



## Effect of surface treatment on hemp fiber reinforced polymer matrix composite

**Venkatakrishnan .R**

Dept of mechanical  
IFET COLLEGE OF  
ENGINEERING  
Villupuram, India

**Surya Prakash. S**

Dept of mechanical  
IFET COLLEGE OF  
ENGINEERING  
Villupuram, India

**Sabinesan.P**

Dept of mechanical  
IFET COLLEGE OF  
ENGINEERING  
Villupuram, India

**Abstract**—According to environmental concern, synthetic and artificial fibers pollute soil and execrable soil erosion. Sludge has discovered synthetic fiber in soil over that last 15 years. Approximately 200 000 to 500 000tons of micro plastic are produced for usage of multipurpose industries. However, natural fibers are typically more resilient and provide comparable strength to synthetic fiber, lasting longer for the wearer than synthetic fiber and having no negative environmental effects. In this investigation of hemp fiber, the fibers needs to be chemically cleansed to remove the nucleus before being sprayed with an epoxidized zinc phosphate primer. The hemp and jute fibers that have been coated, Fibers serve as reinforced and epoxy resin serves as the composite's matrix. By combining natural and synthetic resin, a hybrid composite is created than have been coated, fibers serve as reinforced , and epoxy resin serves as the composite's matrix. By combining natural and synthetic resin, a hybrid composite is created that has an equal amount of strength, The field of composite material is appropriate for applying a product to practical items like engineering technologies. The composite product will undergo testing in according with an ASTM standard for a amount of water absorption, hardness, tensile strength, and textural rigidity. The field of composite material is appropriate for applying a product to practical items like engineering technology.

**Keywords**— *Hemp and Jute fiber , Mechanical properties, Fiber coating of epoxidized zinc phosphate primer.*

### I. INTRODUCTION

Improve the development of new product and the environment by using hybrid composite materials that use natural fibers and polymer matrix composites as reinforcement. In additional, look for research papers to make up for synthetic fiber that are connected with polymer matrix composite as reinforcement. In addition, look for research papers to make up for synthetic fibers composite materials. By using fibers like

hemp and jute fibers that are connected with polymer matrix, past research publication have studies the production of thermoplastic and thermosetting plastic materials. Additionally, in the case studies, the coating process involved dipping and electroplating. While comparing with the synthetic fibers.

The biggest drawback of an not using natural fiber is that it absorbs water due to the production of cellulose in the fiber's layer. The primary component of biodegradable materials is cellulose, hence natural fibers are only used in a small number of production processes. To be formed, the intended composite must be made.Utilize test equipment. It is meant to use precisely timed, repeatable cycles to load a specimen to failure. The apparatus able to be constructed to withstand the expected so properly measure to applied a loading of an element and the resulting deracination or strain. Additionally, the system needs to be safe to usage and equipped with enough security measures to protect users from any threats.

The reinforcement is applied to either the mold cavity or the mold surface. The matrix may be applied to the reinforcement either before or after in this. A merging event in the matrix forces the part's form. Depending on the type of matrix, this merging process may take place in a number of multiple ways, such as chemical polymerization for thermoset polymer matrix composite, solidification from an molten state on matrix of thermoplastic polymers composites, and more. By using Na-OH and hydrogen peroxide in a chemical process, the cellulose in the fiber layer is reduced to lower the amount of water absorption in the fiber. Micro pores can be generated by fully removing the cellulose, and the fiber will then have layers of polymer coating to fill the pores. By spraying, the epoxidized Zinc Phosphate primer will be applied to the fiber. Then, the coatings layers varied between the various samples. There will

be five different types of samples created, including untreated, treated, One layer, two layers, and three layers of coating. Traditional hemp and jute fibers are also employed in a variety of treatments and applications. Composites made on polymer matrices are rarely used. Additionally, the characteristics of the zinc phosphate-coated hemp fiber and jute-reinforced epoxy resin matrix composite were studied in the research work on the material matrix composite.

The development and research study of organic fiber and inorganic fiber composite materials are used in the large amount of sustainable product increased by the studies by the benefits of comparing synthetic fiber and natural fiber to fabricate the cost effective material, non-flammable material by the scientist, The materials are Glass, carbon, metal, silica, carbide, and ceramic. The fabricated materials are used in the various industries such as aerospace, construction, packaging, automobile industries.

