Review on Recent Developments in Natural Fiber Composites

Ashwin Sailesh
Post Graduate Student,
Department of Mechanical & Production Engineering,
Sathyabama University,
Chennai-600 119.

Dr.S.Prakash
Professor & Head (Academics),
Department of Mechanical and Production Engineering,
Sathyabama University,
Chennai-600 119.

Abstract

Over the last two to three decades composite materials have been used tremendously in many engineering fields due to the proven fact that the composite materials provide high stiffness and high strength to weight ratio. Modern composite materials constitute a major proportion of the engineering materials ranging from those used in day-to-day use products to those used in highly sophisticated applications. Natural fiber composites are one among them. This review paper deals with the universal review report on natural fiber composites. Also, this paper deals with the applications of natural fiber composites.

1. Introduction

1.1 Composite-An Overview

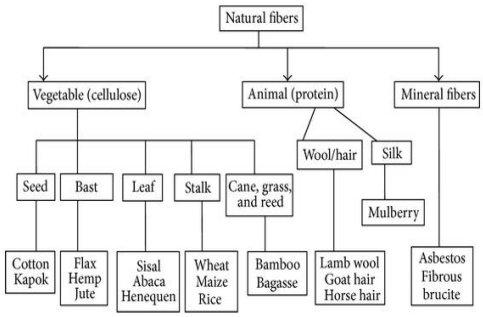
Composites are materials which are made from two or more constituent materials which are significantly different in physical and chemical properties, that when combined, produce a material with characteristics different from the individual components. The most widely used definition of composites which has been postulated by Jartiz is "Composites are multifunctional material systems that provide characteristics not obtainable from any discrete materials, different in composition and characteristics and sometimes in form". The individual components maintain their physical and chemical identities, yet their combination performs a function which cannot be obtained by each constituent acting singly.

1.2 Natural fiber reinforced composites

Natural fibers have recently become popular and attractive among researchers, engineers and scientists as an alternative to fiber reinforced polymer composites. Conventional fibers such as glass, aramid and carbon fibers are being replaced by the natural fibers due to their low cost, fairly good mechanical properties, high specific strength, non-abrasiveness, eco-friendly and bio-degradability characteristics. The natural fiber composites are used in the construction of railway coaches, aerospace vehicles, also used in military applications, packaging, building and construction industries.

1.3 Classification of Natural fibers

Generally, natural fibers are classified into three main groups or categories namely: Vegetable fibers (cellulose), Animal fibers (protein) and Mineral fibers. The broad classification is given below:



2. Application and Merits of natural fiber composites

2.1 Application of Natural fiber composites

The natural fiber composites can be used as a cost effective material for the following application:

(a) Building and construction industries.
(b) Electric devices such as electrical switches, cables.
(c) Storage devices such as bio-gas containers, grain storage silos, post-boxes, milk-boxes.
(d) Used for military vehicles where high strength and stiffness is required.
(e) Also used to manufacture gift articles with perfect aesthetics.

2.2 Merits of Natural fiber composites

The main advantages of natural fiber composites are as follows:

(a) Low specific weight resulting in higher specific strength and stiffness than glass fiber.
(b) Natural fiber is a renewable source and the production of natural fiber composites require less energy.
(c) Involves low investment cost.
(d) Natural fiber composites possess good thermal and acoustic insulating properties.
(e) Reduced tool wear and healthier working condition.

3. Literature Survey

Engineers, researchers have started to focus on the natural fiber composites which are also known as biocomposites. The natural fiber composites are composed of natural or synthetic resin reinforced with natural fibers. Natural fibers possess more superior properties when compared to other conventional fibers. A keen interest is shown towards natural fiber reinforced polymer composites both in terms of their industrial applications and fundamental research. Natural fibers such as jute, sisal, abaca, pineapple and coir are now-a-days used as reinforcement and filler in composites. The most commonly used natural fiber is the banana fiber. The reinforcement of banana fiber into a rubber matrix increases the hardness of the composite and this is related to strength and toughness [1]. It has been proved that composites made from starch and cellulose fibers have improved mechanical properties because of good fiber-starch interactions. Grinding of sugarcane bagasse fibers to micron size without delignification significantly improves the resistance of starch films to moisture uptake and also improves the mechanical properties [4].

Natural fibers or biological fiber reinforced composite possess the potential to enhance the mechanical and physical properties of composites and makes the composite suitable for a wide range of potential applications [5].

Most natural fibers are moisture sensitive and sometimes their strength can change drastically when the natural fiber absorb or desorbs moisture. In order to increase the moisture sensitivity some physical treatment and chemical modification is necessary. The natural fiber composites made by pultrusion will be a good choice for manufacturing construction board, insulation board and can also be used as reinforcement for other structural materials [7].

The waste involved in the production of natural fiber reinforced composites can be easily disposed and is also economical [2]. It has been reported that hybridization of natural fiber composites with some amount of synthetic fibers makes the natural fiber composites to be more suitable for technical applications such as automotive applications [3]. Banana fiber with high specific strength can be utilized to produce light weight composites which can be used to manufacture light weight automobile interior parts [6].

