Preparation and Characterization of Coir, Luffa Reinforced Polypropylene Composites

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Abstract— Natural fibres have been used to reinforce materials for over 3,000 years. More recently they have been employed in combination with plastics. Many types of natural fibres have been investigated for use in plastics including coir, luffa, flax, hemp, jute, sisal, and banana. Natural fibres have the advantages that they are renewable resources and have marketing appeal. These agricultural wastes can be used to prepare fibre reinforced polypropylene composites for commercial use. Application of composite materials to structures have presented the need for the engineering analysis this work focuses on the fabrication of polymer matrix composites by using natural fibres like coir, and luffa which are abundant nature in desired shapes by the help of various structures of patterns and calculating its material characteristics (tensile strength, flexural modulus, flexural rigidity, hardness number, % gain of water) by conducting tests like tensile test, flexural test, hardness test, water absorption test, impact test, density test, SEM analysis and their results are measured on sections of the material and make use of the natural fibre reinforced polypropylene composite material for automotive seat shell manufacturing.

Keywords— nature fibre, polymer and sem analysis.

INTRODUCTION

NATURAL FIBER COMPOSITE MATERIAL

Materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct at the macroscopic or microscopic scale within the finished structure.

Natural fiber composites combine plant-derived fibers with a plastic binder. The natural fiber component may be wood, sisal, hemp, coconut, cotton, luffa , flax, jute, abaca, banana leaf fibers, bamboo, wheat straw or other fibrous material, and the binder is often recycled plastic (usually polypropylene). Advantages of natural fiber composites include light weight, low-energy production and sequestration of carbon dioxide reducing the “greenhouse effect”.

In most cases, the reinforcement is harder, stronger and stiffer than the matrix. The reinforcement is usually fibers are particulate. Particulate composites have dimensions that are approximately equal in all direction. They may be spherical, platelets or any other regular or irregular geometry. Particulate composites tend to be much weaker and less stiff than continuous fiber composites, but they are usually much less expensive.

Particulate reinforce composites usually contain less reinforcement (up to 45-50 volume percent) due to processing difficulties and brittleness. A fiber has a length that is greater than its diameter. The length to diameter (l/d) ratio is known as the aspect ratio and can vary greatly. Continuous fibers have long aspect ratio, while discontinuous fibers have short aspect ratios.

Problem identified

- As we already known that if the weight of the vehicle increases the speed as well as the mileage of the vehicle gets reduced.
- Thus by reducing the weight of the material used conventionally by using the composites materials
- The composite materials are usually made with combining glass fibers and resins called matrix.
- But the use of glass fiber increases the cost.

Natural fiber preparation

The pattern is designed by as per astm standard. The pattern is made up of oil hardened non-shrinking steel. The pattern size is 300 x 40 x 10 mm (astm) the pattern consist of three parts.

- Two injection mold
- Ejector mold

The mold consists of two primary components, the injection mold (a plate) and the ejector mold (b plate). Plastic resin enters the mold through a sprue or gate in the injection mold; the sprue bushing is to seal tightly against the nozzle of the injection barrel of the molding machine and to allow molten plastic to flow from the barrel into the mold, also known as the cavity.

The sprue bushing directs the molten plastic to the cavity images through channels that are machined into the faces of the a and b plates. These channels allow plastic to run along them, so they are referred to as runners. The molten plastic flows through the runner and enters one or more specialized gates and into the cavity geometry to form the desired part.
Requirements for fabricate natural fiber composites

- Polypropylene
- Natural fiber
- Sodium hydroxide (NaOH)
- Weighing machine
- Injection moulding

fabrication process

In this project injection molding is used for fabricate the natural fiber reinforced polypropylene composites.

- The support plate is support the center frame
- For fabricate the reinforced polypropylene composites 80% and remaining coir, luffa are used.
- With injection molding, granular plastic is fed by gravity from a hopper into a heated barrel.
- as the granules are slowly moved forward by a screw-type plunger, the plastic is forced into a heated chamber, where it is melted.
- as the plunger advances, the melted plastic is forced through a nozzle that rests against the mold, allowing it to enter the mold cavity through a gate and runner system.
- the mold remains cold so the plastic solidifies almost as soon as the mold is filled.

FABRICATED NATURAL FIBER COMPOSITES

- Coir Reinforced Polypropylene Composites
- Luffa Reinforced Polypropylene Composites
- Coir, Luffa Reinforced Polypropylene Composites

In this fabricated material, we used 80% of polypropylene and 20% of coir in a particulate form.

Properties of natural fiber

Coir Reinforced Polypropylene Composites

In this fabricated material, we used 80% of polypropylene and 20% of luffa in a particulate form.

Luffa Reinforced Polypropylene Composites

In this fabricated material, we used 80% of polypropylene and 10% of coir, 10% of luffa in a particulate form.
RESULTS AND DISCUSSION

MATERIAL PROPERTIES

The main objective of this project is to determine the material properties (tensile strength, Flexural modulus, flexural rigidity, Hardness number, % gain of water, density, Impact Strength and SEM analysis) of natural fiber reinforced composite material by conducting the following respective tests.

- Tensile test
- Flexural test
- Hardness Test
- Water absorption Test
- Density Test
- Impact Test
- SEM analysis

TENSILE TEST SCOPE

The essential parts of a testing machine for evaluating stress-strain properties are

1. A mechanism for applying the load to the specimen.
2. A device for balancing and measuring the applied load.

In addition to that various accessory parts like devices for gripping supporting the test pieces, the power unit, recorders, speed indicators and absorbers make up the universal testing machine. Universal testing machine are used for tension, compression bending and transverse shear tests. Universal testing machine are generally hydraulic type. fig. shows the essential features of universal hydraulic machines. A motor driven pump is used to transmit oil to cylinder thereby producing pressure against a piston. The pressure transmits a force to the tensile specimen by means of upper cross head. The lower cross head can be moved up or down by means of an electric motor within the range fixed by automatic cut-outs. The force on the lower cross head which is fixed during a test is transmitted to a hydraulic weighing capsule. The weighing capsule is connected to a Bourdon tube for measuring the load on the specimen. Most of the hydraulic machines are provided with devices for applying loads at various rates. These variable load rates are made possible by setting the valve that controls the flow of oil from the pump to the loading cylinder.

