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Study of Tensile Strength of Agave Americana Fibre Reinforced Hybrid Composites

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Abstract

In the growing environmental problems, the waste disposal and the dwindling of limited amounts of exhaustible resources have stimulated the use of green materials compatible with the environment to reduce environmental impacts. Therefore, there is a need to use natural resources in the design of products. Natural fibres seem to be a good alternative since they are abundantly available and there are a number of possibilities to use all the components of fibre-yielding crop; one such fibre-yielding plant is *Agave Americana*. The fibres yielded by the leaves and other parts of this plant can be utilized in various applications. The objective of the present work is to investigate the tensile properties of four varieties of hybrid composites. The composites include Agave Fibre-Glass composite (FB-GL-FB-GL-FB), Agave Fibre-Copper Foil Composites (FB-Cu-FB-Cu-FB), Agave Fibre –Aluminium foil composite (FB-Al-FB-Al-FB), and Agave Fibre-Copper foil-Glass-Aluminium foil composites (FB-Cu-GL-Al-FB). The Agave Americana fibre reinforced hybrid composites are produced through hand Lay- up technique. These fibres were treated with 7% NaOH (alkali treatment) and cured for 35 minutes at 85^0C for better fibre matrix adhesion and tensile properties. The number of plies of fibre taken in each type of composite are three, and the total number of plies used in each hybrid composite are five.
Each of these composites is prepared in 0^0 orientations (i.e., fibres in parallel direction to each other) and 90^0 orientations (i.e., fibres in perpendicular direction to each other). It is observed from the results that, the tensile strength of FB-Cu-FB-Cu-FB

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composite with 0^0 orientation is high (99.73 MPa) and that of FB-GL-FB-GL-FB composite with 90^0 orientations is low (13.73 MPa). There is a fairly low amount of difference in tensile strength (4 MPa) between the 0^0 and 90^0 orientations of FB-Cu-GL-Al-FB composite. It is also found from the results that, the percentage elongation is high (5%) for FB-GL-FB-GL-FB composite and low (0%) for FB-Cu-GL-Al-FB composite.

Keywords: Agave Americana, natural fibre, hybrid composite, fibre glass, copper, aluminium.

1. Introduction

Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics. The natural fibres containing composites are more environmentally friendly, and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling paneling, portion boards), packaging, consumer products, etc. Their availability, renewability, low density and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibres used in the manufacturing of composites.

Nomenclature

Al	Aluminium foil
Cu	Copper foil
GL	Glass mat
FB	Agave Americana fibre

Joshi et.al [9] compared life cycle environmental performance of natural fibre composites with glass fibre reinforced composites and found that natural composites are environmentally superior in the specific applications studied. Rana et al. [15] in their work showed that the use of compatibilizer in jute fibres increases its mechanical properties. At 60% by weight of fibre loading, the use of the compatibilizer improved the flexural strength as high as 100%, tensile strength to 120%, and impact strength by 175%. Shah and Lakkad [17] tries to compare the mechanical properties of jute reinforces and glass-reinforces and the result shows that the jute fibres, when introduced into the resin matrix as reinforcement, considerably improve the mechanical properties, but the improvement is much lower than that obtained by introduction of glass and other high performance fibres. Ray et.al [16] has done alkali treatment to jute fibres with 5% NaOH solution for 0,2,4,6 and 8 hrs at 30^0 C. It was found that there is improvement in properties both for fibres and reinforced composites. The fibres after treatment were finer; having less hemi cellulose content, increased crystallinity, reduced amount of defects resulting in superior bonding with the vinyl ester resin. Saha et.al [12] treated jute fibres with alkali (NaOH) solution and physical-chemical properties of jute fibres were investigated. The treatments were applied under ambient and elevated temperatures and high pressure steaming conditions. The results indicated that the uniaxial tensile strength increased by up to 65% for alkali-steam treatment. They used MAH-PP copolymers as coupling agents in jute-propylene composites. It is found that the flexural strength was increased by 40% and flexural modulus by 90%. SEM investigation showed the improved fibre-matrix adhesion which was due to the chemical bonds between fibre and matrix provided by the coupling agent.

Monteiro S.N.Rodriquez et.al [10] tried to use the sugar cane bagasse waste as reinforcement to polymeric resins for fabrication of low cost composites. They reported that composites with homogenous microstructures could be fabricated and mechanical properties similar to wooden agglomerates can be achieved. Hassan et.al [6] has converted the bagasse into a thermo formable material through esterification of the fibre matrix. The dimensional stability and mechanical properties of the composites prepared from the esterified fibres were reported in this work. B.C.Ray [4] used 3-point flexural test to qualitatively assess the effects for 55,60 and 65 weight percentages of E-glass fibres reinforced epoxy composites during cryogenic and after thawing conditions. The specimens were tested at a range of 0.5 mm/min to 500 mm/min crosshead speed to evaluate the sensitivity of mechanical response during loading at ambient and sub-ambient (-8^0C temperature). Paramasivam and Abdul Kalam [11] studied tensile test on