Kenaf fiber (a natural fiber) is considered as a cellulosic source with economic and ecological advantages. The energy utilized for producing 1kg of Kenaf fiber is less when compared to the production of same quantity of glass fiber [10]. It has been investigated and reported that treatment of sugarcane bagasse fibers with sodium lignosulphonate (NaLS) solution strengthens the interactions at the interface of the fiber and matrix [8].

The reinforcement of sugarcane fibers in the tapioca starch as the matrix material several environmental benefits can be achieved. The sugarcane fiber cellulose (SCFC) possess good specific strengths, impact resistance, economical viability, low weight and low density. The combination of SCFC as reinforcement fiber, tapioca as the matrix material and glycerol as plasticizer can be used produce a composite which can be used as alternative materials for food packaging application [9].

It has been reported that Starch/banana fiber composites and starch/bagasse fiber composites can be manufactured by compression molding in the presence of commercial glycerol and crude glycerin respectively as plasticizers [12]. It has been reported that the moisture absorption capability of the natural fiber reinforced composites is increased with an increase in the loading of fibers in the composite. Also, the cellulose fibers from sugarcane bagasse can be used as reinforcing filler in high density polyethylene (HDPE) composites [11].

4. Conclusion

A significant amount of research work has been carried out in the field of natural fiber composites and yet more investigations has to be made with respect to Sisal, Roselle polymer composites. Composites made from sugarcane bagasse and from banana fibers are becoming popular among industries and researchers. This is due to the fact that the raw materials are readily available and also it is cost effective. One of the most important reasons for the increase trend in the production of natural fiber composites is due to easy and economical disposal of the wastes. There is a lot of scope in the future for researchers and industrialists in the field of natural fiber reinforced composites.

5. References

[1]S.Raghavendra, Lingaraju, P.Balachandra Shetty, P.G.Mukunda, "Mechanical Properties Of Short Banana Fiber Reinforced Natural Rubber Composites", *International Journal of Innovative Research in Science, Engineering and Technology*, May 2013, pp. 1652-1655.

[2] Sevgi Hoyur, Kerim Cetinkaya, "Production of Banana/Glass Fiber Bio-Composite Profile and its Bending Strength", *Usak University Journal of Material Sciences*, 2012, pp.43-49.

[3]D.Verma, P.C.Gope, M.K.Maheshwari, R.K.Sharma, "Bagasse Fiber Composites-A Review", *Journal of Materials and Environmental Science.3 (6)*, 2012, pp.1079-1092.

[4]WN.Gilfillan, PA.Sopade, Wos Doherty, "Moisture Uptake and Tensile Properties of Starch-Sugarcane Fiber Films", *Proceedings of the 34th Australian Society of Sugarcane Technologists*, 2012.

[5]Akmal Hadi Ma' Radzi, Noor Akmal Mohamad Saleh, "Banana Fiber Reinforced Polymer Composites", *UMTAS 2011*, 2011.

[6]Rajesh Ghosh, G.Reena, Dr.A.Rama Krishna, Bh.Lakshmipathi Raju, "Effect of Fiber Volume Fraction on the Tensile Strength of Banana Fiber Reinforced Vinyl Ester Resin Composites", *International Journal of Advanced Engineering Sciences and Technologies, Volume.4, Issue,No.1*, pp. 89-91.

[7]Xi.Peng, Mizi Fan, John Hartley, Majeed Al-Zubaidy, "Properties of Natural Fiber Composites made by Pultrusion Process", *Journal Of Composite Materials, 46(2)*, 2011.

[8]C.G.Silva, E.Frollini, "Thermoset Matrices Reinforced with Sugarcane Bagasse Fibers" at the *International Conference on Composite Structures*, 2011.

[9]A.R.Jeeferie, O.Nurul Fariha, A.R.Mohd. Warikh, M.Y.Yuhazri, Haeryip Sihombing, J.Ramli, "Preliminary Study on the Physical and Mechanical Properties of Tapioca Starch/Sugarcane Fiber Cellulose Composite", *ARPN Journal of Engineering and Applied Sciences, Vol.6, No.4*, 2011, pp.7-15.

[10]H.M.Akil, M.F.Omar, A.A.M.Mazuki, S.Safiee, Z.A.M.Ishak, A.Abu Bakar, "Kenaf Fiber Reinforced Composites: A Review", *Elsevier*, 2011.

[11]Daniella Regina Mulinari, Herman J.C.Voorwald, Maria Odila H.Cioffi, George J.Rocha, Maria Lucia C.Pinto Da Silva, "Surface Modification of Sugarcane Bagasse Cellulose and its Effect on Mechanical and Water Absorption Properties of Sugarcane Bagasse Cellulose/HDPE Composites", from *BioResources 5(2)*, 2010, pp. 661-671.

[12]J.L.Guimaraes, F.Wypych, C.K.Saul, L.P.Ramos, K.G.Satyanarayana, "Studies of the Processing and Characterization of Corn Starch and its Composites with Banana and Sugarcane Fibers from Brazil", *Elsevier published under Carbohydrate Polymers*, 2010, pp.130-138.