International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 09, RTMSE-2026

Recent Advancements in Natural Fiber Reinforced Composites - A Review

Lakhvir Singh
Assistant Professor/ Yadavindra Department of Engineering,
Punjabi University Guru Kashi Campus, Talwandi Sabo, Punjab, India
e-mail address: lakhvir_ydoe@pbi.ac.in

Balraj Singh Brar
Professor/ Yadavindra Department of Engineering,
Punjabi University Guru Kashi Campus, Talwandi Sabo, Punjab, India
e-mail address: brarbalraj@yahoo.com

Devanand
Research Scholar / Yadavindra Department of Engineering,
Punjabi University Guru Kashi Campus, Talwandi Sabo, Punjab, India
e-mail address: kdev3330@gmail.com

Manmeet Singh Shergill
Ph.D Research Scholar,
Department of Mechanical Engineering,
Punjabi University Patiala (Punjab), India
e-mail address: manmeetsheargill@gmail.com

Abstract—Currently there is a significant advancement in green technology in material science, mainly through the production of natural fiber-reinforced composite materials. The global advancement of high-performance engineering products derived from natural resources is gradually expanding. This study intends to explore the mechanical properties and various applications of natural fiber composites. Natural fibers are currently attracting the focus of academic and industrial researchers because of their accessibility, excellent strength and stiffness, superior thermal and acoustic insulation qualities, high specific strength, light weight, water resistance, high impact strength, low weight, low cost, fairly good mechanical properties, non-abrasiveness, environmental friendliness, and biodegradability. The study concludes that natural fiber-reinforced composites assist as an environmentally friendly and sustainable opportunity that can partially or wholly replace synthetic fiber composites in the automotive, furniture, construction, packaging, and consumer product industries.

Keywords—Natural fibers, Reinforcement, Matrix, Green Composites, eco-friendly, Natural fiber composites

I. INTRODUCTION

In manufacturing, materials are taken as pillar of any industry. In manufacturing industry several materials have employed from pure metals to the composite materials. Because of shortcoming of pure metals, the composite materials are fabricated to fulfil the expectations of modern industries [1]. Currently, manufacturing industries extensively produced composite materials to replace the various materials due to strong damping capacity, high specific strength and high specific modulus. In 1940 the composite fiber was fabricated first time by using the fiber as reinforcement material. Composite materials are embracing of two or more materials having distinct properties [2] .

Reinforcement is the primary constituent of composite material and has to takes maximum of the load applied on the composite material. As reinforcement consumes load, it must be hard, brittle and have high strength. For sustainable development, it is challenge as well as need of every industry to minimize or replace the non-sustainable products with the sustainable ones [3]. Plant-based fibers strongly contribute to this environmentally sustainable endeavor. In composite materials field, industry as well as customer as a interested to use the naturally available materials [4].

In today's market, it is essential to use currently available natural fibers to overcome synthetic fiber and also to explore new plants that produced natural fibers in with low cost and easy method of extraction. This method produced natural fiber without effect the various properties of natural fibers. So, in this way the overall cost of composite material can be reduced [5].

II. NATURAL FIBRE-REINFORCED BIO-COMPOSITES

Usually depending upon the type of the constituents, natural fiber composites are classified in two main categories as eco-friendly and green composite materials [6] . In Green composite materials, all its elements are obtained from renewable resources. This can reduce the emission of carbon dioxide and the dependence on materials derived from petroleum. Whereas partially eco-friendly composite materials have one of the elements, either fibre or matrix, is not extracted from renewable resources [7].

