International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org || PP. 14- 20

Experimental Analysis on Wear Behaviour of Banana - Pineapple Hybrid Natural Fiber Composites

K V P P Chandu[1], S.V.Gopala Krishna[2], B V Subrahmanyam[3], K Venkateswar Rao[4]

[1,2&3]*(Assistant Professor, Department of Mechanical Engineering, Sir C R Reddy college of Engineering, Eluru, India)*
[4]*(Professor & Head, Department of Mechanical Engineering, Sir C R Reddy college of Engineering,Eluru, India)*

Abstract: *According to the environmental aspect, natural fibre composites have been developed for making eco-friendly products. The present investigation has been made to find out the wear rate of Natural hybrid composites fabricated from banana and pine apple fibres. Fibres of 12%(weight fraction) are chopped into 5mm length and mixed with epoxy resin and hardener of 88% (weight fraction).The compositions of fibres of pine apple and banana were chosen as 50/50,70/30 &30/70 and then the composite samples were prepared by hand lay-up technique. Experimentations were carried out with the varying loads (2kg, 4kg &6kg),at different sliding velocities (1m/s, 0.75m/s) for determining the wear loss & fictional force by pin on disc test ring. The samples were compared with the pure epoxy, banana epoxy & pine apple epoxy. Wear rate and frictional force were found to be increasing with the applied load increases.*

Keywords: *Natural fibers, Wear rate, hybrid composite, frictional force*

I. Introduction

India endowed with abundant availability of natural fibers such as Jute, Coir, Sisal, Pineapple, Bamboo and Banana etc, has focused on the development of natural fiber composites to explore value added applications. Such natural fiber composites are well suited as wood substitutes in the housing and construction sector. The development of natural fiber composites in India is based on strategies of preventing depletion of resources as well as ensuring good economic returns of the cultivation of natural fibers.

The literature survey is carried out as a part of the thesis work to have an overview of the production process, properties and tribological behavior of polymer composites. A review of a available literature is done to put forward the background information on the issues to be considered in this thesis and to highlight the importance of present study.

Gyanaranjan Mishra et.al[01] Investigated on Characterization Of Hybrid FRP Composites With Hydrothermal Exposure Under Varied Ambient Conditions .This aims at assessing the effect of moisture and temperature on FRP composites

Dr.ing,Dipl [02] studied Applications of natural fiber composites for constructive parts in Aerospace, Automobiles and Other Areas. An interesting option is where construction materials made of renewable resources that consist of natural fibers are embedded in so-called biopolymers, as these also involve economically and ecologically acceptable manufacturing technologies

Daimler Benz have used door panels made from natural fiber-reinforced plastic for their Mercedes G class cars. Once developed, the technology would be revolutionary making a vast array of Eco-friendly products.

N. Vijaya Kumar et.al [04] Studied the wear behavior of polymer composites at different loads and at varied sliding velocities, and found that the coefficient of friction decreases when increasing of load. It was also observed that the addition of filler increases the coefficient of friction up to 12.5% and decreases after 15% additional onwards. The coefficient of friction decreases with increase in load and increases with addition of filler at 75 cm/sec & 100cm/sec sliding velocities.

A.Thimmana Gouda, et.al [05] studied of 12%, 24% and 36% of Hybrid Fiber (Natural fiber- Sisal, Jute and Hemp) and observed that 12% Hybrid Natural fibre Polymer Composites have wear rate of 37 micrometers for 20N, 220 micrometers for 40N and 58 micrometers for 60N and 222 micrometers for 80N. From these results it is found that as weight increases the wear rate also increases.

K Vignesh., et.al [06] investigated the abrasive wear performance in the coconut shell powder (CSP) and coir fiber reinforced polyester resin composites. polymer matrix composites 400μm grit size abrasive paper was used in the study with the velocity of 2.0 m/s at the varying load conditions 5N, 10N, 15N, 20N and 25N. The wear rate is decreased with the addition of CSP and coir fiber. It was observed that when the applied load is increases, the friction at the contact surface of the material and rotating disc is also increases.

