Mechanical behavior of Bamboo Fiber and Glass Fiber composite

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Abstract- **A bamboo as a green engineering material fiber-reinforced polyethylene (PE) composite was prepared and its mechanical properties were tested. To enhance the adhesion between the bamboo fiber and the polyethylene matrix, maleic anhydride-grafted polyethylene (MAPE) used as a compatibilizer for the composite. The demand for HDPE products is rising significantly over the globe. Research in green technology is being done to generate bamboo fiber and glass fiber composite. Additionally, They are inexpensive, low density, highlyspecific, biodegradable. Recycled High density polyethylene is employed as a matrix and is combined with bamboo fiber and glass fiber in this investigation. A compression molding technique was used to create each sample. The mechanical characteristics of the prepared samples were characterised. The specimens were created based on the mass ratio of bamboo fiber and glass fiber to polymer. Flexural and Compressive, tests revealed that increasing the amount of Bamboo fiber and glass fiber content improves mechanical characteristics. The findings imply that BF/GF/rHDPE polymer composites could be utilised in the stress bearing restorations sheets,films and pipes.**

Key words: **Bamboo fiber, compressive strength, flexural strength, impact strength, polymer composite, rHDPE, reinforced, tensile strength,**

I. INTRODUCTION

A composite material is one that has been combined from two or more materials, each of which has unique physical and chemical properties, yet the finished product still clearly distinguishes the individual components. Strengthened by fiber incorporating high strength fibres like glass, basalt, aramid, etc. into a polymer matrix creates polymer, a composite material. Vinyl ester, polyethylene, epoxy, and polyester resins are the most common polymers.[1]. A noteworthy advancement in material science technology has been the development of natural fiber reinforced composites, as there is a growing need for high-quality engineered products made from natural resources. From 2015 to 2020, the market for natural fiber composites is anticipated to expand at a compound yearly growth rate of 8.2%. [2]. bamboo fibers are commonly used reinforced natural fibers with many well-established applications. Bamboo fibers are known as "nature's glass fiber" because of their superior microfibrillar angle with the fiber axis, strong, stiff structure, and thicker cell wall.[3] Bamboo and glass fibers have been hybridized, according to studies.[4,5]The interlayer method is the simplest and cheapest way for producing a hybrid composites. However, the layering sequences will have great influential on the final performance of the composites. Most solid materials expand upon heating and contract when cooled.[6] The shape of the FRP components is established using a stiff structure. Mostly, the fiber reinforced polymeric parts are created with a tool or a mold. Wet layup, bladder molding, compression molding, mandrel wrapping, filament winding, and other techniques are some of the numerous ways to make things. [7] Recent study on natural fiber as an alternative reinforcement in polymer composites has piqued the interest of many researchers and scientists due to environmental concerns and the rising expense of synthetic materials. Natural fibers include both plant and animal fibers, including flax, hemp, jute, coir, cotton, wool, bamboo, banana, sisal, and a variety of others. [8] Bamboo fiber is a regenerated cellulose fiber made from the starchy pulp of bamboo plants processed from bamboo culms. Bamboo fiber is extremely resilient and durable[9]. It has been discovered to possess outstanding qualities such as high tensile strength, high specific strength, low cost when compared to synthetic fiber, ease of availability, eco- friendly nature, etc. [10]. The field of materials engineering has given composite materials a lot of attention. Products with composite integration are made for a variety of diverse uses, from sporting goods to aircraft components. [11,12] The rapid development of conservation in the recent few decades have produced in a significant increase in solid waste production and strong box usage. Therefore, it has become especially crucial to apply solid waste in its whole (including waste plastic, bamboo powder, farming leftovers, artificial garbage, etc.) [13,14]. This study's goal is to create a new composite material, bamboo fiber-reinforced plastic (BFRP) composite, as a less expensive alternative to wood. Because bamboo is a plentiful natural resource in Asia and because its general mechanical qualities are similar to those of wood, bamboo fiber was chosen as the reinforcement. In addition, bamboo matures more faster than wood—in just 6 to 8 months as opposed to 10 years. Engineers have used thermoplastic matrix composites in semi-structural applications. The fact that thermoplastic polymers are recyclable in addition to being simple to fabricate utilising a variety of forming techniques is a major factor in their current and future operations.[15,16]

II. MATERIAL AND EXPERIMENTAL

Materials

The Recycled High Density Polyethylene (rHDPE) were used as a matrix. In the present investigation recycled high density polyethylene of the compression moulding grade P100 purchased from Maheshwary polymer vruksha composite Andhra Pradesh. According to the provider. Its density is 0.953 g/cm3, and its melt flow index (MFI) is 2.1 g/10min (190 °C/2.16 kg)., Bamboo Fiber and Glass Fiber provided by vruksha composite, Andhra Pradesh.

