# TENSILE AND DIELECTRIC PROPERTIES OF YEPI FIBER-REINFORCED POLYESTER COMPOSITES

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## ABSTRACT

Day by day increase in the technological advancements invite the development and production of new composites. In that concern natural fiber plays a very vital role in many engineering applications. The present work makes an attempt to make natural fiber reinforced composites using netted fibers like yepi which have no adverse effect on the environment, to compare with the established filamentary fibers like coconut, palm and sisal and to determine various properties like tensile strength, specific tensile strength, specific tensile modulus and dielectric strength with varying proportions of fiber in the matrix. The tensile strength and specific tensile modulii for these composites are 2.9 and 2.5 times those for matrix when tested in its pure condition i.e. without fiber. The dielectric strength of yepi fiber reinforced composites is comparable with sisal, coconut and palm fiber reinforced composites.

**Keywords:** Natural fiber, composite, mechanical properties, dielectric strength.

## 1. INTRODUCTION

Engineered composite materials are well known for their superior properties. For instance, fiber-reinforced composites have superior mechanical properties over their un-reinforced matrices. The properties of a fiber-reinforced composite depend strongly on the type, amount of reinforcement and direction of measurement.

Various methods are available for the fabrication of fiber reinforced polymer composites like hand lay-up technique, bag molding process, resin transfer molding, filament winding, pultrusion, compression molding. Hand lay-up is found to be an appropriate technique for the preparation of fibrous composites.

Naturally obtained fibers are called natural fibers. Using the natural fibers so many researchers have made FRP composites, which has been reported in the literature. Bisanda, E. T. N.; reported that the corrugated composites made by using chemically treated sisal fibers are suitable for roofing and other construction purposes in tropical developing countries [1]. Cardanol derivative of tolune disocynate (CTDIC) treated sisal /LDPE composites showed superior mechanical properties and better dimensional stability compared to untreated composites under identical ageing conditions [2].

Natural rubber was reinforced with sisal and oil palm fibers. Biocomposites were prepared by varying the weight fraction of the fibers. The dielectric properties such as dielectric constant, volume resisitivity and dielectric loss factor of the biocomposites were evaluated as a function of fiber loading, frequency and chemical modification of fibers [3].

Different formulations of rubber with chopped coconut fiber (treated and untreated) as reinforcing agent were prepared. The bonding between the rubber and fillers were improved by the addition of bonding agents [4].

Acetylated empty fruit bunch (EFB) and coir composites showed superior retention of tensile and impact properties after aging in water up to 12 months [5].

Use is made of the transport of organic solvents such as benzene, toluene and xylene to understand the interfacial interaction in cross-linked coir-fiber-reinforced natural rubber composites. Attempts were made to analyze the interfacial bonding in

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the composites containing coir fibers subjected to different chemical treatments [6].

Mechanical properties of several laminates of date palm leave (DPL) reinforced composites are investigated. The produced laminates were very stable to handle all required machining processes as construction panels. They were successfully subjected to several machining processes such as milling, end milling, hack sawing and drilling [7].

Natural rubber is reinforced with untreated coir fiber chopped to different lengths, viz., 6, 10, and 14 mm. Mixes were also prepared using 10 mm-long coir fibers treated with 5% sodium hydroxide solution for different time intervals, viz., 4, 24, 48, and 72 h. These composites were vulcanized at 150°C. The rubber coir interface bonding was improved by the addition of a resorcinol-hexamethylenetetramine dry-bonding system [8].

Introducing new natural fibers used as fillers in a polymeric matrix enabling production of economical and lightweight composites for load carrying structures [9].

The resistance of bamboo fiber reinforced polypropylene composite (BFRP) and bamboo-glass fiber reinforced polypropylene hybrid composite (BGRP) to hygrothermal aging and their fatigue behavior under cyclic tensile load were studied. Results suggest that BGRP has better fatigue resistance than BFRP at all load levels tested [10].

The development of composites for ecological purposes (Eco-composites) using bamboo fibers and their basic mechanical properties were studied [11].