S.Madhusudan, et.al [07] were studied The war behaviour of coir fibre reinforced epoxy composites with the taguchi method.It is found that the treated fibre composite shows better wear resistance than the untreated fibre composites. Abrasive wear rate is decreased with increasing the coir dust amount. As the load increase the wear rate increases also observed similar trend also observed in velocities also. Sandhya rani bishwas et.al [08] investigated hybrid composites reinforced with synthetic fibres and a natural fibres is to get advantage of superior tribological properties and economy.

Antaryami Mishra, et.al [09] investigated with Composite pins of rubber dust collected from tyre retreading centres of trucks, cars and buses et, and epoxy with weight percentages of 10. 15 and 20 % of rubber (weight fractions of 9, 13 and 17 % respectively)and found that the specimens have exhibited very low coefficient of friction and low wear rates under dry sliding condition. He also concluded that the specimen with 10% rubber dust by weight has shown lowest wear rates. However a peculiar result i.e. decreasing trend has been obtained with 20% reinforcement of rubber in epoxy while rubbed against steel at varying speeds.

S.k.Acharya, et.al [10] investigated erosive wear behaviour of untreated luffa cylindrica fibre and glass fabric reinforced epoxy hybrid composites. Composite laminates were fabricated by hand lay-up technique. these composites have been evaluated at different impingement angles (30º,45º,60°,90°) and at four different particle speeds (V=48, 70, 82, 109 m/s). It was concluded that the erosive wear behaviour of natural fibres can be improved significantly by hybridizing with synthetic fibre glass.

II. Methodology

The procedure sequentially touches various stages involved in a fabrication process aimed to avoid typical and repetitive mistakes. Various important stages during preparation of test specimens as follows

- Collection and preparation of fibers.
- Computation of volume fraction to weight fraction.
- Preparation of moulds.
- Cutting length of 5 mm both the fibers.
- Sequence of recording the data.
- Resin mixing preparation.
- Pouring of resin into mould.
- Extraction of specimen and finishing.
- Cutting and reducing the diameter as per ASTM standards

Raw Materials:

Raw materials used in this experimental work are:

i. Natural fibers Banana and pineapple
ii. Epoxy resin
iii. Hardener

Fabrication of composite:

For the preparation of the composites, Percentage of fibers, polymer and hardener required were calculated as tabulated below .A wooden mould of dimension 300*50*150mm was taken and 12mm diameter holes are drilled with drill depth of 120mm

Table 2.1 Composition and designation of composites

S. No	Banana (%)	Pineapple (%)	Epoxy (%) Matrix	Fiber (%)
1	100	0	88	12
2	70	30	88	12
3	50	50	88	12
4	30	70	88	12
5	0	100	88	12
6	0	0	100	0

***Fig* 2.1 Test Specimens**

2.1 Experimental Procedure:

Composites were prepared with matrix reinforcements as the given method in the above table poured in a test tube . The whole setup is placed into the wooden mould. The curing time for the preperation is 48 Hours and then the test tube is seperated from mould all test tubes were breaked in order to remove the specimen and they were kept of sun light for removing of moisture in composites The test specimens were prepared accordingly to ASTM G-99 standards (American Society for Testing Materials).

2.2 Experimental Setup:

Wear test have been conducted in the Pin-on-disc type Friction and Wear monitor (DUCOM TL20) with data acquisition system which was used to evaluate the wear behaviour of the composites. It is versatile equipment designed to study wear under sliding condition only. Sliding generally occurs between a stationary specimen Pin and a rotating disc against hardened ground steel disc (En- surface roughness (R a) 0.5 µm.

Fig 3.16 Experimental Setup

The disc rotates with the help of a D.C. motor; having speed range 0-2000rev/min with wear track diameter of 100 mm. Load is applied on pin (specimen) by dead weight through pulley string arrangement.

Wear Test by Pin on disc Test Machine:

Wear occurs due to the surface contact between the two components. In these two components, one is fixed and other one is movable or both the components are movable in opposite direction. Controlling the friction and the wear during the movable member of the equipment is one of the critical factors in the industrial department. It is essential to contain the analysis of comparable data with the variables such as moisture, temperature and lubricant. The most universal test assemble utilize either a pin or a ball to press against the flat face of the disc. Pictorial representations of probable conditions of the wear occurrence in pin and disc the wear occurs while the pin directly contact with the flat rotating disc. This can be occurs in three possible ways. The probable paths are

a) The wear occurs only in the pin,
b) The wear occurs only in the disc and
c) The wear occurs on both the pin and the disc.