Most of the automobile and machine based industries are used the inorganic (or) synthetic fiber to compensate the natural fiber based composite material because of its strength. The inorganic materials are used in the composite material to produced the eco-sustainable product by the fabrication of natural based composite material in this study.

## II. METHODOLOGY

In order to developing an study of natural fiber (Hemp and Jute Fiber) as a reinforced polymer with Natural Epoxidized Resin Coating and Epoxy based Resin Matrix Composites, and to investigation of an mechanical property and physical properties for both fibers of Hemp and Jute fiber composites, the materials and methods used are detailed in this chapter.

### ● *Hemp and jute fiber*

Hemp fiber, jute fiber, natural epoxidized resin (canola oil, cashew oil), hardener, mould release wax, Na-OH pellets (commercial grade), mallex sheet, and natural epoxidized resin are the basic materials required for the construction of the composites Hemp fiber is smooth, straight, and a light brown tint. Bast fiber plants are distinguished by their relatively long, slender primary fiber on the outer section of the stem. It was most likely initially used in Asia. Hemp was also a popular fiber among ancient Asians long before the advent of Christ. It can be either long or short. Hemp cordage is regarded for its strength, durability, stretch-ability, affinity for specific dyestuff's, and resistance to deterioration in saltwater. This means that hemp retains its gleaming luster after washing, never dulls, and releases stains more easily than other materials.

- Anti-microbial
- Excellent abrasion resistance and durability.
- UV resistance. Mold, mildew
- Mildew resistance.

In terms of production and the number of uses, jute fiber is a second most affordable natural fiber after the cotton. Cellulose and lignin are typically found in plants, which are also the source of jute fibers. Jute fiber and kenaf, industrial hemp, flax (linen), ramie, and others, is a kind of natural basic of natural fiber, which is made from the phloem (or "skin") of the plant. Jute fiber is known in the industry as raw jute. The fibers are 1-4 meters (3-13 feet) long and range in color from off-white to brown. Due of its beautiful color in an great monetary worth of , jute is frequently referred to as the "golden fiber". India and Bangladesh are the primary producers in South Asia, which is where the majority of the world's jute commerce is situated. The

bulk of jute is utilized in for the reinforcement , And the jute fibers are classified as two types they are **White jute** and **Tossa jute**.

- **Extraction fibers:** The stalks of the jute plant are used to make jute fiber. Jute plant stalks are wrapped together and it can be steeped in water for roughly 20 days after harvesting will be occurs. The fibers are then rinsed in clear, flowing water after being separated from the stem in long threads. Mostly the jute fibers are used to manufacture cloth for wrapping raw cotton bales, as well as sacks and coarse cloth.Curtains, chair coverings, carpets, area of rugs, hessian material fabric, and linoleum backed material are also made from the fibers. The fibers may used to alone or in combination with an anyother types of fiber to make twine, rope.
- Examine the outcomes: While testing is completed, the results are analyzed to determine the material's fatigue behavior. This includes the much more cycles before the failure, any pressure of concentrations or other composite material by weak points, and much other materials are in relevant accomplishment metrics.
- MEKP (Methyl ethyl ketone peroxide)

Methylene ethyl ketone is a very explosive organic peroxide similar to acetone peroxide. MEKP is a colorless, oily liquid at STP, whereas acetone peroxide is a white powder. MEKP is somewhat more stress and temperature resistant, and it stores better.



Fig .1 MEKP, or methyl ethyl ketone peroxide)

MEKP is a catalyst for vinyl ester and polyester resins that is utilized in the composites industry. The resin reacts with it in order to cure (change from a liquid to a solid) it. For organic peroxide, see MEKP. These compounds are mixed with inert substances to create industrial catalysts since they are unstable when used alone. This mixture results in a range of gel times for MEKP, which may be obtained in different grades. Even though there are various catalysts for curing polyester and vinyl ester resins, contact moulding uses MEKP the most frequently since it cures at room temperature.

### ● **HYBRID NATURAL COMPOSITES FABRICATION**

The composites manufacturing process is divided into two broad categories:Both open and closed molding are used. Using open molding, the gel coat and laminate are left out in the open throughout the fabrication process. The composite is vacuum-bagged or closed-molded in a two-sided mold set. There are several processing techniques for both open and closed molding.

