

Investigating the Mechanical Properties of Borassus Fruit Fibre Reinforced With Vinyl Ester Resin

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ABSTRACT: Over the most recent thirty years of composite materials, plastics and ceramics have been the dominant emerging material. The volume and number of applications of composite materials have grown progressively, piercing and conquering new markets relentlessly. Modern composite materials constitute an important proportion of the engineered materials market ranging from everyday products to complicated applications. While composites have already confirmed their worth as weight-saving materials, the current challenge is to make them cost effective. This paper discuss about the physical properties of borassus fruit fibre includes wax, ash, moisture, density, lignin and cellulose content. Then the composites were fabricated using vinyl ester resin and tensile, compression, flexural and impact test was explored on the specimen with the volume fraction of 65-35, 70-30 and 75-25.

KEYWORDS: Borassus fruit fibre, physical properties, fibre chemical composition, vinyl ester resin.

I.INTRODUCTION

In today's engineering world many classes of composite materials have emerged, including fiber reinforced Plastics (FRP), natural fiber composites, metal matrix composites (MMC) and ceramic matrix composites (CMC). During the last few years, a series of works have been done to replace the conventional synthetic fiber with natural fiber composites. Sisal, jute, cotton, flax and broom are the most commonly fibers used to reinforce polymers. In addition, fibers like jute, oil palm, bamboo, wheat and flax straw, waste silk and banana have been proved to be good and effective reinforcement in the thermoset and thermoplastic matrices. A number of investigations have been conducted on several types of natural fibers such as kenaf, hemp, flax, bamboo and jute to study the effect of these fibers on the mechanical properties of composite materials. In recent composite technology research and development, efforts have focused on new out-of-autoclave material forms, and automated processes that can markedly increase stiffness, toughness, ambient & high temperature strength production efficiencies.

II. LITERATURE REVIEW

In order to exploit the excellent attractive mechanical properties of Empty Fruit Bunch (EFB) fibers, enormous effort is being made by the researchers to develop the EFB-reinforced polymer matrix composites. Mustafa Hauwa Mohammed, Benjamin [1] presented a paper on "Unsaturated polyester resin reinforced with chemically modified natural fibre" In this paper, It was observed that the surface of the sisal fibres before treatment was filled with hemicelluloses, waxes, lignin, pectin, impurities etc. covered up by cementing materials. Ahmed et al [2] studied the physical and mechanical properties of oil palm empty fruit bunch fiber reinforced with polypropylene. They observed that tensile strength has

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considerably increased with oxidized fiber reinforcement and water absorption capacity is optimum till 25 wt. % of fiber. Beyond this water absorption capacity has increased. Nadendla Srinivasababu, J. Suresh Kumar, K. Vijaya Kumar Reddy[3] Presented a paper on “Manufacturing and Characterization of Long Borassus Palm/Borassus Flabellifer Petiole Fibre Reinforced Polyester Composites”. The main aim of the work is to extract the neat fibre and is characterized for its tensile and surface characteristics. Narayan C. Nayak, Antaryami Mishra[4] presented a paper on “Development And Mechanical Characterization Of Borassus Fruit Fibre Reinforced Epoxy Composites”. In recent years, lingo cellulosic fibres are increasingly used as reinforcements in many thermoset and thermoplastic matrices for the production of low-cost and lightweight materials. Gowthaman Swaminathan[5] presented a paper on “Mechanical Performance of Glass and Carbon/Vinyl Ester Composites for Marine Structures”.

III. MATERIALS AND METHODS

3.1 Borassus Fruit Fibre

Borassus fruit fiber is a lingo cellulosic source which is available as substrate in cellulose production. The application of cellulose to produce bio-ethanol (alternative source of fuel) is handicapped by high cost. The use of fruit bunch, wastage from Borassus will reduce the cost of enzyme production comparable to other sources. Advantages of Borassus fruit bunch fibers are its availability, renewability, low cost and high strength. These materials have been taken from the local areas.

3.2 Vinyl Ester Resin

Vinyl ester resins are addition products of various epoxide resins and unsaturated monocarboxylic acids, most commonly methacrylic acid. They have terminal reactive double bonds derived from the carboxylic acid used. These reactive groups can form a cross-linked network with or without the **addition of a co-monomer. In many industrial** products, vinyl ester resins are comprised of 40-50 wt. % styrene.