According to the research literature evidence it is clear that up to now there is a much focus in making natural FRP composites using filamentary fibers. In this work an attempt is made to make yepi, netted fiber is used in making the FRP composites.

## 2. EXPERIMENTAL PROGRAM

In a tropical country like India, there are large varieties of regenerative plants and trees with fiber content. Some of them are cultivated over the generations and some are wild plants, trees, and creepers that grow in forests and woods. It is an established fact that any material in its fibrous form is stronger than in bulk form. Therefore, these strong fibers are used to reinforce the weak materials. Yepi is a moderate to large tree, nearly ever green with graceful dropping slender branched and grayish green leaves. Everywhere the trees have been much mutilated by pollarding for the sake of fodder, manure or bast fiber. The bast yield fiber, which is largely employed for ropes and the branches are much lopped for manure and cattle-fodder [5]. After cutting down one branch from the tree number of young shoots are generated causing absolutely no affect on environment. Utilization of such fibers for the engineering applications other than the regular day-to-day applications is obviously a significant subject.

Hand lay up technique is adopted to fill the prepared mold with ECMALON 4411-grade polyester resin, supplied by Ecmas Resins Pvt. Ltd., Hyderabad as matrix and the netted fibers yepi, filamentary fibers sisal, coconut, palm as various reinforcements for the preparation of different composite specimens. Much care is taken in the fabrication of netted fiber reinforced composite, because to impregnate the resin into the aggregate. The prepared composite specimens have been tested in order to investigate various properties like tensile strength, specific tensile strength, specific tensile modulus and dielectric strength with varying percentage volume of fiber and the graphs were plotted.

### 2.1 Extraction of fiber

The fibers sisal, coconut, palm are extracted using retting and manual extraction procedures [12]. Netted fibers yepi is extracted using chemical extraction procedure. A method of degumming designed by Gangstad et al. cited by Maiti [13] has been taken as the basis for chemical extraction. The bark fibers from the trees and tree branches like yepi cannot be extracted by the normal process of retting used for conventional filamentary fibers, because the bark presents a high quality of gum, pectin and cellulose. In the manual decortication the fibrous layer is peeled in the form of ribbons from the young branches of the tree, and is dried off in the sun. The ribbons of fiber removed from the bark contain tissues and gums. After decorticating, the dry fiber is extracted by means of a chemical process of decomposition called degumming, in which the gummy materials and the pectin are removed. The Chemical extraction process yields 41.42% of netted fiber from the raw fiber. The density of fibers is measured by the picnometric procedure. The density of yepi, sisal, coconut and palm fiber is 1330, 1450, 1150 and 1030 $kg/m^3$ respectively.

### 2.2 Tensile testing of composites

A 2 ton capacity Electronic Tensometer, METM 2000 ER-1 model supplied by M/S Mikrotech, Pune was utilized for tensile testing of preapared composite specimens. The standard test method for tensile properties of fiber-resin composites ASTM-D638M is used to prepare the specimens as per the dimensions. The test specimen has a constant cross section with tabs bonded at the ends. The mold is prepared on smooth ceramic tile with rubber shoe sole to the required dimension.

### 2.3 Dielectric testing of composites

The dielectric test equipment having 0-60 KV output and 100 mA capacity, supplied by Rectifiers and Electronics, New Delhi is used to test the dielectric break down of the composites. Digital micrometer of 0.001 mm least count is used to measure the thickness of the specimen. Fiber reinforced composites are tested for dielectric strength at 50 Hz frequency. The test voltage is applied using simple test electrodes on opposite faces of the specimens. Step-by-step test (method-B) specified by ASTM D149-87, titled, "Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies" is performed. The dielectric strength values are calculated in KV/mm.