### **Molding that is open**

1. Spray-up Hand Lay-Up

## 2. Winding of Filament

**Molding that is enclosed**

1. Pultrusion and compression molding
2. Resin Transfer Molding (RTM)
3. Reinforced Reaction Injection Molding (RRIM)
4. Continuous Lamination Vacuum Bag Molding

● **Hand Layup**

Hand lay-up is an most fundamental and olden method open molding process used in hybrid composite manufacturing. It's a labor-intensive, low level method best suitable for larger component materials are boat hulls. Glass and some other reinforcement materials such as woven fabric is physical positioned in the open layer molding before resin are poured in mould, brushed the resin in a mould, or sprayed by an compressed air and into the glass plies.

The normal Room temperature can be curing in a polyester and epoxies are an most commonlu used composite material matrix resins. The resin curing time must be initiated by a catalytic converter in the resin system, which hardener can be harden the fiber reinforced and matrix to make a composite material without the need of supplitmentry heat.

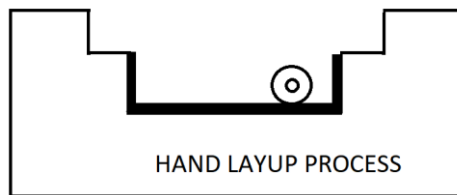


Fig .2 Hand layup process

**III. SAMPLE PREPARATION**

1.
  - a) **Dust removal:** The samples are generated using Na-OH and Hydrogen Peroxide chemically fiber composites with treated and untreated fiber contents ranging from (0, 10, 20, 30, and 40)% wt. The fiber can be soaked in the hydrogen peroxide solution in till 24 hrs like a one and one night and then washed into the running water clean water then dried into the sunlight , After the wash the fibers can be look like in golden brown colour by the chemical treatment.
  - b) **Surface treatment:** When the fiber soaked in the hydrogen preoxide solution by the chemical treatment and The order of hydroxyl group of natural fibers cellulose element and lignin shows that they can be altered. The cellulose hydroxyl groups molecules may participate in hydrogen bonding, lowering the activity towards the matrix. These groups might be chemically activated, or new molecules could be introduced that successfully interlock with the matrix. Pre treatments can clean the surface of the fiber, chemically modify it, stop the process of absorbing moisture, and raise the rough surface finish. All other fibres were rinsed five times with water, dried at room temperature for 48 hours, and then washed with very mild hydrochloric acid (HCl) before being submerged in a 10% sodium hydroxide solution within a day to remove the leftover alkali. By the reaction the biological parameters such as 77.77% of cellulose, 10% hemicellulose, 6.8% lignin , 1.73 eater soluble content and 2.9% of pectin has been removed in the treatment.



Fig .3 Dust removal and cleaning process

2. **Coating process:** After the chemical wash the fiber can be colour change into golden brownish and Then fibers can be coated with the epoxidized zinc phosphate primer by the spray method.



Fig ,4. Coating of fiber

3. **Mixing ratio of epoxy with hardner:** First, a 10:1 mixture of Epoxy Resin and MEKP Catalyst was made. Accelerators are added drop by drop, 10ml for every 100ml of resin. Resin was acquired locally.



Fig 5. Mixing of resin

4. **Mould Preparation:** A glass sheet measuring 50\*50 cm and a rubber block piece measuring 25 cm 25 cm on four sides were used to create the mould. The lay-up technique was used to create the piece by hand. Prior to the the hand layup technique, the prepared moulding had been treated with a coupling agent to guarantee that are an art would not stick by the sample mould.To prevent debris from entering the composite parts during curing, the top and bottom plates were coated with glass sheet, and the fibers were crushed using epoxy glue.



Fig .4 Mould Preparation.