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 09, RTMSE-2026

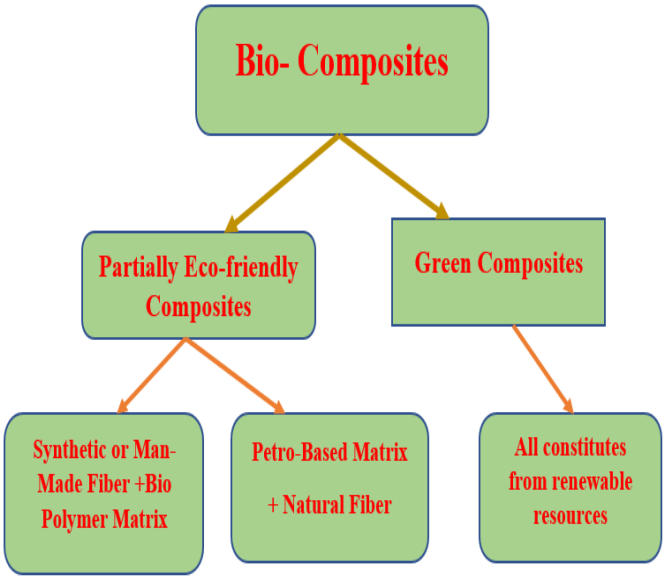

Figure 1: Types of Bio-Composites Materials

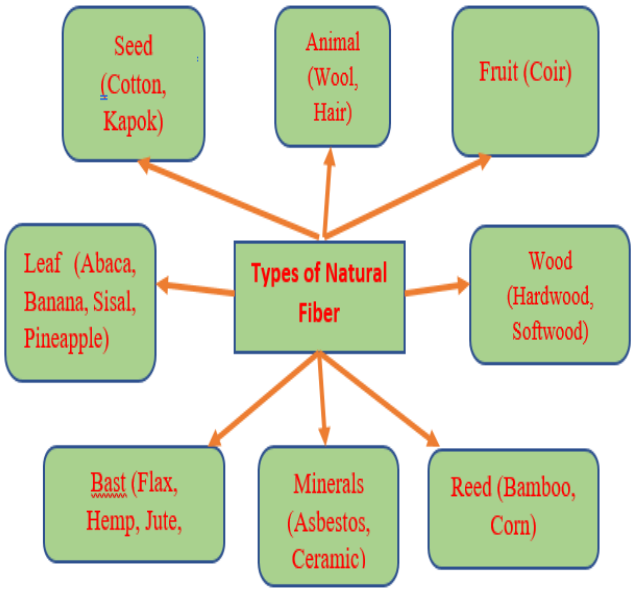

Figure 2: Types of Natural Fibers

A. Bio-Polymeric Matrix:

The mechanical properties of a composite material also depend on matrix material as well as well fiber. The Matrix material can be fabricated from either synthetic (Petro based) or bi-based (animal or plants). Bio-polymer materials are also biodegradable in nature because polymer bio-degrades by the action if living organism. Mostly polylactic acid (PLA) or starch or cellulose ester or protein are biodegradable bio-based polymers available at industrial level. Presently approximately 6% biopolymers are used at global polymer market which is extremely low [8].

Before selection of polymer material mechanical properties, chemical resistance, dimensional stability, manufacturing process must be considered for to recycle or biodegrade for future ability.

B. Natural Fibres

Besides, according to the source or origin of fiber natural fibres are usually categorized animal, mineral, and plant. In specific, organic fibres are favored. Plant fibre is the furthermost needed type of fibre because it encompasses cellulose, but animal fibre is predominantly protein-rich, and mineral fibre is associated to health. A report by Pickering et al. notwithstanding, plant fibre is stronger and securer than animal fibre. Figure 2 shows the various types of natural fiber that are used in manufacturing industry [9].

Literature examined that most of the researchers focuses on Sugarcane bagasse, Bamboo, Jute, Kenaf, Flax, Grass, Sisal, Hemp, Coir Abaca Costa, Rica, Oil palm, Pineapple, Rice husk, Rice straw and Wood fiber [10] [11] [12].

