Mechanical Properties of Luffa Cylindrica, Jute and Bamboo Polymer Fibre Composite

Sonali Singh[1] Sasank Sekhar Panda[2]
[2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]Gandhi Institute of Engineering and Technology, Gunupur, India

Abstract— Environmental perception today encourages empiricism worldwide on the learning of plant or natural fibre reinforced polymer composite and cost efficient alternative to synthetic fibre reinforced composites. The accessibility to natural fibres and simplicity in manufacturing have persuaded researchers to aim for locally existing low cost fibres and to investigate their possibility of reinforcement intensions and up to what extent they can satisfy the essential detailing of superior reinforced polymer composite intended for different application program. In this study, three Fibre namely Luffa fibre, Bamboo and Jute are mixed with polymer base and hybrid composite is prepared. This process is done through hand lay-up process.

Keywords: Natural fibre, Jute, Bamboo, Luffa, Hand lay-up

I. INTRODUCTION

Polymer composite material (PMC) is broadly used in various industrial applications as a result of its advanced properties and has occupied every functional area namely household items, construction, automotive industries and aerospace. Glass, kevlar and carbon fibre reinforced composites do have advanced mechanical properties but are non-biodegradable, non-renewable, non-ecofriendly and can cause human health issues. The natural fibre reinforced composites were developed because of its ability to reducer replace manmade synthetic fibres in many engineering applications. Due to the ecofriendly nature, renewability, non-abrasiveness, low cost, correction resistance, light weight and easy process ability, it attracts the attention of many researchers all over the world.

In this study the fibres are selected on the basis of its easy accessibility, cost-efficiency, mechanical properties. Jute is one of the most affordable natural fibres. Jute fibres are composed primarily of the plant materials cellulose and lignin. The industrial term for jute fibre is raw jute. The fibres are off-white to brown, and 1–4 metres (3–13 feet) long. Jute is also called the golden fibre for its colour and high cash value. Bamboo is an outstanding natural composite: it is rapidly growing, low-cost and abundantly available, light, yet stiffer and stronger than both timber and (chopped strand mat) glass fibre composites. Structural use of the material in raw form as a hollow cylinder is limited by geometrical and mechanical variability. Luffa cylindrica (LC) is a tropical plant belonging to the family of Cucurbitaceous, The fruit of this plant has a vascular system with a fibrous arrangement. The fruit of sponge guard (Luffa cylindrica) belongs to Cucurbitacea, family and is naturally available in many countries.

II. EXPERIMENTAL PROCESS

A. Materials

The raw materials involved in the fabrication were Epoxy resin-BN9523, Hardener-BN9515, Jute, Bamboo and luffa-cylindrical.

B. Material preparation

The bamboo is collected locally .Raw bamboo culm was split into strips of about 10 cm long. The bark was scraped off and the strips were rinsed with water and dehydrated in an air blast oven at 80 _C for 4 h. The strips were soaked in 0.5MNaOH in 1 dm3 of water maintained at room temperature for 3 days. Afterwards the strips were subjected to a pressure of to loosen the fibres. Fibres were obtained by manually scraping the pressed strips. The extracted fibres were rinsed with water and dried in an oven at 50 _C for 24 h before cutting to shorter lengths of 25mm. The jute fibres is collected from local market. The fibres were first cutted into length of 10cmlong. Freshly drawn fibres generally include lots of impurities that can adversely affect the fibre matrix bonding. Consequently the composite material made from such fibres may not possess satisfactory mechanical properties. Therefore it is desirable to eliminate the impurity content of the fibres and perhaps enhance the surface topography of the fibres to obtain a stronger fibre-matrix bonding. The fibres were left to treat with 5% NaOH for 3-4 hrs. Later they were drawn and dried under sunlight for 2 days. Dried Luffa Cylindrica was collected locally. These fibres were then treated with water for 24 hrs in order to remove wax, lignin and oil from the external surface of luffa fibre and then dried at room temperature. After these the fibres were cut with appropriate dimensions (15×14 cm) and then these fibres were kept between two wooden boards followed by pressing it into the bench vice to straighten the fibres. For performing this treatment, Firstly the Luffa Cylindrica fibre were kept in a solution containing 5%NaOH at room temperature for 4hrs. Secondly, the fibers were washed many times with water in order to remove the NaOH sticking to the fibre surface followed by neutralizing with dilute acetic acid and washed with distilled water, so that pH of 7 was maintained. Lastly, the fibers were dried at room temperature for 48hrs followed by oven drying for 6hrs at 100ºC.

