Development & Characterisation of Smart Helmet Using Coconut Shell Powder and Waste Plastic – EnhancedPolymer Matrix Composites

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Abstract **– The project "Development and Characterization of Smart Helmets with Coconut Shell and Waste Plastic- Enhanced Polymer Matrix Composites" aims to create a safer and more advanced helmet. By using special materials like Coconut shell powder & waste plastics, we have manufactured a helmet that's not only stronger but also smarter. Ultimately, the goal is to enhance safety gear at a lower cost, ensuring that improved safety on the road.**

Keywords **– Coconut shell powder, Helmet, waste plastic, composites**

I. INTRODUCTION

Composites can be defined as 'compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated in the mix as to take advantage only of theirattributes and not of their shortcomings' in order to obtain improved materials. Helmet can protect vehicle riders from severe injuries during traffic accidents. Nowadays, many scientists and researchers have showna great deal of interest in making environmentally friendly products that have enhanced appeal to use natural fibers, as they replace the exhausting sources of petroleum. As reinforcements in polymer matrix composites among all rein forcing fibers, natural fibers have earned great attention. Investigations have been performed on natural fibers rein forced by cement and plastics, such as banana, coir, bamboo, sisal, wood, and jute fibers. Waste plastics are non-biodegradable wastes which are not utilized to the cent percent. As the waste plastics harm the environment, waste plastics now a daysare used to make things like jeans, bags, etc. Coconut shells are household waste that currently is not optimally utilized. As a result, it somehow becomes a problem in the local community. Most of coconut shells are used as traditional fuel in cooking, turned into charcoal, and sometimes made into homemade crafts like bowl, shirt button, household utensil, and so forth. Besides these uses, helmet manufacturing is also a way of utilization. Therefore, this research focuses on making use the coconut shell powder and waste plastics as the materials in redesigning and recreating the secondhand helmet into a more valuable, eco-friendly, and strong helmet. This innovation can be used to replace the currently main component of motorcycle helmet which is synthetic materials. In order to do so, this research also tried to find out the characteristics of coconut shell and waste plastics that are suitable to be used as strong and endurable helmet coating so that it can work at its best. The manufacturing of coconut shell powdered and waste plastics helmet even reduces the wastage because the waste is second hand helmet. It can be found within the corner of many households or warehouses. Because of the lack of awareness and idea to make use of them, many helmet waste are typically abandoned. Respondingto the constrained utilization of coconut shell and waste plastic, a similarly innovative and modern follow-up isneeded to make use of the waste. Therefore, this research focused on reduction in non-biodegradable materials with the coconut shell powderand waste plastics becausethe substances in developing the helmet into anextra valuable and strong helmet. This innovation may be used to replace the presently essential component of motorcycle helmet which is synthetic materials. For you to do so, this research also tried to find out the traits of coconut shell that are appropriate to beused as strong and endurable helmet so that it is able to work at its exceptional.

II. METHODOLOGY

2.1 Materials Used:

- Coconut shell powder
- Isophthalic polyester resin (Grade: ISO-P, espo 1tm-30.00)
- Waste plastic
- Catalyst
- Releasing agent
- Sand paper
- ISI helmet
- Chopped strand mat
- Cobalt

2.2 Tools Used:

- Universal testing machine
- Grinder
- Scales
- Impact testing machine
- Hardness durometer

2.3 Research procedure:

2.3.1. Pre – Research:

- Preparing needed tools and materials
- Designing the helmet

2.3.2. Specimen making and testing:

- Creating ASTM standard specimens of different composition.
- Conducting the tests for the specimens made.

2.3.3. Observing the results of specimens:

- Results are documented.
- Based on the results the composition for helmet manufacturing is selected.

2.3.4. Manufacturing of Helmet mould:

- Resin coat is applied on the reference helmet.
- Chopped strand mat is applied.
- Mould is left to dry.

2.3.5. Manufacturing of Helmet

- Coconut shell powder and waste plastic with resin mix and chopped strand mat is appliedlayer by layer respectively on different moulds.
- The helmet is left to dry.
- The helmet is removed from the mould by open mould technique.

