The Improvement in Mechanical Properties of Coconut Shell Powder as Filter in HDPE Composites

Aradhula Thirumala Vasu¹, Chetan Reddy, Srinadh Danaboyina², Gopala Krishna Manchala³ and Murthy Chavali⁴* 

Abstract
Composites have been prepared using the coconut shell powder and high density polyethylene (HDPE) as the components. Coconut shell powder was mixed with HDPE via compounding of coconut shell powder and HDPE of HDPE and Coconut shell powder. The resultant materials were cast in three outlines and dried which resulted in composites. Their mechanical properties have been studied in detail and compared with the conventional composite made from the coconut shell powder used as reinforcement and high density polyethylene (HDPE) which was used as a matrix. The resulting material can be used in the applications of Aerospace and Automobile etc.

Keywords
Coconut shell powder; Polyethylene matrix composite; Mechanical properties

Introduction
Composite materials were developed as a class of materials capable of advanced aerospace, electronics, structural, automotive and wear applications. This composite material used in our study was coconut shell powder and HDPE (High-Density Polyethylene). The advantage of the composite materials is their tailored mechanism which includes low density, high specific strength [1-4]. The top five coconut producing countries are Indonesia, Philippines, India, Brazil and Sri Lanka. The places in India include Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Bihar, Andhra Pradesh, West Bengal, Orissa, and Assam. A coconut usually contains coconut water and core which is consumed and the remaining is left a shell as waste. These shells contain Natural fibers which are eco-friendly, biodegradable and have various mechanical properties. HDPE works like a hardener; the only type of polyethylene produced was LDPE. A German scientist (Karl Ziegler) made the greatest contribution in producing high-density polyethylene. The mechanical properties change drastically over high-density polyethylene to low density polyethylene. In general, the degree of branching in polyethylene determines its mechanical properties. HDPE is more crystalline than LDPE because it contains fewer branches. Unlike LDPE, a composite material which consists of coconut shell powder with different hardeners like coir fiber reinforced polyester composites, polymer matrix composites, Phenol Formaldehyde Epoxy Resin, and Polyester [10-16]. In this paper, the composites are tested by bending, impact and tensile tests.

Materials and Methods
Materials required for this composite are coconut shell powder and high-density polyethylene. The cleaned coconut shell was dried in open air; the pulverizing machine is used to make coconut shell into powder. High-density polyethylene, the only type of Low-Density polyethylene was produced at extremely high pressures. This high-pressure polymerization created polyethylene with many branches; these branches are created due to intermolecular and intramolecular chain transfer during polymerization. The mechanism involved in the polymerization of low-density polyethylene is free radical polymerization. The uses of low-density polyethylene are limited due to the high number of branches. Because of the extreme pressure needed to create low-density polyethylene and its limited uses, Karl Ziegler tried in creating polyethylene at atmospheric pressure [17].

Coconut Shell powder and HDPE was used in ratios of, 10-90%, 20-80%, 30-70%, and 40-60% respectively. The various methods used in testing of composite materials are a tensile test, bending test and impact test.

The samples were prepared in different concentrations and in different shapes by the process of injection molding and casting technique for testing. These prepared samples were subjected to various mechanical tests like a tensile test, bending test and impact test.

Experimental Method
The powder was collected from dried coconut shell by breaking the shells into pieces and grinding them. The collected powder was sieved to different mesh sizes. The coconut shell powder is incorporated with high-density polyethylene by using injection molding and casting technique with the respective percentages of coconut shell powder. The ambient temperature of the high-density polyethylene is 200°C. The mixture was prepared into the required shape and size by using the molds of injection molding. All the samples will be tested through above mentioned tests, hence, a total of 15 pieces are required, the dimensions and shapes of those pieces are in Figure 1. The samples are tested for the mechanical properties; the samples which are compared with the standard, the one which matches with the standard it is acceptable for application in various mechanical fields (Tables 1-3).

