International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-09, Dec 2018

State of Arts: Natural Fiber Composite

Prof. Ketul B. Brahmbhatt, Research scholar, Department of Mechanical Engg, Rai University, Gujarat & Assistant Professor, Department of Mechanical Engg, BVM Engineering College, Gujarat kbrahmbhatt@bvmengineering.ac.in

Dr. K. B. Judal , Professor, Department of Mechanical Engg, Government Engineering College-Palanpur, Gujarat, kbjudal@gmail.com

Abstract **Nature and sustainability. The aim of this review article is to provide a comprehensive review of the foremost appropriate as well as widely used natural fiber reinforced polymer composites and their applications. A number of drawbacks of NFPCs like higher water absorption, inferior fire resistance, and lower mechanical properties limited its applications. Impacts of chemical treatment on the water absorption, tribology, viscoelastic behaviour, relaxation behaviour, energy absorption flames retardancy, and biodegradability properties of NFPCs were also highlighted. The applications of NFPCs in automobile and construction industry and other applications are demonstrated. Among the various natural fibres such as, sisal fibres, bamboo fibres, coir fibres and jute fibres are of particular interest as these composites have high impact strength besides having moderate tensile and flexural properties compared to other lignocellulosic fibres. Among the various natural fibres, sisal fibre reinforced composite, bamboo fibre reinforced composite, coir reinforced composite and jute fibre reinforced composite are of particular interest as these composites have high impact strength besides having moderate tensile and flexural properties compared to other lignocellulosic fibres. Hence encouragement should be given for the use of natural fibres such as sisal fibres, bamboo fibres, coir fibres and jute fibres which are locally available.**

Keywords —Abaca, Jute, Natural fiber, Sisal

I. INTRODUCTION

Composite materials derived from natural, renewable sources have received significant interest in recent years, in particular due to the increased awareness of and drive towards more environmentally sustainable technologies. In many cases bio-based materials offer weight reduction, added functionality likes damping impact absorption and occupational health benefits. The environmental benefits of bio-based material sources include low embodied energy, CO2 sequestration, reduction of fossil-based resources and a positive impact on agriculture. [1] [2]

Thus, in recent years there has been a growth in the development of materials that meet global trends as economic sustainability, uses, costs and ecological impact. Natural fibres, such as hemp, flax, jute and kenaf, have good strength and stiffness, whilst being significantly lighter than. Conventional reinforcements such as glass fibres, and they are relatively low cost and biodegradable. A number of naturally-derived polymers and resins have been launched commercially, the most notable being polylactic acid (PLA) from corn starch and polyfurfuryl alcohol resins from waste sugarcane biomass. [2]

Fiber reinforced polymer matrix got considerable attention in numerous applications because of the good properties and superior advantages of natural fiber over synthetic fiber in term of its relatively low weight, low cost, less damage to processing equipment, good relative mechanical properties such as tensile modulus and flexural modulus, improved surface finish of molded parts composite, renewable resources, being abundant, flexibility during processing, biodegradability, and minimal health hazards. NFPCs with a high specific stiffness and strength can be produced by adding the tough and light-weight natural fiber into polymer (thermoplastic and thermoset) .Natural fibres are currently used in significant quantities, in particular in automotive interior components, to reinforce synthetic polymers such as polypropylene (PP). [3]

II. NATURAL FIBERS

A wide range of natural fibres exist and they can be classified into three main groups – plant, animal and mineral. The most interesting fibres for composite reinforcements are from plants, in particular bast, leaf and wood fibres. Bast fibres, such as flax, hemp, jute and kenaf, are taken from the stem of the plant and are most commonly used as reinforcements because they have the longest length

 DOI : 10.18231/2454-9150.2018.1222

and highest strength and stiffness. Flax and hemp are of particular interest in the UK and Europe because they are native to the region. [5]

These types of plant fibres are composed principally of a combination of cellulose, hemicellulose and lignin. From an environmental perspective, these fibres are biodegradable, recyclable and are 'carbon positive' since they absorb more carbon dioxide than they release. [5]

