

# Experimental Investigation of Thermal and Mechanical Properties of Palmyra Fiber Reinforced Polyester Composites With and Without Chemical Treatment and Also Addition of Chalk Powder

C.Mahesh<sup>1</sup>, B.Kondapanaidu<sup>2</sup>, K.Govindarajulu<sup>3</sup>, and V.Balakrishna murthy<sup>1</sup>

<sup>1</sup>Department of Mechanical engineering V R Siddhartha engineering college, Vijayawada, 5220007, India

<sup>2</sup>M Tech Student V R Siddhartha engineering college, Vijayawada, 5220007, India

<sup>3</sup>Department of Mechanical engineering JNTU Ananthapur 521501, India

**Abstract—** The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. The natural fiber composites are more environmentally friendly. The main objective of this project is to investigate effect of chemical treatment and addition of chalk powder (additive) to the composite on thermal and mechanical properties of (Palmyra bract fiber) natural fiber reinforced polyester composites. The composites have been made by with and without chemical treatment to Palmyra fiber and addition of chalk powder to the polyester matrix. Mechanical properties such as tensile properties (such as tensile strength, tensile modulus), Flexural properties (such as Flexural Strength, Flexural Modulus), Impact Strength when subjected to varying weights of fiber (0.5, 1, 1.5, 2, 2.5 grams) and thermal properties such as conductivity, specific Heat capacity, thermal diffusivity of composites are studied. The tensile strength, flexural strength, impact strength of chemical treated fiber composite increased when compared with untreated fiber composite by increasing fiber content. Thermal properties of treated fiber composite also increased when compared with untreated fiber composite. With addition of chalk powder to the treated composite Thermal conductivity, Specific Heat capacity, Thermal diffusivity of the composite are increased. But mechanical properties almost equal when compared to without addition of chalk powder to the composite.

**Keywords—** Palmyra fiber, natural composite, Chemical treatment, chalk powder, Mechanical properties, Thermal properties.

## 1 INTRODUCTION

The word “composite” means two or more distinct parts physically bounded together”. Thus, a material having two more distinct constituent materials or phases may be considered a composite material. Fiber-reinforced composite materials consist of fiber of high strength and modulus embedded in or bonded to a matrix with distinct interfaces (boundary) between them. In this form, both fiber and matrix retain their physical and chemical identities, yet they produce a combination of properties that cannot be achieved with either of the

constituents acting alone. In general, fiber are the principal load-carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperatures and humidity etc. The properties that can be improved by forming a composite material include strength, stiffness, corrosion resistance, wear resistance, attractiveness, weight, fatigue life, temperature-dependent behavior, thermal insulation, thermal conductivity, acoustical insulation and electrical insulation. Naturally, neither all of the properties are improved at the same time nor is there usually any requirement to do so. Composite materials have a long history of usage. Their beginnings are unknown, but all recorded history contains references to some form of composite material. For example, straw was used by the Israelites to strengthen mud bricks. Plywood was used by the ancient Egyptians when they realized that wood could be rearranged to achieve superior strength and resistance to thermal expansion as well as to swelling owing to the presence of moisture.. More recently, fiber reinforced resin composites that have high strength-to-weight and stiffness-to-weight ratios have become important in weight-sensitive applications such as aircraft and space vehicles.

Various products around us are made from plastics. One of them is fiber-reinforced plastics (FRP). Advantages of FRP are that specific strength is bigger than that of aluminum plate, and weight of FRP is lighter than that of aluminum plate, etc. Therefore, FRP are used in wide range of fields, for example, automobile field, aerospace field, sport field, and so on. Glass-fiber reinforced plastic (GFRP) in FRP has a lot of excellent functions such as high-strength, lightness, and chemical stability. But, this GFRP has a serious environmental fault that disposal and recycling are difficult after usage there is an increase demand for environmental friendly materials such as natural fiber composites to replace the traditional fiber (i.e. carbon, glass, and aramid fiber) composites. The reasons are: biodegradability, less emissions to the atmosphere, abundant, renewable, availability and can be produced at

low cost in many parts of the developing world [1]. Recently there is study of "green" composites (the biodegradable composite materials or eco-composites) [2]. Composed of a biodegradable resin and high strength natural fibers have been developed. There are various Reinforced fiber. Advantages of natural fiber are low weight, they are recyclable and biodegradable. They are also renewable and have relatively high strength and stiffness. On the other hand, there are also some disadvantages: moisture uptake, quality variations and thermal stability [3]. And, in fact, the mechanical property of natural fiber was much more inferior to that of glass fiber. Therefore, essential functional strength for structural materials or progress of strength and toughness of green composites and securement of reliability are not enough. Because it is necessary that the mechanical property of natural fiber approach that of glass fiber, and natural fiber have the optional functions [4].