1.2 PROCEDURE

Measure the length of the specimen at several sections with a Vernier calliper to obtain a mean value. The gauge length is marked off by means of Centre punch and is measured. Firmly grip one end of the specimen in the fixed head of the testing machines such that the punch marks face the front of the machine. Mount the extensometer centrally on the specimen, the fixing screws being located in punch marks. Removed the locking bars of the extensometer. Set the load dial of the machine to a suitable range and adjust the testing machine and extensometer to read zero grip the other end of the specimen. Apply the load at slow speed and mark simultaneous observation of load and extensometer readings. When an increment of loads leads to disproportionate extension (indicating the yield point) replaces the locking bars and removes the extensometer. Continue to load the specimen, taking the extension by means of the graduated scale. Record the yield point, maximum load and the load at fracture. Remove the broken specimen from the machine.

Table 1 Tensile Strength Results

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PP (80%) + COIR (20%)</th>
<th>PP (80%) + LUFFA (20%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE OF SPECIMEN</td>
<td>300<em>40</em>10mm</td>
<td>300<em>40</em>10mm</td>
</tr>
<tr>
<td>SPECIMEN BREAKING LOAD</td>
<td>11250N</td>
<td>9000N</td>
</tr>
</tbody>
</table>
FLEXURAL TEST SCOPE

The flexural test measures the force required to bend a beam under three point loading conditions. The data is often used to select materials for parts that will support loads without flexing. Flexural modulus is used as an indication of a material’s stiffness when flexed. Since the physical properties of many materials (especially thermoplastics) can vary depending on ambient temperature, it is appropriate to test materials at temperatures that simulate the intended end use environment.

TEST PROCEDURE

Most commonly the specimen lies on a support span and the load is applied to the center by the loading nose producing three points bending at a specified rate. The parameters for this test are the support span, the speed of the loading, and the maximum deflection for the test. These parameters are based on the test specimen thickness and are defined differently by ASTM and ISO.

FORMULA USED

\[ E = \frac{FL^3}{48\gamma I}\text{ N/mm}^2 \]

\[ E I = \frac{FL^3}{48\gamma B}\text{ N-mm}^2 \]

\[ I = \frac{12}{B} \]

E – Modulus of elasticity
E I – Flexural Rigidity
\( \gamma \) – Deflection in mm
F – Load in N

MODEL CALCULATION

\[ E = \frac{61.31 \times 300^3}{48 \times 5.48 \times 3333.33} \]

\[ E = 1887.97 \text{ N/mm}^2 \]

\[ EI = \frac{6.29 \times 10^6 \text{ N-mm}^2} \]

\[ = (61.31 \times 300^3)/(48 \times 5.48) \]

\[ EI = 6.29 \times 10^6 \text{ N-mm}^2 \]

DENSITY TEST

Table 2 Density Test Result

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PP (80%) + COIR (20%)</th>
<th>PP (80%) + LUFFA (20%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE OF SPECIMEN</td>
<td>50<em>40</em>10mm</td>
<td>50<em>40</em>10mm</td>
</tr>
<tr>
<td>BEFORE WEIGHT OF SAMPLE</td>
<td>18 grams</td>
<td>17 grams</td>
</tr>
<tr>
<td>VOLUME OF SAMPLE</td>
<td>20000mm³</td>
<td>20000mm³</td>
</tr>
<tr>
<td>DENSITY</td>
<td>900 Kg/m³</td>
<td>850 Kg/m³</td>
</tr>
</tbody>
</table>

MICRO STRUCTURE

SCANNING ELECTRON MICROSCOPE ANALYSIS SCOPE

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with electrons in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Specimens can be observed in high vacuum, low vacuum and in environmental SEM specimens can be observed in wet conditions.

Fig 7 SEM Machine
Figure shows that coir fiber reinforced in polypropylene matrix. In this the coir fiber distributed properly in matrix with good bonding.

**Fig 8 Coir Reinforced Polypropylene Composites**

Figure shows that luffa fiber reinforced in polypropylene matrix. In this the luffa fiber distributed is partially bonded.

**Fig 9 Luffa Reinforced Polypropylene Composites**

Figure shows that morphology of coir, luffa reinforce polypropylene matrix.(hybrid composites with coir(10%),luffa(10%)and remaining of polypropylene).Both fiber distributed in equal amount.So the bonding between matrix and fiber in good with proper preparation.

**Fig 10 Coir,Luffa Reinforced Polypropylene Composites**

**CONCLUSIONS**

- COIR, LUFFA REINFORCED POLYPROPYLENE COMPOSITES WAS SUCCESSFULLY FABRICATED AND CHARACTERIZED.
- THE MATERIAL PROPERTIES OF FABRICATED COIR, LUFFA REINFORCED POLYPROPYLENE COMPOSITES WERE OBSERVED.
- IT WAS FOUND THAT COIR REINFORCED POLYPROPYLENE COMPOSITES WERE THE BEST AMONG ALL SET OF COMBINATION.
- IT CAN BE USED FOR MANUFACTURING OF AUTOMOTIVE SEAT SHELLS AND BACK BAMBER AMONG THE OTHER NATURAL FIBER COMBINATIONS.

**REFERENCES**

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