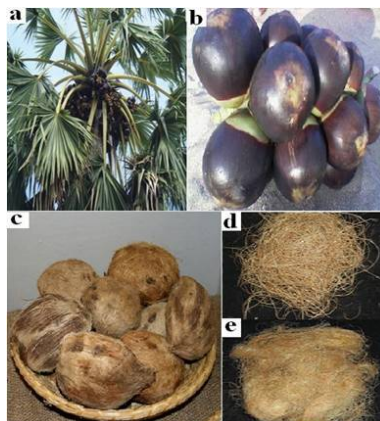


Fig 1 (a) borassus tree (b) fruit (c) dried fruits
(d) coarse fibre (e) fine fibre.

3.3 Specimen Preparation

Borassus fibres of 10-15 mm were cut for mixing with vinyl ester resin to prepare the test bars of ASTM D-3039, ASTM D-790, ASTM D-256 standards for tensile, flexural, impact tests. Here the composites were prepared by the compression moulding technique. There are three types of volume fraction composites were prepared as 65-35, 70-30, 75-25. Then the composites were cut into the ASTM standards to do the various tests.

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Fig 2 test specimens for tensile, compression, flexural, impact.

Fibre Chemical Composition Testing	Borassus Fruit Fibre
Cellulose content, %	63.04
Lignin content, %	20.06
Wax content, %	0.56
Ash content, %	6.37
Moisture content, %	9.64
Density, g/cc	1.484

IV. RESULT AND DISCUSSION

4.1 Fibre Chemical Composition Test

In this test chemical properties of untreated borassus fibre were found. The chemical properties such as lignin content, wax content, moisture content, cellulose content, ash content and density. The result as shown in below.

4.2 Tensile Test

Here the tensile test is carried out by using universal testing machine. A standard specimen is prepared as shown in figure 2. The test process involves placing the test specimen in the UTM and applying tension to it until it fractures. From this test we understood that the tensile strength of fibre increased with increase in volume fractions of fibres.

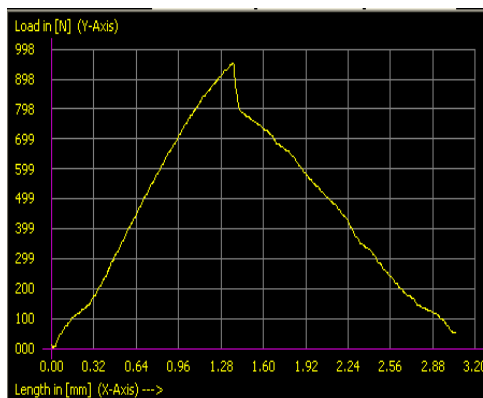


Fig 3 load curve for tensile test

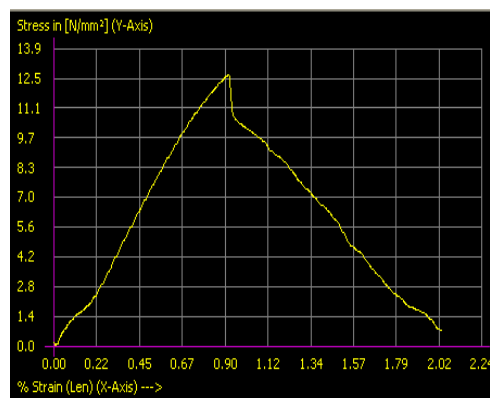


Fig 4 stress strain curve for tensile test

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4.3 Compression Test

The compression test is also carried out by using universal testing machine. A standard test specimen is prepared as shown in figure 2. Here the force is applied until the test specimen fractures. Then the load curve were drawn.

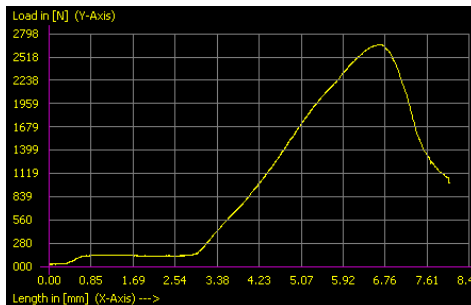


Fig 4 load curve for compression test

4.4 Flexural Test

The flexural test is also carried out by using universal testing machine. A standard test specimen is prepared as shown in figure 2. Here the force is applied until the test specimen fractures. Then the load curve were drawn.

