EXPERIMENTAL INVESTIGATION OF ARECA/JUTE/GLASS FIBER REINFORCED HYBRID COMPOSITE PLATES

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Abstract:

The hybrid composites have emerged has the potential reinforcement material for composites and thus gain attraction by many researchers. This is mainly due to their applicable benefits such as low density, low cost, renewable biodegradability and environmentally harmless and also comparatively good mechanical properties with synthetic fiber composites. In continuing to that, the industries are focused to find new materials to overcome the drawbacks. Due to this, great part of the scientific research is directed towards using areca plate, glass woven fiber and jute woven cloth. These fibers are combined to form hybrid composite materials which are fabricated by using epoxy resin with hardener. The performance of hybrid composite has extensive engineering applications such as Aeronautics, automotive industries and home applications.

Key Words: Hybrid Composites, Hand layup method, Mechanical testing, Automotive applications.

1.Introduction

Natural fibre reinforced composite materials are considered as one of the new class of engineering materials. Interest in this area is rapidly growing both in terms of their industrial applications and fundamental research as they are renewable, cheap, completely or partially recyclable and biodegradable. Manmade fibres using glass, carbon, boron etc. are being used as reinforcingmaterials in hybrid fibre reinforced composite materials which have been widely accepted as materials for structural and non-structural applications. Glass fibre reinforced polymers (GFRP) is a fibre reinforced polymer made of a plastic matrix reinforced by the fine fibres of glass. Glass fibre is a lightweight, strong, and robust material used in different industries due to their excellent properties. The main reasonfor the incorporation of these hybrid composites is due to their properties like specific modulus, high stiffness, and strength to weightratio compared to other conventional materials.Nowadays natural fibres like cotton, jute, and other natural fibres haveattracted the attention of scientists and technologists for applications in packaging,low-cost housing, and other structures. Among all the natural fibres, jute appears to be a promising material because it is relatively inexpensive and commercially available in the required form. It has been found that the hybrid fibrecomposites possess required mechanical strength and other properties with betterelectrical resistance, good thermal and acoustic insulating properties, and highresistance to shocks and fracture. The increasing interest in introducing degradable,renewable, and inexpensive reinforcement materials which have been environment friendlyhas stimulated the use of hard cellulose fibres. The low cost, less weight,and density make the hybrid fibres an attractive alternative.

In this paper, the mechanical properties of the fibres extracted from areca are determined, and compared with the other known natural fibre. Further, these areca fibres were chemically treated to improve the mechanical properties using NaOH in a known concentration of NaOH for different periods. Also the effect of this chemical treatment on maize fibre is studied. The composites were prepared with different proportions short areca fibres reinforced in maize stalk fine fibres and phenol formaldehyde. Variations in the static bending strength of these composites are analysed. Other mechanical properties using adhesion strength, moisture absorption test, and biodegradable tests are carried out and results were reported. Of their reasonably high tensile modulus and elongation at break.

2.Experimental Procedure

2.1Materials:

Among all the natural fibre reinforcing materials, areca fibre appears to be a promising material because it is inexpensive, availability is abundant and a very high potential perennial crop. Jute fibre in the form of circular woven cloth is taken as jute possess some unique properties like high tenacity, bulkiness, low thermal conductivity, heat insulation property etc. E-glass fibres in the form of woven mat of 280GSM are purchased. Epoxy LY556 and Hardener HY951 are purchased.

Fig2.1. Areca fibre

Fig 2.2. Jute fibre

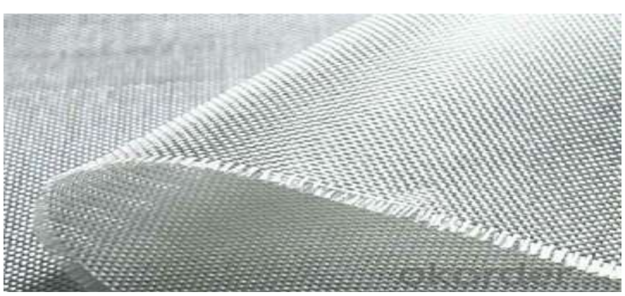

Fig 2.4. Glass fibre

2.2 Preparation Of Epoxy- Hardener Mixture:

The mixture is prepared by mixing the 10gms of hardener for every 100gms of epoxy resins, in the ratio of 1:10 (for 10gms of epoxy, 1gms of hardener is used). For every layer of composite, 400gms of prepared mixture is taken.

2.3 Sample Preparation:

In this study, the composites are prepared with fibres like areca fibre, glass fibre and jute woven type cloth and randomly distributed in epoxy and hardener which having a weight ratio of 10ml hardener to combined 100ml epoxy resin. This matrix of resin randomly distributed in the required shape of the fibre surface before cutting the fibre in required shape. The bonding of fibre is carried out by hand layup method. And distributed the resin at the fibre surface evenly, which used the hand roller. And cold press method is used for bonding the fibres. This same type of process is followed to form more than three composite plate at different layer formation. And finally added the load at top of the composite plate. This load is remaining fixed to stay nearly five days at the same time to increase the mechanical properties of the composite plate.

