Investigation on the mechanical properties of natural fibers reinforced with egg shell

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ABSRACT

Composites are known as the composition of two or more materials. Due to addition of some materials the mechanical properties of the composite is improved. Aerospace, automobiles, marines are mostly focused on use of composite materials. The applications are decided according to the properties of the material. Nowadays, the organic composites are most commonly used because of their superior mechanical properties as compared with other composites, reduced cost to manufacturing the composites. In this work coconut coir with egg shell composites are prepared by using compression molding process. The samples sizes were prepared according to the ASTM standards. In which egg shell powder is used as reinforced material to make composites. Then the mechanical properties such as impact strength, tensile strength and flexural strength were investigated and the water absorption test also carried out.

KEY WORDS: Egg shell powder, ASTM standards, organic composites.

1. INTRODUCTION

A composite material is the composition of two or more materials in which one of the material is formed. While preparing composites two phases are considered according to the properties required which are matrix or continuous phase and dispersed or reinforcing phase. The constituent presence in the reinforcing phase will be fibers, sheets or particles and the constituent presence as encapsulated particles is called matrix phase.

More than twenty years passed since the potentials of filamentary composite materials were identified. Natural fiberis identified as the important thing in the cost reducing process and it has increase in strength to weight ratio. Natural fibers easily obtained from the plant, animal, minerals and so on. Due to its biodegradability and renewable characteristics it is assessed as environmentally correct materials. For example, thermoset and thermoplastic matrices have good reinforcement such as sisal, jute, coir, oil palm.

Nowadays, the increasing costs of metals and its weight, renewable characteristics are elevated the natural fiber needs among the people and they are prefer organic composite materials due to its low cost and environmental advantage over traditional inorganic reinforcements. In searching for such new material, a study has been made where coconut fiber (also known as coir fiber) is compounded with composite material. Coir is the natural fiber which is obtained from the coconut husk where it is a thick and coarse but durable fiber. It is relatively water proof and has resistant to damage by salt water and microbial degradation.

2. EXPERIMENTAL

Materials: Coir fiber was mechanically extracted from the coconut fruit (*Cocos nucifera*) fibrous mesocarp which is in between the excerpt and the endocarp (outer shell).Coconut fiber is 100% organic and it is biodegradable renewable resource and strong air porosity. Due to lignin deposited on the coconut fiber walls prepared fiber appears yellowish-golden. The obtained coir is washed in normal water and this wet coir is dried in the hot sun to reduce coir moisture. 5% of NaOH solution is mixed with water in coir for 24 hrs to remove unwanted layer. Final stage water is used to remove the NaOH solution and then the coir is dried in hot sun for 24 hrs. Then the chemical treatment is carried out over the prepared fiber, the chemical used to treat fiber is 7-9% of NaOH mixed with distilled water. The chemical treatment removes the lignin content from the fiber. Young's modulus depends on amount of lignin content, if it is higher; young's modulus will be low. Then the coir prepared treated and untreated for the various lengths of 10mm, 30mm, and 50mm respectively.

Dibasic organic acids and polyhydric alcohols pays main role in polyester formation. These two organic compounds are reacting with each other and form polyester resin. Epoxy resins are characterized by the presence of more than one epoxide groups per molecule. Curatives are introduced to achieve cross linking and the curatives are react with epoxy and hydroxyl groups.

Egg shell is pulverized to average particle size 63 micron meters. Egg shell kept at atmospheric temperature at vacuum for getting constant weight. 10% of NaOH is mixed with egg shell and stirred for 6mins. Then the egg shell is dried in the atmospheric temperature to reduce the moisture.

Methods: Compression molding is used to fabricate the plate which dimension is 275×275×3 mm and the weight is 300g. The components of the epoxy resins, coconut fibers and egg shells were mixed and made a sample plate. Then the polyester resin, coconut coir fiber, egg shell powder mixed together and made another sample plate. The pressure applied for compression is 1500Psi, this pressure is maintained for 1 hour, after remove the composite plates while the composite gets cured. The average of three samples was used during the entire test for every fabrication plates. The samples are formed according to the ASTM standard, Tensile strength is calculated after the yield point. It is the maximum strength of the material while pulling out after this strength, when load is applied the material will failure. The prepared dimension of specimen is (250x25x3) mm and typical points of interest when testing a material include: ultimate tensile strength (UTS), % of elongation and the rupture (R) or fracture point where the specimen separates into pieces. Universal testing machine (UTM) Instron 5500R is used to get tensile properties and both obtained samples results are compared. ASTM D790 is the standard we have decided to determine tensile properties by using the Instron 5500R.