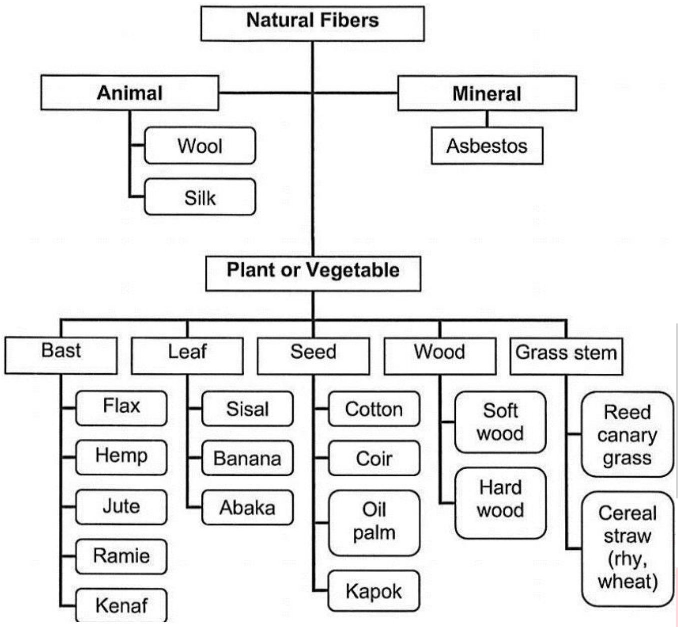

Figure1: Types of Natural Fibers [5]

Often bast fibres have higher tensile strength than other kinds, and are used in high-quality textiles also sometimes in blends with cotton or synthetic fibres, ropes, yarn, paper, composite materials and burlap. A special property of bast fibres is that they contain a special structure, the fibre node that represents a weak point. Seed hairs, such as cotton, do not have nodes. Hemp is biodegradable and eco-friendly fiber with highest tenacity in natural fiber. The molecular structure of hemp fiber is stable, degree of molecular arrangement orientation is good, and it has very low capacity to generate static electricity. Dry hemp fiber is a poor conductor of electricity and good insulating material, Electrical breakdown resistance capacity is higher of 30% than cotton. Ramie is one of the strongest natural fibers. It exhibits even greater strength when wet. Ramie fiber is known especially for its ability to hold shape, reduce wrinkling, and introduce a silky luster to the fabric appearance. It is not as durable as other fibers, and so is usually used as a blend with other fibers such as cotton or wool. It is similar to flax in absorbency, density and microscopic appearance. However it will not dye as well as cotton. Because of its high molecular crystallinity, ramie is stiff and brittle and will break if folded repeatedly in the same place; it lacks resiliency and is low in elasticity and elongation potential. [6]

Natural Fibre	**Synthetic Fibre**
The fibers which we get from nature are known as natural fibre.	The fibers which are developed by man are known as man-made fiber.
It is comparatively less durable.	It is comparatively more durable than natural fire.
For natural fibre, we have to depend on nature.	It can grow everywhere. No dependence on nature.
Number of molecules is controlled by nature.	No. of molecules controlled by man.
The fabric made from natural fibre is more comfortable and also good for health.	Man-made fibre is not comfortable and good for health as natural fiber.
Normally, natural fibers are hydrophilic.	Man-made fibers are hydrophobic.
It is hygienic.	Some are not hygienic.
It is expensive.	It is cheaper than natural fibre.
The length cannot be controlled here.	Length can be controlled.
It is not favorable for finishing.	It is favorable for finishing.
Here, no need spinneret.	Spinneret needs to produce filament.
It is easy to dye.	It is not easy to dye.
Uses of natural fiber are limited.	There are so many uses of man-made fibers.
No spinning process is required to produce filament.	Different spinning process like melt, dry, wet etc. are required here.
Natural crimp is remained here.	No natural crimp is remained.
Impossible to change structure.	Possible to change structure here.
In most cases, scouring and bleaching are done.	Very often, bleaching and scouring are done.
Dust and trash are remained in fibre.	No dust and trash are remained.
Its comparatively have less life time.	Its comparatively have more life time.
Natural colour are found here.	No natural color is found here.

