BIO-COMPOSITE HELMET

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Abstract

Recently, bio composite materials are synthesized using natural fibers as reinforcements together with matrix, which have attracted the attention of Researchers due to their low density with high specific mechanical strengths, availability, renewability, degradable and being environmental-friendly. The present work attempts to make an improvement in the current existing helmet manufacturing methodology and materials used to have better mechanical properties as well as to enhance the compatibility between fibers and the matrix. The bio composite are prepared with the epoxy resin matrix and fibers such as coconut coir and areca using hand lay-up method with appropriate proportions to result in helmet shell structure. The fabricated bio composite helmets are evaluated for mechanical properties such as impact strength, Compression and hardness. The results show that bio-composite could be a potential application for helmet with further optimization of volume fraction of natural fibers.

Keywords: Coconut coir, Areca, Epoxy resin, Surface treatment of fibers, Hand lay-up method, Mechanical Peoperties.

1. Introduction

Recently, the major environmental problem faced today is the non-degradable plastic wastes. The tremendous production and use of plastics in every segment of our life has increased the plastic waste in huge scales. The waste disposal problems, have directed great part of the scientific research to eco-composite materials that can be easily degraded or bio assimilated. Natural fibers have advantages such as low cost and very light weight. However they suffer from lower Mechanical properties compared to glass fibers. To overcome this drawback, hybrid fibers could be a potential solution and investigated by few researchers. Nowadays biodegradable polymers, the number of polymer matrices that could be used in eco-based composite formulations are significantly increased. The research field of biodegradable polymers is still in its early stages, but is growing in popularity every day. In the present study, an attempt has been made to reinforce, epoxy resin matrix with multiple natural fibers and to characterize its mechanical performances to evaluate their suitability for helmet applications.

2. MATERIALS AND METHODS

This chapter describes the details of processing of the composites and the experimental procedures followed for their mechanical characterization. The raw materials used in this work are

2.1. MATERIALS USED

- ✓ Epoxy resin (LY-556)
- ✓ Hardener(HY-951)
- ✓ Natural Fibers (Areca , Coconut Coir)
- ✓ NaOH Solution

Plant Fibrs	Density (kg/m^3)	Tensile Strength (Mpa)	Young's Modulus Value (Gpa)
Cocunut fiber	1150-1250	106-175	6-8
Areca fiber	800-1050	65-95	3-5

Table 2.1 Properties of Natural Fiber

2.2 METHODOLOGY

2.1 Step 1: Selection of matrix material

Epoxy LY-556 resin belonging to the Epoxide family was taken as the matrix. HY 951 was used as the hardener.

2.2 Step 2: Selection of reinforcement and Natural fibers

Natural fibers such as Coconut coir, Areca were taken to fill as reinforcements in the Polymer composite.

2.3 Step 3: Extraction of fibers

Coconut Coir Fiber

Coconut coir- Coconut fruit peel were gathered and soaked in water. Later clean fibers were drawn manually from them.

Fig2.1Coconut Coir Fiber

Areca fiber

Areca fiber reinforced epoxy composites were studied under 40%, 50%, 60% and 70% fiber loadings. Impact strength increased with increase in fiber loading up to 60% and then showed a decline for all untreated and chemically treated areca fiber reinforced epoxy composites. The acrylic acid treated areca fiber reinforced epoxy composites with 60% fiber loading showed highest impact strength of 28.28 J/mm2 amongst all untreated and chemically treated areca/epoxy composites with same 60% fiber loading. Mechanical behavior of areca composites was studied by few investigators and they found to have a good flexural strength and adhesion tensile properties at 60% fiber loading4-

8.Chemical interlocking at the interface was enhanced and better adhesion with the matrix was observed after potassium permanganate treatment of natural lignocellulosic fibers10-11. 6% and 33% improvement on tensile strength and moisture resistance properties.

Fig2.2 Areca Fiber

3.2 Step 4: Surface treatment of fibers

Freshly drawn fibers generally include lots of impurities that can adversely affect the fiber matrix bonding. Consequently the composite material made from such fibers may not possess satisfactory mechanical properties. Therefore it is desirable to eliminate the impurity content of the fibers and perhaps enhance the surface topography of the fibers to obtain a stronger fiber-matrix bonding. The fibers were left to treat with 5% NaOH for 3-4 hrs. Later they were drawn and dried under sunlight for 1-2 hours.

Fig2.3Surface Treatment With NaOH

2.2.5 Step 5: Wet Hand lay-up technique

Hand lay-up technique is the simplest method of composite processing.

3. SAMPLE COMPOSITIONS

3.1 Sample compositions

Specimen -1: Coconut Coir- 70%; Areca Fiber- 30%

Specimen -2: Coconut Coir - 30%; Areca Fiber- 70%

Specimen -3: Coconut Coir- 50%; Areca Fiber- 50%

Fig 3.1 Sample composition

3.3 Compositions

COCONUT COIR FIBER
ARECA FIBER

4. RESULTS

4.1Impact test results

The following tables provide the details of the Impact test results obtained for various combinations of Natural fibers reinforced bio-composites.

Specimen	Impact energy (joules)
Sample-1	6
Sample-2	4.9
Sample-3	5.8

Table 4.1 Impact test result

4.2 Hardness test results

Specimen	Rockwell Hardness Test
Sample-1	30
Sample-2	25
Sample-3	27

Table 4.2 Hardness test result

4.3 Compression Test Results

Specimen	Compression Test (Kgf)
Sample-1	140
Sample-2	130
Sample-3	120

Table4.3 Compression test

4.4. Test Result of Bio Composite Helmet

The impact, compression and hardness test are conducted, from the results we concluded the test specimen 70% coconut coir and 30% areca fibers were given better results compared to other two test specimen so we are decided to make a composite helmet by using 70% coconut coir and 30% areca fibers composition.

5. Fabrication of bio-composite helmet

Fabrication of the helmet was carried out by adopting the following hand lay process procedure. Initially a layer of epoxy – LY-556 and hardener HY-951 mixture is coated inside the glass fiber mould shown in, which will act as an adhesive for a bottom layer of

Table 4.4 Test results

Specimen	Impact	Compression	BHN
Sample 1	6	140	30
Sample 2	4.9	130	25
Sample 3	5.8	120	27

coconut coir. Over the coconut coir onc again a layer of epoxy is applied, subsequently the natural fiber reinforcements such as chopped areca fiber, coconut coir fibers are placed respectively. Finally, a layer coconut coir is placed as a top layer. Now these fibers are compressed with help of inner mould as shown in, to ensure the proper bonding between reinforcement and fibers. Subsequently, allowed for settling time of about 12 – 24 hours, then mould was released. The coconut coir used prevents the de-bonding of the fibers. After releasing well cured and dried helmet from the mould, the extra projections were cut, filed and smoothened with help of sand paper to achieve the desired shape.

Fabricated Helmet

CONCLUSION

In the present work, bio-composite with natural fibers such as Coconut coir, areca fibers have been successfully reinforced with the epoxy resin by simple and inexpensive hand lay-up technique. The mechanical testing results of fabricated bio composite helmet indicate that, concept of using multiple natural fibers is viable for helmet application. However, there is a scope to optimize the volume fraction of natural fibers as reinforcements to achieve enhanced mechanical properties of helmet. So, it is clearly indicates that reinforcement of natural fibers have good and comparable mechanical properties as conventional composite materials.

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