2.3.6. Testing of helmet

- Conducting tests for Manufactured helmets.

2.4. Finishing:

- Smoothening the surface of the helmet

Methods:

Firstly, to achieve the desired particle size, grinding and sieving of the coconut shell to make it into fine powder.

Fig.1: Coconut shell powder

Preparing the resin and adding the coconut shell powder gradually to achieve a homogenous mixture in different compositions (like 30%, 40%, 50%, of resin with the reinforcement), Hardner and catalysts used are MEKP- methyl ethyl ketone per oxide respectively. Applying the composite into the helmet mold, ensuring even distribution and compaction of the mixture. Allowing the composite to cure. The last step is to remove it from the mould as open mould technique is followed. A helmet mold to shape the plastic material. Mixing the resin with the plastic material, ensuring it's evenly distributed. Applying the composite mixture into the mold with different compositions (like 30%, 40%, 50%, of resin with the reinforcement) and Cobalt naphtholate is used as accelerator, Methyl ethyl ketone peroxide (MEKP) is used as catalyst, Poly vinyl alcohol is used as releasing agent. making use of the composite into the helmet mold, making sure even distribution and compaction of the combination. allowing thecomposite to therapy. The last step is to cast off it from the mould as open mildew method is followed. Trimming excess material and refine the surface for asmooth finish.

RESULTS & DISCUSSIONS

3.1. *COMPRESSION STRENGTH*

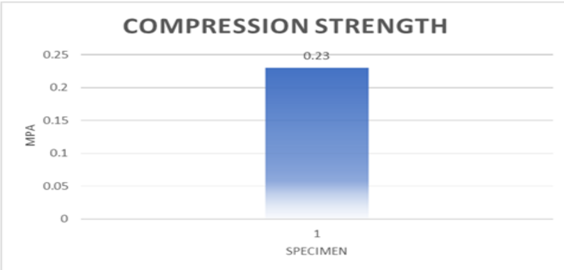


Fig. 4: Compression strength of coconut shell specimen

The Compression strength test was performed as per ASTM D695 using Universal Testing Machine at Mysore, India. The test was performed at a spindle speedof 20 mm/min. The sample sizes used were 20 mm 20 mm x 25 mm, and the test result of compression strengthis illustrated in Fig. 4 & 5. It is noticed that Compressive strength was decreasing with the reduction in reinforcement. Maximum compressive strength wasachieved at 50% coconut shell powder loading, which is 0.23MPa. The results indicate that coconut shell powder better compressive characteristics for a higher percentage of carbon fiber for composition. The experiment results of the coconut shell powder composite show that natural reinforcement have stronger and comparable compressive strength when compared to carbon fiber, which earlier concluded to have better compressive strength compared the properties with conventional materials.

3.2. FLEXURAL STRENGTH

The 3-point flexural bending test was performed by using Universal Testing Machine (5569A Instron) at Mysore, India, as per ASTM D790. Results of the flexural strength of the specimen are illustrated in Fig.4 & 5. The Effect on the flexural strength with different coconut shell powder loading was analyzed. At first, the flexural strength increases with reduced coconut shell powder loading, but it is declined with further decreasingthe coconut shell powder loading. Maximum flexural strength is achieved at 50% coconut shell powder loading, which is 335 MPa. Curing treatment significantly increases the consistency of inter molecular binding among matrix, which in turn contributes to wards the improved composite flexural characteristics.