Table1. Material Compositions

SAMPLES	LAYER ARRANGEMENT
S1	A + J + G + J + A
S2	A + G + J + G + A
S3	A + J + J + G + G + A

(G- Glass Fibre, J- Jute Fibre, A- Areca Fibre)

3.Testing Methodology

3.1 Tensile Test:

The tensile test is conducted as per the ASTM D638 Standard. A dog bone-shaped specimen of total length of 190mm and width of 22m at gauge length section, 35mm width at ripping section and a uniform thickness of 10mm is used for the tension test. The specimen is loaded in the universal testing machine with computer interface for acquiring data at constant crosshead speed of 1mm/min until the failure of the specimen occurs.

3.2 Flexural Test:

The flexural test is performed according to the ASTM D3410 and a specimen with diameter of 25mm and length of 60mm is used for the test. The three point bending test is conducted according to the ASTM D790. Test specimens of 50mm width, 240mm length and 10mm thickness are prepared. The span of the test beam is kept at 100 mm. the specimen is loaded at centre of the span through the loading cell.

3.3 Impact Test:

The Charpy and Izod methods of impact testing are conducted as per the ASTM-D256-90 using the notched specimens. Using the impact test, the energy needed to break the material is noted and used to measure the toughness of the material and the yield strength. The effect of strain rate on fracture and ductility of the material is also been analysed.

4.Results and Discussion

4.1 Tensile Properties:

The tensile strength of the composite in the direction normal to the surface was determined. A Round specimen of 137.73mm side and thickness 10.45 as that of prepared plate is considered for the test. The specimen was loaded in the Universal testing machine and loaded gradually until the failure of the specimen occurs. The Load – deflection curves for the various areca-reinforced composite plates. The tensile stress-strain strength of composite plate increases in % in composite. The maximum tensile stress of Areca- reinforced composite plate specimen Maximum tensile load is 18.47MPa in a composite plate.

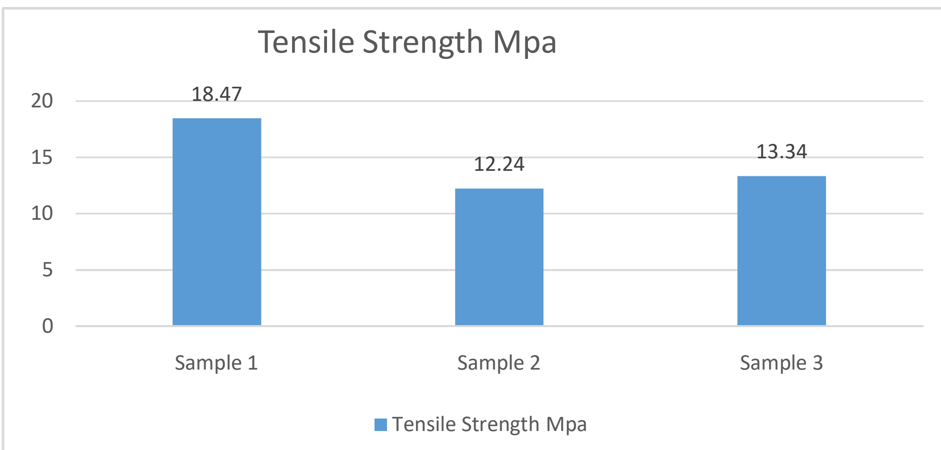

Fig3.1 Tensile Strength of Samples

4.2 Flexural Properties:

The deflection diagrams of areca fiber and epoxy composite with alkali-treated fibers has a higher flexural strength compared to that of the untreated fibers, the difference being substantial. The deflection at failure in the case of the composite with alkali-treated fibers is considerably greater than that for a composite with untreated fibers. The variation of flexural strength with curing time/weightratio of fibers to matrix for both treated and untreated fibers. It is shown that the variation of flexuralfailureloadwithcuringtime.Itisseenthatthevariationislinearwithfailure load increasing with the time. Indicates that the combination of areca fibers and epoxy resin (present study) exhibits a higher flexural failure load than the combination of arecafibers.

