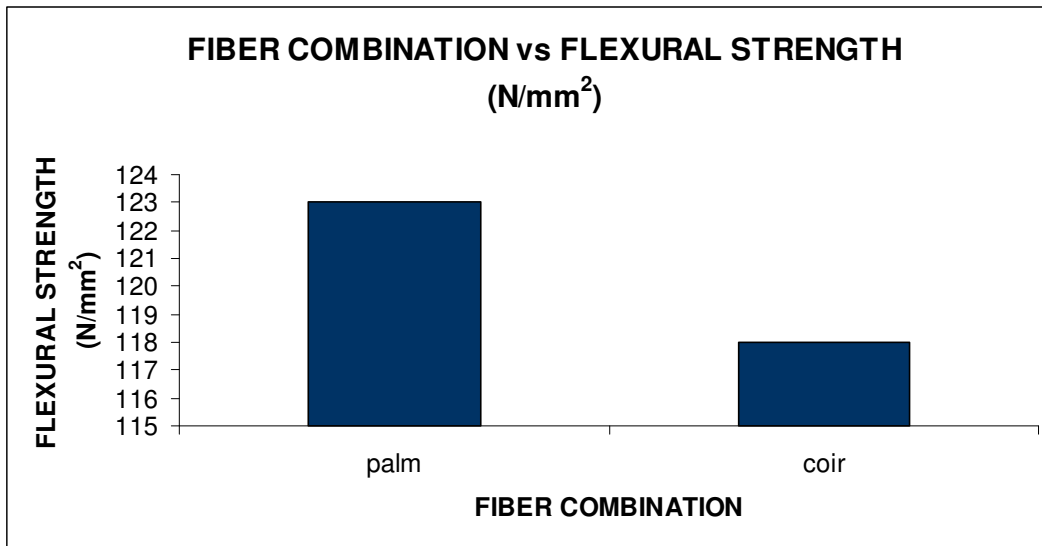


Figure 3 Comparison of effect of fiber combination on flexural strength.

4.3 Impact Properties

The impact responses of both composites were presented in Figure 4. The Palm based composite posses higher impact strength that leads to the higher toughness in the material.

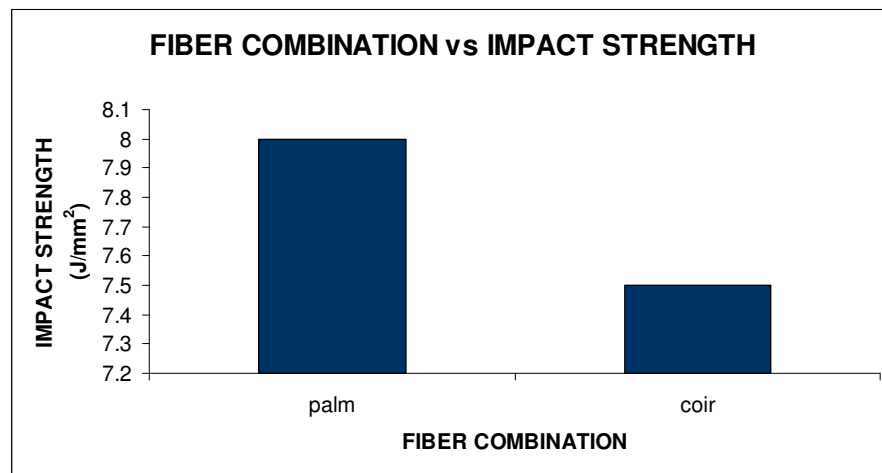


Figure 4 Comparison of effect of fiber combination on Impact length.

4.4 Wear Properties

Figure 5 represents the effect of fiber combination on the weight loss of the specimen. It was observed that palm specimen holding superior wear resistance on comparison with coir specimen. Also the weight loss on coir based composite was higher than palm based composites.

