Analysis and Characterization Helm Based on Hyacint Water Composites

IOP Conf. Series: Materials Science and Engineering **598** (2019) 012045 doi:10.1088/1757-899X/598/1/012045

Analysis and Characterization Helm Based on Hyacint Water Composites

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Abstract. Material engineering in the field of natural fiber composites has potential prospects. The availability of natural resource was very abundant. Composite with natural fiber reinforcement was called Bio composite. The promising natural resource were water hyacinth. Water hyacinth was a source of fiber that can be used optimally as a filler in composites. Bio composite properties are be affected by several factors including filler volume, process parameters and filler interface properties in the matrix. The use of water hyacinth bio composite was developed as a substitute for shipbuilding materials, board and leg sockets for prosthetic limbs. This research identified the nature of fibers as fillers in the application of motorcycle helmet that meet Standar Nasional Indonesia (SNI). Hyacint fibers are made from water hyacinth plants, the plant is dried by sun shine. The material was crushed into powder and woven fibers with yarn spinner and the both materials are mixed using resin. The bio composite was tested by tensile test and impact test using variations weight fraction. The best high strength of bio composite was used as material helm shell by using a vacuum bagging system. The value of Impact absorption strength and penetration testing will be tested on helmet shell composites. Tests conducted on bio composite helmets are carried out to meet standard safety according to SNI 1811: 2007.

1. Introduction

Water hyacinth is known as a water weed plant, because its growth fast that it can covers the water surface and has an impact on decreasing production in the fisheries sector and environmental problems, such speed up of lakes evaporation. Water hyacinth can be used to provide an added value as paper-making materials, furniture, handicrafts, and medium of straw mushrooms [1]. Currently utilization of composite material was growing rapidly. Advantage of the composite is easy-formed so it encourage the use of composites as a substitute for metal materials in various products. Natural fiber reinforced matrix polymer composites attract attention in their applications because they provide many advantages such as low density, cost effectiveness, availability and biodegradation [2]. The composite using a natural fiber reinforcement is called biocomposite. It has superior ecological effects than plastics. They promote an improvement in the mechanical properties. The materials were appropriate for the engineering application. In Indonesia, the water hyacinth is an available as a natural ingredient that has not been explored maximally [3]. The application of the biocomposite hyacinth was done continually to to obtain composite materials that are cheap and meet technical requirements, especially in motorcycle helmets.

Motorcycle helmets are an equipment that can be used to safety in the transportation to protect from head accident. Meanwhile, motorbikes are the means of transportation that have the highest risk level in traffic accidents and have the lowest level of protection against drivers, especially the head [4]. The effort to improve the quality of security of drivers, especially helmets is very important and must be given special attention. Helmets are not just protection devices, but also must be able to provide maximum comfort and protection for the wearer in anticipating and reducing head injuries due to collisions in traffic accidents [5].

Research in the use of natural fiber reinforced bio composite on helmet shells has been carried out by other researchers. It has good results to be applied as a substitute for shell material on helmets. Bharath et al. conducted a study of making composite helmets with areca fiber, sisal fiber, banana fiber which were successfully reinforced with epoxy resin. The results of mechanical testing of composite helmets show the concept of use natural fibers is feasible for application [6]. On the other hand Wajan Berata et al. also conducted a study to make composite helmets reinforced carbon fiber-epoxy-sisal fiber-hollow glass microsphere with the results helmet shells cannot be penetrated by penetration tests that meet SNI 1811–2007 regulations [7]. Water hyacinth is a commodity of natural fiber which contains lignocellulose so it is a potential raw material in making helmet's shell.

2. Preliminary Research

Table 1 and Table 2 shows the results of a previous study of composite based water hyacinth which has a strength exceeds ABS and Polycarbonate that commonly used as helmet's shell material. The composite of water hyacinth fiber can be used as material for the manufacture of SNI standard helmet.