Thermal conductivity of samples of PLA as a function of sample's fiber content. The thermal conductivity decreases with increasing fiber content. It is because hollow portion of reinforced fiber contains the air. Figure 3 shows a cross-sectional view of PLA-based composites sample. Thermal conductivity of the air is 0.026 [W/(mK)] at 25 degrees C. It has an excellent heat insulation effect. The volume percent of the air increases with increasing fiber content. Therefore, thermal conductivity decreases with increasing fiber content. The thermal conductivity of the composites with fiber content of 76wt.% is 0.190 [W/(mK)]. Natural fiber-reinforced composites have excellent thermal insulation properties. The thermal conductivity of Manila hemp fiber reinforced composites decreases with increasing fiber content [5].

In order to get a good composite material, these fibers should change from hydrophilic to hydrophobic characters. From the finite element method analysis, it is confirmed that there is possibility of reducing the stress concentration in the matrix and at the fiber interface by increasing the fiber content to an optimum content. More stress deviation in the fiber, matrix and interface regions of the composite leads to chances of fiber deboning. Vacuum infusion method used in this study offers more benefits than hand lay-up method due to better of fibers to resin ratio resulting in stronger and lighter laminates. Thermo gravimetric analysis and differential scanning calorimetric tests were carried for maize fiber and polyester resin coated maize fiber samples, they provide useful information on thermal degradation values of composite. It is seen from thermal gravimetric analysis, the initial degradation temperature was around 200°C but  $T_{max}$  for raw fiber is around 330°C and for the polyester coated maize fiber, it was around 410°C, and thus increase in thermal stability could be seen. Also it can be concluded from DSC profiles,

the endothermic peak is noticed at around 97°C for raw fiber and 67°C for polyester coated fiber and are mostly due to adsorbed moisture. The exothermic peaks are due to the degradation of the maize fiber noticeable above 300°C in case of raw fiber. Certain amount of variations in comparison of numerical and experimental results is shown. Limitations include a propensity to moisture uptake resulting in property degradation, and a large variation in fiber properties. The geometry and properties of natural fibers depend on the species, growing conditions, cambium age, harvesting, deliberation and processing conditions. This variation makes it more difficult to analyze the effects of the fibers and their interfaces on the thermal properties of the composite material. These difficulties call for development of new strategies [6].

The thermal conductivity of unsaturated polyester based sisal/ glass hybrid composite has been studied as a function of fiber content. It is observed that the thermal conductivity of sisal/glass fiber hybrid component is higher than sisal fiber reinforced composite, but lower than the glass fiber reinforced composite. The effect of chalk powder on thermal conductivity of sisal/glass fiber hybrid composite has also been studied and it is observed that as the chalk powder quantity by weight of resin increases then the thermal conductivity also increases. The thermal conductivity of a material depends on the nature of the material, the area of cross section normal to the direction of heat flow and the temperature gradient between the hotter part and the colder part of the material [7].

The variation of thermal conductivity of untreated and treated fiber composite with respect to fiber content is shown in Figure 3. It is clearly evident that the thermal conductivity of the composites is found to decrease with increase in fiber content. This behavior of composite seems to be justified because the fiber loaded in the matrix has a lower thermal conductivity. It is found that the thermal conductivity of treated fiber composite is more than the untreated fiber composite. This observation indicates that the composites under study have good insulating properties [8].

The specific heat capacity of all samples increased with increase of temperature (30°C - 85 °C), and then decrease beyond 85 °C Hence, the addition of silica exhibit favorable both in mechanical and thermal properties. Further, the authors investigating the effect of silica on fire behavior of composite which is under process [9].

## **2 EXTRACTION OF FIBER**

Fiber is available in the form of bract on a Palmyra tree .First collect dried bracts from the Palmyra tree then after segregate fibers from the bract then after

Fibers are cleaned and dried under sun for two days to remove moisture content. Further, the fibers were kept in oven for 2 hours at 70<sup>0</sup> C to ensure that maximum moisture was removed. The above fibers extracted by different methods are used for making composite specimens and tested as per ASTM standards.



**Fig.1. Palmyra ( Bract ) fiber.**

After cleaned fibers are kept in 4% (NaOH) solution for 4 hours for chemical treatment. Then after remove the fiber and clean with water. Then after keep in a sun light for 24 hours due to this entire moisture is removed from the fiber.

### **3 FABRICATION OF COMPOSITE SPECIMEN**

#### **3.1 MECHANICAL SPECIMENS:**

##### **3.1.1 Tensile and flexural testing specimens:**

The standard test method for Mechanical properties of fiber-resin composites, ASTM-D790M-86 is used to prepare specimens as per the dimensions. The test specimen has a constant cross section with tabs bonded at the ends.

