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EVALUATION OF MECHANICAL PROPERTIES OF ROYAL PALM FIBER AND TODDY PALM FIBER REINFORCED POLYMER COMPOSITES

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ABSTRACT

In this paper, tensile, Compression and flexural tests were carried out using Royal palm and toddy palm fiber composite material. Initially the optimum fiber length is estimated. To improve the tensile, compressive and flexural properties of saturated Royal palm and toddy palm fibers was reinforced with Epoxy resin. This work shows that the addition of Epoxy in saturated royal and toddy palm fiber composites of up to 20% by weight results in increasing the mechanical properties. In this research work, shows the successful fabrication ofRoyal palm and Toddy palm fibre reinforced epoxy composites with different fibre weights is possible by simple Hand lay-up technique. And the tests were conducted by using the Universal Testing Machine (UTM) as per ASTM standards and the effects of fiber treatment and concentration on the mechanical properties of a natural fiber reinforced polymer composites are investigated. The fibers were subjected to 10% sodium hydroxide solution treatment for 24 hrs. The mechanical properties of composites with treated fibers are compared with theoretical results.

Keywords: *Composites, Royal palm fiber, Toddy palm fiber, Epoxy- LY 556, HY - 951, alkali treatment, Hand-layup technique, UTM.*

I. INTRODUCTION

In recent years, natural fibers have been used as reinforcement fillers for thermosetting and thermoplastic matrices to prepare composites by satisfying both economic and ecological interests. But the presence of moisture and defects in the natural fibers affects the mechanical and physical properties of natural fiber polymer composites. Plant fibers can work effectively through the limited and controlled occurrence of defects, which are irregularly spaced along their length. As a result, the tensile strength of the fibers decreases with their length, and a pronounced strain rate effect can also be observed [1, 2, 25].

Natural Fiber Reinforced Polyester (NFRP) composites are likely to be environmentally superior to glass fiber composites in most cases and natural fiber production has lower environmental impacts compared to glass fiber production [3]. The effect of matrix on the tensile properties of royal palm and toddy palm fibers with epoxy resin were studied by C.Girisha et. al [4]. They observed that the alkali treatment of natural fibers achieved moderate mechanical properties as well as better adhesion between fibers and matrix. Studies were made to improve fiber quality or reduce the effectof the presence of fiber defects on the final material via improved processing or fiber treatment [5, 6]. The improvements in properties, especially stiffness, can be obtained using chemical treatments of fibers [27]. The strength and modulus of the longitudinal composites in tensile and flexural loading increased with fiber content, as predicted with the rule of mixtures. Industrial fiber like glass fiber composites well enable properties such as Good mechanical strength, light weight, being easy to shape, resistance to corrosion and chemical attack, and good surface finish. However, it is environmentally hazardous, and hence for the past few decades researchers have been trying to find a suitable alternative composite made up of natural fibers which can provide comparatively good mechanical strength and, at the same time, is environmentally less hazardous, easy available, recyclable, renewable and of low cost. As mentioned above, the work was actually to prepare and find out the mechanical properties and water absorption behaviour of Royal palm and toddy palm fiber composites.

Various surface treatments like sliver bleaching e.g., with alkali (NaOH) were studied to reduce the sensitivity of natural fiber composites.

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Natural Fiber Reinforced Polyester (NFRP) composites are likely to be environmentally superior to glass fiber composites in most cases and natural fiber production has lower environmental impacts compared to glass fiber production [3]. The effect of Matrix on the tensile properties of Royal palm and Toddy palm fibers with epoxy resin were studied by C.Girisha et. al [4]. They observed that the alkali treatment of natural fibers achieved moderate mechanical properties as well as better adhesion between fibers and matrix. Studies were made to improve fiber quality or reduce the effect. DOI: 10.5604/12303666.119661791FIBRES & TEXTILES in Eastern Europe 2016, Vol. 24, 1(115) to weathering [8 - 10]. The changes in properties of palm fibers were investigated during surface treatment. Alkali Royal and Toddy palm fibers treated with NaOH solution of 2% and 14% concentration for 48 h and 3% for 1 h showed improvements in fiber properties by 110% and 11%, respectively [28, 29]. Investigations were carried out on the alkali treatment of isometric palm yarns. The improvements were attributed to the greater reactivity of the fibers treated with the resin, administering superior bonding [30, 31].

Royal palm and Toddy palm fibers are abundant in India. For the last decade, they have been traditionally used in age-old applications in the form of low weight and high strength ropes to lift heavy-weight objects. Experiments were conducted on composite specimens as per ASTM standards with percentage weight 20%.The improvement in mechanical characteristics was achieved by palm fibers. The main aim of this research work was to analyse Royal and Toddy palm fibers in the manufacturing of roof sheets, door panels, dashboards, etc in order to avoid glass fibers due to environmental damage.

