APPLICATIONS AND PROCESSING TECHNOLOGIES OF BAMBOO

Guravtar Singh Mann[1],Satnam Singh[2]

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

Abstract

Fiber based composites are picking up noticeable quality because of the higher solidarity to weight proportion. Further, producing forms add to the non-recyclable squanders which are hurtful to the earth. Be that as it may, the present part tends to the points of interest and uses of creature fiber based composites. Besides, different investigations on the creature fiber based composites are ordered and displayed. What's more, unique creature based filaments which are being used are examined. The writing demonstrated advantages and processing technologies of bamboo for various applications .

Keywords: Green Composites, Bamboo Fiber, constructional applications, automotive applications

1 Introduction

Over the top utilization of items from oil, flooding unrefined costs and exponential ascent in risks caused due to contamination have brought about unexpected interest of ecological neighborly materials. [1], accordingly, the sustainable materials, for example, cellulose, proteins, starch, vegetable oils are being examined for the green polymer composite [1]. Known as the green composites and bio composites, the fortifications of these materials are removed got from characteristic assets [2],[3]. Since days of yore, the materials have been utilized to manufacture abodes and production apparatuses. Alongside a few different applications. [4]. Recently, much development has been seen in the plolymer business and the creations are eco cordial and feasible. [5]. A few substitutes are presently being viewed as attributable to significant components like cost-viability, eco-cordiality, and biodegradability, to be specific - wood fiber, sisal, kenaf, flax, jute, hemp, and silk [6],[7]. Not exclusively are the materials usable in recorded of materials bundling, car, vitality division, sports, and relaxation industry yet additionally have supportability for biomedical applications such in inserts and therapeutic gadgets [8]. The significant points of interest of these materials are, these can be manufactured according to the necessities for different applications by including different epoxies and, unsaturated polyester tars to these materials. Use of ordinary filaments has been in closeness for specific ages, in any case, the disclosure and following synthetics things, for example, glass, aramids, and carbon strands ethically supported on plan and mid-twentieth century accomplished the diminished propensity for trademark filaments in various applications. The high usage of things reliant on oil has a negative environmental effect.[9].Becoming normal care has in like manner set off an adjustment in context towards arranging materials great with nature. By virtue of growing regular mindfulness and ordered essentials, the usage and end-of-life ejection of standard composite structures, normally made of carbon, glass or aramid strands, are getting continuously noteworthy. Bio composites got from regular strands and standard thermoplastics or thermosets are not sufficiently normally all around arranged considering the way that structure gums are non-biodegradable. Be that as it might, these bio composites do now keep up an amicability between budgetary perspectives and condition empowering them to be considered for applications in the vehicle, building, furniture and packaging adventures. In addition, their biodegradability have helped in them in all cases for different applications like in car segment flying and development businesses. Accordingly some green strands like jute oil palm fiber, hemp and sisal, Jute, and so forth are someregular fibers most ordinarily used as reinforcing materials in polymer composite industry [10,11] The significant contemplations for preparing of these strands are their hygroscopic conduct and low protection from high temperature because of which just restricted pitches could be utilized as network. The systems and hardware utilized for manufacture of these strands are like that of ordinary inorganic fiber composites. The normal procedures utilized for creation of these materials incorporate expulsion/infusion, fiber winding, pressure, what's more, pultrusion process. From most recent couple of years, it has been seen that there has been a sensational move for utilizing common strands, for example, flax, jute, hemp, pineapple and sisal and so forth for causing composites as the disintegrations of these materials to don't severy affect nature for all inclusive manageability one such important material is bamboo Bamboo shown

in figure1 creations dated back to a large number of years prior and along these lines they are rich with conventional components. Bamboo normally, reasonable for assortments of employments and advantages. Bamboo regularly utilized as materials for developments or utilized as the crude materials for the creation of paper sheet, they are likewise used to control disintegration and furthermore for embellishments[12]. Therefore in this paper various applications of bamboo and its manufacturing technologies are discussed.

Figure1. Bamboo plantings[13]

Commercial applications

These days bamboo fibres are widely utilized in place of wood fibre for various applications. There is lot of research going on for using these fibres in building, furniture, objects, transportation, bundling and in packaging industry, which makes it important material for commercial applications by substituting traditional wood interior and exterior products such as skates shown in figure 2 [14]. This shows that this material consistency is establish to be multiple times more grounded than wood materials[15]. This material becoming popular due to its dimensional soundness, life span, climate safe, high-effect safe, low-maintenance, non-hazardous, low fire spread, and so on[16].