The specimen is tested as per the testing standard ASTM G99 to investigate the abrasive wear rate. The force is applied on the flat rough surface rotary disc through the testing specimen. The testing specimen is weighted before the wear test. The testing specimen is held by the chuck with the grit size of 0.2microns. The normal load is applied to the testing specimen. The specimen is contacted with the rotating disc. Due to the contact between the specimen and rotating disc, the friction is occurs. The specimen is getting the wear. The testing specimen is soft compared to the rotating disc. This is the reason for the testing specimen to get the wear.

The rotating disc speed is 1.0 and 0.75m/s. The sliding distance is 200m. The load is applied in various ranges such as 20N, 40N and 60N. As per ASTM standard, determine the wear rate by measuring proper dimensions of both the specimens such as the ball and the disc before and after the experiment or by means of weighing both the specimens in the pre-test and post- test. During the test even the linear measurements must be noted down.

III. Results And Discussions

Mechanical Characteristics Of Composites:

Natural fibres have been developed day by day due to their superior properties. In this part, the investigation of the wear behaviour of banana and pineapple reinforced hybrid composites of randomly oriented of different fibre weight fractions are carried out.

.

Results Of Wear Properties Of Hybrid Composites:

Table 3.1 Weight loss at different loads and at 1m/s sliding velocity

LOAD	SP1 50B/50P	SP2 70B/30P	SP3 30B/70P	SP4 0B/100P	SP5 100B/0P	SP6 PURE EPOXY
2 KG	0.001	0.002	0.001	0.001	0.001	0.001
4KG	0.002	0.001	0.001	0.001	0.001	0.002
6KG	0.003	0.002	0.003	0.002	0.002	0.003

Table 3.2 Weight loss at different loads and at 0.75m/s sliding velocity

LOAD	SP1 50B/50P	SP2 70B/30P	SP3 30B/70P	SP4 0B/100P	SP5 100B/0P	SP6 PURE EPOXY
2 KG	0.001	0.001	0.002	0.001	0.001	0.001
4 KG	0.002	0.002	0.001	0.001	0.001	0.001
6 KG	0.003	0.001	0.002	0.002	0.002	0.002

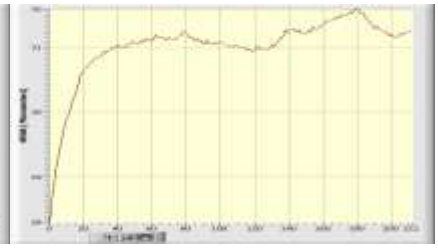
Table 3.3Coefficient of friction at different loads and at 1m/s sliding velocity

LOAD	SP1 50B/50P	SP2 70B/30P	SP3 30B/70P	SP4 0B/100P	SP5 100B/0P	SP6 PURE EPOXY
2 KG	0.05	0.04	0.02	0.02	0.04	0.05
4 KG	0.08	0.07	0.06	0.05	0.06	0.07
6 KG	0.13	0.13	0.08	0.1	0.13	0.12

Table 3.4Coefficient of friction at different loads and at 0.75m/s sliding velocity

LOAD	SP1 50B/50P	SP2 70B/30P	SP3 30B/70P	SP4 0B/100P	SP5 100B/0P	SP6 PURE EPOXY
2 KG	0.05	0.1	0.16	0.06	0.03	0.02
4 KG	0.10	0.05	0.17	0.14	0.15	0.10
6 KG	0.19	0.12	0.04	0.10	0.09	0.21

