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EXPERIMENTAL INVESTIGATION OF PALM& SISAL FIBER BASED POLYMER MATRIX COMPOSITE COUPONS

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Abstract : Recently there has been a greater inclination towards natural fiber reinforced plastic composites because these are environmental friendly and cost effective to synthetic fiber reinforced composites. The availability of natural fiber and ease of manufacturing have tempted researchers worldwide to try locally available inexpensive fiber and to study their feasibility of reinforcementpurposes and to what extent they satisfy the required specifications of good reinforced polymer composite for structural application. Natural fibers were initially used in composite materials to predominately improve bulk and reduce cost rather than improving mechanical properties.In order to conserve natural resources and economize energy, weight reduction has been the main focus of machine parts manufacturers in the present scenario. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The Palm and sisal fiber reinforced composite is one of the potential items for weight reduction of about 20% - 30%.In this project our ultimate aim is to fabricate the new class of epoxy based composites reinforced with short Palm and sisal fiber. Evaluate the mechanical properties such as tensile strength and hardness of prepared reinforced composite and to check the cracks present in the material using Die Penetrant NDT technique.

Key Words : Natural Fiber- Reinforced Plastic Composites- Environmental Friendly- Mechanical Properties- NDT

1 INTRODUCTION

It is a truism that technological development depends on advances in the field of materials. One does not have to be an expert to realize the most advanced turbine or air-craft design is of no use if adequate materials to bear the service loads and conditions are not available. Whatever the field may be, the final limitation on advancement depends on materials. Composite materials in this regard represent nothing but a giant step in the ever constant endeavor of optimization in materials.

Strictly speaking, the idea of composite materials is not a new or recent one. Nature is full of examples wherein the idea of composite materials is used. The coconut palm leaf, for example, is nothing but a cantilever using the concept of fiber reinforcement. Wood is a fibrous composite: cellulose fibers in a lignin matrix. The cellulose fibers have high tensile strength but are very flexible (i.e. low stiffness), while the lignin matrix joins the fibers and furnishes the stiffness. Bone is yet another example of a natural composite that supports the weight of various members of the body. It consists of short and soft collagenfibers embedded in a mineral matrix called apatite. In addition to these naturallyoccurring composites, there are many other engineering materials that are composites in a very general way and that have been in use for very long time. The carbon black in rubber, Portland cement or asphalt mixed with sand, and glass fibers in resin are common examples. Thus, we see that the idea of composite materials is not that recent. Nevertheless, one can safely mark the origin of the distinct discipline of the composite materials as the beginning of the 1960s. It would not be too much off the mark to say that a concerted research and development effort in composite materials began in 1965. Since the early 1960s, there has been an increasing demand for materials that are stiffer and stronger yet lighter in fields as diverse as aerospace, energy and civil constructions. The demands made on materials for better overall performance are so great and diverse that no one material can satisfy them. This naturally led to a resurgence of the ancient concept of combining different materials in an integral-composite material to satisfy the user requirement. Such composite material systems result in a performance unattainable by the individual constituents, and they offer the great advantage of a flexible design; that is, one can, in principle, tailor-make the material as per specifications of an optimum design.

OBJECTIVE OF THE PRESENT RESEARCH WORK

The knowledge gap in the present literature review has helped us to setthe objectives of this research work which are pointy highlighted below:

- Fabrication of a new class of epoxy based hybrid compositesreinforced with Palm and Sisal fiber.
- Evaluation of mechanical properties such as tensile strength andhardness of composites.
- Go for NDT based DP test for identifying the cracks present in thecomposite material.