Figure 2. Skates fabricated from bamboo((www.pinterest.co.uk/pin).

2. Applications in construction industry

For many years Timber has been used as a structural material, in any case the usage of bamboo as the foundational material in construction exercises in some parts of Asia has existed since the time of human advancement began to develop[17]. The usage of this material in construction industry has demonstrated its supremacy since quite some time ago by building new homes using 100 percent traditional bamboo [18]. This material have good sustainability and mechanical properties due to which it is still used in construction applications. This is obviously dependent once again on the tractable consistency needed in advancing the bamboo link before the primary world war. The interruption associate was first made using bamboo to cross the stream and corporate relations.

Around at that point, the bamboo used model outside use just bamboo, which is on different occasions as strong as within [19].Progressions in bamboo advancement offer new open entryways for gigantic degree improvement of this viable material. From long-go column cross overlaid secured bamboo board, joinery, bamboo has shown to be shielded and solid for city structures and homes and it wind up being used in critical urban territories around the world [19]. Various organizers and designers convince bamboo as the most normally all around arranged in the world. Scientific and mechanical advancement have achieved cross breed biocomposites from bamboo can make various types of fortified exterior that has a significant impact, particularly in improvement [6]. Various bamboo changes were conveyed by analysts to improve the idea of the various pieces of bamboo, for example in China, bamboo is used in the structure of the housetop with the tip verified with garnishing tiles to shield from cascade water, upgrade the housetop [18]. Numerous methods have been made to convey a strong housetop sincerely steady system. In the Philippines the housetop work improved by using the divided bamboo roof and produces a fragile surface to support the movement of air and water in bamboo [20]. Housetop configuration is generally fitting as material plans by then. Arrangement pre-collected section system has an edge will be verified with bamboo load up, support and mortar to make a waterproof housetop and can last up to 15 quite a while with customary upkeep. Reliable and imaginative advancement have achieved crossbreed natural composites from this material has the ability to convey various sorts of reinforced veneer that has a significant impact, mainly for improvement [21]. Housetop building is generally sensible as material game plans by then. Arrangement pre-collected section structure has a packaging will be verified with bamboo load up, strip and mortar to make a waterproof housetop and can last up to 15 quite a while with standard upkeep. The trademark superbness of bamboo classy use has driven bamboo to be by and large displayed as a major aspect of the groupings all around. Bamboo has been commonly recognized to be an option that is other than the material by the modelers and organizers yet moreover can be used to light up and decorate. Bamboo has a comparable particular display for all intents and purposes indistinguishable from the solid wood and steel yet release humbler carbon impression [22].

3. Interior design applications

Some airports in the world Spain are designing sustainable Building using Bamboos as greener materials [23] for the world. Richard Rogers, fashioner of the world's greatest prominent air terminals which consists of tenderly bent overlaid bamboo roof slat, the biggest enterprise on the planet in the bamboo industry. Universal Airport was manufactured utilizing overlaid this material slats from all strolls of bamboo facade. Various methods are identified how the configuration method can be applied in yield structures with the use of materials and textures which can make an outstanding customer experience, energetic and calm climate. Despite the fact that terminal is highlighted by the effortlessness of the design idea, it does offer everything. Some of the decorative material is shown in figure 3

Figure 3. Decorative material from Bamboo(courtesy: ww.webpackaging

4. Furniture applications

The structure is a component of an imaginative and creative way of showing attention to the meaning of the requirements and the quality of life. Income-consciousness these days, lot of furniture plan on the market attentive on the coherence between current needs and natural anxieties to ensure the valuation of the existence cycle due to item advantage. These materials are beneficial for environmental sustainability bolstered by accomplishment in applying originator structure furnishings to integrate structural elements with natural links to upgrade the item all together to pick up highlight consideration [24].In some countries governments have set up organizations for helping their furniture industry for enhancing their exports. One such example is Malaysia which is exporting this furniture to over 100 nations. As bio-composites of this material have high favourable circumstances as an elective material for the making of furniture and different parts. A diversity of new furniture plans have been made using splendid materials is considering the showed superiority furniture stand out from solid wood material. High progression in this fibre can expand the sturdiness even contorted and shaped materials, for instance, solid wood [25]. Lot of innovations are being done for manufacturing bio-based furniture goods as bamboo has the features of materials and surfaces are useful for fashioners to make an exceptional arrangement and one of a kind, it is fundamental that customers reacted distinctly [25]. Some of innovative designs of furniture are shown in figure 4

