BENEFITS AND LIMITATIONS OF USING NATURAL FIBERS AS REINFORCEMENT MATERIALS

Guravtar Singh Mann[1], Jaswinder Singh[2], Ankur Bahl[3], Satnam singh[4]

[1,2,3,4]School of Mechanical Engineering, Lovely Professional University, Phagwara 144411 India

Abstract

In the manufacture of goods and applications the renewability and longevity of materials are becoming extremely important concerns because of which lot of research is going on in the field of natural fibes. As these fibers, which have become important substitutes to glass and carbon fibres in some applications because these are in less costly, more reliable and more environmentally sustainable materials. Moreover their light weight and long fiber lengths are suitable for various applications. In this various benefits of using natural fibers as reinforcement materials are discussed.

Keywords: Natural fibers, Green composites, Particulate Reinforcement, Fibrous Reinforcement

1. Introduction

Over the most recent couple of years, the consumption of oil assets, the expanding mindfulness toward the earth and the incredible concern for nursery impact have animated businesses (for example car, building, nautical) to supplant ordinary engineered materials utilizing reasonable ones. Looking at these issues , green composites, made of sustainable rural and ranger service feedstock, speak to an appropriate option in contrast to manufactured fibre fortified composites.[1] A composite material can be described as a macroscopic mixture, having an identifiable interface among two or more separate continuous and discontinuous intermediate materials. The stiffer and heavier intermittent medium than the ceaseless stage is called strengthening, and the purported steady stage is called matrix[2] A composite material can have magnificent and unique mechanical and physical properties, as it joins the most alluring attributes of its constituents while simultaneously taking out the least attractive[3]. The qualities of a composite rely upon the properties and their spread and association of the constituent materials. Natural fibers have attracted considerable exposure in recent decades as an appropriate reinforcement in polymer composites due to their advantages over conventional glass and carbon fibres[4] Not only are the materials usable in filed of materials packaging, automotive, energy sector, sports, and leisure industry but also possess sustainability for biomedical applications such in implants and medical devices [5].Table1 shows the production of various fibers across globe. Becoming natural mindfulness has likewise set off a change in perspective towards planning materials good with nature. On account of expanding natural awareness and enacted prerequisites, the utilization and end-of-life expulsion of customary composite structures, typically made of carbon, glass or aramid fibres, are getting progressively significant. Bio composites got from common fibres and customary thermoplastics or thermosets are not sufficiently naturally well disposed in light of the fact that framework gums are non-biodegradable. Therefore in this paper various advantages and disadvantages of using natural fibers are discussed.

2. Classification based upon Particulate Reinforcement

Particulate common fillers, for example, saw residue and coconut shell powder, are utilized to improve high temperature execution, increment wear obstruction, and lessen erosion as well as shrinkage. A great part of the time, particulate fillers are used to lessen cost; under these conditions, the additional substance is known as a down to earth filler (fundamentally filler), however when a critical change in the properties of the composite occurs, the additional substance is known as a help filler (basically fortress). The particles in addition share the pile with the lattice, anyway to a lesser degree than strands. Thusly, much of the time, particulate help improves solidness, not quality. Hard particles in a delicate cross section cause confined weight centers in the system, which diminish the all around impact quality and make the composite down to earth[6].

Table 1. Production of natural fibers around the globe[7]

Fiber type (plant)	Botanical name	Origin	Production (10^3 tons)
Abaca	Musa textilis	Leaf	91
Bagasse	Saccharum officinarum L.	Stem	1,02,000
Banana	Musa uluguruensis Warb	Leaf	200
Bamboo	Gigantochloa scortechinii Dendrocalamus apus	Stem	10,000
Coir	Cocos nucifera L.	Fruit	650
Cotton	Gossypium spp.	Seed	19,010
Flax	Linum usitatissimum	Stem	830
Hemp	Cannabis sativa L.	Stem	214
Jute	Corchorus capsularis,Corchorus olitorius	Stem	2850
Kapok	Ceiba pentandra	Seed	123
Kenaf	Hibiscus cannabinus	Stem	970
Phormium	Phormium tenax	Leaf	-
Pineapple	Ananas comosus Merr.	Leaf	-
Ramie	Boehmeria nivea Gaud	Stem	100
Sisal	Agave sisalana	Leaf	318.8