When load is given to the material it withstands against load without deform it is called flexural strength. Inter-laminar shear strength (ILSS) is evaluated by performing short beam shear (SBS) tests on the composites samples. This test is conducted as per ASTM-D638 standard using UTM. The dimension of the specimen is (130x13x5) mm. The flexural strength is expressed as modulus of rupture (MR) in psi (MPa).Flexural MR is about 20 to 30% of compressive strength depending on the type, size and volume of coarse aggregate used. The three point loading is prepared to determine flexural strength which means load is given to the material on both ends and another load is given at middle of the composite. The data obtained from these test is used to determine the flexural stregth. The impact strength of notched specimen was determined by using an Izod impact testing machine according to ASTM-D256standards.

The microstructure of the specimen is viewed by scanning electron microscopy JEOL JSM-6390. The test specimen is placed in the microscope; the size of the specimen is 8mm to 15mm. vacuum is produced in the chamber of specimen. Then the enlarged image of the structure is shown on the computer monitor attached to the microscope. Specimen is focused on x=80mm, y=40mm.

ASTM D 570-98(2005) is the standard which is prepared to get water absorption values on both treated and untreated samples. Distilled water is filled in the container kept at room temperature and the samples were placed into the container based on the standard and the water uptake for different swelling times was measured. Average values obtained from four samples. The percentage of water absorption was calculated by,

% of water absorption=$\frac{W_N - W_d}{W_d} \times 100\%$

Where, W_N −Wet weight, W_d −Dry weight.

3. RESULTS AND DISCUSSION

Mechanical properties: Tensile strength is the maximum amount of the tensile stress which occurs before the material failure. In Fig. 1the curves are plot between % of the elongation and length of treated and untreated coconut fiber using epoxy resin. We have taken the % of elongation in Y-axis and the length of the fiber in X-axis. The test is made over the 10mm, 30mm, and 50mm plates. Results shows if the length of the fiber increased then the elongation also will increase.

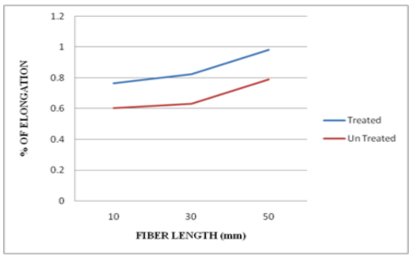

Figure.1. % of elongation on fiber Length of the tensile strength With epoxy resin

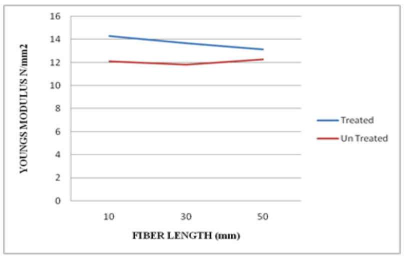

Figure.2. Young's modulus on fiber length of the tensile strength with epoxy resin

Practically material stiffness is denoted as young's modulus of the material. Stiffness of the material identified based on the young's modulus value. Fig.2, shows the relation between young's modulus and length of the fiber both treated and treated.

Another sample plate made by using polyester resin and coconut coir fiber is tested and the graph is plot between percentages of the elongation, length of the treated and untreated fiber. The Fig.3, shows the relation between % of elongation and length of the fiber both treated and untreated fiber. This graph also shows increase in length results in increase in % of elongation.