Figure 4. Furniture designed from bamboo [26],[27]

5. Applications in automotive field

Normal fiber has experienced development in automobile advertising, especially in Southeast Asia, which is more so in Europe. Therefore green composite development is expanding in the worldwide research field every year as it guarantees sensitive costs and implementation in comparison to contested progress. The new Industrial Revolution is progressing in transport by making steam-controlled vessels and airplane engines. In 1930, in comparison to existing materials, a second new transition is a significant time in the manufacture of vehicle compartments using fiber as choice. Some acclaimed vehicle designers are using natural materials in vehicles for reducing the weight of vehicles. The European Union (EU) and the some nations of Asia have also supported the establishment of regulations in the global automotive industry[28].

An analysis reveals that minimal effort is profoundly potential for standard fiber bamboo materials to be used in car component's [28]. Various guidelines produced in 2006 arranged all car companies to supply reinforced car plastic using standard fibre. In extension, the European Union (EU) concentrating on 80% of the vehicle partition must be used again or then again reused and the total should be extended by 2015 to be 95%. Through past research has made various pieces of the vehicle which has been organized using typical fibers as the crucial fragment. Typical fiber composites with thermoplastic and thermoset structures have been commonly used in the amassing of passage sheets, rearward sitting arrangements, headliners, group plate, dashboards, and within the vehicle makers' world [29]. This is maintained by various academics who exhibited quality and reasonability this material as an elective material in the vehicle creating industry.bamboo concept car is shown in figure 5.

Figure 5. Concept car fabricated from Bamboo[29]

6. Green Composites Manufacturing

The creation of normal composites is a difficult undertaking as the inborn properties of these filaments are very unique in relation to inorganic filaments. The significant contemplations for preparing of these strands are their hygroscopic nature and low protection from high temperature because of which just constrained saps could be utilized as lattice. The procedures and hardware utilized for creation of these strands are like that of regular inorganic fiber composites. The handling technique for these strands as a rule relies on the lattice tars and preparing conditions rely upon the sort of normal fiber utilized. In this way low consistency thermosetting tars are generally utilized as a grid as these can undoubtedly impregnate the characteristic filaments and don't cause any harm identified with warm debasement. The normal handling techniques utilized for the manufacture of these strands are pressure forming, Injection embellishment, (RTM) and (VARTM). The strands can be utilized as mats or in woven structure. Pressure and infusion forming strategies are favored advances for large scale manufacturing of plastics also, regular composites parts because of their high accuracy and quick process durations. Rajendran et al.[30] created the biocomposites utilizing infusion forming process for mechanical portrayal. new biodegradable polymer mix based network framework was utilized for creation and impact of soften preparing parameters on the effect quality of the bio composite was considered by planning full factorial test structure. The outcomes uncovered that preparing parameters, fiber length fundamentally influenced the effect quality of the bio composites. Cho et.al [31] manufactured the regular strands (jute, kenaf and henequen) fortified thermoplastic (poly(lactic corrosive) and polypropylene) and thermosetting (unsaturated polyester) framework composites utilizing pressure shaping process and explored the mechanical properties of fabricated strands in addition surface treatment of filaments was additionally conveyed utilizing faucet water by static dousing and dynamic ultra sonication strategies. The outcomes uncovered that there was a critical improvement in the mechanical properties of the composite. H.Park et.al[32] manufactured and examined the mechanical properties of characteristic filaments of flax utilizing A Vacuum Assisted Resin Move Moulding(VARTM) process. The examination of made strands was finished with information from references. The outcomes uncovered that there was a decent improvement in the mechanical properties of the manufactured fiber. Xi Peng et al.[33] watched the mechanical properties of the pultruded composite bars made from hemp and fleece fiber fortifications. The mechanical and morphological portrayal was finished. The results demonstrated that there was an improvement in the mechanical properties of the that utilizing the polyurethane gum the composites can accomplish has higher explicit malleable and compressive quality. Fabrication of bamboo boat hull is shown in figure 6.

