FABRICATION AND ANALYSIS OF COMPOSITE BASED INDUSTRIAL SAFETY HELMET

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Abstract - *Currently the interest in using natural fibers as reinforcement in polymer composite material has increased significantly. The natural fibers prove to have wide area of research since it has low density, light weight and better mechanical properties. All the Helmets attempt to protect the users head by absorbing the mechanical energy and protecting against penetration. Industry helmet are normally made up of polyethylene thermoplastic. In this present work, testing was done on taking two specimen of natural fibers such as a combination of glass, Sisal, Bamboo along with the glass fibers as the Reinforcement and Epoxy Resin used as matrix. A sample was fabricated using Hand-Layup Technique and the properties were analyzed. The Impact Strength, Tensile Strength and Hardness were found out .The Drop Test and Weight Drop test were experimented on the Helmet for two specimen. It is found that specimen with composition of glass, jute and sisal fibers give a better result with respect to impact strength, hardness, flexural strength.*

Key Words: NFRP Composites, Safety Helmet, Hand lay up, Mechanical Property

INTRODUCTION

A composite material is made by combining two or more dissimilar materials. They are combined in such a way that the resulting composite material or composite possesses superior properties .which are not obtainable with a single constituent material. So, in technical terms, we can define a composite as a multiphase material from a combination of materials, differing in composition or form, which remain bonded together, but retain their identities and properties, without going into any chemical reactions.

A composite material consists of two or more physically and/or chemically distinct, suitably arranged or distributed phases, with an interface separating them. It has characteristics that are not depicted by any of the components in isolation. Most commonly, composite materials have a bulk phase, which is continuous, called the matrix, and one dispersed, non-continuous, phase called the reinforcement, which is usually harder and stronger. Reinforcements for the composites can be fibers, fabrics particles or whiskers. Fibers are essentially characterized by one very long axis with other two axes either often circular or near circular. Particles have no preferred orientation and so does their shape. Whiskers have a preferred shape but are small both in diameter and length as compared to fibers.

SURFACE TREATMENT OF FIBERS

Chemical treatment with NaOH removes moisture content from the fibers thereby increasing its strength. Also, chemical treatment enhances the flexural rigidity of the fibers. Last, this treatment clears all the impurities that are adjoining the fiber material and also stabilizes the molecular orientation.

Surface treatments are potentially able to overcome the problem of incompatibility. Chemical treatments can increase the interface adhesion between the fiber and matrix, and decrease the water absorption of fibers. Therefore, chemical treatments can be considered in modifying the properties of natural fibers. Some compounds

Most chemical treatments have achieved various levels of success in improving fiber strength, fiber fitness and fiber–matrix adhesion in natural fiber reinforced composites.

Procurement of Fibers & Preparation of Mold

The natural fibers such as Jute, Sisal were purchased from the nearby supplier and the Bamboo fiber was woven from the shop. The glass fiber mat of 0.125 mm was purchased from the supplier. The hessian cloth of proper selection was purchased and selected for fabrication. A wooden plywood mould is selected for preparation of the test specimen the mold dimension is 300 x 200 mm.

Composition Calculations

Specimen - 1

Matrix- 60 %

Needed volume of composite - 300x150x4 mm

=1.8 x 10^-4 m3

Matrix used is Epoxy Resin

Density of Epoxy Resin = 1150 kg/m3 Volume of

Matrix=1.08 x 10^-4 (60%)

Density =

Mass of Matrix= 1.08x 10^-4 x 1150 Mass of Epoxy Resin = 0.1242 kg

Fiber - 40% Jute fiber - 20%

Volume of Jute = 3.6 x 10^-5 m3 Mass of Jute = Volume x density

= 3.6 x 10^-5 x 1300

Mass of Jute = 0.0468 kg

Sisal Fiber - 10%

Volume of Sisal Fiber = 1.8 x 10^-5 m3 (10%) Mass of Sisal fiber = Volume x Density

= 1.8 x 10^-5 x 1500 = 0.027 kg

Glass Fiber - 10%

Volume of Glass Fiber = 1.8 x 10^-5 m3 (10%) Mass of Glass Fiber = Volume x Density

= 1.8x10^-5 x 2550

= 0.0459 kg

Specimen -2

Matrix- 60 %

Needed volume of composite - 300x150x4 mm

=1.8 x 10^-4 m3

Matrix used is Epoxy Resin

Density of Epoxy Resin = 1150 kg/m3 Volume of Matrix=1.08 x 10^-4 (60%)

Density =

Mass of Matrix= 1.08x 10^-4 x 1150 Mass of Epoxy Resin = 0.1242 kg

Fiber - 40%

Bamboo Fiber- 20%

Volume of Bamboo = 3.6 x 10^-5 m3 Mass of Bamboo = Volume x density

= 3.6 x 10^-5 x 1400

Mass of Bamboo = 0.0504 kg

Sisal Fiber - 10%

Volume of Sisal Fiber = 1.8 x 10^-5 m3 (10%) Mass of Sisal fiber = Volume x Density

= 1.8 x 10^-5 x 1500

= 0.027 kg

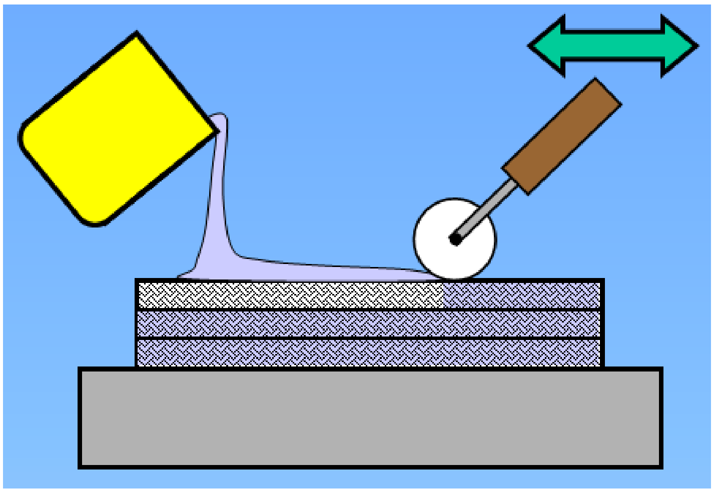
Glass Fiber - 10%

Volume of Glass Fiber = 1.8 x 10^-5 m3 (10%) Mass of Glass Fiber = Volume x Density

= 1.8x10^-5 x 2550

= 0.0459 kg

The fiber volume ratio in both the specimen was calculated and hence the necessary weights were taken as per the calculation suitably.