#### 5. Preparation of sample:

- i. Jute fiber mat and hemp are used as reinforcing materials, with epoxy resin serving by an matrix composite material, to produce hybrid natural composites. The epoxy resin and hardener can be provided by Kamachi resin (P) Ltd, Puducherry. Initially, Moulds with size of 50 x 50 cm were designed primarily for composite manufacture.
- ii. The natural composite samples are made by variety the proportion of fiber ratio in the composite materials (10%,20%,30%, and 40%), then covering the resin and fiber with a glass sheet. By Placing the Jute fibers manufactured mat on top layer of the resin. Hemp lamina is alternatively placed in order by one layer to another one, and resin is put intermedian of the lamina layers.
- iii. To construct double layer laminated hybrid composite material; from IIII layers of Hemp and Jute lamina. Entrapped by an air ball bubbles are carefully eliminated with a sliding rolling method before the mould is closed for open days of curing at 30°C with a intermediant load of 10 kilograms.
- iv. After completion of curing, the composites are removed from the mould plate. Fabricated material samples are put in a dry environment to increase their solid gel strength. Repeat the technique for all samples of hybrid natural hybrid composites preparation.
- v. Following sample preparation, the material should be sliced for mechanical testing in accordance with the ASTM standard.

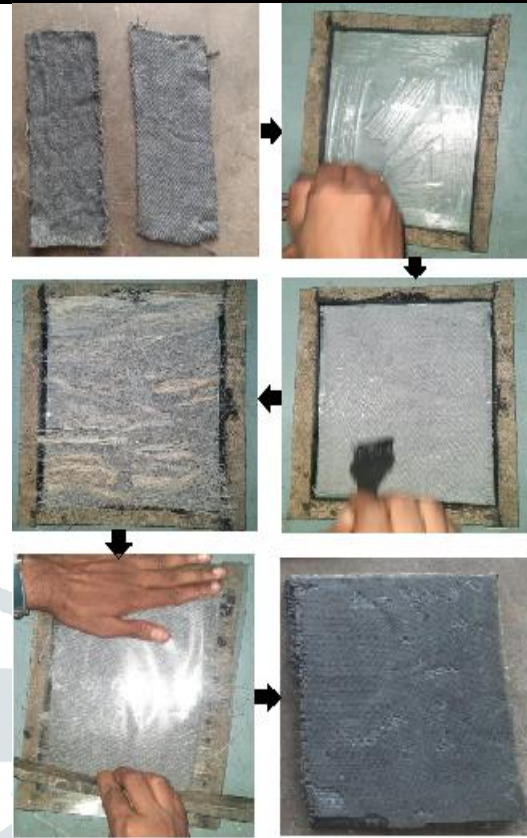


Fig .5 Preparation of samples.

#### 6. Sample preparation for mechanical test:

After the sample preparation the material should be cut for the several shape and structure for mechanical test like tensile, hardness ,water absorption of The drawbacks of present fatigue testing equipment are highlighted. The sample should be cut under the ASTM Testing standard to find the characterization and properties of the hybrid composite material.



Fig .6 Preparation of samples.

### III. RESULT AND DISCUSSION

#### a) Mechanical properties:

Bonding material at the fiber matrix composite interface has a significant impact on The mechanical properties of behavior of

Hybrid composite materials. The matrix's primary role in polymer matrix composites is to disperse applied stress among the fibers to find the mechanical property and characterization. Transversed and longitude, and the material shear strength of the hybrid polymer matrix composite are largely dependent in the inter facial bond strength. Thus, if the full strength of the reinforcing fiber the matrix can absorbed the entire load be utilized, bonding must be maximized, necessitating accurate evaluation of inter-facial bonding in composite materials. The primary goal of the test is to determine the characterisation and mechanical material properties of the natural hybrid composite material. That mechanical properties may identified by the several methods mainly we used these method natural fiber composite material. The testing methods are applied by the universal testing machine such as , Bending test, compressive test, harness test , water absorption test.

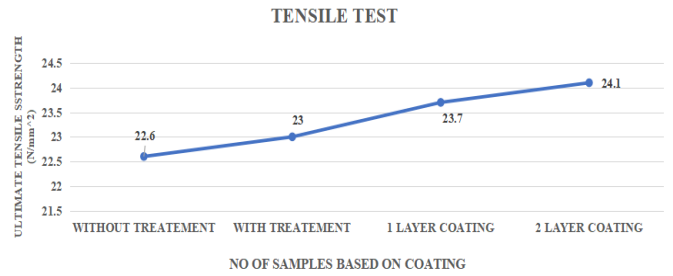
**i. Tensile test.**

The mechanical property in a behaving of the composite material manufactured utilizing the generated samples may be assessed using a testing load range of up to 5 Ton and a gear rotation speed of 1.25, 1.5, and 2.5 mm/min in the Universal Tensile Testing Machine. The experiments were conducted at ordinary and usual room temperatures. Cutting machining was used to cut the test specimens in compliance with ASTM standards. Tensile strength may determined by using of ASTM D638 with a standard cutting measurement length of 50mm and a cross head feed rate of 1.25 mm/min.



