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Review Article

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Development of Reinforced Composites from Areca Fibres

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Abstract

Use of natural fiber as reinforcement is a burgeoning field of research because of the ease of procuring raw materials, bio-degradable and environment friendly nature along with mechanical properties of the resulting composites that are comparable to synthetic fiber-reinforced composites. Areca owing to these very reasons along with low cost, light-weight further advocated by its tensile strength has pervaded the field of composite manufacturing. Different natural fibers have been used by many researchers for the development of bio-composites, but areca leaf fibers as a feasible fiber has seldom been researched or spoken about. The development and study of mechanical behavior of a natural fiber reinforced epoxy composite of areca fiber with different configuration of areca fiber orientation has been discussed herein. The factors considered for areca fibres have been youngs modulus, specific modulus, tensile strength, specific modulus and are found to be greater than those for the popular coir fibre. Another important aspect considered is the sheath fibre angle of orientation of the composite.

Keywords: Composites; Natural fibres; Fibre orientation; Mechanical properties; Experimental Analysis.

Introduction

Since the past decade there has been a steady increase in research for natural fiber reinforced composites because of its potential to replace synthetic fiber reinforced plastics at lower cost with improved sustainability in various engineering applications and industries. The age of composites began when there was a need for high strength to weight ratio in components that demanded high performance and efficiency, which invited the developments of various polymer matrix composites with a variety of fiber reinforcements such as carbon fiber, glass fibers, aramid, natural fibers, hybrid, etc. Considering the factor of environmental friendly materials and the need to produce various sustainable engineering and industry oriented components, natural fiber composites play an important role. Natural fibres [1] play an inevitable role as a reinforcement agent because of their good mechanical properties and bio-degradable nature [2] and it is found abundantly all over the world. Many natural fibres like jute, kenaf, sisal, hemp, bamboo, areca, pineapple [3], banana [4] and coir hold the position of key materials in many areas of research because of their availability and cost effectiveness to develop an inexpensive reinforcing material. Use of different natural fibres as a reinforcement agent in composite materials, has given us an array of properties that can be used advantageously for various applications. It has been found that natural fibre reinforced composites possess resistance to electricity, good thermal insulating [5] property and also provide good corrosion resistance. The past research works on volume fraction shows that the tensile strength of natural-polymer composites increases with increase in volume fraction of the fibre [6]. It has been shown in the study of the tensile characteristic of the untreated areca sheath composite that the longer the fibre length more is the strength of the composite. Considering the fact that chemical treatment of the fibers will bring out the changes in its mechanical properties it is found that by alkali treatment of the areca nut fibre shows enhanced mechanical strength than the untreated fibers. Curing time of the composite also plays a vital role in determining the full potential strength of the composite. From the work done by Srinivasa Chikkol Venkateshappa [7].

Literature Review

It is evident that the strength of the composite increases as the curing time of the composite increases. Other mechanical properties such as impact strength, hardness and flexural strength of the areca fibre composite were studied in which the influence of volume fraction, post curing time and alkali treatment for effective bonding were taken into account. From the research work by S.C.Venkateshappa it is found that the flexural strength increases with increase in fibre loading percentage and comparing to the untreated fibre, there has been a significant increase in flexural strength for the alkali treated fibres [8,9]. The results drawn from the research work done by C.V. Srinivasa is it found that the impact strength increased with the post curing time and it is also shown as the curing time increased the alkali treated composites became brittle [10]. This research is focused on the tensile property of the non-chemically treated areca fibre sheaths which is water soaked, hot pressed and compressed into the thickness of 2.5 mm to 3 mm, which is commonly available in India as areca fibre plates and using this as reinforcing agent in epoxy polymer composite to study its tensile properties and effects of the different combinations of the orientation angles of the fibre which influences the tensile property of the composite (Figure 1).

Figure 1: Different combinations of the orientation angles of the fibres.

Fiber properties

As the areca sheath fibres are initially obtained in an anhydrous state it is mainly composed of 66.08% of α-cellulose, 7.40% of hemicellulose and 19.59% of lignin [11] which mainly contributes to the bond strength. In addition, it also comprises of minor constituents such as pectic matters and fatty and waxy matters that contributes in a relatively low matter to the bond strength, it is resistive to electric discharges and can be degraded with the action of fungus and bacteria, thus making the areca sheath fibre a bio-degradable material. The properties of the fibre sheath that was obtained due to pure tensile failure have been determined. Sheath as a whole comprises of infinite number of fibres, it is evident from the results that the strength taken along the direction of the fibre will be more than the strength taken along the normal direction of the fibre. Taking the density of the sheath, the specific modulus Young's modulus and the specific strength of the sheath fibre are calculated accordingly.

Areca fiber reinforced epoxy polymer composite

In making of areca sheath reinforced epoxy composite, the volume fraction of the fiber, chemical treatment of the fiber and the curing time for the composite plays an important role. In this paper the volume fraction of fiber to composite is 75% and it is kept constant through the whole process, no chemical treatment is done to the areca sheaths and the curing time for the preparation of each individual specimen is kept constant. The composite specimen was made according to the tensile standard A iSTM D 638 in which five composites were prepared. Within every composite the angular orientation of the sheath fiber is changed with respect to the x-coordinate, within the fiber layers of the composite [12]. The Young's modulus results for various combinations of different orientation of fiber layers within a composite.

