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MECHANICAL CHARACTERIZATION OF BETEL NUT NATURAL POWDER REINFORCED EPOXY COMPOSITES

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Abstract

Natural fiber reinforced polymer composites materials are implemented today in different structural and engineering applications. Regularly increases the production of these composites because of natural fiber composites replace the synthetic fiber due to their various advantages such as low weight, low cost, easily available biodegradable, non-abrasive and environmentally friendly. In this present experimental work betel nut powder (40%) reinforced epoxy based green composites materials has been developed through hand layup techniques and determined their mechanical behaviors like as tensile and flexural strength, tensile and flexural modulus, impact strength for both types i.e. Izod and Charpy test, water absorption behaviors of this developed material has been investigated experimentally.

Keywords: *betel nut powder, composites, water absorption, tensile strength, flexural strength*

Introduction

Natural fibre composites are now days widely used instead of synthetic fibres because of various advantages such as biodegradability, less cost, light weight, and high specific strength [1]. Synthetic fibre composites have very high mechanical properties than natural fibre composites but since they are more costly &non-biodegradable, they are only used for aircraft and military applications. Natural fibres are mostly extracted from plants such as jute, flax, bamboo, banana, sugarcane and coconut etc [2]. These plants are extensively found in all over world. Mechanical properties of any types of natural composites materials depend on many factors like as strength of fibers, length of fibers, orientation of fibers, content of fiber as well as interfacial adhesive bonding between fiber and matrix [3]. Betel nut fruit obtained from Areca Palm Tree (Betel Nut Tree) a species of Palm tree, which is mostly found in Malaysia and now a days planted across all

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over Asia. Betel Nut Husk is the main part of the fruits and fiber was extracted from these parts, which is mostly equals to 60-80% of weight of betel nut [4]. Betel nut tree bearing the betel nut fruits in the shapes of round/oval which contains various phases of maturity as raw, ripe and dry along with the different colors. Betel nut husk contains three different zones and fibrous part present in the middle layer. A single piece of fruits contains 0.15-0.25g of BNH Fibers [5]. Borah et al. [6] experimentally invested that betel nut fibers (5% weight) have a better mechanical and thermal properties than any other content of betel nut. This paper also showed that weight percentage of betel nut fiber increases, decreases its mechanical and hardness properties. This can be due to lack of bonding materials i.e., Matrix. Banjo et al. [7] experimentally investigated fabrication and mechanical characterization such as surface morphology, thermal and chemical properties of Betel Nut Fruits husk fiber reinforced polymer composites. Due to presence of high cellulose (57.35%) and low wax (0.12%) betel nut fiber provides better strength and bonding. they are suitable for light weight applications because of low density and moderate tensile strength provides enough specific strength. Yusriah and Sapuan [8] reported that the effect of age of betel nut fruit fiber was investigated to have a very minimum effect on the mechanical behaviors of the betel nut fiber reinforced epoxy composites with compared to different content of the fiber. The addition of 10 wt.% ripped betel nut fiber in the matrix resin provided a positive increase in thermal, mechanical and thermo physical properties of the BNH/VE composites and better interfacial attraction between the ripe betel nut fiber and vinyl ester resin was obtained at 10 wt.% fiber contents. Jay Amani et al. [9] investigated that physical and thermal behaviors of betel nut fiber reinforced epoxy composites as well as effect of chemical treatment and fiber loading influence the mechanical behaviors and found that 10% content of betel nut fiber and 5 % NaOH treated fiber obtained maximum mechanical properties and good interfacial bonding between fiber and matrix. It was also found that chemically treated fiber composites improved the sound absorption coefficient, thickness of composites also effect the sound absorption coefficient means thickness of fiber improve sound absorption also improved. Srinivasa et al. [10] experimentally investigated that chemically treated areca fiber such as alkali treated as well as potassium hydroxide treated areca fiber reinforced composites obtained more physical properties such as impact strength and flexural strength as compared to untreated fiber composites. Because of chemically treated fiber obtained good interfacial bonding between fiber and matrix. After chemical treatment remove the hemicellulose and other impurity present on the surface of fiber and fiber gets rougher than untreated fiber.From the above discussion it is clear that betel nut fiber affects the mechanical behaviors of different class of composites. Therefore, in the present experimental work focuses on the fabrication of betel nut powder reinforced epoxy composites and also evaluate their mechanical properties and water absorption behaviors.