Experimental

Analysis of mechanical properties

Bamboo Fiber was used as primary reinforcement material. Composite samples were fabricated by using compression mould. The samples were prepared as per ASTM standards for testing. Tensile test was performed as per ASTM D638 standard with a test speed of 2 mm/min. Flexural test and Impact test were performed by ASTM D790 and ASTM D256, respectively. And compressive test was performed as per ASTM D695.

III. COMPOSITE

Fabrication Materials Used

The materials used in the present study and the method by which these materials are processed. The materials that are used in the present concern of study are

1. Recycled High Density Polyethylene (rHDPE),
2. Bamboo Fiber (BF) and 3. Glass Fiber (GF)
4. Maleicanhydride-grafted polyethylene (MAPE)

Fabrication methods

First mixed the bamboo Fiber, Glass Fiber with rHDPE and MAPE. Before the mixture was placed inside the iron mould, the mould has initially been polished with a release agent to prevent thecomposites from sticking onto it upon removal then mixture slowly placed in the mould, afterthat kept in compression moulding machine at 210°, on completion of time kept it till set and released from the mould. The tensile, flexural and impact specimens were cut from the prepared composite sheets according to ASTM standards.

IV. DETERMINATION OF MECHANICAL PROPERTIES OF COMPOSITE.

According to ASTM standards, mechanical testing on the test specimens were performed.

MECHANICAL TESTING

On the polyethylene and bamboo Fiber, glass fiber reinforced polyethylene composite specimen, mechanical tests (tensile, flexural, impact and compressive) are conducted. Three separate specimens of each composite are tested and their average value is reported.

1. Tensile Strength

An Instron model 3382 testing machine was used to assess the tensile strength of composite samples in accordance with ASTM D 638. Composite samples in the shape of rectangle were evaluated.[4]. At a crosshead speed of 1.5 mm/min, samples were put under stress and evaluated until they failed. For the purpose of measuring strain, an extensometer was fastened to the sample's gauge portion. To ensure that the results could be repeated, five samples were tested. Elongation at break and tensile strength were measured.

2. Flexural properties

According to ASTM D 790, a three-point bending test on composite samples was conducted. Using an

Instron Machine Model 3382, composite samples underwent a flexural test. At room temperature, rectangular samples were evaluated at a cross-head speed of 3 mm/min. 51.00 mm served as the support span for the flexural test. As a result, an average of three samples of each type of sample were reported. [19]

3. Impact Test

The overall durability of the polymeric material is directly correlated with its impact qualities. The ability of the polymer to absorb applied energy is what is meant by durability. Durability is measured by impact energy. The durability improved as the impact energy of the material improved, and vice versa.

4. Compressive Test

Compressive testing shows how the material will react when it is being compressed. Compression testing is able to determine the material's behavior or response under crushing loads and to measure the plastic flow behavior and ductile fracture limits of a material. Compression tests are important to measure the elastic and compressive fracture properties of brittle materials or low-ductility materials. Compression tests are also used to determine the modulus of elasticity, proportional limit, compressive yield point, compressive yield strength, and compressive strength. These properties are important to determine if the material is suited for specific applications or if it will fail under specific stresses. ASTM D695 Standard test method for compressive properties of rigid plastics.

V. RESULT AND DISCUSSION

Mechanical properties of composite

The characterization of the composites reveals that the Bamboo Fiber and Glass Fiber is having significant effect on the mechanical properties of composites. The properties of the composites under this investigation are presented in Figure 1-2. Result shows the effect of Bamboo Fiber and Glass Fiber with MAPE Compatibilizer on the tensile, flexural, impact and Compressive properties and it has been found that the composite having BF and GF with rHDPE had the highest Compressive and flexural strength as compared to neat HDPE.

Table 1. Optimization of recycled High-density polyethylene composite with Bamboo Fiber and Glass Fiber.

Designation of Composition			Tensile Strength	Flexural Strength	Flexural Modulus	Impact Strength	Compressive Strength
	rHDPE Wt%	Fiber Wt %					
HBG0	100	0	22.7	14.54	460.23	24.66 J/m	88.3
HBG1	95	5	20.5	22.34	466.03	22.86 J/m	90.2
HBG2	90	10	18.8	25.54	472.32	19.92 J/m	93.8
HBG3	85	15	15.3	29.14	476.83	17.06 J/m	95.5
HBG4	80	20	10.8	32.85	479.92	15.15 J/m	97.8