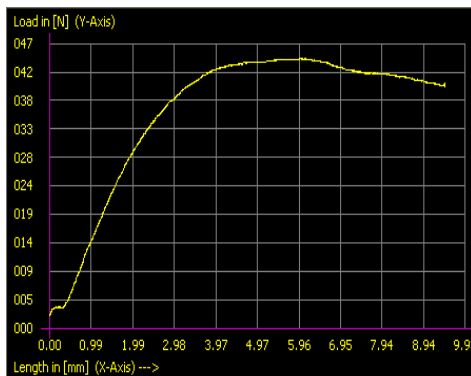


Fig 5 load curve for flexural test

4.5 Impact Test

Impact test is carried out by using impact testing machine. Initially the standard test specimen is prepared as per the ASTM standards. Then the sudden load is applied on the basis of materials. After that its impact strength were calculated.

Table 2 shows the various strengths of borassus fruit fibre.

Test	Area(mm ²)	Peak Load(N)	Strength(MPa)/J
Tensile test	75	950.648	12.675
Compression test	75	2664.435	35.522
Flexural test	39	44.636	36.051
Impact test	---	---	0.95 J

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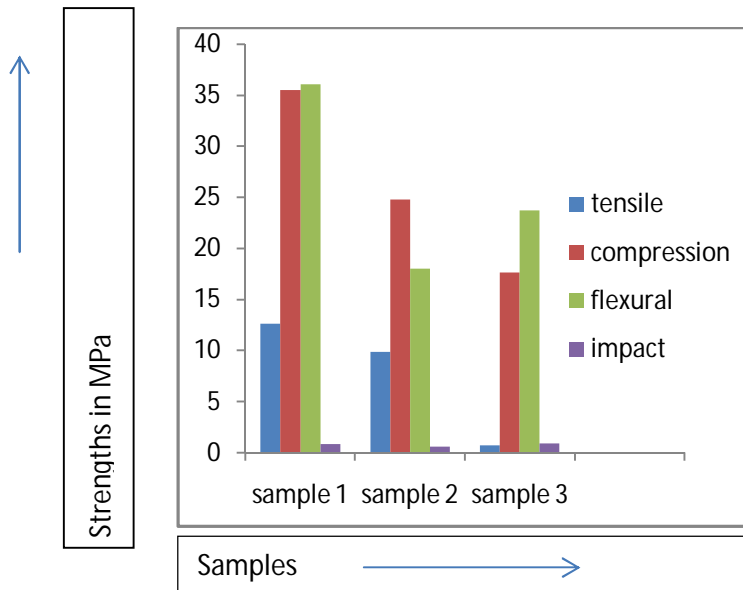


Fig 6 strengths for various samples

V.CONCLUSION

It is observed from the tensile tests that the tensile strength and modulus increases with the increase in volume fraction of fibers. Of course with less fiber reinforcement there is slight decrease in strength which might have occurred due to higher amount of matrix material. Further it is seen that at around 35% of fiber content highest strength and modulus has been achieved for this type of composite. These composites can be very well suitable for structural applications in dry environment due to higher strength.