III. ABACA FIBERS

Abaca fiber also known as manila hemp, **Abaca** is extracted from the leaf sheath around the trunk of the **abaca** plant, a close relative of the banana, native to the Philippines and widely distributed in the humid tropics. Harvesting **Abaca** is labourious. Each stalk must be cut into strips which are scraped to remove the pulp. The fibres are then washed and dried.

 DOI : 10.18231/2454-9150.2018.1222

Figure2: Plant of Abaca and Fiber of Abaca

Abaca is a leaf fibre, composed of long slim cells that form part of the leaf's supporting structure. Lignin content is a high 15%. Abaca is prized for its great mechanical strength, buoyancy, resistance to saltwater damage, and long fibre length – up to 3 m. The best grades of **Abaca** are fine, lustrous, light beige in colour and very strong. [7]

The world's leading **Abaca** producer is the Philippines, While the crop is also cultivated in other Southeast Asian countries, the Philippines' closest rival is Ecuador, where abaca is grown on large estates and production is increasingly mechanized during the 19th century **Abaca** was widely used for ships' rigging, and pulped to make sturdy manila envelopes. Today, it is still used to make ropes, twines, fishing lines and nets, as well as coarse cloth for sacking. There is also a flourishing niche market for **Abaca** clothing, curtains, screens and furnishings. Paper made from **Abaca** pulp is used in stencil papers, cigarette filter papers, tea-bags and sausage skins, and also in currency paper -Japan's yen banknotes contain up to 30% **Abaca**.

Figure3: Mercedes Benz use of Abaca fibres in parts

Mercedes Benz has used a mixture of polypropylene thermoplastic and **Abaca** yarn in automobile body parts. Production of **Abaca** fibre uses an estimated 60% less energy than production of glassfibre.

IV. JUTE FIBERS

Jute is extracted from the bark of the white **jute** plant, *Corchorus capsular is* and to a lesser extent from toss a **jute**. It flourishes in tropical lowland areas with humidity of 60% to 90%. A hectare of jute plants consumes about 15 tonnes of carbon dioxide and releases 11 tonnes of oxygen. Yields are about 2 tonnes of dry **jute** fibre per hectare.

Figure4: Jute Plant and Fibers

The fibre Dubbed the "golden fibre", **jute** is long, soft and shiny, with a length of 1 to 4 m and a diameter of from 17 to 20 microns. It is one of nature's strongest vegetable fibres and ranks second only to cotton in terms of production quantity. **Jute** has high insulating and anti-static properties, moderate moisture regain and low thermal conductivity.

Bangladesh and West Bengal in India the world's main **jute** producers, with Myanmar and Nepal producing much smaller quantities. In India and Bangladesh some 4 million farmers earn their living - and support 20 million dependents - from **jute** cultivation, while hundreds of thousands work in the **jute** manufacturing sector.

Jute production fluctuates, influenced by weather conditions and prices. Annual output ranges from 2.3 to 2.8 million tonnes, on a par with wool. India produces 60% of the world's **jute**, with Bangladesh accounting for most of the rest. Bangladesh exports around half as raw fibre, and half as manufactured items. India exports only 200 000tonnes of **jute** products, the remainder being consumed domestically.

During the Industrial Revolution, jute yarn largely replaced flax and hemp fibres in sackcloth. Today, sacking still makes up the bulk of manufactured jute products.