Results and Discussions
The experimental curves for tensile strength from Universal testing machine of 10% CSP (coconut shell powder) filled, 20% CSP filled, 30% CSP filled and 40% CSP filled composites are shown in Figures 2-5 respectively.
Figure 1: Sample, Shapes and dimensions of composite sample.

<table>
<thead>
<tr>
<th>Composite sample</th>
<th>Shape</th>
<th>Dimensions</th>
</tr>
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</table>
| ![Image](image1.png) | ![Image](image2.png) | Length = 12.4 cm.  
Thickness = 3mm.
Edges width = 1.85cm  
Middle width = 1.3cm. |
| ![Image](image3.png) | ![Image](image4.png) | Length = 9.5cm.  
Thickness = 3mm.  
Width = 1cm. |
| ![Image](image5.png) | ![Image](image6.png) | Length = 6.2cm.  
Width = 1cm.  
Thickness = 9mm. |

Peak Load: 608 N at Length: 9.3 M  
Break Load: 216 N at Length: 10.6 M

Figure 2: Sample, Shapes and dimensions of composite sample.
Figure 3: Load versus displacement curve of 20% CSP composite for tensile strength.

Peak Load: 589 N at Length: 11.3 MM
Break Load: 560 N at Length: 11.6 MM

Figure 4: Load versus displacement curve of 30% CSP composite for tensile strength.

Peak Load: 550 N at Length: 10.9 MM
Break Load: 532 N at Length: 11.2 MM
Figure 5: Load versus displacement curve of 40% CSP composite for tensile strength.

Peak Load: 550 N at Length: 7.8 MM
Break Load: 275 N at Length: 8.2 MM

Figure 6: Load versus displacement curve of 10% CSP composite for bending strength.

Peak Load: 30 N at Length: 0.4 MM
Break Load: 30 N at Length: 0.45 MM
The experimental curves for tensile strength from Universal testing machine of 10% CSP (coconut shell powder) filled, 20% CSP filled, 30% CSP filled and 40% CSP filled composites are shown in Figures 2-5 respectively.

The tensile strength results in Table 3 for composite samples which are prepared with CSP filled and HDPE at different volume Fractions, the samples results are shown in load versus displacement curves in Figures 2-5, it illustrates that the maximum tensile strength is obtained from the composite prepared with 10 % CSP volume fraction and the composite prepared with 40% CSP volume fraction has lower tensile strength.

The experimental curves for bending strength of Universal Testing Machine of 10% CSP filled, 20% CSP filled, 30% CSP filled and 40% CSP filled composites are shown in Figures 6-9 respectively.

The bending strength results in Table 4 for the composites which are prepared with CSP filled and HDPE at different volume Fractions, the samples results are shown in load versus displacement curves in Figures 6-9, it illustrates that the constant bending strength is obtained for the composites prepared with 10%, 20%, 30%, and 40% CSP volume fraction.

The impact strength of 10% CSP filled, 20% CSP filled, 30% CSP filled and 40% CSP filled composites of its strengths are shown in the following Table 5.

The impact strength results in Table 5 for composite sample which are prepared with CSP filled in HDPE at different volume fraction illustrate that the maximum impact strength is obtained for the composite prepared with 20% CSP volume fraction. The coconut shell powder HDPE composite with the higher fraction of filler 40% has lower strength [18-25].

Conclusion

The experimental characterization of Coconut shell powder for composite leads to the maximum tensile strength is obtained from the composite prepared with 10% CSP volume fraction and lower tensile strength is obtained for the composite prepared with 40% volume fraction of CSP. The bending strength is same for the all CSP volume fractions (i.e. 10%, 20%, 30% and 40%), the maximum impact strength is obtained from the composite prepared with 20% CSP.
CSP volume fraction and lower strength is obtained for the composite prepared with 40% volume fraction. The composite is prepared with 10% to 20% Coconut shell powder for hybrid composite can be used as an alternative material for the interiors of aircraft, spacecraft, ships, electronics, and automobiles.

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References