III. PROPERTIES OF NATURAL FIBERS

a) Chemical Properties of Natural fibers:

The cells or natural fiber is generally consisting of the primary wall and other one is secondary wall. The primary or first wall comprises hemicellulose, pectins, proteins, and disordered cellulose microfibrils, which provides flexibility. It also acts as Skelton for the fiber. On the other hand, secondary wall accountable for the fiber's high mechanical properties and much stiffer [13] .

b) Physical Properties of Natural fibers:

The main constraints in consideration of fiber properties consist of cell number, cell aspect ratio, crystalline cellulose content and microfibrillar angle. lower microfibrillar angle and Higher cellulose content are important for high fiber strength. Fibers are further categorized by their aspect ratio [14].

c) *Mechanical Properties of Natural fibers:*

The obtain the optimal mechanical properties of Natural fiber reinforced composites (NFRC) various factors must be considered like: physical properties, chemical properties, bonding of matrix and fiber, moisture absorption, impurities, volume fraction of the natural fiber to be used in fabrication. The mechanical properties of natural fibers are given below in Table No. 1

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 09, RTMSE-2026

Table 1: Mechanical Properties of Natural fibers [15]

Natural Fiber	Density (g/cm^3)	Tensile Strength (MPa)	Young's Modulus (GPa)
Bagasse	0.8–1	250–300	17–20
Banana	0.5–1.5	711–789	4.0–32.7
Hemp	1.1–1.6	285–1735	14.4–44.0
Cotton	1.5–1.6	287–800	5.5–12.6
Flax	1.3–1.5	340–1600	25–81
Sugarcane	1.1–1.6	170–350	5.1–6.2
Jute	1.3–1.5	393–773	13–26.5
Coir	1.2–1.6	170–230	3.0–7.0
Kenaf	0.6–1.5	223–1191	11–60
Oil Palm	0.7–1.6	50–400	0.6–9.0
Sisal	1.3–1.6	468–640	9.4–22
Ramie	1.4–1.5	400–938	61–128
Bamboo	1.2–1.5	500–575	27.0–40.0

There are numbers of applications where these natural fibers used in manufacturing industry. As per application or use type of reinforcement or natural fiber is taken. Table no. 2 Shows several common of natural fiber in manufacturing sectors.

Table 2: Applications of various Natural Fibers [5], [6]

S No.	Natural fibres used in the study	Recommended Applications
1	Flax plant fiber	Vehicle bonnet, Carrier for covered door panel, seat back panels, armrests, floor tray
2	Jute, coir, kenaf, flax, abaca, sisal, hemp	Automobile application, seat backs
3	Leucas Aspera	Brake pads
4	Azadirachta indica	Automobile application
5	Banana fibers with leather	Automobile application
6	Areca sheath	Automobile dashboard panel
7	Jute fibers	Frontal bonnet of a vehicle
8	Pineapple and cassava flour	Automotive interior parts
9	Flax fiber	Vehicle bonnet
10	Coconut flower cover fiber	Seat bottoms, back cushions and head restraints, interior trim and seat cushioning, seat surfaces/backrests
11	Glass fibre with hemp fibre	Automobile application
12	Kenaf fibres	Automobile components such as dash boards, door interiors, and underfloor components
13	Abaca fibre	Automobile application
14	Palm sheath and sugarcane bagasse fibres	Vehicle dashboard applications
15	Sisal/kenaf fiber	interior door linings and panels, door panels

There are several reasons behind the use of natural fibers by researchers as well industry. Figure No. 3 shows citation of research articles for three years i.e. from 2016 to 2018 [16]. Most of Researchers used cotton natural fiber followed by followed by pineapple and bamboo. Ravindran et al. concludes that in year 2015 the publication of research paper related to natural fiber materials was approximately 100 with just 2000 citations which crosses 400 publications and 10000 citations in 2022 [17] .