**Fig .7** Tensile test occur in fatigue testing machine .

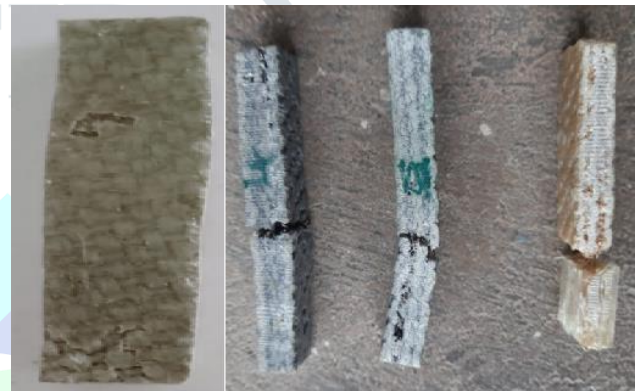
The tensile tested composite material are used in the more and more safety applications such aerospace , marine , military and fire safety applications .Because the composite materials are high durable. Less weight, more strength, fire resistance, electrical retardant the composite materials can be used. The composite material made shoes ,jacket and other fire safety equipment can made. In automobile indutries the brake shoes, clutch plate such material can me made to the vehicle parts. By the less weight only the composite materials are used in aerospace industry.



**Fig.8.** Sample comparison of tensile test sample.

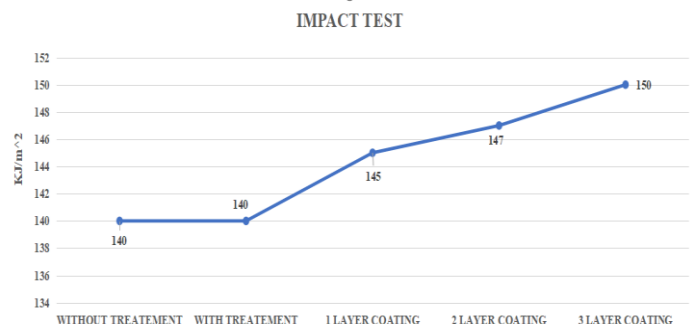
**ii. Impact test.**

Izod impact testing equipment was used to test the composite material by sudden impact resistance in accordance with ASTM D256 standard. The specimen had a depth under the notch of 2.5 mm in the side of sample and The dimensions were 65.5\*12.7\*3 mm. The izod impact test can be higher-quality standard. strain rate test that quantifies how much energy a material absorbs while in sudden impact before it fractures .



**Fig.9.** Sample specimen after impact.

In the impact test should be tested in the sample specimen to find the heavy load applied suddenly the sample . After the impact test the sample should be compared for impact value. When applying of load to sample specimen the ductile and brittleness of the sample material should be identified by sudden load attains by the imact test.



**Fig.9** Impact test comparison for the sample specimen

**iii. Flextural test**

The flextural test may measure the load or force applied to the sample in required bending a beam while in three main load point in pressure situation . By the three load point the bending test may occur with the 790 standard in ASTM.D. In the specified sample can cut into a 50.8\*12.7\*3mm respectively.

When the main data can often used to selected the element for the several parts are may supported the applied load with or without an inflection material occurred by the mechanical properties of the composite material to an element particle.

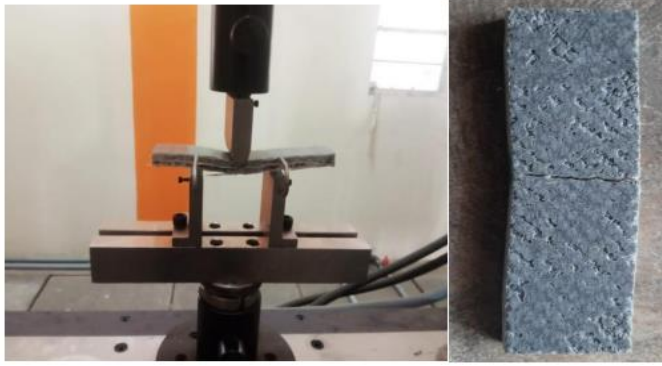


Fig .10 Flextural test in fatigue test machine

In the flextural modulus can used in a every indication of a material stiffness without an deflection. While in a every elements with a physical property are depending upon a ambient temperature, and it is a appropriate to the test material at a temperature to indented in the every environment.