IV. Wear Test Graphs:



3.1 Time Vs Wear curves are generated by varying loads (2 kg,4 kg &6kg) with sliding velocities(1 m/s&0.75 m/s)

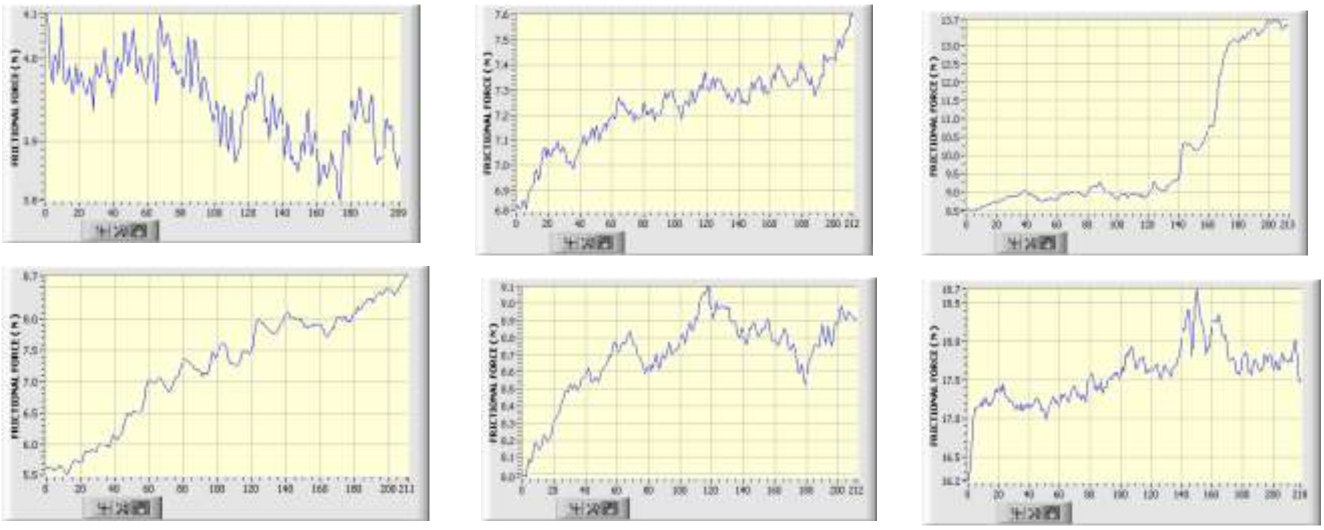


Fig: 3.2 Time Vs Frictional Force curves are generated by varying loads (2kg, 4kg &6kg) with sliding velocities (1m/s&0.75m/s).

%Composition Vs Weight loss, frictional force, wear &coefficient of friction at sliding velocity 1.0 M/S:

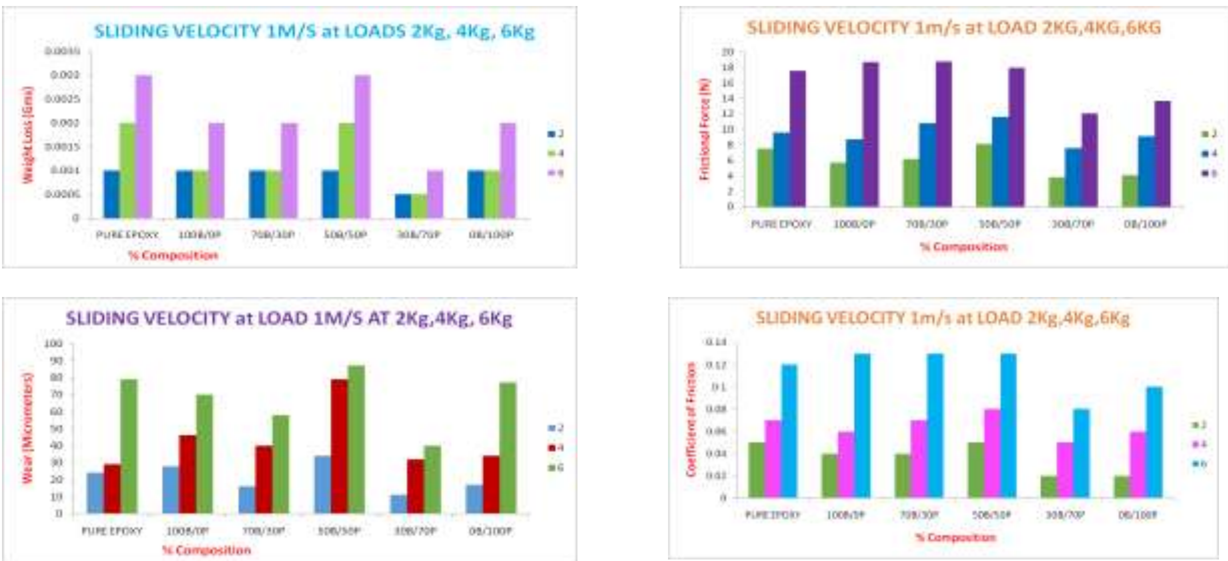
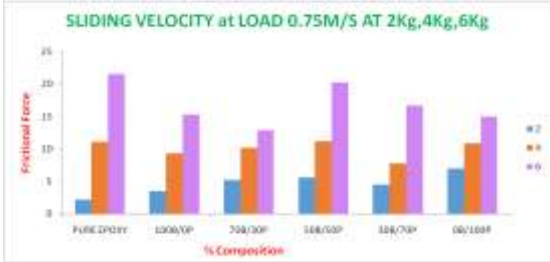