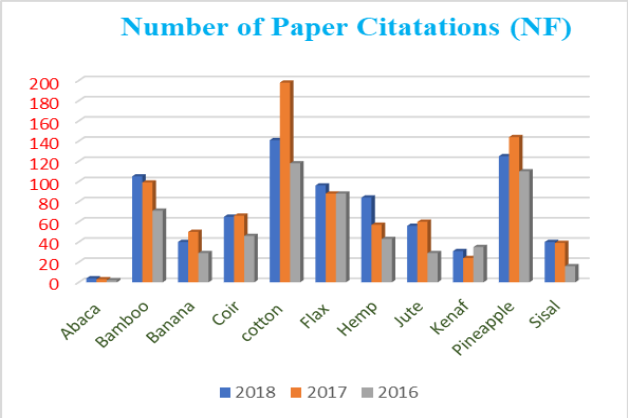

Figure 3: Natural Fibers used paper citations

IV. COMPARISON OF VARIUOS VARIOUS NATURAL'S FIBER COST

Dittenber and GangaRao gathered data of various natural fiber and glass fiber publication and compare the cost per weight as shown in figure No.4. Moreover, the cost of several natural

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 09, RTMSE-2026

fibers also depends upon the geographic area from where these fiber are taken for use [18] .

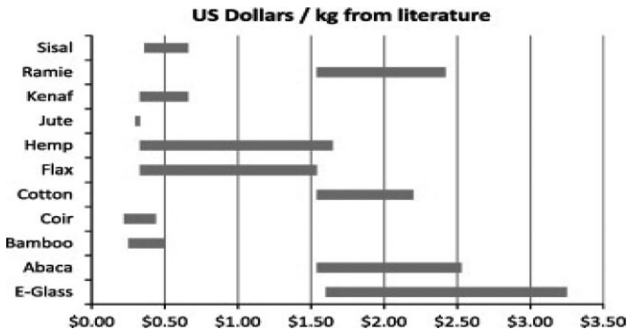

Figure 4: Ccomparisons between glass and natural fiber's cost [19]

V. CONCLUSION

The paper concludes that, for fabrication of composites materials the researchers focus on several natural fibers because natural fibers have comparable properties to the synthetic fibres. The demand of natural fiber reinforced composite materials increases in field of aerospace, automotive, construction and various industrial applications because of specific stiffness and strength, lighter weight, flexibility of manufacturing, renewable in nature and environment friendly. In market the demand of these composite is high due to bio-based and biodegradable polymers. For further improvement processing techniques of fibers, treatment of fibers to improve the adhesion between fiber and the biopolymer can be adopted.

VI. REFERENCES

[1] L. Kerni, S. Singh, A. Patnaik, and N. Kumar, "A review on natural fiber reinforced composites," *Materials Today: Proceedings*, vol. 28, pp. 1616–1621, 2020, doi: 10.1016/j.matpr.2020.04.851.

[2] M. C. Tanzi, S. Farè, and G. Candiani, "Organization, Structure, and Properties of Materials," in *Foundations of Biomaterials Engineering*, Elsevier, 2019, pp. 3–103. doi: 10.1016/B978-0-08-101034-1.00001-3.

[3] D. Rajak, D. Pagar, P. Menezes, and E. Linul, "Fiber-Reinforced Polymer Composites: Manufacturing, Properties, and Applications," *Polymers*, vol. 11, no. 10, p. 1667, Oct. 2019, doi: 10.3390/polym11101667.

[4] R. Kumar, M. I. Ul Haq, A. Raina, and A. Anand, "Industrial applications of natural fibre-reinforced polymer composites – challenges and opportunities," *International Journal of Sustainable Engineering*, vol. 12, no. 3, pp. 212–220, May 2019, doi: 10.1080/19397038.2018.1538267.

[5] Research Scholar (VTU-RC), CMR Institute of Technology, Bengaluru 560037, India, V. Naik, M. Kumar, Assistant Professor, MVJ College of Engineering, Bengaluru 560067, India, V. Kaup, and Professor, CMR Institute of Technology, Bengaluru 560037, India, "A Review on Natural Fiber Composite Material in Automotive Applications," *Eng. Sci.*, 2021, doi: 10.30919/es8d589.

[6] P. Peças, H. Carvalho, H. Salman, and M. Leite, "Natural Fibre Composites and Their Applications: A Review," *J. Compos. Sci.*, vol. 2, no. 4, p. 66, Nov. 2018, doi: 10.3390/jcs2040066.