The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with manson hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand layup method is adopted to fill the prepared mould with general-purpose polyester resin. ECMALON 4411 is an unsaturated polyester resin of orthophthalic acid grade with clear colourless or pale yellow colour. Its viscosity is 500-600 CPS (Brookfield

Viscometer) and specific gravity is 1.13 grams/c.c. at 250 C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 1.5% of the volume of resin. The gel time is found to be about 20 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fiber is placed along the longitudinal direction of the specimen so that the fibers are oriented 0<sup>0</sup> along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and a pressure of 0.05MN/m<sup>2</sup> is applied and left for 24 hours to cure. Later the specimen is removed and filed to obtain the final dimensions. The specimen is cleaned with NC thinner and wiped off to remove dirt particles. The ends of both flat sides of the specimen are roughened enough using a sandpaper, so as to bond the end tabs.

Two such identical specimens are prepared for each fiber content in the specimen. Six different fiber contents (0.5, 0.1, 1.5, 2.0, 2.5, grams) are incorporated in the specimen. Two of plain polyester is also prepared in order to compare the results of natural fiber reinforced composites. The percentage volume of fiber present in the specimen is determined for each set.

The fiber is treated with 4% NaOH after treated fiber clean with water and dried in a sun light for 4 hours then after cut this fiber into required lengths for fabrication of composites and also add chalk powder to resin(1%,2%) with the help of sonicator then after fabricate composites with treated fiber as mentioned above.

##### **3.1.2 Impact testing specimens:**

The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with manson hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand lay-up method is adopted to fill the prepared mould with general-purpose polyester resin. ECMALON 4411 is an unsaturated polyester resin of orthophthalic acid

grade with clear colourless or pale yellow colour. Its viscosity is 500-600 CPS (Brookfield Viscometer) and specific gravity is 1.13 grams/c.c. at 25<sup>o</sup> C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 1.5% of the volume of resin. The gel time is found to be about 20 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fiber is placed along the longitudinal direction of the specimen so that the fibers are oriented 0<sup>o</sup> along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and a pressure of 0.05MN/m<sup>2</sup> is applied and left for 24 hours to cure. Later the specimen is removed and filed to obtain the final dimensions (63.7mm\*12.6\*10mm). The specimen is cleaned with NC thinner and wiped off to remove dirt particles. The ends of both flat sides of the specimen are roughened enough using a sandpaper, so as to bond the end tabs.

Five such identical specimens are prepared for each fiber with and without silica. Five plain polyester and composite specimens are also prepared in order to compare the results of effect of silica on natural fiber reinforced composites. The present of silica and fiber in the specimen is determined for each set.

### **3.2 THERMAL SPECIMENS:**

#### **3.2.1 Thermal conductivity specimens:**

The standard test method for thermal conductivity of fiber-resin composites is ASTM-E 1530 which is used to prepare specimens as per the dimensions. The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with manson hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand lay up method is adopted to fill the prepared mould with general purpose polyester resin of ECMALON 4413 grade, supplied by ECMAS RESINS PVT. LTD, Hyderabad, as matrix and various fibers as reinforcement. ECMALON 4413 is an unsaturated polyester resin of orthophthalic acid grade with clear colorless or pale yellow

colour. Its viscosity is 500-600 CPS (Brookfield Viscometer) and specific gravity is 1.13 grams/c.c. at 25<sup>o</sup> C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 1.5% of the volume of resin. The gel time is found to be about 25 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fiber is placed along the longitudinal direction of the specimen so that the fibers are oriented 0<sup>o</sup> along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and left for 24 hours to cure. Later the specimen is removed and machined to obtain the final dimensions. The specimen is cleaned with NC thinner and wiped off to remove dirt particles. Five such identical specimens are prepared for each fiber content in the specimen. Five different fiber contents are incorporated in the specimen. With each fiber content, five identical specimens are prepared for each variety of fibers. Five plain polyester specimens are also prepared in order to compare the results of natural fiber reinforced composites. The percentage volume of fiber present in the specimen is determined for each set. This process do repeatedly and prepare treated and 1%, 2% addition of chalk powder to resign. The mixing of chalk powder with the polyester resin is done by using sonicator which works on the principle of processor high frequency vibrations are produced by the s.s. velocity horn which is immersed into the liquid to be processed. The vibrations give rise to millions of intense microscopic vacuum bubbles which form and implode at a very high rate (twenty thousand times per second) this phenomenon is known as cavitations. Cavitations thus give rise to intense local pressure waves and micro-streaming of the liquid round the points of collapse this in turn produces high-shear gradients which are responsible for the above stated application. Prepare circular shape specimen of 1%,2% of chalk powder to the resin and also treated fiber composites. The specimen dimensions are 10mm thick and 50mm dia.



Fig.2. Thermal conductivity testing specimens

3.2.2 Specific heat capacity specimens:

For Specific Heat capacity testing specimens are in powder form which is prepared from untreated, treated, addition of chalk powder to the treated composite by using grinding machine.



Fig.3. Specific Heat specimens.



Fig.4. Composites specimens

4 RESULTS AND DISCUSSIONS

4.1 MECHANICAL PROPERTIES

4.1.1 Tensile strength:

Tensile strength of composite increases with increase in weight of fiber. When compare untreated and treated fiber composites the tensile strength of treated fiber composite high with untreated one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them. The tensile strength of a untreated fibered composite is 51.53 N/mm<sup>2</sup> (for

maximum weight of fiber). Treated fibered composite tensile strength is 67.23 N/mm<sup>2</sup> (for maximum weight of fiber).