2 LITERATURE REVIEW

S.M. Sapuan et al. [1] were carried out the experiments of tensile and flexural (three-point bending) tests using natural fiber with composite materials (Musaceae/epoxy). It was found that the maximum value of stress in x-direction is 14.14 MN/m2, meanwhile the maximum value of stress in y-direction is 3.398 MN/m2. For the Young s modulus, the value of 0.976 GN/m2 in x- direction and 0.863 GN/m2 in y-direction were computed. As for the case of three-point bending (flexural), the maximum load applied is 36.25 N to get the deflection of woven banana fiber specimen beam of 0.5 mm. The maximum stress and Young s modulus in x-direction was recorded to be 26.181 MN/m2 and 2.685 GN/m2, respectively. Statistical analysis using ANOVA-one way has showed that the differences of results obtained from those three samples are not significant, which confirm a very stable mechanical behaviour of the composites under different tests.

Z.N. Azwa et al. [2] evaluates the characteristics of several natural fibre composites exposed to moisture, thermal, fire, and ultraviolet degradation through an extensive literature review. The effects of chemical additives such asfibre treatments, fire retardants and Ultraviolet (UV) stabilizers are also addressed. Based on the evaluation conducted, optimum fibre content provides strength in a polymer composite but it also becomes an entry point for moisture attack. They concluded that an optimum blend ratio of chemical additives must be employed to achieve a balance between strength and durability requirements for natural fiber composites.

C.H. Chandra Rao et al. [10] has been investigate the wear behavior of treated and untreated coir dust filled epoxy resin matrix composite. It is found that the treated fiber composite shows better wear resistance than the untreated fiber 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.

Girisha.C et al. [11] study the effects of water absorption on the mechanical properties. Natural fibers like coconut coir (short fibers) and sisal fibers (long fibers) were used in hybrid combination and the fiber weight fraction of 20%, 30% and 40% were used for the fabrication of the composite. The tensile and flexural properties of Natural fiber reinforced Epoxy composite specimens were found to decrease with increase in percentage moisture uptake.

D. Senthilnathan et al. [12] are prepared six types of laminates by using the resin of LY556 and hardness HY951.The six types of laminates are Glass fiber reinforced plastic (GFRP) Coconut coir reinforced plastic (CCRP), Humanhair reinforced plastic (HHRP), Glass – Coconut coir - human hair- Glasshybrid composite (GCHGRP), Coconut coir-glass- human hair-coconut coirhybrid composite (CGHCRP) and human hair-coconut coir-glass-human hair hybrid composite (HCGHRP).

3.MATERIALS AND METHODS

This chapter deals with the details of processing of the composites and the experimental procedures followed for their mechanical characterization. Theraw materials used are:

Epoxy resin * Palm fiber *Sisal fiber * Hardener

SPECIMEN PREPARATION

Borassus flabellifer, the Asian Palmyra palm, toddy palm, or sugar palm, is native to the Indian subcontinent and Southeast Asia, including Nepal, India, Bangladesh, Sri Lanka, Cambodia, Laos, Burma, Thailand, Vietnam, Malaysia, Indonesia and the Philippines. It is reportedly naturalized in Mauritania, Socotra, and parts of China. It is a palm tree, one of the sugar palm group.Palm Fiber

The palm tree is the official tree of Tamil Nadu. Highly respected inTamil culture, it is called "karpaha Veruksham" ("celestial tree") because all its parts have a use. Panaiveriyamman, named after panai, the Tamil name for the Palmyra palm, is an ancient tree deity related to fertility linked to this palm.This deity is also known as Taalavaasini, a name that further relates her to all types of palms.

FIGURE 1 PALM FRUITS

Figure 2 Separation of Fiber

SISAL FIBER

Sisal, with the botanical name Agave sisalana, is a species of Agave native to southern Mexico but widely cultivated and naturalized in many other countries. It yields a stiff fiber used in making various products. The term sisal may refer either to the plant's common name or the fiber, depending on the context. It is sometimes referred to as "sisal hemp", because for centuries hemp was a major source for fiber, and other fiber sources were named after it.

The sisal fiber is traditionally used for rope and twine, and has many other uses, including: paper, cloth, wall coverings, carpets, and dartboards.

The native origin of Agave sisalana is uncertain. Traditionally it was deemed to be a native of the Yucatán Peninsula, but there are no records of botanical collections from there. They were originally shipped from the Spanish colonial port of Sisal in Yucatán (thus the name). The Yucatán plantations now cultivate Henequen (Agave fourcroydes).