 DOI : 10.18231/2454-9150.2018.1222

Figure5: Jute Fabrics with uses

Jute yarn and twines are also woven into curtains, chair coverings, carpets, rugs and backing for linoleum. Blended with other fibres, it is used in cushion covers, toys, wall hangings, lamp shades and shoes. Very fine threads can be separated out and made into imitation silk. **Jute** is being used increasingly in rigid packaging and reinforced plastic and is replacing wood in pulp and paper. Geotextiles made from **jute** are biodegradable, flexible, absorb moisture and drain well. They are used to prevent soil erosion and landslides. [8]

V. APPLICATION OF NATURAL FIBERS

Natural fibres reinforced composites are emerging very rapidly as the potential substitute to the metal or ceramic based materials in applications that also include automotive, aerospace, marine, sporting goods and electronic industries. Natural fiber composites exhibit good specific properties, but there is high variability in their properties. Their weakness can and will be overcome with the development of more advanced processing of natural fiber and their composites. Their individual properties should be a solid base to generate new applications and opportunities for bio composites or natural fiber composites in the 21st century "green" materials environment. The exploitation of natural fiber composites in various applications has opened up new avenues for both academicians as well as industries to manufacture a sustainable module for future application of natural fiber composites . Many automotive components are already produced with natural composites, mainly based on polyester or Polypropylene and fibres like flax, hemp, or sisal. The adoption of natural fiber composites in this industry is managed by motives of price, weight reduction, and marketing rather than technical demands [5]. [8]

The use of natural fiber as reinforcement in polymer matrix focused the attention towards environmental awareness among all over the world. A hybrid composite is a combination of two or more different types of fiber in which one type of fiber balance the deficiency of another fiber. Natural fiber reinforced polymer composites have been proven alternative to Synthetic fiber reinforced polymer composites in many applications. Many Natural fiber composite products being developed and marketed, very few natural fiber composites have been developed, with most of their technologies still in the research and development stages. Natural fiber composites in automobile include for parcel shelves, door panels, instrument panels, armrests, headrests and seat shells. The passenger car bumper beam is manufactured by kenaf/ glass epoxy composite material. Recently, banana fiber reinforced composites are coming into in interest due to the innovative application of banana fiber in under-floor protection for passenger cars. Automobile parts such as rear view mirror, visor in two wheelers, billion seat cover, indicator cover, cover L-side, name plate were fabricated using sisal and roselle fibres hybrid composites.

Fiber	**Application in building, construction, and others**
Hemp fiber	Construction products, textiles, cordage, geotextiles, paper & packaging, furniture, electrical, manufacture bank notes, and manufacture of pipes
Oil palm fiber	Building materials such as windows, door frames, structural insulated anel building systems, siding, fencing, roofing, decking, and other building materials
Wood fiber	Window frame, panels, door shutters, decking, railing systems, and fencing
Rice husk fiber	Building materials such as building panels, bricks, window frame, panels, decking, railing systems, and fencing
Flax fiber	Window frame, panels, decking, railing systems, fencing, tennis racket, bicycle frame, fork, seat post, snowboarding, and laptop cases
Sisal fiber	In construction industry such as panels, doors, shutting plate, and roofing sheets; also, manufacturing of paper and pulp
Bagasse fiber	Window frame, panels, decking, railing systems, and fencing
Stalk fiber	Building panel, furniture panels, bricks, and constructing drains and pipelines
Kenaf fiber	Packing material, mobile cases, bags, insulations, clothing-grade cloth, soilless potting mixes, animal bedding, and material that absorbs oil and liquids
Cotton fiber	Furniture industry, textile and yarn, goods, and cordage
Jute fiber	Building panels, roofing sheets, door frames, door shutters, transport, packaging, geotextiles, and chip boards
Coir fiber	Building panels, flush door shutters, roofing sheets, storage tank, packing material, helmets and postboxes, mirror casing, paper weights, projector cover, voltage stabilizer cover, a filling material for the seat upholstery, brushes and brooms, ropes and yarns for nets, bags, and mats, as well as padding for

 DOI : 10.18231/2454-9150.2018.1222

ISSN : 2454-9150 Vol-04, Issue-09, Dec 2018

	mattresses, seat cushions
Ramie fiber	Use in products as industrial sewing thread, packing materials, fishing nets, and filter cloths. It is also made into fabrics for household furnishings (upholstery, canvas) and clothing, paper manufacture