4.3 Impact Properties:

Impactresistanceistheabilityofamaterialtoresistbreakingunderashockloading or the ability to resist the fracture under stress is applied at high speed. Impact behavior is one of the most widely specified mechanical properties of the engineeringmaterials.BothIzodandCharpymethodsperformimpacttestsonareca fibers reinforced with epoxy composite specimens as per ASTM-D256-90. The variations of impact strength with respect to fiber volume fraction and composite curing time as shown in Figures Charpy and Izod method of impact test. These figuresindicatethat,theimpactstrengthofcompositesincreaseswithcuringtimeat a greater degree when compared to other fiber volume in the composite. The important aspect regarding impact strength of the areca composite is that, as the composite curing time increases the alkali treated composites becomes more brittle than the untreatedfibers

S.NO	Name of the Specimen	Tensile Strength MPa	Flexural Strength KN	Impact Strength Joules
1	Sample1	18.47	0.28	2
2	Sample2	12.26	0.63	2
3	Sample3	13.34	0.58	2

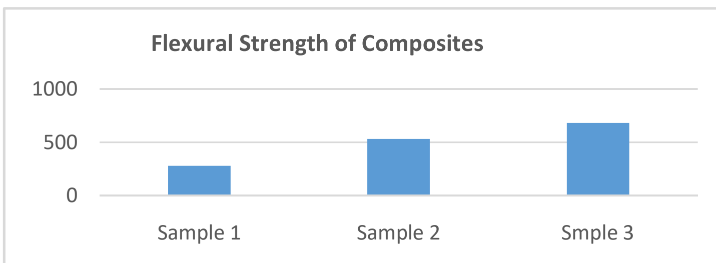

Table 2. Mechanical Properties of Prepared Samples

4.4 WATER ABSORPTION TEST:

The water absorption test is conducted according to ASTM D570-99 procedure (ASTM 1999). The composite samples are first dried by heating in an oven at 50◦C for about 24 h, then cooled in a desiccator and weighed immediately to the nearest 0.001g. To measure the water absorption of the composites, all the samples are immersed in a beaker containing water for about 24 h at room temperature. After every 24 h, the specimens are taken out and the excess water on the surface of the samples is removed before weighing. The percentage increase in weight due to immersion is calculated. This specimen is tested and the average result is taken. The amount of water absorbed by the composites is presented. It indicates that the alkali treatment on fibres reduces the percentage of water absorption. It is also seen thatthecompositehavinghigherfibrecontenthasalowerwaterabsorptionthanthe composite with a lower fibre content. It is also observed that the areca fibre- reinforced epoxy composites have greater affinity for water absorption when lake water is used. These results show that the composites made of alkali-treated areca fibres have less water absorption compared with wood-based particleboard.

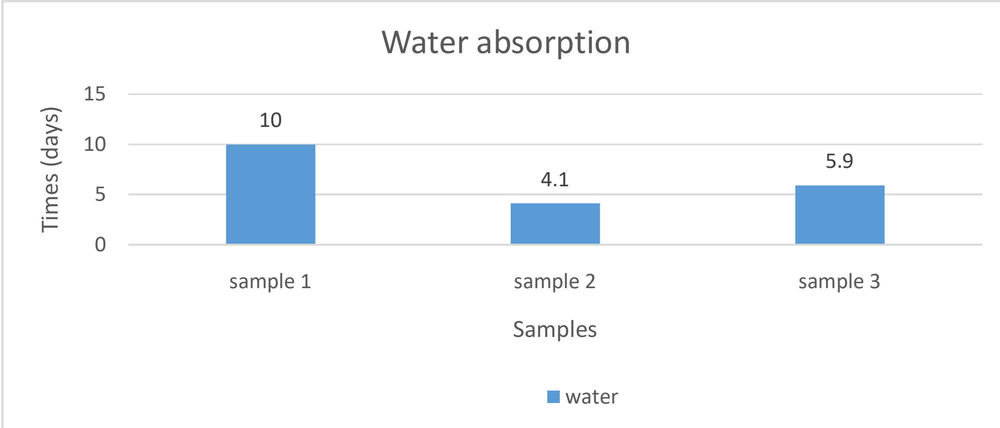

Fig4.3 Bar chart for water Absorption

5.Conclusion

Inthepresentwork,experimentalstudiesoncompositeswitharecafibersandepoxy resin have been carried out using the tension, compression, flexural, impact, and hardness tests. Both the alkali-treated and untreated areca fibers are considered in theinvestigation.Thearecafibersareinexpensiveandabundantlyavailableinindia and other Asian countries. This study has been undertaken as a part of an attempt to find alternative material for wood based composites. The parameters considered in the present work are (i) alkali-treated/untreated fibers, (ii) weight ratio of fiber to matrix, the composites made using alkali-treated areca fibers show higher strength and higher performance compared with those with the untreated fibers. It is also noticed that the strength increases with the curing time and the weight ratio of fiber tomatrix.Itisconcludedthatthecompositesusingarecafiber,jutewoventypecloth andglassfiberwithhelpofepoxyresintobondingacompositeplateformings, arepromisingalternativematerials,whichcanbeusefullyemployedinautomobiles, office furniture, packaging industry, partition panels, and so on. In the upcoming years the researchers may focus on hybrid composites and fully biodegradable composites. The future of the hybrid composites appears to bebright.

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