Investigation of Mechanical Properties in Areca (Betel Nut) and Sisal Fiber with Epoxy Composite

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Abstract

In this work, Investigation into experimental study of Areca (betel nuts) fiber and sisal fiber reinforced epoxy composite was carried. Composite laminates are prepared by mixing Areca betel nuts fiber, Sisal fiber and Epoxy with proper curing agents. The mould was pressed on 1500PSI for 24 hours of 1000C temperature. The Areca betel nuts and Sisal Fiber Reinforced Epoxy Resin Composites were manufactured at various ratios such as (15:20:65, 20:15:65 & 17.5:17.5:65). In this, we analyse and test the Mechanical Properties of Areca nuts and Sisal Fiber reinforced epoxy resin composites like Tensile Strength, Flexural Strength and Water Absorption capacity.

Keywords: Mechanical Properties, Areca (Betel Nuts) Fiber and Sisal Fiber, Epoxy Resin

I. INTRODUCTION

In recent years, the environment is contaminated by plastic materials. So in order to replace, the natural fiber composite materials are used. Because they are eco-friendly and bio-degradable. The natural fibers are easily available and it does not cause any harmful and toxic to the environment. In this, we use sisal and Areca Betel nuts fiber with epoxy composite. The sisal fiber generally has good mechanical properties. The sisal fibers are mainly noted for its strength Sisal fiber was prepared from the plant sisal. The areca betel nut fiber is commonly known as betel nut fiber. It is prepared from the outer layer of nuts. The low cost, less weight and density make the natural fiber as an attractive alternative for the synthetic fiber. The epoxy resin (Araldite LY556) and Hardener (Aradur HY951) was used.

II. EXPERIMENTAL INVESTIGATION

A. Fiber Treatment

Sisal plant is member of the cactus family. Sisal in natural fiber and it is fully bio-degradable. Sisal fiber is extracted by a process known as decortication. In this process, leaves are crushed and beaten by a rotating wheel set with blunt knives. So the fiber remains. After, the fiber is washed with water to remove the waste particles and dried to get the sisal fiber. The areca betel nuts fiber is prepared from the areca husk. The areca betel nuts were collected from the areca plant. The husk is removed from the nut and is dried to remove the moisture content. After the removal of moisture, the fibers are extracted.

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III. METHODOLOGY

A. Natural Fiber Preparation

Natural fiber has been used in the fabrication of the natural fiber composites. The preliminary steps are cleaning the natural fiber with the distilled water. Then the wet fibers are dried. The dried natural fibers are again cleaned by chemical cleaning process. In chemical cleaning process the 60% sodium hydroxide is mixed with 40% distilled water. The dried natural fiber is dipped in the diluted sodium hydroxide solution. After the chemical treatment process, it is again dried in the sun light. The dried natural fibers are cut below the length of 10 mm by water jet machine or through manual. The natural fibers which were chopped are used in the fabrication of natural fiber composites.

B. Mould Preparation

The fabrication of the various composite materials is carried out through the hand lay-up technique or by the compression moulding machine. The mould used for preparing composites is made from two rectangular chromium- plated mild steel sheets having dimensions of 300 mm×300 mm. Four beadings were used to maintain a 3 mm thickness all around the mould plates. The functions of these plates are to cover and compress the fiber after the epoxy is applied, and also to avoid the entering air into the composite parts during the curing time. For the mould preparation the temperature should be at 150^0C and the pressure should be at 1500.It is allowed to be at rest for about 2 hours in compression machine moulding.

C. Preparation of Epoxy and Hardener

The matrix used to fabricate the fiber specimen was epoxy LY556 of density 1.15 to 1.20 g/cm3, mixed with Hardener HY951 of density 0.97 to 0.99 g/cm3. The weight ratio of mixing epoxy and hardener was 10:1.

