ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 2, Issue 11 , November 2015

A Review on Natural and Bamboo Fiber Composites

V.M.Manickavasagam, B.Vijaya Ramnath, C.Elanchezhian

Research Scholar, Department of Mechanical Engineering, Vels University, Pallavaram, Chennai, Tamil Nadu, India

Professor, Department of Mechanical Engineering, Sri Sai Ram Engineering college, Chennai, Tamil Nadu, India

Professor, Department of Mechanical Engineering, Sri Sai Ram Engineering college, Chennai, Tamil Nadu, India

ABSTRACT: Composite materials are one of the major developments in material technology in which the chief constituents are reinforcement and matrix. The usage of using fibers obtained from plants like bamboo, jute, oil-palm, flax, vakka, date, sisal, pine-apple, screw-pine etc., instead of manmade artificial fibers like glass or aramid with or without treatment as reinforcement is the current trend due to various advantages like bio-degradability. Such natural fiber based composite materials have different applications in aerospace industry, automotive industry, marine industry, textile industry and so many other industries. This paper makes a brief review on bamboo fiber, bamboo fiber based composites and related applications**.**

KEYWORDS: Composites, natural fiber, bamboo fiber, reinforcement, properties, applications

I. BAMBOO FIBER

Natural fibers obtained from plans are called cellulosic fibers, whereas those from animals are called protein fibers [1, 2]. Natural fibers are cheaper, bio-degradable and have no health hazards. Further more natural fiber reinforced fibers are seen to have good potential in the future as a substitute for synthetic fibers [3]. They have low abrasion, low density, high toughness, acceptable specific strength properties, good thermal properties, and enhanced energy recovery [4-8]. The advantages are low cost, renewability, biodegradability, low specific gravity, abundance, high specific strength, and non-abrasiveness. The natural fiber based composites have many advantages [9]. The natural fibers are made as reinforcement with polymer matrices classified as thermosets plastics and thermoplastics which are petroleum based. Research efforts are currently being carried out in developing a new class of fully biodegradable "green" composites by combining natural/bio fibers with biodegradable resins or matrices [10]. Examples for such natural biopolymers are crop derived bio plastics like Soy-based plastics, starch Plastics, polyacitides (PLA) and bacterial polyesters like Poly hydroxyalkanoates etc. Also fillers, tougheners, colorants, flame retardants, ultraviolet absorbers, coupling agents, lubricants, heat stabilizers, and forming agents may also be added to the matrices to impart various properties. Bamboo plantation is shown in figure 1. Bamboo fiber is shown in figure 2. Bamboo is characterized as a renewable, biodegradable and energy efficient natural resource with a great potential as a sustainable structural building material. They are widely grown in Asia, middle and South America. Bamboo fiber is often known as natural glass fiber [11]. It has high strength to weight ratio compared to conventional materials such as concrete, timber and steel [12-14]. Vijaya ramnath et al [15] studied flexural characteristics of Flax and Abaca Hybrid Epoxy Composite made by hand layup method and found that hybrid composite has very good mechanical behavior than mono fiber composite. The bamboos are a subfamily (Bambusoideae) of flowering perennial evergreen plants in the grass family Poaceae. Some varieties of bamboo species are Ci bamboo, Moso bamboo, Lv bamboo, Dan bamboo, Ma bamboo [16]. Though bamboo is having many characteristics similar to those of hardwood, it is not wood and belongs to the family of grass that is much denser, stronger and fast-grower making it an easier replenisahble one. It grows 3 times as fast as Eucalyptus.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 2, Issue 11 , November 2015