Figure 6. Fabrication of bamboo boat hull[34]

7. Conclusion

With the rise in global energy crisis and environmental risk, the unique benefits of biological fibers such as abundance, non-toxic, hair, eye or respiratory irritation, non-corrosive properties, biological fiber-reinforced polymer materials are attarcting considerable attention due to their ability to serve as alternatives to synthetic ones. Because of their ecological and economic benefits, the use of natural fibers in composites is increasing. Natural fiber composite materials of high performance were created from decades of research. To order to improve the properties, extensive work is currently being carried out worldwide on natural fibers and their composites. The fibers and composites are categorized with respect to applications with multiple utilizations for different properties. Renewable animal fibers provide an exciting opportunity to develop bio-composite materials that are sustainable. Because of their easy availability, light weight, low cost and eco-friendly nature, researchers ' focus has now been increased on these animal fiber reinforced composites. . The material will give long lasting response to the problems of humidity retention (poor gum similarity), affectability in outdoor environment and impotence for withstanding long-haul presentation, swaying, and unforgiving street trail conditions; some of the fundamental obstacles to their fully developed modern solicitation. It appears that the use of these type of materials in vehicle body sheets is possible to the degree that green composites have equivalent mechanical execution with manufactured ones. Then again, because of their decomposable existence, green composites appear, by all accounts, to be truly dangerous. The issue of biodegradability is one that needs to be looked at when it is essential to apply 100% bio-based composites, especially when monitoring external sheet assistants for future vehicles The development of service among end customers, along with ongoing policy and the association of standard bodies, would help achieve further progress in the future. The only concern is whether these can be pooled in the most suitable way to achieve the degree of execution of their precursors at a low cost. The approach shown above could be an initial phase of multifaceted basic leadership in the tremendous region.

References

1. Luo, S., & Netravali, A. N. (1999). Mechanical and thermal properties of environment-friendly “green” composites made from pineapple leaf fibers and poly (hydroxybutyrate-co-valerate) resin. *Polymer composites*, *20*(3), 367-378.
2. Netravali, A. N., & Chabba, S. (2003). Composites get greener. *Materials today*, *4*(6), 22-29.
3. Thakur, V. K. (2013). *Green composites from natural resources*. CRC Press.
4. Gilbert, R. D. (1994). *Cellulosic polymers, blends and composites*. Hanser.
5. Ouajai, S., & Shanks, R. A. (2009). Preparation, structure and mechanical properties of all-hemp cellulose biocomposites. *Composites Science and Technology*, *69*(13), 2119-2126.
6. Rowell, R. M. (2012). *Handbook of wood chemistry and wood composites*. CRC press.
7. Cheung, H. Y., Ho, M. P., Lau, K. T., Cardona, F., & Hui, D. (2009). Natural fibre-reinforced composites for bioengineering and environmental engineering applications. *Composites Part B: Engineering*, *40*(7), 655-663.
8. Ratner, B. D. (1996). Biomaterials science: an interdisciplinary endeavor. In *Biomaterials science* (pp. 1-8). Academic Press.
9. El-Tayeb, N. S. M. (2008). A study on the potential of sugarcane fibers/polyester composite for tribological applications. *Wear*, *265*(1-2), 223-235.
10. Gujjala, R., Ojha, S., Acharya, S. K., & Pal, S. K. (2014). Mechanical properties of woven jute–glass hybrid-reinforced epoxy composite. *Journal of Composite Materials*, *48*(28), 3445-3455.
11. El-Tayeb, N. S. M. (2008). A study on the potential of sugarcane fibers/polyester composite for tribological applications. *Wear*, *265*(1-2), 223-235.
12. Bar-Yosef, O., Eren, M. I., Yuan, J., Cohen, D. J., & Li, Y. (2012). Were bamboo tools made in prehistoric Southeast Asia? An experimental view from South China. *Quaternary International*, *269*, 9-21.

13. Akihiro, T., & Eka, A. (2001, July). Application of MDI binder towards environmental friendly wood-based industry. In *Seminar on Wood-Based Panel Products* (pp. 10-11).