S.no	Weight of fiber (grams)	Un-treated fibered composite Tensile strength(N/mm <sup>2</sup> )	Treated fibered composite Tensile strength(N/mm <sup>2</sup> )
1	0	38.97	38.97
2	0.5	41.33	41.856
3	1	43.16	45.76
4	1.5	46.04	48.67
5	2	49.44	59.64
6	2.5	51.53	67.23

Table:1 Tensile strength of treated and untreated fibered composite by varying fiber

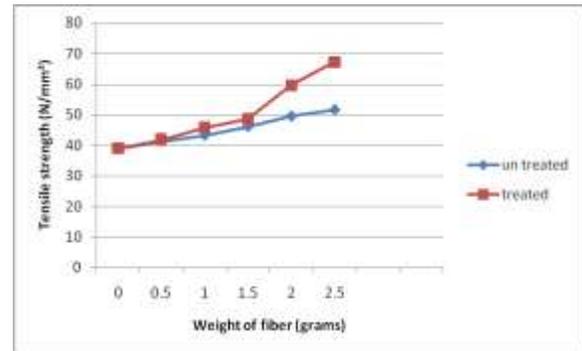


Fig.5. Tensile strength for varying fiber content

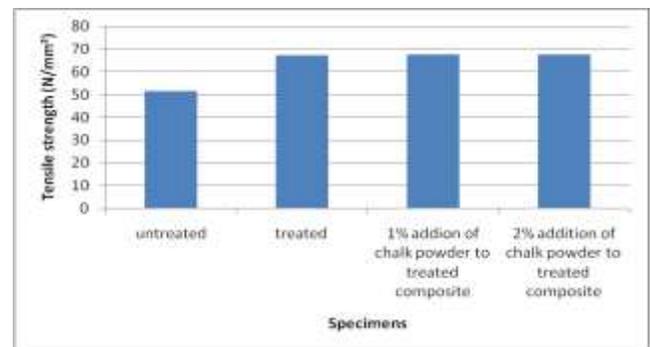


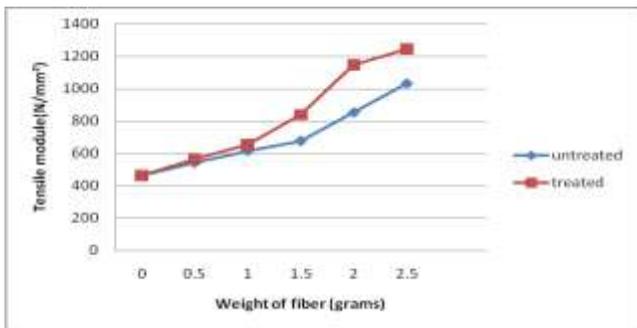
Fig.6. Tensile strength of specimens with addition of chalk powder

**Table.2. Tensile strength of specimens with addition of chalk powder**

Specimens	Tensile strength (N/mm <sup>2</sup> )
Un-treated	51.53
Treated	67.23
1% Addition of chalk powder to treated composite	67.492
2% Addition of chalk powder to treated composite	67.518

The addition of chalk powder (1%, 2%) to the matrix material the tensile strength of this composite is not changed.

**4.1.2 Tensile module:**

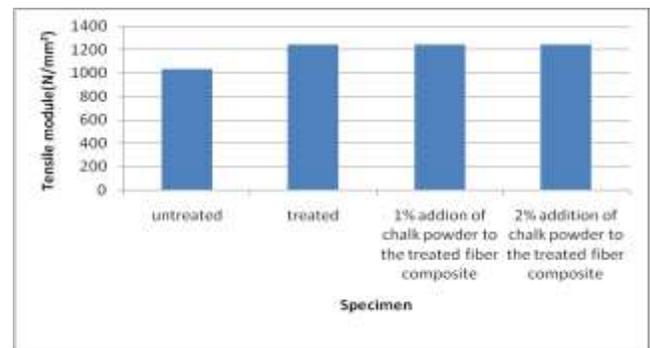


**Fig.7. Tensile module of treated and untreated fibered composite by varying fiber**

Tensile module of composite increases with increase in weight of fiber. When compare untreated and untreated fiber composites the tensile module of treated fiber composite high with untreated one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them. The tensile module of a untreated fiber composite is 1030.6 N/mm<sup>2</sup> (for maximum weight of fiber). Treated fiber composite tensile strength is 1244.4 N/mm<sup>2</sup> (for maximum weight of fiber).