Table 1. Properties of impact strength materials

Material	Impact Strength (KJ/M^2)	Reference
ABS	29.0	[8]
Polycarbonate	30.0	[8]
Composites polypropylene matrix reinforced water hyacinth	52.6	[9]
Composites epoxy matrix reinforced water hyacinth	118.3	[10]

Table 1 show the impact strength of the variation of water hyacinth material. The highest of impact strength is composite epoxy matrix reinforced water hyacinth [10].

Table 2. Properties of tensile strength materials

Material	Tensile Strength (MPa)	Reference
ABS	46.0	[8]
Polycarbonate	60.0	[8]
Composites ortho-up matrix reinforced water hyacinth treated with alkaline NaOH	53.7	[11]
Composites epoxy matrix reinforced by Hyacinth-Coconut Shell Powder	83.7	[12]
Composites paper mulberry biometrix reinforced water hyacinth	128.0	[13]
Composites polyester matrix reinforced woven water hyacinth	47.1	[1]

Table 2 show the tensile strength of the variation of water hyacinth material. The highest of Tensile strength is composites biometrix paper mulberry reinforced water hyacinth [11]. Material composite based water hyacinth can be used as material helmet meet the quality according to the Indonesian Standard SNI 1811-2007.

The Helmet shells must be carried out to absorb impact tests to meet safety standards. Emran et al. conducted a study of natural fiber composites and said that woven natural fiber composites have a higher mechanical value than those of natural fiber composites that are not woven, as well as Energy Impact

absorption capabilities of woven natural fibers better than those not woven [14]. and Suhad et al. Conducted an examination of the absorption of energy impact on composites of natural fibers with different of direction of woven, found that natural fiber composite in the direction of 450/-450 had a higher impact strength value than composite with fiber direction 000/900 [14]. Zhu stated in his research that the composite of woven fiber with the direction 00/450/900/-450 has a good distribution in all directions, and this makes the composite has the best absorption of shock energy [16].

This paper discuss about of manufacturing helmet. That will be controlled by adding of hyacinth in matrix polyester resin. The percentage of hyacinth 10%, 20%, 30% weight.

3. Method and Material

This research is an experimental design, which aims to make helmet shell bio composite from a polyester resin matrix reinforced with water hyacinth woven fiber. The test refers to the Indonesian Standard SNI 1811-2007 which details requirements and testing methods for structural testing of helmets.

The manufacture of helmet shell bio composite uses a vacuum bagging method wherein a method of making composite specimens by pressing uses an airtight bag to press a laminate from the resin matrix until water hyacinth woven fibers and other layers on the mold fuses as a structural composite material. Vacuum bagging is easy to control and production, it can be used for almost all forms of helmet shells [5].

The test refers to the Indonesian Standard SNI 1811-2007. Helmet test use impact absorption test equipment that carried out by placing a helmet on a carrier weighing 5 kg at a height of 2 meters and then dropping at a collision speed of 5.6 m/s on a flat steel plate. Helmet use the penetration test equipment that carried out by dropping an iron tapering weighing 3 kg from a height of 1.6 m dropping freely about the helmet shell. It is expected that the results of the study of water hyacinth bio composite when tested do not break or crack and meet the requirements of SNI helmet standards quality.

3.1. Woven Fiber Water hyacinth

Take the water hyacinth plant with the same height about 40 cm. Choose water hyacinth plants with good quality. Plants washed to remove dirt, dry for 10 days by drying the sun to dry. Then moisture content measured at the ministry of industry in Semarang.

Choose good and uniform fiber quality, water hyacinth is brushed in a long direction in the direction of the wire brush. Water hyacinth fiber is then spun and knitted into woven water hyacinth fiber sheets with manual loom.

Figure 1. Manual Loom (ATBM)

Figure 2. Woven Fiber Water hyacinth

3.2. Water Hyacinth Powder

Prepare dried water hyacinth. Water hyacinth fiber is cut ± 2 cm. Then the fiber is blended until it becomes powder. Then sift the water hyacinth powder with a 140 meshes sieved to get size around 0.1 mm.