II. MATERIALS AND METHOD

i. Matrix

The matrix material used was based on commercially available unsaturated polyester resin. The resin Epoxy LY556 of density 1.15–1.20 g/cm3, mixed with hardener HY951 of density 0.97–0.99 g/cm3 is used to prepare the composite plate. The weight ratio of mixing epoxy and hardener is 10:1. This has a viscosity of 10-20 poise at 25^0C. Hardeners include anhydrides (acids), amines, polyamides, dicyandiamide etc.

ii. Fiber preparation

Royal and Toddy palm fibers were collected from various local sources, whereas palm fibers were extracted in a laboratory using the retting and mechanical extraction procedure. The extractions of palm fibers were explained in detail in an earlier work [11]. The nominal mixture ratio of the Resin/ hardener/accelerator is 100:90:1. As regards the characteristics of the fibers [24], the water content is high in the fibers. The estimated water content in the fibers were reduced using the alkali treatment of fibers [30].

III. EXPERIMENTAL SET-UP

Specifications

i. **Alkali treatment of Royal and Toddy palm fibers:**

A good wetting of the fibers with the matrix was obtained by interfacial bonding and the formation of a chemical bond between the fibers surface and matrix. By imparting hydrophobicity to the fibers by mechanical, surface and chemical treatments, the mechanical properties and environmental performance of the composites were improved. Mwaikambo LY et al. [14] reported that a change in the surface topography of the fibers and their crystallographic structure was achieved by the alkalisation or acetylation of fibers. Treatment with sodium hydroxide was prior to the washing of fibers. The sodium hydroxide opened up the cellulose structure, allowing the hydroxyl groups to get ready for the reactions. During washing with sodium hydroxide, the wax, cuticle layer and part of the lignin and hemi cellulose were removed. A major reaction took place between the hydroxyl groups of cellulose and the chemical used for the surface treatment. In this contribution, short royal palm and toddy palm fibers were soaked in a 10% NaOH solution at room temperature. The fibers were kept immersed in the alkali solution for 24 h. The fibers were then washed with fresh and distilled water to remove any NaOH sticking to the fiber surface and neutralised with diluted acetic acid several times. The short royal and toddy palm fibers were then dried at room temperature for 24 h, followed by oven drying at room temperature for 24 h.

ii. Preparation of mould

The mould used in this work was made of well-seasoned teak wood of 250 × 250 × 3 mm dimensions with eight beadings. Casting of the composite material was done in this mould by the hand lay-up process. The top and bottom surfaces of the mould and walls were coated with remover and allowed to dry. The functions of the top and bottom plates are to cover and compress the fiber after the unsaturated polyester is applied, and also to prevent debris from entering into the composite parts during the curing time.

iii. Preparation of composites

The matrix was prepared by mixing the hardener to epoxy. The epoxy and hardener ratio was maintained at 10 : 1. To get the well-cured and a standard-quality specimen, the epoxy and hardener must be mixed smoothly and slowly for approximately 10 min. Initial layer of the mould was filled with epoxy resin mixture and then the percentage weight 20% of fibers were placed such that epoxy mixture completely spread over the fibers. Again, epoxy mixture was poured on the fiber. Thus, the starting and ending of the layers were of epoxy resin. The plastic releasing film was placed on the top of the uncured mixture. Before applying compression, efforts were made to remove all bubbles with roller. Finally, the compression pressure was applied evenly to achieve the uniform thickness of 3 mm and cured for 24 h at room temperature. The obtained composite laminates are of the size 150 × 150 × 3 mm^3. After the curing process, test samples were cut to the required sizes prescribed in the ASTM standards.[24], with the surface of the plates nearly smooth.

IV. TESTING OF COMPOSITES

Tensile, compression and flexural:
As per ASTM standards, the test specimens underwent a large amount of mechanical tests after the fabrication process was over. ASTM 3369 D76 standards were used for the tensile test shown in fig.1. The ASTM D7264 standards were used for flexural strength shown in fig.3 and the ASTM D3410 standards shown in fig.2 were used for compression strength determination. A computerised INSTRON 3369 universal testing machine was used for computation of the tensile, flexural and compression tests.