HAND LAYUP TECHNIQUE

Hand lay-up technique is the simplest method of composite processing. Each layer is placed one above another such as Glass, Jute, Sisal as in combination 1 and Glass, Bamboo, Sisal in combination - 2. This method is mainly suitable for thermosetting polymer based composites. Capital and infrastructural requirements less as compared to other methods. Production rate is less and high volume fraction of reinforcement is difficult to achieve in the processed composites.

Specimen - 1 (JUTE, SISAL, GLASS)

Specimen -2 (BAMBOO, SISAL, GLASS)

Mechanical Testing of Composite Laminates

The mechanical properties of the both the composite specimen are analyzed with the help of Destructive Tests such as Flexural Test , Hardness Test , Impact Test .

Tabulated results of both Specimen I, II

TEST	SPECIMEN-1	SPECIMEN-2
FLEXURAL	266.67N/mm²	88.88 N/mm²
HARDNESS	HRB 39	HRB 34
IMPACT	7.03 J/mm²	0.45 J/mm²

Through these Test we were able to differentiate the better material from these two based on its Impact Strength, Hardness and also its Bending Strength. Hence the combination of Jute, Sisal, Glass with Epoxy resin is selected as material to fabricate a Composite Industrial Helmet. These test provided a relevant data in order to make the Composite a better material to use it as a Industrial Helmet.

INDUSTRIAL SAFETY HELMET USING COMPOSITES

The fiber combination of **JUTE, SISAL, GLASS** were selected as the reinforcements for the composites and the **Epoxy resin (LY-556)** along with **Hardener (HY- 951)** was selected as the Matrix. The same Hand-Layup Technique was followed for the fabrication of the Helmet.

Orientation of layers in Composite Helmet

FIBER TYPE	**LAYER THICKNESS**	**NO OF LAYERS**
Glass	0.125 mm	4
Jute	0.35 mm	2
Sisal	0.25 mm	2

Fabricated Helmet after the Drop test and weight Test. No significance damage or dent observed during the Drop test and Impact test test. Hence we can able to conclude that it can be used as a suitable replacement for the existing Industrial Helmet.

Conclusion

A detailed study was done on the natural fibers along with glass fibers as reinforcement in Composite material and Epoxy resin serves as the matrix. The Composite combination were tested and the combination of Jute, Sisal, Glass, Epoxy were selected for fabrication of Industrial Helmet. The Helmet shell as per given dimensions were created and several tests were done. The test include Drop test along with Weight drop test and no significant damages were visible. Hence this serves as good mechanical properties. The fibers like jute fibers, glass fiber, bamboo fibers, sisal fibers were successfully used to fabricate bio-composites with varying the fiber percentage. The aim of the project is to provide a suitable alternative to conventional industrial helmet shell and also select a suitable fibers for the composites. There is a scope to optimize the volume fraction of natural fibers as reinforcements to achieve enhanced mechanical properties of helmet. The ratio of fibers and matrix plays a vital role in enhancement of the strength of these composites. The cost of the raw materials are considerably less. The manufactured composites not only serves the purpose of industry helmet but finds its application in several other fields.

REFERENCES

1. Dr. J. O Akindapo., " Development of a military helmet using coconut fiber reinforced polymer matrix composite" , European Journal of Engineering and Technology .Vol.3 No.7, ISSN2056-5860 ,pp. 55-65 , 2018

2. Jayabal, S, V., Navaneethakrishnan, P., and Palanikumar, K., (2011), "Mechanical and Machinability Behaviours of woven coir fiber reinforced Polyester composite", Bull. Mater. Sci., 34, 1563–1567

3. Kuruvilla Joseph., " A review on sisal fiber reinforced polymer Composites ", revista brasileira de engenharia agrícola e ambiental, v.3, n.3, p.367-379, 11999

4. Mansoor.p ., " A Relative Comparative investigation on Jute and Sisal Fiber Composite Material " , International Research Journal of Engineering and Technology (IRJET) ,pp1578-1582 , Volume: 04 Issue: 05 , May -2017

5. B.Murali, D.Chandramohan., "Fabrication of Industrial Safety Helmet by using Hybrid Composite Materials", Journal of Middle East Applied Science and Technology (JMEAST), pp. 584-587, 2014.

6. K.L. Pickering.," A review of recent developments in natural fibre composites and their mechanical performance"

7. Md. Rafiquzzaman, Md. Taimum Islam, Md. Raihan Hossain, Md. Fazla Rabby, Md. Rifat Hashar. Fabrication and Performance Test of Glass-Bamboo Fiber Based Industry Safety Helmet American Journal of Mechanical and Materials Engineering. Vol. 1, No. 1, 2017, pp. 20-25,2017

8. Xue Li ., " Chemical Treatments of Natural Fiber for Use in Natural Fiber- Reinforced Composites: A Review " , Journal of Polymers and the Environment , pp 25-33 , 2007