REFERENCES

1. Abdul Khalil, H.P.S., Jawaid, M., Bhat, A.H., and Abu Baker, A. (2011) 'Impact Properties of Natural Fibre Hybrid Reinforced Epoxy Composites', *Advanced Material Research* Vol.264, pp.688-693.
2. Ahmed, A.S., Alam, M.A., Piee, A., Rahman, M.R., and Hamdan, S.(2010) 'Study of Physical and Mechanical Properties of Oil Palm Empty Fruit Bunch Fibre Reinforced Polypropylene Composites', *Jou. Of Energy and Environment* Vol.2, pp.16-21.
3. Razak, N. W. A. and Kalam, A. "Effect of OPEFB Size on the Mechanical Properties and Water Absorption Behaviour of OPEFB/PP nanoclay/PP Hybrid Composites," *Procedia Engineering* Vol.41 (2012) pp.1593 – 1599.
4. Boopathi, L, Sampath, P.S., Mylsamy, K. "Influence of Fiber Length in the Wear Behaviour of Borassus Fruit Fibre Reinforced Epoxy Composites," *Int. Jou.of Engineering Science and Technology*, Vol.4, Sept. 2012, pp. 4119-4129.
5. Velumurugan, G., Vadivel, D., Aravind, R., Vengatesan, S.P. and Mathizhagan, A. "Tensile Test Analysis of Natural Fibre Reinforced Composites," *Int. Jou.of Mechanical and Industrial Engineering*, Vol.2, Issue-4, 2012, pp.56-60.
6. Sudhakar, P., Obi Reddy, K., Venkata Prasad, C., Jagadeesh, Dani., Kim, H. S., Kim, B. S., Bae, S. I., Song, J. I., 2013. Studies on Borassus fruit fiber and its composites with Polypropylene, *Composites Research*, 26, p. 48.
7. Dabade, B. M., Ramachandra Reddy, G., Rajesham, S., UdayaKiran, C., 2006. Effect of fiber length and fiber weight ratio on tensile properties of sun hemp and palmyra fiber reinforced polyester composites, *Journal of Reinforced Plastics and Composites*, 25, p. 1773.
8. Venkatesha Gowdagiri Prasanna, Venkata Subbaiah, K., 2013. Modification of tensile, compressive properties & Chemical resistance of hybrid biocomposites, *International Journal of Nanomaterials and Biostructures*, 2, p. 9.
9. Velmurugan, R., Manikandan, V., 2005. Mechanical properties of glass/palmyra fiber wate sandwich composites, *Indian Journal of Engineering & Material Sciences*, 12, p. 563.
10. Thiruchitrambalam, M., Shanmugam, D., 2012. Influence of pre-treatments on the mechanical properties of palmyra palm leaf stalk fiber-polyester composites, *Journal of Reinforced Plastics and Composites* 31, p. 1400.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

11. Prasad, V. V. S., 2012. Evaluation of mechanical, thermal, electrical properties of palm fibre reinforced polyester composites, International Journal of Engineering Science and Technology, 4, p. 1746.
12. Shanmugam, D., Thiruchitrabalam, M., 2013. Static and dynamic mechanical properties of alkali treated unidirectional continuous Palmyra Palm Leaf Stalk Fiber/jute fiber reinforced hybrid polyester composites, Materials and Design, 50, p. 533.
13. VenkateshaPrasanna, G., VenkataSubbaiah, K., 2013. Modification, flexural, impact, compressive properties & chemical resistance of natural fibers reinforced blend composites, Malaysian Polymer Journal, 8, p. 38.
14. NadendlaSrinivasababu, Suresh Kumar, J., Vijaya Kumar Reddy, K., 2012. Mechanical and Dielectric Properties of PTSL FRP Composites, Advanced Materials Research, 585, p. 311.
15. Srinivasababu, N., Murali Mohan Rao, K., Suresh Kumar, J., 2010. Tensile properties of turmeric fibre reinforced polyester composites, Indian Journal of Fibre & Textile Research, 585, p. 311.
16. Sreekumar PA, Joseph K, Unnikrishnan G, Thomas S. A comparative study on mechanical properties of sisal-leaf fibre-reinforced polyester composites prepared by resin transfer and compression moulding techniques. Compos Sci Technol 2007;67(3-4):453-61.
18. Devi LU, Bhagawan SS, Thomas S. Mechanical properties of pineapple leaf fiber-reinforced polyester composites. J Appl Polym Sci 1997;64(9):1739-48.
19. Holbery J, Houston D. Natural-fiber-reinforced polymer composites in automotive applications. JOM 2006;58(11):80-6.
20. Ragoubi M, Bienaimé D, Molina S, George B, Merlin A. Impact of corona treated hemp fibres onto mechanical properties of polypropylene composites made thereof. Ind Crops Prod 2010;31(2):344-9.
22. Seki Y, Sever K, Sarikanat M, Güleç HA, Tavman IH. The influence of oxygen plasma treatment of jute fibers on mechanical properties of jute fiber reinforced thermoplastic composites. In: 5th International advanced technologies symposium (IATS'09), May 13-15, 2009, Karabük, Turkey;2009. p. 1007-10.
23. Cao Y, Sakamoto S, Goda K. Effects of heat and alkali treatments on mechanical properties of kenaffibers. Presented at 16th international conference on composite materials, 8-13 July, 2007, Kyoto, Japan.