H.S. Gentry hypothesized a Chiapas origin, on the strength of traditional local usage. Evidence of an indigenous cottage industry there suggests it as the original habitat location, possibly as a cross of Agave angustifolia and Agave kewensis. The species is now naturalized in other parts of Mexico, as well as in Spain, Libya, Morocco, the Canary Islands, Cape Verde, many parts of Africa, Madagascar, Reunion, Seychelles, China, the Ryukyu Islands, India, Pakistan, Nepal, Burma, Cambodia, Thailand, the Solomon Islands, Queensland, Polynesia, Micronesia, Fiji, Hawaii, Florida, Central America, Ecuador, and the West Indies.

Traditionally, sisal has been the leading material for agricultural twine (binder twine and baler twine) because of its strength, durability, ability to stretch, affinity for certain dyestuffs, and resistance to deterioration in saltwater. The importance of this traditional use is diminishing with competition from polypropylene and the development of other haymaking techniques, while new higher-valued sisal products have been developed.

Apart from ropes, twines, and general cordage, sisal is used in low-cost and specialty paper, dartboards, buffing cloth, filters, geotextiles, mattresses, carpets, handicrafts, wire rope cores, and Macramé. Sisal has been utilized as an environmentally friendly strengthening agent to replace asbestos and fiberglass in composite materials in various uses including the automobile industry. The lower-grade fiber is processed by the paper industry because of its high content of cellulose and hemicelluloses. The medium-grade fiber is used in the cordage industry for making ropes, baler and binder twine. Ropes and twines are widely employed for marine, agricultural, and general industrial use. The higher-grade fiber after treatment is converted into yarns and used by the carpet industry.

Other products developed from sisal fiber include spa products, cat scratching posts, lumbar support belts, rugs, slippers, cloths, and disc buffers.

Sisal wall covering meets the abrasion and tearing resistance standards of the American Society for Testing and Materials and of the National Fire Protection Association.

As extraction of fiber uses only a small percentage of the plant, some attempts to improve economic viability have focused on utilizing the waste material for production of biogas, for stock feed, or the extraction of pharmaceutical materials. Sisal is valuable forage for honey bees because of its long flowering period. It is particularly attractive to them during pollen shortage. The honey produced is however dark and has a strong and unpleasant flavor. Because sisal is an agave, it can be distilled to make a tequila-like liquor.

FIGURE 3 AFTER PREWASHED

FIGURE 4 SISAL FIBER

ALKALI TREATMENT

In order to get improved mechanical and physical characters of the composites, Palm and Sisal fiber is subjected to alkali treatment process. In alkali Treatment, fibers are firstly prewashed with huge amount of distilled water and dried at constant temperature of 50 0C. The alkalization process consisted of immersing coir and sugarcane fibers of certain weight in a 5%(w/v) Na OH aqueous solution for 3 h at 700C. After that, fiber is removed fromalkali solution and is dipped in 5 % acetic acid solution for neutralizing. Then it is washed with plenty of distilled water and is dried in an electric oven at a temperature of $110\,^{0}C$ for 2 hours.

COMPOSITE FABRICATION

Fabrication of composite is done by conventional method called hand lay-up method. Epoxy resin with its corresponding hardener in a ratio of 10:1 is thoroughly mixed. Mold releasing silicon spray is applied to mold releasing sheet and then the chopped fiber, mixed with the resin is gently poured on the sheet which is placed inside the mold. The purpose of releasing agent is to facilitate easy removal of the composite from the mold after curing. The mixture is allowed to set inside the mold for a period of 24 hours under a pressure of 20kg over the cast. Then the specimen is cut into appropriate dimension for mechanical and thermal tests. In this fabrication procedure, three classes of composites are made with different compositions are shown in the table no: 2.

