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Processing and Testing of Epoxy Polymer Composites using Tender Palm Shoot Fiber and Aluminium Particles as Hybrid Reinforcements

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Abstract*: Every year tons of plant and animal wastes are produced in the world. Some of these waste products may find some potential application in our day-to-day life. Also pure polymers are non-biodegradable and usually don't possess requisite mechanical strength. For the first time, tender palm shoots are used as fiber reinforcement in the epoxy resin. The main objective is to compare and fabricate natural fiber reinforced hybrid epoxy composites with tender palm shoots, palymra fiber, as natural reinforcements which are generally leftovers and Aluminium powder as conductive filler by hand lay-up process at various weight percentages. Different mechanical properties, water absorption characteristics, flammability and electrical conductivity are evaluated as per ASTM standards. The test results show that these composites can be used as alternative materials for low tensile and high impact applications.

***Keywords* : Epoxy, Tender palm shoots, Palmyra fiber, Hand layup.**

INTRODUCTION

Now a day's globally extensive research is focused on in development of natural fiber composites. Increase in awareness of environment throughout the world has developed an interest in natural fibres because of biodegradability. Plant fiber based composite are use in automobile and building industry. In order to meet the industrial needs, by keeping environmental aspects in mind several researchers have put their effort in manufacturing plant and animal waste fiber composites for some day today life applications. Some of the research is carried out with plant fiber like banana, coconut, pineapple-leaf, jute sisal etc [1, 2, 4, 6] and aquatic bio waste like fish scales [3, 5] evaluated natural fiber as an alternative to man-made fiber in composites. In the present work, natural fibers are added so that at least a small quantity of plastic which is equal to the weight percentage of fiber is bared from usage. A comparative study was done on the effect of adding different proportions of reinforcement fibers (tender palm shoot central stem and palmyra palm fibers) and Al powder in epoxy resin. Epoxy is a well-known thermosetting plastic and it is widely used because of its low cost and easy formability. Despite its great potential, there is a negative effect on the environment because of the post consumed epoxy products, Virgin epoxy is not bio-degradable and on incineration of epoxy, toxic gases are released which are harmful to the environment. The tender palm shoot (Borassus flabellifer) is the part emerging from the centre portion of tender palm fruits. These shoots are thin and about 150 to 200 mm long.

Fig.1 Tender palm shoots and central fiber

Fig. 2 Palmyra palm fruit with fibers

It is starch based root (shown in figure 1) surrounded by a thin fibre layers and a central stem. The part used for extraction of fiber is the central stem of the shoots which is a leftover part of the tender palm shoots.

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After consuming the starch part, the fibres are thrown as a bio-waste, this waste fiber is used as a reinforcement in the current study. In order to compare the potentials of newly made tender palm shoots composites the already exiting palmyra palm fiber (shown in figure 2) composites are also prepared. In this study, epoxy is used as the main matrix with tender palm shoots and aluminium powder as reinforcements. The volume percentage of reinforcements is kept in the range of 5%-20%. The use of fillers will bring down the overall amount of epoxy usage and the natural fibers will be replaced by synthetic. In order to induce electric conductivity in composites small amount of aluminium powder is also used in preparation but there was no

Table- I: Composite samples

Code	*Composite*	*Epoxy* *Wt%*	*Tender palm shoots* *Wt%*	*Palmyra fiber* *Wt%*	*Aluminium Powder* *Wt%*
S1	Epoxy	100	0	0	0
S2	Epoxy + tender palm shoots + Al powder	85	10	0	5
S3		70	20	0	10
S4	Epoxy + Palmyra fiber + Al powder	85	0	10	5
S5		70	0	20	10

conductivity. Different tests results show that these composites can be used as alternative materials for low tensile and high impact applications in automobile and packaging industries.

II. MATERIALS AND PROCESSING

Hand layup technique was used in preparing the composites with different weight percentages of reinforcements which is shown in table 1. Central stem of tender palm shoots were extracted and treated with NaOH solution to improve interfacial bonding same was done for palmyra palm fibers also.

First a sample (S1) with only epoxy was made for comparative studies. New hybrid composite with four different combinations (S2, S3, S4 and S5) with 5wt%, 10wt% of reinforcement like tender palm shoots, aluminium powder and palmyra fiber aluminium powder with varying weight percentages were produced in rectangular wooden mould which is shown in figure 3.

Fig.3 Hand-layup of S2, S3 samples

Air bubbles or voids weakens the desired characteristics of the composites. So these are avoided by blowing hot air while filling the measuring cups with matrix materials. The composite is left to cure for 30 hrs with a dead weight of 5 kilograms. After 30 hrs, the mould is dismounted and composite specimen is dried in shade for 48hours before machining.

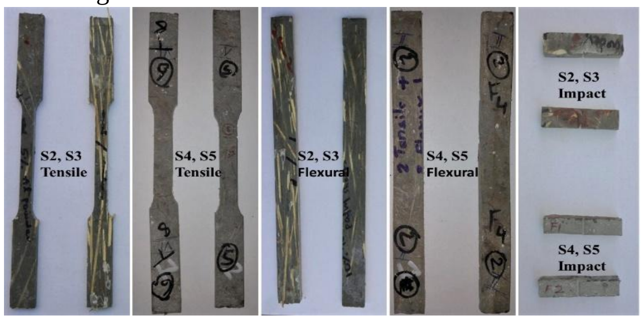

Fig.4 Machined samples for testing

Prepared composite samples were machined for tensile, flexural and impact tests as shown in figure 4. The results of different tests performed on prepared composites were shown in table 2.