C. Fabrication process

Initially, wooden moulds with dimensions of 140 x 120 × 10 mm3 were prepared for the fabrication. For different number a layer of fibre, epoxy resin and hardener (ratio of 2:1 by weight) with a calculated amount was mixed thoroughly in a glass jar. Mould release sheet was put over the glass plate and a mould release spray was sprayed over the inner

surface of the mould for quick and easy removal of composite. After keeping the mould on a ply board a thin layer of the mixture was poured. Then the fiber lamina was distributed on the mixture. Then again resin was applied over the fiber laminate and the procedure was repeated to get the desired thickness. The remaining mixture was then poured into the mould. Precaution was taken to prevent the air bubbles formation. Then from the top pressure was applied and the mould was kept at room temperature for 72 hrs. During application of pressure some amount of mixture of epoxy and hardener squeezes out. Care has been taken to consider this loss during manufacturing of composite sheets. After 72 hrs the samples were taken out of the mould.

Fig. 1: Mould used for fabrication of composite

Fig. 2: Prepared sample

III. Mechanical Characterization

A. *Tensile test*

The tensile properties of jute, bamboo and luffa cylindrica were composites were tested according to ASTM D638 using UTM machine supplied by BS pyromatic LTD, India. The cross-head movement rate of 2 mm.min−1to test the specimens of composites. The test was conducted using five specimens. The average is calculated to get the result.

B. *Compression test*

The test was performed in accordance with ASTM D 695-02standard BS pyromatic LTD, India using universal testing machine with2 mm.min−1movement rate of cross head. The gauge readings were noted for five specimens to evaluate the mean value. The compression force has been recorded as a function of displacement and also the compressive strength of the specimen was evaluated.

C. *Impact test*

The Izod and Charpy impact testing machine has been used to test the impact properties of all specimens in accordance with ASTMD256 standard. The impact strength was directly measured from the machine. Similar to tensile tests, five test samples were in use during testing and finally the average value was obtained.

D. *Rockwell hardness test*

Rockwell hardness testing isan indentation testing method. It measures the permanent depth of a groove produced by a force/load on an indenter. The Rockwell Hardness Number (RHN)is calculated from the depth of permanent deformation of the indenter into the sample. The indenter is either a conical diamond or a hard steel ball.

IV. Result and Analysis

The obtained tensile strength is 53.393MPa. The compressive strength 111.496MPa. The Charpy and Izod impact test shows the following result 4joules and 5joules respectively. The Rockwell hardness test gives the Rockwell number of 40 RHN.

V. Conclusion

In the present work, bio-composite with natural fibers such as jute fibers, bamboo and Luffa cylindrical have been successfully reinforced with the epoxy resin by simple and inexpensive hand lay-up technique. The aim of this project is to find the tensile, compressive, hardness and impact strength of natural fibre reinforced bio-composites. The mechanical testing results of fabricated bio composite sample indicate that, concept of using multiple natural fibres is viable for different application. However, there is a scope to optimize the volume fraction of natural fibers as reinforcements to achieve enhanced mechanical properties of sample. So, it is clearly indicates that reinforcement of natural fibres have good and comparable mechanical properties as conventional composite materials

References

[1] Artur Camposo Pereira, et al Charpy impact tenacity of epoxy matrix composites reinforced with aligned jute fibers: J MATER RES TECHNOL. 2 0 1 7;6(4):312–316, http://dx.doi.org/10.1016/j.jmrt.2017.08.004
[2] Radhika Londhe, Ashok Mache, Aparna Kulkarni, An experimental study on moisture absorption for jute-epoxy composite with coatings exposed to different pH media: Engineering and Material Sciences Perspectives in Science (2016) 8, 580—582. http://dx.doi.org/10.1016/j.pisc.2016.06.026
[3] Md. Rashnal Hossain, Md. Aminul Islama, Aart Van Vuurea, Ignaas Verpoest, Tensile behavior of environment friendly jute epoxy laminated composite: Procedia Engineering 56 (2013) 782 – 788 . http://dx .doi: 10.1016/j.proeng.2013.03.196
[4] Tetsuo Kikuchi, Yuichiro Tani, Yuka Takai,Akihiko Goto, Hiroyuki Hamada, Mechanical Properties of Jute Composite by Spray up Fabrication Method; Energy Procedia 56 (2014) 289 – 297.