14. Chen, H., Miao, M., & Ding, X. (2009). Influence of moisture absorption on the interfacial strength of bamboo/vinyl ester composites. *Composites Part A: Applied Science and Manufacturing*, *40*(12), 2013-2019.

15. Adnan, N., & Othman, N. (2012). The relationship between plants and the Malay culture. *Procedia-Social and Behavioral Sciences*, *42*, 231-241.

16. SITI, S., ABDUL, S., WAN, O., & Jawaid, M. (2013). Bamboo Based Biocomposites Material, Design and Applications. *Chap*, *19*, 489-517.

17. Bar-Yosef, O., Eren, M. I., Yuan, J., Cohen, D. J., & Li, Y. (2012). Were bamboo tools made in prehistoric Southeast Asia? An experimental view from South China. *Quaternary International*, *269*, 9-21.

18. Tan, T., Rahbar, N., Allameh, S. M., Kwofie, S., Dissmore, D., Ghavami, K., & Soboyejo, W. O. (2011). Mechanical properties of functionally graded hierarchical bamboo structures. *Acta biomaterialia*, *7*(10), 3796-3803.

19. Wiedemann, J. (Ed.). (2010). *Product design in the sustainable era*. Taschen.

20. Zhou, A., Huang, D., Li, H., & Su, Y. (2012). Hybrid approach to determine the mechanical parameters of fibers and matrixes of bamboo. *Construction and Building Materials*, *35*, 191-196.

21. Khalil, H. A., Bhat, I. U. H., Jawaid, M., Zaidon, A., Hermawan, D., & Hadi, Y. S. (2012). Bamboo fibre reinforced biocomposites: A review. *Materials & Design*, *42*, 353-368.

22. Scurlock, J. M., Dayton, D. C., & Hames, B. (2000). Bamboo: an overlooked biomass resource?. *Biomass and bioenergy*, *19*(4), 229-244.

23. Bovea, M. D., & Vidal, R. (2004). Increasing product value by integrating environmental impact, costs and customer valuation. *Resources, Conservation and Recycling*, *41*(2), 133-145.

24. Suhaily, S. S., Khalil, H. A., Asniza, M., Fazita, M. N., Mohamed, A. R., Dungani, R., ... & Syakir, M. I. (2017). Design of green laminated composites from agricultural biomass. In *Lignocellulosic Fibre and Biomass-Based Composite Materials* (pp. 291-311). Woodhead Publishing.

25. Holbery, J., & Houston, D. (2006). Natural-fiber-reinforced polymer composites in automotive applications. *Jom*, *58*(11), 80-86.

26. Kubba, S. (2010). *Green construction project management and cost oversight*. Butterworth-Heinemann.

27. Kubba, S. Chapter 6- Choosing Materials and Products. Green Construction Project Management and Cost Oversight. Boston: Architectural Press; (2010). , 221-266.

28. Proemper, E. New Automotive International from Natural Fiber Materials. International AVK-TV Conference for Reinforced Plastics and Thermoset Molding Compounds; Sept Germany (2004). , 28-29.

29. Bledzki, A. K., Faruk, O., & Sperber, V. E. (2006). Cars from bio-fibres. *Macromolecular Materials and Engineering*, *291*(5), 449-457.

30. Muthuraj, R., Misra, M., Defersha, F., & Mohanty, A. K. (2016). Influence of processing parameters on the impact strength of biocomposites: A statistical approach. *Composites Part A: Applied Science and Manufacturing*, *83*, 120-129.

31. Cho, D., Seo, J. M., Lee, H. S., Cho, C. W., Han, S. O., & Park, W. H. (2007). Property improvement of natural fiber-reinforced green composites by water treatment. *Advanced Composite Materials*, *16*(4), 299-314.

32. Kong, C., Park, H., & Lee, J. "Study on structural design and analysis of flax natural fiber composite tank manufactured by vacuum assisted resin transfer molding", Materials Letters, 130, 21-25, 2014.

33. Peng, X., Fan, M., Hartley, J., & Al-Zubaidy, M. (2012). Properties of natural fiber composites made by pultrusion process. *Journal of Composite Materials*, *46*(2), 237-246.

34. LSMAIL, H., Edyham, M. R., & Wirjosentono, B. (2001). Dynamic properties and swelling behaviour of bamboo filled natural rubber composites: the effect of bonding agent.