Mr.M.Maniyarasan, 2023, 11:2
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology

An Open Access Journal

Performance Analysis of Hybrid Composite Helmet Mechanism

Assistant Professor Mr.M.Maniyarasan, K.Jeeva, N.Jeeva, M.Kathiravan, D.Lingeshwaran
Mechanical Engineering, Kongunadu college of engineering and technology, Trichy, India

Abstract- Hybrid composite helmet technologies are now a crucial factor in the creation of household goods and accessories for automobiles. A natural fibre hybrid composite helmet has been developed using materials like banana fibre, coconut coir, luffa fibre, etc., largely for safety purposes. These natural fibres have low costs, a low density, and excellent particular qualities. These are non-abrasive and biodegradable. Due to its unique mechanical characteristics, fibre reinforced materials are now being used more frequently in all technical fields (including automotive, industrial, and medical). Banana, coconut, and luffa fibre are employed as fibre reinforcements in this project. Epoxy resin makes up 62% of the laminates' weight (616g), along with 7% of hardener(60g), luffa fibre accounts for 15% of the weight (130g), coconut coir for 3% (20g), banana fibre for 5% (44g), and coconut fibre for 10% (70g) and carrying out the penetration test, flammability test, and shock absorption test. In the present work, the epoxy composite based industrial safety helmet has been designed by CATIA V5 software.

Keywords- Coconut coir, Luffa fibre, Banana fibre, Epoxy resin, Hardener, Shock absorption test, Flammability test and Penetration test.

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. All helmets attempt to protect the user's head by absorbing mechanical energy and protecting against penetration. Their structure and protective capacity are altered in high-energy impacts. The safety helmet selected should satisfy certain performance requirements including shock absorption, resistance to penetration. To achieve this improvement in fibre materials are using composite material will be studied in this project. A composite material is formed by combining two or more materials to give a unique combination of properties. Natural fibre composites include coir, and banana etc. Natural fibres come from plants. Natural fibers are eco-friendly, lightweight, strong, renewable, cheap and biodegradable. It is a fibre abundantly available in India the second highest in the world after Philippines. It consists of water, fibres and small amounts of soluble solids. The components of helmet production are checked. Mechanical properties of the composite material have been studied in this paper by considering various parameters such as fibre content, fibre geometry, volume fraction, fibre size, epoxy resin properties, and fibre orientation, etc. The fibres obtained are washed and dried with water. Hybrid polymer composites combines the properties of different constituents (different fibres) and result in a more versatile product. This work focused on the development and characterization of hybrid natural composite materials reinforced epoxy composite for industrial safety helmet.. The authors showed that natural fibre hybrid composites can replace the existing industrial safety helmet materials which are eco-friendly and light in weight. The purpose of the present investigation is development and mechanical characterization of hybrid fiber reinforced epoxy composites for industrial safety helmet. In this study, the consequences of hybridization of jute fiber with glass fiber reinforced epoxy composite are examined. The applications of natural fibers are growing in many sectors such as automobiles, furniture, packing and construction. This is mainly due to their advantages compared to synthetic fibres, i.e. low cost, low weight, less damage to processing equipment, improved surface finish of moulded parts composite, good relative mechanical properties, abundant and renewable resources. Banana plants generally produce 30 large leaves. Jute is a best fibre whose scientific name is Corchorus capsular is of Tiliaceae family. Plant of jute takes nearly 3 months to grow to a height of 12 - 15 feet.

Qualities of natural fibres are strongly influenced by growing environment, age of plant, species, temperature, humidity, and quality of soil. Various fields where natural fibres can be employed are: structural composites, automobile, non-structural composites, geo textiles, packaging, molded products, sorbents, filters, and in combinations with other materials. Jute-based green composites would be suitable for even primary structural applications, such as indoor elements in housing, temporary outdoor applications like low-cost housing for defense and rehabilitation and transportation. The main reason sure the ecological benefits combined with the good specific mechanical properties. The tensile and flexural properties of composites made from coconut shell filler particles and epoxy resin have been studied by S.M. Sapuan et al.