Figure 3. 140 meshes sieve

Figure 4. Water Hyacint Powder

3.3. Matrix Epoxy Resin and Hardener

Epoxy has high mechanical properties. It has high heat and chemical resistance. It's have Low viscosity, which is possible to wet the fibers well and prevent fiber irregularities during processing. Low shrinkage levels which reduce the tendency to get a large shear stress bond between epoxy and reinforce.

3.4. Composite Manufacture Process

The fabrication methodology is shown in Figure 5.

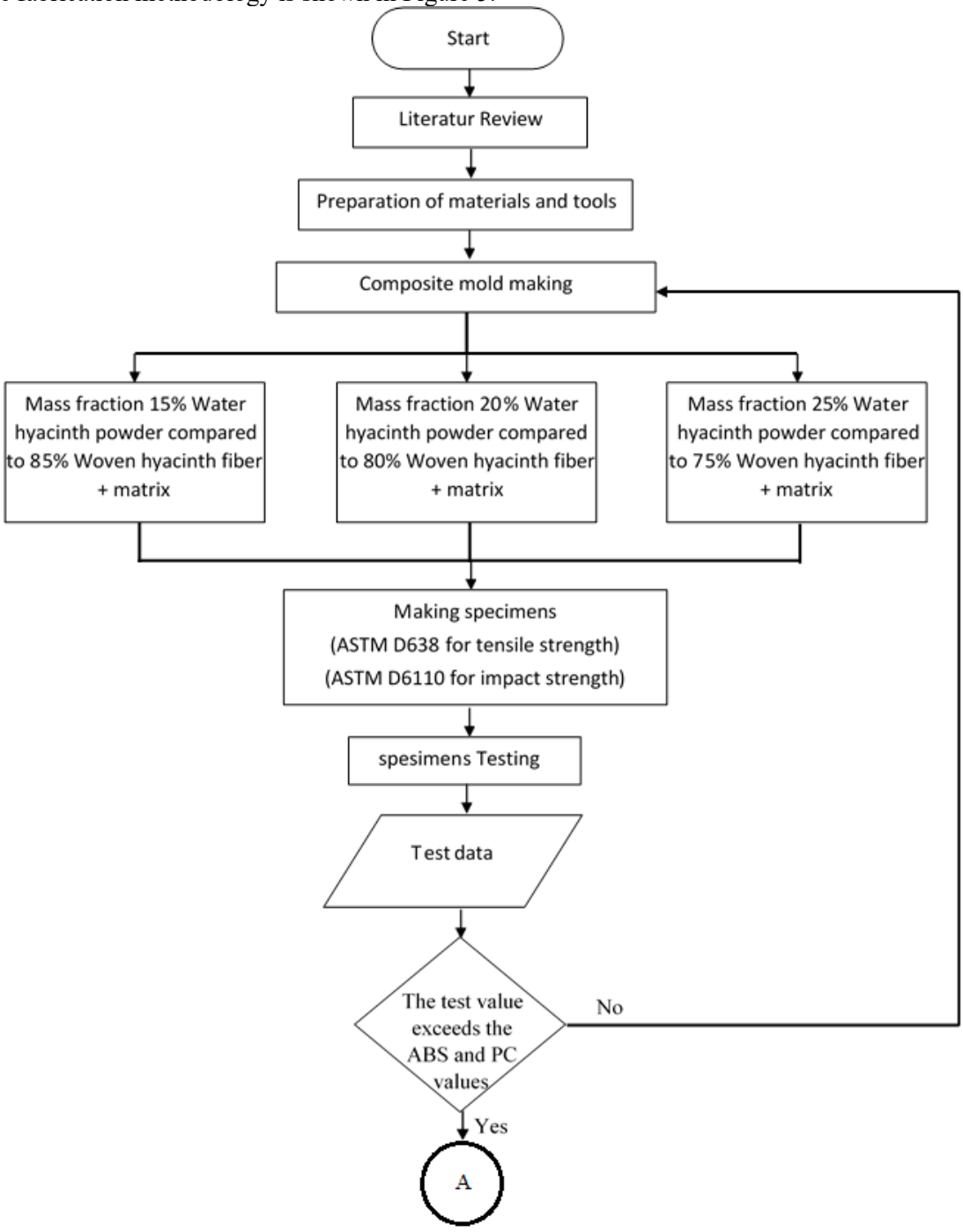

Figure 5. Fabrication methodology

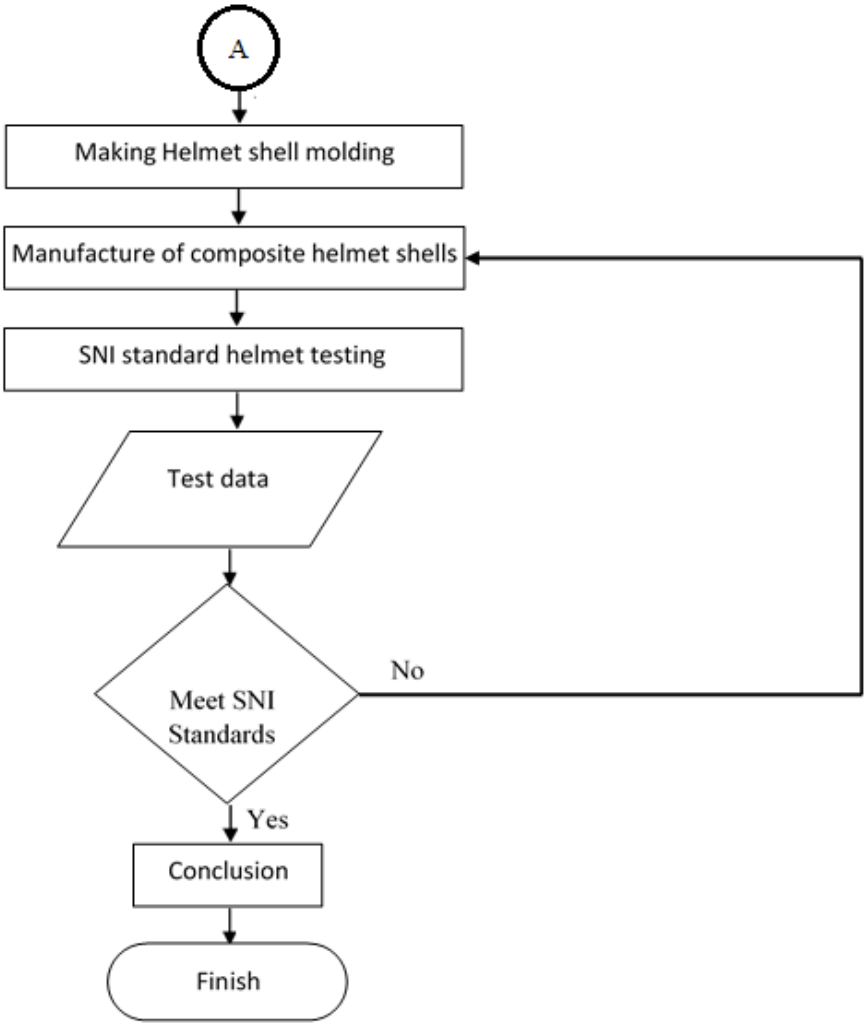

Figure 5. Fabrication methodology (cont.)

4. Result and Discussion

In this experimental study design, this study has only reached the stage of making specimen tests.

Figure 6. Test specimens

The next specimens formed according to the size of ASTM D638 for tensile test and ASTM D6110 for impact test. If the test exceeds standard, then the composition with the highest strength will be chosen and then made as material for the helmet shell. The composite shell helm from the matrix epoxy resin with water hyacinth reinforced and assembled with other components to form a helm unit expected having a good test result and safety according to SNI 1811-2007.

5. Conclusion

Based on the results of the specimen on composite based on water hyacinth. it can be concluded that during work on lamination process, the water hyacinth fiber looks strong can be assembled with other components. Water hyacinth fiber has an opportunity become potential reinforcing materials and able to withstand for shock impact for material shell helmet.

6. Acknowledgement

The authors would like to thank Mr. Sulistyo, Mr. Sri Nugroho and all mechanical engineer of Diponegoro University for guidance and direction during progress performance.

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