S.no	Weight of fiber (grams)	Un-treated fibered composite		Treated fibered composite	
		Tensile module (N/mm <sup>2</sup> )	module	Tensile module (N/mm <sup>2</sup> )	module
1	0	463.92		463.92	
2	0.5	543.85		565.54	
3	1	616.6		654	
4	1.5	677.05		838.91	
5	2	825.4		1146.92	
6	2.5	1030.6		1244.4	

**Table.3. Tensile module of treated and untreated fibered composite by varying fiber**



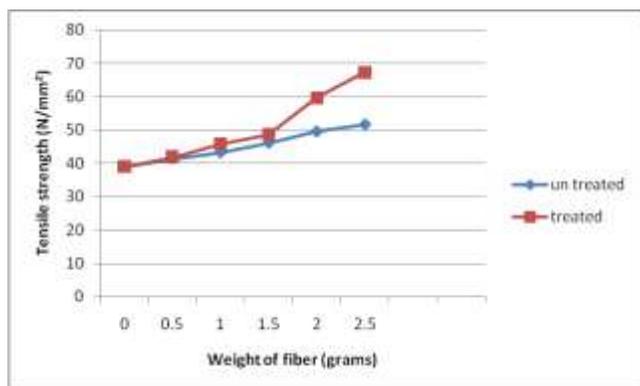
**Fig.8. Tensile module of specimens with addition of chalk powder**

**Table.4. Tensile module of specimens with addition of chalk powder**

Specimens	Tensile strength (N/mm <sup>2</sup> )
Un-treated	1030.6
Treated	1244.4
1% Addition of chalk powder	1245.2
2% Addition of chalk powder	1245.3

The addition of chalk powder (1%, 2% by weight) to the treated composite the tensile module of this composite is not changed.

**4.1.3 Flexural strength:**



**Fig.9. Flexural strength of treated and untreated fibered composite by varying fiber**

Flexural strength of composite increases with increase in weight of fiber. When compare untreated and untreated fiber composites the flexural strength of treated fiber composite high with untreated one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them.

S.no	Weight of fiber (grams)	Un-treated fibered composite Flexural strength(N/mm <sup>2</sup> )	Treated fibered composite Flexural strength(N/mm <sup>2</sup> )
1	0	109.87	109.87
2	0.5	117.620	119.94
3	1	123.6	129.55
4	1.5	137.34	146.2
5	2	152.4	169.386
6	2.5	173.96	184.48

**Table.5. Flexural strength of treated and untreated fibered composite by varying fiber**

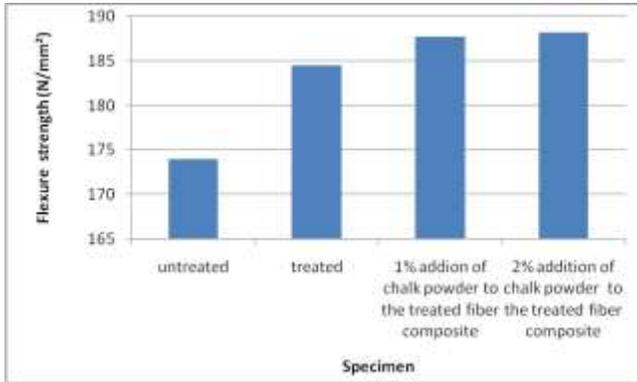


Fig.10. Flexural strength of specimens with addition of chalk powder.

Table.6. Flexural strength of specimens with addition of chalk powder.

Specimens	Tensile strength (N/mm <sup>2</sup> )
Un-treated	173.96
Treated	184.48
1% Addition of chalk powder	187.69
2% Addition of chalk powder	188.155

The Flexural strength of a untreated fiber composite is 173.96 N/mm<sup>2</sup> (for maximum weight of fiber). Treated fibered composite tensile strength is 184.48 N/mm<sup>2</sup> (for maximum weight of fiber). The addition of chalk powder (1%, 2% ) to the matrix material the flexural strength of this composite is increased by 1 N/mm<sup>2</sup>

#### 4.1.4 Flexural module:

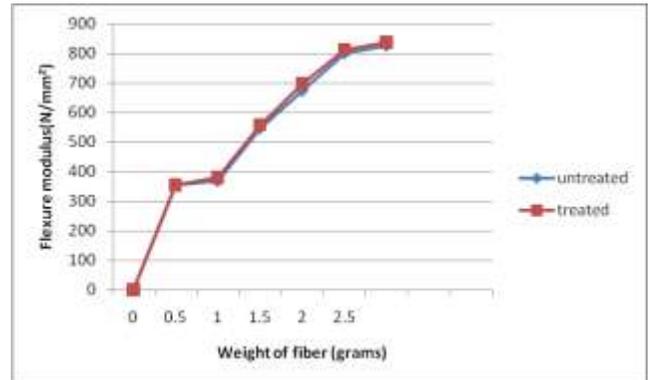


Fig.11. Flexural module of treated and untreated fibered composite by varying fiber

Table.7. Flexural module of treated and untreated fibered composite by varying fiber

S.no	Weight of fiber (grams)	Un-treated fibered composite Flexural module(N/mm <sup>2</sup> )	Treated fibered composite Flexural module(N/mm <sup>2</sup> )
1	0	355.7	355.7
2	0.5	368.4	381.11
3	1	546.25	558.96
4	1.5	673.29	698.7
5	2	800	813.31
6	2.5	825.74	838.44

Flexural module of composite increases with increase in weight of fiber. When compare untreated and untreated fibered composites the flexural module of treated fibered composite high with untreated one due to proper

adhesion of fiber and matrix material due to this proper bonding is created between them.