Table.1 Different proportion of Composites

Sl. No	Epoxy (Wt. %)	Alkali treated Palmfiber (Wt. %)	Alkali treated sisalfiber
1.	100	0	0
2.	80	10	10
3.	90	5	5

Based on the above designation we are fabricated the specimens as per theASTM standard which is shown in the below figures 11 to 13.

FIGURE 5 FABRICATED COMPOSITES AT 0% FIBERS, 5% FIBERS, 10% FIBERS

4 TESTS AND ANALYSIS

TENSILE STRENGTH

The tensile test of the composites will be performing as per the ASTM D3039 standards. The test will be complete using a universal testing machine.A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile stressand compressive strength of materials. It is named after the fact that it can perform many standard tensile and compression tests on materials, components, and structures.

Figure 6 Before testing the work pieces

Figure 7 After testing the work pieces

COMPONENTS

Load cell - A force transducer or other means of measuring the load is required. Periodic calibration is usually required by governing regulations or quality system.

Cross head - A movable cross head (crosshead) is controlled to move up or down. Usually this is at a constant speed: sometimes called a constant rate of extension (CRE) machine. Some machines can program the crosshead speed or conduct cyclical testing, testing at constant force, testing at constant deformation, etc. Electromechanical, servo-hydraulic, linear drive, and resonance drive are used.

Means of measuring extension or deformation - Many tests require a measure of the response of the test specimen to the movement of the cross head. Extensometers are sometimes used.

Output device - A means of providing the test result is needed. Some older machines have dial or digital displays and chart recorders. Many newer machines have a computer interface for analysis and printing.

Conditioning - Many tests require controlled conditioning (temperature, humidity, pressure, etc.). The machine can be in a controlled room or a special environmental chamber can be placed around the test specimen for the test.

Test fixtures, specimen holding jaws, and related sample making equipment are called for in many test methods.

The set-up and usage are detailed in a test method, often published by a standards organization. This specifies the sample preparation, fix Turing, gauge length (the length which is under study or observation), analysis, etc.

The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips.

Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen. Machines range from very small table top systems to ones with over 53 MN (12 million lbf) capacities.

TABLE 2 TABULATION FOR TENSILE TEST

Sl. No	Epoxy (Wt. %)	Alkali treatedSisal fiber (Wt. %)	Alkali treatedPalm fiber (Wt. %)	Tensile Strength(MPa)
1.	100	0	0	15.83
2.	90	5	5	26.15
3.	80	10	10	32.34

HARDNESS

Rockwell Hardness ASTM D785 test is a hardness measurement based on the net increase in depth of impression as a load is applied. Hardness numbers have no units and are commonly given in the R, L, M, E and K scales. Higher numbers indicate harder materials. A standard specimen is placed on the surface of the Rockwell Hardness tester. A minor load is applied and the gauge is set to zero. The major load is applied by tripping a lever. After 15 seconds the major load is removed. The specimen is allowed to recover for 15 seconds and thenthe hardness is read off the dial with the minor load still applied.

Table 3 Tabulation for Hardness Test

Sl. No.	Epoxy (Wt %)	Alkali treated Sisal fiber (Wt %)	Alkali treated Palm fiber (Wt %)	Indenter	Load(kg)	RHN
1.	100	0	0	1/16 inchesBall	150	116
2.	90	5	5	1/16 inchesBall	150	107
3.	80	10	10	1/16 inchesBall	150	119

DIE PENETRANT TEST

Dye penetrant inspection can be performed at any time (after the grinding operation is most common) and is used to highlight cracks on the roll surface.A red colored dye penetrant is applied to the roll surface and the dye enters crack interfaces through capillary action. After a specific amount of time, theroll is wiped dry with clean, dry cloths. The dye will seep back out of the cracksthrough reverse capillary action. Developer is applied to the surface and the cracks are highlighted as red lines on the white background. Dye penetrant testing can also be done using a florescent dye. The cracks are then highlighted using a florescent black light instead of developer.