Table – 1
ASTM Standard

Test	*Standard*
Tensile	*ASTM D3039*
Flexural	*ASTM D790*
Water absorption	*ASTM D570*

D. Preparation of Composites

The composites reinforced with various amounts of natural fibers were prepared by mixing Epoxy with the two alkalis treated natural fibers, and the fibers were betel nuts and Sisal.

Table – 2
Weight Ratio of Fibers

Sl. No	*Weight ratio*	*Betel nut %*	*Sisal %*	*Matrix %*
1	*35:65*	*15*	*20*	*65*
2	*35:65*	*20*	*15*	*65*
3	*35:65*	*17.5*	*17.5*	*65*

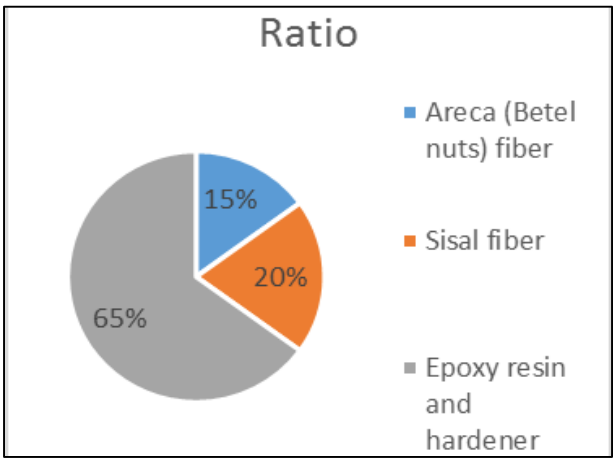

Fig. 1: Sample Weight Ratio of the Areca (Betel nuts), Sisal fiber and Epoxy Composites

The ratio of the composite was 65% epoxy and the hardener mixture in the ratio of 10:1 and 35% prepared fibers. The mould which is used for the preparation is coated with the wax for the better finishing. The two natural fibers which were chopped are poured in the mould randomly then the resin hardener mixture is applied without any gap. The roller is rolled in the mould to get the flat surface. The setup is kept inside Compression moulding with hot temperature 100^0C.After 2hours the mould is taken away from the pattern; finally, the natural fiber composite is fabricated.

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E. Fabrication Process

The compression moulding is used in the fabrication of natural fiber composites.

F. Properties of Material

The main Objective is to determine the mechanical properties (Flexural strength, flexural modulus, % of elongation, ultimate tensile strength % gain of water,) of natural fiber reinforced composite material by conducting the following tests.

- Tensile Test
- Flexural Test
- Water absorption Test

IV. RESULT

The test results are shown below

A. Tensile Test Result

For the tensile testing the specimen is prepared according to the ASTM D 3039, using tensile testing machine with cross head speed of 2mm/min. The percentage of elongation and the ultimate tensile strength were calculated.

Fig. 2: Tensile test specimen before testing

Fig. 3: Tensile test specimen after testing

From each samples three specimens were tested and the mean values were calculated. While comparing the three samples the second sample gives the best result.

Table – 3
Tensile Strength for Three Samples

Ratio (%)	*15:20:65*	*20:15:65*	*17.5:17.5:65*
Sample 1	*10.850*	*16.785*	*12.792*
Sample 2	*14.225*	*13.136*	*13.381*
Sample 3	*15.980*	*16.520*	*11.733*
Average	*13.685*	*15.480*	*12.635*

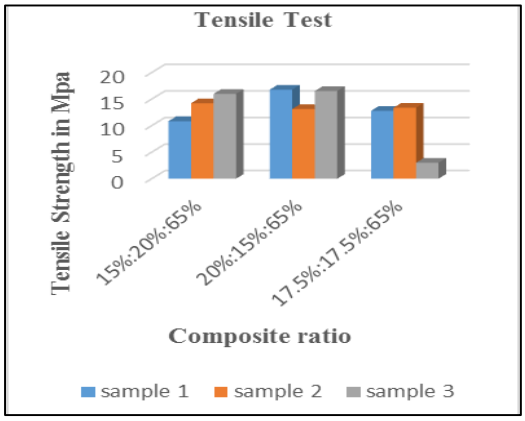

Fig. 4: Tensile Strength for Three Samples

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Flexural Test Result

For the flexural testing the specimen is prepared according to the ASTM D 790, and the cross head is speed of 2mm/min. From each specimen samples three specimens were tested and the mean values are calculated.