Fig 3.3 %Composition Vs Weight loss , frictional force, wear &coefficient of friction at sliding velocity 1.0 M/S

Fig 3.3 Shows the comparison between % of composition verses weight loss, frictional force, wear and coefficient of friction of composites with different loads at 1m/s sliding velocity. It is observed that hybrid composite 30B-70P shows lower weight loss, frictional force, wear and coefficient of friction when compared to pure composites and other hybrid composites due to proper bonding between matrix and reinforcements.

%Composition Vs Weight loss , frictional force, wear &coefficient of friction at sliding velocity 0.75M/S:



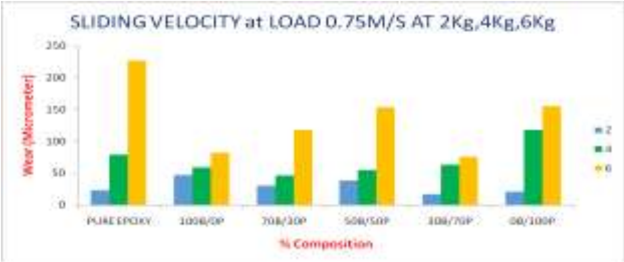


Fig 3.4 %Composition Vs Weight loss , frictional force, wear &coefficient of friction at sliding velocity 0.75m/s

Fig 3.4 similarly shows the comparison between % of composition verses weight loss, frictional force, wear and coefficient of friction of composites with different loads at 0.75m/s. It is observed that hybrid composite 30B-70P shows lower weight loss, wear and coefficient of friction when compared to pure composites and other hybrid composites due to proper bonding between matrix and reinforcements.

The wear resistance of polymer composites depends on the applied load, chemical bonding and the mechanical properties of materials. The surface of polymeric materials is smooth when compared to the surface of conventional materials. The load was increased gradually and the weight loss also proportionately increased due to the higher amount of penetration. Sliding velocity is directly proportional to the wear rate of material. The random distribution of the fiber in resin and sliding direction must have definitely affected the formation of chemical bonding subsequently influenced the friction coefficient of polymeric materials. The matrix present in between the fiber were easily split and brushed away by the hard and rough interaction resulting in high wear

V. Conclusion

From the experimental investigation on banana-pineapple fibres reinforced hybrid composites the following conclusions have been arrived at Banana-Pineapple fiber reinforced hybrid composite has been fabricated successfully by using hand lay-up technique for low cost, light weight and eco-friendly. For a given composites with defined constitutes of fiber and matrix the wear rate proportionate due to increase in the normal applied load. The coefficient of friction almost remains constant. The results demonstrate that there is a direct relationship between the sliding distance and wear rate as the sliding distance increases proportionately wear rate increased

It is found that hybrid composites 30B-70P shows lower weight loss, frictional force, wear and coefficient of friction with different loads at 1m/s sliding velocity when compared to pure composites and other hybrid composites due to proper bonding between matrix and reinforcements.

References

[1] Gyanaranjan Mishra, Chaitanya Prasad Baske et.al "Characterization Of Hybrid Frp Composites With Hygrothermal Exposure Under Varied Ambient Conditions".

[2] Dr.ing,Dipl "Applications of natural fiber composites for constructive parts in Aerospace, Automobiles and Other Areas.