http://dx .doi: 10.1016/j.egypro.2014.07.160
[5] Subhankar Biswas,Sweety Shahinur, Mahbub Hasan, Qumrul Ahsan, Physical, Mechanical and Thermal Properties of Jute and Bamboo Fiber Reinforced Unidirectional Epoxy Composites; Procedia Engineering 105 (2015) 933 – 939 . http://dx. doi: 10.1016/j.proeng.2015.05.118
[6] Vivek Mishra, Sandhyarani Biswas, Physical and Mechanical Properties of Bi-directional Jute Fiber epoxy Composites: Procedia Engineering 51 (2013) 561 – 566. http://dx.doi: 10.1016/j.proeng.2013.01.079
[7] Toshihiko HOJO, Zhilan XU, Yuqiu Yang, Hiroyuki Hamada, Tensile Properties of Bamboo, Jute and Kenaf Mat-Reinforced Composite: Energy Procedia 56 (2014) 72 – 79 http://dx. doi: 10.1016/j.egypro.2014.07.13
[8] Darshil U. Shah, Bhavna Sharmal, Michael H. Ramage, Processing bamboo for structural composites: Influence of preservative treatments on surface and interface properties: International Journal of Adhesion and Adhesives 85 (2018) 15–22. https://doi.org/10.1016/j.ijadhadh.2018.05.009
[9] Weifeng Zhao, Zhuosheng Chen, Bin Yang, Axial compression performance of steel/bamboo composite column: Procedia Engineering 210 (2017) 18–23. http://dx. doi: 10.1016/j.proeng.2017.11.043
[10] Ramachandran M., Sahas Bansal, Pramod Raichurkar, Experimental study of bamboo using banana and linen fibre reinforced polymeric composites: Perspectives in Science (2016) 8, 313—316. http://dx.doi.org/10.1016/j.pisc.2016.04.063
[11] Milene M. E. Costa, et al Influence of physical and chemical treatments on the mechanical properties of bamboo fibers: Procedia Engineering 200 (2017) 457–464. http://dx. doi: 10.1016/j.proeng.2017.07.064
[12] Bhavna Sharma, Ana Gatóo, Michael H. Ramage, Effect of processing methods on the mechanical properties of engineered bamboo: Construction and Building Materials 83 (2015) 95–101. http://dx.doi.org/10.1016/j.conbuildmat.2015.02.048
[13] R.Panneerdhass, A.Gnanavelbabu, K.Rajkumar, Mechanical Properties of Luffa Fiber and Ground nut Reinforced Epoxy Polymer Hybrid Composites: Procedia Engineering 97 (2014) 2042 – 2051. http://dx.doi: 10.1016/j.proeng.2014.12.447
[14] Vinay Kumar Patel, Anil Dhanola, Influence of CaCO3, Al2O3, and TiO2 microfillers on physico-mechanical properties of Luffa cylindrica/polyester composites: Engineering Science and Technology, an International Journal 19 (2016) 676–683. http://dx.doi.org/10.1016/j.jestch.2015.10.005
[15] Ykhlef LAIDANI, Salah HANINI, Ghania HENINI, Study contribution of the phenol adsorptiondynamics of the system fiber Luffa Cylindrical: Energy Procedia 18 (2012) 384 – 394. http://dx.doi: 10.1016/j.egypro.2012.05.050
[16] Soma Dalbehera, S.K.Achary Impact of stacking sequence on tribological wear performance of woven jute-glass hybrid epoxy composites: Material Today Procedia(2015) 2389 –2398 https://doi.org/10.1016/j.matpr.2015.07.176
[17] Ajith Gopinatha , Senthil Kumar.M, Elayaperumal A, Experimental Investigations on Mechanical Properties Of Jute Fiber Reinforced Composites with Polyester and Epoxy Resin Matrices: Procedia Engineering 97 (2014) 2052 – 2063 http://dx.doi: 10.1016/j.proeng.2014.12.448
[18] A.Saaidia, A.Bezazi, A.BelbahH, Bouchelaghem, F.Scarpa, S.Amirouche, Mechano-physical properties and statistical design of jute yarns: Measurement Volume 111, December 2017, 284-294. https://doi.org/10.1016/j.measurement.2017.07.054
[19] M.A.A Ghani, Z. Salleh, Koay Mei Hyie, M.N.Berhan, Y.M.D. Taib, M.A.I. BakriMechanical Properties of Kenaf/Fiberglass Polyester Hybrid Composite: Procedia Engineering 41 (2012) 1654 – 1659. http://dx.doi: 10.1016/j.proeng.2012.07.364
[20] M.R.Bambach, Compression strength of natural fibre composite plates and sections of flax, jute and hemp Thin-Walled Structures Volume 119, October 2017, Pages 103-113. https://doi.org/10.1016/j.tws.2017.05.034