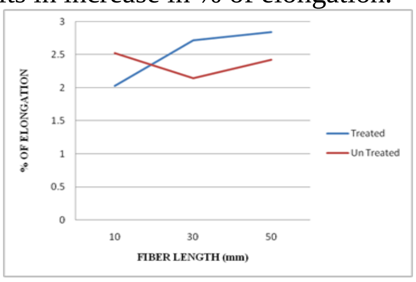

Figure.3. % of elongation on fiber Lengthof the tensile strength with polyester resin

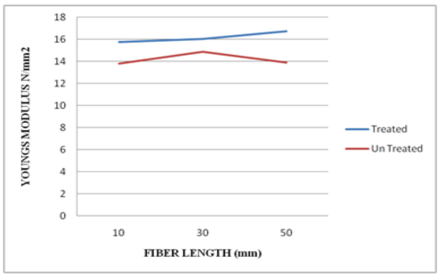

Figure.4. Young's modulus on fiber length of the tensile strength with polyester resin

Young's modulus test for another sample is carried out over the coconut fiber using polyester resin. The Fig.4, shows the relation between young's modulus and length of the fiber. Here, the untreated sample gets decrease in young's modulus due to increase in length and the treated sample gets increased young's modulus.

Flexural strength is the ability of the material to withstand load without deformation. The Fig.5, shows the relationship between flexural strength and length of the fiber. The graph shows the increase in length results in decrease in flexural strength.

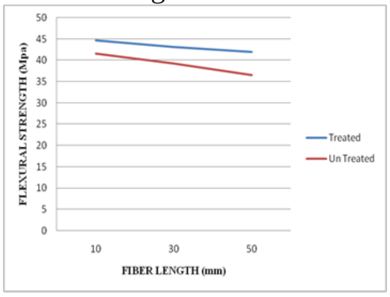

Figure.5. Flexural strength on fiber length of the tensile strengthwith epoxy resin

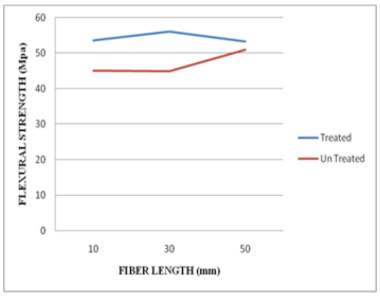

Figure.6. Flexural strength on fiber length of the tensile strength with polyester resin

Fig.6, shows different results obtained from treated and untreated coconut fiber using polyester resin. Here, the graph shows that the treated sample gets decrease in flexural strength due to its low stiffness. But untreated sample gets increase in flexural strength.

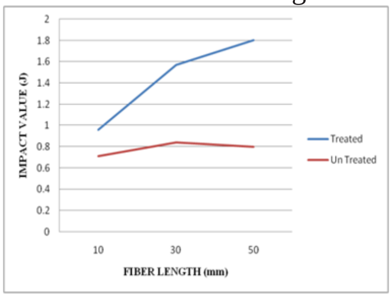

Figure.7. Impact values on fiber length of the tensile strength with epoxy resin

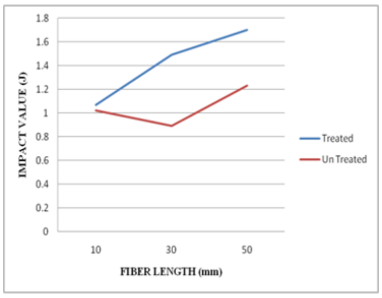

Figure.8. Impact values on fiber length of the tensile strength with polyester resin

Characterization of fibers: SEM is used to examine microstructure of the treated and untreated coconut coir and also it provides excellent images of the coir surface. Examination of the untreated fibers shows a large amount of scrap sticking over the surface of the fiber bundles, because these fibers are coated with non-cellulosic material Fig.(a). Then untreated coconut coir went under some treatments and the SEM analysis carried out on the treated coir. The presence of the coir after treatment was tiny pores on surface of the fiber Fig.9b. Elimination of superficial layer (parenquimas cells) also verified in the SEM image, increasing the contact area of globular marks (salience) and fibrils (reentrance). As a consequence, if the roughness of the fiber increases, adhesion between fibers and matrix can increase.

Figure.9. SEM of coconut fibers (a) Untreated (b) Treated

4. CONCLUSION

From obtained results we concluded that the epoxy resin and the polyester resin pays main role to get desired mechanical property on the natural fibers. Both treated and untreated coir shows when the length increases, the flexural strength decrease. From this we have conclude that the flexural strength depends on length of the samples. Epoxy resin based samples get more deformation than polyester resin based samples. While coming to stiffness the polyester resin based samples have high stiffness than epoxy resin and impact strength also increase in the polyester resin based sample.

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