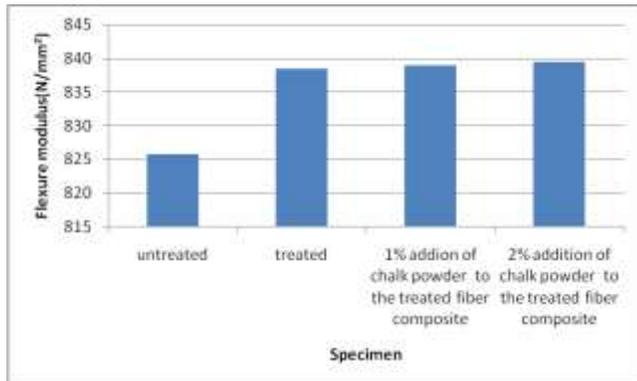


Fig.12. Flexural module of specimens with addition of chalk powder

Table.8. Flexural module of specimens with addition of chalk powder

Specimens	Flexural module (N/mm <sup>2</sup> )
Un-treated	825.74
Treated	838.44
1% Addition of chalk powder	839
2% Addition of chalk powder	839.5

#### 4.1.5 Impact strength:

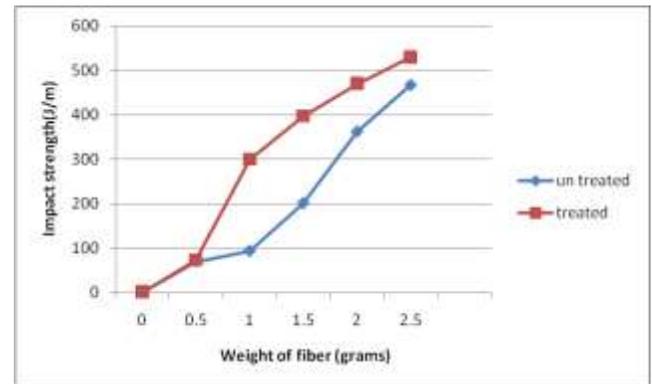


Fig.13. Impact strength of treated and untreated fibered composite by varying fiber

Table.9. Impact strength of treated and untreated fibered composite by varying fiber

Impact strength of composite increases with

S.no	Weight of fiber (grams)	Un-treated fibered composite Impact strength (J/m <sup>3</sup> )	Treated fibered composite Impact strength (J/m <sup>3</sup> )
1	0	1.15	1.15
2	0.5	70.35	73
3	1	93.75	300
4	1.5	201.25	397
5	2	362.5	470
6	2.5	467.5	530

increase in weight of fiber. When compare untreated and

untreated fiber composites the Impact strength of treated fiber composite high with untreated one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them. The Impact strength of a untreated fiber composite is 467.5 J/m (for maximum weight of fiber). Treated fiber composite tensile strength is 530 N/m (for maximum weight of fiber).

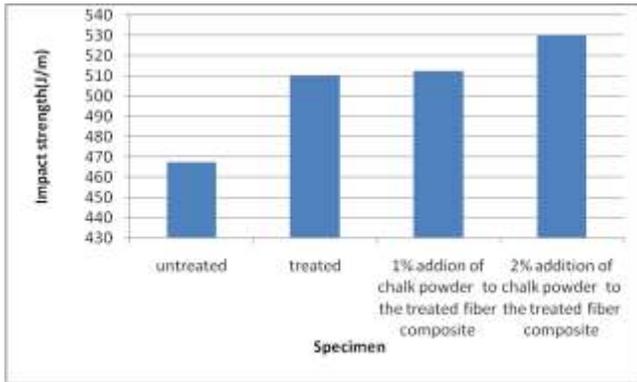


Fig.14. Impact strength of specimens with addition of chalk powder

Table.10. Impact strength of specimens with addition of chalk powder

Specimens	Impact strength (J/m)
Un-treated	467.5
Treated	510
1% Addition of chalk powder	512.5
2% Addition of chalk powder	530

The addition of chalk powder (1%, 2%) to the composite the impact strength of this composite is increased

## 4.2 THERMAL PROPERTIES

### 4.2.1 Thermal conductivity:

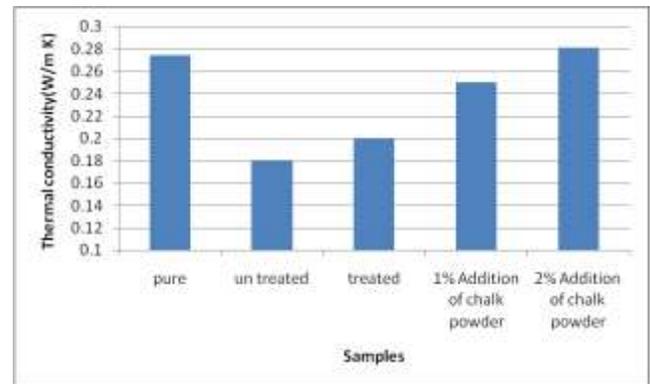


Fig.15. Thermal conductivity of specimens at 55°C.