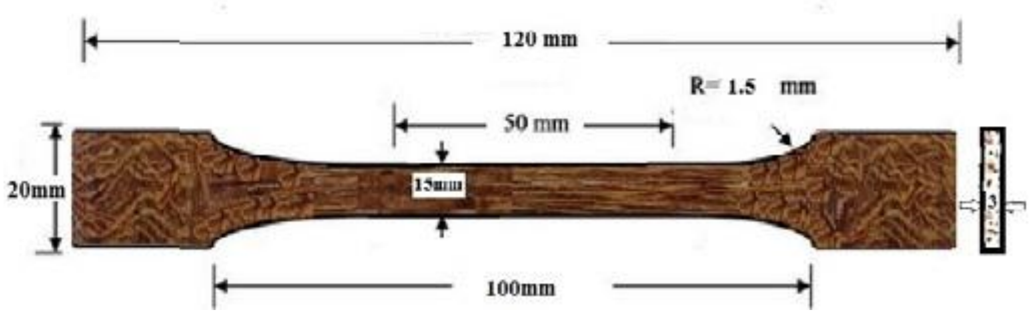

Figure 1: Tensile test specimen

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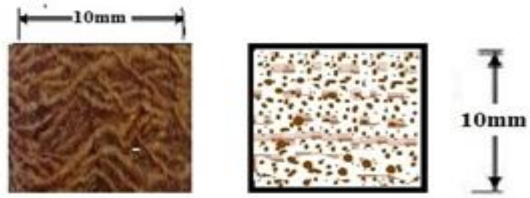

Figure 2: Compress test specimen

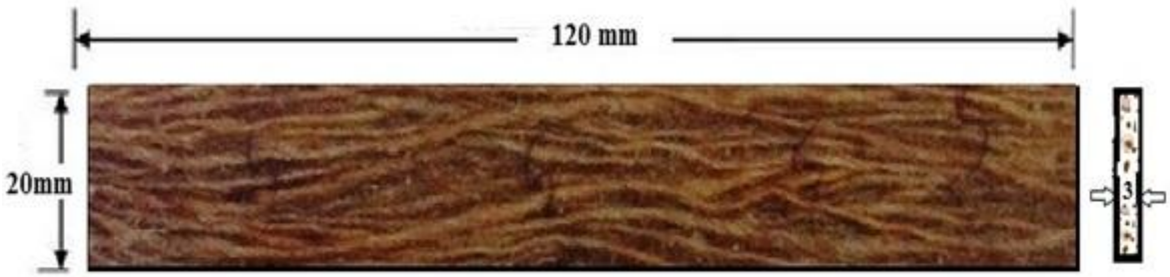

Figure 3: Flexural test specimen

V. RESULTS AND DISCUSSION

When compare the royal palm and toddy palm fiber composites, Observed from table 1. Maximum tensile strength (67.54 MPa) and Modulus of elasticity (5758.54 MPa) values are obtained for royal palm fiber composites. Observed from table 2. Combined effect of Royal and toddy palm fiber composites gives maximum compressive strength (201.54 MPa). Observed from table 3. Toddy palm fiber composite shows the maximum flexural strength (411.79 MPa).

Table 1. Tensile properties of Royal (R), Toddy (P) and Royal + Toddy (R+P) palm fiber Composites

Name of the fiber composite	Load (N)	Tensile Stress (MPa), σ	Young's Modulus (MPa), E	Strain
R	2026.17	67.54	5758.54	0.0168
p	1905.35	63.51	4632.62	0.0175
R + P	780.63	26.02	3277.76	0.0095

Table 2.Compressive properties of Royal (R), Toddy (P) and Royal + Toddy(R+P) palm fiber Composites

Name of the fiber composite	Load (KN)	Compressive Stress (MPa), σ	Modulus (MPa)
R	1.18	9.31	2938.2064
p	2.05	16.22	3597.72
R + P	2.54	201.14	2020.8024

Table 3.Flexural properties of Royal (R), Toddy (P) and Royal + Toddy(R+P) palm fiber Composites

Name of the fiber composite	Load (KN)	Max. Stress (MPa), σ	Flex.Modulus (MPa)
R	0.37	204.98	16782.24
p	0.74	411.79	49397.29
R + P	0.06	34.14	6057.33

VI. CONCLUSION

Composite materials have good Mechanical, chemical, and electrical properties. The resulting can be concluded based on the study of Natural Reinforcement Composites for Mechanical properties.This work shows the successful fabrication ofRoyal palm and Toddy palmfiber Reinforced epoxy composites with different fibre weights are possible by simple Hand lay-up technique. And the tests were conducted by using the Universal Testing Machine (UTM).

In the present study we conclude that

- Toddy palm having high flexibility compared to the royal palm fiber.
- Combination of royal palm and toddy palm fiber gives high enhancive properties than individual fiber.
- Combination of royal and toddy palm fiber gives the high compressive strength compared to individual.

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