[7] D. Thapliyal *et al.*, "Natural Fibers Composites: Origin, Importance, Consumption Pattern, and Challenges," *J. Compos. Sci.*, vol. 7, no. 12, p. 506, Dec. 2023, doi: 10.3390/jcs7120506.

[8] O. Kilanko, K. O. Babaremu, O. S. I. Fayomi, and I. G. Akande, "Overview of Composite Materials from Green Product in Mechanical Application," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 655, no. 1, p. 012043, Feb. 2021, doi: 10.1088/1755-1315/655/1/012043.

[9] G. Ravindran, V. Mahesh, N. Bheel, S. Chittimalla, K. Srihitha, and A. Sushmasree, "Usage of Natural Fibre Composites for Sustainable Material Development: Global Research Productivity Analysis," *Buildings*, vol. 13, no. 5, p. 1260, May 2023, doi: 10.3390/buildings13051260.

[10] I. Elfaleh *et al.*, "A comprehensive review of natural fibers and their composites: An eco-friendly alternative to conventional materials," *Results in Engineering*, vol. 19, p. 101271, Sep. 2023, doi: 10.1016/j.rineng.2023.101271.

[11] S. K. Ramamoorthy, M. Skrifvars, and A. Persson, "A Review of Natural Fibers Used in Biocomposites: Plant, Animal and Regenerated Cellulose Fibers," *Polymer Reviews*, vol. 55, no. 1, pp. 107–162, Jan. 2015, doi: 10.1080/15583724.2014.971124.

[12] R. Malkapuram, V. Kumar, and Yuvraj Singh Negi, "Recent Development in Natural Fiber Reinforced Polypropylene Composites," *Journal of Reinforced Plastics and Composites*, vol. 28, no. 10, pp. 1169–1189, May 2009, doi: 10.1177/0731684407087759.

[13] I. Elfaleh *et al.*, "A comprehensive review of natural fibers and their composites: An eco-friendly alternative to conventional materials," *Results in Engineering*, vol. 19, p. 101271, Sep. 2023, doi: 10.1016/j.rineng.2023.101271.

[14] D. Saravana Bavan and G. Mohan Kumar, "Potential use of natural fiber composite materials in India," *Journal of Reinforced Plastics and Composites*, vol. 29, no. 24, pp. 3600–3613, Dec. 2010, doi: 10.1177/0731684410381151.

[15] S. H. Kamarudin *et al.*, "A Review on Natural Fiber Reinforced Polymer Composites (NFRPC) for Sustainable Industrial Applications," *Polymers*, vol. 14, no. 17, p. 3698, Sep. 2022, doi: 10.3390/polym14173698.

[16] P. Peças, H. Carvalho, H. Salman, and M. Leite, "Natural Fibre Composites and Their Applications: A Review," *J. Compos. Sci.*, vol. 2, no. 4, p. 66, Nov. 2018, doi: 10.3390/jcs2040066.

[17] G. Ravindran, V. Mahesh, N. Bheel, S. Chittimalla, K. Srihitha, and A. Sushmasree, "Usage of Natural Fibre Composites for Sustainable Material Development: Global Research Productivity Analysis," *Buildings*, vol. 13, no. 5, p. 1260, May 2023, doi: 10.3390/buildings13051260.

[18] D. B. Dittenber and H. V. S. GangaRao, "Critical review of recent publications on use of natural composites in infrastructure," *Composites Part A: Applied Science and Manufacturing*, vol. 43, no. 8, pp. 1419–1429, Aug. 2012, doi: 10.1016/j.compositesa.2011.11.019.

[19] O. Faruk, A. K. Bledzki, H.-P. Fink, and M. Sain, "Progress Report on Natural Fiber Reinforced Composites: Progress Report on Natural Fiber Composites," *Macromol. Mater. Eng.*, vol. 299, no. 1, pp. 9–26, Jan. 2014, doi: 10.1002/mame.201300008.