Table- II: Test Results of Different Composite Samples

Code	*Tensile Strength* *MPa*	*Flexural load* *kN*	*Impact Energy Joule*	*Flammability* *Seconds*
S1	30	0.31	2	8.39
S2	16	0.22	11	9.86
S3	15	0.19	23	10.52
S4	7.1	0.12	10	8.43
S5	8.3	0.17	19	8.52

III. TESTING AND RESULTS

A. Tensile Test

The prepared composite samples were cut to a dog bone shape and tensile test was carried out in UTM machine as per ASTM D638 standard. From the table 2 it is clear that pure epoxy (S1) is having a maximum tensile strength of 30 MPa and least tensile strength of 7.08 MPa is found for (S4). However by adding tender palm shoots there is no appreciable increase in the tensile property when compared to pure epoxy but it is higher than already existing palmyra fiber composites. Hence tender pam shoot composites are better choice than Palmyra composites where ever low tensile applications are desired.

B. Flexural Test

To find the stiffness of a composites flexural test is performed on the samples based on ASTM D790 standard. The strain rate is 0.01in/in/min. Maximum Flexural load taken by the sample before bending is obtained in this test. Even in flexural test from table 2 it is clear that composites with tender palm shoots are better than Palmyra fibers.

Higher weight percentages of reinforcement did not yield in improved flexural values. Sample S1 with 10% fiber is having a better value of 0.22KN.

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C. Charpy Impact Test

Impact test is performed to measure the toughness of a material. Samples are fabricated and tested based on ASTM D256 standard. Impact energy absorbed by the samples before fracture is noted and results can be seen in table 2. For S3 tender palm shoots composites, the improvement is almost 11 times and for S5 composites, it is 7 times when compared to virgin epoxy resin. Hence these tender palm shoot composites may be used for high impact applications.

D. Water Absorption Test

Composites of circular shape has been submerged in water for 48 hrs and its dimensions are measured before and after submersion. The weight of the sample remained same i.e., 127 grams as measured on digital weighing machine and there was no change in dimensions as well. Pure epoxy does not absorb water even by addition of fibers has no effect on water absorption.

E. Flammability Test

Generally pure epoxy burns and takes only few seconds for epoxy to catch fire. Samples of 70 mm length are taken and subjected to flame and the time at which the sample caught fire is noted and is shown in table 2. Addition of Al powder and reinforcements has very little effect on flammability of the composites. The tender palm shoot fiber composite (S3) have higher fire retardant property when compared to other samples.

F. Electrical Conductivity Test

Al powder is added during preparation to check if conductivity is possible in epoxy. Samples S2, S3, S4 and S5 are tested in both dry and wet conditions on the setup. Samples of length 50mm are cut from test specimen and few samples are submerged in clean water for 48 hrs. Different voltages like 12V DC, 230V AC and 2kV AC are applied to samples in dry and wet conditions.

A setup is made using two copper plates as electrodes, a 12V DC battery and multimeter to measure current. Current is measured without any sample between the electrodes and 0.66 amp current is recorded on multimeter. In the next attempt, sample is placed between electrodes and tried to record the current in the multimeter no conductivity is observed in the samples. Next 230V AC is also applied to the sample but no conductivity is observed.ve

IV. CONCLUSION

Among all the test results, impact values are good for all the types with 20% tender palm shoots composites being the better material. Almost 11 times increase in the impact value is observed when compared to pure epoxy. Natural fiber composites are generally known to absorb moisture. But there is moisture absorption in case of these composites for a time period of 48hours. Addition of aluminium powder made the composites ductile. And also there is no appreciable improvement in the mechanical properties. This may be due to poor bonding of matrix and Al powder phase with reinforcement. Flammability test for tender palm shoots shown the positive results. Al powder which is used as conductive filler in these composites did not have any effect on electrical conductivity even at a high voltage of 2kV AC. Electrical conductivity might be possible when greater amounts of Al powder are added.

REFERENCES

1. Begum K. et al, (2013), 'Natural Fiber as a substitute to Synthetic Fiber in Polymer Composites: A Review', Research Journal of Engineering Sciences, Vol. 2(4), pp. 46-53.
2. V.D. Shinde et al, (2014), 'Review on natural fiber reinforcement polymer composite', International Journal of Engineering Science and Innovative Technology, vol. 3, no. 2, pp. 431–436.
3. V. Gopi et al, (2016), 'Characterization of Fish Scale Reinforced Composites', International Journal of Engineering Science and Computing, Volume 6 Issue No. 5.
4. K. Alagarraja et al, (2014), 'Fabrication and Testing of Fibre Reinforced Polymer Composites Material', IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 2/18, pp 27-34.
5. Ali Razmavar et al, (2012), 'Mechanical Characterization, Fabrication and FTIR Spectroscopic Analysis of Fish Scale Reinforced Epoxy Composites',Advanced Materials Research Volume 445, pp 889-892.
6. N. Sankar et al, (2015), 'A Study on Mechanical Behaviour of Natural Fiber Reinforced Composite', (IJ0SER), Vol 3 Issue 5, 3221 5687, (P) 3221 568X.
7. Sanjeevamurthy et al, (2012), 'Tensile Properties of Natural Fiberreinforced Epoxy-Hybrid Composites', (IJMER), Vol.2, Issue.2, pp-471-474.
8. Madhukiran J. et al, (2013), 'Fabrication and Testing of Natural Fiber Reinforced Hybrid Composites Banana/Pineapple', (IJMER), Vol. 3, pp-2239-2243
9. T. Madhusudhan et al, (2016), 'A Review on Mechanical Properties of Natural Fiber Reinforced Hybrid Composites', (IRJET), Volume: 03, p-ISSN: 2395-0072
10. M. R. Sanjay et al, (2016), 'Studies on Mechanical Properties of Jute/E-Glass Fiber Reinforced Epoxy Hybrid Composites', Journal of Minerals and Materials Characterization and Engineering.

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