Materials and method

Materials used for developing the composites

Betel nut powder was used in the present experimental work which was extracted from betel nut fruits also known as Areca Nut; these are mostlybastage in tobacco industry without any usages. We collected betel nut fruits from local sources and then made its powder manually. Resin epoxy-LY556 and hardener-HY951 were purchased from Go-green Pvt. Ltd., Chennai, India. Other required materials taken from the local near market.

Preparation of composites

Fabrication of betel nut powder reinforced epoxy composites is done by using hand-lay-up techniques. A mould with dimensions 200 mm×170 mm×6 mm was used for fabrication of composites sheets. The weighted epoxy resigns and hardener taken for preparation of composites was 10:01 by weight recommended by suppliers. Epoxy and hardener taken in glass jar according to the size of mould and mixed manually with stirring rod then after addition of betel nut powder 40% by weight. The betel nut powder and epoxy resin mixed thoroughly so that uniformly distributed the powder in the matrix. Before pouring the mixture of betel nut powder and epoxy matrix, mould has been cleaned first and polished, and then sprayed releasing agent on the mould surface because composite plates removal easily from mould after drying. The mixture was then inserted into the mould and uniformly arranged, after that roller was used to remove air bubbles trapped in the mixture of fiber and matrix. After rolling a load approx. 50 kg was applied on the mould for 24 hours to conform curing then composites sheets cut for testing according to ASTM standard.

Specimen's preparation for testing

Tensile Test: For tensile testing specimens were cutting according to based on ASTM D638 on Zwick/Roel UTM Z250 machine. The samples were prepared from laminated composite sheets.

Flexural Test: It is also known as three point bending test were performed according to ASTM D790 standard on same UTM machine. This test is very important for composites materials.

Impact Test: Impact test were performed on universal impact pendulum types testing machine, samples were prepared according to ASTM D256 for Izod Impact test and as per as ASTM A370 for Charpy Impact test respectively.

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Water Absorption Test: This test was performed according to ASTM D570 standard [11]. The entire samples were immersed in water and their weight was taken at certain regular interval of time up to saturation point. After all the mechanical and water absorption testing, three samples were taken for each and every type of test and average value was taken for result

Results and discussion

Tensile strength and tensile modulus

The composites specimens were cut from laminated composites sheets according to ASTM D638 standard were taken foe tensile testing. There were three samples taken for testing and average value was taken for result. All the mechanical testing was performed at normal temperature and pressure. The specimens of betel nut powder reinforced epoxy composites were cut from laminated sheets of dimension 170 mm x 25 mm x 7 mm with a gauge length of 100 mm and constant cross head speed 1mm/min. Both ends of specimens were fixed in between the grip and load was applied. The maximum load obtained after each test was recorded. The tensile strength and corresponding tensile modulus was obtained for each specimen as shown in Fig. 1. Average tensile strength and modulus obtained after experiment of samples S1, S2 and S3 was 13.4 MPa and 3.71 GP respectively.

Flexural strength and flexural modulus

The flexural strength and flexural modulus of betel nut seed powder reinforced epoxy composite was obtained after experiment. In this test, the specimens were cut from laminated composites sheets according to ASTM standard of dimension 100 mm x 25 mm x 7 mm respectively. In three point bending test, the outer rollers were 80 mm apart and samples were placed on two rollers and load was applied by nose parts, load applied at a constant rate of 1 mm/min. Now the test was ended when specimens achieved 25% deflection or break. The value of flexural strength and flexural modulus obtained of samples S1, S2 and S3 as shown in Fig. 2 and average value of tensile strength and tensile modulus was 19.5 MPa and 2.91 GPa respectively.

Impact strength

Impact test was performed in universal pendulum type Impact Testing Machine. The samples were made by according to ASTM standard. Size of specimens for Charpy Impact Test was 55 x 10 x 10 respectively, and for Izod Test size of specimens 75 mm x 10 mm x 10 mm respectively. V-Notched specimens were used for testing, now three samples were taken for testing (S1, S2 and S3) as shown in Fig. 3 and average value was taken for result. Average value of impact energy for Charpy Test was 2.34 J and for Izod tests 1.77 J

