Effect of Composition of Fibers on Properties of Hybrid Composites

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ABSTRACT

Fibers embedded in the matrix of another material are the best example of modern day composite materials. Hybrid Composites made out of an amalgamation of Natural Fibers such as banana, jute, and coir along with glass fiber embedded in polymers have potential applications in automotive, aircraft and marine industries for their unique characteristics like high specific strength, light weight, design flexibility, corrosion resistance, biodegradability and low cost. In this work, epoxy hybrid composites reinforced with glass fiber mats and banana, jute, coir fibers of random lengths between 10-25 mm are prepared by varying their compositions in terms of weight percentage. The composites are fabricated by hand lay-up process and cut into test specimens as per ASTM Standards. Their mechanical characteristics such as Tensile Strength, Flexural Strength, Impact Strength, Hardness, Density and Water Absorption Capacity are evaluated and analysed.

KEYWORDS

Banana Fiber, Bisphenol-A, Coir Fiber, Density, E-Glass, Flexural Strength, Hand Lay-Up, Hardness, Hybrid Composites, Jute Fiber, Polyamide, Tensile Strength, Water Absorption

INTRODUCTION

Generally, Composites consists of fibers and a matrix which binds the fibers. According to Nitin Jauharia et al. (2015) fibers which are discontinuous hold the load that is applied. Matrix which are continuous bind the fibers as well as transmit the load to the fibers. Natural fibers are renewable and they are a new type of reinforcement which enhances the properties of polymer based materials. Sanjay M.R. et al. (2016) established that natural fiber composite materials are environmental friendly and therefore gaining importance in manufacturing of Hybrid composites. Natural fibers are one such proficient material which replaces the synthetic materials and its related products either partially and fully for the less weight and energy conservation applications. These fibers can be classified as Mineral fibers, Animal fibers, and Vegetable fibers. According to Hoi-yen Cheung (2009), Giuseppe Cristaldi (2010), and Nguong. C.W. (2013), vegetable fibers are very extensively used and classified as: Fruit fibers like Coir, Leaf fibers like Ukum, Pineapple, Sisal, Bagasse, Flax, Jute, banana, Hemp, etc. and Seed fibers like cotton. The fibers extracted from Kenaf, Hemp, Jute, Sisal Bamboo and Flax are best suited for reinforcements in Composites because of their excellent mechanical characteristics. Natural fibers have many beneficial properties such as better strength to weight ratio, low weight, high stiffness, high fatigue strength, low thermal expansion, high corrosion

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resistance, good bending, impact, compressive, tensile strengths, recyclability, no health threat, no irritation to the skin, non-depletable and non-abrasive to the equipment. Nitin Jauharia et al. (2015) noted that the energy required for production of these natural fibers is almost less than half of the amount needed for glass fibers. Therefore, Natural fibers are ideal for reinforcing composites along with glass fibers to gain economical advantage as well as to realize a score of benefits. However, Puglia et al (2005) observed few disadvantages such as incongruity with the water-resistant polymer materials, the propensity to develop aggregates during processing and reduced resistance to wetness reduce the prospective use of natural fibers as reinforcements in polymers. Therefore, utmost care should be exercised during processing to avoid aggregates and suitable coatings shall be applied to avoid dampness is required.

LITERATURE REVIEW

Importance of Hybrid Composites is increasing because of the reasons stated above including the possibility of replacing fully or partially synthetic fiber in reinforced plastics at lower cost with improved sustainability. Composites reinforced with the synthetic and natural fibers are having wide applications in industry (Navdeep Malhotra et al., 2012). Hybrid Composites are one of the most advanced and adaptable engineering materials (Arpitha et al., 2017). The natural fibers obtained from undepletable resources have been contributing towards progressive ecological conservation and environmental protection (Mohanty et al., 2002). Earlier investigations in this area are restricted to reinforced plastics. (Espert et al., 2004, Singleton et al., 2003; Joseph et al., 2002). The natural fibers do have limitations such as poor thermal stability (degrading above 200-250°C); Swelling of fibers due to poor adhesion between fibres because of hydrophilic nature and moisture absorption. The problems stated above lead to early ageing by loss of strength and degradation (Herrera-Franco, 2005). Due to poor mechanical properties and inferior performance of some natural fibers, precincts are observed concerning the expected final application. In order to prevent these precincts, hybrid composites combining natural and glass fibers are developed with the aim of improving the physical and mechanical performance with low production cost (Thwe and Liao, 2002; Seena et al., 2002). Hybrid composites have been fabricated and investigated both in academic and industrial research; however, in the beginning investigations are done with synthetic fibers (Mander et al., 1981). Only during last the decade attention has been given to combinations of synthetic and natural fibers (Rowell et al., 2000; Thwe and Liao, 2002; Mishra et al., 2003; Sapuan et al., 2006; Ravikumar et al., 2013). It is established that Jute/E-glass/Epoxy hybrid composite has higher elastic strain energy storage capacity than both steel and E-glass/Epoxy composites and they are economical (Amrita Srivastava et al. 2013). The properties of natural fibers vary considerably depending on the chemical and structural composition, fiber type and growth conditions, physical and mechanical properties of the constituents and interface between them. Major properties found in literature concerning few known natural fibers are stated in Table 1.

Hybridization of the composites increases the mechanical properties by increasing the bonding strength between the fibre and resin. The mechanical strength of woven natural fiber hybrid composites increases due to the hybridization of the fibers (Alavudeen et al., 2015). A fiber orientation of ±45° helps to boost up the mechanical properties of the composites. (Stanly Jones Retnam et al., 2014). It appears that the largest effect of increase in flexural strength is shown by the addition of glass fiber to natural fiber composites. (Akil et al., 2010). The Young’s modulus of the natural fiber reinforced polymer composites increases with increasing fiber loading (Ku et al., 2011). There is a great interest in the application of natural fiber as substitutes for glass fibers, motivated by potential advantages of
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