Dye penetrant inspection is accurate at highlighting large, wide cracks; however, if the crack is too narrow, the penetrant cannot seep into the crack and will not be highlighted when developed. It is generally preferred to perform the test after locating surface indications with eddy current and ultrasonic inspection. Only the general area of the indications can then be tested rather than the entire roll body. The following is a simplified procedure for performinga dye penetrant test using the red colored dye technique.

- Identify the defect area using Ultrasonic and Eddy Current techniques, approximately within one quadrant. Position this area where it is convenient to work on.
- Wipe the quadrant clean with a rag to remove excess grease, dirt, etc.
- Take a rag and spray the Magnaflux cleaner/remover onto the rag (sprayheavily), Use this damp rag to wipe the area again to remove residue and allow a minute to dry. Don’t spray cleaner directly on the roll; it will yield substandard results!

- Spray the area to be tested with penetrant (red dye), holding the can about 8" away from the roll surface. It is OK to overlap and to spray heavily, but too much provides no benefit.
- Allow the penetrant to soak into the roll for at least 10 minutes (longer isbetter).
- Wipe the roll down with a clean dry rag to remove most of the penetrant. Change to a clean portion of the rag periodically to avoid smearing the dye.
- After the area is visibly clean, spray the cleaner/remover onto another clean rag. Use the moistened rag to remove any residual red dye. Periodically change to a clean portion of the rag as before.
- Spray the developer onto the area to be tested, holding the can about 8" to 10" away from the roll surface. Use a side to side motion to apply the developer evenly.
- As the developer begins to dry, red lines will appear to highlight any macro cracks that exist. If no lines appear, then no macro surface cracks exist in the tested area.

FIGURE 8 CLEANER IS APPLIED INITIALLY

Figure 9 Penetrate (red dye) being applied to the suspected area

FIGURE 10 DEVELOPER BEING APPLIED TO THE SUSPECTED AREA ON THE WORK PIECE

Figure 11 After Cleaning the Work pieces

5 CONCLUSION

A detailed study has been conducted on the mechanical behavior of Palm and Sisal epoxy composite on the basis of different weight concentration of fiber. Alkali treatment of the Palm and sisal fiber has also been done. The study led to the conclusions mentioned below.

- Epoxy resin reinforced with alkali treated fiber has been fabricated by hand lay-up method. Palm Epoxy composite has been fabricatedwith same technique.
- Evaluation of mechanical properties such as tensile strength and hardness etc. of composites has been completed.
- From the result of the Die Penetrant NDT test. There is no cracks were appeared on the prepared composite.

6 REFERENCES

1. S.M. Sapuan, A. Leenie, M. Harimi, Y.K. Beng, Mechanical properties of woven banana fibre reinforced epoxy composites. Materials and Design 27 (2006) 689–693.
2. Z.N. Azwa, B.F. Yousif, A.C. Manalo, W. Karunasena, A review on the degradability of polymeric composites based on natural fibres. Materials and Design 47 (2013) 424–442.