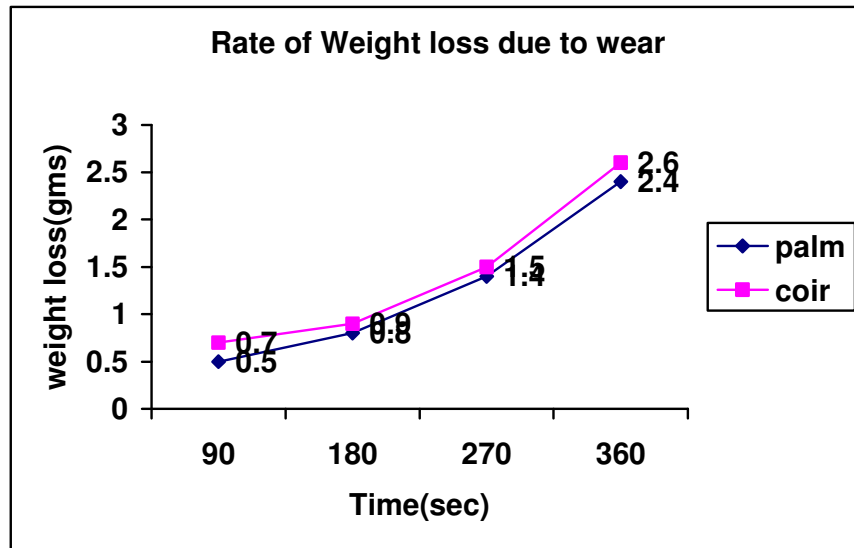


Figure 5 Comparison of effect of fiber combination on rate of weight loss due to wear.

4.5 Moisture absorption Test

Figure 6 shows the comparison of rate of absorption of moisture content between the two composites. It was observed that Palm fiber composites absorbed less moisture on comparing with coir fiber composites and holds a better result that they can be used in areas where the requirement is dry.

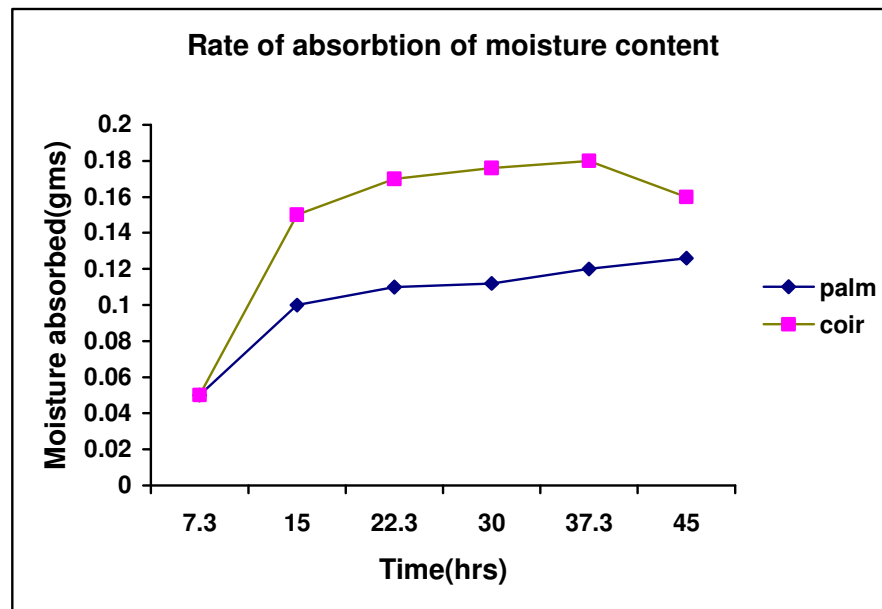


Figure 6 Comparison of effect of fiber combination on rate of absorption of moisture content.

5. CONCLUSION

The effects of fiber combinations (palm fiber and coir fiber) with polyester resin on mechanical properties like tensile strength, flexural strength, impact strength, wear resistance and water absorption behaviour were studied. The various tests reveal that the palm fiber based composite was superior to those of coir fiber based composite. Hence the palm fiber based composite shall be recommended for fabrication of automobile components with low cost, light weight and with high strength.

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