Figure 1 Bamboo plantation

Figure 2 Bamboo fiber

Bamboo has a very long history with human kind. Bamboo is also one of the oldest building materials. It takes about 4 years before it can be used in construction. However, it can be used for various purposes, at various stages of its life. Bamboo is a hollow tube, sometimes with thin walls, and consequently it is more difficult to join bamboo than pieces of wood. In bamboo, there are no rays or knots, which give bamboo a far more evenly distributed stresses throughout its length. The bamboo fiber is made from the starchy pulp of bamboo plants. In fact, bamboo fiber is a regenerated cellulose fiber, which is produced from bamboo pulp processed from bamboo culms. It looks like cotton in its un-spun form. The specific gravity of bamboo varies between 0.4 and 0.8 depending mainly on the anatomical structure. The moisture content of bamboo varies vertically from the bottom to the top portions and horizontally from the outer layer to the inner layers. Bamboo possesses very high moisture content. Wettability is the ability of a liquid to form a coherent film on a surface, owing to the dominance of molecular attraction between the liquid and the surface over the cohesive force of the liquid itself. Wettability of bamboo has a significant influence on adhesion and other related properties. Bamboo fiber contains 26% to 43 % of Cellulose and 21% to 31% Lignin, The mean diameter of bamboo fiber is 0.014 mm and the mean length of the same is 2.7 mm. The figure 3 shows the scanning electron microscope images (SEM) of bamboo fiber [16].

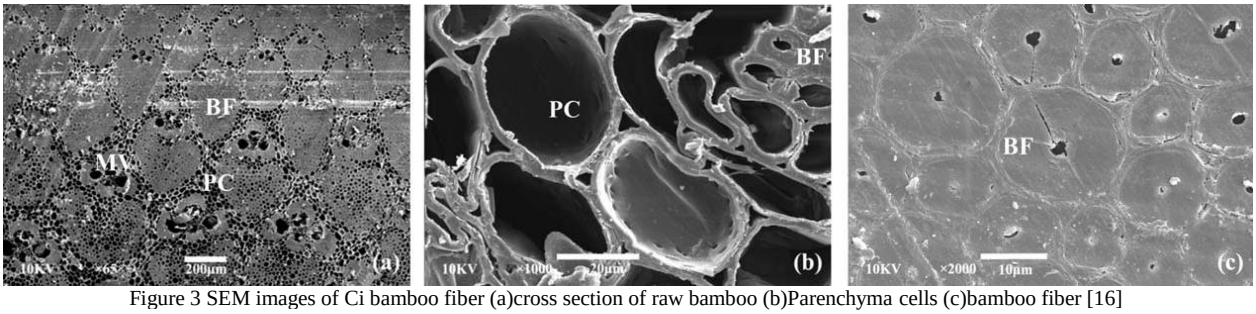

Figure 3 SEM images of Ci bamboo fiber (a)cross section of raw bamboo (b)Parenchyma cells (c)bamboo fiber [16]

II. APPLICATIONS OF BAMBOO FIBER, ITS COMPOSITES AND THEIR APPLICATIONS

Bamboo is one of the oldest materials used by humans from hunting to housing, containers to food. Bamboo's potential and significance in mitigating deforestation and global warming is remarkable. Bamboo stalk is hollow inside and the outer wall is circular. The outer wall consists of pulp and membranes. The thin outside green layer is high density silicon that yields hardness equivalent to hardwoods and a smooth surface of wax like material. The thicker inside yellow layer is loose and fragile. Stem is the source of fiber. It is strong and having natural anti-bacterial properties. It is light in weight and flexible. It can even withstand seismic effects. China, India and Japan are the key producers in the

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 2, Issue 11 , November 2015