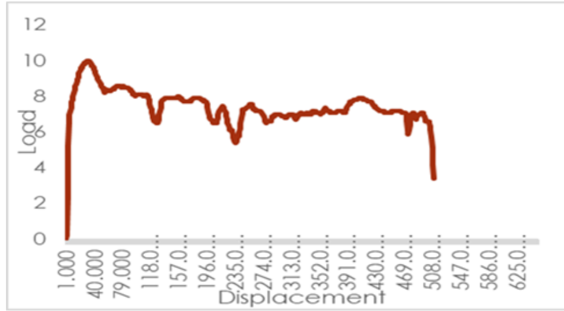


Fig. 5: Flexural strength of waste plastic specimen

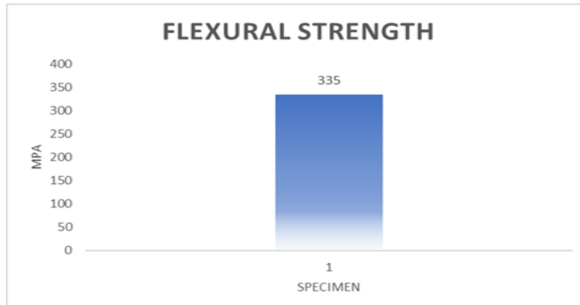
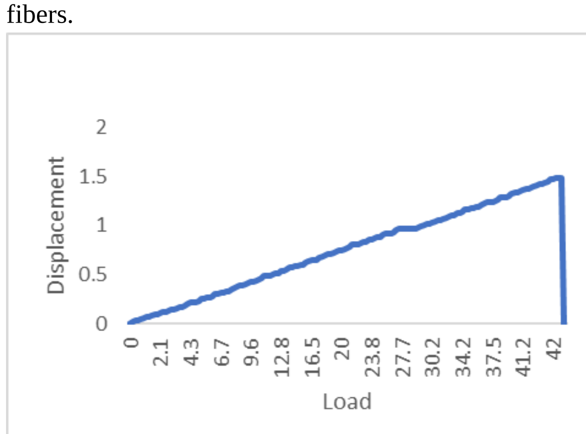


Fig. 6: Flexural strength of coconut shell specimen

3.3. IMPACT STRENGTH

Impact Test was conducted to identify the toughness of coconut shell powder and waste plastic/ resin hybrid composite using Izod Impact Tester at Mysore, India. Manufactured coconut shell powder and waste plastic/ resin hybrid composite has been found to be able to absorb more energy before fracturing. The energy absorbed by composites made from coconut shell powder is also greater than that of carbon fiber. The observation leads to the conclusion that coconut shell powdered reinforced composites are better than regular helmet, as possesses impact strength up to 1 J/m. When compared to the proposed composite, it reported quite better impact strength relative to regular fibers.



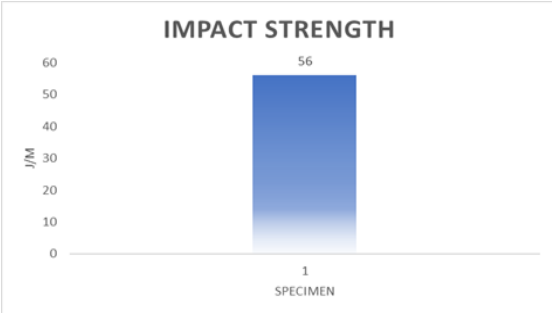


Fig. 7: Impact strength of waste plastic specimen

Fig. 8: Impact strength of coconut shell specimen

3.4: *THERMAL CHARACTERIZATION*

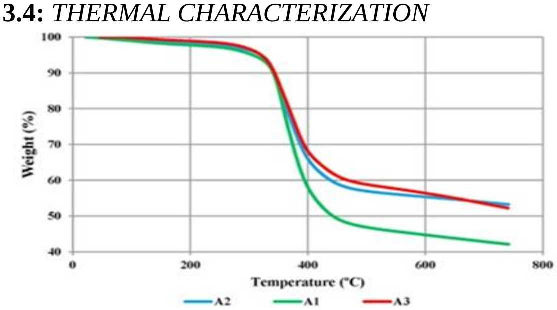


Fig. 9: Thermal characterization

3.3.1. Thermal characterization Thermogravimetric analysis, the Thermo-gravimetric analyzer was used to calculate the material's thermal stability as a function of temperature. The samples were exposed to anatmosphere of nitrogen during this test, and also, heating the samples gradually at a constant rate. Samples were subjected to a temperature of 400 C maximum. The samples were heated at the constant rate of 20 C/min resulting in the material being thermally degraded, and weight loss is reported. The result of the overall experimental was prepared in graph form with the ordinate percentage of mass and abscissa temperature. The thermal stability depends strongly on the temperature in the coconut shell powder composite. TGA helps to investigate the thermal stability of fabricated hybrid composite, accountable for factors such as absorption rate of moisture, thermal expansion, and heat contraction.

