Design and Fabrication of Bio Composite Helmet

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Abstract— Recently, bio composite materials are synthesized using natural cellulose 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 unsaturated polyester matrix and fibers such as jute, sisal, coconut, areca and banana using hand lay-up method with appropriate proportions to result in helmet shell structure. The fabricated helmet is planned to evaluate its mechanical properties such as Impact Strength and Compression Strength.

Key words: Bio Composite, Epoxy LY-556 Resin, Natural Fibres, Hardener HY-951

I. 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 fibres have advantages such as low cost and very light weight. However, they suffer from lower mechanical properties compared to glass fibres. To overcome this drawback, hybrid fibres could be a potential solution investigated by few researchers. Nowadays bio degradable polymers, the number of polymers matrices that could be used in eco-based composite formulations are increased. In the present study, an attempt has been made to reinforce, epoxy resins matrix with multiple natural fibres and to characterize its mechanical performances to evaluate their suitability for helmet application.

II. METHODOLOGY

1) Step 1: Selection of matrix material

EpoxyLY-556 resin belonging to the epoxide family was taken as the matrix HY951 was used as the hardener.

2) Step 2: Selection of reinforcement and natural fibers

Natural fibers such as sisal, coconut coir, arecanut, ridge gourd and tamarind were taken to fill as reinforcement in the polymer composite.

3) Step 3: Extraction of fibers

Sisal is a natural fiber of agavaceae. Its fully biodegradable and highly renewable resource. Arecanut is also known as betel nut. They composed of cellulose and varying proportions of hemicelluloses, lignin, pectin, and protopectin. Jute is along soft, shiny plant fiber can be spun into coarse, strong threads. It is produced from plants in the genus Corchorus. Banana fiber contains cellulose, hemicelluloses and lignin. Coconut coir –coconut fruit peel was gathered and soaked in water.

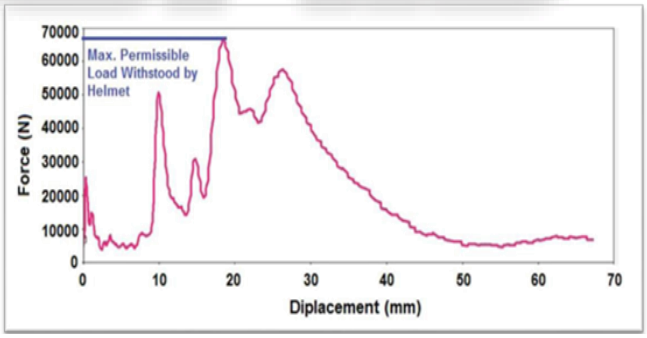
4) Step 4: Surface treatment of fibers

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 to prography of the fibers to obtain stronger fiber matrix bonding.

5) Step 5: Wet hand lay-up technique

Hand lay-up technique is the simplest method of the composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mold plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats are cuts as per the mold size and placed at the surface of mold after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardner and poured onto the surface of mat already placed in the mold.

III. EXPERIMENTATION



Fabrication of the helmet was carried out by adopting the following hand lay process procedure. Intially a layer of epoxy-LY-556 and hardener HY-951 mixture is coated inside the glass fiber mould. Which will act as an adhesive for a bottom layer of the jute mat. Over the jute mat again the layer of epoxy is applied, subsequently the natural fiber reinforcement such as chopped sisal fiber, banana fiber, areca fiber, coconut coir fibers are placed respectively. Finally,a layer jute mat is placed as a top layer. Now these fibers are compressed with help of inner mould. To ensure the proper bonding between reinforcement and fibers. Subsequently, allowed for setting time of about 6-8 hours,then mould was released. The jute mat used prevents the de-bounding of the fibers. After realising 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.

IV. RESULT AND DISCUSSION

The drop weight impact tests were performed on the fabricated bio-composite helmet. Although, the maximum permissible limit of 19.5KN impact load is required for drop weight impact analysis, due to limitation of test rig, we performed the test with drop mass of 430N.The impact load against displacement for tested bio composite helmet. It could be observed that maximum permissible load withstand by the helmet is 68.57KN and the impact energy absorbed by the helmet was found to be 1397.913 KJ by post processing the experimentally acquired data.

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