## 3. RESULTS

The effect of percentage volume of fiber with tensile strength is shown in Fig. 1. For the same percentage volume of fiber tensile strength of the composites increasing in the order of coconut, palm, sisal, yepi. It is found that the tensile strength of fiber reinforced composites increased with increase in percentage volume of fiber for the yepi, sisal, palm fiber reinforced composites and decreased for coconut fiber reinforced composites. The tensile strengths of palm and coconut fiber reinforced composites, at high percentage volume of fiber, are not appreciably increased. This is because, the failure of the composites are due to shear between fiber and matrix, i.e., weak interfacial bond. The tensile strength of yepi fiber reinforced composites is 2.9 times than that of matrix.

The effect of percentage volume of fiber with specific tensile strength is shown in Fig. 2. The specific tensile strength of the composites increasing in the order of coconut, palm, sisal, yepi at the same percentage volume of fiber. Specific tensile strength is increased with increase in percentage volume of fiber for the yepi, sisal and palm fiber reinforced composites and decreased for coconut fiber reinforced composites.

The effect of percentage volume of fiber with specific tensile modulus is shown in Fig. 3. The specific tensile modulus of the composites increasing in the order of coconut, yepi, palm and sisal at the same percentage volume of fiber. Specific tensile modulus is increased with increase in percentage volume of fiber for the yepi, sisal, palm fiber reinforced composites and decreased for coconut fiber reinforced composites. It is also observed that the specific tensile modulus increase with increase in percentage volume of fiber and then decrease even though there is an increase in percentage volume of fiber for palm fiber reinforced composites. The tensile strength of palm and coconut fiber reinforced composites, at high percentage volume of fiber, are not appreciably increased. This is because, the failure of the composites are due to shear between fiber and matrix, i.e., weak interfacial bond. The specific tensile modulus of yepi fiber reinforced composites is 2.5 times than that of matrix.

The effect of percentage volume of fiber with dielectric strength is shown in Fig. 4. With increase in percentage volume of fiber the dielectric strength of fiber reinforced composites decreases. The dielectric strength decreases in the order of sisal, palm, coconut, and yepi fiber reinforced composites. The dielectric strength of yepi fiber reinforced composites is comparable with the sisal, coconut and palm fiber reinforced composites. Palm fiber reinforced composites showed more dielectric strength than that of sisal, coconut and yepi fiber reinforced composites at approximately 10% volume of fiber.

## 4. CONCLUSIONS

It is possible to make natural fiber reinforced polymer composites using netted fibers like yepi without disturbing the ecological balance. Hand lay up technique can be used for the preparation of natural fiber-reinforced composites using netted fibers like yepi successfully. Tensile strength, Specific tensile strength, Specific tensile modulus of yepi, sisal and palm fiber reinforced composites increased with increase in percentage volume of fiber where as in the case of coconut fiber reinforced composites it is decreased. sisal fiber reinforced composites showed better specific tensile modulus than that of coconut, palm and yepi fiber reinforced composites and an interesting point observed is that the specific tensile modulus of sisal fiber reinforced composites crosses the other fibers at approximately 22 percentage volume of fiber for untreated fibers. The dielectric strength increases with decrease in percentage volume of fiber for yepi, siasal, coconut and palm fiber reinforced composites. Sisal fiber reinforced composites showed more dielectric strength than that of cocnut, palm, yepi fiber reinforced composites and the dielectric strength of yepi fiber reinforced composite is comparable with that of other filamentary fiber reinforced composites like sisal, coconut and palm.

## ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support extended by the All India Counsil for Technical Education, IG Sports Complex, IP state, New Delhi, India, (F. No. 8017/RDII/BOR/TMAT 049/Rec. 416) under Thrust Area Programme in Technical Education to carryout the Research project.