Water Absorption Test

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Water absorption test of betel nut powder reinforced epoxy composites was performed to evaluate the maximum moisture absorption capacity of these particular composites. In this analysis sample were prepared according to ASTM standard of size 25 mm x 25 mm x 5mm respectively. Before immersed in water, the sample was placed in hot air oven for 2 hours to remove the moisture present in the sample. After that weight of dry and cool samples were taken by of electronic weighing machine of accuracy of 0.001gr then again immersed in glass jar. After 24 hours samples were removed from glass jar and cleaned with neat and clean cloth to remove excess water present on surface and measure the weight immediately. The same methods were repeated several days and the weight was measured up to saturation point. Percentage (%) of water absorption of three samples i.e, (S1, S2 and S3) and average of all three are shown in Fig. 4. The percentage (%) of water absorption calculated by giver below equation$\%\ of\ water\ absorption\ = \frac{w_2 - w_1}{w_1} \times 100$where w1 and w2 are weight of specimens before water absorption and after water absorption respectively [12]

Water absorption increases regularly with time, initially rate of absorption was high from 1 to 5 days and after 5 to 6 days absorption rate slowly increases and finally after 11-12 days water absorption was almost same. The maximum water absorption was 10.75 % in 12th days.

Conclusions

In this Present experiment work successes fully fabrication of betel nut powder reinforced epoxy composites and following conclusion can be drawn.

1. Tensile strength and tensile modulus were obtained maximum value 13.4 MPa and 3.71 GP respectively.
2. Maximum Flexural strength and flexural modulus were obtained 19.5 MPa and 2.91 GP respectively.
3. Impact energy for both Charpy Test and Izod Test were obtained 2.34 J and 1.77 J respectively.
4. Average water absorption for betel nut powder reinforced epoxy composites was obtained 10.75 %.

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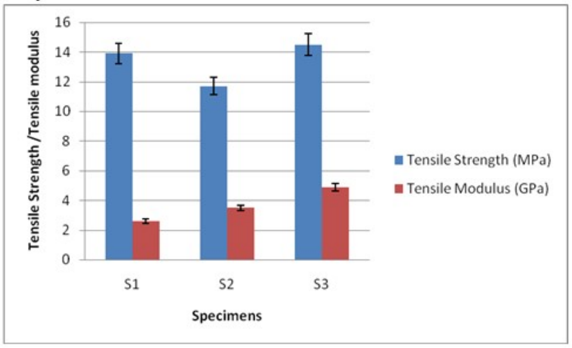

Figure 1: Tensile strength and tensile modulus of betel nut powder/epoxy composites

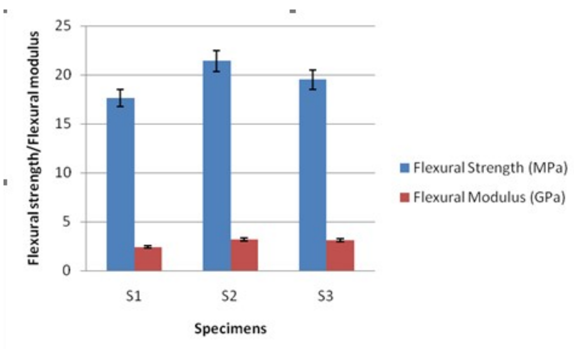

Figure 2: Flexural strength and flexural modulus of betel nut powder/epoxy composites

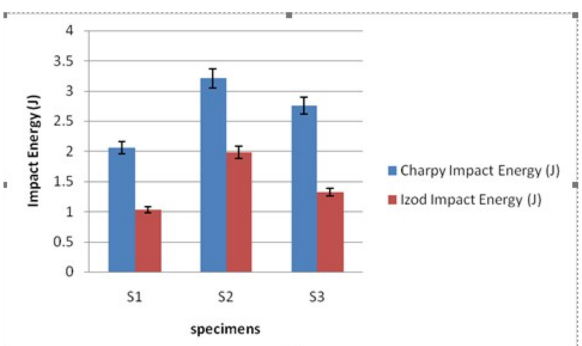

Figure 3: Charpy and Izod impact energy of betel nut powder/epoxy composites

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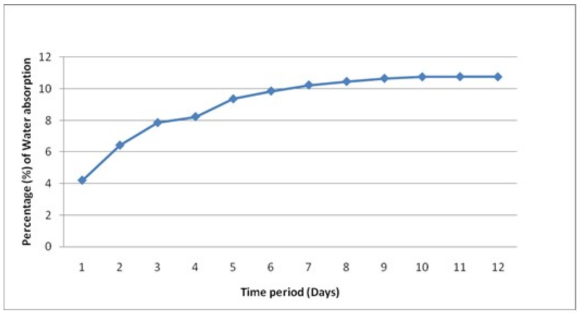

Figure4: Percentage of water absorption behaviors of betel nut powder/epoxy composites