3.5. *HARDNESS TEST:*

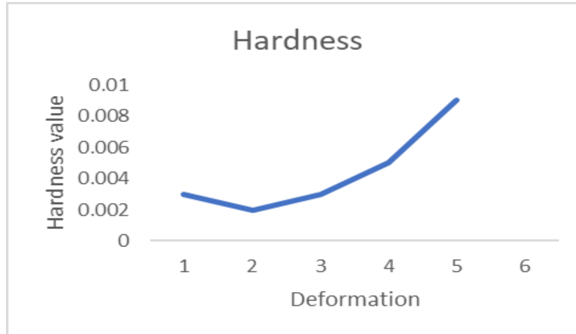


Fig. 10: Hardness of coconut shell powder

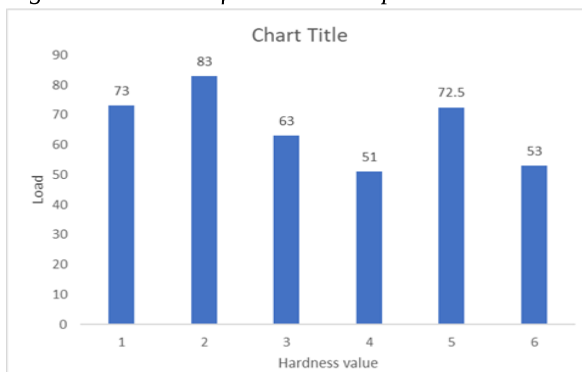


Fig. 11: Hardness of Wate plastics

Figure 10 presents the results of hardness testing based on the coconut shells weight or mass. From the graph, it can be inferred that the heavier the mass of the coconut shells gets, the higher the hardness level is. The testing results were also indicated that the mass of the coconut shells brings effect on the hardness level. As a result, coconut shell powder is assumed to be effectively usedas helmet coating because it has a good hardness level. Figure eleven presents the outcomes of hardness tryingout primarily based on the waste plastic weight or mass. From the graph, it may be inferred that the heavier the mass of the coconut shells gets, the higher the hardness stage is the trying out effects have been additionally indicated that the mass of the waste plastic brings effect on the hardness level. As a result, waste plastic is thought to be successfully used as helmetcoating because it has a good hardness level.

III. CONCLUSION

In conclusion, the development and characterization of smart helmets incorporating coconut shell powder, petplastics, and epoxy resin have yielded promising results in improving each the protective and smart functions of conventional helmets. the mixing of coconut shellpowder as a reinforcement material has shown capability in enhancing the mechanical properties of the composite, contributing to accelerated impact resistance and durability. using pet plastics and epoxy resin as matrix substances has provided a balance between lightweight design and structural integrity.

Furthermore, the incorporation of smart technologies in those helmets has marked a significant development in safety equipment. the mixing of sensors for impact detection, conversation modules, and otherwise functions demonstrates a commitment to not only fortifying physical protection but also enhancing userexperience and safety on the street.

The complete testing and characterization procedures undertaken have provided valuable insights into the mechanical power, flexibility, and smart functionalities of the advanced helmets. The outcomes advise that these composite materials, whilst combined with modern technology, have the capacity to redefine industry requirements for helmet safety.

As we move ahead, continuous studies and improvement efforts must focus on refining the manufacturing processes, optimizing the composition of materials, and similarly validating the clever capabilities for actual- international applicability. The end result of this challenge signifies a step toward a new generation of safety gear, in which sustainability, advanced substances, and smart layout converge to create helmets that no longer only guard however also adapt to theevolving desires of modern customers. in the long run, these smart helmets maintain the promise of contributing significantly to the continued efforts to enhance road protection and protect people in a dynamically changing environment.

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