3. Fibrous Reinforcement

Sinewy support speaks to a physical instead of a synthetic methods for evolving a material to suit different building applications. The part materials of fiber-fortified composites are strands and grid and the composite show anisotropy in properties. The deliberate quality of most engineered materials is substantially less than anticipated hypothetically because of the defects as splits opposite to the applied burden that are available in mass materials. Common filaments have a lot higher longitudinal qualities, on the grounds that the bigger defects are not by and large present in such little cross-sectional regions[8]. In the composite, all things considered fibers are the noteworthy weight passing on people while the including matrix keeps them in the perfect territory and heading. In addition, the structure goes about as a store move medium and shields the strands from environmental damages on account of raised temperature besides, tenacity. The possibility of the interface between them is noteworthy to the degree the properties of the composites are concerned. The fibres dissipated in the composite cross section can be steady or broken. Table 2 shows comparison between natural and synthetic fibers the In constant fiber support, the move of the stack from cross section to the strands will be straightforward and fruitful, while in unpredictable (or short fibre) fibre support, the strands must have sufficient length (essential fibre length) to move the store effectively. The high calibre and moduli of these composites can be tweaked to the high weight headings[9].

Table 2. Comparison between natural and synthetic fibers [10]

Fibre	Density (g/cm^3)	Length (mm)	Failure strain (%)	Tensile strength (MPa)	Stiffness/Young's modulus (GPa)	Specific tensile strength (MPa/gCm^3)	Specific Young's modulus (GPa/gcm^3)
Ramie	1.4	900–1200	2.0–3.8	400–938	44–128	270–620	29–85
Flax	1.4	5–900	1.2-3.2	345–1830	27–80	230–1220	18–53
Hemp	1.4	5–55	1.6	550–1110	58–70	370–740	39–47
Jute	1.4-1.5	1.5–120	1.5-1.8	393–800	10–55	300–610	7.1–39
Harakeke	1.3	4–5	4.2-5.8	440–990	14–33	338–761	11–25
Sisal	1.3-1.5	900	2.0-2.5	507–855	9.4–28	362–610	6.7–20
Alfa	1.4	350	1.5-2.5	188–308	18–25	134–220	13–18

Cotton	1.5-1.6	10–60	3.0-10	287–800	5.5–13	190–530	3.7–8.4
Coir	1.2	20-150	15-30	131–220	4–6	110–180	3.3–5
Silk	1.3	Continuous	15-60	100–1500	5–25	100–1500	4–20
Feather	0.9	10–30	6.9	100–203	3–10	112–226	3.3–11
Wool	1.3	38–152	13.2-35	50–315	2.3–5	38–242	1.8–3.8
E-glass	2.5	Continuous	2.5	2000-3000	70	800–1400	29

4. Benefits of using natural fibers as reinforcement

The major advantage of using these fibers is their low specific weight resulting in greater physical strength and steadiness than glass. The utilization of natural inexhaustible filaments prompts practical growth. Traditional fiber-strengthened polymer composites presently go before engineered fiber-fortified composites in properties, for example, biodegradability, substance reactivity, weight, non-harmfulness, diminished contamination, ease, and recyclability. These points of interest put the composites of common strands among the substantial presentation composites with ecological and monetary favourable circumstances. The poor strengthening effect of these cellulosic strands in elastomers was overpowered by giving unequivocal changes. The usage of trademark strands in the vehicle business has become rapidly all through the latest 5 years. The extent of things in the vehicle business reliant on ordinary fibers relies upon polymers, for instance, plastics what's more, elastomers, and fibers, for instance, flax, hemp, and sisal. Starting late, regard included composite materials were made from neisan jute surface and polypropylene having redesigned mechanical properties and diminished hydrophilicity .The going with zones rapidly talk about the sort and properties of customary strands used for arranging trademark flexible (NR) composites and their properties[11].

5. Properties of Green composites

Plant strands, as support, have as of late pulled in the consideration of specialists as a result of their favourable circumstances over other set up materials. They are earth inviting, completely biodegradable, liberally accessible, sustainable and modest. The biodegradability of plant filaments can add to a sound biological system while their minimal effort and elite satisfies the financial enthusiasm of industry. At the point when characteristic fiber–strengthened plastics are oppressed, toward an amazing finish cycle, to ignition procedure or landfill, the discharged measure of CO_2 of the filaments is impartial regarding the acclimatized sum during their development [12]. The rough idea of regular fiber–fortified plastics is a lot of lower driving to points of interest with respect to the specialized and reusing handling of the composite materials when all is said in done. Normal fiber–strengthened plastics, by utilizing biodegradable polymers as frameworks, are the most ecological agreeable materials, which break down toward a mind-blowing finish cycle. Plant fiber composites are utilized instead of glass for the most part in non structural applications. Various car segments recently made with glass composites are currently being produced utilizing ecologically well-disposed composites.