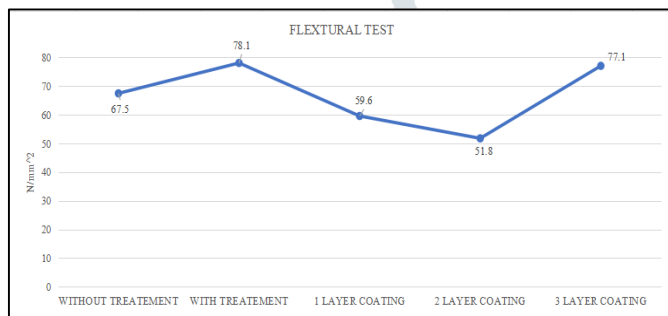


Fig .11 Flextural test sample comparison.

iv. Water absorption Test

Water absorption may be used to calculate the particular amount of water can be absorbed in under specific conditions. Pre-dried samples (25\*25\*3 mm) were immersed in ordinary water and distilled water can may separately at the particular room temperature to assess water absorption. In accordance, the ratio effects by an water absorption in hemp and jute fiber reinforced polymer matrix composites was examined. The specimens were dried for 24 hours at a particular room temperature. The specimens were weighed with a precision of 1 micron. Water absorption tests were performed on the composite specimens by immersing them in ordinary water and sea water in a plastic tub at room temperature for 14 days. After a 14-day delay, the samples were thoroughly wiped to eliminate any extra water on the surface.

For the same 14-day time intervals, the % weight increase of the samples was assessed for ordinary water and sea water. The weight difference was used to compute the moisture absorbed by the sample. The % weight growth of the samples for sea water and ordinary water was measured at 14-day intervals, and the moisture content of the sea and usual water was plotted.

$$\text{Water Absorption Percentage} = \frac{[(\text{Wet Weight} - \text{Dry Weight}) / \text{Dry Weight}] \times 100\%}{}$$

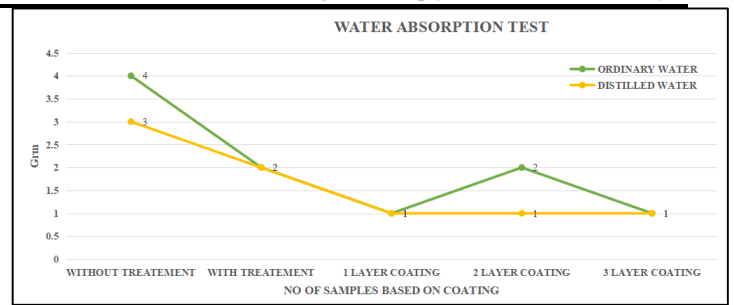


Fig.12. Water absorption rate of coated samples

v. Hardness test

The hardness testing method The resisting of a elemental composite material to prolonged deformation induced by the penetration of another harder substance. The Rockwell Hardness test, Brine Hardness test, and Vickers Hardness test are the three basic hardness testing methodologies. The primary purpose of the hardness test is to determine the compatibility of a material or the specific treatment to which it has been subjected. The hardness value should always be evaluated in relation to the type of indent er and its shape. The capacity of a substance to endure permanent deformation, penetration, indentation, and scratching is defined as its hardness. The hardness test may be used to determine the HRC rate of a material. By delivering the maximum load on a specific sample The hardness rate of an specimen should be measured from the dwell-point by applying of mean load .