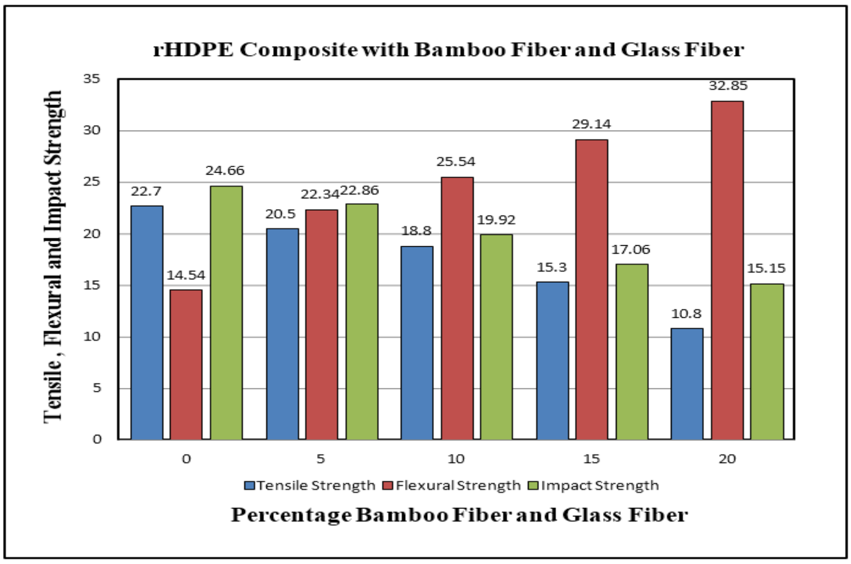

Figure 1. Shows the Tensile Strength, Flexural Strength, and Impact Strength of BF/GF/rHDPE Composite.

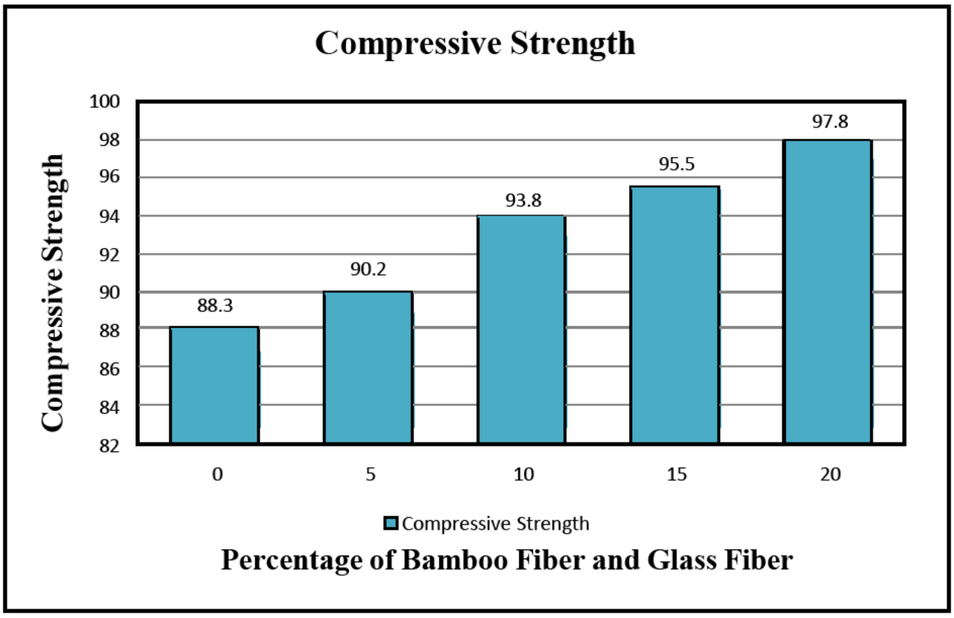

Figure 2. Shows the Compressive Strength of BF/GF/rHDPE Composite.

The result shows that the tensile strength, flexural strength , impact strength and Compressive Strength of the composite (0, 5, 10, 15, 20) was enriched. The variation of Tensile with weight percentage of Glass fiber and Bamboo Fiber show in figure and Table.

VI. CONCLUSION

The conclusions from this comprehensive review aiming at developments of recycled plastic fiber reinforced composite based on recycled matrix are given below:

a. The mechanical properties of recycled plastic composites are strongly linked to the interfacial adhesion, compatibility and interaction of fiber with matrix. With incorporation of suitable compatibilizer and their concentration.

b. The Mechanical Properties Flexural and compressive strength can be improved.

c. The tensile strength of the composite lower than that of neat recycled HDPE composite, showing that the addition of Glass fiber and Bamboo Fiber reduce the tensile and impact strength due to poor adhesion between bamboo Fiber, glass fiber and rHDPE polymer matrix. but Compressive and Flexural Strength is increasing at 20 wt. percent.

d. The results indicate the variation of the composite properties with the reinforcement content in figure [1,2].

e. Considerable enhancement in the mechanical properties such as Flexural and Compressive Strength were obtained by the addition of Bamboo Fiber and Glass fiber in the rHDPE polymer matrix.

f. The conclusions imply that BF/GF/rHDPE polymer composites could be utilised inthe stress bearing restorations sheets, films and pipes.

VII. REFERENCE

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