6. Various disadvantages of natural fibres

Theese fibers hydrophilic in nature and assimilate dampness. The expanding conduct of characteristic strands is commonly influenced by physical and synthetic structures. Therefore these fibers change their measurements due to the presence of moisture content, as the cell mass of these polymers contains hydroxyl and other oxygen containing molecules. Which absorb moisture in dampness through hydrogen holding. [13].The waxy materials present on the surface plays integral role in retaining water .The porous help in the intake of water while the hydroxyl pack (– OH) in the cellulose, hemicellulose, and lignin helps to build a great deal of hydrogen bonds between the macromolecules in the plant fiber cell divider. Joly et al.[14]. All around, moistness content in like manner strands changes some place in the scope of 4% and 8%. Therefore the removal of moisture from fibers is fundamental before the arranging of the composites as the moistness substance can provoke poor processability and may realize porous things. The moisture can be reduced by suitable surface modifications.

7. **Conclusion**

Natural fibers have played an significant part in human scientific and cultural history as these fibers plays an important role in the manufacture of advanced bio-based products . Therefore because of their their environmental and financial advantages, the applications of these materials expanding. Normal fiber composite materials of superior were made from many years of research. Therefore lot of work is at present being completed worldwide on common strands and their composites. The strands and composites are arranged regarding applications with various usages for various properties. Inexhaustible creature strands give an energizing chance to create bio-composite materials that are economical. In view of their simple accessibility, light weight, minimal effort and eco-accommodating nature has now been expanded around these plant fiber strengthened composites. . The material would giving enduring reaction to the issues of moistness maintenance (poor gum closeness), affectability in outside condition and weakness for withstanding long stretch introduction, influencing, and unforgiving road trail conditions; a portion of the major impediments to their completely created present day sales.

References

1. Amash, A., & Zugenmaier, P. (1998). Study on cellulose and xylan filled polypropylene composites. *Polymer Bulletin*, *40*(2-3), 251-258.
2. Saheb, D. N., & Jog, J. P. (1999). Natural fiber polymer composites: a review. *Advances in Polymer Technology: Journal of the Polymer Processing Institute*, *18*(4), 351-363.
3. Vallo, C., Kenny, J. M., Vazquez, A., & Cyras, V. P. (2004). Effect of chemical treatment on the mechanical properties of starch-based blends reinforced with sisal fibre. *Journal of Composite Materials*, *38*(16), 1387-1399.
4. Gore, A., & O'Connor, J. (2007). *An inconvenient truth: The crisis of global warming*. New York: Viking.
5. Prasanth, R., Shankar, R., Dilfi, A., Thakur, V. K., & Ahn, J. H. (2013). Eco-friendly fiber-reinforced natural rubber green composites: A perspective on the future. In *Green Composites from Natural Resources* (pp. 218-267). CRC Press.
6. Richardson, M. O. W. (Ed.). (1977). *Polymer engineering composites*. Elsevier Science & Technology.
7. Shah, D. U., Porter, D., & Vollrath, F. (2014). Can silk become an effective reinforcing fibre? A property comparison with flax and glass reinforced composites. *Composites Science and Technology*, *101*, 173-183.
8. Hill, C. A. S., & Abdul Khalil, H. P. S. (2000). Effect of fiber treatments on mechanical properties of coir or oil palm fiber reinforced polyester composites. *Journal of Applied Polymer Science*, *78*(9), 1685-1697.
9. Zimniewska, M., Wladyka-Przybylak, M., & Mankowski, J. (2011). Cellulosic bast fibers, their structure and properties suitable for composite applications. In *Cellulose fibers: bio-and nano-polymer composites* (pp. 97-119). Springer, Berlin, Heidelberg.
10. Dong, C. (2018). Review of natural fibre-reinforced hybrid composites. *Journal of Reinforced Plastics and Composites*, *37*(5), 331-348.
11. Satyanarayana, K. G., Kulkarni, A. G., & Rohatgi, P. K. (1981). Potential of natural fibers as a resource for industrial materials in Kerala. *Journal of Scientific & Industrial Research*, *40*(4), 222-237.
12. Almgren, K. M. (2010). *Wood-fibre composites: Stress transfer and hygroexpansion* (Doctoral dissertation, KTH).
13. Feughelman, M., & Nordon, P. (1962). Some mechanical changes during sorption of water by dry keratin fibers in atmospheres near saturation. *Journal of Applied Polymer Science*, *6*(24), 670-673.
14. Joly, C., Gauthier, R., & Escoubes, M. (1996). Partial masking of cellulosic fiber hydrophilicity for composite applications. Water sorption by chemically modified fibers. *Journal of Applied Polymer Science*, *61*(1), 57-69.