II. LITERATURE REVIEW

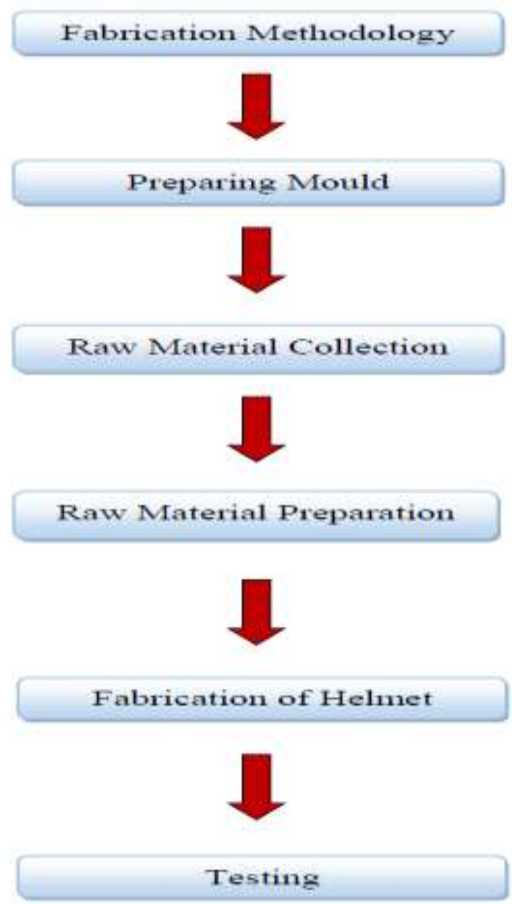
Bastos, A.C et.al, (1979), in recent years, the improvement of properties of natural fibre reinforced laminates over the pure polymeric matrix has been thoroughly investigated with the aim of providing a possible replacement of E- glass fibre reinforced composites for some large-volume applications. In the present study, the properties of a jute/polyester laminate are compared with those yielded by two E-glass fibre woven laminates. These are an E- glass/polypropylene commingled twill weave laminate (®Twintex) and a plain woven-roving E-glass/polyester composite. These two materials are representative of a large part of glass fibre reinforced laminates currently used, since Twintex is widely used e.g., in automotive industry, while glass mat/polyester laminates are still very popular in naval applications. All the materials have 60% wt. fibre content. A number of tests were carried out, including mechanical tests, interlaminar shear strength tests, Charpy impact and falling weight impact tests. After that, the consolidation of the composites was investigated by interlaminar shear strength tests and observing the porosity present in the materials under an optical microscope. The results confirm the concerns on impact performance of natural fibre reinforced composites. Moreover, mechanical and impact properties on jute fibre reinforced composites show not negligible scattering, that makes it difficult to measure the maximum load values that can safely be applied to these materials during their service. This variation of properties is due mainly to not constant fibre fraction in the composite and to the scattering in properties between the single fibres and fibre bundles. In spite of this, the mechanical and impact properties of jute/polyester laminates as a whole proved promising.

Faouzi Sakli, et.al, (2011), the effect of chemical modification, reinforcement structure and fiber weight ratio on the flexural proprieties of Luffa-polyester composites was studied. A unsaturated polyester matrix reinforced with a mat of Luffa external wall fibers (ComLEMat), a short Luffa external wall fibers(ComLEBC) and a short Luffa core fibers (ComLCBC) was fabricated under various conditions of fibers treatments (combined process, acetylating and cyanoethylating) and fiber weight ratio. It resorts that acetylating and cyano ethylating enhance the flexural strength and the flexural modulus. The fiber weight ratio influenced the flexural properties of composites. Indeed, a maximum value of strength and strain is observed over a 10% fiber weight ratio. The uses of various reinforcement structures were investigated. The enhancement of elongation at break and the strain values of the composite reinforced by natural mat were proved.

Jorillo Jr. P. et.al, (1992), Cementations materials such as mortar and concrete are brittle and have an inherent weakness in resisting tension. They are known to crack under low levels of tensile strains. The addition of discontinuous fibers to such matrices leads to a drastic improvement in their toughness. It is generally agreed that the fiber contribute primarily to the post- cracking response of the composite by bridging the cracks and providing resistance to crack opening. The transmission of forces between the fibers and the matrix is achieved through interfacial bond, defined as the shearing stress at the interface between the fiber and the surrounding matrix. Bond has been recognized as a major factor in composite action. There is hardly any property of the composite that is not dependent on bond. Thus there exists a genuine need to provide a fundamental understanding of bond and bond mechanism in fiber reinforced cement composites. The nature of bond in today's fiber reinforced cementations composites is very complex because of the presence and the combined action of several bond components.

Alsubari, S, et.al, (2021), in recent years, most boat fabrication companies' use 100% synthetic fiber-reinforced composite materials, due to their high performance of mechanical properties. In the new trend of research on the fabrication of boat structure using natural fiber hybrid with Kevlar/fiberglass-reinforced composite, the result of tensile, bending, and impact strength showed that glass fiber reinforced polyester composite gave high strength with increasing glass fiber contents. At some point, realizing the cost of synthetic fiber is getting higher; researchers today have started to use natural fibers that are seen as a more cost-effective option. Natural fibers, however, have some disadvantages, such as high moisture absorption, due to repelling nature; low wettability; low thermal stability; and quality variation, which lead to the degradation of composite properties. In recent times, hybridization is recommended by most researchers as a solution to natural fiber's weaknesses and to reduce the use of synthetic fibers that are not environmentally friendly.

