The Utilization Of Coconut Shell Waste As The Helmet Coating Materials For Motorcycle Riders

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Abstract. Coconut tree is a plant that can be easily found almost in every corner of Indonesian archipelago, therefore there are plentiful number of coconut produced here. Currently, the utilization of coconut shell waste is still limited to homemade furniture industries and crafts. It has not been made into technology product. The utilization of coconut shell waste as the helmet coating materials to be creative business product is an innovation in the form of helmet product making use of coconut shell waste. The second-hand helmet can be redesigned and recreated by making use the coconut shell waste as the outer coating. In other words, the ordinary or broken helmet can be transformed into a helmet which has unique, aesthetic and economical values. It is because coconut shell waste has a big potential to be made as a strong coating of motorcycle helmet that is more eco-friendly and is supporting the idea to utilize the waste into a valuable and sophisticated product. Accordingly, this research was conducted to make use the potential of coconut shell waste as unique, endurable, strong, and valuable helmet coating in order to answer the problem related to the large amount of coconut shell waste. This research found that coconut shell waste can be successfully turned into and used as helmet coating and in making a strong helmet from coconut shell waste, the thickness and weight of a coconut shell may have effect on the hardness level of the shell. The most effective hardness of coconut shell discovered in this research was 3.3 mm thick with 5 grams of weight.

Keywords: helmet, coconut shell, waste, unique, creative

1. Introduction
The industrial world development has a rapid change, especially in motorcycle automotive industries. The marketing and consumption of motorcycle rapidly increase from year to year. Based on the data from AsosiasiIndustriSepeda Motor Indonesia (AISI), the distribution of motorcycle all across Indonesia until May 2018 has reached 2.627.719 (two million six hundred twenty seven thousand and seven hundred nineteen) units of motorcycle. Those numbers clearly show that the consumption and buying power of the Indonesian motorcycle consumers are increasing every year. Accordingly, the need to buy additional motorcycle gears or equipment, such as helmet, are also increasing. These trends push the motorcycle gear industries to produce various riding gear products with affordable price and high quality to catch the consumers’ interest to buy them.
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 coconut shells, another waste is second-hand helmet. It can be found in the corner of many households or warehouses. Because of the lack of knowledge and idea to utilize them, many helmet waste are usually abandoned. Responding to the limited utilization of coconut shell and helmet waste, a further creative and innovative follow-up is needed to utilize the waste.

Therefore, this research focused on making use the coconut shell waste 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 that are suitable to be used as strong and endurable helmet coating so that it can work at its best.

2. Method

2.1 Research Materials
- Coconut shell
- Resin
- Catalyst
- Varnish
- Putty
- Sandpaper 1000 grit
- Wood glue
- Indonesia National Standard (SNI) Helmet

2.2 Research Tools
- Hardness testing machine (Universal Hardness Tester with its supporting equipment)
- Ruler / caliper
- Digital scales
- Optical microscope
- Grinder
- Drill

2.3 Research Procedure
2.3.1 Pre-research
- Preparing the needed tools and materials
- Designing the helmet

2.3.2 Hardness testing
- Creating hardness testing specimen
- Conducting the hardness testing

2.3.3 Observing the micro-structure
- Observing the shells’ surface after receiving heavy pressure

2.3.4 Creating coconut shell coating
- Selecting the coconut shells
- Shaping the coconut shells
- Attaching the shells to the helmet
• Finishing (smoothing the attached coconut shells)

3. Results and Discussions

3.1 Coconut Shell Hardness

The hardness testing was conducted to find out how strong the shells are and to make sure that it is safe to be used as coating materials. The tested materials or specimen used during the process were varied based on the thickness level. There were six specimens tested as shown below.

![Figure 1. Hardness testing specimens](image)

The hardness testing results showed that as the thickness level was increased, there were some changes on the hardness level of the coconut shells. It can be concluded that the thickness level is affecting the hardness level of coconut shells. The hardness testing results of the coconut shells were shown in the following graph.
Figure 2. Hardness testing results based on the thickness level

The hardness testing results in Figure 2 were shown based on thickness level. The graph data showed that the most effective thickness level of coconut shells is on 3.3 mm. It is implied that coconut shells can be effectively used as coating materials for helmet because they have a good hardness level and are not too thick.

The next testing was based on the weight or the mass of the coconut shells. The results of the testing were shown in Figure 3.

Figure 3. Hardness testing results based on the weight or mass

Figure 3 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 is assumed to be effectively used as helmet coating because it has a good hardness level.

### 3.2 Coconut Shell Helmet

#### 3.2.1 Designing the motorcycle helmet

The design process used a software named Solidworks 2016. The designed helmet model is shown in Figure 4.

![Helmet design in 3D](image)

**Figure 4. Helmet design in 3D**

#### 3.2.2 Sorting the coconut shells

The sorting process was done to get the best quality coconut shells. The coconut shell then were cleaned using sandpaper and hand grinder.

#### 3.2.3 Shaping the coconut shells

In the third phase, the coconut shells were cut into the desired shape using hand grinder. The shaping process was meant to make the shells more easier attached to the helmet.

![Pieces of coconut shells](image)

**Figure 5. Pieces of coconut shells**

#### 3.2.4 Attaching the coconut shells on the helmet

The helmet used in this process was an Indonesia National Standard (SNI) certified helmet. The coating process used resin and wood glue which is categorized as strong adhesive. The attachment of coconut shell may vary depending on the design and motif. It can be all over the helmet surface or just in some parts.
3.2.5 Finishing

After the coconut shells were all attached into the helmet, then it was coated using putty. The coated helmet was then dried under the sunlight until it got dried and hard enough. The following steps was smoothing the helmet using grinder and sandpaper until the surface is smooth and refined. After that, the helmet was coated using varnish to make it shiny and even smoother. The last process was installing the visor of the helmet.

![Coconut Shell Helmet](image)

**Figure 6.** Coconut Shell Helmet

4. Conclusion

Based on the discussions and data analysis, it can concluded that the helmet with coconut shell coat made from the overly matured Javanese red coconut shells is strong enough to be used as safety gear for motorcycle riders and it also does not affect the Indonesia National Standard (SNI).

The optimum hardness level of coconut shell to be effectively used as coating materials is within 3.3 mm thickness and 5 grams of weight. From the testing result, it can also be deduced that the thickness and weight level of coconut shells affect its hardness level.

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