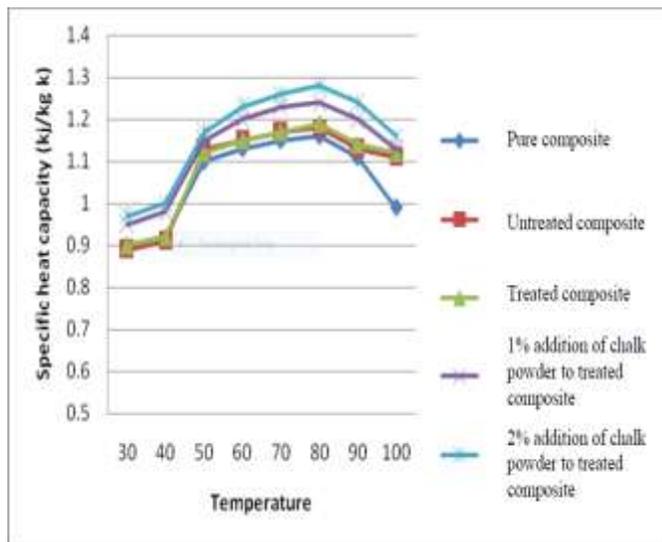
Table.11. Thermal conductivities of specimens.

Specimens	Thermal conductivity (W/m k)
Pure	0.274
Un-treated	0.18
Treated	0.2
1% Addition of chalk powder	0.25
2% Addition of chalk powder	0.281

It was observed that for maximum fiber weight the thermal conductivity of composite is less compared to pure where as for composite of Addition of chalk powder (1%, 2%) to the treated fiber composite increases slightly. And also compare to treated and untreated Thermal conductivity of treated is slightly higher than untreated. Those values at 55°C.

**4.2.2 Specific Heat capacity:**

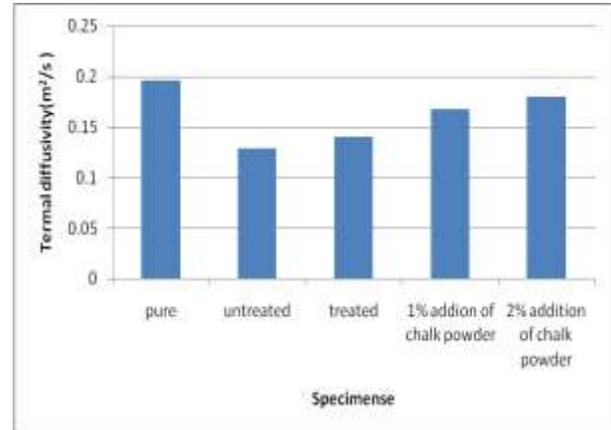
Specific heat capacity is one of the most important thermodynamic properties of the engineering materials. The specific heat capacity was independent of the mass and shape of the material shows the variation in specific heat values of samples with respect to temperature. It is observed that specific heat values of all the measured samples increased gradually in the temperature range of 30°C to 80 °C i.e. better storage of heat is possible. In the temperature range (30°C - 80 °C), this shows that specific heat of a composite increases with Addition of chalk powder. Specific heat is decrease beyond 80 °c that is heat storing capacity decreases.



**Fig.16. Specific heat of specimens**

**7.2.3 Thermal diffusivity:**

Thermal diffusivity of all specimens are tabulated and graphical represented below. It shows that thermal diffusivity of pure is higher than the composites but addition of chalk powder to the resin thermal diffusivity of this composite reaches to pure at 55°C.



**Fig.17. Thermal diffusivity of specimens**

**Table.12. Thermal Diffusivity of specimens**

Specimens	Thermal diffusivity (m <sup>2</sup> /s)
Pure	0.196
Untreated	0.129
Treated	0.14
1% Addition of chalk powder	0.168
2% Addition of chalk powder	0.18

When compared to un-treated and treated composites thermal diffusivity of treated composite is slightly higher. Thermal diffusivity of composite increased with addition of chalk powder.

**5 CONCLUSIONS**

The thermal and mechanical properties such as thermal conductivity, specific heat, thermal diffusivity, tensile strength, flexural strength, impact strength of natural

fiber reinforced composites are determined experimentally.