III. EXPERIMENTAL METHODOLOGY



IV. FABRICATION

Composite fabrication processes typically involve some form of moulding, to shape the resin and reinforcement. A mould tool is required to give the unformed resin/fibre combination its shape prior to and during cure. There are lots of different ways to build with composite materials the variety can make it. Adding to the complexity is the fact that two very different techniques can produce what looks like the same outcome. This process is an overview of the most commonly used methods of manufacturing composite parts with a focus on thermosets. Where possible, I will supply links to my series of videos showing the construction of flat panel laminate samples because watching a guy make a sheet of something is a great way to strip away lots of distracting variables.

Figure 1. Fibre soaking

Preparing Mould

Moulds made of sand are relatively cheap, and sufficiently refractory even for steel foundry use. In addition to the sand, a suitable bonding agent is mixed or occurs with the sand. The mixture is moistened, typically with water, but sometimes with other substances, to develop the strength and plasticity of the clay and to make the aggregate suitable for moulding. The sand is typically contained in a system of frames or mould boxes known as a flask. The mould cavities and gate system are created by compacting the sand around models called patterns, by carving directly into the sand, or by 3D printing.

Figure 2. Die mould

These castings are made using sand moulds formed from "wet" sand which contains water and organic bonding compounds, typically referred to as clay. The name "M-sand" comes from the fact that the sand mould is not "set", it is still in the "grey" or uncured state even when the metal is poured in the mould. Contrary to what the name suggests, "M-sand" is not a type of sand on its own, but is rather a mixture of: There are many recipes for the proportion of clay, but they all strike different balances between mould ability, surface finish.

Fabrication of 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 coir fibre mould which will act as an adhesive for a bottom layer of jute mat. Over the jute mat once again a layer of epoxy is applied, subsequently the natural fibre reinforcements such as banana fibre, luffa fibre coconut coir fibres are placed respectively. Finally, a layer jute mat is placed as a top layer. Now these fibres are compressed with help of inner mould to ensure the proper bonding between reinforcement and fibres. Subsequently, allowed for settling time of about 6 – 8 hours, then mould was released.

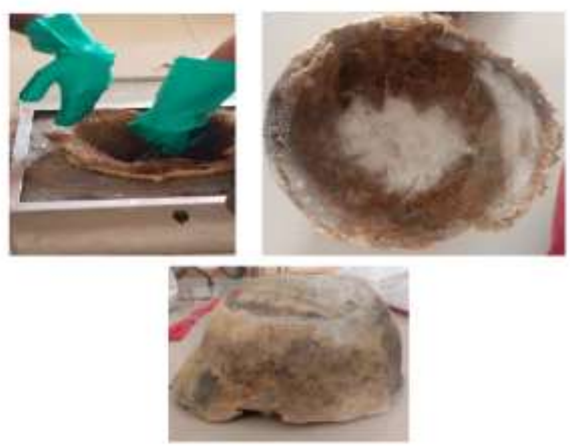


Figure 3. Fabrication of helmet

The jute mat used prevents the de-bonding of the fibres. 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. Composite fabrication processes typically involve some form of moulding, to shape the resin and reinforcement. A mould tool is required to give the unformed resin/fibre combination its shape prior to and during cure.

"Tooling" for an overview of mould types as well as materials and methods used to make mould tools. The most basic fabrication method for thermoset composites is hand layup, which typically consists of placing layers, called plies of either dry fabrics, or prepare(fabric pre-impregnated with resin), by hand onto a tool to form a laminate stack.

V. RESULT AND DISCUSSION

Flammability Test

Flame retardant test equipment is designed and developed for fire helmet safety testing. The flame retardant test equipment is manufactured according to safety helmet flame retardant testing machine is widely used in fire research institute, helmet production enterprises, national quality inspection dept. Flame retardant test equipment is designed and developed for fire helmet safety testing,

Figure 4. Flammability testing

Shock Absorption Test

Scientists at Johns Hopkins University have developed a shock-absorbing material for safety helmets and vehicles that protects just as well as a fibre, but is lighter, reusable and also increases its protection capability. The researchers had observed that the standard materials for such protective devices were not able to perform well from high-speed impacts and tend not to be reusable, so they looked to improve their energy absorption while also reducing weight. This new material offers extreme energy absorption capability and greater protection from a wide range of impacts. Helmet protection to vulnerable two wheeler riders presents many challenges including those of weight, ergonomics appearance and convenience. Safety provided to a two wheeler riders head is mainly dependent on the level of shock getting propagated to the brain during the accident situations and therefore the design of the layer of shock absorbing padding assumes great importance.