Fig. 5. Flexural test specimen before testing

Fig. 6. Flexural test specimen after testing

While comparing the three samples the second sample gives the best result.

Table – 4
Flexural Test for Three Samples

Ratio (%)	*15:20:65*	*20:15:65*	*17.5:17.5:65*
Sample1	*2506.347*	*3097.983*	*2113.467*
Sample2	*2564.763*	*2794.507*	*2696.020*
Sample3	*2165.293*	*3118.820*	*2556.214*
Average	*2412.134*	*3003.77*	*2455.234*

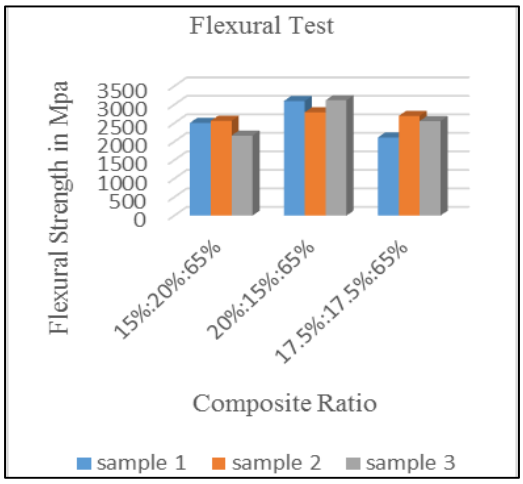

Fig. 7: Flexural Test for Three Samples

B. Water Absorption Test

For performing the water absorption test, the specimen was prepared according to the ASTM D 570.The specimen was kept in water for about 48 hours and the result has been taken. From each specimen three samples were tested and mean value has been calculated.

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Fig. 8: Sample

Table – 5
Water Absorption Test for Three Samples

Ratio (%)	*15:20:65*	*20:15:65*	*17.5:17.5:65*
Sample1	*16.3*	*10.1*	*15.7*
Sample2	*17.4*	*17.2*	*16.8*
Sample3	*16.2*	*16.3*	*20.4*
Average	*16.63*	*14.53*	*17.63*

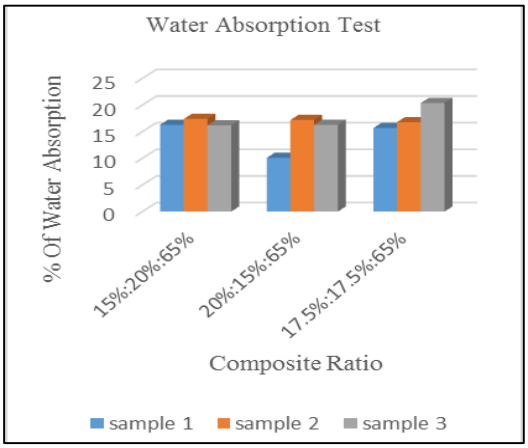

Fig. 9: Water Absorption Test for Three Samples

V. CONCLUSION

The natural fiber reinforced composites tested for its tensile strength, flexural strength and water absorption test as per the ASTM D standard (tensile test-ASTM D3039, flexural test-ASTM D790, water absorption test-ASTM D570). From the result it is noted that the tensile strength and flexural strength is increased by increasing the betel nut fiber than the sisal fiber. The water absorption capacity is best in this composition. Thus the second (20% of Areca Betel nuts fiber, 15% of Sisal fiber, 65% of Epoxy Resin) composition gives the best result in all aspects.

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