Discussion

The data from the obtained results shows that the composite which had the sheath fiber orientation 90°-90°-90° has the highest young's modulus value. Comparing the fiber orientations 90°-90°-90° and 90°-0°-90°, young's modulus value of 90°-0°-90° composite decreased because of the zero degree orientation of the fiber which was less effective in taking up the force applied on the composite. Comparing the fiber orientation 45°-90°-45° and 45°-0°- 45°, even though the inter-angular difference between the adjacent layer is 45°, the 90° orientation of the fiber sheath increased the young's modulus of the overall composite [13]. As the fiber angle approaches zero the young's modulus decreased because comparing to the individual fiber properties for the 0° oriented fiber, as the load is applied along the perpendicular direction to the fiber orientation, transverse young's modulus comes into the play with yields a lesser young's modulus value than the longitudinal one. Comparing the models 45°-0°-45° and 30°-60°-30° the young's modulus value is the least from the model 30°-60°-30°, as the majority fiber sheath angle is two layers of 30° in this case and it holds a least angular difference the orientation and the x-axis its local strength when resolved to the global strength, it's strength is much lesser when compared the 90° oriented fiber's global stress.

So it is observed from this that the angle of orientation of the reinforcing fiber plays an important role in determining the overall Young's modulus of the composite in which the global strength of the composite increased as the angular orientation with reference to the x-axis increased. As the load increased, the first failure occurred in the fiber sheath that had less fiber angle orientation with respect to the x-axis, it was followed by the corresponding fiber sheath that had minimum angle of orientation [14,15].

Conclusion

The Young's modulus and the tensile strength of hot pressed, non-chemical treated areca sheath fiber was evaluated experimentally and its specific modulus was found to be 55.5% more than that of coir and 39.79% greater than that of medium density fiber board which is a engineered wood product commonly used for domestic appliances. Composites with different orientation in the sheath fiber angle were prepared and tensile test was performed, in which it was observed that the composite that had the sheath fiber orientation as 90°-90°-90° had the highest strength and it's Young's modulus was estimated to be 1.798 GPa. The maximum elongation for the composite before the first failure of the specimen occurred was evaluated. Composite with sheath fiber orientation of 90°-90°-90° had the highest elongation of about 11.6% of its original length. As the sheath fiber angle of orientation in a composite decreased, there was a significant reduction in the young's modulus value, the extension of the total composite also reduced. Composite that had least fiber orientation witnesses less longitudinal Young's modulus and it failed easily under loading and this effect was also felt in a significant manner in the composite. The composite that had 90°-90°-90° orientation of fiber gave the advantage to withstand higher strength when the load was applied only along the longitudinal direction of the sample. If the loading is of bidirectional in nature the composite with fiber orientation 45°-90°-45° can be used as the optimum one because the 45° oriented fiber enhances the composite strength when load is applied in the inclined direction with reference to the longitudinal axis.

References

1. Taj S, Munawar MA, Khan S (2007) Natural fiber-reinforced polymer composites. J Proc Pak Acad Sci 44:129-144.
2. Desai RH, Krishnamurthy L, Shridhar TN (2016) Effectiveness of Areca (Betel) Fiber as a Reinforcing Material in Eco-friendly Composites: A Review. Ind J Adv Chem Sci 27-33.
3. LaUma Devi, Bhagawan SSb, Thomas Sa (2012) "Polyester composites of short pineapple fiber and glass fiber: Tensile and impact properties", Polymer Composites 33:1064-1070.
4. Jeyasekaran AS, Kumar KP, Rajarajan S (2016) Numerical and experimental analysis on tensile properties of banana and glass fibers reinforced epoxy composites. Sādhanā 41:1357–1367.
5. Siva I, JT WJ, Sankar I, Amico SC, Ravindran D (2013) Effect of fiber volume fraction on the mechanical properties of coconut sheath/usp composite. J Manuf Eng 8:60-63.
6. Chethan MR, Krishna SGG (2016) Effect of fiber length on tensile characteristics of untreated natural areca sheath frp green composites. Int J Mech Prod Eng Special 90-92.
7. Venkateshappa SC, Jayadevappa SY, Puttiah PK (2012) Mechanical Behaviour of Areca Fibre Reinforced Epoxy Composites. Adv Polym Technol 31:319–330.
8. Venkateshappa SC, Bennehalli B, Kenchappa MG, Ranganagowda RPG. Flexural behaviour of areca fibres composites. BioRes 5:1846-1858.

9. Srinivasa CV, Arifulla A, Goutham N, Santhosh T, Jaeethendra HJ, et al. (2011) Static bending and impact behaviour of areca fibers composites. Mater Des 32:2469-2475.
10. Srinivasa CV, Bharath KN (2011) Impact and Hardness Properties of Areca Fibre-Epoxy Reinforced Composites, J Mat Environ Sci 2:351-356.
11. Poddar P, Islam MS, Sultana, Nur HP, Chowdhury AMS (2016) Mechanical and Thermal Properties of Short Arecanut Leaf Sheath Fiber Reinforced Polypropyline Composites: TGA, DSC and SEM Analysis. J Mat Sci Eng 5.
12. Pickering KL, Efendy MA, Le TM (2016) A review of recent developments in natural fibre composites and their mechanical performance. Compos Part A Appl Sci Manuf 83:98-112.
13. Ravikumar HB, Ranganathaiah C, Kumaraswamy GN (2005) Influence of free volume on the mechanical properties of Epoxy/poly (methyl methacrylate) blends. J Mater Sci 40:6523–6527.
14. Mini KM, Lakshmanan M, Mathew L, Mukundan M (2012) Effect of fibre volume fraction on fatigue behaviour of glass fiber reinforced composite, Fatigue Fract Eng Mater Struct. Wiley Publishing Ltd 35:1160–1166.
15. George G, Jose ET, Jayanarayanan K, Nagarajan ER, Skrifvars M, et al. (2012) "Novel bio-commingled composites based on jute/polypropylene yarns: Effect of chemical treatments on the mechanical properties, Compos Part A Appl Sci Manuf 43:219-230.