[3] Keshav Singh Bisen, Vikas Sahu, Murali Krishna.M "Mechanical Behaviour of Banana and Pineapple Hybrid Composites Reinforced with Epoxy Resin" *International Journal of IT, Engineering and Applied Sciences Research (IJIEASR) ISSN: 2319-4413 Volume 4, No. 2, February 2015*

[4] Vijaya kumari, Gowthami priyanka Et.al "Evolution of Wear Properties of Jute Reinforced Polypropylene Composites". *International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181IJERTV3IS111035 Vol. 3 Issue 11, November-2014*

[5] Thimanna gouda, Jagadish Et.al "Wear Study on Hybrid Natural Fibre Polymer Composite Materials used as Orthopaedic Implants*". International Journal of Recent Development in Engineering and Technology Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 3, Issue 1, July 2014).*

[6] Vignesh, nataraj Et.al "Wear Behaviour of Coconut Shell Powder and Coir Fibre Reinforced Polyester Composites*". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334XPP 53-57.*

[7] Madhusudhan, Chandra rao Et.al "Investigation into Wear Behaviour of Coir Fibre Reinforced Epoxy Composites with the Taguchi's Method".*International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 5, September- October 2012, pp.371-374.*

[8] Sandhya Rani Bishwas Et.al "Erosion wear Behaviour of Bamboo/glass Fibre Reinforced Epoxy Based Hybrid Composites*". International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-1, Issue-4, 2012.*

[9] Antaryami mishra Et.al "Dry sliding wear Behaviour of Epoxy-rubber Dust Composites*". International Scholarly and Scientific Research & Innovation* 6(7) 2012.

[10] Acharya, niharika Et.al "Effect of fibre Content on Abrasive Wear of Lantana Camera Fibre Reinforced Polymer Matrix Composite". *Indian journal of engineering and material science, vol. 17,june 2010,pp. 219-223.*

[11] Venkateswara rao,sri rama murthy Et.al "Investigation IN TO Erosion Wear performance of Hybrid Composites using Taguchi Approach". *International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622www.ijera.com Vol. 2, Issue 5, September- October 2012, pp.375-378*

[12] L.UMA DEVI, S.S.BHAGAWAN, Et.al "Mechanical Properties of Pineapple Leaf Fiber-Reinforced Polyester Composites". *1997 John Wiley & Sons, Inc. CCC 0021-8995/97/091739-10.*

[13] Chandra Sekhar, Dr. V. Pandurangadu, Et.al "Biodegradation of Emu Feather Fiber Reinforced Epoxy Composites*". IJERT ISSN: 2278-0181 Vol. 4 Issue 06, June-2015.*

[14] Ragavendra, Gopi chand Et.al "Abrasive wear behaviour of bamboo-glass fibrereinforced epoxy composites using taguchi approach". *International Journal of Advances in Engineering & Technology, Nov. 2012. IJAET ISSN: 2231-1963.*

[15] Rajashekaran, Et.al "experimental analysis on wear behaviour of natural fibre reinforced polymer composites". *Journal of Manufacturing Engineering, September 2015, Vol. 10, Issue.3, pp 139-143*

[16] Venkateswara Rao T, Venkatarao K, Et.al "Mechanical Properties of Bamboo Fiber filled with Fly Ash filler Reinforced Hybrid C composites*". IJERT ISSN: 2278-0181 Vol. 3 Issue 9, September- 2014.*

[17] Madhukiran.J, Dr. S. Srinivasa Rao, Et.al "Fabrication and Testing of Natural Fiber Reinforced Hybrid Composites Banana/Pineapple". *IJMER Vol. 3, Issue. 4 July-august 2013, pp-2239-2243 ISSN: 2249-6645.*

[18] N.Venkateshwaran, A.ElayaPerumal, Et.al "Mechanical and Water Absorption Behavior of Banana/Sisal Reinforced Hybrid Composites".

[19] Vikas Sahu, Keshav Singh Bisen, Et.al "Mechanical Properties of Sisal and Pineapple Fiber Hybrid Composites Reinforced With Epoxy Resin". *IJMER ISSN: 2249–6645 Vol. 5, Iss.1, Jan. 2015.*

[20] Kotresh Sardar, Dr.T.Ranga swamy, Et.al "Fabrication and Investigation of Bending Test on Hybrid (Sisal and Banana) Fiber Reinforced Polyester Composite Material*". IJMER ISSN 2347-6435Volume 3, Issue 6, December 2014).*

[21] Chama Ajay Srinivas, G Dilli Babu Et.al "Mechanical and Machining Characteristics of Calotropis Gigentea Fruit Fiber Reinforced Plastics". IJERT ISSN: 2278-0181.