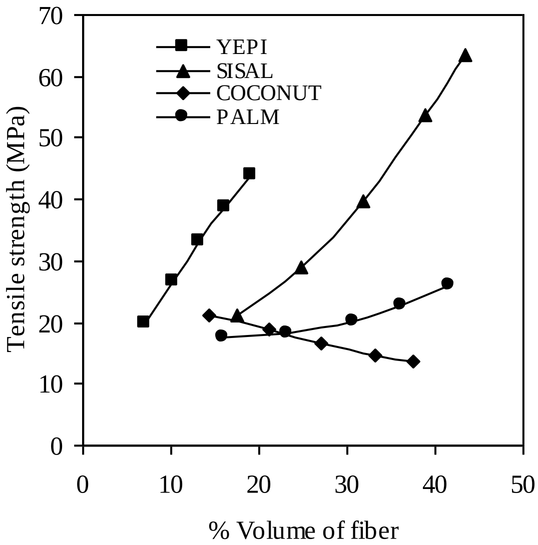


Fig. 1. Effect of percentage volume of fiber with tensile strength

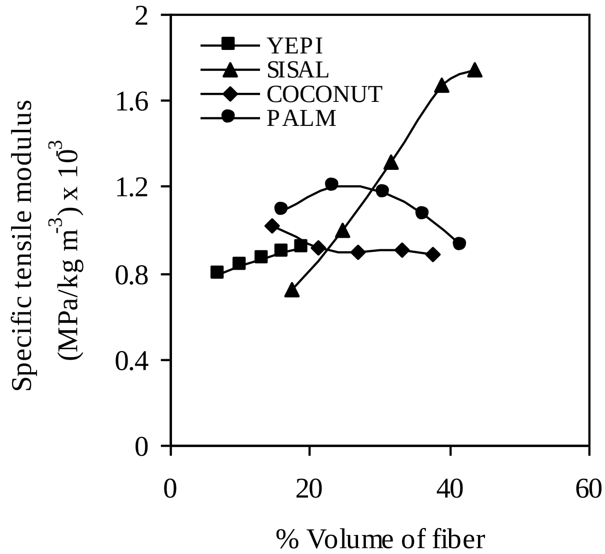


Fig. 3. Effect of percentage volume of fiber with specific tensile modulus

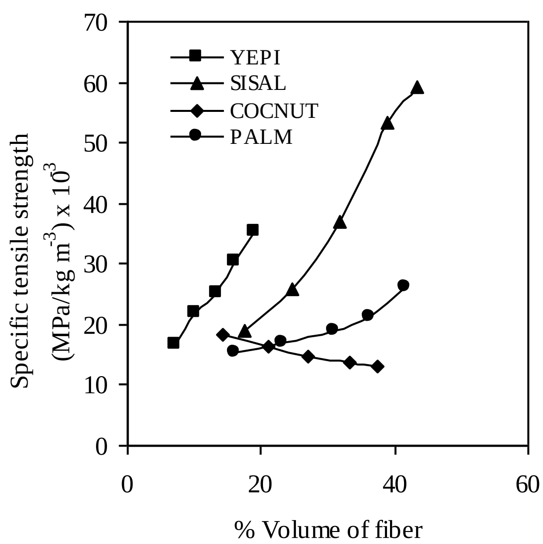


Fig. 2. Effect of percentage volume of fiber with specific tensile strength

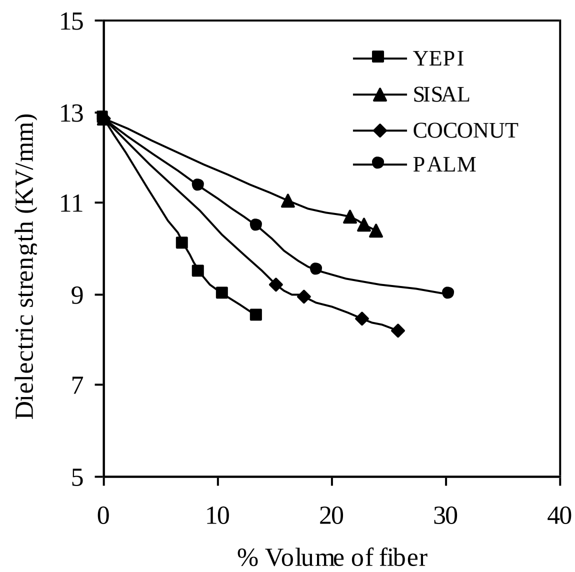


Fig. 4. Effect of percentage volume of fiber with dielectric strength

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