- 1) By using chemical treatment we can increase the Tensile, flexural and impact strengths.
- 2) By adding chalk powder (1%, 2%) we can increase the impact strength and flexural strength but tensile strength remains same.
- 3) It can be seen that by varying volume of fiber the mechanical properties of the composite also change. by increase in volume of fiber in composite mechanical properties also increased up to maximum loading.
- 4) It can be seen that there is an appreciable increase in Tensile properties on chemically treated composite when compared to un treated fibered composites they are( 51.53N/mm<sup>2</sup> for untreated tensile strength,67.23N/mm<sup>2</sup> for treated composite).
- 5) Flexural properties and Impact strength also increased with chemically treated fibered composite when compared with untreated fibered composite (Flexural strength are 173.96 N/mm<sup>2</sup> for un treated, 184.48 n/mm<sup>2</sup> for treated fibered composite. Impact strengths are 467.5 J/m for un treated, 510 J/m for treated fiber composite.
- 6) Addition of chalk powder (1%, 2%) to the resin and prepare composite with this the mechanical properties are slightly changed.
- 7) Thermal conductivity of the composite which is prepared by chemically treated fibered composite increased from 0.18 to 0.2 w/mk at 55<sup>0</sup>C temperature.
- 8) Specific heat capacity of the composite which is prepared by chemically treated fibered composite increased at30<sup>0</sup>C to 80<sup>0</sup>C temperature. At this temperature composite holds high temperature.
- 9) Thermal diffusivity of the composite which is prepared by chemically treated fibered composite increased from 0.129 to 0.14.
- 10) By addition of chalk powder (1%, 2%) to the matrix material the thermal properties are increased when compare to without addition.
- 11) When compared to 1% addition of chalk powder to composite to 2% addition of chalk powder to composite thermal diffusivity increased by 0.168 to 0.18.
- 12) When compared to 1% addition of chalk powder to composite to 2% addition of chalk powder to composite specific heat capacity is increased(30<sup>0</sup>c to 80<sup>0</sup>)

## REFERENCES

1. Mori H., Takagi H., Hino J. and Nakaoka M., Damping Properties of Bamboo Fiber
2. Reinforced Eco-Composites, Journal of Ecotechnology Research, Vol. 10, No. 4, 174-175, 2004.
3. Netravali, A.N. and Chabba, S., Composites Get Greener, A Review Feature, Materials Today, 6, 4, 22-29, 2003.
4. Oksman, K., Skrifvars, M. and Selin, J.-F., Natural fibers as reinforcement in polylactic acid (PLA) composites, Compos Sci Technol, 63, 1317-1324, 2003.
5. Okubo, K., Takagi, H. and Goda, K., Green Composites' Research and Today's Progress, Journal of the Society of Materials Science, Japan, Vol. 55, No. 4, 438-444, 2006.
6. THERMAL CONDUCTIVITY BEHAVIOR OF NATURAL FIBER-REINFORCED COMPOSITES Ryosuke Osugi1\*, Hitoshi Takagi2, Ke Liu1, and Yusuke Gennai1 Graduate School of Advanced Technology and Science, The University of Tokushima 2-1 Minamijousanjima-cho, Tokushima 770-8506 Japan 2 Institute of Technology and Science, The University of Tokushima 2-1 Minamijousanjima-cho, Tokushima 770-8506 Japan .
7. Thermal Properties of Maize Fiber Reinforced Unsaturated Polyester Resin Composites Saravana Bavan D and Mohan Kumar G C. Member, IAENG.
8. Effect of Alkaline Treatment on Mechanical and Thermal Properties Oftypha Angustifolia Fiber Reinforced Composites M.Dedeepya, T.Dharma Raju & T. Jayananda Kumar.
9. Effect of Silica on Thermal and Mechanical Properties of Sisal Fiber Reinforced Polyester Composites.
10. Thermal Conductivity Characterization of Composite Materials Bhyrav Mutnuri Thesis Submitted to the College of Engineering and Mineral Resources at West Virginia University.
11. Mechanical and Thermal Behaviour of Ecofriendly Composites Reinforced by Kenaf and Caroà Fibers *P. Persico, D. Acierno, C. Carfagna, and F. Cimino* Institute of Chemistry and Technology of Polymers National Research Council of Italy, Via Campi Flegrei, 34 80078 Pozzuoli (Na), Italy.
12. The Effect of Curative Concentration on Thermal and Mechanical Properties of Flexible Epoxy Coated Jute Fabric Reinforced Polyamide 6 Composites Smith Thitithanasarn1\*, Kazushi Yamada1, Umaru

S. Ishiaku, Hiroyuki Hamada Department of Advanced Fibro-Science, Kyoto Institute of Technology, Kyoto, Japan; Department of Textile Science and Technology, Faculty of Science, Ahmadu Bello University, Zaria, Nigeria.

13. Effect of Chemical Treatment on Physical, Mechanical and Thermal Properties of Ladies Finger Natural Fiber S. I. Hossain, M. Hasan, Md. N. Hasan, and A. Hassan Department of Materials and Metallurgical Engineering, Bangladesh University of Engineering and Technology, Dhaka 1000, Bangladesh.