3. J. Rout, M. Misra, S.S. Tripathy, S.K. Nayak, A.K. Mohanty, The influence of fibre treatment on the performance of coir-polyester composites. Composites Science and Technology 61 (2001) 1303–1310.
4. Thi-Thu-Loan Doan, Hanna Brodowsky, Edith Mäder, Jute fibre/epoxy composites: Surface properties and interfacial adhesion. Composites Science and Technology 72 (2012) 1160–1166.
5. S. Harish, D. Peter Michael, A. Bensely, D. Mohan Lal, A. Rajadurai, Mechanical property evaluation of natural fiber coir composite. Materials Characterization. 6 0 (2 0 0 9) 4 4 – 4 9.
6. D. Verma, P.C. Gope, A. Shandilya, A. Gupta, M.K. Maheshwari, Coir Fibre Reinforcement and Application in Polymer Composites: A Review. J. Mater. Environ. Sci. 4 (2) (2013) 263-276 Verma. ISSN: 2028-2508.
7. Tara Sen, H. N. Jagannatha Reddy, Application of Sisal, Bamboo, Coir and Jute Natural Composites in Structural Up gradation. International Journal of Innovation, Management and Technology, Vol. 2, No. 3, June 2011.
8. Gopinath. S, K. Senthil Vadivu, Mechanical Behavior of Alkali Treated Coir Fiber and Rice Husk Reinforced Epoxy Composites. International Journal of Innovative Research in Science, Engineering and Technology. Volume 3, Special Issue 1, February 2014.
9. S JAYABAL, U NATARAJAN and S SATHIYAMURTHY, Effect of glass hybridization and staking sequence on mechanical behaviour of interply coir–glass hybrid laminate. Bull. Mater. Sci., Vol. 34, No. 2, April 2011, pp. 293–298. Indian Academy of Sciences.
10. C.H.Chandra Rao, S.Madhusudan , G. Raghavendra, E. Venkateswara Rao, Investigation in to Wear behavior of coir Fiber Reinforced Epoxy Composites with the Taguchi Method. Journal of Engineering Research and Applications ISSN: 2248-9622 Vol. 2, 2012, pp.371-374.
11. Girisha.C, Sanjeevamurthy, Gunti Ranga Srinivas, Sisal/Coconut Coir Natural Fibers – Epoxy Composites: Water Absorption and Mechanical Properties. International Journal of Engineering and Innovative Technology. Volume 2, Issue 3, September 2012.
12. D. Senthilnathan, A Gnanavel Babu, G. B. Bhaskar, KGS. Gopinath, Characterization of Glass Fibre – Coconut Coir– Human Hair Hybrid Composites. International Journal of Engineering and Technology. ISSN: 0975-4024 (2014).
13. Arpitha G R, Sanjay M R, L Laxmana Naik, B Yogesha, Mechanical Properties of Epoxy Based Hybrid Composites Reinforced with Sisal/SIC/Glass Fibers. International Journal of Engineering Research andGeneral Science Volume 2, 2014 ISSN 2091-2730.
14. Nam, T. H., Ogihara, S., Tung, N. H., & Kobayashi, S. (2011). Effect of alkali treatment on interfacial and mechanical properties of coir fiber reinforced poly (butylene succinate) biodegradable composites. Composites Part B: Engineering, 42(6), pp.1648-1656.
15. Rout, J., Misra, M., Tripathy, S. S., Nayak, S. K., & Mohanty, A. K. (2001). The influence of fibre treatment on the performance of coir-polyester composites. Composites Science and Technology, 61(9),pp.1303-1310.
16. Biswas, S., Kindo, S., & Patnaik, A. (2011). Effect of fiber length on mechanical behavior of coir fiber reinforced epoxy composites. Fibersand Polymers, 12(1), pp.73- 78.
17. Romli, F. I., Alias, A. N., Rafie, A. S. M., & Majid, D. L. A. A. (2012). Factorial Study on the Tensile Strength of a Coir Fiber-Reinforced Epoxy Composite. AASRI Procedia, 3, pp.242-247.
18. Lu, T., Jiang, M., Jiang, Z., Hui, D., Wang, Z., & Zhou, Z. (2013). Effect of surface modification of bamboo cellulose fibers on mechanical properties of cellulose/epoxy composites. Composites Part B: Engineering, 51, pp.28-34
19. Samal, S. K., Mohanty, S., & Nayak, S. K. (2009). Polypropylene— Bamboo/Glass Fiber Hybrid Composites: Fabrication and Analysis of Mechanical, Morphological, Thermal, and Dynamic MechanicalBehavior. Journal of Reinforced Plastics and Composites, 28(22), pp.2729-2747.
20. Mishra, V., & Biswas, S. (2013). Physical and Mechanical Properties of Bi-directional Jute Fiber Epoxy Composites. Procedia Engineering, 51, pp.561-566.
21. Mir, S. S., Nafsin, N., Hasan, M., Hasan, N., & Hassan, A. (2013). Improvement of physico-mechanical properties of coir-polypropylene bio composites by fiber chemical treatment. Materials & Design, 52, pp.251- 257.

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