VI. CONCLUSION

A wide range of natural fibres can be used for composite reinforcement but flax, jute and hemp are the most commonly used as they have the highest mechanical properties. Fibre quality is significantly influenced by the retting and fibre extraction methods used and currently there is a move towards mechanical processing of 'green' fibre to improve consistency and reduce costs. For composite reinforcement, the fibre length must be preserved and the impurity content must be low. Aligned natural fibre yarns and fabrics offer higher mechanical properties than short, random fibre reinforcements but the yarns must have low twist so that the fibres remain on-axis and they can be fully impregnated by resin. A range of treatments have been investigated to reduce the hydrophilic characteristic of natural fibres and improve compatibility with polymers and, of these, acetylation currently appears to be of most interest. Fully bio-based composites, containing natural fibres and bio-based matrices, have been under development for several years and some are now being used commercially. Regarding life cycle assessment, natural fibres are generally considered to have lower environmental impact than glass fibres due to reduced CO_2 emissions and energy consumption during production. During the use phase, natural fibres can have a significant positive impact on the environment, for example through reduced weight, energy consumption and emissions in the automotive sector. The durability of natural fibres, particularly their resistance to moisture, requires more investigation. A number of treatments have been developed to reduce moisture uptake and resistance to fungal attack. At the end of life, natural fibre composites can be recycled, biodegraded, or can be incinerated for energy recovery.

VII. REFERENCES

[1] M. N. M. A. P. Layth Mohammed, "A Review on Natural Fiber Reinforced Polymer," International Journal of Polymer Science, vol. Volume 2015, no. Article ID 243947, , p. 15 pages, 2015, . "Advanced Composite Materials," in Chepter 7.

[2] H. N. J. R. Tara Sen, "Application of Sisal, Bamboo, Coir and Jute Natural Composites in Structural Upgradation," International Journal of Innovation, Management and Technology,, Vols. Vol. 2, No. 3, no. 3, pp. 186-191, June 2011.

[3] L. L. N. M. R. Sanjay, "Applications of Natural Fibers and Its Composites: An Overview," Natural Resources, , pp. 108-114, 2016.

[4] A. K.-t. Lau, Natural Fiber-Reinforced Biodegradable and Bioresorbable Polymer Composites, United Kingdom: Elsevier Ltd. , 2017.

[5] C. V. Stevens, Industrial Applications of Natural Fibres, Germany: A John Wiley and Sons, Ltd., Publication.

[6] P. A. B. K. van Rijswijk, "Application of Natural Fibre Composites," Application of Natural Fibre Composites in the Development of Rural Societies, December 2001.

[7] M. E. TOYGAR, " An Investigation of Fracture Toughness of Carbon/Epoxy Composites," Journal of REINFORCED PLASTICS AND COMPOSITES, , vol. Vol. 25, no. No.18, pp. 1887-1895, 2006.

[8] D. K. Brahmbhatt, "State of Arts: Tribological Properties of Composite materials," International Journal of AdvancedResearch in Science, Engineering and Technology, pp. 6141 - 6147, 2018.

[9] H. P. K. B. J. K. anan Shah, "Vibration Analysis of Natural Fiber Composite Beam under Various End Conditions," International Journal of Engineering Research & Technology, pp. 6-12, 2018.

[10] H. P. K. B. Manan Shah, "VIBRATION ANALYSIS OF NATURAL FIBER COMPOSITES BEAM UNDER VARIOUS END CONDITIONS USING ANN," International Journal of Advance Engineering and Research Development, pp. 1818-1825, 2018.

[11] H. P. Ketul Brahmbhatt Manan S. Shah, "Using Different End Conditions Experimental and Theoretical Analysis for Vibrational Properties of Natural Fiber Composites Beam," Trends in Machine Design (STM Journal), pp. 33-41, 2018.

[12] D. H. P. K. B. Jay Khatri, "Analysis of Mechanical Properties of Natural Fiber Composite Beam," Kalpa PublicationsinEngineering, pp. 236-238, 2017.

 DOI : 10.18231/2454-9150.2018.1222