Figure 5. Shock absorption testing

VI. CONCLUSION

The new hybrid composite helmet produced with natural fibres as reinforcement's gives good mechanical properties as compared with pure matrix material. These hybrid bio-composite helmets can be used in bike driving and automobile applications. In this project, composite helmet of natural fibres have been successfully reinforced with the epoxy resin by simple and inexpensive hand lay-up technique. The mechanical testing like shock absorber test, flammable test and penetration test was determined the results of fabricated composite helmet indicate that, concept of using multiple fibres is variable for helmet application. Fibre reinforced composite helmet and thermoplastics helmet are near equal same values and thus can be used in industries.

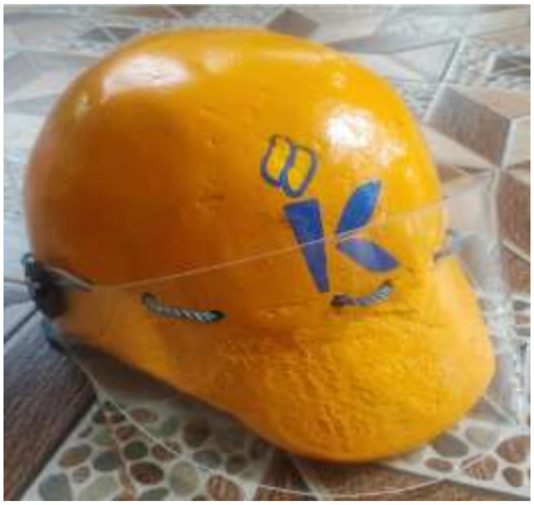


Figure 6. Final Product

In addition to that, these materials have advantages like less weight, high strength, very cheaper, very easy to fabricate and eco-friendly. Thus, from the experimental results, it has shown that, Natural fibre reinforced composite helmet material has a sustainable strength for the application of Motorcycle Safety helmets and industrial safety helmets. In this project according to the results, luffa fibre accounts for 15% of the weight (132g), coconut coir for 2% (17.6g), banana fibre for 5% (44g), and coconut fibre for 8% (70.4g) successfully completed. The test requirements are such as Shock absorption test is max 500 KGF, Flammability test is 5seconds and penetration test is max 10mm. And the observation such as Shock absorption test is withstand in 100 KGF found ok, Flammability test is 5seconds no burning and penetration test is 9mm found ok test is successfully completed.

REFERENCES

1. Abhinav Anand, Alcoholic detection, Department of Electronics and Telecommunications, IJEETC, 2015.
2. Akram, W.; Islam, N.; Ali, H.; Siddique, A Yusuf, S.;. Impact Strength of Natural Fiber Reinforced Composites: Taguchi Method. Adv. Mater. Sci. 2020, 20, 54–70.
3. Akshay betageri, Dr. Anila kumar C.P, “Comparative study of strength properties of coconut coir fiber reinforced concrete due to partial replacement of cement by pozzolanic materials”, 2018.
4. Alsubari,S.; Asyraf, M.R.M, Ishak, M.R.; Ilyas, R.A.; Sapuan, S.M.; Zuhri, M.Y.M.; Potential of Natural Fiber Reinforced Polymer Composites in Sandwich Structures: A Review on Its Mechanical Properties. Polymers 2021, 13, 423.
5. Ankul Oriya and Rohit Rajvaidya. "Characterization of ABS composites reinforced short glass fiber" IJRET [International Journal of Research in Engineering and Technology-2015.
6. Ashok, K.G.; Chakravarthy, P.R.K, Ilango, T.; Jino, R.; Pugazhenthi, R.; Enhancement of Mechanical Properties of Luffa Fiber/Epoxy Composite Using B4C. J. Adv. Microsc. Res. 2017, 12, 89–91.
7. A Singh, SK Yadav, “An experimental study on coconut fiber reinforced concrete”, 2019.
8. Bharath, B., Chandrashekhar, B., Girisha, C., Shivanna, G., Sajjad Hussain, B.A.Sunilraj “Fabrication and Mechanical Characterization of Bio- CompositeHelmet” Volume 5, Issue 1, Part 3- Science Direct, Elsevier- 2018.
9. Carpenter J, Hughes M, Hill C. Deformation and fracture behavior of flax fibre reinforced thermosetting polymer matrix composites. J Mater Sci 2007; 42: 2499–511.
10. Chandramohan, D., Murali, B., “Fabrication of Industrial Safety Helmet by using Hybrid Composite Materials”, Journal of Middle East Applied Science and Technology (JMEAST), pp.584-587, 2014.
11. Faouzi Sakli, Lassaad Ghali, Slah Msahli, Mondher Zidi, 2011,” Effects of Fiber Weight Ratio, Structure and Fiber Modification onto Flexural Properties of Luffa-Polyester Composites”, Advances in Materials Physics and Chemistry, 2011, 1, 78-85.
12. Folgar, F.; Shaughnessy, W. F, Riewald, P. G.; Yang, H. H.; Light weight Helmet from a New Aramid Fiber. Proc. 23rd SAMPE Tech. Conf., NY, 1991.