same order. But unlike China, India, while being the second largest grower of bamboo in the world under-utilizes this wonder grass vastly. China has the advantage of having the Monopodium (straight) variety of bamboo that is easier to grow and process whereas India is home to the Sympodial (clumpy) variety which is tougher. Around 136 species of bamboo are reported in India. World is using bamboo many ways. Dasso, a China based company is well known for its bamboo based products worldwide. Dasso products range from flooring to ceiling, furniture to paneling and outdoor item as well. Decorative items, sports goods etc can produce. The specialty of bamboo products is their unique pureness, elegance, special grain and color. It even uses bamboo for making wind turbines; BMW makes its car dash board with "Dasso bamboo". Many parts of Europe use bamboo charcoal in water purifiers. In Columbia, bridges are made out of bamboo. Belgium leads the world in **bamboo tissue culture.** The Clinton library in Germany uses **bamboo paneling**. A lot of researches have been completed at the Ningbo University to promote the application of the laminated bamboo panel since 2005 [17–20]. Many researchers have devoted themselves to develop bamboo and bamboo products as new modern structural building materials. Bamboo reinforced concrete has a long history of research and applications in civil engineering [22, 23]. Other researchers developed many composite materials with superior mechanical properties utilizing bamboo fibers [24, 25]. A few research works have been carried out to develop a laminated bamboo lumber using adhesive to join bamboo strands or flattened surfaces taken from the bamboo stem [26]. Vijaya Ramnath et al [21, 27, 28, 29] experimentally studied and concluded that hybrid composites made up of banana jute and abaca jute hybrid composites and concluded that hybrid composite and composite with inter laminar arrangement good mechanical properties than mono fiber composites. Bamboo as a reinforcement in structural concrete elements is examined by Khosrow Ghavami [30]. Many states in India are doing the cultivation of bamboo. Andhra Pradesh, Assam, Bihar, Goa, Gujarat, Haryana, Tamilnadu, Tripura, Andaman and Nicobar Island are a few to name. In India, **bamboo mat corrugated sheets** are being used in railway stations (Haridwar, Anand Vihar in New Delhi). Karnataka State Road Transport Corporation (KSRTC) uses **bamboo flooring** on some of its buses. In India National bamboo mission having head quarters at New Delhi, carries out a lot of research in bamboo based products. Figure 4 shows some typical applications of the bamboo fiber [31].

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 2, Issue 11 , November 2015

Figure 4 Typical applications of Bamboo fiber [31]

REFERENCES

[1] Mohanty AK, Misra M, Drzal LT, Selke SE, Harte BR and Hinrichsen G. Natural fibers, biopolymers, and biocomposites: an introduction. In: Mohanty AK, Misra M and Drzal LT (eds) . Boca Raton, FL Natural fibers, biopolymers and biocomposites: CRC Press, Taylor & Francis Group, 2005, pp. 1–36.
[2] John MJ and Thomas S. Biofibers and bio composites. Carbohydr Polym 2008a; 71(3): 343–364.
[3] N.Venkateshwaran and A. Elayaperumal Banana Fiber Reinforced Polymer Composites - A Review Journal of Reinforced Plastics and Composites 2010 29: 2387. 2010.
[4] Bullions, T. A., Gillespie, R. A., Price-O'Brien, J., and Loos, A. C. J. The effect of maleic anhydride modified polypropylene on the mechanical properties of feather fiber, kraft pulp, polypropylene composites. Journal of Applied Polymer Science Volume 92, Issue 6, pages 3771–3783, 15 June 2004
[5] Mohanty, A. K., Misra, M., and Hinrichsen, G. Biofibers, biodegradable polymer and biocomposites: Macromol. Mater. Eng. 276/ 277:1-24 (2000).
[6] Joseph, P. V., Joseph, K., and Thomas, S. Effect of processing variables on the mechanical properties of sisal-fiber-reinforced polypropylene composites Compos. Interf. 9, 171 (2002)
[7] Cantero, G., Arbelaiz, A., Llano-Ponte, R., and Mondragon, I. Effects of fibre treatment on wettability and mechanical behaviour of flax/polypropylene composites Compos. Sci. Technol.63, 1247 (2003)
[8] Buck, S. E., Lischer, D. W., and Nemat-Nasser, 'The Durability of E- GlassA/inyl Ester Composite Materials Subjected to Environmental Conditioning and Sustained Loading" S. J. Compos. Mate. 32, 874 (1998)
[9] Michael Karus & Markus Kaup : Natural Fibres in the European automotive Industry, Journal of Industrial Hemp, 7:1, 119-131, 2002.
[10] Netravali, A. N., Chabba, S. Composites get greener. Materials Today, 6:22–29. April 2003
[11] Kazuya Okubo, Toru Fujii, Yuzo Yamamoto Development of bamboo-based polymer composites and their mechanical properties. Composites: Part B, 35: 337-383. (2004)
[12] Albermani F, Goh GY, Chan SL. Lightweight bamboo double layer grid system. Engineering Structures 2007; 29:1499–506.
[13] Jain S, Kumar R, Jindal UC. Mechanical behaviour of bamboo and bamboo composite. Journal of Materials Science 1992; 27:4598–604
[14] Nogata F, Takahashi H. Intelligent functionally graded material: bamboo. Composites Engineering 1995; 5:743–51.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 2, Issue 11 , November 2015