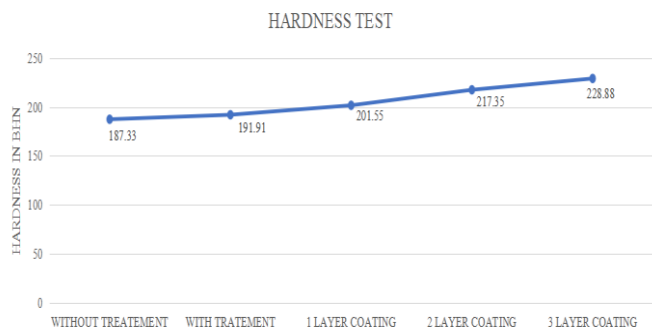


Fig.13. Water absorption rate of coated samples

V. CONCLUSION

This study looked at the specification mechanical qualities of an hybrid based Natural composite. The mechanical strength of composites can reinforcing with NaOH and Hydrogen peroxide treated and Zn3(PO4)2 coated fiber reinforced (EPOXY) is more than that of composite material can reinforced with chemical treated hybrid fibers. Fiber treatment with NaOH and hydrogen peroxide, as well as Zn3(PO4)2 coating, increases the physical bonding strength in between fiber and Epoxy Resin of an composite materials. According to the data, the maximum tensile and flexural strength was attained at 30% fiber content may occur in the fiber. Because of the strong bonding strength of Epoxy Resins materials, the maximum impact strength was attained at 10% fiber content composite.

The results show that distilled water has the lowest level water absorbing while when compared to regular water absorption tests. The water resisting in 3layer coated of fiber content composite material is due to the good water resisting in Epoxy Resin materials. As a result, it can be inferred that the best

qualities of Hybrid Natural Composites may be obtained at 30% fiber content. While comparing to the without treatment sample material the coated material can give a positive result in strength.

### REFERENCE

1. The Natural fibers' employment as reinforcements in composites has been governed by the waste management issue of natural fibers and the drawbacks of synthetic fibers. Incorporating a single type of reinforcing fiber does not always result in composites.
2. Increasing the production of high-performance natural fibers while minimizing their environmental effect is a task that flax cannot solve on its own. In flax's typical production areas, hemp can be a supplementary source of high added value fibers if the output of long and long line fibers can be optimized to levels comparable to flax's
3. The effect of fiber content and alkali treatment on the mechanical characteristics of partly biodegradable epoxy composites reinforced with *Roystonea regia*. Bull. Mater. Sci., December 2011, Vol. 34, No. 7, pp. 1575-1581. The Indian Academy of Sciences is a scientific organization in India.
4. Composites of Shell Liquid Resin. ISSN 1927-0585 E-ISSN 1927-0593 Journal of Materials Science Research; Vol. 1, No. 4; 2012. The Canadian Center for Science and Education published this article. Rice Husk Mechanical Properties Cashew Nuts Filled
5. "Mechanical characterisation of Coir and rice husk reinforced Hybrid polymer composite". Progress in polymer science 1999;24:221-74.
6. Tensile Strength of Teak Wood Saw Dust – Cashew nut shell liquid resin composites. 2014 IJEDR | Volume 2, Issue 1 | ISSN: 2321-9939
7. Mechanical Properties of Natural Fibre (Banana, Coir, Sisal) Polymer Composites. SCIENCE PARK ISSN: 2321 – 8045 Vol-1, Issue-1, July 2013
8. Tensile Strength of Banana – Bamboo – glass Fiber Reinforced Natural Fiber Composites. Applied Mechanics and Materials Vols. 592-594 (2014) pp 1195-1199
9. "Thermal conductivity of Sisal/Glass Fibre Reinforced Hybrid Composites". International Journal of Fiber and Textile Research. Universal Research Publications. All rights reserved.
10. "Influence of fibre-surface treatment on structural, thermal and mechanical properties of jute fibre and its composite". Bull. Mater. Sci., Vol. 32, No. 1, February 2009, pp. 65–76. © Indian Academy of Sciences.
11. "TGA, DSC, DTG Properties of Epoxy Composites Reinforced with Feather Fibers of 'Emu' Bird". International Journal of Innovative Research in Science, Engineering and Technology. Vol. 3, Issue 5, May 2014.
12. "Effect of Alkaline Treatment on Mechanical and Thermal Properties of typha *Angustifolia* Fiber Reinforced Composites".
13. "Thermal study of phenol–formaldehyde resin modified with cashew nut shell liquid". Thermochemica Acta 512 (2011) 105–109.
14. "Effect of cashew nut shell liquid on gelation, cure kinetics, and thermomechanical properties of benzoxazine resin". Thermochemica Acta 520 (2011) 84–92.