[15] Vijaya Ramnath B, Elanchezhian C, JayaKumar C.V , Manickavasagam U. S. Aswin, H. Eashwar, P. Kavirajan, D. Murugan, , 'Investigation of Flexural Characteristics of Flax and Abaca Hybrid Epoxy Composites', International Journal Applied Mechanics and Materials, Volume 766-767, 2015, Pages 183-186

[16] Yang-Lun Yu, Xian-Ai Huang, Wen-Ji Yu High performance of Bamboo-based fiber composites from long bamboo fiber bundles and phenolic resins J. Applied polymer science, 2014, 131, 40371

[17] Li Y, Shan W, Huang Z, Experimental study on mechanical behavior of profiled steel sheet-bamboo plywood composite slabs. Journal of Building Structures 2008;29.

[18] Li Y, Zhang W, Shen H, et al. Experimental study on flexural behavior of multiple-interlink profiled steel sheet-bamboo plywood composite slabs.Journal of Building Structures 2009;30:176–81.

[19] Li Y, Shan W, Han T, et al. Experimental study on mechanical behavior of cold-formed thin-walled steel bamboo plywood composite slabs. Journal of Harbin Institute of Technology 2009; 41:101–5.

[20] Shan W, Li Y, Li J, et al. Quasi-static test on profiled steel sheet-bamboo plywood composite walls. Journal of Harbin Institute of Technology 2009; 41:125–9

[21] P. Sathish, R. Kesavan, B. Vijaya Ramnath. And C Vishal " Effect of Fiber Orientation and Stacking Sequence on Mechanical and Thermal Characteristics of Banana-Kenaf Hybrid Epoxy Composite", Silicon, 2015.

[22] Ghavami K. Ultimate load behaviour of bamboo-reinforced lightweight concrete beams. Cement and Concrete Composites 1995; 17:281–8

[23] Sethunarayanan R, Chockalingam S, Ramanathan R. Natural fiber reinforced concrete. Transportation Research Record 1989:57–60.

[24] Jain S, Kumar R. Processing of bamboo fiber reinforced plastic composites. Materials and Manufacturing Processes 1994; 9:813–28

[25] Jiang J, Yang Z, Zhu L Structure and property of bamboo fiber. Journal of Beijing Forestry University 2008; 30:128–32.

[26] Mahdavi M, Clouston PL, Arwade SR. Development of laminated bamboo lumber: review of processing, performance, and economical considerations. ASCE Journal of Materials in Civil Engineering 2011; 23(7):1036–42.

[27] B.Vijaya Ramnath, R. Sharavanan, M. Chandrasekaran, C. Elanchezhian, R. Sathyanarayanan, R. Niranjan Raja, and S. Junaid Kokan, "Experimental Determination of Mechanical Properties of Banana Jute Hybrid Composite", Fibers and polymers, Volume 16, Pages 164-172, 2015.

[28] B Vijaya Ramnath,*, V.M.Manickavasagam, C Elanchezhian, C Vinodh Krishna, S Karthik, K Saravanan "Determination of mechanical properties of intra-layer abaca–jute–glass fiber reinforced composite ", Materials and Design, Volume 60, August 2014, Pages 643-652

[29] B.Vijaya Ramnath, R. Niranjan Raja, S. Junaid Kokan, R. Sathya Narayanan, A.R.Rajendra Prasad, C.Elanchezhian and V.M.Manickavasagam, "Evaluation of mechanical properties of abaca–jute–glass fibre reinforced epoxy composite", Materials and design, Volume 51, October 2013, Pages 357-366

[30] Khosrow Ghavami Bamboo as reinforcement in structural concrete elements, Cement & Concrete Composites 27 (2005) 637–649

[31] S.Siti suhaily, H.P.S. Abdul Khalil, W.O. Wan Nadirah and m.Jawaid Bambo based biocomposites materials, design and applications. http://dx.doi/org/10.5772/56057.